

# TOWARDS A NEW STRUCTURE FOR FEDERATING ASTRONOMICAL AND GEOPHYSICAL DATA ANALYSIS SERVICES

## *FAGS “White Paper”* (10 July 2007)

### **Introduction**

This “White Paper” is intended to provide the views of the current ICSU (International Council for Science) FAGS (Federation of Astronomical and Geophysical Data Analysis Services) interdisciplinary body on the prospects for a future grouping of astronomical and geophysical data analysis services in the framework of the new arrangements within ICSU for data coordination.

The need for a FAGS “White Paper” emerged from the FAGS Council meeting of 29 March 2006 in which the FAGS Council members, the IAU and IUGG General Secretaries and the URSI assistant General Secretary participated.

This document is based on the outcome of the 2005 and 2006 FAGS meetings and input from FAGS Council members, the three parent international scientific unions (IAU, IUGG and URSI) and some of the FAGS Service directors in answer to a call for comments that was circulated after the 2006 meeting. A first draft was submitted for comments and a revised version was discussed during the FAGS meeting on 2-3 April 2007 at ICSU in Paris that was mainly devoted to agreeing on FAGS views on the future and preparing a final version of that paper. The final version was adopted during the FAGS General Committee meeting in Perugia (on 2 July 2007).

The paper first recalls the background (Sect. 1) and describes the situation of FAGS within ICSU (Sect. 2); it provides a brief summary of the situation within ICSU of the two other ICSU interdisciplinary bodies on data and information, namely the World Data Centers System (WDCs) and CODATA, respectively (Sect. 3 and 4) and reports on other organizations involving astronomical and geophysical scientific services (Sect. 5). The paper then compares the situation and inter-relations between different organizations (Sect 6) and provides the FAGS views (Sect. 7) on the future of a federation of services. It summarizes the most relevant points regarding the current services and what should be the most appropriate organization to replace FAGS, given the up-to-date characteristics of the existing astronomical and geophysical analysis services, the needs of the Unions for their scientific services and the needs of society (Sect. 7). The future relationship with the WDCs is especially relevant, given that the WDCs’ situation within ICSU is also intended to evolve along the lines of the ICSU strategic plan on Scientific Data and Information. Future relationship with the ICSU Geosciences interdisciplinary programmes should also be clarified. Section 8 provides a straw man proposal for the future of FAGS and WDC activities in this new context.

Annexes 1 and 2 contain the 2006 calls for comments and the corresponding answers from the three Unions and some FAGS Services, respectively. Annex 3 provides the current status of the FAGS components (i.e. FAGS Council membership, Unions General Secretaries, list of the FAGS services, with the corresponding names and addresses of their directors). Annex 4 provides the official information on the ICSU ad-hoc *Strategic Committee on Information and Data* (SCID) that was recently established in order to guide and oversee the reform of the WDC system and FAGS. Finally, Annex 5 provides notes on various categories of UNESCO centres, which was one possible option that was considered by FAGS in 2005.

## 1. Background

In response to the ICSU proposals, developing over the past 3 years, it was recommended that FAGS would not continue to be an ICSU body from 2005. Therefore, a FAGS Council meeting in Paris (2-3 May 2005) at UNESCO with Service Directors and Unions General Secretaries studied several alternatives for the future. One alternative that the FAGS Council has been investigating was its rebirth as a virtual Centre (CAGS) under the auspices of UNESCO (see Annex 5). UNESCO would consider a joint grouping with the three Unions in principal. Advantages could have been more government recognition and funding for FAGS Services. Another alternative was to create an ad hoc committee across the three Unions, which would have had the weakness of being without a prestigious umbrella, such as ICSU, or UNESCO.

However, during the ICSU 28th General Assembly, China, 18-22 October, 2005, it was eventually decided to extend ICSU's sponsorship of FAGS for a period of three years. FAGS was asked for the next three years to work to establish new arrangements within ICSU for data co-ordination. During this 3-year period, FAGS will continue to fulfil its role of coordination among the Services, while ICSU will examine integration of this function within its activities in data and information. This decision resulted from a strong action from the IAU, IUGG and URSI who submitted this alternative to the ICSU GA and this received a strong majority of votes among both the National Member and Union delegates of ICSU.

A FAGS meeting was organized on 29-30 March 2006 at Paris Observatory with the Service Directors, the Unions and the ICSU Representative in order to re-consider the future of FAGS with the new situation. During this meeting, it was acknowledged that, contrary to what was discussed during the 2005 FAGS meeting, there was a future for FAGS within ICSU. A proposal was asked to be prepared for building a new federation of services in order to adapt to the modern astronomical and geophysical services operation, the ICSU WDC system evolution and the current ICSU strategic plan. There has been interesting and positive discussion during that meeting from which have emerged preliminary views on the current FAGS strengths and weakness and on a recommended organisation for a future Federation of Services that could (i) be a benefit for the Services and the Unions and (ii) fit the current ICSU strategic plan and especially the Priority Area Assessment (PAA) on Scientific Data and Information.

Since that time an "Ad hoc Strategic Committee on Information and Data" (SCID) was established by ICSU, according to the ICSU Strategic Plan 2006-2011, in order to achieve the recommendations of the Priority Area Assessments PAA on Scientific Data and Information. The SCID terms of reference have been adopted (see Annex 4). These ToR are especially relevant to the current reflection about the future of FAGS, which is reflected in the fact that the membership of the committee will include two FAGS representatives.

This makes clear that the FAGS "White paper" must be aimed at being an input to the work of the *ad hoc* SCID, which strengthens the reasons for having this paper ready within the planned timeline of the committee (the first meeting of which will be at the end of July 2007). The almost final version of the "White paper" was prepared during the FAGS meeting in April 2007 in Paris, where the FAGS views were discussed with the Services, the Unions, the ICSU, and the WDC and CODATA representatives as well. The last developments were considered during the FAGS General Committee meeting at the IUGG General Assembly, on 2 July 2007 in Perugia (Italy).

## 2. The Federation of Astronomical and Geophysical Analysis Services (FAGS) within ICSU

### 2.1 Establishment and purpose of FAGS

In 1956, FAGS, a federation of permanent services for astronomy, geophysics and related sciences, was established, in the framework of the 1957-1958 International Geophysical Year (IGY), under the International Council of Scientific Union (ICSU), now International Council for Science. Its principal purpose has been to encourage, the analysis of observational data likely to be of long-term value in astronomy, geophysics and related sciences.

In 2007 FAGS includes 12 Permanent Services (see the list of FAGS Services in Annex 3), each operating under the authority of one or more of the interested Scientific Unions: The International Astronomical Union (IAU), International Union of Geodesy and Geophysics (IUGG) and Union Radio-Scientifique Internationale (URSI).

### 2.2 Functions of the data analysis services according to the FAGS statutes

The general tasks of the FAGS Services are (i) to continuously collect observations, information and data related to astronomy, geodesy, geophysics and allied sciences, (ii) to analyse, synthesize, and draw conclusions from them; (iii) to distribute data; and to publish the results obtained.

More precisely, according to the statutes of FAGS, “a data analysis service, shall be a scientific organization placed under the supervision of one or several Scientific Unions and entrusted with some, or all, of the following tasks:

- to collect, as a continuous activity, information and observational data related to astronomy, geophysics, or related to the sciences referred to in § 1 (*i.e. previous paragraph*) and to put them in machine-readable form (*now provided through specific web pages and ftp sites*),
- to analyse and synthesize them,
- to draw conclusions from them,
- to ensure the homogeneity of the evaluated data,
- to fill gaps in the series of observations,
- to revise long series of observations when appropriate,
- to publish the results obtained,
- to compile and distribute information important for the international scientific communities concerned,
- to assist in the coordination and execution of international observational programmes
- to supply data on request.”

### 2.3 Characteristics of the current FAGS Services

All of the current FAGS Services carry out most or all the tasks described above, though there have different characteristics:

- A few of them (IERS, IVS, IGS) consist of an international collaboration of organizations, with distributed functions, such as the *Central Bureau, Analysis Centers, Product Centers, Combination Centers, Data Centers*, etc, which are autonomous components hosted by various institutions, but reporting to the Service Board. The activities of those services thus involve the voluntary contributions of many groups throughout the world, supported by their national institutions. There are several key roles in the Services, such as the Director of the Central Bureau, the analysis coordinator, the chairs of essential Working Groups that have their own Terms of reference, etc. Some of the functions are shared between several collaborating organizations in different countries. The Directing Board has an important role of reviewing the work of the different components of the Service, coordinating their actions and deciding the policy. The role of each component is essential for the work of the Service and the DB Chair is very important for the evolution of the Service. The

Central Bureau has primarily administrative functions and operates a data base for the relevant Service products and data. With such FAGS services, the Director of the Central Bureau serves in FAGS as the Director of the Service.

- There are strong interactions between some of the Services. The major one is that IVS and IGS, while being autonomous services with their own ToR, serve as Technique Centres for the IERS; consequently, those services have representatives on the IERS Board and conversely IERS has a representative on the IVS and IGS Boards.
- Other Services are hosted by only one national organization and are therefore maintained nationally, but they are sometimes cooperating with other components in the world for providing the Service products. Note that, for example, ISES has an interest in ISGI and SIDC products. See more information on common interests in Table 1.
- Except from IVS and IGS, which are parts of the IERS, the services are independent, but ICSU and the union co-sponsors contribute to the coordinating function, which is performed by the Council of the Federation.
- Except from a small allocation from FAGS, the current FAGS Services are funded and maintained by their host countries on behalf of the scientific community.

#### *2.4 Role and functioning of the FAGS Council*

According to the FAGS statutes, the federation of Services forming FAGS is administrated by a Council (see the composition and the current membership in Annex 3), which shall meet every year. This Council is in charge of approving the financial accounts and adopting the budget of the federation. It shall also examine the application for FAGS membership, or suggestions from Unions for withdrawal of services. It shall review the activity reports of the Services and consider any possibilities of cooperation with other international organization or activity. It shall distribute the grants allocated to the Services by FAGS. The coherence between the members of the federation shall be furthered and their cooperation is encouraged by a General Committee composed of the Council membership, the Service Directors and the Chairpersons of the Directing Boards.

The Council is inter-acting with Services: there is one FAGS Representative (from the Council membership) as ex-officio member of the Directing Board of each FAGS Service.

The role of the FAGS Council for distributing grants to the Services has largely decreased over the recent years due to the diminishing budget. Originally coming mostly from ICSU, it is now coming only from the Unions and consists of an annual amount of the order of \$ 20 000.

### **3. The World Data Center System (WDCs) within ICSU**

#### *3.1 Establishment and purpose of the WDC System*

The World Data Center (WDC) system was created to archive and distribute data collected from the observational programs of the IGY. Originally established in the United States, Europe, Russia, and Japan, the WDC system has since expanded to other countries and to new scientific disciplines. In 1968, ICSU established a Panel on WDCs to coordinate and monitor the activities of the centers. The WDC system now includes 52 Centers in 12 countries. Its holdings include a wide range of solar, geophysical, environmental, and human dimensions data. These data provide baseline information for research in many ICSU disciplines. WDCs are funded and maintained by their host countries on behalf of the international science community. They accept data from national and international scientific or monitoring programs as resources permit. All data held in WDCs are available for no more than the cost of copying and sending the requested information (*now provided through specific web pages and ftp sites*).

### 3.2 WDC data

The World Data Center system works to guarantee access to solar, geophysical and related environmental data, and since recently, to a wider range of data. It serves the whole scientific community by assembling, scrutinizing, organizing and disseminating data and information, which are intended to constitute the raw material of scientific understanding.

## 4. The Committee on Data for Science and Technology (CODATA) within ICSU

### 4.1 Establishment and purpose of CODATA

CODATA is an interdisciplinary Scientific Committee established in 1966 by ICSU to promote and encourage, on a world-wide basis, the compilation, evaluation and dissemination of reliable numerical data of importance to science and technology, now enlarged to science and society. It works to improve the quality, reliability, management and accessibility of data of importance to all fields of science and technology. It is a resource that provides scientists and engineers with access to international data activities for increased awareness, direct cooperation and new knowledge. It is concerned with all types of data resulting from experimental measurements, observations and calculations in every field of science and technology, including the physical sciences, biology, geology, astronomy, engineering, environmental science, ecology and others. Particular emphasis is given to data management problems common to different disciplines and to data used outside the field in which they were generated.

### 4.2 The CODATA objectives are:

- the improvement of the quality and accessibility of data, as well as the methods by which data are acquired, managed, analysed and evaluated, with a particular emphasis on developing countries,
- the facilitation of international cooperation among those collecting, organizing and using data,
- the promotion of an increased awareness in the scientific and technical community of the importance of these activities,
- the consideration of data access and intellectual property issues.

### 4.3 CODATA activities

The four primary CODATA activities, all in support of its fundamental aim of fostering worldwide cooperation in scientific and technical data, are:

- sponsorship of a biennial CODATA International Conference on data, which attracts approximately 300 data specialists from around the world,
- specialist meetings of scientific data experts addressing issues specific to one discipline or topic,
- publications on data handling and compilation, surveys of data activities, conference proceedings,
- sponsorship of Task Groups, Working Groups, Commissions and other groups addressing specific data issues, such as coordination of multinational data project; establishment of format standards to promote data exchange, sharing, and compatibility; guidelines to presentation of data in the primary literature or archival databanks; supplying information on sources of reliable data; education and training; preparation of key data sets for which consistent international use is desirable; organization of conferences and workshops.

## 5. Other relevant organization involving astronomical and geophysical scientific services

### 5.1 The international Services within the International Association of Geodesy (IAG)

The IAG has a special recognition of international services that are considered, since the recent IAG re-organization in 2001, as IAG components belonging to IAG sections. There are three Service Representatives on the IAG Executive Committee, which makes the Services more visible than they were in the past.

The current IAG Services are the twelve following ones:

- IERS (International Earth Rotation and Reference Systems Service)
- IGS (International GNSS Service)
- ILRS (International Laser Ranging Service)
- IVS (International VLBI Service for Geodesy and Astrometry)
- IGFS (International Gravity Field Service)
- IDS (International DORIS Service)
- BGI (Bureau Gravimétrique International)
- IGeS (International Geoid Service)
- ICET (International Centre for Earth Tides) (Belgium)
- PSMSL (Permanent Service for Mean Sea Level)
- BIPM (Bureau International de Poids et Mesures -time section)
- IBS (IAG Bibliographic Service)

Six out of these services, i.e. IERS, IGS, IVS, BGI, ICET, PSMSL, are members of FAGS, but the other ones are not, i.e. ILRS, IGFS, IDS, IGeS, BIPM time-section and IBS, although some of them look very similar to FAGS Services. For example, ILRS and IDS have an organization quite similar to IVS and IGS, for satellite (or lunar) laser ranging (ILRS) and DORIS observations (IDS), respectively, and IGeS has an organization for geoids, similar to BGI for gravity data. Being or not being part of FAGS seems to result partly from historical circumstances. Among those IAG services that did not join FAGS are services that developed more recently to create a logical coverage of Earth systems geodetic services. Note that establishing an International Altimetry Service is currently under study by the IAG. The overall goal of IGFS is to coordinate the servicing of the geodetic and geophysical community with gravity field-related data, software and information. It functions as a unifying service for the gravity-field related IAG services, called "IGFS Centres", namely BGI, IGeS, ICET, and also the International Centre for Global Earth Models (ICGEM) and possibly IDEMS, the International DEM Service (IDEMS) (although being not an IAG Service). The BIPM time-section has a specific structure: it is part of the BIPM, which is an international body set up in 1875 by the "Convention du Mètre" and working under the supervision of the "Comité International des Poids et Mesures"(CIPM), which ensures the international financing of the operation and human resources dedicated to this service.

### *5.2 The Global Geodetic Observing System (GGOS)*

GGOS (Global Geodetic Observing System) was developed by a planning group from 2001 to 2003 and the proposal was accepted by the IAG Executive Committee and the IAG Council at their meetings at the 23d IUGG General Assembly in Sapporo in summer 2003. It was endorsed by the IUGG at the same General Assembly. GGOS serves as a flagship of IAG to coordinate the geodetic research work and to represent geodesy in other sciences and in society. It is a basic component of the Global Earth Observation System of Systems (GEOSS), providing not only the accurate geodetic reference frame required by all other systems, but also valuable observations of the Earth's geometry, gravity field and rotation and their changes over time. As a first step, the 2007-2009 GEO working plan includes the task "Global Geodetic reference frames".

The IAG services are the major components of GGOS, which is reflected in their representation in the GGOS Steering Committee. In April 2006, GGOS was accepted as partner in the Integrated Global Observing Strategy Partnership (IGOS-P), which is one of the Monitoring/Observation ICSU bodies participating in the United Nations IGOS. It is worthwhile to mention that UNESCO strongly supported the GGOS membership in IGOS-P. At the latest IUGG General Assembly (in Perugia, July 2007), IAG acknowledged GGOS as an IAG component.

## **6. Situation and inter-relation between FAGS, WDCs, CODATA, IAG and GGOS**

The scientific services described in the previous sections have different situations with respect to various international bodies, such as IAU, IUGG, URSI, IAG and ICSU and are inter-related in different ways.

FAGS, WDCs and CODATA are three ICSU bodies involved in collecting and distributing scientific data, but their roles are historically very different: the WDCs were in charge of providing raw data in various areas, while the FAGS Services were in charge of providing astronomical and geophysical data together with validation, analysis, etc.; on the other hand, CODATA has been in charge of addressing data issues in domains of science and society.

WDCs and FAGS have in common that they enforce the policies of CODATA, especially with regard to full and open access. However, there have not been strong links between FAGS and CODATA, while there are strong inter-connections between FAGS and the WDC System. For example, ICET is the WDC for Earth Tides and SIDC is the WDC for Sunspot Index; data from the ISGI is available through the WDCs for Geomagnetism; the International Geophysical Calendar is prepared for ISES by the WDC for Solar Terrestrial Physics, Boulder; ISES Spacewarn Bulletin is produced by the WDC for Rockets and Satellites, Greenbelt; and data from WGMS flows into the WDC for Glaciology, Boulder, the WDC for Rotation of the Earth publishes partly data of the Earth Orientation IERS PC. For more details, see the FAGS-WDCs cross-connection grid in Table 1.

WDCs do not have a prime task of providing operational services, but in practice some WDCs do contribute to or manage these activities. Some WDCs archive data and also provide value added services. Conversely, some FAGS Services (eg. IERS, IVS, IGS) includes specific Data Centers, which are not WDCs. In fact, the variation between individual FAGS services, or between individual WDC services, is at present as large as the difference between FAGS and WDC services; there is no longer a logical distinction between FAGS and WDC operations. Some of each are more data management and some more analytical.

WDCs, which were originally created to archive and distribute data related to the IGY, evolved to include ecology, biology and social sciences, while FAGS, which is strongly union oriented, still includes only astronomical and geophysical services. Among the differences between FAGS and WDC are the large number of centers (50) as compared to that of the FAGS services (12) and the regional coordination of the WDCs versus the purely international coordination of the FAGS Services. Another difference is the supervision of the WDCs by a Panel versus the supervision of the FAGS services by a Council including Unions representatives. According to the FAGS statutes, the FAGS Services are placed under the supervision of one or several scientific unions.

As already noted, a part of the IAG services are members of FAGS, but not all of them and that is for reasons that are not quite logical. This means that a better coordination between these different grouping of scientific services with the responsibility of scientific unions would be required in the future. Moreover, the IAG services are now the major components of GGOS, which show the strong interrelations between different kinds of grouping.

The FAGS and IAG Services (except for the BIPM time-section) and GGOS as well are based solely on the voluntary commitment of organisations, institutes and individuals to provide infrastructure, human resources, data and products. On the one hand, this voluntary 'best effort' principle allows for a rapid response to the growing scientific demands, but on the other hand, it also makes the services vulnerable to fluctuations in shifting funding strategies and priorities. This highlights the fundamental funding issue and especially the question about possibilities of recognition by an international body such as ICSU.

## 7. FAGS Views on the future of a Federation of Services

Preliminary conclusions can be drawn on the current FAGS strengths and weakness and on the possible evolving organization to replace FAGS, given the up-to-date characteristics of the existing astronomical and geophysical analysis services and the needs of the Unions for their scientific services. These conclusions are based on the views expressed by the Unions (see Annex 1) and the FAGS Services (see Annex 2) as well as by the FAGS Council members through the e-mail discussion when preparing this paper. The final version of these views is the outcome of the FAGS 2007 meetings.

In the period since FAGS was constituted in 1956, the nature and relevance of the Services has evolved. Older Services have merged, and new ones have been established. Activities initially of mainly scientific interest such as sea levels, and characteristics of Earth rotation (e.g. the international terrestrial reference system, or the definition of UTC), have become important for intergovernmental agreements and conventions and for society in general. Moreover GEOSS, IPY and eGY are driving new concepts of data management. The future organization should (i) benefit the Services and the Unions and (ii) fit the current ICSU strategic plan and especially the Priority Area Assessment (PAA) on Scientific Data and Information. The possibilities will be considered in detail by the ICSU ad hoc *Strategic Committee on Information and Data* (SCID) (see Annex 4 providing the ICSU official document) that will work over the 2007-2008 period with the participation of two FAGS Representatives.

The most important points extracted from the FAGS views mentioned above are summarized in the following sections.

### 7.1 Summary of the key roles of the services and the federation of services

- The astronomical and geophysical data analysis services add critical value to the interpretation of data and information.
- Services may include real-time products, such as alerts and warnings, in addition to many products with greater latency.
- The Services fulfill a principal objective of ICSU to serve society.
- The Services, while independently funded by their home agencies, need to have the international imprimatur of ICSU in order to maintain their priority status in their home institutions.
- FAGS Services are certified by their sponsoring Unions (one or more); services can and do evolve based on decisions of their scientific advisory committees.
- A grouping entity:
  - . represents and defends common interests of data services
  - . allows service directors to exchange views on service specific problems and challenges
- FAGS should be restructured to include more data products and to serve more useful coordinating and interfacing functions than at present.
- The word “Service” may be changed in order to adapt to the range of information available.

It was suggested that a new ICSU data/information entity could provide “one-stop shopping” – a way that scientists could discover world resources and obtain guidance on how to deposit and retrieve the data and information; and policy makers could ask relevant questions and be led to relevant and credible answers. The Unions could be enlisted to ensure that information was reliable.

### 7.2 Possibilities for a renewed Federation

- Coordinating the Services with a renewed set of WDCs within a new ICSU data/information entity.
- The new entity should be a way that:
  - . scientists could discover world resources and obtain guidance on how to deposit and retrieve the data and information,
  - . policy makers could ask relevant questions and be led to relevant and credible answers,
  - . the Unions could be enlisted to ensure that information was reliable.
- Planning a future call from the Unions for new services to become members of the new entity and asking the current FAGS services to make a new application to the new entity.
- Including not too many components in order to be able to review their activities.
- Introducing other services in the federation in order to fill existing gaps between services and initiating new required ones.
- Facilitating as necessary small data analysis services to merge in order to address a more inclusive field (Atmosphere, Gravity, Solar environment, ...)

### 8. Straw man proposal for the future of FAGS and WDC activities

ICSU defines a grouping called *ICSU World Data Centres and Services* (WDCS) in which

- WDCS *Services* are defined by:

- (a) a general principle of full and open access to data,
- (b) value-added, either in data or wider provision,
- (b) specialisation in long time-series of global relevance,
- (d) quality in service overseen by WDCS Council in general and approved Directing Board mechanisms in each case (e.g. via the scientific unions),
- (e) having interdisciplinary activities that provide data that are relevant to “science for society”.

- WDCS *Data Centres* would be devoted primarily to data flow and/or archive. They would also be subject to quality control procedures approved by WDCS Council

Each Service and Centre would be expected to demonstrate to WDCS Council:

- (a) that it is hosted by recognized institutions with assured funding for future,
- (b) local oversight by scientists and data manager of international repute (for Services) or data specialists (for Centres),
- (c) established approved quality control mechanisms and reports, etc.
- (d) high quality web access in order to give quality and authority and provide efficient communication with users,
- (e) interoperability between relevant services.

ICSU WDCS Council would provide:

- (a) coordination and quality control oversight of the Centres and Services,
- (b) responsibility for communications to the public, etc., on the importance of high quality long time series data for global monitoring.
- (c) coordination with CODATA.