Impact of aerosol definition on regional climate simulations over North Africa, Middle East and Europe

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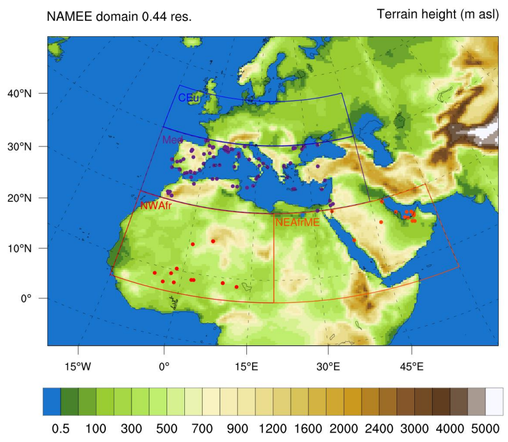
Most of the currently used Regional Climate Models (RCMs) deal with aerosol-radiation interactions using one of a limited number of aerosol climatologies, mainly Tanré-1984 (Tanré *et al.* 1984), GADS/OPAC (Hess *et al.*, 1998; Koepke *et al.* 1998) or Tegen-1997 (Tegen *et al.* 1997). These climatologies significantly differ on the spatio-temporal characterization of aerosol loads and optical properties (Hoggeneger and Vidale, 2005; Zubler *et al.* 2011), which influences the RCMs estimates of the radiative budget and, hence, other climatic variables.

This work analyses the **effect of aerosol climatologies on dynamic downscaling simulations** over the **North Africa, Middle East and Europe** (NAMEE) region, by means of the **NMMB/BSC-CTM model**. We focus on the effect of **spatio-temporal variability** and **optical properties**, by using and modifying the GADS/OPAC and GOCART datasets. An **online** approach for the simulation of **mineral dust - radiation interaction** is applied, allowing us to account for full dust-climate feedbacks.

NMMB/BSC-CTM NAMEE

ECMWF ERA Interim (Dee *et al.* 2011) as driver
0.44º horizontal resolution
40 vertical layers up to 50 hPa



STUDIED CASES:

1994-2013 period

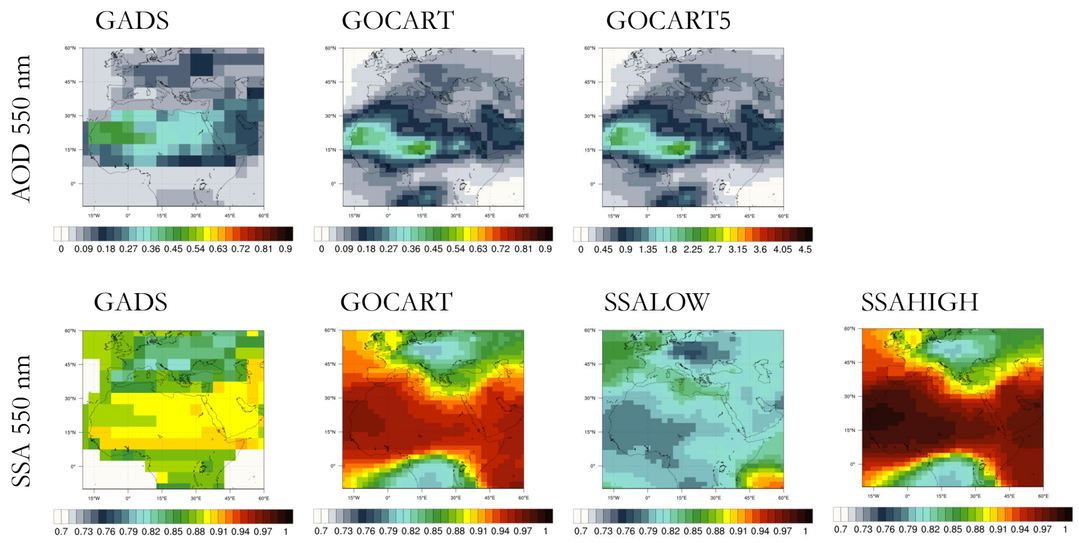
- No aerosols (NA)
- GADS
- GOCART
- NMMB/BSC-CTM online DUDT (GOCART climatology for other aerosols)

1994-1998 period

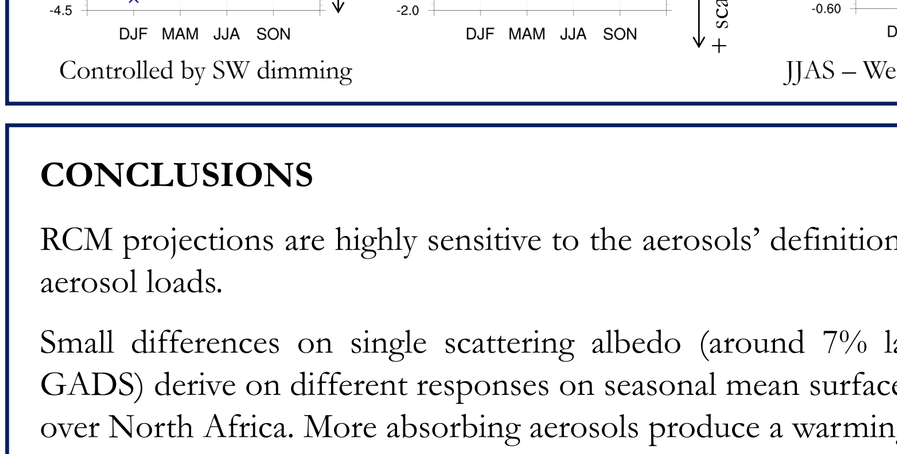
- GOCARTFIX (constant value for the aerosol load throughout the year)
- GOCART5 (aerosol load = 5 times GOCART values)
- SSAHIGH (GOCART aerosol distribution, with SSA for mineral dust = 1)
- SSALOW (GOCART aerosol distribution, with 20% lower SSA for mineral dust)

Optical properties in the study cases

JJA Aerosol Optical Depth (AOD) and Single Scattering Albedo (SSA) at 550 nm as defined in the defined cases



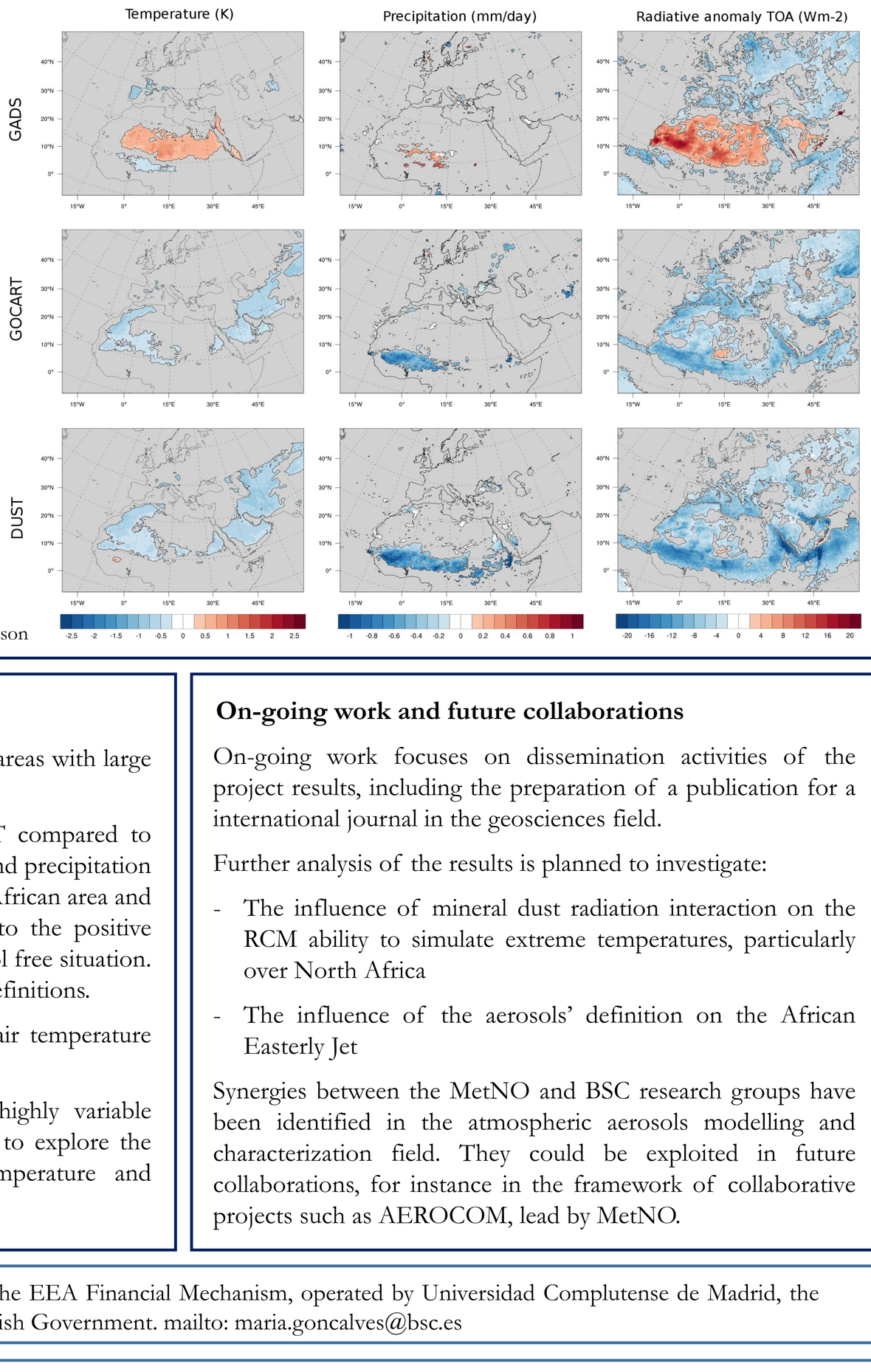
Radiative feedback on seasonal mean mineral dust AOD at 550 nm



Difference in JJA mean Mineral dust AOD at 550 nm from NMMB/BSC-CTM 1994-2013 Radiatively active vs. non-radiatively active

NMMB/BSC-CTM/ERAInterim 1994-2013

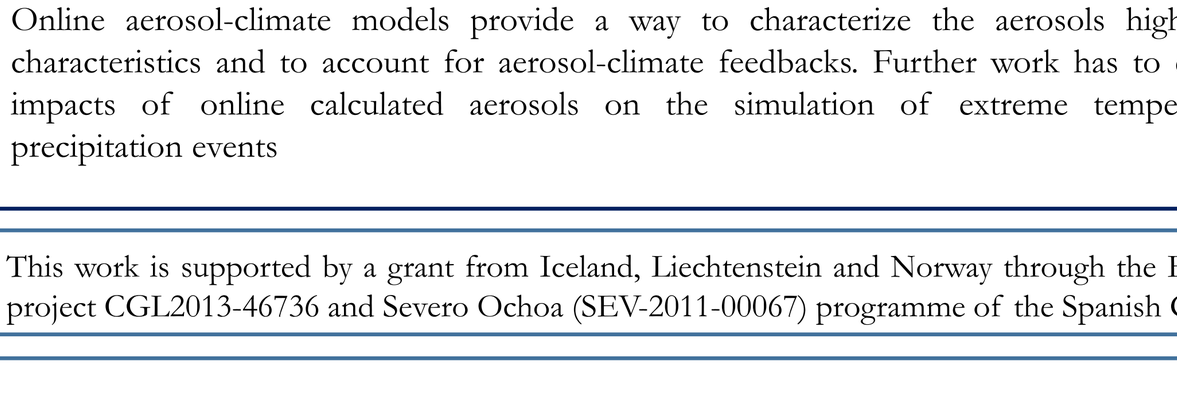
Difference in JJA mean surface air temperature (K), precipitation (mm/day) and all sky-radiative anomaly at TOA (Wm-2) between the GADS , GOCART and DUST cases and an aerosol free simulation. 1994-2013



NMMB/BSC-CTM/ERAInterim 1994-1998

Seasonal mean differences of daily minimum and maximum temperature (K) and precipitation (mm/day) over North West Africa, between the different cases and the aerosol free run. 1994-1998.

SSAHIGH
SSALOW
GOCART5
GOCARTFIX
DUST
GOCART
GADS



Controlled by SW dimming

JJAS – West African Monsoon season

CONCLUSIONS

RCM projections are highly sensitive to the aerosols' definition, particularly over areas with large aerosol loads.

Small differences on single scattering albedo (around 7% larger in GOCART compared to GADS) derive on different responses on seasonal mean surface air temperature and precipitation over North Africa. More absorbing aerosols produce a warming over the North-African area and increased precipitation during the West African Monsoon season (associated to the positive anomaly at TOA and the migration north of the ITCZ), with respect to an aerosol free situation. Surface cooling and reduced precipitation occurs with more scattering aerosols' definitions.

Aerosol monthly-varying fields increase the intra-annual variability of surface air temperature over North-Africa.

Online aerosol-climate models provide a way to characterize the aerosols highly variable characteristics and to account for aerosol-climate feedbacks. Further work has to explore the impacts of online calculated aerosols on the simulation of extreme temperature and precipitation events

On-going work and future collaborations

On-going work focuses on dissemination activities of the project results, including the preparation of a publication for a international journal in the geosciences field.

Further analysis of the results is planned to investigate:

- The influence of mineral dust radiation interaction on the RCM ability to simulate extreme temperatures, particularly over North Africa
- The influence of the aerosols' definition on the African Easterly Jet

Synergies between the MetNO and BSC research groups have been identified in the atmospheric aerosols modelling and characterization field. They could be exploited in future collaborations, for instance in the framework of collaborative projects such as AEROCOM, lead by MetNO.

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