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Supercomputing
Center**
Centro Nacional de Supercomputación



Modelling and forecasting Sand and Dust Storms

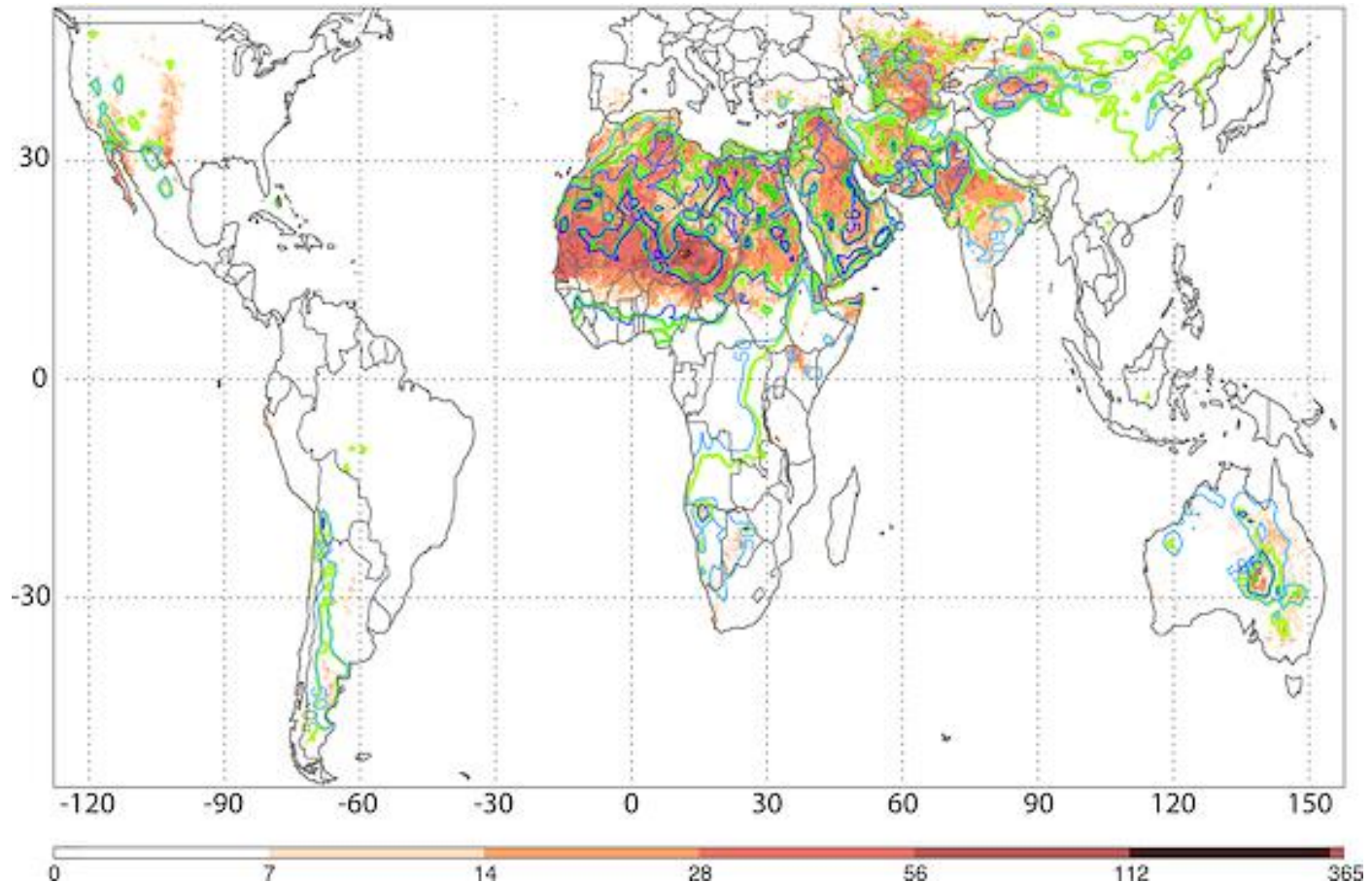
Sara Basart (sara.basart@bsc.es)

*Earth Sciences Department,
Barcelona Supercomputing Center (BSC)*

*WHO Headquarters, 29th October 2018, Geneva,
Switzerland*

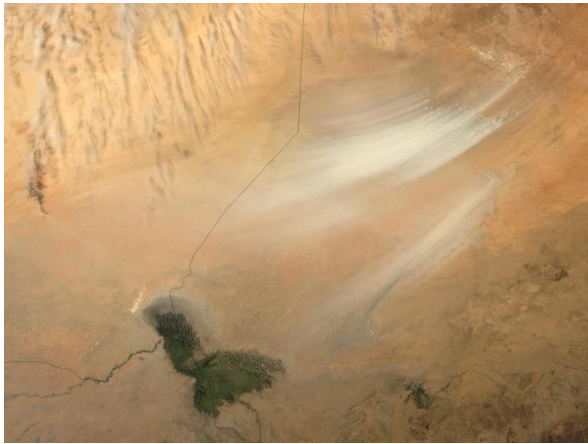
Dust cycle and associated processes

Dust global distribution

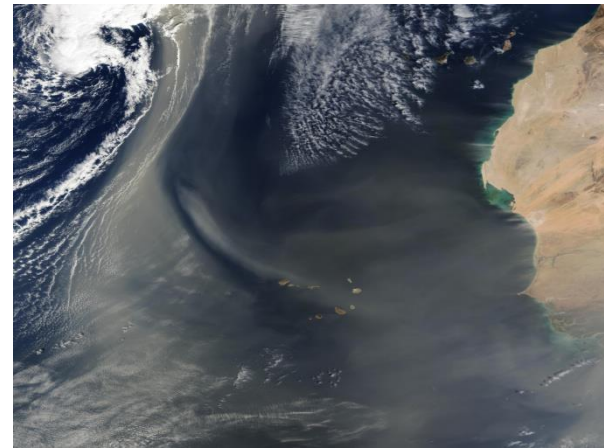


Global-scale attribution of anthropogenic and natural dust sources and their emission rates based on MODIS Deep Blue aerosol products by Ginoux et al. (2012)

Dust cycle and associated processes



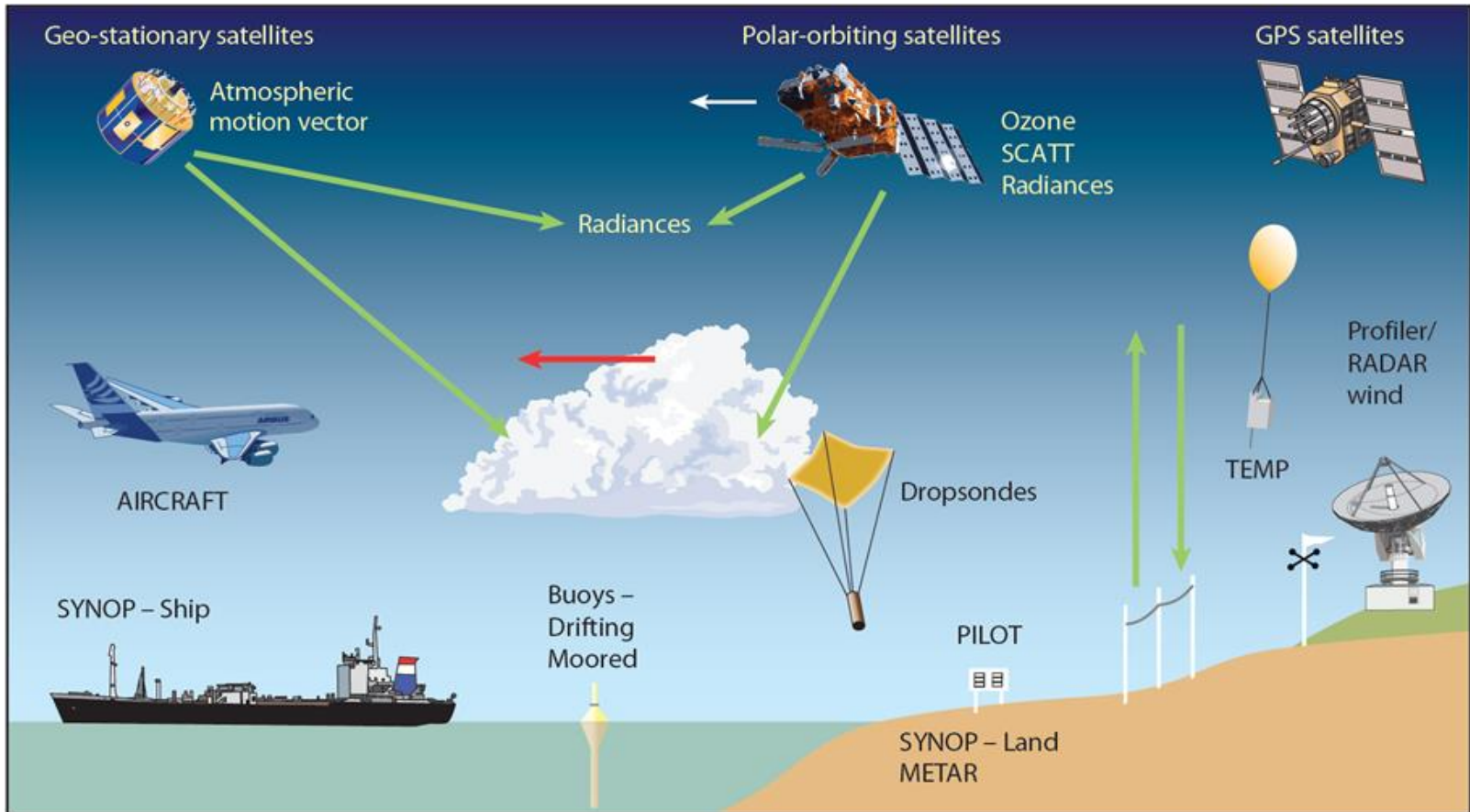
MODIS true colour composite image for March 2005 depicting a dust storm initiated at the Bodélé Depression (Chad Basin)



MODIS True color Western Africa – Atlantic Ocean

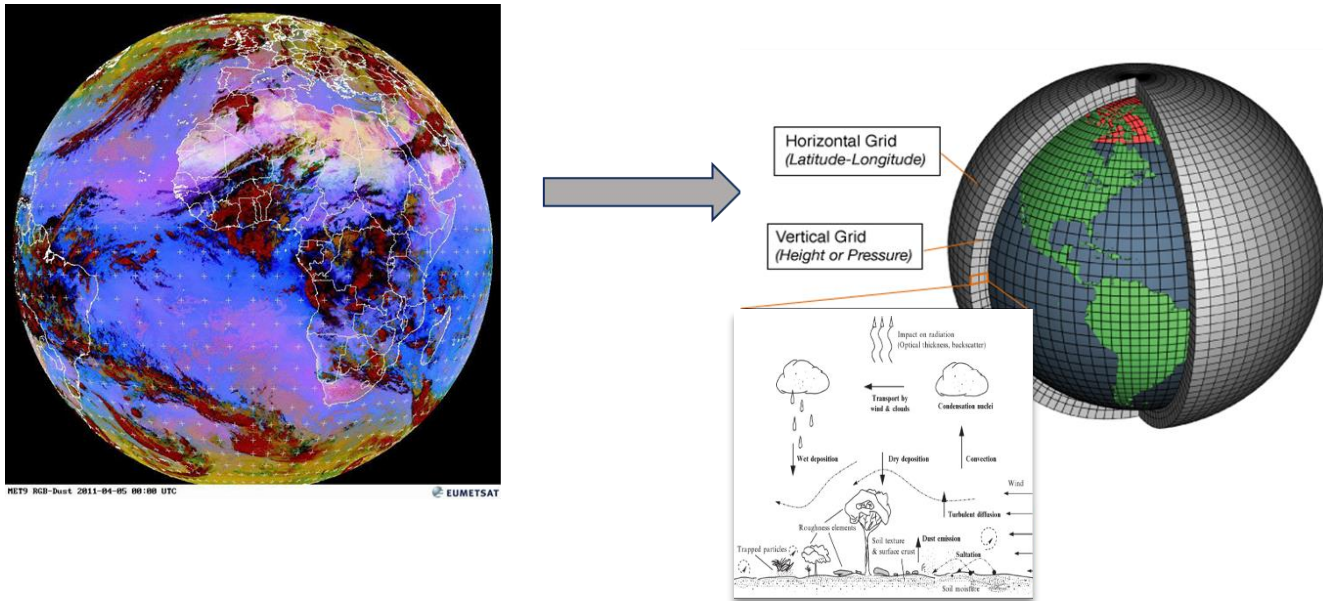
Dust transport is a global phenomenon. However, dust emission is a threshold phenomenon, sporadic and spatially heterogeneous, that is locally controlled on small spatial and temporal scales.

Observations



Dust forecasting models

Dust models are a mathematical representation of atmospheric dust cycle.



- ✓ To complement dust-related observations, filling the temporal and spatial gaps of the measurements.
- ✓ To help us to understand the dust processes and their interaction with climate and ecosystems.
- ✓ To predict the impact of dust on surface level concentrations used as **SHORT-TERM FORECASTING TOOLS** (3-5 days ahead)

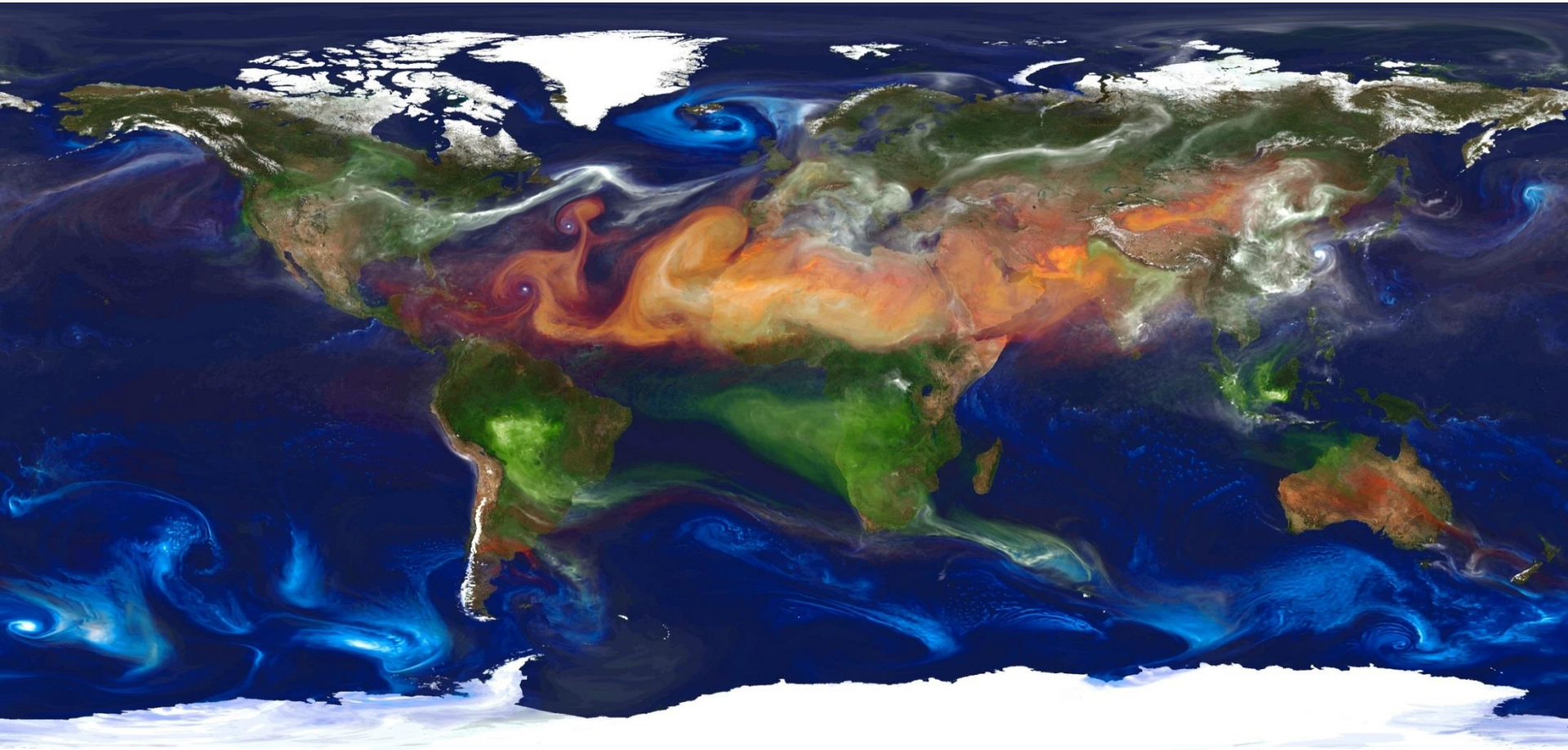
Dust forecasting models

Dust forecasting models do **not** take account dust resuspension



Kathmandu, Nepal, March 2017

Dust impacts and its extension



Organic Carbon + Elemental carbon

Dust

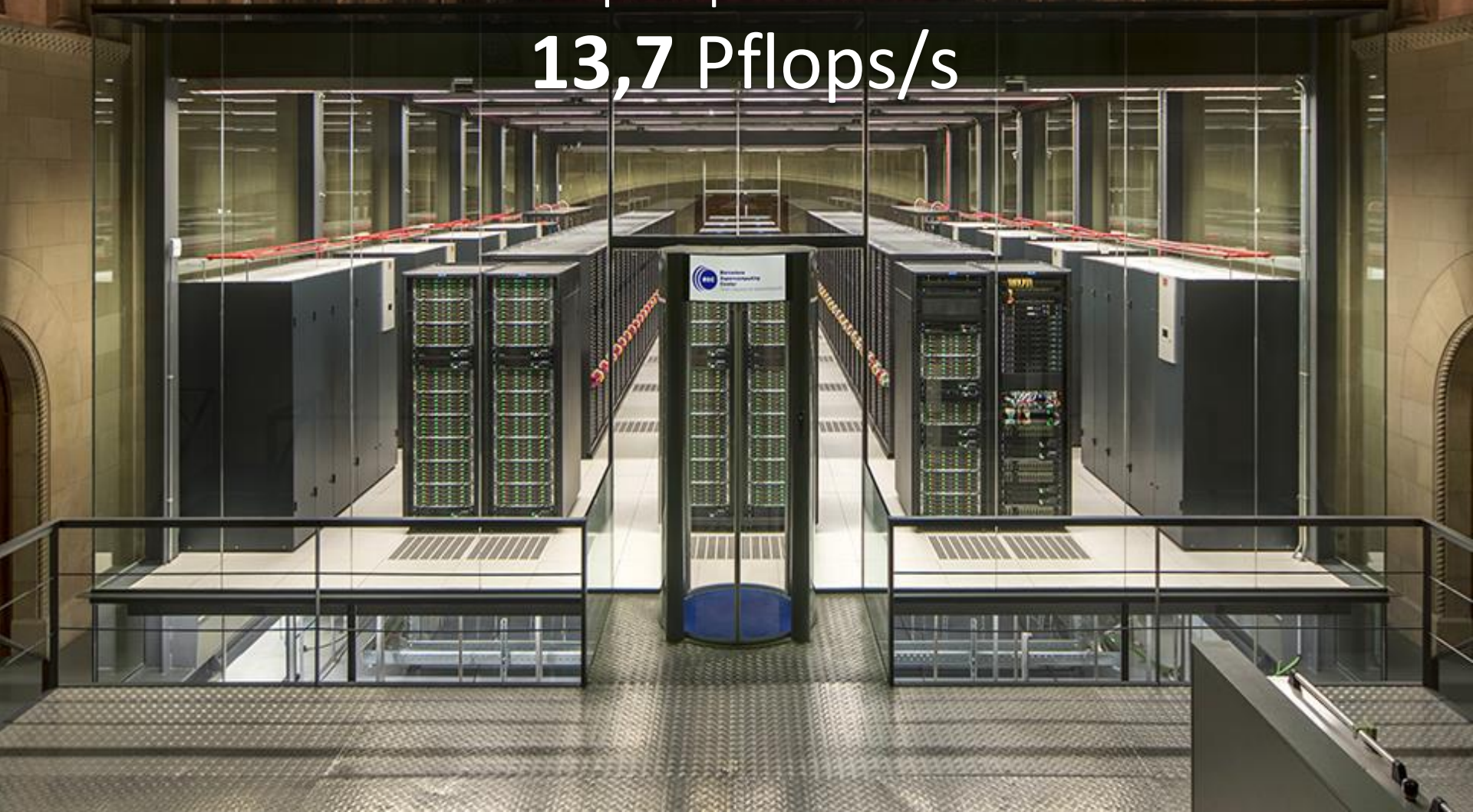
Sulfate

Sea salt

Barcelona Supercomputing Center The MareNostrum 4 supercomputer

Total peak performance:

13,7 Pflops/s



Earth Sciences Department at BSC

Environmental modelling and forecasting, with a particular focus on weather, climate and air quality



AXA
Research Fund

Service Users Sectors



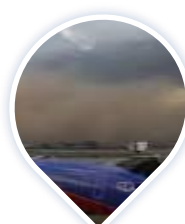
Infrastructures



Solar
Energy



Urban
development



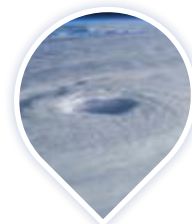
Transport



Wind
Energy



Agriculture



Insurance

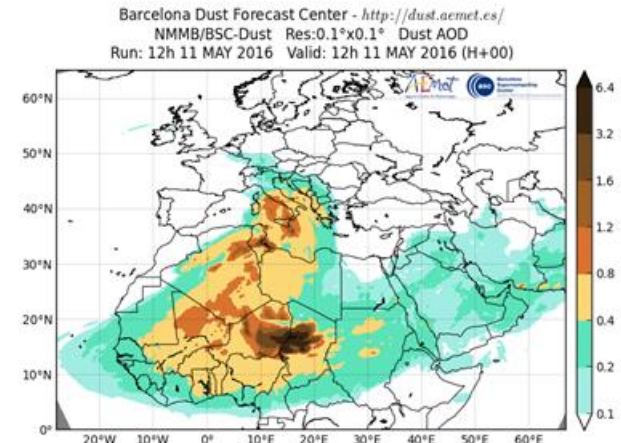
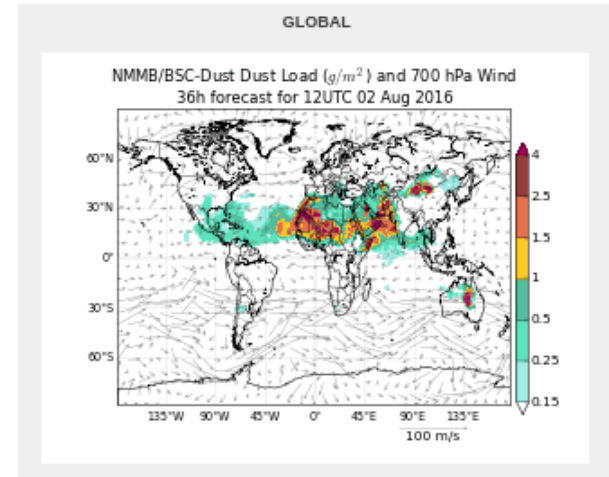


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www.bsc.es/ess/

Mineral Dust Services

- **BSC dust operational forecast** (global and regional domains)
 - Contribution to the **SDS-WAS** (regional) and **ICAP** (global) multi-model ensembles
- **WMO Dust Regional Centers**
 - **Barcelona Dust Forecast Center.** First specialized WMO Center for mineral dust prediction. Started in 2014 - **Operational**
 - <http://dust.aemet.es>
 - *@Dust_Barcelona*
 - **SDS-WAS Regional Center.** Sand and Dust Storm Warning Advisory and Assessment System. Started in 2010 – **Research**
 - <http://sds-was.aemet.es>



The WMO SDS-WAS project

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World Meteorological Organization
Weather • Climate • Water

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WWRP > SDS >

WMO Sand and Dust and Asses (SD



The SDS-WAS programme at WMO

SDS-WAS was established in 2007 in respon to improve capabilities for more reliable san products from atmospheric dust models may areas of societal benefit. It will rely on real-

More than 15 organizations currently prov regions. The SDS-WAS integrates research agricultural users). SDS-WAS is establishe regional nodes. At the moment two nodes Europe Node (hosted by Spain) and the Asi is to achieve comprehensive, coordinat capabilities of sand and dust storms in or storms to increase the understanding of th capabilities.

Scientific background and modeling of sand

SDS-WAS

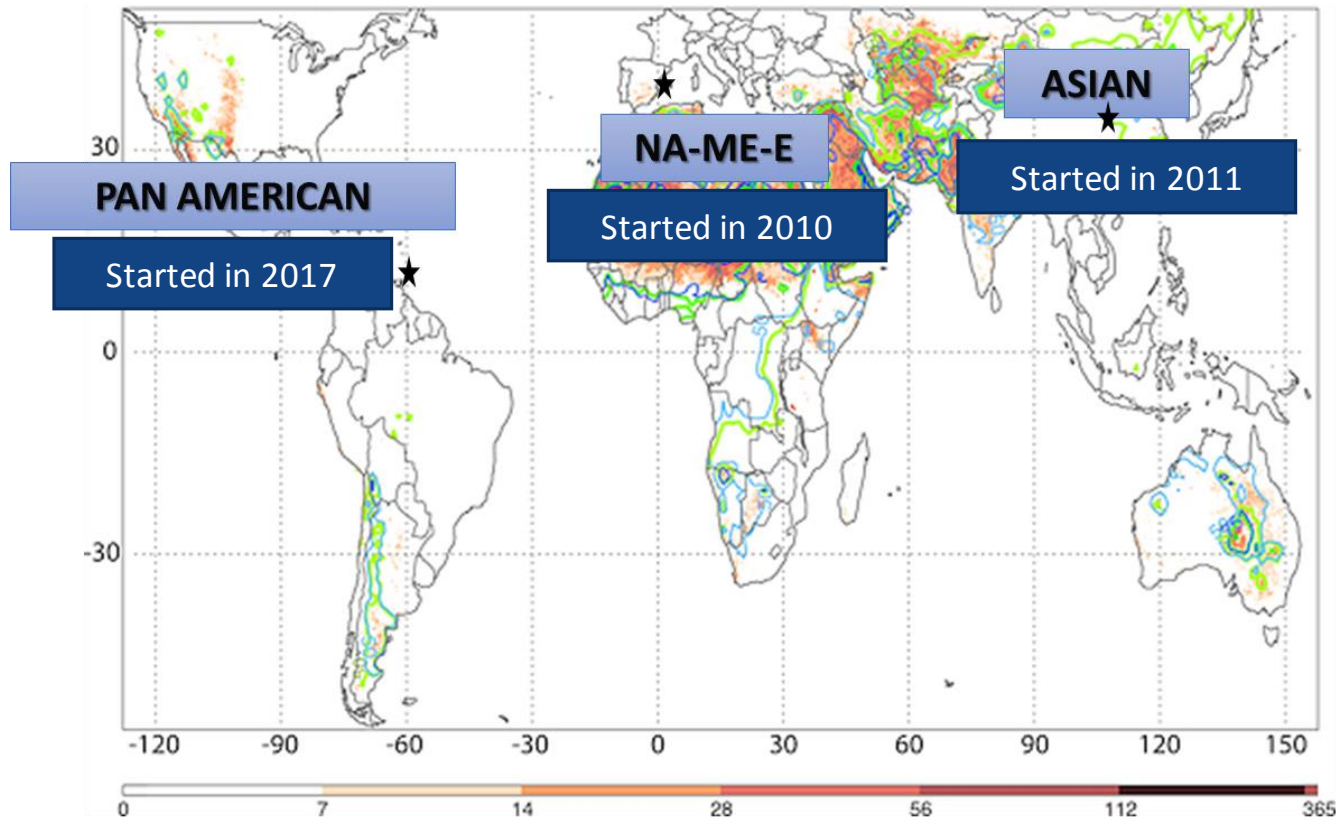
Science and I

Organizations currently

OBJECTIVES:

- Identify and improve products to monitor and predict atmospheric dust by working with research and operational organizations, as well as with users
- Facilitate user access to information
- Strengthen the capacity of countries to use the observations, analysis and predictions provided by the WMO SDS-WAS project

SDS-WAS and the Regional Nodes/Centers



Annual mean frequency distribution of M-DB2 (2003–2009) DOD > 0.2 (red), TOMS (1980–1991) aerosol index ≥ 0.5 (blue), and OMI (2004–2006) aerosol index ≥ 0.5 (green). The isocontours of TOMS and OMI have been removed over oceans for clarity.

Extracted from Ginoux et al. (2012, Rev. Geophys.)



WORLD
METEOROLOGICAL
ORGANIZATION

SDS-WAS and the NAMEE Regional Center

<http://sds-was.aemet.es/>

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NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

World Meteorological Organization
WMO SDS WAS || Asia Regional Center || America Regional Center

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Northern Africa-Middle East-Europe (NA-ME-E) Regional Center
by Francesco Benincasa — last modified May 29, 2012 03:33 PM

Outstanding

- [The InDust COST Action website has been launched](#)
- [RGB dust product from Himawari-8 and GOES-16](#)
- [Training Workshop on Sand and Dust Storms in the Arab Region](#)
- [The 9th International Workshop on Sand / Dust storm and Associated Dustfall. Call for Abstracts](#)
- [InDust](#)

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To be informed about our activities, news and events related to dust. Frequency is almost monthly.

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Your email

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Portal manual

Please find a brief manual [here](#).

Latest News

- [Paper on statistical evaluation of dust events in West Asia](#)
May 08, 2018
- [CAMS releases first five years of new global reanalysis data](#)

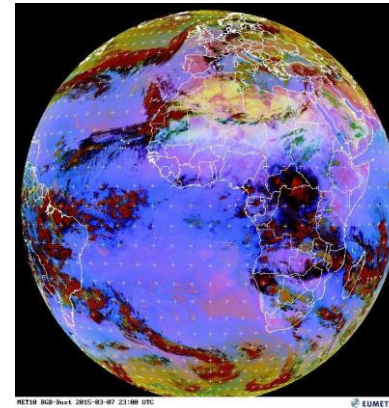
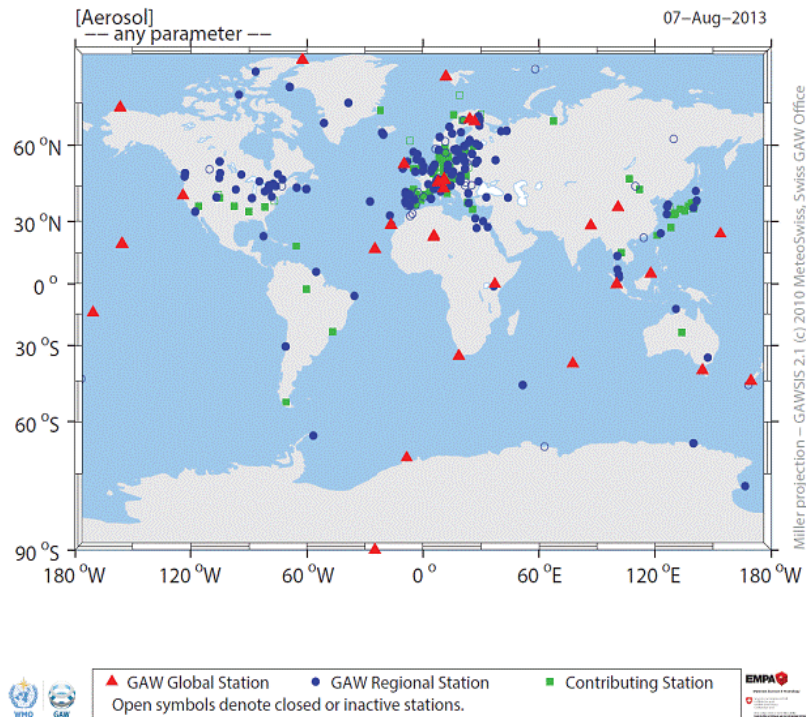
Dust forecasts

WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)

Dakar (Senegal) - April 2018

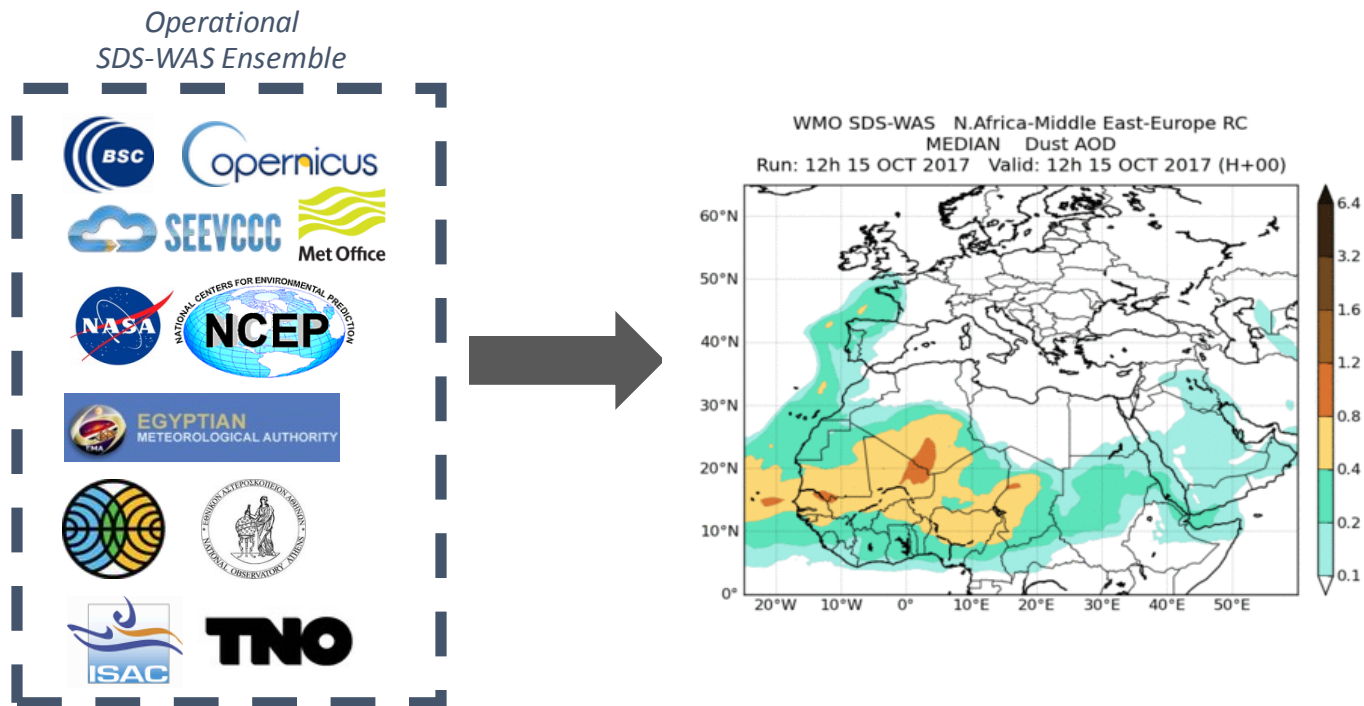
SDS-WAS NAMEE: Observations

- Better understanding and track of SDS → **Dust-filtered observations**
- Used for model evaluation and data assimilation
- **Lack of observations**, particularly in Africa



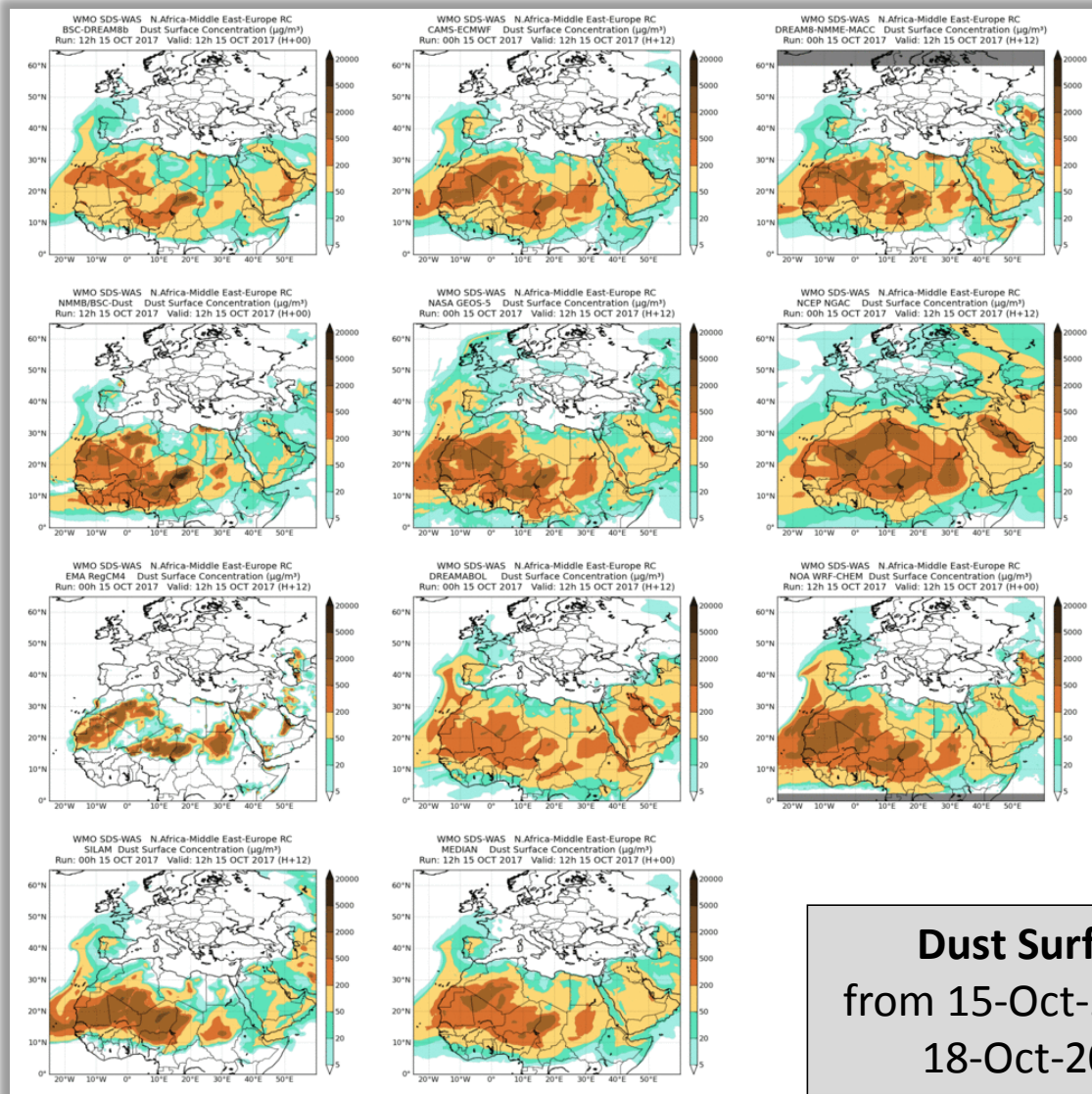
SDS-WAS NAMEE: Modelling

Products: surface concentration and DOD maps, the SDS-WAS multi-model product



12 Global – Regional models from ~ 100 to 10 km

SDS-WAS NAMEE: Joint Visualization



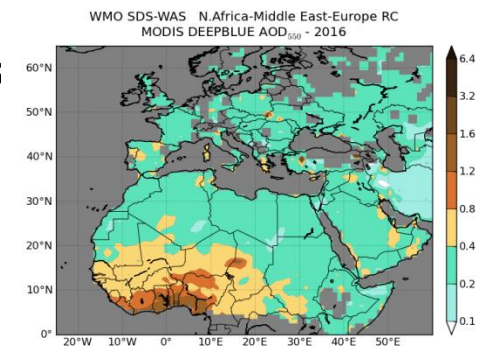
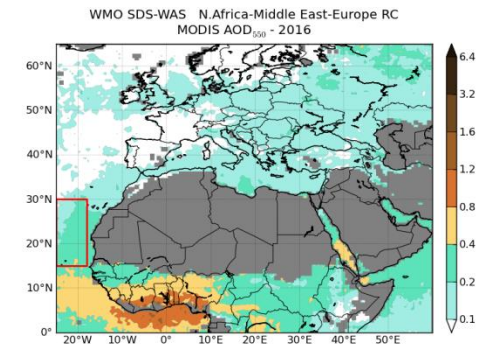
Dust Surface Conc.
from 15-Oct-2017 12:00 to
18-Oct-2017 00:00

SDS-WAS NAMEE: DOD Model Evaluation

- **Evaluation with AERONET data**
 - Graphical NRT Evaluation by site
 - Evaluation scores monthly/seasonal/annual and sites
- **Evaluation with MODIS data onto the Atlantic**
 - Evaluation scores monthly/seasonal/annual

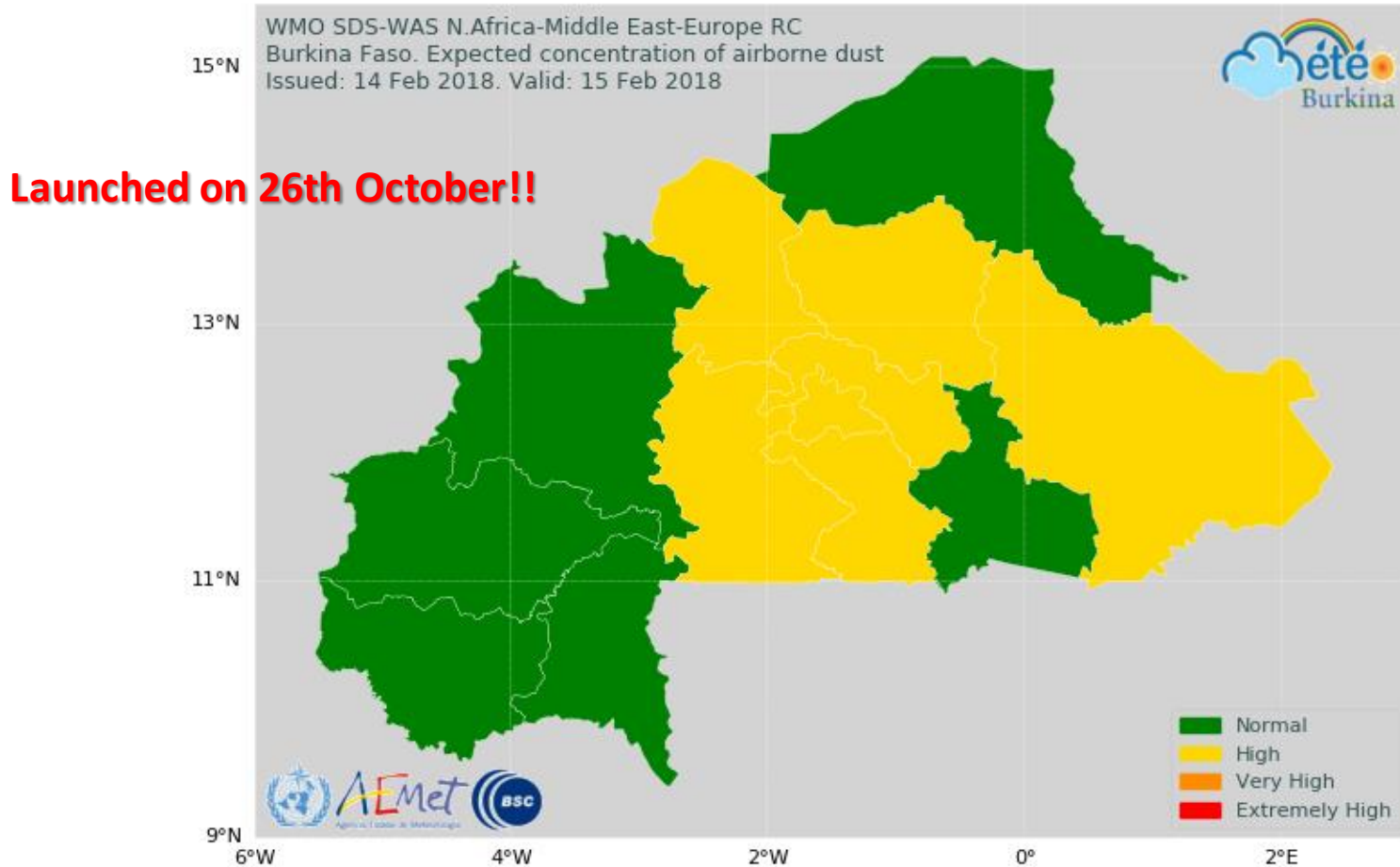


- **Evaluation of dust models with MODIS Deep Blue retrievals**
 - Evaluation scores monthly/seasonal/annual



<http://sds-was.aemet.es/forecast-products/forecast-evaluation>

SDS-WAS NAMEE: Early Warning System for Burkina Faso





<https://sds-was.aemet.es/forecast-products/burkina-faso-warning-advisory-system>

Barcelona Dust Forecasting Center

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LATEST NEWS

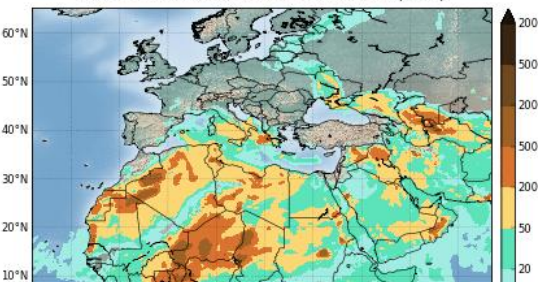
Barcelona Dust Forecast Center starts operations

The Center will release operational dust forecasts for Northern Africa, Middle East and Europe

[Read More](#)



Barcelona Dust Forecast Center
NMMB/BSC-Dust Res: 0.1°x0.1° Dust Surface Conc. (µg/m³)
Run: 12h 19 MAY 2014 Valid: 18h 20 MAY 2014 (H+30)



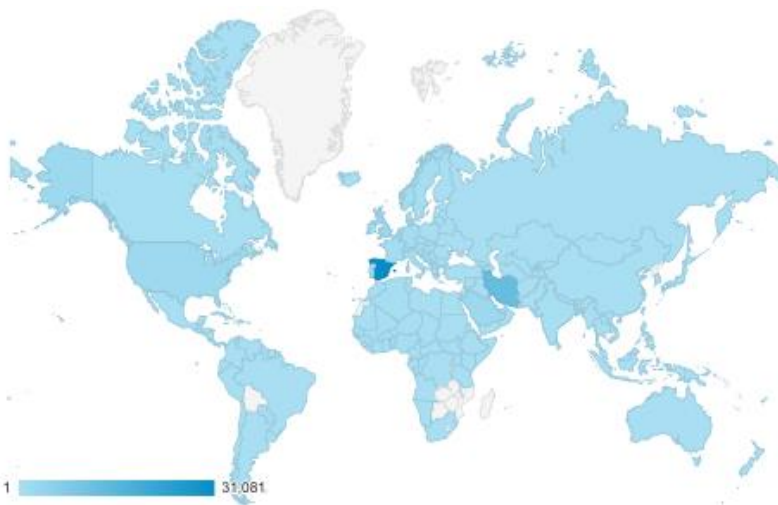
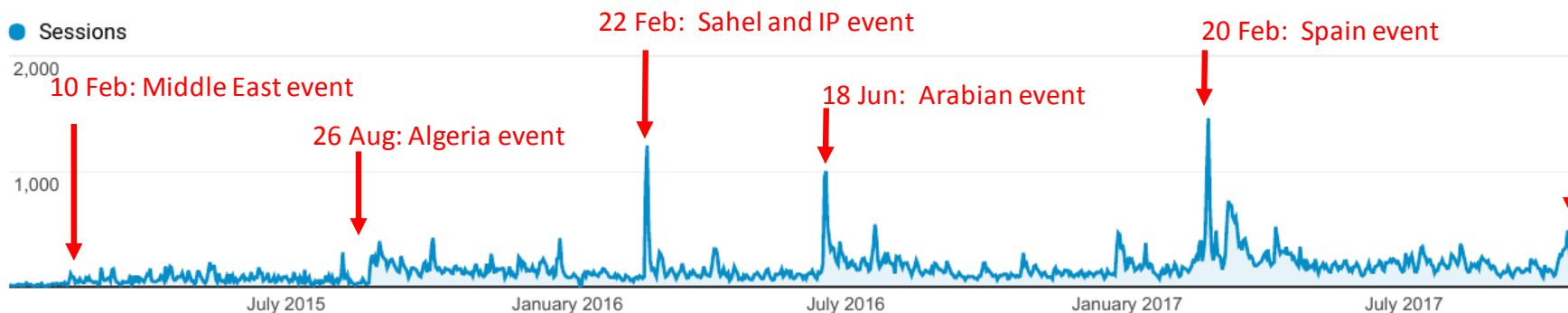
Dust forecast

Latest dust forecast for Northern Africa, Middle East and Europe

[Check it here](#)

Barcelona Dust Forecasting Center

Website visits (<http://dust.aemet.es/>): 1 January 2015 – 20 October 2017



Agencia Estatal de Meteorología

BSC

Tweets 736 Siguiendo 102 Seguidores 1.583 Me gusta 268

Barcelona Dust
@Dust_Barcelona Te sigue

Barcelona Dust Forecast Center - The

Tweets Tweets y respuestas Multimedia

Barcelona Dust retweeted
WMO | OMM @WMO - 5 h
The cones from Khartoum. Subs from @MohammedShawi. Find out more

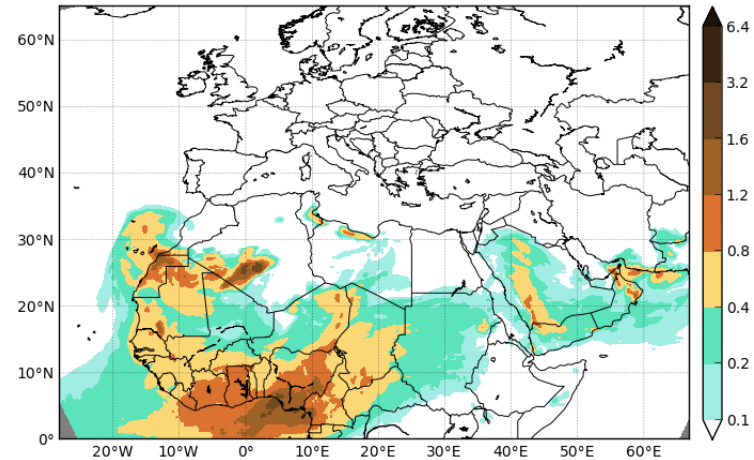
 **@Dust_Barcelona**

Barcelona Dust Forecasting Center

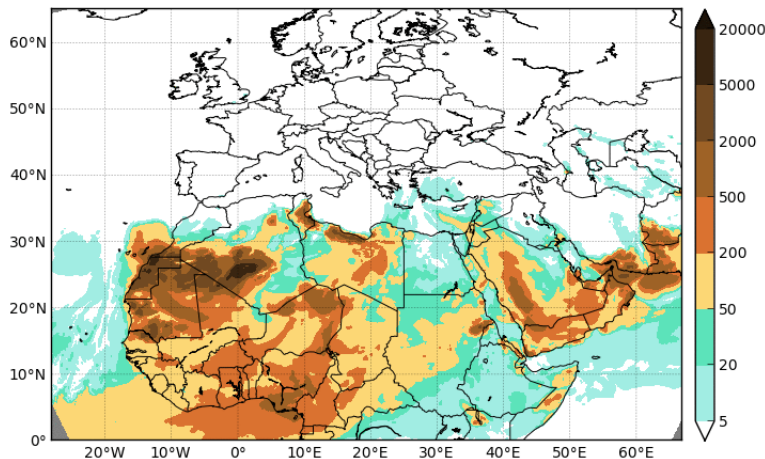
72-hours forecasts of:

- *Dust Optical Depth at 550nm*
- *Dust Dry and Wet Deposition*
- *Dust Load*
- *Dust Surface Concentration*
- *Dust Surface Extinction at 550nm*

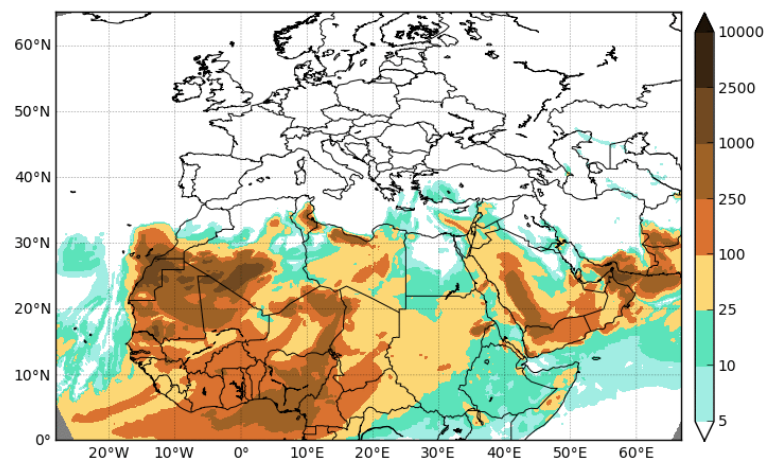
Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Ext. (Mm^{-1})
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)

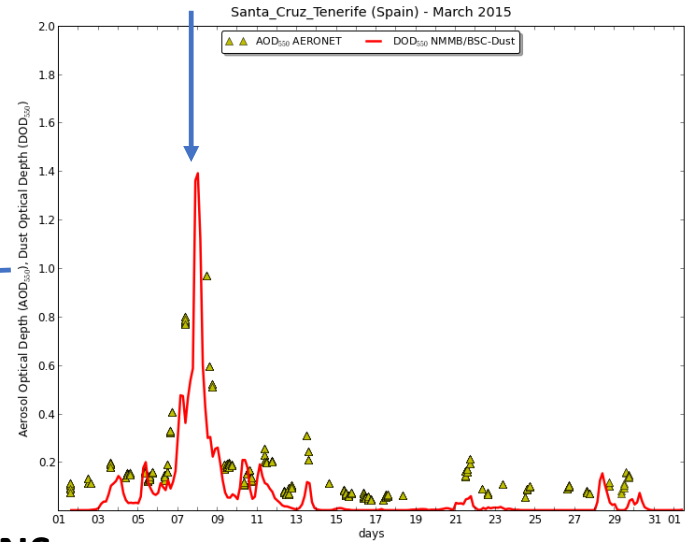
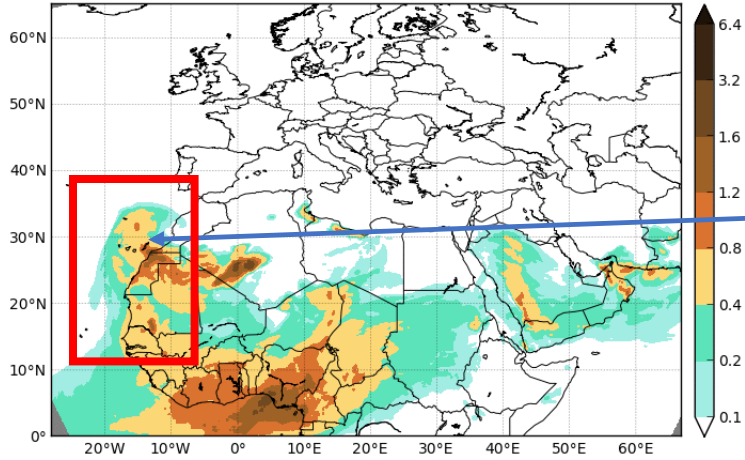


Barcelona Dust Forecasting Center

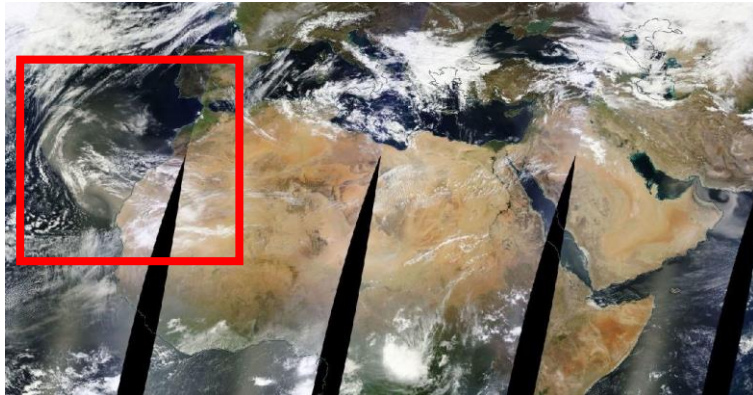
— Model
 ▲ AERONET Obs.

MODEL

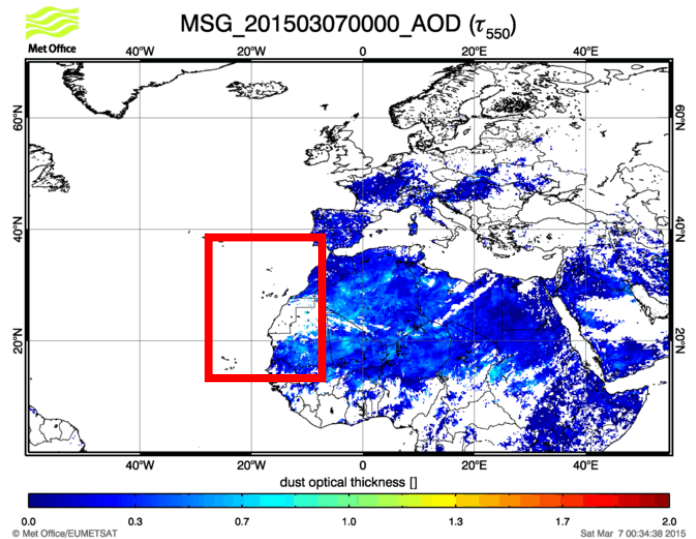
Barcelona Dust Forecast Center
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



OBSERVACIONES



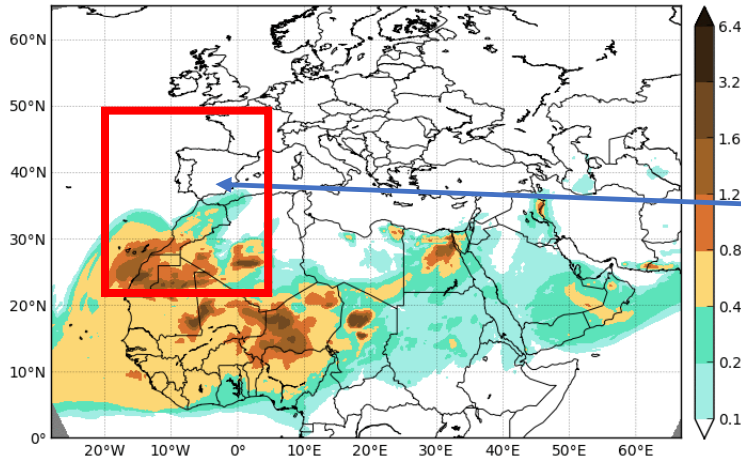
MODIS composite 8th March
 from EOSDIS World Viewer



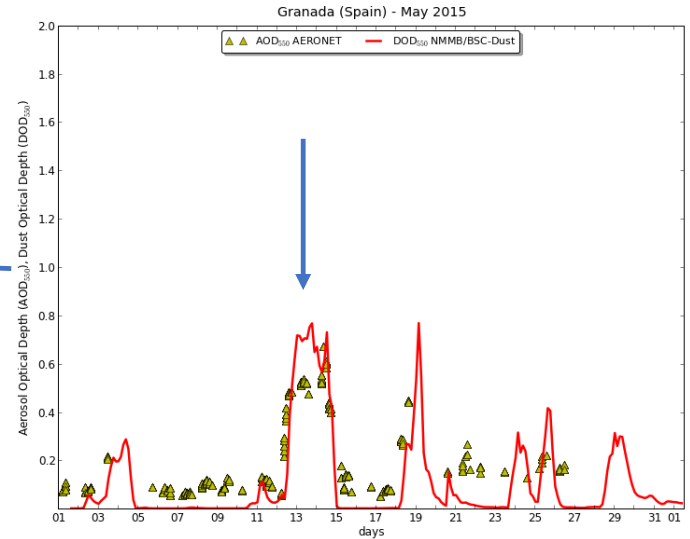
Barcelona Dust Forecasting Center

MODEL

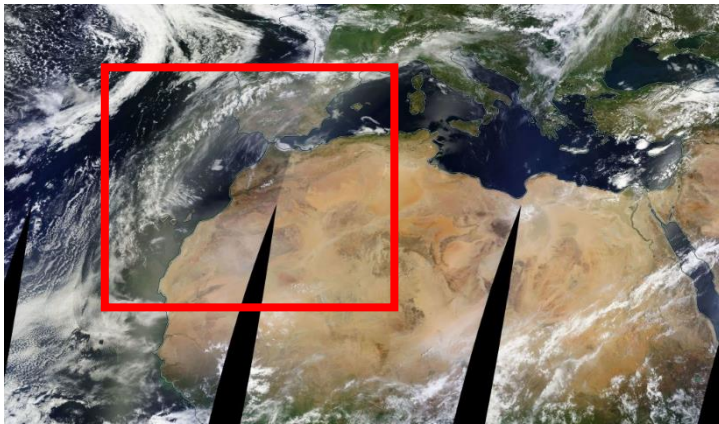
Barcelona Dust Forecast Center
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 11 MAY 2015 Valid: 12h 11 MAY 2015 (H+00)



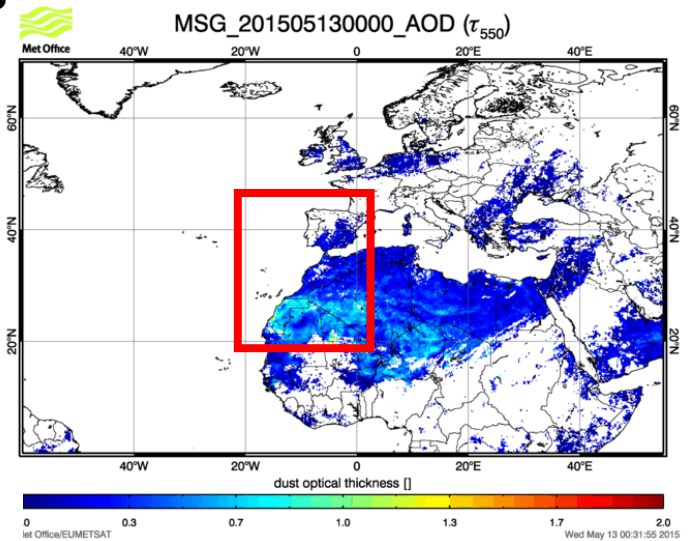
— Model
 ▲ AERONET Obs.



OBSERVACIONES



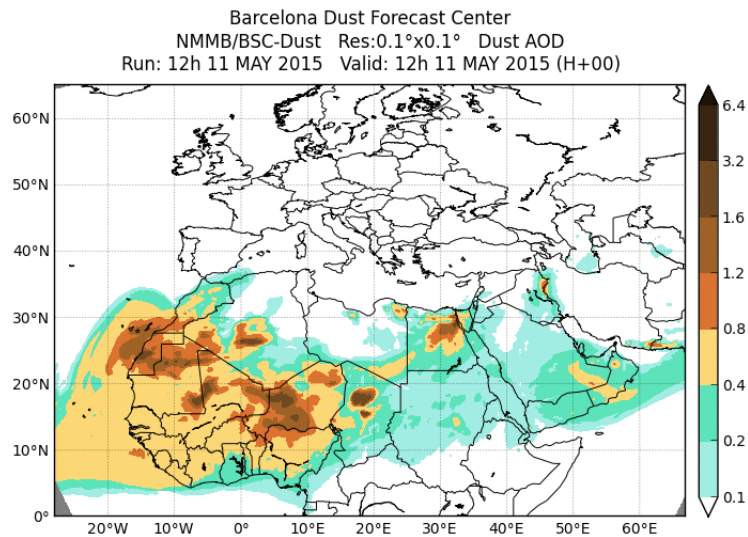
MODIS composite 13th May
 from EOSDIS World Viewer



End-users?

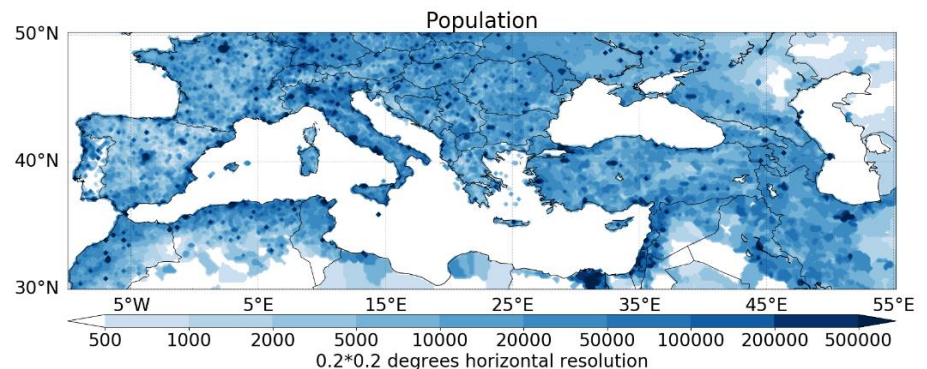
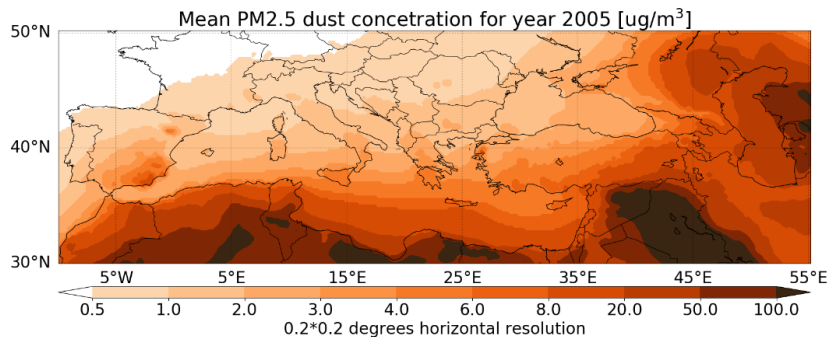
72-hours forecasts of:

- *Dust Optical Depth at 550nm*
- *Dust Dry and Wet Deposition*
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- *Dust Surface Concentration*
- *Dust Surface Extinction at 550nm*



Pilot studies on health impact

NMME-DREAM model simulations



CRF functions

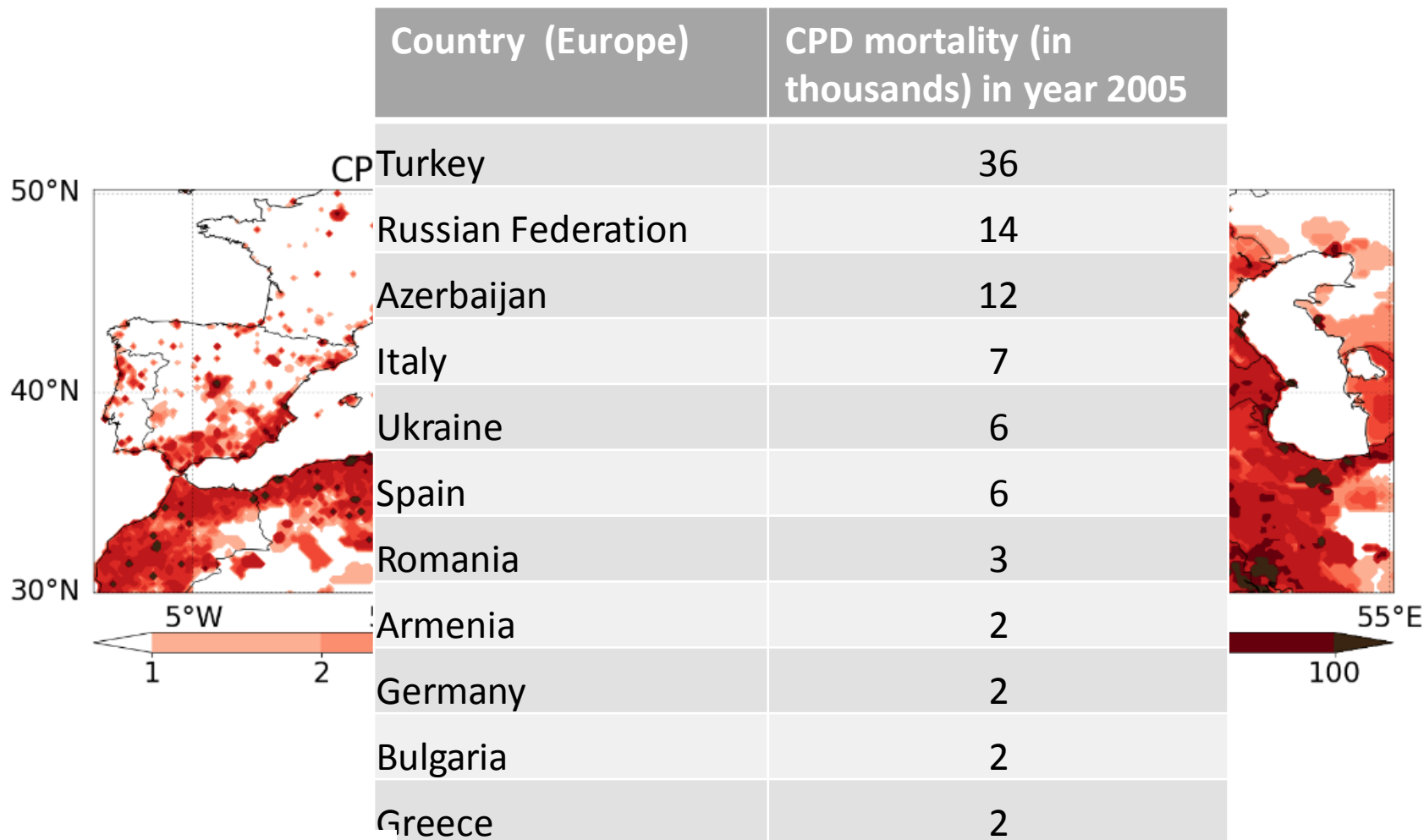
- $\Delta\text{Mort} = y_0 * (1 - e^{-\beta \Delta X}) * \text{Population}$

where ΔMort is the change in annual mortality due to a pollutant, y_0 the baseline mortality rate (BMR) for a given population, β the concentration–response function (CRF), ΔX the change in concentration of a given pollutant X relative to clean conditions

- Concentration response function describes increased risk of a population to certain diseases when exposed to a particular pollutant
- The CRFs used in this study (Krewski et al. (2009), Lelieveld et al. (2013)) based on American Cancer Society (ACS) Cancer Prevention Study II (CPS-II). **CRFs used may not be representative for all regions**

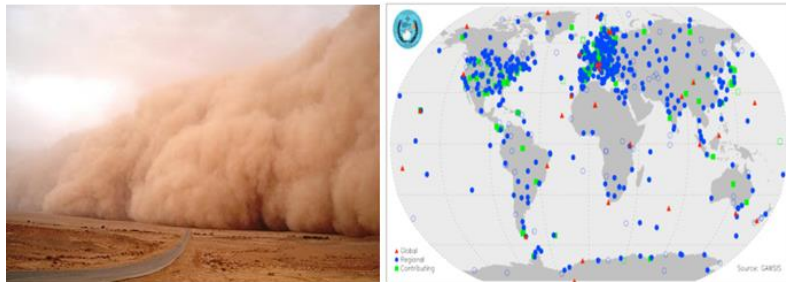
Pilot studies on health impact

Cardio Pulmonary Diseases Mortality with dust contribution to PM2.5

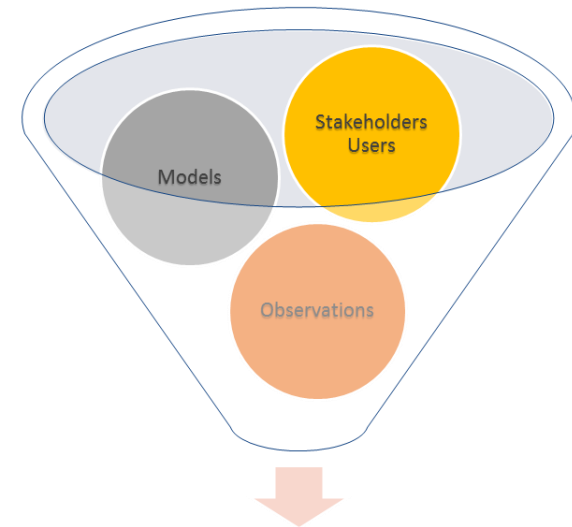


Dust Storms Assessment for the development of user-oriented Climate Services in Northern Africa, Middle East and Europe

- SDS is a serious hazard for life, health, environment and economy
- Lack of dust observations (past trends and current conditions)



GOAL: Develop dust-related services to specific socio-economic sectors based on an advanced dust reanalysis for the NAMEE region



Dust-related Climate Services



International Network to Encourage the Use of Monitoring and Forecasting Dust Products

inDust

COST Action CA16202



Background

- Sand and Dust Storms (SDS) play a significant role in different aspects of weather, climate and atmospheric chemistry and represent a **serious hazard** for life, health, property, environment and economy.
- Understanding, managing and mitigating SDS **risks** and **effects** requires fundamental and cross-disciplinary knowledge.



Tehran, Iran, June 2014



Our goals

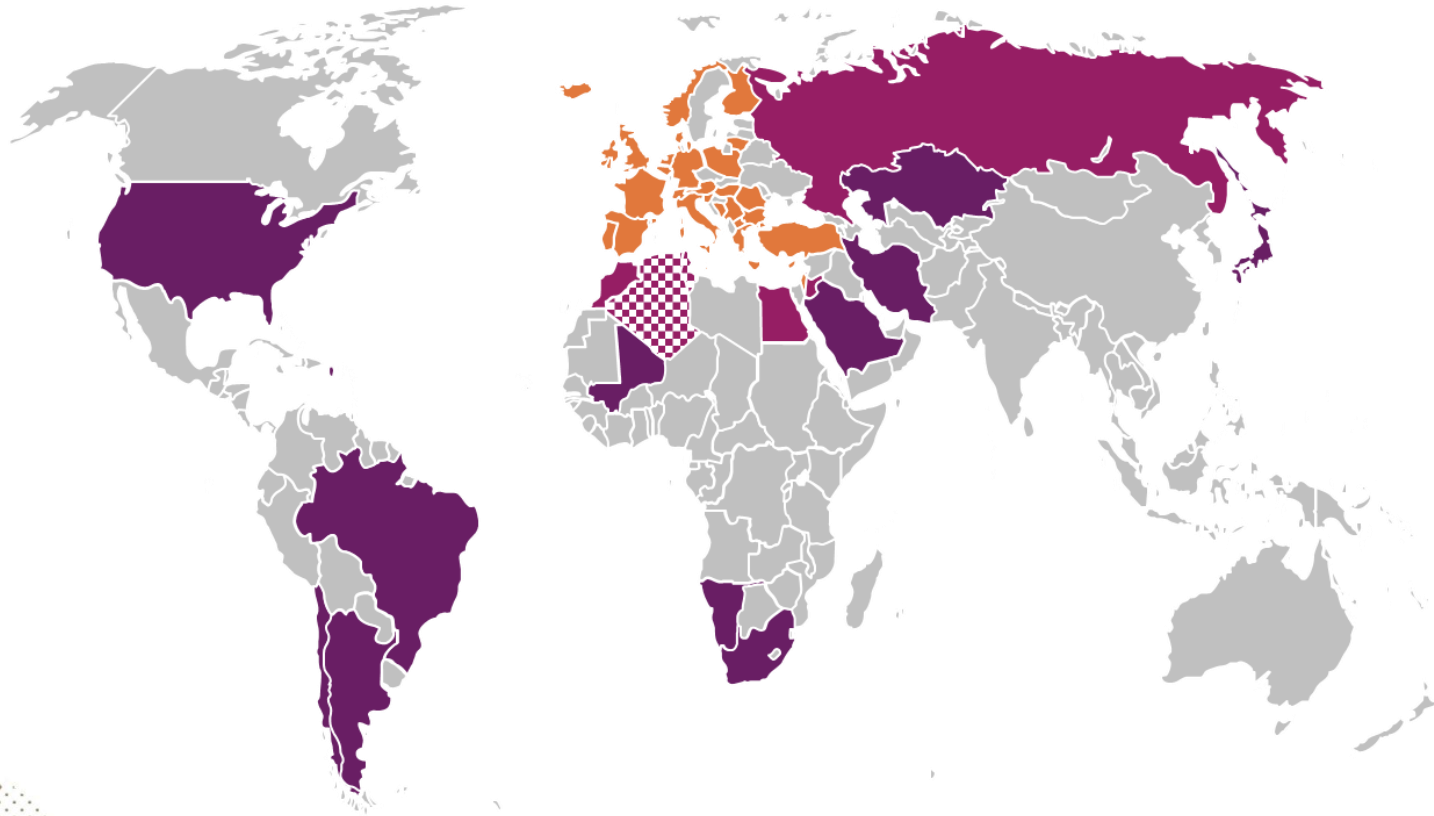
- To **establish a network** involving research institutions, service providers and potential end users of

inDust is looking for
dust user-oriented services

- To **assist** the diverse socio-economic sectors affected by the presence of high concentrations of airborne mineral dust.



inDust Countries



- COST countries (in total 29)
- Near-Neighbour Countries (Egypt, Jordan, Lebanon, Morocco, Russia, *Algeria*)
- International Partner Countries
- International organisation (WMO, *ECMWF*)



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InDust

COST ACTION CA16202





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Thanks!



inDust



Acknowledge to AERONET, MODIS, U.K. Met Office MSG, MSG Eumetsat and EOSDIS World Viewer principal investigators and scientists for establishing and maintaining data used in the present contribution. Also special thank to all researchers, data providers and collaborators of the WMO SDS-WAS NA-ME-E Regional Node.

InDust (COST Action CA16202, www.cost-indust.eu) and ERA4CS are gratefully acknowledged. Also thanks to AXA Research Fund for funding aerosol research at the Barcelona Supercomputing Center through the AXA Chair on Sand and Dust Storms.

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Barcelona Dust Forecasting Center

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 27 OCT 2018 Valid: 12h 27 OCT 2018 (H+00)

