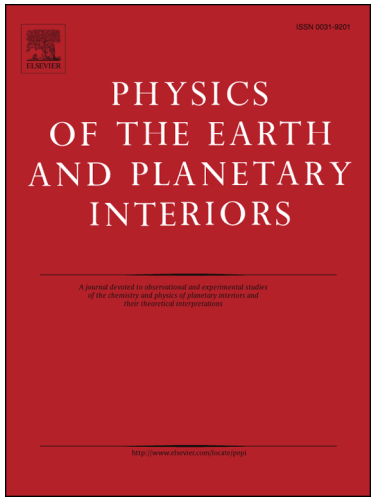

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Scaling rates of true polar wander in convecting planets and moons

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Abstract

Mass redistribution in the convecting mantle of a planet causes perturbations in its moment of inertia tensor. Conservation of angular momentum dictates that these perturbations change the direction of the rotation vector of the planet, a process known as true polar wander (TPW). Although the existence of TPW on Earth is firmly established, its rate and magnitude over geologic time scales remain controversial. Here we present scaling analyses and numerical simulations of TPW due to mantle convection over a range of parameter space relevant to planetary interiors. For simple rotating convection, we identify a set of dimensionless parameters that fully characterize true polar wander. We use these parameters to define timescales for the growth of moment of inertia perturbations due to convection and for their relaxation due to true polar wander. These timescales, as well as the relative sizes of convective anomalies, control the rate and magnitude of TPW. This analysis also clarifies the nature of so called "inertial interchange" TPW events, and relates them to a broader class of events that enable large and often rapid TPW. We expect these events to have been more frequent in Earth's past.

Keywords: Rotational variations; polar wobble, Paleomagnetism, Models of interior structure, Planetary interiors, Convection currents and mantle plumes,
PACS: 91.10.Nj, 91.25.Ng, 91.35.Cb, 91.45.Bg, 91.45.Fj

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