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Broadband assessment of polar motion excitation determined from recent gravity field solutions

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Variations in Earth's rotation, including polar motion (PM) and changes in the length of the day (LOD), are primarily caused by the varying distribution and movement of mass within the atmosphere, oceans, and hydrosphere. Identifying the different sources of these rotational changes is crucial for understanding processes occurring within the Earth system.

Large-scale mass variations are reflected in changes of spherical harmonic coefficients of geopotential. In the study of variations in Earth's rotation, coefficients of degree two and order one (ΔC_{21}, ΔS_{21}) are particularly important, as they are linearly related to the equatorial components (χ_1, χ_2) of PM excitation. ΔC_{21}, ΔS_{21} coefficients can be measured using various techniques, with satellite gravimetry and Satellite Laser Ranging (SLR) being most popular in recent years. Various data centres around the world produce temporal gravity solutions based on data from Gravity Recovery and Climate Experiment (GRACE) and its successor GRACE Follow-On (GRACE-FO). There are currently many solutions available determined from either GRACE/GRACE-FO data alone or their combinations with various techniques such as SLR or satellite-to-satellite tracking.

In this study, we reassess the mass-related excitation of PM computed from various ΔC_{21} and ΔS_{21} solutions based on GRACE/GRACE-FO, SLR, and combinations of these techniques. We also provide a combined series of PM excitation achieved by minimizing noise in the input data. All series are analysed for various oscillations, including seasonal, non-seasonal long-term, and non-seasonal short-term variations. They are then evaluated by comparison with geodetic angular momentum obtained from precise geodetic measurements of Earth’s rotation. We show that combining various series of ΔC_{21} and ΔS_{21}-derived PM excitation enhances its consistency with the observed PM excitation for the studied oscillations.