Using satellites to improve our understanding on air pollution

CESAM
&
Dep. Environment and Planning

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CESAM - Associated Laboratory

centre for environmental and marine studies

CESAM mission: to develop fundamental research in the Coastal and Marine Environment, understood in an integrated manner involving the atmosphere, biosphere, hydrosphere and lithosphere

6 departments,
400 researchers (150 with PhD degree)

http://www.cesam.ua.pt

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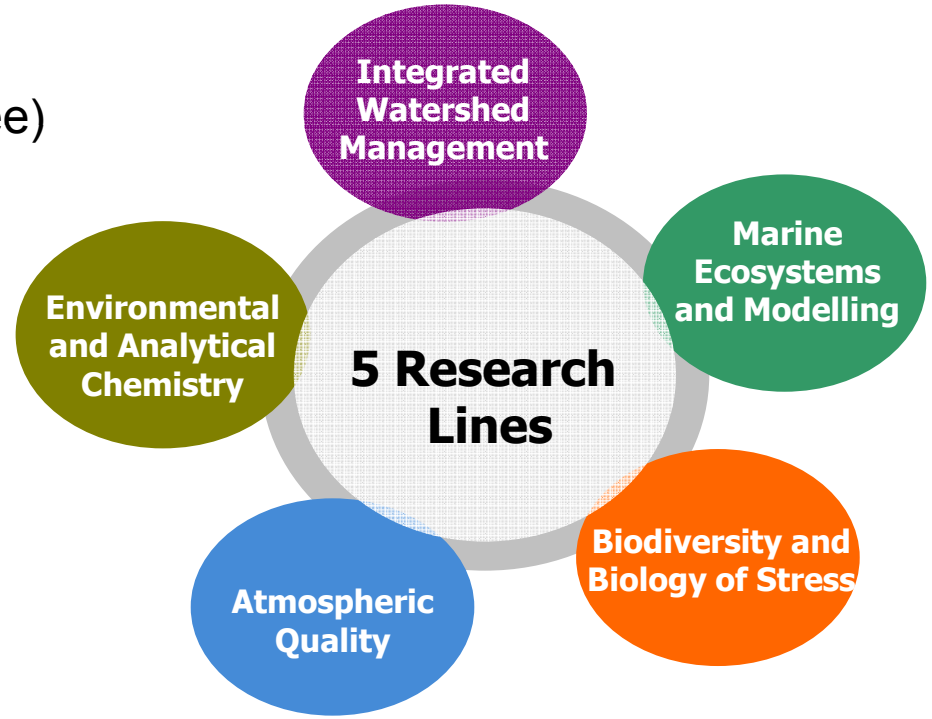

Department of Environment and Planning

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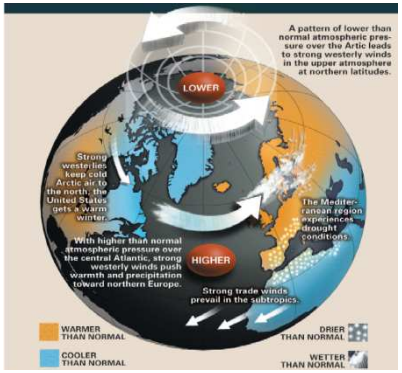
Atmospheric Quality line

priority themes:

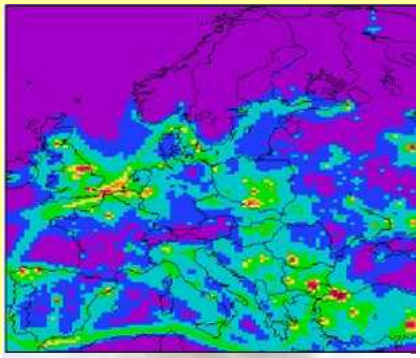
Global climate studies

- Weather and climate variability
- Heat waves and side effects
- Carbon cycle and carbon balance



Air pollution

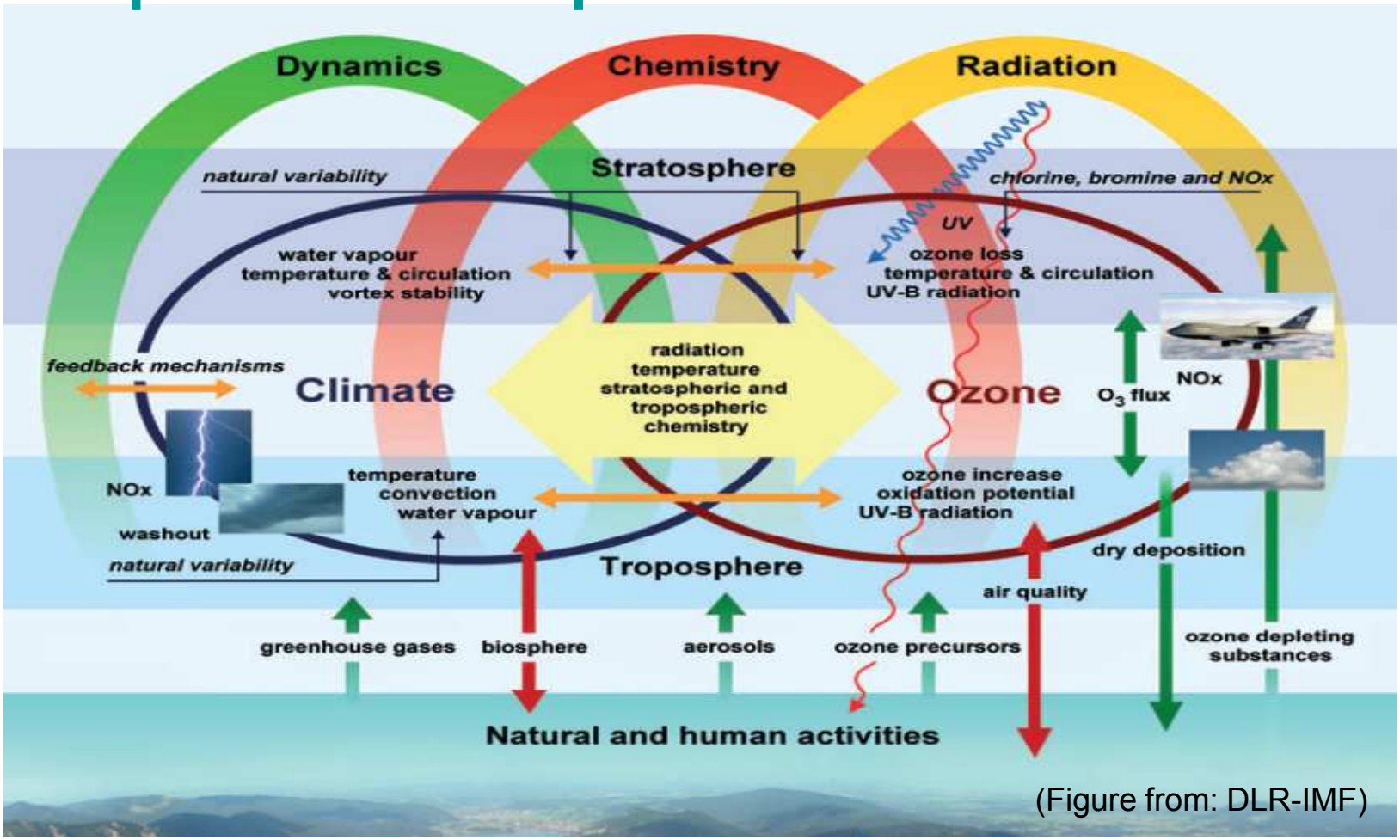
- Physical and chemical processes
- Source emission and apportionment
- Environmental and health effects



Forest fires

- Fire emissions
- Smoke dispersion and chemical transformation
- Environmental impact of biomass burning

Air pollution: complex interactions



(Figure from: DLR-IMF)

significant change of the atmosphere composition on short and long timescales

⇩

needs for global measurements at representative spatial and temporal sampling

Satellite observations

- complement ground-based and airborne measurements
- provide regular, global information with known quality

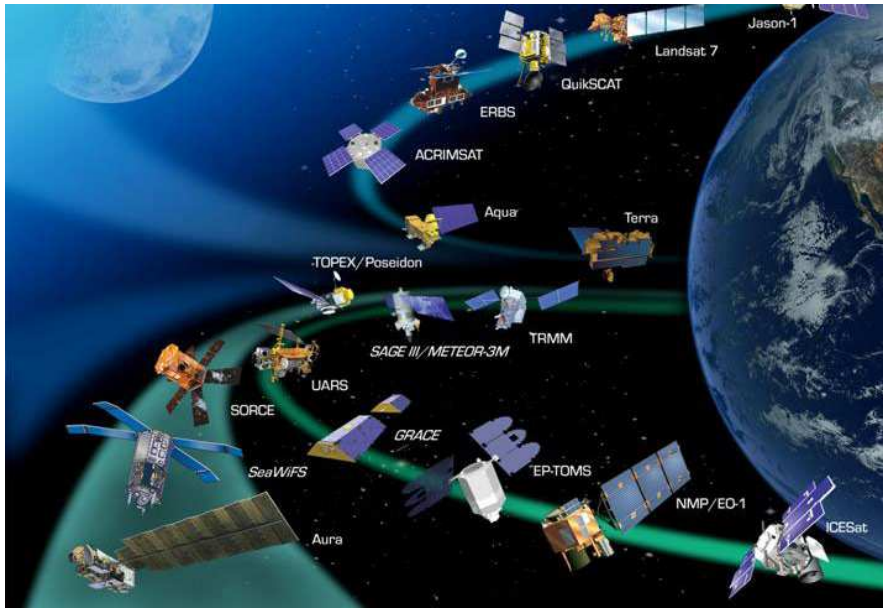
Atmospheric chemistry observations from space - for nearly 30 years!

Main issues:

- Stratospheric Ozone;
- Climate Change.
- Air Pollution;

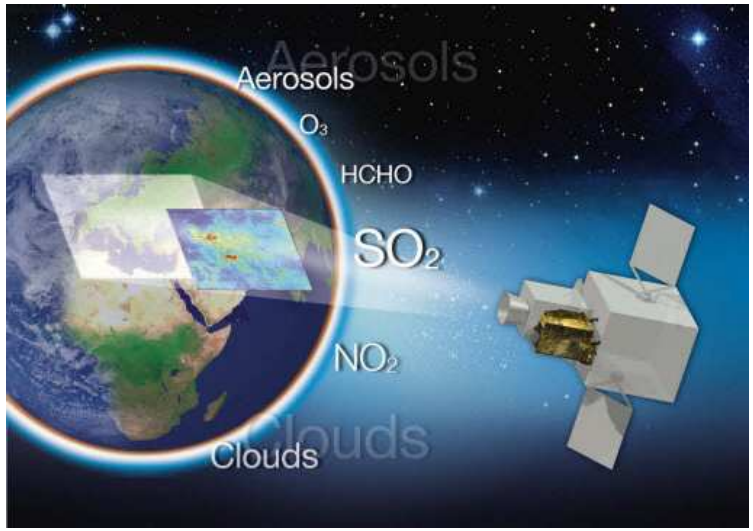
Key species involved
Spatial/temporal resolution
Vertical profiles

- **Aerosol products**
- **Trace gases**
- **Land products**



Satellite observations

Integrated observation system for regional/urban air quality research and applications is currently missing



Future missions:

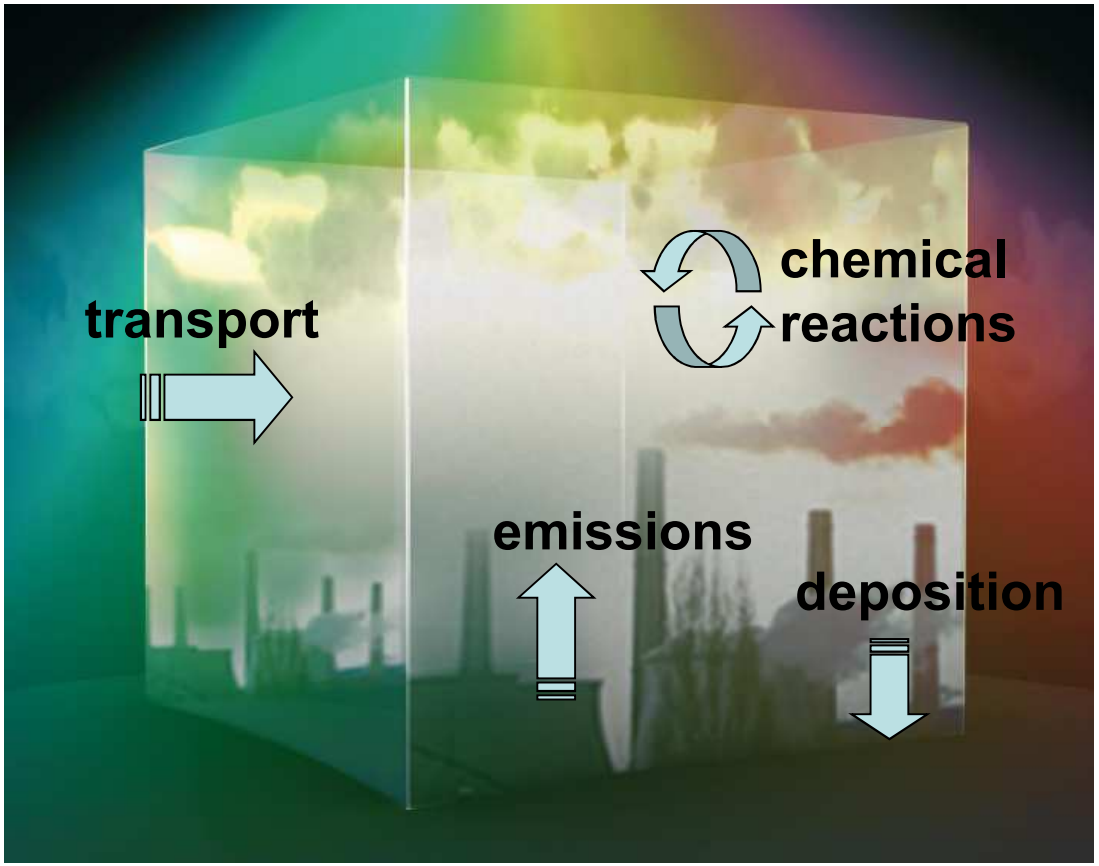
sentinel-4
GMES Geostationary atmospheric mission

sentinel-5 precursor
GMES low Earth orbit atmosphere mission

covers the needs for continuous monitoring of the atmospheric chemistry at high temporal and spatial resolution

Satellite data **together** with models will increase understanding of atmospheric change.

Air pollution modelling



- Primary and secondary pollutants;
- Aerosol composition
- Near surface concentrations and 3D profiles

Emission data

anthropogenic AND natural sources

Information required:

- magnitude,
- geographical distribution,
- temporal variation

Approaches for the emission quantification:

emission modelling:
(em.factor x activity)

Land products

Bottom-up

Top-down

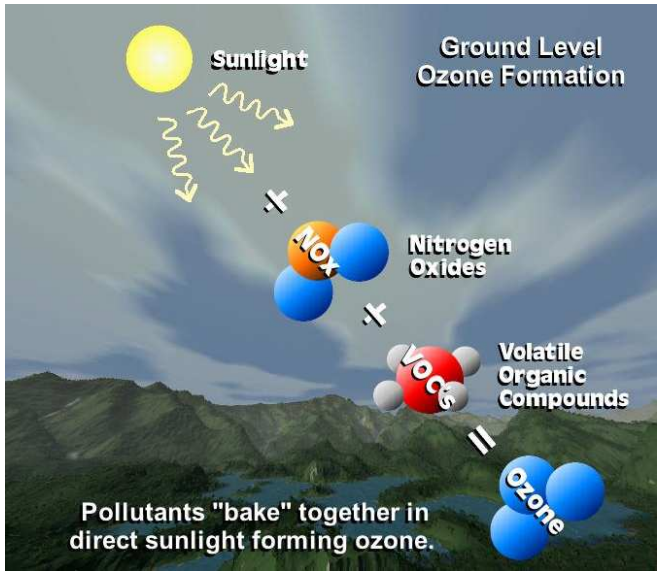
inverse modelling techniques: from concentration observations

Aerosol and trace gases

Study Case 1: Biogenic emissions

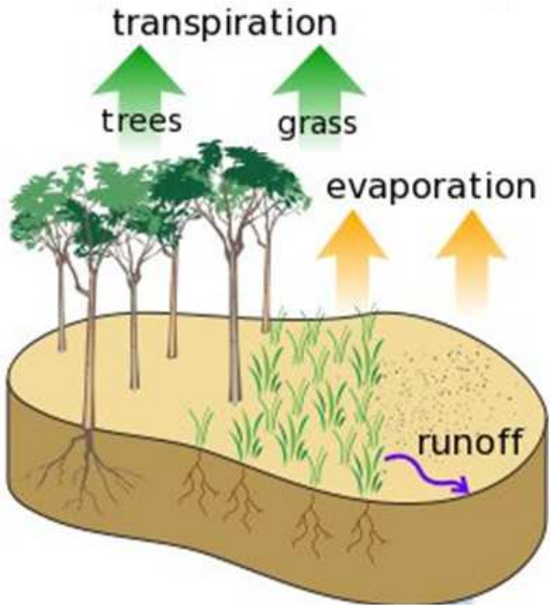
Using of satellite data allow to characterise biogenic emissions to be used in atmospheric pollution modelling

Volatile Organic Compounds:



- Ground level Ozone formation (O_3)
- Secondary Organic Aerosols (SOA)

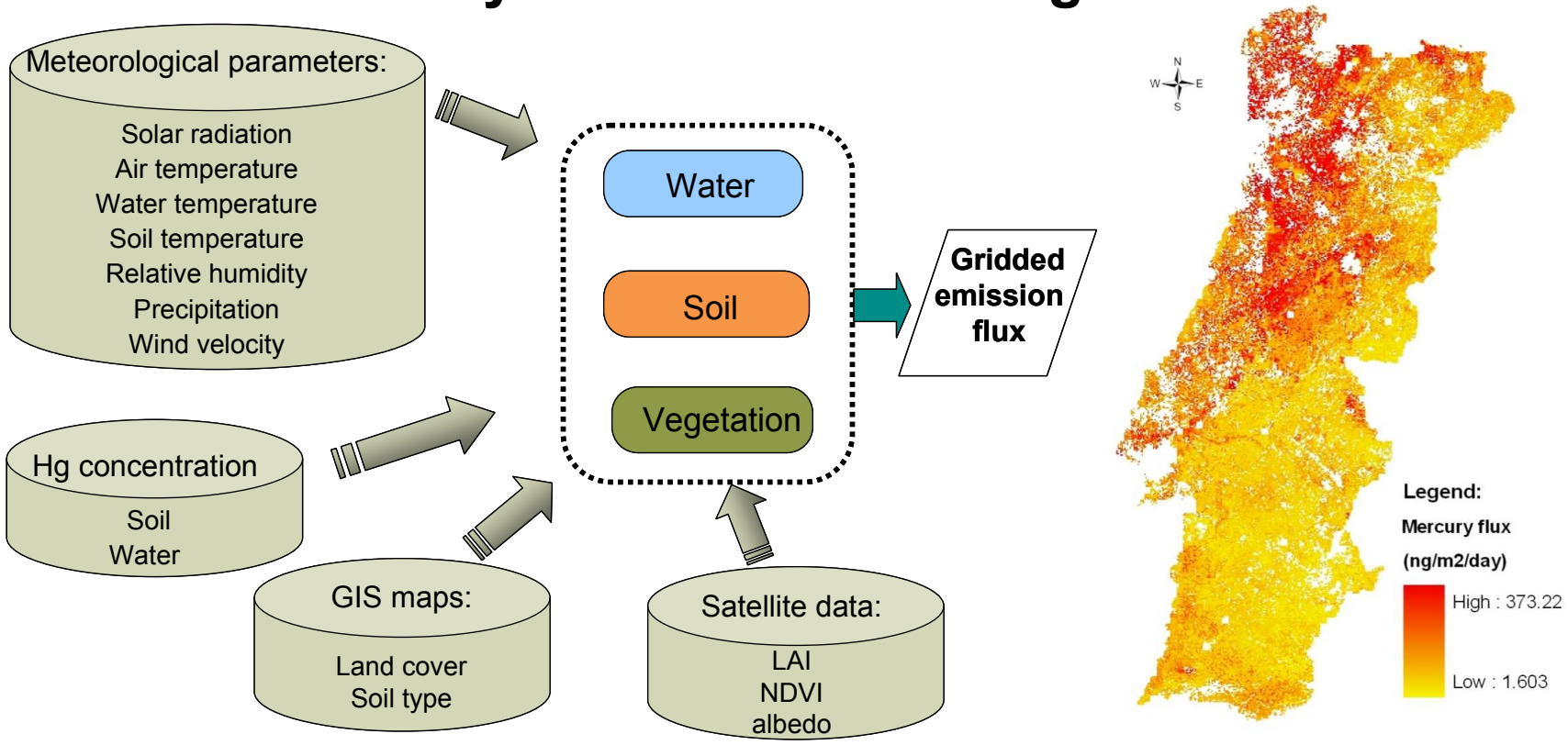
Mercury emissions:



Hg is highly toxic, persistent and bio accumulative - risks to human health and ecosystems

Study Case 1: Biogenic emissions

Mercury emissions from vegetation



EMOSAT project - Characterisation of emission sources using advanced atmospheric modelling and satellite data (PTDC/CTE-ATM/103253/2008)

Contribution to **GEOSS, HE-09-02d** Global Monitoring Plan for Atmospheric Mercury

Study Case 2 – Mineral dust

Using of satellite data in combination with air pollution modelling opens the challenging perspective to improve air quality forecast

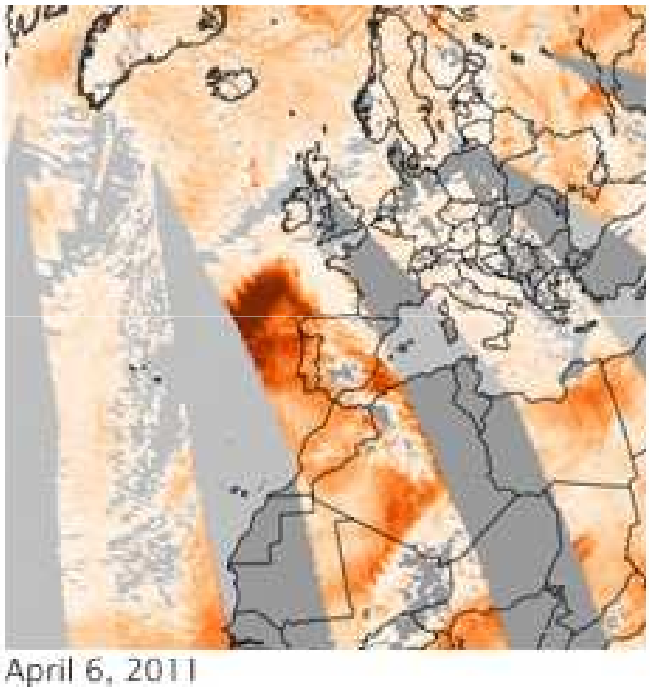


Image provided by OMI

Long-range transport of mineral dust – exceedances!

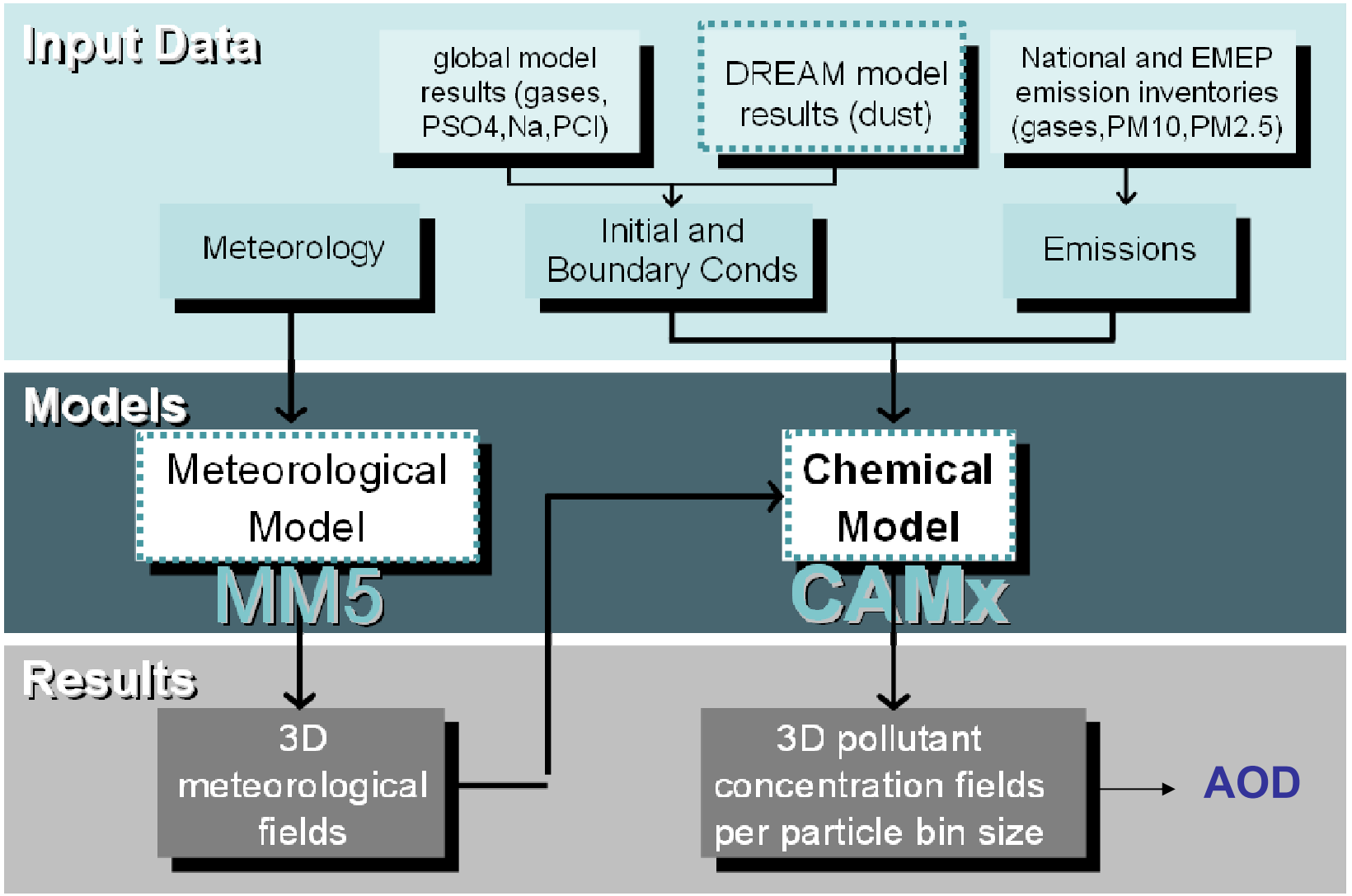
At European level, contribution of the natural sources to the PM levels may range from 5% to 50%

- Analyse **spatial and temporal variations** of aerosols for Portugal using a combination of CTM and satellite observations

- Assess the **contribution of long-range transport** of mineral dust from North Africa to the pollution levels in Portugal

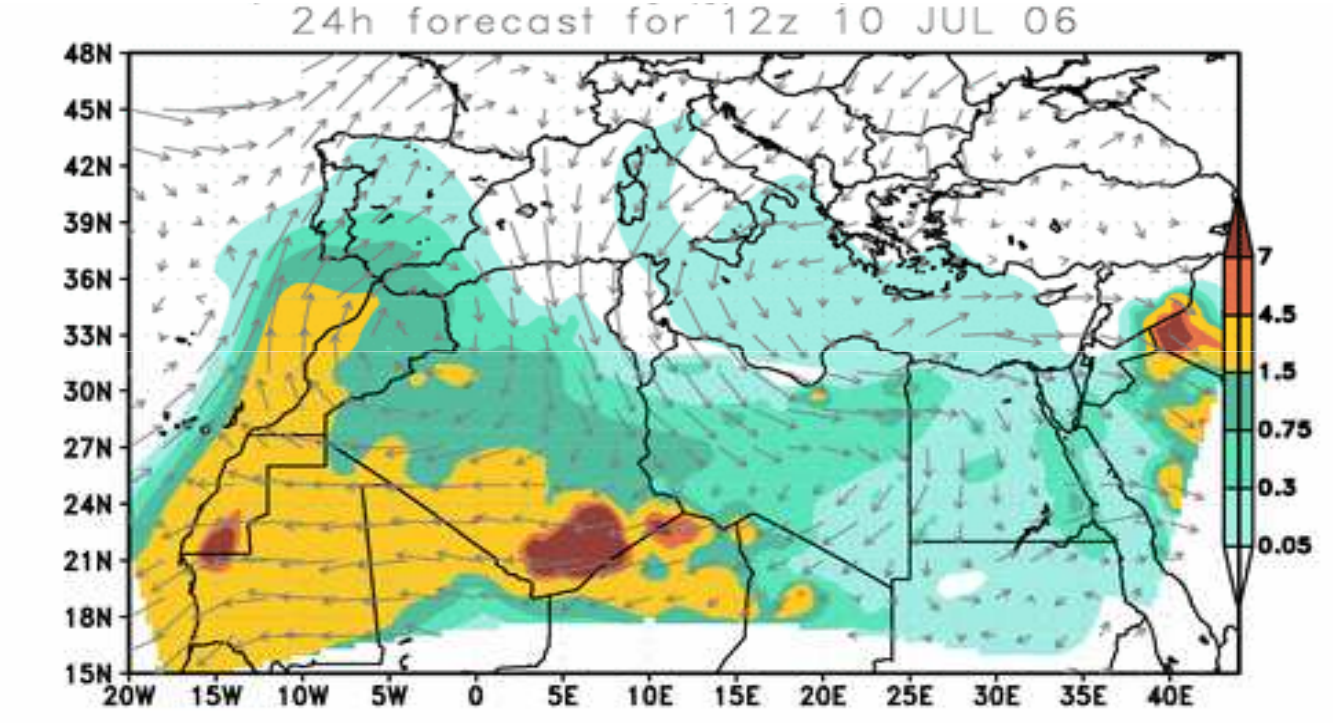
Study Case 2 – Mineral dust

Modelling system



Study Case 2 – Mineral dust

Dust Loading (g/m^{-2}) and 3000m Wind



- Study period July 2006
- CAMx: for Iberian Peninsula resolution 27 x 27 km^2
  10 km vertival column subdivided in 15 levels
  8 size bins for aerosols

Collaboration with Barcelona Super Computer Center

Study Case 2 – Mineral dust

Satellite data – OMI Products

Aerosol Optical Depth (AOD),

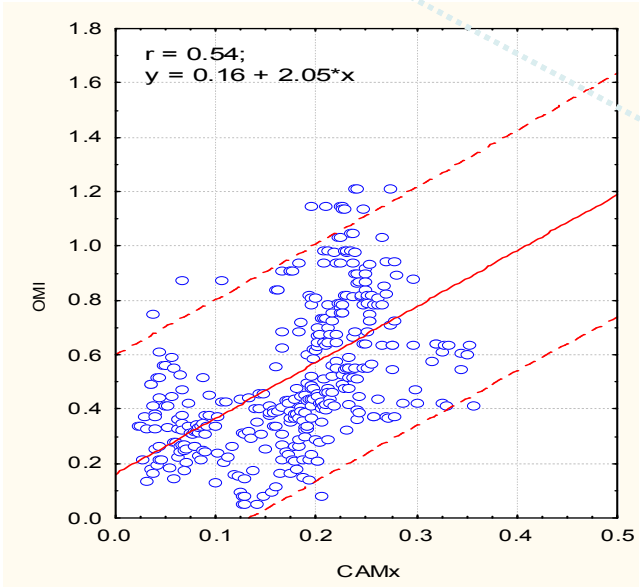
Aerosol Absorption Optical Depth (AAOD),

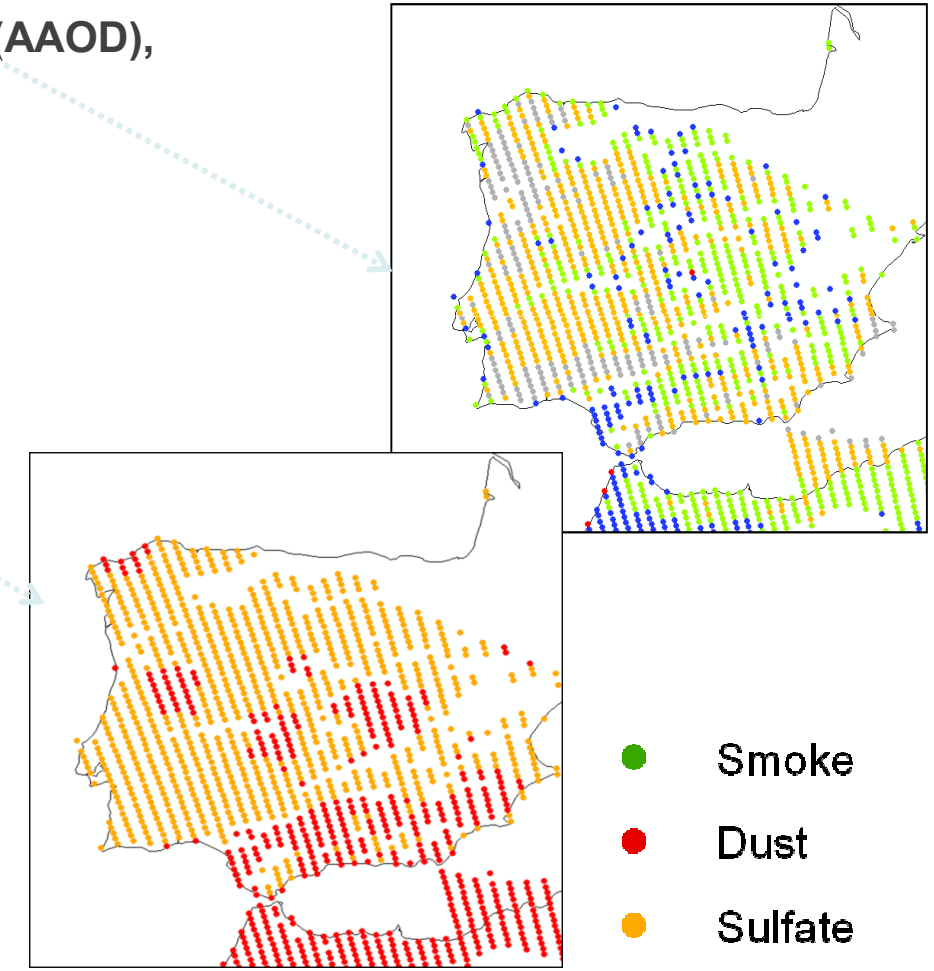
UV Aerosol Optical Depth,

Surface albedo,

Aerosol Index,

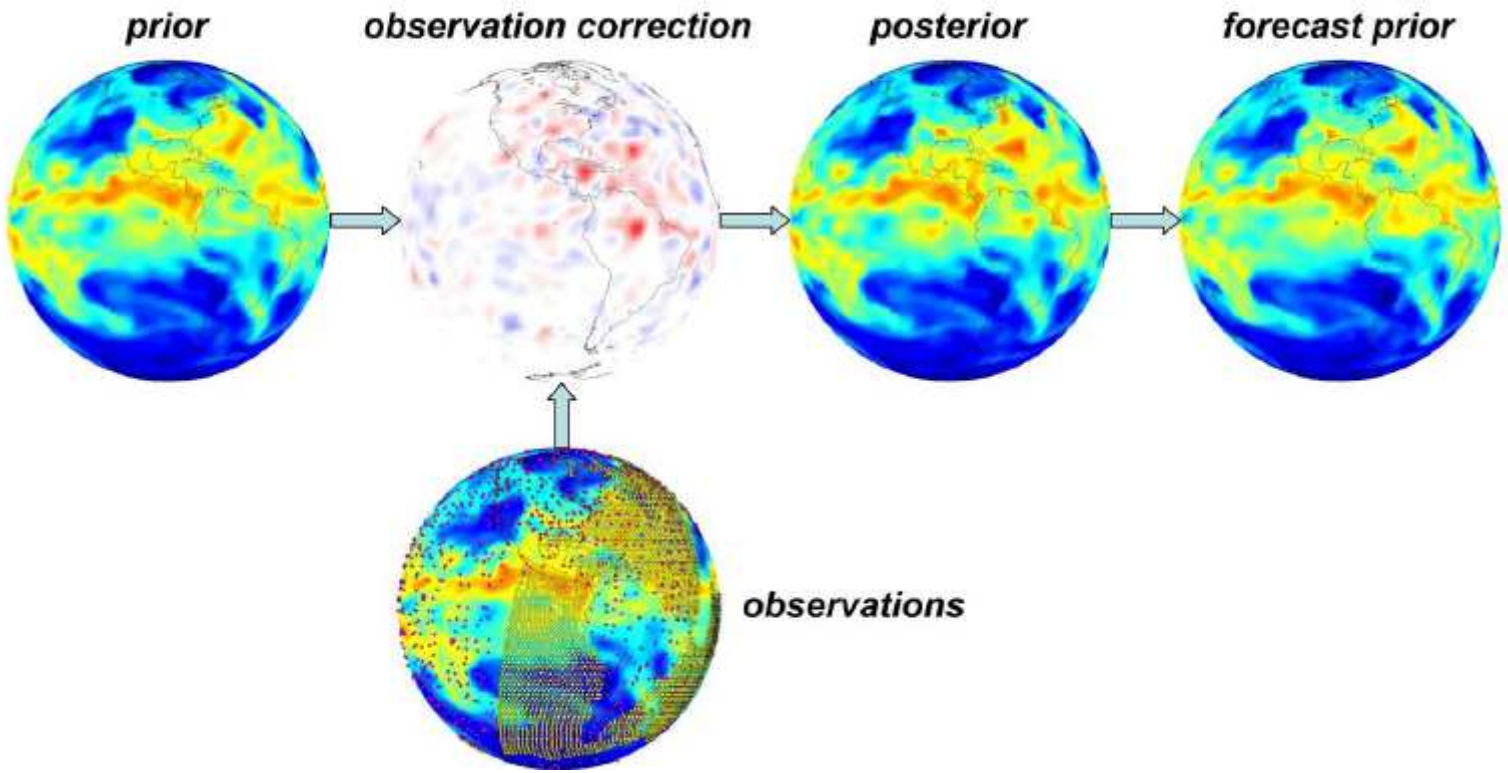
Aerosol Type,





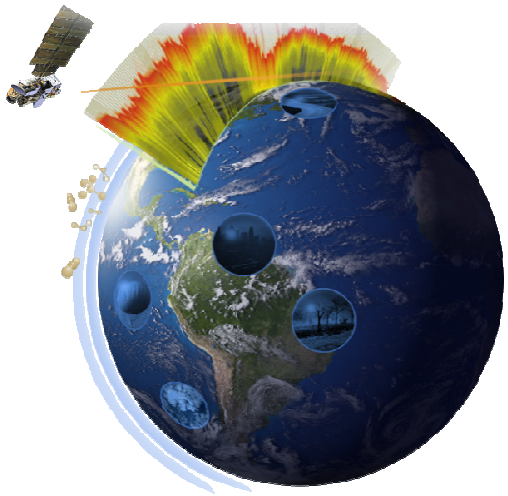
Study Case 2 – Mineral dust

Future work: assimilation of the satellite data in air pollution modelling



Data assimilation is a methodology to combine measurement and model information in na optimised way.

Final remarks:



Major issues on air pollution where satellite data are important:

- **Quantify changes in air quality on global, regional and urban scales**
  - Spatial distribution and variability, temporal variations
- **Quantify the strenght and distribution of the sources and sinks of trace gases and aerosols**
  - source categories, speciation of aerosols
- **Quantify the role of tropospheric composition changes in global climate change**
  - radiative forcing by primary and secondary aerosols, 3D distribution

Thank you!