On the origins of earth rotation anomalies: New insights on the basis of both "paleogeodetic" data and GRACE data

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The theory previously developed to predict the impact upon Earth's rotational state of the Late Pleistocene glaciation cycle is extended. In particular we examine the extent to which a departure of the infinite time asymptote of the visco-elastic tidal Love number of degree two, " ", from the observed "fluid" Love number, " kf ", impacts the theory. A number of tests of the influence of the difference in these Love numbers on theoretical predictions of the model of the glacial isostatic adjustment (GIA) process are explored. RSL history predictions are shown not to be sensitive to the difference even though they are highly sensitive to the influence of the changing rotational state itself. We also explore in detail the accuracy with which the GRACE satellite system is able to observe the global GIA process including the time dependent amplitude of the degree two and order one spherical harmonic components of the gravitational field, the only components that are significantly influenced by rotational effects. It is explicitly shown that the GRACE observation of these properties of the time varying gravitational field is sufficiently accurate to rule out the values predicted by the ICE-5G (VM2) model of Peltier (2004). However, we also note that this model is constrained by data from an epoch during which no significant melting of the great polar ice-sheets was occurring and that such loss of grounded continental ice from the polar regions, as well as from small ice sheets and glaciers globally, is expected to strongly influence the evolving rotational state of the planet and thus the values of these time-dependent Stokes coefficients as they are currently being measured by the GRACE satellite system. A series of sensitivity tests are employed to demonstrate this fact. We suggest that the accuracy of scenarios for modern land ice melting may be tested by ensuring that such scenarios conform to the GRACE observations of these crucial time dependent Stokes coefficients.