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Filtering of polarity reversals in MHD dynamo simulations with a stably stratified layer in a rotating spherical shell

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The structure of the outer core in the Earth would have a stably stratified region ranging 70 to 300 km below the core-mantle boundary inferred from seismological data analyses [Tanaka, 2007; Helffrich and Kaneshima, 2010]. Regarding with numerical dynamo simulations, a stably stratified region near the outer boundary works as the filter of small-scale structures of radial magnetic field [Christensen, 2006; Christensen and Wicht, 2006]. The important mechanism for understanding such an effect is that the zonal flow induced by thermal wind balance and power caused by Coriolis and Lorentz force cannot penetrate into the stratified region [Nakagawa, submitted].

There are many numerical dynamo simulations with polarity reversals [Olson et al., 2007; Driscoll and Olson, 2009; Takahashi et al., 2007]. Their models have not investigated how the stably stratified region works in the situation of polarity reversals. Here we show a couple of examples for numerical dynamo simulations with a stably stratified region under physical parameters occurring the polarity reversals. The main result is that the time-scale of polarity reversals is very different between unstratified and stratified cases. The stratified case would have much longer time-scale of polarity reversals than for the unstratified case or no reversals. The filtering effect caused by a stably stratified region near the outer boundary would work to avoid occurring the polarity reversals as well as the smaller-scale of magnetic field changes into the dipolar field.

Keywords: stably stratified layer, polarity reversals, dynamo, Earth's core