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Linking Plate Kinematics and True Polar Wander over the last 250 Myrs

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The flux of subducting slabs into the mantle is an essential component of the Earth's mantle convection. However, the slab flux remains poorly known for pre-Jurassic times because of the absence of preserved oceanic seafloor. Sinking of subducted slabs within the mantle perturbs Earth's moment of inertia, which, in addition to perturbations related to upwellings, results in long-term motion of the solid Earth relative to the rotation axis, resulting in so-called True Polar Wander (TPW). This motion, which can be inferred using paleomagnetic data, should therefore yield crucial information about the large-scale subduction kinematics back in time. However, it is not yet clear how to separate the numerous contributions to TPW, since these result from the superimposition of a complex distribution of mantle mass heterogeneities that are advected through time. In this study, we developed a new approach to assess the impact of subducting slabs on TPW based on the harmonic decomposition of plate kinematics into large-scale patterns. We constructed simple plate models that yielded pure dipole and pure quadrupole and net stretching kinematics, which represent the spherical harmonic degree 1 and degree 2 components of relative plate motions, respectively. We then implemented these three patterns of large-scale plate motions, and their subduction zones, into three simple mechanistic models and computed mantle mass heterogeneities through time. We then calculated changes to Earth's moment of inertia tensor to predict the resulting TPW. In this contribution, we will first show the results of these sensitivity experiments highlighting the evolution of inertia perturbations associated to each of these three large-scale patterns. We will then show the calculated TPW using the harmonic decomposition of full-plate models over the last 250 Myrs and discuss the influence of each of these three plate kinematic components on the observed TPW. Finally, we will discuss how the observed TPW can help better constrain the evolution of mantle mass heterogeneities and rates of subduction flux for past times.