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Relating plate tectonics, mantle convection and variations in paleomagnetic reversal frequency

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Mantle control through time-dependent CMB heat flux pattern and magnitude is a possible external cause to variable reversal frequency of the geodynamo. Necessary CMB heat flux characteristics for reversals in numerical dynamos include most notably a strong average value and a heat flux larger than average at low latitudes. Since plate tectonics affect mantle convection, and thus CMB heat flux and core dynamics, they constitute a possible influence on reversal frequency .

We perform numerical experiments of mantle convection with a prescribed plate velocity history at the surface and analyze the time evolution of CMB heat flux in the light of specific criteria promoting or inhibiting reversals. These are systematically compared to the observed reversal frequency for the Earth. The main parameters we investigate for mantle convection are the rheology and the nature of a possibly denser layer in the lowermost region of the mantle.

Our study includes a larger number of mantle convection models than previously considered by the few pioneering studies on the same topic and lead to methodological conclusions concerning which of the CMB heat flux criteria are most pertinent and on the time period during which a comparison with paleomagnetic data is meaningful. Preferred mantle models as well as general considerations on the buffering effect of mantle dynamics between plate tectonics and CMB heat flux will be presented. Combining paleomagnetic observations, models for the time-evolution of plate tectonics, inferences from numerical dynamos and mantle convection simulations, our results may provide an important constraint on the structure and dynamics of Earth's mantle.