FEDERATION OF DIGITAL BROAD BAND SEISMOGRAPH NETWORKS (FDSN)

Summary of the founding meeting, Kiel, R.F.A., August 27, 1986.

The founding meeting took place during the joint meeting of the EGS-ESC and followed an initial meeting (April 4. 1986. Karlsruhe R.F.A.)during which representatives of a number of countries involved in the deployment of broad band networks had expressed their interest and wish to form a Federation and had agreed on a text representing the statement of purpose of this Federation (EOS, Trans. AGU June 24, 1986, report by B. Romanowicz and A Dziewonski).

The meeting in Kiel began by an introduction by H.P. Harjes. chairman, followed by short descriptions of on-going national programs regarding broad band networks.

The affiliation of the Federation to two international organisations : IASPEI and ILP (International lithosphere program) was discussed and seeked. The chairman of the Federation will be a member of the ILP commission and attend IASPEI meetings. ILP and IASPEI will send representatives to Federation meetings. Reports and minutes of Federation meetings will be published in the IASPEI and ICL newsletters.

The terms of reference of the Federation, as given in Appendix I, were discussed and approved.

Provision was made for representatives of other countries or programs which have not yet joined the Federation to be kept informed of its activities and be allowed to attend the meetings of its steering committee as observers.

Nine national programs joined the FDSN as founding members. The list is given in Appendix II The list of participants to the Kiel FDSN meeting is given in Appendix III.

A chairman and two vice chairmen were then elected to the bureau of the Federation

- Chairman : Michael BERRY (Geological Survey of Canada)
- Vice Chairmen Adam DZIEWONSKI (Harvard U. USA)
  Barbara ROMANOWICZ (Institut du Globe Paris)

Four working groups were formed to address technical matters :

1 - Review of siting plans (chairman R Engdahl USGS)
2 - General specifications of broad band systems (chairman E. Wielandt ETH Zurich)
3 - Specifications for data collection and exchange (chairman J. Scheimer, IRIS, USA)
4 - Data Centers (chairman E. Husebye, ORFEUS)

Working group I will produce several maps of the worldwide distribution of stations, distinguishing "regional" and "global" stations, as well as short term and long term plans of each program.

Working group II will define the standards required for stations to qualify as "global" (suited for global studies of structure and seismic sources) or "regional" (designed for more specific regional scale studies).

This will follow a draft document by E. Wielandt presented at this meeting which proposed as minimum requirements for a "broadband system" (regional station) that a seismograph must record all seismic signals that can now be recovered from WWSSN SP and LP seismographs. A development goal (or standard for global station) would be the ability to record from ground noise to amplitudes expected from a magnitude 9 earthquake at 20° distance in the band from 3000 sec to 10 Hz (cf.VBB STS seismometer with 24 bit digiter).

Working group III will be concerned with defining common formats for the collection and exchange of data, as well as possible recommendations for hardware supports for both data collection and exchange.

As for working group IV a general consensus was reached to try and follow the concept of a "distributed data center",as opposed to a multitask centralized facility (for which extra funding on the international level would be required).

The next meeting of the FDSN was tentatively scheduled for the Fall 86 AGU. Proposals by the working group will then be discussed.

Barbara Romanowicz, Paris, September 7, 1986.

APPENDIX I

TERMS OF REFERENCE

Federation of digital Broad-Band Seismograph Networks

The International Seismological Community recognizes new opportunities within its field for improved understanding of the internal structure and dynamical properties of the Earth provided by recent developments in seismograph network technology.

It also recognizes that rapid access to seismic data networks of modern broad-band digital instruments wherever they might be. is now possible.

The developments include greatly improved broad-band seismographic systems that capture the entire seismic wave field with high fidelity, efficient and economical data communications and storage and widely available, powerful computing facilities.

The federation is open to all national and international programs committed to the deployment of broad-band seismographs and willing to contribute to the establishment of an optimum global system with timely data exchange.

I. Goals

In view of the above, and to take advantage of existing developing global and regional networks the "Federation of Digital Broad-Band Seismograph Networks (FDSN)" is formed to provide a forum for :

- developing common minimum standards in seismographs (e.g. bandwidth) and recording characteristics (e g. resolution and dynamic range) ;
- developing standards for quality control and procedures for archiving and exchange of data among component networks ;
- coordinating the siting of additional stations in locations that will provide optimum global coverage.

II. Institutional Frame

The Federation is an independent international association and is affiliated with two international organisations : the Inter Union Commission on the

Lithosphere (ICL) and the International Association for Seismology and Physics of the Earth's Interior (IASPEI).

III. Membership and Organization

- Membership in the FDSN is open to national and international programs committed to both the development and operation of broad-band digital networks and complying with the goals of the federation.

- The activities of the federation will be coordinated by a steering committee whose membership may not exceed one representative from each of any national or international program.

- The members of the steering committee will be appointed or selected from within the country or the organization they represent

- The steering committee will be headed by a chairman elected for a two year term, assisted by two vice-chairmen.

- The steering committee will form all necessary working groups or special technical committees as required to reach the objectives of the FDSN.

- The steering committee will meet at least once a year.
  Special meetings may be called by the chairman as appears necessary for the progress of the FDSN.

- Concerning all recommendations made and actions to be taken, each member of the FDSN will have one vote, and an affirmative vote by 2/3 of members present at a steering committee meeting will be required.

- A majority of members of the FDSN will constitute a quorum for the steering committee meetings.

- No fees are imposed but voluntary contributions may be requested to cover costs for communications.

- Any member may resign at any time by giving written notice to the chairman.

APPENDIX II

F.D.S.N. MEETING, Kiel, August 27

List of founding members

Program	Representative
USGS (USA)	R. ENGDAHL
IRIS (USA)	St. SMITH
GEOSCOPE (France)	B. ROMANOWICZ
ORFEUS (Europe)	E.S. HUSEBYE
CDSN (Rep. of China)	Xu SHAOXIE
CANDIS (Geological survey of Canada)	P. W. BASHAM
AUSTRALIA	K. MUIRHEAD
JAPAN GLOBAL SEISMOLOGY SUBCOMMITTEE OF JAPANESE NATIONAL COMMITTEE OF SEISMOLOGY AND PHYSICS OF THE EARTH'S INTERIOR	Y. FUKAO
FKPE (W. Germany)	H. AICHELE

APPENDIX III

FDSN MEETING, KIEL, AUGUST 27 , LIST OF PARTICIPANTS

Name	Address
R.D. ADAMS	International Seismological Centre. U.K.
P.W BASHAM	Geological Survey of Canada
R BODVARSON	University of UPPSALA Sweden
B BUTTKUS	BGR Hannover F R.G.
A CHRISTOFFERSON	University of Uppsala, Sweden
B. DOST	University of Utrecht, Netherlands
A.M. DZIEWONSKI	Harvard Univ., U.S A.
H.J DURBAUM	BGR, Hannover F.R G.
E.R. ENGDAHL	U.S.G.S., Denver, CO, USA.
K. FUCHS	Universität Karlsruhe F.R.G.
Y. FUKAO	Nagoya Univ. Japan,
W. GROSSE-BRAUCKMANN	IGM Überlingen. R.F.A.
W. HANKA	BRG. Hannover
H.P. HARJES	University Bochum, F.R.G.
J. HJELME	Geodetic Institute, Charlottenlund. Denmark
E. HURTIG	Central Institute of Physics of the Earth, Acad. Sc. GDR, Potsdam, D.R G.
E. HUSEBYE	Dept. of Geology. Oslo. Norway
S IVANSSON	National Defense Research Institute, Stockholm. Sweden
J. KLUSSMANN	Inst. für Geophysics, Univ. Hamburg, R.F.G.
H. KORHONEN	Inst of Seismology, University of Helsinki. Finland
B. MASSINON	CEA/LDG, France
D. McGREGOR	ISC U.K
K. MUIRHEAD	Bureau of Mineral Resources, Canberra, Australia
St. MUELLER	ETH-Geophysics Switzerland
J.A. ORCUTT	IGPP, Scripps Inst. of Oceanography. La Jolla.CA. U.S.A
R.G. PEARCE	Department of Geology University College. Cardiff U.K.
S. PIRHONEN	Inst. of Seismology, Univ. of Helsinki, Finland
A PLESINGER	Geophysical Institute. Czechosl. Acad. Science. Prag, Czech.
B ROMANOWICZ	I.P.G., Paris. France
A. RYALL	Center for Seismic Studies , Arlington VA, U.S.A.
W SCHAECHER	Teledyne Geotech. Texas U.S A.
J. SCHEIMER	IRIS, U.S.A.
Xu SHAOXIE	Institute of Geophysics, State Seismological Bureau Beijing, China
St. SMITH	IRIS, U.S.A.
N. SPRIGGS	Teledyne Geotech, London, England
B. STORK	SZGRF
R. UNGER	DELFT Univ. of Technology, Netherlands
E. WIELANDT	ETH, Zurich. Switzerland
M. YAMAMOTO	Japan Meteorological Agency

ply this information. For mankind to benefit from what is learned about the unique environmental effects of karst terrain, communication is critical. The organizers hope that this meeting, like its 1984 predecessor, will generate state-of-the-art geology, engineering, and environmental impact papers. Topics to be considered include geology and engineering studies of karst areas, with emphasis on sinkholes and other practical aspects; hydrogeology and environmental problems of karst; international examples of applied karst geology and hydrology; specific engineering considerations of karst terrain; and any additional related areas.

Meeting Report

Toward a Federation of Broadband Seismic Networks

Introduction

Seismologists from many parts of the world are convinced that this is the time to undertake a major initiative in instrumenting the surface of the earth with a network of high-quality modern seismographs. Realization of the compatibility of the efforts that arose nearly simultaneously in several countries led to a meeting in Karlsruhe, Federal Republic of Germany, April 10–11, 1986. The meeting was organized as part of a symposium of the International Lithosphere Program and was convened during the Annual Meeting of the German Geophysical Society. A proposal was made at the meeting to form an organization that would aid in the coordination of national programs by establishing common instrumentation standards and a mechanism for the timely exchange of data.

Seismologists have always relied on free and open exchange of seismic data and international cooperation. Little of what we now know about the earth's interior structure or the global pattern of stress release would have been discovered if the mechanisms for sharing data or observations had not been instituted as early as the turn of this century. Nearly instantaneous analysis of global seismic data is now a societal concern because of the population growth in seismic and coastal areas. With the development of worldwide communication technology, rapid access to seismic data from arrays of modern broadband digital seismograph systems, regardless of institutional and national boundaries, is now possible. Thus national, societal, and scientific needs can be better met, to the benefit of all.

From a scientific point of view, a worldwide system of national, regional, and global seismic stations tied by communication links to data centers and research institutions will make it possible to reach an understanding of our planet at an unprecedented rate. The global nature of seismology and the difficulty and expense of the endeavor require that seismologists and governments of the world cooperate to achieve these scientific and social goals.

Background

The contributions of seismology to our understanding of the structure and dynamics of the earth's interior has always been of prime importance. Seismic waves traveling through the earth carry a wealth of information on the earthquake that generated them as well as on the earth's internal structure. Seismologists have often dreamed of being able to record the entire generated wave field precisely and then exploit it efficiently for more accurate mapping of earthquake sources and the fine structures of the mantle and core.

In the past few years, advances in mapping the earth's interior in three dimensions and spaciotemporal properties of seismic sources have revealed how much more we could learn about our planet with properly deployed arrays of digital stations. At the same time, the technological developments made such plans entirely feasible.

There are now broadband seismographs that allow registration of the seismic signals from 10 Hz to tidal frequencies in a single data stream. These sensors are able to resolve ground noise at a quiet site and to record on scale, at distances beyond 30°, signals from the largest earthquakes (this corresponds to a dynamic range of 140 dB). Modern analog-to-digital 24-bit encoders can convert this range of signals without the distortion that is introduced by gain ranging. Microcomputer technology allows us to develop station processors capable of performing many complex functions. Storage technology allows the recording, archiving, and merging of unprecedented quantities of data. Progress in telecommunications makes it practical to transmit large volumes of data in real time or near real time. Expansion of computer facilities, including supercomputers, opens new possibilities with respect to the dimension of the data sets used and the complexity of the analysis.

Several nations have recognized the potential of these scientific and technological advances and are developing (or planning to develop in the near future) networks of such broadband systems on a global, regional, or national scale. While all these networks will use similar instrumentation, each of them was conceived to address a different problem or to cover a different area. None of them, however, will ever be able to deploy enough instruments to fully resolve problems on a planetary scale; for example, the details of the mantle or core structure beneath the array, or the reconstruction of the source process of an important earthquake. Thus there is a strong need to coordinate the individual efforts so that the instrumentation is fully compatible and the data exchange is as efficient as possible, for the benefit of all scientific projects involved.

When we consider the way that astronomers cooperate on an international scale to build a telescope of unsurpassed capabilities that would be unaffordable by any one nation, or marine geophysicists use joint facilities to survey the ocean bottom, the idea of coordinating national efforts in an international federation of broadband seismic networks emerges naturally. It was the concensus of the meeting that this is an appropriate time to create such a federation, since not all the operational decisions have yet been made for the individual systems involved: the ongoing projects can still modify their recording specifications and adjust station locations, while the networks in the planning stages can be designed to reflect the need for compatibility within the global system of the new generation of seismic networks.

It was with this in mind that this first informal meeting was called to establish the feasibility of forming such a federation and whether such a federation could benefit the individual national projects and the seismological community at large. The reporters on global seismic networks for ILP Working Group 6 (B. Romanowicz, Institute de Physique du Globe (IPG), Paris, and A. Dziewonski, Harvard University, Cambridge, Mass.) were asked to organize the meeting. An invitation was extended to representatives of all countries that are deploying or are planning to deploy a broadband digital network. The meeting was intended as a forum for the exchange of views on how to coordinate the various existing and planned efforts. It was chaired by M. Berry (Energy, Mines, and Resources, Ottawa); the list of participants is given in Table 1.

The first session, on April 10, was dedicated to a review of current plans for broadband station or network deployment, followed by a discussion of the objectives and nature of the proposed federation. Issues addressed were whether specific standards should be defined for instrumentation and data rates, in what form and by what means the data should be exchanged, and whether ILP was the appropriate organization to serve as an "umbrella" for the federation.

By the end of the session a clear consensus had developed that a platform was desirable to debate common interests and to exchange and coordinate plans for station deployment; also, that the main objective was the efficient and timely exchange of data from the different networks so that the data could be made be available to the seismological community. It was proposed that a draft document reflecting the points of agreement of this session of the meeting be prepared and that its terms be debated and finalized the next day.

We will first give a review of the current projects, as presented at Karlsruhe, followed by the statement of purpose for the formation of the federation, which was agreed upon April 11. Finally, we will give the proposed agenda for the next meeting and describe the actions that will be taken in the meantime.

Review of Current Efforts

Romanowicz described the current status of the French digital global network GEOSCOPE: 14 operating stations, with the ultimate goal of 20–30 stations distributed worldwide, each station equipped with three-component Streckeisen STS Seismometers (manufactured by G. Streckheisen and Co., Switzerland; see E. Wielandt and G. Streckeisen, *Bulletin of the Seismological Society of America*, vol. 72, p. 2349, 1982) and a microprocessor-based recording system. The current recording specifications are continuous recording with 0.1 samples per second (sps) for the very long period (VLP) channel and triggered recording at 5 sps for the broadband channel (BRB). The data are received at IPG in Paris by airmail, and network tapes are made available for outside distribution with a format similar to the Global Digital Seismograph Network (GDSN) tapes. In addition, two stations are equipped with quasi real time telemetry that uses a packet switching communication system (France, Guyana) and this will be extended to about 10 stations. Future plans include modification of the stations to very broadband (VBB; see E. Wielandt and J. M. Steim, abstracts in *Eos*, April 30, 1985, p. 312) and possible increase of data rates. Later on, M. Cara (IPG, Strasbourg, France), who also represented GEOSCOPE, briefly presented plans for a mobile array of broadband stations and an additional fixed station in France.

R. Masse (U.S. Geological Survey (USGS), Golden, Colo.) presented the current USGS plans. The survey is cooperating with the People's Republic of China in establishing a network of nine three-component broadband stations equipped with STS seismometers. The instruments are in place, and the network should be operational soon. The data tapes will be sent to Beijing, where data will be merged. Later, they will be included on the National Earthquake Information Center (NEIC) network day tapes, and in addition, time windows for events of magnitude 5.5 and greater will be added to the NEIC event tapes. It should be noted that the Chinese seismologists are interested in the concept of the federation, have asked to be informed about the developments in Karlsruhe, and have indicated that they might participate in future meetings.

The Global Telemetered Seismic Network (GTSN) will comprise four stations in Africa, four in South America, and another in Antarctica, possibly equipped with KS 54000 bor-

Meetings (cont. on p. 542)

TABLE 1. List of Participants at the Karlsruhe Meeting

Name	Professional Affiliation	International Affiliation*
D. Anderson	California Institute of Technology, Pasadena, Calif.	
P. Basham	Energy, Mines, and Resources, Ottawa	
H. Berckhemer	Institute of Meteorology and Geophysics, Frankfurt, FRG	
M. Berry	Energy, Mines, and Resources, Ottawa	ISC
E. Boschi	Istituto di Fisica, Bologna, Italy	
M. Cara	IPG, Strasbourg, France	
B. Dost	Vening Meines Lab, Utrecht, the Netherlands	
H. Durbaum	Bundesanstalt für Geowissenschaften and Rohstoffe, Hannover, FRG	
A. Dziewonski	Harvard University, Cambridge, Mass.	ILP
K. Fuchs	Institut für Geophysik, Karlsruhe, FRG	ILP
H. Harjes	Institut fur Geophysik, Bochum, FRG	IASPEI, ISC
E. Hurtig	Zentralinstitut für Physik der Erde, Potsdam, German Democratic Republic	
E. Husebye	NORSAR, Oslo	ORFEUS
R. Kind	Seismologische Zentralabs, Erlangen, FRG	
R. Masse	USGS, Golden, Colo.	
S. Mueller	ETH, Zürich	IASPEI
G. Nolet	Vening Meines Lab, Utrecht, the Netherlands	ORFEUS
J. Oliver	Cornell University, Ithaca, N.Y.	ILP
B. Romanowicz	IPG, Paris	ILP
N. Shimazaki	Earthquake Research Institute, Tokyo	
S. Smith	IRIS, Arlington, Va.	
E. Wielandt	ETH, Zürich	
W. Zurn	Observatorium Schiltac, Wolfach, FRG	
H. Zwart	Rijksuniversiteit Utrecht, Utrecht, the Netherlands	ILP

*Some participants hold offices in international organizations that have an interest in the objectives of the federation. These organizations are IASPEI (International Association of Seismology and Physics of the Earth's Interior), ILP (the International Lithosphere Program), ISC (International Seismology Centre), and ORFEUS (Observatories and Research Facilities for European Seismology).

Meetings (cont. from p. 541)

ehole seismometers (Teledyne Geotech, Garland, Tex.) with a VBB velocity response. The data will be transmitted by real-time telemetry and received in Albuquerque, N.Mex. The program should be complete in 1989. Finally, there is a plan for a broadband network across the United States of about 20 stations. Masse concluded by stressing that the NEIC event tape program has proved successful: 25 countries are presently receiving the tapes.

IRIS (the Incorporated Research Institutions for Seismology) plans were presented by its president, S. Smith (IRIS, Arlington, Va.). IRIS is a consortium of 50 U.S. universities; in aspects related to global seismic network it has established close cooperation with the USGS. The initial IRIS plan was to deploy 100 three-component broadband stations in as even a global distribution as possible. Real-time telemetry would be used, at least in North America. The first step will be upgrading five Digital World-Wide Standard Seismograph Network (DWWSSN) sites in the fall of 1986 with STS seismometers. Within the next 5 years, 25 WWSSN/International Deployment of Accelerometers (IDA) and 11 seismic research observatory/abrogated seismic research observatory stations will be upgraded and 12 new sites will be developed, in addition to the establishment of a denser than average deployment within the continental United States. The data will be received at an IRIS/USGS Data Collection Center in Albuquerque, and in addition, an IRIS Data Management Center will be developed for rapid dissemination of data to the users. (For details of the IRIS plans, see "IRIS: A Program for the Next Decade," *Eos*, April 22, 1986, p. 213.)

E. Husebye (Norwegian Seismic Array (NORSAR), Oslo) described the plans of ORFEUS (Observatories and Research Facilities for European Seismology), a project initiated in 1984 that now has a membership of 13 Western European nations. Its first goal is to establish a data center for merging data from all broadband digital stations in Europe and to distribute them in the form of event tapes. The system should be operational in 1988 and will then collect data from about 50 stations. A science plan is now available for this project; copies can be obtained from Husebye, Nolet, or Romanowicz (Nolet et al., *ORFEUS Science Plan*, D. Reidel, Hingham, Mass., 1986).

H. Berckhemer (Institute of Meteorology and Geophysics, Frankfurt, FRG) presented the plans of the Federal Republic of Germany (FRG). The Graefenberg Array was the first broadband network to be equipped with STS seismometers, and it has been operational for 10 years now. The plan for the next 3 years is to expand it into a national network for 20 broadband stations with an aperture of 400 km. The stations will be autonomous and directly accessible, and the data will be retrievable by anyone through a data packet switching network (DATEX). Continuous data are kept at a station for 2 weeks; they will also be sent to a central facility in Erlangen, FRG, for archival storage on laser disks. The Graefenberg Array is the contribution of the FRG to ORFEUS and the Global Digital Network. In addition, there are plans to install a few broadband stations in southeast Asia and the Soviet union. One station equipped with STS seismometers already exists at Roorkee, India, as reported by S. Duda (University of Hamburg, Hamburg, FRG).

Berry presented the plans for Canada: an array of four three-component broadband stations in Yellowknife and Project CANDIS (Canadian Network of Digital Seismometers): a broadband national network of some 12 stations. Four of the stations have now been funded and will be installed within the next 2 years.

E. Boschi (Istituto Nazionale di Geofisica, Rome) reported on one operational very broadband station in l'Aquila, Italy. The station uses STS seismometers, and the station processor is based on the Harvard design (see J. M. Steim and E. Wielandt, abstract in *Eos*, April 30, 1985, p. 312). It continuously records VBB data at 20 sps; in addition, long-period data (1 sps) and very long period data (0.1 sps) are derived by on-line digital filtration. The Istituto Nazionale di Geofisica may deploy several other stations of this type in the near future.

G. Nolet (Vening Meinesz Lab, Utrecht, the Netherlands) described the Network of Autonomously Registering Stations (NARS) portable array of the Netherlands, which comprises 20 broadband stations that form a linear array across western Europe. This system has been operating for 5 years now. The recording is on an event basis, and the data, from 1985 on, are included in the USGS event tapes. The network will be moved to Spain for a year in 1987.

N. Shimazaki (Earthquake Research Institute, Tokyo), who represented the Japanese seismologists as an observer, described the current plans in Japan. There will be a GEOSCOPE station in the last quarter of 1986. A group of seismologists in Japan is currently forming an organizational structure appropriate for participation in the worldwide effort for broadband station deployment.

Efforts of Belgium to install several broadband stations in Africa were mentioned, as well as possible plans in Australia; the Australians have indicated interest in participating in future meetings.

Statement of Purpose: Formation of a "Federation of Digital Broadband Seismograph Networks"

The following text, which describes the objectives of the federation, was unanimously approved at the meeting on April 11, 1986:

The international seismological community recognizes new opportunities within its field for improved understanding of the internal structure and dynamical properties of the earth provided by recent developments in seismograph network technology.

It also recognizes that rapid access to seismic data from arrays of modern broadband digital instruments, wherever they might be, is now possible.

The developments include greatly improved broadband seismographic systems that capture the entire seismic wave field with high fidelity, efficient and economical data communications and storage, and widely available, powerful computing facilities.

In view of the above, and to take advantage of existing developing global and regional networks, it is considered that the federation be formed to provide a forum for

- developing common minimum standards in seismographs (e.g., bandwith) and recording characteristics (e.g., resolution and dynamic range);
- developing standards for quality control and procedures for archiving and exchange of data among component networks; and
- coordinating the siting of additional stations in locations that will provide optimum global coverage.

The federation welcomes the participation of all institutions committed to the deployment of broadband seismographs and willing to contribute to the establishment of an optimum global system with timely data exchange.

Plans for the Founding Meeting

It is expected that the federation will be formally established at a meeting held in Kiel, FRG, during the European Geophysical Society–European Seismologivcal Commission Joint Assembly, August 21–30, 1986.

It was recognized in Karlsruhe that each of the three main objectives of the federation, as stated in the text above, should be the subject of further consultation and discussion and that some preparation is needed before the next meeting. The agenda proposed for this meeting is as follows:

- General specifications of broadband systems (desirable and minimum) will be addressed and agreed upon.
- Specifications for data collection (e.g., event versus continuous recording) and standard procedures for data exchange (formats, etc.) will be addressed and agreed upon.
- Siting plans for the various networks will be reviewed. It is expected that involved national programs will attempt to reconcile possible duplications of effort.
- A chairman and an executive committee will be elected for the federation.

In the meantime, Wielandt (Eidgenössische Technische Hochschule (ETH), Zřich) will prepare a document on the specifications mentioned above and will gather comments from other experts. A group comprising representatives of IRIS, ORFEUS, Graefenberg Array, and GEOSCOPE will examine the specifications and procedures for data collection and exchange. Prospective members of the federation are asked to come to the next meeting with documents that describe the long-term plans for their networks so that the siting plans can be reviewed.

Finally, it was agreed that in its initial stage, the federation could profit from being associated with an existing international organization recognized by the International Council of Scientific Unions. Berry will write to K. Fuchs, the president of ILP, and ask him to investigate the practical aspects of how ILP could provide a "home" for the federation.

The Karlsruhe meeting ended on an enthusiastic note of willingness to cooperate and a feeling that the federation already existed in fact. The founding meeting in Kiel will be chaired by H. P. Harjes (Institut für Geophysik, Universitatstr. 150, D-4630 Bochum, FRG). Those interested in becoming members of the new federation and in attending the meeting should contact him. This report serves as both announcement and invitation to the founding meeting.

This report was contributed by Barbara A. Romanowicz, *Institut de Physique du Globe, Paris, and* Adam M. Dziewonski, *Department of Earth and Planetary Sciences, Harvard University, Cambridge, Mass.*

AGU

AGU Membership Applications

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Bruce J. MacFadden (GP), Christopher Manikas (H), Petrus C. Martens (SS), Robert S. Massey (A), Margaret Rose McCalla (A), Milton W. Meyer (A), Joyce E. Miller (T), Simon A. Mitton (P), Gennady M. Nedlin (S), A. Conrad Neumann (O), Eric Nuttall (H), Richard Oliver (V), Craig L. Olson (SM), Gretchen R. Rich (H), Thomas F. Runge (G), Peter A. W. Schwintzer (G), Irving I. Sochard (T), Daya N. Srivastava (A), Lee R. Stevens (O), Richard D. Sydora (SM), Anthony John Tesoriero (V), Lothar G. Viereck (V), Daniel F. Weill (P), Dennis A. Wentz (H), I. J. Won (GP), Donald C. Woodworth (V), Susan Wyckoff (P), Tuncay Yasar (S), Nancy Kay Zeller (H), Yuro Zhuo (S).

Students

Joseph E. Mazur (SS), Kevin McCartney (O), William Wallace McMillan (P), Peter Nicholas Milionis (V), Gene W. Minnich, Joy E. Moses (O), Charles Joseph Newell (H), Eiichi Oka (O), Daniel Orange (T), Nicholas C. Palczuk (H), Joseph C. Quigley, Linda A. Reinen (GP), Elizabeth E. Roettger (P), Peter J. Saccocia (V), Garen Sahagian (V), Jeffrey Seewald (V), David B. Shepherd (S), Jacqueline C. Shulters (V), Robert John Edward Tarzey (V), Jennifer L. Thomas (T), Ali Tokay (A), Junho Um (S), Paul J. Wallace (V), Steven J. Walter (G), Mingdong Wu (V), Craig L. Young (O).

GAP

Separates

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. *Cost:* $3.50 for the first article and $1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Atmospheric Composition and Structure

0394 Instruments and Techniques
THE GAS FILTER RADIOMETER FOR CARBON MONOXIDE MEASUREMENTS DURING THE 1979 SUMMER MONSOON EXPERIMENT (MONEX)
Henry G. Reichle, Jr. (Atmospheric Sciences Division, M/S 401A, NASA Langley Research Center, Hampton, Virginia, 23665), H. Andrew Wallio, J. C. Casas, and E. P. Condon

The instrumental and data reduction techniques used in obtaining remote measurements of carbon monoxide during the 1979 Summer Monsoon Experiment are described. The form of the signal function (the variation of signal with altitude) and the impact of variations in the vertical distribution of carbon monoxide are discussed. Estimates of the experimental accuracy are made both by assessment of error sources through the use of numerical simulations and by comparison with concurrent measurements made by means of gas chromatography. It is found that the radiometric measurements tend to be about 9% lower than the direct measurements and to have a precision of about 8%.

J. Geophys. Res., D, Paper 6D0252

0355
ALTITUDE AND LATITUDE EFFECTS OF ATMOSPHERIC NEUTRONS
V. L. Bhatt (Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India)

Atmospheric neutrons 10 to 200 MeV are studied at $\lambda = 7.6^\circ$ NGL. Energy spectra at 0 g/cm^2 for total neutrons and albedo are compared with experimental and theoretical results of other authors. Atmospheric depth curves for total neutrons and albedo neutrons at 4 altitudes 4 to 40 mbar are given and results are compared with theory and other experiments. Study of latitude effect gives a variation by a factor 2.3 + 0.4 for $\lambda = 7.6^\circ$ to $\lambda = 41^\circ$ NGL for total neutrons and 2.5 for albedo neutrons of 10-100 MeV, in good agreement with theory and other experimental results. (Atmospheric neutrons, depth curves, energy spectra.)

J. Geophys. Res., A, Paper 5A8273

0365 Troposphere-composition and chemistry
MEASUREMENTS OF NITRIC OXIDE IN THE BOUNDARY LAYER AND FREE TROPOSPHERE OVER THE PACIFIC OCEAN
B.A. Ridley (National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307)
M.A. Carroll, G.L. Gregory

Measurements of NO and O_3 are presented from thirteen aircraft flights made over the Pacific Ocean in the autumn of 1983 during one phase of the NASA Global Tropospheric Experiment (GTE). All of the flights were made between 15 and 42°N and from the coast of California to west of the Hawaiian Islands. Within the upper marine boundary layer the median daytime mixing ratio of NO was near 1 pptv. As well, values of NO less than 10 pptv were often observed up to altitudes near 6 km. Thus, for the location and season of the measurements, a net photochemical destruction of O_3 would be anticipated for the boundary layer region and to altitudes of 2-3 km. At higher altitudes of 7-11 km in the free troposphere, larger mixing ratios and greater variability were usually observed for NO. Both features are consistent with observed examples of injection of NO and O_3 from the lower stratosphere and with the injection of NO from towering, electrically active, cumulonimbus clouds. (Nitric oxide, ozone, marine troposphere.)

J. Geophys. Res., D, Paper 6D0321

0365 Troposphere and Chemistry
ANALYSIS OF REMOTE MEASUREMENTS OF TROPOSPHERIC CARBON MONOXIDE CONCENTRATIONS MADE DURING THE 1979 SUMMER MONSOON EXPERIMENT (MONEX)
G. Mark Doherty, Reginald E. Newell, and Henry G. Reichle, Jr. (Atmospheric Sciences Division, M/S 401A, NASA Langley Research Center, Hampton, Virginia, 23665)

Mixing ratios of tropospheric CO as measured by an aircraft-mounted radiometer over Saudi Arabia, the Arabian Sea, and Northern India during May and June 1979 are reported. During early May, exceptionally high CO levels were detected over Saudi Arabia and strong horizontal gradients in CO mixing ratios were seen to develop over a period of several days. Over the Arabian Sea, mixing ratios of order 150 ppbv were observed before the Monsoon onset, and a pronounced decrease was detected toward the equator. Subsequent measurements after the Monsoon had become established revealed a consistent decrease in CO Mixing ratio across this region. Analysis of aircraft dropsonde data and constant pressure daily streamline charts lend strong support to the hypothesis that this reduction is associated with the influx of CO-poor southern hemisphere air in the Monsoon southwesterlies.

J. Geophys. Res., D, Paper 6D0250

0340 Middle atmosphere--composition and chemistry
SOLAR ULTRAVIOLET RADIATION INDUCED VARIATIONS IN THE STRATOSPHERE AND MESOSPHERE
L. L. Hood (Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, 85721)

Solar ultraviolet induced perturbations of the middle atmosphere occurring on the solar cycle time scale have received the most theoretical attention in the past because of the need for comparison with predicted anthropogenic trends or for evaluation of possible climatological consequences. However, short-term perturbations occurring on time scales comparable to the solar rotation period are more readily observable at present. Studies of these perturbations allow basic tests of our understanding of the relevant physics and chemistry that are needed for more accurate long-term model predictions. Detection of short-term solar UV induced ozone and/or temperature responses is hindered even at low latitudes by endogenic dynamical forcing which results in an inverse phase relationship (for either ozone or temperature) with higher-latitude variations for many events. Nevertheless, consistent correlative evidence for contributions of solar UV variability to ozone temporal behavior in the upper stratosphere and lower mesosphere has been obtained in recent years. The mean amplitude of the ozone response at low latitudes reaches a maximum near the 3 mbar level of approximately 0.5% for a 1% change in the solar flux at 205 nm. The phase lag of the ozone response relative to the 205 nm flux increases with decreasing altitude and is positive below 3 mbar. Above 3 mbar, increasingly negative lags are measured (i.e. the ozone maximum leads the UV maximum). The latter property implies the existence of a positive temperature perturbation following the UV maximum that acts to reduce the amplitude of the ozone response during the latter part of the ozone response cycle. Weak correlative evidence for the presence of the inferred temperature perturbations has been obtained in some studies. It is shown that these temperature perturbations have approximately the correct amplitudes and phase lags needed to explain the negative ozone lags. The derived positive temperature phase lags are approximately twice as large as would be predicted by one-dimensional models that consider only radiative-photochemical coupling. The importance of dynamical coupling in producing these temperature perturbations is therefore indicated. A possible major source of dynamical coupling is alteration of the reflection-transmission properties of planetary waves, a process for which some observational evidence exists on the solar rotation time scale. Lastly, in regions where transport effects on ozone concentration may be neglected, simultaneous measurements of ozone, temperature, and solar UV flux can be combined to calculate parameters that are directly relatable to photochemical theory. These are the odd oxygen photochemical relaxation time (approximately half of the conventional odd oxygen lifetime) and the chemical sensitivity of odd oxygen to local temperature changes. It is therefore possible that observed upper stratospheric and lower mesospheric responses to measured solar irradiance changes will be useful for constraining photochemical theory. (Stratosphere, Ozone, Solar Variability.)

J. Geophys. Res., D, Paper 6D0303

0365 Troposphere-composition and chemistry
PHOTOCHEMICAL FORMATION OF PEROXIDES IN THE BOUNDARY LAYER
L. I. Kleinman (Atmospheric Sciences Division, Department of Applied Science, Brookhaven National Laboratory, Upton, NY 11973)

Boundary layer gas phase concentrations of H_2O_2 and CH_3OOH are calculated using a multi-level Lagrangian photochemical model. A range of emission conditions and resultant pollutant levels are considered such as occur in the northeastern U.S. during summer months. The dependence of peroxide concentrations on chemical rate constants and meteorological variables is analyzed in terms of a budget equation for the formation and removal of radicals in the atmosphere. For representative summer conditions (solar intensity, humidity, and ambient O_3 levels) the production of radicals, primarily from photolysis of O_3, occurs significantly faster than the average NO_x emission rate in the northeastern U.S. A necessary condition of this imbalance is that only a fraction of the radicals introduced into the atmosphere can be removed by reactions with NO and NO_2. The remaining radicals are removed primarily by recombination reactions forming peroxides. Variations in radical production such as might reasonably be caused by changes in precursor concentration, latitude, season, cloud cover and/or humidity can reverse the sense of the inequality between NO_x emissions and radical production and lead to an order of magnitude decrease in the amount of peroxides formed. (Troposphere-composition and chemistry, Pollution-urban and regional.)

J. Geophys. Res., D, Paper 6D0316

0340 Middle atmosphere--composition and chemistry
RECOMBINATION OF ATOMIC OXYGEN NEAR THE MESOPAUSE: INTERPRETATION OF ROCKET DATA
G. Brasseur (Institut d'Aéronomie Spatiale, B-1180 Brussels, Belgium)
D. Offermann

From the observations of atomic oxygen concentrations during the Energy Budget Campaign 1980, heating rates in the lower thermosphere at high latitude for late fall are derived and are found to be rather high. Useful information is also inferred for the vertical transport of mass and heat at these heights. The eddy diffusion coefficient which is derived from the data decreases with decreasing altitude below 100 km and reaches a minimum value of the order of 10 $m^2 s^{-1}$ near the mesopause. Such low value implies a low minimum concentration of nitric oxide (10^5-10^6 cm^{-3}) near 80 km. (Atomic oxygen, heating rate, eddy diffusion coefficient.)

J. Geophys. Res., D, Paper 6D0244

0365 Troposphere - composition and chemistry
ATMOSPHERIC LIFETIME AND ANNUAL RELEASE ESTIMATES FOR $CFCl_3$ AND CF_2Cl_2 FROM 5 YEARS OF ALE DATA
D. M. Cunnold (School of Geophysical Sciences, Georgia Institute of Technology, Atlanta, GA 30332), R. G. Prinn, R. A. Rasmussen, P. G. Simmonds, F. N. Alyea, C. A. Cardelino, A. J.