Spectral modelling of mantle convection in a non orthogonal geometry: Application to subduction zones

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A two-dimensional numerical convection model is presented, in a parallelogram-shaped domain adapted to the geometry of subduction zones. The Navier-Stokes problem is solved by a pseudo-spectral solver (named projection-diffusion) coupled to the Richardson iterative scheme. In the convective domain, representing the upper mantle, plate tectonics are prescribed by imposing the velocities on the boundary. In particular, the subducting plate, located on a lateral side of the box, moves and dips at constant velocity. The model is validated for the zero obliquity configuration, first in the case of free boundaries, then in the case of a rigid upper boundary and, at last, in the case of both a rigid upper and lateral boundary. Then, we report preliminary results of experiments for a non zero obliquity at a Rayleigh number value of 104, a motionless overriding plate, subduction velocities smaller than 4 cm/yr and subduction dip angles higher than 60. Concerning the evolution of the flow and thermal structures with the subduction movement and geometry, the model predicts the occurrence of a recirculation process, characterised by the formation of an extra convection cell. This recirculation starts at a critical subduction intensity depending on the subduction geometry. The lower the subduction dip angle, the lower the critical subduction velocity. A critical subduction geometry is also suggested since the extra cell exists even at very low subduction velocities for dip angles lower than 65.