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Signature of asthenospheric viscosity on long wavelength postseismic gravity perturbations after the 2004 Sumatra earthquake

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Using a theoretical model of global postseismic deformation we computed the effect of 2004 Sumatra earthquake on the time evolution of the low degree zonal coefficients of the Earth gravity field (J_n). In fact, it is reasonable to expect that the exceptional energy release of the Sumatra event has given rise to a perturbation of the long wavelength Earth's gravity field due to internal mass redistribution.

Our analysis is performed varying asthenosphere viscosities, in order to show how the expected signature of the seismic event on the long wavelength deformation field is sensitive to mantle rheology. Low asthenospheric viscosities yield very large J_n variation rates in the first years after the event. Our results show that on the J_2 time-series the postseismic effect remains comparable with the main secular trend for several years after the event if an asthenospheric viscosity of 10^{18} Pa s is assumed, while for lower values the signature in the data should be even stronger.

Since these short time-scale effects are not easily discernible from the available geodetic data because of large seasonal signals, we computed the expected contribution of postseismic relaxation to long term J_n trends as a function of asthenospheric viscosity.

Our results show that the viscoelastic relaxation leaves a not negligible signature on the long term measured time-histories. In the forthcoming years, when geodetic data from recent missions (such as GRACE) will be available, it will be possible to establish if, after the Sumatra event, a significant deviation of J_n time series from its secular trend occurred. In this case it should be possible to infer or at least to put constrains to the mean asthenospheric viscosity that is still one of the big open issues in mantle rheology.