RUSSIAN JOURNAL OF EARTH SCIENCES, VOL. 10, ES2007, doi:10.2205/2007ES000294, 2008

The Electronic Geophysical Year (eGY) and the World Data Center System

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Received 17 September 2007; revised 11 March 2008; accepted 11 March 2008; published 17 March 2008.

[1] The WDC system was created to archive and distribute data collected from the observational programs of the 1957-1958 International Geophysical Year. Originally established in the United States, Europe, Russia, and Japan, the WDC system has since expanded to other countries and to new scientific disciplines. The WDC system now includes over 51 Centers in 12 countries. The WDCs have been very successful over the last 50 years in meeting the needs of ICSU programs. However, in the next 50 years, the WDC system will need to evolve to accommodate the changing needs of ICSU and the global scientific community. Advances in information technology, as promoted by the electronic Geophysical Year, the implementation of new global scientific programs and the rapid increase in global, high-speed network connectivity will require the WDC system to adapt their current infrastructure, reorient their activities and implement new modes of operation. New requirements of existing ICSU programs like the IGBP, the activities of the new international science years (IPY, IHY, eGY, IYPE) and the implementation of the far reaching, long-term, Global Earth Observation System of Systems, will make new demands on the WDCs. The WDC system will respond by placing emphasis on modernizing its capabilities, expanding the WDCs into new disciplines, broadening the System geographically, especially into developing countries, and being more proactive in addressing new requirements from the ICSU and global scientific community. *INDEX TERMS:* 1794 History of Geophysics: Instruments and techniques; 1799 History of Geophysics: General or miscellaneous; 0525 Computational Geophysics: Data management; 9820 General or Miscellaneous: Techniques applicable in three or more fields; *KEYWORDS:* Electronic Geophysical Year, WDC System, GEOSS, space weather, monitoring systems, data mining, near-earth space environment.

Citation: Clark, D., B. Minster, and E. A. Kihn (2008), The Electronic Geophysical Year (eGY) and the World Data Center System, *Russ. J. Earth. Sci., 10,* ES2007, doi:10.2205/2007ES000294.

1. Introduction

[2] The first large-scale international scientific enterprises were the International Polar Years of 1882-1883 and 1932-1933, and inspired the International Geophysical Year (IGY) of 1957-1958. Planning of the IGY was coordinated by CSAGI, the Special Committee for the IGY set up by the International Council of Scientific Unions (ICSU). CSAGI established the World Data Center (WDC) system to serve the IGY, and developed data management plans for each IGY scientific discipline. Because of its success, the WDC system was made permanent and used for post-IGY data exchange. Originally established in the United States, Europe, Russia, and Japan, the original WDC system of 27 centers has since expanded to other countries and to new scientific disciplines. The WDC system now encompasses 51 Centers in 12 countries as shown in Figure 1.

[3] Its holdings include a wide range of solar, geophysical, environmental, and human dimensions data. These data cover timescales ranging from seconds to millennia, and spatial scales ranging from atomic to galactic dimensions; they 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 and monitoring programs as resources permit. All data held in WDCs are available on a full and open access basis for no more than the cost of copying and sending the requested information. In many cases, the data are available online at no cost.

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ISSN: 1681–1208 (online)

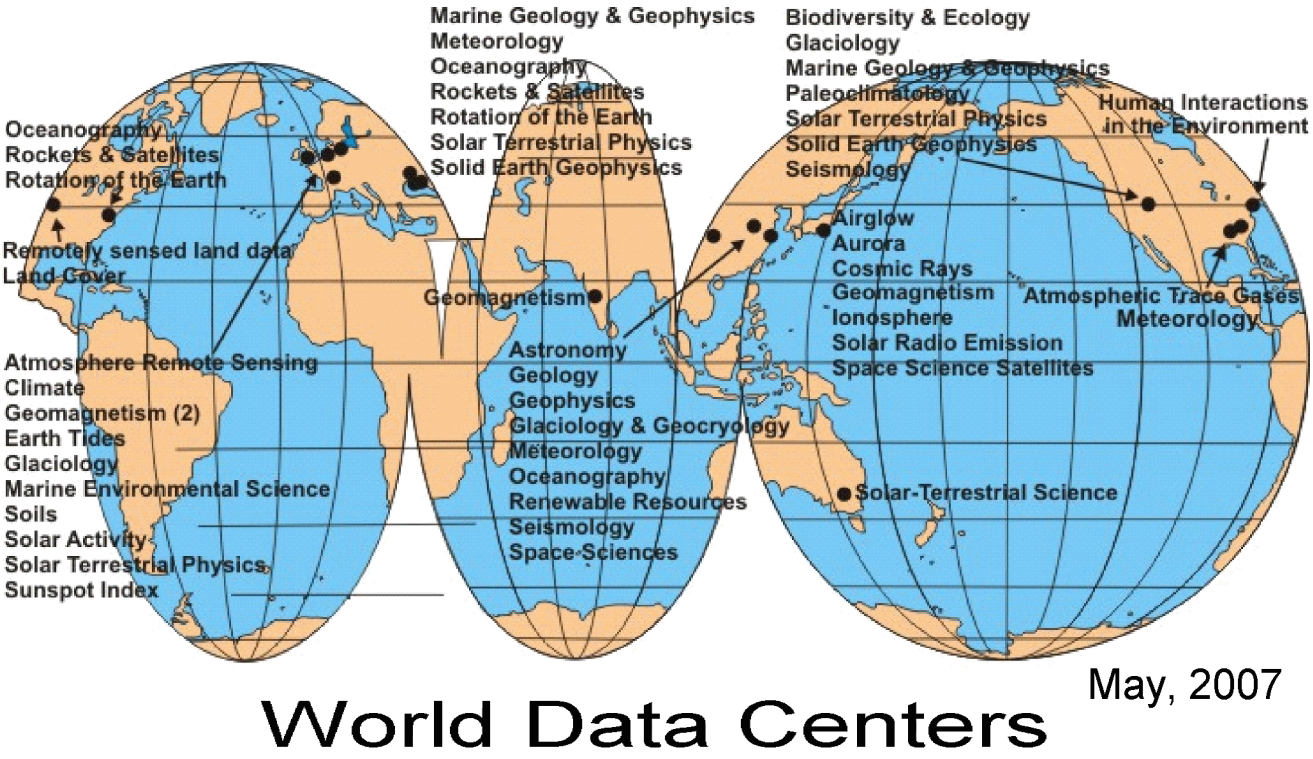

Figure 1. Map showing worldwide distribution of WDCs and their disciplines.

2. Past and Current Activities

[4] The World Data Center system of today is structured as a loose federation of data centers hosted mostly at governmental or academic institutions. Most of the WDCs do not have direct funding from their host, but rather are operated in conjunction with the normal activities of the hosting organization.

[5] Looking back over the last fifty years, the WDC System can boast of a number of significant accomplishments. First and foremost is the preservation of the data from the IGY, the predecessor to the eGY. The data are still preserved today in the WDC system. Also, from the outset, they produced a "Guide to International Data Exchange" [*Rishbeth,* 1996], the first of its kind and the model for the development of future guidelines of this type. The WDCs have always championed full and open data access, the provision of data on an exchange basis or for the minimal cost of reproducing the data. Because it is an ICSU body, the WDC system operates under the premise of non-discriminatory access to data and hence was successful in bridging the East – West divide during the Cold War, which was particularly important in the early years.

[6] The WDCs have initiated numerous data rescue projects in the former Soviet Union, India and China. In more recent years, the System has expanded to China, Australia, India and most recently other parts of Europe. This expansion also carried over into a wide range of discipline areas by adding new diverse WDCs in Biodiversity, Ecology, Astronomy, Soils, Geology, Human Dimensions, Remote Sensing and Land Cover, to name a few.

[7] One of the major focus areas of WDCs in recent years has been the transition from an analog to a digital mode of operation. This evolution to digital technology was carried out as a result of the WDCs being co-located with national or academic data centers. More recently, the WDCs have been initiating new collaborations with other data- oriented organizations and programs. In the early 1990's the WDC Panel entered into a close association with the International Ocean Data and information Exchange (IODE) of the Intergovernmental Ocean Commission. (Some of the IODE national data centers are also WDCs.) To improve international data exchange, the WDC for Solar and Terrestrial Physics (STP), Boulder developed a mirroring/partnering effort (Space Physics Interactive Data Resource – SPIDR) with several of the STP discipline WDCs in China, Russia, Australia, Japan and India as well as other interested organizations world-wide. This is an application of state-of-the-art data network connectivity. Similarly, the WDC for Paleoclimatology initiated mirror/partner sites for capacity building in data management in China, India, Argentina, South Africa and Kenya. Such collaborative efforts represent one of the critical directions to be taken by a revitalized WDC system (see Figure 2).

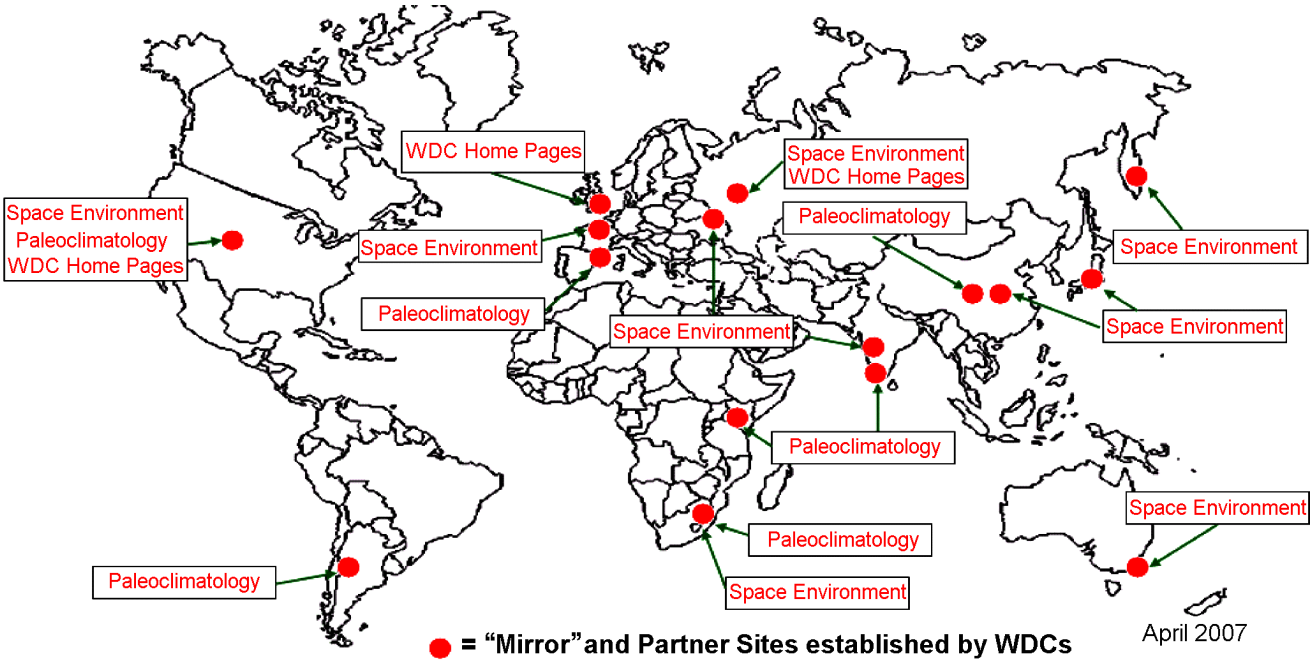

Figure 2. Map showing worldwide distribution of WDC Partners and "mirror" sites

3. Potential Role of the EGY for the WDCs

[8] In 2002, ICSU convened several ad-hoc groups to carry out strategic Priority Area Assessments (PAAs) of key areas. One of these PAAs was on Scientific Data and Information (PAA SDI). http://www.icsu.org/1_icsuinscience/DATA_Paa_1.html The PAA SDI comprises a review of ICSU's data and information activities and organizations, including the Federation of Astronomical and Geophysical Data Analysis Services (FAGS), Committee on Data for Science and Technology (CODATA), and the WDC system. A number of recommendations with regard to the re-focusing of ICSU's existing data and information services were made, notably:

[9] •The World Data Center system and the Federation of Astronomical and Geophysical Data Analysis Services will be reformed, taking account of user needs, including those of existing and new ICSU programmes. This will form part of the development of a broader strategic framework for data and information.

[10] •The Committee on Data for Science and Technology will be encouraged to develop a long-term strategy. Specifically for the WDCs, the PAA SDI recommended that the WDCs

1. implement new data management technologies,
2. adapt new techniques to acquire scientific data,
3. maintain relevance to existing ICSU programs, and
4. ensure relevance to new ICSU programs including GEO/GEOSS, IPY and electronic Geophysical Year (eGY).

[11] The WDCs have begun to address these recommendations. In 2005, a certification process of the WDCs was started in response to the PAA SDI. This process starts with the establishment of administrative and technological criteria for the WDCs; the specification of minimum standards for WDC accreditation; a review of utilization of and compliance with modern data management techniques; and an overall assessment of adherence to national and international standards. The certification process aims to identify, both on a center-by-center basis and on a system-wide basis, specific activities that would facilitate the adaptation and improvement of individual centers, as well as of the entire system, to the current rapid technological revolution. The WDCs are currently seeking the assistance of the eGY in this certification process.

[12] The WDC certification criteria will identify three categories among the existing WDCs (all will be compliant with WDC Principles and Responsibilities): a World Data Center (fully operational modern IT standards), an Associate WDC (intends to adopt modern IT standards), and a Center Under Development (WDC-UD). Specifically, a WDC will hold scientifically significant/relevant data holdings; furnish data on a nondiscriminatory basis, without restriction, for no more than the cost of reproduction; maintain a web-accessible directory of holdings compliant with national /international standards; and provide a means for users to find and download data online. An Associate WDC will furnish data on a nondiscriminatory basis, without restriction, for

no more than the cost of reproduction; maintain a directory of holdings; and provide a means for users to obtain data. A Center Under Development (UD) will undertake to work towards achieving Associate or World Data Center status. The criteria for the WDC-UD have not yet been formalized; this category is generally meant to apply to new Centers in developing countries. It is foreseen that the eGY could provide the technical expertise needed to validate this certification process and review the current WDC for their information technology capabilities. Conceivability, this certification process could be extended to the new WDCs and other data centers outside of the WDC system.

4. The Future of the WDC System

[13] A positive sign for the WDC system is the continuing interest by new scientific communities and countries in establishing new WDCs and WDC infrastructure. There is still a clear need for an international, nongovernmental organization to serve as a coordinating body and quality control mechanism. The WDC system needs to look at approaches taken by other groups that have been more successful in establishing active and sustainable networks of organizations with shared interests and activities. The eGY and its successor could contribute to the development of a new revitalized WDC system.

[14] In 2000, a WDC Modernization Task Team was formed after a meeting of the WDC Directors (http://www.ngdc.noaa.gov/wdc/reports/Modernization_ReportFinal_121203.pdf). It recommended the evolution of a "Global Science Data Network" from the existing collection WDCs. The network would include new technologies, new data, new participants, and new organizational principles. The report also recommended the strengthening of the human resources focused on science data management, with a special focus on developing countries. Specifically, it recommended extending the WDC network by establishing new centers and partner sites; modernizing the system by exploiting new technologies; ensuring data stewardship by providing long-term archive & data rescue; and improving communications by initiating liaisons with key international science programs. Unfortunately, there was little real progress carrying out these recommendations. If the eGY was active in this time frame, it would have been a perfect vehicle for the implementation of these ideas.

[15] In May 2007, the WDC Directors again met to discuss the future of the WDC system. More than 35 WDC Directors or their representatives attended the meeting as well as representatives from ICSU, IODE, CODATA, the Group on Earth Observations and FAGS.

[16] Key topics of discussion at this meeting were the International Polar Year (IPY), which is a major international research program that has recognized the need for long-term data stewardship, and the Global Earth Observing System of Systems (GEOSS), which is looking to the WDC system for data management expertise in developing the next generation of international, interoperable Earth observing systems aimed at both scientific and practical applications. The WDCs individually and as a system need to demonstrate their willingness to work with the international scientific community and the Earth Observations community to make the IPY and GEOSS successful not only in terms of current needs, but long-term data accessibility and usability. The eGY was often mentioned at the meeting a potential source of expertise which could lend itself to the WDCs in accomplishing its new goals of network interoperability and general upgrading of information technology expertise of the WDCs.

[17] The major resolutions from the meeting affecting the future of the WDC system included:

[18] •The WDCs must strongly and actively support the data management needs of the IPY, a major new program of ICSU.

[19] •The WDCs must become an active partner in the planning of the GEOSS data activities.

[20] •The WDCs must implement network links between WDCs utilizing interoperable data systems to support current scientific programs. The WDCs must begin to promote the adoption and promotion of standards within the systems in order to achieve this interoperability. The eGY can contribute to this goal.

[21] •The WDCs must establish a baseline of IT capabilities that will form the backbone of a Global Science Data Network of WDCs. The eGY can play a critical role in the certification of WDC which will lead to this baseline.

[22] •WDCs need to integrate their future IT activities with new state-of-the-art technologies like Virtual Observatories and the activities of the eGY

[23] •The WDCs should be open to look at a new paradigm in restructuring the WDC System (virtual WDCs?).

[24] The future is bright for the WDCs. While there are many challenges ahead, the concept of the WDC system developed 50 years ago is still viable. An active and energetic implementation of this concept is needed now more than ever. It is hoped that the WDC and the eGY will cooperate in the future to address the data needs of the scientific community in the 21st century.

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