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A coupled core-mantle evolution in hydrous mantle convection: Implications for hydrogen cycle in the deep Earth system

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We investigate the deep mantle water cycle in a coupled core-mantle evolution system in hydrous mantle convection model incorporating thermodynamic model of water solubility limits of whole mantle and its possibility for partitioning of hydrogen via metal-silicate coupling at the core-mantle boundary (CMB) based on thermodynamics theory provided from Okuchi (1998) that is described as chemical reaction between metallic iron and water in the silicate melt. The major constraint for core-mantle evolution is to match the size of the inner core and continuous magnetic field generation measured from magnetic dissipation. In order to obtain the consistent size of the inner core ($\sim$1220 km), it would be a lower melting temperature at inner core boundary of iron alloy in hydrous mantle convection than dry mantle convection, which is about 4500 K at the inner core boundary (ICB) for hydrous mantle convection models. This is consistent with the melting temperature measurements of hydrous mantle silicate at high P-T condition (Nomura et al., 2014), which can be reduced by large amount of water in the deep mantle. For the hydrogen partitioning across the CMB, since the partitioning coefficient of hydrogen into metallic hydrogen has a strong temperature-dependence, the temperature at the CMB plays a key role in the hydrogen partitioning of Earth's core. With this modeling, we can imply hydrogen cycle from early to present Earth in the core-mantle evolution system as a result of deep mantle water cycle.