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Long term evolution of surface conditions on Venus: effects of primordial and Late Heavy Bombardment impacts at different timescales.

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We investigate the influence of impacts on the history of terrestrial planets from the point of view of internal dynamics and surface conditions. Our work makes use of our previous studies on Venus' long term evolution through a coupled atmosphere/mantle numerical code.
The solid part of the planet is simulated using the StagYY code (Armann and Tackley, 2012) and releases volatiles into the atmosphere through degassing. Coupling with the atmosphere is obtained by using surface temperature as a boundary condition.
The evolution of surface temperature is calculated from CO_2 and water concentrations in the atmosphere with a gray radiative-convective atmosphere model. These concentrations vary due to degassing and escape mechanisms. We take into account hydrodynamic escape, which is dominant during the first hundred million years, and non-thermal processes as observed by the ASPERA instrument and modeled in various works.
Impacts can have different effects: they can bring (i) volatiles to the planet, (ii) erode its atmosphere and (iii) modify mantle dynamics due to the large amount of energy they release. A 2D distribution of the thermal anomaly due to the impact is used leading to melting and subjected to transport by the mantle convection. Volatile evolution is still strongly debated. We therefore test a wide range of impactor parameters (size, velocity, timing) and different assumptions related to impact erosion, from large eroding power to more moderate ones (Shuvalov, 2010).
Atmospheric erosion appears to have significant effects only for massive impacts and to be mitigated by volatiles brought by the impactor. While small (0-10 km) meteorites have a negligible effect on the global scale, medium ones (50-150 km) are able to bring volatiles to the planet and generate melt, leading to strong short term influence. However, only larger impacts (300+ km) have lasting effects. They can cause volcanic event both immediately after the impact and later on. Additionally, the amount of volatiles released is large enough to modify normal evolution and surface temperatures (tens of Kelvins). This is enough to modify mantle convection patterns. Depending on when such an impact occurs, the surface conditions history can appear radically different. A key factor is thus the timing of the impact and how it interacts with other processes.