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Do4Models: Performance of current climate model dust emission schemes from a 1D box model perspective using field campaign data to constrain the simulated dust emission flux

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Dust emission schemes in climate models are relatively simple and are often tuned to represent observed background aerosol concentrations many of which are thousands of kilometres from source regions. Parameterisations of dust emission in numerical models were developed from idealised experiments such as those conducted in wind tunnels. Improvement of current model dust emission schemes has been difficult to achieve because of the paucity of observations from key dust sources. The Dust Observations for Models project (DO4Models) aims to gather data from source regions at a scale appropriate to climate model grid box resolution.

Here we present the results of 1D box model simulations in which three commonly used parameterisations for the horizontal and vertical dust emission flux (Marticorena and Bergametti 1995, Alfaro and Gomez 2001, Shao et al. 2004) are applied and compared with Do4Models field campaign data retrieved over a typical salt pan dust source (Sua Pan, Botswana). The sensitivity of the schemes to input parameters such as soil moisture content, aerodynamic surface roughness length, shear velocity, soil texture class, and particle size is tested with particular regard to the representation of horizontal-to-vertical-mass-flux ratio. The effects of spatial averaging over 11 field sites is evaluated as is the average dust emission flux of a typical 12x12km model grid box. It is analysed whether the full range of surface processes (temporal changes in roughness, moisture, and soil conditions) is represented sufficiently well after averaging yet. Furthermore, the application of the dispersed soil size distribution on the performance of the emission schemes compared to the typically used undisturbed soil size distribution provided from soil databases is examined.

Preliminary results suggest that the current schemes do not describe the observed emission process well. The scheme after Shao et al. (2004) provides the most accurate horizontal flux estimate so far. However, as our observed horizontal-to-vertical-dust-flux ratio is fairly variable compared to other field sites (e.g. Owens Lake), an accurate representation of the saltating flux does not assure a good simulation of the vertical emission flux. The simpler scheme after Marticorena and Bergametti (1995) can therefore compete in terms of total vertical dust flux despite its deficiencies in representing the full range of physics involved. We show that the moisture correction strongly affects the simulated dust flux and that the drag partition correction after Marticorena and Bergametti (1997) needs a little revision to be applicable to the whole range of observed roughness lengths. The dispersed soil texture data allow for a better representation of the deflatable dust fraction which controls the horizontal flux. It is more consistently constrained with regard to the measured saltating flux.