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Impact of land surface properties on convection in a 40 day convection-permitting simulation over West Africa

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Land surface properties influence the life cycle of convective systems across West Africa via space-time variability in sensible and latent heat fluxes. Previous observational and modelling studies have shown that areas with strong mesoscale variability in vegetation cover or soil moisture induce coherent structures in the daytime planetary boundary layer. In particular, horizontal gradients in sensible heat flux can induce convergence zones which favour the initiation of deep convection. A recent study based on satellite data (Taylor et al. Nature Geoscience 2011), illustrated the climatological importance of soil moisture gradients in the initiation of long-lived Mesoscale Convective Systems (MCS) in the Sahel.

Here we explore the relationships between MCS life-cycles and the underlying surface using a unique convection-permitting simulation over West Africa during the wet season. Under the UK CASCADE project, the Met Office Unified Model was run with a grid length of 4km over a domain of 4000 x 3000 km for the period 25th July to 2nd September 2006. Over the course of the integration, the model generates a large population of MCS to analyse, each creating new soil moisture structures which in turn can feed back on the atmosphere. We track simulated MCS developing in varied environments and examine how land surface features influence convective initiation. We find strong consistency between the previous analysis of satellite data and the model. Specifically, the model captures the observed preference for convective initiation close to strong soil moisture gradients, with storms developing on the upwind side of transitions from dry to wet soil. The model clearly illustrates the pre-storm surface-induced circulation previously hypothesised to be responsible for the land-atmosphere coupling.