Experimental study on elementary hydrological process of rainfall in a forested continental hinterland

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There is an observational fact that a rainfall amount is constant or increases with increasing the distance from the coast (x) in a forest covered continent up to a few thousands kilometers, e.g. Amazon and Yenisei river basins. However, it contradicts the basic law of hydrology as shown in Fig 1a; rainfall (P) is partitioned into evapotranspiration (ET) and discharge (Q) that means P_0 at $x = x_0$ is larger than P_1 at $x = x_1$ ($x_0 < x_1$), because $P_0 = ET_0 + Q_0$ and $P_1 =< ET_0$. The contradiction is solved by Makarieva and Gorshkov (2007, hereafter refer to MG 2007) in which they proposed Biotic Pump of Atmospheric Moisture (BP) as illustrated in Fig. 1b. The principle of BP is that ET from forests (ET(F)) is greater than that from the ocean (ET(O)) that is the driving force to transport moisture from the ocean to a forested continental hinterland.

Nonetheless, MG (2007) and their series of studies did not explicitly mention the reason of large ET from forests. It is great in forests because evaporation of canopy interception (hereafter refer to interception; typically some 20% of rainfall) at the time of rainfall is larger than that from any other vegetative surfaces, though the amount of transpiration is similar independent of vegetation types under a certain climate condition.

Some studies showed that interception is proportional to the rainfall amount on an hourly basis. For example Hashino et al. (2012) observed evaporation rate of more than 10 mm/hour during rainfall that requires latent heat of five times as large as the solar constant. To explain such huge amount of evaporation during rainfall Murakami (2006) proposed splash droplet evaporation mechanism. I believe it is the only explanation of enormous evaporation because small droplets can evaporate and disappear quickly even under very high humidity based on the theory and experiments of cloud physics. On top of that, latent heat is supplied from clouds upon condensation of water vaper. However, splash droplet evaporation along with BP is still a hypothesis.

To prove the splash droplet evaporation hypothesis stable isotope of water is used. Over 1000 of rainwater samples were collected on an hourly basis both under the forest canopy and at the opening simultaneously (Fig. 2). The isotopic ratios are measured and are being analyzed in combine with the meteorological data. The outline of the methodology is presented at the meeting.

References

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Keywords: Biotic Pump of Atmospheric Moisture, canopy interception, splash droplet evaporation, stable isotope of water

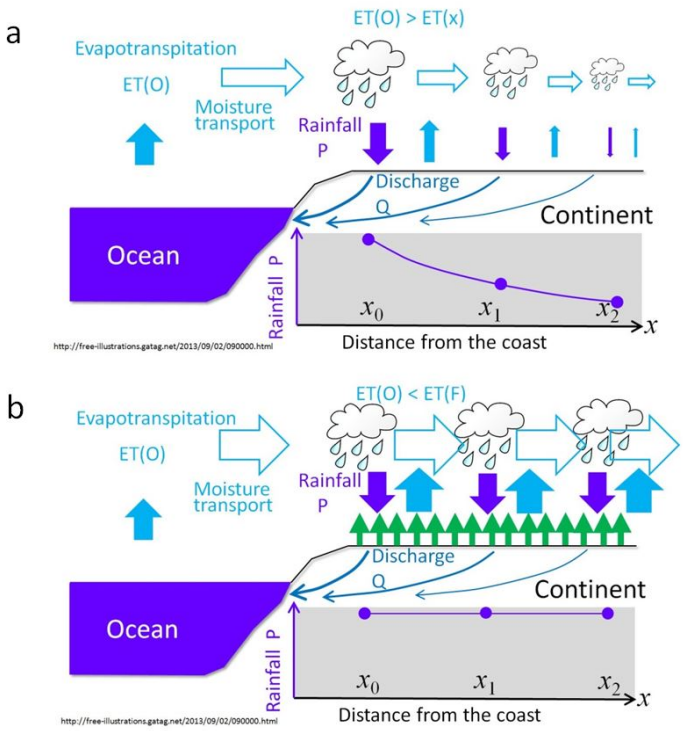

Fig. 1

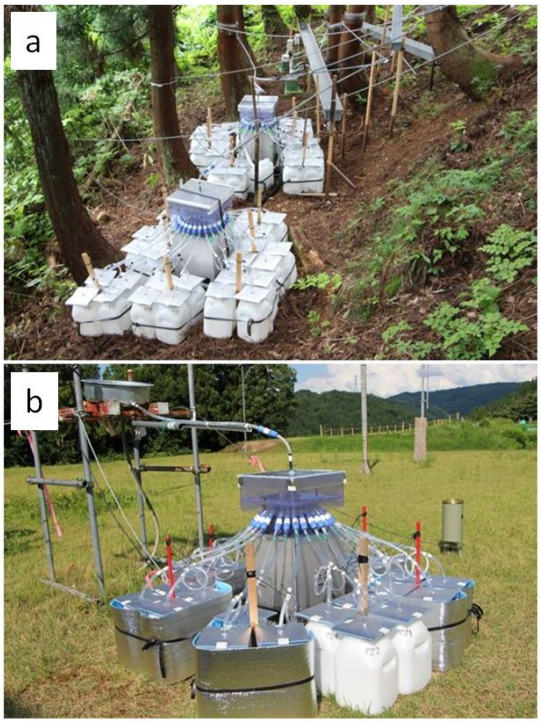

Fig. 2

