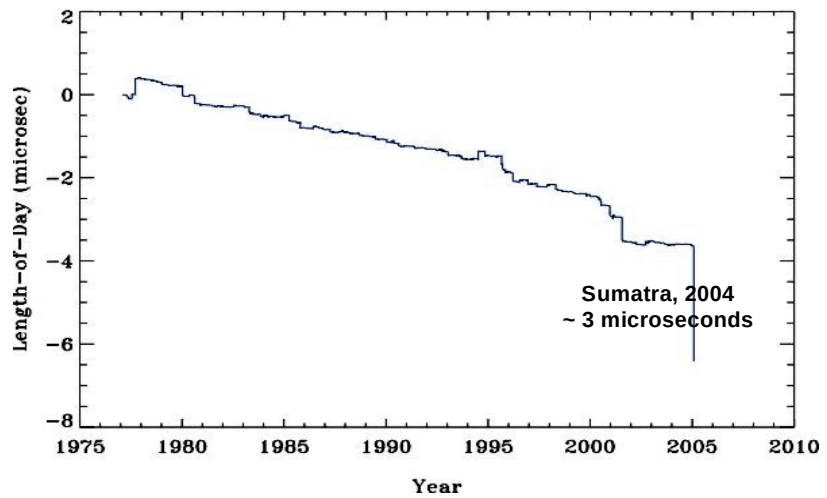


3.5.6.5 Special Bureau for the Mantle

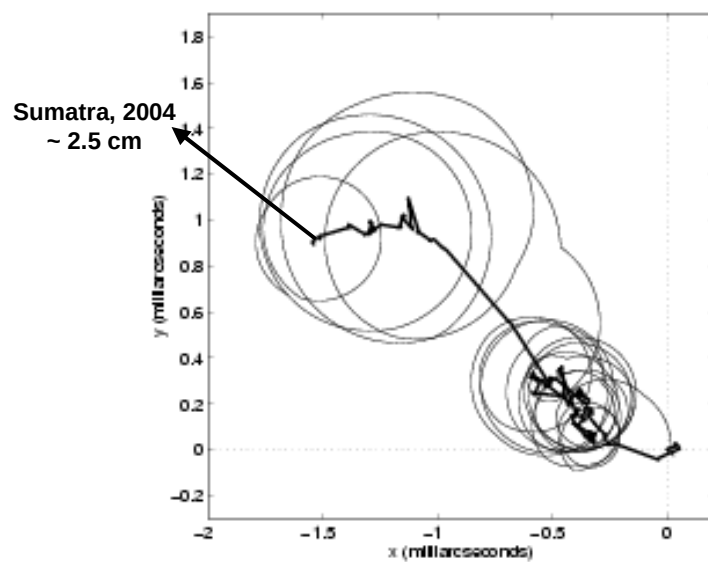
As with any geophysical processes that involve mass transports, large-scale motions in the mantle produce variations in Earth's rotation, gravity field, and geocenter. Among them, two topics have been extensively investigated:

(1) The co-seismic effects on various geodynamic parameters, including low-degree gravitational Stokes coefficients, Earth rotation parameters (length-of-day and polar motion excitation), and Earth's moments of inertia changes. They are shown as cumulative effects for 22,369 earthquakes spanning Jan 1977 through December 2004. The computation is based on Chao & Gross, 1987 (Chao, B. F. and Gross, R. S., Changes in the Earth's rotation and low-degree gravitational field induced by earthquakes, *Geophys. J. Roy. Astron. Soc.*, 91, 569–596, 1987) using the centroid-moment tensor solutions of all major earthquakes larger than magnitude 5 as published in the Harvard CMT catalogue. In particular, during 2004, the seismic event of December 26 in Sumatra that resulted in the devastating tsunami in the Indian Ocean, has produced the following changes in Earth rotation: With a moment magnitude 9.0 ("standard" CMT solution), the change in length-of-day is -2.7 microseconds, in X-pole excitation -0.67 milliarcseconds (mas), in Y-pole excitation 0.50 mas. These calculated values manifest as the conspicuous jumps shown in Figure 1. Being "buried" in much larger signals from other geophysical sources, whether they can be actually detected and identified in Earth rotation data is currently under investigation. (For more detail see Chao and Gross, *EOS, Trans. Amer. Geophys. Union*, 86, 1–2, 2005; also http://bowie.gsfc.nasa.gov/ggfc/sbm_plots.html). Note that these values would be ~ 3 times larger if the moment magnitude of the Sumatra event was 9.3 as claimed by some seismological studies (as opposed to 9.0 adopted here).

(2) Post-glacial rebound, or glacial isostatic adjustment (GIA) modeling output from Erik Ivins (JPL). This set of data consists of graphics and spherical harmonic geopotential rates complete through degree 12 for each of three different cases. The geopotential rates are provided as a function of the lower mantle viscosity ranging from 10^{21} to 10^{23} Pa-sec. The first case uses ICE3G and a standard (Tushingham and Peltier, 1991) Earth model. The second case has an upper mantle viscosity of 3.2×10^{20} Pa-sec (Johnston and Lambeck, 1999) and lithosphere thickness = 80 km. The third case has a fixed deepest mantle (CMB to 650 km above) viscosity at $\eta = 7 \times 10^{22}$ Pa-sec, variable mantle viscosity from 650 km above the CMB to the 670 km seismic discontinuity, an upper mantle viscosity of 5×10^{20} Pa-sec and a lithospheric thickness of 100 km.



(a) Cumulative change in Length of Day by earthquakes since 1976



(b) Cumulative "Mean" Pole Position shift by earthquakes since 1976

Fig. 1: Cumulative change in Earth rotation due to earthquakes since 1976: (a) for length-of-day; (b) for polar motion excitation.

Also posted are a set of GIA modeling data from Prof. Richard Peltier (University of Toronto). This set consists primarily of the graphics from chapter 4 in the recent book "Sea Level rise: History and Consequences" (ed. B. Douglas, M. Kearney, and S. Leatherman, Academic Press, San Diego, 2001).

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