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Overriding plate thickness control on subducting slab curvature

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The curvature of a subducting plate exerts a key control on the amount of gravitational potential energy that is dissipated via bending during subduction. We use 2-D, numerical subduction models to explore the dependence of the subducting plate curvature, quantified as a radius of curvature, on the thickness of the overriding plate. This dependence is examined for subducting plates with viscous and visco-plastic rheologies. We find that the radius of curvature increases with overriding plate thickness for visco-plastic subducting plates, yet we do not observe this correlation for purely viscous subducting plates. The effective viscosity of the slab hinge is weakened in visco-plastic subducting plates and so external forces on the upper slab surface, which are dependent on overriding plate thickness, play a major role in dictating slab curvature. On Earth, we demonstrate that there is indeed a positive correlation between overriding plate thickness, estimated from seismic tomography, and radius of curvature, derived from earthquake hypocenter distributions. We therefore suggest that weakening of the subducting plate hinge, which occurs in the visco-plastic plates, is important in generating the slab curvature systematics observed on Earth.