# International Heliophysical Year

*A Program of Global Research Continuing the Tradition of Previous International Years*

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Overview

In 1957 a program of international research, inspired by the International Polar Years of 1882-83 and 1932-33, was organized as the International Geophysical Year (IGY) to study global phenomena of the Earth and geospace. The IGY involved about 60,000 scientists from 66 nations, working at thousands of stations, from pole to pole to obtain simultaneous, global observations on Earth and in space. There had never been anything like it before. The fiftieth anniversary of the International Geophysical Year will occur in 2007. We propose to organize an international program of scientific collaboration for this time period called the International Heliophysical Year (IHY). Like it predecessors, the IHY will focus on fundamental global questions of Earth science.

**Figure 1 Sputnik I was launched three months after the IGY began. This marked the dawn of the age**

## 1. Introduction

October 4, 1957, three months after the International Geophysical Year (IGY) began, Sputnik was launched. This was the beginning of the space age. Sputnik I and III and Explorer I along with numerous suborbital rocket flights contributed to the tremendous success of the IGY. Space science has made tremendous strides in the last 50 years. We now routinely monitor the Sun, the interplanetary medium, and the atmosphere of Earth from space. The IHY will provide a unique opportunity to coordinate observations from the current impressive fleet of international space missions, with data from solar ground based observatories ground based auroral observatories, neutron monitor observations, magnetic field observatories, ionospheric, meteorological, and other atmospheric observatories. Unprecedented, simultaneous observations with broad coverage of all associated solar, heliospheric, geospace, and atmospheric phenomena will be obtained. The resulting data will allow global studies of the complete Sun-Earth system.

Special intervals of intense observation scheduled during the year will allow coordinated observational campaigns to address time-dependent global scientific problems. In addition special alerts called when the Sun is particularly active will allow multi-disciplinary study of the most interesting heliospheric events using a wide array of instrumentation.

A series of workshops will be held around the world to address the current state of knowledge in these areas, and to report the results of coordinated studies of a few significant events with the intent of developing a new understanding of how the Sun influences the Earth, geospace and the intervening heliosphere. Data from the IHY will be available to scientist of all countries, and the excitement of the scientific results will be communicated to the world public through a series of press releases and public lectures.

We request that the IUGG, SCOSTEP, and COSPAR petition ICSU to form a planning commission representing all of the disciplines to develop the scientific program, coordinate public outreach, and arrange for the publication of results. We propose that a session be convened at the World Space Congress in Houston in 2002 to discuss a program the IHY, with a series of speakers representing all participating disciplines.

# 2. Objectives

The objective of the IHY is to discover the physical mechanisms at work which couple the atmosphere of the Earth to events that drive them from the heliosphere. It has been obvious for some time that events on the Sun can affect geospace, and even the Earth's climate. The systematic global study of this connection is to be the central theme of the IHY. In view of these aims, we propose the following objectives for the IHY.

- To obtain a coordinated set of observations to study at the largest scale the solar-generated events which affect life and climate on Earth
- To document and report the observations and provide a forum for the development of new scientific results utilizing these observations
- To foster international cooperation in the study of Heliophysical phenomena now and in the future
- To communicate the unique scientific results of the IHY to the interested scientific community and to all peoples of Earth

# 3. History

The International Heliophysical Year proposal follows a tradition of international cooperation in scientific research begun in the 19$^{th}$ century with similar scientific objectives and motivations

## *3.1 The First International Polar Year*

The First International Polar Year was the ideas of an Austro-Hungarian Naval lieutenant Carl Weyprecht (de V. Heathcote, Neils H., Annals of the International Geophysical Year, 1, 1959). Weyprecht had just returned from a polar expedition where he commanded one of the research vessels. In January 1875 at the Academy of Sciences in

Vienna, Weyprecht expressed his ideas to establish an international collaboration to obtain a set of simultaneous observations, extending over a considerable time period, at various locations around the Arctic. The concept was presented again in September 1875 at the 4th Meeting of the Association of German Naturalists and Physicists at Gratz. In 1877 a detailed program was prepared and submitted to the International Meteorological Congress. In 1879 the International Meteorological Congress met in Rome and recognized the importance of the proposal.

**Figure 2 Lieutenant Karl Weyprecht first proposed the International Polar Year in 1875 after returning from an Arctic expedition.**

On October 1-5, 1879 the 1st International Polar Conference (IPC) met at Hamburg. It was determined that a minimum of eight arctic stations was needed, to obtain observations of at least one-year duration. The Conference also established the IPC with representatives from Austria, Hungary, Denmark, France, Germany, The Netherlands, Norway, Russia, and Sweden. Dr. G Neumayer of Hamburg was the first Commission president. In July 1880 the 2nd IPC met at Berne. There an Italian representative joined the existing representatives, and Prof. H. Wild became second president. On August 1, 1881 the 3rd IPC met at St Petersburg. The United States joined the group, and a program of observations was adopted. The First International Polar year began Aug 1, 1882 and continued for 13 months to Sep 1, 1883. Scientific results and observational data were published in the Bulletin of the International Polar Commission. In 1884 and 1891 the 4th and 5th Polar Conferences were convened. Weyprecht did not live to see the culmination of his grand concept. He died on March 29, 1881.

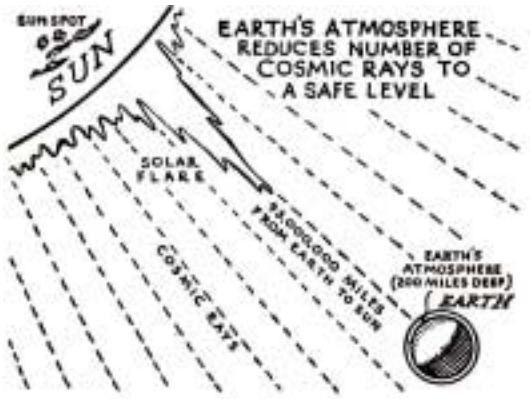


**Figure 3 During the IGY it was known that events on the Sun influence the Earth, but the exact mechamism was unknown. The discovery of the solar wind was a big step.**

### *3.2 Second International Polar Year*

In 1927 Dr. J Georgi at Deutsche Seewarte in Hamburg suggested that a Second International Polar Year be conducted on the fiftieth anniversary of the first (Laursen, V., Annals of the International Geophysical Year, 1, 1959, 211). A proposal was submitted to the International Meteorological Committee, and then forwarded to Reseau Mondial and Polar Meteorology. In June 1928 an informal organizational meeting was held in London to discuss plans for the event. Finally, in 1929 the Meteorological Conference of Directors in Copenhagen endorsed the plan for the cooperative study of magnetic, auroral and meteorological phenomena. Also in 1929

the International Cloud Commission passed a resolution for an international year for clouds coinciding with the Polar Year. The Commission for the Polar Year 1932-1933 was appointed to prepare detailed plans for the observations to be made and the methods for making them. A collaboration was established between the Commission for the Polar Year and the International Union of Geodesy and Geophysics. In August 1930 the first meeting of the Commission for the Polar Year took place in Leningrad, to further refine proposals for the Polar Year. In Dec 1930 at a meeting in London the Commission prepared a detailed a report containing proposals, for research programs in meteorology, terrestrial magnetism, atmospheric electricity, aurora, and aerology. At a subsequent meeting in Sep 1931 the Commission for the Polar Year, despite being urged to delay due to poor economic conditions worldwide, decided to go ahead the Polar Year program. On 1 Aug 1932 the Second International Polar Year began. It continued until 1 Sep 1933.

The Commission introduced the concept of "International Days". The scientific objective was to study phenomena on the largest possible scale with simultaneous observations, same as previous polar year. The most significant new development that affected how the program was conducted was the advent of radio communication.

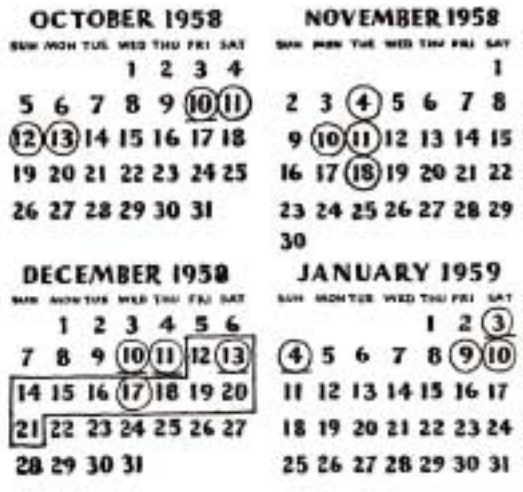


**Figure 4 During the IGY calendars were marked to indicate World Days (circles) and World Meteorological Intervals (box) where more intensive observational campaigns were carried out.**

### *3.3 International Geophysical Year*

In 1950, a proposal for the International Geophysical Year, 25 years after the Second Polar Year, was brought before the Mixed Commission on the Ionosphere, which endorsed it. The Mixed Commission on the Ionosphere was formed by the International Council of Scientific Unions (ICSU) under the sponsorship of the International Union for Scientific Radio (URSI) with the cooperation of the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (IUGG). The IUGG drew up a tentative program, and adopted a resolution to transmit it to the International Council of Scientific Unions (ICSU), which sponsored the event. All bodies endorsed the proposal by 1951.

World Days (typically 3 days per month) were planned as part of the IGY. During these periods special programs of research focused on short-timescale events or special events (e.g. during the times of meteor showers) were carried out.

During times when the Sun was especially active on a day not designated as a World Day, alerts were issued. These could be followed by the declaration of Special World Intervals that followed alerts. These could be called with 8 hr notice. Rocket and balloon launches might take place, and other programs of study might be intensified. World Meteorological Intervals consisted of 10 consecutive days, four times a year, usually near the beginning of seasons for intensive study, rocket campaigns, etc. Data were collected at three centers (US, Europe, and Soviet Union) and made available to all nations.

The IGY was a tremendous success. The newly developed space-flight capability was used to discover and explore Earth's radiation belts, to study the magnetosphere, and to provide the first observations of the emission from the Sun's corona. Public interest in the scientific results of the IGY was high. The IGY provided a forum and a backdrop for discussing the importance of geospace influences on Earth.

## 4. The Case for the IHY

The International Heliophysical Year follows in this tradition. Like the IGY, and the two previous International Polar Years, the scientific objective of the IHY is to study phenomena on the largest possible scale with simultaneous observations from a broad array of instruments. However, unlike previous International Years, today observations are routinely received from a vast armada of sophisticated instruments in space that continuously monitor solar activity, the interplanetary medium, and the Earth (Table 1). These spacecraft together provide an extraordinary view of the Sun and heliosphere, and of the near-Earth environment, and a unique opportunity to study the coupled Sun-Earth system.

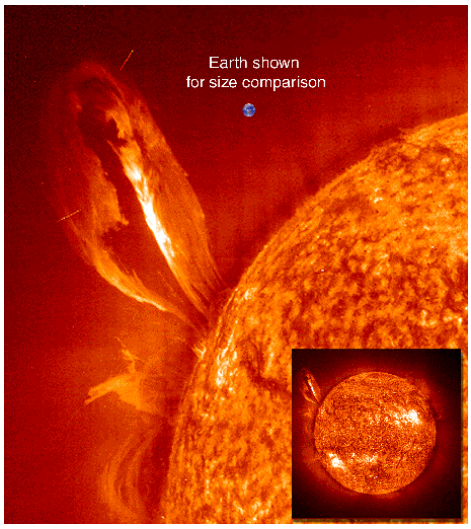


**Figure 5 Image of the Sun in the 304 A emission line of He II from the Extreme-ultraviolet Imaging Telescope (EIT) showing an eruptive prominence.**

Recent international efforts to consider the Sun-Earth relationship have made significant progress. STEP (Solar Terrestrial Energy Program) and ISCS (International Solar Cycle Studies), have made significant advances in communicating the value of multi-disciplinary science and have provided a forum for individuals to discuss the relevant scientific interfaces.

With the advent of the SOHO mission, solar and heliospheric physics mission planning has reached a state of maturity where multi-spacecraft/ground-based observatory Joint Observing Programs (JOPs) have provided very significant advances in solar research. JOPs provide the mechanism for planning and executing multi-instrument schemes within the ISTP project.

**Table 1 A partial list of space missions that could provide data relevant for the IHY. This list is incomplete, and represents only those missions readily known to the author(s). Part of the planning effort will be to complete and refine this list, and to arrange for collaborative observations as required.**

| Mission | Sponsoring Agency | Launch Date | Remarks |
|---|---|---|---|
| Solar and Heliospheric Observatory (SOHO) | ESA/NASA | 1995 | Full time solar observations from L1 |
| Cluster | ESA | 2000 | Multipoint measurements of magnetospheric phenomena from 4 spacecraft formation |
| Solar Orbiter | ESA | 2010 | Imaging and spectral observations close to the Sun and out of the ecliptic |
| Solar Terrestrial Relationships Observatory (STEREO) | NASA | 2004 | Stereo view of solar events from two identical spacecraft in heliocentric orbit |
| High Energy Solar Spectroscopic Imager(HESSI) | NASA | 2001 | Imaged spectra of flare emission from the Sun |
| Advanced Composition Explorer (ACE) | NASA | 1997 | Particle distribution functions and composition, and magnetic field from L1 |
| IMAGE | NASA | 2000 | Global imaging of Earth's magnetosphere |
| WIND | NASA/ESA | 1994 | Measurement of particle and fields in the IPM from L1 |
| Solar Dynamics Observatory | NASA | 2006 | Active region formation from subsurface to corona, and irradiance measurements |
| Pioneer | NASA | | Heliopause and outer heliosphere |
| Voyager 1 and 2 | NASA | | Heliopause and outer heliosphere |
| Solar-B | ISAS | 2005 | High resolution magnetograms of the Sun, coronal imaging and spectra |
| Triana | NASA | 200x | Global Earth monitoring, and particle and magnetic field |

Similar mechanism would be required for the IHY. In the past, multi-spacecraft observations made use primarily of complementary spacecraft configurations, whereas the modern JOP activities make use of dedicated multi-instrument programming. This kind of activity has reached a level of some maturity and can be extended for the IHY. The IHY will now provide the practical tools for exploiting these efforts by establishing the necessary global, coordinated measurements.

The very recent explosion of interest in 'Space Weather' has excited the media and the general public, as well as many industrial colleagues, but it has also highlighted the fact that we know relatively little about the true Sun-Earth relationship. Thus, the IHY provides a method for satisfying the growing demands in this area.

# 5. Proposed Near-term IHY Planning Activities

The precise nature of the activities of the IHY will be decided through wide consultation with the scientific community. It is envisaged that the course of events will be as follows:

**Figure 6 Solar events are responsible for aurora and other terrestrial phenomena.**

### *5.1 Activities in 2001*

A selection of individuals (12-15 people) representing a wide group of countries and disciplines has been invited by the proposers to serve on an *Ad hoc* IHY Preliminary Organizing Committee (POC). The POC will encourage IUGG, SCOSTEP and COSPAR to petition ICSU for a resolution declaring the year 2007 as the beginning of the IHY, and to establish a Multi-disciplinary Planning Commission for the IHY. In addition the POC will seek the endorsement and participation of the space agencies of the world ESA, NASA, ISRO and ISAS.

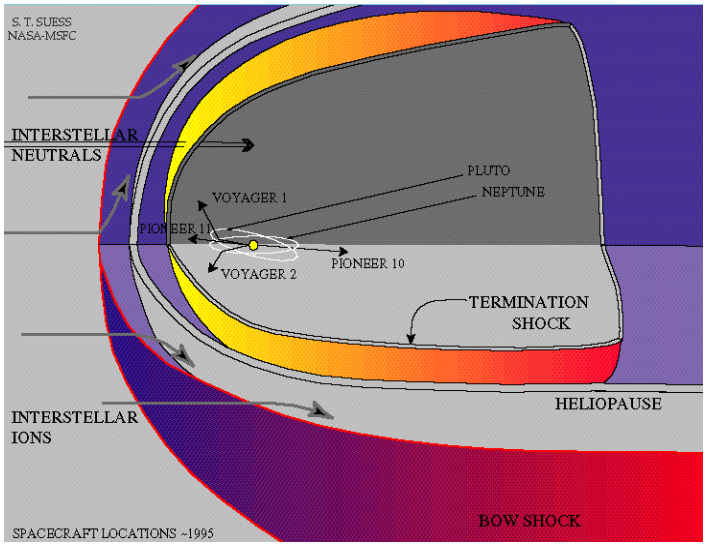


**Figure 7 The global structure of the heliosphere is determined by a balance between the outward expansion of the solar wind, motion of the solar system through the Galaxy, and the inward pressure of the interstellar medium.**

The POC will arrange for a special session at the World Space Congress in Houston in October 2002 to discuss planning for the IHY. The aims of this session are discussed in the paragraph below. A Web site will be set up and the ideas of the IHY widely advertised.

### *5.2 Activities in 2002*

The World Space Congress session at Houston will be used as a forum for open discussion on the nature of the IHY. It will be used to form the basic IHY working plan.

The IHY Planning Commision will meet after the World Space Congress session to continue to develop the working plan. Topical leaders will be defined and work will begin in coordinating observations for the IHY, in defining special observational periods for the IHY, in arranging workshops for the period leading up to, during and after the IHY. Publications and data storage/distribution issues will be discussed. A complete working plan will be developed.

## 6. A Final Word

The 50th anniversary of the International Geophysical Year is a tremendous opportunity to advance our understanding of the Sun-Earth system, and to demonstrate the beauty, relevance, and significance of Earth science to the peoples of the World.

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