the baseline information in a geographical information system with all its enhanced analysis capabilities.

The RADARSAT-1 baseline catalog is currently limited to the data archive of the ASF, which holds nearly 2.7 million potential interferometric pairs. Apart from real-time data collected within the ASF station mask (Figure 1), defining the area for which data can be acquired by the ASF antennas, the ASF archive contains SAR data acquired from the McMurdo ground station in the Antarctica, data downlinked at ASF from the RADARSAT-1 onboard recorder, and other data acquisitions requested for the satellite. The inclusion of additional RADARSAT-1 archive data from other ground stations into the baseline catalog is being investigated. The baseline catalog is updated on a monthly basis. It is accessible at Web site: http://www.asf.alaska.edu/baselines/.

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NSF Geosciences Advisory Committee Solicits Input

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The Geosciences Advisory Committee of the U.S. National Science Foundation (NSF) is soliciting the views and concerns of the geosciences community in advance of the committee's spring meeting scheduled for 11–12 May at NSF Headquarters in Arlington, Virginia. At this meeting, the committee will consider current and future geoscience plans and programs and additional issues of relevance to the community.

The chair and members welcome and solicit the views and concerns of the geosciences community so they may better represent their constituencies at upcoming meetings of the committee.

To contact current members or to obtain additional information about the Geosciences Advisory Committee, including meeting summaries and agenda, visit the committee Web site at: http://www.nsf.gov/geo/advisory.jsp.

The NSF Directorate for Geosciences, through its divisions of atmospheric, earth, and ocean sciences, supports a broad range of innovative research focusing on understanding and predicting Earth's environment and its habitability. The Advisory Committee consists of representatives of the geosciences community who serve terms of three years. The current chair is Robert Detrick of the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

SECTION NEWS

GEOMAGNETISM & PALEOMAGNETISM

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10th Generation International Geomagnetic Reference Field

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The International Association of Geomagnetism and Aeronomy (IAGA) released the 10th Generation International Geomagnetic Reference Field (IGRF) on 12 December 2004. This is the latest version of a standard mathematical description of the Earth's main magnetic field, and is used widely in studies of the Earth's deep interior, crust, ionosphere, and magnetosphere. The coefficients were finalized by a task force of IAGA, Division V, Working Group V-MOD: Geomagnetic Field Modeling. The IGRF is the product of a large collaborative effort between magnetic field modelers and the institutes around the world involved in collecting and disseminating magnetic field data from satellites and observatories.

The IGRF is a series of mathematical models of the Earth's main field and its annual rate of change (secular variation). The sources of the main magnetic field are electric currents in the Earth and the magnetization of crustal rocks. In source-free regions at the Earth's surface and above, the main field, with sources internal to the Earth, can be represented as the negative gradient of a scalar potential V, expanded into spherical harmonics as where

$$V(r,\theta,\lambda,t) = R\sum_{n=1}^{n_{max}}\left(\frac{R}{r}\right)^{n+1}\sum_{m=0}^{n}\left(g_n^m(t)\cos m\lambda + h_n^m(t)\sin m\lambda\right)P_n^m(\theta)$$

r, θ, λ are geocentric coordinates (r is the distance from the center of the Earth, θ is the colatitude, i.e., 90° minus latitude, and λ is the longitude); R is the magnetic reference radius (6371.2 km); $g_n^m(t)$ and $h_n^m(t)$ are the coefficients at time t; and $p_n^m(\theta)$ are the Schmidt seminormalized associated Legendre functions of degree n and order m. The main field coefficients are functions of time.

For the IGRF, the change is assumed to be linear over 5-year intervals. For the upcoming 5-year epoch, the rate of change is given by predictive secular variation coefficients $\dot{g}_n^m$ and $\dot{h}_n^m$. For more details on main-field modelling, the reader is referred to *Chapman and Bartels* [1940)] and *Langel* [1987].

The coefficients of the 10th Generation IGRF are available from the IAGA Web site (www.iugg.org/IAGA) and the World Data Centers listed at the end of this article, as is software to compute magnetic field values from the coefficients. The new coefficients are the preliminary main-field coefficients for 2005.0 and the predictive secular-variation coefficients for 2005.0–2010.0. The previous (9th) generation IGRF with the definitive coefficients for 1995.0 and 2000.0 was finalized at the XXIII General Assembly of the International Union of Geodesy and Geophysics, held at Sapporo, Japan, in July 2003 [*Macmillan et al.,* 2003].

The satellite magnetic missions of the International Decade of Geopotential Research (Ørsted launched 1999, CHAMP launched 2000) are providing an unprec- edented wealth of highly accurate magnetic field measurements. In order to ensure that the accuracy of the IGRF reflects the high quality of available data, IAGA decided in 2001 that the main-field coefficients of the IGRF from the year 2000 onward should extend to degree $n_{max} = 13$ and be quoted to 0.1-nT precision (to reflect improved spatial resolution and instrument precision). Pre-2000 coefficients extend to degree 10 and are quoted to 1-nT precision. The predictive secular variation coefficients $\dot{g}_n^m$ and $\dot{h}_n^m$ for the upcoming 5-year epoch are given to degree 8 with a precision of 0.1 nT/yr.

With the 9th Generation IGRF, there was an update in the nomenclature. Table 1 provides this new nomenclature, as well as a summary of the history of the IGRF. It is important to specify the generation of the IGRF to establish which coefficients were actually used. For example, one cannot recover the original full-field data from an aeromagnetic anomaly data set in order to connect it with adjacent surveys if one does not know which generation of the IGRF was used. Finally, it is now recommended to use the World Geodetic System 1984 (WGS84, $a = 6378.137$ km, $b = 6356.752$ km) when specifying the IGRF in geodetic coordinates.

The new coefficients of IGRF-10 are taken from an average of selected candidate models, produced by T. Chernova, S. Choi, D. Dater, V. Golovkov, V. Lesur, F. Lowes, H. Lühr, S. Macmillan, S. Maus, W. Mai, S. McLean, N. Olsen, M. Rother, T. Sabaka, A. Thomson, and T. Zvereva. Details of the geomagnetic modelling methods will be published later this year in a special issue of *Earth, Planets and Space*.

Acknowledgments

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magnetic survey satellites, observatories, and World Data Centers.

World Data Centers

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Table 1. Summary of Nomenclature and IGRF History

Full Name	*Short Name*	*Valid for*	*Definitive for*
IGRF 10th generation (revised 2004)	IGRF-10	1900.0–2010.0	1945.0–2000.0
IGRF 9th generation (revised 2003)	IGRF-9	1900.0–2005.0	1945.0–2000.0
IGRF 8th generation (revised 1999)	IGRF-8	1900.0–2005.0	1945.0–1990.0
IGRF 7th generation (revised 1995)	IGRF-7	1900.0–2000.0	1945.0–1990.0
IGRF 6th generation (revised 1991)	IGRF-6	1945.0–1995.0	1945.0–1985.0
IGRF 5th generation (revised 1987)	IGRF-5	1945.0–1990.0	1945.0–1980.0
IGRF 4th generation (revised 1985)	IGRF-4	1945.0–1990.0	1965.0–1980.0
IGRF 3rd generation (revised 1981)	IGRF-3	1965.0–1985.0	1965.0–1975.0
IGRF 2nd generation (revised 1975)	IGRF-2	1955.0–1980.0	…
IGRF 1st generation (revised 1969)	IGRF-1	1955.0–1975.0	…

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Macmillan, S. et al. (2003), The 9th-Generation International Geomagnetic Reference Field, *Geophys. J. Int.*, *155*(3), 1051–1056.

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MEETINGS

Environmental Sensor Networks

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This report is based on the 2004 AGU Fall Meeting's session entitled "Special Focus: Advances in Data Acquisition, Management, Analysis and Display: Cyberinfrastructure for Earth Systems Science IV: Sensor Networks."

An environmental sensor network comprises an array of sensors that gather data autonomously and automatically forward the data to a central server. What differentiates modern sensor networks from previous techniques is an emphasis on "intelligence" in the sensor packages as well as the data network. Modern sensor networks also typically publish the data on the server to the World Wide Web and allow real-time access to the data. These networks require a unique combination of technological and environmental understanding, and have the potential of creating a revolution in environmental monitoring, similar in impact to satellite remote sensing in the 1970s.

Within an environmental sensor network, the sensor nodes gather data autonomously and a network is used to pass the data to one or more base stations (Figure 1). While wired networks can be used, for many applications the aim is to move toward a wireless networks (wire is expensive, obtrusive, and can disturb the environment being monitored). When the sensor nodes dynamically intercommunicate in order to establish a network, this is termed an ad hoc network.

Different types of data are collected by the sensor nodes. These include specific environmental parameters (e.g., soil moisture, stress, tilt) as well as generic data such as meteorological or dGPS (differential GPS). These data can be in different forms, digital and analogue, spatial and temporal, database or image, fixed or moving. At the server level the data can be visualized and analyzed within a geographic information system (GIS), combined with a satellite image and/or map, and published via the Web to give researchers seamless access to information.

In some remote or hazardous environments, data on basic environmental processes can be measured for the first time. In addition, sensor nodes can store data (to be released on instruction), make decisions about what data to pass on (e.g., local area summary), and even make decisions about when and what to sense (when conditions are appropriate). The network may be able to respond to data sent by the sensor nodes and act as a vital hazard warning system; e.g., if an oil spill happens or a weather forecast suggests a storm will occur, then the nodes can switch on or change their behavior. The aim of future sensor networks would be the monitoring of the environment at all scales, with the data automatically forwarded to the Internet where it would be integrated and analyzed with different data sets within an "intelligent" cyberinfrastructure.

The development of environmental sensor networks (which have evolved from automated loggers that record data at specific intervals and require manual downloading by a maintenance team) has occurred because of the miniaturization of electronics and wireless technology. In particular, *Chong and Kumar* [2003] have argued that sensor networks integrate research advances from sensors, communication, and computing. In addition, *Martinez et al.* [2004] have argued that understanding environmental processes is another vital component in sensing the environment.

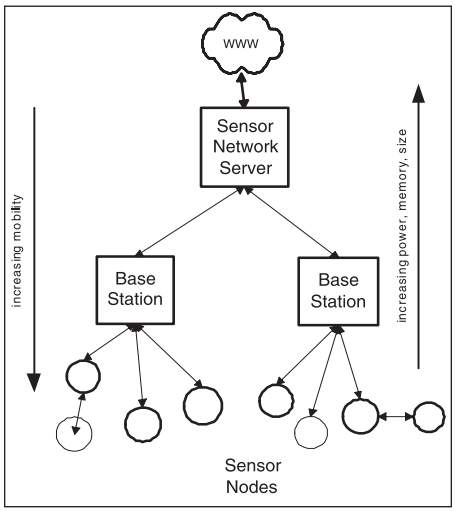

Fig. 1. Schematic diagram of an Environmental Sensor Network.

Sensor nodes need to be low cost (so that many can be deployed to sense the environment at a small scale), low power (otherwise they do not run without constant battery maintenance), robust (due to the hostile nature of most environments), and non-polluting, and preferably need to be camouflaged. Sensor nodes also need to be specifically designed for the environment they are sensing. They also need to be at the appropriate scale, record the necessary environmental parameters at a suitable time interval, and, if possible, behave like a natural part of the environment.

Two examples are the GLACSWEB project [*Martinez et al.*, 2004], which senses glacier