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North Atlantic surface-motion changes in early Paleogene: Observations and geodynamic interpretations

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Mantle convection is a crucial component for providing driving and resisting forces for horizontal motion of tectonic plates, as well as for generating non-isostatic vertical motion commonly termed “dynamic topography”. These two kinds of surface motion are often investigated in isolation. However, the existence of a thin, mechanically weak asthenosphere allows us to study mantle convection in the context of Couette/Poiseuille flow, which links mantle flow properties to temporal changes in both horizontal and vertical motions. In this study, we utilize publicly available finite rotations and stage-resolution stratigraphic dataset in the North Atlantic region to investigate its surface-motion history in early Paleogene, which coincides with the peak Icelandic plume activity deduced from independent geologic constraints. We find that our inferred horizontal and vertical motion changes are temporally correlated. We examine this correlation through a quantitative torque analysis, which incorporates an analytic Couette/Poiseuille flow model. We parameterize this flow model in terms of observed kinematics coupled with flow-flux estimates of Icelandic plume and/or Farallon slab activity. Our analysis indicates (1) that torque-variation tied to the Icelandic plume flux closely resembles our kinematic inferences, and (2) that the inclusion of slab flux does not modify such a scenario significantly. In light of these inferences, our efforts shed light on the role of asthenospheric channelized flow flux in influencing the North Atlantic surface expressions in early Paleogene.