Review of large fires simulations with CHIMERE

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Purposes

- Large fires (forest, oil, ...) can cause major air quality degradations
- Simulation of fire plumes requires evaluation
- Prediction of fire plumes in real time?
- Worst-case scenarios using major fires

Cases under study

- Buncefield oil depot fire
- Portugal 2003 heatwave fires
- Greek fires in 2007

The Buncefield accident

Vautard et al., 2007, Atmos. Environ.

- Overfueling of a tank during nighttime of 10-11 Dec 2005
- Explosion at 6:00 AM, 11 December
- Fire lasted until 15 Dec, but no major smoke after 13 Dec 18:00
- Oil fire duration=60 hour
- 58000 Ton of oil, >8000 PM10 Ton, 6% of annual in England

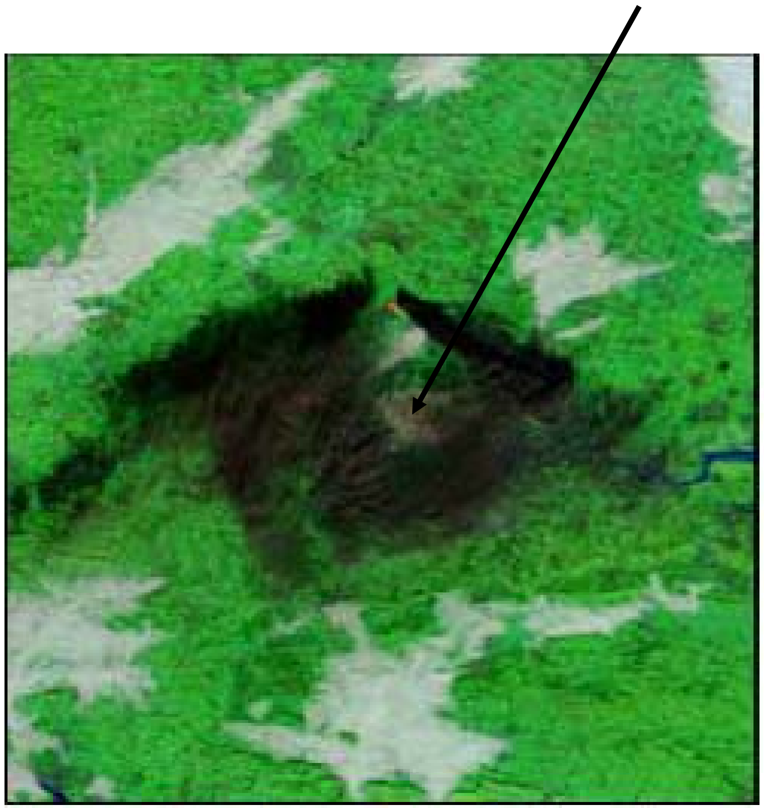
Figure 3.1 Inside the depot during the fires © the Hertfordshire Constabulary

After Targa *et al* 2006

Figure 3.2 Devastated tanks after the fires © the Hertfordshire Constabulary

The plume

MODIS Image



The Buncefield plume photographed from the air – © Chiltern Air Support Unit.

Observed Air Quality

No evidence of plume in AQ monitoring stations in SE England

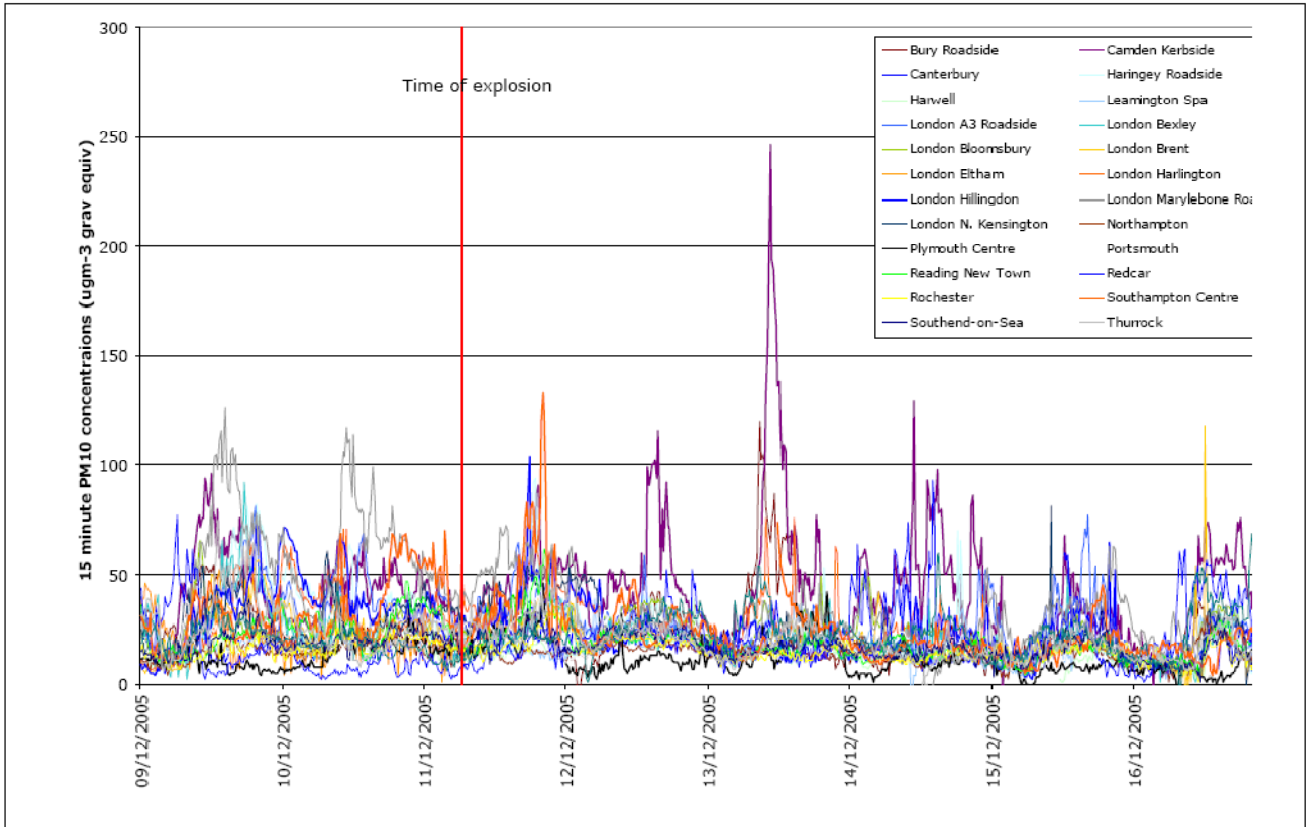


Figure 4.4 15-minute mean PM_{10} measurements between 9th and 16th December 2005 at selected sites across the AURN in England

Plume + AQ simulation

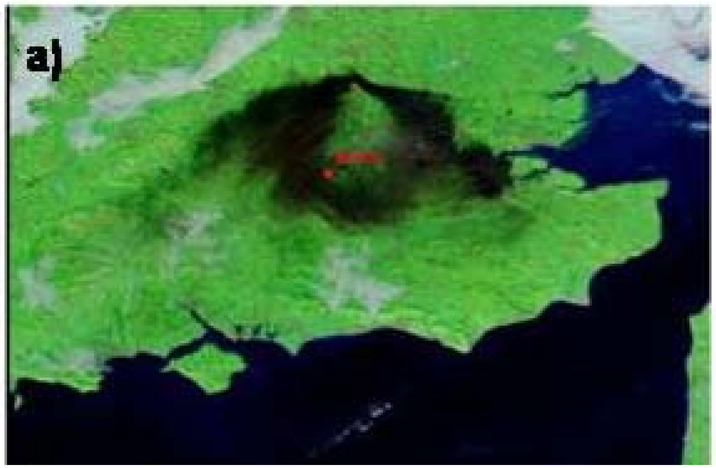
- Use of CHIMERE chemistry-transport model
  - With aerosols and gas phase
- 2 nested domains, with
  - 40 km and 10 km resolutions
  - 8 vertical layers
- Emissions:
  - EMEP (regular)
  - FIRE (Targa et al 2006)

Fire Emissions

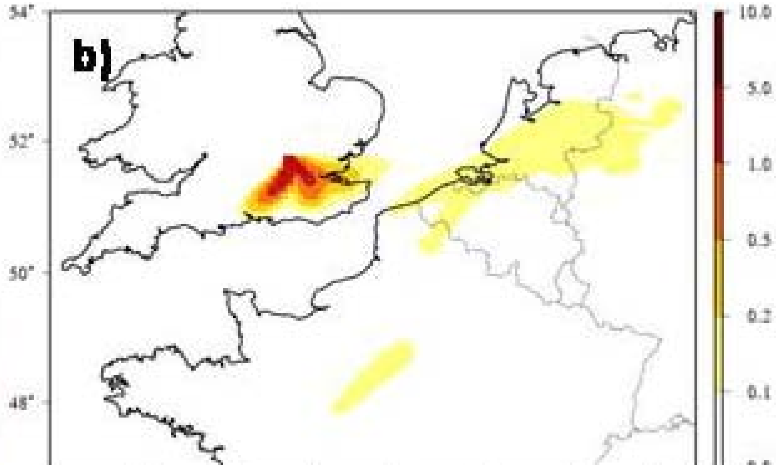
- Mass characteristics (Targa et al 2006):
  - Most probable scenario
  - 58000 Ton of fuel burnt
  - 37 Ton of NOx
  - 101 Ton of NMVOC
  - 8250 Ton of PM10
- Other characteristics
  - Linearly decreasing from 11 Dec 06 UTC to 13 Dec 18 UTC
  - Injection height between 500m and 3000m based on:
    - Observations
    - ALOFT-FT 2D simulations

Initial dispersion

Fair simulation of the plume development under wind shear

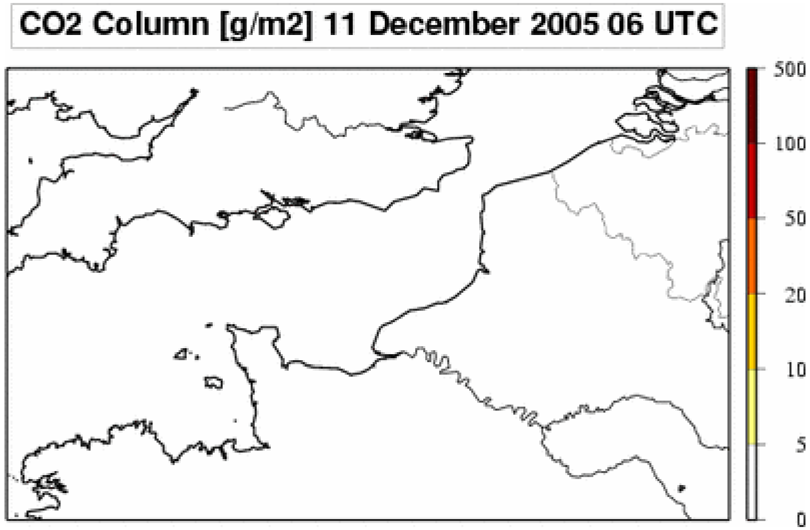


MODIS

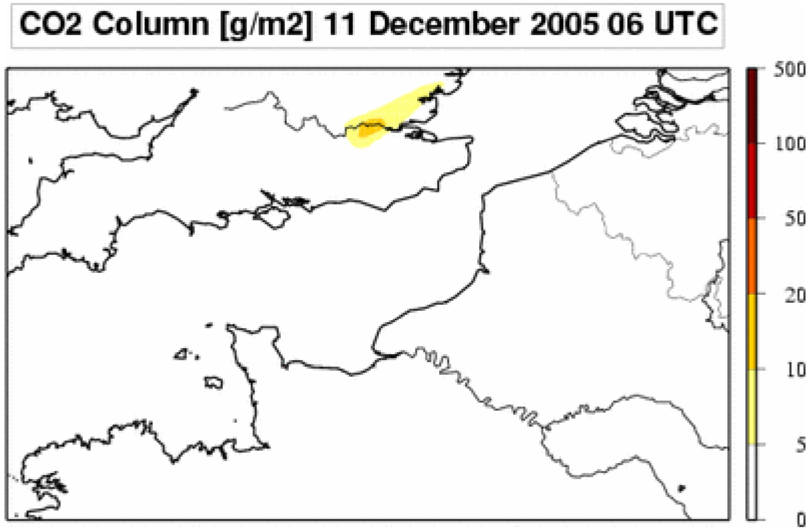


PM10 column

The huge fire smoke release

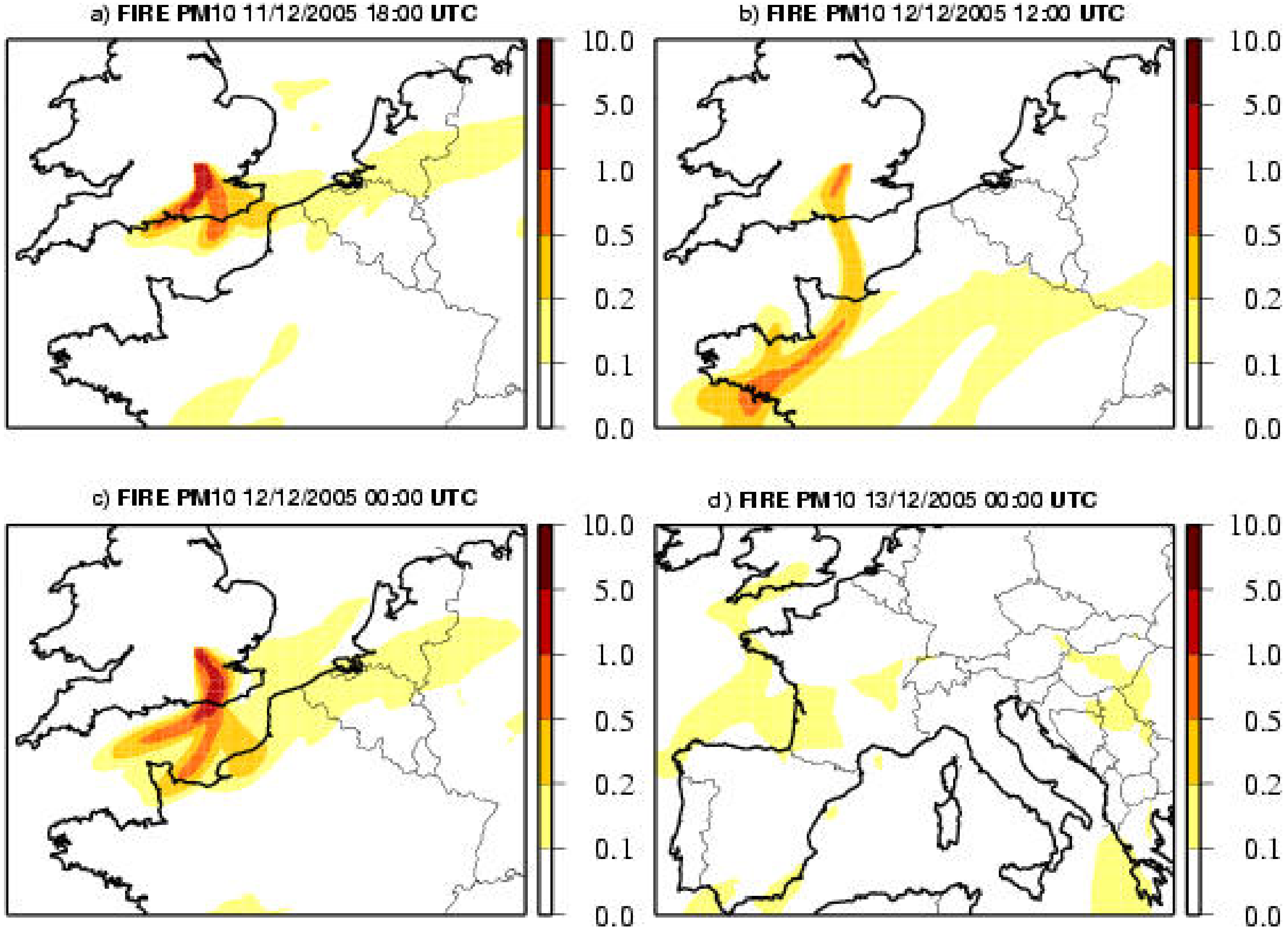


Fire CO2 column



London CO2 Column

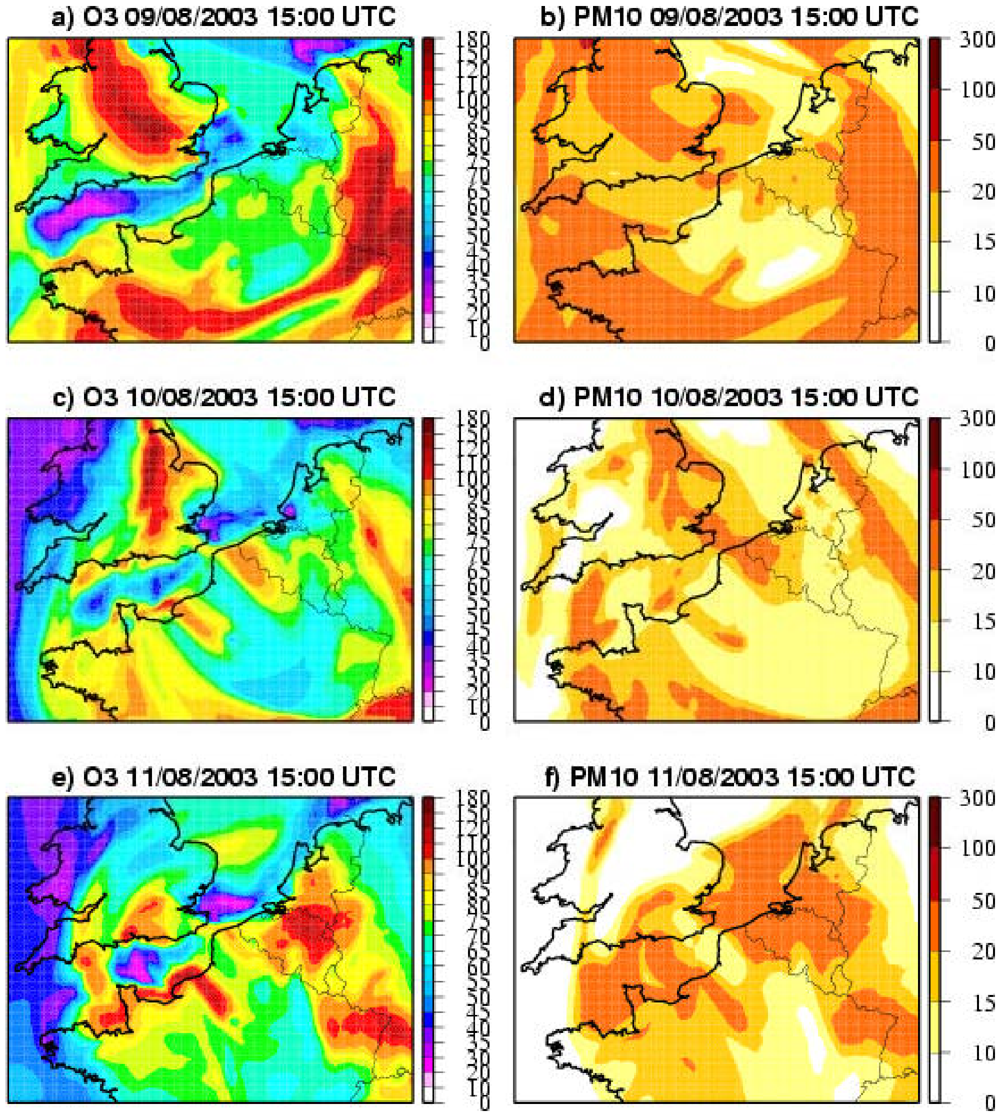
PM10 Plume Dispersion



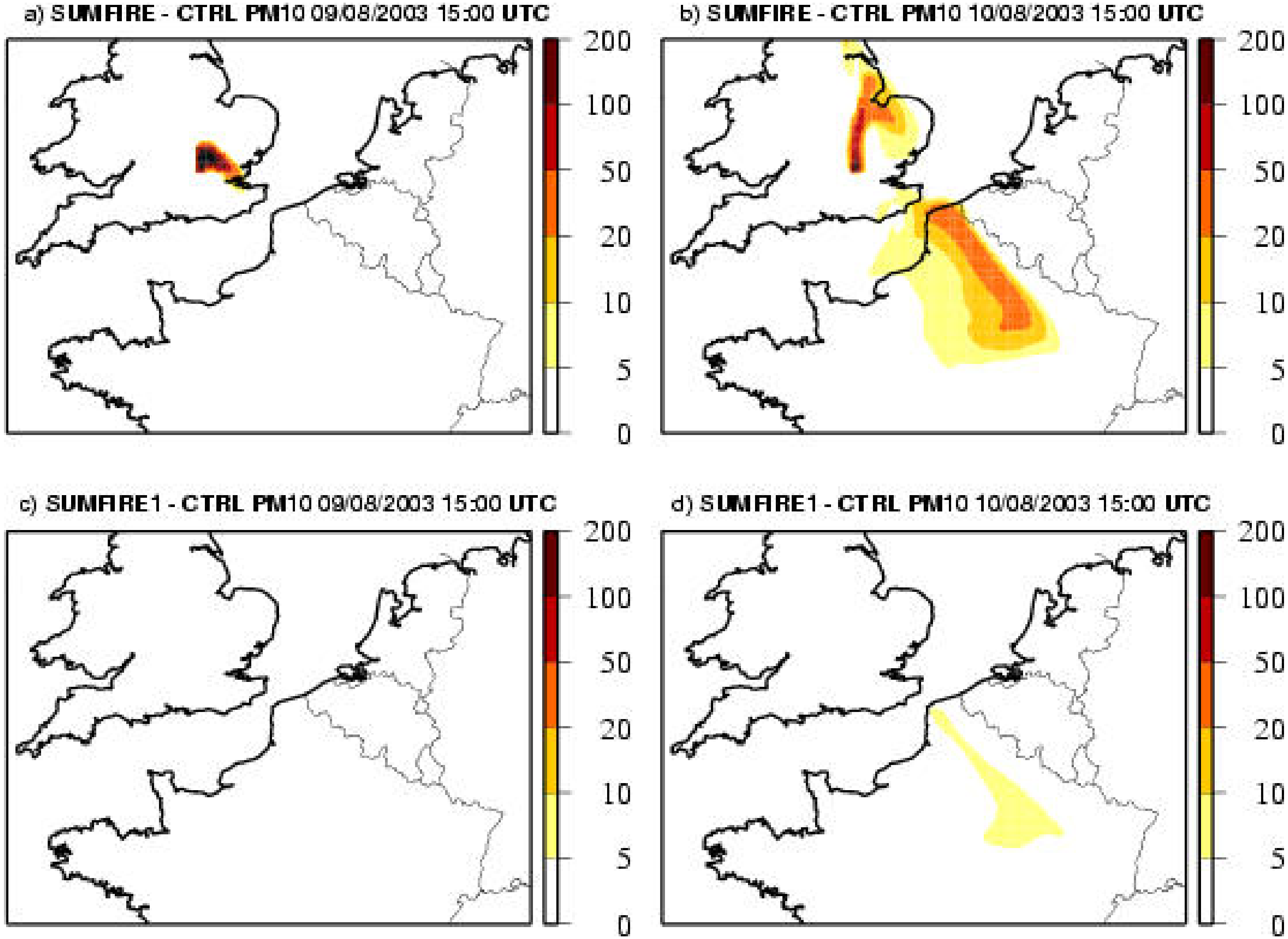
A worst-case scenario?

- More stagnant conditions
- Downward mixing
- Fire emitted during the August 2003 Heat Wave
- Run 1: same injection height (as simulated by ALOFT-FT
- Run 2: 3500-5000m

Ozone and PM10 during the heat wave



Surface PM10 plume



Conclusions from Buncefield study

- Lucky escape of the fire plume in winter
- Potential transport across Europe
- In summer stagnant conditions, could have been much worst
- No impact on ozone

The August 2003 Portugal fires

(Hodzic et al., 2005 ACP; 2007 ACP; Vautard et al., 2007)

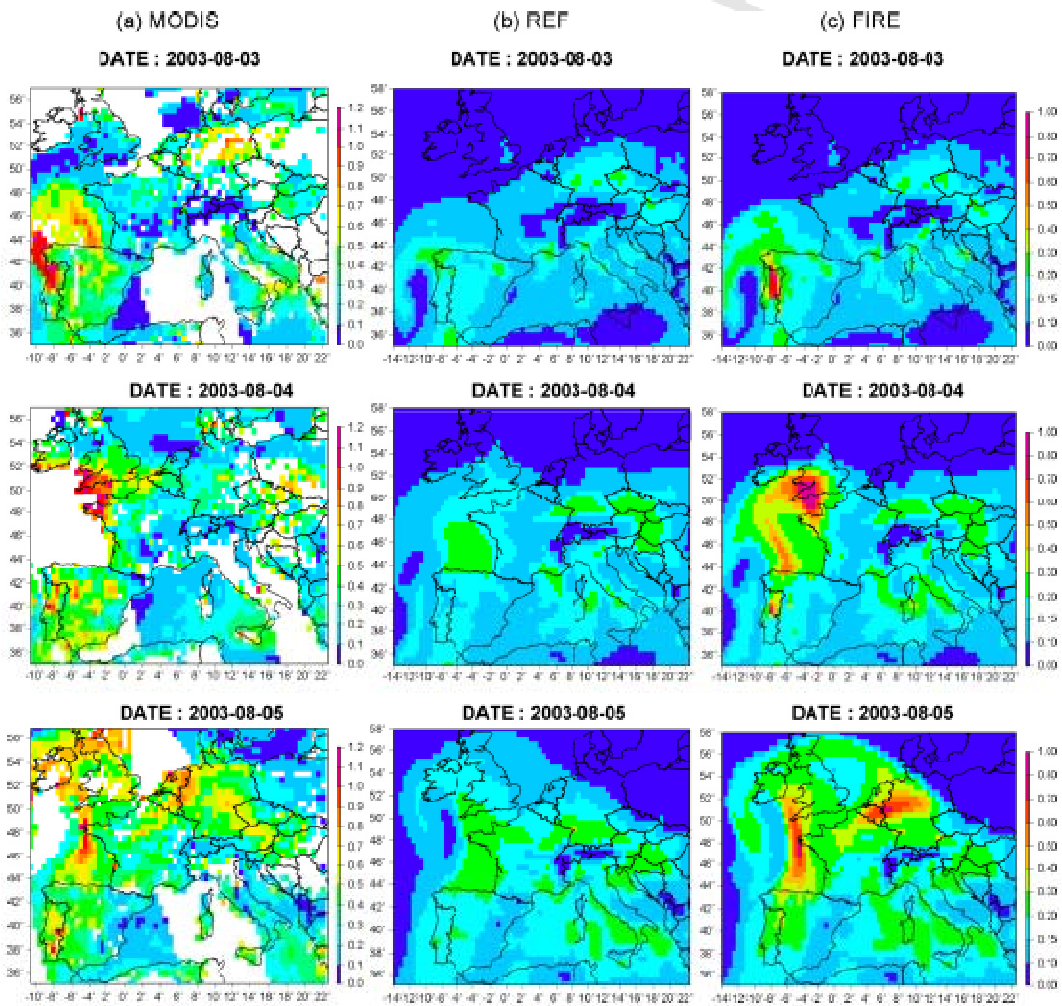
- Continental version of CHIMERE
- Emissions from MODIS fire inventory (Wiedinmyer et al., 2006)
- Comparisons with MODIS
- Impact on photolysis rates

The fire smoke transport across Europe

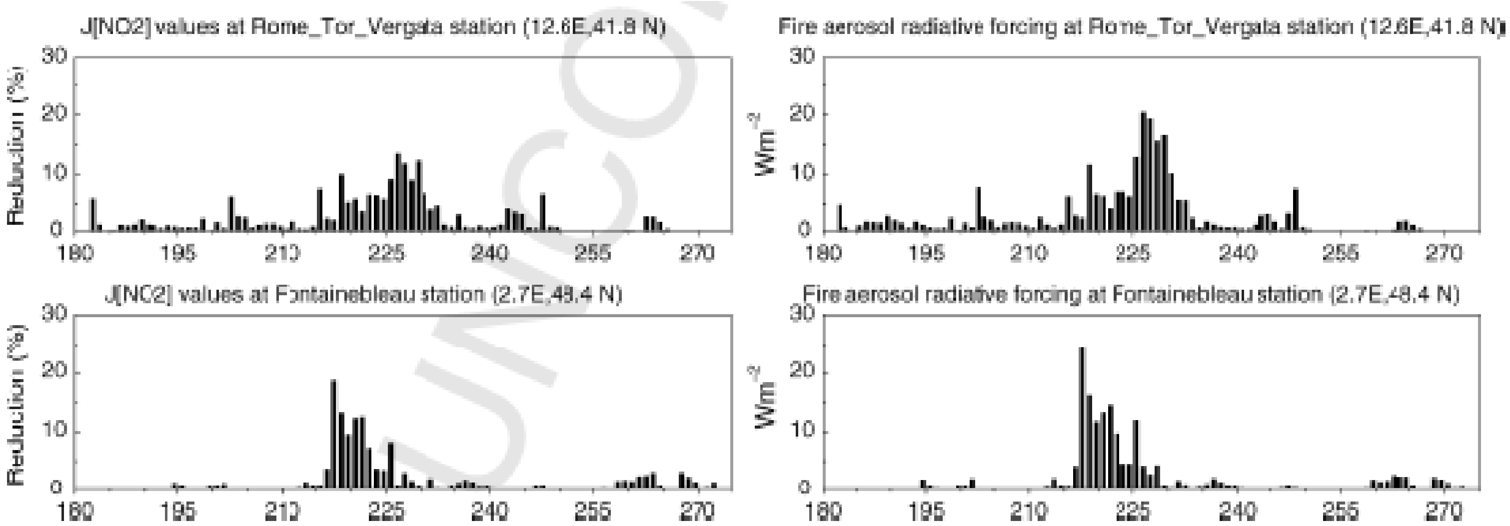
Regional transport of fire fairl well simulated

Most of AOT explained by elevated fire smoke

→ Difficulty for measuring air quality from space



The impact on photolysis rates



Reductions of J(NO2) and J(O1D) of 5-30% (simulated)

The 2007 greek fires

- Completely clear scene

- Same simulations set-up
- Preliminary results
- CO column
- Test injection height
- Test transport schemes
- Test aerosol retrieval
- See additional movie