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Splash Plumes

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I have discovered a new class of thermal upwellings in mantle convection simulations which are not rooted in a thermal boundary layer (ref 1). Since they look a bit like water droplet splashes, I have abbreviated these 'plumes not rooted in thermal boundary layers' as 'splash plumes'.

These mantle convection simulations are high resolution (∼22km spacing) 3D spherical simulations at Earth-like vigour. They have a chondritic rate of internal heating and bottom heating that straddles expected Earth values. There is a realistic depth variation in viscosity, with a stiff lithosphere and lower mantle. The mantle is compressible with the coefficient of thermal expansion decreasing with depth. Some models have phase transitions. The surface of the models is driven by 119Myr of recent plate motion history.

At the end of most simulations (present day) we discover many examples of hot mid-mantle thermal anomalies in the shape of bowls which have hot cylindrical plumes rising from the rim. They originate at a range of depths and are not rooted in thermal boundary layers. These splash plumes are formed from hot mantle collecting beneath the surface, and then a cold instability from the surface descending onto the sheet of hot underlying material pushing it down into the mantle and forming a bowl. The plumes are formed by instabilities coming from the bowl rim edge. In fact the downwellings can push the sheets all the way to the core mantle boundary in certain cases where it is then difficult to tell splash plumes apart from 'traditional plumes'. Splash plumes might provide explanations for weak, short-lived plumes that do not seem to have deep roots (e.g. Eifel).

1 Davies & Bunge, Geology, 5, 349–352, 2006