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Understanding the Role of the Saharan Heat Low in Modifying Atmospheric Dust Distributions – Observations From Two Research Aircraft Flying Simultaneously Over Western Africa

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The near-surface low pressure system that develops over western Africa in Boreal summer (know as the Saharan Heat Low) is thought to have a significant influence on regional and global climate due to its links with the Monsoon, the Northern Atlantic and the Mediterranean climate system. The SHL is associated with the deepest atmospheric boundary layer on the planet and is co-located with the highest dust loadings in the world. The processes that link the heat low and dust distribution are only poorly understood. Improving the representation of the heat low and the processes that control the emission and atmospheric distribution of dust in climate and NWP models is crucial if we are to reduce known systematic errors in climate predictions and weather forecasts.

In collaboration with European partners, the UK-based consortium project "Fennec – The Saharan Climate System" aims at improving our understanding of this complex climate system by integrating for the first time coordinated ground and aircraft observations from the central Sahara, newly developed satellite products, and the application of regional and global models. On 22 June 2011, two research aircraft operating out of Fuerteventura (Spain) surveyed the Saharan Heat Low centred over Mauritania-Mali border. The aircraft flew simultaneously in the morning and in the afternoon on two different tracks thereby sampling each track four times on that day. Both aircraft were equipped with a downward looking LIDAR for aerosol detection. In total, 51 sondes were dropped during the flights making this the most comprehensive dataset to study the spatio-temporal diurnal evolution of the heat low including the interactions between the atmospheric boundary layer and dust distributions.

Combining LIDAR observations, satellite imagery and back-trajectory modelling we show that an aged dust layer was present in the heat low region resulting from previous day's dust activity associated with a south-moving density current from the Atlas mountains and westward-moving Haboob fronts originating along the Algeria-Mali border. We show how the dust is distributed within the atmosphere and how it is modified during the course of the day by various processes including the development of the atmospheric boundary layer and associated dry convection as well as the inflow of moisture-rich monsoon air from the south.