



Radiative effects of atmospheric aerosols over Europe: an on-line modelling approach

Laura Palacios, Rocío Baró, P. Jiménez-Guerrero

Regional Atmospheric Modelling
(RAM), Physics of the Earth

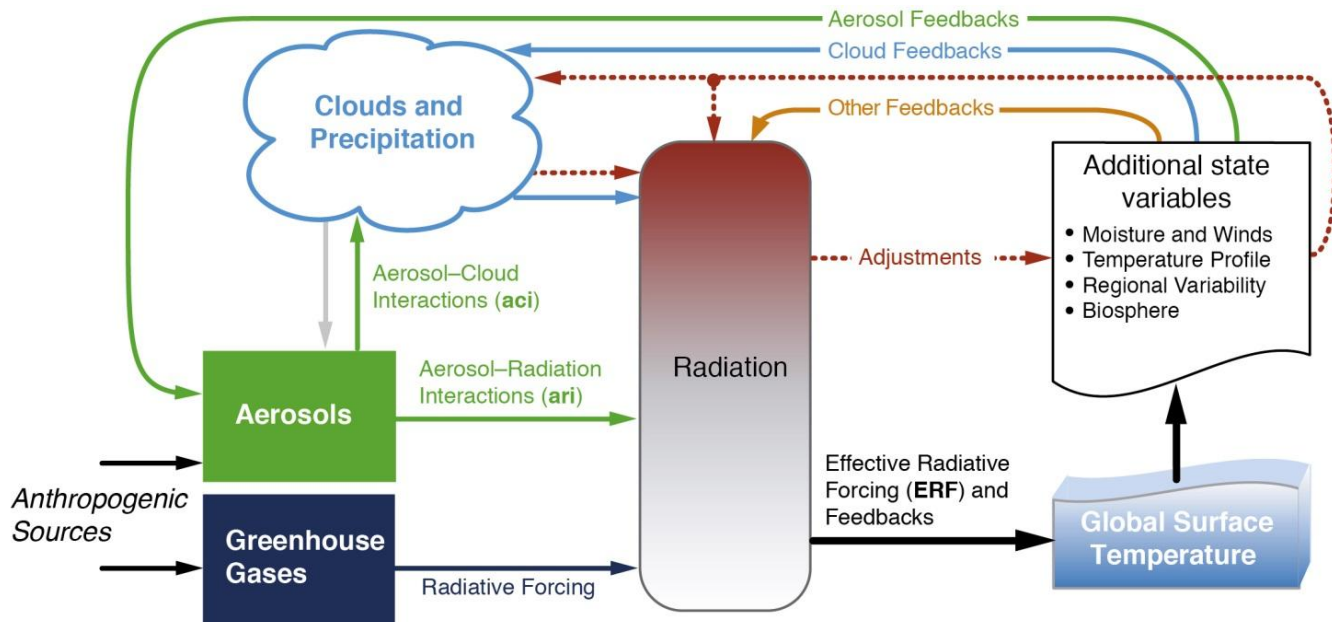
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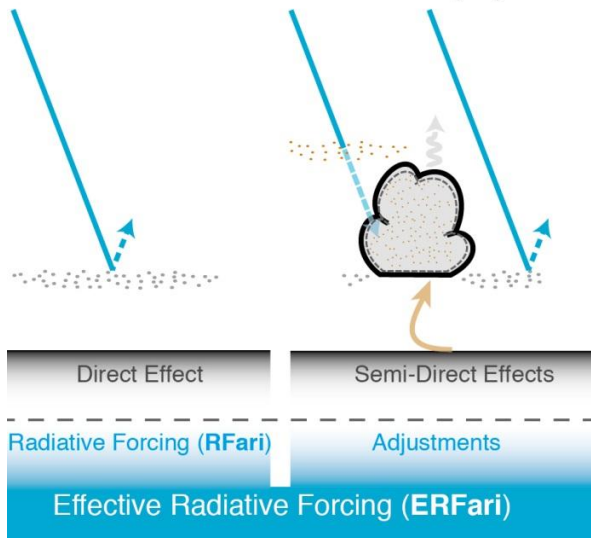


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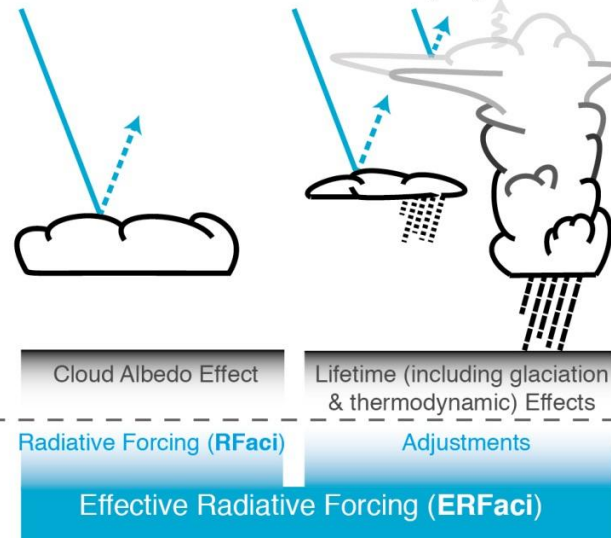
Aerosol radiative effects



Irradiance Changes from Aerosol-Radiation Interactions (ari)



Irradiance Changes from Aerosol-Cloud Interactions (aci)



AR4

AR5

AQMEII: Air Quality Model Evaluation International Initiative

Initiated by JRC Ispra, US-EPA, and Environment Canada

<http://aqmeii.jrc.ec.europa.eu/>

First phase: 2010-2011; Atmospheric Environment 53 (2012)

Second phase with focus on **online coupled models**

European Domain: 20 Participants (1 with offline model)

Cost action ES1004 EuMetChem

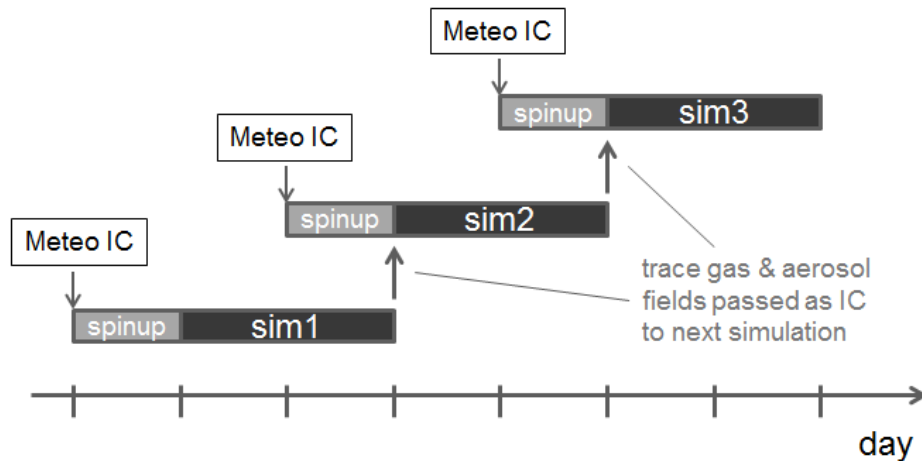
Modelling results presented here validated in Brunner et al. (2014, accepted) for meteorology, Im et al. (2014a, 2014b) for ozone and particulate matter, or Forkel et al. (2014) and Baró et al. (2014) for radiative effects.

7 contributions with WRF-Chem simulations for Europe

Contributions with WRF-Chem

- 1) Univ. L'Aquila, CETEMPS (Gabriele Curci, Paolo Tuceila)
- 2) RSE (Guido Pirovano, Alessandra Balzarini)
- 3) Univ Murcia, MAR-UMU (Pedro Jiménez-Guerrero, Rocío Baró)
- 4) KIT, IMK-IFU (Renate Forkel, Johannes Werhahn)
- 5) Univ. Pol. Madrid, ESMG (Roberto San José, Juan L. Pérez)
- 6) Univ. Ljubliana SPACE-SI (Rahela Žabkar, Luka Honzak)
- 7) ZAMG (Marcus Hirtl)

Spontaneous movement intended to minimize efforts of groups running WRF-Chem over Europe with contributions to pre- and post-processing and code additions from everyone



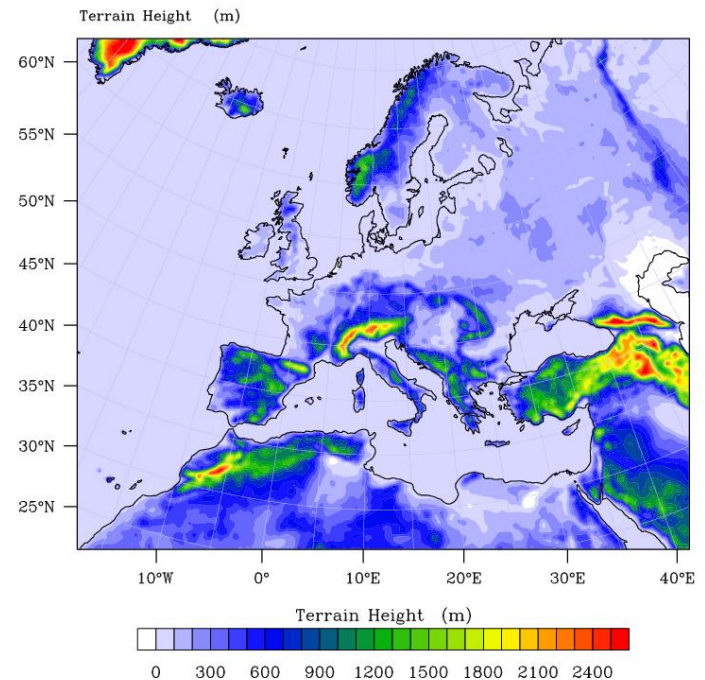
WRF/Chem version 3.4.1 with common modifications (one simulation with 3.5)

- Lambert projection (50N, 12E)
- 270 x 225 cells, dx = 23 km
- 33 eta levels

AQMEII recommendations:

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

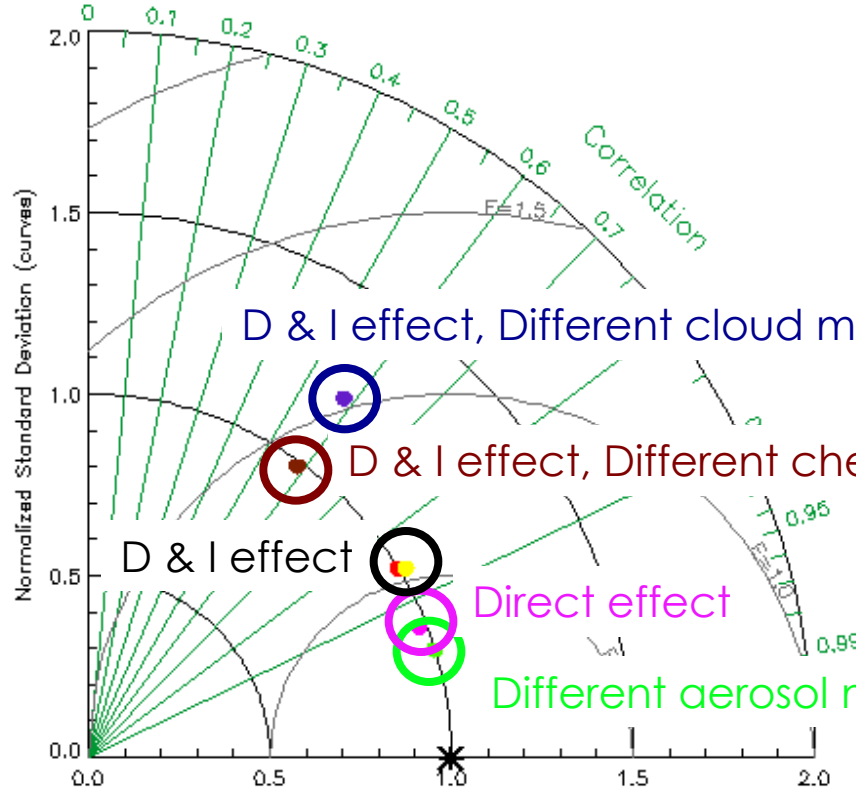
**Long enough to allow feedback ↔
short enough for suppressing
semi-direct effects?**



Magnitude of feedback effects

Case 0316-005 - Taylor diagram - PRECIP Precipitation in cm
 Data time window: from 2010-07-01 00:00 to 2010-10-01 00:00 UTC - Pool: PRECIPMED
 Ensemble A data range: [0.00E+00,3.30E+00] - Models B data range: [0.00E+00,4.30E+00]
 Ensemble A threshold: 0.00E+00 - Ensemble B threshold: 0.00E+00

AQMEI2 EU RECEPTORS
 Meteorology
 Start: 2010-01-01 00:00 UTC



- Ensemble A type: none
 * SI2
- Ensemble B type: none
 • AT1
 • DE4
 • ES1
 • IT1
 • IT2
 • SI1

E = centered RMS difference

Precipitation over MED Summer 2010 (JAS) (Only at AQ stations!)

Increase of precipitation due to indirect effect is quite uncommon but possible.



Magnitude of feedback effects

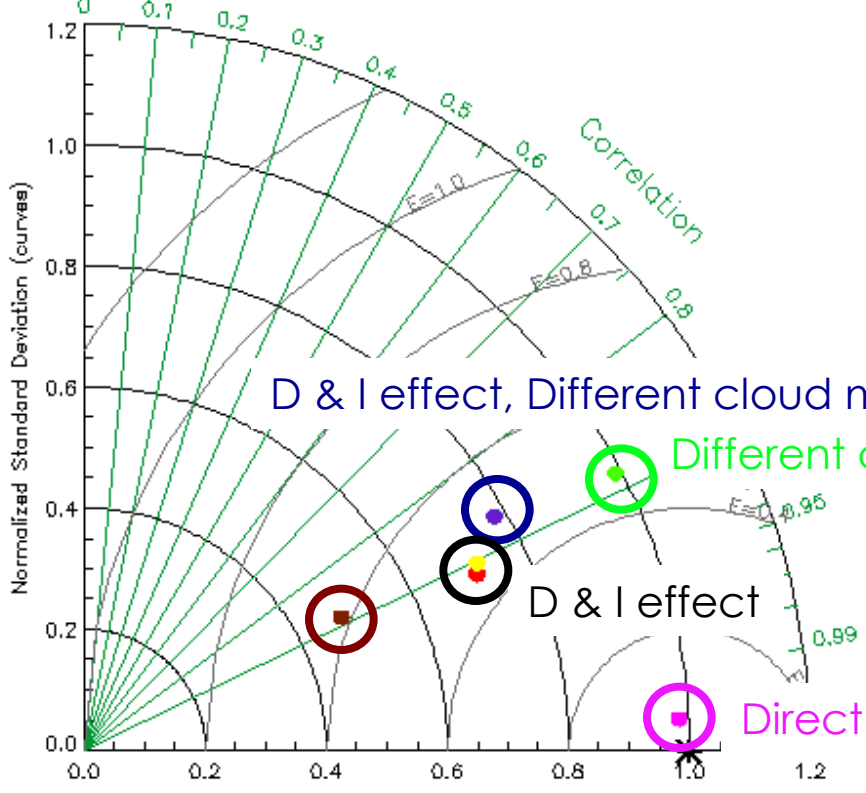
PM10 over Spain Winter 2010 (JFM) (Only at AQ stations!)

Radiative feedbacks tend to strongly suppress PM10 levels over Spain during wintertime. **Not only associated with increased precipitation.**

Case 0316-002 - Taylor diagram - PM10 Concentration (0 m agl) in ug m-3
 Data time window: from 2010-01-01 01:00 to 2010-04-01 00:00 UTC - Pool: PM10spain
 Ensemble A data range: [1.07E+00,2.42E+02] - Models B data range: [3.00E-01,2.35E+02]
 Ensemble A threshold: 0.00E+00 - Ensemble B threshold: 0.00E+00

AQMEII2 EU RECEPTORS
 Aerosol
 Start: 2010-01-01 00:00 UTC

- Ensemble A type: none
 * SI2
- Ensemble B type: none
- AT1
 - DE4
 - ES1
 - IT1
 - IT2
 - SI1



D & I effect, Different chem. mech.



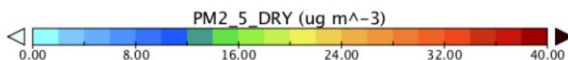
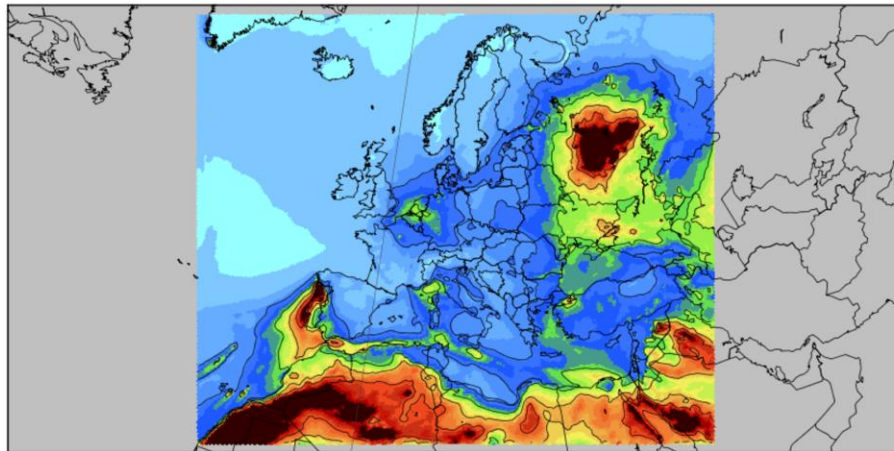
Case studies: Russian fires and Saharan dust COST action ES1004 coordinated study

	Ljubljana	Ljubljana	KIT	ZAMG	Murcia	L'Aquila	RSE	Madrid
Version	3.4.1	3.4.1	3.4.1	3.4.1	3.4.1	3.4.1	3.4.1	3.4.1
Microphys.	Morrison	Morrison	Morrison	Morrison	Morrison	Morrison	Morrison	Morrison
Gas chem.	RADM2	RADM2	RADM2 Integ1mod	RADM2	RADM2	RACM	CBMZ	CBMZ
Inorg. aerosol	MADE	MADE	MADE	DE	MADE	MADE	MOSAIC 4 bins	MOSAIC 4 bins
Org. aerosol	SORGAM	SORGAM	SORGAM	SORGAM	SORGAM	VOC		

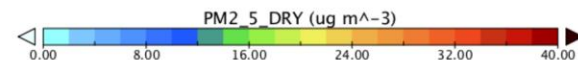
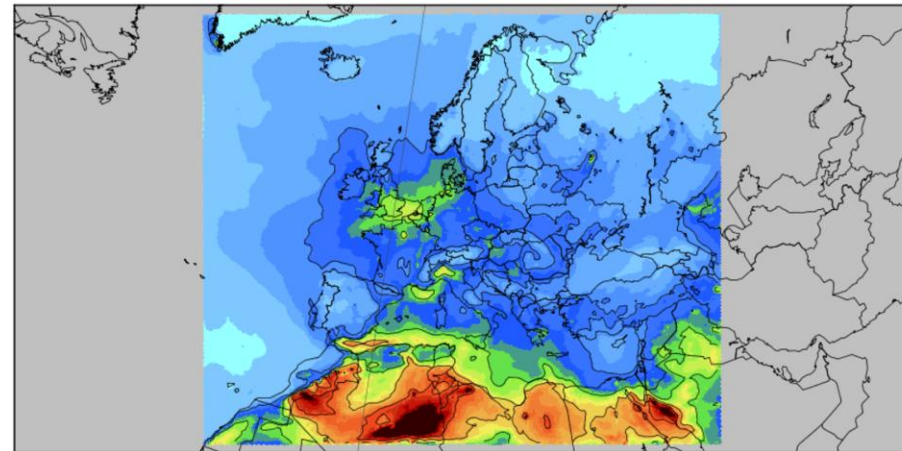
❖ Case studies: Fires over Russia (25 July-15 August 2010)
and Saharan dust (2 October-15 October 2010)

(not everyone contributing to these case studies)

PM2_5_DRY

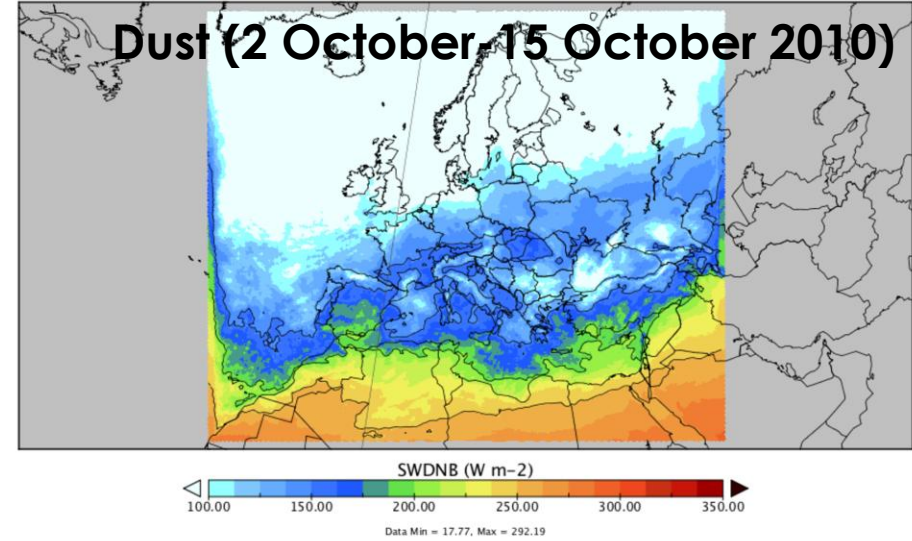
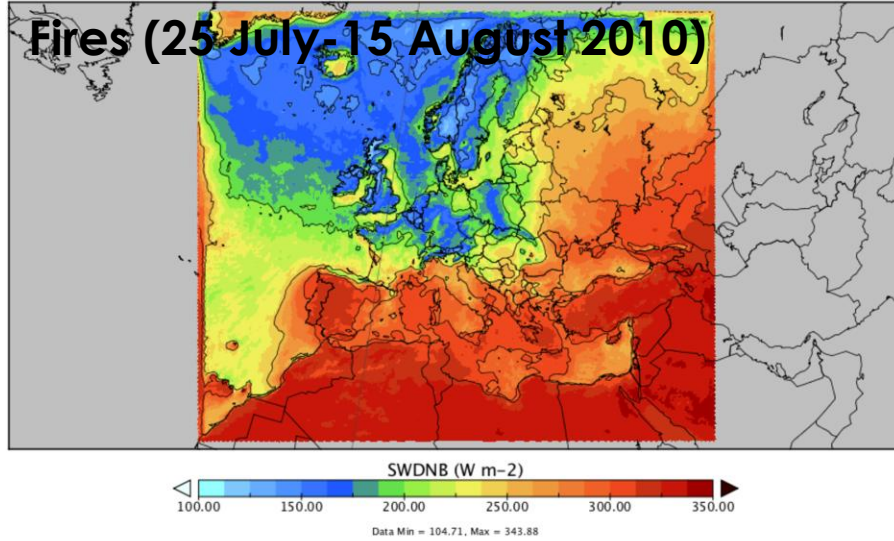


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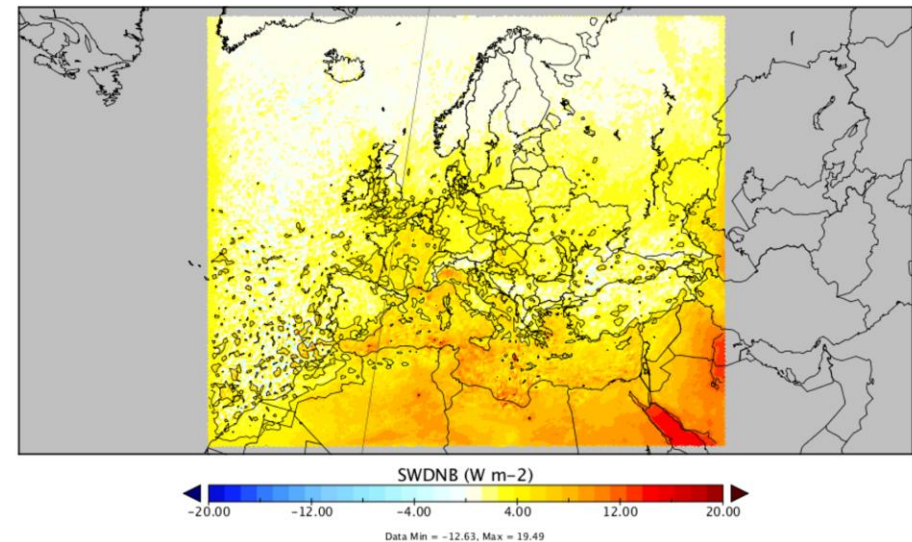
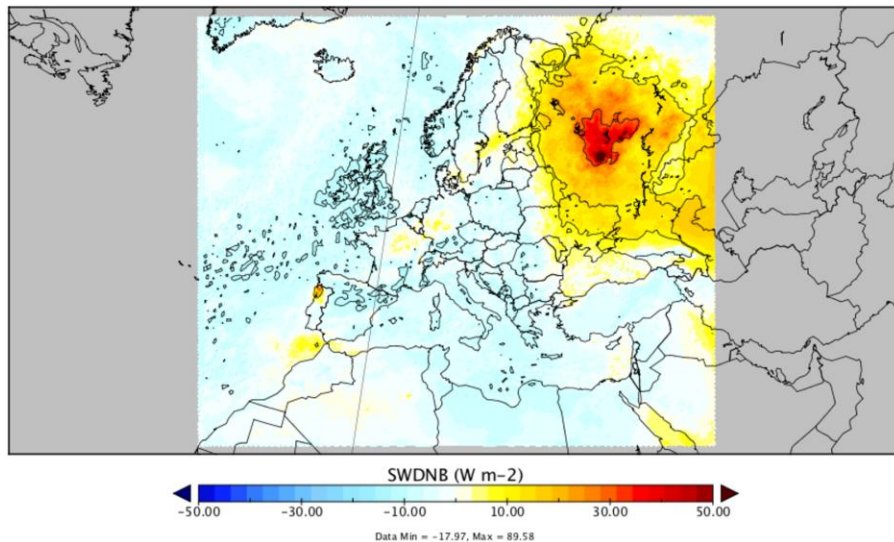


Downward SW radiation at the surface: Case studies

Base (no radiative effects)

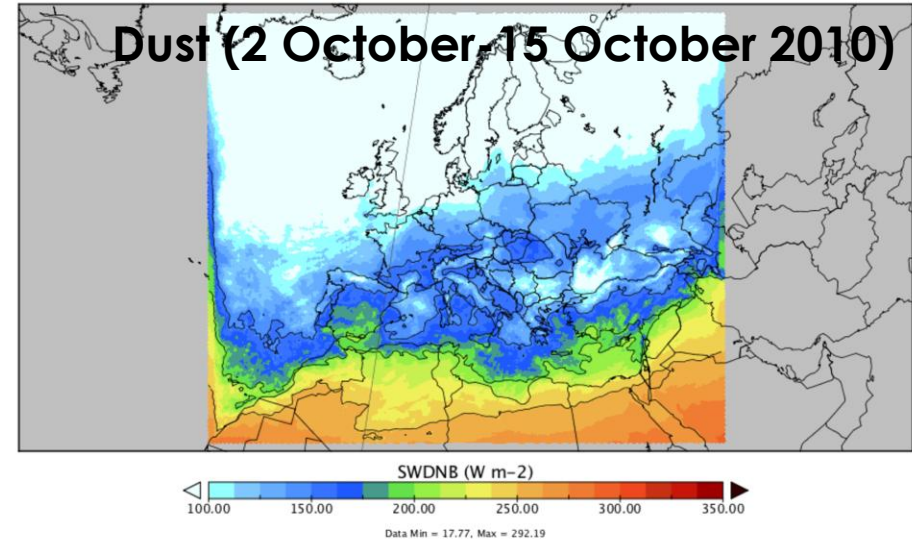
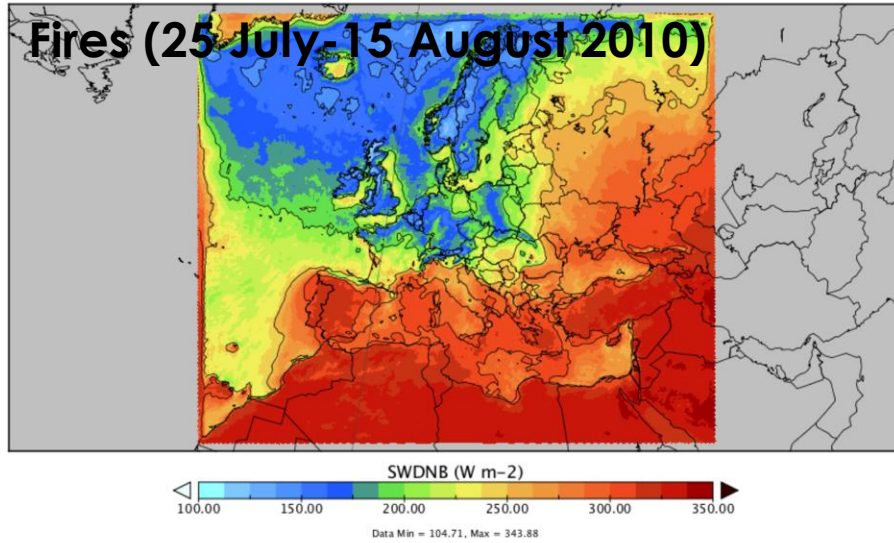


Diff. base - (dir + indir)

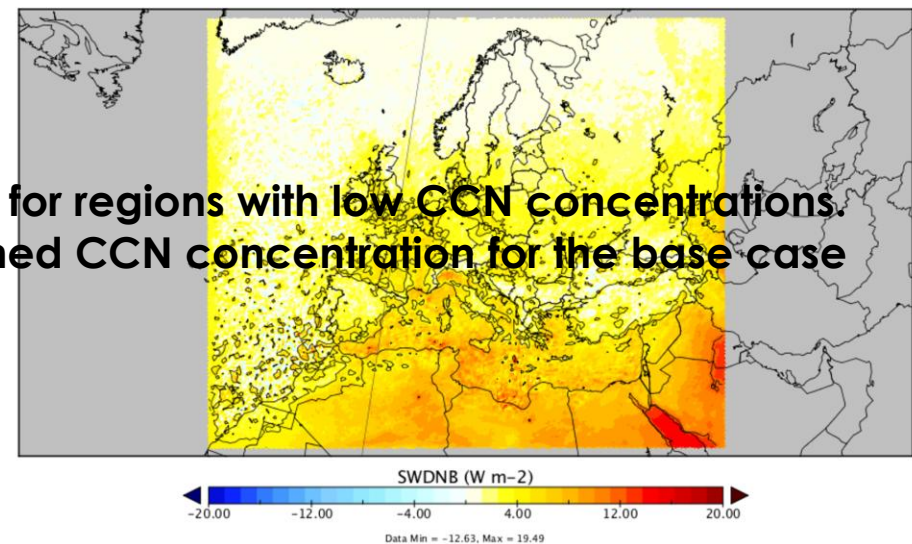
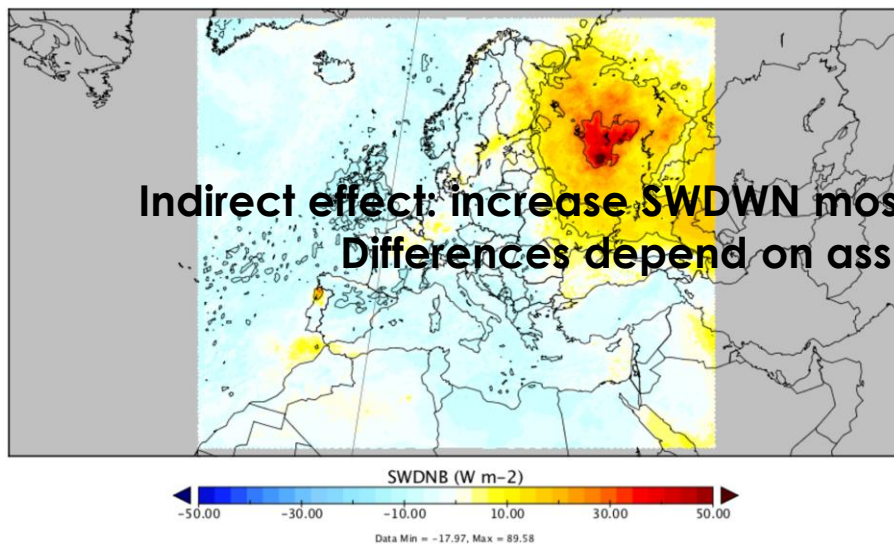


Downward SW radiation at the surface: Case studies

Base (no radiative effects)

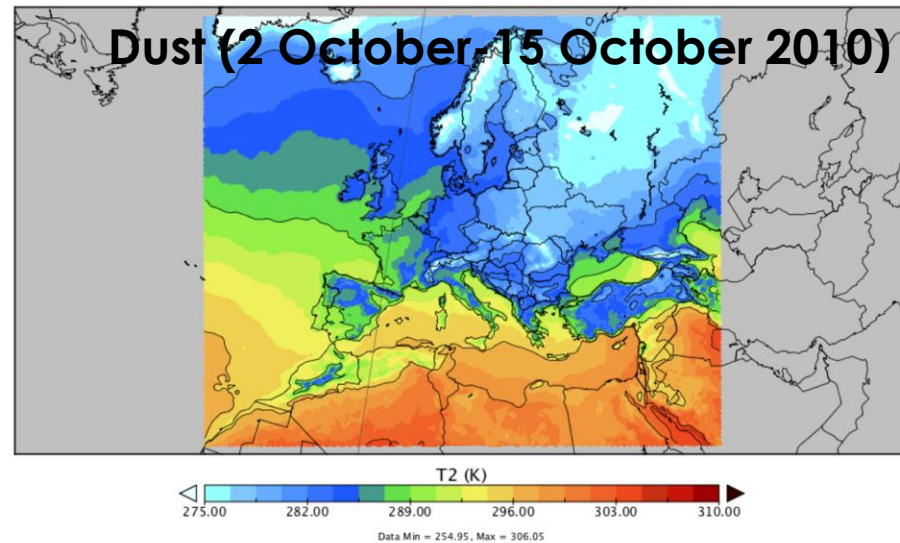
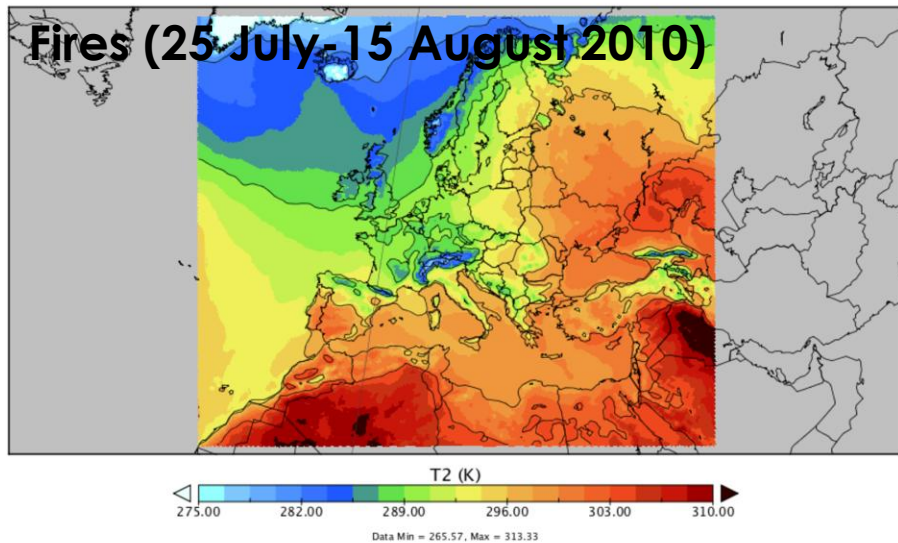


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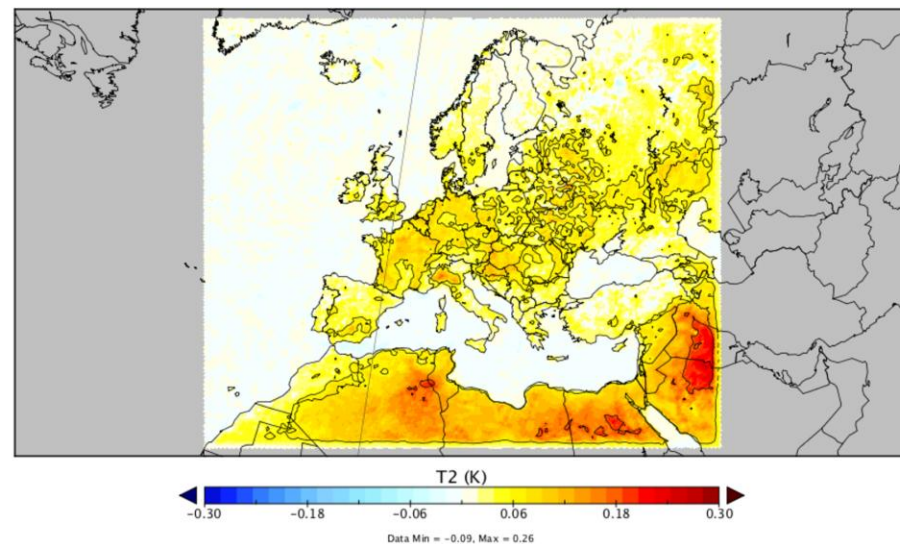
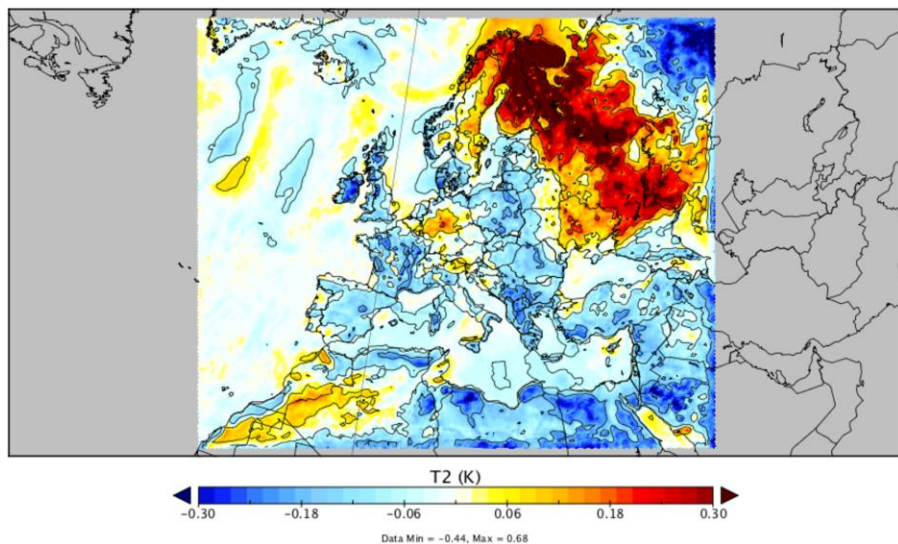


2-m temperature: Case studies

Base (no radiative effects)

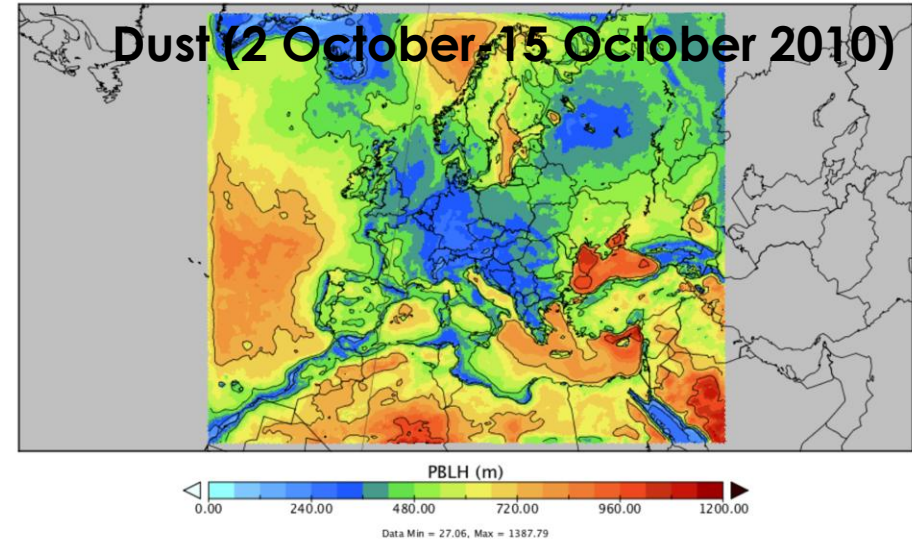
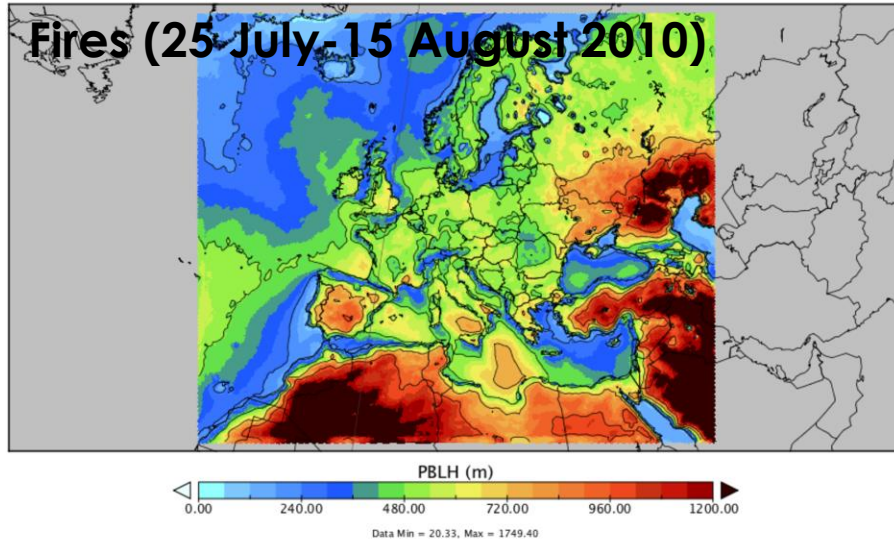


Diff. base - (dir + indir)

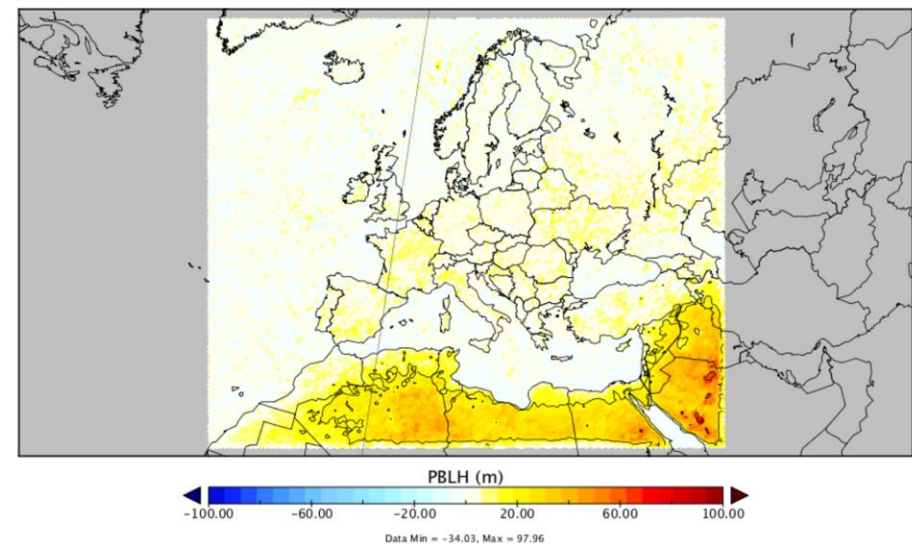
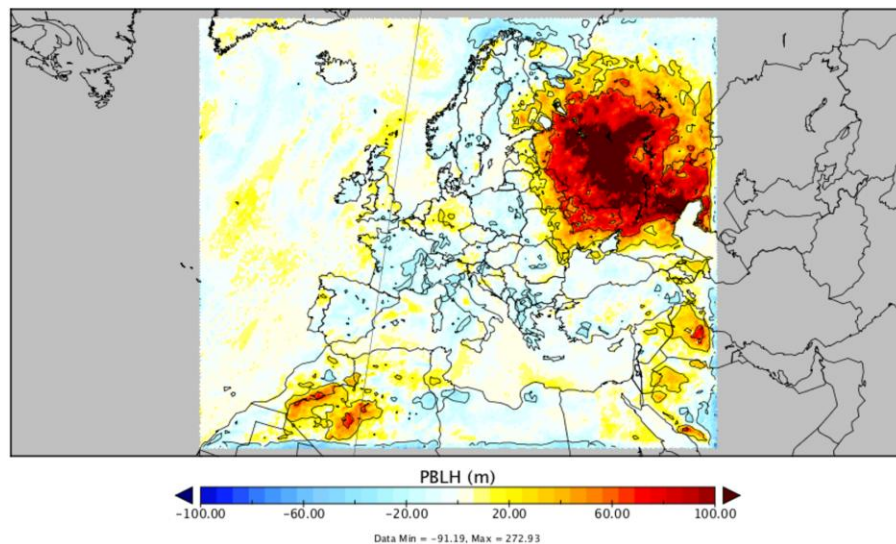


PBL Height: Case studies

Base (no radiative effects)



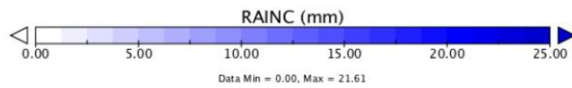
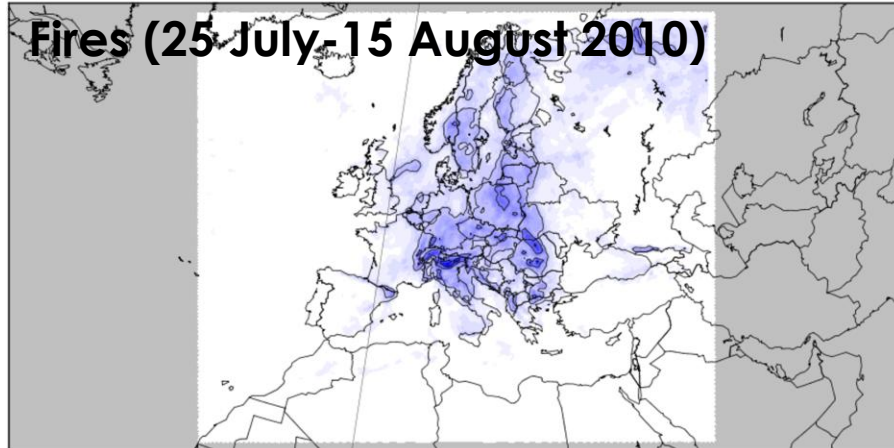
Diff. base - (dir + indir)



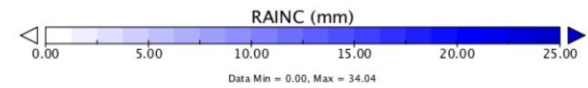
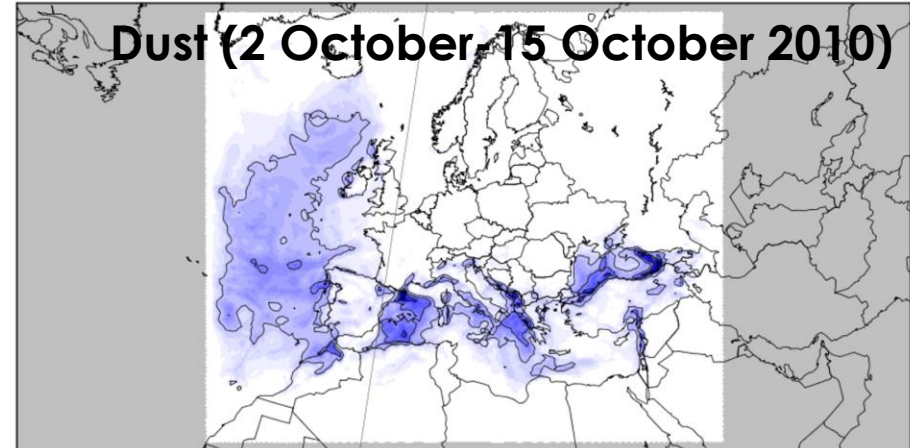
RAIN: Case studies

Base (no radiative effects)

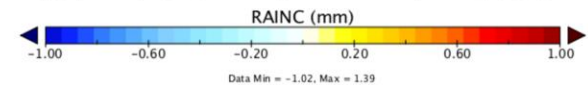
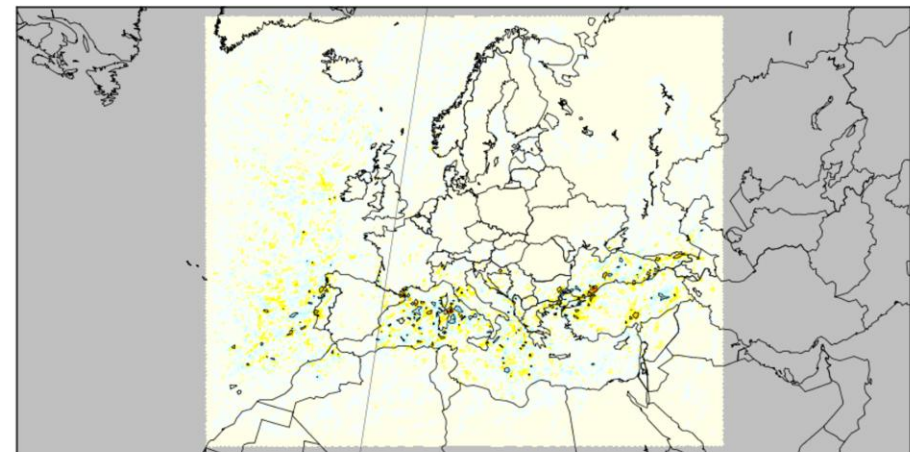
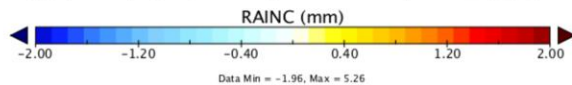
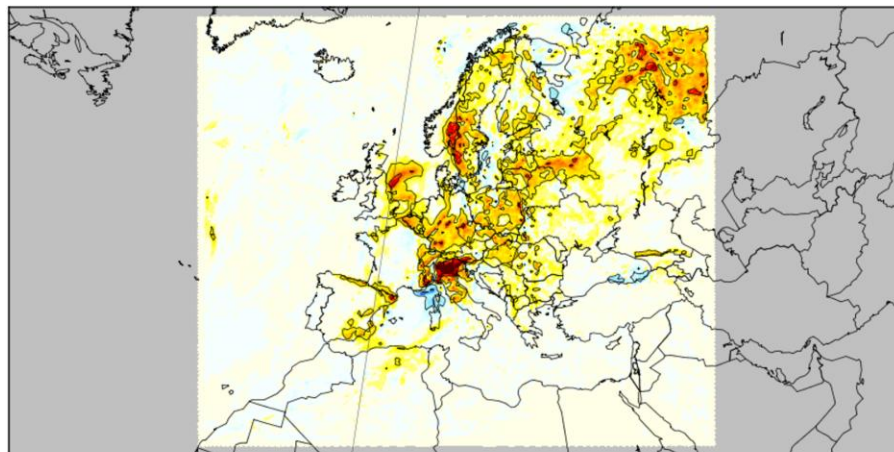
Fires (25 July-15 August 2010)



Dust (2 October-15 October 2010)



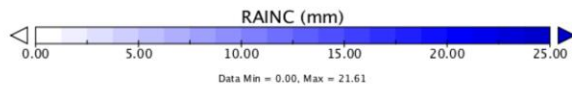
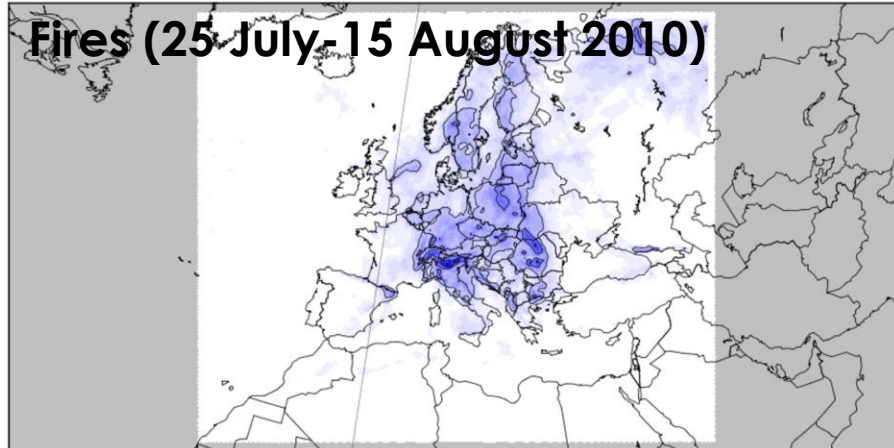
Diff. base - (dir + indir)



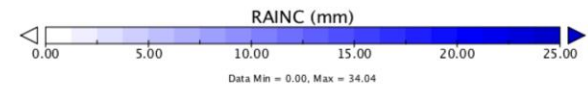
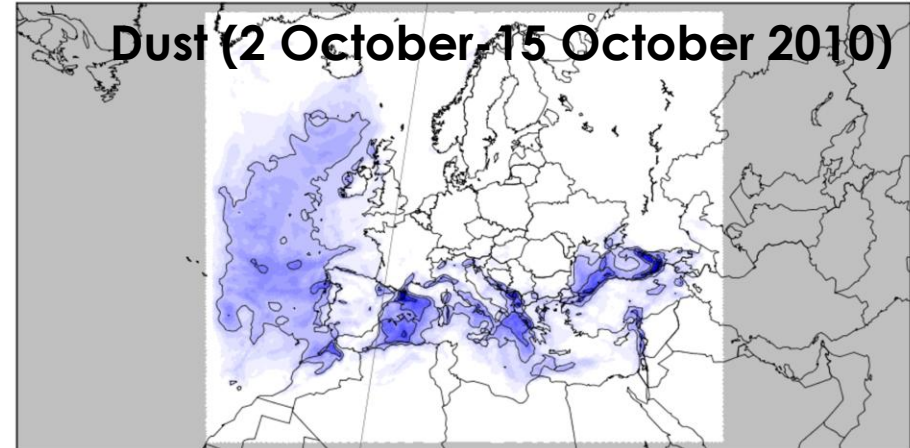
RAIN: Case studies

Base (no radiative effects)

Fires (25 July-15 August 2010)

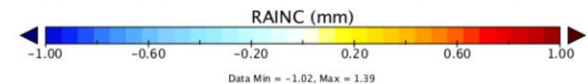
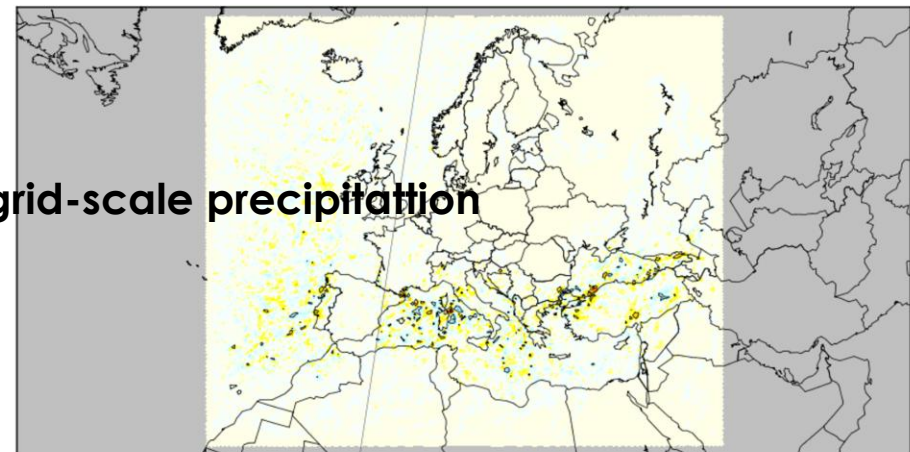
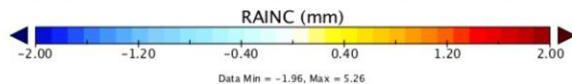
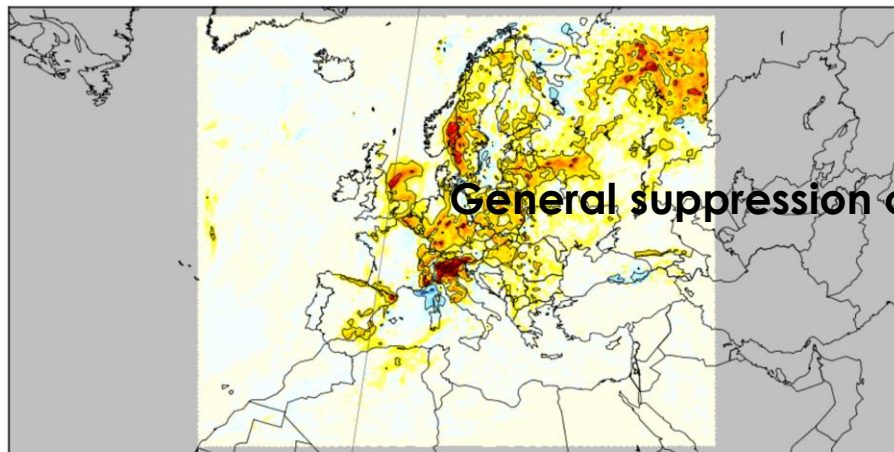


Dust (2 October-15 October 2010)



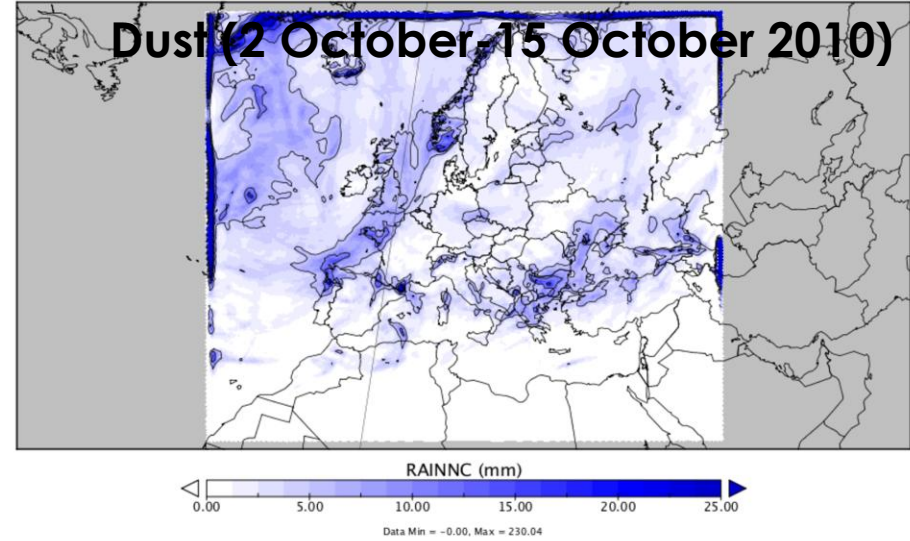
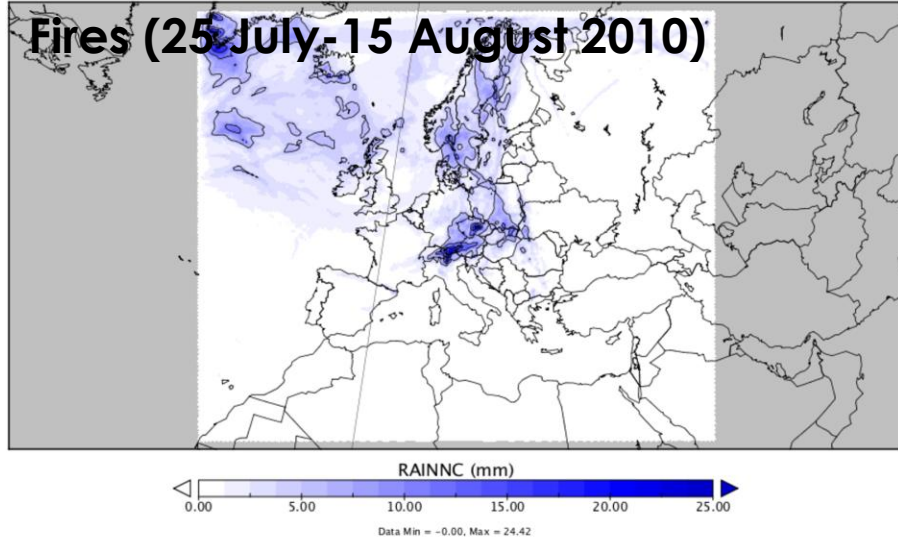
Diff. base - (dir + indir)

General suppression of grid-scale precipitation

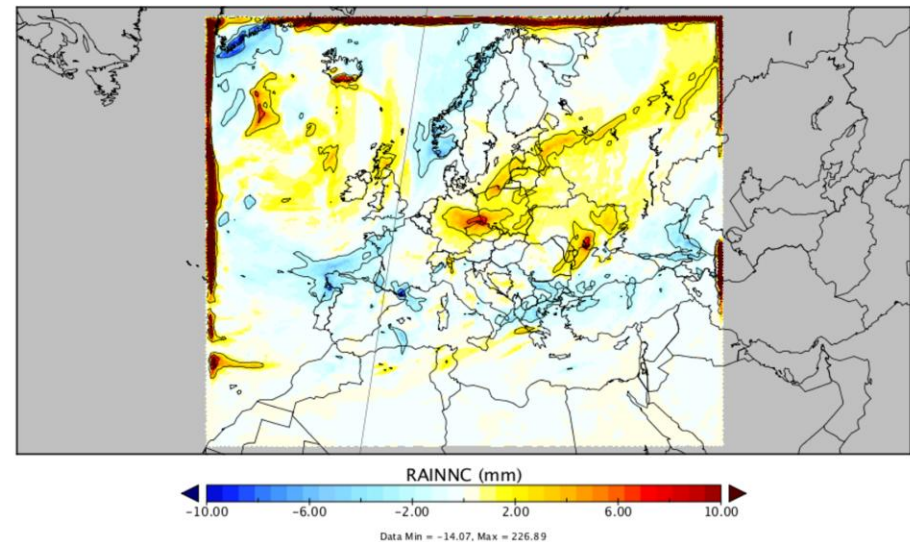
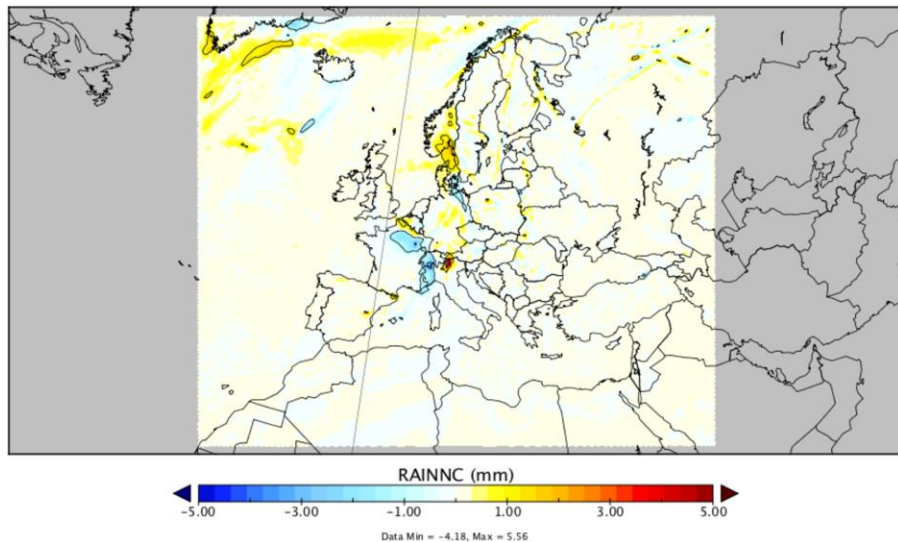


RAINNC: Case studies

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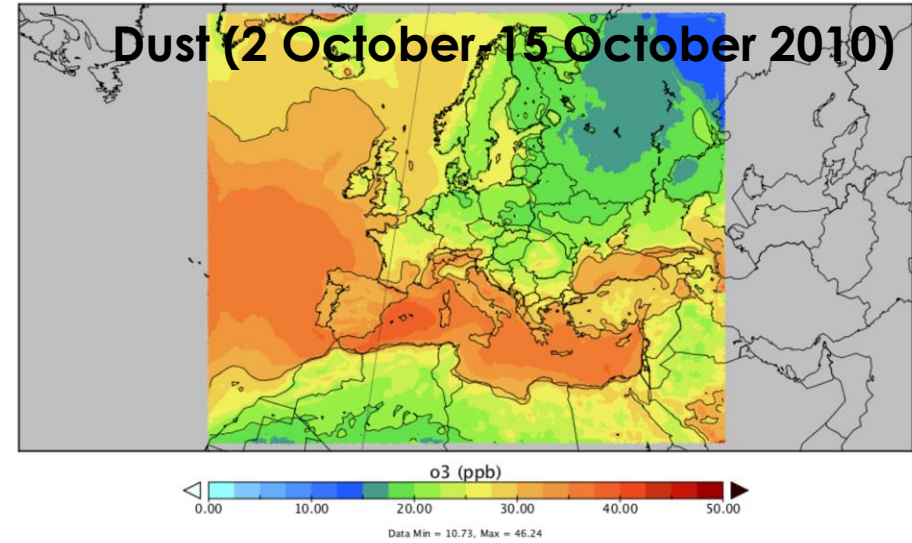
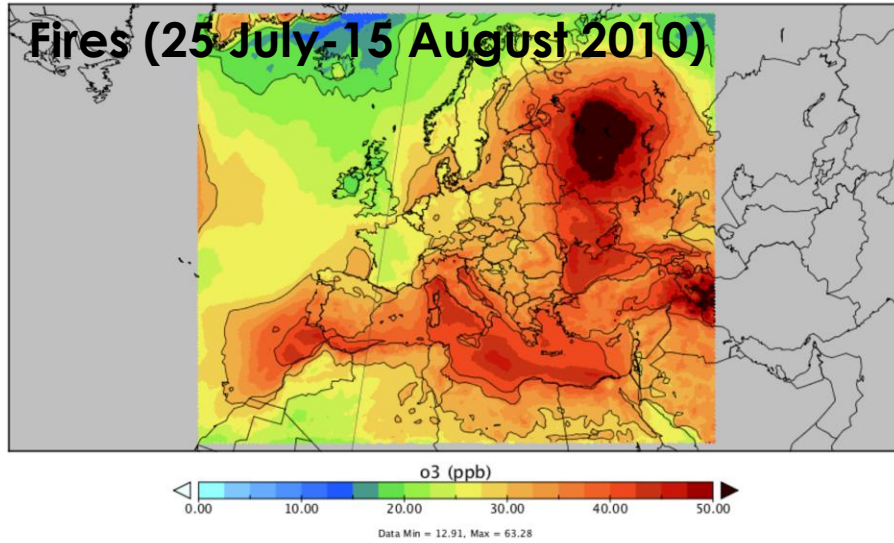


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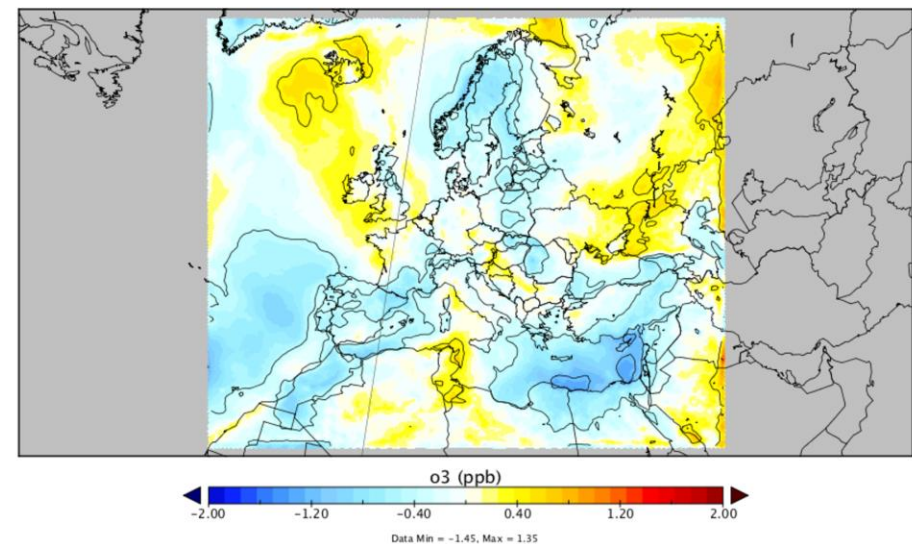
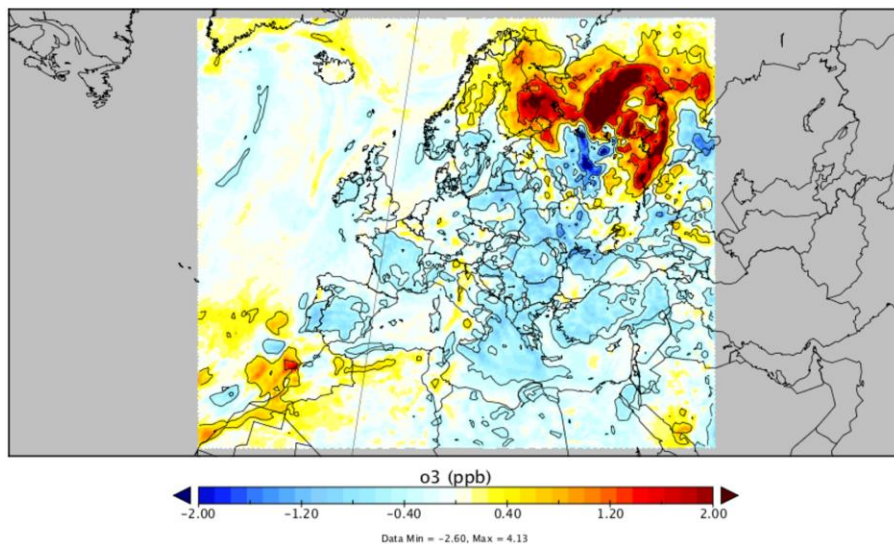


Tropospheric Ozone: Case studies

Base (no radiative effects)

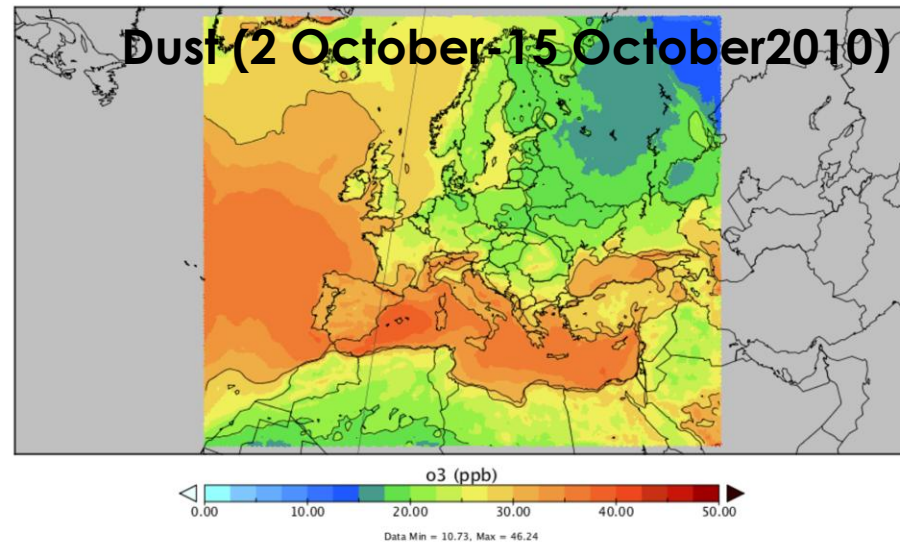
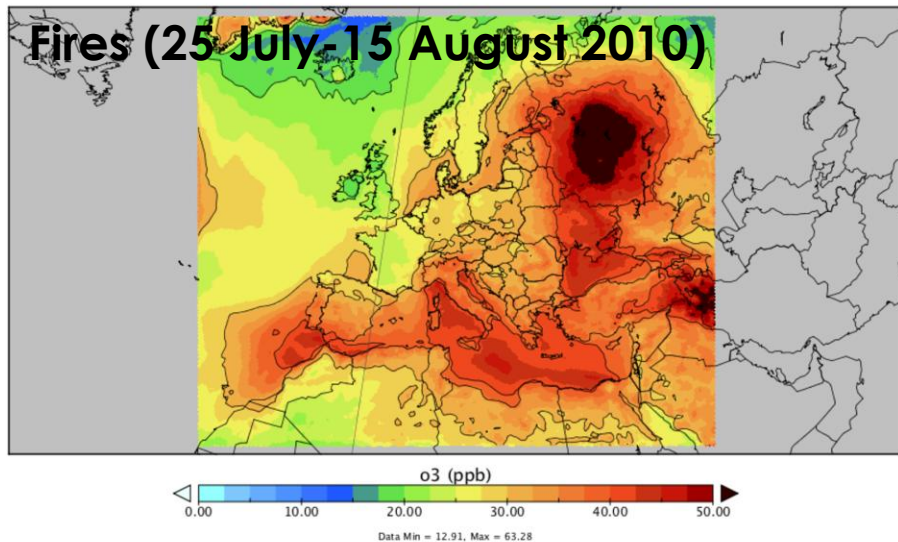


Diff. base - (dir + indir)

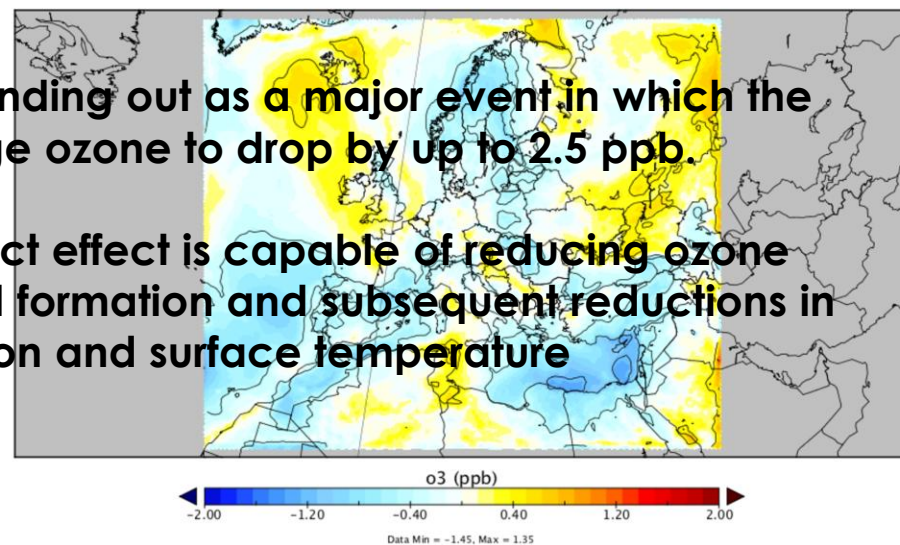
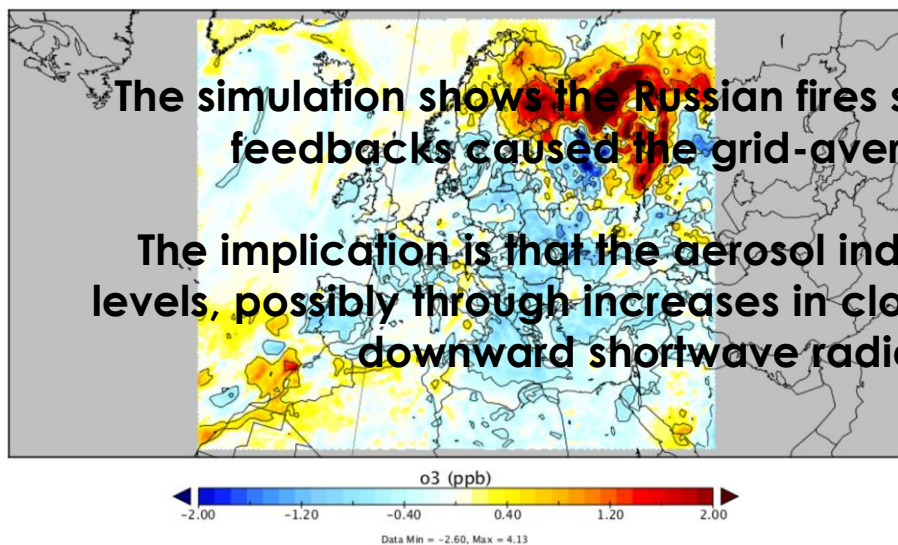


Tropospheric Ozone: Case studies

Base (no radiative effects)

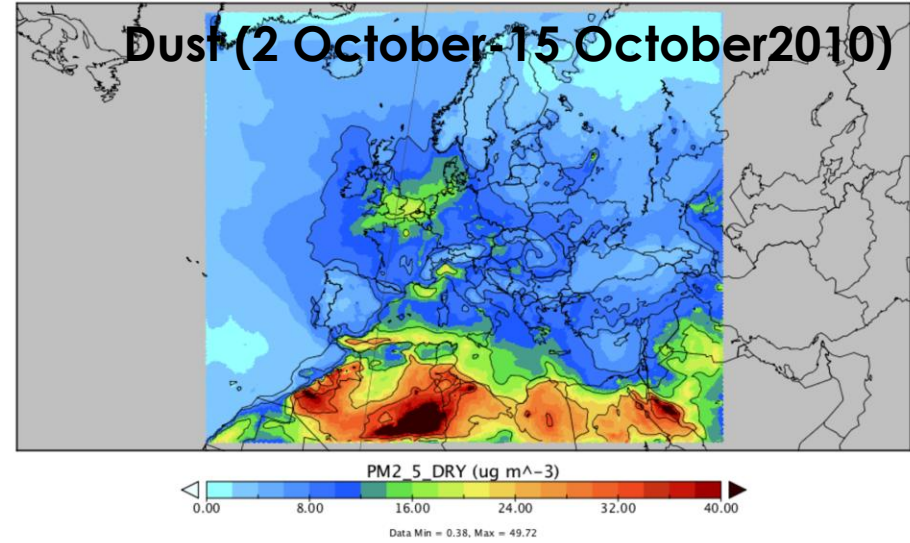
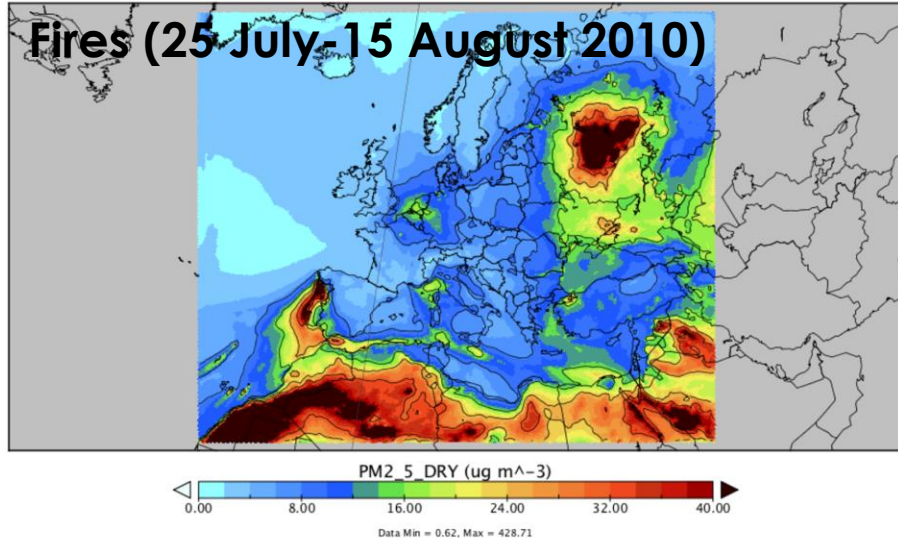


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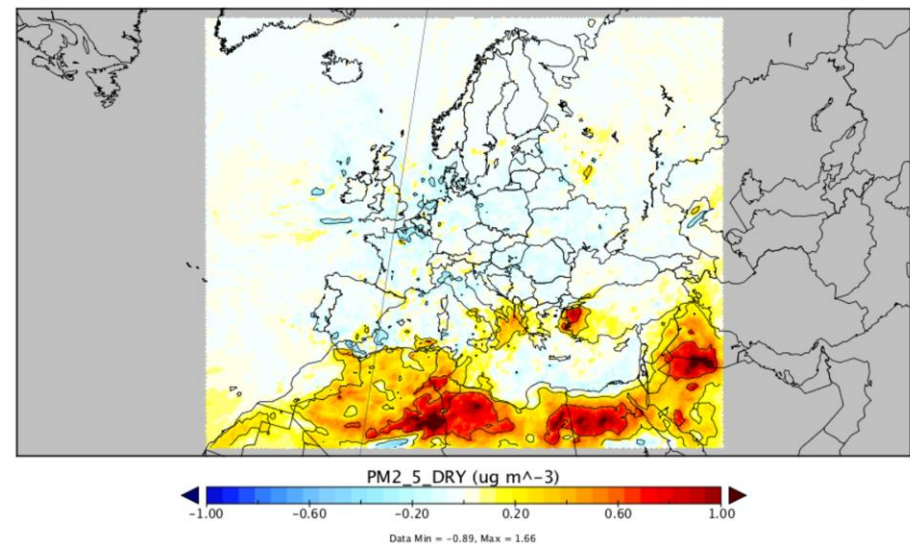
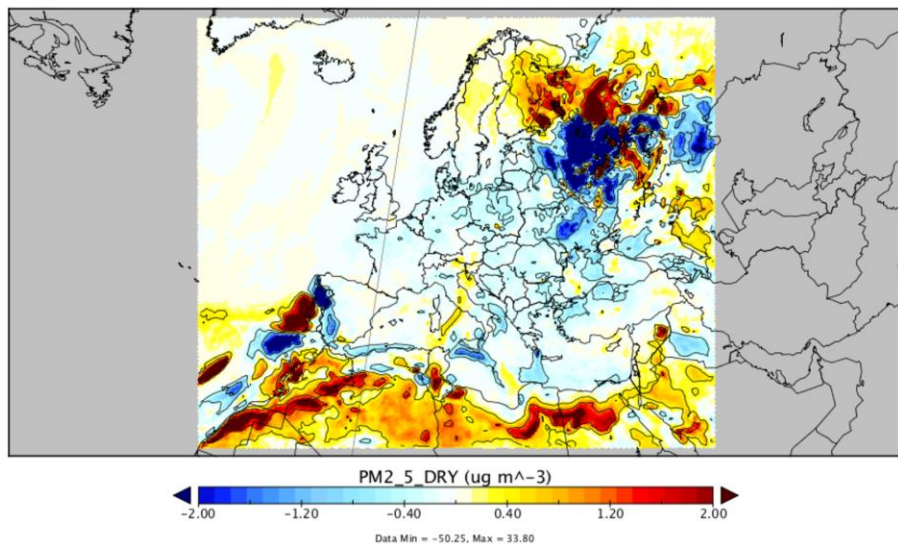


PM2.5: Case studies

Base (no radiative effects)



Diff. base - (dir + indir)



- ❖ Joint effort for AQMEII2 with common grid and input permits analysis of feedback effects on meteorology
- ❖ 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.
- ❖ No 'best' setup
- ❖ Differences depend on the parameters of the 'base case' (e.g. CCN) and considered region (here, inclusion of indirect effect can reduce/enhance precipitation)
- ❖ Pollutants variations come from change in wind direction, speed, atmospheric stability and/or surface temperatures resulting from the feedbacks – these changes modify the height to which the plume of emitted species may rise, the direction and speed of downwind dispersal, and the production rate of secondary pollutants.
- ❖ Cases could have been even more...



Acknowledgments:

- All groups for their contributions to code, pre- and post-processing
- AQMEII-Phase 2 and Cost Action ES1004 EuMetChem
- This work was funded by projects CGL2010-22158-C02-02 and CGL2013-48491-R (also funded by the FEDER programme of the European Union. Dr. Pedro Jiménez-Guerrero acknowledges the Ramón y Cajal Programme of the Spanish Ministry of Economy.

Thank you for your attention