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Gravity variations induced by core flows

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The temporal variation in the density structure associated with convective motions in the outer core causes a change in the Earth's gravity field. Core flows also lead to a gravity change through the global elastic deformations that accompany changes in the non-hydrostatic pressure at the core-mantle boundary (CMB). In this work, we present predictions of the gravity changes from these two processes during the past century. These predictions are built on the basis of flows at the surface of the core that are reconstructed from the observed geomagnetic secular variation. The pressure-induced gravity variations can be reconstructed directly from surface core flows; predicted variations in the Stokes coefficients of degree 2, 3 and 4 are of the order of 10^{-11}, 3×10^{-12} and 10^{-12}, respectively, with a typical timescale of a few decades. These correspond to changes in gravity of 70 nGal, 30 nGal and 15 nGal, and to equivalent geoid height variations of 0.15 mm, 0.05 mm and 0.02 mm, respectively. The density-induced gravity variations cannot be determined solely from surface core flows, though based on certain dynamical assumptions, their amplitude should be much smaller. Although the predicted gravity changes from core flows are small, they are at the threshold of detectability with high-precision gravity measurements from satellite missions such as GRACE. The most important challenge to identifying a core signal will be the removal of inter-annual gravity variations caused by surface processes which are an order of magnitude larger and mask the core signal.