

# Introduction & Dust Cycle

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Workshop on Dust Products Northern and Western Africa  
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# Outline

## 1 Atmospheric Cycle of Mineral Dust

- Aerosol Distribution
- Dust Numbers
- Impacts
- Introduction: SDS-WAS
- Dust Cycle

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## ATMOSPHERIC AEROSOL



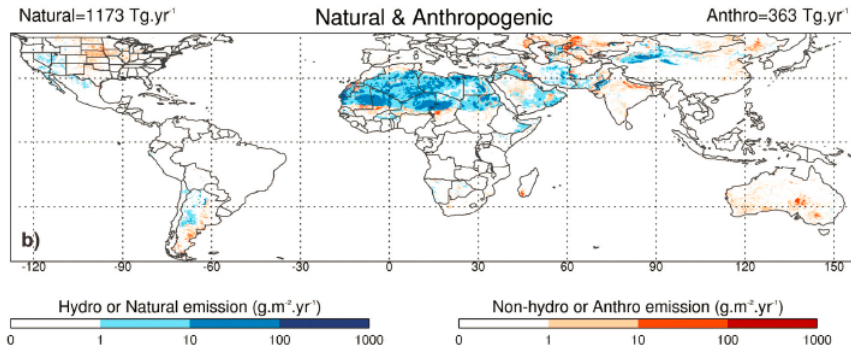
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## Dust Cycle



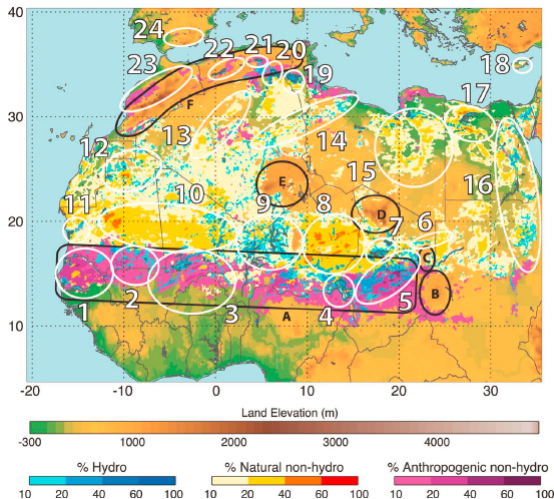
## Dust Cycle

- ## Dust Cycle



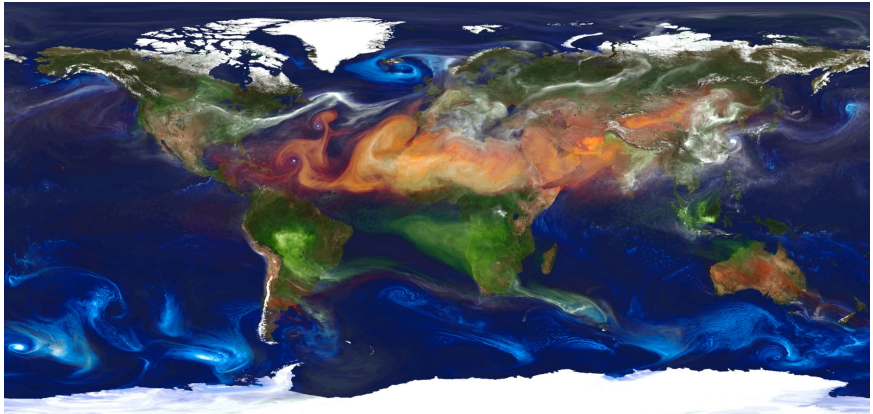
Source: Paul Ginoux et.al, 2012

## Data from MODIS Deep Blue Level 2



## Data from MODIS Deep Blue Level 2

## Geographical Dust Distribution: Global or local problem?



**GEOS 5** : Earth System Modeling and Data Assimilation (50 km)

Orange: Mineral dust

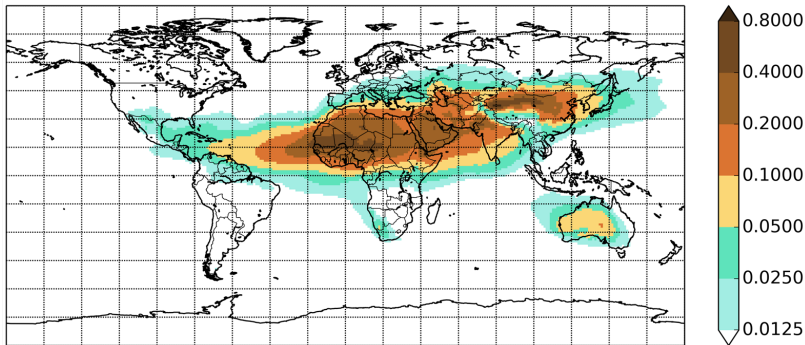
Blue: Seasalt

Green: Carbon from biomass burning

White: Sulfates



# Geographical Mineral Dust Distribution



**CAMS** reanalysis AOD 550 nm (Average value: 2003-2015)

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## GLOBAL ASSESSMENT OF SDS - UNEP 2016

- Total annual global dust emissions of 1,536 Tg yr<sup>-1</sup>
- 25 % anthropogenic sources (principally agriculture)
- 75 % coming from natural dust sources
- Northern Africa contributes to more than half of global dust emissions
- Sahara is the most significant natural source
- Sahel dust emissions are related to land use: agriculture

## Sahara, Bodélé depression & Amazonas (Ilán Koren et al 2006)

- 40 Tg/year from the Sahara to the Amazon basin (5000 km)
- Bodélé depression (largest single dust source): 0.7 Tg of dust per day (winter emission day)
- Half of the Amazonas annual dust supply is emitted from the Bodélé depression

## AQ standards

### Comparison of Pollutant Limits Set by WHO, EEA, and USA

Pollutant	Averaging Period	WHO Limits	EEA (European Union) Limits	EPA (United States) Limits
Carbon Monoxide	8 hours	10 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>	9 ppm or 10 mg/m <sup>3</sup>
Lead	yearly	0.5 mg/m <sup>3</sup>	0.5 mg/m <sup>3</sup>	-
Nitrogen Dioxide	1 hour	200 µg/m <sup>3</sup>	200 µg/m <sup>3</sup>	100 ppb
Ozone	8 hours	100 µg/m <sup>3</sup>	120 µg/m <sup>3</sup>	0.07 ppm
PM <sub>2.5</sub>	1 year	25 µg/m <sup>3</sup>	25 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
PM <sub>10</sub>	1 day	50 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>
SO <sub>2</sub>	1 hour	-	350 µg/m <sup>3</sup>	75 ppb

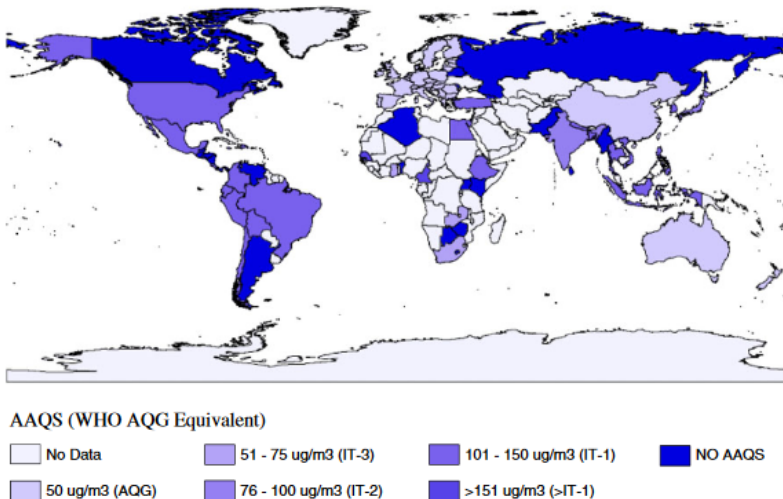


**China:** PM10 24hours: 40 -70 µg/m<sup>3</sup>

**Nouakchott (Mauritania):** PM10 Average annual: 108 µg/m<sup>3</sup>

Link: AQ Standards

# AQ standards



**Fig. 1** Map of national 24-h AAQS for PM<sub>10</sub> AAQS (WHO AQG equivalent)

Source: Candace Vahlsing & Kirk R. Smith, 2011

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## Impacts: Local & Global

### Impacts:

#### Meteorology & Climatology:

Radiative budget, cloud formation, aerosols interaction, ...

**Transport:** visibility reduction, engine maintenance, ...

**Air Quality & Health**

**Solar Energy**

**Agriculture**

**Ecosystems** → Fertilizer



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# SDS-WAS

## SDS-WAS History and Objectives

- 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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## SDS-WAS NAMEE RC and Barcelona Dust Forecast Center

- SDS-WAS NAMEE RC (2010)
- Barcelona Dust Forecast Center (RSMC-ASDF 2014)
- AEMET and BSC (Barcelona Supercomputing Center)



Marenostrum 4: BSC



Bull-Atos: AEMET



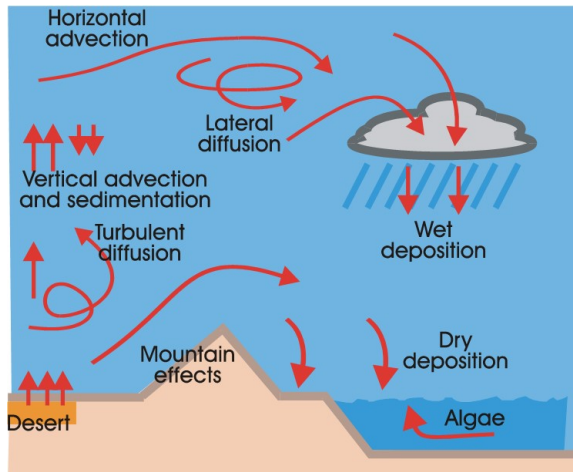


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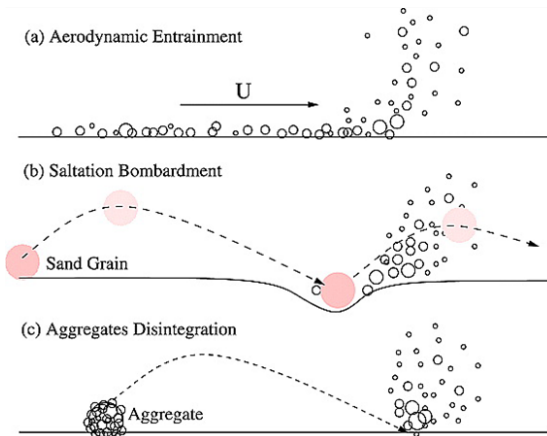
# Dust Cycle



Source: Barcelona Dust Forecast Center

- Emission
- Vertical movement
- Transport
- Wet & Dry Deposition

## Emission: Saltation & Sandblasting



Source: media.springernature.com

- Direct suspension → strong wind
- The most efficient way of dust-emission → **saltation** (horizontal flux) and **sandblasting** (vertical flux)

## Emission: Erosion threshold depends on soil nature and state



Dry session



Wet session → Flooded soil



Crusted soil

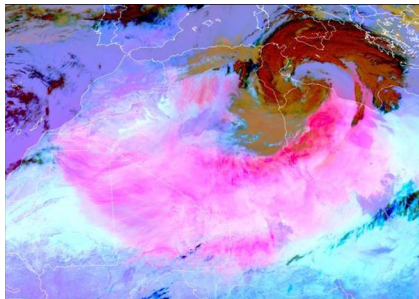


Snow

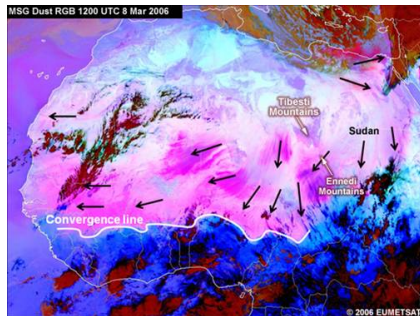
# Meteorological factors

## Synoptic and meso-alpha phenomena

- Frontal system winds
- Trade winds



RGB images: **Magenta** → Dust



## Meteorological factors

### Meso-gamma and microscale phenomena

- Orographic Winds
- Convection: Haboob and Dust devils



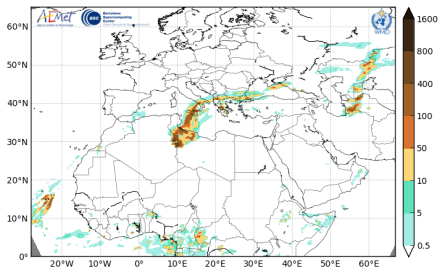
Source & link to the video: DVArchive

## Dust transport

- Chemical composition changes
- Increasing ability of particles to act as CN
- Increasing solubility of Fe

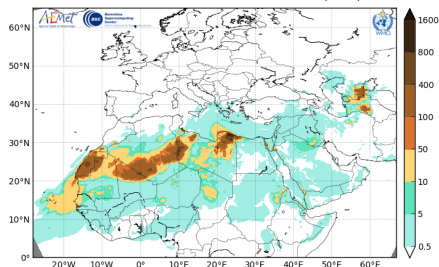
# Wet (rain) & Dry (gravitational force) Deposition

Barcelona Dust Forecast Center - <http://dust.aemet.es/>  
 NMMB/BSC-Dust Res:0.1°x0.1° 3h Acc. Dust Wet Depos. (mg/m<sup>2</sup>)  
 Run: 12h 21 MAR 2018 Valid: 00h 22 MAR 2018 (H+12)



Source: Alfons Puertas. Observatori Fabra

Barcelona Dust Forecast Center - <http://dust.aemet.es/>  
 NMMB/BSC-Dust Res:0.1°x0.1° 3h Acc. Dust Dry Depos. (mg/m<sup>2</sup>)  
 Run: 12h 21 MAR 2018 Valid: 00h 22 MAR 2018 (H+12)



Source: Michael Freeman. Khartoum Haboob



## Videos on Dust

# inDust



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