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The influence of slab-length variations on mantle circulations in the southern Chilean subduction zone

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The depth of the slab base may vary from less than 100 kilometers to several hundred kilometers along the strike of the southern Chilean subduction zone. The variation in slab length would play an important role on shaping the flow pattern. In this study dynamical subduction zone models were constructed to examine the combined effects of slab geometry, plate age, mantle rheology and heterogeneities of plate thickness on the regional mantle circulations. In the models various degrees of slab rollback occur along strike, significantly influenced by the slab length. The differential slab rollback leads to the along-arc pressure gradient causing trench-parallel flow components, while the lower portion of the deep segments acts as a slab edge in part to induce three-dimensional edge flow. These factors together give rise to complex flow patterns, and lead to a great extent of trench-parallel components in the mantle wedge and sub-slab mantle and significant upwelling in the back arc. The length scales of both the poloidal and toroidal components are variable and generally smaller, but the 3D edge flow affects a significantly wider region, compared with flow associated with a slab with a constant length. The model results may help to provide explanations for the complicated anisotropy patterns in the mantle wedge and the sub-slab mantle, the heat sources of the northern Patagonian basalts and the subduction-related components of the MORB from the Chile Ridge. The results may also help to constrain the detailed flow structure in the vicinity of the slab window and the Antarctic slab geometry.