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The influence of the Earth's outer core viscosity on the geodynamo

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The geodynamo respects the process where turbulent flow of liquid metal in the outer core generates the Earth's magnetic field. Numerical simulations of the geodynamo are controlled by mathematical equations and dimensionless parameters. To investigate the effects of relevant parameters on the geodynamo system, we apply the new MoSST model under different levels of viscosity, ν, of the outer core. By spanning nearly three orders of ν, we extract the characteristics between physical fields and the associated typical length scales, and find that ν predominantly affects the velocity field. The average velocity field, u, of the liquid core increases with ν according to a fitted scaling relationship: u$\sim\nu$0.4754. In addition, the magnetic field decreases monotonically with increasing ν, and the variation is no larger than 30%. The temperature perturbation also increases monotonically with ν within a small range of 6%. Furthermore, we conducted a force balance analysis and demonstrated that the balance shifts under different ν. When compared with other scaling laws from previous studies, a weak correlation is obtained between viscosity and magnetic field strength in a certain parameter range, but opposed the assumption that the velocity field is not related to the viscosity of outer core.