Middle Atmosphere Program

HANDBOOK FOR MAP VOLUME 11

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 11

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PART 1

PART 1

CONDENSED MINUTES OF MAPSC MEETINGS

August 13-14, 1983, Hamburg, FRG

Present: S. A. Bowhill, Chairman, J. H. Allen, L. F. Alberca (for J. O. Cardus), M. L. Chanin, J. K. Chao, D. Eccles (for J. W. King), G. Hartmann, I. Hirota, S. Kato, R. G. Roper, P. Simon, Y. U. Somayajulu, C. G. Sucksdorff, T. E. Van Zandt, R. Watson (for G. Mahlman and N. Sundararaman), G. Witt, C. H. Liu, Secretary

1. The Chairman reported with pleasure the progress made in all MAP Projects with new facilities, new techniques, and new results in many areas.

2. The agenda was approved.

3. The minutes of the Ottawa Meetings were approved.

4. MSG Reports

MSG-6 SCIENTIFIC ASPECTS OF AN INTERNATIONAL EQUATORIAL OBSERVATORY

Dr. Kato presented the report drafted by the Study Group (Attachment 1). The criteria for choosing the location are (i) latitude <5°, (ii) dip >5°, (iii) alignment with present stations in longitude sectors, and (iv) proper latitudinal distribution.

Several longitudinal chains of existing stations were considered. Six possible sites were chosen: Nauru, Christmas Island, Galapagos, Kourou, Iquitos and Tumbes. The facilities at the observatory should include MST radar, lidar, balloon, rockets, etc. Several scientific objectives were mentioned, including stratospheric fountain; effects of Andes, etc. For the mode of financing, it was suggested the EISCAT model could be followed.

The Steering Committee requested the Study Group to solicit more inputs from additional groups such as those in USSR and Europe and present to the Committee the final report in 6 months, including more detailed scientific justification for the observatory.

MSG-7 PENETRATION OF SOLAR RADIATION INTO THE ATMOSPHERE

Dr. Frederick sent a written report (Attachment 2). Dr. Simon reported that there will be a meeting on August 22nd of the Study Group.

MSG-8 ATMOSPHERIC CHEMISTRY

Dr. Witt reported on the ESA Symposium in Interlaken in April 1983. It was suggested that the falling sphere experiment should be continued, since it can provide information about the density and temperature at the place where chemical measurements were made. Measurements such as water vapor should be standardized worldwide. The group will meet on August 23.

A report from the Study Group will be ready by the end of 1983.

5. No new MSG's were proposed.

6. MAP Project Reports

(a) AMA - Dr. Nagata presented an interim report on the "where" and "what" of the programs under AMA which were compiled from information sent by countries participating in Antarctic research (Attachment 3). All the observations and experiments are going well. The project will be completed in two more years. Interests and programs of additional nations such as Brazil and the French in Antarctic regions were mentioned.

(b) ATMAP - This group will have a Workshop in Hamburg, August 17. Dr. Forbes sent in a written progress report describing the measurement campaigns and the planned Workshop (Attachment 4). The 1981 campaign will form the focal point for the Workshop (see Attachment 23 for the report of the Workshop). Two additional campaigns are tentatively scheduled for December 1983 and May 1984.

(c) CAMP - Dr. Witt reported the background of the project -- to study the cold arctic mesopause. The first CAMP experimenters' meeting will be held in December 1983 in Sweden. New results from the campaign will be discussed. A Dear Colleague letter from Dr. Kopp is attached (Attachment 5).

(d) CLIMAT - Dr. Russell reported the background, the goal and the progress of the project. The goals are to use available satellite data to produce monthly and seasonal mean altitude vs latitude cross sections of temperature and constituents and to develop a MAP document describing the cross sections (Attachment 6). The group met at Oxford in April 1983. The next meeting will be in Hamburg, August 24. A draft of the report will be ready by December 1, 1984; final report by March 1985.

(e) DYNAMICS - Dr. Labitzke reported that in the current (June 1983) issue of the MAP Newsletter, there is a report of DYNAMICS. SWAMP is now a part of DYNAMICS. A report from DYNAMICS will be published as a future MAP Handbook.

(f) GLOBMET - Dr. Roper reported the highlights of the first GLOBMET meeting held on May 12, 1983 at Schwerin, GDR. A GLOBMET calendar was presented. The calendar was coordinated with ATMAP. An invitation by the Lenin Tajic State University to hold a GLOBMET symposium in Dushanbe, Tajicstan in 1985 was reported (Attachment 7).

(g) GLOBUS - Dr. Offermann sent in a written report (Attachment 8). Dr. Labitzke reported that everything is working well. The report will appear in a MAP Newsletter and Handbook Volume 8.

(h) GOSSA - Dr. McCormick sent in a written report describing the progress of the project (Attachment 9). Dr. Russell reported for him. The March/April 1982 eruptions of El Chichon have provided GOSSA with an excellent opportunity to make significant contributions. Efforts for worldwide collection of aerosol data were described. Drs. Nagata and Hirota mentioned about Japan's effort in Antarctica. Dr. Chanin discussed European data. There will be a two-day meeting next week on the Chichon eruption.

(i) GRATMAP - Dr. Geller sent in a written report (Attachment 10) in which he mentioned that the first meeting of the group will be held during the Hamburg meeting. During the meeting the conclusions of the Urbana MST Radar Workshop and the Alaska Gravity Waves and Turbulence Workshop will be discussed. Future activities of the group will be planned (see Attachment 24 for the report of the meeting). Dr. Hirota reported briefly the results of the Alaska Workshop.

(j) MAE - Dr. Maynard sent in a written report in which the MAE-3 campaign was discussed (Attachment 11). Some results were described. Plans for the MAE-4 campaign were presented. The Committee will meet in Hamburg on August 24 (see Attachment 25 for the report of the meeting).

(k) SSIM - Dr. Simon reported that the report for the last meeting of the group will appear in MAP Handbook Vol. 8. There will be a meeting of the group on August 22 in Hamburg.

(1) WINE - Dr. von Zahn sent in a written report including the minutes of the Second Experimenters Meeting for MAP/WINE held at Interlaken, April 13, 1983 (Attachment 12). Recent developments, status of facilities and resources, science objectives, schedule of operations and the campaign handbook were subjects of the report. Dr. Labitzke reported that there will be the Third Experimenters Meeting, August 20, 1983 in Hamburg (see Attachment 25 for the minutes of the meeting).

7. MSTRAC - Dr. Bowhill reported that the new project has been approved by the Steering Committee through mail balloting. The announcement is attached (Attachment 13). Drs. Balsley and Avery will be the co-chairmen for the group. There will be a meeting of the Group August 24, at 18:00 at Hamburg (see Attachment 26 for the report of the meeting).

8. National Reports

Belgium: Dr. Simon reported that Belgium is active in many MAP activities.

Canada: Dr. Bowhill read a letter from Dr. John Gregory indicating his decision to retire from the Steering Committee (Attachment 14). The Steering Committee expressed thanks to Dr. Gregory on his contribution to MAP.

Czechoslovakia: Dr. Bucha sent a letter announcing a MAP-related symposium to be held in conjunction with the 1985 IAGA General Assembly in Prague (Attachment 15).

Finland: Dr. Sucksdorff reported Finland's plans for MAP activities.

France: Dr. Chanin reported France's participation in WINE, GLOBUS, and Long Duration Balloon Flights. There was a campaign that lasted 50 days last December. There will be three more launches later this year.

Federal Republic of Germany: Dr. Labitzke reported FRG's efforts in WINE, GLOBUS, DYNAMICS and modeling.

India: Dr. Somayajulu reported India's MAP programs that involve many different techniques. Plans to build an MST radar are being finalized and a proposal has been made for consideration of Government funding. He also mentioned about the plan for the establishment of a MAP data exchange center in India. India has also taken over the job of publishing the MAP Newsletter.

Japan: Dr. Kato reported that the MU radar has been on the air since June of this year with 1/10 of the antenna completed. Preliminary results are encouraging. He also reported ozone observations at Antarctica by Japan. A dedicated MAP satellite, EXOS-C, will be launched next February.

Norway: Dr. Witt reported for Dr. Thrane a strong commitment by Norway in MAP/WINE with a large number of meteorological rocket launchings.

Sweden: Dr. Witt reported Sweden's efforts in the study of minor species, CAMP and some spectroscopy work in the future.

Taiwan: Dr. Chao reported that a VHF-ST radar is under construction and will be completed and installed in Chung-Li in October 1984.

United Kingdom: Mr. Eccles reported that plans to construct an MST radar are being studied. Approval is expected by next April. Operation is expected in 1987.

United States: Dr. Watson, substituting for Dr. Mahlman and Dr. Sundararaman, described the Mahlman report (to be published in a MAP Handbook). He also talked about the attitude of the US funding agencies toward MAP projects. In principle, they support MAP, but he urged better communication between MAP scientists and the agencies.

Dr. Bowhill reported his visits to the People's Republic of China and USSR at the invitation of the Academies. He described MAP activities in the two countries from his observations during the trips.

9. Regional Consultative Group

Dr. Chanin reported that the European regional group met in Ottawa. Other smaller group meetings were part of WINE, GLOBUS meetings. It was important for the scientists from Eastern European countries to attend the meeting. The next full meeting is planned during the COSPAR meeting next year in Graz.

10. Data Management Committee Report

Drs. Hartmann and Hirota and Mr. Allen reported the work of the Committee. A new set of questionnaires for MAP data will be distributed. The form of the questionnaire was discussed at length (Attachment 16). It was decided that further comments should be forwarded to J. Allen.

Formating and the parameters to be included in the data were also discussed.

Dr. Nagata proposed that a resolution should be sent to the ICSU Panel for Data Centres expressing our appreciation of their efforts.

July 1, 1984 will be the date for the publication of an interim MAP data catalog; the final catalog by December 31, 1985.

11. Publication Committee Report

Dr. Sechrist sent in a report on the activities of the Committee, including topics of recently published MAP Handbooks and suggested titles for future volumes (Attachment 17). It was suggested that topics for the volumes for the techniques should be circulated among the SC members and suggestions of topics with names of possible contributors should be sent to the guest editors of the volumes.

Dr. Somayajulu suggested that error analysis should be included in these volumes.

Dr. Bowhill expressed gratitude to the Indian MAP committee for their excellent work in putting out MAP Newsletters. He urged project directors to send information to Dr. S. C. Chakravarty for inclusion in the MAPNL.

12. Workshops

PMP-1 Workshop: Dr. Labitzke reported that at the Workshop held in Oxford in April 1983, data from 7 selected days were used in the discussion. The group will meet on Wednesday, August 23. Final report will be ready soon.

MST Radar Workshop: Dr. Bowhill reported the outcome of the Urbana Workshop. There were many recommendations and resolutions to come out of the Workshop. The Steering Committee considered these resolutions and approved most of them (Attachment 18). A few additional recommendations will be discussed in the next session of the SC together with other possible resolutions and recommendations that may come out of the MAP group meetings and the Workshops to be held during the next two weeks in Hamburg (these resolutions are included in Attachments 21, 22).

13. Symposium on Ground-Based Studies of the Middle Atmosphere

Dr. Taubenheim sent in a report on the Schwerin Symposium held May 10-13, 1983 (Attachment 19). More than 80 scientists participated. The extended abstracts will be published in a MAP Handbook.

14. Future Workshops/Symposia

COSPAR Symposium on MAP, June 27-29, 1984, Graz - Labitzke
Kyoto International MAP Symposium, Nov. 26-30, 1984 - Kato (Attachment 20)
MAP Symposium in Prague, August 1985
GLOBMET Symposium, August 1985, Tajicstan
CLIMAT Symposium, September 10-11, 1984, Tasunolica, Greece
CAMP Experimenters Meeting, December 15, 1983, Stockholm - Witt
Second Technical Aspects of MST Radar Workshop, May 1984, Urbana - Bowhill/Liu
Third Technical Aspects of MST Radar Workshop, 1985, France
MAP/WINE Symposium, Fall 1984, Norway

In July 1984 EGS may have a symposium on gravity waves and turbulence.

15. Middle Atmosphere Cooperation (MAC)

It was noted that by next year, the future for MAC will be clearer. Dr. Bowhill urged countries to make funding plans for MAC. A Resolution Drafting Committee (Drs. Simon (Chairman), Nagata and Van Zandt) was set up to draft a resolution for supporting MAC (see Attachment 21).

16. Date and Location of Next MAPSC Meeting

The Committee voted to have the next SC meeting and the second MAP Assembly at Kyoto, Japan in November 1984, in conjunction with the MAP Symposium. Prof. Kato will contact authorities in Japan to arrange for the meetings.

There will be a pick-up meeting of MAPSC during the COSPAR Meetings, in Graz, June 1984 for those Steering Committee members who are present.

17. Other Business

Discussions on noctilucent clouds, long duration balloon and CDAW were made. The Committee decided to hold another session on August 26 at the end of the IUGG Meetings.

MAP STEERING COMMITTEE MEETING

August 26, 1983

Present: S. A. Bowhill, Chairman, K. Labitzke, Vice Chairman, B. B. Balsley, R. Bojkov, J. O. Cardus, G. Fraser, M. A. Geller, R. A. Goldberg (representing N. Maynard), I. Hirota, S. Kato, J. Lastovicka, T. Nagata, P. C. Simon, Y. V. Somayajulu, R. G. Roper, J. Taubenheim, R. A. Vincent (representing J. Forbes), G. Witt

The meeting was chaired by the Vice Chairman, Dr. Labitzke.

1. Minutes of the previous 2 meetings, held on August 13 and 14, 1983 were approved.

2. P. C. Simon presented a resolution concerning MAC; it was modified slightly as shown in Attachment 21, and approved by the Committee. It will be circulated to the National Representatives.

3. Report of MSG-6

Dr. Kato discussed the resolution and background material for the resolution (Attachment 22) concerning the setting up of one or more Equatorial Atmosphere Observatories. There was considerable discussion on the wording of the resolution; the Committee accepted it in principle, but it was decided that Dr. Bowhill would re-write the resolution and send it to Dr. Kato for his agreement. Among the suggestions for improvement were: location is more important than description, and should be mentioned first; and a statement should be added as to what is to be done with the resolution. There was also discussion as to whom the resolution should be sent, other than the minutes and the MAP Newsletter: The National Representatives, WMO, IAGA, and other organizations were mentioned.

4. Reports of Project and Working Group Meetings.

(a) PMP-1 - Dr. Labitzke reported on the two PMP-1 meetings held August 17 and 25 at Hamburg. The comparison of data continues and the report of the group is nearing completion and will be published as a MAP Handbook. Another meeting is planned for next year in the United States. She spoke of the importance of comparing data with new satellites.

(b) Dr. Simon reported for Dr. Frederick on the MSG-7 meeting of August 22. A report of the Group will appear in MAP Handbook Vol. 8. Dr. Bojkov mentioned that a WMO-sponsored meeting together with the IAMAP Ozone Commission will be held in Washington, D.C. in November 1983 to review the new ozone absorption cross section measurements which are made by NBS, Harvard Observatory, and the University of Reims. A final set of ozone absorption coefficients is expected to be available by May 1984 and WMO will formally adopt them. Consequently, recalculations of all previously made vertical ozone distributions by Umkehr methods and by satellites will have to be performed. The common interests of MSG-7 and the IAMAP Ozone Commission were discussed and the Chairman asked that Dr. Frederick be invited to that meeting as liaison between the WMO and MSG-7.

(c) Dr. Witt told of the meeting on August 23 of MSG-8, Atmospheric Chemistry. It was the first meeting of the Group; they discussed the importance of laboratory measurements, discussed the type of areas to be included in the study and decided to divide it into 3 sections, with S. Solomon, G. Brasseur and G. Witt as leaders. They will prepare a report which will be circulated to other members of the Study Group and then it will be sent to MAPSC for publication.

(d) ATMAP - Dr. Vincent reported for J. Forbes on the meeting held August 17; the aim of the group is to study atmospheric tides. One global campaign has been successfully completed with two more planned for the coming year; there was a great exchange of ideas on comparison between theory and observations. A detailed report on the meeting is Attachment 23). The Group plans to hold a Workshop in Kyoto in November 1984.

(e) CLIMAT - (See Attachment 6).

(f) GRATMAP - A report of the meeting held on August 24 is given in Attachment 24. Dr. Geller said a report will be prepared for a MAP Handbook. He spoke of other activities of MAP and other programs related to gravity waves, for example, WINE and the Japanese Antarctic Rocket Program. The USSR proposal for combined measurements of atmospheric response to a large explosion was also mentioned. GRATMAP plans to hold a workshop following the MAP Symposium in Kyoto. Dr. Geller will write a request to Dr. Kato to make the local arrangements.

(g) MAE - A report of the meeting held on August 24 was prepared by Dr. Goldberg, acting for Dr. Maynard, and is given in Attachment 25. Dr. Goldberg mentioned the possibility of this group, working with IAGA Working Group II-A, Middle Atmosphere Electrodynamics, setting up two joint workshops to develop a program to conduct validation and intercomparison studies of instrumental techniques and global atmospheric electrical parameters, with the idea of formulating a global geoelectric index. Dates for the workshops were not suggested, but the MAP Steering Committee expressed encouragement to the idea of cooperation.

(h) MSTRAC - Dr. Balsley explained the purpose of this group was to assist in the transfer of MST radar data to interested users; for example, comparison of data between two radars; and making data available to scientists not otherwise having access to them. He said that after the initial arrangements have been made, the Data Centres will take over the exchange. A summary of the first MSTRAC meeting is given in Attachment 26. It was pointed out that the MAP Newsletter should be used for communication with groups in need of the information. Dr. Balsley will prepare a writeup for the next Newsletter.

(i) SSIM - Dr. Simon told of a joint meeting with the corresponding IAGA Working Group to discuss recent improvements in measurements. There are some discrepancies which are being discussed. A new report should be ready by the end of the year.

(j) WINE - Dr. Labitzke said the program is going well but spoke of the difficulty in communicating rapidly the onset of a warming trend to all interested scientists.

Dr. Bojkov spoke of a WMO-sponsored meeting in October to review the current state of minor-constituent measurements in order to be able to verify chemical-dynamical models. A report would be distributed by WMO in 1984.

The 3rd MAP/WINE Experimenters Meeting was held in Hamburg on August 20. The minutes of the meeting are included (Attachment 27).

Dr. Witt mentioned a possible followup of the CAMP project during MAP. There is a general interest in the program, particularly as a follow-on to the forthcoming WINE project. It was agreed that the approved resolution on MAC would take care of this matter.

5. Other Business

Dr. Bowhill circulated for information a brief description by Dr. H. Friedman of the International Geosphere-Biosphere Program (Attachment 28) and a note by Dr. J. G. Roederer on the same subject (Attachment 29) was also called to the attention of the MAPSC.

Dr. Bowhill relayed a request from Dr. Nagata for a nomination for a MAP representative on the ICSU Panel on WDCs. It was decided to nominate Dr. Labitzke.

There were brief reports from the National Representatives present who had not reported during the earlier meetings.

Dr. Lastovicka (Czechoslovakia) spoke of the 1985 Prague Assembly (see Attachment 15). He noted that the proposed program on Global Change was an important part of the program.

Dr. Fraser (New Zealand) reported on the nitrogen and ozone work in the stratosphere being carried out there.

Dr. Taubenheim (GDR) told of the Workshop on Ground-Based Studies of the Middle Atmosphere recently held in Schwerin. The proceedings of the Workshop will be published in MAP Handbook Vol. 10.

Dr. Bowhill spoke of the activities of IAMAP and IAGA and the Middle Atmosphere Commission of ICMUA that apply to MAP. He asked that a brief report of these be made available to MAPSC. Attachment 30 is an excerpt from the ICMUA meetings at Hamburg; Attachment 31 is an excerpt from IAGA's International Commission on the Middle Atmosphere.

It was suggested that MAP have stationery printed.

It was noted that it would be desirable to publish in each Newsletter the deadlines for receipt of material for the MAP Newsletter.

Dr. Bowhill mentioned the MAP Assembly in Kyoto in November 1984 at which the national programs will be presented, both from scientific and regional standpoints. An announcement will be forthcoming.

The next MAPSC meeting will be in Kyoto, but there will also be a meeting of opportunity of those members present at Graz during the COSPAR meeting.

Agendas for the two meetings are given in Attachment 32.

ATTACHMENT 1. REPORT OF MSG-6 ON THE SCIENTIFIC ASPECTS OF AN INTERNATIONAL EQUATORIAL OBSERVATORY (IEO)

Chairman: S. Kato

Members: B. B. Balsley, J. Blamont, J. M. Forbes, M. A. Geller, I. Hirota, R. A. Vincent, R. F. Woodman

1. FOREWORD

MSG-6 has been set up to study this on the basis that there is need to have observatories very close to the equator so that we may understand equatorial dynamics much more precisely than we do now. Such observatories, which are equipped with MST radars, lidar and other facilities, should be constructed and operated through international cooperation. Specific requirements for the observation of equatorial middle atmosphere dynamics were discussed at the Workshop held 10-12 May 1982 at Estes Park, CO, USA, as will be shown in Section 2. MSG-6 has further worked on the problem, obtaining the opinions of each member as to the following questions: (1) locations of IEOs; (2) specification of the facilities at IEOs; and (3) finanical support on the construction and the maintenance of IEOs.

The proposed locations for IEOs are, in alphabetical order, Christmas Island, Galapagos Island, Kourous, Nauru and Tumbes (or Iquitos).

2. SCIENTIFIC SPECIFICATIONS FOR MIDDLE-ATMOSPHERE DYNAMICS OBSERVATIONS (see Handbook for MAP Vol. 7, pp. 103-150)

3. LOCATION OF IEOs

As to location, IEOs must be close to the geographic equator, say, within 5° from it. However, IEOs should be far enough away from the equatorial electrojet which produces unfavorable echoes; 5° may be a minimum distance from the equatorial electrojet.

Another consideration is that we wish to obtain the maximum possible contribution by IEOs to increase our understanding of middle-atmosphere dynamics. Thus, we favor, at first, those IEOs which take advantage of the existing radar observatory chains. For tidal studies such IEOs are essential. At present, there are three chains along different meridians. One is a chain which consists of Christchurch (44°S, 173°E; partial reflection drift (PRD) radar), Adelaide (35°S, 138°E; PRD radar and ST radar), Kyoto (35°N, 136°E; meteor radar and MST radar) and Khabarovsk (48°N, 135°E; meteor radar). Scott Base (78°S, 165°E; PRD radar). in the Antarctic has just commenced operation. We call this chain the Western Pacific Chain (WPC). Note that Adelaide and Kyoto are geographically conjugate, a characteristic which is very important for tidal mode studies. Nauru (0.5°S, 167°E) is on this chain. Thus, it is a good candidate for an IEO site.

There could be another, though less complete, chain than the WPC. This consists of Poker Flat (65°N, 145°W; MST radar) and two other stations which could be in existence in the future, i.e., Hawaii (20°N, 156°W) and Raratonga (21°S, 160°W). If Christmas Island (2°N, 157°W) is chosen, an important chain will be set up. This chain is called the Central Pacific Chain (CPC).

We may pick up another chain in the American/Atlantic sector. In this sector we have Saskatoon (54°N, 110°W; PRD radar), Durgam (43°N, 71°W; meteor radar), Millstone Hill (42.6°N, 71.5°W; ST radar), Urbana (40°N, 88°W; meteor radar, PRD radar, and MST radar), Atlanta (35°N, 84°W; meteor radar), Arecibo

(18°N, ´8°W; IS and ST radar) and Jicamarca (12°S, 77°W; IS radar). Platteville and Sunset (40°N, 110°W) have also ST radars in good operation. Of these stations, Saskatoon, Platteville and Sunset may be too far deviated towards the west. We call this chain the American-Atlantic Chain (AAC). There are two candidates for IEOs along this chain. They are Tumbes and Iquitos, both being at 3°S and about 65°W in Peru. Though a little deviated toward the west, Galapagos Island (0.3°S, 91°W) can be an additional candidate.

Of the above-mentioned candidates, we should consider some special features that relate to specific scientific interests. Nauru is situated at a very good point for studying the stratospheric fountain where air enters the stratosphere from the troposphere, bringing water vapor upward with the air (NEWELL and GOULD-STEWART, JAS, 38, 2789, 1981). Tumbes, Iquitos and Galapagos would be useful for investigating the impact of the Andes on middle-atmosphere dynamics.

As to transportation, all candidates are acceptable, although there are certain advantages with Nauru, Tumbes and Iquitos. It would be reasonable to expect technical service from all candidates, though there would be degrees of service among them.

The distance from the equatorial electrojet is more than 5° for all candidates (see Table 1).

Kourou in French Guyana (5°N, 53°W) is on the northern boundary for being an IEO site, but would still be suitable for some equatorial dynamics studies except for tidal dynamics which require a location closer to the equator.

Table 1. Locations of each candidate for IEO. The MAGSAT data were used to find dip.

PLACE	LAT°	LONG°	DIP(°)
Nauru	0.53 S	167 E	-11.58
Christmas I	1.57 N	157.27 W	6.03
Galapagos	0.56 S	91.0 W	17.65
Kourou	5.0 N	53.0 W	25.66
Iquitos	3.45 S	73.10 W	18.39
Tumbes	3.59 S	80.43 W	16.41

4. SPECIFICATIONS OF THE FACILITIES OF IEOs

The central facilities of IEOs are middle atmosphere radars which are able to measure the middle atmosphere motion with the required time- and space-resolution, sampling rates, and velocity accuracy. Quick steering of the radar beam would also be preferable. In the case of MST radars, these requirements can be realized by adopting proper pulse widths, pulse repetitions and signal integrations, and quick beam-steering mechanisms. A narrow pulse width for good height resolution implies a wide frequency spreading which may cause interference with other communications. Frequency allocation may be subject to some restrictions in the IEO area. Practically speaking, we must find quiet places with little radio noise to have a good S/N. However, it seems essential to have, as a minimum, a 10^9W m^2 average power-aperture product for operations at about 50 MHz. Easy electric power supply, is a requirement for IEOs. All of the candidate sites mentioned above are satisfactory with respect to this condition.

However, the power would be expensive and comprise an important part of the maintenance cost. The power also would produce various problems for the maintenance, such as requiring large cooling systems. If we use PRD radars instead, the power can be reduced drastically together with other simplifications of the radar systems. Since observed results by PRD radars at Townsville and Adelaide (VINCENT and BALL, JGR, 86, 9159, 1981) and Saskatoon (MANSON, MEEK and GREGORY, JGR, 86, 9615, 1981) have been very successful, PRD radars should seriously be considered as important facilities at IEOs. A scientific restriction of PRD radars is that, in simple PRD radars, we can measure only horizontal translation velocities. The height resolution of PRD radars is inferior to MST radars. But vertical velocities also might be investigated with phase coherent systems. Note that such improvement has recently been done successfully to detect GW in the mesosphere by VINCENT and REID (1982). If a PRD radar is set up, we need, in addition, an ST radar to observe the stratosphere which cannot be measured by a PRD radar.

In addition to radars, lidars would be increasingly important in middle atmosphere observations (HAUCHECORNE and CHANIN, JATP, 44, 577, 1982). Though dependent on weather, lidar systems are able to contribute to our purpose and it is recommended that they also be set up. The facilities are unique in that the atmospheric density perturbation is detected and, assuming the hydrostatic equilibrium of the atmosphere, the atmospheric temperature perturbation is obtained. The time resolution now available is a few ten minutes. Note that the (1,1) mode of tides may suffer a convection instability at the equator and the detection of temperature perturbation is crucial.

Balloon and meteorological rockets have remained important for observing the middle atmosphere, and the facilities not far from IEOs for their launching would be useful. Kourou in French Guyana seems especially favorable for these facilities, though the Ascension Island and Antigua rocket launching sites are available for the AAC. Usual radiosonde facilities are available for all candidates, as mentioned above.

5. FINANCIAL SUPPORT ON THE CONSTRUCTION AND THE MAINTENANCE OF IEOs

Technically, the IEO facility maintenance should be as simple as possible. A minimum number of service personnel is essential for operation. In the case of radars, once an observation has started, no attendance of personnel would be desirable. This implies "fully computerized systems", yet with minimum regular checks which are supplied from outside.

In order to keep periods of stay at IEOs at a minimum, or to avoid staying altogether, computer programs used for observation should be prepared beforehand and checked properly. One solution for the checking would make simulators of the IEO radars to be distributed to each member country. One such simulator is being developed for the MU radar system of Kyoto University for outside users to whom the computer program for "normal mode" observation is ready except for specifying some parameters such as start- and stop-time, beam steering and height range for observation.

A remote control system would be another solution; however this may be expensive and require a control headquarters to be located conveniently in some member country.

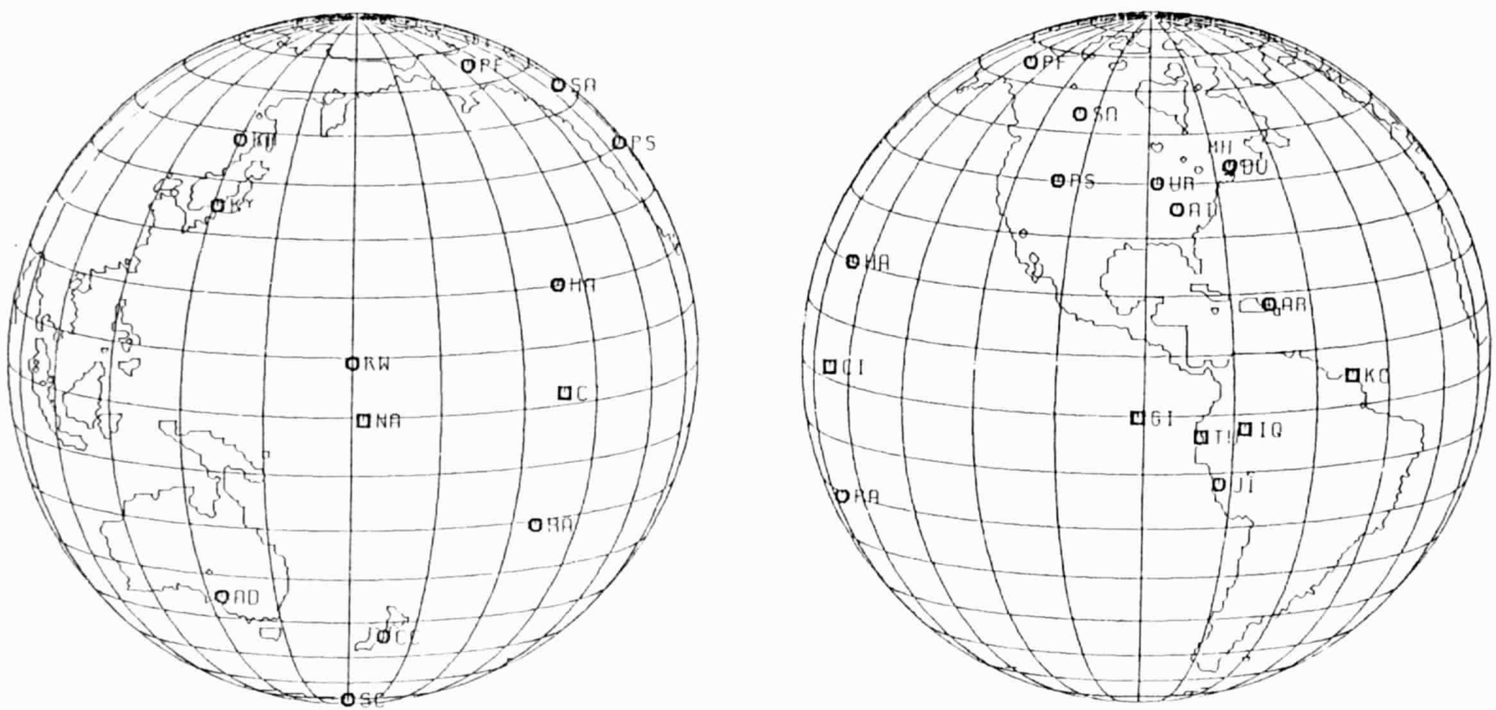
Financial support for the construction and the maintenance of IEOs is a problem to be solved for realizing our idea for setting up IEOs. The cost may be paid by the member countries as in the case of EISCAT, but for now the question will be left unresolved for future investigation.

6. RECOMMENDATION FOR IEOs

It is found that all of the proposed places have significant scientific aspects to constructing IEOs. However, it is practical, for funding considerations, to put a priority for each candidate.

The first choice is Nauru Island because the WPC seems best in coverage of latitudes, and in configuration having an almost exact conjugate pair in mid-latitudes between Adelaide and Kyoto. The location would also be suitable for the study of a very interesting scientific problem, "the stratosphere fountain". Other IEOs are desirable to be added in order to study longitudinal dynamic differences together with other interesting scientific problems characteristic to each location. It should be seriously considered to equip each IEO with those facilities which best suit that location.

We have, however, various other choices. As to low- and midlatitude coverages, the AAC would be excellent in the number of the existing stations and in the capabilities of the existing facilities which include Arecibo and Jicamarca which have contributed tremendously to the study of middle-atmosphere dynamics.



Locations of middle atmosphere dynamics observations.

ATTACHMENT 2. REPORT ON THE ACTIVITIES OF MIDDLE ATMOSPHERE PROGRAM STUDY GROUP - 7

J. E. Frederick (Chairman)

1. SUMMARY OF PREVIOUS ACTIVITIES

The first task of MSG-7 was to assemble a document that describes the present state of knowledge concerning molecular absorption properties that influence the penetration of ultraviolet solar radiation into the middle atmosphere. A major goal of this activity was to assemble a summary of all credible data on the absorption cross sections of molecular oxygen and ozone in the spectral region relevant to photochemical modeling of the middle atmosphere. It is hoped that the resulting document, to appear in Volume 8 of the Handbook for MAP, will serve as a standard reference for workers in the field.

2. MAJOR FINDINGS TO DATE

There is a significant spread among different laboratory determinations of the cross section of molecular oxygen in the Herzberg continuum for wavelengths 200 to 240 nm and in the Schumann-Runge bands from 175 to 200 nm. These discrepancies are large enough to cause very substantial changes in the abundance of trace gases computed in photochemical models. Obviously, changes in the absorption cross section of O_2 will influence the dissociation rate of this molecule. The key point, however, is that the opacity provided by O_2 absorption controls the attenuated solar radiation field that is available to dissociate other gases. In fact, modest changes in the O_2 cross section have significant impacts on the dissociation rates of gases such as N_2O, $CFC\ell_3$, and $CF_2C\ell_2$.

A problem peculiar to the Schumann-Runge bands of O_2 concerns the fact that the cross section, being composed of thousands of rotational lines, is too complex to incorporate directly into photochemical models. In addition, most laboratory data are unable to specify the very small cross section values that exist between the large rotational peaks. Yet, the penetration of solar radiation in these narrow-window regions is a significant contributor to the dissociation of gases at stratospheric altitudes. Here it is necessary to apply detailed modeling procedures to the laboratory data so as to determine the cross section in the windows. This requires assuming a specific line profile shape and adding the individual contributions from hundreds of rotational lines at each point in the spectrum. Once this task is completed, relatively simple parameterizations of the transmission of solar radiation through this spectral region must be developed for the purposes of atmospheric modeling.

Inferences of the Herzberg continuum cross section based on in situ measurements of the attenuated solar irradiance produce smaller values than have laboratory measurements. The available laboratory results are questionable because of the large corrections required for the pressure dependence of the cross section encountered at the large O_2 densities needed to detect the weak absorption.

The atmospheric data are free from this problem but instead require a large correction to account for absorption by ozone. Accurate knowledge of the ozone cross section and ozone column content above the altitude of the measurement are essential here.

3. RECOMMENDATIONS FOR ADDITIONAL WORK

A meeting of several members of MSG-7 and other interested scientists will take place during the Middle Atmosphere Science Symposium of the IUGG General

Assembly. The purpose of this meeting will be to prepare a list of recommended future activities. At present a set of likely recommendations appears to be:

(a) A definitive laboratory measurement of the O_2 cross section in the Herzberg continuum from 200 to 240 nm should be completed and published. Such work is currently underway by D. E. Freeman, a member of MSG-7, at Harvard College Observatory.

(b) The recent Schumann-Runge band absorption data of Yoshino, Freeman, and Parkinson should be processed in a fashion so as to be easily used in photochemical models. This requires combination of the measured band oscillator strengths and rotational line widths with a modeling procedure to determine the magnitude of the small cross sections between the rotational peaks. This activity should be followed by parameterizations of transmission as a function of O_2 column density for practical use in chemical calculations.

(c) Additional measurements of the attenuated solar radiation field between 175 and 240 nm should be performed from balloons at altitudes between 20 and 40 km. These should be accompanied by simultaneous ozone and pressure measurements. These flights are essential to establish the applicability of laboratory results to describing the penetration of ultraviolet solar radiation into the middle atmosphere.

ATTACHMENT 3. ANTARCTIC MIDDLE ATMOSPHERE (AMA) OBSERVATION - EXISTING AND IN DEVELOPMENT

T. Nagata and T. Hirasawa

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Tokyo 173, Japan

1. INTRODUCTION

The information on the MAP observations in the Antarctic and Sub-Antarctic regions was kindly sent to us from countries which are participating in Antarctic Research. By compiling the information, ground-based, air-borne, balloon, rocket and satellite observations of the AMA project are presented. The report would be useful for scientists to organize the effective international coordinated observations in Antarctica and also to coordinate with other international MAP project in the northern polar region.

2. SCIENTIFIC AIMS AND OBSERVATIONS OF THE AMA PROJECT

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

The dynamics, structure, atmospheric composition and aerosol abundance of the lower and middle atmosphere in Antarctica are different from those in the middle and low latitude regions because of differences in the geographic, geophysical and biochemical situations; namely, the influence of the dominant particle precipitation on the chemical and dynamical processes within the polar middle atmosphere; the cooling of the atmosphere by the ice covering the Antarctic continent; the difference in the effective intensity of the solar ultraviolet radiation; and the difference in the biochemical environment from which the minor constituents in the atmosphere originate.

The present data of the Antarctic middle atmosphere are scarce, so it is important to collect basic data about the distribution and variation of the physical and chemical quantities in the middle atmosphere over a wide area in Antarctica. To obtain a comprehensive understanding of the actual conditions of the Antarctic atmosphere, the coordinated observations are carried out at the following Antarctic stations. Symbols of the Antarctic stations are listed in Table 1.

1. Surface meteorology observations (air and dew-point temperature, atmospheric pressure, wind direction and speed, visibility, clouds and ceiling):
BEL,MAR(Argentine). CSY,DUS,MAW,MCQ(Australia). CMA(Chile). AMS,CZT,PAF,DRV (France). GVN(FRD). MIZ,SYO(Japan). AIA,HBA,SGE(UK). MIR,MOL,NVL,VOS,LEN, BEH,RUS(USSR). MCM,PAL,SPL,SPA,(USA). SBA(New Zealand). SNA(South Africa).

2. Upper-air observations (radiosondes: wind direction and speed, pressure, temperature and humidity);
BEL,MAR(Argentine). CSY,DUS,MAW,MCQ(Australia). CMA(Chile). AMS,CZT,PAF,DRV (France). GVN(FRG). SYO(Japan). AIA,SGE(UK). MIR,MOL,NVL,VOS,BEH(USSR). MCM, SPA(USA). SNA(South Africa).

3. Radiation:
Global solar radiation: BEL,BRO,MAR(Argentine). MCQ(Australia). CMA(Chile). PAF,DRV(France). MIZ,SYO(Japan). AIA,HBA,SGE(UK). MIR,MOL,NVL,VOS,LEN,BEN, RUS(USSR). SPA(USA).
Diffuse solar radiation: MCQ(France). CMA(Chile). PAF,DRV(France). MIZ,SYO (Japan). MIR,MOL,NVL,VOS(USSR). SPA(USA). SBA(New Zealand).

Table 1. List of Antarctic stations at which atmospheric observations are carried out.

Station	Symbol	Nation	Geographic coordinate		Geomagnetic coordinate	
			Latitude	Longitude	Latitude	Longitude
Belgrano (Antarctique)	BEL		77.8°S	38.2°W	67.4°S	17.1°E
Brown	BRO	Argentine	64.9°S	62.9°W	49.3°S	9.8°E
Marambio	MAR		64.2°S	56.6°W	48.9°S	13.0°E
Casey	CSY		66.2°S	110.4°E	77.9°S	178.8°E
Davis	DVS	Australia	68.6°S	78.0°E	76.8°S	119.0°E
Mawson	MAW		67.6°S	62.8°E	73.1°S	102.2°E
Macquarie Island	MCQ		54.5°S	159.0°E	61.1°S	243.1°E
CMA FREI	CMA	Chile	62.2°S	58.9°W	51.0°S	8.2°E
Amsterdam	AMS		37.8°S	77.6°E	46.5°S	141.3°E
Crozet	CZT	France	42.4°S	51.9°E	51.2°S	109.4°E
Kerguelen (Port-aux-Francais)	PAF		49.4°S	70.2°E	56.5°S	127.8°E
Dumont d'Urville (Terre-Adelie)	DRV		66.7°S	140.0°E	75.6°S	230.9°E
Geovg-von-Neumayer	GUN	FRG	70.6°S	8.4°W	59.4°S	39.7°E
Mizuho Station	MIZ	Japan	70.7°S	44.3°E	72.3°S	80.6°E
Syowa Station	SYO		69.0°S	39.6°E	70.0°S	79.4°E
Faraday Argentina IS.	AIA	United Kingdom	65.3°S	64.3°W	53.7°S	3.3°E
Halley Bay, Coats Land	HBA	United Kingdom	75.5°S	27.0°W	65.8°S	24.3°E
Grytviken, South Georgia	SGE		54.3°S	36.5°W	44.2°S	26.0°E
Mirny	MIR		66.7°S	93.0°E	77.0°S	122.7°E
Molodezhnaya	MOL		67.7°S	45.5°E	66.6°S	77.3°E
Novolazarevskaya	NVL		70.7°S	11.8°E	62.5°S	51.1°E
Vostok	VOS	U.S.S.R.	78.5°S	106.9°E	89.2°S	91.5°E
Leningradskaya	LEN		69.5°S	159.4°E	78.5°S	276.9°E
Bellingshausen	BEH		62.2°S	59.0°W	47.0°S	11.4°E
Russkaya	RUS		74.8°S	137.0°W	66.8°S	23.0°W
McMurdo Station	MCM		77.9°S	166.7°E	79.0°S	65.6°W
Palmer Station	PAL	U.S.A.	64.8°S	64.1°W	53.4°S	3.9°E
Siple Station	SPL		75.6°S	83.6°W	64.7°S	6.3°W
South Pole Station	SPA		90.0°S	-	78.5°S	0.0°
Scott Base	SBA	New Zealand	77.8°S	166.8°E	76.8°S	65.4°W
SANAE	SNA	South Africa	70.3°S	2.4°W	63.7°S	44.5°E

Direct solar radiation: MIZ,SYO(Japan). AIA,HBA,SGE(UK). SPA(USA). SBA(New Zealand).
Actinometric measurements by radiosondes: SYO(Japan). MIR,MOL,NVL,VOS,BEH(USSR)

4. Ozone:
Surface ozone: MCQ(Australia). GVN(FRG). SYO(Japan). SPA(USA).
Total ozone: MCQ(Australia). SYO(Japan). AIA,HBA,SGE(UK). MIR,VOS(USSR). SPA(USA).
Vertical ozone content by Dobson spectrometer: MCQ(Australia). AIA,HBA,SGE(UK)
Vertical ozone content by radiosondes: GVN(FRG). SYO(Japan). NVL,(USSR, GDR). SPA(USA). MAR(Argentine).

5. Minor constituents in the atmosphere:

At Macquarie Island (Australia): Carbon dioxide; two samples per month. Sampling duration 8 hours and 24 hours. Non-dispersive infrared gas analyzer.

At Mawson (Australia): Carbon dioxide, nitrous oxide, halocarbons; two evacuated flask samples per month. Flasks returned annually for analysis in Australia.

At Amsterdam (France): Carbon dioxide; continuous, non-dispersive infrared gas analyzer. Evacuated flasks, twice a week. Sulfur dioxide, dimethyl sulfur and sulfur gas; 24 hours once a week. Radio activities (Radon-Thoron) in the atmosphere; automatic measurements, every two hours.

At Kerguelen, Crozet and Dumont d'Urville (France): Radio activities (Radon-Thoron); automatic measurements, every two hours. Radio activities (Phosphore 32 and Beryllium 7); evacuated flasks, once a week.

At Georg-von-Neumayer (FRG): Kr-85 in the atmosphere. Sulphur isotopes in precipitation samples. Carbon isotope ratios in atmospheric CO_2. Trace matters (gas and particles) in the atmosphere. Atmospheric condensation nuclei and size distribution of Aitken nuclei.

At Syowa (Japan): Carbon dioxide; continuous, non-dispersive infrared gas analyzer. Nitrous oxide and Halocarbons; two flask samples per month. Flask returned annually for analysis in Japan. Atmospheric trace constituents ($CFCl_3$, CF_2Cl_2, HNO_3, CH_4, NO_x and others); Fourier transform infrared spectrometer. Vertical profile of water vapor content; Lyman-α/OH fluorescence hygrometer, balloon-borne observation. Vertical profile of NO_x distribution; 5000 m^3 plastic balloon, absorption spectroscopy with the sun as a light source. Airborne measurement of N_2O.

At Faraday, Halley Bay and Grytviken (UK): Precipitation samples for isotope analysis; monthly and 3-monthly. Air samples in stainless steel containers; from day to day during summer.

At South Pole (USA): Carbon dioxide; bimonthly, evacuated flasks, infrared gas analyzer. Halocarbons; spot measurements, evactuated flasks, gas chromatograph. Trace metals and halogens; evacuated flasks, neutron, activation, and absorption spectroscopy. Trace-gas; spot measurements, atmospheric emission spectrometer.

At Molodezhnaya (USSR): Tritium concentration in the atmospheric moisture and precipitation.

At Novolazarevskaya (USSR, GDR): Isotopic composition of environmental nuclides.

6. Atmospheric aerosol:

At Casey (Australia): Size distribution of aerosol particles. Polyaromatic hydrocarbon content of atmospheric aerosols.

At Syowa (Japan): Vertical distributions of the atmospheric aerosol; lidar observation, intermittent. Airborne and balloon observations of aerosol up to an altitude of about 35 km.

At McMurdo (USA): Properties of the atmospheric aerosol; impaction filters and CN counter. Airborne measurements of the atmospheric aerosol; flights to McMurdo and other research flights from Christchurch and from McMurdo.

At Mirny (USSR): Properties of the atmospheric aerosol and some gaseous concentrations.

7. Remote-sensing observation:

At Mawson (Australia): Mesospheric temperatures; six channel spectrophotometer records intensities of rotational-vibrational bands of OH and nearby background from which temperatures in altitude range 90-130 km are computed. Dynamics of upper atmosphere; a high resolution, dual, scanning Fabry-Perot spectrometer records atomic emission line profiles from aurora and airglow for determination of temperatures, winds and electric fields in the thermosphere. A three-field six-channel photometer records airglow and aurora fluctuations for determination of gravity waves, winds, turbulence and electric fields. Equipment is set up for recording mesospheric wind by the "partial reflection drifts" method.

At Syowa (Japan): Radar observations of meteorite trace; neutral wind motions in the 80-110 km height region. Laser radar monitoring of the polar middle atmosphere; laser, Ruby (694.3 nm, 347.2 nm). Power of laser pulse, 1J/pulse (Max.). Pulse reception rate, 1 Hz (Ruby), 0.25 Hz (Dye). Receiving telescope, 50 cmϕ. Data display, A-scope and photocounter.

At Molodezhnaya (USSR): Radar observation of meteorite trace. Laser observation of the atmospheric sodium.

At Scott Base (New Zealand): Partial reflection drifts system for the measurement in the mesosphere and lower thermosphere; peak output power 100 kW. Carrier frequency 2.9 MHz. Once an hour. Wind speed and direction within a height range of 67-97 km.

8. Observations by means of rockets balloons and satellites:

At Marambio (Argentine): Stratospheric investigation; launching of balloons and sounding rockets carrying payloads with a capacity to record different parameters from the surface up to an altitude of 70 km. Launching of fourteen balloons with ozone and temperature sensors in order to correlate them with satellite NIMBUS-7. Launching of four Super Loki rockets with temperature sensors in order to correlate them with NOAA-6 satellite. Experiment to correlate with satellite NIMBUS-7 and SME (Stratospheric Mesosphere Experiment). Sundry determinations by both satellites about the formation and destruction of ozone. This experiment encompassed the following launchings: five balloons with ozone and temperature sensors; five Super Loki sounding rockets with ozone sensors; four Super Loki sounding rockets with temperature sensors.

At Kerguelen (France): A series of long-life balloons to study radiative budget, dynamics and water vapor content is planned for the end of 1982.

At Syowa (Japan): Three balloons (5000 m^3) for measuring the vertical distributions of ozone and NO_2. Meteorological rocket soundings; winds, temperatures and ozone up to altitude of about 70 km. Twice a month. Satellite remote measurements of vertical profiles of air-temperature, ozone, and stratospheric minor constituents; reception of data from Japanese MAP satellite (EXOS-C) and TIROS-N/NOAA series meteorological satellites.

At Molodezhnaya (USSR): Meteorological rocket sounding; winds and temperatures up to an altitude of about 90 km. Once a week and additional sounding in June, July and August.

9. Others:

At Faraday, Halley and Grytviken (UK): Observations of the noctilucent and nacreous clouds; visual, 3-hourly synoptic when present.

At Belgrano, Brown and Marambio (Argentine): Observations of noctilucent clouds, halos, coronas, parhelios, rainbows and other phenomena.

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

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

Therefore, in order to make clear the physical process of the effect of the precipitating particles on the polar middle atmosphere, the coordinated observation of upper atmosphere phenomena are carried out at the following Antarctic stations to measure the energy input down to the middle atmosphere from the lower ionosphere.

1. Auroras:

All-sky photographs: CSY,MAW,MCQ(Australia). DRV(France). SYO(Japan). MIR, MOL, VOS(USSR). SPL,SPA(USA). SNA(South Africa).
Auroral photometers: MCQ(Australia). PAF,DRV(France). SYO(Japan). MIR,MOL (USSR). SPL,SPA(USA). SNA(South Africa).
Auroral TV image: SYO(Japan). SNA(South Africa).

2. Ionosphere:

Ionosonde: MAW(Australia). PAF,DRV(France). SYO(Japan). AIA,HBA(UK). MOL, VOS(USSR). SPL,SPA(USA). SBA(New Zealand). SNA(South Africa).
Riometer: BEL,BRO(Argentine). CSY,DVS,MAW,MCQ(Australia). CMA(Chile). PAF, DRV(France). SYO(Japan). HBA(UK). MIR,MOL,NVL(USSR). MCM,PAL,SPL,SPA (USA). SBA(New Zealand).

3. Magnetic field and electromagnetic waves:

Magnetic variations: BEL(Argentine). CSY,DVS,MAW(Australia). CZT,PAF,DRV (France). MIZ,SYO(Japan). AIA,HBA,SGF(UK). MIR,MOL,NVL,VOS,(USSR). SPL, SPA(USA). SBA(New Zealand). SNA(South Africa).
Geomagnetic pulsations: CSY,DVS,MAW,MCQ(Australia). CZT,PAF,DRV(France). MIZ, SYO(Japan). SPL,SPA(USA). SNA(South Africa).
ELF-VLF waves: BEL(Argentine). MCQ(Australia). PAF(France). MIZ,SYO(Japan).

PAL, SPL, SPA (USA).

4. Electric field potential gradient using a field mill:

DUS (Australia). SPA (USA). SNA (South Africa).

5. Remote-sensing observation:

At Mawson (Australia): Sporadic-E ionization investigation; beacon, continuous, transmitter 50 Hz CW. Auroral and disturbance phenomena investigation; off-vertical sounding, Delta array for 4A ionosonde.

At Syowa (Japan): Continuous monitoring of the lower ionosphere within a height range of 80-120 km; 50 MHz and 112 MHz doppler radar. Output power 20 kW.

6. Observations by means of rockets and balloons:

At Syowa (Japan): Rocket observations of auroral TV image, auroral particles, ELF-VLF-HF electromagnetic waves, electron density and temperature, magnetic and electric fields and auroral X-rays; S310JA type rocket (max. altitude 230 km). 3-4 rockets a year. Balloon observations of auroral X-rays and electric fields; 5000 m^3 balloon, 2-3 balloons a year.

Satellite observations of the ionospheric electron density profiles in the altitude range from the F2 peak level to 800 km, plasma waves associated with the precipitating auroral particles, high energy particles with energies higher than 50 keV and electron density and temperature; reception of data from Japanese MAP satellite (EXOS-C) and Canadian satellites, ISIS-1, 2.

At Siple (USA): Rocket observations of VLE-particle interactions; austral summer of 1981-82.

(c) Atmospheric Pollution

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

At Faraday and Grytviken (UK): Some air samples are taken for the studies of the atmospheric pollution.

At Molodezhnaya and Mirny (USSR): Control over the atmospheric pollution, precipitation chemistry, aerosol turbidity of atmosphere; small components in the atmosphere (CO, CH_4, N_2O and others). Sounding of aerosol in the stratosphere.

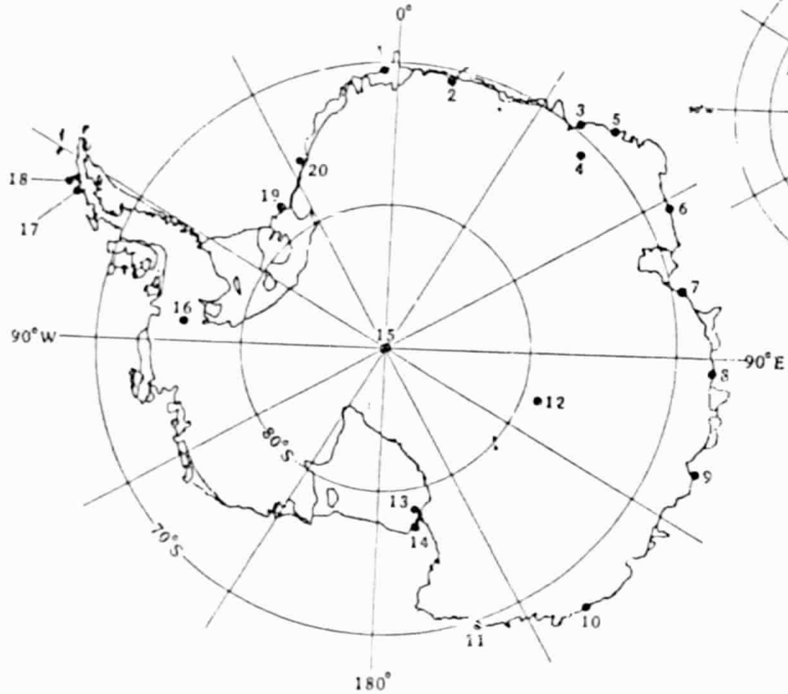
At Amsterdam (France): Surface atmospheric pollution; continuous, infrared spectral analyzer.

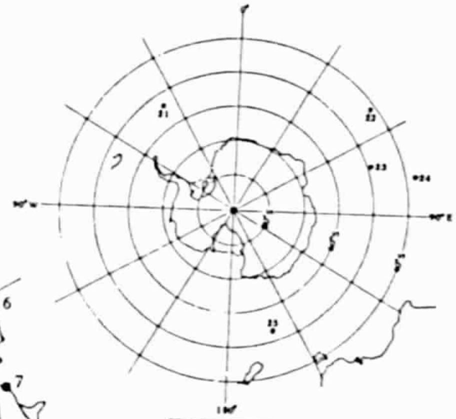
3. OTHER PROPOSED AMA PROJECTS

Middle atmosphere and meteorological observations on board a USSR ship along the Antarctic coast. Coordination with the MAP observations at ground stations, Leningradskaya, Dumont d'Urville, Casey, Mirny, Davis, Mawson, Molodezhnaya and Syowa, is most desirable.

Joint observations to study the South Atlantic Anomaly. Observations of airglow, electric fields, ion composition and X-rays are scheduled to be carried out by balloons. (Argentine, 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 the northern polar region such as the Winter in Northern Europe Project (WINE), Global Observations and Studies of the Stratospheric Aerosols (GOSSA), Cold Arctic Mesopause Project (CAMP) and USSR Arctic MAP observations, is now under consideration.





	STATION	Geographic coordinate	
		Latitude	Longitude
1	SANAE	70.3°S	2.4°W
2	Novolazarevskaya	70.7°S	11.8°E
3	Syowa Station	69.0°S	39.6°E
4	Mizuho Station	70.7°S	44.3°E
5	Molodezhnaya	67.7°S	45.8°E
6	Mawson Station	67.6°S	62.8°E
7	Davis Station	68.6°S	78.0°E
8	Mirny	66.7°S	93.0°E
9	Casey	66.2°S	110.4°E
10	Dumont d'Urville	66.7°S	140.0°E
11	Leningradskaya	69.3°S	159.4°E
12	Vostok	78.5°S	106.9°E
13	McMurdo Station	77.9°S	166.7°E
14	Scott Base	77.8°S	166.8°E
15	South Pole	90.0°S	—
16	Siple Station	75.6°S	83.6°W
17	Argentine Is	65.3°S	64.3°W
18	Palmer Station	64.8°S	64.1°W
19	Belgrano	77.8°S	38.2°W
20	Halley Bay	75.3°S	27.0°W
21	South Georgia	54.3°S	36.5°W
22	Crozet	42.4°S	51.9°E
23	Kerguelen	49.4°S	70.2°E
24	Amsterdam	37.8°S	77.5°E
25	Macquarie Is	54.5°S	159.0°E

The location cf Antarctic stations.

ATTACHMENT 4. ATMOSPHERIC TIDES MIDDLE ATMOSPHERE PROGRAM (ATMAP) PROGRESS REPORT

J. M. Forbes

1. PARTICIPANTS

During June, 1983 a number of experimenters, data analysts, and theoreticians with interest in upper atmosphere tides were invited by me to participate in ATMAP. Attached are the letter of invitation (Attachment 4.1), the list of (prospective) participants (Attachment 4.2), and an ATMAP questionaire (Attachment 4.3) which all invitees were asked to fill out.

2. MEASUREMENTS CAMPAIGNS

Global tidal measurements campaigns conducted during November, 1981, and May, 1982, by the IAMAP/ICMUA Working Group on Tides in the Mesosphere and Lower Thermosphere (J. M. Forbes, Chairman) will be considered part of the overall ATMAP. Results from the 1981 campaign will form the focal point for the "Workshop on Tides in the Mesosphere and Lower Thermosphere" to be held at the IUGG Assembly in Hamburg this August. Two additional campaigns are tentatively scheduled for early December, 1983, and late May, 1984. Firmer plans for these and other future campaigns will emerge from the Hamburg workshop.

Guidelines for preparation of ATMAP campaign reports and publication of results are given in Attachment 4.4.

3. IAMAP/ICMUA WORKING GROUP ON TIDES IN THE MESOSPHERE AND LOWER THERMOSPHERE

Given the adoption of tidal campaign responsibilities by ATMAP, the nature and scope of activities of the ICMUA Working Group have been redefined. Efforts will now primarily concentrate on recommending preferred methods of tidal data analysis, and developing a climatological model of middle atmosphere tides. Use of the ATMAP data base and close coordination with the ICMUA Working Group on Middle Atmosphere Climatology (K. Labitzke, Chairperson) are envisioned. The letter defining the new Working Group goals and inviting participation is attached (Attachment 4.5).

ATTACHMENT 4.1

BOSTON COLLEGE
Chestnut Hill, Massachusetts 02167

(617) 969-0100

Department of Physics

May 26, 1983

Dear

At the COSPAR[1] Meeting in Ottawa, Canada, May, 1982, SCOSTEP[2] accepted the proposed Atmospheric Tides Middle Atmosphere Program (ATMAP), as part of the International Middle Atmosphere Program (MAP), and appointed me Coordinator of ATMAP. A description of ATMAP is attached. Approximately two observational campaigns per year of several weeks duration are planned. Under the auspices of the IAMAP[3]/ICMUA[4] Working Group on Tides in the Mesosphere and Lower Thermosphere, radar campaigns during November 1981 and May 1982 have already been successfully completed. Results of the 1981 campaign will be presented and interpreted at a special workshop to be held on Wednesday, August 17, at the IAMAP Assembly, Hamburg, Federal Republic of Germany, 1983.

The ICMUA Working Group will continue to coexist with ATMAP but with somewhat different and longer term goals, including the development of models, providing contributions to reference atmosphere, development of improved and standardized methods of data analysis, and coordination with other ICMUA working groups and interests. If you are currently a member of the ICMUA Working Group on Tides in the Mesosphere and Lower Thermosphere, a letter redefining and clarifying the goals of this group will be sent to you shortly.

I would like to take this opportunity to formally invite you to serve as a participant in the Atmospheric Tides Middle Atmosphere Program (ATMAP). Committments of experimenters and data analysts would extend as follows:

(1) Participate in approximately 2 global measurements campaigns per year of roughly 1-4 weeks duration, depending on your operating constraints. A 1-week "core" period will be defined.
(2) Participate in the free exchange of your campaign measurements and in interactions with other experimenters and/or theoreticians to interpret the data. You are responsible for stating any restrictions regarding publication of your data to requesters.
(3) Make available your data in summary form for "ATMAP Campaign Reports," and for a MAP data base if one is created. Campaign reports may only be distributed privately, or if appropriate, prepared for publication in a MAP Handbook. Further information on these issues will be provided in forthcoming correspondence from me.
(4) <u>If possible</u>, attend about 1 workshop or symposium per year where these data will be extensively discussed.

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[1]COSPAR Committee on Space Research
[2]SCOSTEP Scientific Committee on Solar-Terrestrial Physics
[3]IAMAP International Association of Meteorology and Atmospheric Physics
[4]ICMUA International Commission on the Meteorology of the Upper Atmosphere

Theoreticians would be expected to:

(1) Gear some of their theoretical and modelling efforts towards problems pertinent to the interpretation of ATMAP campaign data.
(2) Participate in the interpretation of data through collaborative agreements with experimenters and data analysts, and/or active participation in our workshops and symposia.

At this point we must prioritize and schedule our future observational campaigns. A questionnaire is attached to enable you to provide your inputs. Please return this as soon as possible.

For your information the final schedule for the 1-day Workshop in Hamburg is also attached. As you can see, the degree of participation is high, and the workshop is likely to be very productive. However, please note that regrettably the time allotted for presentations is less than many of you requested, due to scheduling constraints.

I hope that you will be able to attend the Workshop at Hamburg this August, and to actively participate in ATMAP during the next few years.

Sincerely yours,

Jeffrey M. Forbes, Coordinator
Atmospheric Tides Middle Atmosphere Program

JMF:jf

Atmospheric Tides Middle Atmosphere Program
(ATMAP)

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:

(1) To delineate the global morphology of tides in the middle atmosphere including temporal and spatial variability on various scales;
(2) To elucidate the role of tides in affecting mean winds and temperatures in the middle atmosphere;
(3) To elucidate the role of tides in giving rise to gravity wave and turbulence through nonlinear cascade and instability processes; and
(4) 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.

ATTACHMENT 4.2. LIST OF PARTICIPANTS
ATMOSPHERIC TIDES MIDDLE ATMOSPHERE PROGRAM (ATMAP)

J. M. Forbes	USA (Coordinator)
R. A. Vincent	S. Australia
G. Elford	S. Australia
A. H. Manson	Canada
J. L. Fellous	France
H. Teitelbaum	France
F. Vial	France
K. M. Greisiger	GDR
R. Schminder	GDR
J. Rottger	Sweden
C. A. Reddy	India
G. Cevolani	Italy
S. Kato	Japan
T. Aso	Japan
G. Fraser	New Zealand
J. K. Chao	Taiwan
S.-S. Hong	Taiwan
S. K. Avery	USA
R. G. Roper	USA
R. R. Clark	USA
W. L. Oliver	USA
B. Balsley	USA
R. L. Walterscheid	USA
S. P. Kingsley	England
G. V. Groves	England
Y. I. Portnyagin	USSR
H. Alleyne	West Indies
D. A. Carter	USA
J. Fejer	Puerto Rico
C. P. Lagos	Peru
R. S. Lindzen	USA

ATTACHMENT 4.3. ATMAP QUESTIONNAIRE

Name (please print) ______________________________

1. I agree to participate in ATMAP Yes________ No_______

2. Please rank the following observational campaigns in the order which you believe would derive the greatest scientific return (currently, we are thinking of scheduling 2 campaigns per year):

*A second early winter period ______ *see end of questionnaire
*A second early summer period ______
*A third early winter period ______
*A third early summer period ______
Fall equinoctial transition period ______
Spring equinoctial transition period ______
Mid-Winter (Stratwarm) period ______
Mid-Summer (planetary-wave) period ______

Comments:

3. How many observational campaigns would you like to see scheduled per year? ______________

4. Other comments or suggestions:

5. Have I excluded anyone from the enclosed list of prospective ATMAP participants?

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*These early winter and early summer campaigns are intended to supplement those performed in 1981 and 1982, respectively. The idea here is to obtain a good global data base during periods where the <u>tidal</u> behavior is generally well-behaved, steady, and characteristic at many stations around the world. Besides intercomparisons between stations, we would hope that analyses of such data would include:

(1) Comparisons with similar periods in other years

(2) Comparisons with the winter and summer periods of the same years (i.e., to what extent are these periods representative of the full solstitial periods?)

These campaigns and analyses would form the basis for determining the feasibility and approach of constructing a model of tides, say for a reference atmosphere.

ATTACHMENT 4.4. GUIDELINES FOR PREPARATION OF ATMAP CAMPAIGN REPORTS AND PUBLICATION OF ATMAP RESULTS

J. M. Forbes, Coordinator

1. ATMAP CAMPAIGN REPORTS

While Global radar and rocket measurements of mesospheric and lower thermospheric winds have accumulated for many years, it is remarkable that a more comprehensive and consistent observational picture of tidal and mean circulation dynamics of the region still does not exist. This is because, apart from some fragmentary studies, available <u>simultaneous</u> measurements have not been thoroughly examined in a <u>global</u> sense. (See JATP, 40, 1978, special issue for at least one exception.) It would seem that apart from coordinating global campaigns, a major responsibility of the ATMAP is to provide efficient and meaningful mechanisms for assembling, interpreting, and disseminating our campaign results. Towards this end, I would like to prepare an "ATMAP Campaign Report" for each of our campaigns, including those conducted during November 1981 (09 Nov. - 03 Dec., 4-day <u>core period</u> 19-22 Nov.) and May 1982 (02-08 May, with 4-day <u>core period</u> 03-06 May). (These "core periods" are slightly different than previously quoted, in order to accommodate a 4-day fit-span for reasons discussed in the following.) The primary purpose of the report would be to collect under a single cover and in a common format summary plots of the campaign data with brief descriptive texts. It is uncertain at this point what medium would be utilized to distribute the reports, although one possibility would be to make them available to the general community in the form of a MAP Handbook. I will approach SCOSTEP with this idea at the appropriate time. In any case, the reports would be distributed privately among ourselves and perhaps to other interested parties for interpretation, comment, and planning, hopefully stimulating further collaborations within our group.

Therefore I am requesting that within 6 months of each campaign (and <u>by December 31, 1983</u> for the November 1981 and May 1982 Campaigns) you provided me with the following:

1. Based on a 4-day Fourier fit at each altitude for the "core" period of the campaign, the following figures (utilizing the <u>enclosed blank figure sheets</u>):
   (a) <u>diurnal mean</u> eastward and northward wind amplitudes as a function of height,
   (b) <u>diurnal</u> eastward and northward wind amplitudes and phases as a function of height; and
   (c) <u>semidiurnal</u> eastward and northward wind amplitudes and phases as a function of height.

A 4-day fit is considered the minimum length to remove non-tidal transients, and is an integer multiple of 2 days recognizing that 48-hour, 16-hour, and 9.6 hour oscillations might be present. State your averaging interval if it does not cover the full 4-day core period. Additional figures are welcome, but optional. For instance, you may wish to "place into context" the above results by providing some description of variability over a period of several weeks, or to make comparisons with previous years' tidal data during similar periods. Note that our nominal altitude is 90 km if any single-height plots are provided.

2. A brief abstract (no more than 1 single-spaced page <u>if possible</u>) using the <u>enclosed abstract guide sheet</u> and addressing some or all of the following points:
   (a) Briefly describe the amplitude and phase characteristics observed.
   (b) Exactly what time period is covered and what type of averaging has been applied?
   (c) Are your tidal structures and prevailing wind conditions typical for

this time of year?

(d) What is your confidence in the data based on (1) intrinsic errors in your systems, and (2) operating difficulties during the campaign?

(e) Give nominal standard deviations for your amplitudes and phases. If they vary with height, display them on the figures.

2. PUBLICATION OF ATMAP RESULTS

The Hamburg Workshop will provide an opportunity for us to gather our thoughts on Middle Atmosphere Tides. I am currently thinking that we should aim for another early winter (early December 1983) and another early summer (late May 1984) campaign to provide a good data base on what appears to be relatively well behaved and characteristic solstice periods. The tentatively scheduled session on "Large-Scale Wave Dynamics" at the Kyoto MAP Symposium (November, 1984) will provide an additional opportunity for those able to attend to present their further interpretations of tidal behavior during these solstice periods. At this juncture (say, early 1985) it may be appropriate to approach a journal (perhaps JATP) to devote a special issue to ATMAP results, covering our 2 early summer and 2 early winter campaigns. I envision that many of the papers would involve intercomparisons between stations delineating symmetric/asymmetric, migrating/nonmigrating, and seasonal/latitudinal behaviors of middle atmosphere tides. Station pairs already beginning collaborations along these lines include Kyoto/Adelaide, Poker/Mawson, Saskatoon/Christchurch, Durham/Urbana, and the USSR network. Others are encouraged to do the same, and hopefully the availability of "ATMAP Campaign Reports" will help to initiate further collaborations. Single-station analyses involving tidal variability characteristics would also be extremely valuable. Of course, none of this precludes or should discourage anyone from publishing their ATMAP campaign data independently, at any time, and in any form they wish. The above is only intended as a guide to coordinate and unify our efforts.

ATTACHMENT 4.5

July 11, 1983

Dear

As you may know, efforts of the IAMAP/ICMUA Working Group on Tides in the Mesosphere and Lower Thermosphere during the past two years have centered around two coordinated tidal measurements campaigns, culminating in the workshop to be held in Hamburg this August. The Atmospheric Tides Middle Atmosphere Program (ATMAP) has been formed to coordinate additional campaigns of this type as part of the international Middle Atmosphere Program (MAP). It is envisioned that ATMAP will continue to exist as long as MAP measurements programs are active and until reduction and archiving of ATMAP data are complete. In light of this development it is necessary to reassess the role of the ICMUA Working Group.

After consulting with Prof. R. Roper, President of ICMUA, it has been decided that the WG will continue to coexist with ATMAP, but with emphasis on somewhat different and longer-term goals. These would include, for instance, development of models, standardization of data analysis techniques, and coordinating with activities of other ICMUA WGs, particularly Dr. Labitzke's newly formed WG, "Climatology of the Middle Atmosphere".

Since the scope and nature of the WG activities has changed, I have decided to dissolve the current membership and to re-issue invitations. Due to your recognized expertise in the area, you are invited to participate as a member of the WG with its newly defined scope of activities. However, the above goals are best achieved, I believe, by a relatively small core of individuals willing to devote real time and effort towards their fruition. Therefore, I hope that you accept this invitation with the understanding that you remain active and productive in WG activities. Expected efforts of members would include (1) helping to formulate perspectives of tidal analyses and modelling from which plans can be developed; and (2) volunteering to accept responsibility of a particular task associated with execution of a plan.

At the present time there are no deadlines to be met. Our work will continue at a rate set by all of our busy schedules and what we can accomplish through the mail, occasionally catalyzed by my prodding. We should make a point to interact on these matters at "meetings of opportunity". A milestone WG meeting might be possible at the IAGA Assembly at Prague in 1985 (ICMUA is tentatively scheduled to meet with IAGA in 1985).

If you are interested in actively serving as a member of the IAMAP/ICMUA Working Group on Tides in the Mesosphere and Lower Thermosphere, please fill out the enclosed questionnaire and send it to me.

Jeffrey M. Forbes
Department of Physics
Boston College
Chestnut Hill, MA 02167 USA

Otherwise I will assume you cannot make the necessary committment of time. Thank you for your cooperation.

Sincerely yours,

Jeffrey M. Forbes, Chairman
ICMUA WG on Tides in the Mesosphere
and Lower Thermosphere

QUESTIONNAIRE

ICMUA Working Group on Tides in the Mesosphere and Lower Thermosphere

NAME ______________________________

1. I am interested in actively participating in WG efforts in the following areas (please check one or more):

   A._____ Development of recommended method(s) of data analysis for the extraction of tides. Hopefully a small subgroup could, after review and approval by the full ICMUA WG, publish recommendations which would hereafter be adopted as a standard for researchers in the field.

   B._____ Development of a climatological model of tidal winds and temperatures in the mesosphere and lower thermosphere that may at some point be appropriate for inclusion, say, in an international reference atmosphere.

   C._____ Development of improved and/or recommended parameterizations of zonally-averaged winds and temperatures, and tidal forcing mechanisms, for use in theoretical models.

2. Concerning (B) above, please comment on as many of the following as possible:

   Given the data available and other problems such as variability, do you think it feasible that a meaningful climatological model of tides could be constructed?

   What would be the key parameters of the model? Should we emphasize vector averages or average amplitudes and phase vertical structures?

   To what extent could theory (e.g., Hough functions or their thermospheric extensions) be utilized?

   What form should the model take?

   Would the availability of such a model be of any value?

3. After addressing the questions in (2) above, one possibility is that we could divide into small subgroups each concentrating efforts on a particular latitude regime. We have Arecibo, Jicamarca, Jamaica, and Townsville in the vicinity of 15°, Kyoto, Adelaide, and Atlanta near 35°, Poker Flat and Scott Base at high latitudes (>65°), and a number of stations between about 45° and 55°. In addition, there exists the USSR network and a number of new facilities coming on line. Please comment:

ATTACHMENT 5. COLD ARCTIC MESOPAUSE PROJECT (CAMP) REPORT

E. Kopp

At the ESA Rocket/Balloon Symposium in Interlaken two meetings were held on April 13 and 15, 1983.

At the second meeting S. Solomon had proposed to us to use the data material for a study of mesospheric ion and neutral constituents, with special emphasis on the hydrogen chemistry (cf. Proposal: Ion and neutral constituents analysis).

The participants of the CAMP-meeting in Interlaken also decided to have another meeting around December 15, 1983 in Stockholm (organizer G. Witt). At this meeting we would like to have presentations of almost final results for positive ion composition, inferred minor constituents and for the optical data. From these results coordinated papers and abstracts for COSPAR 25 (June 27-29, 1984) in Graz for the CAMP-session will be planned. Detailed information for the Stockholm meeting will be distributed to you in 6-8 weeks. Information on CAMP will be mailed to all listed on the CAMP address list.

ATTACHMENT 6. REPORT ON THE MAP CLIMAT PROJECT PRESENTED AT THE MAP STEERING COMMITTEE MEETING, AUGUST 13, 1983

J. M. Russell

The goals of the CLIMAT project are to use available satellite data (1) to produce monthly and seasonal mean altitude versus latitude cross sections of temperature and constituents and (2) to develop a MAP document describing cross sections, accuracy and precision of the data, comparisons of the data with theory, and implications of the comparisons. The primary purposes of this activity are (1) to provide a convenient reference document summarizing observations, theory, and comparisons, and (2) to provide an aid for 2D model studies, a crude check for 3D model results, and improved background information for chemical and dynamical studies.

The study will cover the first year after the NIMBUS 7 launch (October 1981) and the first year after the SME launch (November 1981). The focus will be on chemical variables since temperature and derived dynamical quantities will be covered by a CIRA update activity led by Dr. Labitzke. Also, ozone will be included but not emphasized since the ozone climatology is being developed in another MAP project activity chaired by Dr. Heath. The report will include results from the SAMS experiment (N_2O, CH_4, CO, NO and H_2O), the LIMS experiment (O_3, NO_2, H_2O, and HNO_3), SAGE (O_3, NO_2, and aerosols), SAM II (aerosols), and SME (NO_2 and O_3). Temperature from LIMS, SAMS and SME will be included since it was measured at the same time as the constituents and it will be useful in chemistry calculations. The SBUV ozone profile data will be included to extend the 1979 data base after the LIMS experiment had ended. Help from the experiments has been solicited to provide data in the correct format and to provide a good description of data accuracy and precision.

The plan is to compile all the data at NASA, Langley by April, 1984, distribute it to the Project team, and prepare a first draft report by July. A two-day workshop will be held at the time of the Ozone Commission meeting in Greece to prepare a second draft, and the final report is to be complete in the winter of 1985.

ATTACHMENT 7. MINUTES OF THE FIRST GLOBMET MEETING HELD AT 1600 HOURS ON THURSDAY, MAY 12 AT THE INTERNATIONAL SYMPOSIUM ON GROUND-BASED STUDIES OF THE MIDDLE ATMOSPHERE, SCHWERIN, GDR

R. G. Roper, Chairman

Present were: Bull, Bencze, Ceplecha, Grisiger, Ivanov, Kingsley, de la Morena, Muradov, Neisser, Portnyagin, Roper, Rubtsov, Schminder, Sprenger, Velinov, Viskov, Weiss.

(1) Because of somewhat limited representation of the international meteor radar community, it was decided that Roper should continue to serve as Interim Chairman until the next GLOBMET meeting (with IAGA Division V, Working Group 2 at the IUGG Assembly in Hamburg, August, 1983).

(2) The Chairman recognized the appointment of Dr. O. O. Ovezgeldyev as chairman of the Soviet National Committee for GLOBMET.

(3) Rubtsov communicated the invitation extended by Dr. Babadzhanov, President of the Lenin Tajic State University, to hold a GLOBMET Symposium in Dushanbe, Tajicstan, in 1985.

Since ICMUA will meet with IAGA in Prague in 1985, the Chairman suggested that it might be convenient to hold the Dushanbe meeting either just before or after the IAGA Assembly.

(4) It was proposed that an International Expedition under the sponsorship of GLOBMET be undertaken to an equatorial site by the end of 1985, to conduct at least one, and possibly two years of continuous meteor wind radar measurements.

(5) A specific site will have to be arranged by international agreement, possibly through UNESCO or a similar UN organization. If such an agreement can be reached, it may be possible for the Hydrometeorological Service of the USSR to provide one or two portable radars. Suggested sites were Natal, Brazil; Jicamarca, Peru; Singapore; Africa.

(6) It was proposed that official encouragement from GLOBMET should be given to the Australian attempt to operate a partial reflection drift station on the Western Pacific island of Nauru.

(7) The concept of data exchange through access to already published data (in report form, or in the open literature), in addition to data archived at the World Data Centers, was discussed. It was agreed that the Chairman would prepare and circulate a request for a bibliography of such publications, together with a listing of dates for which data are available, to all known meteor radar and radio drift stations. The results of this survey would then be incorporated in a "Handbook of Published Data" to be distributed amongst the respondents, with notice of its existence appearing in a MAP Newsletter.

The GLOBMET calendar for 1984 was discussed, and a tentative schedule agreed upon (see attached). Any suggestions for changes or additions to this calendar were to be requested from the international community (to be communicated to the Chairman).

It was also suggested that a list of GLOBMET participants should be compiled, together with a tentative operating schedule from each, which would help in program coordination.

GLOBMET CALENDAR

1983: 1. December 6, 1983 - January 6, 1984
1984: 2. March 15 - April 15
3. May 3 - May 10*
4. July 15 - August 15
5. October 16 - 26**

* η Aquarids } Priority intervals for astronomers
** Orionids }

In keeping with previous GRMWSP/CTOP policy, all stations are encouraged to operate on Wednesdays, or periods surrounding Wednesdays, if they are unable to operate continuously.

For stations operating once a month the suggested procedure is to center operations on the Priority Regular World Day each month.

MESOPAUSE LEVEL DYNAMICS DATA SURVEY

Contact Person:

Name:
Address:

Country:
Telex Number:

Type(s) of wind data available: Meteor ( ), Partial reflections ( ), Radiowave ( ), Coherent Scatter ( ), Incoherent scatter ( ), Other ____________

Zonal: Prevailing wind ( ), Diurnal ( ), Semidiurnal ( ), Hour by Hour ( )
Meridional: Prevailing wind ( ), Diurnal ( ), Semidiurnal ( ), Hour by Hour ( )
Bibliography of Data Publications: List on a separate sheet
Intervals for which published data available: List on a separate sheet
Please return, with GLOBMET Participation Survey, to:

Dr. R. G. Roper, School of Geophysical Sciences,
Georgia Tech, Atlanta, Georgia 30332 USA

GLOBMET PARTICIPATION SURVEY

Contact Person:
Name:
Address:

Country
Telex Number:

Do you intend to participate in GLOBMET? (see MAP Handbook No. 7, page 20 for details of this project)

If yes, in which of the planned campaigns (see enclosed calendar) will you participate? (Please circle) 1 2 3 4 5

On which other dates during 1984 do you plan to be operational? Please list.

ATTACHMENT 8. THE MAP/GLOBUS CAMPAIGN 1983

D. Offermann

ABSTRACT

An international campaign of ground-based, airplane, balloon and rocket experiments is prepared for September 1983 at Aire-sur-l'Adour (France) as part of the Middle Atmosphere Program (MAP). The campaign is centered on the determination of stratospheric ozone and NO_x constituents, atmospheric dynamics, and solar irradiation. The scientific objectives of the campaign are described. The experimental set-up is given as it presently stands. A schematic flight sequence of sondes and balloons is also presented.

1. INTRODUCTION

MAP/GLOBUS is a project of the Middle Atmosphere Program (MAP). The acronym stands for "Global Budget of Stratospheric Trace Constituents". Besides laboratory and theoretical work, activities are centered on integrated field measurements. An international campaign of ground-based, airplane and balloon experiments is prepared for September 1983 at Aire-sur-l'Adour, France. Nine highly instrumented balloon payloads are to be launched during the campaign from this place. Their measurements will be co-ordinated with those of a network of eleven ground stations in Western Europe. The same holds for 7 ozone sonde release stations. A Caravelle airplane will be operated in connection with one of the balloons. A few meteorological rockets will be launched from Southern Spain and Western France. Data from a number of satellite experiments are available, too.

2. SCIENTIFIC OBJECTIVES

The major scientific objectives of the campaign are the accurate measurement of ozone and its short-term variability together with the determination of members of the NO_x family as NO, NO_2, NO_3, N_2O_5, and HNO_3. Related important solar fluxes (including scattered fluxes) shall be measured as much as possible. Other important trace species (H_2O) shall be determined simultaneously.

A further scientific objective is the study of atmospheric dynamics, especially of the meteorological background. Therefore special analysis will be performed of the data of respective network stations and satellites. Local wind and turbulence measurements will also be performed.

The detailed objectives of the ozone measurements are the following:

(1) Improvement of measuring accuracy of ozone instruments. This shall be achieved by careful instrument calibration before and after the balloon flights. It is intended to use the same ozone source for calibration of different in situ measuring instruments. As concerns Brewer/Mast ozone sondes, it is planned to use the same preparation and handling procedure at all network stations. Ground-based Dobson spectrometers shall be checked before the campaign.

(2) Determination of accuracy of ozone instruments. For this purpose various in situ measurements on the same gondola shall be compared (gondola G3, see Table 2). Comparison of in-situ experiments on two gondolas flying at short distance shall also be tried (G2a and G8, details of the flight sequence are given below). Different remote sensing measurements made on the same gondola (G3) will be compared, too. It shall further be tried to check remote sensing instruments versus in situ measurements. The infrared experiment on gondola G1 and the microwave experiment on G8 are suitable for this, as they employ azimuth control systems. Finally, comparison of balloon measurements to those taken from

the ground at Observatoire de Haute Provence and at Floirac could be tried if balloon trajectories are favourable.

(3) Determination of O_3 background field. The temporal and spatial structure of the ozone distribution shall be determined by a network of ground-based stations (see Table 1) and by regular releases of ozone sondes from a network of respective stations (see Table 3). Satellite ozone data shall also be used.

(4) Reference of balloon O_3 measurements to O_3 background field. For this purpose each of the balloon gondolas (except the ion spectrometer payloads) will include at least one standard Brewer/Mast sonde. For the same purpose there will be launches of extra Brewer/Mast sondes from four network stations simultaneously with these balloons.

(5) Time series study of height and absolute value of maximum O_3 density. There appears to be a discrepancy between models and experiments as to the altitude at which the ozone maximum occurs. Even more important, the experiments indicate a 20% lower O_3 density around that altitude than the models. This important difference shall be checked by respective balloon flights (G1 through G5, G8) together with Brewer/Mast sondes and lidar measurements.

(6) Study of diurnal variation of O_3. The diurnal variations of O_3 density in the stratosphere are not large (several percent at maximum). They are nevertheless important as they are quite different at 40 km and at the stratopause (and above). This is due to the transition from a NO_x and Cl_x controlled atmosphere to a control by HO_x. The diurnal variations shall be studied during a high altitude flight (40 km) of gondola G3, which shall be flown twice during the campaign.

(7) Atmospheric dynamics. Ozone measurements are also intended to support the determination of atmospheric dynamics during the campaign. This holds for steady atmospheric conditions as well as for possible disturbances. Contributions are expected from the continuous operation of the ground-station network, from satellite data, and from regular and alert releases of ozone sondes from network stations (see below).

The detailed objectives of the NO_x measurements are as follows:

(1) Determination of accuracy of NO_x instruments. Similarly, as with the ozone measurements discussed above, this shall be achieved by intercomparison of balloon measurements. Respective in situ experiments for the determination of NO and/or NO_2 are on gondolas G2a and G8. Suitable remote sensing measurements are taken from gondolas G2b, G4, and possibly G5. Comparison of balloon and ground-based measurements is also possible. Measurements of gondola G4 will be supported by a similar experiment on a Caravelle airplane.

(2) Study of diurnal variation of NO_x. Measurements of NO_x during a full diurnal cycle would be very important for the understanding of NO_x photochemistry. Part of this can be achieved during the campaign by extended measurements of NO_2 and NO, and nearly simultaneous measurements of NO, NO_2, NO_3 and possibly N_2O_5 (G1, G2a, G2b, G4, G5, G8).

As there are NO_2 experiments on all of these six gondolas, some hints as to short-and medium-term variability of NO_2 may also be expected.

(3) NO_2/NO and HNO_3/NO_2 ratios. Simultaneous measurements of NO and NO_2, and HNO_3 and NO_2, respectively, will yield these ratios. The NO_2/NO measurements will in part be accompanied by solar flux and ozone measurements. Model interpretation of the NO/NO_2 ratio would require measurement accuracies well below 10%. This is presently not available. Nevertheless, such measurements are

considered important as long as discrepancies between models and experimental results are a factor of 2 or larger.

Interpretation of the HNO_3/NO_2 ratio is difficult because of the relatively long lifetime of HNO_3. This measurement therefore should be taken under undisturbed stratospheric conditions.

(4) HNO_3 mixing ratio. There is still a considerable discrepancy between calculated and measured HNO_3 mixing ratios at altitudes above 30 km. HNO_3 densities can be measured by gondolas G1, G2b, G4 and -- at lower accuracy -- by G7 (G6?). Respective results shall be intercompared.

3. EXPERIMENTAL SET-UP

(a) Ground-Based Experiments

The eleven ground stations participating in the campaign are listed in Table 1. All stations will measure continuously in September 1983, if not stated differently in Table 1, and if weather allows. To improve the accuracy of total ozone measurements, the Dobson spectrometers will be checked before the campaign.

A total of 16 instruments will be operated. Main emphasis is on ozone and NO_x determination. Important measurements of atmospheric structure and dynamics will also be taken. Maximum distance between two neighboring stations is about 900 km, but most stations are much closer to each other (100-500 km).

(b) Balloons and Airplane

Nine major balloon gondolas are to be flown during the campaign (two of them twice). Gondolas contain between two and nine different experiments. Experimental arrangement fits the above scientific objectives as much as possible. Details as to the gondola instrumentation and flight conditions are given in Table 2 (modifications are still possible).

A grille IR-spectrometer is to be flown on a Caravelle airplane (F. Karcher, CNRM). The instrument is able to measure column densities of O_3, N_2O, NO_2, HNO_3, (and also of H_2O, HCl, HF, COS, CO, CH_4). The airplane is available during the first half of September 1983 for an intercomparison measurement with the grille spectrometer on gondola G4.

(c) Ozone Sondes

A network of seven ozone sonde release stations will be operated during the campaign. Up to 180 ozone sondes are available. These sondes (mostly Brewer/Mast sondes) shall be flown from the various stations for three purposes (in accordance with the above-discussed scientific objectives):

(1) To establish the O_3 background field by regular launches from all stations every Monday, Wednesday, and Friday during the whole campaign. Launch time is 12:00 UT.

(2) Sondes will be flown on alert together with balloons G1, G2a, G2b, G3, G4, G5, G8 from the stations El Arenosillo, Haute Provence, Hohenpeissenberg, and Uccles. One sonde will be launched from each station, except for balloons G3 and G5: for each of these two balloons there will be 3 Brewer/Mast flights from Haute Provence. As said above, each of these balloons carries at least one Brewer/Mast sonde itself. In this way ozone densities during balloon flights can be referred to the O_3 background field.

(3) In case of peculiar atmospheric events (like passage of a cold front) additional ozone sondes will be released on alert in a coordinated way from the stations mentioned above and from Biscarosse. Launches shall be performed at 6 hourly intervals, starting 2 hours before the event, and continuing until it ends.

The network stations and the number of ozone sondes available are summarized in Table 3. All Brewer/Mast sondes shall be prepared in the same way to guarantee comparability of the data.

(d) Radiosondes and Rockets

Radiosonde and rocket measurements will supply basic information about atmospheric dynamics during the campaign. This will be used in conjunction with the above-mentioned ground-based measurements and the satellite data (see below).

Routine radiosonde data will be used for stratospheric weather forecast during the campaign, and for 3D trajectory analysis afterwards. Twenty-seven radiosonde stations are available for these purposes in Western Europe. Extra radiosondes will be launched from Bordeaux together with the balloons. These are especially intended to improve the temperature determinations. They will be tracked by radar and therefore will have accurate altitude data. A total of ten extra sondes are available.

Twelve Superioki rockets with Data Sondes will be launched from El Arenosillo, Spain (Cisneros, CONIE). They will measure temperatures and winds from 55 km to 20 km. Launches will be coordinated with major balloon flights. Further meteorological rockets will presumably be launched from Les Landes and/or Brest.

(e) Satellite Measurements

Data from a number of satellites can be used for various aspects of the campaign. Ozone densities or O_3 column densities as well as temperatures are measured by NIMBUS 7, NOAA 6 + 7, DMSP (Block 5D-2), and SME. Futhermore, on NIMBUS 7 there are experiments for measurements of solar radiation, N_2O, CH_4, and H_2O. SME also takes measurements of solar UV irradiation, NO_2, and possibly H_2O.

4. FLIGHT SEQUENCE

Considering the scientific objectives as well as technical and logistical constraints, a preliminary flight sequence was set up as shown in Table 4. It will be tried to launch the balloons in groups as close together as possible. Table 4 also shows the flights of extra Brewer/Mast sondes, extra radiosondes, and rockets. Most ground stations are operated continuously as said above. The flight sequence shown will be started early in September 1983, as soon as turn-around conditions are present at Aire-sur-l'Adour. All times given in Table 4 are approximate ones.

Table 1. Ground-based experiments.

STATION	EXPERIMENTER (INSTITUTION)	TECHNIQUE/PARAMETER
El Arenosillo 37°N, 7°W	Cisneros (INTA)	Dobson / O_3
Biscarosse 44°N, 1°W	Lovisa (EERM)	Dobson / O_3
Aire-sur-l'Adour 44°N, 0°W	Matthews/Flentje (CNRS/MPI)	Sol. abs. / O_3, NO_2
Floirac 45°N, 2°W	Baudry/de La Noe (CNRS)	Microwave / O_3, CO (during balloon flights: continuous measurements; other days: 11 - 15 UT approx.)
Uccles 51°N, 4°E	De Muer (IRM)	Dobson / O_3
Haute Provence	Chanin (CNRS)	Lidar / T, aerosol
44°N, 6°E	Crochet (Univ. Toul[illegible])	ST-Radar / T , $\vec{v}$
	Jouve/March (FS Reims)	IR spectrometer / NO, HCl, HF Dobson / O_3 Umkehr / O_3
	Megie/Pelon (CNRS)	Lidar / O_3
Jungfraujoch 46.5°N, 8°E	Zander (Univ. Liege)	IR spectrometer / HR, HCl, CH_4 CO, NO, N_2O, H_2O, CO_2, O_3 total, HNO_3?
Zugspitze 47.5°N, 11°E	Rothe (MPI)	Lidar / O_3
Garmisch-P 47.5°N, 11°E	Reiter (FhG)	Lidar / aerosol (with co-ordinated radiosonde and ECC ozone sonde flights)
Hohenpeissenberg 48°N, 11°E	Attmannspacher (DWD)	Dobson / O_3 Brewer / O_3, SO_2 (O_3 Umkehr)
Frascati 42°N, 13°E	Fiocco (Univ. Roma)	Lidar / aerosol, trace gases (?)

Table 2. **Balloon gondolas.**

IDENTIFICATION NUMBER	EXPERIMENTER (INSTITUTION)	TECHNIQUE	GONDOLA WEIGHT	FLIGHT CONDITIONS
G1	Ripple/Offermann (Univ. Wuppertal)	IR spectrometer (limb scan, emission)	350 kg	40 km float altitude: day/ night
	Attmannspacher/ Mathews(DWD/CNRS)	Brewer/Mast (O_3)		
G2a	Fabian/Flentje (MPI)	Chemoluminescence (NO, NO_2)		day flight, 35 km float altitude, valve descent and ascent around noon float into night, slow descent
	Attmannspacher/ Mathews(DWD/CNRS)	Brewer/Mast (O_3)		
	Kondo (Univ. Nagoya0	Chemoluminescence (NO)		
G2b	Pommereau (CNRS)	vis. + UV spectrometer (NO_2, O_3)		35 km float altitude, 2 ascent 2 descent measurements, valve operation near noon
	P. Simon (IAS)	UV photometer (O_3) albedo spectrometer		
	Attmannspacher/ Matthews(DWD/CNRS)	Brewer/Mast (O_3)		
G3	Matthews/Aimedieu (CNRS)	Chemoluminsecence (O_3)	300 kg	two day flights, valve descent around noon (first flight: 35 km second flight: 40 km)
	Matthews/Attmannspacher (CNRS/DWD)	3 x Brewer/Mast (O_3)		
	Robbins (NASA)	Dasibi sonde (O_3)		
	Cisneros (INTA)	30 decoloration tubes (O_3)		
	Perov (TSAO)	Rhodamin-B (O_3)		

Table 2. Continued.

IDENTIFICATION NUMBER	EXPERIMENTER (INSTITUTION)	TECHNIQUE	GONDOLA WEIGHT	FLIGHT CONDITIONS
	P. Simon (IAS)	solar UV abs. (O_3)		
	Komhyr (NOAA)	ECC (O_3)		
	Barat (CNRS)	anemometer (3D-wind)		
G4	Louisnard (ONERA)	Grille spectrometer	430 kg	40 km float altitude, sunrise and day flight
	Roscoe (Univ. Oxford)	PMR (NO, NO_2, N_2O_5)		
	Attmannspacher/Matthews(DWD/CNRS)	Brewer/Mast (O_3)		
G5	Rigaud (Univ. P.+M. Curie)	star occultation (O_3, NO_3, NO_2?) aerosol	350 kg	40 km float altitude, night; no moon
	Attmannspacher/Matthews(DWD/CNRS)	Brewer/Mast (O_3)		
G6	Arnold (MPI)	ion spectrometer		
G7	Arijs (IAS)	ion spectrometer	340 kg	day/night flight, valve; slow descent
	Ackerman (IAS)	"Cavente"		
G8	Helten (KFA Juelich)	matrix isolation (NO_2, HO_2) Brewer/Mast (O_3)	400 kg	two day flights, 35 km float altitude, valve slow descent
	Hans/Schurath (Univ. Bonn)	N_2O photolysis		
	Harries (RAL)	microwaves (emission O_3, H_2O)		
	Junkermann (KFA)	UV-photometers (solar flux, 290-315 nm; 300-420 nm)		
	Attmannspacher/Matthews(DWD/CNRS)	Brewer/Mast (O_3)		

Table 3. Ozone sonde network.

STATION	EXPERIMENTER (INSTITUTION)	TYPE OF SONDE	NUMBER OF LAUNCHES
El Arenosillo 37°N, 7°W	Cisneros (INTA)	ECC	≤ 30 Mo/We/Fr + 8 on alert
Biscarose 44°N, 1°W	Lovisa/Karcher (EERM/CNRM)	Brewer/Mast	Mo/We/Fr (and 4 on alert)
Aire-sur-l'Adour 44°N, 0°W	Attmannspacher/ Matthews (DWD/CNRS)	Brewer/Mast	10 (G1 - G5, G8)
Uccles 51°N, 4°E	DeMuer (IRM)	Brewer/Mast	≤ 40 Mo/We/Fr + on alert
Haute Provence 44°N, 6°E	Megie (CNRS) (+ Attmannspacher)	Brewer/Mast	30 (+ 10) Mo/We/Fr + on alert
Cagliari/Elmas 39°N, 9°E		Brewer/Mast	1/week (Wednesday)
Hohenpeissenberg 48°N, 11°E	Attmanspacher (DWD)	Brewer/Mast	≤ 40 Mo/We/Fr + on alert

Table 4. Flight sequence.

LAUNCH TIME (UT)		VEHICLE
Day 1,	04:30 h	Gondola G3
"	05:30 h	radiosonde (at Bordeaux)
"		6 ozone sondes at (El Arenosillo, Haute Provence, Hohenpeissenberg, Uccles)
"	12:00 h	rocket (Superloki at El Arenosillo)
"	23:30 h	Gondola G1
"		4 ozone sondes
Day 2,	03:00 h	radiosonde
"	03:30 h	rocket
"	04:00 h	Gondola G8
"		4 ozone sondes
"	08:30 h	radiosonde
"	09:00 h	rocket
"	10:00 h	Gondola G2a
"		4 ozone sondes
"	19:00 h	rocket
Day 5,	22:30 h	Gondola G5
"		6 ozone sondes
Day 6,	01:30 h	radiosonde
"	01:30 h	Gondola G4
"		4 ozone sondes
"	02:00 h	rocket (with G5)
"	04:30 h	radiosonde
"	05:00 h	rocket
"	05:30 - 06:30 h	airplane
"	08:00 h	Gondola G2b
"		4 ozone sondes
"	12:00 h	rocket
Day 10,	06:30 h	Gondola G8 (second flight)
"		4 ozone sondes
"	11:30 h	radiosonde
"	12:00 h	rocket
"	14:45 h	Gondola G7
"	17:30 h	radiosonde
"	18:00 h	rocket
Day 11,	05:00 h	Gondola G3 (second flight)
"	07:30 h	radiosonde
"		6 ozone sondes
"	12:00 h	rocket
Day 12,		Gondola G6

ATTACHMENT 9. GLOBAL OBSERVATIONS AND STUDIES OF STRATOSPHERIC AEROSOLS (GOSSA) ANNUAL REPORT

M. P. McCormick, Coordinator

The March/April 1982 eruptions of the volcano El Chichon in Mexico (17.3°N, 93.2°W), have provided the GOSSA project with an excellent opportunity to make significant contributions to atmospheric and climate research. The eruptions have produced the largest stratospheric aerosol perturbation since at least the 1963 eruption of Agung and perhaps the largest in this century.

As coordinator of GOSSA, I have been establishing contacts with various investigators throughout the world community, informing investigators of measurement opportunities, compiling a worldwide data set, and carrying out large field programs to collect data on El Chichon.

A "Dear Colleague" letter (copy attached 9.1) was sent in February 1983 to investigators throughout the world to solicit their support in compiling a table of information that describes their work and results on El Chichon. The table is shown in Figure 1. Over 30 groups responded. This compilation is almost completed; example pages are shown in Figures 2 and 3.

In addition, over the past year, NASA has sponsored five flight campaigns to obtain data on El Chichon; Figure 4 lists these. I participated in four of the five campaigns and in my role as coordinator of GOSSA, informed the community of the details of these campaigns so that the worldwide data set could be enhanced for future analysis. A "Dear Colleague" letter that describes the May 1983 flight is attached as Attachment 9.2. These missions involved not only the aircraft flights with it numerous sensors, but also coordination with balloon launches, high altitude aircraft rendezvous, and satellite simultaneous measurements.

Much of the El Chichon data will be presented at the IUGG meeting during the special session on El Chichon, Friday and Saturday, August 19-20.

In order to disseminate actual data and announcements of campaigns to researchers not on the GOSSA mailing list, I have been reporting information, and suggesting that others report information, to the Smithsonian Institution's Scientific Event Alert Network (SEAN) Bulletin. This bulletin is published monthly and can be obtained at a reasonable cost (telephone (202)-357-1511, telex 89599 SCINET WSH). Excerpts are printed in EOS published by the American Geophysical Union ((800) 424-2488).

Finally, I am attempting to organize a workshop on El Chichon (similar to the one on Mount St. Helens) in the winter or spring of 1984.

ATTACHMENT 9.1. GOSSA "DEAR COLLEAGUE" FEBRUARY 1982 FOR COMPILING WORLDWIDE EL CHICHON DATA SET

Dear Colleague:

Over the past three years we have been experiencing a period of intense volcanic activity with probably the largest enhancement to the stratospheric aerosol that has occurred in our lifetime. Starting with the eruption of Mt. St. Helens in May 1980, a series of violent eruptions have occurred, which include Ulawun in October 1980, Alaid and Pagan in 1981, the "mystery cloud" in January 1982, and the largest, the El Chichon eruption in April 1982.

As coordinator of the Global Observations and Studies of Stratospheric Aerosols (GOSSA) project under the Middle Atmosphere Program (see enclosed announcement and terms of reference), I am compiling a summary of the effects of El Chichon on the stratosphere. The enclosed Table 1 outlines parameters of interest. Some of this information is presently being obtained by NASA in a measurement program to investigate the possible climate effects and effects to remote sensors of the El Chichon stratospheric cloud. The program to date has drawn on the series of measurements listed in Table 2.

The objectives of the GOSSA project are to: (1) establish contact with active groups involved in the measurement of aerosol properties; (2) disseminate alerts corresponding to transient events and coordinated measurement programs; (3) communicate the existence of data sets and their availability to interested researchers; and (4) organize workshops.

As part of these GOSSA objectives, I am requesting your assistance in expanding Tables 1 and 2 by providing a listing of your measurements and the results of your measurements and analyses. Please provide a footnote for each entry in Table 1 that describes the source of the data, i.e. journal publication or private communication, etc. The values have changed with time and altitude, so you may want to list your results by month or season and altitude. Please include with your response hard copies of your journal articles, reports, etc. A bibliography will be developed.

It is anticipated that a workshop on El Chichon will be held in the fall of 1983 which will produce a summary report probably published by NASA. This document will satisfy part of the GOSSA objective of information exchange and your contributions are invited and will be acknowledged. Please let me know if you would be interested in attending and presenting your results at such a workshop.

M. Patrick McCormick
Coordinator, GOSSA

Table 1. Properties and effects of the El Chichon stratospheric cloud.

PARAMETER
Measurement date and location (lat. and long.)
H_{max} of layer
H peak
ΔH, layer thickness
σ_e (km^{-1}), extinction
R_λ, lidar ratio
N_{12}, dustsonde channel ratio
CN count
Time to peak; decay time
n(r), size distribution
$\bar{r}$, mean radius
Refractive index (real, imaginary)
$\Delta\delta(\lambda)$, optical depth
Fluxes (λ)
$\bar{\omega}_o$, single scat. albedo
g asymmetry factor
Mass
Composition
ΔT (strat); ΔT (surface)
SO_2; OCS, H_2S
H_2O, O_3
Other gases
Global circuit time

Table 2.

MEASUREMENT	LOCATION	DATE	PARAMETERS	ALTITUDE
SAM II satellite	64-80°N 64-80°S	Operational 28 profiles/day	σ_E (1.0μm)	To 30 km
A/C lidar (Electra)	42°N-12°N	July 1982	R (0.6943)	10-30 km
A/C lidar (Electra)	46°N-46°S	Oct./Nov. 1982	R (0.6943) δ(λ) 0.38- 4.0 μm diffuse flux	10-30 km Column Above A/C
A/C (Convair 990)	5°S-53°N	Dec. 1982 Jan. 1983	δ(λ) visible 4-12 μm diffuse flux	Column Above A/C
A/C lidar (Electra)	37°N-85°N	Jan./Feb. 1983	R (0.6943) δ(λ), visible	10-30 km Column Above A/C
Dustsonde	40°N	1968-present	N(r>), 0.01, 0.5, 0.25	0-30 km
	23°N	Oct. 1982	N(r>), (0.01, 0.15, 0.25, 0.95, 1.2, 1.8) & boiling point	0-30 km
48-inch lidar ground based	37°N, 76°W	1973-present	R (0.6943 μm)	10-35 km

ATTACHMENT 9.2. GOSSA "DEAR COLLEAGUE" DESCRIBING MAY 1983 FLIGHT MISSION

Dear Colleague:

NASA is preparing to conduct a field mission aboard the CV-990 to characterize the present spatial distribution of stratospheric aerosols produced from the 1982 eruptions of El Chichon. The CV-990 aircraft will depart Ames Research Center on the evening of 8 May 1983 and return on the evening of 20 May 1983. The present schedule is given in Table 1 (enclosed). The experiments to be conducted, and their principal investigators, are listed in Table 2. Latitudes from approximately 70°N to 60°S, mostly over the Pacific Ocean longitudes, will be covered.

You are being made aware of this field mission in the event that your schedule permits you to make stratospheric aerosol or supporting measurements from your home site during this period of time, thereby maximizing the worldwide data set for future studies.

In addition to the above Pacific mission, a number of flights will be conducted over the continental U.S. from approximately April 28 to 7 May 1983. The exact times and locations of these flights are dependent upon a series of large balloon launches from Palestine, TX. Coordination with these aircraft flights is also encouraged especially for continental U.S. investigators. Flight details can be obtained from the undersigned or from Dr. David Thompson ((415) 965-5536, FTS 448-5536) the science team leader for both the continental U.S. and Pacific flight missions.

I hope that your schedules permit coordinated data gathering during these missions and I look forward to your future correspondence and cooperative activities.

Sincerely,

M. Patrick McCormick
(804)-865-2065
FTS 928-2065

Table 1. Schedule for NASA CV-990 flight mission for May 1983*.

DATE MAY 1983	LEAVE (LAT., LONG.)	TIME (Z)	ARRIVE (LAT., LONG.)	TIME (Z)
9	Moffett Fld., CA (37°N, 122°W)	0630	Elmendorf AFB, AL (61°N, 150°W)	1625
11	Elmendorf AFB, AL	1440	Hickham AFB, HI (21°, 158°W)	2050
12	Hickham AFB, HI	1415	Pago Pago (14°S, 171°W)	2015
14	Pago Pago	0135	Christchurch, NZ (44°S, 173°E)	0750 (5/15)
18	Christchurch, NZ	0000	Christchurch, NZ	0520
19	Christchurch, NZ	0055	Pago Pago	0550 (5/18)
18	Pago Pago	2340	Hickham AFB, HI	0455 (5/19)
20	Hickham AFB, HI	2055	Moffett Field, CA	0300 (5/21)

*As of 4/26/83

Table 2. CV 990 experiments for May 1983 flight mission.

EXPERIMENT	PRINCIPAL INVESTIGATOR	AFFILIATION
Lidar (2 λ's)	M. P. McCormick	NASA Langley
Diffuse/Direct Solar Radiometer	J. J. DeLuisi	NOAA Boulder
IR Filter Wedge Spectrometer	F. C. Witteborn	NASA Ames
Net Flux Radiometer	F. P. J. Valero	NASA Ames
Visible Sun Photometer	J. D. Spinhirne	NASA Goddard
SO_2/ O_3 Spectrophotmeter	W. F. J. Evans	AE Canada

Figure 1. Properties and effects of the El Chichon stratospheric cloud.

PARAMETER
Measurement date and location (Lat. and Long.)
H_{max} of layer
H peak
ΔH, layer thickness
σ_e (km^{-1}), extinction
R_λ, lidar ratio
N_{12}, dustsonde channel ratio
CN count
Time to peak; decay time
n(r), size distribution
$\bar{r}$, mean radius
Refractive index (real, imaginary)
$\Delta\delta$ (λ), optical depth
Fluxes (λ)
$\tilde{\omega}_o$, single scat. albedo
g asymmetry factor
Mass
Composition
ΔT (strat); ΔT (surface)
SO_2, OCS, H_2S
H_2O, O_3
Other gases
Global circuit time

Figure 2.

NAME/AFFILIATION	RESPONSE DATE	PARAMETERS OF MEASUREMENT	RESULTS	REMARKS
R. Reiter Frauhofer Inst. for Atmospheric Environmental Res. FRG	3/10/83	(1) 47.5°N, 11.0°E from 1976 to present, 5 1-Cm ground-based lidar at 0.6943 μm 7-35 km. (2) Optical depth at 550 nm	(1) On Aug. 1, lidar ratio research 22.4 at 24.6 km. (2) Optical depth on Aug. 1, 0.06- on Dec. 26 ∿.13.	(1) "The stratospheric aerosol increases in Feb. and Mar., 1982." GRL, 9, 858-859, 1982. (2) Would like to attend Workshop. (3) Hope to cooperate with another group.
J. L. Rasmussen National Weather Service	3/18/83	(1) Provision of strato-spheric analyses and data products, including ozone. (2) Study temperature change in the stratosphere due to El Chichon eruption.		(1) Provide names and addresses of people to contact
E. Raschke Koln	3/14/83	No measurement of El Chichon.		Will keep track of such events in future.
G. Megie and P. H. Flamant Paris	4/20/83	(1) 44°N, 6°E Lidar measurement at 532 nm. (2) Layer peak and lidar ratio at maximum.	(1) In Dec. Jan. Optical thickness can reach 0.25.	
C. F. Sechrist, Jr. Univ. of Illinois	2/22/83			MAP publication committee would consider publishing the workshop report in a volume of the Handbook for MAP. Answered on May 4 -- told him I will consider it.
W. Attmannspacher Hohenpeissenberg		Using Dobson and Brewer spectrophotometer to measure ozone at 47.48°N, 11.01°E from 1967 to present.		No enclosures attached to letter.

Figure 3.

NAME/AFFILIATION	RESPONSE DATE	PARAMETERS OF MEASUREMENT	RESULTS	REMARKS
R. Leifer Environmental Measurements Lab. New York	4/11/83	(1) Mass (2) Composition (3) OCS (4) CO, CO_2, CH_4, Freons, CH_3CCl_3		(1) Will attend workshop if time doesn't conflict. (2) Papers will be submitted to GRL and JGR
G. Fiocco Instituto di Fisica dell'Atmosfera	4/15/83	Lidar measurements at Frascati		(1) Will attend workshop and participate in writing the report. (2) Now in the process of writing summaries of lidar measurement.
L. Chanin Centre National de la Recherche Scientifique	3/16/83	Aerosol data as a byproduct of measuring temperature by lidar from Rayleigh scattering		(1) Will supply an isocontour density map of aerosols very soon. (2) Will present data at El Chichon workshop.
J. J. DeLuisi ERL, NOAA	5/18/83	GMCC Observational Data 1. Mauna Loa 19N,155W a) Ruby lidar b) refractive index c) N (r) d) $\Delta\tau$ at 4 wavelengths e) flumes at 8 wavelengths f) asymmetry factor g) mass h) ΔT i) ozone	1. Mauna Loa a) H peak 27-28 km until Dec. 82; peak 22 km after Dec. 82. b) lidar ratio 350 in 4/82 to 8 in 4/83 c) N (r) lognormal with flat peak .3 - .4 μm d) $\Delta\tau$=0.6→0.07 from 5/82 to 5/83 e) Asymmetry factor = 0.78 June and July '82 f) Mass = 0.06 gm/m^2 column g) ΔT = 2 to 4°C near 25 km July and Aug. '82	
		2. South Pole a) $\Delta\tau$ at 4 wavelengths	2. South Pole a) $\Delta\tau$ increase of 0.02 above background during summer 82-83	
		3. Barrow, Alaska (72N,157W) a) $\Delta\tau$ at 4 wavelengths	3. Barrow, Alaska a) $\Delta\tau$ at 0.2 above background, Spring '82	
		4. Boulder, CO (40N,104W) a) $\Delta\tau$ at 4 wavelenghts b) Broadband pyranometer and pyrheliometer.	4. Boulder, CO $\Delta\tau$ values are above background	

Figure 4. El Chichon flight campaigns.

DATE	AIRCRAFT	FLIGHT PATH	LAT. COVERED
July 1982	Electra	New York to coast of Venezuela	42°N to 12°N
Oct./Nov. 1982	Electra	North Dakota to Southern Chile	46°N to 46°S
December 1982	Convair 990	Alaska to Panama	53°N to 5°S
Jan./Feb. 1983	Electra	Florida to Greenland	25°N to 76°N
May 1983	Convair 990	Alaska to South of New Zealand	72°N to 56°S

ATTACHMENT 10. GRATMAP

The first meeting of the GRATMAP (Gravity Waves and Turbulence in the Middle Atmosphere Program) Steering Committee will be held during the XVIII General Assembly in Hamburg, Federal Republic of Germany. The present membership of the Steering Committee is as follows:

Dr. B. B. Balsley	USA
Prof. S. A. Bowhill	USA
Dr. M.-L. Chanin	FRANCE
Prof. D. C. Fritts	USA
Dr. M. A. Geller (Coordinator)	USA
Dr. J. Klostermeyer	FRG
Prof. R. S. Lindzen	USA
Prof. A. H. Manson	CANADA
Prof. H. Tanaka	JAPAN
Dr. J. Teitelbaum	FRANCE
Dr. R. A. Vincent	AUSTRALIA
Dr. R. F. Woodman	PERU
plus member(s) to be determined	USSR

One purpose of this meeting is to discuss the conclusions of the SCOSTEP/URSI/MAP Meeting on Technical Aspects of MST Radar that was held in Urbana, Illinois, during the period May 23-27, 1983, and the U.S. Agency sponsored Workshop on Gravity Waves and Turbulence in the Middle Atmosphere to be held near Fairbanks, Alaska during the period July 18-22, 1983. The other purpose of this meeting is to plan future activities of GRATMAP. These may include recommending research activities to MAP investigators, holding MAP workshops and/or symposia on the subject, or other activities that will advance our knowledge of middle atmosphere gravity waves and turbulence and their interactions with large scale middle atmosphere dynamics and structure.

ATTACHMENT 11. MAP PROJECT ON MIDDLE ATMOSPHERE ELECTRODYNAMICS (MAE)

N. C. Maynard (Chairman)

The MAE-3 campaign was successfully completed in March as part of Project Antarqui from the Punta Lobos Range in Peru. This series of rockets attempted the first 24-hour time sequence of middle-atmosphere electrodynamic measurements. Four Nike-Orion payloads intermingled with six Super Arcas payloads for electric field and conductivity measurements, and five falling spheres and four datasondes for wind measurements were distributed throughout the period from 11 AM local time on March 8 to 8 AM on March 9. Good data were obtained from all; however the electric field measurements were lost on one Nike-Orion when the nosecone failed to eject. Two of the Nike-Orions were instrumented with X-ray detectors to look for changes in conductivity from the presence of X-rays from SCO-X.

Large mesospheric electric fields were not seen over this period with the exception of the Arcas flight just before sunset (nine payloads had functional electric-field instruments). This one flight was low in apogee due to rocket underperformance and thus did not completely penetrate the layer. Thus, at least on this day, large mesospheric electric fields were not a common feature of the equatorial mesosphere. Data at the millivolt/meter level were also obtained in the nighttime D region and in the nighttime electrojet. Good conductivity measurements were obtained over the complete sequence. Indications of a population of very low mobility ions were seen. The conductivity increases from the effects of SCO-X were observed as the X-ray source became visible after midnight and reached its zenith near dawn. Analyses of results are in progress. Principal investigators participating in this campaign were R. A. Goldberg (X-rays), L. C. Hale (electric fields and conductivity), A. Kudecki (Jicamarca radar), N. C. Maynard (electric fields), J. Mitchell (conductivity), and F. Schmidlin (neutral winds).

MAE-4 will be an intercalibration campaign for middle atmosphere electric-field measurement techniques. Two salvos, each of four different rockets and techniques, are planned from Wallops Island this Fall. One salvo will be during pre-dawn hours, and the other will be during post-dawn hours. Payloads for this series are now under construction. Principals are the same as above with the exception of Kudecki.

A future summer high-latitude campaign is presently in the planning stages (possibly in 1986). Kiruna is a possible site. The emphasis will be on neutral wind - large electric field relationships and noctilucent clouds. We are particularly interested in adding to the campaign measurements of heavy ions and charged aerosols.

A Steering Committee for the project has been appointed. Members are N. C. Maynard (Chairman) (USA), A. Brekke (Norway), R. A. Goldberg (USA), L. C. Hale (USA), and H. Volland (FRG). The Committee will meet in Hamburg on August 24.

ATTACHMENT 12. MINUTES OF SECOND EXPERIMENTERS MEETING FOR THE PROJECT MAP/WINE

U. von Zahn

During the second experimenters meeting for the project MAP/WINE the following topics were discussed and most of them decided upon as listed below.

1. RECENT DEVELOPMENTS IN MAP/WINE (U. VON ZAHN)

(a) Meteorological Rockets

At ARR the falling spheres will be launched on Viper 3A boosters which extend the altitude range of measurements to about 95 km. The USSR will contribute to MAP/WINE about 140 metrocket soundings. On the other hand, NASA decided not to contribute any hardware to MAP/WINE. In consequence of this, we had to forego our plans for metrocket launches from Thule, Greenland.

(b) Soviet Contributions towards MAP/WINE

The USSR has decided to join the MAP/WINE project and has committed major resources in the way of metrockets, sounding rockets, and ground-based experiments for MAP/WINE. Details are described in the MAP/WINE Campaign Handbook, pp. 17, 18 and 24-30.

2. STATUS OF FACILITIES AND RESOURCES

(a) Ground-Based Installations

Dr. Rottger announced formation of a MAP/WINE Working Group within the EISCAT Scientific Association. All scientists interested to perform or use EISCAT measurements related to the MAP/WINE campaign should get in contact with Dr. J. Rottger, if they have not done so already (see pp. 43-46 of Campaign Handbook).

The SOUSY radar will measure in the vertical and 3 different, off-vertical directions (pp. 39-41 of Campaign Handbook).

The Tromso photometer experiment will be moved to ARR for the MAP/WINE campaign.

Further details on ground-based installations can be found in the Campaign Handbook.

(b) Airborne Experiment

Basically because for reasons of cost the airborne microwave radiometer measurements (pp. 61/62 of Campaign Handbook) will be performed in conjunction with one or both launches of MT-Payloads <u>before</u> Christmas 1983.

(c) Metrockets

The regular radiosonde ascents from Bodo and Stavanger will be used to analyze and complete the profiles obtained from the metrockets at ARR and Lista, respectively. The possibilities to use special high-altitude balloons for those radiosondes which fly simultaneously with metrockets will be investigated by Dr. E. Thrane.

Different opinions were voiced regarding the preferred local time for the routine launchings of the metrockets (p. 17 of Campaign Handbook). A decision has to be taken during the next experimenters meeting.

Only datasondes will be launched from ESRANGE. They will be launched from a Loki-tube available from the range and tracked by the range radar. An early pilot launch was recommended.

(d) Sounding Rockets

Due to limitations of the star sensors it was agreed to lower the nominal spin rate of the MT-payloads to 4 ± 1 rps.

The latest information on the apogee of the MT-payloads is for the BUGATTI version 123.9 km; and the IOMAS version 121.4 km. Additional information, presented during the meeting, has been incorporated into the Campaign Handbook.

(e) Satellite Remote Sensing Data

Prof. C. A. Barth of the University of Colorado has agreed to support the MAP/WINE campaign with observations and data from the Solar Mesosphere Explorer satellite. Specifically, for the period Dec. 1, 1983 to Mar. 15, 1984 he will do the following: (1) transmit temperature-latitude data via telefax to Prof. K. Labitzke in Berlin to assist in our stratalert effort; and (b) supply geophysical SME data to the University of Bonn where Dr. K. H. Fricke will maintain a SME data bank for European scientists. Prof. Barth will make 1982 and 1983 SME data available to this data bank as the normal analysis proceeds.

3. MAP/WINE SCIENCE OBJECTIVES

An extended and fruitful discussion took place on the MAP/WINE science objectives. The results were incorporated into the Campaign Handbook, pp. 12-16.

One additional detail not spelled out in the Campaign Handbook is the following: the CNIRPS instrument (pp. 79-83 of the Campaign Handbook) aboard the MT-payloads will measure besides temperature profiles H_2O profiles on 6 flights and O_3 profiles on 2 flights.

4. LAUNCH CRITERIA; SCHEDULE OF OPERATIONS

The schedule for launches of MT-payloads <u>before</u> Christmas 1983 was confirmed and the start of metrockets soundings in western Europe shifted to December 3, 1983 (p. 17 of Campaign Handbook).

A number of details for the rocket soundings <u>after</u> Christmas 1983 were agreed upon (see pp. 17/18 of Campaign Handbook). Quite a few questions, however, were left unanswered and will have to be decided during the next experimenters meeting in Hamburg.

5. OPERATIONS OVER THE CHRISTMAS PERIOD

The last metrocket launches <u>before</u> Christmas will take place on December 21, the first <u>after</u> Christmas on December 28 (see p. 35 of Campaign Handbook). In the case that a major midwinter disturbance develops in late December 1983 one MT-payload would be launched on December 29 and Salvo D (=disturbed) on December 30, 1983 (p. 18 of Campaign Handbook). Again, further details have to be discussed and agreed upon during the 3rd experimenters meeting.

A number of MAP/WINE participants have already decided to stay over

Christmas at AAR, e.g., Dr. Philbrick (AFGL), Mr. Langfermann (GSH Wuppertal), Mr. Klein (Univ. Bonn) and myself.

Please let Mr. R. Bjurstrom and me know early if you would like to join the arctic Christmas party!

6. CAMPAIGN HANDBOOK

Its content and schedule of preparations was discussed and agreed upon. Since then, the Campaign Handbook has been printed and mailed.

7. NEXT MEETINGS

It was agreed to hold the last pre-campaign experimenters meeting during the IUGG conference in Hamburg (August 1983) and the first post-campaign experimenters meeting during the second week of the COSPAR conference 1984 in Graz, Austria (first week of July 1984).

ATTACHMENT 12.1. EXPERIMENTERS MEETING FOR THE PROJECT MAP/WINE

Dear Colleague:

Most of us will attend part or the entire IUGG conference in Hamburg. This event therefore provides us with a relatively easy means to assemble for a last pre-campaign MAP/WINE meeting. Henceforth I am calling for the

3. MAP/WINE experimenters meeting
Saturday, August 20, 1983,
in Hamburg, Congress Centrum,
starting 9:00.

The meeting room will be announced separately (the latest in the registration room of the IUGG conference).

It is hoped that the general meeting can be limited in time to the morning of August 20, and that discussions on subjects, which concern only a few participants, can be shifted to the afternoon of August 20.

The agenda of the meeting shall include:

(1) Status of ground-based, airborne, rocket-borne, and satellite-borne experiments.

(2) Launch criteria for the two major salvos. Launch sequences within salvos. Launch criteria for remaining MT-payloads and metrockets. This topic will be the main discussion point of the meeting.

(3) Special projects based on metrocket soundings: Science objectives and launch criteria.

(4) Alert and travel arrangements after Christmas 1983.

(5) Future conference presentations.

(6) Miscellaneous items.

I presume that the MAP/WINE meeting at Andoya on June 30 and July 1, 1983 will answer most of the yet open technical and organizational questions. Whatever item is left-over from this meeting, shall be included in topic (6) of the Hamburg meeting.

Last, but not least, I enclose the abbreviated minutes of the 2. experimenters meeting in Interlaken. They are abbreviated because many of the results of this meeting were incorporated into the Campaign Handbook. The latter has been sent out since 2 weeks ago and you all should have received your copy by now. If this is not the case, please let me know.

U. von Zahn

ATTACHMENT 13. MST RADAR COORDINATION (MSTRAC)

B. B. Balsley and S. K. Avery

As a result of discussions at the Workshop on Technical Aspects of MST Radars held in Urbana, May 1983, it was proposed that a group be initiated under MAP to serve as a forum for data exchange discussions and MST activities coordination. The proposed name of this group is MST Radar Coordination (MSTRAC), and approval has been requested from the MAP Steering Committee. The undersigned have accepted the responsibility of chairing this committee for a one-year period. The remaining membership will be informal and will consist of potential data users and representatives from the data "source" community.

One of the points that was brought out at the Urbana meeting was the need for an exchange of MST/ST radar data between sources and users. A number of existing facilities (Arecibo, Chatanika, Jicamarca, Millstone Hill, Platteville, Poker Flat, Sunset, and Urbana, and possibly Sousy) have agreed in principle to provide a sample data set for distribution to interested users. A typical data set might include, for example, horizontal velocity (u,v), signal strength, spectral width, and noise levels. Interested users should contact specific facilities regarding the availability of such data. Pertinent addresses are listed on the attached addendum.

A copy of your request should be forwarded to the MSTRAC committee prior to the Hamburg symposium this coming August. At some time during the Hamburg meeting we propose to meet with the available members of the user/source community. At that meeting we will: (1) Attempt to assess the interest in this data exchange program; and (2) Discuss possible data formats for future data exchange.

The success of the above efforts will be examined during the coming months. We will also help to facilitate any cooperative efforts that have been proposed during this period. Future directions will be determined based on the response to the above program.

Dr. Ben Balsley
NOAA/Aeronomy Laboratory
Boulder, CO 80303 USA
(303) 497-3892

Dr. Susan K. Avery
CIRES, Campus Box 449
University of Colorado
Boulder, CO 80309 USA
(303) 492-6940

ADDENDUM

MSTRAC DATA EXCHANGE CONTACTS

Arecibo:	Dr. Ronald F. Woodman Instituto Geofisico del Peru Apartado 3747 Lima, Peru
Chatanika:	Dr. B. J. Watkins Geophysical Institute University of Alaska 903 Koyukuk Avenue N Fairbanks, AK 99701 USA
Jicamarca:	Dr. Ronald F. Woodman Instituto Geofisico del Peru Apartado 3747 Lima, Peru
Millstone Hill:	Dr. P. K. Rastogi Department of Electrical Engineering Case Western Reserve University Cleveland, OH 44106 USA
Platteville:	Dr. Ben Balsley NOAA Aeronomy Laboratory, R/E/AL3 325 Broadway Boulder, CO 80303 USA
Poker Flat:	Dr. Ben Balsley NOAA Aeronomy Laboratory, R/E/AL3 325 Broadway Boulder, CO 80303 USA
Sunset:	Mr. John L. Green NOAA Aeronomy Laboratory, R/E/AL3 325 Broadway Boulder, CO 80303 USA
Urbana:	Dr. S. A. Bowhill Department of Electrical Engineering University of Illinois 1406 West Green Street Urbana, IL 61801 USA

ATTACHMENT 14.

John B. Gregory, Former Member, MAP Steering Committee

On my retirement from university life, and my consequent resignation from the Steering Committee of MAP, I would like to express my pleasure in the progress of middle atmospheric studies to date, and my confidence in their future.

MAP was initiated as a worldwide economic recession was developing. Nevertheless, projects have been funded. Such disadvantages as have resulted from the recession have been mainly delays to proposed projects, rather than failure to implement them, and this will not greatly affect the success of middle atmospheric studies in the longer term.

Our planning of the program was as comprehensive as we then knew. By emphasizing scientific objectives, we encouraged our colleagues to develop activities as they saw best, and they responded with new and innovative projects. This is in the best traditions of international science.

So far, one theme has emerged which was not foreseen in the Planning Document; perhaps there are others. As studies to date, including my own, have shown, the neutral middle atmosphere is responding much more strongly to the longer-term variable output of the Sun than had been realized. Furthermore, the solar signature is being modified by the inherent variability of the global circulation. Since the time scale undoubtedly includes the 11-year cycle, one implication is that MAP-like studies will be required for at least the next quarter century, and on a global scale with additional attention to the tropics. These studies will make possible the completion of a statement of the influence of the variable component of solar output on the planet's atmosphere. This is a great goal, central to SCOSTEP. Those of us who took part in the initial discussions, under IUCSTP, leading to MAP, and I here record the initiative of Dr. E. A. Lauter of Kuhlungsborn, send every encouragement to you who will complete this task.

I conclude by expressing my deep appreciation of the cooperation of many of you and my lasting pleasure in the friendships I have made during my association with MAP.

Sincerely,

John Gregory
Professor Emeritus,
University of Saskatchewan

ATTACHMENT 15

Dear Prof. Bowhill,

The General Assembly of IAGA in 1985 will be held in Prague. We would like to include a MAP-related symposium (like the MAS Symposium in Hamburg) into the scientific programme of the General Assembly. Please be so kind as to include this item into the agenda of MAP Steering Committee meeting in Hamburg in August 1983. We will be present in Hamburg during the IUGG General Assembly, but not during the MAP Steering Committee meeting. As regards the date of the symposium, it is to be fixed in coordination with the date of the expected MAP-related symposium during the IAMAP General Assembly.

Sincerely yours,

Dr. J. Lastovicka
Member of Local Organizing Committee
Czechoslovak Representative in MAP

Prof. Dr. V. Bucha
Chairman of Local Organizing Committee
Member of IAGA Executive Committee

ATTACHMENT 16

For MAP Steering Committee Meeting, August 13-14, 1983, Hamburg

REF. REPORT OF THE MAP DATA MANAGEMENT COMMITTEE
G. K. Hartmann, I. Hirota and J. H. Allen

Mainly because of the well-known aversion against questionnaires, a feeling which we very much share too, our last questionnaires, mailed to the individual Principal Investigators (PIs) yielded insufficient information. After discussions at Urbana/Champaign and at WDC-A-STP at Boulder we would like to suggest and discuss the attached two new questionnaires. The first to be mailed directly to all national MAP representatives the second — after completion of the first -- to be mailed to all PIs. The first should be mailed in autumn this year and the second in spring 1984 if they are approved and/or modified by the MAP Steering Committee.

REF. UPDATING OF MAP HANDBOOK AND PREPARATION OF DATA CATALOGUES
(To all national MAP representatives)

Dear

Mainly because of the well-known aversion against questionnaires, a feeling which we share too our last questionnaires, mailed to the individual Principal Investigators (PIs) yielded insufficient information. Thus we have to make another, different attempt.

1. We did extract from the MAP Handbook (∿ Data Inventory) all your national projects and listed them in Appendix 1. Please check whether they are correct and complete.
2. If we don't get a reply by the end of November 1983 we will assume that everything is o.k. Otherwise we would like to ask you to send us the updated version, which will be used for an updating of the MAP 1984 Handbook.
3. Having these answers we'll again start to send the questionnaire 2 -- Appendix 2 -- to the individual PIs. If there is no reply they will <u>not</u> be mentioned in the first issue of the MAP Data Catalogue.
4. Since we would also like to learn your views on the role of WDCs from the MAP standpoint, we include questionnaire 1 which was modified and approved by the MAP Steering Committee in August 1983, together with some recommendations selected from the CODMAC report.

Please send your questionnaire 1 response and the corrected list -- Appendix 1 -- to:

Joe H. Allen
WDC-A for STP, NOAA, D63
325 Broadway
Boulder, CO 80303 USA

Many thanks for your efforts and cooperation in this matter.

Yours sincerely,

G. K. Hartmann, J. H. Allen, I. Hirota

QUESTIONNAIRE 1

a) Role of WDCs from standpoint of MAP activities

Please indicate the order of importance of each of the following options with 1 = least important and 5 = most important. Comments relative to these items or other, unspecified alternatives are welcome. Also, comments about items on Form A or B may be added below. In 1979, MAP participant responses were essential in creation of the MAP Directory. The results from this request for more detailed information should make possible a useful, quantitative summary of MAP data activities. Responses to this Form may guide the existing WDC system in using the other information and in deciding whether to continue past services or place emphasis on redirecting efforts to service new needs.

Priority Rating

( ) Continue "traditional" data collecting, archiving, and exchanging on request (major efforts devoted to data of matrix element B-III-3); see questionnaire 2.

( ) Organization of workshops at WDCs.

( ) Issuing Data Inventories for data held away from WDCs, including data that is not processed up to the standard III-3; see questionnaire 2.

( ) Issuing Data Catalogues for data held at WDCs (primarily III-3).

( ) Advice or other services.

Date ____________ Signature ___________________________

b) Recommendations

1. From CODMAC
Data Management and Computation Vol. 1: "Issues and Recommendations" by Committee on Data Management and Computation (CODMAC)
Space Science Board
Assembly of Mathematical and Physical Sciences
National Academy Press
Washington, DC 1982, USA
(Available from: Space Science Board, 2101 Constitution Avenue, Washington, DC 20418, USA).
a) We recommend that greater emphasis be given to documentation of space-science and application data to make them interpretable and useful to scientists not directly associated with initial acquisition of data. Included in such documentation should be information and software to extract physical units from the raw data. Those who gather the data should also be responsible for assessing their validity as part of the documentation.
b) In some cases, data acquired from past missions have not been properly archived. We recommend that under scientific overseers, NASA vigorously pursue the archiving and preservation of such space-science data that should be permanently stored, and data no longer required for future scientific use be purged.
c) We recommend that more emphasis be given to production of user-oriented catalgoues and browse files for space-science data.

2. See also: G. K. Hartmann "Problems of Data Bases in Geophysics", MPAE-L-100-83-01, 1983.

Dear MAP Colleagues,

The two Co-Chairman: Dr. G. K. Hartmann, and Dr. I. Hirota and the secretary J. H. Allen drafted the following questionnaire 2 as a first step for the preparation of a Data Catalogue. This questionnaire was modified and approved by the MAP Steering Committee in August 1983. Mainly because of the well-known aversion against questionnaires, a feeling which we very much share too, our previous questionnairec, mailed to the individual Principal Investigators (PIs) yielded insufficient information, nevertheless we have to optimize the future MAP Data Activities (MAP DA) because of the increasing economic constraints under which all programs must operate.

If we don't get a response from you within the next two months you will not be mentioned in the MAP Data Catalogue.

Many thanks for your efforts and cooperation.

Please send your questionnaire 2 response to:

Joe H. Allen
WDC-A for STP, NOAA D63
325 Broadway
Boulder, CO 80303 USA

Yours sincerely,

G. K. Hartmann, I. Hirota, J. H. Allen

QUESTIONNAIRE 2

MAP Project ___________________
Name of PI: ___________________

Temporal duration (t) and spatial coverage (x) of the measurements

Please indicate the appropriate element of this 3x3 matrix into which your MAP data snould be placed. If you have more than one experiment, please copy this form and use a separate sheet for reporting about each experiment. Although a single program may involve launching six rockets from one location during an extended period of time, the experiments would be "Local" and "Instantaneous", i.e. classified I-1.

t \ x	I LOCAL	II REGIONAL	III GLOBAL
1. Instantaneous ($\leq$ day)	e.g. ground, balloon or rocket	(rocket, salvo, instrument network)	?
2. Short term (weeks to months)	ground	aircraft	Low-altitude satellite, Space Transportation System (STS)
3. Long term (years)	ground (e.g. Dobsen network)	e.g. national ionosonde net	Ground network orbiting satellite (s)

Please indicate with "x" if data are obtained by remoting sensing and with "o" if obtained in situ. Please indicate by () if the data are to be used in deriving a product such as a contour map.

	month	year	
Data already available since:			
Data will be available from:			(estimated)

Technical format and scientific status of MAP data

Please indicate into which element of this 3x3 matrix a given percentage of your data probably will be placed (rough estimates are satisfactory and should total 100%). Only data processed into category III-3 are likely to be collected by, catalogued, and distributed by the WDCs. Data in other elements may be listed in Data Inventories maintained there and efforts made to assist in their international exchange; however, the resources required for extensive data processing to improve the technical format or convert a mass of data into a summary product may preclude such WDC support for MAP projects.

Scientific / Technical (format)	I Only for PI use, i.e individual evaluation, small datography, pre-edited data.	II Also for "Regional Data Center" use, i.e. refined, broad evaluation, medium datography	III Also for World Data Center, i.e. broad evaluation, large datography
1. Only for PI use, i.e. local, individual formats			
2. Processed for collection in Regional Data Centers			
3. Processed for deposit with World Data Centre, i.e. in international exchange format			

If less than 5% of the collected data will be processed to the level III-3, please estimate the additional resources required (only as percentage of total experiment cost) in order to increase the quantity of type III-3 data to 10% and indicate that value here ________________.

Date ______________ Signature ______________________

ATTACHMENT 17. MAP PUBLICATIONS COMMITTEE REPORT

C. F. Sechrist, Jr.

1. COMMITTEE MEMBERSHIP

C. F. Sechrist, Jr.
R. D. Bojkov
S. C. Chakravarty
V. V. Viskov

2. MAP NEWSLETTER

During 1982, three issues of the MAP Newsletter were 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.

During the meeting of MAPSC in Ottawa in 1982, it was proposed by Dr. A. P. Mitra, Chairman of the Scientific Advisory Committee of the Indian Middle Atmospheric Program, that India publish future issues of the MAP Newsletter.

The first issue, published in March 1983, was edited by Drs. S. C. Chakravarty (ISRO) and C. V. Subrahmanyam (NPL), and printed at INSDOC, New Delhi. The Newsletter will be issued every three months, approximately.

Contributions for the MAP Newsletter should be sent to:

Dr. S. C. Chakravarty
ISRO Headquarters
Cauvery Bhavan
Bangalore 560009
INDIA

3. HANDBOOK FOR MAP

Volumes 1 through 7 have been published and distributed.

Volume 8 contains MAP Project Reports by DYNAMICS, GLOBUS, and SSIM. It includes MAP Activities in Czechoslovakia, and the MSG-7 Report. It will be distributed during the latter part of August 1983.

4. FUTURE VOLUMES OF THE HANDBOOK FOR MAP

VOLUME	EST. PUB. DATE	TOPIC(S)
9	9/83	MST Radar Workshop held in Urbana, Illinois, in May 1983
10	10/83	Symposium on Ground-Based Studies, held in Schwerin, GDR, in May 1983
11	11/83	MAPSC Meeting (Hamburg, 1983), DYNAMICS Workshop Report, Equatorial Observatory Study, etc.
12	12/83	Ground-based Techniques, Guest Editor: R. A. Vincent
13	2/84	Satellite Techniques, Guest Editor: C. B. Farmer

14	4/84	Balloon Techniques, Guest Editor: D. G. Murcray
15	6/84	Rocket Techniques, Guest Editor: R. A. Goldberg

5. CONTRIBUTORS TO MAP HANDBOOK (VOLUME 12) ON GROUND-BASED TECHNIQUES FOR MEASURING MIDDLE ATMOSPHERE PARAMETERS.

Editor: Dr. R. A. Vincent

Dr. B. H. Briggs	"On the analysis of spaced sensor records
Drs. M. L. Chanin and A. Hauchecorne	"Lidar studies of temperatures and densities"
Dr. G. Fiocco	"Lidar studies of aerosols"
Dr. B. R. Clemesha	"Lidar studies of alkali metals"
Dr. G. J. Fraser	"Partial reflection spaced antenna wind measurements"
Dr. F. Jacka	"Fabry-Perot interferometer measurements of temperatures and winds"
Dr. A. Manson and C. Meek	"Partial reflection D-region electron densities"
Dr. J. Mathews	"Incoherent scatter radar studies of the mesosphere"
Drs. G. Megie and J. Pelon	"Lidar measurements of ozone and minor constituents in the middle atmosphere"
Dr. J. Meriwether	"Optical methods for nighttime observations of mesospheric temperatures from the ground"
Dr. J. Noxon	"Optical studies of nitric oxide"
Dr. J. Olivero	"Microwave studies of composition and structure"
Dr. R. G. Roper	"Meteor wind radars"
Dr. J. Rottger	"MST radar techniques"
Dr. R. Schminder and D. Kurschner	"LF radio observations of mesospheric winds"
Drs. R. Woodman, M. P. Sulzer and D. T. Farley	"Coding techniques for radar studies of the middle atmosphere"

6. CONTRIBUTIONS FOR THE MAP NEWSLETTER

More contributions on a regular basis are urgently needed. News items from Project Coordinators, Study Group Chairmen, et al. are needed in order to publish the Newsletter on a regular schedule.

7. SUGGESTIONS AND CONTRIBUTIONS FOR THE 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: Prof. C. F. Sechrist, Jr., Aeronomy Laboratory, Department of Electrical Engineering, University of Illinois, 1406 West Green Street, Urbana, IL 61801 USA.

ATTACHMENT 18. SCOSTEP/URSI/MAP WORKSHOP ON TECHNICAL ASPECTS OF MST RADAR

Urbana, Illinois 61801 USA
May 23-27, 1983

1. INTRODUCTION

More than 50 scientists from ten nations participated in the Workshop. On the first day, keynote papers were presented in a combined session on the nine subjects:

1. Meteorological and dynamical requirements for MST radar networks
2. Interpretation of radar returns from clear air
3. Techniques for measurement of horizontal and vertical velocities
4. Techniques for studying gravity waves and turbulence
5. Capabilities and limitations of existing and planned MST radars
6. Design considerations for high-power VHF radar transceivers
7. Optimum radar antenna configurations
8. Data analysis techniques
9. MST radar data-base management

The following three days were devoted to contributions and discussions on the subtopics of these nine subjects. More than 100 position papers were presented during the three-day period when two simultaneous sessions were held. Resolutions and recommendations were made in each of the sessions. On the morning of May 27, concluding remarks by the convenors of the nine topical sessions were presented. The resolutions and recommendations were discussed. It was decided that a second Workshop on Technical Aspects of MST Radar will be held next year at Urbana, Illinios.

The keynote papers, positions papers and recommendations and resolutions will be published as a volume of Handbook for MAP.

2. TOPIC 2, INTERPRETATION OF RADAR RETURNS FOR CLEAR AIR

Draft recommendation from discussion in Topic 2:

Recognizing the importance for an accurate characterization of the spectrum of refractive index irregularities for the efforts to understand mechanisms of turbulence generation and to measure with MST radar, winds, turbulence and stability; Noting the spectral sampling capability of steerable, multiple wavelength radars we Recommend that: Multiple frequency radar observations supported by in situ measurements be carried out with exisiting equipment such as at Arecibo and other radar facilities.

3. TOPIC 6, DESIGN CONSIDERATIONS -- RECOMMENDATIONS

Transmitter designs for operation at higher frequencies such as 200 MHz and 400 MHz should be investigated for use as portable ST systems and for faster recovery times for lowering the minimum altitude capabilities of MST systems.

A/D converters with a minimum of 10-bit resolution should be utilized in all future radar systems to optimize the dynamic range capabilities of new MST radars.

4. TOPIC 8, DATA ANALYSIS TECHNIQUES

Draft Recommendation:

The Group, Noting with concern that many MST observatories have inadequate data processing facilities, and with pleasure that major advances in developing powerful but low cost digital equipment have been made in recent years, Recommends that existing observatories investigate the cost effectiveness of upgrading their computing facilities and that adequate attention be given to this topic in planning new facilities.

5. TOPIC 9, MST RADAR DATA-BASE MANAGEMENT

A note prepared as a result of discussion during Topic 9:

A study is currently taking place at Rutherford-Appleton Laboratory with the aim of providing a central data-base for all geophysical data derived from both UK satellite and ground-based measurements. Those people interested in the study are asked to contact Dr. P. Dickerson and Dr. G. Harrison of the Geophysics and Radio Division.

Draft Recommendation from Group 9: Establishment of MSTRAC

Considering that there are many issues of common concern to scientists in various countries involved in MST and ST radar activities; and noting that many countries are now planning new MST and ST radar facilities, we recommend that a new group, MST Radar Coordination (MSTRAC) be established as a project initially under MAP, with a chairman, vice-chairman, and informal representation from all current and planned MST or ST radars and from the data user community.

Draft Resolution from Group 9:

Tape Format Considerations: To further the aim of exchanging high quality data conveniently, we further recommend a tape format to be chosen that will meet certain criteria:

- Flexibility concerning the number of parameters, the sample frequency and integration time, and the number of ranges.
- Inclusion of both the parameter and its uncertainty.
- Inclusion of information about the assumptions used to drive the parameters and the uncertainties.
- Sufficient flexibility to enable the inclusion of data obtained with other techniques.

Exchange Tape Format: Recognizing the desire of scientists involved in MST research to exchange data (both raw and processed) more easily and conveniently, we recommend that an exchange tape format be adopted at an early date, such as the first or second MSTRAC meeting.

ATTACHMENT 19. INTERNATIONAL SYMPOSIUM ON GROUND-BASED STUDIES OF THE MIDDLE ATMOSPHERE, SCHWERIN (GERMAN DEMOCRATIC REPUBLIC)

May 10-13, 1983

J. Taubenheim

The International Symposium on Ground-Based Studies of the Middle Atmosphere was held in Schwerin, GDR, on May 10-13, 1983, under the co-sponsorship of SCOSTEP and IAGA, in collaboration with COSPAR. It was organized by the Academy of Sciences of the German Democratic Republic, Central Institute of Solar-Terrestrial Physics, in cooperation with the National Committee on Geodesy and Geophysics. The Scientific Program Committee was chaired by J. Taubenheim.

The symposium was attended by about 80 participants, 37 of these coming from 13 foreign countries, e.g., USSR, USA, UK, FRG, Canada, and several other European countries. They included the Vice-Chairman of the International MAP Steering Committee, Prof. K. Labitzke, the President of ICMUA and Convenor of the GLOBMET Project, Prof. R. G. Roper, the Chairman of the MAP Commission of the USSR, Prof. A. D. Danilov, and many prominent other scientists in the field of middle atmosphere science.

The 44 papers were grouped into topics (a) Diagnostics of the Middle Atmosphere from D-Region Observations (invited speakers A. D. Danilov, M. Friedrich and J. Taubenheim and 5 contributed papers); (b) Winter Anomaly (invited speaker Z. Ts. Rapoport, and 4 contributed papers); (c) Seasonal Variations, Transitions, and Disturbances (invited speakers K. Labitzke and E. A. Lauter, and 4 contributed papers); (d) Dynamics and Theoretical Models (invited speakers A. I. Ivanovsky and G. Schmitz, and 4 contributed papers); (e) Winds and Waves, and Their Tracking by Ground-Based Methods (invited speakers R. G. Roper, Yu. I. Portnyagin, A. H. Manson and E. S. Kazimirovksy, and 3 contributed papers); (f) Lower Thermosphere Phenomena (invited speaker N. N. Shefov, and 3 contributed papers), and (g) Solar-Terrestrial Influences Upon the Middle Atmosphere (invited speakers J. K. Hargreaves, E. A. Lauter, J. Lastovicka, and 5 contributed papers).

In addition to this program, Dr. R. G. Roper held an informal meeting on the GLOBMET Project, and most of the participants from abroad took the opportunity to visit the Observatory of Ionosphere Research of the CISTP at Kuehlungsborn.

The Symposium has pointed out the valuable contribution which ground-based investigations, with their particular ability of long-term continuous monitoring of atmospheric processes and parameter variations on various time scales, can render to the scope of the present Middle Atmosphere Program. It made obvious that significant progress in middle atmosphere science is to be expected from a growing interplay between the approaches of aeronomy and meteorology. Lively discussions indicated that the Symposium was a useful forum for the exchange of information and ideas in the wide spectrum of problems of the middle atmosphere.

Extended Abstracts of all papers presented at the Symposium will be published in a special volume of the "Handbook for MAP", issued by SCOSTEP

ATTACHMENT 20. INTERNATIONAL MAP SYMPOSIUM IN KYOTC 1984

November 26-30, 1983
Kyoto, Japan

1. THE SYMPOSIUM

This symposium will be held in conjunction with MAP (the Middle Atmosphere Program), an international scientific cooperative program for the period January 1, 1982 - December 31, 1985 held under the aegis of the Scientific Committee on Solar Terrestrial Physics (SCOSTEP).

The general aim of this symposium is to provide a review and to discuss the scientific achievements that have taken place thus far during the period of MAP and to aid in establishing closer and more fruitful cooperation in the latter phases of this global enterprise.

The symposium is intended to be as comprehensive as possible with respect to the current interests of MAP, with some emphasis on specific MAP projects and other relevant topics.

The symposium will be supported by the Radio Atmospheric Science Center, Kyoto University.

The organization of the symposium is being handled by the Organizing Committee in the MAP Committee of Japan with an Advisory Board, Local Committee and Program Committee acting with the approval of the International MAP Steering Committee.

The symposium is co-sponsored by SCOSTEP, URSI, IAGA, IAMAP and COSPAR.

2. THE PROGRAM

The scientific program will have the following five topical sessions to be convened by scientists indicated therein.

(1) Climatology of the Middle Atmosphere: Prof. K. Labitzke (Berlin Free Univ., West Germany), and Prof. I. Hirota (Kyoto Univ., Japan)
(2) Large-Scale Wave Dynamics: Prof. J. M. Forbes (Boston College, USA), and Prof. T. Matsuno (Univ. of Tokyo, Japan)
(3) Gravity Waves and Turbulence: Dr. M. A. Geller (NASA/GSFC, USA), and Prof. S. Kato (Kyoto Univ., Japan)
(4) Transport Processes of Trace Species and Aerosols: Dr. M. P. McCormick (NASA/LARC, USA), and Prof. A. Ono (Nagoya Univ., Japan)
(5) MAP in the Antarctica: Prof. T. Hirasawa (Polar Res. Inst., Japan), and Prof. Y. Iwasaka (Nagoya Univ., Japan)

Each session will be composed of invited keynote talks and contributed papers. The balance between invited and contributed talks will depend upon the response of interested scientists and finally on the convener's decision. No parallel sessions are anticipated. Informal roundtable discussions on specific subjects can be arranged as needed.

3. PUBLICATIONS

Accepted papers will be published in Proceedings after the symposium. Details will appear in the second circular.

4. ACCOMMODATION

The symposium will be held at the Kyoto Kaikan (Assembly Hall) near the Heian Shrine in the middle of the Kyoto city area, Japan.

5. SCHEDULES

Scientists who are interested in attending this Symposium and wish to receive further notifications are asked to return the Preliminary Registration Form so that it will be received by 30th September, 1983.

The second circular including the call for papers will be sent out in December 1983. The deadline for paper submission will be in April, 1984. The acceptance of contributed papers will be announced by the end of May, 1984.

The third circular describing details of session schedules, accommodations and other symposium information will be sent in June, 1984.

6. CORRESPONDENCE

All correspondence and further inquires should be sent to:

Prof. Susumu Kato
Chairman of the Organizing Committee of the
International MAP Symposium in Kyoto 1984
Radio Atmospheric Science Center
Kyoto University
Gokanosho, Uji, Kyoto 611, Japan

Telephone: (0774) 32-3111, ext. 3331

ATTACHMENT 21. DRAFT RESOLUTION OF MAPSC

NOTING the decision of SCOSTEP to designate a period of Middle Atmosphere Cooperation (MAC) from 1 January 1986 through 31 December 1988 for intensive observations of the middle atmosphere and also noting the culmination of development of several powerful techniques during the period of MAP.

THE MAPSC CALLS ON all countries now to plan their scientific participation for the MAC period.

ATTACHMENT 22. FIRST DRAFT RESOLUTION

CONSIDERING the great scientific importance of understanding the special dynamical characteristics of the equatorial middle atmosphere -- like equatorial waves, breaking of tides, gravity wave non-linearities and critical level interactions -- and

CONSIDERING further the paucity of data and poor understanding of the above dynamical processes which have a vital influence on middle latitude atmospheric processes, it is RESOLVED that one or more Equatorial Atmosphere Observatories be set up as early as possible through the joint effort of interested scientific groups. A typical observatory would comprise at the very minimum a relatively sensitive MST/ST radar, a sensitive lidar and a partial-reflection system. It is further RESOLVED that the observatories be set up with ±5° of the geographic equator at a suitable location like the midwestern Pacific or the 75° meridian. Such a chain would benefit from existing latitudinal chains of middle atmosphere observing stations.

CONSIDERING the valuable scientific information that can be gathered at other near-equatorial locations, it is RESOLVED that a major scientific effort should be made to intensify the observations at all other low latitudes by setting up additional facilities if necessary.

BACKGROUND OF RESOLUTION

Within a few degrees of the equator there are a number of atmospheric processes in the troposphere, stratosphere and mesosphere that are both poorly observed and poorly understood: (1) the temporal and spatial variability of atmospheric circulation patterns, specifically including the vertical circulation component; (2) the generation, propagation and dissipation of equatorial waves, gravity waves, and tides; and (3) vertical exchange processes that inject important, long-lived atmospheric components such as ozone and water vapor into the equatorial stratosphere and mesosphere. Improved understanding of these processes and their interrelationship is crucial to an improved understanding of such localized phenomena as El Nino, the southern oscillation and oceanic-atmospheric energy exchange, as well as global weather and climate dynamics in general.

In particular, it is now well recognized that the dynamical motions and injection/transport of minor constituents in equatorial atmosphere play a vital role in influencing the atmospheric processes at middle latitudes.

Greatly improved information on all of the above processes is possible using existing technology. Observatories using a number of complementary ground-based systems can provide high temporal and spatial resolution on winds, waves, turbulence, density, temperature, and minor constituent structure throughout most of the atmosphere up to the lower thermosphere. Specific systems include MST/ST radars, lidars, partial reflection or meteor wind radars, as well as conventional weather balloons and sounding rockets.

While complete coverage of the entire equatorial region with all of the above techniques is clearly not feasible, it is possible by a judicious choice of systems and locations to make use of already-existing facilities and thereby maximize information gain with a minimum of attendant costs. Because of the extent of the needed data base in both technique and geography, such an effort is clearly international in scope, and will require careful planning and co-operation.

Preliminary considerations point to the desirability of establishing one or more equatorial observatories (comprising at the very minimum a relatively sensitive MST/ST radar, a sensitive lidar, and a partial reflection system) either in the area of the central-western Pacific or near the 75°W meridian. Either location would benefit from a meridional chain of already-existing facilities, i.e., meteor radars . Kyoto and Khabarovsk, partial reflection radars in Adelaide, Christchurch and Scott Base, the MST radar at Kyoto and the ST radar at Adelaide for the central-western Pacific site; and incoherent scatter/MST/ST radars at Jicamarca and Arecibo for the 75°W site. Either chain would yield a unique data set (a zeroth-order, non-orograhic data set in the western Pacific and/or a data set incorporating extensive orography at 75°W near the Andes). The latitudinal limits of the equatorial observatories should not exceed ±5° of the geographic equator to assure accurate measurement of the equatorial wave morphology.

We recommend that consideration of such observatories be given prompt high priority attention, in order to facilitate rapid scientific advancement in this very important area.

In addition, observatories in other equatorial locations like India should be intensified and coordinated as far as possible with those of the equatorial observatories. This will greatly contribute to the overall understanding of the latitudinally varying processes linking the equatorial atmosphere to the temperate latitude atmosphere and to the understanding of the longitudinal structures/inequalities.

ATTACHMENT 23. REPORT ON WORKSHOP ON TIDES IN THE MESOSPHERE AND LOWER THERMOSPHERE

Susan Avery

The workshop was held under the auspices of ICMUA and was convened specifically to consider coordinated global observations of tides and their possible theoretical interpretation.

Observations

The first session concentrated on observations made during a core period of 19-23 November 1981. Results were reported from 8 stations using either meteor or partial reflection wind techniques and some information was also available from measurements made at Arecibo and Jicamarca. Data for each station were discussed in short presentations which emphasized the representativeness of the tidal amplitudes and phases in comparison with observations made in other campaigns. There was general consensus that the core period was essentially undisturbed and that the mean circulation was representative of early solsticial conditions. Intercomparison of observations made at the same latitude but different longitudes showed that the tidal phases could differ by several hours. A comparison of data taken at stations in the Northern and Southern Hemispheres showed significant differences in the tidal structures, especially for the diurnal tide.

Shorter presentations were also given on observations taken at stations which were established subsequent to the November campaign. Information from these stations can be expected to add significantly to future campaigns.

For ease of comparison, the tidal amplitudes and phases measured at each station at a mean height of 90 km were plotted as a function of latitude. These were compared with theoretical curves which summarized the predictions of current tidal models due to three different groups.

Theoretical Studies

Although there has been much progress in the modelling of tides in recent years, several areas requiring additional research were emphasized. These included the studies of nonmigrating tides, the breaking of tides in the mesosphere, longitudinal asymmetries in ozone and water vapor heating fields, and the interaction of tides with gravity waves and planetary waves. Recent studies show that longitudinal surface heating asymmetries can excite nonmigrating modes. In particular, convection over the oceans produce diurnal variations.

Another theoretical problem that should be addressed is the relative importance of reflection of tides and the interaction of tidal modes. This is motivated by several observations at all latitudes that show amplitude nodes and associated 180° phase jumps. Arguments were presented that suggested that the reflection mechanism was more important than mode interaction in describing these observations.

Panel Discussion - Interpretation of results

A panel discussion on the possible interpretation of the results concentrated first on the consistency of the observations. There was general agreement that the observations were remarkably consistent as a function of latitude but there were a number of significant deviations from theory. At high latitudes the theoretical amplitudes for the semidiurnal tide were significantly in excess of the observed amplitudes. The predicted variations in phase as a function of latitude were, however, in better agreement with the results. Possible reasons for these discrepancies were discussed and it was felt that the models may underestimate the role of damping. There was also a vigorous discussion of what might be better ways to compare observations with theory since the latter are based on seasonally averaged conditions. The final part of the discussion centered on the need for stations in new locations with some preference for the equatorial regions in order to better define the contribution of asymmetric tidal modes.

Panel Discussion - Data Analysis Techniques

The panel discussion on data analysis techniques centered on two topics: the fit span required to extract tides and the advantages and disadvantages of bandpass filtering, Groves analysis, and Fourier fits. It was generally agreed that a minimum data set length of four days is needed to determine the "mean" tidal structure. Two reasons for a four-day minimum were discussed. These were: the time it takes to set up a global tide, and geophysical noise. No decision was made as to which mechanism was more important. For studying variability, one-day or two-day fits to the 12- or 24-hr oscillation will diagnose the time variations. Another technique that will analyze variability is complex demodulation.

The discussion on various tidal analysis techniques was lively. It was recognized that most meteor radars require the Groves technique to extract the tides from the data. However this assumes a model fit in height and time. Temporal Fourier analysis at each height was regarded to be a better method than the "Groves technique" since it treats the data at each height independently. Bandpass filtering must be used with caution since the interpretation of the results depends critically on the number of components retained after filtering.

To test the various routines that are used, it was suggested that each of us use a common set of simulated data. This received a favorable response.

Future plans

The workshop concluded with recommendations that further global campaigns be made in December 1983 and June 1984. It was resolved that the results of these campaigns be discussed in a workshop to be held in conjunction with the MAP symposium in Kyoto during November, 1984.

ATTACHMENT 23.1. WORKSHOP ON TIDES IN THE MESOSPHERE AND LOWER THERMOSPHERE

Date: Wednesday, 17 August 1983, Hamburg, Germany

Sponsored by: (ICMUA), Working Group on Tides in the Mesosphere and Lower Thermosphere

Convener: Dr. Jeffrey M. Forbes (ICMUA, IAMAP)

Program Committee: Dr. Jeffrey M. Forbes (ICMUA, IAMAP)
Dr. Robert A. Vincent (ICMUA, IAMAP)
Dr. Susan K. Avery

Wednesday 17 August

SESSION 1: Presentations of Data Pertaining to the November, 1981, Global Campaign

Chairman: R. A. Vincent

R. A. Vincent	Introductory Remarks
S. K. Avery	Summary of Global Measurements at 90 Km
A. H. Manson, C. E. Meek, M. J. Smith, and J. B. Gregory	Tidal Variability and Mean Winds during the Early Winter (Oct.-Dec.) of 1981, Including the Global Campaign Interval, at Saskatoon (52°N, 107°W); with some Intercomparisons
R. G. Roper	Meteor Winds over Atlanta
J. Rottger	Measurements of Tidal Winds with a VHF Radar at Arecibo
T. Aso, J. Rottger, Y. Maekawa, P. Czechowsky, R. Ruester, G. Schmidt, I. Hirota, R. F. Woodman, and S. Kato	A Comparison of Stratospheric and Mesospheric Wind and Tides Observed Simultaneously with VHF Radars at Jicamarca and Arecibo
R. A. Vincent	Adelaide and Kyoto Observations: Asymmetric Behavior
S. K. Avery	Poker Flat Meteor Winds
R. R. Clark	Comparison Between Durham and Urbana Meteor Winds
G. J. Fraser	Tidal Measurements at Christchurch (44°S) and Scott Base (78°S)
J. L. Fellous	Tides at Monpazier (45°N) in Winter
C. A. Reddy	Tidal Winds from the Indian Meteor Radars
M. L. Chanin	Lidar Observations of Tides

SESSION 2: Interpretation of Campaign Results; Methods of Data Analysis; Announcements

Chairman: R. G. Roper

S. Kato	Summary of Theoretical Model Predictions
F. Vial, J. L. Fellous, H. Teitelbaum	Reflection of Tides in Mesospheric Temperature Profiles
G. V. Groves	Thermal Excitation of Atmospheric Tides: Asymmetric and Nonmigrating Aspects

PANEL DISCUSSION I: Interpretation of Results

Chairman: G. Elford; panel: R. G. Roper, S. Kato

PANEL DISCUSSION II: Methods of Tidal Analysis

Chairman: S. K. Avery; panel: R. R. Clark, A. H. Manson, R. A. Vincent

R. A. Vincent	Announcements of Future Activities

ATTACHMENT 24. GRATMAP MEETING 8-24-83

Present:

Members		Observers	
M. A. Geller (Chairman)	USA	J. Mathews	USA
S. A. Bowhill	USA	S. Kato	Japan
B. B. Balsley	USA	S. Fukao	Japan
R. Vincent	Australia	R. Roper	USA
A. Manson	Canada	T. Van Zandt	USA
H. Tanaka	Japan		
H. Teitelbaum	France		
M. L. Chanin	France		
J. Klostermeyer	FRG		
A. A. Chernikov	USSR		

The GRATMAP Steering Committee discussed two reports. One is a result of a MAP workshop on MST radars that was held in Urbana, Illinois. The other was a workshop on gravity waves and turbulence that was held in Alaska. It was decided that Dr. Geller would extract the main conclusions of these reports for a GRATMAP write-up to appear in a MAP Handbook. The Alaska report would be an appendix to this write-up. This will be circulated to all GRATMAP Steering Committee members before being given for publication.

There was discussion about ongoing investigations of gravity waves and turbulence, particularly about MAP-WINE, the Japanese Antarctic rocket program, and a program in the USSR to study the atmospheric response to large conventional explosions.

It was also decided to attempt to hold a GRATMAP workshop following the Kyoto 1984 MAP meeting for a period of 2-3 days. A formal request for this workshop will be sent to Dr. Kato by Dr. Geller asking if such a workshop may be held in connection with the Kyoto 1984 meeting.

ATTACHMENT 25. MAP PROJECT ON MIDDLE ATMOSPHERIC ELECTRODYNAMICS (MAE)

Minutes of Steering Group, 8/24/83

On the evening of August 24, 1983, the MAP Steering Group on MAE convened for a short meeting. In attendance were R. Goldberg, L. Hale, and A. Brekke who make up a majority of the membership.

The agenda included an overview of the project and its objectives, a discussion of preliminary results from project CONDOR conducted in Peru in March 1983, and plans for the next facet of the program, to be conducted at Wallops Island, VA this coming Fall. It was determined that Project CONDOR had been quite useful scientifically, and would also permit some diagnostic evaluation of the electric field measuring techniques.

The group agreed unanimously to make the following recommendations.

1. That MAP support activities in this field by endorsing future rocket and balloon programs coordinated with ground-based techniques.

2. That MAP help implement the organization of two workshops proposed by the MAE Working Group II-A of IAGA. The workshops would be concerned with
   (a) Development of an experimental program to conduct validation and intercomparison studies of various instrumental techniques used to study MAE.
   (b) Development of global atmospheric electrical parameters toward a geoelectric index.

R. A. Goldberg

ATTACHMENT 26. SUMMARY OF MSTRAC MEETING (#1)

An initial meeting of MSTRAC was scheduled during the Hamburg IAGA/IAMAP Joint Meeting (August 1983) for a twofold purpose:

1) To assess the interest of the MAP community with regard to an interchange of sampled data from a variety of MST/ST radar facilities. Such an interchange could occur between facilities or between a specific radar facility and an interested analysis group.

2) To discuss possible data formats for the distributed data.

Seven scientists were able to be present at this meeting and their names and institutions are addended to this summary report. Apart from the attendees, a total of eight separate expressions of interest in the program were reported. This list is also attached.

With regard to the first purpose of the meeting, the collective number of attendees and requests for data indicated that MSTRAC could fill a need to initiate communications between data users and facilities (it should be stressed that the purpose of MSTRAC is primarily to initiate and coordinate such an interchange and not to function as a general clearing house for data interchange).

Regarding the second purpose, a number of points were brought out during the discussion of the possible data formats for interchange, and these are listed below. They should be considered only as a consensus of the attendees. Further comments and opinions would be welcomed.

1) The initial data interchange is intended to acquaint interested members of the scientific community with the data-gathering methods of individual facilities. Additional interchange of a more extensive data set should be initiated between the interested parties and not through MSTRAC.

2) The initial data should be considered as "free" data, namely, to be examined and analysed by the user as needed. In the event that this process results in a publication, it is suggested that a preprint be sent to the originating facility as a courtesy. This also helps to prevent the novice user from falling into the morass of artifactual errors well known to the experimenter but possibly not known to the neophyte user.

3) Insofar as possible, the data set format should consist roughly of one-minute data points of the first three spectral moments (echo power, mean velocity, spectral width) or their equivalents in the time domain. Noise levels should also be included if possible. The sampled data set would then comprise a few days of data at a number of heights in the troposphere, stratosphere, mesosphere, or any combination thereof.

4) Finally, it was suggested that MSTRAC attempt to determine a catalog of existing data at each of the facilities that could be of some use for possible intercomparisons. Pertinent inquiries toward this end will be made during the next few months.

MSTRAC Meeting Hamburg (August 24, 1983)

Attendees

S. K. Avery, USA
B. B. Balsley, USA
S. A. Bowhill, USA

W. G. Elford, Australia
S. Fukao, Japan
S. Kato, Japan
L. Thomas, United Kingdom

<u>Requests Received</u>

Ginzburg	Gorki State University, U.S.S.R.
J. Lastovicka	Geophysical Institute - Prague, Czechoslavkia
K. K. Mahajan	N.P.L., India
Narayanan	India
RamanaMurty	N.P.L., India
B. V. RamanaMurty	Pune, India
Y. V. RamanaMurty	Fed. Republic Germany
Yang	Beijing, China
Zhuang	Beijing, China

ATTACHMENT 27. MINUTES OF THRID EXPERIMENTERS MEETING OF PROJECT MAP/WINE (HAMBURG, AUGUST 20, 1983)

The agenda of the Third Experimenters Meeting of the Project MAP/WINE is attached to these minutes. It is used in the following as a guideline for my report on the results of the meeting.

(1) Recent Developments

Many of the recent developments are described in the attached document "Planned Activities for the Field Campaign..." (status: Sept. 1, 1983). Some items, not mentioned in the Planned Activities Document are:

a) A correction to the minutes of the 2. Experimenters Meeting is that the CNIRPS instruments aboard the M-T payloads will measure 4x ozone and 4x water vapor.

b) It has been confirmed that F. Schmidlin of the NASA Wallops Flight Facility will participate in the MAP/WINE campaign in Scandinavia and that he will also conduct processing and analysis of MAP/WINE meteorological rocket data at Wallops.

c) Two enclosed data questionnaires inform you about the participation by G. Keating and J. Lastovicka in the MAP/WINE project.

d) Through hardware and software contributions by the AF Geophysics Laboratory, the University of Bonn, and the DFVLR/Mobile Raketenbasis it will be possible to evaluate the metrocket data at ARR and FU Berlin will be performed via telefax.

e) There are a number of changes and additions to the MAP/WINE Mailing List, a revised edition of which is enclosed.

f) For European scientists the following data from the SME satellite are available through Dr. K. H. Fricke, Physikalisches Institut, Universitat Bonn:

ozone from airglow	Jan. 1 - June 29, 1982
ozone from UV	Jan. 1 - June 29, 1982
temperature (36 to 50 km)	Jan. 1 - Apr. 30, 1982

More data are forthcoming in the near future.

(2) Status of Preparations

Basically all planned activities are on schedule.

(3) Dates of Arrival of Personnel of the Ranges

M-T	BUGATTI	Nov. 1
"	IOMAS	Nov. 5
M-E		Dec. 5
M-I		Nov. 28
M-S		(Nov. 10)
M-W		?

Agenda Items 4 - 8

Results of the discussions on these agenda items have been incorporated in the Planned Activities Document (with status of Sept. 1, 1983).

(9a) Next Experimenters Meeting

It was agreed to schedule the next (4th) Experimenters Meeting for the Monday and Tuesday following the COSPAR 1984 Conference, that is July 9 and 10, 1984 at the Institut fuer Nachrichtentechnik und Wellenausbreitung, Technische Universitat Graz, Inffeldgasse 12, Graz, Austria.

(9b) First Major Presentation of MAP/WINE Results at an International Conference

It was agreed to have such a presentation during the 5th Scientific Assembly of IAGA (jointly with ICMUA) in Prague, Czechoslovakia in the period August 5-17, 1985.

For preparation of the presentations we will need a workshop (= 5th MAP/WINE experimenters meeting) before the deadline of abstracts to the IAGA conference, preferably in central Europe. This workshop shall last 3 working days. I will be grateful for your suggestions, where and when to arrange this workshop.

(10) Miscellaneous

a) Dr. Witt suggested a number of launch constraints for the M-W payloads. The conditions preferred by him are now incorporated in the Planned Activities Document. It will need further contact between Dr. Witt and me to find out how strict these launch constraints have to be met for launches of M-W payloads.

b) Dr. Thrane accepted the task of making sure that the radiosondes from Bodo and Stravanger will be launched on special high-altitude balloons on the days of M-T payload launches.

c) Beginning December 15, 1983 the Meteorologische Institut, FU Berlin will add one of the following 4 messages to its regularly issued stratalerts:

- MAP/WINE not concerned.
- Salvo D perhaps after (December ...)
- Salvo D scheduled for (January ...)
- Salvo D launched on (January ...)

d) Some discussions took place on the details of how the participants in the MAP/WINE field campaign will be notified after Christmas 1983 when it was decided that at least one representative of each participating nation will be contacted by phone and/or TWX from ARR as soon as a decision has been reached to resume the launchings. Quite a number of details have yet to be worked out, however.

e) Dr. E. Thrane made a brief presentation of his proposed "EPSILON Program" which is aimed at a study of turbulence in the mesosphere and lower thermosphere in the autumn of 1986. Anyone interested in this program should get in contact with Dr. Thrane.

U. von Zahn

Third Experimenters Meeting of Project MAP/WINE
(Hamburg, August 20, 1983; building A,)
room A 11

AGENDA

1.	Welcome and report on recent developments (by von Zahn)	9:00 a.m.
2.	Status of range preparations IR instrumentation lidar instrumentation MST radar payloads	9:15 a.m.
3.	Dates of arrival at the ranges of personnel and payloads	9:45 a.m.
4.	Sequence of launches within the salvos	10:00 a.m.
5.	Launch conditions for - salvos - M-T Payloads - falling spheres	10:15 a.m.
6.	Launch constraints	11:30 a.m.
7.	Stratalert operations and travel	11:45 a.m.
8.	EISCAT in MAP/WINE	12:00 noon
9.	Future experimenters meetings and conference presentations	12:15 p.m.
10.	Epsilon-program	12:30 p.m.
	Close of meeting — the latest at	1:00 p.m.

Only the start time of the meeting should be considered firm.

MAP/WINE Data Specification

I am proposing to share with scientists participating in the project MAP/WINE the following geophysical and/or meteorological data:

Name: Jan Lastovicka, Geophysical Institute, Czechosl. Acad. Sci., Bocni II, 141 31 Prague 4, Czechoslovakia
Telephone no.: Prague - 762548
Telex no.: 121546 ionp c

Parameter(s) to be measured: (a) A3 HF radio wave absorption
(b) SID monitoring
(c) A3 LF radio wave absorption

Parameter(s) to be derived from the measurement(s):
conditions in the lower ionosphere

Instrument used for measurement: radio wave receivers
Location(s) of observation: (a), (b) - Panska Ves, (c) - Pruhonice near Prague
Altitude range: about 60-100 km integral information
Altitude resolution:
Time period of measurement(s): continuous (since 1960)
Frequency of repetitive measurement during observation period:
continuous measurements

Special conditions for the observations:

- only daylight	(a)	yes	not applicable
- only nighttime			not applicable
- only clear sky			not applicable
- only weekdays			not applicable
- only on special			not applicable
- essentially daylight	(b)	yes	
- essentially nighttime	(c)	yes	

The data, which I expect to make available for MAP/WINE data exchange, will be processed on the following type of computer:

The preferred means of data transfer is:

- number listings	no
- punched cards	no
- magnetic tapes	no
if yes, which type	
- graphs, maps	no
- other means	Table of SID events and of half-hour (a) or routine special-interval (c) average absorptions. Copies of original records, if required.

I estimate the time after collecting the raw data required to prepare the data into a form suitable for exchange to be:

Information is regularly available: (b) - once a day
(a), (c) - once a month

If required, may be available: (b) - immediately
(a), (c) - once a day

15 August 1983
Date

J. Lastovicka
Signature

MAP/WINE DATA SPECIFICATION

I am proposing to share with scientists participating in the project MAP/WINE the following geophysical and/or meteorological data:

Name: G. M. Keating, NASA Langley Research Center, MS 401 B, Hampton, VA 23165

Telephone No.: (804) 865-2084

Parameter(s) to be measured:

3175 A & 3600 A backscattered radiation

Parameter(s) to be derived from the measurement(s):
total column ozone & albedo

Instrument used for measurement:
spin-scan imaging system aboard Dynamics Explorer I

Location(s) of observation:
Polar orbit about 20,000 km above Atlantic Ocean allows ozone and cloud images every 12 minutes covering North Atlantic and Europe.

Altitude range:
column measurement

Altitude resolution:
Ozone variations high correlated with dynamics near tropopause.
Spatial resolution 100 km

Time period of measurement(s):
Nov. 83 - March 84 with best measurements in March 1984.
Measurements obtained on dayside from morning to evening.

Frequency of repetitive measurement during observation period:
12 minutes

Planned Activities for the Field Campaign of the Project "Winter in Northern Europe (WINE)" of the "Middle Atmsophere Program (MAP)"

(Status: Sept. 1, 1983)

Abstract: This report summarizes the currently planned activities during the winter 1983/84 for the project "Winter in Northern Europe (WINE)" of the "Middle Atmosphere Program (MAP)". It delineates the observational periods and launch criteria for the planned ground-based, air-borne, balloon-borne, rocket-borne, and satellite-borne observations.

1. INTRODUCTION

The project MAP/WINE is aimed at the study of the structure and dynamics of the middle atmosphere above northern Europe from about 50°N to 80°N during the winter season 1983/84. The project MAP/WINE will be concentraring on the following science goals:

(a) To measure the morphology of small-scale dynamic features, such as turbulent structures, gravity waves, and tidal waves in the winter mesosphere, to study the control exerted by gravity waves and tides on the mean flow in the mesosphere, and to develop improved parameterizations of the interactions of small-scale dynamic processes with mesospheric temperature, structure, and mean flow.

(b) To study sudden stratospheric warmings, their cause, the time history of their large-scale spatial structures, and in particular their effect on the mesosphere temperature and dynamics.

(c) To study the effects of dynamics and temperature structure on the distribution of minor constituents, including ionospheric plasma, in the middle atmosphere.

(d) To intercompare established and recently developed remote sensing and in-situ techniques for measuring mesospheric parameters.

A more extended outline of the MAP/WINE science background and objectives, as well as a listing of the parameters to be measured during the MAP/WINE campaign, has been given by von Zahn (ESA SP-183, pp. 147-159, 1983). This report shall summarize the currently planned activities during the winter 1983/84 MAP/WINE campaign. It delineates the status of preparations, observational periods, and launch criteria for the planned experiments and observations.

2. GROUND-BASED OBSERVATIONS

2.1 Overview

Various methods will be employed to measure density, temperature, a number of dynamics parameters, and selected trace constituents of the middle atmosphere by means of ground-based methods. These experiments shall start routine data recording on November 1, 1983 and operate until March 15, 1984.

2.2 Optical Methods

2.2.1 Passive Techniques

The following airglow emissions will be measured during any clear night of the observation period:

C-2

- OH^*	spectrophotometer	at Andenes, Norway	(69°N)
	interferometer	at Skibotn, Norway	(69°N)
	spectrometer	at Kiruna, Sweden	(68°N)
	interferometer	at Kiruna, Sweden	(69°N)
	spectrophotometer	at Lista, Norway	(58°N)
- OI	interferometer	at Skibotn, Norway	(69°N)
	interferometer	at Kiruna, Sweden	(68°N)
- $O_2(^1\Delta)$	radiometer	at Kiruna, Sweden	(68°N)
- N_2^+	interferometer	at Kiruna, Sweden	(68°N)

Furthermore, the total amount of ozone will be measured by means of a Dobson spectrophotometer at Oslo (60°N).

2.2.2 Active Techniques

In order to determine middle atmosphere density and temperature profiles from the measurement of Rayleigh backscatter, lidar experiments will be operated at

- Heiss Island (81°N)
- Skibotn, Norway (69°N)
- Andoya, Norway (69°N)
- Aberystwyth, UK (52°N)
- Garmisch, FRG (48°N)
- Obs. Haute Provence, France (44°N)
- Bedford, US (42°N)

All these stations are already in operation, except for the ones at Andoya and Bedford. The preparations for the latter two are on schedule, however, and they are expected to start their measurements before or at November 1, 1983.

The station in Andoya is designed to measure in addition temperature profiles for the altitude region 80 to 100 km from the measurement of the Doppler width of the $Na(D_2)$ hyperfinestructure lines.

2.3 Methods Employing Radio Waves

Active (radar) techniques for measuring electron density, wind, and turbulence in the mesosphere and lower thermosphere are employed at various locations. Ordered in terms of their transmitted frequencies these are:

2.3.1 Spaced Antenna Drifts Radar and Partial Reflection Radar (0.1 to 3 MHz)

Designed to measure the wind vector and/or turbulence in the altitude region from 60 to 120 km the following existing stations participate in MAP/WINE:

- Ramfjord, Norway (70°N)
- Gorki, USSR (56°N)
- Irkutsk, USSR (54°N)
- Saskatoon, Canada (52°N)
- Collm, GDR (51°N)

2.3.2 Microsonde and Ionosonde (0.2 to 10 MHz)

Designed to measure electron density profiles vs. virtual height in the ionosphere a microsonde is operated at Aberystwyth, UK (52°N) and numerous ionosondes are in operation in western and eastern Europe.

2.3.3 Meteor Wind Radar (appr. 40 MHz)

Designed to measure profiles of the wind vector in the 80 to 110 km altitude region the following existing meteor wind radar facilities participate in MAP/WINE:

- Heiss Island, USSR (81°N)
- Obninsk, USSR (55°N)
- Sheffield and Aberdeen, UK (53°N/56°N)
- Kuhlungsborn, GDR (54°N)
- Volgograd, USSR (48°N)

2.3.4 MST Radar (53.5 MHz)

The SOUSY MST radar of the Max-Planck-Institut fur Aeronomie is currently being installed on the island Andoya, about 4 km south-west of the Andoya Rocket Range (ARR). It will have the capability of measuring in the vertical and in 3 different off-vertical directions (towards the north-west, north, and north-east). Routine operational data taking by this installation is foreseen to start about November 15, 1983.

2.3.5 Incoherent Scatter Radar (933 MHz)

The tristatic UHF system of the EISCAT facility near Tromso, Norway (70°N) will be in full operation during the winter 1983/84. In support of MAP/WINE science goals it can be used in particular to determine temperature, wind vector, and electron density in the lower thermosphere with a height resolution down to 1 km. The steerability of the UHF system will allow to measure the geographical distribution of some scalar parameters within some 100 km distance around Tromso.

Within the EISCAT Sci. Association a MAP/WINE Working Group (chairman Dr. J. Roettger) has been set up to enhance and coordinate the MAP/WINE related activities involving EISCAT.

3. AIR-BORNE OBSERVATIONS

A DFVLR jet plane carrying the air-borne microwave radiometer of the Max-Planck-Institut fur Aeronomie / Universitat Bern will arrive at Kiruna on December 12, 1983. It will be available for measurements of middle atmosphere temperature, water and ozone profiles jointly with a M-T payload (see 5.3.3) sounding in the period from December 13 through 15. This M-T payload shall contain the ion mass spectrometer.

4. BALLOON-BORNE OBSERVATIONS

Radiosonde data will be received from many stations via the appropriate WMO channels. For processing and analyzing the data obtained from metrockets at Andoya and Lista, the radiosonde ascents from Bodo and Stavanger, respectively, are of particular importance. A special effort is under way to have the stations at Bodo and Stavanger launch their radiosondes on special high-altitude balloons (reaching at least 30 km/10 mb) on the days of the M-T payload launchings.

At ESRANGE such high-altitude balloons are launched routinely once a week to obtain information on high-altitude winds. These balloons will also be made available in connection with the launchings of sounding rocket salvos D and R (see 5.3.2). If supplemented by radiosondes and appropriate TM equipment at the ground, these soundings would also yield pressure and temperature information.

5. ROCKET-BORNE OBSERVATIONS

5.1 Meteorological Rockets

5.1.1 Overview

Both the US and the USSR carry out regular metrocket soundings from a number of launch sites. On behalf of MAP/WINE the number of soundings carried out by the USSR will be increased beyond the normal level. Furthermore, a regular schedule of metrocket launches for MAP/WINE will be instituted from two Norwegian sites.

With respect to the science objective of MAP/WINE, the data obtained from metrocket soundings are essential

- to enhance and support studies of large-scale dynamic processes in the stratosphere and

- to enhance and support studies of small-scale dynamic processes in the mesosphere.

The planned metrocket soundings can loosely be subdivided into

- routine launchings, taking place at one or more fixed days each week,

- special MAP/WINE launchings, supporting studies of special geophysical events such as sudden stratospheric warmings or enhanced gravity wave activity.

Routine launchings will take place from the following sites (only those north of 40°N are listed):

Heiss Island, USSR	81°N / 58°E
Andoya, Norway	69°N / 16°E
Lista, Norway	58°N / 7°E
Primrose Lake, Canada	55°N /110°W
Shemya, US	53°N /175°E
Volgograd, USSR	48°N / 46°E
Akhtopol, Bulgaria	42°N / 28°E

The launch site at Lista will be installed and operated especially for the MAP/WINE project. A total of 5 metrockets will be launched in addition from ESRANGE (68°N/21°E) in support of the sounding rocket salvos D and R (see 5.3.2). The nations supporting these metrocket launchings are the US, USSR, and Fed. Rep. of Germany.

At all Scandinavian and US sites the payloads will consist of datasondes which provide information on wind below about 70 km and temperature below 65 km when in darkness (below 60 km when sunlit). Only at the Andoya Rocket Range additional metrockets will be launched carrying passive falling spheres (more than 50 systems) which allow to extend the density measurements up to 95 km altitude and wind measurements to 90 km.

5.1.2 Routine Launchings in the Time Period November 1, 1983 until March 15, 1984

During the MAP/WINE observational period (Nov. 1, 1983 until Mar. 15, 1984) routine launchings of metrockets will take place according to the following schedules:

Heiss Island	each Wednesday; twice weekly in Jan. and Feb, 1984
Andoya	Dec. 1983: datasondes each Wednesday and Saturday (except for Dec. 24)
	Jan. 1984: datasondes each Monday, Wednesday, and Saturday falling spheres each Tuesday, Thursday, and Sunday
	Feb. 1984: Same as in Dec. 1983
Lista	Dec. 1983: each Wednesday and Saturday (except for Dec. 24)
	Jan. 1984: each Monday, Wednesday, and Saturday
	Feb. 1984: each Wednesday and Saturday
Primrose Lake	each Wednesday
Shemya	each Monday, Wednesday, and Friday
Volgograd	each Wednesday; twice weekly in Jan. and Feb. 1984
Akhtopol	each Wednesday; twice weekly in Jan. and Feb. 1984

Launchings at Andoya and Lista are planned close to 2100 MET, those at Primrose Lake and Shemya close to local noon.

5.1.3 Special Launchings

As indicated in Table 1 metrockets will be launched in connection with the MAP/WINE sounding rocket salvos D and R. The launch sequences are defined in 5.3.2 (a).

Additional metrockets will be launched in connection with the flights of the M-T payloads from the Andoya Rocket Range (see 5.3.3(b)).

A (t.b.d.) number of additional metrocket launches will take place at Heiss Island, Volgograd, and Akhtopol in support of studies of a sudden stratospheric warming.

Table I

Use of meteorological rockets and chaff payloads at the Andoya Rocket Range, Lista, and ESRANGE

Range	Project		Data-sondes		Falling spheres	Chaff
ARR	(a) Routine soundings		30		30	
	(b) Salvos		2		4	4
	(c) M-T launchings	about	3	about	3	10
	(d) Optional programs				14	
	(e) Spares *)		5		7	4
		Total	40		58	18
Lista	(a) Routine soundings		30			
	(b) Salvos					
	(c) M-T launchings					
	(d) Optional programs					
	(e) Spares		5			
		Total	35			

ESR	(a) Routine soundings	
	(b) Salvos	4
	(c) M-T launchings	
	(d) Optional programs	
	(e) Spares	1
	Total	5

*) Spares estimates:
approx. 15% for datasondes and for falling spheres,
approx. 30% for chaff payloads.

5.1.4. Optional Launchings

About 14 falling sphere systems are available at ARR for optional launchings. The MAP/WINE Working Group recommended the following priorities for the science objectives of such programs:

(1) Obtain falling sphere soundings once a day throughout a sudden stratospheric warming, in particular in the days between the salvo D and salvo R.

(2) Study the spectrum and propagation properties of gravity waves in the mesosphere through a series of falling sphere launches with temporal separations in the order of 20 minutes.

5.1.5. Test Launchings

Two test launches of the VIPER 3A/falling sphere system and one of the stretched Super Loki/chaff system will be performed at the NASA Wallops Flight Center during the week of September 12, 1983.

One test launch of the Super Loki/datasonde system will be performed at each ARR and Lista on November 30, 1983.

5.2 Chaff Clouds

On a number of occasions clouds of chaff will be produced and tracked by radar to determine mesospheric winds, including their vertical components. 18 such payloads will be available at Andoya, and 14 each at Heiss Island and Volgograd. These numbers are clearly not large enough to include chaff launchings into the routine launching program. Hence they are destined for the special launch programs.

The chaff payloads available at Andoya will all be launched in conjunction with the sounding rocket salvos D and R, as well as with the other M-T payloads (see Table 1). Due to the use of a stretched Super Loki booster it is expected that these experiments will give quantitative information on horizontal and vertical winds in the (80) to 95 km altitude region.

5.3 Sounding Rockets

5.3.1 Overview

For launch from ARR and ESRANGE a total of 16 major sounding rockets are available for a study of the winter mesosphere and lower thermosphere. Their instrumentation is briefly listed in Table 2. Ten payloads are designated for launch from ARR. The remaining six will be launched from ESRANGE, because they all carry recovery systems.

The 16 payloads divide into five different types: 4 types come in pairs of two payloads each (that is M-E, M-I, M-S, and M-W) and one type is available eightfold (M-T). Of the latter, 6 payloads will be used to study structural, dynamical, and compositional parameters of the altitude region conditions. The remaining 5 pairs of payloads will be arranged in 2 salvos, these salvos shall be launched close to the peak of a sudden stratospheric study conditions during the recovery phase after the sudden warming. It is designated salvo R (for "recovery").

Major stratospheric warmings are relatively rare events, occurring on average once every two winters. Of all those recorded so far, about 50% started to develop in the last week of December. Therefore, in order to maximize our chances for a study of a major stratospheric warming two demands on the overall campaign organisation are to be observed:

- all payloads shall be fully integrated and checked-out at their respective ranges before the Christmas break in range operations. This is to allow reasonable dense launch schedules right after Christmas in the case that a sudden stratospheric warming is then occurring,

- the (unavoidable) Christmas break in launch operations shall be kept as short in time as possible.

5.3.2 Salvo Launchings

(a) Launch Sequences

TM and/or radar tracking times for the various payload types are estimated as follows:

M-T	6 min
M-E	30 min
M-I	15 min
M-S	45 min
M-W	15 min
M-M(d) = datasonde	45 min
M-M(s) = falling sphere	20 min
M-C = chaff cloud	30 min

The sequence of launches during the two salvos shall be as follows:

ARR: M-C, M-M(d), M-M(s), M-T, M-E, M-M(s), M-C
ESR: M-M(d), M-I, M-W, M-S, M-M(d)

For ARR the salvo is estimated to take about 3.5 hr. At ESR the sequence of M-W and M-S launches may be reversed in order to accommodate better the lunar launch constraints of M-W.

At the two ranges the payloads M-T and M-I should be launched simultaneously (within a few minutes). All other launches shall take place as close in time as possible to the M-T and M-I launches. To this end the M-T payload shall not be tracked by radar, but rely on slant range information for trajectory reconstitution. The time separation of the M-T and M-E launches shall again be as short as possible (primarily determined by the necessity to switch the range telemetry station from M-T to M-E channels).

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Table 2. MAP/WINE rocket soundings.

Payload Designation	M-M (metrockets)						M-T	M-.	M-S	M-E	M-C	M-W
Payload Representative	von Zahn			Kokin			Thrane	Grossmann	Arnold	Holtet	Widdel	Witt
Status of Payload	confirmed			proposed			confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
Instruments	data sondes and Robin spheres	data sondes	data sondes and Robin spheres	data sondes and additional instruments			CNIRPS, BUGATTI/IOMAS, particle counter, Gerdien Probe, Faraday antenna	IR spectrometer, O res. lamp, IR photometer, electron spectrometer	2 parachute-borne mass spectrometers (= STRAFAM)	electric field measurement, precision falling sphere.	chaff	4 reson. lamps for O,Ar,Kr,Xe
Countries Contributing to Payload	G, US			USSR			G, N, A	G	G	N, US	G	S, UK
Number of Payloads	45 + 58	30	5	52	52	36	8	2	2	2	18	2
Motor	Super Loki/Viper 3A			M-100 B			Nike Orion	Skylark	Orion	Nike Orion	Super Loki	
Apogee	85 km/115 km			85 km			122 km	180 km	75 km	120 km	100 km	
Launch Site	ARR Norway	Lista Norway	ESR Sweden	Heiss Isl. USSR	Volgograd USSR	Akhtopol Bulgaria	ARR	ESR	ESR	ARR	ARR	ESR

Comments:
- CNIRPS = cryo-cooled narrow-band IR photometer system (2 channels)
- BUGATTI = Bonn University gas analyzer for turbulence and turbopause investigations
- IOMAS = ion mass spectrometer (cryo-cooled)
- ARR = Andoya Rocket Range
- ESR = Esrange

A = Austria
G = Fed. Republic of Germany
N = Norway
S = Sweden
US = United States of America
USSR = Union Soc. Soviet Rep.

Four M-T payloads will contain the BUGATTI instrument, and four will contain the IOMAS instrument. In addition, 15 MR-12 sounding rockets will be launched from Heiss Island by the Inst. Appl. Geophys., Moscow, USSR.

(b) Trajectories

The launch azimuth and elevation of the M-T and M-E payloads shall be chosen such that both payloads sample about the same volume at their downlegs near the 100 km level.

(c) Launch Criteria

Launch criteria for the salvo D are:

- launch at or after December 29, 1983
- the temperature at the 90 km level above Andoya, as monitored by the OH*-spectrophotometer and the Na hyperfinestructure lidar, has dropped 15 K below its mean level 30 days previous to the launch date. To obtain a maximum amount of information on the behavior of the mesopause temperature the above-mentioned two experiments will be kept in operation also throughout the Christmas period.
- the radiances from the channel 26 (centered at 4 mbar) of the SSU aboard the NOAA satellites have risen at least 15 $mW/m^2 sr\ cm^{-1}$ over a time period of 5 days. The implied temperature rise must not necessarily occur over Scandinavia, rather than anywhere north of 40°N and in the longitude band 0° to 90° E.
- zero to moderate geomagnetic activity

Launch constraints for the M-T and M-I payloads within salvos D and R are

- solar zenith angle $>$ 102°
- local time: after 1800 MET
- no clear sky required
- no constraint due to position of the moon

Launch constraints for the M-W payloads within salvos D and R are
- solar zenith angle $>$ 100°
- lunar zenith angle $>$ 85°
- auroral conditions: green line intensity $<$ 10 kR. No auroral arc in launch direction

In the event that no sudden stratospheric warming develops, launching of salvo D will take place February 1, 1984.

(d) Stratalert

To trigger the launches of salvo D and R a dedicated alert system for sudden stratospheric warmings will be set up and operated by K. Labitzke (Freie Universitat Berlin) and myself. Evaluations of the stratospheric and, as far as possible, the mesospheric meteorological situation will be done daily on the basis of

- satellite remote sensing data, in particular from the NIMBUS 7, NOAA, and SME satellites,
- ground-based measurements of the mesosphere and mesopause temperatures, and
- in situ measurements by radiosondes and metrockets.

In the case that a sudden stratospheric warming develops right after Christmas 1983 a stratalert would be issued about 1500 MET at December 27, 1983 by the project scientist via telephone and/or telex. This alert would trigger all persons participating in salvo D launchings to travel to the ranges on December 28. Metrockets would be already launched on December 28. Salvo D would follow on December 29.

In the unlikely, but not impossible case that absolutely no sudden stratospheric warmings occur, persons would stay home at standby until January 23, 1984 the latest. Under these circumstances once weekly launches of M-T payloads would be resumed (see 5.3.3) on January 25, 1984. Launching of salvo D would then occur February 1 and that of salvo R two to three weeks after salvo D, depending on the meteorological conditions,

5.3.3 M-T Payloads

(a) Composition and Launch Criteria of M-T Payloads

No.	Launch Date or Allocation	Type of Spectrometer	CNIRPS	Geomagnetic Activity
1	Dec 7	BUGATTI	O_3	0.1 to 0.5 dB
2	Dec 14	IOMAS	H_2O	0.5 dB
3	salvo D	BUGATTI	H_2O	0 to moderate
4	salvo D + 4 days	IOMAS	(tbd)	< 0.5 dB
5	salvo D + 9 days	(tbd)	(tbd)	< 0.5 dB
6	salvo R	IOMAS	O_3	0 to moderate
7	clear sky program	BUGATTI	O_3	0.1 to 0.5 dB
8	spare	(tbd)	(tbd)	tbd

Payloads no. 7 and 8 could be launched at any date during the field campaign at ARR, except for the time period Dec. 16 through Dec. 28, 1983.

Further launch constraints for M-T payloads, which also apply to their launches within salvos D and R, are:

- solar zenith angle < 102°
- local time: after 1800 MET
- no constraint due to position of the moon
- clear sky much desired, but not required for payloads no. 1 through 6
- clear sky required for launch of payload no. 7

As indicated above, a clear sky is not a requirement for launching the M-T payloads no. 1 through 6. At least one payload, however, shall be launched with clear sky and only after the OH*-spectrophotometer, the Na-lidar, and the MST radar have obtained continuous data for more than 3 hours. This M-T payload shall contain the BUGATTI mass spectrometer and a CNIRPS instrument measuring ozone.

(b) Launch Sequence for M-T Payloads

For each of the M-T payloads no. 1, 2, 4, 5, 7, and 8 the launch sequence shall be

M-C, M-T, M-M(s), M-M(d), M-C

(c) Trajectory Reconstitution

The first two M-T payloads (launched in December 1983) shall be skin-tracked by the MPS-36 radar. This will allow a comparison of the trajectories obtained from the radar and from the slant range system incorporated in the payloads. In subsequent launchings of the M-T payloads, the radar will be used to track either falling spheres or chaff clouds launched near-simultaneously with the flight of the M-T payloads.

(d) Miscellaneous Items

All M-T payloads are equipped with an ejectable, split nose cone of new design.

The nominal spin rate of the payloads has been chosen as 4 + 1 rps. The current estimate on the apogee of the M-T payloads is for the

BUGATTI	version	123.9 km
IOMAS	version	121.4 km

5.3.4 Soviet Sounding Rockets

About 15 MR-12 sounding rockets will be launched from Heiss Island, USSR in January/February 1984 in close coordination with the launch activities at ARR and ESRANGE.

6. SATELLITE-BORNE OBSERVATIONS

Quick-look data from the satellites NIMBUS 7, NOAA, and SME will be transmitted to the Freie Universitat Berlin within 24 h after sampling the data. There they will be analyzed, jointly with the ground-based and metrocket data, to provide a picture of the meteorological state of the stratosphere and lower mesosphere in the Northern Hemisphere. This information will be transmitted via telefax to the project office at the Andoya Rocket Range for use in the day-to-day campaign planning.

U. von Zahn

Mailing List for the MAP/WINE Project
(Status: Sept. 1, 1983)

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Dr. H. Auchter, FRG
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Dr. J. J. Barnett, UK
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Dr. R. D. Bojkov, Switzerland
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Prof. P. Blum, FRG
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ATTACHMENT 28. IGBP PROPOSAL

From a talk by Academy member Herbert Friedman leading off a symposium, "The Legacy of the IGY," during the 120th annual meeting of the National Academy of Sciences, April 1983.

The success of the International Geophysical Year (IGY) has prompted contemporary geoscientists to consider the possibility of a second generation IGY, to which we have tentatively given the name International Geosphere-Biosphere Program (IG-BP). Biosphere studies were essentially neglected during the IGY but concern for the environment has heightened our awareness of the need for scientific understanding of atmospheric pollutants and biogeochemical cycles, and of the links between geophysical and biological processes.

IGBP is still an unstructured concept. It is essential that the programs be global in character to derive substantial benefits from international cooperation. The science involved must have strong cross-disciplinary content to connect the diversity of scientific subdisciplines that constitute the whole of geoscience.

It is possible to frame scientific programs of a global character with well defined emphases in several major categories, i.e., solar-terrestrial relationships, lithospheric dynamics, oceans and atmosphere, and the biosphere. Within each of these major blocks of geoscience the value of organized international cooperation is unquestioned. In each major block many special projects are already planned or under serious discussion. The question we raise is whether a general umbrella plan for all of these major blocks of geoscience can be formulated to enhance the cross-disciplinary exchange of ideas in such a way that the totality of scientific progess will be greater than the sum of the constituent parts.

If we search for cross-disciplinary connections they turn out to be more common than uncommon. Let me offer some examples, using such widely separated elements as the sun and the earth.

*We learn about the interior of the earth from seismology. In the past decade, solar physicists have taken their cue from seismologists and used observations of solar vibrations to learn about the interior of the sun.

*NASA has on the drawing board a project called "Starprobe" which will approach within four solar radii in a highly eccentric orbit and measure the mass distribution of the solar interior just as geosatellites have done for the earth and lunar orbiters for the moon.

*Solar magnetism is related to its internal spin and convection much as we believe terrestrial magnetism derives from rotation and convection in the earth's liquid core. Solar magnetism reverses every 22 years, terrestrial magnetism every million years. The similarities, in principle, of the physical processes are impressive.

Unlike the IGY, which was planned to run less than two years, the IGBP must be designed to cover one or two decades because many of the natural geosphere-biosphere cycles are that long or longer.

IGY contributed greatly to international understanding, but the stimulus for international cooperation has been wearing thin over the years. I believe we should try to revive it again.

ATTACHMENT 29. REPORT ON THE ICSU COLLOQUIUM ON GLOBAL CHANGE

Warsaw, August 3, 1983

by Juan G. Roederer

The origin of the Colloquium goes back to reflections on the IGY and post-IGY programs at the ICSU General Assembly in 1982, and to discussions by several groups on the desirability of exploring a major international program which would focus on the interactions among physical, chemical and biological processes that link the principal components of the geosphere-biosphere system, namely the atmosphere, the oceans, the lithosphere and the solar-terrestrial chain. The program would have a strongly interdisciplinary character, would build on and strengthen ongoing programs with congruent objectives, would incorporate latest developments in techniques, instrumentation and data handling and analysis capability, and would have as central ultimate goal the enhancement of our ability to manage more intelligently the processes relevant to biological productivity and human habitability.

The declared objective of the Colloquium was to initiate a discussion among a small group of people concerning a scientific strategy for a program along the above-mentioned lines that would be attractive to the international scientific community and make pertinent recommendations to the ICSU General Committee.

The Colloquium consisted of formal presentations and a general discussion. The formal part started with a report by J. G. Roedererон a Workshop held by the US National Academy of Sciences the week before, on the subject "Toward an International Geosphere-Biosphere Program" (IGBP), which concluded that "a major program focussing on the interaction between the intervening systems of the geosphere-biosphere and their dynamic change is of sufficient scientific and practical importance, that consideration of this issue by ICSU during the next 12 months is warranted and thus should be supported". This presentation was followed by a presentation by R. West from IAU, who emphasized the importance of comparative planetology for a comprehensive study of global change. Dr. H. J. Bolle reported on existing and planned COSPAR-sponsored programs relevant to the subject under discussion. Academician N. M. Emanuel presented four suggested biological problems of relevance, and E. A. Flinn discussed the International Program on the Lithosphere and its implications on the proposed program under discussion.

During the general discussion, consensus was reached on the following points:

1. Desirability of defining a major program which would be carried out under ICSU auspices before the end of the century, concerning global change and related processes in the geosphere-biosphere, including the impact of human activity on the system.

2. The program should be truly interdisciplinary, focus on interactions between components, not limited to just a few disciplines and not necessarily limited to the natural sciences only.

3. The program should only include those tasks that demand international cooperation and concentrate on studies that cannot be carried out in traditional fashion.

4. The program, while interdisciplinary, should focus on a very limited number of major areas or projects, and have a well-defined time-scale. However, individual disciplines may set up "satellite" or "tributary" projects feeding crucial information to the main international program.

5. The program should pay special attention to new techniques, especially for handling and analysis of large data bases on an international basis.

6. The program should involve developing countries and if possible help promote scientific activity and education in these countries.

The following steps and courses of action were recommended to the ICSU General Committee:

(i) That a study be undertaken to define such a program
(ii) That a small group of persons be charged with
- (a) making an inventory of existing and planned relevant programs and their interrelations
- (b) identifying areas which are not adequately covered
- (c) select those areas which conform to the above-mentioned key points 1-6
- (d) define the program in detail after appropriate consultation
- (e) organize a Symporium on Global Change to take place prior to the 20th General Assembly of ICSU in Ottawa in 1984.

(iii) Based on the comments from ICSU members and on the work of the Symposium, a comprehensive recommendation for further action would be addressed to the General Assembly.

The ICSU General Committee endorsed these recommendations on August 4 and established the ad-hoc group with T. F. Malone and J. G. Roederer (both USA) as chairman and co-chairman, respectively, and the following initial core of members: E. Ayensu, H. Bolle, E. Flinn, J. LaRiviere, W. Manshard, R. Stewart and R. West (ex officio). Additional members will be appointed from within and outside ICSU.

ATTACHMENT 30. XVIII GENERAL ASSEMBLY OF THE IUGG

Hamburg, August 15-27, 1983

Excerpts of the ICMUA President's Report

"...Both the Solar/Terrestrial Relations Group (Dr. A. D. Belmont) and the Middle Atmosphere Climatology Group (Prof. K. Labitzke) are holding organizational meetings at this Assembly, as is the Noctilucent Cloud Group (Dr. O. Avaste), which is also preparing a "state of the art" report and planning a workshop to be held in Tallin in August, 1984.

The Working Group on Tides in the Middle Atmosphere (Dr. J. M. Forbes) is holding its first workshop during this Assembly. In addition to chairing this working group, Dr. Forbes is also chairman of ATMAP, Atmospheric Tides in the Middle Atmosphere Project, a MAP committee. ATMAP will coexist with the ICMUA Working Group, with the latter having somewhat different and longer term goals, including the development of models, providing contributions to reference atmospheres, development of improved and standardized methods of data analysis, and coordination with other ICMUA working groups and interests.

ICMUA is making a large contribution to this Assembly in its involvement in two symposia, co-convened with IAGA; IUGG Union Symposium 14 (your President is co-convenor with Dr. Rex Megill of IAGA) and the Middle Atmosphere Science Symposium (co-convened by our Secretary, Dr. Adolf Ebel, and Dr. Paul Simon representing IAGA)."

ATTACHMENT 30.1. MINUTES OF THE SUB-COMMISSION ICMUA-CLIMATOLOGY OF THE MIDDLE ATMOSPHERE

Prof. K. Labitzke
ICMUA-Climatology

The group which was established via correspondence, met for the first time on 23 August, and 9 members attended.

At first the objectives of the group were discussed. There was general agreement that it would be useful to collect available information to compile a climatology of the M.A. mean state and variability. This would be a needed addition to any reference atmosphere, as e.g., the new CIRA (COSPAR INTERNATIONAL REFERENCE ATMOSPHERE) for which some members of the group are also contributing.

As a first part of this climatology, Dr. A. H. Manson (Canada) will begin compiling a Climatology of Annual Zonal and Meridional Winds Cross-Section Data (Height/Time), based on several sets of radar observations (60/80-105 km), which are available from different NH and SH stations. These will be of use for Tidal and Gravity Wave modelling, General Circulation Model output comparisons, and satellite-derived geostrophic wind comparisons.

It is tentatively planned to ask the MAP Steering Committee to publish this report as a MAP Handbook.

Membership:
The group wants to invite Dr. M. L. Chanin (France) and Dr. G. J. Fraser (New Zealand) as members.

ATTACHMENT 31. IAGA INTERDIVISIONAL COMMISSION ON THE MIDDLE ATMOSPHERE

The IAGA Interdivisional Commission on the Middle Atmosphere, at its Business Meeting during the IUGG General Assembly in Hamburg on 19 August 1983, discussed its future activities. Prof. J. Taubenheim (GDR), former Co-Chairman of this Commission, was appointed new Chairman, and Dr. P. C. Simon (Belgium) new Co-Chairman. In addition to its already existing Working Group on "Irradiances Relevant to Aeronomic Processes in the Middle Atmosphere" (Chairman: P. C. Simon), which held a meeting at Hamburg, also, the Interdivisional Commission approved the formation of two new Working Groups: "Aeronomic Processes of the Middle Atmosphere" (Chairman: G. Megie, France), and "Global Survey of Chemical Processes and Related Airglow Phenomena in the Middle Atmosphere" (Chairman: G. E. Thomas, USA). Further, the meeting considered a proposal to establish a working group on "External Forcing of the Middle Atmosphere" (e.g., forcing by events of solar origin, and by long-term or quasi-periodic variations in solar UV radiation and other agents, etc.), provided that there is a sufficient response of interest from the international scientific community. Comments and announcements of interest to the latter proposal are welcome, and should be sent to Dr. J. Lastovicka (Geophysical Institute, Bocni II, CA-14131 Prague, Czechoslovakia), who has agreed to serve as a co-chairman of the proposed working group, or to Prof. J. Taubenheim (Central Institute of Solar-Terrestrial Physics, DDR-1199 Berlin, GDR).

ATTACHMENT 32. MAP STEERING COMMITTEE

Room 05, Building A, Uuiversity of Hamburg
Hamburg, FRG

0900-1700, August 13-14, 1983

TENTATIVE AGENDA

1. Opening Remarks

2. Approval of Agenda

3. Minutes of Ottawa Meetings

4. MSG Reports: MSG-5 Ions and Aerosols - Arnold/McCormick
   MSG-6 Scientific Aspects of an International Equatorial Observatory - Kato
   MSG-7 Penetration of Solar Radiation into the Atmosphere - Frederick
   MSG-8 Atmospheric Chemistry - Witt
   MSG-9 Measurement of Atmosphere Parameters by Long Duration Balloon Flights - Blamont

5. Proposals for new MSGs

6. MAP Project Reports: AMA - Hirasawa
   ATMAP - Forbes
   CAMP - Witt
   CLIMAT - Russell
   DYNAMICS - Labitzke
   GLOBMET - Roper
   GLOBUS - Offermann
   GOSSA - McCormick
   GRATMAP - Geller
   MAE - Maynard
   OZMAP - Heath
   SSIM - Simon
   WINE - von Zahn

7. New MAP Project: MSTRAC

8. Comments by National Representatives Present at the Meeting

9. Regional Consultative Group Report - Chanin

10. Data Management Committee Report - Hartmann/Hirota

11. Publications Committee Report - Sechrist

12. Workshop Reports: PMP-1, Oxford - Labitzke
    Technical Aspects of MST Radar, Urbana-Bowhill/Liu

13. Symposium on Ground-Based Studies of the Middle Atmosphere Report - Taubenheim

14. Future Workshops/Symposia: COSPAR, First Achievements of MAP, Graz June 1984 - Labitzke
    MAP Symposium, Kyoto, November 1984 - Kato
    IAGA, MAP Symposium, Prague, 1985

15. Middle Atmosphere Cooperation (MAC)

16. Date and Location of Next MAPSC Meeting

17. Other Business

ATTACHMENT 32.1. SECOND MEETING OF THE MAPSC

Friday, August 26, 1983 1230, Room A 05

AGENDA

1. Approval of draft condensed minutes of August 13-14 meeting (distributed)

2. Report of Subcommittee on resolution for MAC -- Simon

3. Report of MSG-6, Scientific aspects of an international equatorial observatory, meeting held on August 22, and presentation of recommendation -- Kato

4. Reports of other Project and Working Group Meetings, and presentation of recommendations, if any

   (a) PMP-1 (meeting of August 17) -- Labitzke

   (b) MSG-7 Penetration of solar radiation into the atmosphere (meeting of August 22) -- Frederick

   (c) MSG-8 Atmospheric Chemistry -- Witt
   (d) ATMAP (Workshop on August 17) -- Vincent
   (e) CLIMAT (meeting of August 24) -- Russell
   (f) GRATMAP (meeting of August 24) -- Geller
   (g) MAE (meeting of August 24) -- Goldberg
   (h) MSTRAC (meeting of August 24) -- Balsley
   (i) SSIM (meeting of August 22) -- Simon
   (j) WINE (meeting of August 20) -- Labitzke
   (k) Any other reports

5. Any other business

PART 2

Research Recommendations for Increased U.S. Participation in the Middle Atmosphere Program (MAP)

Prepared by the Panel on the Middle Atmosphere Program

Preface

The Middle Atmosphere Program (MAP) is a cooperative international scientific venture spanning the years 1982-1985. The middle atmosphere is somewhat loosely defined as that region between the upper troposphere and the lower thermosphere, an approximate range of 10 to 100 km in altitude.

Within the United States, the Committee on Solar-Terrestrial Research of the National Research Council, through its Panel on the Middle Atmosphere Program, is concerned with fostering U.S. participation in MAP and with facilitating the effectiveness of MAP. Liaison between the Panel and various federal agencies is accomplished through the Interagency Coordination Committee for MAP, appointed by the U.S. government Subcommittee on Atmospheric Research.

The present report is the second report of the Panel on the Middle Atmosphere Program. The first report, issued in 1980, offered possibilities on how U.S. research efforts could fit into the international MAP structure. The present report identifies specific scientific problems in which increased attention is required to support the objectives of the international MAP. As such, it is intended to be useful to agency planners within the United States, as well as to the international MAP community.

This report was reviewed and endorsed by the Committee on Solar-Terrestrial Research in April 1983 prior to review by a group approved by the National Research Council's Report Review Committee. The Panel on MAP is indebted to members of the Interagency Coordination Committee for MAP, the Committee on Solar-Terrestrial Research, and the various reviewers for their valuable comments and suggestion during the course of this study.

INTERNATIONAL MIDDLE ATMOSPHERE PROGRAM

The Middle Atmosphere Program (MAP) is an international cooperative scientific venture, and the major MAP Objective is

> . . . to obtain a comprehensive understanding of the structure, chemistry, dynamics, and energetics of the middle atmosphere.

MAP was formed under the auspices of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) of the International Council of Scientific Unions (ICSU). It was designed to span the years 1982 to 1985 and is guided by the MAP Steering Committee of SCOSTEP.

MAP was established to facilitate international plans for coordinated observations of the middle atmosphere (~10- to 100-km altitude). To a large degree, many of the observational programs existed before the establishment of MAP. Therefore the main role of MAP was to broaden and strengthen the level of participation in such programs rather than to initiate new ones.

DOMESTIC PROGRAMS

Within the United States, many of the pre-existing middle atmosphere research programs have been initiated and funded by government agencies that have rather sharply focused objectives. The range of objectives for middle atmosphere research of any given agency are encompassed in, but are more narrowly focused than, the international "MAP Objective." Because of this, there is no designated lead agency for implementing MAP goals and programs. More significantly, perhaps, there have been no designated agency funds allocated in direct support of international MAP research. However, many U.S. scientists participate in international MAP activities in order to enhance their individual research objectives.

The United States officially participates in MAP through the Committee on Solar-Terrestrial Research (CSTR) of the National Research Council (NRC). The CSTR, which serves as the U.S. National Committee for SCOSTEP, established a Panel on the Middle Atmosphere Program to enhance the effectiveness of MAP, both nationally and internationally.

Complimentary to the NRC MAP Panel, the U.S. government Subcommittee on Atmospheric Research (of the Committee on Atmospheres and Oceans) created an Interagency Coordination Committee for MAP. This group (see Appendix) is composed of representatives from each of the interested federal agencies and is working with the MAP Panel to address the scientific problem areas identified in this report.

APPROACH TO RECOMMENDATIONS

Given the above U.S. and international MAP structure, the panel was faced with the problem of how best to enhance the effectiveness of MAP. Because the MAP Objective is centered on the encouragement of sound scientific understanding, the panel decided that all of its deliberations and activities would be centered about that objective. It was reasoned that progress toward the MAP Objective would ultimately serve all middle atmosphere interests of the agencies through the fostering of improved scientific understanding.

The panel also realized that many well-conceived programs of middle atmosphere research are already in place. Furthermore, meaningful, up-to-date reviews of the state of middle atmosphere science have been published recently (e.g., NASA, 1979; WMO, 1981). The panel, therefore, decided to emphasize those areas in which progress toward fulfillment of the MAP Objective is likely to lag unless incremental resources and attention are devoted to them.

Thus, this report contains no direct assessment of the existing programs in which significant progress toward development of middle atmosphere understanding is being achieved. However, the ongoing research must be regarded as the cornerstone of this report. Without such a strong base of research progress, it would be meaningless for the panel to attempt to identify those special subjects in which increased research attention is required.

Consequently, the recommendations should not be interpreted as a threat to impede ongoing (and already planned) research. This consideration should be emphasized since some important problems are conspicuously absent from the list of recommendations below, simply because they are currently receiving significant attention from the scientific community and the funding agencies. Important examples include theoretical studies, comprehensive three-dimensional modeling, measurement of "fast chemistry" species, laboratory spectroscopy and chemical kinetics, the Upper Atmosphere Research Satellite program (UARS), and satellite temperature soundings. If the research funding in any of these fundamental areas were to be significantly reduced, the incremental research priorities established by this panel would change drastically.

Finally, it cannot be overemphasized that these recommendations are based on a perception of important problems in which progress would likely lag behind that in other areas. There is no implication that these problems are easy to solve or present high-leverage opportunities. In some cases the opposite is true. These problems are highlighted here because they are difficult areas in which real progress is required before a satisfactory comprehensive understanding of the middle atmosphere can be claimed.

The ordering of research priorities was determined by the following procedure. At a meeting of the MAP Panel, informal reports from panel members representing each of the U.S. MAP Initiatives (Panel on the Middle Atmosphere Program, 1980) were presented and discussed. From these discussions, a large initial list was reduced to nine basic problem areas identified as being of special interest and scientific importance for the MAP Objective. This list of problem areas was then defined more clearly for presentation to the panel at a later date. Each panel member then chose about five problems in order of priority; the choices by each member were backed by an analysis of the justification for the priorities chosen. This process led to the research priorities as listed and explained below.

RECOMMENDATIONS FOR INCREASED RESEARCH

In this section the recommendations for increased research are set into three broad categories: highest priority, high priority, and important. In this context, these designators represent the degree of consensus among the diverse panel members relative to the MAP Objective and the perceived need for greater scientific and funding attention.

Highest Priority

The Upper Mesosphere: Radiation, Chemistry, and Dynamics

Of all the unsolved problems of the middle atmosphere, more seem to occur in the upper mesosphere than in any other region. These problems include, for example, the reversed meridional temperature gradients and associated closed-off zonal jets, the temperature lapse-rate change, ozone chemistry, ion chemistry, non-LTE (local thermodynamic equilibrium) infrared radiation, interaction with the lower thermosphere, and the "deferred" shortwave-heating phenomenon. These unsolved problems provide serious barriers to our comprehensive understanding of this region.

One general reason for the accumulation of problems here is that radiative, chemical, and dynamical equations used to model the regions below the upper mesosphere all contain simplifications, which, in one form or another, invoke "scale-separation" approximations. At upper mesospheric heights, these approximations tend to break down. This implies that the theories and modeling for this region require special attention beyond that usually required for the regions above or below it.

Another set of difficulties that arises in the upper mesosphere is related to measurement errors. This region is higher than can be easily and inexpensively reached with in situ instrumentation. Unfortunately, measurement capabilities of satellites also tend to be diminished here, for a variety of reasons. These difficulties have led to a situation where both the quantity and quality of measurements raise serious barriers against a reliable determination of the structure of this region.

A particularly noteworthy example of measurement problems throughout the mesosphere is provided by the severe difficulties in determining the ozone climatology of that region. Although a great number of ozone measurements have been made in the upper mesosphere, the scatter in the measurements is so large as to raise serious questions about their validity. Because of this, any analysis approach that cannot separate out the incorrect measurements will lead to confusing results. Owing to the importance of ozone in the mesospheric thermal and chemical structure, either better measurements or better analyses must be forthcoming. Without this, our knowledge of the chemical and radiative effects in this region will remain seriously incomplete.

Perhaps the MAP period provides an opportune time to begin a more concentrated interdisciplinary approach to the solution of these problems. Improvements in measurement and theory of the upper mesosphere will require careful planning before a valid research strategy can be developed.

Nature of Middle Atmosphere Gravity Waves and Turbulence

The contribution of gravity waves and their breaking into turbulence appears to occupy a more important role in the large-scale dynamics of the entire middle atmosphere than previously assumed. Not only can the dissipation of such waves exert a large influence on the zonal flow, but also they can contribute directly to the dissipation of the larger-scale disturbances. Until the structure and morphology of such waves and their associated turbulence can be identified, it will be extremely difficult to construct quantitatively acceptable parameterizations of their net effects for use in dynamical models of the middle atmosphere.

Another problem in which the contribution of gravity waves might be important is in the transport of trace constituents and heat in the middle atmosphere. The breakdown of such waves into turbulence may influence transport in at least two significant ways. First, the presence of turbulent "patches" would act to provide a mechanism for irreversible transport of trace constituents or heat. Second, the deceleration of zonal momentum produced by dissipating gravity waves can contribute to enhanced excitation of a significant meridional mean motion of air parcels. This systematic large-scale effect could prove to be even more important than the local transport effect.

One of the major unsolved questions concerning gravity waves and turbulence concerns their relative importance in the 30- to 60-km region. Below 30 km, measurements suggest a relatively minor role in comparison to larger-scale motions, whereas above 60 km, such effects are important and possibly dominant. To claim a proper understanding of the 30- to 60-km region, it is essential that the role of gravity waves, their associated turbulence production, and their impact on larger-scale motions be clarified.

With the successful development of the mesosphere-stratosphere-troposphere (MST) radar and lidar systems, it now appears that the required smaller-scale information might be obtainable in these previously inaccessible regions of the middle atmosphere. However, experience strongly suggests that improved theoretical frameworks will be required to facilitate a meaningful analysis and interpretation of the forthcoming data. Without significant support of the required complementary theory and analysis, the new measurement capabilities could fall far short of their potential.

Long-Term Measurement of Climatically and Chemically Important Quantities

A number of questions concerning climatically and chemically significant anthropogenic perturbations are of real concern in the middle atmosphere. This is because the thermal response to various anticipated perturbations (e.g., CO_2 and O_3) are expected to be large in this region. Thus, long-term measurements can provide an invaluable baseline for evaluating change over a period of years. Without this, we will be unable to determine the character of such changes, or, indeed, if they happened at all.

At first glance, it may appear to be inappropriate that a special period such as that of MAP be used as a forum for initiating a long-term measurement activity. A counter argument is that the enhanced attention to the middle atmosphere because of MAP might provide the stimulus required to set in place at least a well-posed minimum network. Also, it should be pointed out that even the MAP Objective implicitly requires this, simply because the unperturbed middle atmosphere no longer exists. Thus, an understanding of the middle atmosphere as it is already requires an understanding of how it may be changing owing to altered conditions. Furthermore, even if there were no expectation of systematic long-term trends, it would still be important to understand the mechanisms leading to middle atmosphere variability on time scales ranging from yearly to at least that of the 11-year solar cycle.

Although there is a long list of items for which sustained measurement is desirable, there appears to be an irreducible set that needs to be considered:

1. Measurements of O_3, temperature, and ultraviolet solar flux. This combination is necessary for separation of O_3 and CO_2 signals.

2. Measurements of stratospheric aerosol content and its radiative properties (size, chemical composition, index of refraction, for example). This allows assessment of effects of volcanic perturbations. This is particularly relevant for the MAP period in view of the recent massive stratospheric injection from the eruption of El Chichon. The stratosphere will be quite anomalous in this sense throughout the MAP period. In fact, a number of remote-sensing instruments have received contaminated readings owing to the dust effects.

3. Measurements of radiatively important long-lived ozone chemistry precursors (N_2O, CH_4, $CFCL_3$, CF_2CL_2 and H_2O, for example). may allow determination of the changing input to ozone chemistry as well as their independent greenhouse radiative effects. Time series of profiles from the ground to the middle/upper stratosphere at selected locations should prove to be invaluable in this regard. It is also of special interest that the NIMBUS-7 SAMS satellite has recently obtained preliminary middle stratospheric measurements of CH_4 and

As in most, if not all, such problems of a global character, individual groups or agencies cannot solve them in isolation. Much intergroup, interagency, and even international planning and cooperation is required. It is the panel's view that this process must be accelerated and that increased institutional (and personal) commitments must be made. Optimum planning, to the degree that it is even possible, will require an unusual level of interaction and cooperation among theorists, modelers, data analysts, statisticians, instrumentalists, and administrators.

High Priority

Increased Analysis of Available Data

It is, perhaps, surprising to argue for a more complete analysis of available data during the special MAP period in which great emphasis is being placed on the acquisition of more data. The fact is, however, that previous successful efforts to obtain data have nearly always been followed by serious underutilization of the available data. It is reasonable to assume that, unless special steps are taken, history will repeat itself. In this case, the assessment of our previous measurement efforts could be significantly improved through a greater commitment to analyze such data.

Through a widely varied set of personal research experiences, the members of this panel are aware of the many reasons why such data sets tend to remain underanalyzed.

First, measurement programs tend to be conceived and carried out by scientists with strong interest in measurement technique. These skills are not necessarily the same ones that result in strong analysis and interpretation of data.

Second, all data sets tend to contain serious problems in terms of measurement accuracy and sampling density. This often leads to an understandable unwillingness to spend the considerable time and effort required to extract the information available from a given data set. It is normally much more exciting to plan for a new data set that will not contain the problems in the previous set. A serious flaw in such reasoning is that often it is only careful analysis efforts that allow fuller understanding of the earlier deficiencies. Analysis also provides a sharper understanding and focus of the scientific issues that should be addressed through such data sets. Without such intensive effort, many of the mistakes made earlier will merely be repeated. It is encouuraging that there is beginning to be an increased awareness of these problems on the part of some agencies. This slowly increasing agency awareness needs to be accompanied by a stronger commitment toward data analysis on the part of the scientific community.

In many cases the data available for more intensive analysis span a decade or more. This implies that considerable information can be gained on the longer time scales commensurate with the interannual variability, as well as to long-term means of basic and derived quantities. Some obvious possibilities for increased attention are:

1. Quasi-geostrophic dynamical climatology from satellite-measured temperature data;
2. Ozone climatology from satellites, balloons, and rockets;
3. Statistical and time-series analyses from the meteorological rocket network;
4. Statistical and time-series analyses of various types of radar data. Also, efforts must be made to bridge the gap between radar signals and traditional quantities, such as temperature, winds, and trace-constituent mixing ratios.

Water Transport near the Tropical Tropopause

After all the studies of the past 30 years, the precise mechanisms leading to the observed desicated stratosphere have yet to be identified with clarity. It is still agreed that significant "cold-trapping" of upward-moving air in the vicinity of the tropical tropopause provides a central mechanism for the removal of water. However, there remain a number of opinions as to the space and time scales of motions dominating this removal at very low temperatures (say, -83°C). It is difficult to see how much further progress can be made without implementation of properly focused measurement programs. This would involve coordinated measurements of three-dimensional wind components, temperature, and a number of trace constituents, in addition to the required measurements of water vapor and ice. Such measurements would most profitably be made by properly instrumented aircraft. However, supplemental measurements from balloons, lidars, and radars could prove to be invaluable for advancing an overall understanding of transport in this region.

The water budget problem is given high priority because the amount of water (and its possible changes) is an important contributor to the photochemical and radiative balances in the stratosphere. This importance is magnified when one considers the probable high sensitivity of the lower stratosphere water content to relatively modest (a few degrees) changes in mean temperature near the tropical tropopause. Finally, progress on this problem provides another test of our understanding of transport of trace constituents with complex source and sink distributions.

Important

In this category are topics considered by the panel to be important although less so than the previous topics.

Improved Trace-Constituent Measurements in the 30- to 80-km Region

Our understanding of trace constituent transport in the lower to middle stratosphere has been greatly improved by the availability of observations of a number of constituents. For the region above 30 km, however, only a few constituents (e.g., H_2O and CH_4) have been measured directly; there have been doubts about the reliability of even these. In addition, the chemistry of the sources and sinks of these constituents remains rather uncertain (in this case, owing to the remaining uncertainty in determining OH amounts).

An important test of our overall theoretical understanding might be obtained through good measurements of tracers of opportunity. Possible candidates might be transient CO_2, SF_6, CF_2CLCF_3 (CFC-115). For all three gases, concentrations are building up owing to anthropogenic sources. SF_6 and CO ha no significant chemistry below 80 km, while CFC-115 has a relatively inefficient (but understood) stratospheric photodestruction. Careful balloon or rocket grab grab samples or satellite detection could go a long way toward improving our knowledge here, especially when the results are carefully analyzed and compared against independeut three-dimensional model simulations.

Structure of Tropical Waves and Their Sources

It is generally accepted that low-latitude waves of various kinds are of central importance for understanding the tropical middle atmosphere and that virtually all such waves originate in the troposphere. However, we still lack an adequate knowledge of the structure of these waves, let alone their ultimate source mechanisms. Studies of many types are going to be required before full understanding can be claimed. The varied approaches of direct observation, linear analysis, mechanistic models, and general circulation models are needed if we are to effect real progress.

Measurement of Solar Ultraviolet Spectral Irradiance

A significant barrier to modeling the atmosphere above 30 km at a quantitative level is the large uncertainty in our knowledge of the absolute spectral irradiance in the ultraviolet. At shorter wavelengths the uncertainty becomes particularly large. The difficulty of measuring ultraviolet irradiance accurately is compounded by the increased natural and systematic variations in the solar output at shorter wavelengths. Quantitative modeling of radiation and chemistry in these regions requires accurate mean values of spectral irradiance as well as their systematic variations.

To obtain the desired information requires high absolute accuracy and safeguards against instrument calibration degradation over extended time periods. This has now become a well-recognized problem within MAP, and a special committee has been formed to address it. However, we include it on this list because of its absolutely fundamental role in a number of radiative and chemical problems (see recommendation on long-term measurements).

Solar Protons: Effect on Temperature and Neutral Chemistry

Although solar-proton flux "events" exert a number of well-documented and scientifically interesting effects on the middle atmosphere, their net influence on the mean thermal structure and neutral chemical balances remains controversial. If the various hypothesized connective links can be established with some accuracy, their physical effects can be examined in radiative-chemical-dynamical models of the neutral atmosphere. The quantification of such effects may require some extremely well-planned observational experiments.

COMMENT

The panel would like to re-emphasize that many of the research topics identified here are ones in which rapid progress is difficult. In virtually all cases, considerable extra study and planning will be needed before well-posed specific plans of action can emerge.

REFERENCES

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Panel on the Middle Atmosphere Program (1980). The Middle Atmosphere Program: Prospects for U.S. Participation, Committee on Solar-Terrestrial Research, National Research Council, Washington, D.C., 24 pp.

WMO (1981). The Stratosphere 1981: Theory and Measurements, R. D. Hudson, ed., WMO Global Ozone Research and Monitoring Project Report No. 11, World Meteorological Organization, Geneva, 503 pp.

APPENDIX: Panel on the Middle Atmosphere Program

JERRY D. MAHLMAN, Geophysical Fluid Dynamics Laboratory/NOAA, Chairman
STEPHEN B. FELS, Geophysical Fluid Dynamics Laboratory/NOAA
MARVIN A. GELLER, Goddard Space Flight Center/NASA
DENNIS L. HARTMANN, University of Washington
DAVID J. HOFMANN, University of Wyoming
JAMES R. HOLTON, University of Washington
HAROLD S. JOHNSTON, University of California, Berkeley
GEORGE C. REID, Aeronomy Laboratory/NOAA
RAYMOND G. ROBLE, National Center for Atmospheric Research

Liaison Representatives

RICHARD S. GREENFIELD, National Science Foundation
DONALD HUNT, National Oceanic and Atmospheric Administration
JOHN T. LYNCH, National Aeronautics and Space Administration
N. SUNDARARAMAN, Federal Aviation Administration
WILLIAM SWIDER, Air Force Geophysics Laboratory

PART 3

GRATMAP ACTIVITIES

At the May 1982 MAP Steering Committee in Ottawa, GRATMAP (GRAvity Waves and Turbulence in the Middle Atmosphere Program) was approved as a MAP project. A GRATMAP Steering Committee was subsequently established and held its first meeting in Hamburg during the August IUGG Meeting. The Steering Committee membership is as follows:

Member	Country
Dr. B. B. Balsley	USA
Professor S. A. Bowhill	USA
Dr. M.-L. Chanin	France
Dr. A. A. Chernikov	USSR
Professor D. C. Fritts	USA
Dr. M. A. Geller (Coordinator)	USA
Dr. J. Klostermeyer	FRG
Professor R. S. Lindzen	USA
Professor A. H. Manson	Canada
Professor H. Tanaka	Japan
Dr. H. Teitelbaum	France
Dr. R. A. Vincent	Australia
Dr. R. F. Woodman	Peru

At the Hamburg meeting of the GRATMAP Steering Committee, the three main items of business were as follows:

(1) discussion and endorsement of those recommendations relating to the study of gravity waves and turbulence that emerged from the MAP Workshop on Technical Aspects of MST Radar that was held in Urbana, Illinois, during the period May 23-27, 1983;

(2) discussion and endorsement of the recommendations that emerged from the United States Agencies sponsored Workshop on Gravity Waves and Turbulence in the Middle Atmosphere that was held in Alaska during the period July 18-22, 1983;

(3) discussion and endorsement of holding a GRATMAP Workshop for 2-3 days during the week following the 1984 International MAP Symposium to be held in Kyoto, Japan, during the period November 26-30, 1984.

Each of these three subjects is discussed in the following in more detail:

MAP Workshop on Technical Aspects of MST Radar

Urbana, Illinois, USA
May 23-27, 1983

The GRATMAP Steering Committee endorses the following recommendations that are relevant to the study of gravity waves and turbulence, that resulted from this meeting:

(1) We recommend increased activity toward using in situ aircraft, balloon, and rocket techniques to achieve simultaneous measurements of atmospheric turbulent parameters with ST and MST radars.

(2) Given that MST radars are powerful major ground-based facilities but that they produce incomplete observations of atmospheric parameters by themselves (e.g. wind only and the 40-60 km gap), we recommend that other ground-based instrumentation (e.g. lidar, meteor radar,

and partial reflection drifts) be collocated with major MST radar facilities.

(3) Given that gravity wave periods down to several minutes exist and that time averaging the radar signals before recording data is an irreversible process, we recommend that signal averaging before recording be done for as short times as is practical. In most cases, this should be a fraction of a minute. ST and MST radars should be capable of range resolutions on the order of 150 m. The coarser the vertical resolution of MST and ST radars, the more difficult results are to interpret due to multiple returns in the beam.

(4) Velocity variance measurements are preferred over C_n^2 measurements to characterize the energetics of atmospheric turbulence. Narrow beam width (~1°) systems are required to obtain measurements of v'^2 that can be easily interpreted.

(5) It is desired to obtain simultaneous spectra of horizontal and vertical velocities versus frequency and horizontal and vertical wavelengths to resolve theoretical models.

(6) We urge that networks of ST and MST radars be set up for a variety of spacings and representative of a variety of geophysical conditions to measure gravity wave parameters.

(7) We recommend that observational programs be planned to increase our understanding of gravity wave sources.

(8) Given the importance of understanding gravity wave drags on the large-scale flow, we recommend that MST radar facilities determine u'w' as a function of season and geographical location.

(9) We recommend that rotary spectral analysis be employed at MST sites to better understand the climatology of upward and downward propagating gravity waves.

In addition to these recommendations, we also agree on the importance of the following scientific issues for the study of gravity waves and turbulence:

(1) ST radar find effective diffusivities of ~0.1 $m^2 s^{-1}$ in the tropical lower stratosphere. This is about one order of magnitude larger than previous analyses of aircraft observations have indicated. This discrepancy is presently unresolved and deserves further attention.

(2) There commonly exist long-lived thin layers of large horizontal extent (~100 km) in both the stratosphere and mesosphere. This requires theoretical explanation.

(3) Given the fact that the VHF radars commonly probe eddy sizes that are comparable to the thickness of thin turbulent layers, it is questionable if the formulations of homogeneous and isotropic turbulence can be used to interpret these observations. Further work is required on this situation.

(4) Much of the analysis of gravity waves take place on the rather rare occasions when significant energy is found in almost monochromatic wave activity. Given that these events occur infrequently, it is questionable whether their analysis yields results that are representative of average atmospheric behavior.

Alaska Workshop on Gravity Waves and Turbulence in the Middle Atmosphere

July 18-22, 1983

The GRATMAP Steering Committee examined and endorsed the document "Research Status and Recommendations from the Alaska Workshop on Gravity Waves and Turbulence in the Middle Atmosphere." A copy of this document is attached to this GRATMAP report as an Appendix. In particular, we strongly endorse the "Future Research Needs" section of this document.

Proposed GRATMAP Workshop in Kyoto

The GRATMAP Steering Committee endorsed holding a GRATMAP Workshop for 2-3 days in the week following the Kyoto 1984 International MAP Symposium. Contact has been made with Dr. S. Kato, the Chairman of the Symposium Organizing Committee, to seek his assistance in making the physical arrangements for this workshop.

Topics to be covered at this workshop include the following:

(i) intercomparison of gravity wave and turbulence climatologies at different locations as a function of time of year, meteorological condition, etc.

(ii) discussion of needed observations of gravity waves and turbulence;

(iii) discussions of the appropriateness of GRATMAP campaigns.

APPENDIX A

RESEARCH STATUS AND RECOMMENDATIONS FROM THE ALASKA WORKSHOP ON GRAVITY WAVES AND TURBULENCE IN THE MIDDLE ATMOSPHERE

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ABSTRACT

Recently, a small group of atmospheric scientists met to discuss gravity wave and turbulence processes in the middle atmosphere. Our objectives were both to review the current theoretical understanding and observational capabilities in this field and to suggest additional studies that would further our knowledge of these processes and their effects of the large-scale circulation of the middle atmosphere. It is hoped that our review and recommendations will be useful in the design of future programs for studies of middle atmosphere dynamics.

While our current theoretical understanding of gravity wave and turbulence processes in the middle atmosphere is fairly primitive, it is likely that theoretical and modeling studies will contribute important quantitative information on gravity wave excitation, propagation, and dissipation mechanisms and effects over the next few years. Likewise, our knowledge of gravity wave and turbulence morphology, parameters, and processes will likely expand substantially following the installation, and particularly the combination, of various observing systems.

INTRODUCTION

The influence of small-scale motions on the large-scale circulation is one of the most challenging asects of the study of the general circulation of the atmosphere. It is well known that small-scale moist convection is an essential feature of the tropospheric general circulation, but it is less appreciated that gravity waves and turbulence are essential contributors to the general circulation of the middle atmosphere. It is possible to produce a qualitatively correct simulation of the tropospheric circulation (at least outside the tropics) without including moist convection. But in the mesosphere, the meridional temperature distribution and the mean meridional wind cannot even qualitatively be simulated without incorporating the drag that gravity waves exert on the mean flow. In the stratosphere, the role of gravity waves is less obvious, but there are indications that gravity wave drag may be important in the winter polar stratosphere.

Some of the evidence supporting the role of gravity waves in the middle atmosphere described above is reviewed in the remainder of this section. Then in Section 2, we briefly describe two types of models that have been used in previous studies of the middle atmosphere. A discussion of the characteristics and the likely middle atmosphere effects of gravity waves is provided in Section 3. Section 4 describes a variety of observational systems that have been employed for gravity wave and turbulence studies. Also presented are a discussion of their present and likely future capabilities, and a review of some of the observational results obtained to date. Finally, Section 5 provides a discussion of the modeling, theoretical, and observational (both measurement and equipment) needs identified by the workshop participants.

A crude model of the middle atmosphere structure can be obtained by calculating the zonally symmetric middle atmosphere temperature structure that corresponds to radiative equilibrium (see Figure 1) and the resulting mean zonal geostrophic wind (see Figure 2) following GELLER (1983). Compared with observations, this radiative equilibrium state predicts too warm (cold) a summer (winter) mesopause. Also, magnitudes of both the summer and winter mesospheric jets are too large, and the vertical shear of the mean zonal wind fails to reverse in the upper mesosphere. Meridional and vertical motions are absent in this radiative and geostrophic equilibrium solution.

Figure 3 shows the results of the same calculation but with an appropriately chosen Rayleigh drag incorporated to approximate the effects of gravity wave dissipation (GELLER, 1983). In this case the summer stratopause is cooler and the winter stratopause is warmer than the summer mesopause. These features are in line with existing observations. Furthermore, the mean zonal jet structure closes with altitude in both hemispheres and has wind speeds more consistent with observations. Recent models also yield a summer to winter meridional flow, with upward motion (with accompanying expansion cooling) in the summer hemisphere, and downward motion (with accompanying compression heating) in the winter hemisphere. Such results indicate that the middle atmosphere temperature, zonal wind, and constituent structure (through the induced meridional and vertical motions) strongly depend on zonal momentum drag processes. This momentum is presumably transported upward from sources in the troposphere.

Outside the tropics gravity waves appear to be essential for understanding the annual cycle of the large-scale circulation. In the equatorial middle atmosphere the semiannual and quasi-biennial oscillation are of much stronger amplitude than the annual cycle. For the quasi-biennial oscillation and the stratospheric semiannual oscillation, it is believed that large-scale equatorial waves are the primary drivers. However, there is also a strong semiannual oscillation near the mesopause (peak amplitude at 80 km) which is likely to be

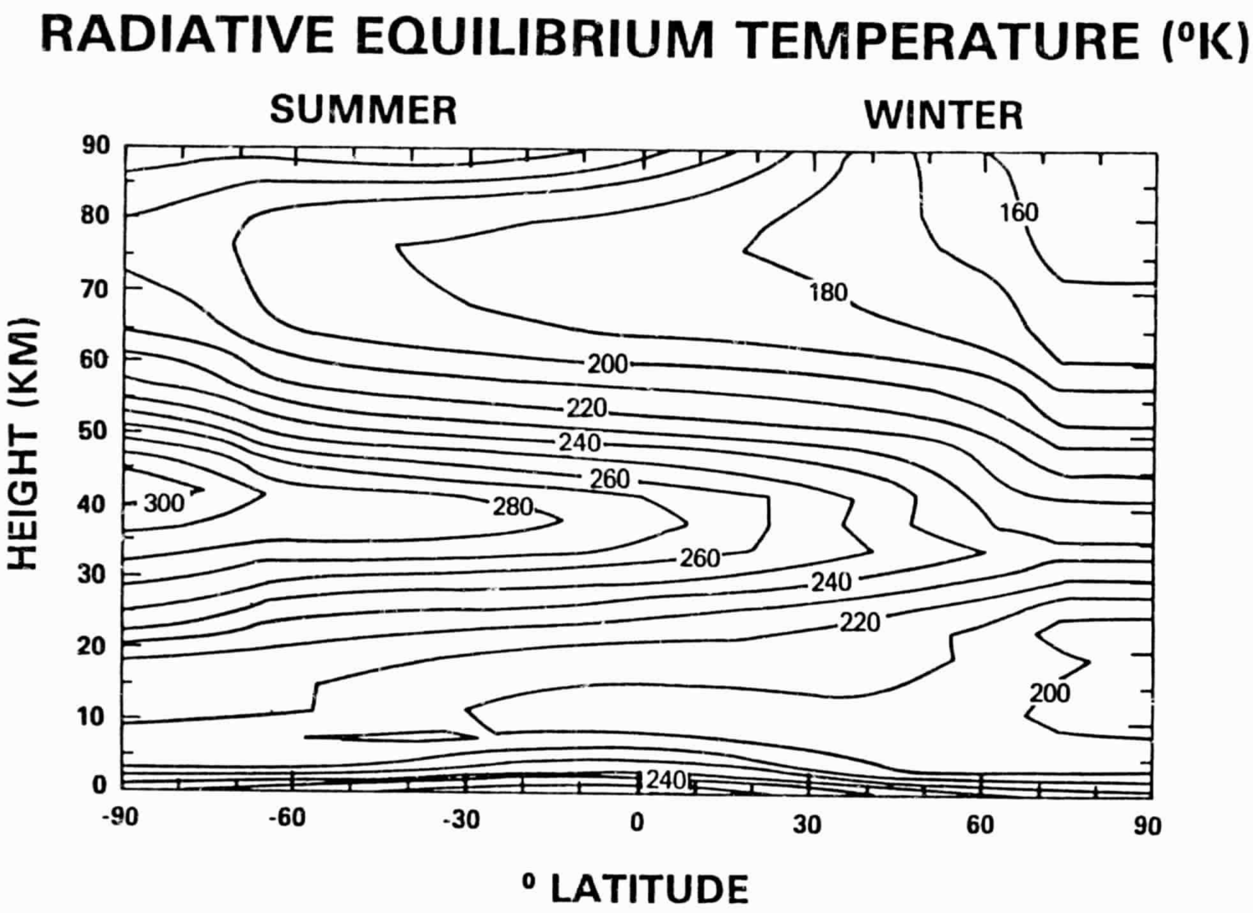

Figure 1. Calculated radiative equilibrium temperatures as described in the text. Units are K.

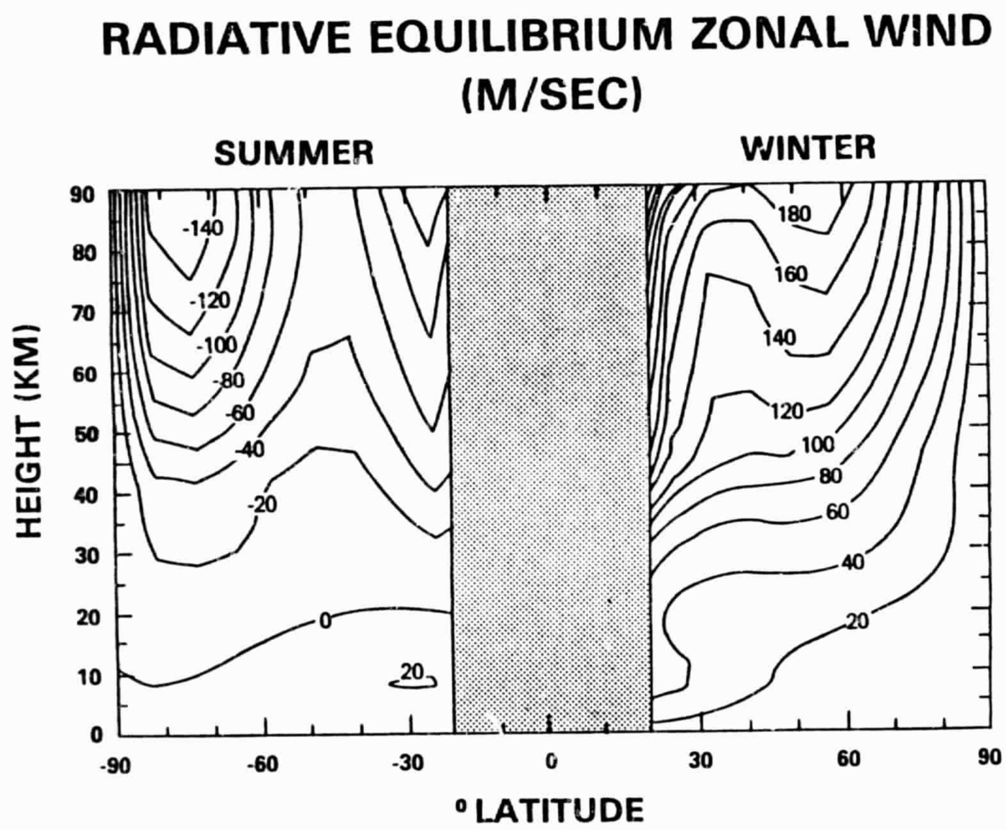

Figure 2. Geostrophic mean zonal winds calculated from the radiative equilibrium temperatures shown in Figure 1. No values are shown near the equator because of the inapplicability of the geostrophic formula there. Units are m/s, and westerly winds are positive while easterly winds are negative.

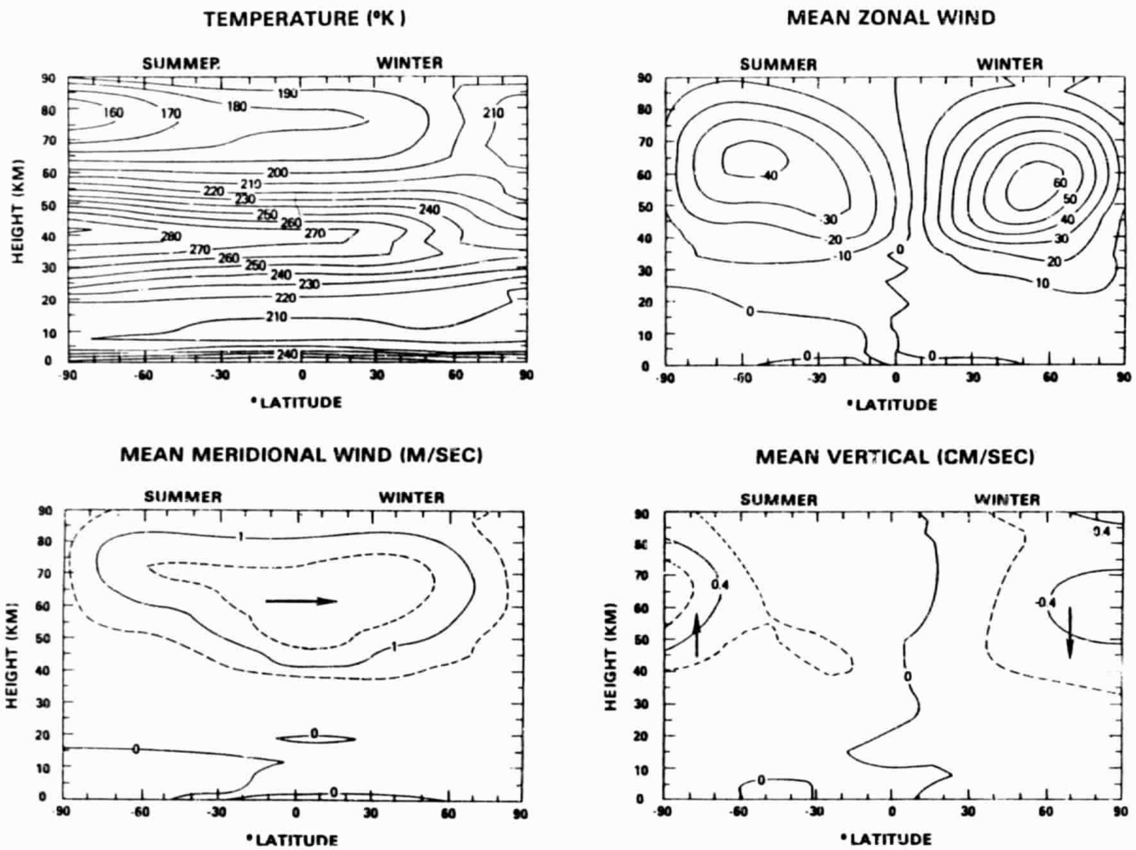

Figure 3. Model calculated zonally averaged temperature field in K (left-top); mean zonal wind in m/s (right-top); mean meridional wind in m/s (left-bottom); and mean vertical motion in cm/s (right bottom).

driven by gravity waves and tides. However, to date no suitable mesospheric observations of gravity waves and turbulence in the equatorial zone have been made.

Gravity waves are thought to be mainly responsible for the vertical transport of momentum. The reasoning behind this is that the drag processes are required in both winter and summer, and gravity waves are present in both seasons. The other leading candidate, planetary waves, is known to be very weak in the summer.

The action of gravity waves is schematically indicated in Figure 4. In the absence of dissipation or reflection, a gravity wave grows exponentially with height (as indicated below the height of wave breaking) so that, eventually, the conditions for shear or convective instability result. At this point, the wave is assumed to lose energy through the production of turbulence so that the amplitude remains constant in the absence of varying $\bar{u}$. This causes a departure from exponential growth and a divergence of the vertical flux of horizontal momentum, causing an acceleration of the flow towards the phase speed of the wave. For a gravity wave spectrum of tropospheric origin, the result is a deceleration of the large-scale flow.

2. MIDDLE ATMOSPHERE MODELS

We may distinguish between two types of middle atmosphere models -- the mechanistic models and the general circulation models. General circulation models (GCMs) attempt to simulate all aspects of the large-scale circulation, while mechanistic models are designed to focus on only a limited range of dynamical processes. For middle atmosphere studies, mechanistic models typically do not seek to faithfully reproduce the details of the tropospheric circulation but rather specify the tropospheric forcing near the bottom of the middle atmosphere. Examples of this type of model are the works of MATSUNO (1971), SCHOEBERL and STROBEL (1978), and HOLTON and WEHRBEIN (1980). The middle atmosphere general circulation model, on the other hand, seeks to explicitly model the entire troposphere-middle atmosphere system. An example of this type of model is FELS et al. (1980).

a. Mechanistic Models of the Middle Atmosphere

Although all mechanistic models are simple when compared to GCMs, there is a wide spectrum of mechanistic models ranging from one-dimensional wave-mean flow interaction models to three-dimensional primitive equation models.

The minimum model which appears to be required to consider the effects of internal gravity waves on the general circulation of the middle atmosphere is a zonally symmetric, quasi-geostrophic beta-plane channel model. In such a model the mean wind and temperature are coupled through the thermal wind equation, and compensation for gravity wave driving in the momentum and thermodynamic energy equations occurs in the form of an induced mean meridional circulation. Such models have been used by MATSUNO (1982) with a wave-damping parameterization, and HOLTON (1982) with LINDZEN'S (1981) wave-breaking parameterization. In these models, only a single meridional mode was allowed so that the meridional scale (and hence the Rossby depth) was imposed. However, despite their simplicity such models appear to be very useful for studying the response of the mean mid-latitude circulation to parameterized gravity wave driving.

Attempts to simulate the full latitudinally varying, zonally symmetric solstice circulation have been made by MIYAHARA (1983) and HOLTON (1983). Miyahara's model utilized the viscous wave-damping parameterization of MATSUNO (1982), but with a more restricted wave spectrum. Holton adopted LINDZEN'S

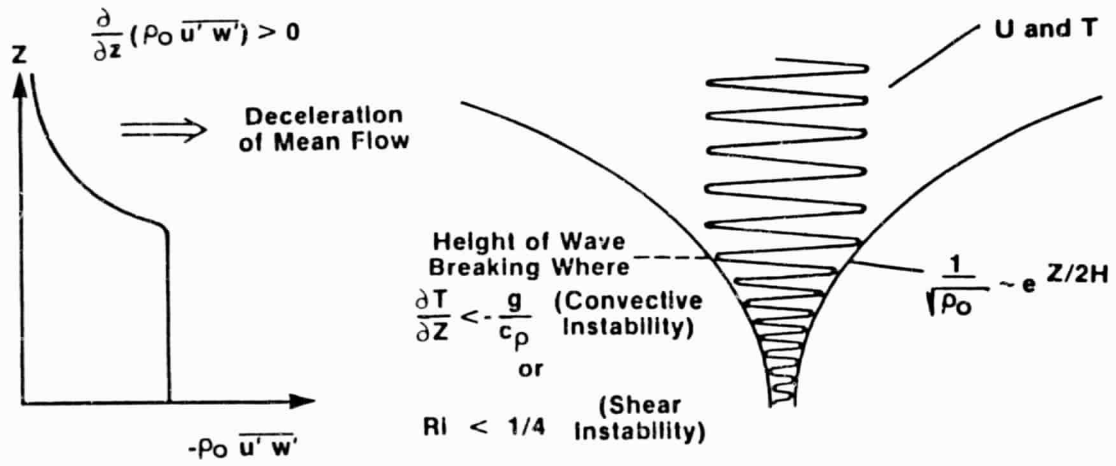

Figure 4. Schematic of gravity wave breaking and the resulting vertical flux of zonal momentum.

(1982) wave breaking parameterization. Both models were successful in simulating the gross features of the zonal mean circulation in both the summer and winter hemispheres although important differences between models and observations remain. Holton's model also incorporated a single zonal harmonic forced planetary wave in the winter hemisphere in some experiments, and he found dramatic effects due to the modulation of gravity wave transmission by planetary wave-mean flow interactions. Holton, however, did not consider any zonal dependence of wave breaking which should occur in the presence of nonzonal gravity wave sources and large-amplitude planetary waves; nor did he consider the refraction of gravity wave ray paths in the presence of longitudinally and latitudinally varying mean flows. The possible importance of these effects has been emphasized by SCHOEBERL and STROBEL (1983) and LINDZEN (1983).

b. General Circulation Models of the Middle Atmosphere

General circulation models of the middle atmosphere have not included parameterizations of gravity wave and turbulence effects to date. One reason for this is that, in most cases, the wave drag formulations that have been used in mechanistic middle atmosphere models have been tuned to give reasonable looking circulations. While such tuning is easily done in simple models, it is very time-consuming and expensive in general circulation models. Middle atmosphere general circulation models that extend to the mesosphere sometimes use fixed diffusion profiles of the type that appear in one-dimensional photochemistry models, but with smaller magnitudes (see CUNNOLD et al., 1980, Figure 5, and HUNT, 1981, Figure 1). FELS et al. (1980) use a Richardson number dependent parameterization for the vertical mixing of heat and momentum that is dependent on vertical grid resolution.

3. THEORETICAL DISCUSSION

Internal gravity waves are disturbances whose intrinsic frequencies k(c-u) are smaller than the Brunt-Vaisala frequency. Their importance arises because:

i) They are the major components of the total flow and temperature variability fields of the mesosphere (i.e. shears and lapse rates) and hence constitute the likely sources of turbulence, and

ii) They are associated with fluxes of momentum that communicate stresses over large distances. For example, gravity waves exert a drag on the flow in the upper mesosphere. However, in order that gravity waves exert a net drag on the atmosphere, they must be attenuated.

There are two general types of processes that seek to attenuate gravity waves -- dissipation and saturation. Dissipation is any process that is effective independent of the wave amplitude while saturation occurs when certain wave amplitude conditions are met. Radiative damping is an example of dissipation while convective overturning, which arises when the wave breaking condition $|\frac{\partial T}{\partial z}| \sim \Gamma$ (or $u' \sim |c-\bar{u}|$) is met, is an example of saturation. The two processes are not mutually exclusive.

Saturation implies that the wave field has reached amplitudes such that either secondary instabilities (LINDZEN, 1981; DUNKERTON, 1982a) or nonlinear interactions, such as the parametric subharmonic instability (LINDZEN and FORBES, 1983), can occur which limit further wave growth. In the atmosphere, amplitudes sufficient for saturation may result either from exponential growth with height or from the approach of a wave packet to a critical level. The saturation mechanism considered most common is the generation of convective or Kelvin-Helmholtz (KH) shear instabilities. Both instabilities were observed in the laboratory study of gravity wave propagation by KOOP and MCGEE (1983), but convective instabilities were found to dominate when both were possible. Local development of convective and dynamical instabilities may result in the radiation of secondary gravity waves (DUNKERTON and FRITTS, 1983); however, the most important result is the production of turbulence. Turbulence generation is initially confined to regions of dynamical or convective instability within the wave field. Following generation, turbulence may be advected away from the unstable zone, whereas the actively unstable region propagates with the wave.

The most important consequence of saturation on the dynamics of the large-scale circulation is the momentum deposition resulting from the amplitude-limiting mechanism (LINDZEN, 1981). Secondary effects produced by the turbulent layers include heat as well as constituent transport. The study by SCHOEBERL et al. (1983) suggests that the turbulent heat transport drives the mean state towards an adiabatic lapse rate. Using a quasi-linear initial-value model, WALTERSCHEID (1983) found large-amplitude gravity wave saturation to produce a rapid reduction in both the intrinsic phase velocity of the wave and the eddy diffusion needed to balance wave growth. There is also some heating due to wave and turbulence dissipation.

The above describes a very simplistic view of the saturation of an isolated monochromatic gravity wave. Not well understood is the detailed evolution of the wave field during saturation, including the production of turbulence and possible wave frequency broadening (WEINSTOCK, 1976, 1982). Advances in this area will have immediate consequences for observational programs. For example, to what extent can waves be partially reflected from neutrally buoyant layers produced by turbulent zones or from large velocity shears due to differential momentum deposition? And could we expect to see evidence of such reflections in the data? Reflection at an internal shock and wave scattering due to localized dissipation were observed in the numerical experiments of DUNKERTON and FRITTS (1983). Finally, there is some evidence which suggests that multiple wave interaction can lead to saturation although this process has not been studied in detail.

The spatial and temporal variability of gravity waves entering the mesosphere is poorly understood at present. Clearly, the upward flux of waves at the stratopause is a function of the production of waves in the troposphere, their transmission, and zonal and meridional propagation (DUNKERTON, 1982b; SCHOEBERL and STROBEL, 1983). The obvious tropospheric gravity wave sources are unstable wind shear, topography, and convection. Others may be important as well. Wind shear produces waves with phase velocities characteristic of tropospheric wind speeds, while topography generates gravity waves with a phase velocity distribution centered about zero. Of the three dominant gravity wave sources, the phase velocity spectrum associated with convection is the least understood. However, it is reasonable to suppose that the phase speed distribution is broad and centered near tropospheric wind speeds. Characteristic scales and amplitudes, as well as the distribution and variability of the above sources, are not well known at present (LINDZEN, 1983). Such information requires additional theoretical work and detailed tropospheric observations of gravity wave forcing and structure.

The transmission of gravity waves into the mesosphere is controlled by their propagation in and interaction with a variable environment. Important effects include refraction, reflection, and critical-level absorption due to variations of $\bar{u}$ and N^2 with height. These variations cause changes in the vertical wavelength and group velocity of the wave and may lead to selective filtering of the gravity wave spectrum (BOOKER and BRETHERTON, 1967; HINES and REDDY, 1967). For motions with small intrinsic frequencies, non-stationary mean flows and radiative damping are also likely to be important (FRITTS, 1982; SCHOEBERL et al., 1983). Spatial inhomogeneities of gravity wave sources or transmissivity are likely to produce a vertical smoothing and broadening of the zonally averaged momentum deposition as well as the excitation of large-scale gravity waves and planetary waves. In order to understand the consequences of gravity wave momentum deposition and turbulence production in the middle atmosphere, however, the morphology of the flux of gravity waves into and through the middle atmosphere must be better known.

4. OBSERVATIONS

A wide variety of techniques have been used to study gravity waves and turbulence in the middle atmosphere. These are discussed briefly below in terms of not only their present capabilities and their relative advantages and disadvantages but also in terms of future developments. The list is not exhaustive, but represents the view of a limited number of atmospheric scientists concerning which combinations of systems are likely to produce the maximum amount of useful information on many of the important problems of middle atmospheric dynamics. More comprehensive descriptions of each technique can be found in MAP Handbooks, Volumes 13-16.

While a number of important wave and turbulence parameters have already been measured, there is a need for simultaneous measurements of those parameters that unambiguously define wave characteristics before there can be significant advances in our understanding of the middle atmosphere. In the following section, some specific recommendations are made as to how currently existing stations and future systems or groups of systems could best be deployed to improve our knowledge of the wave and turbulence fields.

a. Techniques

1. MST Radars

Powerful radars operating at VHF and UHF can be used to measure winds, waves, and turbulence parameters in the middle atmosphere by observing the intensity, Doppler shift, and spectral width of echoes obtained from refractive index irregularities. The radars have a temporal resolution as short as 1-2 minutes and a spatial resolution (along the radar beam) as short as 30-300 m. These radars have the unique capability of being able to measure vertical velocities with reasonable accuracy. Three radar beam directions are required to fully resolve the wind components. Winds in the troposphere and stratosphere (up to 30 km) can be measured continuously. In the mesosphere, wind measurements are possible in the 60-90 km region by day and (using echoes from ionized meteor trails) in the 80-105 km region by day and night, subject to sufficient electron density gradients. The "gap" region from roughly 35-55 km is difficult if not impossible to observe with existing MST radars without extensive temporal averaging.

A radar with sufficient sensitivity to obtain useful echoes from the mesosphere, stratosphere and troposphere (MST) can cost in excess of $1M but smaller radars which can study the lower stratosphere and troposphere (ST) cost an order of magnitude less. It has been demonstrated that these radars can operate continuously with minimum maintenance, which considerably reduces operating costs. The smaller systems can be made easily transportable so that networks of ST radars with variable spacing are possible.

2. Partial Reflection Radars

Partial reflection (PR) radars operating at frequencies near 2-3 MHz use the spaced antenna technique to measure the horizontal wind field in the 60-100 km height range by day and in the 80-100 km range by night. The meridional and zonal components are observed simultaneously in a common volume that typically has a radius of about 4-15 km and a depth determined by the pulse length, which is 2-4 km. PR radars are well suited for studies of gravity waves with periods greater than about 15 min because of the excellent height and time coverage and moderate-to-good spatial and temporal resolution. Although the observations are affected by the intermittency of the reflecting mechanisms - usually turbulent in character above 80 km and quasi-specular in nature at lower levels - the data are usually quite continuous with height. PR radars can operate for long periods with little attention. Small PR radars can be made transportable and with low cost (>$20K). To improve the system sensitivity it is possible to implement signal processing techniques such as coherent integration of the signal and pulse coding. These improvements could extend the observable altitudes down to perhaps 50 km at mid-day. By making the radars phase coherent, it may also be possible in the future to measure vertical velocities.

3. Meteor Radars

Meteor radars measure the line-of-sight Doppler velocities of meteor trails drifting under the influence of the wind. The trails occur randomly in space and time and are usually observed in the 80-105 km height region with a large diurnal variation of echo rates. Significant averaging in space and time is usually required to obtain the winds, so that meteor radars are best suited to measuring the prevailing and tidal components. However, some meteor radars with good (~2 km) height resolution can be used to measure gravity wave amplitudes and vertical wavelengths. Multi-station techniques can be used to investigate turbulence and small-scale wind structure in the lower thermosphere. MST radars can also be used to obtain meteor winds.

4. Lidars

Lidars use Rayleigh scattering from atmospheric molecules to measure neutral density and temperature. The height covered is 30-90 km at night and 30-60 km during the day. The height and time resolution depend on the amount of temporal averaging used, and values in the range 100 m-1 km and 15 min-1 hr are currently achieved. The errors in temperature at night typically range between 0.1 K at 30 km and 10 K at 80 km for data averaged over 2 hours with a height resolution of 2 km. Lidar systems can operate continuously subject to meteorological conditions, and can be made easily transportable. In the near future it should be possible to achieve a ten-fold gain in accuracy by increasing the laser mean power and the collecting area of the receiving telescope. It may also be possible to measure winds in the lower stratosphere by, for example, utilizing the Doppler shift of scattering from aerosols. The current cost of a lidar station is about $200-300K.

5. Rocket Techniques

The Meteorological Rocket Network (MRN) provides data on the zonal and meridional wind components and temperature in the height range 20-70 km with a vertical resolution of a few hundred meters. Although the time resolution of rocket observations is poor (two soundings per week on average at each station), gravity waves can be studied by removing the mean background state from individual profiles. Valuable information is provided in the gap region not presently covered by MST radars. Observations have been made for more than 15 years at stations covering a wide range of latitudes, longitudes, and seasons.

Recently, a variety of high-resolution rocket-borne measurement systems have been employed for detailed studies of middle atmosphere structure and composition. Those of relevance to the study of gravity wave and turbulence processes include high-frequency accelerometers, electron density probes and trace constituent sensors, among others.

Future prospects in this field appear to be primarily in those ongoing high-technology rocket programs designed to study specific aspects of the gravity wave and turbulence fields. Nevertheless, the MRN data analysis of gravity waves will remain important as a counterpart to MST radar measurements and a complement to lidar measurements in the future.

6. Balloon Techniques

Radiosondes provide a large set of data on the temperature and wind fields in the range 0-30 km. The accuracy of the measurements is sufficient for meteorological purposes (1 K in temperature and 5 ms^{-1} in wind speed) but they typically do not provide a detailed description of the wind structure. However, large balloons carrying two vertically separated anemometers have provided temperature and wind measurements in the stratosphere with excellent height resolution (1 m) and accuracy (0.05 K and 0.1 ms^{-1}) and have been used to study gravity waves and turbulence.

7. Aircraft Techniques

In the lower stratosphere (up to 21 km) research aircraft equipped with inertial platforms, air motion sensors, and temperature and trace species sensors can be utilized to provide information on wave and turbulence structure with a high degree of accuracy at the smaller horizontal scales. Such measurements could provide data complementary to the remote sensing methods.

8. Other Techniques

Photographic studies of airglow emissions such as from OH and Na and of noctilucent clouds can provide very useful information on the horizontal structure and phase velocities of waves near the mesopause. High vertical resolution (~100 m) investigations of the sodium layer by lidars can provide information on the periods and vertical wavelengths of waves in the 80-100 km region.

b. Topics

Radar methods provide a powerful tool for studying turbulence in the middle atmosphere (for details, see BALSLEY and GAGE, 1980; ROTTGER, 1980). The backscattered echo power and the Doppler spectral width of the signal returns are directly related to turbulence intensity. The echo power is a direct measure of one spatial Fourier component of the refractive index variation produced by a turbulent region, while the spectral width (used with caution) is a measure of the variance of turbulence velocities.

Turbulence spatial characteristics have already been studied at a number of sites via the backscatter power structure. The presence of vertically thin, horizontally extended turbulent regions that exist for many hours has been noted in both the stratosphere and lower mesosphere (CZECHOWSKY et al., 1979; SATO and WOODMAN, 1982). While some exceptions to this general picture exist (i.e. in the high-latitude summer mesosphere), they can probably be considered typical.

Estimates of vertical diffusion can be made using statistical properties of the thin turbulent regions (WOODMAN et al., 1981). This is of particular importance in the current context since enhanced diffusivity increases gravity wave damping and the corresponding mean flow accelerations. Estimates of stratospheric diffusion and turbulence dissipation have been obtained from the observed dispersion of rocket vapor trails (ROSENBERG and DEWAN, 1975) and high-resolution balloon data (CADET, 1977) among others. Current radar estimates of vertical diffusivity in the lower stratosphere suggest values that may be appreciably larger than those obtained by aircraft techniques (LILLY et al., 1974). Further measurements appear necessary to address this disparity.

The possibility of using radar systems with very good vertical resolution (tens of meters) to study the space-time structure of turbulence within the layers is exciting, and should allow us to better understand the underlying generation mechanisms (i.e. dynamical and convective breaking of the waves). In this regard, the use of special rocket and balloon-borne techniques (PHILBRICK et al., 1983; BARAT, 1983) concurrent with radar observations to obtain high-resolution structure of turbulent regions would appear important for understanding the generation mechanisms of turbulence and would enable a valuable intercomparison between techniques.

The use of Doppler spectral width to measure turbulence intensity has yet to be fully exploited (SATO and WOODMAN, 1982; HOCKING, 1983). Since the velocity variance is directly related to the eddy dissipation rate, it is clear that a greatly increased observational program using spectral width estimates of eddy dissipation rates would have direct relevance to the development of more accurate general circulation and mechanistic models. Energy dissipation rates can also be used to infer vertical diffusivity and heating, thus spectral width measurements may provide an alternative method of determining vertical diffusivity. Spectral width measurements, however, require a narrow radar beam and a correspondingly large antenna area.

Finally, the general characteristics of the turbulence structure profiles can be expressed in terms of the refractive index structure constant C_n^2 (TATARSKII, 1971). This parameter is useful, for example, in comparing radar, optical, and other turbulence measurements.

2. Gravity Waves

A significant amount of information on middle atmosphere gravity waves has already been obtained by existing techniques. Radars can provide a detailed description of the wind field as a function of height and time. They can also produce spectral descriptions of the wind field fluctuations as a function of frequency (BALSLEY and CARTER, 1982). Lidars provide similar information for the temperature fluctuations (Chanin and Hauchecorne, 1981). Data from rocket networks can reveal long term statistics on the geographical and seasonal variation of the wave field (HIROTA, 1983). Rocket data also provides instantaneous profiles of temperature and wind (THEON et al., 1967) from which gravity wave processes can be inferred.

Two important parameters about which relatively little information has been collected are the horizontal wavelengths (λ_h) and phase velocities (c) of gravity waves. Some information on these parameters has been obtained from studies of airglow emissions and noctilucent clouds (ARMSTRONG, 1982; HERSE et al., 1980; HAURWITZ and FOGLE, 1969). Initial radar estimates of λ_h and c were made by VINCENT and REID (1983) and FRITTS et al. (1983). VINCENT and REID (1983) also made the first direct measurements of another important quantity, the upward flux of horizontal momentum ($\overline{u'w'}$) in the mesosphere, and VINCENT (1983) used rotary spectra to obtain a lower limit on the fraction of upward propagating, low-frequency gravity waves in the mesosphere and lower thermosphere. The latter study suggests an upward flux of energy and momentum consistent with the requirement of gravity wave drag.

Two interpretations have been advanced to account for the low-frequency ($\omega < N$) and low (horizontal) wavenumber spectra observed in the middle atmosphere. One is that the motions are due to a spectrum of internal gravity waves analogous to the "universal" wave spectrum applied to the ocean (VANZANDT, 1982). Such a theory is consistent with both the apparent role of gravity wave transport, drag, and diffusion in middle atmosphere dynamics and the observed spectral character of atmospheric fluctuations. A second interpretation, based upon the theory of two-dimensional turbulence, also appears to be consistent with certain spectral observations (GAGE, 1979; LILLY, 1983), but this theory requires the presence of propagating gravity waves as the primary coupling between the lower and middle atmosphere and is concerned primarily with the spectral distribution of kinetic energy. The actual state of the atmosphere, of course, may involve a combination of gravity waves, two-dimensional turbulence, and other motions, with further studies needed to delineate their relative importance.

Gravity wave observations to date have provided good preliminary information on motions, processes, and spectra using a variety of techniques. Often, however, such observations are made without knowledge of the mean velocity and static stability profiles. This is a major shortcoming (particularly the lack of $\overline{u}$) because it causes ambiguities in the determination of the characteristics and/or consequences of the wave motions that might otherwise be inferred.

5. FUTURE RESEARCH NEEDS

a. Modeling Needs

Because they tend to be computationally efficient and allow individual processes to be studied in isolation, mechanistic models will probably continue to play a major role in the development and testing of parameterizations for gravity wave-mean flow interactions. Both the quasi-geostrophic models and the global primitive equation models will be useful tools. We anticipate, however, that there may be less emphasis on zonally symmetric models in the future, particularly for the study of wave-mean flow interactions in the winter hemisphere. The current primitive state of knowledge of gravity wave morphology and of the detailed physics of wave breaking allows for a wide range of assumptions in present models. Ideally, mechanistic models that properly handle wave-mean flow interactions will provide some useful constraints on the possible characteristics of the observed wave climatology. However, there is little prospect that modeling can be in any sense a substitute for observations.

It should be cautioned that measured gravity wave fluxes and other parameters will not be able to be used directly in middle atmosphere models. One reason for this is that measured quantities depend on atmospheric conditions in the troposphere, stratosphere, and mesosphere that may be very different from those existing in a model. However, measurements of the global gravity wave morphology should allow the development of schemes that can consistently represent the proper dependence of the large-scale flow on gravity wave processes.

b. Theoretical Needs

Theoretical studies are needed to address a number of problems that are unlikely to be solved using existing observational techniques. The most obvious of these relate to the saturation process itself. In particular, studies are needed that address the detailed mechanisms and consequences of saturation, including wave scattering and reflection, multiple wave saturation, and the effects of temporal and spatial variability of saturation. The former studies are necessary to understand the evolution of a saturating gravity wave spectrum; the latter is needed to correctly incorporate the effects of saturation and its variability in mechanistic and general circulation models of the middle atmosphere.

Other areas in which theoretical work is needed are the identification and quantification of the dominant tropospheric sources of gravity waves and studies of wave propagation and filtering through wave-wave and wave-mean flow interactions. Theoretical studies of gravity wave sources in conjunction with high-resolution observations may help determine the phase speed and horizontal wavelength distributions as well as their geographical and temporal variability.

These distributions are poorly known at present, but they are expected to have a major impact on the occurrence and the effects of saturation in the middle atmosphere. Likewise, the propagation of gravity waves through and their interaction with a variable environment will influence the character and occurrence of saturation. It is also important to determine to what extent the concept of a universal gravity wave spectrum can be applied to the atmosphere.

c. Observational Needs

1. Gravity Wave and Turbulence Climatology

There is a clear need to extend our studies of the climatology of atmospheric gravity waves and turbulence. Observations of the geographical and temporal distributions of gravity wave sources, energies, and momentum and heat fluxes as well as turbulent diffusion are required. The distributions of momentum fluxes ($\overline{u'w'}$ and $\overline{v'w'}$) and heat fluxes ($\overline{v'T'}$ and $\overline{w'T'}$), in particular, have direct implications for modeling the large-scale circulation and will depend on the dominant sources and the propagation of gravity waves into the middle atmosphere. Measurements of turbulent diffusion and spectral width are needed to address the rate of gravity wave energy dissipation and the effects of diffusion in the middle atmosphere.

It is also important to address the vertical transport of energy and momentum by the full spectrum of gravity waves under various conditions. To this end, studies of low-frequency motions using rotary spectra and filtering through radiative cooling, wave-wave, and wave-mean flow interactions appear relevant.

Momentum flux, energy, turbulence intensity, and rotary spectrum measurements are currently possible with multiple-beam radar systems; heat fluxes could be determined with combinations of radars and lidars.

2. Case Studies

Case studies of nearly monochromatic wave motions providing the mean and perturbation wind fields and the distributions of vertical wavenumber would permit comparisons with theoretical models and provide evidence of important processes and interactions. Independent measurements of the associated temperature fields would permit a check on the wave parameters inferred from radar measurements. Observations of wave excitation and dissipation (or saturation) are particularly important in this regard. It would also be useful to identify the frequency of occurrence of the various gravity wave processes and interactions thought to be important in the middle atmosphere.

One example of a useful case study is nearly monochromatic gravity wave saturation. Saturation is associated with either $|\frac{\partial T}{\partial Z}| \sim \Gamma$ or $|u'| \sim |c-\bar{u}|$. Because there are uncertainties in estimating c using data from a single station, however, saturation may be identified most unambiguously in measurements of the temperature structure. Because c is constant and $\bar{u}$ may change with height, $|u'|$ need not remain constant above the saturation level.

3. Measurement of λ_h and c

Two gravity wave parameters of particular significance are the horizontal wavelength (λ_h) and the (horizontal) phase velocity (c). They are important because they are essentially constant following the wave motion and they determine the occurrence and distribution of gravity waves in the middle atmosphere. Other relevant wave parameters like the intrinsic frequency ($k(c-\bar{u})$) and the vertical wavenumber ($m = \frac{2\pi}{\lambda_Z}$) are not constant, but depend on N^2 and $\bar{u}$. Determination of the phase speed distribution of gravity waves near their source regions in the troposphere and in the middle atmosphere would permit a quantitative assessment of the effects of filtering and wave-wave interactions as the gravity waves propagate vertically. Horizontal wavelength measurements would help establish the degree of homogeneity in the mesospheric response to gravity wave saturation.

Estimates of λ_h and c can be obtained in certain instances with present radar and lidar systems using multiple-beam techniques. However, such estimates are subject to potentially large errors and may be biased towards relatively small-scale waves ($\lambda_h \lesssim 200$ km) because of small horizontal beam separations. It would be desireable, therefore, to make more direct radar and lidar measurements at a range of spacings from a few tens of km upwards in order to measure those wavelengths and phase velocities most relevant to middle atmospheric dynamics. Such spacings are considerably less than that required to address the geographical distribution of gravity wave saturation and turbulent diffusion.

4. Measurement of Mean Winds

In addition to gravity wave and turbulence measurements, long term measurements of the mean zonal and meridional wind components in the mesosphere and lower thermosphere are required. At present, the climatology of the mean zonal wind at these levels is not well known, especially in the tropics. The current data base for the mean meridional wind is completely inadequate. The latter is particularly important since gravity wave drag in the mesosphere is primarily balanced by the Coriolis torque due to the mean meridional motion.

d. Observational Networks

As discussed in several of the above sections, it would be desireable to establish networks of radar and/or lidar systems for the following reasons:

i) The horizontal wavelengths and phase velocities of monochromatic atmospheric gravity waves can be measured more reliably by making observations from at least three spatially separated points. Because the wavelengths of longer wave cannot be accurately determined using small spacings, it will be necessary to use a range of spacings.

ii) Studies of the global morphology of gravity waves require that several such facilities be established at geographically distinct locations. Such systems should make extended observations to determine seasonal and inter-annual variability. The potentially important effects of orography can be examined by establishing sites near extensive mountain ranges and by comparing these results with observations taken in orographically smooth regions.

Other combinations of observing systems would also provide important information on gravity wave propagation and dissipation processes and morphology. Co-located lidar and radar facilities, for example, would permit much more detailed observations of gravity wave saturation in the mesosphere. Saturated wave amplitudes could then be compared directly with perturbation lapse rates for both narrow- and broad-spectrum saturation. Meteorological rockets would provide an important complement to both radar (MST or PR) and lidar facilities through the addition of mean wind, temperature, and gravity wave structure in regions where no balloon or radar wind data is available. Such data would make possible studies of gravity wave propagation and the onset of saturation.

One final recommendation pertains to establishing such observatories in the tropics. Extended tropical observations, particularly within a few degrees of the equator, will yield (in addition to the low-latitude gravity waves) important new information on long-period equatorial waves. These waves exist only in the tropics and comprise the major mechanism for momentum transport into the middle atmosphere in that region.

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GLOSSARY

c	horizontal phase velocity
k	horizontal wavenumber ($= \frac{2\pi}{\lambda_h}$)
m	vertical wavenumber ($= \frac{2\pi}{\lambda_z}$)
N	Brunt-Vaisala frequency
T	temperature
$\overline{u}$	mean horizontal motion
u'	horizontal perturbation velocity
z	height coordinate
Γ	adiabatic lapse rate ($= \frac{g}{C_p}$)
λ_h	horizontal wavelength
λ_z	vertical wavelength
ω	intrinsic wave frequency ($= k(c-\overline{u})$)

PART 4

MSG-7 REPORT
THE PENETRATION OF ULTRAVIOLET SOLAR RADIATION INTO THE MIDDLE ATMOSPHERE: CONCLUSIONS AND RECOMMENDATIONS

J. E. Frederick (Chairman)

Members: A. J. Blake, D. E. Freeman, R. W. Nicholls, T. Ogawa, and P. C. Simon

On August 22, 1983, several members of MSG-7 met, together with other interested scientists, during the IUGG General Assembly in Hamburg, FRG. The objective of the meeting was to review the conclusions of the MSG-7 document that appeared in Volume 8 of the Handbook for MAP (July 1983) and to assemble a set of recommendations for future studies that could improve our understanding of the penetration of ultraviolet solar radiation into the middle atmosphere. The major concern of MSG-7 has been the assessment of available cross section data for molecular oxygen, and to a lesser extent ozone, in the wavelength region greater than 165 nm plus Lyman Alpha.

Laboratory measurements of the O_2 absorption cross section in the vicinity of the hydrogen Lyman Alpha line (121.6 nm) show relatively minor disagreements among themselves. It is now widely recognized that data of high spectral resolution are needed to allow for convolution of the solar line profile with the variable cross section over a wavelength interval of approximately 0.15 nm. Additional data would be useful in confirming details of the cross section shape and magnitude at temperatures typical of the upper mesosphere. However, this is not identified here as a major need.

Solar radiation in the Schumann-Runge continuum of O_2, at wavelengths less than 175 nm, is responsible for the large atomic oxygen concentrations above the mesopause which can influence lower altitudes via transport. Comparison of the available laboratory cross section data in the 165-175 nm spectral region shows excellent agreement among different workers. Additional measurements here are therefore not a high priority need for middle atmospheric research. At wavelengths longer than 175 nm absorption by excited vibrational states occurs in the continuum and this effectively fills in the window regions between the Schumann-Runge bands in the 175 to 180 or 185 nm region. Knowledge of this temperature sensitive continuum is necessary for accurate calculations of solar energy penetration into the upper mesosphere. However, most laboratory measurements have not explicitly addressed these excited state transitions and their temperature dependence. Additional data on absorption by vibrationally excited states would be valuable here.

Several independent sets of laboratory absorption data for the Schumann-Runge bands of O_2, 175-205 nm, have been published in the last five years. There is now general agreement that the rotational linewidths are greater than believed on the basis of earlier measurements, although the discrepancies among different oscillator strengths and especially linewidth results are still larger than desirable for some bands. Measurements with sufficient spectral resolution to yield linewidths directly are preferred here since indirect inferences, as have been necessary in most experiments, can produce results with substantial error bars. Additional determinations of the spectroscopic constants for the upper electronic state of the Schumann-Runge transition are required to resolve the discrepancies that now exist among different linewidth results. We identify this as the major current need in this region of the spectrum. In addition, the "hot bands" with $v''=1$ are not negligible at typical stratopause temperatures. When these absorption features lie in the window regions between the $v''=0$ bands they can make a significant contribution to atmospheric opacity. The lack of laboratory values for the Schumann-Runge $v''=1$

oscillator strengths is identified as a significant deficiency in the available data base.

A major need identified at the Hamburg meeting is for the development of a standard format for treating the transmission of solar radiation in the Schumann-Runge bands and incorporating this information into photochemical models. The primary issue here is that the data deduced in most experiments, being band oscillator strengths and rotational linewidths, are not immediately useful for atmospheric modeling applications. However, even if the complete cross section as a function of wavelength were available, it would not be feasible to include the necessary level of detail in practical calculations. It is therefore recommended that standardized parameterizations which are convenient for use in photochemical models be designed and implemented. These parameterizations should include temperature dependence and allow straightforward calculations of the transmission of the 175-205 nm solar radiation through the atmosphere and of the molecular oxygen photodissociation rate for any solar zenith angle. Although several parameterizations have been reported in the past, they have not utilized the most recent laboratory data which are now available. These parameterizations should be developed in association with experienced atmospheric modelers to assure a convenient format for meshing with photochemical calculations.

The Herzberg continuum lies beneath the Schumann-Runge bands, and at wavelengths longer than 200 to 205 nm is responsible for the dissociation of molecular oxygen which leads to formation of the stratospheric ozone layer. The spread among the available laboratory results is unacceptably large and reflects the difficulty in deducing the zero-pressure limit of a cross section which is on the order of 10^{-24}-10^{-23} cm^2. Inferences based on in situ measurements of the attenuated solar irradiance imply smaller cross sections than have most past laboratory results. However, recent laboratory determinations which accurately correct for the pressure dependence are now producing cross sections that are near the _in situ_ values. A definitive laboratory determination of the continuum cross section between 200 and 240 nm is here identified as a major need for atmospheric calculations. This measurement should be done independently by two or more groups. The laboratory results should then be checked under atmospheric conditions by at least one balloon-borne measurement of the attenuated solar irradiance in the middle stratosphere.

Measurements of the ultraviolet absorption cross section of ozone have two major roles in atmospheric studies. The first concerns their use in photochemical model calculations and the second involves atmospheric ozone measurements. It is the latter of these that places the most stringent accuracy requirements on our knowledge of the cross section. Most available data give only relative cross sections since few absolute measurements have been performed. Furthermore, there are significant unresolved discrepancies among the absolute cross sections that now exist, being in the vicinity of 6% for wavelengths greater than 300 nm. In addition to the absolute values, it is critical to establish the temperature dependence of the cross section over the entire wavelength range of relevance to atmospheric studies. Although work of this type is currently underway, definitive results are not yet available in the literature. Because the detection of very small changes in atmospheric ozone is a high priority task, it is essential that we be able to separate the effects of temperature variations from true ozone changes. Emphasis to date has focused on the spectral region longward of 300 nm where the temperature dependence is most pronounced. However, for the purpose of unambiguous detection of ozone profile variations, it is necessary to have temperature dependent absolute cross sections over the entire spectral range 250-340 nm. This is identified as a major need for interpretation of satellite-based ozone observations to be conducted throughout the 1980s and 1990s. At least two independent research groups should obtain definitive cross section results at the same set of two or more temperatures that span the range of atmospheric variability. In addition, cross section measurements extending shortward to at least 200 nm and preferably to 175 nm would be valuable for resolving discrepancies that exist among previous data sets in this spectral region. These short wavelength measurements are necessary for proper interpretation of the attenuated solar radiation field at stratospheric altitudes.

Laboratory studies of the absorption cross sections of O_2 and O_3 provide the capability to predict the solar ultraviolet radiation field in the stratosphere and mesosphere. It is recommended that such predictions be tested by new in situ measurements of the attenuated solar irradiance from balloons and rockets. Additional atmospheric measurements designed specifically to examine ultraviolet penetration would be useful in both the Herzberg continuum and Schumann-Runge bands of O_2. We here note that such measurements done in the past first indicated that the Herzberg continuum cross sections were smaller than generally believed based on laboratory results. Furthermore, near 200 nm in wavelength, we also require an accurate knowledge of the cross section for Rayleigh scattering.

Atmospheric studies of the Herzberg continuum absorption of O_2 are best carried out from balloons since attenuation of solar radiation in the vicinity of 200-220 nm does not become significant until altitudes less than 40 km for typical midday solar zenith angles. A complete payload should include pressure sensors to define the O_2 column content above the observation point and high accuracy ozone monitors to determine the abundance and scale height during balloon ascent and descent. A solar pointed ultraviolet spectrometer should scan the direct solar beam over the entire wavelength range 185-300 nm. Although only the shorter wavelengths, 185-240 nm, are of concern for O_2 absorption, the remaining portion of the spectrum is needed for deriving the ozone column abundance above the balloon. Spectral resolution in the vicinity of 0.1-1.0 nm is adequate for this work.

For the Schumann-Runge bands, atmospheric measurements are required over the spectral range 175-205 nm supplemented by the same supporting data discussed above. Observation of photons at wavelengths shorter than 185 nm require ascent to altitudes near and above the stratopause thereby necessitating the use of rockets. An altitude of at least 60 km should be attained in this work, and greater spectral resolution is desirable than was the case at longer wavelengths. Although it is not feasible to observe all band structure that exists in the spectrum, a resolution in the range 0.01-0.10 nm is advised.

Although O_2 and O_3 are the major gases that attenuate the solar radiation field, several other trace species can be significant in selected spectral regions and merit further investigation. Prominent among these is the absorption by SO_2 near and longward of 300 nm. Particularly after volcanic activity the absorption bands of SO_2 can have a substantial impact on solar transmission in the wavelength range used for ground-based ozone measurements. New laboratory measurements of the cross section including its temperature dependence should be performed to allow correction for this contamination. Similar absorption bands of NO_2 exist in the 305-340 nm region and under polluted atmospheri conditions might impact ozone determinations. Improved cross section data would be of value here.

The isotopes of O_2, $O^{16}O^{18}$ and $O^{18}O^{18}$, have atmospheric abundances similar to many chemically active trace species. Dissociation of these isotopes in their Schumann-Runge band systems constitute an odd oxygen source of poorly known magnitude. This process also produces stratospheric heavy ozone which has been observed by balloon-borne mass spectrometers. Experimental studies to define the positions of the isotope rotational lines and the absorption cross sections would contribute to our understanding of this issue.

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