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Modelling stress accumulation and dissipation and the causes of intermediate depth seismicity in subduction zones

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The accumulation and dissipation of stress in the subducting lithosphere is directly responsible for Wadati-Benioff zone seismicity. Determining the development of these stresses remains as yet unresolved. Stress accumulation and dissipation within the subducting slab occurs through the superposition of contributions from slab-bending, slab-pull, thermal stresses and metamorphic phase changes, and ductile and brittle deformation. The resulting stress distribution has a complex relationship with depth, forming planes of alternating down-dip compression and tension as observed in double and triple Wadati-Benioff seismic zones. The formation of these double and triple seismic zones provides a powerful constraint on understanding stress accumulation and dissipation within the subducting slab and the cause of intermediate depth earthquakes. In this work we focus on stresses in the subducting slab down to 300 km whilst acknowledging that it is necessary to include deeper structures such as the 410km and 660km discontinuities in our model. We use coupled mechanical - thermal diffusion finite element code (powered by MILAMIN, Dabrowski et al 2008) to model a subduction zone. Temperature-dependent viscosity and density are used to calculate subduction flow velocities, deformation and stresses, which are used in turn to calculate the advection of temperature and slab material. The increases in mantle viscosity at the 410 km and 660 km phase transitions exert a strong control on subduction slab stress. We explore the evolution of subducting slabs and their stresses for a variety of imposed parameters including plate convergence velocity, subduction dip angle and roll-back velocity. From the analysis of steady-state and transient solutions, we hope to better understand the relative contributions of the different mechanisms to the accumulation and dissipation of stress in the subducting slab.