The Geophysics of Past and Future Variations in the Earth's Rate of Rotation

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Timescales have been defined by quantum effects for the past 57 years. Before that they were implicitly defined by conservation of angular momentum: for 7 years by the angular momentum of the Earth around the sun, and for all of history before that by the angular momentum of the solid Earth around its rotation axis. Variations in the rotation rate remain important in linking quantum timescales to civil time. These variations mostly arise from transfers of angular momentum between the solid Earth and the fluids above it (the ocean and atmosphere) and below it (the liquid core), along with torques and deformations produced by the gravity gradient (tidal gravity) from the Moon and Sun. These effects produce variations in the Earth's angular velocity over times from days to gigayears. I will present a review of what we know (and do not know) about these variations and their causes, with particular attention to predicting future variations over intervals from a month to a century. Prediction over more than a few years is much less certain than what can be done over much shorter intervals, as the cause of change shifts from fluids we can observe to those we cannot.

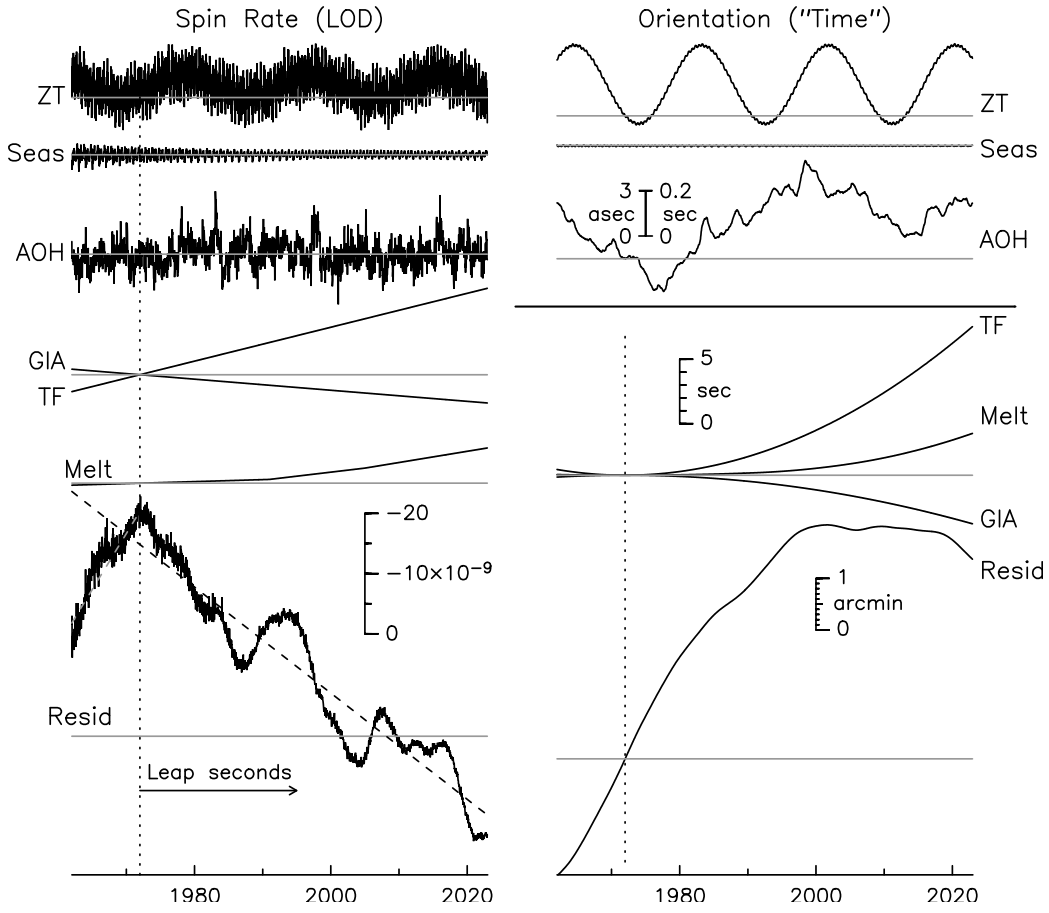

Figure 1: Variations in the Earth's angular velocity (left) and orientation (right) since 1962, decomposed into various effects. ZT is zonal tides (Earth's moment of inertia [MI]); Seas and AOH are from variations in ocean and atmosphere angular momentum [AM]. GIA is Glacial Isostatic Adjustment (solid Earth MI), TF is tidal friction (tidal torques), Melt is changes in MI of water, and Resid is everything else, presumably AM changes in the fluid core. Angular velocity changes are fractional amount; orientation scales are given both for angle and "time".