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Long-term true polar wander of the Earth including the effects of mantle convective processes and continental drift

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Long-term true polar wander of the Earth (TPW) was examined by taking into account the effects of simplified convective processes in the Earth's mantle and continental drift. The TPW, for a given viscoelastic Earth model, is wholly determined by both the magnitude of non-forcing elements for moments of inertia, Dij(t), and the rates for forcing elements, dD_{23}(t)/dt and dD_{13}(t)/dt. The rates of forcing elements are largely related to the time-dependent convective processes in the mantle and also the continental drift. The rates for continental drift are 10^{30} kg m^2 Myr^{-1} (Dickman, 1979), whereas it is extremely difficult to estimate those for convective processes. In this study, I modeled relatively realistic time-dependent non-forcing elements by adopting the rate for D33(t) with 10^{31} kg m^2 Myr^{-1} (Ricard et al., 1993) and the present-day values, $D_{ij}*$, inferred from the non-hydrostatic geoid. Then I examined the polar wander speed and the TPW magnitude for a viscoelastic Earth with plausible viscosity models. The long-term TPW significantly contributes to the observed present polar wander speed when the rates of the magnitude for forcing elements are 10^{31} kg m^2 Myr^{-1}, which are similar to the value of dD_{33}(t)/dt estimated by Ricard et al. (1993) and one order of magnitude larger than that for the continental drift. On the other hand, the TPW magnitude of 30 degree, which might have occurred in late Mesozoic and Cenozoic time, is predicted for models with the rates of forcing elements of 10^{30} kg m^2 Myr^{-1}, similar to those by continental drift. However, the magnitude of the TPW is less significant if the rates are rather smaller than 10^{30} kg m^2 Myr^{-1}. Thus the continental drift might have contributed to the long-term TPW as its forcing, whereas the convective processes have determined the gross features of the TPW.