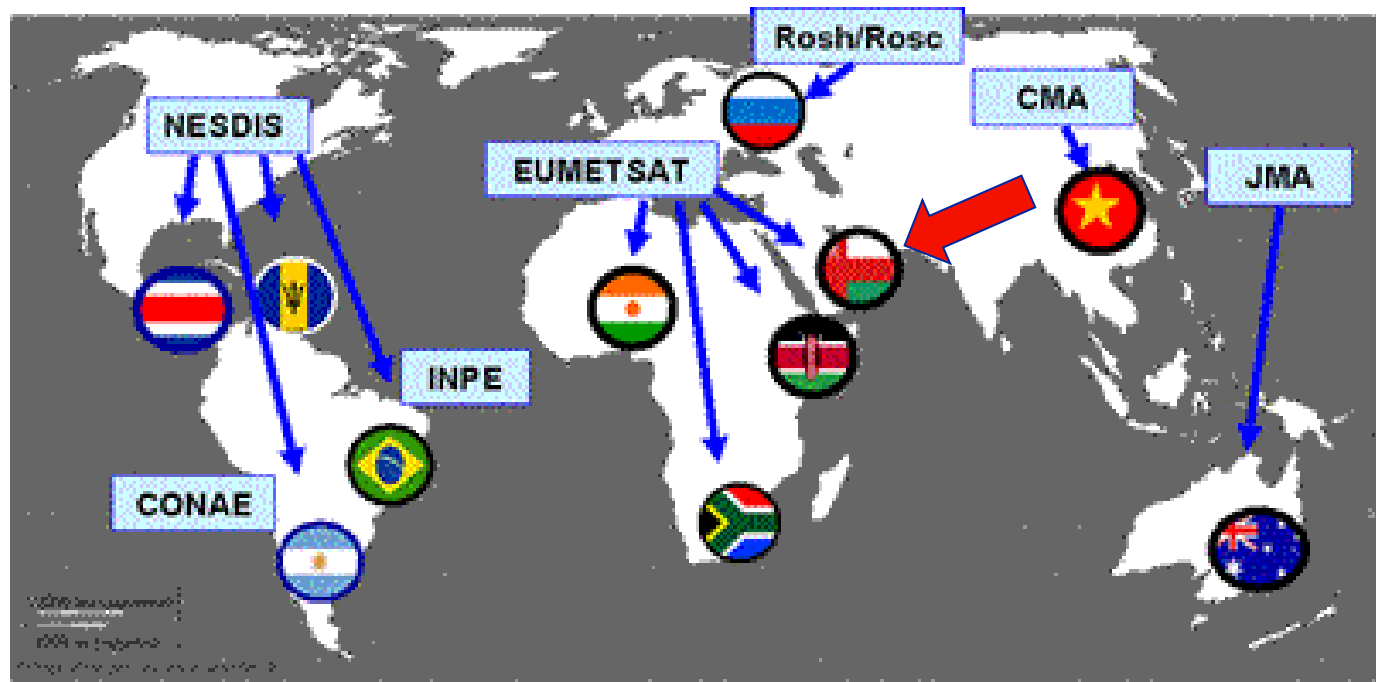


DUST

Source Regions & Climatology

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Content

- Impacts of dusty Air
- Differences between dust and sand storms
- Dust Sources around the world
- Characteristics of favourable dust sources
- Dust indices for climatological Studies
- Study: Main Dust source affecting Middle East

Dust impacts?

Positive impacts

Fertilizer

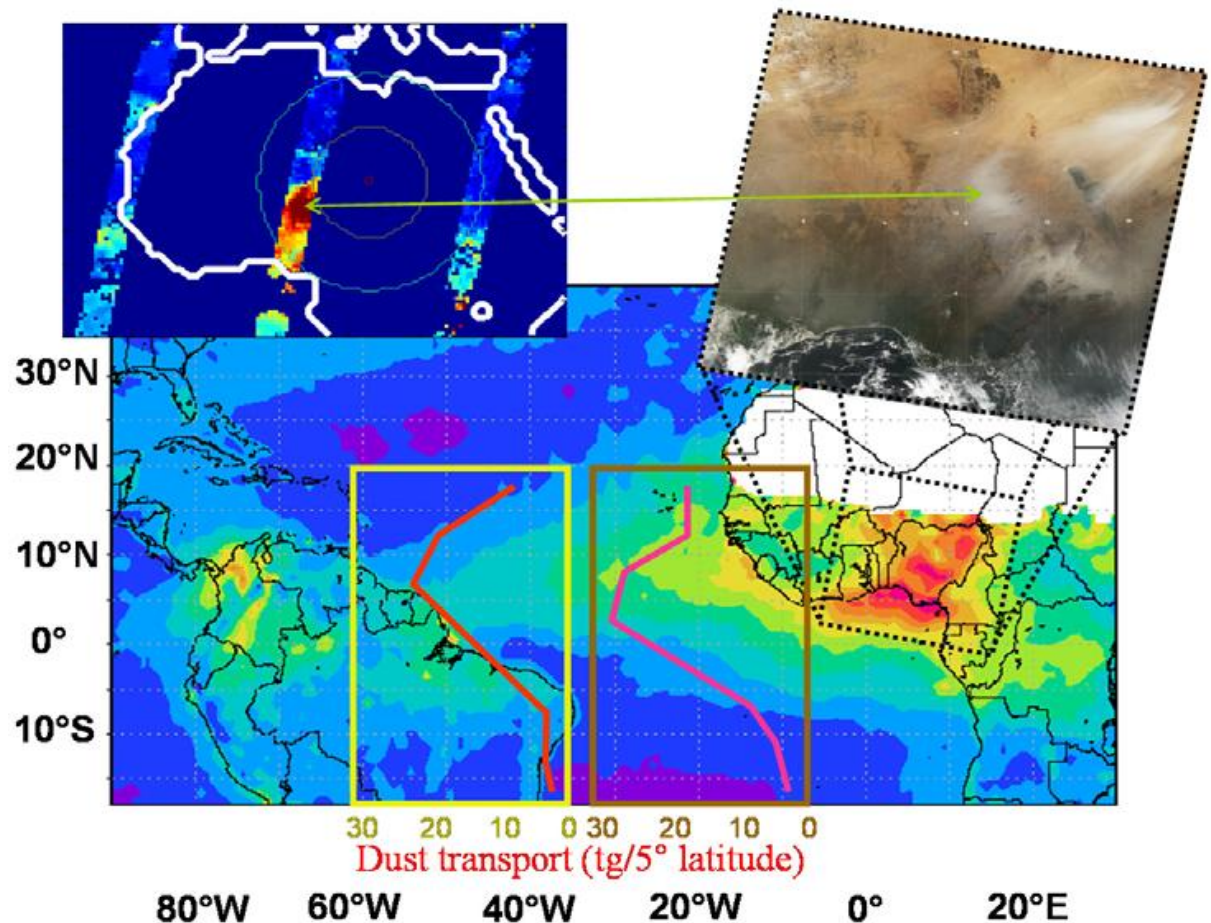
Mega-Chad lake Fertilize
Amazon forest

(Bodele Depression Ex)

— MODIS

“They showed that a total of some 50 million tons of dust make their way from Africa to the Amazon region every year”

“The data revealed that some 56 percent of the dust reaching the Amazon forest originates in the Bodele valley”

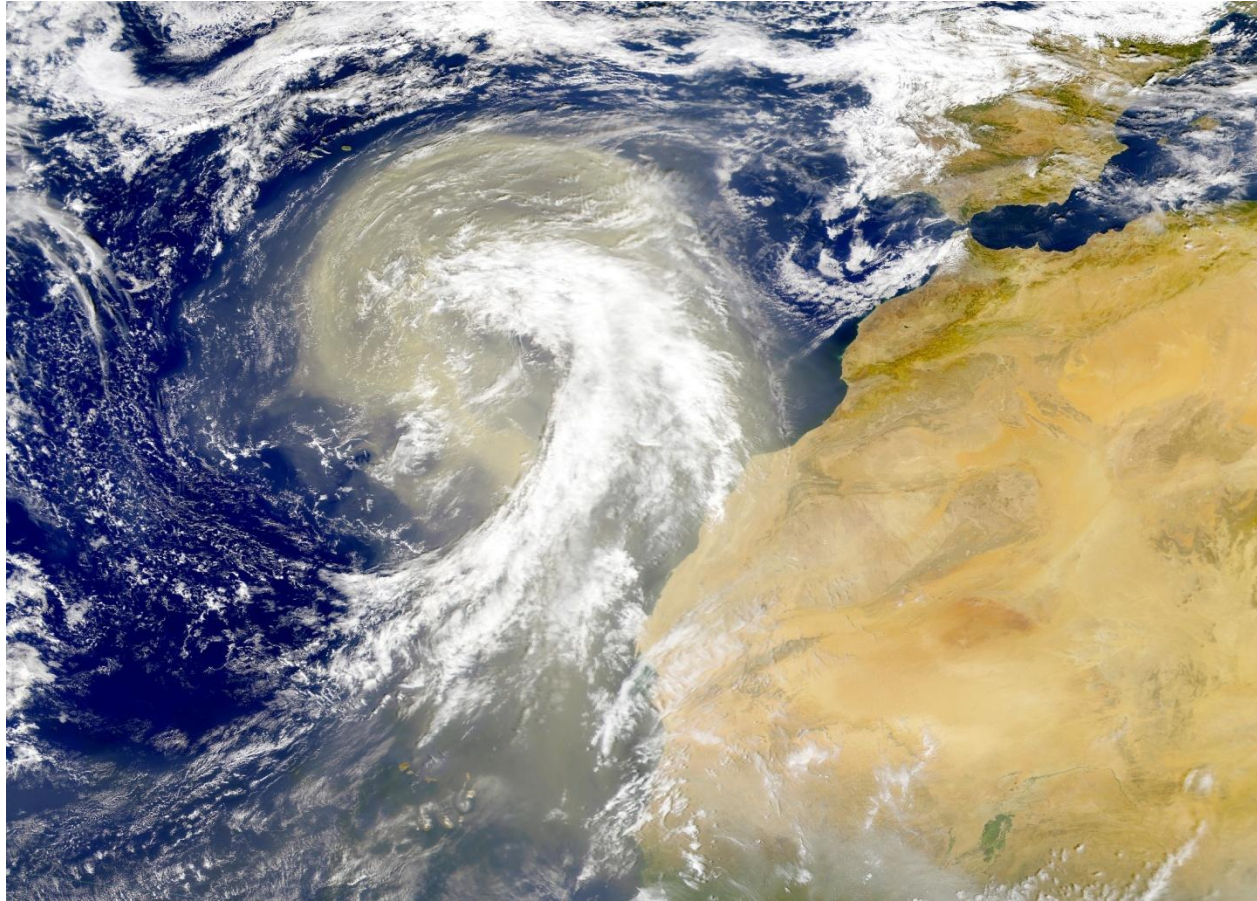


Dust impacts?

Positive impacts

Global cooling !

Global Dimming opposes Global warming
(Indian Ocean experiment)



Dust impacts?

Negative impacts

➤ Health

- Direct effect on the respiration system
- Moving dust from polluted areas



Dust impacts?

Negative impacts

➤ Equipments damage

- The more sophisticated an electrical system is, the more dust will affect it
- Reduce engines efficiency by reducing Heat exchange
- interruption of radio services
- Cause leak from the electrical power lines.



➤ Aviation and traffic hazards

- Sudani Airline incident (2003/12/13)



Dust impacts?

Negative impacts

➤ **Affect the rain process !**



Difference between Dust and Sand Storms

- Both need high Surface wind speed
- Reported according to their effect on Horizontal Visibility

Sand ?

- Diameter size of greater than 100 μm
- Average size is 200 μm
- Top height 50 feet
- Affect the source and adjoining areas
- Need stronger surface wind to be created



Difference between Dust and Sand Storms

- Both need high Surface wind speed
- Reported according to their effect on Horizontal Visibility

Dust ?

- Diameter size of less than $100\text{ }\mu\text{m}$
- Average size is $2\text{ }\mu\text{m}$
- Top height 20000 feet
- Affect areas Thousands of miles away



Dust constitution

Earth's crust erosion in the Semi- Arid , Arid and hyper arid areas

Earth's crust erosion:

Oxides SiO_2 , Al_2O_3 , FeO , Fe_2O_3 , CaO ,

Carbonates CaCO_3 , MgCO_3

Other many minor constituents and pollutants

Dust Sources around the World

East of Asia Dust Sources

Takla Makan Desert.

means go in and you'll never come out!



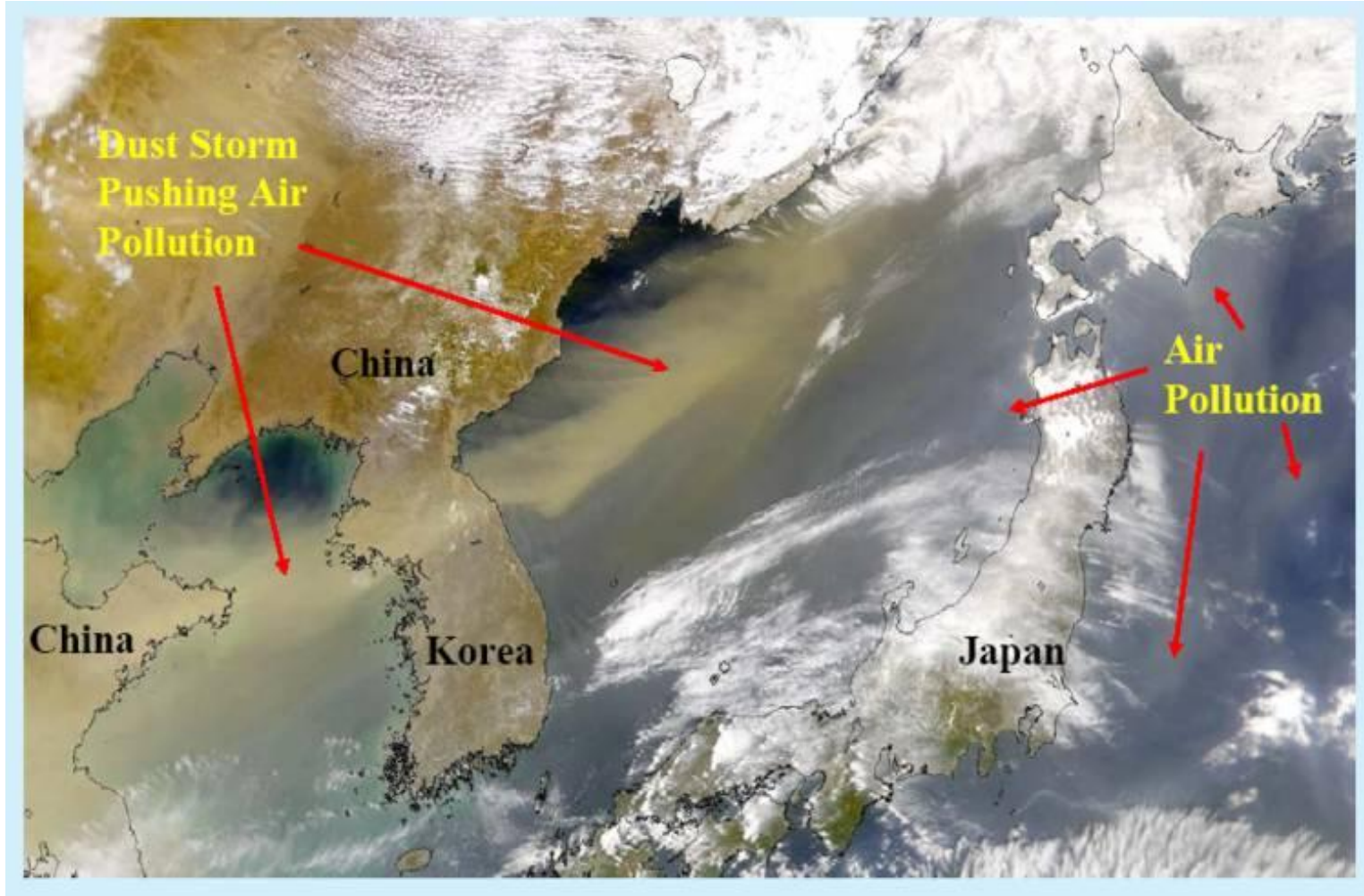
East of Asia Dust Sources

Gobi Desert.

East of Takel Makkan Desert,
One of the Fastest growing desert



East of Asia Dust Sources



Asian dust storm and air pollution that impacted Korea & Japan,
April 2001

Australian Dust Sources

Occupy 18% of the content



American Dust Sources

Great Basin Desert



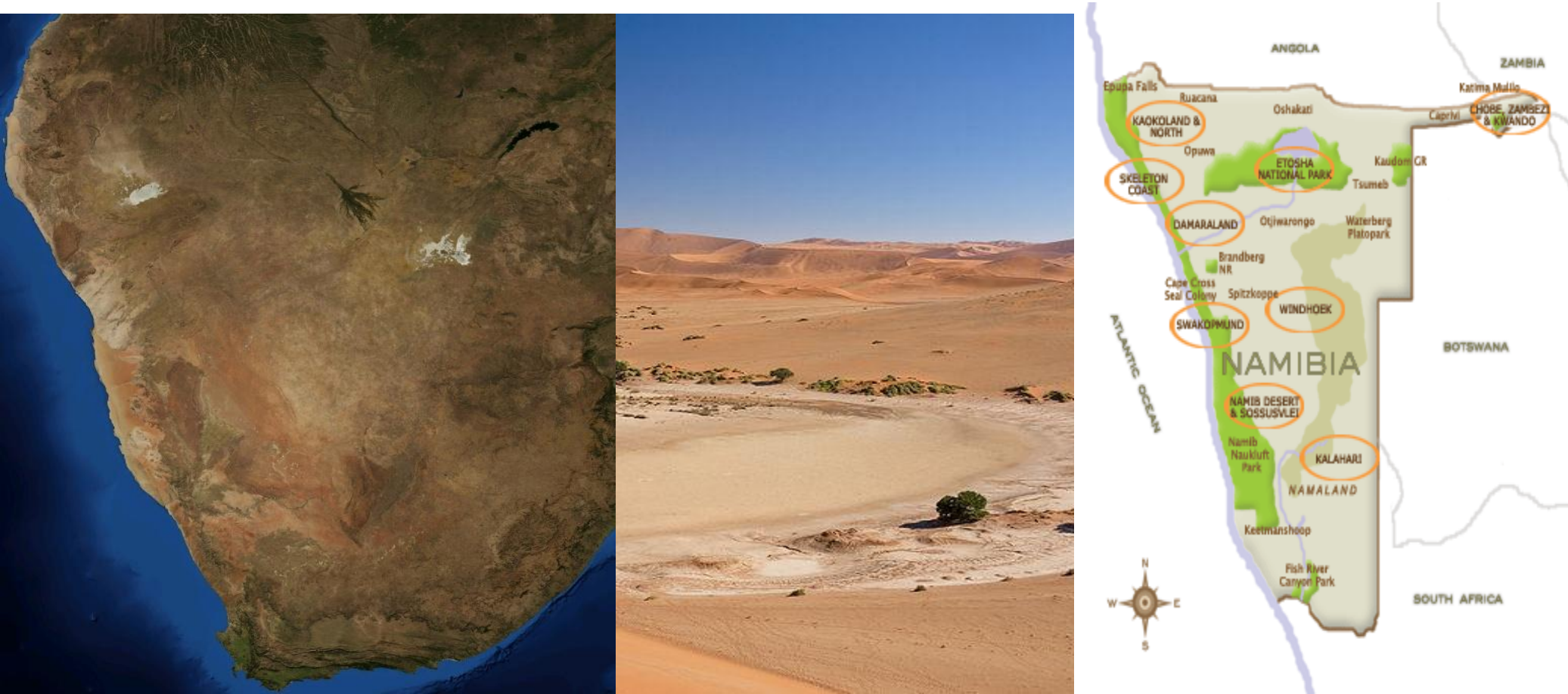
Patagonian Desert



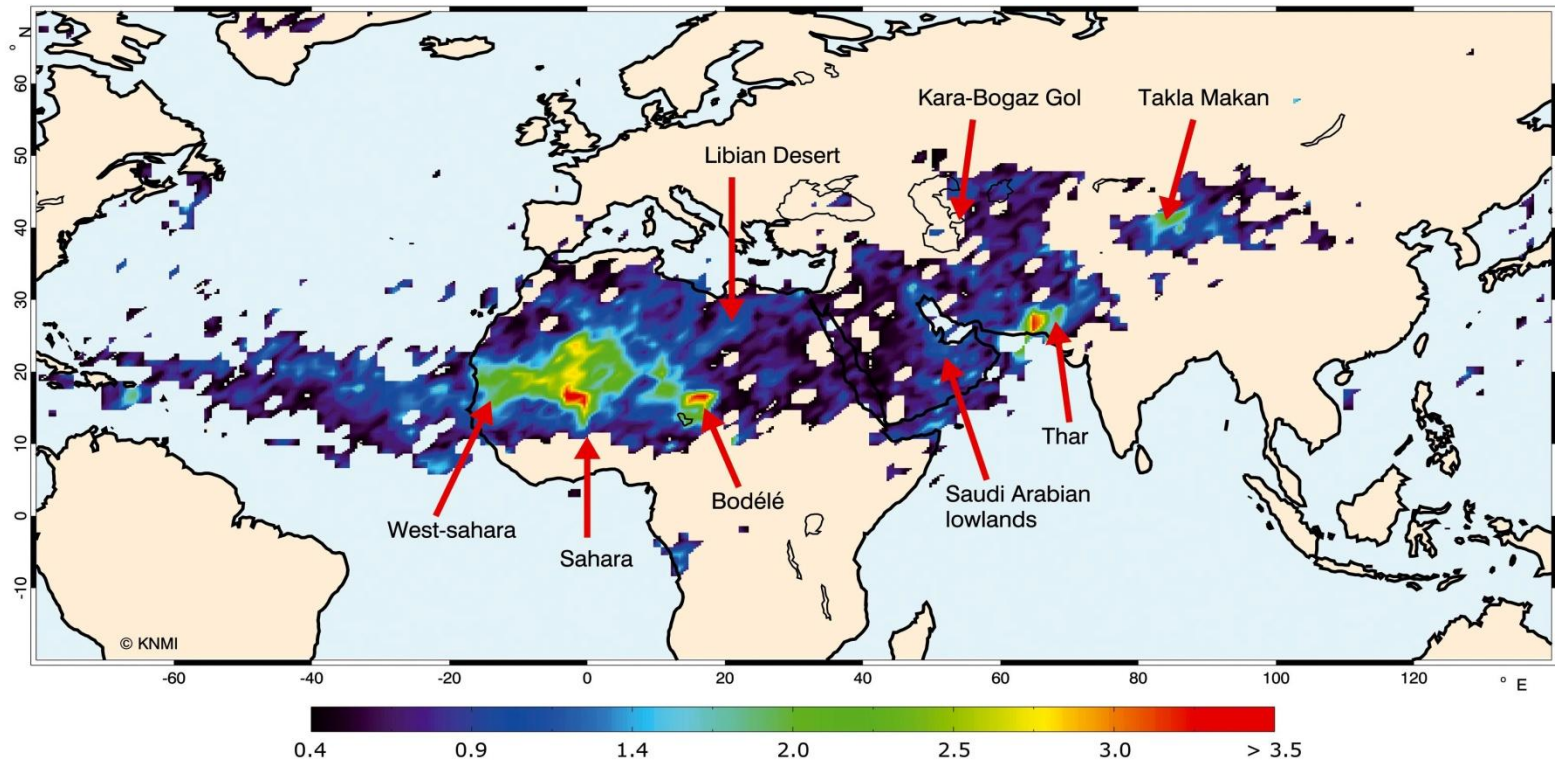
South Africa Dust Sources

The **Namib Desert** > Nama origin and means vast
Oldest Desert on Earth > 55 Million years

Kalahari Desert > Most of Botswana, and parts of South Africa



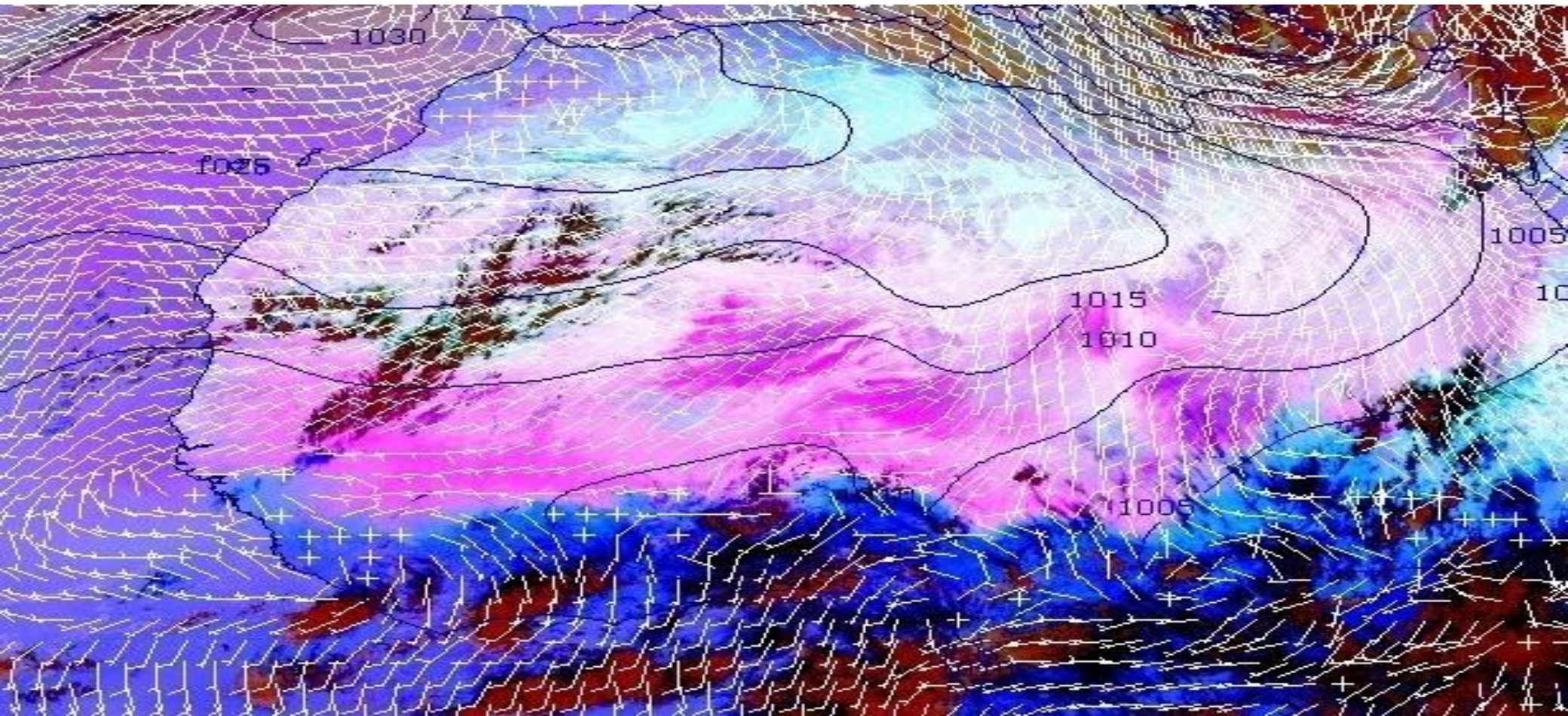
Dust Sources Belt



Aerosol Index of the period 01st to 20th of June 2004(German Aerospace Center,2007)

Sahara Dust

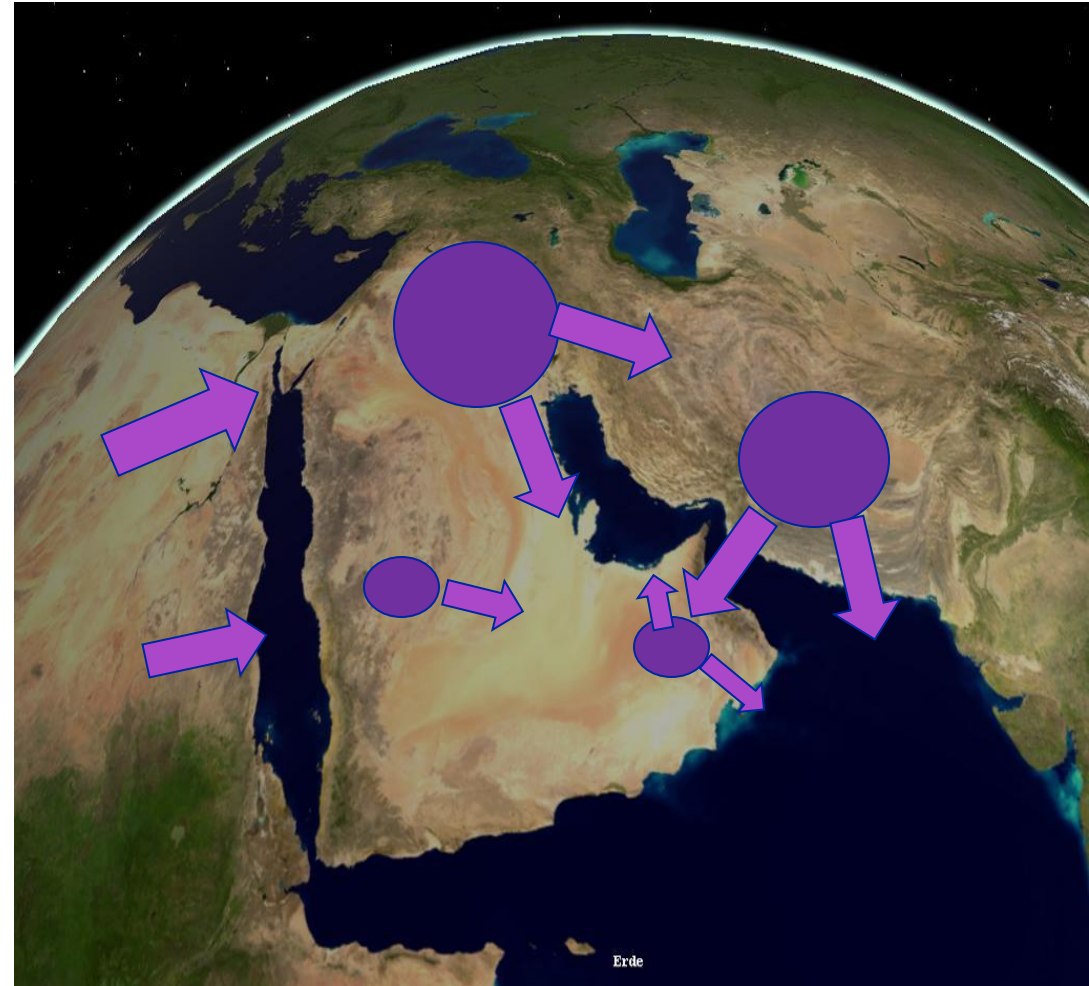
The major source on Earth of mineral dust
(60-200 millions of tons per year).



Main Dust sources Affecting Middle East

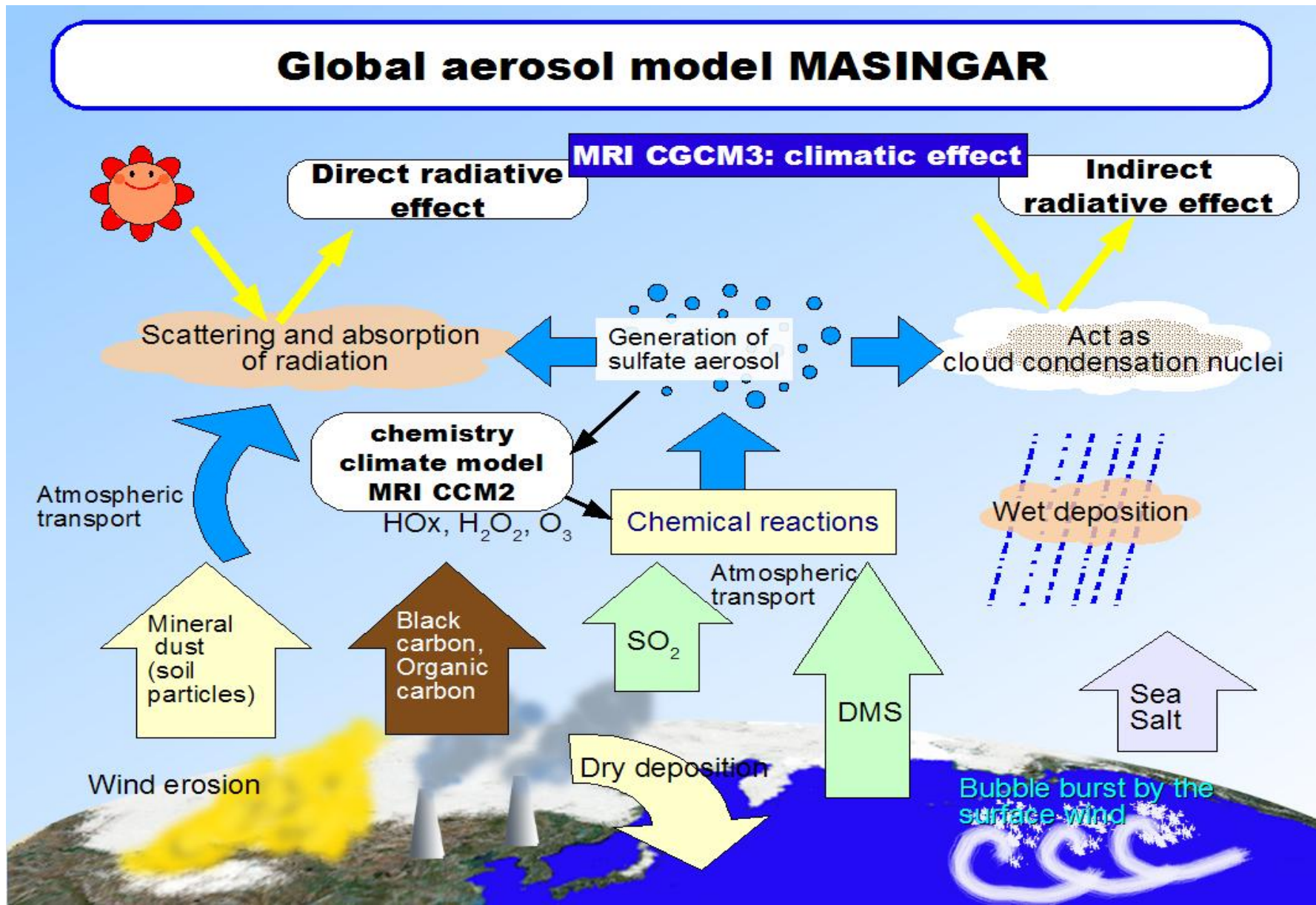
Hyper Arid

- Tigris and Euphrates rivers basin
- Sistan Basin & Balouchistan
- East of Alhejaz Mountains
- Southwest Alhajar Mountains



Dust indices for climatological studies

Dust indices for climatological studies



Dust indices for climatological studies

Aerosol Mass Concentration

- **Other Names**

Aerosol Concentration, Aerosol Density

- **Definition**

It is a measure of aerosol density ($\mu\text{gm}/\text{cm}^2$) which is the total aerosols mass in a vertical column of atmosphere.

- **Remote Sensing equipments: MODIS**

Can be measured directly

Dust indices for climatological studies

Aerosol Index

- **Other Names**

Aerosol Absorbing Index, Aerosol Absorbing Indicator, AI, AAI

- **Definition**

It is an index that detects the presence of uv-absorbing aerosols such as dust and soot.

AI uses two wavelength intervals around 340 nm and 380 nm.

Dust indices for climatological studies

Aerosol Index

$$AI = 100 \left[\log_{10} (I_{360}/I_{331})_{\text{measured}} - \log_{10} (I_{360}/I_{331})_{\text{calculated}} \right]$$

where **I** is the intensity of the light

Positive values of Aerosol Index generally represent absorbing aerosols (dust and smoke) while small or negative values represent nonabsorbing aerosols and clouds.

- **Remote Sensing equipments:** TOMS, GOME

Dust indices for climatological studies

Dust optical Depth

Other Names

Aerosol Optical Thickness, τ , tau

Definition

"Aerosol Optical Depth" is the degree to which aerosols prevent the transmission of light.

Dust indices for climatological studies

Dust optical Depth

It can be shown :

$$\frac{I}{I_0} = e^{-\kappa \rho s}$$
$$= e^{-\tau}$$

τ is the **optical depth** of a material. where I_0 is the incoming intensity of the light, I is the decline in intensity of the outgoing light. s is the distance it travels, and ρ is the density of the material.

The variable κ , called the **opacity** or **absorption coefficient**

Dust indices for climatological studies

Dust optical Depth

- **Remote Sensing equipments :**
OMI , TOMS, SEVIRI

Dust indices for climatological studies

- **Other Applications**

- (1) Atmospheric correction of remotely sensed surface features
- (2) Air Quality
- (3) Monitoring of sources and sinks of aerosols
- (4) Health and Environment
- (5) Monitoring of volcanic activities
- (6) Earth Radiation Budget & Radiative Transfer Model
- (7) Climate Change

Characteristics of Favourable Dust Sources

Characteristics of Favourable Dust Sources

Significant Dust emitter are certain areas in the hyper arid , Arid and Semi Arid Regions.

Loose surface with fine particles (size less than 100 microns)

Characteristics of Favourable Dust Sources

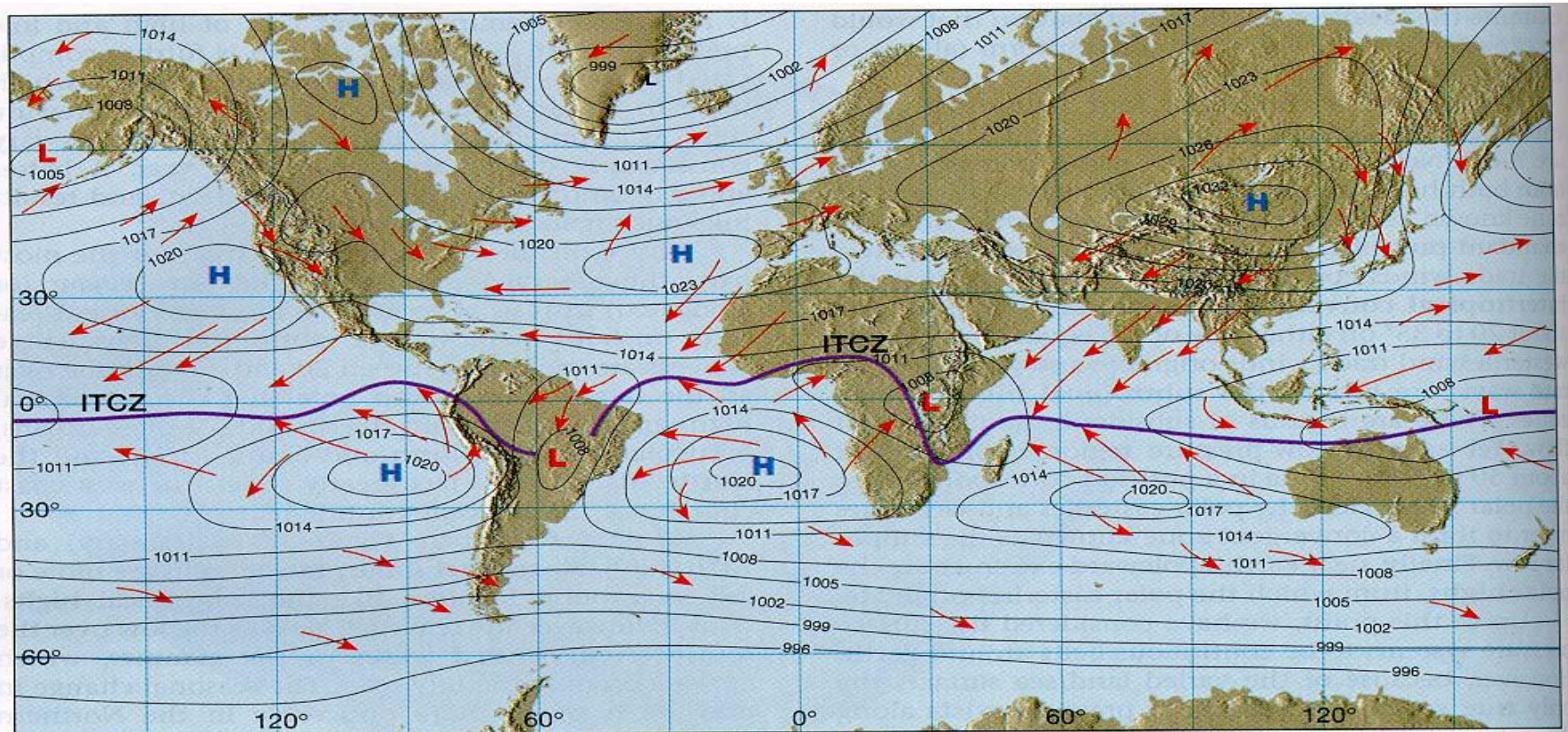
These Dust sources (Lose surface) usually created by two or more of the following factors:

- High temperature,
and high fluctuation
- Recent aridity
- Occasionally flooded
Areas
- Topographical Role
- Human activities

Characteristics of Favourable Dust Sources

Hadley Cell > High temperature ,high fluctuation,

- High temperature and the diurnal difference increase erudition process
- The Significant dust sources located in the bounds of subtropical High



(a) January

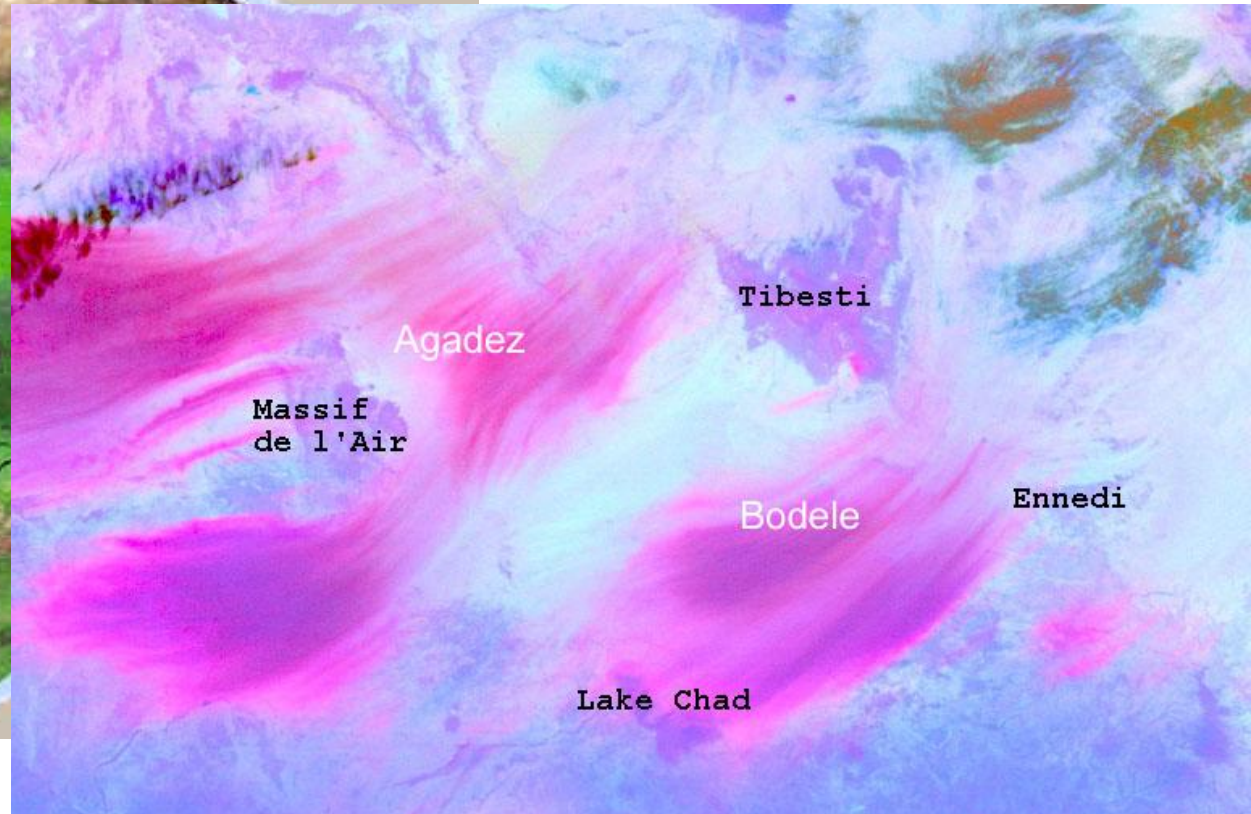
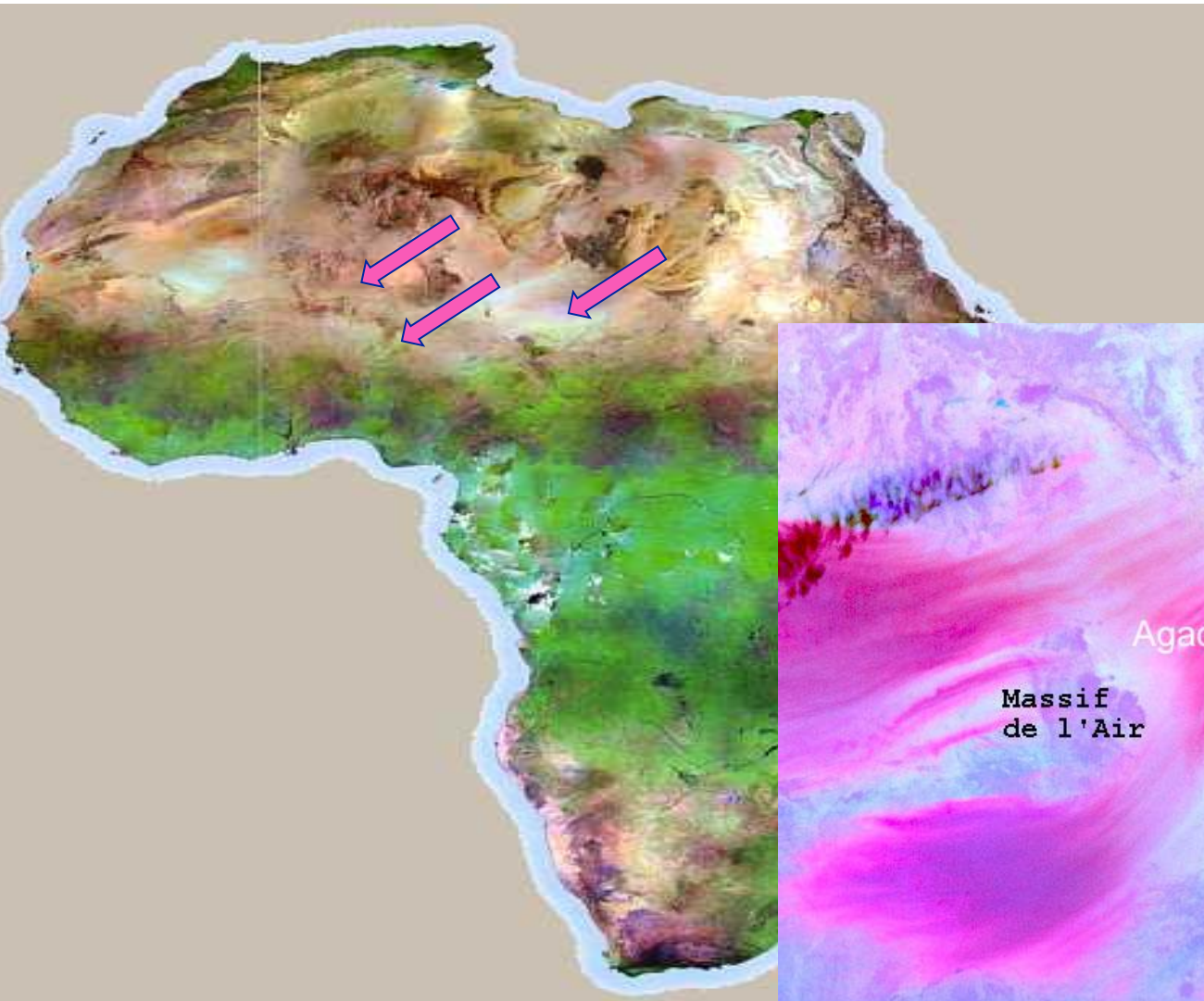
Characteristics of Favourable Dust Sources

Recent Aridity , High Rainfall Anomalies,
Frequently Flooded Area



Characteristics of Favourable Dust Sources

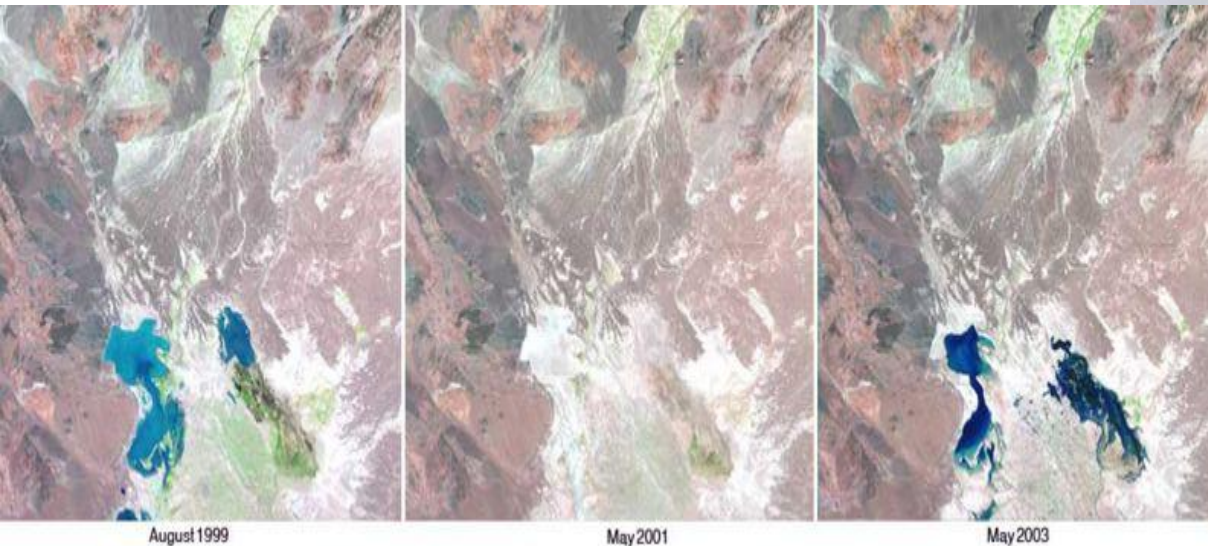
Topographical Role



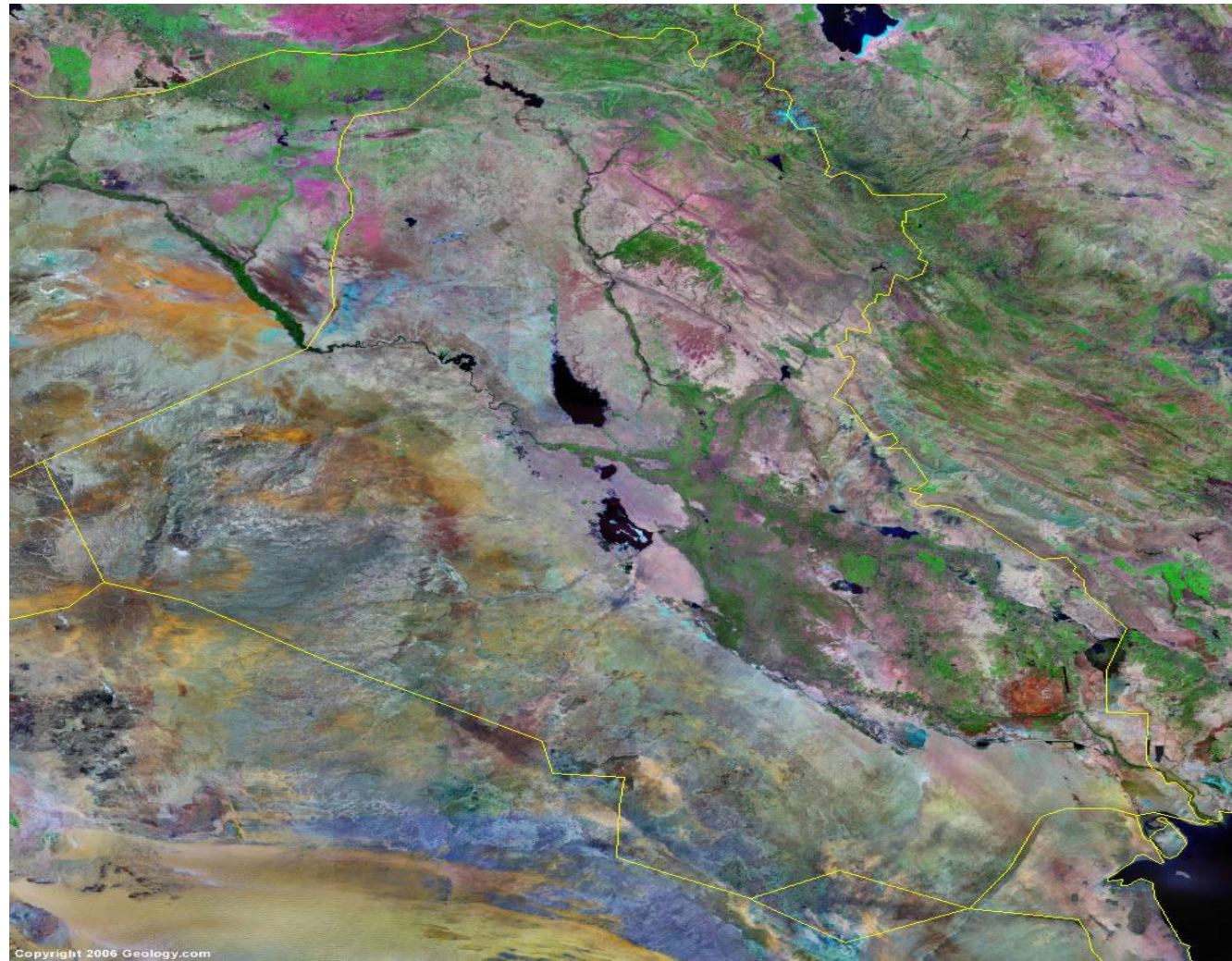
Characteristics of Favourable Dust Sources

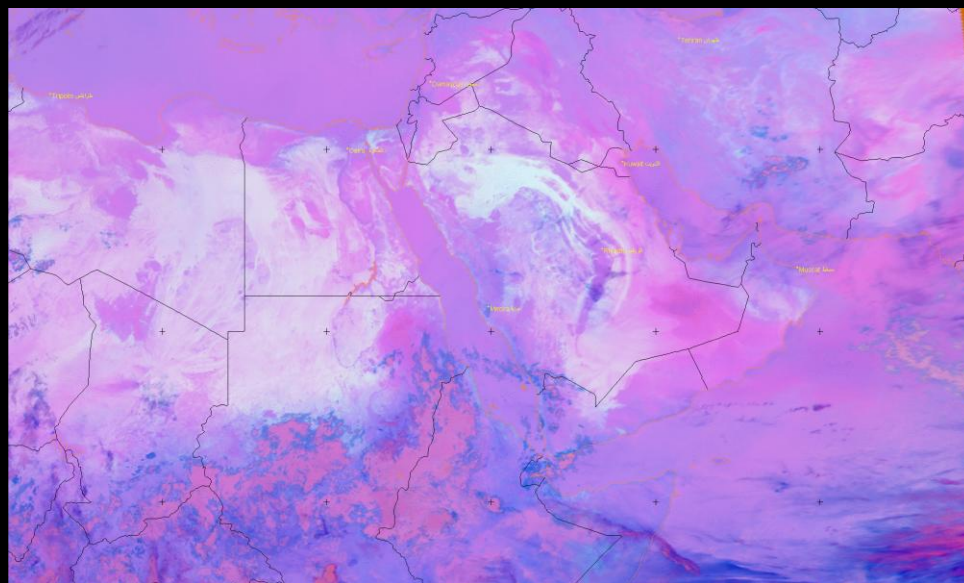
Human Activities

- Desertification (unwise use of the water resources)
- Change of natural rivers routes
 - Aral sea Disaster
 - Helmand lake
 - Euphrates and Tigris rivers



Study: Main Dust source affecting Middle East

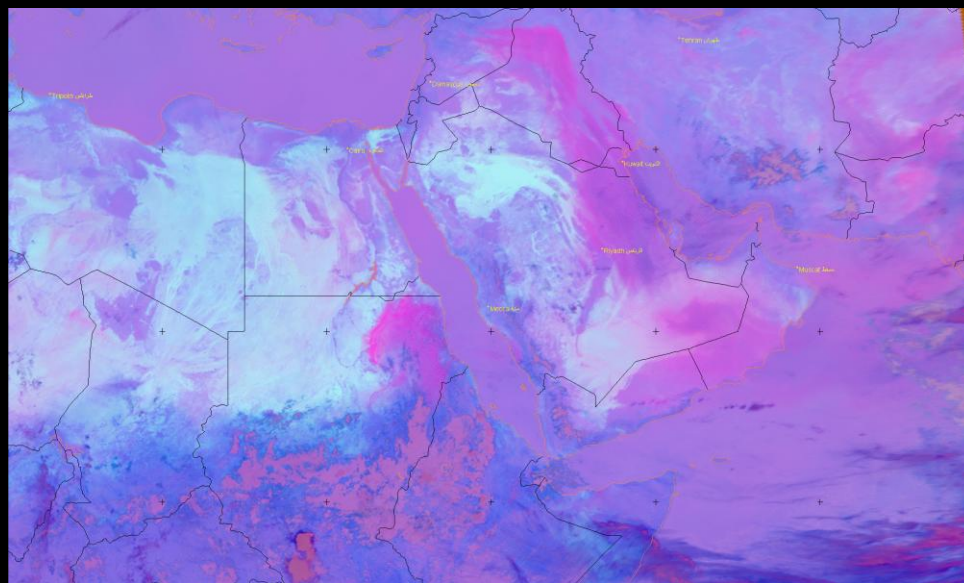




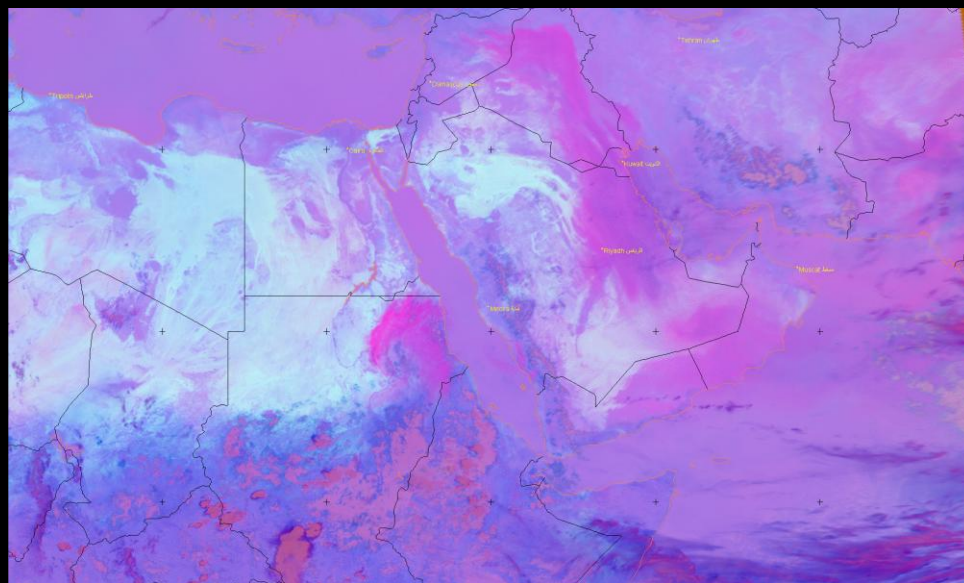
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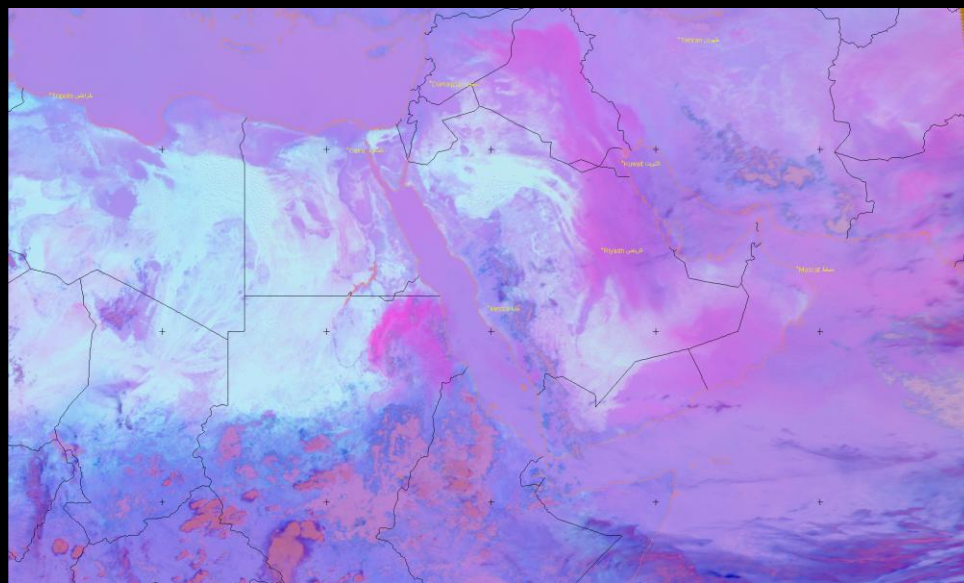
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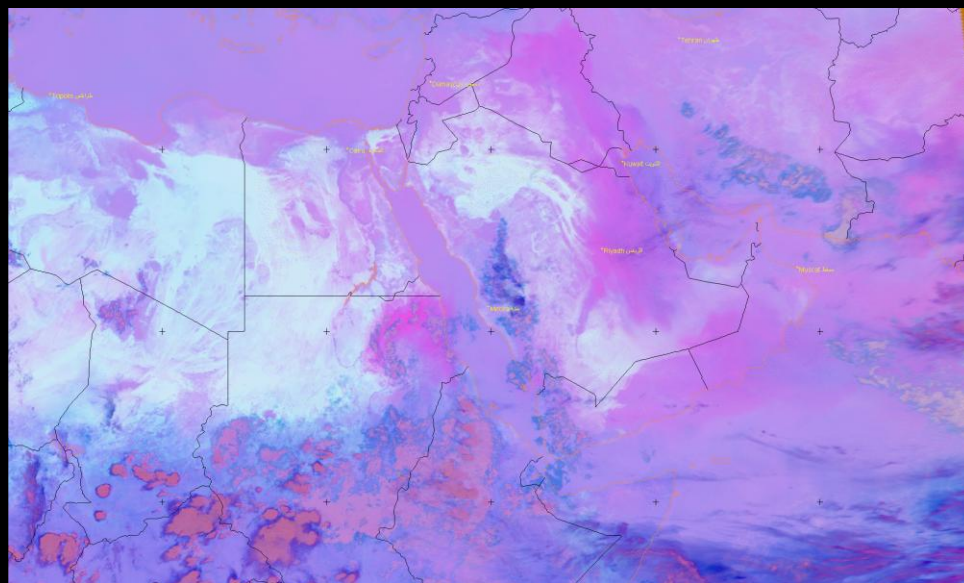
20080616-1000



20080616-1200



20080616-1400



20080616-1600



Kuwait 20080616

Study: Main Dust source affecting Middle East

Tigris and Euphrates Rivers Basin

- High temperature and high fluctuation



- Recent aridity



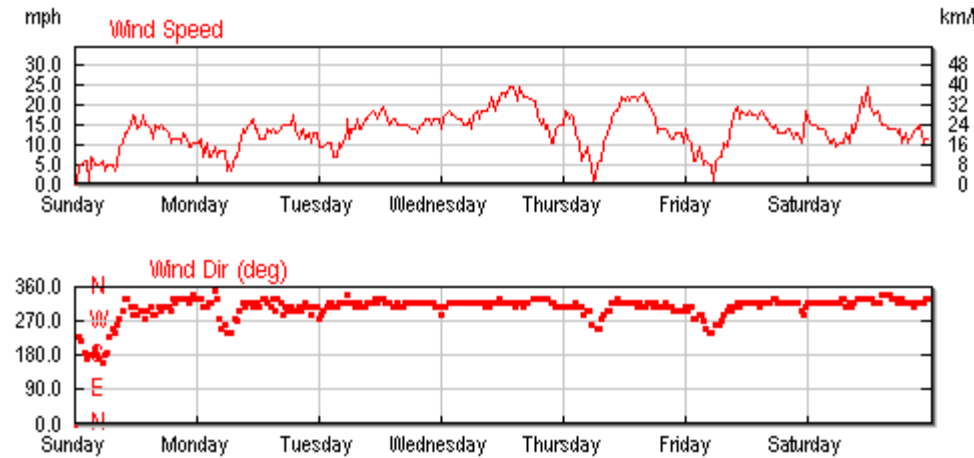
- Occasionally Flooded



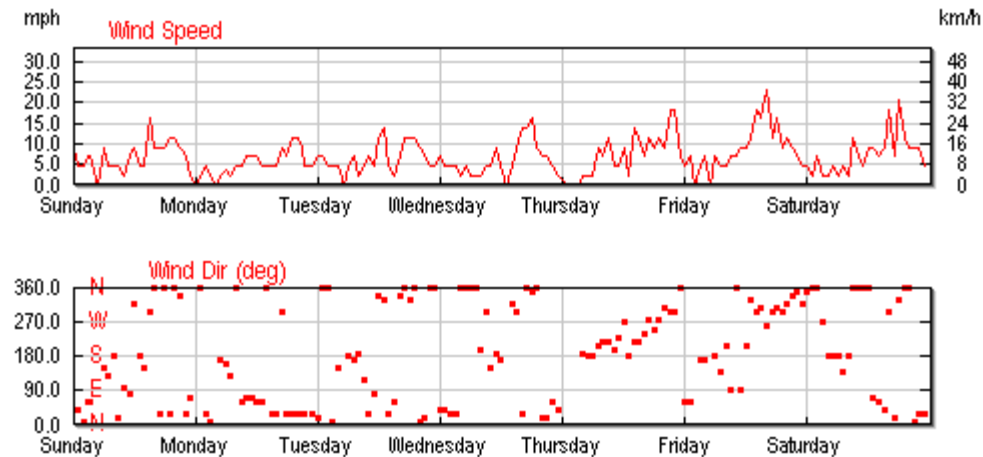
- Topographical Role

- Human activities





August 11, 2007 wind speed , direction of Kuwait airport weather station



August 11, 2007 wind speed , wind direction of Hail weather observation station (Saudi Arabia) showing the randomness of the wind direction suggesting the absence of funnelling effect

Study: Main Dust source affecting Middle East

Tigris and Euphrates Rivers Basin

- High temperature and high fluctuation



- Recent aridity



- Occasionally Flooded



- Topographical Role



- Human activities



Questions ?

Dust Storm Video

<http://www.youtube.com/watch?v=cv4BhZV5mAA>