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Latitudinal dependence of some effects of anisotropic thermal diffusivity in the Earth's core

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It is likely that turbulent motions occur in the Earth's fluid outer core with very small molecular viscosity. Such small-scale flows, which are highly anisotropic because of the Earth's rapid rotation and a strong magnetic field, can enhance a large-scale thermal diffusive process in the core. This suggests that a thermal eddy diffusivity should not be a scalar but a tensor. We have been carrying out numerical simulations of magnetohydrodynamic (MHD) turbulence in a rapidly rotating system to investigate the effect of anisotropy on dynamics in the core, by prescribing elements of anisotropic thermal diffusion tensor.

We have found that a certain degree of anisotropy has an insignificant effect on the character, like kinetic and magnetic energy, of magnetoconvection in a small region with periodic boundaries in the three-directions. However, in a region with top and bottom rigid boundary surfaces, the same degree of anisotropy can enhance kinetic and magnetic energy in magnetoconvection depending not only on prescribed anisotropic tensor diffusivity but also on location of the computational region expressed in terms of direction of gravity, or latitude. This implies that anisotropic tensor diffusivity, consequent on the anisotropy of turbulent flows, affects dynamics in the core near the boundary surfaces depending on the latitude.

Keywords: anisotropic diffusivity, magnetoconvection, Earth's core