Modeling Extrasolar Planetary Surfaces

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Next decade, the Terrestrial Planet Finder missions, TPF-C and TPF-I, will provide our first opportunities to spectroscopically study the global characteristics of Earth-like planets beyond our solar system, and to search for clues as to whether these planets support life. To inform mission development, we should understand the global characteristics of planets that support life, at each stage in their evolutionary development. This talk will describe current work by the Virtual Planetary Laboratory to provide the framework for understanding the links between biogeochemical cycles and detectable global parameters, e.g. atmospheric composition and surface spectral characteristics, for a range of plausible extrasolar terrestrial planet types.

We will describe the ongoing development of a mosaic of models that aim to capture the biogeochemical and physical behavior of elements as they cycle in environments ranging from the highest mountains to the abyssal ocean plains. These models are generally process based and therefore need not be limited to modeling conditions similar to those on Earth. The central module in this talk is a state-of-the-art reactive transport model that captures weathering and diagenetic processes at the interfaces between a planet's atmosphere/hydrosphere on the one hand and the lithosphere on the other, i.e the planetary surface. This model will be used to predict fluxes of gases in and out of 'soils' as well as the composition of 'soil' profiles under a wide variety of climatic and atmospheric conditions. Predicting how planetary surface compositions evolve is likely to be especially valuable in preparing for the TPF-C mission.