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

M. Gonçalves-Ageitos[1,2], O. Jorba[2] , C. Pérez García-Pando[3] and M. Schulz[4]

[1]Department of Engineering Projects, Technical University of Catalunya, Barcelona, 08034, Spain.
[2]Department of Earth Sciences, Barcelona Supercomputing Center – Centro Nacional de Supercomputación, Barcelona, 08034, Spain.
[3]NASA Goddard Institute for Space Studies, New York, 10025, USA.
[4]Climate Modelling and Air Quality Division, Norwegian Meteorological Institute, Oslo, 0313, Norway.

Keywords: aerosol-radiation interaction, dynamic downscaling, online mineral dust modelling.
Presenting author email: maria.goncalves@upc.edu

Most of the currently used Regional Climate Models (RCMs) compute aerosol-radiation interactions using one of a limited number of aerosol climatologies. 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 (i.e. Zubler *et al.* 2011).

This work analyses the effect of aerosol climatologies on dynamic downscaling simulations over the North Africa, Middle East and Europe (NAMEE) region, a region which holds important sources of mineral dust and anthropogenic aerosols. We focus on the effect of spatio-temporal variability and optical properties, by using and modifying different aerosol datasets, at this point GADS/OPAC (Hess *et al.*, 1998; Koepke *et al.* 1998) and GOCART (Chin *et al.* 2002), including cases with time-constant versus varying aerosol fields. Finally, an online approach for the simulation of mineral dust - radiation interactions is applied, allowing us to account for full dust-climate feedbacks.

The NMMB/BSC-CTM model (Janjic, 2005, Janjic *et al.*, 2011 Pérez *et al.* 2011) driven by the ERA-Interim reanalysis (Dee *et al.*, 2011) at 0.44º resolution for the 1994-2004 period is applied in the NAMEE domain. The RRTM radiative module (Mlawer *et al.* 1997; Iacono *et al*., 2000) is setup to consider no aerosols, the selected aerosol climatologies, and the online computed mineral dust from NMMB/BSC-CTM (using GOCART fields for other than dust atmospheric aerosols)

GADS/OPAC produces a surface heating effect over North-Africa and the Middle-East (locally up to 3ºC in spring and summertime), and a cooling in the tropics (south of 10ºN) in summertime, associated with a slight increase in precipitation, when compared to the no-aerosol case. GOCART climatology finer resolution, larger Aerosol Optical Depth and higher single scattering albedo than GADS/OPAC over Africa, results in a more limited surface heating on summertime, and a cooling effect over western and eastern African areas during spring. A slight decrease in summertime precipitation over the tropics is also found.

Aerosol monthly-varying fields increase the intra-annual variability of surface air temperature over North-Africa (standard deviation of monthly fields up to 7% larger than in cases with no-aerosol or constant fields).

In conclusion, RCMs projections are sensitive to the aerosols' definition over areas with high aerosol loads, such as the North-African region, where part of the intra-annual variability depends on the temporal definition of the aerosol fields. Differences in the aerosols characterization can result in opposite forcing at TOA, leading to different precipitation and surface air temperature projections in the area studied.

This work is supported by a grant from Iceland, Liechtenstein and Norway through the EEA Financial Mechanism, operated by Universidad Complutense de Madrid, the project CGL2013-46736 and Severo Ochoa (SEV-2011-00067) programme of the Spanish Government.

Chin, M. *et al.* (2002). *J. Atmos. Sci.* 59, 461–483.
Dee, D. P *et al.* (2011). *Q. J. R. Meteorol. Soc.* 137, 553–597.
Hess, M., Koepke, P. and Schult, I. (1998). *B. Am. Meteorol. Soc.* 79(5), 831-844.
Hohenegger, C. and Vidale, P.L. (2005). *J. Geophys. Res.* 110, D06201.
Iacono, M.J. *et al.* (2000). *J. Geophys. Res.* 105, 14873-14890.
Janjic, Z. (2005). *Geophys. Res. Abstr.* 7, 5582, 2005.
Janjic, Z., Janjic, T. and Vasic, R. (2011*). Mon. Weather Rev.* 139, 1556-1568.
Koepke, P. *et al.* (1997). *Global Aerosol Data Set*, rep. 243, MPI-M, Hamburg, Germany, 44 pp.
Mlawer, E.J. *et al.* (1997). *J. Geophys. Res.* 102(D14), 1663-16682
Pérez, C. *et al.* (2011). *Atmos. Chem. Phys.* 11, 13001-13027.
Zubler, E.M. *et al.* (2011). *Geophys. Res. Lett.* 38, L15705.