Aerosol modeling for regional climate studies: application to a dust event over a Mediterranean domain

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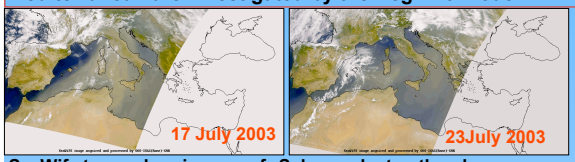
ABSTRACT

The Regional Climate Model RegCM (Version 3.1), developed at the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, has been used to investigate dust particle impacts over the Mediterranean basin during the 16-17 and 23-25 July, 2003 dust outbreaks .

The model performance is tested in simulating aerosol parameters against remotely satellite and ground-based observations at five different sites of the Mediterranean basin for different model spatial resolutions and for different aerosol input emission data sets.

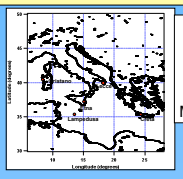
The main aim of this study is to investigate how input data sets influence model results.

Two strong Saharan dust outbreaks that occurred in the second half of July 2003 (16-17 July and 23-25 July) over the Mediterranean are investigated by the RegCM3 model.



SeaWifs true-colour images of Saharan dust outbreaks

The main peculiarity of the RegCM model is that it makes use of two different modules to takes into account aerosol impacts: an aerosol module that includes sulphur dioxide, sulphate, hydrophobic and hydrophilic black carbon (BC) and organic carbon (OC) and a dust module (Zakey et al., 2006) that includes dust particles.



Selected sites over the Mediterranean

Results

Simulation 1

Temporal domain: 1July – 15 August, 2003;

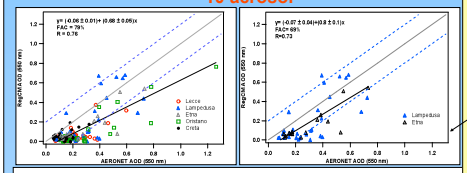
spatial domain = 10010 km*4542 km;

horizontal spacing = 50 km;

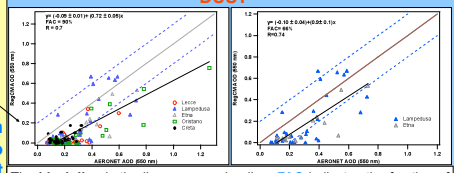
Input aerosol emission data sets: Edgar 2003.

Scatterplots between daily averaged values of AERONET sunphotometer and RegCM3 AODs at 550 nm. RegCM3 AODs are calculated for a box of 50x50 km² centered at the AERONET sites.

10 aerosol



DUST



The scatterplots reveal that RegCM3 AODs are underestimated with respect to AERONET AODs.

RegCM3 AODs are in better accordance to AERONET AODs at Lampedusa and Etna.

The **black line** is the linear regression line, **FAC** indicates the fraction of values within the y = x ± 0.2 lines (dashed blue lines), **R** is the correlation coefficient.

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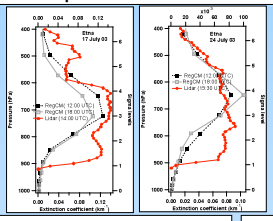
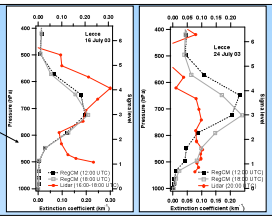
Comparisons between RegCM3 extinction coefficient profiles at 550 nm and Lidar profiles at 532 nm on Etna site.



Comparisons between RegCM3 extinction coefficient profiles at 550 nm and Lidar profiles at 351 nm on Lecce site.



•The simulated RegCM3 extinction coefficient profiles are able to capture dust profiles.

•The accordance between RegCM3 and Lidar profiles is better at Etna where the profile's wavelengths are closer.

Results

Simulation 2

Temporal domain: 1July - 15August 2003;

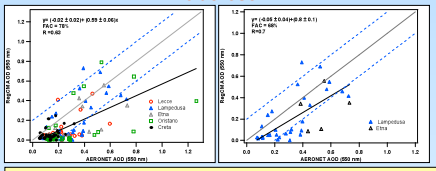
spatial domain = 10010km*4542 km;

horizontal spacing = 40 km;

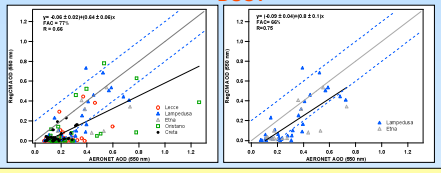
Input aerosol emission data set: Edgar 2003

Scatterplots between daily averaged values of AERONET sunphotometer and RegCM AOD at 550 nm. RegCM AODs are calculated for a box of 50x50 km² centered at the AERONET sites.

10 aerosol



DUST



•The scatterplots reveal an understimation of the simulated RegCM AOD respect to the observations.

•The slopes and the R values of the scatterplots, reveal that the accordance between the model and observed AODs values is better for the Simulation 1.

Simulation 3

Temporal domain: 1July - 15August 2003;

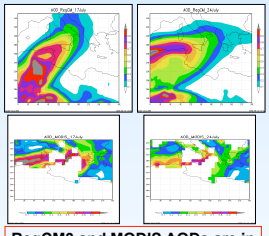
spatial domain = 10010km*4542 km;

horizontal spacing = 50 km;

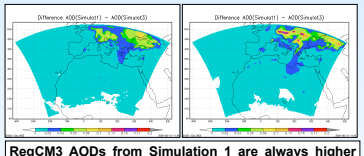
Input aerosol emission data set: Edgar 2000

Results

Comparisons between RegCM AOD values from Simulation 1 and Simulation 3



RegCM3 and MODIS AODs are in good accordance



RegCM3 AODs from Simulation 1 are always higher than AODs from Simulation 3 during the investigated dust days.

|AOD(RegCM)-AOD(aeronet)/AOD(aeronet)|*100

Lecce

Date	Simul 3	Simul 1
17/07/03	49,6%	46,7%
23/07/03	63,8%	69%
24/07/03	6,8%	0,8%

Lampedusa

Date	Simul 3	Simul 1
17/07/03	13,7%	15,1%
23/07/03	18,7%	14,9%
24/07/03	11,6%	13,2%

Oristano

Date	Simul 3	Simul 1
17/07/03	76,6%	75,8%
23/07/03	30%	28,6%
24/07/03	12,4%	11,2%

Etna

Date	Simul 3	Simul 1
17/07/03	27,5%	26,3%
23/07/03	37,4%	33%
24/07/03	10,6%	8,3%

Creta

Date	Simul 3	Simul 1
17/07/03	84%	70,5%
23/07/03	56%	29%
24/07/03	36%	18%

The differences (%) between AERONET AODs and RegCM AODs from Simulation 1 and from Simulation 3 are smaller for Simulation 1.

Comments

•All tested RegCM3 simulations provide AODs smaller than AERONET and MODIS AODs at all sites;

•The 50 km horizontal-spacing simulation and the Edgar 2003 aerosol emission data set (Simulation 1) provide AODs in better accordance with AERONET AODs;

•Differences between AERONET and RegCM3 AODs are smaller at Lampedusa and Etna: the sites closer to African desert;

•The lower AODs provided by the RegCM3 are probably due to the underestimation of sulphur dioxide, sulphate, black carbon and organic carbon emissions;

•RegCM3 extinction coefficient profiles calculated for Simulation 1 appear able to catch the dust plume profiles both at Etna and Lecce;

•RegCM AODs from Simulation 1 are always larger than AODs from Simulation 3 ⟹ the Edgar 2003 data set provides AODs in better accordance with AERONET AODs.