

IV.7 Global Geophysical Fluids Center

Introduction The Global Geophysical Fluids Center (GGFC) was established by the International Earth Rotation Service (IERS) on IERS's 10th anniversary day January 1, 1998, in an effort to expand IERS's services to the scientific community, which had already included those of the Sub-Bureau for Atmospheric Angular Momentum since 1989. Under the GGFC, seven Special Bureaus (SB) were established, each to be responsible for research activities relating to a specific Earth component or aspect of the geophysical fluids of the Earth system.

The geophysical fluids of the Earth system include the atmosphere, ocean, solid Earth, and core, and geophysical processes associated with tides and hydrological cycles. Mass transports in the atmosphere-hydrosphere-solid Earth-core system, or the "global geophysical fluids", will cause observable geodynamic effects on a broad time scale. The GGFC and the SBs have the responsibility of supporting, facilitating, and providing services to the worldwide research community in areas related to the variations in Earth rotation, gravitational field and geocenter that are caused by mass transport in the geophysical fluids. Under GGFC/SBs, angular momenta and the related torques, gravitational coefficients, and geocenter shift will be computed for all geophysical fluids based on global observational data, and/or products from state-of-the-art models some of which assimilate such data. The computed quantities, algorithm and data formats will be standardized. The data products are, and additional ones will be, archived and made available to the scientific research community.

Present Organization The following overview gives the heads of the GGFC and of the Special Bureaus as well as their host institutions. For addresses and details on electronic access see Chapter V.4 and Appendix 2.

GGFC

Head: Benjamin F. Chao
Space Geodesy Branch, NASA's Goddard Space Flight Center
Greenbelt, USA

Special Bureaus

ATMOSPHERE (SBAtmosphere)
Head: David A. Salstein
Atmospheric and Environmental Research, Inc.
Lexington, USA

OCEANS (SBOceans)
Head: Richard S. Gross
Jet Propulsion Laboratory
Pasadena, USA

TIDES (SBTides)
Head: Richard D. Ray
Space Geodesy Branch, NASA's Goddard Space Flight Center
Greenbelt, USA

HYDROLOGY (SBHydrology)
Head: Clark R. Wilson
Department of Geological Sciences, University of Texas, Austin
Austin, USA

MANTLE (SBMantle)
Head: Benjamin F. Chao
Space Geodesy Branch, NASA's Goddard Space Flight Center
Greenbelt, USA

CORE (SBCore)
Head: Veronique Dehant
Royal Observatory of Belgium/Observatoire Royal de Belgique
Brussels, Belgium

GRAVITY/GEOCENTER (SBGravity/Geocenter)
Head: Michael M. Watkins
Jet Propulsion Laboratory
Pasadena, USA

The GGFC Website is located at NASA's Goddard Space Flight Center, at URL <<http://bowie.gsfc.nasa.gov/ggfc/>>. The Special Bureaus can be readily linked from this portal site. The Websites contain detailed information of GGFC and the SBs, including description and availability of archived data, useful graphics, members/associates list, call for participation, planned activities, and bibliography, etc. In particular, the following article defining GGFC, published in 2000, is posted on the GGFC website, courtesy of the American Geophysical Union:

Chao, B. F., V. Dehant, R. S. Gross, R. D. Ray, D. A. Salstein, M. M. Watkins, and C. R. Wilson, Space geodesy monitors mass transports in global geophysical fluids, *EOS, Trans. Amer. Geophys. Union*, 81, 247-250, May 30, 2000.

Activities Update Below is a list of activities during 2000-2001:

GGFC Two GGFC meetings were conducted: (1) December 15, 2000, San Francisco, USA, during the American Geophysical Union's 2000 Fall Meeting; (2) March 29, 2001, Nice, France, during the European Geophysical Society General Assembly. The first meeting was an "invitation-only" small business meeting attended by the SB Heads and several interested scientists. The second meeting was a well attended open discussion by 30 scientists. SB Heads all made reports, and some lively discussions led to a proposal to establish a new Special Bureau for Loading, the process of which is now underway and expected to be completed in the beginning of 2002.

Two GGFC collective papers were presented by B. Chao at: (1) EGS2000 General Assembly, Nice, France, March, 2000; (2) Ocean Hemisphere Project Symposium, Japan, January 2001.

SBGravity/Geocenter Archiving of the previous Geocenter Campaign information data (from J. Ray) is completed. They are now available at the SBGravity/Geocenter website (see above).

SBCore The members of the SBCore have organized AGU and EGS sessions and have participated actively in the SEDI meeting (Study of the Earth Deep Interior). Following an AGU Union session, V. Dehant has been organizing and editing a new AGU monograph entitled "Core dynamics, structure and rotation", ed. V. Dehant, K. Creager, S. Karato, S. Zatman. It contains an impressive list of authors.

SBCore has sent out a call for participation for getting data, comments, and bibliography inputs through the SEDI email list. The ROB (Royal Observatory of Belgium) staff has updated the SBCore website and its bibliography, with new links to other sites of interest to the scientific community, and in particular with the websites of new satellites undergoing magnetic measurements including Oersted and Champ. A USA mirror site has been set up by B. Chao at Goddard.

New data series are available in the website, which brings the total number of data series to six. Apart from numerical geodynamo simulations, only indirect calculations using geomagnetic data can be performed to estimate core angular momentum as there are no direct observations of the core flow to lead to well-constrained models as in the case of the oceans and atmosphere. The hypotheses used for these computations are detailed on the website.

SBMantle In addition to seismic effects time series that have been archived since last year, the SBMantle has received two sets of post glacial rebound modeling data. The first set is from Eric Ivins (JPL). This

set of data consists graphics and spherical harmonic geopotential rates complete through degree 12 for each of three different cases. The geopotential rates are provided as a function of the lower mantle viscosity ranging from 1×10^{21} to 1×10^{23} Pa sec. The first case uses ICE3G and a standard (Tushingham and Peltier, 1991) earth model. The second case has an upper mantle viscosity of 3.2×10^{20} Pa sec (Johnston and Lambeck, 1999) and lithosphere thickness = 80 km. The third case has a fixed deepest mantle (CMB to 650 km above) viscosity at $\eta = 7 \times 10^{22}$ Pa sec, variable mantle viscosity from 650 km above the CMB to the 670 km seismic discontinuity, an upper mantle viscosity of 5×10^{20} Pa sec and a lithospheric thickness of 100 km.

The second set of data is from Prof. Peltier (University of Toronto). This set consists primarily of the graphics from chapter 4 in the recent book "Sea Level rise: History and Consequences" (ed. B. Douglas, M. Kearney, and S. Leatherman). Web/presentation friendly forms will be made available, in addition to the full post-script files. For both sets of data, we are in the process of preparing the data for inclusion on the website, and expect to have it available online in the very near future.

SBTides SBTides continues to add tidal datasets to its primary web site. Recent additions include tabulations of spherical harmonic expansion coefficients for several ocean tide models and at least one atmospheric tide model. Such expansions are useful for satellite orbitography and other space geodetic applications, in addition to Earth rotation study applications. The Special Bureau's web site receives roughly two dozen hits per day, excluding hits from web crawlers. The most popular page is the short tutorial explaining the effects of tides on the Earth's rotation. This page is linked from a number of other web sites related to tides, which no doubt helps account for its popularity.

SBHydrology The near-term goal of the SBHydrology is to provide internet access to water storage datasets that provide estimates of surface load variations for all land areas of the world. A trial dataset is on the website <<http://www.csr.utexas.edu/research/ggfc/>>. The website format was improved during the summer of 2001. A web site format for selecting individual river basin load time series is under development. A new member of the advisory group, Anny Cazenave, has been added, and a member of her research group, Marie-Claude Gennero, has begun efforts to establish a parallel website for providing internet access to related datasets, as reported at the EGS meeting, Nice, 2001. The URL for this effort is <<http://www.obs-mip.fr/omp/gos/resultats/geofluid.htm>>.

SBOceans Two OAM (Oceanic Angular Momentum) series, one spanning 1985-1996 at 5-day intervals, and the other spanning 1990-1993 at 15-day intervals, have been archived and can be downloaded from the SBOceans web site.

A bibliography of over 150 papers relating to oceanic processes and their influence on the solid Earth continues to be updated and expanded. The most recent version can be downloaded from the SBOceans web site. Information packets about the SBOceans continue to be distributed to potential customers at scientific conferences. More than 100 packets have been distributed to date.

A fortran program that computes the SBOceans core products (OAM, oceanic center-of-mass, and ocean-bottom pressure) has been written and is available upon request to <Richard.Gross@jpl.nasa.gov>.

A meeting for the Joint IAG/IAPSO Working Group on Geodetic Effects of Non-tidal Oceanic Processes was held on March 29, 2001, Nice, France, during the European Geophysical Society General Assembly.

SBAAtmosphere In conjunction with the U.S. National Oceanic and Atmospheric Administration (NOAA), the SBAAtmosphere has produced data from 4 different operational meteorological centers. We have also produced data from atmospheric reanalyses, spanning back to 1948. SBAAtmosphere organized a system to operate in two modes. In the first, it supplies the data in near real time through the service at NOAA. In the second mode, it updates monthly archives of the data on the FTP server at the Atmospheric and Environmental Research, Inc. (AER).

The principal data prepared relate to atmospheric excitations of Earth rotation vector, as forced by changes in the winds and surface pressure of the atmosphere, known respectively also as the motion and mass terms of the atmospheric angular momentum AAM. For the axial component, related to length of day, the stronger term is the motion one, and for the equatorial term, related to polar motion, the mass term dominates. An "inverted barometer" correction is produced to the mass terms, designed to model an equilibrium condition of the oceans in which the ocean depresses in response to a higher atmospheric pressure and rises in response to a lower one.

SBAAtmosphere also computes the AAM terms, locally, in a number of equal-area sectors distributed around the globe, as well as globally. In addition, SBAAtmosphere computes the mean atmospheric surface pressure over the globe, and various spherical harmonics, which are related to the Stokes coefficients of the Earth gravity field. Users log in to our ftp sites to obtain the desired information. Having kept track of our data usage during a recent pe-

riod, for example, the data were accessed by 35 different IP (Internet Protocol) addresses between March and October 2000.

Two reports have been prepared:

Salstein, D. A., O. de Viron, M. Yseboodt, and V. Dehant, 2001;

High-frequency geophysical fluid modeling necessary to understand Earth rotation variability, in press, EOS.

Salstein, D. A., and A. J. Miller, 2001: The special bureau for the atmosphere of the International Earth Rotation Service, submitted, IERS Technical Note, ed. B. F. Chao, International Earth Rotation Service.

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Richard D. Ray, David A. Salstein, Michael M. Watkins,
Clark R. Wilson*