



# Towards operational GMES atmosphere services: MACC/MACC-II global production at ECMWF

Richard Engelen



## **MACC team at ECMWF**

Anna Agusti-Panareda, Angela Benedetti, Johannes Flemming, Antje Inness, Luke Jones, Johannes Kaiser, Sebastien Massart (CERFACS), Jean-Jacques Morcrette, Vincent-Henri Peuch, Miha Razinger, Adrian Simmons, and Martin Suttie

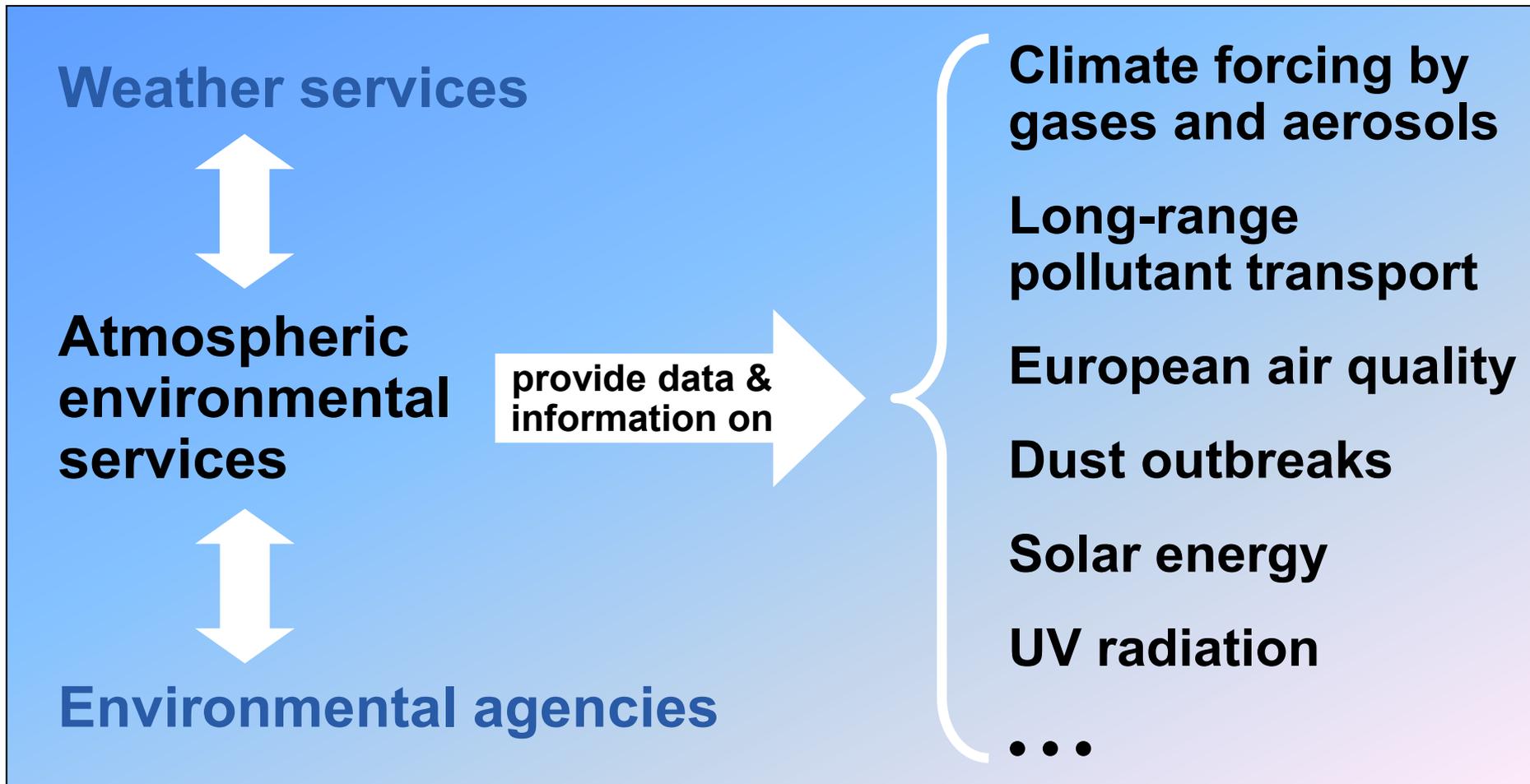
## **ECMWF staff supporting MACC**

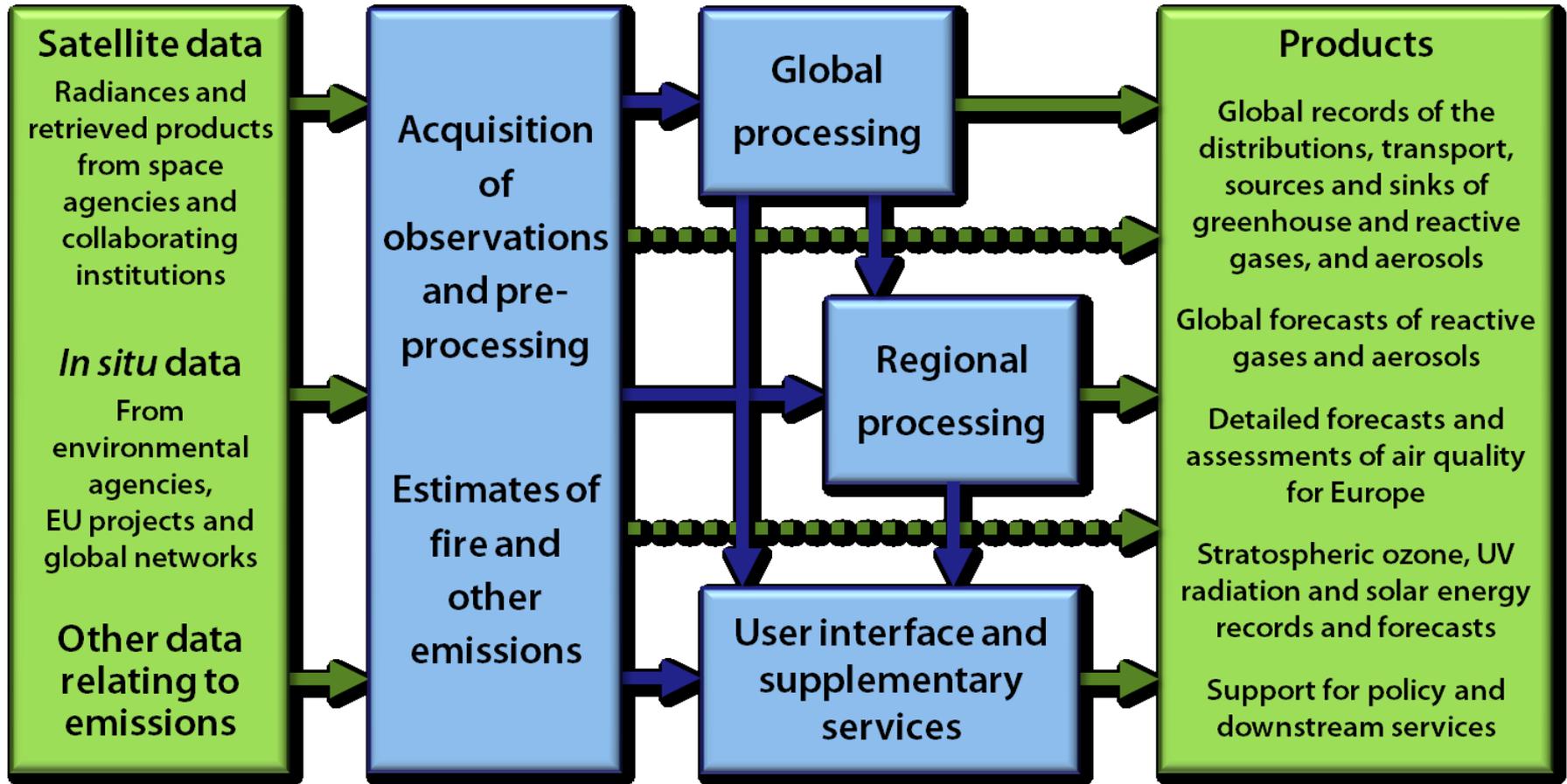
## **MACC staff from partner organizations**

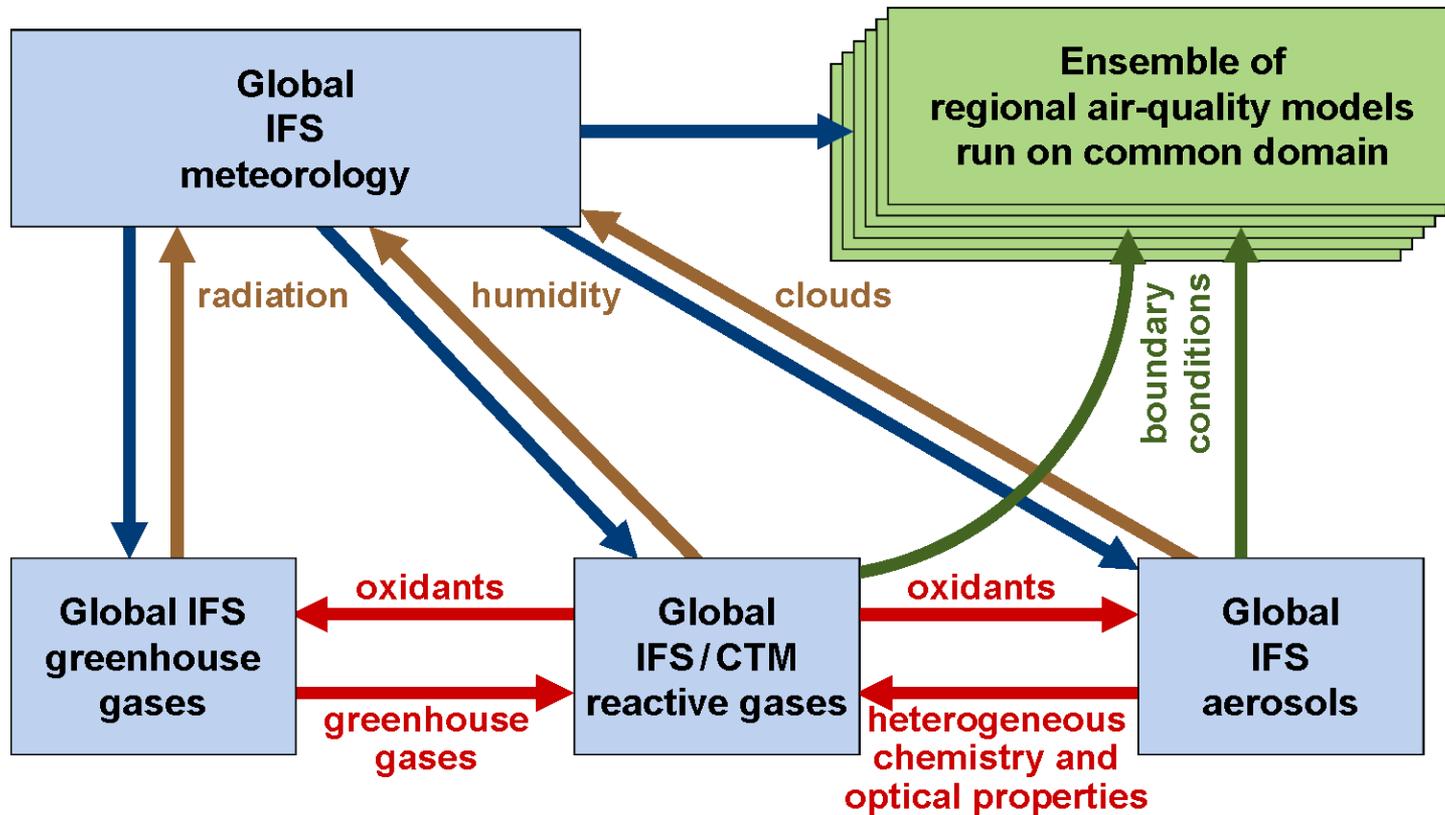
- **MACC is a component of Europe's Global Monitoring for Environment and Security (GMES) initiative**
  - which provides services for atmosphere, land, ocean, emergency response and security
- **The atmospheric programme comprises**
  - developing operational space-based observation of constituents (Sentinels)
  - strengthening the provision of *in situ* observations (GISC)
  - developing and operating associated data and information services (MACC, MACC-II)



## Services related to the chemical and particulate content of the atmosphere







**Global system is based on the ECMWF Integrated Forecasting System (IFS), coupled to a global chemical transport model**

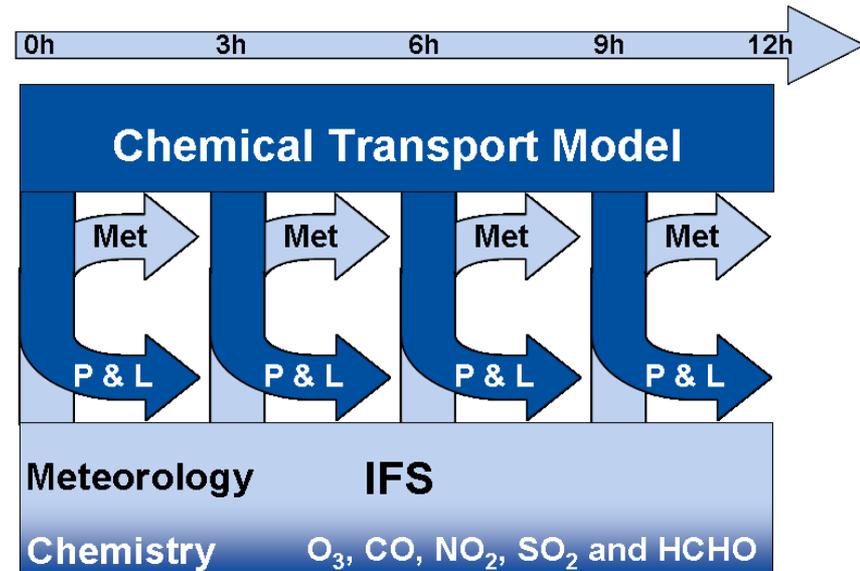
- **Based on the 4D-Var scheme of the IFS**
- **CO<sub>2</sub>, CH<sub>4</sub> and aerosols are incorporated in the IFS**

Data assimilation has been developed for AIRS and IASI radiances, SCIAMACHY retrievals, MODIS aerosol optical depth, ... GOSAT ...

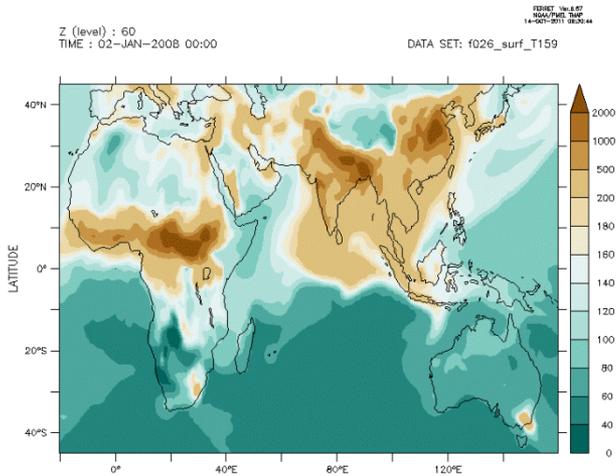
- **IFS also carries O<sub>3</sub>, CO, NO<sub>2</sub>, SO<sub>2</sub> and HCHO**

Chemical production and loss come from the coupled CTM

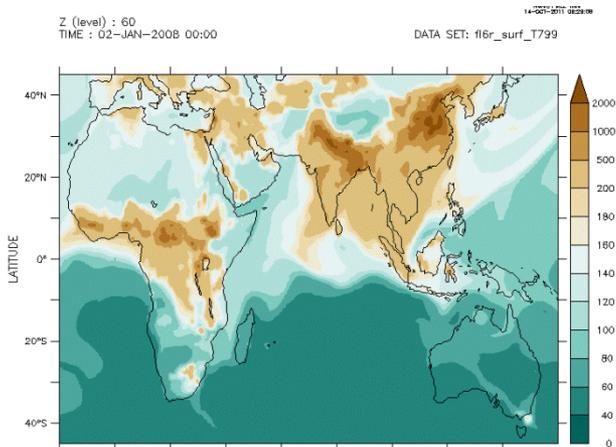
Data for assimilation come from GOME, GOME-2, IASI, MIPAS, MLS, MOPITT, OMI, SBUV/2, SCIAMACHY, ...



- **Chemistry modules are being built fully into IFS**



Coupled



Integrated

Integrating the chemistry in the IFS model instead of coupling with an off-line CTM allows more efficient running of the chemistry.

Much higher resolution can be achieved for the same cost.

Also, data archiving and dissemination can be harmonized.

# MACC PRODUCTS

Monitoring atmospheric composition & climate

maccc Monitoring atmospheric composition & climate

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**maccc** - Monitoring Atmospheric Composition and Climate is the current pre-operational atmospheric service of the European GMES programme. MACC provides data records on atmospheric composition for recent years, data for monitoring present conditions and forecasts of the distribution of key constituents for a few days ahead. MACC combines state-of-the-art atmospheric modelling with Earth observation data to provide information services covering European Air Quality, Climate, and UV and Solar Energy.

**Services by theme**

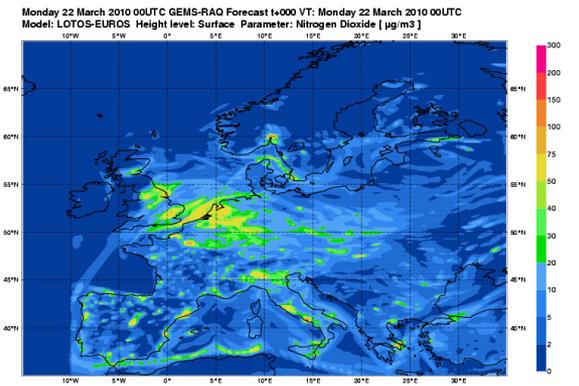
- European Air Quality
- Global Atmospheric Composition
- Climate
- UV and Solar Energy

**Services by user**

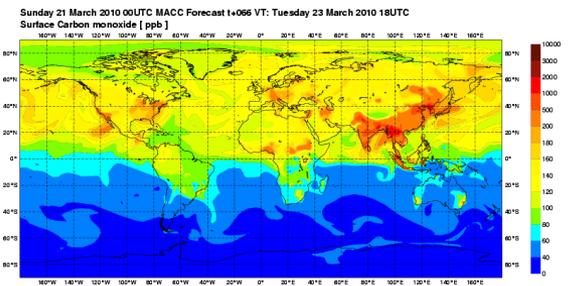
- Health
- Environment
- Science Community
- Citizen
- Meteorology

MACC is a Collaborative Project (2009-2011) funded by the European Community under the 7th Framework Programme. It is coordinated by the European Centre for Medium-Range Weather Forecasts and operated by a 45-member consortium.

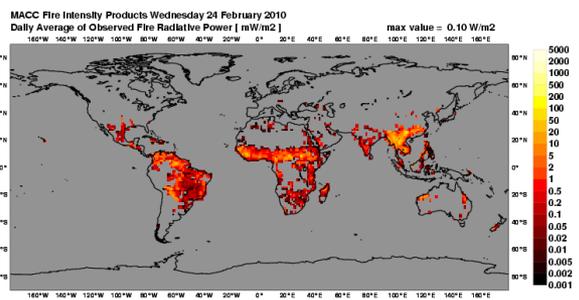
Air quality



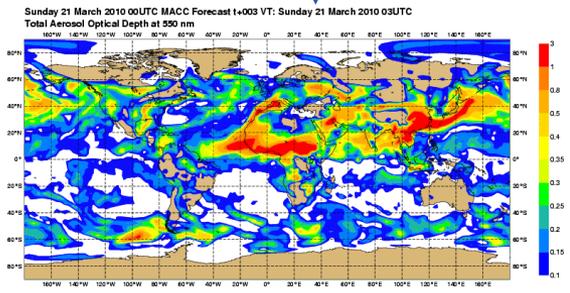
Global Pollution



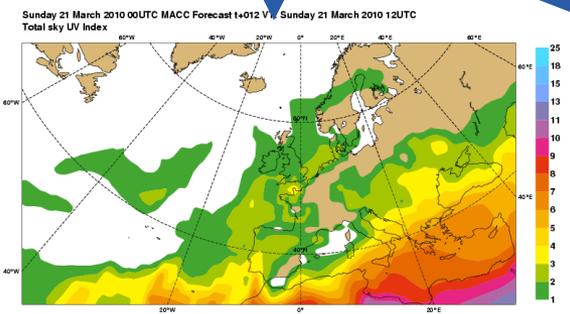
Biomass burning



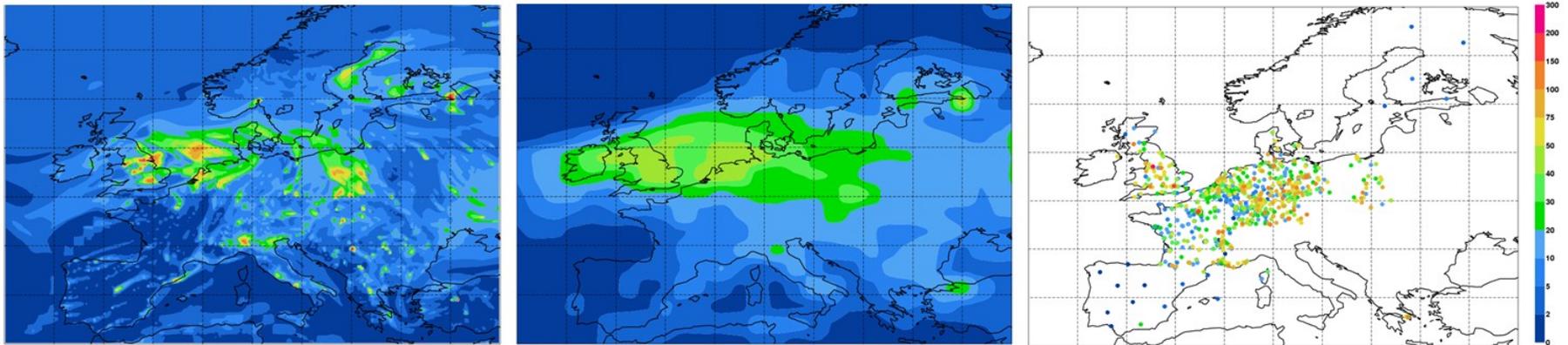
Aerosol



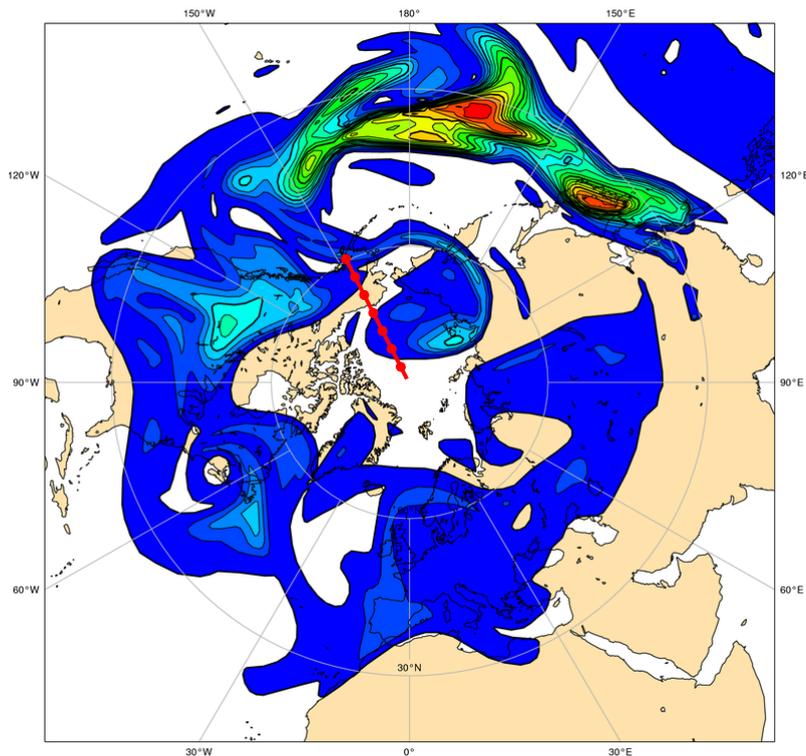
UV index



2-day nitrogen dioxide forecasts for 25 February 2010 from the MOCAGE regional model (left) and the coarser-resolution global model (middle) validated with observations (right).



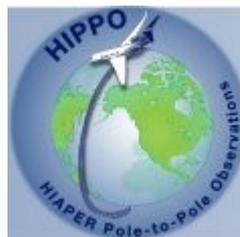
**MACC provides forecasts of European air quality from an ensemble of regional models. All forecasts are being validated with observations from the various European member states.**



**MACC provides support to scientific aircraft observation campaigns by forecasting constituent concentrations around the proposed flight track.**

**This way, scientists can anticipate what they will likely measure.**

**Carbon monoxide plume from East Asia reaching the Arctic region for a proposed HIPPO campaign flight (red line).**



**BBC** Low graphics Help

**NEWS** LIVE BBC NEWS CHANNEL

**ABC News**

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News Front Page Page last updated at 10:42 GMT, Wednesday, 23 September

## Desert dust storm chokes Sydney



Sydney's red dust has been blown from the outback

**A large stretch of Australia's east coast, including the largest city Sydney, has been shrouded in red dust blown in from the desert outback.**

Visibility in Sydney was so bad that flights were diverted and harbour ferry traffic disrupted.

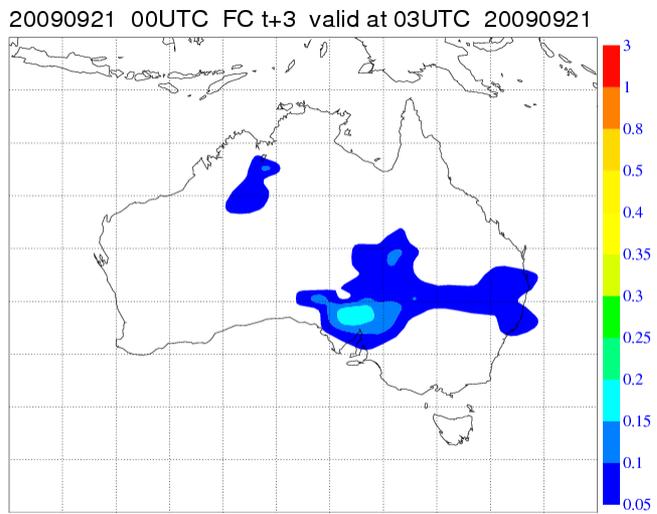
## Dept admits error in air quality forecast

Posted 11 hours 54 minutes ago  
Updated 11 hours 51 minutes ago

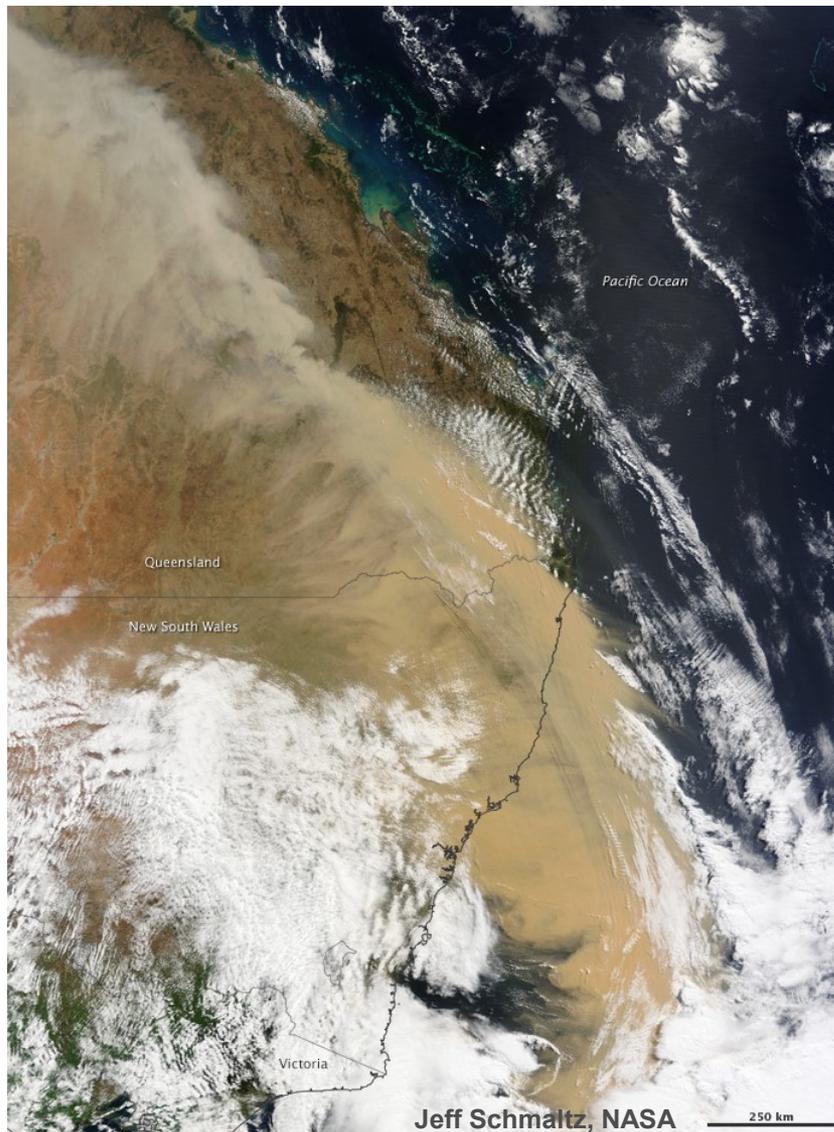
**The New South Wales Environment Department has admitted its forecast for air quality in Sydney today was wildly wrong after a dust storm prompted hundreds of emergency calls due to breathing difficulties.**

**Audio:** Respiratory expert Dr Christine Jenkins speaks to ABC Local Radio (ABC News)

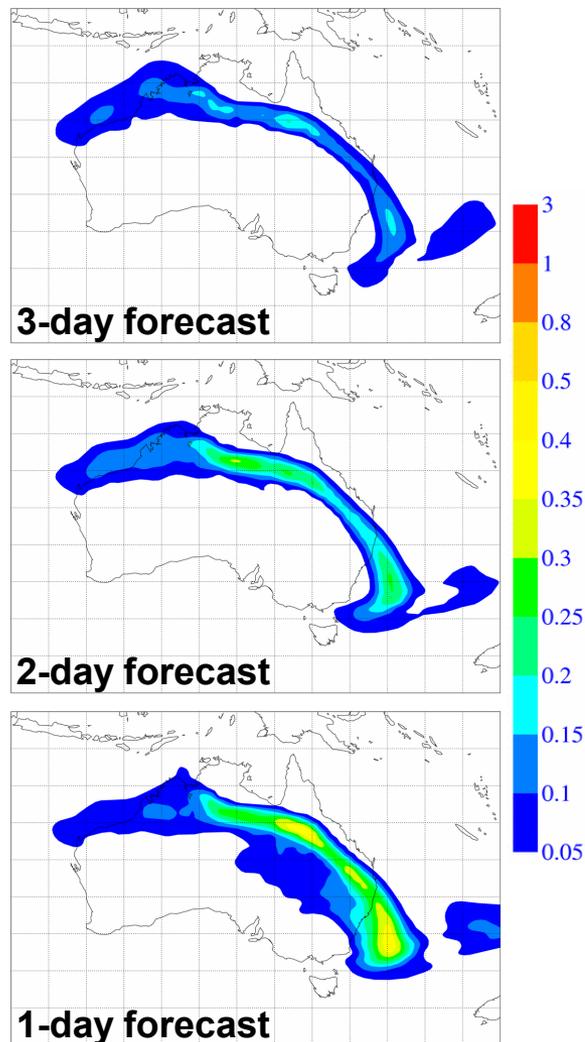
Until this morning, the department's website was forecasting conditions would be good.



**MACC dust aerosol optical depth**



**Dust aerosol optical depth  
00UTC 23 September**



**Dust-band is consistently located in successive forecasts, but intensity is lower at longer ranges**

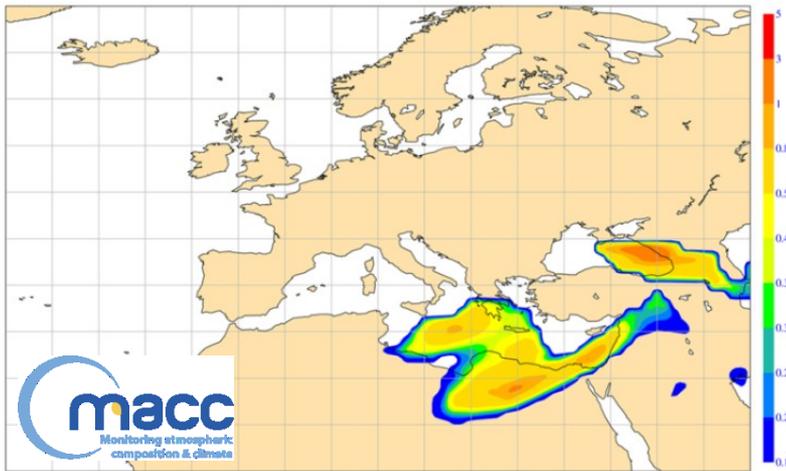
**Underestimation of dust in background forecast is corrected by assimilating MODIS and other data**

**Possible factors:**

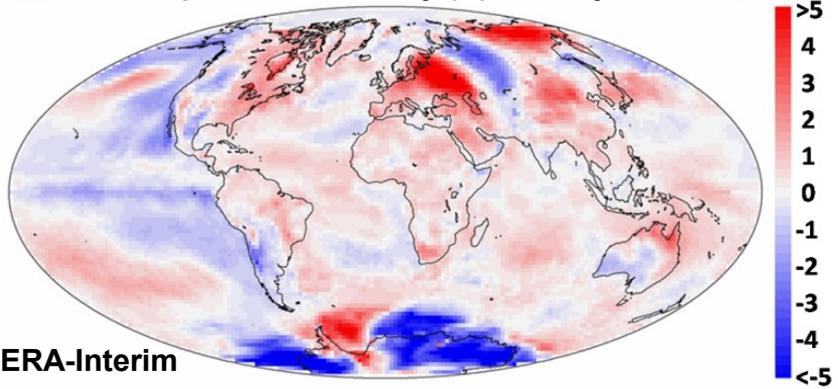
- parameterization of dust mobilization or sedimentation
- resolution of global system (~125km grid)
- soil moisture analysis
- aerosol retrieval over bright surfaces

**MACC successfully forecasted high desert dust aerosol loads over the Mediterranean 2 days ahead of time.**

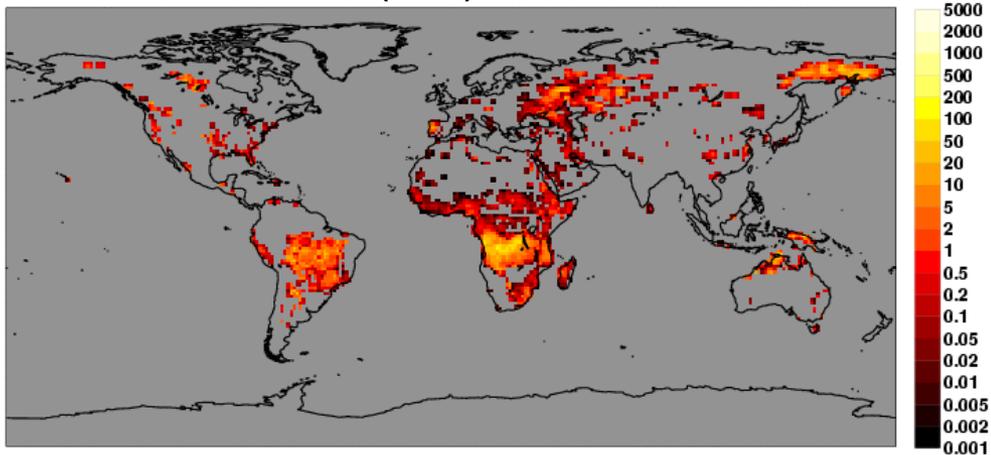
**MACC's desert dust warning index will be a helpful tool for forecast and health authorities.**



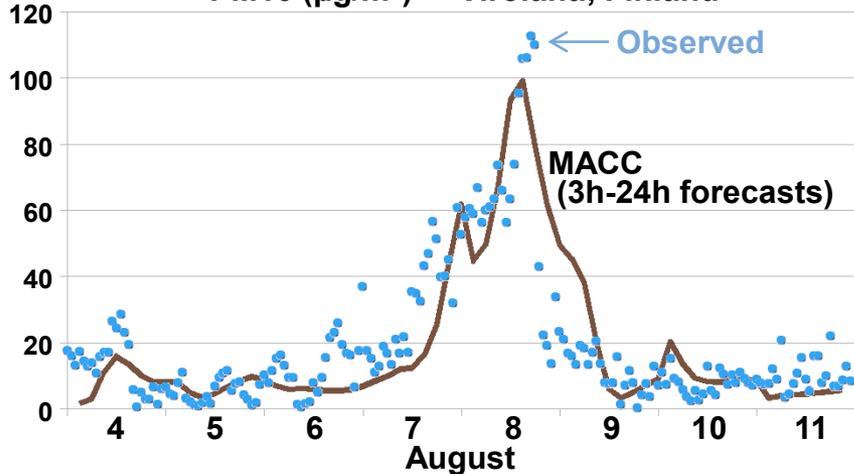
2m temperature anomaly (C) for July 2010



Fire Radiative Power ( $Wm^{-2}$ ) from SEVIRI and MODIS

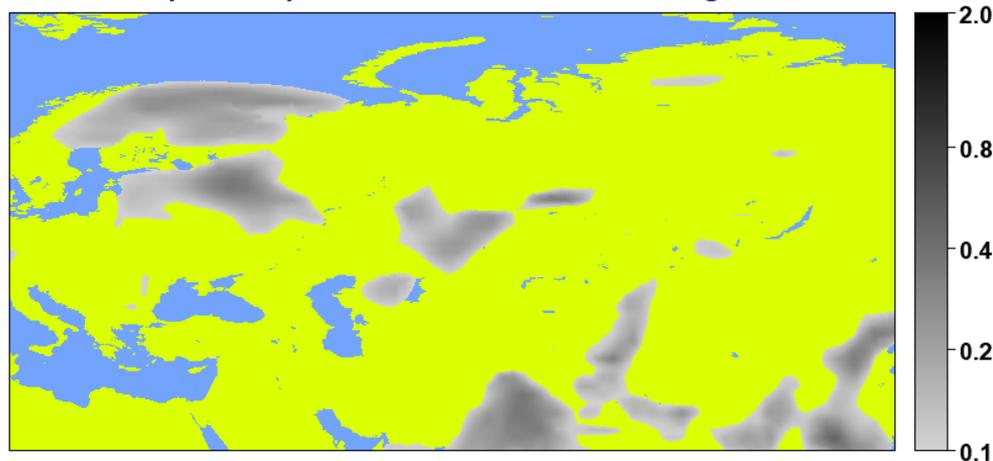


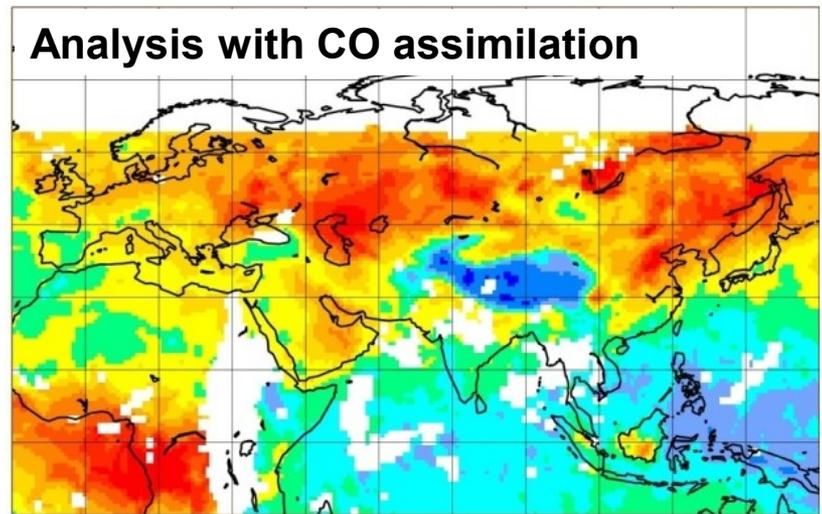
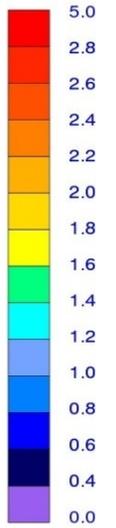
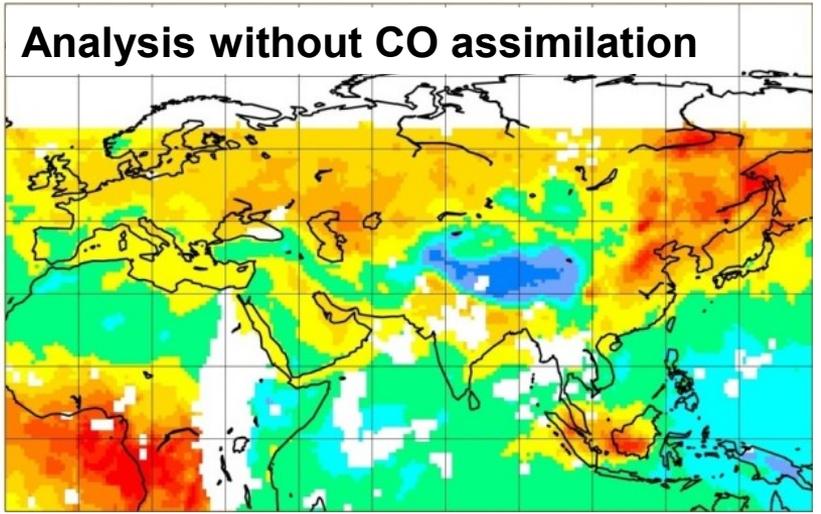
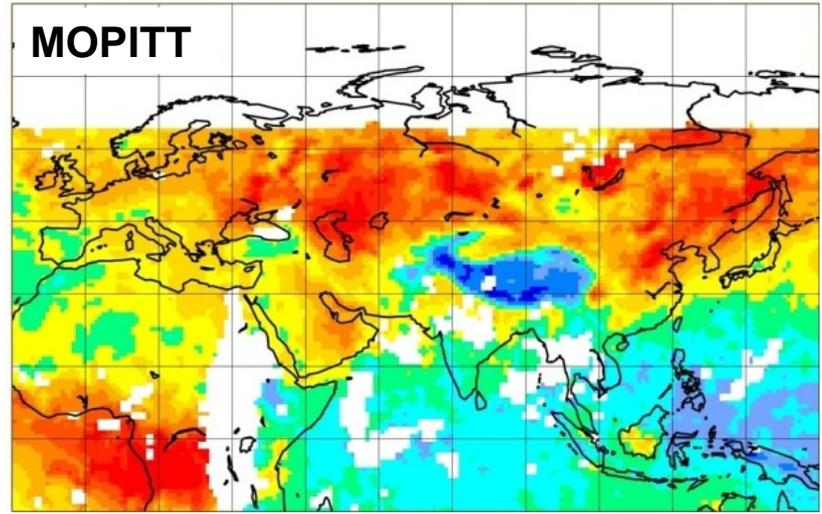
PM10 ( $\mu g/m^3$ ) Virolahti, Finland



2010072603

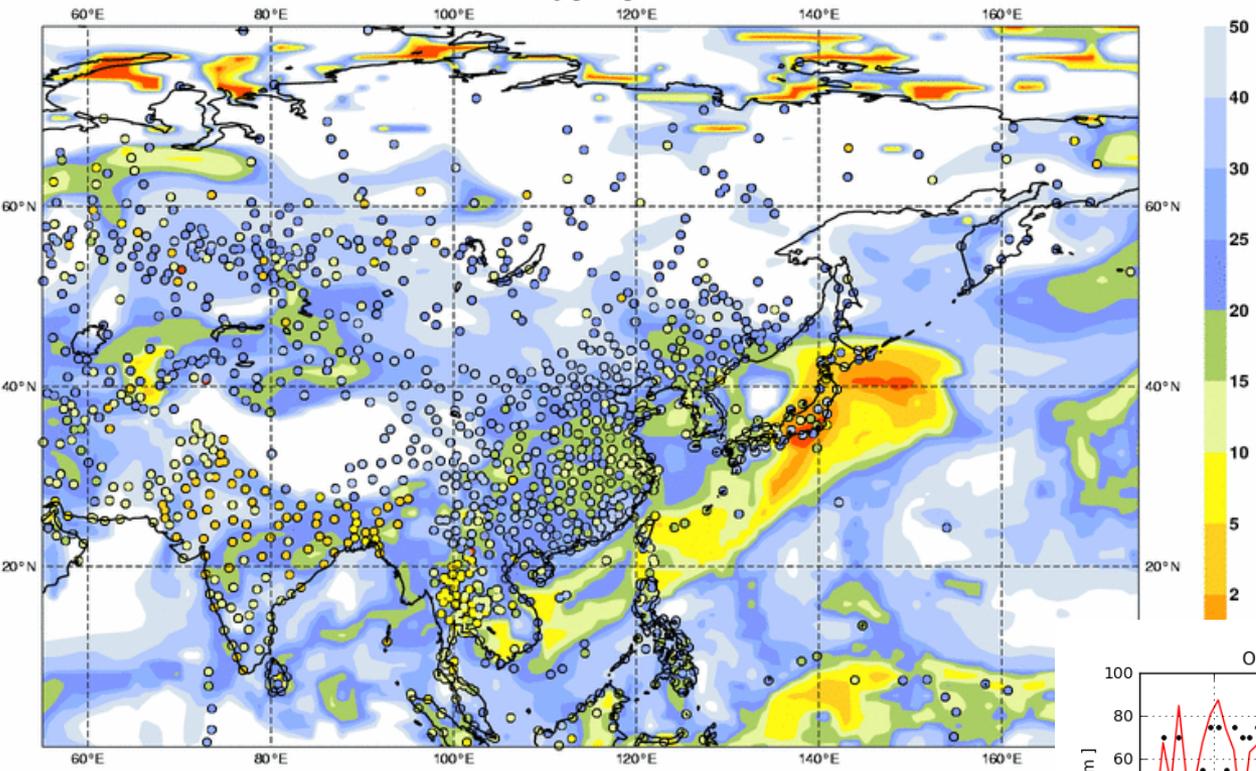
Aerosol optical depth due to black carbon and organic matter





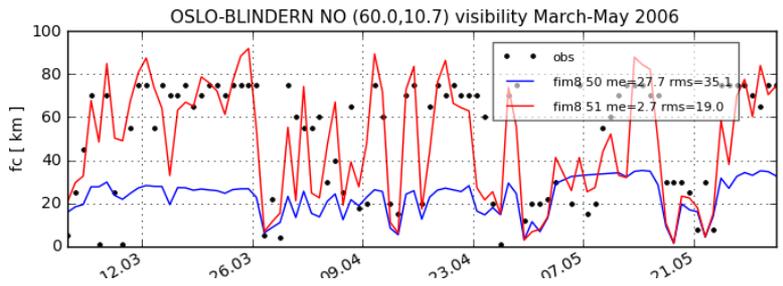
**CO ( $10^{18}$  molec/cm<sup>2</sup>)**  
**Averaged from 1-17 August 2010**

MACC Visibility fim8 I:51 VT: 2006-03-01 12UTC  
 SYNOP observations + forecast surface visibility [ km ]



**Forecast of visibility is a new MACC product that is currently being tested against observations.**

Visibility is a function of aerosol optical depth, humidity, and cloud liquid water.



# DATA PROVISION

Monitoring atmospheric composition & climate

maccc Monitoring atmospheric composition & climate

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**Services by theme**

European Air Quality | Global Atmospheric Composition | Climate

**Services by user**

Health | Environment | Science Community

MACC is a Collaborative Project (2009-2011) funded by the European Commission. It is coordinated by the European Centre for Medium-Range Weather Forecasts.

Monitoring atmospheric composition & climate

maccc Monitoring atmospheric composition & climate

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Home > Services > RegionalAirQuality >

**Regional Air Quality**

**Ensemble Analysis and Forecasts**

European Air Quality | Global Atmospheric Composition | Climate

**Services by user**

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Stratospheric ozone service

LATEST: 2011-2012 Access to NRT assimilation data

Most recent quick-looks for O3 at 50 hPa

BASCOE | IFS-MOZART | SACADA

Context and content of this MACC service

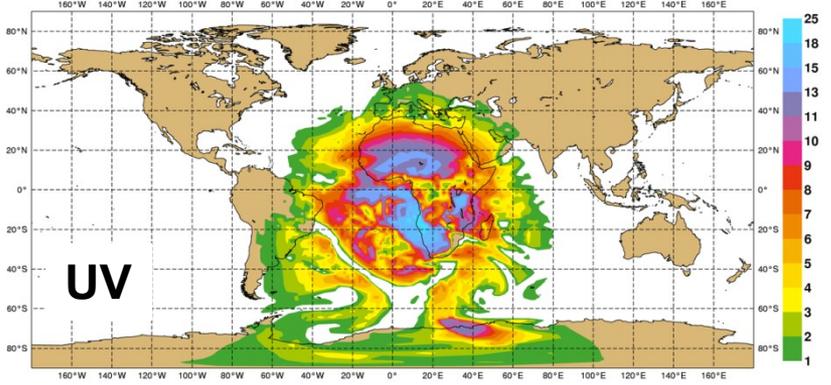
The MACC project (Monitoring Atmospheric Composition and Climate) provides the pre-operational atmospheric environmental service of GEMS. It is operating and improving the data analysis and modelling systems for a number of atmospheric trace gases, among which O3, NO2, CO, SO2 and formaldehyde. It is funded under the 7th Framework Programme of the European Union.

The MACC stratospheric ozone service consists of two main parts:

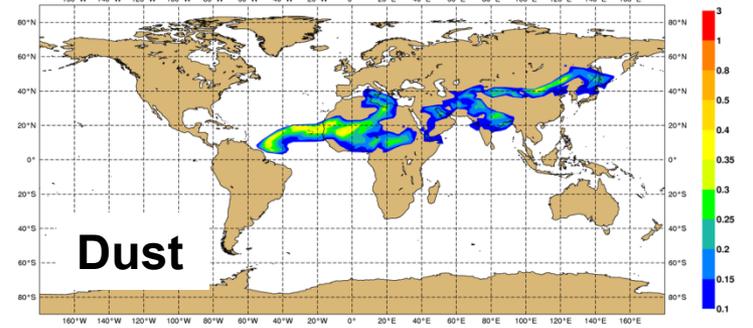
- The quasi-operational stream includes vertically resolved gridded fields and total ozone columns from analyses by the 4D-Var models IFS-MACC, BASCOE, and SACADA, as well as total ozone columns from the Kalman-filter model TM3DAM. The quasi-operational stream additionally provides L2 O3 data from OMI, SCIAMACHY, and GOME-2, in continuation of the PROMOTE service.
- The historic data records comprise both total ozone columns from long-term reanalyses starting in 1978 based on multiple instruments via the TM3DAM approach and 3D gridded fields and total ozone columns from the three above-mentioned 4D-Var models.

**Web server distributed over MACC partners, but mostly based on existing NWP software**

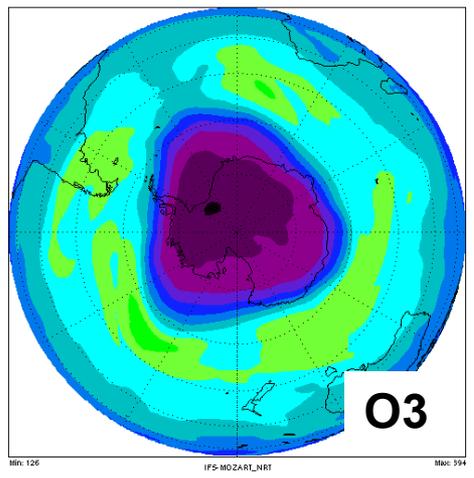
Monday 31 October 2011 00UTC MACC Forecast t+036 VT: Tuesday 1 November 2011 12UTC  
Total sky UV Index



Sunday 30 October 2011 00UTC MACC Forecast t+048 VT: Tuesday 1 November 2011 00UTC  
Dust Aerosols Optical Depth at 550 nm

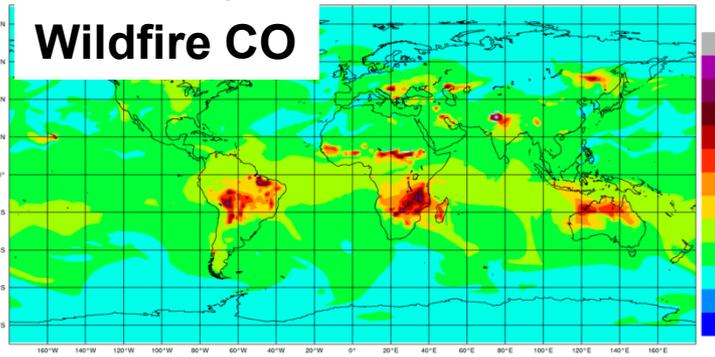


go3 [Dobson Units] by ECMWF

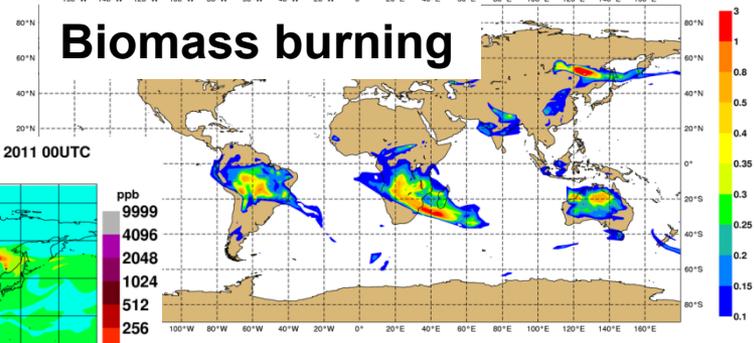


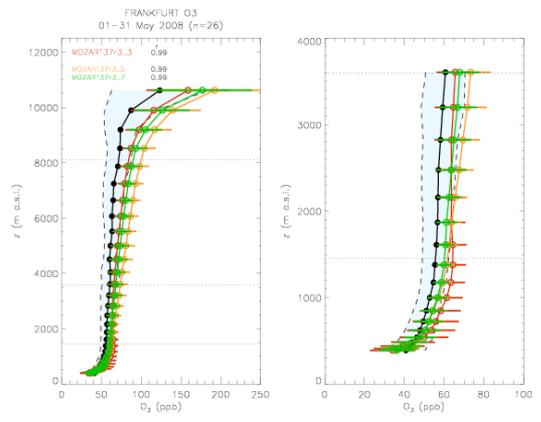
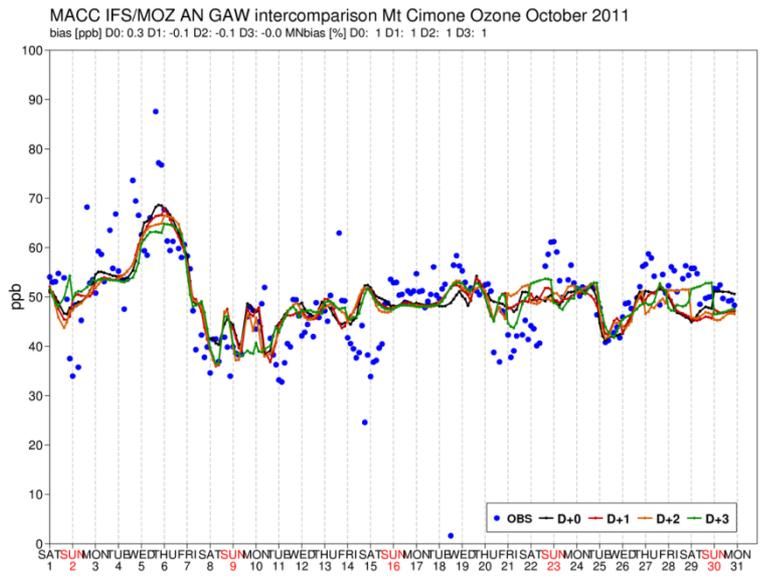
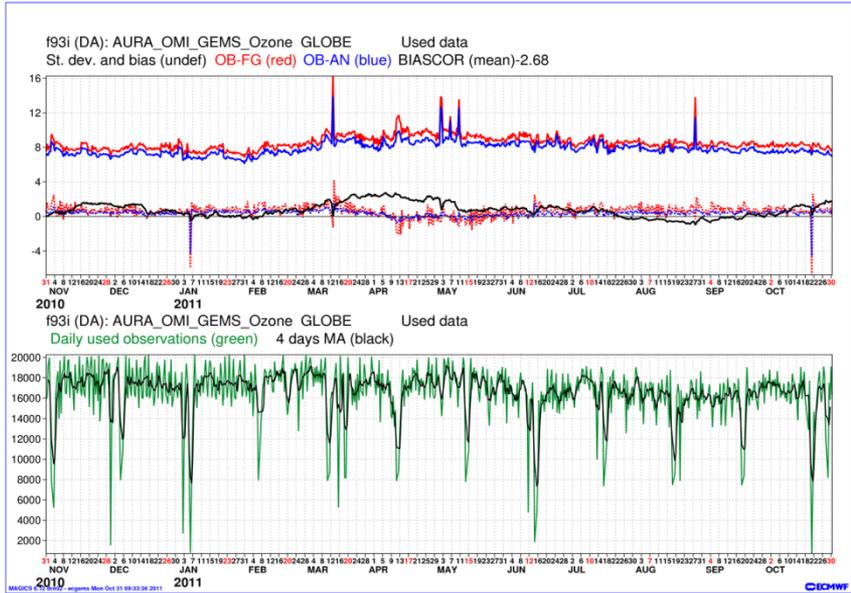
29-Oct-2011 00:00

Sunday 30 October 2011 00UTC MACC Forecast t+048 VT: Tuesday 01 November 2011 00UTC  
Surface NRT Biomass-Burning Carbon Monoxide Tracer

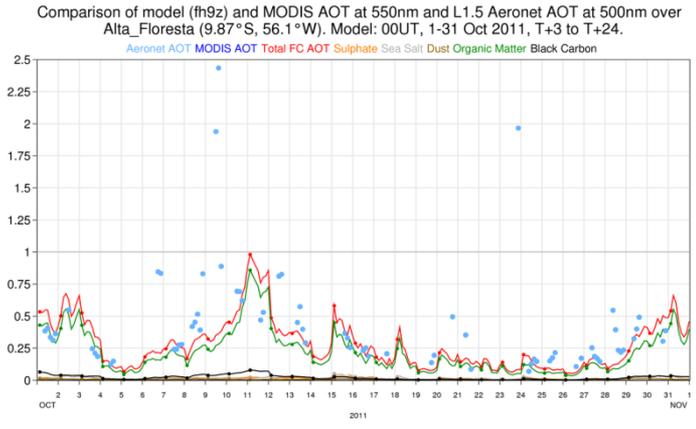


Sunday 30 October 2011 00UTC MACC Forecast t+048 VT: Tuesday 1 November 2011 00UTC  
Biomass Burning Aerosols Optical Depth at 550 nm





**Input data is monitored and output data is continuously checked against independent observations.**

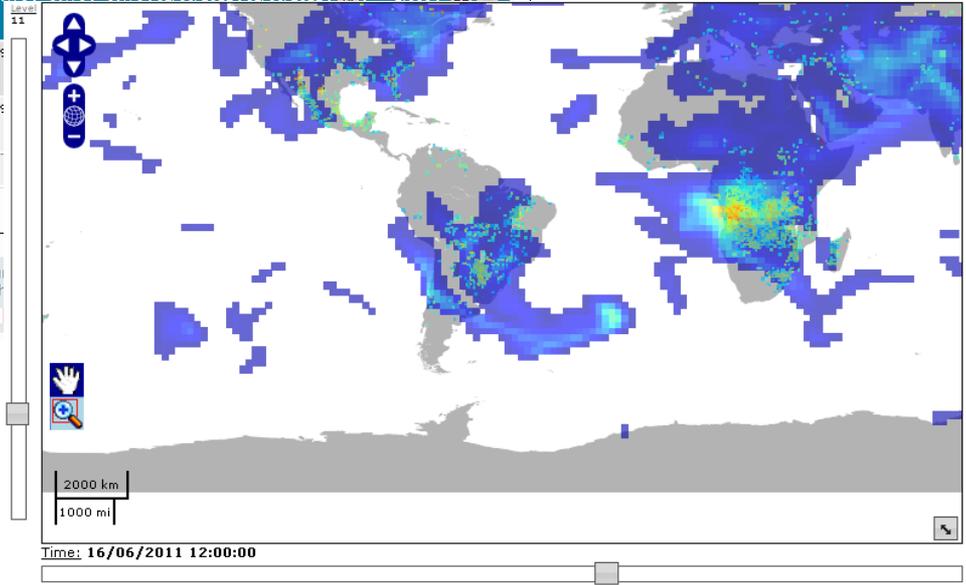


Workspace (under construction)

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+	GFAsv1_20110602 (GFAsv1_20110602_0004.nc) (md5: 677d653d8168227a21bc27be5ad5a77)	08/06/2011 09:15:55	0.25	359.75	-89.75	89.75	02/06/2011 12:00:00	02/06/2011 12:00:00	1	1.003	
+	GFAsv1_20110531 (GFAsv1_20110531_0002.nc) (md5: e895473006133b1d76a3f70d7102220)	08/06/2011 09:15:54	0.25	359.75	-89.75	89.75	31/05/2011 12:00:00	31/05/2011 12:00:00	1	1.003	
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+	GFAsv1_20110604 (GFAsv1_20110604_0001.nc) (md5: 6d901ce731e24f506cfa9ec96cbb627)	08/06/2011 09:15:12	0.25	359.75	-89.75	89.75	04/06/2011 12:00:00	04/06/2011 12:00:00	1	1.003	

Filter:  Identifier  select all:

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Layer:

- Wildfire flux of Org  
GFAsv1\_20110616\_0001.nc
- black carbon (hydri  
MACC\_20110614\_0002.nc

+ Add layer

A WCS web server hosted in Juelich provides data and plots from the global MACC forecasts.



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MACC Re-analysis >

## MACC Re-analysis

- Type of level
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  - [Pressure levels](#)
  - [Surface](#)

**Note:** In order to retrieve data from this server, you first have to accept the [condi](#)

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### Select date

*Select a date range between 2003-01-01 and 2009-12-31:*

Start date:  End date:

*Select a list of month:*

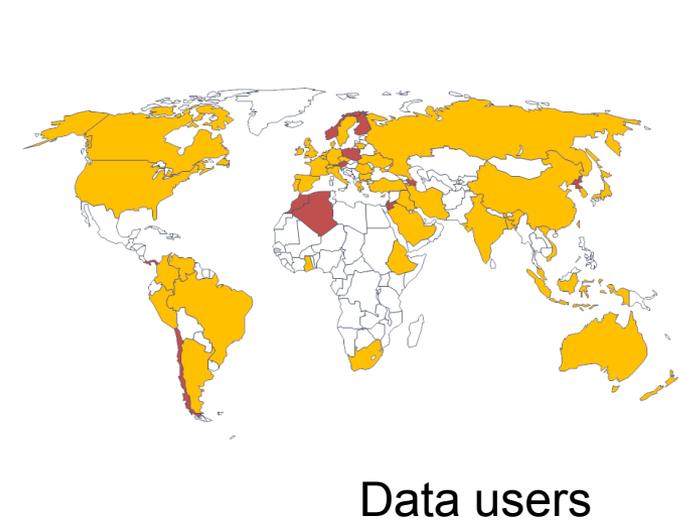
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<b>2005</b>	<input type="checkbox"/>	<b>2006</b>	<input type="checkbox"/>																						
<b>2007</b>	<input type="checkbox"/>	<b>2008</b>	<input type="checkbox"/>																						
<b>2009</b>	<input type="checkbox"/>																								

Select **All** or **Clear**

### Select Time

00:00:00
  06:00:00
  12:00:00
  18:00:00

Select **All** or **Clear**



Data users

- See also...
- [Data FAQ](#)
  - [Data Servers](#)
  - [Data Services](#)
  - [GRIB decoder](#)



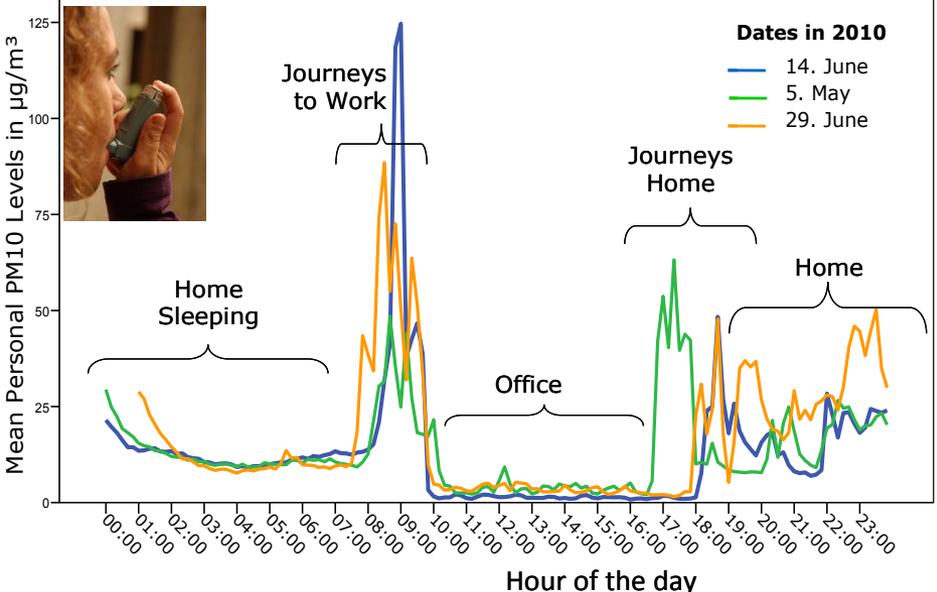
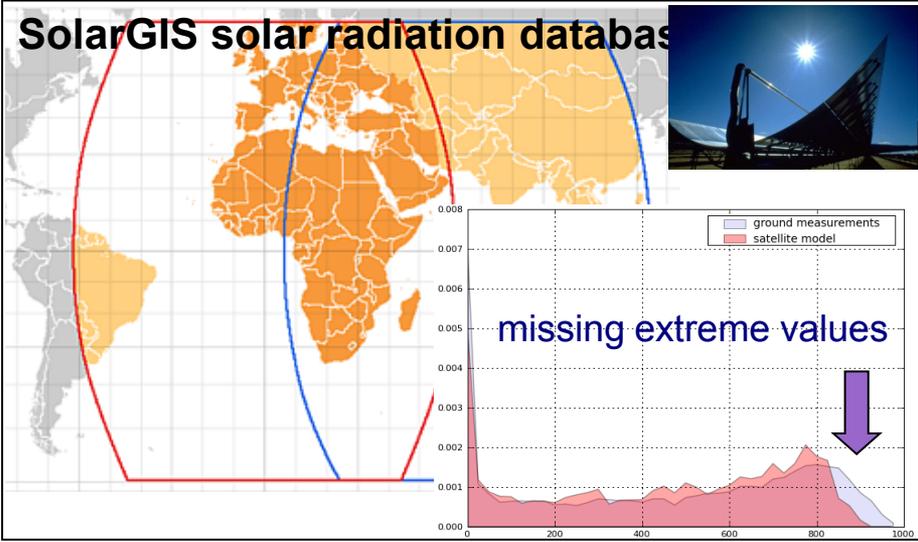
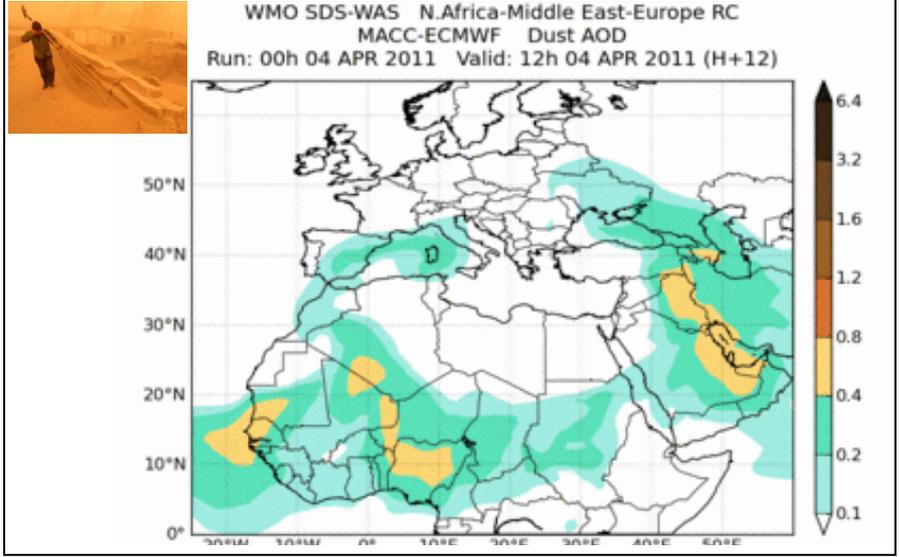


Landesamt für Natur,  
Umwelt und Verbraucherschutz  
Nordrhein-Westfalen



GeoModel  
S O L A R





- MARS and ECFS access for member states and MACC partners
- FTP server for daily forecasts on model grid
- Boundary condition WCS server
- ECMWF data server for Reanalysis
- Daily provision of many web plots
  
- Many users are not used to GRIB format
  - NetCDF format
  - Support with GRIB decoding
  - New ways....?



Deforestation fire, Brazil (M. O. Andreae)