Studying Circum-Pacific Subduction Zones with Geodynamic Models

Dr. Diandian PENG (彭典典博士)

University of California

Geodynamic modeling is helpful for us to understand the evolution of Earth's internal dynamics and surface tectonic responses. The circum-Pacific ring of fire has most of the Earth's active subduction zones. The geometry of slabs beneath subduction zones varies a lot. Specifically, some of them are flat lying beneath the overriding plate (e.g., part of the Nazca slab) or stay stagnated in the mantle transition zone (e.g., Tonga slab). We have run 2D models, 3D regional models and 3D global models using CitcomS to study these special slabs beneath circum-Pacific subduction zones. All these models are based on the same sequential data-assimilation method. The results show that the slabs from the global model match seismic tomography much better than the regional results in East Asia and South America; the main reason is that the regional models prohibit large-scale mantle flow as that in the global case, due to the non-penetrating side walls cutting off far-field forces. This limitation of regional models cannot be resolved by varying the model domain. In contrast, for North America and Fiji-Tonga, global and regional models produce similar slab structures, both matching tomography. This reflects that their fast-retreating overriding plates play an important role on the regional mantle flow and slab dynamics. We find that the slab stagnation beneath East Asia is mainly because of a regional-scale mantle wind, while the Tonga slab geometry is controlled by the fast trench retreat.

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Enquires: 3943 5494 eesc@cuhk.edu.hk