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Evaluating the Met Office Unified Model simulated land surface temperature (LST) using a multi-platform approach

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The Met Office Unified Model (UM) has a significant cold bias in land surface temperature (LST) in semi-arid regions at global resolution, and limited area 4.4 km and 2.2 km configurations. The daytime LST cold bias simulated by the JULES land surface scheme within the UM is present throughout the annual cycle in semi-arid regions of the globe in comparison to IASI retrievals. These errors are largest in late spring and early summer and have magnitudes of 5 to 15 K, dependent on model resolution. This work will show verification of model biases through ground-based, in-situ airborne and satellite observations during the Semi-Arid Land Surface Temperature and IASI Calibration Experiment (SALSTICE) in semi-arid south-eastern Arizona in May 2013.

Airborne observations of LST from the FAAM research aircraft using the Airborne Research Interferometer Evaluation System (ARIES) were used to investigate the spatial distribution of the model errors and evaluate IASI retrievals. Airborne retrievals of surface temperature were found to broadly agree with IASI retrievals; uncertainties are attributed to the spatial variability in the ARIES measurements compared with the IASI footprints and due to differences within the retrieval, such as assumed emissivity. The UM errors in LST were found to vary with model resolution as well as topographic complexity, with the coarse resolution global model having larger errors than the limited area models. Regions with complex terrain had the highest LST errors while the errors over the less complex basins were lower, in the range of 4-5 K.

Evaluation of the JULES land surface scheme has been performed for flux tower sites in the Walnut Gulch Experimental Watershed in south-eastern Arizona. An annual dataset of flux tower measurements confirms the LST biases seen with aircraft and satellite observations and indicates that night-time LST biases are of the order of those observed during the day. Comparisons of different model resolutions show the night time bias is largest in the 2.2 km model resolution (6.5 K) compared with the global 25 km model (3 K). Verification of this diurnal pattern in LST biases with model resolution has been achieved using MODIS retrievals.

Flux tower measurements have shown that JULES simulated turbulent heat fluxes are larger compared with observations (21 W m^{-2}, monthly average) and ground heat fluxes too small (3.5 W m^{-2}, monthly average). The accurate representation of bare soil vegetation fraction in JULES simulations is shown to be of particular importance, reducing biases in the sensible heat flux (16 W m^{-2}, monthly average).