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Testing the performance of current dust emission schemes from a box and climate model perspective

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Dust emission schemes in climate models are relatively simple and are tuned to represent observed background aerosol concentrations many of which are many thousands of kilometres from source regions. Representations of dust emission in the models were developed from idealised experiments such as those conducted in wind tunnels. Improvement of current model dust emission schemes is hampered by a paucity of observations from key dust sources. The Dust Observations for Models project (DO4Models) was aiming on gathering data from source regions at a scale appropriate to climate model grid box resolution.

Here we present (1) the results of 1D box model simulations using three commonly used parameterizations for the horizontal and vertical dust emission flux, and (2) HadGEM3 regional climate model simulations using the current model setup for dust emissions. We are comparing both models with Do4Model field campaign data retrieved over a typical dust source.

The box model performance is tested using observed soil moisture content, aerodynamic surface roughness, shear velocity, and soil properties. Results for the first part of the field campaign suggest that all current dust emission schemes do not capture the observed emission flux well. The saltation flux is hugely overestimated, whereas the vertical flux is moderately overestimated. The choice of the sand transport, soil moisture correction and roughness correction scheme is important but insufficient to bring modeled fluxes into agreement with observed dust fluxes. Potential reasons for the diagnosed mismatch are discussed and the impact of spatial averaging over the 11 field sites within the g12x12km grid is evaluated. Furthermore, it is tried to answer the question whether the application of the dispersed soil size distribution increases the performance of the emission schemes over the typically used undisturbed soil size distribution provided from soil database

HadGEM3 is tested with regard to its capability to reproduce the observed meteorological conditions. Very good agreement with regard to the magnitude of the diurnal cycle in 10m wind speed, wind gusts and surface shear stress is found. The onset of the breakdown of the nocturnal low-level-jet is out of phase by an hour, but overall the model performance is sufficient to focus on the shortcomings of the deployed dust emission scheme which is found to be the largest source of uncertainty with regard to the simulated dust emission flux. Given the multiple tuning choices, box and climate model emission fluxes differ considerably.