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A comparison between Bayesian and least-squares method for the inversion of the FCN parameters

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Because of the fluidity of the core, the Earth has a rotational mode, called the Free Core Nutation (FCN) with a period almost diurnal in Earth-fixed coordinates. The FCN parameters (period, damping) strongly depend on the coupling mechanism at the core-mantle boundary (flattening, topography, electro-magnetic coupling…). The FCN can be detected by its effect on the planet rotation, using the VLBI network analyses, or by studying its effects on the gravity field. The FCN has a period almost diurnal in the solid Earth reference frame. As the tidal potential contains also some diurnal components, a resonance occurs in the diurnal frequency band. This resonance effect can be observed in time-varying gravity data recorded on the Earth's surface by Superconducting Gravimeters (SGs) of the Global Geodynamics Project (GGP) network. The FCN resonance in gravity data is commonly represented by a damped harmonic oscillator model that we inverse in order to determine the FCN frequency, quality factor Q and the transfer function of the mantle (or the resonance strength). The usual approach to solve this non-linear inverse problem is to use a linearized least-squares method optimized based on the Levenberg-Marquardt algorithm (Marquardt, 1963 – Numerical Recipes Fortran Chapter 15.5- see for instance Defraigne et al. 1994 and 1995). However Florsch and Hinderer (2000) have demonstrated the inadequacy of using such a least-squares method, since the solution is definitely not Gaussian. They have proposed instead the use of a Bayesian approach to inverse for the FCN parameters, since the Bayesian method best propagates the data information to the parameters and the result is the probability law for each parameter as shown by Tarantola and Valette (1982). Here we propose a comparison of the results given by the linearized least squares method optimized by the Levenberg-Marquardt algorithm

with the Bayesian inversion applied on SG gravity records. The oceanic loading effect has been corrected using the most recent ocean model FES-2004 (Lyard et al. 2006).

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