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Satellite-observed vegetation responses to intraseasonal rainfall variability

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The response of vegetation to changes in rainfall is a key factor in understanding terrestrial water availability, as well as land-atmosphere feedbacks that can occur as a result of the changes in evapotranspiration, albedo and surface roughness.

Studies of vegetation responses to rainfall have typically focused on variations at the seasonal timescale or longer. However, there is considerable rainfall predictability associated with atmospheric modes of intraseasonal (25 to 60 day) variability, for example the Madden-Julian Oscillation. An improved understanding of land surface predictability at the intraseasonal timescale could aid decision-making in areas such as water management or agriculture, as well as feeding back onto atmospheric predictability. Quantifying intraseasonal vegetation responses could also highlight required improvements in dynamic vegetation modelling for land surface models.

Here, we use satellite-based measurements of rainfall and Vegetation Optical Depth (VOD) to assess the relationships between the intraseasonal variability of rainfall and vegetation across the tropics and mid-latitudes. VOD is a proxy for vegetation water content and is also linked to biomass dynamics. Since it is derived from microwave observations, it can be retrieved under cloudy conditions, giving sufficient daily observations to permit the investigation of variations on the 25-60 day timescale in regions with frequent cloud cover such as the tropics. We use cross-spectral analysis to characterise the intraseasonal vegetation responses at a 0.25° pixel scale in each season.

Coherent intraseasonal relationships between rainfall and vegetation are typically found in arid or semi-arid regions, where vegetation is water-limited and hence sensitive to wet and dry spells. We also analyse the phase difference between rainfall and vegetation, i.e. by how many days one lags the other. Changes in vegetation are generally found to lag changes in rainfall, with increased rainfall followed by increased VOD. The results show that the observations capture distinct distributions of phase difference according to land cover type, with very fast (0-5 day) vegetation

responses most likely in sparsely vegetated areas. Following strong intraseasonal wet events, the increase in VOD can persist for at least two months after the peak in rainfall.