



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



Modeling the dust cycle at BSC

From R&D to operational forecast

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C. Pérez García-Pando, O. Jorba, E. Di Tomaso, E. Terradellas, G. García-Castrillo, F. Benincasa and K. Serradell

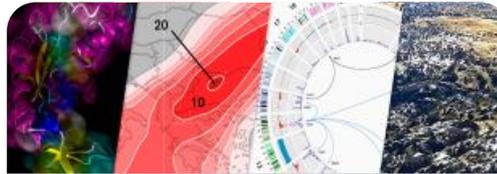
*7th Training Course on WMO SDS-WAS Products,
Ahvaz, Iran, 10-14 November 2018*

Barcelona Supercomputing Center Centro Nacional de Supercomputación

BSC-CNS objectives



Supercomputing services
to Spanish and
EU researchers



R&D in Computer,
Life, Earth and
Engineering Sciences



PhD programme,
technology transfer,
public engagement

BSC-CNS is
a consortium
that includes

Spanish Government

60%



Catalonian Government

30%



Univ. Politècnica de Catalunya (UPC)

10%



The MareNostrum 4 supercomputer

Total peak performance:

13,7 Pflops/s



80%



Access: prace-ri.eu/hpc_acces

16%



RED ESPAÑOLA DE
SUPERCOMPUTACIÓN

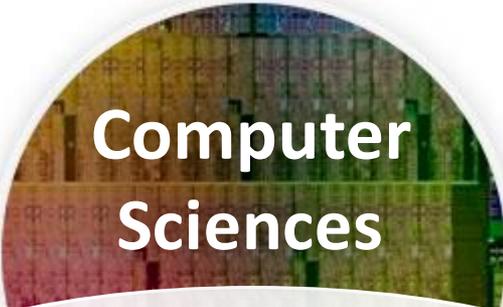
Access: bsc.es/res-intranet

4%



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Mission of BSC Scientific Departments



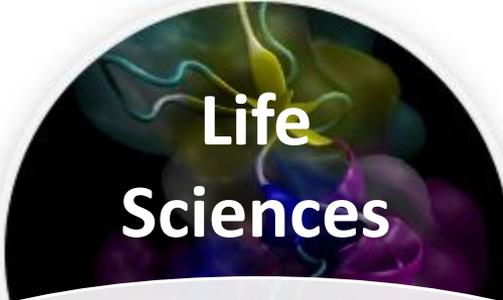
Computer Sciences

To influence the way machines are built, programmed and used: programming models, performance tools, Big Data, computer architecture, energy efficiency



Earth Sciences

To develop and implement global and regional state-of-the-art models for short-term air quality forecast and long-term climate applications



Life Sciences

To understand living organisms by means of theoretical and computational methods (molecular modeling, genomics, proteomics)



CASE

To develop scientific and engineering software to efficiently exploit super-computing capabilities (biomedical, geophysics, atmospheric, energy, social and economic simulations)

Earth Sciences Department

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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Earth Services

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CALOPE



RESILIENCE prototype



Seasonal Hurricane Predictions



BSC Dust Daily Forecast



WMO Dust Research Center



WMO Dust Operational Center



Aire CDMX



Image Catalogue



BSC Dust Numerical Database



Energy factsheets



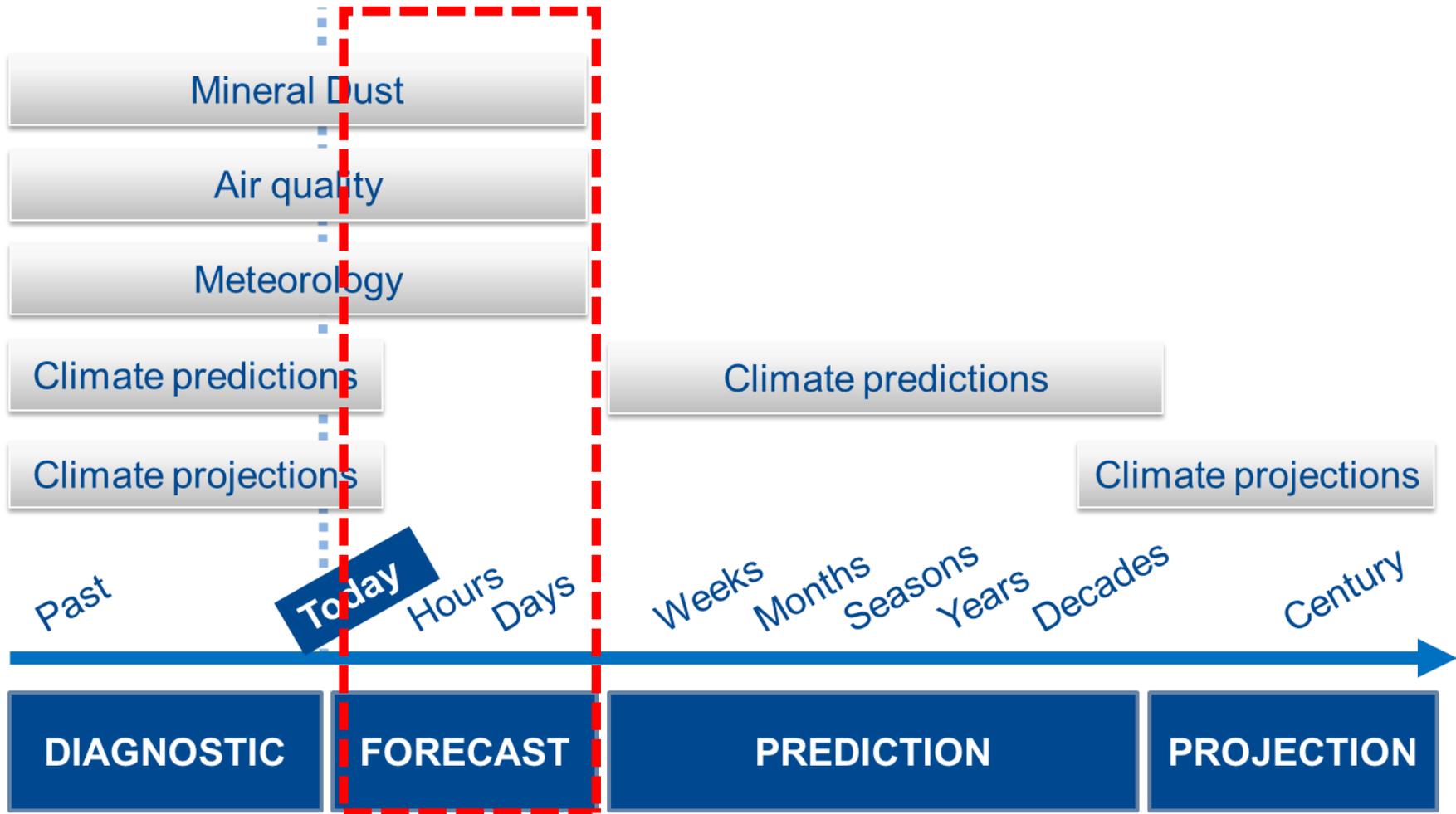
Wind bulletins



Wind energy case studies

dictions

BSC Earth Sciences Department



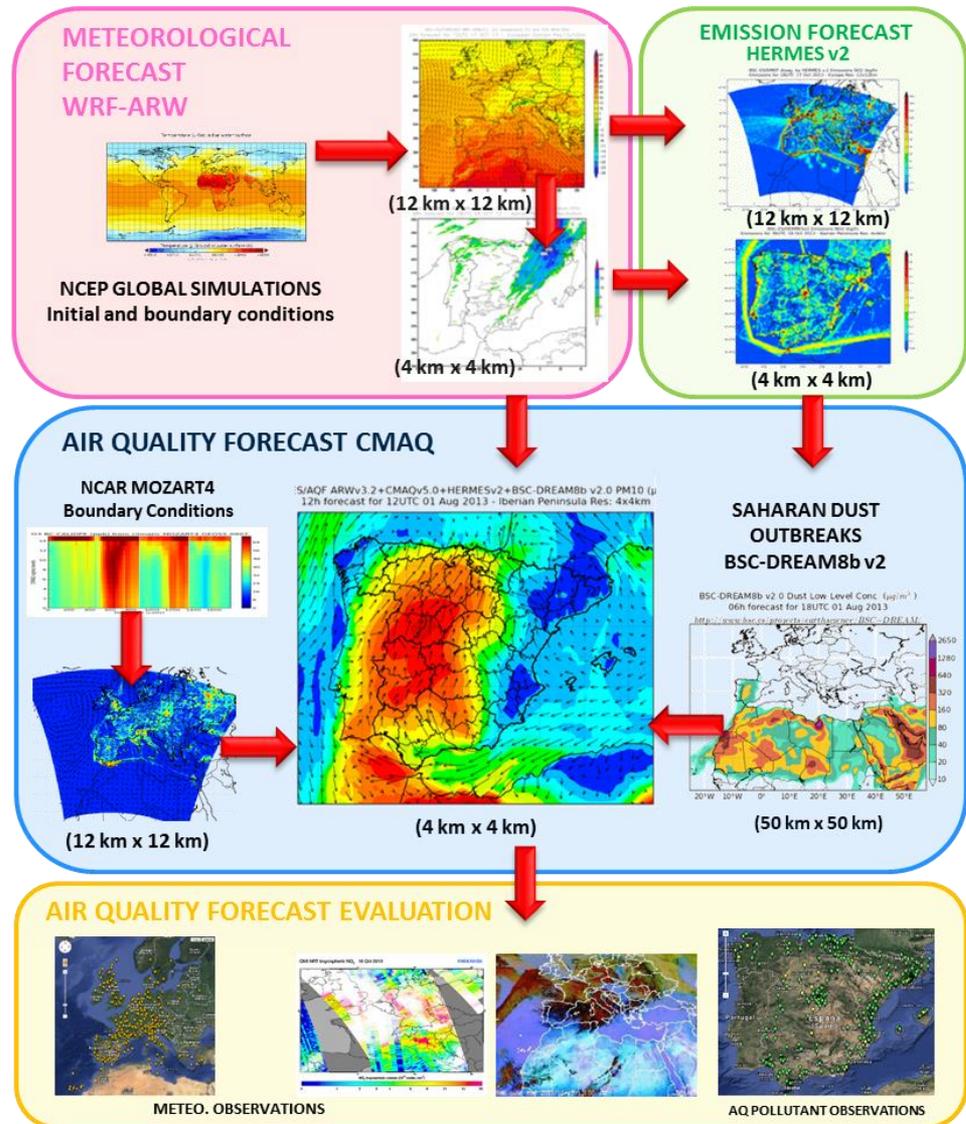
Air Quality Modelling

CALIOPE (www.bsc.es/caliope)

- Quantify relation between emissions, meteorology and air concentration
- Forecast air pollution episodes
- Provide and develop short and long term mitigation plans

Domains:

Europe (12 km, 480 x 400 cells)
Spain (4 km, 399 x 399 cells)



CONSEJERÍA DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO



GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE



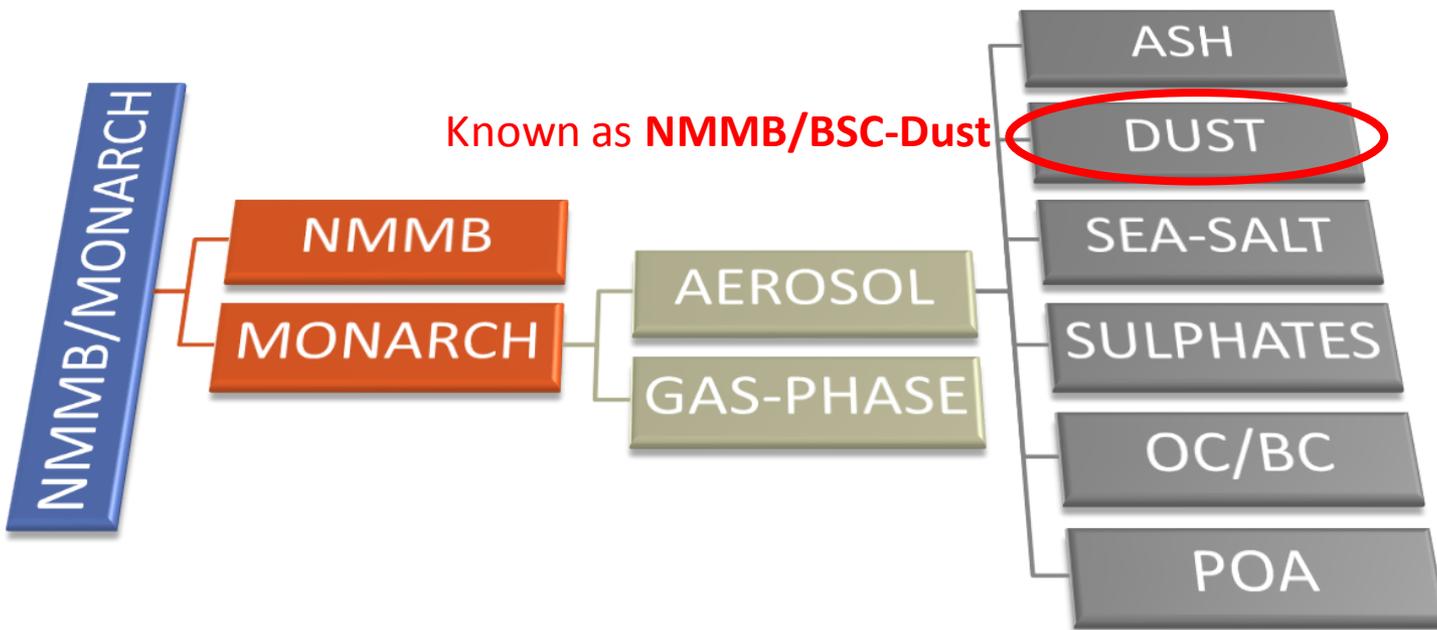
Consejería de Educación, Universidades y Sostenibilidad



Generalitat de Catalunya
Departament de Territori i Sostenibilitat

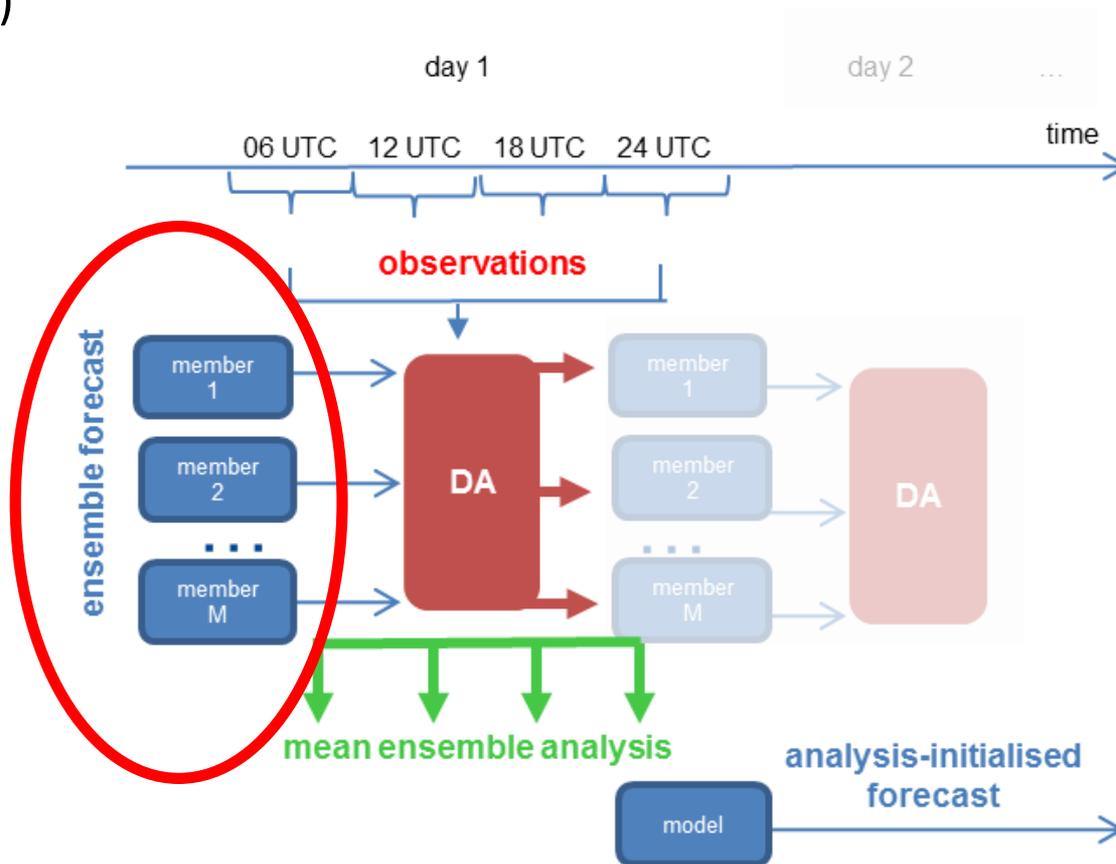
NMMB-MONARCH: Atmospheric Composition and Air Quality

- The main system is build on the **meteorological driver NMMB**
- **Multiscale**: global to regional scales allowed (nesting capabilities)
- **Nonhydrostatic** dynamical core: single digit kilometre resolution allowed
- Fully **on-line** coupling: weather-chemistry feedback processes allowed
- Enhancement with a **data assimilation** system



NMMB-MONARCH: Data Assimilation Ensemble perturbations

The implementation of the **ensemble forecast** is based on known uncertainties in the physical parametrizations of the dust scheme (*imperfect model scenario assumption*)



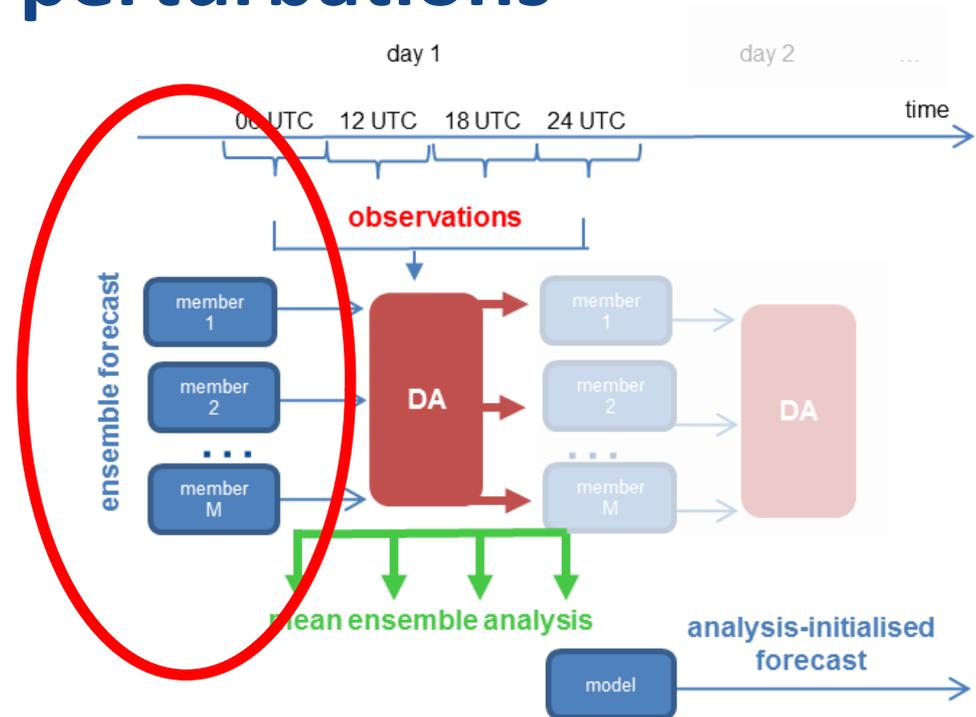
NMMB-MONARCH: Data Assimilation Ensemble perturbations

The ensemble forecast has been designed considering model uncertainties with respect to:

- surface winds,
- soil humidity,
- vertical flux distribution at sources,

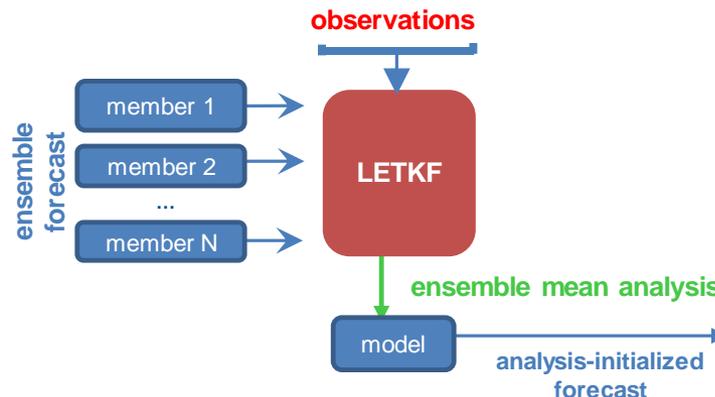
by perturbing:

1. the **threshold friction velocity** which is soil moisture-dependent, and determines the velocity above which the soil particles begin to move in horizontal saltation flux;
2. the **vertical flux of dust in each of the eight dust transport bins**



NMMB-MONARCH: Data Assimilation

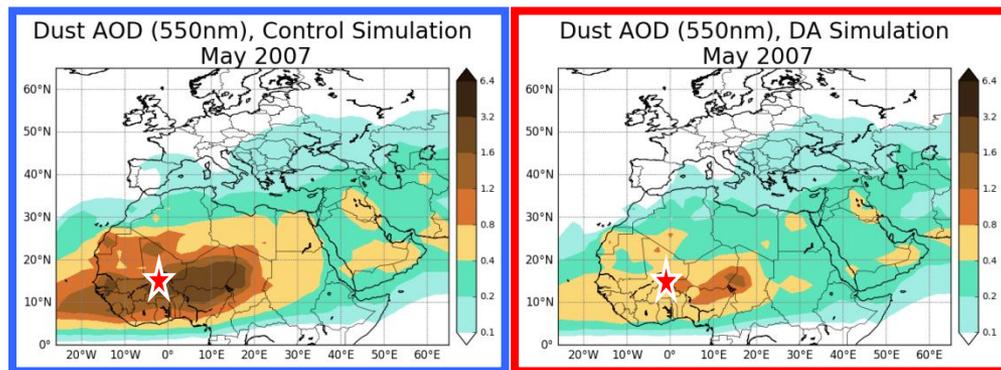
NMMB-MONARCH coupled with a Local Ensemble Transform Kalman Filter (**LETKF**) for the assimilation of aerosol optical depth observations



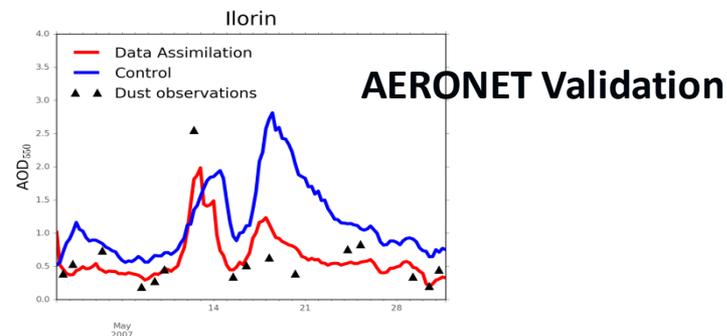
Mineral dust application

The ensemble forecast is based on uncertainties in the dust emission scheme

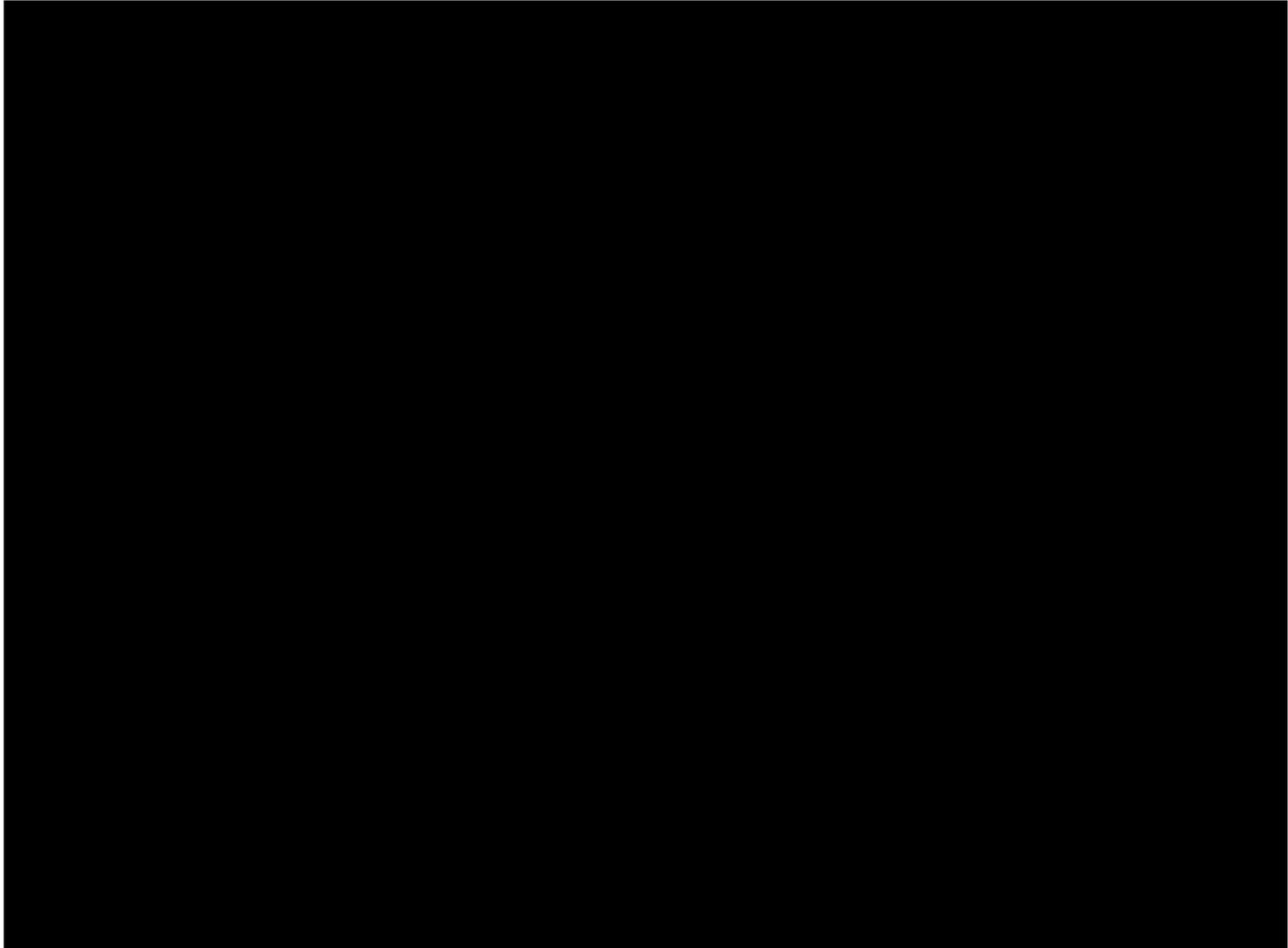
- vertical flux,
- size distribution at emission
- threshold on friction velocity



(DiTomaso et al., GMD, 2016)

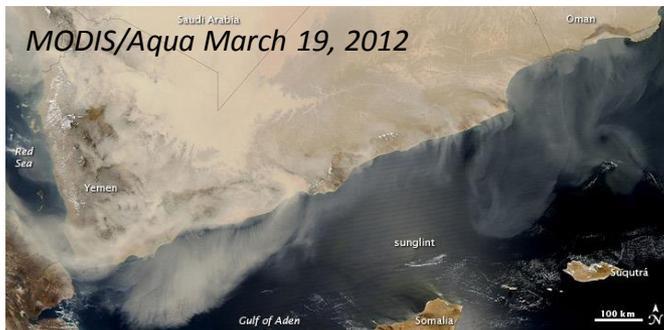
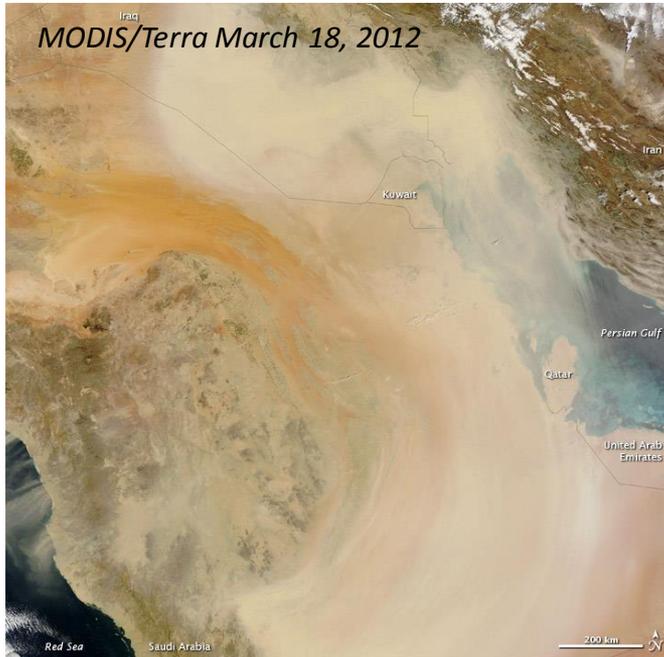


Mineral Dust modelling: Topography

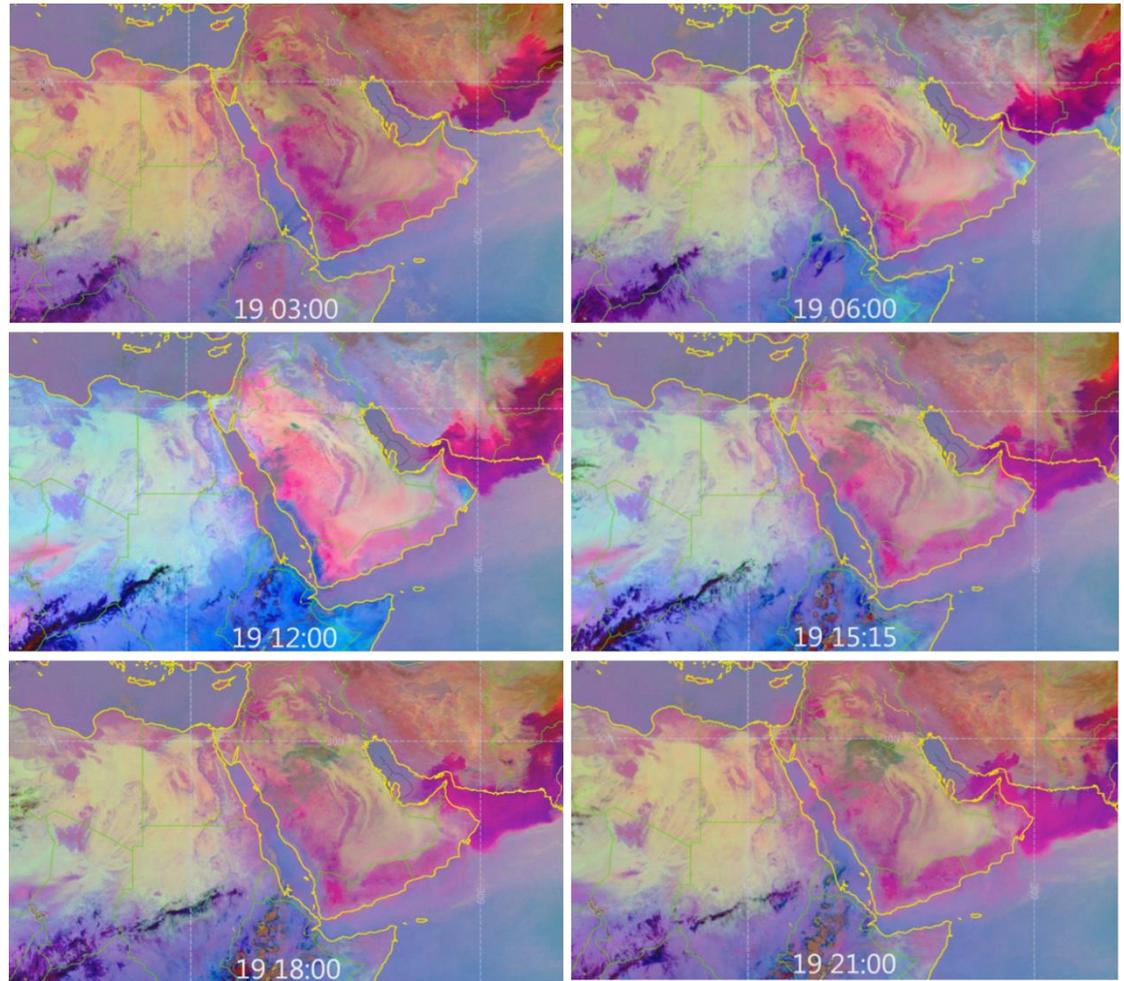


Mineral Dust modelling: Topography

Impact of the topography on dust transport



MSG/RGB March 19, 2012

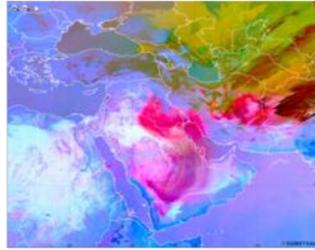
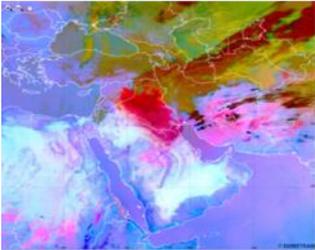


(Basart et al., Aeolian Research, 2016)

Mineral Dust modelling: Topography

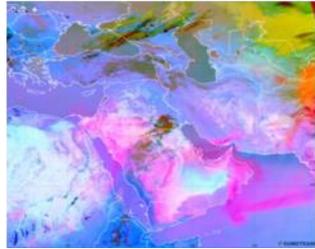
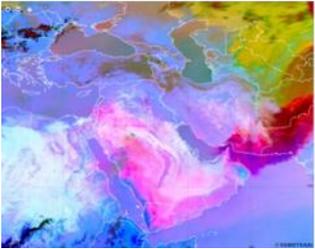
17 Mar 2012 12UTC

18 Mar 2012 12UTC



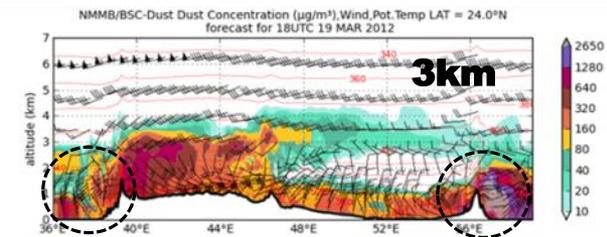
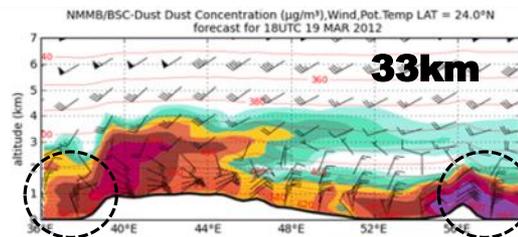
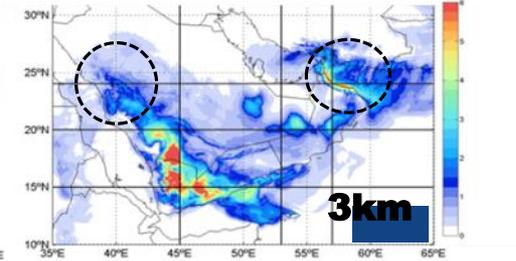
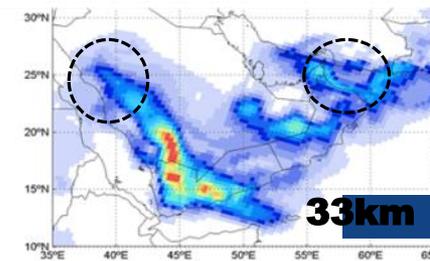
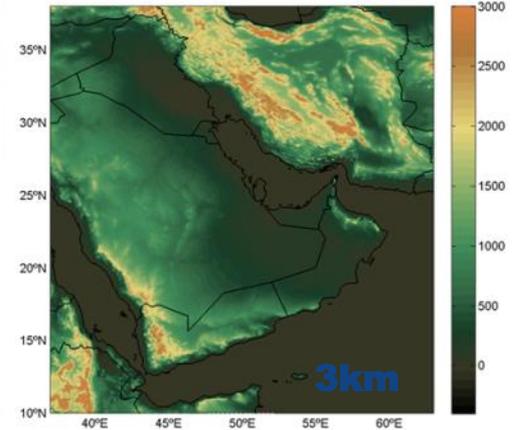
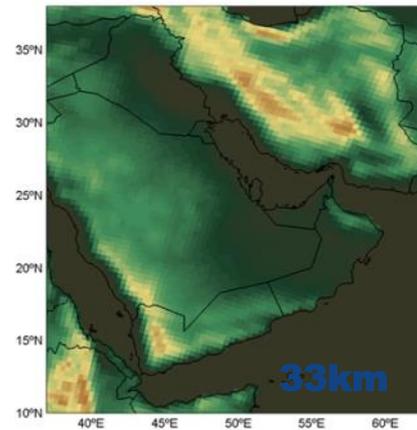
19 Mar 2012 12UTC

20 Mar 2012 12UTC



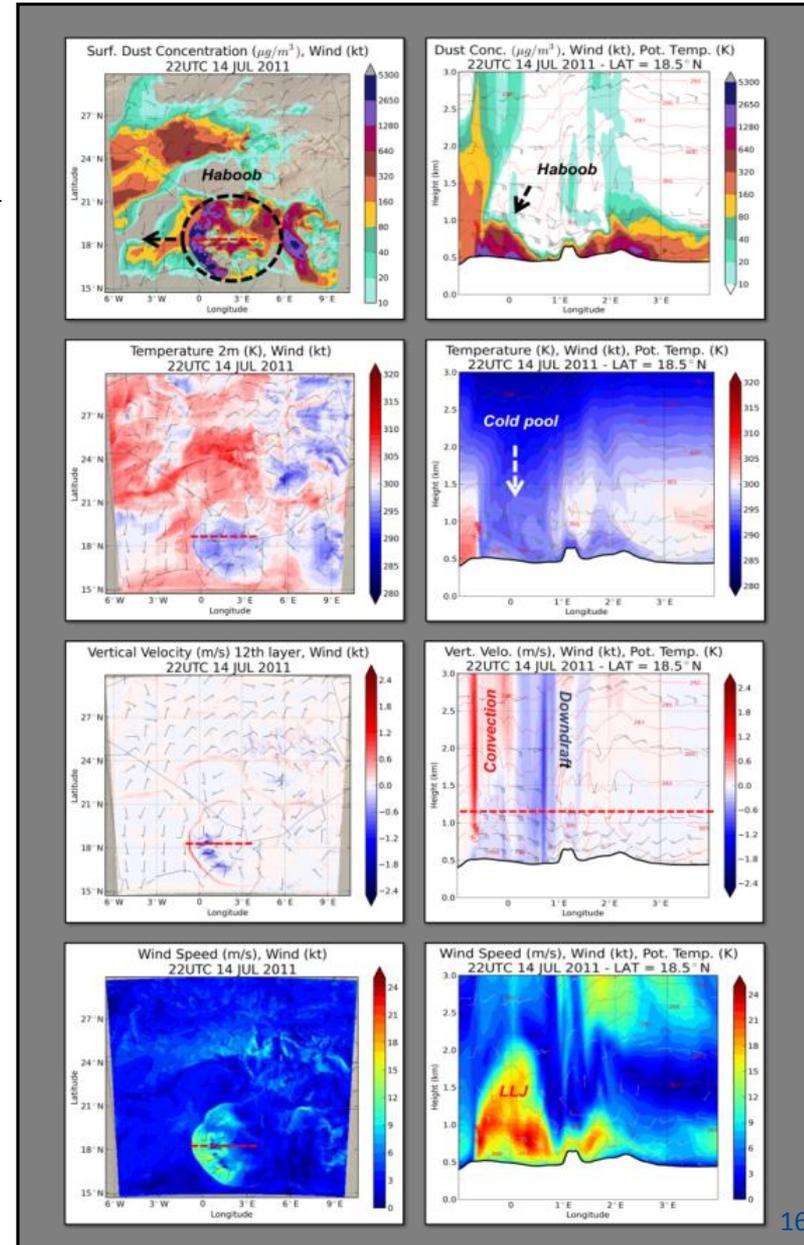
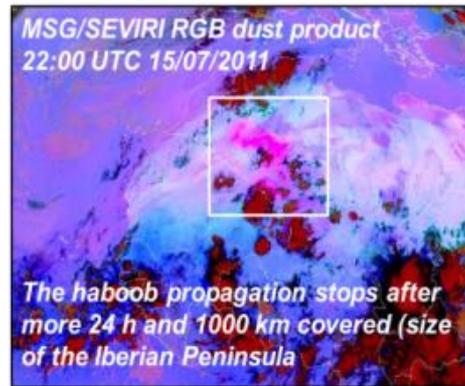
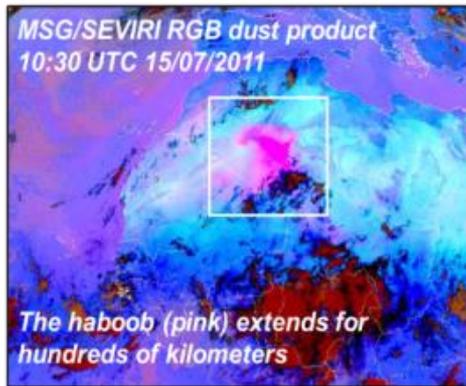
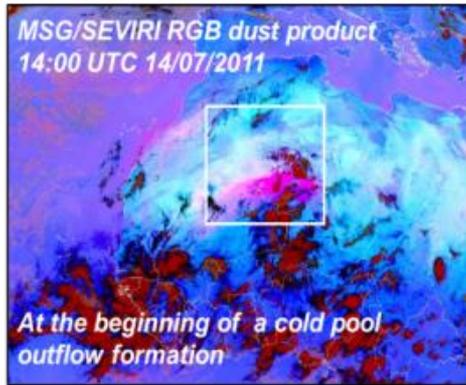
Two simulations using the **NMMB/BSC-Dust** model demonstrates results demonstrate how the dust prediction in the vicinity of complex terrains improves using high-horizontal resolution simulations.

NMMB/BSC-Dust 19-March-2012 18UTC



(Basart et al., Aeolian Research, 2016)

Mineral Dust modelling: Haboobs



MODEL CONFIGURATION

Study domain: 6°W-10°E to 15°N-31°N

Study period: from 14 to 15 July 2011

Horizontal resolution: 0.03°x0.03° (about 3 km) → **allowing explicit convection**

Vertical resolution: 60 σ -layers (12-15 σ -layers in the first 1000 m)

Cold start (No data assimilation)

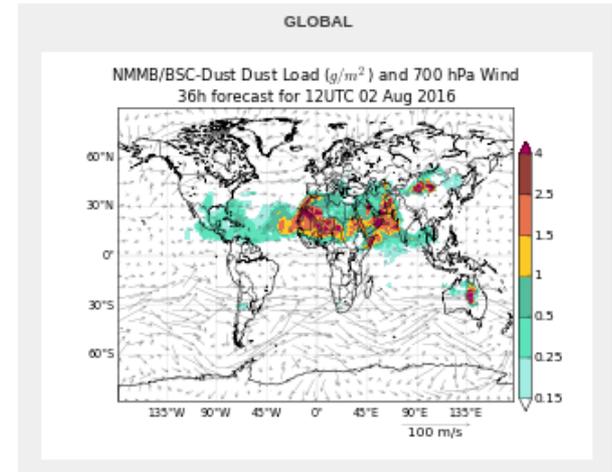
(Vendrell et al., in preparation)

Mineral dust Services

BSC dust operational forecast (global and regional domains)

<http://www.bsc.es/ESS>

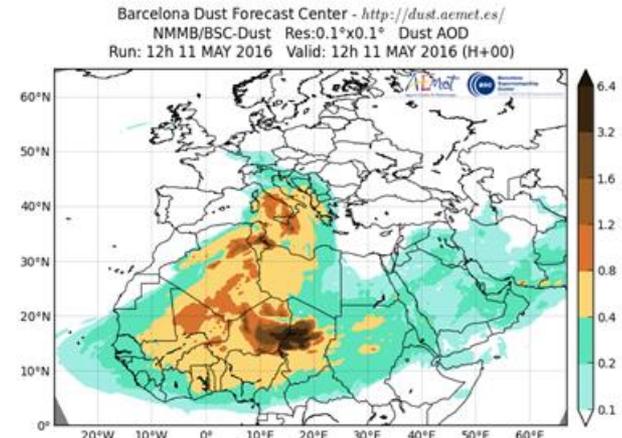
✓ Contribution to the **ICAP** multi-model ensemble (global) <http://icap.atmos.und.edu>



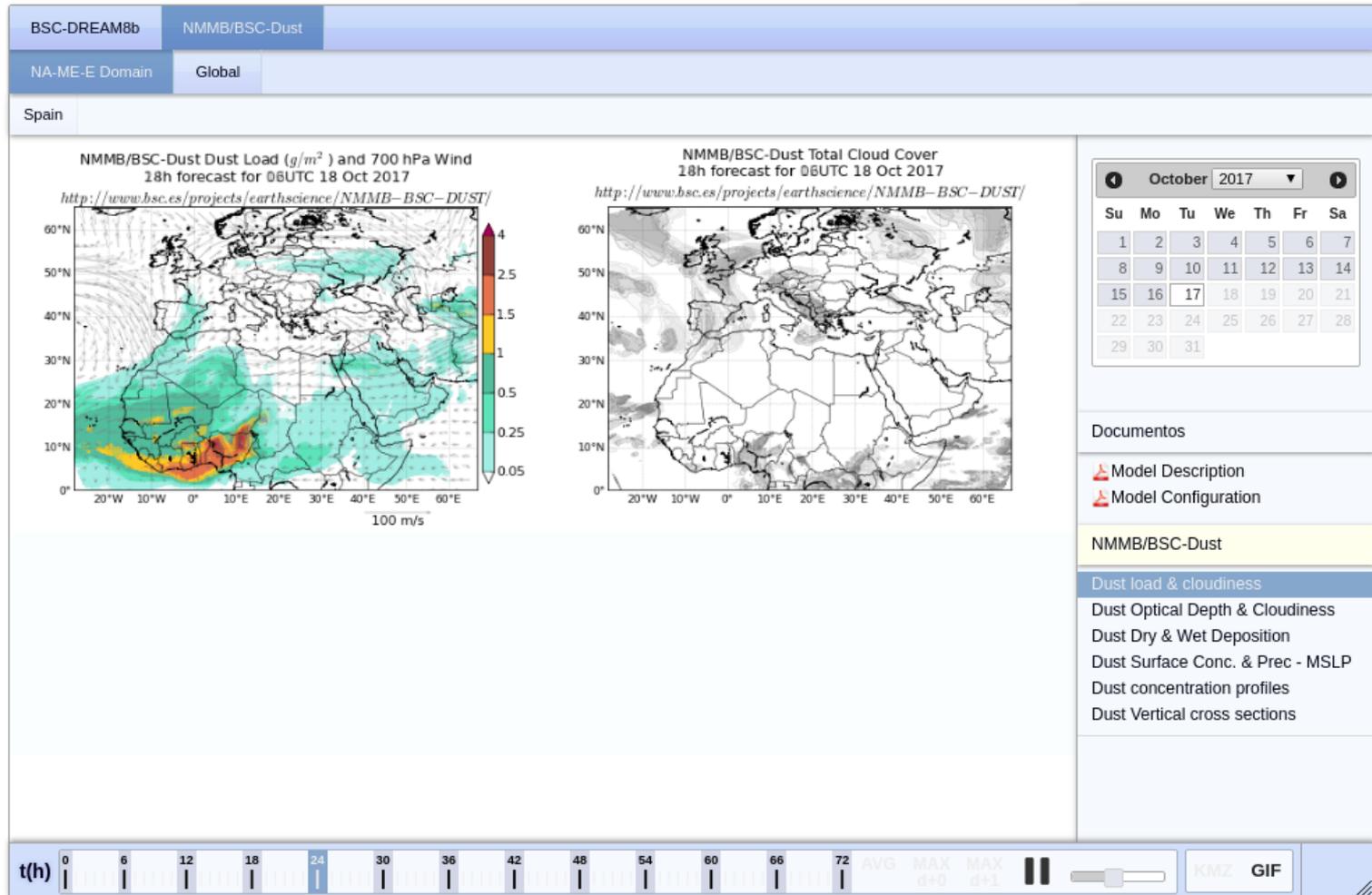
WMO Dust Centers

**SDS-WAS. North Africa, Middle East and Europe
Regional Center.** <http://sds-was.aemet.es>
started in 2010 – **Research**

Barcelona Dust Forecast Center.
First specialized WMO Center for mineral dust prediction.
<http://dust.aemet.es> started in 2014 - **Operational**



BSC dust operational forecast



<http://www.bsc.es/ESS>

The WMO SDS-WAS project

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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

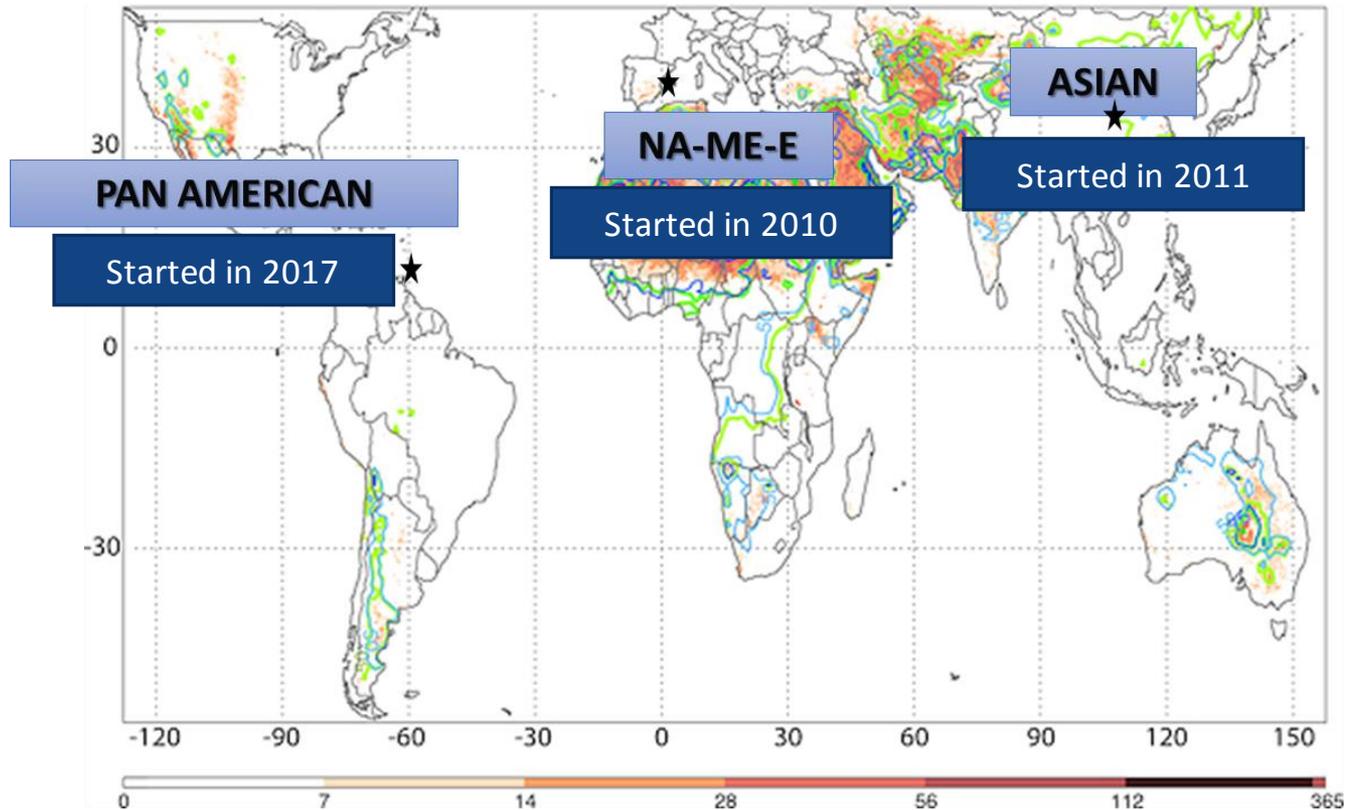
Science and I

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 NAMEE RC

[Log in](#)

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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Latest News

[Atmosphere. Special issue "Studying the effects of dust on weather"](#)
Oct 20, 2017

[Impact of dust deposition on wheat production](#)
Oct 19, 2017

[Paper on the pulsating nature of large-scale Saharan dust transport](#)
Oct 17, 2017

Upcoming Events

[International Workshop on Middle East \(Regional\) Dust Sources and Their Impacts](#)
Oct 23, 2017 - Oct 25, 2017 — Istanbul, Turkey

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

by Francisco Botneca — last modified May 25, 2012 03:33 PM

Outstanding

[Addressing Sand and Dust Storms in Sustainable Development Goals Implementation](#)

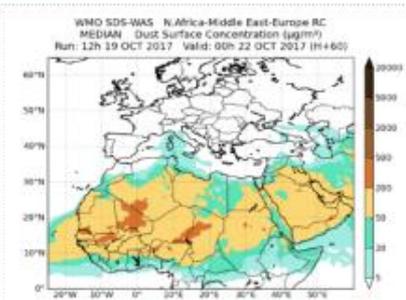
[WMO supports the International Conference on sand and dust storms currently held in Tehran](#)

[SDS-WAS will contribute to UN Conference on sand and dust storms to be held in Tehran](#)

[New members of the SDS-WAS Regional Steering Group for Northern Africa, Middle East and Europe](#)

[6th Training Course on WMO SDS-WAS Products \(Satellite and Ground Observation and Modelling of Atmospheric Dust\)](#)

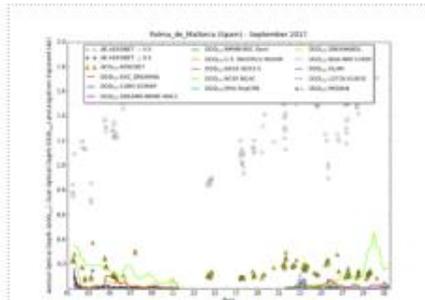
Dust forecasts



WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration (µg/m³)
Run: 12h 19 OCT 2017 Valid: 00h 22 OCT 2017 (H+60)

Compared Dust Forecasts

Forecast Evaluation



Malheria, Malheria (Spain) - September 2017

Forecast Evaluation

Subscribe to the Public Newsletter!

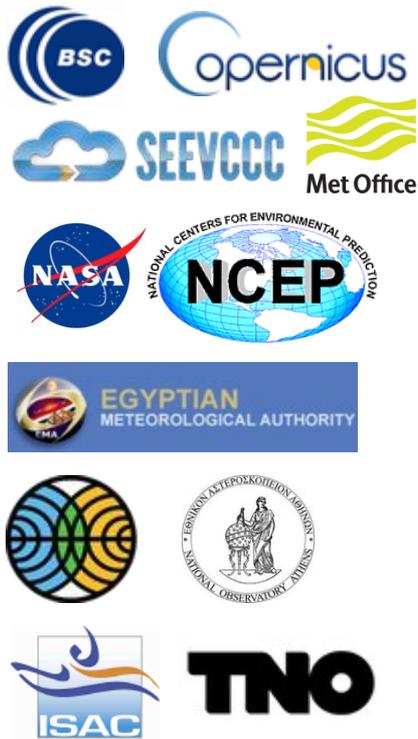
To be informed about our activities, news and events related to dust. Frequency is almost monthly.

Portal manual

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

SDS-WAS NAMEE: Dust Forecasts

Dust prediction models provide 72 hours (at 3-hourly basis) of dust forecast (AOD at 550nm and surface concentration) covering the NAMEE region.



MODEL	RUN TIME	DOMAIN	DATA ASSIMILATION
BSC-DREAM8b	12	Regional	No
CAMS ECMWF	00	Global	MODIS AOD
DREAM8-NMME	00	Regional	CAMS analysis
NMMB/BSC-Dust	00	Regional	No
MetUM	12	Global	MODIS AOD
GEOS-5	00	Global	MODIS reflectances
NGAC	00	Global	No
RegCM4 EMA	00	Global	No
DREAMABOL	12	Regional	No
WRF-CHEM NOA	12	Regional	No
SILAM	12	Regional	No
LOTOS-EUROS	12	Regional	No

SDS-WAS NAMEE: Files Download

BSC-DREAM8b v2.0	PUBLIC Files RESTRICTED Files	Model website	
CAMS-ECMWF	PUBLIC Files RESTRICTED Files	Model website	
DREAM-NMME-MACC	PUBLIC Files RESTRICTED Files	Model website	

	Title	Size	Modified
NMNB/BSC-I			
NASA-GEOS-1	latest - <i>(download all)</i>	4.0 kB	Oct 19, 2017 10:40 PM
NCEP-NGAC	2017 - <i>(download all)</i>	4.0 kB	Oct 03, 2017 10:40 PM
	2016 - <i>(download all)</i>	4.0 kB	Dec 03, 2016 10:40 PM
DREAMABOL	2015 - <i>(download all)</i>	4.0 kB	Mar 07, 2016 12:49 PM
	2014 - <i>(download all)</i>	4.0 kB	Mar 07, 2016 12:49 PM
EMA-RegCM4	2013 - <i>(download all)</i>	4.0 kB	Mar 07, 2016 12:49 PM
	2012 - <i>(download all)</i>	4.0 kB	Mar 07, 2016 12:49 PM

- Daily forecasts of dust surface concentration and dust optical depth will be displayed on a page together with a menu to allow visualization of the archived products and/or download of the numerical files for a selected range of dates.
- Access to the download pages shall be restricted to those groups that authorize the exchange of their own data.

Needed registered user!

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

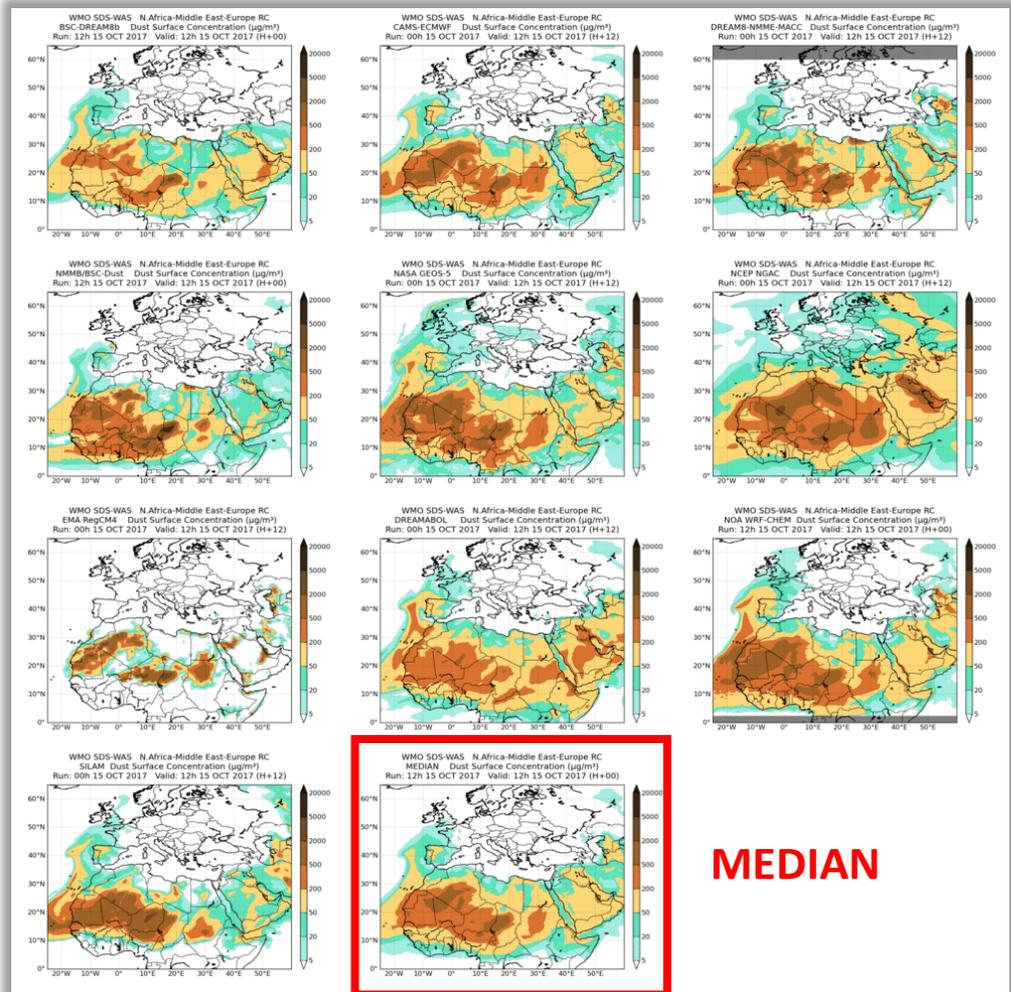
SDS-WAS Multi-model

SDS-WAS product



12 Global – Regional models
(from ~ 100 to 10 km)

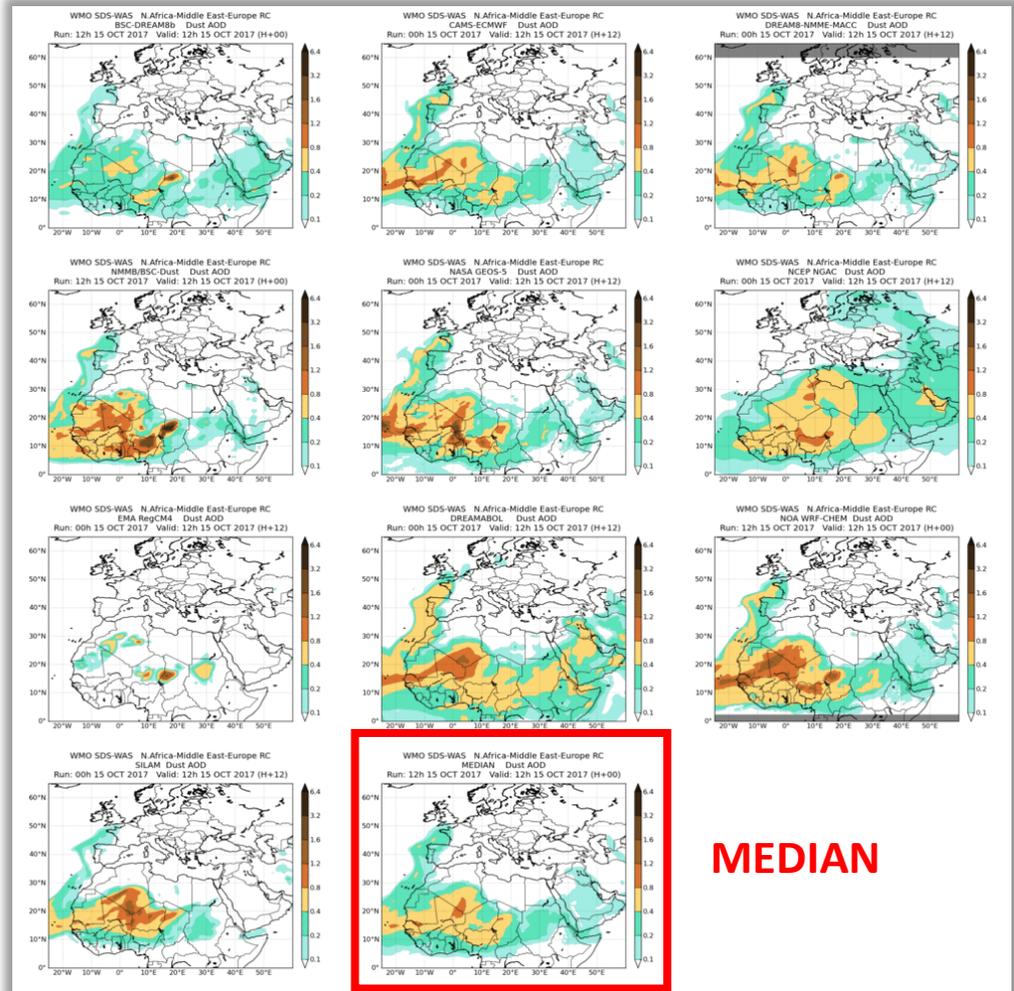
Dust Surface Conc.
from 15-Oct-2017 12:00 to 18-Oct-2017 00:00



SDS-WAS Multi-model

SDS-WAS product

Dust Optical Depth at 550nm
from 15-Oct-2017 12:00 to 18-Oct-2017 00:00



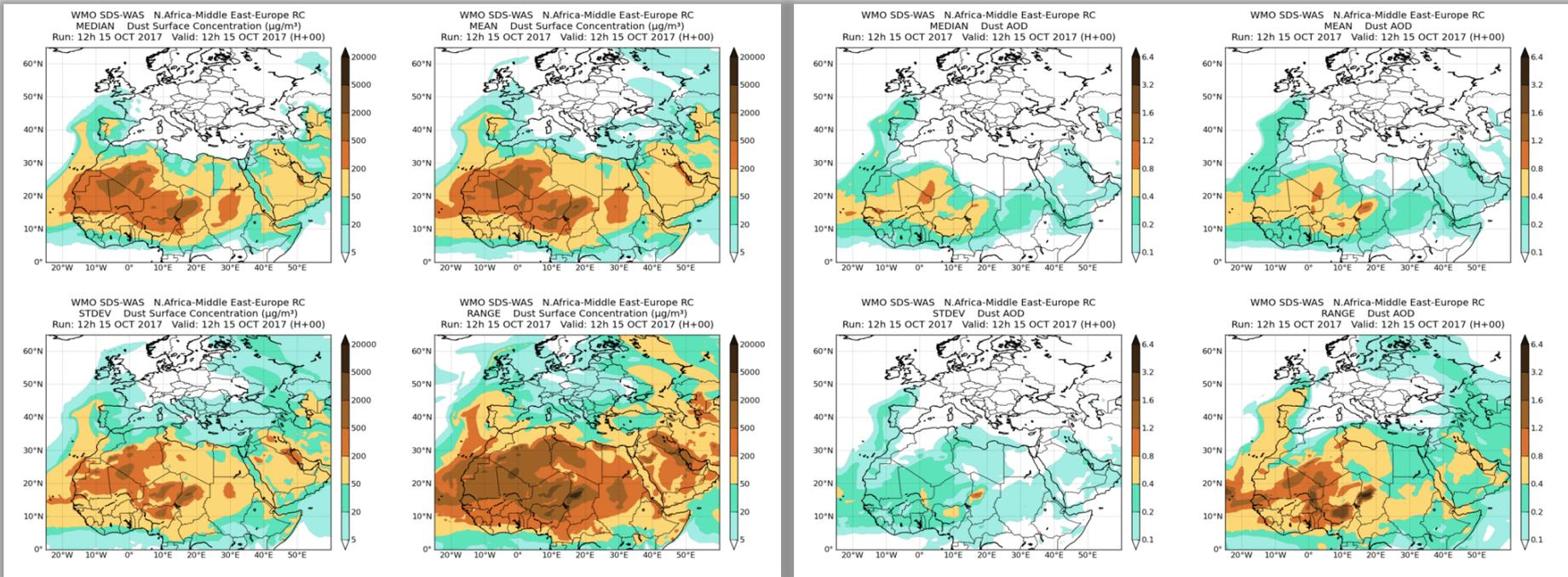
MEDIAN

12 Global – Regional models
(from ~ 100 to 10 km)

SDS-WAS NAMEE: Multi-model

Surface concentration

Dust AOD at 550nm



from 15-Oct-2017 12:00 to 18-Oct-2017 00:00

Model outputs are bi-linearly interpolated to a common $0.5^\circ \times 0.5^\circ$ grid mesh. Then, different multi-model products are generated:

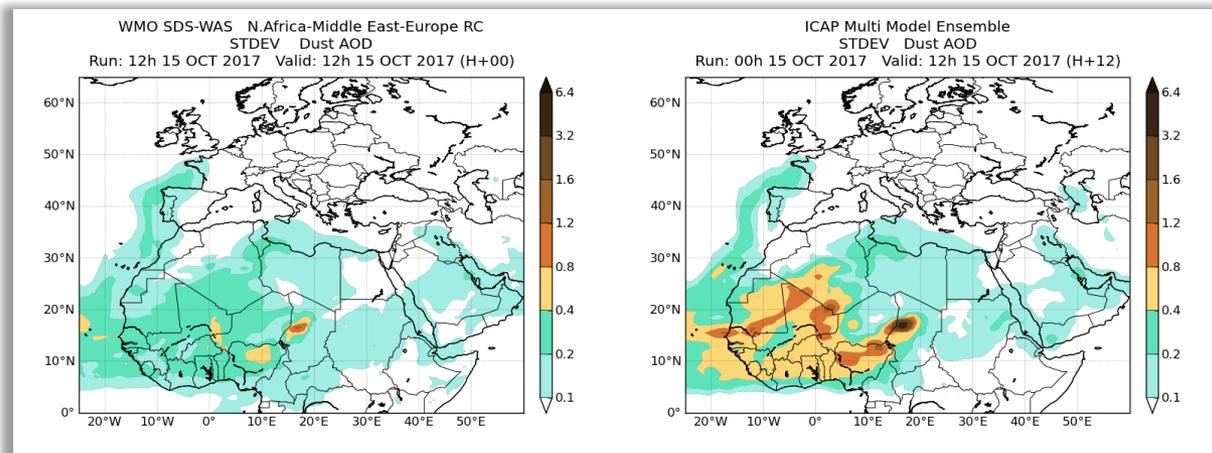
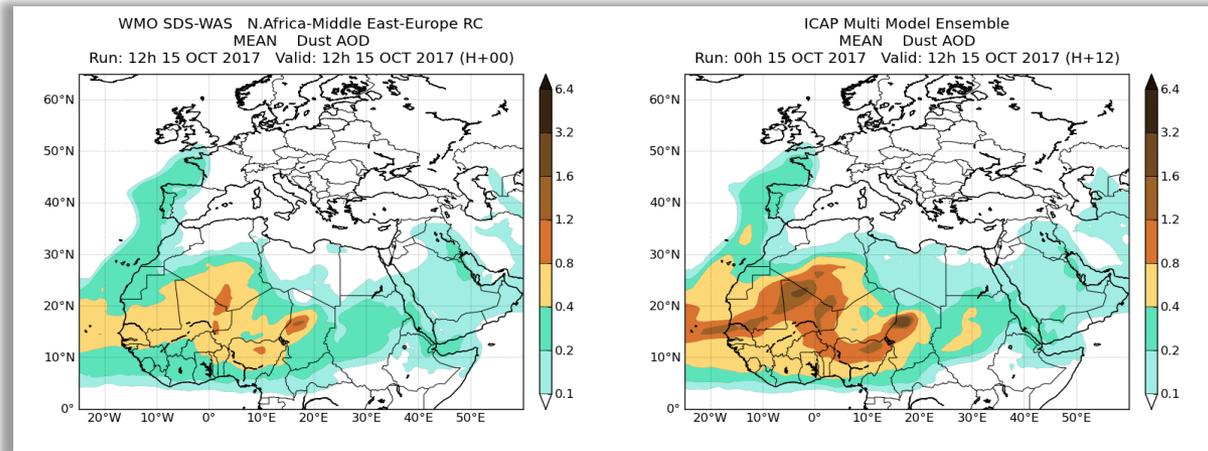
CENTRALITY: median - mean

SPREAD: standard deviation – range of variation

SDS-WAS NAMEE: Multi-model - ICAP

Only global models!

Dust AOD at 550nm
from 15-Oct-2017 12:00 to 18-Oct-2017 00:00

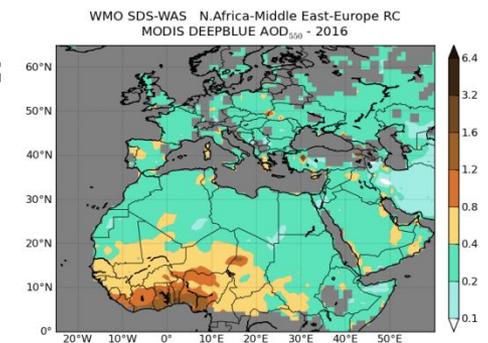
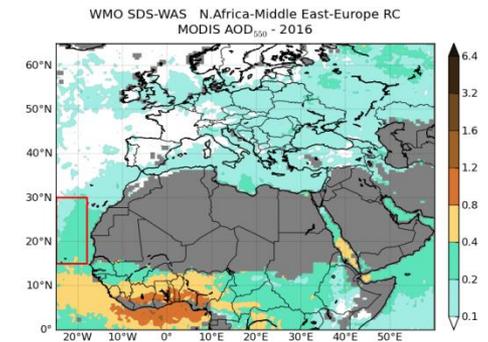


SDS-WAS NAMEE: DOD Model Evaluation

- **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

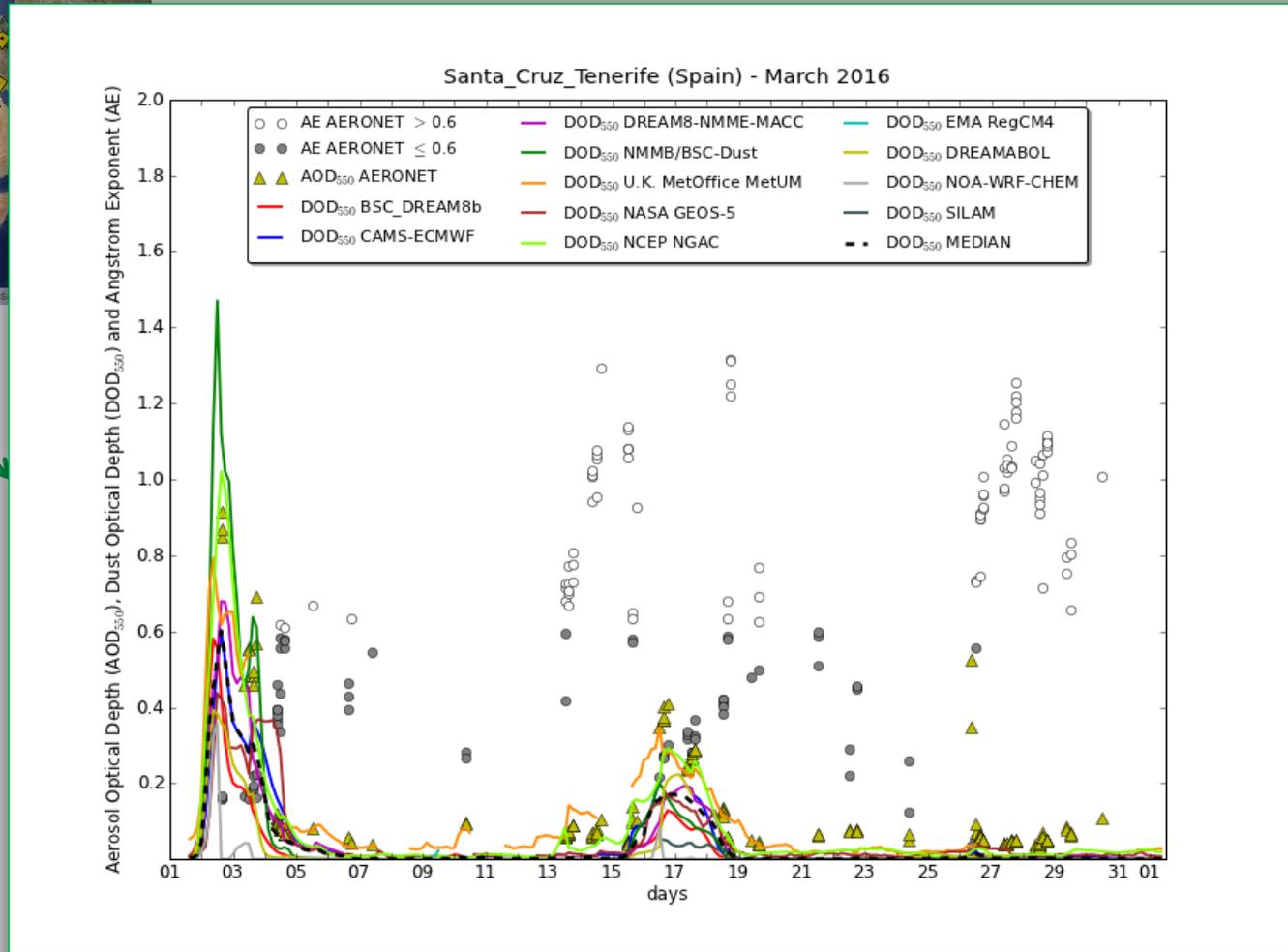


- **Evaluation of dust models with MODIS Deep Blue retrievals**
 - Evaluation scores monthly/seasonal/annual



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

SDS-WAS NAMEE: DOD AERONET Evaluation



SDS-WAS NAMEE: DOD AERONET Evaluation



Date:

Jan 2016 - Dec 2016. Dust Optical Depth.
Threshold Angstrom Exponent = 0.600

BIAS

	BSC_ DREAMb	CAMS- ECMWT	DREAMS- NMME- MACC	NMMB/ BSC-Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	NOA-WRF- CHEM	SILAM	MEDIAN
Sahel/Sahara show stations	-0.30	-0.17	-0.20	-0.11	-0.16	-0.20	-0.06	0.03	-0.13	-0.13	-0.06	-0.18
Middle East show stations	-0.12	-0.10	-0.05	-0.17	-0.12	-0.16	-0.11	1.13	0.06	-0.14	0.01	-0.13
Mediterranean show stations	-0.16	-0.12	-0.12	-0.15	-0.10	-0.14	-0.05	-0.02	-0.09	-0.12	-0.10	-0.13
TOTAL	-0.24	-0.14	-0.16	-0.13	-0.14	-0.18	-0.06	0.08	-0.10	-0.13	-0.07	-0.16

ROOT MEAN SQUARE ERROR

	BSC_ DREAMb	CAMS- ECMWT	DREAMS- NMME-MACC	NMMB/ BSC-Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	NOA-WRF- CHEM	SILAM	MEDIAN
Sahel/Sahara show stations	0.51	0.42	0.45	0.43	0.44	0.42	0.39	0.64	0.48	0.44	0.82	0.42
Middle East show stations	0.35	0.25	0.28	0.44	0.27	0.31	0.29	11.39	0.34	0.32	0.62	0.28
Mediterranean show stations	0.30	0.29	0.30	0.29	0.27	0.29	0.27	0.40	0.30	0.31	0.44	0.28
TOTAL	0.44	0.37	0.39	0.39	0.38	0.38	0.35	2.86	0.42	0.39	0.71	0.37

CORRELATION COEFFICIENT

	BSC_ DREAMb	CAMS- ECMWT	DREAMS- NMME-MACC	NMMB/ BSC-Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	NOA-WRF- CHEM	SILAM	MEDIAN
Sahel/Sahara show stations	0.42	0.33	0.40	0.54	0.40	0.50	0.55	0.17	0.31	0.41	0.10	0.50
Middle East show stations	0.35	0.25	0.28	0.44	0.27	0.31	0.29	0.02	0.34	0.32	0.62	0.28
Mediterranean show stations	0.30	0.29	0.30	0.29	0.27	0.29	0.27	0.40	0.30	0.31	0.44	0.28
TOTAL	0.44	0.37	0.39	0.39	0.38	0.38	0.35	2.86	0.42	0.39	0.71	0.37

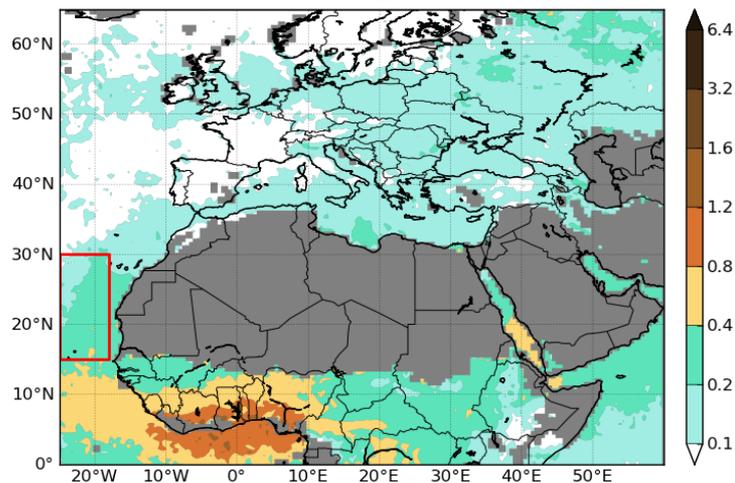
A set of evaluation metrics are selected: **Bias**, **RMSE**, **correlation coefficient** and **FGE**

Calculations evaluation metrics are done for:

- **monthly/seasonal/annual**
- **sites and regions**

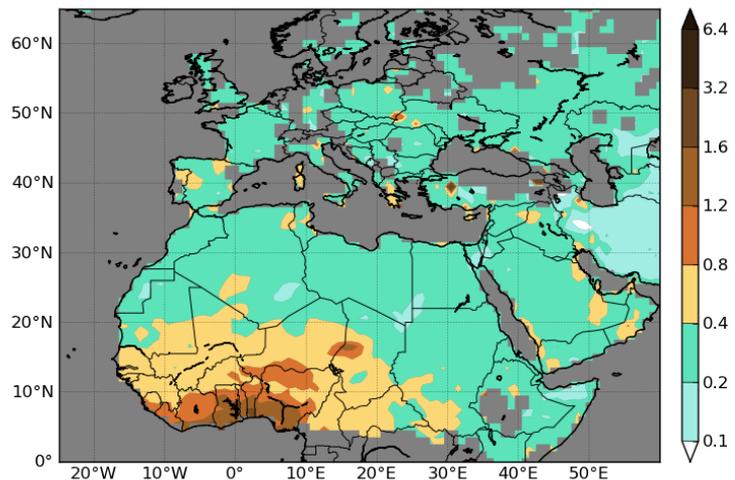
SDS-WAS NAMEE: DOD MODIS Evaluation

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



	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.16	0.26	0.70	0.97	18493
NMMB/BSC-Dust	-0.11	0.22	0.72	0.83	18293
NCEP NGAC	0.08	0.21	0.79	0.51	18465
EMA RegCM4	0.03	0.35	0.34	1.11	8039
DREAMABOL	-0.06	0.27	0.51	0.84	17834
NOA-WRF-CHEM	-0.00	0.18	0.79	0.71	18141
SILAM	0.03	0.48	0.45	0.93	12302

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



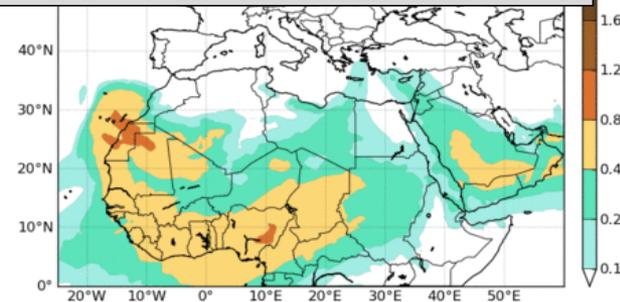
	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.16	0.32	0.40	0.76	189314
NMMB/BSC-Dust	-0.10	0.29	0.66	0.82	188183
NCEP NGAC	-0.03	0.27	0.52	0.55	189348
EMA RegCM4	0.25	1.51	0.07	0.82	94099
DREAMABOL	-0.01	0.36	0.24	0.70	181446
NOA-WRF-CHEM	-0.04	0.25	0.61	0.59	186946
SILAM	0.10	0.79	0.27	0.93	142429

SDS-WAS NAMEE: Model Evaluation



7 March 2015

New observational datasets for model evaluation in Northern Africa and Middle East

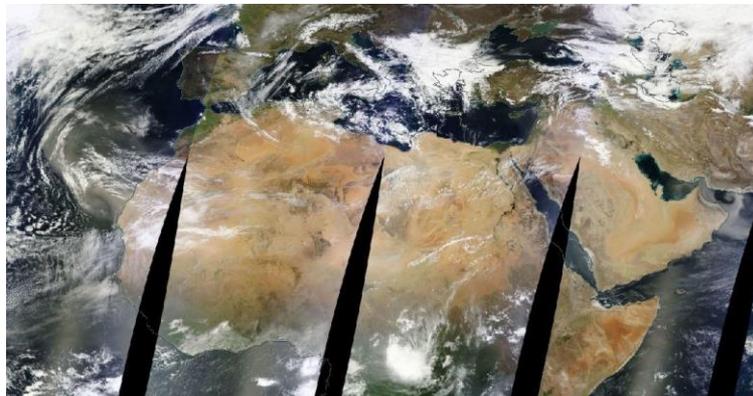


NOTE: There is available an historical archive of the MSG RGB dust products.

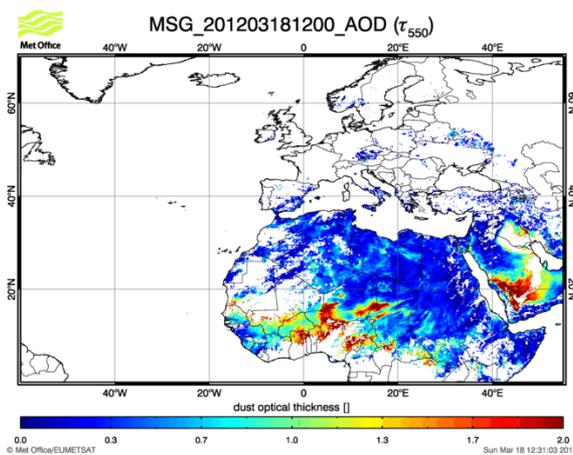
SDS-WAS NAMEE: Model Evaluation

New observational datasets for model evaluation in Northern Africa and Middle East

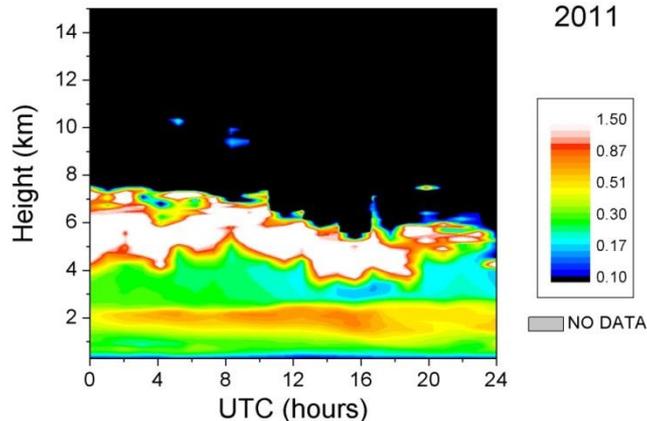
- Visibility
- MSG/SEVIRI
- MODIS
- OMI
- CALIPSO
- PARASOL
- MPLNET
- PM₁₀



MODIS composite 8th March 2015 from EOSDIS World Viewer

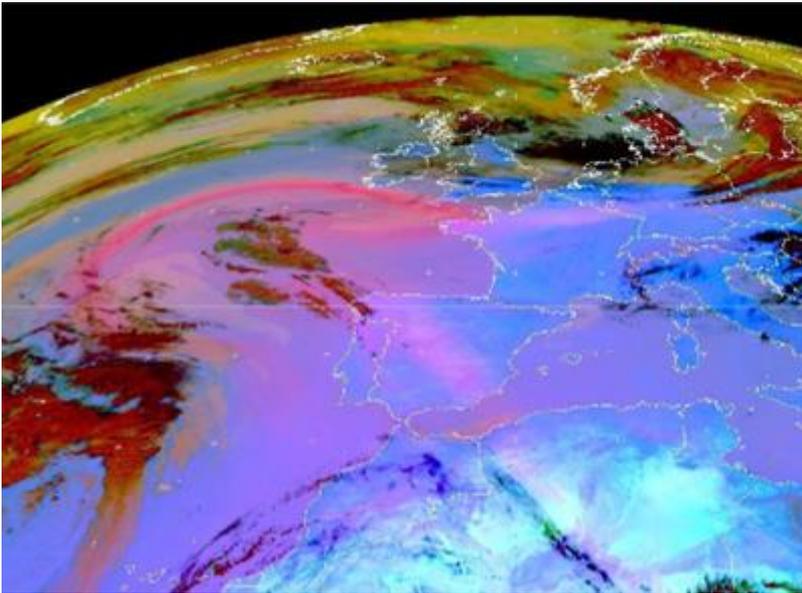


Micro Pulse LIDAR - Sta. Cruz de Tenerife 08 Dec 2011



SDS-WAS NAMEE: Studies

Model Intercomparison: European dust outbreak on April 2011

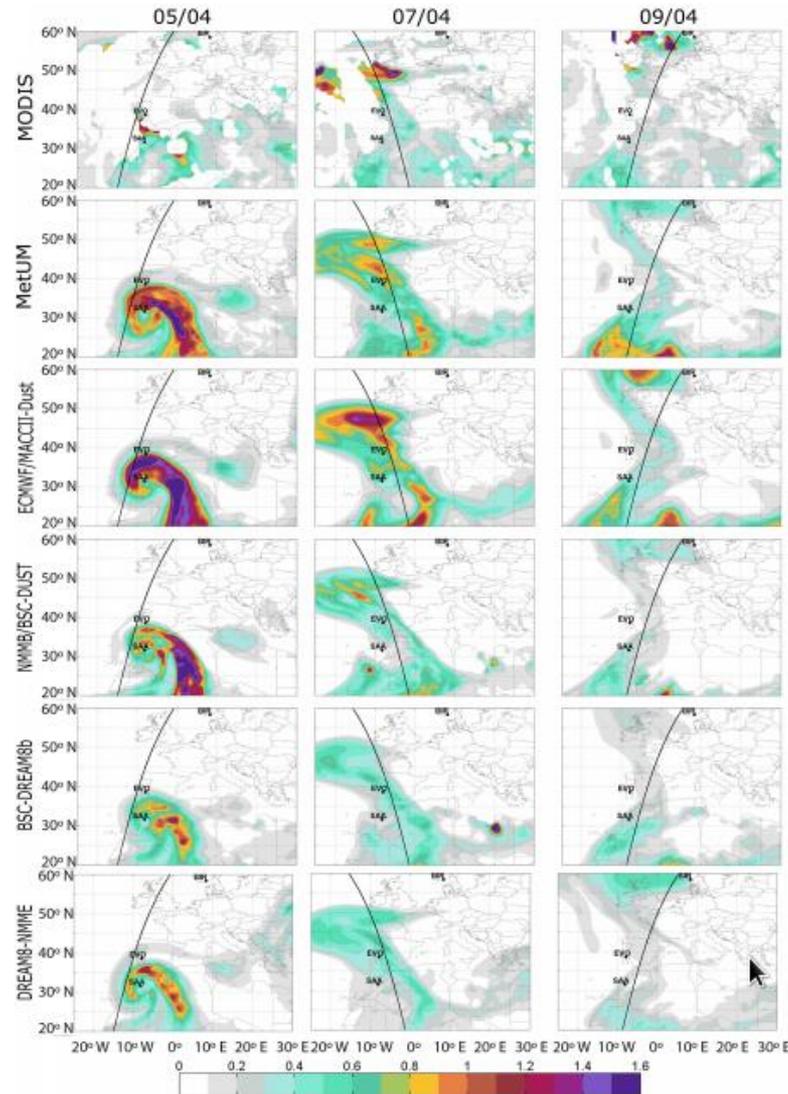


*MSG/SEVIRI RGB product 7 April
Courtesy of EUMETSAT*

- The selected dust event corresponds to the one which occurred between the 5th and 11th of April of 2011.
- Participating models: BSC-DREAM8b, NMMB/BSC-Dust, ECMWF-MACC, UKMetOffice-UM and NMME-DREAM-MACC
- Comparison of each forecast (at 24, 48 and 72h) output to in-situ measurements of AOD (from AERONET), surface concentration (PM) and satellite retrieved AOD (MODIS, CALIPSO) and meteorology.

SDS-WAS NAMEE: Studies

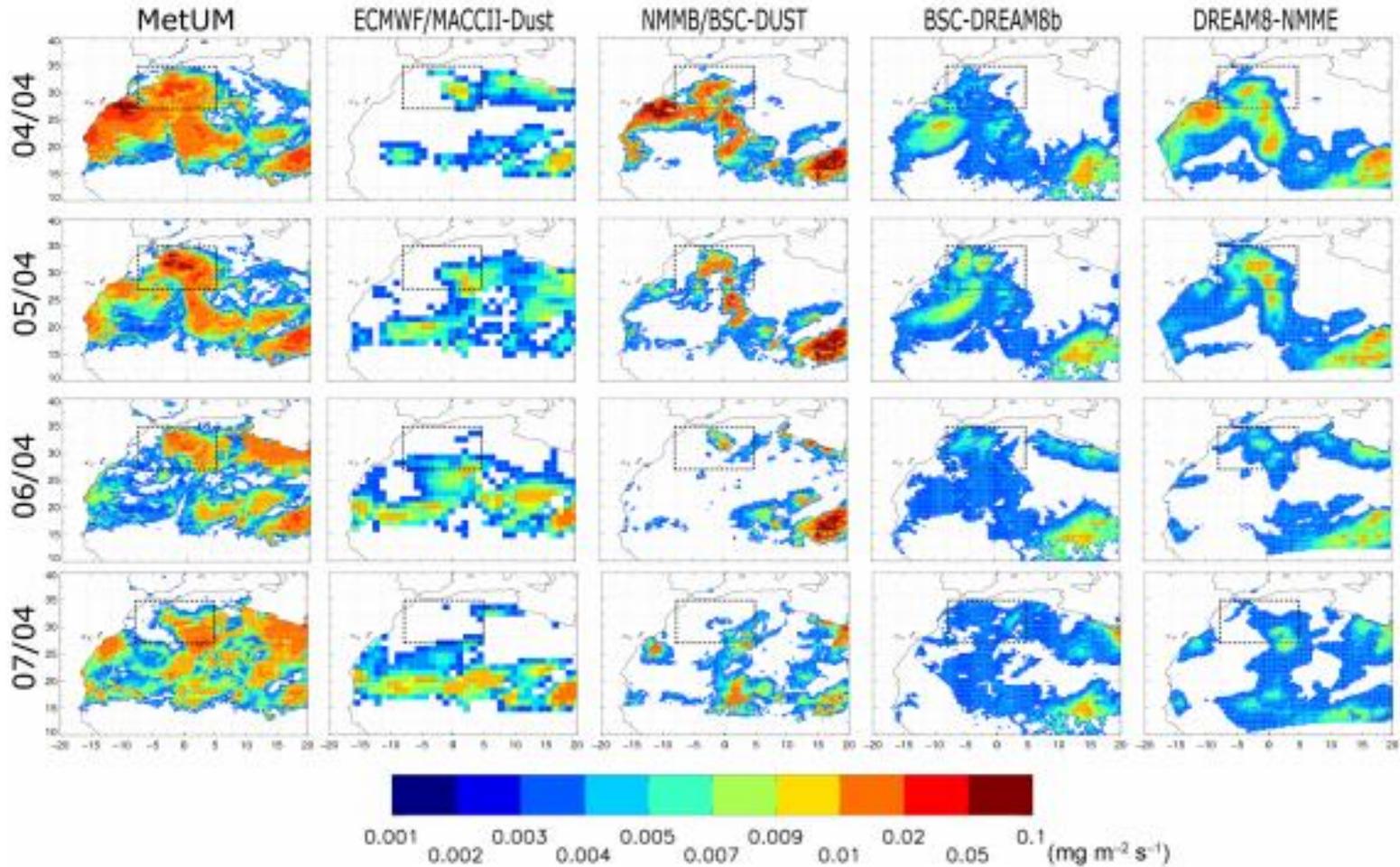
Model Intercomparison: European dust outbreak on April 2011 – DOD



(Huneus et al., ACP, 2016)

SDS-WAS NAMEE: Studies

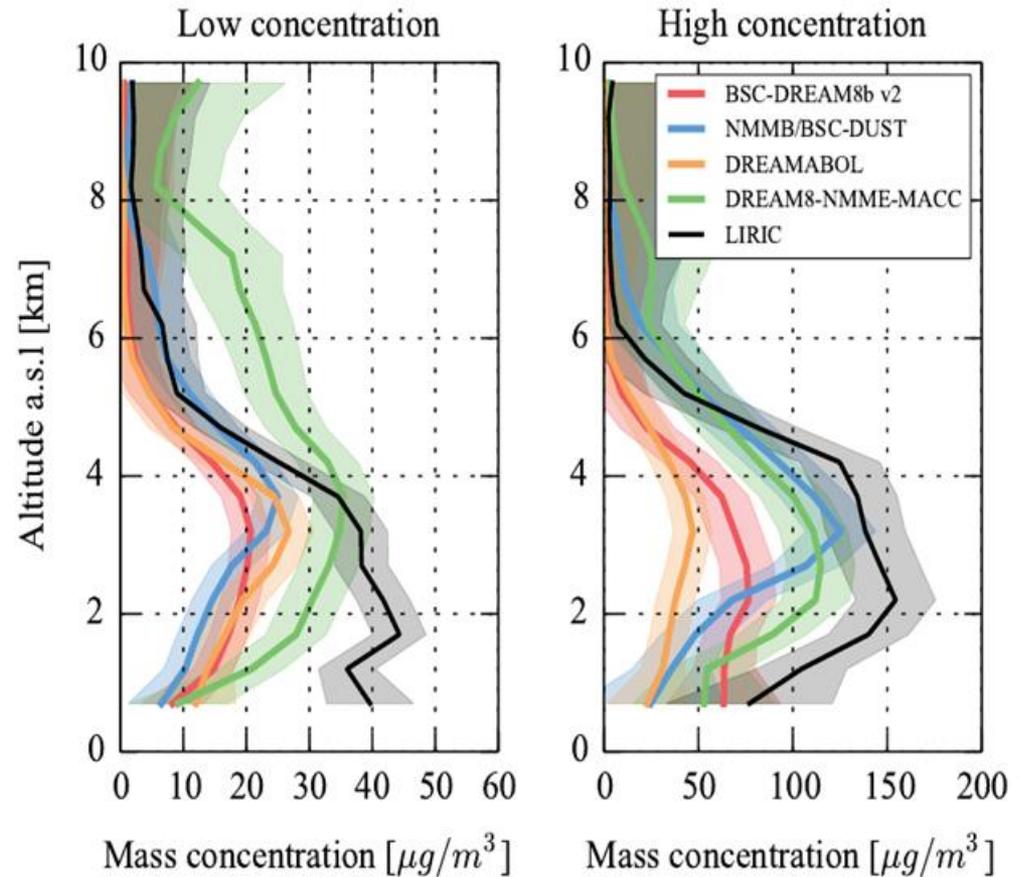
Model Intercomparison: European dust outbreak on April 2011 - Emissions



(Huneus et al., ACP, 2016)

SDS-WAS NAMEE: Studies

Model Intercomparison: EU-EARLINET vertical dust profiles: 2011-2013



(Biniotoglou et al., ATM, 2015)

SDS-WAS NAMEE: Studies

The extreme dust storm occurred in Tehran (Iran) on **2nd June 2014** lasting less than 2 hours according to public evidence.

Based on public news, the dust storm caused several deaths, reduction of visibility to several tenths meters in the city, and adverse disturbance of the public traffic. The blowing wind reached 110 km/h.

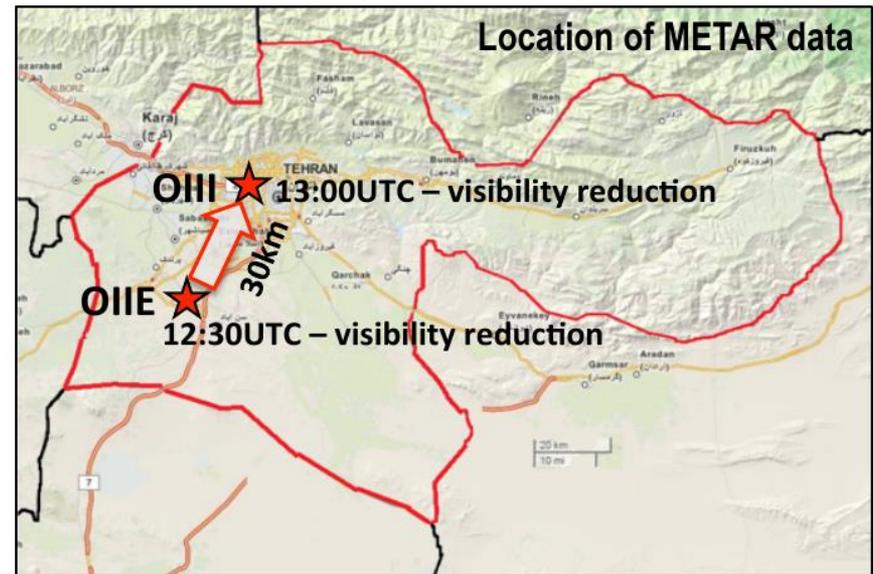
This project aims to **better understand generation and development of small-scale dust storms** contributing so to exploring a potential of dust models to more accurately simulate such events, considering them as the most difficult ones to be operationally predicted.



Iranian Haboob: Teheran 2nd June 2014

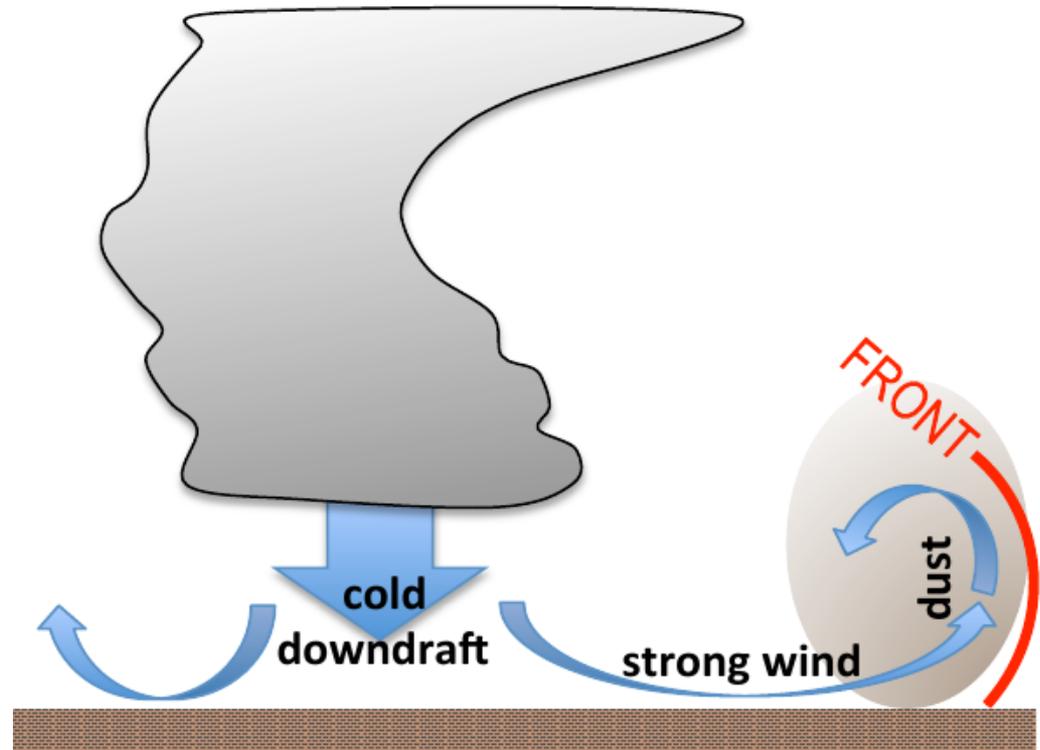
Information from reports

- reached city at 5.30 p.m. local time;
- passing of the sand storm over the fixed site lasted about 15min;
- storm duration less than 2h;
- reduction of visibility to ~10m; wind velocity reached 110 km/h;
- temperature dropped from 33 to 18°C in several min;
- at least 5 deaths, 82 injured; multiple vehicle collision;



Iranian Haboob: Teheran 2nd June 2014

Intensive cold downbursts from convective cells produced high velocity surface wind, creating cold front which was lifting, mixing and pushing dust towards the city;

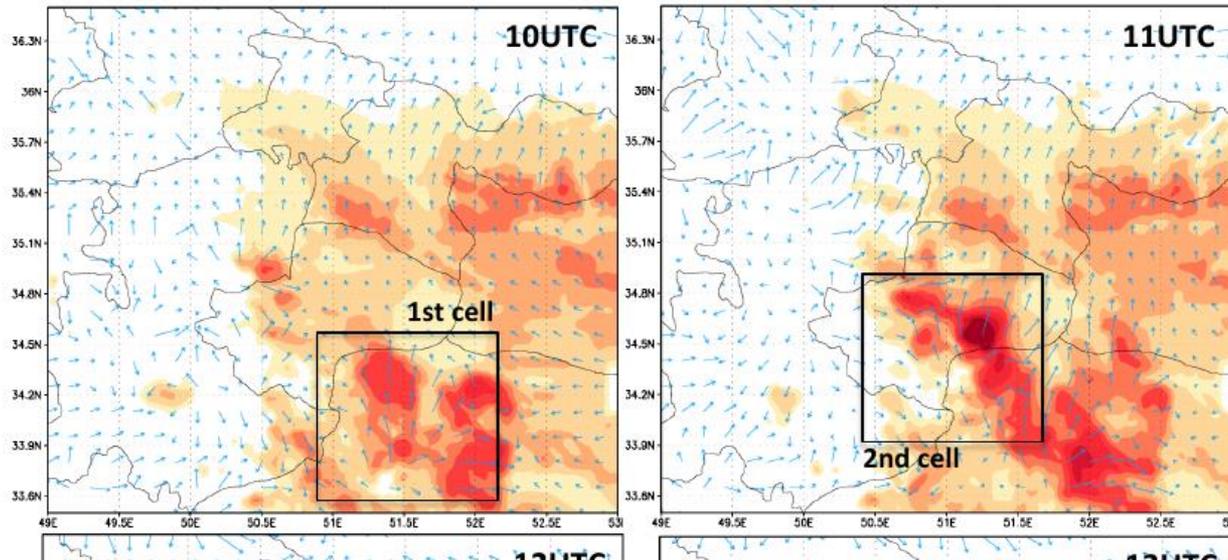


Expected: high wind speed, drop in temperature, rise in humidity, rise in pressure, reduction of visibility.

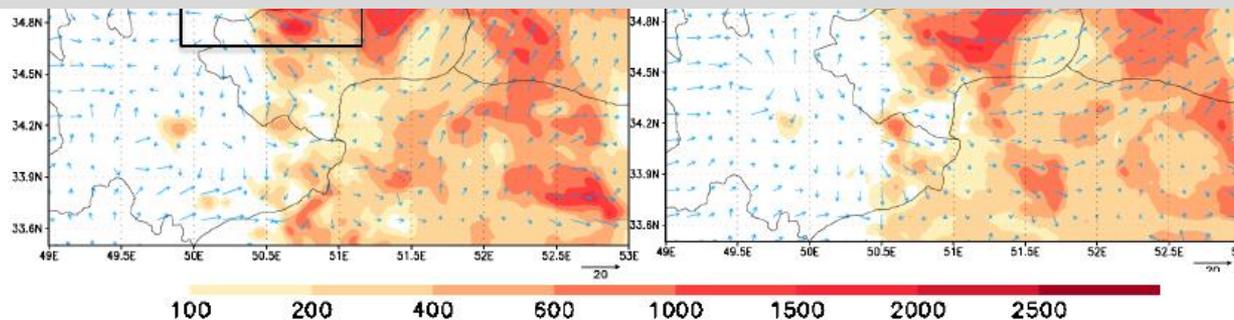
Iranian Haboob: Teheran 2nd June 2014

DNC
(surface)
Dust Number
Concentration
*number of dust
particles in cm³*

Dust uplift and
transport
controlled with
three main cells.



Explicit convection simulations are highly dependent on the initial conditions and the microphysical scheme
→ *Probabilistic dust forecast based on model ensembles*



SDS-WAS NAMEE: PM10 Evaluation



AMMA network: PM10 in Sahel for the year 2013



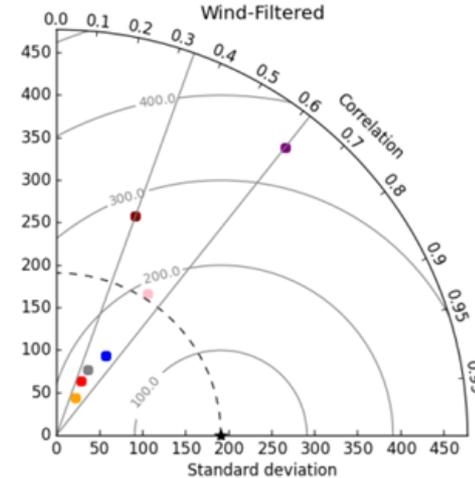
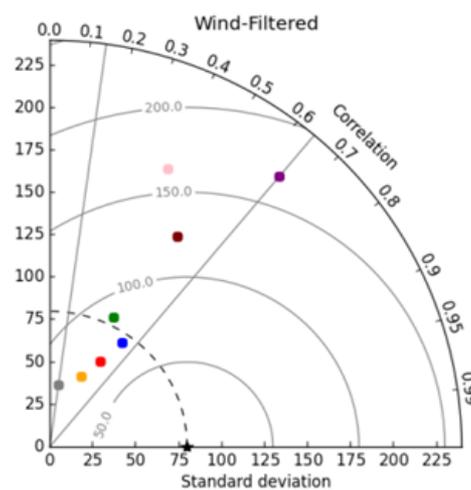
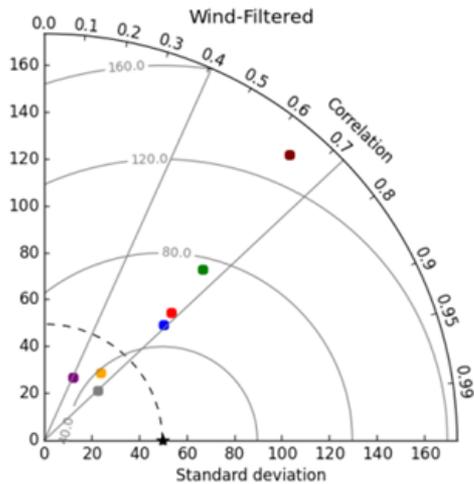
Not all PM10 is dust: Local and biomass burning from Savannah fires.

Dust filter: Considering the localizations of the desert dust sources the filter is based on wind direction.

M'Bour-Senegal

Cinzana-Mali

Banizoumbou-Niger

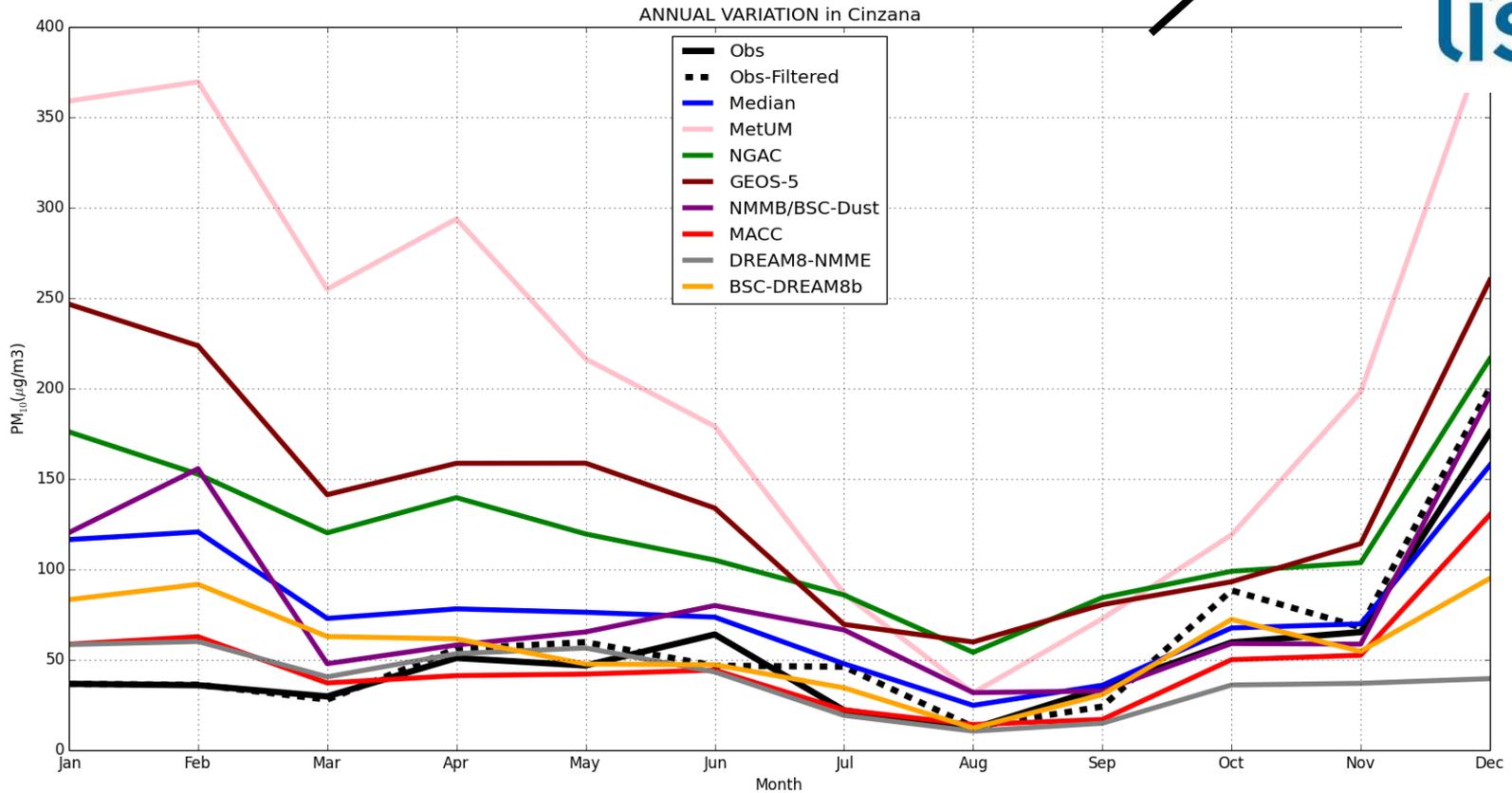


- ★ Reference
- CAMS
- Median
- NGAC
- NMMB/BSC-Dust
- BSC-DREAM8b
- GEOS-5
- MetUM
- DREAM8-NMME

AMMA (Marticorena et al., 2010)

SDS-WAS NAMEE: PM10 Evaluation

AMMA network: PM10 in Sahel for the year 2013

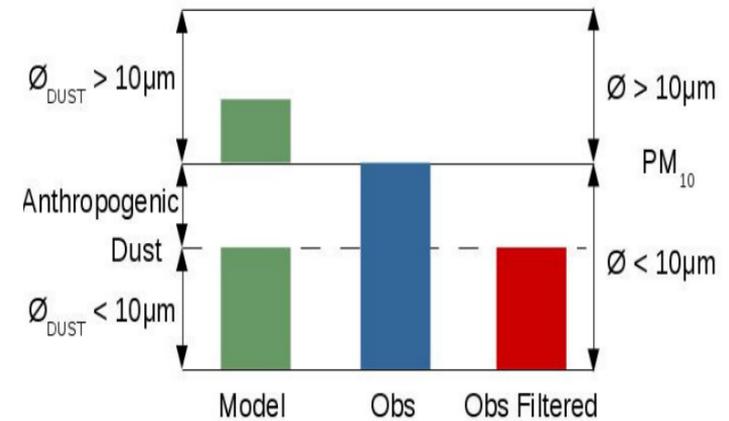


SDS-WAS NAMEE: PM10 Evaluation

AQ network: Canary Islands 2013-2014

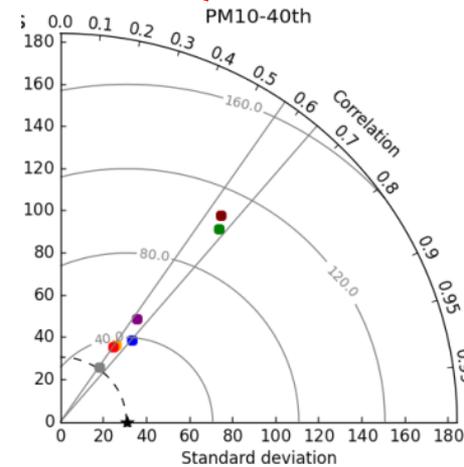
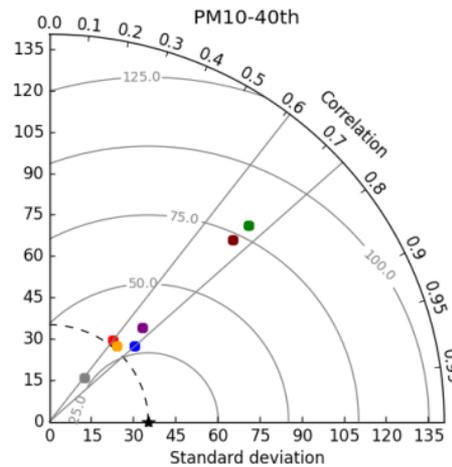
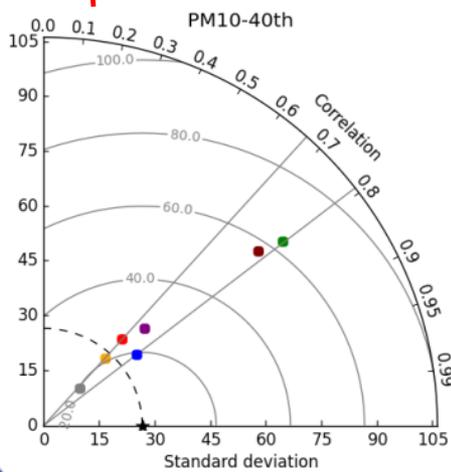
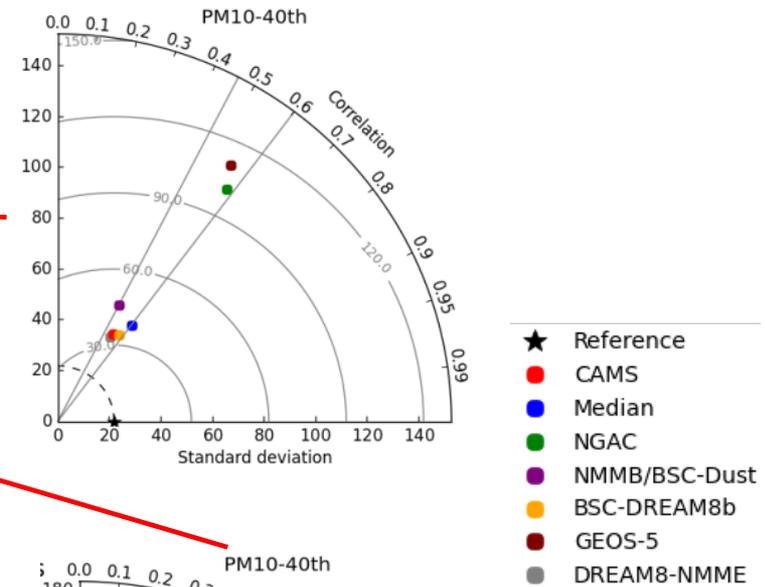


Not all PM10 is dust: Local sources
Dust filter: Moving 40th percentile of 30 days, 15 days before and 15 days after (Escudero at al. 2007).



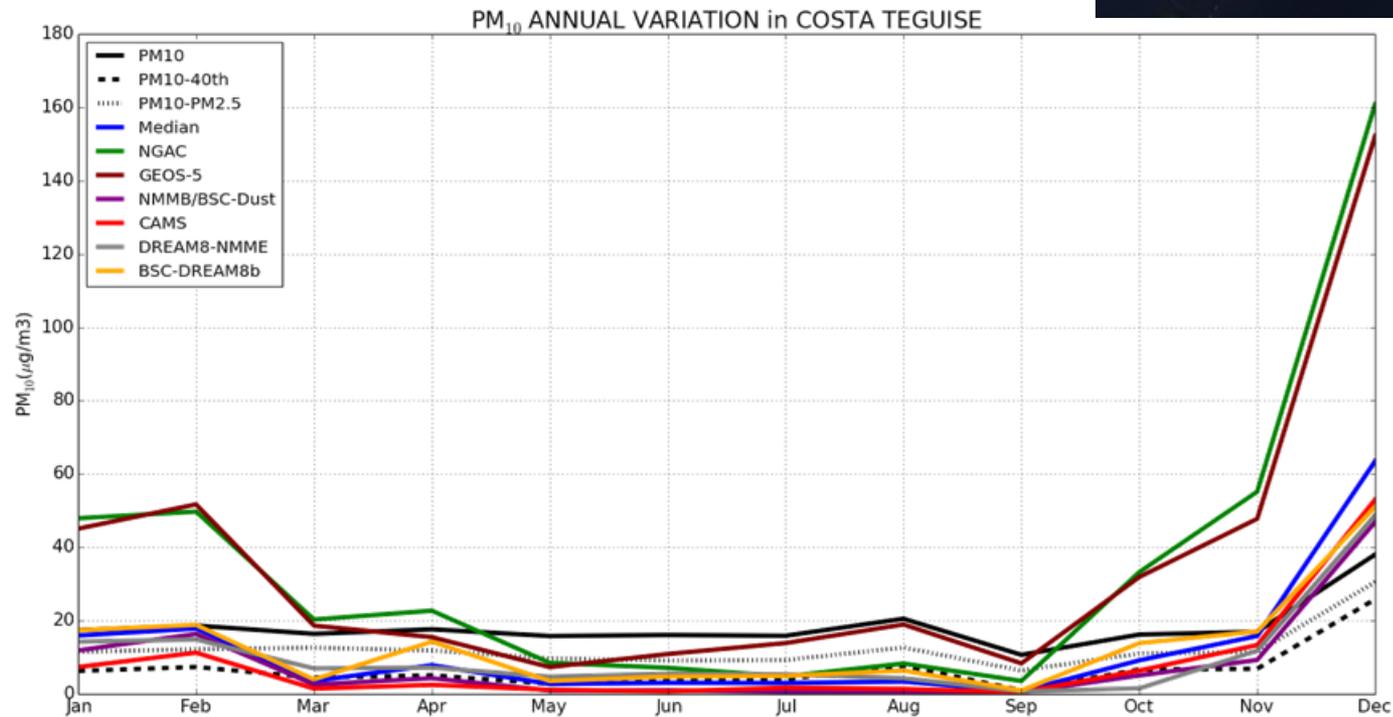
SDS-WAS NAMEE: PM10 Evaluation

AQ network: Canary Islands 2013-2014



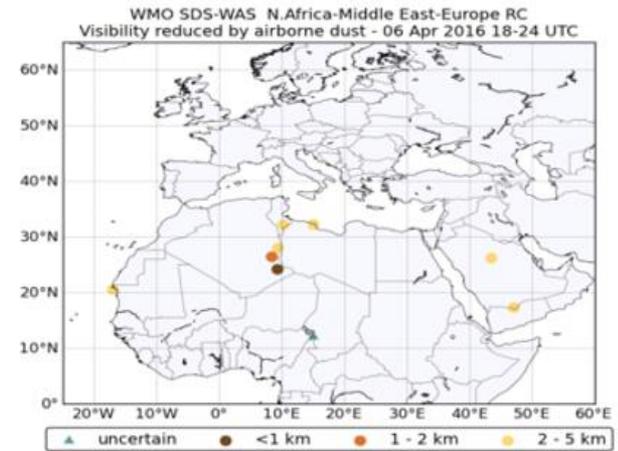
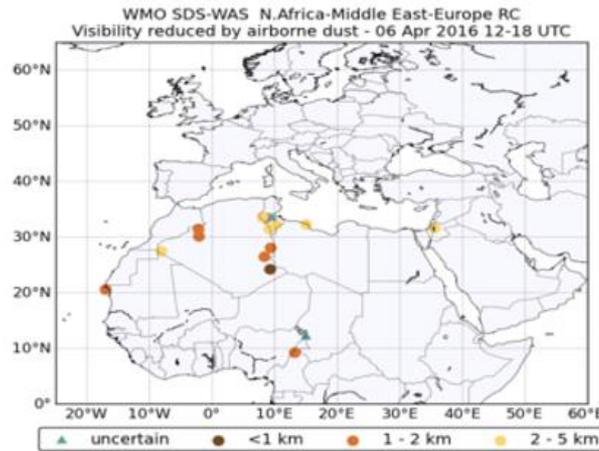
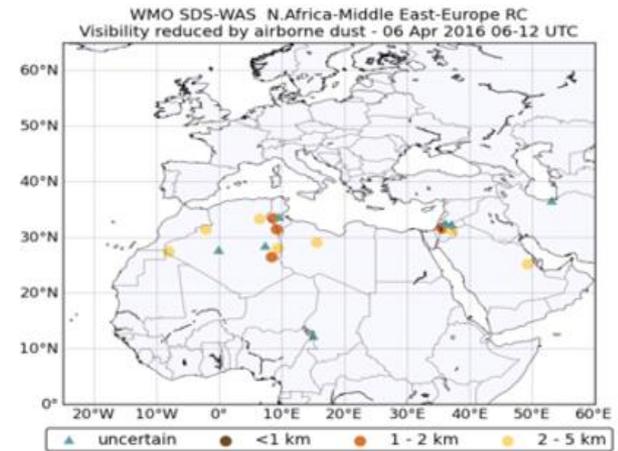
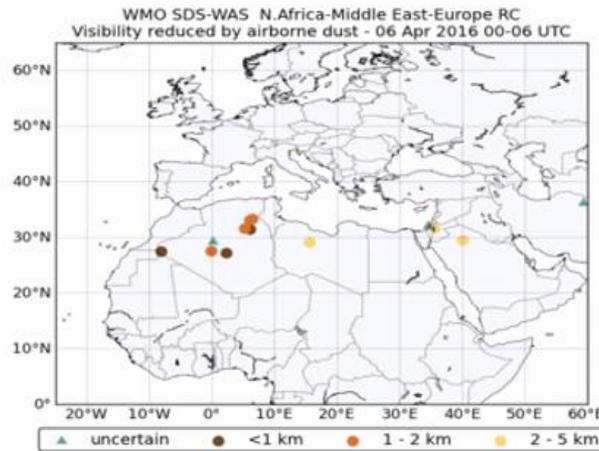
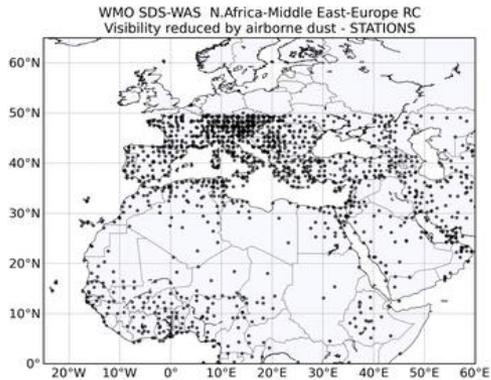
SDS-WAS NAMEE: PM10 Evaluation

AQ network: Canary Islands 2013-2014



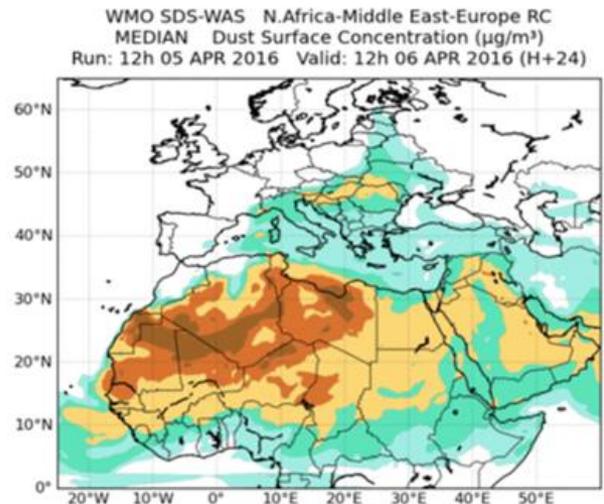
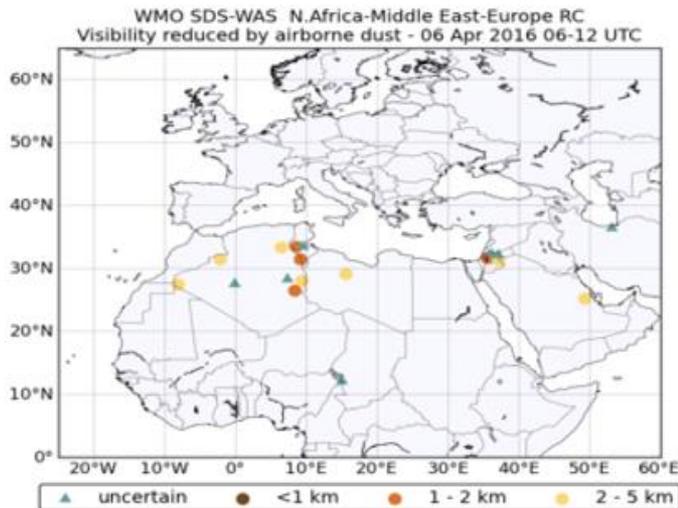
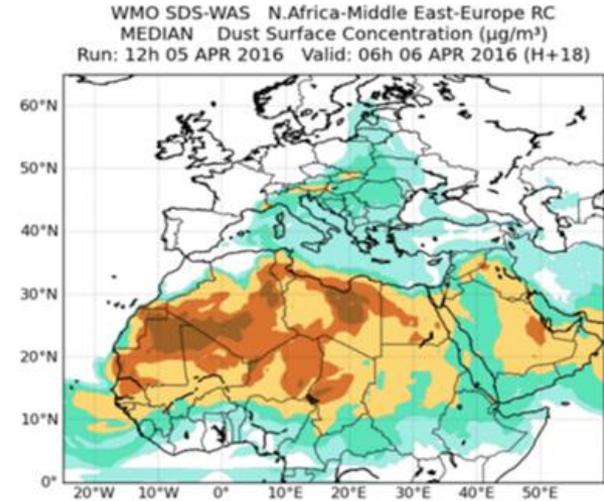
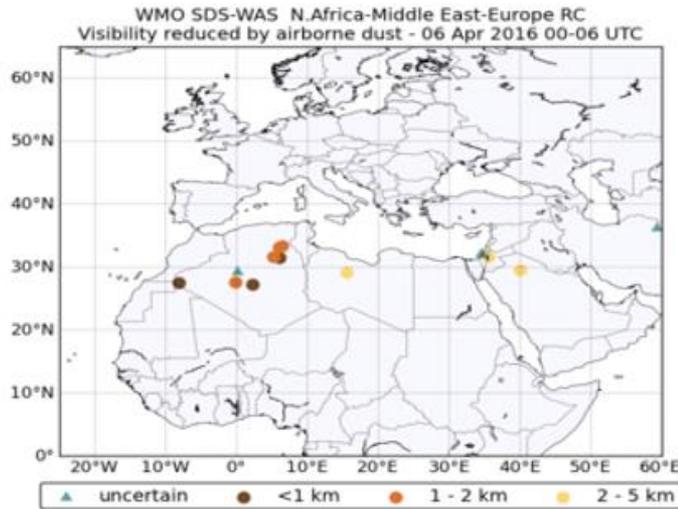
SDS-WAS NAMEE: Visibility vs Surf. Conc.

NRT visibility evaluation: 6th April 2016 0-12UTC



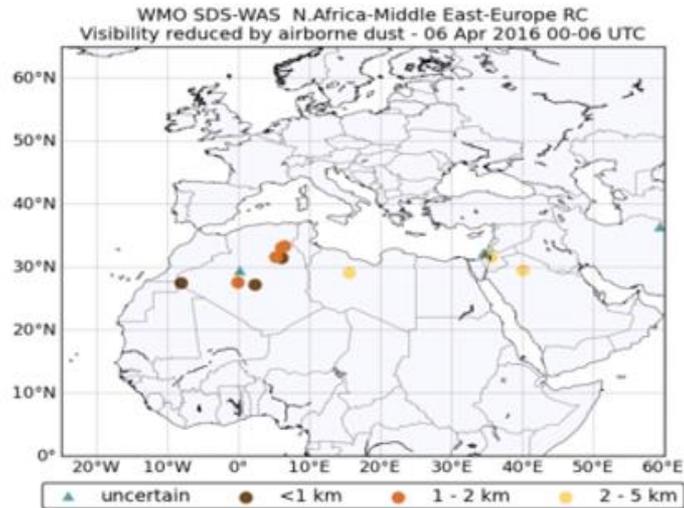
SDS-WAS NAMEE: Visibility vs Surf. Conc.

NRT visibility evaluation: 6th April 2016 0-12UTC

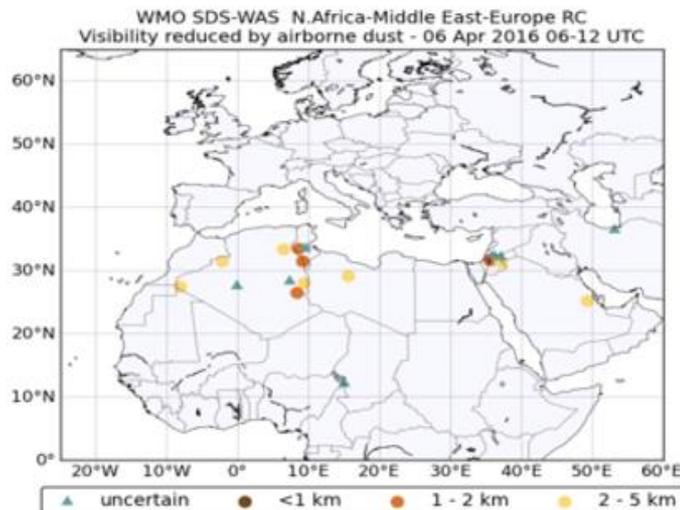
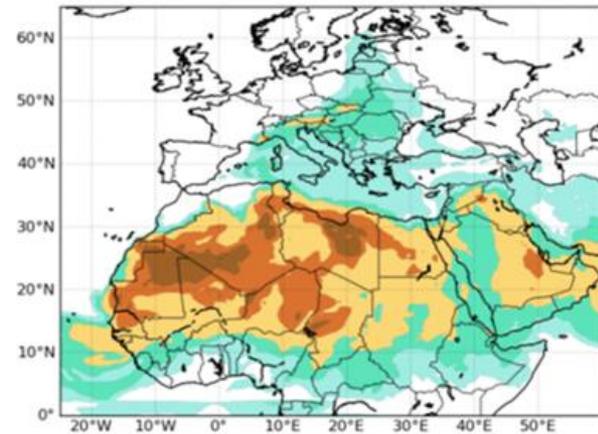


SDS-WAS NAMEE: Visibility vs Surf. Conc.

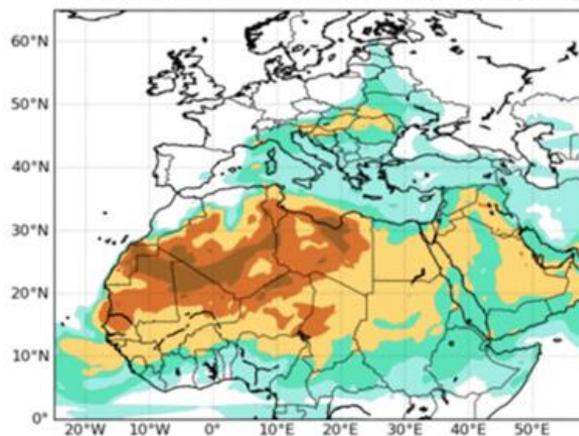
NRT visibility evaluation: 6th April 2016 0-12UTC



WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12h 05 APR 2016 Valid: 06h 06 APR 2016 (H+18)

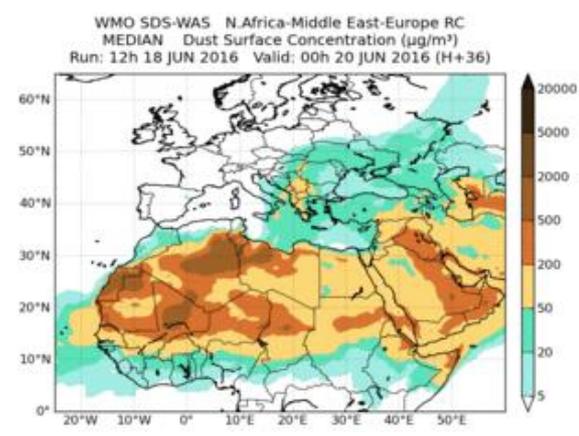
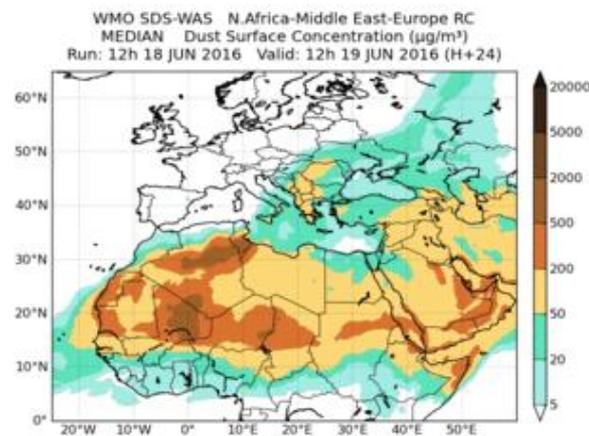
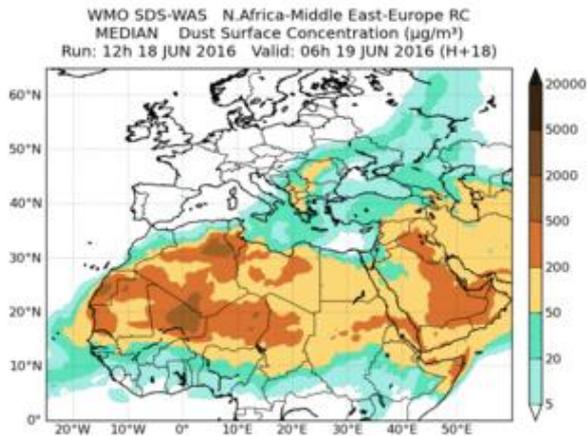
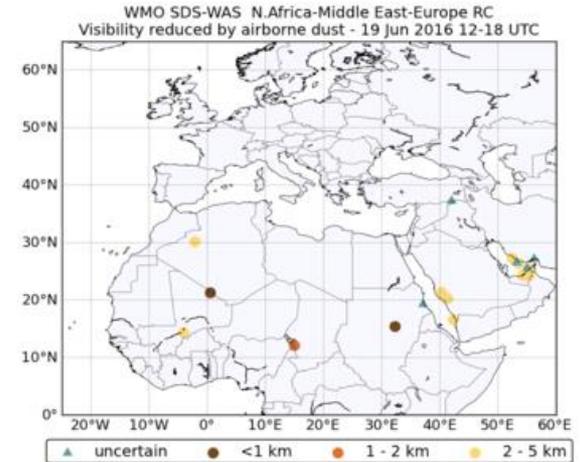
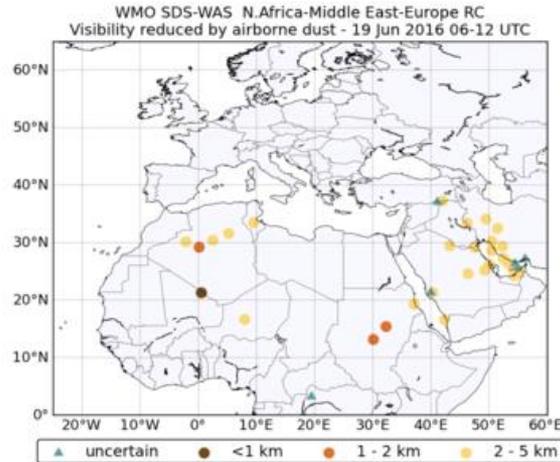
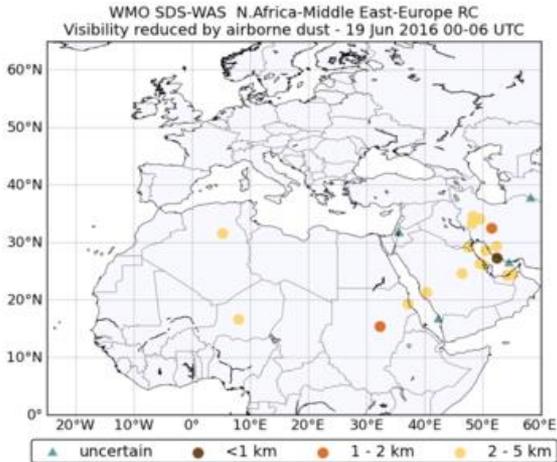


WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12h 05 APR 2016 Valid: 12h 06 APR 2016 (H+24)



SDS-WAS NAMEE: Visibility vs Surf. Conc.

NRT visibility evaluation: 19th june 2016



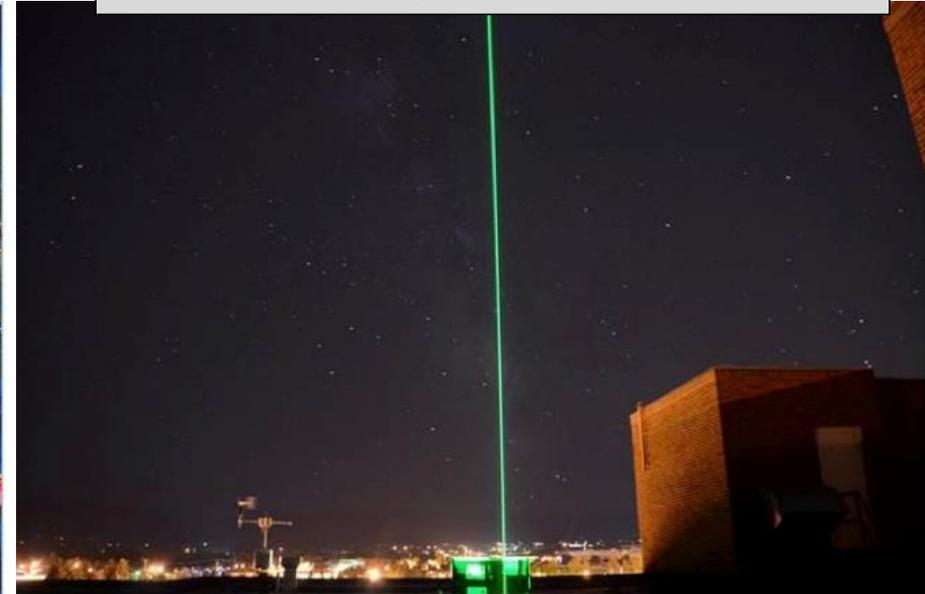
SDS-WAS NAMEE: Dust Profiles Evaluation



+ High density of stations
- Qualitative products



- Low number of stations
+ Quantitative products



<http://sds-was.aemet.es/projects-research/evaluation-of-model-derived-dust-vertical-profiles>

SDS-WAS NAMEE: Dust Profiles Evaluation



OBSERVATIONS

*Extinction profiles at 12UTC
available in a window of 24 hours*



3 ceilometers
1 lidar



SDS-WAS MODELS

- **BSC-DREAM8b**
- **NMMB/BSC-Dust**
- **CAMS**
- **DREAM8-NMME**
-

```
2016040512_3H_BSC_DREAM8B_profiles {  
  dimensions:  
    time = 73;  
    station = 67;  
    lev = 24;  
}
```

Data format

*Exchange operational protocol
includes 72 hours forecasts*

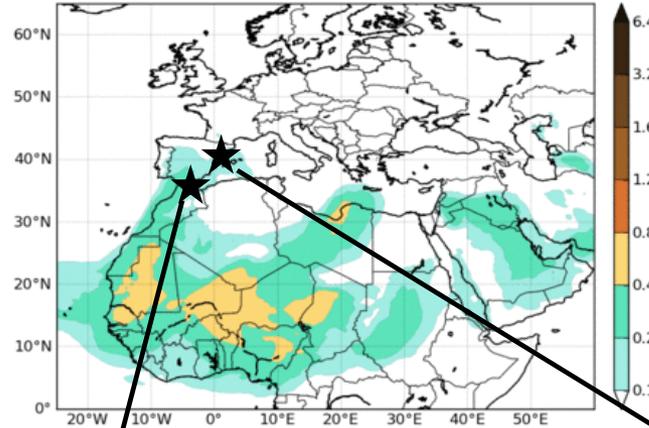
```
char station_name(station, strlen);  
station_name:missing_value = -9999. ;  
station_name:long_name = "station long name" ;  
station_name:units = "-. " ;  
char station_code(station, codlen);  
station_code:missing_value = -9999. ;  
station_code:long_name = "station code" ;  
station_code:units = "-. " ;  
double time(time);
```

<http://sds-was.aemet.es/projects-research/evaluation-of-model-derived-dust-vertical-profiles>

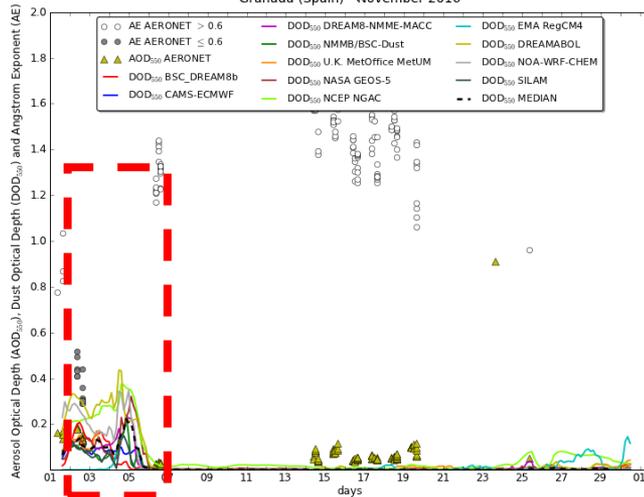
SDS-WAS NAMEE: Dust Profiles Evaluation

W. Mediterranean dust event: 2 - 5 November 2016

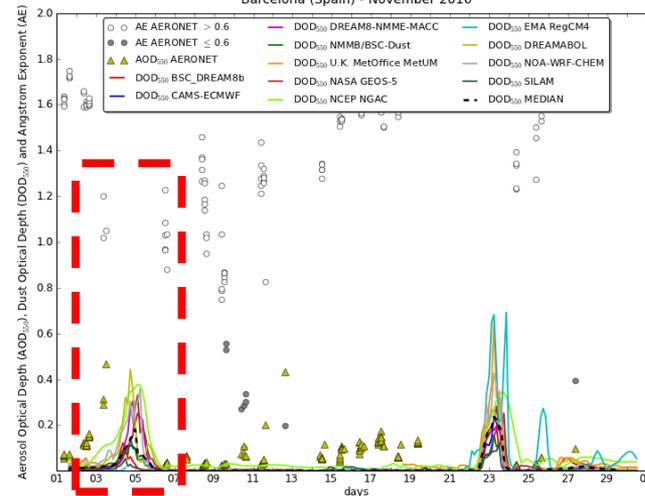
WMO SDS-WAS N.Africa-Middle East-Europe RC
 MEDIAN Dust AOD
 Run: 12h 04 NOV 2016 Valid: 12h 04 NOV 2016 (H+00)



Granada (Spain) - November 2016



Barcelona (Spain) - November 2016

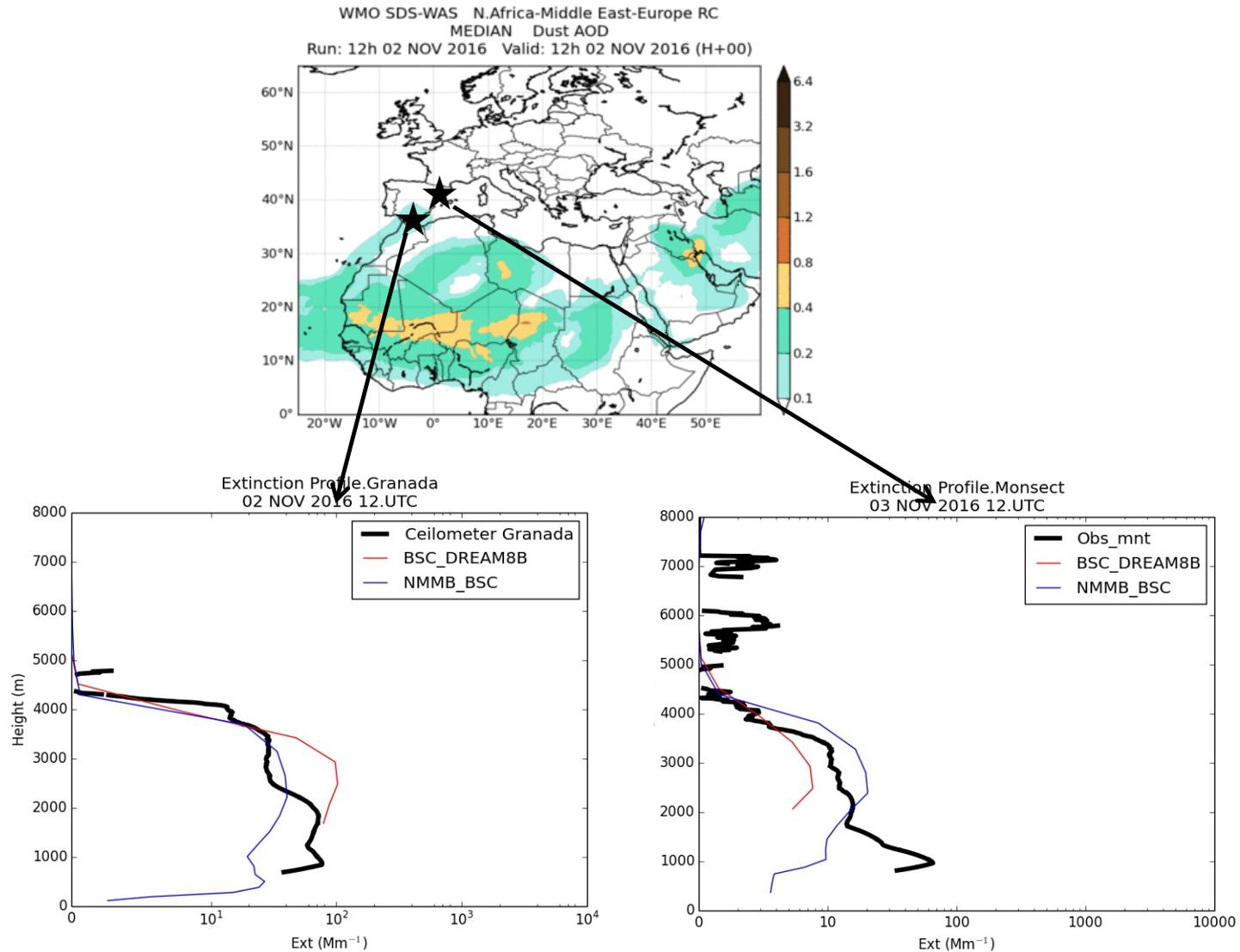


AERONET



SDS-WAS NAMEE: Dust Profiles Evaluation

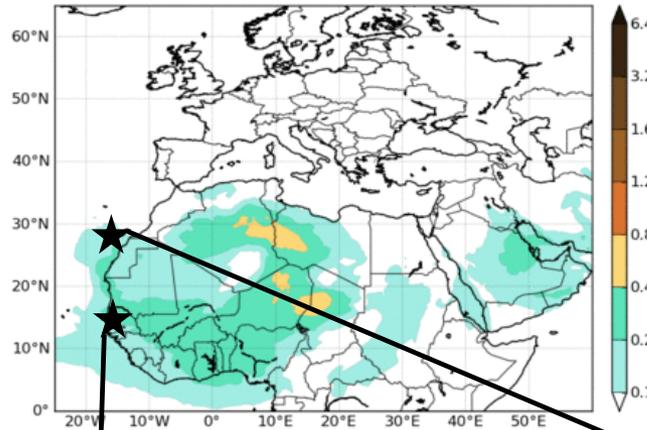
Atlantic dust event: 2 - 5 November 2016



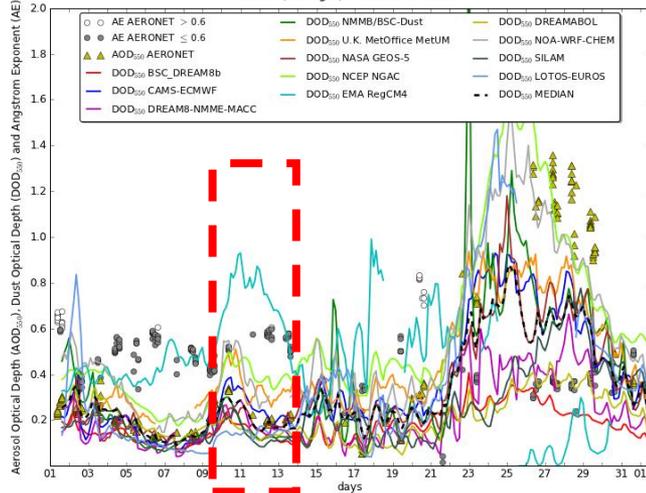
SDS-WAS NAMEE: Dust Profiles Evaluation

Atlantic dust event: 9 - 12 December 2016

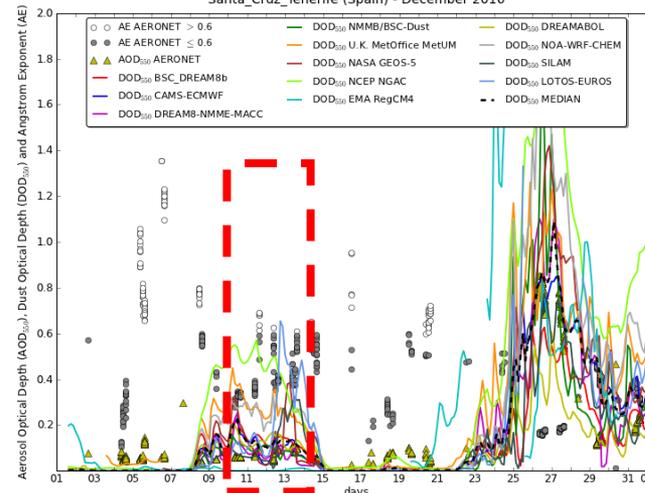
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 09 DEC 2016 Valid: 12h 09 DEC 2016 (H+00)



Dakar (Senegal) - December 2016



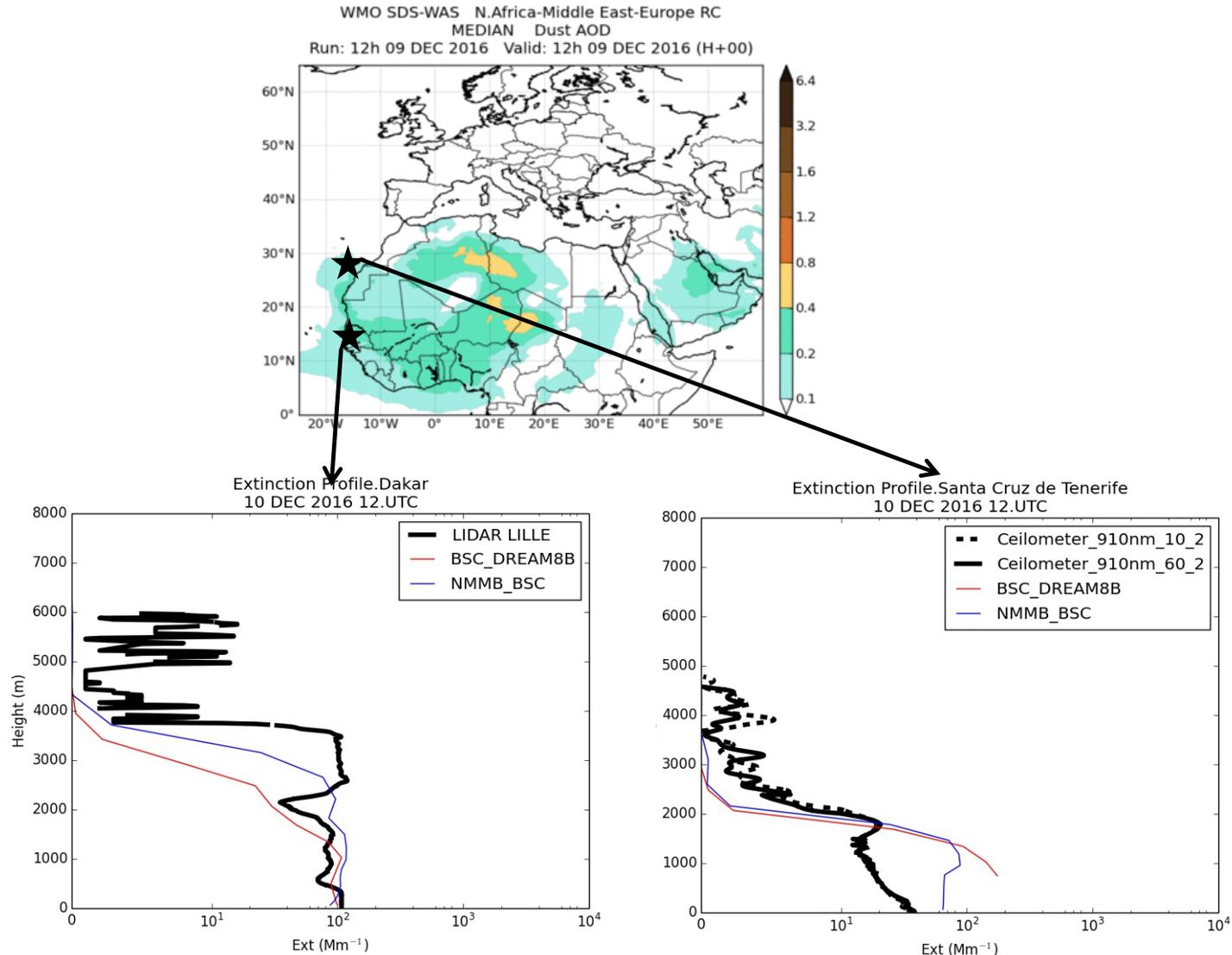
Santa_Cruz_Tenerife (Spain) - December 2016



AERONET

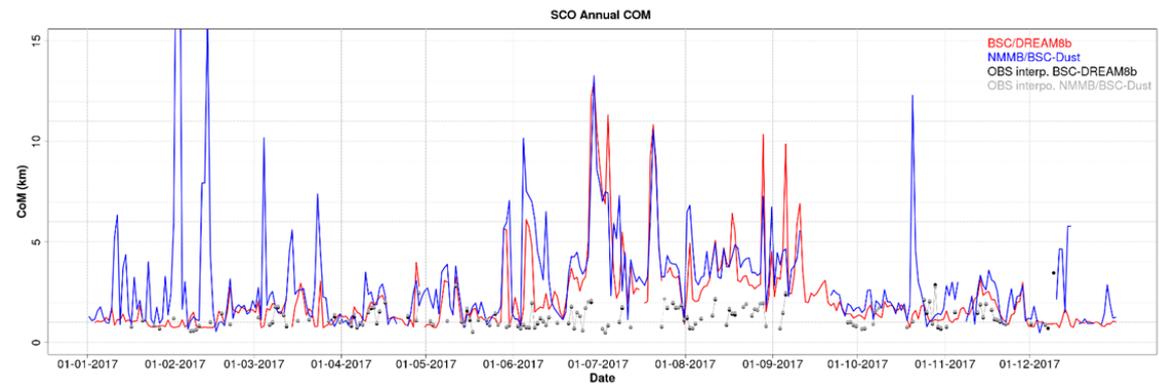
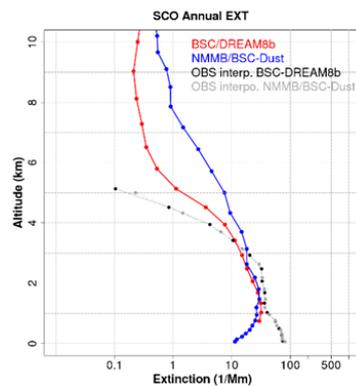
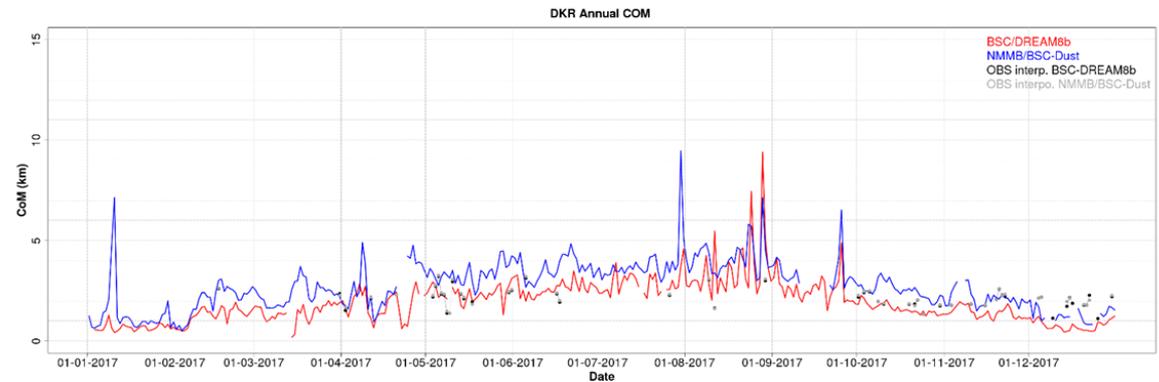
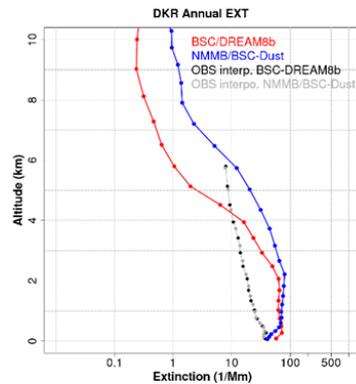
SDS-WAS NAMEE: Dust Profiles Evaluation

Atlantic dust event: 9 - 12 December 2016



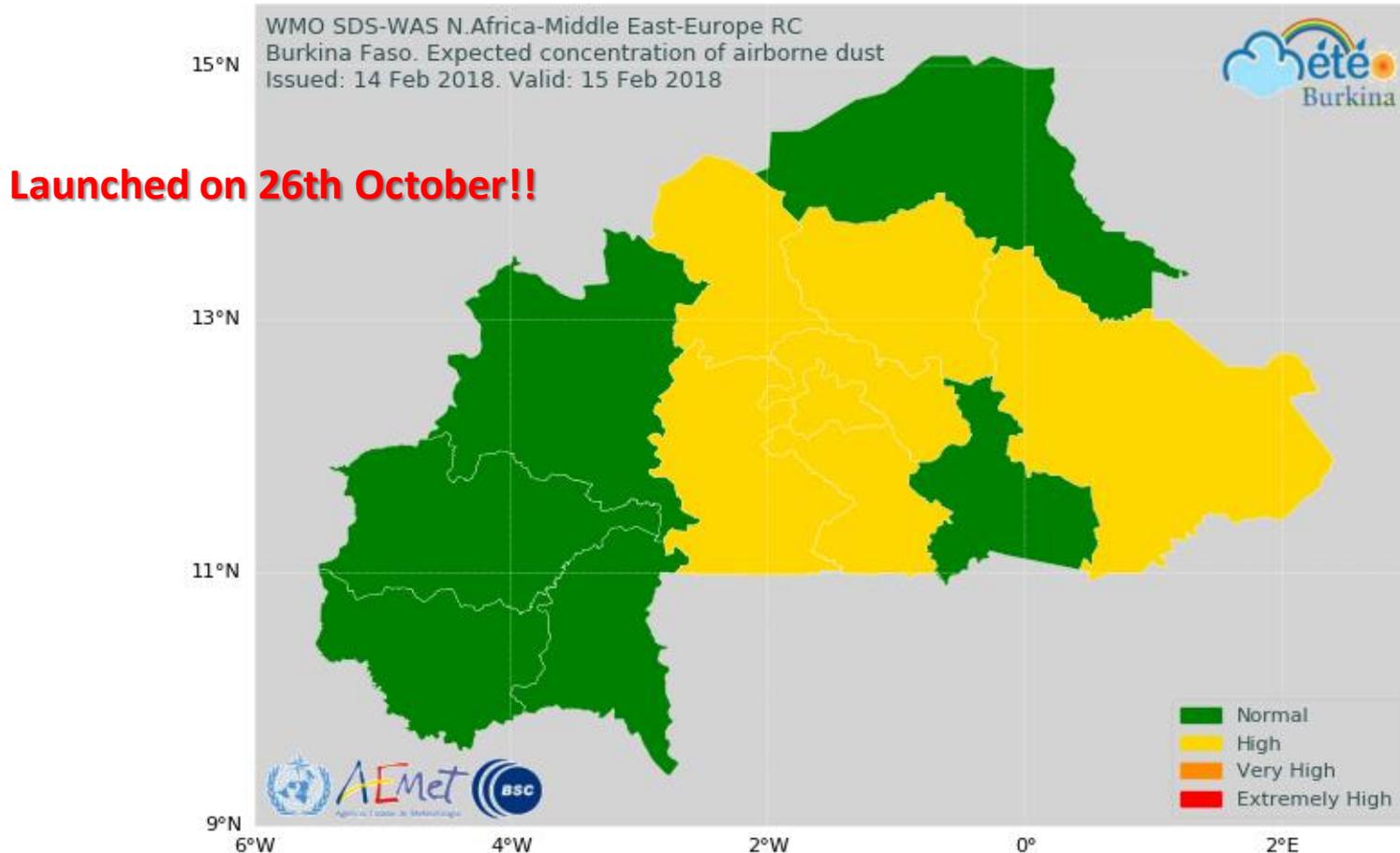
SDS-WAS NAMEE: Dust Profiles Evaluation

Skills scores: Preliminary results for the year 2017



<http://sds-was.aemet.es/projects-research/evaluation-of-model-derived-dust-vertical-profiles>

SDS-WAS NAMEE: Early Warning System for Burkina Faso

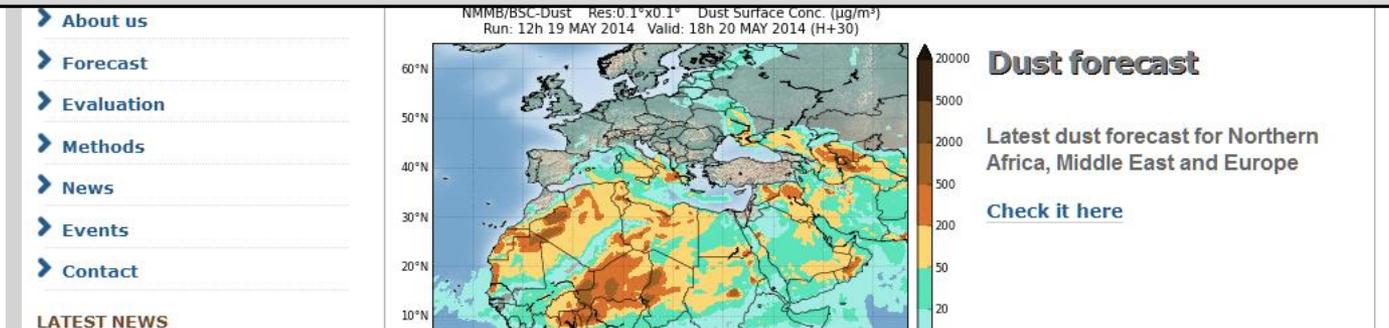


<https://sds-was.aemet.es/forecast-products/burkina-faso-warning-advisory-system>

Barcelona Dust Forecasting Center



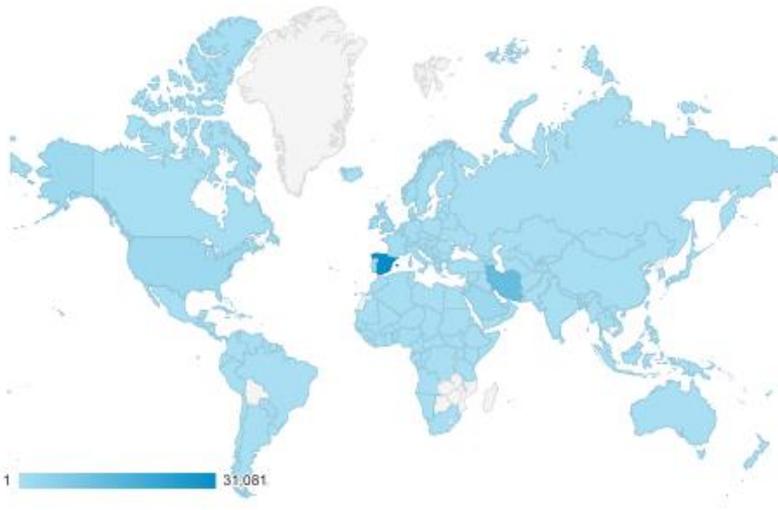
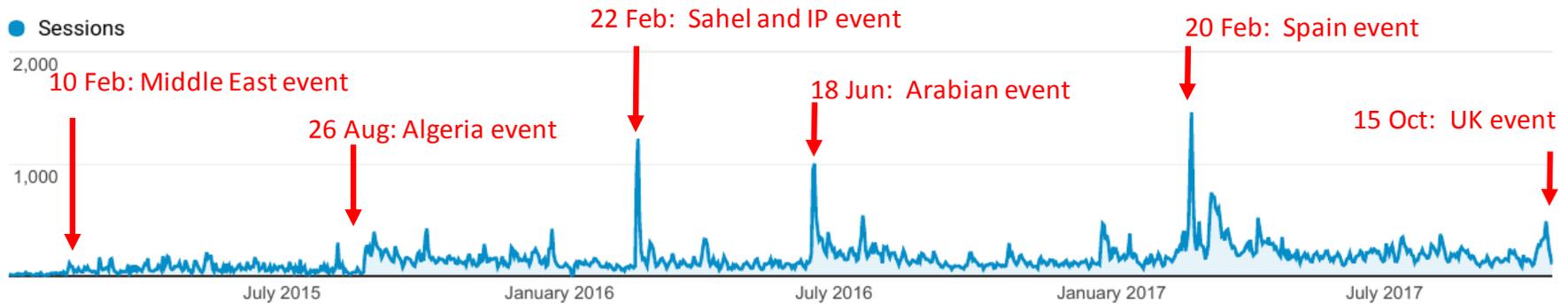
In 2014, the First Specialized Center for Mineral Dust Prediction of WMO is created
NMMB/BSC-Dust selected to provide operational forecasts for NAMEE region



Barcelona Dust Forecasting Center

Website visits: 1 January 2015 – 20 October 2017

<http://dust.aemet.es/>



A screenshot of the Twitter profile for Barcelona Dust (@Dust_Barcelona). The profile includes the AEMet logo (Agencia Estatal de Meteorología) and the BSC logo (Barcelona Supercomputing Center). The profile statistics are:

- Tweets: 589
- Siguiendo: 101
- Seguidores: 1,342
- Me gusta: 223

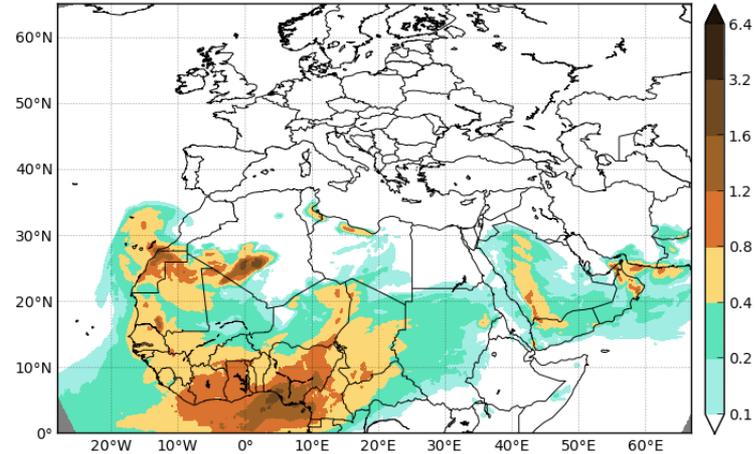
The profile is currently following the user.

A recent tweet from Barcelona Dust (@Dust_Barcelona) is shown, dated 3 hours ago, with the text: "Atmosphere. Special issue 'Studying the effects of dust on weather:'".

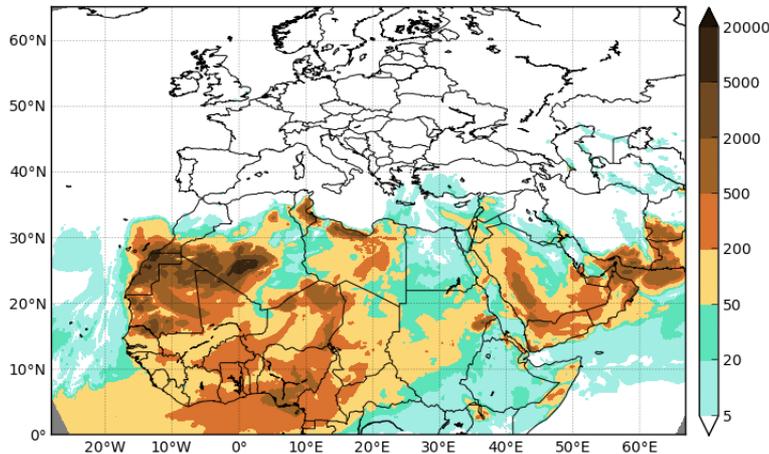
BDFC: Operational Products

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

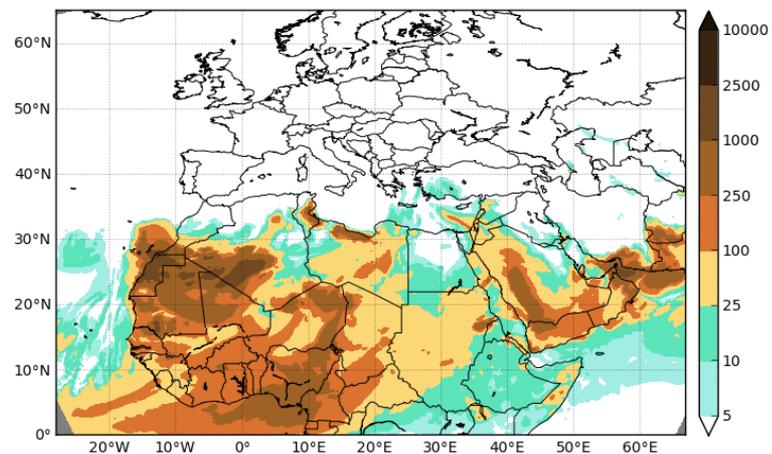
Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



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)

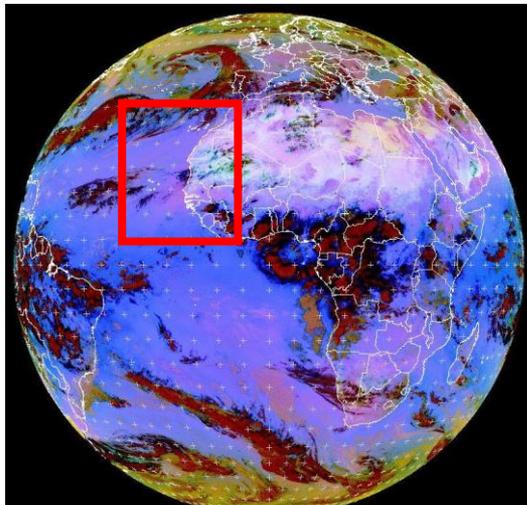
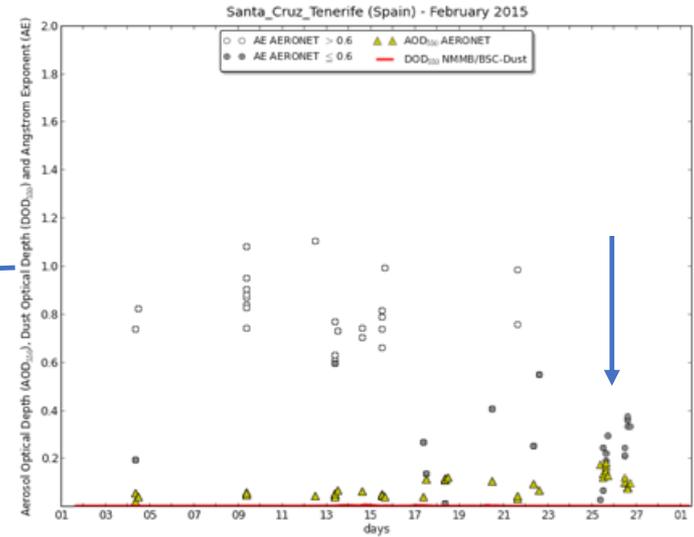
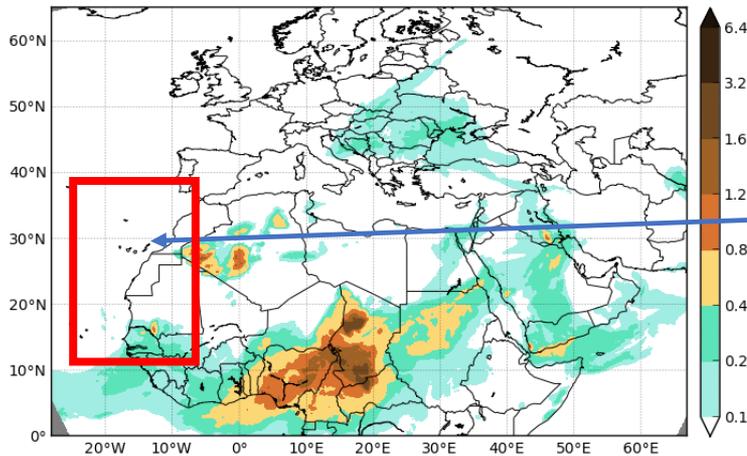


Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Ext. (Mm^{-1})
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



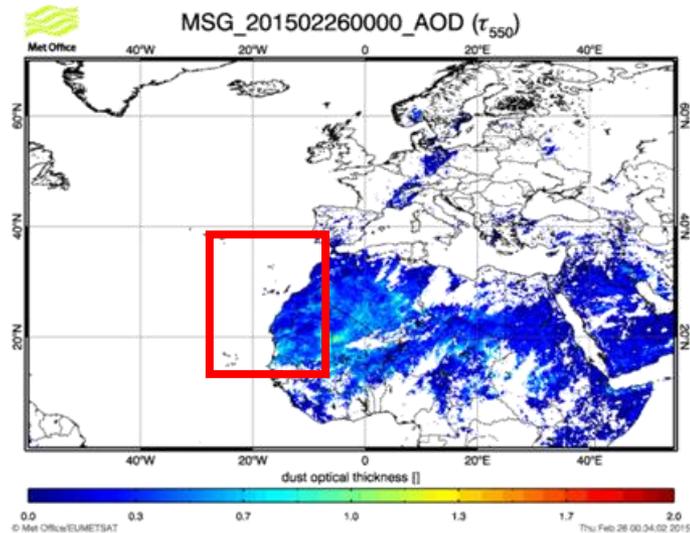
BDFC: Dust event Canary Islands Feb 2015

Barcelona Dust Forecast Center
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 25 FEB 2015 Valid: 12h 25 FEB 2015 (H+00)



NET10 RGB-Dust 2015-04-23 21:00 UTC

EUMETSAT



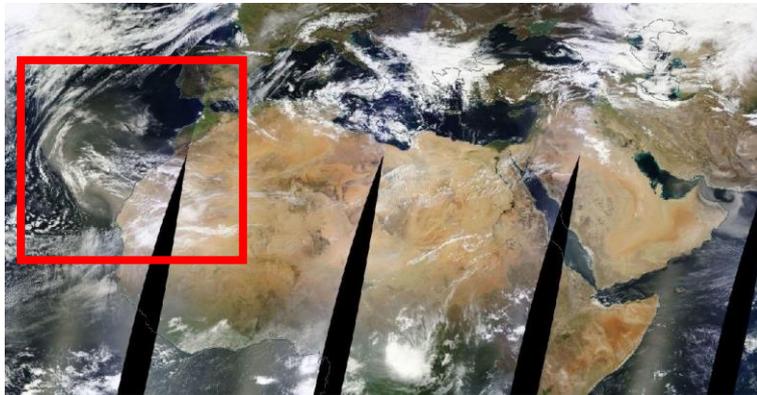
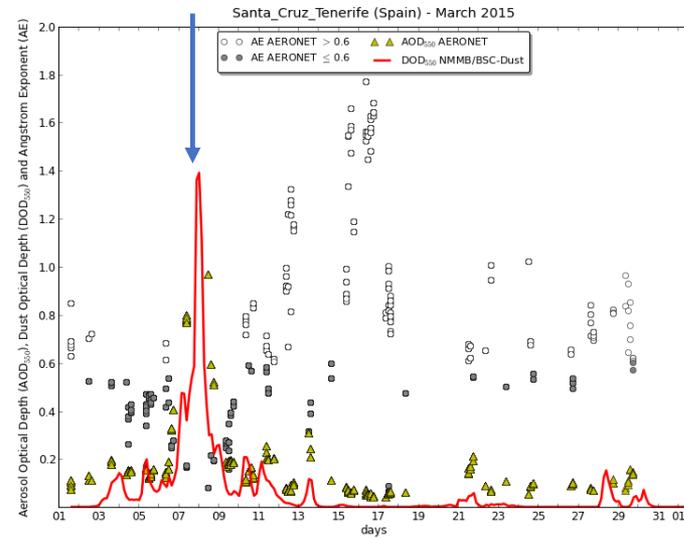
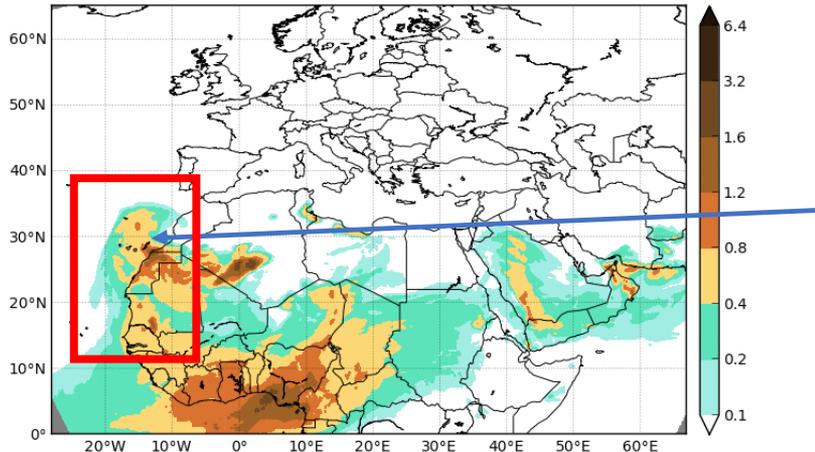
© Met Office/EUMETSAT

Thu Feb 26 00:04:02 2015

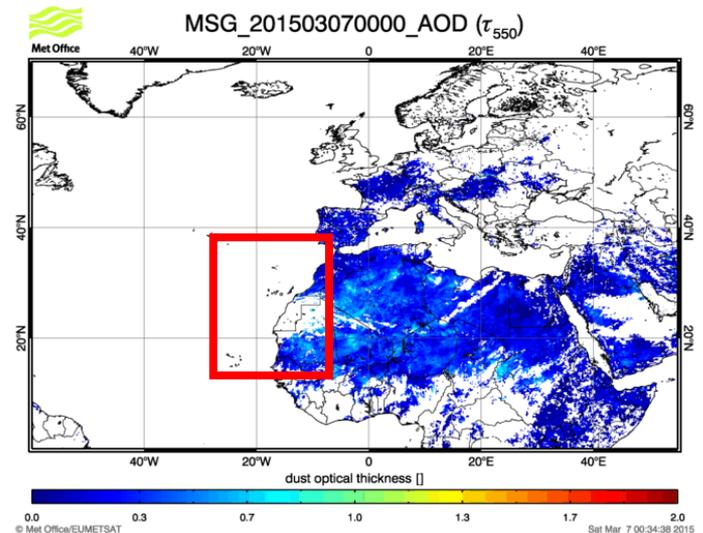
<http://dust.aemet.es/>

BDFC: Dust event Canary Islands Mar 2015

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)



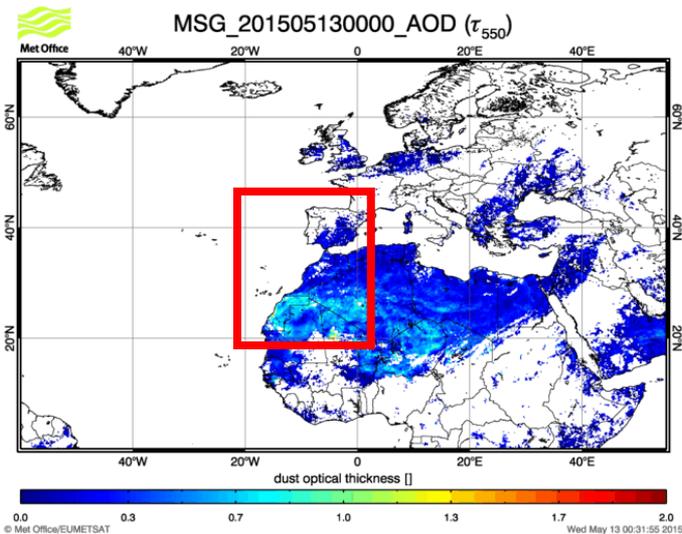
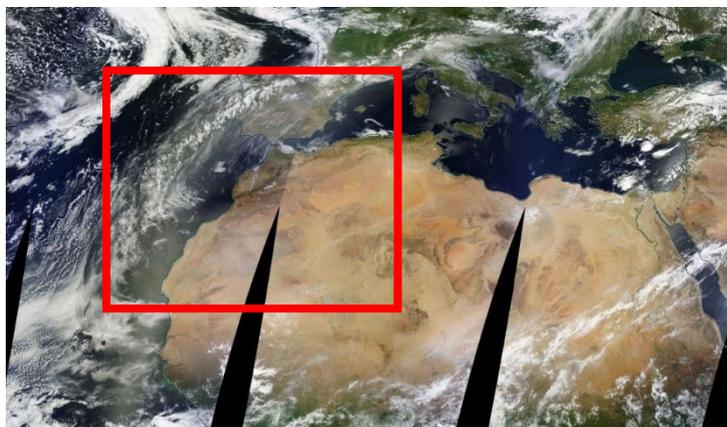
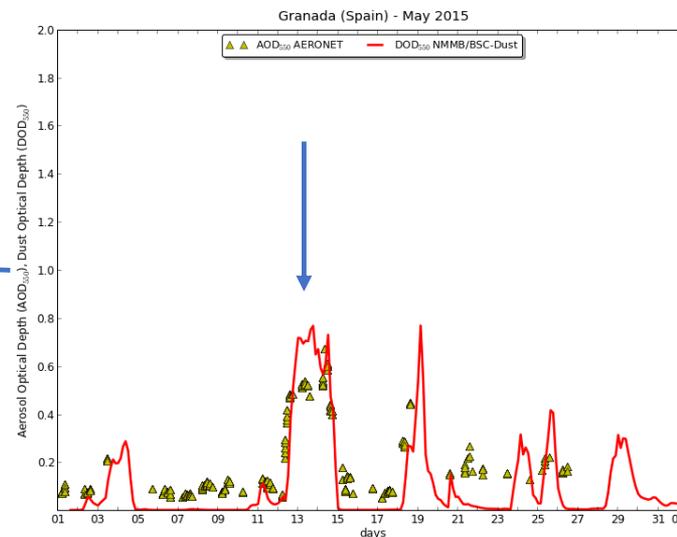
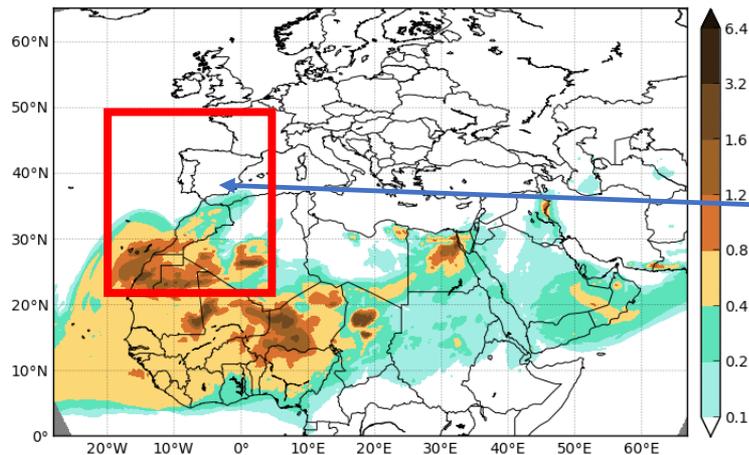
MODIS composite 8th March 2015
 from EOSDIS World Viewer



<http://dust.aemet.es/>

BDFC: Dust event Europe May 2015

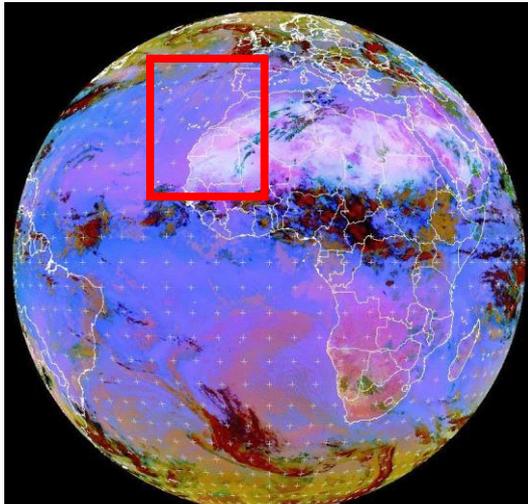
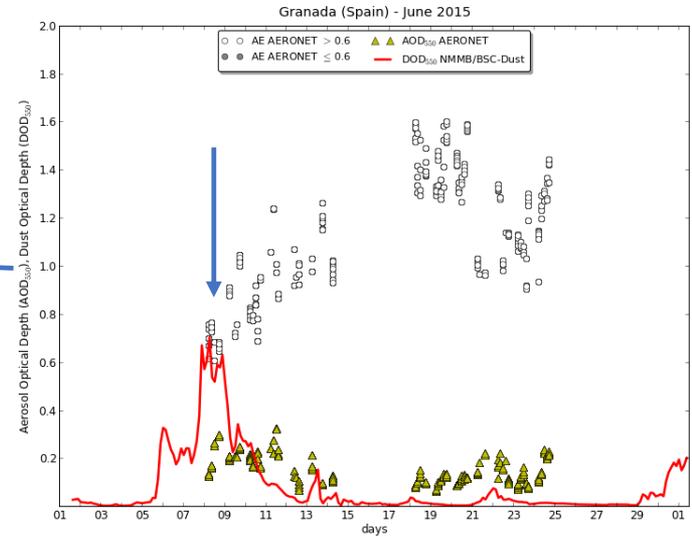
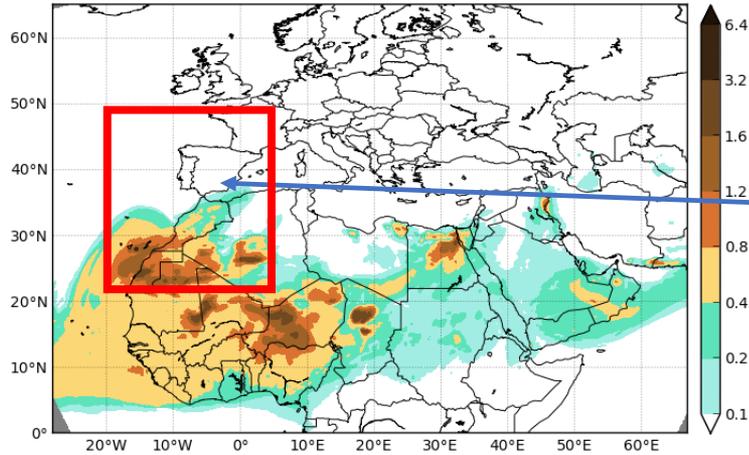
Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 11 MAY 2015 Valid: 12h 11 MAY 2015 (H+00)



<http://dust.aemet.es/>

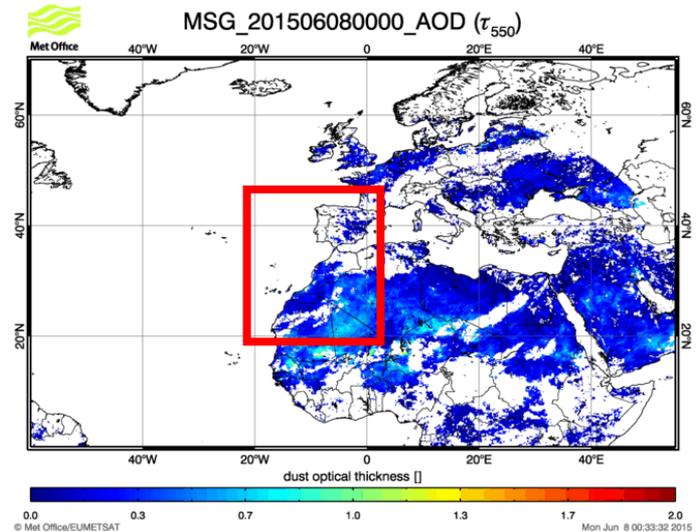
BDFC: Dust event Europe June 2015

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)



RET18 BCD-Dust 2815-06-25 22:00 UTC

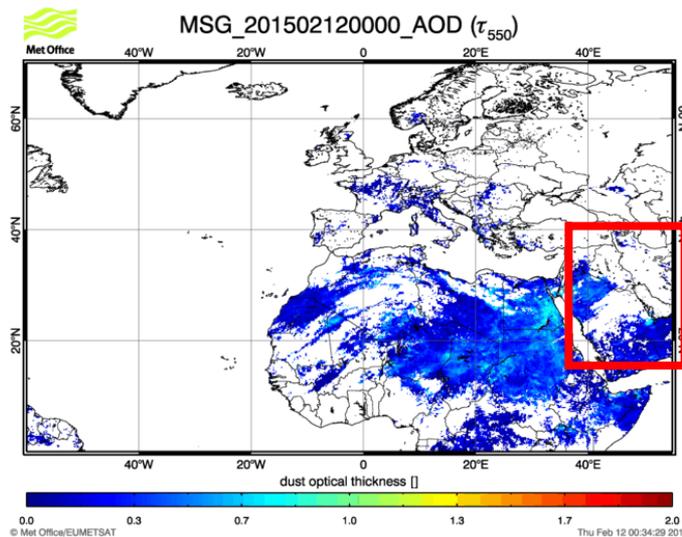
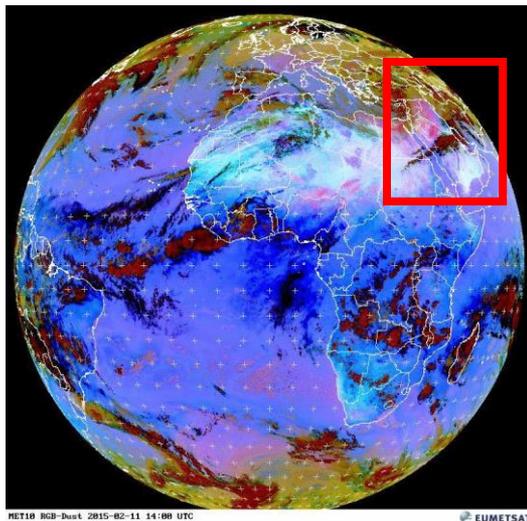
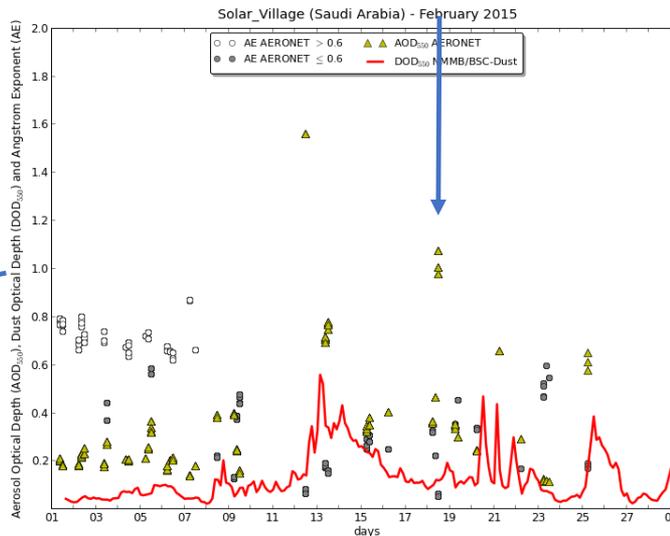
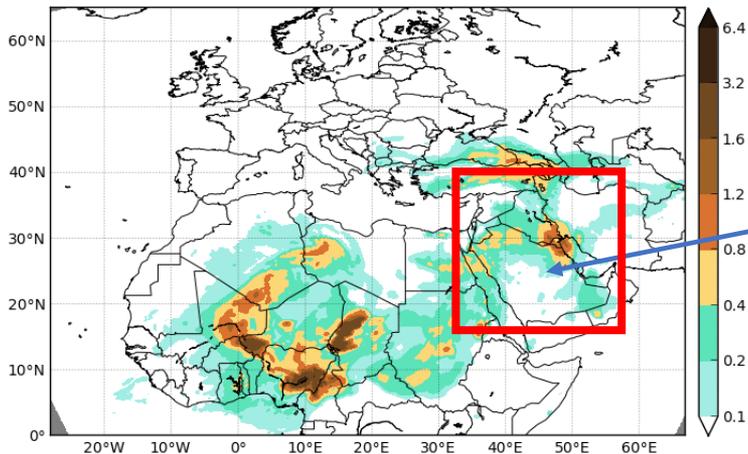
EUMETSAT



<http://dust.aemet.es/>

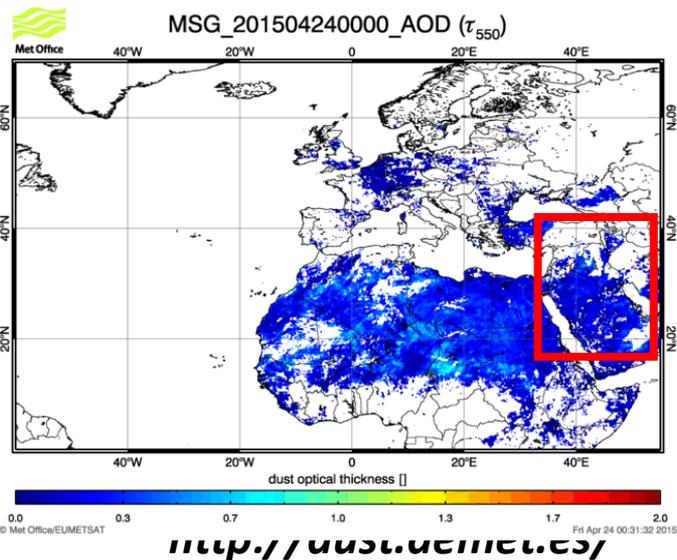
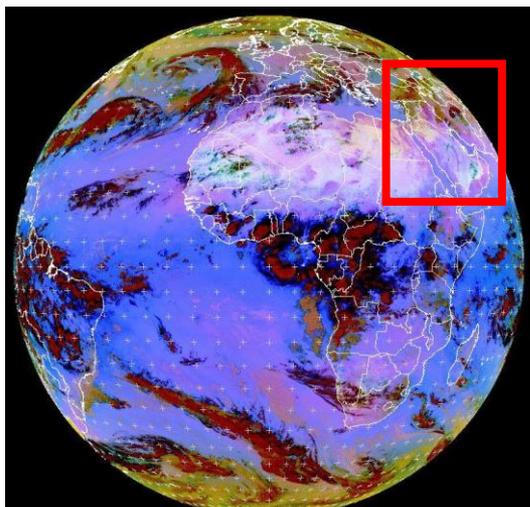
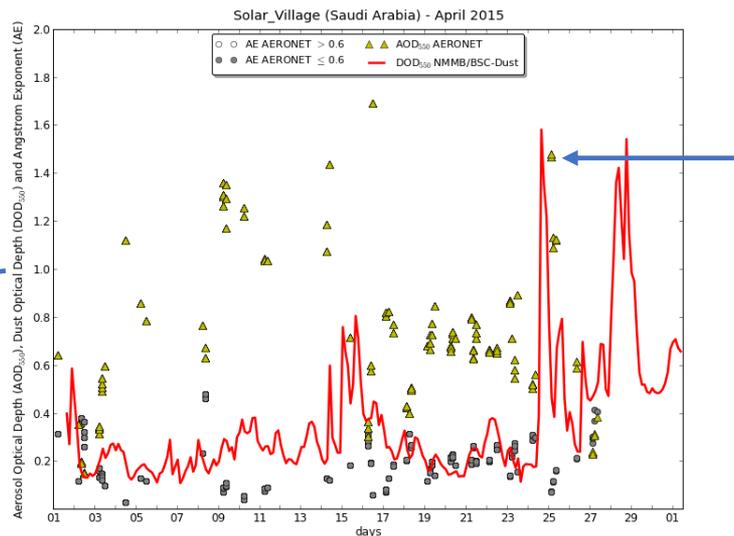
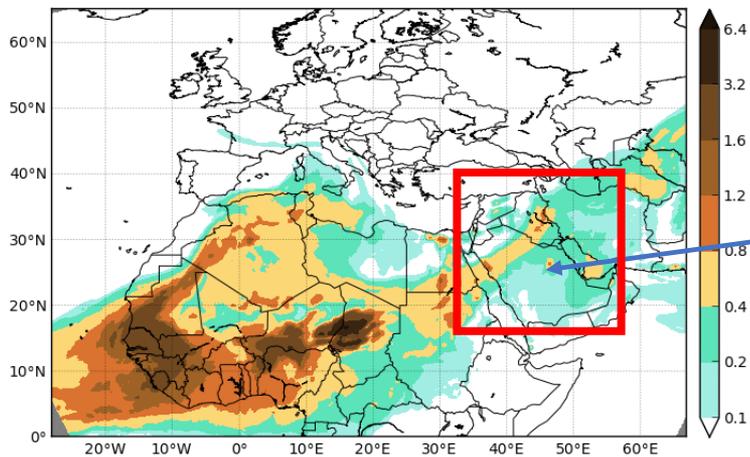
BDFC: Dust event Middle East Feb 2015

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



BDFC: Dust event Middle East Apr 2015

Barcelona Dust Forecast Center
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 23 APR 2015 Valid: 12h 23 APR 2015 (H+00)



WMO Dust Regional Centers

Lessons learnt:

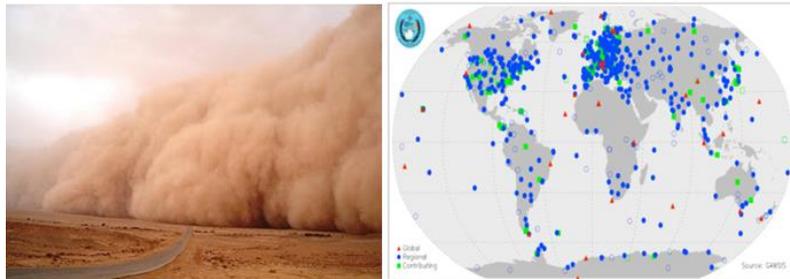
- Lack of coordination between measurement and modelling groups.
 - Measurement products lack harmonised quality controls, data formats and measurements schedules
 - This is more dramatic when you consider Northern African and the Middle East where we find the deserts
- Advertise about Sand and Dust Storms
 - Enhance the visibility of the dust impacts to the society at large and the most affected socio-economic sectors in particular
- Not “really” tailored user-oriented products
 - Few existing channels of communication between scientific research and user (socio-economic) communities.



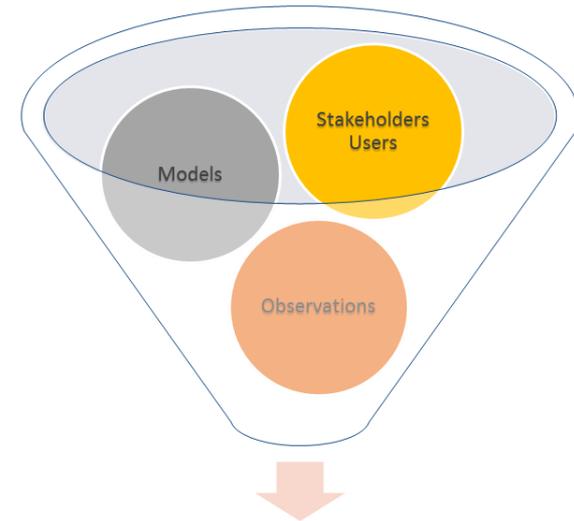
<http://sds-was.aemet.es/>

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

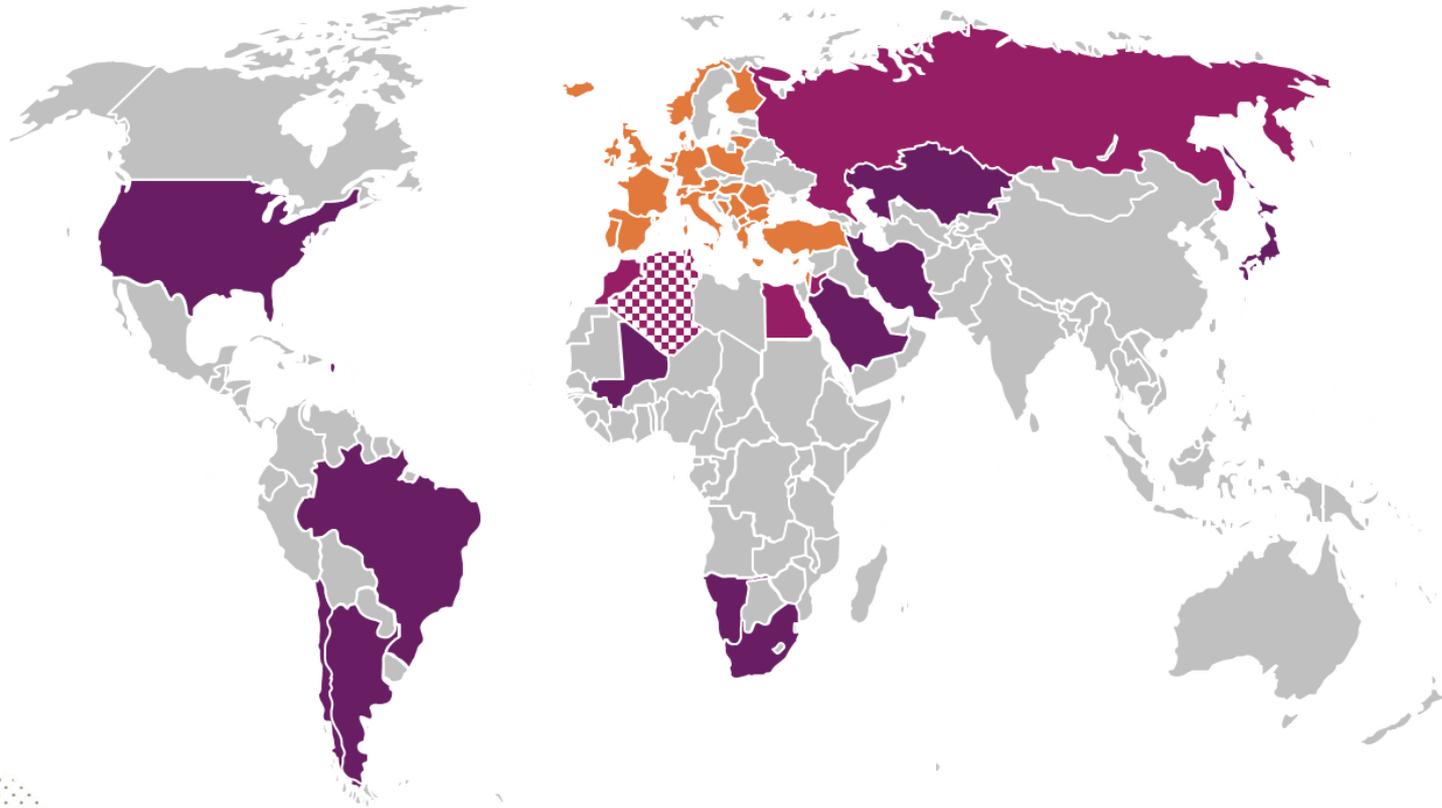
- To **establish a network** involving research institutions, service providers and potential end users of

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*)



[THE ACTION](#) ▾ [PEOPLE](#) ▾ [GRANTS](#) ▾ [EVENTS](#) ▾ [MEDIA ROOM](#) ▾ [GET IN TOUCH](#) [MEMBERS AREA](#) ▾

InDust

COST ACTION CA16202





**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



AXA
Research Fund



**EXCELENCIA
SEVERO
OCHOA**

inDust



AEMet
Agencia Estatal de Meteorología



Thank you

Acknowledge to Carlos Pérez García-Pando, Emilio Cuevas, Slodoban Nickovic, Francesco Benincasa, Gerardo García-Castrillo, Enza DiTomaso, Oriol Jorba, Kim Serradell, Enric Terradellas as well as 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.

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sara.basart@bsc.es