



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación



EXCELENCIA
SEVERO
OCHOA

Possible use of BSC facility for SEE-MHEWS Advisory System

Francesco Benincasa



- **Presentation**
- The WMO SDS-WAS NA-ME-E Regional Center
- The Barcelona Dust Forecast Center
- The BSC-CNS supercomputing facilities
- The NMMB-MONARCH model
- Some estimations

What

Environmental modelling and forecasting

How

Develop a capability to model air quality processes from urban to global and the impacts on weather, health and ecosystems

Implement climate prediction system for subseasonal-to-decadal climate prediction

Develop user-oriented services that favour both technology transfer and adaptation

Use cutting-edge HPC and Big Data technologies for the efficiency and user-friendliness of Earth system models

Why

Our strength ...

- ... research ...
- ... operations ...
- ... services ...
- ... high resolution ...

Earth system
services

Climate
prediction

Atmospheric
composition

Computational
Earth sciences

- Computer scientist working as Research Support Engineer
- Computational Earth Sciences Group - Data and Diagnostics Team
- Specialist in (Big) Data analysis and management
- Developer and maintainer of the two WMO dust centers:
 - WMO SDS-WAS NA-ME-E Regional Center: <http://sds-was.aemet.es>
 - Barcelona Dust Forecast Center: <http://dust.aemet.es>

- Presentation
- The WMO SDS-WAS NA-ME-E Regional Center
- The Barcelona Dust Forecast Center
- The BSC-CNS supercomputing facilities
- The NMMB-MONARCH model
- Some estimations



You are here: Home

Northern Africa-Middle East-Europe (NA-ME-E) Regional Center

by Francesco Benincasa — last modified May 29, 2012 03:33 PM

Outstanding

Latency in the provision of numerical forecasts

WMO Bulletin: Airborne Dust article

Kick-off meeting of the WMO SDS-WAS Steering Committee

The edge of crisis: Dust and sand storms

New product to monitor dust events

Subscribe to the Public Newsletter!

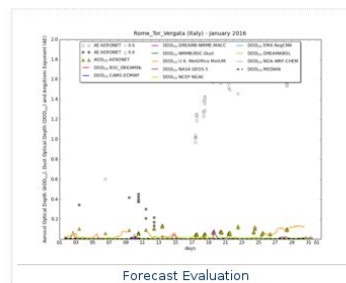
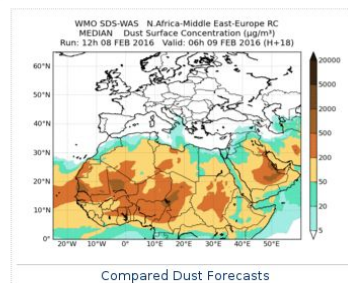
To be informed about our activities, news and events related to dust. Frequency is almost monthly.

Subscribe

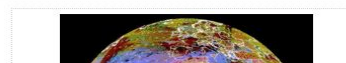
Portal manual

Please find a brief manual here.

Dust forecasts



Dust observations



Latest News

Released article introducing a new climatological index that modulates dust activity over SW Asia

Jan 13, 2016

Materials from the workshop on the health impact of dust held in Amman

Dec 17, 2015

National Observatory of Athens contributes to the SDS-WAS model intercomparison

Dec 17, 2015

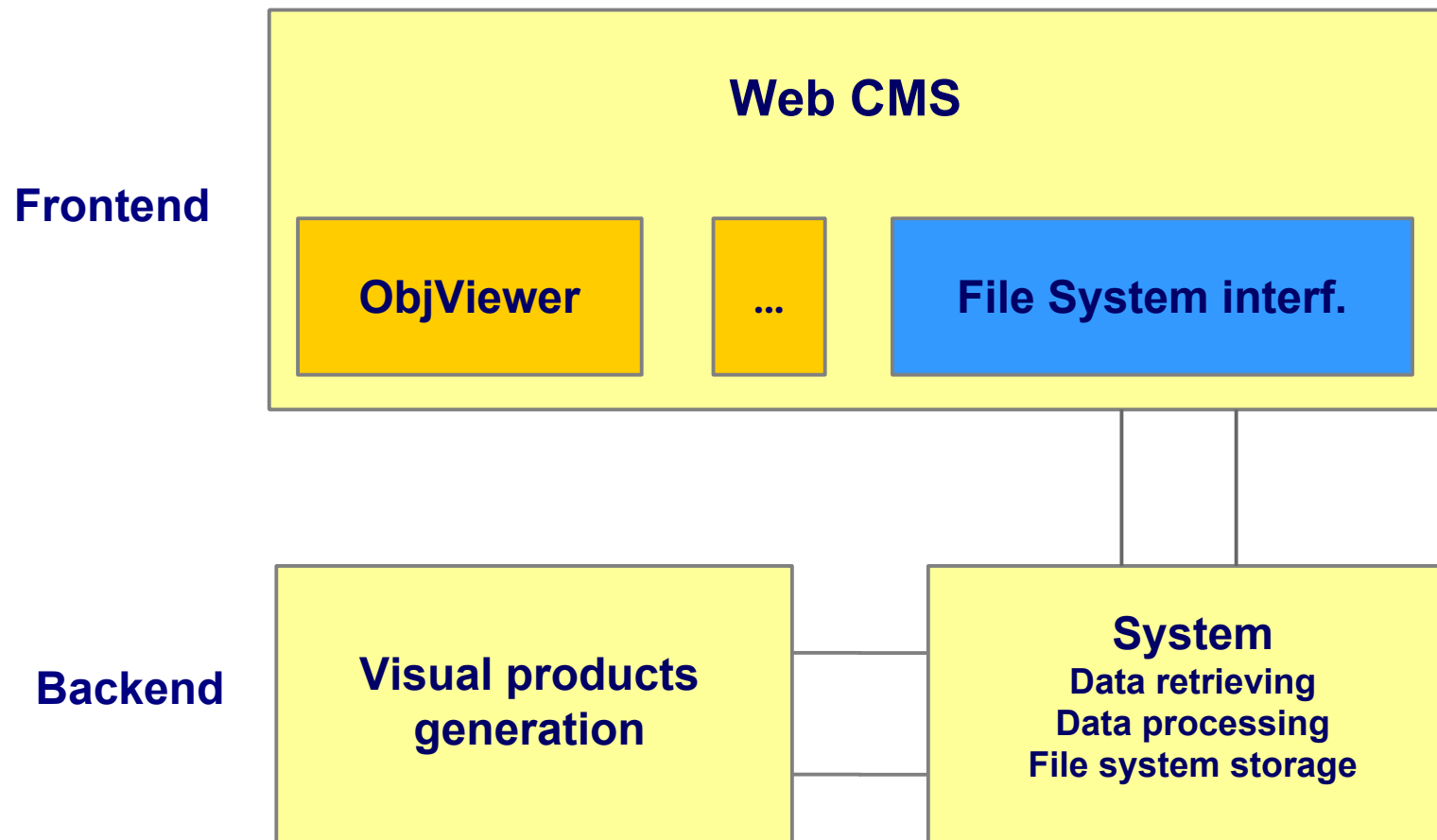
Upcoming Events

34th National & 2nd International Geosciences

- *Research and development warning advisory & assessment system*
- *Ensemble of models provided by various international partners*
- *Provides:*
 - . *Model inter-comparison*
 - . *Multi-model products*
 - . *AERONET evaluation*
 - . *Satellite (MODIS, ...) evaluation*
 - . *Numerical scores (BIAS, ...)*
 - . *Datasets download*

The system is managed by a consortium of AEMET and BSC in Barcelona, Spain

Current Architecture



Retrieving

- Data models from 12 contributions of 11 institutions of 9 countries (Spain, UK, Serbia, US, Egypt, Italy, Greece, Norway, Netherlands) with 2 variables (SCONC_DUST, OD550_DUST)
- Data observations (AERONET, MODIS, MODIS DB, ...)
- External observational products (MSG RGB EUMETSAT, MSG UK MetOffice, Debra-Dust, ...)

Producing

- 72h 6-hourly dust forecasts of 2 variables (Surface concentration and Aerosol optical depth) of 12 numerical models + 4 multi-model products
- Models evaluation against observations
- Time averaged values
- Studies of dust episodes
- Workshops, training courses and seminars (with materials)

Browsable images

○ Forecast

You are here: [Home](#) > [Forecast & Products](#) > [Dust forecasts](#) > [Compared dust forecasts](#)

Compared dust forecasts

by Francesco Benincasa — last modified Mar 06, 2015 02:57 PM

Date: 2015-10-29  H+ anim 

[Doc on model inter-comparison](#)

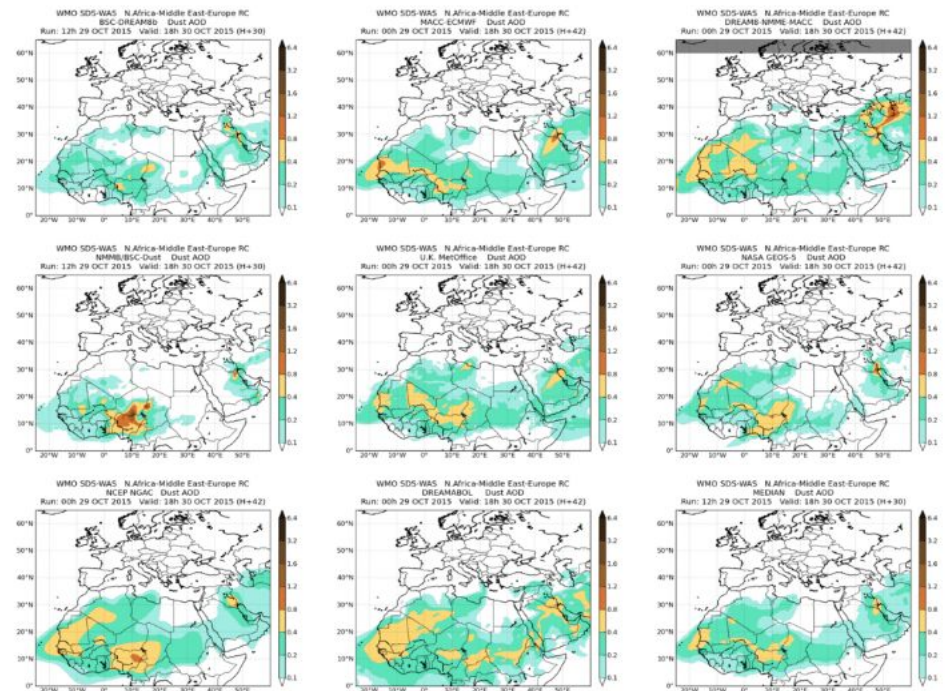
[Forecast evaluation](#)

[Multimodel Products](#)

Please be sure to read the [data policy](#).

NOTE: Click on the images to enlarge.

Dust optical depth:



[Download full image](#)

Browsable images

- Forecast
- Multi-model Products

You are here: [Home](#) > [Forecast & Products](#) > [Dust forecasts](#) > [Multimodel Products](#)

Multimodel Products

by [Francesco Benincasa](#) — last modified Oct 14, 2014 12:30

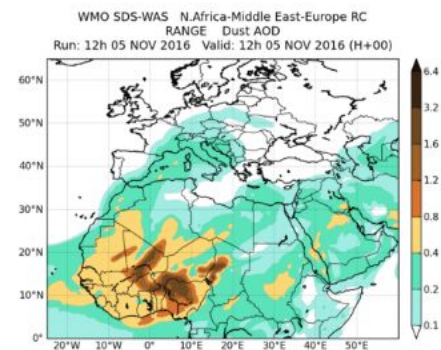
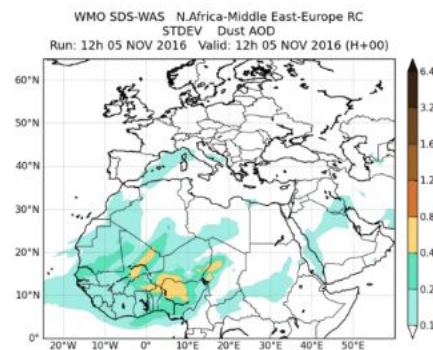
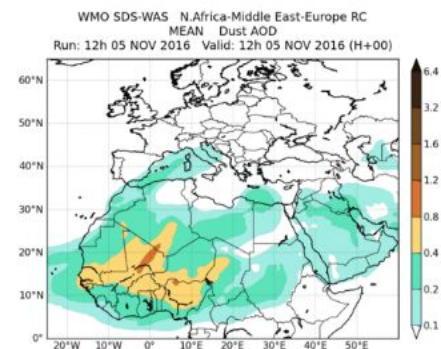
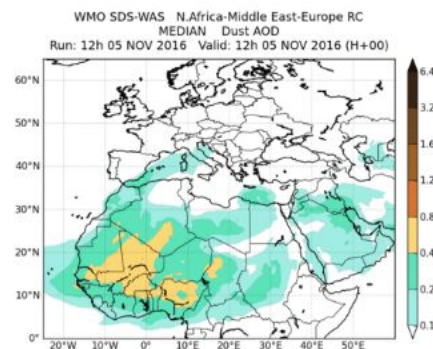
Date: 2016-11-05  H+ 

Compared dust forecasts

Evaluation of the multi-model median

NOTE: Click on the images to enlarge.

Dust optical depth:



[Download full image](#)

Browsable images

- Forecast
- Multi-model Products
- Evaluation
 - AERONET

You are here: [Home](#) > [Forecast & Products](#) > [Forecast evaluation](#) > [Santa_Cruz_Tenerife - Spain](#)

Santa_Cruz_Tenerife - Spain

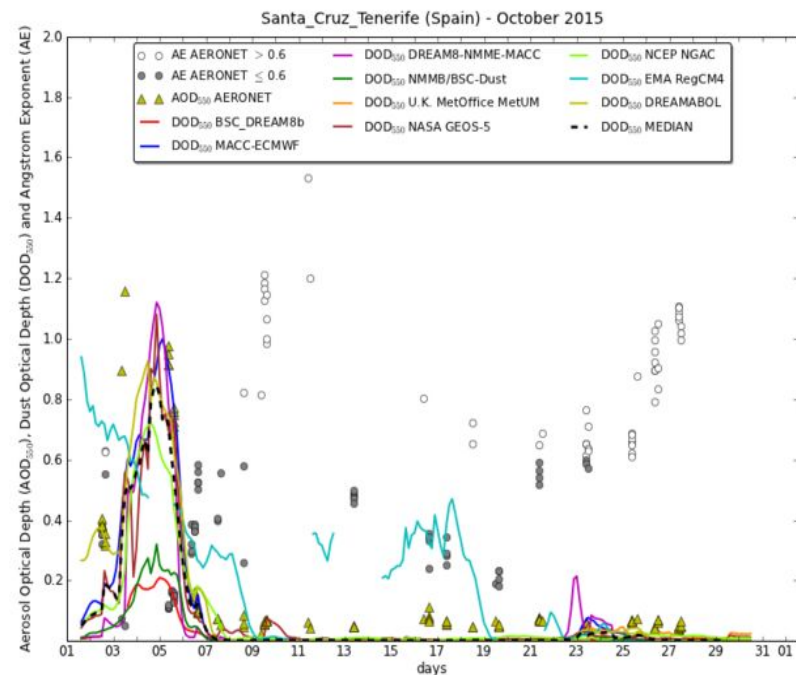
by [Francesco Benincasa](#) — last modified Jul 17, 2014 06:20 PM

Select another station

Date:

[<< Back to Station Selection](#)

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Browsable images

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- Multi-model Products
- Evaluation
 - AERONET
 - MODIS DT

You are here: [Home](#) > [Forecast & Products](#) > [Forecast evaluation](#) > [Evaluation of Saharan Dust Transport onto the Atlantic](#)

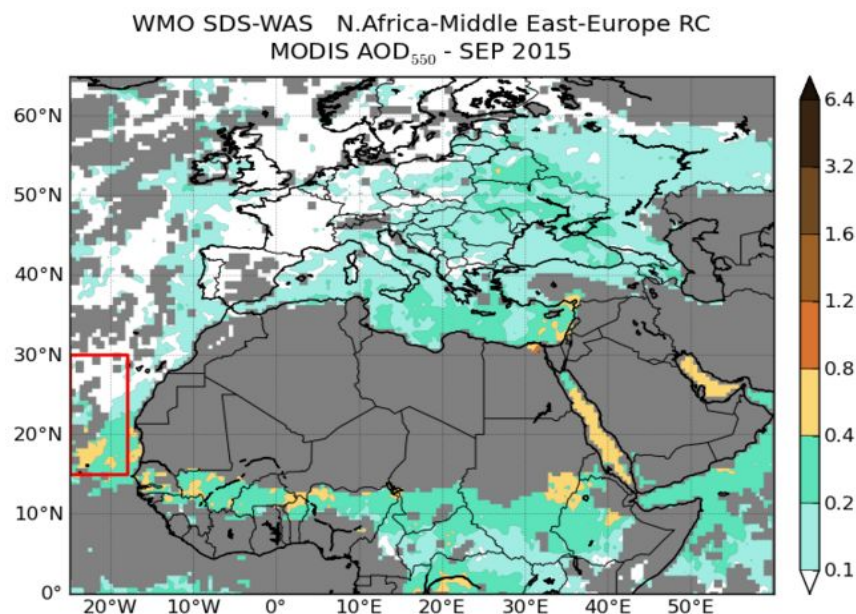
Monthly Evaluation

by [Francesco Benincasa](#) — last modified Dec 03, 2014 01:25 PM

Date: 

[Go to Seasonal evaluation](#)

Average values of the MODIS retrievals used in the evaluation. The plot has been generated from products between the 2nd of the stamped month and the 1st of the following one.



[Download full image](#)

	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.15	0.19	0.80	1.14	1239

Browsable images

- Forecast
- Multi-model Products
- Evaluation
 - AERONET
 - MODIS DT
 - MODIS DB

You are here: [Home](#) > [Forecast & Products](#) > [Forecast evaluation](#) > [Evaluation of dust models with MODIS Deep Blue retrievals](#)

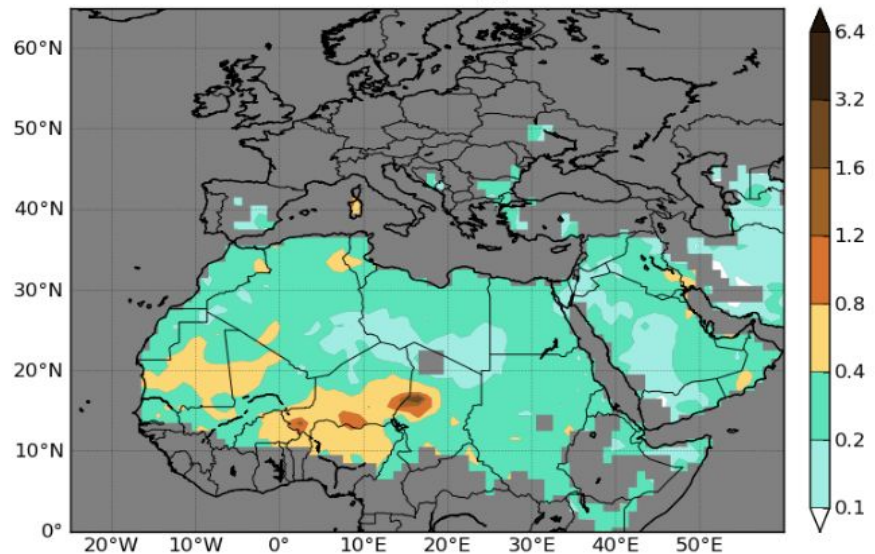
Monthly Evaluation

by [Francesco Benincasa](#) — last modified Jul 29, 2014 06:50

Date: 

Average values of the MODIS retrievals used in the evaluation (data with an Angstrom exponent above 1.0 have not been considered). The plot has been generated from products between the 2nd of the stamped month and the 1st of the following one.

WMO SDS-WAS N.Africa-Middle East-Europe RC
MODIS DEEPBLUE AOD₅₅₀ - OCT 2016



[Download full image](#)

	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.13	0.23	0.45	0.67	17766

Browsable images

- Observations
 - In-situ

You are here: [Home](#) > [Forecast & Products](#) > [Dust observations](#) > [In-situ measurements](#) > [Granadilla - Spain](#)

Granadilla - Spain

by [Enric Terradellas](#) — last modified Aug 01, 2014 10:43 AM

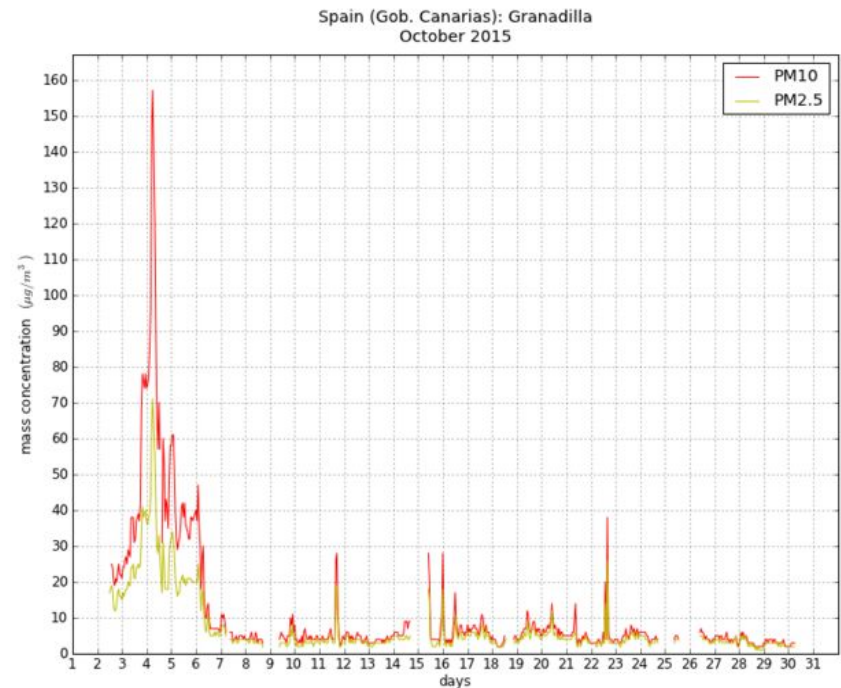
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[Check Backtrajectories >>](#)

NOTE: Click on the image to enlarge



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
Browsable images

- Observations
 - In-situ
 - MSG UK MO

You are here: [Home](#) > [Forecast & Products](#) > [Dust observations](#) > [MSG – U.K. Met Office](#)

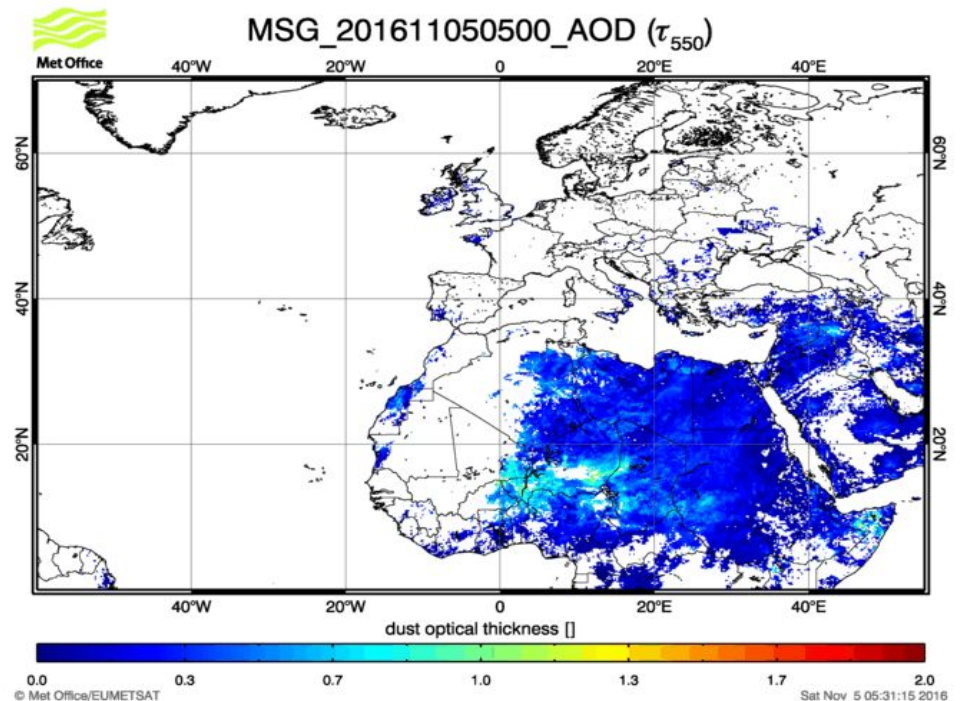
MSG – U.K. Met Office

by [Francesco Benincasa](#) — last modified Feb 12, 2013 02:03

Date: 2016-11-05  

The U.K. Met Office MSG dust product shows an estimation of the dust optical thickness retrieved from empirical relationship between SEVIRI infrared (10.8 μm) radiance and aerosol optical depth at 550nm. It is generated by transforming original retrievals to regularly-spaced grids (0.18 degree) using simple average method.

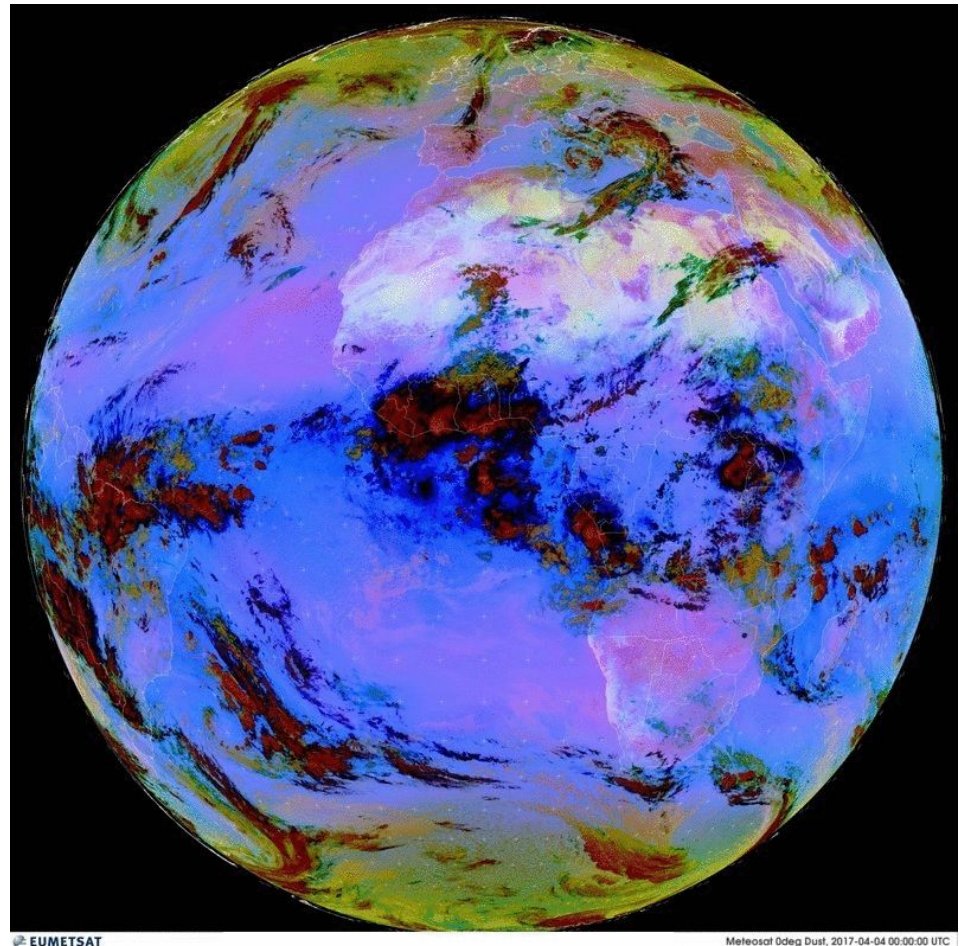
WARNING: Some level of cloud contamination may exist in the MSGAOD product due to the lack of temporal differencing scheme in the cloud processing. These artefacts are predominant over the Sahel and southern latitudes.



[Download full image](#)

Browsable images

- Observations
 - In-situ
 - MSG UK MO
 - EUMETSAT



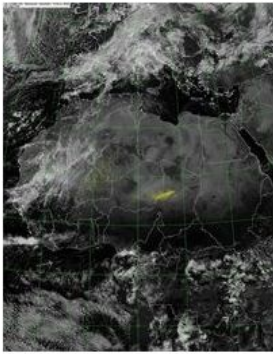




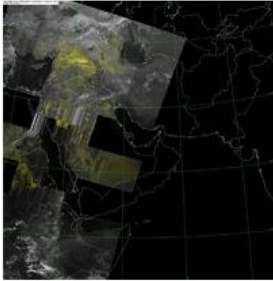



Browsable images

- Observations
 - In-situ
 - MSG UK MO
 - EUMETSAT
 - DEBRA-Dust

You are here: [Home](#) > [Forecast & Products](#) > [Dust observations](#) > [DEBRA-Dust](#)

DEBRA-Dust

by [Enric Terradellas](#) — last modified Jul 11, 2016 04:30

MSG - Africa			MSG - Atlantic	
	Latest Image 5-hour loop 4-week archive	  		Latest Image 5-hour loop 4-week archive
Suomi NPP VIIRS - West Asia				
	Latest Image 3-day loop 4-week archive	  		

Browsable images

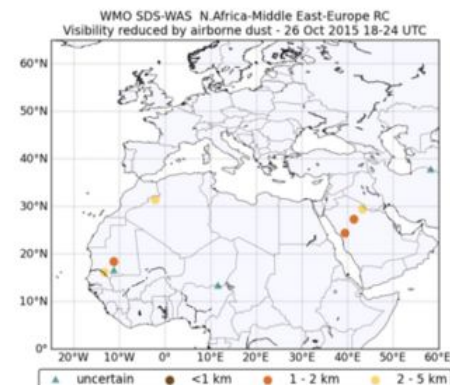
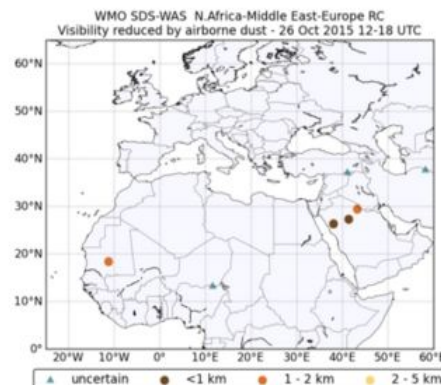
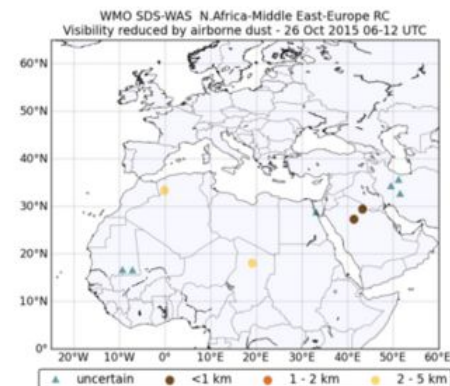
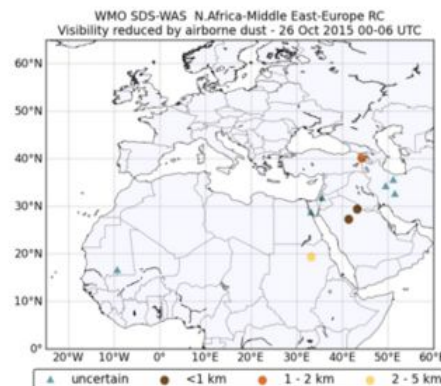
- Observations
 - In-situ
 - MSG UK MO
 - EUMETSAT
 - DEBRA-Dust
 - Visibility

You are here: Home > Forecast & Products > Dust observations > Visibility

Visibility

by Francesco Benincasa — last modified Oct 28, 2015 09:32 AM

Date 2015-10-26



[Download full image](#)

WMO SDS-WAS NA-ME-E RC

- Numerical evaluation scores

You are here: [Home](#) > [Forecast & Products](#) > [Forecast evaluation](#) > [Model evaluation metrics](#)

Monthly scores

by [Francesco Benincasa](#) — last modified Nov 27, 2014 11:51 AM

Date: 

Sep 2015. Dust Optical Depth.
Threshold Angstrom Exponent = 0.600

BIAS

	BSC_ DREAMsb	MACC- ECMWF	DREAMB- NMME-MACC	NMMB/BSC- Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	MEDIAN
Sahel/Sahara show stations	-0.28	-0.16	-0.12	-0.32	N/A	-0.20	-0.09	-0.05	0.02	-0.17
Middle East show stations	-0.28	-0.24	-0.22	-0.46	N/A	-0.27	-0.36	-0.23	0.02	-0.27
Mediterranean show stations	-0.31	-0.24	-0.23	-0.36	N/A	-0.25	-0.22	-0.20	-0.16	-0.26
TOTAL	-0.30	-0.20	-0.18	-0.35	N/A	-0.23	-0.17	-0.13	-0.06	-0.22

ROOT MEAN SQUARE ERROR

	BSC_ DREAMsb	MACC- ECMWF	DREAMB- NMME-MACC	NMMB/BSC- Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	MEDIAN
Sahel/Sahara hide stations	0.48	0.42	0.41	0.50	N/A	0.43	0.40	0.49	0.42	0.42
Capo_Verde	0.27	0.12	0.17	0.31	N/A	0.19	0.16	0.30	0.17	0.16
Dakar	0.60	0.48	0.44	0.65	N/A	0.51	0.43	0.51	0.43	0.48
IER_Cinzana	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Banizoumbou	0.67	0.60	0.56	0.68	N/A	0.60	0.56	0.59	0.54	0.58
Zinder_Airport	0.23	0.19	0.14	0.26	N/A	0.21	0.15	0.34	0.28	0.17
Santa_Cruz_ Tenerife	0.10	0.12	0.13	0.14	N/A	0.10	0.10	0.25	0.17	0.11
Zouerate- Fennec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tamanrasset_ INM	0.35	0.20	0.24	0.37	N/A	0.25	0.23	0.34	0.37	0.22

WMO SDS-WAS NA-ME-E RC

- Numerical evaluation scores
- Numerical data archive

Files Download

by [Francesco Benincasa](#) — last modified Jan 16, 2015 01:31 PM — [History](#)

This page allows downloading numerical dust forecasts issued by different dust prediction models. Dust models may have very different characteristics (global or regional, horizontal and vertical resolutions, dust emission and deposition parameterizations, presence or absence of data assimilation, feedback to the meteorological model, ...). Information on the characteristics and configurations of the models can be found on their respective websites.

Please be sure to read the [data policy](#).

Models currently available are:

BSC-DREAM8b v2.0	DOWNLOAD FILES	Model website	 Barcelona Supercomputing Center <small>Centro Nacional de Supercomputación</small>
MACC-ECMWF	DOWNLOAD FILES	Model website	 mac <small>Monitoring atmospheric composition & climate</small>
DREAM-NMME-MACC	DOWNLOAD FILES	Model website	 SEEVCCC
NMMB/BSC-Dust	DOWNLOAD FILES	Model website	 Barcelona Supercomputing Center <small>Centro Nacional de Supercomputación</small>
NASA-GEOS-5	DOWNLOAD FILES	Model website	
NCEP-NGAC	DOWNLOAD FILES	Model website	 NCEP <small>NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION</small>
DREAMABOL	DOWNLOAD FILES	Model website	 ISAC
EMA-RegCM4	DOWNLOAD FILES	Model website	 EGYPTIAN METEOROLOGICAL AUTHORITY
Multimodel MEDIAN	DOWNLOAD FILES	Model website	 WMO <small>World Meteorological Organization</small>

WMO SDS-WAS NA-ME-E RC

- Numerical evaluation scores
- Numerical data archive
- Data download

Title	Size	Modified
latest - (download all)	4.0 kB	Nov 18, 2014 10:40 PM
2014 - (download all)	4.0 kB	Nov 01, 2014 10:40 PM
2013 - (download all)		
2012 - (download all)		

Title	Size	Modified
11 - (download all)	4.0 kB	Nov 18, 2014 10:40 PM
10 - (download all)		
09 - (download all)		
08 - (download all)		
07 - (download all)		
06 - (download all)		
05 - (download all)		
04 - (download all)		
03 - (download all)		
02 - (download all)		
01 - (download all)		

Title	Size	Modified
20141118_BSC_DREAM8b_V2.nc	47.7 MB	Nov 18, 2014 0
20141117_BSC_DREAM8b_V2.nc	47.7 MB	Nov 17, 2014 0
20141116_BSC_DREAM8b_V2.nc	47.7 MB	Nov 16, 2014 0
20141115_BSC_DREAM8b_V2.nc	47.7 MB	Nov 15, 2014 0
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20141110_BSC_DREAM8b_V2.nc	47.7 MB	Nov 10, 2014 0
20141109_BSC_DREAM8b_V2.nc	47.7 MB	Nov 09, 2014 0
20141108_BSC_DREAM8b_V2.nc	47.7 MB	Nov 08, 2014 0
20141107_BSC_DREAM8b_V2.nc	47.7 MB	Nov 07, 2014 0

Data files download (only for institutions that agree to distribute)

- Register to the portal
- Go to *data download* page and download manually: follow model link and choose year, month and/or day ...
- Data availability
 - NRT for partners (restricted download)
 - 2-days delay (public download)

WMO SDS-WAS NA-ME-E RC

Data files download

... or download automatically with a program (i.e. [WGET](#)):

- a single file:

```
wget --http-user="YOUR_REGISTRATION_EMAIL"  
--http-password="YOUR_REGISTRATION_PASSWORD"  
--auth-no-challenge http://MODEL_REPOSITORY_URL/YYYY/MM/YYYYMMDDMODEL_NAME.nc
```

- an entire month/year:

```
wget --http-user="YOUR_REGISTRATION_EMAIL"  
--http-password="YOUR_REGISTRATION_PASSWORD"  
--auth-no-challenge http://MODEL_REPOSITORY_URL/YYYY/MM/@@download -O FILENAME.zip
```

- the latest file:

```
wget --http-user="YOUR_REGISTRATION_EMAIL"  
--http-password="YOUR_REGISTRATION_PASSWORD"  
--auth-no-challenge http://MODEL_REPOSITORY_URL/latest/@@download -O FILENAME.zip
```


Data policy (1)

- Data, images and other products from the SDS-WAS available on the server may be used solely for **research and education** purposes.
- SDS-WAS partners **cannot guarantee that the data are correct** in all circumstances. Neither do SDS-WAS partners accept any liability whatsoever for any error or omission in the data, or for any loss or damage arising from its use.
- Data must not be supplied as a whole or in part to any third party without **authorisation**.

Data policy (2)

- Articles, papers, or written scientific works of any form, based in whole or in part on data, images or other products supplied by the SDS-WAS, will contain an **acknowledgment** concerning the supplied data, every time they are used.
- In the case of establishing links to the contents of this website, **kindly inform us** via email.

- EUDAT

- Ongoing integration with the EUDAT storage platform to have:

- *Data sync & exchange*
- *Data replication*
- *Data discovery & search*
- *Data repository & sharing*
- *Data staging*

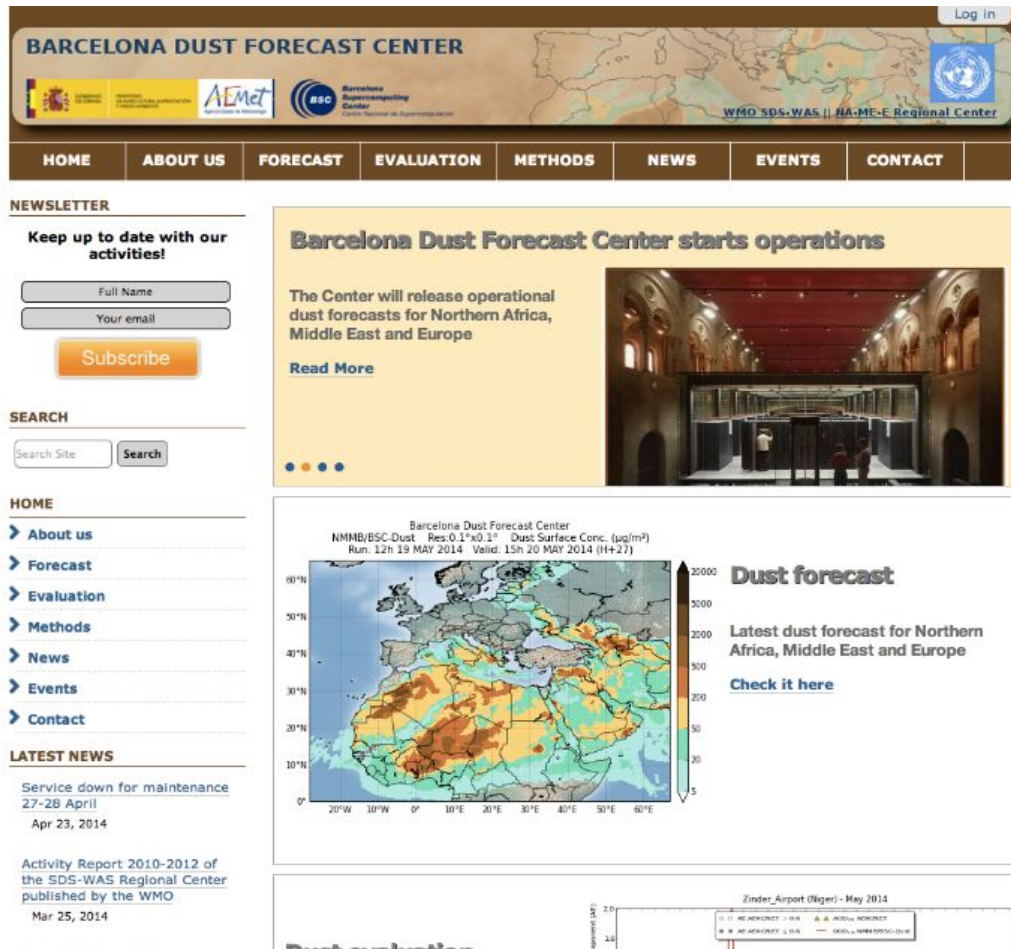


- RDA Interest Group in “Weather, climate and air quality”

- Discuss the challenges for the use and efficient analysis of large and diverse datasets from the climate, weather and air quality communities
- Strong pressure from a large user community



- Presentation
- The WMO SDS-WAS NA-ME-E Regional Center
- **The Barcelona Dust Forecast Center**
- The BSC-CNS supercomputing facilities
- The NMMB-MONARCH model
- Some estimations



The screenshot shows the homepage of the Barcelona Dust Forecast Center. At the top, there is a navigation bar with links: HOME, ABOUT US, FORECAST, EVALUATION, METHODS, NEWS, EVENTS, and CONTACT. Below this is a 'NEWSLETTER' section with a 'Keep up to date with our activities!' message and a 'Subscribe' button. A 'SEARCH' section is also present. The main content area features a headline 'Barcelona Dust Forecast Center starts operations' with a photo of the center's interior and a 'Read More' link. Below this is a 'Dust forecast' map showing dust concentrations over North Africa, the Middle East, and Europe, with a color scale from 5 to 20,000 $\mu\text{g}/\text{m}^3$. The map is titled 'Barcelona Dust Forecast Center NMMB/BSC-Dust Res: 0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$) Run: 12h 19 MAY 2014 Valid: 15h 20 MAY 2014 (H+27)'. To the right of the map, there is a 'Check it here' link. At the bottom, there is a 'Dust evaluation' section with a line graph titled 'Zinder_Airport (Niger) - May 2014' showing dust concentration over time.



- *First Specialized WMO Center for Mineral Dust Prediction*
- *Numerical forecasts based on the NMMB/BSC-Dust model at 0.1° resolution*
- *Provides forecasts to WMO GTS, EumetCAST and AEMET*
- *NRT evaluation*
- *Some personalized products (zooms over specified areas)*

The Center is managed by a consortium of AEMET and BSC in Barcelona, Spain

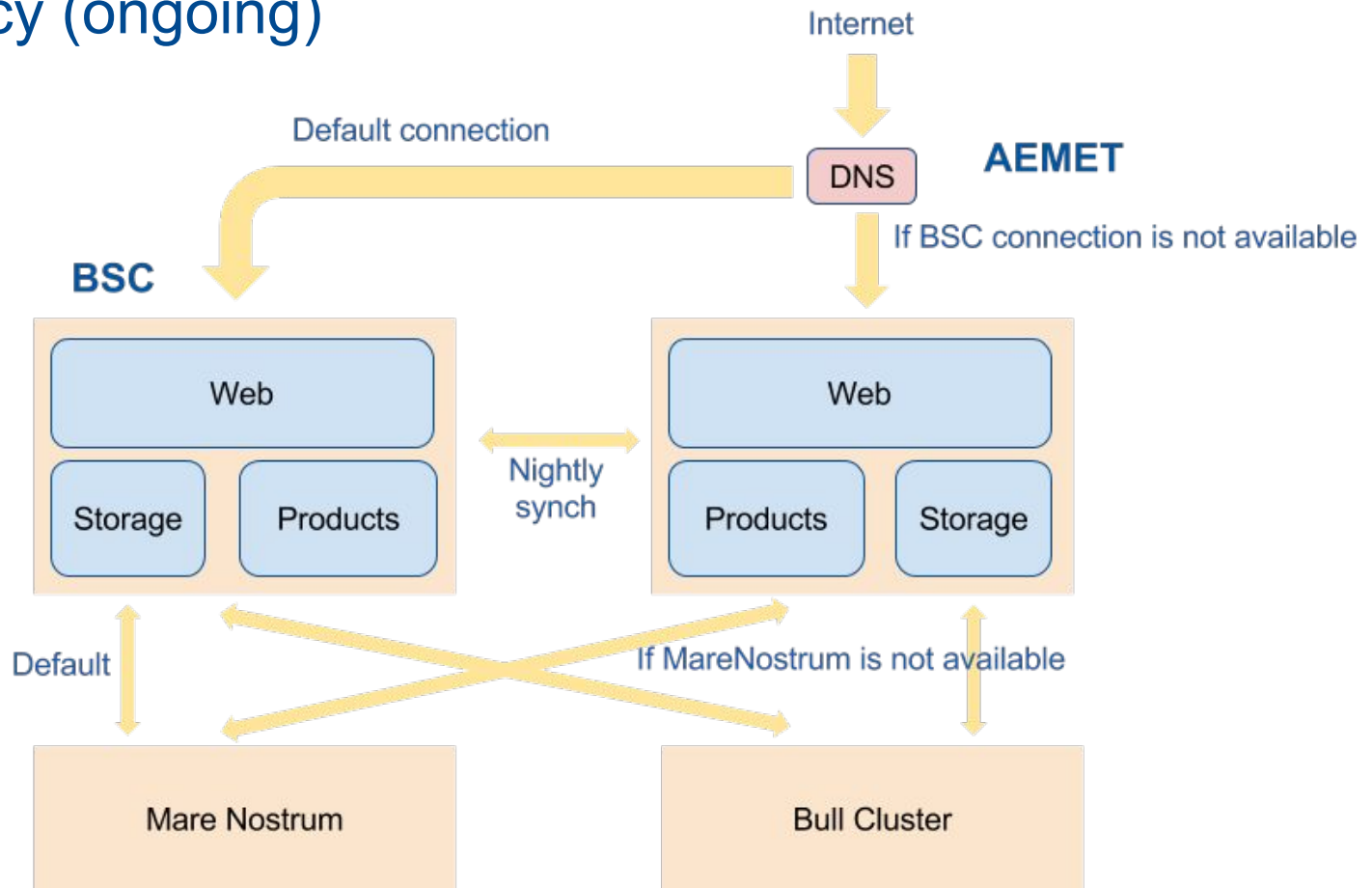
Barcelona Dust Forecast Center

Operational center

- Operated by BSC and AEMET
- Officially recognized by the WMO
- 72 hours forecast (3-hourly) model developed at BSC NMMB-MONARCH (~1GB per daily dataset)
- 6 variables - 1 level (Optical depth, Dry and Wet deposition, Load, Surface concentration, Surface extinction)

Barcelona Dust Forecast Center

Redundancy (ongoing)



Products

- Forecast images
- Google Earth integration (KML/KMZ files)
- Averaged values images
- Zoomed area forecast images (Spain, Burkina Faso, ...)

Barcelona Dust Forecast Center

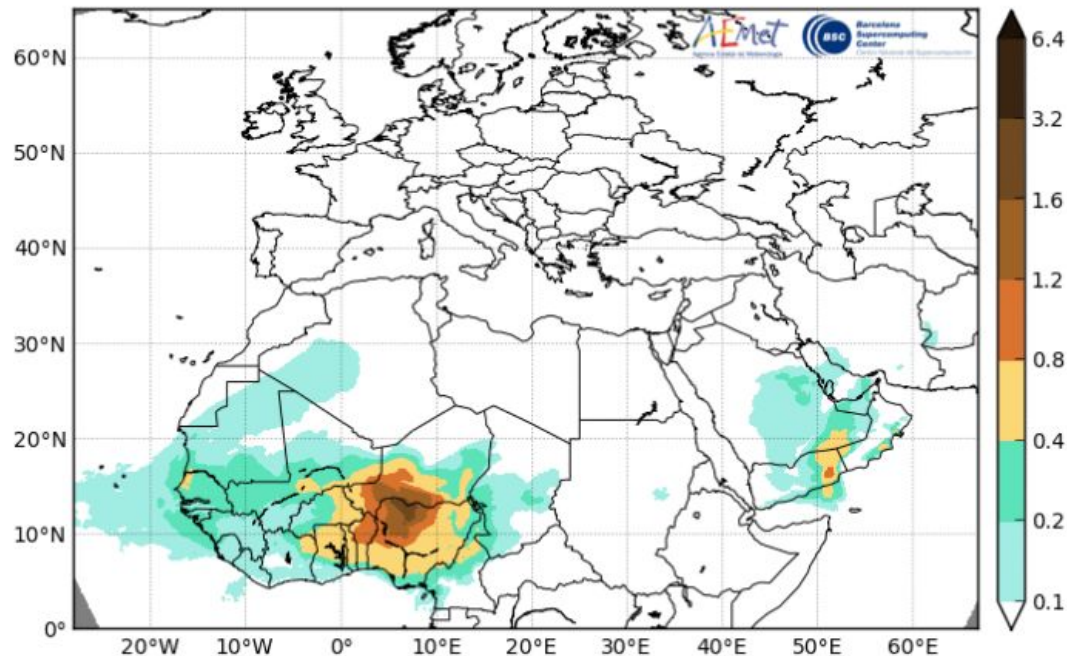
You are here: [Home](#) / [Forecast](#)

Dust Optical Depth

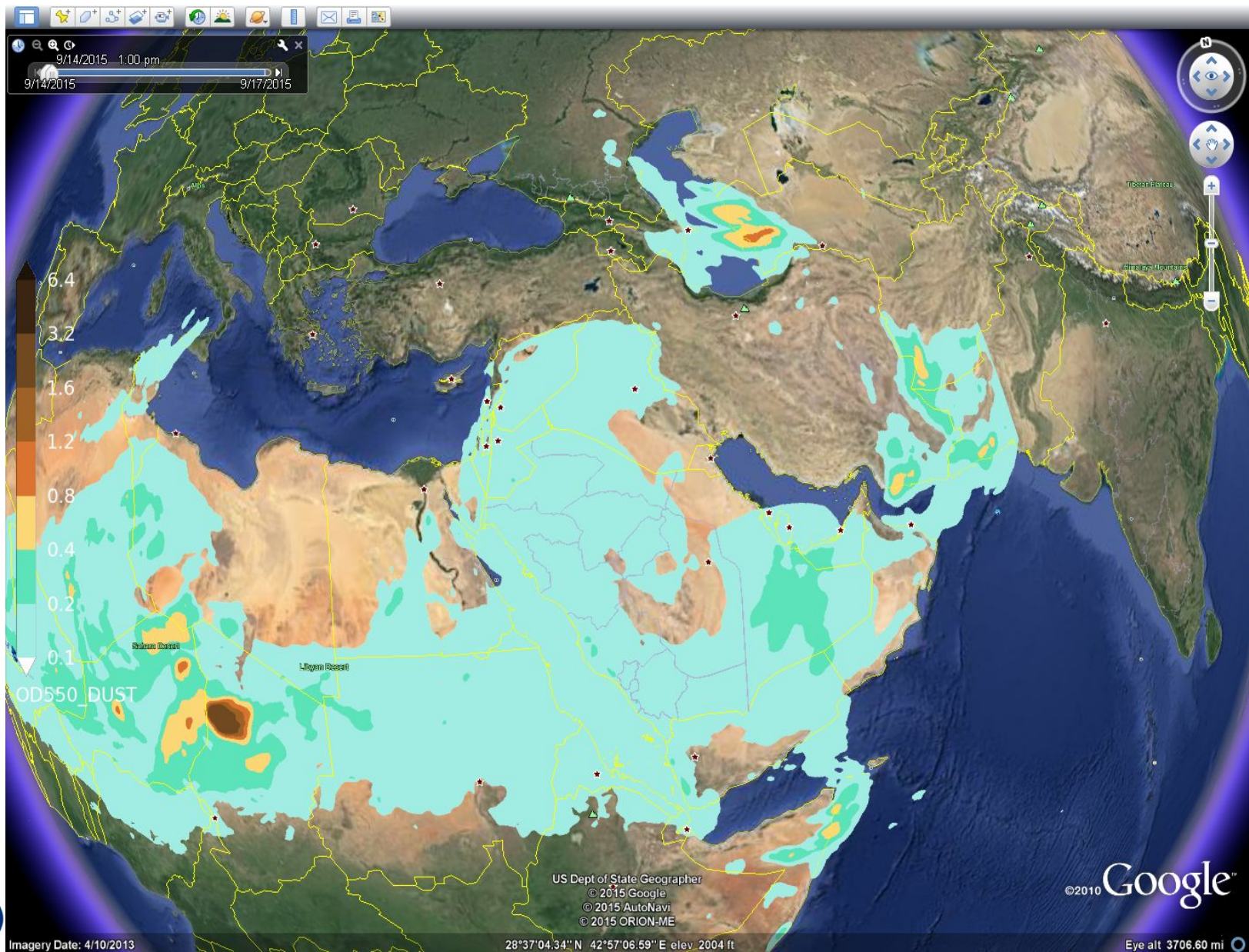
Date H+ Variable

The NMMB/BSC-Dust model

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 29 OCT 2015 Valid: 06h 01 NOV 2015 (H+66)



Barcelona Dust Forecast Center



Barcelona Dust Forecast Center

You are here: [Home](#) / [Other products](#) / [Averaged values](#)

Monthly averaged values

Monthly averaged values of dust surface concentration and dust load computed from the daily runs of the NMMB/BSC-Dust model.

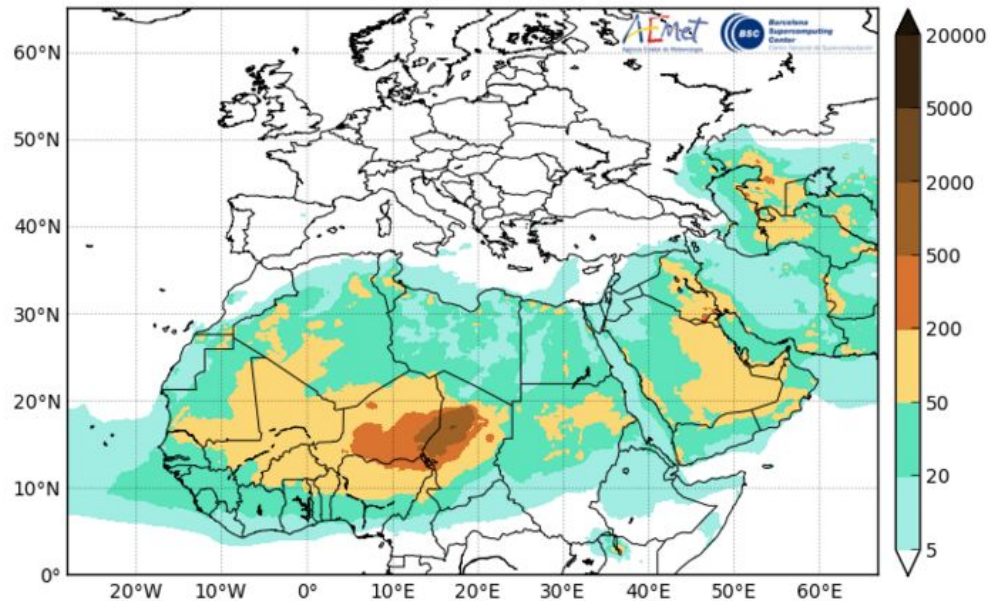
Date 2015-10

[Methods: Time-averaged values](#)

NOTE: Click on the images to enlarge

Monthly Averaged Dust Surface Concentration ($\mu\text{m}/\text{m}^3$)

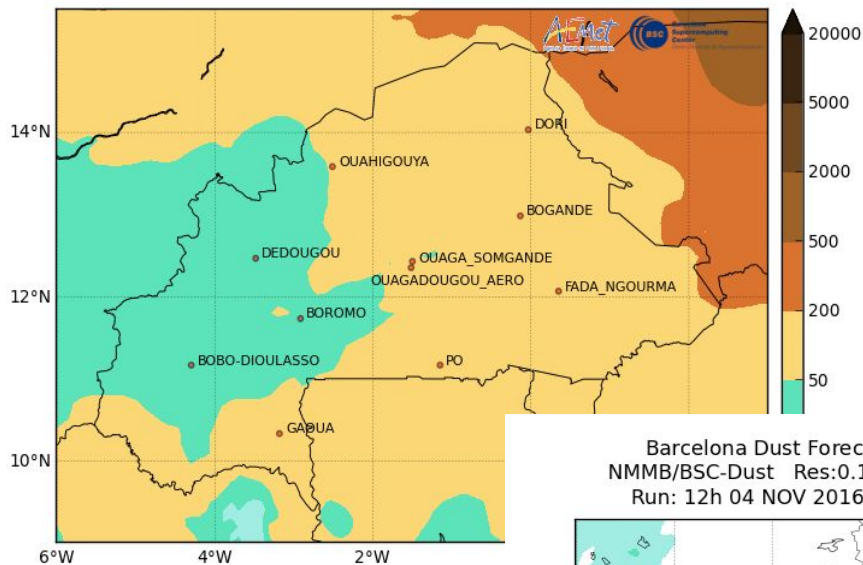
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Average: OCT 2015



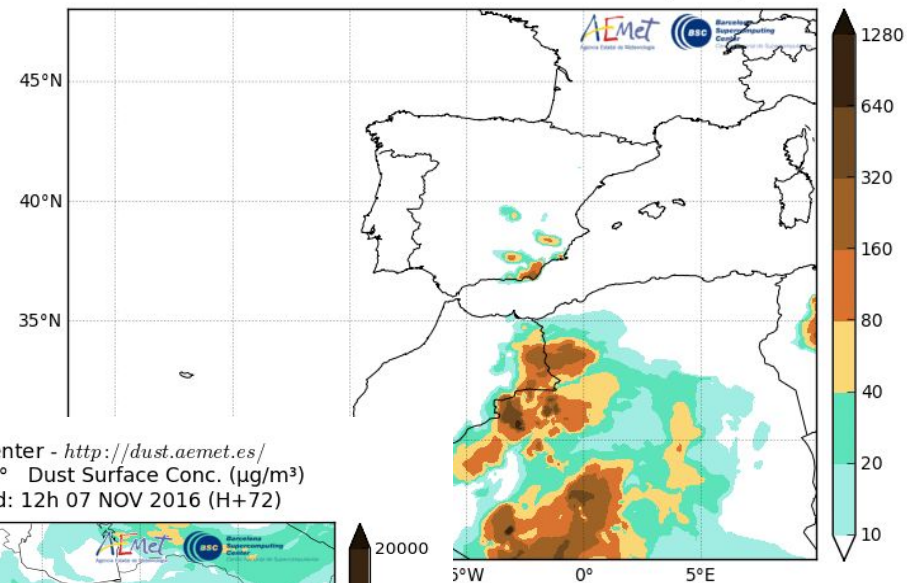
[Download Image](#)

Barcelona Dust Forecast Center

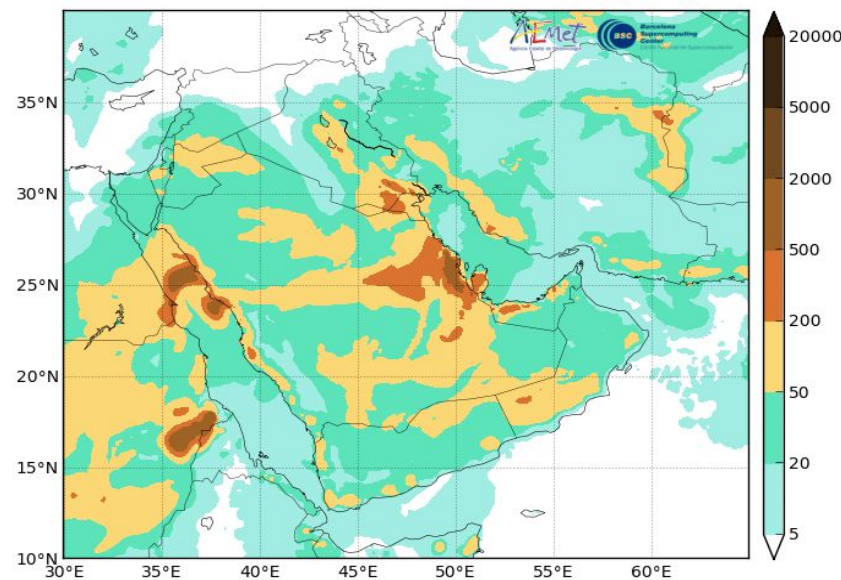
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Run: 12h 29 OCT 2015 Valid: 12h 01 NOV 2015 (H+72)



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Run: 12h 29 OCT 2015 Valid: 12h 01 NOV 2015 (H+72)



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Run: 12h 04 NOV 2016 Valid: 12h 07 NOV 2016 (H+72)

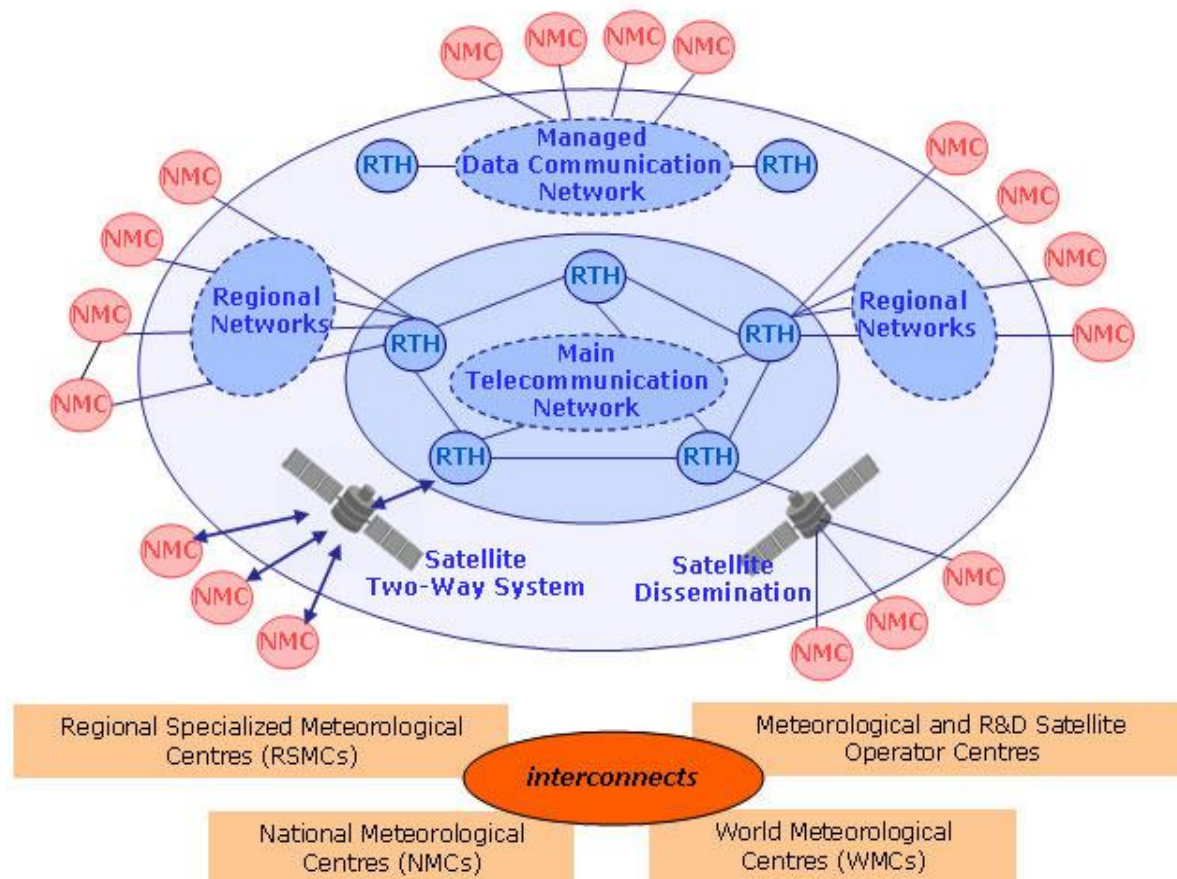


Services

- Forecast images dissemination
 - WMO GTS (Global Telecommunication System)
 - EUMETCast (EUMETSAT's primary dissemination mechanism)
 - UNEPlive
- News & Events, Newsletter

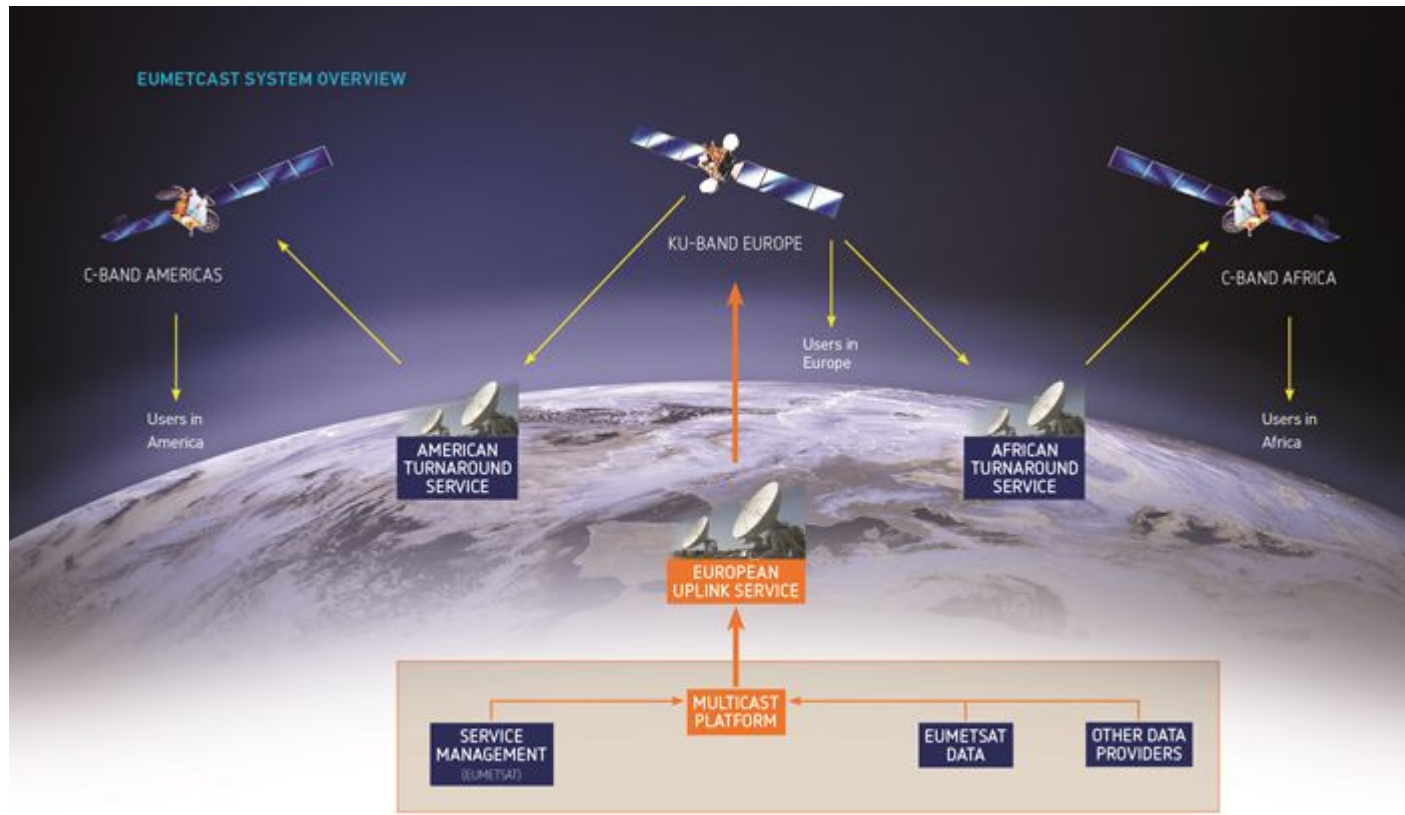
Barcelona Dust Forecast Center

WMO GTS



Barcelona Dust Forecast Center

EUMETCast

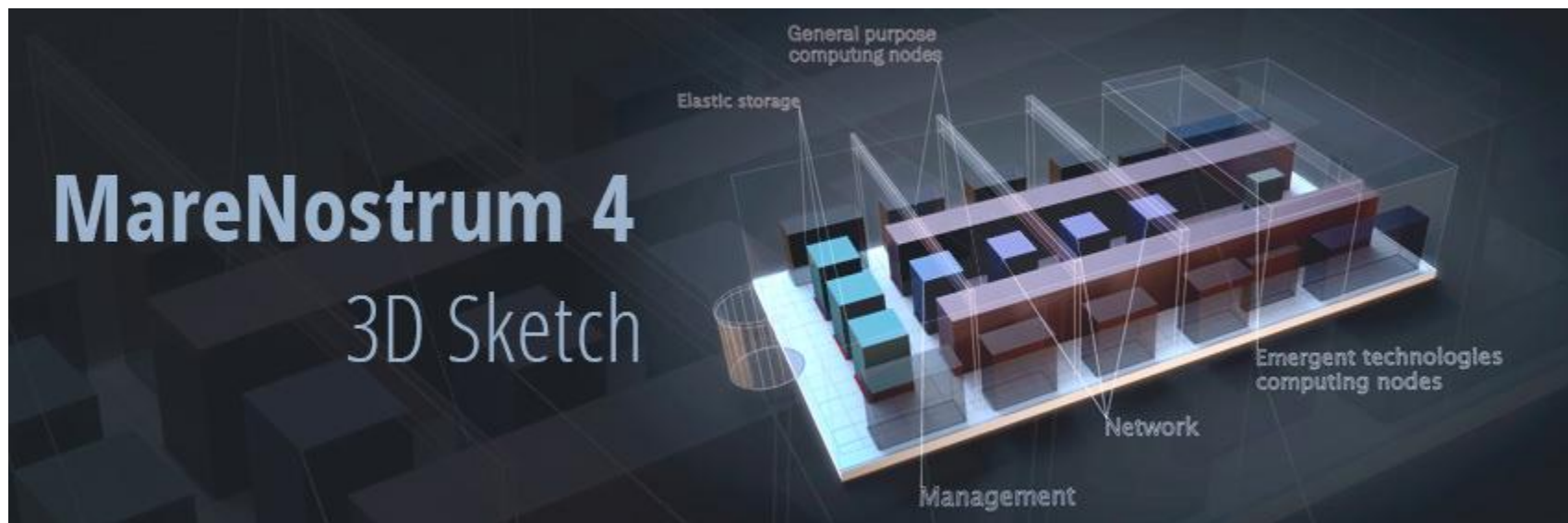


- Presentation
- The WMO SDS-WAS NA-ME-E Regional Center
- The Barcelona Dust Forecast Center
- **The BSC-CNS supercomputing facilities**
- The NMMB-MONARCH model
- Some estimations

- Peak performance of 1.1 Petaflops
- 48.896 Intel Sandy Bridge processors
- 3.056 nodes
- More than 115 TB of main memory
- 2 PB of GPFS disk storage

Important: BSC HPC facility is intended for research purpose, cannot be considered operational.





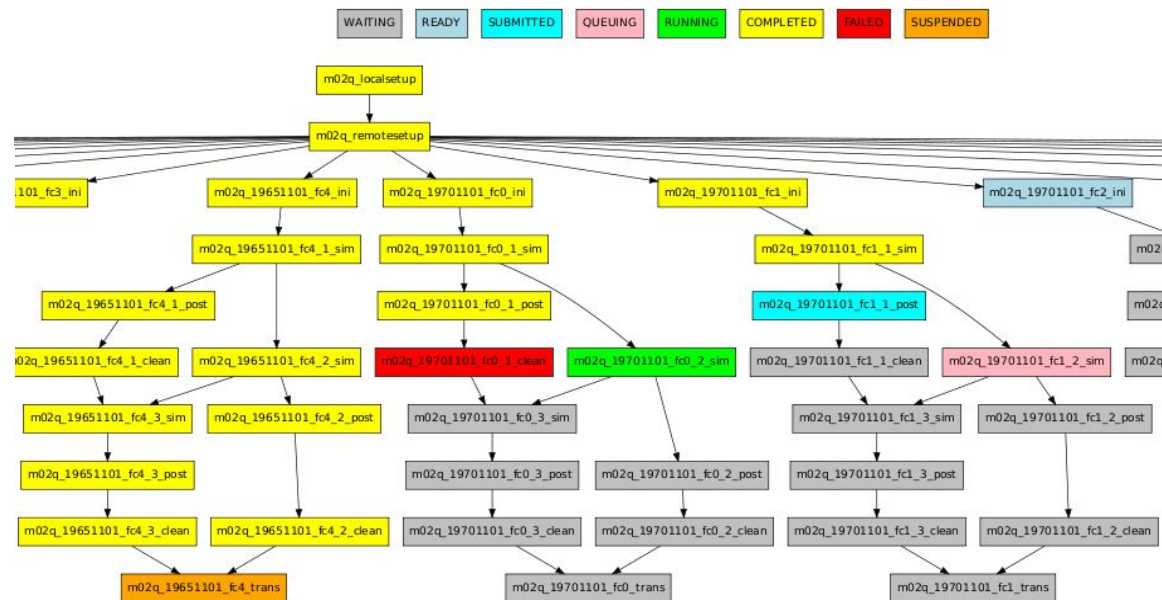
- Peak performance 13.7 Petaflop/s
- Central memory of 390 Terabytes
- Disk storage capacity exceeding 10 Petabytes
- Connected to the Big Data infrastructures of BSC-CNS, which have a total capacity of 24.6 Petabytes

- Presentation
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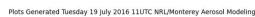
- Multiscale Online Nonhydrostatic AtmospheRe CHemistry model
 - Meteorological core developed in NCEP
 - Aerosols and chemistry in gas phase in BSC
- Domain North Africa, Middle East and Europe [25° W – 65° E and 0° – 65° N] (lon, lat)
- 0.1° x 0.1° x 40 layers
- Temporal resolution: 72h 3-hourly
- Post-processed output: 11 Gb, 15 pres levels, ~50 variables
- 16 nodes - 256 cores
- Execution time on MN3: ~48m (-O3, ifort 13.0.1, Open MPI)

- **Automatisation:** Preparing and running, post-processing and output transfer, all managed by Autosubmit. No user intervention needed.
- **Provenance:** Assigns unique identifiers to each experiment and stores information about model version, configuration options, etc
- **Failure tolerance:** Automatic retrials and ability to repeat tasks in case of corrupted or missing data.
- **Versatility:** Currently run EC-Earth. NEMO and NMMB models on several platforms.

Workflow of an experiment monitored with Autosubmit (yellow = completed, green = running, red = failed, ...)



- WAITING READY SUBMITTED QUEUING RUNNING COMPLETED FAILED SUSPENDED



Plots Generated Saturday 23 July 2016 11UTC NRL/Monterey Aerosol Modeling



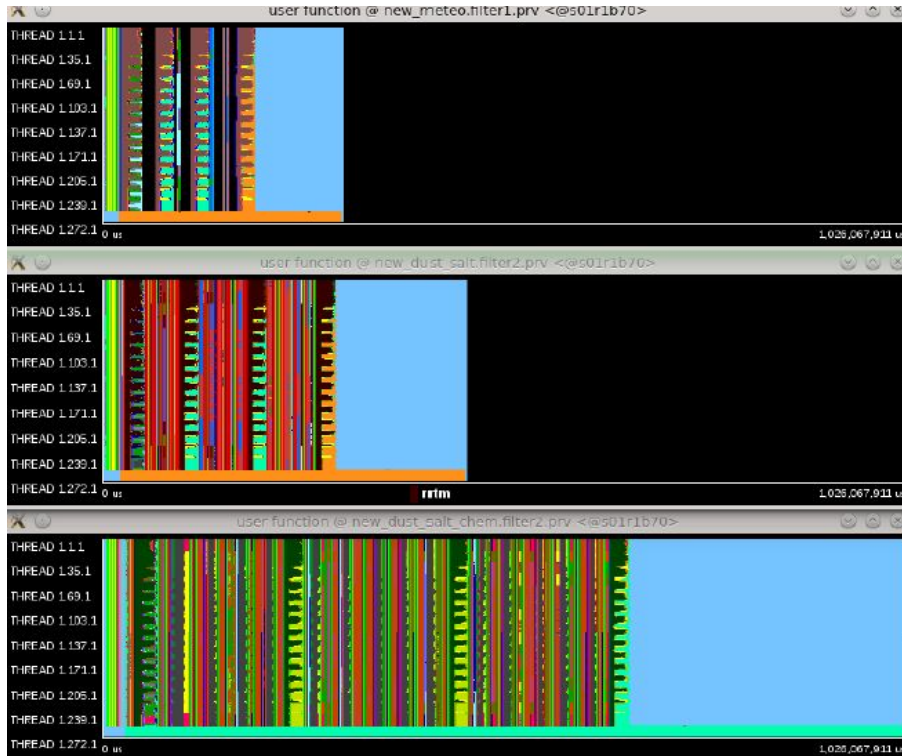
- Presentation
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- The BSC-CNS supercomputing facilities
- The NMMB-MONARCH model
- **Some estimations**

- Estimated execution time for a similar configuration on Mare Nostrum 3 on other domains at 4 km spatial resolution:
 - ~1h30m (256 cores) for a domain including Ukraine, Romania, Belarus
 - ~30m (128 cores) for a small domain including Jordan, Israel, Lebanon
- Storage estimation for global configuration:

	Horizontal resolution (grid cell size)	Output size of one year of 48h daily forecasts, global fields (including meteorology, aerosols and gas-phase chemistry)
Standard Resolution	10 km	4.6 PB
High Resolution	4 km	18.2 PB
Ultra High Resolution	1 km	73 PB



- To be estimated



meteo:
9 tracers

meteo + aerosols:
9 + 16 tracers

meteo + aerosols + gases:
9 + 16 + 53 tracers

One hour simulation of NMMB/BSC-CTM, global, 24km, 64 layers



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación



Thank you!

francesco.benincasa@bsc.es