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Evaluating the Unified Model and JULES in a semi-arid environment

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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 model (LAM) 4.4 km and 2.2 km configurations. Evaluation of the JULES land surface scheme has been performed for flux tower sites in the Walnut Gulch Experimental Watershed in south-eastern Arizona. Flux tower measurements have shown that JULES simulated turbulent heat fluxes are larger compared with observations (21 W m^{-2}, May monthly average) and ground heat fluxes too small (3.5 W m^{-2}, May monthly average). The accurate representation of the bare soil cover fraction is shown to be of particular importance, reducing biases in the sensible heat flux.

Offline simulations with JULES are used to compare UM configurations with observed bare soil and vegetation parameters (surface type fractional cover, leaf area index and canopy height) in order to attribute the LST biases to some model parameter errors. JULES observed vegetation simulations increase the modelled daytime surface warming; daytime LST (O-B) biases are reduced to -0.4 K compared with 4.8 K in the standard configuration simulations when compared with ground-based IRT measurements. Similar trends are seen when the model is compared with MODIS LST retrievals; Aqua LST biases showed a large initial bias of 7.4 K with the standard configuration, reduced to 1.0 K in observed vegetation simulations.

The results suggest that there is a large component of the LST bias that is due to errors in the way in which the surface energy balance of sparse vegetation is simulated by JULES. The incorrect specification of vegetation parameters, the fractional coverage of each surface type and soil hydraulic and thermal properties have all been shown to lead to errors in the prediction of surface temperatures.