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The formation and dust lifting processes associated with a large Saharan meso-scale convective system (MCS)

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This work focusses on the meteorology that produced a large Mesoscale Convective System (MCS) and the dynamics of its associated cold pool. The case occurred between 8th-10th June 2010 and was initiated over the Hoggar and Aïr Mountains in southern Algeria and northern Niger respectively. The dust plume created covered parts of Algeria, Mali and Mauritania and was later deformed the by background flow and transported over the Atlantic and Mediterranean.

This study is based on: standard surface observations (where available), ERA-Interim reanalysis, Meteosat imagery, MODIS imagery, Tropical Rainfall Measuring Mission (TRMM) rainfall estimates, Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), CloudSat and a high resolution (3.3km) limited area simulation using the Weather Research and Forecasting (WRF) model.

A variety of different processes appear to be important for the generation of this MCS and the spreading of the associated dusty cold pool. These include: the presence of a trough on the subtropical jet, the production of a tropical cloud plume, disruption to the structure of the Saharan heat low and the production of a Libyan high. These features produced moistening of the boundary layer and a convergence zone over the region of MCS initiation. Another important factor appears to have been the production of a smaller MCS and cold pool on the evening of the 7th June. This elevated low-level moisture and encouraged convective initiation the following day. Once triggered on the 8th June some cells grew and merged into a single large system that propagated south westward and produced a large cold pool that emanated from its northern edge.

The cells on the northern edge of the system over the Hoggar grew and collapsed producing a haboob that spread over a large area. Cells further south continued to develop into the MCS and actively produce a cold pool over the system's lifetime. This undercut the dusty air from the earlier cold pool and forced dust high into the atmosphere. As well as the expected behaviour of a gravity current there also seems to be a complex relationship between the cold pool and diurnal variation in boundary layer structure. These include: (1) the production of nocturnal low-level jet in the area previously covered by the cold pool allowing for further dust uplift the following morning, (2) the development of a bore on the nocturnal boundary layer travelling ahead of the cold pool and capable of deflating dust further into the desert and (3) the production of bores on the nocturnal boundary layer by the collision of fronts formed through the collapse of the well mixed daytime boundary layer and nocturnal frontogenesis.

It is hoped that this work will add to the understanding of the production of large Saharan MCSs and the processes that can influence their formation. Also it shows the complex dynamical interactions that occur within the Saharan boundary layer and how these might impact our understanding of dust uplift processes associated with the passage of MCSs.