



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación

Dustpredictionmodels

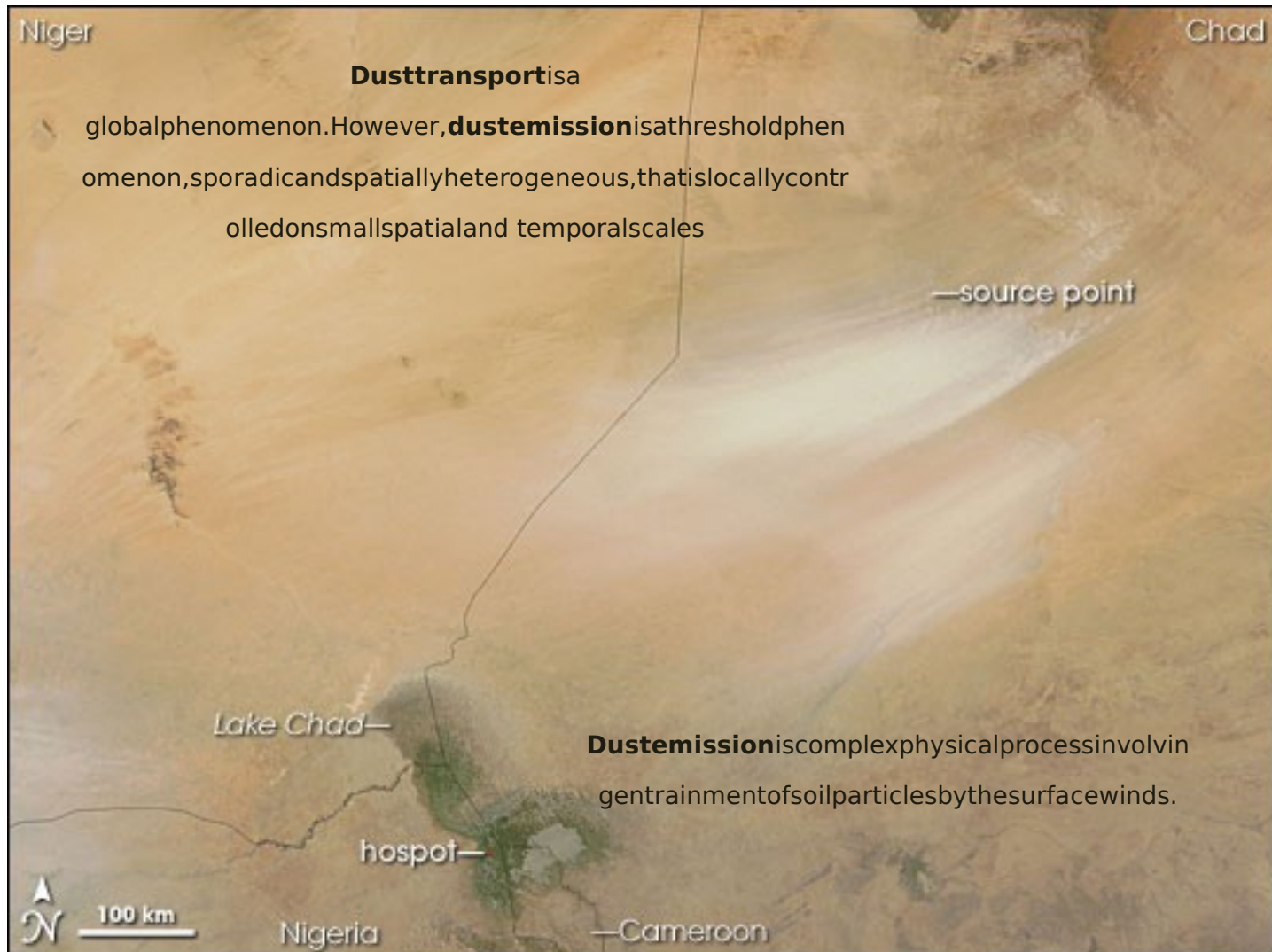
Sara Basart(sara.basart@bsc.es)

EarthSciencesDepartment, BarcelonaSupercomputingCenter

Questions will be welcome!

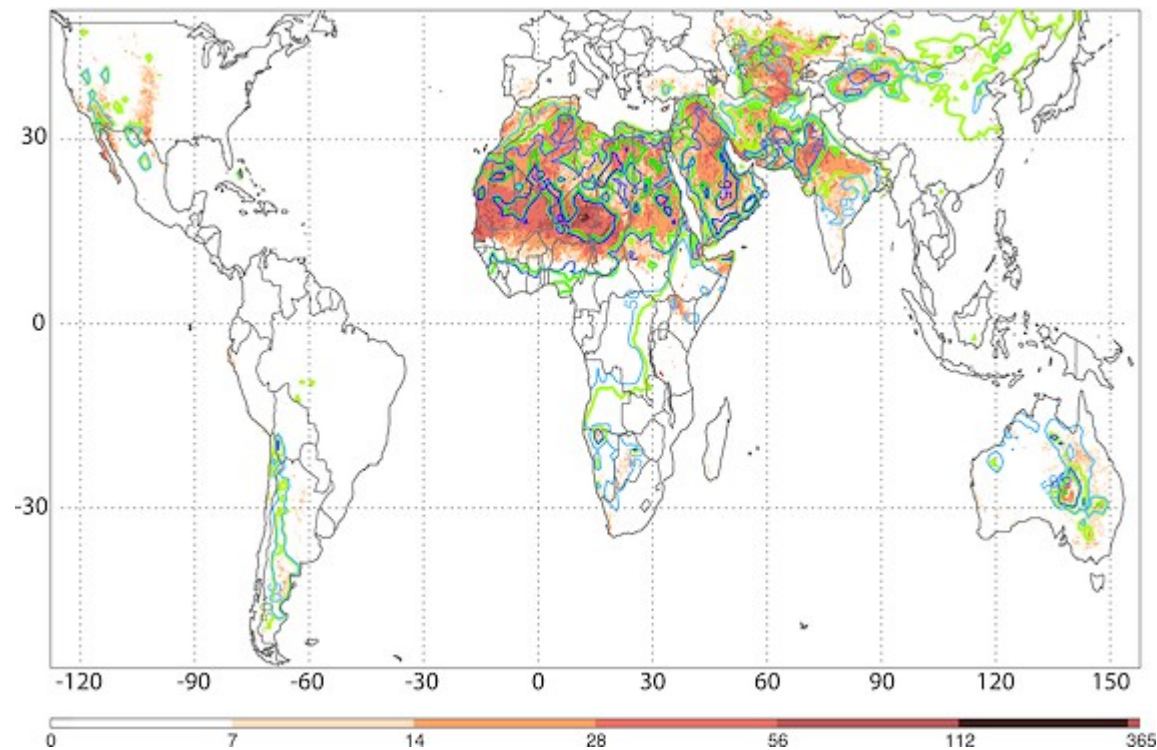


Dust cycle and associated processes



Dust cycle and associated processes

Global-scale attribution of anthropogenic and natural dust sources and their emission rates based on MODIS Deep Blue aerosol products (extracted from Ginoux et al., 2012)



Natural dust sources globally account for 75% of emissions; anthropogenic sources account for 25%.

Types of dust storms:

Synoptic dust storms (large scale weather systems)

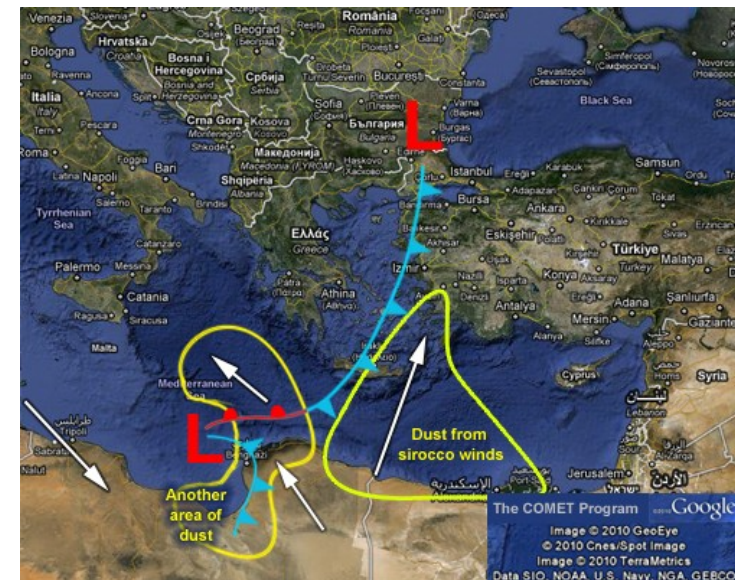
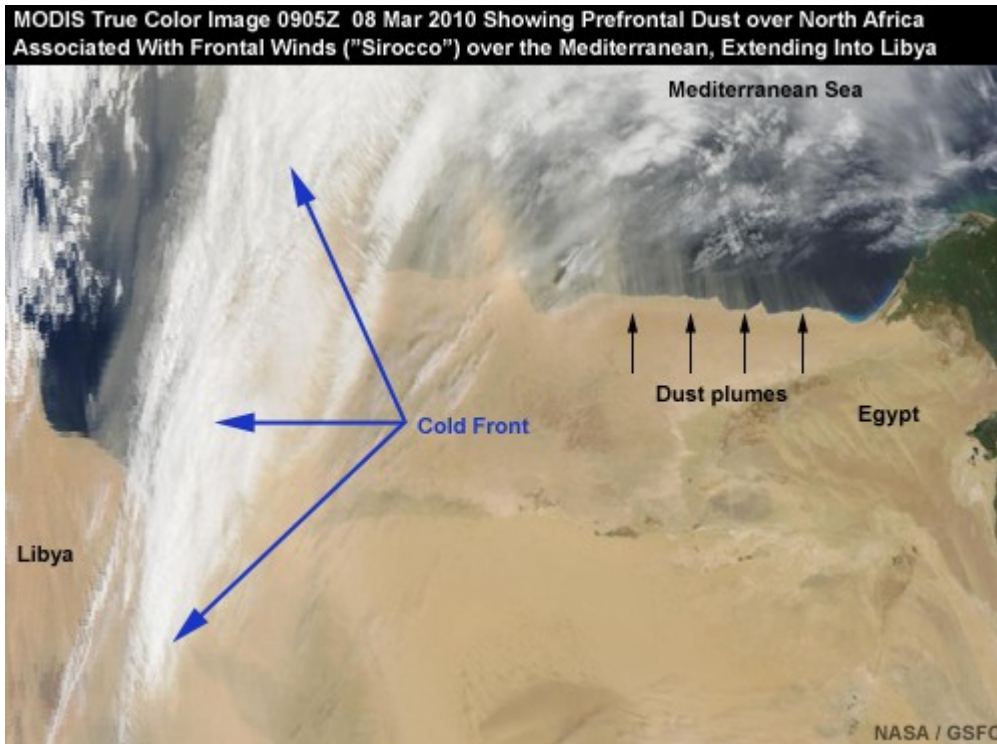
- Prefrontal winds
- Postfrontal winds
- Large-scale Trade winds
- ...

Mesoscale dust storms

- Downslope winds
- Gap flow
- Convection and Haboobs
- Inversion downburst storms
- ...

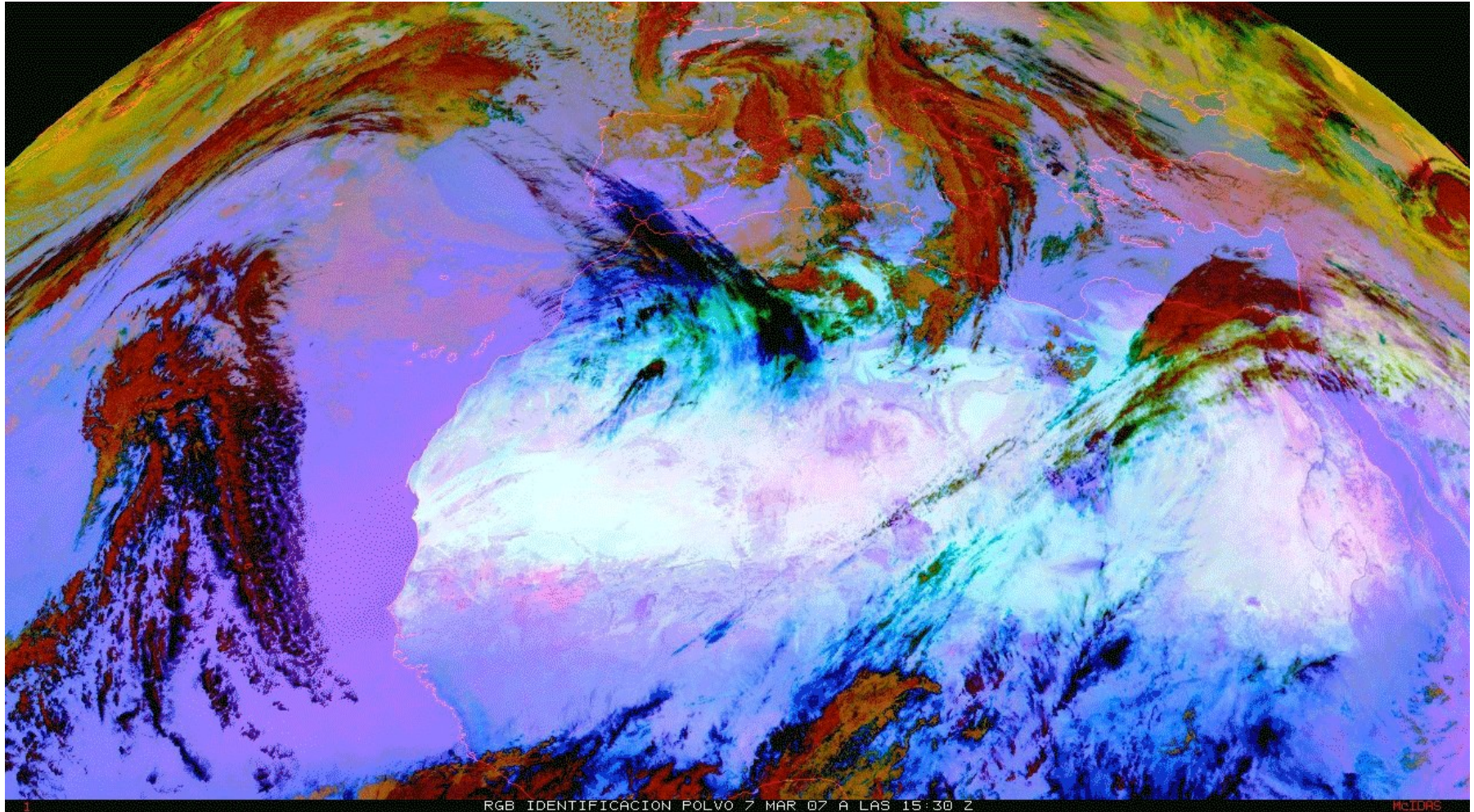
Dust cycle and associated processes

Synoptic dust storms: Pre-frontal



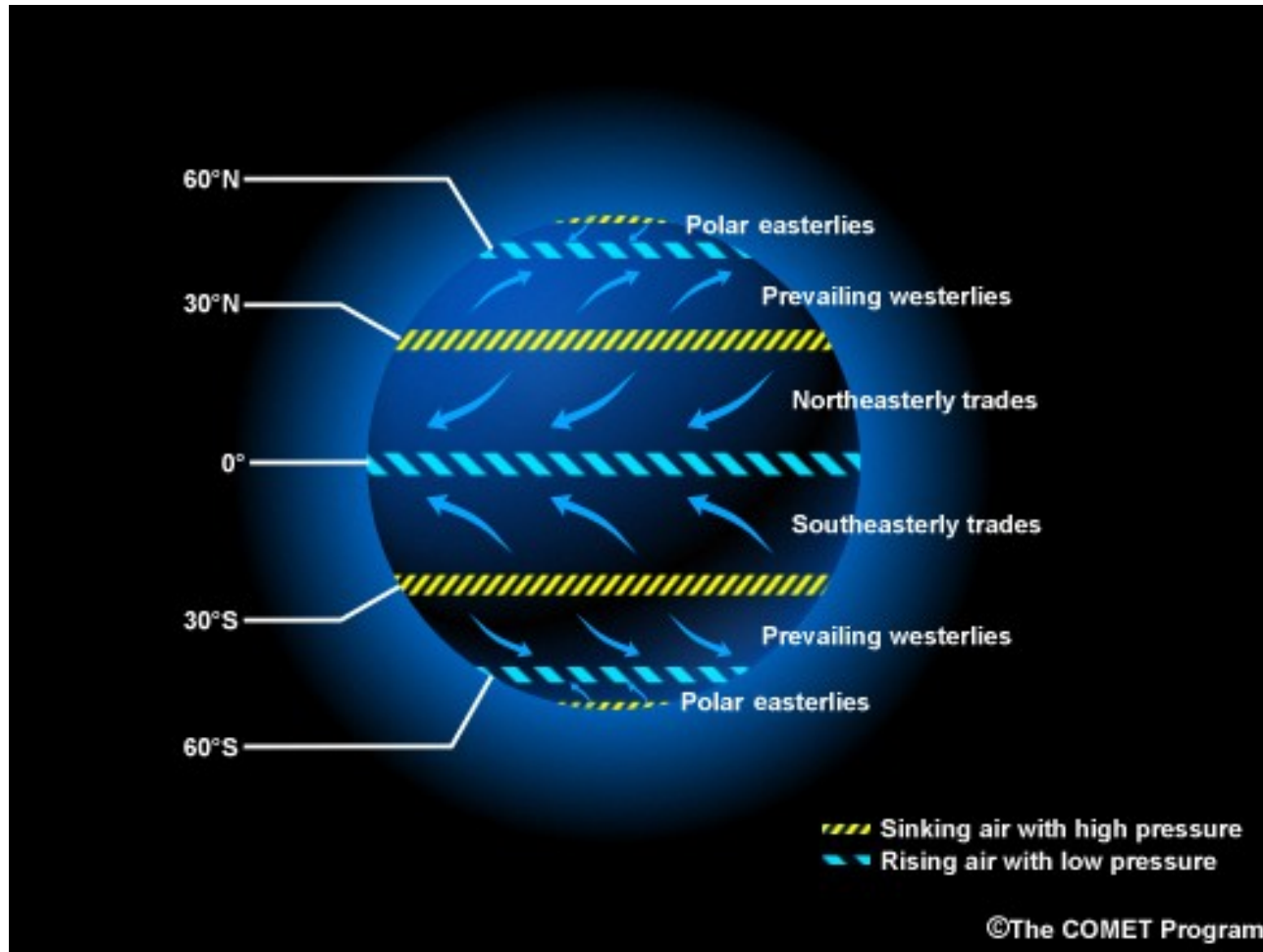
Dust cycle and associated processes

Synoptic dust storms: Post-frontal



Dust cycle and associated processes

Synoptic dust storms: Large-scale trade winds



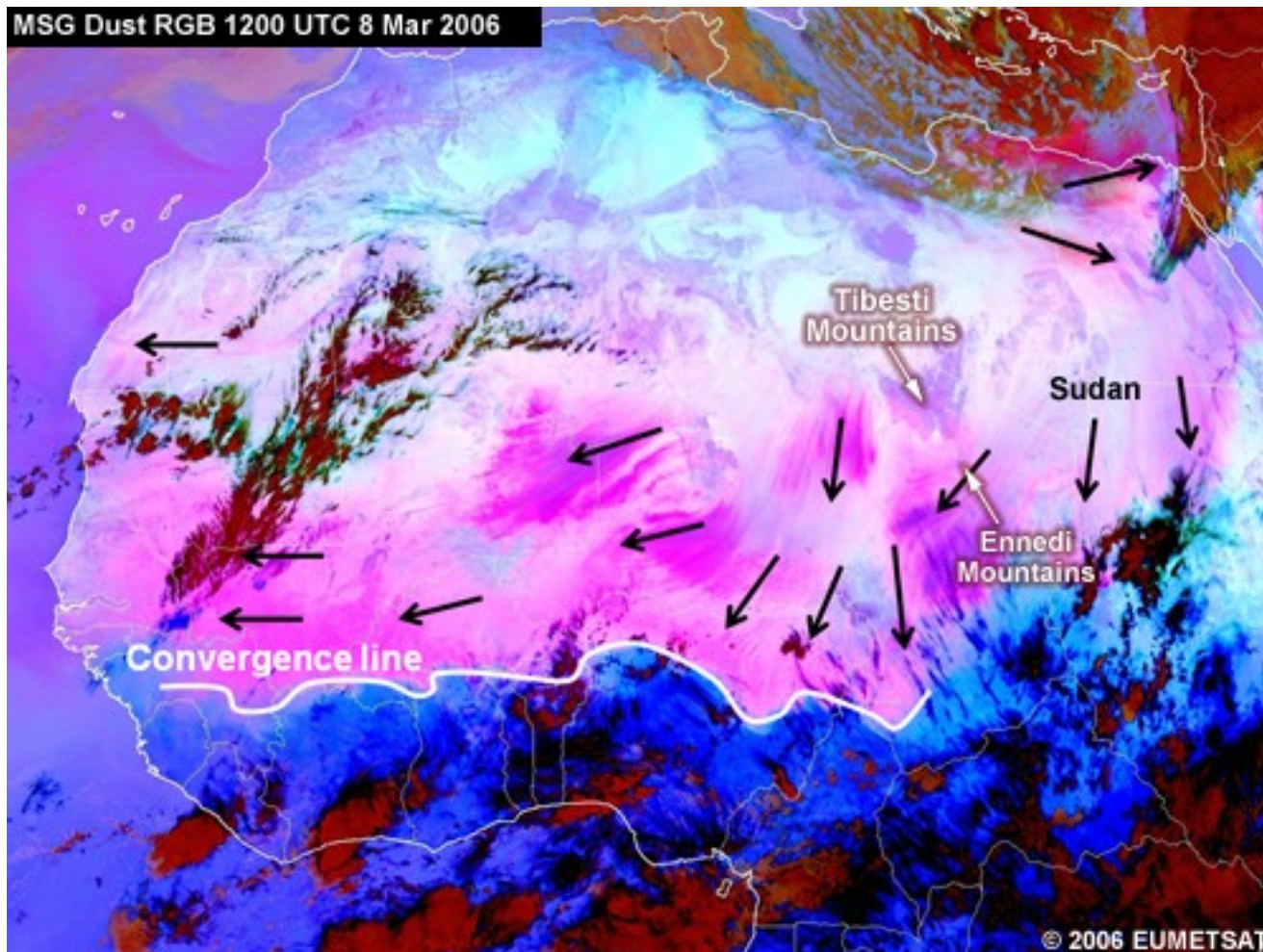
www.bsc.es



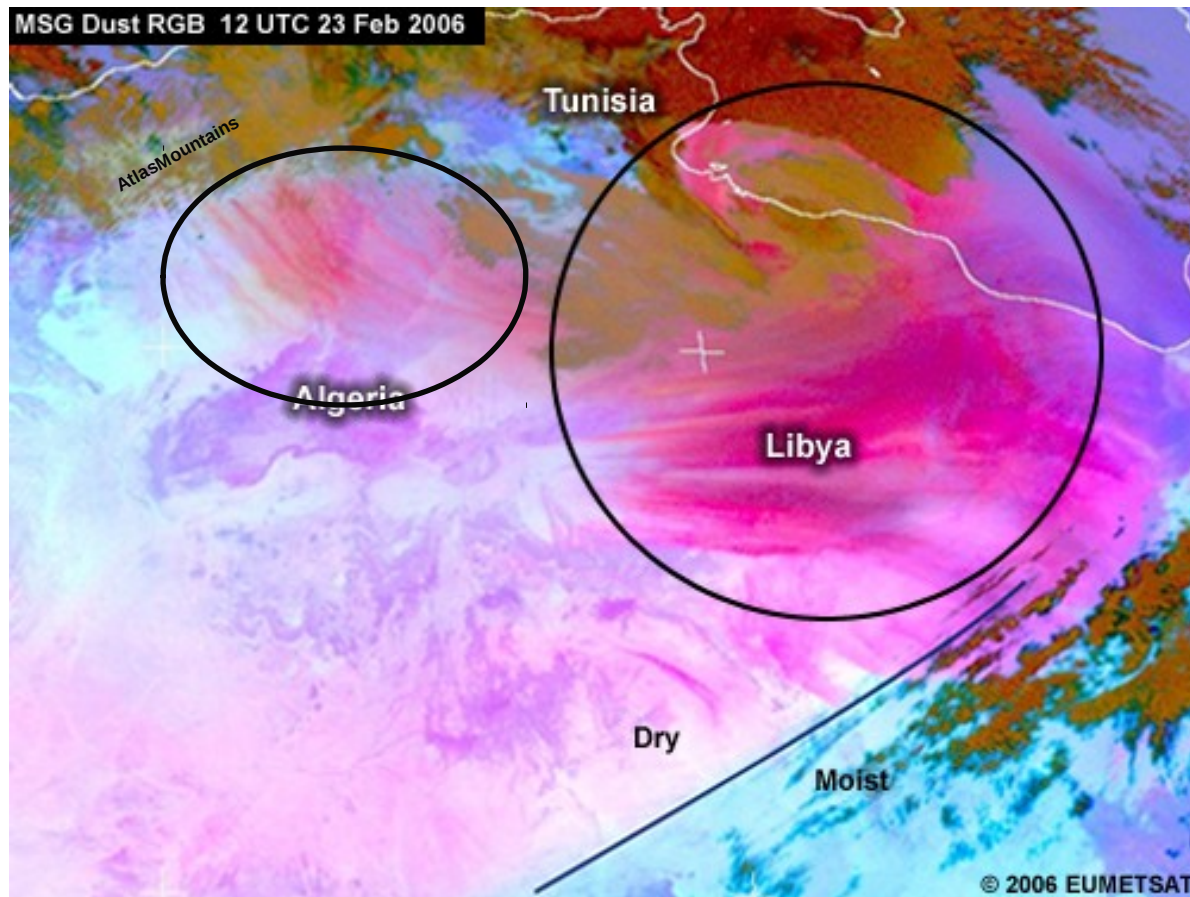
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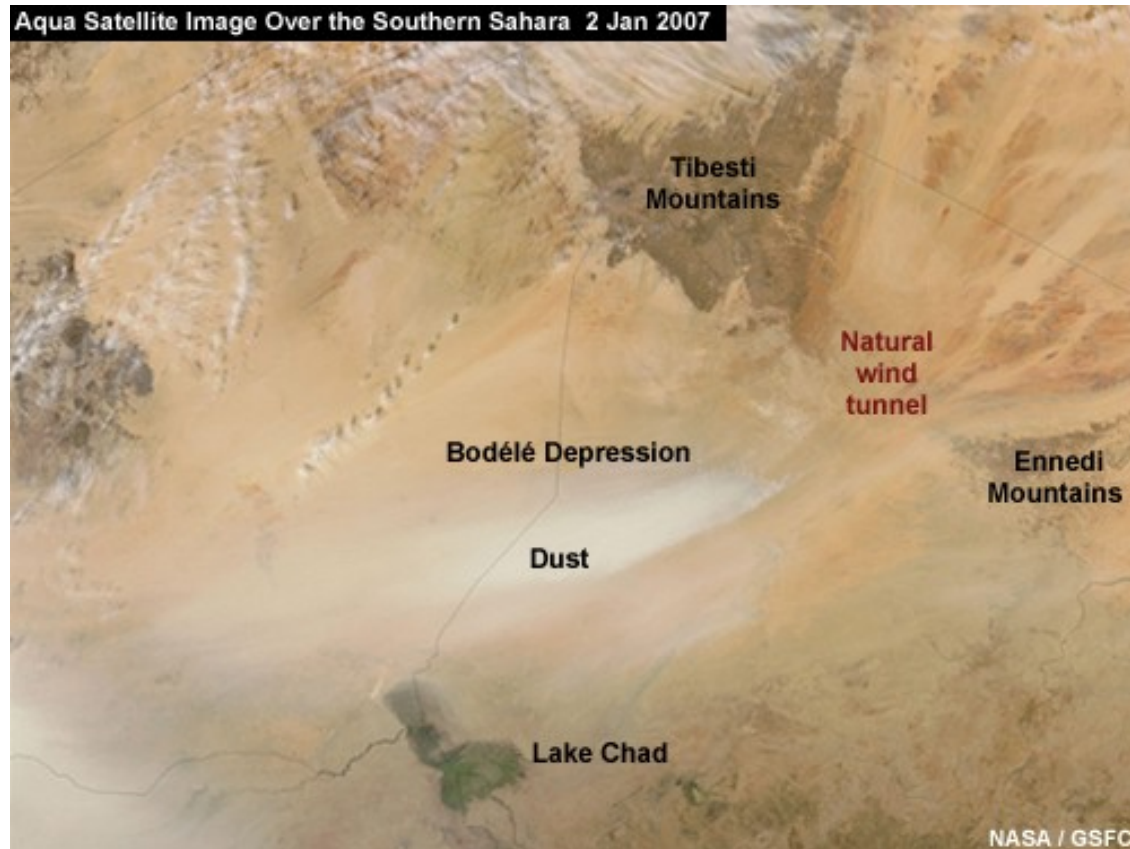
Synoptic dust storms: Large-scale trade winds



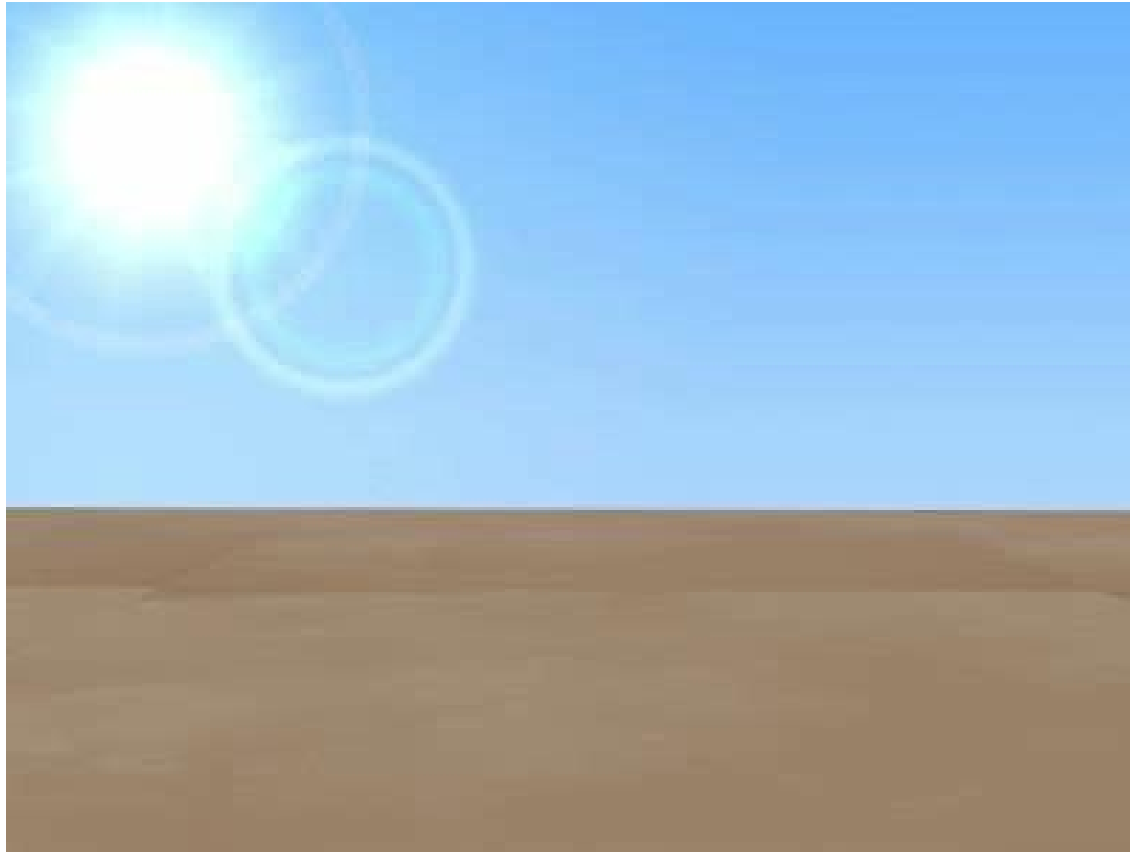
Mesoscaleduststorms:Downslopewinds



Mesoscaleduststorms: Gapflow



Mesoscaleduststorms:Dustdevils(convection)



Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

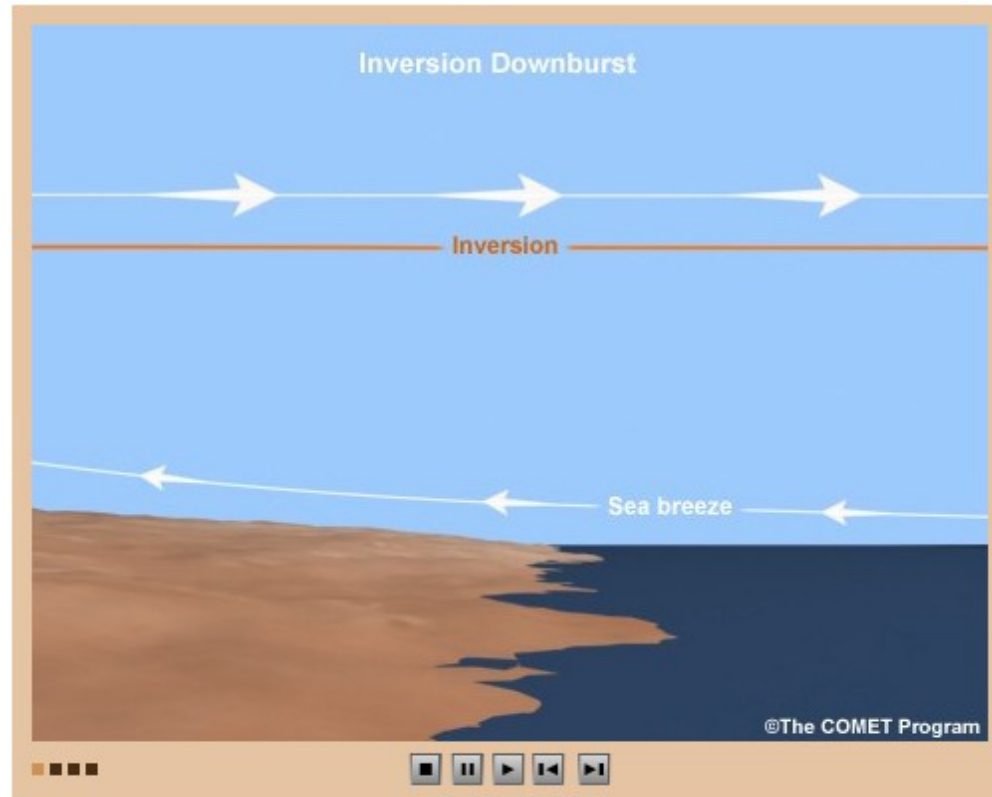
Mesoscale dust storms: Haboobs



Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

Dust cycle and associated processes

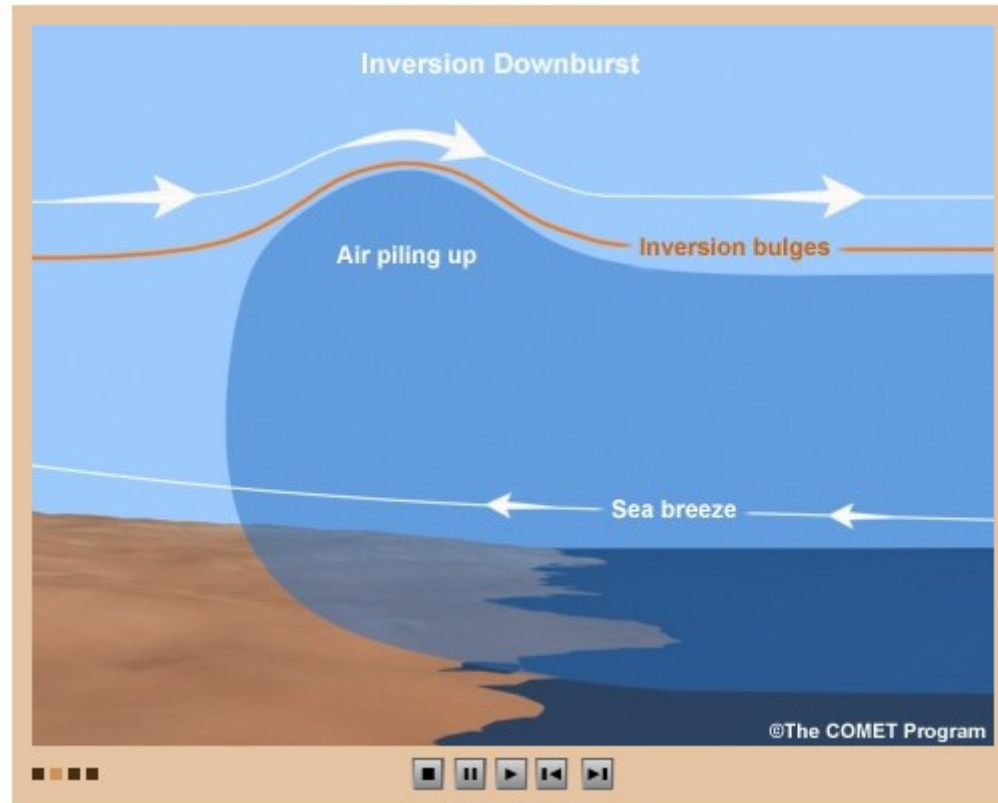
Mesoscale dust storms: Inversion downbursts



Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

Dust cycle and associated processes

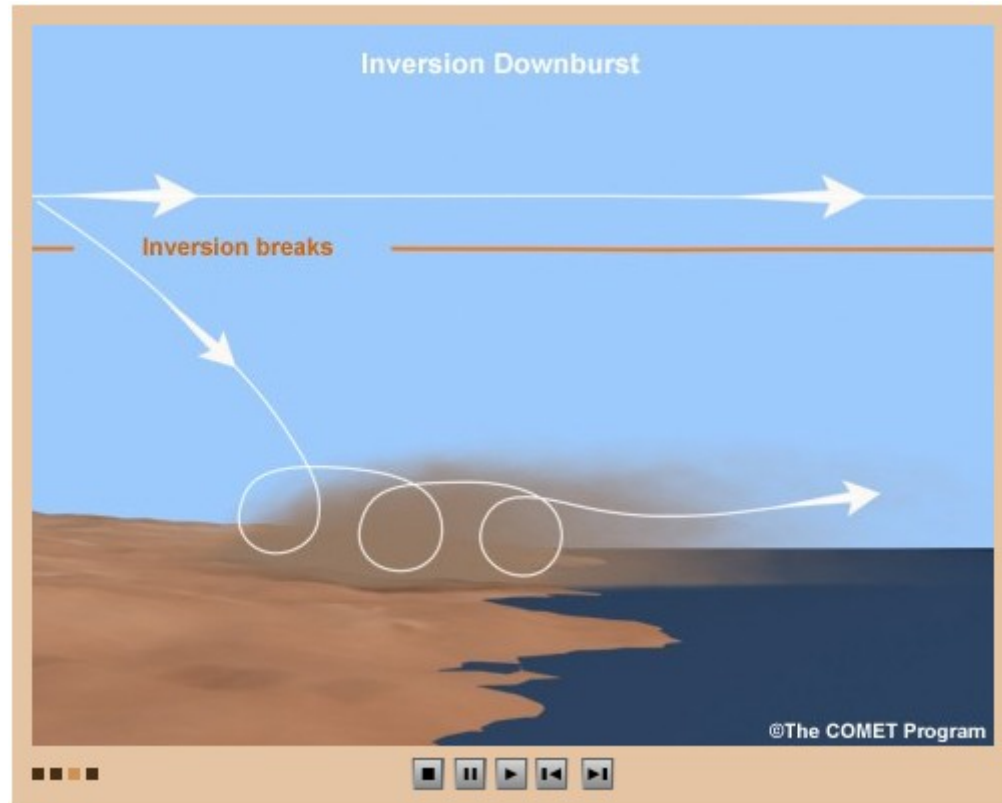
Mesoscale dust storms: Inversion downbursts



Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

Dust cycle and associated processes

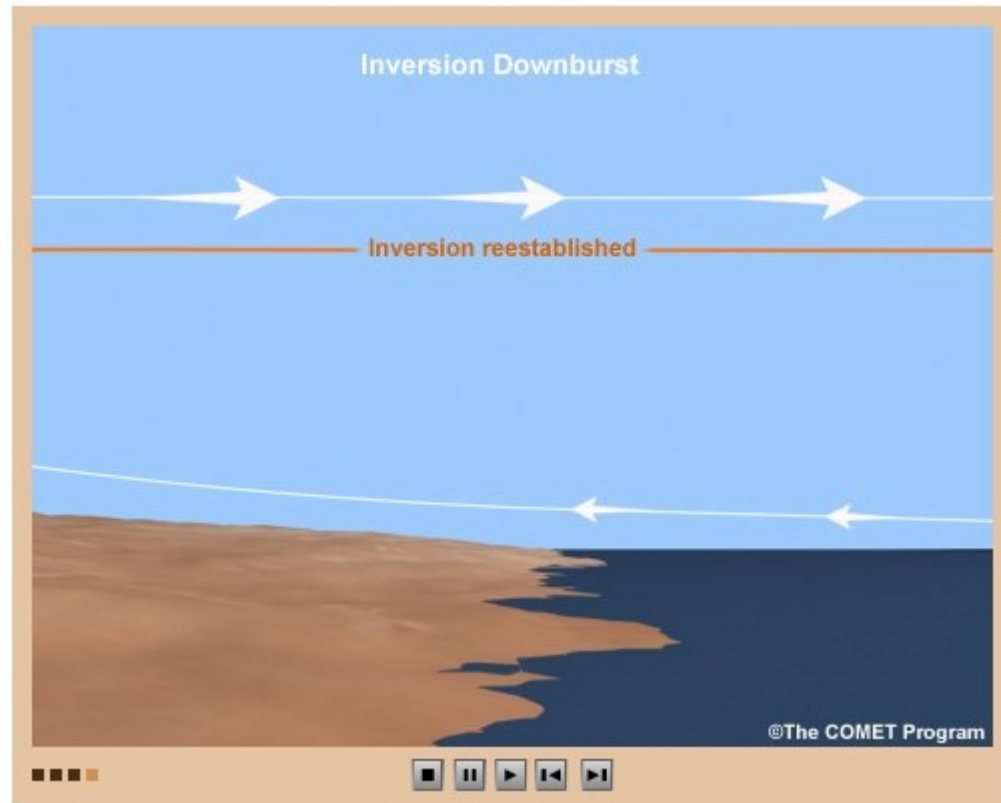
Mesoscaleduststorms:Inversiondownbursts



Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

Dust cycle and associated processes

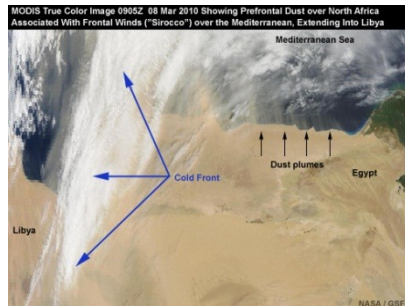
Mesoscaleduststorms:Inversiondownbursts



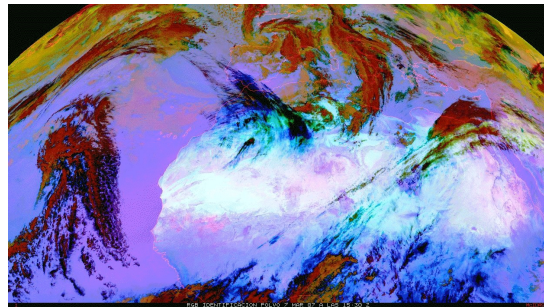
Movie from the COMET program at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR)

Dust cycle and associated processes: Types of dust storms

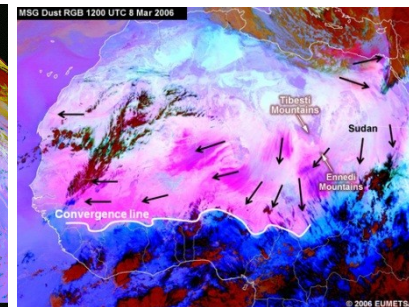
Synoptic dust storms (large scale weather systems)



Pre-frontal winds

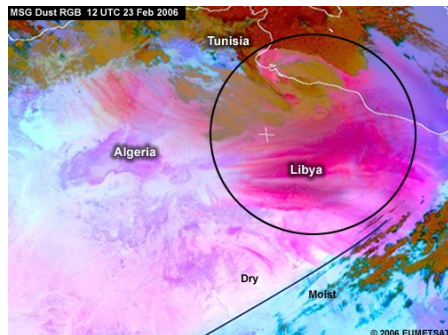


Post-frontal winds

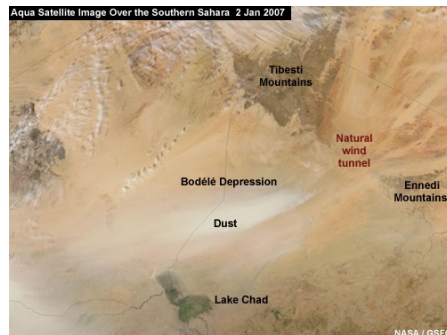


Large-scale trade winds

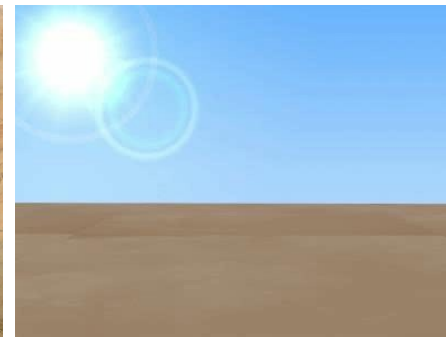
Mesoscale dust storms



Downslope winds



Gapflow



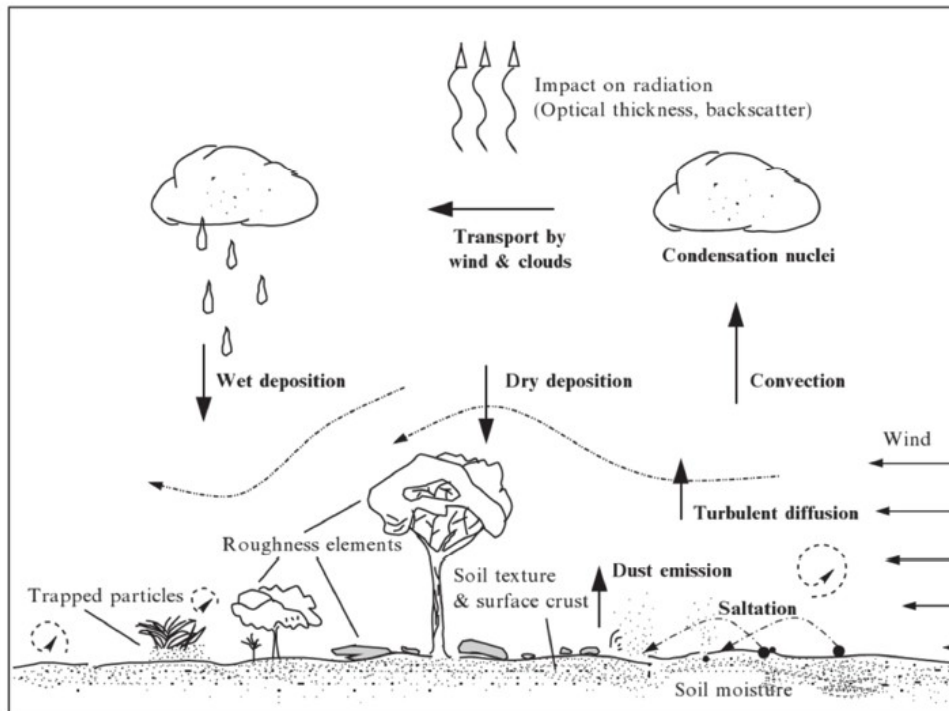
Convection & Inversion downbursts



Haboobs

Dustforecasting models

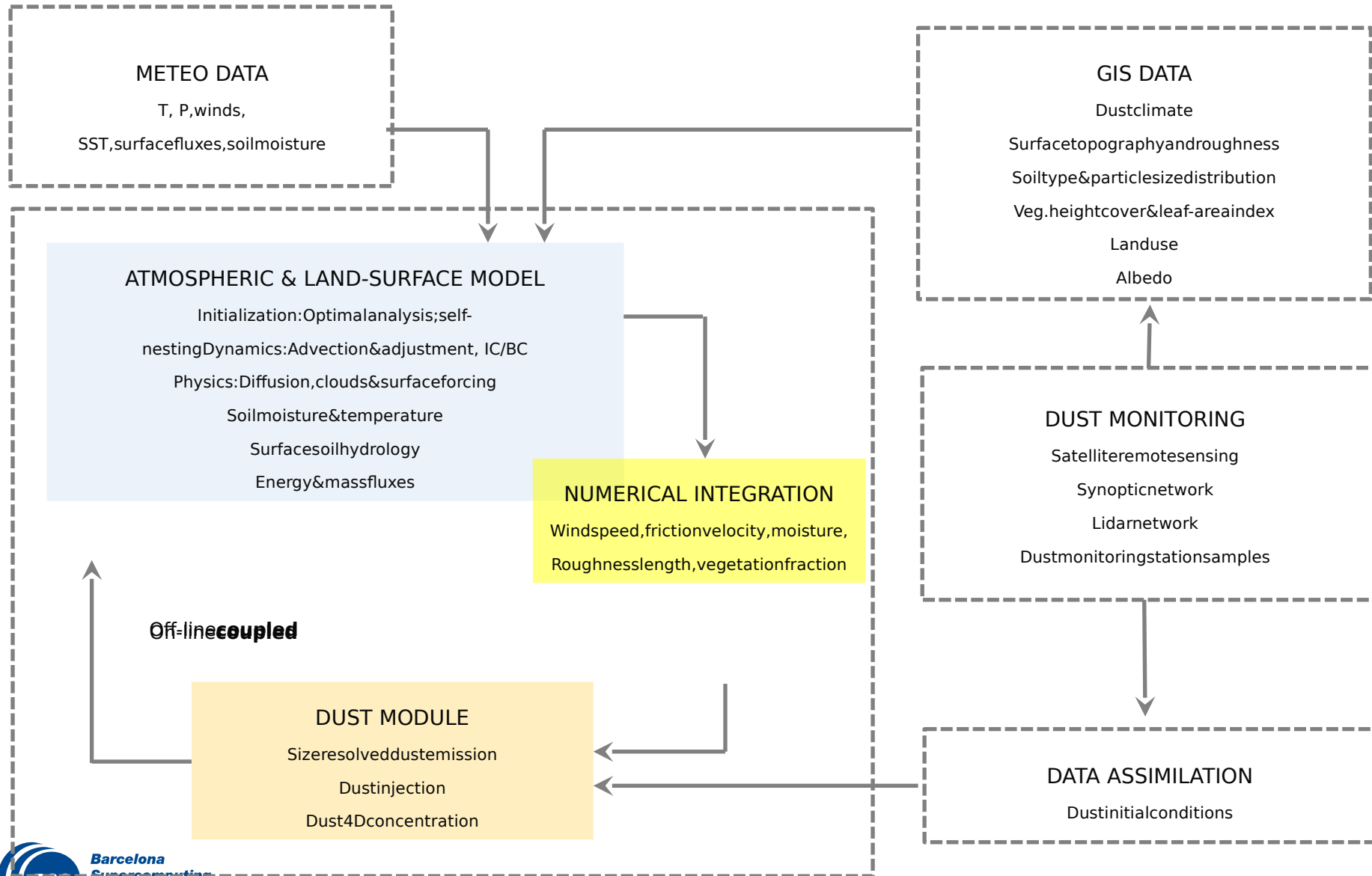
Dustmodels are a mathematical representation of atmospheric dust cycle.



Extracted from Shao (2008)

- ✓ To complement dust-related observations, filling the temporal and spatial gaps of the measurements.
- ✓ To help us to understand the dust processes and their interaction with climate and ecosystems.
- ✓ To predict the impact of dust on surface level concentrations used as **SHORT-TERM FORECASTING TOOLS** (3-5 days ahead)

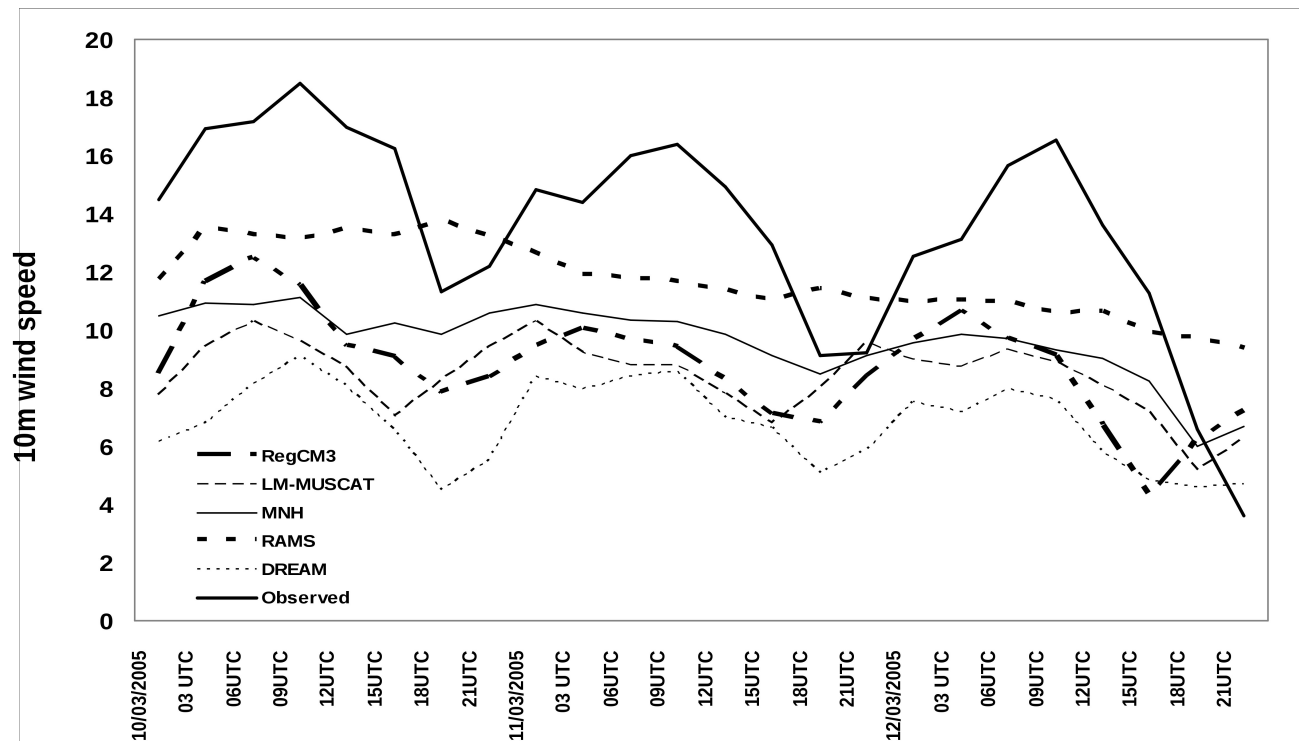
Dust forecasting models



Dust forecasting models

Experimental campaigns: BODEX 2005 (Todd et al. 2008, JGR)

First regional model intercomparison in the Bodélé hot spot



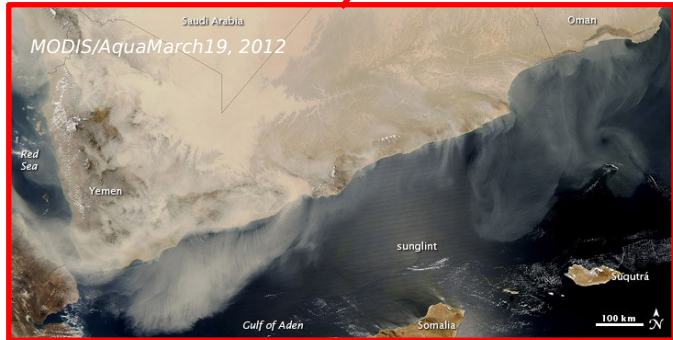
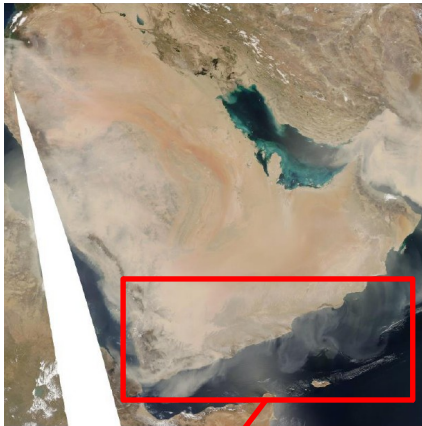
Strong differences between models!!!! → Meteorology and emissions scheme

March 2012, West Asia

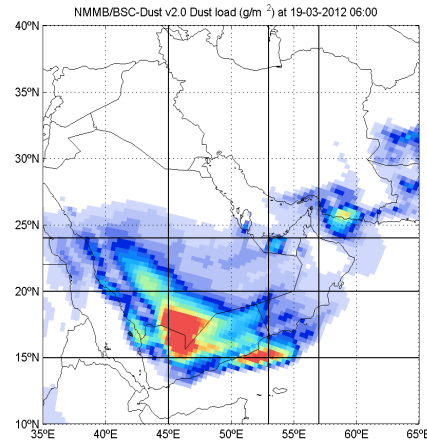
Dust forecasting models

Impact of the topography on dust transport

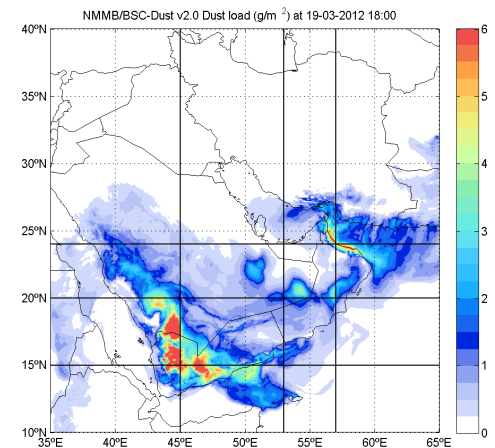
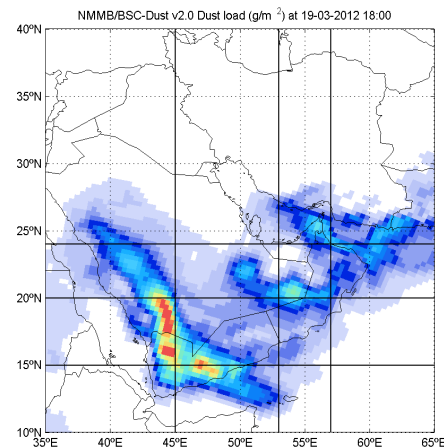
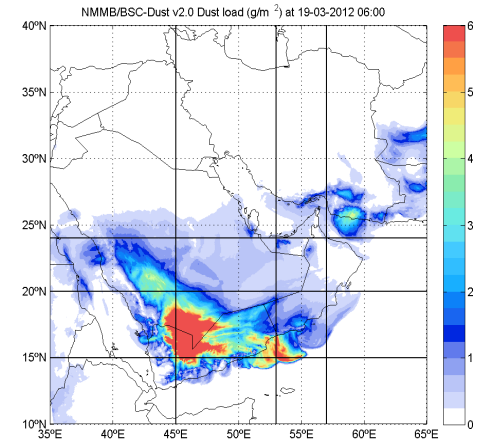
The impact of model resolution in dust propagation in a complex terrain region such as West Asia: **19th March 2012**



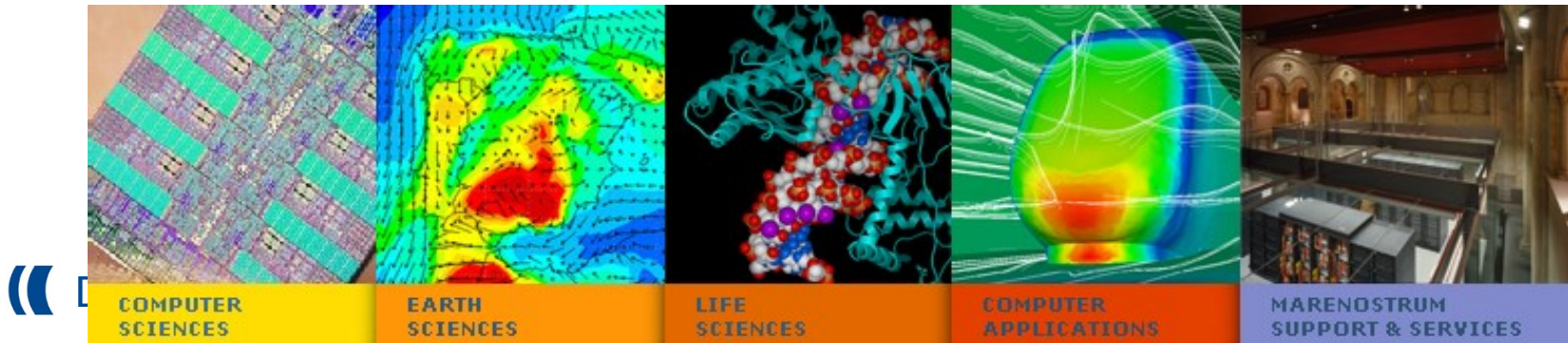
Exp. 0.33° x 0.33°



Exp. 0.03° x 0.03°



ES-BSC: Mineral Dust Modelling



— BSC-DREAM8D

<http://www.bsc.es/projects/earthscience/BSC-DREAM/>

— NMMB/BSC-Dust:

<http://www.bsc.es/projects/earthscience/NMMB-BSC-DUST/>



ES-BSC: WMO Dust Centers

NORTHERN AFRICA-MIDDLE EAST-EUROPE (NA-ME-E) REGIONAL CENTER
WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

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World Meteorological Organization
AEMet
BSC Barcelona Supercomputing Center

WMO SDS-WAS || Asia Regional Center

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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

available for dust forecast

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 || Africa-Middle East-Europe RC
M2014M Dust Surface Concentration (µg/m³)
Run: 11h 25 FEB 2013 Valid: 18h 27 FEB 2013 (H+54)

0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000

30°N 40°N 50°N 60°N 70°N 80°N 90°N

0° 10°E 20°E 30°E 40°E 50°E 60°E 70°E 80°E 90°E

0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000

30°W 20°W 10°W 0° 10°E 20°E 30°E 40°E 50°E 60°E 70°E 80°E 90°E

RESEARCH

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



BARCELONA DUST FORECAST CENTER

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WMO SDS-WAS || NA-ME-E Regional Center

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LATEST NEWS

Barcelona Dust Forecast Center starts operations

The Center will release operational dust forecasts for Northern Africa, Middle East and Europe

Read More

Barcelona Dust Forecast Center
NMMB/BSC-Dust Res: 0.1°x0.1° Dust Surface Conc. (µg/m³)
Run: 12h 19 MAY 2014 Valid: 18h 20 MAY 2014 (H+30)

0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000

30°N 40°N 50°N 60°N 70°N 80°N 90°N

0° 10°E 20°E 30°E 40°E 50°E 60°E 70°E 80°E 90°E

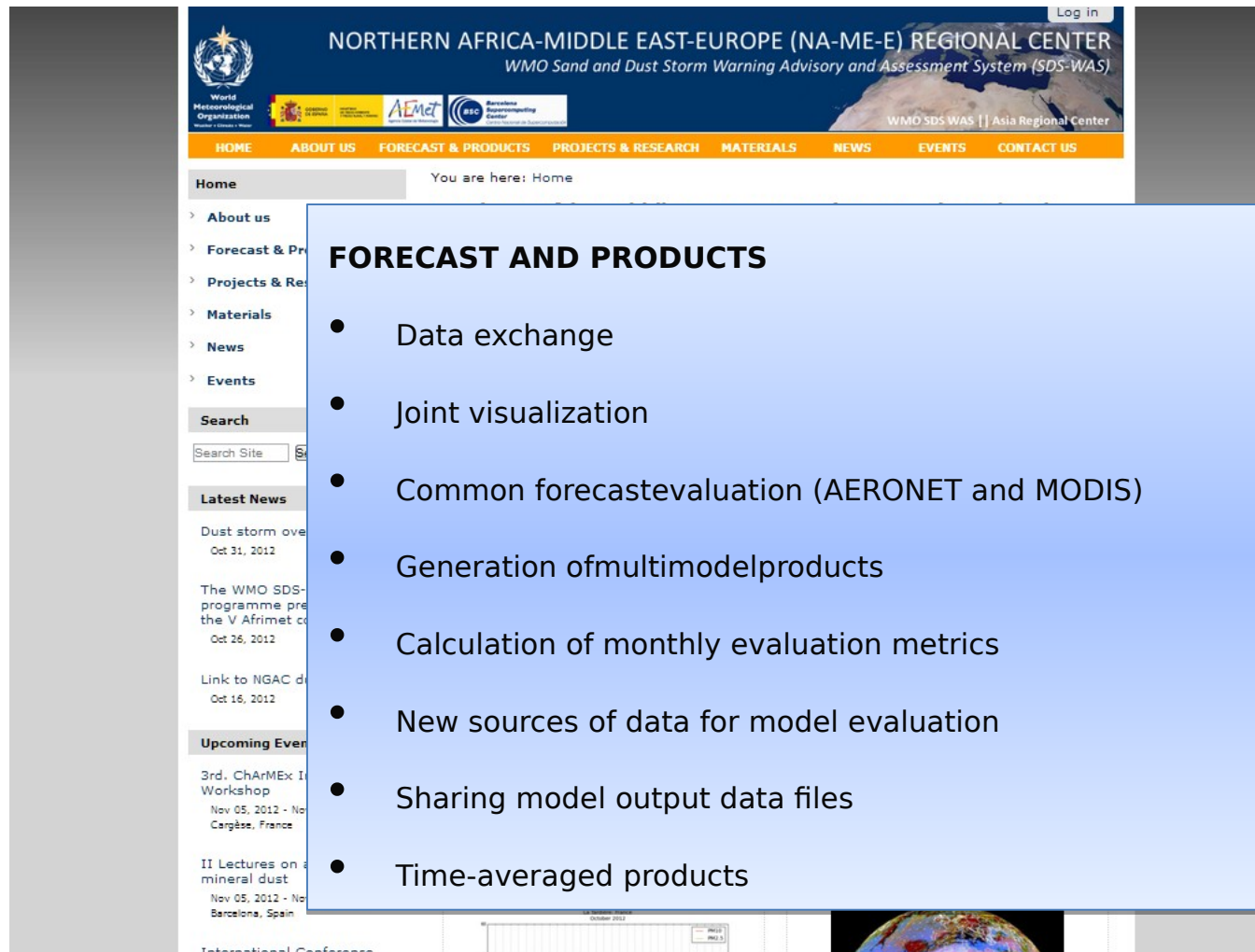
0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000

30°W 20°W 10°W 0° 10°E 20°E 30°E 40°E 50°E 60°E 70°E 80°E 90°E

Dust forecast

Latest dust forecast for Northern Africa, Middle East and Europe

[Check it here](#)



The screenshot shows the website for the Northern Africa-Middle East-Europe (NA-ME-E) Regional Center of the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). The header includes logos for the World Meteorological Organization, AEMET, and the Barcelona Supercomputing Center. A navigation bar lists: HOME, ABOUT US, FORECAST & PRODUCTS, PROJECTS & RESEARCH, MATERIALS, NEWS, EVENTS, and CONTACT US. The main content area is partially obscured by a large blue box with the title "FORECAST AND PRODUCTS" and a bulleted list of features. The left sidebar contains links to "About us", "Forecast & Products", "Projects & Research", "Materials", "News", and "Events", along with a search bar and "Latest News" and "Upcoming Events" sections.

FORECAST AND PRODUCTS

- Data exchange
- Joint visualization
- Common forecast evaluation (AERONET and MODIS)
- Generation of multimodel products
- Calculation of monthly evaluation metrics
- New sources of data for model evaluation
- Sharing model output data files
- Time-averaged products

SDS-WAS:Dustmodels



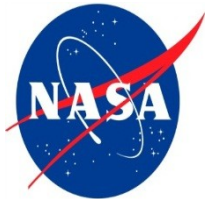
LMD



LSCE



Met Office



Consiglio
Nazionale delle
Ricerche



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Supercomputing
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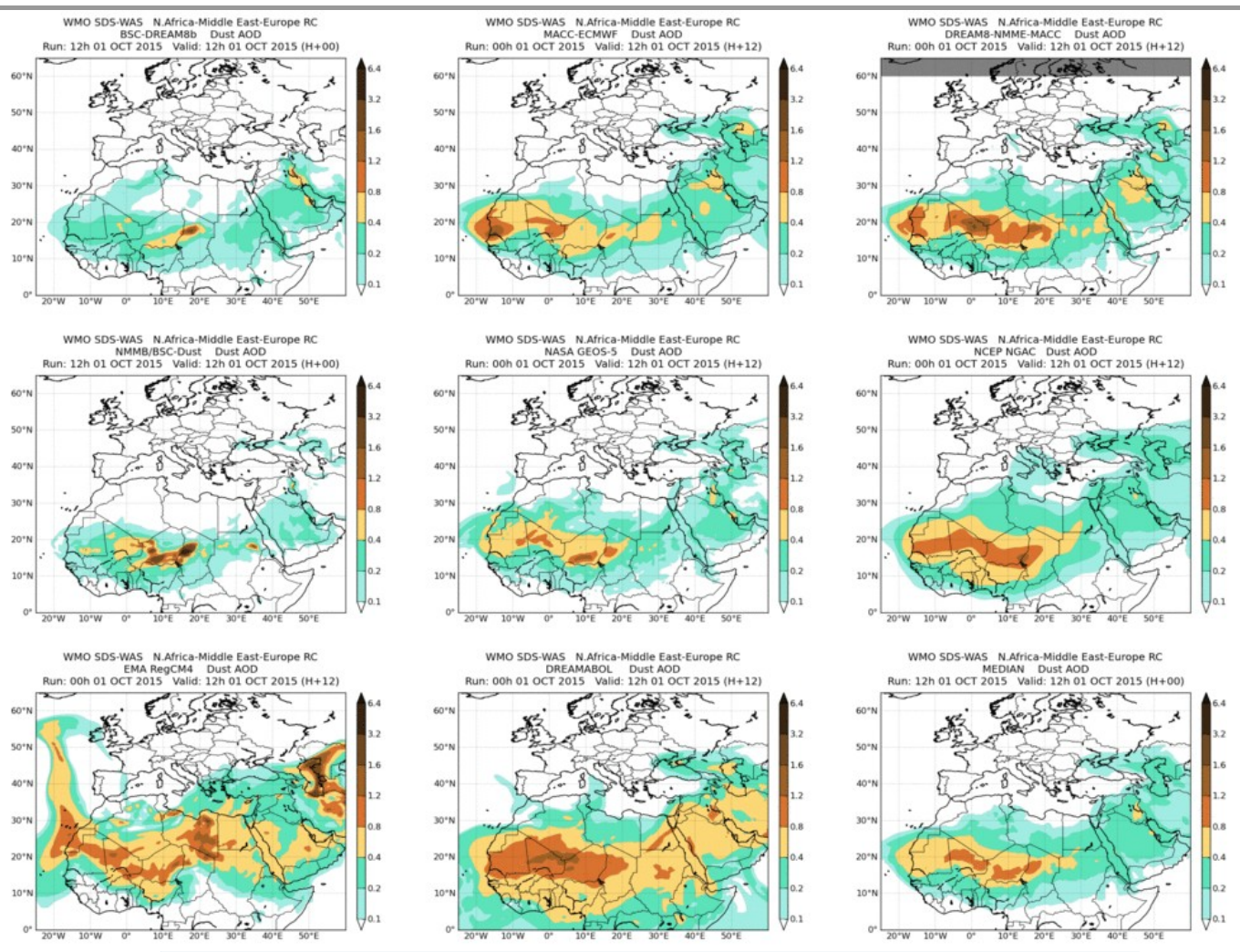
Monitoring atmospheric
composition & climate



SEEVCCC

MODEL	RUN TIME	DOMAIN	DATA ASSIMILATION
BSC-DREAM8b	12	Regional	No
CHIMERE	00	Regional	No
LMDzT-INCA	00	Global	No
MACC	00	Global	MODIS AOD
DREAM-NMME-MACC	12	Regional	MACCAnalysis
NMMB/BSC-Dust	12	Regional	No
MetUM	00	Global	MODIS AOD
GEOS-5	00	Global	MODISreflectances
NGAC	00	Global	No
EMA REG CM4	12	Regional	No
DREAMABOL	12	Regional	No

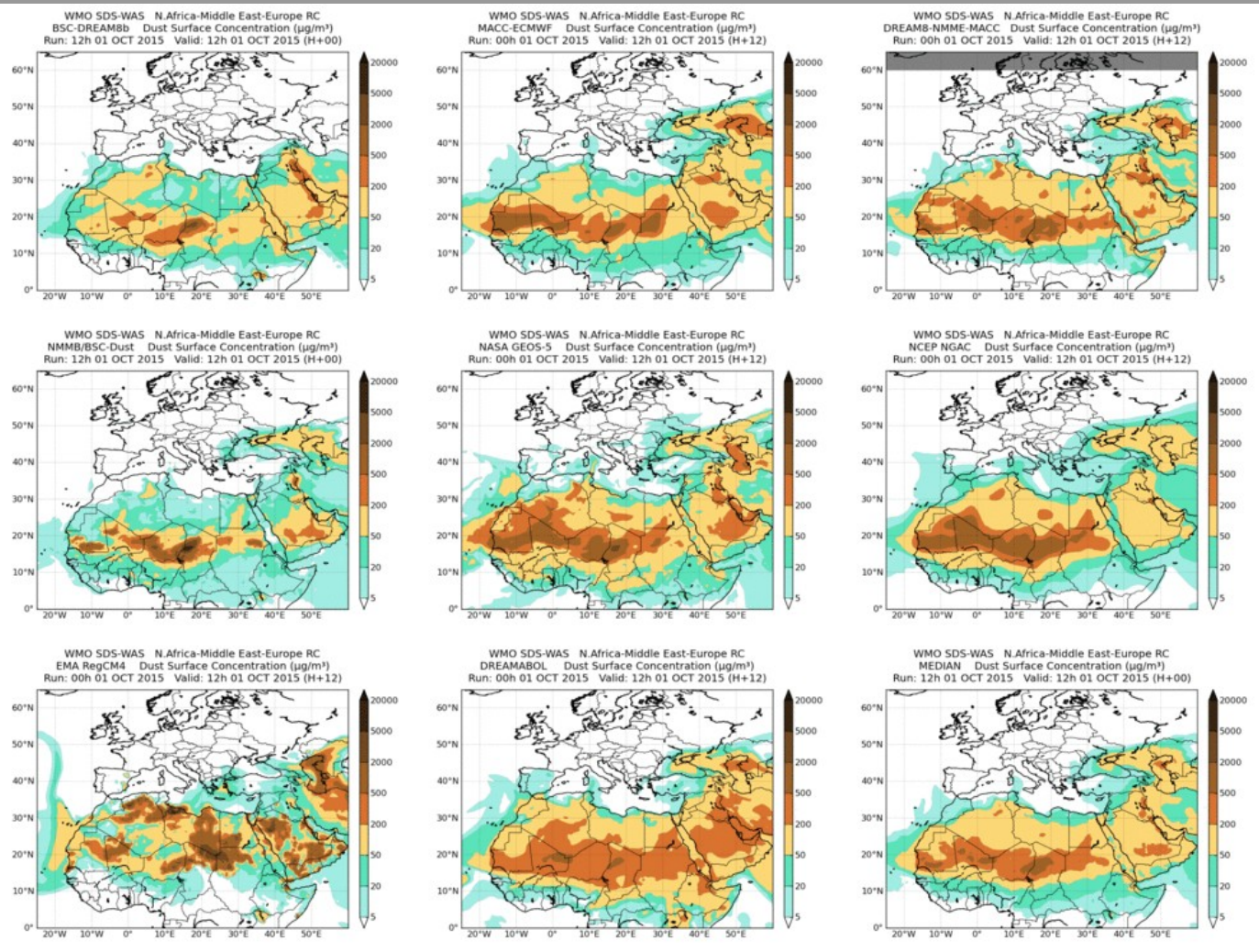
SDS-WAS:AODjointvisualization



AOD at 550nm

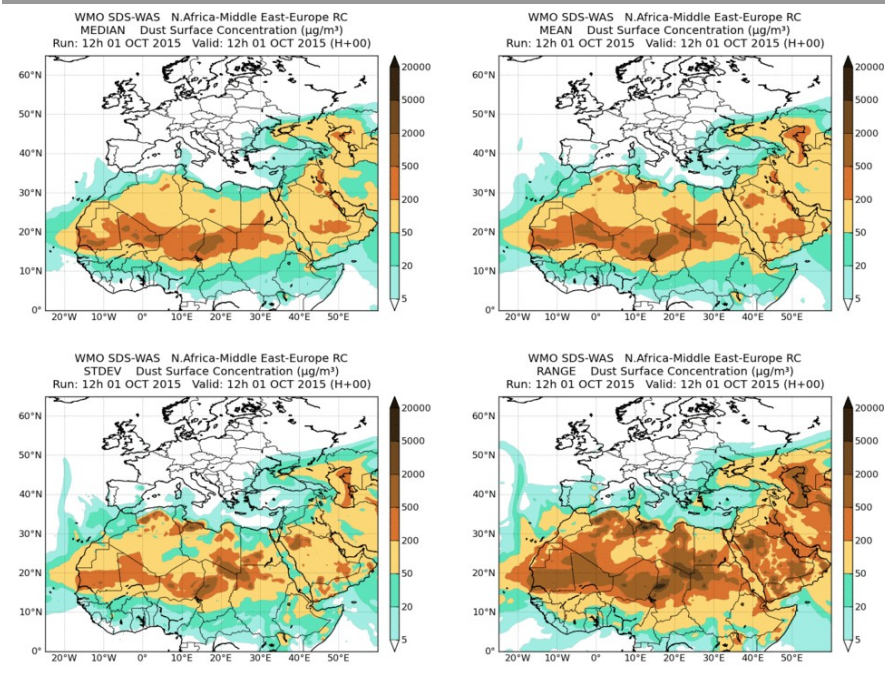
from 1-Oct-2015 12:00 to 3-Oct-2015 00:00

SDS-WAS: Surface concentration joint visualization

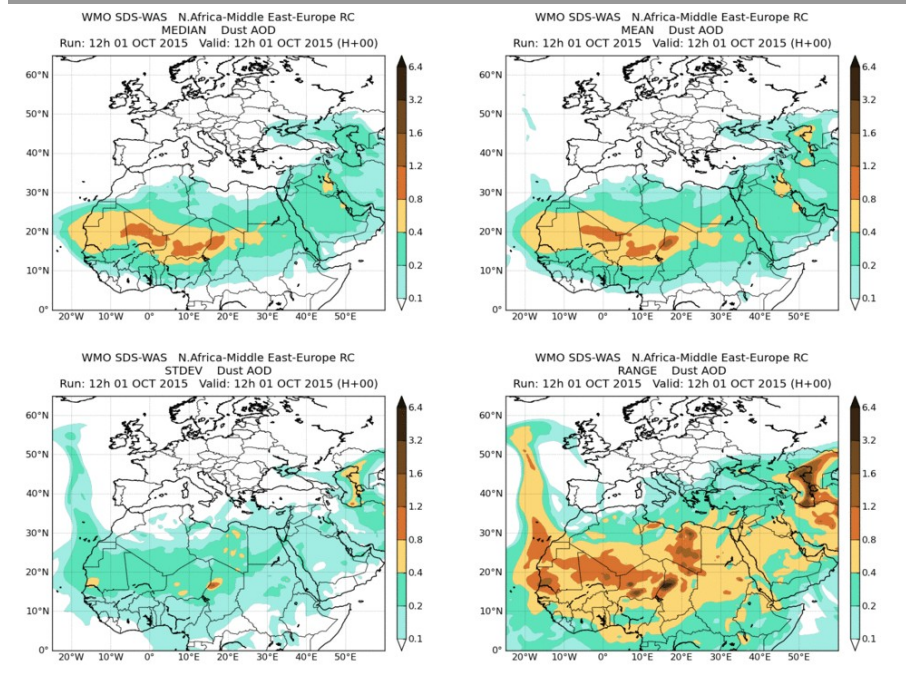


SDS-WAS: Generation of multi-model products

Surface concentration



AOD at 550nm



from 1-Oct-2015 12:00 to 3-Oct-2015 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:

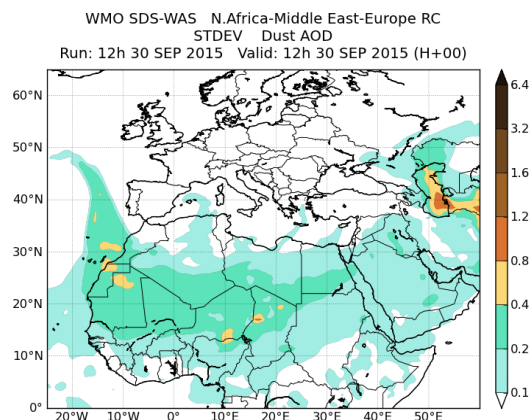
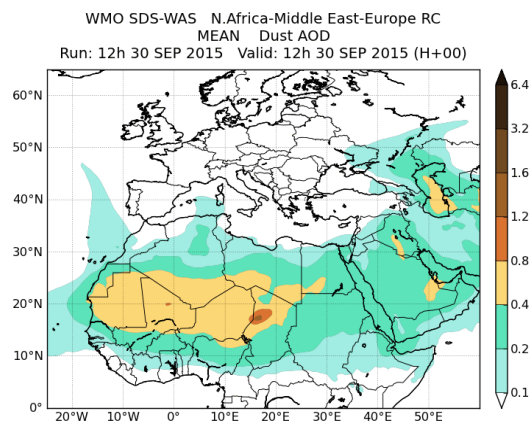
CENTRALITY: median - mean

SPREAD: standard deviation - range of variation

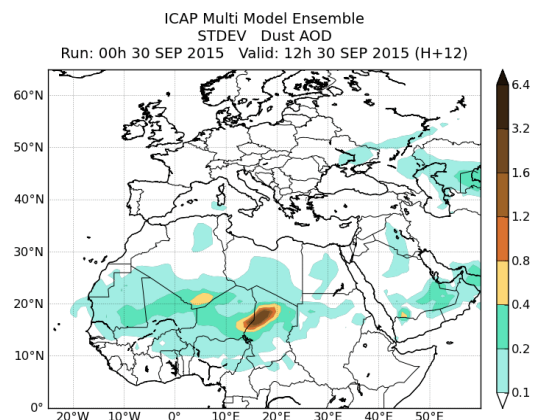
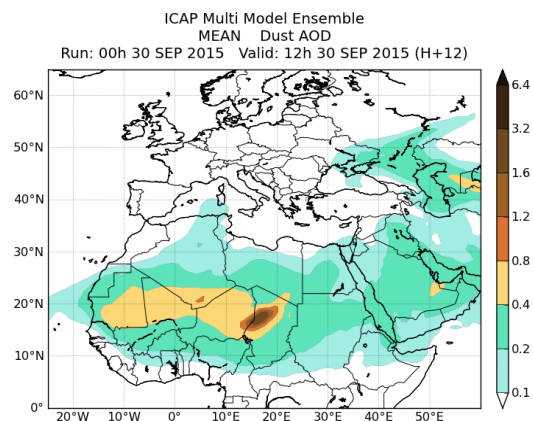
SDS-WAS: Generation of multi-model products

SDS-WAS and ICAP multi-model products

SDS-WAS



ICAP

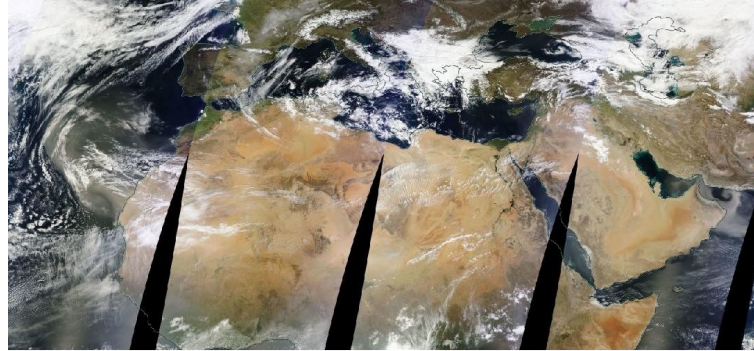


AOD at 550nm

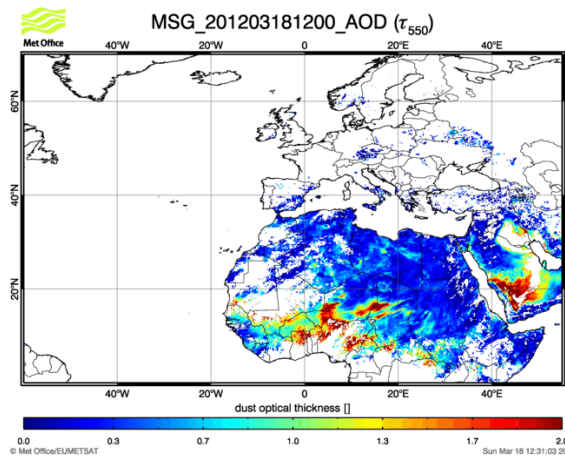
from 1-Oct-2015 12:00 to 3-Oct-2015 00:00

Newsourcesof dataformodelevaluation

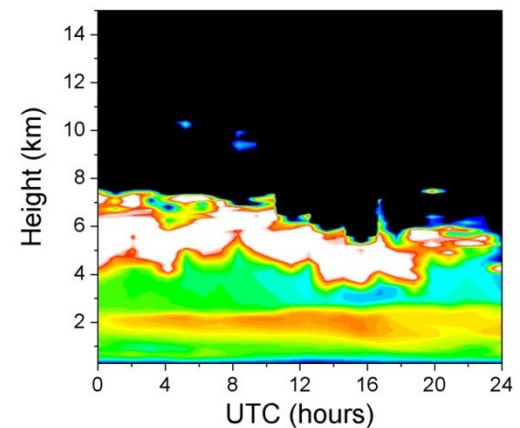
- Visibility
- MSG/SEVIRI
- MODIS
- OMI
- CALIPSO
- PARASOL
- MPLNET
- PM₁₀



MODIS composite 8th March 2015 from EOSDIS World Viewer

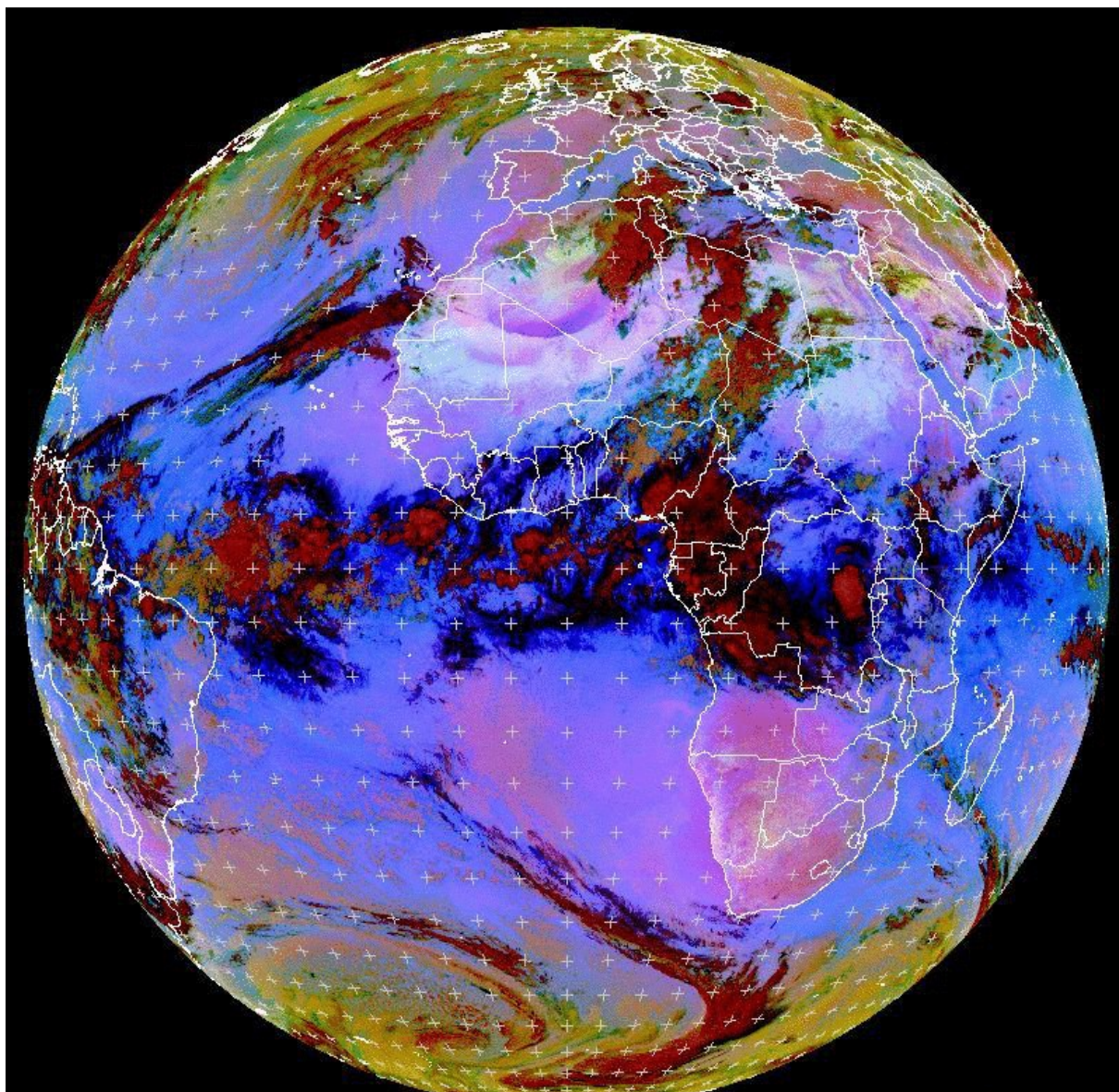


Micro Pulse LIDAR - Sta. Cruz de Tenerife



08 Dec
2011

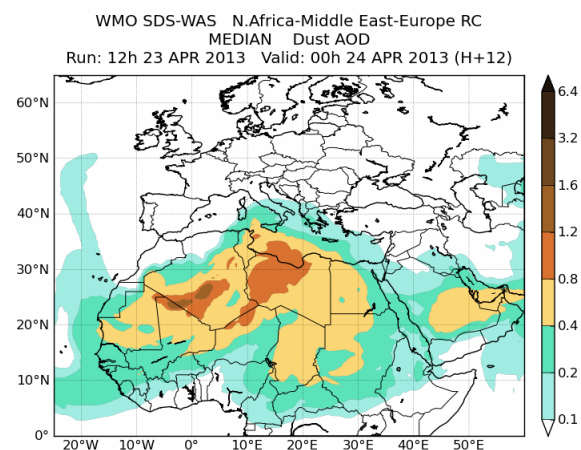
SDS-WAS: NRTEvaluationusing satellite aerosol products



MET10 RGB-Dust 2013-04-24 00:00 UTC



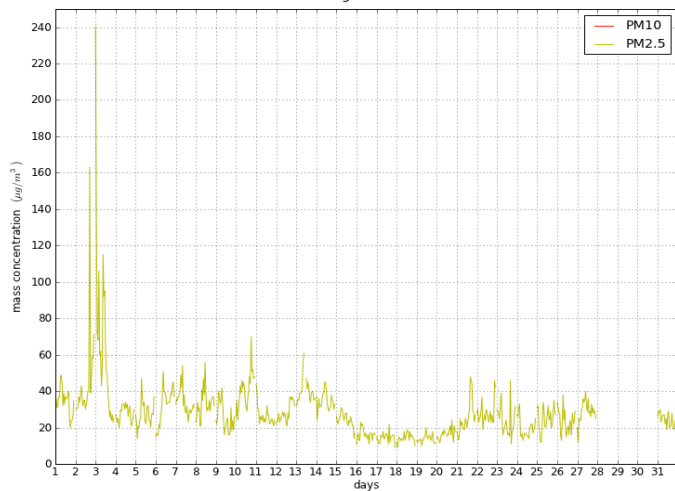
24 April 2013



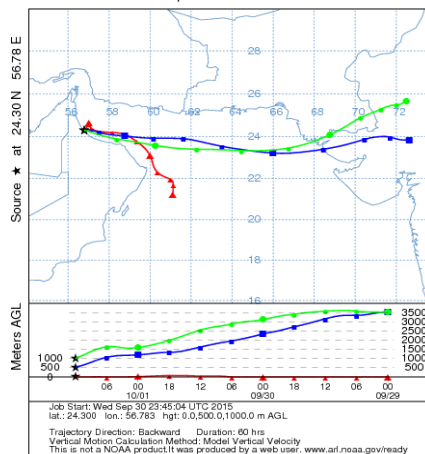
SDS-WAS: NRTEvaluationusingsurfaceconcentration



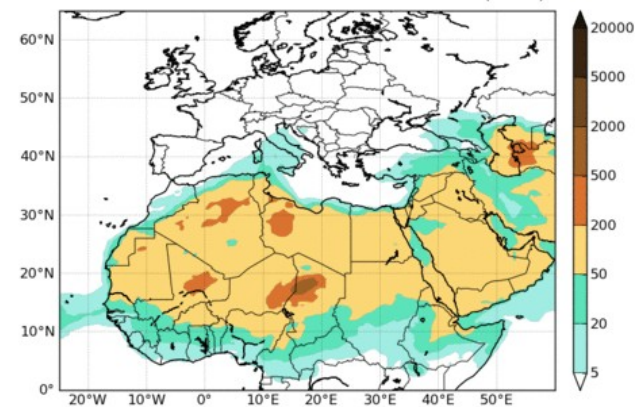
Oman: Sohar University
August 2015



NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 01 Oct 15
12 UTC 30 Sep GFS Forecast Initialization

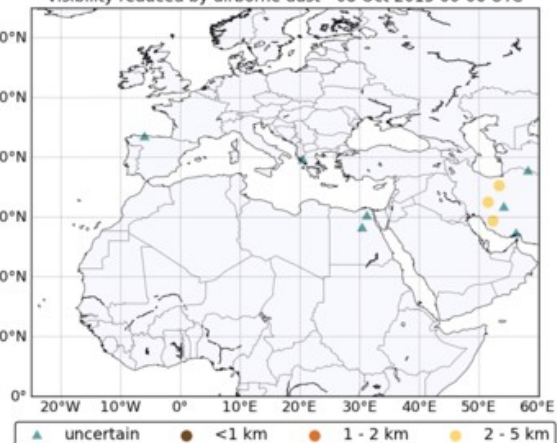


WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12h 14 OCT 2015 Valid: 12h 14 OCT 2015 (H+00)

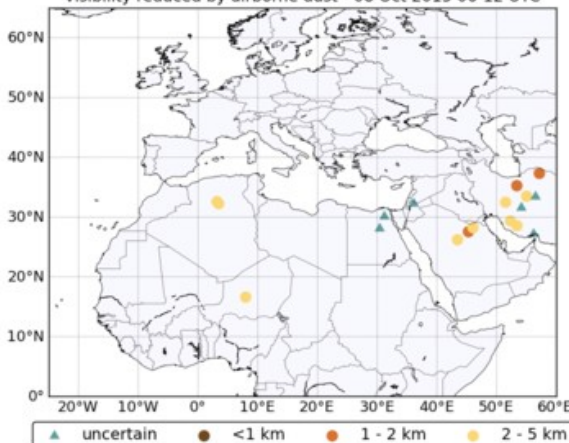


SDS-WAS: NREvaluationusingVISIBILITY data

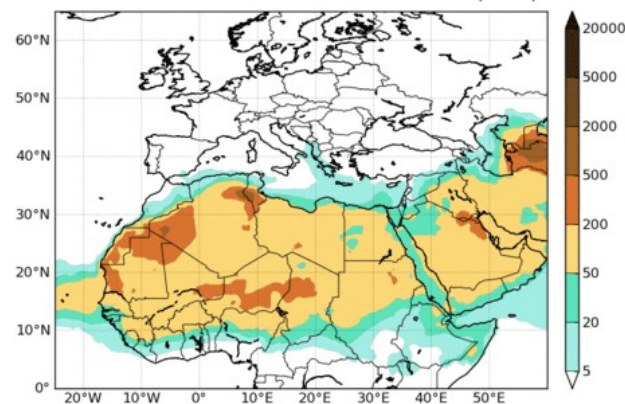
WMO SDS-WAS N.Africa-Middle East-Europe RC
Visibility reduced by airborne dust - 08 Oct 2015 00-06 UTC



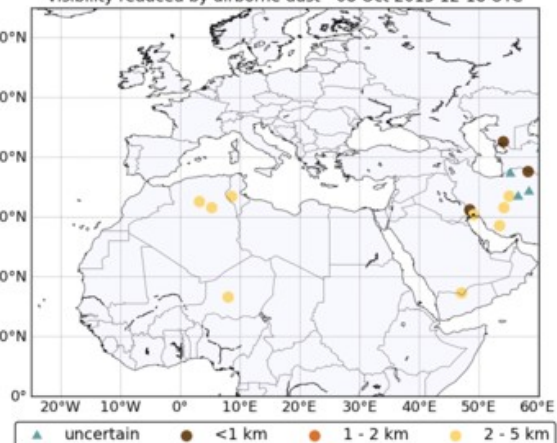
WMO SDS-WAS N.Africa-Middle East-Europe RC
Visibility reduced by airborne dust - 08 Oct 2015 06-12 UTC



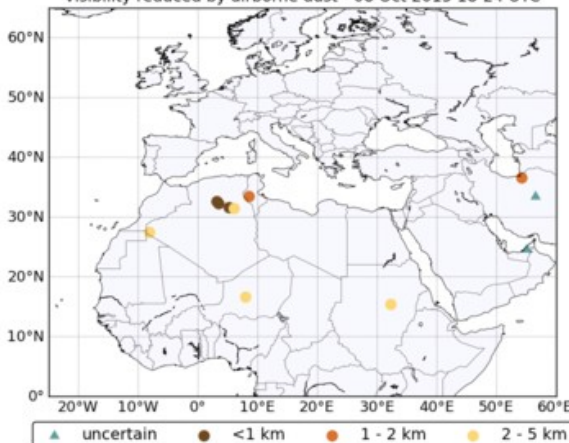
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12h 08 OCT 2015 Valid: 00h 09 OCT 2015 (H+12)



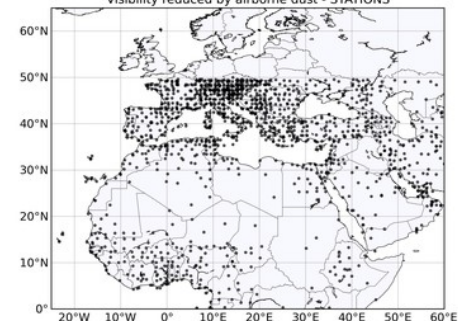
WMO SDS-WAS N.Africa-Middle East-Europe RC
Visibility reduced by airborne dust - 08 Oct 2015 12-18 UTC



WMO SDS-WAS N.Africa-Middle East-Europe RC
Visibility reduced by airborne dust - 08 Oct 2015 18-24 UTC



WMO SDS-WAS N.Africa-Middle East-Europe RC
Visibility reduced by airborne dust - STATIONS



VISIBILITY on 8-Oct-2015

SDS-WAS:NRTEvaluationusingAERONET

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You are here: **MACC PROJECT** **MODEL INTERCOMPARISON** **Model Intercomparison**

Northern Africa-Middle East-Europe (NA-ME-E) Regional Center
by Francesco Benincasa — last modified May 29, 2012 03:33 PM

Outstanding

- II Lectures on Atmospheric Mineral Dust. A few seats are still available
- WMO SDS-WAS NA-ME-E Regional Center will be a Regional Specialized Meteorological Center
- Guidance for forecasters
- Forecast evaluation
- Compared dust forecasts

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

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Latest News

Link to NGAC dust forecasts
Oct 16, 2012

The NCEP-NGAC model joins the WMO SDS-WAS dust model intercomparison
Oct 10, 2012

II Lectures on Atmospheric Mineral Dust. A few seats are still available
Sep 28, 2012

Upcoming Events

ACCENT/GLOREAM. 24th. Workshop on Tropospheric Chemical Transport Modelling
Oct 17, 2012 - Oct 19, 2012 —
Barcelona, Spain

3rd. ChArMEx International
search/model-intercomparison

Dust forecasts

WMO SDS-WAS - N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration (µg/m³)
Run: 09-14 OCT 2012. Valid: 12h-14 OCT 2012 (H+00)

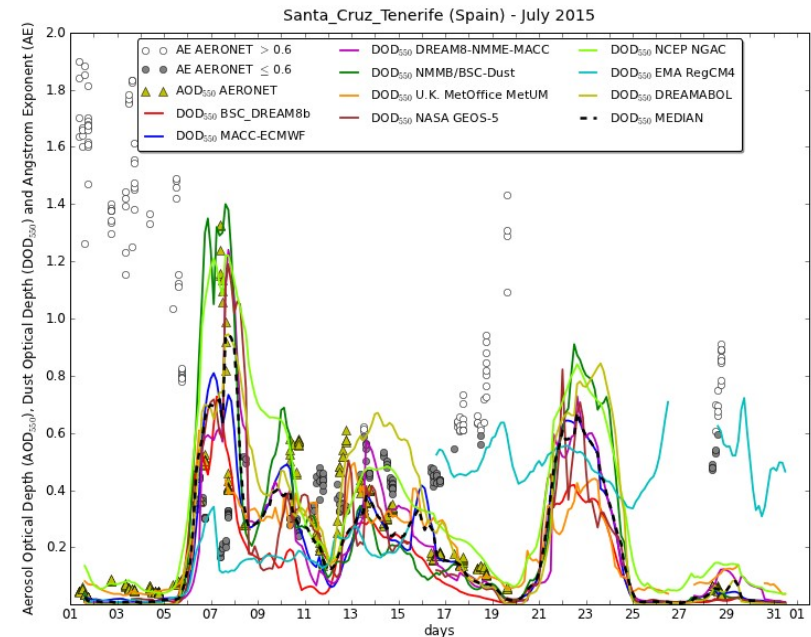
Compared Dust Forecasts

Forecast Evaluation

Dust observations

Italy-Ciuti-Locusts-Punta Prieta
September 2012

SDS-WAS: NRTEvaluationusingAERONET



Model evaluation metrics (bias, correlation, RMSE and FGE) are calculated:

- By regions: NA-ME-E, Sahel/Sahara, Middle East and Mediterranean
- By time periods: monthly, seasonal and annual

SDS-WAS: NRTEvaluationusingAERONET

Annual scores

by Francesco Benincasa — last modified Nov 27, 2014 11:52 AM

Date: - Select Year - ▼

Jan 2014 - Dec 2014. Dust Optical Depth.
Threshold Angstrom Exponent = 0.600

BIAS

	BSC_ DREAMb	MACC- ECMWF	DREAMB-NMME- MACC	NMMB/BSC- Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	MEDIAN
Sahel/Sahara show stations	-0.23	-0.07	-0.08	-0.13	-0.07	-0.12	-0.01	0.32	-0.09	-0.10
Middle East show stations	-0.16	0.00	0.07	-0.14	-0.04	-0.12	-0.09	0.53	-0.02	-0.06
Mediterranean show stations	-0.18	-0.11	-0.10	-0.18	-0.10	-0.15	-0.08	0.11	-0.10	-0.13
TOTAL	-0.21	-0.08	-0.08	-0.15	-0.08	-0.13	-0.04	0.24	-0.09	-0.11

ROOT MEAN SQUARE ERROR

	BSC_ DREAMb	MACC- ECMWF	DREAMB-NMME- MACC	NMMB/BSC- Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	MEDIAN
Sahel/Sahara show stations	0.40	0.32	0.35	0.36	0.31	0.33	0.30	0.69	0.38	0.31
Middle East show stations	0.26	0.23	0.24	0.25	0.21	0.24	0.25	0.67	0.20	0.22
Mediterranean show stations	0.30	0.27	0.29	0.29	0.25	0.27	0.26	0.49	0.26	0.26
TOTAL	0.36	0.30	0.33	0.33	0.29	0.31	0.28	0.62	0.33	0.29

CORRELATION COEFFICIENT

	BSC_ DREAMb	MACC- ECMWF	DREAMB-NMME- MACC	NMMB/BSC- Dust	U.K. Met Office	NASA GEOS-5	NCEP NGAC	EMA RegCM4	DREAM ABOL	MEDIAN

A set of evaluation metrics are selected:

- Bias
- RMSE
- correlation coefficient
- FGE

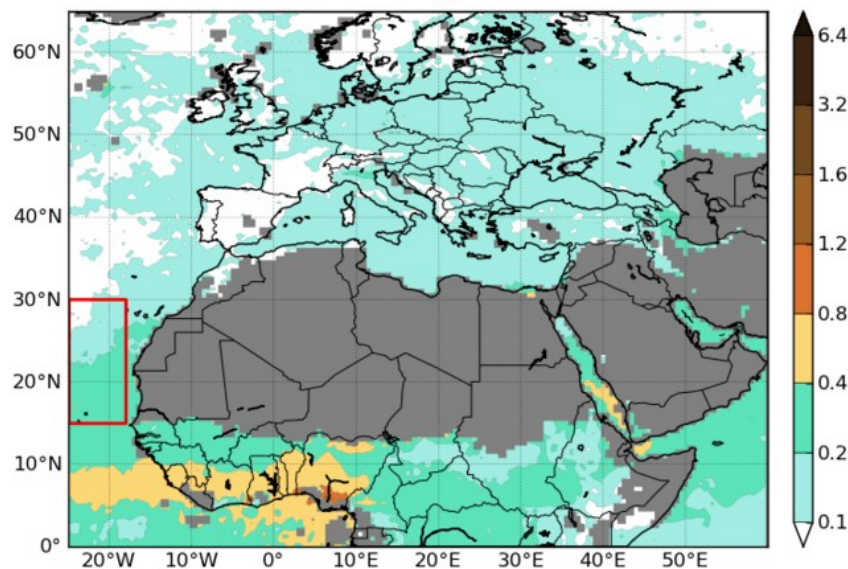
Calculation of evaluation metrics are done for:

- monthly/seasonal/annual
- sites and regions



SDS-WAS: NRTEvaluationusingMODIS

WMO SDS-WAS N.Africa-Middle East-Europe RC
MODIS AOD₅₅₀ - 2014



A set of evaluation metrics are selected:

- Bias
- RMSE
- correlation coefficient
- FGE

Calculation of evaluation metrics are done for:

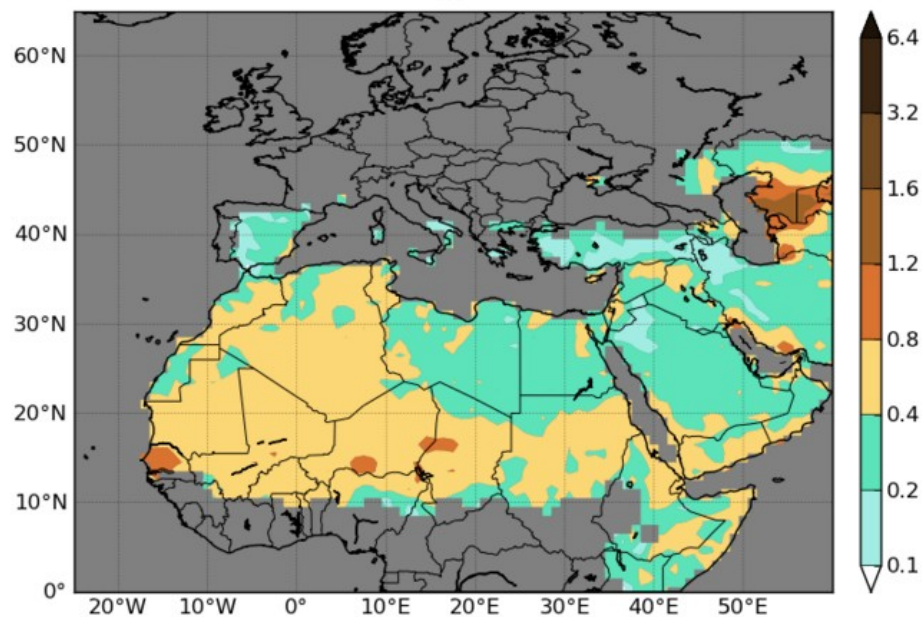
- monthly/seasonal/annual

[Download full image](#)

	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.14	0.20	0.72	1.07	22154
NMMB/BSC- Dust	-0.13	0.18	0.79	1.09	22154
NCEP NGAC	0.04	0.15	0.81	0.59	21608
EMA RegCM4	-0.04	0.37	0.26	1.09	13300
DREAMABOL	-0.04	0.17	0.69	0.92	13611

SDS-WAS: NRTEvaluationusingMODISDeepBlue

WMO SDS-WAS N.Africa-Middle East-Europe RC
MODIS DEEPBLUE AOD₅₅₀ - JUN 2014 - AUG 2014



A set of evaluation metrics are selected:

- Bias
- RMSE
- correlation coefficient
- FGE

Calculation of evaluation metrics are done for:

- monthly/seasonal/annual

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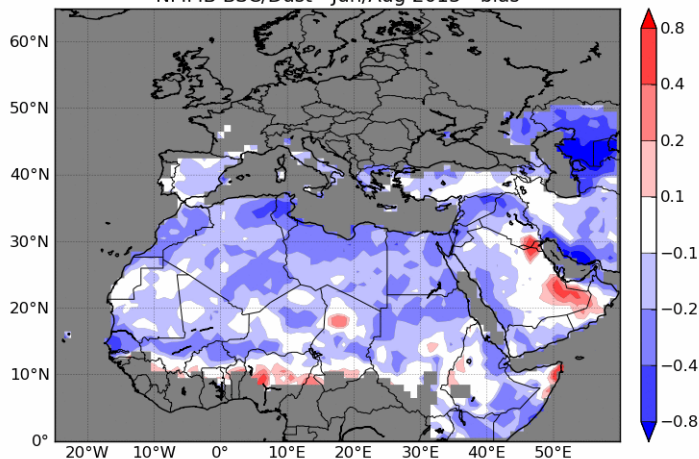
	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
BSC_ DREAM8b	-0.17	0.35	0.26	0.84	100952
NMMB/BSC- Dust	-0.12	0.39	0.32	0.84	100952
NCEP NGAC	-0.01	0.31	0.39	0.59	99159
EMA RegCM4	0.48	0.95	0.19	0.97	88666
DREAMABOL	0.07	0.34	0.36	0.71	64441

SDS-WAS: NRTEvaluationusingMODISDeepBlue

MB

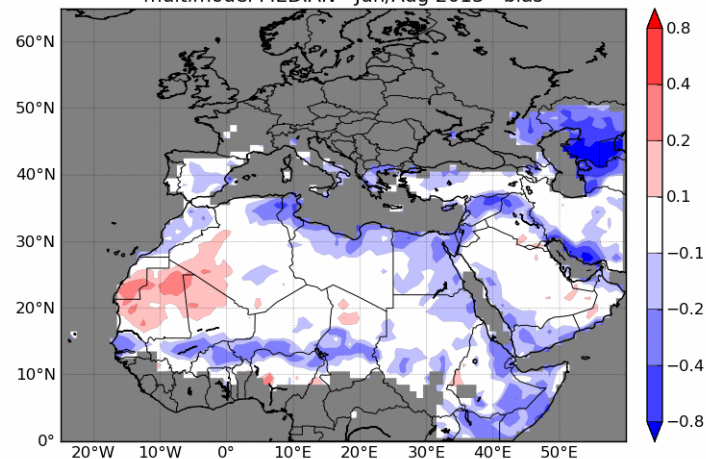
NMMB-BSC/Dust

WMO SDS-WAS N.Africa-Middle East-Europe RC
NMMB-BSC/Dust - Jun/Aug 2013 - bias

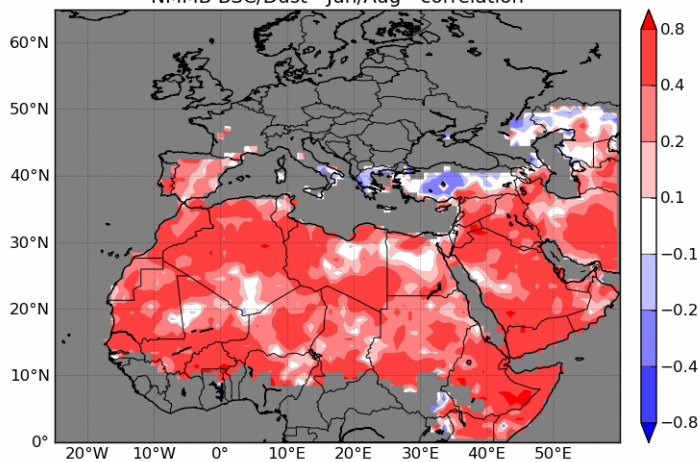


MultimodelMEDIAN

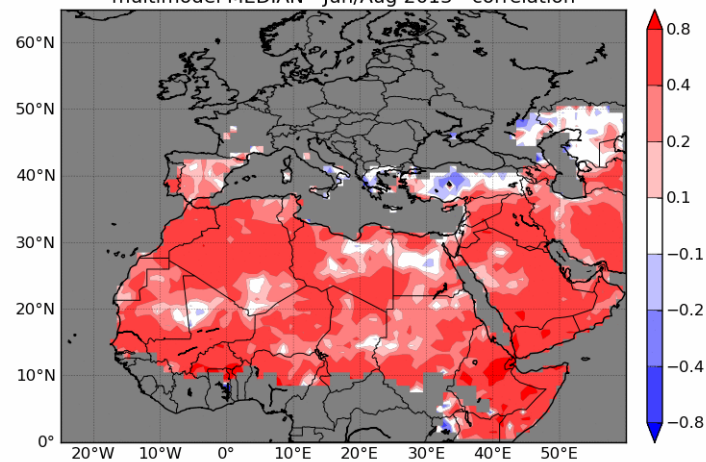
WMO SDS-WAS N.Africa-Middle East-Europe RC
multimodel MEDIAN - Jun/Aug 2013 - bias



WMO SDS-WAS N.Africa-Middle East-Europe RC
NMMB-BSC/Dust - Jun/Aug - correlation



WMO SDS-WAS N.Africa-Middle East-Europe RC
multimodel MEDIAN - Jun/Aug 2013 - correlation



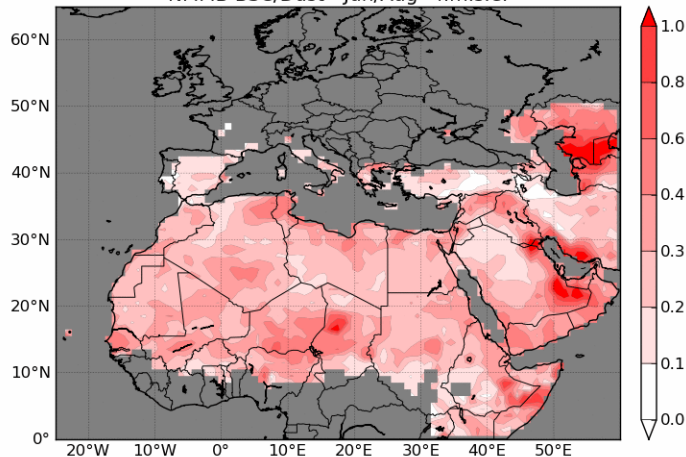
Correlation

SDS-WAS: NRTEvaluationusingMODISDeepBlue

RMSE

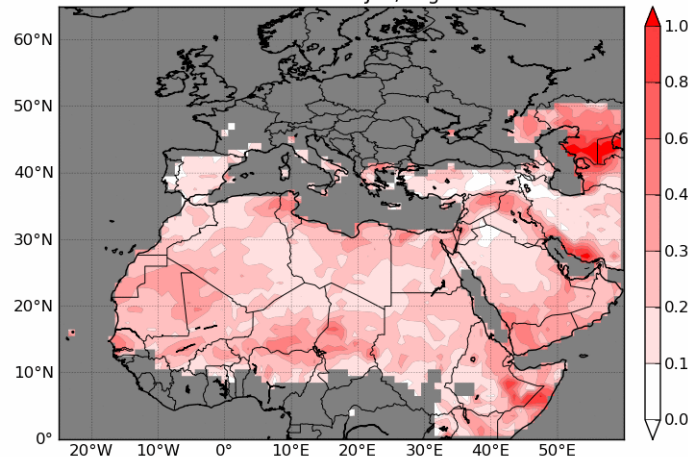
NMMB-BSC/Dust

WMO SDS-WAS N.Africa-Middle East-Europe RC
NMMB-BSC/Dust - Jun/Aug - r.m.s.e.



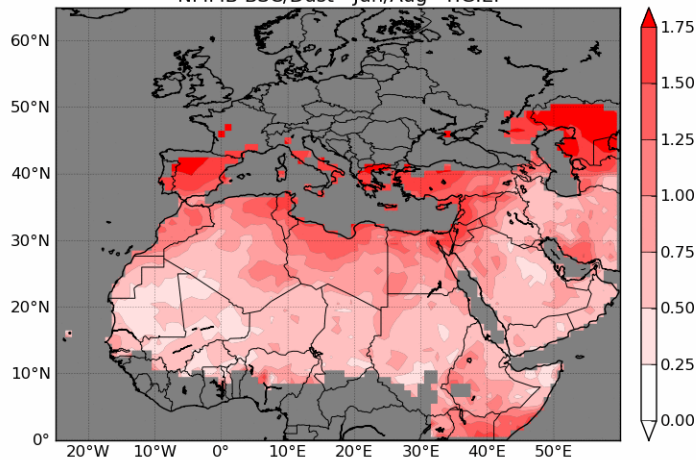
MultimodelMEDIAN

WMO SDS-WAS N.Africa-Middle East-Europe RC
multimodel MEDIAN - Jun/Aug - r.m.s.e.

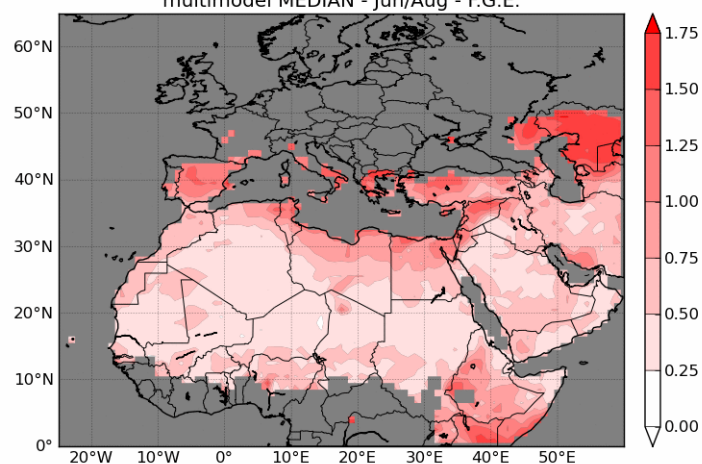


FGE

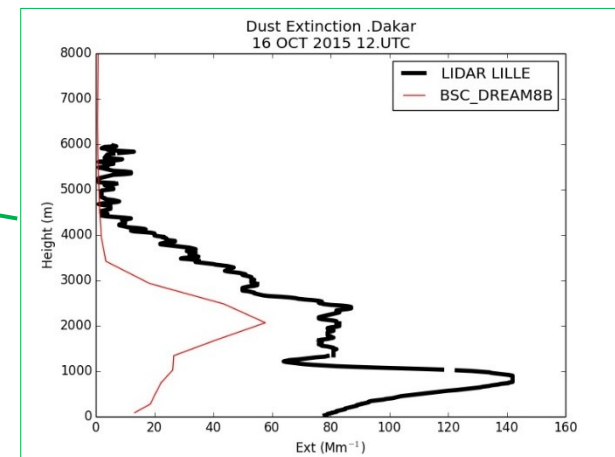
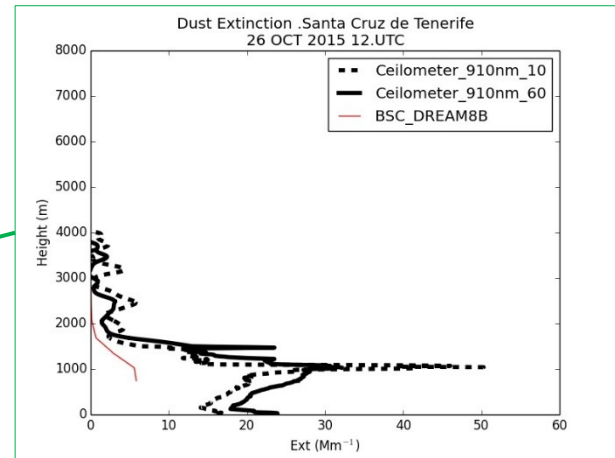
WMO SDS-WAS N.Africa-Middle East-Europe RC
NMMB-BSC/Dust - Jun/Aug - F.G.E.



WMO SDS-WAS N.Africa-Middle East-Europe RC
multimodel MEDIAN - Jun/Aug - F.G.E.



SDS-WAS:EvaluationusingLIDAR/Ceilometersdata



SDS-WAS: Model intercomparison

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World Meteorological Organization
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Aemet
BSC Barcelona Supercomputing Center

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- International Cooperative for Aerosol Prediction (ICAP)
- DIAPASON
- SDS-WAS studies**

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Latest News

The book "Mineral Dust - A key player in the Earth system" has been released
Sep 08, 2014

You are here: Home > Projects & Research > SDS-WAS studies

SDS-WAS STUDIES

by Enric Terradellas

Forecasting the North African dust outbreak towards Europe occurred in April 2011



Four state-of-the-art dust forecast models are examined to assess their performance to predict up to 72 hours ahead an intense Saharan dust outbreak over Western Europe up to Scandinavia between 5th and 11th April 2011. The capacity of the models to predict the evolution of the dust cloud is assessed by comparing their results with aerosol optical depth from AERONET and MODIS, as well as with dust surface concentration from air-quality monitoring stations. In addition, the CALIOP vertical profiles of extinction are used to examine the predicted vertical dust distribution of each model. To identify possible reasons for the different model performance, the wind fields yield by the simulations are evaluated with 10-m winds observed at meteorological stations and the vertical wind profiles from two radio sounding stations in the source region.

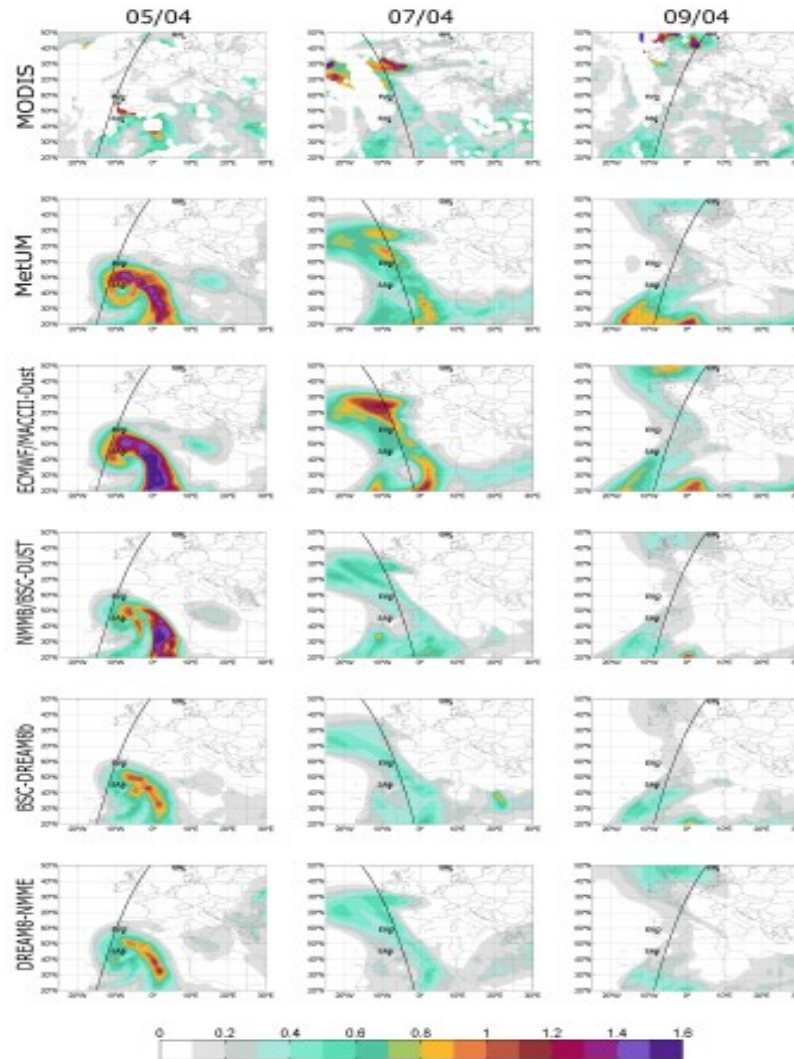
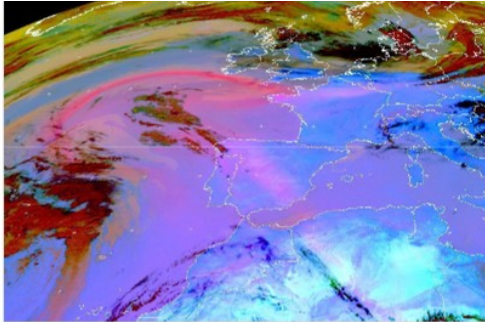
Huneus, N. et al. (2014): Forecasting the North African dust outbreak towards Europe in april 2011: A model intercomparison. MACC II Open Science Conference, Brussels

Basart, S. et al. (2012): Dust forecast model intercomparison: Case study of the dust cloud of April 2011. 24th ACCENT/GLOREAM Workshop, Barcelona

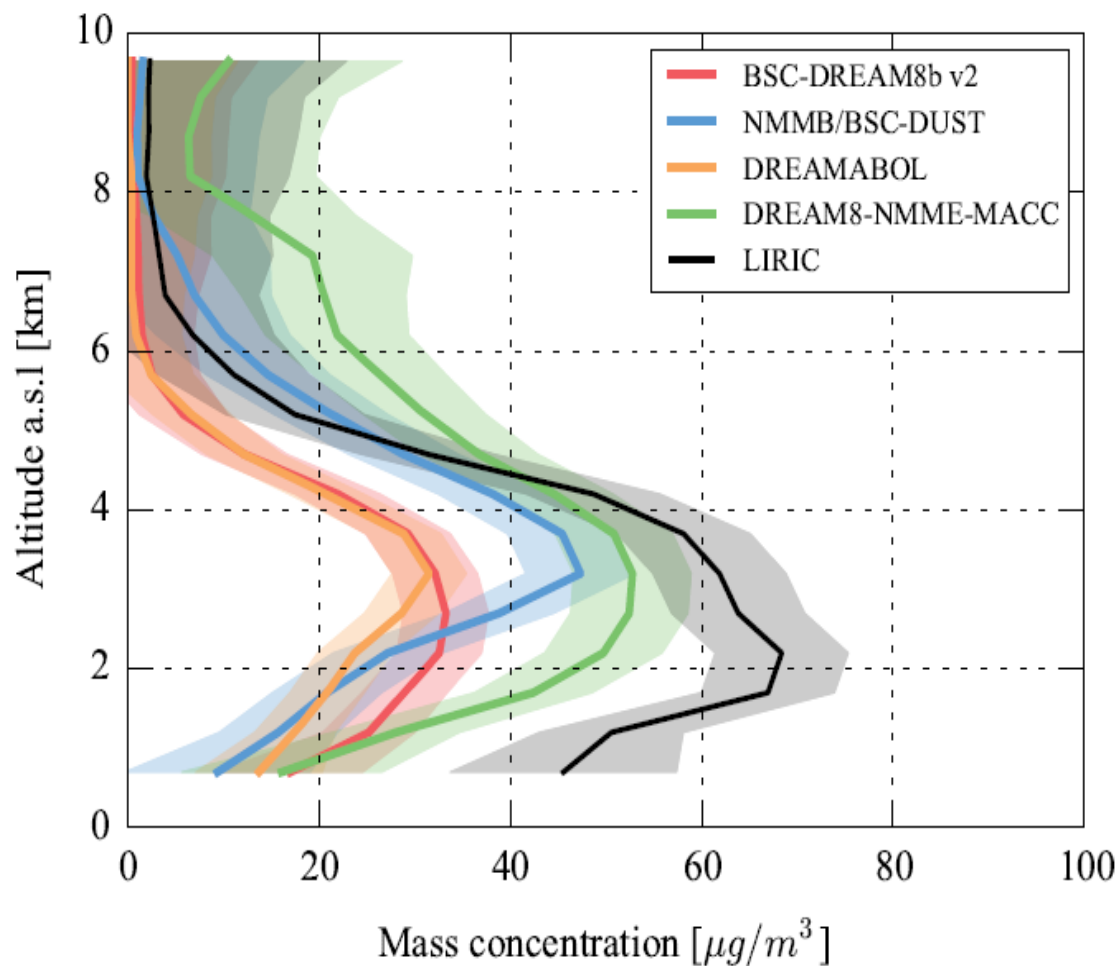
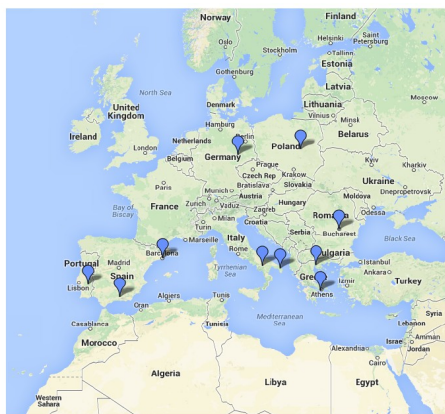
contact: Nicolás Huneus (nhuneus@dnf.uchile.cl)

sds-was.aemet.es/projects-research

Study of a dust outbreak over Europe in April 2011



EARLINET vertical profiles 2011-2013



Study of a haboob in Iran in 2014



Case study of the small-scale extreme dust storm occurred in **Tehran** on **2nd June 2014**, at 5:30 PM local time, 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.

Contact: Slobodan Nickovic (nickovic@gmail.com)

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BARCELONA DUST FORECAST CENTER



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Barcelona Dust Forecast Center starts operations

The Center will release operational dust forecasts for Northern Africa, Middle East and Europe

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Barcelona Dust Forecast Center
NMMB/BSC-Dust · Res: 0.1°x0.1° · Dust Surface Conc. (µg/m³)
Run: 12h 19 MAY 2014 · Valid: 18h 20 MAY 2014 (H+30)



Dust forecast

Latest dust forecast for Northern Africa, Middle East and Europe

First Specialized Center for Mineral Dust Prediction of WMO

NMMB/BSC-Dust selected to provide operational forecasts at high resolution (10km) for NAMEE region

DustOpticalDepthat 550nm

DustDryDeposition

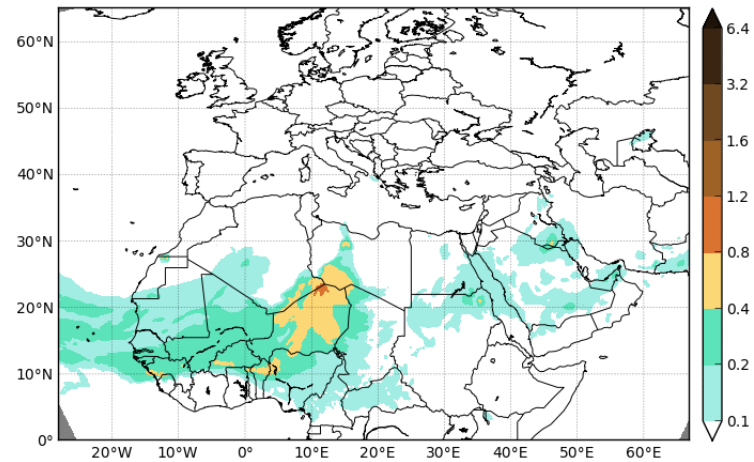
DustLoad

DustSurfaceConcentration

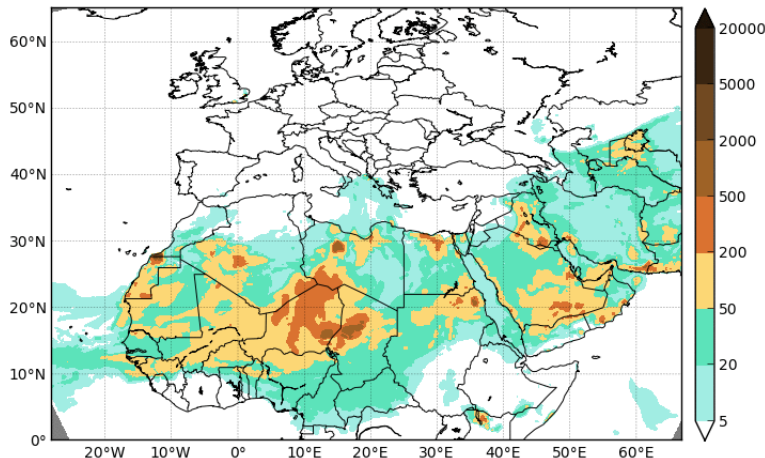
DustSurfaceExtinctionat 550nm

DustWetDeposition

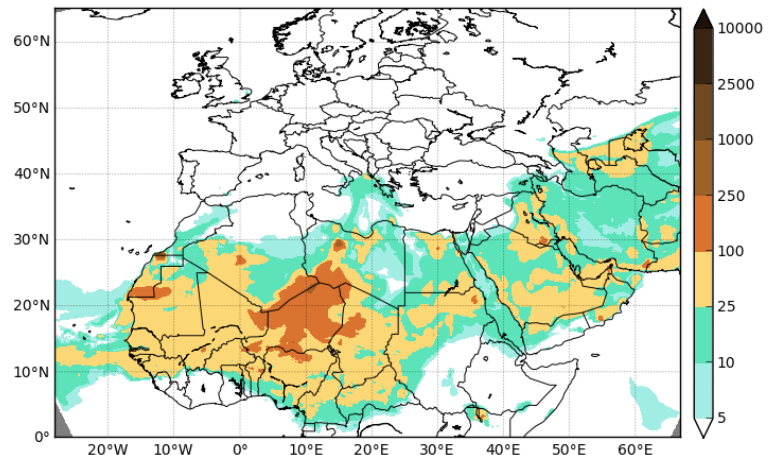
Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 06 OCT 2014 Valid: 12h 06 OCT 2014 (H+00)



Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Conc. ($\mu\text{g}/\text{m}^3$)
Run: 12h 06 OCT 2014 Valid: 12h 06 OCT 2014 (H+00)



Barcelona Dust Forecast Center
NMMB/BSC-Dust Res:0.1°x0.1° Dust Surface Ext. (Mm^{-1})
Run: 12h 06 OCT 2014 Valid: 12h 06 OCT 2014 (H+00)



BDFC:NRTEvaluationusingAERONET



Jan 2014 - Dec 2014. Dust Optical Depth.
Threshold Angstrom Exponent = 0.600

	BIAS	ROOT MEAN SQUARE ERROR	CORRELATION COEFFICIENT	FRACTIONAL GROSS ERROR	NUMBER OF CASES
Sahel/Sahara show stations	-0.12	0.38	0.51	0.75	7427
Middle East show stations	-0.10	0.27	0.39	0.64	112
Mediterranean show stations	-0.19	0.30	0.46	1.34	4623
TOTAL	-0.15	0.35	0.52	0.98	12162

A set of evaluation metrics are selected:

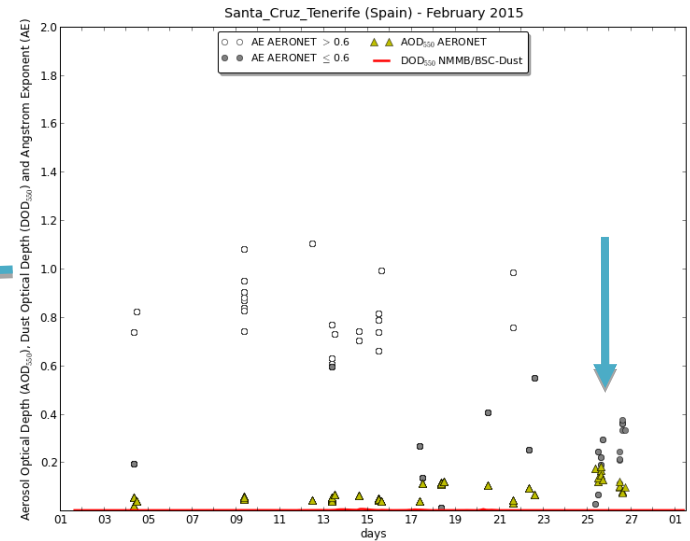
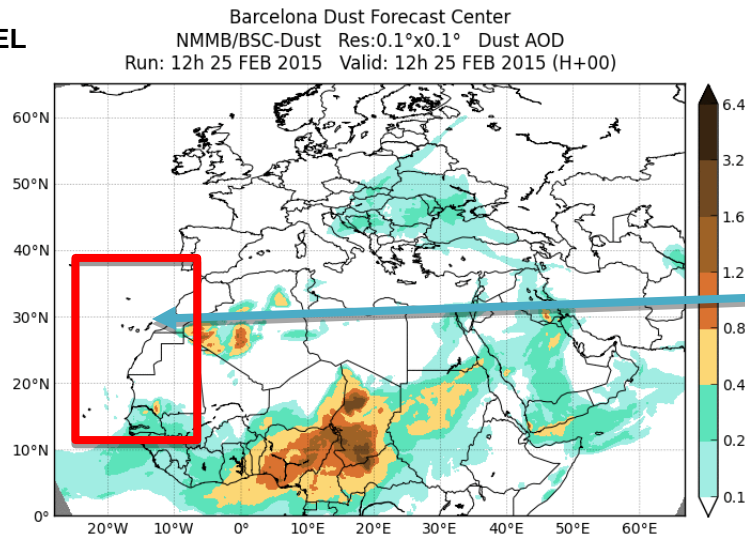
- Bias
- RMSE
- correlation coefficient
- FGE

Calculation of evaluation metrics are done for:

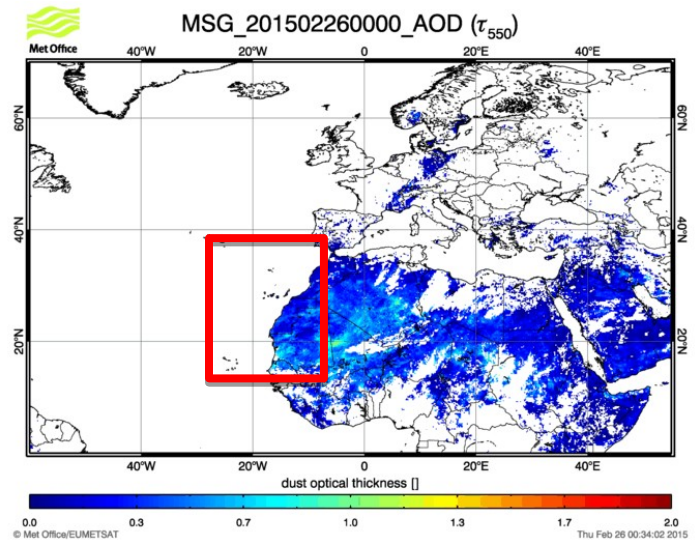
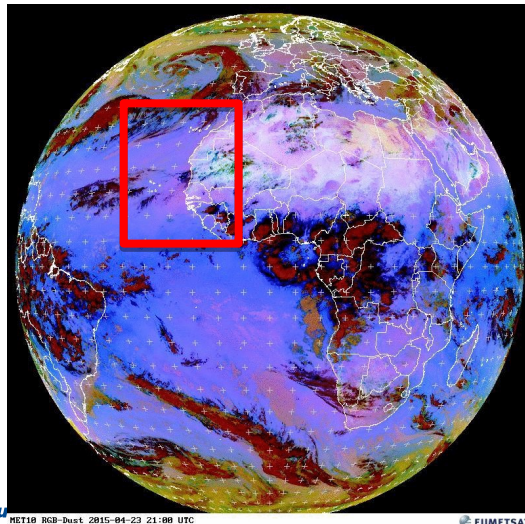
- monthly/seasonal/annual
- sites and regions

Canary Islands dust event February 2015

MODEL

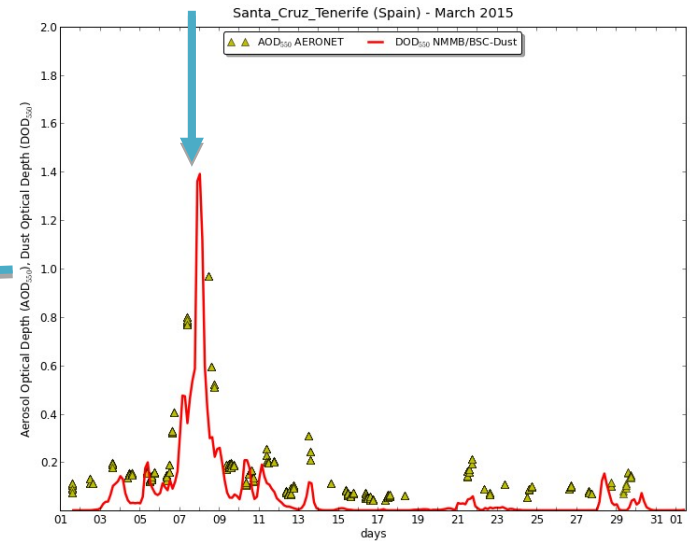
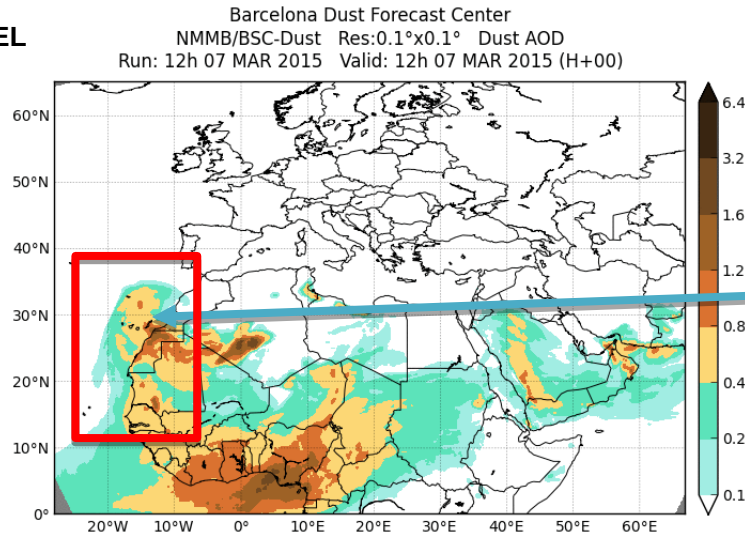


OBSERVATIONS

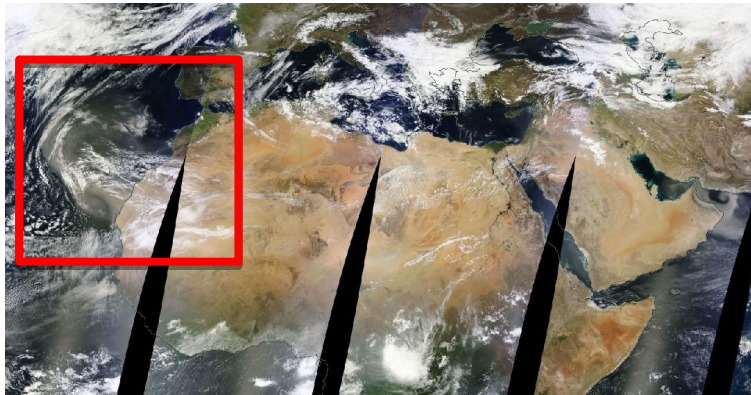


Canary Islands dust event March 2015

MODEL



OBSERVATIONS

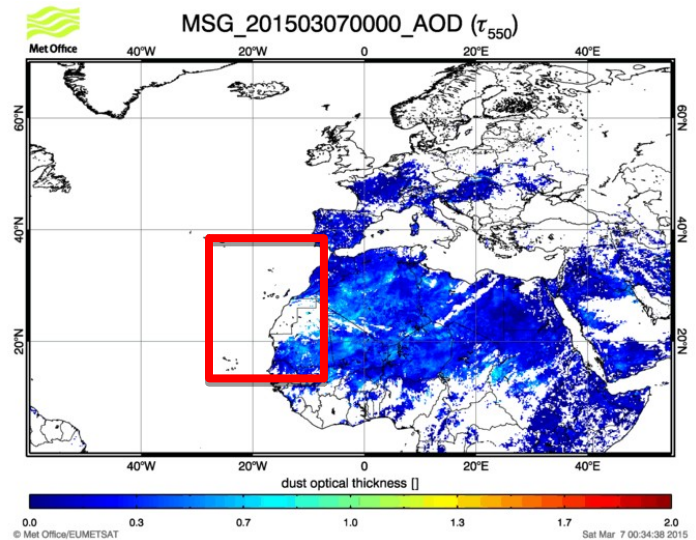


MODIS composite 8th March

from EOSDIS World Viewer

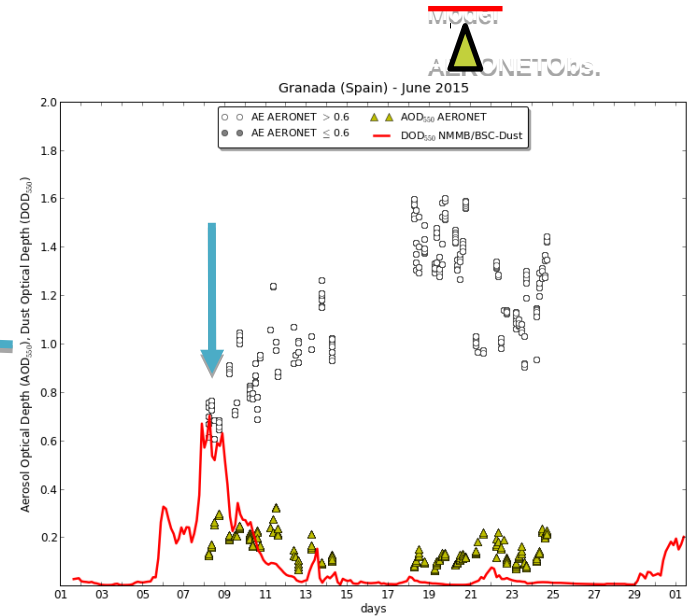
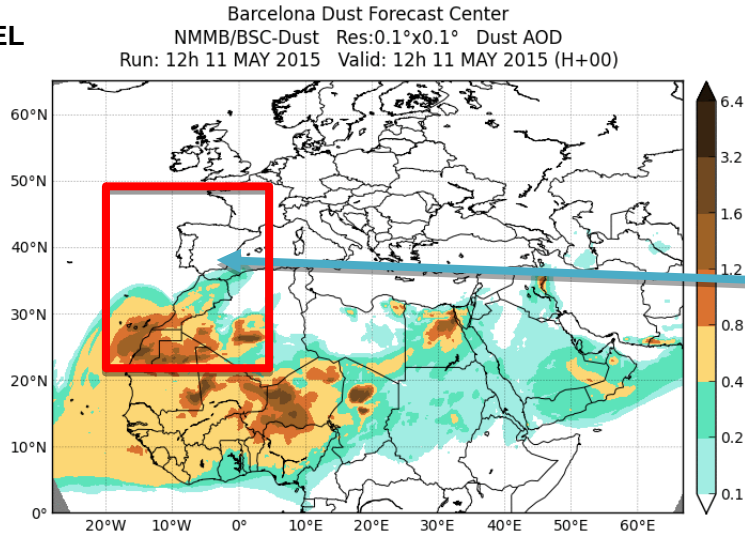


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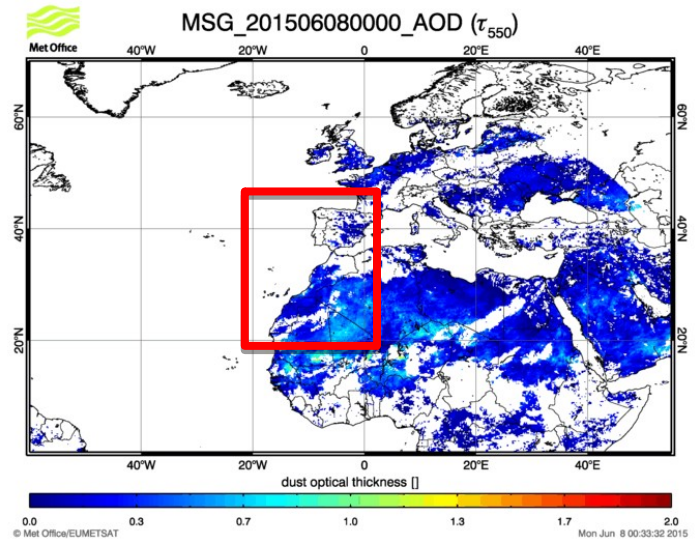
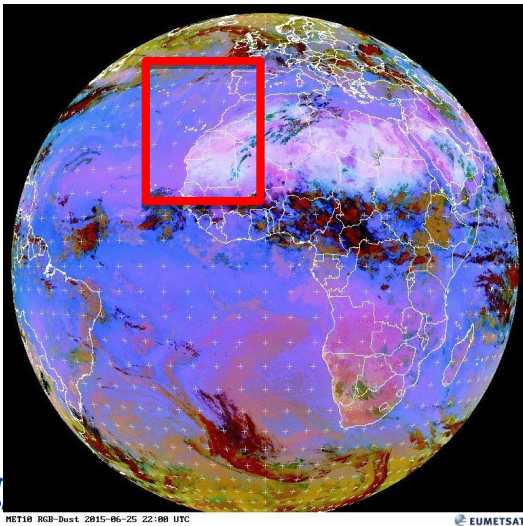


Europe dust event June 2015

MODEL



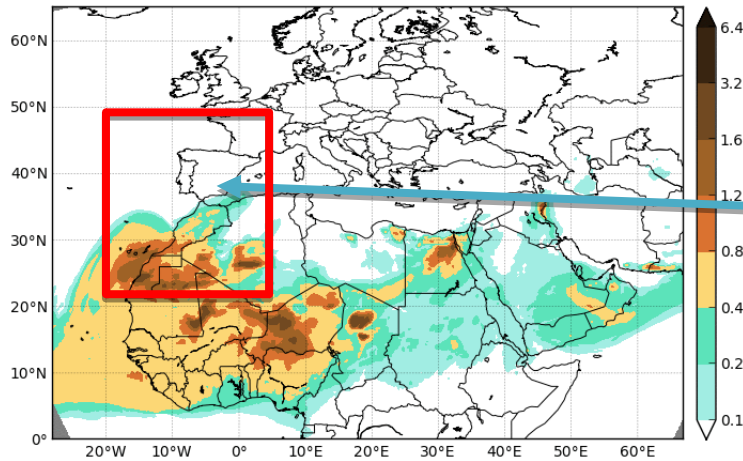
OBSERVATIONS



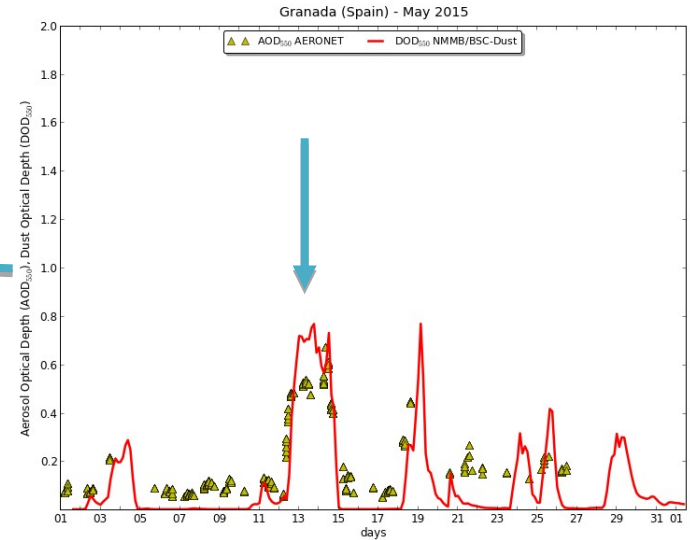
Europe dust event May 2015

MODEL

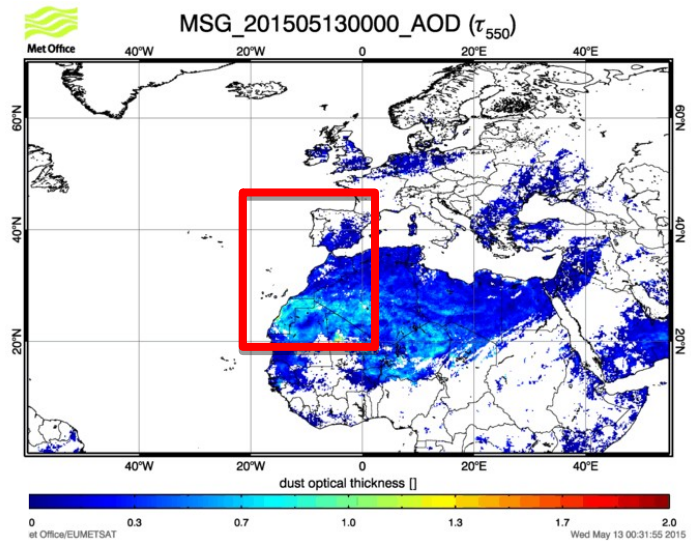
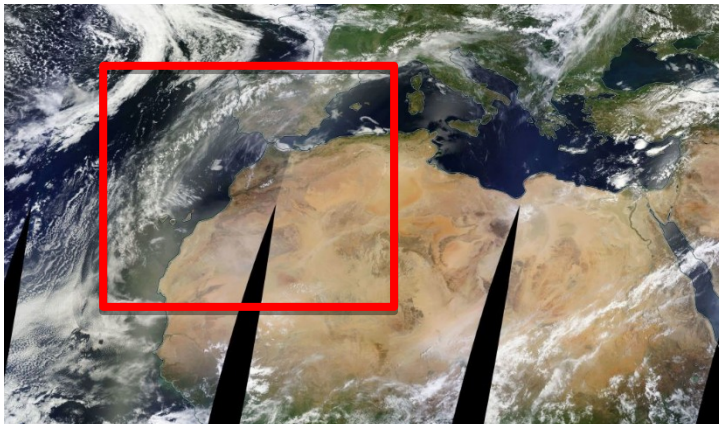
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NMMB/BSC-Dust Res: 0.1°x0.1° Dust AOD
Run: 12h 11 MAY 2015 Valid: 12h 11 MAY 2015 (H+00)



W.P. CIST
AERONET OBS.



OBSERVATIONS

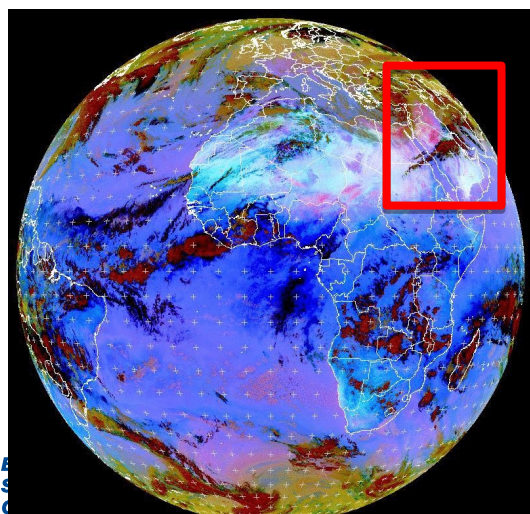
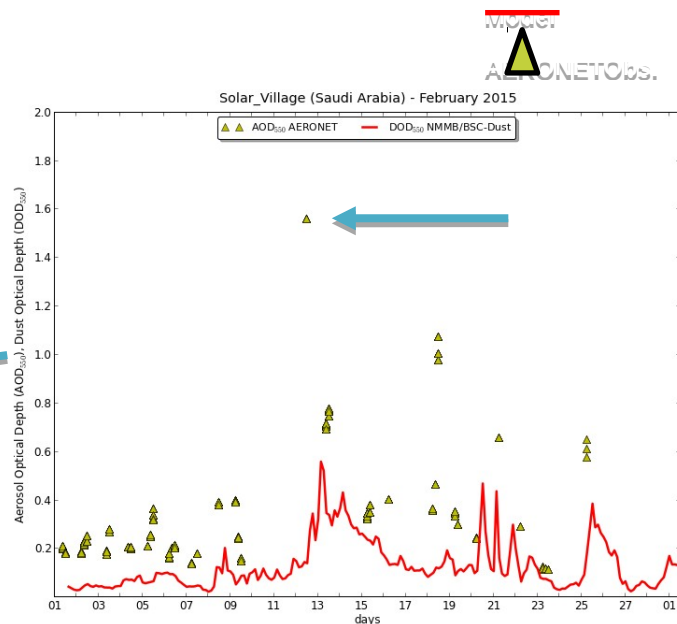
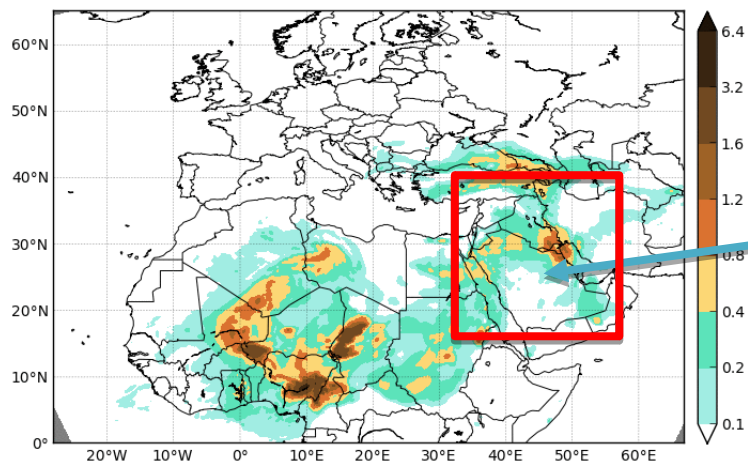


MODIS composite 13th May
from EOSDIS World Viewer

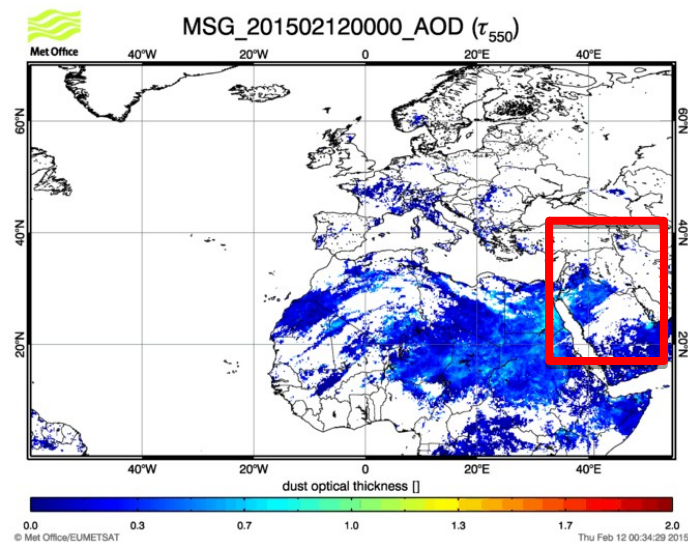
Arabian dust event February 2015

MODEL

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)



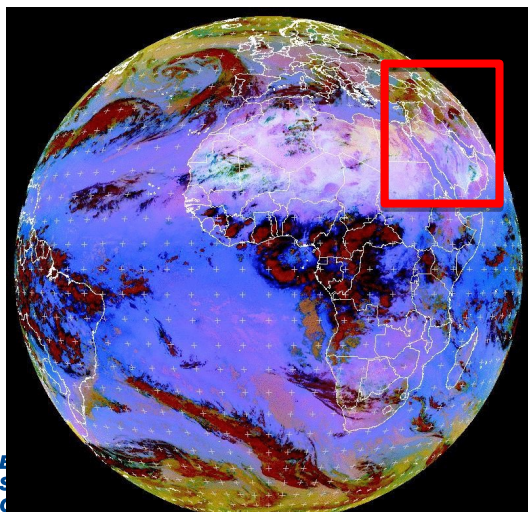
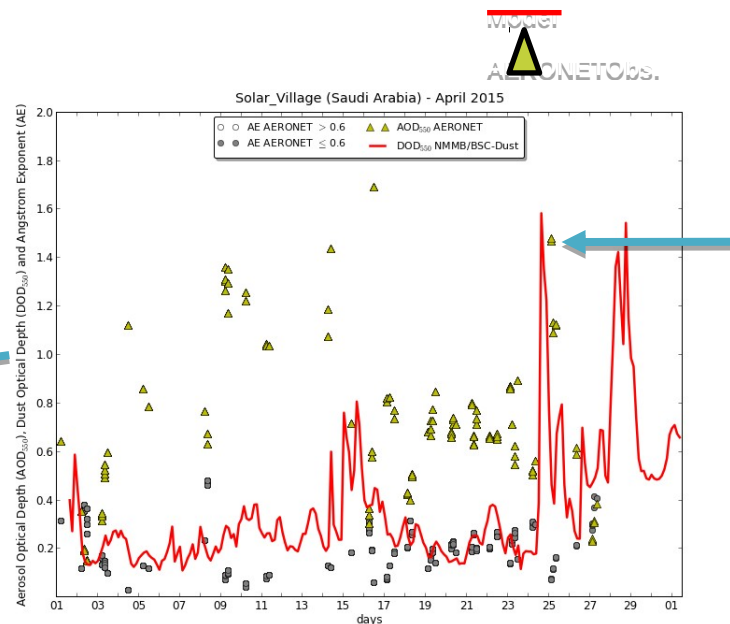
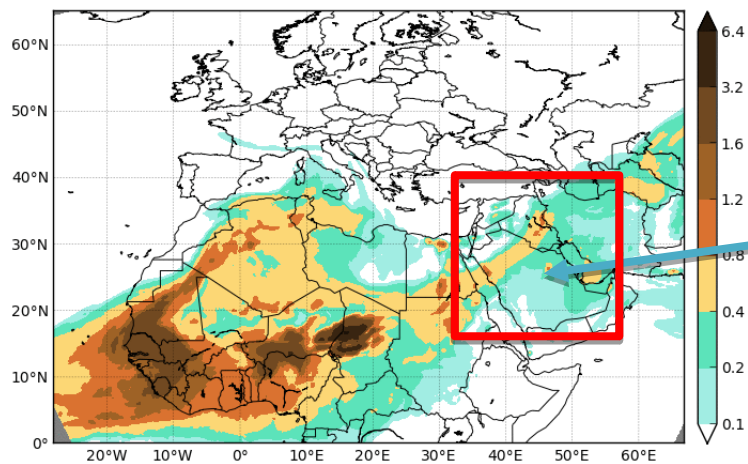
OBSERVATIONS



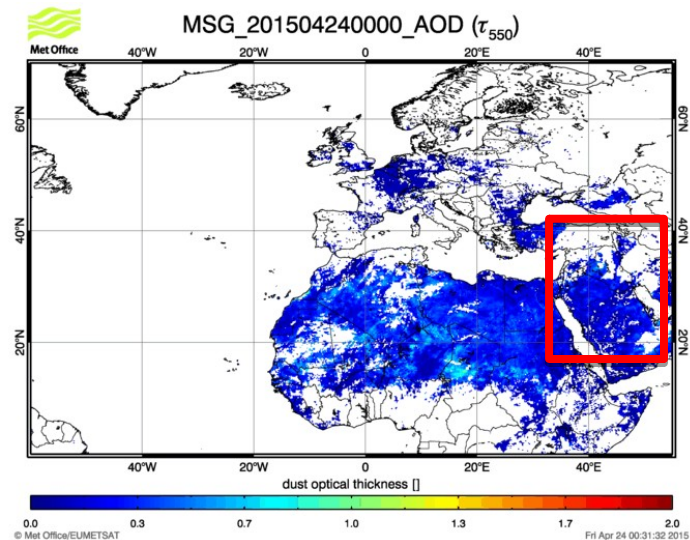
Arabian dust event Abril 2015

MODEL

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)



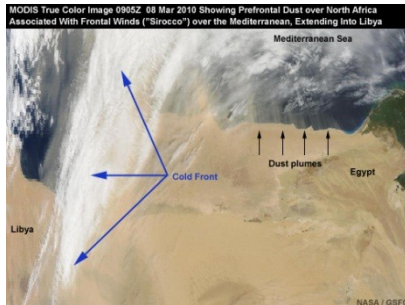
OBSERVATIONS



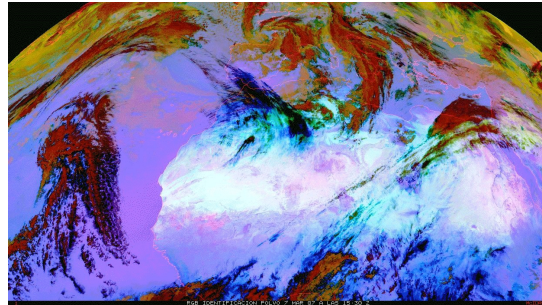
Dust cycle and associated processes: Types of dust storms

Synoptic dust storms (large scale weather systems)

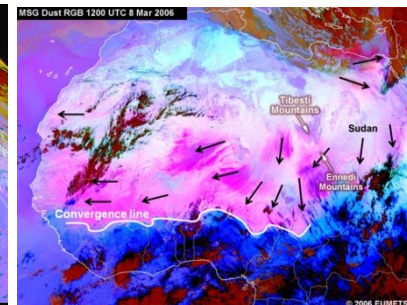
Well captured by models.



Pre-frontal winds



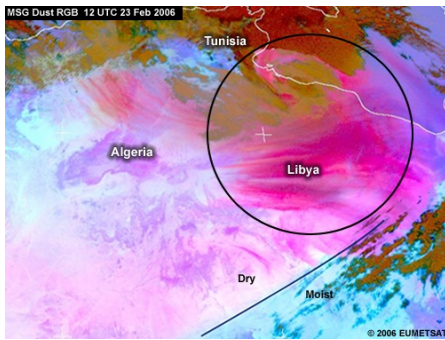
Post-frontal winds



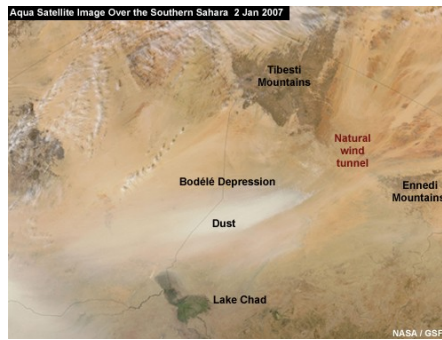
Large-scale trade winds

Mesoscale dust storms

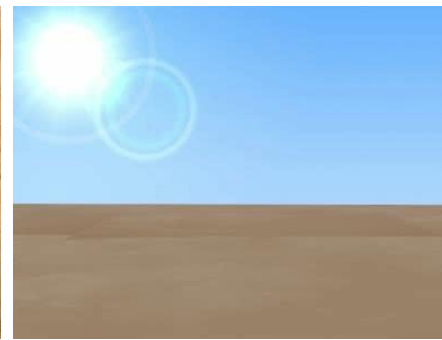
Poorly captured by models. Some types improve in regional models.



Downslope winds



Gapflow



Convection & Inversion downbursts



Haboobs



Barcelona Supercomputing Center

Centro Nacional de Supercomputación

1st Africa/Middle-East Expert Meeting and Workshop on the health impact of airborne dust
Amman, Jordan, 2nd November 2015

Thankyou *غراسياس*

Acknowledgements to José M^a Baldasano, Francesco Benincasa, Oriol Jorba, Kim Serradell, Enric Terradellas, Gerardo García-Castrillo and the collaborators of the WMO SDS-WAS NAMEE Regional Center.

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Satellite data used in this presentation were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC. We acknowledge the NASA and AERONET mission scientists and Principal Investigators who provided the data used in this research effort.