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Cloud radiative impact over West Africa

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Clouds have a major impact on the redistribution of water within the atmosphere and on the radiative fluxes at the surface and at the top of the atmosphere. The cloud types, occurrence and radiative effects in West Africa have not been extensively documented nor quantified. Taking advantage of the one year ARM Mobile Facility (AMF) deployment in 2006 in Niamey (Niger) Bouniol et al. (JAMC 2012) documented and quantified the various cloud types occurring over this semi-arid region, their diurnal and seasonal cycles and radiative impact at the surface. It was found that deep convection is, by far not the only cloud system type that affects this region, but that other cloud types, namely low level, mid level and cirrus, occur with a substantial impact at the surface in the shortwave and longwave domains.
In this paper, satellite data, in particular those collected by the A-Train are used in order to extend the local climatology deduced from the ground based measurements at the scale of West Africa, for several monsoon and pre-monsoon periods. The transect strategy described in Hourdin et al. (BAMS 2009) is used. It consists in taking advantage of the relative zonal symmetry of the West African climate to analyse the data in a North-South cross section extending from the ocean up the Sahara desert.
We find that the same cloud types, as the ones observed at Niamey, are present all over West Africa. Deep convection and low level clouds have a seasonal cycle which is strongly correlated with the monsoon cycle whereas mid-level and cirrus clouds occur whole year long over a major part of West Africa, even over Sahara for mid-level clouds. A particular attention is given to the cloud radiative effect associated with each cloud types, both at the top of the atmosphere and at the surface. This effect is quantified using ground based data when possible or various satellite products. Their comparison provide a confidence level on the estimates.
This dataset is further used to evaluate the representation of the cloud seasonal cycle and associated radiative effects in climate models participating to the Assessment Report 5 of the IPCC exercise. It assesses the model skill in terms of seasonal and intra-seasonal variations of West African monsoon and related cloud and radiative processes. Thanks to high frequency extraction (30 minutes) from the model simulations at selected points along the north-south transect over West Africa, the processes implied in the cloud radiative effect can be assessed up to the diurnal scale.
Overall, it appears that the simulation of clouds and cloud radiative impacts remain a major challenge over this wide tropical land area.