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Contribution of water-limited regions to their own supply of rainfall during wet and dry years

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The occurrence of wet and dry spells in water-limited regions remains poorly understood. When these precipitation anomalies happen during the growing season, they can impact carbon and water budgets and hinder the regional management of natural resources. The difficulties to understand and predict these anomalies are partly owed to the complex role that water-limited ecoregions play in the genesis of their own rainfall: the increases in biomass and transpiration during the growing season are expected to influence the local input of rainfall.

In this presentation, we unravel the origin and immediate drivers of growing-season rainfall in the ten major water-limited ecoregions on Earth. We use novel satellite data of vegetation water content and transpiration, combined with Langrangian atmospheric trajectory modelling. The extent to which these ecoregions themselves contribute to their own supply of rainfall is analyzed for dry and wet years separately.

Results show that persistent anomalies in growing-season precipitation—and subsequent biomass impacts—are caused by a complex interplay of anomalies in land and ocean evaporation, air circulation and local atmospheric stability. Nonetheless, the specific drivers vary depending on the region of interest. For instance, in Kalahari and Australia, local atmospheric instability and evaporation in the surrounding regions play a central role. In these regions, the volumes of moisture recycling decline in dry years, providing an overall positive feedback that intensifies dry conditions. Despite these declines in the volumes of recycled rainfall, recycling ratios increase over 40% during dry times. This implies that transpiration in periods of water stress partly offsets the decreases in incoming precipitation that are mainly triggered by external conditions. Findings highlight the need to adequately represent vegetation–atmosphere feedbacks in models to predict biomass changes and simulate the fate of water-limited regions in our warming climate.