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Impact of surface heterogeneities on daytime convective initiation in the Sahel and modelling issues

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A number of modeling studies point to the significance of surface heterogeneities on boundary layer and convective processes over land, through varied mechanisms and feedbacks loops. However, the feedbacks which actually operate in reality are still to be fully determined. This poster focuses on the sensitivity of daytime storm triggering to surface properties over land and builds upon the recent results of Taylor et al. (Nature Geoscience 2011). In short, they show, from the analysis of multi-year satellite datasets (MSG infra-red brightness temperature and land surface temperature product, AMSR-E soil moisture estimates), that the frequency of storm initiation is enhanced over mesoscale (~ 10 km) soil moisture patterns, in the semi-arid Sahelian region. The results also suggest the emergence of distinct mechanisms operating on different scales during the monsoon. In this transition zone, lying in between the wet Tropics and the Sahara desert, observations show that, for scales on the order of 40 km x 40 km, there is no obvious relationship between the mean surface soil moisture and the frequency of convective initiations. However, when considering anomalies with respect to the mean at larger scale (200 km x 200 km), daytime convection is favored over the drier surfaces. Then, a strong sensitivity to surface heterogeneities is found at even smaller scale (~ 10 km). Notably, the frequency of daytime storm triggering doubles in the presence of strong soil moisture gradients oriented along the low-level wind direction, compared to more uniform surfaces conditions. Meteorological analyses further indicate that this sensitivity to surface heterogeneities is more pronounced when the atmospheric environment is less favorable to convective development (larger convective inhibition, elevated level of free convection). These results point to the significance of mesoscale surface soil moisture patterns which are currently not considered in GCMs. They raise new issues about the modeling of daytime convection, and questions regarding the climatic sensitivity of this land-atmosphere coupled phenomenon. This study also provides a large observational database, comprising several thousand documented cases of convective initiation within a wide range of environments. It is further used to address modeling issues in weather forecast models (ECMWF and ARPEGE). Namely, daily forecasts of the sampled cases are systematically evaluated, the development of convection being diagnosed from rainfall fields. In line with previous studies, convection appears to be initiated too early in several cases. However, for a number of cases, convection does not occur at all in the forecasts. Overall, convective initiations appear to be more sensitive to the atmospheric environment in the forecasts than in the observations.