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HANDBOOK FOR MAP VOLUME 7

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 7

Edited by

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

December 1982

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AMA	Antarctic Middle Atmosphere Program
ATMAP	Atmospheric Tides Middle Atmosphere Program
CAMP	Cold Arctic Mesopause Project
DYNAMICS	Dynamics of the Middle Atmosphere in Winter-Coordinated Studies
GLOBMET	Global Meteor Observation System
GLOBUS	Global Budget of Stratospheric Trace Constituents
GOSSA	Global Observations and Studies of Stratospheric Aerosols
GRATMAP	Gravity Waves and Turbulence in the Middle Atmosphere Program
MAC	Middle Atmosphere Cooperation
MACVAZACS	Meteorological and Chemical Variables as Zonal Averaged Cross Sections
MAE	Middle Atmosphere Electrodynamics
MAP	Middle Atmosphere Program
MAPCIEO	MAP Central Information Exchange Office
MAPNL	MAP Newsletter
MAPSC	MAP Steering Committee
MSG	MAP Study Group
OZMAP	Observations of and Sources of the Spatial and Temporal Variability of Ozone in the Middle Atmosphere on Climatological Time Scales
PMP	Pre-MAP Project
SSIM	Solar Spectral Irradiance Measurements
STRATALERT	Stratospheric Warming Alert
STRATWARM	Stratospheric Warming
SWAMP	Stratwarm Mesospheric Project
WINE	Winter in Northern Europe Project

MAP STEERING COMMITTEE MEETING
Monday, May 17, 1982
1400 - 1800 hours

CONDENSED MINUTES

1. Chairman S. A. Bowhill welcomed the attendees to the meeting. He mentioned that this was the first MAPSC meeting since the beginning of MAP on January 1, 1982. All indications are MAP is off to a resounding start. PMPs and MSGs have been very successful in catalyzing work in different areas of the middle atmosphere, and the Committee will hear reports from the groups during the course of the meeting. He also briefly described the progress made in the Publication, Dynamics Calendar and Data Management Committees.

2. The Minutes of the last Steering Committee Meeting, at Edinburgh, U.K., August 13-14, 1981 were approved.

3. Following a decision made during the last Steering Committee Meeting, the Chairman wrote to the Chairmen of PMPs and MSGs asking them to decide on the future of their groups and report to the Steering Committee. The following are the brief reports and proposals of the groups and actions taken by MAPSC on their proposals:

PMP-1 - Dr. K. Labitzke: PMP-1 has completed its job; workshops have been successful; it should continue as a MAP project entitled "Dynamics of the Middle Atmosphere in Winter - Coordinated Studies" (DYNAMICS) with increased membership. The Committee agreed.

PMP-2 - Dr. I. Hirota: Previous reports of the Project have been published in Volumes 1 and 2 of the MAP Handbook. Further discussions and suggestions were made at Estes Park during the Workshop May 10-12, 1982. The project will be discontinued but the study of equatorial wave dynamics will continue throughout MAP. The Committee agreed to discontinue the Project.

PMP-3 - Dr. J. Gille (report made on May 18, but included here for continuity): Past activities concern six or seven experiments involving SAGE, SME, SAM-II and LIMS. Future activities appear to be low. NASA is becoming more active in the area. There will be some experiments flying on the Space Shuttle, and some planned for UARS. Propose the Group issue a final report and discontinue the project; agreed by the Committee.

PMP-4 - Dr. J. Barnett (report made on May 21, included for continuity): The project should be continued as a MAP project. It is now technically possible to carry out the study, but more manpower is needed. Dr. Bowhill will discuss the problem with Drs. Barnett, Thomas and Gille and report to the committee. (Note: After the SC meeting, Dr. Bowhill talked to James Russell who agreed to serve as the Organizer of the Project.)

PMP-5 - Dr. P. Simon: During the Workshop at Washington, D.C. the previous week, all participants agreed that the activity should be continued as a MAP project with the same title. MAPSC approved the pr. ect with the recommendation that the group should be reconstituted with enlarged membership.

MSG-1: Dr. Holton had proposed (by mail) to discontinue the group. Final report was presented last year. MAPSC agreed.

MSG-2: Dr. Mahlman had proposed (by mail) to discontinue the group. Final report was presented last year. MAPSC agreed.

MSG-3: Dr. Geller - Report was published as part of MAP Handbook 3. The group should be discontinued. Two new MAP projects will be proposed. MAPSC agreed to discontinue the group.

MSG-4: Dr. Volland - The report was published in MAP Handbook. The group should be continued as a new MAP project with a new Chairman. The Committee agreed that the work should continue. The Chairman will contact the new Chairman to ask him to submit a prospectus for the new project.

MSG-5: Communication from Dr. Arnold stated that the Study Group should continue; he suggested Dr. P. McCormick as the co-chairman and Dr. E. Arijs as a new member of the Group. MAPSC agreed. Dr. Arnold also mentioned that a report on MSG-5 is being prepared and should be received for publication in a MAP Handbook in the near future.

4. Reports of MAP Projects: The approved MAP projects are MAP/WINE, GLOBUS, AMA, and CAMP.

MAP/WINE: Dr. U. Von Zahn reported that the original coordinator of the project, Dr. Krankowsky, has resigned. The Committee agreed that Dr. Von Zahn will succeed him as the coordinator. Dr. Von Zahn presented the status of the project.

MAP/GLOBUS: Dr. U. Von Zahn reported that the coordinator of the project, Dr. Seiler, has resigned and the Committee agreed that Dr. D. Offermann will be the new coordinator. Two integrated campaigns are presently in the planning stage. Details are included on the National MAP report of FRG (to be included in Volume 7 of Handbook for MAP).

MAP/AMA: Dr. T. Nagata reported the activities for Dr. Hirasawa, who could not attend the meeting.

MAP/CAMP: Dr. G. Witt reported the activities for Dr. Bjorn.

5. New MAP Projects:

Global Observation and Studies of Stratospheric Aerosols (GOSSA): The project was originally proposed in Hamburg last year. The Chairman has received approval by mail ballots from members of the Steering Committee. The emphasis of the project is entirely on the coordination of experiments making measurements of stratospheric events for morphological studies. The Committee approved the project. Dr. P. McCormick will be the coordinator.

Atmospheric Tides Middle Atmospheric Program (ATMAP): This is one of the new projects proposed by MSG-3. Dr. Geller presented the proposal to the Committee. Dr. J. Forbes agreed to coordinate the project. The committee approved the project in principle, subject to an understanding with ICMUA of IAMAP.

Gravity Wave and Turbulence in the Middle Atmosphere Program (GRATMAP): This is the second of the new projects proposed by MSG-3. Dr. Geller presented the proposal to the Committee. The project was approved by the Committee. The Chairman will discuss with Dr. Geller the membership of the group.

Global Meteor Observation System (GLOBMET): The project was originally proposed last year in Edinburgh. The SCOSTEP Bureau has appointed an ad hoc committee to study the proposal. At its meeting this week, the Bureau decided that GLOBMET should be in MAP. Drs. Roper and Kashcheev prepared the planning document. The Committee approved it as a new MAP project.

Stratwarm Mesospheric Program (SWAMP): Dr. Offermann proposed this program of coordinated winter measurements of atmospheric parameters (temperature, wind, etc.) at mesospheric heights for the period December 1, 1981 to spring 1984. It will be a sub-project of the DYNAMICS project. The Committee approved the proposal.

Synoptic Ozone Maps: During the Steering Committee Meeting last year, Dr. A. D. Belmont proposed this project. Some revisions were suggested, resulting in a new proposal to the Committee. Dr. W. L. Godson commented that WMO has considered the effort of setting up global networks for ozone measurements to be too expensive and will not be supported by member nations. It was suggested that the Chairman should discuss the question with interested scientists and report to the Committee by mail.

Transport: (Discussed on May 21, included here for continuity.) Dr. J. Gille proposed this project to study the transport of species. It was recognized that, to some degree, this is similar to Dr. Belmont's proposal. It was suggested that Drs. Gille and Belmont discuss this matter and define the project more clearly and submit a written report to the Steering Committee for consideration.

6. New MAP Study Groups:

Measurements of Middle Atmosphere Parameters by Long Duration Balloon Flights: During the Hamburg Meeting last August, Dr. J. Blamont proposed the project. The task of coordinating such long duration circumpolar flights internationally is difficult. MAP can certainly make a contribution. The proposal was announced in the last issue of the MAP Newsletter; two proposals have been received from France. Following the decision at the last Steering Committee Meeting, the Chairman polled the members of the Steering Committee by mail. A favorable but not unanimous response was received. The Committee approved a Study Group to firm up the plans for measurements, to include more international groups and to extend the scope to both hemispheres.

International Equatorial Observatory: As an outcome of the Workshop at Estes Park, a new MST radar in the equatorial region was proposed. The aim is to study tides, equatorial waves, gravity waves, strato-mesosphere interactions, etc. The Committee suggested that the scope be broadened beyond just an MST radar facility. Other types of facilities such as Lidar, etc. should also be included. The Committee approved a Study Group on Scientific Aspects of International Equatorial Observatory. The Chairman will ask Dr. Kato to chair the group.

Atmospheric Penetration of Solar Radiation in the Range of Schumann-Runge Bands: (Discussed May 18.) Dr. J. E. Frederick proposed this project last year. The Committee suggested that the study should not be limited to just Schumann-Runge Bands. It approved the proposal. Dr. Frederick will be the Chairman.

Atmospheric Chemistry. (Discussed on May 18 and May 21.) Dr. Simon originally suggested the Study Group last year with ozone chemistry as the main subject. The Committee suggested the study be broadened to atmospheric chemistry and to include the mesosphere, especially the mesopause. The Committee approved the establishment of the Study Group with Dr. G. Witt as Chairman.

7. Data Management Committee Report: Co-Chairman Drs. Hirota and Hartmann reported.

Several circular letters started the activities in October 1982.

J. H. Allen of WDC-A-STP Boulder, has agreed to serve as Secretary of the MAP-Data Management Committee and to issue and circulate the necessary information in cooperation with the two Co-Chairmen Dr. I. Hirota and Dr. G. Hartmann.

At Ottawa, first discussions will be started on a revised "MAP-C Chapter" for the Guide to International Data Exchange which will be discussed by the ICSU Panel for World Data Centers in September.

A short questionnaire will be prepared for the next MAP Newsletter to get latest information from the MAP Principal Investigators (MAP PI). If necessary, this questionnaire might be issued by J. H. Allen (WDC-A) rather than with the MAP Newsletter.

8. Publications Committee report: The Secretary presented Dr. Sechrist's report to the committee:

Committee Membership: C. F. Sechrist, Jr., Chairman, R. D. Bojkov, R. J. Murgatroyd, and V. V. Viskov.

MAP Newsletter: The MAP Newsletters are now published as Special Issues of the Upper Atmospheric Programs Bulletin which is funded jointly by the NASA Upper Atmospheric Research Program and the High Altitude Pollution Program of the Federal Aviation Administration. MAP Newsletters were published and distributed in July 1981 and in January 1982. The next issue of the MAP Newsletter will contain condensed minutes of the MAP Workshops and MAP Steering Committee Meetings held in May 1982. It will be distributed in August 1982.

Handbook for MAP: Volumes 1, 2 and 3 have been published and distributed. Volume 4, covering the MAP Assembly and MAP Open Meeting, was published and distributed in April 1982. Volume 5, A Dynamic Climatology of the Stratosphere, was published in early May 1982. It will be distributed during the latter part of May 1982.

Proposed Future Topics for Volumes in the Handbook for MAP: MAP Directory (Volume 6, July 1982); MAP Workshops and Symposia (Volume 7, September 1982); Satellite experiments including SAGE, SME, HALOE, ATMOS, LRIR, NOAA, DE, EXOS-C (Volume 8, January 1983); and ground-based techniques including partial reflection ionization drifts, middle-atmosphere radar, laser radar, meteor radar (Volume 9, April 1983).

Contributions for the MAP Newsletter: More contributions for the MAP Newsletter are urgently needed, in order to publish the Newsletter on a regular schedule.

Suggestions and Contributions for Handbook for MAP: The Publications Committee welcomes suggestions of future topics for volumes of the Handbook for MAP. Suggestions and contributions should be sent to: Professor C. F. Sechrist, Jr., Department of Electrical Engineering, University of Illinois, 1406 W. Green Street, Urbana, Illinois 61801 USA.

The question of the MAP Newsletter was discussed. The Committee decided on the following dates for publication of the Newsletter: 4 issues per year, August 1, November 1, February 1, and May 1. Deadlines for receipt of contributions in Urbana: July 1, October 1, January 1 and April 1. The Committee agreed unanimously on the usefulness of volumes of the MAP Handbook.

MAPSC MEETING

Tuesday, May 18, 1982
1000 - 1300

1. Dynamic Calendar Committee Report: Dr. Van Zandt reported that the MAP calendar for 1983 is under preparation. It will have the same format as the one for 1982. He asked that comments and information be sent to him within the next 2 to 3 weeks.

2. MAP Workshops:

PMP-1 Workshop (Drs. Labitzke and Gille): The workshop was held at NCAR, Boulder, Colorado, May 11-14. Twenty scientists from FRG, France, Japan, United Kingdom and USA participated. Data from four satellites were compared with conventional data. Three selected days were displayed for discussion (1/2/79, undisturbed; 1/26/79, wave 1; 2/16/79, wave 2). Good agreement was obtained, especially for 1/2/79, but more difficult for disturbed days. Dr. Labitzke will write to USSR for data exchange. Dr. E. R. Schmerling mentioned that if preselected days are possible, NASA can work with two days' notice. This will be considered by the DYNAMICS project. Later Workshops were suggested.

Workshop on Solar Spectral Irradiance Measurements (Dr. P. C. Simon): The Workshop was held in Washington, D.C., May 12-14. UV measurement calibration procedures and new methods were discussed. Plans were made for future long term measurements to prepare for experiments on the Space Shuttle and UARS. Standard calibration procedures should be followed by each group.

Future Workshops were proposed. Workshop on Equatorial Middle Atmosphere Measurements and Middle Atmosphere Radars (Drs. Hirota, Kato; local arrangements, Drs. Balsley and Van Zandt): May 10-12. There were about fifty participants from Australia, Canada, France, India, Japan, Taiwan, United Kingdom, and USA. Six sessions and two panel discussions were held. The future of middle atmosphere radar was discussed. The need for an equatorial MST radar was addressed.

Summaries of the three Workshops will be provided by the organizers and published in MAP Handbook Volume 7.

3. New MAP Workshops:

PMP-1 Workshops: Drs. Labitzke and Gille proposed to hold two more PMP-1 Workshops. One similar to the first PMP-1 Workshop, is planned to be held sometime in March-April, 1983 at Oxford, UK. The Oxford group will host it. Another more elaborate workshop is planned to be held at Hamburg, FRG, during IUGG, August 1983, with emphasis on scientific results derived from data. The Committee approved the proposal.

Workshop on Technical Aspects of MST Radar: Inspired by the successful Workshop at Estes Park, Drs. Bowhill and Liu proposed this Workshop to concentrate on such topics as the optimization of design parameters; lumped vs. distributed systems; nature of the targets and economic aspects of global network, etc. The Workshop will be held in Urbana, Illinois, May 23-27, 1983. Dr. Van Zandt mentioned that a symposium on waves and turbulence will be held in March/April 1983 at Boulder, Colorado. The Urbana Workshop may also be timed with respect to that symposium. Drs. Bowhill, Liu, and Van Zandt will discuss the matter. The Committtee approved the proposal. Dr. Witt reported that CAMP is planning a Workshop in the summer of 1983 which might be the same one planned by Dr. G. Reid. He will coordinate and submit a formal proposal by July 1st.

4. MAP TWO: Because of the long lead time necessary in many countries in planning scientific programs and also due to the expected delay of some projects in MAP, MAP TWO was suggested at Edinburgh. The Chairman has polled the Steering Committee on this question by mail and has received responses from many members with varying degrees of support of the idea. He presented a time scale; MAP 1982 - 1985, using existing facilities and techniques to study the climatology, processes and interaction of the middle atmosphere; MAP TWO, 1986 - 1989, using new networks of stations and new techniques developed during MAP, to measure new parameters of middle atmosphere and solve related atmospheric problems; TESS (Transfer of Energy in the Solar System), after 1990, using all solar-terrestrial measurement techniques to understand the energy budget of the solar system from the surface of the sun to the surfaces of the planets. National Representatives reported the approximate time schedules for new MAP facilities in their countries that vary from late 1983 to 1985. The continuity of the project and the need for long term time series to study atmospheric phenomena were pointed out by several Representatives. Dr. K. D. Cole, the President of SCOSTEP, explained to the Committee the operational philosophy of SCOSTEP. Each scientific program goes through three phases; the planning phase, the experimental phase and the data analysis phase. SCOSTEP provides different levels of funding for the different phases. MAP is now the principal project of SCOSTEP. After the extensive observation period of MAP, MAP TWO cannot expect the same level of funding from SCOSTEP. After the data-collecting period of MAP, time will be needed to digest the data and to study the physics. Dr. Bowhill then proposed the following resolution:

The MAP Steering Committee,
CONSIDERING that many new measurement facilities will come into existence only near the end of MAP;
CONSIDERING the requirement of atmospheric observations for a long time series;
RECOGNIZING that SCOSTEP may initiate new programs in the late 1980s; and

ANTICIPATING that MAP scientists will fully participate in those programs with the new techniques;
REQUESTS the Bureau of SCOSTEP to approve a further period of MAP (MAP TWO) for the time period January 1, 1986 through December 31, 1988.

The Committee voted to postpone the decision on the resolution until the next session on Friday, May 21.

MAPSC MEETING

Friday, May 21, 1982
1000 - 1300 hours

1. Middle Atmosphere Cooperation (MAC): The resolution put forward by Dr. Bowhill during the last session was discussed. Dr. Godson suggested an amendment to change "MAP TWO" to "Middle Atmosphere Cooperation (MAC)"; this was passed by the Committee. Dr. Bowhill explained that the level of funding during MAC will be negotiated with the SCOSTEP Bureau. Also if UARS is launched during 1989, then UARS-related ground-based programs could be MAP contributions to TESS (or some other equivalent SCOSTEP program). The Committee approved the motion. The request will be sent to the SCOSTEP Bureau for approval. (It was subsequently approved by the SCOSTEP Bureau, Saturday, May 22.)

2. National Reports: Representatives from twelve countries presented their national MAP reports. They were:

Czechoslovakia	Dr. V. Bucha
Finland	Dr. S. Urpo
France	Dr. M. L. Chanin
FRG	Dr. U. Von Zahn (reported May 17)
GDR	Dr. J. Taubenheim
Hungary	Dr. P. Bencze (written report)
India	Dr. A. P. Mitra
Sweden	Dr. G. Witt
Japan	Dr. S. Kato
Taiwan	Dr. J. K. Chao (written report)
U.K.	Dr. L. Thomas (reported May 17)
U.S.A.	Dr. M. A. Geller

The written reports will be published in MAP Handbook Volume 7.

3. Regional Consultative Groups: European Regional Consultative Group: Dr. Chanin reported the activities of the group during the last year.

This group was constituted in Edinburgh where its first meeting was held. A second meeting took place in Paris, France, on December 16, 1981. The European participation in CAMP and WINE were widely discussed, and suggestions of complementary experiments by groups not already involved in those programs were made. A discussion on the role of EISCAT in the MAP program was also discussed, as well as the role of a long-life balloon program in MAP. Some preliminary ideas about the way the European countries saw the evolution of the GLOBUS program were discussed.

A short meeting was held in Ottawa on Tuesday, May 18, 1982. The main topic of discussion was the participation of the USSR in the WINE and CAMP programs, which could not be discussed at the Paris meeting. A short exchange of views about the GLOBUS program was started, but the group did not intend to interfere with the Steering Committee of the program. This discussion was carried on later in the week in more detail under the direction of the new GLOBUS Chairman, D. Offermann.

Keeping in mind that this group should not overlap with the activities of the different Steering Committees of the MAP programs involving European contributions, it is proposed to maintain the existence of this group with the possibility that any of its members may suggest a meeting which may be necessary for topics which are not included in a recognized MAP program. MAPSC agreed to keep the group in existence. Dr. Chanin will continue to be the Chairperson.

Asian Regional Consultative Group: No meeting took place since Edinburgh. Dr. Kato mentioned that there were exchanges of information between Japan and Taiwan and he expects more interaction in the future. These, however, were local. The Committee decided to dissolve the group, but the members can write to the Chairman asking to revive the group if necessary.

4. Future Symposia:

Ground-Based Studies of the Middle Atmosphere: May 9-13, 1983, Schwerin, GDR; Dr. J. Taubenheim, Organizer. The First circular included as an Attachment. Will not overlap with IAGA, IAMAP meetings in Hamburg.

Joint IAGA - IAMAP Symposium on Middle Atmosphere: August 20-26, 1983, Hamburg, FRG; Dr. R. Megill, Organizer. Topics are similar to the Edinburgh Symposium. There will be 11 sessions.

International MAP Symposium in Japan: 1984, Kyoto, Japan; Dr. Kato, Organizer. The first circular included as an Attachment. The emphasis will be on comprehensive coverage of all topics of MAP. To decide on the dates Dr. Kato will coordinate with the Ozone and Radiation Commissions of IAMAP and COSPAR to avoid conflicts in timing with their symposia. He will also seek co-sponsorship from SCOSTEP, COSPAR, URSI, IAGA, and IAMAP. Coordination with Equatorial Aeronomy Symposium, March 1984, Hong Kong was also suggested.

MAP Symposium, First Achievements of MAP, in COSPAR: May, 1984, Graz, Austria; Dr. K. Labitzke, Organizer. SCOSTEP Co-sponsorship is being sought.

5. MAPCIE OFFICE:

Following the successful information exchange center during IMS, MAP has planned to establish such an office to provide a focal point for providing timely information concerning events, campaigns, etc. Letters have been sent out by Dr. Bojkov to meteorological services and by Dr. Cole to Academies of Sciences of the nations to ask them to consider sending scientists to WDC-A, working 1/2 time on research and 1/2 time on MAPCIE for a period of 1 to 2 years. Two tentative replies have been received, one from the FRG and one from India. Dr. A. P. Mitra presented a new proposal from India. If the MAPCIE could be located in India, then his country will be able to absorb the total costs in operating MAPCIE, including the publication of the MAP Newsletter. The Committee accepted the offer by acclamation. Details to be worked out by Drs. Bowhill, Mitra and Daniel.

6. J. H. Allen reported that Dr. Hartmann, co-chairman of the Data Management Committee, has interacted with MONSEE. A set of questionnaires will be distributed in the MAP Newsletter to survey the MAP community on data information.

7. Dr. J. Gille suggested a tentative workshop on Eulerian and Lagrangian descriptions of atmospheric chemistry problems. He will discuss this with Dr. Godson to finalize the ideas.

8. Next Meeting of MAPSC: The Committee voted to hold the next MAPSC meeting the week before IUGG at Hamburg, FRG, in August 1983.

9. Next MAP Assembly: The Chairman proposed to hold the second MAP Assembly in late 1984 or early 1985 to discuss the future of MAP. Dates and place to be decided.

MAP STEERING COMMITTEE MEETINGS

Ottawa, Canada
May 17-21, 1982

AGENDA

1. Opening remarks
2. Approval of agenda
3. Minutes of previous meetings
4. Reconstituted PMP reports
5. Reconstituted MSG reports
6. MAP Project reports
7. Reports on National MAP activities
8. Proposals for new MAP Projects
9. Proposals for new MSGs
10. Data Management Committee report
11. Publications Committee report
12. Dynamic Calendar Committee report
13. Reports on Workshops:
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    PMP-1
    Solar spectral irradiance
14. Future Workshops
15. Future Symposia:
    Graz, with COSPAR
    Japan
    GDR, IAGA-IAMAP
    FRG, IAGA-IAMAP
16. Question of MAP TWO
17. MAPCIE Office
18. Date and location of next meeting

MAPSC MEETINGS

Ottawa, Canada
May 17, 18, and 21, 1982

ATTENDANCE LIST

NAME	DATES ATTENDED	AFFILIATION
L. A. Alexandrov	(18)	MAP, USSR
J. H. Allen	(21)	WDC-A
J. J. Barnett	(21)	MAP
A. Belmont	(17, 21)	IUPAP
G. Beynon	(18)	SCOSTEP
S. A. Bowhill	(17, 18, 21)	SCOSTEP
G. Brasseur	(21)	Representing P. Simon, IAU
A. Brekke	(17, 18)	SCOSTEP
V. Bucha	(18, 21)	Representing J. Lastovicka
M. L. Chanin	(17, 18, 21)	National Representative, France
J. K. Chao	(17, 18)	National Representative, Taiwan
K. D. Cole	(18, 21)	SCOSTEP
E. R. Dyer	(17, 18)	SCOSTEP
M. Geller	(17, 18, 21)	MAP
J. C. Gille	(18, 21)	COSPAR
W. L. Godson	(18, 21)	WMO
J. B. Gregory	(17, 18, 21)	SCOSTEP
G. Hartmann	(17)	MAP
I. Hirota	(17, 18, 21)	IAMAP
S. Kato	(17, 18, 21)	National Representative, Japan
K. Labitzke	(17, 18, 21)	COSPAR
C. H. Liu	(17, 18, 21)	SCOSTEP Secretary
L. R. Megill	(17, 18, 21)	IAGA
A. P. Mitra	(18, 21)	Representing Y. V. Somayajulu
T. Nagata	(17, 18)	SCAR
E. R. Schmerling	(18)	NASA
P. C. Simon	(17, 18)	IAU
A. V. Shirochkov	(17, 18)	Representing E. S. Kazimirovsky
N. Sundararaman	(17, 18)	MAP Coordinator, USA
J. Taubenheim	(17, 18, 21)	IAGA
L. Thomas	(17, 18, 21)	National Representative, UK
E. V. Thrane	(21)	National Representative, Norway
S. Urpo	(21)	COSPAR
T. E. Van Zandt	(17, 18, 21)	URSI
H. Volland	(17)	MAP
U. Von Zahn	(17, 21)	MAP National Representative, FRG
M. Wada	(17, 18, 21)	IUPAP
C. Witt	(17, 18, 21)	MAP

ANTARCTIC MIDDLE ATMOSPHERE (AMA) PROJECT

T. Hirasawa and T. Nagata

At the MAP Steering Committee meeting held at Hampton, Virginia in May 1981, the Antarctic Middle Atmosphere (AMA) program was adopted as one of the cooperative international MAP research projects. Dr. T. Hirasawa of the National Institute of Polar Research, Tokyo, became the international coordinator.

At the MAP Assembly in Edinburgh, Dr. T. Hirasawa presented an outline of the Scientific aims of AMA. These include investigations of dynamics, structure, atmospheric composition, particle precipitation, middle atmosphere-low ionosphere interactions, atmospheric pollution, and northern-southern polar atmosphere comparisons.

MAP projects could be usefully coordinated in the Antarctic and Sub-Antarctic regions, as follows.

Ground-Based Observations:

Radar observations of the electron density and electric field irregularities in the lower ionosphere. (Australia, Japan, USSR, USA)

Spectroscopic observations on the visible and infrared region for the measurement of various atmospheric species, such as CH_4, N_2O, CO, O_3 and NO_x. (USA, JAPAN)

Lidar observations of 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. (Australia, Japan)

Observations of particle precipitation; all sky camera, auroral zenith photometers; geomagnetic meridian scanning photometer; high sensitive TV camera; vertical incidence ionosonde; riometer. (Australia, France, Japan, New Zealand, UK, USSR, USA)

Balloon Experiments:

Several balloon campaigns are foreseen to be devoted to dynamics, structure, aerosols, atmospheric species, electron and ion densities, electric field and auroral X-ray studies. (France, South Africa, FRG, Japan, UK, USSR and USA)

Sounding Rocket Experiments:

Some rocket campaigns are scheduled to make the following measurements: dynamics and structure of middle atmosphere, O_3, NO_x density, electron density and electron temperature, electron and proton energy spectrum, flux of high energy particles dc electric and magnetic fields. (Japan, USSR, USA and others)

Other Proposed Projects:

Proposed cruise by USSR ship along Antarctic coast, Leningradskaya to Molodezhnaya. Coordination with the MAP observations at ground stations is most desirable.

Joint observations to study the South Atlantic Anomaly. Observations of airglow, electric fields, ion composition and X-rays will be scheduled to be carried out by balloons. (Argentina, Brazil, South Africa and others)

Projects which would be coordinated between south and north polar MAP observations.

The desirability is stressed of southern-northern polar atmosphere comparisons. The coordination with other international and national MAP projects in northern polar region such as Winter in Northern Europe Project (WINE), Global Observations and Studies of Stratospheric Aerosols (GOSSA), Cold Arctic Mesopause Project (CAMP) and USSR Arctic MAP observations, is now under consideration.

The program and practical ways for the effective coordination of AMA project will be discussed at SCAR Upper Atmosphere Physics WG meeting to be held in July 1-3, 1982 in Leningrad.

ATMOSPHERIC TIDES MIDDLE ATMOSPHERE PROGRAM (ATMAP)

J. M. Forbes

Atmospheric tides, oscillations in meteorological fields occurring at subharmonics of a solar or lunar day, comprise a major component of middle atmosphere global dynamics. The nature of atmospheric tides requires investigations and coordination on a global, and hence international, scale. The purpose of ATMAP is to create an interaction among observationalists, data analysts, theoreticians and modellers working towards the following goals:

- To delineate the global morphology of tides in the middle atmosphere including temporal and spatial variability on various scales;

- To construct models for the mean and time variable tides;

- To elucidate the role of tides in affecting mean winds and temperatures in the middle atmosphere;

- To elucidate the role of tides in giving rise to gravity waves and turbulence through nonlinear cascade and instability processes; and

- To examine the influence of the mean wind and temperature fields on tidal wave propagation.

The focus for this interaction will be a series of 1-2 week global observational campaigns involving ground-based remote sensing methods. The mechanism for interchange will be workshops or symposia dealing specifically with the interpretation of these measurements. In addition, standardizations of data formatting and analyses will be defined to facilitate the exchange of information.

Anticipated international participation includes:

Canada	USSR
Japan	India
USA	France
Australia	Taiwan
United Kingdom	Peoples Republic of China
GDR	Italy
FRG	

COLD ARCTIC MESCPAUSE PROJECT (CAMP)

L. Bjorn

The project CAMP (Cold Arctic Mescpause Project) proceeds according to plans. The most active period of observations will be July 26 - August 16, 1982 when the rocket campaign is scheduled at ESRANGE. Most rocket experiments are built and tested. The rocket instrumentation will contain positive and negative ion mass spectrometers, measurements of total plasma density and ionizing radiation, optical instruments for detec. of NLC and derivation of NLC particle size, and measurement of neutr. density and atomic oxygen concentration. It will, further, conta: lling sphere experiment for derivation of temperature and wind and a Li-trail experiment also for wind retrieval. There will be a net of ground-based measurements, the extent of which is still to be defined. Attempts will be made to measure stratospheric and possibly mesospheric density and temperature (LIDAR) and of IR-emissions with both spectrometers and interferometer.

An experiment will be carried out with EISCAT during this period. All EISCAT member countries will participate and the aims of the experiment will be:

- to detect the upper boundary of the negative ion regime
- to try to measure extremely heavy positive ions
- to try to measure D-region electron densities
- to measure wave and wind activities.

The experiment will complement the ground-based experiment, and give a picture of the mesopause region during the period of field measurements with regards to neutral and plasma properties. Two aircraft will be used - one for monitoring and photography of NLC and one for making microwave radiometry of mesospheric H_2O and O_3.

Finally, satellite data will be used to the extent it shows possible. Primarily SME data on NO, O_3, NLC occurrence and if possible on NLC particle size distribution will be included in the data. The launch criteria for the main rocket salvo will be the presence of NLC over the launch area and low geomagnetic activity.

AIRCRAFT

Monitoring of NLC Photography	MISU
Microwave Radiometry (H_2O, O_3)	MPI-A
	IAP-B

GROUND BASED

IR Spectrometer	UW, MISU
IR Interferometer	USU, MISU
Fabry-Perot Etalon	UCL
Lidar	SA, UT
EISCAT	UCW, CNET, UIO
Meteor Radar	US

SATELLITE

SME NO, O_3, NLC	LASP, NCAR

ROCKETS

S 37 (2)	Ion Composition	UB
CAMP	(1 Positive, 1 Negative)	
(Nike-Orion)	Plasma Density	UIO
	Energetic Electrons	UIO
	Ion Mobility	MISU
	NLC-Photometer	MISU
SOAP (2)	Gas Density (Ar-Sonde)	MISU
(Nike-Orion)	Gas Density (Xe - O_3 Sonde)	MISU
	Atomic Oxygen Concentration	RAL
	NLC Particle Size Distribution	MISU
	Gas Temperature	UCW
RAL (1)	Atomic Oxygen Concentration	RAL
(Petrel)	Electron Density	RAL
	Gas Temperature	UCW
STRAFAM (1)	Ion Composition	MPI-K
(Nike-Orion)		
TAD (1)	Temperature (Falling Sphere)	AFGL
(Nike-Orion)	Density, Winds, Turbulence	
	Li-Trail	UCL
MPI-K (1)	Ion Composition	MPI-K
(Petrel)		

GLOBAL METEOR OBSERVATION SYSTEM (GLOBMET)

R. G. Roper

FOREWORD

The Global Meteor Observation System (GLOBMET) project is a complex program of meteor research for the eighties, first proposed by the Soviet Geophysical Committee in 1981. It was discussed at the IV IAGA Scientific Assembly in Edinburgh in August, 1981, by the IAGA Working Group V-2 of IAGA Section V, by the IAGA Executive Committee and at the business meeting of the MAP Steering Committee. These discussions resulted in Resolution 9 of IAGA, which recommended, in part, that international cooperation in meteor research be undertaken through a Global Meteor Observation System. The project draft was also discussed and endorsed by the III Scientific Assembly of IAMAP in Hamburg in August 1981 (IAMAP Resolution No. 1).

Following these recommendations by IAGA and IAMAP, the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) created the GLOBMET Ad Hoc Committee, with representatives from IAGA, IAMAP, IAU and URSI. The committee was assigned the task of preparing the GLOBMET Planning Document.

This version of the Planning Document was produced after due consideration of several amendments and proposals by representatives from most major centres of meteor research.

The ad hoc committee charged with its preparation was headed by Dr. B. L. Kascheyev. Members of this committee were Dr. W. G. Elford (IAU), Dr. S. P. Kingsley (URSI), Dr. V. I. Nechitailenko (Secretary), Dr. R. G. Roper (IAGA/IAMAP) and M. Simek (COSPAR).

At the SCOSTEP and MAP Steering Committee meetings in Ottawa in May, 1982, GLOBMET was approved as a MAP project, with R. G. Roper as interim coordinator. The first GLOBMET meeting will be held during the Schwerin, GDR, Symposium on Ground-Based Studies of the Middle Atmosphere, May 9-13, 1983

INTRODUCTION

The Global Meteor Observation Project is aimed at intensifying research in Meteor Geophysics and Astronomy in the eighties by making wider use of the latest achievements in this field and expanding international coordination in meteor research.

For many years, the existing global radar network has been successfully providing information that had proved especially useful in various international geophysical projects. The data obtained has made it possible to determine the basic characteristics of atmospheric circulation and meteorid flux within the 80-110 km height range. Most of the difficulties associated with data collection, reduction and analysis have been resolved, and the basic parameters necessary for a viable global observational network determined.

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.

Only a greater degree of cooperation between existing observatories, and methodical expansion of the global network, including partial reflection drift measurements, MST radars, rocketsondes and other appropriate techniques can further our understanding of the dynamics of this region. While global measurement of atmospheric parameters is, in principle, best done with orbiting satellites, the fact that current (and proposed) satellite instrumentation does not have adequate height resolution at these altitudes makes a ground-based network our only alternative for the foreseeable future.

Radio meteor data are subject to the influence of various factors of selectional, astronomical, equipmental and interpretive nature. Standardization of hardware, observation techniques and algorithms of interpretation is important in a global program.

In most instances, correct interpretation calls for knowledge of the structure of the meteor flux, which cannot be obtained without undertaking a simultaneous meteor astronomy program. Such research will make it possible to ensure a rapid accumulation of the experimental data necessary to resolve problems facing Meteor Geophysics and Astronomy.

The present Project envisages simultaneous theoretical and experimental studies of closely related phenomena, and defines the organization necessary to achieve those ends. The project will continue and expand on the research that has been carried out under the GRMWSP program and by the IAU/IAGA Special Committee on Radar Observations of Meteor Flux and Radiants and Anomalies at the Base of the Thermosphere.

The main objective of the project is to organize a network of meteor observatories, which will provide experimental data: (1) for testing of models of atmospheric circulation which include the meteor region; (2) on the influx of meteors and the distribution of meteoroids in the neighborhood of the earth; and (3) for testing models of meteoroid/atmosphere interaction.

THE PRINCIPAL SCIENTIFIC OBJECTIVES OF GLOBMET

(a) In Meteor Geophysics

- To create global models of seasonal changes in basic characteristics of dynamical processes in the upper mesosphere and lower thermosphere, considering not only prevailing winds, planetary waves and tides, but also internal gravity waves and turbulence.

- To investigate the variation in space and time of atmospheric dynamical processes in the meteor zone and their role in the global circulation at 70-110 km altitude.

- To study the relation between dynamical processes in the meteor zone of the atmosphere and those in the other atmospheric layers and between the former and solar geomagnetic variations.

- To study latitudal-and-seasonal fluctuations in temperature, pressure and density at the mesopause and in the lower thermosphere.

- To study the physics of the interaction of meteors with the Earth's atmosphere and to devise techniques for determining atmospheric parameters using meteor observation results.

- To study disturbances in the Middle Atmosphere caused by cosmic and man-made bodies.

- To study the influence of large meteoriods on the pollution of the upper and middle atmosphere and the dependence of dust-producing capacity on the mass and velocity of such meteors.

(b) In Meteor Astronomy

- To determine the time and space structure of the near-Earth meteor complex.

- To determine the flux of meteoroids over 10^{-3}g for each month of a year.

- To determine the radiant distribution of meteoroids over 10^{-3}g for each month of a year.

- To estimate the flux density of meteors over 10^{-4}g as a function of the longitude of the Sun for the Quadrantid, Geminid, n-Aquarid and Orionid meteor showers and to study their fine structures.

- To study deceleration, ablation, structure and mechanism of interaction with the atmosphere of decimetre bodies at 120-20 km heights.

- To carry out complex observation of meteoroids and the atmosphere using radar and television techniques combined with geophysical rocketsondes.

(c) Applied Tasks of GLOBMET

- To create reference model atmosphere for the 70-110 km height range based on data obtained from an appropriate observational radar network, and to combine them with standard atmosphere models for other heights.

- To construct forecast models of meteorological parameters at the mesopause and in the lower thermosphere using the data obtained by the network of meteor radars and partial reflection stations.

- To investigate the possible use of meteor radar data for long-term weather and climate forecasts.

- To study the fine structure of meteor influx in different mass ranges and to create meteor hazard forecast models.

- To create models of radio-wave meteor propagation, and standards and protocols for meteor radar data exchange using meteor scatter links between stations.

MAIN METHODOLOGICAL PROBLEMS OF METEOR OBSERVATIONS

The complex of tasks to be solved by means of a meteor network determines essentially the choice of criteria for optimization of both the network proper and the parameters of the measuring systems. The observed meteor flux possesses similar space and time scales to the atmospheric circulation, namely diurnal, seasonal and global variations. The mechanism of transformation of the genuine wind field to the observations obtained by radars contains information not only on the investigated wind field, but also on the investigated tracer, the latter distorting the wind estimates. This distortion is a function primarily of the radar system used, although the interpretive algorithms used to deduce the wind field from the measured data can contribute to such distortion. The greatest single contributor to the minimization of this distortion is the measurement of echo arrival angle, and the height of each echo. The necessity of using information on atmospheric dynamical regime especially on the height gradients of the wind velocity, for a more accurate derivation of the velocity and coordinates of individual meteor radiants, calls for the organization of a program emphasizing both geophysical and astronomical aspects.

Thus, the basic methodological problems to receive priority of attention under GLOBMET are:

(a) To Perform a Comparative Analysis of Software and Hardware for Meteor Research

- To analyze the compatibility of data on the wind regime in the meteor zone obtained by the meteor radar method and other methods.

- To analyze the influence of astronomical and hardware factors on the accuracy of wind regime parameters obtained by the radar method.

(b) To Specify the Dependence on Parameters of the Physical Theory of Meteors as well as on the Theory of Radio-wave Scatter by the Plasma of a Meteor Trail in Determining the Selection Effects in Meteor Observations. Including:

- The study of the interaction of meteor trails with both the neutral atmosphere and the geomagnetic field.

- The study of the influence of irregularities in ionization on radio-wave scattering, and the phenomena taking place in long-lived trails.

(c) To Standardize and Optimize Meteor Radars and Meteor Radar Network Parameters

The meteor radar method is characterized by considerable sensitivity to both the directly registered properties of a meteor and the parameters found using the corresponding interpretation procedures. The real distribution of meteor substance in the solar system cannot be observed directly. Is it possible, by studying meteors from the Earth, to detect variations in the original distribution of meteors? Can these variations be measured by meteor radars? In order to define reasonable demands or the level of standardization of meteor radar parameters it appears necessary to solve another set of problems:

- To determine the lowest threshold variations of the real distribution of meteor parameters below which interpretation is unreasonable.

In addition, in interpreting meteor geophysical observation data, consideration of astronomical selection factors is needed. This gives rise to the following tasks:

- To determine the threshold estimates of the real meteor parameters above which interpretation of geophysical observation using the properties of a meteor flux as a neutral tracer is unreasonable.

The carrying out of the proposed GLOBMET observations by means of a meteor radar network, organizing an effective meteor data exchange and creating data archives naturally calls for solving a number of other problems defined in the Manual on Meteor Radar Observations (in preparation).

- To define meteor radar characteristics affecting the parameters of a recorded complex of meteor bodies, and those invariant to these parameters, and to construct on this basis a generalized Radar Meteor Data Index (RMD-Index).

RMD-Index, as it is defined in the Manual on Meteor Radar Observations, is a generalized characteristic of a set of data used as a criterion of compatibility of sets of data produced by different types of radar.

- To obtain effective estimates of the basic parameters of a meteor radar, i.e., the threshold registered radio magnitude and the parameters of effective observation area for different regimes of observation and different meteor radars.

- To optimize meteor radar parameters in order to deduce the original distribution variations from the astronomical observation of meteors, and, to ensure the correct interpretation of geophysical observations.

- To compile proposals for optimization of the structure of a global meteor radar network designed to promote the study of dynamic processes in the meteor zone.

(d) Development of Effective Interpretation Algorithms to Ensure:

- Obtaining information on the meteor activity and the properties of the meteoroid influx from the observation grid provided by meteor wind radars.

- Excluding pseudosynoptical drift observations and other effects connected with variations in the meteor flux structure from the wind results.

The quantitative analysis of these effects can be done using imitation experimental data obtained by modeling the meteor as a tracer of the medium. The experimental test calls for holding simultaneous observations of the circulation using various techniques during the well-known meteor showers.

- Obtaining correct estimates of radiant coordinates while measuring atmospheric disturbances in the meteor zone.

(e) Modeling Studies of Meteor Phenomena

This requires the development of mathematical models that include all three constituents, i.e., "medium" (atmosphere, its physical and dynamic characteristics), "tracer" (meteor flux with account of astronomical, physical and geometric selectivity factors) and "radar" (including selectivity characteristics, observation and processing procedures). Such models can provide specifications for various observation programs. There are three possible approaches to the problem:

- A model that gives information as to when and how often measurements must be taken;

- A model whose output is used for including its data into real or hypothetical measuring systems (networks). Some of the system biases due to various errors or sampling limitations can then be estimated;

- A model that combines both simulated and observed data simultaneously. Thus, simulated data and observational data coexist in the model to produce a more realistic analysis.

OBSERVATIONAL METHODS AND THE SETTING UP OF AN OBSERVING NETWORK

(a) Observational Methods

- Radar methods of estimating the parameters of meteor trails (meteor velocities, ionization profiles and inferred masses) position of the reflection point, meteor radiant coordinates and the velocity of meteor trail drift in the atmosphere at 80-110 km heights.

This will constitute the bulk of observational data under the GLOBMET Calendar. The meteor radar method combines measurements important for both Meteor Geophysics and Astronomy.

- Optical methods of meteor observations including photographic, image-intensifier and TV.

- Partial Reflections Drifts Method (PRD).

Inclusion of the PRD under GLOBMET serves three objectives: (1) it enables a more detailed study of the physics and dynamics of atmosphere in the meteor zone, including the study of short-period gravity waves, (2) it will provide further intercomparisons of the two methods, and (3) for several hours around noon, winds can be determined down to 65 km.

- Recording of meteor activities by receiving distant VHF broadcasting stations.

This method enables meteor fluxes to be monitored with simpler equipment and lower operating expenses.

(b) The GLOBMET Observing Network

The GLOBMET observing network proposes using the following measuring systems:

meteor wind radars,
multi-purpose meteor radars,
partial reflection radars,
meteor and solid photographic patrols,
image-intensifier and TV systems,
meteor forward scattering radars (particularly in the Soviet Union, where many stations are within forward scatter communication distance of another (other) station(s)).

One of the main considerations of GLOBMET is the installation of a network of meteor radar observatories which will provide the best possible estimates of the meridional and zonal profiles of the middle atmosphere wind field, in addition to recording the distribution of meteor radiants over the whole celestial sphere.

One of the major tasks involved in the carrying out of the recommendations adopted by IAGA, IAMAP and IAU for expanding the network is the introduction of additional observing systems (stationary or mobile) at such geographical points as would, in combination with the existing radar network, ensure the necessary spatial sampling as to comply with the purpose of the draft Project. Taking into consideration the existing network, the possibilities of participation by IUGG national committees and existing research institutions, the progress being made in the development of new automatic meteor radars (of the fourth generation in particular), the positive experience gained by expeditions (e.g. to the Equator, Arctic and Antarctic) and also that ground-based radars present fewer logistic difficulties than shipborne radars, the following recommendations are made:

(1) Along the 35° meridian, where a group of Soviet radars is already in operation (Obninsk, Kharov, Kazan, Volgograd and Molodezhnaya) additional radars in the vicinity of the Arctic Circle, the tropics and the Equator;

(2) Along the 135° meridian, with current operation in Khabarovsk, Kyoto and Adelaide, additional radars on the Arctic and Antarctic Circles;

(3) 75° meridian (Northern Hemisphere). Currently operating are stations in Dushanbe and Frunze. Additional radars should be placed close to 67°N, 50°N and 23°N;

(4) 50° parallel. In the neighborhood of this parallel is a group of European observatories as well as some U.S. meteor radar stations, and a Canadian PRD facility. A worthwhile expansion would be the placing of radars close to 70°E and 105°E.

These proposals for expanding the existing radar network have taken due account of (1) construction of a regularly operating network of measuring points for reliable verification of global circulation models, (2) distributing measuring points along the meridians and parallels within a half of the radius of correlation of weather systems that should enable the production of circulation patterns along the 33°E, 135°E meridians and the 50°N parallel.

Up until now, regular observation in the Southern Hemisphere has been conducted only in Adelaide, Christchurch and Molodezhnaya. Meteor wind and meteor influx observations in Africa and South America, especially around the Southern tropic, are of special importance. Such observations, interesting by themselves, will become doubly so when considered in the context of GLOBMET.

The installation and operation of facilities in countries lacking the appropriate expertise would require various bi- or multi-lateral research projects, including expeditions to different parts of the globe.

PRINCIPAL RECOMMENDATIONS FOR THE GLOBMET CALENDAR

The basic criterion for the choice of observation intervals and compilation of the calendar is to obtain the maximum amount of useful information (both geophysical and astronomical) throughout the GLOBMET network.

The total observational interval, as envisaged by the Project, should last for at least one cycle of solar activity (1980-90). During this period, the greatest priority should be given to the Intensive programs during the maximum and minimum solar activity periods, with special emphasis being given at these times to the deployment of mobile radars. The principal limitations to the achievement of the objectives of GLOBMET is financial. Hence the emphasis on the extremes of the solar cycle falling in this decade. The experience gained by the Soviet Equatorial Meteor Expedition, together with the current circulation models suggest the proposed two-year intervals as optimum for intensive (especially expeditionary) observation, with no less than 8-month intervals, including both Equinoxes, for observations on the network located parallel to the Equator.

In choosing observational intervals, due consideration must also be given to (1) the geophysical value of the period, (2) the inclusion of other techniques sampling other altitudes, and (3) the feasibility of organizing and carrying out expeditions (possibly ship as well as ground-based) to interesting geographical points.

One of the most interesting intervals in the coming years is the second half of the MAP observational phase (1984-85). This interval should be considered the First Interval of the Highest Priority under GLOBMET.

Considering the need for close coordination of the geophysical part of GLOBMET with MAP, the GLOBMET Dynamic Calendar should be based on the MAP Dynamic Calendar which, in its turn, is an adaptation of the International Geophysical Calendar to the needs of MAP.

The suggested GLOBMET Dynamic Calendar has been prepared so as to maximize the amount of information for all of the proposed tasks, while requiring the minimum amount of time and funds, especially in those cases where continuous observation cannot be made. Thus the bulk of observational data is to be obtained around Regular Geophysical Days (RGD) and Regular World Days (RWD).

The study of mesospheric dynamics by means of meteor radars and other techniques should concentrate on the RGDs and RWDs and Priority RWDs (PRWDs).

Consideration should also be given to the following: since observing runs of at least ten days are needed to study planetary waves and tides it is recommended that such runs be centered on PRWDs with Quarterly World Days (QWDs) so as to ensure maximum correlation with rocketsondes and incoherent scatter measurements. Several problems can be studied only by continuous observations during long periods of time. If continuous observations are not feasible, long period observations should be initiated by a MAGSTORM or STRATWARM alert.

The Calendar for Meteor Flux Observations by Statistical Methods coincides with the Calendar for Meteor Trail Drift Observations.

General Meteor flux observations and the study of pseudosynoptical effects should coincide either with the Calendar of Meteor Showers which is a component part of the International Geophysical Calendar or with the forecast of possible meteor showers associated with the return of long-period comets.

The correct interpretation of meteor showers requires consideration of the background; therefore observations should be held for 1-2 days before and after the shower occurs.

Recommended for regular observations are the Quadrantid (Jan. 2-6) and Geminid (Dec. 3-17), n-Aquarid (May 3-10) and Orionid (Oct. 16-26) showers. The former two provide the best opportunity for calibration of measuring systems and the latter coincide with the orbit of Halley's Comet.

DATA REQUIREMENTS AND INTERNATIONAL DATA EXCHANGE

(a) Data Conception

The data needed to ensure the completion of the above-mentioned tasks requires homogeneity in reduction and analysis, and the availability of an adequate global observational grid of meteor radars. These requirements can be met by adequate regulation of metrologic and space-and-time characteristics including (1) the standardization of measuring system parameters, algorithms and techniques for observation, (2) the structural optimization of the network and (3) the proposed observation calendar.

Realistically, the first step towards structural and technical standardization of the existing radars should include only minimal demands. This minimum involves the unification of all radar parameters that can be determined by their relation to the meteors recorded, and the estimated atmospheric parameters, i.e., the minimum recorded meteor radio magnitude; the selection characteristics with respect to maximum and minimum values of velocities and other parameters under study; height resolution; and scanning regimens, and methods and schemes of observation.

These requirements will be detailed in the Manual on Meteor Radar Observation which, while making no drastic metrological or other requirements for data analysis within the GLOBMET framework, fixes the definitions of: estimates of basic parameters that should be regarded as most desirable for the existing measuring installations, including observational methods and data reduction and interpretation algorithms; specifications for development of new hardware and software; and representative formats and data exchange procedures.

(b) Data Exchange

In line with the ICSU General Assembly Resolution (1978) concerning data exchange for all new interdisciplinary ICSU programs, WDC-A and WDC-B will be the media of international data exchange for GLOBMET.

Within the hierarchy of data exchange adopted by the above two centres, the GLOBMET data falls in the following three categories:

<u>The First Level</u>:

- average hourly wind velocity estimates
- meteor activity records.

The first level data obtained for each year is to be exchanged unconditionally and transferred to WDCs within six months after the corresponding observation period ends.

Meteor radar data presented to WDCs must undergo the standard editing, processing and analyzing procedures recommended by the Manual on Meteor Radar Observations.

The Second Level:

- individual estimates of wind velocity and reflection point coordinates
- results of measuring physical properties of meteors and the atmosphere
- meteor radiant, orbit and flux density observations.

These data will be filed in the archives of participating organizations and will be available upon request. The information on the data in possession of these organizations will be sent periodically to the appropriate WDC to be catalogued.

The Third Level:

- data (such as reports, etc.) assigned to the WDC to be used by visiting scientists rather than disseminated to users.

The description of data types and formats as well as the amount and time of presentation of each type of data to the archives is to be found in the Guide to International Data Exchange (Meteors) and other Manuals that are to be prepared and agreed upon during the preparatory stage of GLOBMET.

APPENDIX

IAGA Resolution No. 9 Edinburgh, 15.08.81

IAGA, noting that most radar meteor systems are now automated, considering the need for a more effective geographical distribution of radar meteor stations and recognizing the high degree of coordination necessary to undertake simultaneous worldwide observations recommends that

(1) IAGA member countries be encouraged to support and extend the radio meteor network.

(2) international coordination be undertaken through a Global Meteor Observation System (GLOBMET) and that this coordination be effected in the immediate future through the Middle Atmosphere Program in SCOSTEP

(3) a committee be formed within SCOSTEP with representatives from IAGA, IAMAP, IAU and URSI to produce a GLOBMET planning document.

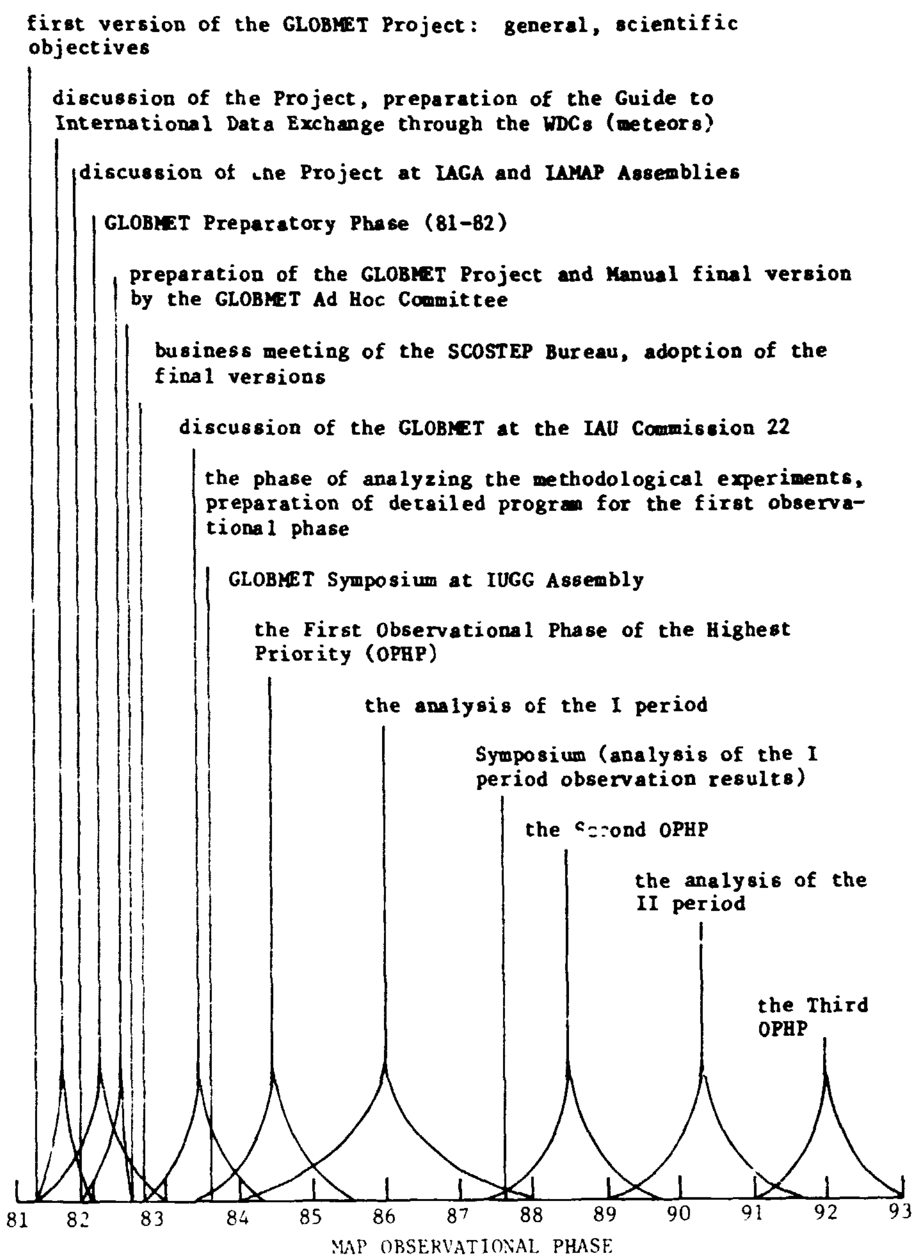
IAMAP Resolution No. 1 Hamburg, 27.08.81

IAMAP, _noting_ IAGA resolution concerning the Soviet Geophysical Committees' Global Meteor Observation (GLOBMET) System proposal passed at the Edinburgh Assembly, August 1981, and _considering_ the need for simultaneous worldwide observations of mesopause region dynamics, _recommends_ that:

(1) IAMAP member countries be encouraged to support and extend such observations, using all practical techniques and

(2) IAMAP accept the invitation extended by IAGA to further this cooperative effort by endorsing a committee to be formed within SCOSTEP with representatives from IAGA, IAMAP, IAU and URSI to undertake international coordination through a Global Meteor Observation (GLOBMET) System.

THE PLANNED ACTIVITIES UNDER GLOBMET



GRAVITY WAVES AND TURBULENCE IN THE MIDDLE ATMOSPHERE PROGRAM (GRATMAP)

M. A. Geller

SCIENTIFIC BACKGROUND

The MAP Planning Document briefly addressed the importance of understanding gravity wave and turbulence structure in the middle atmosphere. This was expanded upon later in the MAP Study Group 3 Report on tides, gravity waves, and turbulence. Thus, this section is only a brief update on the discussion in those documents.

Gravity waves and turbulence are intimately related in the middle atmosphere. Gravity wave breaking generates turbulence which in turn limits the gravity wave growth with altitude, when viewing spectra of the middle atmosphere motions. It is difficult in many cases to clearly distinguish interacting gravity waves from a saturated turbulent medium. What is very clear, however, is that gravity waves and turbulence greatly influence the global middle atmosphere structure. They redistribute momentum. They both redistribute heat and give rise to conversions of mechanical energy to thermal energy, and they also give rise to transport of minor constituents in the middle atmosphere.

It is the goal of the proposed GRATMAP to delineate the global morphology of gravity waves and turbulence in the middle atmosphere including geographical and seasonal variability and to develop physically based parameterizations of the influence of gravity waves and turbulence on middle atmosphere temperature, wind, and constituent structure.

GRATMAP AS AN INTERNATIONAL MAP PROJECT

It is logical that GRATMAP be an international MAP project for the following reasons. The global scale of this project transcends national boundaries. The different nations of the world have different areas of expertise to apply to GRATMAP, but no single country possesses all areas of expertise. International communication in such areas as standardization of data analysis procedures and in arranging workshops is required. Since strong interactions among theorists with observationalists and modellers is required to meet the goals of GRATMAP, and different nations have different strengths in these areas, international cooperation is desired. Finally, an international MAP project will facilitate multi-national, multi-instrument campaigns. It should be noted that such campaigns need not be carried out synchronously around the world as is the case for tides due to the seasonal nature of gravity wave and turbulence effects.

PROJECT ACTIVITIES

It is proposed that a steering committee for GRATMAP be set up initially to plan measurement programs that are aimed at accomplishing the project's goals; e.g., determining the morphology of mesoscale gravity waves and turbulence in the middle atmosphere. They would determine the required accuracy, spatial (both horizontal and vertical), and temporal resolutions of the measurements. They, or a successor group, would then coordinate the measurement efforts of GRATMAP. Later activities would then involve looking after the analysis and exchange of data as well as subsequent archiving of data. It is emphasized that these groups must include theorists, observationalists, and modellers to accomplish the GRATMAP goals.

ANTICIPATED INTERNATIONAL PARTICIPATION

GRATMAP requires the participation of radar, lidar, balloon, rocket, and aircraft experimenters as well as theorists and modellers. Countries having, or planning, significant efforts in these areas include the following: United States, Norway, Peru, Federal Republic of Germany, German Democratic Republic, Japan, United Kingdom, Australia, New Zealand, India, United Soviet Socialist Republic, Peoples' Republic of China, Taiwan, Canada and France. We anticipate all would contribute representatives to GRATMAP. We envision the steering committee of GRATMAP to be smaller, however, perhaps six to eight, to facilitate its effective functioning in its planning and coordinating functions.

STRATWARM MESOSPHERIC PROGRAM (SWAMP)
(a sub-project of DYNAMICS)

D. Offermann

Stratospheric Warmings are well known as the strongest disturbances in middle atmosphere parameters (as temperature, wind, etc.) during Northern Hemisphere winters. Not too much is known, however, on how these phenomena extend into the higher atmosphere, i.e. the mesosphere and lower thermosphere. Considerable modification of vertical temperature profiles are expected here (see for instance Cole and Kantor, Air Force Reference Atmosphere, 1978). Very substantial changes of the wind fields can also occur, as is for instance demonstrated by the recent measurements of Schminder and Kurschner, (Gerlands Beitr. Geophysik, 1, 22, 1981) and the earlier data of Gregory and Manson (J. Atmos. Sci., 32, 1676, 1975). Interesting wave and turbulent activity at mesospheric heights has been observed by the SOUSY-MST radar during a minor stratospheric warming (Ruster et al., Geophys. Res. Lett., 7, 999, 1980).

It is obvious, that a stratospheric warming and its effects at higher altitudes cannot be determined just by measuring a vertical profile of one atmospheric parameter. This is because during such events many atmospheric parameters vary in three dimensions and in time. It is well known, for instance, that the phase of the temperature wave changes with height, resulting in a 180° shift between the stratosphere and mesosphere (mesospheric cooling, see for instance Hou, Quart. J. Roy. Met. Soc., 104, 1, 1978). This phase shift has, however, to be carefully monitored because deviations from this rule appear to be possible: During the peak of the recent very strong stratospheric warming in Jan./Feb. 1981 the mesopause temperatures obtained from OH* emissions were just normal (private communication: G. Lange, K. Labitzke, J. Barnett). Therefore the phase variation with altitude of this and other atmospheric parameters, and the medium scale horizontal variations linked to it should be a very interesting scientific objective.

There are quite a number of proven techniques available in Europe today, which are able to measure from the ground upper atmosphere parameters which are influenced by a stratospheric warming, such as temperature, winds, waves, and turbulence. These include radar, lidar, and other Doppler techniques as well as plasma drift and absorption and airglow measurements. Obviously a combined operation of such a network of stations for the study of stratospheric warmings/ mesospheric coolings has not yet been tried in Europe. It is therefore suggested that a program of joint winter measurements be started beginning in December 1981 and extending at least until spring 1984 (SWAMP = Stratwarm Mesospheric Program). The operation scheme of the program would be very simple: the instruments should be ready for operation early in December each winter. They should take some reference measurements by that time. Afterwards they would be kept on stand-by until a stratwarm occurs, and detailed informations/recommendations for operations are received by TWX. Stratalert information will be supplied by K. Labitzke, Berlin. After each observation period (in spring or early summer) a short workshop for data comparison should be held. A by-product of "SWAMP" might be the development of an improved alert scheme for the rocket launches of the upcoming MAP/WINE Campaign (winter 1983/84).

A list of ground-based stations with possible interest in participation in SWAMP is attached. The response from experimenters contacted was very positive. Comments and suggestions for the program, its scope, duration, organization, etc., are welcome.

INSTRUMENT TECHNIQUE	PARAMETER MEASURED	LOCATION	EXPERIMENTER
Meteor Radar	Wind	Sheffield Aberdeen	Muller, Kinsley, Univ. Sheffield
" "	"	Garchy	Fellous, CNET, Paris
" "	"	Budrio	Cevolani, CNR, Bologna
" "	"	Kuhlungsborn	Taubenheim, HHI, Berlin
Partial Reflection Radar	Turbulence	Ramfjord	Brekke, Univ. Tromso
Incoherent Scatter Radar	Wind Temperature	St. Santin	Bauer, CNET, Paris
Incoherent Scatter radar	Wind Temperature	EISCAT	Thrane, NDRE, Kjeller Kohl, MPI, Lindau
MST Radar (SOUSY)	Wind Turbulence	Lindau/ Andoya	Rottger et al., MPI Lindau
HF-CW Doppler	Wind	Leicester (Ramfjord?)	T. B. Jones, Univ. Leicester
LF ion drift	Wind	Collm	Schminder, Univ. Leipzig
" "	"	De Bilt	Vesseur, KNMI, De Bilt
VLF (Ω)	10 kHz reflection height	Tromso (?)	Thrane, NDRE, Kjeller
" "	"	?	T. B. Jones, Univ. Leicester
" "	"	?	Volland, Univ. Bonn
Ionosonde Network	f_{min}		Dickinson, Rutherford and Appleton Lab.
A1, A3 absorption	n_e	Lindau	Schwentek, MPI Lindau
" "	n_e	Kuhlungsborn	Taubenheim, HHI Berlin

A1, A3 absorption	n_e	Coberg/Graz	Friedrich, Univ. Graz
" "	n_e	De Bilt	Vesseur, KNMI, De Bilt
" "	n_e	Aberystwyth	E. R. Williams, UC Wales
Lidar	Density, Temperature	Haute Provence	Chanin, CNRS, Verrieres-le-Buisson
" "	"	Skibotn	Chanin/Harang, CNRS/ Univ. Tromso
" "	"	Slough (?)	L. Thomas, Rutherford and Appleton Lab.
" "	"	Andoya	v. Zahn, Univ. Bonn
Fabry-Perot, 5577 A	Temperature, Wind		Rees, UC London
" "	"		R. W. Smith, Ulster College
airglow spectrometer	O, NO, OH*	Stockholm	G. Witt, Univ. Stockholm
airglow photometer	O	Lindau	Lauche, MPI Lindau
IR spectrometer	Temperature, OH*, $O_2(^1\Delta)$	Wuppertal	Lange, Univ. Wuppertal
IR radiometer	Temperature	Nimbus 6, 7	Barnett, Univ. Oxford
	Strat. Alerts	Berlin	Labitzke, FU Berlin
Partial Reflection Radar	Wind	Saskatoon, Canada	A. Manson, J. Gregory, Univ. Saskatchewan

SYNOPTIC OZONE MAPS*

A. D. Belmont

Ozone is one of the major parameters in the radiation balance of the middle atmosphere. In recent years it has become possible to obtain global measurements of total ozone, its vertical distribution from about 25 to 50 km, and with recent techniques to obtain profiles from 10 to 30 km using total ozone and meteorological parameters. The middle atmosphere is the region in which most ozone is found. All models of the middle atmosphere must consider the variations in ozone. Without ozone there would likely not be a warm layer of the atmosphere which we call stratosphere. Detailed observational studies in four dimensions will provide a basic framework to help develop dynamic models of the middle atmosphere.

Preliminary techniques for preparing lower stratosphere profiles have been discussed, most recently, at the Ozone Symposium at Boulder in 1980. These techniques can be greatly improved if ozonesonde, total ozone, and radiosonde profiles can all be taken within a few hours. One of the present difficulties is that regressions of these data are not completely valid because the data are taken at widely different times. A remedy would be to organize a network of ozonesonde stations which would take their observations near the time of satellite overpass, as well as being near normal radiosonde observation times. As radiosondes are taken at 00 and 12 Greenwich and Nimbus satellites take their observations near local noon, the longitudes within about 45° of Greenwich and of 180° would be most suitable. These would include all of Europe and the Western USSR, most of Africa, and Japan, Australia and Alaska as regions from which regression data could be compiled. There are other satellites which observe total ozone and which have different observation times which may be convenient observation times for other localities.

International cooperation will be required to establish these coordinated observations, both for the purpose of establishing improved regressions in the early phases of the project and later to serve as ground truth with which to verify the maps produced to verify these regressions.

The preparation of daily synoptic maps at selected altitudes, which could include the years since 1970 is too large a project for a single group. Furthermore, regressions can be developed independently by several groups using different techniques. From these the best could be selected for application to map preparation. Thus, scientific collaboration is essential.

*Proposed at Ottawa MAPSC meeting.

The final results of the derived ozone fields will be the basis of a three-dimensional climatology which will not only describe the changes in ozone globally, but can serve both as input and verification for the many different middle atmospheric dynamic models which are currently being prepared.

In a preliminary manner this proposal was introduced at Urbana and Hamburg. It is now being proposed more formally, having received indications of interest from scientists in other countries, as a MAP project.

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WINTER IN NORTHERN EUROPE (WINE) PROJECT

U. Von Zahn

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: (a) density, pressure and temperature; (b) composition; (c) motion (on all scales); and (d) 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.

ORGANIZATION OF MAP

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

World Meteorological Organization	(WMO)
International Union of Radio Science	(URSI)
International Association of Meteorology and Atmospheric Physics	(IAMAP)
International Association of Geomagnetism and Aeronomy	(IAGA)
Committee on Space Research	(COSPAR)

Inter-Union Commission on Radio Meteorology (IUCRM)

Scientific Committee on 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 on 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. Bowhill (University of Illinois, Urbana, IL 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 (Physikalisches Institut, Universitat Bonn, 12, Nussallee, 5300 Bonn 1, FRG).

SCHEDULE OF ACTIVITIES

The years 1979 to 1981 were designated a 'Pre-MAP' interval in which a number of special research projects (PMPs) have been carried out and MAP Study Groups (MSGs) were set up. The major observational programs of MAP are 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 of the structure, motions, and composition of the middle atmosphere between about 50° and 70° northern latitudes. The northern Europe 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.

A list of atmospheric parameters to be measured during the MAP/WINE project, as well as their altitude range ar : location of observation is attached as an appendix.

(b) Organization 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 has been the initial international project coordinator. He is now succeeded in this job by Dr. U. von Zahn (University of Bonn, Bonn, FRG). An international MAP/WINE Working Group has been set up 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:

Dr. M.-L. Chanin, Serv. d'Aeronomie du CNRS	France
Dr. D. Krankowsky, MPK-K	FRG
Dr. R. Philbrick, AF Geophysics Laboratory	United States
Dr. E. Thrane, NDRE	Norway
Dr. E. Williams, Univ. College of Wales	United Kingdom
Dr. G. Witt, Univ. Stockholm	Sweden
Dr. U. von Zahn (chairman), Univ. Bonn	FRG

(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,

- airplane-borne, balloon-borne, and rocket-borne experiments,

- 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 the winter 1983/84 (approx. November 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: Solar Mesosphere Explorer, NOAA-E/F, DMSP 5D, Dynamics Explorer.

- In-situ measurements of middle atmosphere parameters by means of special MetRocket launchings. At least 3 sites north of 55°N are desired and the following locations have been selected:

Andoya	(approved)	69°N / 16°E
Lista	(approved)	58°N / 7°E
Thule	(under consideration)	77°N / 69°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 the 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.

Besides these soundings especially performed for MAP/WINE supporting data are expected from regular MetRockets launchings from the following sites:

Primrose Lake	55°N / 110°W
Poker Flat	65°N / 147°W
Shemya	53°N / 175°E
Heiss Island	81°N / 58°E

- 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 (see Table 1).

3. Data processing and analysis phase.

MAP/WINE CONTRIBUTIONS FROM THE FEDERAL REPUBLIC 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 US remote sensing satellites.

In early 1981 the Bundesministerium fur Forschung und Technologie (BMFT) has 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 fur Luft- und Raumfahrt e.V. (DFVLR), Bereich fur Projekt-Tragerschaften (BPT). There will be both purely German payloads as well as payloads comprised of an international complement of instrument. Table 1 gives an overview about the current 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 Norwegian scientists participation in sounding rocket .

experiments for MAP/WINE as given in Table 1. Furthermore, NTNF is actively 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 Tromso University,
- Monitoring of the mesosphere/ionospheric D-region by means of the HF partial reflection radar operated by Tromso 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 Tromso 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
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.

MAP/WINE CONTRIBUTIONS FROM AUSTRIA

The Technical University Graz will perform electron density measurements on each of the eight M-T payloads through ground-based observations of the Faraday rotation at three frequencies, emitted from the M-T payloads.

MAP/WINE CONTRIBUTIONS FROM THE GERMAN DEMOCRATIC REPUBLIC

The Central Institute of Solar-Terrestrial Physics and the Geophysical Observatory Collm will perform upper mesosphere/lower thermosphere wind measurements, using the meteor radar technique and spaced-receiver l.f method, respectively.

MAP/WINE CONTRIBUTIONS FROM CANADA

The University of Saskatoon will perform near continuous measurements of winds in the 60 to 100 km altitude region using Saskatoon HF radar.

Table 1: MAP/WINE rocket soundings
(Abbreviations: see below)

payload designation	M-M (metrockets)			M-T	M-I	M-S	M-V	M-C	M-O	M-G
status of payload	FRG contribution confirmed US participation suggested			confirmed	confirmed	confirmed	confirmed	confirmed	suggested	suggested
instruments	Robin spheres and data sondes	data sondes	data sondes	CHIRPS, BUGATTI/IONMAS, particle counter, Gerdien probe, Faraday antenna.	IR spectrometer	2 parachute-borne mass spectrometers (= STRAFAM)	electric field measurements, precision falling sphere.	chaff	ozone sonde	IR spectrometer, O resonance lamp, photometer, particle counter, dc probe.
countries contributing to payload	G, US			G, N, A	G	G	N, US	G	US	US
number of payloads	60 + 40	30	10	8	2	2	2	20	10	1
motor	Super Loki			Nike Orion	Sergeant	Orion	Nike Orion	Super Loki	Super Arcas	Taurus Orion
apogee	100 km			130 km	180 km	75 km	160 km	100 km	75 km	180 km
launch site	ARR Norway	Lista Norway	Thule Greenland	ARR	ESR	ESR	ARR	ARR	ARR	ARR

Comments : CHIRPS = cryo-cooled narrow-band IR photometer system
BUGATTI = Bonn university gas analyzer for turbulence and turbopause investigations
IONMAS = ion mass spectrometer (cryo-cooled)
ARR = Andoya Rocket Range
ESR = Esrange

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

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

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APPENDIX

List of atmospheric parameters to be measured during the MAP/WINE project.

PARAMETER	ALTITUDE RANGE (km)	MEASUREMENT TECHNIQUE	VEHICLE OR PAYLOAD	LOCATION	NUMBER OF SOUNDINGS
Temperature	0-30 (> 10 mb)	radiosonde	balloon	weather stations	regular meteor. soundings
	0-35 (> 5 mb)	radiosonde	balloon	Andenes, Kiruna, Lista, Thule	with each data-sonde launch
	0-30	7 channel microwave sounder	satellites DMSP 5D	all latitudes < 82°	four times daily
	0-40 (> 1 mb)	vertical remote sensing in a total of 21 spectral channels	satellites NOAA - E/F	all latitudes < 81°	twice a day
	20-80	4 channel IR radiometer (limb scanning)	satellite SME	all latitudes < 82°	twice a day
	20-70	datasonde (metrocket)	Super-Loki	Andenes	40
	20-70	datasonde (metrocket)	Super-Loki	Lista	30
	20-70	datasonde (metrocket)	Super-Loki	Thule	30
	25-70	datasonde (metrocket)	Super-Loki	Kiruna	5
	30-90	microwave spectroscopy of O_2 emissions	airplane	North Scandinavia	(flexible)
	30-80 and 100-125	15 μm CO_2 emission	M-T	Andenes	8
	~ 85	OH* with spectrophotometer	ground-based	2 stations in Scandinavia	any clear night
	80-100	lidar (Na resonance fluorescence)	ground-based	Skibotn	any clear night
	80-100	lidar (Na resonance fluorescence)	ground-based	Andenes	any clear night
	90-100	incoherent scatter radar (EISCAT)	ground-based	Tromsø, Norway	if $n_e > 10^4$ cm^{-3}
		indirect determination through integration of measured density profiles	← see table of density measurements →		
Mass density	30-60	lidar (Rayleigh scatter)	ground-based	Garmisch, FRG	any clear night
	30-50	lidar (Rayleigh scatter)	ground-based	Andenes	any clear night
	30-70	lidar (Rayleigh scatter)	ground-based	Haute Provence, France	any clear night
	30-80	lidar (Rayleigh scatter)	ground-based	Skibotn, Norway	any clear night
	30-90	falling sphere (metrocket)	Super-Loki	Andenes	40
	30-90	falling sphere (metrocket)	Super-Loki	Kiruna	5
	90-125	neutral mass spectrometer	M-T	Andenes	4
	55-150	falling sphere (instrumented)	M-T	Kiruna	1 (2)

PARAMETER	ALTITUDE RANGE (km)	MEASUREMENT TECHNIQUE	VEHICLE OR PAYLOAD	LOCATION	NUMBER OF SOUNDINGS
Neutral Atmosphere Composition:					
Ar, N_2	90-125	mass spectrometer	N-T	Andenes	4
H_2O	30-65	4 channel IR radiometer (H_2O at 6.3 μm)	satellite SME	all latitudes < 82°	twice daily
	30-90	microwave emission	airplane	North Scandinavia	to be defined
	50-90	2 channel photometer (H_2O at 6.3 μm)	N-T	Andenes	8
	60-120	FIR spectrometer	N-I	Kiruna	2
	60-85	indirectly from water cluster ion measurements by ion mass spectrometer	N-T	Andenes	4
O_3		multichannel vertical sounding	satellites NOAA - E/F	all latitudes < 81°	twice daily
	30-90	UV spectrometer/IR radiometer ([illegible] μm emission)	satellite SME	all latitudes < 82°	twice daily
	20-65	parachute ozone drop sonde	N-O	Andenes	to be defined
	60-100	IR spectrometer (O_3 at 9.6 μm)	N-C	Andenes	to be defined
	60-110	IR spectrometer (O_3 at 9.6 μm)	N-I	Kiruna	2
O	85-130	FIR spectrometer (at 63 μm)	N-I	Kiruna	2
	85-	O resonance lamp	N-[illegible]	Andenes	to be defined
	85-130	O resonance lamp	N-U	to be defined	to be defined
NO_2, OH*, $O_2(^1\Delta)$	(variable)	visible and IR spectrometers	satellite SME	all latitudes < 82°	twice daily
NO, OH*, $O_2(^1\Delta)$, CO	(variable)	FIR spectrometer	N-I	Kiruna	2
NO	60-170	IR spectrometer (NO at 5.3 μm)	N-C	Andenes	to be defined
Charged Particles, Electric Field:					
Electron Density	65-90	Faraday rotation (3 frequencies)	N-T	Andenes	8
	80-160	incoherent scatter radar (EISCAT)	ground-based	Tromsø	if n_e > 5000 cm^{-3}
Ion Density	50-125	electrostatic probe and drop sondes	N-T	Andenes	8
Ion Composition	65-125	ion mass spectrometer	N-T	Andenes	4
	10-60	ion mass spectrometer	N-S	Kiruna	2
Energetic Particles	< 125	multichannel particle analyser, e^-: 15 to >210 keV p^+ > 4 MeV	N-T	Andenes	8
Electric Field	< 125	3-axis orthogonal probe system + asymmetric probe	N-E	Andenes	2

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PARAMETER	ALTITUDE RANGE (km)	MEASUREMENT TECHNIQUE	VEHICLE OR PAYLOAD	LOCATION	NUMBER OF SOUNDINGS
Turbulence	2-25	neutral density and humidity fluctuations from MST radar (SOUSY)	ground-based	Andenes	near continuous
	60-90	electron density fluctuations from MST radar (SOUSY)	ground-based	Andenes	(daytime)
	60-90	electron density fluctuations from partial reflection radar	ground-based	Ramfjord, Norway	(daytime)
	50-80	temperature fluctuations from 15 μm photometer	N-T	Andenes	8
	60-120	ion density fluctuations from drop sondes	N-T	Andenes	8
	90-130	argon mixing ratio fluctuations from neutral mass spectrometer	N-T	Andenes	4
Wind vector	0-30 (> 10 mb)	radiosonde	balloon	all weather stations	regular meteor. soundings
	0-35 (> 5 mb)	radiosonde	balloon	Andenes, Kiruna, Lista, Thule	with each datasonde launch
	20-70	datasonde (metrochet)	Super-Loki	Andenes	40
	20-70	datasonde (metrochet)	Super-Loki	Lista	30
	20-70	datasonde (metrochet)	Super-Loki	Thule	30
	20-70	datasonde (metrochet)	Super-Loki	Kiruna	5
	30-85	falling sphere (metrochet)	Super-Loki	Andenes	40
	30-85	falling sphere (metrochet)	Super-Loki	Kiruna	5
	2-25 60-90	MST radar (SOUSY)	ground-based	Andenes (?)	to be defined
	80-95	chaff		Andenes	20
	80-11	meteor wind radar	ground-based	Sheffield, UK Aberdeen, UK	continuous
	90-100	meteor wind radar	ground-based	Kuhlungsborn, GDR	continuous
	~ 90	spaced antenna drifts radar	ground-based	Collm, GDR	to be defined
	60-120	spaced antenna drifts radar	ground-based	Saskatoon, Canada	to be defined
	80-100	incoherent scatter radar (EISCAT)	ground-based	Tromso, Norway	if n_e > 5000 cm^{-3}
	50-150	falling sphere (instrumented)	N-E	Kiruna	1 (2)

CZECHOSLOVAK ACTIVITY IN MAP

J. Lastovicka

The Czechoslovak national MAP program consists of 7 scientific sub-programs. One of them has been preliminarily approved as a MAP project:

Disturbances of the Atmosphere at Heights of 120 to 40 km by Penetration of Meteoriods of Metre and Decimetre Dimensions - Dr. Ceplecha (Astronomical Institute, Czech. Acad. Sci., Ondrejov): Regular observations at 18 stations in Czechoslovakia, 23 stations in FRG, 6 stations in Holland and 2 stations in Austria yielded multistation records of 12 meteoroids in the first three months of 1982. Four meteoroids penetrated the whole middle atmosphere. These observations are coordinated and evaluated by the Astronomical Institute in Ondrejov.

The new theoretical concept of the penetration of meteoroids through a general model of atmospheric density could provide instantaneous values of atmospheric density, particularly at 70-40 km. The influence of the earlier neglected deviations of instantaneous atmospheric density from the model density attains several kilometers along the path, which is much more than the uncertainty in photographic observations. This makes a realistic determination of instantaneous density profiles possible.

Other sub-programs:

Winter Anomaly - Dr. Lastovicka (Geophysical Institute, Czech. Acad. Sci., Prague): On the basis of 22 years of A3 absorption measurements at the Panska Ves Observatory. the major stratospheric warmings and related changes in the prevailing zonal wind in the upper mesopause region have been found to decrease rather than increase the radio-wave absorption. The PMP-1 winters of 1978/79 and 1980/81 have been found typical winters with a well-developed winter anomaly. The winter of 1981/82 is strongly "contaminated" by extreme geomagnetic activity. The winter of 1979/80 displays the most exceptional pattern of the whole 22-year period studied, partly due to the distribution of the geomagnetic activity and stratwarm-zonal wind effects.

Aeronomic Studies with the Use of Ground-Based Measurements of Radio-Wave Propagation - Dr. Lastovicka (Geophysical Institute, Czech. Acad. Sci., Prague): As input data, the AE-E satellite Lyman-alpha measurements were corrected and the role of X-rays and Lyman-alpha radiation in the 1539 kHz radio-wave absorption was assessed.

The Interplanetary Magnetic Field Effects in the Ionosphere and Atmosphere - Dr. Lastovicka (Geophysical Institute, Czech. Acad. Sci., Prague): The effect of the IMF sector boundary crossings in the mid-latitude lower ionosphere has been found to be seasonally and diurnally dependent. It is of geomagnetic type at night, of tropospheric type on the winter day, and we observe no effect on the equinoctial day.

The Geomagnetic Activity Influence on the Troposphere, Climate and Weather - Dr. Bucha (Geophysical Institute, Czech. Acad. Sci., Prague): The best correlation (correlation coefficient 0.65) between the geomagnetic activity and the atmospheric pressure at the 500 mbar level has been found over the northern auroral oval in some selected periods. The geomagnetic activity serves in fact as an indicator of particle penetration, which is responsible for the observed effects. The periods under study must be carefully selected to suppress possible overlapping by internal meteorological effects (filtering of the Rossby waves etc.)

Airglow Variations - Dr. Rybansky (Astronomical Institute, Slovak Acad. Sci., Tatranska Lomnica): A photometer working in laboratory conditions is being tested now. Continuous observations are expected to begin in the autumn of 1982.

The Dynamics of Penetration of Convective Clouds into the Stratosphere - Dr. Podhorsky (Hydrometeorological Institute, Bratislava): The primary radar data on radio echoes from upper boundaries of the cumulonimbus type clouds penetrating into the stratosphere were evaluated. The relative occurrence of these penetrations was computed for Central Europe with respect to orography and airlines. A hypothesis was developed on the relation between increasing occurrence of cumulonimbus penetration into the stratosphere and main airlines crossings in Central Europe; in other words, on the influence of tropopause-region contamination (by jet planes) on the cumulonimbus development above the level of spontantaneous crystallization.

In summary it may be said that all the Czechoslovak MAP sub-programs are under way and making good progress.

MAP ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY

U. von Zahn

MAP research activities in the Federal Republic of Germany are focused on two international MAP projects:

WINTER IN NORTHERN EUROPE (WINE)

The main scientific aims of the WINE project are the exploration of the structure and dynamics of the wintertime mesosphere and stratosphere over northern Europe. In addition, the neutral and ion chemistry of the middle atmosphere will be studied emphasizing the investigation of those constituents which measurements yield supplementary information on transport processes acting in the middle atmosphere. The observations will be gathered during the winter period November 1983 to March 1984 and shall cover the more regular winter conditions in November/December, as well as the generally disturbed period from January through March. Observing methods will include ground-based and satellite-borne remote sensing techniques, and in situ measurements by balloon-borne and rocket-borne experiments.

The WINE project is sponsored by a number of European countries, the US and Canada. An international MAP/WINE Steering Committee has been set up, so far consisting of U. von Zahn (FRG; chairman), M.-L. Chanin (France), D. Krankowsky (FRG), R. Philbrick (US), E. Thrane (Norway), E. Williams (UK), and G. Witt (Sweden). The former coordinator of the WINE project, D. Krankowsky (Max-Planck-Institute for Nuclear Research, FRG) resigned from his position in March 1982. His successor is U. von Zahn (University of Bonn, FRG). A more detailed description of the project WINE is available as a separate document.

GLOBAL BUDGET OF STRATOSPHERIC TRACE CONSTITUENTS (GLOBUS)

Two integrated campaigns of various experimental techniques are presently discussed concentrating on two specific objectives of the MAP/GLOBUS project:

- Comparative and complementary measurements of stratospheric trace gases. The aim is to check on the accuracy of the various experimental techniques, determine the natural variability of the trace gases, and, if possible, determine the time scale of this variability. It is presently being investigated whether or not this campaign could take place in Aire-sur-l'Adour in 1983.

- Measurements of latitudinal distribution of stratospheric trace gases. The aim is to perform near simultaneous balloon flights at low, medium and high latitudes. Flights from equatorial sites, Palestine, and Canada/Alaska are being discussed to be performed in 1984.

Laboratory experiments, model activities, and the preparation of ground-based experiments are well under way.

The coordinator of this project, W. Seiler (Max-Planck-Institute for Chemistry, FRG), resigned from his position early in April 1982. His job was taken over by D. Offermann (Wuppertal University, FRG). A steering committee for MAP/GLOBUS is presently being formed. Members so far are D. Offermann (FRG), M. Ackerman (Belgium), J. E. Harries (UK), and U. Schmidt (FRG).

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 U. von Zahn.

Our activities in the MAP projects WINE and GLOBUS have received special funding from the Deutsche Forschungsgemeinschaft (DRG) and the Bundesministerium fur Forschung und Technologie (BMFT). A total of 27 individual research projects have been funded, each contributing towards the scientific aims of either WINE or GLOBUS, or to both. The latter applies in particular to efforts towards improved models of the middle atmosphere. Of the approved projects four are laboratory studies of photochemical reactions and of questions concerning the technique of grab sampling, nine involve in situ measurements and eight remote-sensing measurements of middle atmosphere parameters, and six are aimed at improved theoretical and empirical models of the middle atmosphere.

On February 24 and 25, 1982 the progress and a few initial results of our MAP activities were reviewed in a well-attended workshop in Bonn-Bad Godesberg, which was sponsored by the DFG.

MAP ACTIVITIES IN FINLAND

Finland has no special MAP-program, but the following works going on or planned may be of some importance for the international Middle Atmosphere Program.

1. The incoherent scatter facility EISCAT started observations in 1981 and will be in operation for several years recording different parameters in the ionosphere, also its low levels.

2. Lower levels of the ionosphere are monitored continuously using a chain of riometers in Finland. One station is situated in Spetsbergen.

3. A chain of magnetometers will be installed in Finland and Norway in September 1982 to monitor the electric currents in the ionosphere.

4. A method has been developed to use all-sky photographs for the determination of the altitude of auroral arcs and thus the penetration of auroral particles into the atmosphere.

5. Studies of atmospheric electricity and its relations to ionospheric phenomena have been started.

The national contact for MAP-activities in Finland is the Finnish National Committee of IUGG, address:

Finnish National Committee
of Geodesy and Geophysics
c/o Finnish Meteorological Institute
Postbox 503, SF-00101 Helsinki
FINLAND

THE MAP PROGRAM IN FRANCE

M.-L. Chanin

The French MAP program has also been described in detail: in Handbook for MAP Volume 1, the list of the teams involved and the description of the main topics of research and the means existing or in development were given. The organization put in place to allow the realization of the national program was described in Volume 2 of Handbook for MAP.

The main scientific themes of this program are: the variability of stratospheric minor constituents; the stratospheric-tropospheric transport; and the middle atmosphere dynamics. Each of these topics either has already been the object of a successful action or is being planned for action in the near future. Let us mention briefly:

- the campaign of ozone intercomparison using conjugate ground-based, balloon and satellite observations involving about 10 different techniques. Two workshops were held to present and discuss the data. After the release of the definite results this summer, decision on a new campaign in 1983 is likely to be made.

- An intensive study of Dynamics: planetary waves, tides, gravity waves, and turbulence has already started using radar, lidar, balloon-borne anemometer, photometry and star scintillation techniques. Several projects are planned in the next few months: Intercomparison of NO_x measurement techniques with NASA; latitudinal variability of stratospheric constituents - project STRATOZ; and a study of stratospheric minor constituents at tropical latitudes by balloon-borne IR spectroscopy.

- A series of long-life balloons (M.I.R.) in the Southern Hemisphere to study radiative budget, dynamics and water vapor content is planned for the end of 1982 and it is hoped to be the start of an important MAP Program.

In parallel with those national activities should be mentioned the participation in international programs, PMP-1 (recently renamed DYNAMICS), CAMP, WINE, and GLOBUS.

This report is not meant to be exhaustive and doesn't mention long-term developments which will be reported at a future meeting.

MAP ACTIVITIES IN THE GERMAN DEMOCRATIC REPUBLIC

Studies of the middle atmosphere in the GDR are carried out by

ZISTP: Central Institute of Solar-Terrestrial Physics (Heinrich Hertz Institute) of the Academy of Sciences of the GDR

GOC: Geophysical Observatory Collm of the Karl Marx University Leipzig

Coordinator of the MAP activities is Prof. Dr. J. Taubenheim, ZISTP, DDR-1199 Berlin-Adlershof, GDR.

During the entire MAP period, the existing ground-based observational programmes will be continuously maintained for the monitoring of: radar meteor winds at Kuhlungsborn (ZISTP, Prof. K. Sprenger); ionospheric drifts by spaced-receiver LF method at Collm (GOC, Dr. R. Schminder); and 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).

From these observations, data are made available for MAP Projects: the Coordinated Studies of Dynamics of the Middle Atmosphere in Winter (DYNAMICS), the Stratwarm Mesospheric Program (SWAMP), the European Stratospheric Energy Budget Campaign, as well as for the forthcoming project Winter in Northern Europe (WINE) and similar campaigns. After 1983, the above continuous programs will probably be supplemented by height records with the ionospheric drift measurements (GOC), and partial-reflection measurements of D-region electron densities during selected periods (ZISTP). The above observations have already been used for many years in our institutes for detailed scientific studies, particularly of the winter phenomena in the mesosphere and the D-region plasma, being continued during MAP with the aims of detection and diagnostics of regular and disturbed variations of neutral and ionized atmosphere structure, dynamics, and photochemistry in the midlatitude 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
- solar-terrestrial events, e.g., energetic particle precipitation, solar-flare effects, etc.

Theoretical, modeling, and data analysis studies are carried out at the ZISTP on

- planetary waves and circulation in the tropo-, strato-, and mesosphere,
- photochemical energy transfer and neutral/plasma interaction in the mesosphere and lower thermosphere, including the ionospheric D region.

Results of middle atmosphere research have been presented at the Middle Atmosphere Dynamics Symposium at Urbana, 1980, the IAGA and IAMAP Scientific Assemblies at Edinburgh and Hamburg, 1981, and the Solar-Terrestrial Physics Symposium at Ottawa, 1982. Related papers have been published in Volume 2 of the Handbook for MAP, in J. Atmos. Terr. Physics, in the publication series 'Physica Solariterrestris' in the Zeitschrift f. Meteorologie and other journals (see the attached reference list).

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MAP ACTIVITIES IN HUNGARY

P. Bencze

Research activities relevant to MAP has been carried out according to the plan approved by the Hungarian National Committee of SCOSTEP.

Thus, balloon measurements of temperature, pressure and humidity were carried out at stations of the State Meteorological Service. The total ozone content has been measured by means of a Dobson spectrophotometer in the Central Institute for Atmospheric Physics, Budapest. For the study of the electrodynamics of the middle atmosphere the atmospheric electric potential gradient, point discharge currents have been recorded at the Geophysical Observatory near Nagycenk of the Geodetical and Geophysical Research Institute, Sopron. The recording of the vertical air-earth current is planned to begin in May. Similarly, in the Geophysical Observatory near Nagycenk the ionospheric absorption of obliquely incident radio waves in the LF range and relative phase height have been measured for the investigation of changes of solar and meteorological origin in the mesosphere and lower thermosphere.

In connection with the study of changes of solar and meteorological origin in the mesosphere and lower thermosphere the level of atmospheric radio noise has been studied after geomagnetic disturbances. It has been shown that following selected geomagnetic disturbances the level of atmospheric radio noise at midlatitude stations shows increased values lasting about a fortnight, if simultaneously a clear storm aftereffect is observed in Pc-1 type pulsations. Pc-1 type pulsations are used as indicators of increased plasma turbulence in the plasmasphere resulting in the precipitation of energetic electrons.

The turbulence at the top of the middle atmosphere has been studied by means of a method based on the parameters of sporadic-E layers. The method has been applied for the determination of turbulent parameters above midlatitude stations at first in geomagnetically disturbed periods. It has been found that this method gives results agreeing with other investigations and indicates the decrease of turbulent parameters above 120 km in these intervals. The approximations and procedures are now proved, since the computations give values of the turbulent parameters too low as compared to the other methods. However the advantage of this method is its applicability for synoptic investigations.

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INDIAN MIDDLE ATMOSPHERE PROGRAM (IMAP)

A. P. Mitra

INTRODUCTION

In the recent past, Indian scientists have made valuable contributions to the investigations of ionospheric phenomena, geomagnetism and meteorology. Special mention may be made about the studies which have improved our understanding on equatorial electrojet, ionospheric irregularities, geomagnetic field variations and monsoon circulation and energetics. Also, Indian scientists have had good experience in executing cooperative research projects; notable amongst these being IGY (1957-58), IQSY (1963-64), ISMEX-1973, MONEX-77, MONEX-79, ATS-6 radio beacon experiments and the rocket campaign during the solar eclipse of February 16, 1980. As a result of these efforts, and the progress made in space technology, fairly comprehensive infrastructural facilities and trained manpower have been generated in India for carrying out further research in the fields of atmospheric sciences. Some of the important existing facilities include ground-based airglow photometers, atmospheric and ionospheric radars, atmospheric LIDAR system, three sounding rocket ranges at Thumba, Sriharikota and Balasore, balloon-launching station at Hyderabad capable of launching plastic balloons carrying heavy payloads for studies in aeronomy and astronomy, a network of meteorological balloon stations of IMD, balloon, rocket and satellite payload development facilities at a few institutions and expertise on design, development and launching of satellites in ISRO. It is with this background that the atmospheric scientists in India have planned to participate in the International Middle Atmosphere Program (MAP) by utilising the existing facilities, and trained manpower and developing a few more facilities needed specifically for these investigations.

Following the successful completion of the International Magnetospheric Study (IMS), the International Middle Atmosphere Program (MAP) has been approved by the International Council of Scientific Unions (ICSU), as a coordinated scientific endeavour to investigate the atmospheric phenomena and processes in the height region of 10-100 km during the period January 1982 - December 1985. The main objective of this program is to obtain a comprehensive understanding of the structure, chemistry, energetics and dynamics of the middle atmosphere.

PLANNING FOR IMAP

Recognizing the importance of investigating the middle atmospheric phenomena of fundamental importance and the socio-economic benefits that are likely to accrue out of the role of the middle atmosphere in climatic variation, assessment and control of environmental pollution, radio and satellite communications and remote sensing of earth's resources, the Indian National Committee for Space Research (INCOSPAR) set up a National Steering Committee to recommend the scope and nature of Indian participation in MAP. The report submitted by the Committee contained the necessary justification and scientific elements, but was highly ambitious in terms of its cost and implementation as a cohesive and integrated program. A series of meetings of scientists then took place to sharpen and crystallize the scientific elements under the constraints of limited finances, resources and practicability of implementation within the time schedule of four years. This resulted in the formulation of the basic framework of the multi-institutional Indian Middle Atmosphere Program (IMAP) costing about Rs. 2.3 crores. Based on this, IMAP has been approved as a national program with the participation of and financial contribution from DOS, DST, CSIR, DOE, DOEn, MTCA and UGC.

Following the approval of IMAP, a detailed project report has been prepared primarily through the efforts of ten IMAP Working Groups (WGs), six of them dealing with different scientific aspects of the middle atmospheric processes - radiation, atmospheric dynamics, minor constituents and atmospheric chemistry, ionization and electrodynamics, modelling of the middle atmosphere and of troposphere-stratosphere circulation, and four of them dealing with technological aspects of the program — balloons, rockets, satellite data and software and IMAP information cell. The individual WG reports containing information on scientific objectives, identification of ongoing experiments and their continuation during IMAP, proposed development of new experiments, observational plans and time schedules, identification of individuals and groups in different institutions/universities for conducting the experiments and investigations, modelling/theoretical studies, requirement of balloons, rockets for experiments and satellite data have been integrated in the project report, the salient details of which are summarized in the following sections.

SCIENTIFIC OBJECTIVES OF IMAP

The broad framework of IMAP scientific objectives has been structured within the basic premise of the International Middle Atmosphere Program (MAP) that scientists will collaborate internationally:

1. To determine the structure and composition of the atmosphere in the region 10-100 km, especially in regard to the minor species of importance.

2. To determine the interaction of radiation from the sun, the earth and the atmosphere with the middle atmosphere, and

3. To investigate motions of the middle atmosphere on all scales, including the interaction with troposphere and magnetosphere, an' to

monitor these motions on a continuing basis.

MAP, by virtue of its global character, thus emphasizes the understanding of various phenomena on a global scale, achievable through the coordinated efforts of MAP projects by different countries and through satellite remote sensing observations, giving wider spatial and temporal coverage and repeatability of the measurements of various atmospheric parameters.

The main scientific objective of IMAP is the investigation of the low latitude middle atmosphere in relation to its (1) radiation transfer and exchange processes including troposphere-middle atmosphere coupling and roles played by aerosols and radiatively active atmospheric minor constituents like ozone, carbon dioxide, nitric oxide etc., (2) atmospheric dynamical features including generation, amplitude and phase variations, propagation and amplification, reflection and dissipation of planetary waves, equatorial waves, tides, gravity waves and turbulence, (3) structure and composition including ozone chemistry, role of minor constituents in controlling D-region ionization processes and role of aerosols in influencing earth's radiation budget and in ionic reactions in the stratosphere, (4) ionization and electrodynamics including D-region ionization state, complex ion chemistry of the stratosphere and mesosphere and the role of solar and non-solar sources and their changes on the electric field in the middle atmosphere and its implications on the global electrical circuit, (5) modelling of the distribution of neutral atmosphere, minor constituents, dynamical components (winds and waves), ionization and ion composition and effects of perturbations due to variations of one or more of these on others and (6) modelling of troposphere-stratosphere dynamical coupling including mean flow and wave interactions, radiative exchange and transport phenomena between these two regions.

EXPERIMENTS AND OBSERVATIONS

The activities of conducting different experiments and observations during IMAP can be summarized as follows:

1. Radiation studies include (1) ground-based lidar and multiwavelength radiometric measurements of temperature profile, aerosol density and their scattering properties giving aerosol particle size distribution, radiometric measurements of solar UV-B radiation received on the earth and influenced by stratospheric ozone and monitoring of airglow emission from $O_2(^1\Delta_g)$ and OH at infrared wavelengths, (2) balloon-borne experiments for measuring terrestrial upwelling radiation, emissions from $O_2(^1\Delta_g)$, solar UV radiation and optical scattering by aerosols, (3) rocket experiments for measuring UV scatter at .3μ, UV intensities between .2-.3μ and .22-.25μ wavelength bands giving ozone and NO profiles, respectively, Lyman-α and $O_2(^1\Delta_g)$ emission fluxes and (4) satellite data reception from NOAA to derive

temperature profiles between 15-45 km and use of NIMBUS-7 satellite data for deriving the profiles of vertical temperature and minor constituents and estimation of incoming solar radiation and outgoing earth's radiation.

2. Studies of atmospheric dynamics include (1) ground-based experiments of meteor wind and partial-reflection radars for measurement of mesospheric winds, and Fabry Perot interferometer to monitor airglow emission from which winds and temperature can be derived, (2) balloon-borne measurements of meteorological parameters using high altitude rubber balloons and chemical puff release experiments using polyethylene balloons from Hyderabad for eddy diffusion coefficient and vertical winds, (3) rocket-borne measurements of meteorological parameters using M-100 and RH-200 rockets and of winds in the thermosphere using RH-300 and RH-560S rockets and temperature measurements in the stratosphere/mesosphere using RH-200/M-100 rockets for the study of stratospheric warmings and (4) satellite data for vertical profiles of temperature.

3. Studies of minor constituents and atmospheric chemistry include (1) ground-based measurements of total ozone content using Dobson's spectrophotometers, airglow emissions of $O_2(^1\Delta_g)$ for estimating mesospheric ozone content indirectly and of OH emissions, (2) balloon-borne measurements of ozone profiles using electrochemical sonde carried in high altitude rubber balloons, measurements of vertical profiles of a number of minor constituents O, NO, $O_2(^1\Delta_g)$, HNO_3, NO_2, aerosols etc., using photometers and photoionization mass spectrometers, (3) rocket-borne measurements of vertical profiles of ozone and nitric oxide using optical ozonosonde and γ-band photometry payloads, respectively, and (4) use of data from NOAA-6 and NIMBUS-7 satellites for deriving the profiles of ozone and of a number of minor constituents such as CO_2, CO, NO, water vapour, N_2O and CH_4.

4. Studies of ionization and electrodynamics include (1) ground-based measurement of D-region electron-density profiles using partial reflection, cross modulation and Al absorption experiments (2) balloon-borne measurement of electric fields and ions in the stratosphere using double Langmuir probe, Gerdian condenser and Blunt probe and (3) rocket-borne measurement of electron density profiles and their variations with solar zenith angle using Langmuir probes, propagation experiment and Gerdian condenser and of electric fields using double Langmuir probes.

5. Modelling studies of the middle atmosphere include (1) generation of time-independent models involving distribution of chemical species particularly ozone, aerosols, electron and ion densities, solar and terrestrial radiation fields and dynamical fields of winds and waves, (2) generation of 2- and 3-dimensional photochemical models incorporating vertical eddy diffusion coefficents, latitudinal gradients, dependence on time, and interactions between

chemistry, radiation and dynamics by incorporating a simplified chemical scheme in the general circulation models, (3) generation of two-dimensional models of a number of important minor species for which the lifetimes are large and (4) efforts on three-dimensional modelling with interactive radiative, chemical and dynamical processes.

6. Modelling studies of troposphere-stratosphere circulation include (1) interaction between wave motions on different time and space scales, (2) response of stratosphere and the lower mesosphere to forcings by energetic systems in the troposphere, (3) effects of clouds and aerosols on the energy/heat budget of the middle atmosphere and (4) vertical propagation of planetary wave energy from the troposphere.

IMPLEMENTATION OF IMAP

Various individual elements of experiments and observations mentioned above have been integrated with the overall activity of IMAP. Efforts have been initiated to ensure the availability of various experiments during the IMAP timeframe and broad sequences of observations, multitechnique and multiparameter-based observations to study a special middle atmospheric phenomenon and coordinated data analysis and interpretation have also been planned. In order to achieve this task it has been agreed that the activities of IMAP will be implemented primarily, (1) by conducting studies using past data to consolidate the information relating to certain specific aspects of physical and chemical processes in the middle atmosphere, and (2) by carrying out well planned campaigns of experiments/observations identified for investigating certain specific phenomena of the middle atmosphere. A number of such consolidation studies and campaigns have been planned to be carried out during IMAP, some of which are summarized in the following sections.

(a) Consolidation Studies

Upwelling Radiation: IMD has been conducting ground-based and balloon-borne measurements of terrestrial radiation from a few locations in India. The results will be consolidated taking into account inter-calibration of instruments, variations with season and different types and extent of cloudiness.

Studies on Airglow Emissions: Observations of airglow emissions of 6300 A and 5577 A have been carried out by PRL and Poona University for more than a decade. These emissions take place from layers of the atmosphere around 250 and 100 km, respectively. From the intensity and Doppler line width measurements, it is possible to indirectly determine the atomic oxygen concentrations and temperature at these altitudes. In addition, observations have also been carried out on intensity measurements of emissions from sodium and OH molecules. Results obtained from these studies will be consolidated.

Rocket Data on Atmospheric Temperature and Winds: Since 1970, weekly M-100 rockets have been continuously launched from Thumba. Using these data, a number of investigations have been conducted dealing with different aspects of temperature structure and dynamics of the middle atmosphere. The results reported so far will be summarized and a consolidation report published.

Low Latitude Ozone Profiles: A zero-base model of ozone concentration profiles for the low latitude region will be made using the existing Dobson's spectrophotometric data, and observations from balloon, rocket and satellites from the stations in the global ozone network.

Reference Minor Constituents Model: From the available global data a zero-base reference minor constituents model will be generated which is appropriate for the Indian region.

D-Region Electron-Density Profiles: From the available data on electron-density profiles measured using rocket-borne experiments, ground-based partial-reflection and cross-modulation experiments, and International Reference Ionosphere data, a reference low latitude D-region ionosphere will be derived.

(b) Campaigns

Aerosols: This campaign will include balloon-borne measurements of number densities and scattering properties, rocket-borne measurements of UV scatter at .3μ, extinction measurements by ground-based multi-wavelength radiometers in the visible band giving aerosol size distribution and balloon- and rocket-borne measurments of stratospheric ions. The main objective is to characterize optical properties of aerosols for radiation budget studies and for understanding the ion-aerosol reactions.

Radiation Budget: Coordinated measurements of balloon-borne upgoing and downcoming radiation flux measurements, cloud cover and satellite-derived cloud-top temperatures to study troposphere-stratosphere radiation exchange and radiative flux divergence in different layers up to the stratosphere.

Solar UV Radiation: Ground-based B-UV and multi-wavelength radiometer measurements including high resolution UV observations, balloon- and rocket-borne radiation measurements of MUV (0.2-0.3μ) and Lyman-α flux to study the UV energetics of the middle atmosphere and to understand various photochemical and dynamical processes governed by this solar radiation.

Stratospheric Warming. LIDAR-based, M-100/RH-200 rocket and balloon-borne temperature measurements will be carried out during a strong stratospheric warming event for a detailed study of the development and horizontal extent of this phenomenon. Simultaneous measurements of ionospheric absorption, D-region ionization profile using a partial-reflection experiment and of stratospheric/mesospheric winds will also be conducted to study the effect of this warming on neutral and ionized regions of this middle atmosphere.

Mesospheric Temperature: With the help of balloon-borne temperature measurements up to stratospheric heights, temperature measurements using M-100 rockets carrying USSR-made sensors and RH-200 rockets carrying Indian-made sensors, an intercomparison experiment will be undertaken specially in relation to mesospheric temperature values which are not known accurately at present.

Atmospheric Tides: It is proposed to have simultaneous balloon and rocket measurements of winds at least four times a day from a few stations for selected months representing different seasons. This will help investigate the tidal patterns, their generation, propagation and dissipation in the middle atmosphere. This campaign will be attempted under a separate proposal.

Ozone Intercomparison: Intercomparison and measurements of ozone concentrations using various techniques of ground-based experiments, e.g., Dobson's spectrophotometers and IR phocometers for $O_2(^1\Delta_g)$, balloon-borne electrochemical ozonosonde and rocket-borne UV-absorption ozonosonde will be carried out for at least two locations - Thumba and Balasore/SHAR. These observations will help determine the relative values of measurements of vertical ozone profiles and its variations within the low latitude region. Wherever possible the experiment timings will be adjusted to coincide with satellite passes for further comparison with satellite-derived ozone concentration profiles.

D-Region Ionization: Intercomparison of electron-density measurements with different rocket payloads (Gerdian condenser, propagation experiment and Langmuir probe) simultaneous with D-region electron-density measurements using ground-based partial-reflection, cross-modulation and multi-frequency Al absorption techniques will be carried out.

Conductivity: Near-simultaneous measurements of thunderstorm activity, electric fields near the surface using Kytoons, at balloon and at rocket altitudes along with ion-density measurements with balloon-borne payloads will be carried out for investigating the electrodynamical processes in the D region.

Mesosphere/Mesopause Processes: The near-simultaneous measurements of various parameters will include ground-based meteor wind and partial-reflection radars for mesospheric winds, M-100 rocket flights for measurement of temperature and winds in the mesosphere, RH-300 rocket measurements of electron-density profiles, atomic oxygen, nitric oxide and Lyman-α flux. The main objective is to study various physical and chemical processes, and their interplay especially near the mesopause where the values of the above parameters undergo considerable changes.

Based on the above-mentioned plans of the six IMAP Science Working Groups and various campaigns, the detailed time schedules of individual experiments have been worked out by the IMAP Technology Working Groups on balloons, rockets and satellite data and software. These will be further refined, based on the readiness of various experiments/payloads, availability of balloons/rockets etc. For an adequate flow and exchange of information regarding various activities of participating scientists and for providing the necessary interface with the International MAP, the IMAP Information Cell will collect, compile, store and disseminate information of scientific experiments, data availability and progress made on coordinated efforts in campaigns and consolidation studies.

PARTICIPATION OF SCIENTIFIC GROUPS IN IMAP

More than 200 scientists working at different universities, national laboratories/institutions and government departments have already been identified for participating in various IMAP activities. These scientists are being supported by a large number of engineering and technical staff for design, development and operation of different experiments and for conducting scientific observations and research. Some of the major groups belong to the following institutions - Physical Research Laboratory, Ahmedabad, National Physical Laboratory, New Delhi, Vikram Sarabhai Space Centre, Trivandrum, Space Applications Centre, Ahmedabad, Indian Institute of Technology, Indian Institute of Science, India Meteorological Department, Indian Institute of Tropical Meteorology, Poona, Gujarat, Delhi, Andhra, Calcutta, Udaipur, Kerala, Nagpur, and Marathwada Universities.

It has been agreed that the whole IMAP activity will be carried out with the existing manpower in participating institutions and that Research Fellowships/Associateships agreed to be provided by some of the funding Agencies will be used for specific needs of carrying out experiments, observations, data analysis and interpretation. However, for running the program in an integrated manner, a limited number of staff will be required to coordinate various activities, monitoring progress and time schedules, service to be provided by the Information Cell, operating the budget and keeping the accounts of expenditures incurred under various activities.

CONCLUSION

Thus, the atmospheric scientists and technologists all over India are now geared to concentrate their research activities on investigations of the middle atmospheric phenomena and processes during the four-year period of 1982-85. Built on the strength of existing trained scientific and technical personnel and available large- and medium-scale facilities, IMAP promises to t one of the major cooperative exercises of scientific research in .ndia and has in store many possibilities of breakthroughs in the field of atmospheric research which may have far reaching implications on our understanding of the earth's environment.

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MAP IN JAPAN

S. Kato

The MAP community in Japan is engaging in various activities. In January 1982 a MAP Symposium was held at the Institute of Space and Astronautic Sciences, Tokyo, with about 100 participants and about 50 paper presentations on dynamics, composition, aerosol, radiation and modeling. The Antarctic observations were discussed in detail. Such a symposium is planned to be held each year during the MAP period. MAP News has been issued twice, reporting up-to-date status of various MAP activities; MAP News will be issued periodically during the MAP period. In general, Japan's national programs for MAP have started according to plans.

As to winds and waves, the Kyoto meteor radar has been in operation regularly, usually for a couple of days per week and continuously during campaign periods as in November 1981. The data have accumulated to such an extent as to be able to analyze lunar tides. We finished successfully a Jicamarca radar observation in November, 1981 in cooperation with an Arecibo observation by the Max Planck group and others (campaign organized by ICMUA). An observational network for HF Doppler measurements by the standard radio method has been organized, consisting of several stations.

As to composition, ground-based observations of ozone and other minor constituents by laser heterodyne spectroscopy and ultraviolet lidar is in preparation. Balloon sampling of the constituents will soon be in operation.

As to aerosol and radiation, aircraft and balloon experiments will start in 1982. Lidar observations have already been active in detecting aerosols in intense fluctuations by the Mt. St. Helens eruption.

The Antarctic Observation will be in full operation from 1983 as an international program as discussed in Edinburgh last year.

The MU radar construction is progressing at Shigaraki, to be complete in 1984 (to be partly in operation from 1983). The EXOS-C satellite will be launched, as scheduled, in spring, 1984. Besides observation programs, data analysis, modeling and theoretical studies are strongly encouraged to draw maximum benefit from MAP observations. An international MAP symposium is planned to be held in early summer in Kyoto in 1984.

MAP-RELATED RESEARCH IN THE REPUBLIC OF CHINA

T. Tsay

1. Department of Atmospheric Science, National Taiwan University:

   - Wave oscillations near the tropopause in the subtropical region.

2. Department of Atmospheric Physics, National Central University:

   - Theoretical study of atmospheric tides and acoustic waves.

   - A VHF radar, which can be used both in the SAD (Spaced Antenna Drift) and DBS (Doppler Beam Swing) modes, is in the planning process and will be constructed on campus and in operation in the summer of 1983.

   - Other experimental studies of ionospheric disturbances by using micro-barograph, three-component magnetometer and HF Doppler sounder will also be conducted.

3. Department of Chemistry, National Tsing-Hwa University:

   - Upper and middle atmospheric chemistry.

4. Telecommunication Laboratory, Directorate General of Telecommunications:

   - Real-time HF Doppler sounder and microbarograph recording as well as observation of D-region absorption phenomena by riometer at Lunping Observatory (25°00'N, 121°10'E).

   - Observational study of lightning flash counting.

MAP ACTIVITIES IN THE UNITED KINGDOM

L. Thomas

A report on the UK plans for MAP, prepared by the British National Committee for Solar-Terrestrial Physics, was widely circulated in the summer of 1981. It foresaw activities in three areas: stratospheric composition, mesospheric and lower ionospheric structure and composition, and dynamics.

The stratospheric composition studies are to be based on current UK experiments on Nimbus 7 and the Tiros N series of satellites, balloon and aircraft-borne experiments, and ground-based measurements. Firm plans are now being formulated for balloon campaigns, both national and in collaboration with the Federal Republic of Germany and NASA.

As a result of financial cut-backs, the UK small rocket program, on which the planned mesospheric and lower ionosphere studies are largely based, is being cancelled for two years from April 1982; for this period certain groups have arranged to provide payloads for foreign rockets as part of collaborative projects, and this procedure will help maintain expertise for the possible reinstatement of the UK programme in 1984. Thus the involvement of two UK rocket groups in the Swedish CAMP project has been confirmed and experiments will also be provided for the Canadian OASIS campaign. The latter represents an extension of the successful campaign carried out on 23 March this year to study the excitation processes of atomic and molecular oxygen airglow emissions from the mesosphere/lower thermosphere; this involved six Petrel rockets launched from S. Uist and carrying experiments from the UK, Swedish and Canadian groups.

The transfer of the meteor radar from Stornaway to Aberdeen, to operate in conjunction with the system at Sheffield for studies of gravity waves and turbulence, is proceeding. Plans for carrying out studies of these scales of motion at lower heights, using a VHF radar system, have been considered and a design study of such a system is in hand.

MAP PUBLICATIONS COMMITTEE REPORT

C. F. Sechrist, Jr.

Committee Membership

C. F. Sechrist, Jr., Chairman
R. D. Bojkov
R. J. Murgatroyd
V. V. Viskov

MAP Newsletter

The MAP Newsletters are being published in 1982 as Special Issues of the Upper Atmospheric Programs Bulletin which is funded jointly by the NASA Upper Atmospheric Research Program and the High Altitude Pollution Program of the Federal Aviation Administration.

MAP Newsletters were published and distributed in July 1981 and in January 1982.

The next issue of the MAP Newsletter will cont. n condensed minutes of the MAP Workshops and MAP Steering Committee meet gs held in May 1982. It will be distributed in August 1982.

Contributions for the MAP Newsletter during 1982 should be sent to:

Bulletin Editor (AEE-300)
c/o Dr. N. Sundararaman
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591 USA

Handbook for MAP

Volumes 1, 2 and 3 have been published and distributed.

Volume 4, covering the MAP Assembly and MAP Open Meeting, was published and distributed in April 1982.

Volume 5, a dynamic climatology of the stratosphere, was published in early May 1982. It will be distributed during the latter part of May 1982.

Proposed Future Topics for Volumes in the Handbook for MAP

°MAP Directory (Volume 6, 1982)

- MAP Workshops and Symposia (Volume 7, 1982)
- Satellite experiments including SAGE, SME, HALOE, ATMOS, LRIR, NOAA, DE, EXOS-C (Volume 8, 1983)
- Ground-based techniques including partial reflection ionization drifts, middle atmosphere radar, laser radar, meteor radar (Volume 9, 1983).

<u>Contributions for the MAP Newsletter</u>

More contributions for the MAP Newsletter are urgently needed. These are needed in order to publish the Newsletter on a regular schedule.

<u>Suggestions and Contributions for Handbook for MAP</u>

The Publications Committee welcomes suggestions of future topics for volumes of the Handbook for MAP. Suggestions and contributions should be sent to:

Professor C. F. Sechrist, Jr.
University of Illinois
Department of Electrical Engineering
1406 W. Green Street
Urbana, Illinois 61801 USA

N85-20441

PMP-1 REPORT

THE FOURTH WINTER OF PMP-1, 1981/82: A WINTER WITH SEVERAL INTERESTING FEATURES

K. Labitzke, et al.

ABSTRACT

A synoptic description is given for the fourth winter of PMP-1, 1981/82. The main characteristics of this winter are a Canadian warming in the beginning of December, a very strong minor warming in January, and an early final warming in mid-March. In the second part the eddy momentum budget, calculated from the daily height and temperature charts, is discussed in terms of the divergence of the Eliassen-Palm-Vector.

SYNOPTIC DESCRIPTION

The winter 1981/82 started with a Canadian warming in the beginning of December, which showed the most intense development of height wave 1 (amplitudes of temperature and height waves 1 and 2 at 30 mbar are shown in Figure 2b and 2e) observed since 1965. The maximum of this wave lies typically over Canada, as noticeable in the 10-mbar chart of 5 December 1981. As the Canadian warmings are confined to the lower and middle stratosphere the peak in the march of temperatures over the North Pole (Figure 1b) was stronger at 30 mbar than at 10 mbar and the radiance data of the uppermost channels of the SSU (Figure 1a) did not show much of the warming during this time. Moreover, the temperature gradient between the North Pole and 60°N was reversed for a longer time at 30 mbar than at 10 mbar (Figure 2d). There was only weak upward directed geopotential flux through 30 mbar at 60°N (Figure 2c) but the eddy heat transport by the wave number 2 was strongly directed northward at 30 mbar (Figure 5). The mean zonal wind at 60°N considerably weakened at 30 and 10 mbar, and north of 75°N easterly winds even occurred at 30 mbar (Figure 3).

In mid-December a warming period was observed at the upper stratosphere as can be seen by the radiance data of channel 27 (maximum weight around 1.7 mbar) of the SSU at the North Pole (Figure 1a), and the northern hemispheric distribution of channel 27 radiances showed a reversal of the gradient between the North Pole and 60°N for several days (as an example see the chart of 17 December 1981, Figure 4). During the same time the lower and middle stratosphere continuously cooled (Figures 1b and 3), the mean zonal wind steadily increased (Figures 2a and 3), and on 20 December a first wintertime minimum of temperature was reached. This was connected with an amplification of temperature and height wave 2 (Figure 2b and 2e) by which in the zonal

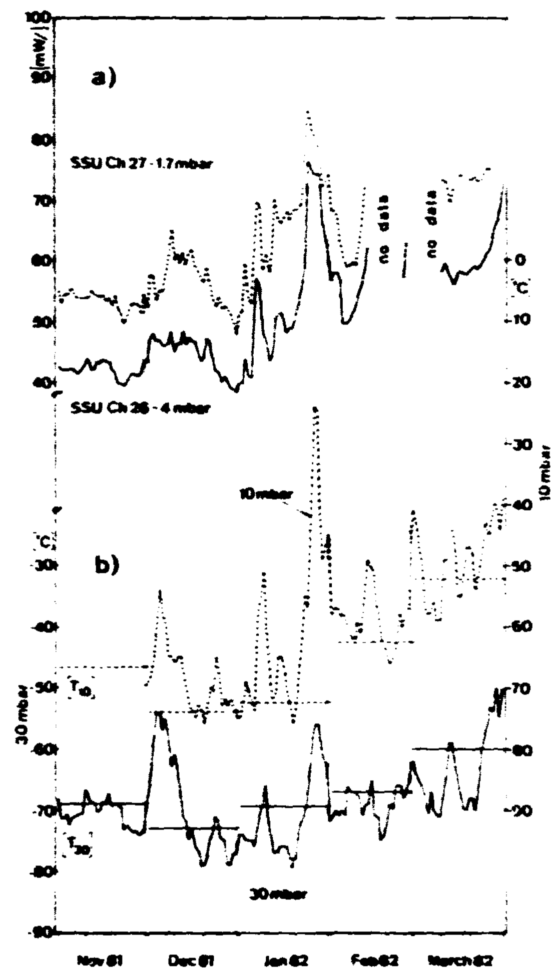


Figure 1. March of radiances and temperatures over the North Pole: a) Radiances [mW/m^{2}sr cm^{-1}] of channel 27 and 26 of the SSU, maximum weight around 1.7 and 4 mbar (courtesy Meteorological Office Bracknell, U.K.) b) Temperatures [°C] at 10 and 30 mbar (horizontal lines are long-term monthly means).

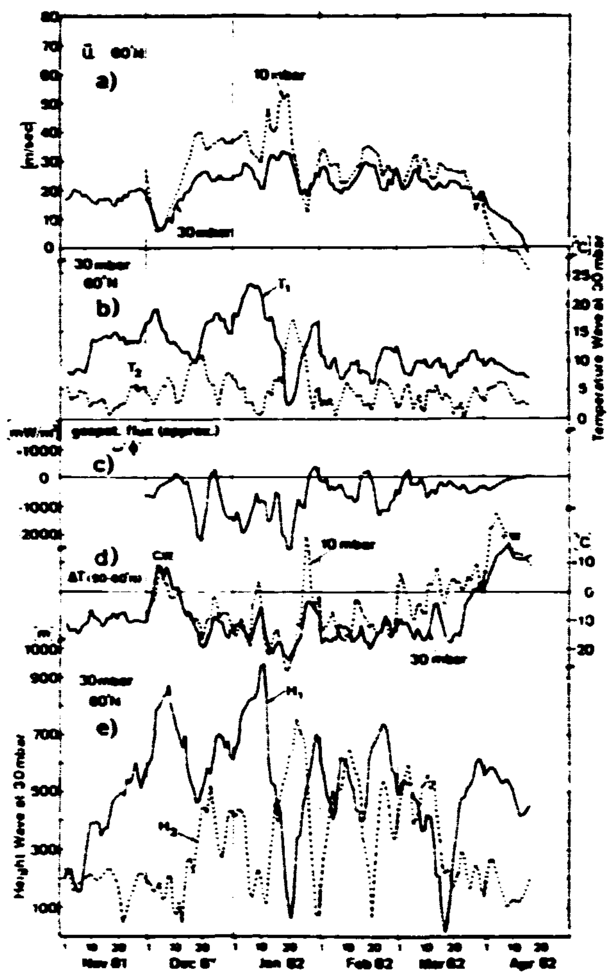
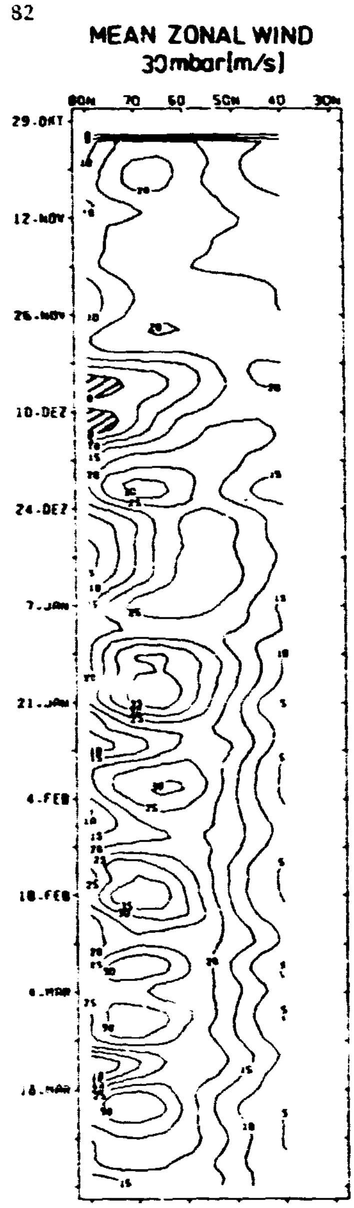


Figure 2. Derived quantities (daily values) describing the winter 1981/82: a) Mean zonal wind [m s^{-1}] at 60°N, 10 and 30 mbar; b) Amplitudes of temperature waves 1 and 2 [°C] at 60°N, 30 mbar; c) Geopotential flux [mW m^{-2}] through 30 mbar at 60°N; d) Temperature differences [°C] between North Pole and 60°N, 10 and 30 mbar; e) Amplitudes of height waves 1 and 2 [geopot. m] at 60°N, 30 mbar.



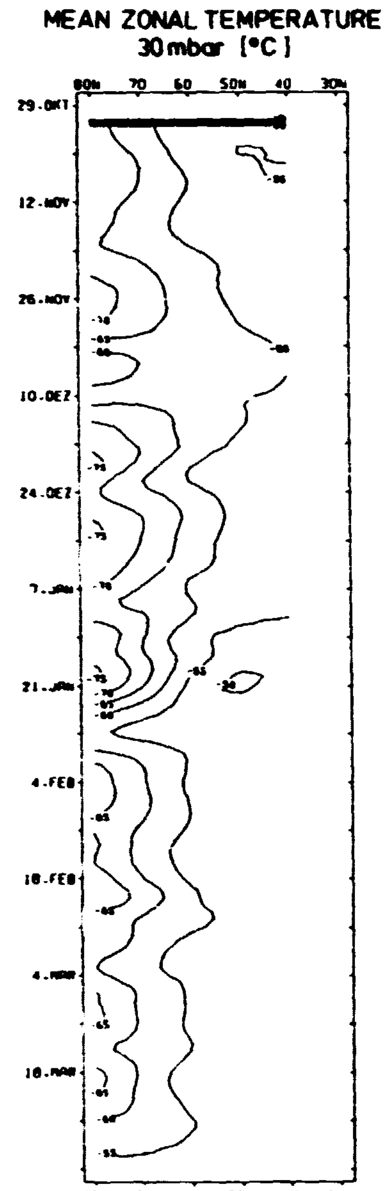


Figure 3. Meridional time sections from November 1981 to March 1982 of mean zonal wind [m s^{-1}] (shaded areas represent negative values, i.e., winds from the east) and mean zonal temperature [°C] at 30 mbar.

momentum as well as heat was transported northward (Figure 5). The geopotential flux upward through 30 mbar reached a maximum (Figure 2c) but the warming of the upper levels did not propagate much downward in the following time, there was only a small temperature peak at the North Pole around the Christmas days (Figure 1b).

After a relatively quiet and cold period around the change of the years where the second wintertime temperature minimum over the North Pole was reached (Figures 1 and 3), a strong warming occurred in January which developed within two pulses. Until 10 January a very strong height and temperature wave 1 developed (Figure 2b and 2e) while the height wave 2 concurrently showed a pronounced minimum, which is one of the pre-conditions for the onset of a major warming, as pointed out by Labitzke (1977). The radiances and temperatures at the North Pole (Figure 1) reached a maximum and the temperature gradient between the Pole and 60°N was reversed for a short time at 10 mbar (Figure 2d) and above. The strong wave 1 transported not only heat but also momentum northward (Figure 5) and the mean zonal wind at 60°N (Figure 2a) was decelerated only to a small amount (the momentum budget will be discussed later).

During the following ten days the lower stratosphere cooled again over polar regions, leading to the third temperature minimum of this winter on 20 January when the strongest negative temperature difference between the North Pole and 60°N was observed because the second warming pulse simultaneously occurred over mid-latitudes (Figures 1b, 2d, 3). The mean zonal wind strengthened and reached the wintertime maximum between 60 and 70°N with more than 50 m/s at 10 mbar (Figures 2a and 3), and the geopotential flux through 30 mbar upward reached the highest value of this winter (Figure 2c). It was during this cooling period that the European Centre for Medium Range Weather Forecasts at Reading, U.K., predicted a split of the polar vortex within the next week based on the initial 50-mbar analysis of 17 January (Klinker, 1982), and a major warming was predicted by the daily STRATALERT messages of Berlin. As can be seen in Figure 2b and 2e, a very strong temperature and height wave 2 developed and the 10-mbar chart of 22 January 1982 shows the climax of this wave with the split vortex and strong anticyclones associated with warm regions over the northern Pacific and Atlantic oceans.

The warming of the polar region progressed within the next days and the radiance chart of channel 27 of the SSU show the strong thermal ridging across the Pole on 24 January 1982. Three days later the peak of the warming was reached at the lower and middle stratosphere (Figures 1a and 1b) but the temperature gradient between the Pole and 60°N again was only reversed at 10 mbar (Figure 2d) and above, and a circulation reversal (i.e., mean zonal wind from the east from 60°N to the Pole) was not observed below 40 km altitude. The mean zonal wind at 60°N and northward only weakened considerably in the lower stratosphere (Figures

2a and 3). The 10-mbar chart of 27 January 1982 shows the circulation on the day with the strongest temperature gradient reversal and the lowest mean zonal wind at 60°N. As can be seen by Figure 5, there was a strong northward directed heat and momentum transport by wave 2, while the transports by wave 1 simultaneously were directed southward. The momentum budget and its effect on the change of the mean zonal wind will be discussed in the second section. Finally, no break-down of the polar vortex was attained and this event should be called a strong minor warming.

During February until the middle of March the temperature distribution at 10 mbar and above remained slightly disturbed and two warming pulses were observed at upper levels in mid-February and in the beginning of March which did not much penetrate downward (Figure 1). On the contrary, the 30-mbar temperature over the North Pole was quite below the long-term mean during this period (Figure 1b). The radiance chart of channel 27 of the SSU from 13 February 1982 shows one of these warming periods (Figure 4) during which the warm centre at the 10-mbar level was situated over Europe, as the axis tilted westwards with increasing height.

In mid-March an early final warming began. At the 10-mbar level the warm centre over northeastern Asia strengthened (as usually is observed during final warmings) and spread northeastward over the Canadian Arctic toward the Pole. The temperature over polar regions increased (Figures 1 and 3) and the reversal of the temperature gradient between the Pole and 60°N (Figure 2d) continuously propagated downward reaching the 50-mbar level at the end of March. The radiance chart of channel 27 of the SSU from 30 March 1982 (Figure 4) and the 10-mbar chart from 31 March 1982 show the strong warming with temperatures well above summertime values. The mean zonal wind at 60°N (Figure 2a) and further to the north (Figure 3) steadily weakened (see Figure 5 for the southward eddy momentum transport by wave 2 and more intense by wave 1 during March). The measurements of the prevailing winds at mesopause heights over Central Europe from the Geophysical Observatory Collm, GDR, showed the transition to winds from the east already in the middle of March, which was defined as a very early start of the so-called spring anomaly within the circulation of the mesopause region. At the 10-mbar level the mean zonal wind at 60°N reached negative values on 6 April and ten days later the wind reversal was accomplished at 30 mbar, too (Figure 2a). Thus, a weak zonal flow from east to west governed the region from 60°N to the North Pole from 30 mbar upward at the middle of April.

CALCULATION OF THE MOMENTUM BUDGET

The planetary waves (see Figure 2 for amplitudes at 30 mbar at 60°N of wave number 1 and 2) transport heat and momentum and are able to change the mean zonal wind. But the mean meridional circulation

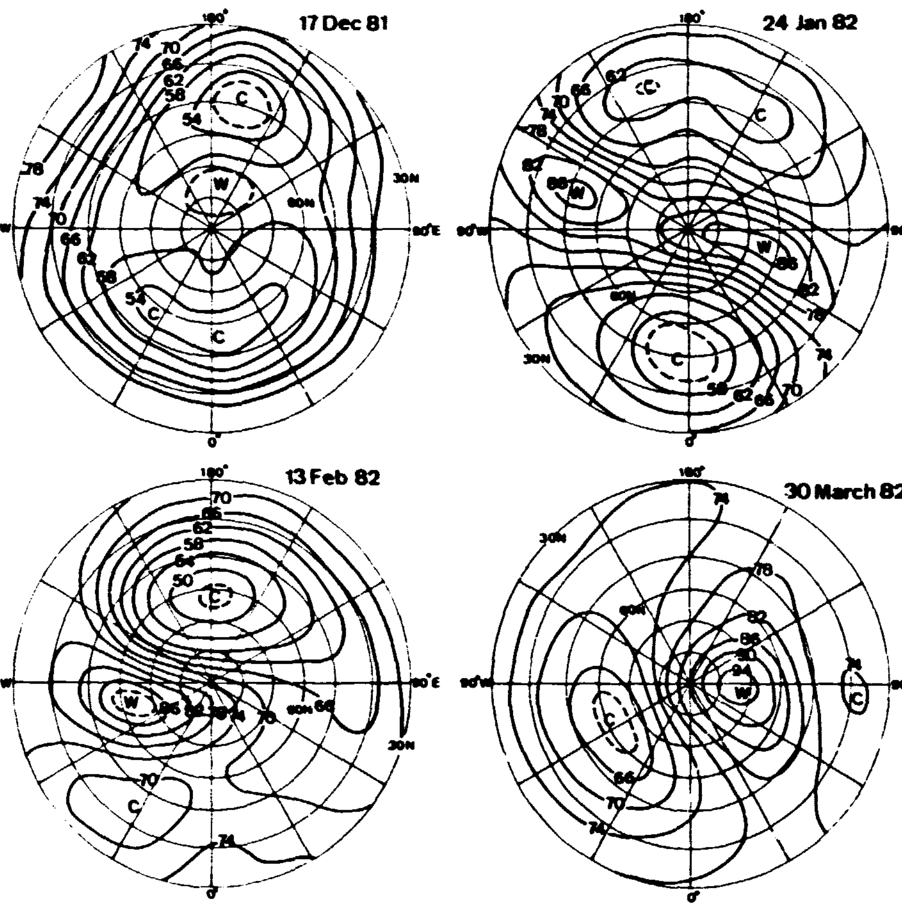


Figure 4. Charts of radiances [$mW/m^2 sr\ cm^{-1}$] at channel 27 of the SSU, maximum weight around 1.7 mbar (courtesy Meteorological Office Bracknell, U.K.)

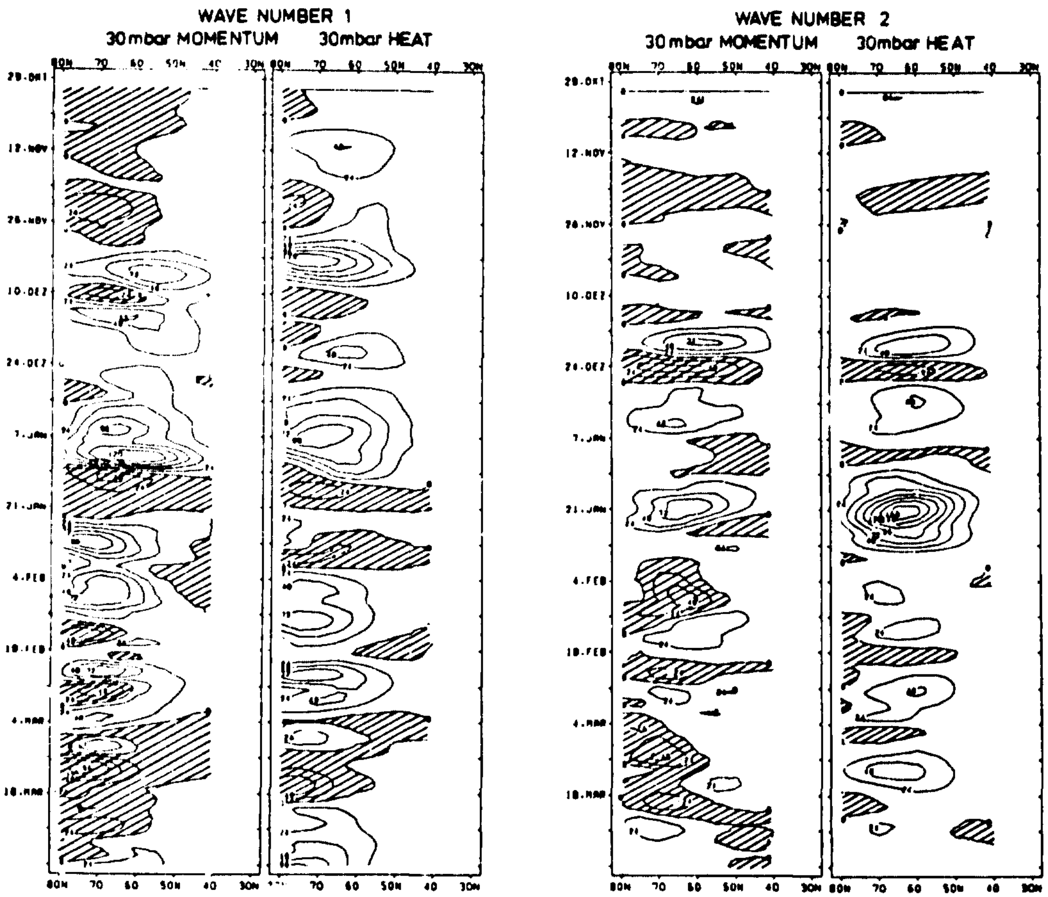


Figure 5. Meridional time sections from November 1981 to March 1982 of zonally averaged eddy momentum transport $[m^2s^{-2}]$ and eddy heat transport $[K\ m\ s^{-1}]$ by the planetary waves 1 and 2 at 30 mbar (shaded areas represent negative values, i.e., southward transport).

simultaneously forced by the steady conservative waves compensates these eddy transports by the steady waves (adiabatic temperature change by the Coriolis torque of the horizontal component), so that only transient waves are responsible for the weakening or strengthening of the mean zonal wind by interaction with the waves. Andrews and McIntyre (1976) introduced a transformed momentum equation which shows that for quasigeostrophic assumptions the change with time of the mean zonal wind is caused by three processes being frequently of opposite sign:

- Change with latitude of the mean eddy momentum transport $\overline{u'v'}$
- Change with height of the mean eddy heat transport $\overline{v'T'}$
- Coriolis torque of the mean horizontal meridional circulation $\overline{v}^*$, which is derived by subtraction of the uneffective part due to the steady waves from the mean north-south velocity.

The formula for the computation is (with A = radius of the earth and θ = potential temperature).

$$\frac{\partial \bar{u}}{\partial t} = f\bar{v}^* - \frac{1}{A\cos\varphi}\frac{\partial}{\partial\varphi}\left(A\cos\varphi\,\overline{v'u'}\right) + f\frac{\partial}{\partial p}\left(\overline{v'\theta'}/\frac{\partial\bar{\theta}}{\partial p}\right) = f\bar{v}^* + \frac{1}{A\cos\varphi}\nabla\cdot\mathbb{F}$$

where the vector F, named Eliassen-Palm-Vector, represents the flux of wave energy, the eddy forcing on the zonal mean flow is contained in the divergence of this vector: Divergence (convergence) is causing acceleration (deceleration) of the mean zonal wind.

The budget of the three terms in the transformed momentum equation was computed from the temperature and height charts of the middle stratosphere during this winter. In December, January, and February the mean eddy momentum transport as well as the mean eddy heat transport was mostly to the north (Figure 5), but the former predominantly accelerated the westerly wind while the latter caused deceleration (Figure 6a). Illustrating the budget for the change of the mean zonal wind with time Figure 6b shows that at 10 mbar periods with continuous deceleration of the mean flow were caused by the waves because the Eliassen-Palm-Vector was strongly convergent (6 Jan, 21 Jan, 4 Feb, 21 Feb, 28 Mar). The mean meridional motion compensated partly the effect of the waves but the direction of the change (negative sign) was determined by the convergence of the Eliassen-Palm-Vector. This total convergence happened on those days when - besides the mostly convergent vertical component - the horizontal component was convergent, too (Figure 6a). The deceleration of the westerly wind by interaction with the waves did not lead to a breakdown of the stratospheric polar vortex during this winter. But the flow of wave energy into the polar cap in the middle of March, indicated by the northward directed Eliassen-Palm-Vector (eddy momentum transport to the south, as seen in Figure 5 for 30 mbar and in Figure 6a for 10 mbar marked by N), led to an early reversal into summerly circulation features with the breakdown of the westerly winds of the polar vortex.

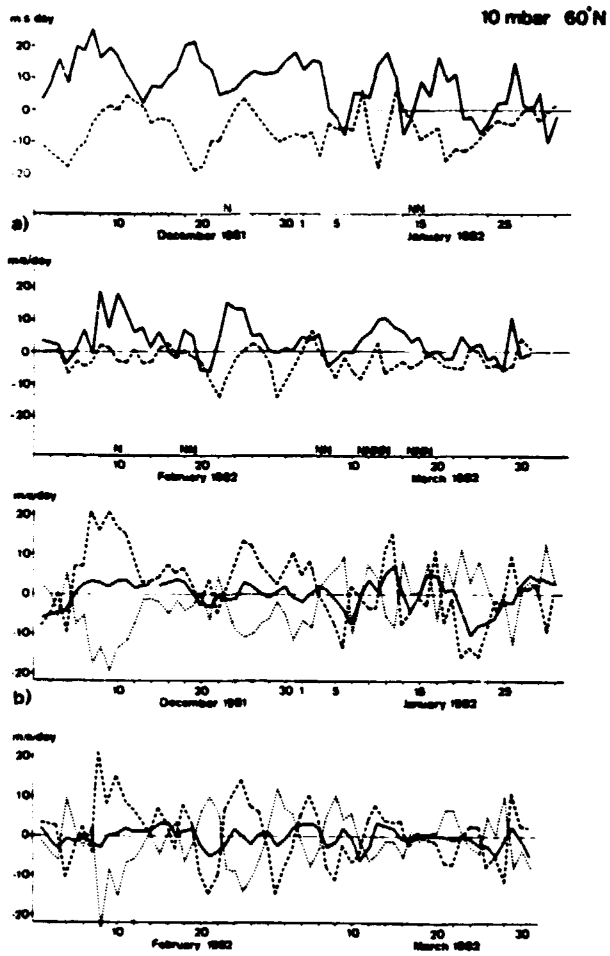


Figure 6. a) Divergence of the Eliassen-Palm-Vector at 60°N at 10 mbar [m s^{-1}/day] — horizontal amount $\frac{1}{A\cos\phi}\frac{\partial}{\partial\phi}(-A\cos\phi\overline{v'u'})$, --- vertical amount $f\frac{\partial}{\partial p}(\overline{v'\theta'}/\frac{\partial\bar{\theta}}{\partial p})$, b) Terms of the transformed quasigeostrophic zonal mean momentum equation [m s^{-1}/day] — change of mean zonal wind $\frac{\partial\bar{u}}{\partial t}$, --- divergence of the Eliassen-Palm-Vector $\nabla\cdot F$, ··· Coriolis torque of the residual meridional motion $f\bar{v}^*$.

ACKNOWLEDGEMENT

For monitoring the stratospheric-mesospheric wintertime circulation and preparing the daily STRATALERT messages we obtained the following additional information.

- from the Metecrological Office Bracknell, U.K.: Daily charts of radiances for the Northern Hemisphere of channels 26 and 27 of the SSU (Stratospheric Sounding Unit) onboard the NOAA satellites and the preliminary 10- and 1-mbar height charts derived from these data.

- from the Clarendon Laboratory, Oxford, U.K.: Retrieved temperature distributions over the Northern Hemisphere at 1, 0.3 and 0.1 mbar from the SAMS (Stratospheric and Mesospheric Sounder) onboard Nimbus 7.

- from the Geophysikal Observatory Collm, GDR: Prevailing winds at mesopause heights over Central Europe from low frequency drift measurements.

- from the Physics Department of the University Wuppertal: Temperatures at 85 km altitude measured with a ground-based infrared spectrometer at Wuppertal.

All this support is gratefully acknowledged.
We thank the members of the Stratospheric Research Group (Berlin) for the professional and technical assistance.

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PMP-2 REPORT

EQUATORIAL WAVE DYNAMICS

I. Hirota

INTRODUCTION

Pre-MAP Project 2 (PMP-2) was proposed and accepted in 1978 at the first MAP Steering Committee meeting held in Innsbruck. This report briefly describes the activity of PMP-2 during the past four years of 1978 through 1981 and some scientific problems to be studied further.

The main purposes of PMP-2 were as follows:

1. To survey current problems related to the dynamics of the equatorial middle atmosphere, as an extension of the review on this subject presented in the MAP Planning Document (1976),
2. To continue observational studies with use of available data sets such as those obtained from satellites and rockets,
3. To develop theoretical and numerical models to clarify the nature of equatorial waves and their interaction with the mean zonal flow,
4. To carry out special experimental programs with the aid of high-power radars located in the tropical region, and
5. To propose further measurement programs for newly defined problems.

An interim report on items (1), (2) and (3) has been published in the Volume 1 of Handbook for MAP (1981), and a brief review of observations of equatorial waves also appeared in the Volume 2 (1981).

OUTSTANDING PROBLEMS

During the 1960s, the dynamics of the equatorial stratosphere, especially the generation of the quasi-biennial oscillation of the mean zonal wind, was extensively studied in terms of the wave-mean flow interaction.

However, as pointed out at the MAP Planning Conference (1976), there were large gaps in our knowledge of the nature of the mean wind and waves in the equatorial mesosphere and lower thermosphere, mainly because of the lack of adequate observations in this height range. In particular, the mechanism for generating the westerly flow associated with semiannual oscillations around the stratopause and mesopause was

C-2

one of the most outstanding problems concerning the dynamics of the equatorial middle atmosphere.

Since theoretical studies indicate the possibility of upward propagation of various equatorial wave modes into mesospheric levels, it was recommended, at the starting point of Pre-MAP, that special observations were needed to establish the nature of these wave modes.

RESULTS

(a) The Semiannual Oscillation and Kelvin Waves

The existence of the semiannual cycle in the equatorial middle atmosphere was reconfirmed by satellite infrared measurements from the Nimbus 6 PMR (Crane, 1979).

In order to test the theoretical hypothesis that the vertical propagating Kelvin wave is responsible for the westerly acceleration of the equatorial zonal flow in the semiannual cycle, Hirota (1978, 79) tried to find evidence of Kelvin waves in the upper stratosphere and mesosphere by using rocket and satellite (Nimbus 5 SCR) data. It was found that a Kelvin wave with long vertical scale (15-20 km) and zonal wave number 1 is predominant and moves eastward with a short period (4-9 days).

Numerical modelling by Dunkerton (1979) shows that such a Kelvin wave gives rise to the observed westerly acceleration associated with the semiannual zonal wind oscillation.

(b) Planetary Rossby Waves

On the other hand, it has been considered that the equatorward propagating, planetary-scale Rossby wave is responsible for the easterly acceleration of the semiannual zonal wind oscillation, in addition to the effect of the global-scale mean meridional circulation in the middle atmosphere.

Recently, using the Tiros N SSU observations, Hirota (1981) showed evidence of the semiannual cycle in the horizontal eddy momentum flux convergence at the tropical stratopause level associated with planetary Rossby waves in the winter hemispheres.

Numerical simulations of the semiannual oscillation in the equatorial middle atmosphere have been made by global models (Holton and Wehrbein, 1980a, 1980b; Mahlman and Sinclair, 1980).

(c) Upper Mesospheric Waves

Regarding the dynamics of the equatorial upper mesosphere and lower thermosphere, however, very little is known about the nature of waves and their inter-relation to the mean flow.

Recent progress in VHF radar observations made it possible to obtain mesospheric wind velocities. From continuous observations at Jicamarca (12S) and Arecibo (18N), evidence of the day-to-day variation of mesospheric winds in the height range of 60-90 km has been obtained from a special observation program by the Kyoto University group and the Max-Planck Institute group (Fukao et al., 1980; Hirota et al., 1982; Rottger et al., 1982). This wind variation has a characteristic time scale of about 5 days or so, and is considered to be due to the passage of travelling planetary Rossby waves.

Moreover, a simultaneous observational program at Jicamarca and Arecibo was carried out by the two groups in November 1981, and the data obtained are currently under investigation.

(d) Gravity Waves

The momentum dissipation by small-scale motions is also a very important mechanism for the mean flow variation in the tropics as well as in middle and higher latitudes. In particular, upward-propagating gravity waves are considered to play an important role in the long-term variation of the mean zonal flow in the mesosphere.

Recently, theoretical development on this problem has been made by several authors (Lindzen, 1981; Matsuno, 1982; Holton, 1982; Dunkerton, 1982). Results of these studies strongly suggest the need for the delineation of global and seasonal morphology of gravity wave modes in the middle atmosphere. Only fragmental evidence for the predominance of short-period wind fluctuation has been obtained from the VHF radar observations, in relation to the mean zonal wind and its vertical shear (Rottger et al., 1981; Hirota et al., 1982).

WORKSHOP ON EQUATORIAL MIDDLE ATMOSPHERE MEASUREMENTS AND MIDDLE ATMOSPHERE RADARS

As was mentioned above, for the purpose of studying the dynamics of equatorial waves, further observations are needed, and the newly emerging middle atmosphere radar technique would be very promising for the measurement of winds and waves.

In this connection, a workshop was held in May 1982, as a part of the PMP-2 activity, under the sponsorship of MAP. The goal of this workshop was to improve our knowledge of the equatorial middle atmosphere dynamics and measurement techniques, and subsequently to develop proper methods to obtain useful data for the study of outstanding problems.

CONCLUDING REMARKS

During the period of PMP (1978-1981), some significant improvements have been obtained in both theories and observations of the dynamics of the equatorial middle atmosphere. Consequently, problems to be studied in the near future became more definite. In addition, recent progress in observing techniques such as MST radars and satellite limb infrared measurements has allowed the detailed structure of various wave modes to be investigated both in space and time.

Therefore, although PMP-2 does no longer continue, the study on the equatorial wave dynamics will be extensively continued during the period of MAP.

Finally, it is emphasized that many efforts have to be made internationally on analysis, exchange and archiving of data.

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J6

N85-20443

MSG-7: ATMOSPHERIC PENETRATION OF SOLAR RADIATION IN THE RANGE OF SCHUMANN-RUNGE BANDS

J. E. Frederick

In recent years there have been major efforts in measuring the extraterrestrial solar irradiance for use in atmospheric studies well as in photochemical models. The quantity of immediate relevance to theoretical studies is the number of photons which reach a given altitude in the middle atmosphere. Current models compute the attenuated radiation field but the cross sections available for the major absorbers, O_2 and O_3, often come from experiments that are now quite old. Solar irradiance measurements made in the middle atmosphere can provide a check on the calculations. However, there has been relatively little work done toward making in situ observations of the attenuated irradiance even though this quantity is the fundamental driver of photochemical processes.

Balloon measurements show some significant differences between the predicted and observed ultraviolet radiation field between 30 and 40 km. Such discrepancies were reported as early as 1965. In addition, it is now widely recognized that the radiation field which results from Rayleigh scattering and reflection from the ground and clouds is a significant factor in the dissociation of weakly bound polyatomic gases. Yet the way these processes are included in calculations varies from one modeling group to another.

The wavelength region to be studied by the Study Group includes Lyman alpha plus the range 175 nm to the visible. Specific topics to be addressed include:

(1) Our present understanding of the cross sections of the major absorbers, O_2 and O_3. This would include the Schumann-Runge bands as a subset.

(2) Comparison of in situ measurements of the attenuated radiation field with calculations.

(3) The relevance of the scattered and reflected radiation fields on middle atmospheric processes.

N85-20444 D7

WORKSHOP ON COMPARISON OF DATA AND DERIVED DYNAMICAL QUANTITIES DURING NORTHERN HEMISPHERE (PMP-1) WINTERS

J. C. Gille and K. Labitzke

INTRODUCTION

The workshop was held at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado from 11-14 May, 1982. Approximately 20 scientists from the Federal Republic of Germany, France, Japan, the United Kingdom, and the United States attended. The list of attendees is included as Appendix 1.

The purposes of the workshop were the intercomparisons of the basic meteorological variables temperature and geopotential height, and the quantities derived from them for application to stratospheric dynamics. The data for comparison were those from conventional sources (radiosondes and rockets), the Limb Infrared Monitor of the Stratosphere (LIMS) and the Stratosphere and Mesosphere Sounder (SAMS), which flew on Nimbus 7; the Stratospheric Sounding Unit (SSU), and data from the U.S. National Meteorological Center (NMC) from NOAA 5 and TIROS N Sounders (including SSU). For the satellite instruments, of course, the temperature and height are themselves derived from radiance measurements.

Data from the winters 1978-79 through 1981-82 were discussed, but most attention was devoted to days during the winter of 1978-1979, the first of the PMP-1 winters, and the only one for which LIMS data are available. For other systems this period is not necessarily typical of results to be expected at later times, due to changes in the instruments and analysis methods.

In order to cover the range of situations in the atmosphere, an earlier decision had been made to concentrate on one day believed to be relatively undisturbed, 2 January, and two strongly disturbed days, 26 January and 26 February, all in 1979. Participants were requested to bring maps and cross sections of temperatures, height, zonally averaged winds, wave 1 and 2 amplitudes and phases, heat transports, momentum transports, and Eliassen-Palm fluxes.

The agenda for the meeting is attached as Appendix 2. The participants responsible for data production brought most of the requested information. During the first day, there was a general background discussion of the experiments, including methods of data reduction and analysis. In the following days, the data were posted, and all participants had the chance to compare and discuss the different data products. For some cases numerical differences were available. In general, the participants were pleasantly surprised by the agreement between the data products resulting from the different experiments. As had been expected, the agreement tended to be better for undisturbed situations than for disturbed days and locations. Some local differences were larger than desired, especially for disturbed days. The workshop focused on the identification of problems, in order to provide guidance for future work to improve the results, and reduce or at least understand the differences. Discussions of the data and of some particular comparisons are presented below.

DESCRIPTION OF DATA

Mapped products of temperature and height based on conventional radiosonde measurements were available from the National Meteorological Center (NMC) of the U.S. and the Free University of Berlin. The latter are subjective analyses at 50, 30 and 10 mb, in the Northern Hemisphere. The NMC maps at 100 mb use conventional data (with satellite data over the oceans) in an optimal interpolation analysis scheme. At 70, 50, 30 and 10 mb, NMC analyses use only conventional data in a Cressman type successive approximation analysis.

The NOAA-5 Vertical Temperature Profile Radiometer (VTPR) and the TIROS N Stratospheric Sounding Unit (SSU) are nadir viewing IR sounders which provided data for NMC maps above 10 mb. Before 23 February, empirical regression coefficients were used to derive temperature and thickness from the outputs of the two VTPR channels with the highest altitude weighting functions.

The SSU is a pressure modulated IR radiometer. For the winter of 1979, radiances were available for retrieval only from channels peaking at 15 and 5 mb; information from an additional, higher, level is available from later instruments. After 25 February, readings from the SSU channels were used with calculated regression coefficients to give temperature and thickness. In 1979 neither set of coefficients was stratified by latitude or season.

The British Meteorological Office, which furnished the SSU, also determined the thickness between 100 mb and several higher levels by regressing them on the radiance. The regression coefficients also did not vary with latitude or season for the period in question; this modification was introduced in June 1979.

The LIMS is a limb scanning IR radiometer, which flew on Nimbus 7 and provided temperatures from 100 to 0.05 mb. Radiation emitted by the 15 μm bands of CO_2 is measured in 2 spectral channels, from which the temperature was inferred as a function of pressure, using an iterative retrieval scheme. The vertical field of view (FOV) is 2 km, leading to high vertical resolution. The thickness between standard pressure levels was calculated, and added to the NMC 50 mb height to give height fields. The analysis used a Kalman-filter on data around latitude circles. This is being further refined. The use of detectors cooled by a solid cryogen limited its life to 7 months.

SAMS is another IR limb scanning radiometer on Nimbus 7. Temperature is derived as a function of pressure from measurements of 15 μm radiance, along the orbital track using a recursive estimation approach to determine 10 eigenfunctions. The vertical FOV is 10 km. The temperatures and derived thicknesses are Fourier-analyzed around latitude circles each day. Heights were built up from the SSU 20 mb heights (see below).

TEMPERATURE COMPARISONS

(a) SAMS-SSU Comparisons

There is general agreement between SSU radiances and simulated radiances derived from SAMS temperature profiles. Where the differences are greater than 1 K in brightness temperature, they can be explained qualitatively by: time evolution of the field; data voids; and tides. It is expected that proper treatment of these three areas will reduce differences to less than 1 K everywhere.

Comparisons of thicknesses from 100 mb show the same general features. The agreement in undisturbed regions is better than expected in view of the lack of information from both instruments between 100 mb and 20 mb.

(b) SAMS-LIMS Comparison

Further detailed numerical comparisons are required in this area, and will be carried out in the near future. Qualitatively agreement is good, but differences are larger than SAMS-SSU. Differences may be consistent with the lower vertical resolution of SAMS. Amplitudes of waves are slightly smaller from SAMS, but the locations of warm and cold areas agree well. In the zonal mean, LIMS temperatures appear to be slightly higher at the stratopause. A feature of amplitude 10 K which slopes steeply eastward is visible in LIMS 26 January at 20N above 2 mb which is not apparent in SAMS data. It may be of narrow vertical extent.

(c) SAMS-LIMS - Berlin Comparisons

In undisturbed regions where there is adequate radiosonde data, there is general agreement to within 3 or 4 K. In disturbed regions, agreement is better on 26 January than on 2 January or 26 February. This appears to be due to the systems sloping on the latter two days, while the phase of the wave is almost independent of height on 26 January. It seems likely that the retrieval or analysis methods are causing the wave to be shifted in height or in latitude. Both SAMS and

LIMS have the warm center a few degrees further north than the Berlin analysis on 2 January. The problem may be one of vertical and/or horizontal resolution in the retrieval and/or analysis.

(d) LIMS-NMC Comparisons

Quantitative comparisons are complicated by the change by NMC from the NOAA 5 VTPR to the TIROS N SSU in February 1979. Initial comparisons show LIMS agreeing in the mean with NMC to $\sim\pm 2°$ from 100 to ~ 1 mb. Map features are in generally good agreement. At 10 mb, where the NMC analysis uses only radiosondes, large differences occur over the oceans.

HEIGHT ANALYSIS

The agreement between analyses was found to be generally very good, only the very demanding situation of 26 February showing large differences, with those limited mainly to the upper stratosphere. Maxima and minima usually agreed to within 10-20 decameters. The representation of gradients has yet to be evaluated quantitatively. Charts appeared generally similar, though there were signs that the extent of smoothing used in satellite analysis may benefit from further study. Some very localized errors were found to be associated with gaps in data coverage, which could lead to incorrect features in the flow.

Even in the worst case, February 26, the serious differences were limited to the region of intense warming.

The range of 1 mb heights in the warm pool was rather large, the highest being the SSU analysis and the lowest NMC, with SAMS and LIMS close together in between. The high SSU value is largely a consequence of the lack of channel 27 data in the upper levels so that the high temperature below is extrapolated upwards. The values were in order of the depth of their weighting functions. This explanation is consistent also with the observed sharp drop in the intensity of the temperature maximum with height in the upper stratosphere and lower mesosphere. The reason for the large difference between the NMC and SSU analysis is not clear, since they both use SSU observations (but with very different retrieval and analysis procedures).

COMPARISON OF DAILY ZONAL WINDS

For January 2, the zonally averaged zonal wind ($\bar{u}$) derived from SAMS, SSU, LIMS and NMC data generally agree well over most regions except at the top level around 0.4 mb and 26°N where the LIMS results are apparently greater than those from SAMS and SSU (but in agreement with nearby rocket measurement winds).

On January 26, $\bar{u}$ derived from SAMS and SSU generally agree within

5m/sec although larger differences are present in the region of the jet core. The values of $\bar{u}$ calculated using SAMS, SSU, NMC and LIMS data are reasonably close in the middle latitude regions, but differ in polar and subtropical regions. The stratospheric jet in the NMC data spreads over a wider area than in the LIMS results.

Again on February 26, in the middle latitude regions agreement among SAMS, SSU, and LIMS was reasonably good, but there were differences in $\bar{u}$ in high and low latitudes. The LIMS and SSU analyses tend to yield somewhat different positions for the zero wind line and region of easterlies in the tropics.

WAVE AMPLITUDE AND PHASE FOR TEMPERATURE AND GEOPOTENTIAL HEIGHT

A comparison of the amplitude and phase distributions of planetary waves 1 and 2 in the Northern Hemisphere stratosphere was carried out for the 3 days. No distributions of the wave amplitudes and phases were available from the SAMS data. The comparison was thus primarily limited to the LIMS and SSU data. Some conventional information was also available for the 50 and 30 mb levels from the Berlin group.

The comparison of the wave 1 and 2 amplitude distributions from the LIMS and SSU data showed good agreement with regard to the height of the maximum wave amplitude. The latitudinal position of the maximum wave 1 amplitude also agreed quite well. The LIMS and SSU wave amplitude and phase distribution were similar for the days in question, except that the LIMS maximum wave 2 amplitude was situated somewhat farther north. The sensitivity of heat and momentum transports to the phase and amplitude structure is such that detailed quantitative comparisons are necessary to get meaningful results.

On 26 January, a difference of 300 gpm was present between the maximum wave 1 amplitude values for the LIMS and SSU data while a difference of 50 gpm was present in the same type of comparison for wave 2. In each case, the LIMS wave amplitudes were larger than the SSU amplitudes, possibly resulting from its higher vertical resolution. These differences amounted to only 10-15% of the wave amplitudes.

ELIASSEN-PALM FLUXES, HEAT AND MOMENTUM TRANSPORTS

Comparison of the Eliassen-Palm (EP) fluxes were made for two days during the period of the minor warming of January 1979. At the height of the warming of January 26, SSU and LIMS data were in good agreement regarding the direction of the fluxes, both showing upward directed fluxes from the troposphere, strongly curved equatorward in the middle stratosphere, presumably due to the effect of the zero wind line. On January 22, the direction of the fluxes were also in qualitative agreement, showing strong upward propagation to the upper stratosphere.

In comparison, however, there were noticeable differences in the magnitudes of the divergences of the EP flux. Differences were apparent between two independent analyses of the LIMS data for January 22, one showing a region of divergence around 60N extending from 1 mb down to 10 mb which was observed neither in the second LIMS analysis nor in the SSU data. The differences between the two LIMS results appear to be associated with the data editing and analysis procedures, and resulted in different high latitude momentum fluxes, rather than significantly different heat fluxes.

On February 26, there was also an appreciable difference in high latitude momentum fluxes between LIMS and SSU data in the lower stratosphere, again apparently associated with the LIMS analysis. In this instance the Berlin analysis agreed well with the SSU values, both showing negative momentum fluxes in high latitudes. In view of the large geopotential amplitudes associated with warmings, only small phase gradients were necessary to explain the observed fluxes.

In conclusion, it was felt that these diagnostics have highlighted characteristics of the different analyses which may need further attention. Additional work should improve the particularly sensitive features of such analyses.

CONCLUSIONS

The quality of the data from all these sources is generally good, especially when one notes that the disturbed and difficult conditions that were chosen severely test the observing systems. The basic fields of temperature and height, based on these comparisons, are believed to be correct for the most part. Problem areas have been noted. Improvements are possible in a number of cases. For the derived quantities, it is necessary to be especially careful when taking derivatives of quantities in these basic fields, especially derivatives higher than the first.

The participants agreed that this workshop had been useful in identifying problems, and areas of concern. Preliminary plans were made to resolve problems which were identified here, and understand those differences among them. It was felt that this workshop had served as a beginning, not as an end to the data comparison. In order to complete a more quantitative comparison of the agreed upon data, plans were made to hold a second workshop in the spring of 1983, probably in Oxford. As part of the preparations for such a meeting, the data producers agreed on additional days to intercompare, and to a complete exchange of comparison data, on magnetic tape, before that time. At the second meeting, greater emphasis will be placed on understanding the meaning of the data, and understanding the physics of the stratospheric winter disturbances. Preliminary plans were formulated for a final meeting, to be held in Hamburg at a time close to the IUGG meeting, to complete the data comparison, but to focus much more strongly on the understanding of stratospheric winter phenomena.

APPENDIX 1

WORKSHOP ON COMPARISON OF DATA AND DERIVED DYNAMICAL QUANTITIES DURING NORTHERN HEMISPHERE WINTERS (PMP-1 WINTERS)

11-14 May 1982
Boulder, Colorado

PARTICIPANTS

M.-L. Chanin	France
S. A. Clough	United Kingdom
R. Dickinson	USA
F. G. Finger	USA
R. R. Garcia	USA
M. A. Geller	USA
W. L. Grose	USA
D. L. Hartmann	USA
A. Hauchecorne	France
I. Hirota	Japan
J. R. Holton	USA
W. J. Kohri	USA
K. Labitzke	FRG
R. Madden	USA
J. D. Mahlman	USA
T. Matsuno	Japan
T. N. Palmer	USA
K. Petzoldt	FRG
C. D. Rodgers	United Kingdom
M.-F. Wu	USA

APPENDIX 2

PROPOSED AGENDA

WORKSHOP ON DATA COMPARISON AND DERIVED DYNAMICAL QUANTITIES DURING NORTHERN HEMISPHERE WINTERS (1978-1982)

South Damon Room
National Center for Atmospheric Research
Boulder, Colorado USA
11-14 May 1982

Tuesday, 11 May

	Topic	Lead Discussant
AM	Introductory Remarks	Gille
	Goals of the Workshop	Labitzke, Gille
	Data Requirements for Observation Studies	Madden
	Conventional Data	Petzoldt
	NOAA and TIROS N Satellites	Finger
PM	Description and Evaluation of the Data Types and Analyses	
	LIMS (Limb Infrared Monitor of the Stratosphere)	Gille
	SAMS (Stratospheric and Mesospheric Sounder)	Rodgers
	SSU (Stratospheric Sounding Unit)	Clough
	Lidar Sounding of the Atmosphere	Hauchecorne
	Data Requirements for Theoretical Studies	Holton

Wednesday, 12 May

AM and PM Temperature and Height Field Comparisons
Wave 1 and 2 Amplitude and Phase, for Temperature and Height

Thursday, 13 May

AM Momentum Transports

PM Heat Transports

Friday, 14 May

AM EP Fluxes and Other Derived Quantities

PM Concluding Discussions
What has been learned.
What are the courses for future action.

WORKSHOP ON EQUATORIAL MIDDLE ATMOSPHERE MEASUREMENTS AND MIDDLE ATMOSPHERE RADARS

Convenors: S. Kato and I. Hirota

INTRODUCTION

The Workshop was held to effect a close interaction among theorists, modellers, MST- and ST-radar scientists and other experimenters working on the middle atmosphere. The Workshop determined the required observations, based on recent progress in middle atmosphere research. MST and ST radars now under construction, or in design and planning stages, were described. The present report presents the workshop program, a summary of each session, and edited versions of two panel discussions.

The convenors acknowledge the excellent arrangements of the meeting by Local Arrangements co-chairmen, Drs. T. E. VanZandt and B. B. Balsley, NOAA, Boulder. The convenors' thanks are due to various co-sponsoring organizations including SCOSTEP, COSPAR, IAGA, IAMAP and URSI.

SCIENTIFIC PROGRAM

Monday, 10 May 1982

Session 1. DYNAMICS: THEORIES AND MODELS

Chairman and Reporter, first half-session: I. Hirota, Kyoto University, Kyoto
Chairman and Reporter, second half-session: J. M. Forbes, Boston College, Chestnut Hill

J. M. Forbes and R. S. Lindzen, Waves in the equatorial mesosphere: Theories and observational needs (invited review).

Contributions by, inter alios:
R. S. Lindzen and J. M. Forbes, Mesospheric turbulence.
T. J. Dunkerton, Gravity waves and inertial instability.
M. L. Salby, Normal features over the equator: prospects for observations and identification.
L. Coy, A slowly varying model of gravity wave-mean flow interaction in a compressible atmosphere.
T. E. VanZandt, A universal spectrum of buoyancy waves in the lower middle atmosphere.

Session 2. OBSERVATIONAL RESULTS I

Chairman, first half-session (A): M. A. Geller
Reporter: L. Coy, University of Washington, Seattle
Chairman, second half-session (B): J. K. Chao
Reporter: J. Rottger, Max Planck Institute, Lindau

P. L. Bailey and J. C. Gille, Satellite data reduction and the observation of middle atmosphere waves (invited review).

Contributions by, inter alios:
M. L. Salby, D. Hartmann, P. L. Bailey, and J. C. Gille, Evidence for equatorial Kelvin modes in Nimbus-7 LIMS.
K. S. Gage, Observed variability of the tropical tropopause.
M.-L. Chanin, Lidar results in middle atmosphere dynamics at middle latitudes.
M. Petitdidier and R. Woodman, A Green's function simulation of a stratospheric 30-minute period wave packet.
P. Czechowsky, R. Rottger, R. Ruster and G. Schmidt, Implications for middle atmosphere research deduced from VHF radar observations at the Arecibo Observatory.
R. A. Vincent, The use of multibeam Doppler radars to study gravity wave momentum fluxes.

Tuesday, 11 May 1982

Session 3, OBSERVATIONAL RESULTS II

Chairman, first half-session: J. Rottger
Chairman, second half-session: M.-L. Chanin
Reporter: B. B. Balsley, NOAA, Boulder

B. B. Balsley, Overview of MST observational capabilities (invited review)

Contributions by, inter alios:
R. H. Wand, P. K. Rastogi, B. J. Watkins, and G. B. Loriot, Radar evidence for thin turbulent structures in tropo-stratosphere at Millstone Hill.
W. K. Hocking, On the extraction of turbulence parameters from power spectra measured by radar.
J. Barat and F. Bertin, In situ measurements in stratospheric turbulent layers.
K. S. Gage, MST radar detection of tropopause height.
J. Rottger, MST radar investigations applying spaced antenna techniques (invited review).
J. Rottger and C. E. Meek, A detailed analysis of wind velocity data deduced with the spaced antenna drift method.

Panel Discussion: Is there need for a middle atmosphere radar facility in equatorial latitudes?
Members: S. Kato (Chairman), B. B. Balsley, J. M. Forbes, K. S. Gage and I. Hirota

Session 4. MST RADARS, PLANNED OR UNDER CONSTRUCTION

Chairman: B. B. Balsley
Reporter: S. Fukao, Kyoto University, Kyoto

S. Kato, The Mu Radar under construction at Shigaraki, Japan (invited review)
S. Fukao and S. Kato, MU radar system and its antenna design (invited review)
R. A. Vincent, The Adelaide MST radar (invited review)
S. A. Bowhill, A proposed large MST radar for middle latitudes (invited review)
A. P. Mitra, The Indian MST radar (invited review)
J. Brosnahan, The Chung Li radar in Taiwan

Wednesday, 12 May 1982

Session 5. RADAR TECHNIQUES

Chairman, first half-session: R. A. Vincent
Chairman, second half-session: R. F. Woodman
Reporter: D. T. Farley, Cornell University, Ithaca

D. T. Farley, Review of MST radar probing techniques (invited review)
R. F. Woodman, On-line signal processing for MST radars (invited review)

Contributions by, inter alios:
S. A. Bowhill, A fast integrating preprocessor for a coherent-scatter radar system.
S. A. Bowhill, Interactive microcomputer systems for radar control and data acquisition using the FORTH language.
G. B. Loriot and R. H. Wand, Implementation of phase-coding for ST observations at Millstone Hill.
K. Wakasugi, M. Matsuo, S. Fukao and S. Kato, A complementary code sequence for MST radar observations.
M. P. Sulzer and R. Woodman, Optimization of mesospheric observations through new coding techniques.
M. P. Sulzer and R. Woodman, Quasi-complementary codes: A new set of phase codes for stratospheric radar sounding.
P. K. Rastogi and G. B. Loriot, Practical spectral moment estimation for low-elevation ST experiments at Millstone Hill.
C. E. Meek, A real-time ionospheric drift system.
C. Cornish, B. B. Balsley, D. T. Farley and R. Woodman, Evidence for echoes from the gap region.

Session 6. SUMMARY

Chairman: S. A. Bowhill
Reporter: R. G. Roper, Georgia Institute of Technology, Atlanta

R. G. Roper, VHF radars as meteor wind radars and the SCOSTEP GLOBMET (Global Meteor Observations) (invited review).

Panel Discussion: The Future of Middle Atmosphere Radar
Members: S. A. Bowhill (Chairman), D. T. Farley, K. S. Gage, J. Rottger, R. A. Vincent and R. F. Woodman

SESSION REPORTS

SESSION I. DYNAMICS: THEORIES AND MODELS

WAVES IN THE EQUATORIAL MESOSPHERE: THEORIES AND OBSERVATIONAL NEEDS

J. M. Forbes and R. S. Lindzen

Summary. Current knowledge of mesospheric gravity-type waves at equatorial latitudes is reviewed with a view towards evaluating the possible contributions of an equatorial MST radar. Based on theoretical considerations, diurnal series of rocket launchings, and radar measurements, diurnal propagating tides and especially the gravest symmetric (1,1) mode with 28 km vertical wavelength, are anticipated to be especially prominent in the equatorial mesosphere. SEASAT measurements of column H_2O densities suggest the possibility of nonmigrating as well as asymmetric diurnal propagating modes being excited, with vertical wavelengths in the 20 km to 60 km range. Recently, geographically symmetric radars at Kyoto (35°N) and Adelaide (35°S) have delineated strongly asymmetric tidal behavior about the equator in both diurnal and semidiurnal components, between 80 and 100 km altitude. For eigensolutions of Laplace's tidal equation (which may be distorted under actual conditions due to background winds and meridional temperature gradients), asymmetric tides are characterized by nonzero N-S velocities and zero E-W velocities at the equator, whereas the reverse is true for symmetric components. An equatorial MST radar could, therefore, contribute significantly to the deconvolution of tidal structures in the middle atmosphere.

On theoretical grounds it is expected that the (1,1) mode is capable of producing significant turbulence via nonlinear cascade or convective instability mechanisms, and a mean easterly equatorial jet ($\sim$ 50 m sec^{-1}) peaking near 105 km due to momentum deposition in the region where the tide is dissipated. An equatorial MST radar would, therefore, also provide the opportunity to observe the important middle atmosphere processes of wave-mean flow interaction and wave/turbulence coupling for a known wave forcing. As these phenomena primarily occur above 75 km, it is imperative that measurements extend as far into the lower thermosphere as possible, preferably to 105 km. Consequently, placement of such a radar must avoid possible interference by the equatorial electrojet.

Required system constraints including altitude and local time coverage, time and height resolutions, etc. are outlined. It is also emphasized that placement of the radar must consider the availability of mesospheric sounders at other latitudes within the same longitude sector.

Discussion

R. Woodman: (Ref. to measurements of tides at Natal and Kourou as compared to theory) There appear to be large phase discrepancies, as much as 180°, between the model and data at the lower heights (30-60 km).

J. Forbes: Yes. However, these phases correspond to very small amplitudes and are not really of any consequence.

S. Bowhill: One can see the amplitudes are below the noise level, and the phase doesn't mean anything at those altitudes. What limitation is involved in obtaining a diurnal tide from 12 hours of data?

J. Forbes: One cannot extract a diurnal tide from 12 hours of real data.

S. Bowhill: Twelve hours is typical for an MST radar.

J. Forbes: Using meteor radar observations, one could possibly obtain 24 hours of data within the 80 to 100 km height region.

S. Bowhill: If tides in that height region are of interest, then a meteor radar would be satisfactory.

R. Roper: I object to the practice of plotting turbulence intensities less than local diffusion values.

J. Forbes: My comments with regard to this topic pertain to the mesospheric region where turbulence values are greater.

D. Farley: Jicamarca is not shown on the map of mesospheric tidal observation stations.

J. Forbes: I omitted Jicamarca since the radar observes only 12 hours of the day in the mesospheric region. The other sites are mainly meteor radars or partial reflection drift radars.

MESOSPHERIC TURBULENCE

R. S. Lindzen

Summary. It is generally recognized that as internal gravity waves reach amplitudes for which they are unstable, they will break down, generating turbulence sufficient to inhibit further growth. This

has been hypothesized to be a major source of mesospheric turbulence. The possibility that such waves might generate turbulence at smaller amplitudes, via a cascade of energy from stable waves to waves of smaller scale which eventually go unstable, is investigated here. An iterative technique is utilized whereby a converged internally consistent solution is obtained for a wave which feeds upon itself. Formulas are derived for the breaking scale and resulting eddy diffusion coefficient, and sample simulations presented for the (1,1) diurnal propagating tide. In addition, two characteristics of this mechanism are noted which may be amenable to observations: (1) Internal waves are characterized by horizontal scales which are much larger than vertical scales, wher[illegible] or convective instabilities horizontal and vertical scales are [illegible]able. Thus, as one observes smaller and smaller vertical sca[illegible] ne should begin to see a breakdown in horizontal coherence as the unstable scale is approached. (2) Similarly, convective elements are generally associated with shorter time scales than are internal waves. Presumably a time-vertical space spectral analysis could reveal such a transition.

<u>Discussion</u>

B. Balsley: Concerning the cascading of a wave, how are different frequencies generated?

J. Forbes: It is hypothesized that the cascade occurs via some type of nonlinear interaction.

S. Bowhill: How is it different from the classical Kelvin-Helmholtz instability?

J. Forbes: First of all, it is assumed the primary wave remains stable. A cascade down to higher wave numbers is allowed and despite the reduced amplitudes (as specified by some power law), unstable temperature gradients might be generated, and hence convective instability. In the Kelvin-Helmholtz case, there is a limiting wind shear beyond which instability and presumably turbulence is generated.

H. Tanaka: I believe the Kelvin-Helmholtz instability will occur before the convective instability.

T. VanZandt: In the presence of a mean shear, perhaps.

S. Bowhill: Can this cascade occur in the absence of a shear?

J. Forbes: Yes. We don't consider the presence of a mean wind shear.

D. Farley: These waves are linear, yet some nonlinearity must exist to have a cascade.

J. Forbes: Yes. The nonlinear cascade does not preclude the primary wave, feeding energy at some low wave number, from being linear and stable.

S. Bowhill: Is it fair to characterize the model as beginning with a tidal structure with certain λ_z, which gives rise to a shear which can then induce an instability?

J. Forbes: No. In our model the primary wave can generate turbulence even at stable amplitudes via the cascade process.

R. Woodman: Steepening of a wave is one way of generating higher harmonics without instabililty.

S. Bowhill: Do these higher harmonics that are generated have the effect of steepening a wave, or do they have the effect of being a random component that represents turbulence? I think there is a real difference between a high frequency which is coherent with the original spatial frequency and one which is not.

J. Forbes: It is not incoherent until the unstable scale (in the wave number spectrum) is reached.

S. Bowhill: It is in fact a steepening of a wave that we are considering, and not the generation of turbulence per se.

J. Forbes: In principle a finite amount of turbulence will always be generated (in our model) at some critical scale where a transition occurs between coherence and noncoherence (turbulence). Whether this turbulence will amount to anything depends on the primary wave amplitude and scale, the background temperature gradient, and on the assumed power law.

T. VanZandt: Are these vertical wave numbers represented in the cascade power law?

J. Forbes: Yes.

S. Bowhill: The power law for steepening is not known.

J. Forbes: Yes. We examined the effect of varying the power law as shown in the figure.

S. Bowhill: Does the (1,1) tide generate uniform turbulence throughout this region?

J. Forbes: Only at the zeroth iteration in our model. The eddy diffusion coefficient is proportional to some power of the wave temperature gradient divided by the static stability.

S. Bowhill: This is normally not what is observed. The turbulence tends to concentrate in the regions of greatest steepening.

R. Woodman: Based on your model, would you expect the turbulence to occur in thin layers or to be more homogeneously distributed?

J. Forbes: The view in this particular calculation is that the distribution would be more homogeneous. On the other hand, we have not attempted to account for critical levels or diurnal variations.

S. Bowhill: This model provides one possible explanation for the small background turbulence which occurs in this region in addition to the very strong turbulence (a thousand times as strong) which occurs in very thin layers. It's very difficult to understand how shear can sustain turbulence throughout an entire volume.

Unidentified: In 1967 Lindzen suggested that breaking of the diurnal tide in the tropics is the primary mechanism for creating turbulence there. What's your view of the relative importance of this mechanism?

J. Forbes: This is an alternative view. In the present configuration it is not necessary for the tide to go unstable in order to generate turbulence.

GRAVITY WAVES AND INERTIAL INSTABILITY

T. Dunkerton

Summary. Gravity waves (including Kelvin waves and tides) and their unstable breakdown is a topic closely interwoven with the inertial stability of the equatorial middle atmosphere. The enhanced diffusion associated with breaking waves would presumably stabilize the observed cross-equatorial mean wind shear. Without this enhanced diffusion, one expects the atmosphere, as an essentially inviscid system, to exhibit inertial instability in the tropical winter mesosphere. Recent

theoretical progress suggests that this instability may not necessarily be zonally symmetric, and that it may be closely related to the Kelvin wave instability found by Boyd (1982, JAS).

At the same time, gravity waves (including Kelvin waves and tides) appear to provide a plausible explanation of the mesopause semiannual oscillation. The underlying concept is selective transmission, whereby vertically propagating waves are able to generate mean wind reversals at upper levels. In this case, the phase reversal in the total semiannual oscillation is explained by this concept. Considerably more observational work will be required to assess this theory.

Finally, there is new interest in the saturation mechanisms underlying the unstable breakdown of equatorial Rossby-gravity waves. It is plausible to invoke as many as three distinct candidates as possible sources of instability; the order of preference is inertial, barotropic, and static instability. By looking for regions of unstable breakdown in the observed Rossby-gravity wave in the lower stratosphere, it is conceivable that the answer to this difficult question might be partly provided by radar observations.

Discussion

M. Salby: What is the speed of the Kelvin wave which deposits westerly momentum in the mesopause region?

T. Dunkerton: The phase speed estimated from Dr. Hirota's paper is about 50 m sec^{-1}.

B. Balsley: What is the altitude range where the inertial instability might occur?

T. Dunkerton: The theoretical model has no vertical shear or vertical dependence. The greatest shear occurs in the winter mesosphere.

Unidentified: What is a typical vertical scale?

T. Dunkerton: That's arbitrary and related to the viscosity. For typical shears, the scale is 1-2 km.

Unidentified: What latitude band does the inertial instability span?

T. Dunkerton: It is confined to the tropical winter mesosphere within 10° of the equator.

S. Bowhill: Do the westerlies and easterlies provide the forcing?

T. Dunkerton: The coriolis interaction causes a northerly flow to generate easterlies which then lead to more northerly motion.

S. Bowhill: If they are produced by the instability, what is the source of energy?

T. Dunkerton: It's kinetic energy conversion from an initial linear shear to a cross-equatorial shear leading to the instability similar to Taylor's concentric cylinders.

R. Woodman: Are the east-west winds needed to start the whole system?

S. Bowhill: Perhaps they are a consequence of the instability.

T. Dunkerton: It's a matter of semantics. One is the consequence of the other. Cross-equatorial advection may be thought of as the "first cause" by creating a cross-equatorial mean wind shear.

J. Mahlman: In my numerical modeling work I have not observed the inertial instability found by Hunt.

T. Dunkerton: Hunt's model shears were about twice as strong as the observed shears.

NORMAL FEATURES OVER THE EQUATOR: PROSPECTS FOR OBSERVATION AND IDENTIFICATION

M. L. Salby

Summary. Several planetary normal modes are expected to achieve large wind signals in the middle atmosphere over the equator. Rossby-gravity mode amplitudes of wave numbers 1-3 increase rapidly in the upper stratosphere and mesosphere. A many-fold increase at mesospheric altitudes over surface values is predicted by linear calculations. The wind oscillations are predominantly meridional over the tropics, maximizing near the equator. Propagation of these modes is westward at periods near 1.2, 1.6, and 2.1 days, respectively. Spatial and temporal characteristics of the latter are not inconsistent with features of the "2-day wave", (Rodgers and Prata, 1981, JGR, 86, 9661).

In addition to the Rossby-gravity modes, the wave number 1 Kelvin normal mode also exhibits appreciable vertical growth in the presence of realistic winds. Propagation is eastward at a period near 1.4 days, the wind perturbation being predominantly zonal and maximizing over the equator. Matsuno (1980, JMSJ, 58, 281) has tentatively identified this mode in surface pressure fluctuations.

Because these modes (1) propagate fast enough to grow vertically in the presence of realistic winds, (2) are quasi-free oscillations, and (3) are sufficiently removed in frequency from the "red" end of the spectrum, they have the potential for achieving statistically, significant signals in the middle atmosphere -- even if totally masked by noise at the surface.

"Conventional" means of retrieving synoptic fields from asynoptic satellite data cannot faithfully recover features of such short period. This leaves ground-based radar techniques as one of the few means of observing the phenomena. Simultaneous measurements, however, will be vital in identifying these features.

Discussion

J. Stanford: Please comment further on the statement that present satellite observations cannot resolve 1-day period waves. How do you retrieve synoptic features from asynoptic data?

M. Salby: Conventionally it has been done by some form of space-time correlation; and an aggregate of methods has been used, some of them statistical. There has been uncertainty as to what frequencies and wave numbers are determinable. The majority of these methods used to estimate synoptic fields strongly attenuate or filter the shorter periods or smaller scales. Basically, the short period waves cannot be recovered synoptically because they evolve (propagate) appreciably during the time (one day) it takes the satellite to encircle the globe.

A SLOWLY-VARYING MODEL OF GRAVITY WAVE-MEAN FLOW INTERACTION IN A COMPRESSIBLE ATMOSPHERE

L. Coy

Summary. The vertical propagation of an equatorial Kelvin wave is investigated by considering the initial switch-on at a lower boundary of a two-dimensional internal gravity wave. Modulation equations have been developed for a single zonal harmonic which predict wave action, wave phase speed, and the mean zonal wind as functions of height and time. These equations are integrated numerically. The results show that the waves are capable of generating mean flows greater than the phase speed of the wave forcing. The wave phase speed increases in the interior of the domain due to the accelerating mean flow. At present such accelerated waves have not yet been observed but may be relevant to theories of the quasi-biennial and semiannual oscillations.

Discussion

Unidentified: What is the phase speed of these Kelvin waves?

L. Coy: 30 m sec^{-1}.

I. Hirota: It is difficult to understand the physical meaning of a switch-on model in equatorial wave-mean flow interaction. In the equatorial region, there is a quasi-equilibrium. What is your interpretation?

L. Coy: If there is no sudden switch-on, it makes it difficult to interpret this simple experiment in a physical way. I do think the amplitudes change somewhat, so some of these results may be meaningful.

M. Schoeberl: Would ~ :t summarize the major differences between your model a.d Dunkerton's?

L. Coy: In his model the flow above is a descending shear zone which is limited by the phase speed of the forcing wave. In my model they can be larger.

J. Stanford: What is the time scale?

L. Coy: One unit is the time to travel one vertical scale height at the linear group velocity. This is about 10 days for the Kelvin wave.

A UNIVERSAL SPECTRUM OF BUOYANCY WAVES IN THE MIDDLE ATMOSPHERE

T. E. VanZandt

Summary. Although power spectra of the mesoscale fluctuations of wind and temperature in the troposphere and lower stratosphere have been available for many years, there is no generally accepted dynamical explanation for them. In this work the power spectra of mesoscale fluctuations of the horizontal wind in the range of frequencies from the inertial frequency (1 to 2 x 10^{-5} cycles/s in middle latitudes) to the buoyancy frequency (4 x 10^{-3} c/s in the stratosphere) and in corresponding ranges of horizontal and vertical wave numbers are considered. It is shown, first, that they exhibit a considerable degree of universality; that is, both the shape and the amplitude of the spectra tend to be independent of geographical location and season. It is then shown that the spectra can be described in terms of a spectrum of gravity (or buoyancy) waves, which is a slight modification of the universal spectrum introduced by Garrett and Munk (1972, 1975) to describe the mesoscale spectra in the ocean. The dynamical processes

that might maintain a universal shape and amplitude are discussed. The implications of a universal spectrum for middle atmosphere dynamics are explored.

Discussion

Unidentified: In the ocean the temporal spectrum would be referred to intrinsic frequency. In the atmosphere this couldn't possibly be since the wind speed is usually greater than or equal to the wave speed.

T. VanZandt: It is puzzling why the Garrett and Munk spectrum, which is applicable to the ocean where the doppler shift is small, works so well for the atmosphere where the doppler shifts are large.

Unidentified: I have reservations about applying consistency relations (ratios of spectra) to verify spectral laws. In comparing internal gravity waves, for instance, one might expect an equipartition of K.E. and P.E., whereas for geostrophic turbulence one might expect a ratio of 2 or 3. The observations may differ from both of these. In any case, I don't think they would be sufficiently different to be conclusive.

T. VanZandt: Comparing any one spectrum or consistency relation is not enough. One must evaluate all information available, and take into account the number of adjustable parameters and experimental errors.

Unidentified: Based on the observations, what are the space and time scales for which this relation breaks down?

T. VanZandt: In the horizontal wave number spectra the largest scale to be dominated by gravity waves is 1000 km. The spectra end before the smaller scales are reached. For the vertical scales the buoyancy wave model fits from 4 km to 100 m where the data end and the model still fits very well there.

R. Woodman: Concerning the cut off at the Brunt-Vaisala frequency, it does not seem plausible if one considers the relatively large doppler shift occurring in the atmosphere.

R. Rottger: You mentioned that we observed this peak in the spectrum when the wind velocities are low. I made some interferometer measurements which I will discuss tomorrow, and found the horizontal phase speed of these waves compared to the wind speed. The phase speed is much larger, so one can disregard the doppler shift.

T. VanZandt: What was the phase speed?

R. Rottger: A factor of 5 or so larger.

T. VanZandt: We don't know the phase velocity of the waves contributing to these continuous spectra. The waves that are studied observationally are mostly discrete waves which are a subclass of the continuum of waves. They may not be typical.

R. Rottger: It is my impression that the phase velocity of a wave which is very close to the Brunt-Vaisala frequency is stationary. It just stays there in an up and down motion.

S. Bowhill: It is possible the cutoff that's observed is not due to the situation there, but at the point where the waves were first generated. At this point the wind velocity may have been quite a bit less. Once the frequency of the wave is determined, it can propagate into regions where the wind velocity is greater and it will retain the same temporal frequency. Therefore, its relationship to the Brunt-Vaisala frequency will remain the same regardless of the doppler shift.

Unidentified: It may help to look for breaks in the slope of the spectrum, say at the Brunt-Vaisala frequency or at the buoyancy scale length.

T. VanZandt: In the vertical velocity spectra that I showed there isn't a break in slope but a sudden drop in energy density by an order of magnitude.

W. Ecklund: We have examined a number of vertical spectra in the stratosphere at Platteville and Alaska, and have found the occurrence of a sharp break at the buoyancy frequency to be the exception (about 1% of the cases) rather than the rule. The rest of the time there is no apparent transition.

SESSION 2. OBSERVATIONAL RESULTS (A)

SATELLITE DATA REDUCTION AND THE OBSERVATIONS OF MIDDLE ATMOSPHERE WAVES

P. L. Bailey and J. C. Gille

P. L. Bailey described some of the characteristics of satellite data. Satellite data have stable systematic errors and a characterizable precision. The coverage is nearly global, includes both day and night observations, and is capable of good vertical resolution. The temporal, zonal and vertical resolution of satellite data has applications in the study of atmospheric waves and such data have been historically an important source for planetary wave studies.

Two viewing methods have been used, nadir and limb. The nadir viewing gives better global coverage than the limb viewing but the limb viewing has much better vertical resolution. High vertical resolution is necessary for answering some important questions about the middle atmosphere, including ozone transport.

The processing of satellite data was considered as a series of steps: data collection, data mapping, calibration of the orbiting instrument, retrieval of geophysical parameters, objective analysis, and the calculation of derived quantities.

An important part of the processing of the Nimbus 7 Limb Infrared Monitor of the Stratosphere (LIMS) instrument is the use of the Kalman filter sequential estimation technique. This technique represents the data field by 6 zonal harmonics at each latitude of interest and gives prediction equations for the wave coefficients and the error of each coefficient. The coefficients and their errors are updated each time a new data point is obtained. For a given data set the filter is applied both forward and backward in time and the two estimates are combined. When the filter was tested on manufactured data it was found to give very accurate results for large amplitude stationary waves but the amplitude was attenuated for waves with high phase speeds.

Results from LIMS were illustrated in a latitude height section showing wave 1 amplitude and phase, and in component time series showing temporal wave amplitude variations and wave phase propagation.

<u>Questions</u>

What would be a characteristic value of the RMS error in the temperature profiles? About 3-4° in the tropics and 5-6° in the polar latitudes.

Can the vertical resolution be increased at higher altitudes? Instrument noise limits the LIMS on Nimbus 7. Interpretation of measurements at high latitudes becomes more difficult due to the breakdown of LTE.

What is the horizontal resolution of LIMS? The horizontal weighting function is about 280 km.

EVIDENCE FOR EQUATORIAL KELVIN MODES IN NIMBUS 7 LIMS

M. L. Salby, D. Hartmann, P. L. Bailey and J. C. Gille

Kelvin waves are known to be an important source of westerly momentum in the quasi-biennial oscillation and are believed to be important in the semiannual oscillation. Two data samples from the Nimbus 7 LIMS were examined for Kelvin waves. The first time period revealed an eastward moving wave 2 in the temperature field with a period of about 7 days. The second time period was long enough (60 days) to allow a complete spectral analysis. The data showed wave 1 with periods of 6.7-8.6, and 3.5-4.0 days and wave 2 with periods of 6.0-7.5 and 3.0-4.3 days. All waves were eastward propagating. The amplitude structure of the different wave modes were shown as functions of height and latitude. The vertical wavelengths were estimated to be 10-32 and 41 km for the wave 1 modes and 7-13 and 10-32 km for the wave 2 modes. The use of MST radar data in the future would be helpful for detecting shorter wavelength modes (if they exist) and in forming a better synoptic picture.

OBSERVED VARIABILITY OF THE TROPICAL TROPOPAUSE

K. S. Gage

Large variations in the tropopause height are seen at midlatitudes. Most of the observed variations can be explained by midlatitude weather systems and the annual cycle. The annual height variations in the Northern Hemisphere and Southern Hemisphere are out of phase. Tropical rawinsonde data were used to observe the annual cycle of the Pacific tropical tropopause. The annual cycle was found to be in phase throughout the tropics with an amplitude variation of about 1 km and with the minimum heights occurring during the Northern Hemisphere summer.

Results were shown from a model calculation of the annual cycle of the tropical tropopause height which agreed well with the observations. The model related changes in the height of the tropopause to changes in incoming solar radiation. The tropopause height would increase with increased convection resulting from high sea surface temperatures. An important part of the annual cycle in the model comes from the annual variation in the Sun-Earth distance.

Interannual variability of the tropical tropopause height was shown from 1953-1969 along the Zurich sunspot number. The two curves appeared to be well correlated.

LIDAR RESULTS IN MIDDLE ATMOSPHERE DYNAMICS AT MIDDLE LATITUDES

M.-L. Chanin

Some results were shown which illustrated the potential of the Lidar technique to study short-term variations in the atmosphere. The technique measured laser backscatter from which temperature profiles can be constructed in the 30-85 km region.

All the temperature profiles showed short-term variations from 30 minutes to 2 hours. Spectral analysis gave vertical wavelengths from 3 to 9 km with only the longer 6 to 9 km wavelengths appearing in summer. Other than the tides, which showed up at 12- and 24-hour periods most of the power was from periods of 2.5-4 hours.

SESSION 2. OBSERVATIONAL RESULTS I (B)

A GREEN'S FUNCTION SIMULATION OF A 30 MIN STRATOSPHERIC WAVE PACKET

M. Petitdidier and R. Woodman

In this paper short-period gravity wave events observed with the 430-MHz radar at Arecibo were described and model calculations were presented to explain the observations. The characteristics of the event were a quasi-sinusoidal oscillation of the zonal wind of about 20 min period and 3-4 ms^{-1} amplitude in the altitude region between 12 and 15 km. The beginning of the event was characterized by an impulse-like transitory variation; in the altitudes lower than 11 km the period of oscillation was about 30 minutes.

The classic equation of gravity-wave propagation in the presence of a source was solved to determine the Green's function. The height variation of this function above the source was calculated and it was shown that the event can be separated into a transitory and an oscillating part. Whereas the transitory part was very similar and occurring exactly at the same time at each altitude, the gravity-wave oscillations after a while changed in different altitudes and were not observable at the lower heights. Not only time variations but also spatial variations of the source (e.g. cumulus cloud activity) were included in the model. It was shown that one cannot observe any variations after the transitory part if the equivalent buoyancy frequency $\omega_c = \omega_B \cdot z/R$ (z = altitude above the source, and R = distance from the source to the observation region) is out of the range of the source spectrum.

The computations were carried out for an isothermal atmosphere and no background wind which may account for minor differences between observational and computational results. It was pointed out that this method to compute the atmosphere response to an impulse-like source may be less problematic and more realistic than the approach applying the dispersion relation to a single wave event. This type of work, combining radar observations with model calculations, can be regarded as a most valuable approach to understanding source mechanisms of gravity waves.

IMPLICATIONS OF MIDDLE ATMOSPHERE RESEARCH DEDUCED FROM VHF RADAR OBSERVATIONS AT THE ARECIBO OBSERVATORY

P. Czechowsky, J. Rottger, R. Ruster and G. Schmidt

This paper reported preliminary results from several experimental campaigns carried out in 1980 and 1981 at the Arecibo Observatory where a transportable 30-kW/120-kW VHF radar of the Max-Planck-Institut fur Aeronomie was operated with the large Arecibo dish antenna. Using a best height resolution of 300 m, it was possible to investigate in detail mesospheric turbulence structures. It is evident that different layer types occur in the lower and the upper mesosphere. Whereas the layers at altitudes lower than 75-80 km are stratified (deduced from a considerable aspect sensitivity), thin and laminated, the layers above 80 km are several kilometers thick and appear "cloud-like". The lower layers have a narrow spectrum, and the upper layers a very wide spectrum, i.e., strongly fluctuating velocities. It appeared that the layers on the average are separated by 12-15 km in height and sloping downward during the day, suggesting a connection with the diurnal tide. This is supported by the observation that the strongest layers often occurred in regions of highest shear of the mean wind which was measured simultaneously with the radar. Superimposed on the mean wind were often gravity-wave oscillations of about 10-min periods, and it was suggested that the mesospheric layers below 80 km are caused by wave-induced turbulence. However, one also has to consider the variation of D-region electron-density profiles which influence the VHF radar detection of mesospheric turbulence. The upper mesospheric layers with strongly turbulent velocities could be generated by hydrostatic instability since the Richardson number could get negative due to the diurnal tide near the equator (as pointed out in an earlier paper by Lindzen). It remains presently unsolved if this still holds for the latitude of 19° where Arecibo is located.

Although the intermittent nature of mesospheric turbulence limited in some manner the continuity of VHF radar measurements of winds in the mesosphere, average wind profiles could be deduced over a longer period of almost 40 days from December 1980 to January 1982. The measurements taken around the noon hours again indicated the presence of the diurnal tide; however, considerable day-to-day variability was observed. One may assume that this variability is due to planetary waves. A significant peak-to-peak amplitude of 6 ms^{-1} was found in the zonal wind at a period of 6 days, but not in the meridional wind. It was consequently assumed that this was due to a Kelvin wave. Since these tropical wave disturbances can supply westerly momentum to the zonal mean flow in the mesosphere, the continuous observation of wind profiles by radars will be a valuable contribution for global circulation models. A brief example of a Kelvin-Helmholtz instability observed in a strong jet below the tropopause was finally presented, which again proved the unique applicability of high-resolution radars to investigate atmospheric dynamics.

THE USE OF MULTIBEAM DOPPLER RADARS TO STUDY GRAVITY WAVE MOMENTUM FLUXES

R. A. Vincent

This presentation described a new and unique appplication of radar measurements. He stressed the possible importance of this technique to estimate horizontal wavelengths and momentum fluxes of gravity waves which recently turned out to be required input parameters for mean-flow models. The experimental layout of this technique involves antenna beams at equal off-set from the vertical and the measurement of Doppler velocities in these directions. Assuming that the velocity statistics are similar at the beam positions, Vincent showed that the correlation $\overline{u'w'}$ between the horizontal and vertical velocity fluctuations is the difference of the mean square velocities, calculated over suitable time intervals and divided by a geometrical factor. This correlation $\overline{u'w'}$ is directly proportional to the momentum flux. By means of a cross-spectrum analysis the horizontal wavelength and phase velocities of gravity waves and from the mean Doppler velocities the prevailing winds can be deduced.

R. A. Vincent showed experimental results obtained with the Buckland Park 1.98 MHz radar applying the described technique. He used two beams at zenith angles of 11.8° corresponding to 35 km horizontal separation in mesospheric altitudes (72-94 km) and confined the analysis to velocity variations between 8 min and 8 h period. The momentum flux in the mesosphere changed from westward towards eastward in the higher altitudes. Vincent argued that the estimated body force of acceleration of 15-20 ms^{-1}/day could help to explain the off-set of wind velocities in the mesosphere deduced by theory and experiment. The estimated horizontal zonal wavelength of gravity waves with periods less than 60 min was 40 to 80 km on the average, which is similar to values deduced from noctilucent cloud observations. The zonal phase velocity distribution had an asymmetry in the lower heights 80-86 km with dominating westward propagation, whereas in the upper height a symmetrical distribution was observed. An extension of this experiment, using different beam directions, is planned. After a longer and detailed discussion it was generally agreed that this is a perfectly correct and very suitable method to determine gravity-wave parameters in the middle atmosphere.

PROPAGATION OF PLANETARY WAVES AS SEEN BY LIDAR DURING THE WINTER

A. Hauchecorne

This report presented evidence for the capability of this method to measure temperatures in the middle atmosphere between 30 and 80 km. He showed some examples of the propagation of planetary waves through the mesosphere and stratosphere, manifested by the downward descent of cooling or warming events. By comparing these measurements with global observations of the prevailing wind it was possible to show that these events are signatures of planetary waves. It was pointed out that this is a major technique to study stratospheric warming events. However, clear skies are obviously needed to allow these temperature measurements as well as supplementary radiosonde ascents to cover the altitudes below 30 km.

SESSION 3. OBSERVATIONAL RESULTS II

A number of papers were presented describing observations of both turbulent and stable atmospheric structures. All but one of the papers involved radar observations at frequencies ranging between a few MHz and 1295 MHz; the remaining paper presented in situ observations of turbulent structure obtained using a zero-pressure balloon technique.

An invited review paper describing the observational capabilities of MST (Mesosphere, Stratosphere, Troposphere) radar systems (Balsley) showed that the MST technique holds a great deal of promise in the near future for examining many aspects of atmospheric dyanmic processes including turbulence, gravity waves and atmospheric stability.

The thickness of turbulent layers observed by the Millstone radar appears to be of the order of a few tens of meters (Wand, Rastogi, Watkins and Loriot). It appears to be possible to estimate the thickness of turbulent layers by measuring the magnitude of the shear region. Such estimates indicate maximum turbulent layer thicknesses of 10 m - 100 m in the troposphere and 50 m - 500 m in the stratosphere.

Estimates of the turbulence dissipation rate in the mesosphere can be obtained from radar echo spectral width under certain conditions. Hocking reports ϵ values ranging between 0.02 w/kgm - 1.0 w/kgm, with typical values lying between 0.02 w/km - 0.1 w/kgm.

VHF radar techniques can also be used to measure the height of the tropopause with an accuracy better than the radar pulse width (Gage). The technique makes use of the fact that VHF radar returns from stable stratospheric structures are much stronger when observed at vertical incidence.

Although most of this session was concerned with observations using the Doppler radar technique, the two final papers (Rottger; and Rottger and Meek) discussed the technique of using spaced antennas to obtain comparable atmospheric results. This technique also makes use of the enhanced echoes observed at vertical incidence. At least two of the MST radar systems currently under construction will make use of both techniques in order to establish their relative advantages and disadvantages.

Finally, zero-pressure balloon results (Barat and Bertin) show striking evidence of many thin (10 m - 240 m) turbulent layers in the stratosphere (25 km - 276.5 km) in regions of large vertical shear. Richardson numbers between 0.08 and 0.25 were measured in these regions. Concurrent estimates of vertical heat flux range between 10 - 10 .

PANEL DISCUSSION

IS THERE NEED FOR A MIDDLE ATMOSPHERE RADAR FACILITY IN EQUATORIAL LATITUDES?

S. Kato

The panel consisted of five members: Drs. I. Hirota, M. A. Geller, J. M. Forbes, B. B. Balsley and R. A. Vincent and was chaired by the present reporter. It was found that a middle atmosphere radar facility is needed in equatorial latitudes, the present facilities at Jicamarca and Arecibo being located not close enough to the equator for investigating precise structures of equatorial waves. More than one facility is required to learn the longitudinal structure of the waves, etc. Specified requirements for the observation of atmospheric waves, i.e., tides, Kelvin waves, G.W. and infrasonic waves were discussed as reported below. Finally, it was suggested that an equatorial observatory equipped with MST radars and other useful facilities as lidars be established and operated under international cooperation. For this purpose a working group should be set up and work on the planning.

CONTRIBUTIONS OF AN EQUATORIAL MIDDLE ATMOSPHERE RADAR TO THE STUDY OF ATMOSPHERIC TIDES

J. M. Forbes

Scientific objectives. Atmospheric tides, oscillations in meteorological fields at subharmonics of a solar and lunar day, comprise an important component of middle atmosphere dynamics. Tidal oscillations in the middle atmosphere can to first order be viewed as the superposition of several "quasi-modes" each with somewhat distinguishable and identifiable horizontal structures and vertical wavelengths. The specific mixture of these structures, which might be comprised of migrating and non-migrating, vertically propagating and evanescent, and symmetric and asymmetric components, determines the global spatial variability of the tidal oscillations. Recently, geographically symmetric radars at Kyoto (35°N) and Adelaide (35°S) have delineated strongly asymmetric tidal behavior about the equator in both diurnal and semidiurnal components, between 80 and 100 km altitude. For "true" modes (that is, eigenfunctions of Laplace's tidal equation), asymmetric tides are characterized by nonzero N-S velocities and zero E-W velocities at the equator, whereas the reverse is true for symmetric components. A properly placed equatorial radar could, therefore, contribute significantly to the deconvolution of tidal structures in the middle atmosphere. However, it must be emphasized that an equatorial radar will yield most fruitful results if utilized simultaneously in conjunction with at least two other similar radars within the same longitude sector ($\Delta \phi \approx 30°$).

The gravest symmetric diurnal propagating (1,1) mode is thought to be capable of producing significant turbulence via nonlinear cascade or convective instability mechanisms, and a mean easterly jet (~ 50 m sec^{-1}) peaking near 105 km due to momentum deposition in the region where the tide is dissipated. An equatorial radar would, therefore, also provide the opportunity to observe the important middle atmosphere processes of wave-mean flow interaction and wave/turbulence coupling for a known wave forcing. However, these phenomena will primarily occur above 75 km, so that it is imperative that measurements extend as far into the lower thermosphere as possible, preferably to 105 km. Therefore, placement of the radar must avoid possible interference by the equatorial electrojet.

Radar system constraints/requirements.

desired altitude range:	15-105 km	
local time coverage:	24 hours	
Δt:	60 minutes	
Δh:	$\sim$ 2-4 km	$h > 60$ km
	$\sim$ 1-2 km	$h < 60$ km
accuracy:	$\sim$ 2 msec^{-1}	$h > 60$ km
	$\sim$ .5 msec^{-1}	$h < 60$ km

Desired coordinated measurements.

(1) Simultaneous 24 hour local time mesospheric soundings at 2 other latitudes within 30° longitude of the equatorial radar, preferably geographically conjugate, and preferably within ±30° latitude.

(2) Simultaneous lidar measurements from which tidal temperature variations can be obtained. Besides providing complementary information on tides, such measurements would delineate the occurrence of statically unstable conditions as a function of height and time, which can be compared with the spatial/temporal distribution of turbulence.

SCIENTIFIC REQUIREMENTS FOR THE NEW MST RADAR IN THE EQUATORIAL REGION

I. Hirota

Subject. Observation of equatorial waves in the mesosphere.

Background. During the Pre-MAP period (1978-1981) there has been significant progress in observational and theoretical studies of large-scale wave dynamics in the equatorial middle atmosphere, in connection with the quasi-biennial oscillation in the tropical stratosphere and the semiannual oscillations at the stratopause and mesopause levels.

In regard to equatorial waves, the vertical propagation of Kelvin waves into the mesosphere with a characteristic time scale of several days has been observed by satellites (Hirota, 1979; Salby et al., 1982), and the interaction of this wave with the mean flow is considered to be a mechanism for the generation of the semiannual zonal wind oscillation at the stratopause level (Dunkerton, 1979). A recent theoretical study by Dunkerton (1982) shows that the penetration of Kelvin waves into the upper mesosphere, as well as that of short-period gravity waves, is likely to be responsible for the generation of the mesopause semiannual cycle. This result suggests the need for further observations of equatorial waves in the mesosphere.

Requirements.

(1) Location: In order to detect equatorially trapped wave modes it is desirable that the new observation station is located near the equator, i.e., within ±5° latitude.
(2) Height range: Up to the lower thermosphere (≈100 km).
(3) Quantities to be observed: Three components of wind velocities.
(4) Resolution: Less than one kilometer (vertical)
Less than one hour (time)
(5) Additional remarks: In order to separate the wind variations due to planetary scale waves, tides and gravity waves, it is necessary to carry out continuous measurements throughout the daytime. It is also required to cover the various phase of long-term variations such as biennial, annual and semiannual cycles.

GRAVITY WAVES, TURBULENCE AND MEAN FLOW

B. B. Balsley

The establishment of a low-latitude MST radar would provide a unique and valuable opportunity to determine the importance of both turbulence and gravity wave processes in the equatorial middle atmosphere. At present very little is known about either of these processes or about their effects on weather and climate or higher latitudes. Similarly, little is known of the general circulation patterns of equatorial latitudes, particularly in the stratosphere and mesosphere.

In order to mount a reasonable experimenal program to study gravity waves, turbulence and the general circulation at equatorial latitudes, the data should be obtained essentially continuously for a number of years. This process allows studies of both annual and interannual variability. Time resolutions of the data base should be about three minutes in order to resolve fluctuations down to buoyancy wave periods. Accuracies of the velocity measurement should be at least ±2 m/s (horizontal) and ±1 cm/s (vertical). A height resolution of $\leq$500 m would be desirable.

INFRASONIC WAVES

S. Kato

Infrasonic waves are those atmospheric waves whose periods range between a few seconds and a few minutes. The waves behave as sonic pressure waves with some dispersion with increasing periods. The atmospheric temperature and wind distribution with height is effective on the propagation of infrasonic waves. It is well known that the stratosphere and mesosphere make up various waveguides for the waves. Besides unusual conditions under which the waves are excited as AIW (auroral infrasonic waves) and those by volcanic eruption, we have constant generators of the pressure waves as ocean waves. It seems interesting to investigate the role such infrasonic waves may play in dynamical and thermal structure of the middle and upper atmosphere; the pressure waves tend to be amplified in the course of upward propagation due to the decreasing ambient air density and could be detected with fairly intense waves in the middle atmosphere. Because of their short period of a few ten's of seconds at most, we need a good time resolution, much better than that for gravity waves. What follows show requirements for detecting infrasonic waves:

time resolution: > 10^2 sec
height resolution: a few hundred meters
height range to be investigated: 10 - 100 km
velocity resolution: < 1 cm/s in the stratosphere and
< 10 cm/s in the mesosphere.

UPPER TROPOSPHERIC CIRCULATION AND CONVECTION
UPPER TROPOSPHERE-STRATOSPHERE INTERACTION

K. Gage and R. Grossman

An equatorial ST or MST radar would yield valuable information on convection and upper tropospheric circulation in the tropics. The tropics are known to play a vital role in global climate but are still only poorly observed. An equatorial ST or MST radar would enable improved mesoscale observation and at the same time provide a nearly continuous long-running data base which should prove most valuable for climate studies.

ST and MST radars have the ability to measure the three-dimensional wind vector as well as indicate tropopause height with a sampling rate ranging from the synoptic (~ twice/day) to meso-scale (~ 1/5 min). Furthermore, the ST/MST system can be rotated around the zenith (VAD scans) to provide meso-scale estimates of divergence and vertical motion on time scales of the order of 10-15 minutes as well as larger area estimates of horizontal wind vector (compared to vertical pointing mode). These capabilities of the ST/MST radar could be used both in single and network modes to provide new insights concerning the description and nature of tropospheric/stratospheric motion fields in the tropics. Among the many topics upon which ST/MST radars could shed light are: convective cloud and cloud cluster interaction with tropospheric/stratospheric wind field and tropopause dynamics; gravity waves on stable layers in the troposphere/stratosphere; turbulent motions at very high altitudes and their relationship to meteorological phenomena such as tropical cyclones; and mountain/flow interactions in the tropics. Compared to conventional radar wind apparatus the ST/MST radar has the potential of costing less per unit of information and operating remotely from areas which are difficult to supply. This capability has the potential of providing well defined tropical wind networks over a long time period which would aid in our understanding of planetary scale phenomena such as the Southern Oscillation, monsoon and Walker circulations, and dynamical events associated with El Nino.

SESSION 4. MST RADARS: PLANNED OR UNDER CONSTRUCTION

Five MST radar systems currently planned or under construction were reviewed in this session. Firstly, the general design concept of the MU radar under construction in Japan was shown by S. Kato, Kyoto University, and then S. Fukao of the same University described the details of the design of the array and elements of the MU radar antenna. Secondly, the Spaced Antenna radar being constructed in South Australia was reviewed by R. A. Vincent, University of Adelaide. S. A. Bowhill of the University of Illinois described the upgrading of the Urbana Radar to one of the most sensitive radars in middle latitudes. It was announced by A. P. Mitra, National Physical Laboratory of India, that an MST radar system was being planned in India, although some details, including the location and the operational frequency were not yet decided. Finally, J. Brosnahan of TYCHO Technology Inc., explained the dual mode (Doppler and Spaced Antenna) radar, the construction of which was scheduled to start this September in Chung-Li, Taiwan. All radars except the Indian one are expected to start operation (fully or partially) in a couple of years.

Table 1 lists the location of these MST radar facilities, and their parameters are presented in Table 2. In what follows we describe in greater detail the individual radar systems.

THE MU RADAR

S. Kato and S. Fukao

The radar now being constructed in Japan is named MUR or MU radar after the middle and upper atmosphere that will be principally investigated with this system. The system is a pulse-modulated monostatic radar, operating at 46.5 MHz. The configuration is quite different from the existing MST radars. A circular array with an aperture of 8330 m^2 is composed of 475 crossed Yagi antennas, each of which is provided with a low-power solid-state amplifier (TR module). A peak output power of more than 1 MW is generated when the whole system is coherently activated. In this system, phase shifting is performed at a low-power level by electronically controlled phase shifters, which enable rapid and continuous scanning of the antenna. The whole system is monitored and controlled by a network of microprocessors.

The antenna array designed by numerical computation is a circular array with the equilateral triangular grid with spacing of 0.7 λ (λ: wavelength). In this element arrangement, the antenna beam can be tilted up to 30° from the zenith, and the sidelobes at angles of elevation lower than 20° are more than 40 dB down from the mainlobe for the whole scan range.

TABLE 1 LOCATION OF MST RADAR FACILITIES PLANNED OR UNDER CONSTRUCTION

FACILITY	AFFILIATION	LOCATION	LATITUDE/LONGITUDE
MU radar	Kyoto University	Shigaraki Japan	34.85°N / 136.10°E
Adelaide radar	University of Adelaide	Buckland Park Australia	34.63°S / 138.48E
Urbana radar	University of Illinois	Urbana Illinois	40.17°N / 88.17°W
Indian radar	National Physical Laboratory	Not yet decided	— / —
Chung-Li radar	National Central University	Chung-Li Taiwan	25°N / 121°E

TABLE 2 BASIC PARAMETERS OF MST RADARS PLANNED OR UNDER CONSTRUCTION

	MU	ADELAIDE	URBANA	INDIAN	CHUNG-LI
Type†	D/SA	SA	D	D	SA/D
Frequency (MHz)	46.5	54.1	40.92	45-55	53
Power-aperture product (W m^2)	4.2×10^8	2.7×10^6	$\sim 1 \times 10^{10}$	1.3×10^9	1.7×10^7
Transmitter					
Peak power (kW)	1,000	50	6,000	2,500	180
Average power (kW)	50	.35	~100	60	4
Minimum pulse width (μs)	1	7	1	1	1
Antenna					
Array configuration	Circular	TX: Square RX: Square x 3	Square	Rectangular	Square x 3
Element††	Yagi	TX: Co-Co RX: Yagi	Dipole	Co-Co	Yagi
Aperture (m^2)	8,330	TX: 7,744 RX: 150 x 3	≈100,000	21,000	~1,500 x 3
Beamwidth (deg)	3.6	3.2	≈1	≈2-3	~3
Polarizations	Circular x 2 Linear x 2	Linear	Linear	Linear x 2	Linear
Beam directions (Zenith angle:deg)	0-30 continuous	0	0/ ≈30	0/ ±20 EW/ ±20 NS	0/ ≈±15 EW/ ≈±15 NS

†D:Doppler, SA:Spaced Antenna ††Co-Co:Coaxial-collinear

The three-subelement Yagi antenna was designed to optimize its performance for an infinite array. The Yagi antenna has an element gain of 7.2 dB that is the highest gain expected for the present element spacing. Impedance matching to the feed line is also excellent. These properties show little deterioration over the whole scan range and over the frequency bandwidth of 2 MHz. The edge effect to be included in the finite array is found to be small except for the outermost array elements.

A CW receiver on board Japanese satellite EXOS-C (to be launched in 1984) will be used to test the antenna directivity. One tenth of the antennas and TR modules are scheduled to be constructed by March 1983, starting the preliminary observation of the troposphere and the lower stratosphere. The whole system will be completed in summer 1984.

THE ADELAIDE RADAR

R. A. Vincent

The system is designed as the Space Antenna radar. The transmitting array with a square aperture of 88.6 x 87.7 m^2 consists of 32 north-south rows of 48 half-wavelength dipoles of the coaxial collinear type. Each row of dipoles has its own coaxial feed-line to the transmitter located at the center of the array. The array beam is directed vertically for the Spaced Antenna mode.

The receiving antenna consists of three spaced arrays, each consisting of 4 x 4 five-subelement Yagi antennas. They are located west of the transmitting array, the center of each array being on the vertices of an equilateral triangle having sides of length 10 λ. Signals from the three receiving arrays are preamplified near the arrays and then fed to the main building at the east end of the radar site.

Pulse repetition frequency is variable from 64 to 1024 Hz. Number of samples and height range to be observed are also programmable.

Due to the comparably low power-aperture product of the present system, the height range to be covered will be restricted to below 30 km. It is planned that the peak output power is increased to 400-500 kW at the next construction stage in 1983. It is also envisaged that the Doppler mode of operation will be used for the transmitting array by installing the TR switch. However, the beam steering will be limited only in the EW plane due to the arrangement of the dipoles.

It should be noted that this radar will be situated adjacent to the existing 2 MHz partial-reflection radar and very near the conjugate point of the MU radar of Japan. This radar will be the first MST radar in the Southern Hemisphere when completed late this year.

THE URBANA RADAR

S. A. Bowhill

The Urbana radar operating at 40.92 MHz is scheduled to be upgraded soon. The upgrading will apply to all aspects of the present system. Firstly, the antenna of the square array is to be enlarged to 10^5 m^2 -- almost ten times the present aperture. The array is composed of 12 x 12 modules, each consisting of 4 x 4 dipole elements. Although the antenna beam of the present system is fixed to approximately 1.5° southeast of the zenith, a limited beam steerability will be afforded for the upgraded system, by phasing each element of the modular array by 90° steps.

Secondly, the peak output power of the transmitter will be increased to 6 MW with the maximum duty ratio of near 1%. The bandwidth of the transmitter will be enlarged to almost 1 MHz, which improves the height resolution from the present value of 3 km to near 150 m. The 1 megabaud phase switching will also be implemented. The drive circuit of the transmitter as well as the TR switch will be improved.

The receiver bandwidth will be matched to the transmit pulse width. A sophisticated integrating preprocessor will be installed.

Finally, the currently used computer, a PDP-15 with a paper tape I/O device, will be replaced by a floating-point processor (7 MFLOPS).

It is expected that this system will be the most sensitive MST radar in middle latitudes when completed, comparable to the Jicamarca and Poker Flat radars in low and high latitudes, respectively.

THE INDIAN RADAR

A. P. Mitra

The Indian MST radar currently planned by National Physical Laboratory has basically a similar configuration to the Poker Flat radar in Alaska. The radar will operate in the 50 MHz band, but the exact operational frequency will depend on the frequency clearance by the Indian government.

The transmitter will be composed of 24 modular transmitters along with the total peak output power of 2.5 MW and an average power of 60 kW. Each module has a peak output power of 100 kW with the maximum duty ratio of 2.5%. These modules operate with pulse length from 1 μs to 32 μs (1 μs steps) with pulse repetition frequency from 256 Hz to 8 kHz (binary steps).

The antenna consists of two superimposed arrays, with the dipoles of each array arranged at right angles to each other. One array is used for one linear polarization. The array with an aperture of 128 x 168 m^2 is composed of 48 rows of four separate coaxial collinear antennas. Each antenna is constructed of 16 half-wavelength dipoles. Eight such adjacent antennas are fed from a common modular transmitter. The two arrays will be switched to the transmitters and phased to point in five directions; zenith and ±20° from the zenith in the EW and NS planes.

The data aquisition, calculation of spectra, and initial analysis will be done on-line by a minicomputer, and the whole system will be controlled either by the same minicomputer or by a network of micro-processors.

THE CHUNG-LI RADAR

J. Brosnahan

The 53 MHz radar in Taiwan is designed to be operated in both the Doppler mode and the Spaced Antenna mode. The switching between the two modes will be done on a time scale of seconds. This capability will enable direct comparison between the two modes that has not yet been made before.

Three separate subarrays which are required for the Spaced Antenna mode are each provided with identical transmitters and receivers. The subarrays are initially composed of 32 Yagi antennas with an aperture of near 1500 m^2, but easily expandable to 8 x 8-element arrays in the future. The element spacing and the number of subelements have not yet been determined.

By using 0, 90, 180, and 270° delay lines, a fairly simple beam steering is realized. The number of beam positions is <u>five</u>; zenith and off-zenith in four azimuths. The beam steering system also allows the alternate elements to be fed out of phase to provide <u>two</u> orthogonal twin lobe patterns providing a null at the zenith. These twin lobe patterns provide Doppler data with both positive and negative components, the difference between the two lobes giving data on momentum transport. The three subarrays can be operated independently or together in all combinations of these <u>seven</u> beam patterns.

The minicomputer will initially be utilized only to write integrated data onto the magnetic tape and provide a minimum of real time display.

The sensitivity of this radar will be 6 dB down from the SOUSY radar in the Spaced Antenna mode of operation. The construction will start this September, and be completed in late 1983.

SESSION 5. RADAR TECHNIQUES

MST radar probing techniques were reviewed by D. T. Farley. The points discussed include: (1) antenna near-field effects (the Arecibo antenna, for example, is actually too big for optimum MST work), (2) range and frequency aliasing, (3) coherent vs. incoherent integration, (4) various forms of pulse compression, and (5) the dependence of the signal-to-noise ratio (SNR) and signal detectability on pulse length (range resolution). The backscattered signal strength is actually proportional to the inverse of the antenna area in the near field (unless the antenna is focused). Arecibo is the only observatory where this effect is currently a significant problem. It was pointed out that coherent integration is simply a form of digital low-pass filtering. With optimum processing the effective SNR or detectability of the received signal is usually proportional to (average transmitter power) x (pulse length) x (integration time)1/2. High average power can be achieved by pulse compression (at the expense of added ground clutter) or by using a high pulse repetition frequency (at the expense of possible range ambiguity problems). The pulse length dependence disappears for very thin scattering layers. A suggested increased dependence for 'coherent' layers was mentioned and was discussed at some length in session 7 (most discussants believed that horizontal coherent had no effect on pulse length dependence).

R. F. Woodman reviewed the hardware implementations of on-line digital signal processing at several MST radars, especially Arecibo (at both 430 MHz and S-band) and SOUSY. He emphasized the convenience of interchanging coherent integration and pulse decoding; the decoding of phase-coded (compressed) pulses after integration rather than before greatly reduced the number of digital operations required, especially for VHF radars, for which the signal Doppler shifts are very small. Arecibo is fortunate in having available several extremely high-speed special-purpose digital devices designed for radar astronomy observations. The speed of these devices exceeds most MST requirements and has made possible some stratospheric observations at S-band with a resolution of 30 m. Woodman and his collaborators have developed an algorithm which very effectively removes most of the ground clutter, etc. from Arecibo data.

S. A. Bowhill described the data pre-processing system planned for the upgraded Urbana Radar. Since it is designed for a specific system and does not need much flexibility, it is quite simple and inexpensive, but nevertheless it can sample 600 altitudes at 150 m intervals with a 2.5 ms interpulse period. In a second talk, Bowhill described what can be done with a very simple system using an Apple computer and only floppy disk storage. A single disk can accommodate an hour's data from 20 altitudes. The FORTH computer language is particularly convenient for such a system.

G. B. Loriot and R. H. Wand described the phase coding and data processing schemes used at the Millstone Hill Observatory. Data are transferred directly into an Array Processor, permitting very fast processing. The primary limiting factor is the size of the AP memory (large memories are very expensive). With their present system the available on-line options range from a 4096 point FFT at only one altitude in real time to 32 point FFTs at 270 altitudes. Coherent integration is not as useful for UHF radars as for VHF, as mentioned earlier, and so the processing requirements are more severe. There was some brief discussion of various ways to achieve unbiassed phase codes (equal time at both phases).

K. Wakasugi discussed detailed calculations of his (with M. Matsuo, S. Fukao, and S. Kato) of the full ambiguity function of various complementary code sequences and showed how the range sidelobes behave for targets giving various Doppler shifts. It was pointed out in the ensuing discussion that, for most MST applications, the Doppler shifts actually encountered are not large enough to cause difficulties.

M. P. Sulzer and R. F. Woodman next described some intriguing work carried out at the Arecibo Observatory. They developed sets of pseudo-random codes designed to operate well in the 'real world', in which the radar transmitter doesn't generate exactly the phase-coded pulses intended. Because of such transmitter imperfections, the range sidelobes near the central peak are not zero, as they should be theoretically, for complementary code pairs. They are still small (about -20 dB typically at Arecibo), but reducing them further is desirable for some measurements. One scheme described to achieve a reduction for mesospheric observations involve transmitting a sequence of 256 different 52-baud codes, each of which must be decoded separately. The 256 'best' codes were chosen out of about 10^7 possibilities by a computer search involving some 10 hours (!) of Array Processor time. A similar scheme for the stratosphere uses 48 32-baud sequences grouped in quasi-complementary quadruples. The search for the optimum quadruples required more than 300 hours (!!) of AP time -- not a route for the fainthearted. The use of such schemes requires special purpose hardware since no data reduction via coherent integration is possible. The codes adopted give near-in range sidelobes about 30 dB lower than the main peak (roughly 10 dB better than that actually achieved by the supposedly complementary codes).

P. K. Rastogi and G. B. Loriot discussed some of the procedures currently used in ST experiments at Millstone Hill to reduce the effects of ground clutter and power line interference. After determining the nature of the interfering signals, digital notch filters were applied to the data.

C. E. Meek then gave a description of the system used in Saskatoon to study drifts using the partial-reflection technique. The system is controlled by an Apple computer and runs unattended. Useful data are obtained in the range 75-125 km with 3 km resolution with a transmitter having only 10 W of average power (but 50 kW peak power). The observations were in good agreement with rocket data.

Finally, C. Cornish showed some data from vertical incidence radar measurements at Jicamarca. Echoes were obtained from the entire MST range, including the difficult 40-50 km region. The range resolution was 2.5 km, the peak transmitter power was about 3 MW, and the average power was about 170 kW.

SESSION 6. SUMMARY

VHF RADARS AS METEOR WIND RADARS, AND THE GLOBMET (GLOBAL METEOR OBSERVATIONS) PROJECT

R. G. Roper

While the ability of MST radars to measure winds from 1 km to 100 km altitude is theoretically feasible, some limitations do exist. In particular, the diurnal variation in D-region ionization makes continuous recording (necessary for the delineation of tidal winds) virtually impossible, except for high latitude stations in summer. However, by using the MST radar as a meteor wind radar, continuous wind measurements can be made over the 80 to 100 km height range (as has been demonstrated by Susan Avery in results presented at the IAMAP Meeting, Hamburg, August 1981).

The lower powered and less expensive ST radars also have the potential for use as meteor wind radars, and this possibility should be taken into account in the design of these facilities.

The GLOBMET (Global Radio Meteor Observations) program, currently in the planning stages, is designed to further not only the wind measurements currently being performed under the IAGA Global Radio Meteor Wind Studies Project and the URSI/IAGA Coordinated Tidal Observations Program, but also the better measurement on a global scale of meteor rates, velocities and orbits, and the understanding of the physics of meteors and their interaction with the earth's atmosphere.

The author briefly mentioned his recent visit to Moscow, to work on the GLOBMET Planning Document (to be presented at the COSPAR meeting in Ottawa later this month), and also to Dushanbe, Tajicstan, for a tour of the Astrophysical Observatory, which is unique in its application of optical, TV imaging and radio techniques to the observation of comets and meteors. It appears that the 50 km altitude "hole" in MST radars will probably require the use of the lidar technique currently being used by the French, and reported by Marie-Lise Chanin earlier in the meeting. R. Woodman showed a viewgraph of echoes from Arecibo, obtained using the 5 MHz heating facility as an MST radar. Close scrutiny showed that echo strength decreased rapidly below 60 km, and that the plotted ground clutter was many times stronger than 50 km echoes.

Panel Discussion: The Future of Middle Atmosphere Radars

Panel members were: S. A. Bowhill (Chairman), D. T. Farley, K. S. Gage, J. Rottger, R. A. Vincent, and R. F. Woodman

J. Rottger: We should not overlook the possibility of using medium frequency or low HF to take advantage of the higher reflection coefficient in the partial reflection mode, plus the fact that man-made noise tends to be a minimum in the neighborhood of 2 MHz in the daytime.

R. Vincent: Use of the Buckland Park array on 2 to 3 MHz has revealed a clutter problem, and various methods of integrating out the clutter are being investigated. In addition to the clutter problem, another question should be addressed: What is the scientific merit of using a radio method to fill in the "hole", when it can be done more easily by other means (c.f. paper preceding this discussion)?

S. Bowhill: Clutter can be a real problem on 40 MHz. Its occurrence is seasonal. In general, its effects can be minimized by varying the interpulse period.

K. Gage: Our ability to discriminate against clutter (or any non-atmospheric and therefore undesired signal) depends on how well we understand the desired signal reflection process. We have developed a model based on a "volume filling" reflector which indicates a 2 dB/km falloff in returned power in the stratosphere at all latitudes (the height of the tropopause determines the behavior at lower altitudes, and provides a tool for monitoring tropopause height). Atmospheric stability and density are of prime importance in this model.

S. Bowhill: One strategy which can be applied is to integrate returns coherently for, say, the first second, then integrate the real and imaginary parts of the complex correlation function (if the vertical velocity is constant, this is equivalent to coherent integration). If ground clutter is serious, perhaps one should look off-vertical, and integrate for an hour to find the horizontal velocity, thereby integrating out the ground clutter (and, of course, the shorter period gravity waves).

D. Farley: We need to be aware that simply changing acquisition, reduction, or analysis schemes will not defeat the fundamental concepts of information theory. Since spectra are transforms of correlations, the inherent limitations of one appear in the other. With regard to the use of lower frequencies, bandwidth limitations result in a drastic loss of height resolution.

S. Bowhill: It does appear that one needs to use medium frequencies in order to see into the gap.

R. Woodman: Proposals can be made to the Arecibo Observatory by anyone who wishes to use the heater facility there.

J. Rottger: Because of the long pulse widths at lower frequencies, one needs to look at low elevation angles in order to see returns from the stratosphere, and off-vertical antenna gains fall rapidly. There are plans to use the Tromso heating facility to investigate the stratosphere, but off-vertical antenna gain may limit its usefulness at these altitudes.

S. Bowhill: Returning to clutter rejections, coherent integration is essential.

P. Rastogi: Higher signal-to-noise ratios in the "hole" region should surely arise during PCA events at high latitudes. Coherent integration will be required.

R. Vincent: Yes. The effects of such events have been seen at least as low as 50 km at Mawson, Antarctica using a coherent integration partial-reflection drifts system.

S. Bowhill: Partial reflection drift systems have traditionally not used coherent integration.

C. Meek: Coherent integrators are being installed in the Saskatchewan partial reflection drifts system.

S. Bowhill: In addition to PCA events, it might be profitable to look during solar flares.

R. Woodman: Where bandwidth allows, coding techniques can be helpful in improving signal-to-noise radio and clutter rejection.

J. Green: A simple two bit 180° phase code helps, particularly against man-made interference.

S. Bowhill: The standard clutter rejection is a notch at zero frequency. However, this will not help with F-region backscatter. Sea clutter usually appears as +ve and -ve drifters around zero. Can other frequencies be produced by the ocean?

R. Woodman: Ships can be a problem.

S. Bowhill: Because Illinois is so flat, we have never seen clutter from surface features appearing in the stratosphere or mesosphere.

R. Vincent: There is clutter at 50 km at Adelaide due to hills. It appears to move very slowly, probably due to changes in refractive index with time over the clutter path.

W. Hocking: Yagi antennas are sometimes used to identify ground clutter, but this can be difficult in that different propagation paths are involved.

J. Rottger: We have a clutter problem at 55 km which is due to a TV tower. We are investigating possible changes in clutter signatures with transmitted frequency, as compared to actual atmospheric echoes, and also comparisons with radiosondes to "calibrate out" the clutter.

B. Balsley: We have no detectable clutter at Poker Flat.

R. Woodman: It is certainly easier to discriminate clutter at 50 MHz than it is at 430 MHz; there is considerably more fading at the higher frequency. The intrinsic width of clutter is less than that of atmospheric echoes. For further comments see Sato and Woodman in the preprint volume of the American Meteorological Society Radar Meteorological Conference No. 19 (1980).

P. Rastogi: It is possible to remove clutter by a deconvolution in the frequency domain.

S. Bowhill: Concerning the topic of D-region incoherent scatter, it is observed at 430 MHz. Has it been observed at 50 MHz?

R. Woodman: Possibly, but it was not recognized! The question has yet to be resolved and we are planning to search for it at Jicamarca.

D. Farley: The best indicator is the time constant. For incoherent scatter, the molecular diffusion time constant is appropriate. For coherent scatter, the eddy diffusion time constant. Turbulent echoes will be wider than incoherent scatter echoes.

P. Rastogi: The variation of the turbulence microscale with height, with a large microscale at greater heights, is an observable phenomenon. One must always be careful in distinguishing turbulence from incoherent scatter.

B. Balsley: At 50 MHz the top of the echoing region is 85 km because of the increase of the turbulence microscale with height. Perhaps we should easily observe incoherent scatter at 50 MHz above 85 km.

S. Bowhill: When one observes essentially no coherent echoes below 175 km is the time to search for incoherent scatter echoes at those altitudes. Much more information can be obtained from mesospheric spectra than we have obtained thus far.

T. VanZandt: Reference has been made to long-lived sheets of turbulence in the atmosphere in the same terms as those which exist in the ocean. Fossile turbulence refers to the temperature fluctuations (C_T^2) left over after velocity fluctuations (C_V^2) have ceased. The decay of velocity is controlled by kinematic viscosity; the decay of temperature by thermal diffusivity; and the decay of concentration by molecular diffusivity. In the ocean, these go as 100:10:1. Velocity fluctuations decay 10 times faster than temperature fluctuations. In the atmosphere, these parameters are roughly equal and all fluctuation fields decay at the same rate.

R. Roper: It is simply a question of Prandtl number.

T. VanZandt: There is, in fact, no need for "fossil turbulence" to explain long-lived sheets of turbulence in the atmosphere. They are associated with long-lasting wind shears. There is a real need to correlate turbulent sheets with wind shear at small scales. Current correlations are less than unity probably because, at the limit of height resolution for wind measurement, the shears are not large enough to drive the Richardson number below critical, whereas, at still smaller scales, they are.

J. Rottger: MST radars can be subdivided at this stage of development into two classes: (1) Beam swinging (VAD or velocity azimuth display; or pointing in three directions), and (2) Spaced antenna. Can we settle on a precise nomenclature for these classes?

(Considerable discussion followed, resulting mostly from the fact that techniques now in the process of development, such as interferometers, seemed not to be easily classified at this time.)

It was finally resolved that the technique using spaced antennas should be called the SPACED ANTENNA technique, and that, since all other techniques at present in use measure line-of-sight dopplers, the so-called "beam swinging" techniques would best be referred to under the collective heading of DOPPLER techniques.

S. Bowhill: Let us now consider the problem of backscattered signal strengths and range resolution.

W. Hocking: If there are several "reflectors" within a layer, do the powers reflected by each add (incoherent scatter process, Δr dependence) or do the voltages add (coherent scatter processes, $(\Delta r)^2$ dependence)? For a single transmitted frequency, the dependence is on $(\Delta r)^2$. However, a finite pulse is not a single frequency, and the smaller of the pulse length or the individual "reflector" thickness is responsible for the reflected power. On the average the powers will add, rather than the voltages. That is, more than one scale is responsible for the scattering.

R. Woodman: In verifying this hypothesis, one needs to be certain that both signal-to-noise ratio and receiver bandwidth are appropriate to the task. A Δr dependence will result if the receiver bandwidth is narrower than the pulse.

D. Farley: I support the Δr dependence and believe we are dealing with random scatterers.

K. Gage: The medium has many components in the Fourier domain. The question is: Is a coherent scattering process possible? In the book "Short Wave Radio Propagation" (edited by D. E. Kerr) there is an appendix by Seibert and Goldstein which discusses incoherent vs. coherent scatterers. Spatially varying structures are coherent. Structures fluctuating in time are incoherent. The argument can be settled by a properly designed experiment. The Gage model, which assumes a $(\Delta r)^2$ dependence, appears to describe the data well. By observing vertically (maximizing the specular) and off vertically (maximizing the turbulent) a comparison of range resolution dependence could be made.

J. Green: We have the data (from specular and oblique soundings) and should be able to resolve the problem.

J. Rottger: With 150 m resolution and observing a single, well-defined layer, it appears that neither a Δr nor a $(\Delta r)^2$ dependence suffices. For this case another theory is required.

S. Bowhill: The final topic for discussion is the appropriateness of distributed vs. a single transmitter for MST radars.

S. Fukao: The MU (middle and upper atmosphere) radar at Shigara, Japan uses a distributed transmitter. Investigators involved with the design are particularly interested in small-scale motions, with a high priority being placed on rapid beam swinging. With distributed transmitters the array can be more easily segmented and inexpensive stable phase shifters can be made using PIN diodes at low power levels. Sidelobe accuracy should be greater. This is necessary to minimize interference in Japan.

B. Balsley: The rationale for the Poker Flat radar (64 transmitters) centered on reliability for continuous and unattended operation, for which it is obviously necessary to minimize catastrophes! If one or two final amplifiers fail, the system still records useful data. The Poker Flat MST radar has been "on the air" continuously since February, 1979.

S. Bowhill: At Illinois, we already have a big transmitter. While there is a switching problem associated with modularizing the antenna at high power levels, we believe we can solve it with a large ceramic "wafer" switch. Rapid switching is not contemplated. There is at least one benefit of a "single component" transmitter -- bandwidths are more easily widened.

R. Woodman: A completely solid-state transmitting system, such as the MU radar, is more costly than one using vacuum tube?

S. Fukao: We believe that system reliability will be better and the solid-state system will be less expensive in the long run.

S. Bowhill: I wish to thank the Workshop convenors, Professors Kato and Hirota, for organizing an outstanding and very timely meeting, and also the committee under Drs. Balsley and VanZandt for the local arrangements.

LIST OF ATTENDEES

Attendees	Affiliation
Paul Bailey	National Center for Atmospheric Research
Ben B. Balsley	National Oceanic and Atmospheric Administration
John Brosnahan	Tycho Technology
Sidney A. Bowhill	University of Illinois
Martin R. Bowman	Rutherford Appleton Laboratory
David A. Carter	National Oceanic and Atmospheric Administration
G. S. Chandrasekharan	Bharat Electronics Ltd.
Marie-Lise Chanin	Service d'Aeronomie
Jih Kwin Chao	National Central University
Wallace L. Clark	National Oceanic and Atmospheric Administration
Charles Cornish	Cornell University
Lawrence Coy	University of Washington
Peter Czechowsky	Max-Planck-Institut fur Aeronomie
Timothy Dunkerton	National Center for Atmospheric Research
Warner L. Ecklund	National Oceanic and Atmospheric Administration
Donald T. Farley	Cornell University
Jeffrey M. Forbes	Boston College
David C. Fritts	University of Alaska
Shoichiro Fukao	Kyoto University

Kenneth S. Gage	National Oceanic and Atmospheric Administration
Rene Garello	National Oceanic and Atmospheric Administration
Marvin A. Geller	NASA/Goddard Space Flight Center
Michel Glass	CNET
William E. Gordon	Rice University
John L. Green	National Oceanic and Atmospheric Administration
Robert Grossman	University of Colorado
A. J. Hall	Rutherford Appleton Laboratory
Alain Hauchecorne	Service d'Aeronomie
Isamu Hirota	Kyoto University
Wayne K. Hocking	The University of Adelaide
S. Kato	Kyoto University
Douglas Lilly	National Center for Atmospheric Research
George B. Loriot	Northeast Radio Observatory Corp.
Daren Lu	National Oceanic and Atmospheric Administration
J. D. Mahlman	National Oceanic and Atmospheric Administration
C. E. Meek	University of Saskatchewan
A. P. Mitra	National Physical Laboratory
A. K. Majumdar	Bharat Electronics Ltd.
Monique Petitdidier	CNRS/Service d'Aeronomie
Prabhat K. Rastogi	Northeast Radio Observatory Corp.

George C. Reid	National Oceanic and Atmospheric Administration
Anthony C. Riddle	National Oceanic and Atmospheric Administration
Robert G. Roper	Georgia Tech
Jurgen Rottger	EISCAT Scientific Association
Kathryn J. Ruth	National Oceanic and Atmospheric Administration
Murry Salby	National Center for Atmospheric Research
Mark R. Schoeberl	Naval Research Laboratory
R. A. Serafin	National Center for Atmospheric Research
M. J. Smith	University of Saskatchewan
John L. Stanford	Iowa State University
Michael P. Sulzer	Arecibo Observatory
Hiroshi Tanaka	Nagoya University
Thomas E. VanZandt	National Oceanic and Atmospheric Administration
Robert A. Vincent	University of Adelaide
Koichiro Wakasugi	Kyoto Institute of Technology
James M. Warnock	National Oceanic and Atmospheric Administration
Brenton J. Watkins	University of Alaska
Jerome Weinstock	National Oceanic and Atmospheric Administration
V. B. Wickwar	National Science Foundation
Ronald F. Woodman	Instituto Geofisico del Peru

ANNOUNCEMENT

INTERNATIONAL SYMPOSIUM ON

GROUND-BASED STUDIES OF THE MIDDLE ATMOSPHERE

May 9-13, 1983

Schwerin, German Democratic Republic

organized by the
Academy of Sciences of the German Democratic Republic, Central Institute of Solar-Terrestrial Physics (Heinrich Hertz Institute), together with the National Committee on Geodesy and Geophysics.

co-sponsored by the
ICSU Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)

The Symposium is intended to focus upon those studies of the middle atmosphere for which ground-based methods, with their abilities of continuous monitoring of both long-term and event-like processes, are particularly suitable. It should discuss results and methodical questions of ground-based observations as well as their complementary relations to space techniques and other theoretical and aeronomical studies relevant to the projects of the international Middle Atmosphere Program.

The program is to consist of invited and contributed papers on the following topics:

- Diagnostics of the middle atmosphere by D region observations
- Seasonal and interannual variations
- Troposphere-stratosphere-mesosphere coupling
- Winds and waves, and their tracking by radar and radio sounding methods
- The mesopause, and links to the thermosphere (NLC, Airglow, Na Lidar, Sporadic-E)
- Solar-terrestrial influences on the middle atmosphere

Convener: Prof. Dr. J. Taubenheim
Zentralinstitut fur Solar-Terrestrische Physik
(Heinrich-Hertz-Institut)
DDR-1199 Berlin, German Democratic Republic

ANNOUNCEMENT

INTERNATIONAL MAP SYMPOSIUM IN JAPAN

Date: Early summer, 1984

Venue: Kyoto (Kyoto City Hall near Heian Shrine)

Sponsor: Radio Atmospheric Science Center, Kyoto University

Co-sponsors: Main National and International Bodies supporting MAP (under consideration)

Number of attendents expected: 150-200

Subjects for discussion: All subjects in MAP are covered, but "interaction among dynamics, chemistry and radiation" may be a stimulating subject.

ANNOUNCEMENT

Joint IAMAP/IAGA Symposium on Middle Atmosphere Sciences (MAS), XVIII Assembly of IUGG, Hamburg, FRG, 15-27 August 1983.

MAS is being jointly organized by the International Association of Meteorology and Atmospheric Physics (IAMAP) and by the International Association of Geomagnetism and Aeronomy (IAGA). It is cosponsored by SCOSTEP and COSPAR. IAMAP groups involved are the International Commissions on the Meteorology of the Upper Atmosphere (ICMUA, leading), Atmospheric Chemistry and Global Pollution (ICACGP), Atmospheric Electricity (ICAE), Dynamic Meteorology (ICDM), Ozone (IOC), and Radiation (IRC). The emphasis of the program will be on the dynamics, energetics and chemistry of the middle atmosphere (about 10 to 120 km height). Special problems included are the electrodynamics of the middle atmosphere and the physics and chemistry of ions, aerosols and noctilucent clouds. Mutual interactions of the middle atmosphere regions and coupling with the troposphere and upper mesosphere will be discussed. Contributed papers on significant observational, theoretical, and experimental results are solicited.

The Middle Atmosphere Sciences Symposium is immediately preceded by a special IUGG Symposium with review papers on the Middle Atmosphere Program. 11 half-day sessions starting on August 20 are planned for the Middle Atmosphere Sciences.

- Modeling of the middle atmosphere, including radiation budget
- Coupling between the stratosphere, mesosphere, and thermosphere
- Climatology of the middle atmosphere
- Gravity waves and turbulence, and parametrization of related transport in middle atmosphere models
- Dynamics, including troposphere coupling
- Remote sensing
- UV flux, photochemical processes and related chemistry
- The electrodynamics of the middle atmosphere
- Trace species in the middle atmosphere
- Noctilucent clouds
- Physics and chemistry of ions and aerosols in the middle atmosphere

Deadline for the submission of abstracts is 1 March 1983. The original should be sent to the Secretary General of IAMAP, Mr. S. Ruttenberg, NCAR, P. O. Box 3000, Boulder, CO 80307, USA, and a copy to each of the conveners Dr. A. Ebel (IAMAP), Institute for Geophysics and Meteorology, University of Cologne, D-5000 Cologne 41, Federal Republic of Germany, and Dr. P. C. Simon (IAGA), Institute d'Aeronomie Spatiale, 3 Ave. Circulaire, B-1180 Bruxelles, Belgium. Detailed instructions about the abstract format are included in the Second Circular of the IAMAP General Assembly (available from the IAMAP Secretary General, Mr. S. Ruttenberg) or the Third Circular of the XVIII IUGG General Assembly (available from the Chairman of the Local Organizing Committee, Dr. W. Zahel, Institute fur Meereskunde der Universitat Hamburg, Heimhuderstrasse 71, 2000 Hamburg 13, FRG).

CORRIGENDUM

Figures 1 and 2 below were inadvertently omitted in the National Report of the United Kingdom, published in Volume 4 of the Handbook for MAP. The editor regrets any inconvenience caused by this omission.

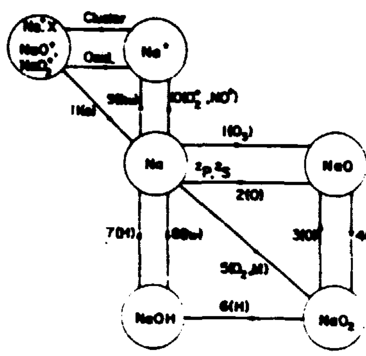

Figure 1. Photochemical processes influencing the concentrations of neutral and ionized sodium constituents. The numbers associated with the different processes are those referred to in the text.

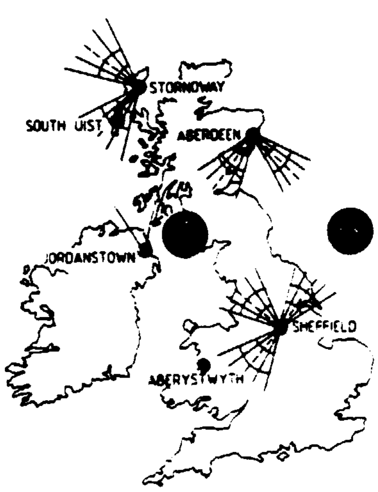

Figure 2. Location of existing and proposed experimental facilities in the U.K. for the study of motions in the middle atmosphere. Hatched circles represent the common volumes sounded by meteor wind radars to be operated at Sheffield and Aberdeen.