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Temporal variations in the convective style of planetary mantles

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Investigations of mantle convection with temperature and stress dependent viscosity have shown the existence of fundamentally different convective styles: By varying e.g. the Rayleigh number, the viscosity contrast or the stressdependency of viscosity, the planform of convection in the asymptotic stationary state changes from the so-called stagnant lid regime to an episodic behavior and further to a state characterized by a permanently mobilized surface. Our studies suggest that this transition may not only be induced by a change of parameters but also occurs temporally for fixed parameters. We have in fact observed convective systems in the stagnant lid regime that show isolated events of surface mobilization occurring out of a thermally equilibrated state. We use a 3D numerical mantle convection model to investigate mantle convection and surface dynamics as a coupled fluid dynamical system. Our studies focus on the occurrence of temporal variations in the style of convection especially between the stagnant lid and the episodic regime. We were able to deduce a mobilization criterion that describes the stability of the stagnant surface, thus allowing for a quantitative analysis of the transition to a (temporarily) mobilized surface. This criterion is also suitable to predict the occurrence of surface mobilization events.