REPUBLIC OF TURKEY
The Ministry of Forestry and Water Affairs
TSMS

Sand and Dust Observations and Observation Network

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RESEACH DEPARTMENT

2016 - ISTANBUL

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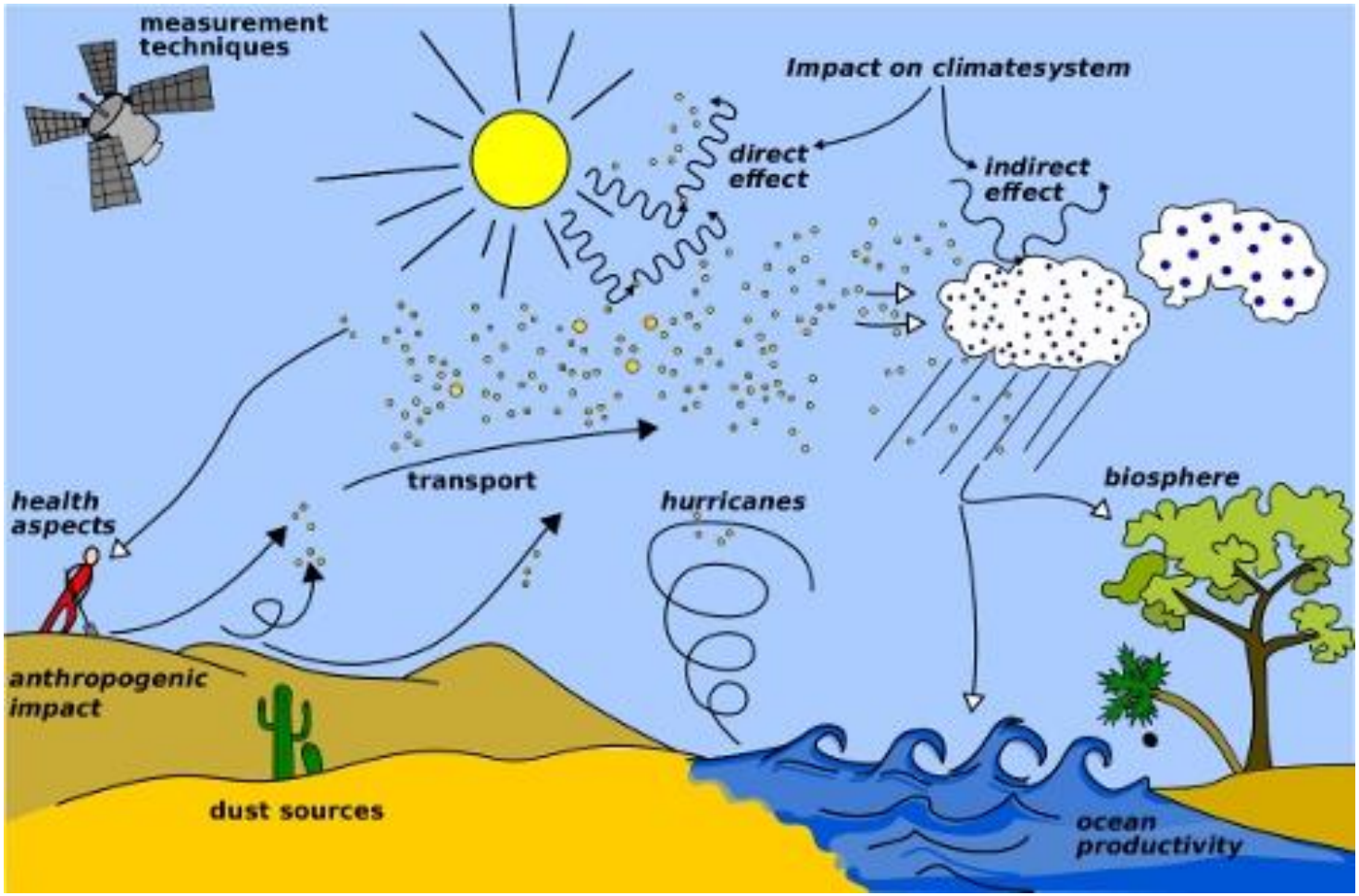
Orman ve Su İşleri
Bakanlığı

Dust



Dust Impact on Atmosphere

Dust plays an important role in weather forecast and climate.

(1) Indirect effect: modification of the cloud droplet concentration and size distribution

(2) Direct effect: change radiation budget by absorbing and scattering solar radiation

Objetives of the Regional Center

- Lead the implementation and operation of an integrated system of observation and prediction
  - Identify and improve observational and forecast products
  - Promote the creation and improvement of observational networks in developing countries.
- Facilitate user access to information
  - Create and maintain a website
  - Create alternative systems tailored to users
- Build capacity of countries to use the products supplied

Observation Network

- mineral dust forecasting
- early warning system for real-time monitoring,
- validation
- verification of numerical prediction models and data assimilation schemes

<u>The main data sources</u>

- in-situ measurements,
- aerosol optical depth and derived products retrieved from ground-based radiometer measurements and satellite products

Aerosol Optical Depth

<u>important information about</u>

- concentration,
- size distribution,
- variability of aerosols (desert dust, sea salt, haze, and smoke particles) in the atmosphere

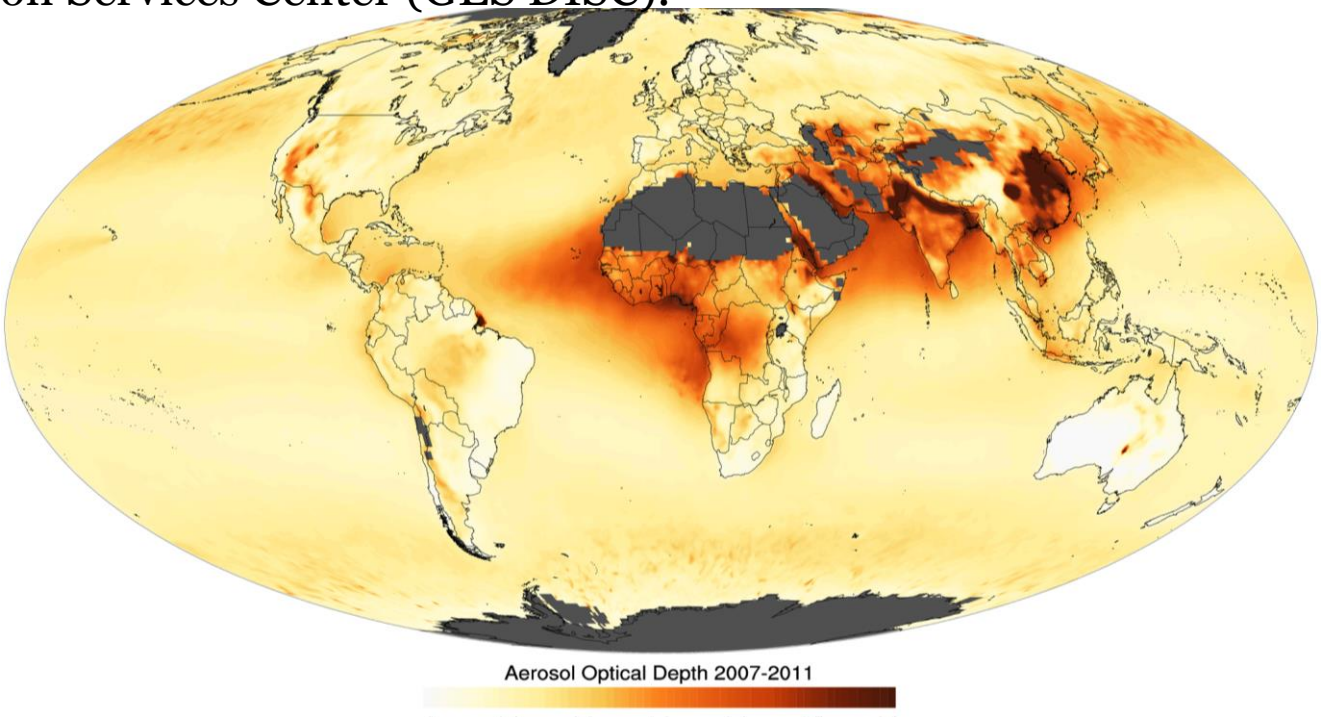
- dimensionless number that is related to the amount of aerosol distributed within the vertical column of atmosphere over the observation location,
- aerosol particles in the atmosphere can block sunlight by absorbing or by scattering light,
- AOD is used as a quantitative measure of the extinction of solar radiation by aerosol scattering and absorption

- Heavy dust regions - higher than 0.3
- Around deserts - above 1.0 and usually below 3.0

Aerosol Optical Depth

- Giovanni website provides a simple way to visualize, analyze, and access Earth science remote sensing data, particularly from satellites, without having to download the data.
- It includes data for aerosols, atmospheric chemistry, atmospheric temperature and moisture, and rainfall. It was developed by the Goddard Earth Sciences Data and Information Services Center (GES DISC).

- giovanni website



Angstrom Exponent

- Additional information on the particle size, aerosol phase function and the relative magnitude of aerosol radiances at different wavelengths.
- The Angstrom exponent (AE) is an exponent that expresses the spectral dependence of aerosol optical thickness (τ) with the wavelength of incident light (λ)
- AE relation

$$\tau_\lambda = \tau_{\lambda_0} \left(\frac{\lambda}{\lambda_0}\right)^{-\alpha}$$

$$\alpha = Angstrom\ exponent$$

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Angstrom Exponent

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- useful quantity to evaluate the particle size of atmospheric aerosols or clouds, and the wavelength dependence of the aerosol/cloud optical properties
- inversely related to the average size of the particles in the aerosol.

The smaller the particle size, the larger the Angstrom exponent. Therefore, low AE values indicate strong presence of coarse aerosols relating to the dust events.

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SDS-WAS Regional Centres

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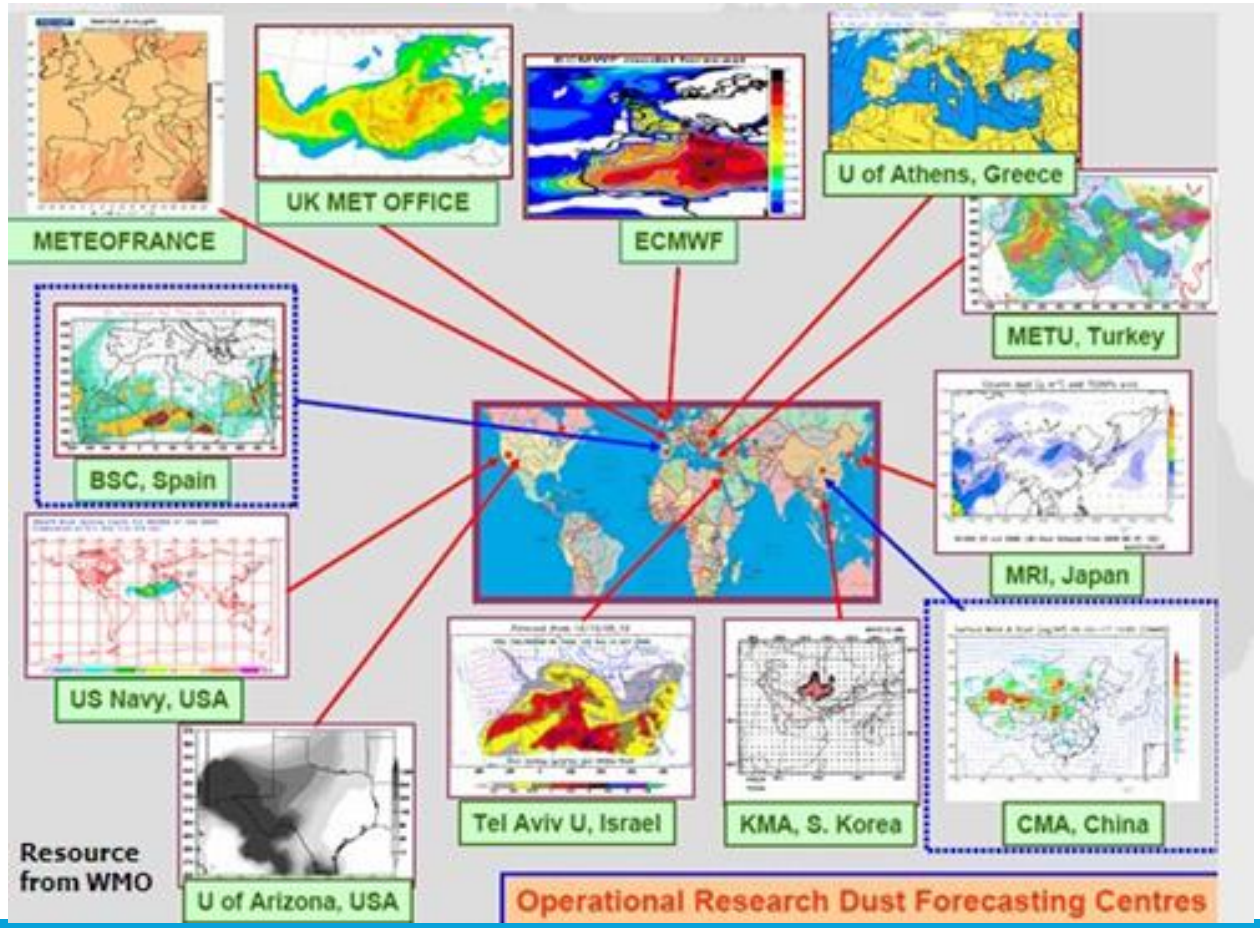
global network of SDS-WAS research and operational partners implementing SDS-WAS objectives



In-situ measurements

- particulate matter concentration
- size distribution

- the air quality standards, such as the European Union 2008/50/EC Directive, set maximum atmospheric concentrations for specific pollutants.

- the EU 24-hour-mean limit value for particles with aerodynamical diameter less than 10 μm (PM10) is **50 μg/m³**, with 35 permitted exceedences each year, and the annual-mean limit value is **40 μg/m³**

In-situ measurements

Reference method to measure concentrations of particulate matter

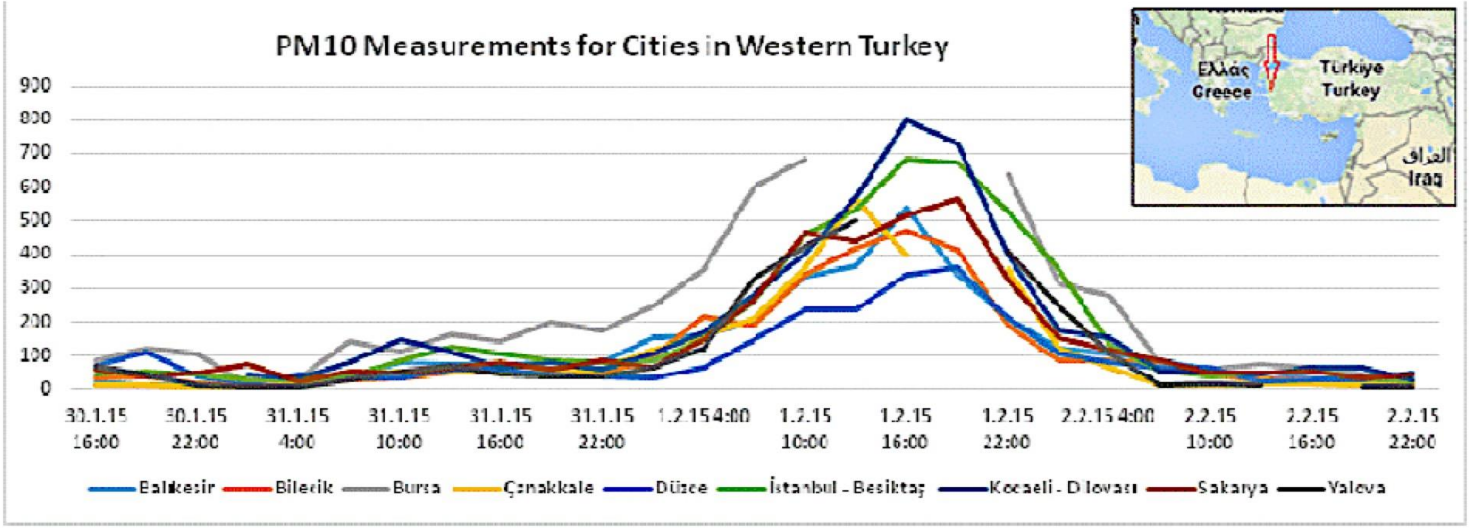
- the gravimetric or filter-based sampling

In-situ measurements

- concentration values of total suspended particles (TSP), PM10 or PM2.5.
- monitoring mineral dust events,
- Keep in mind that air quality stations measure the overall concentration of particles, not just dust. Moreover, it is important to consider the station site, since the abundance of anthropogenic particulates close to cities, large industrial plants or motorways can mask the presence of mineral dust.

Feb 1, 2015

- The intense signature of the dust transport on Feb 1, 2015 appeared in concentration of particulate matters (PM10) at the ground.
- Daily average values of PM10 were very high up to 800 µg/m³ on Feb 1, 2015



Measured PM10 values for several cities.

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Dust Event over Eastern Mediterranean on 1 February 2015

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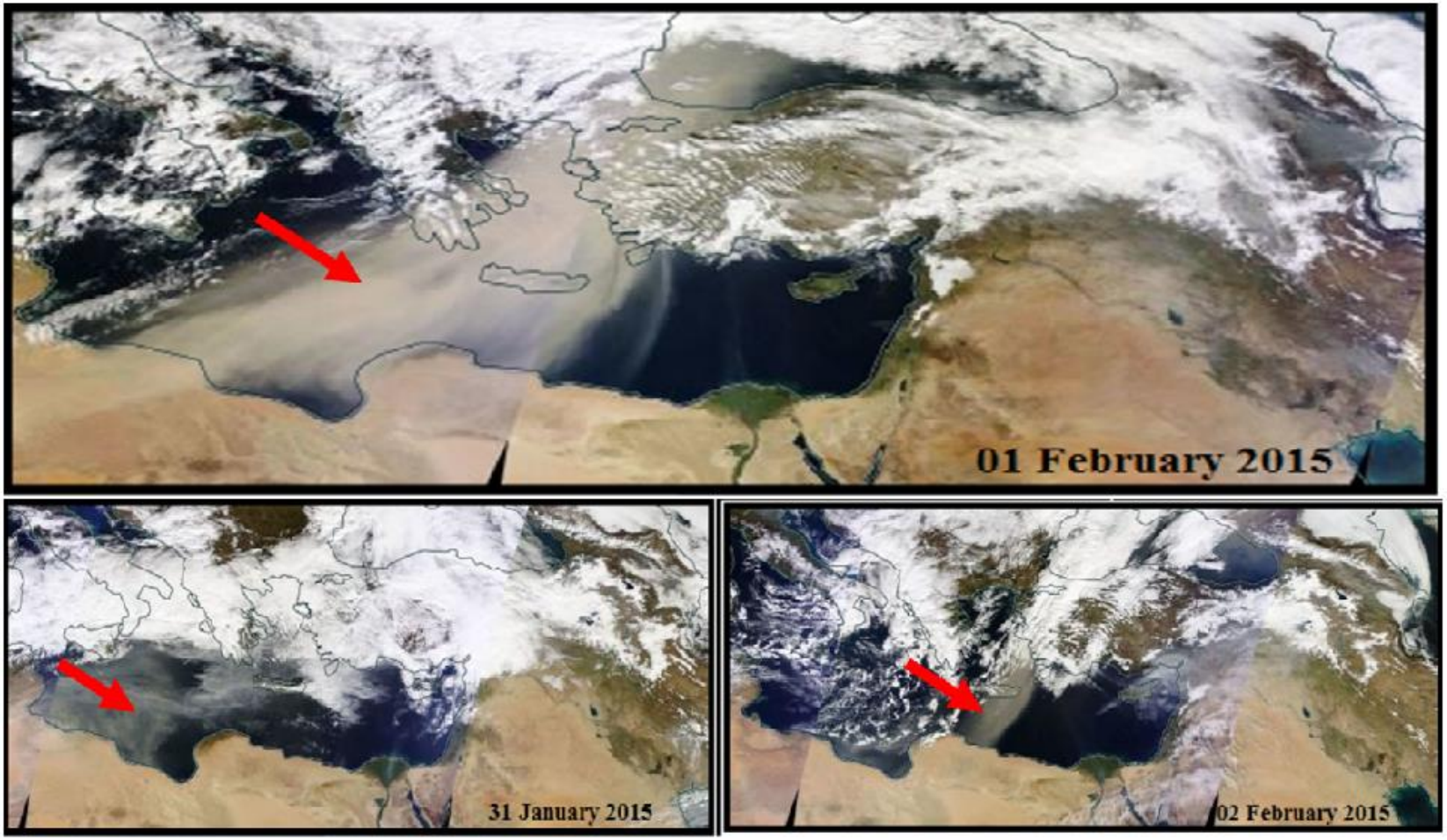

MODIS real-time images for
31 January – 2 February 2015

Integrated observational system

- **Ground-based**
  - **In-situ**
  - **Indirect Observations: visibility**
  - **Sun photometers (AERONET)**
  - **Lidar, ceilometers**
- **Satellite-based**

AERONET

AERONET (AErosol Robotic NETwork)

- Federation of ground-based remote sensing aerosol networks.
- Discrimination of aerosol types can be done from the aerosol optical depth and its spectral variations.
- Established by NASA and LOA-PHOTONS (CNRS) and is greatly expanded by collaborators from national agencies, institutes, universities, individual scientists, and partners.
- The program provides a long-term, continuous and readily accessible public domain database of aerosol optical, microphysical and radiative properties for aerosol research and characterization, validation of satellite retrievals.
- http://aeronet.gsfc.nasa.gov/new_web/data.html

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AERONET
AEROSOL ROBOTIC NETWORK

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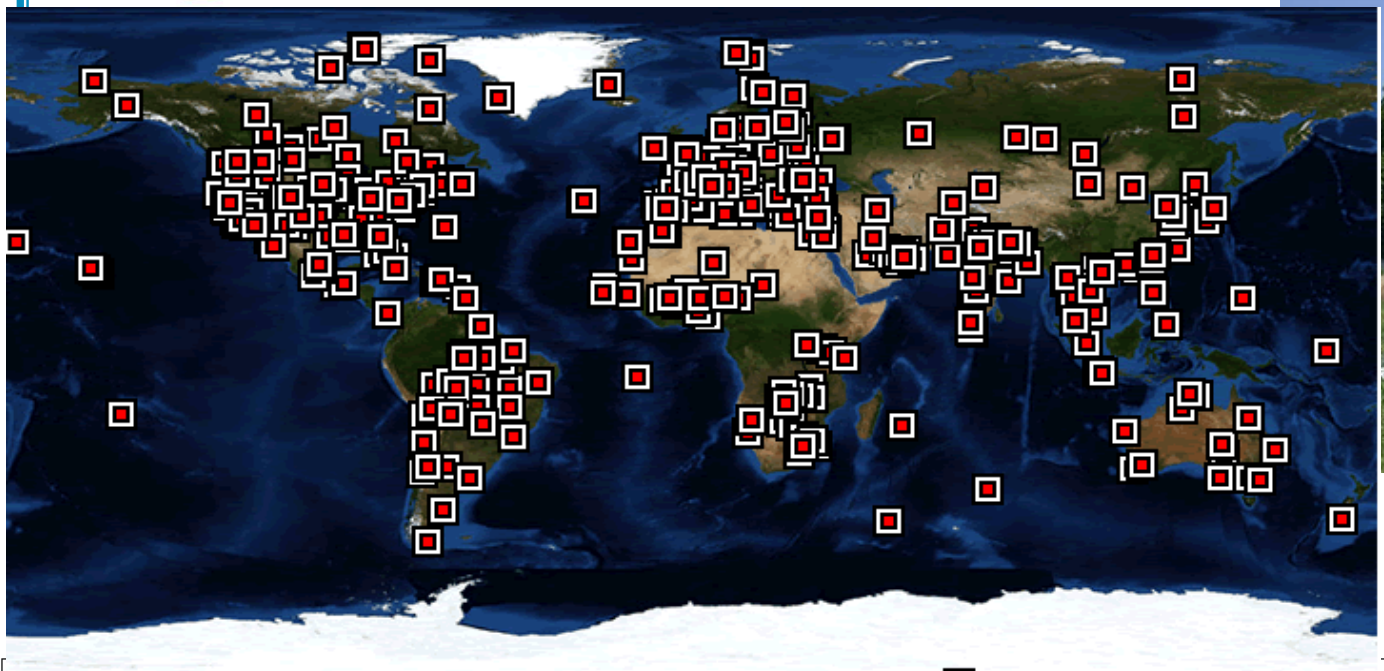
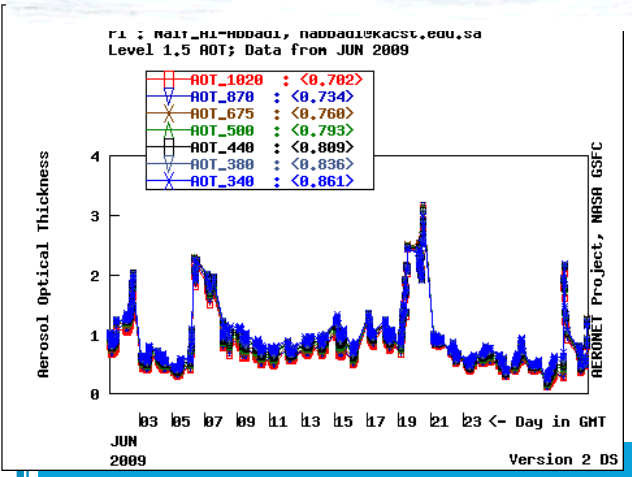
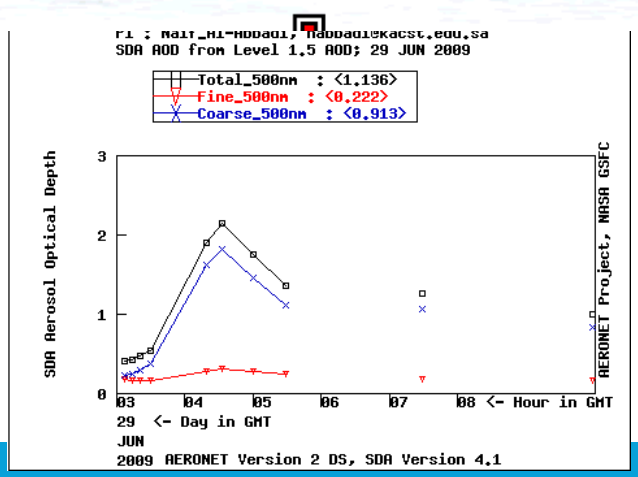
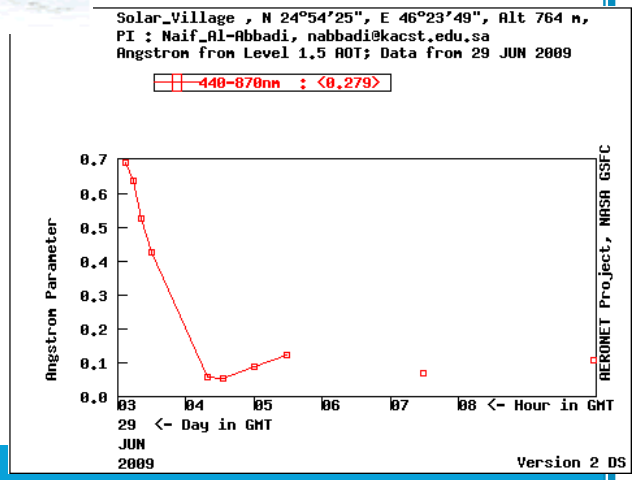


Cimel Electronique CE318

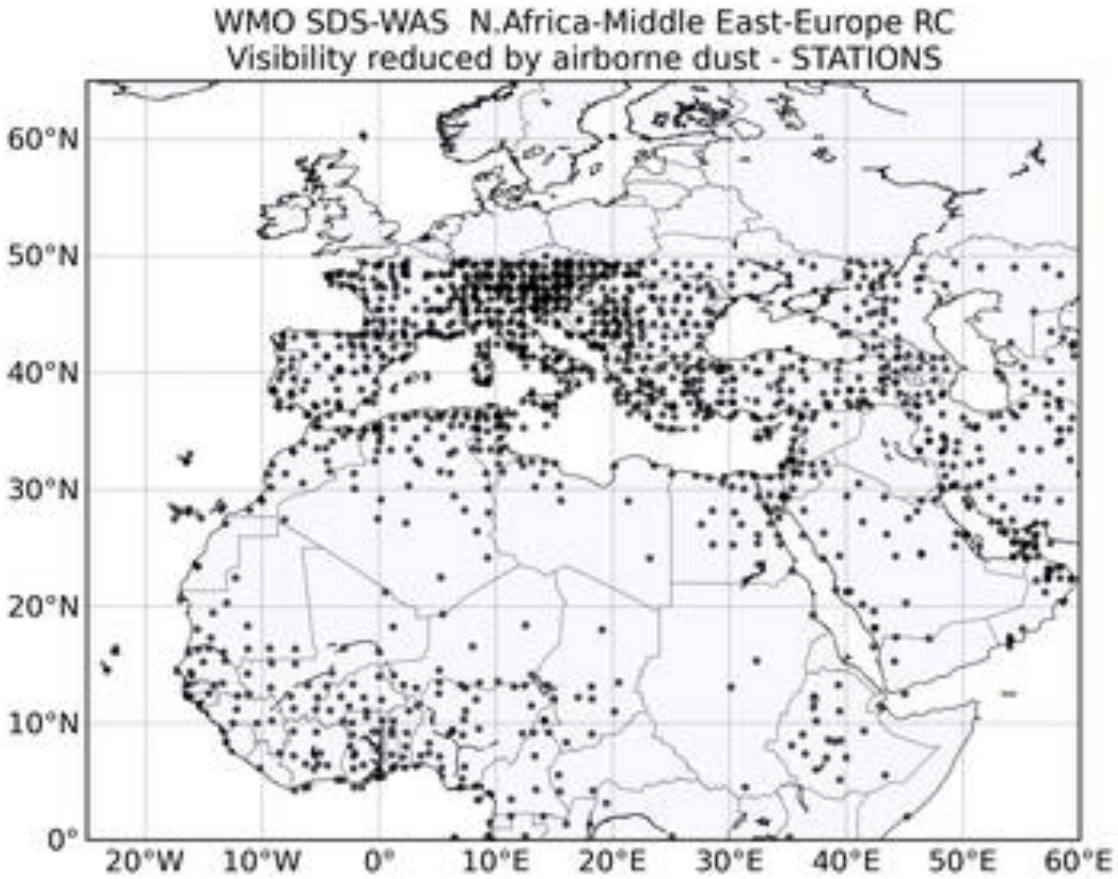






June 2009 **29 June 2009 – Solar Village, Saudi**

Visibility



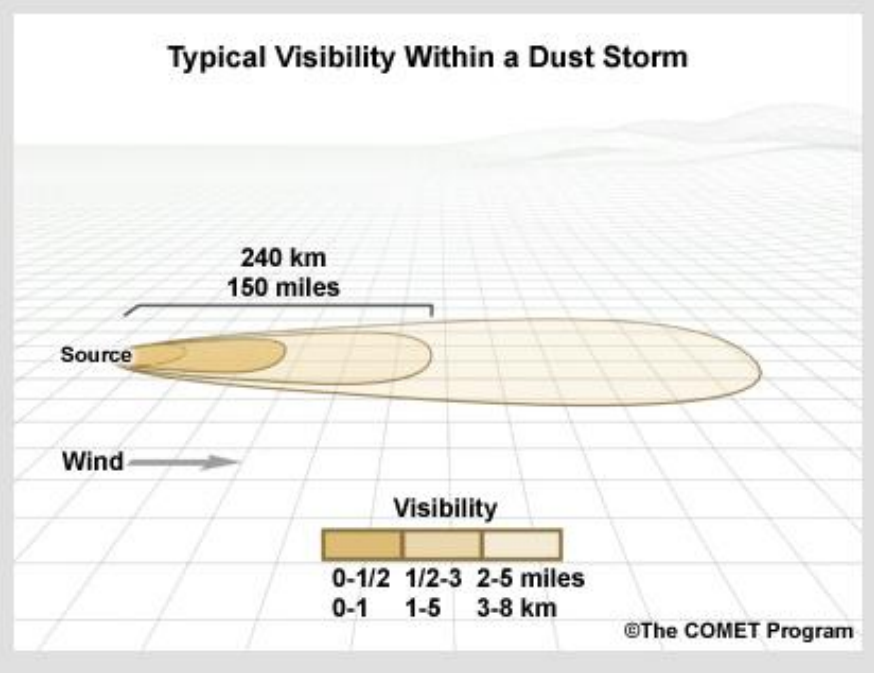
The map shows cases of visibility reduction by sand or dust to less than 5 km reported in **METAR** or **SYNOP** bulletins. More than 1,500 stations are checked every 6 hours. Brownish circles indicate stations where '**sand**' or '**dust**' has been explicitly reported

Visibility

- Visibility data included in meteorological observations can be used as an alternative way to monitor dust events.
- Visibility is mainly affected by the presence of aerosol and water in the atmosphere. Therefore, the use of visibility data has to be complemented with information on present weather to discard those cases where visibility is reduced by the presence of hydrometeors (fog, rain, etc.).

Visibility

- Intense dust storms reduce visibility to near zero in and near source regions, with visibility improving away from the source.
- From the edge of blowing dust to within 240 (150 miles) km downstream, visibility can range from 800 to 4800 meters.



(http://www.meted.ucar.edu)

LIDAR

LIDAR (LIght Detection And Ranging)

- Radar system using ultraviolet, visible or near-infrared light
- The aerosol lidar systems estimate vertical profiles of particulate from the backscatter profiles.
- Comparison of backscatter at different wavelengths provides some indication of particle size.
- If polarized light is used, the non-spherical character of particles can be determined: since dust particles are usually less spherical than other aerosol types, the method allows distinction between mineral dust and other pollutants.

Ceilometers

- Device that uses a laser or other light sources for remote sensing of the atmosphere.
- Ceilometers were primarily used in aviation meteorology for detecting cloud layers and determining their base height.
- Ceilometers can also provide vertical profiles of aerosol backscattering ---- an important source of data for dust monitoring, dust model evaluation and eventually for data assimilation.

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MODIS
(MODerate resolution Imaging Spectrometer)

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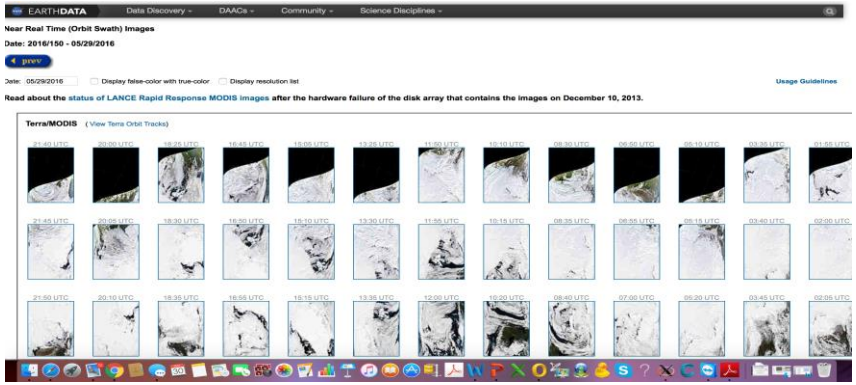
- It flies onboard NASA's Aqua (2002-now) and Terra (2000-now) satellites. Both satellites orbit the Earth from pole to pole, seeing most of the globe every day.

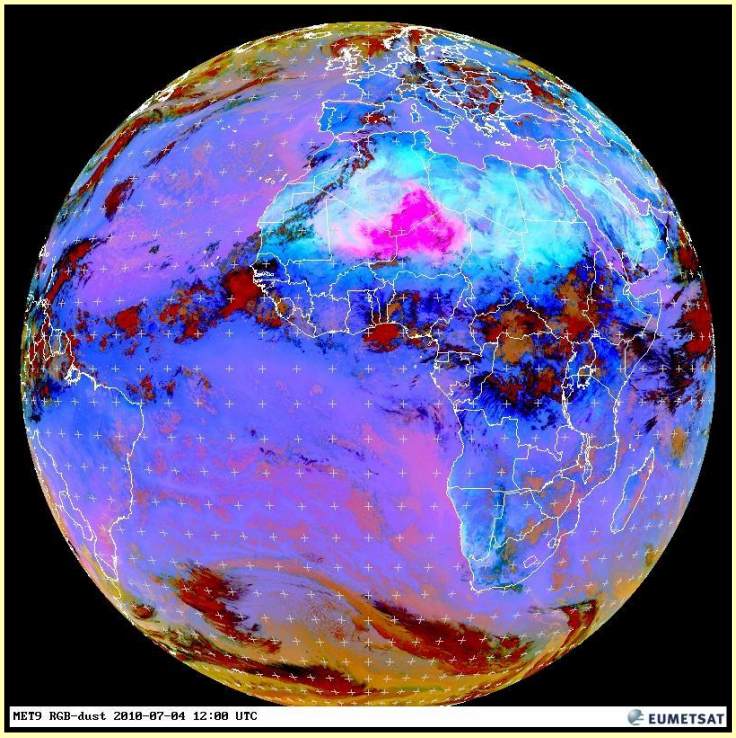


- Onboard Terra, MODIS sees the Earth during the morning, while Aqua MODIS orbits the Earth in the afternoon. MODIS performs measurements in the solar to thermal infrared spectrum region in 36 channels between 0.41 and 14.2µm with high spatial resolution

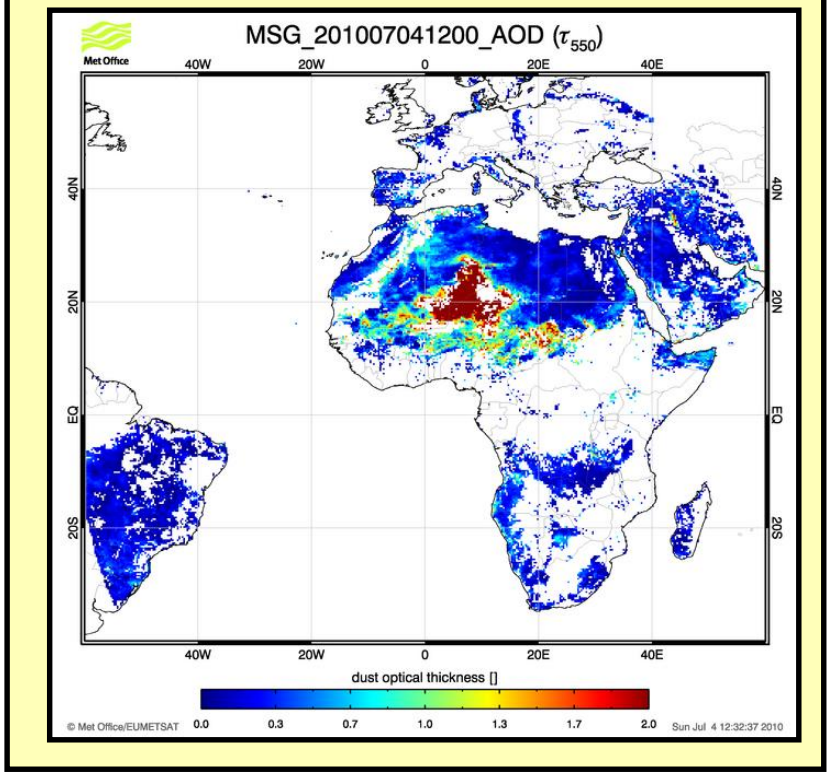
GEO satellites
Products from SEVIRI

EUMETSAT

4 July 2010 12:00 UTC



EUMETSAT RGB-dust (qualitative)



UKMO dust AOD 550 nm (quantitative)

SEVIRI

- The SEVIRI instrument onboard the MSG satellites allows generation of RGB products that offer a qualitative detection of dust clouds with a good spatial and time resolution and an excellent and permanent coverage of the SDS-WAS RC geographical domain.

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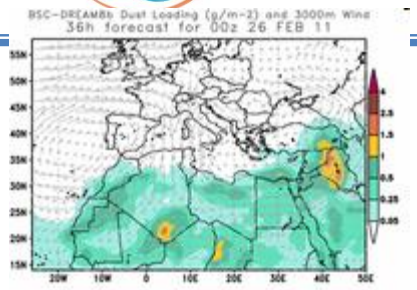
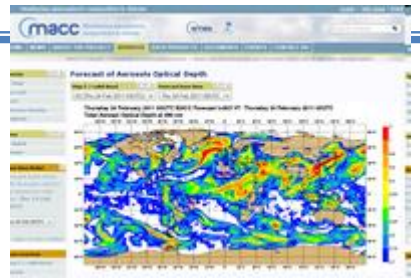
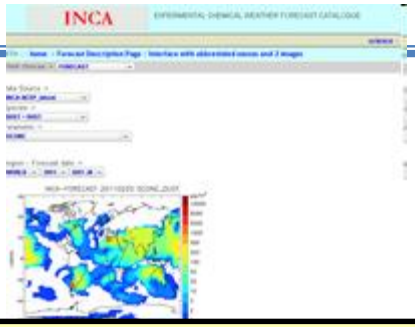
METEOROLOJİ

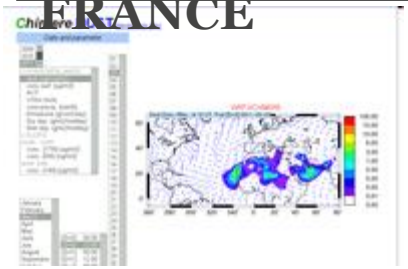
Dust models

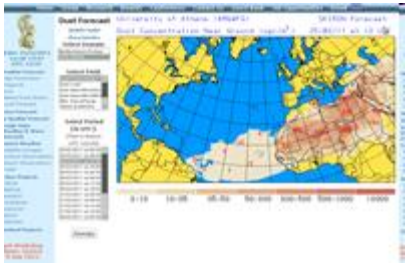


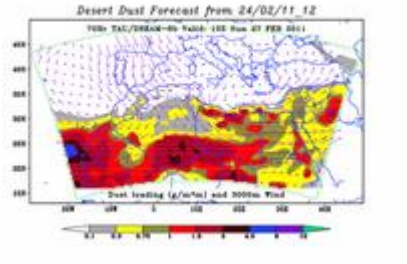


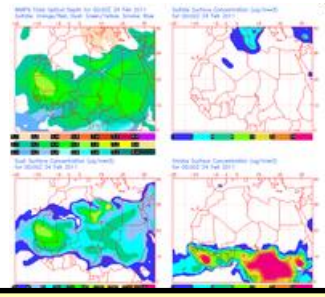


BSC-DREAM8b **MACC-ECMWF** **INCA-LMDzT** **MÉTÉO-FRANCE**





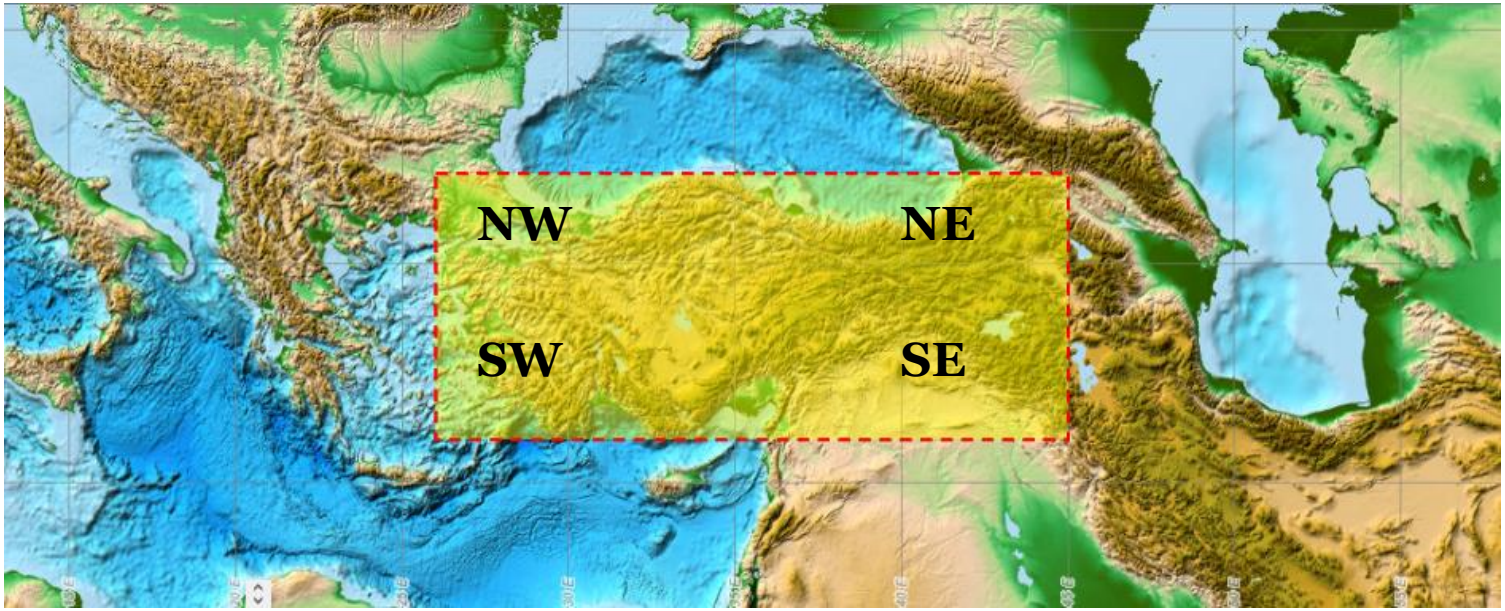




CHIMERE **SKIRON** **TAU-DREAM8b** **NAAPS**

DREAM8-SEEVCCC

AOD and AE Analysis



Research domain
(http://maps.ngdc.noaa.gov/viewers/wcs-client/)

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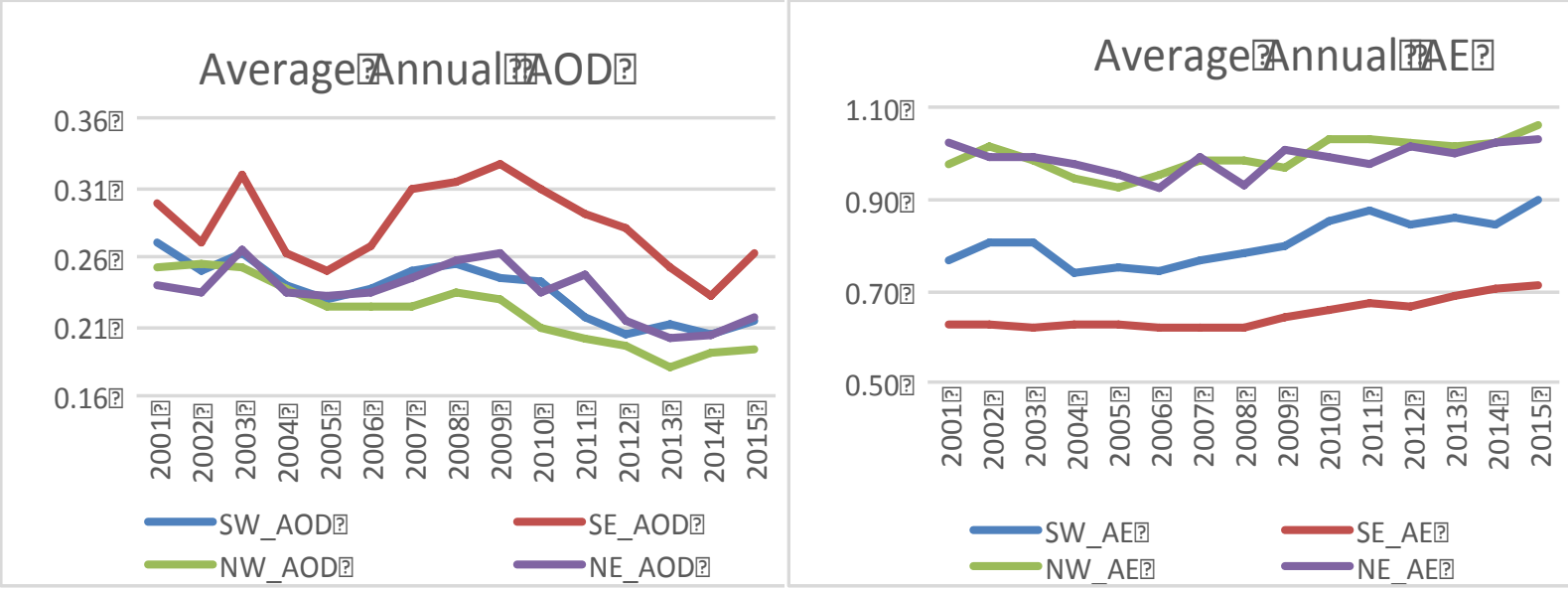
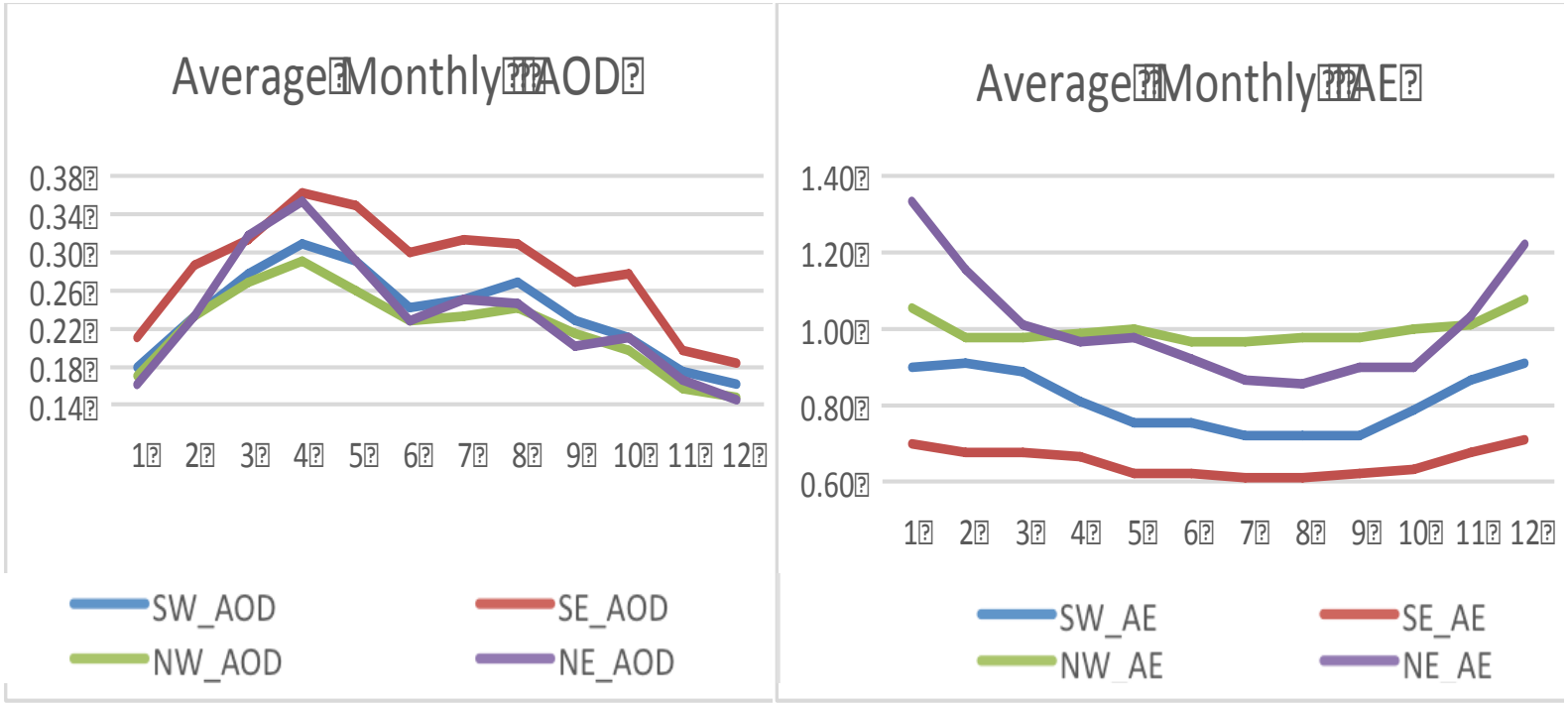


Average annual (a.) AOD and (b.) AE

Sand and Dust Observations and Observation Network



Average monhtly (a.)AOD and (b.)AE

Thank you for your attention ☺

KEEP
CALM
PRESENTATION IS OVER
ANY
QUESTIONS?