# Impact of the extreme meteorological conditions during the summer 2003 in Europe on air quality – an observation and model study

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## Introduction

Important processes for air quality as emission, transport, chemistry and deposition are highly depending on meteorological parameters. Changing meteorological conditions on short as well as on long timescales have therefore an effect on these processes and thus also on the concentration of pollutants in the atmosphere. In order to analyze this effect a synoptic situation in the past which is expected to occur more often in the future is analyzed in terms of air quality.

## Method

The **summer of 2003** is taken as an example for a future summer in Europe. It was characterized by persisting heat waves with high temperatures, stagnation and little precipitation over large parts of Europe. In order to investigate the effect of these meteorological conditions on observed and modeled total **PM10** and **secondary inorganic aerosols (SIA)** concentrations, the **observations** (EMEP-network) and the results of **chemical transport model (CTM)** simulations of the summer 2003 are compared to the average of the summers of a five year period (2003-2007).

## Model set-up

Participating CTMs are the German **REM/Calgrid (RCG)** and the Dutch **LOTOS-EUROS** model:

RCG : PM10=PPM2.5+PPM(10-2.5)+BC+OC+road dust+ windblown dust+seasalt+SO4+NH4+NO3+SOA

LOTOS-EUROS: PM10=PPM2.5+PPM(10-2.5)+BC+sea salt+ +SO4+NH4+NO3

Meteorological input: diagnostic model TRAMPER for RCG, ECMWF analysis for LOTOS-EUROS

The emissions of 2005 are used for every year, to isolate the effect of meteorological conditions.

## Results

### PM10 observations and simulation results:

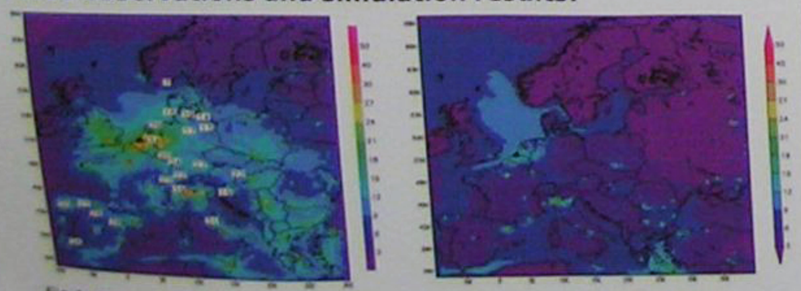

Fig.1: Summer average 2003 for PM10 in µg/m3 for the observations and the simulation results of RCG (left) and LOTOS-EUROS (right).

The highest PM10 concentrations during the summer 2003 were observed in southern regions, cities and industrial areas. The spatial distribution of the PM10 concentrations is represented by both models but the concentrations are underestimated especially by the LOTOS-EUROS model.

### Effect of summer 2003 conditions compared to the summer average of the years 2003-2007:

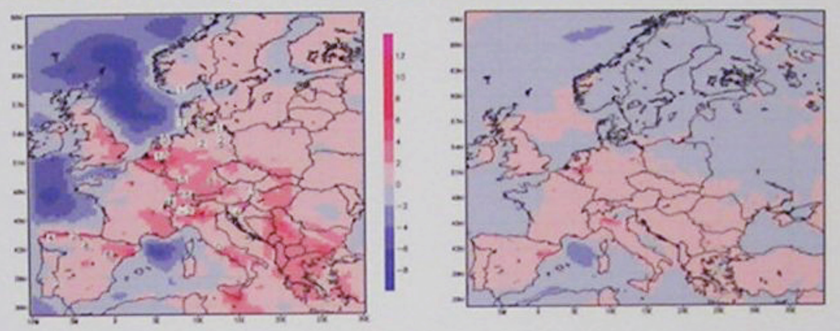

Fig. 2: Difference of the summer average 2003 and 2003-2007 for PM10 in µg/m3 for the observations and the simulation results of RCG (left) and LOTOS-EUROS (right).

Higher concentrations were observed in the summer 2003, especially in areas with elevated PM10 concentrations (Fig.1). The models simulate also mostly higher concentrations for the summer 2003 but the differences between the two periods are smaller for RCG (0-6µg/m3) and for LOTOS-EUROS (±2µg/m3) compared to the observations.

### Meteorological parameters and air quality:

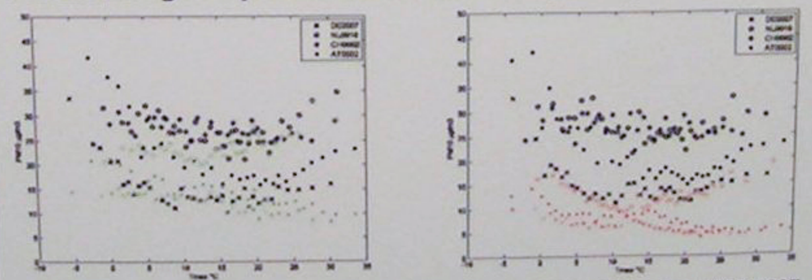

Fig.3: PM10 concentrations versus daily maximum temperature for 2003-2007, Left: EMEP (black) and RCG results (green) with Tramper meteorology, Right: EMEP and LOTOS-EUROS results (red) with ECMWF meteorology on different stations in Europe. The data are sorted by the daily maximum temperature and averaged over 50 data points.

PM10 concentrations versus daily maximum temperature:

High/low daily maximum temperature is connected to high/low daily maximum mixing height, low wind speed and a low precipitation amount. Both situations favor the accumulation of pollutants (not shown).

Observed high PM10 concentrations are related to conditions with low and high daily Tmax (Fig.3).
The models are not able to reproduce this relation; they underestimate the increased concentration with high daily Tmax (Fig.3).

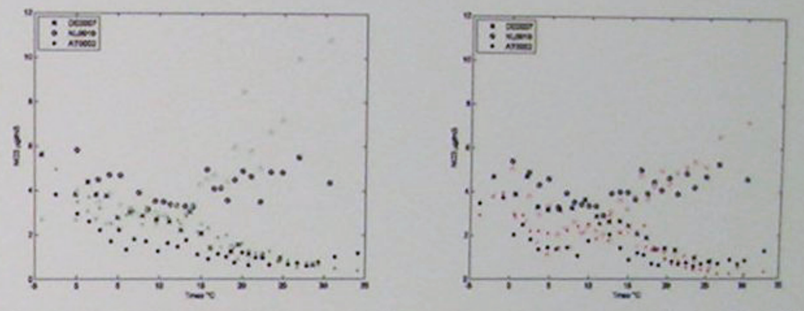

Fig. 4: Nitrate concentrations versus daily maximum temperature, sorted and binned for 2003-2007, Left: EMEP (black) and RCG results (green) with Tramper meteorology, Right: EMEP and LOTOS-EUROS results (red) with ECMWF meteorology on different stations in Europe.

SIA concentrations versus daily maximum temperature:

The relation between daily Tmax and the SIA is highly dependent on the component and location (Fig.4). High concentrations are connected to conditions with low daily Tmax, and depending on the species and station, also to high daily Tmax. Both models reproduce these observed relations.

The modeled PM10 concentrations are dominated by the SIA as the sum of the other components of PM10 is highly underestimated. Since the LOTOS-EUROS model include less components this is more obvious for this model (not shown).

## Conclusions

- observed PM10 concentrations were higher in the summer 2003
- the models partly reproduce that:
  - the SIA dependency on temperature is reproduced correctly
  - the high PM10 concentrations related to conditions with high daily maximum temperature are underestimated
  - the weather cor[illegible] m[illegible]use[illegible] emissions which [illegible]th[illegible] for example forest fires, SOA and resuspended dust
  - great care should be taken when using CTMs for coupling with climate models

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