The dust cycle

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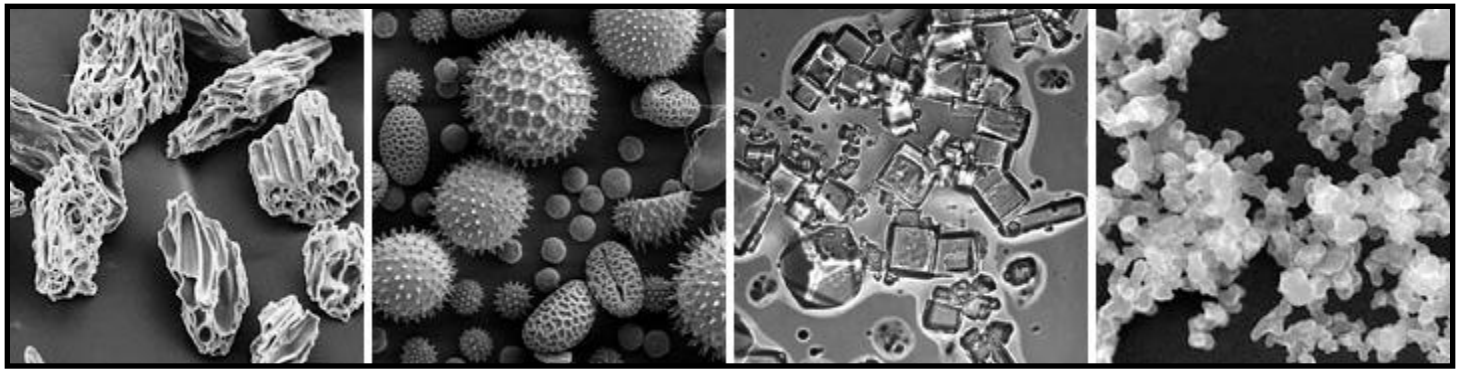
WMO SDS-WAS Regional Center for Northern Africa, Middle East and Europe
Barcelona Dust Forecast Center

1st Africa / Middle East Expert Meeting and Worshop on the Health Impact of Airborne Dust
Amman, Jordan, 2 Nov 2015

Atmospheric aerosol

Solid or liquid particles suspended in the air. They have different

- Origin (primary / secondary, natural / anthropogenic)
- Size (Diameter: ~ 2 nm – 100 µm)
- Chemical, mineralogic composition
- Optical properties
- …



USGS science for a changing world

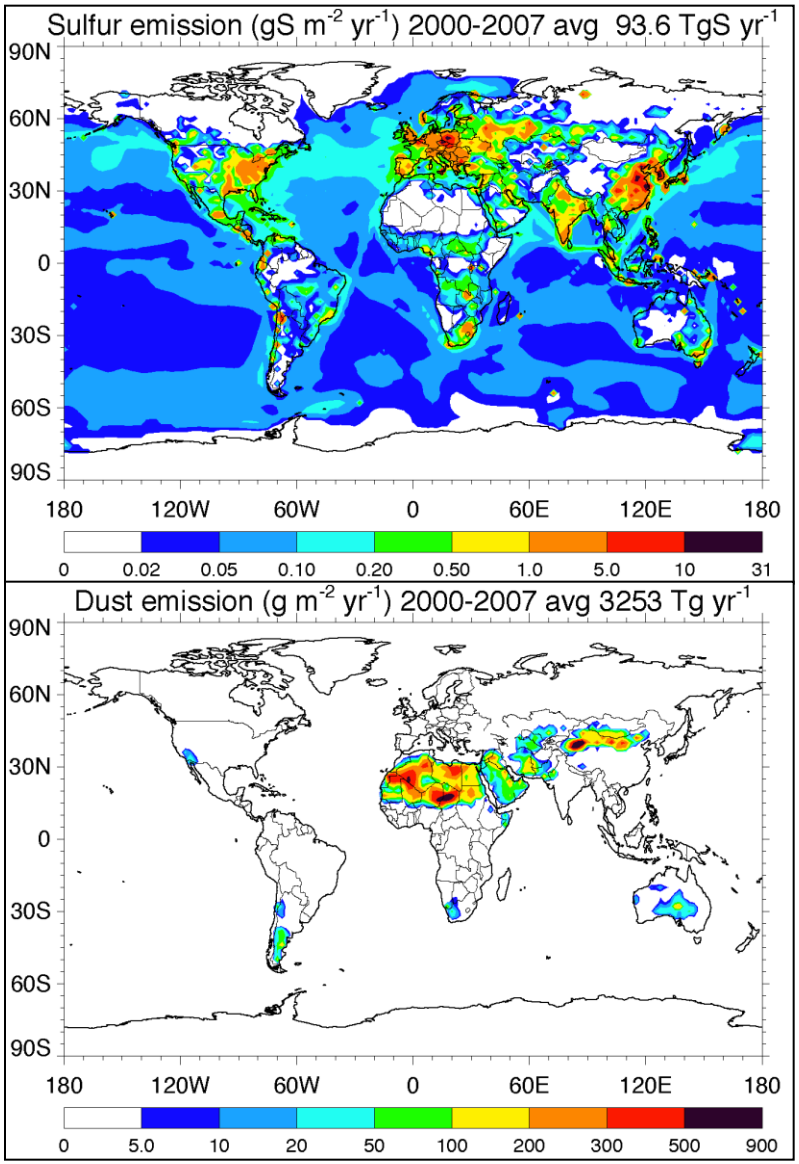
UMBC AN HONORS UNIVERSITY IN MARYLAND

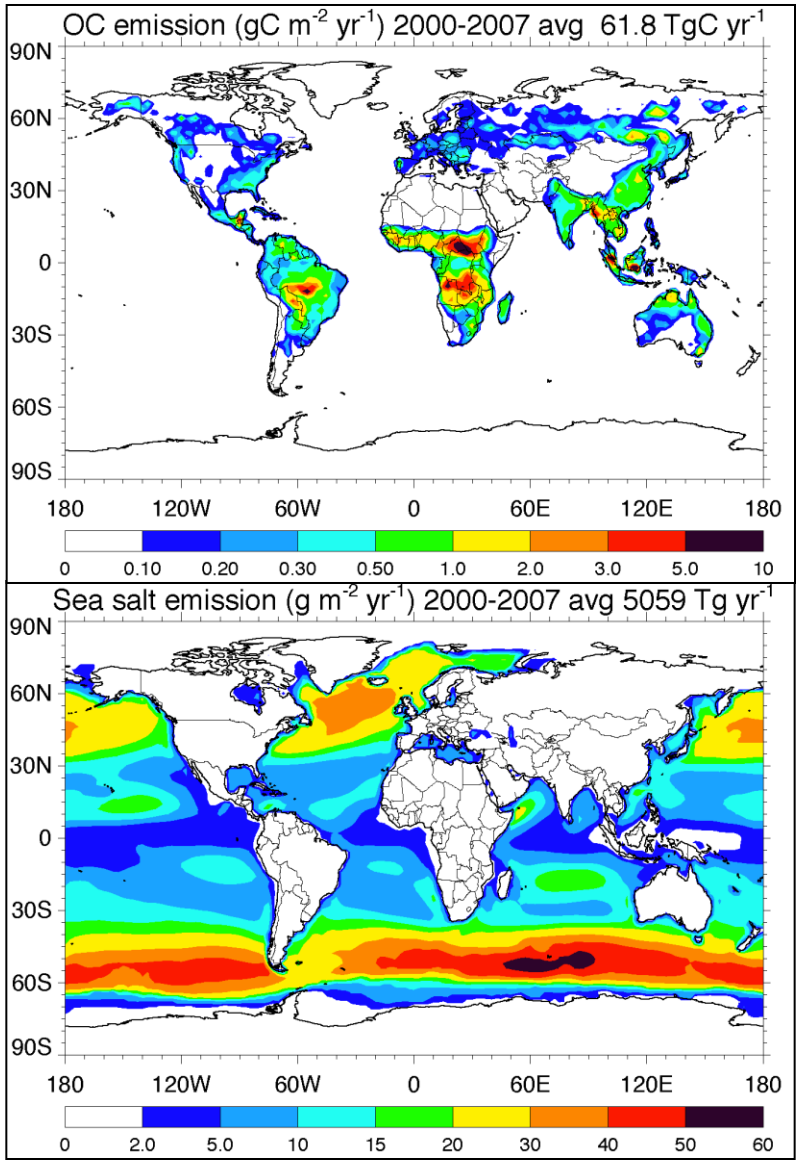
ASU ARIZONA STATE UNIVERSITY

Atmospheric aerosol. Sources

- Volcanic eruptions
- Sea salt
- Biomass burning
- Anthropogenic pollution
- Organic particles
- **MINERAL DUST**

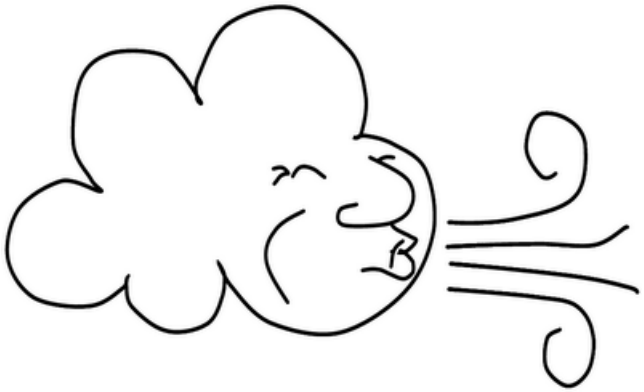
Atmospheric aerosol. Emissions





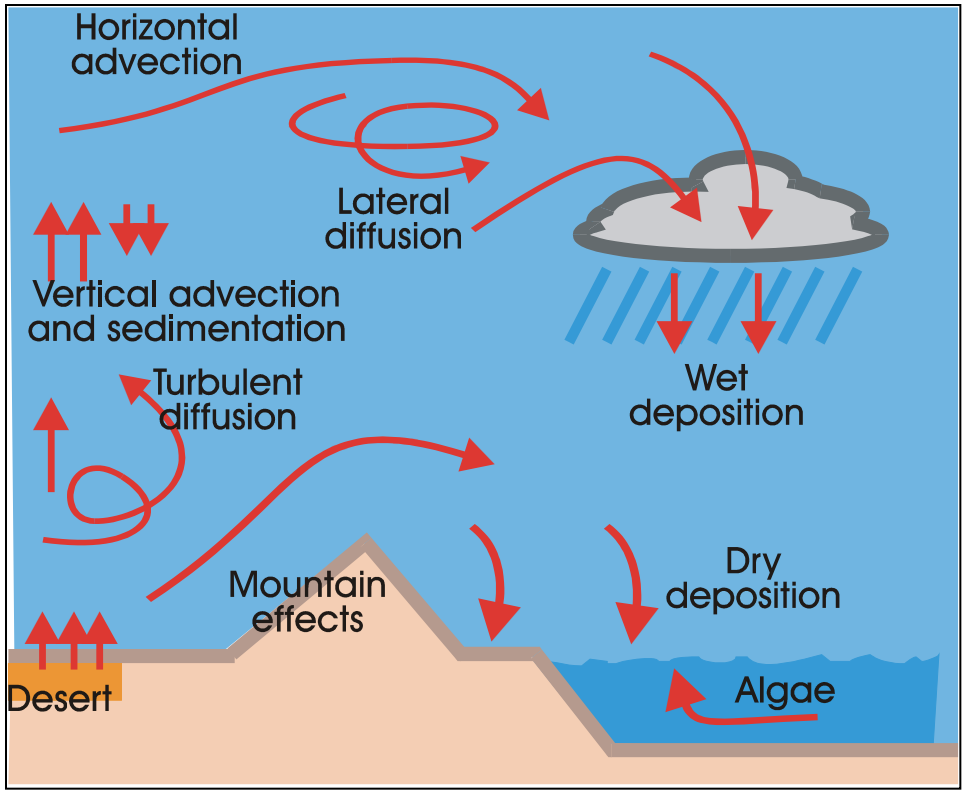
Chin et al. (2009)

The dust cycle



MODIS 4 Feb 2013

The dust cycle

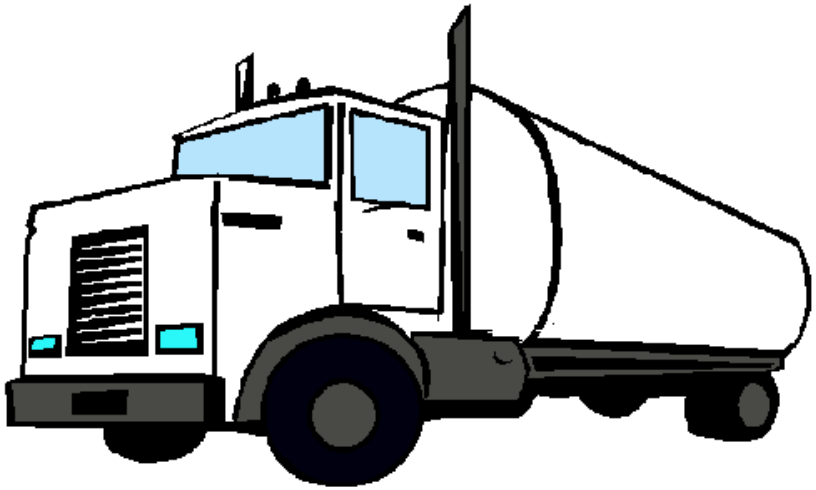


- Dust release (emission)
- Turbulent mixing
- Long-distance transport
- Dry / wet deposition

The dust cycle. Total emissions

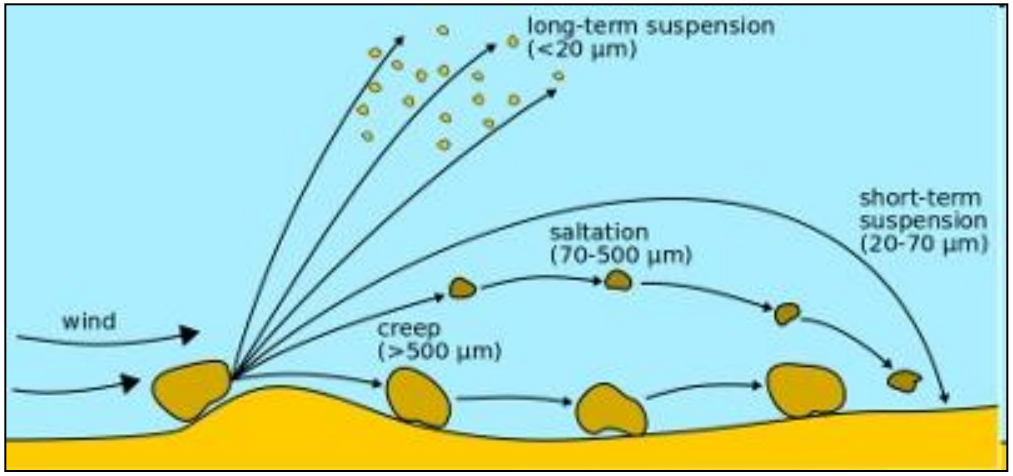
~ 30,000 – 60,000 kg / s
~ 1 – $3 \cdot 10^{12}$ kg / year

50,000,000 lorries



3,000 ULCC

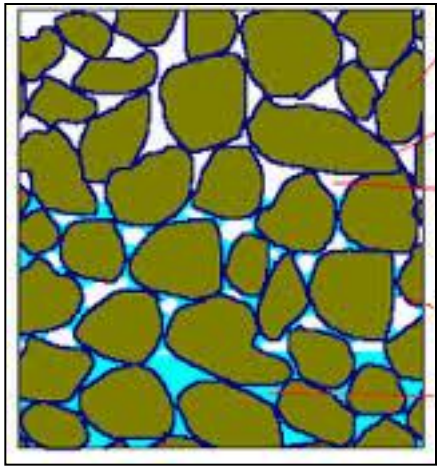
Dust emission



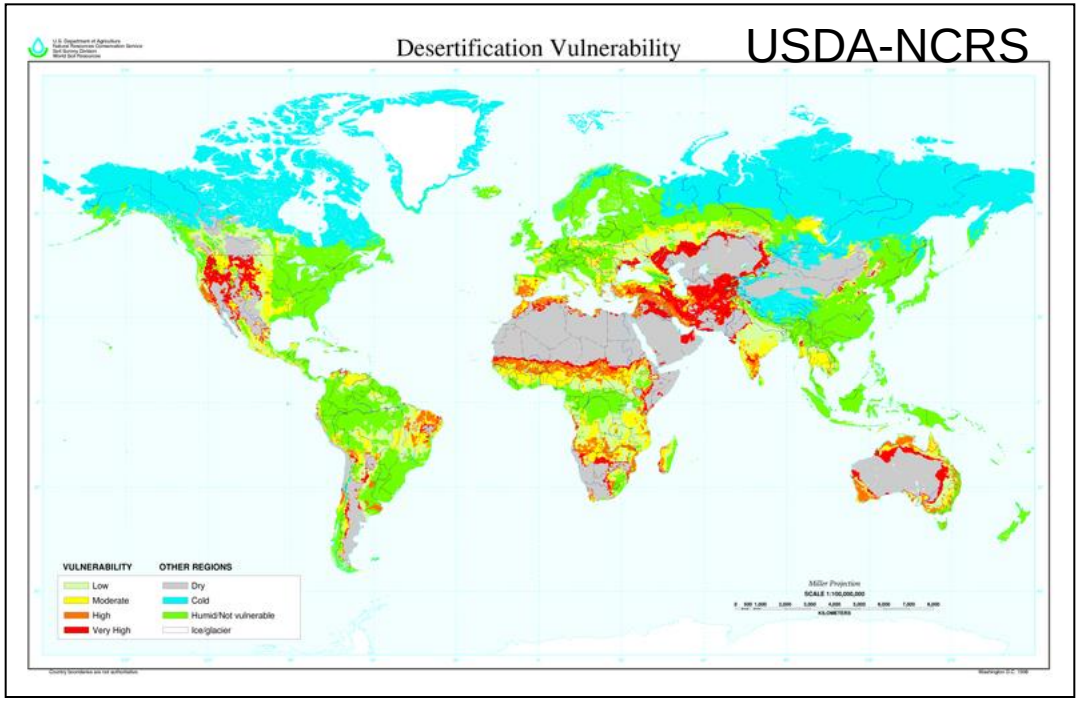
The threshold wind for the mobilisation of soil particles depends on the forces acting to keep these particles in the soil (weight, cohesion between particles, cohesion induced by moisture)

Meteorological factors:
- Wind
- Near-surface turbulence

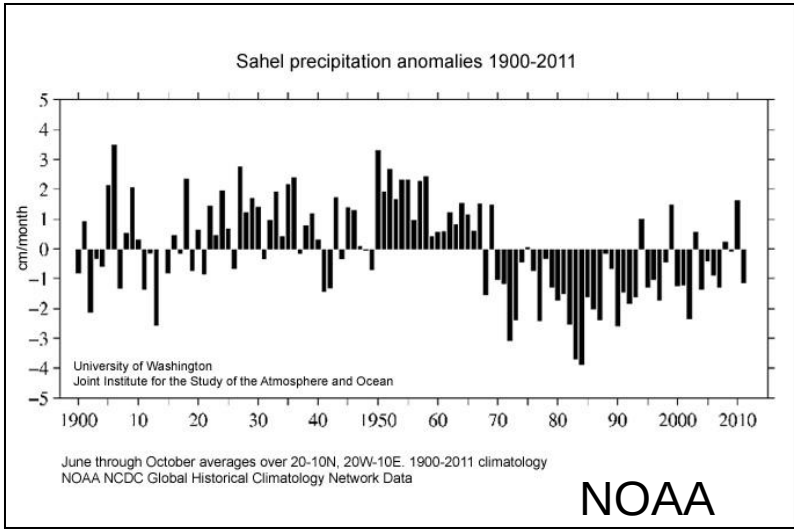
Soil factors:
- Soil texture
- Soil humidity
- Vegetation



Desertification



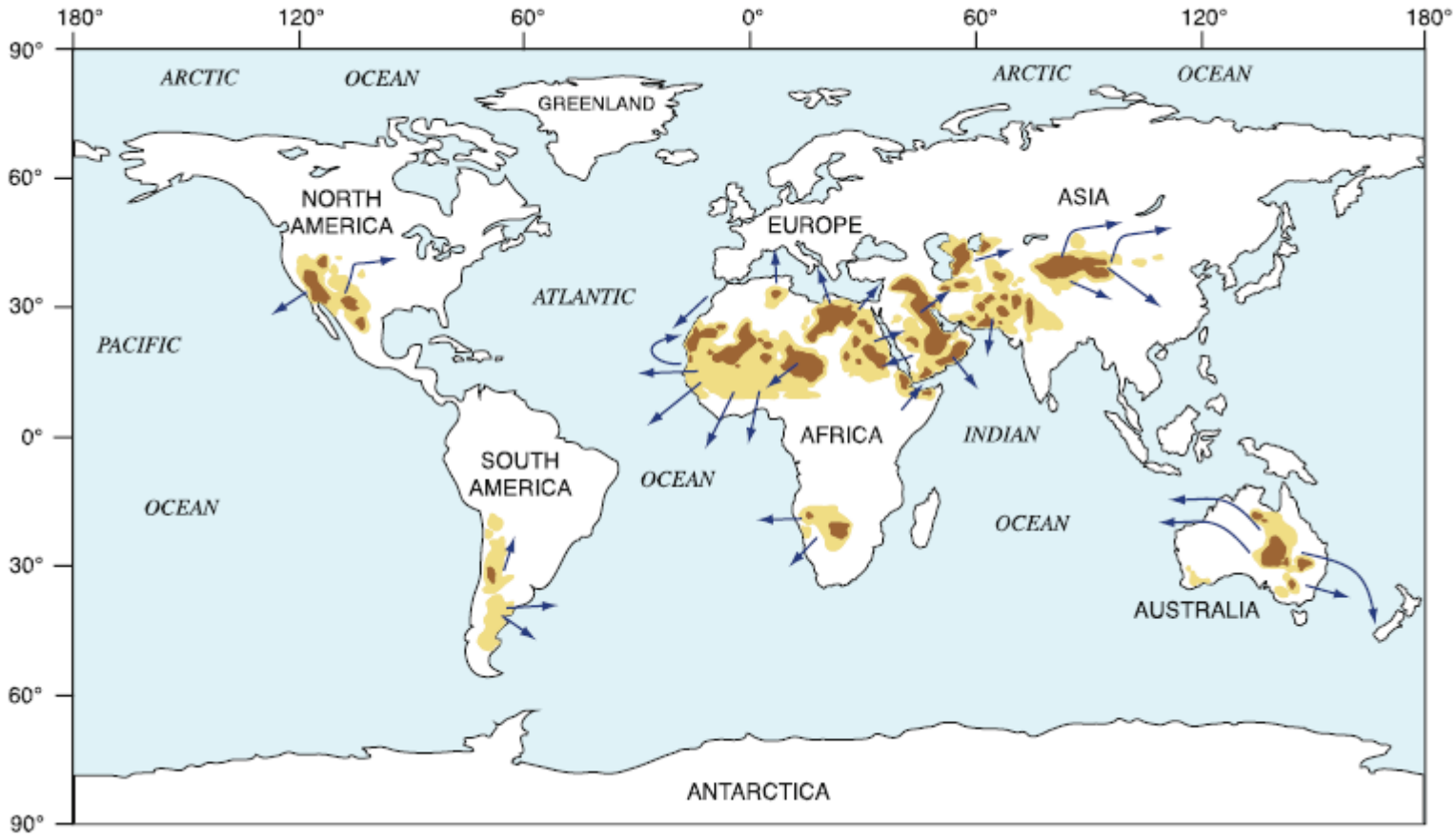
USDA-NCRS



NOAA

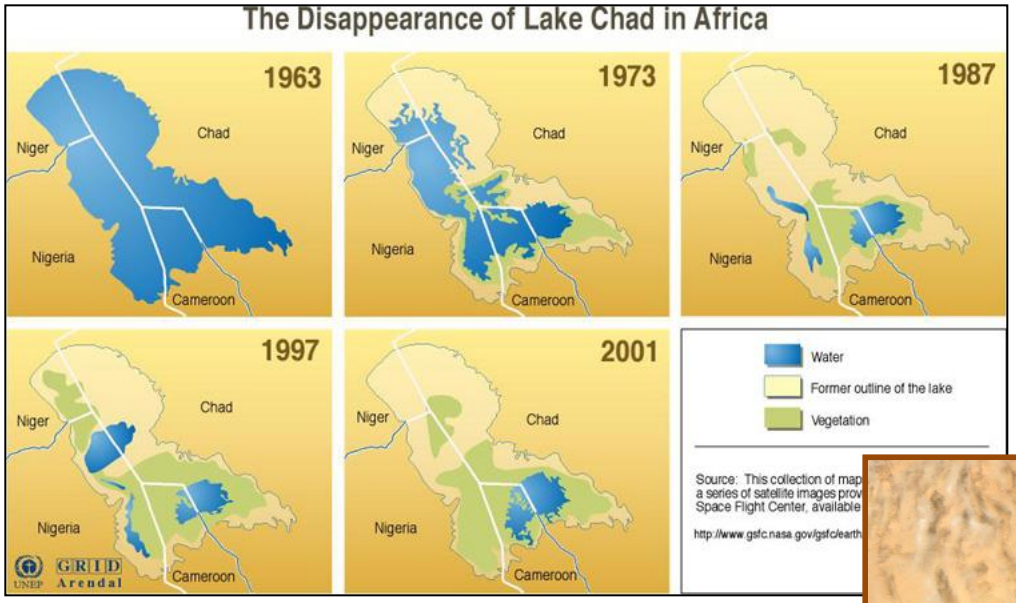
- Drought
- Poor farming practices
- Overgrazing
- Deforestation
- Inadequate water management

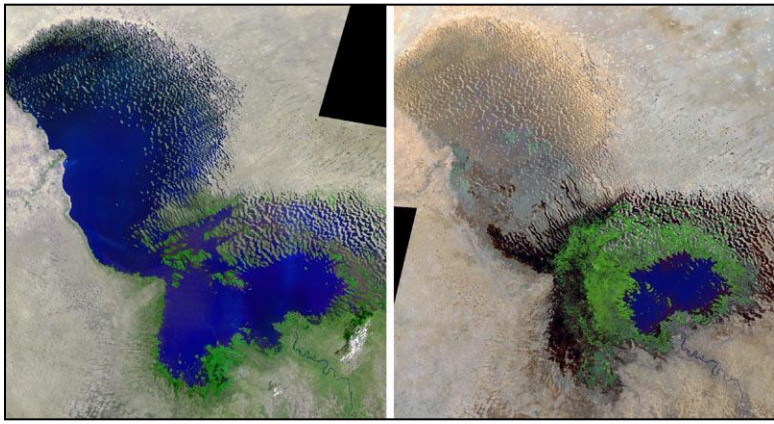
Dust sources

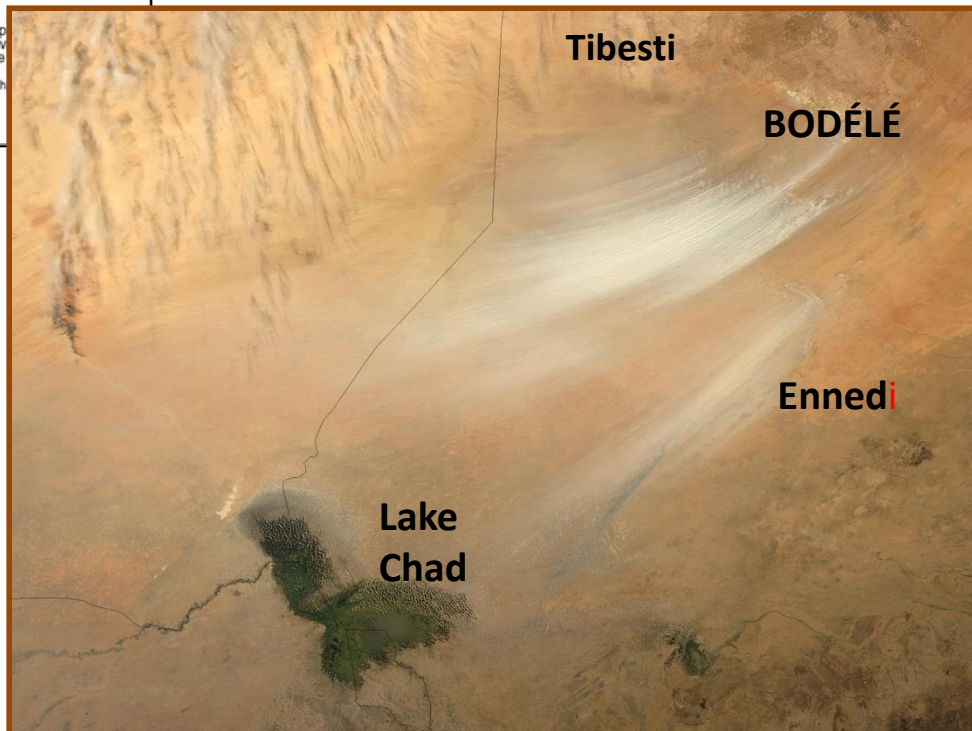


Identification of dust sources based on TOMS' aerosol absorbing index

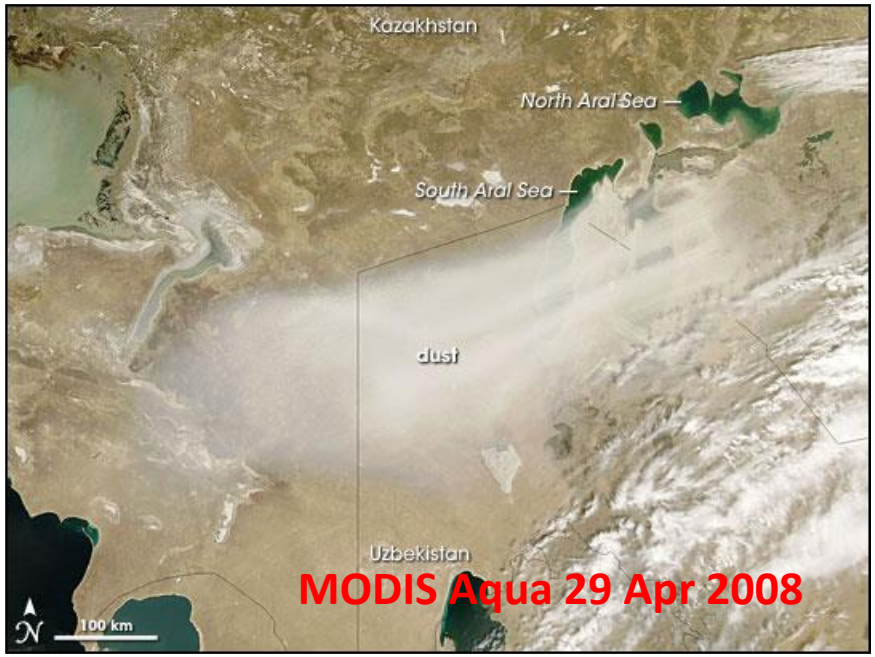
Dried lakes: the Bodélé depression







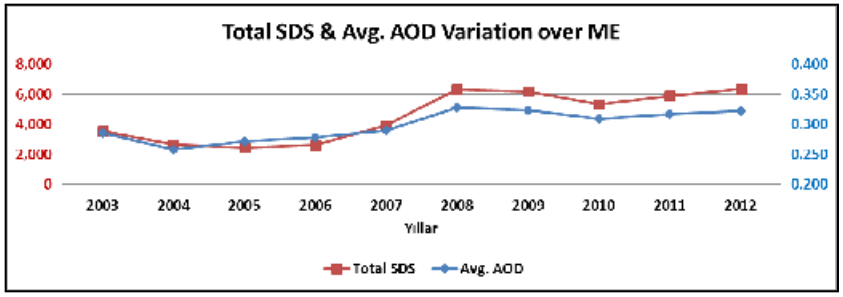
Dried lakes: the Aral sea



Southern Iraq's marshes

2011

1974



Courtesy of Cihan Dundar (TSMS)

2009

Owens lake mitigation program

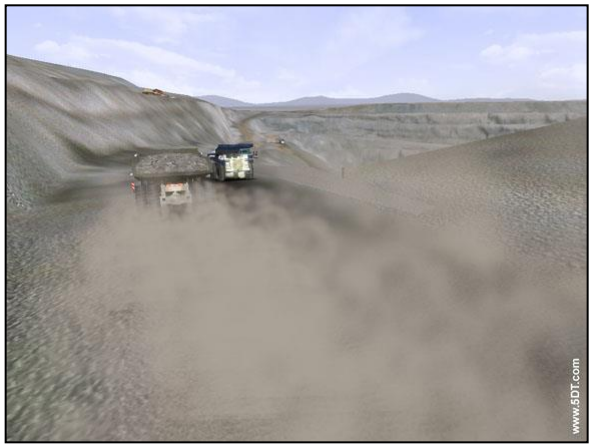
Shallow flooding

Managed vegetation
(saltgrass)

Gravel blanket

Anthropic emissions

Agriculture

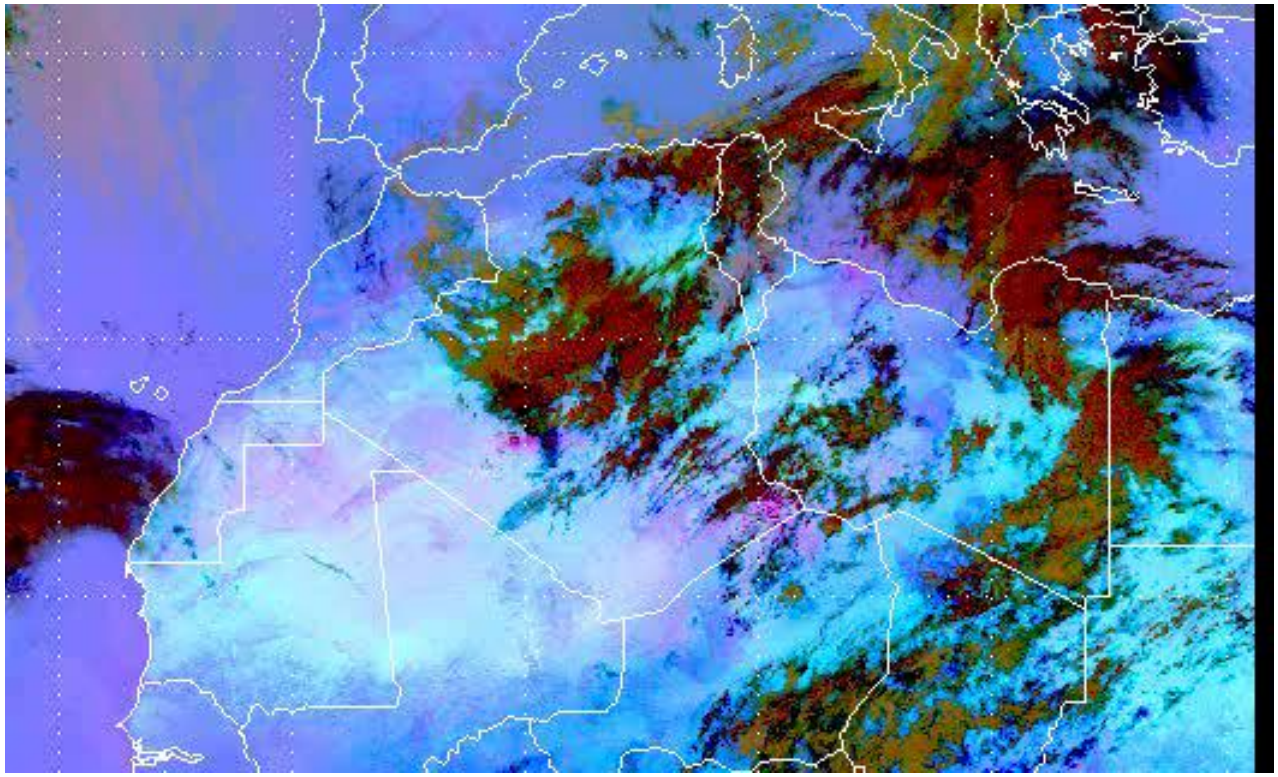


Opencast mining

Construction, demolition

Driving on unpaved roads

Meteorological conditions



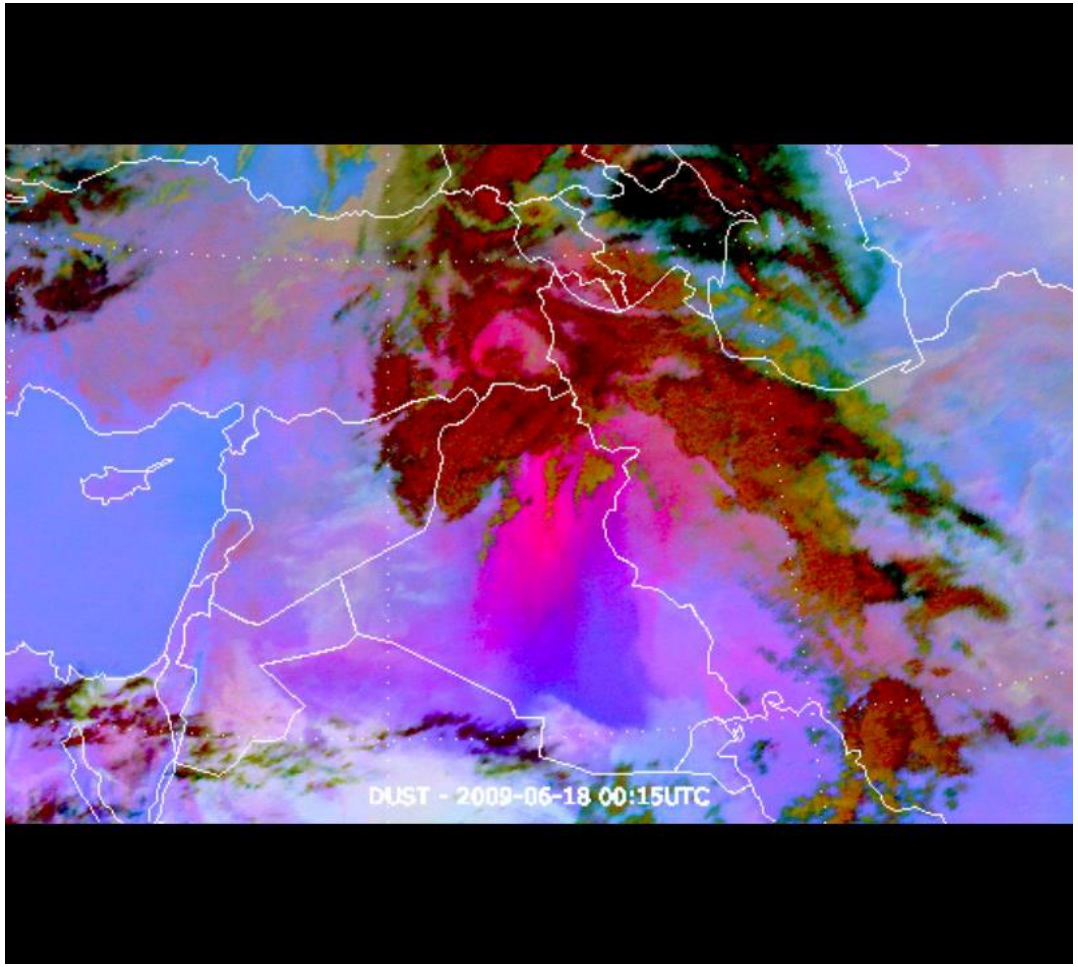
24 Apr 2013

EUMETSAT

SYNOPTIC SCALE

- Frontal systems
- Reinforced trade winds

Meteorological conditions



18 Jun 2009

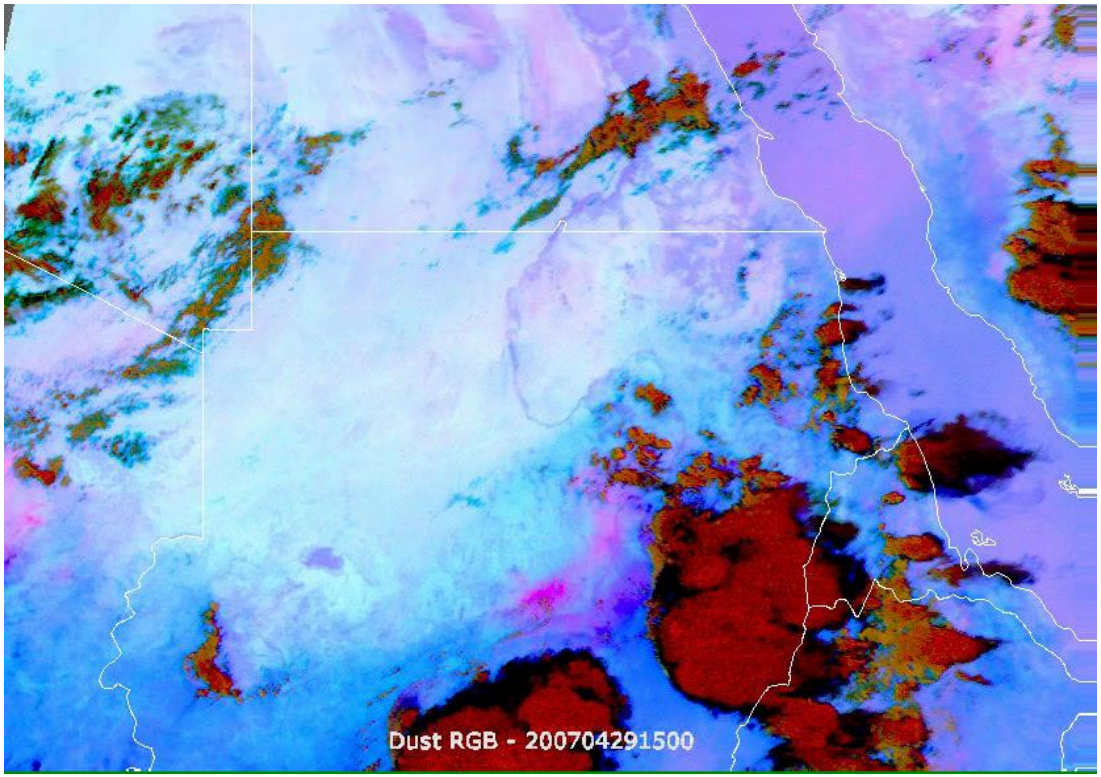
EUMETSAT

Meteorological conditions

MESOSCALE - MICROSCALE

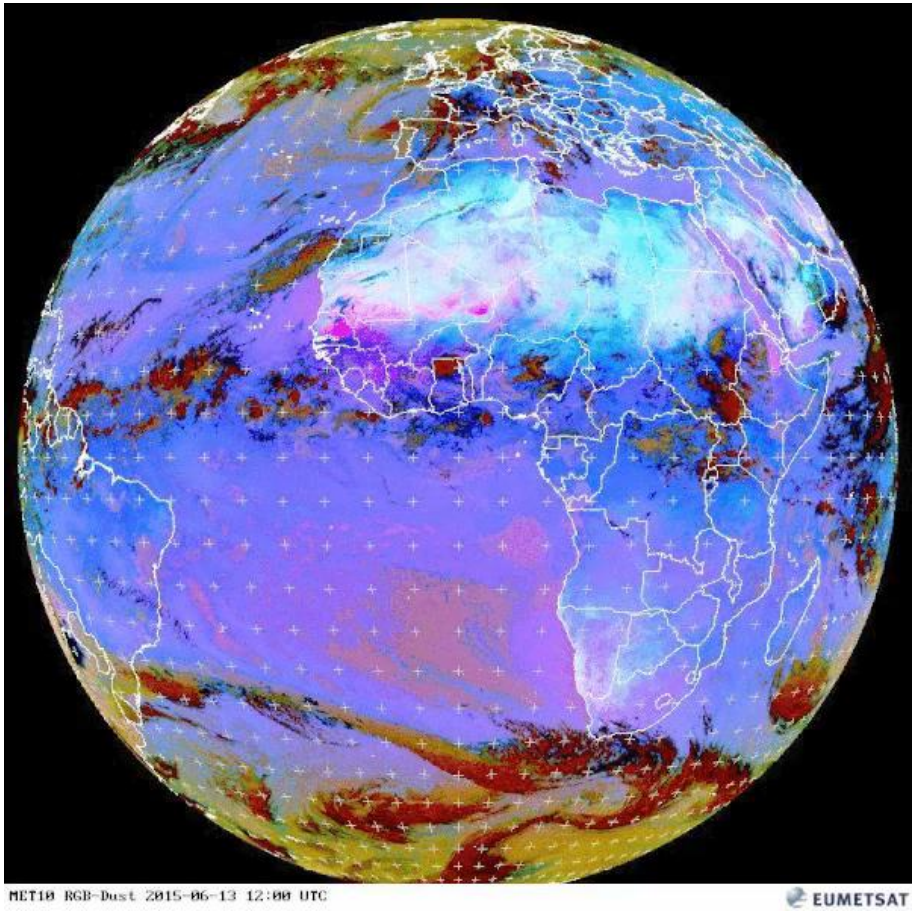
- Convection
- Drainage (katabatic) winds
- Low-level jets
- Gap winds

Meteorological conditions



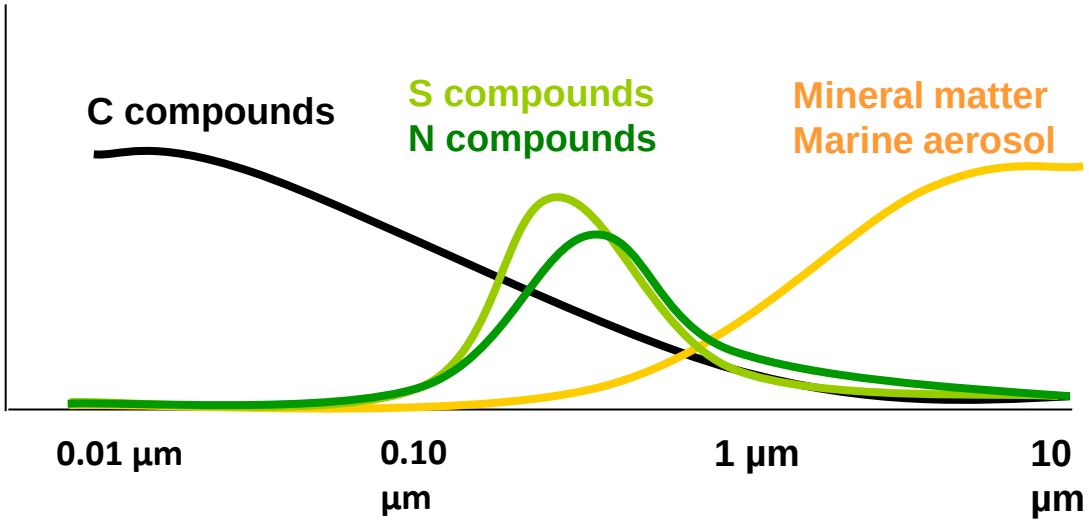
Sudan, 29 apr – 1 May 2007

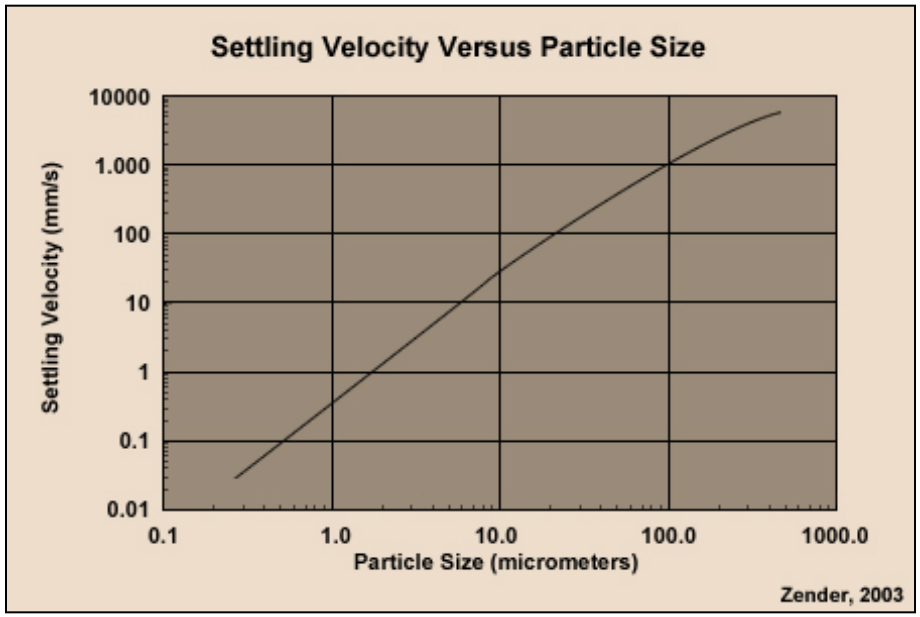
Long-term transport



EUMETSAT RGB Dust 13-16 Jun 2015

Particle size





SIZE (µm)	AVERAGE LIFETIME (h)
0.1 - 0.18	231
0.18 - 0.3	229
0.3 - 0.6	225
0.6 – 1	219
1 - 1.8	179
1.8 – 3	126
3 – 6	67
6 - 10	28

Tegen and Lacis (1996)

Dust composition

MINERALOGIC COMPOSITION (X-ray difractometry)

- Silicates: quartz, feldspar, phillosilicates (illite, kaolinite, smectite)
- Carbonates: calcite, dolomite
- Hematite, gypsum, halite

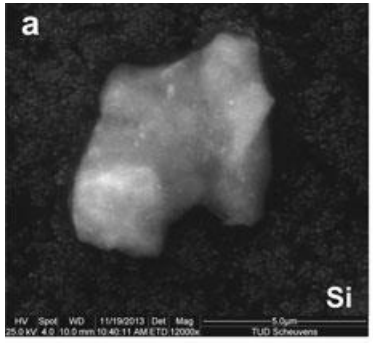
ISOTOPIC COMPOSITION

- Sr, Nd, Pb

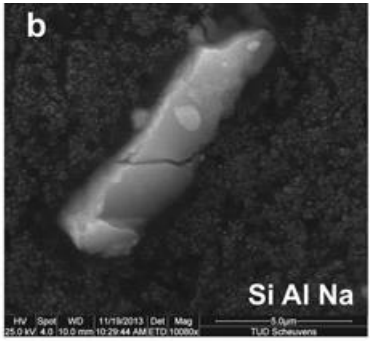
CHEMICAL COMPOSITION (spectroscopy)

- Si, Al, Ca, Mg, Fe, K, Na, Mn, Ti, P, ..

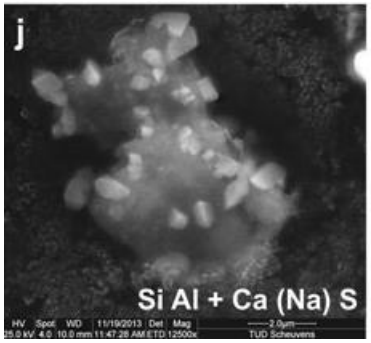
- Information on the dust source
- Influence on the dust impact on health, ecosystems, …
- Influence on the optical properties



Quartz

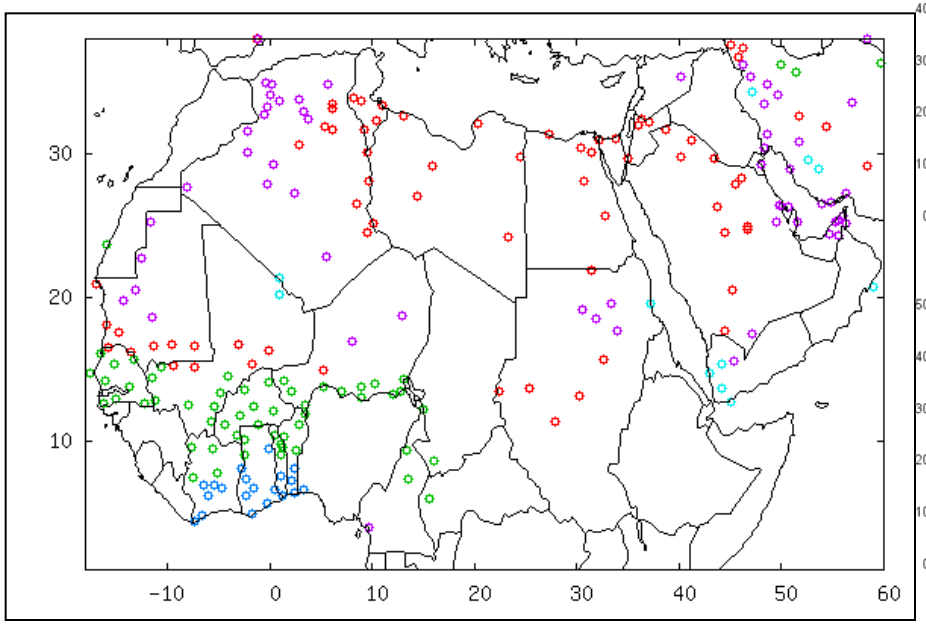


Albite

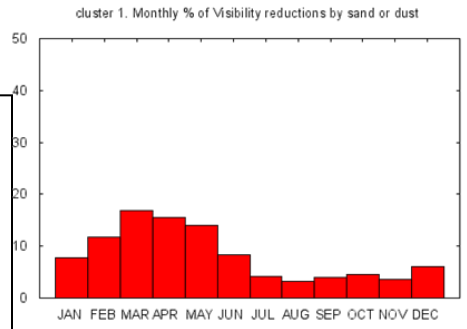


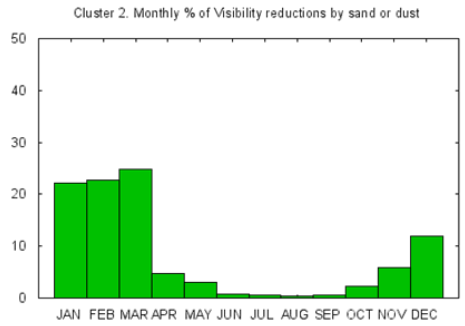
Gypsum

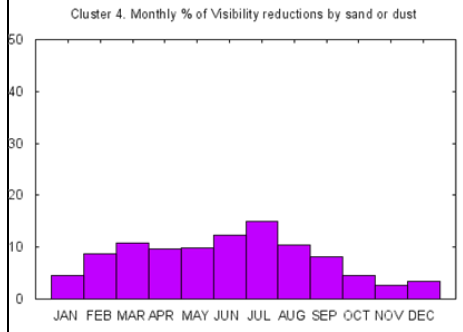
Seasonal variability

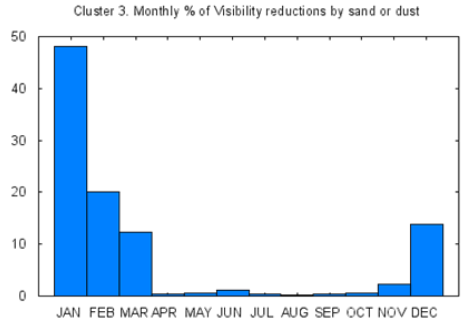


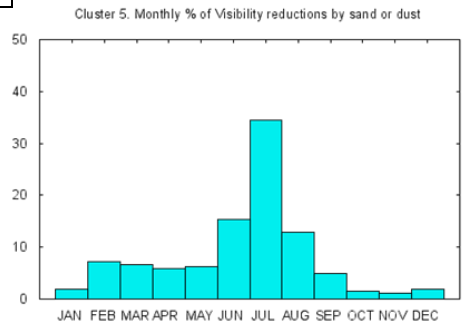
1996 - 2010









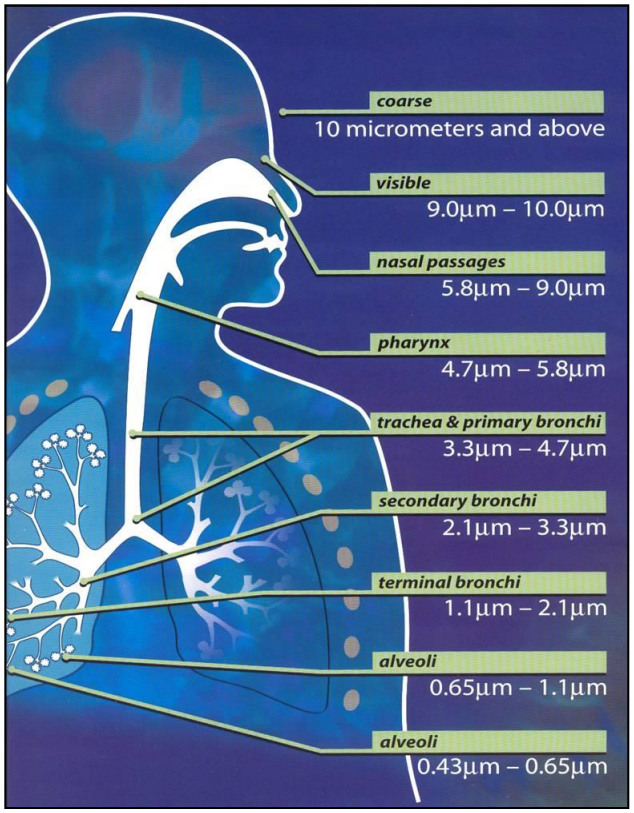


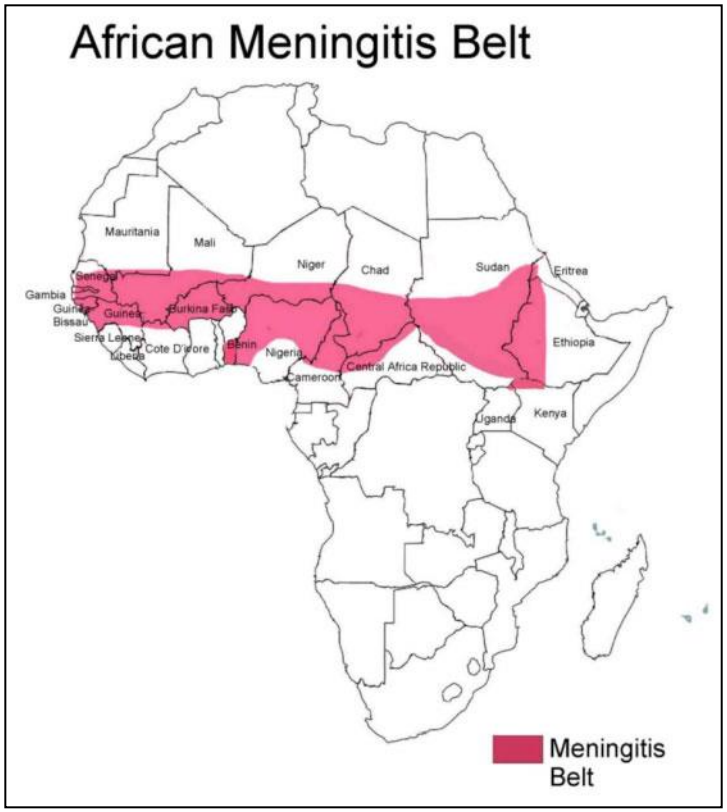
(Terradellas et al., 2012)

Dust impacts

- Air quality and health
- Weather and climate
- Transportation
- Solar energy
- Agriculture
- …

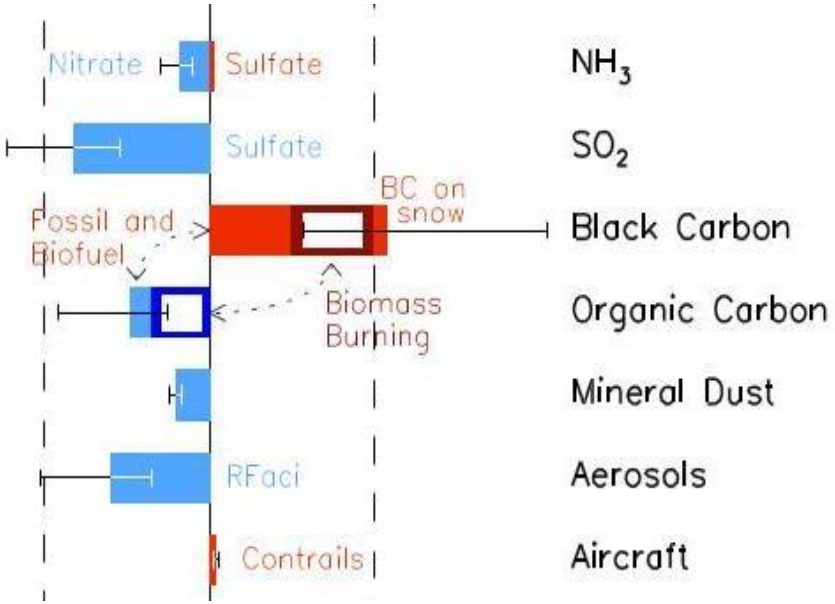
Impact on human health

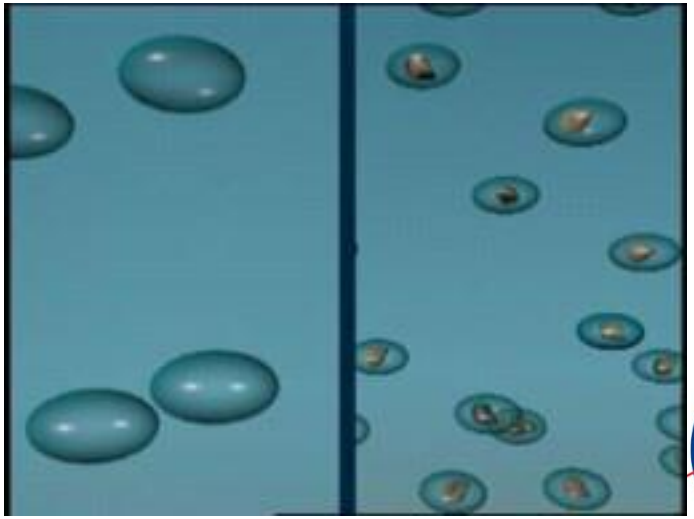


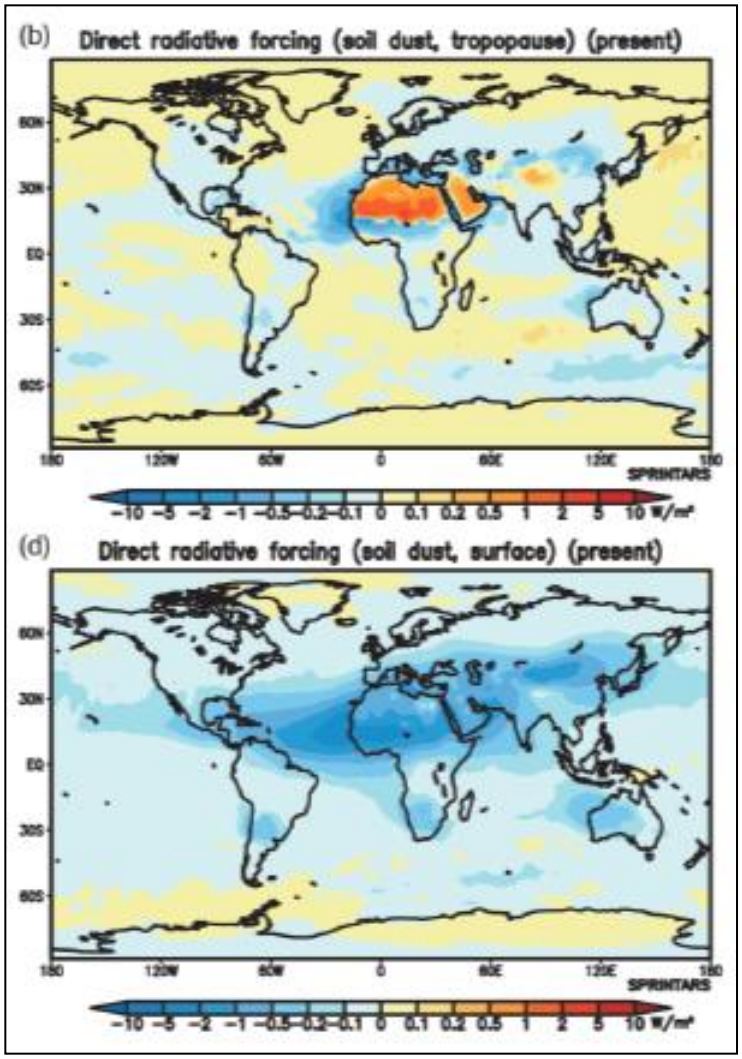


- Particle size
- Chemical and mineralogical composition
- Pathogens (bacteria, fungi, viruses, …) transported by dust
- Time snd intensity of exposition

Impact on climate and weather

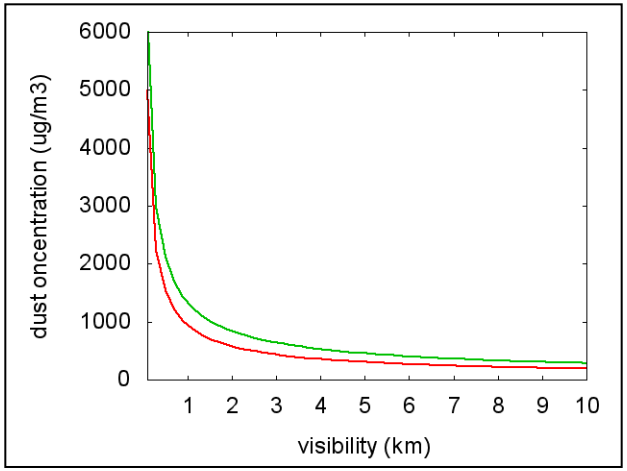






Takemura et al., (2009)

Impact on transport



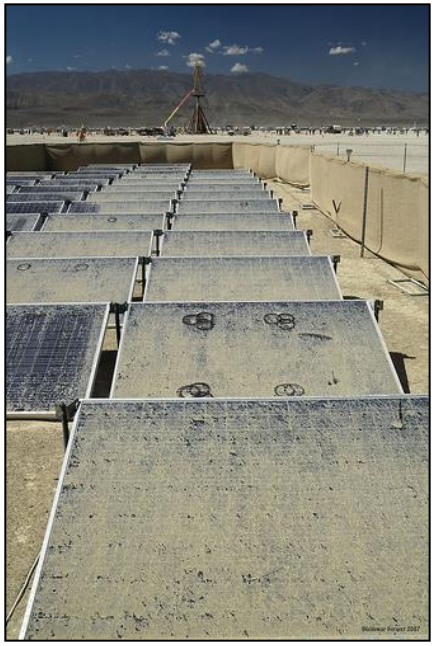
D'Almeida (1986)
Ben Mohamed et al. (1992)

Arizona, 29 Oct 2013

Tunisia, 7 May 2002

Impact on solar energy

- Reduction in available energy
- Reduction in system efficiency
- Need for costly maintenance
- Need much water



Impact on agriculture

- Crop damage (loss of plant tissue and reduced photosyntetic activity)
- Loss of topsoil
- Damage to infrastructure (irrigation canals, roads, …)
- Reduction of water quality
- Supply of nutrients to the soil (Na, K, Mg, Ca, P)

WMO SDS-WAS

Mission:

Improve the capacity of countries to produce and distribute to end users accurate forecasts of the mineral dust content in the atmosphere

Structure:

- Regional Center for Northern Africa, Middle East and Europe. Barcelona, Spain
- Regional Center for Asia, Beijing, China
- Regional Center for Pan America
- Regional center for West Asia ???

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

The Center is jointly managed by the State Meteorological Agency of Spain (AEMT) AND THE Barcelona Supercomputing Center (BSC)

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
AEMet Agencia Estatal de Meteorología

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

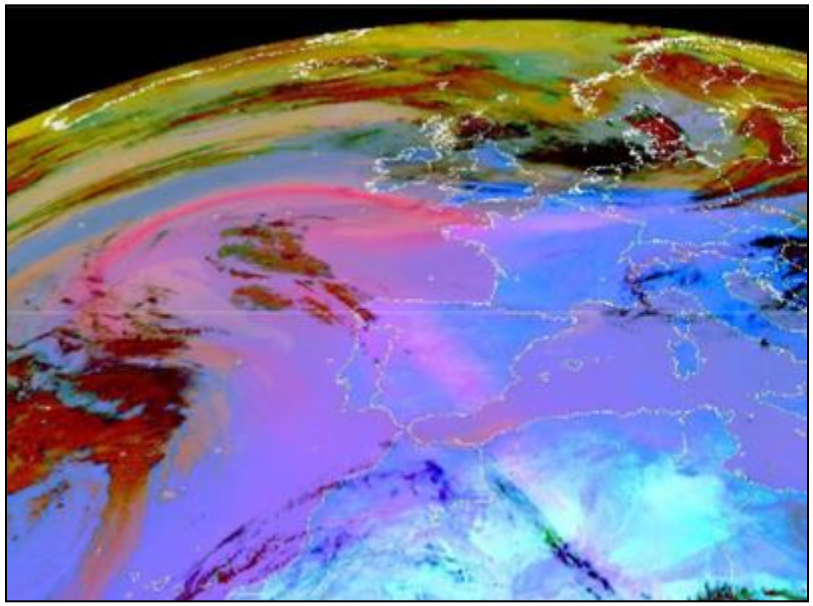
UPC campus. Nexus II building

Marenostrum 3 supercomputer

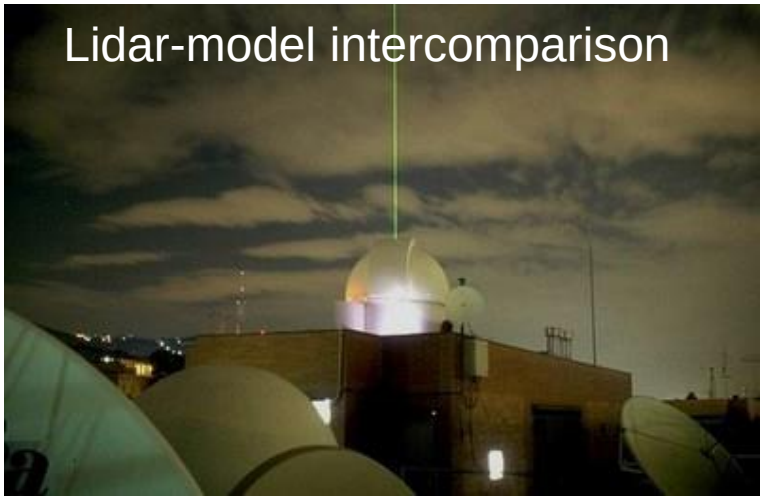
Regional Center. Objectives

- **Identify and improve products for dust monitoring and prediction through collaboration with research and operational organizations, as well as with end-users**
- **Facilitate user-access to information**
- **Strengthen the capacity of countries to use observations, analysis and predictions supplied**

Cooperative research

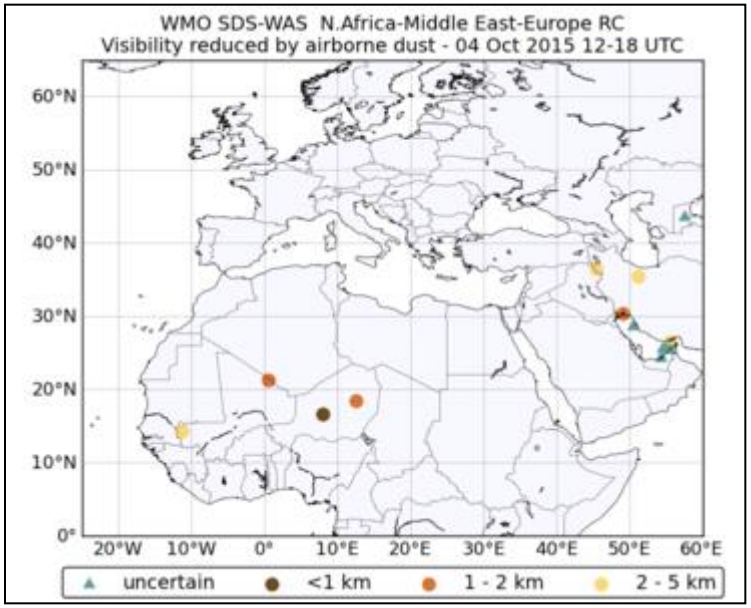


Model inter-comparison for a Saharan dust outbreak into Europe (Apr 2011).



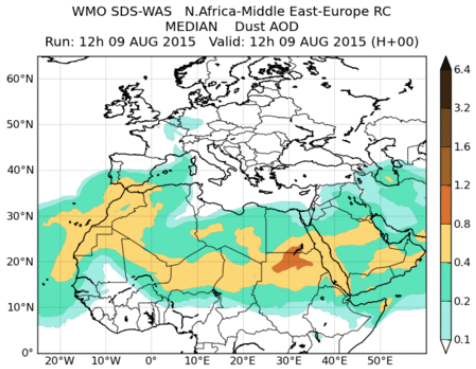
Study of a haboob in Tehran (Jun 2014)

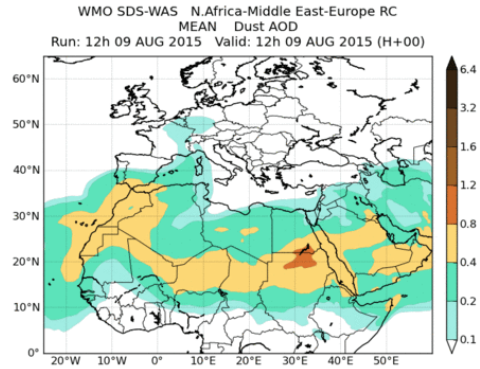
New products

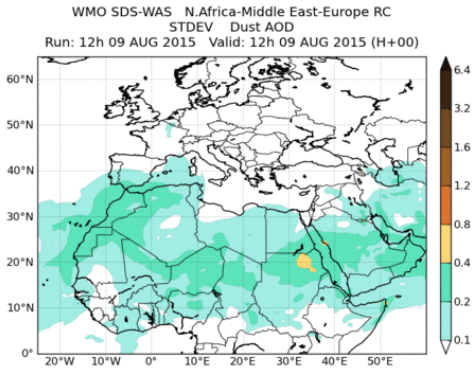


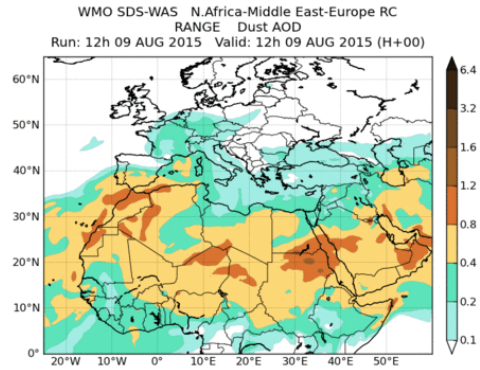
4 Oct 2015 12-18 UTC

9 Aug 2015





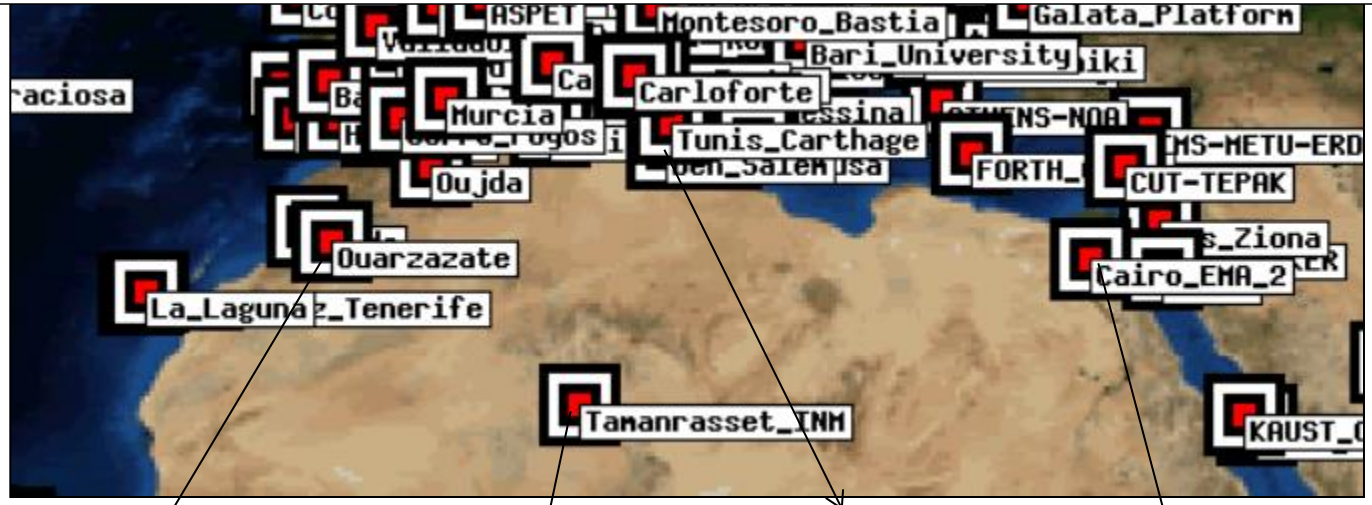




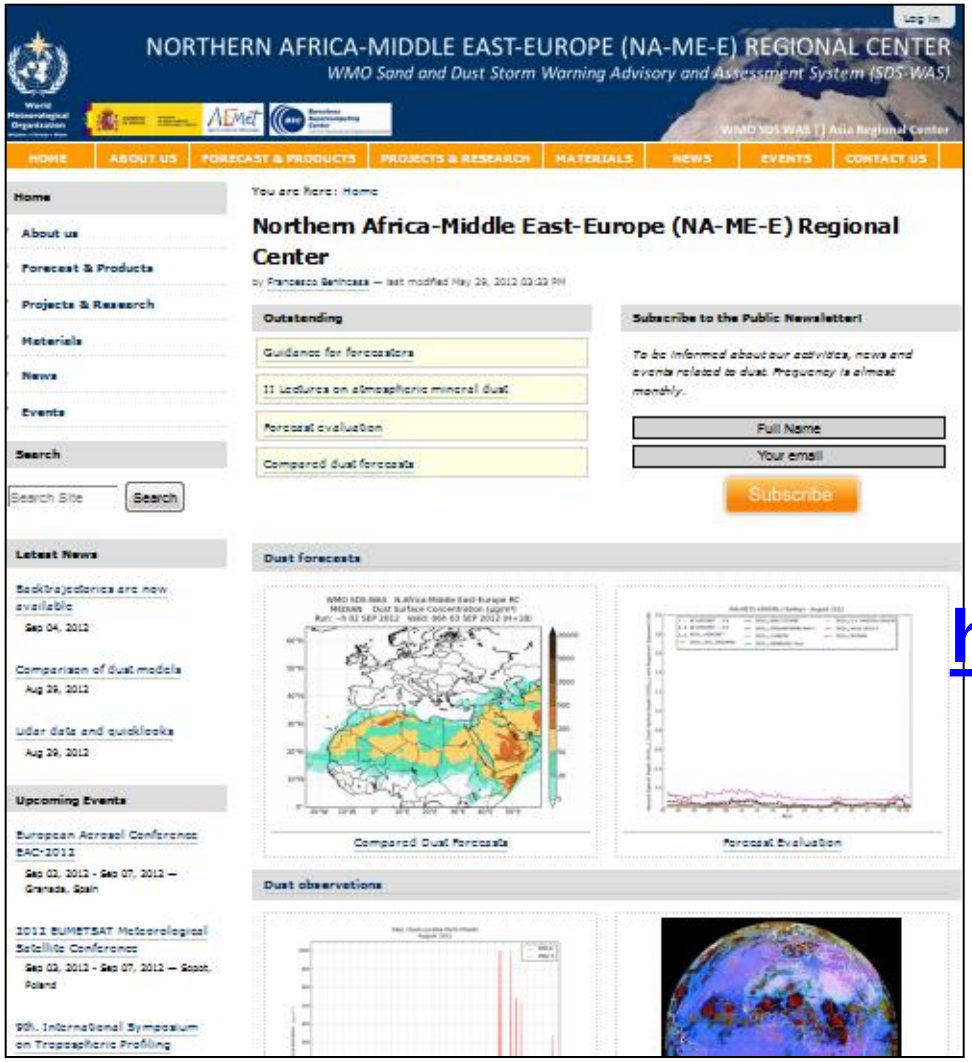
SDS Africa

Agencia Estatal de Meteorología

AGENCIA ESPAÑOLA DE COOPERACIÓN INTERNACIONAL



Website



http://sds-was.aemet.es

sdswas@aemet.es

Capacity building

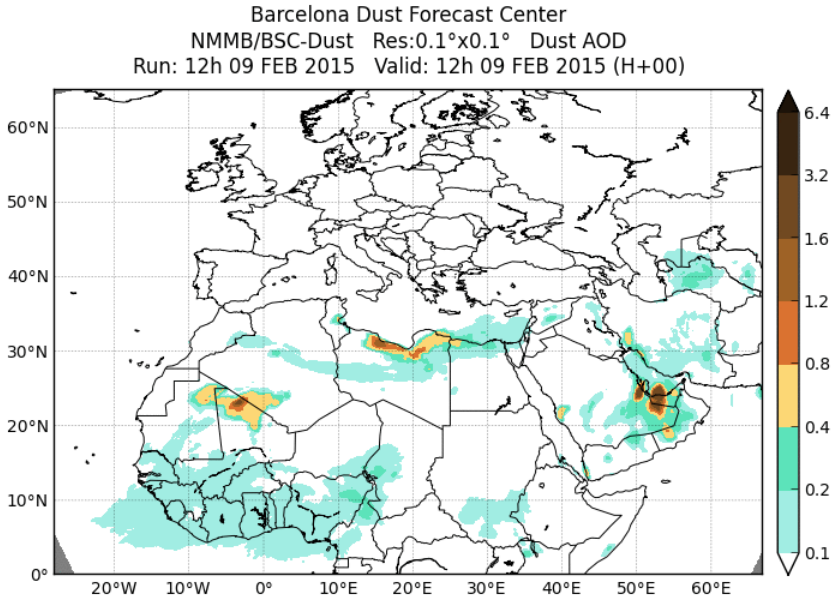
TRAINING COURSES

- Accra
- Addis-Ababa
- Ankara
- Antalya
- Barcelona
- Casablanca
- Istanbul
- Muscat
- Niamey
- Ouagadougou

VISITORS FROM

- Iraq
- Romania
- Turkey

Barcelona Dust Forecast Center



May 2013

WMO designates the consortium of AEMET and BSC to host the first RSMC-ASDF. The Center will generate and distribute operational dust forecasts for Northern Africa (north of equator), Middle East and Europe

Feb 2014

The Center, called Barcelona Dust Forecast Center (BDFC) starts operations

Jun 2015

The BDFC is presented at the 17th WMO Congress

Thanks for your attention

شكرا على انتباهك

WMO SDS-WAS Regional Center for Northern Africa, Middle East and Europe

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Barcelona Dust Forecast Center

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