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The Amazon forest-rainfall feedback: the roles of transpiration and interception

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In the Amazon, deep-rooted trees increase local transpiration and high tree cover increase local interception evaporation. These increased local evapotranspiration fluxes to the atmosphere have both positive effects on forests down-wind, as they stimulate rainfall. Although important for the functioning of the Amazon, we have an inadequate assessment on the strength and the timing of these forest-rainfall feedbacks.

In this study we (i) estimate local forest transpiration and local interception evaporation, (ii) simulate the trajectories of these moisture flows through the atmosphere and (iii) quantify their contributions to the forest-rainfall feedback for the whole Amazon basin.

To determine the atmospheric moisture flows in tropical South America we use a Lagrangian moisture tracking algorithm on 0.25° (c. 25 km) resolution with eight atmospheric layers on a monthly basis for the period 2003–2015. With our approach we account for multiple re-evaporation cycles of this moisture. We also calculate for each month the potential effects of forest loss on evapotranspiration. Combined, these calculations allow us to simulate the effects of land-cover changes on rainfall in downwind areas and estimate the effect on the forest.

We found large regional and temporal differences in the importance how forest contribute to rainfall. The transpiration-rainfall feedback is highly important during the dry season. Between September-November, when large parts of the Amazon are at the end of the dry season, more than 50% of the rainfall is caused by the forests upstream. This means that droughts in the Amazon are alleviated by the forest. Furthermore, we found that much moisture cycles several times during its trajectory over the Amazon. After one evapotranspiration-rainfall cycle, more than 40% of the moisture is re-evaporated again. The interception-evaporation feedback is less important during droughts. Finally from our analysis, we show that the forest-rainfall feedback is essential for the resilience of the south-western and northern parts of the Amazon forest. Without the forest-rainfall feedbacks, these forest wouldn’t exist.