SPACE ENVIRONMENT LABORATORY

Environmental Research Laboratories

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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INTRODUCTION

The Space Environment Laboratory conducts research in solar-terrestrial (ST) physics; develops techniques for forecasting solar disturbances and provides real-time environment monitoring and forecasting services.

The SEL is the contemporary component of the DOC which has provided ST research and services for more than three decades. NOAA and its predecessor organizations have provided such services since 1942 when military operations required ionospheric radio propagation predictions for communications purposes. Since then, the increased reliance of society on sophisticated technological systems, which are sensitive to perturbations in the solar-terrestrial environment, has created a growing need for an understanding of ST relationships and technically advanced solar-terrestrial services.

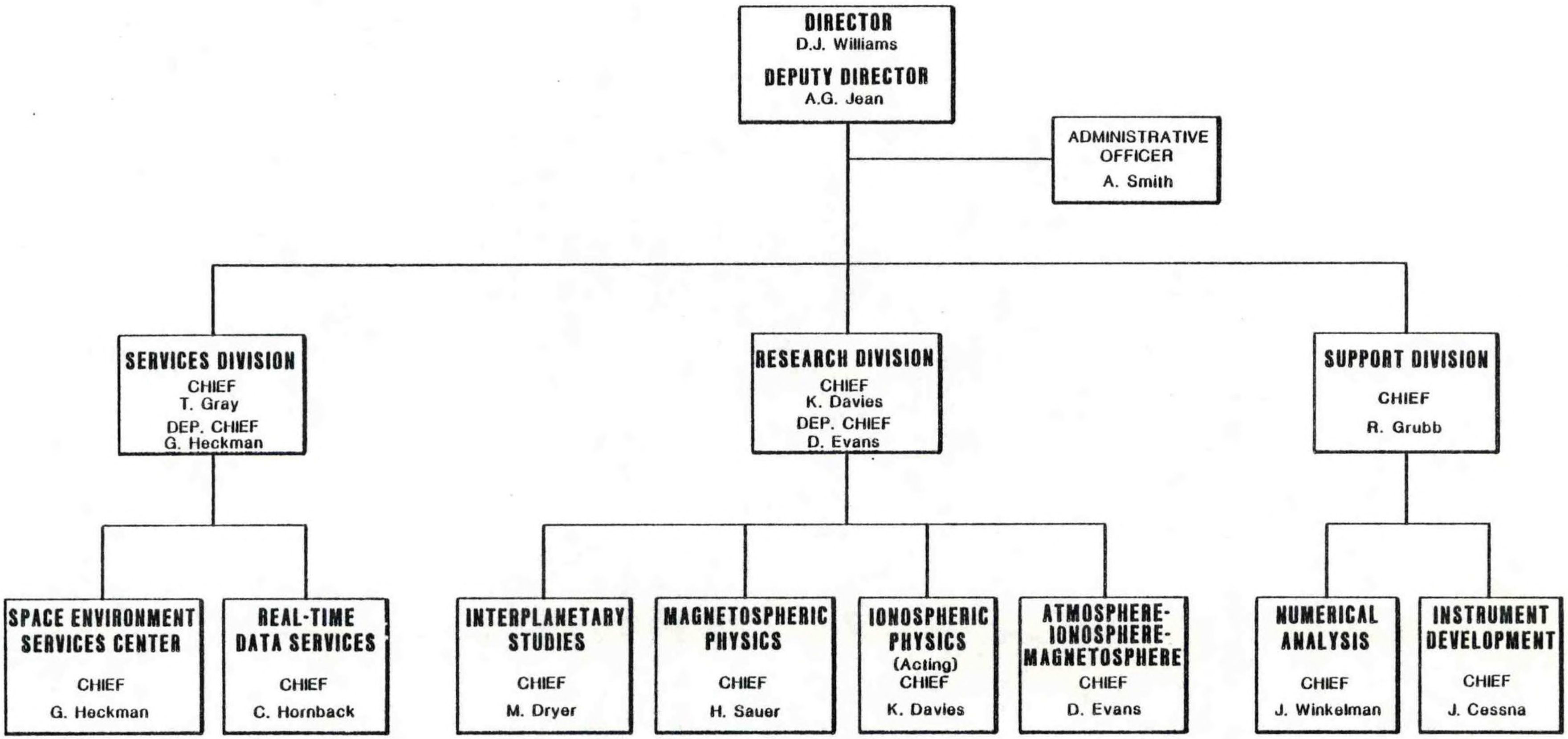
The focal point for the nation's present solar-terrestrial services is in the SEL at Boulder where, with the cooperation of the Air Weather Service, the monitoring and forecasting services are carried out to meet a wide variety of civilian, military, commercial and federal agency requirements. The scope of the services ranges from the real-time collection of solar-terrestrial data to issuance of forecasts, alerts and warnings of adverse solar-terrestrial conditions, to the archiving and processing of solar-terrestrial data from all over the world, to the development of an understanding of the behavior of the solar-terrestrial environment to yield significant service improvements.

The SEL program studies the solar-terrestrial environment (the Sun-Earth system) as a set of several subsystems with strong interactions that produce significant environmental effects. For instance, at Earth's surface induced currents accompanying geomagnetic storms produce adverse effects on electric power distribution systems and telephone lines at high latitudes. In the atmosphere there appears to be a relationship between solar activity and weather. Recent findings also indicate that the ozone layer which protects the Earth from the solar ultraviolet radiation may be affected by protons from solar flares. In the ionosphere, there are undesirable effects on high frequency radio communications, on very high frequency radio communications from Earth to satellites, on radar systems, and on navigation aids at very low and at high radio frequencies.

Theoretical and experimental research studies are conducted on the fundamental physical processes responsible for the observed energy release in the form of electromagnetic and particle radiation from solar flares; the propagation of this energy through the interplanetary medium to the near-Earth environment; the transfer of this energy from the near-Earth interplanetary medium into the Earth's magnetic field, the magnetosphere; and the behavior and subsequent effects of this energy within the magnetosphere, the ionosphere, and upper atmospheric regions. Knowledge gathered from these studies is used to develop prediction techniques that can, with the extensive real-time data service maintained by the Laboratory, forecast solar events and their ground-based effects. Early warning and real-time information concerning the solar-terrestrial environment, especially the near-Earth environment, is provided to a variety of users.

SPACE ENVIRONMENT LABORATORY

ORGANIZATIONAL CHART



ORGANIZATION

The organizational arrangement is shown in the accompanying chart. Note that the Services Division consists of the Space Environment Services Center (SESC) and the Real Time Data Service (RTDS); the Research Division consists of the Interplanetary, Magnetospheric, the Ionospheric, and the Atmospheric-Ionospheric-Magnetospheric (AIM) groups; and the Support Division consists of the Numerical Analysis and the Instrument Development Groups.

Functionally, there is constant cooperation and interchange between staff in the three divisions and their branches to accomplish the goals of relatively short-term projects as well as the long-term goals of the Laboratory. The interchange between the Research, Support and Services Divisions is evident in the "activities and plans" portions of this report and applies equally to activities funded by NOAA and by other government agencies and to national and international cooperative programs. The following table lists programs and SEL participation in those programs, which are essential to attainment of the SEL services and research goals. These programs consist of NOAA and NASA satellite programs, and national and international cooperative programs.

BUDGET AND FUNDING

The SEL has traditionally received appreciable support from other government agencies. In FY 1980 the support from other agencies was 33% of the total funding. Ninety-three percent of the other-agency funds paid 81% of the laboratory's other objects costs, of which 69% was for contracts with industry and other government agencies. Seven percent of the other-agency funds was used to pay 4% of the laboratory's labor costs.

Eighty-nine percent of NOAA funds paid 96% of the total laboratory labor costs while 11% of NOAA funds paid 19% of laboratory other objects costs.

At the time of writing, an increment for FY 1981 for improvement of ST Services is pending. If received, this increment will enable the replacement of the old data system with a new one termed SELDADS II as described in this report. Failure to receive the increment will lead to the predicted overloading of the existing data system and a deterioration in services.

SERVICES

1) GOES and TIROS Satellites (Current)

NOAA operational satellites providing mainly weather observations. These satellites also carry Space Environment Monitors (SEM) which provide data on solar X-rays, charged particles and magnetic data for use in solar-terrestrial monitoring.

2) Solar Maximum Year (SMY) and Solar Maximum Mission Satellite (SMM) (Current)

The SMY is a worldwide, cooperative study to gain insight on solar flares. It consists of three subprograms: Flare Buildup Study (FBS), Study of Energy Release from Flares (SERF), and Study of Traveling Interplanetary Phenomena (STIP).

The NASA SMM satellite, one of the SMY activities, was launched in late 1979 to provide data on solar activities near the peak of Solar Cycle 21. SMM carries six experiments capable of sophisticated studies of solar activity.

3) ISEE-3 (Current)

The NASA ISEE-3 satellite is in a heliocentric orbit 234 Earth radii upstream of the Earth in the solar wind. Spacecraft 1 and 2 measure dynamical processes in the magnetosphere that have been influenced by interplanetary conditions monitored by 3 about 1 hour earlier.

4) The International Magnetospheric Study (IMS) (Ending)

The official international program ended 1980; however, through special arrangements made by National Science Foundation, the operation of the magnetometer chain will be extended two additional years.

RESEARCH

1) International Sun-Earth Explorer (ISEE-1, 2) (Current)

A joint NASA-European Space Agency program. Three-spacecraft comprehensive study of the magnetospheric boundaries and the interplanetary medium. ISEE-1 and 2 carry matched payloads in elliptical orbits. They are separated by a small, controllable distance which makes possible the separation of temporal and spatial variations.

The SEL role in these programs involve the Research Division in provision of guidance on parameters to observe and instruments; the Support Division in provision of instrument design and production; and the Services Division in the collection of the data in real-time and the user of the data for forecasting, alerting, etc.

The SEL Services Division operates at NASA Goddard a real-time data, briefing and forecasting service for SMM Principal Investigators to effectively coordinate ground and satellite observations. The solar target must be selected 19 hours in advance of the coordinated observations. The SEL staff provides twice-daily briefings to PIs on solar activity to enhance the opportunities for observing flares. This service will continue (via contract) through FY 1981, 1982.

Real-time ISEE-3 data are received at Boulder and used by the SESC to observe disturbances approximately one hour before they arrive at the Earth to provide advance warning of magnetic disturbances. The availability of these data in real time is due to a joint NOAA-NASA project.

SEL role in IMS included the provision of an IMS coordinator, and support in establishing a 26-station magnetometer network, real-time relay of these data by GOES satellite; the Real-Time Data Branch has managed and maintained the real-time data collection and processed magnetometer data for PIs and for archiving. The real-time data collection has been extended for two years beyond the formal IMS. Funding for the network stations was provided by the National Science Foundation.

Dr. Williams is the Principal Investigator for an energetic electron, proton and ion composition instrument on both ISEE-1 and 2 built in cooperation with the Max-Planck Institute for Aeronomy (MPAE) in Lindau, Federal Republic of Germany. SEL responsibilities include design and construction of ISEE-1 instrument, data reduction and construction of master data files containing time-merged data from ISEE-1 and 2 energetic particle and magnetometer data, provision of data to co-investigators at Max-Planck Institute for Aeronomy, FRG, and University of Kiel, FRG, and data analysis, interpretation, and publication of results.

RESEARCH (Continued)

2) Digital Ionosonde Program (Current)

In 1975, NSF/NOAA resources were combined to produce a prototype, modern digital ionosonde for the benefit of the research community. A very versatile ionosonde was produced at Boulder for NSF and used as a prototype for additional units: one for NSF titled to SEL; one for Utah State University; one for British Antarctic Survey; one for U.S. Army; one for Max-Planck Institute, Germany.

3) Solar Maximum Year (SMY) (Current)

A worldwide, cooperative project to gain insight on solar flares. The Study of Traveling Interplanetary Phenomena (STIP) is one of three subprograms in the SMY to study after-effects of flares in interplanetary space using coordinated data from several satellites.

4) Galileo (Under Construction)

A space exploration to Jupiter. The first planetary mission to use the Space Shuttle as an interplanetary launch vehicle. Spacecraft consists of an orbiter to explore the atmosphere, magnetic field of Jupiter, and a probe to penetrate the atmosphere and land on the surface of Jupiter to gather information on the origin and evaluation of the solar system.

Launch scheduled for 1984. Travel time to Jupiter: 1000 days, or 3-1/2 years . Orbiter planned to orbit Jupiter eleven times over a period of 20 months encountering a new environment and near Jupiter satellite each orbit.

5) Origin of Plasmas in the Earth's Neighborhood (Planning)

A four-satellite program for the mid-1980s to observe the geospace energy chain; the Interplanetary Physics Laboratory will measure solar wind, magnetic fields and particles; the Polar Plasma Laboratory will measure solar wind entry at the high latitude magnetopause, ionospheric output and deposition of energy into the neutral atmosphere at high latitudes; the Equatorial Magnetospheric Laboratory will measure solar wind entry at the low latitude magnetopause, the transport and storage of plasma in the ring current and near earth plasma sheet; the Geomagnetic Tail Laboratory will measure solar wind entry, transport and storage of plasma in the geomagnetic tail.

The SEL Instrumentation Branch designed and produced the prototypes and five additional units and the Analysis Branch developed the operational and scientific software for the digital ionosondes. All units are operational and engaged in cooperating research campaigns. The SEL Research Division has planned campaigns with two units in Alaska, Canada, and Arecibo, P.R.

Staff of the Interplanetary Branch of the Research Division are Guest Investigators with NCAR/HAO coronograph-polarimeter experiments on SMM. They will examine solar coronal transient events (as described in this report). They are also involved, as organizers of STIP, in a worldwide organization of scientific workshops which will examine, analyze, and interpret the results found during SMY by both ground- and space-based observations of solar activity.

Dr. Williams is the Principal Investigator for the energetic particles instrument with co-investigators at Johns Hopkins University, Applied Physics Laboratory, Max-Planck Institute for Aeronomy in Germany, Bell Laboratories, University of Alaska, and University of Kansas.

SEL provides overall project and science management, advanced instrument design, data reduction and creation of master science tapes, dissemination to co-investigators, and joint data analysis, interpretation, and publication of results.

SEL provided three members (including the Co-Chairman) for the Scientific Definition Working Group charged by NASA to identify the next logical thrust for near earth space plasma research, and to define a program to implement this scientific thrust in the 1980s. OPEN is the program identified. It is now a high-priority candidate for a NASA FY 83 new start. Reports and brochures describing OPEN are available on request from SEL or NASA Headquarters.

RESEARCH DIVISION

The aim of the Research Division is to conduct fundamental long-term research into those factors that affect the solar-terrestrial environment. This research requires an understanding of emission processes on the sun, the propagation of magnetohydrodynamic disturbances through the interaction of the solar wind with the earth's magnetosphere and the interaction of the magnetosphere with both the ionosphere and the neutral upper atmosphere.

ACCOMPLISHMENTS FY 80

The new Research Division was formally established on October 1, 1980. During the year the Division was structurally divided into three Branches in the areas of Interplanetary, Magnetospheric and Ionospheric Physics. Within this Division two new programs were organized: (1) Atmosphere-Ionosphere-Magnetosphere (AIM) Interactions and (2) Solar UV Radiation Research Project.

PLANS FY 80

INTERPLANETARY STUDIES BRANCH

M. Dryer

The principal activity of the Interplanetary Branch is the development of magnetohydrodynamic (MHD) models of the transfer of plasma, mass momentum, energy and magnetic flux from the sun to the earth's magnetosphere. One-dimensional (1-D), two-dimensional (2-D) and three-dimensional (3-D) models have been constructed for a variety of applications as discussed in previous annual reports. An essential element of this theoretical and computer-oriented research is the testing of these models by direct confrontation with ground-based and spacecraft observations.

ACCOMPLISHMENTS FY 80

In cooperation with a group from Tel-Aviv University, important steps were made in solar wind theory (Cuperman, Weiss and Dryer, 1980) which includes, in the time domain, explicit higher moment equations for a multi-component, non-equilibrium solar wind plasma. This theoretical advance will enable computation of the heat flux in a highly turbulent, non-steady solar wind.

As part of NASA's Skylab Solar Flare Workshop a collaborative program was completed with a publication that firmly established a model of coronal transients developed by the Interplanetary Branch and the University of Alabama at Huntsville (see Rush et al., 1979) as a lead effort in understanding coronal mass motions following solar eruptions. Several other efforts in this direction include: (i) collaboration with the Harvard College Observatory on solar radio observations as a guide for the consideration of a theoretical thermal pulse to simulate the September 5, 1973, flare observed by Skylab (Maxwell and Dryer, 1980); (ii) the influence of an ambient solar wind on the MHD coronal transient model (Wu et al., 1980); (iii) criticism of a fallacy in another published model for self-propelled coronal loop-transients (Yeh and Dryer, 1980a); and (iv) work which suggests that loop transients are driven by the bouyancy present in a preexisting solar wind plasma and background magnetic field (Yeh and Dryer, 1980b) rather than by self-induced magnetic pressure. Dryer and Wu (1979) proposed that this MHD coronal transient model, with its self-consistent shock wave, is an appropriate explanation for the propagation of secondary cosmic rays which are formed about 10-15 minutes following the start of a solar flare. The SEL model is the first to provide a numerical self-consistent 2-D MHD solution and this will serve as a vehicle for particle energization studies (i.e., as opposed to cartoon representation).

The research of the Interplanetary Branch has continued in the area of solar-wind energy budget in collaboration with the University of Tokyo. A correlation has been established between the soft x-ray energy flux from a series of solar flares on July 4-5, 1974, and the sum of the kinetic, thermal and potential energy fluxes measured at 1 A.U. - just ahead of the earth's bow shock (Tanaka, Smith and Dryer, 1980). The 1-D MHD modeling studies utilizes Pioneer 11 solar plasma and magnetic field observations at 2.8 A.U. (Dryer, Steinolfson and Smith, 1979). These data have been used as "input" to the 1-D model which then determined the evolution of shocks and other discontinuities enroute to 4.9 A.U. In Figure 1 are shown: the input data, the ensuing evolution of small forward and reverse compression waves (labeled f and r) into large shock waves (labeled F and R) and the predicted properties at 4.9 A.U. The same plasma properties (velocity, etc), as measured by the radially-positioned sister spacecraft, Pioneer 10, at 4.9 A.U. are compared with the model calculations in Figure 2.

Research has continued also with the 2-D MHD model in the development, in the ecliptic plane, of a magnetic bubble produced within an Archimedean spiral by a hypothetical "turning-on" of a high-speed flow from a coronal hole (Dryer, Wu and Han, 1980). Studies have been made on the attenuation, in the ecliptic plane, of a solar flare disturbance which would have been observed at positions other than the central meridian of the flare. This effect has been explicitly demonstrated in a self-consistent simulation (D'Uston et al., 1980).

Research has continued on the interaction between the solar wind and celestial obstacles such as ionospheres, comets, etc. A fluid continuum hypothesis of viscous interactions has been applied between a cometary ionosphere and a solar-wind shock (Perez-de-Tejada, Orozco and Dryer, 1980) for the prediction of boundary layer profiles and the growth of the downstream direction of the "ionopause." Grib et al., (1979) have applied the classical shock-on-shock theory to the case when an interplanetary shock wave collides with the bow-shock and magnetopause of the Earth (or any other planet with a magnetosphere).

In August 1979, an important scientific meeting was organized which brought together solar and interplanetary physicists under the auspices of the International Astromonical Union's Symposium No. 91 entitled "Solar and Interplanetary Dynamics" (see Dryer and Tandberg-Hanssen, 1980a). A report on this meeting for the astrophysical community (Dryer and Tandberg-Hanssen 1980b) has also been prepared. Furthermore, a review of one of the three volumes of the Colgate Committee on Solar and Space Plasma Physics has been published (Dryer, 1980).

Several proposals for cooperative studies have been submitted to NASA: (i) Guest-investigator program for the Pioneer-Venus mission; (ii) Co-investigator on two Comet Halley Mission proposals - Plasma, with the University of Southern California and Magnetic Field, with the Jet Propulsion Laboratory; (iii) two OPEN plasma proposals for the IPL and GTL spacecraft with the University of Southern California and (iv) a theoretical OPEN proposal with the University of Alabama at Huntsville.

Several specific achievements have been realized in the global structure of the solar corona and solar-wind flow in the corona. A model of gas-magnetic field interactions has been developed which treats the corona in an axisymmetric approximation, and it has been used: to study coronal energetics; to continue the analyses of solar cycle variations; and to place an upper bound on the strength of the solar magnetic field during the Maunder Minimum ($\approx$ A.D. 1650-1700). This work (Steinolfson, Suess and Wu, 1980) is productive and is stimulating plans for future research. To further this work there will be close cooperation with the Institute for Plasma Research at Stanford University to expedite the analysis and for improvement of coronal models. This cooperation will also enable the Branch to gain familiarity with the data set at the Stanford Solar Observatory part of which is used by the Space Environment Services Center and which will eventually provide boundary conditions for the coronal models.

A new model of coronal polar plumes has been established (Suess, in press) that predicts conditions at the base of a plume and raises important new questions about the relationship between the photospheric and coronal magnetic fields. Earlier models of the Hermean magnetosphere have led to a new program for magnetic field line mapping and to an understanding of solar wind plasma access to that planet's magnetosphere via the cusp, tail and direct input on the surface. Suess and Goldstein, (1979) have shown how the solar wind can be the source of all the neutral helium observed.

PLANS FY 81

The time-dependent higher-order moment equations will be programmed using only protons to determine the deviation from a Maxwellian energy distribution. Measured velocity data will enable computation of the heat flux in the solar wind.

The Branch's role as Guest Investigators, with NCAR/HAO coronagraph/polarimeter experiment, on NASA's Solar Maximum Mission will include examination of a number of coronal transient events observed during the Mission. The observations will be interpreted in terms of the 2-D MHD model and this model will be extended to include all three velocity components and magnetic field components. Preparations will be made for the SCOSTEP Solar Maximum Year Workshop at Anency, France (October 5-10, 1981) by identifying events observed in common by Solar Maximum Mission, the Air Force's P 78-1, ISEE-3, ISEE 1-2, Pioneer-Venus and the Helios spacecraft.

The modeling will involve consideration of interplanetary energy flux in terms of 1-D and 2-D MHD models including all three velocity and magnetic field components. A comparison will be made of simulated solar flares from the same active region with observations at widely-separated (45° ecliptic longitude) Prognoz and Pioneer 9 spacecraft during August 1972. The response of the Jovian magnetosphere to a series of corotating interaction regions in 1973 and 1974 will be computed with the 1-D model (in the two-component mode).

Development of coronal models with a new numerical technique will be carried out with the help of Stanford University and NASA-Ames where the specific techniques and analyses were developed for aerodynamic applications. A comparison will be made of coronal structures, x-rays, sector boundaries and changes in the mean magnetic field of the sun. A proposal has been submitted to use the existing coronal model, together with solar data, to predict coronal structures rather than to make parameter surveys as in the past.

Participation will continue in national and international programs such as: the National Academy of Sciences' Study on National Goals for Solar-Terrestrial Physics in the 1980's; SCOSTEP's Study of Travelling Interplanetary Phenomena (STIP) and Solar Maximum Year (SMY); STIP symposia in France, October 1981, in Maynooth, Ireland (August 1982) and possibly others in the People's Republic of China; and the organization of bilateral Indo-U.S projects on topics in solar and interplanetary physics.

MAGNETOSPHERIC PHYSICS BRANCH — H. Sauer

The Magnetospheric Physics Branch conducts experimental and theoretical investigations of magnetospheric physics comprising the study of the geomagnetic field and the several particle populations within it, and the dynamics of the complex electromagnetic processes by which the particles interact. Emphasis is placed on the analysis of satellite instrumentation data sets, obtained from both research and operational satellite series.

The schematic causal chain of magnetospheric dynamics may be simplistically divided into three regimes. The entry of mass (particles) and energy into the earth's magnetospheric system; the temporary storage of the energy and particles in the principal storage regions within the magnetosphere, the radiation belts and ring current, the plasma sheet in the tail, and the geomagnetic field; and finally the frequently impulsive energization of particles and their subsequent precipitation into the ionosphere resulting in geomagnetic and ionospheric disturbances of consequence to human activity. Of course, these regimes are not independent but interact with each other in a complex fashion, however, this simple model provides a context for determining the critical questions in magnetospheric research. These questions are clearly of: How are particles and energy transmitted through the magnetospheric boundary from the solar wind? How are the storage regions supplied and maintained? And finally, how are the stored particles and energy precipitated into the ionosphere, resulting in geomagnetic and ionospheric effects?

ACCOMPLISHMENTS FY 80

Multisatellite studies of magnetospheric dynamics continue with particular emphasis on the analysis of data from the Medium Energy Particle Experiment of the ISEE A and B spacecraft launched Oct. 22, 1977. These data comprise complete three-dimensional scans of the particle distributions over an energy range of 24 keV to greater than 1 MeV. These complex data have been merged with data from several correlative experiments aboard the spacecraft in a pioneering cooperative effort to provide efficient, cooperative analysis.

Using the remote sensing technique of the magnetospheric boundary developed by scientists of this laboratory, the character of the dayside magnetospheric boundary has become increasingly well defined. The technique allows the determination of the distance to the boundary and its orientation with respect to the line of sight. Figure 3 illustrates a sequence of such orientation angles (β) obtained during November 1977 (Williams, 1980) which clearly demonstrates the wave structure on the magnetospheric boundary. Theory has predicted that the interaction of the streaming solar wind with the surface of the magnetosphere may result in such wave structure and may be a mechanism for momentum transfer across that boundary. These phenomena are currently under investigation.

Further, the boundary and it's associated boundary plasma has been determined to be remarkably thin. Flows of the boundary plasmas comprise the currents necessary for the maintainence of the magnetosphere. Figure 4 illustrates the observation of the boundary plasma, plotted in the bottom trace and emphasized by the hatched area, whenever the spacecraft found itself within about 150 km from the boundary. Recognition and understanding of the character and morphology of the boundary are of course crucial to an understanding of the dynamics of the boundary and questions of energy and mass transport through it. Studies are underway to establish the properties of the boundary as a function of local time.

Studies of a series of major magnetic storms have been made and indicate clearly that some storms have a much greater impact on the terrestrial space environment than others. Post storm decay of very energetic ion fluxes trapped in the earth's radiation belts after storm-time injections may take several months to return to normal levels. This can be explained in terms of known plasma processes in the magnetosphere (Spjeldvik and Fritz, 1980b, c) and further research on the implications for diffusive transport of this trapped high energy radiation is underway. It has further been shown (Lyons and Williams, 1980) that large trapped flux increases near the earth ($L \lesssim 4$) responsible in part for increases in the ring current strength and consequent decreases of the surface geomagnetic fields, can be explained by radial displacement toward the earth of the pre-existing radiation belt particles rather than an infusion of new particles. Certainly injection of new particles must occur at higher altitudes ($L \gtrsim 5$) and study of the plasma sheet boundary in the magnetotail indicates that most of the magnetotail particle flows associated with magnetic substorms, auroral and some ionospheric disturbances take place in a rather thin layer near the boundary between the "hot" plasma sheet and the nearly empty (from a plasma point of view) tail lobe region. Such flows are frequently seen directed toward the earth (Spjeldvik and Fritz, 1980a) and may well constitute the principal source region for energization of particles in the magnetosphere.

Using observations of electric fields and precipitating electrons from a rocket flight over discrete aurora, the high altitude electric potential has been inferred and used to solve the ionospheric current continuity equation. This analysis assumes that the field aligned current along auroral field lines is governed by single particle motion along these field lines. The solution gives ionospheric potentials and precipitating energy fluxes in good agreement with those observed throughout the flight. Figure 5 illustrates the comparison of the calculated precipitated electron energy flux with that from Lyons (1980).

PLANS FY 81

The significant progress in understanding of magnetospheric phenomena has far from exhausted the potential of the comprehensive data available from such satellite data sets as those from the ISEE Program. These data sets and other cooperative multi-satellite comparisons will continue to be exploited.

IONOSPHERIC PHYSICS BRANCH

R. F. Donnelly

The Ionospheric Branch conducts theoretical and experimental research of the physical processes that govern the ionosphere, including the production, loss and movement of plasma and the influence of the underlying neutral atmosphere and the overlying magnetosphere. The theoretical research involves computer modeling based on our current knowledge of ionospheric physics. Such modeling is an essential complement to the experimental studies. Modeling is used to analyze observations to account for the known physics in order to study the portion that is not adequately understood. The experimental research includes measurements by digital ionosondes, trans-ionosphere observations of satellite radio beacon transmissions, and satellite measurements of solar radiation.

ACCOMPLISHMENTS FY 80

A study of the seasonal anomaly in the Indian sector has been carried out (Anderson and Bouwer, 1980) to see if measured values of Nmax (F2) (the maximum electron density at the peak of the ionospheric F region) over Kodaikanal in October 1975 and July 1976 could be modeled satisfactorily. The seasonal anomaly refers to the fact that daytime Nmax (F2) values are substantially greater during equinoctial periods than during solstitial months. The calculations show that the vertical electromagnetic drift pattern needed to bring about agreement between calculated and observed values changes significantly between October and July and that the neutral atmosphere model employed in the study can satisfactorily explain the lower plasma densities during July. Briefly, the lower electron densities are due to a lower O/N_2 ratio during July which affects the production and loss of ionization. A comparison between measured vertical drifts in the American sector (Jicamarca, Peru) and the inferred drifts over Kodaikanal indicate that during July, daytime upward drifts are comparable but nighttime downward drifts are $1\frac{1}{2}$ times stronger in the Indian sector.

A review of low-latitude, ionospheric-F region modeling, with an emphasis on recent calculations demonstrating electromagnetic drift effects was presented at the Sixth International Symposium on Equatorial Aeronomy held in Aquadilla, Puerto Rico, July, 1980. These calculations show that:

1. Incorporating characteristic vertical drift values measured at Jicamarca, Peru during solar cycle maximum and minimum equinoctial periods produce the observed solar cycle change in the diurnal variation of Nmax (F2) at Huancayo, Peru.

2. Including east-west electromagnetic drifts observed at Jicamarca in the continuity equation produce only secondary effects on the calculated values of Nmax (F2) over the magnetic equator, and for most purposes can be neglected.

3. A comparison between calculated and observed bottomside electron density scale heights between 1800 and 2000 LT indicates reasonable agreement when observed drifts are included. Based on various rocket experiments over the magnetic equator, the observed scale height at the altitude where $N_e = 1 \times 10^5$ el/cm^3 is between 15 and 20 km at 2000 LT. The calculated value at this time is 16 km at the altitude where $N_e = 1 \times 10^5$ el/cm^3. At $N_e = 1 \times 10^4$ el/cm^3 the scale height decreases to 8 to 10 km. No recourse to a height variation in east-west or vertical drift velocity is necessary to bring about the agreement.

A theoretical model was developed to study the ionospheric effects produced by the launch of the HEAO-C (High Energy Astrophysical Observatory) satellite. This is accomplished by solving the time-dependent ion continuity equations for O^+, H^+, OH^+, H_2O^+ and H_3O^+ incorporating a realistic rocket exhaust trajectory with realistic, time-dependent effluent flow rates (Bernhardt et al., 1980). Important questions which need to be answered are: (1) can the latitude and altitude (200 to 600 km) extent of the depleted region be adequately modeled? (2) are the calculated airglow intensities consistent with observations (8 kilo Rayleighs at 6300A)? (3) do calculated electron content reductions match the observed values (a reduction from 20×10^{16} el/m^2 to 4×10^{16} el/m^2)? and (4) why didn't the plasmasphere fill in the depleted ionosphere?

The experimental phase of the ATS6 Radio Beacon program has been completed with publications by Bouwer et al., (1980), Davies et al., (1979) Donnelly et al., (1979), etc. The observations of this program are now the data source for theoretical research, such as the study of the equatorial seasonal anomaly discussed above. A review of recent progress in satellite radio beacon studies was published (Davies, 1980a). Analyses of radio beacon data (Davies and Paul, 1980) showed the varying behavior of the plasmaspheric electron content with increasing sunspot numbers. At low sunspot number the plasmaspheric content has a nighttime maximum whereas at high sunspot numbers there is little or no diurnal variation.

In FY 80, the editing, publication and distribution of Volumes II, III and IV of the Solar-Terrestrial Predictions Proceedings were completed. The titles of the individual volumes are as follows:

Volume I.	Prediction Group Reports (Superintendent of Documents Stock No. 003-023-0041-9)
Volume II.	Working Group Reports and Reviews (No. 003-017-00471-6)
Volume III.	Solar Activity Predictions (No. 003-017-00473-2)
Volume IV.	Prediction of Terrestrial Effects of Solar Activity (No. 003-017-00479-1)

Volume I reviews the current practive in solar-terrestrial predictions. Volume II presents the recommendations and reports developed by the working groups at the workshop held in Boulder, April 23-27, 1979. Topical reviews and papers on the current and future needs for predictions are also included. Volumes III and IV present individual suggestions for particular prediction schemes. Volume I (432 pp), Volume II (733 pp), Volume III (517 pp), and Volume IV (727 pp) are currently available with soft covers for $8.00, $12.00, $9.50, and $13.00, respectively, (plus shipping charge for non-U.S. addresses - 25% of each volume price) from the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, U.S.A., phone 202-783-3238.

A review of the progress made in prediction of ionospheric phenomena as a result of the Workshop has been prepared (Davies, 1980b). This project has been completed.

Field tests of the new HF radar (ionosonde) held at the new Brighton, Colorado Field Site, were completed. This radar which was partially funded by NSF, was then moved to the new field site at Cleary, Alaska, where it is now operational. A second machine, partially funded by NSF but now owned by NOAA, commenced field tests at Brighton. Examples of some of the early ionograms taken with the NOAA radar at Brighton are shown in Figure 6. Ionograms display virtual height of the ionosphere versus the frequency of transmission on a logarithmic scale, from 1 to 10 MHz in these examples. These data are used to determine the electron density as a function of altitude and time in the ionosphere. Figure 7 shows examples of early ionograms recorded in Alaska, where the structure and temporal variations are much more complicated. The new sounders will be better able, than the traditional sounders, to handle the complicated ionospheric structures and temporal variations observed in high latitudes because of the instrument's ability to observe the direction of the returned signals and Doppler shifts caused by ionospheric motions.

To achieve the full use of these additional features requires further software development and testing, so much of this year's effort involved further software development. The off-line software for ionogram processing and analysis included the development and testing of the following routines: (1) computation of critical frequencies for ordinary and extraordinary components, (2) polarization discrimination, (3) separation of overlapping ordinary and extraordinary echoes based on the new echo sampling procedure (equal reference time, EQR), (4) estimate of height of F-region maximum and half thickness, (5) computation of the radio propagation parameters MUF(3000) and M(3000), (6) estimate of Doppler frequency, (7) computation of virtual heights from phase change with frequency corrected for Doppler frequency, and (8) estimate of angle of arrival.

A paper on mapping of F layer critical frequencies foF2 was presented at the COSPAR meeting in Budapest. This led to further investigation of the global distribution of the spectral components of foF2 and their dependence on the sunspot cycle. One surprising result was that the "background term" (period >> 1 year) varies linearly with sunspot numbers at the same relative rate worldwide, while other components show strong latitude dependence in their variation with sunspot numbers.

A system of data processing methods is under development, now affording options given in Tables 1 and 2. Most of these options provide (computer microfilm) graphical and tabular output in publication-ready form. In addition, the system provides a variety of trace-extraction zoom data-smoothing, and spline-fitting options. New features this year include the "Dopplionogram" and "Gonionogram" which respectively display the frequency dependence of echo Doppler and reflection location (Figure 8). Several initiatives have been taken to develop and define modes of data acquisition which are more complex, compact, efficient and informative than the existing modes.

Under Atmospheric Gravity Wave (AGW) Studies, efforts are aimed at the measurement, analysis, and understanding of effects in the ionosphere, as detected by multifrequency total-reflection sounding techniques. The fundamental objectives are to reconcile the theories of AGW propagation, and their effects on the ionospheric plasma with observations. We seek procedures for deducing the AGW source location, energy, and propagation characteristics. A computer simulation system is being developed by which an AGW is imposed on a chosen ionosphere and then, by radio ray-tracing, it calculates its effects in terms of group path, echolocation, doppler, etc. Figure 9 shows echo-producing ray paths (projected onto the direction of the AGW) for a typical medium-scale disturbance originating in high latitudes. Dotted lines give the 2-dimensional paths obtained when lateral deviation is neglected. The regions over which multiple echoes are observed, and the changes in amplitude, range and direction of arrival, are quite different for the two cases.

The Dopplionogram and Gonionogram together have provided a concise demonstration of many ionospheric phenomena (Wright and Pitteway, 1981a, b; Wright, 1981). Figure 10, for example, shows the ionogram and Gonionogram variations during a "traveling disturbance" observed at Brighton with the new ionospheric sounder.

PLANS FY 81

Theoretical modeling investigations will include:

Study of the effects on the equatorial ionosphere of a measured height variation in vertical electromagnetic drift after sunset.

Investigation of the effects of a zonal neutral wind on calculated electron densities at Ascension Island where electron densities are observed to increase around midnight.

Incorporation of a realistic geomagnetic field model to calculate the diurnal variation of Nmax(F2) at the conjugate locations of Arecibo, Puerto Rico (20°N, geog.) and the southern tip of Argentina (55°S, geog.). The purpose would be to estimate a neutral wind model in the southern hemisphere which would bring about agreement between calculated and observed electron density distributions.

A continuation of the modeling work related to total electron content measurements made between Boulder and the ATS-6 satellite.

HF radar studies will include:

The Multifrequency Riometer Mode will become operational with the ionospheric sounder at Cleary, Alaska, for the measurement of radio noise across the high-frequency radio spectrum.

The partial reflection mode will become operational at Brighton, Colorado, for the measurement of electron density profiles and dynamics of the D region.

A new method of N(h) inversion will be incorporated into the sounder data processing system, and its automatic, adaptive features will be developed.

The Atmospheric Gravity Wave simulation work will be applied to actual examples, observed at Brighton and elsewhere.

A theoretical study, will be made, of radio echo waveforms resulting from the dispersive ionospheric reflection process, with potential applications to ionospheric drifts, spread F, scintillations, etc.

Two sounder campaigns are anticipated; one at Arecibo, for comparison with data from the incoherent scatter radar, and the other at Cape Parry, NWT, Canada for observations of the dependence of the magnetospheric cleft on local time and geomagnetic activity.

ATMOSPHERIC-IONOSPHERIC-MAGNETOSPHERIC COUPLING — D. Evans

It is important to view the neutral atmosphere, the ionosphere and the magnetosphere as a single interactive system in which each element is acted upon and reacts on the other elements. For example the aurora are manifestations of the coupling between a magnetospheric "dynamo" and an ionospheric "load" which leads to the production of large electrical potential differences which, in turn, enhance the energy flow into the neutral atmosphere by energetic particle precipitation and by electrical current (Joule) heating.

ACCOMPLISHMENTS FY 80

The prime motivation for this program was the realization of the magnitude of the energy input to the ionosphere and the upper neutral atmosphere by processes in which both the ionosphere and the magnetosphere must participate. This energy input is illustrated in Figure 11 in which the estimated power input to the polar hemisphere by energetic particle precipitation, as measured by the NOAA-6 Space Environment Monitor, is plotted for September 1979. The peak power inputs (estimated at 2×10^{11} watts per hemisphere or 4×10^{11} watts world wide) are of the same magnitude as the power input to the upper atmosphere by the absorption of solar extreme ultraviolet and long-wave-length x-rays. Perhaps more important, the variability exhibited in the power input due to particle precipitation (during Sept., 1979 this parameter ranged from about 10^{10} watts to more than 10^{11} watts world wide) is greater in absolute magnitude than the variability exhibited by the solar radiation shorter than 2500 Å over a solar cycle.

Clearly, the energy input to the upper atmosphere by particle precipitation is so large that it can dominate the behavior of both the ionosphere and the neutral atmosphere in the polar regions. A model of the global response of the neutral atmosphere above 100 km to these intense energy inputs in the polar regions has been created. Not only are large pressure gradients, significant winds, and gravity waves generated in the upper atmosphere by the energy input, but changes in the wind pattern and internal structure of the upper atmosphere propagate to middle latitudes (and in extreme cases to tropical latitudes). These changes, in turn, modify the electrical currents in the ionosphere at these lower latitudes and partially control geomagnetic disturbances in middle and low latitudes.

It should be pointed out that the energy input due to particle precipitation measured by the TIROS/NOAA instrument is only one of two components of the energy transfer between the magnetosphere and the ionosphere-atmosphere, i.e., the mechanical component. Of equal importance in terms of contribution to the energy input is that due to electrical current flow in the ionosphere and the associated Joule power dissipation. While the TIROS/NOAA instrument is incapable of measuring the Joule contribution to the energy input, estimates of this component suggest that at times the total world-wide power input due to energy transfer from the magnetosphere to the ionosphere/atmosphere attains 10^{12} W. While the mechanical transfer of energy (the precipitation of particles) is relatively well understood in terms of the scattering of magnetically trapped charged particles into the "atmospheric loss cone," the physics which govern the generation of an EMF in the magnetosphere, the creation of a three-dimensional current system which threads the ionosphere, and the consequent transfer of energy from a magnetospheric reservoir to an atmospheric sink is not well understood.

PLANS FY 81

As the research effort in Atmospheric-Ionospheric-Magnetospheric coupling begins, a three-pronged effort is envisioned. The first involves modeling the behavior of the upper atmosphere and thermosphere under the influence of large energy inputs into the polar regions. This is a continuation of work already begun although with the availability of quantitative observations of at least one component of the power input by the TIROS/NOAA instrument the quality and relevance of such modeling should improve. A second thrust of the program will be an exploitation of the TIROS/NOAA data set. Already preliminary associations between these data and the commonly used magnetic indices have been made. An example shown in Figure 12, which utilized all available 1979 data, plots the three hour averaged hemispherical power input against the concurrent Kp index is one such result. In addition, the TIROS/NOAA total energy observations (which are expected to continue for many years) are used to create a synoptic data bank. It is hoped that this data set will be utilized in research concerning the behavior of both the upper and lower atmosphere under the influence of the magnetospheric energy input. The third AIM effort will be directed toward a fundamental understanding of the electric interaction between the magnetosphere and ionosphere which result in the extraction of energy from a magnetospheric reservoir and its dissipation into the ionosphere/atmosphere. This work will necessarily involve the basic understanding of how EMF's arise within hot plasmas and what is required to couple these EMF's to external volumes of space by means of electrical current flow. The problem is (from a basic physics view) similar to a commercial power company but without the advantages of well defined geometries such as wires.

As of the beginning of FY 81 a new branch devoted to this work will be established in the Research Division.

SOLAR UV RADIATION RESEARCH PROJECT

The long-term objective of the new NOAA-ERL-SEL Solar UV Radiation Program is to determine the intensity and time scales of variations in the solar ultraviolet radiation as a function of wavelength in the 110-400 nm range in terms of their significance to climate, molecular dissociation, atmospheric chemistry, upper atmospheric heating and measurements of minor atmospheric constituents. The current requirements for wavelength resolution and accuracy for this program are those adopted at the NOAA-ERL-SEL workshop "Monitoring the Solar Constant and Solar Ultraviolet."

The temporal scales of solar variability include: (a) short-term variations (seconds, minutes, hours) involving solar flares, disruption of solar filaments and prominences, etc., (b) intermediate-term variations (days, weeks, months) involving active region evolution, solar rotation, sector boundary passages, etc., and (c) long-term variations (years to decades) involving sunspot cycle evolution and the 22-year solar magnetic field cycle. Satellite UV measurements are quite appropriate for the first two categories. Rocket measurements and, in the future, shuttle-based measurements will also be appropriate for the latter two time ranges and for recalibrating satellite measurements. Our program plan involves a short-term plan (five years), which involves cooperative programs with existing, or currently planned UV measurements and will concentrate on temporal scales (a) and (b) above, and a long-term program that involves cooperative programs to develop improved instruments and solar UV monitoring measurements to meet the high accuracy requirements for NOAA solar UV monitoring.

The short-term portion of the program emphasizes the use of available data from existing and currently planned UV experiments to study:

(a) the measurement errors and data validations in the current generation of solar UV spectral irradiance instruments to provide guidance in the design of the next generation instruments,

(b) the short-term solar UV variations (important in the interpretation of long-term measurements consisting of a series of short-term rocket or shuttle measurements), and

(c) the variations of the solar UV flux ratios at wavelengths pertinent to ground-based monitoring meaurements of minor atmospheric constituents, e. g., Dobson ozone monitoring measurements.

ACCOMPLISHMENTS FY 80

The most important solar UV data that currently exists are those from the Solar-Backscatter Ultraviolet (SBUV) Experiment on the NIMBUS-7 satellite. These data are particularly important to the Program because that SBUV instrument is the predecessor of SBUV instruments currently planned for the joint NASA-NOAA ozone and Solar UV Monitoring measurements on the TIROS-N series of environmental satellites. They are also important because they are concurrent with solar constant measurements that show important decreases during the solar central meridian passage of large sunspot groups. A contract with Systems and Applied Sciences Corporation (SASC) has been signed for a cooperative research program with NASA and NOAA to study the short term UV variations, measurement errors and variations of flux ratios at the wavelength bands used in Dobson ozone measurements. SASC's data processing work has just started.

One component that is believed to be a main source of instrument degradation in SBUV instruments is the diffuser or scatterer plate that is injected into the instruments field of view. A contract with the Laboratory of Atmospheric and Space Physics of the University of Colorado was signed for research to study and develop improved diffusers. This same contract included upgrading of LASP's UV calibration facility to achieve higher accuracy for their current series of rocket measurements of solar UV irradiance.

A successful two day workshop on solar UV monitors was held July 31 and August 1, 1980, at the College Inn Conference Center of the Univ. of Colorado. The first draft of the workshop proceedings is nearly complete and the editing for the second draft is also nearly complete. Highlights of the workshop are as follows: (1) the gaps between recently achieved accuracies and accuracy goals for solar UV irradiance measurements were clarified. (2) the expected improvements in currently planned instruments were discussed, (3) the areas where further improvements are needed and probably achievable were identified, (4) problems with UV diffusers and suggestions for improving them were discussed, and (5) apparent differences between the LASP rocket results and Hinteregger's satellite results near the recent sunspot minimum were resolved.

One scheme for improving the accuracy of measuring solar UV variations involves using UV broadband cavity-radiometers for good intensity precision together with UV spectrometers for higher wavelength resolution. A contract was let with Atmospheric and Environmental Research, Inc. to determine the precision limits for such cavity radiometers for measurements of solar UV variability.

One hope for improving the accuracy of solar UV measurements from satellites or shuttle flights is to include on-board secondary calibration standards. A contract was let with the National Bureau of Standards for research and development of improved flyable secondary standards.

The long-term plan has been recently set to include solar UV irradiance measurements from three groups of observing platforms, namely satellites, shuttle flights and rockets. The satellite SBUV measurements will be studied in SEL and instrument accuracy and calibrations analyzed. However, the instruments and flights will be funded by NASA and NOAA-NESS in their joint program for operational monitoring of the solar ozone distribution and temporal variations. For the next five years, we shall participate in shuttle measurements through cooperative work with NASA. Most of the funds in the NOAA-ERL-SEL Solar UV Radiation Research Project will be directed to rocket measurements of solar UV irradiance with a new improved instrument through contracting to an appropriate university, not profit or commercial research group, etc.

PLANS FY 81

A Request for Proposals for developing an improved solar UV irradiance monitor and conducting a long-term monitoring program will be developed and issued. Research of NIMBUS-7 solar UV irradiance measurements will be conducted in cooperation with NASA-GSFC. The properties and problems of diffuser plate and UV wavelengths will be studied in cooperation with scientists at the Univ. of Colorado. The limits of precision of cavity radiometers at UV wavelengths will be determined by scientists at AER, Cambridge, Mass., and NBS in Washington.

As of the beginning of FY 81 this project will be relocated in the Interplanetary Studies Branch.

TABLE I -PLOTYPES IN DSNDPLT

PLOTYPE Name

Ionogram mode and Basic mode

IONOGRAM	Group range vs. frequency, R (f)
VERTIONOGRAM	Vertical component of R (f): Z (F); horizontal component R_{xy} (f) and R (f) - Z (f) above penultimate height line.
AMPLIONOGRAM	Echo amplitude A(f) along range axis below echo and (or) above penultimate height line.
ECHOLOCATE	Skymap at upper left corner of ionogram; shows polar diagram of R_x, R_y at R_z, for all R (f) within the ionogram frame; may be combined with GONIONOGRAM (below).
GONIONOGRAM	Echolocations R_x (f) and R_y (f) with R (f) as origin and (or) about penultimate height line.
(or)	signifies option under control of LAST parameter

Basic mode

DOPPLIONOGRAM	V*(f) along range axis (m/sec) and (or) about penultimate height time.

TABLE 2 - POLARIZATION OPTIONS IN DSNDPLT

Option	Function
U	Undiscriminated plotting of all quantities (R, A, V* etc.) whether of ordinary (O) or Extraordinary (X) polarization.
P	Plasma frequency scale. O and X data discriminated with large and small symbols respectively. For O, $f_p = f$; for X, $f_p = (f^2 - f.fH)^{\frac{1}{2}}$ where fH is gyrofrequency.
D	Discriminated as to O (large symbols) or X (small symbols): observing frequency scale.
O	Ordinary polarization echo data only.
X	Extraordinary polarization echo data only.

PUBLICATIONS IN PREPARATION

Davies, K., Review of recent progress in ionospheric predictions, (to be submitted to Radio Science).

Friedman, H., D. S. Intriligator, M. Dryer, et al., Solar Terrestrial Research for the 1980's, National Academy of Sciences, (in preparation).

Wright, J. W. and M. L. V. Pittaway, Data Processing for the Dynasonde; The Dopplionogram, (in preparation).

Wright, J. W. and M. L. V. Pittaway, Application of Dopplionograms and Gonionograms to Atmospheric Gravity Wave Disturbances in the ionosphere, (in preparation).

Wright, J. W., The application of Dopplionograms to an understanding of Sparodic E, (in preparation).

OTHER PUBLICATIONS (not elsewhere listed)

Davies, K. and M. P. Paul, ATS6-Boulder Measurements of Plasmaspheric and Total Electron Content during Phase III, Proceedings of the COSPAR/URSI Symposium, Warsaw, Poland, May, 1980 (in press).

Suess, S. T. and B. E. Goldstein, Compression of the Hermaean Magnetosphere by the Solar Wind, JGR, 84, 1979.

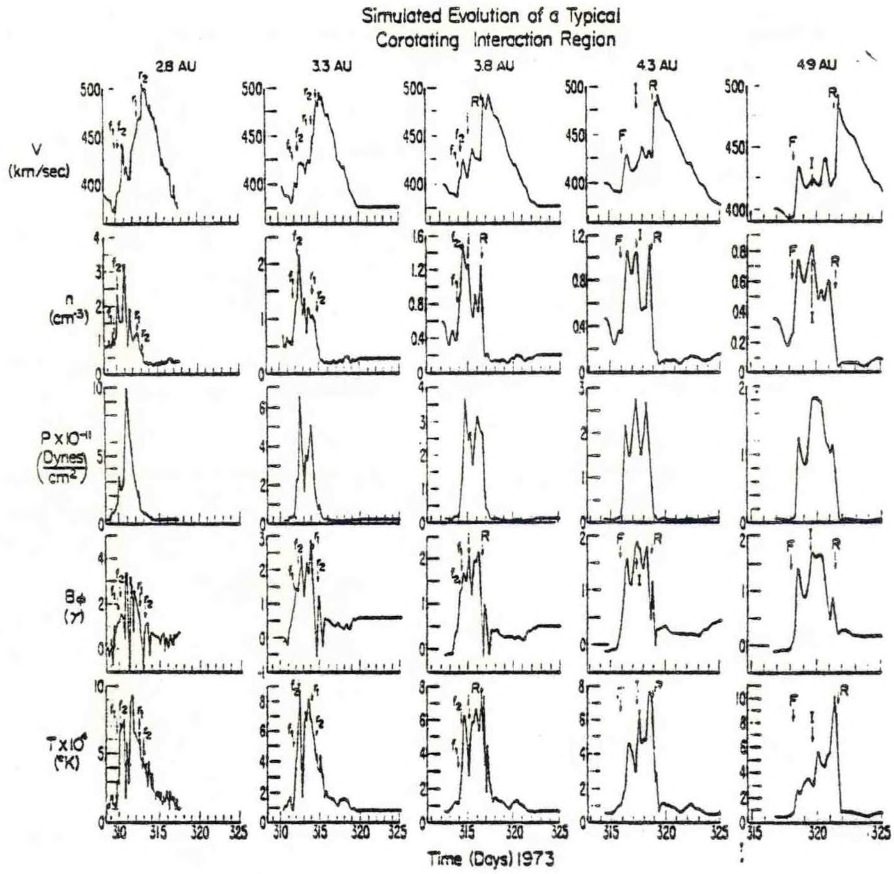


Fig. 1 Evolution of velocity, density, pressure, proton temperature, and magnetic azimuthal component between 2.8 AU and 4.9 AU. The left-most column shows the actual data as measured by Pioneer 11 at 2.8 AU and as used as "input" for SEL's 1-D MHD, time-dependent model. The computed results for the evolving solar wind streams, shocks, and discontinuities are shown at increments of $\sim$ 0.5 AU as "observed" as a function of time by imagninary spacecraft. The right-most column shows the prediction at 4.9 AU. The lower-case f and r refer to forward-facing and rearward-facing compression waves which steepen into forward and reverse MHD shock waves at the more distant position where the structure has evolved into a "classical" corotating interaction region.

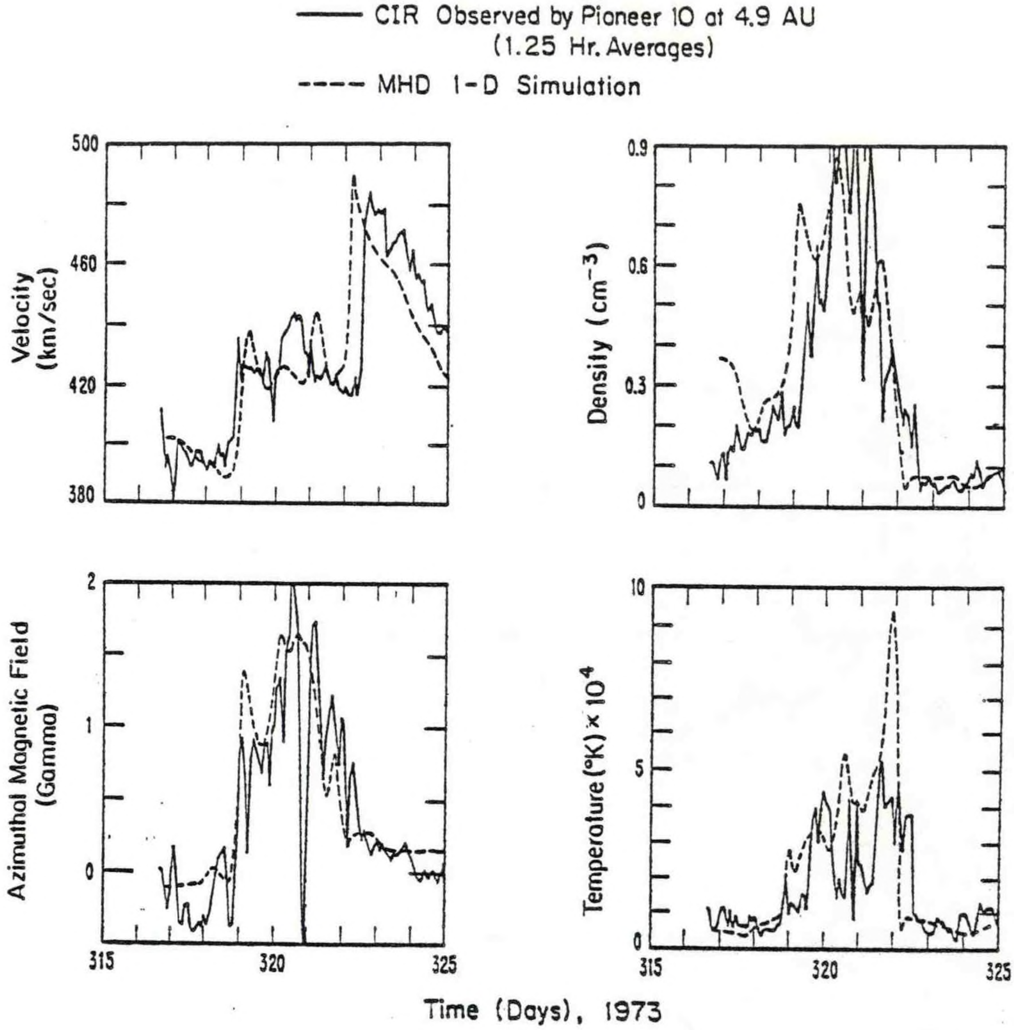


Fig. 2 Comparison of the predicted solar wind parameters at 4.9 AU with the observations by the radially-positioned sister spacecraft, Pioneer 10. The agreement suggests that similar modeling could be carried out between the sun and the Earth's magnetosphere, with improved physical considerations such as the multi-component, multi-dimensional, non-equilibrium higher-order fluid equations mentioned in the text.

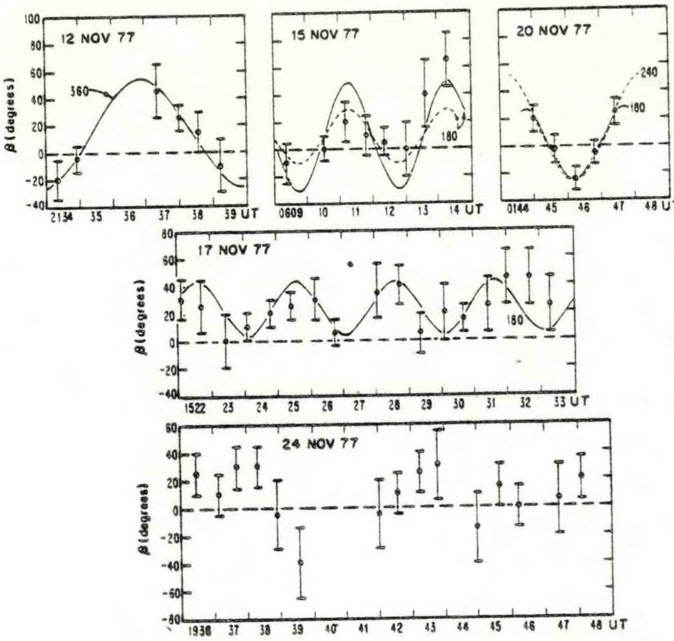


Fig. 3 Five time intervals for which nearly contiguous determinations of the magnetopause orientation angle could be made. β is plotted versus time for consecutive 1-min intervals as indicated Periodic variations with the indicated period in seconds are shown for reference. Two amplitudes at a 180-s period are shown in the November 15, 1977, panel.

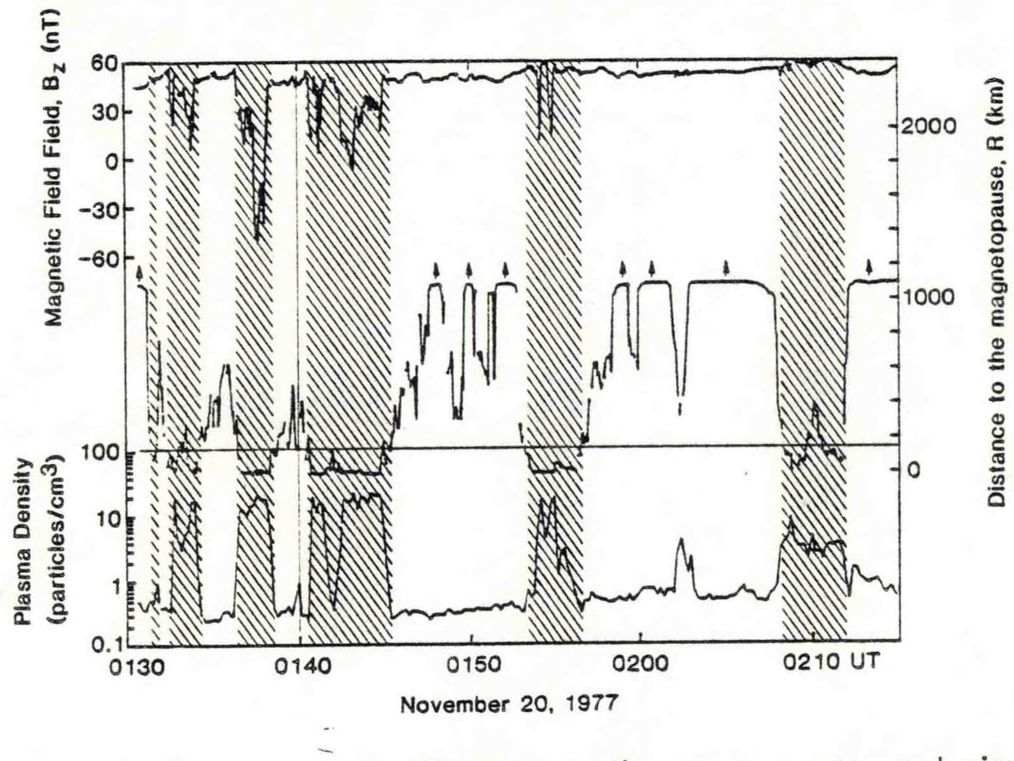


Fig. 4 Determinations of the distance to the magnetopause, and simultaneous measurement of the local plasma density. The hatched region emphasizes the penetration of the magnetosheath plasma whenever ISEE comes within about 150 km of the magnetopause boundary.

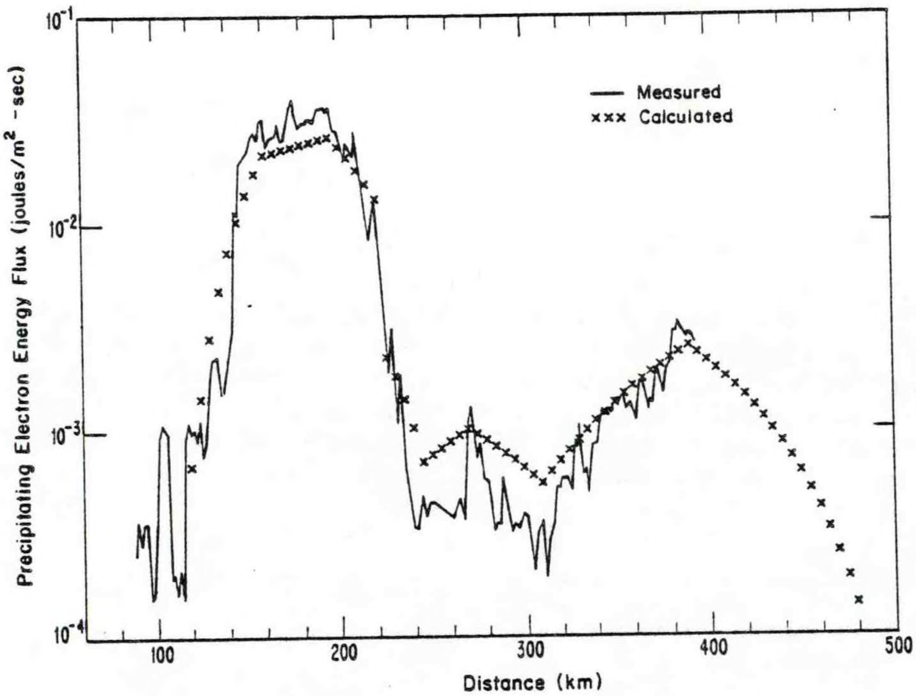


Fig. 5 Measured precipitating electron energy flux from the POLAR 3 flight and the calculated precipitating electron energy flux from the solution to the ionospheric current continuity equation.

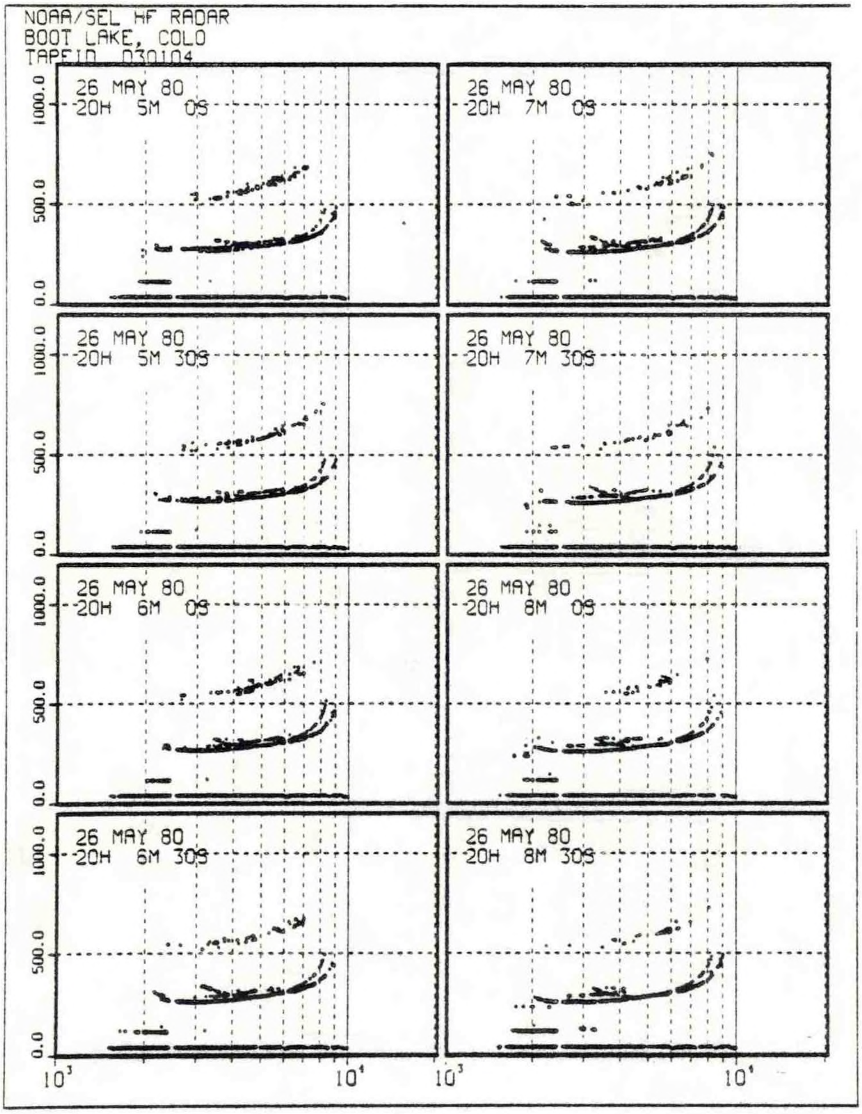


Fig. 6 NOAA Ionosonde Observations at the Brighton, Colorado Field Site.

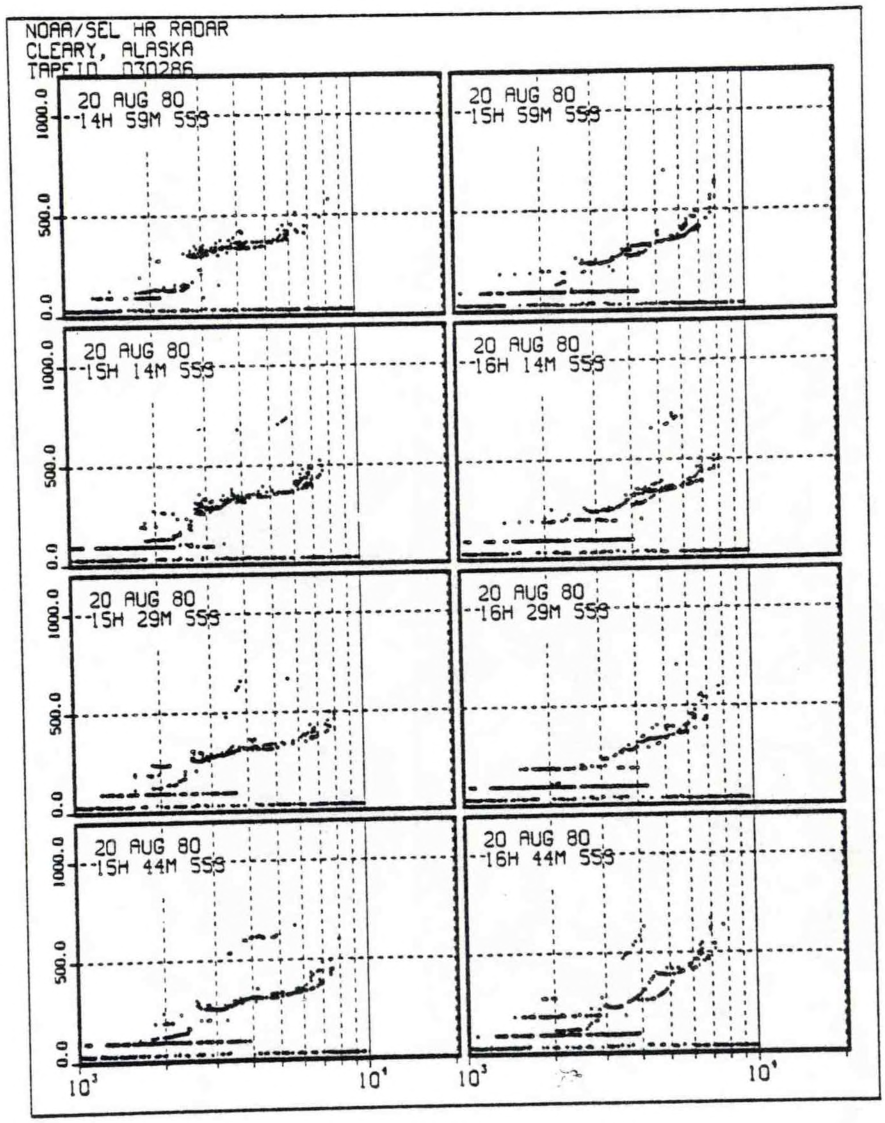


Fig. 7 NSF Ionosonde Observations at Cleary, Alaska.

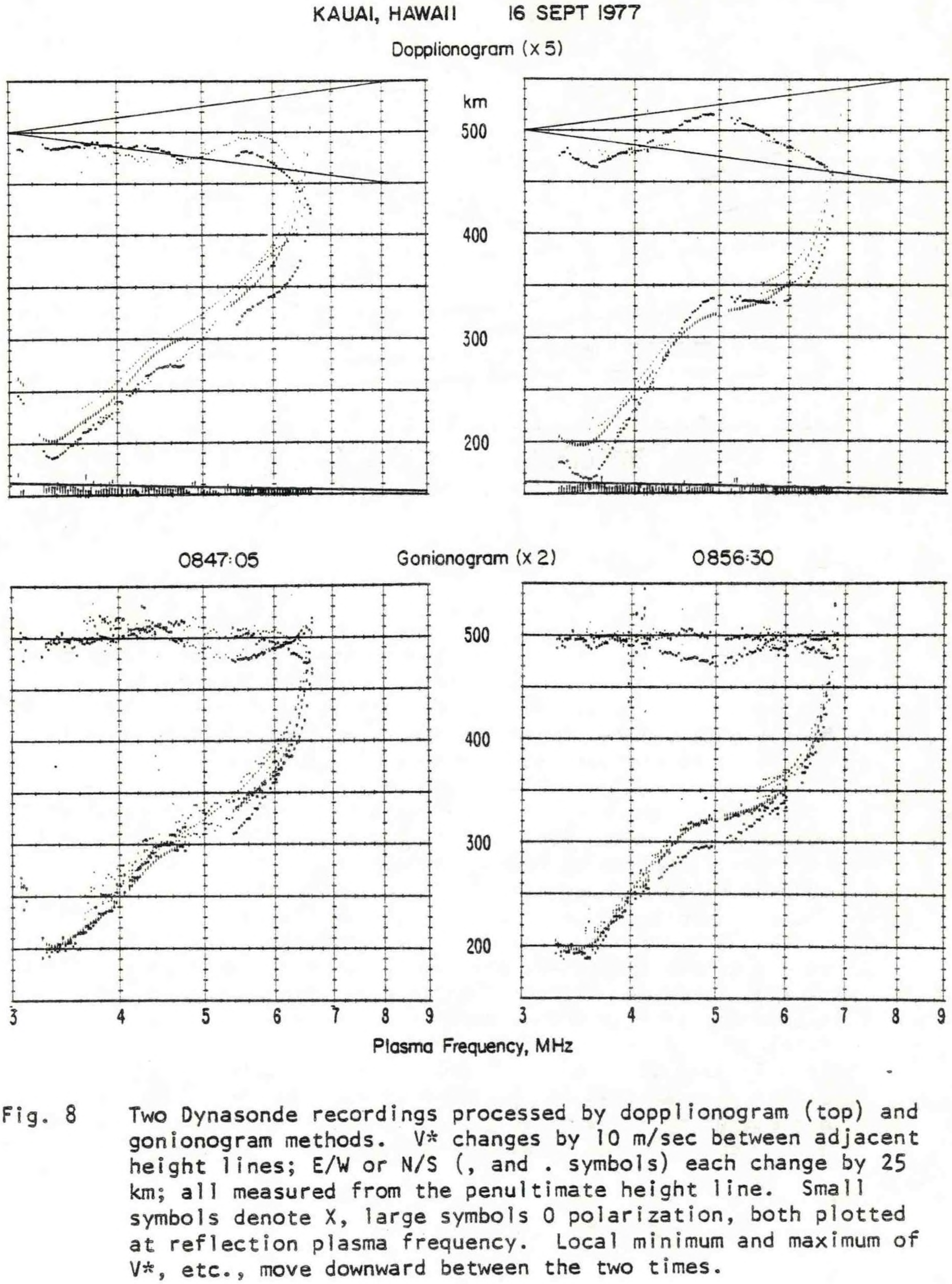


Fig. 8 Two Dynasonde recordings processed by dopplionogram (top) and gonionogram methods. V* changes by 10 m/sec between adjacent height lines; E/W or N/S (, and . symbols) each change by 25 km; all measured from the penultimate height line. Small symbols denote X, large symbols O polarization, both plotted at reflection plasma frequency. Local minimum and maximum of V*, etc., move downward between the two times.

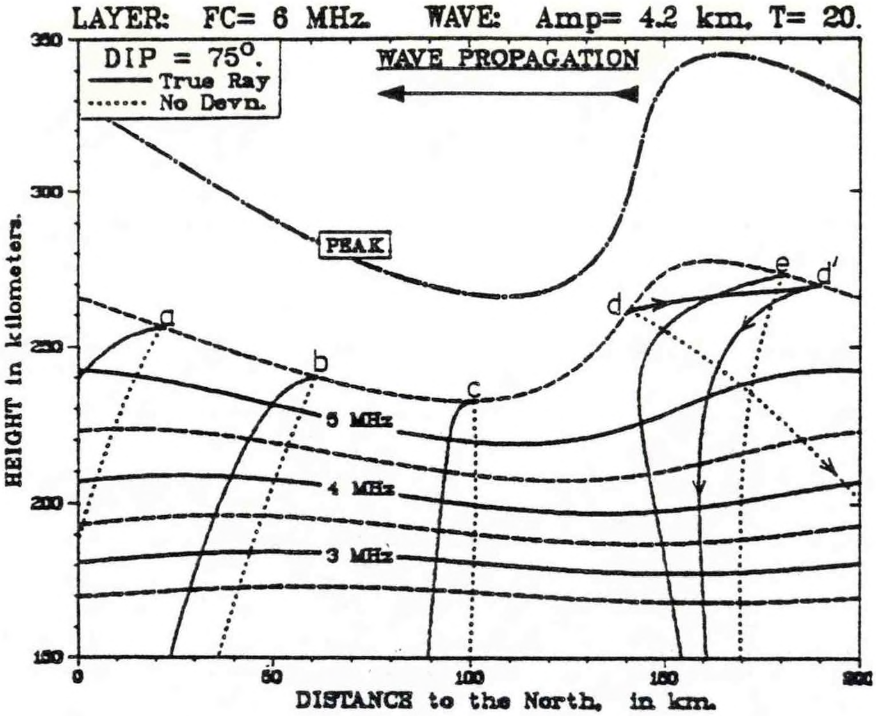


Fig. 9 The Effects of a Typical AGW Disturbance. The vertical atmospheric motion is 4.2 km at a height h of 230 km, and 7.8 at h = 300 km. This causes fluctuations of 40 km in the peak height of a Chapman layer. Lower broken and solid lines show the isoionic contours at intervals of 0.5 MHz.

Solid lines show the exact ray paths for an ordinary-ray frequency of 5.5 MHz. Rays reflect at points a to e with a uniform horizontal spacing of 40 km in the ionosphere. All rays start perpendicular to the magnetic field. When the tilt of the reflection contour exceeds + 15°, the initial direction is 15° above the horizontal (ray d). This commonly gives a ray reversal or Spitze (d') as the wavenormal component, in the plane of Fig. 1, passes through the field dirction. Rays d and e then reach similar ground points, although approximate (dotted line) calculations indicate widely separated ground points. Thus for any disturbance in which the reflection contours have a tilt greater than (90 - DIP) degrees from the horizontal, neglect of ray-wavenormal separation gives a completely erroneous picture of the ionosphere ray paths.

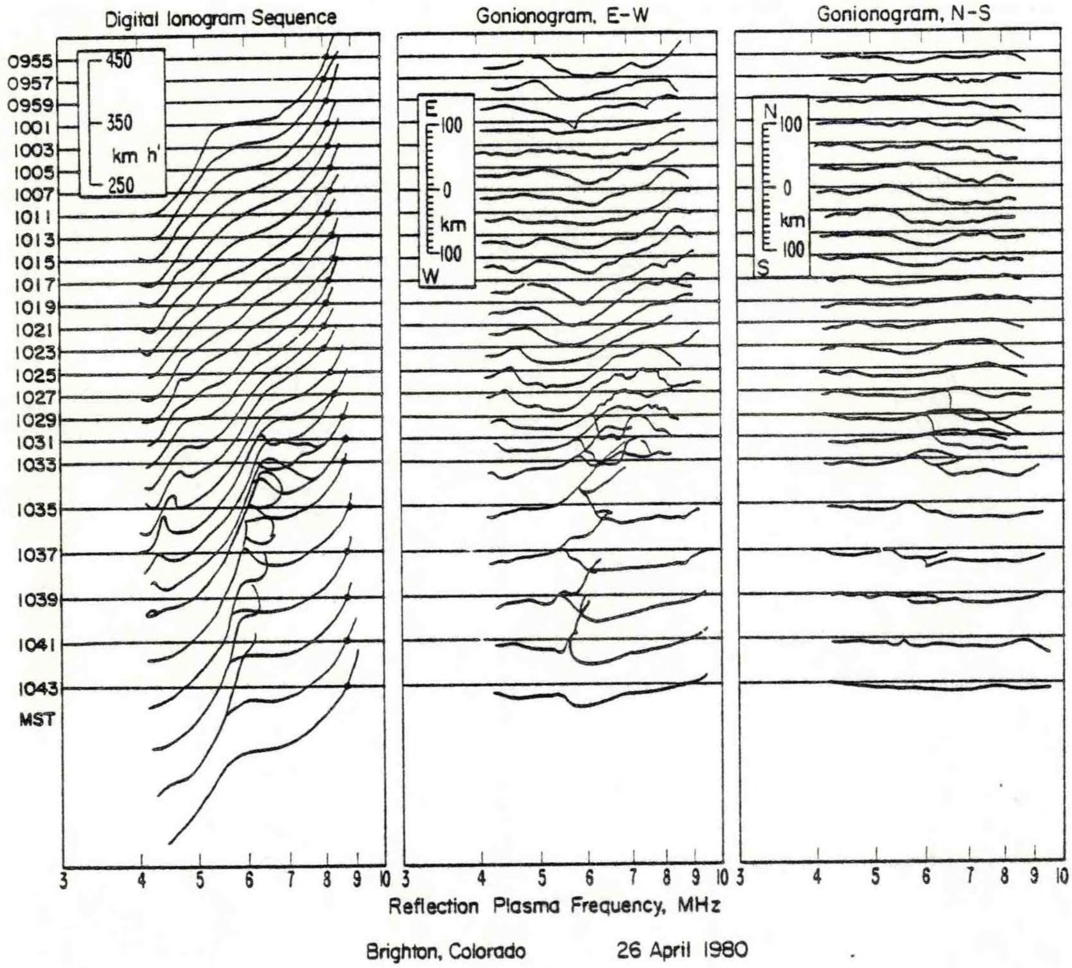


Fig. 10 Montage of 23 digital ionogram recordings, processed by ionogram (left panel) and gonionogram (middle and right panel) methods. A weak perturbation descends the h'(f) trace at lower frequencies, followed (after 1027 MST) by a much more intense disturbance at greater frequencies (hence, heights). The gonionograms show similar behavior, mainly in the EW component of echolocation.

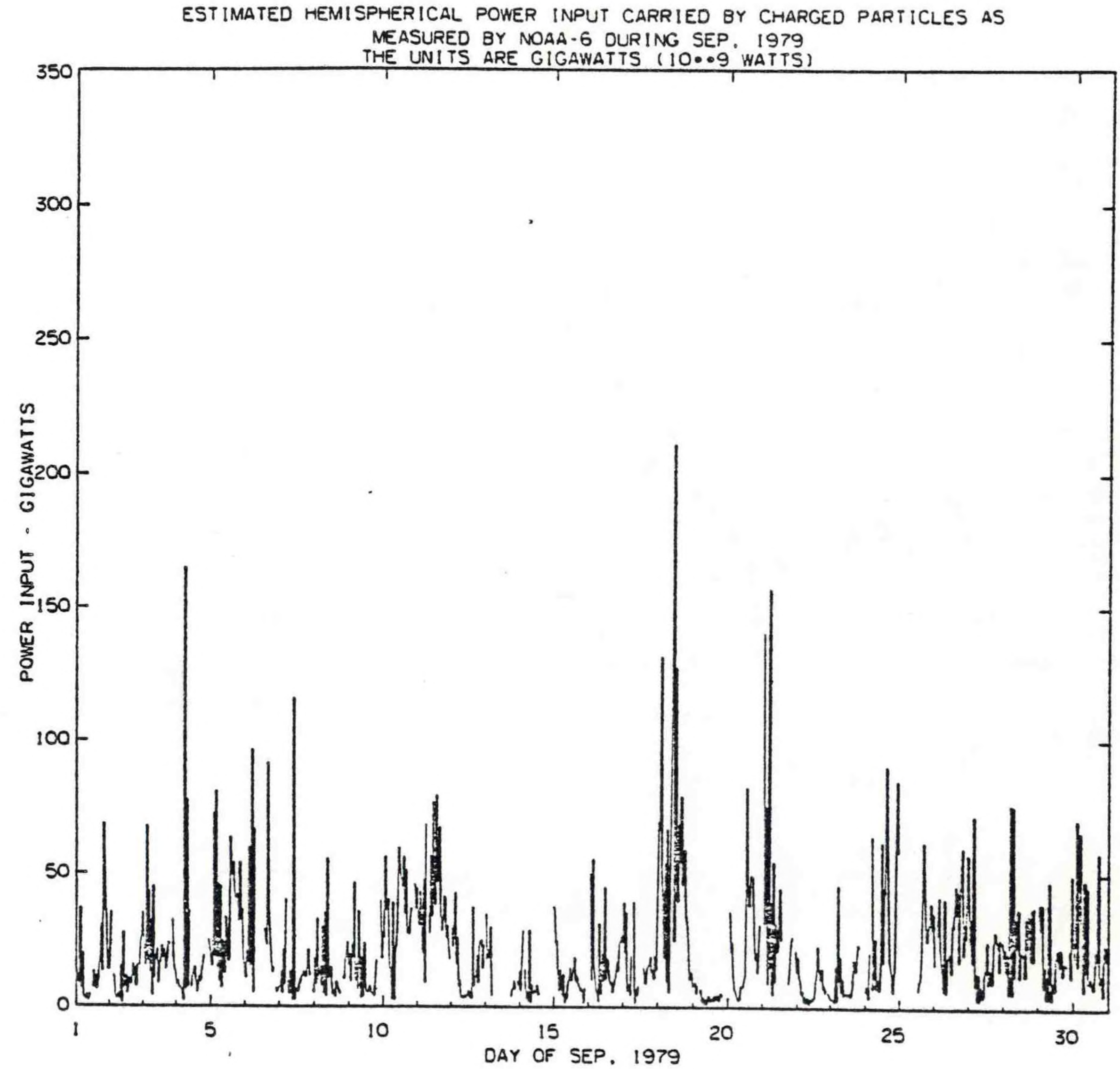


Fig. 11 Estimated hemispherical power input carried by charged particles as measured by NOAA-6 during September 1979.

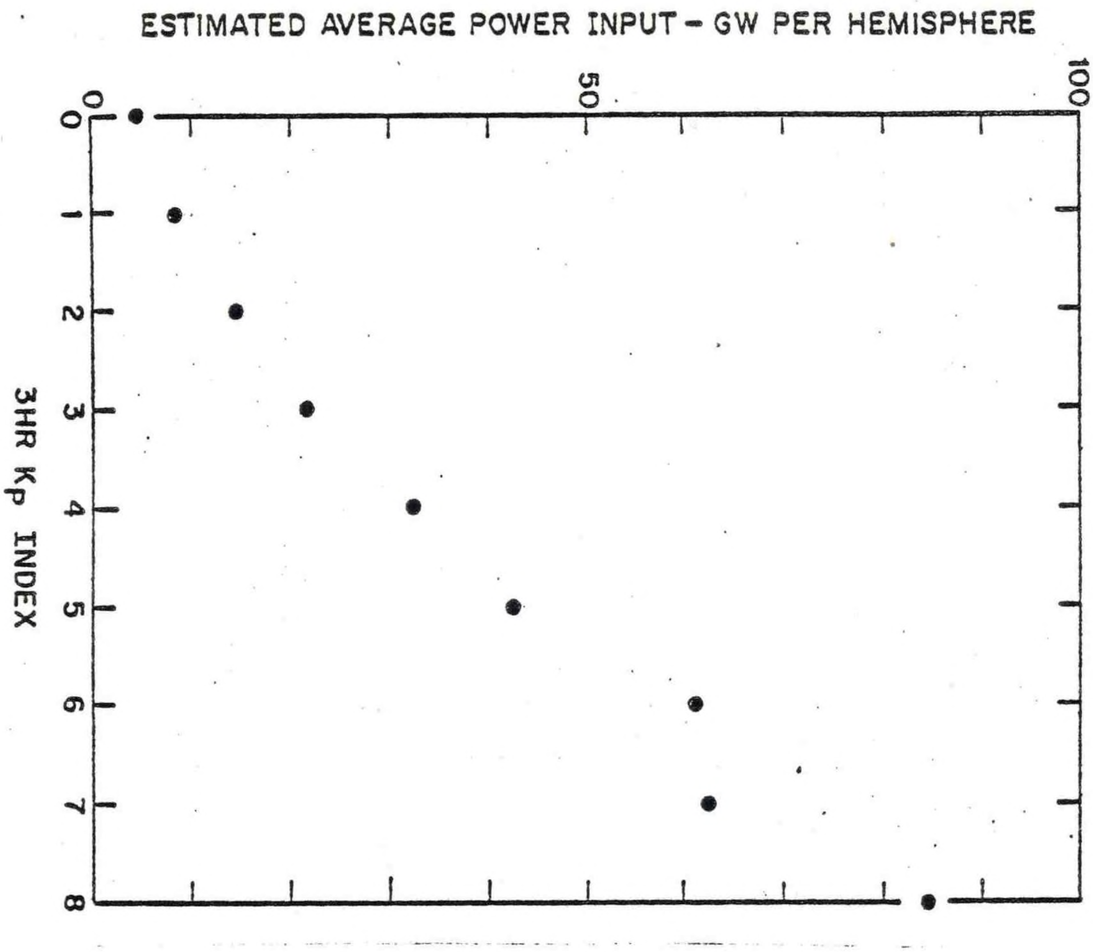


Fig. 12 An association between estimated hemispherical power input and Kp index.

SUPPORT DIVISION R. GRUBB

The Support Division provides assistance to all laboratory projects; in the use of computers for the acquisition and analysis of data through the Analysis Branch; and in the development of instrument hardware, engineering software and data systems design, through the Instrument Development Branch.

Typical contributions to the laboratory research and services are the development of ground-based and satellite instrumentation for experimental and observational data collection and in the analysis of data used in research publications.

ANALYSIS BRANCH J. WINKELMAN

The Analysis Branch provides computer programming support to the rest of the laboratory. It maintains a large library of experimenter data tapes from satellite and ground-based experiments, which are routinely processed and analyzed. Members of the Analysis Branch combine expertise in computer usage with general knowledge of the scientific endeavors of the lab and, therefore, provide advice and assistance to the scientists in the use of computer techniques to further their research.

ACCOMPLISHMENTS FY 1980

International Sun Earth Explorer (ISEE) Satellite. ISEE archive tapes have been produced through day 32 of 1979, so there remain about 7 months of ISEE-1 data to process. ISEE-2 tapes will continue to be written through the life of the satellite. Production of ISEE tapes, as well as other computer work, was slowed by an operating system changeover in July of 1980 and by problems in computer service throughout the year. Most of these problems seem to be clearing up.

During the ISEE data processing, an error was discovered in our understanding of the satellite sector timing, which required some changes in the display programs. The correct timing and magnetometer processing was added to the Pulse-Height Analyzer (PA) data on the archive tapes. Many requests, mostly for ISEE data cassettes for Tektronix 4051s, were filled for scientists both inside and outside the lab. The data analysis workshops were supported with magnetic tapes of selected ISEE data. Programs to produce a set of flux, spectra and plasma flow analysis plots for ISEE-1 are nearing completion and will soon be in production.

Special handling was required to produce archive tapes for the early slow-spin-rate ISEE-2 data, which has been sent to Max Planck Institute in Lindau in accordance with our agreement. Two programs using an exciting new medium, color tonal plotting on a Tektronix 4027 terminal, have been developed to display ISEE data.

HF Radar (Ionosonde). Work has continued to support the SEL HF Radar system with software. A milestone reached in January was the issue of a standardized operating package with documentation which forms the basis for all future updates. Several important new features have been added since that issue. A comprehensive scheduler is now available to permit the intermixing of different modes during unattended operation. A new test task has been added to permit better diagnostic operation of the front-end signal processor (FEP) in conjunction with an assembler for FEP code developed by Brunell University in London. The availability of these two latter features enabled the production of a number of new experimental signal processing modes both for pulsed sounding and for spectrum surveillance.

A package of software for the CDC 6600 has been developed to permit off line analysis and display of data from the HF Radars. This permits ionogram display, unpacking and reformatting to enable the data to be used with earlier Dynasonde data analysis software. This package is being used to analyze data from the 60 field tapes acquired by the system in order to evaluate performance and provide the basis for the development of auto calibration and better analysis graphics. Indexing and survey programs have also been written to support the radar tape library.

An encouraging development is the number and quality of new programs and modifications coming from the other international groups with identical HF Radar systems. In the long run this should help considerably with the exploitation of the hardware potentialities.

Miscellaneous Programs

ATS-6 satellite archive production has continued. Work on display programs for the ATS-6 and SMS/GOES series X-ray data is in progress.

Two microfilm plotting routines were written and are running on archived TIROS-N satellite data. Archive production for the IMP-J satellite is current and in progress. Requests continue to be processed for IMP-H and J data.

A new microfilm plotter software package, DPPLOT, was written for the ERL Central Computer and is available for experimental use by the computer user community. The Concordance Program, also available generally to computer users, was rewritten in ANSI Standard Fortran. Work is in progress to convert another support program, the compositor, to the large batch computer.

The Analysis Branch has also been involved in the ongoing work on the 1982 ERL Computer Initiative, hoping to see the future installation of a centrally-controlled, distributed computer system throughout ERL.

PLANS FY 1981

FY 80 projects are expected to continue in some degree into FY 81. ISEE-1 production should be completed, and new plotting programs run on a production basis for a full year of data. HF Radar software development should move into a lower key phase with a smaller total effort devoted to new operating and display modes and the maintenance of the data base and data base analysis programs. With installation of the Interdata software development computer and the availability of 6600 unpackers and utilities, a larger proportion of future software will likely come from the scientific staff.

The Instrument Development Branch (IDB) provides general support to the laboratory in the areas of instrument hardware, engineering software, and data system design. This general support includes involvement throughout the entire lifetime of a laboratory program, often beginning with system conceptual development and proposal writing support, continuing through the design, fabrication, and test phases, to support in field deployment or launch operations and often involving continuing evaluation and consultation during data reduction and analysis. Further, contractor technical supervision and program management are provided for larger program efforts.

ACCOMPLISHMENTS FY 1980

Operational Space Environment Monitors. The IDB provided continuing contractor technical monitoring for the procurement of instruments for the TIROS/NOAA Space Environment Monitor (SEM), and provided technical support to the National Earth Satellite Service and the Goddard Space Flight Center for the GOES SEMS. Considerable effort was devoted to proposing, developing specifications, and providing continuing justification for a new Solar X-ray Imager, Low Energy Particles Instrument and an Ionospheric Beacon to be flown on future GOES satellites.

GOES D was successfully launched on September 9, 1980. Each of the SEM subsystems were functionally checked for proper operation and calibration data taken. All units appear to be operating as predicted. The SEL ground station has acquired the GOES D telemetry signal and is receiving good data. GOES D has the first High Energy Proton and Alpha Particle Detection Subsystem to be flown on a geostationary satellite which gives us real-time data for the first time on the whole energy range of solar particles constituting radiation hazards to high flying aircraft and spacecraft operations.

Solar X-ray Imager Feasibility Demonstration. Fabrication is nearly complete on a "brassboard" X-ray Imager instrument and image display system. This NESS funded hardware study is intended to demonstrate in the laboratory that electronic despinning of the image will improve instrument sensitivity for a spinning satellite application while still maintaining high spatial resolution. An opportunity is also provided to refine our knowledge of spectral coverage, sensitivity, and dynamic range for a CCD image array through tests to be performed in the X-ray chamber at MSFC. Glancing incidence X-ray optics for this test system were designed by MSFC and are being fabricated by an industrial contractor.

Ionospheric Beacon. A prototype beacon receiver for high time resolution differential group delay measurements was completed, and preliminary tests were performed with a simulated dual-frequency pseudo-random code modulated beacon transmitter. The group delay measurement system, for use in operational ionospheric total electron content measurements, is built around a microprocessor system. Initial tests indicated that performance exceeds operational requirements. A paper on these results was presented at the URSI/COSPAR symposium on the Scientific and Engineering Applications of Satellite Radio Beacons in Warsaw in May 1980.

HF Radar. In early summer, the HF Radar constructed for the National Science Foundation (NSF) was transferred from the Brighton field site of SEL to the Cleary, Alaska, site of the University of Alaska Geophysical Institute. Although some difficulty has been experienced with the generator power at this remote site, the system is now operational.

The assembler program for the front-end signal processor was completed and subsequently used to produce test software to support the installation and testing of the NSF system at Cleary. FEP software is now easier to produce and new test and system software is in preparation.

The NOAA HF Radar replaced the NSF unit as the operational sounder at the SEL Brighton field site. The main effort there has centered on resolving routine operational problems and preparing hardware and software modifications as needed for the Partial Reflection Experiment.

The Interdata Software Development Computer System was installed in the instrumentation laboratory and will allow continued Software Development while the radar instruments are in the field.

Two fixed frequency 100 KW transmitters and power supplies were designed and are nearly completed. These will be used in conjunction with the HF Radars in partial-reflection experiments to be conducted at Cleary, Alaska.

Galileo Energetic Particles Detector (EPD). The launch of the Galileo satellite has been slipped by two years, to February 1984. Consequently, the EPD team has realigned the development schedule to take advantage of this extra time. During FY 80, IDB effort consisted primarily of overall program management for the EPD team and hardware development for the time-of-flight (TOF) portion of the ion composition experiment. The TOF engineering model modules have been fabricated and are installed on a test board awaiting interface tests with the rest of the system. Overall, the EPD engineering unit and bench checkout equipment are well along in the fabrication process.

PLANS FY 1981

Continuing support will be provided for SEMS as required by the TIROS and GOES launch schedules. TIROS-C is scheduled for launch in April 1980 and GOES E is scheduled for launch in March 1981.

Laboratory tests of image despinning for the brassboard Solar X-ray imager will be conducted early in the year. The system will then be integrated with the optics and tests will be performed in the X-ray chamber at MSFC.

Continuing support is expected to be required for further definition and/or modification of the new GOES SEM instrument specifications for potential use on GOES G & H or the follow-on new generation geostationary weather satellites.

The two supplementary fixed frequency high power transmitters for the NSF and NOAA systems will be completed, and it is expected that the partial reflection and multifrequency riometer modes will be brought into operation.

A high speed data link will be installed between the instrumentation lab in Boulder and the Brighton field site so that operation at the unmanned site can be monitored in the laboratory.

Planned expeditions for the NOAA HF Radar System include: Arecibo, Puerto Rico, and Cape Parry, Canada.

An FEP interface board will be constructed for the Software Development System and the prototype FEP installed. This will allow writing, testing, and debugging FEP Software in the lab. General support, as required for the existing 6 HF Radar Systems, will continue.

EPD program plans include completion of the engineering model and beginning construction of the flight model. Preliminary calibrations will be performed using the engineering model.

A detailed investigation into the timing characteristics of microchannel plates will be conducted. This effort is aimed at the development of an improved ion composition measurement instrument employing an ultra thin solid state detector and using microchannel plates to collect secondary electrons from the ion interaction at the detector surfaces. This effort, funded by NASA, is expected to yield a sensor design for use on the NASA Origin of Plasmas in the Earth's Neighborhood Program and other future research and operational programs.

SERVICES DIVISION — T. GRAY

The Services Division provides a variety of services to a growing national and international community of users who are concerned with the effects of solar activity on the environment. The Real-Time Data Services Branch and the Space Environment Services Center which comprise the Services Division jointly consititute the major activity of the United States in the area of solar-terrestrial monitoring, forecasting, and real-time data collection and dissemination. Many of the services activities are joint activities of NOAA and the USAF.

SPACE ENVIRONMENT SERVICES CENTER — G. HECKMAN

The Space Environment Services Center (a joint operation of NOAA and the USAF Air Weather Service) continued to provide a schedule of predictions, alerts and data for a variety of users whose systems are affected by disturbances in the space environment or who are conducting scientific experiments dedicated to improved understanding of that environment. Predictions and summaries of activity are distributed daily to users throughout the United States and the world. Customers making use of the services included the DOD, NASA, DOE, FAA and NSF federal agencies, universities and research foundations and industrial and commercial users.

ACCOMPLISHMENTS FY 1980

The Services activities increased as solar activity increased and perhaps reached the maximum activity for this Solar Cycle. Major solar flares are occurring frequently producing communications blackouts. Thus far, however, the flares have not produced the full range of terrestrial effects typical of most solar cycles. This is not unexpected--energetic proton events, for example, tend to cluster in the declining years of the solar cycle.

Some activity highlights for the year include the following:

- The start of real-time support for the Solar Maximum Mission (SMM)
- Increased activity in the Solar Maximum Year program
- New customers interest in solar effects on their systems, including solar flare effects on computer systems and occasional failures in power systems at high latitudes
- Starting 24-hour operation of the SESC
- Planning for 24-hour continuous operation of the SESC
- Planning for a new Space Environment Laboratory Data Acquisition and Display System (SELDADS)
- The reception of NOAA unit citation for the Services Staff

Forecast Center

Twenty-Four Hour Operation

A careful plan was made to inaugurate 24-hour operation of the SESC. Some important considerations included:

- Restructuring the schedule for operating procedures.
- Investigating means of obtaining data to accommodate the new schedule.
- Ascertaining and solving any conflicts generated in the new operations, that might affect the NOAA/USAF operation.
- Determining feasibility of initiating new services products, changing old ones, etc.
- Possibilities for acquisition of data from the Eastern Hemisphere observatories, including the purchase of satellite transmission time.

An immediate change was provision for a new forecast to be issued at 1200 UT daily to serve research-oriented users including solar observatories, rocket launch campaigns and satellite missions that run according to Western Hemisphere time. This new product emphasizes discussion of physical conditions necessary for carrying out scientific experiments. The 2200 UT forecast was then directed toward operational guidance for Department of Defense systems, communications operators and other commercial users.

Support to Solar Maximum Year and Solar Maximum Mission

The Solar Maximum Year is an international cooperative program to study solar flares in three sub-programs:

- The Flare Buildup Study (FBS)
- The Study of Energy Release from Flares (SERF)
- The Study of Traveling Interplanetary Phenomena (STIP)

The SMY began August 1, 1979, and will continue for approximately nineteen months. Coordination of ground-based and space observations is required to ensure that all instruments look at the same solar region at the same time. These observations must be planned well in advance with the solar target selected 19 hours before the observing time. Selection of a solar target is very difficult and was tested during the FBS and SERF trial periods in May 1979. The SESC had an active role in these trial periods, providing priority schedules, alerts, solar data and solar forecasts.

The Solar Maximum Mission Satellite, launched February 14, 1980, will provide space observatories during the SMY.

During the SMY, space observations will be promoted by, particularly, the Solar Maximum Mission (SMM) satellite, the ISEE-C satellite and the P78-1 satellite. SESC staff were assigned to the Goddard Space Flight Center to provide forecasts and data to assist the SMM Principal Investigators in developing observing plans that result in the best utilization of the SMM instruments. The SESC staff provide seven days/week forecasting services to the SMY and SMM principal investigators following the successful launch and checkout of the SMM spacecraft. On February 14, 1980, the SESC support team provided daily solar activity forecasts tailored to the specific scientific requirements of all experiments for such events as non-energetic coronal transients and gamma ray bursts. The team also maintains the SMM event listing which compiles correlative ground-based and satellite data and are circulated to SMM investigators. Eight hundred events were observed in the first six months of the SMM program.

The SESC team at Goddard has been featured in the NASA public relations for SMM. Briefings have been conducted for NBC, CBS, TBS, Aviation Week, Discovery, WRC (a Washington, D.C. broadcast station), a NASA film, New Scientist and the Washington Post.

In the future, this continuing service to NASA will be provided under a contractual operation supervised by the SESC, due to continuing reductions in the government workforce.

Automation of Forecast Activities

In a continuing effort to improve services, more forecaster duties are being automated with the aid of the SELDADS. For example, the SMM/SMY observing plans are now available in the SELDADS computer to all solar observatories and experimenters. Thus, forecasters no longer need to call each experimenter to distribute the schedule of activities.

Memorandum of Agreement for DOD Shuttle Support

A Memorandum of Agreement between the Air Force Air Weather Service and NOAA for space environmental support for Department of Defense Shuttle payloads has been drafted. The plan provides for SESC support to be provided directly to the DOD payload control center.

Demonstration of Data System for NASA Headquarters

The SESC conducted a demonstration for NASA officials of real-time solar-terrestrial data acquired from the GOES and ISEE satellites.

Manual of Operations

The Forecast Center Manual of Operations was prepared for submission to the cooperating observatories to aid in collecting data for the (solar active) Region Analysis program; work began to standardize operational procedures and forecasters' utilization of SELDADS; and procedures established for interacting with the SMM forecasters at NASA, Goddard Space Flight Center.

Miscellaneous Operational Activities

Selected changes were made in the solar-terrestrial information broadcast on station WWV.

Cooperation continued with the USSR in their analysis of parameters collected for the Regional Analysis program.

Responses to recurring questions about the SESC operations were standardized.

Daily reports were issued on magnetic values for publication in Materials Performance for pipeline companies. (Magnetic activity encourages piepline corrosion.)

Maintained records which were started in 1974 of: the daily maximum X-ray event; ground-level proton events; polar cap absorption; and satellite proton events.

Alerts

A computerized system was placed into operation which provides a list of customers to be notified when certain threshholds of solar-terrestrial activity are met or are forecast. Eighty-one customers are provided this alert service. In three quarters of operation the following alerts were provided:

Solar Flares	Magnetic Disturbances	Radio Disturbances	Proton Events	"Presto" Messages
84	58	85	2	76

Some examples of customers alerted include:

NASA Director of Flight operations
NAI Senior Field Engineer
Helios (satellite) Operations Manager
FAA
Russian Cosmonauts
University of Maryland
Utah State University
Goddard Space Flight Center
Arecibo Radio Observatory
Air Force Geophysics Laboratory

(A list of new customers for all types of services is included in the appendix.)

International Ursigram and World Days Service (IUWDS)

New codes for the international exchange of real-time, solar-terrestrial data were released. Operational experience has been gained in using the new codes and, so far, no major problems have developed. In its role as the IUWDS World Warning Agency, SESC has acted as the distribution center for solar active region targets and observing plans for the Solar Maximum Year/Solar Maximum Mission. This information is distributed daily to all regional warning centers and associate regional warning centers in Australia, Japan, Europe and Asia, as well as directly to solar observatories in North and South America.

Utilization of SOON Data

Data from the Solar Optical Observing Network (SOON) are different from data from traditional observatories. The SOON emphasizes mapping and quantification of solar features rather than the verbal and subjective descriptions used heretofore. Major emphasis has been placed on acquiring, standardizing and evaluating these data. An observational program to utilize the unique capabilities of the TRACK BALL data encoder has been established and a study was initiated to statistically evaluate the importance of magnetic field gradients in solar flare production.

Utilization of ISEE-3 Satellite Data

A preliminary study of the ISEE magnetometer data was conducted. Principal results were that southward B_z component of field of more than five gammas do correlate with magnetic disturbances but during storm conditions B_z can vary wildly. Most sudden impulses in the H-component of low and mid-latitude, ground-based stations appear as a jump in the magnitude of the interplanetary field. The time delay between the ISEE and ground-based signatures is typically about 45 minutes. No obvious geomagnetic signature could be associated with changes in the azimuthal angle of the interplanetary magnetic field.

Twenty-Four Hour Flare Forecasting

Software was developed by the lead SOON site which enables all SOON observatories to send coded region analysis data to SESC for use in our 24-hour flare forecast model. A verification program was developed which will evaluate the computer model forecasts. Data for updating the model is currently being stored on tape. The final report on the model by the NBS Statistical Engineering Laboratory was sent to the Air Force Geophysical Laboratory for publication.

Non-Flare Geomagnetic Forecasts

The primary development work for geomagnetic predictions from disappearing filaments is now completed. A forecaster training session was held September 30, and the paper documenting this study has been submitted to the Journal of Geophysical Research. After SESC experience with the guidelines accumulates, revisions may be necessary. It does seem apparent that a numbering system forcing a daily inventory of solar filaments will be required.

Long-Range Solar Predictions

Work on real-time displays of large-scale evolution of solar magnetic fields continued. Concepts of shear and convergence were applied to produce 27-day forecasts. A small-scale study with Helen Dobson-Prince and Ruth Hedeman was initiated to make objective comparison of this solar cycle with earlier cycles.

Data Archiving (Provided to the World Data Center)

- Monthly SESC data including hydrogen-alpha prints and sunspot drawings.
- New items include: 1200 UT forecast, solar-activity summary, Sacramento Peak Observatory green-line data, Mt. Wilson Observatory calcium plage report.

- TIROS satellite data is complete from November 1, 1978, through September 30, 1980. NOAA-6 data is complete from June 26, 1978, through September 30, 1980.
- GOES satellite data processing procedures were revised.

SELDADS II

A budget initiative for FY 1981 was pending at the time of writing for improving the Services. A major task is the replacement of the existing Space Environment Laboratory Data Acquisition and Display System (SELDADS) with a new system designated SELDADS II.

Work is progressing on the definition of functional requirements of SELDADS II. Efforts have begun to trace data flow through system module functional statements. Task group reports have been organized into a first draft of a requirements document. The requirements document will go through a series of reviews and revisions. Efforts to modify and expand SELDADS II functional modules will begin in order to accommodate forecast center data requirements. Responsibility for the functional specification of SELDADS II has been assigned to staff of the SESC as follows:

Overview
Data Collection
Editing
Data Management
Data Dissemination
Date Archiving
Real-Time Monitoring
Solar Observatory
Solar Mapping
Interplanetary/Solar System Mapping
Geomagnetic/Magnetospheric Mapping
Modeling
Time Lines and Plot Package
Listings and Special Displays
Scheduled Reports
Crisis Reports
As-Requested Reports

Observatories

Boulder Observatory

Daily hydrogen-alpha solar pictures and sunspot drawings were made for use by the duty forecaster. Daily pictures, spot drawings and neutral line drawings were sent to: Lockheed Aircraft, University of Hawaii, Goddard Space Flight Center, Astrogeophysics Department of University of Colorado, University of Alaska, High Altitude Observatory, Fisk Planetarium, and University of Colorado.

Kitt Peak National Observatory

The joint program with KPNO, NASA and NOAA for daily synoptic solar magnetograms, coronal hole maps and special observations in support of the SMM and SMY missions continued.

Marshall Space Flight Center Field Site at Huntsville, Alabama

An SESC person stationed at MSFC conducts solar observations in support of SMM and SESC observing/forecasting activities. Real-time support consits primarily of photographic active region magnetograms.

Learmonth (Australia) Solar Observatory

The joint American/Australian Observatory at Learmonth is now fully operational. It is part of the Air Weather Service Solar Optical Observing Network (SOON) and the Radio Solar Telescope Network (RSTN). This observatory is jointly manned by a NOAA Corps Officer and several Air Force and Australian personnel. This observatory fills a vital "hole" in the worldwide solar observations.

Culgura (Australia) Solar Observatory

Ths observatory is operational and supplies real-time data in support of the SMM/SMY, NOAA/SESC, USAF/AWS and Australian Ionospheric Prediction Service programs. It is manned by a NOAA Corps Officer and observers from the Australian Department of Science.

New Requests for Services

As the peak of solar activity for solar cycle 21 was approached, the SESC inaugurated 24-hour service and a large increase occurred in the number of requests for services. Appendix I lists the agency or program from which requests were received for non-routine services.

Several requests for long-term forecasts of daily 10 cm wavelength solar radio emission and the AP index of magnetic activity were received and resulted in the development of a new 27-day forecast of these parameters issued weekly.

The SESC participated in the preliminary planning sessions for the interim GOES satellite instruments including the proposed X-ray imager, plasma detectors and the total electron content radio beacon.

At the request of the National Science Foundation and several research centers, SESC forecasters prepared a drawing of the expected solar corona for the February 16, 1980, solar eclipse which were used by eclipse expeditions in India and Africa for planning their observations. Preliminary reports indicated the SESC drawings were of great assistance to the observers.

SESC PLANS FY 1981

A busy year lies ahead with a continuation of operations summarized above, the continued development and refinements of requirements for the new data system, improvements in service products in connection with the resumption of 24-hour operation of SESC, the move into new quarters at the start of training in the use of the new SELDADS II system.

SERVICES DIVISION

Appendix I

Requests for non-routine support for FY 1980, by quarter.

First Quarter

1.	U.S. Army, White Sands	Solar flare alert for rocket launch
2.	University of California, Berkeley	Balloon studies of x-ray sources
3.	Aerospace Corporation	Forecast for best times for P-78 data collection
4.	NASA, Goddard Space Flight Center	Action Region pointing coordinates on rocket payload
5.	Jet Propulsion Laboratory	Major flare alert for HEO-C
6.	Very Large Array, National Radio Observatory	Active region coordinates for AS&E rocket payload
7.	University of Washington	Auroral forecast
8.	NASA, Ames Research Center	Proton forecast during Saturn encounter
9.	Martin Marietta Corp.	27-day 10 cm and Ap forecasts
10.	Lockheed	Active region forecasts for rocket payload
11.	University of Denver	Daily forecast for balloon flight
12.	Air Force Research Lab.	Quiet sun forecast to support rocket launch
13.	NASA, Goddard Space Flight Center	Limb activity support for coronal research
14.	National Oceanic & Atmospheric Admin.	Alerts to study SID effects on Omega systems
15.	National Aeronautics & Space Administration	Flare alerts for balloon gamma ray study
16.	University of Maryland	Flare alert
17.	Cincinnati Gas & Electric	Geomagnetic forecast and alerts
18.	Commonwealth Association	Effects of geomagnetic disturbances on power systems
19.	NASA, Goddard Space Flight Center	10 cm forecast for satellite lifetime
20.	Larry Glass Cattle	Solar activity effects on cattle
21.	Atmospheric Scientific Laboratory	Correlative studies with eclipse observations
22.	Northwest Utility Service Co.	Geomagnetic effects on power systems
23.	University of Maryland	27-day forecasts for rocket-balloon program in Antarctica
24.	High Energy Astrophysical Observatory	WWV announcement for ionospheric disturbance monitoring
25.	DECCA Survey, Ltd.	Activity affecting Skywave propagation
26.	Maryland County Police	Alerts on geomagetic disturbances affecting communications

Second Quarter

1.	GEO Magazine	Image data for use with article on solar eclipse

2.	High Altitude Observatory	Forecast of coronal structures for eclipse
3.	University of Calgary	Geomag forecast for balloon flight
4.	National Radio Astronomy Obs.	Region positions and activity forecast
5.	National Physical Labratory, India	Geomagnetic forecasts for studies of equatorial electrojet
6.	Naval Post Grad School	Data for studies of underwater geomagnetic variations
7.	NAI computers	Solar effects on computer systems
8.	Astrophysics Observatory de Arcetri, Italy	Data and forecasts for solar research
9.	Lockheed	Studies on solar origin in sporadic electronic triggering
10.	Noel Zinn, California	Solar activity effects on Navy NAV satellites
11.	Eng. Heritage Comm	Sunspot cycle information
12.	Project Flare Watch	Flare event summaries

Third Quarter

1.	Illinois Dept. of Transportation	Verify geomagnetic effects of radio propagation
2.	Utah State University	Geomagnetic forecasts
3.	Naval Research Laboratory	TIROS-N data
4.	J. Walter Thompson Co.	Solar event data for skin cancer studies
5.	Burlington Northern Railroad	Sun elevation angles
6.	Martin Company	Solar studies
7.	University of California	Balloon studies of solar activity
8.	Hanford Site, Washington	Geomagnetic forecast
9.	PMEL	Geomagnetic forecast
10.	Craig Swain	Solar activity influence on commodity market
11.	Goddard Space Flight Center	Geomagnetic forecast for rocket studies
12.	DISCOVER Magazine	Pictures for first issue
13.	Natt Harvester Company	Solar effects on data processing systems
14.	EDIS	TIROS-N data and programs
15.	Boeing Aerospace	Proton event effects on solar cells
16.	Project Firewheel	WWV announcements on planned barium release
17.	Lab for Energy-related research	Solar activity summaries
18.	Riverside Medical Center	Solar effects on computer operations
19.	ABC News	Solar flare film footage
20.	Services de Electricidade, Brazil	Geomagnetic data and forecast for possible effects on power systems
21.	Canadian Geomagnetic Obs.	Long-range geomagnetic forecast
22.	Atlantic Richfield	Geomagnetic effects on power systems
23.	Astrogeo Exploration	Geomagnetic effects on mineral surveys
24.	Kansas City Power & Light	Disturbances associated with power outages
25.	Exxon Research & Engineering	Possible pipeline problems from geomagnetic disturbances
26.	Douglas Aircraft	Solar/geomagnetic effects on aircraft
27.	Naval Research Laboratory	Solar/geomagnetic forecasts for 1 month

Fourth Quarter

1.	National Institute of Health	Correlations of solar activity and cancer
2.	University of Cleveland	Flare predictions for D-Region studies
3.	Larry Taylor	Geomagnetic forecasts for ship survey
4.	University of Denver	Solar forecasts for balloon program
5.	AFGL	Proton forecast for rocket study of D-Region
6.	University of Minnesota	Geomagnetic forecasts for rocket study
7.	Mission Research Corp.	X-ray data
8.	Goddard Space Flight Center	Geomagnetic forecast for rocket study in polar regions
9.	AFGL	Solar activity forecast for rocket calibration of UV experiment
10.	National Radio Observatory	Forecasts and alerts for geomagnetic activity
11.	University of Wuppertal	Geomagnetic forecasts for study of Joule heating in auroral regions
12.	White Sands	Active region descriptions for rocket study
13.	Sacramento Peak Observatory	Solar activity forecast
14.	Inst. for Psycho Energetics	Correlations with solar activity
15.	Mill Run Farms	Study of solar activity and weather
16.	NOAA Days	Display booth with slow-scan TV images of the sun along with information about solar activity

The Real-Time Data Services (RTDS) operates systems which provide data from various solar and geophysical sensors for supporting the Space Environment Services Center (SESC) forecast operations. There are three operational components in the RTDS: (1) the Data Display Systems (DDS) in the NOAA NBS Radio Building at Boulder, Colorado, (2) the Table Mountain Observatory (TMO) at Table Mountain, 10 miles north of Boulder, and (3) the High-Latitude Monitoring Station (HLMS) at Anchorage, Alaska. Systems at the three sites operate 24 hours per day, 7 days per week. The sites are manned during normal working hours and, at other times, personnel are on call for taking care of problems.

ACCOMPLISHMENTS FY 1980

Data Display System (DDS)

The DDS houses the SELDADS (Space Environment Laboratory's Data Acquisition and Display System) which acquires data from many sources; stores and archives, processes and displays the data for use by the SESC. In addition, it services an AF GWC data link.

SESC Console

The SESC console contains CRT displays, computer terminals, printers, and strip charts necessary for supporting the forecast operations. There are no changes contemplated for the immediate future.

SELDADS

The SELDADS system provides facilities to acquire, process, display and archive a wide range of solar geophysical data for use by the SESC forecaster, for relay to the USAF Air Weather Service at Offutt Air Force Base, Nebraska, and for direct used by a number of industrial and scientific groups. Data from this system are also recorded on magnetic tape which are sent to the National Archives. A pictorial diagram of SELDADS is shown in Figure 13.

As a backup for the SELDADS user computer (DG S-200) plotting system, programs were written to allow for plotting of all the data in the NOVA 2 system. At present, the plotting of IMS, ISEE, GOES-2 and GOES-4 data can be accommodated by the NOVA 2 system and TIROS-N data will be available in November 1980.

Astrogeophysical Teletype Network (ATN) Data

The ATN data contains many data messages from observatories around the world including the HLMS. These messages are decoded in the SELDADS and the data stored in data bases for retrieval and displays in the SESC.

AF-AWS Data Link

The AF-AWS data link between the SELDADS and GWC is used to transfer data between the two stations.

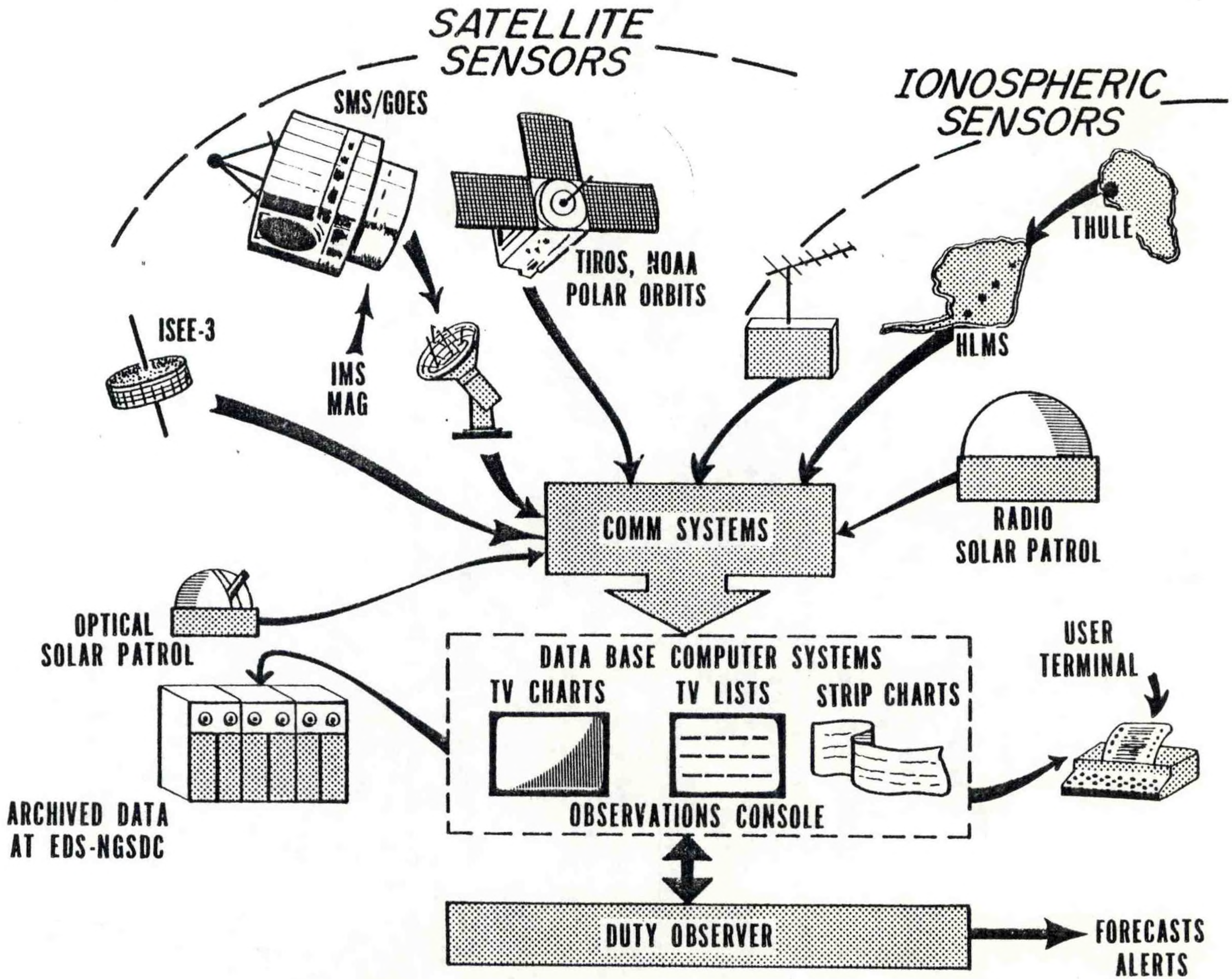


Figure 13. **NOAA/ERL/SEL REAL-TIME DATA ACQUISITION AND DISPLAY SYSTEM (SEL DADS)**

GOES Data

Data from the SEM on two GOES are routinely received at the Table Mountain Observatory and sent to the SELDADS. The data re processed, displayed, and archived.

GOES-4 was launched successfully on September 9, 1980. The SEM is up and functioning nominally. We are receiving the data in the XDS 930 computer at Table Mountain. The data compares favorably with GOES-2. It is being displayed on the SESC Beehive monitor and strip charts.

The development computer has been operating well. Programming is progressing for handling all the data in a way that each data set can be filtered, checked, or manipulated to improve the quality of the output data. Considerable effort is being required to accommodate the new GOES-4 format and the old format simultaneously.

GOES 2 and 3 data are being processed by the SELDADS NOVA 1 computer and displayed by the SELDADS S-200. GOES 2 and 4 are being processed by the TMO 930 computer and displayed in SESC via the digital highway. GOES 2 and 4, one-minute values are also sent to the NOVA 2 system and can be displayed or plotted via the Tektronix 4051 terminal. The coefficients for GOES-4 are presently being determined and the data are being compared to GOES-2.

GOES 2 and 3 data are being recorded and sent to EDIS for archiving from the SELDADS. GOES-2 and 4 are being recorded at TMO for future reference.

TIROS/NOAA Satellite Data

Space Environment Monitor (SEM) data are received from NESS from two of the TIROS/NOAA (TIROS-N and NOAA-6) polar orbiting satellites by the SELDADS. The data are to be stored in a data base, displayed by the SESC, sent to Global Weather Center (GWC) at Offutt Air Force Base, Nebraska, and archived.

IMS Magnetometer Data System

The SELDADS receives, processes, displays and archives the IMS magnetometer data for the U.S. magnetometer network. Because the data are received at the SELDADS, there is considerable system monitoring and communications with the USGS, University of Alaska, UCLA, and University of New York, who maintain the magnetometer sites.

ISEE Data

Data from the ISEE-3 electric field, solar wind, x-ray, and magnetometer sensors have been transmitted to the XDS 930 computer since February 20, 1980. The data are now being processed and one-minute summaries are being sent to the SELDADS. The data are displayed in real-time on strip charts and a CRT in the SESC.

Information has been received from Dr. William Feldman of LASL on the method of converting the electron solar-wind data to engineering units. The equipment at GSFC must be modified so that the electron data will be sent to us. Programming for converting the electron data will be complated next quarter.

Programs have been written and stored on microprocessor Programable Read Only Memories (PROMS) for the data extractor at GSFC. Two attempts have been made to install the new PROMS without success. However, there is hope that the next try will produce good results.

SESC Information Dissemination

There is a need for efficiently disseminating the SESC information products to the public. A possible technique for implementing this service using the SMS/GOES satellites has been proposed to NESS. The proposed system would broadcast a set of solar-geophysical parameters via the SMS/GOES Data Collection System Interrogate Signal which presently broadcasts NBS time information. This information can be received by users within site of the satellites. NESS is presently trying to establish a policy for handling requests for information broadcasts.

Table Mountain Observatory (TMO)

The TMO acquires, processes, displays and archives solar-terrestrial data observed from ground-based and satellite sensors.

A spare drum memory was acquired from surplus and has been checked out. This provided some additional backup to the SELDADS.

High-Latitude Monitoring System (HLMS)

The HLMS acquires, processes, displays, and archives geophysical data observed from local and remote ground-based sensors located across Alaska and at Thule, Greenland. The site is jointly operated with the Air Force Air Weather Service. A local HF propagation and magnetic forecast is prepared along with special products for the AF AWS needs. Data summaries are sent out every 15 minutes on the AF Astrogeophysical Teletype Network.

The Polarimeter was installed by Mr. Frank Gorman at HLMS. The equipment is owned by the U.S. Army at Fort Monmouth, N.J. The programming has been installed on the XDS 920 and the data is now on-line to the AFGWC.

The old SCC computer core memory failed during the last quarter of Fiscal Year 1980. Our only backup now is a trip to Anchorage to fix one or the other computers, or both if the XDS 920 fails.

STS-85

Planning to support the design and replacement of the present SELDADS was begun.

PLANS FY 1981

The present SELDADS must continue until the replacement system is capable of taking over the support of SESC. Few changes in the existing system are planned with all development activities devoted to the new system now tentatively planned to become operational in mid-1983.

SEL STAFF

OFFICE OF THE DIRECTOR, Donald J. Williams, Director

Ahl, Irene V.	Secretary
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599 ANDERSON D N, EQUATORIAL ELECTRODYNAMICS - THEORETICAL MODELS, RPT OF WORKSHOP ON EQUATORIAL PHYSICS - PHYS OF THE EQUATORIAL UPPER ATMOSPHERE, CORNELL UNIV, OCT 22-23, 1979, APPENDIX A2, 1980/03.

511 ANDERSON D N, REVIEW OF THEORETICAL MODELING IN THE LOW LATITUDE IONOSPHERE, COSPAR SYMP SERIES, LOW LATITUDE AERONOMICAL PROCESSES (A P MITRA, ED), PERGAMON PRESS, VOL 8, PP 93-106, 1980/06.

509 ANDERSON D N, RUSCH D W, COMPOSITION OF THE NIGHTTIME IONOSPHERIC F1 REGION NEAR THE MAGNETIC EQUATOR, J GEOPHYS RES, VOL 85, NO A2, PP 569-574, 1980/02.

616 BARNES J A, SARGENT H H III, TYRON P V, SUNSPOT CYCLE SIMULATION USING A NARROWBAND GAUSSIAN PROCESS, NBS TECHNICAL NOTE 1022, 1980/09.

609 BERNHARDT P A, DA ROSA A V, PRICE K M, SIMPSON R A, BENDER D C, HALL S C, DOWN J N, ANDERSON D N, HEAO-C LAUNCH OBSERVATIONS AND RELATED THEORETICAL STUDIES, PROC OF THE WORKSHOP/SYMP, NOVEMBER 11-13, 1979, BOSTON, MASS, PP 18-39, 1980/06.

501 BERNSTEIN W, LEINBACH H, KELLOGG P J, MONSON S J, HALLINAN T, FURTHER LABORATORY MEASUREMENTS OF THE BEAM-PLASMA DISCHARGE, J GEOPHYS RES, VOL 84, NO A12, PP 7271-7278, 1979/12.

537 BERNSTEIN W, WHALEN B A, HARRIS F R, MCNAMARA A G, KONRADI A, LABORATORY STUDIES OF THE CHARGE NEUTRALIZATION OF A ROCKET PAYLOAD DURING ELECTRON BEAM EMISSION, GEOPHYS RES LETTERS, VOL 7, NO 1, PP 93-96, 1980/01.

548 BLANC M, RICHMOND A D, THE IONOSPHERIC DISTURBANCE DYNAMO, J GEOPHYS RES, VOL 85, NO A4, PP 1669-1686, 1980/04.

595 BOUWER S D, DAVIES K, DONNELLY R F, GRUBB R N, JONES J E, TAYLOR J H, RASTOGI R G, DESHPANDE M R, CHANDRA H, SETHIA G, ATS-6 RADIO BEACON ELECTRON CONTENT MEASUREMENTS AT OOTACAMUND, INDIA OCTOBER 1975-JULY 1976, WDC-A FOR SOLAR-TERR PHYS, RPT UAG-74, 1980/03.

518 CORONITI F V, FRANK L A, WILLIAMS D J, LEPPING R P, SCARF F L, KRIMIGIS S M, GLOECKLER G, VARIABILITY OF PLASMA SHEET DYNAMICS, J GEOPHYS RES, VOL 85, NO A6, PP 2957-2977, 1980/06.

544 CUPERMAN S, WEISS I, DRYER M, HIGHER ORDER FLUID EQUATIONS FOR MULTI-COMPONENT NON-EQUILIBRIUM STELLAR (PLASMA) ATMOSPHERE AND STAR CLUSTERS, ASTROPHYS J, VOL 239, NO 1, PART 1, 1980/07.

484 DAVIES K, RECENT PROGRESS IN SATELLITE RADIO BEACON STUDIES WITH PARTICULAR EMPHASIS ON THE ATS-6 RADIO BEACON EXPERIMENT, SPACE SCI REV, VOL 25, PP 357-430, 1980/02.

440 DAVIES K, OVERVIEW OF PUBLISHED RESEARCH USING THE ATS6 RADIO BEACON, PROCEEDINGS OF COSPAR SYMP ON BEACON SATEL MEAS OF PLASMASP AND IONOSP PROPTS, PP 1(1)-1(49), 1979/12.

556 DAVIES K, DEGENHARDT W, HARTMANN G K, LEITINGER R, SOME MEASUREMENTS OF TOTAL ELECTRON CONTENT MADE WITH THE ATS-6 RADIO BEACON, PROC OF THE SYMP OF THE COSPAR SATEL BEACON GROUP ON BEACON SATEL MEAS OF PLASMAS AND IONOS PROPTS, PP 5(1)-5(15), 1979/12.

592 DAVIES K, DEGENHARDT W, HARTMANN G K, LEITINGER R, COMPARISON OF TOTAL ELECTRON CONTENT MEASUREMENTS MADE WITH THE ATS-6 RADIO BEACON OVER THE U.S. AND EUROPE, J ATMOSPHERIC TERREST PHYS, VOL 42, PP 411-416, 1980/06.

414 DAVIES K, DONNELLY R F, GRUBB R N, RAO P V S RAMA, RASTOGI R G, DESHPANDE M R, CHANDRA H, VATS H O, SETHIA G, ATS6-SATELLITE RADIO BEACON MEASUREMENTS AT OOTACAMUND, INDIA, PROC OF THE SYMP OF THE COSPAR SATEL BEACON GROUP ON BEACON SATEL MEAS OF PLASMASP AND IONOSP PROPTS, PP 2(1) - 2(33), 1979/12.

558 DEGENHARDT W, HARTMANN G K, DAVIES K, DETERMINATION OF TRAVELLING IONOSPHERIC DISTURBANCES, PROC OF THE SYMP OF THE COSPAR SATEL BEACON GROUP ON BEACON SATEL MEAS OF PLASMAS AND IONOS PROPTS, PP 27(1)-27(7), 1979/12.

557 DESHPANDE M R, RASTOGI R G, VATS H O, SETHIA G, CHANDRA H, DAVIES K, GRUBB R N, JONES J E, ACHIEVEMENTS OF ATS-6 BEACON EXPERIMENT OVER INDIAN SUB-CONTINENT, PROC OF THE SYMP OF THE COSPAR SATEL BEACON GROUP ON BEACON SATEL MEAS OF PLASMAS AND IONOS PROPTS, PP 3(1)-3(6), 1979/12.

534 DONNELLY R F, THE INTERNATIONAL SOLAR-TERRESTRIAL PREDICTIONS WORKSHOP, TRANSACTIONS OF THE AGU. EOS--MEETING REPORT SECTION, VOL 60, NO 41, PP 707-708, 1979/12.

438 DONNELLY R F, ANDERSON D N, DAVIES K, RAO P V S RAMA, INTERPRETATION OF THE SHAPE FACTOR AT OOTACAMUND, INDIA, COSPAR SYMP ON BEACON SATEL MEAS OF PLASMASP AND IONOSP PROPTS. HELD IN FLORENCE, ITALY, 5/22-25/78, PP 17(1)-17(15), 1979/12.

497 DONNELLY R F, DAVIES K, ANDERSON D N, THE EQUATORIAL TOTAL ELECTRON CONTENT AND SHAPE FACTOR, J GEOPHYS RES, VOL 84, NO A12, PP 7359-7364, 1979/12.

566 DONNELLY R F EDITOR, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS. VOL III. SOLAR ACTIVITY PREDICTIONS, INTERNATIONAL SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS AND WORKSHOP PROGRAM, BOULDER, CO APR 23-27, 1979, VOL III, US GPO, SD STOCK NO 003-017-00473-2, 1980/03.

560 DONNELLY R F EDITOR, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS. VOL II. WORKING GROUP REPORTS AND REVIEWS, INTERNATIONAL SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS AND WORKSHOP PROGRAM, BOULDER, CO APR 23-27, 1979, VOL II, US GPO, SD STOCK NO 003-017-00471-6, 1979/12.

573 DONNELLY R F EDITOR, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS. VOL IV. PREDICTION OF TERRESTRIAL EFFECTS OF SOLAR ACTIVITY, INTERNATIONAL SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS AND WORKSHOP PROGRAM, BOULDER, CO APR 23-27, 1979, VOL IV, US GPO, SD STOCK NO 003-017-00479-1, 1980/03.

587 DRYER M, (BOOK REVIEW) SOLAR SYSTEM PLASMA PHYSICS, VOL 1, SOLAR AND SOLAR WIND PLASMA PHYSICS (E N PARKER, C F KENNEL, L J LANZEROTTI, EDS), EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION, VOL 61, NO 30, PG 547, 1980/07.

505 DRYER M, SHEA M A, REQUIREMENTS FOR PREDICTIONS AND REAL-TIME MONITORING FOR THE STUDY OF TRAVELLING INTERPLANETARY PHENOMENA, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL II, WORKING GROUP REPORTS AND REVIEWS, PP 340-345, 1979/12.

500 EVANS D S, MOORE T E, PRECIPITATING ELECTRONS ASSOCIATED WITH THE DIFFUSE AURORA: EVIDENCE FOR ELECTRONS OF ATMOSPHERIC ORIGIN IN THE PLASMA SHEET, J GEOPHYS RES, VOL 84, NO A11, PP 6451-6457, 1979/11.

516 FLOWERS W E, SPACE WEATHER AS AN AID TO SATELLITE OPERATIONS, SATELLITE COMMUNICATIONS, PP 19-22, 1979/11.

471 GLASMACHERS A, CESSNA J R, WINKELNKEMPER W, AN INVESTIGATION OF FAST LOW POWER CHARGE SENSITIVE PREAMPLIFIER DESIGN, IEEE TRANS ON NUCLEAR SCIENCE, NS-27, NO 1, PP 308-312, 1980/02.

479 GRIB S A, BRUNELLI B E, DRYER M, SHEN W-W, INTERACTION OF INTERPLANETARY SHOCK WAVES WITH THE BOW SHOCK-MAGNETOPAUSE SYSTEM, J GEOPHYS RES, VOL 84, NO A10, PP 5907-5921, 1979/10.

459 GRUBB R N, RADIO BEACON MODULATION SCHEMES FOR DIFFERENTIAL GROUP DELAY MEASUREMENTS: A BEACON FOR THE 1980'S, PROC SYMP ON BEACON SATEL MEAS PLASMASP AND IONOS PROPTS, HELD IN FLORENCE ITALY, 5/22-25, 1978, PP 51(1)-51(6), 1979/12.

543 GRUBB R N, THE NOAA SEL HF RADAR SYSTEM (IONOSPHERIC SOUNDER), NOAA TECH MEMO, ERL-SEL-55, 1979/10.

465 HERON M L, DAVIES K, THE USE OF LOW FREQUENCY HF BEACONS TO DERIVE LAYER SHAPE, COSPAR PROC SYMP ON BEACON SATEL MEAS PLASMASP AND IONOS PROPTS, HELD IN FLORENCE ITALY, 5/22-25/78, PP 43(1)-43(8), 1979/12.

486 JOSELYN J, MUNRO R H, HOLZER T E, MASS FLOW AND THE VALIDITY OF IONIZATION EQUILIBRIUM ON THE SUN, SOLAR PHYS, VOL 64, PP 57-69, 1979/11.

577 JOSELYN J A, ADDENDUM. WORKSHOP REPORT ON GEOMAGNETIC DISTURBANCE PREDICTIONS, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL IV, PREDICTION OF TERRESTRIAL EFFECTS OF SOLAR ACTIVITY, PP A115-A117, 1980/03.

504 KANE S R, FROST K J, DONNELLY R F, RELATIONSHIP BETWEEN HARD X-RAY AND EUV SOURCES IN SOLAR FLARES, ASTROPHYS J, VOL 234, PP 669-682, 1979/12.

523 KRALL K R, SMITH J B JR, MCGUIRE J P, ON THE PHYSICS OF A LONG DECAY X-RAY EVENT, SOLAR PHYS, VOL 66, PP 371-391, 1980/06.

492 KROEHL H W, RICHMOND A D, MAGNETIC SUBSTORM CHARACTERISTICS DESCRIBED BY MAGNETIC POTENTIAL MAPS FOR 26-28 MARCH 1976, ASTROPHYS AND SPACE SCI SERIES, D REIDEL PUBLISHING CO, DYNAMICS OF THE MAGNETOSPHERE, S.-I. AKASOFU (EDITOR), PP 269-286, 1979.

565 LUNDIN R, LYONS L R, PISSARENKO N, OBSERVATIONS OF THE RING CURRENT COMPOSITION AT L < 4, GEOPHYS RES LETTERS, VOL 7, NO 6, PP 425-428, 1980/06.

515 LYONS L R, GENERATION OF LARGE-SCALE REGIONS OF AURORAL CURRENTS, ELECTRIC POTENTIALS, AND PRECIPITATION BY THE DIVERGENCE OF THE CONVECTION ELECTRIC FIELD, J GEOPHYS RES, VOL 85, NO A1, PP 17-24, 1980/01.

499 LYONS L R, WILLIAMS D J, A SOURCE FOR THE GEOMAGNETIC STORM MAIN PHASE RING CURRENT, J GEOPHYS RES, VOL 85, NO A2, PP 523-530, 1980/02.

601 MCINTOSH P S, BROWN G M, BUHMANN R, CLARK T, FOUGERE P F, HUNTER H, LINCOLN J V, SARGENT H H III, TIMOTHY J G, LIN Y -Z, WORKING GROUP REPORT ON SOLAR ACTIVITY PREDICTIONS. LONG-TERM SOLAR ACTIVITY, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL 2, WORKING GROUP REPORTS AND REVIEWS, PP 246-257, 1979/12.

494 MOORE T E, EVANS D S, DISTRIBUTION OF ENERGETIC POSITIVE ION SPECIES ABOVE A DIFFUSE MIDNIGHT AURORA, J GEOPHYS RES, VOL 84, NO A11, PP 6443-6450, 1979/11.

564 NEIDIG D F, WIBORG P H, SEAGRAVES P H, HIRMAN J W, FLOWERS W E, MULTIVARIATE DISCRIMINANT ANALYSIS APPLIED TO SOLAR FLARE FORECASTING, SIXTH CONFERENCE ON PROBABILITY AND STATISTICS IN ATMOSPHERIC SCIENCES, 4.3, PP 80-82, 1979/10.

412 PEREZ-DE-TEJADA H, OROZCO A, DRYER M, VISCOUS BOUNDARY LAYER BETWEEN THE SOLAR WIND AND COMETARY PLASMAS, ASTROPHYS SPACE SCI, VOL 68, PP 233-243, 1980/03.

398 RICHMOND A D, IONOSPHERIC WIND DYNAMO THEORY. A REVIEW, J GEOMAGN GEOELECTR, VOL 31, PP 287-310, 1979/11.

572 RICHMOND A D, BLANC M, EMERY B A, WAND R H, FEJER B G, WOODMAN R F, GANGULY S, AMAYENC P, BEHNKE R A, CALDERON C, EVANS J V, AN EMPIRICAL MODEL OF QUIET-DAY IONOSPHERIC ELECTRIC FIELDS AT MIDDLE AND LOW LATITUDES, J GEOPHYS RES, VOL 85, NO A9, PP 4658-4664, 1980/09.

552 ROSENAU P, PROPAGATION OF TWO-FLUID INTERPLANETARY SHOCK WAVES, J GEOPHYS RES, VOL 84, NO A10, PP 5897-5906, 1979/10.

496 RUST D M, HILDNER E, DRYER M, HANSEN R T, MCCLYMONT A N, LAWLOR S M, MCLEAN D J, SCHMAHL E J, STEINOLFSON R S, TANDBERG-HANSSEN E, TOUSEY R, WEBB D F, WU S T, MASS EJECTIONS, SOLAR FLARES, A MONOGRAPH FROM SKYLAB SOLAR WORKSHOP II, PP 273-339, 1980/01.

542 SARGENT H H III, VERY LARGE GEOMAGNETIC DISTURBANCES DURING SUNSPOT CYCLE 21 - A PREDICTION, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL II, WORKING GROUP REPORTS AND REVIEWS, PP 193-197, 1979/12.

551 SAUER H H, ON SATURNIAN COSMIC RAY CUTOFF RIGIDITIES, GEOPHYS RES LETTERS, VOL 7, NO 3, PP 215-217, 1980/03.

559 SETHIA G, CHANDRA H, DESHPANDE M R, RASTOGI R G, MURTHY B S, DAVIES K, TOTAL ELECTRON CONTENT FROM ATS-6 GROUP DELAY MEASUREMENTS AT OOTACAMUND, INDIA, PROC OF THE SYMP OF THE COSPAR SATEL BEACON GROUP ON BEACON SATEL MEAS OF PLASMAS AND IONOS PROPTS, PP 14(1)-14(7), 1979/12.

533 SINGER H J, RUSSELL C T, KIVELSON M G, FRITZ T A, LENNARTSSON W, THE SPATIAL EXTENT AND STRUCTURE OF PC 3, 4, 5 PULSATIONS NEAR THE MAGNETOSPHERIC EQUATOR, GEOPHYS RES LETTERS, VOL 6, NO 11, PP 889-892, 1979/11.

491 SPJELDVIK W N, LYONS L, ON THE PREDICTABILITY OF RADIATION BELT ELECTRON PRECIPITATION INTO THE EARTH'S ATMOSPHERE FOLLOWING MAGNETIC STORMS, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL IV, PREDICTION OF TERRESTRIAL EFFECTS OF SOLAR ACTIVITY, PP B59-B73, 1980/03.

575 STEINOLFSON R S, DYNAMIC MODELING OF CORONAL TRANSIENTS AND INTERPLANETARY DISTURBANCES, UNIV OF ALABAMA IN HUNTSVILLE TECH CONTRACT RPT, UAH RESEARCH REPORT NO 235, CONTRACT NOAA/04-78-B01-6, 1980/01.

507 SU S Y, KONRADI A, FRITZ T A, ON ENERGY-DEPENDENT MODULATION OF THE ULF ION FLUX OSCILLATIONS OBSERVED AT SMALL PITCH ANGLES, J GEOPHYS RES, VOL 84, NO A11, PP 6510-6516, 1979/11.

468 SU S Y, MCPHERRON R L, KONRADI A, FRITZ T A, OBSERVATIONS OF ULF OSCILLATIONS IN THE ION FLUXES AT SMALL PITCH ANGLES WITH ATS-6., J GEOPHYS RES, VOL 85, NO A2, PP 515-522, 1980/02.

476 SUESS S T, LARGE SCALE STRUCTURE OF THE SOLAR WIND, IAU COMM 49 TIANNUAL RPT ASTRON, JAN 1976-DEC 1978, VOL XVII-PART 1, PP 204-213, 1979/12.

510 SUESS S T, STEINOLFSON R S, THE DEPENDENCE OF CORONAL HOLE SIZE ON LARGE SCALE MAGNETIC FIELD STRENGTH, PROC SYMP ON STUDY OF SOLAR CYCLE FROM SPACE, NASA CONFERENCE PUBLICATION 2098, PP 209-217, 1980/02.

490 TEUBER D L, REICHMAN E J, WILSON R M, SMITH J B, A PREDICTION METHOD FOR THE SOFT X-RAY FLUX OF SOLAR FLARES, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL III, SOLAR ACTIVITY PREDICTIONS, PP C173-C188, 1980/03.

571 WATANABE T, SOLAR-TERRESTRIAL PREDICTIONS USING IPS TECHNIQUE, SOLAR-TERRESTRIAL PREDICTIONS PROCEEDINGS (R F DONNELLY, ED), VOL III, SOLAR ACTIVITY PREDICTIONS, PP B(38)-B(47), 1979/12.

508 WATANABE T, AN ESTIMATION OF THE DISTANCES OF HIGH VELOCITY HI CLOUDS AND THE MEGELLANIC STREAM, BULL, AMER ASTRON SOC, VOL 11, NO 2, PG 416, 1980/07.

519 WILKEN B, KORTH A, KREMSER G, FRITZ T A, MULTIPLE-SATELLITE OBSERVATIONS OF LARGE SCALE TRAPPING BOUNDARY MOTIONS, PROC OF CHAPMAN CONF, ALPBACH, AUSTRIA, JUNE 11-15, 1979, ESA SP-148, PP 161-163, 1979/08.

531 WILLIAMS D J, OPEN--A STUDY OF THE ORIGINS OF PLASMA IN EARTH'S NEIGHBORHOOD, AMERICAN ASTRONAUTICAL SOCIETY PROC, SPACE SHUTTLE: DAWN OF AN ERA, VOL 41, ADVANCES IN THE ASTRONAUTICAL SCIENCES, PP 605-621, 1980/01.

550 WILLIAMS D J, MAGNETOPAUSE CHARACTERISTICS AT 0840-1040 HOURS LOCAL TIME, J GEOPHYS RES, VOL 85, NO A7, PP 3387-3395, 1980/07.

481 WILLIAMS D J, RING CURRENT COMPOSITION AND SOURCES, ASTROPHYS AND SPACE SCI LIB SERIES, D REIDEL PUBLISHING CO, DYNAMICS OF THE MAGNETOSPHERE, S.-I. AKASOFU (EDITOR), PP 407-424, 1979.

532 WILLIAMS D J, FRANK L A, ISEE 1 CHARGED PARTICLE OBSERVATIONS INDICATIVE OF OPEN MAGNETOSPHERIC FIELD LINES NEAR THE SUBSOLAR REGION, J GEOPHYS RES, VOL 85, NO A5, PP 2037-2042, 1980/05.

503 WILLIAMS D J, FRITZ T A, WILKEN B, KEPPLER E, AN ENERGETIC PARTICLE PERSPECTIVE OF THE MAGNETOPAUSE, J GEOPHYS RES, VOL 84, NO A11, PP 6385-6396, 1979/11.

522 WRIGHT J W, PAUL A K, TOWARD GLOBAL MONITORING OF THE IONOSPHERE IN REAL TIME BY A BOTTOMSIDE SOUNDING NETWORK: THE GEOPHYSICAL REQUIREMENTS AND THE TECHNOLOGICAL OPPORTUNITY, AGARD CONFERENCE PROCEEDINGS (CONF ON SPECIAL TOPICS IN HF PROPAGATION, LISBON, PORTUGAL, 28 MAY-1 JUNE 1979), NO 263, PP 10(1)-10(21), 1979/11.

444 WRIGHT J W, PAUL A K, PITTEWAY M L V, ON THE ACCURACY AND INTERPRETATION OF DYNASONDE VIRTUAL HEIGHT MEASUREMENTS, RADIO SCIENCE, VOL 15, NO 3, PP 617-626, 1980/06.

443 WRIGHT J W, PITTEWAY M L V, REAL-TIME DATA ACQUISITION AND INTERPRETATION CAPABILITIES OF THE DYNASONDE 2. DETERMINATION OF MAGNETOIONIC MODE AND ECHOLOCATION USING A SMALL SPACED RECEIVING ARRAY, RADIO SCIENCE, VOL 14, NO 5, PP 827-835, 1979/10.

445 WRIGHT J W, PITTEWAY M L V, REAL-TIME DATA ACQUISITION AND INTERPRETATION CAPABILITIES OF THE DYNASONDE 1. DATA ACQUISITION AND REAL-TIME DISPLAY, RADIO SCIENCE, VOL 14, NO 5, PP 815-825, 1979/10.

620 VAN HOVEN G, ANZER U, BARBOSA D D, BIRN J, CHENG C -C, HANSEN R T, JACKSON B V, MARTIN S F, MCINTOSH P S, NAKAGAWA Y, PRIEST E R, REEVES E M, REICHMANN E J, SCHMAHL E J, SMITH J B, SOLODYNA C V, THOMAS R J, UCHIDA Y, WALKER A B C, THE PREFLARE STATE, SOLAR FLARES, A MONOGRAPH FROM SKYLAB WORKSHOP II, (P A STURROCK, ED), COLORADO ASSOCIATED UNIVERSITY PRESS, CHAPTER 2, PP 17-81, FEBRUARY 1980.

PUBLICATIONS IN PROCESS

591 ANDERSON D N, BOUWER S D, A STUDY OF THE SEASONAL VARIATION IN TOTAL ELECTRON CONTENT AND PEAK ELECTRON DENSITY IN THE INDIAN SECTOR, PROC OF THE COSPAR/URSI SYMP.

597 BAKER D N, FRITZ T A, WILKEN B, HIGBIE P R, KAYE S M, KIVELSON M G, MOORE T E, STUDEMANN W, MASLEY A J, SMITH P H, VAMPOLA A L, OBSERVATION AND MODELING OF ENERGETIC PARTICLES AT SYNCHRONOUS ORBIT, J GEOPHYS RES.

393 CESSNA J R, OPTIMUM FILTERING FOR TIME ESTIMATION AT THE LOW ENERGY LIMIT, IEEE TRANSACTIONS ON NUCLEAR SCIENCE.

568 CUPERMAN S, METZLER N, DRYER M, ON THE MODELING OF THE THREE-FLUID STRUCTURE OF THE QUIET SOLAR WIND, ASTROPHYS J.

567 CUPERMAN S, ROTH I, ON THE PARAMETRIC DEPENDENCES OF THE BEAM-PLASMA-DISCHARGE AT LOW PRESSURES AND MAGNETIC FIELD STRENGTHS, GEOPHYS RES LETTERS.

570 DAVIES K, HERON M L, THE HEIGHT OF ELECTRON CONTENT CHANGES IN THE IONOSPHERE FROM ATS 6 BEACON DATA, J ATMOSPHERIC TERREST PHYS.

583 DAVIES K, PAUL M P, MEASUREMENTS OF PLASMASPHERIC COLUMNAR ELECTRON CONTENT FROM ATS6 AT BOULDER, CO AND LORMAN, MS FROM DECEMBER 1976 TO MAY, 1978, POLISH ACADEMY OF SCIENCES.

475 DRYER M, SOLAR-GENERATED DISTURBANCES AND THEIR PROPAGATION THROUGH THE INTERPLANETARY MEDIUM, PROC OF SOLAR WIND FOUR SYMP.

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594 DRYER M, WU S T, HAN S M, TWO-DIMENSIONAL, TIME-DEPENDENT MHD SIMULATION OF THE DISTURBED SOLAR WIND DUE TO REPRESENTATIVE FLARE-GENERATED AND CORONAL HOLE-GENERATED DISTURBANCES, GEOFISICA INTERNATIONAL.

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603 FRITZ T A, WILLIAMS D J, PASCHMANN G, RUSSELL C T, SPJELDVIK W N, THE THICKNESS OF THE MAGNETOPAUSE CURRENT AND BOUNDARY LAYERS ON NOVEMBER 20, 1977, J GEOPHYS RES.

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489 HECKMAN G R, VERIFICATION OF SOLAR FLARE FORECASTS AT THE SPACE ENVIRONMENT SERVICES CENTER FOR THE YEARS 1969-1974, SEL TECH REPORT.

610 HERNANDEZ G, ROBLE R G, EVANS D S, ALLEN J H, ASYMMETRICS IN THE THERMOSPHERIC RESPONSE TO GEOMAGNETIC DISTURBANCES OBSERVED OVER FRITZ PEAK, COLORADO, EOS.

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602 JOSELYN J A, BRYSON J JR, MAGALERT: AUGUST 27, 1978, SOLAR AND INTERPLANETARY DYNAMICS, PROC OF IAU SYMP NO 91, 27-31 AUG 1979 (M DRYER, E TANDBERG-HANSSEN, EDS).

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582 STEINOLFSON R S, WU S T, DRYER M, TANDBERG-HANSSEN E, MAGNETOHYDRODYNAMIC MODELS OF CORONAL TRANSIENTS IN THE MERIDIONAL PLANE. III. EMERGING MAGNETIC FLUX, ASTROPHYS J.

482 STEINOLFSON R S, WU S T, DRYER M, TANDBERG-HANSSEN E, EFFECT OF EMERGING MAGNETIC FLUX ON THE SOLAR CORONA, PROC SOLAR WIND FOUR SYMPOS SERIES LECTURE IN PHYSICS.

506 SU S Y, KONRADI A, FRITZ T A, PRESERVED SIGNATURES OF ION FLUX MODULATIONS OBSERVED BY ATS6, J GEOPHYS RES.

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433 TANDBERG-HANSSEN E, SHEELEY N R JR, SMITH J B JR, SKYLAB X-RAY AND XUV OBSERVATIONS OF A SMALL SOLAR FLARE, SOLAR PHYS.

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528 WILLIAMS D J, THE OPEN PROGRAM. AN EXAMPLE OF THE SCIENTIFIC RATIONALE FOR FUTURE SOLAR-TERRESTRIAL RESEARCH PROGRAMS, PROC INTERNATIONAL ASTRONOMICAL UNION (IAU) SYMPOSIUM 91.

441 WILLIAMS J A. DONNELLY R F, X-RAY OBSERVATIONS OF THE SEPTEMBER/NOVEMBER 1977 SOLAR EVENTS, UAG REPORT OF WORLD DATA CENTER FOR SOLAR TERRESTRIAL PHYSICS.

613 WRIGHT J W, PITTEWAY M L V, DATA PROCESSING FOR THE DYNASONDE: THE DIPPLIONOGRAM, RADIO SCIENCE.

588 WU S T, STEINOLFSON R S, DRYER M, TANDBERG-HANSSEN E, MAGNETOHYDRODYNAMIC MODELS OF CORONAL TRANSIENTS IN THE MERIDIONAL PLANE. IV. EFFECT OF SOLAR WIND, ASTROPHYS J.

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578 YEH T, DRYER M, AN ACCELERATION MECHANISM FOR LOOP TRANSIENTS IN THE OUTER CORONA, SOLAR PHYS.

605 YEH TYAN, SELF-INDUCED MAGNETIC FORCE OF A TOROIDAL CURRENT, J PLASMA PHYS.

SEL TALKS

Arthur, Carlene W., "Multiple Satellite Observation of a Long Duration Pc4 Pulsation at Synchronous Orbit." IUGG XVII General Assembly, Canberra, Australia, December 8, 1979.

Donnelly, Richard F., "Solar Radiation From the Viewpoint of Its Atmospheric Effects." Meteorology of the Upper Atmosphere, University of Colorado, Boulder, Colorado, February 25, 1980.

Dryer, Murray, "Theoretical MHD Simulations of Interplanetary Observations." SCOSTEP/STIP Symposium on Solar Radio Astronomy, Interplanetary Scintillations, and Coordination with Spacecraft, Narrabri, N.S.W., Australia, November 28-30, 1979.

Dryer, Murray, "Magnetohydrodynamic Modeling of Transient Phenomena in the Corona and Interplanetary Medium." Physical Research Laboratory, Ahmedabad, India, December 13, 1979.

Dryer, Murray, "Theoretical Aspects of Solar-Terrestrial Physics." Department of Physics, Gujarat University, Ahmedabad, India, December 13, 1979.

Dryer, Murray, "Time-Dependent Phenomena in the Solar Wind: Recent Progress." Department of Physics and Astronomy, Tel-Aviv University, Ramat-Aviv, Israel, December 19, 1979.

Dryer, Murray, "Transients Near and Far From the Sun." Solar Maximum Year Workshop, Crimea, USSR, March 18-21, 1980.

Dryer, Murray, "A Transient MHD Model Applicable for the Source of Solar Cosmic Ray Acceleration." Symposium on Cosmic Rays in the Heliosphere, Budapest, Hungary, June 2-4, 1980.

Heckman, Gary R., "Space Environment Services Center." NOAA R & D Seminar, NOAA Headquarters, Rockville, Maryland, October 26, 1979.

Heckman, Gary R., "Solar Activity and Its Terrestrial Effects." American Meteorological Society, Pikes Peak Chapter, Colorado Springs, Colorado, January 24, 1980.

Heckman, Gary R., "Solar Activity and Its Effects on Commercial Aircraft Operation." Meteorology Committee of the Air Transport Association, Boulder, Colorado, September 16, 1980.

Joselyn, J. C., "SELDADS: An Operational Real-Time Solar-Terrestrial Environment Monitoring System." International Union of Geodesy and Geology, Canberra, Australia, December 4, 1979.

Joselyn, J. C., "Solar Weather - Why do we care?" Monthly Luncheon Meeting of the Retired Boulder Valley Teachers, Boulder, Colorado, April 14, 1980.

Joselyn, J. C., "Solar Weather - Why do we care?" Denver Astronomical Society - September Meeting, Denver University, Denver, Colorado, September 27, 1980.

Suess, Steven T., "Magnetic Merging and Magnetospheric Equilibrium Configurations at Mercury." American Geophysical Union Fall Meeting, San Francisco, California, December 1979.

Suess, Steven T., "The Corona and the Large Scale Magnetic Field of the Sun." 14th ESLAB Symposium on "Physics of Solar Variations," Scheveningen, The Netherlands, September 18, 1980.

Suess, Steven T., "Polar Coronal Plumes." Institute für Astronomie, of the Eidgenossische Technische Hochschule of Zurich, Zurich, Switzerland, September 23, 1980.

Tamao, Tsutomu, "Interaction Between the Ionosphere and Magnetosphere Through Adiabatic Processes Along Field Lines." Scientific Talk, Department of Physics, University of Denver, Denver, Colorado, September 24, 1980.

Williams, D. J., "OPEN--A Study of the Origins of Plasma in the Earth's Neighborhood." American Astronautical Society Annual Meeting "Space Shuttle: Dawn of an Era," Los Angeles, California, October 30, 1979.

Williams, D. J., "Solar-Terrestrial Research Plans in the 1980's." Symposium at University of Auckland, Auckland, New Zealand, November 20, 1979.

Williams, D. J., "Voyager-Jupiter Results." Symposium at University of Auckland, Auckland, New Zealand, November 21, 1979.

Williams, D. J., "Field Aligned Particle Asymmetries Indicative of Open Field Lines." First International Symposium on IMS Results, Melbourne, Australia, November 27, 1979.

Williams, D. J., "Remote Sensing of the Magnetosphere." First International Symposium on IMS Results, Melbourne, Australia, November 27, 1979.

Williams, D. J., "Prospects for Solar-Terrestrial Physics in U.S. in the 1980's." XVII IUGG General Assembly, Canberra, Australia, December 5, 1979.

Williams, D. J., "International Sun-Earth Explorer Satellite - Update." Informal Briefing to NASA Headquarters on ISEE, Washington, D.C., June 24, 1980.

Williams, D. J., "ISEE Particle Observations - The Magnetopause and Magnetosphere." The University of Texas at Dallas - Seminar, Richardson, Texas, June 25, 1980.

Williams, D. J., "Origin of Plasmas in the Earth's Neighborhood - Solar Terrestrial Programs in the 1980's." Informal Briefing at NASA Goddard Space Flight Center, Greenbelt, Maryland, July 10, 1980.

Williams, D. J., "Origin of Plasmas in the Earth's Neighborhood - Solar Terrestrial Programs in the 1980's." Informal Briefing at NASA Headquarters, Washington, D.C., August 11, 1980.

Williams, D. J., "ISEE Results: The Magnetopause, Field Line Interconnection, Particle Leakage and Magnetic Storms." University of Maryland Seminars Astrophysics Series, College Park, Maryland, September 15, 1980.

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