Project: **883**

Project title: **Modelling of Saharan mineral dust**

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Progress Report (01/2014 – 12/2015)

The project aims at evaluating and improving the performance of the aerosol-climate model ECHAM6-HAM2 (Stevens et al., 2013) to capture the relevant dust emission processes in the Sahara desert as identified in regional modelling studies. The idea is to implement new land-surface parameterizations, which have been successfully tested in a regional model, and to analyse their impact on the modelled dust distribution together with the model capability to represent the variability in dust emission and transport.

As the first of several planned measures, dust source activation (DSA) observations from Meteosat Second Generation (MSG) satellite (Schepanski et al., 2007; 2012) were used to replace the original source area parameterisation over the Sahara in ECHAM6-HAM2 (Fig. 1).

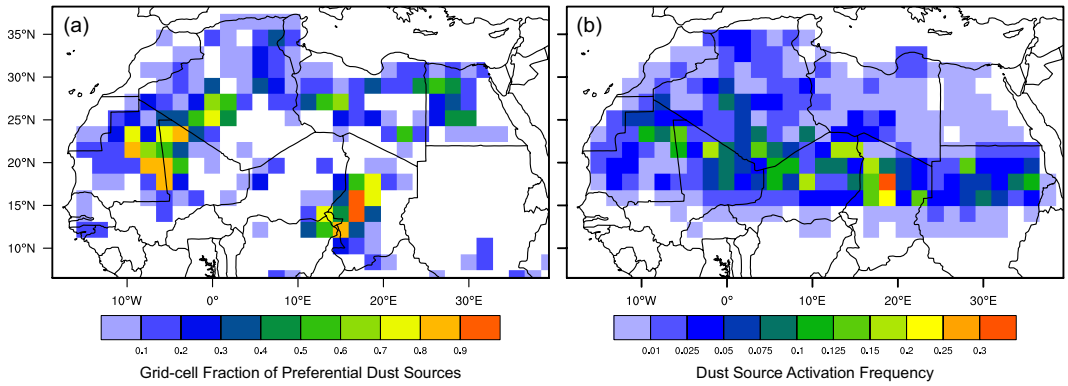

Fig. 1: Preferential dust sources in the Sahara on grid T63. (a) Original source map calculated from the extent of potential lake areas (Tegen et al., 2002) and (b) MSG-based DSA frequencies for 03/2006 to 02/2010 (Schepanski et al., 2007, 2012).

In addition to 2-year sensitivity studies with prescribed sea surface temperatures (SST) and sea ice extent, the new model setup was tested in nudged simulations for the period 2007 to 2008. The evaluation was based on comparisons to dust emission events inferred from MSG dust index imagery, AERONET sun photometer observations, and satellite retrievals of aerosol optical thickness (AOT). The model results agree well with AERONET measurements. Good correlations between model results and MSG-SEVIRI dust AOT as well as Multi-angle Imaging Spectro-Radiometer (MISR) AOT indicate that also the spatial dust distribution is well reproduced. ECHAM6-HAM2 computes a more realistic geographical distribution and up to 20% higher annual Saharan dust emissions, using the MSG-based source map (Fig. 2). The representation of dust AOT is partly improved in the southern Sahara and Sahel. In addition, the spatial variability is increased towards a better agreement with observations depending on the season. Thus, using the MSG DSA map can help to circumvent the issue of uncertain soil input parameters. An important issue remains the need to improve the model representation of moist convection and stable nighttime conditions. Compared to sub-daily DSA information from MSG-SEVIRI and results from a regional model, ECHAM6-HAM2 notably underestimates the important fraction of morning dust events by the breakdown of the nocturnal low-level jet, while a major contribution is from afternoon-to-evening emissions.

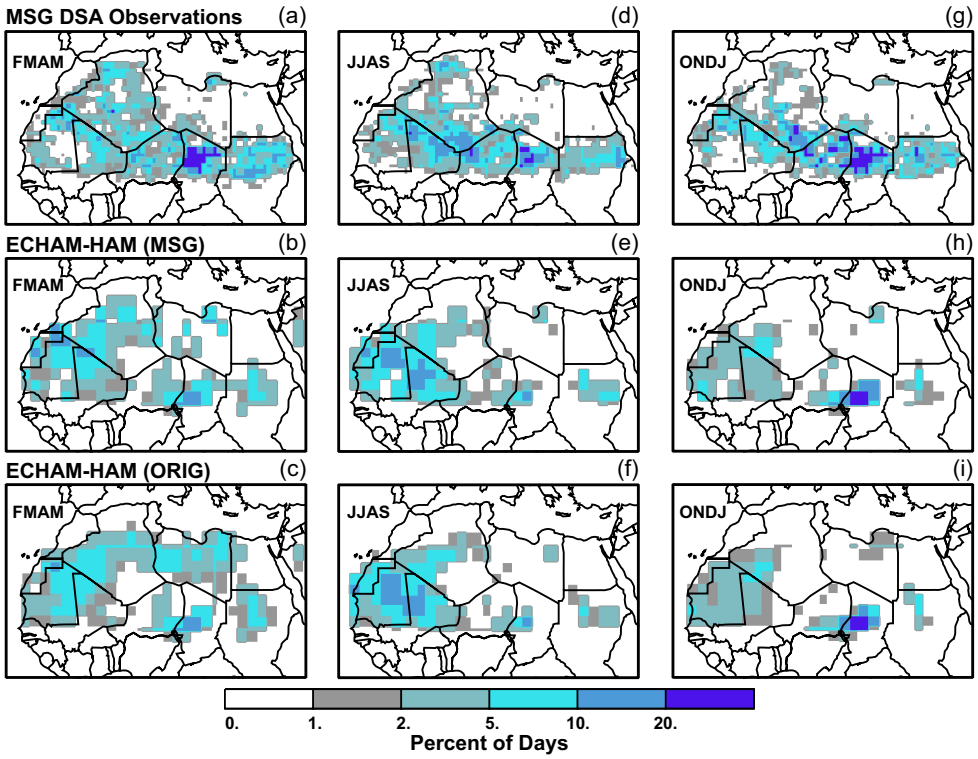

Fig. 2: Saharan dust source activations in percent of days as derived from MSG-SEVIRI dust index (top panels) and computed by ECHAM6-HAM2 with MSG-based (middle panels) and original source map (bottom panels). The values are averages for 2007 to 2008 as well as for the months February to May, June to September, and October to January.

Perspectives

Constraining Saharan dust sources by satellite observations can partly compensate for uncertainties in soil properties and the misrepresentation of dust-generating winds. However, the improvements in this study are less important than seen in the simulations with the regional dust model COSMO-MUSCAT. We expect a larger benefit for free-running models, whose wind fields show larger uncertainties. Therefore, additional free climate runs, together with a systematic investigation of dust-generating winds, are needed for a concluding evaluation. This, however, could not be realised in 2015 and will be subject of the application period 2016.

Utilisation and Publication

The results were presented in a talk at the 2014 HAMMOZ workshop in Oxford/UK and, recently, were published by Heinold et al. (2015) in Geoscience Model Development Discussions. In addition, the model development and required input data were made available to the scientific community through the HAMMOZ website (https://redmine.hammoz.ethz.ch) and repository.

References

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