



Secular Trends in Earth Rotation Parameters in the GRACE Era: A Global Scale Impact of the Global Warming Process

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Trends in the two primary anomalies in the rotational state of the planet, namely those associated with polar wander and with the non-tidal acceleration of the rate of axial rotation (via the measurement of the changing oblateness of the Earth's shape), are known to contain a significant secular component, which has been unambiguously associated with the lasting influence of the Late Quaternary ice-age cycle, via the Glacial Isostatic Adjustment (GIA) process.

We present here evidence that a change in the secular trends in the rotational observables became evident at the same time, for both rotational observables, subsequent to approximately 1992, resulting in departures from the rates that had been established for a century or more and which have been fully explained as a consequence of the GIA response to the Late Quaternary ice-age cycle. Although it was previously noted qualitatively at the recent Helsinki meeting on the GIA process (Gross and Poutanen, *Eos Trans. AGU*, 90(41), 365, 2009) that such a change had become evident in the record of polar motion, our analysis identifies more accurately the time by which the change occurred and shows that at the same time the secular variation in the non-tidal acceleration of rotation also began to deviate from its Late Quaternary ice-age determined rate.

This evidence is important, as it helps understand the apparent misfit between values of the time derivatives of the degree two and order one Stokes coefficients inferred from the Gravity Recovery and Climate Experiment (GRACE) and the values inferred from Late Quaternary ice-age influence, as predicted by the ICE-5G (VM2) model of the GIA process. Our analysis provides observational evidence supporting the suggestion by Peltier and Luthcke (*JGR*, vol. 114, B11405, 2009), which is that the misfit is due to the fact that the ICE-5G (VM2) model of the GIA process is designed to fit only data that is unambiguously associated with the Late Quaternary ice-age, and does not include the influence of the additional changes in continental ice-cover associated with the modern global warming process. Since the degree 2 and order 1 Stokes coefficients are very strongly controlled by the influence of polar wander, and since our analysis demonstrates that polar wander has shifted into a new state during the GRACE era, quite possibly due to the increased melting of continental ice cover linked to global climate change, we believe we have more firmly established the plausibility of the hypothesis presented in the Peltier and Luthcke paper.