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Asteroid and comet impacts on Mars and their influence on atmospheric mass evolution and habitability.

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Impacts by asteroids and comets could have significant affects on the habitability and atmospheric evolution of terrestrial planets by removing part of its atmosphere, by delivering into it material and volatiles. Large impacts could have repeatedly destroyed the existing biosphere, but in the mean time new subsurface habitats have likely formed from impact induced hydrothermal systems.

Early in its history, Mars could have a much denser atmosphere and higher surface temperatures to sustain the presence of stable liquid water or saline solution at the surface, as suggested by several studies. The environmental effects of a period of impact bombardment on terrestrial planets remain poorly constrained. In this study we revisit the atmospheric loss and delivery of volatiles on Mars between the end of the Noachian and present using numerical models.

Following an impact, the quantity of escaped atmosphere, as well as impactor and target materials can be estimated using numerical simulations. Studies on the atmospheric loss and delivery due to impacts differ sometimes by orders of magnitude, mainly due to different equation of state and dynamical models used.
The hydrocode simulations designed to simulate a single impact are not suitable to study the cumulative effect of impact erosion and delivery in the long term due to their extremely high computation costs. Instead, empirical approximations based on hydrocode simulations have been used to estimate atmospheric evolution. Comparison between different hydrocode results and atmospheric mass evolution upon impacts based on empirical models will be presented using revised model parameters. In addition, different delivery and lost mechanisms including volcanic outgassing and non-thermal escape, can be taken into account to study various atmospheric evolution scenarios.

Our results suggest that impacts alone can hardly remove a significant amount of atmospheric mass over this period. Contribution of additional factors such as outgassing and non- thermal escape processes can not explain neither the presence of surface pressure larger than few hundreds of mbars 3.9 Gyr ago. Based on extreme case scenarios, maximum surface pressures at the end of the Noachian, could be as much as 0.25 bar or 1.9 bar, with and without CO_2 storage into carbonate reservoirs, respectively.