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The role of phase transitions at subduction zones

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The role of phase transitions on the Earth's internal dynamics has been extensively investigated in the past by means of thermo-mechanical, 2D/3D global models of mantle convection. Among the different solid-solid phase transformations, the post-spinel transition, occurring at about 660 km depth in the Earth's mantle, profoundly affects the dynamic of mantle convection, favouring a layered pattern that is intermittently replaced by whole mantle convection.
In this contribution, I will focus mostly on regional models of subduction where a range of metamorphic and melting reactions takes place. After reviewing the most important reactions characterizing convergent margins, I will discuss, based on recent 2D petrological-thermo-mechanical simulations, how phase transition in the mantle affect the subduction dynamics and the subduction-induced flow patterns. In particular, models without phase transitions develop poloidal convective cells with a large aspect ratio (width/height). In these models, cells width is similar to lithospheric plates width, producing drifting of the entire overriding plate. On the contrary, models accounting for phase transitions are characterized by poloidal cells with aspect ratio of about 1, yielding eventually to the break-up and drifting of a portion of the overriding plate. This last, more realistic simulation of subduction well reproduce the fragmentation of supercontinents and the opening of oceanic basins, highlighting the important role played by phase transition in the subduction zone dynamics.