Towards co-evolution model of water ocean and deep Earth's interior –Constraints for total amount of water in Earth's system

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Revealing an evolution of Earth's system in terms of co-evolution of surface environment and deep interior, an interaction between water ocean and plate motion is very crucial. In a series of our previous studies, a boundary condition for water migration equation caused by hydrous mantle convection has been assumed that the amount of water ocean is an infinite. With this assumption of boundary condition, the mantle water content may increase rapidly ('burst' of mantle water content), which is caused by efficient heat and mass transfer due to vigorous plate motion but not so efficient with episodic and stagnant lid mode of hydrous mantle convection. However, this assumption is not realistic. Here we set a new boundary condition for water transport equation in mantle convection simulation that can be addressed with a 'finite' amount of water ocean. The input parameter of this type of modeling is the total amount of water in both surface and deep interior, which is assumed as 2 Ocean Masses (1 Ocean Mass = 1.4×10^{21} kg), 5 Ocean Masses and Infinite mass. Applying a finite amount of water ocean, the 'burst' of mantle water content may also occur with vigorous plate motion and water ocean is drought up in about a few billion years of time-scale that is shorter than the age of Earth if the total amount of water in Earth's system is assumed as 2 Ocean Masses. To get around 1 Ocean Mass at the age of the Earth, at least 3 to 5 Ocean masses of water in Earth's system seems to be required, which is still consistent with formation theory of water ocean in evolution of early Earth.

キーワード：海洋、プレート運動、地球システム変動
Keywords: ocean, plate motion, Earth's system dynamics