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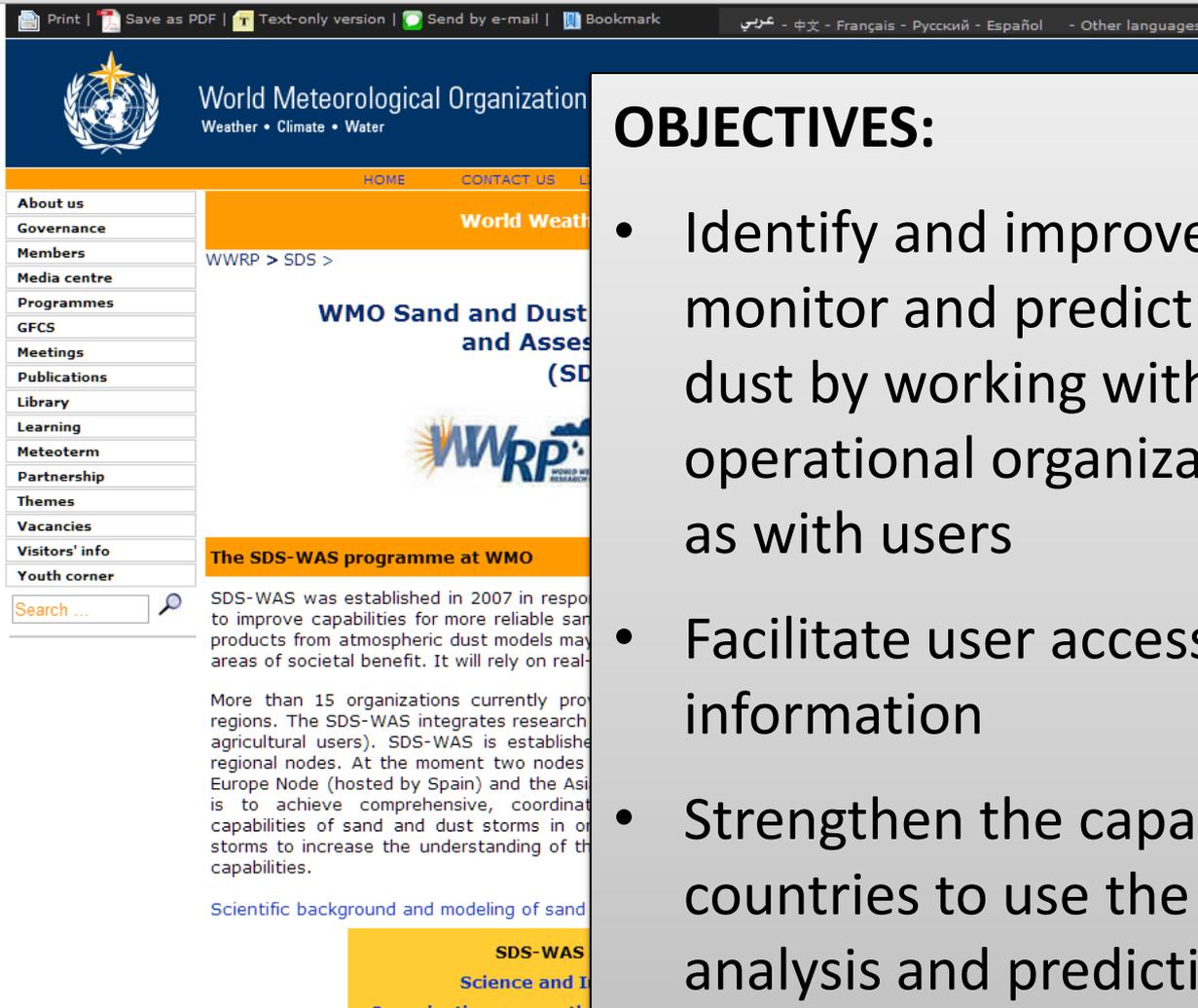
Centro Nacional de Supercomputación



TOWARDS CONTINUOUS EVALUATION OF DUST PROFILES IN THE WMO SDS-WAS

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P. Goloub, A. Mortier, A. Cazorla, A. Alastuey, F. Benincasa and E.
Terradellas



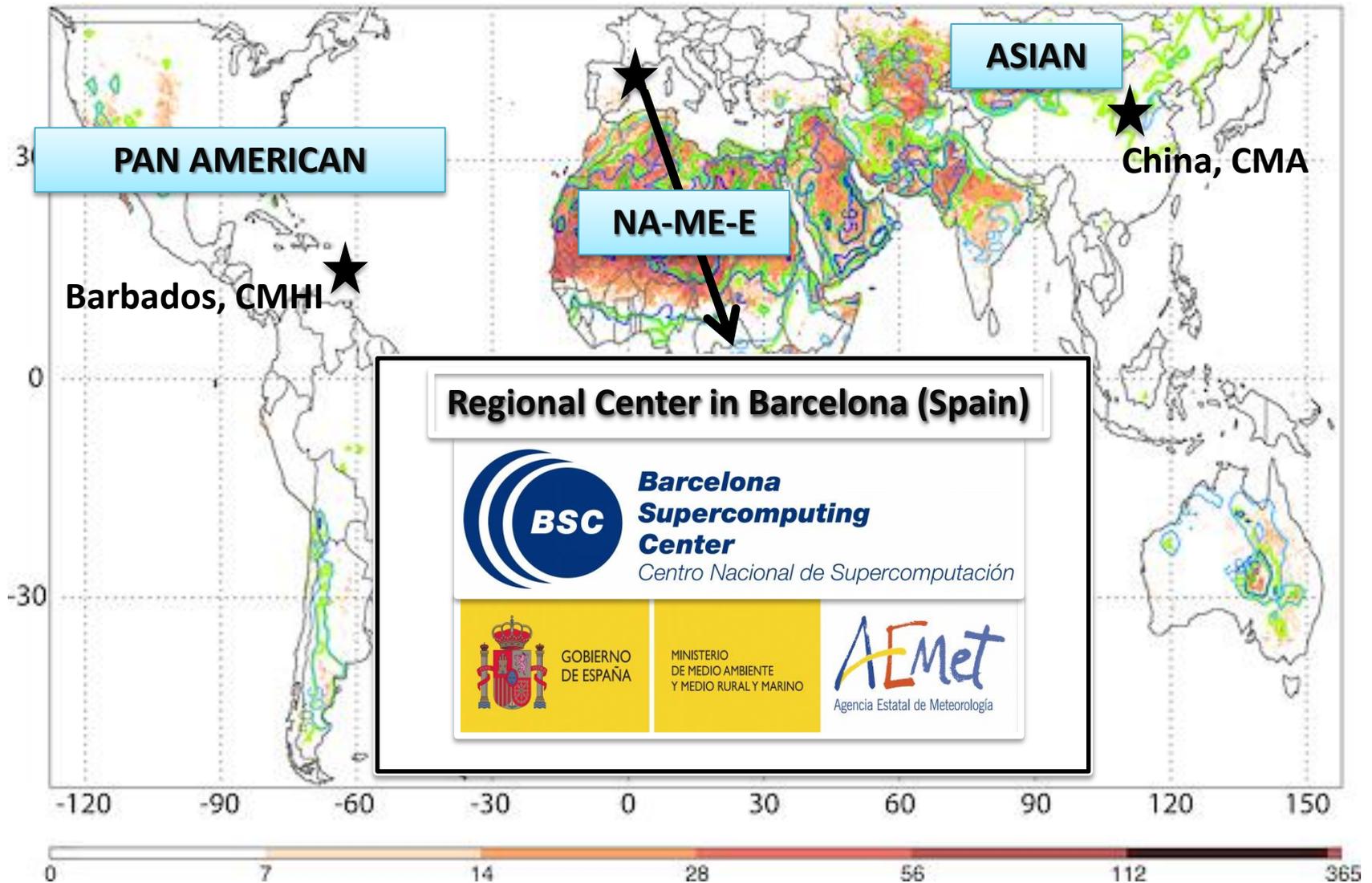


The screenshot shows the WMO SDS-WAS website interface. At the top, there is a navigation bar with links for 'HOME' and 'CONTACT US'. The main header features the WMO logo and the text 'World Meteorological Organization Weather • Climate • Water'. A left sidebar contains a menu with items like 'About us', 'Governance', 'Members', 'Media centre', 'Programmes', 'GFCs', 'Meetings', 'Publications', 'Library', 'Learning', 'Meteoterm', 'Partnership', 'Themes', 'Vacancies', 'Visitors' info', and 'Youth corner'. Below the menu is a search box. The main content area has a title 'World Weather' and a breadcrumb 'WWRP > SDS >'. The main heading is 'WMO Sand and Dust and Assessment (SDS-WAS)'. Below this is a sub-heading 'The SDS-WAS programme at WMO'. The text describes the establishment of SDS-WAS in 2007 to improve capabilities for more reliable sand products from atmospheric dust models may areas of societal benefit. It will rely on real-time observations and modeling. More than 15 organizations currently provide data from various regions. The SDS-WAS integrates research and operational capabilities (e.g., for agricultural users). SDS-WAS is established through regional nodes. At the moment two nodes exist: the Europe Node (hosted by Spain) and the Asia Node. The goal is to achieve comprehensive, coordinated capabilities of sand and dust storms in order to increase the understanding of the capabilities.

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 Regional Centers



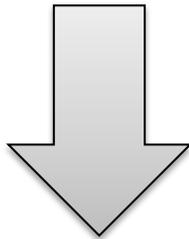


GOBIERNO DE ESPAÑA
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SDS-WAS. North Africa, Middle East and Europe Regional Center - Research
Started in 2010

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

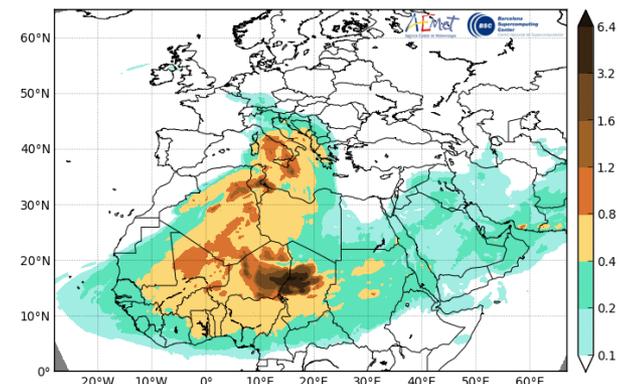


Barcelona Dust Forecast Center - Operations
First specialized WMO Center for mineral dust prediction. Started in 2014

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



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 11 MAY 2016 Valid: 12h 11 MAY 2016 (H+00)



SDS-WAS NAMEE: Dust Forecasts



NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER

WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

Log in

WMO SDS WAS | Asia Regional Center

World Meteorological Organization

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Search

Search Site

Latest News

UN Envoy Supports Greenbelts in Iraq to Combat Sandstorms
Feb 25, 2013

UNEP Global Environmental Alert Service releases 'Forecasting and early warning of dust storms'
Feb 18, 2013

Scholarship on desert dust at the Univ. of Reading, UK

DUST FORECASTS Forecast & Products

DUST OBSERVATIONS

GUIDANCE FOR FORECASTERS

TIME-AVERAGED VALUES

FORECAST EVALUATION

REANALYSIS

DATA POLICY

N.Africa-Middle East-Europe (NA-ME-E) Regional

last modified May 29, 2012 03:33 PM

Subscribe to the Public Newsletter!

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

Full Name

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Multimodel Products

WMO SDS-WAS NA-ME-E Regional Center will be a Regional Specialized Meteorological Center

Forecast evaluation

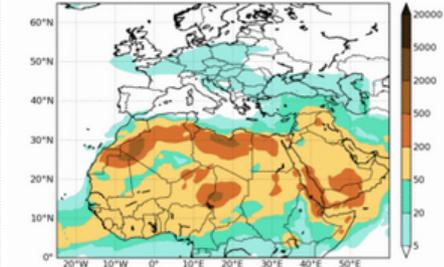
Compared dust forecasts

Dust forecasts

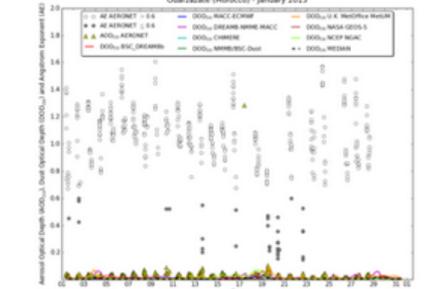
WMO SDS-WAS N.Africa-Middle East-Europe RC

MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)

Run: 12h 25 FEB 2013 Valid: 18h 27 FEB 2013 (H+54)



Ourzazate (Morocco) - January 2013



<http://sds-was.aemet.es/> 4

SDS-WAS NAMEE: Daily Dust Forecasts



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



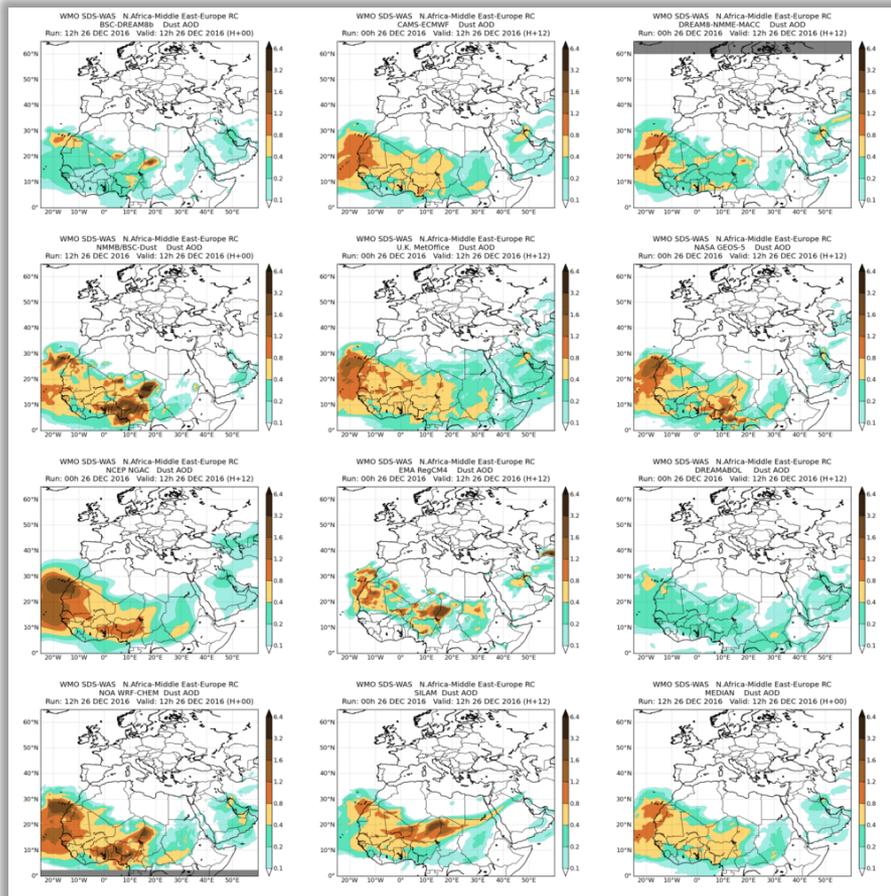
MODEL	RUN TIME	DOMAIN	DATA ASSIMILATION
BSC-DREAM8b	12	Regional	No
CAMS ECMWF	00	Global	MODIS AOD
DREAM8-NMME	00	Regional	CAMS analysis
NMMB/BSC-Dust	00	Regional	No
MetUM	12	Global	MODIS AOD
GEOS-5	00	Global	MODIS reflectances
NGAC	00	Global	No
RegCM4 EMA	00	Global	No
DREAMABOL	12	Regional	No
WRF-CHEM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

SDS-WAS NAMEE: Daily Dust Forecasts

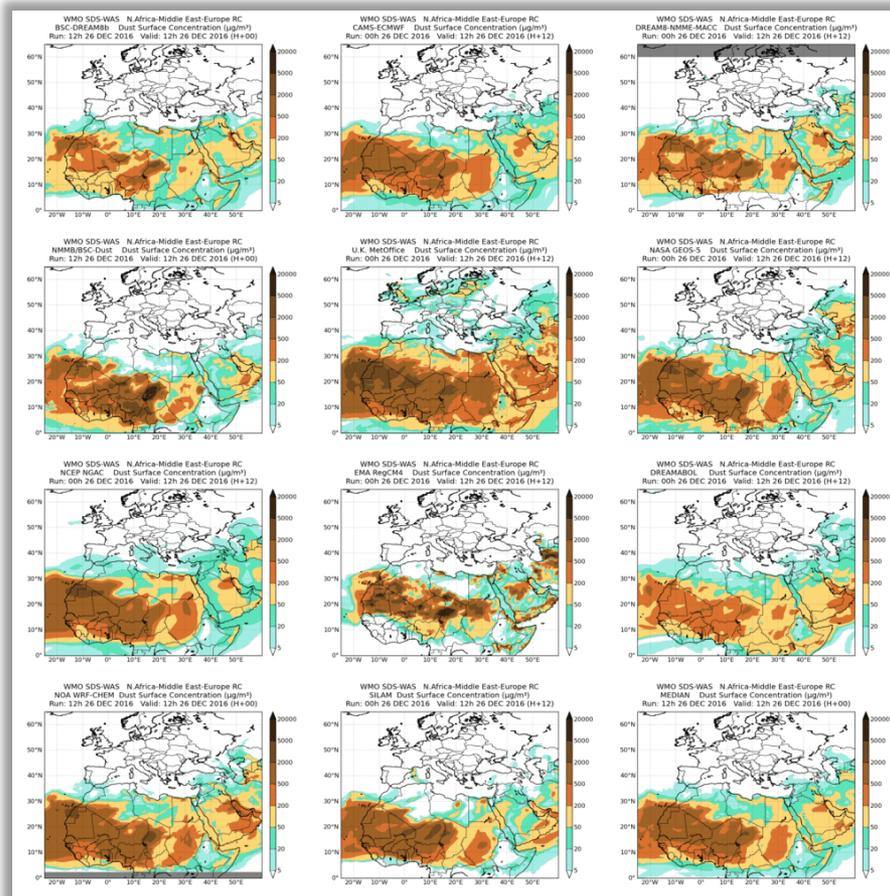


Joint visualization

DOD at 550nm



Surface concentration

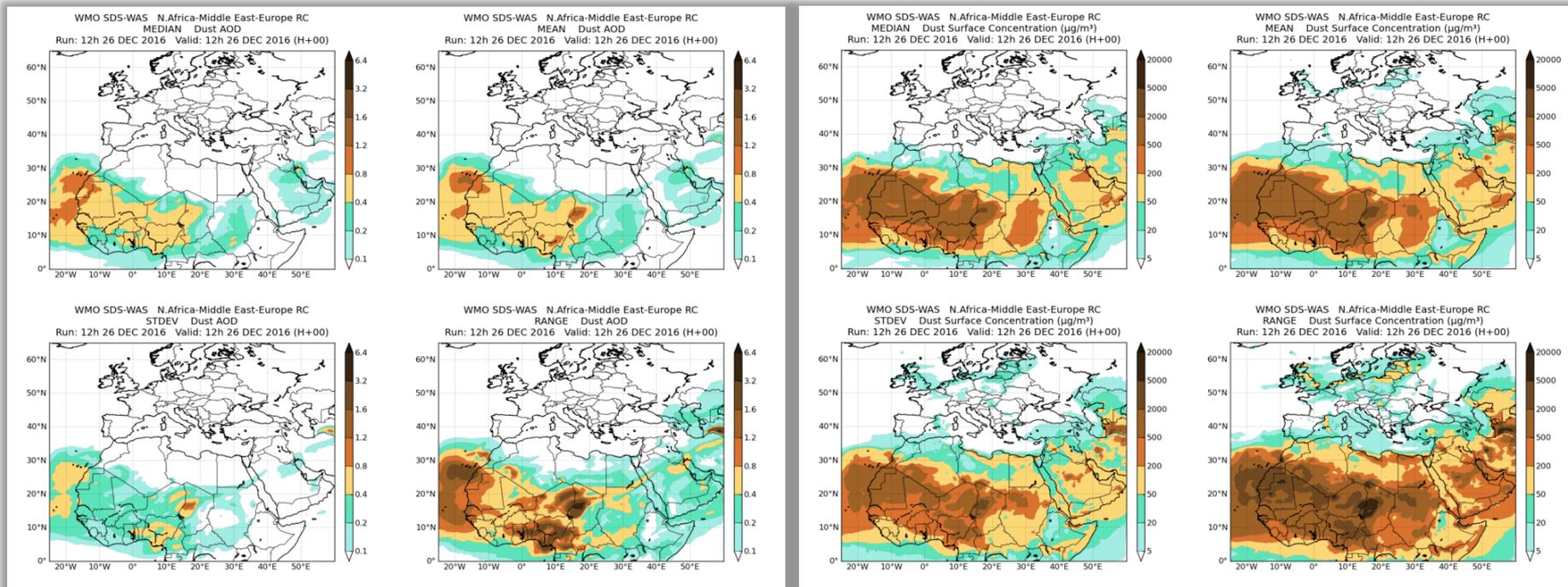


From 26-Dec-2016 12:00 to 29-Dec-2016 00:00

Multimodel Products

DOD at 550nm

Surface concentration



From 26-Dec-2016 12:00 to 29-Dec-2016 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: Forecast Evaluation



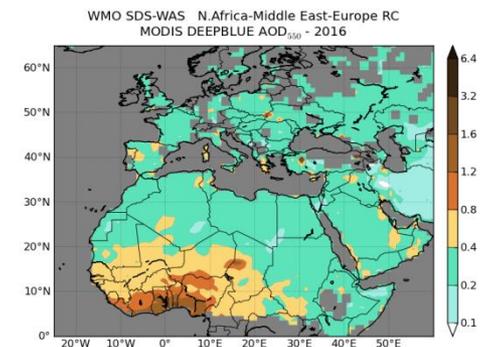
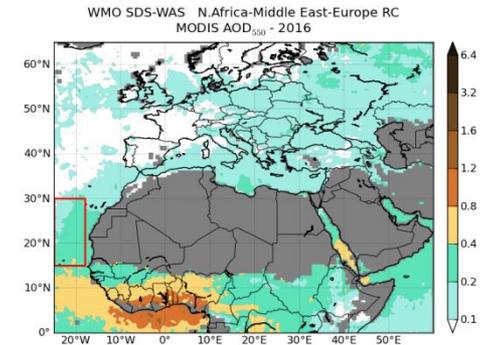
- **Evaluation with AERONET data**
 - Graphical NRT Evaluation by site
 - Evaluation scores monthly/seasonal/annual by regions and sites



- **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



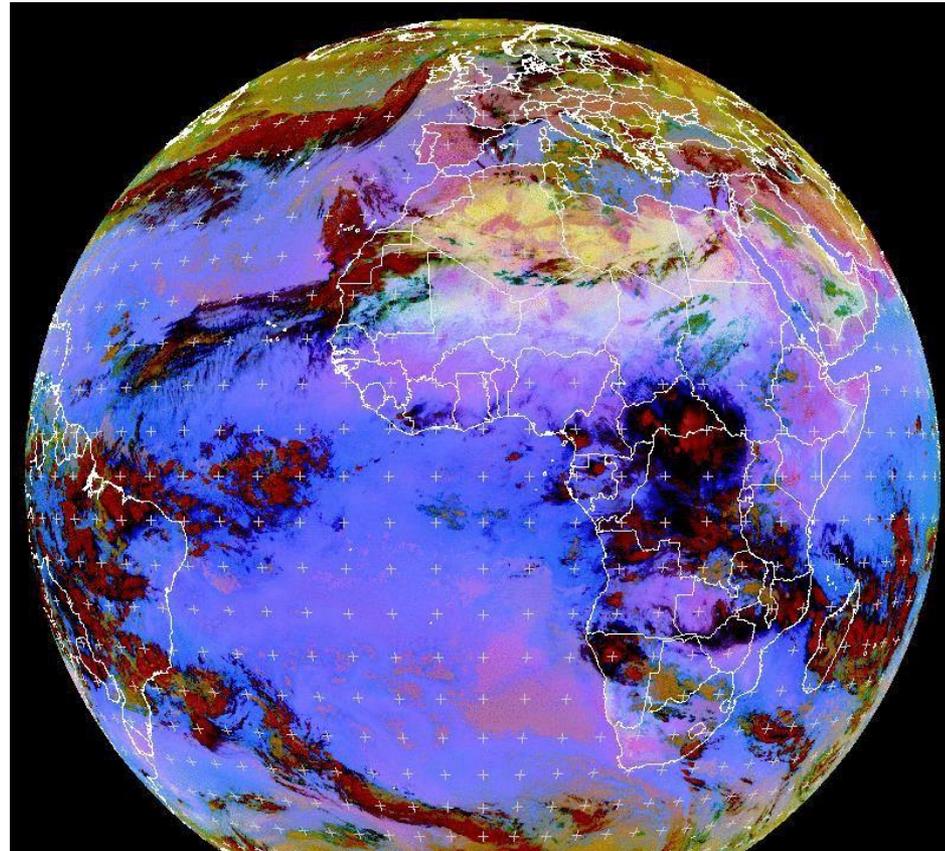
SDS-WAS NAMEE: Forecast Evaluation



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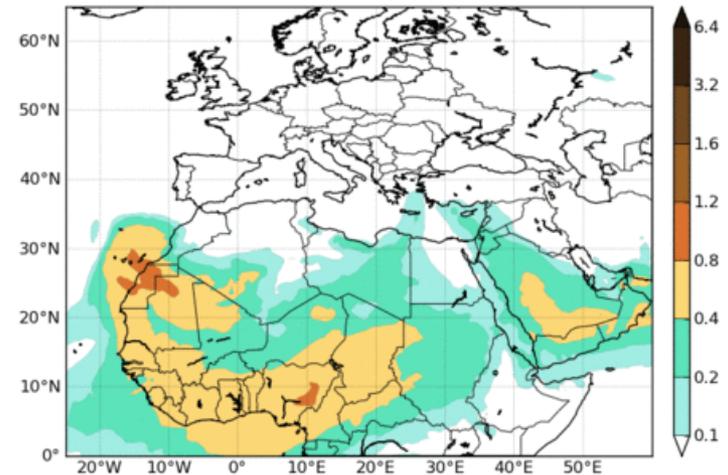


NRT dust evaluation: 7th March 2015



7 March 2015

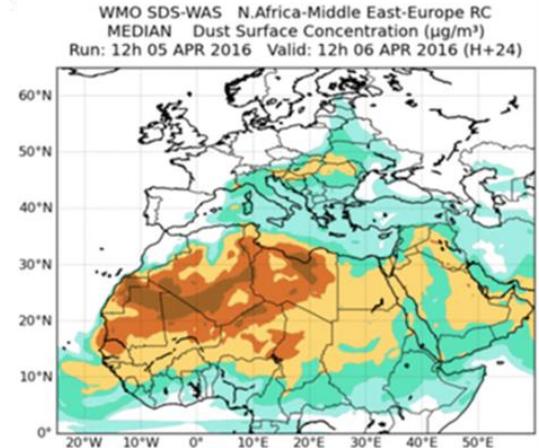
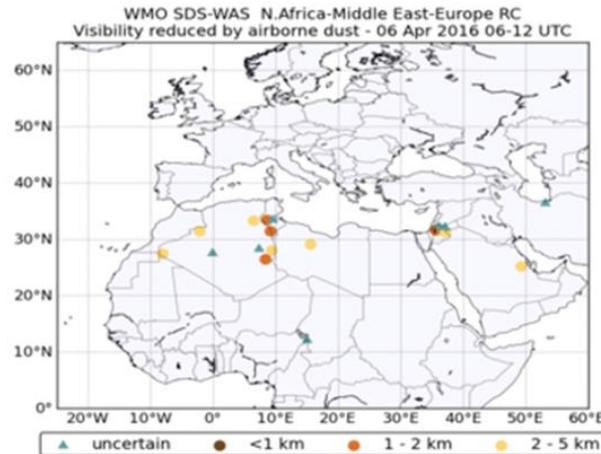
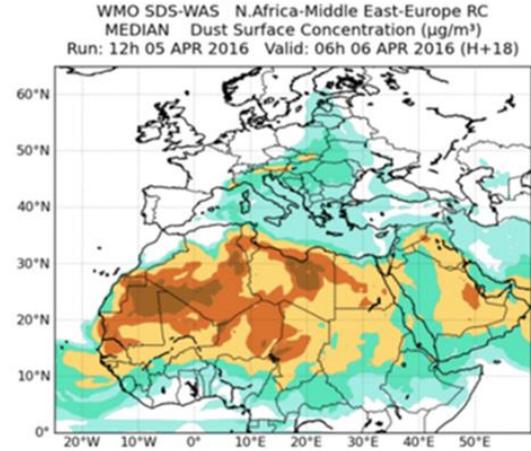
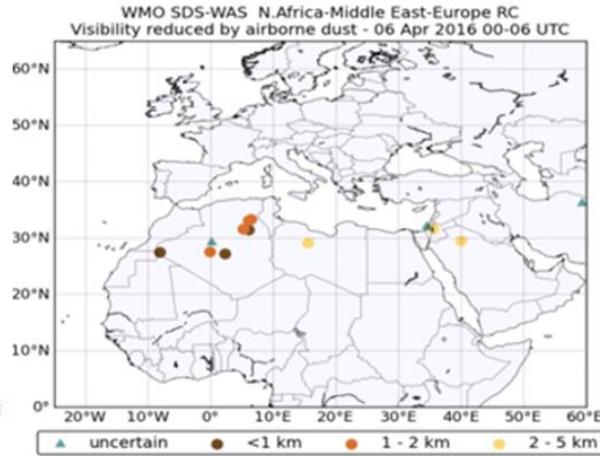
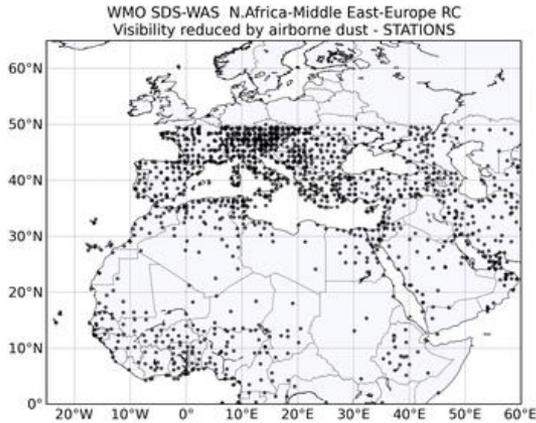
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)



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

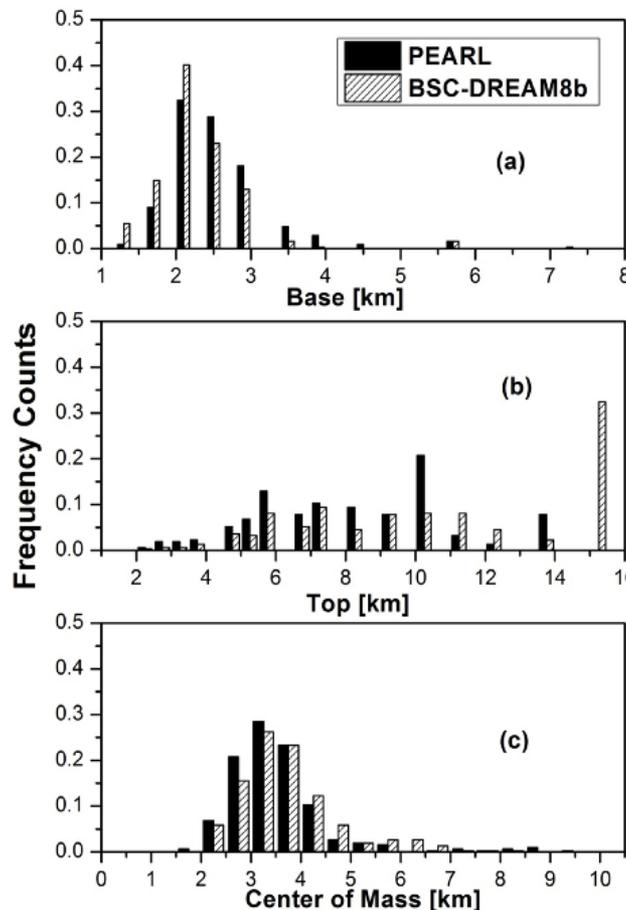
<http://sds-was.aemet.es/>

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



In *Mona et al. (2014, ACP)*, systematic comparison of 12-year modeled extinction dust profiles by **BSC-DREAM8b** vs. Raman lidar measurements in **Potenza EARLINET** site (Italy).

- 310 dust cases
- May 2000–July 2012

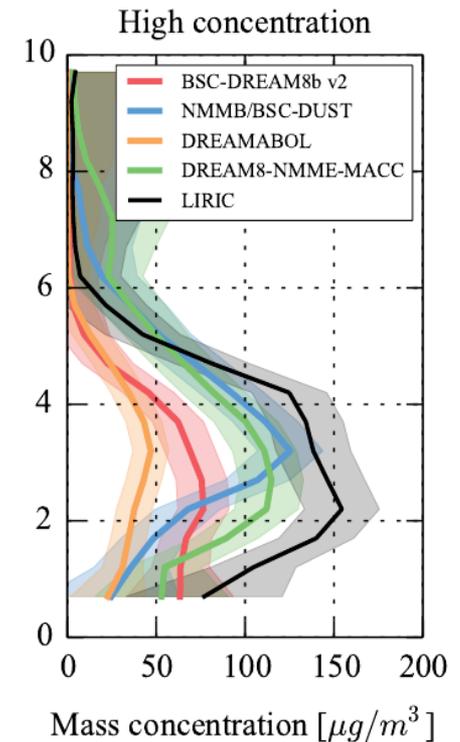
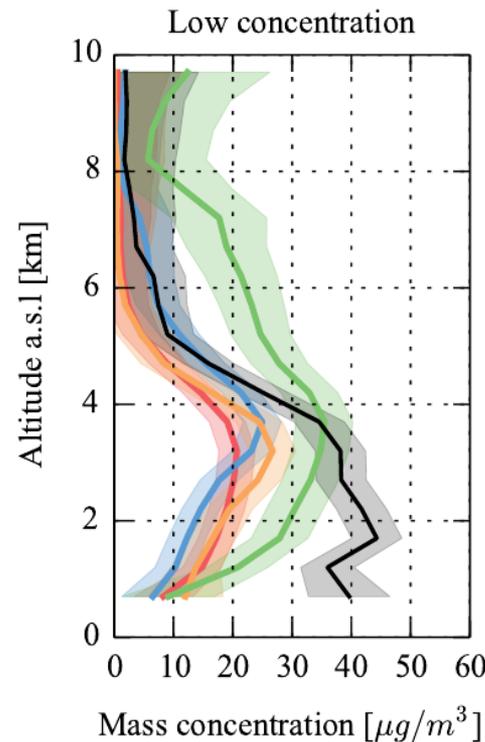
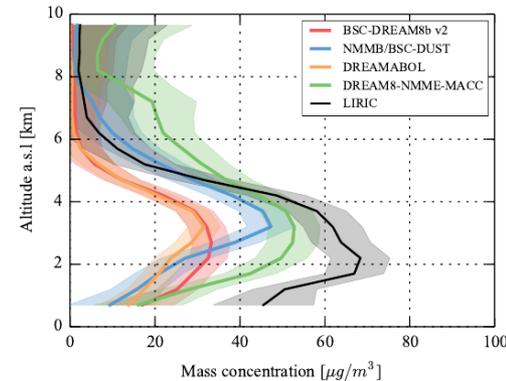


PEARL mean	2.5 ± 0.7 km
BSC-DREAM8b mean	2.3 ± 0.6 km
<i>Linear Fit</i>	
Linear Correlation	0.96
Intercept	-0.1 ± 0.8 km
Slope	1.01 ± 0.04
PEARL mean	8.0 ± 2.7 km (6.3 ± 1.6 km)
BSC-DREAM8b mean	10 ± 4 km (6.5 ± 1.6 km)
<i>Linear Fit</i>	
Linear Correlation	0.80 (0.93)
Intercept	2.3 ± 1.6 km (-0.5 ± 1.2 km)
Slope	0.50 ± 0.08 (0.7 ± 0.1)
PEARL mean	3.5 ± 1.0 km
BSC-DREAM8b mean	3.8 ± 1.3 km
<i>Linear Fit</i>	
Linear Correlation	0.98
Intercept	1.5 ± 1.1 km
Slope	0.90 ± 0.03

*Mona et al. (2014): “The dust layer **CoM** is likely the most suitable geometrical parameter for evaluating the capability of the dust model to reproduce the dust vertical layering. “*

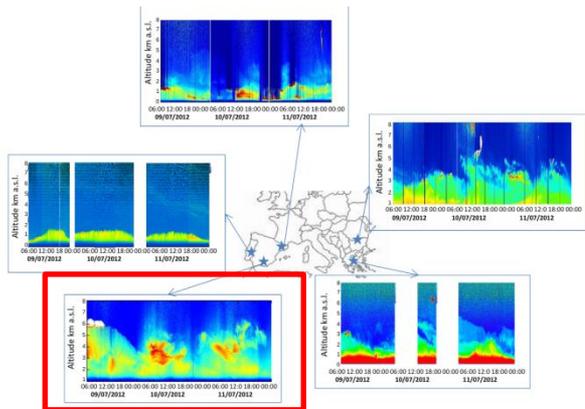
In *Biniatoglou et al. (2015, ATM)*, a methodology for the examination of dust model data using volume concentration LIRIC profiles is proposed:

- 10 EARLINET sites
- 55 dust cases
- Jan 2011 – Jun 2013
- 4 regional SDS-WAS models

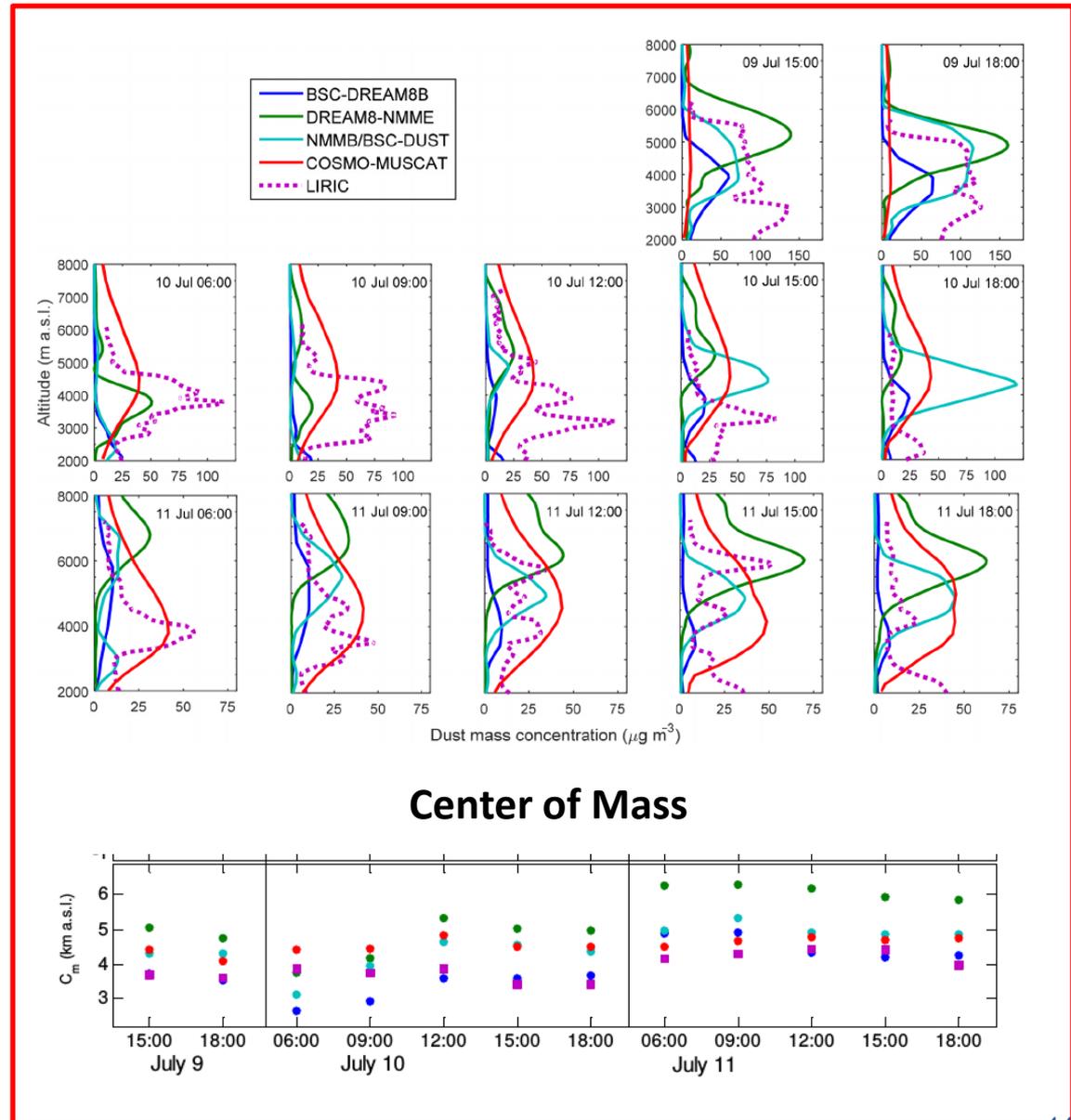


In **Granados-Muñoz et al. (ACP, 2016)**, dust model data is compared using volume concentration LIRIC profiles.

During and in support of the ChArMEx/EMEP 2012 field campaign (9–11 July 2012), five lidar ground-based stations performed 72h of continuous lidar measurements.



GRANADA, SPAIN



CEILOMETERS

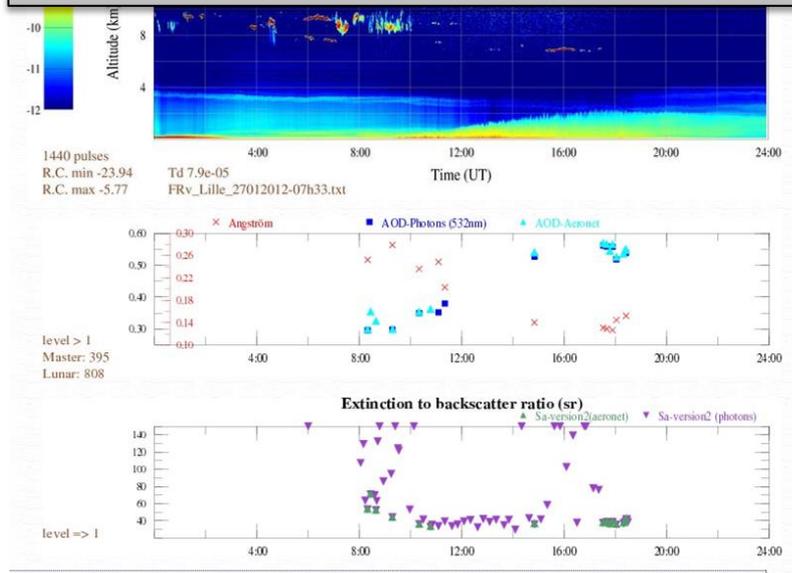
VS.

LIDARS

+ High density of stations
- Qualitative products



- Low number of stations
+ Quantitative products



NRT aerosol extinction profiles: At present

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

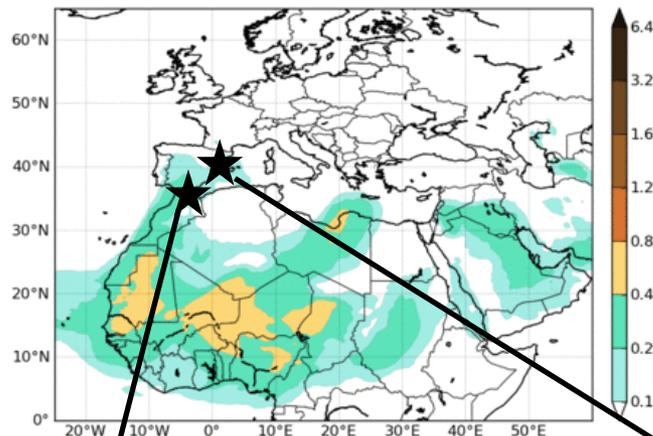
*Exchange operational protocol
includes 72 hours forecasts*

```
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);
```

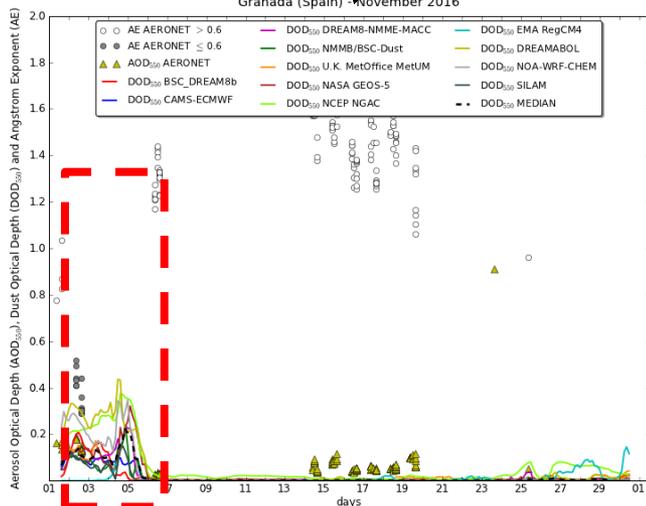
SDS-WAS NAMEE: NRT Evaluation profiles

W. Mediterranean dust event: 2 - 5 November 2016

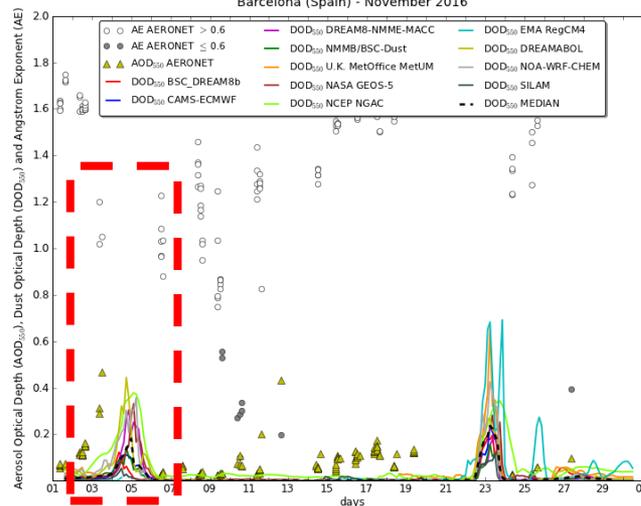
WMO SDS-WAS N.Africa-Middle East-Europe RC
 MEDIAN Dust AOD
 Run: 12h 04 NOV 2016 Valid: 12h 04 NOV 2016 (H+00)



Granada (Spain) - November 2016



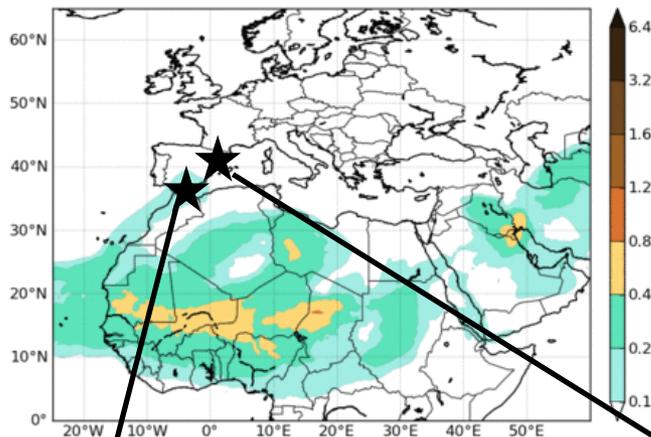
Barcelona (Spain) - November 2016



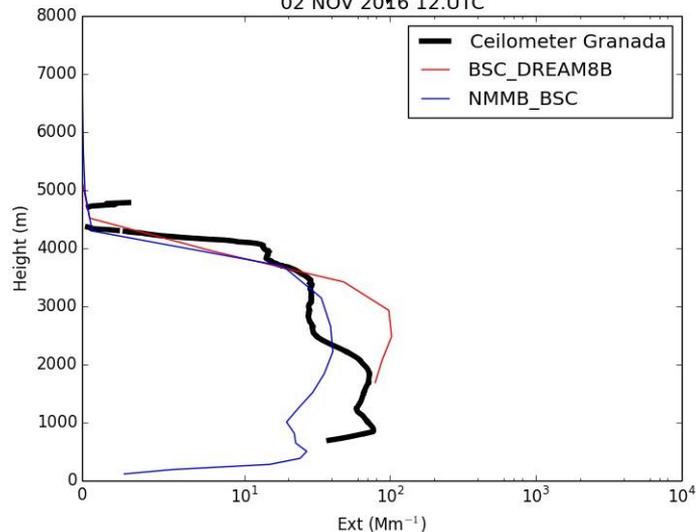
AERONET

Atlantic dust event: 2 - 5 November 2016

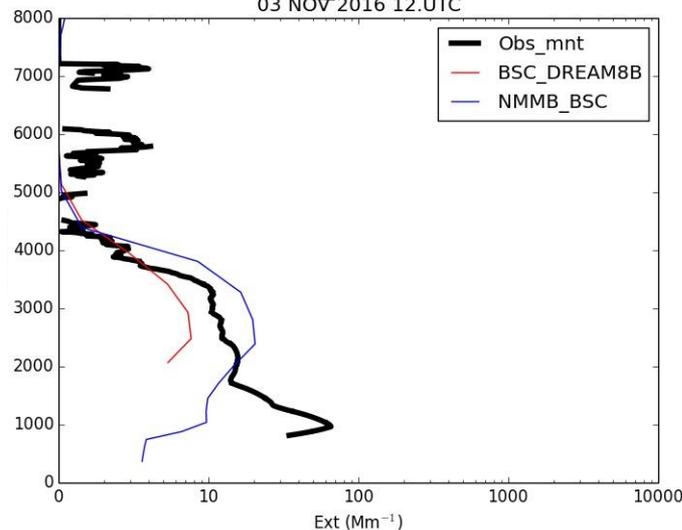
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 02 NOV 2016 Valid: 12h 02 NOV 2016 (H+00)



Extinction Profile.Granada
02 NOV 2016 12.UTC



Extinction Profile.Monsect
03 NOV 2016 12.UTC

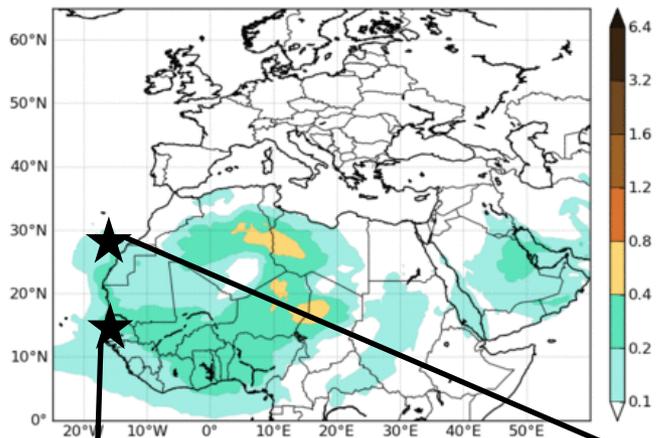


SDS-WAS NAMEE: NRT Evaluation profiles

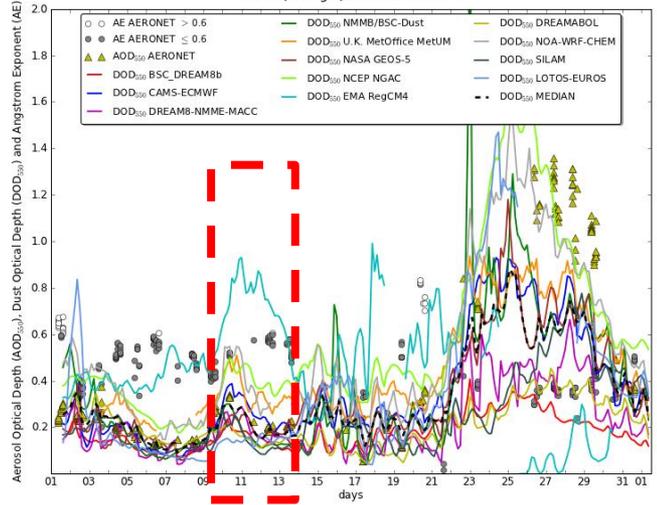


Atlantic dust event: 9 - 12 December 2016

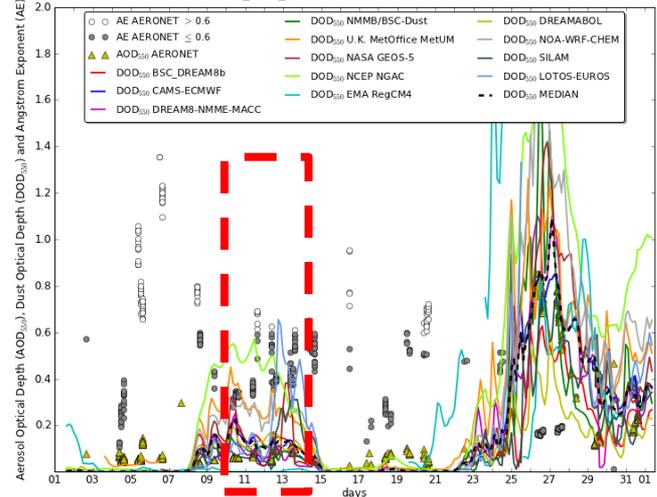
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 09 DEC 2016 Valid: 12h 09 DEC 2016 (H+00)



Dakar (Senegal) - December 2016



Santa_Cruz_Terente (Spain) - December 2016



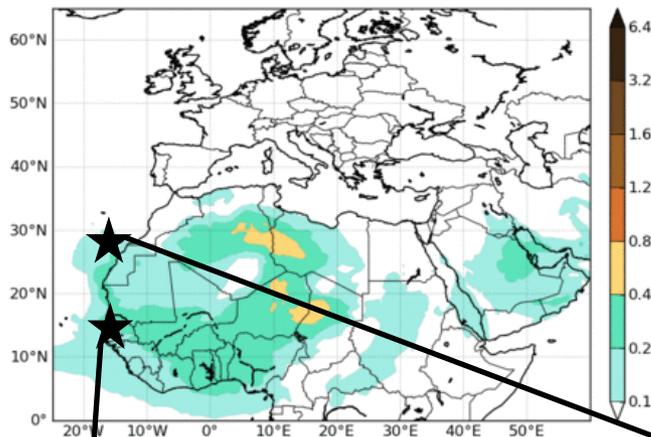
AERONET

SDS-WAS NAMEE: NRT Evaluation profiles

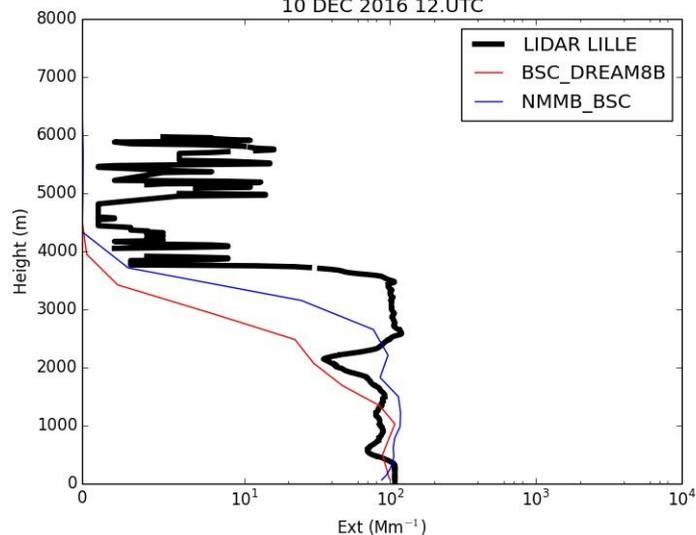


Atlantic dust event: 9 - 12 December 2016

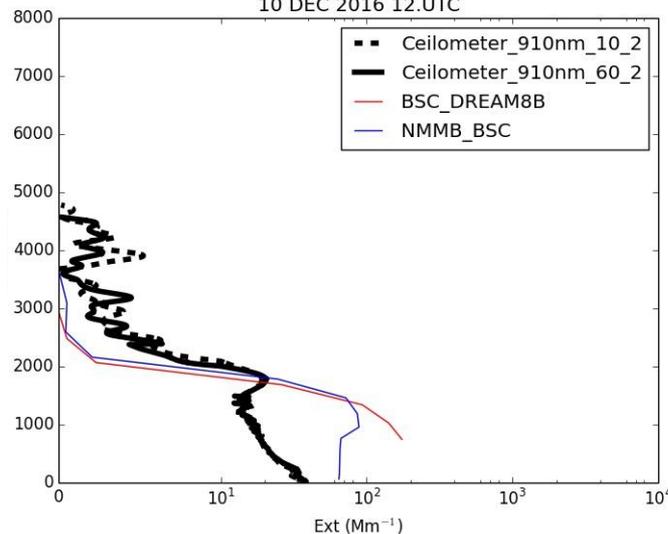
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 09 DEC 2016 Valid: 12h 09 DEC 2016 (H+00)



Extinction Profile.Dakar
10 DEC 2016 12.UTC



Extinction Profile.Santa Cruz de Tenerife
10 DEC 2016 12.UTC



Model intercomparison and evaluation is recognised as a core part of the **WMO SDS-WAS Regional Center**.

- *The current routine dust model evaluation is focused in total-column dust concentration (from AERONET, MODIS and MSG) and surface concentration (from AQ networks and visibility observations)*
- *In the framework of ACTRIS-2, nowadays, the Regional Center started working in the establishment of a NRT model evaluation profile system based on lidar and ceilometer measurements.*
 - *Ceilometers represent a potential dataset for operational dust model evaluation.*

Next steps include the development of a quantitative evaluation methodology which includes considerations for the **selection of a suitable data set** and **appropriate metrics** for the exploration of the results.

- *The model evaluation will focus on two main features: the description of the **aerosol layering** (peak altitude and shape of the profile) and the aerosol concentrations for all the models.*



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Thank you!

The authors thank Canary Government 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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