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Global trench-migration velocities in different "absolute" reference frames: Geodynamic constraints to find the optimal reference frame

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Since the advent of plate tectonics different "absolute" reference frames have been used to describe the motion of plates and trenches. The difference in plate motion and trench migration between different reference frames can be substantial (up to 4 cm/yr). It is important to determine which reference frame most likely describes the true absolute motion of plates to get an understanding of the forces driving plate tectonics and mantle convection. It is proposed that, based on geodynamic considerations and geodynamic modelling, the best candidate is the one, which optimises the number of trench segments that retreat, minimizes the amount of trench migration in the centre of wide (>4000 km) subduction zones, and minimizes the cumulative amount of the absolute of the trench-perpendicular trench migration velocity for all subduction zones on Earth. Calculations for eight different reference frames show that these conditions are best met in one particular Indo-Atlantic hot spot reference frame and one particular no-net-rotation reference frame. In these two reference frames, 75% and 68% of the trench segments (200 km wide with a total of 244) of mature subduction zones retreat, the trench-perpendicular trench migration velocity in the centre of wide subduction zones is always small, and the absolute of the trench-perpendicular trench migration velocity is small as well. Calculations further show that, irrespective of the reference frame, trench retreat always dominates over trench advance, with 62-78% of the 244 trench segments retreating, and the mean and median trench velocity are always positive (retreating). These calculations are predicted by geodynamic models, in which plate motion, trench motion and mantle flow result self-consistently from subduction of dense slabs, suggesting that trench velocities and plate velocities are indeed primarily controlled by the negative buoyancy and width of subducting slabs.