COMPARISON OF HYDROLOGICAL AND GRACE-BASED EXCITATION FUNCTIONS OF POLAR MOTION IN THE SEASONAL SPECTRAL BAND

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ABSTRACT. Understanding changes in the global balance of the Earths angular momentum due to the mass redistribution of geophysical fluids is needed to explain the observed polar motion. The impact of continental hydrologic signals, from land water, snow, and ice, on polar motion excitation (hydrological angular momentum-HAM), is still inadequately known. Although estimates of HAM have been made from several models of global hydrology based upon the observed distribution of surface water, snow, and soil moisture, the relatively sparse observation network and the presence of errors in the data and the geophysical fluid models preclude a full understanding of the HAM influence on polar motion variations. Recently the GRACE mission monitoring Earths time variable gravity field has allowed us to determine the mass term of polar motion excitation functions and compare them with the mass term derivable as a residual from the geodetic excitation functions and geophysical fluid motion terms on seasonal time scales. Differences between these mass terms in the years 2004 - 2005.5 are still on the order of 20 mas. Besides the overall mass excitation of polar motion comparisons with GRACE (RL04-release), we also intercompare the non-atmospheric, non-oceanic signals in the mass term of geodetic polar motion excitation with hydrological excitation of polar motion.

1. DATA AND ANALYSES

Three different sets of degree-2, and order-1 harmonics of the gravity field, derived from Gravity Recovery and Climate Experiment (GRACE) data, processed at the GeoforschungsZentrum (GFZ-RL04), Jet Propulsion Laboratory (JPL-RL04), and Center for Space Research (CSR-RL04), http://grace.jpl.nasa.gov, are used to compute the polar motion excitation functions (Fig.1).

The geodetic mass excitation function (G - WC) is obtained by a time domain deconvolution formula applied to the IERS C04 series of polar motion, based on a combination of geodetic observing techniques. The mass term of the geodetic excitation function is estimated by removing the atmospheric winds (W) and oceanic currents (C) terms (Figs. 1, 2).

Atmospheric excitation function (AAM) is from the U.S. NCEP-NCAR reanalysis [Kalnay et al., 1996], including pressure with inverted barometer correction (PIB) and wind terms. ECCO_kf049f series - oceanic excitation function (OAM) [Gross et al., 2003] – the modification of the MIT ocean model forced by atmospheric surface wind stress, heat flux, and freshwater flux data based on the NCEP-NCAR reanalyses, with 1 day sampling, January 1993 - March 2006. The OAM series, mass and motion terms, are based on the distribution of bottom pressure and currents, respectively.

Hydrological excitation function (HAM) are computed using the Chen and Wilson [2005] formulation from the three hydrological models: CPC, GLDAS, and LaD. Two total series are analysed: PAO series is the sum of the atmospheric (PIB) and oceanic pressure terms of polar motion excitation functions, PAOH series is the sum of the atmospheric (PIB) and oceanic pressure terms of excitation functions of polar motion and the average of the CPC and GLDAS and LaD hydrological excitation functions.

To ensure consistent availability at the same set of time steps, all series were interpolated by applying a Gaussian smoother [Feissel and Lewandowski, 1984] with output step 30 days, FWHM = 30 days and least squares (LSQ) fit of the model comprising the 1st order polynomial and sum of complex sinusoids with periods 1, 1/2 and 1/3 years. Each of the three GRACE-based polar motion excitation functions

(RL04) is compared with the mass term of geodetic excitation function of polar motion (G-WC) in Fig. 1.

The mass term of the geodetic excitation function G-WC is compared with the mean GRACE-RL04 and the total PAOH excitation functions of polar motion, showing some agreement of the annual oscillation in χ_1, especially for GRACE RL04, and good agreement in χ_2 (Fig. 2). The differences of these curves are of the order of 10 mas. Next the annual oscillations were isolated by filtering from the mass term of the geodetic excitation functions G-WC, GRACE(RL04) and geophysical excitation functions (PAO, PAOH). Residuals obtained after removing seasonal oscillations (annual, semiannual, terannual) from these series reach maxima of about 20 mas (Fig. 3)

2. CONCLUSIONS

Differences between mass term of the geodetic excitation function G - WC and the three GRACE polar motion excitation functions (JPL - RL04, GFZ - RL04, CSR - RL04) as well as their mean in the years 2004 - 2005.5 are still on order of 20 mas (Fig. 1).

There are distinct annual oscillations in variations of χ_2 of all considered series (Figs. 1,2). Differences between mass term of geodetic excitation function (G - WC) and the total geophysical excitation functions PAOH and the mean GRACE RL04 are on order of a few mas (Fig. 2).

Residuals obtained after removing seasonal oscillations (annual, semiannual, terannual) from the considered series reach in maximum about 20 mas (Fig. 3).

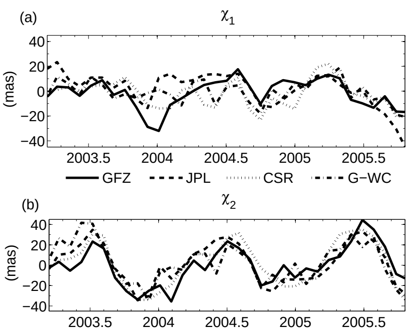

Figure 1

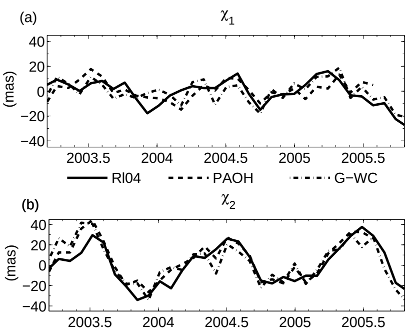

Figure 2

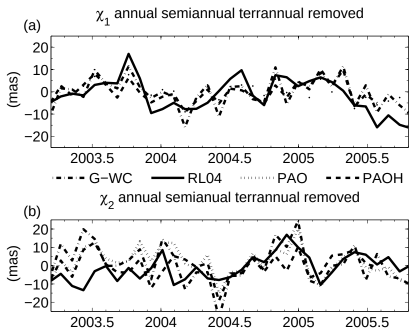

Figure 3

Figure 1: Comparison of mass term of the geodetic excitation function (G-WC; dash-dotted), with three GRACE-RL04 polar motion excitation functions (GFZ solid, JPL dashed, CSR dotted).
Figure 2: Comparison of mass term of the geodetic excitation function (G-WC; dash-dotted), with the mean GRACE polar motion excitation function (GRACE RL04 dotted) and the total series (PAOH dashed).
Figure 3 : Comparison of mass term of the geodetic excitation function (G-WC; dash-dotted), with the mean GRACE polar motion excitation function (GRACE RL04 dotted line) and the total series (PAOH dashed).

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3. REFERENCES

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