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The EuMetChem multi-model case studies on aerosol feedbacks

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Objective

"Working group 2 (WG2) of EuMetChem investigates the importance of different processes and feedbacks in online coupled chemistry-meteorology models for air quality simulations and weather prediction."

One activity to investigate aerosol-meteorology interactions within EuMetChem are case study simulations using different online coupled models.

Previous work in the context of AQMEII2 also included some analysis aerosol-meteorology interactions

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Conclusions from AQMEII2 case studies

- Too few simulations for detailed analysis of feedback effects
- For the applied horizontal resolution, the impact of aerosol feedbacks on pollutant distributions was frequently smaller than the effect of the choice of the chemistry mechanism and aerosol module, and microphysics scheme.
- Exceptions are extreme effects: local improvements
- Sometimes feedback improves results, sometimes not
- Complete analysis of the indirect effect will require simulations with higher resolution or aerosol awareness in convective scheme (first incomplete implementation in WRF-Chem 3.6)

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COST ES1004 Case Studies

AQMEII phase2 evaluation of online coupled models:

- Only some groups were able to perform multiple model simulations for AQMEII phase2 which is necessary for the investigation of aerosol feedback effects.
- For Europe, all of these studies were made with WRF-Chem.

→ **Further case studies with different models are necessary**

→ **COST ES1004 Case Studies are performed for shorter episodes with high aerosol concentrations**

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Two episodes in the year 2010 were selected:

- The Russian heat wave and wildfires episode in July/August
- A period in October 2010 with enhanced cloud cover and rain and including an of Saharan dust transport to Europe

Simulations for each of the two episodes:

- Base case without feedbacks (or no interactions with simulated aerosol)
- Direct aerosol effect only
- Direct and indirect aerosol effect

Not all contributions will cover all of these six cases

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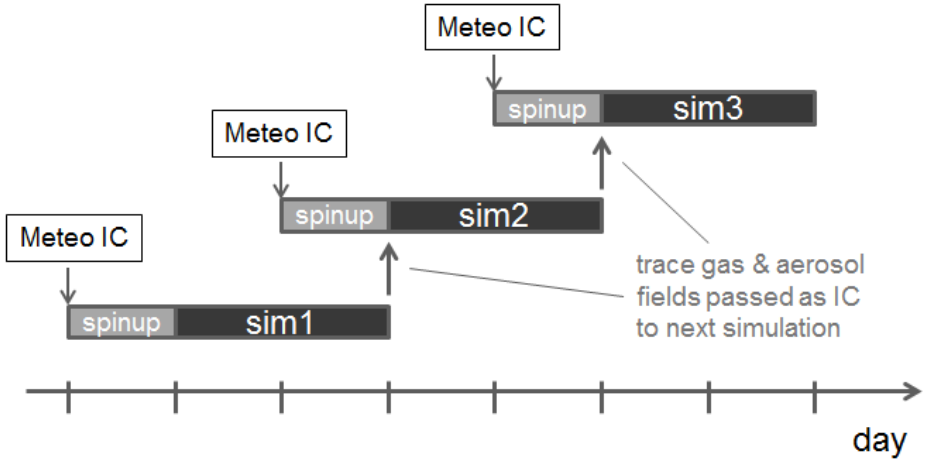
COST ES1004 Case Studies: Setup

General setup following AQMEII recommendations:

- 1-day meteo-only spin-up +
- 2-days simulations with chemistry
- Chemistry restarted from previous 2-day run

Long enough to allow feedback ↔ short enough for suppressing semi-direct effects?



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Modeling protocol The modeling protocol developed by Dominik Brunner was distributed to EuMetChem WG2/WG4 mailing list members + 5 additional possible participants on June 24th.

Response:

- Mostly none
- 9 positive (four of them for a joint effort, participation of one - until Oct. 2014 - non-member)
- 3 „perhaps, if time“
- 2 negative

Some of the positive responses became much less definite in the mean time

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Current contributions and status

	Institution	Model	Episode	Runs	Status
DE3	IFT Leipzig	COSMO Muskat	Fire, dust	Base, direct	Dust uploaded
ES1	Univ. Murcia	WRF-Chem (a)	Fire, dust	Base, direct, dir&indir	Uploaded
ES3	UPM-ESMG	WRF-Chem (b)	Fire, dust	Base, direct, dir&indir	Uploaded
CS1	Univ. Lubljana, KIT/IMK-IFU *	WRF-Chem (c)	Fire, dust	Base, direct, dir&indir	Uploaded
CS2	Univ. Lubljana, KIT/IMK-IFU *	WRF-Chem (d)	Fire	Base, direct, dir&indir	Uploading
CH1	EMPA	COSMO-ART	Fire, dust	Base, direct	Partly uploaded
ES2	BSC	NMMB/BSC-CTM	Fire, dust	Base, direct	Starting

(a) RADM2/MADE-SORGAM, Lin microphysics
(b) CBMZ/MOSAIC
(c) RADM2/MADE-SORGAM
(d) same as (c), but with higher resolution

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

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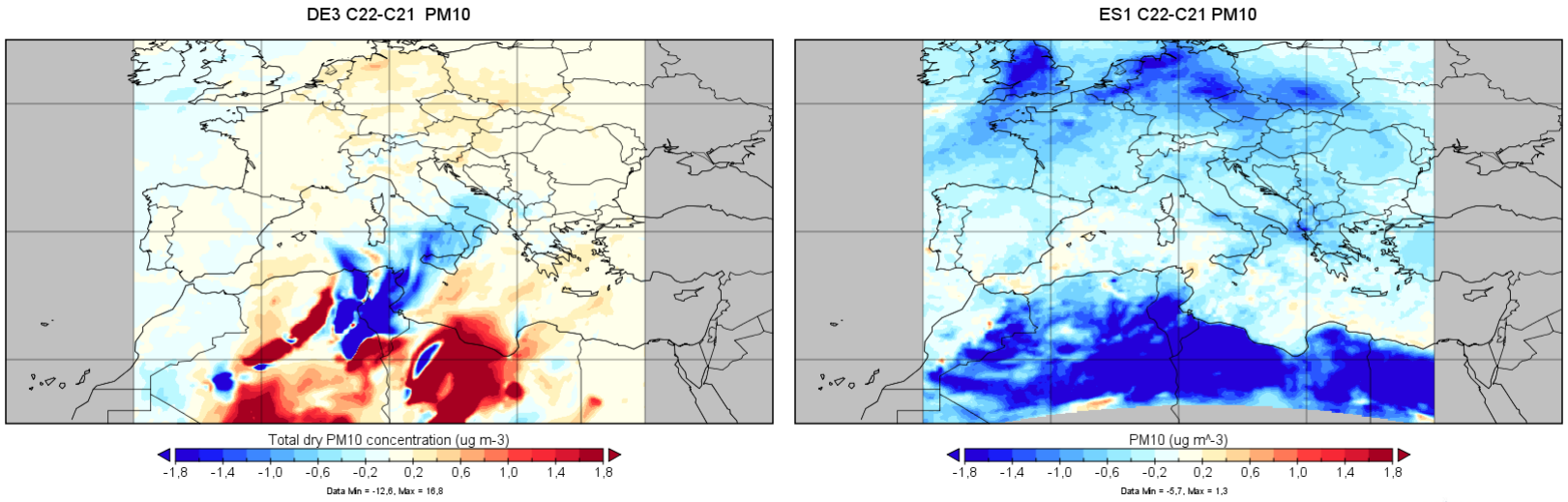
First results

Results so far not analyzed!

Just some first impressions of differences and common features!

Mostly direct effect only

‚Dust' episode, 2.-15. Oct. 2010: Difference in PM10 for DE3 and ES1



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Variability of results: Baseline PM10

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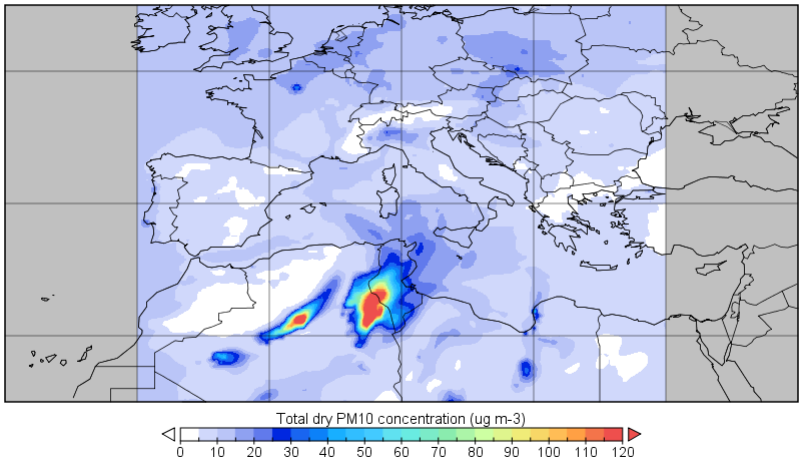
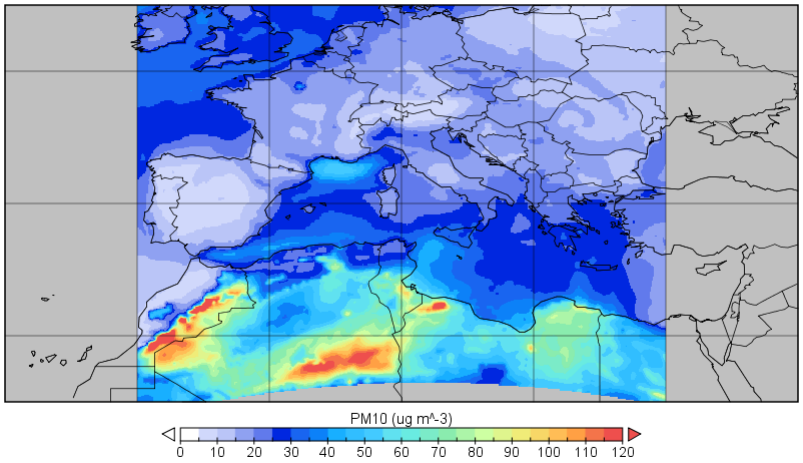
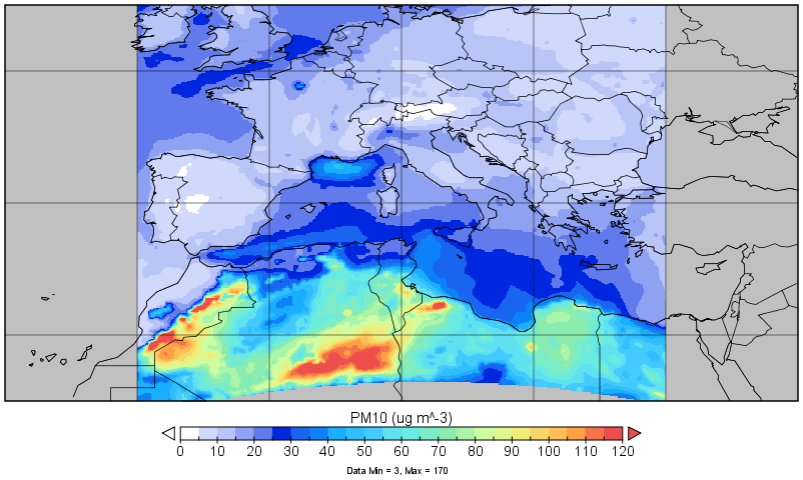
DE3 C21 PM10



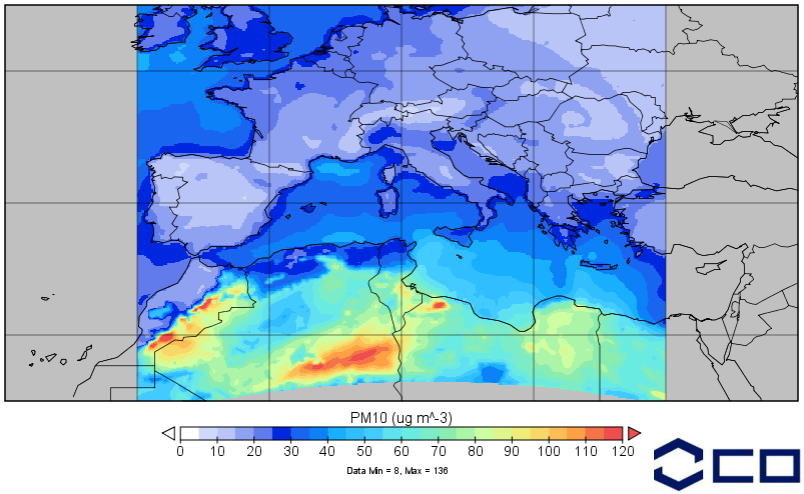
CS1 C21 PM10



ES1 C21 PM10



ES3 C11 PM10



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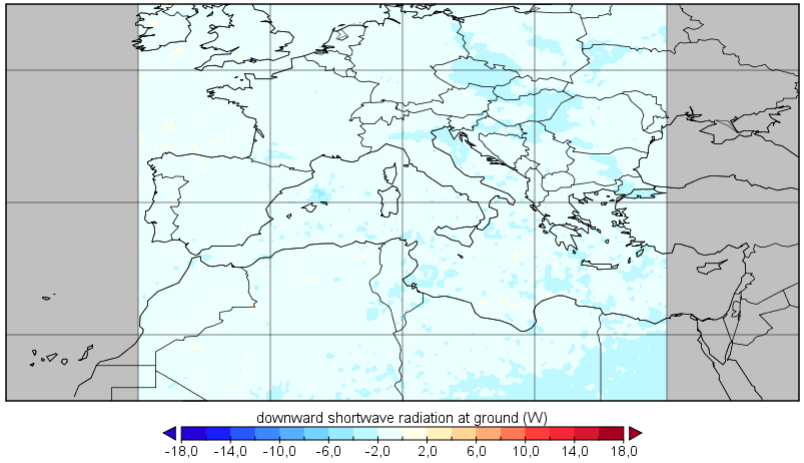
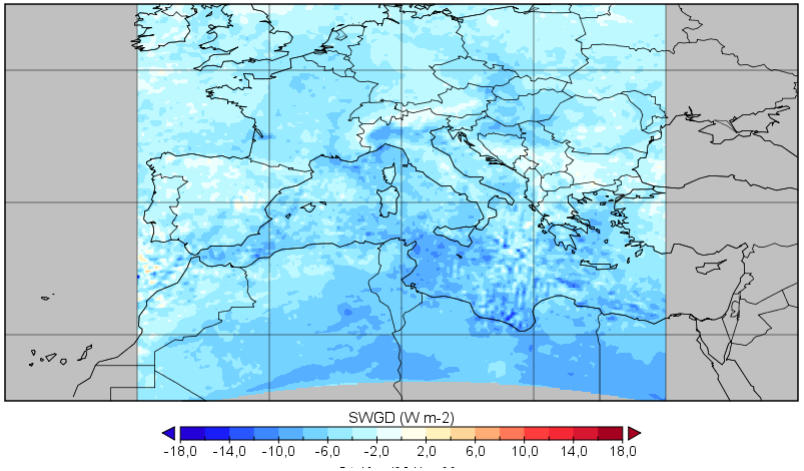
Variability of results: direct effect

Difference in downward solar radiation

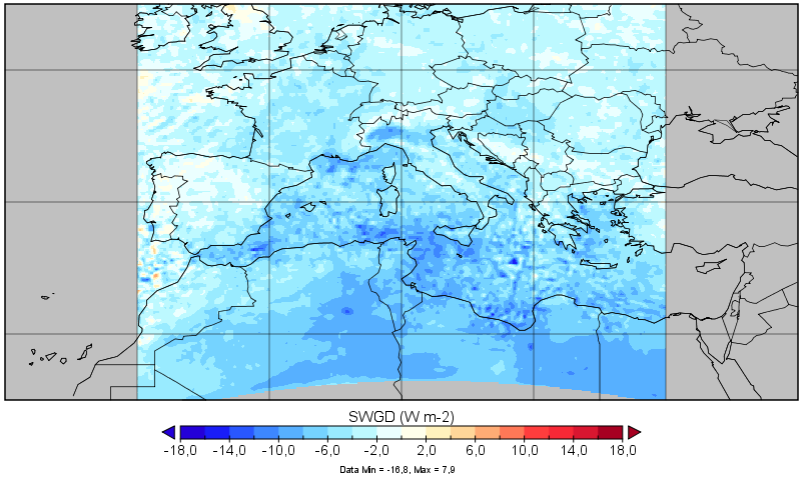
DE3 C22-C21 Downward shortwave radiation



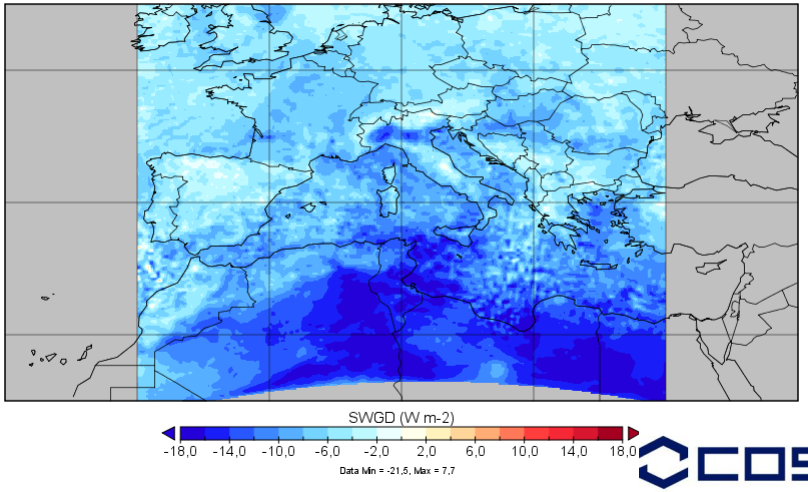
CS1 C22-C21 Downward solar radiation



ES1 C22-C21 Downward solar radiation



ES3 C22-C21 Downward solar radiation



2.-15. Oct. 2010

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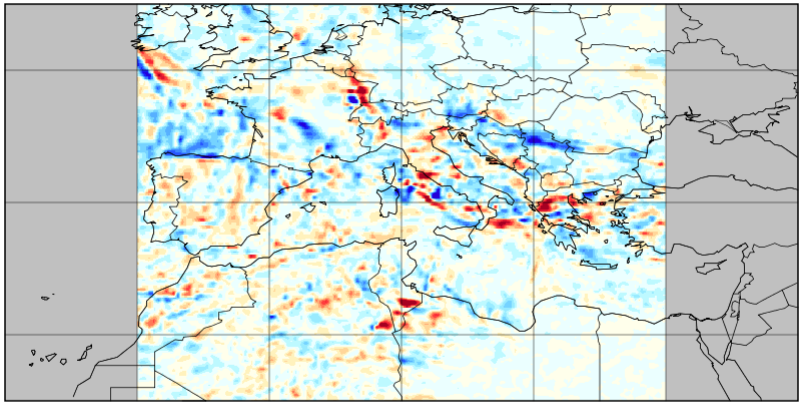
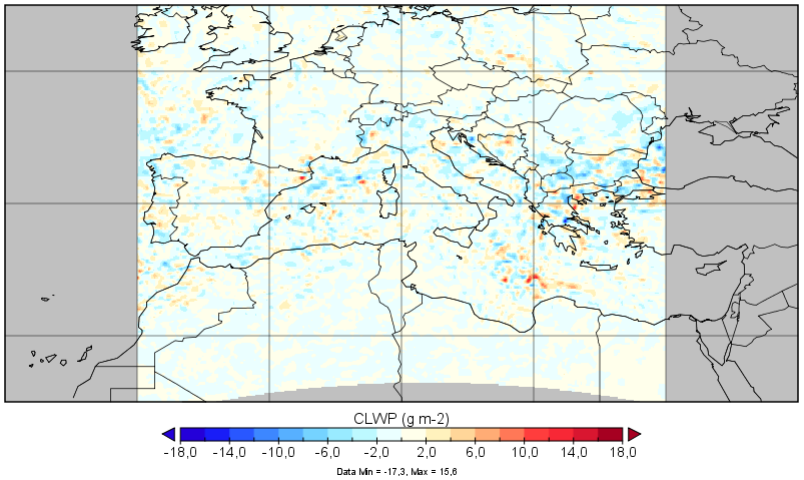
Variability of results: direct effect

Difference in cloud liquid water path

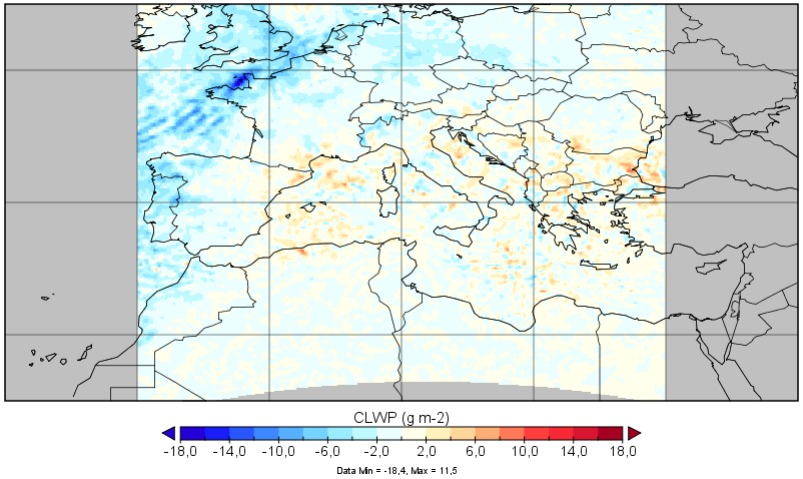
DE3 C22-C21 Cloud liquid water path



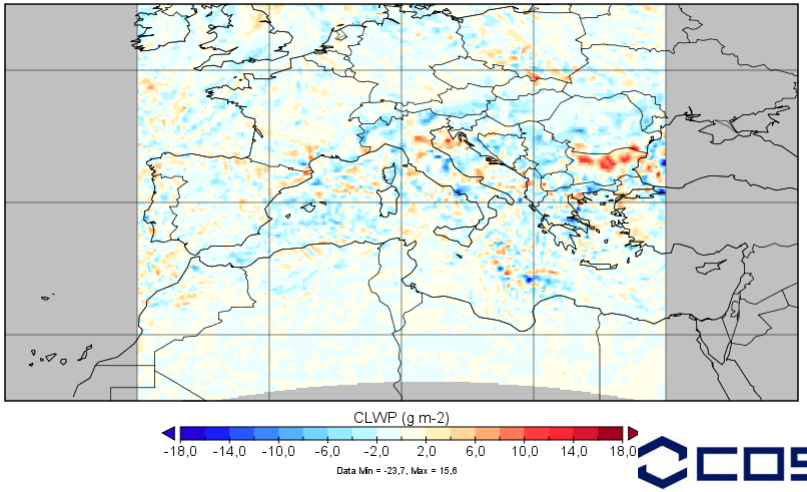
CS1 C22-C21 Cloud liquid water path



ES1 C22-C21 Cloud liquid water path



ES3 C22-C21 Cloud liquid water path



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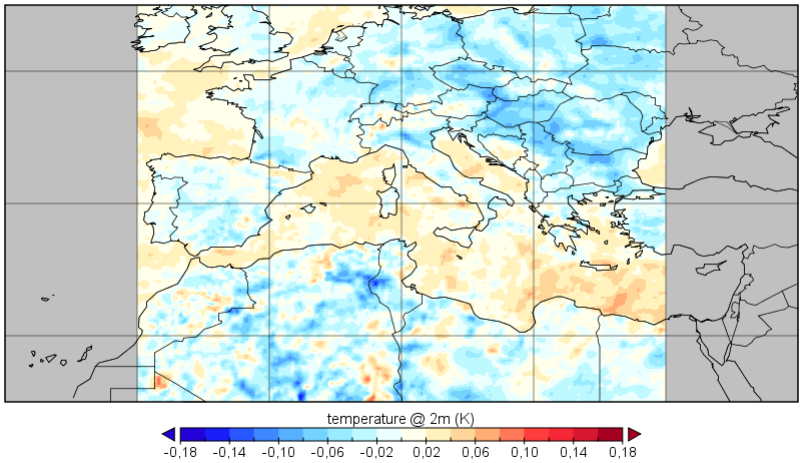
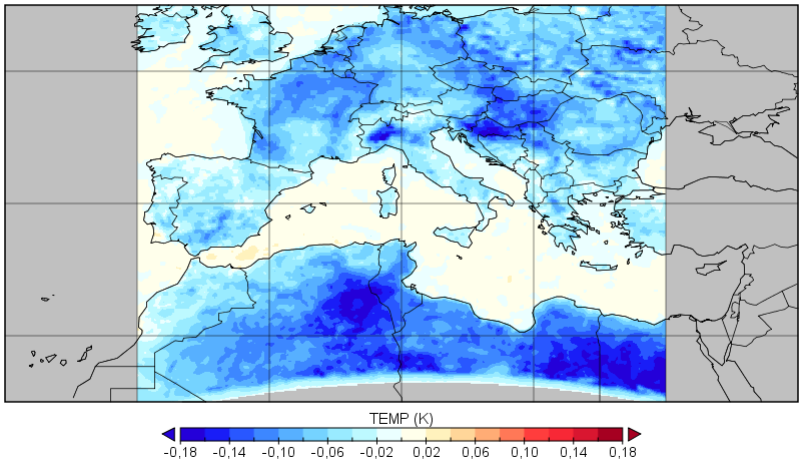
Variability of results: direct effect

Difference in temperature (note: dT< 0.2 K)

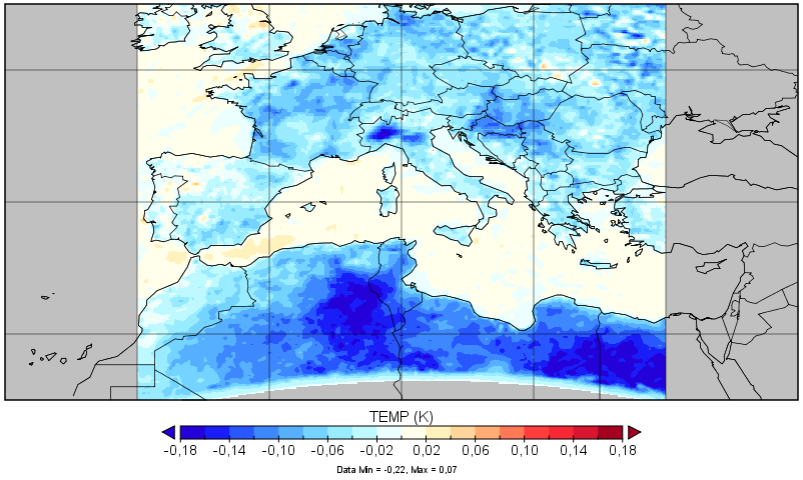
DE3 C22-C21 T @ 2m



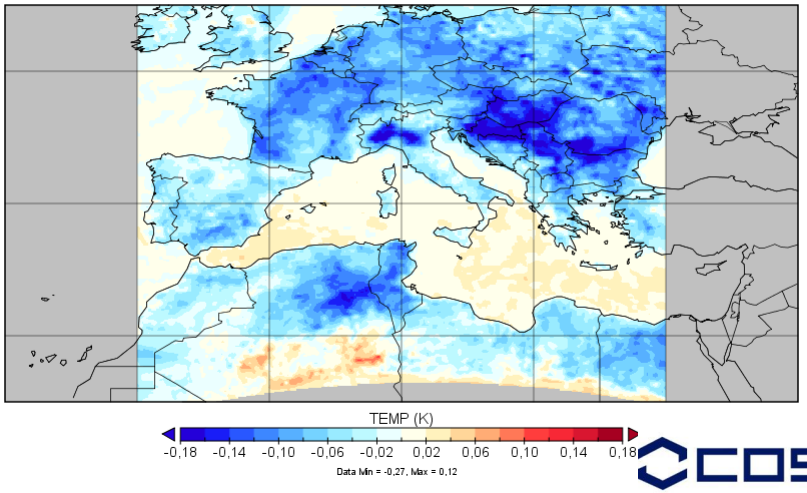
CS1 C22-C21 T @ 2m



ES1 C22-C21 T @ 2m



ES3 C22-C21 T @ 2m



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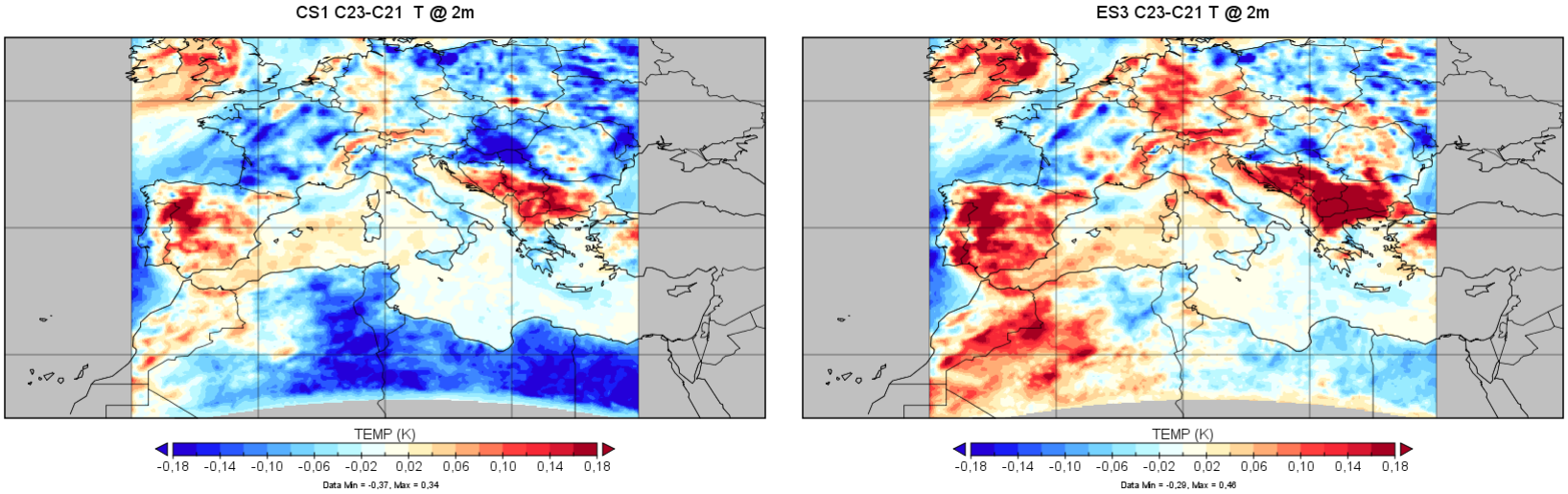
Variability of results: dir. + indir. effect

Difference in temperature



- On mean values only small effect on mean values (< 2%)
- Detailed analysis of processes and common and distinct handling of feedback processes in different models

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Conclusions from ES1004 case studies

- Even for the selected extreme cases the impact of aerosols results depends strongly on the description of processes in the different models
- For interpretation, a thorough considerention of the baseline is required. Simulated „feedback effects“ from case studies with different models are not always comparable
- Comparison with observations: More met & chem observations at same location would be nice
- So far the case studies are still strongly dominated by WRF-Chem applications

⇒ Further contributions are still **very** welcome

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- UL for the space on their FTP server

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- ECMWF/MACC project & Météo-France/CNRM-GAME (chemical boundary conditions)
- FMI (fire emissions)
- Joint Research Center Ispra/Institute for Environment and Sustainability (ENSEMBLE system): Ulas Im, Stefano Galmarini
- Enviroware (ENSEMBLE system): Roberto Bianconi
- Members of the Cost action ES1004 EuMetChem

Thanks to everyone who contributes!

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Previous work in the context of AQMEII2

Publications in Atmospheric Environment Joint Issue:

a) Papers by Makar et al.

- GEM-MACH simulations for the US without and with feedback
- WRF-CHEM simulations for the US without and with feedback
- WRF-CMAQ simulations for the US without and with feedback
- WRF simulations and WRF-Chem simulations with RACM/MADE-VBS for Europe with full feedback and WRF-Chem simulations with RADM/MADE-SORGAM for Europe with and without direct effect

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Previous work in the context of AQMEII2

(cont.)

b) Paper by San José et al.

- WRF-Chem simulations with CBM-Z/MOSAIC for Europe without and with full feedback

c) Paper by Forkel et al. (and some results later in this talk)

- WRF-Chem simulations with RADM2/MADE-SORGAM for Europe with three different degrees of feedback

d) Paper by Kong et al.

- WRF-Chem simulations for fire episode with RADM2/MADE-SORGAM for Europe without and with full feedback

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