

SDS-WAS Products

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InDust Training School Aveiro, Portugal
Feb 4th-6th 2019



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AEMet
Agencia Estatal de Meteorología



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación

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- Impacts on health, transport, industry, climatology, ...
- SDS-WAS WMO mission (2004-2007)
- Sand and Dust Storm Warning Advisory and Assessment System
- Improvement of Sand and Dust Storm Observation and Forecast
- Difusion of knowledge and products
- Regional Centers: Beijin (Asia 2008), Barcelona (NAMEE 2010), Barbados (America 2016-2017)



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**GAW**

http://sds-was.aemet.es
https://dust.aemet.es

[illegible]






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LATEST NEWS

[DustEvolution 3.0 beta: new dust products](#)

Aug 10, 2014

[DustEvolution 3.0 beta: new dust products](#)

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Aug 10, 2014

UPCOMING EVENTS

[DustEvolution 3.0 beta: new dust products](#)

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[DustEvolution 3.0 beta: new dust products](#)

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Training Workshop on Sand and Dust Storms in the Arab Region

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Dust forecast

Latest dust to watch for Morocco, Algeria, Middle East and Europe

[Check it here](#)



Dust evolution

Full evolution of dust for missions against Aerosols observations

[Check it here](#)

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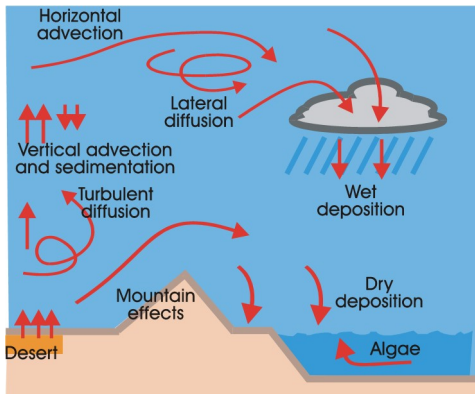
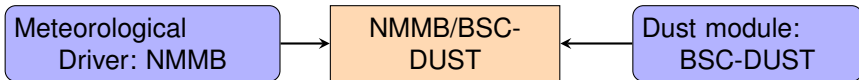
Outline

- 1 Introduction SDS-WAS
- 2 SDS-WAS Products**
- 3 Burkina Faso Warning Advisory System
- 4 Calima on Canary Islands
- 5 Shamal dust event
- 6 Harmattan and Bodélé Depression

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 - NMMB/BSC-DUST
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Operational Dust Model: NMMB/BSC-DUST



NMMB/BCS-DUST: Operational Products

Surface

- Dust Surface Concentration [$\mu\text{g}/\text{m}^3$]
- Extinction [Mm^{-1}]

Integrated or columnar

- Dust Load [g/m^2]
- Dust Optical Depth $[-]$ $\tau = \ln \frac{I_{top}}{I_{bottom}} \cos \theta$

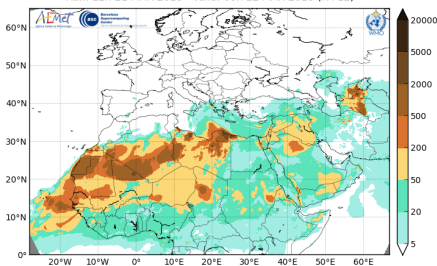
Dust Deposition (3h accumulation)

- Dry Deposition [mg/m^2]
- Wet Deposition [mg/m^2]

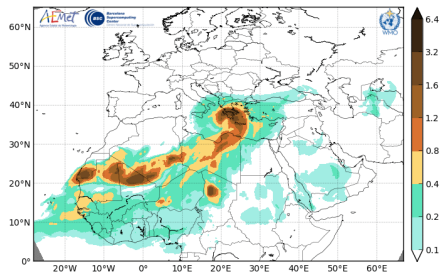
NMMB/BCS-DUST: Operational Products

● Dust Surface Concentration and Dust AOD

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BCS-Dust Res: $0.1^\circ \times 0.1^\circ$ Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
 Run: 12h 21 MAR 2018 Valid: 00h 22 MAR 2018 (H+12)



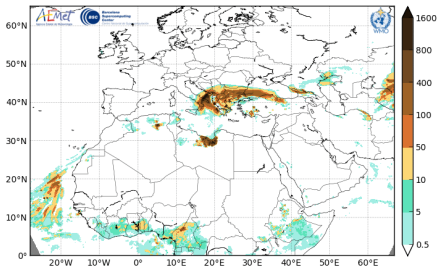
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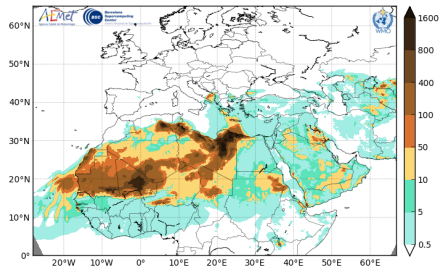
NMMB/BCS-DUST: Operational Products

● Dust Dry and Wet Deposition

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BCS-Dust Res: $0.1^\circ \times 0.1^\circ$ 3h Acc. Dust Wet Depos. (mg/m^2)
 Run: 12h 21 MAR 2018 Valid: 12h 22 MAR 2018 (H+24)



Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BCS-Dust Res: $0.1^\circ \times 0.1^\circ$ 3h Acc. Dust Dry Depos. (mg/m^2)
 Run: 12h 21 MAR 2018 Valid: 12h 22 MAR 2018 (H+24)



Operational Model: NMMB (Non Hydrostatic Multiscale Model BGrid)

NMMB

- Daily forecast: 12 UTC run, 72 h forecast, 3 h step
- Multiscale: $0.1^\circ \times 0.1^\circ$
- Initial Conditions: NCEP global analysis $0.5^\circ \times 0.5^\circ$
- Boundary conditions: 6-hourly NCEP GFS forecasts $0.5^\circ \times 0.5^\circ$
- Soil Map: STATSGO-FAO

BSC-DUST

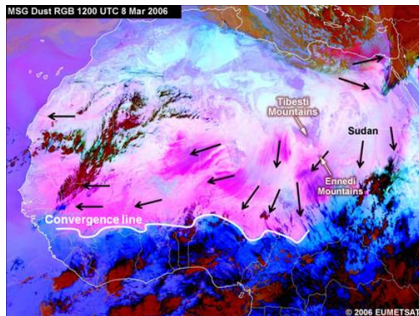
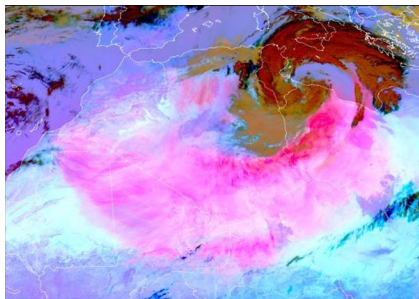
- 4 soil textures: Sand fine/medium and coarse, clay, silt
- Initial Conditions: previous 24 h forecast
- On line coupled
- No data assimilation (work in progress)

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Synoptic and meso-alfa: Well captured by dust models

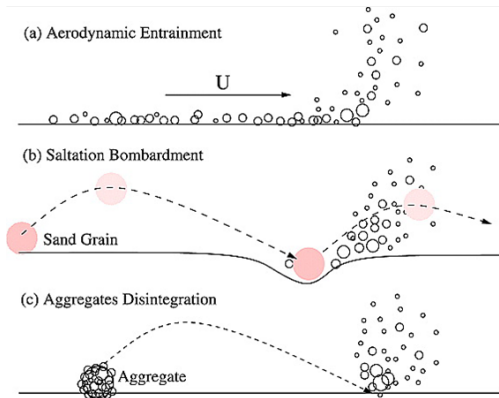
- Frontal system winds
- Synoptic winds: trade winds, Harmattan



- Orographic Winds: Bodélé Depression
- Convection: Haboob and Dust devils



Limitations: Local Scale emission processes



Dust particles: Creep and suspension

- Direct suspension (<50 μm)
- **Saltation(50-500 μm) + Sandblasting:** horizontal dust flux + vertical dust flux

Limitations: Local Scale emission processes

Tegen et al. (1994)

$$F = \sum_i C_i u^2 (u - 6.5)$$

Marticorena et al. (1997)

$$F = \alpha \frac{\rho}{g} u_*^3 \sum_i s_i \left(1 + \frac{u_{*tri}}{u_*}\right) \left(1 - \frac{u_{*tri}^2}{u_*^2}\right)$$

Ginoux et al. (2001)

$$F = CS \sum_i u^2 s_i w_0 (u - u_{tri})$$

Wind Speed

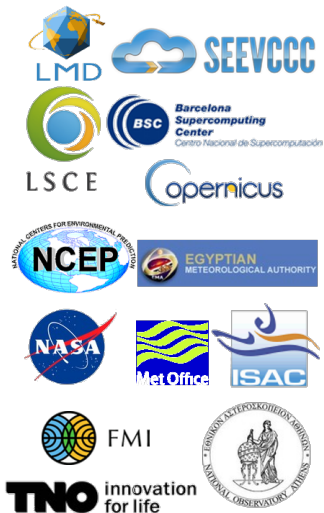
- Emission proportional to the 3th power of wind speed
- **Need for a very accurate wind forecast**
- NMMB/BSC-DUST: Marticorena et al.

- Incomplete information of soil state and nature
- Incomplete knowledge of the physical processes involved in the dust cycle
- Lack of adequate and appropriate observations for model assimilation and verification



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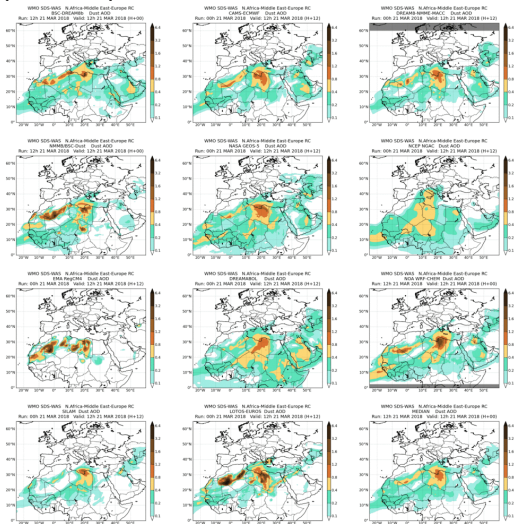
Dust Models



MODEL	RUN TIME	DOMAIN	DATA ASIMILATION
CAMS-ECMWF	00	GLOBAL	MODIS-AOD
BSC-DREAM8BV2.0	12	REGIONAL	NO
DREAM8-NMME	00	REGIONAL	CAMS analysis
NMMB/BSC-DUST	12	REGIONAL	NO
MetUM	00	GLOBAL	MODIS-AOD
GEOS-5	00	GLOBAL	MODIS reflectances
NGAC	00	GLOBAL	NO
EMA REG CM4	00	REGIONAL	NO
DREAMABOL	00	REGIONAL	NO
NOA WRF-CHEM	12	REGIONAL	NO
FMI-SILAM	00	GLOBAL	NO
LOTOS-EURO	00	REGIONAL	MODIS-AOD

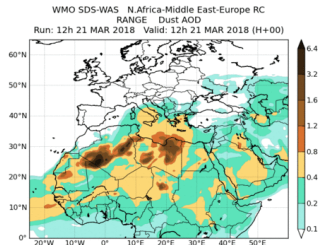
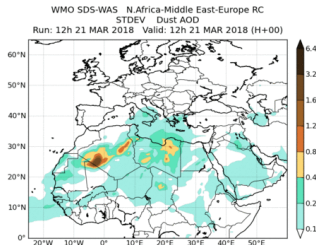
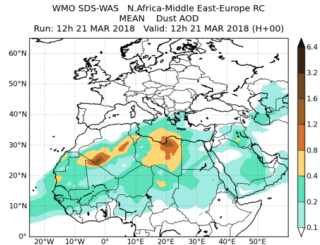
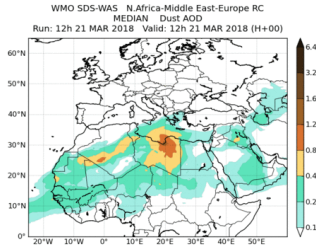
Dust model inter-comparison

Dust Optical Depth 550 nm. Models runtime: 21 Mar 2018

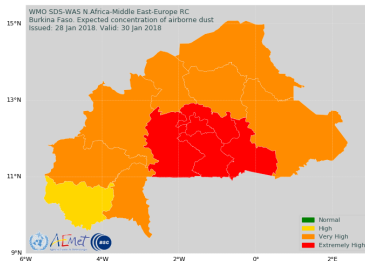
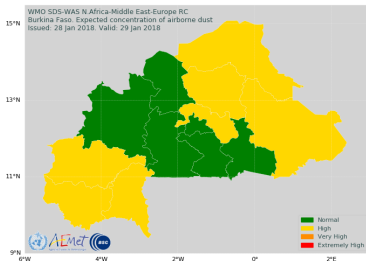


Multimodel Products

Dust Optical Depth 550 nm. Models runtime: 21 Mar 2018



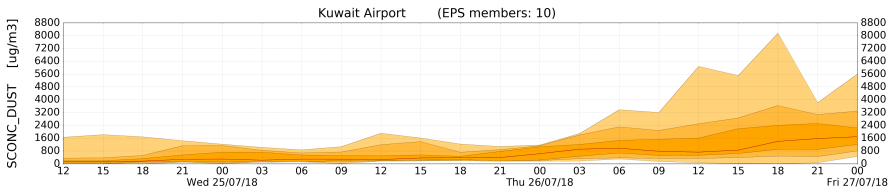
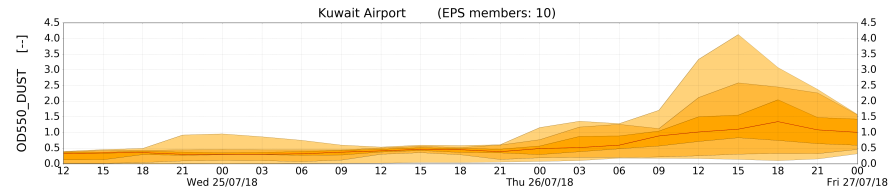
Burkina Faso Early-Warning System (EWS)



SDS-WAS Regional Center NAMEE

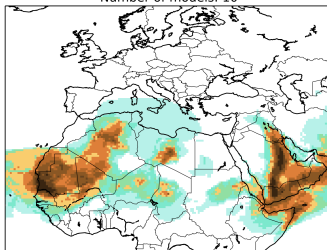
- Daily maximum value of the Dust SFC Concentration multimodel median
- Yellow: Perc 80, Orange: Perc 90 Red: Perc 97.5

AOD and Dust SFCCConcentration EPSgrams

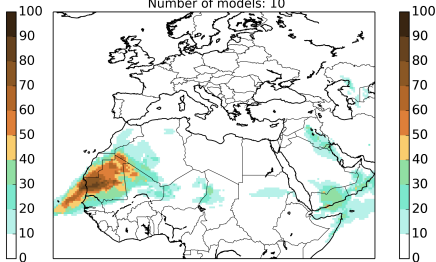


Probability maps

AOD probability of exceeding 0.5
Date: 20180712 Leadtime: D1 Resolution: 0.5°
Number of models: 10



AOD probability of exceeding 1
Date: 20180716 Leadtime: D2 Resolution: 0.5°
Number of models: 10



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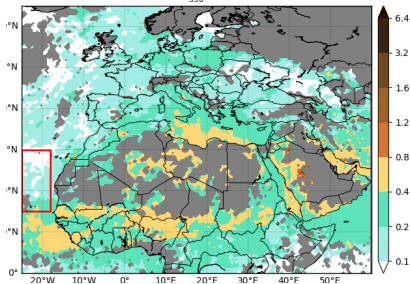
AERONET
Aerosol Robotic Network



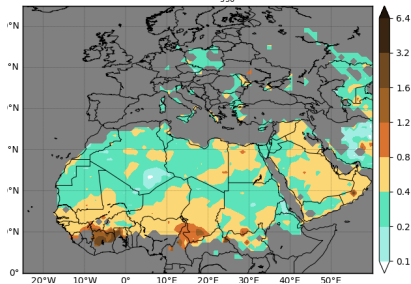
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Deterministic Evaluation: MODIS

WMO SDS-WAS N.Africa-Middle East-Europe RC
MODIS AOD₅₅₀ - APR 2018



WMO SDS-WAS N.Africa-Middle East-Europe RC
MODIS DEEPBLUE AOD₅₅₀ - APR 2018



MODIS Evaluation:
Monthly
Seasonally
Annually

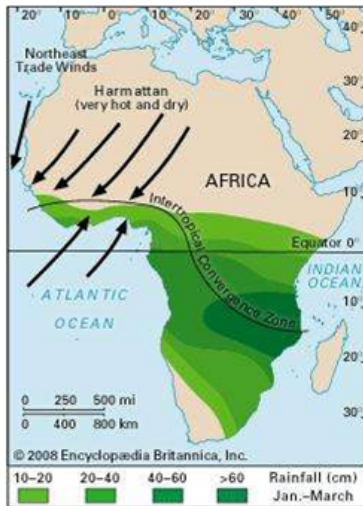
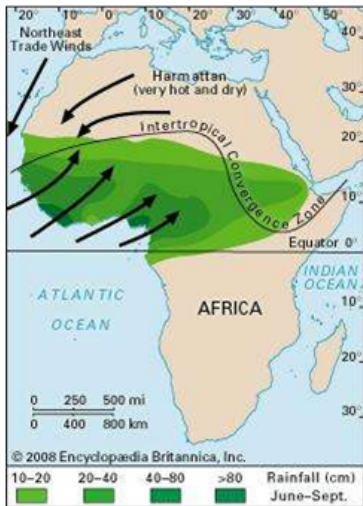
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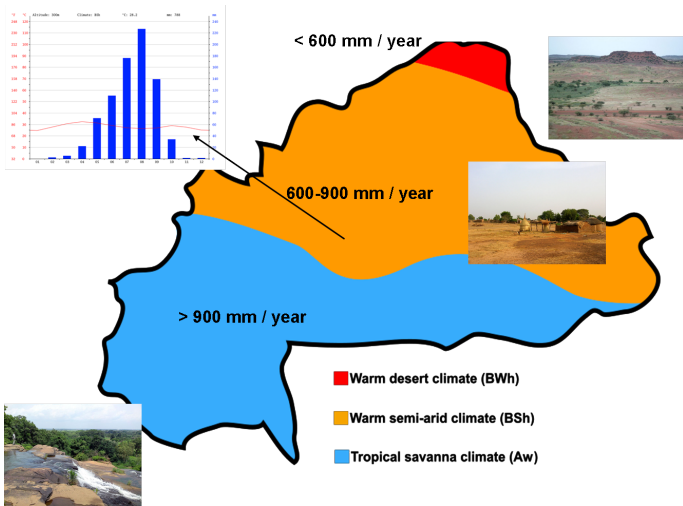
Burkina Faso



Burkina Faso: Clima

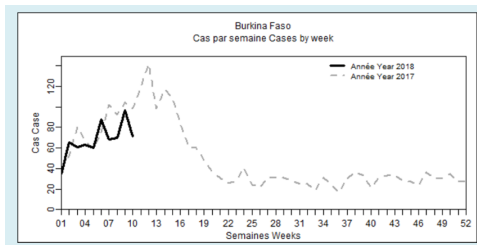
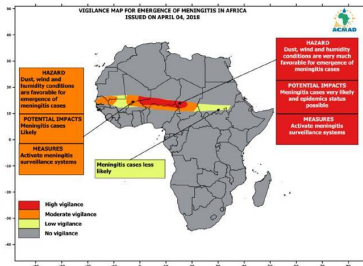
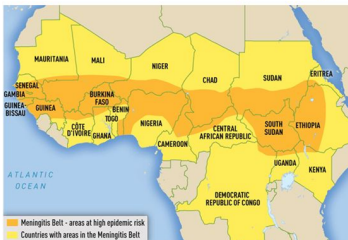


Burkina Faso: Precipitation

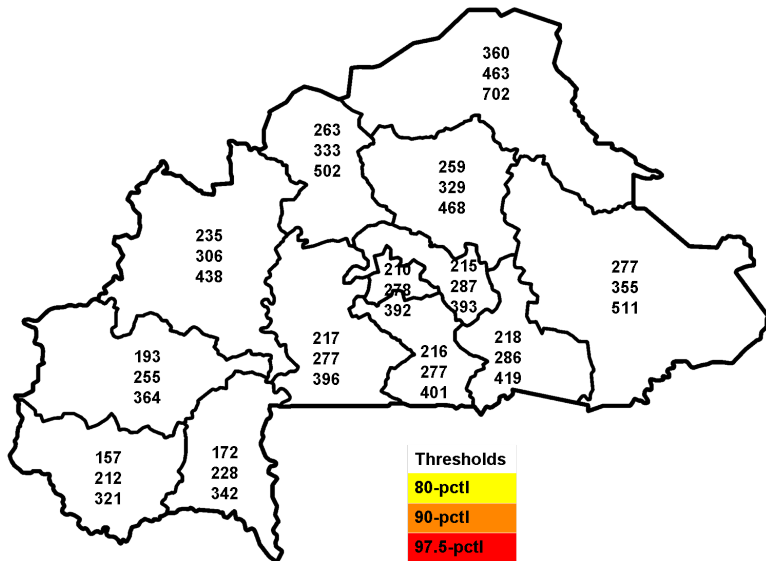


Burkina Faso: Health Impact

Map 3-11. Areas with frequent epidemics of meningococcal meningitis

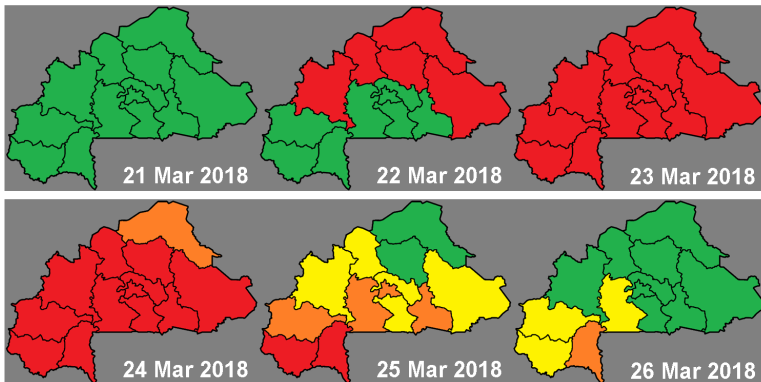


Burkina Faso: WAS percentiles



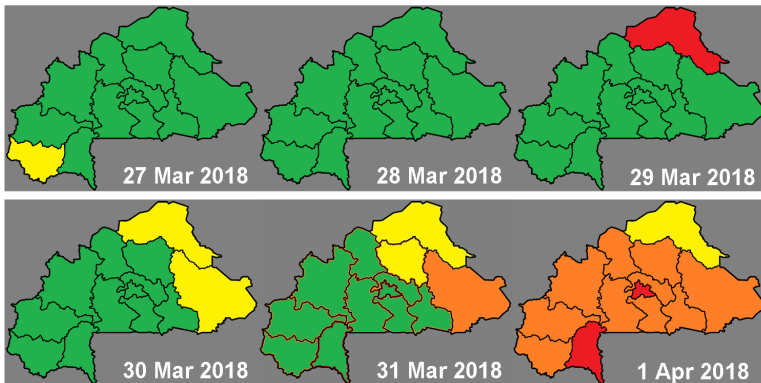
Burkina Faso: WAS

SDS-WAS: Burkina Faso

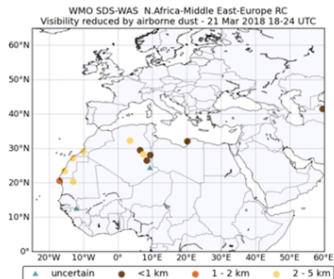
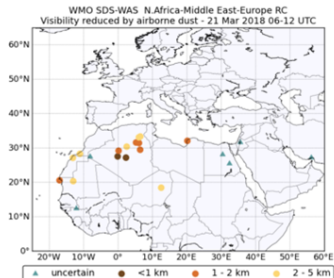


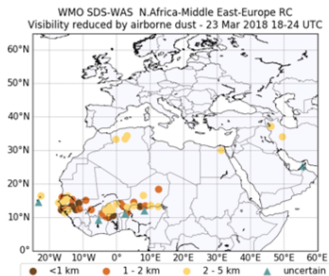
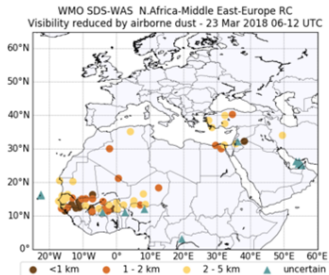
Burkina Faso

SDS-WAS: Burkina Faso

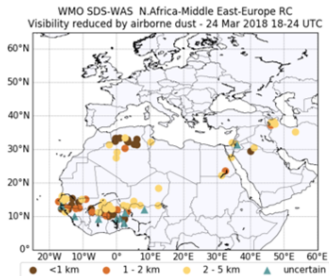
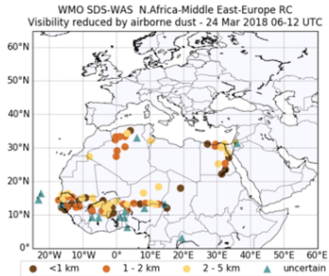


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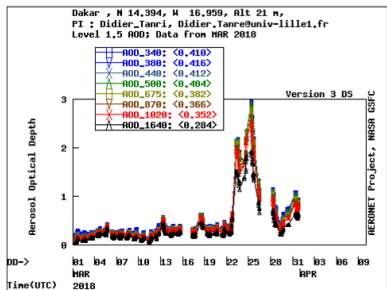
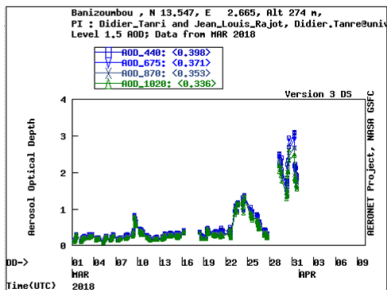




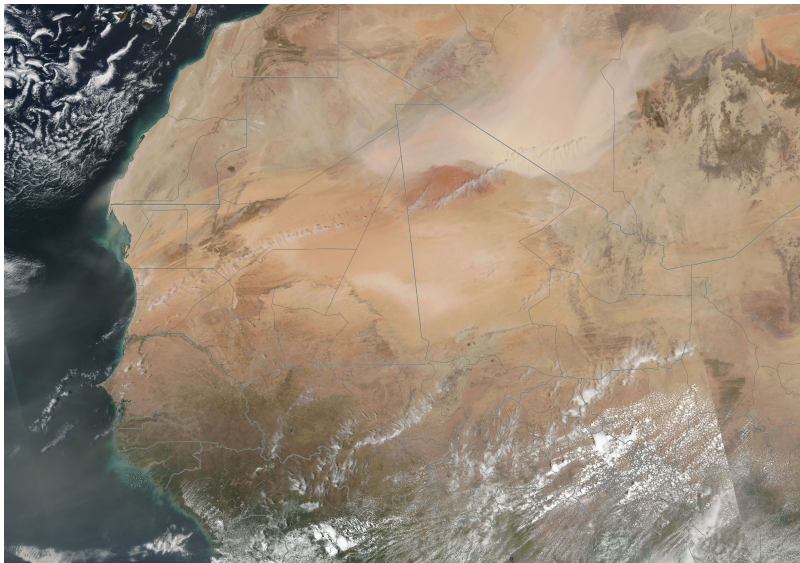
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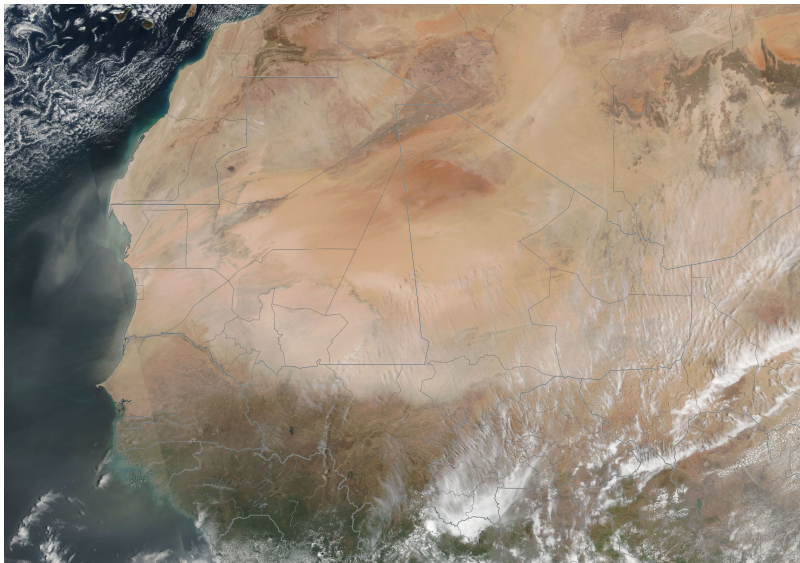
AERONET: Banizoumbou and Dakar



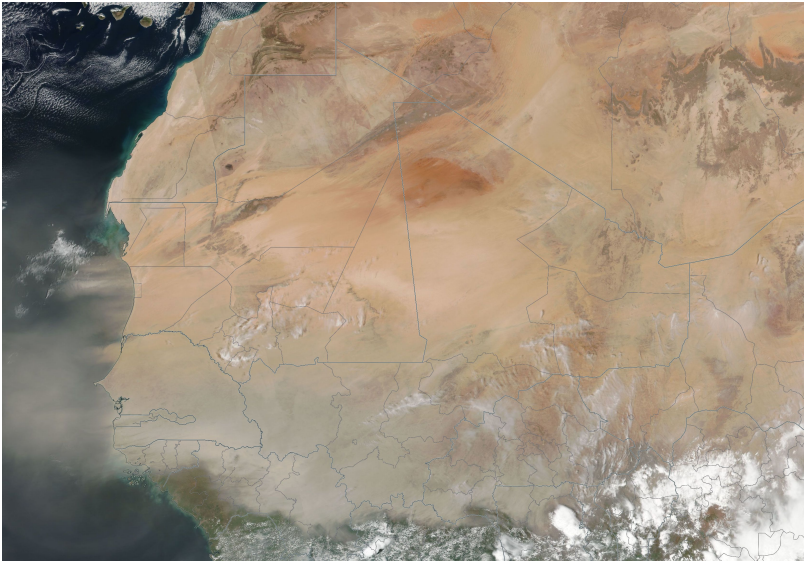
Satellite: Suomi 21/03/2018



Satellite: Suomi 22/03/2018



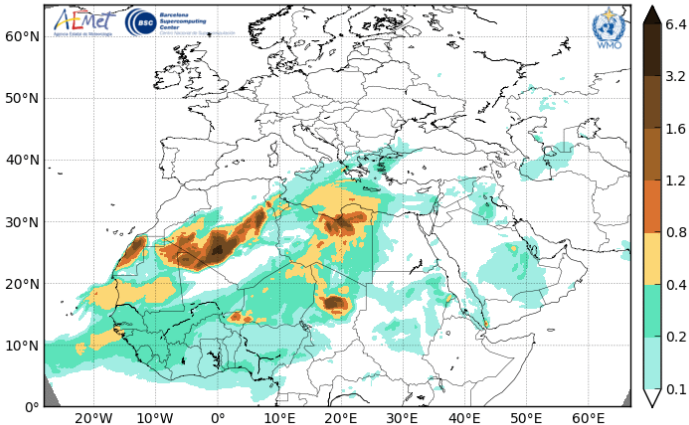
Satellite: Suomi 23/03/2018





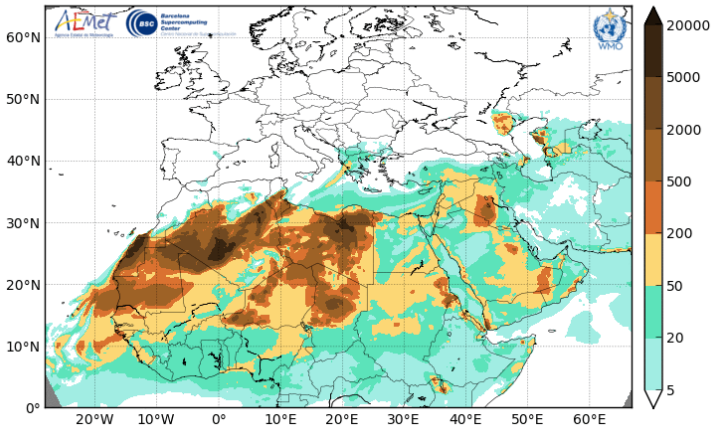
Operational Model: AOD

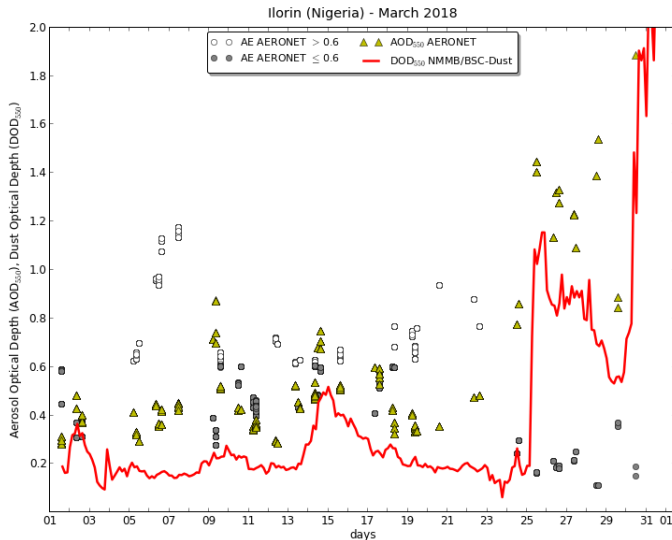
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 21 MAR 2018 Valid: 12h 21 MAR 2018 (H+00)



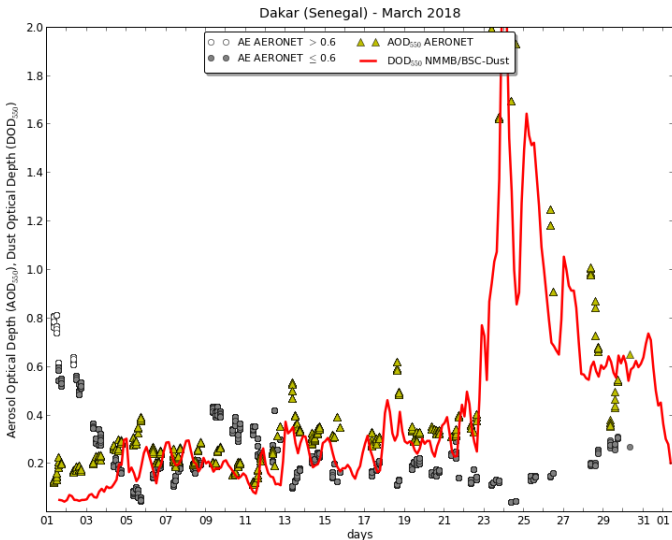
Operational Model: Dust Surface Concentration

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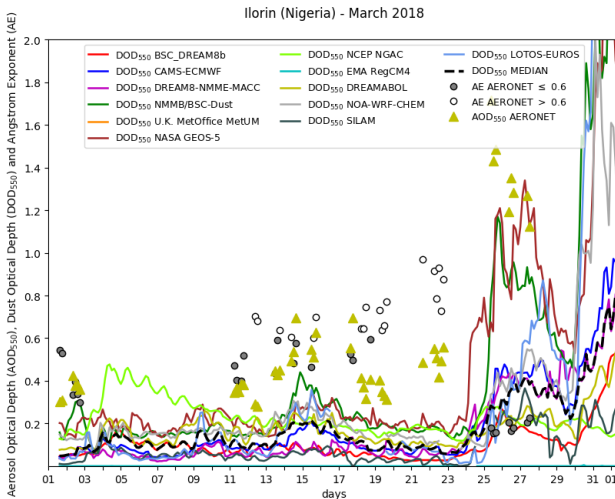




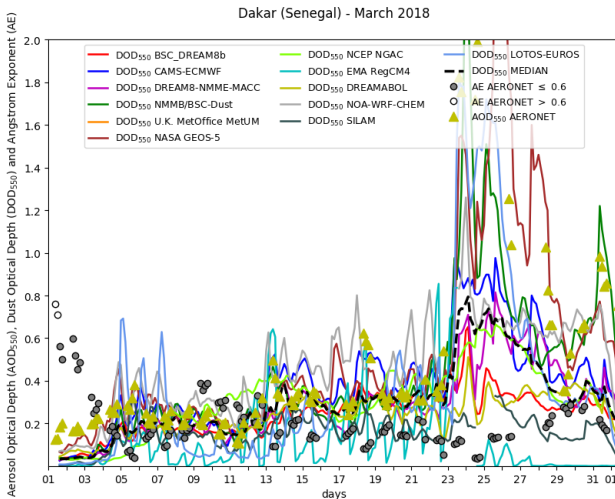
Operational Model: Validation AERONET Dakar



Multimodel: Validation AERONE Ilorin



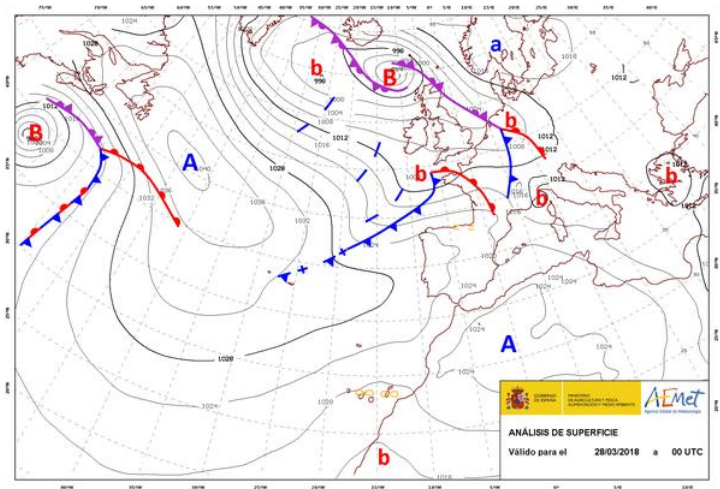
Multimodel: Validation AERONE Dakar



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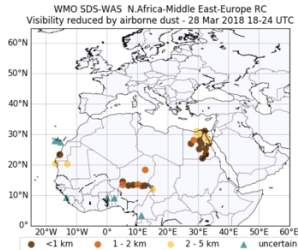
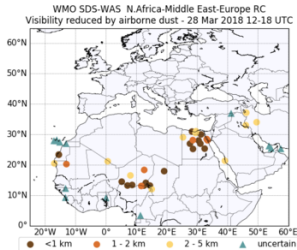
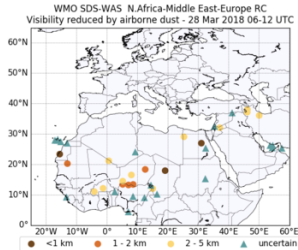
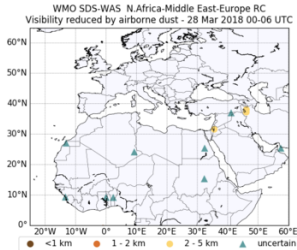
Meteorological situation

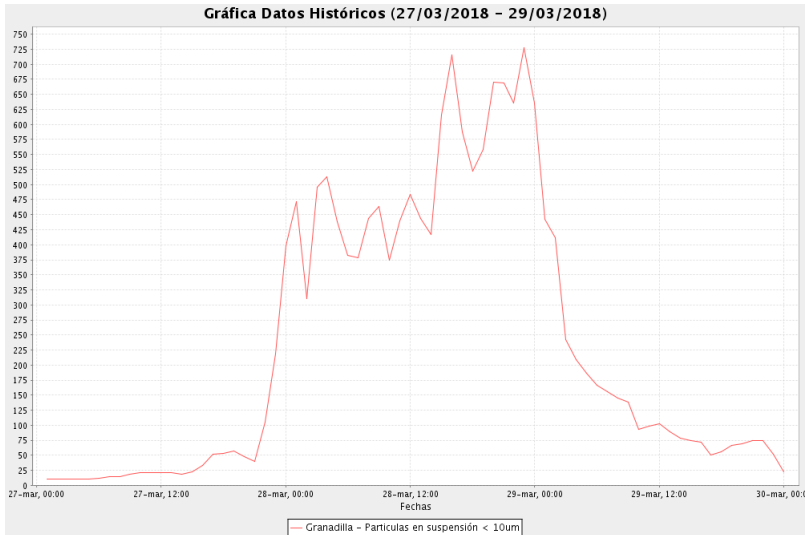


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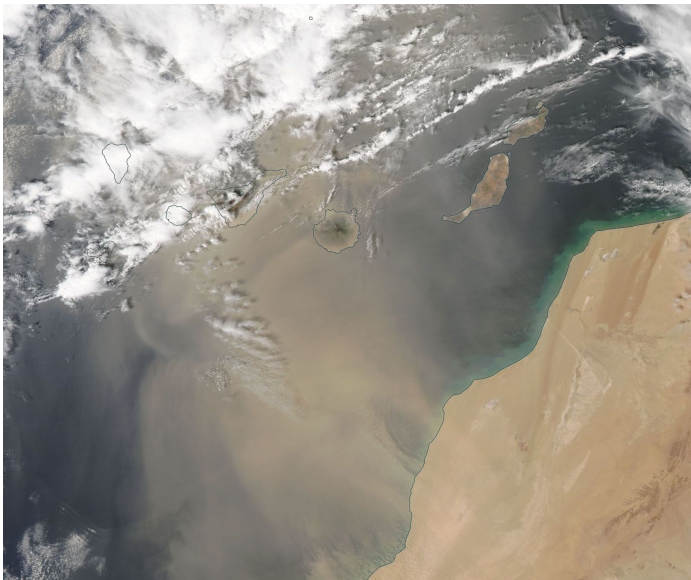


Visibility: METARS and SYNOPS

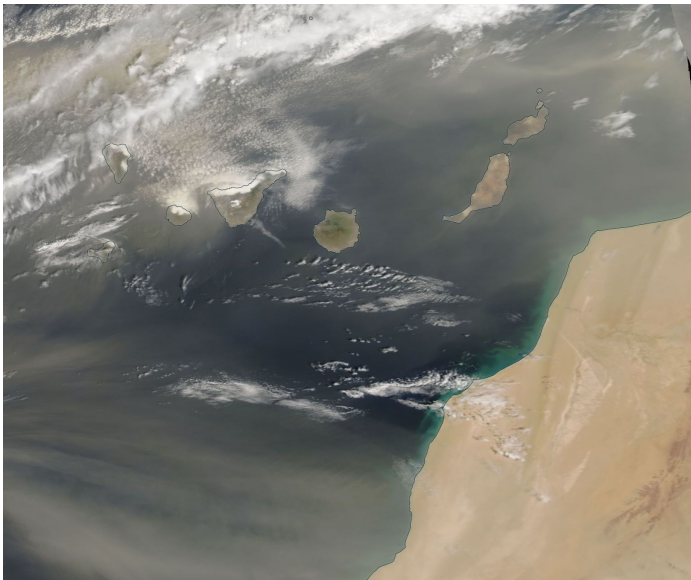


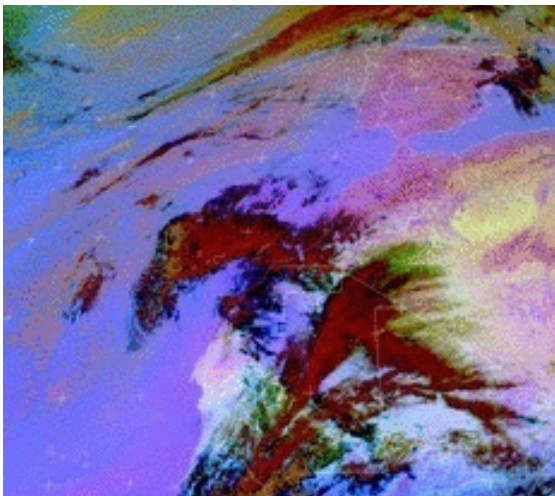


Polar satellite: Aqua Modis 28/03/2018



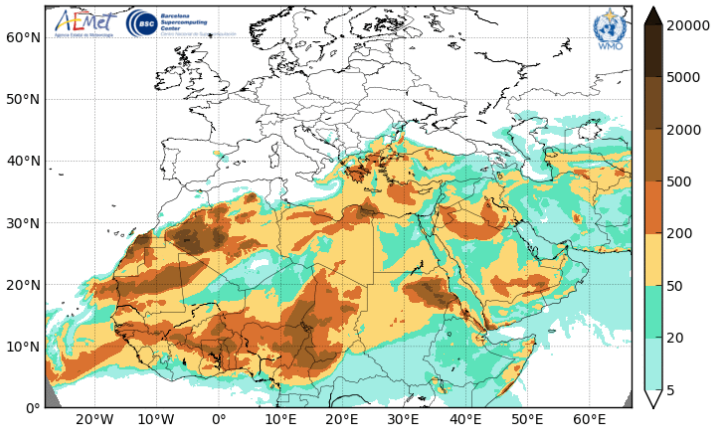
Polar satellite: Aqua Modis 29/03/2018



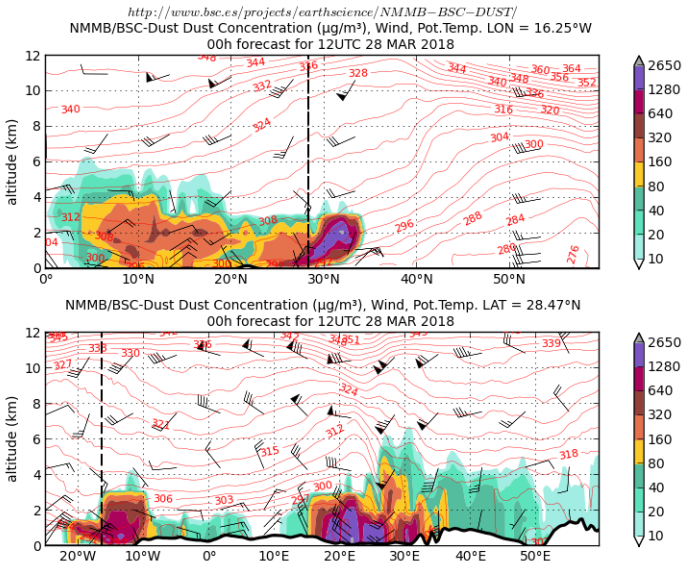


Operational Model

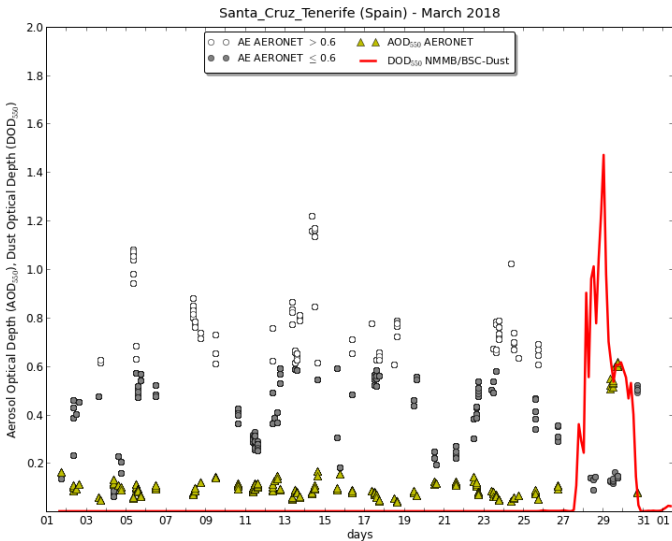
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
 Run: 12h 26 MAR 2018 Valid: 12h 26 MAR 2018 (H+00)



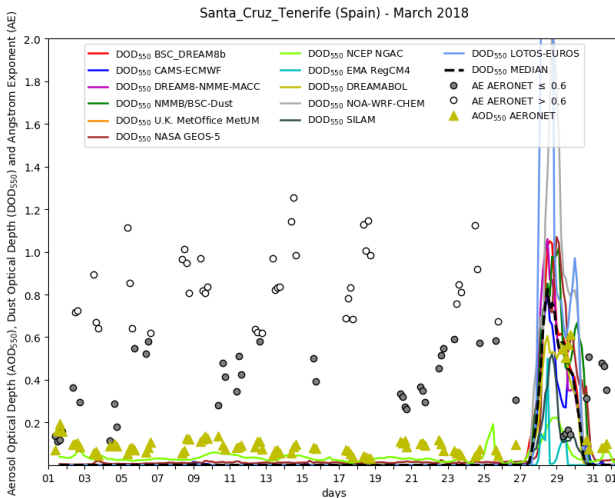
Operational Model: Cross Section



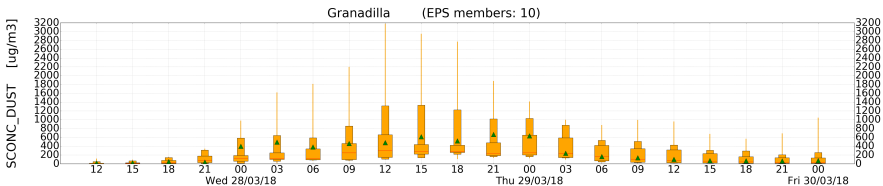
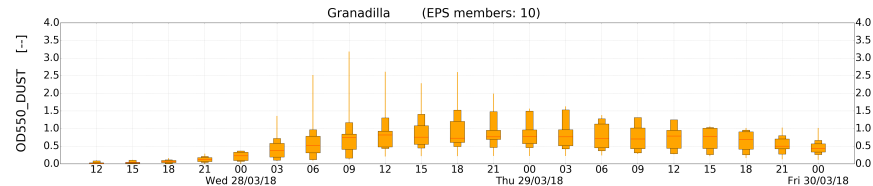
Operational Model: Validation AERONET



Multimodel: Validation AERONET

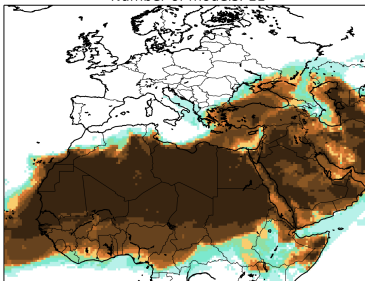


SDS-WAS Ensemble: EPSgramas AOD and Dust SFC

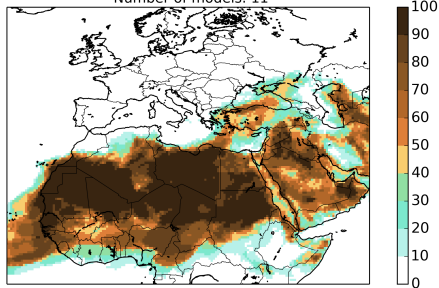


SDS-WAS Ensemble: Probability maps

SFC probability of exceeding $50 \mu\text{g}/\text{m}^3$
 Date: 20180328 Leadtime: D1 Resolution: 0.5°
 Number of models: 11

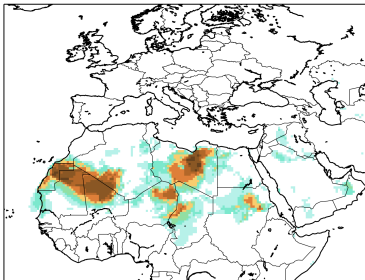


SFC probability of exceeding $100 \mu\text{g}/\text{m}^3$
 Date: 20180328 Leadtime: D1 Resolution: 0.5°
 Number of models: 11

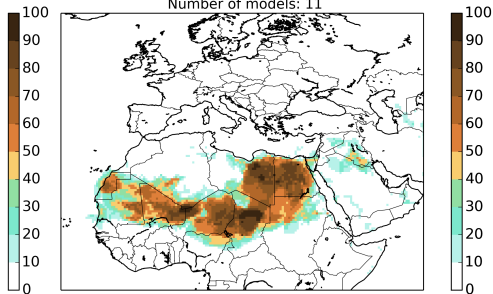


SDS-WAS Ensemble: Probability maps

SFC probability of exceeding $700 \mu\text{g}/\text{m}^3$
 Date: 20180327 Leadtime: D1 Resolution: 0.5°
 Number of models: 11



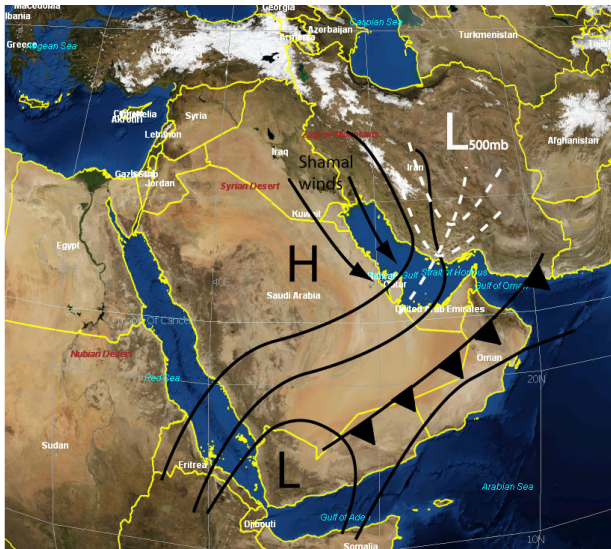
SFC probability of exceeding $700 \mu\text{g}/\text{m}^3$
 Date: 20180327 Leadtime: D2 Resolution: 0.5°
 Number of models: 11



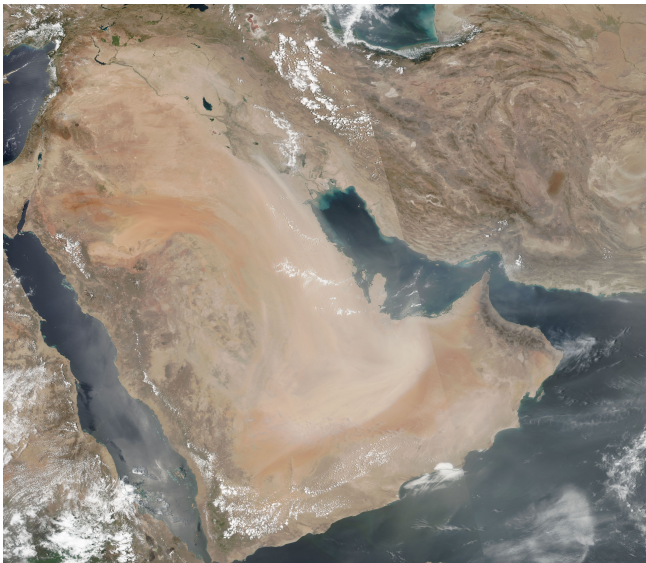
Outline

- 1 Introduction SDS-WAS
- 2 SDS-WAS Products
- 3 Burkina Faso Warning Advisory System
- 4 Calima on Canary Islands
- 5 Shamal dust event**
- 6 Harmattan and Bodélé Depression

Shamal dust event

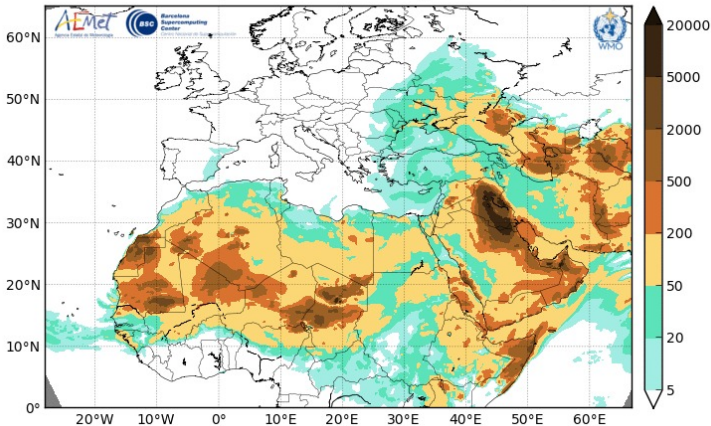


Fuente: By Pcirus - Own work, CC BY-SA 3.0



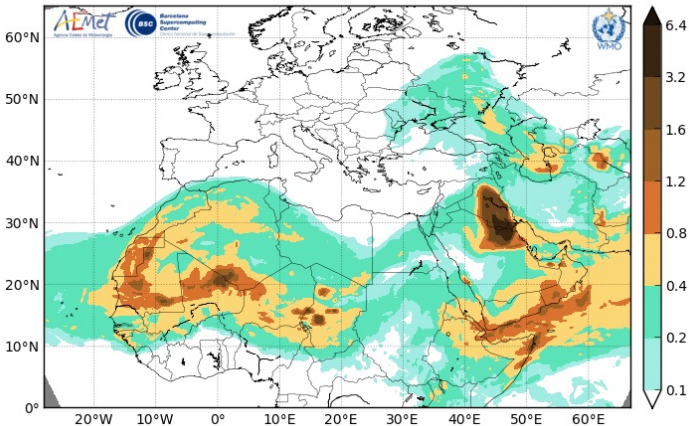
Operational Model Dust Surface Concentration: 26/07/2018

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
 Run: 12h 26 JUL 2018 Valid: 12h 26 JUL 2018 (H+00)

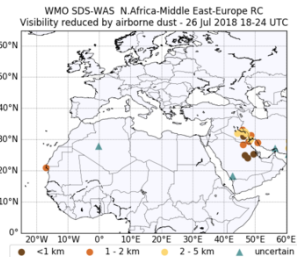
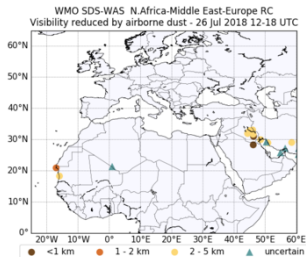
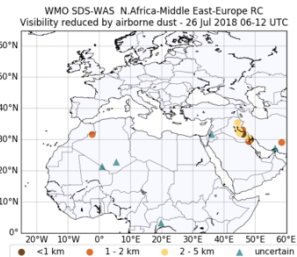
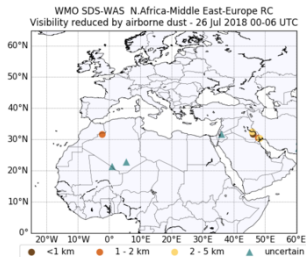


Operational Model Dust AOD: 26/07/2018

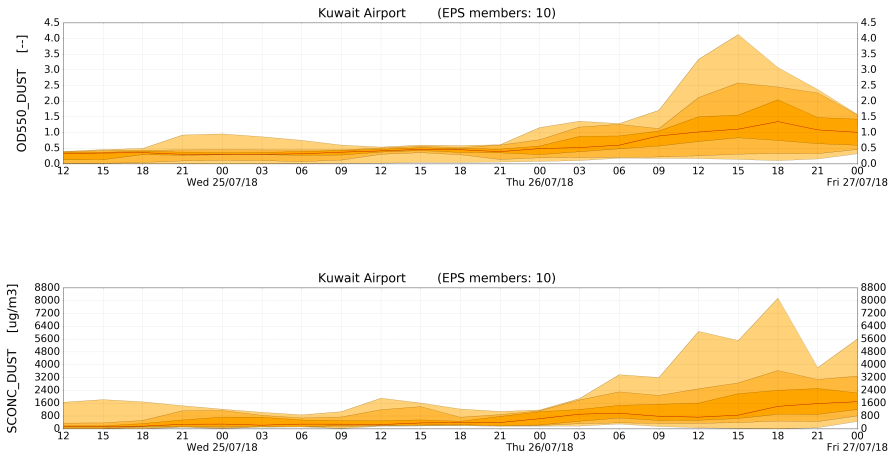
Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 26 JUL 2018 Valid: 12h 26 JUL 2018 (H+00)



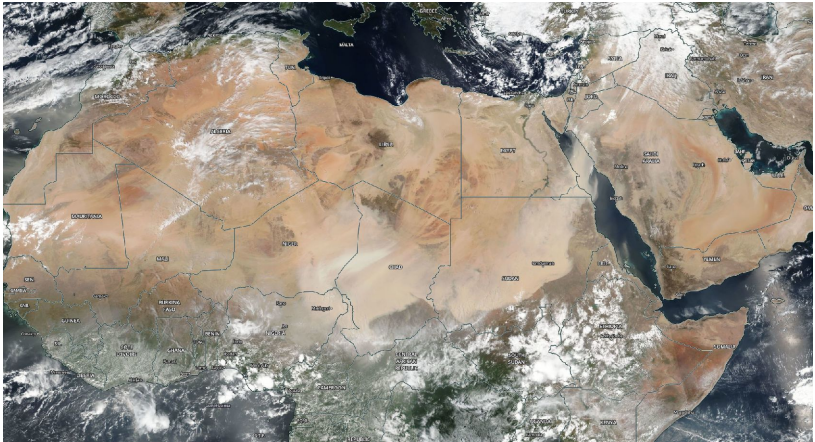
Visibility METARS and SYNOPS 26-27-28-29/07/2018



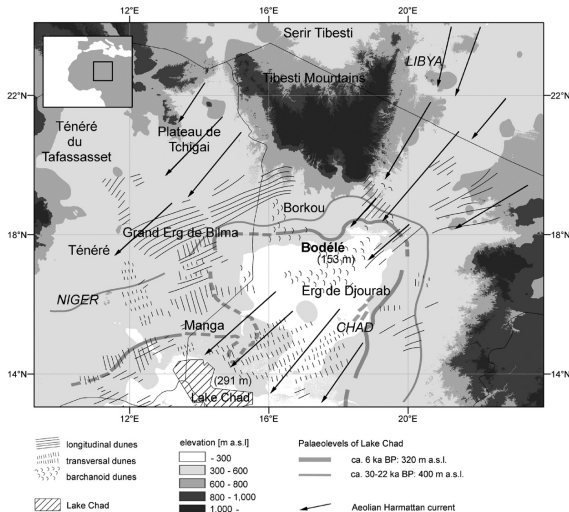
Multimodel: EPSgrams AOD and Dust SFC 26/07/2018



Harmattan and Bodélé Depression

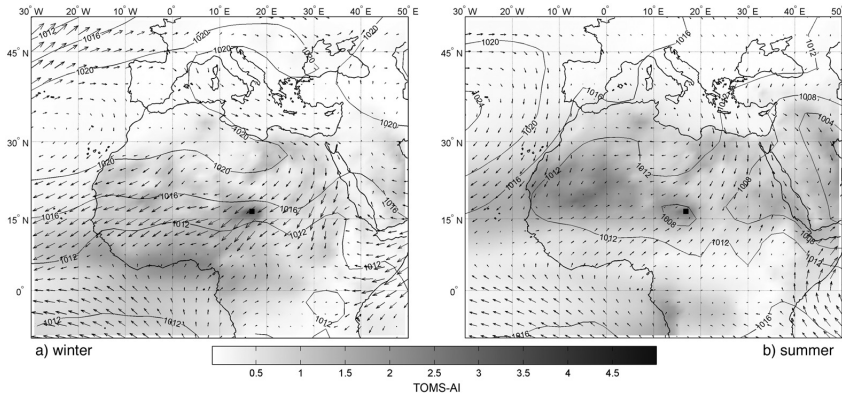


Harmattan and Bodélé Depression



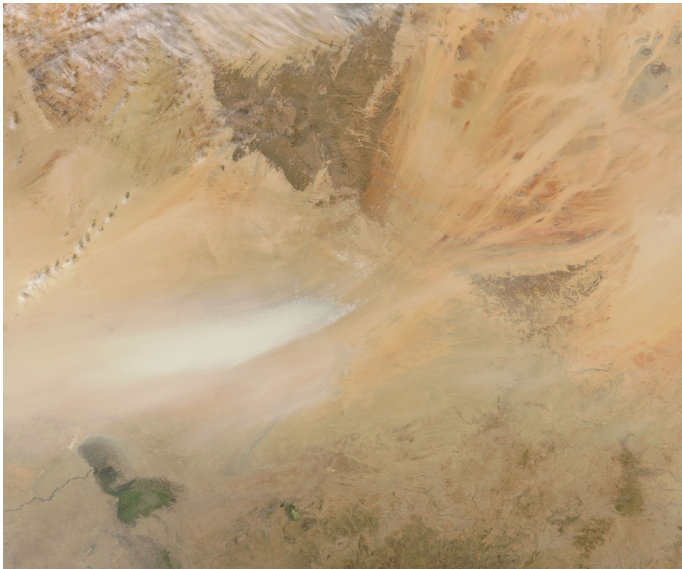
Fuente: Meteorological causes of Harmattan dust in West Africa W. Schwanghart , B. Schütt

Harmattan and Bodélé Depression



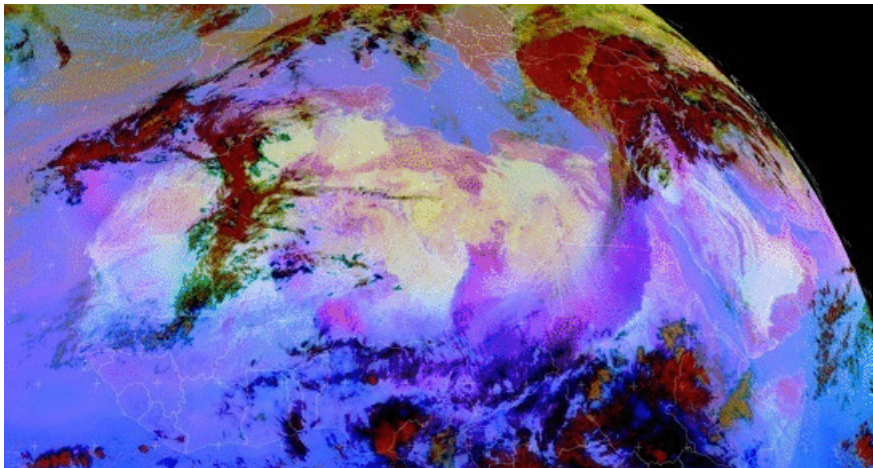
Fuente: Meteorological causes of Harmattan dust in West Africa W. Schwanghart , B. Schütt

Polar satellite Aqua and Terra: Modis 02/01/2007

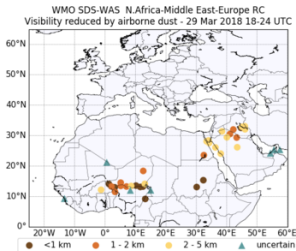
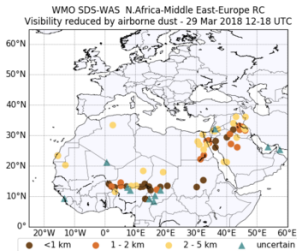
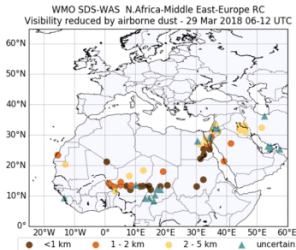
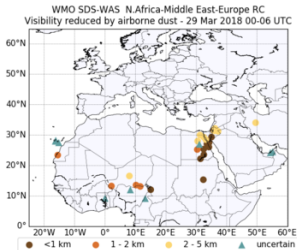


Polar satellite Aqua and Terra: Modis 29/03/2018

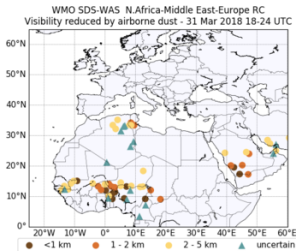
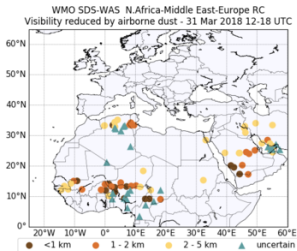
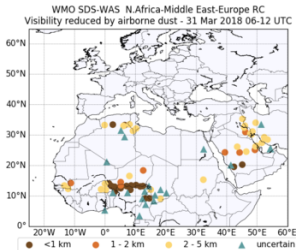
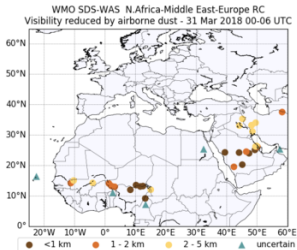




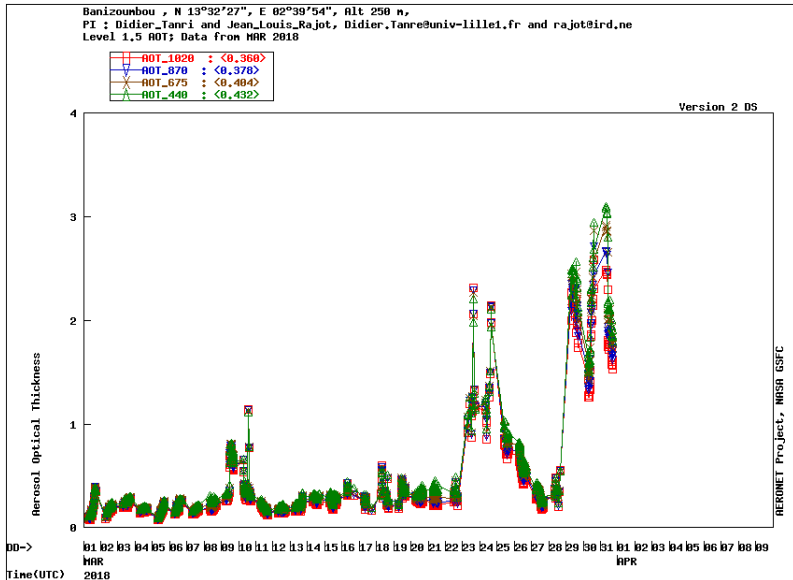
Visibility: METARS and SYNOPS 29/03/2018



Visibility: METARS and SYNOPS 31/03/2018

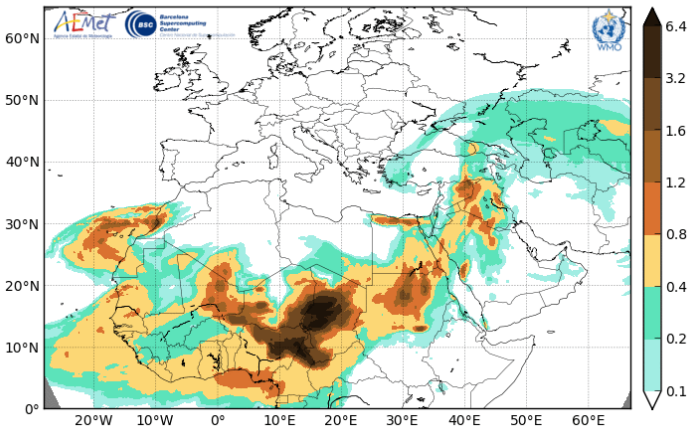


AERONET (Aerosol RObotic NETwork): Fotometros solares



operational Model

Barcelona Dust Forecast Center - <http://dust.aemet.es/>
 NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
 Run: 12h 29 MAR 2018 Valid: 12h 29 MAR 2018 (H+00)



http://sds-was.aemet.es
https://dust.aemet.es



sdsawas@aemet.es