Sensitivity of planetary mass in a life time of surface sea water in plate-mantle dynamics system: Application to exosolar rocky planets

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Recent debate on exosolar rocky planets focuses on if there would be plate-like surface dynamics induced from mantle convection and possibility sea water on the surface or not, which is essential processes on habitable planet such as the Earth. In order to reply these topics, the size dependence of plate-mantle dynamics system in global-scale mantle convection model with a finite size of surface water reservoir would be quite helpful, which has been developed in Nakagawa et al. (submitted to PEPS) A possibility of surface water ocean on the exosolar rocky planets was examined in a simplified parameterized convection approach (Schaefer and Sasselov, 2015; Komacek and Abbot, 2016), which suggests that a shorter life time of surface sea water seems to be expected as getting larger size but not examined in plate-mantle dynamics system in numerical mantle convection. Here, assessing such a suggestion from simplified models, I introduce a size dependence on a life time of surface sea water in numerical mantle convection simulations with a finite size of surface water reservoir. On the Earth-size planet, the surface sea water seems to be completely drought up in about several 100s million years to 1 billion years if the total water stored in the system is around 6 ocean masses of present Earth and more than 10 ocean masses are required to survive the surface sea water over 5 billion years. When the size of planet is ~1.5 times larger than the Earth, the life time of surface sea water would be strongly dependent on mantle temperature and storage capacity of water in bridgemanite suggested from 0.001 wt. % to 0.1 wt. %. In the presentation, I will also present a life time of water ocean as functions of size of planets, strength of water-dependent viscosity and storage capacity of bridgemanite with various amount of total water in the planetary system.

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