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Characteristics of mid-level clouds over West Africa

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Clouds have a major impact on the distribution of water and energy fluxes within the atmosphere. They also represent one of the main sources of uncertainties in global climate models as a result of the difficulty to parametrize cloud processes. However, in West Africa, the cloud type, occurrence and radiative effects have not been extensively documented.
This region is characterized by a strong seasonality with precipitation occurring in the Sahel from June to September (monsoon season). This period also coincides with the annual maximum of the cloud cover. Taking advantage of the one-year ARM Mobile Facility (AMF) deployment in 2006 in Niamey (Niger), Bouniol et al (2012) documented the distinct cloud types and showed the frequent occurrence of mid-level clouds (around 6 km height) and their substantial impact on the surface short-wave and long-wave radiative fluxes. Furthermore, in a process-oriented evaluation of climate models, Roehrig et al (2013) showed that these mid-level clouds are poorly represented in numerical models.
The aim of this work is to document the macro- and microphysical properties of mid-level clouds and the environment in which such clouds occur across West Africa.
To document those clouds, we extensively make use of observations from lidar and cloud radar either deployed at ground-based sites (Niamey and Bordj Badji Mokhtar (Sahara)) or on-board the A-Train constellation (CloudSat/CALIPSO). These datasets reveal the temporal and spatial occurrence of those clouds. They are found throughout the year with a predominance around the monsoon season and are preferentially observed in the Southern and Western part of West Africa which could be linked to the dynamics of the Saharan heat low. Those clouds are usually quite thin (most of them are less than 1000m deep). A clustering method applied to this data allows us to identify three different types of clouds : one with low bases, one with high bases and another with large thicknesses. The first two clouds families are associated with potential temperature inversions at the top of the clouds. Complementary observations such as radiosondes and radiation measurements allow us to determine the thermodynamical stratification in which they occur as well as their radiative properties.