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Onset of convection within mid-sized icy satellites

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The medium-sized icy satellites orbiting around Saturn display a variety of surface features that are best explained by endogenic processes. The present study investigates the conditions that lead to subsolidus convection into the icy shells of these satellites. Because the convective process can happen only late in the evolution of these satellites, this paper focuses on the onset time of convection and its effects on the thinning of the lithosphere. It shows that the onset time cannot allow convection to start before the temperature of the ice gets to a value of 250 K. Before stationary convection can be reached, a transient period that can last several billions years thins the lithosphere. Convective heat transfer models also predict a lower amount of partial melt in the ice layer compared to the case of purely conductive heat transfer. Consequently, differentiation of a rocky core is very limited. During this transition period, the heat flux is much less than that predicted by scaling laws that describe well the convective process once stationary convection is attained. Implications for the evolution of Iapetus, Enceladus and other icy satellites are described.