Fire in the GMES Atmosphere Component Service (GACS)

Johannes W. Kaiser,
M.G. Schultz, M.J. Wooster, G. van der Werf , A. Benedetti, A. Dethof, R. Engelen, J. Flemming, L. Jones, J.-J. Morcrette, A. Simmons

GMES Atmosphere Component Service

- Part of Europe's Global Monitoring for Environment and Security initiative

  GMES
  Observing our planet for a safer world

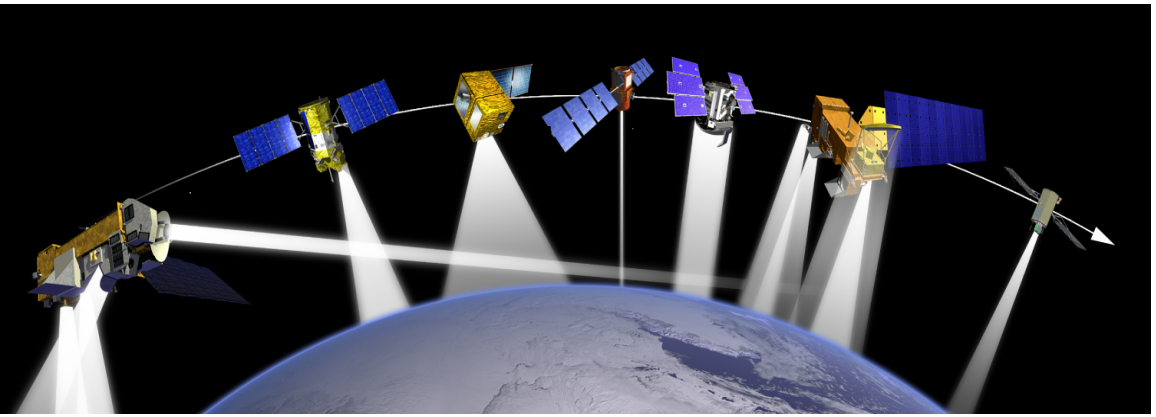
  - development of operational space-based observation
  - strengthening of complementary in-situ observing systems
  - development and operation of associated data and information services, based on core integrated assimilation and forecasting
    - Three environmental services for Land, Ocean and Atmosphere

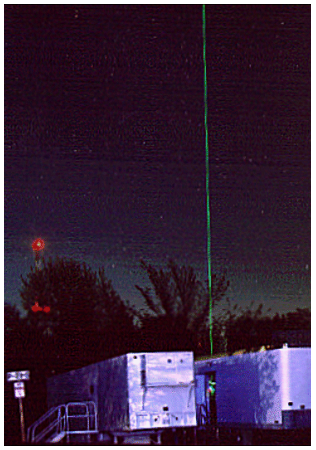
- A 48-partner EC-funded project called MACC:

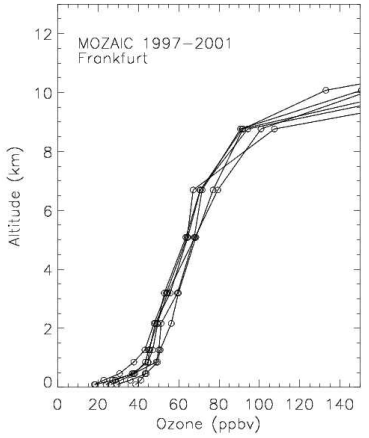
  macc
  Monitoring atmospheric composition & climate

  - provides pilot GMES Atmosphere Component Service
  - succeeds earlier projects GEMS and PROMOTE
  - coordinated by ECMWF

MACC data use & modelling



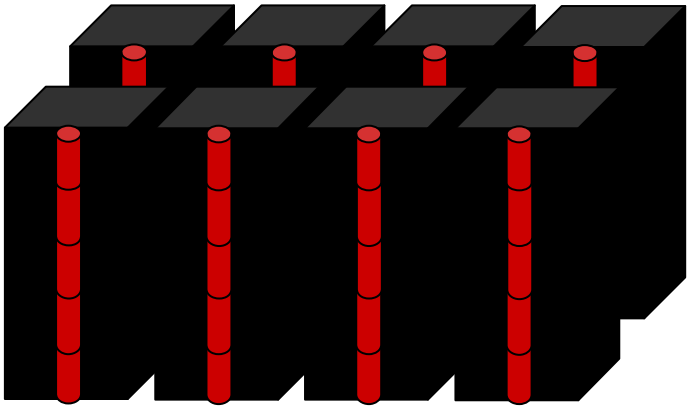




validation

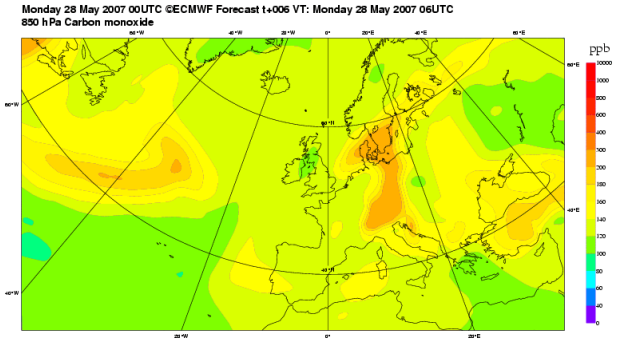
data assimilation

meteo data, CO_2, CH_4, CO, O_3, NO_2, SO_2, aerosol



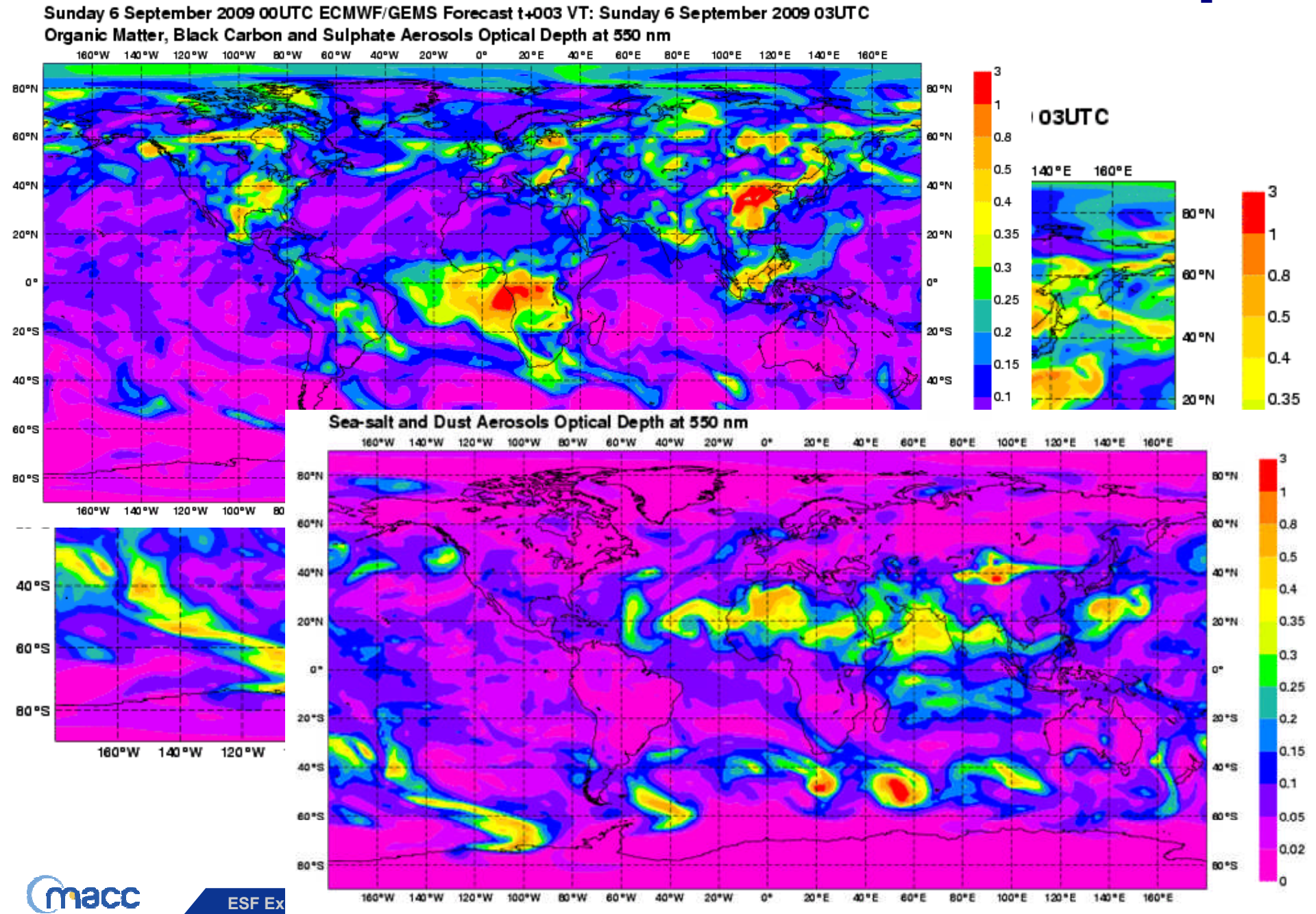
analysis & forecast

global and regional data and web products



CO

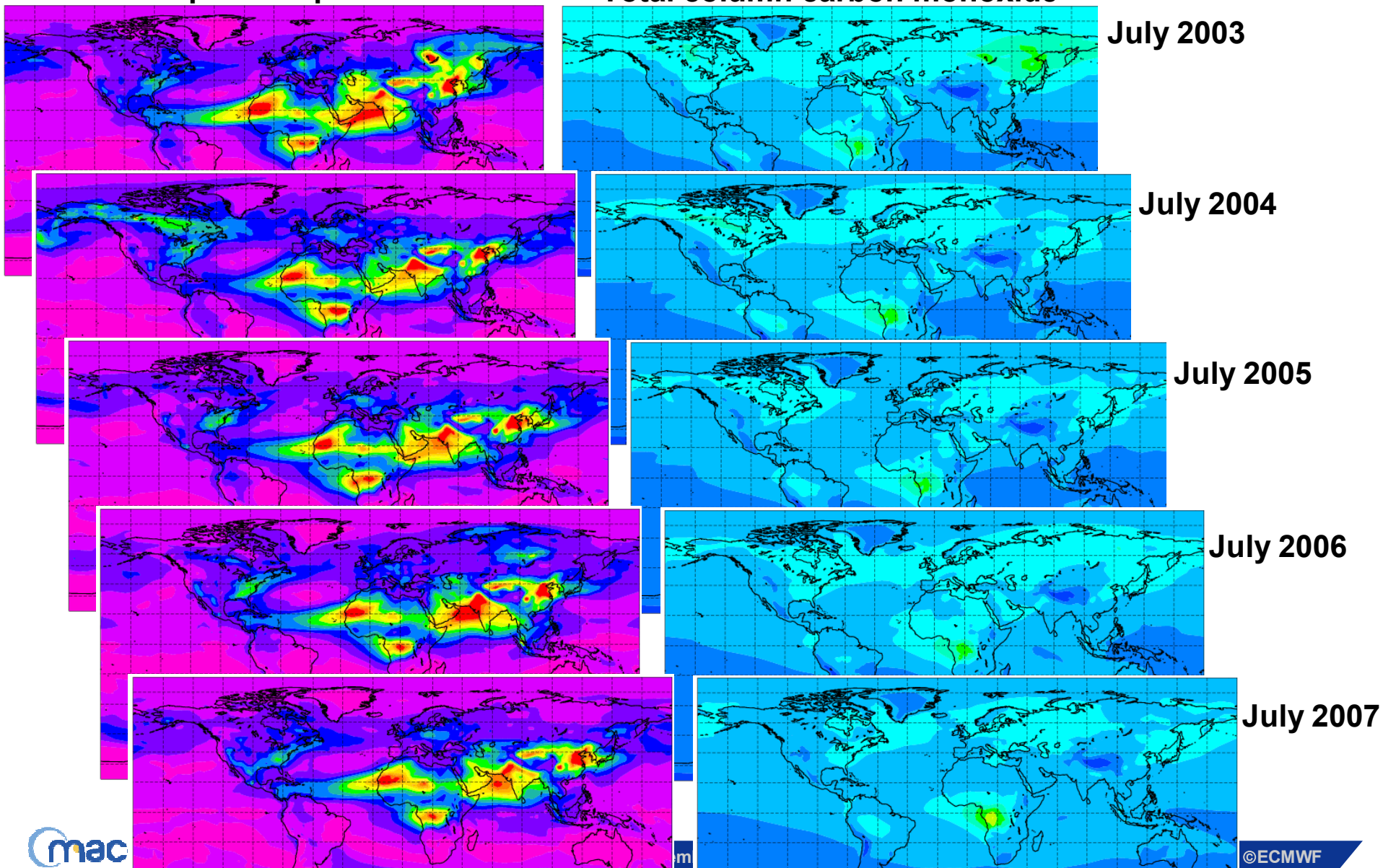
3-day Global Forecast: Aerosol Optical Depth



Reanalysis for 2003-8

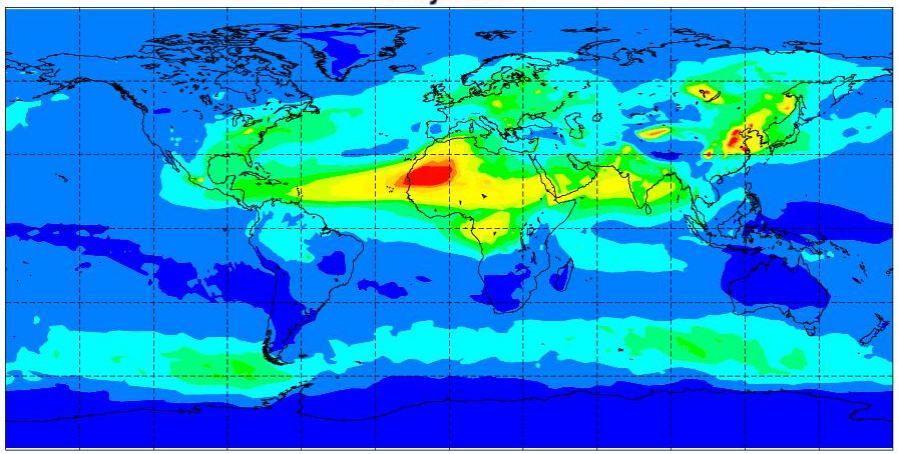
Aerosol optical depth at 550nm

Total column carbon monoxide

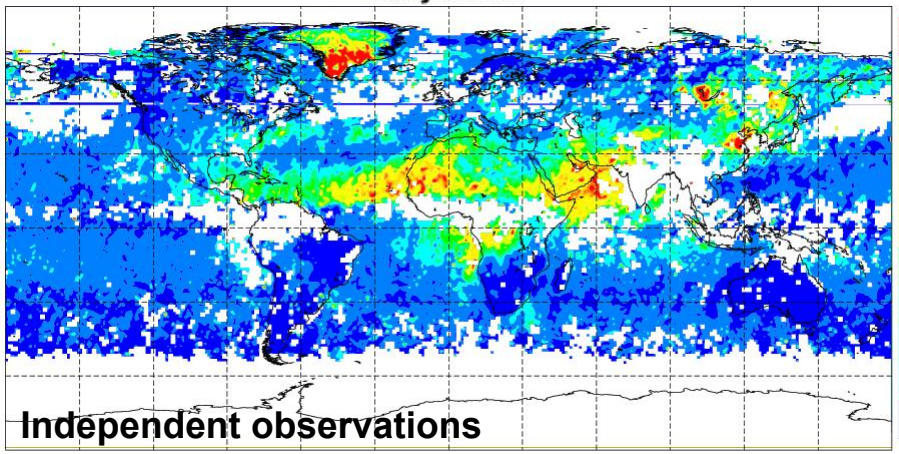


Comparison of GEMS simulated and analysed aerosol optical depth with MODIS and MISR for July 2003

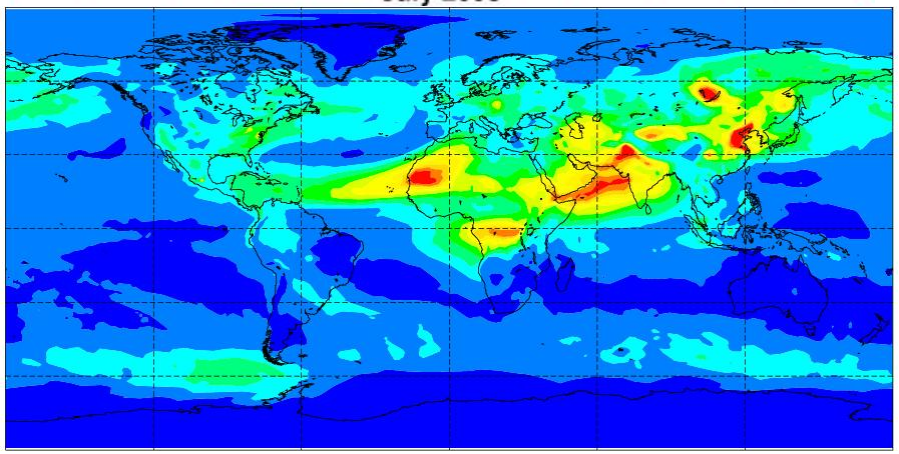
Aerosol Optical Depth at 550 nm from Unconstrained Model Run
July 2003



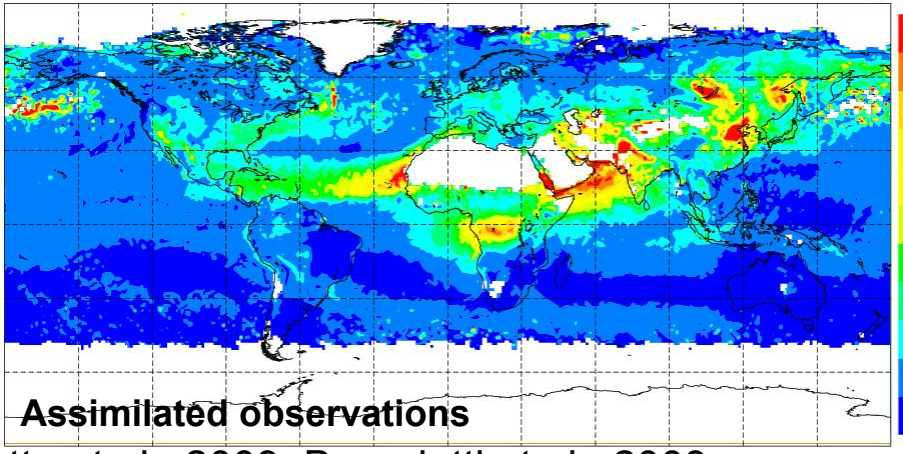
MISR Terra Aerosol Optical Depth at 557.5 nm [unitless]
July 2003



Aerosol Optical Depth at 550 nm for Reanalysis using MODIS AOD
July 2003

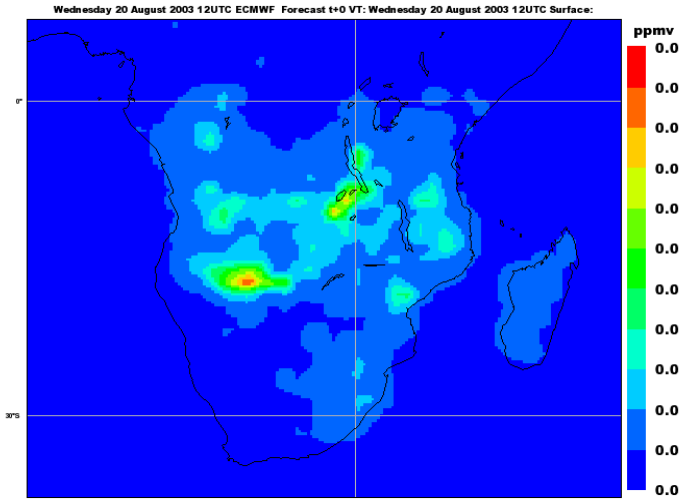


MODIS Terra MOD08-M3.005 Aerosol Optical Depth at 550 nm [unitless]
July 2003

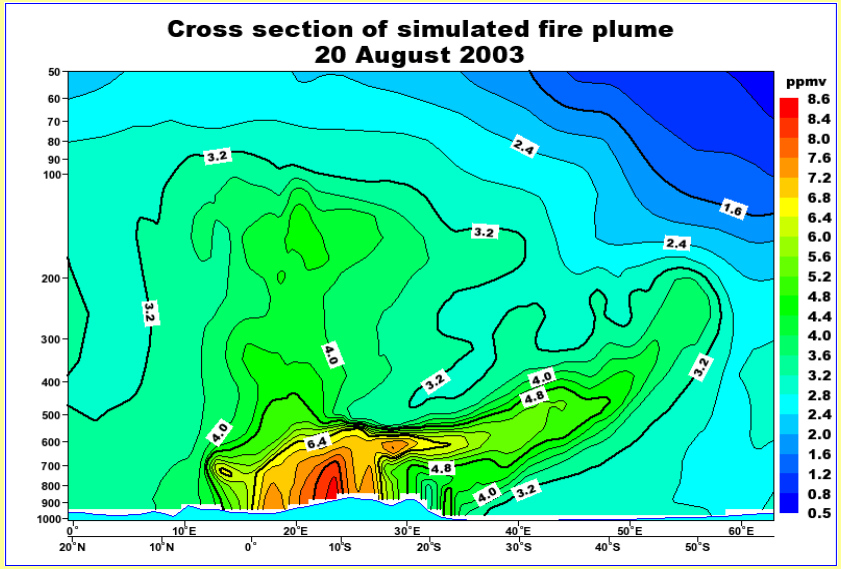


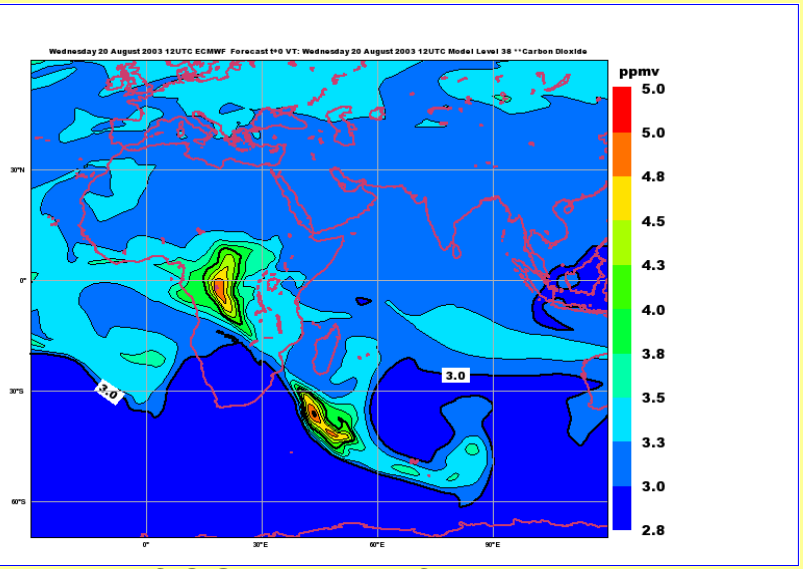
Morcrette et al., 2009; Benedetti et al., 2009

Fire emissions prescribed in model simulation

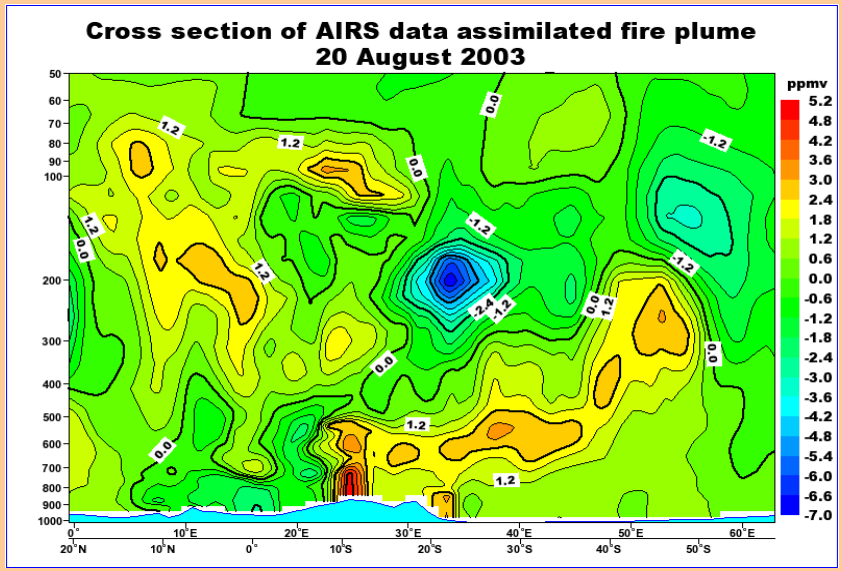


Cross-section of CO2 plume from model simulation





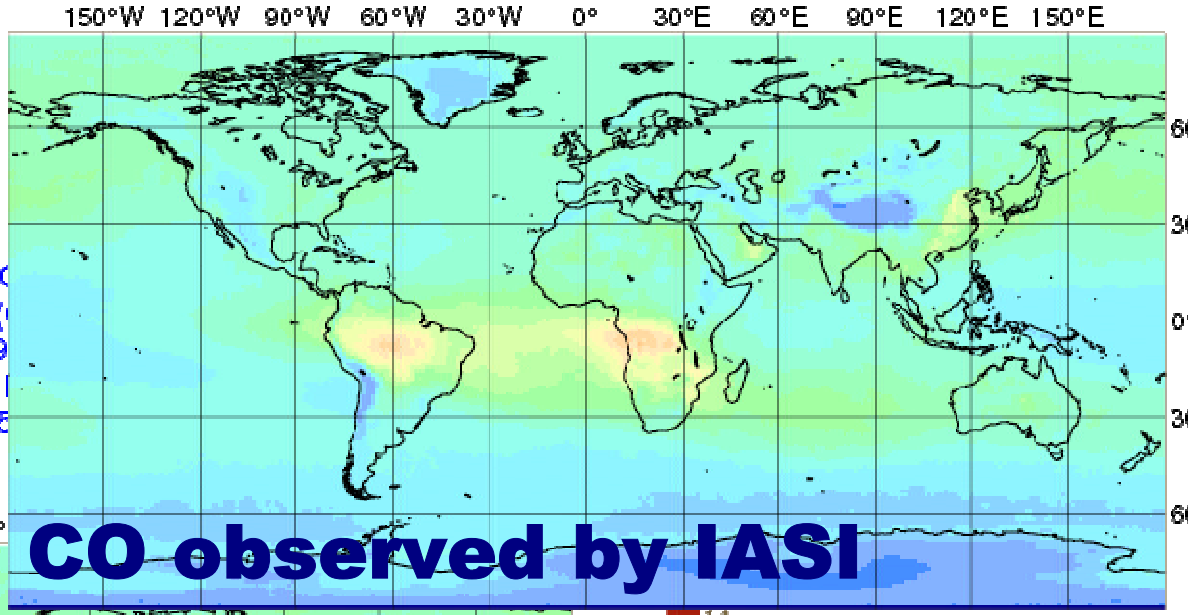
Extent of CO2 plume from model simulation



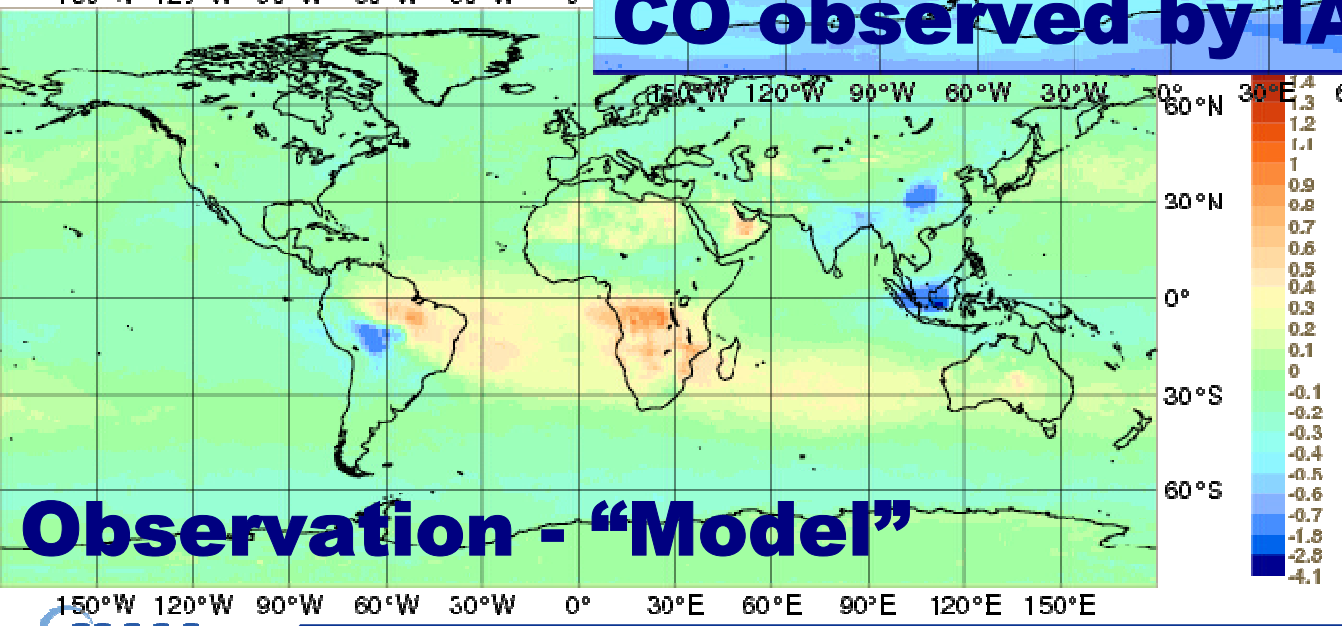
preliminary data

Cross-section of plume from AIRS assimilation

STATISTICS FOR CO FROM IASI / CO
MEAN OBSERVATION [10^18 MOL/CM2] (ALL)
DATA PERIOD = 2008-09-01 00 - 2008-10-31 12
EXP = F7YS, LEVEL = 01
Min: 0.691301 Max: 3.5041 Mean: 1.5872

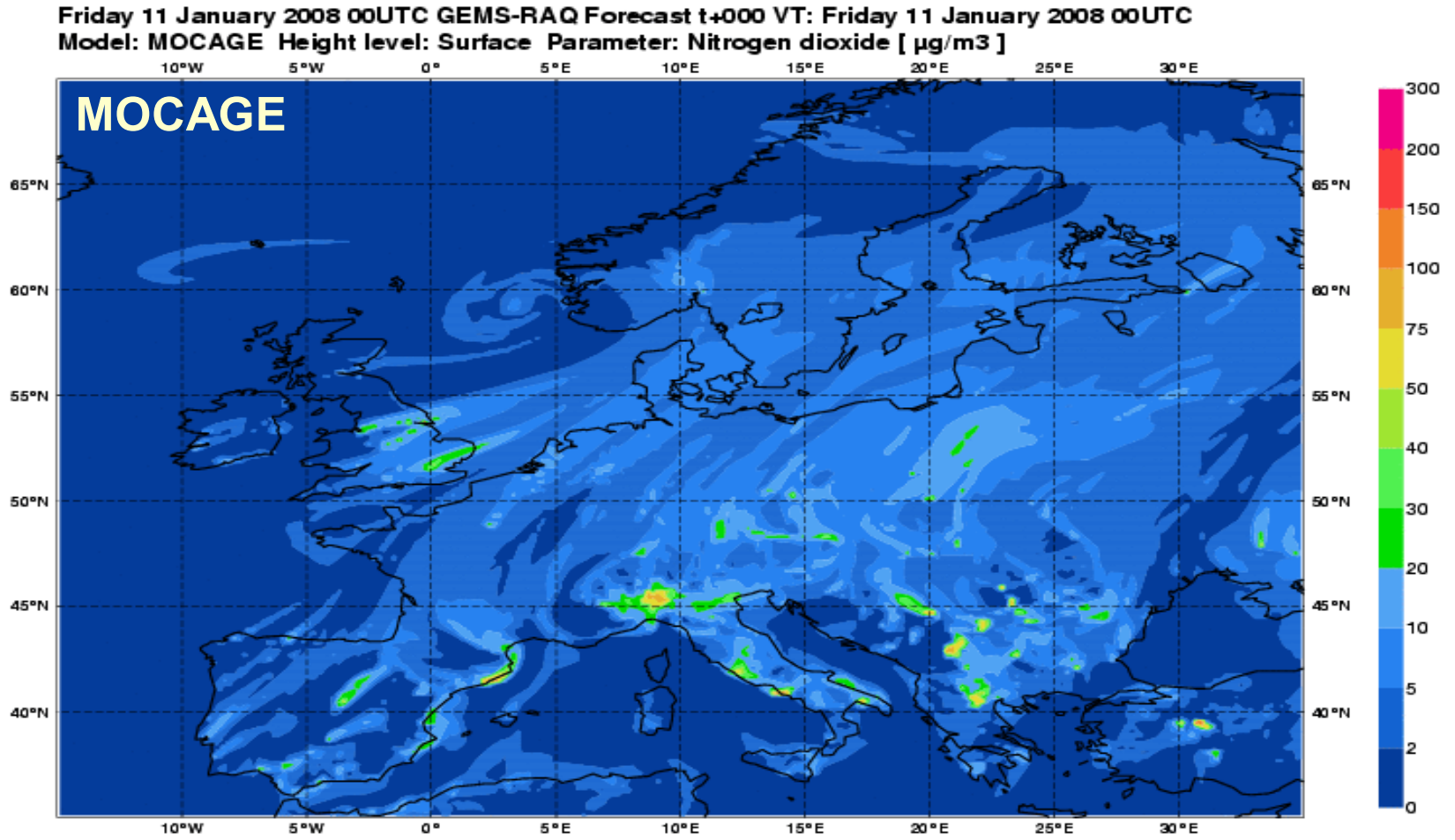


CO observed by IASI



Observation - "Model"

3-day European Air Quality Forecast: NO2 (single member of the ensemble shown)

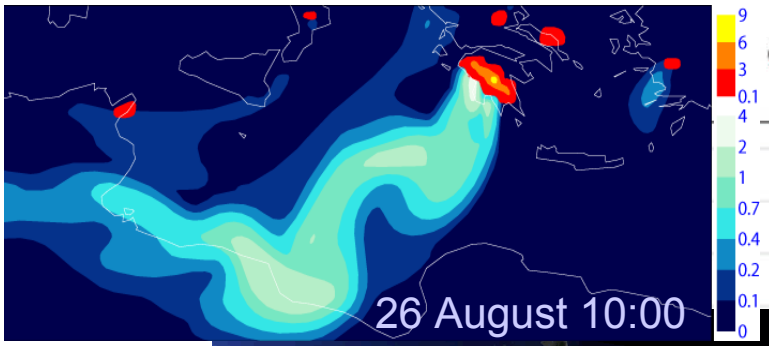


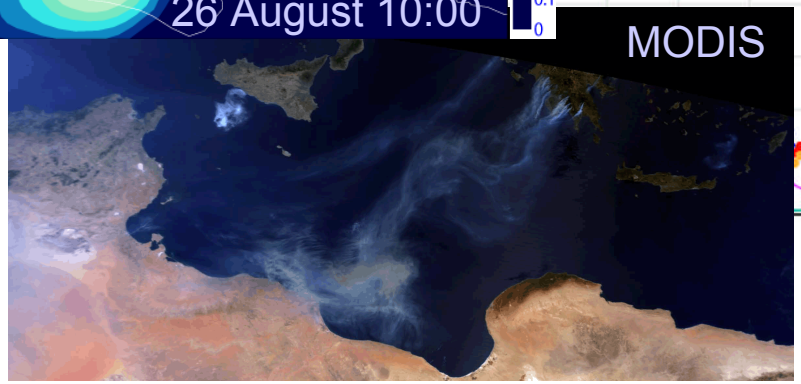
Modelled AOD of Greek Fire Plumes, August 2007

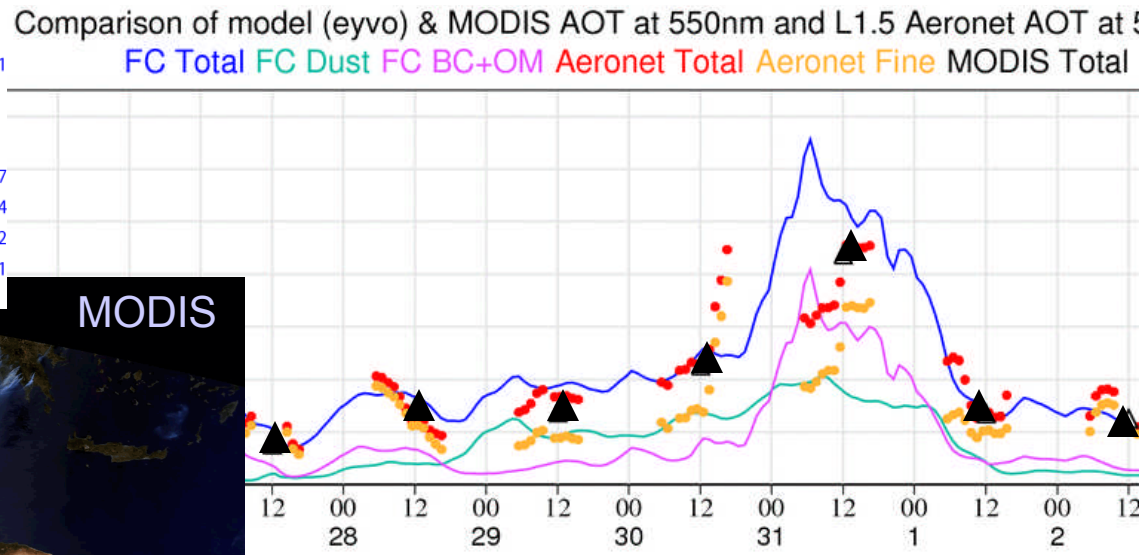
Emissions calculated from Fire Radiative Power observed by SEVIRI on Meteosat.

Emission factors from *Andreae & Merlet 2001* and *Ichoku & Kaufman 2005*.

Run at 25km global resolution, which is typical for regional models.



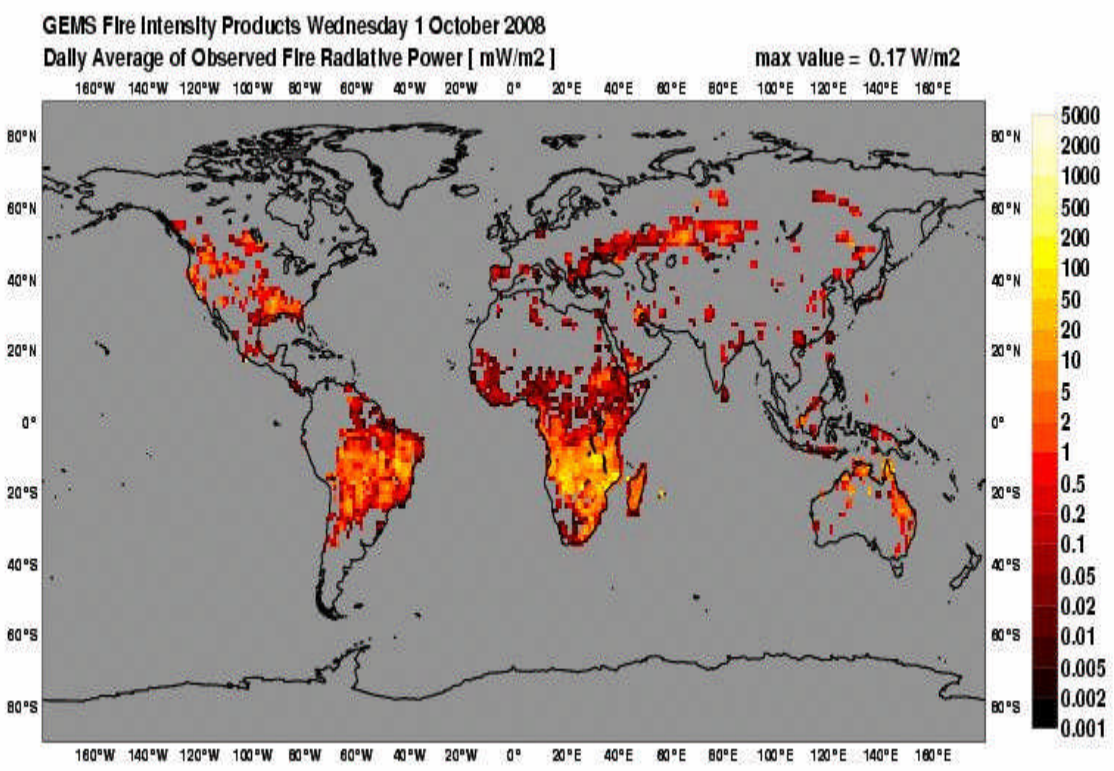




NRT Fire Emissions

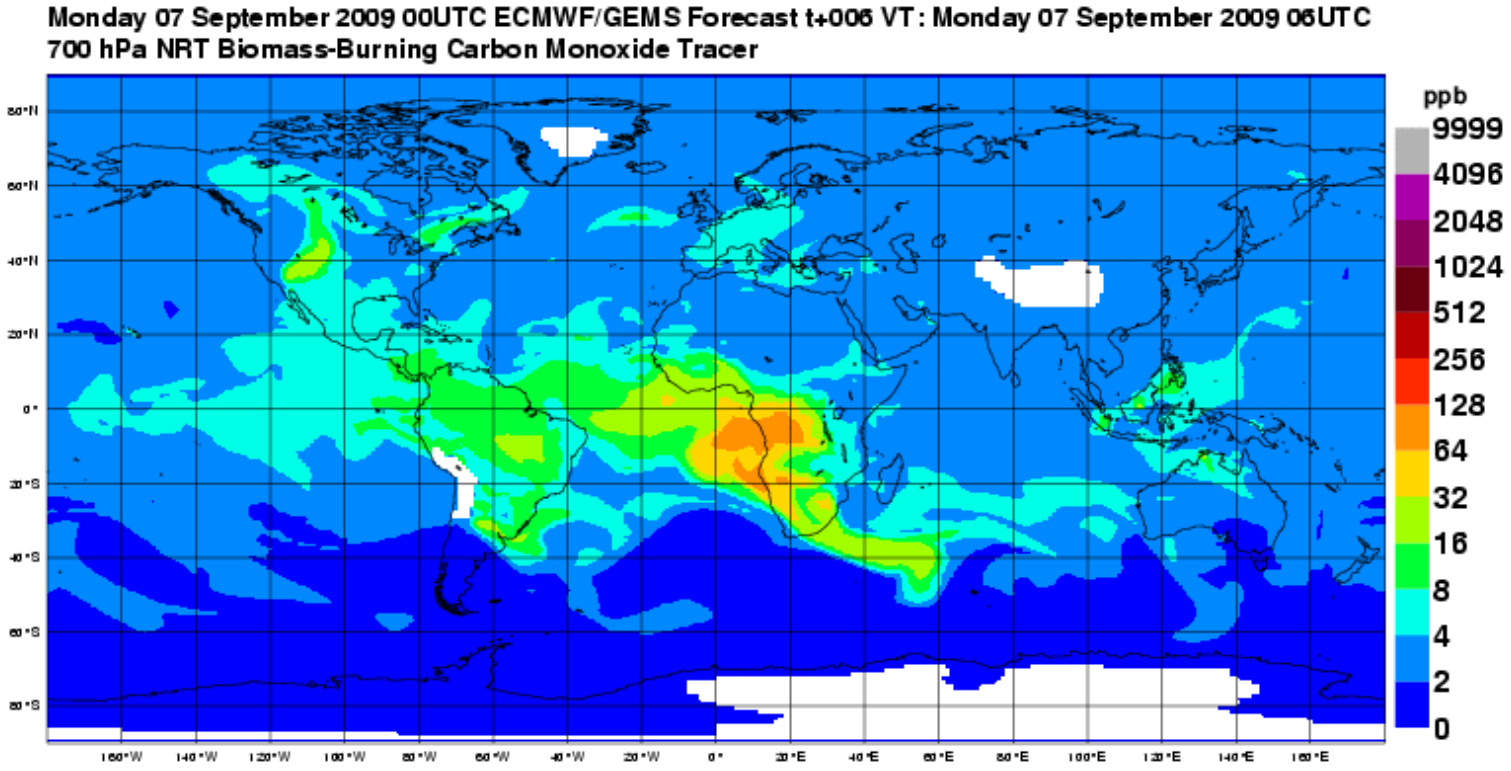
- ✓ FRP-based (MODIS & SEVIRI)
- ✓ real time with 5 hours lag
- ✓ global

- ✗ 125 km spatial resolution
  - ✓ to be changed to 10 km
- ✗ 1 day temporal resolution
  - ✓ to be changed to 1 hour



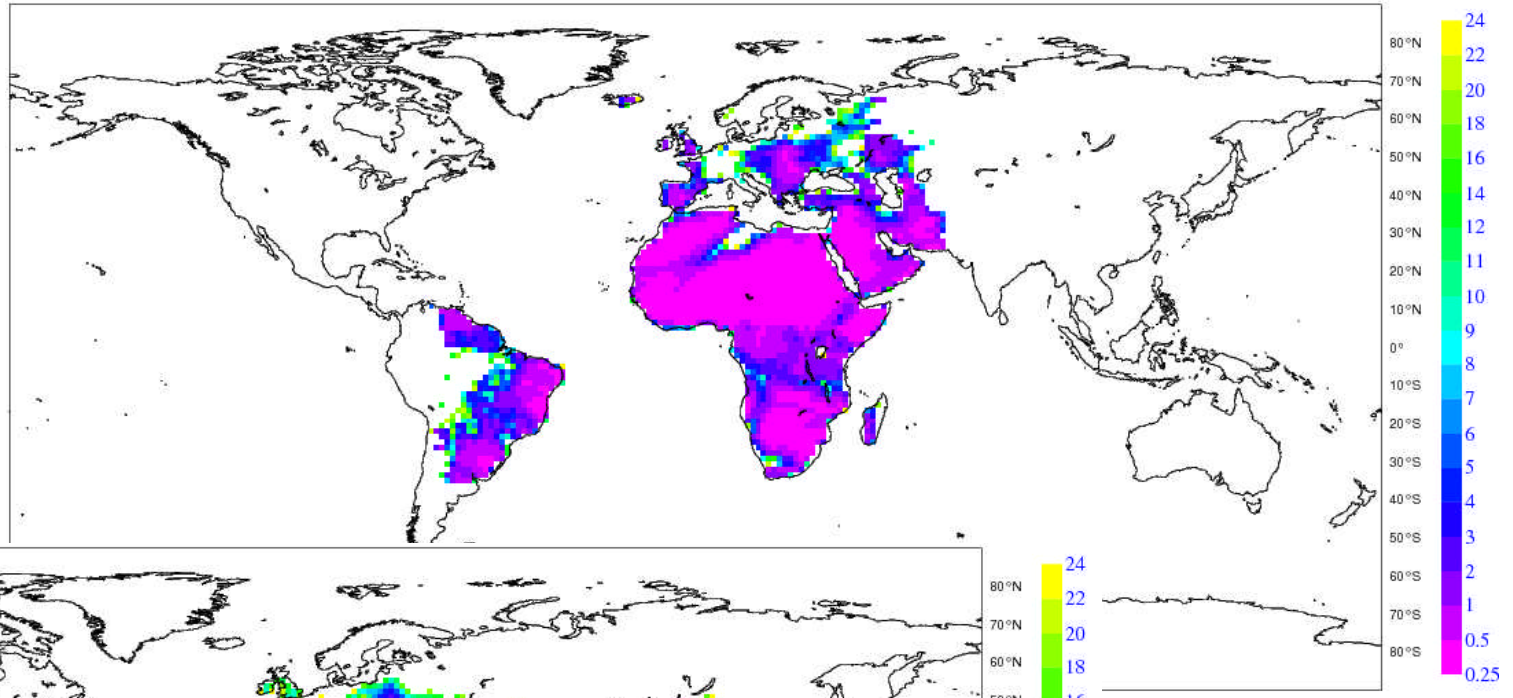
- ✗ cloud cover affected
  - → needs assimilation
    - ✓ measure of observation density
    - ✓ **FRP=0 observations included**
- ✗ emission factors calibrated with historic GFEDv2 emissions

Pyrogenic CO Tracer 3-Day Forecast

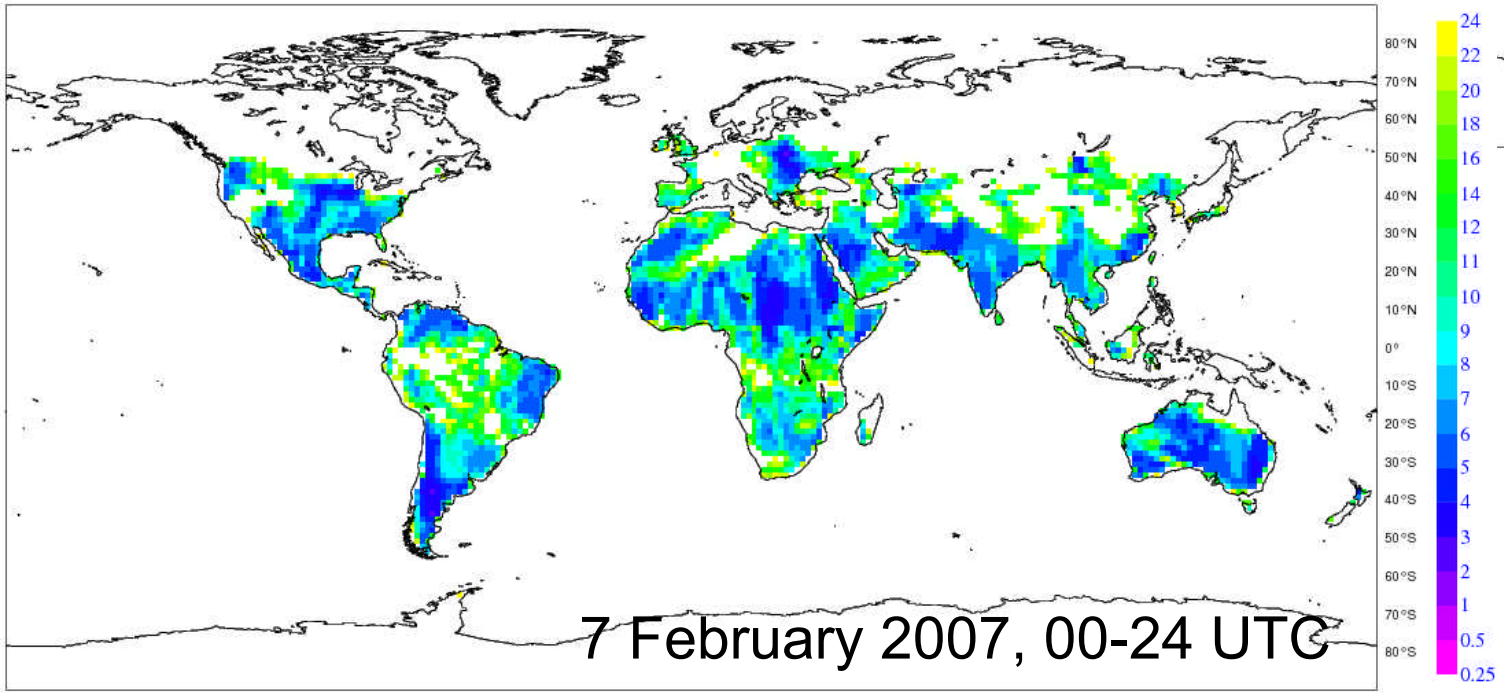


Observation Return Periods (hours)

SEVIRI



MODIS



7 February 2007, 00-24 UTC

Plans for the Future

- Global Fire Assimilation System
  - 10 km
  - 1 hour
  - real time
- add FRP from GOESs & MTSAT
- FRP forecast depending on meteorology
  - representation of diurnal cycle
  - up to about day 3

- real-time operation of GFEDv3

- injection height estimates
- improved emission factors

Conclusions

- MACC is merging FRP observations from several satellites to monitor global fire emissions.
  - Accurate global fire emission model/parameterisation needed, but emission estimates have large uncertainties.
- The emissions are used to forecast global and regional atmospheric composition.

- Observations of aerosols, CO, CO2, CH4, O3 are assimilated into the ECMWF model to produce
  - reanalyses
  - real time analyses & forecasts (aerosols & reactive gases)
  - of all the major C fluxes from fires

- Inversion techniques could determine fire parameters from merged fire and assimilated plume observations.
  - Which parameters can be derived?
  - Which inversion technique can use?
  - Which parameters are most suitable
    - for emission estimation?
    - for other applications?

More Information

- http://www.gmes-atmosphere.eu/
- http://gems.ecmwf.int/

- Benedetti, A., et al. (2009), Aerosol analysis and forecast in the European Centre for Medium-Range Weather Forecasts Integrated Forecast System: 2. Data assimilation, J. Geophys. Res., 114, D13205
- Kaiser, Suttie, Flemming, Morcrette, Boucher, Schultz Global Real-time Fire Emission Estimates Based on Space-borne Fire Radiative Power Observations, *AIP Conference Proceedings,* vol. 1100, pp. 645-648, 2009
- Kaiser et al. Smoke in the Air, *ECMWF Newsletter*, no. 119, pp. 9-15, 2009
- Kaiser, Flemming, Schultz, Suttie, Wooster The MACC Global Fire Assimilation System: First Emission Products (GFASv0), *ECMWF Technical Memorandum,* no. 596, 2009
- Hollingsworth, A., R.J. Engelen, C. Textor, A. Benedetti, O. Boucher, F. Chevallier, A. Dethof, H. Elbern, H. Eskes, J. Flemming, C. Granier, J.W. Kaiser, J.-J. Morcrette, P. Rayner, V.-H. Peuch, L. Rouil, M.G. Schultz, A.J. Simmons & GEMS Consortium, 2008: Toward a monitoring and forecasting system for atmospheric composition: The GEMS Project. Bull. Am. Meteorol. Soc., 89, 1147–1164.
- Roberts and M.J. Wooster. Fire detection and fire characterization over africa using Meteosat SEVIRI. *IEEE TGRS*, 46(4 Part 2):1200–1218, 2008.

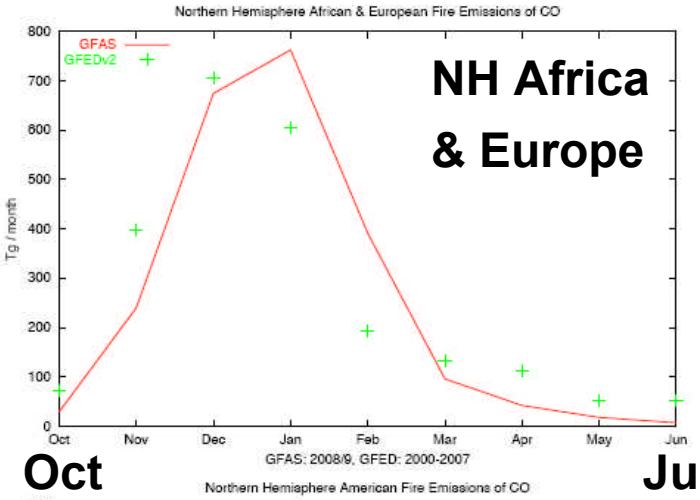
GFASv0

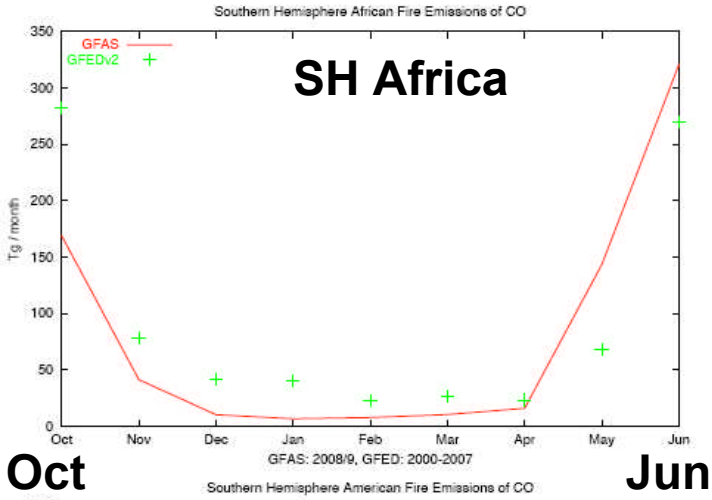
Oct2008-Jun2009

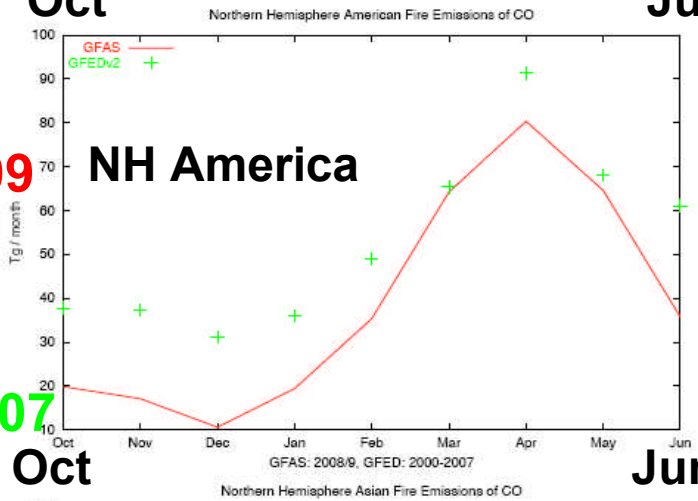
vs.

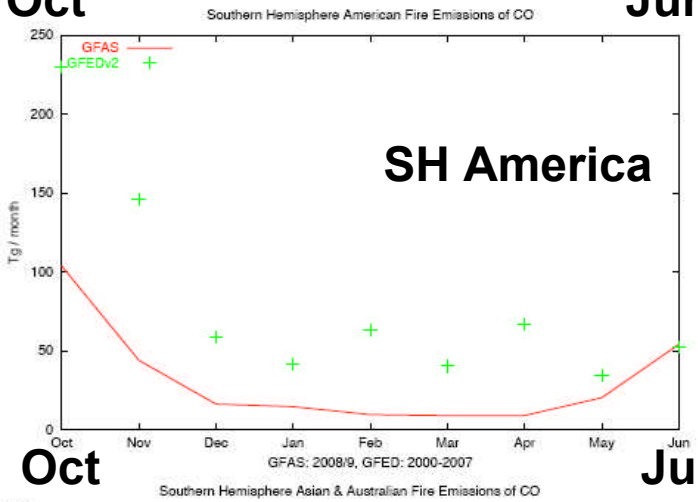
GFEDv2

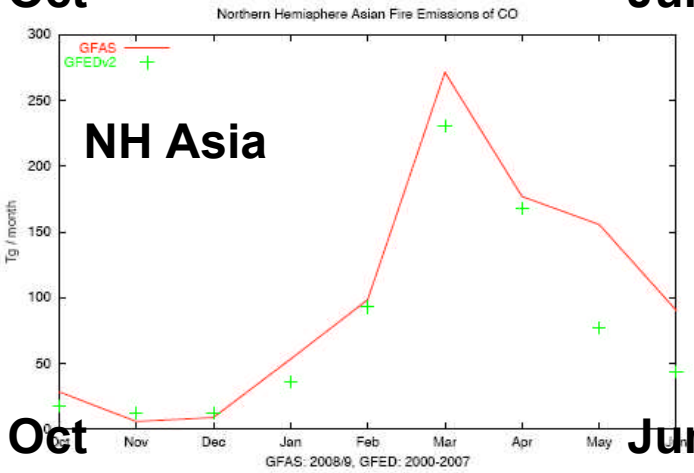
Average 2000-2007

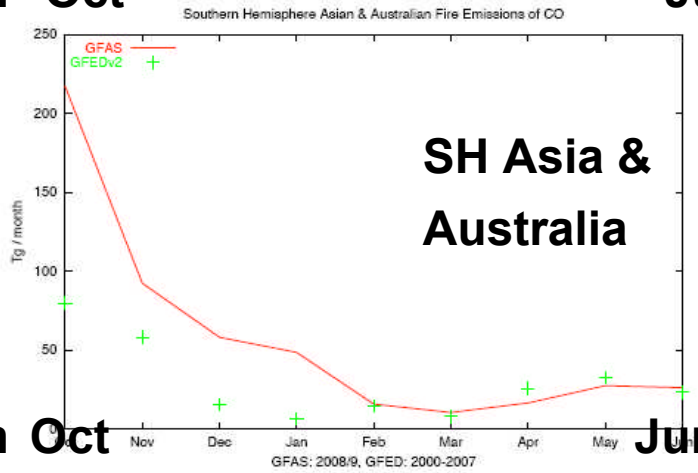












Modelled PM2.5 at Surface [µg/m³]