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Large impacts and the evolution of Venus; an atmosphere/mantle coupled model.

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We investigate the evolution of atmosphere and surface conditions on Venus through a coupled model of mantle/atmosphere evolution by including meteoritic impacts mechanisms. Our main focuses are mechanisms that deplete or replenish the atmosphere: volcanic degassing, atmospheric escape and impacts. The coupling is obtained using feedback of the atmosphere on the mantle evolution.
Atmospheric escape modeling involves two different aspects: hydrodynamic escape (dominant during the first few hundred million years) and non-thermal escape mechanisms as observed by the ASPERA instrument. Post 4 Ga escape is low.
The atmosphere is replenished by volcanic degassing, using an adapted version of the StagYY mantle dynamics model (Armann and Tackley, 2012) and including episodic lithospheric overturn. Volatile fluxes are estimated for different mantle compositions and partitioning ratios.
The evolving surface temperature is calculated from CO_2 and water in the atmosphere with a gray radiative-convective atmosphere model. This surface temperature in turn acts as a boundary condition for the mantle dynamics model and has an influence on the convection, volcanism and subsequent degassing.
We take into account the effects of meteorites in our simulations by adapting each relevant part of the model. They can bring volatiles as well as erode the atmosphere. Mantle dynamics are modified since the impact itself can also bring large amounts of energy to the mantle. A 2D distribution of the thermal anomaly due to the impact is used and can lead to melting. Volatile evolution due to impacts (especially the large ones) is heavily debated so we test a broad range of impactor parameters (size, velocity, timing) and test different assumptions related to impact erosion going from large eroding power (Ahrens 1993) to recent parameterization (Shuvalov, 2009, 2010).
We are able to produce models leading to present-day-like conditions through episodic volcanic activity consistent with Venus observations. Without any impact, CO_2 pressure only slightly increases due to degassing. On the other hand, water pressure varies rapidly leading to variations in surface temperatures of up to 200K, which have been identified to have an effect on volcanic activity. We observe a clear correlation between low temperature and mobile lid regime.
We observe short term and long term effects of the impacts on planetary evolution. While small (less than kilometer scale) meteorites have a negligible effect, large ones (up to around 100 km) are able to bring volatiles to the planet and generate melt both at the impact and later on, due to volcanic events they triggered due to the changes they make to mantle dynamics. A significant amount of volatiles can be released on a short timescale. Depending on the timing of the impact, this can have significant long term effects on the surface condition evolution. Atmospheric erosion caused by impacts, on the other hand, and according to recent studies seems to have a marginal effect on the simulations, although the effects of the largest impactors is still debatable.