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Properties and challenges of mineral dust aerosol modelling in the latest Earth System Models

Ramiro Checa-Garcia[1], Yves Balkanski[1], Tommi Bergman[2], Ken Carslaw[3], Mohit Dalvi[4], Beatrice Marticorena[5], Martine Michou[6], Pierre Nabat[6], Lars Nieradzik[7], Twan van Noije[8], Declan O'Donnell[2], Dirk Olivie[9], Fiona O'Connor[4], Michael Schulz[9], and Catherine Scott[3]

[1]CNRS, LSCE (Le Laboratoire des Sciences du Climat et de l'Environnement), Paris, France (ramiro.checa-garcia@lsce.ipsl.fr)
[2]Finnish Meteorological Institute(FMI), Helsinki, Finland
[3]University of Leeds, Leeds, United Kingdom
[4]MetOffice, Exeter, United Kingdom
[5]Laboratoire Interuniversitaire des Systèmes Atmosphériques(LISA), Paris, France
[6]MeteoFrance, Toulouse, France
[7]Lund University, Lund, Sweden
[8]Royal Netherlands Meteorological Institute (KNMI), Netherlands
[9]Norwegian Meteorological Institute , Oslo, Norway

Mineral dust aerosols participate in the climate system and biogeochemistry processes due to its interactions with key components of Earth Systems: radiation, clouds, soil and chemical components. A central element to improve our understanding of mineral dust is through its modeling with Earth Systems Models where all these interactions are included. However, current simulations of dust variability exhibit important uncertainties and biases, which are model-dependent, whose cause is our imperfect knowledge about how to best represent the dust life cycle. For these reasons a continuous evaluation of the performance and properties of the different models compared against measurements is a crucial step to improve our knowledge of the dust cycle and its role in the climate system and biogeochemical cycles. Here we present an exhaustive evaluation of mineral dust aerosols in CRESCEND-ESMs over global, regional and local scales. We compare models against three networks of instruments for total dust deposition flux, yearly surface concentrations, and optical depths. Global and regional dust optical depths are compared with MODIS and MISR derived products. Specific analyses are done over the Sahel region where improved and compressive dust observational datasets are available. The results indicate that all the models capture the general properties of the global dust cycle, although the role of larger particles remains challenging. Differences are partially due to surface winds as nudged simulations improve the inter-model comparison and the performance in optical depth compared to MODIS. At the regional scale, there is an optical depth reasonable agreement over main source areas, but a joint inter-comparison including fluxes and concentration indicates larger differences. At the local scale, the uncertainties increase and current models are not able to reproduce together several observables at the same time.