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Rejuvenation of Venus' surface: Insights from Numerical Modelling

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Venus is considered to be currently in the stagnant lid regime of mantle convection, in contrast to Earth. Several previous attempts towards understanding Venus' evolution, however, also suggest the possibility of an episodic global resurfacing event (Sleep, 2000; Reese et al,1999). The timing of this resurfacing event is constrained based on impact crater studies that suggest an average mean surface age of 0.75±0.25 Ga (McKinnon et al., 1997), with rather small age variation across the surface. Yet, it remains unclear which of these two geodynamic regimes, stagnant-lid vs. episodic overturn, is better capable of explaining the above surface age characteristics. In this work, we investigate both geodynamic regimes further in self-consistent 2D and 3D numerical models. The roles of mantle viscosity, and internal heating rates are analyzed. Also, the efficiency of melt eruption is varied, which is linked to the production of new basaltic crust at the surface. These parameters govern planetary evolution and system variation of them allows us to better constrain feasible conditions to reproduce the mean surface age as well as the uniformity of the surface age distribution. Our results thus help to provide better insight into Venus' current structure and dynamic state. In the stagnant lid regime our models predict much thicker basaltic crust (i.e. 111±5 km) and very small global mean surface age (i.e. 0.25±0.15 Ga). In models with episodic resurfacing, increasing the yield stress has a great influence on the occurrence and frequency of overturn events. This further shows a direct influence on mean surface age distributions.