



Atmospheric and
Environmental Research, Inc.

Establishing an IERS Sub-Center for Ocean Angular Momentum

Principal Investigator: RUI M. PONTE

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Submitted by:

Atmospheric and Environmental Research, Inc.
131 Hartwell Avenue
Lexington, MA 02421-3126 USA
Phone: (781)761-2288

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FINAL REPORT

The project entitled “Establishing an IERS Sub-Center for Ocean Angular Momentum” came to existence at AER on September 21, 1998, under the direction of the Principal Investigator R.M. Ponte, and lasted for two and a half years with a total funding of \$97,800. The focus of the project was to establish a new archival center for ocean angular momentum (OAM) products — the Special Bureau for the Oceans (SBO) — as part of a broader effort by the International Earth Rotation Service (IERS) to create a Global Geophysical Fluids Center (GGFC) dealing with all fluids affecting the rotation of the Earth. This report summarizes activities carried out under the project.

To get the SBO off the ground, major efforts were directed at calculating and analyzing OAM quantities from several ocean models. Particular attention was given to OAM time series computed from 11+ years of output from the MIT primitive equation model described in Ponte et al. (1998, *Nature*, 391, p. 476). Detailed analyses of OAM variability in relation to regional changes in oceanic currents and mass field and to Earth rotation parameters were performed. Results on the axial OAM component were written up as a paper entitled “Global and regional axial ocean angular momentum signals and length-of-day variations (1985–1996)”, co-authored with D. Stammer. The paper appeared in the July 15, 2000 issue of the *Journal of Geophysical Research-Oceans*. A reprint is appended to this report. As part of the project, we completed the process of preparing, documenting, and archiving the MIT model OAM series (all its three components about the polar and equatorial axes). The dataset is now publicly available at SBO.

Another major effort was dedicated to the analysis of an OAM dataset obtained from an MIT model run that was constrained by a number of available global ocean observations (sea level from altimetry, monthly mean hydrography, and sea surface temperatures). The potential improvements on OAM values provided by the data constraints were addressed in detail. Results were written up in a paper entitled “Improving ocean angular momentum estimates using a model constrained by data” co-authored with D. Stammer and C. Wunsch. The paper is now in press at *Geophysical Research Letters*. A reprint is appended to this report. An invited talk focusing on these results was also prepared and delivered by the PI at the EGS General Assembly held in Nice in April 2000. These OAM series are under consideration for potential archival at SBO.

To be able to provide OAM series spanning at least several decades, feasibility checks on a number of available ocean products were carried out. A 50-year ocean analysis product recently developed at the University of Maryland by James Carton and collaborators was chosen based on those checks. Contact with the relevant investigators was established and appropriate data was obtained. Software to calculate OAM quantities from the ocean fields was developed and tested. Extensive analyses of the monthly time series in comparison with

other OAM products and in the context of the Earth's rotation budget were performed. The 50-year long series reveals the importance of OAM for polar motion excitation at interannual periods. Work towards a paper documenting the new data set and analysis was initiated. Release of the new dataset to SBO archives is envisioned in the near future.

In addition to long OAM time series, the need for high temporal resolution products, important in studies of rapid rotation signals, was also considered. Calculation of 6-hourly OAM values was pursued using the barotropic model of Ponte (1993, *Dynamics of Atmosphere and Oceans*, 18, p. 209), which accounts for both wind and pressure forcing effects. Preliminary results were obtained from a model run with optimized parameters, as judged from comparisons with altimeter sea level measurements. Six-hourly time series beginning in 1992 have been created and plans were laid out to analyze and test their overall quality.

On other miscellaneous activities, the PI began examining the possible calculation of torque quantities representing exchanges of OAM with the solid Earth and atmosphere. A number of ocean models were explored with regard to their formulation of the momentum equations, and conservation equations for the three OAM components consistent with the model approximations were derived. Work towards developing the best procedures and software to compute the torques for future MIT model runs was carried out.

The PI participated in a number of meetings directly related to SBO activities. These meetings included the IERS Workshop that took place in October 1998, in Potsdam, Germany, where the PI presented an invited talk entitled "Importance of ocean signals in the excitation of polar motion" on the session dedicated to GGFC. The PI also participated in informal SBO meetings that took place in October 1998 at Keystone, Colorado, and October 1999 at St. Raphael, France, on the occasion of TOPEX/Poseidon-Jason1 meetings, and in April 2000 in Nice, France, on the occasion of the EGS General Assembly, where SBO activities were discussed and planned.

Throughout the project, the PI was involved in exchanges with other investigators to define the scope of SBO activities and products, which led to the preparation of a document entitled "The IERS Special Bureau for the Oceans", by Gross et al. This note will be published as part of an IERS Technical Report and serves as an introduction of SBO to the geophysical community. The PI also helped in setting up the SBO web page, hosted at the Jet Propulsion Laboratory and available for use by all interested investigators at <http://euler.jpl.nasa.gov/sbo/>.

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