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Mantle circulation models at high numerical resolution

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A key insight gained from geodynamics over the past two decades has been to recognize that plates constitute the cold upper thermal boundary layer of the convecting mantle. A corollary implies that thermal mantle heterogeneity, and thus a large portion of mantle driving forces, can be explained from a record of past subduction. One can test this powerful hypothesis explicitly with analytical and numerical mantle flow models to predict the geoid, true polar wander, the evolution of plate driving forces and Earth mantle's lateral heterogeneity structure. Plate motion histories furthermore place strong constraints on deep mantle flow, due to the highly viscous nature of mantle convection and the resulting elliptic nature of the momentum equation, so that one can develop mantle circulation models. A fundamental shortcoming of these models is their lack of proper initial condition information. The problem can be overcome in part through a range of data assimilation techniques, which are commonly used in meteorologic and oceanographic circulation models. A long term goal of mantle circulation modeling is aimed at exploring time-dependent mantle dynamics models to improve constraints on the rheology of the mantle. This talk will review simple concepts of mantle circulation modelling integrating seismic tomography, plate kinematics and subduction history in global mantle dynamics models at high numerical resolution.