BARCELONA DUST FORECAST CENTER
(WMO Regional Specialized Meteorological Center with activity specialization on Atmospheric Sand and Dust Forecast)

Activity Report 2017

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1. Introduction

The **Barcelona Dust Forecast Center** (BDFC, [1]) was created in February 2014 by the **State Meteorological Agency** of Spain (AEMET) and the **Barcelona Supercomputing Center** (BSC) to fulfil the commitment acquired with **World Meteorological Organization** (WMO) to host the first Regional Specialized Meteorological Center with activity specialization on Atmospheric Sand and Dust Forecast (RSMC-ASDF). The Center operationally generates and distributes dust predictions for Northern Africa (north of equator), Middle East and Europe.

As described in its Activity Report 2014 (Terradellas et al., 2015) available at ([2]), the BDFC daily releases regional forecast fields using the **NMMB/BSC-Dust** model (the mineral dust module of the online and multiscale NMMB-MONARCH model (Pérez et al., 2011; Haustein et al., 2012; Jorba et al., 2012; Spada et al., 2013; Badia et al., 2017; Di Tomaso et al., 2017) over a domain covering Northern Africa, Middle East and Europe (25°W - 65°E, 0° - 65°N, Figure 1). BDFC predictions include dust load, dust surface concentration, dust optical depth (DOD) at 550 nm, dust surface extinction at 550 nm and 3-hour accumulated dry and wet deposition from the starting time (12 UTC) up to a lead time of 72 hours. Monthly averages of dust surface concentration and dust load are computed for long-term monitoring.

2. Model integration

The NMMB/BSC-Dust model is daily executed at a horizontal resolution of 0.1° longitude per 0.1° latitude with 40 σ-vertical layers over the domain of interest in HPC infrastructures. The primary run is executed at the BSC MareNostrum IV supercomputer using dedicated resources (288 cores). A backup integration is daily performed with the same configuration at Nimbus, the AEMET supercomputing facility.

Both model runs use initial meteorological conditions (at 12UTC) from the U. S. National Centers for Environmental Prediction (NCEP) global analysis at a 0.5° latitude x 0.5° longitude horizontal resolution and 6-hourly boundary meteorological conditions from the NCEP Global Forecast System at the same resolution.

1 https://dust.aemet.es

2 https://dust.aemet.es/about-us/report-2014

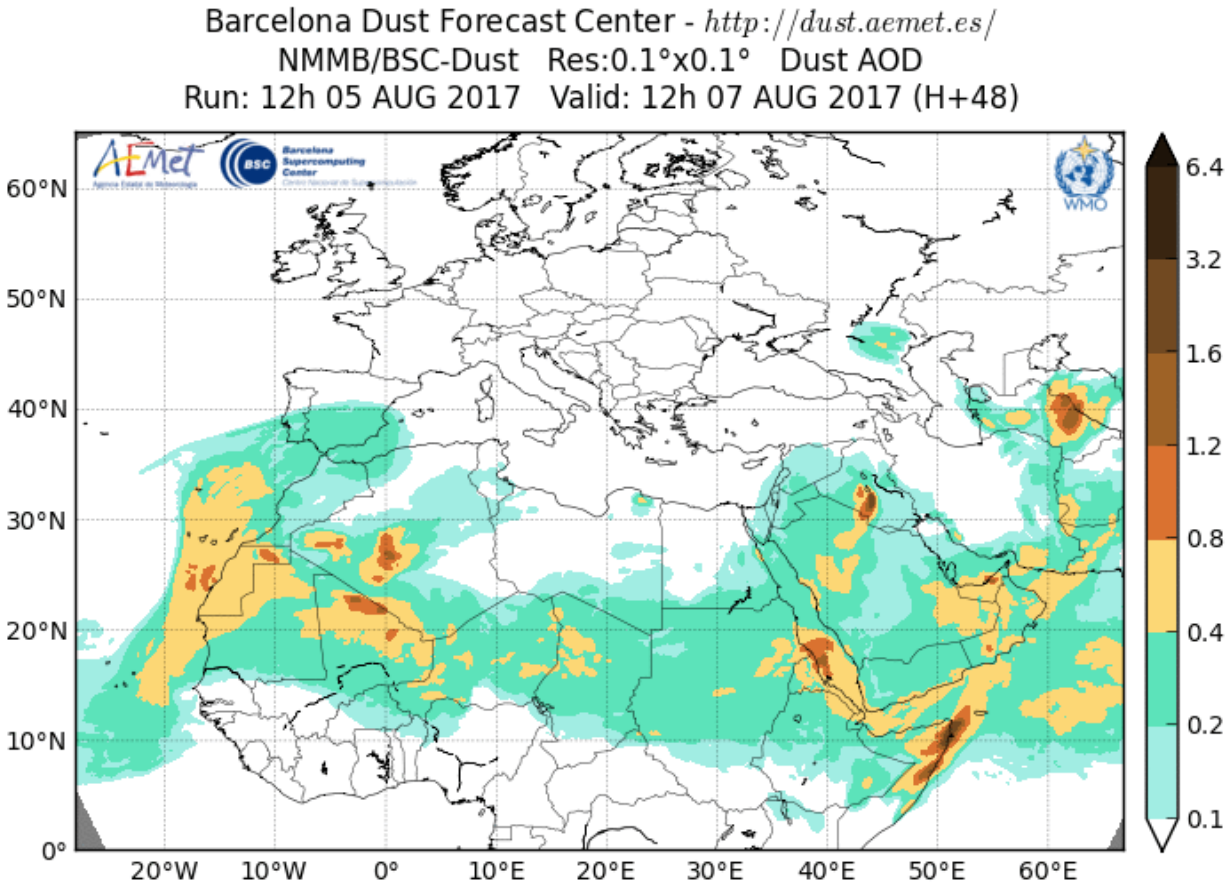

Figure 1: 48-hour forecast of dust optical depth at 550 nm valid for 7 Aug 2017 at 12 UTC

3. Forecast evaluation

The BDFC conducts regular evaluation of the predicted DOD. In the Near-Real-Time (NRT) evaluation, forecasts of DOD at 550 nm with lead times from 0 to 24 hours are compared with total aerosol optical depth (AOD) provided by the **AErosol RObotic NETwork** (AERONET, [3]); Holben et al., 1998; Dubovik and King, 2000) for 40 selected dust-prone stations (Figure 2). Then, evaluation scores are computed on a monthly, seasonal and annual basis by site and considering particular regions (i.e. Sahara/Sahel, Mediterranean and Middle East). To minimize the sources of error, it is intended to restrict the comparison to situations in which mineral dust is the dominant aerosol type. Threshold discrimination is made by discarding observations with an Ångström exponent 440-870 nm higher than 0.6. However, other particles are always present in the atmosphere (anthropogenic aerosol, products from biomass burning, etc.) and therefore a negative bias can be expected. The annual evaluation scores for 2017 are summarized in Table 1.

3http://aeronet.gsfc.nasa.gov/

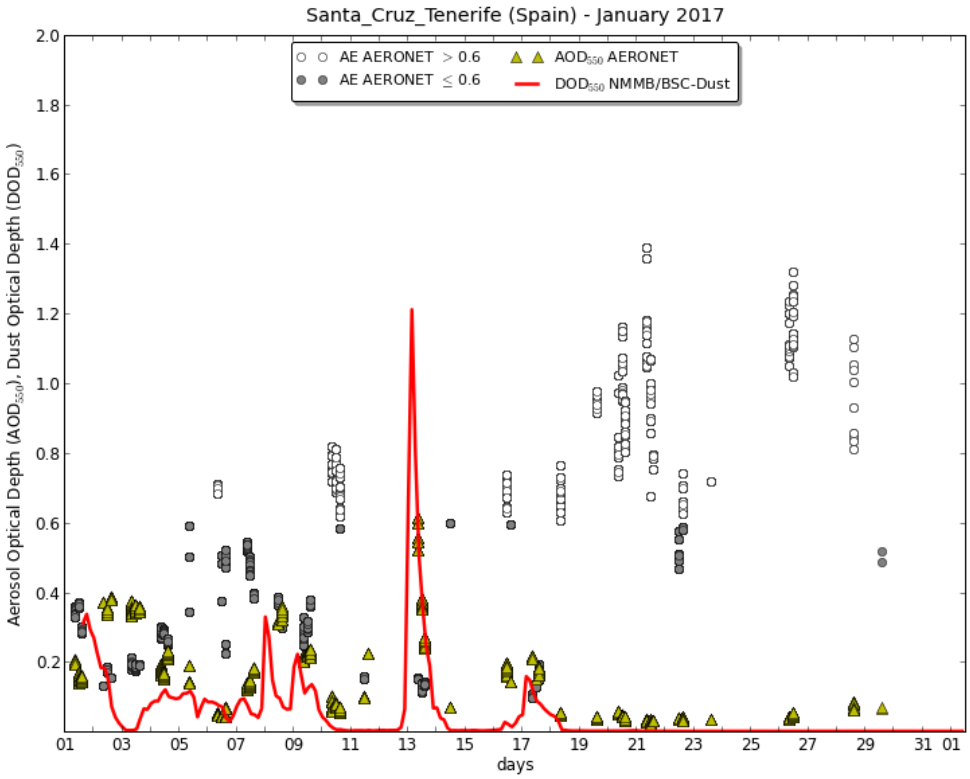

Figure 2: Evaluation of dust optical depth for January 2017 in Santa Cruz de Tenerife. Yellow triangles show the AERONET retrievals of total AOD, Black and white dots show the Ångström exponent

Region	MB	RMSE	r	FGE	NData
Sahel / Sahara	-0.15	0.48	0.43	0.74	7189
Middle East	-0.21	0.51	0.23	0.84	1045
Mediterranean	-0.15	0.26	0.53	1.18	3886
TOTAL	**-0.16**	**0.43**	**0.46**	**0.87**	**12120**

Table 1: Annual evaluation scores for the forecasts released by the BDFC in 2017: mean bias (MB), Root Mean Square Error (RMSE), correlation coefficient (r), Fractional Gross Error (FGE) and the number of observations considered for verification (NData).

4. Product dissemination

Operational forecasts are made available 12 hours after the starting forecast time on the Center's web portal ([4]), on the WMO **Global Telecommunications System** (GTS) and on **EUMETCast** ([5]), which is a dissemination system based on commercial telecommunication geostationary satellites that uses digital video broadcast standards. It is managed by EUMETSAT.

4 https://dust.aemet.es/forecast

5 http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast

A selection of daily forecasts are also available on the WMO website ([6]) and on UNEPLive, a UN system-wide open platform of environmental information designed for global, regional and national data sharing and assessment ([7]), ([8]) .

5. High availability of products

In previous years the system had been operating over 98% of the time. However, a plan was designed to reduce disruptions and ensure higher availability of products. The plan is based on adding redundancy and eliminating single points of failure. Its main elements are:

- Duplication of the Center's webserver at AEMET headquarters (Madrid, Spain).
- Duplication of the model run on the Nimbus (Bull) cluster, also at AEMET headquarters

The system architecture is represented in Figure 3. The AEMET Domain Name System (DNS) by default directs the web requests to the main BDFC server. However, in case of connection failure, it transfers the request to the secondary server. The two web servers are daily synchronize at 1 UTC, after receiving the forecast files.

Regarding the model forecasts, both runs are done in a totally independent way. Then, once each integration is completed, output files are loaded into both servers.

6 https://www.wmo.int/pages/prog/arep/sdswas/
7 http://uneplive.unep.org/region/index/af#data_tab
8 http://uneplive.unep.org/region/index/WS#data_tab

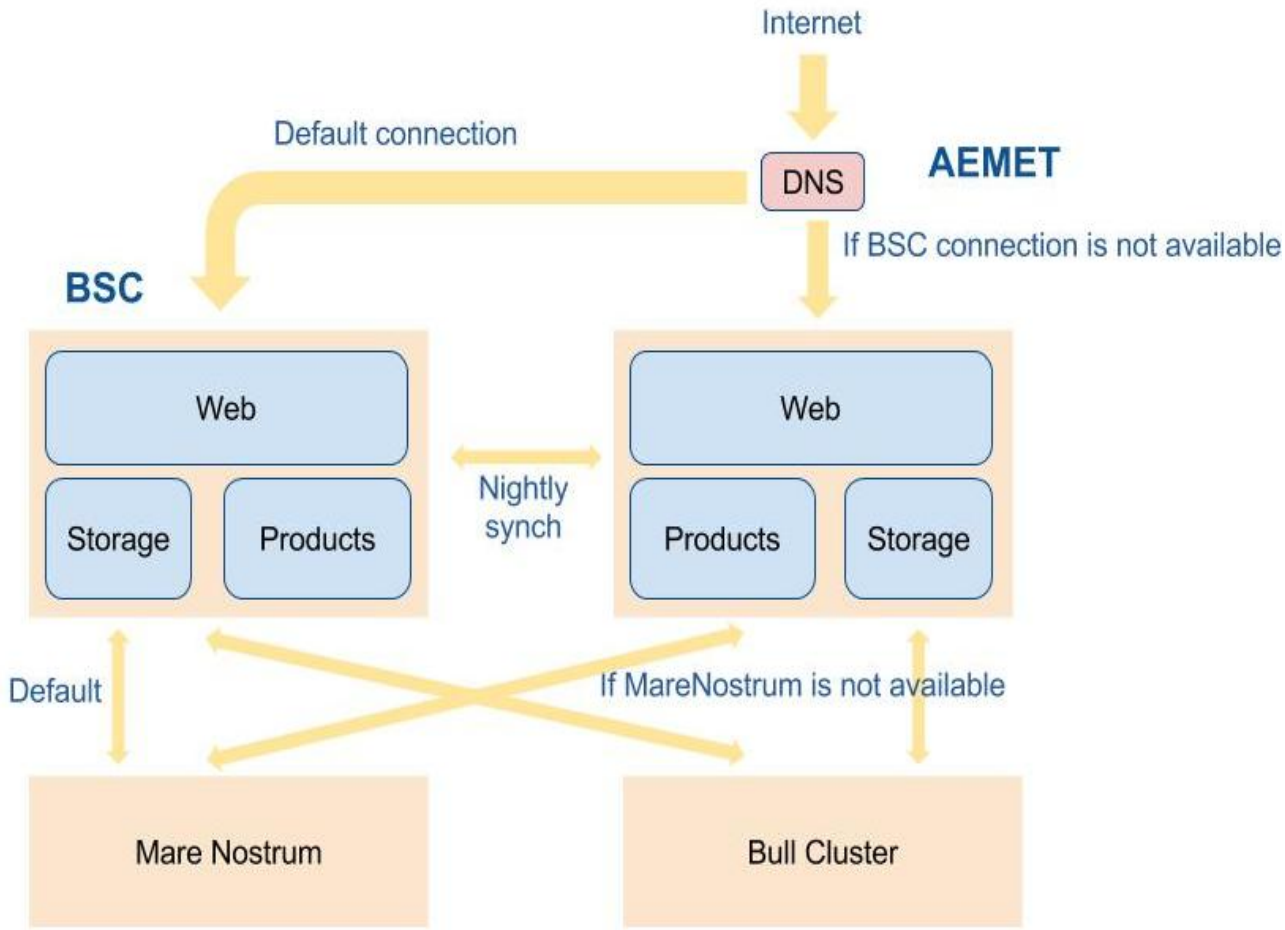

Figure 3: Configuration of the BDFC systems

6. Capacity building

The **6th Training Course on WMO SDS-WAS Products** (Satellite and Ground Observation and Modelling of Atmospheric Dust) was held in Istanbul, Turkey, on 25-27 October 2017. It was organized by the Turkish State Meteorological Service (TSMS), World Meteorological Organization (WMO) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) with cooperation of the State Meteorological Agency of Spain (AEMET) and the Barcelona Supercomputing Center (BSC). It was attended by 35 meteorologists and technicians from Turkey, Saudi Arabia, Iran, Afghanistan, Mauritania, Somalia and Senegal.

The event was targeted to operational and research meteorologists, although it was also attended by technicians from air quality agencies as well as early career scientists (advanced students, PhD candidates and postdoctoral researchers) with interest on the Earth system sciences.

Figure 4: 6th Training Course on WMO SDS-WAS Products

The team of lecturers included Jose Prieto (EUMETSAT), Enric Terradellas and Sergio Rodríguez (AEMET), Sara Basart (BSC), Richard Engelen (ECMWF), Ali Darvishi (Tehran University) and Cihan Dündar (TSMS)

Materials from this training course are available on the website of the WMO **SDS-WAS Regional Center for Northern Africa, Middle East and Europe** ([9]).

7. Staff

Enric Terradellas, technical director
Sara Basart, research and operations
Francesco Benincasa and **Kim Serradell**, technical support
Carlos Pérez García-Pando and **Emilio Cuevas**, scientific advisers

8. Users

The BDFC conducts regular monitoring of website access. The results (Table 2) show the number of sessions and page views.

9 https://sds-was.aemet.es/materials/training/6th-training

Season	Sessions	Page views
Dec 2016 – Feb 2017	19,249	36,919
Mar – May 2017	24,520	46,837
Jun – Aug 2017	18,216	33,022
Sep – Nov 2017	17,188	30,176

Table 2: Quarterly overview of web access during 2017.

Compared with the previous years, there has been an important and steady increase of web accesses, as shown in table 3

Year	Sessions	Page views
Dec 2014 – Nov 2015	31,578	62,443
Dec 2015 – Nov 2016	55,270	98,378
Dec 2016 – Nov 2017	79,173	146,954

Table 3: Evolution of annual web access

The top five countries ranked by number of visitors are Spain, Iran, United Kingdom, Saudi Arabia and United States.

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