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A huge amount of evaporation from forest during rainfall and active transport of water vapor from Ocean to Continent

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Rainfall amount under forest canopy is less than that at an opening, because some part of rainwater evaporates from the canopy. Evaporation from forest canopy occurs not only after the cessation of rainfall but also during rainfall. Surprisingly, evaporation amount during rainfall is proportional to the rainfall intensity, typically 20% of rainfall. For example, hourly evaporation by interception reached 5 mm $h^{-1}$for hourly rainfall of some 20 mm h^{-1}at the Hitachi Ohta Experimental Watershed, Ibaraki, Japan. However, conventional heat budget approach, which considers evaporation from canopy surface, cannot elucidate this phenomenon.

Murakami (2006, 2007) proposed splash droplet evaporation to explain a huge amount of evaporation by canopy interception. The size and the specific number of raindrops increase with rainfall intensity (Marshall-Palmer distribution), and the number of small droplets produced by raindrops hitting the canopy also augments with rainfall intensity. The numerous splash droplets with huge combined surface area evaporate effectively from the canopy. The hypothesis of splash droplet evaporation (SDE) includes controversial problems on the transport of heat and energy. Firstly, in most cases, water vapor does not saturate even under the condition of high humidity during rainfall. That means enormous water vapor must be removed rapidly, although the sink and the mechanism are not known. Secondary, a huge amount of latent heat must be supplied, e.g. 6814 W m^{-2}at 20 degrees Celsius (five times solar constant) for evaporation rate of 5 mm h^{-1}, and again the source and the transport mechanism are not known. If it were not for the source, the sink and the mechanisms, enormous evaporation by canopy interception is not maintained.

Molecular weight of water (18) is smaller than that of air (29). This difference works as buoyancy for water vapor. Based on this point Makarieva and Gorshkov (2007) advocated "evaporative force". The more water vapor the air contains, the stronger the buoyancy becomes. If water vapor ascends and reaches to the condensation level, it condenses and is removed since it turns into liquid water, namely, cloud. They claim that this simple principle has been overlooked by meteorologists. Their theory also includes important hypothesis concerning evaporation from forest. As is well known, generally, the amount of evaporation from forest is larger than any other surfaces on our planet. A continental landmass covered with forest evaporates much water than the sea surface of the adjacent ocean. As a result, water vapor above the ocean is "sucked in" by forest in the landmass due to the difference in evaporation amount. This principle is termed "Biotic Pump Theory" (BPT). BPT explains precipitation of the continent covered with forest is kept constant from the coast to the inland as far as thousands of kilometers from the sea coast, e.g. Amazon, Congo, and Yenisey basins.

Though Makarieva and Gorshkov did not discuss canopy interception, the amount of evaporation from forest is higher since canopy interception by forest is larger than that of other vegetations and interception is almost zero for non-vegetative surfaces. In other words, Biotic Pump functions thanks to forest canopy interception. Conversely, SDE is not explainable without evaporative force

(Murakami, 2009). Both BPT (and evaporative force) and SDE are still hypotheses. The proof of them not only leads to atmospheric science revolution but also changes our sense of value for forest.

References

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