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A fundamental cause of an enormous amount of evaporation during rainfall by canopy interception: Evaporative force proposed by Makarieva and Gorshkov

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An enormous amount of evaporation from forest canopy is observed during rainfall as canopy interception. The evaporation rate often exceeds well over 10 mm h^{-1} that requires latent heat of five times solar constant (6814 W m^{-2} at 20ºC). On top of that, evaporation rate is proportional to the rainfall intensity. Namely, once the saturation of canopy is reached, the ratio of canopy interception to gross rainfall remains constant during the rainfall regardless of the intensity of the storm, e.g. approximately 20% of the rainfall in a Japanese cypress stand.

This enigmatic phenomenon includes several cardinal problems to solve. As for the mechanism of a huge amount of evaporation, Murakami (2006, 2007; J. Hydrol.) proposed splash droplet evaporation, and is supported by Dunkerley (2009; J. Hydrol.). As the size and the number of raindrops increase with rainfall intensity (Marshall-Palmer distribution), so does the number of splash droplets produced by raindrops hitting the canopy. A host of small droplets with huge combined surface area highly boost evaporation, which means water evaporates from the splash droplets as well as the canopy.

However, unless water vapor above canopy is removed and transported somewhere else, water vapor saturates and evaporation stops. Makarieva and Gorshkov (2007; HESS) advocated a new theory that can elucidate an enormous amount of evaporation and water vapor transport termed "evaporative force" or "the Biotic Pump Theory"(BPT). Though they do not deal with evaporation during rain events explicitly, it is applicable to the evaporation for the period of rainfall, i.e. canopy interception. Molecular weight of H_2O, 18, is smaller than the average value of air 29 that works for water vapor as buoyancy. As a result, water vapor is removed since it goes up by itself and condenses at the bottom of cloud. In the cloud latent heat is released that will be transported down to the canopy being pulled down with raindrops or in exchange for water vapor ascending from the canopy. It is postulated that both latent heat and water circulate between the canopy and the cloud.

Though Makarieva and Gorshkov (2007) claims that forest makes rain inland due to the strong evaporation from forest that "sucks in" water vapor from the ocean, they give canopy interception only a one-line mention. Canopy interception is a major component of evapotranspiration from forest that enables forest to evaporate larger amount of water than other surfaces on the earth, and the Biotic Pump does not function without canopy interception. Conversely, the mechanism of canopy interception is not explainable without evaporative force, and the fundamental cause of canopy interception is evaporative force. BPT is strongly supported by the observational facts of canopy interception and the splash droplet evaporation hypothesis. The study of canopy interception can be used as the tool to verify evaporative force that has the high potential of the development in the atmospheric boundary layer study.