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Global dust model intercomparison in AeroCom phase I

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The results of a broad intercomparison of a total of 15 global aerosol models within the AeroCom project will be presented. Each model is compared to observations related to desert dust aerosols, their direct radiative effect, and their impact on the biogeochemical cycle, i.e. aerosol optical depth (AOD) and dust deposition. Additional comparisons to Angström exponent (AE), coarse mode AOD and dust surface concentrations are included to extend the assessment of model performance and to identify common biases present in models. These data comprise a benchmark dataset that is proposed for model inspection and future dust model development. There are large differences among the global models that simulate the dust cycle and its impact on climate. In general, models simulate the climatology of vertically integrated parameters (AOD and AE) within a factor of two whereas the total deposition and surface concentration are reproduced within a factor of 10. In addition, smaller mean normalized bias and root mean square errors are obtained for the climatology of AOD and AE than for total deposition and surface concentration. Characteristics of the datasets used and their uncertainties may influence these differences. Large uncertainties still exist with respect to the deposition fluxes in the southern oceans. Further measurements and model studies are necessary to assess the general model performance to reproduce dust deposition in ocean regions sensible to iron contributions. Models overestimate the wet deposition in regions dominated by dry deposition. They generally simulate more realistic surface concentration at stations downwind of the main sources than at remote ones. Most models simulate the gradient in AOD and AE between the different dusty regions. However the seasonality and magnitude of both variables is better simulated at African stations than Middle East ones. The models simulate the offshore transport of West Africa throughout the year but they overestimate the AOD and they transport too fine particles. The models also reproduce the dust transport across the Atlantic in the summer in terms of both AOD and AE but not so well in winter-spring nor the southward displacement of the dust cloud that is responsible of the dust transport into South America. Based on the dependency of AOD on aerosol burden and size distribution we use model bias with respect to AOD and AE to infer the bias of the dust emissions in Africa and the Middle East. According to this analysis we suggest that a range of possible emissions for North Africa is 400 to 2200 Tg yr^{-1} and in the Middle East 26 to 526 Tg yr^{-1}.