The Impact of Non-Tidal Oceanic Processes on Geodesy

by

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- **The oceans have a major impact on global geophysical processes of the Earth**
  - Oceanic currents and bottom pressure
    - Affect the Earth's rotation (length-of-day, polar motion, nutation)
  - Redistribution of oceanic mass
    - Causes temporal variations of the Earth's gravitational field
    - Affects the Earth's geocenter (center-of-mass of solid Earth)
    - Loads the oceanic crust and mantle, thereby affecting the positions of stations located near the oceans
- **The IERS has established a Special Bureau for the Oceans as part of the its Center for Global Geophysical Fluids in order to**
  - Maintain liaisons with ocean modeling groups, advocating the calculation of relevant products
  - Archive and distribute these ocean-model products
  - Facilitate research on the effects of oceanic processes on solid Earth geophysics, including geodesy and geodynamics

Vertical Displacements Caused by Non-Tidal Ocean Loading

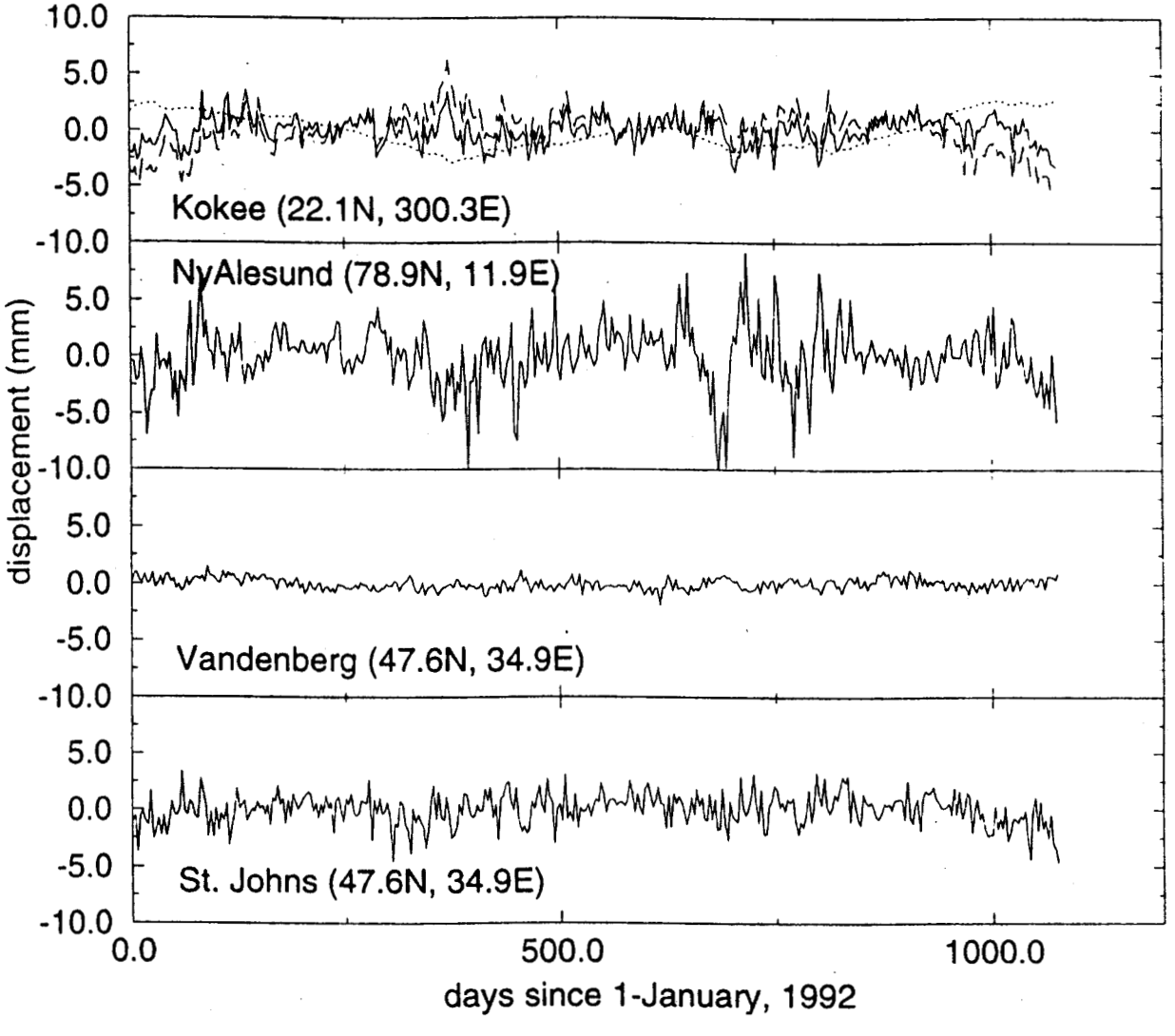


Figure 1. Vertical crustal motion at four coastal GPS sites, caused by non-tidal ocean loading and predicted by the OGCM model. The results are the sum of contributions from the sea-surface and density effects. Results for the sea-surface (dashed line) and density effect (dotted line) contributions are shown separately for Kokee.

vanDam et al. (1997)

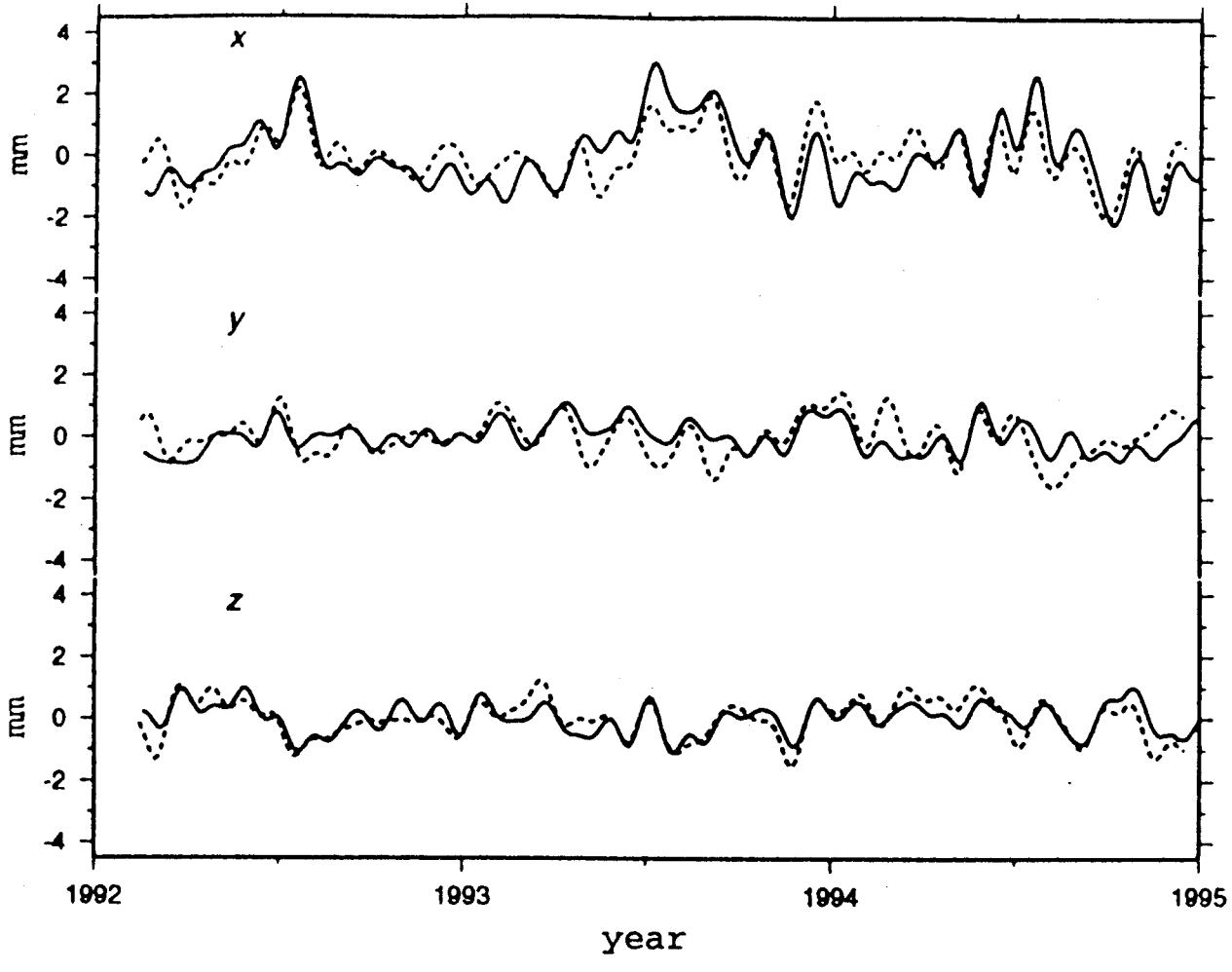


Figure 2: Geocenter variation from ISO model (solid line) and MOM model (dashed line). Both series passed band-pass filtering with the cutoff period from 30 day to 10 year.

Dong et al. (1997)

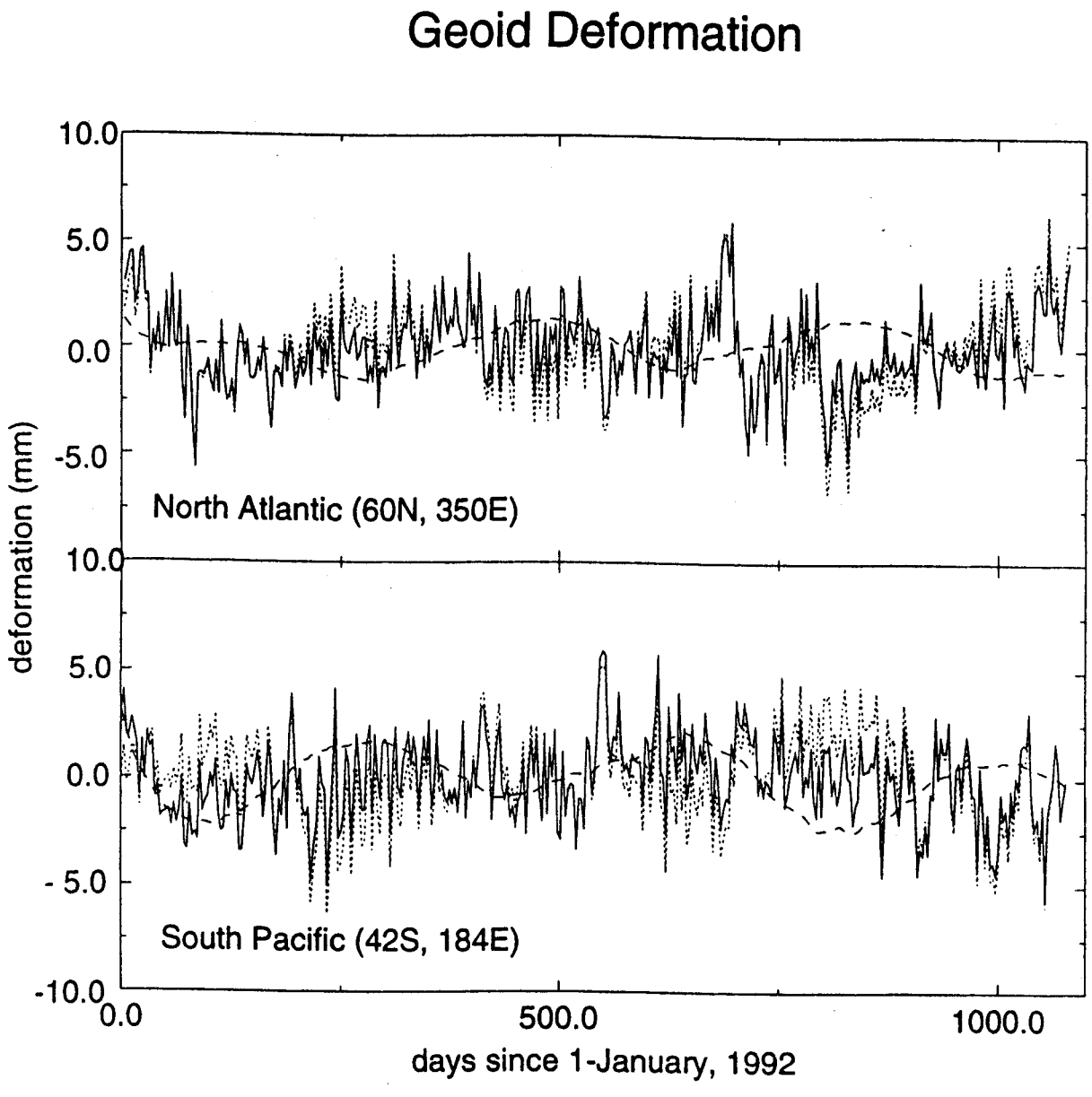
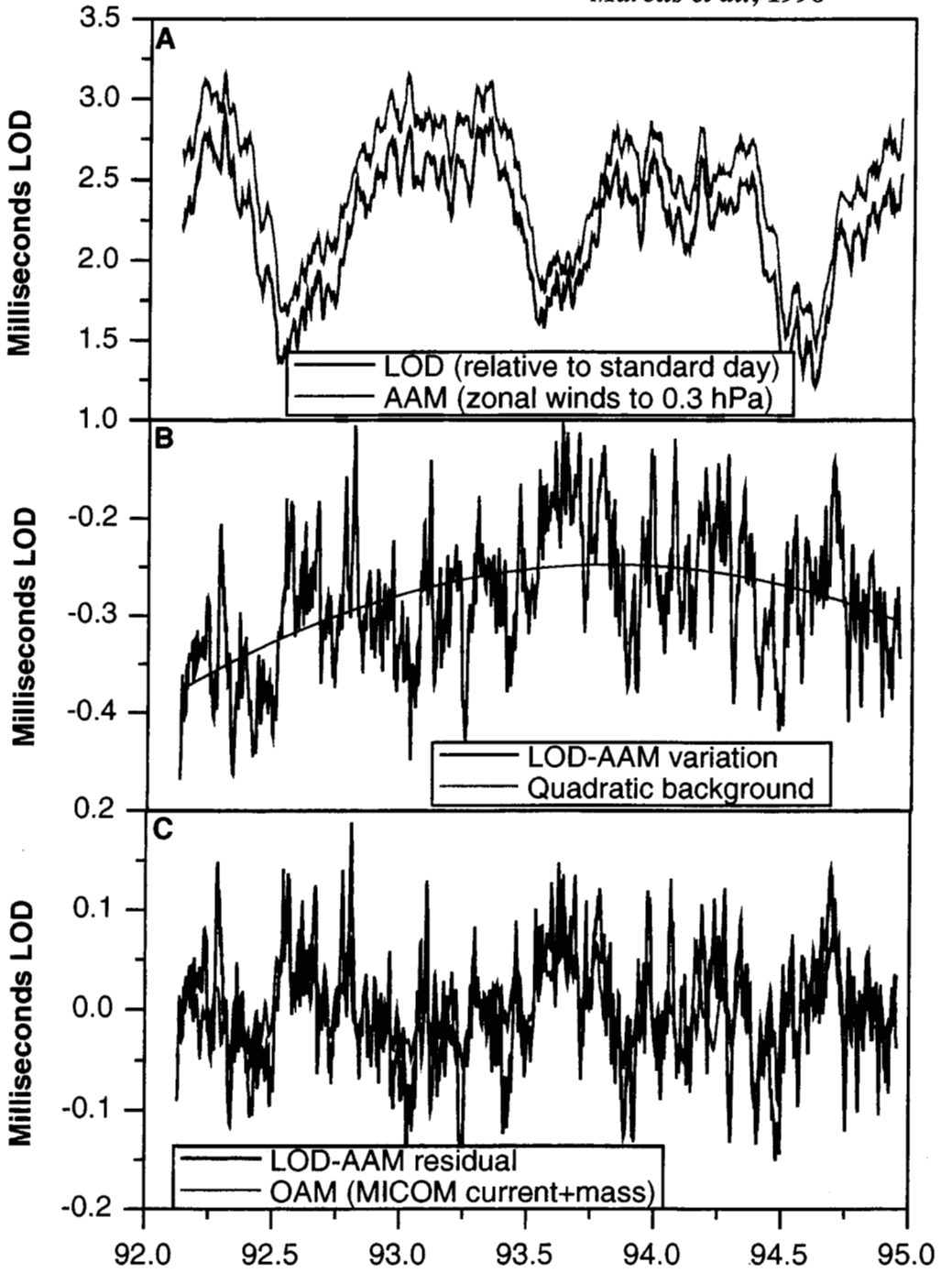


Figure 3. Time-dependent fluctuations in the geoid due to non-tidal ocean loading, estimated at two representative sites in the North Atlantic and South Pacific using results from the OGCM model. Results for the sea-level (dotted line) and density effect (dashed line) contributions and for the sum of the two (solid line) are shown for each location.

vanDam et al. (1997)

Marcus et al., 1998

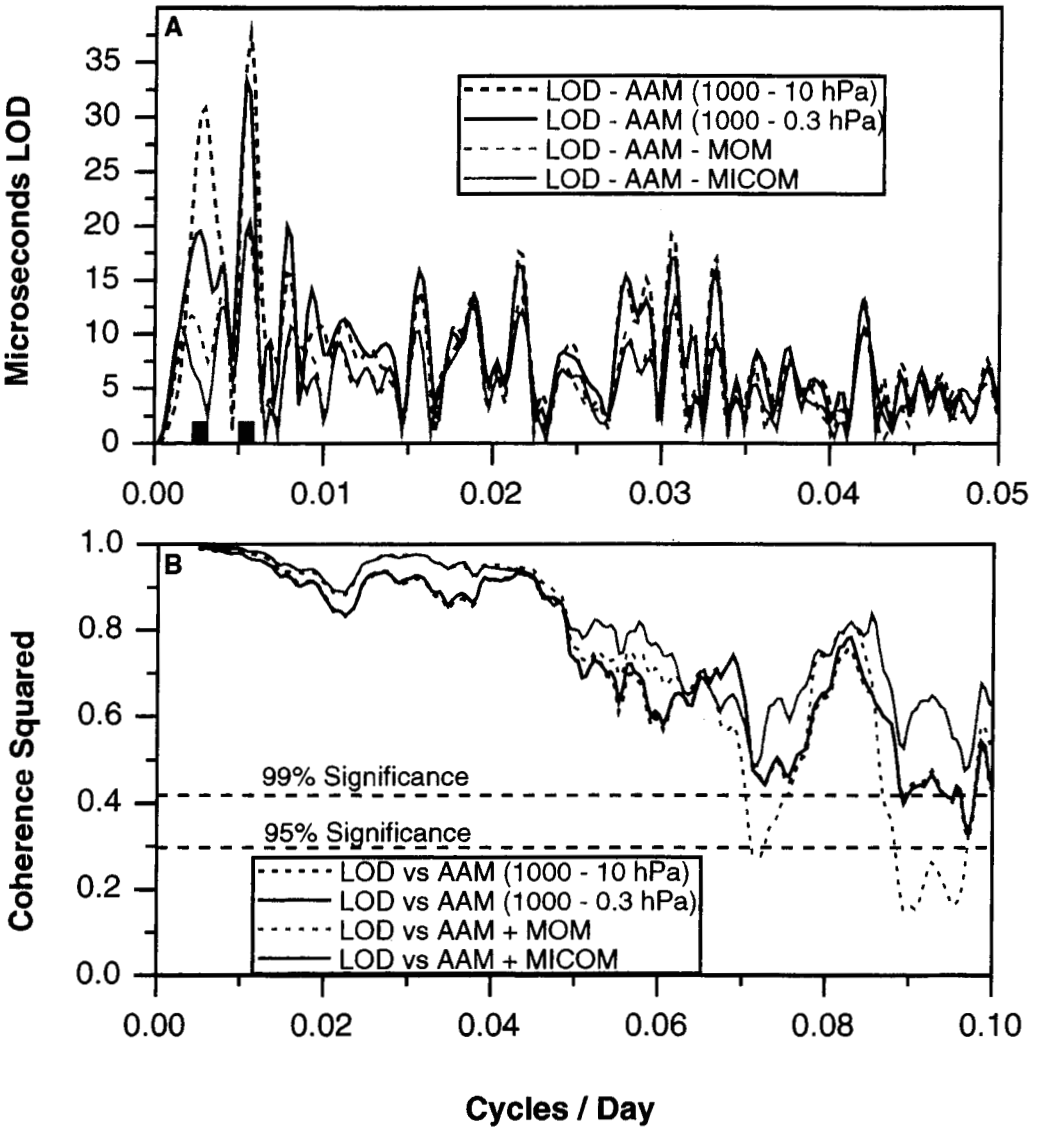


(A) Comparison of observed LOD with atmospheric forcing, computed from zonal winds integrated from 1000 to 0.3 hPa. Because the LOD is defined with respect to an arbitrary reference value, its vertical offset has no physical significance.

(B) Difference between the LOD and AAM curves plotted in frame (A) compared with a least-squares-fit second-order polynomial used to represent the effects of core-mantle coupling.

(C) Difference between the LOD-AAM and quadratic terms plotted in frame (B) compared with total OAM computed from the MICOM simulation.

Marcus et al., 1998



(A) Amplitude spectra of LOD residuals after subtraction of atmospheric and oceanic excitation. AAM was computed from winds supplied by the ECMWF and JMA analysis and NCEP reanalysis campaigns for the 1000 - 10 hPa layer, and from BADC winds for the 10 - 0.3 hPa layer; the full (1000 - 0.3 hPa) AAM was used in combination with the OAM computed from the MOM and MICOM results. Spectral bandwidth is given by the width of the green bars, which are centered on the abscissa at the annual and semiannual frequencies.

(B) Coherence squared of LOD with atmospheric and combined atmopheric and oceanic excitation sources (note difference in the frequency scale).

INTERNATIONAL EARTH ROTATION SERVICE

- **Began operation on January 1, 1988**
  - By the IUGG and the IAU to replace the International Polar Motion Service (IPMS) and the Earth rotation section of the Bureau de l'Heure (BIH)
- **Primary objective**
  - To serve the astronomical, geodetic, and geophysical communities by providing
    - International Celestial Reference System and Frame (ICRF)
    - International Terrestrial Reference System and Frame (ITRF)
    - Earth orientation parameters (EOPs) required to study Earth orientation variations and to transform between the ICRF & ITRF
    - Geophysical data to interpret temporal and/or spatial variations of the ICRF, ITRF, and EOPs, and to model such variations
    - Standards, constants, and models (conventions)
- **Activities**
  - Collect, archive, and distribute products
    - ICRF, ITRF, and monthly Earth orientation data
    - Daily rapid service estimates of near real-time Earth orientation data and their predictions
    - Difference between astronomical and civil time
    - Leap second announcements
    - Products related to global geophysical fluids
    - Annual report and technical notes on conventions & other topics
    - Long-term Earth orientation information

GLOBAL GEOPHYSICAL FLUIDS CENTER OF THE IERS

- **Established January 1, 1998**
  - For the purpose of facilitating research on the interaction between the solid Earth and its fluid envelope and core
- **Consists of a Coordinating Center & 7 Special Bureaus**
  - Coordinating Center
    - Coordinator: Ben Chao, GSFC
    - Coordinates activities of the Special Bureaus
  - Special Bureau for the Atmosphere
    - Head: David Salstein, AER
  - Special Bureau for the Oceans
    - Head: Richard Gross, JPL
  - Special Bureau for Hydrology
    - Head: Clark Wilson, U. Texas
  - Special Bureau for Tides
    - Head: Richard Ray, GSFC
  - Special Bureau for the Mantle
    - Head: Ben Chao, GSFC
  - Special Bureau for the Core
    - Head: Veronique Dehant, Royal Observatory of Belgium
  - Special Bureau for Gravity and Geocenter
    - Head: Mike Watkins, JPL
  - Special Bureaus are responsible for collecting, calculating, analyzing, archiving, and distributing data relating to the processes of that Special Bureau that affect the Earth's rotation, deformation, gravitational field, and geocenter

IERS SBO PRODUCTS

- **Core products**
  - Oceanic angular momentum
  - Oceanic center-of-mass
  - Ocean-bottom pressure
- **Extended products**
  - Time-dependent gravitational field coefficients
    - Caused by ocean-bottom pressure changes
    - CHAMP and GRACE will soon measure the time-dependent gravitational field coefficients of the entire Earth
  - Oceanic torques (frictional and topographic)
    - Enables investigations into how angular momentum is exchanged between the oceans and solid Earth
- **Auxiliary products**
  - Land-ocean mask and time-dependent oceanic mass
    - Needed when imposing mass conservation upon products of Boussinesq ocean models (which conserve volume, not mass)
  - Ocean-bottom topography
    - Needed for certain calculations involving ocean-bottom pressure
- **Product availability**
  - IERS SBO products are available by request to Richard Gross
    - Richard.Gross@jpl.nasa.gov
  - A World Wide Web home page and anonymous ftp site are currently under development

IERS SBO TEAM

Oceanography

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Atmospheric Sciences

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Earth Rotation

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