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Satellite observations of the convective response to deforestation in Southern West Africa

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The loss of tropical forest has affected much of southern West Africa. In Côte d'Ivoire and Ghana, only "islands" of intact forest remain, typically within protected areas, on length scales of up to several tens of kilometres. This deforestation produces mesoscale patterns of surface fluxes of heat, water and momentum, which depend on both the nature of the agriculture which follows deforestation (for example cocoa plantations) and the phase of the seasonal cycle. This is likely to affect rainfall patterns in the region, as in the much more studied Amazon Basin. Here we use satellite observations to document how deforestation since the 1990s has impacted on convective storms.

We identify deforestation "events" on scales $\sim$ 10 km using both the ESA CCI Land Cover (1992-2015) and University of Maryland Global Forest Change (2000-2017) datasets. We can corroborate the timing and spatial extent of the deforestation with independent Land Surface Temperature data (from Meteosat and MODIS); the impact of deforestation on the surface energy balance is clearly evident in increased daytime temperatures during the dry season. The surface temperature rises post-deforestation due to a combination of decreases in both aerodynamic roughness and evapotranspiration. The availability of long-term cloud-top temperature data from the Meteosat series of satellites allows us to examine changes in the diurnal and seasonal cycles of convection associated with particular deforestation events within the time series.

We find enhanced afternoon convective initiations in deforested areas compared to nearby forests. Within larger-scale clouds, we identify convective cores using the approach of Klein et al (JGR-Atmos, 2018). This reveals a strong sensitivity of convection within mesoscale convective systems to deforestation. The study provides unique observational evidence showing how West African deforestation has impacted rainfall patterns, and raises questions about the effects of future land use changes on rainfall and water resources in this rapidly developing region.