Geophysical Research Abstracts
Vol. 19, EGU2017-15704, 2017
EGU General Assembly 2017
© Author(s) 2017. CC Attribution 3.0 License.

The relative importance of water vapour and dust in controlling the variability in radiative heating of the summertime Saharan heat low

John H. Marsham (1), Douglas J. Parker (1), Martin C. Todd (2), Jamie R. Banks (3), Helen E. Brindley (3), Luis Garcia-Carreras (1), Alexander J. Roberts (1), and Claire L. Ryder (4)

(1) School of Earth and Environment, University of Leeds, Leeds, UK, (2) Department of Geography, University of Sussex, Brighton, UK, (3) Space and Atmospheric Physics Group, The Blackett Laboratory, Imperial College, London, UK, (4) Department of Meteorology, University of Reading, Reading, UK

The summertime Sahara heat low (SHL) is a key component of the West African monsoon (WAM) system but is a key source of uncertainty in global models. There is considerable uncertainty over the relative importance of water vapour and dust concentrations in controlling the radiation budget over the Sahara. This limits our ability to explain the variability and trends in the SHL and WAM systems, and so hampers our ability to reduce model biases.

Here we use in situ observations from Fennec supersite-1 in the central Sahara from June 2011 and 2012, as well as satellite retrievals from GERB, to quantify how total column water vapour (TCWV) and dust aerosols control day-to-day variability in the energy balance in observations and ECMWF reanalyses (ERA-I).

Results show that the earth-atmosphere system is radiatively heated in June 2011 and 2012. While we are not able to completely disentangle the roles of water vapour, clouds and dust from the observations, the analysis demonstrates that TCWV provides a far stronger control on TOA net radiation, and so the net heating of the earth-atmosphere system, than AOD does. Variations in dust provide a much stronger control on surface heating, but the reduction in surface heating associated with high dust loadings are largely compensated by associated increases in atmospheric heating, and so dust control on net TOA radiation is weak. Dust and TCWV are both important for direct atmospheric heating.

ERA-I assimilated radiosondes from the Fennec campaign but uses a monthly dust climatology, and so cannot capture the impact of daily variations in dustiness. Despite this, ERA-I managed to capture the control of TOA net flux by TCWV, with a positive correlation (r = 0.6) between observed and modelled TOA net radiation. Variations in surface net radiation, and so the vertical profile of radiative heating, are not captured in ERA-I, given it does not capture variations in dust. Results show that ventilation of the SHL by cool moist air leads to a radiative warming, which stabilises the SHL with respect to such perturbations.

It is known that models struggle to capture the advective moistening of the SHL, especially when driven by mesoscale convective systems. Our results show that the typical model errors in Saharan water vapour will cause substantial errors in the modelled TOA energy balance (tens of W m−2), which will lead to errors in both the SHL and the WAM.