COMPARISON OF POLAR MOTION EXCITATION FUNCTION DERIVED FROM EQUIVALENT WATER THICKNESS DATA, OBTAINED FROM FILTERED STOKES COEFFICIENTS

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ABSTRACT. It is known that the estimates of the Earth's gravity field produced by the Gravity Recovery and Climate Experiment (GRACE) satellite mission can be used to infer changes in equivalent water thickness (EWT). However, inadequately smoothed GRACE satellite mission EWT data contain significant striping and thus ought to be filtered to improve signal to noise ratio. We used Stokes coefficients data from GFZ (GeoForschungsZentrum), JPL (Jet Propulsion Laboratory) and CSR (Center for Space Research), filtered by decorrelation anisotropic filters: DDK3, DDK2 and DDK1 (Kusche et al., 2009) and made available in the ICGEM (International Center for Global Earth Models). To determine gravimetric excitation function of polar motion for the entire globe or selected areas, we convert gravity coefficients into Equivalent Water Thickness fields. To eliminate stripes from the maps of the EWT, one uses anisotropic filters (Kusche et al., 2009) that are smoothing the EWT data. In this study we investigate the influence of decorrelation anisotropic DDK filters used to process the GRACE EWT fields on the determined polar motion gravimetric excitation functions. We investigate the effect of these filters for four regions: 1) entire Earth, 2) ocean area, 3) land area and 4) Tibetan Plateau area (a rectangle bounded by 4 points A(37°N,78°E), B(37°N,102°E), C(28°N,78°E), D(28°N,102°E). Stokes coefficients are made available on the ICGEM web site. The data contain spherical harmonic coefficients delivered by three research centers: CSR, GFZ, JPL. The time span of the data is 2002 - 2010. The time resolution is 30 days. The ICGEM delivers either the raw Stokes coefficients or filtered Stokes coefficients after application of the anisotropic filters.

Computation were based on the following equations: The global and regional gravimetric excitation of polar motion (Eubanks, 1993) is given by

$$\begin{bmatrix} \chi_1 \\ \chi_2 \end{bmatrix} = -\frac{1.098R_{\oplus}^2}{C-A}\int\int \triangle q(\phi,\lambda,t)sin(\phi)cos(\phi)\begin{bmatrix} \cos(\lambda) \\ \sin(\lambda) \end{bmatrix} dS \ . \tag{1}$$

The function that converts gravity coefficients into maps of Equivalent Water Thickness reads (Chambers, 2008)

$$\triangle q(\phi,\lambda,t) = \frac{R_{\oplus}\rho_{\oplus}}{3\rho_W}\sum_{n=0}^{40}\sum_{m=0}^{n}\frac{(2n+1)}{(1+k_n)}P_{nm}(sin\phi)[\triangle C_{nm}(t)cosm\lambda + \triangle S_{nm}(t)sinm\lambda] \ . \tag{2}$$

χ_1, χ_2 - components of polar motion excitation function
$\triangle q(\phi,\lambda,t)$ - change of water storage in a unit area ($\frac{kg}{m^2}$)
$R_{\oplus}$ - mean Earth radius (6378km)
$\rho_{\oplus}$ - mean density of the Earth ($5517\frac{kg}{m^3}$)
dS - surface area element
C, A - principal moments of inertia
ρ_W - density of fresh water ($1000\frac{kg}{m^3}$)
ϕ, λ, t - latitude, longitude and time
k_n - load Love number of degree n
$P_{nm}(\cdot)$ - fully normalized associated Legendre polynomials degree n and order m

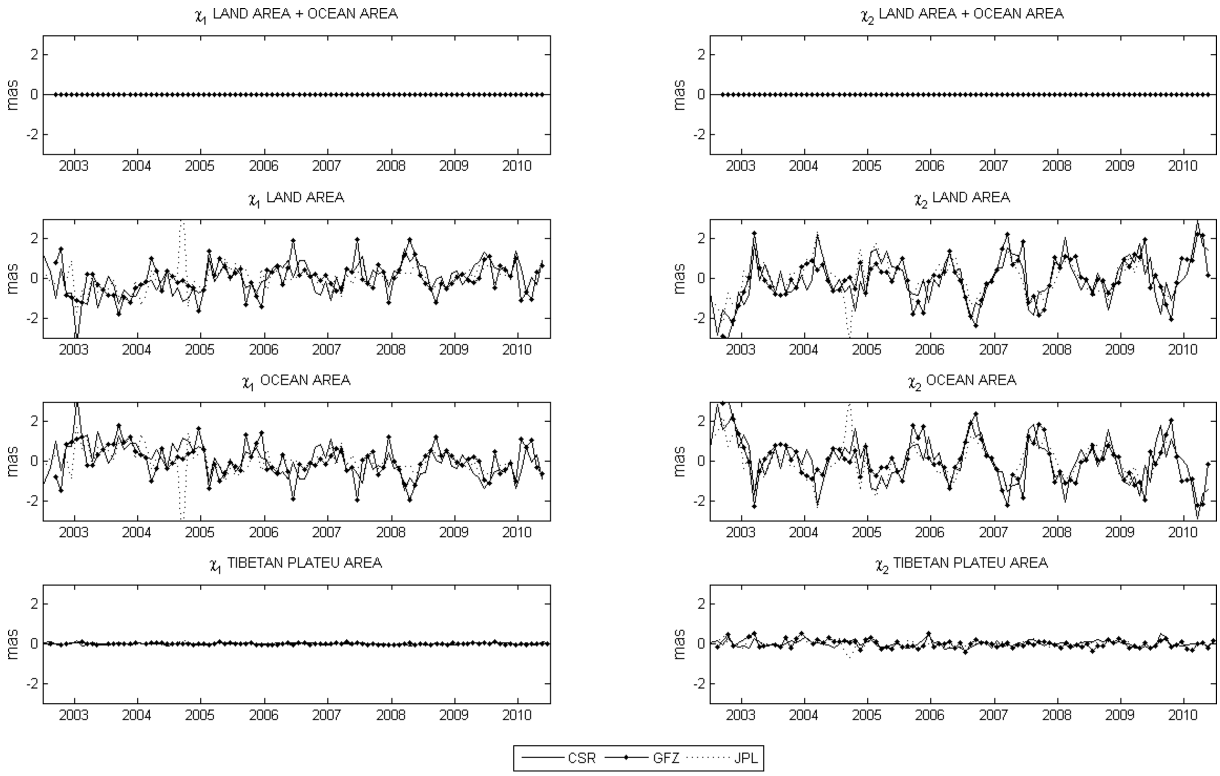

Figure 1: The differences between polar motion excitation computed from Stokes coefficients filtered by DDK3 and DDK2. Coefficients from CSR, GFZ and JPL are processed by the ICGEM. In the subsequent panels there are presented the excitation functions successively for the area of the entire Earth, ocean area, land area and Tibetan Plateau area.

Figure 1 shows comparison of excitation functions from the three research centers CSR, GFZ and JPL at two levels of filtering. In each panel there are plotted the excitation functions from CSR, GFZ and JPL. The analysis shows that the smoothing of Stokes coefficients at two levels of filtering does not affect the excitation function computed for the area of the whole globe. There are significant differences with respect to gravimetric excitation functions determined from filtered data if we take into account smaller areas such as: ocean area, land area or the Tibetan Plateau. Figure 1 also compares the impact of DDK3 and DDK2 filtering. Similar results are seen if we compare DDK1 and DDK2 or DDK1 and DDK3 filtering.

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