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Double-diffusive inner core convective translation

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The hemispherical asymmetry of the inner core has been interpreted as resulting form a high-viscosity mode of inner core convection, consisting in a translation of the inner core. With melting on one hemisphere and crystallization on the other one, inner core translation would impose a strongly asymmetric buoyancy flux at the bottom of the outer core, with likely strong implications for the dynamics of the outer core and the geodynamo. The main requirement for convective instability in the inner core is an adverse radial density gradient. While older estimates of the inner core thermal conductivity favored a superadiabatic temperature gradient and the existence of thermal convection, the much higher values recently proposed makes thermal convection very unlikely. Compositional convection might be a viable alternative to thermal convection: an unstable compositional gradient may arise in the inner core either because the light elements present in the core are predicted to become increasingly incompatible as the inner core grows (Gubbins et al. 2013), or because of a possibly positive feedback of the development of the F-layer on inner core convection. Though the magnitude of the destabilizing effect of the compositional field is predicted to be similar to or smaller than the stabilizing effect of the thermal field, the huge difference between thermal and chemical diffusivities implies that double-diffusive instabilities can still arise even if the net density decreases upward. We propose here a theoretical and numerical study of double diffusive convection in the inner core that demonstrate that a translation mode can indeed exist if the compositional field is destabilizing, even if the temperature profile is subadiabatic, and irrespectively of the relative magnitude of the destabilizing compositional gradient and stabilizing temperature field. The predicted inner core translation rate is similar to the mean inner core growth rate, which is more consistent with constraints from the geomagnetic field morphology and secular variation (Aubert *et al.*, 2013) than the higher translation rate predicted for a thermally driven translation (Alboussière *et al.*, 2010).