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# Middle Atmosphere Program

(NASA-CR-175482) MIDDLE ATMOSPHERE PROGRAM.

HANDBOOK FOR MAP, VOLUME 4 (International

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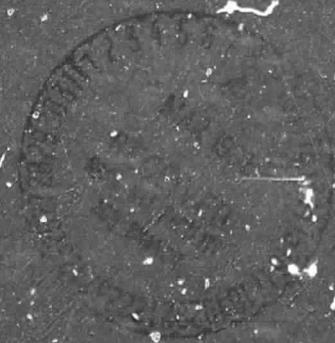
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HANDBOOK  
FOR MAP  
VOLUME 4

Edited by  
C. F. Sechrist, Jr.



M I D D L E  
A T M O S P H E R E  
P R O G R A M

HANDBOOK FOR MAP

VOLUME 4

Edited by

C. F. Sechrist, Jr.  
Chairman  
MAP Publications Committee

April 1982

Copies available from SCOSTEP Secretariat, University of  
Illinois, 1406 W. Green Street, Urbana, Illinois 61801

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## CONDENSED MINUTES - MAP ASSEMBLY

14-15 August 1981  
Edinburgh, UK

### OPENING REMARKS

Professor K. D. Cole, President of SCOSTEP and President of IAGA, welcomed approximately 75 attendees to the First MAP Assembly held in the Appleton Tower at the University of Edinburgh. He briefly discussed: the move of the SCOSTEP/MAP Secretariat to the University of Illinois; the importance of augmenting the financial resources of SCOSTEP; the need for Visiting Scientists to assist the MAP Central Information Exchange Office (MAPCIE) in Boulder; the role of MAP as a SCOSTEP program; forthcoming STP Forum to be held in Ottawa following the STP Symposium in May 1982; and the importance of the World Data Centers. He urged the MAP National Representatives to persuade their respective countries to increase their annual subscriptions to SCOSTEP because MAP will be a major component of SCOSTEP in the early 1980's.

Professor S. A. Bowhill, Chairman of the MAP Steering Committee, described the background, aims, and scope of the Middle Atmosphere Program. He emphasized the need for a coordinated attack on the outstanding multidisciplinary scientific problems of the global middle atmosphere, and the consequent need for cooperation of middle atmosphere scientists on an international scale. He urged the MAP scientific community to make special efforts in the area of data exchange. This should promote a unification of the MAP scientists, resulting in a better understanding of the complex interactions among chemical, radiative, and dynamical processes.

### FMP-1 REPORT

Dr. K. Labitzke, Chairman of FMP-1 on Coordinated Study of the Behavior of the Middle Atmosphere in Winter, presented a report on the last three winters 1978-79, 1979-80, and 1980-81 in the Northern Hemisphere. Several groups are preparing hemispheric charts depicting middle atmosphere temperatures, geopotential heights, and winds. Major warmings were observed and are under investigation. Data are obtained from radiosonde observations, rocketsondes, satellite measurements of radiance, and ionospheric drifts experiments.

### FMP-2 REPORT

Dr. I. Hirota, Chairman of FMP-2 on Equatorial Wave Dynamics, outlined a report on the plans for equatorial measurements of middle atmosphere motions. He emphasized the need to study dynamic phenomena peculiar to the equatorial region, using various techniques. Future studies include satellite observations of planetary-scale waves,

coherent-scatter radar observations of winds and waves, and computer studies of mechanistic dynamics models in 2 and 3 dimensions and long time scale.

#### FMP-3 REPORT

Dr. J. C. Gille, Chairman of FMP-3 on Study of Photochemical Processes in the Upper Stratosphere and Mesosphere by Complementary Spacecraft, *in situ*, and Ground Measurements, emphasized the need for combined use of several techniques and the development of a uniform standard for intercomparison of data. More complete data sets are required, and comparative data studies are now possible using data from satellite experiments such as SAGE, SAM, SAM II, and LIMS. Future satellites and experiments include Solar Mesosphere Explorer (SME), Dynamics Explorer, SAGE (aerosols, O<sub>3</sub>, NO<sub>2</sub>), HALOE, SpaceLabs I and III, and UARS.

#### FMP-5 REPORT

Dr. P. C. Simon, Chairman of FMP-5 on Solar Spectral Irradiance Measurements, presented an outline of a report to be published in Volume 3 of the HANDBOOK FOR MAP. He noted that solar ultraviolet irradiance and its temporal variations are not sufficiently well known for middle atmospheric science and that new observations are needed.

#### MSG-2 REPORT

Dr. R. J. Murgatroyd, a member of MSG-2 on Transport of Trace Constituents in the Stratosphere, reported that MSG-2 had prepared a comprehensive report which will be published in Volume 3 of the HANDBOOK FOR MAP. This report reviews our understanding of stratospheric trace constituents transport, and poses a set of outstanding questions as possible guides to future research.

#### MSG-3 REPORT

Dr. L. Thomas, a member of MSG-3 on Tides, Gravity Waves and Turbulence, stated that MSG-3 had prepared a report which will appear in Volume 3 of the HANDBOOK FOR MAP. This report reviews our present understanding of tides, gravity waves, and turbulence. The report includes a discussion on gaps in our knowledge of these phenomena, and briefly outlines programs to advance our understanding during MAP.

#### PUBLICATIONS COMMITTEE

Dr. C. F. Sechrist, Jr., Chairman of the MAP Publications Committee, reported that future issues of the MAP Newsletter will be published as Special Issues of the joint FAA-NASA Upper Atmospheric Programs Bulletin. Contributions to the Newsletter should be sent to

Dr. Sundararaman's office at the FAA in Washington, D. C. He also reported that Volume 1 of the HANDBOOK FOR MAP had been published and distributed. Volume 2 is scheduled for distribution in August 1981, and Volume 3 should be mailed in November 1981. The contents of future volumes were presented and discussed. It was emphasized that publication of articles in the HANDBOOK FOR MAP does not preclude publication in scientific journals, and that middle atmosphere workers may reference items in the HANDBOOK provided permission is granted by the author.

#### NATIONAL PROGRAMS

National Programs for MAP were outlined by MAP National Representatives. Reports ranged from brief one-page outlines to comprehensive and detailed plans. Representatives of the following countries presented reports:

<u>Country</u>	<u>Representative</u>
Argentina	J. R. Manzano
Australia	W. G. Elford
Belgium	P. C. Simon
Bulgaria	E. S. Kazimirovsky
Canada	J. B. Gregory
Czechoslovakia	V. Bucha
Finland	C. Sucksdorff
France	M. L. Chanin
FRG	U. von Zahn
GDR	J. Taubenheim
India	Y. V. Somayajulu
Japan	S. Kato
New Zealand	W. G. Elford
South Africa	F. J. Kuhn
Spain	J. O. Cardus
Sweden	G. Witt
Taiwan	J. K. Chao
UK	L. Thomas
USA	G. C. Reid
USSR	E. S. Kazimirovsky

#### REMARKS BY U.S. MAP COORDINATOR

Dr. N. Sundararaman, the U.S. Coordinator for MAP, spoke to the MAP Assembly. His remarks may be summarized as follows:

- (a) The U.S. MAP Coordinator was appointed by the Subcommittee on Atmospheric Research, under the U.S. Committee on the Atmosphere and Oceans. Dr. Sundararaman chairs a working group comprising representatives from several government agencies. This is the Inter-Agency Committee for MAP (ICMAP).

- (b) Although the U.S. has no formal MAP program at this time, there are numerous MAP-related programs.
- (c) Future issues of the MAP Newsletter will be published jointly as special issues of the Upper Atmospheric Programs Bulletin, by NASA and the FAA.
- (d) There is an urgent need for a Visiting Scientist to assist with the operation of the MAPCIE Office in Boulder.
- (e) Pre-MAP funding of MAP-related research in the U.S. was about \$40M in 1981, and a similar figure is expected in 1982. There is a strong emphasis on stratospheric composition investigations motivated by the ozone depletion problem.
- (f) There is a reasonable agreement between funding priorities and the results of the survey conducted by the U.S. MAP panel.
- (g) Stratospheric composition studies will continue to be important in the future. In addition, future studies are anticipated in the areas of: Short-period dynamics, troposphere-atratosphere exchange processes, and thermosphere-mesosphere exchange processes.

#### APPROVED MAP PROJECTS

Dr. U. von Zahn presented an updated report on the status of the Winter in Northern Europe (WINE) project which is now scheduled for the winter of 1983-84. The WINE Working Group comprises representatives from FRG, France, Norway, Sweden, UK and USA. Observations will concentrate on Northern Europe winter variability from about 50°N to 70°N, and observing methods will include ground-based facilities, balloon-borne and rocket-borne experiments, and remote sensing techniques from satellites.

Dr. T. Hirasawa, coordinator of the Antarctic Middle Atmosphere (AMA) project, presented an outline of the scientific aims of AMA. These include investigations of dynamics, structure, atmospheric composition, particle precipitation, middle atmosphere-lower ionosphere interactions, atmospheric pollution, and northern-southern polar atmosphere comparisons.

#### PROPOSED MAP PROJECTS

Dr. L. Bjorn described the scientific objectives of a proposed MAP project named Cold Arctic Mesopause Project (CAMP). This would comprise measurements on the high-latitude mesopause region in summer and includes studies of noctilucent clouds, neutral and ion composition, dynamics, structure, and temperature. The MAP Steering Committee approved CAMP as a new MAP Project.

Prof. B. L. Kashcheev described the GLOBMET Project for setting up a global system of meteor observation, that had been prepared by the Soviet Geophysical Committee. The project is aimed at intensifying research in the field of meteor geophysics and astronomy. SCOSTEP will establish an ad hoc committee on GLOBMET, with close coordination with MAP, because of the multidisciplinary and international aspects of this global project.

#### REMARKS BY URSI REPRESENTATIVE TO MAP

Dr. J. W. King, the URSI Representative to MAP, addressed the MAP Assembly. His remarks have been summarized as follows:

- (a) There are nine sponsoring organizations of MAP, namely; SCOSTEP, COSPAR, WMO, IAGA, IAMAP, IUPAP, SCAR, IAU, and URSI.
- (b) Commissions F and G of URSI have strong interests in MAP. These are concerned with wave propagation in and the remote sensing of nonionized media and the ionosphere, respectively. Within Commission G, there are ten different radiowave projects all of which have been mentioned in MAP national reports. These are relevant to composition and dynamics studies of the atmosphere and ionosphere.
- (c) The URSI Inter-Commission Working Group on Remote Sensing organized a symposium on remote sensing of earth's environment. This was held during the General Assembly in Washington, and included three sessions on oceans and land, and three sessions on the atmosphere.
- (d) MAP has a wide appeal at this time, and it is important to avoid overlapping subjects at meetings in different locations.
- (e) URSI scientists have a strong interest in MAP workshops, symposia, etc. A good example is the proposed workshop on MST radars. Also, the MAP Dynamics Calendar is of great interest.
- (f) The Unions expect MAP to play a dominant role in the coordination of middle atmosphere science.
- (g) MAP must continue to be highly visible in the international community.
- (h) Portions of some national programs were created in response to the high visibility of MAP.

## REGIONAL DEFINITION GROUPS

Reports of the Regional Definition Groups were presented by M. L. Chanin (Europe), Y. V. Somayajulu (Asia), J. B. Gregory (N. America) and J. Gledhill (Southern Hemisphere and Antarctic). These ad hoc groups were created in order to identify middle atmosphere phenomena peculiar to the region and to note the existence of rocket and balloon launch sites, ground-based experiment stations, within the region.

The European Group reported that two programs proposed by European countries are WINE and CAMP. An important facility in Europe for MAP-related studies is the EISCAT radar and associated experiments.

The Asian Group identified the following areas for coordination and cooperation during MAP: Cooperative meteor-radar observations, cooperative lidar studies, cooperative rocket and balloon experiments, EXOS-C satellite, and MST radar.

Cooperation between Canadian and U.S. scientists is inherent to the North American scene. Dynamics and chemistry programs in Canada with relevance for MAP have separately established close ties with U.S. counterparts.

Southern Hemisphere and Antarctic projects which could usefully be coordinated are: S. Atlantic anomaly studies of airglow, ionosphere, electric fields, X-rays, and Mg ions; long-life balloon campaigns; north and south polar observations; atmospheric tidal observations and gravity waves; and, satellite programs such as SME, HALOE, among others.

## PROPOSED MAP WORKSHOPS

Dr. G. C. Reid proposed a Workshop on Thermosphere-Mesosphere Coupling and Physics of the Mesopause. Consideration of this was deferred to the MAP Open Meeting on 19 August 1981 in Hamburg. It was noted that the CAMP project is closely related to the theme of this proposed workshop.

A FMP-1 Workshop on the Middle Atmosphere in Winter was proposed by Dr. K. Labitzke, to be held in or near Boulder in May 1982 prior to the STP Symposium and COSPAR meeting in Ottawa.

Workshops on Equatorial Middle Atmosphere Measurements, and Middle Atmosphere Radars were proposed by I. Hirota and S. Kato, respectively. It was recommended that these be held consecutively at or near the same location, possibly Boulder, in May 1982.

A Workshop on Solar Spectral Irradiance Measurements was proposed by Dr. P. C. Simon, to be held in the Washington, D. C. area in May 1982, prior to the STP Symposium and COSPAR Meeting in Ottawa.

## MAPSC ACTIONS - 14 AUGUST 1981

At its meeting on the night of 14 August 1981, the MAP Steering Committee considered the following items: approval of CAMP as a MAP project, the future of the MSGs and PMPs, and the dissolution of the regional definition groups. Also, the extension of MAP beyond 1985, and proposed MAP Workshops were discussed.

## CONSULTATIVE GROUPS

It was agreed that European and Asian Consultative Groups would be created for a one-year period. These groups will not be decision-making bodies, and will serve mainly to coordinate MAP activities in the European and Asian regions.

## MAP TWO

Following a lively discussion on the need for an extension of MAP beyond 1985, it was decided to postpone a decision until the meeting of the MAP Steering Committee, to be held in Ottawa during the week of the STP Symposium in May 1982. The final decision rests with the nations adhering to MAP.

## RESOLUTIONS

Three resolutions were presented to the MAP Assembly and adopted in the closing plenary session. These related to: Assistance required at the MAP Central Information Exchange Office in Boulder; designation of MAP National Representatives by SCOSTEP member countries; and, expression of appreciation to Dr. E. R. Dyer for his role in the formulation and promotion of the original idea of MAP.

FMP-1: A COORDINATED STUDY OF THE BEHAVIOR OF THE  
MIDDLE ATMOSPHERE IN WINTER

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The last three northern winters 1978/79-1980/81 are the winters which are considered "FMP-1 winters". During all three winters very interesting events took place, and extremely cold midwinter periods have been observed as well as minor and major warmings. Short reports on these warmings have been given after each winter in the MAP-Newsletter.

For the investigation of the middle atmosphere the following observations were available regularly: The radiosonde data which are distributed through arrangements made by WMO; the rocketsonde data which are irregularly distributed, mainly also through WMO-channels; the infrared radiances of the SSU (Stratospheric Sounding Unit onboard the operational NOAA satellites).

Other data of more experimental nature which are or will become available are, e.g., data from the Nimbus-7 satellite, especially from the experiments SAMS (Stratospheric and Mesospheric Sounder) and LIMS (Limb Infrared Monitor of the Stratosphere), but only for the winter 1978/79. Also, wind observations of the mesosphere are available, more or less regularly, from different observational methods, and we attempted to collect these data and to integrate them into the large-scale meteorological field analyses.

Different groups are using the data to analyze fields of meteorological parameters on a hemispheric scale, such as, e.g., temperatures, geopotential heights, and winds. From these fields they derive parameters necessary for the understanding of the large-scale dynamics of the middle atmosphere. These investigations are far from finished and they will continue during the next years. Also, most groups dealing with the analyses of the middle atmosphere are also developing different types of circulation models and are comparing the model results with the observations.

Brief descriptions of the three FMP-1 winters:

1978/79: (see Figure 1) - The midwinter period December 1978 and the first half of January 1979 was rather quiet and the temperatures over the polar region were below the average most of the time. The march of the radiances (at 80N) of channel 26 of the SSU which has its maximum weight near 4 mbar, is rather parallel to the 10-mbar pole temperatures. During the last 10 days of January the first of three

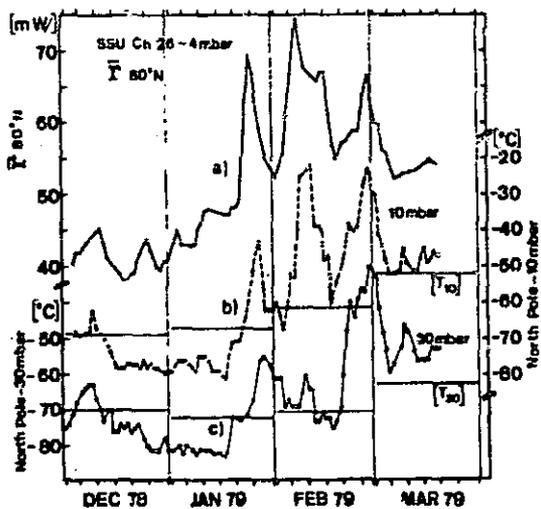


Figure 1 a) March of radiances of Ch. 26 of the SSU (zonal means at 80 N [ $\text{mW}/\text{m}^2\text{sr}(\text{cm}^{-1})$ ], maximum weight at about 4 mbar);  
 b) temperatures [ $^{\circ}\text{C}$ ] over the North Pole at the 10-mbar level;  
 c) same but at the 30-mbar level; horizontal lines are long-term mean values.

warming pulses is noticeable. In the upper stratosphere the second pulse at the beginning of February was the most intense, while the breakdown of the polar vortex (i.e., net easterly winds north of 60N at the 10-mbar level) was accomplished finally with the third warming pulse at the end of February when the lower stratosphere warmed also.

1979/80: (see Figure 2) - With respect to the stratospheric circulation the winter 1979/80 may be divided into three distinctly different phases. At the beginning of the winter in November/December a "Canadian warming" occurred in the middle and lower stratosphere, hardly influencing the upper stratosphere. During the midwinter period from mid-December to mid-February an extremely cold lower and middle stratosphere was observed, but several "minor warmings" were noticeable in the upper stratosphere. At the end of February a "major warming" took place, influencing the whole of the stratosphere and leading to the transition into summer conditions, i.e., to the "final warming".

1980/81: (see Figure 3) - The third winter of FMP-1 is characterized by an extremely cold mid-winter followed by a remarkable "major warming" which developed at the end of January. This warming resulted in the highest temperatures observed at the 30-mbar level since regular observations are available, i.e., since 1956, and the temperature gradient between the North Pole and 60N was reversed at the 10-mbar level during most of February and the first 10 days of March. The second criteria for a "major warming" which is the reversal of the mean zonal wind north of 60N was, however, not quite fulfilled. But as the wind decelerated drastically from unusually strong winds and changed to east at about 65N, it can only be a revision of the criteria set up several years ago. Altogether, there can be no doubt that this midwinter disturbance belongs into the group of "major warmings". Consistently, the "late-winter cooling period" affected the middle stratosphere in such a way that the "final warming", i.e., the transition into summer, was finished extremely late.

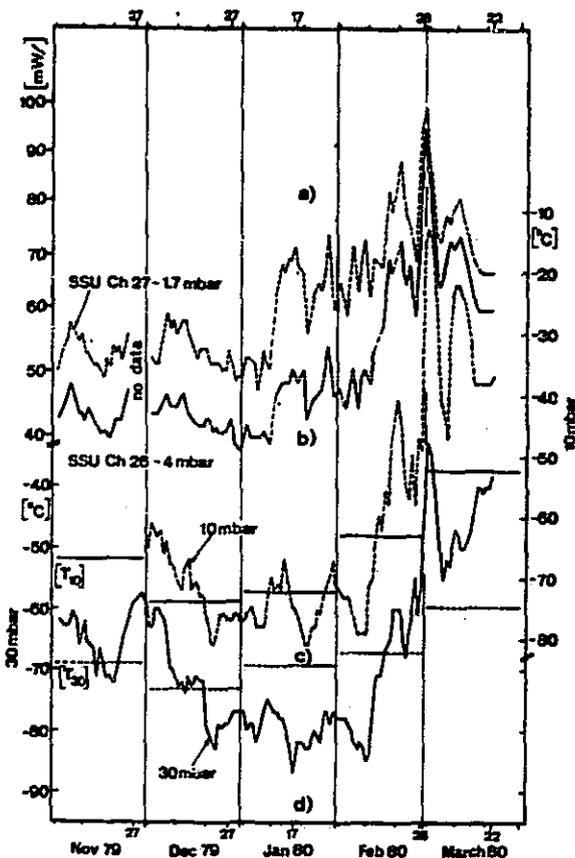


Figure 2 March of radiances or temperatures over the North Pole  
 a) Radiances [ $\text{mW}/\text{m}^2\text{sr}(\text{cm}^{-1})$ ] of Channel 27 of the SSU;  
 b) radiances of Channel 26 of the SSU [ $\text{mW}/\text{m}^2$ ];  
 c) temperatures of the 10-mbar level [ $^{\circ}\text{C}$ ];  
 d) temperatures at the 30-mbar level [ $^{\circ}\text{C}$ ] (horizontal lines in curves (c) and (d) are long-term monthly means)

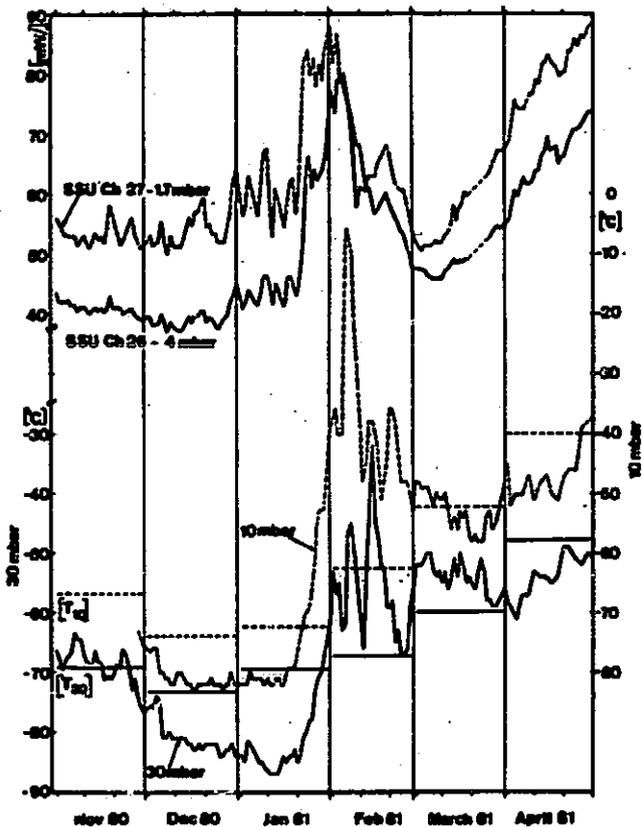


Figure 3 March of radiances or temperatures over the North Pole: radiances [ $\text{mW m}^{-2} \text{sr}^{-1} (\text{cm}^{-1})^{-1}$ ] of Channel 27 of the SSU (maximum weight around 1.7 mbar, broken line) and of Channel 26 (maximum weight around 4 mbar, solid line); temperatures [ $^{\circ}\text{C}$ ] at the 10-mbar level (broken line) and at the 30-mbar level (solid line) (horizontal lines are long-term means). The SSU data have been provided by the Meteorological Office, Bracknell, UK.

## PMP-2: EQUATORIAL WAVE DYNAMICS

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## INTRODUCTION

After the discovery of the quasi-biennial oscillation (QBO) in the stratospheric zonal wind, there have been, in the last two decades, a large number of observational and theoretical studies on the structure and behavior of the mean zonal wind and waves in the tropical stratosphere. From these studies it has been widely recognized that planetary-scale, vertically propagating equatorial waves play an important role in producing the QBO through the mechanism of wave-mean flow interaction (see reviews of Wallace (1973), for instance).

Concerning the dynamics of the equatorial upper stratosphere and mesosphere, however, little was known about the possible wave motions, except for tides, mainly because of the lack of adequate observations in this region.

Thus the main purpose of this PMP-2 is to provide the nature of various types of equatorial wave modes, with the aid of improved sounding techniques and sophisticated numerical modellings.

## RECENT STUDIES

In recent years, observational studies have shown some evidence of wave motions and theoretical studies have stressed the dynamical significance of waves in the general circulation of the tropical middle atmosphere. These results are summarized as follows:

## (a) Analysis of Rocket and Satellite Data

Statistical analysis was made of middle atmospheric wind and temperature variations by the use of conventional meteorological rocket data at Ascension Island (8S) and Kwajalein (9N). Evidence of short-period Kelvin type waves was presented in relation to the semiannual cycle of mean zonal winds at the tropical stratopause level (Hirota, 1978), and the presence of 2-day oscillation was found in the upper stratosphere (Coy, 1979).

Global analysis of infrared radiance data obtained from Nimbus satellites was also made to confirm the semiannual cycle in the mesospheric temperature (Crane, 1979), and Kelvin waves relevant to the semiannual oscillation (Hirota, 1979). However, there still remains the

defect of crude vertical resolution in satellite observations.

(b) VHF-UHF Radar Observations

The VHF-UHF radar technique is quite adequate to observe the equatorial wave structure because of its high accuracy in time and vertical resolution, despite the limitation of observation stations.

Recently, some special observations have been made by the Kyoto University group and by the Max-Planck Institute group at Jicamarca (12S) and Arecibo (18N). Significant evidence of quasi-periodic day-to-day wind variations are found, besides gravity waves and tides (Fukao et al., 1980, 1981; Rottger et al., 1981; and others).

(c) Theoretical and Numerical Studies

Pure theoretical and mechanistic numerical studies have also been continued for further understanding of the equatorial wave dynamics and their interaction with the mean flow. In addition, there has been an effort to extend the comprehensive general circulation model up to the mesosphere (Dunkerton, 1979, Mahlman, 1979, Holton and Wehrbein, 1980, Plumb and Bell, 1981, and others).

#### FUTURE REQUIREMENTS

As is stressed in the reports of MAP Study Group (MSG) 1-3, much additional observational work is needed to support the validity of various assumptions, such as the parameterization of transport processes due to waves, which are used in theoretical models mentioned above. Although there is some evidence of wave activities in the equatorial middle atmosphere, what is still less clear is the quantitative aspect of temporal and spatial variations of various wave modes including not only equatorially trapped modes but also planetary Rossby waves, tides and internal gravity waves.

In this regard, most promising research plans will be: Detailed analysis of Nimbus 7 satellite data such as obtained from LIMS and SAMS with higher spatial resolution; and new MST radar observation at Christmas Island (or Kwajalein), which is proposed by Dr. B. Balsley (NOAA).

Thus, during the period of MAP, the study on this subject should be continued through coordination of observational and theoretical works, as a part of new MAP Projects which will be determined in this MAP Assembly.

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## MAP PUBLICATIONS COMMITTEE REPORT

Dr. C. F. Sechrist, Jr., Chairman of the MAP Publications Committee, announced that Dr. R. J. Murgatroyd, Dr. R. D. Bojkov, and Dr. V. V. Viskov are members of the Committee.

Future issues of the MAP Newsletter will appear as Special Issues of the Upper Atmosphere Programs Bulletin which is published jointly by the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration. He requested that contributions for the Newsletter be sent to Dr. N. Sundararaman in the High Altitude Pollution Program Office of the FAA.

Dr. Sechrist described the first three volumes of the Handbook for MAP as follows:

Handbook for MAP

<u>Volume</u>	<u>Contents</u>	<u>Estimated Pub. Date</u>
1	National Plans, PMP Reports, MSG Report, Approved MAP Projects	July 1981
2	Extended Abstracts from International Symposium on Middle Atmosphere Dynamics and Transport (held July 28 - August 1, 1980 at Urbana, Illinois)	August 1981
3	PMP Report, MSG Reports, Approved MAP Project, Updated Chapter 2 of the MAP Planning Document (Relationship to Applications), WMO Meeting on Stratospheric Circulation Analysis and Ozone, EXOS-C, Condensed Minutes of MAP Steering Committee Meetings	September 1981

The contents of Volumes 1, 2, and 3 were described briefly as follows:

MAP Handbook Volume 1 - Contents

Part 1 NATIONAL PLANS  
Czechoslovakia  
France  
India

Japan  
 United Kingdom  
 USA  
 USSR

- Part 2 PRE-MAP PROJECT (PMP) REPORTS  
 PMP-1: Coordinated Study of the Behavior of the Middle Atmosphere in Winter  
 PMP-2: Equatorial Wave Dynamics  
 PMP-3: Studies of Middle Atmospheric Chemistry Through Combined use of Satellite and *in situ* Measurements
- Part 3 MAP STUDY GROUP (MSG) REPORT  
 MSG-4: Electrodynamics of the Middle Atmosphere
- Part 4 APPROVED MAP PROJECTS  
 The Middle Atmosphere Program: Winter in Northern Europe (MAP/WINE)  
 The Middle Atmosphere Program: Global Budget of Stratospheric Trace Constituents (MAP/GLOBUS)

MAP Handbook Volume 2 - Symposium Session Topics

Techniques for Observing Middle Atmosphere Dynamics  
 Climatology of the Middle Atmosphere  
 Planetary Waves  
 Stratospheric Warmings  
 Equatorial Waves  
 Tides  
 Gravity Waves and Turbulence  
 Transport between the Stratosphere and Troposphere  
 Interactions between Dynamics and Radiation and Chemistry in the Middle Atmosphere  
 Middle Atmosphere Responses to Solar Activity  
 Future Directions  
 Panel Discussion  
 Attendees

MAP Handbook Volume 3

- Part 1 PRE-MAP PROJECT (PMP) REPORT  
PMP-5: Solar Spectral Irradiance Measurements
- Part 2 MAP STUDY GROUP (MSG) REPORTS  
MSG-1: Tropospheric-Stratospheric Coupling, Chemical and Dynamical  
MSG-2: Transport of Trace Constituents in the Stratosphere  
MSG-3: Tides, Gravity Waves, and Turbulence
- Part 3 APPROVED MAP PROJECTS  
The Middle Atmosphere Program: Antarctic Middle Atmosphere (MAP/AMA)
- Part 4 UPDATED CHAPTER 2 OF THE MAP PLANNING DOCUMENT  
Relationship to Applications
- Part 5 WMO GLOBAL OZONE RESEARCH AND MONITORING PROJECT  
Meeting of Experts on Stratospheric Circulation Analysis and Ozone
- Part 6 TECHNICAL INFORMATION ON EXOS-C
- Part 7 CONDENSED MINUTES OF MAP STEERING COMMITTEE MEETINGS  
Innsbruck, 23-25 May 1978  
Geneva, 7-9 March 1979  
Canberra, 11 December 1979  
Urbana, 27 July and 1-2 August 1980  
Hampton, 22-23 May 1981

Proposed future topics for volumes in the Handbook for MAP include:

- a) Proceedings of the MAP Assembly
- b) Dynamic Climatology of the Stratosphere
- c) MAP Directory
- d) MAP Workshops and Symposia
- e) Satellite experiments including SAGE, SME, HALOE, ATMOS, LRIR, NOAA, DE, EXOS
- f) The Middle Atmosphere as Observed from Balloons, Rockets and Satellites (Discussion arranged by the British National Committee on Space Research and Solar-Terrestrial Physics, and held December 12-13, 1978 at the Royal Society).

- g) WMO Meeting on Measurement of Atmospheric Constituents of Importance to  $O_3$ .
- h) NLC Research
- i) Discussion Meeting on Solar-Terrestrial Physics (Middle Atmosphere) held August 29-30, 1980 at LaTrobe University, Australia.
- j) Ground-based techniques, including partial-reflection ionization drifts, middle atmosphere radar, laser radar, meteor radar.

**National Plans and Reports**

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## MAP ACTIVITIES IN ARGENTINA

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ARGENTINA

The National Program of Radiopropagation of Argentina will be engaged in MAP Projects starting in 1982. A brief summary of these is given below.

## GRAVITY WAVE PROJECT

Simultaneous measurements of rapid variations of electron density and height of  $E_s$  layers at different locations in the South American Sector will be carried out. Spectral analysis techniques will be used to obtain gravity waves parameters as shown by A. E. Giraldez ("Evidence of Gravity Waves at E Region Heights", Geophysical Research Letters, Vol. 7, N°2, p. 170, Feb. 1980).

Gravity waves will be also studied measuring the airglow temperature fluctuations of OH and  $O_2$  atmospheric band emission arising near 85 and 95 km heights (Noxon, J. F., "Effect of Internal Gravity Waves Upon Night Airglow Temperature", Geophysical Research Letters, Vol. 5, N°1, p. 25, 1978). These observations will be made from El Leoncito (31.8°S, 69.3°W) and Abra Pampa (23.1°S, 65.7°W) and a location at a latitude greater than 45°S in Argentina.

The information obtained by the ionospheric and photometric observations will be used in numerical simulation of atmospheric fluid models, to study the generation and propagation of gravity waves in the mesosphere and lower thermosphere.

## VLF AND IONOSPHERIC ABSORPTION PROJECT

VLF signals from Omega-Argentina Station (43°S, 65°W) recorded at Tucuman will be used to monitor D region variations, in particular during geomagnetic events (Abdu, M. A. et al. "Magnetic Storm Associated Enhanced Particle Precipitation in the South Atlantic Anomaly: Evidence from VLF Phase Measurements", Journal of Geophysical Research, in press, 1981).

Data will be compared with those obtained by Brazilian groups that will record the same signals. East-west variations will be defined in the region of the South Atlantic Anomaly.

The information obtained will be compared with D region electron density models to use VLF data as monitor for large scale changes of minor constituents in the mesosphere. (Radicella, S. M. and Restbergs, V., "Oxygen Allotropes Concentrations and Electron Density Profiles in the Nighttime D Region", Journal of Atmospheric and Terrestrial Physics, Vol. 43, p. 1, Jan. 1981).

Ionospheric absorption using the pulse method will be measured at Ushuaia (54.9°S, 68.3°W) and Trelew (43.1°S, 65.2°W). These data will be also used as monitor of mesospheric changes.

#### SOUTH ATLANTIC ANOMALY COOPERATIVE PROJECT

A cooperative project among Argentina, Brasil and South Africa for the study of the aeronomic effects of the South Atlantic Anomaly (SAA) is under preparation. It would include coordinated measurements of ionospheric parameters, airglow emissions, electric field and X rays in and out the SAA. In particular, effects at mesospheric heights would be analyzed.

A campaign of measurements including the use of the oceanographic ships Cape Agulhas (South Africa) and Puerto Deseado (Argentina) is being planned.

## AUSTRALIAN MIDDLE ATMOSPHERE PROGRAM

W. G. Elford

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AUSTRALIA

The Australian Middle Atmosphere Program is co-ordinated by a sub-committee of the National Committee for Solar-Terrestrial Physics. The members of the sub-committee and their affiliations are:

Dr. W. G. Elford (Chairman), University of Adelaide

Prof. K. D. Cole, La Trobe University

Dr. A. J. Dyer, CSIRO Division of Atmospheric Physics

Mr. B. G. Hunt, Australian Numerical Meteorology Research Centre

Dr. F. Jacka, Mawson Institute, University of Adelaide

## PROJECTS

1. Winds between 80 and 100 km will be measured by a meteor radar at Adelaide, and by partial reflection drift systems at Adelaide, Broken Hill, and Mawson (Antarctica).

2. A new VHF radar will be commissioned at Adelaide in mid-1982. It will initially measure winds in the troposphere and stratosphere. It is proposed that eventually it will become a MST radar facility.

3. Airglow observations will be undertaken at Adelaide and Mawson (Antarctica).

4. Lunar tides in the E-region will be studied at La Trobe (Melbourne).

5. Ozone observations will be continued by the CSIRO Division of Atmospheric Physics, Melbourne, while short-term changes in ozone depth will be studied at Adelaide.

6. Electric field measurements will be continued at Mawson (Antarctica).

7. Further developments of large scale atmospheric modelling will continue at the Australian Numerical Meteorological Research Centre, Melbourne.

## MAP-RELATED ACTIVITIES IN BELGIUM

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MAP-related activities in Belgium fall into the two categories of observational programs and theoretical studies.

Included in the observational programs are: solar irradiance measurements in the 170-3200 nm wavelength range, using balloons and Spacelab; trace species composition measurements in the stratosphere and mesosphere, using UV absorption, IR absorption, and IR emission techniques; and mass spectrometric measurement of ions and aerosols using balloon-borne instruments. Intercomparisons of these measurements are planned with investigators in France, Switzerland, Federal Republic of Germany, and the United States.

Included in the theoretical programs are: studies of photo-dissociation processes; ion chemistry; odd nitrogen chemistry; 1-D and 2-D chemical modelling in the 10 to 100 km region; and climate studies. Included in the climate program is the climatology of the stratosphere.

Organizations involved in middle atmosphere research include: IASB, IRM, University of Brussels, and the Institute for Astrophysics at the University of Liege.

## MAP-RELATED ACTIVITIES IN CANADA

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CANADA

## EXTENT OF PARTICIPATION

Canadian scientists have traditionally been active in the field now known as magnetospheric physics, due to the accessibility to them of high latitude geomagnetic phenomena. Substantial commitments for conduct of programs involving international collaboration, e.g. rocket campaigns in the Arctic, have been made in the past five years. In consequence relatively few Canadian scientists, including those under training at universities, are available to engage in MAP activities.

## STATUS OF ORGANIZATION

Potential interests in MAP within Canada have been identified, and the scale of financial and other support has been estimated. At present, discussions are under way to determine channels of financing.

## MAP-RELATED ACTIVITIES

Canadian scientists working in areas related to the Middle Atmosphere Program are as follows:

R. P. Lowe, University of Western Ontario, London, Ontario:  
Observation of O<sub>2</sub> singlet delta emission from ground level with Michelson interferometer. Using same instrument to measure airglow continuum in 1.1 to 1.6  $\mu\text{m}$  regions and 45-60 km ozone concentrations.

J. K. Walker, Energy, Mines & Resources, Government of Canada:  
Large magnetic disturbances in relation to upper atmosphere temperature and pressure changes. Joule and energetic particle heating of upper atmosphere and magnetic disturbances.

E. J. Fjarlie, Royal Military College, Kingston, Ontario:  
Temperature and magnetic field measurements on Space Shuttle. Magnetic micropulsations with a squid and ground-based temperature measurements.

E. J. Llewellyn, Institute of Space & Atmospheric Studies, University of Saskatchewan:  
Measurements of significant minor constituents in upper atmosphere and mesosphere leading to understanding of the molecular processes concerned and anthropogenic influences involved.

R. W. Nicholls, Centre for Research in Experimental Space Science, York University:

Observation of high resolution long path atmospheric absorption spectra, laboratory measurements and theory of spectral intensity parameters of atmospheric and astrophysical molecules. Solar rocket spectroscopy.

H. I. Schiff, B. A. Ridley, D. Hastie, and S. Madronovich, York: Development and flight of tunable diode laser spectrometer for balloon borne measurements of NO, NO<sub>2</sub> and HNO<sub>3</sub> during a complete diurnal cycle with *in situ* measurements of NO<sub>2</sub> photolysis rate.

W. F. J. Evans, C. T. McElroy, J. B. Kerr, H. Fast, G. L. Mateer, and R. A. Olafson, Atmospheric Environment Service: High altitude balloon program for measurement of key stratospheric components, correlative measurements for LIMS, SAMS, SBUV. Ground based NO<sub>2</sub> measurements. Monitoring of ozone layer over Canada. International ozonsonde intercomparison. Hydroxyl intercomparison with NASA Goddard. 1981-82 ground truth measurements for HALOE on space shuttle.

D. J. McEwen, Institute of Space & Atmospheric Studies, University of Saskatchewan:

Stratospheric measurements of solar UV radiation and ozone concentrations.

G. G. Shepherd, Centre for Research in Experimental Space Science, York University:

Measurements of winds and temperature in mesosphere with WAMI (Doppler).

A. Vallance Jones, Herzberg Institute of Astrophysics, National Research Council:

Auroral excitation and chemistry processes.

J. B. Gregory, Institute of Space and Atmospheric Studies, University of Saskatchewan:

Measurement of electron densities and winds from 60 to 90 km.

H. M. Sullivan, University of Victoria:

Measurement of sodium, potassium and lithium emissions in the mesosphere.

L. L. Cogger, University of Calgary:

Investigation of structure and dynamics of upper atmosphere using optical techniques.

J. C. McConnell, G. G. Shepherd, W. H. Morrow, M. L. Morrow, B. Solheim and E. J. Llewellyn, Centre for Research in Experimental Space Science:

Rocket program to measure O, OH, NO, Cl, O<sub>3</sub> in the mesosphere.

CZECHOSLOVAK PARTICIPATION IN MAP

J. Lastovicka

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 CZECHOSLOVAKIA

PARTICIPATING INSTITUTES

Geophysical Institute (Prague) and Astronomical Institute (Ondrejov) of the Czechoslovak Academy of Sciences; Astronomical Institute (Skalnate Pleso) of the Slovak Academy of Sciences; Hydro-meteorological Institute Bratislava (Bratislava).

SCIENTIFIC SUBPROGRAM

Geophysical Institute, Prague:

Winter anomaly (A3 absorption and modelling) - Dr. Lastovicka.

Studies of recombination processes and of ion and neutral composition in the lower ionosphere with the use of ground-based measurements of radio wave propagation - Dr. Lastovicka.

The interplanetary magnetic field (particularly sector boundary crossing) effects in the ionosphere and atmosphere - Dr. Lastovicka.

The influence of geomagnetic activity on the troposphere, climate and weather - Dr. Bucha.

The two last subprograms are related to MAP only in part

Astronomical Institute, Ondrejov:

Disturbances of the atmosphere at heights of 120 to 40 km by penetration of meteoroids of metre and decimetre dimensions - Dr. Cepelcha - suggested as an international MAP subprogram.

Astronomical Institute, Skalnate Pleso:

Airglow variations, Hydromet. Institute Bratislava.

The dynamics of penetration of convective clouds into the stratosphere - Dr. Podhorsky.

All the subprograms are based on ground-based measurements.

EUROPEAN INCOHERENT SCATTER

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FINLAND

The following outline of Finland's MAP plans were provided by Dr. C. Sucksdorff. He is secretary of the National Committee of the IUGG, which serves as the MAP National Committee.

1. The results from the European Incoherent Scatter Facility (EISCAT) will probably be of some importance for the MAP.
2. Lower levels of the ionosphere (D-layer) will be monitored using a chain of riometers.
3. In connection with EISCAT, modeling of current systems in the lower ionosphere will be made utilizing a new network of digitized magnetometers.
4. Studies of atmospheric electricity at the earth's surface and correlations with electric phenomena in the ionosphere (aurora) have been planned.
5. Depending on funds available, Finland plans to start observations of the stratospheric ozone layer.

## FRENCH ACTIVITIES RELEVANT TO MIDDLE ATMOSPHERE RESEARCH

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This report will describe the different actions which have been undertaken, and the program for the following years.

### ORGANIZATION OF THE FRENCH MIDDLE ATMOSPHERE COMMUNITY

A MAP Committee was named in 1979; it includes:

- Dr. Marie-Lise Chanin, Service d'Aeronomie, Verrieres-Le Buisson, President.
- Dr. Andre Berroir, Director Laboratoire de Meteorologie Dynamique, Palaiseau.
- Dr. Pierre Bauer, C.R.P.E., Issy-les-Moulineaux.
- Dr. James Hieblot, Director, C.R.P.E., Orleans.
- Dr. Pierre Jouve, Director, Laboratoire de Physique Moleculaire, Reims.

The role of this committee is the coordination of the programs directly relevant to MAP.

Three different actions were decided by our scientific agencies. Even though they do not intend to limit their support to MAP accepted programs, a large part of their domain of interest concerns Middle Atmospheric Research.

#### (a) Interface Between Atomic and Molecular Physics and Atmospheric Physics

This program was created in 1979 with the joint sponsorship of CNRS, CEA and DGRST. Its annual budget has been 1.5 million francs in 1980 and 1981.

Its committee includes: Mrs. M. L. Chanin (President), MM. Le Bras (Secretary), Berroir, Nicolet, Camy Peyret, Chedin, Fouquart, Girard, Jacquet, Jouve, Lesclaux, Loitiere, Oppeneau, Robert, Roth, Mrs. Merlivat, MM. Waldteufel, Leach, Aubry, Decoms, Jerome, Foglizzo.

Its purpose is to stimulate laboratory work in Spectroscopy and Photochemistry to answer the needs of atmospheric physics (from the boundary layer to the mesopause).

Up to date, 20 contracts have been given to laboratories, which,

for most of them, had not been involved before in atmospheric measurements.

This action will be pursued with extended interests: "Study of atmospheric clusters" and "development of improved metrology" are new themes proposed to be added to the preceding topics.

#### (b) Middle Atmosphere

A new research program called "Middle Atmosphere" was created in June 1981 jointly by CNRS, CNES and DGRST. Its budget is 1.5 million francs in 1982.

Its committee includes: Dr. Ph. Waldteufel (President), P. Mascart (Secretary), Bertin, Blamont, Cariolle, Chanin, Chedin, Girard, Nieblot, Jerome, Muller, Ramon, Sommeria.

These topics relevant to Middle Atmospheric Research have been proposed:

- Tropospheric-stratospheric transfer,
- Distribution of interacting minor species in the stratosphere and study of their variations and of their role in the ozone photochemistry,
- Role of ions and clusters in the physics and physicochemistry of the middle atmosphere,
- Interaction between the general circulation and instabilities.

In this framework, organisation of campaigns in France or participation in international campaigns (whether they are or not recognized by the MAPSC) could receive the required financial support.

#### (c) Atmospheric Exchanges

A third research program called "Atmospheric Exchanges" organized by the DGRST and the Ministry of Environment is being set up now.

Its committee is presided by Professor A. Berroir and includes: MM. Biren, Bouscaren, Carriole, Deschamps, Jacquet, Jerome, Lambert, Laurent, Lesclaux, De Lamare, Madelaine, Mascart, Megie, Nicolet, Oppeneau, Rigaud, Sommeria, Vie Le Sage, Morelli.

It will welcome proposals relevant to tropospheric and stratospheric dynamics and physicochemistry, to help with making equipment operational and to develop and use numerical models for prediction.

#### DEFINITION OF THE PROGRAM: PRIORITIES

After several consultations of the concerned community and taking into account the competence and existing experimental facilities, a program for the period 1982-1985 was submitted and accepted by CNRS.

The priorities concerning the Middle Atmosphere can be summarized as follows:

Modelling of vertical transports in the middle atmosphere by studying the redistribution of energy, momentum and matter, and more specifically:

- Wave generation and transmitted energy budget,
- Wave propagation and their effect on the atmospheric medium,
- Turbulence and transfer.

Theoretical and experimental study of spatial and temporal variability of minor constituents of the atmosphere along with five different aims:

- Spatial distribution and temporal variability of minor constituents and physical parameters,
- Simultaneous study of chemically related components,
- Modelling 1-D, 2-D, 3-D, taking into account coupling processes with radiation and general circulation,
- Variability of solar flux and its influence on photodissociation and photochemical equilibrium,
- Role of ionic clusters on the physicochemical equilibrium of the middle atmosphere.

Stratospheric-tropospheric exchange: flux of matter, energy and momentum - Quantification of those exchanges.

#### EXPERIMENTAL SUPPORT AVAILABLE

In the preceding report, a detailed description of the experimental support was given. It will only be briefly recalled here:

##### (a) Ground-Based Geophysical Stations

Two sites have been selected:

- At middle latitude, the Observatory of Haute Provence (44°N, 6°E) has been equipped with highly-performing equipment in the last two years; high resolution UV and IR spectrometry and a multi-purpose lidar station are already in operation. A S.T. radar will be set up in 1982. Microwave spectroscopy has been developed and is operated from the Observatory of Bordeaux (600 km away).

- At high latitude, Tromsø, (Norway) (69.5°N, 20°E), an ensemble of instruments has been set-up to operate in connection with EISCAT (The European Radar Facilities): it includes a lidar, a Michelson interferometer, and several photometers.

## (b) Balloon-Borne Equipment

In the past years, sophisticated payloads have been developed and have already been used on board stratospheric balloons:

- IR grille spectrometer,
- Chemiluminescent ozonometer,
- Water vapor fluorescence photometer,
- Sonic and ionic anemometers ...

More recently, some of these equipment have been miniaturized in order to fly on long lifetime balloons.

## (c) Balloon Development

The National Space Agency, CNES, has been pursuing an intensive program of balloon development for years and more recently the emphasis was put on developing long life balloons: two types have been studied. They have led to successful flights and should be operational in 1982:

- Superpressurized balloon,
- Hot air balloon (or M.I.R.).

While the first type floats at a constant level, the M.I.R. is able to perform several vertical excursions during daytime (from 18 to 28 km). Such a vehicle is very promising to provide the vertical description of atmospheric parameters on a global basis.

## (d) Satellite and Spacelab Programs

The French Space Agency does not plan any atmospheric satellite in the next few years. But French teams had experiments accepted on board Spacelab and UARS which should bring an important contribution to MAP.

Among them are:

- IR grille-spectrometer (stratospheric constituents) on board Spacelab I,
- OH wave photometer (mesospheric waves) on board Spacelab I,
- Solar spectroscopic measurements from 170 to 3200 nm on board Spacelab I,
- Hydrogen and helium concentrations on board Spacelab I,
- Wide angle Michelson measurements of T and winds on board UARS.

## PROPOSALS FOR THE YEARS 1982-1985

Before describing the French proposals for MAP, it should be men-

tioned, that even though it was not a MAP program, an intercomparison  $O_3$  campaign was organized in France in June 1981, under the auspices of DGRST.

15 scientific teams participated in this experiment (10 from France, 1 from Belgium, 3 from the U.S. and 1 from RFA). The first purpose of the program was the intercomparison of different techniques of ozone measurements: 12 different methods of measuring  $O_3$  were used from ground stations and balloons not including the 3 satellite experiments which will also be used in this comparison. Technically the campaign was a total success: 15 consecutive days of  $O_3$  survey from the ground (with Dobson, UV, IR,  $\mu$ wave spectrometry, lidar) and two successful balloon flights with 5 instruments on board. Day-to-day variation and diurnal variation of vertical profile and total content, should also come out as an output of this campaign.

The organization of such campaigns is to be repeated in the next few years: the next scientific theme will be the diurnal variation of the  $NO_x$  and it is likely that the ozone intercomparison campaign will be repeated. The program will be fulfilled with the help of ground and balloon-borne experiments available in France, with the contribution of foreign experimenters who will be willing to cooperate. From our last experience, the time constant to prepare such a reasonable size campaign could be reduced to a year.

As a supplement to those campaigns, the program that we would like to develop in the next few years is centered around the study of tropospheric-stratospheric exchange using long life balloons (MIR). The equipment to measure the more important tracers ( $H_2O$  and  $O_3$ ) are in development and dynamic parameters could be measured very accurately with already existing anemometers.

A first series of MIR equipped with those 3 equipments is scheduled for May 1983, but there is concern that such a program should be open to as many experimenters as possible. The development of payloads able to fly for such long periods of time may require several years and should then be started as early as possible.

Finally, the French community is willing to participate in some of the already announced MAP programs (even though some of them are not yet officially accepted).

C.A.M.P. (summer 1982): The French equipment based in Tromsø will be able to measure temperature and winds in the mesosphere, temperature in the stratosphere and height distribution of noctilucent clouds.

WINE (winter 1983-1984): The participation of the French community in WINE has also been discussed and may include, in addition to what is already mentioned above, balloon-borne measurements of winds and composition, as well as other ground-based experiments.

MAP IN THE FEDERAL REPUBLIC OF GERMANY

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FEDERAL REPUBLIC OF GERMANY

Dr. von Zahn, the MAP National Representative of the Federal Republic of Germany described the two Approved MAP Projects, GLOBUS and WINE, coordinated by Dr. W. Seiler and Dr. D. Krankowsky, respectively.

GLOBUS is described in Volume 1 of the Handbook for MAP.

WINE is described in Volume 1 and also in the Proceedings of the MAP Assembly held in Edinburgh (refer to page 138 in this volume).

PARTICIPATION OF THE GERMAN DEMOCRATIC REPUBLIC IN THE  
INTERNATIONAL "MIDDLE ATMOSPHERE PROGRAM" (MAP)

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PARTICIPATING INSTITUTES

ZISTP: Central Institute of Solar-Terrestrial Physics (Heinrich Hertz Institute) of the Academy of Sciences of the G.D.R.

GOC: Geophysical Observatory Collm of the Karl Marx University Leipzig.

OBSERVATIONAL PROGRAMMES DURING MAP

Ground-based continuous daily monitoring of:

Radar meteor winds at Kuhlungsborn (ZISTP, Prof. K. Sprenger);

Ionospheric drifts by spaced-receiver l.f. method at Collm (GOC, Dr. R. Schminder);

Characteristics of the D region by radio wave propagation methods, e.g., phase-height and absorption at Kuhlungsborn, and ionograms 0.2 to 20 MHz at Juliusruh/Rugen (ZISTP, Prof. K. Sprenger);

Near-surface gravity waves (ZISTP, Prof. K. Sprenger).

Partial-reflection measurements of D region electron densities will be carried out at Juliusruh for selected periods (ZISTP).

SCIENTIFIC RESEARCH RELATED TO MAP

The above observational programs will contribute data to the MAP projects, and their scientific use in the participating institutes is particularly aimed at the detection and diagnostics of regular and disturbed variations of neutral and ionized atmosphere structure, dynamics, and photochemistry in the mid-latitude middle atmosphere, such as: winter variability and stratosphere-mesosphere coupling; energetics of the different seasonal basic states; mechanisms and variability of the inter-seasonal change-over periods; and solar-terrestrial events, e.g., energetic particle precipitation, solar-flare effects, etc.

Theoretical, modeling, and data analysis studies are carried out at ZISTP on: planetary waves and circulation in the tropo-, strato-, and mesosphere; and photochemical energy transfer and neutral/plasma interaction in the mesosphere and lower thermosphere, including the ionospheric D region.

## HUNGARIAN RESEARCH ACTIVITIES RELEVANT TO THE MIDDLE ATMOSPHERE PROGRAM

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## INTRODUCTION

The interest of Hungarian scientists, dealing with the investigation of the middle atmosphere, is concentrated on the study of the structure and dynamics of the stratosphere and mesosphere. Thus, in the framework of MAP the intensification and extension of this research work is planned utilizing the advantages of international cooperation. The Middle Atmosphere Program is considered as the first joint effort of atmospheric scientists to fill the gap of knowledge between the lower and upper atmosphere. It will yield an insight into the solar-weather relations, too.

## ACTIVITIES PLANNED TO SUPPORT MAP

## (a) Structure of the Stratosphere

The structure of the stratosphere will be investigated by means of balloon measurements. The payload of the balloons enables the determination of temperature, pressure and humidity, as well as their vertical profiles at stations of the Central Meteorological Institute, Budapest, State Meteorological Service. Thus, the relation of stratospheric structure to dynamical processes can be studied.

## (b) Ozone Climatology

The study of ozone climatology is planned in the Central Institute for Atmospheric Physics, Budapest, State Meteorological Service, on the basis of measurement of the total ozone content, as well as by means of ozone profiles deduced from satellite data. For the measurement of the total ozone content, a Dobson spectrophotometer is used and the ozone profiles will be computed from satellite data available by recording the data of meteorological satellites open for common use.

## (c) Stratospheric Dynamics

As a further contribution to the study of the stratosphere the investigation of stratospheric dynamics is planned in the Central Meteorological Institute, Budapest, with special regard to the transition periods in spring and in autumn. This research activity is based on the balloon measurements carried out at the stations of the Institute.

(d) Electrodynamics of the Middle Atmosphere

For the investigation of the electro-dynamics of the middle atmosphere, ground-based measurements of the atmospheric electric potential gradient and the vertical air-earth current are planned in the Geophysical Observatory Nagycentk of the Geodetical and Geophysical Research Institute, Sopron, Hungarian Academy of Sciences. Former studies revealed a relation between the atmospheric electric potential gradient and absorption of radio waves in the ionosphere in geomagnetically disturbed periods. Further investigation extended to other parameters may contribute to the explanation of this relation and to the understanding of the electro-dynamics of the middle atmosphere. The atmospheric electric measurements in the observatory are supported by geomagnetic, earth-currents and ionospheric measurements, the latter aimed at the investigation of the lower ionosphere.

(e) Changes of Solar and Meteorological Origin in the Mesosphere and Lower Thermosphere

Observation of changes of solar and meteorological origin in the mesosphere and lower thermosphere by means of ground-based methods are planned in the Geophysical Observatory Nagycentk of the Geodetical and Geophysical Research Institute, Sopron. The measurements of the absorption and phase height of radio waves incident obliquely in the ionosphere will be used for the investigation of solar flare effects, the effect of Forbush decreases, the primary and after effect of geomagnetic storms, as well as the winter anomaly. Data on the level of atmospheric radio noise will also be included in these studies. Great importance is attributed to the separation of effects of different origin. Further understanding of processes is expected of the separation of effects due to a Forbush decrease and that of a geomagnetic storm in the mesosphere. Another phenomenon to the solution of which the separation of effects may contribute is the winter anomaly.

(f) Turbulence

An important factor in atmospheric processes in the middle atmosphere is turbulence. The determination and investigation of turbulent parameters, turbulent intensity, rate of turbulent dissipation, vertical turbulent diffusivity, at the top of the middle atmosphere deduced from ionospheric sporadic E parameters are planned in the Geodetical and Geophysical Research Institute, Sopron. Assuming the validity of the wind shear theory of midlatitude sporadic-E, wind shear is calculated. This is used then to determine the gradient Richardson number, after the vertical gradient of temperature has been computed from atmospheric models. The turbulent parameters can be calculated by means of the appropriate equations of the turbulence theory relating these parameters to the gradient Richardson number. The computed values will be used to study dynamical processes in the lower thermosphere affecting the region both below and above the turbopause.

## MAP IN INDIA

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## BACKGROUND

The Middle Atmosphere Program as envisaged in the international scene as well as in the Indian Program has two aspects: the scientific and the practical.

The upper atmosphere is a region of great intrinsic scientific interest and of considerable practical importance as the near environment in which man lives. In terms of basic science, it represents a transition from the lower atmosphere or a region of weather and the near vacuum of interplanetary space. This is a seat of a variety of physical phenomena, many of which involve complex interactions among fluid dynamics, radiative effects and chemistry, plus it has an electrically charged component -- the ionosphere.

The intrinsic practical importance of the upper atmosphere has recently received widespread attention in connection with the hazard due to depletion of the protective ozone layer. Its extreme fragility was recognised only after catalysts were identified that are very effective in destroying ozone and that are introduced into the stratosphere both by natural processes and man's various activities. This has resulted in a tremendous boost for stratospheric research. At the same time this intensive activity also underlined our inadequate knowledge of this region, the stratosphere, with its complexities due to an interplay of dynamics, radiation and photochemistry.

Although the ozone layer problem has provided the most dramatic focus on the practical importance of the upper atmosphere, there are other important aspects e.g., the infrared properties of the upper atmosphere influence the overall radiative balance of the earth-atmosphere system and hence may have a direct effect on global surface temperatures. The possible existence of strong positive feedbacks in the coupling among dynamics, radiation and chemistry may serve to amplify small perturbations in the system and the feedbacks may have an important role in the observed relationship between solar activity, weather, and climate, currently an area of wide interest and speculation. Equally important is the electrically charged component of the upper atmosphere, namely the ionosphere, which has considerable practical importance through its effects on radio communications. Ionospheric irregularities are known to induce scintillations which can adversely

affect not only ionosphere-supported communication systems but also the much higher-frequency satellite links. Global navigation systems are dependent on LF radio waves whose propagation is strongly influenced by the extremely complex D region of the ionosphere.

#### INTERNATIONAL MIDDLE ATMOSPHERE PROGRAM

The Middle Atmosphere Program (MAP) is an international cooperative effort with its chief objective to obtain a comprehensive understanding of the structure, composition, chemistry, energetics, neutral atmospheric dynamics and electrodynamics of the middle atmosphere. It is officially scheduled to begin January 1, 1982, extending through December 31, 1985. For the MAP, the middle atmosphere is defined as the region extending upward from the tropopause, including the stratosphere, mesosphere and lower thermosphere (10 to 100 km).

At the international level MAP is an accepted program of the International Council of Scientific Unions (ICSU) with principal responsibility from SCOSTEP, along with the international unions concerned with environment, such as COSPAR, WMO, URSI, IUGG/IAMAP/IAGA, and IAU.

The international plan of the operations under MAP is for coordinated observations from ground-based facilities, aircraft, balloons, rockets and spacecraft. Although it is largely based on what is already planned for 1982-85, it entertains the hope that the participating countries will be willing to complement the program with relatively inexpensive but important additions. In fact, with the experience gained from the International Geophysical Year (IGY) and other International Geophysical Campaigns, it is expected that the analysis phase (may be called post-MAP) may continue until 1990. The MAP also encourages cooperative data management, information exchange on all appropriate time scales, and interaction between observationalists, modellers and theoreticians.

To take advantage of the international plans, the Indian scientific community started its planning exercises in 1979. With active support from the Indian National Committee for Space Research (INCOSPAR) and the Indian Space Research Organization (ISRO), a national steering committee was established, consisting of active scientists from national laboratories and universities, and scientific representatives of the government departments (University Grants Commission, Department of Science and Technology, India Meteorological Department) which brought out a national planning document which projected the scope of participation in the MAP, taking into account the available facilities, scientific expertise and infra-structure available in the country. After detailed deliberations of the recommended program the final shape of the Indian MAP (IMAP) has been formulated after taking account of the funds that would be available. The highlights of the IMAP and the time schedules

are given in the annexures.

## EXISTING FACILITIES FOR MAP IN INDIA

### (a) Scientific Institutions

India has a large number of scientific groups in the universities, national laboratories and other research institutions who are engaged in ionospheric and atmospheric studies. These groups have established scientific and technical expertise in many of the areas of work envisaged by the international MAP. Several of these programmes coming under MAP are already on-going programmes of these institutions, e.g., meteor radar, partial reflection, etc. In tune with the philosophy of MAP there will be intensification of activities and required additional funding in identified areas to solve specific scientific problems in a coordinated manner. In some cases some new and major facilities will be established to serve the objectives of MAP. An example of the special facilities is the MST radar.

An illustrative list of the institutions and universities actively engaged in the middle atmospheric studies is given below:

1. National Physical Laboratory, New Delhi.
2. Physical Research Laboratory, Ahmedabad.
3. Vikram Sarabhai Space Centre, Trivandrum.
4. Space Applications Centre, Ahmedabad.
5. India Meteorological Department, New Delhi.
6. Indian Institute of Sciences, Bangalore.
7. Indian Institute of Tropical Meteorology, Poona.
8. Indian Institute of Geomagnetism, Bombay.
9. Vedhshala, Udaipur.
10. Universities of Andhra, Poona, Marathwada, Delhi, Calcutta, Kerala, Gujarat, Punjabi, Udaipur etc.

### (b) National Facilities

**Rocket and Satellite Facilities of ISRO:** There are three rocket launching stations covering the equator and low latitudes, at Thumba, Shar, and Balasore. The Indian Space Research Organization has indigenous rocket fabrication and payload testing facilities for small rockets like RH 200 and larger ones such as RH 300/Centaure II. In addition, it also has satellite design, development and data acquisition facilities at Ahmedabad, Bangalore, Shar and Thumba.

**National Balloon Facility at Hyderabad:** Facilities exist for the design and development of large-volume balloons, launching, telemetry tracking and telecommand.

**India Meteorological Department:** The India Meteorological Depart-

ment with its headquarters at Delhi has a large number of meteorological observatories distributed throughout the country. Regular meteorological balloon launchings are made daily up to 20 km from 25 locations measuring winds, temperature, and pressure. Also imported balloons going up to 30-35 km are being launched for monitoring stratospheric ozone from three stations.

Various institutions have good ground-based equipment, payload fabrication facilities for balloon, rocket, and satellite experiments.

Computer facilities at several institutions exist for data processing, theoretical and modelling studies related to the middle atmosphere.

#### SOME SPECIAL FEATURES OF IMAP

India is particularly well placed geographically for studies relating to equatorial and low-latitude middle atmosphere since it covers a latitude range of  $8^{\circ}\text{N}$  to  $37^{\circ}\text{N}$ . These regions have unique features due to the presence of non-geostrophic flow patterns, equatorial waves, such as Kelvin waves and Rossby waves, semiannual and biennial oscillations in the wind pattern, higher and colder tropopause, relatively lower ozone concentration, higher effective solar radiation and monsoon circulations. Studies on these unique features have imparted scientific significance to the understanding of various atmospheric processes. One of the principal objectives of the Indian MAP is therefore to conduct suitable experimental, theoretical and modelling studies to achieve a better understanding of the various middle atmosphere phenomenon at equatorial and low latitudes.

Within this broad objective the following specific areas of studies are included:

1. Dynamics of the tropical middle atmosphere including coupling of various motion fields such as wave-wave and wave-mean flow interactions, generation of equatorial wave modes, influence of synoptic and planetary scale waves, turbulence and its effects, gravity waves etc.

2. Photochemical, radiative and dynamical coupling between the stratosphere and troposphere with special emphasis on the ozone cycle and its control on tropospheric phenomena and climatic variations.

3. Mesospheric turbulence generation due to forcings from the troposphere/stratosphere and plasma-neutral wind couplings and tidal modulations.

4. Electrodynamics of the middle atmosphere. In India considerable data were collected during ISMEX-1973 (India-Soviet meteorological experiments). MONEX-77 and MONEX-79 gave data on middle

atmospheric temperature and winds. Some continuity of these experiments has been planned which would be directly helpful for the experimental programme of IMAP. Provision has already been made under MONEX continuity programme with the India Meteorological Department and the Indian Space Research Organisation to have weekly rocket launchings for studying wave motions using RH 200 rockets from Balasore, Shar, and Thumba.

A total of 200 rockets were launched up to June 1981. IMD will carry out weekly balloon flights (going up to 35 km) from ten stations and ozonesondes (using balloons going up to 35 km) from Trivandrum, Poona, and New Delhi during the MAP period. In addition, from 28 radiosonde/Rawinsonde fields, station IMD is launching routine meteorological balloons up to 20 km.

Under the ISRO-USSR collaboration, M-100 rockets were being launched from Thumba every week for temperature and wind data. These launchings would be continued during the MAP period up to the end of 1984. In case it is not possible to extend this collaboration, suitable provisions would be made for additional RH-200 flights from Thumba.

The Space Applications Centre (SAC, Ahmedabad) have already successfully derived a few temperature profiles from satellite telemetry data from the Tiros-N satellite. This activity will be continued and, if possible, efforts will be made for receiving data from other satellites like Nimbus-7, and others to be launched during MAP for atmospheric constituent, temperature and wind profiles.

It has been decided to set up one national MST radar facility for studying various wave motions in the troposphere, stratosphere and mesosphere. These radars have been found very useful for studying small-scale motions such as gravity waves, tidal waves and turbulence.

#### DATA MANAGEMENT PLAN

In any observation programme of this magnitude, an adequately formulated data-management system is necessary to ensure availability of important data to all interested and capable scientific groups within the country that could result in maximum scientific returns. For this purpose a MAP Data Centre is proposed to be established at the ISRO Headquarters.

#### IMPLEMENTATION OF IMAP

The funding for the IMAP would come from several agencies including Department of Space, University Grants Commission, Department of Science and Technology, India Meteorological Department, Department of Environment, Electronics Commission, etc. This programme will be managed by an IMAP Inter-Agency Board which will be assisted by an IMAP Scientific

Advisory Committee with the Department of Space (DOS) as the focal point. The total task is divided into four areas: the scientific projects, services, MST radar facility and MAP Data Centre.

## ANNEXURE 1

## Priorities of Scientific Experiments

PARAMETERS TO BE MEASURED	TECHNIQUE	TYPE OF EXPERIMENT ROCKET BORNE (RB) GROUND BASED (GB) BALLOON BORNE (BB)	INSTITUTION(S) INVOLVED IN THE DEVELOPMENT OF TECHNIQUE AND THE DEVELOPMENT STATUS P = Planned D = Developed
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Minor Constituents (Mesosphere)

## PRIORITY-I

NO	$\gamma$ -band photometry	RB	NPL (P) PRL (P)
	Absorption photometry Airglow	BB	Poona University PRL (P)
O	Resonance fluorescence	RB	NPL (P)
	Indirectly from $O_2(^1\Delta_g)$ and OH emission photometry - airglow	GB/ RB	PRL Poona University (D)
O <sub>3</sub>	Dobson spectrophotometer/Umkehr	GB	IMD, PRL Poona University (D)
	Optical rocket ozonesonde	RB	NPL, PRL (D)
	Indirectly from OH & $O_2(^1\Delta_g)$ airglow emissions	GB/ RB	PRL, Poona University (D)
	Chemiluminescence	RB	IISC (P)
Na	Laser and optical technique	GB	VSSC (D) Poona University (P)

## PRIORITY-II

CH <sub>4</sub>	Both for stratosphere/ mesosphere (chemical technique)	BB/ GB	NPL (P)
ClO	-do-	BB	NPL (P)

## Priorities of Scientific Experiments (Cont.)

Minor Constituents (Stratosphere)

## PRIORITY-I

	O <sub>3</sub> optical ozonsonde	RB	NPL, PRL (D) for upper stratosphere
	Electrochemical ozonsonde	BB	IMD (D)
Aero-	Direct sampling mass spectrometer	GB/ BB	BARC (P) VSSC (P)
sols	Lidar	GB	VSSC (D)
Water	Chemical sensors	BB	NPL (P)
Vapour			

## PRIORITY-II

NO	Photoionisation mass spectrometer	BB/ RB	NPL (P)
HNO <sub>3</sub>	-do-	RB/ BB	NPL (P)

Radiation Studies

## PRIORITY -I

UV flux	(~3000 A) radiometers	GB	NPL (D) VSSC (P) IMD (D) University to be involved for observations
Lyman- $\alpha$	UV absorption	RB	PRL (D), NPL (D)

Dynamics

## PRIORITY -I

Mesospheric Dynamics	Meteor wind radar	GB	Andhra University (D) VSSC (D)
Stratospheric temperature/winds	Rawinsonde payload	BB	IMD (D)
Mesosphere temperature winds	M-100 met payload	RB	USSR (D) IITM (P)
	Falling sphere	RB	IISC (P)

## Priorities of Scientific Experiments (Cont.)

Middle Atmospheric motions	MST radar	GB	To be developed as a national facility
Stratospheric/meso-spheric motions	Chemical release experiment	BB/ RB	PRL (P)

Middle Atmospheric Ionization & Electrodynamics

## PRIORITY-I

Electron density	Partial reflection	GB	PRL (D) Andhra University (P)
	Cross modulation	GB	Delhi University (D)
	Propagation receiver	RB	PRL, NPL (D)
	Langmuir probe	RB	PRL (D), NPL (D)
	Impedance probe	RB	PRL (D)

## PRIORITY-II

Electron density	Absorption ( $A_1, A_2$ & $A_3$ techniques)	GB	PRL, Calcutta University, Andhra University, Gujrat University (D)
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## PRIORITY-I

Positive ions	Cylindrical probe & Gerdien condensor Langmuir probe	RB/	NPL (D)
		BB	PRL (D)
	Quadrupole mass-spectrometer	BB/	PRL (D)
		RB	NPL (P)
Electric field	Probes	RB/	NPL, VSSC, IIG (P)
		BB	PRL (D)

## ANNEXURE 2

## Time Schedule of Observations

(NOTE: This is a very tentative timetable for observational programs which would need to be finalised by the Science Committee. The names of the Institutions/Universities have been included to provide immediate information without restricting participation by others.)

MAP Elements	1980	1981	1982	1983	1984	1985	Beyond 1985
<u>Ground Based Observations</u>							
Airglow photometers for O, OH, Na, O <sub>2</sub> ( $\Delta$ ) (PRL, Poona University)							
Dobson photometer observations at Srinagar, Delhi, Varanasi, Ahmedabad, Mt. Abu, Poona & Kodaikanal (IMD)							
Aerosol studies by gas chromatography (BARC)							
Lidars for aerosols (VSSC)							
MST radar							
300 $\mu$ radiation monitoring (NPL)							
Multiwavelength radiometer							
Partial reflection experiment (PRL)							
Cross modulation experiment (Delhi University)							

Time Schedule of Observations (Cont.)

MAP Element	1980	1981	1982	1983	1984	1985	Beyond 1985
Meteor radar (Andhra University)							
Meteor radar (VSSC)							
<u>Balloon Observations</u>							
o 2-3 Kg payload balloons (up to 35 km) for temperature, winds, pressure, humidity from 10 stations (IND)							
o 2-3 Kg payload balloons (up to 35 km) for ozone profile from 3-4 locations (IND)							
o 200 Kg payload balloons for quadrupole mass spectrometer, IR sensors, aerosol sampling mass spectrometers etc. (NPL, PRL, Poona University)							
o 100 Kg payload balloons for airglow emission profiles, aerosols and electric fields (Poona University, NPL, PRL)							
o -30 Kg payload balloons (Tetrocons) for gradient condensers, ozone sensors, UV photometry, Langmuir probe etc., (NPL, PRL, IITM)							

Time Schedule of Observations (Cont.)

MAP Elements	1980	1981	1982	1983	1984	1985	Beyond 1985
<u>Rocket Observations</u>							
o RH-200 for winds (chaff payload) - One per week from two stations	Monex Continuity		Add.				
o RH-200 for ozone (NPL/PRL payloads) .. One per month from three stations	Test Flights for payloads		Observational phase				
o M-100 weekly flights	Existing Program		Extension of	INDO USSR Collaboration for MAP			
o RH-300 flights for minor constituents (O, NO, O <sub>3</sub> , NO <sub>2</sub> , CH <sub>4</sub> , CO <sub>2</sub> , N <sub>2</sub> O, HNO <sub>3</sub> etc). Lyman- $\alpha$ and UV measurements, thermospheric winds by chemical release experiments, Langmuir probes, impedance probes, cylindrical probes, retarding potential analysers, gerdien condensers, mass spectrometers etc.	+ New payload development						

## MAP IN JAPAN: ORGANIZATION AND PROJECTS

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## THE OUTLINE OF MAP PLANNING IN JAPAN

In 1976 the MAP Working Group was organized within the National Committee on Solar Terrestrial Physics of the Science Council of Japan. This Working Group prepared a plan for the Japanese program of MAP. The National Committee on Solar Terrestrial Physics, the Special Committee for International Scientific Cooperative Enterprises, the National Committee for URSI, the National Committee for Geophysics, the 4th Division (Pure Science) and 5th Division (Engineering) of the Science Council of Japan supported Japan's participation in the MAP program which had been internationally recommended. The Science Council approved the proposal in October in 1978 and recommended to the Government to provide the financial support for the participation. Later, in January 1979, the Japanese Government set up the MAP Working Group under the Geodesy Council of the Ministry of Education, Science and Culture for funding the relevant national programs. It is now concluded that Japan will participate in the following five MAP projects:

- Project 1. Winds and waves
- Project 2. Constituents
- Project 3. Aerosols and radiation
- Project 4. Coordinated observations in Antarctica
- Project 5. Data analysis and modelling.

Scientific descriptions of these projects will be given in more detail.

There are now two national organizations for MAP. The first is responsible for funding and is called the 'MAP Special Committee'. It is under the Geodesy Council (Chairman: T. Nagata, Polar Research Institute). The other, responsible for scientific activities, is called the 'MAP Science Committee' and is under the Science Council of Japan.

## PROJECTS AND PROBLEMS IN EACH PROJECT

## (a) Winds and Waves

The longitudinally averaged zonal wind in the middle atmosphere is characterized by a pair of jets near an altitude of 60 km and by westerly jets at 10 km. The wind near the 60 km level undergoes a seasonal reversal between winter westerlies and summer easterlies. The mean wind of the middle atmosphere is marked by the presence of various wave disturbances that propagate both vertically and horizontally. These include planetary waves with periods of ~10 days, diurnal and semidiurnal tidal waves, acoustic-gravity waves with periods ranging from a few hours to a few minutes, and rapidly changing turbulent motions. The wave disturbances are superposed on the mean wind, and interaction among them makes the wind field very complicated. What follows describes the planned experiments relative to these dynamic states of the middle atmosphere.

**Meteor Radar Observations:** Meteors penetrating into the upper atmosphere from the interplanetary space collide with air molecules producing ionized trails in the 80-100 km altitude region that reflect radar pulses. When we measure Doppler phase shifts, slant range and arrival angles of a radar echo from the meteor trail which moves with the neutral winds, we can determine the wind system present in the upper atmosphere. The radar has been operating at the Shigaraki station (34°51'N, 136°6'E) since 1977. The radar is a coherent pulse radar with a phase sequenced interferometer system. The accuracy in height determination is about 1 km and that in velocity a few meters per sec.

**Balloon Observation of Stratospheric Turbulence:** Observations have demonstrated that multiple thin layers of strong turbulence exist in the middle atmosphere in spite of its stable stratification. Such turbulent layers are considered to be associated with internal gravity waves, which play an important role in the vertical transport of momentum, heat, energy and many kinds of gases and aerosols.

The main objective of this experiment is to clarify the *raison d'être* of the turbulent layers by means of sophisticated balloon measurements of wind and temperature fluctuations.

**TMA Luminescent Cloud Release From Rockets:** TMA (Trimethyl aluminium) cloud experiment is conducted at altitudes between 60 km and 90 km. The wind velocities, diffusion constant and scales of disturbance in the middle atmosphere will be measured from photographs taken at several ground stations.

**Detection of Atmospheric Waves by the HF Doppler Method:** Frequency fluctuations of order 1 Hz are usually observed on HF radio waves reflected from the ionosphere. Atmospheric waves excited in the middle

atmosphere are considered to be one of the causes of these fluctuations. Quantitative analysis of the fluctuation data observed at multi stations will clarify the wave mode, propagating mechanism and the origins of these atmospheric waves.

**Observations of Atmospheric Motion by Infrasonic Waves:** Natural infrasounds, or microbaroms are generated by the ocean waves in stormy regions offshore. Especially in the winter season, they are generated almost constantly near the Aleutian Islands and propagate to Japan from the east. In winter the height of the acoustic duct for their propagation to the west is in the lower thermosphere, and is subject to atmospheric tidal motions. From the amplitude of the natural infrasounds the tidal motions in the lower thermosphere can be monitored continuously. Infrasonic waves generated by volcanic explosions propagate to the east in several atmospheric ducts, from which some information about the upper stratosphere will be obtained.

**Routine Ionospheric Sounding:** The ionospheric vertical soundings in Japan are operated much more completely through prompt exchanges of ionogram and ionosonde data among the Radio Wave Observatories, Wakkanai (45°N, 142°E), Akita (40°N, 140°E), Kokubunji (36°N, 139°E), Yamagawa (31°N, 131°E) and Okinawa (26°N, 128°E).

**Ionospheric Oblique-Vertical Sounding:** The ionosphere as a radio environment is routinely observed at each ionosphere sounding station of the Radio Wave Laboratories by intercepting HF radio waves which are propagated from other stations at intervals of 15 minutes. Usable system outputs are the relative propagation distance D-f and the relative propagation loss F-f recorded as hard or soft copies for rapid computerized data processing. They are usefully analyzed for studies of the dynamical relationship between the lower ionosphere and the mesosphere.

**Atmospheric Motion at Meteor Heights and its Relation to Dynamical Aspects of E<sub>s</sub> Layers:** Radio pulses transmitted from Akita Radio Wave Observatory (39°43'N, 140°08'E) and forward-scattered via meteor trails and E<sub>s</sub> layers are to be received at Kokubunji (35°42'N, 139°29'E), Tokyo, to measure the doppler shifts of scattered waves and the angle of arrival. Also, the long distance transmission experiment of VHF (50 and 100 MHz) radio waves will be conducted to study the characteristics of oblique propagation via E<sub>s</sub> layers and the behavior of the E<sub>s</sub> layers over Japan. Lastly, FM broadcast radio waves forward-scattered via meteor trails and E<sub>s</sub> layers are being measured to investigate spatial and temporal variations of the E<sub>s</sub> layers.

**Observations of Atmospheric Motion and Turbulence by a C-Band Doppler Radar:** Data of the radar reflectivity factor have been accumulated continuously for a few years at Kashima (36°N, 141°E). Using these data the vertical distribution of rain is obtained and the effect

of rain on the vertical diffusion near the tropopause will be estimated. An attempt will be made to detect clear air turbulence.

**Investigation of Disturbances in the Lower Ionosphere by Measuring the Absorption of HF and LF Radio Waves:** The ionospheric absorption of radio waves will be investigated using the oblique propagation data of HF waves, special emphasis being placed upon clarification of the structures and behavior of the D layer at times of SID and winter anomaly days.

**Observation of the Lower Ionosphere Using VLF Radio Waves:** Phases and amplitudes of several LF and VLF radio waves propagating through high, middle and low latitude regions are monitored at Inubo Radio Wave Observatory (36°N, 141°E). These give information on the lower ionosphere and the earth's magnetosphere.

#### (b) Constituents

Ozone is one of the most important constituents in the middle atmosphere. It absorbs the solar ultraviolet radiation and absorbs/emits the infrared radiation to affect the radiative heating and cooling of the atmosphere. The atmospheric ozone controls the penetration of the solar ultraviolet to the earth's surface; the ultraviolet dose is closely related to human health, the crops and the ecosystem.

There are many other minor constituents ( $\text{NO}_x$ ,  $\text{HO}_x$  and  $\text{ClO}_x$  and their parent gases) in the middle atmosphere. They play an important role in the chemical reaction system controlling the ozone content,

The objectives of this particular subject of observations are as follows:

**Observation of the Vertical Distribution of Ozone:** The line profile of infrared absorption by ozone is measured with the aid of high-resolution diode laser heterodyne spectroscopy. This system was recently developed in Japan and gives the vertical distribution of ozone.

Ozone profile observation is also made by the use of ultraviolet laser radar.

**Observation of Ozone-Related Constituents:** In order to understand the structure and behaviour of the ozone layer, measurements of minor constituents in the middle atmosphere are planned in various ways such as infrared and ultraviolet absorption spectroscopy for OH,  $\text{N}_2\text{O}$ , and  $\text{CO}$ , visible absorption spectroscopy for  $\text{NO}_2$ , balloon measurement of NO and ion densities, and so forth. Sampling and *in situ* measurements of

stratospheric minor constituents by means of balloons and aircrafts will be made also.

**Satellite Observation of Atmospheric Constituents:** Remote sensing will be made of the global distribution of ozone, aerosols, water vapour and other minor constituents by the EXOS-C satellite to be launched in 1984.

**Measurement of Atmospheric Temperature:** A ground-based radiometric method at the frequency of the 60 GHz oxygen absorption band will be developed. It is expected that the resolution of atmospheric temperature by this radiometric method will be comparable to that of the balloon-borne *in situ* method.

### (c) Aerosols and Radiation

A few kilometers above the tropopause, a highly structured aerosol layer of several kilometers in thickness exists, called the 'Junge layer'. This is a worldwide stratospheric phenomenon.

An increase of the aerosol content of the stratosphere as a result of natural causes or human activity can lead to a net stratospheric warming and/or a cooling at the earth's surface. It is well established that aerosols put into the stratosphere by explosive volcanic eruptions can significantly affect climatic conditions.

The magnitude of the radiative effect of stratospheric aerosols depends on the altitude at which they are located, their concentration and size distribution and their properties relevant to scattering and absorption of radiation.

To understand the possible role of stratospheric aerosols on radiation, the following integrated aerosol-radiation experiments will be carried out to obtain all their relevant properties as a function of altitude and time.

**Ground-Based Monitoring of Stratospheric Aerosols and Related Gases by Lidar.** Observations of aerosols and ozone in the lower stratosphere and of sodium in the mesosphere are made at several stations in Japan by the use of a lidar system with lasers of various wavelengths (e.g. Nd-YAG lasers, dye lasers and their second harmonics). Characteristics of aerosols such as the size distribution and depolarization rate are measured. Models can then be established for the aerosol density distribution, by which the mechanism of formation and persistence and the roles in the heat budget of the atmosphere are discussed quantitatively. Ozone concentration is measured in parallel and its relation with aerosols is investigated.

*In situ* Observation of Stratospheric Aerosols and Related Trace Gases by Aircraft and Balloons: The following balloon and aircraft experiment will be carried out;

1. Direct sampling of aerosol particles in the stratosphere by a balloon-borne impactor and subsequent physical analysis using an electron microscope. Chemical analysis (using a reagent thin film technique) of individual particles will be carried out to investigate simultaneously the size distribution, concentration and the chemical nature of aerosol particles in the stratosphere.

2. Direct filter sampling of tropospheric and stratospheric  $\text{SO}_2$  and  $\text{NH}_3$  (the presumed atmospheric precursor for the stratospheric aerosol layer) by aircraft. Subsequent chemical analysis (using a chemi-luminescence technique) will be carried out to investigate the source and formation of the stratospheric aerosol layer.

Observation of Radiation by Aircrafts and Balloons: To obtain quantitative informations concerning optical properties of stratospheric aerosols and their effects on the radiation budget of the earth-atmosphere system, the following aircraft and balloon experiment will be performed;

1. Determination of the spectral optical thickness of the stratospheric aerosol layer and the spectral phase function through measurements of the sky brightness (including aureole) with the help of filter photometers and spectral instruments.

2. *In situ* measurements of optical properties of stratospheric aerosols by a high-precision polar nephelometer and an optical aerosol counter.

3. Measurements of spectral downward and upward fluxes of solar radiation and infrared radiation at various levels in the stratosphere as well as the radiation measurements at the surface. Determination of the radiative flux divergences and net radiation in different atmospheric layers.

4. Calculations of all the radiation characteristics of the atmosphere for its known states with the help of precise transfer theory, and comparison of the results of calculation with the observed values.

Laboratory Experiment on Aerosol Formation by UV Radiation: In laboratory experiment, it is found that aerosol particles are produced by UV radiation (2000 Å ~ 3000Å) in various kinds of gaseous organic molecules; terpene ( $\alpha$ -pinene,  $\beta$ -pinene,...), aromatic compounds (benzene, toluene, chlorobenzene, phenol, naphthalene,...), halo-carbons (freon, carbon tetrachloride,...) etc. During the MAP period, we are

planning to study these aerosol particles. We shall attempt to determine the initial and final products and their formation mechanisms, and the measurement of rate constants and temporal changes in size distribution.

**Ground-based Monitoring of Minor Constituents Using Infrared Millimetric Waves:** A radiometer with a range from millimeter to infrared wave-lengths is planned to be developed, to observe the spectrum of those gases which are associated with aerosol formation. The vertical profile of various minor constituents will be obtained by means of the inversion technique applied to the observed spectrum.

(d) Coordinated Observations in Antarctica

The major objective of the coordinated observations in Antarctica is to obtain a comprehensive, quantitative understanding of the dynamics, structure and minor constituent densities of the middle atmosphere in the polar region in relation to the middle and low altitude ones. In the polar middle atmosphere, some significant phenomena have been observed especially during the winter season, such as the frequent occurrence of the sudden warming in the stratosphere and mesosphere, the maximum transport of minor constituents, and the energy flows down to the middle atmosphere from the lower ionosphere heated by the auroral particle precipitations.

For the detailed study of the physical structure of the polar middle atmosphere and ionosphere, extensive observations comprising ground-based, aircraft, balloon and rocket programs in close correlation with spacecraft missions will be carried out around the Japanese Antarctic station, Syowa, during the Map-period.

It should also be pointed out that the differences in dynamics, mean structure and compositions of atmospheric species between the northern and southern hemispheres are largest in winter in the polar middle atmosphere. The emphasis is therefore placed on the need to make well-coordinated observations in both hemispheres for middle atmosphere research.

**Main Ground-Based Observations:** Lidar observations are planned for the vertical profiles and time variabilities of air molecules and minor constituents, such as aerosols and ozone in the stratosphere and alkali metal atoms and aerosols in the mesosphere and the lower thermosphere. VHF radar observations for the ionospheric irregularities, and spectroscopic observations in the visible and infrared region for the measurements of various atmospheric species, such as  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{O}_3$  and  $\text{NO}_x$ , are also planned.

**Balloon-Experiments:** About 20 balloon flights are foreseen carrying a 30 kg payload to an altitude of 30 km. The foreseen payloads

are devoted to aerosols, atmospheric species, electron and ion densities, electric field and auroral X-ray studies.

**Rocket Experiments:** Twenty rockets are scheduled to make the measurements, of  $O_3$  and  $NO_x$  densities, electron and proton energy spectra, ion compositions and electron density.

**Reception of Polar Orbiting Satellite Data:** The satellite data receiving facilities have been built up at Syowa to obtain physical information from the middle atmosphere, the ionosphere and the magnetosphere. The Japanese polar-orbiting satellite EXOS-C will be launched at the beginning of 1984. The data receptions from EXOS-C are scheduled at Syowa Station during the MAP period.

#### (e) Data Analysis and Numerical Modelling

One of the most important projects of MAP should be to make the best use of observational data for the full understanding of the nature of the middle atmosphere on a global scale.

It can be expected that a great deal of observational data on various aspects of the middle atmosphere would be obtained during the period of MAP from the many observation programs proposed by each country including the Japanese National Projects mentioned earlier. In this regard, there is a need for the establishment of systematic methods of data analysis as well as the acquisition and archiving of MAP data.

In addition, it should be emphasized that the numerical modelling of the middle atmosphere would be a powerful tool giving a deeper insight into the mechanism of physical processes in the middle atmosphere.

For these purposes, four research programs have been planned as follows:

**Analysis of Global Structure and Circulation of the Middle Atmosphere Based on Satellite Observations:** The main subjects of this program are; zonal mean structures of temperature and wind and their seasonal variations, planetary wave propagation related to sudden warmings, equatorial waves in connection with the semiannual oscillation, global ozone distribution and dynamical transport of ozone. Presently available satellite data for this program are mainly those obtained by Nimbus 5 and 6 and Tiros N. Measurements from Nimbus 7 satellite are now being processed and are expected to be available after 1981. Therefore, joint work is planned with the NCAR group in Boulder for the analysis of Nimbus 7 LIMS data and with the Oxford group for Nimbus 7 SAMS data, during the period of MAP. In addition, the use of ground-based measurements of mesospheric winds by high-power radars could conceivably complement the satellite data.

**Coupling of Energy Processes Between the Upper and Lower Atmosphere:** Global data analysis is planned to study the coupling between dynamical processes in the neutral atmosphere and energetics in the ionized atmosphere. Special attention is focused on the relationship between the day-to-day change of geomagnetic Sq fields due to ionospheric wind variations and the vertical energy propagation associated with atmospheric tides and planetary waves. It is also intended to build up long-term statistics of climatic change in relation to the variation of solar activity and geomagnetic field.

**Numerical Modelling of the Middle Atmosphere:** For the understanding of the detailed mechanism of physical processes such as the dynamics, radiation, photochemistry and their mutual interactions, the following model studies are planned in this project.

1. Three-dimensional, time-dependent global circulation model including dynamical-radiative-photochemical processes for the stratosphere, mesosphere and lower thermosphere.
2. Rather simple mechanistic models to investigate individual processes such as the wave-zonal flow interaction and radiative balance for O<sub>3</sub>, H<sub>2</sub>O and CO<sub>2</sub>.

As for the general circulation model, co-operative works with the U.S. groups as GFDL and NCAR GCM groups are planned.

**Establishment of a MAP Data Bank in Japan:** National data stations for MAP will be established and consolidated at three institutes in Japan to assemble primary data not only from Japanese observatories but also from all over the world. The main purpose of this data bank is to supply research scientists with processed data suitable for individual subjects, as a counterpart to World Data Centers. There is a need for the provision of some new facilities and systems for the compilation of large amounts of MAP data.

**Comprehensive Analysis of Ionospheric D Region Disturbances:** Analysis based on simultaneous and global observations of disturbance phenomena which occur mainly in the D region, such as sudden ionospheric disturbances and ionospheric winter anomaly effects will advance our understanding of the D region.

**ROUTINE METEOROLOGICAL OBSERVATIONS DURING THE MAP PERIOD BY JAPAN  
METEOROLOGICAL AGENCY**

**(a) Rawinsonde Observations with Balloons**

Routine upper-air observations (including wind obs.) will be continued at 18 stations (see Table 1) at 00 and 12 GMT every day.

TABLE 1

STATION	Station List			ELEVATION ABOVE M.S.L.
	II iii	LAT. (N)	LONG. (E)	
Wakkanai	47 401	45°25'	141°41'	10.9 m
Sapporo <sup>2,3</sup>	47 412	43 03	141 20	18.6
Nemuro	47 420	43 20	145 35	26.2
Akita	47 582	39 43	140 06	10.0
Sendai	47 590	38 16	140 54	39.4
Wajima	47 600	37 23	136 54	6.3
Tateno <sup>2,3</sup>	47 646	36 03	140 08	30.5
Hachijojima/Omura	47 678	33 07	139 47	153.4
Yonago	47 744	35 26	133 21	7.8
Shionomisaki	47 778	33 27	135 46	69.0
Fukuoka	47 807	33 35	130 23	14.2
Kagoshima/Yoshino <sup>2,3</sup>	47 827	31 38	130 36	282.6
Naze/Funchatoge	47 909	28 23	129 33	295.0
Ishigakijima	47 918	24 20	124 10	6.8
Naha/Kagamizu <sup>2</sup>	47 936	26 12	127 40	29.1
Minamidaitojima	47 945	25 50	131 14	14.7
Chichijima	47 971	27 05	142 11	4.1
Minamitorishima	47 991	24 18	153 58	9.0
Ryori <sup>1</sup>	47 513	39 02	141 50	265.0

Note: The above stations except Ryori are for rawinsonde obs.;  
 The '1' shows a station for met. rocket obs. only;  
 The '2' shows stations for ozone obs. with Dobson, additionally;  
 The '3' shows stations for ozonesonde obs. additionally.

The instrument for these routine observations is a new type rawinsonde, RS8-80, which has been developed recently and will be in operational use from March 1981, in place of the old so called 'code sending' type, RS II-56T.

The new type rawinsonde is a variable audio-frequency type which modulates a fixed radio-frequency. The audio-frequency is controlled by electric resistances of the temperature, humidity and pressure sensors. The main characteristics are in Table 2.

#### (b) Meteorological Rocket Observations

Wind and temperature observations in the stratosphere and lower mesosphere will be made with the meteorological rocket, MT-135P, at the Meteorological Rocket Observation Station at Ryori (see Table 1), every Wednesday as a rule.

#### (c) Ozone Observation

Atmospheric ozone observations with the Dobson spectrophotometer will be continued at 4 stations every day, and vertical sounding with the ozonesonde, KC-79, will be made at 3 stations (see Table 1) once or twice per month.

### EXOS-C SCIENTIFIC OBSERVATIONS

#### (a) General Description of the Satellite EXOS-C

EXOS-C is the ninth scientific spacecraft of ISAS. The purpose of its observations is (1) remote sounding of minor constituents in the middle atmosphere, and (2) investigation of the wave-particle interactions in the ionospheric plasma over the Brazilian geomagnetic anomaly and the auroral zone.

launch date: February, 1984

Launch site: Kagoshima Space Center, Uchinoura, Japan

Launch vehicle: M-3S Rocket

Weight: 200 kg

Planned Orbit

Periapsis/Apoapsis: 300 km/1000 km

Inclination: 65°

Period: 100 min

Data recorder

Memory: 20 M bits

Recording speed: 8k bits/s and 2 k bits/s

Playback speed: 32.8 k bits/s

Links to/from the ground

Ground stations: Uchinoura, Japan, and Syowa in Antarctica

Down link: 136 MHz (50 mW), 400 MHz (0.1 W), and S band (0.1 W)

TABLE 2

## Main Characteristics of the Rawinsonde

<u>PARAMETER</u>	<u>SENSOR</u>	<u>RANGE</u>
Temperature	Thermistor	+40 to -85°C
Humidity	Carbon hygrometer	0-100% RH
Pressure	Aneroid, of constant elastic alloy, with resistor contacts	1045-5 mb
Carrier freq.	1680 MHz	
Audio-freq.	0-2000 Hz	
Battery	20 V, 150 mA, water-activated	
Weight	About 650 g including battery	

Uf link: 148 MHz (1 kW), and S band (10 kW)

(b) Mesospheric Ozone

Investigators: T. Makino, H. Yamamoto, and H. Sekiguchi, Physics Department, Rikkyo University.

Objective: This experiment is to measure the ozone concentration in the mesosphere (approximate altitude range: 50-90 km) by observing the 1.27  $\mu\text{m}$  day airglow emission of the molecular oxygen excited through the ozone photodissociation.

Method and Accuracies: A limb scanning photometer is used to measure the altitude distribution of the 1.27  $\mu\text{m}$  airglow emission at various local times. The optical system is shown in Figure 1. The first mirror (M1) is controlled to move every 2° step with a reference signal from the CO<sub>2</sub> 15  $\mu\text{m}$  radiation, which can be measured with the fourth mirror (M4) as a part of the incoming radiation. The main influx is focussed by an optical lens (L1; 5 cm  $\phi$ , f=5 cm) after passing through an interference filter (F1;  $\lambda_0=1.268 \mu\text{m}$ ,  $\Delta\lambda=240 \text{ \AA}$ ).

To detect the 1.27  $\mu\text{m}$  radiation, a 4x5 array PbS detector with a size each of 0.1x0.1 mm<sup>2</sup> is mounted on the focal plane of the lens L1. A detector array (D2) which consists of 4 thermistor bolometers with a size each of 0.1x0.1 mm<sup>2</sup> is used to detect the 15  $\mu\text{m}$  radiation with the same spatial resolution as D1. A Ge lens (L2; 2cm  $\phi$ , f=5 cm) and an interference filter (F2;  $\lambda_0=15 \mu\text{m}$ ,  $\Delta\lambda=2 \mu\text{m}$ ) are used for the latter radiation. Both lenses L1 and L2 are specially coated to reduce the surface reflection. Tuning forks chop the incoming radiations at a rate of 190 Hz for the 1.27  $\mu\text{m}$  radiation and of 21 Hz for the 15  $\mu\text{m}$ .

The height resolution for this limb observation is about 5 km. The ozone profile will be obtained between the altitudes 50 and 85 km with sufficient accuracy. The upper altitude should be limited by the detector noise, whereas the lower one should be limited by the predominance of the solar resonance fluorescence for the 1.27  $\mu\text{m}$  excitation.

(c) Stratospheric Ozone

Investigators: T. Ogawa, K. Suzuki and N. Iwagami, Geophysics Research Laboratory, University of Tokyo.

Objective: The objective of this experiment is to measure the backscattered ultraviolet radiance (BUV) from the terrestrial atmosphere. The spectral intensities in the wavelength regime 2500  $\text{Å}$  ~ 3500  $\text{Å}$  are measured by a spectrometer. The global distribution of the ozone density in the stratosphere and the mesosphere will be deduced.

Method and Accuracies: This particular instrument consists of a

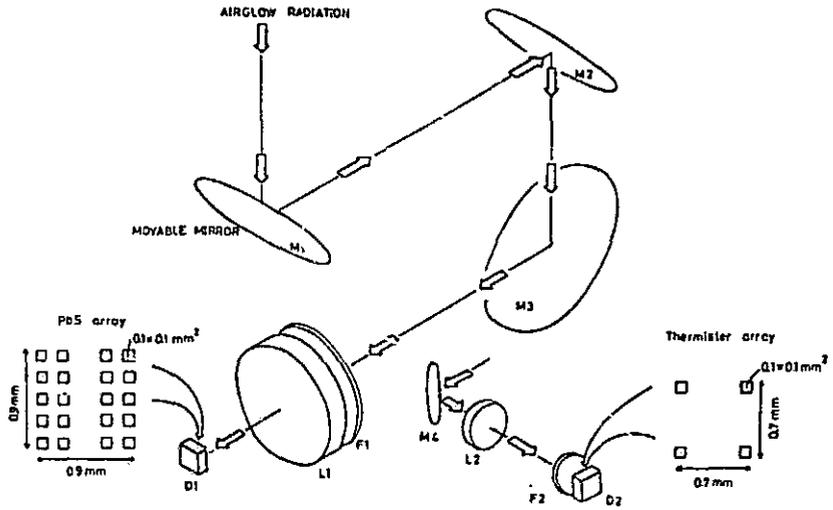


Figure 1

spectrometer and a narrowband filter photometer whose optical axes are in the same direction (see Figure 2).

The spectrometer has a holographic concave grating with a linear dispersion of 80 Å/mm. A broad UV band-pass filter is inserted in front of the entrance slit to reject the stray light in the visible wavelength region. A solar-blind photomultiplier with a CsTe photocathode is used as a detector. The field of view is  $10^\circ \times 15^\circ$ .

The filter photometer consists of an interference filter for 4050 Å with a passband of 30 Å and a photodiode tube. It has a  $10^\circ$  circular field of view.

A Hg discharge lamp installed in the spectrometer to calibrate the detector sensitivity and the wavelength accuracy of the spectrometer.

The wavelength scanning is performed by rotating the grating in the fixed range every 2 sec. 256 data are sampled to measure the spectral intensity with a resolution of 5 Å, and after 12 bits digitization they are stored in the buffer memory. The photometer data are sampled every 125 m sec. The spectrometer and the photometer data are transmitted within 8 sec in the high transmitting bit rate and within 32 sec in the low.

The spacial resolution of the spectrometer will be approximately 250 km at the apoapsis and 80 km at the periapsis. In the normal operation the optical axis will be oriented toward the anti-solar direction.

#### (d) Stratospheric Aerosol and Ozone

Investigators: M. Takagi and Y. Kondo, Research Institute of Atmospherics, Nagoya University.

Objective: Measurement of the global distributions of aerosol content, its size parameter and ozone concentration in the stratosphere with a height resolution less than 1 km.

Method: The density of aerosol, its size distribution and ozone concentration are estimated from the limb absorption of solar radiation at 500, 600 ( $O_3$  Chappuis band), 700 and 1000 nm, when the sun is rising or setting. With reference to the solar intensity as observed at the small solar zenith angle, the optical depths are determined as the function of the tangent height of the solar ray path. The vertical distributions of extinction coefficients for aerosol and ozone are obtained by the inversion technique. Size parameter is given by estimating the contributions of Rayleigh scattering and ozone absorption and by subtracting them from measured total optical depths.

Instrumental: To attain the high resolution, the system is

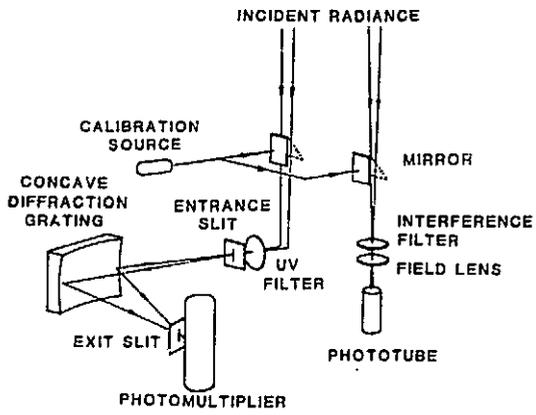


Figure 2

composed of lenses of 100 mm focal length, interference filters for the selection of the wavelengths and CCD area image sensors. The diameter of the solar image at the focal plane is about 0.9 mm. As the size of one element of the CCD area image sensor is  $36 \times 24 \mu\text{m}$ , the solar image is divided into 26 (horizontal)  $\times$  39 (vertical) sections. The time required to obtain one solar image is less than 60 m sec. The solar images at respective wavelengths are recorded in every 3 sec. The payload weight is 3.3 kg, and the power required is 4.5 W. Accuracies are shown in Table 3.

#### (e) Stratospheric Minor Constituents

Investigators: Y. Nakamura, A. Matsuzaki, and T. Itoh, Institute of Space and Astronautical Science.

Objective: This experiment is to measure the seasonal variations of the global distribution of carbon dioxide, methane, nitrous oxide, ozone, and water vapor in the stratosphere and mesosphere by observing the infrared absorption spectra.

Method and Accuracies: This infrared absorption spectra will be observed for the atmospheric occultation of the solar radiation. The solar infrared is introduced into the monochromator by lens systems with a view angle of  $3^\circ$ . The focal length and aperture of the monochromator are 100 mm and F/3.5, respectively. The spectral regions observed are 2.7-3.4  $\mu\text{m}$ , 3.8-6.3  $\mu\text{m}$ , and 7.8-11  $\mu\text{m}$ , and the average resolutions are 0.77  $\text{cm}^{-1}$ , 5.2  $\text{cm}^{-1}$ , and 4  $\text{cm}^{-1}$ , respectively.

These three spectra in the different wavelength regions are measured simultaneously within 500 m sec, but it takes 2 sec to process these spectral data on board. This means that several revolutions of the satellite are necessary to obtain the altitude distributions of the stratospheric molecules with an altitude resolution of 2-4 km.

#### (f) Planetary Plasma Sounder

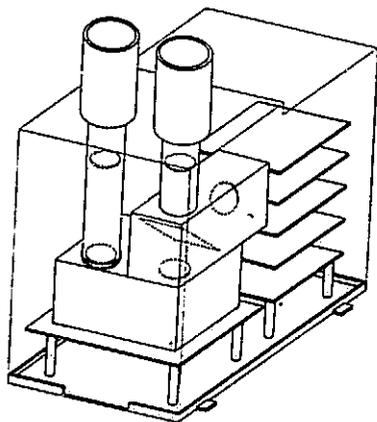
Investigators: H. Oya, A. Morioka, H. Miyaoka and T. Obara, Geophysical Institute, Tohoku University.

Objectives: The main objective is the measure the ionospheric electron density profiles in the polar region and the region of the South Atlantic geomagnetic anomaly where the enhanced particle precipitation is expected, in the altitude range from the F2 peak level to 800 km. The plasma waves due to the plasma turbulence associated with the precipitating particles can be observed by the passive observation. The radio waves emanated from the celestial bodies such as the sun, the earth and planets in the radio frequency (RF) range from 200 kHz to 3 MHz is also expected to be observed by means of the passive observation.

TABLE 3  
Accuracies of Aerosol and Ozone Measurements

<u>PARAMETER</u>	<u>HEIGHT RANGE</u>	<u>ACCURACY</u>
Aerosol	10-25 km 25 km	20% 50%
Aerosol size parameter		50%
Ozone	10-20 km 20 km	20-50% 5-10%

The vertical resolution will be 1 km or better



**Methods and Accuracies:** Plasma sounder (active experiment) - An RF sounder was designed to transmit the frequencies from 100 kHz to 10 MHz. The sounding pulse with a power of 300 watt is fed on a 40 m dipole antenna. The transmitted RF pulse has a width of 100 sec and a repetition interval changeable from 3.3 to 13.2 msec depending on the frequency band. The ionospheric echo of the transmitted signal is received by the sweeping frequency analyzer at a rate from 16 to 64 sec per sweep, either with the narrow (3 kHz) bandwidth or wide (30 kHz) one. The vertical profile of the electron density can be obtained with a height resolution of 10 km.

When the sounding pulse is applied, the stimulated plasma waves can be also measured in the frequency range from 100 kHz to 10 MHz. The *in-situ* plasma parameters such as the electron density, magnetic field intensity and the temperature can be deduced with an accuracy of 0.8% by applying the frequency sweep system which consists of a quartz-controlled PLL frequency synthesizer.

**Natural plasma wave receiver (passive experiment)** - The naturally generated plasma waves and radio waves are planned to be observed in the passive experiment, with the aid of the sweeping frequency analyzer used for the plasma sounder. The receiver works as a frequency analyzer for the frequency range from 100 kHz to 10 MHz. Dynamic spectra for the planetary and interplanetary radio waves can be obtained with a high resolution. The radiometer also measures the absolute value of the energy flux and polarization of the waves at five fixed frequencies.

The very low frequency (VLF) wave will be also analyzed by the on-board spectrum analyzer that has a fast switching period of 125 msec for 64 frequency steps in the range from 200 Hz to 30kHz.

#### (g) Power Line Radiation

**Investigators:** T. Yoshino and I. Tomizawa, University of Electro-Communications.

**Objective:** The objective of this experiment is a global monitoring of the magnetic field intensity at 50 Hz and 60 Hz, and the electric field intensity at their harmonic frequencies below 4 kHz. These electromagnetic waves are radiated from the power line networks, high power generators, and other electric power apparatus on the ground.

**Method and Accuracies:** The magnetic field intensity is detected by a cored loop antenna which is installed together with a preamplifier outside the satellite body. The fundamental frequencies of the world-wide power line system are observed at 50 Hz and 60 Hz through a narrow band filter of the 1 Hz bandwidth with reference to a 55 Hz band as the background level. The receiver gain can be selected with three 20 dB steps. The highest gain can measure the magnetic field intensity approximately from  $0.1 \text{ pT}/\sqrt{\text{Hz}}$  to  $10 \text{ pT}/\sqrt{\text{Hz}}$ .

The power line harmonics between 500 Hz and 4 kHz can be analyzed with a resolution of 20 Hz with the aid of the 64-channel spectrum analyzer of the plasma sounder.

Instrumental characteristics are shown in Table 4.

#### (h) Electron Density

Investigators: T. Takahashi and H. Oya, Geophysical Institute, Tohoku University; and Y. Watanabe, Institute of Space and Astronautical Science.

Objective: The instrument is designed for the *in-situ* measurement of the ionospheric electron density within an error of  $\pm 3\%$ . The sheath capacity is also measured to provide the information on the plasma temperature. The charge-up effects due to the particle precipitation can also be deduced from the capacitance measurement. This particular instrument may survey the plasma environment in the ionosphere on the global scale, with special attention to the ionospheric phenomena associated with South Atlantic geomagnetic anomaly and to the auroral ionosphere.

Method and Accuracies: The equivalent capacitance of a cylindrical probe immersed in the ionospheric plasma changes with the applied signal frequency. The electron density can be deduced by detecting the upper hybrid resonance frequency at which the equivalent capacitance takes its minimum value. Since the effective capacitance in a low frequency range well below the gyro-frequency depends on the sheath thickness, the capacitance observed may give the information on the electron temperature and the probe potential due to charging-up effects of the probe.

A block diagram of this particular instrument is given in Figure 3. Two small cylindrical probes with a length of about 450 mm and a diameter of 20 mm are put orthogonally on the edge of the solar paddles. The two probes are planned to be switched alternatively in every 8 sec to observe out of the wake of the moving space vehicle. The frequency of the search signal for the impedance measurement is changeable by 512 steps from 0.1 MHz to 10 MHz.

The accuracy of the electron density measurement is restricted by the frequency resolution of the search signal. The error is about  $\pm 2\%$  for a number density of  $3 \times 10^4$  electrons/cm<sup>3</sup>. The probe capacitance can be measured within an error of  $\pm 0.05$  pF. The time resolutions of the density measurement are 2 sec and 8 sec, corresponding to the approximate spatial resolutions of 16 km and 64 km, respectively.

#### (i) Electron Temperature

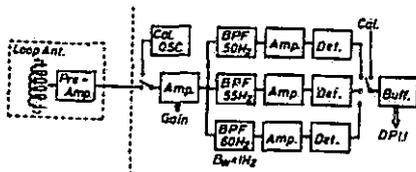
Investigators: K. Hirao and K. Oyama, Institute of Space and

TABLE 4

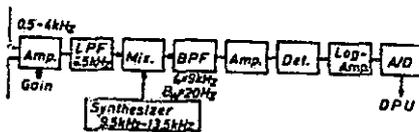
## Power Line Radiation

## Instrumental Characteristics

	<u>FUNDAMENTAL FREQUENCIES</u>	<u>HARMONIC FREQUENCIES</u>
Observed Field	Magnetic field	Electric field
Frequency	50/60 Hz	500 Hz-4 kHz
Bandwidth	1 Hz	20 Hz
Sensitivity Range	0.1 pT/ $\sqrt{\text{Hz}}$ -1 nT/ $\sqrt{\text{Hz}}$	0.1 V/m/ $\sqrt{\text{Hz}}$ -1 mV/m/ $\sqrt{\text{Hz}}$
Sampling Rate	2 sec/cycle	16 sec/sweep



Receiver for the fundamental frequency



Receiver for the harmonic frequency

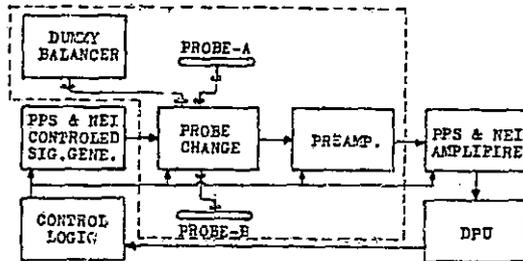


Figure 3

Astronautical Science; and F. Yasuhara, Chukyo University.

**Objective:** The objective of this experiment is to measure the electron temperature at all heights and latitudes where the satellite exists. Main interest may be extended to several special phenomena such as the South Atlantic anomaly, the midlatitude trough and the plasma bubbles of the equatorial ionosphere.

**Method and Accuracies:** Electron temperature is obtained by detecting the floating potential shifts of the electrode for the sinusoidal waves applied. The instrument basically consists of a sinusoidal wave oscillator, a dc amplifier with high input impedance and an interface unit for command control and data telemetry (as shown in Figure 4). Amplitude of the HF signal (30 kHz) is variable stepwise from 0.5 V to 3 V in 2 sec to check the deviation from the Maxwellian distribution for the electron energy. Since four sensors are mounted at the edges of four solar paddles, at least one of the four sensors is outside of the satellite wake. The best data is therefore selected from four sensor outputs.

$T_{\perp}$  and  $T_{\parallel}$  can be measured when two of four sensors become perpendicular and parallel to the geomagnetic field depending on the satellite attitude and location. This instrument is also designed to measure the satellite potential which might be changed by particle precipitation and photo emission. The electron temperature ranging from 300°K to 4000°K can be measured with an accuracy of  $\pm 50$  K in the ambient plasma density of  $10^4 - 10^6$  el/cm<sup>3</sup>.

#### (j) High Energy Particles

**Investigators:** T. Doke and J. Kikuchi, Waseda University; M. Tsukuda, A. Nakamoto and H. Murakami, Rikkyo University; and K. Nagata, Tamagawa University.

**Objective:** The objective of this particular observation is to measure the energy spectra and flux of electrons, protons and alpha-particles with energies higher than 50 keV in the region of the South Atlantic geomagnetic anomaly and in the auroral zone. The isotopic ratio of hydrogen <sup>2</sup>H/<sup>1</sup>H and helium <sup>3</sup>He/<sup>4</sup>He will be measured also to clarify the origin of energetic particles.

**Instrumental:** The sensors (shown in the figure) consist of five silicon detectors, two ΔE detectors, two E detectors and an anticoincidence detector. The characteristics of the detectors are shown in Table 5. The geometrical factor of the sensor is 0.14 cm<sup>2</sup>.str. Two identical sensors are mounted 90° apart in the look direction: one looks at the anti-solar direction, and the other perpendicular to the solar direction.

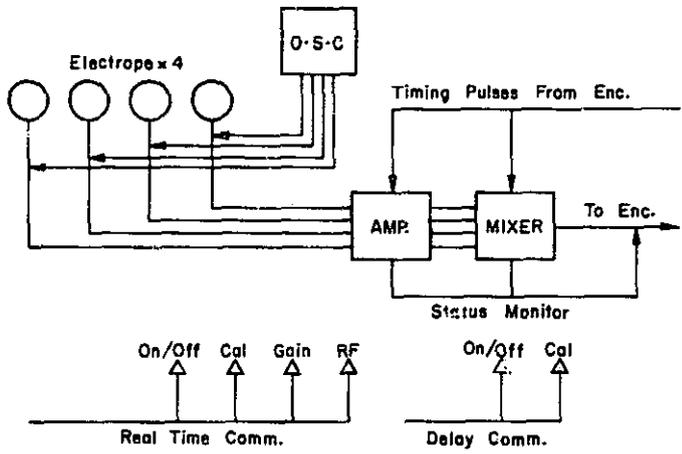


Figure 4

TABLE 5

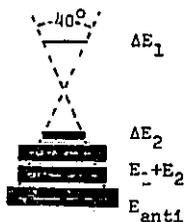
## High Energy Particle Measurements

## Measured Parameters

Energy range, electron+proton	0.05-0.18 MeV
electron	0.19-3.2
proton+helium	0.18-3.2
proton	3.2-37
helium	13-150
Energy resolution	25 keV
Angular resolution	20°
Geometrical factor	0.14 cm <sup>2</sup> ·str

## Detector Characteristics

Detector	Diameter	Thickness
$\Delta E_1$	10 mm	0.1 mm
$\Delta E_2$	10	1
$E_1 + E_2$	20	3+3
$E_{anti}$	25	3



Setup of the sensors.

Discrimination of electrons is made with a threshold method, Particles producing energy loss lower than 140 keV in the  $\Delta E_1$  detector are electrons. Protons in the energy 0.19-13 MeV and helium nuclei in the 13-50 MeV are identified by a combination of the  $\Delta E_1$  and  $\Delta E_2$  detectors, and protons in 13-37 MeV and helium nuclei in 50-150 MeV are identified by a combination of the  $\Delta E_2$  and  $E_1+E_2$  detectors.

Measured parameters are shown in Table 5.

(k) Low Energy Particles

Investigators: T. Mukai, H. Kubo, T. Itoh and K. Hirao, Institute of Space and Astronautical Science and N. Kaya and H. Matsumoto, Kobe University.

Objective: The objective of this experiment is to study the energy spectra of auroral particles, the secondary electrons produced by precipitating particles, the photoelectrons escaping from the topside ionosphere, and the low energy particles in the region of the South Atlantic geomagnetic anomaly.

Method and Accuracies: The instrument will measure electron fluxes in the energy range 4 eV-16 keV, and ion fluxes in the energy range 200 eV-16 keV using the following 3 analyzers:

1. Hemispherical electrostatic analyzer

Species	electrons
Energy range	4 eV-300 eV
$\Delta E/E$	6%
Geometrical factor	$8 \times 10^{-4} \text{cm}^2 \text{str}$
Direction of view	parallel to the satellite main axis
Field of view	$6.8^\circ$ cone

2. Quadrispherical electrostatic analyzer

Species	electrons
Energy range	200 eV-16 keV
$\Delta E/E$	16%
Geometrical factor	$6.25 \times 10^{-4} \text{cm}^2 \text{str}$
Direction of view	5 directions in a plane including the satellite main axis
Field of view	$10^\circ \times 10^\circ$

3. Hemispherical electrostatic analyzer

Species	ions
Energy range	200 eV-16 keV
$\Delta E/E$	5%

Geometrical factor	$5.4 \times 10^{-3} \text{ cm}^2 \text{ str}$
Direction of view	perpendicular to the satellite main axis
Field of view	$5^\circ \times 30^\circ$

## MIDDLE AND UPPER ATMOSPHERE RADAR (MUR)

### (a) Scientific Requirements

The principal requirement of the MU radar is its capability to investigate atmospheric dynamics, especially in microscale and mesoscale processes, occurring in the middle and upper atmospheres. A three-dimensional wind field, including a small but important vertical component, is continuously observed both in time and in space with good temporal and spatial resolution. Fast and continuous beam steerability is needed for determining fine spatial structures of the fast dynamic processes. Appropriate binary phase coding is preferred for attaining a good range resolution within the limited average transmit power.

Also, the MU radar is expected to be employed in various sophisticated experiments, such as interferometry and monopulse (or simultaneous lobing) experiments using two or more simultaneous beams. It is also envisaged that a small portion of the antenna array can be excited to observe meteor trails as tracers of nighttime mesospheric winds.

Moreover, polarization properties of radio wave scattering which may give an important clue as to the scattering mechanism are investigated. Hence linear as well as circular polarizations can be generated as desired.

Finally, it is necessary to process a large amount of received data with sufficient speed. A programmable array processor is more susceptible to the aforementioned various sophisticated observational setups than the special-purpose hardware.

### (b) General Design

The MU radar is a pulse-modulated monostatic Doppler radar system similar to the Jicamarca (Peru), SOUSY (Germany), Poker Flat (Alaska), Summit (Colorado), and Platteville (Colorado) radars. The MU radar works at a frequency of the lower VHF range, near 46.5 MHz, with a bandwidth of about 1 MHz. The bandwidth is limited by government frequency allocation restrictions in Japan.

The basic parameters of the MU radar are listed in Table 6 and the general concept of the configuration is given by the block diagram in Figure 5.

TABLE 6

## Mu Radar Design Specifications

## SPECIFICATIONS

Radar system	monostatic pulse radar; active phased array system
Operational frequency	46.5 MHz
Transmitter	
peak power	1 MW min
average power	50 kW min (duty ratio of 5% min)
pulse length	2-200 $\mu$ s (variable)
pulse repetition freq.	2.5 kHz min for pulse length of 2 $\mu$ s (smaller for longer pulses)
Antenna	
polarizations	linear and circular
aperture	circle of about 100 m in diameter
beam width	3.6° (full antenna)
Receiver	
dynamic range	70 dB min
IF bandwidth	1 MHz maximum
Master oscillator	rubidium vapor

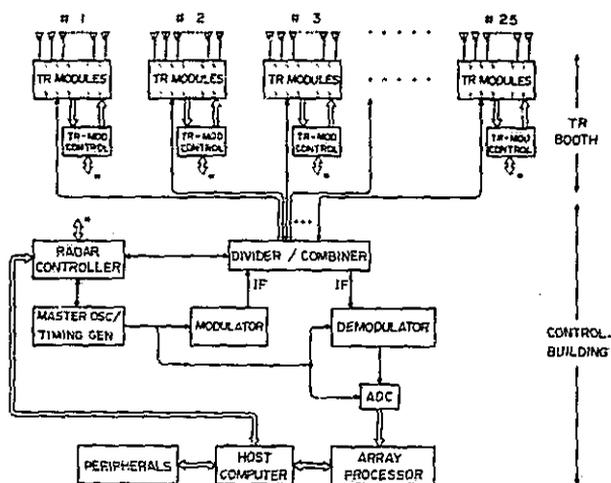


Figure 5

Block diagram of the MU radar. Asterisks show that the radar controller and the TR module controllers are connected. Each array element is provided with an independent TR module consisting of a high-power amplifier, low-noise preamplifier, etc. TR modules in each subsystem are controlled by a TR module controller. Sets of TR modules and TR module controller are housed in six booths built in the antenna site. Monitor and control of the overall radar operation, modulation and demodulation, and data processing are performed in the control building.

A marked feature of this system is that each element of the phased array is activated by its own power amplifier. The peak output power of each amplifier is envisaged to be more than 2.5 kW, and it is supposed that more than 400 of these amplifiers are coherently driven to attain a total peak power of more than 1 MW.

Each element of the phased array is also provided with a receiver preamplifier, so that both the up-convert from and the down-convert to the intermediate frequency (IF) can be done near each element. Both the power amplifier and the preamplifier are mounted on a transmitter-receiver (TR) module located in booths in the array and connected to each element via a measured coaxial cable.

The whole system is grouped into 25 subsystems that can be independently activated in order to generate several separate beams. The TR modules are housed in six booths built within the array site; there are about four subsystems in each booth.

The pulse modulation and demodulation and the data processing are done in the control building. A microcomputer network monitors and controls the antennas and the TR modules. The transfer of the IF and control signals between the TR booths and the control building is done via multicore coaxial cables of equal length.

The following advantages of this system expected to fulfill the scientific requirements are worth mentioning:

1. A phase shift is obtainable at a low power level by variable phase shifters controlled by electronic means. This enables fast and continuous scanning of the antenna.
2. The system can be divided into many subsystems, and it is possible to generate simultaneously the desired number of independent beams. This capability allows for various sophisticated experiments to be performed.
3. Two-way losses produced in the feeding network of a passive phased array are not important.
4. A particular aperture distribution of excitation may be more readily obtained, since the amplitude and phase of each element of the array can be, in principle, individually controlled. This makes it theoretically possible to achieve an antenna with extremely low side lobes.

The MU radar system will be placed adjacent to the meteor radar system of Kyoto University in a national forest, Shigaraki, Shiga (34°N, 136°E). The construction is scheduled to start in 1981. In the first 2 years the radar system with the full aperture will be completed with a

peak output power of about several tens of kilowatts. The power will be increased up to more than 1 MW in the following 2 years. The directivity of the antenna will routinely be checked by a monitoring receiver (MUM) on board Japanese satellite EXOS-C after the completion of the system.

It is expected that the MU radar will play an important role in the middle atmosphere program (MAP) between 1982 and 1985 in the Asian sector, where there are no such facilities. One of the strong technical advantages of the MU radar is that it will be possible to realize almost any desired scale of similar system in the 50-MHz range by changing the number of the TR modules which may be standardized.

Figure 6 shows an artist view of the radar.

#### A SPECIAL PROJECT FOR THE ANTARCTIC MIDDLE ATMOSPHERE

The Draft Minutes of the MAP Steering Committee Meeting held at Urbana, Illinois, from 27 July to 2 August 1980 carries the following report: "The Committee agreed that the Japanese special project for the Antarctic could become a part of MAP if organized on an international scale. It was suggested that the Japanese invite other countries to participate. These other countries will need a sufficiently detailed description of the project, so that they can see what form their cooperation can take. Dr. Takeo Hirasawa of the Polar Research Institute is the coordinator and would become the international coordinator if the project becomes an official MAP project. This question can be decided at the 1981 MAP Assembly". The present report has been prepared on the basis of the above report by Dr. E. R. Dyer, Jr., the former Secretary of SCOSTEP.

It is our desire to invite, in particular, those countries which maintain observatories in the northern and southern polar regions. We would like to suggest the setting up of an organization of the participants to discuss, plan and coordinate the programs of various experiments relative to the polar middle atmosphere.

#### (a) Introduction

The Special Committee of Solar Terrestrial Physics, Japan, has recommended the coordinated observations of the middle atmosphere in Antarctica should be carried out as one of the major projects of the Japanese national Middle Atmosphere Program (MAP). In order to make comprehensive observations of the polar middle atmosphere over the wide Antarctic region, the observations should be carried out in cooperation with the other countries which participate in the Antarctic Research Expedition. This document describes the scientific objectives of polar middle atmosphere research in Antarctica and the Japanese observations which will be performed around the Japanese Antarctic station, Syowa.

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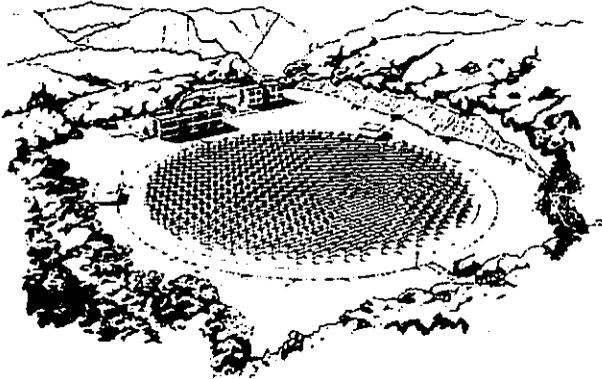


Figure 6 MUR at Shigaraki.

This is to provide MAP-participating countries with a detailed description of the scientific project so that they can consider their positive cooperation towards the better accomplishment of the MAP enterprise. It is hoped to establish the project as an international cooperative effort involving many countries also interested in these objectives.

(b) Scientific Aims of the Project

**Dynamics, Structure, and Atmospheric Composition of the Middle Atmosphere in Antarctica:** The dynamics, structure, atmospheric composition and aerosol abundance of the middle atmosphere in Antarctica are different from those in the middle and low latitude regions because of differences in the geographic, geophysical and biochemical situations; namely, the influence of the dominant particle precipitation on the chemical and dynamical processes within the polar middle atmosphere; the cooling of the atmosphere by the ice covering the Antarctic continent; the difference in the effective intensity of the solar ultra-violet radiation; and the difference in the biochemical environment from which the minor constituents in the atmosphere originate. The present data of the Antarctic middle atmosphere are scarce, so it is important to collect quantities in the middle atmosphere over a wide area in Antarctica. Based on these data, it is possible to obtain a comprehensive understanding of the actual conditions of the Antarctic middle atmosphere in relation to middle and low latitudes.

We therefore propose intensive coordinated observations in Antarctica of the following items temporarily and spatially;

1. The mean distribution of temperature, pressure and density and its seasonal evolution; and the influence of radiation and motion on the distribution of these quantities.
2. Composition of minor constituents and excited species, and their vertical profiles and time variabilities.
3. Role of the ozonosphere and quasi-recurrent features of sudden warming.

**Particle Precipitation and Interaction of the Middle Atmosphere with the Lower Ionosphere:** In the polar region, of particular interest is the dominant particle precipitation from the magnetosphere into the upper atmosphere. The particle fluxes exert an influence on the chemical and dynamical processes in the polar middle atmosphere, namely, joule heating in the lower ionosphere by the precipitating particles; propagation of kinetic and electromagnetic energy down to the middle atmosphere and its influence on the structures and motions of the middle atmosphere; particle fluxes from the magnetosphere and their chemical and dynamical effects on the composition of the middle atmosphere.

Therefore, in order to make clear the physical process of the effect of the precipitating particles on the polar middle atmosphere, coordinated GBR (ground-based, balloon and rocket) observations should be carried out to measure the distributions of  $O_3$ ,  $NO_x$ , ion and electron compositions, X ray input and precipitating particle flux.

**Atmospheric Pollution:** As the biological and chemical activities in Antarctica are very low because of its severe natural environment, it is reasonable to consider that most of the minor constituents (of biological or chemical origin) in the Antarctic middle atmosphere have originated in the middle and low latitude regions where these activities are very high. Based on the data of the stable minor constituents obtained in Antarctica in relation to those in the middle and low latitude regions, it is possible to discuss the diffusion on a large scale of the middle atmosphere toward the polar region from the lower latitudes. Furthermore, because Antarctica is the farthest from the middle and low latitude regions in the northern hemisphere where atmospheric pollution is most dominant, the Antarctic region is the most suitable place for monitoring the global diffusion of the atmospheric pollution.

We therefore propose routine-based observations of the minor constituents in the middle atmosphere, such as  $CO_2$ ,  $NO_x$ ,  $CO$ ,  $CH_4$ ,  $O_3$  and  $SO_2$ .

**Difference Between the Northern and Southern Polar Middle Atmosphere:** Although both the Arctic and the Antarctic are located in the polar regions, their geographical and biochemical environments are very different from each other. It has been pointed out that the difference between the Arctic and the Antarctic regions is largest in the winter of both hemispheres in so far as the average structure dynamics, constitution and aerosol content in the middle atmosphere are concerned.

In order to compare the dynamics, structure and composition in both hemispheres, the emphasis should be placed on making co-ordinated GBR observations in both hemispheres.

(c) Japanese Polar Middle Atmosphere and Ionosphere Research Activities Planned for 1982 to 1985 (MAP Period)

Careful planning should be done to insure well-organized ground-based, aircraft, balloon and rocket programs, in close correlation with spacecraft missions. Extensive observations will be carried out at the Japanese Antarctic station, Syowa ( $69^{\circ}00'S$ ,  $39^{\circ}35'E$ ; geomagnetic lat.  $-70.4^{\circ}$ , long.  $79.4^{\circ}$ ). The outline of the development of our programs is given below.

**Ground-Based Observations:** Lidar observations for vertical profiles and time variabilities of air molecules and minor constituents,

such as aerosols and ozone in the stratosphere and alkali metal atoms and aerosols in the mesosphere and the lower thermosphere.

Spectroscopic observations in the visible and infrared region for the measurement of various atmospheric species, such as  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ,  $\text{CO}$ ,  $\text{O}_3$  and  $\text{NO}_x$ .

VHF radar observations for the electron density and electric field irregularities in the lower ionosphere.

Observations of particle precipitation; all sky camera (35 mm; every 10 sec); auroral zenith photometers for rapid variations (4278 Å); multicolor geomagnetic meridian scanning photometer (5577 Å, HB); high sensitive TV camera with filters (5577 Å, 6300 Å); vertical incidence ionosonde; riometer (20, 30, 50, 70 MHz).

Observations of electro-magnetic waves; narrow band intensity recorder (0.75, 2, 5, 8, 12, 25, 75, 150 kHz), ELF hiss recorder (0.2-2 kHz); chorus recorder (50 Hz-4 kHz); fluxgate magnetometer; induction magnetometer.

Ballon Experiments: During the MAP period, about 20 balloon flights are foreseen carrying a 30 kg payload to an altitude of 30 km. Their size is 5000-10000 m<sup>3</sup>. The anticipated payloads are devoted to aerosols, atmospheric species, electron and ion densities, electric field and auroral X-rays studies. More than 100 small balloons (about 5 m<sup>3</sup>) will be flown for observations of the ozonosphere.

Sounding Rocket Experiments: Twenty rockets will be used during the MAP period. Rockets of the 17 S310 type (ceiling altitude ~230 km, payload ~40 kg) and 3 S520 type (ceiling altitude ~350 km, payload ~80 kg) are scheduled to make the following measurements:  $\text{O}_3$ ,  $\text{NO}_x$  density, electron density and electron temperature, electron and proton energy spectrum in the 3 energy ranges (1-10 Kev, 3-100 Kev, and 500 Kev), flux of high energy particles ( $E > 30$  Kev), DC electric and magnetic fields, electric and magnetic fields in the frequency range of 0.2-10 kHz, electric fields in the frequency range of 0.1-10 MHz.

Aircraft Measurements: Two airplanes (Pilatus Turbo Porter PC-6 and Cessna 185) are available around Syowa Station to observe contents of minor species, aerosol abundance and solar radiation.

Reception of Polar Orbiting Satellite Data: Satellite data receiving facilities for ISIS-I and II and Tiros have been built up at Syowa to obtain physical information on the middle atmosphere, the ionosphere, and the magnetosphere. The Japanese polar-orbiting satellite EXOS-C will be launched at the beginning of 1984. Data reception from EXOS-C is scheduled to be made for Syowa Station during the MAP period.

Cooperative Balloon Observations in the Northern and Southern Polar Regions: In September 1980, the National Institute of Polar Research, Japan performed balloon flights at SSC Esrange, Sweden, in collaboration with Swedish scientists. Ozone content, X-rays and VLF waves were measured to study the high-latitude (auroral zone) upper-atmospheric phenomena associated with magnetospheric/ionospheric activities. During the MAP period, the balloon observations in the geographic and geomagnetic conjugate area (European region) of Syowa Station, Antarctica, will be continued to investigate the differences of the physical conditions of the polar middle atmosphere between both hemispheres.

Schedule: The ground-based, balloon, aircraft measurements and the reception of satellite data described in this document will start at the beginning of 1982 around Syowa Station in Antarctica. Sounding rocket experiments will be carried out from 1984 to 1986. The coordinated observations in Antarctica will extend over a period of 4 years to obtain sufficient data on the seasonal evolution of the physical and chemical quantities in the polar middle atmosphere.

(d) List of the Principal Investigators

Ground-Based Observation:

	Names	Affiliation
Lidar	Y. Iwasaka	Water Research Institute, Nagoya University, Chikusa-ku, Nagoya, Japan
Spectroscopy	M. Tanaka	Geophysical Institute, Tohoku University, Aramaki Aoba, Sendai, Japan
VHF	R. Fujii	National Institute of Polar Research, Kaga Itabashi-ku, Tokyo, Japan (NIPR)
Auroras	M. Ayukawa	NIPR
Electromagnetic waves	H. Fukunishi	NIPR

Balloon, Rockets, Aircraft and Satellites:

T. Hirasawa NIPR

## MAP-RELATED ACTIVITIES IN NEW ZEALAND

W. J. Baggaley

Department of Physics  
 University of Canterbury  
 Christchurch  
 NEW ZEALAND

Tides, gravity waves and turbulence	Meteor drifts	W. J. Baggaley (Univ. of Canterbury, Christ- church)
	Partial reflection drifts (Christchurch and Antarctica)	G. J. Fraser (Univ. of Canterbury, Christ- church)
	Airglow studies (Louder)	R. S. Unwin (DSIR Physics & Engineering Labs)
Electrodynamics of the middle atmosphere	Al absorption measure- ments (Christchurch and Antarctica)	G. J. Fraser (Univ. of Canterbury, Christ- church)
	Electron density pro- file from polarimeter measurements (Christchurch and Antarctica)	G. J. Fraser (Univ. of Canterbury, Christ- church)
	D-region electron densities from VLF/ELF propagation	R. S. Unwin (DSIR Physics & Engineering Labs)
Stratospheric composition	Optical monitoring of oxides of nitrogen (Louder)	R. S. Unwin (DSIR Physics & Engineering Labs)

## MAP-RELATED ACTIVITIES IN SPAIN

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ROQUETES (TARRAGONA)  
SPAIN

Although the MAP-related activities in Spain are quite limited at this time, the following information on the "El Arenosillo" Atmospheric Sounding Station was furnished by Dr. D. Morena, Atmospheric Sounding Station, Instalaciones de "El Arenosillo", Mazagon (Huelva), Spain.

Situated in southwestern Europe (Huelva-Spain),  $37^{\circ}05' 45''$  N -  $6^{\circ} 44' 30''$  W, 42 meters over MSL altitude and a mild climate (300 days of clear skies) El Arenosillo is an internationally well-known sounding rocket range with 476 rockets launched, of 19 different types. Since its inauguration in October 1966, other scientific activities have systematically developed, related to studies of middle and upper atmosphere parameters. This is a general description:

Vertical Incidence Ionospheric Sounder (model J5W): Supplies information about ionospheric layers E, F1 and F2 through a frequency scan of 0.25 to 20.25 MHz, with programmable scans up to altitudes of 2000 km. The ionograms are filmed through 35 and 16 mm cinematographic cameras, in order to analyse the electron density in these layers. Records are programmable, being performed normally each hour with 1 minute duration.

The measured parameters are sent to WDC A (USA), WDC C1 (U.K.), IEN Galileo Ferraris (Italy) and Observatorio del Ebro (Spain).

Absorption Meter (A3 Method): Supplies information about the integrated value of the electron density in ionospheric D layer.

A transmitter located 424 km from the receiver transmits a fixed frequency of 2.83 MHz, supplying information every 5 minutes.

The measured parameters are sent to WDC A (USA), WDC C1 (U.K.), Siberian Institute IRKUTSK (USSR) and Observatorio del Ebro (Spain).

Dobson Spectrophotometer Number 120: Used to derive the atmospheric ozone total content. Daily records are kept following the international ozone program recommendations.

The measured parameters are sent to WDC (CANADA), Siberian Institute IRKUTSK (USSR) and Environmental Research Laboratories, Boulder (USA).

Electrical Potential Meter at 1 m Altitude Over the Ground: This equipment is being installed with normal operation expected at the end of 1981.

Hourly records will be kept to be sent to the appropriate World Data Centers. These records are open to the International Scientific Community.

## MAP-RELATED RESEARCH IN SWEDEN

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SWEDEN

Research in the Middle Atmosphere in Sweden is carried out by a limited number of scientific groups. The research program is strongly oriented toward scientific problems genuine for the high geographic and geomagnetic latitude of the country. Following a tradition this program is based to a great extent on international cooperation involving both the exchange of scientists, participation of foreign groups in specific Swedish rocket payloads and the organization of coordinated field campaigns for investigating interrelated phenomena. The research program is funded by: Swedish Board for Space Activities (rockets, balloons); and the Science Research Council (all ground-based research). The groups actively engaged in MAP-related research are:

Dept. of Meteorology, University of Stockholm

- Atmospheric optics and spectrophotometry
- Photochemistry and transport of minor gas constituents (odd oxygen, odd nitrogen, odd hydrogen)
- Auroral spectroscopy
- Noctilucent clouds

Uppsala Ionosphere Observatory

- Ion chemistry of the lower ionosphere
- Noctilucent clouds

A national representative has been appointed by the National Committee for Geodesy and Geophysics in 1981. The opportunity to coordinate Swedish research projects with complementary efforts within MAP is being recognized and at least one current investigation (Project Camp) has been considered as a possible MAP project.

The Cold Arctic Mesopause Project (CAMP) is aimed at the exploration of physical and chemical processes related to the cold summertime mesopause and the nature of noctilucent clouds. A coordinated campaign involving both rockets, balloons and ground-based instrumentation is scheduled for the summer of 1982. The coordinator of CAMP is Mr. L. Bjorn, Uppsala Ionosphere Observatory.

A considerable basis of experimental resources exist, including both ground-based instrumentation and recovered sounding rocket payloads as listed on the following page.

### Rocket Payloads

S35 OXYGEN launched 1981 (multi-wavelength photometry of airglow emissions related to the chemistry of oxygen compounds).

S27 TWILIGHT launched 1978 and 1979 (differential-absorption grating polychromator for measuring nitric oxide and other ultraviolet emission features in the day and twilight airglow and auxiliary filter photometers).

Selective Optical Atmospheric Sonde (SOAP) to be launched 1982 (active optical devices for measuring the molecular density and atomic oxygen using RF-excited noble gas lamps, complemented by a pair of photopolarimeters).

### Ground-based Resources

Mobile 1 - Scanning Ebert spectrometer and photometers used in auroral and airglow studies.

Wide Angle Michelson Interferometer (WAMI) - For measuring neutral winds and temperature in the thermosphere in coordination with EISCAT (Kiruna).

List of objectives of the current scientific research:

Spectroscopy and photochemistry of atomic oxygen.

Aeronomy of H<sub>2</sub>O and noctilucent clouds.

Penetration of solar UV radiation into the mesosphere.

Nitric oxide in polar latitudes.

Auroral optical emission features relevant to EISCAT and rocket-borne plasma and particle experiments.

Thermospheric winds and temperature in the auroral zone.

Ion composition of the lower ionosphere.

## MAP-RELATED ACTIVITIES IN TAIWAN

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Taipei, Taiwan  
REPUBLIC OF CHINA

Listing of MAP-related projects proposed for Taiwan follows:

Department of Atmospheric Sciences, National Taiwan University:

1. Measurements of stratospheric conductivities and electric fields.
2. Wave oscillations near the tropopause in subtropical regions.

Department of Atmospheric Physics, National Central University:

1. Thermospheric tides.
2. Characteristics of gravity waves associated with severe weather and ionospheric disturbances.
3. Neutral atmosphere and ionosphere coupling.

Telecommunications Laboratory, Directorate General of Telecommunications

1. Real-time recording of the high-frequency doppler frequency shift at Luning Observatory (25°N, 121°10'E).
2. Micro-barographic recording at Luning Observatory.
3. Observations of D region absorption phenomena by use of riometer at Luning Observatory.
4. Continuous counting of lightning flashes in middle and upper atmosphere.

## U.K. PARTICIPATION IN THE MIDDLE ATMOSPHERE PROGRAMME

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Responsibility for promoting and coordinating MAP activities within the U.K. rests with the British National Committee for Solar-Terrestrial Physics. A survey carried out by this Committee in 1978 revealed that at least twenty separate groups planned to participate in MAP and it is likely that other groups are conducting research relevant to MAP objectives. Following a workshop-type meeting held on 30 June 1980, three general areas of study were identified: Stratospheric composition, mesospheric and lower ionospheric structure and composition, and middle atmosphere dynamics.

As laboratory investigations of chemical reactions and of spectroscopy play an essential role in middle atmosphere studies, a brief review of relevant U.K. laboratory studies is given in the section "Laboratory investigations".

## STRATOSPHERIC COMPOSITION

For field measurements, a variety of techniques and platforms are to be used by groups at the University of Oxford, Meteorological Office, National Physical Laboratory, Atomic Energy Research Establishment (Harwell), and Rutherford and Appleton Laboratories. The interests and aims of the groups appear to be focused on four basic areas:  $\text{NO}_x$  chemistry, stratospheric  $\text{H}_2\text{O}$ , the importance of dynamics in changing the pure-chemistry constituent field, and the processes of exchange (mass, energy and momentum) between the stratosphere and troposphere. Activities are described below in order of decreasing altitude, corresponding to the height levels of the different observational platforms; modelling activities are outlined in Modelling Studies.

## (a) Satellite-Borne Experiments

Remote-sounding measurements from satellites offer the only means of studying the stratosphere on a truly global basis. It can be shown that many of the major unsolved scientific problems require a global-scale measurements of temperature, composition and wind fields in order to achieve a satisfactory understanding of the radiative, chemical and dynamical processes that are occurring. As examples of such problems may be cited: the role of transport in the stratosphere through both mean and eddy motions, the distributions of chemical sources and sinks, and the energy, momentum and mass transfer processes between troposphere

and stratosphere and between stratosphere and mesosphere. Satellite-borne experiments are likely to remain central to the study of the stratosphere in the current decade and U.K. groups will be involved.

At Oxford, the current programme of satellite experiments for atmospheric studies is centred on the SAMS (Stratospheric and Mesospheric Sounder) experiment on Nimbus 7. SAMS, an infra-red limb-sounding spectrometer containing a variety of pressure modulated radiometer (pmr) channels, is designed to investigate stratospheric and mesospheric temperature, composition and, to a limited extent, winds on a global basis. Constituents being measured with SAMS are  $H_2O$ ,  $CH_4$ ,  $N_2O$ , CO and NO. SAMS was preceded by other instruments on earlier satellites in the Nimbus series, all of which successfully made measurements in the middle atmosphere. Analysis of SAMS data (and, it is to be hoped, the continued operation of the SAMS experiment) will continue well into the MAP period.

Plans are well advanced to fly an improved version of SAMS (ISAMS) on the NASA Upper Atmosphere Research Satellite (UARS) in 1987. This instrument (again based on the pmr principle) will measure a wider range of constituents, as well as temperature and winds, with greater accuracy (than SAMS) by virtue of improved detectors. Though somewhat late for the Middle Atmosphere Programme, UARS and ISAMS will make a major contribution to our understanding of the middle atmosphere

Objective analysis of stratospheric temperatures on a global scale is carried out routinely by the Meteorological Office in near real time using data from the stratospheric sounding units on the Tiros N series of operational satellites, received by a direct line from NOAA. It is hoped that this activity will be continued throughout the MAP.

#### (b) Balloon-Borne Experiments

Studies of stratospheric composition with balloon-borne experiments have been carried out by groups at Oxford University, the National Physical Laboratory (NPL), and AERE (Harwell); balloon-borne measurements could be one of the major contributions to the MAP by U.K. scientists.

The power of the balloon technique is that it allows much greater vertical resolution in the stratosphere than do other methods. The vertical structure of the stratosphere on a fine scale of, say, 10 - 100 m is currently of great interest, and may be observable through measurements of temperature,  $H_2O$  and  $O_3$  with good vertical resolution. In addition, balloons permit *in-situ* study of the dominating chemical reactions, often using quite complex and heavy instruments which cannot be easily flown on other vehicles. Balloon-borne experiments can also make a significant impact in the study of tropospheric-stratospheric energy and mass exchange processes, by allowing measurements of vertical

temperature and composition distributions, for example, in regions of mid-latitude tropopause folding.

Further balloon measurements of NO, NO<sub>2</sub> and other species, such as HCl and, possibly, CH<sub>2</sub>O and ClONO<sub>2</sub>, are to be made by the Oxford group using balloon-borne pressure modulator instruments, continuing an extensive and significant series of measurements by this team. The simultaneous measurement of a pair of reactive constituents like NO and NO<sub>2</sub> allows a much more sensitive test of chemistry and of the possible role of transport, than does a measurement of either one alone.

It is expected that the SIBEX (Submillimetre and Infra-red Balloon Experiment) series of experiments by the NPL group will be continued into the MAP period. In SIBEX, two novel spectrometers, one a liquid-nitrogen cooled 8 to 12 m grating spectrometer, the other a 100 to 1000 um very high resolution Michelson interferometer (contributed by the Institute of Research on Electromagnetic Waves, Florence), make emission spectroscopic measurements of such species as H<sub>2</sub>O, O<sub>3</sub>, HNO<sub>3</sub>, CF<sub>2</sub>Cl<sub>2</sub>, CFC<sub>3</sub>, N<sub>2</sub>O, CO, HCl and HF. A current experiment entitled NOBLE (Nitrogen Oxides Balance Experiment) includes an improved version of the NPL cryogenic spectrometer and a set of Oxford pressure modulated radiometers to study the diurnal variations in the densities of the NO<sub>x</sub> family (NO, NO<sub>2</sub>, N<sub>2</sub>O, HNO<sub>3</sub> and N<sub>2</sub>O<sub>5</sub>): the simultaneous and continuous measurement of these constituents has not been achieved previously. This theme of coordinated measurements to attack a specific topic is likely to be continued by these groups.

At AERE (Harwell), studies of stratospheric composition are being made by balloon-borne cryo-capture techniques with subsequent laboratory analysis using gas chromatography and mass spectrometry. This work is being carried out in collaboration with scientists from the Federal Republic of Germany, using balloons flown from the launch centre in southern France.

A Rutherford and Appleton Laboratories group plans the development of balloon-borne microwave heterodyne radiometer systems, initially to make measurements of H<sub>2</sub>O and O<sub>3</sub> at 183 and 184 GHz, but later of other species which are spectrally active in the 100 to 400 GHz range. These planned balloon flights are listed in Table 1.

### (c) Aircraft-Borne Experiments

Aircraft-mounted experiments permit detailed examination of the dynamics, chemistry and radiation fields at selected heights, particularly in and around the tropopause. Plans have been formulated by AERE (Harwell) for sampling measurements during two flights of a Lear Jet during 1981. It is hoped that these measurements will continue into the MAP period.

TABLE 1

U.K. Balloon- and Aircraft-Borne Experiments Pertaining to the  
Middle Atmosphere Programme

<u>GROUP</u>	<u>MISSION</u>	<u>DATE (OF FLIGHT)</u>
(a) Balloons		
Oxford University (with National Physical Laboratory)	NOBLE	spring 1981
Oxford University	pressure modulated radiometer	continuing throughout MAP
National Physical Laboratory (with University of Florence and Oxford University)	SIBEX III	summer 1982
AERE (Harwell)	cryo-capture ex- periment (as part of German balloon flight programme)	1981
Rutherford and Appleton Laboratories	microwave spectro- meter experiment	1983-84
(b) Aircraft		
AERE (Harwell)	air samples (Lear Jet)	1981
Meteorological Office	measurements with gas chromatograph, frost-point hygro- meter, and grab samples	continuing throughout MAP

The Meteorological Office operates a Hercules aircraft which will be used to make tropospheric measurements of minor constituents and trace species which are important to studies of stratospheric composition.

These plans for airborne experiments are shown in Table 1.

(d) Ground-Based Studies

In the U.K., ground-based optical observations of the high atmosphere are frequently limited by cloud. However, such observations clearly have a contribution to make especially since the time resolution possible using a stationary ground-based experiment is virtually limitless. Lidar methods can also yield very good vertical spatial resolution. The Meteorological Office makes ground-based measurements of stratospheric O<sub>3</sub>, as part of the Dobson network, using the scattered skylight technique. This method is capable of a high absolute accuracy (of a few per cent) in the total stratospheric column of O<sub>3</sub>.

(e) Modelling Studies

At Oxford, a two-dimensional model of the stratosphere and mesosphere has been developed, and is continually being improved. Aspects of the general circulation (e.g., mean and eddy fluxes) and a wide range of chemical reactions are included, and the model is refined by comparing it with data acquired from satellite- and balloon-experiments. Extensive modelling in both one-dimension and three-dimensions has been carried out at the Meteorological Office for a number of years, and is expected to continue into the MAP period. A one-dimensional radiative-photochemical model has been used to study the effects of fluorocarbons and of CO<sub>2</sub> on the ozone layer. A three-dimensional general circulation model has been used to examine fluxes of water vapour across the tropopause and to infer a global OH distribution. Objective analysis of stratospheric temperatures from Tiros N satellites is carried out routinely and used in simulation studies with a three-dimensional stratosphere-mesosphere model, particular attention being paid to stratospheric warming effects. The Meteorological Office also plans to participate in the UARS programme in providing a data assimilation scheme for analysis purposes.

An important aim of the U.K. contribution to the MAP will be to ensure the maintenance of a close and continuous interaction between modellers and experimenters, for such a combination of expertise can be expected to yield valuable insights.

## MESOSPHERIC AND LOWER IONOSPHERIC STRUCTURE AND COMPOSITION

*In-situ* observations of the mesosphere and lower ionosphere rely on the use of Petrel rockets. The potential U.K. contribution based on

this vehicle is described in terms of specific scientific projects in Thermal Structure through Neutral Constituents at High Latitudes, while observations with the EISCAT facility are outlined in EISCAT Observations of the Lower Ionosphere.

#### (a) Thermal Structure

*In-situ* observations of temperatures at heights above about 60 km have been carried out at only a few sites and at sparse intervals. These observations, using the grenade-sounding and pitot-static tube techniques, have revealed a number of temperature-structure variations which could not arise from radiative influences alone. At middle and high latitudes, a large seasonal variation is observed near the mesopause, summer temperatures being lower than those in winter by about 20 to 70 K depending on latitude. The thermal balance at these heights is not understood. Large-scale redistribution of heat is likely to be important, infra-red cooling is complicated owing to the absence of local thermodynamic equilibrium, small-scale phenomena through eddy conduction or dissipation may play important roles, and the effect of chemical heating owing to atomic oxygen recombination must be included.

Seasonal variations of temperature are significant in understanding the boundary between the thermosphere and the underlying mesosphere. The mesopause can be of such low temperature during the summer that it forms an efficient cold trap in the vertical transport of water vapour. Furthermore, the inversion above the mesopause must in all seasons impose great stability on that part of the atmosphere. The small-scale vertical structure revealed by *in-situ* measurements provides clear evidence of the presence of atmospheric gravity waves at mesospheric heights. In addition, a knowledge of temperature with a height resolution of about 1 km is required for composition studies, since a correct representation of both the neutral and ion chemistry involved needs to take account of the temperature-dependence of many chemical reactions. From these considerations, it is evident that collaborative investigations of mesospheric or D-region phenomena need to include measurements of the height variation of temperature.

There seems to be no prospect of measuring the small-scale temperature structure of interest with satellite-borne instruments, not even with limb-scanning radiometers. Plans are in hand for deriving temperatures in the mesosphere and lower thermosphere from measurements using two techniques employed on Petrel rockets. Flights using the pitot-static method are being undertaken by the University of Aberdeen, and an approach depending on the different convective heat transfers to two wires, one of which has undergone heat treatment under vacuum, is under development at the University College of Wales, Aberystwyth. Summer and winter rocket-borne temperature measurements at South Uist are planned, probably beginning in July 1982. Comparisons with temperature data derived from simultaneous observations of the mesospheric absorption of

solar Lyman- $\alpha$  in day-time and with the fine structure in electron density distributions are also planned.

Coordinated meteor radar measurements of mesospheric winds are to be arranged and the night-time temperature measurements will be linked with ground-based airglow measurements using the Southampton University television system, the Fabry-Perot interferometer of Ulster College, and the Michelson interferometer of Aberdeen University. In addition, consideration is being given to the possibility of making air-borne optical observations (probably with the Southampton television system) of the mesosphere above South Uist.

#### (b) Height Distribution of Sodium

The characteristics of the mesospheric layer of sodium atoms, and its seasonal and diurnal changes, have been clearly demonstrated by ground-based observations of resonance scattering of tuned laser beams, and of the dayglow. A reduced scale height above the peak, compared with that of the mean atmosphere, is a persistent feature of the distributions. The observed increases in concentrations associated with meteor showers support the idea of a meteor ablation source for the sodium atoms.

The nightglow emission of the ( $^2P-^2S$ ) doublet has revealed the presence of Na( $^2P$ ) atoms in the night sky, while rocket-borne observations have shown that the major emission is from heights near 90 km. Metallic ions have also been observed consistently at D- and E-region heights by rocket-borne mass-spectrometers, the Na $^+$  ions constituting about 10% of the total metallic ion concentration.

The types of processes believed to be operating in the neutral and ion chemistry are illustrated in Figure 1. It has to be acknowledged that, except for reaction 5, the neutral reactions have not been studied in the laboratory and there is some uncertainty about the exothermicity of certain reactions (such as 3 and 6). In model studies, it has been customary to adopt rate coefficients deduced from the analogous hydrogen reactions, yet reaction 1 as well as 2 and 4, might proceed by the 'electron jump' mechanism. On this basis, it is expected that the value of  $k_1$  might be enhanced by a factor of about 25 relative to that based on the analogous hydrogen value, and the adoption of the larger value helps to explain the observed doublet intensity in the nightglow. However, a comparison of *in-situ* measurements of the sodium atoms distribution and doublet emission profile, coupled with a knowledge of O $_3$  concentrations, is needed to make a direct test of the 'electron jump' hypothesis in relation to reaction 1.

Rocket measurements will be relevant to observations of the reduced

scale height on the topside of the sodium distribution. It is believed that ionization processes contribute to the reduction in this scale height and these processes are indicated in Figure 1. The subsequent formation of molecular ions is thought to occur by the oxidation of and clustering to  $\text{Na}^+$  ions, the dissociative recombination of these molecular ions again yielding sodium atoms. Coordinated measurements of positive-ion composition and of sodium atom distribution are required for a detailed study of these neutral atom/ion interchanges.

A study to identify the major photochemical processes determining the night-time height distribution of sodium will involve a coordinated set of rocket-borne experiments. Possible groupings of experiments in individual Petrel rockets are indicated in Table 2.

The measurements of atomic hydrogen and of the height variation of the OH bands should yield information on  $\text{O}_3$  concentrations which will be supplemented by data obtained from satellites.

The delays between the successive launches of the Petrel rockets (at least six in number) will need to be minimized. To choose quiescent periods, use will be made of data from ground-based magnetometers, airglow photometers (observing the mesosphere above South Vist from remote sites and perhaps from an aircraft), and satellite measurements of temperature - if available. A campaign date during equinox months (March - April or September - October) should ensure a low degree of atmospheric variability and a night-time period of reasonable duration over South Vist. Campaigns prior to and following a meteor shower would be desirable. Because of the infrequent occurrence of clear skies above South Vist, no ground-based optical experiments are planned for this site.

### (c) The Oxygen-Hydrogen Atmosphere

The oxygen-hydrogen constituents in the 60 to 100 km height range are of interest because of their involvement in the airglow, the ion chemistry of the lower ionosphere, the thermal balance of this part of the atmosphere, and other aspects of aeronomy. For example, the presence of  $\text{H}_2\text{O}$  is relevant to the formation of water cluster ions,  $\text{H}^+(\text{H}_2\text{O})_n$ , at heights below 85 km, to the quenching of vibrationally excited  $\text{CO}_2$  involved in the radiative loss of energy, and to the formation of noctilucent clouds. Furthermore, for water vapour the major chemical loss at all heights is by photodissociation and, above 75 km, the loss rate greatly exceeds the production rate. The actual height distribution of the molecule above this height then provides an estimate of vertical transport, normally assumed to be by eddy diffusion.

The important production and loss processes, controlling the densities of  $\text{O}(^3\text{P})$ ,  $\text{O}_3$ ,  $\text{H}_2\text{O}$  and constituents arising from the dissociation of these two molecules at mesospheric heights, have been examined in a number of theoretical studies. The proposed rocket cam-

TABLE 2

Petrel Rocket-Borne Experiments for Studies of the  
Night-Time Sodium Layer

<u>EXPERIMENT</u>	<u>GROUP</u>
resonant lamp for measurements of $O(^3P)$ (130.2 - 130.6 nm)	Rutherford and Appleton Laboratories with Univer- sity College of Wales, Aberystwyth
resonant lamps for measurements of $H(121.6 \text{ nm})$ and $Na(589 \text{ nm})^*$	Rutherford and Appleton Laboratories with Univer- sity College of Wales, Aberystwyth
photometers for measurement of $Na(^2P)$ and $(OH)$ nightglow emissions	Queen's University, Belfast
ion mass spectrometer	Max Planck Institute, Heidelberg
pitot-static tube and/or hot wire sensor for measurements of temperature	Aberdeen University and/or University College of Wales, Aberystwyth
Faraday-rotation and Langmuir probe for measurement of electron density distribution	University College of Wales, Aberystwyth

\*Development under consideration

paign is to be directed towards the coordinated measurements of the first and third of these constituents and of the OH vibration-rotation bands; from the OH band data and  $O_3$  concentrations retrieved from satellite observations, information on the H atoms concentration at middle mesospheric heights can be deduced. H, OH, and  $HO_2$  have chemical time constants in the mesosphere which are short in comparison with the mixing time constant  $H_{av}^2/K$ , where  $H_{av}$  represents the scale height of the total atmosphere and  $K$  the eddy diffusion coefficient. These three constituents are, therefore, in chemical equilibrium with one another and, thus, from a knowledge of the H,  $O(^3P)$ ,  $O_2$  and  $O_3$  concentrations, those of OH and  $HO_2$  can be secured. Comparisons will be made between the measured or derived constituent concentrations with those produced by an existing theoretical model, for which the distribution of  $H_2O$  will provide a check on the eddy diffusion coefficient values.

A total of three Petrel flights is envisaged at night-time, the individual measurements being made of the height distributions of  $O(^3P)$  and temperature, of  $H_2O$ , and of the OH bands.

The payload for the OH bands would be furnished by Queen's University, Belfast, while those for the other parameters would be provided as part of the RAL/UCW programme.

#### (d) Neutral Constituents at High Latitudes

Hitherto, relatively little attention has been paid to changes in neutral constituents associated with enhanced particle precipitation at high latitudes. Satellite-borne measurements have indicated enhancements of up to about an order of magnitude in concentrations of NO in the lower thermosphere at latitudes above  $60^\circ$ ; still larger increases have been deduced from rocket-borne observations of ion composition. However, no such large change has been demonstrated by direct rocket-borne observations of NO, except in an early neutral mass spectrometer measurement. These enhancements in NO are believed to result directly from increases in the concentrations of the excited ( $^2D$  or  $^2P$ ) states of atomic nitrogen associated with large particle fluxes. Furthermore, enhancements of NO at stratospheric heights in association with solar particle events have been predicted.

Emission from thermospheric  $O(^1S)$  at high latitudes produces the well-known green auroral line, but a number of excitation mechanisms have been invoked. The direct influence of auroral particles on atomic oxygen concentrations from  $O$  dissociation is expected to be significant only for events persisting for several hours. However, changes in the lower D region arising indirectly from enhancements of certain ions during solar particle events have been predicted theoretically; the increased concentrations of water cluster ions,  $H^+(H_2O)_n$ , are expected to give rise to increased concentrations of OH and  $HO_2$  radicals during their dissociative recombination with electrons. The reactions with

these radicals represent major chemical loss processes for  $O(^3P)$ , and reductions in concentrations of this constituent would therefore be expected. During the solar particle events, and also during conditions of large electron precipitation, the transition heights between water cluster ions  $H^+ \cdot (H_2O)_n$  and  $NO^+$  with  $O_2^+$  observed in summer and winter suggest a seasonal difference in the neutral atmosphere at middle and lower mesospheric heights. Specifically, a difference in the height distribution of  $O(^3P)$  or in temperature seems to occur.

A combination of Petrel rocket payloads directed towards observations of atomic oxygen (RAL) and temperature (UCW or Aberdeen), auroral emissions (Belfast), high-energy electron and protons spectra (RAL) and ion composition (MPI, Heidelberg) will be required during both summer and winter. Complementary measurements of NO would enhance the value of such a cooperative campaign. The measurements will be carried out at either Andoya or Kiruna, possibly as part of a more extensive high-latitude campaign.

#### (e) EISCAT Observations of the Lower Ionosphere

More continuous observations of the disturbed high-latitude E- and D-regions using the EISCAT facility are planned by the University of Lancaster and the Rutherford and Appleton Laboratories. The most direct application of the facility will be to studies of electron density distributions and their relation to the spectra of precipitating energetic particles during both auroral and solar proton events. Both the beam swinging capability of the VHF system and the split-beam arrangements possible with the VHF system will enable observations of the spatial structure of auroral precipitation events. It is expected that the presence of negative ions should be demonstrated, and that the system sensitivities will be sufficient to enable the associated changes of these ions and electrons during twilight periods to be measured and information obtained on electron detachment processes. Observations of the ion line spectra should be capable of yielding information on collision frequencies and neutral temperatures, and perhaps of demonstrating the change in positive-ion species - between water cluster ions and  $O_2^+$  or  $NO^+$  in the middle and lower D region. The temperature measurements in the lower thermosphere will be relevant to studies of thermal balance mentioned in Thermal Structure above.

#### MIDDLE ATMOSPHERE DYNAMICS

The programme planned for studying middle atmosphere dynamics is based primarily on particular scientific projects; since these correspond to different observational techniques (satellite-borne sensors, meteor radar, photometer and rocket experiments for the mesosphere and lower thermosphere, with VHF radar for lower heights), they are described here in that sense.

(a) Satellite-Borne Measurements to Deduce Mean Circulation

It is customary to describe the general circulation by zonally averaged quantities and deviations from them which represent waves or eddies. The zonally averaged motions are primarily driven by the latitudinal gradient of radiative heating and cooling, together with the convergence of eddy heat and momentum fluxes. The north-south pressure gradients set up are balanced by the Coriolis forces, the resulting motion being described as geostrophic. To determine the horizontal pressure gradients and hence the geostrophic winds, a knowledge of the vertical temperature distribution from a standard pressure surface is required. A knowledge of these winds is essential in detailed studies of atmospheric dynamics. In addition, systematic global-scale changes in temperature can be identified as the effects of planetary waves, both internal and external modes being present. Temperature data for the stratosphere and mesosphere are now available for long periods from satellite-borne radiometers. An analysis of such data for periods of about one year is to be conducted at the University of Oxford.

The meridional motions are not in geostrophic equilibrium, but may be derived from considerations of momentum and heat flux balances. The magnitudes are small and this renders their determination by direct measurement difficult. The geostrophic approximation cannot be made at latitudes between about  $20^{\circ}\text{N}$  and  $20^{\circ}\text{S}$  and, furthermore, ageostrophic motions generally play a more important part at greater heights. These considerations indicate the need for direct wind measurements in the middle atmosphere. One method developed at University College, London (UCL) uses a satellite-borne multiple-etalon Fabry Perot interferometer to observe the wind-induced Doppler shifts of scattered sunlight and airglow emissions; discrete  $\text{O}_2$  and  $\text{H}_2\text{O}$  atmospheric lines of sunlight scattered from the atmosphere can be used for measurements up to 60 km, and the 557.7 nm emission of oxygen for those in the upper mesosphere and lower thermosphere. Use of the instrument in the limb-scanning mode should provide measurements with a height resolution of 5 km or better, averaged over a horizontal distance of about 500 km. Test flights of the instrument are being carried out on balloons and its flight on the Shuttle and on UARS is planned by UCL in conjunction with the University of Michigan. The Oxford ISAMS experiment on UARS will also measure wind components by a different technique employing gas correlation spectroscopy.

(b) Meteor Radar Observations of Winds, Waves and Turbulence in the Mesosphere and Lower Thermosphere

The meteor wind radar technique has now reached a level of reliability such that long data series of up to one year can be obtained in semi-automatic systems with good temporal and spatial resolution. The altitude range is from about 75 to 110 km with a height resolution of the order of 1 km. At present, two meteor radar installations exist in

the U.K.: one at Sheffield (53°N) and the other at Stornoway (58°N). Figure 2 shows the sectors covered by these radars with aerial systems directed NW and SW at both locations (the directions can be changed as necessary). Because of the oblique upward propagation of radio waves, meteor trails are observed in areas between 200 and 300 km distant from the radar. Combining data from two separate meteor collecting regions poses no problem provided the horizontal scale sizes of wind systems are large compared with the separation of the regions. This is satisfied in the case of tidal and planetary waves as well as for general background winds, but not in the case of small-scale gravity waves and turbulence.

Current problems in tidal studies concern the presence at the higher altitudes of higher harmonic modes with small vertical wavelength and the non-linear interaction between tides and small-scale gravity waves, the unstable breakdown of tidal modes at the upper levels with the possible production of turbulence, and non-migrating modes. In addition to studies based on U.K. measurements, participation is envisaged in MAP-related cooperative international campaigns, the aims of which include: the delineation of the global morphology of tides, the identification of the role of tides in influencing mean winds and temperatures, and the examination of the effect of the mean wind and temperature on tidal-wave propagation. Such world-wide measurements for extended periods would also be relevant to the observation of planetary waves in the upper parts of the middle atmosphere and, particularly, to the inhibition of their upward propagation in summer owing to easterly winds in the stratosphere. Recent studies of atmospheric free modes, as revealed by quasi-two-day oscillations in the wind at meteor heights observed by the University of Sheffield and in stratospheric temperatures by the University of Oxford, are to continue.

In order to resolve the smaller-scale features corresponding to gravity waves and turbulence, it is proposed to install a third meteor radar at the University of Aberdeen, transmitting in the SW and SE sectors. Figure 2 shows the two common volumes (hatched circles) resulting when simultaneous transmission towards the NW and the NE is made from Sheffield. While one common volume would be sufficient for the resolution of small-scale variations in the wind, the presence of two such volumes represents a particular advantage in that it permits the study of zonally travelling modes across the whole spectrum of atmospheric waves. The use of meteor radar soundings for studies of gravity waves at lower thermospheric heights will be complemented by the corresponding measurements carried out in day-time by VHF radar systems. Programmes of such using the EISCAT facility are planned by the Rutherford and Appleton Laboratories.

(c) VHF Radar Studies of Waves and Turbulence in the Upper Troposphere and Stratosphere

Plans for using the VHF radar component of the EISCAT facility for

studying gravity waves and turbulence in the 15 to 40 km height region have been formulated by the Rutherford and Appleton Laboratories; the lower level of this height range is fixed by equipment limitations and the upper limit by the expected height variation of the turbulence scale sizes. Within the steering limitations of sections of the VHF antenna, associated measurements of vertical and horizontal velocities should be possible. The study of gravity waves envisaged include a comparison of the component motions with the polarization relationship predicted by theory, the relative importance of sources such as penetrative convection during thunderstorms and wind shears, and the propagation of waves across critical layers - in which the horizontal phase velocity of the wave matches that of the mean wind. For studies of waves of very small vertical wavelength and of turbulent layers, a height resolution of 150 m will be required.

The EISCAT facility was designed for ionospheric and magnetospheric studies and is not optimized for these investigations of the neutral atmosphere. As a consequence, and because of the limitations in observing time and the difficulties associated with the use of a remote facility, consideration is being given to the establishment of a SERC VHF facility within the U.K. Such a facility could be applied to problems associated with the interchange between the upper troposphere and lower stratosphere. Coordination of such studies with measurements of the detailed variations of constituents in this height range would be of particular interest.

(d) Other Measurements Using Ground-Based Photometer and Radio Techniques, and Rocket-Borne Experiments

A number of additional techniques is to be applied to the observations of winds, waves and turbulence at mesospheric and lower thermospheric heights, namely:

1. Imaging photometry of moving patterns in OH and Na airglow emissions (University of Southampton);
2. Airglow Doppler photometers in Scandinavia, supplemented by observations of chemical releases from rockets (UCL) and in Antarctica and N. Ireland (Ulster College, Jordanstown);
3. Ionospheric sounder measurements of ionization drifts in the E region (British Antarctic Survey);
4. Airglow and noctilucent cloud observations (University of Aberdeen).

Some of these observations will be carried out in conjunction with those outlined in Satellite-Borne Measurements to Deduce Mean Circulation; Meteor Radar Observations of Winds, Waves and Turbulence in the

Mesosphere and Lower Thermosphere; and VHF Radar Studies of Waves and Turbulence in the Upper Troposphere and Stratosphere, above or in support of the rocket measurements of the mesosphere outlined in MESOSPHERIC AND LOWER IONOSPHERIC STRUCTURE AND COMPOSITION.

(e) Dynamical Modelling

It is expected that the data acquired on, for example, atmospheric turbulence will result in the extension of dynamical-model studies in groups such as those at Imperial College, London, and the University of Cambridge. Improved information on middle atmosphere structure will also be applied in the ray-tracing studies (at University College of Wales, Aberystwyth) carried out to identify tropospheric sources of travelling wave disturbances in the F region.

LABORATORY INVESTIGATIONS

Several U.K. groups are active in laboratory photochemical studies, including those at the Universities of Cambridge, Oxford and Birmingham, at Queen Mary College, London, University College of Wales, Aberystwyth, and AERE (Harwell). At Cambridge, particular attention will be paid to reactions which determine the mixing ratios in the lower stratosphere of the nitrogen oxides, and of hydroxyl and hydroperoxyl radicals (using laser magnetic resonance spectroscopy and diode laser spectroscopy), studies of atom-radical reactions and of the reactions of metastable chlorine atoms with stable molecules, of chemiluminescent processes including the excitation of  $O(^1S)$  atoms by  $O(^3P)$  recombination, and of sodium atom reactions. At Oxford, work will include studies of the reaction of  $O(^1D)$  with fluorocarbons, reactions of the  $NO_3$  radical, cross-radical reactions such as  $ClO + HO_2$ , as well as sodium atom reactions. At Queen Mary College, considerable work has already been carried out on halogen reactions, and is to be continued. At AERE (Harwell), a range of reactions involved in stratospheric chemistry is being investigated. Ion-neutral reaction measurements of relevance to the whole range of the middle atmosphere form part of the programmes at Birmingham and Aberystwyth.

Laboratory spectroscopy aimed at providing data on line positions, strengths and half-widths has not been hitherto a major subject of study within the U.K. However, a Rutherford and Appleton Laboratories group is undertaking a programme of studies of stratospheric molecules, beginning with  $H_2O$  and  $O_3$ . A low-temperature long-path cell is being constructed, and a very high resolution ( $0.004 \text{ cm}^{-1}$ ) Michelson interferometer will be used to make measurements on individual lines across complete spectral bands. The emphasis of this programme will be on determining the temperature dependence of half-widths, and on studies of line-shape. At the National Physical Laboratory, spectra of gases of tropospheric and stratospheric interest are being measured using a tunable diode laser spectrometer; a similar programme is being established

at the University of Hull. The use of such data for predicting the detailed form of the atmospheric spectrum has been studied at University College, London, while, at Oxford, laboratory studies of the transmittances of infra-red-active atmospheric gases are being made in support of the pmr satellite experiments.

#### SUMMARY

Analysis of the SAMS data from Nimbus 7 will continue into the MAP period.

It is expected that an improved version of SAMS (ISAMS) will be flown on UARS.

It is expected that analysis of Tiros N temperature data will continue throughout the MAP period.

Observations of stratospheric composition will be made using balloon-borne pressure modulated radiometers, heterodyne radiometers, spectrometers and cryo-capture techniques.

It is expected that aircraft-borne instruments will be used to make tropospheric composition measurements.

Ground-based measurements of stratospheric composition using lidar and other optical techniques will continue throughout the MAP period.

Extensive modelling studies of middle atmosphere composition and dynamics will be undertaken.

Measurements of the detailed mesospheric temperature structure will be carried out using two rocket-borne instruments and will be coordinated with relevant ground-based observations.

Coordinated rocket observations of composition and nightglow emissions will be directed towards a study of processes controlling the mesospheric sodium layer.

Coordinated rocket observations of composition, temperature and nightglow emissions will be carried out in an investigation of the oxygen-hydrogen constituents in the 60-100 km height range.

Coordinated rocket observations will be carried out to investigate the changes in neutral constituents in the mesosphere associated with particle precipitation at high latitudes.

The EISCAT facility will be used in studies of the electron density distribution, on composition and collision frequencies in the lower ionosphere.

The large-scale circulation of the middle atmosphere will be investigated using various satellite techniques.

Meteor radar observations will be made of winds, waves and turbulence in the mesosphere and lower thermosphere; complementary ground-based techniques will also be used.

Consideration is being given to the establishment of a VHF radar for studies of waves and turbulence in the upper troposphere and stratosphere.

Laboratory investigations relevant to middle atmosphere processes will be undertaken by several groups.

## MAP-RELATED ACTIVITIES IN THE UNITED STATES

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### U.S. CONTRIBUTIONS TO THE MIDDLE ATMOSPHERE PROGRAM - A PROGRESS REPORT

The counterpart of SCOSTEP within the U.S. is the Committee on Solar-Terrestrial Research, a committee of the National Academy of Sciences' Geophysics Research Board. CSTR has appointed a Panel on the Middle Atmosphere Program to examine U.S. contributions to MAP and to direct new MAP-associated projects.

In 1980, the Panel published a document entitled "The Middle Atmosphere Program: Prospects for U.S. Participation", which outlined a number of scientific areas in which new initiatives were desirable, and called for the establishment of a coordinating office within the Government to handle MAP affairs. An Interagency Coordinating Office has now been set up under the direction of Dr. N. Sundararaman of the Federal Aviation Administration, and is currently assessing the size and nature of U.S. involvement in middle-atmosphere research.

As a step toward designing specific programs, a questionnaire was sent to all U.S. individuals on the MAP mailing list asking for an indication of willingness to participate in planning and carrying out projects within each of the areas of the MAP Initiatives described in the document. About 120 replies to the questionnaire were received, and many of the respondents described their current interests and plans, as well as indicating the areas in which they were willing to become involved. The result has been a useful overall picture of present and future middle-atmosphere research in the U.S. Some of the results are described in the following pages.

#### (a) Institutions with Active Interest in Middle Atmosphere Research

Aerospace Corporation  
Air Force Geophysics Laboratory  
Arecibo Observatory (Cornell University)  
Bell Labs  
Boston College  
Brookhaven National Laboratory  
California Institute of Technology  
Case Western Reserve University  
Colorado State University  
Control Data Corporation  
Department of Energy

Drexel University  
Dupont Co.  
Environmental Protection Agency  
Georgia Institute of Technology  
Harvard University  
Institute for Defense Analyses  
Illinois Institute Of Technology Research Institute  
Jackson State University  
Jet Propulsion Laboratory  
Lamont-Doherty Geological Observatory  
Lawrence Livermore Laboratory  
Los Alamos Scientific Laboratory  
Massachusetts Institute Of Technology  
McDonnell-Douglas Corporation  
National Aeronautics & Space Administration/Ames Research Center  
National Aeronautics & Space Administration/Goddard Institute for Space  
Studies  
National Aeronautics & Space Administration/Goddard Space Flight Center  
National Aeronautics & Space Administration/Johnson Space Center  
National Aeronautics & Space Administration/Langley Research Center  
National Center for Atmospheric Research  
National Oceanic & Atmospheric Administration/Aeronomy Laboratory  
National Oceanic & Atmospheric Administration/Geophysical Fluid Dynamics  
Laboratory  
National Oceanic & Atmospheric Administration/National Earth Satellite  
Service  
National Oceanic & Atmospheric Administration/Space Environment Labora-  
tory  
National Oceanic & Atmospheric Administration/National Meteorological  
Center  
National Science Foundation  
Naval Research Laboratory  
New York State Department of Health  
Ohio State University  
Pennsylvania State University  
Perkin-Elmer Corporation  
Photometrics, Inc.  
Princeton University  
R & D Associates, Inc.  
Sandia Corporation  
San Diego State University  
Smithsonian Astrophysical Observatory  
Southwest Research Center  
SRI International  
Stanford University  
University of Alabama at Huntsville  
University of Alaska  
University of California at Los Angeles  
University of Colorado

University of Denver  
 University of Illinois  
 University of Indiana  
 University of Maryland  
 University of Michigan  
 University of Pittsburgh  
 University of Tennessee  
 University of Texas at Dallas  
 University of Utah  
 University of Washington  
 University of Wyoming  
 US Geological Survey  
 Utah State University  
 White Sands Missile Range (US Army Atmospheric Research Laboratory)

- (b) Responses to Questionnaire Sent to U.S. Middle-Atmosphere Community Asking for Interest in Helping Develop MAP Initiatives Identified in "The Middle Atmosphere Program: Prospects for U.S. Participation" (National Academy of Sciences, 1980).

	INITIATIVE	NO. OF RESPONSES
MI-15	Theoretical Studies and Modeling	37
MI- 2	Stratospheric Composition	31
MI- 8	Troposphere-Stratosphere Coupling	30
MI- 3	Mesospheric Composition	27
MI- 5	Planetary Waves	24
MI- 7	Tides, Gravity Waves, and Turbulence	23
MI-12	Effects of Energetic Particles and X-Rays	22
MI-10	Aerosol Formation and Properties	21
MI-14	Electrodynamics	20
MI- 1	Ozone Climatology	19
MI- 9	The Middle Atmosphere and Climate	19
MI-16	Balloon and Rocket Facilities	18
MI-13	Ion Composition	15
MI- 4	Basic Climatology	14
MI-17	Data Archiving, Dissemination, and Exchange	12
MI-11	Solar Radiation	10
MI- 6	Equatorial Waves	6

- (c) Spacecraft Experiments Launched and Still Operating

NIMBUS-7: Launched 1978. Experiments still in operation include:

- SBUV/TOMS - Providing ozone profiles above the maximum, total ozone column, solar UV irradiance.  
 SAM II - Measures aerosol extinction at satellite sunrise and sunset in polar regions.

SAGE: (Stratospheric Gas and Aerosols Experiment)

Launched 1979. Measures solar occultation in IR, giving profiles of aerosols, O<sub>3</sub>, NO<sub>2</sub>.  
4-channel photometer, with wide geographical coverage.

SAGE II scheduled for launch 1984 with Earth Radiation Budget Satellite.

Solar Mesosphere Explorer (SME): Launch September 1981.

Solar UV Spectrometer: Measures solar irradiance in regions responsible for O<sub>2</sub> dissociation ( $\lambda < 0.242 \mu\text{m}$ ), O<sub>3</sub> dissociation ( $\lambda < 0.31 \mu\text{m}$ ), Lyman- $\alpha$ .

Ozone UV Spectrometer: Limb-scan measurements of combined Rayleigh scattering and O<sub>3</sub> absorption in Hartley-band region centered at 0.255  $\mu\text{m}$ .

Infrared Radiometer: Limb-scan measurements of thermal emission from O<sub>3</sub>, H<sub>2</sub>O, CO<sub>2</sub>. Latter will measure temperature profile.

Near Infrared Spectrometer: Limb-scan measurements of 1.27  $\mu\text{m}$  emission from O<sub>2</sub>(<sup>1</sup> $\Delta$ ) and OH emissions.

NO Spectrometer: Measures NO<sub>2</sub> in 20-40 km height region from absorption of 0.439  $\mu\text{m}$  band.

Solar-Proton Alarm: Orbit: circular sun-synchronous (600 km altitude, 97.8° inclination). Dayside 3 pm, nightside 3 am.

(d) Experiments Scheduled for Launch in MAP Time Frame

HALOE (Halogen Occultation Experiment): Launch with ERBS late 1984.  
Also on Spacelab II with ATMOS.

Infrared solar occultation to measure profiles of temperature, O<sub>3</sub>, HCl, HF, CH<sub>4</sub>, H<sub>2</sub>O, NO, CF<sub>2</sub>Cl<sub>2</sub> in stratosphere, plus O<sub>3</sub> and CH<sub>4</sub> in lower mesosphere.

Uses 2.5 - 12  $\mu\text{m}$  wavelength band.

Will extend Nimbus-7 measurements of constituents important in NO<sub>x</sub> chemistry to cover those involved in ClO<sub>x</sub> chemistry.

ATMOS (Atmospheric Trace Molecule Spectroscopy): On Spacelab III (and possibly pre-Spacelab I).

High-resolution Michelson interferometer covering 2-16  $\mu\text{m}$  wave-

length band. Occultation experiment measuring most of the above gases plus such ultra-minor ones as  $\text{ClO}$ ,  $\text{ClONO}_2$ ,  $\text{CH}_3\text{Cl}$ ,  $\text{COF}_2$ ,  $\text{HBr}$ ,  $\text{HCHO}$ , and  $\text{OCS}$ .

Height range tropopause to 120 km.

(e) NOAA Operational Satellite Series

SPACECRAFT	NOMINAL LAUNCH
NOAA-C	April 1981
-D	Sept. 1981
-E	April 1983
-F	Sept. 1983
-G	April 1985
-H	Sept. 1985
-I	April 1987
-J	Sept. 1987

TIROS Operational Vertical Sounder on all satellites. Measures temperatures up to 1 mb pressure level. Consists of:

Stratospheric sounding unit (on NOAA-C, -E, -G, -I)

Microwave sounding unit (NOAA-C-J)

High-resolution infrared sounder (NOAA-C-J)

Operational version of SBUV instrument will be on NOAA-F, G, and possibly H-J. Will provide ozone total columns and vertical profiles, as well as solar spectral irradiance in 160-400 nm wavelength band.

(f) Balloon and Rocket Programs

MEASUREMENTS	INSTITUTION	INVESTIGATOR(S)
Stratospheric composition	NCAR	R. Cicerone
Stratospheric composition	NOAA	D. Albritton
Spectroscopic measurements	U. of Denver	D. Murcray
	Cal. Tech.	C. B. Farmer
Aerosols and ozone	U. of Wyoming	D. Hoffmann
Electrical parameters	Aerospace Corp.	R. Holzworth
Mesospheric composition	U. of Michigan	J. Horvath
		W. Sharp
		D. Stedman
		E. Stone
Energetic particles, ion composition, electron densities	NASA/GSFC	R. Goldberg
	U. of Illinois	L. Smith

## (g) Ground-Based Programs

TECHNIQUE	LOCATION	INVESTIGATOR
MST and ST radars	Sunset, Colo.	T. VanZandt
	Poker Flat, Alaska Arecibo, P.R.	B. Balsley R. Woodman J. Mathews
Meteor-wind radars	Urbana, Ill.	S. Bowhill
	Atlanta, Ga.	B. Balsley S. Avery R. Roper
Airglow interferometry	Boulder, Colo. Pittsburgh, Pa.	G. Hernandez M. Biondi
Lidar	Urbana, Ill.	C. Sechrist, Jr.

## (h) Outstanding Middle Atmosphere Problems

## Short-Period Dynamics:

The MST radar technique is well suited for studies of such short-period dynamical effects as tides, gravity waves, and turbulence. An important objective of such studies would be to determine the extent to which these short-period effects feed into the longer-period phenomena, such as planetary waves and the general circulation of the middle atmosphere.

## Troposphere-Stratosphere Interchange:

There is a need for coordinated international programs aimed at a detailed study of the mechanisms of troposphere-stratosphere coupling at all latitudes. The use of aircraft will be especially valuable.

## Thermosphere-Mesosphere Interchange:

There is a need for programs aimed at determining the importance of the thermosphere (and magnetosphere) as a source of energy and material for the middle atmosphere. Related to this is a need for exploration of the mesopause region.

To what extent do existing or planned programs help up explore these topics? Can we design reasonable additional programs that will help?

## SOVIET NATIONAL MIDDLE ATMOSPHERE PROGRAM

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## INTRODUCTION

In the last decade it became clear that many important problems of atmospheric physics are connected with the altitude region 15-120 km, often called the "middle atmosphere", the knowledge about which, however, is rather sparse. Recently, partly due to achievements in remote sensing, it became possible to study processes in the middle atmosphere on a global scale with appropriate vertical and horizontal resolution.

Such problems as solar-atmosphere relations, interaction of atmosphere layers and others, require joint and coordinated efforts of specialists engaged in various fields of atmospheric physics and the ionosphere. In its turn, the global character of the research implies international cooperation.

The Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) proposed an international research program of the middle atmosphere (MAP). This program was approved and sponsored by COSPAR, IAGA, IAMAP, URSI, WMO and other international scientific organizations.

## PRINCIPAL OBJECTIVES OF MAP

1. Determination of the structure and chemical composition of the atmosphere within the stratosphere and mesosphere layers.
2. Analysis of the interaction between solar radiation and atmosphere at middle atmosphere heights.
3. Analysis of all-scale motions in the middle atmosphere including the interaction with the troposphere and magnetosphere.

The global scale of the program implies a great amount of measurements, processing and monitoring. Data handling would be entrusted to the World Data Centers.

Results of MAP research, no doubt, would be of fundamental scientific significance; they also would help to solve practical problems concerning the aerodynamics of launch facilities, atmosphere pollution, climate and weather forecasting, forecasting of short-wave

radio conditions and so on.

To organize and coordinate the MAP research within the USSR, a National Commission on Soviet participation in MAP was established at the Soviet Geophysical Committee. Dr. A. D. Danilov is its Chairman, Dr. E. S. Kazimirovsky its Vice-Chairman, and Dr. V. V. Viskov its Scientific Secretary.

The National Commission prepared the National MAP Program described below with due regard for the specific features of the research related to the MAP field and carried out in various institutions of the Soviet Academy of Sciences, Academies of Sciences of Union's Republics, National Committee on Hydrometeorology and Control of the Environments, Ministry of Higher and Secondary Special Education

The National Program also considers location of ground-based and satellite stations for remote sensing of the atmosphere, existence in the USSR of the prospective experimental techniques, and achievements in the research of thermodynamical parameters of the upper atmosphere, ozone, noctilucent clouds, ionosphere drifts, radio meteors, wave-like processes, etc.

The Soviet National program comprises seven subprojects:

1. Lower thermosphere: structure and dynamics (E. S. Kazimirovsky, Coordinator).
2. High-latitude energetic sources and their effect on the structure and dynamics of the upper atmosphere under conditions of the polar night (A. D. Danilov, Coordinator).
3. Climate of the stratosphere and mesosphere: effect of various energetic sources on its formation (A. I. Ivanovskii, Coordinator).
4. Winter variability of the lower ionosphere (A. D. Danilov, Coordinator).
5. Noctilucent clouds: climatology, dynamics, nature and genesis (Ch. I. Willmann, Coordinator).
6. Wave processes and structure and dynamics of the stratosphere and mesosphere (A. I. Ivanovskii, Coordinator).
7. Dynamics of the ozone layer (A. H. Khrgian, Coordinator).

Each subproject is headed by coordinators -- members of the National Commission on MAP.

## SUBPROJECT: STRUCTURE AND DYNAMICS OF THE LOWER THERMOSPHERE

## (a) Timing of the Research

The timing of the research is 1979-1985.

## (b) Analysed Altitude

The analysed altitude is 80-120 km (mesopause, meteor zone, D, E, and E<sub>s</sub> ionospheric layers).

## (c) The Problem

It is commonly known that transport plays an essential role in any physical phenomenon. In lower thermospheric physics the problem of the dynamical regime is treated as the most significant.

Theoretically, the motion of an incompletely ionized plasma at the analysed altitudes can be described by a system of momentum transport equations for three components: ions, electrons and neutrals. Solution of these equations requires parameters of the medium: temperature, density, electron concentrations, and minor constituents. It is also necessary to regard motions related to the relatively lower atmospheric layers. In recent years it became clear that the basic energy controlling the type of the general atmospheric circulation at the ionospheric layers is the energy of the solar wind. It is injected into the atmosphere by particles precipitated to the auroral zone and by means of the Joule dissipation of the ionospheric current systems generated by interaction between the solar wind and the geomagnetic field.

Our knowledge about these processes is rather deficient and, therefore, we lack a satisfactory three-dimensional model for lower thermospheric dynamics.

## (d) Scientific Objectives

1. Determination of climate elements in the lower thermosphere of middle and high latitudes in the Eastern Hemisphere (temperature, density, wind, electron concentration).
2. Analysis of the time spectrum and spatial wave structure of the lower thermosphere (planetary, tidal, gravity waves and turbulence); and relation of the waves in the thermosphere with the processes in the lower layers.
3. Analysis of physical mechanisms for the formation of the structure and dynamics of the lower thermosphere and numerical simulations of these processes.

4. Relation between dynamic properties of the lower thermosphere and solar and geomagnetic activity.

5. Establishment of the capacity and restrictions of the radio-meteor and other techniques in the research of circulation, and of the algorithms for processing the observational data.

- a. Global distribution of the main type of winds and of tidal variations by the results of natural and numerical experiments.
- b. Effect of the variations in the parameters of meteor radars (MR) on the properties of the observation series, in particular, when performing measurements in a meteor-radar network.
- c. Composition of the threshold interpretation models of wind variations and other atmospheric parameters.
- d. Requirements of the equipment parameters unification when studying circulation by the radio-meteor method, by the DI method, and others.

(e) Experimental Methods

1. Radar and optical observations of the meteor-trail drifts.

2. Rocket measurements of thermodynamic parameters of the lower thermosphere.

3. Tracing of injected components (alkaline metals, etc.).

4. Analysis of variations of atmospheric emission parameters (of Na, O, OH, etc.).

5. Method of the incoherent radio-wave scattering (plasma drift along the radar ray).

6. Measurement of horizontal drifts by spaced long-wave receivers.

7. Measurement of horizontal drifts by vertical radio-sounding (partial reflection within the interval 70-120 km and complete reflection over 100-km altitude).

8. Measurement of phase variations by receiving distant radio signals within long-wave and middle-wave range (i.e. phase-altitude measurements).

9. Study of drifting ionosphere disturbances in the lower ionosphere (synchronic measurements by spaced ionosonde instruments, by Doppler radar techniques, etc.).

10. Satellite measurement of corpuscular and electromagnetic emissions.

## (f) Observation Programs

1. Coordination of the time schedule.
2. Constant monitoring in accordance with the schedule and with technical and economical capacities of the research teams.
3. Intensive winter research programs, during November 15 - March 15.
4. Complex experiments with simultaneous studies of aeronomical and thermodynamical parameters within the entire region.
5. Intensive programs within the fall (August - October) and spring (March - May) circulation reversals.
6. Program of methodical observations.
  - a. Strictly synchronic measurements in various points by the same method and also by various methods.
  - b. Observations in various latitudes at  $5^\circ - 10^\circ$  intervals by a mobile meteor-radar designed especially for this purpose.
  - c. Combined observations by D1 and D2 methods.
  - d. Combined observations from rockets and ground-based meteor-radar with a phase angle meter.

It is planned, as a result of this subproject, prepare an empirical model for spatial-temporal variations of temperature, density, electron concentration and wind in the region in question; to define the role of wave phenomena in physical processes controlling the lower thermosphere, and to perform mathematical modelling of the formation mechanism of the structure and dynamics of the lower thermosphere.

**SUBPROJECT: INVESTIGATION OF HIGH-LATITUDE ENERGETIC SOURCES AND THEIR EFFECT ON THE STRUCTURE AND DYNAMICS OF THE UPPER ATMOSPHERE AND IONOSPHERE DURING THE POLAR NIGHT**

## (a) Timing of the Research

The timing of the research is 1980-1982.

## (b) Analysed Altitude

The analysed altitude is 20-180 km.

## (c) The Problem

Investigation of the upper atmosphere within high latitudes has great significance in the modelling of ionospheric-magnetospheric rela-

tions, in analysing ionospheric disturbances, etc. In the high-latitude region there occurs an additional energy generation from sources different from solar ultraviolet. These sources are: protons and precipitating electron fluxes, Joule heating, etc. Intensity and input of these sources is significantly affected by external conditions but mainly by the character and intensity of disturbances.

Energy generation due to the above-mentioned sources leads to considerable variation in the high-latitude upper atmosphere. These changes are of a great variety: increases in the concentration and temperature of electrons, origination of electric fields, change in ion composition, increase in temperature of the neutral gas, turbulent regime variations in the atmosphere in the area of the turbopause, etc. It is significant that all these effects in the same phenomenon can be quite different in various polar regions, for instance, within and outside the auroral oval.

#### (d) Scientific Objectives

Investigation of energetic sources spatial distribution (current systems, particles, waves, etc.), their intensity and effect on the structure and dynamics of the upper atmosphere as the result of solar and geophysical activity.

Joint analysis of the available experimental and theoretical data.

Dynamics of the lower ionosphere as a function of stratosphere-mesosphere processes. The influence of these processes on the lower thermosphere through turbulent and wave mechanisms.

Correlation between the dynamics of the polar upper atmosphere and ionosphere and various parameters of solar and geophysical activity, the interplanetary medium and magnetosphere.

#### (e) Experimental Methods to Solve Theoretical Problems

The present subproject is based on the experimental study of the upper atmosphere and ionosphere carried out at Heiss Island during November - December 1981. Rocket complexes MP-12 and M-100 were used as well as data obtained from the Arctic ground-based geophysical network.

Within the framework of the project 10 rockets of MP-12 type and 8 rockets of M-100 type were launched.

Composition of the instruments (MP-12) and measured parameters:

##### Payload N 1:

1. Cloud release container of the "trace" type is aimed at

measuring temperature, diffusion and wind within the altitude interval of 80-160 km.

2. Radio-frequency mass-spectrometer (measurement of the neutral composition).

3. Ion probe to measure density and temperature of the atmosphere at the altitude 80-140 km.

4. Auto-oscillative probe for the electron concentration.

5. Impedance probe for electron concentration.

6. High-frequency probe to measure the electron temperature.

7. Corpuscular radiation counters (energy interval 0.5 - 20 keV, over 30 keV).

The Payload N 2:

1. Mass-spectrometer (ion-neutral).

2. Impedance probe to measure the concentration of electrons.

3. Modulative probe to measure the temperature and concentration of electrons.

4. Double electrostatic probe to measure electric fields.

5. Corpuscular radiation counters (energy interval 0.5 - 20 keV, over 30 keV).

The Payload N 3:

1. Double electrostatic probe to measure electric fields.

2. Auto-oscillative probe to measure concentration of electrons and ionospheric irregularities.

3. Corpuscular radiation counters.

Distribution of the Payloads:

5 launches of rockets with the payloads N 1;

3 launches of rockets with the payloads N 2;

2 launches of rockets with the payloads N 3.

Meteorological rockets M-100 were equipped with standard techniques aimed at measuring thermodynamic parameters of the atmosphere at the

altitude 20-80 km.

Complex of Ground-Based Measurements:

1. Laser radar to measure dynamic and temperature parameters at altitude 80-100 km.
2. Magnetometers.
3. Ionospheric sounding.
4. Riometer absorption.
5. All-sky cameras.
6. Aurora and airglow photometers.

(f) Research Program

Rocket experiments were carried out during November - December 1980.

The experiments were coordinated as far as it was possible with the International Energy Budget Campaign. The Campaign headed by Dr. D. Offermann (FRG) included rocket flights from Kiruna and Andoya with instrumentation similar to that described above and prepared by scientists from several western countries including Norway, Austria and Great Britain.

The present project is to estimate the effect of the stratosphere-mesosphere processes upon the dynamics of the lower ionosphere, in particular, the effect of these processes on the lower theimosphere through turbulence and wave mechanisms, to establish the correlation between the upper atmosphere dynamics in the polar region and various parameters of solar activity, interplanetary medium, dynamics of the magnetosphere, among others.

SUBPROJECT: CLIMATE ELEMENTS OF STRATOSPHERE AND MESOSPHERE; ROLE OF VARIOUS ENERGETIC SOURCES IN ITS FORMATION

(a) Timing of the Research

The timing of the research is 1981-1985.

(b) Analysed Altitude

The analysed altitude is 15-80 km.

### (c) The Problem

The problem of climate, of its natural and anthropogenic variations is stressed in a number of documents adopted by WMO and other international bodies. To study these climate variations it is necessary to investigate its present state. For middle atmosphere research it is possible to model standard and reference atmospheres.

At present, these models include information only on thermodynamic parameters and wind. They do not regard information about ozone, minor constituents and other middle atmosphere parameters. The COSPAR reference atmosphere-CIRA - does not consider longitudinal and hemispherical differences. Neither does it contain any information about average zonal data on thermodynamics for latitudes over 70°. It also seems acute to analyse charged components of the atmosphere which seem to affect greatly radio-wave propagation.

Our knowledge about season-latitude parameters of planetary and gravity waves is far from being complete. We also lack much information about energy transport by waves, wave influence on climatic properties for turbulence of various scales. Meanwhile, existing measurement techniques and networks are capable (special programs are being organized) of presenting required data to make climatic evaluation of these magnitudes.

Many of the middle atmospheric structures and phenomena cannot be interpreted in theory. Thus, it would be interesting to reveal the origin of non-zonal features of the pressure field and wind over the winter hemisphere, to analyse the role of current systems and electric fields in formation of the wind in the lower thermosphere, etc.

Of prime significance in the analysis of the human-activities effect upon climate variations is the empirical climatic modelling of ozone and trace components, which would consider in detail the chemical composition of the middle atmosphere. It is also important to build multidimensional (two- or three-dimension) models of ozone, water vapour and carbonic acid, all of them considering general circulation patterns and sufficiently complete turbulence patterns, taking into account minor constituent chemistry based on effective reaction rate constants.

### (d) Scientific Objectives

1. To establish climatic regularities and variations (temperature, pressure, density, wind).
2. Hemispheric differences in climatic regularities.
3. Turbulence in the stratosphere and mesosphere and its role in energy transport.

4. Season-latitude distribution of trace constituents in the mesosphere and stratosphere (ozone, water vapour, aerosols, atomic oxygen) and their effect on middle atmosphere energetics.

5. Energy of wave processes in stratosphere and mesosphere.

6. Solar radiation in the middle atmosphere.

(e) Experimental Methods

1. Radio-sounding measurements of temperature and wind.

2. Rocket measurements of temperature, pressure, density, wind, minor components and turbulence.

3. Balloon measurements of turbulence.

4. Satellite data on solar radiation fluxes.

5. Ground-based measurements (ozone, aerosols).

6. Radio-physical methods.

(f) Program of Observations

1. Coordination of the research time schedule.

2. Coordination of complex programs for more frequent observations and experiments.

3. Regular observations.

The subproject purpose is to obtain coordinated in space and time average global fields of meteorological variables in the middle atmosphere, to measure energy exchange between various atmospheric layers, to determine the climatic regularities for temperature, pressure, density and wind in the middle atmosphere and climatic drifts of these parameters, to get reference data on the distribution of ozone concentration and other minor constituents.

SUBPROJECT: WINTER ANOMALY IN THE LOWER IONOSPHERE

(a) Timing of the Research

The timing of the research is 1980-1985.

(b) Analysed Altitudes

The analysed altitudes are 60-100 km.

### (c) The Problem

The phenomenon of the winter anomaly refers to the fact that radio-wave absorption in the midlatitude ionosphere in winter is higher than in other seasons at the same zenith angle of the sun. It is usually observed in medium- and high-frequency bands at middle latitudes of both the Northern and the Southern Hemispheres.

According to some authors, the winter anomaly is mainly due to increased electron density at ~75-100 km which, in turn, is associated with increased concentration of NO at these altitudes. Another point of view attributes the anomalous absorption to the ionizing effect of energetic corpuscular fluxes penetrating into the lower ionosphere. The data available are insufficient to choose between these hypotheses.

Besides, the problem involves some other questions that still are not clear: i.e., what is the extent of the region of anomalous absorption; does the anomaly occur at high latitudes; where is it disguised by continuous intrusion of energetic particles; has it any relationships with geomagnetic disturbances? Further investigations are required of the aeronomical processes in the lower ionosphere, which cause the winter anomaly.

### (d) Scientific Objectives

1. Specification of spatial-temporal characteristics of the phenomenon and the dynamical properties of its low-latitude boundary.
2. Investigation of electron density vertical distribution and its relation to processes in the neutral atmosphere.
3. Relationship between the winter anomaly, and wave and corpuscular radiation.
4. Interactions between different atmospheric regions.
5. Study of relationships between electron density and internal gravity waves.

### (e) Experimental Methods

1. Measurements of the ionospheric radio-wave absorption by different methods (A1, A2, A3,  $f_{min}$ ).
2. Rocket measurements of neutral and ionized atmospheric constituents and precipitating particles on launching sites Volgograd and Heiss Island.
3. Ground-based measurements of electron density and other para-

meters by incoherent scatter, partial reflection and phase height techniques.

4. Ground-based measurements of ionospheric drifts by different methods.

5. Measurements of the rotational temperature of atmospheric hydroxyl emission.

(f) Program of Observations

Ground-based observations of absorption will be carried out from August 15 till April 15 and (for comparison) in the summer period of June 5 - July 10 accompanied by simultaneous coordinated radio soundings and ground-based measurements using incoherent scatter, partial reflection, and drift techniques.

Rocket measurements will be taken during a month (in January). During this period, all equipment involved in the subproject will operate at reduced intervals.

(g) Expected Results

As a result of implementation of the subproject it is supposed:

To specify the spatial-temporal characteristics of the phenomenon under investigation, to study the dynamics of its low-latitude boundary, to reveal the features of anomalous absorption at subauroral and auroral latitudes;

To establish the relationships between the winter anomaly and wave and corpuscular radiation;

To specify the relationships between the winter anomaly and dynamical processes in the middle atmosphere, i.e., turbulent diffusion, mean wind, wave motions of various scale;

To specify the interaction between the winter anomaly and meteorological parameters (temperature, density of neutrals, etc.);

To produce models of the processes responsible for the winter anomaly in the lower ionosphere.

All this will contribute to a better understanding of the phenomenon as a whole, as well as of its driving mechanisms, which in turn will stimulate the development of a prediction capability.

**SUBPROJECT: NOCTILUCENT CLOUDS: CLIMATOLOGY, DYNAMICS, GENESIS AND ORIGIN****(a) Timing of the Research**

The timing of the research is 1975-1985.

**(b) Analysed Altitudes**

The analysed altitudes are 65-95 km.

**(c) The Problem**

The subproject is dedicated to further extensive investigation of noctilucent clouds with stress on their relationships and interaction with atmospheric processes at the altitude 80-82 km.

Along with routine ground-based observations ("Climatology of noctilucent clouds" and "Dynamics and morphology of noctilucent clouds"), it is supposed to carry out spacecraft investigations of noctilucent clouds on orbiting stations and spaceships.

The previous experiment on "Salut-4" and "Salut-6" proved the space methods to be highly efficient and promising.

An essential problem that still has no unambiguous solution is that of the origin of noctilucent clouds.

For solving the problem, it is supposed to use all available flying means (meteorological rockets, satellites, orbiting stations), as well as to undertake a number of theoretical and experimental works on modelling the formation processes of noctilucent clouds.

The section entitled "Genesis of noctilucent clouds, their relation to meteorological conditions and solar and geophysical events; occurrence prediction" is the most extensive part of the project. Here the attention is concentrated on phenomena and processes that take place in the transition zone of noctilucent cloud occurrence and may be associated with possible sources of the latter. One of the practical results of this study is the attempt to predict the occurrence of noctilucent clouds using observations of accompanying or associated phenomena.

As a part of the Middle Atmosphere Program, the described subproject is closely connected with others. The data acquired by ground-based, aircraft, rocket and satellite methods in the process of realization of each subproject are supposed to supplement each other and be widely used in experimental and theoretical studies in the scope of this subproject.

## (d) Scientific Objectives

**Climatology of Noctilucent Clouds:** Determination of spatial-temporal characteristics of noctilucent occurrences. Acquisition of reliable data series on noctilucent clouds from ground-based and space observations both in the Northern and the Southern Hemispheres. Special attention will be paid to discontinuities in noctilucent occurrence within each series.

**Dynamics and Morphology of Noctilucent Clouds:** Investigation of morphological and kinematic properties of noctilucent field structures (waves of different kind, jet flows vortices, multilayer fields).

Determination of horizontal and vertical velocity components, orientation of various structural features of noctilucent cloud fields and also the drift of the field as a whole by low-speed basic filming and stereophotogrammetry.

**Constitution of Noctilucent Clouds:** Investigation of physical and chemical properties of particles forming noctilucent clouds; determination of optical parameters characterizing the cloud field as a whole.

Determination of physical and chemical composition and volume density of particles; optical depth, spectral, brightness and other characteristics of the cloud field.

**Genesis of Noctilucent Clouds Including Their Relation to Meteorological, Solar and Geophysical Phenomena; Occurrence Prediction:** Investigation of the conditions required for noctilucent cloud formation:

1. Investigation of water vapour transport to the mesosphere and temperature variations at the mesopause level.
2. Investigation of relationships between solar activity variations, content of ozone in the atmosphere and the types of global atmospheric circulation.
3. Investigation of global aerosol distribution in the mesosphere.
4. Modelling of physical conditions of the mesopause level; study of dynamical processes of water vapour condensation in ice crystals.

Investigation of relationships between solar and geophysical phenomena and the occurrence of noctilucent clouds:

1. Complex studies of geomagnetic disturbances (K-index), OH and O<sub>2</sub> emissions, ion and electron composition, behavior of E<sub>s</sub>-layer during the occurrence, lifetime and disappearance of noctilucent clouds.

2. Investigation of noctilucent occurrences correlation with solar activity, meteor fluxes, ionospheric conditions in D, E and E<sub>s</sub>-regions, OH and O<sub>2</sub> emission intensities, meteorological conditions in the troposphere and mesosphere.

3. Correlation of noctilucent cloud occurrences with volcanic activity and anthropogenic factors.

(e) Experimental Methods

1. Ground-based and spacecraft (including scientific orbiting stations) monitoring.

2. Rocket experiments.

3. Sounding by radio techniques.

4. Aerophotogrammetric measurements and low-speed filming.

(f) Program of Observations

Monitoring observations during the period of May 15 - August 15 within the international program (International Noctilucent Cloud Observation Manual, WMO-Nr. 250, TP. 138, 1970).

Implementation of this subproject will: yield data on correlation between the occurrence of noctilucent clouds and meteorological and geophysical factors; expand our knowledge of the composition and origin of noctilucent clouds; and create a basis for their prediction.

**SUBPROJECT: THE ROLE OF WAVE PROCESSES IN FORMATION OF THE MIDDLE ATMOSPHERE STRUCTURE AND DYNAMICS**

(a) Timing of the Research

The timing of the research is 1981-1985.

(b) Analysed Altitude

The analysed altitude is 15-80 km.

(c) The Problem

Analysis of the middle atmosphere dynamics is significant for realization of its climate formation. To describe these processes it is quite natural to present them within the wave processes concept. The wave processes (and oscillations) in the stratosphere, mesosphere and lower thermosphere have certain regularities that make them rather different from similar processes in the troposphere, though closely

connected with the latter. The properties of planetary waves in the middle atmosphere, propagation characteristics of acoustic and gravity waves, the nature of small-scale turbulence are not yet sufficiently studied. The development of a climate theory would require a thorough investigation of energy, pulse and angular momentum transport by planetary waves from the viewpoint of macroturbulence concepts.

The data obtained at ionospheric and radiometeor sounding stations suggest that the gravity waves in the height range of 80-110 km may be considered as an energy and turbulence source.

The nature of stratospheric warmings in winter still remains unclear. In some cases, they are attributed to interactions between a wave of tropospheric origin and a standing wave in the mesosphere. Further analysis of stratospheric warmings based on the wave concept seems to be rather promising.

The solution of the above-listed problems requires special coordinated programs of routine observations supported with harmonic and spectral analysis of long data series obtained hitherto. Besides, the subproject involves a number of urgent and complicated problems of solar-atmospheric relations; first of all those associated with manifestations of the 11-year cycle of solar activity and with recurrent disturbances connected with the sun rotation.

#### (d) Scientific Objectives

1. Investigation of wave processes including standing waves of the planetary scale and progressive waves with a period of 12 hours to 2 years, based on a combined analysis of radio sounding, rocket, satellite and ground-based data.

2. Analysis of physical mechanisms responsible for the structure and dynamics of the stratosphere and mesosphere; numerical modelling of corresponding processes.

3. Correlation of the structure and dynamics of the stratosphere and mesosphere with solar and geomagnetic activity.

4. Investigation of possible mechanisms of stratospheric and mesospheric winter warmings in the Northern Hemisphere.

#### (e) Experimental Methods

1. Temperature and wind measurements by radio sounding methods.

2. Rocket measurements of the temperature, wind, minor neutral and charged constituents.

3. Satellite measurements of radiation fluxes.

4. Ground-based measurements by the methods of partial reflection, cross-modulation, phase heights, etc.

(f) Program of Observations

1. Timing of the observation.

2. Coordinated observations and experiments with closer intervals.

3. Routine observations.

As a result of implementation of the subproject, it is expected to determine the physical mechanisms responsible for the structure and dynamics of the stratosphere and mesosphere, to construct a numerical model of corresponding processes, to specify the mechanisms of stratospheric and mesospheric winter warmings in the Northern Hemisphere, to estimate the role of different physical mechanisms in the thermal balance of the middle atmosphere and to establish electro-dynamical relations between the middle atmospheric parameters and characteristics of solar and geomagnetic activity.

SUBPROJECT: OZONODYNAMICAL PROJECT (ODP)

(a) Timing of the Research

The realization of the ODP is divided into two stages:

1. Regular network, registrations of the total ozone content (X) and its vertical distributions (VD) by the reversal method as well as by periodic horizontal aircraft soundings; April - May - June and September - October, 1979-1982.

2. Special "alerts" within the time intervals established in (1). These alerts are announced by the Hydrometeorological Service and usually last for 2-4 days. Their purpose is to concentrate the attention of observers on the events indicated above in the section "Scientific Objectives on the ODP".

(b) Analysed Altitude

Mainly 10-35 km with occasional rocket measurements up to 70 km.

(c) The Problem

One of the principal and most complicated problems associated with atmospheric ozone is that of its transport in the earth's atmosphere. The transport plays an essential role in the distribution of the gas,

which is continuously generated in the stratosphere of the tropical zone due to photochemical processes. Then it is carried away and accumulated in the high-latitude stratosphere where it is partly destroyed photochemically and partly penetrates into the troposphere.

The dynamic exchange of ozone-bearing air masses in the stratosphere is realized through atmosphere circulations: global circulations, current systems of continental scale, and cyclonic systems. These types of motion are characterized by corresponding time scales. The motions are stronger when the synoptic processes have a meridional character and they are weaker when they are of a zonal type. The intensity of the motions differs from one longitude zone to another.

The main purpose of the project is to study the vertical and horizontal transport of ozone as a dynamic factor affecting its distribution in the atmosphere.

Since the transport is governed by air currents participating in the regular synoptical (dynamical) processes in the atmosphere, the former should obviously be investigated in conjunction with the latter. An emphasis should be made on the exchange between the subtropical and high-latitude zones.

Besides, the project includes among its objectives the composition of ozonosphere models in conformity with the above-mentioned circulations. In particular, these models should provide estimates of characteristic relaxation times of ozone under various conditions, in the presence of different minor constituents etc. The models are supposed to clarify the following questions:

1. What types of circulation can present the evolution pattern of the ozonosphere corresponding to that observed during the project realization?
2. What currents (their driving forces, geopotential fields etc.) are able to provide and account for the observed interlatitude and intra-cyclonic ozone exchange?
3. What are the mechanisms, velocities and regions of ozone exchange between the stratosphere and troposphere; what is the role of low and high latitudes, the tropopause structure etc. in this exchange? As far as possible, the ozonosphere models under consideration should involve the models of circulation, turbulence etc. based on direct observational data. This part of the project should not depend upon the complete models of general circulation of various scales and upon their approbation.

(d) Scientific Objectives of the ODP

The principal objective of the ODP is the study of vertical and horizontal transport of ozone associated with large-scale atmospheric disturbances (such as fronts, cyclones, jet flows and long waves); in particular, with long-range motions of Arctic air masses to the south and tropical air masses to the north.

Another task is the construction of reasonable two- and three-dimensional ozonospheric models of both global and synoptical scale that would describe the transport and photochemical effects of ozone in agreement with observational data. In particular, attention should be paid to the transition layer (30-40 km) between the regions of prevailing photochemical and dynamical effects, as well as to the methods of diagnostics of real photochemical transformations in the atmosphere.

#### Experimental methods:

1. Routine observations of the total ozone content, and its vertical distribution by using the reversal method.
2. Ozone soundings with closer intervals in connection with special objects, i.e., cyclones or jet flows.
3. Coordinated day and night observations of ozone.
4. Horizontal aircraft soundings of X along the chosen trajectories.
5. Rocket soundings of the stratosphere and mesosphere using ozone sensors, accompanied by simultaneous temperature and other meteorological measurements.
6. Mapping the trajectories of ozone transport.

#### Program of observation.

The program of regular observations will include:

1. Ground-based measurements of the total ozone content by means of ozonometers and Dobson spectrophotometers.
2. Observations of the vertical distribution of ozone by the reversal method on the stations equipped with Dobson or other type spectrophotometers.
3. Ozone soundings.
4. Aircraft measurements of the total ozone content.
5. Rocket ozone soundings.

## 6. Satellite measurements.

A detailed program will be developed taking into account the experimental facilities of all participants and the needs of other MAP subprojects.

As a result of implementation of the project it is expected:

To obtain data on ozone transport associated with large-scale atmospheric disturbances, such as fronts, cyclones, jet flows and long waves;

To construct global ozonosphere models taking into account photochemical processes, circulation of the middle atmosphere and solar activity effects;

To obtain new data on ozone distribution over the seas and continents, the intensity of penetrating UV radiation and interactions of ozone with aerosols.

## DATA COLLECTION AND DISTRIBUTION

The International Council of Scientific Unions (ICSU) has urged the international bodies in charge of projects to make plans for data management at an early stage.

The Soviet Geophysical Committee and its Commission on MAP plan to take part in the elaboration of the MAP data concept in the MAP Committee (SCOSTEP), in IAGA and IAMAP (IUGG), and in the ICSU Commission on WDC in geophysics and solar-terrestrial physics. It is necessary to establish to what extent the available international data exchange, through the WDC system, is capable of providing sufficient information on global processes and events to all MAP participants. It is also necessary to find out what type of principally new data will be collected in the course of the MAP research, in what volume and form, and the means of data exchange through WDC. It is necessary to discuss what activities should be performed at the data analysis stage to assure adequate international approbation of obtained results. Soviet MAP participants plan to present at corresponding MAP meetings and workshops concrete proposals on the function of the MAP data exchange system.

At present, the basis of MAP data is formed by data collected by WDC "A" and "B" for 1957-1985. The list of data accumulating in WDC is being kept in the governing body on the international data exchange through WDC (4th edition, June, 1979, ICSU, Commission on WDC in geophysics and solar-terrestrial physics; and Reports of WDC "A" and "B").

There are some visible defects, however, in data exchange, for instance, in the field of meteor research. Data exchange is performed

without proper regard of the interests of the MAP participants. Thus, Soviet specialists in this field would propose to IAGA to realize the GLOBMET project which, in particular, implies a regular data exchange about meteor traces.

Results of many special experiments performed in various countries within the MAP should be published in special issues and become available to international exchange through WDCs. Special attention should be paid to detailed description of factual data, so that they can be also used by other specialists who apply other methods of data interpretation.

International cooperation and division in the field of data programming and computing are prime requirements which should be observed to analyse global data units, to correlate data on various disciplines and data obtained in various countries. It, first of all, implies data exchange through WDCs in a computer-readable form, and also establishment of available data banks in these centers which will include both results of routine observations and of special experiments.

#### SOVIET COMMISSION FOR MIDDLE ATMOSPHERE PROGRAM (MAP)

- |                             |   |  |
|-----------------------------|---|--|
| Danilov, A. D. (Prof.)      | - | Chairman, Institute of Applied Geophysics, National Committee on Hydrometeorology and Control of the Environments                            |
| Kazimirovsky, E. S. (Prof.) | - | Vice-Chairman, Siberian Institute of the Earth's Magnetism, Ionosphere and Radio-Wave Propagation, Siberian Dept., Academy of Sciences, USSR |
| Viskov, V. V. (Dr.)         | - | Scientific Secretary, Soviet Geophysical Committee, Academy of Sciences, USSR  |
| Willmann, Ch. I. (Dr.)      | - | Institute of Astro-Physics and Atmosphere Physics, Academy of Sciences of the Estonian Soviet Socialist Republic                             |
| Kokin, G. A. (Prof.)        | - | Central Aerological Observatory, National Committee on Hydrometeorology and Control of the Environments.                                     |

- Rapoport, Z. Tz. (Dr.) - Institute of the Earth Magnetism, Ionosphere and Radio-Wave Propagation, Academy of Sciences, USSR
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- Benediktov, E. A. (Dr.) - Research Radio-Physical Institute
- Ivanovskii, A. I. (Dr.) - Central Aerological Observatory, National Committee on Hydrometeorology and Control of the Environments
- Kascheev, B. L. (Prof.) - Kharkov Institute of Radioelectronics, Ministry of Higher and Secondary Special Education, Ukrainian Soviet Socialist Republic
- Odintsova, I. N. (Dr.) - Scientific and Organizing Dept. of the Presidium, Academy of Sciences, USSR
- Powsner, A. D. (Dr.) - Soviet Geophysical Committee, Academy of Sciences, USSR
- Tulinov, G. F. (Dr.) - Institute of Applied Geophysics, National Committee on Hydrometeorology and Control of the Environments
- Ferberov, V. A. - Control of Cosmic Systems, National Committee on Hydrometeorology and Control of the Environments
- Sheffov, N. N. (Prof.) - Institute of Physics of the Atmosphere, Academy of Sciences, USSR

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THE MIDDLE ATMOSPHERE PROGRAM:  
WINTER IN NORTHERN EUROPE (MAP/WINE)

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THE MIDDLE ATMOSPHERE PROGRAM (MAP)

(a) MAP Scientific Goals

The middle atmosphere is comprised mainly of the stratosphere and mesosphere, and is the region of the atmosphere about which we know the least. The reasons are partly the complexity of the physical processes and partly the inaccessibility of the region to satellite investigations. It is the region where two strong energy sources interact: solar ultraviolet light absorbed by the atmosphere to give chemically active constituents, and wave motions forced from the troposphere into the stratosphere and mesosphere.

The major aim of the Middle Atmosphere Program will be the development of an adequate description and understanding of the middle atmosphere, from altitudes of about 10 to 100 km, particularly in relation of the global fields of: (1) density, pressure and temperature; (2) composition; (3) motion (on all scales); and (4) the interaction between these fields. The program will require observations which are both intensive, so that interactions may be determined, and extensive, so that the global picture is complete. Theoretical models will be required, and these must be adequate to describe both dynamical and aeronomic aspects of the middle atmosphere. Since both the troposphere below and the thermosphere above influence the stratosphere and mesosphere, middle atmosphere research must be conducted with regard to the study of the former regions, both in respect to theory and to observational programs. Also, it will be necessary to consider all physical and chemical processes in the light of significant time and space scales, including those appropriate to climatic change for which long-term observations may be necessary.

(b) Organisation of MAP

MAP is being sponsored by several international scientific bodies whose disciplines are related to the science of the middle atmosphere:

World Meteorological Organisation

(WMO)

International Union of Radio Science	(URSI)
International Association of Meteorology and Atmospheric Physics	(IAMAF)
International Association of Geomagnetism and Aeronomy	(IAGA)
Committee on Space Research	(COSPAR)
Inter-Union Commission on Radio Meteorology	(IUCRM)
Scientific Committee for Solar-Terrestrial Physics	(SCOSTEP)

During its 17th General Assembly in September 1978 the International Council of Scientific Unions (ICSU) officially approved MAP as a major international cooperative research program.

MAP is now carried out under the auspices of the Scientific Committee for Solar-Terrestrial Physics (SCOSTEP). Planning and coordination of MAP activities is performed by an international MAP Steering Committee (MAPSC), which is presently chaired by Prof. S. A. Bowhill (University of Illinois, Urbana, Ill., USA). Specific MAP projects are to be proposed by individual scientists or research institutions for endorsement by the MAPSC and adoption as an official MAP project. Funding to carry out these projects has to come, however, from the national agencies involved in the respective research programs.

Planning and coordination of the German MAP activities is performed by the Commission of Atmospheric Sciences of the Deutsche Forschungsgemeinschaft (DFG). The German representative for MAP is presently Prof. U. von Zahn.

#### (c) Schedule of Activities

The years 1979 to 1981 are designated a 'Pre-MAP' interval in which a number of special research projects (PMP's) are carried out and MAP Study Groups (MSG's) are set up. The major observational programs of MAP will be performed in the period January 1st, 1982 to December 31st, 1985, followed by an analysis phase of about 2 years. In addition, the MAPSC is currently considering a second phase of MAP to take advantage of experiments scheduled after 1985.

#### THE MAP PROJECT 'WINTER IN NORTHERN EUROPE (MAP/WINE)'

##### (a) MAP/WINE Scientific Aims

During winter at high latitudes the structural parameters of and

the dynamic processes acting in the middle atmosphere display a strong variability, in contrast to fairly steady conditions during summertime. Much of this variability during the winter season can be interpreted as being due to an enhanced level of wave activity on a very wide range of spatial and temporal scales. A well-known example of this variability is the occurrence of sudden stratospheric warmings. The causes for the enhanced wave activity, however, are not well understood. Furthermore, observational data on conditions in the winter mesosphere are rather scarce.

In order to get a deeper insight into the causes and effects of this winter variability one needs to measure as completely as possible the structural parameters of the middle atmosphere (pressure, temperature) and the dynamical processes of global scales (planetary waves, tides), mesoscales (gravity waves, jet streams) and small scales (turbulence).

For many years meteorological satellite data have provided important information on global scale processes. The more recent development of MST radars, lidar sounders, and sophisticated rocket-borne density measuring devices make it now possible to measure at least at selected sites also the small scale and mesoscale dynamic processes on an almost continuous basis. Furthermore, special high altitude radiosondes, meteorological rockets, meteorwind radars, and sounding rockets can provide for additional and vital data which are not routinely available from WMO observations or remote sensing satellite experiments.

Hence during a full winter season a coordinated and international study will be performed on the structure, motions, and composition of the middle atmosphere between about  $50^{\circ}$  and  $70^{\circ}$  northern latitudes. The northern European sector is considered particularly well suited for this study because the stratospheric polar vortex is usually shifted in the European sector of the arctic. Therefore the stratospheric jet flowing southward of the polar vortex is located over Scandinavia. In addition within this sector the disturbances of the middle atmosphere during sudden stratospheric warmings appear to be most intense due to the prevailing tropospheric circulation being blocked by a high pressure system in the North Atlantic region.

The project MAP/WINE is directed toward a better understanding of

- the interaction of planetary waves of tropospheric origin with the mean flow in the stratosphere and mesosphere,
- the temporal and spatial development of sudden stratospheric warmings including the pre-warming conditions and the trigger mechanism for the warming,
- the temporal and spatial development of mesospheric cooling events in

conjunction with stratospheric warmings,

- the vertical and horizontal transport of minor constituents like trace gases, excited species, and charged particles,
- the effects on the chemistry of neutral and charged species of the large temperature changes occurring during stratospheric warmings and mesospheric coolings,
- sources of turbulent energy in the mesosphere and turbopause region,
- the temporal and spatial development of turbulent layers, and
- the contributions of dynamical processes to the heating and cooling of the mesospheric and turbopause region.

(b) Organisation of MAP/WINE

The project MAP/WINE was originally proposed to the MAPSC by the Commission of Atmospheric Sciences of the DFG. It was formally approved as part of the international MAP effort by the MAPSC during its meeting in August 1980. Dr. D. Krankowsky (Max-Planck-Institut für Kernphysik, Heidelberg, Fed. Rep. of Germany) has been designated international project coordinator. He is currently setting up an international MAP/WINE Working Group which is responsible for planning and coordinating the specific research activities to be performed during the MAP/WINE project. The following members of the Working Group have been nominated so far:

Fed. Rep. of Germany	Dr. D. Krankowsky, MPI-K (Chairman)
France	Dr. M.-L. Chanin, Serv. d'Aeronomie du CNRS
Norway	Dr. E. Thrane, NDRE
Sweden	Dr. G. Witt, Univ. of Stockholm
United Kingdom	Dr. E. Williams, Univ. College of Wales
United States	Dr. R. Philbrick, AF Geophysics Laboratory

Participating nations also include: Austria, Canada, Czechoslovakia, and the German Democratic Republic.

(c) Workplan for MAP/WINE

The project MAP/WINE will center on the study of the middle atmosphere during the winter 1983/84. The observations will concentrate on Northern Europe from about 50°N to 70°N. As MAP/WINE is performed

within the scope of the international MAP program it should be possible for data collection to make maximum use of existing meteorological and geophysical facilities in many countries. This shall allow the investigation of phenomena of both small and large scales (up to hemispheric). Observing methods will include: ground-based facilities, balloon-borne and rocket-borne experiments, and remote sensing techniques from satellites.

The project MAP/WINE is to proceed in three phases:

#### 1. Preparatory phase:

Some new experiment techniques have to be developed or be made operational in northern Europe (e.g. parachute-borne mass spectrometers, lidar sounding of stratospheric and mesospheric parameters).

Ground-based facilities (e.g. MST radars, partial reflection stations, ionosondes, riometers, spectrometers and photometers, ozone sounding stations) have to be installed in suitable areas.

Appropriate programs for processing and analysis of the data from meteorological rockets, balloon-, rocket-, and satellite-experiments have to be prepared.

Theoretical models of the processes acting in the middle atmosphere and the response of the structural parameters to various forcing functions have to be set up, e.g. for large scale dynamics, gravity waves, turbulence, and photochemical processes.

#### 2. Observational phase:

Remote sensing data acquisition by ground-based and satellite observations during winter 1983/84 (approx. October 1983 to March 1984) allowing the description of the general status and development of the middle atmosphere. By participation of many international groups these observations will cover the area of high latitudes over the whole northern hemisphere. Suitable remote sensing satellites are: Nimbus 7, Solar Mesosphere Explorer, Dynamics Explorer, and Tiros.

*In situ* measurement of middle atmosphere parameters by means of MetRocket launchings. At least 3 sites north of 55°N are desired and the following locations are under consideration:

- Andoya	(approved)	69°N/16°E
- Lista	(under consideration)	58°N/ 7°E
- South Uist	(suggested)	57°N/ 7°W
- Thule	(suggested)	78°N/68°W

Datasonde launchings are to take place once a week from each station in

the time period November 1, 1983 through March 15, 1984. Additional launchings are planned in case of the occurrence of a stratospheric warming. In addition Robinsphere launchings are to take place once a week from Andoya Rocket Range in the time period November 1, 1983 through March 15, 1984 with an intensified launch schedule in case of the occurrence of a stratospheric warming.

Intensive field campaigns as the kernel of the MAP/WINE project will be performed in December 1983 and in January/February 1984. *In situ* measurements of structural, dynamical, and chemical parameters of the stratosphere and mesosphere will be performed with the aid of balloons and rockets which are to be launched from several places in northern Europe.

### 3. Data processing and analysis phase.

#### MAP/WINE CONTRIBUTIONS FROM THE FED. REP. OF GERMANY

In late 1980 the Deutsche Forschungsgemeinschaft (DFG) approved special funding for MAP activities. More specifically for MAP/WINE the DFG will support:

- theoretical studies and model development (5 projects approved so far)
- the installation and operation of new ground stations in northern Europe for remote sensing measurements of the middle atmosphere (3 projects approved so far: MST radar, IR spectrometer/photometer, sodium lidar for temperature measurements in mesopause region)
- analysis of data obtained from U.S. remote sensing satellites.

In early 1981 the Bundesministerium für Forschung und Technologie (BMFT) agreed to fund those German investigations required for MAP/WINE which can only be performed by sounding rockets. These resources will be administered by the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V. (DFVLR), Bereich für Projekt-Tragerschaften (BPT). There will be both purely German payloads as well as payloads comprised of an international complement of instruments. Table 1 gives an overview about the present planning status of the sounding rocket activities.

#### MAP/WINE CONTRIBUTIONS FROM NORWAY

In a meeting on May 19, 1981 the Norwegian Space Research Committee approved that Norwegian scientists participate in sounding rocket experiments for MAP/WINE as given in Table 1. Furthermore, NTNF is studying the possibility of installing a MetRocket launching site at the southern tip of Norway for regular MetRocket firings during the MAP/WINE winter.

#### Ground-based measurements:

- Routine optical and radio measurements by Tromsø University,
- monitoring of the mesosphere/ionospheric D-region by means of the HF partial reflection radar operated by Tromsø University (turbulence, electron densities),
- possible use of EISCAT for mesospheric studies,
- MAP will be supported by the routine observations of the Norwegian Meteorological Office.

#### MAP/WINE CONTRIBUTIONS FROM FRANCE

The Middle Atmosphere Working Group of CNRS has approved a program of ground-based observations for MAP/WINE in the Tromsø area using the following instruments:

- Michelson interferometer for monitoring of OH\*, Na\*, O\*, temperature from linewidth, and winds from Doppler shifts,
- tunable narrow band lidar for density and temperature measurements from about 10 to 100 km altitude,
- photometers for airglow emissions,
- all sky camera.

In addition the installation of a French meteor wind radar station in northern Scandinavia is under consideration.

The ground-based observations at the Observatoire de Haute Provence (44°N/6°E) will continue and may serve as reference measurements for midlatitude conditions.

#### MAP/WINE CONTRIBUTIONS FROM THE UNITED KINGDOM

The University of Sheffield will participate in MAP/WINE by observing "meteor winds" continuously throughout the winter 1983/84 from two stations: Sheffield, looking NW and NE; and Aberdeen, looking SW and SE. The station at Sheffield is already in operation and installation of the Aberdeen station is in progress now.

#### MAP/WINE CONTRIBUTIONS FROM THE UNITED STATES

Various contributions from the U.S. are currently under consideration. They range from the launchings of MetRockets and participation in sounding rocket experiments (see Table 1) to the contribution of data from remote sensing satellites as mentioned earlier.

TABLE 1  
MAP/WINE rocket soundings.  
(Abbreviations - see below)

PAYLOAD DESIGNATION	M-N (METROCKETS)	M-T	M-I	M-S	M-E	M-C	M-O	M-C
status of payload	suggested	confirmed	confirmed	confirmed	suggested	suggested	suggested	suggested
instruments	Robin spheres and data sondes	CHIRPS, BUGATTI/IONMAS, particle counter, gradient probe, Faraday antenna.	IR spectro-meter	2 parachute-borne mass spectrometer (= STRAFAN)	electric field measurement	chaff	sonne sonde	IR spectrometer, photometer, particle counter, dc probe.
countries contributing to payload	G US	G, M, A	G	G	N, US	G	US	US
number of payloads	30 + 30	B	2	2	2	20	10	1
motor	Super Loki	Nike Orion	Sergeant	Orion	Nike Orion	Super Loki	Super Arcon	180 km
apogee	100 km	130 km	180 km	75 km	160 km	100 km	75 km	ARR
launch site	ARR Lista Norway	ARR Thule Greenland	ESR	ESR	ARR	ESR(?)	ARR	ARR

Comments: CHIRPS = cryo-cooled narrow-band IR photometer system  
BUGATTI = Bonn University gas analyzer for turbulence and turbulence investigation  
IONMAS = ion mass spectrometer (cryo-cooled)  
ARR = Andaya Rocket Range

ESR = Esrange  
A = Austria  
G = Fed. Republic of Germany  
N = Norway  
US = United States

Four M-T payloads will contain the BUGATTI instrument, and four will contain the IONMAS instrument.

THE MIDDLE ATMOSPHERE PROGRAM:  
A SPECIAL PROJECT FOR THE ANTARCTIC MIDDLE ATMOSPHERE (AMA)

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### INTRODUCTION

The Special Committee of Solar Terrestrial Physics, Japan, has recommended that coordinated observations of the middle atmosphere in Antarctica should be carried out as one of the major projects of the Japanese national Middle Atmosphere Program (MAP). In order to make comprehensive observations of the polar middle atmosphere over the wide Antarctic region, the observations should be carried out in cooperation with the other countries which participate in the Antarctic Research Expedition. This document describes the scientific objectives of polar middle atmosphere research in Antarctica and the Japanese observations which will be performed around the Japanese Antarctic station, Syowa. This is to provide MAP-participating countries with a detailed description of the scientific project so that they can consider their positive cooperation towards the better accomplishment of the MAP enterprise. It is hoped to establish the project as an international cooperative effort involving many countries also interested in these objectives.

### SCIENTIFIC AIMS OF THE PROJECT

(a) Dynamics, Structure, and Atmospheric Composition of the Middle Atmosphere in Antarctica

The dynamics, structure, atmospheric composition and aerosol abundance of the middle atmosphere in Antarctica are different from those in the middle and low latitude regions, because of differences in the geographic, geophysical and biochemical situations; namely, the influence of the dominant particle precipitation on the chemical and dynamical processes within the polar middle atmosphere; the cooling of the atmosphere by the ice covering the Antarctic continent; the difference in the effective intensity of the solar ultra-violet radiation; and the difference in the biochemical environment from which the minor constituents in the atmosphere originate. The present data of the Antarctic middle atmosphere are scarce, so it is important to collect basic data about the distribution and variation of the physical and chemical quantities in the middle atmosphere over a wide area in Antarctica. Based on these data, it is possible to obtain a comprehensive understanding of the actual conditions of the Antarctic middle atmosphere in relation to middle and low latitudes.

We therefore propose intensive coordinated observations in Antarctica of the following items temporally and spatially;

1. The mean distribution of temperature, pressure and density and its seasonal evolution; and the influence of radiation and motion on the distribution of these quantities.

2. Composition of minor constituents and excited species, and their vertical profiles and time variabilities.

3. Role of the ozonosphere and quasi-recurrent features of sudden warming.

(b) Particle Precipitation and Interaction of the Middle Atmosphere with the Lower Ionosphere

In the polar region, of particular interest is the dominant particle precipitation from the magnetosphere into the upper atmosphere. The particle fluxes exert an influence on the chemical and dynamical processes in the polar middle atmosphere, namely, joule heating in the lower ionosphere by the precipitating particles; propagation of kinetic and electromagnetic energy down to the middle atmosphere and its influence on the structures and motions of the middle atmosphere; particle fluxes from the magnetosphere and their chemical and dynamical effects on the composition of the middle atmosphere.

Therefore, in order to make clear the physical process of the effect of the precipitating particles on the polar middle atmosphere, coordinated GSR (ground-based, balloon and rocket) observations should be carried out to measure the distributions of  $O_3$ ,  $NO_x$ , ion and electron compositions, X-ray input and precipitating particle flux.

(c) Atmospheric Pollution

As the biological and chemical activities in Antarctica are very low because of its severe natural environment, it is reasonable to consider that most of the minor constituents (of biological or chemical origin) in the Antarctic middle atmosphere have originated in the middle and low latitude regions where these activities are very high. Based on the data of the stable minor constituents obtained in Antarctica in relation to those in the middle and low latitude regions, it is possible to discuss the diffusion on a large scale of the middle atmosphere toward the poleward region from the lower latitudes. Furthermore, because Antarctica is the farthest from the middle and low latitude regions in the northern hemisphere where atmospheric pollution is most dominant, the Antarctic region is the most suitable place for monitoring the global diffusion of the atmospheric pollution.

We therefore propose routine-based observations of the minor constituents in the middle atmosphere, such as  $CO_2$ ,  $NO_x$ ,  $CO$ ,  $CH_4$ ,  $O_3$  and  $SO_2$ .

(d) Difference Between the Northern and Southern Polar Middle Atmosphere

Although both the Arctic and the Antarctic are located in the polar regions, their geographical and biochemical environments are very different from each other. It has been pointed out that the difference between the Arctic and the Antarctic regions is largest in the winter of both hemispheres in so far as the average structure dynamics, constitution and aerosol content in the middle atmosphere are concerned.

In order to compare the dynamics, structure and composition in both hemispheres, the emphasis should be placed on making co-ordinated GBR observations in both hemispheres.

JAPANESE POLAR MIDDLE ATMOSPHERE AND IONOSPHERE RESEARCH ACTIVITIES PLANNED FOR 1981 TO 1985 (MAP PERIOD)

Careful planning should be done to insure well-organized ground-based, aircraft, balloon and rocket programs, in close correlation with spacecraft missions. Extensive observations will be carried out at the Japanese Antarctic station, Syowa (69°00S, 39°35'E; geomagnetic lat. -70.4°, long. 79.4°). The outline of the development of our programs is given below.

(a) Ground-Based Observations

Lidar observations for vertical profiles and time variabilities of air molecules and minor constituents, such as aerosols and ozone in the stratosphere and alkali metal atoms and aerosols in the mesosphere and the lower thermosphere.

Spectroscopic observations in the visible and infrared region for the measurement of various atmospheric species, such as CH<sub>4</sub>, N<sub>2</sub>O, CO, O<sub>3</sub> and NO<sub>x</sub>.

VHF radar observations for the electron density and electric field irregularities in the lower ionosphere.

Observations of particle precipitations; all sky camera (35 mm; every 10 sec); auroral zenith photometers for rapid variations (4278 Å); multicolor geomagnetic meridian scanning photometer (5577 Å, H $\beta$ ); high sensitivity TV camera with filters (5577 Å, 6300 Å); vertical incidence ionosonde; riometer (20, 30, 50, 70 MHz).

Observations of electro-magnetic waves; narrow band intensity recorder (0.75, 2, 5, 8, 12, 25, 75, 150 kHz), ELF hiss recorder (0.2 - 2 kHz); chorus recorder (50 Hz - 4 kHz); fluxgate magnetometer, induction magnetometer.

**(b) Balloon Experiments**

During the MAP period, about 20 balloon flights are foreseen carrying a 30 kg payload to an altitude of 30 km. Their size is 5000 - 10000 m<sup>3</sup>. The anticipated payloads are devoted to aerosols, atmospheric species, electron and ion densities, electric field and auroral X-ray studies. More than 100 small balloons (about 5 m<sup>3</sup>) will be flown for observations of the ozonosphere.

**(c) Sounding Rocket Experiments**

Twenty rockets will be used during MAP period. Rockets of the 17 S310 type (ceiling altitude ~ 230 km, payload ~ 40 kg) and 3 S520 type (ceiling altitude ~ 350 km, payload ~ 80 kg) are scheduled to make the following measurements: O<sub>3</sub>, NO<sub>x</sub> density, electron density and electron temperature, electron and proton energy spectrum in the 3 energy ranges (1-10 Kev, 3-100 Kev, and 500 Kev), flux of high energy particles (E>30 Kev), DC electric and magnetic fields, electric and magnetic fields in the frequency range of 0.2-10 kHz, electric fields in the frequency range of 0.1-10 MHz.

**(d) Aircraft Measurements**

Two airplanes (Pilatus Turbo Porter PC-6 and Cessna 185) are available around Syowa Station to observe contents of minor species, aerosol abundance and solar radiation.

**(e) Reception of Polar Orbiting Satellite Data**

Satellite data receiving facilities for ISIS-I and II and Tiros have been built up at Syowa to obtain physical information on the middle atmosphere, the ionosphere, and the magnetosphere. The Japanese polar-orbiting satellite EXOS-C will be launched in the beginning of 1984. Data reception from EXOS-C is scheduled to be made for Syowa Station during the MAP period.

**(f) Cooperative Balloon Observations in the Northern and Southern Polar Regions**

In September 1980, the National Institute of Polar Research, Japan, performed balloon flights at SSC Esvange, Sweden, in collaboration with Swedish scientists. Ozone content, X-rays and VLF waves were measured to study the high-latitude (auroral zone) upper-atmospheric phenomena associated with magnetosphere/ionospheric activities. During the MAP period, the balloon observations in the geographic and geomagnetic conjugate area (European region) of Syowa Station, Antarctica, will be continued to investigate the differences of the physical conditions of the polar middle atmosphere between both hemispheres.

## (g) Schedule

The ground-based, balloon, aircraft measurements and the reception of satellite data described in this document will start at the beginning of 1982 around Syowa Station in Antarctica. Sounding rocket experiments will be carried out from 1984 to 1986. The coordinated observations in Antarctica will extend over a period of 4 years to obtain sufficient data on the seasonal evolution of the physical and chemical quantities in the polar middle atmosphere.

## LIST OF THE PRINCIPAL INVESTIGATORS

## (a) Ground-based observation:

	NAMES	AFFILIATION
Lidar	Y. Iwasaka	Water Research Institute Nagoya University, Chikusa-ku, Nagoya, Japan
Spectroscopy	M. Tanaka	Geophysical Institute, Tohoku University, Aramaki Aoba, Sendai, Japan
VHF radar	R. Fujii	National Institute of Polar Research, Kaga Itabashi-ku, Tokyo, Japan (NIPR)
Auroras	M. Ayukawa	NIPR
Electromagnetic waves	H. Fukunishi	NIPR

## (b) Balloon, Rockets, Aircraft and Satellites

	T. Hirasawa	NIPR
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## INTERACTION OF LARGE METEOROIDS WITH THE ATMOSPHERE

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## PROJECT

Disturbances of the atmosphere at heights of 120 to 40 km by penetration of meteoroids of meter and decameter dimensions.

## AIM

Acquisition of unbiased data on atmospheric penetration of large meteoroids, determination of their supply to gas and dust components of the middle atmosphere and their connection with the noctilucent clouds.

## METHODS

To utilize the existing photographic fireball networks (Czechoslovakia, USSR, FRG, Austria, England, Canada: altogether 140 different observing stations) in systematic acquiring of geometric, dynamic and photometric data on bright fireballs with the purpose of studying the gas and dust component of the middle atmosphere, their time variations and their instantaneous disturbance effects.

To utilize and enlarge the existing system of acquiring data on visual sightings of fireballs with the aim of determining the global variations in their rates.

## EXPLANATORY DETAILS

The mass range of meteoroids from kilograms to hundreds of tons was recently proposed (McCrosky, 1968, Ceplecha 1976) as one of the most important sources of meteoric dust in the Earth's atmosphere. The contribution of these large bodies to the Earth's environment is more than 1 kg per second per the whole globe. This in fall produces a fairly continuous source of fine dust between heights of 100 and 40 km. The variation of the meteoric dust content in the atmosphere depends partly on the variation of the rate of fireballs. The dimensions of the dust originating as the debris or condensation products of the fireball phenomenon are somewhat uncertain, but if  $10^{-15}$  g would be the typical mass of a dust grain, then 1 particle per  $\text{cm}^2$  is available every 5 seconds on an average.

A part of the mass of fireballs is ultimately vaporized. This is

probably one of the most important sources of small variable admixtures of Fe, Mg, Si, Ca, Na and several others in the middle atmosphere. To link individual bright fireballs to changes in admixture contents may help to distinguish different sources of these constituents.

The seasonal and other variations in temperature and density of the middle atmosphere result in measureable effects upon the luminous trajectory of a fireball. The improvement of quantification of these effects may improve our understanding of fireballs as indicators of the density and temperature variations in the middle atmosphere.

The exact role of the cosmic dust particles in the Earth's atmosphere is not known, but their streaming down to the surface may add to the condensation nuclei modulating the precipitation phenomena and take part in other processes in the lower atmosphere.

The noctilucent clouds are one of the demonstrations of the meteoric dust in the atmosphere: due to their heights the fireball dust should be less important for them than the interplanetary dust directly impinging the atmosphere. Thus, comparison of fireball observations with the noctilucent-cloud observations may help to separate the two widely different sources of the meteoric dust in the atmosphere: ablation products of fireballs from interplanetary dust.

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## THE GLOBAL METEOR OBSERVATION SYSTEM (GLOBMET)

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## FOREWORD

For many a year the existing global radar network has been successfully yielding information that proved especially helpful for various international geophysical projects. The data obtained in this way made it possible to determine the basic characteristics of atmospheric circulation and the influx of meteor substance within the 80-110 km height interval. It also supplied experimental material for solving the cardinal methodological problems of data interpretation and further improving the existing meteor radar network.

Along with this, however, a number of important problems pertaining to the construction of adequate models of circulation in the meteor zone and its correlation with the processes taking place in the lower atmospheric layers remain unsolved. This can be explained on the one hand by the objective difficulties inherent in the job and on the other - by the uncontrolled ways of the original formation of the existing network.

Besides, the very essence of many problems of interpretation of radar observation data and optimization of observation systems and networks have been realized but recently. This is due thanks to a thorough analysis of the obtained data and an impressive amount of theoretical studies and the study of mathematical simulation of meteor phenomena in particular.

The recent years have shown that the observation data is subject to the influence of various factors of selectional, astronomical, equipmental and methodological nature. That is why the unification of hardware, observation techniques and algorithms of interpretation prove to be an important condition of obtaining qualitative information.

Moreover, correct interpretation calls for operative information on the structure of the influx of meteor substance which, in turn, cannot be effected without undertaking a complex research of meteor phenomena. Such research, as was shown by the Soviet Equatorial Meteor Expedition in 1968-70, could considerably intensify observation programs and consequently facilitate obtaining experimental data necessary for solving the problems of meteor science and engineering.

## SCIENTIFIC OBJECTIVES

The present draft envisages simultaneous, theoretical and experimental studies of closely related phenomena as well as the necessary organisational undertakings.

The main objective of the project is preparation for and conducting meteor research with a view to constructing on the basis of experimental data models of atmospheric circulation, the influx and distribution of meteor substance in the near space, and models of meteor-to-atmosphere interaction which is of tremendous importance for solving fundamental and applied tasks of Meteor Geophysics and Astronomy.

### (a) Scientific Objectives in the Field of Geophysics

1. To determine the space-and-time structure of the prevailing motion, tides and principal non-regular components in the meteor zone;
2. To create global models of circulation in the lower thermosphere and its correlation with the processes in the layers lying below;
3. To analyze the structure and dynamics of macroscale systems in the meteor zone on the basis of data obtained by local radar networks;
4. To analyze the threshold models of circulation and study the secondary (pseudosynoptical) effects on atmospheric circulation caused by changes in the structure of meteor influx;
5. To study the dependence of the circulation on the solar and geomagnetic activity in various latitudes, especially in the lower and upper ones;
6. To study the meteor-atmosphere interaction, including meteor geomagnetic effects.

### (b) Scientific Objectives in the Field of Astronomy

1. To construct models of meteor influx, of the structure of sporadic and shower meteors;
2. To analyze and construct global models of the distribution of radiant coordinates and the selection factors;
3. To analyze the structure of meteor influx in the northern and southern hemispheres.

### (c) Scientific Objectives in the Field of Application

1. To construct reference models of atmosphere for shuttle flights

on the basis of homogeneous observation rows;

2. To develop meteorological forecast models for the meteor zone;
3. To develop the methods of using radio meteor data for long-term weather and climate forecasts;
4. To study the fine structure of the meteor influx in various mass ranges and create models of meteor hazards forecast;
5. To create models of forecasting meteor propagation of radio-waves.

#### DATA CONCEPTION

The conception of data that could ensure the solution of the above-mentioned tasks is the homogeneity and availability of the observation rows obtained on the global meteor radar network. This can be provided for by an adequate regulation of metrologic and space-and-time characteristics including: the unification of measuring system parameters, algorithms and techniques of observation; the structural optimization of the network; and that of the observation calendar.

##### (a) Unification

Considering realities, the first steps towards structural and technical unification of the existing radars should include but minimal demands. This minimum involves the unification of all radar parameters that can be determined by their relation to the registered complex of meteors and estimated atmospheric parameters, i.e. the limited registered meteor radiomagnitude; the selection characteristics in respect of large and small values of velocities and other parameters under study; height resolution; and scanning regimes, methods and schemes of observations.

It must be noted that these demands are to be verified in the Manual of Radio Meteor Observation that are being worked out by the IAGA Working Group V-2 and the Joint IAU/IAGA Committee on Radar Observations of Meteor Flux and Radiants, and Anomalies at the Base of the Thermosphere.

##### (b) Structure

One of the main conditions for achieving the objective of the research under study is the installation of a network of meteor radar sounding which in the best possible way answers the task of establishing the meridional and zonal profiles of the middle atmosphere wind field as well as that of registering radiants of the whole celestial sphere.

The job of carrying out the adopted IAGA recommendations for expanding the network must be aimed primarily at introducing additional observation systems (stationary or mobile) in such geographical points as would, in combination with the existing radar network, ensure the necessary spatial structure of data to comply with the purpose of the draft project. Considering the existing network and the possibility of IUGG national committees and research institutions, the analysis of the work on developing new automatic meteor radars (of the fourth generation in particular) and also the positive experience gained by expedition (e.g. to the Equator and Antarctica) the following scheme of distributing radar stations is proposed (Figure 1).

The proposed variants for expanding the existing radar network have been worked out taking due account of: constructing a regular network of measuring points for reliable verification of the global circulation models; and distributing measuring points along the meridians and parallels within a half of the radius of correlating weather systems that would yield information on the circulation profiles along the 33°E, 135°E meridians and the 50°N parallel.

The 75°E meridian and the pairs of observation points placed central-symmetrical to the Equator (for instance, Adelaide-Kampala-Atlanta and Rio-de-Janeiro-Kampala-Hanoi) are suggested as an alternative.

It is supposed that the installation of observation points in some countries would call for various bi- or multi-lateral research projects including expeditions to different points of the globe.

### (c) Calendar

The basic criterion for the choice of observation intervals and compilation of the calendar is getting the maximum of useful information (both geophysical and astronomical) in the observation rows obtained by the radar network.

The whole observational interval, as envisaged by the project, should last for no less than one cycle of solar activity (1980-90) During this period, as was mentioned earlier, the countries concerned should see to it that the intensive programs for the maximum and minimum solar activity be carried out using the observation data obtained both by the stationary and mobile radars.

Due to various limitations, the above programs must be completed within relatively small space of time. The experience gained by the SEME and the present circulation models make it possible to adopt a two-year interval as an optimal duration of intensive (especially for expeditions) observation, and no less than an 8-month interval including both Equinoxes for observation on the network located parallel to the

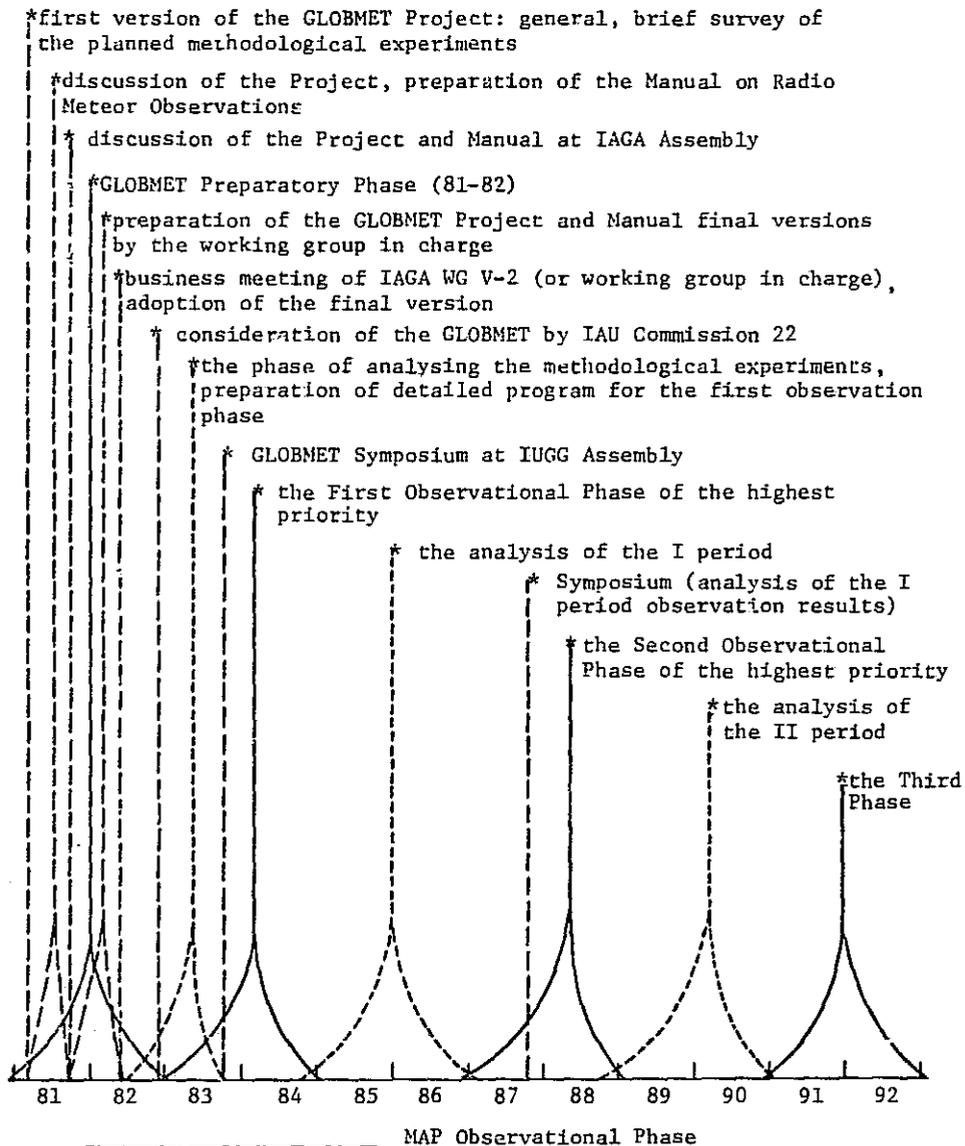


Figure 1 Tentative GLOBMET calendar.

## Equator.

In the choice of observation intervals one must also be guided by: the degree of geophysical value of the period; the scheduled complex of atmospheric research using other techniques and other altitudes; and the feasibility of organising and sending expeditions (both ground- and ship-based) to interesting geographical points. It is obvious that the second half of the MAP observational phase will be a most interesting interval in the coming cycle of solar activity.

## COLLECTION AND EXCHANGE OF DATA

In line with the recommendations of IAGA WG V-2 the data depositors are to be the World Data Centres. The data to be submitted to the international centres include: average hour-by-hour wind velocity (the code of data type is IFLAG-2); and prevailing winds and tides (IFLAG-3).

The deposits of organisations sides to the project include: results of observation of meteor radiants and orbits; echo-by-echo records (IFLAG-1); and results of measuring physical parameters of meteor and atmosphere as well as registration of meteor activity.

The organisations-participants in the project are to submit to the World Data Centres summarized information on the data in hand within the periods to be established for each kind of information.

It is suggested that data formats, yet to be adopted, should be developed and agreed upon within the framework of the Guide to International Data Exchange through the World Data Centres that are being prepared.

## WORKING GROUP

To ensure an adequate management of the research in line with the present project the development and coordination of the current programs and observation calendars as well as the analysis of research progressing, a working group should be created including representatives of IAGA, IAMAP, IAU, URSI and specialists, representatives of the leading centres of meteor research.

COLD ARCTIC MESOPAUSE PROJECT (CAMP):  
SCIENTIFIC OBJECTIVES

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BACKGROUND

During late summer 1978 a rocket campaign was carried out at Esrange. The scientific aim of the campaign was to study the ion chemistry and composition at and around the extremely cold arctic mesopause, particularly in connection with observations of NLC (=noctilucent clouds). The campaign was a result of a European cooperation with groups participating from Sweden, the Federal Republic of Germany, U.K. and from Switzerland. Altogether seven rocket payloads were launched with a great variety of instruments. Several plasma parameters were measured as, for example, density of electrons and positive ions and composition of both positive and negative ions. A few measurements of the neutral atmosphere were also made, for instance, measurement of the concentration of atomic oxygen, determination by optical means of the height of the NLC and the light-scattering properties of the cloud particles as well as of the number density scale height of the atmosphere from which a temperature profile was derived. A report on the results from the campaign will appear in *J. of Geophys. Res.*, 1981.

The composition of positive ions was measured with a combination of two ion mass spectrometers, one (magnetic) having a very good mass resolution in the mass range 14-220 AMU and one (quadrupole) having a poorer mass resolution but instead a very good height resolution ( $\approx 200$  m) and a wide mass range ( $\approx 750$  AMU). At a height of 90.1 km, both spectrometers detected a narrow layer ( $\approx 200$  m) with very heavy proton hydrates ( $H^+ \cdot (H_2O)_n$ ;  $n < 20$ ). With the present ion chemical models of the hydration processes it is not possible to explain the existence of such big proton hydrates at reasonable temperatures. The time difference between the flights of the two spectrometers was round 1/2 hour which shows that the layer had a persistence of at least this time. Interesting is that the NLC was detected at a height of 83 km, i.e., about 7 km lower in altitude than the heavy ion layer.

The concentration of atomic oxygen shows a profile which above 82 km compares well with a typical daytime profile at lower altitudes, while below 82 km it is low compared to a midlatitude daytime profile by a factor of three to four. According to present ion chemical models, atomic oxygen controls the formation of negative ions. This is done mainly through the reaction of atomic oxygen with  $O_2^-$  (which is the primary initial negative ion formed) giving  $O_2$  and a free electron.

Through this reaction, atomic oxygen concentration exceeding  $10^{10}$  at/cm<sup>3</sup> (above 82 km in this case) effectively prevents negative ions to be formed. In addition to the high oxygen concentration, the upper atmosphere was sunlit which through rapid photodissociation of negative ions according to present reaction schemes should prevent a population of negative ions to be formed. In spite of this, the measurements of the densities of electrons and positive ions show a deficiency of electrons below 91 km height. At this height there was a very sharp ledge in the electron concentration with a decrease in concentration of an order of magnitude over a height interval of 1 km. The composition of the negative ions has not yet been analyzed, but with the instrument used it will probably be very difficult to determine their identity. The interesting point, however, is that negative ions or negatively charged aerosol particles did exist. This raises the question if low temperatures ( $T$  was derived to have a minimum of 130 K at 86 km but was probably even lower at 90 km) will alter the rates of the production and loss processes enough to allow for a population of negative ions to exist or if there exist formation mechanisms other than the ones presently known.

#### THE PLANNED CAMP PROJECT

For further and more extensive study of the formation processes of NLC and the general ion chemistry of the D-region at low temperatures, a new project is being planned. The project has been named CAMP (Cold Arctic Mesopause Project) and will also be an international cooperative project performed during later summer 1982. Similar experiments as in the previous project will be performed but increased efforts will be made to achieve improved measurements of negative ion concentration and composition, temperature, density as well as size of NLC particles, winds, waves, and, if possible, water vapor concentration. This will be done by using rocket techniques, possibly satellites, ground-based instruments and to some extent balloons. An additional study still under consideration is the repeated measurement of the optical structure of the middle atmosphere by small rockets carrying a simple photopolarimeter.

In a recently developed model of the growth of ice particles around the mesopause, Bjorn et al. (to appear in *J. of Geophys. Res.*) have shown that it is possible that the heavy ions found at 90.1 km can grow by condensation and stabilize as a condensation nuclei and while subsequently sedimenting through the atmosphere, grow big enough to eventually form NLC particles. A necessary condition for this to happen is that the temperature around the mesopause is lower than about 140 K, which has normally been found in earlier measurements, but also that there is a narrow layer where the particles (and ions) are formed in which the temperature is as low as around 120 K. The necessary width of this layer depends on the temperature below it and varies between a few meters and a few hundred meters for conceivable mesopause conditions.

One of the main scientific aims of CAMP is therefore to measure the temperature profile in the mesopause region with the best possible accuracy and height resolution obtainable to date.

A further question concerning the formation of condensation nuclei is the role of negative ions. First of all, negative ions do, like positive ions, form large clusters. If these grow to large enough size, they can as well as positive cluster ions act as condensation nuclei. Furthermore, any removal of electrons by formation of negative ions or negatively charged aerosol particles will increase the kinetic lifetime of the positive ions and thereby also increase their possibility to grow big. As current ion chemical models for mesospheric negative ions fail to explain even the existence of negative ions under typical NLC conditions, it is of primary importance to confirm their existence and to have a positive identification of their mass numbers. This is the second important scientific aim of CAMP.

As the total lifetime of an NLC particle is several hours (can in fact be 24 hours or longer), even rather low wind velocities will carry the particles over large horizontal distances. It is, therefore, important to obtain information on the wind and wave motions in the height range of interest to be able to estimate the location of the production region. These parameters can be measured with different rocket techniques and also with ground-based radio wave experiments. The main reason for waves to be of interest is that the temperature of an air parcel, which through wave motions is subject to adiabatic compression or expansion, can vary extensively for rather limited wave amplitudes. This, in turn, might very well cause a change between favourable and non-favourable conditions for NLC particle production, and can possibly explain some of the typical wavy structures normally seen in NLC displays.

Finally, a very important parameter is the concentration of water vapor. Unfortunately, there does not exist any method to measure this parameter with the desired height resolution but all available techniques integrate over rather large volumes. In spite of this lack of good techniques, attempts will be made to include one or possibly a few of the existing ground-based, rocket-borne or satellite techniques in the experiment. The launch period will extend from about July 25 to August 15, 1982 with the rocket-borne instruments being launched in two salvos. One of these salvos will be the main salvo and contain one set or each experiment. Monitoring of the presence of NLC will be made from an aircraft.

Below, a list has been included of the scientific groups which till now have been directly involved in the planning of the experiment. The groups have been listed payloadwise with their respective experiments.

In addition to these groups, several other experimenters have ex-

pressed their interest in participating with ground-based measurements and experiments carried by balloons and aircrafts. As examples of such experiments can be mentioned: EISCAT (CNET, UIO), meteor radar (CNET, Univ. Sheffield), microwave limb-scanning for detection of mesospheric  $H_2O$  and  $O_3$  (MPI-A, Lindau), Lidar (CNRS), selective optical detection of atmospheric emissions (UCL, MISU, Univ. Wuppertal) and photolytic detection of stratospheric  $H_2O$  (NOAA).

CAMP	(2)	NIKE-ORION
Univ. Bern		Magnetic positive ion mass spectrometer
Met. Inst. Stockholm		Magnetic negative ion mass spectrometer
Univ.		NLC photometer
Uppsala Ionospheric		Heavy ion trap
Observatory		Electrostatic pos. ion probe
		Langmuir probe
		Faraday experiment
		Energetic electron detector (0.1-20 keV)
SOAP	(2)	NIKE-ORION
Met. Inst. Stockholm		Ar, Kr and $O_2$ resonance lamps
Univ.		Photometers and polarimeters
		Ly $\alpha$ and Schumann-Runge ion chambers
		NLC photometer
RAL, Slough Univ. College,		Oxygen resonance lamp
Wales, Aberystwyth		Temperature sensor
AFGL	(1)	NIKE-ORION
Univ. College, London		Falling sphere experiment
		Li vapor trail experiment
STRAFAM	(1)	NIKE-ORION
MPI-K, Heidelberg		Double quadrupole ion mass spectrometer
UCL	(2)	PETREL
Univ. College, London		Li vapor trail experiment
RAL	(2)	PETREL
RAL, Slough		Atomic oxygen resonance lamp
Univ. College, Wales,		Langmuir probe
Aberystwyth		Temperature sensor
MPI-K	(1)	PETREL
MPI-K, Heidelberg		Ion mass spectrometer

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END

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## REGIONAL DEFINITION GROUP REPORTS

Four Regional Definition Groups were organized several days prior to the MAP Assembly. One objective of each group was to meet and to exchange information concerning MAP plans, programs, activities, etc. in the various countries of the region. Following this, each group identified several areas in which coordination of programs and activities would be desirable. Also, experimental facilities relevant to MAP were identified within each region, including rocket ranges, balloon launch facilities, MST radars, among others.

### European Regional Programs M. L. Chanin

Among the European Projects relevant to MAP, some of them can be regarded as Regional for one or the other of the two following reasons: either the scientific theme is concerned with a geophysical problem localized in Europe, or the required means to carry a program of global interest are localized around European sites.

In the first category, two programs proposed by European countries are already insured of the participation of almost all of the European MAP-involved countries: WINE (Winter in Northern Europe) and CAMP (Cold Arctic Mesopause Program).

Two types of participation have been announced: participation in the campaign itself (rocket flight, ground observations...) or by the organization of a conjugate campaign with the same scientific aims (in USSR particularly). The participation of other scientific teams from all over the world is obviously welcomed in these projects.

In the second category, the existence of localized experimental means (rocket and balloon launch sites, geophysical stations...) are going to play an important role in projects which interests are not restricted to regional problems, and which will also benefit from the use of global means (satellites) or from the utilisation of other ground stations.

Among the proposed programs, one theme common to several European countries could benefit from coordination within Europe: the study of stratospheric constituents and of their variability. Such programs, if organized, could be an important part of the GLOBUS project.

Four European countries at least are interested in participating in balloon campaigns using the French balloon site as well as the ground geophysical station situated nearby (Belgium, France, Germany, United Kingdom). The Definition of the successive campaigns is to be done in the next year.

Another important facility in Europe is going to trigger an intense activity partly relevant to MAP; this is the EISCAT radar and all the associated experiments.

This represents the summary of discussions which took place on August 12 with the participation of P. Simon (Belgium), U. VonZahn (FRG), J. Taubenheim (GDR), P. Bencze (Hungary), E. V. Thrane (Norway), G. Witt (Sweden), L. Thomas (UK), E. S. Kazimirovsky (USSR), M. L. Chanin (France) convener.

The Asian Regional Program  
Y. V. Somayajulu

At a meeting of the representatives of the Asian region the national plans of these countries were discussed for the purpose of identification of areas for cooperation and/or coordination. The following representatives participated:

- S. Kato (National Representative, Japan)
- E. S. Kazimirovsky (National Representative, USSR)
- Y. V. Somayajulu (National Representative, India)
- C. A. Reddy, India
- R. Raghavarao, India
- B. Kashcheev, USSR
- J. K. Chao, Taiwan
- T. Ishimine, Japan

As a result of the deliberations the following areas were identified for coordination and cooperation during MAP.

(a) Cooperative Meteor Radar Observations

It is well known that meteor radars are fairly simple and yet important facilities for observing the motion at meteor heights. In the Asian region there are several of the facilities which are fairly well aligned along latitudes around 20°. It is very desirable to take advantage of this unique situation and try to derive maximum benefit in the observation of meteor regions during the MAP period. The following subjects will suit the purpose:

1. Tidal modes both solar and lunar and also planetary scale waves
2. Acoustic gravity waves which are excited in the polar upper atmosphere and the lower atmosphere in the equatorial as well as other regions.
3. During the regular and special observations, coordinated measurements will be made by the participating countries, using HF doppler, ionospheric absorption, VHF radar, drifts, etc.

(b) Cooperative Lidar Studies

The possible coordination of observations and cooperation in the area of LIDAR studies on the middle atmosphere was discussed. Four or five scientific groups in Japan are using LIDAR techniques, while one group in India has already developed techniques and two more groups are planning to develop LIDAR systems. It was felt that it would be scientifically useful to make coordinated simultaneous observations from different locations on the stratospheric dust layers and minor constituents, and on the alkali metal layers (like sodium) at 93 km altitude. It is recommended that scientists who are interested in knowing more details about the Japanese programme of LIDAR studies should contact Prof. Ono of Nagoya University, Japan, and try to work out a programme of coordinated observations. At a later stage, a more detailed programme of intercomparison of results is to be worked out with a view to understanding the interplay of dynamics and aerosols in the middle atmosphere in the Asian region.

(c) Cooperative Rocket and Balloon Experiments

India and Japan have been collaborating in rocket experiments which are of interest to MAP, such as distributions of D-region ionisation, nitric oxide, ozone, etc. During the MAP period the collaborative experiments between India and Japan will continue using rockets and balloons for studying ionisation, minor neutral constituents, aerosols, etc.

(d) EXOS-C Satellite

Japan is expected to launch EXOS-C Satellite around February 1984. This mission includes optical experiments to study the distributions of minor constituents in the middle atmosphere. Cooperation and collaboration in the scientific data utilisation is possible.

(e) MST Radar

India and Japan have indicated firm plans of building one MST radar facility each in these countries. Work has already started in Japan on the construction and is expected to be completed in 3 to 4 years to be able to be operational during the MAP period. The Indian MST radar is also expected to become operational by early 1985. It was considered desirable to share the experience of the Japanese group with the Indian group for making the MST radar data to be directly intercompared. It is recommended that support for all the groups should, wherever needed, be augmented/intensified so as to optimise scientific returns.

It is further recommended that each country establish a national data centre which could liaise with regional World Data Centres.

North American Regional Programs  
J. B. Gregory and G. C. Reid

The matter of cooperation between Canada and the United States concerning MAP has been the subject of correspondence between us prior to the establishment of MAP regions, and has been further discussed at Edinburgh.

We are agreed that no immediate action is necessary, for the following reasons:

The establishment of a Canadian MAP Committee is not yet complete, though it may be expected in 1982.

Cooperation between Canadian and US Scientists is inherent to the North American scene, and is a daily reality. (The two largest programs in Canada with relevance for MAP have separately established close ties with US counterparts, and when formal structures are complete, can be officially announced as MAP cooperation.)

Within the North American frame of reference, further developments in cooperation can be expected, and will be transmitted to MAPSC for information as they occur.

Southern Hemisphere and Antarctic Regional Programs  
J. A. Gledhill

Countries represented: Argentina (AR), Australia (AU), France (F), FRG (G), Japan (J), New Zealand (NZ), South Africa (SA), United Kingdom (UK), Soviet Union (SU), USA (US). Not represented: Brazil (B).

All countries have ongoing programmes which will continue through MAP. Many of these are already coordinated on a world-wide basis, e.g. ionograms each 15 min.

(a) Projects Which Could Usefully be Coordinated on a Regional Basis

1. Joint expedition to study the South Atlantic Anomaly (proposed for July 1983, not yet formally approved). Airglow, ionosphere (AR, B, SA), electric fields and X-rays by balloons (B,F(?)), mapping of Mg ions and electric fields from balloons (G(?)).

2. Proposed cruise by ship of SU along Antarctic coast, Leningradshaya to Molodezhnaya (some time before 1985). Coordination with other activities in the neighbourhood is most desirable.

3. Several balloon campaigns are envisaged. Long-life balloons (F) launched from Pretoria (SA); Globus balloons measuring stratospheric

trace constituents (G); NASA sounding balloons at the 5-10 mb level (UK, US). Coordination may be difficult but there are opportunities for participation by other countries in tracking and interpretation.

(b) Projects Which Would be Coordinated on a Global Basis

4. The desirability was stressed of coordination between north and south polar observations for comparative purposes.

5. Some Australian atmospheric tidal observations are already coordinated by CTOP. Other observations such as gravity waves may benefit by being coordinated also.

(c) Projects Which Offer Opportunities for International Participation

6. Satellite programs (US) such as Solar Mesosphere Explorer, Halo, and NASA remote sensing satellites. Also 1, 3 above.

The Regional Definition Groups for the MAP Assembly

European Region

Belgium	P. C. Simon
Czechoslovakia	Z. Lastovicka
Finland	C. Sucksdorff
France	M. L. Chanin (convener)
FRG	U. von Zahn
GDR	J. Taubenheim
Hungary	P. Bencze
Ireland	P. Lynch
Italy	G. Fiocco
Norway	E. V. Thrane
Sweden	G. Witt
U.K.	L. Thomas
U.S.S.R.	E. S. Kazimirovsky

Asian Region

India	Y. V. Somayajulu (convener)
Israel	J. Joachim
Japan	S. Kato
Taiwan	A. Tran
U.S.S.R.	E. S. Kazimirovsky

North American Region

Canada	J. B. Gregory (convener)
U.S.A.	G. C. Reid

## WORKSHOP DEFINITION GROUP REPORTS

Three Workshop Definition Groups were established prior to the MAP Assembly in order to assess the need for workshops in several active areas of middle atmosphere research. These groups were as follows:

Mesosphere-Thermosphere Coupling and Physics of the Mesopause

G. C. Reid (convener)

Equatorial Middle Atmosphere Measurements

I. Hirota (convener)

MST Radars

S. Kato (convener)

Proposal for Workshop on Thermosphere-Mesosphere Coupling

G. C. Reid

The mesopause, forming the interface between the mesosphere and the thermosphere, is a particularly interesting atmospheric boundary. The coldest temperatures of the atmosphere are found at the high-latitude summer mesopause, and the temperature gradients on either side can be remarkably steep. Transport of minor atmospheric constituents takes place across the mesopause, but one might expect their distribution to be significantly affected by the presence of such a sharp and cold boundary.

Direct experimental investigation of the mesopause has not been extensive, and many important questions remain unanswered. Among these are:

1. What is the role of vertical motions in producing the low temperatures of the high-latitude summer mesopause?
2. What are the special conditions associated with the formation of noctilucent clouds?
3. How do eddy transport properties change across the mesopause?
4. What are the rates of diffusion of thermospherically produced species, such as O and NO, into the mesosphere.

These and other questions are likely to require coordinated international programs. A workshop to examine these problems and to propose specific programs to attack them would be very worthwhile.

Proposed Workshop on Equatorial Middle Atmosphere Measurements

I. Hirota

It has been widely recognized that vertically propagating

equatorial waves, including planetary waves and gravity waves, play an important role in producing the mean zonal flow variation through the mechanism of wave-mean flow interaction (see the report of FMP-2 and MSG-1).

However, there still remain questions as to the detailed structure and behavior of wave motions in the upper stratosphere and mesosphere, mainly because of the lack of adequate observations in the equatorial middle atmosphere.

Therefore, a workshop on equatorial middle atmosphere measurements is proposed. Subject to be discussed are:

1. Open questions on dynamical processes in the equatorial middle atmosphere.
2. Requirements for future observations (e.g. physical quantities, height range, resolution, accuracies, etc.).
3. Possible techniques (e.g. MST radars, satellites, rockets, etc.).
4. Data archiving.

In view of our recognition that the MST radar is one of the most powerful tools for observations of wave motions in the middle atmosphere, it is recommended that this workshop should be held jointly with a workshop on middle atmosphere radars (proposed by Prof. S. Kato), with the participation of both scientifically and technically oriented people.

Proposed Workshop on Middle Atmosphere Radars  
S. Kato

Recent developments of VHF and HF radars of the MST, ST and partial reflection type offer novel and unique methods for observing the dynamics of the middle atmosphere. These systems will play an important role in the MAP observations, 1982-1985. The ST systems are likely to become important tools in synoptic meteorology. In order to derive maximum benefit from existing systems and to assist in the planning of new systems, it is proposed that a workshop be held in 1982 to examine the technical developments to date and to discuss the scientific issues. Detailed discussions will include:

1. Technical aspects of antenna design and radar signal-processing, e.g. implementation of pulse coding.
2. Data reduction techniques to reduce the effect of clutter, spectral analysis etc.

3. A discussion of the scientific and meteorological requirements (e.g. height resolution, vertical velocities, errors, etc.).

4. Data archiving and the needs of the meteorological community (e.g. operating schedules, data format, etc.).

In view of the proposed use of these systems in MAP it is recommended that the workshop be held no later than the middle of 1982.

It is noted that an "Equatorial Middle Atmosphere Measurements Workshop" has also been proposed and a number of participants both scientifically and technically oriented, will be interested in attending both workshops. It is suggested that these workshops be held consecutively at the same location.

Two additional workshops were proposed during the MAP Assembly as follows:

Intercomparison of Basic Data and Derived Dynamics during Disturbed Winter Conditions

K. Labitzke (proposer)

Intercomparison of Solar UV Irradiance Measurements and Related Instrument Calibrations

P. C. Simon (proposer)

## RESOLUTIONS

## 1. THE MAP ASSEMBLY,

Noting that some SCOSTEP member countries have not yet designated a MAP representative,

urges them to nominate a scientist, preferably involved in middle-atmosphere research, to act as MAP Representative, prior to the beginning of MAP on January 1, 1982.

## 2. THE MAP ASSEMBLY,

noting the importance of rapid dissemination of information concerning MAP Projects and other activities of the countries during the Middle Atmosphere Program commencing January 1, 1982,

recommends to the member countries of WMO and SCOSTEP that they respond favorably to the requests by WMO and by the President of SCOSTEP, respectively, that one or more scientist, on a rotating basis, be seconded to assist the MAP Scientific Information Exchange Office at Boulder, Colorado, during the period of MAP.

## 3. THE MAP ASSEMBLY,

noting the outstanding role played by Dr. E. R. Dyer in the formulation and promotion of the original idea of MAP,

expresses its appreciation to Dr. Dyer on his retirement from the position of Scientific Secretary of SCOSTEP, and

looks forward to his continued counsel during the coming years as an Administrative Advisor of the SCOSTEP Bureau.

The resolution below was proposed by Dr. P. C. Simon in the MAPSC Meeting on 15 August 1981, following the adjournment of the MAP Assembly. Following minor revisions, it was endorsed by the MAPSC.

## THE MAP STEERING COMMITTEE,

considering that solar ultraviolet irradiance and its temporal variations is not sufficiently well known for middle atmospheric science and that new observations are badly needed to improve the accuracy and the precision of irradiance values,

recognizing that improvements in calibration procedure are expected to close the gaps between current accuracy goals and achievements,

recommends the improvement of calibration of new instrumentation by means of the maintenance of synchrotron calibration facilities, the intercomparison of the different spectral irradiance standards, and the use of a common calibration source for all future experiments to make possible the intercomparison of the new data.

## ACTIONS TAKEN BY THE MAP ASSEMBLY

## 1. MAP-II:

There is general agreement that extension of MAP shall possibly be needed. The Assembly decided to postpone the consideration of formal extension to the next MAPSC meeting at Ottawa in May 1982.

## 2. Future of Pre-MAP Projects (PMPs):

The Assembly agreed that PMPs should submit written reports to MAPSC by the end of March 1982. In this report the accomplishments of each PMP should be outlined and the intention of the group as to whether it wants to continue as a MAP project should be indicated. If the group decides to continue, new plans, terms of reference, etc. should also be included in the report. The PMPs will continue on an interim basis until the next MAPSC meeting in May 1982.

3. The Assembly voted to establish two regional consultative groups for the European and Asian regions for a period of one year.

4. Three resolutions were passed by the Assembly.

## ATTENDEES

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- A. H. Manson  
ISAS/Physics Department, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA
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Washington, DC 20591

J. Taubenheim                    Central Institute of Solar-Terrestrial  
Physics, DDR-Berlin-Adlershof, GERMAN  
DEMOCRATIC REPUBLIC

- L. Thomas                      University College of Wales, Aberystwyth,  
Dyfed, UNITED KINGDOM
- R. A. Vincent                   Physics Department, University of Adelaide,  
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- U. von Zahn                    University of Bonn, FEDERAL REPUBLIC OF  
GERMANY
- M. Wada                         Institute Phys. Chem Research, Itabashi,  
Tokyo 173, JAPAN

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<b>Part 2. Condensed Minutes of MAP Steering Committee Meetings Held in Edinburgh</b>	<b>Page</b>
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MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
Monday, August 10, 1981  
1930 hours

CONDENSED MINUTES

1. The tentative Agenda was received and approved.
2. Minutes of the Fifth Meeting of MAPSC, Hampton, VA, 22-23 May 1981 were approved.
3. Four Regional Definition Groups were organized. The groups are to meet during this week to define regional cooperative MAP activities in the regions and report to the MAP Assembly on Friday afternoon.
4. Three Workshop Definition Groups were organized. The conveners of the groups will organize meetings of specialists this week to discuss possible workshops on these subjects, to be held in the next year or two, and report to the MAP Assembly on Friday afternoon.

An additional Workshop Definition Group on Troposphere-Stratosphere Coupling was proposed. The Committee decided to postpone the discussion until the IAMAP Assembly next week.

At the Hampton meeting a new MAP Study Group on Neutral Chemistry was proposed. A new title for the group "Chemistry of Ozone and Related Species" was suggested.

5. The general question of liaison between MAP and major operating agencies in the nations was discussed.
6. Restructure of MAP-4 was discussed. It was suggested that a definite task should be defined. A possible project is to prepare a publication for the climatology of the middle atmosphere, essentially to extend the work by Dr. Labitzke in 1972 to cover the entire middle atmosphere. WMO may be involved. Dr. Gregory and Dr. Labitzke will prepare suggestions for the Friday meeting. The possibility of asking COSPAR to prepare the cross sections (similar to the International Reference Ionosphere effort) was discussed.
7. The Chairman reported that J. H. Allen has asked to be relieved as a co-chairman of the MAP Data Management Committee. The Committee agreed to recommend Dr. G. K. Hartmann to replace him. It was suggested that the Data Management Committee should prepare a guide for international data exchange for MAP as a subset of the ICSU STP data exchange guide.

The preparation of a data catalog for MAP was discussed. At the MAP

Assembly, National Representatives will be asked to discuss their national needs for such a catalog with regard to its contents, format, etc.

Dr. Roper advised the Committee that a IAMAP-wide upper atmosphere data commission will discuss related problems next week at the IAMAP Assembly.

8. The question of membership of the various FMPs and MSGs was discussed. The National Representatives on the Steering Committee expressed their thoughts on the problem. It was generally felt that representation should depend on the activities of the individual nations on the specific subject.

The question of whether the FMPs should be continued was discussed. The Committee decided to ask the FMPs to report to the Steering Committee on their future plans. A written report should be submitted by the end of March 1982. In this report, the accomplishments of the FMPs should be outlined and the intention of the group as to whether it wants to continue as a MAP project should be indicated. If the group decides to continue, new plans, terms of reference, etc. should also be included in the report. The FMPs will continue on an interim basis until the next MAPSC meeting in May 1982, Ottawa.

9. Two proposals for MAP projects were presented and discussed:
  - (a) Global Meteor Observation System (GLOBMET)
  - (b) Cold Arctic Mesopause Project (CAMP)
10. The Chairman announced that the MAPSC meeting will reconvene on Friday, August 14 at 1930 hours.

MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
Monday, August 10, 1981

AGENDA

1. Approval of Agenda
2. Minutes of Fifth Meeting of MAPSC, Hampton, VA, 22-23 May 1981.
3. Regional Definition Groups:  
Europe; Asia; North America; Southern Hemisphere and Antarctica
  - (a) Terms of Reference
  - (b) Formulation of Tasks
4. Workshop Definition Groups:
  - (a) Mesosphere-Thermosphere Coupling and Physics of the Mesopause
  - (b) Equatorial Middle Atmosphere Measurements
  - (c) Troposphere-Stratosphere Coupling
  - (d) MST Radars

Proposed New MAP Study Group: Chemistry of Ozone and Related Species.
5. Coordination of Satellite Experiments
6. Restructuring of EMP-4
7. MAP Data Management Committee
8. Membership Revisions for EMPs, etc.
9. Proposed MAP Projects:
  - (a) Global Meteor Observation System (GLOBMET)
  - (b) Cold Arctic Mesopause Project (CAMP)
10. Date and Time of Continuation of Meeting -- 1930 Friday, August 14
11. Other Business

## DEFINITION GROUPS FOR MAP ASSEMBLY

## REGIONAL DEFINITION GROUPS

European Region

Belgium	P. C. Simon
Czechoslovakia	Z. Lastovicka
Finland	G. Sucksdorff
France	M. L. Chanin (convener)
FRG	U. von Zahn
GDR	J. Taubenheim
Hungary	P. Bencze
Ireland	P. Lynch
Italy	G. Fiocco
Norway	E. V. Thraae
Sweden	G. Witt
U.K.	L. Thomas
U.S.S.R.	E. S. Kazimirovsky

Asian Region

India	Y. V. Somayajulu (convener)
Israel	J. Joachim
Japan	S. Kato
Taiwan	A. Tran
U.S.S.R.	E. S. Kazimirovsky

North American Region

Canada	J. B. Gregory (convener)
U.S.A.	G. C. Reid

Southern Hemisphere and Antarctic Region

Argentina	J. R. Manzano
Australia	W. G. Elford
France	M. L. Chanin
FRG	U. von Zahn
Japan	S. Kato
New Zealand	W. J. Baggaley
S. Africa	G. J. Kuhn
U.K.	L. Thomas
U.S.S.R.	E. S. Kazimirovsky
S. Africa	J. Gledhill (convener)

## WORKSHOP DEFINITION GROUPS

Mesosphere-Thermosphere Coupling and Physics of the Mesopause

G. C. Reid (convener)

Equatorial Middle Atmosphere Measurements

I. Hirota (convener)

MST Radars

S. Kato (convener)

MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
Monday, August 10, 1981

## ATTENDANCE LIST

<u>Name</u>	<u>Affiliation</u>
S. A. Bowhill	SCOSTEP
E. R. Dyer, Jr.	Observer (US MAP Panel, NAS)
J. B. Gregory	SCOSTEP
I. Hirota	IAMAP
S. Kato	National Representative, Japan
E. Kazimirovsky	Representing Dr. Danilov (COSPAR)
C. H. Liu	SCOSTEP Secretary
L. R. Megill	IAGA
T. Nagata	SCAR
R. G. Roper	Observer (IAGA/IAMAP)
C. F. Sechrist, Jr.	Chairman, MAP Publications Committee
P. C. Simon	IAU
J. Taubenheim	IAGA
L. Thomas	National Representative, UK
M. Wada	IUPAP

MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
Friday, August 14, 1981  
1930 hours

CONDENSED MINUTES

1. Agenda was approved
  2. Minutes of the August 10th meeting of MAPSC were approved.
  3. The Chairman reported that SCOSTEP will establish an ad hoc Committee on GLOBMET having close coordination with MAP. The Committee endorsed this arrangement.
  4. CAMP (Cold Arctic Mesopause Project) was approved as a MAP project.
  5. Proposal from Dr. Ceplecha on atmospheric disturbances by meteoroids. Dr. P. C. Simon will obtain a response from the IAU and then report to the Committee.
  6. It was decided that MAP Projects should be assigned letters, MAP-A, MAP-B, etc., to be determined by the MAP Secretariat.
  7. Future of FMPs. The Committee agreed that written reports should be submitted by the end of March 1982. In these reports, the accomplishments of the FMPs should be outlined and the intentions to continue as MAP Projects should be indicated. If the decision is to continue, new plans, terms of reference, etc. should also be included in the report. The FMPs will continue on an interim basis until the next MAPSC meeting in Ottawa, May 1982.
  8. Future of MSGs. The MAPSC is studying the topic. Two approaches are possible:
    - (a) If the MSG report has specific recommendations for workshops, it should be continued and workshops should be organized to include experimentalists and modellers to prepare proposals for MAP projects.
    - (b) If the MSG report does not have specific recommendations, then the Group should be dissolved and its findings announced to the MAP community. Development of proposals for MAP projects will be encouraged.
- The MAPSC will consider the topic of MSG categories.
9. GLOBUS (Global Budget of Stratospheric Trace Constituents). The Committee decided to ask the coordinators for more information on

specific goals of the project.

10. Regional Definition Groups. The Chairman will inform the National Representatives that in principle the Regional Definition Groups are dissolved. However, MAPSC will entertain proposals to reconstitute such groups for a limited time if necessary. The nations involved should agree on the proposal to establish such a group. The regional groups need not be the same as the four ad hoc Regional Definition Groups formed in Edinburgh. When approved, MAPSC will recognize the Group as a formal MAP Committee.
11. MAP-II. The Committee agreed that there is a need for extending MAP beyond 1985. The Chairman will indicate to the National Representatives that MAPSC is considering MAP-II and will make a decision next year at the MAPSC meeting in Ottawa.
12. Proposals for MAP Workshops.
  - (a) Workshop for Mesosphere-Thermosphere Coupling and Physics of the Mesopause. The Committee agreed to consider this together with the CAMP Project as a future workshop when results from CAMP are available.
  - (b) Discussion on a proposed Workshop for Equatorial Middle Atmosphere Measurements and MST Radars will be continued at the MAPSC meeting on Saturday, August 15th, following the closing plenary session of the MAP Assembly.

MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
August 14-15, 1981

AGENDA

1. Approval of Agenda.
2. Minutes of Fifth Meeting of MAPSC, Hampton, VA, 22-23 May 1981.
3. Reports and minutes on Definition Meeting of MAPSC, August 10.
4. Questions and discussion on Committee reports
  - (a) Publications
  - (b) Dynamics Calendar
  - (c) Data Management
5. Questions and discussion on FMP and MSG reports.
6. Report on SCOSTEP Bureau meeting.
7. Future of FMPs and MSGs.
8. New MAP Projects and MAP Study Groups, CAMP, GLOBMET, Proposal from Geplecha.
9. Permanent Regional Groups.
10. MAP symposia, topics and locations.
11. MAP workshops.
12. MAP Committee on Satellite Schedules and Coordination; Satellite Situation Center
13. MAPSCIE office
14. MAP II
15. WMO challenge
16. Formulation of final resolutions
17. Date and time of next MAPSC meeting
18. Other business

Edinburgh, UK  
Friday, August 14, 1981

## ATTENDANCE LIST

<u>Name</u>	<u>Affiliation</u>
L. Bjorn	MAP/CAMP Coordinator
S. A. Bowhill	SCOSTEP
E. R. Dyer	Observer (U.S. MAP Panel, NAS)
J. C. Gille	COSPAR
J. A. Gledhill	Observer
J. B. Gregory	SCOSTEP
T. Hirasawa	MAP/AMA Coordinator
I. Hirota	IAMAP
S. Kato	National Representative, Japan
E. Kazimirovsky	Representing Dr. Danilov (COSPAR)
J. W. King	URSI
K. Labitzke	COSPAR
L. R. Megill	IAGA
R. J. Murgatroyd	IAMAP
T. Nagata	SCAR
G. C. Reid	MAP Panel, USA
C. F. Sechrist, Jr.	Chairman, MAP Publications Committee
A. Shirochkov	IARI, USSR
P. C. Simon	IAU
N. Sundararaman	MAP Coordinator, USA
J. Taubenheim	IAGA

L. Thomas

National Representative, UK

M. Wada

IUPAP

MAP STEERING COMMITTEE MEETING  
Edinburgh, UK  
Saturday, August 15, 1981  
1120 - 1230 hours and 1330 - 1730 hours

CONDENSED MINUTES

1. Committee reports

- (a) Publications: The MAP Newsletter was discussed. Contributions should be sent to Dr. Sundararaman or Dr. Sechrist. MAP should review the material. Possible funding for a MAP Handbook volume on "Dynamic Climatology of the Stratosphere" was discussed. The Chairman will contact UNEP through the CCF (Climate Coordinating Forum). In the future, it may be necessary to charge a nominal fee for volumes of the MAP Handbook.
- (b) Dynamics Calendar: Dr. Van Zandt was not present, but a letter from Dr. Manson to the Chairman was distributed for information.

2. Restructure of FMP-4

A new project to develop an "International Reference Middle Atmosphere" (IRMA) was proposed. An exploratory group comprising Gregory (convener), Labitzke, Gille and Murgatroyd was appointed. The MAPSC authorized the group to define the general scope of the task and then approach a government agency (possibly a research laboratory) for support. After the support has been obtained, an advisory group would be established to define quantities to be presented, common terms of reference, a common format, and to advise the people actually carrying out the task.

Future activities of FMP-4 should follow the same procedure as the other FMPs.

3. The Secretary reported on the SCOSTEP Bureau Meeting at Abingdon, UK, July 29-31. The 1981 allocation of \$6,000 for MAP is expended. The 1982 budget for MAP is \$15,000.
4. The Future of MSG's

The Committee agreed on the following action for the future of the MSG's: A notice from the Chairman of the MAPSC in the MAP Newsletter will inform the MAP community about the published MSG reports. Comments on these reports and suggestions for projects to be implemented as the result of these studies should be sent to the Chairman of the MAPSC. He will then negotiate with the MSG's on

the question of whether the MSG will be continued and eventually developed into a MAP project. If so, new membership, new plans, and terms of reference will also be discussed.

5. Future MAP Symposia:

May 1982, Ottawa: STP Symp. - 8 half-day sessions; COSPAR - 4 half-day sessions.

August 1983, Hamburg: IAMAP/IAGA - 6 half-day sessions.

Possible Future Symposia:

Ground-based techniques for MAP, 1983, GDR; MAP General Symp., 1984, Japan; and Symp. on Polar Middle Atmosphere, after 1983, USSR (dates may be announced at Ottawa SCOSTEP meeting).

6. MAP Workshops Proposed:

(a) Workshop on Measurements of Winds and Waves in the Tropical Middle Atmosphere (convener: Hirota).

(b) Coherent Scatter Radar Technique Workshop (convener: Kato).  
(a) and (b) should be held in succession.

Possible time: May 10-12, 1982  
Possible place: Boulder, Colorado

(c) Comparison of Results of FMP-1 (convener: Labitzke)

Possible time: May 11-14, 1982  
Possible place: Boulder, Colorado

(d) Solar Spectral Irradiance Workshop (convener: Simon)

Possible time: May 12-14, 1982  
Possible place: Washington, D.C.

The Chairman noted that workshops with MAP endorsement and financial support should have open participation. Any person who wishes to participate should be given the chance to show to the organizer that he will be able to make useful contributions. This can be accomplished by procedures such as sending abstracts or reports to the organizer for review. Workshops must be announced in the MAPNL with statements on open participation. The organizer should keep the chairman of the MAPSC informed. The organizer will have the freedom to invite participants.

For the workshops planned for 1982 (a,b,c,d above) the organizers should send detailed plans to the chairman in a month.

The chairman set a maximum contribution from MAP funds of \$1,500

for each workshop.

7. MAP Committee on Satellite Schedules and Coordination:

The MAPSC recommended the establishment of a MAP Committee for Satellite Coordination.

Possible members are:

Carl Knott for ESA (convener)

The chairman will write to Dr. Obridka (USSR) requesting suggestions for a contact.

He will also contact NASA for a US contact. Dr. Hirota will write to Prof. Itoh for suggestions for a Japanese contact.

8. Three resolutions were passed by the Assembly.

9. MAP-II:

MAP-II was discussed in the Assembly. All agreed that there is a need for possible extension of MAP. Two different views developed. On the one hand there is the desire for an early decision on MAP-II because of the long lead time required in countries for funding. On the other hand there is the concern about discussing MAP-II when MAP-I has not officially begun.

The Assembly voted to postpone the decision on MAP-II until the next MAPSC meeting to be held in Ottawa in 1982.

Because of the possible conflicts of schedules with the SCOSTEP General Meeting in May 1982 the chairman will write to MAPSC members for their opinions on MAP-II and other matters in March 1982. Replies are desired by the end of April 1982. The chairman can present the decisions to the SCOSTEP Bureau for action in Ottawa.

10. WMO Challenge:

At the Hampton MAPSC meeting, Dr. Bojkov discussed troposphere-stratosphere interaction, solar influences on the stratosphere, ozone-related species measurements as examples of WMO projects related to MAP. He asked MAP to propose fully developed projects to be presented to WMO.

The committee discussed several possibilities: stratospheric warmings and effects on ozone; transport of ozone from stratosphere to ground level caused by tropopause folding, etc. It was pointed out that projects of interest to WMO most likely have been already

studied by WMO. It was also discussed that the work on penetration of solar radiation in the Schumann-Runge bands in the stratosphere could be a part of a study on solar influences on the stratosphere. Influence of the stratosphere on the formation of blocking was also mentioned. The WMO challenge will be discussed in the future.

It was also suggested that the MAPSC should urge WMO to recommend upgrading high-latitude radiosonde stations.

11. A resolution directed to NASA and NBS on synchrotron calibration facilities was introduced. The MAPSC recommended that it be referred to the Radiation Commission of IAMAP for their endorsement.
12. A new category: "MAP Activity" was discussed. There is a need for MAP-related activities that complement MAP Projects.
13. Next MAPSC meeting will be in the week of May 17, 1982 at Ottawa during STP symposium. 3 half-day meetings will be scheduled. Exact time and location will be decided and announced.

MAP STEERING COMMITTEE MEETING  
 Edinburgh, UK  
 Saturday, August 15, 1981  
 1120 - 1230 hours and 1330 - 1730 hours

ATTENDANCE LIST

<u>Name</u>	<u>Affiliation</u>
S. A. Bowhill	SCOSTEP
M. L. Chanin	Observer
E. R. Dyer	Observer (US MAP Panel, NAS)
J. Gille	COSPAR
J. B. Gregory	SCOSTEP
I. Hirota	IAMAP
S. Kato	National Representative, Japan
E. Kazimirovsky	Representing Dr. Danilov (COSPAR)
J. W. King	URSI
K. Labitzke	COSPAR
C. H. Liu	SCOSTEP Secretary
L. R. Megill	IAGA
R. J. Murgatroyd	IAMAP
M. J. Rycroft	British Antarctic Survey
C. F. Sechrist, Jr.	Chairman, MAP Publications Committee
P. C. Simon	IAU
J. Taubenheim	IAGA
L. Thomas	National Representative, UK
M. Wada	IUPAP

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MAP OPEN MEETING  
Hamburg, FRG  
19 August 1981

CONDENSED MINUTES

OPENING REMARKS

Dr. Godson, President of IAMAP, extended his welcome to the attendees of the MAP Open Meeting and noted that middle atmospheric activities in IAMAP dated back to 1919 when the Ozone Commission started. Not only is ICMUA now closely related to MAP, but other commissions (Radiation, Ozone, Climate, etc.) also have interests in MAP. On behalf of IAMAP, he offered facilities, involvement, and participation in MAP.

Dr. Bowhill thanked IAMAP for the arrangements made for the meeting.

SUMMARY OF MAP ASSEMBLY

Dr. Bowhill reported the activities of the MAP Assembly held in Edinburgh during 14-15 August 1981.

FMP AND MSG REPORTS

Dr. Labitzke reported for FMP-1, Dr. Hirota for FMP-2, Dr. Geller for MSG-3, and Dr. Volland for MSG-4.

NATIONAL PLANS FOR MAP

National reports were presented by: Dr. Chanin (France), Dr. Dr. Hirota (Japan), Dr. Reid (USA), and Dr. Koshelkov (USSR).

PROPOSED MAP PROJECTS

Two new MAP projects were discussed. The first: Coordination of Global Observations and Studies of Stratosphere Aerosols. The proposed convener is Dr. M. P. McCormick. The second: Measurements of Middle Atmosphere Parameters by Long-Duration Balloon Flights. The proposed convener is Dr. J. Blamont. Dr. Blamont will organize an informal group initially. In the next issue of the MAP Newsletter, he will solicit suggestions from the MAP community. Formal approval as MAP projects will be requested at the next MAPSC meeting to be held in Ottawa in May 1982.

COORDINATION OF GLOBAL OBSERVATIONS AND STUDIES OF  
STRATOSPHERIC AEROSOLS (GOSSA)

M. P. McCormick

Stratospheric aerosols are being measured currently by a variety of techniques, including:

1. Satellite sensors (solar occultation): SAM II, SAGE
2. Ground-based and airborne lidar systems
3. Balloon and aircraft *in situ* measurements
4. Ground-based photometric extinction measurements

Activities of this project will include the following:

1. Establishment of contact with all active groups involved in the following aspects of measurement of aerosol characteristics:
  - a) concentration
  - b) composition
  - c) radiative properties
  - d) backscatter and extinction
  - e) precursor gases
2. Dissemination of alerts and calendars corresponding to the occurrence of:
  - a) volcanic penetrations into the stratosphere
  - b) satellite measurement locations and times
  - c) coordinated field-measurement campaigns
3. Communication of data sets and their availability to experimenters and other interested experimenters.
4. Organization of workshops.

## ATTENDEES

<u>Name</u>	<u>Address</u>
F. Arnold	MPI for Nuclear Physics FEDERAL REPUBLIC OF GERMANY
S. K. Avery	University of Illinois USA
B. Balsley	NOAA-ERL USA
A. Belmont	Control Data Corporation USA
J. Blamont	CNRS - Aeronomie FRANCE
S. A. Bowhill	University of Illinois USA
D. Cadet	Florida State University USA
M. L. Chanin	CNRS - Aeronomie FRANCE
J. M. Cisneros	INTA-CONIE SPAIN
P. Czechowsky	MPI for Aeronomy FEDERAL REPUBLIC OF GERMANY
R. Donnelly	NOAA-ERL USA
A. Ebel	University of Cologne FEDERAL REPUBLIC OF GERMANY
J. M. Forbes	Boston College USA
M. Geller	NASA-Goddard Space Flight Center USA
W. L. Godson	President, IAMAP CANADA
S. Gough	Meteorological Office UNITED KINGDOM

M. Hirono	Kyushu University JAPAN
I. Hirota	Kyoto University JAPAN
J. W. King	Rutherford and Appleton Laboratories UNITED KINGDOM
J. Klostermeyer	MPI for Aeronomy FEDERAL REPUBLIC OF GERMANY
Yu. P. Koshelkov	Geophysical Committee USSR
K. Labitzke	Freie University, Berlin FEDERAL REPUBLIC OF GERMANY
C. H. Liu	University of Illinois USA
C. W. Loan	CSIR SOUTH AFRICA
M. P. McCormick	NASA-Langley Research Center USA
A. H. Manson	University of Saskatchewan CANADA
H. K. Paetzold	University of Cologne FEDERAL REPUBLIC OF GERMANY
K. Petzoldt	Freie University, Berlin FEDERAL REPUBLIC OF GERMANY
A. Plumb	CSIRO AUSTRALIA
Yu. Portniagin	Hydrometeorological Service USSR
G. C. Reid	NOAA-ERL USA
R. Reiter	Fraunhofer Institute for Atmospheric and Environmental Research FEDERAL REPUBLIC OF GERMANY

R. Roper	Georgia Institute of Technology USA
J. Rottger	MPI for Aeronomy FEDERAL REPUBLIC OF GERMANY
J. M. Russell	NASA-Langley Research Center USA
R. Ruster	MPI for Aeronomy FEDERAL REPUBLIC OF GERMANY
G. Schmitz	ADW DDR
D. G. Stephenson	MPI for Aeronomy FEDERAL REPUBLIC OF GERMANY
C. Sun	Institute of Space Physics REPUBLIC OF CHINA
N. Sundararaman	Federal Aviation Administration USA
H. Tanaka	Nagoya University JAPAN
R. A. Vincent	University of Adelaide AUSTRALIA
H. Volland	University of Bonn FEDERAL REPUBLIC OF GERMANY

INFORMAL MAPSC MEETING  
Hamburg  
August 19, 1981

## ATTENDANCE LIST

<u>Name</u>	<u>Affiliation</u>
A. Belmont	SCOSTEP
R. D. Bojkov	WMO
S. A. Bowhill	SCOSTEP
M. L. Chania	National Representative, France
J. M. Cisneros	Observer
W. G. Elford	National Representative, Australia
M. A. Geller	Chairman, MSG-3
J. C. Gille	COSPAR
I. Hirota	IAMAP
A. Khrgian	MAP Committee, USSR
J. W. King	URSI
Yr. Koshelkov	Geophysical Committee, USSR
K. Labitzke	COSPAR
C. H. Liu	SCOSTEP Secretary
P. Lynch	National Representative, Ireland
M. P. McCormick	Representative, MSG-5
P. C. Simon	IAU