# 2007: International Heliophysical Year

**The International Heliophysical Year is an international programme of global research to understand the external drivers of the space environment and climate, continuing the tradition of previous International Years. It is introduced here by Richard Harrison, Andy Breen, Barbara Bromage and Joe Davila.**

The International Heliophysical Year (IHY) follows a tradition of international cooperation in scientific research begun in the 19th century with similar scientific objectives and motivations. After the first International Polar Year (IPY) from 1882–1883, focusing on Arctic research, the second in 1932–33 grew to include atmospheric science and geophysics; then came the International Geophysical Year (IGY) in 1957–1958 (see "International Years and World Days", page 3.28). The impact of IGY and the polar years has been significant, in particular providing us with a heritage for data storage and access, and facilities that still exist today. This includes the formation and running of the World Data Centres, and the birth of COSPAR, to name but two. The scientific influence – through collaboration, data and facility access, and coordination – cannot be measured but is certainly huge.


## Abstract

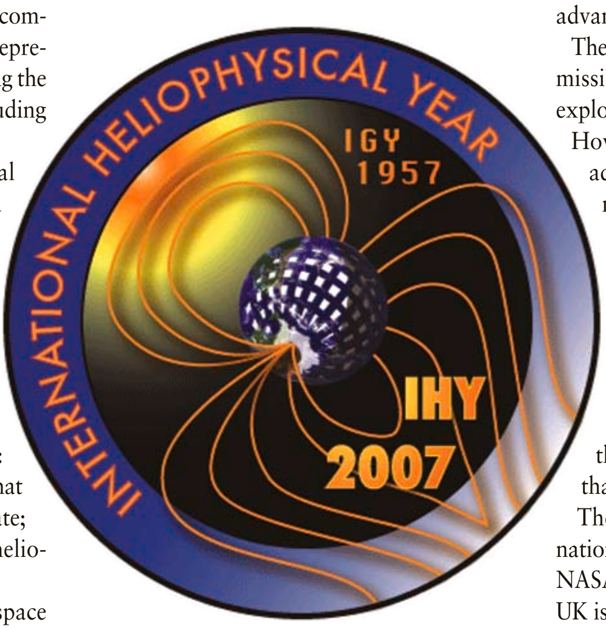
In 1957 a programme of international research was organized as the International Geophysical Year (IGY) to study global phenomena of the Earth and geospace. This programme was a follow-on to the International Polar Years in 1882–83 and 1932–33. The IGY involved about 60 000 scientists from 66 nations, working at thousands of stations, from pole to pole. There had never been anything like it before. The 50th anniversary of IGY will occur in 2007. Plans are well under way to organize an international programme of scientific collaboration for this time period to focus not just on the Earth but extending our horizons to the heliosphere, including the Sun, and thus including the drivers of geophysical processes, and making use of the fleet of spacecraft and numerous ground-based systems in place. This programme is called the International Heliophysical Year.


## IHY concept and objectives

It is for these reasons that an International Heliophysical Year was suggested in 2001. It is not simply a celebration of the 50th anniversary of IGY; those involved are determined that it should be of practical benefit both to the research community and to the public. In a sense, IHY represents a logical next-step from IGY, extending the studies into the heliosphere and thus including the drivers of geophysical change.

IHY should be seen as an international effort to coordinate operations and data access of the fleet of solar, heliospheric and near-Earth spacecraft and ground-based facilities, as well as research programmes – especially for specific observational and research campaigns. In this way it is enhancing the investments we have already made rather than providing new hardware. The basic objectives of IHY are:

- To understand the processes and drivers that affect the terrestrial environment and climate;
- To provide a global study of the Sun–heliosphere system outward to the heliopause;
- To foster international cooperation in space science now and in the future;
- To communicate the unique scientific results of the IHY to the scientific community and to the public.




One has to consider why an IHY should be run now – what are the programmatic drivers for a campaign in 2007? First, we have a large armada of existing or planned spacecraft, which are or will be in place to provide the most comprehensive global measurements of the Sun–Earth–interplanetary system yet obtained. In 2007 these missions could include SOHO, Solar-B, STEREO, TRACE, RHESSI, Cluster, ACE, IMAGE and possibly Ulysses and Polar. Such a group of missions is not likely to be available again in our lifetimes. In addition, we have a wide array of Earth-based observatories, such as EISCAT, ionosondes, solar H-α and radio observatories, as well as global magnetic monitoring, to name but a few activities. International collaboration is easier today than in previous international years, with abundant and cheap electronic communication and data access. Also, the programmes mentioned come from various countries and organizations and it is clear that some level of basic coordination would be advantageous. The time is ripe for IHY.

The plan is not for IHY to create and fund new missions and facilities, but to enhance the exploitation and coordination of what we have. However, in parallel with this, given the advances in computer capabilities, the arguments for observational and data access coordination apply equally well to the coordination of modelling activities, and this should also be an integral part of IHY. The availability of a spacecraft fleet and modern computer facilities means that we are dramatically updating and exploiting the IGY concept, yet keeping the spirit of collaboration and cooperation that drove previous international years.

The IHY is being coordinated by an international committee, chaired by Joe Davila of the NASA Goddard Space Flight Center, USA. The UK is represented on the committee by Richard

## International Years and World Days

The first International Polar Year (IPY) was the idea of an Austro-Hungarian naval lieutenant, Carl Weyprecht (Heathcote and Neils 1959). Weyprecht (figure 1) had just returned from a polar expedition for which he had 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. Over the following years the concept was discussed, a detailed programme prepared and in October 1879 the 1st International Polar Conference (IPC) met at Hamburg. It was determined that a minimum of eight Arctic stations were needed, to obtain observations of at least one year duration. The Conference also established the International Polar Commission with representatives from Austria, Hungary, Denmark, France, Germany, the Netherlands, Norway, Russia and Sweden. In later years Italian and US representatives joined the group.

The first IPY began on 1 August 1882 and continued for 13 months to 1 September 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 29 March 1881.

In 1927 Dr J Georgi at Deutsche Seewarte in Hamburg suggested that a second IPY be conducted on the 50th anniversary of the first (Laursen 1959). 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

1: In January 1875 Carl Weyprecht suggested a coordinated study of the north polar region.

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. In December 1930, at a meeting in London, the Commission prepared a detailed report containing proposals for areas such as meteorology, terrestrial magnetism, atmospheric electricity, aurora and aerology. At a subsequent meeting in September 1931 the Commission for the Polar Year, despite being urged to delay due to poor economic conditions worldwide, decided to go ahead on time. On 1 August 1932 the second IPY began and continued until 1 September 1933.

The Commission introduced the concept of "International Days", which persists to the present day. The scientific objective was to study phenomena on the largest possible scale with simultaneous observations on selected days. The most significant new development that affected how the programme was conducted was the advent of radio communication.

In 1950 a proposal for the International Geophysical Year (IGY), 25 years after the second IPY, was brought before the Mixed Commission on the Ionosphere, which duly 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 of Radio Science (URSI) with the cooperation of the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (IUGG). All bodies endorsed the proposal by 1951.

World Days (typically three days per month) were selected to take place during the IGY, during which special programmes were to be carried out, for example during the times of meteor showers. During times when the Sun was especially active on a day not designated as a World Day, alerts were to be issued. These could be followed by the declaration of Special World Intervals which followed alerts – these could be called with eight hours' notice. Rocket and balloon launches might take place and other programmes 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 centres (USA, Europe and the Soviet Union) and made available to all nations.

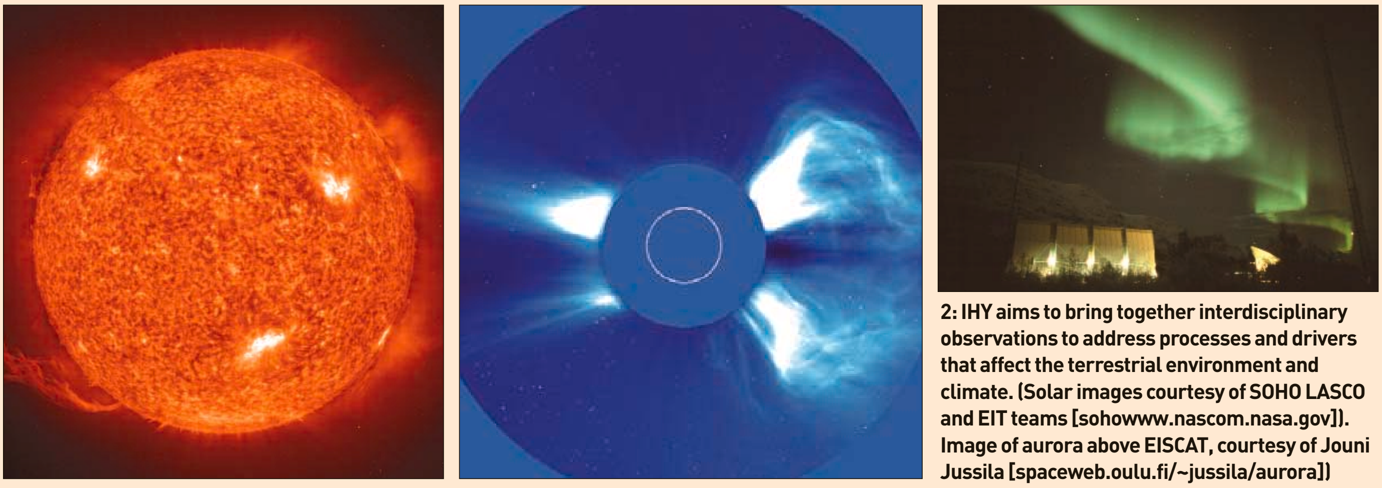
Finally, we must mention that in 1964 there was an International Quiet Sun Year (IQSY). This was born out of the IGY concept, though somewhat smaller in scale. The basic idea, which is a view held by many today, is that it is far easier to investigate the influences of solar drivers at a time of minimum activity. Solar maximum can be rather confusing!

Harrison (RAL) and Andy Breen (Aberystwyth). The Committee is taking great pains to ensure that IHY is *not* yet another red-tape activity, generating unnecessary panels, committees, working groups and meetings. It is being set up as an enabling activity for the grass-roots scientist to drive coordinated observations or to encourage international collaborations. The IHY activities and concept are described in detail at the official IHY website at http://ihy2007.org. Anyone can visit that website and register an interest in IHY. Since the beginning of the project a UK website has been run, in parallel with the US website, at http://www.ihy.rl.ac.uk. This contains similar information with a UK bias, but also includes a pilot study for a project-planning facility, which will be mentioned below. There is now an official European web facility at http://www.lesia.obspm.fr/IHY/. Of course, it must be noted that these websites are being continually updated as the programme definition approaches maturity.

Plans for IHY were discussed at community meetings at the 2002 World Space Congress in Houston and at EGS/EGU and AGU meetings over the last three years, and at "local" meetings, in particular in the USA and UK. A key meeting for the UK was held at the RAS in December 2003, at which the UK community confirmed its intention to participate fully in IHY.

IHY has received endorsements from organizations such as COSPAR, AGU, IAU, NASA, IUGG and SCOSTEP. It has also been selected by the UN Office for Outer Space Affairs as the theme for a three-year series of workshops on Basic Space Science (see http://www.oosa.unvienna.org). This will ensure that international scientists, in particular from developing countries, can participate in IHY, providing an international

## IHY: Interdisciplinary observations



**2: IHY aims to bring together interdisciplinary observations to address processes and drivers that affect the terrestrial environment and climate. (Solar images courtesy of SOHO LASCO and EIT teams [sohowww.nascom.nasa.gov]). Image of aurora above EISCAT, courtesy of Jouni Jussila [spaceweb.oulu.fi/~jussila/aurora])**

forum and global access to IHY projects.

The IHY project has also been proposed and accepted recently as a major component of the plans for an IPY in 2007. Clearly the IPY and IHY goals are similar and, although they cover some very different disciplines and physical locations, there is scientific overlap, and that has been formally recognized in forging a relationship between the two. Indeed, within IPY, the IHY project has been selected to act as a leading or coordinating activity. This does not change the goals or activities of IHY, but brings the programme to a wider community and ensures some exposure to scientists in areas of peripheral scientific interest to IHY.

In effect, it is still early days. We are in the process of setting up the arrangements for running IHY and there is a great need for the community to say what it wants from such a project. Richard Harrison gave presentations on IHY at the 2004 MIST/UKSP meeting in Edinburgh and the 2005 NAM/UKSP meeting in Birmingham and the ideas met with general approval and enthusiasm as something from which the UK could benefit.

Thus, as we finalize the IHY project over the next two years, we still require the community to play its part in suggesting schemes and ideas for the best exploitation of IHY for the UK.

### What's in it for me?

Having said that, and having given a brief history of IHY and of those involved, we must address the question, posed by a hypothetical grass-roots scientist in the UK: "What does it do for me?" The intention is to provide the following:

- To enable campaigns/access to instruments/data;
- To encourage and coordinate a synoptic heliospheric campaign;
- To coordinate meetings to encourage collaboration (e.g. the UN Basic Space Science Workshops);
- To act as a focus for information dissemination, operations planning, public relations, etc.

Let us address the first point in some detail, considering what practical approaches could be adopted specifically in the UK, although the models discussed could be adopted for many countries. The basic approach is to introduce a scheme for proposing multi-instrument or multifacility projects, fuelled by clear information about the available projects and instruments, the contact information for those projects and instruments, and including a coordination or clustering of instruments to enable better coordination.

One major approach being adopted is the use of Coordinated Investigation Programmes (CIPs). This is a concept adopted from the highly successful Joint Observing Programmes (JOPs) developed and run for the SOHO mission. It recognizes the fact that the most basic, lowest level building block of any campaign is the set of observations required by a single scientist or collaboration to satisfy a specific scientific question. It is suggested that the IHY activity ought to be seen as the sum of many such fundamental building blocks.

For SOHO, much of the mission operation has been based on the JOP approach. Each JOP scenario involves more than one SOHO instrument and, commonly, they involve other spacecraft instruments and ground-based observations. The JOP defines one set of operations designed to address the specific scientific question of that JOP. For SOHO, about 200 JOPs have been designed and run by the community, with some JOPs run numerous times. To browse through the SOHO JOP descriptions, go to http://sohowww.nascom.nasa.gov (click on operations).

To illustrate the JOP approach we describe JOP 67. This is a study of the solar Coronal Mass Ejection (CME) onset using SOHO extreme-UV spectroscopic observations combined with coronagraph data. In other words, the principal instruments are the CDS and LASCO instruments on SOHO, but the JOP includes supporting UV/X-ray and ground-based data from SOHO, other spacecraft and observatories. For example, over the years, JOP 67 has been run with involvement from Yohkoh and TRACE, in addition to the CDS, SUMER, LASCO and UVCS instruments on SOHO, and incorporating synoptic data from the GOES spacecraft, the EIT and MDI instruments on SOHO, and ground-based radio and H-α observations. The most basic aim of the JOP is to obtain plasma diagnostic information of the CME source regions in the low solar corona, in order to investigate the ejection process (figure 3). The JOP has been run on many occasions since 1996. The scheme has been used to identify what we now call coronal dimming, witnessed in specific spectral lines, which reveals the removal of plasma from the low corona as the CME erupts. It is not the purpose of this report to discuss the scientific output of one JOP, so for more details, the reader is referred to Harrison and Lyons (1999), and Harrison *et al.* (2003)

**This is a concept adopted from the highly successful Joint Observing Programmes developed for SOHO**

With the IHY in mind, we note that there are several important issues relating to such a JOP approach, which we list here:

- JOP 67 was proposed and run by scientists from the Rutherford Appleton Laboratory and Birmingham University. JOPs are proposed by the grass-roots scientist; there is no overall JOP manager dictating what should be run.
- The JOP authors submit the basic description to the SOHO PI team. The submission may be refined in discussion with the instrument teams and then it is scheduled and run. Thus the JOP is effectively "owned" by those that proposed it. This ownership ensures an efficient use and exploitation of the SOHO mission.
- The original JOP submission is made to the SOHO PI group and is placed in a JOP library at http://sohowww.nascom.nasa.gov.
- In general, the solar community is well aware

of the procedure, i.e. how and where to submit a JOP and how it is refined and scheduled.

The last point is important and is at the heart of what IHY is all about, i.e. *the access is the key to success*.

All of the above can be a lesson for the IHY CIP approach. In addition, as with the SOHO JOPs, the CIP proposer need not be bothered with the global IHY programme or the IHY management team activities. He or she simply needs to know where and how to submit a CIP, presumably through a web facility or email. Indeed, the UK IHY website already contains a pilot scheme where people can propose a CIP. Everyone is encouraged to take advantage of this. Some CIPs have been established already and, at the time of writing, are about to be displayed on the UK website, providing an example that people may find useful.

It should be stressed that although the emphasis of the discussion so far has been with combinations of observations, a CIP would equally well be a scheme to combine the analysis of "old" datasets in a particular way, or a collaboration of particular modelling activities. Any research activity in this way can be recognized as an IHY CIP. As noted above, it is hoped that the bulk of the IHY campaign will be built out of such CIPs.

During 2005/6, the CIPs should be defined, refined and scheduled, as the operational programme of IHY is put into place. The originator of each CIP – the CIP leader or author – will be able to track his or her own CIP at any point, for example to check on its scheduling.

## Contacts and instrument clusters

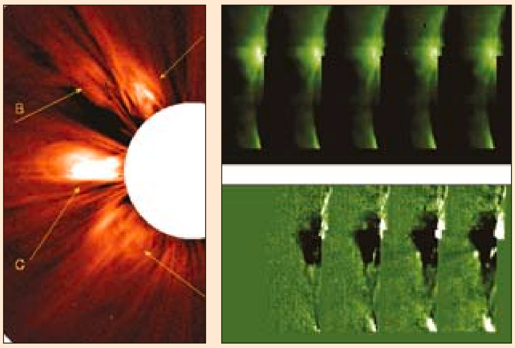
The CIP approach demands two other features to be established within the IHY activity. First, there must be a list of contacts for instruments, facilities, data-sets, models, etc, which prospective CIP authors can use as consultants to design their CIPs. For example, a CIP author may wish to use UV spectroscopic data but be unaware of the relevant instrument parameters for the observation they require. The instrument contact can provide these details. Thus the websites will contain lists of instruments, databases and archives, facilities and modelling facilities that should be available in 2007, along with the contact information. This alone would be a useful facility for the UK.

We also recognize that in any particular country there are relatively few hardware teams. These are the key groups for access to the operations and data. Consider an example, in the UK. In 2007 the solar community may well have SOHO, Solar-B and STEREO in operation. In the UK, operation of all three is coordinated through the hardware teams at the Rutherford Appleton Laboratory and the Mullard Space Science Laboratory. Thus it should be easy to establish a formal link to receive multispacecraft CIPs, to coordinate these three missions for the benefit of the UK. These groups are also involved with the Solar Dynamics Observatory, which is due for launch just after the IHY period, and have links to the TRACE mission. The community simply needs to know how to propose targets, and IHY can provide such a mechanism, setting up such multi-instrument or interdisciplinary key groups as coordinators and by advertising them to the community. This approach could be defined as a logical planning "cluster" – in this case linking (a cluster of) three or more missions. Including the solar example, such clusters for the UK could logically include the following, where we list the key institutes involved and a key individual who could act as the interface:

- SOHO/Solar-B/STEREO – RAL/MSSL – Richard Harrison;
- Cluster/EISCAT – RAL – Jackie Davies;
- Ulysses/Cluster/Cassini – Imperial College – Bob Forsyth;
- IPS (EISCAT/Jodrell)/SOHO – Aberystwyth – Andy Breen.

Clearly this is just a set of preliminary examples. More community involvement will bring more such clusters. It is clear that a well-defined set of contacts or groups providing natural UK links to clusters of missions or instruments, or even databases or models, in this way, will provide a solid route for CIP authors to suggest particular campaigns or projects.

### Example of SOHO Joint Observing Programme



**3: Data from the SOHO JOP 67, showing (left) coronagraph and (right) extreme-UV (EUV) observations of the underlying eastern solar limb in emission from highly ionized iron (Fe XVI 36 nm). The EUV images show 2 million K plasma in the corona. The coronagraph image shows a narrow coronal mass ejection propagating from the eastern equator. A series of five EUV scans of the limb (top, right) show little change at the time of the eruption, but differenced images (bottom, right) show a significant dimming due to mass expulsion. (SOHO LASCO and CDS teams)**

## IHY synoptic programme

One goal of the IHY project is to ensure a coordinated synoptic observation programme of the heliosphere, from the Sun to the heliopause. The resulting dataset must be available to everyone. There are many ground-based and space-based systems that are – or will be – operating in a synoptic mode, providing useful data for such a grand synoptic scheme, for example the coronagraphs on SOHO and STEREO, the full-Sun extreme-UV imagers on SOHO and STEREO, heliospheric wide-angle imaging/monitoring on STEREO, the near-Earth environment from Cluster. To some extent this will happen with or without IHY. However, some aspects need definition and the establishment of a synoptic programme, to ensure that there are no gaps, and we need to establish one place (a web facility) where the wider community can access all of the data. For example, to ensure a complete picture, we may wish to consider and establish an extreme-UV spectroscopic synoptic programme, to continue the programme adopted for SOHO, to provide detailed Carrington maps of the Sun across a wide range of temperatures; we may wish to consider ionospheric monitoring activities using synoptic programmes with, for example, EISCAT; we may wish to ensure some synoptic operation of planetary missions such as Mars Express, Cassini, etc. These are just preliminary suggestions. The IHY community needs to consider what the best approach is and to act as a lobby to ensure that the most complete programme possible is run and that the data are available.

## Final words

It is pretty clear from what has been said here and elsewhere that much is yet to be defined. However, IHY will happen – with or without a UK contribution – and to embrace it and even influence the way it is established in the next year or two will pave the way for a better exploitation of activities in which we have already invested. To that end, everyone is invited to have their say. Please contact any of the authors, visit the websites and get involved. ●

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