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Tomotectonic reconstructions validated via mantle circulation models in a closed-loop experiment

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Mantle slabs imaged by seismic tomography provide complementary subsurface information that could improve global plate reconstructions because they are indications of ancient tectonic plates. Linking mantle slabs to the surface plates requires approaches that follow geodynamic principles in a highly vigorous mantle. Here, we propose a new workflow that couples a slab unfolding approach and a mantle circulation model through which tomotectonic reconstructions can be performed, evaluated, and improved in a closed-loop experiment. We found that intra-oceanic subductions are crucial for understanding the evolution of the mantle and surface tectonics in the Pacific realm. Our closed-loop experiment allows us to reinterpret published tomotectonic reconstructions based on the vertical sinking slabs hypothesis. We conclude that highly vigorous mantle flow that allows lateral slab transport up to 4,000 km and non-constant sinking rates that deviate by up to 10 mm yr^{-1} locally within a 1,000 km area must be accounted for in tomotectonic reconstructions.