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A case study on the impact of aerosol-radiation feedback on meteorological and regional pollutant distributions

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Motivation

- Air Quality Model Evaluation International Initiative (AQMEII)
- Online coupled meteorological-chemistry model (COST-Action ES1004)
- Aerosol feedback mechanism
- Direct/indirect effects

Model Setup

- Model: WRF/chem 3.3 (April 2011)
- RADM2 gas phase chemistry
- MADE/SORGAM modal aerosol module
  - Nucleation mode < 0.1µm; accumulation mode 0.1-2 µm; coarse mode >2 µm
- Summer episode: 2 months - June / July 2006
- Free development of feedback effects → no FDDA
- Hourly AQMEII 'standard' emissions → TNO
- Biogenic emissions online → Guenther et al., 1994
- Sea salt emissions → Ginoux et al., 2001

Model runs

- Baseline case; without any aerosol feedback effects
  → BASE
- Direct aerosol-radiative effect and semi direct effect
  → RFB
- Direct aerosol-radiative effect plus indirect aerosol effect (semi-direct effects; first and second indirect effect included)
  → RFBC

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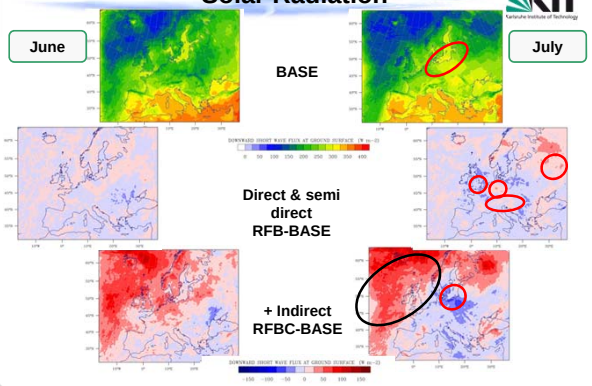
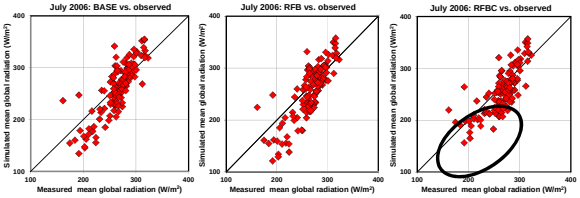
Definitions

- **Direct effect**
  - → downward solar radiation
- **Semi direct effect**
  - → temperature, boundary layer and subsequent effect on radiation, change of cloud properties, e.g. “burning off” , liquid water path
- **Indirect effect**
  - → radiation properties of clouds (e.g. cloud albedo, lifetime, cloud droplet number)

Solar Radiation

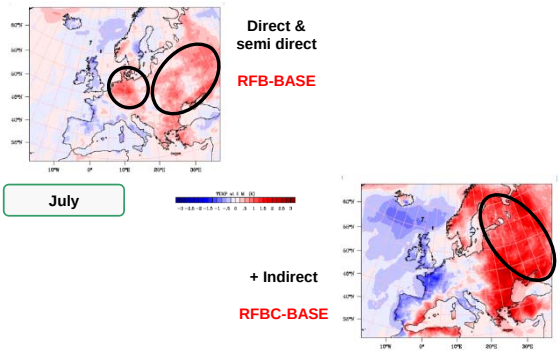


Solar Radiation



Simulated versus Observed

Temperature



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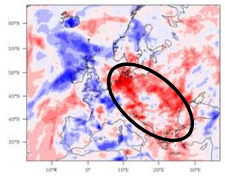
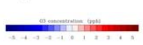
Ozone

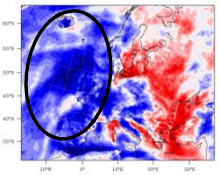


Direct & semi direct

RFB-BASE

July



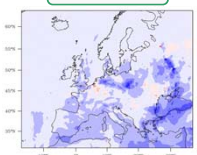


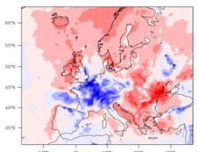
+ Indirect

RFBC-BASE

PM10

June





Direct & semi direct

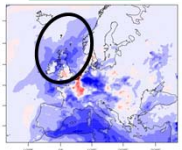
RFB-BASE

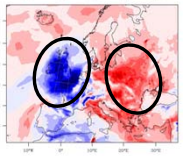
Development

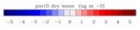
+ Indirect

RFBC-BASE

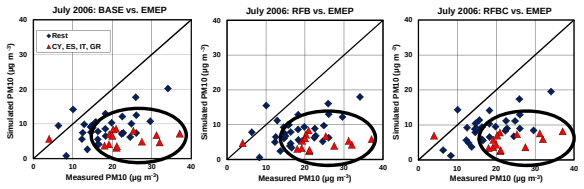
July







PM10



Simulated versus Observed

Conclusions

- snapshot of investigation → episode of a specific meteorological situation
- further investigations are necessary (e.g. higher horizontal resolution, cloud resolving resolution)
- semi - direct effects (temperature, boundary layer, clouds) dominated the direct effect
- Development of semi direct effects become more dominant in July
- Indirect effects result in a decrease of up to 70 % cloud water content and higher precipitation over parts in the Northern Atlantic
- better agreement for cloudy conditions by considering indirect effects

…and continuation of the story within the AQMEII II phase and at the ITM in Utrecht…

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