Karlsruhe Institute of Technology

Institute for Meteorology and Climate Research
Atmospheric Environmental Research (IMK-IFU)

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Response of different regional online coupled models to aerosol-radiation interactions

R. Forkel (1), J. Werhahn (1), A. Balzarini (2), D. Brunner (3), R. Baró (4), G. Curci (5), M. Hirtl (6), L. Honzak (7), P. Jiménez-Guerrero (4), Oriol Jorba (8), J. L. Pérez (9), G. Pirovano (2), R. San José (9), W. Schröder (10), P. Tuccella (5), R. Wolke (10), R. Žabkar (11)

(1) KIT, IMK-IFU, Garmisch-Partenkirchen; (2) RSE, Milano; , (3) Empa, Dübendorf, Switzerland, (4) University Murcia, MAR-UMU; (5) University L'Aquila, CETEMPS; (6) ZAMG, Vienna; (7) BO-MO, d.o.o. Ljubljana, Slovenia; (8) Earth Sciences Department, Barcelona Supercomputing Center, Spain; (9) Technical Univ. Madrid, ESMG; (10) Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany, (11) Slovenian Environmental Agency, Slovenia

Introduction

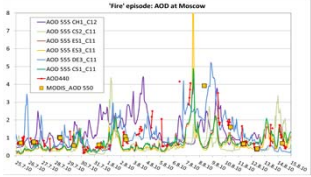
- Aerosol-meteorology interactions and their representation in online coupled regional atmospheric chemistry-meteorology models were investigated in the COST Action ES1004 (http://eumetchem.info/).
- Case studies for Europe with different models were coordinated in order to analyze the aerosol direct and indirect effects and the response of different models to aerosol-meteorology interactions
- Two episodes were chosen due to their potential for direct and indirect aerosol effects on meteorology:
  1. The Russian heat wave and wildfires episode from July 25 to August 15 2010 **('Fire' episode)**
  2. The period 2–15 October 2010 with enhanced cloud cover and rain and a small event of Saharan dust transport to Europe during the second week **('Wet/Dust' episode)**.
- Results of case study simulations were supplied for COSMO-Muscat, COSMO-ART and four different configurations of WRF-Chem.

Model configurations and data availability

Contribution	Lead Institution	Model	Episode(s)	Runs	Resolution
CS1	Univ. Ljubljana, KIT/IMK-IFU *	WRF-Chem (RADM2, MADE-SORGAM)	Fire Wet/Dust	Base, direct, direct&indirect	23 km
CS2	Univ. Ljubljana, KIT/IMK-IFU *	WRF-Chem (RADM2/ MADE-SORGAM)	Fire	Base, direct, direct&indirect	9.9 km
ES1	Univ. Murcia	Like CS1, but with different microphysics	Fire Wet/Dust	Base, direct, direct&indirect	23 km
ES3	UPM-ESMG	WRF-Chem (CBMZ/ MOSAIC 4 bins)	Fire Wet/Dust	Base, direct, direct&indirect	23 km
DE3	IFT Leipzig	COSMO-MUSCAT (RACM-MIM2, EMEP 2 bins)	Fire Wet/Dust	Base, direct	0.15°
CH1	EMPA	COSMO-ART (RADM2/ MADE-Soot)	Fire (3 days missing)	Base, direct	0.22°

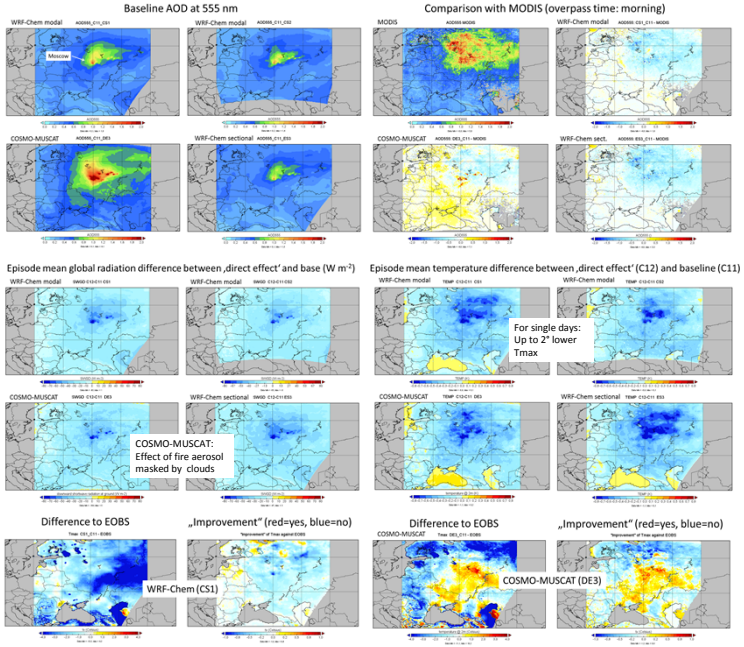
*: Joint effort, also including ZAMG, RSE, UPM-ESMG

Ideally, each contribution should include a simulation without aerosol-meteorology interactions, with direct aerosol effect, and with direct plus indirect effect for both episodes, which was not always the case.

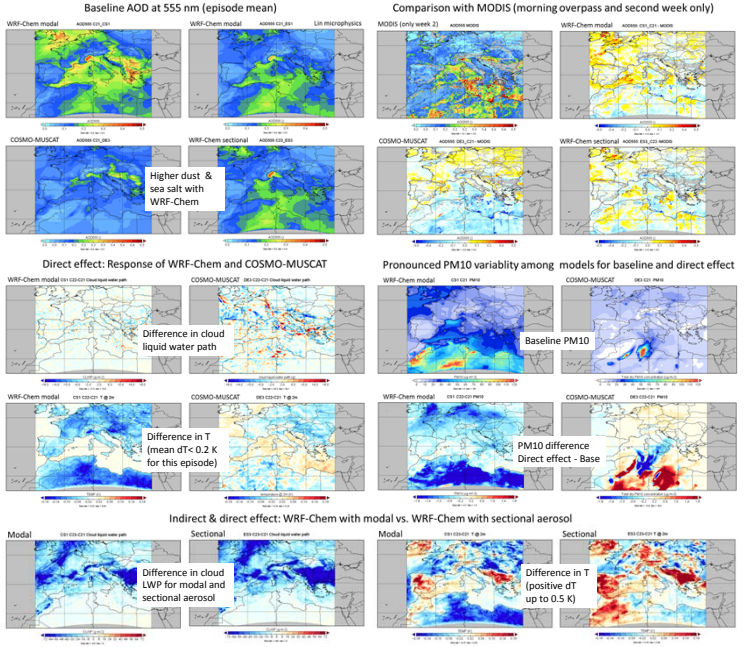


Variability of model results comparison with observations: AOD at 555 nm at Moscow during the 'Fire' episode from simulations, Aeronet, and MODIS.

Results: 'Fire' episode



Results: 'Wet/Dust' episode



Results: Summary

- Decrease in downward solar radiation and daytime temperature due to the direct aerosol effect is robust for all model configurations.
- Generally similar response to direct aerosol effect for WRF-Chem and the COSMO-MUSCAT for high aerosol concentrations. Strong variability for low AOD and cloudy conditions.
- Improvement of simulated temperature only for single cloud free days with very high AOD.
- Aerosol effect on downward solar radiation and temperature is only statistically significant for fire hotspot areas with very high AOD during a few days (and only for α=0.1).
- Baseline cloud cover, induced changes in cloud cover, simulated humidity profile, and different baseline assumptions can strongly affect the model response to aerosol.
- Induced changes in cloud cover more pronounced for COSMO-MUSCAT than for WRF-Chem.
- Inter-model differences in simulated chemical and meteorological variables are often larger than aerosol direct and indirect effects. There are still many degrees of freedom in spite of coordinated simulations with prescribed setup!

Contact: renate.forkel@kit.edu

References: Forkel et al., 2015, Atmos. Environment 115; San José et al., 2015, Atmos. Environment 115; Im et al., 2015, Atmos. Environment 115