Project: **883**

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

Project lead: **Bernd Heinold**

Report period: **1.1.2017 - 31.12.2017**

Progress Report

The central aim of this DKRZ project is to evaluate and further improve the representation of mineral dust in the aerosol climate model ECHAM6-HAM2. While in the earlier allocation periods the emphasis was mainly on the Saharan Desert, this year, we have directed our focus to the region of Central Asia. Central Asia is a hot spot of climate change (Giorgi, 2006) and both source and receptor area for mineral dust aerosol. After drastic land-use changes forming new dust sources in the last century, Central Asia today is facing a dramatic shrinking of high mountain glaciers due to global warming with yet unclear impacts of and on mineral dust. However, despite the potential importance of dust as an important factor impacting climate and air quality in this region, only little information on dust sources, transport pathways and effects are available so far. Steep topography and a great variety of sources make dust modelling in Central Asia challenging. One of the challenges is to reproduce the typical seasonality with the main dust activity from March to October peaking in summer months as well as long-term trends and inter-annual variability. Uncertainties in global and regional simulations are largely caused by an insufficient representation of dynamic surface characteristics.

Within the frame of the BMBF project Central Asian Dust Experiment (CADEX; Hofer et al., 2017), the ECHAM6-HAM2 model has started to be used to investigate dust from the different distant and local sources. CADEX aims to investigate optical and radiative properties of dust aerosol over Tajikistan by long-term field measurements, including lidar and sun photometer remote sensing in the Tajik capital Dushanbe from March 2015 to August 2016. For this dust transport study dust was computed within this project with the setup of ECHAM6.3-Ham2.3 at resolution T63L31. The model experiments were carried out in nudged mode for the campaign period.

An initial evaluation of the model results highlight the challenges of dust modelling in Central Asia. Timing as well as placement of modelled dust plumes not always satisfyingly agree with satellite imagery and sun photometer observations (Figure 1). Here, further analysis of potential reasons for the mismatches and appropriate model improvements are required. In particular, the representation of preferential sources and surface roughness in Central Asia needs to be revised to adequately represent the complex terrain in the region.

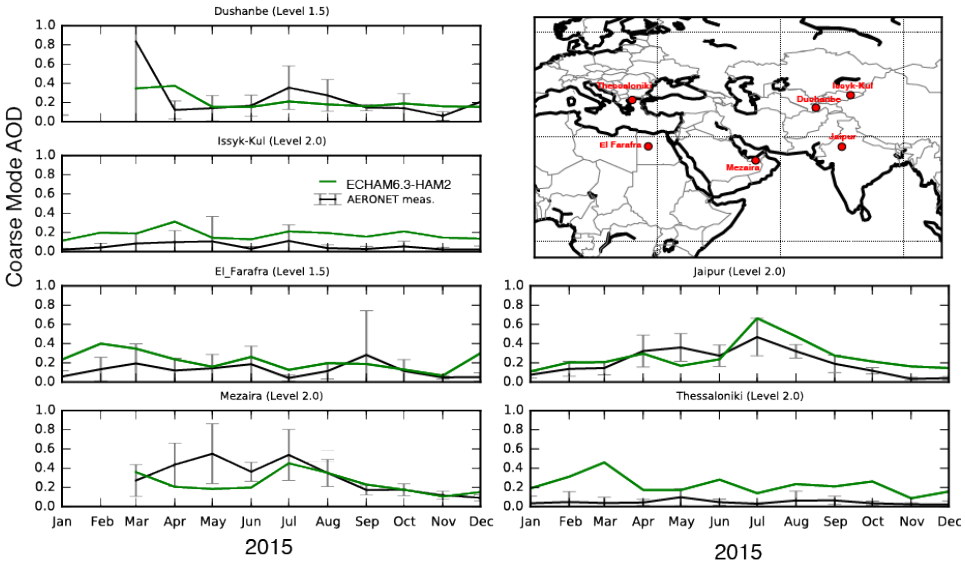

***Figure 1**: Aerosol optical depth (AOD) at Dushanbe, Tajikistan and surrounding AERONET stations. Compared is the AERONET 500-nm coarse-mode data (black line) and the modelled dust AOD from ECHAM6.3-HAM2.3 (green line).*

Preliminary results of a source apportionment study of dust at the CADEX field site Dushanbe indicate a major contribution of Arabian dust throughout the year 2015 in accordance with the CADEX observations. Central Asian sources mainly contributed to the dust burden in spring and at a generally lower level in autumn (Figure 2). These results highlight the importance of taking into account long-range transport and local emissions for modelling dust in Central Asia.

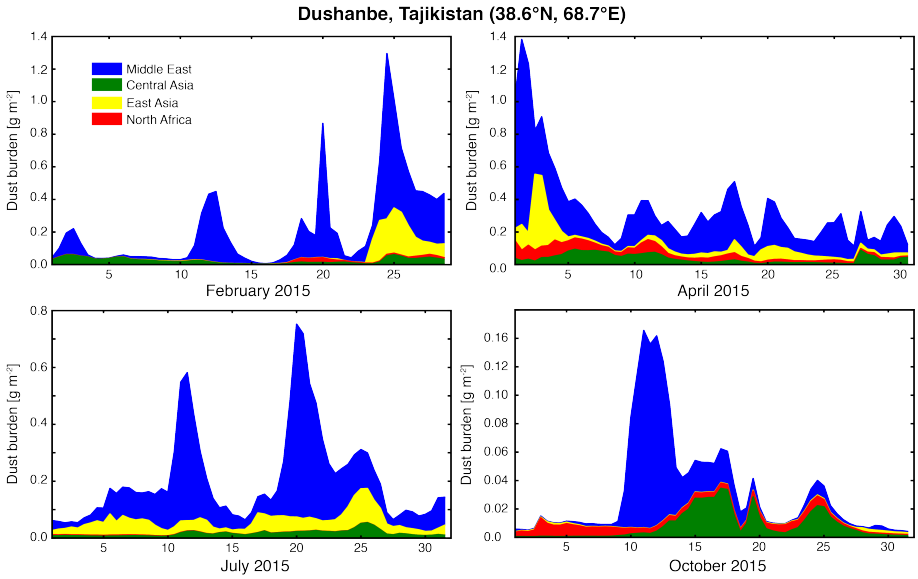

***Figure 2**: Mineral dust source apportionment at the CADEX station Dushanbe, Tajikistan for the year 2015, based on ECHAM6.3-HAM2.3 model results (note the different scales).*

Perspectives

The ECHAM6-HAM2 simulations of desert dust in this study help better characterise dust emission and transport as well as dust feedback mechanisms and climate forcing in the Central Asian region. It is planned to continue the model evaluation with latest soil and land-cover data at high spatial and temporal resolution. A novel approach for dust emission computations will be tested by which black-sky albedo instead of the widely-used roughness length is used.

Utilisation and Publication

The work has been an important part of the preliminary work for a proposed DFG project on desert dust in Central Asia, in which context the results will be published. All relevant model developments and required input data are made available to the scientific community through the HAMMOZ website (https://redmine.hammoz.ethz.ch) and repository.

References

Giorgi, F.: Climate change hot-spots, Geophys. Res. Lett., 33, L08707, doi: 10.1029/2006GL025734, 2006.

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