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The Impact of Very Large Meteoritic Impacts on Early Mars Modeled with a Hierarchy of Numerical Models

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The origin of the formation of the Martian valley networks is now a half-century mystery. It has been proposed that very large meteoritic impacts could have triggered a long-term climate change conducive to the formation of these valley networks. We use a hierarchy of numerical models (the 3-D LMD Generic Global Climate Model, the 1-D LMD Generic radiative-convective model, and the 2-D StagYY Mantle Dynamics model) to test that hypothesis and more generally explore the environmental effect of very large meteoritic impacts (Rimpactor > 100 km, or Dcrater > 1000km) on the atmosphere, surface and interior of early Mars.

We find that the environmental effect of the largest impact events recorded on Mars are characterized by:

(i) a short impact-induced warm period (a few tens of Martian years maximum), (ii) a low amount of precipitation (with almost no surface re-evaporation of precipitation), (iii) deluge-style precipitation, and (iv) precipitation patterns that are spatially uncorrelated with the observed regions of valley networks formation.

Altogether, these arguments indicate that the largest impact events recorded on Mars are unlikely to be the direct cause of formation of the Noachian valley networks.