Geophysical Research Abstracts
Vol. 20, EGU2018-18245, 2018
EGU General Assembly 2018


# Long-term water and carbon cycles as a coupled system on planets with and without plate tectonics

Dennis Höning (1,2), Nicola Tosi (1), Wim van Westrenen (2), and Tilman Spohn (1)

(1) German Aerospace Center (DLR), Institute of Planetary Research, Berlin, Germany (dennis.hoening@dlr.de), (2) VU Amsterdam, Department of Earth Sciences, Amsterdam, The Netherlands

The habitability of terrestrial planets is strongly affected by volatile cycles, in particular by the long-term carbon cycle and the global water cycle. On the one hand, the carbon cycle, including degassing, weathering, and – in the case of plate tectonics – subduction, regulates the surface temperature. On the other hand, the water cycle regulates the distribution of water between the surface and the mantle, with consequences on the weathering rate and on the mantle viscosity. Since the mantle viscosity affects melting processes at depth and thus the degassing rate, the water cycle feeds back on the carbon cycle. The latter in turn feeds back on the water cycle via the surface temperature. However, the interaction between the carbon and water cycles during planetary evolution has received little attention so far.

We present a model of the interior evolution of terrestrial planets in the stagnant-lid and plate tectonics mode. The model is based on a parameterization of the convective heat transport. The viscosity is dependent on the mantle water budget and thermal state. The carbon cycle model includes cycling between different reservoirs: sediments, crust, mantle, atmosphere, and oceans. Volatile extraction is calculated based on a parameterized model of mantle melting, and the recycling of volatiles into the mantle accounts for the contribution of volatile-rich sediments and crust. While plate tectonics recycles volatiles via subduction, a transfer of volatiles into the mantle of a stagnant lid planet can occur via weathering of basaltic crust, thickening of the crust via volcanism, and crustal delamination.

We will present first results of planetary evolution models including the carbon and water cycles as a coupled system. We will focus on the differences of our results compared to models that treat both cycles separately or neglect one of them. Finally, we will highlight the similarities and differences in evolution comparing planets with and without plate tectonics.