Meteorological Data for Geodynamics Use: IERS Special Bureau for the Atmosphere

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131 Hartwell Avenue, Lexington, MA 02421

Final Report

NASA Contract NAS5-99009

ABSTRACT

During the life of this contract, the PI set up and operated a data center known as the "Special Bureau for the Atmosphere" of the International Earth Rotation Service (IERS) at Atmospheric and Environmental Research, Inc., and in conjunction with the U.S. National Oceanic and Atmospheric Administration. The role of the center is to calculate, archive, analyze, and distribute atmospheric data related to Earth rotation, polar motion and other motions of the Earth. We have produced data from 4 different operational meteorological centers. We have also produced data from atmospheric reanalyses, spanning back about a half a century. The center is one of several centers under the Global Geophysical Fluids Center (GGFC) of the IERS; the GGFC is centered at NASA's Goddard Space Flight Center. Our data center has made data available to a large variety of scientists worldwide.

1. Introduction and history

The Principal Investigator has been supplying atmospheric data for geodyamics uses for a number of years. First, under the Subbureau for Atmospheric Angular Momentum (Salstein, 1993) of the International Earth Rotation Service, he has been calculating and supplying these data since 1989, in conjunction with A. J. Miller of NOAA. When the IERS was reorganized, the Subbureau for AAM data center was selected through a proposal call of the IERS to become the Special Bureau for the Atmosphere, one of several special fluid bureaus under the aegis of the Global Geophysical Fluids Center, housed at NASA Goddard Space Flight Center. Because the Special Bureau under the IERS needed support for its operations, we sought it from NASA that time.

We organized a system to operate in two modes. In the first, we supply the data in near real time through the service at NOAA. In the second mode, we update monthly our archives of the data on the FTP server at AER. Our users log in to the AER site to gain

access to values describing the atmospheric terms related to Earth rotation and polar motion, including excitation values related to the mass and momentum of the atmosphere.

2. Data description

A list of the data files from the AER ftp site is as follows:

aam.ecmwf	1715 Kb	Fri Jul 23 00:00:00 1999
aam.ecmwf.2	634 Kb	Wed Jan 5 00:00:00 2000
aam.jma	1486 Kb	Fri Jul 23 00:00:00 1999
aam.jma.2	971 Kb	Wed Jan 5 00:00:00 2000
aam.ncep	2490 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.2	742 Kb	Wed Jan 5 00:00:00 2000
aam.ncep.reanalysis.1948.1957	3724 Kb	Fri Jul 21 14:52:00 2000
aam.ncep.reanalysis.1958.1967	3723 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.reanalysis.1968.1978	4096 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.reanalysis.1979.1996	6703 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.reanalysis.1997	372 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.reanalysis.1998	372 Kb	Fri Jul 23 00:00:00 1999
aam.ncep.reanalysis.1999	372 Kb	Wed Jan 5 00:00:00 2000
aam.ncep.reanalysis.2000	373 Kb	Tue Jan 16 16:22:00 2001
aam.ncep.reanalysis.2001	91 Kb	Thu Apr 19 14:07:00 2001
aam.ukmo	1321 Kb	Fri Jul 23 00:00:00 1999
aam.ukmo.2	173 Kb	Wed Jan 5 00:00:00 2000
ftorque.ncep.reanalysis	460 Kb	Tue Dec 14 00:00:00 1999
mtorque.ncep.reanalysis	460 Kb	Tue Dec 14 00:00:00 1999
pcoeff.ncep.reanalysis.1975.1998	57253 Kb	Fri Jul 23 00:00:00 1999
pcoeff.ncep.reanalysis.1999	2383 Kb	Wed Jan 5 00:00:00 2000
pcoeff.ncep.reanalysis.2000	2390 Kb	Fri Mar 2 18:12:00 2001
readme.aam.ecmwf	2 Kb	Fri Jul 23 00:00:00 1999
readme.aam.jma	1 Kb	Fri Jul 23 00:00:00 1999
readme.aam.ncep	3 Kb	Fri Jul 23 00:00:00 1999
readme.aam.ncep.reanalysis	2 Kb	Fri Jul 23 00:00:00 1999

readme.aam.ukmo	1 Kb	Fri Jul 23 00:00:00 1999
readme.pcoeff	1 Kb	Fri Jul 23 00:00:00 1999
readme.torque.ncep.reanalysis	814 bytes	Tue Dec 14 00:00:00 1999

A list of the directory of the NOAA files is as follows:

Current directory is /pub/cpc/long/aam

ecmwf/
jma/
nmc/
ukmo/

and a sample of the directory nmc , for example, is:

Current directory is /pub/cpc/long/aam/nmc

Up to higher level directory
000606.anl
000607.anl
000607.fcst
000608.anl
000608.fcst
000609.anl
000609.fcst
000610.anl
000610.fcst
000611.anl
000611.fcst
000612.anl
000612.fcst
000613.anl
000613.fcst
000614.anl

000614.fcst

000615.anl

000615.fcst

000616.fcst

where "anl" stands for the analysis (valid at time indicated) and the "fcst" fields represent forecasts made every 12 hours out to 120 hours (5 days).

3. Content of data

The principal data that have been prepared under the subject contract are an extension of what was first described by Salstein et al. (1993), and updated by Salstein and Miller (2001). They relate to atmospheric excitations of Earth rotation and polar motion, as forced by changes in the winds and surface pressure of the atmosphere, known respectively also as the motion and mass terms. 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. We also produce the "inverted barometer" correction 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. To calculate such an effect, the mean surface pressure over every point in the ocean replaces the surface pressure value at each grid point over the ocean.

We have also computed terms related to earth rotation and polar motion, locally, in a number of equal-area sectors distributed around the globe, as well as globally. We also compute the mean atmospheric surface pressure over the globe, and various spherical harmonics (related to Stokes coefficients) that are of interest to scientists interested in Earth gravity measurements.

4. Users

We service a number of Users of our data, who come from several agencies, laboratories, observatories, and universities in the US as well as in other countries. The Users log in to our ftp sites to obtain the desired information. The data are useful for a number of studies, relating to astronomy, spacecraft navigation, understanding of Earth motions and geophysics, reference frames, and climate theory.

Having kept track of our data usage during a recent period, we can report, for example, that our data were accessed by 35 different IP (Internet Protocol) addresses between March and October 2000.

We have compared the spread of data from the seven analyses for the three different components of the atmospheric angular momentum (excitation) functions. Results show that the signal-to-noise ratio is stronger for the pressure terms than for the wind terms in the equatorial functions (related to polar motion), and those of the wind terms are stronger than the pressure terms in the axial functions (related to earth rotation or length-of-day).

5. Presentations and publications

We have presented our work at a number of forums including the Spring and Fall Meetings of the American Geophysical Union, the International Union of Geodesy and Geodynamics General Assembly (Birmingham), and the European Geophysical Society (Nice). At these meetings, there are separate meetings of the Global Geophysical Fluids Center of the IERS. In these meetings, we have interacted with the other Special Bureau heads and with the Head of the Global Geophysical Fluids Center. We have contributed a report to the IERS Technical note series describing the duties and data within our Special Bureau for the Atmosphere (Salstein and Miller 2001). Additionally, we published the following papers closely related to the reported work:

Abarca del Rio, R., D. Gambis, and D. A. Salstein, 2000: Interannual signals in length of day and atmospheric angular momentum, *Ann. Geophysicae.* **18**, 347-364.

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

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.

And report: Salstein, D.A., and A. J. Miller, 2001: The special bureau for the atmosphere of the International Earth Rotation Service, Technical Note, IERS, B.-F. Chao, editor., International Earth Rotation Service, Frankfurt, Germany.

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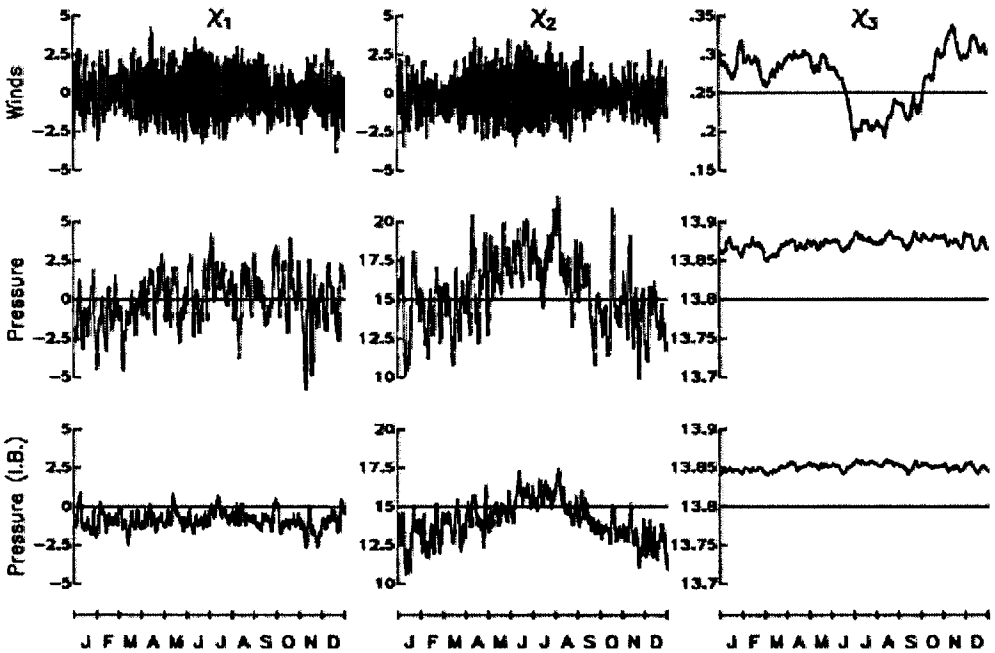

Data for 1999 of the angular momentum of the atmosphere in two directions in the equatorial plane (χ_1 and χ_2), related to motions of the Earth's pole, and in the axial direction (χ_3) related to changes in the rotation rate of Earth. Based on four-times daily winds and surface pressure fields from the National Centers for environmental Prediction/National Center for Atmospheric Research reanalyses. A parallel set for the pressure term is included, involving the impact of the ocean according to the Inverted Barometer relationship.

Funding: $93,300

Contact: David A. Salstein, 617-547-6207
salstein@aer.com

Description:

Acquire, calculate, evaluate, archive, and distribute multiple atmospheric data sets relating to geodetic properties, including Earth rotation, polar motion, and gravity fields. Effort is in cooperation with the other special bureaus of the Global Geophysical Fluids Center of the International Earth Rotation Service

Conduct 3 operations:

- Update datasets based on long-term reanalyses of the atmosphere
- Coordinate with NOAA staff to obtain operational analyses of the atmosphere, which are available in near-real time
- Make data available to and give advice to geodetic community of scientists on use of atmospheric data in this discipline

Strategic Importance:

- Understand role of atmosphere in Earth system dynamics
- Estimate quality of various atmospheric analyses
- Use in systems for positioning in astronomy and space navigation

Anticipated benefit:

- Establishment of center to supply scientists special atmospheric data for geodynamics

Project schedule:

Proposal submission	- November 1997
Contract start date	- November 1998
Final report due	- May 2001

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During the life of this contract, the PI set up and operated a data center known as the "Special Bureau for the Atmosphere" of the International Earth Rotation Service (IERS) at Atmospheric and Environmental Research, Inc., and in conjunction with the U.S. National Oceanic and Atmospheric Administration. The role of the center is to calculate, archive, analyze, and distribute atmospheric data related to Earth rotation, polar motion and other motions of the Earth. We have produced data from 4 different operational meteorological centers. We have also produced data from atmospheric reanalyzes, spanning back about a half a century. The center is one of several centers under the Global Geophysical Fluids Center (GGFC) of the IERS; the GGFC is centered at NASA's Goddard Space Flight Center. Our data center has made data available to a large variety of scientists worldwide.

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