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Temporal variations of the convective style in 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 Rayleighnumber, the viscosity contrast or the stress-dependency 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 mobile surface. Our studies suggest that this transition may not only be induced by a change of parameters but also occurs temporally, i.e. a system that initially shows an episodic behavior falls into the stagnant lid mode of convection as time proceeds. Such a temporal variation can probably describe the evolution of terrestrial planets like Mars, which is assumed to have undergone a change of convective style in its early history.

In this contribution we present a 3D fluiddynamical model that shows a change of the convective style for temporally constant parameters. We also describe the methods developed to characterize different regimes and to identify the transitions observed.