Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East and Balkans and Developing Links with GEO related intiatives toward GEOSS

GEO-CRADLE Project Meeting 2
Thursday, 16th November, 2016

Adaptation to Climate Change user needs in North Africa and Middle East

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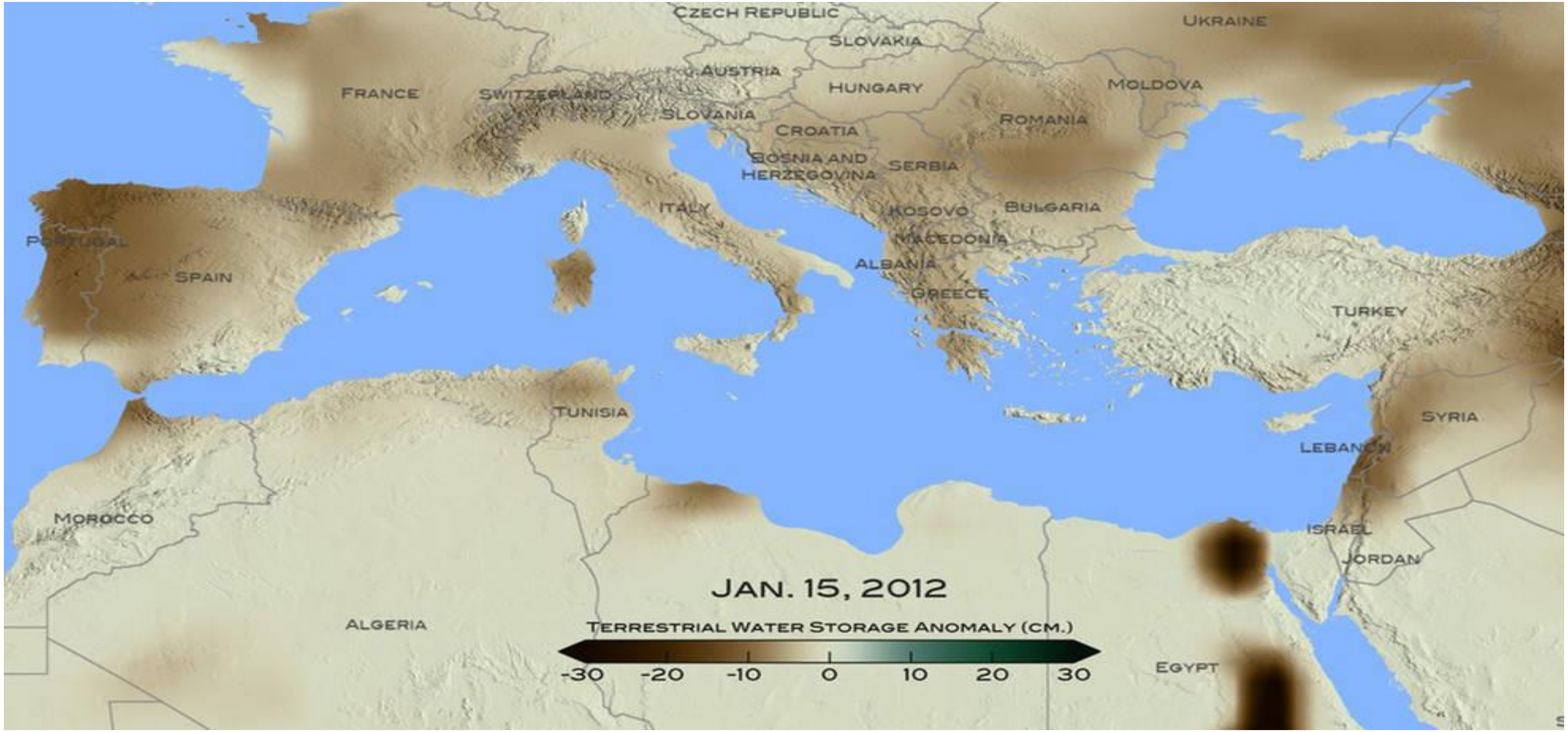
The GEO-CRADLE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690133.

NASA Finds Drought in Eastern Mediterranean and North Africa Worst of Past 900 Years (March 1st 2016)



For January 2012, brown shades show the decrease in water storage from the 2002-2015 average in the Mediterranean region. Units in centimeters. The data is from the Gravity Recovery and Climate Experiment, or GRACE, satellites, a joint mission of NASA and the German space agency.

Sand-and dust storms in North Africa and Gulf: opportunities to better monitor and prediction

- The Sahara Desert is the largest source of mineral dust aerosol and contributes 50-70 per cent of the dust emitted worldwide.
- For countries in and downwind of the Saharan Desert, airborne sand and dust present serious risks to the environment, property and human health.
- Saharan dust also plays an important role in climate and weather due to their direct (radiative forcing) and indirect (clouds, precipitation) impacts on the atmosphere.

- Dust storms phenomenon appears as:
  - A strong turbulent winds blowing over desert surfaces
  - Frequently lift large quantities of fine dust into the air reducing visibility to few meters
  - Producing deep gloom or even total darkness
  - Serious environmental impacts, considerable hardships, causes loss of income, disrupts communications, affects human health and can cause death in extreme cases, destroy livestock and crops in affected areas.

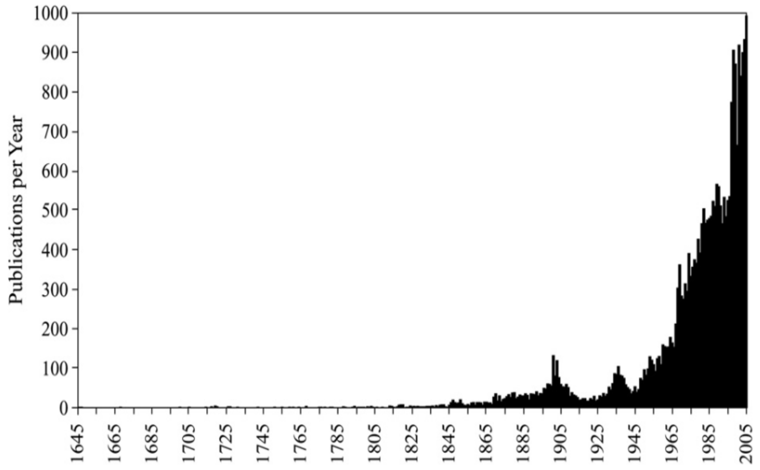
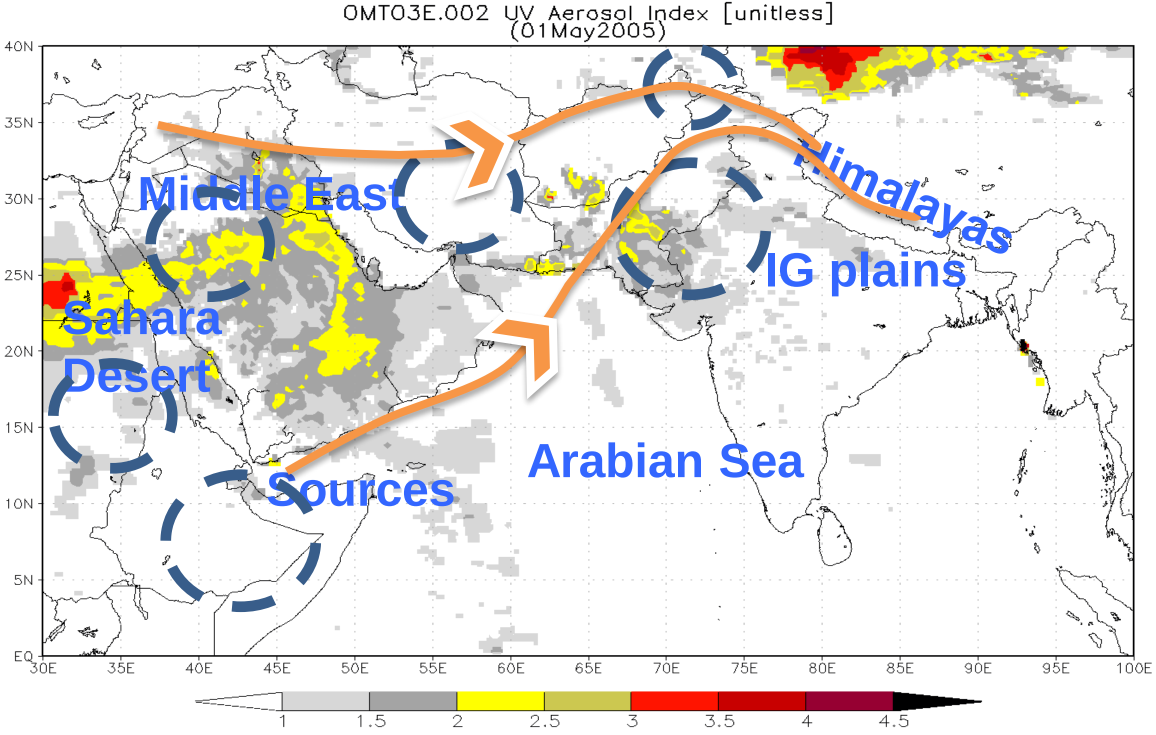
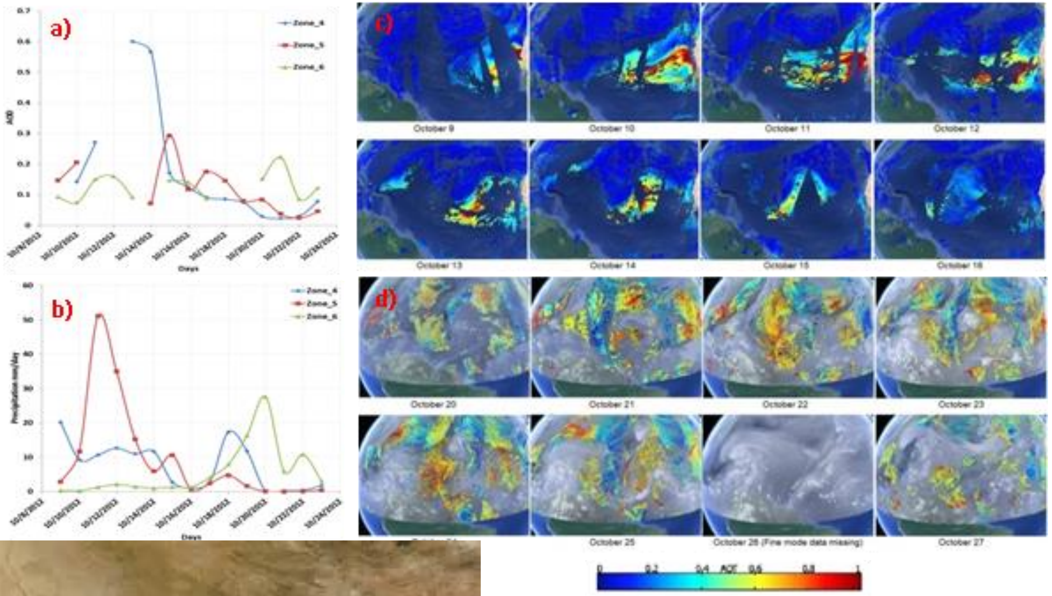


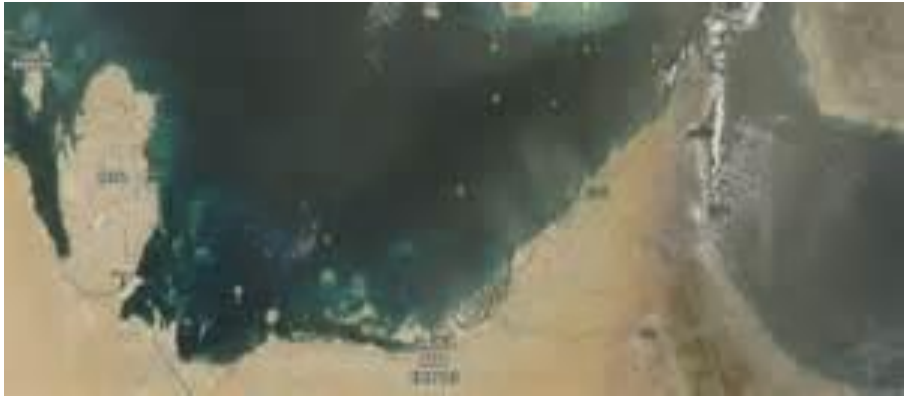
Figure 1. Publications/year on dust-related subjects (Stout et al. 2009)

Dust storms (May 7-8-9, 2005)

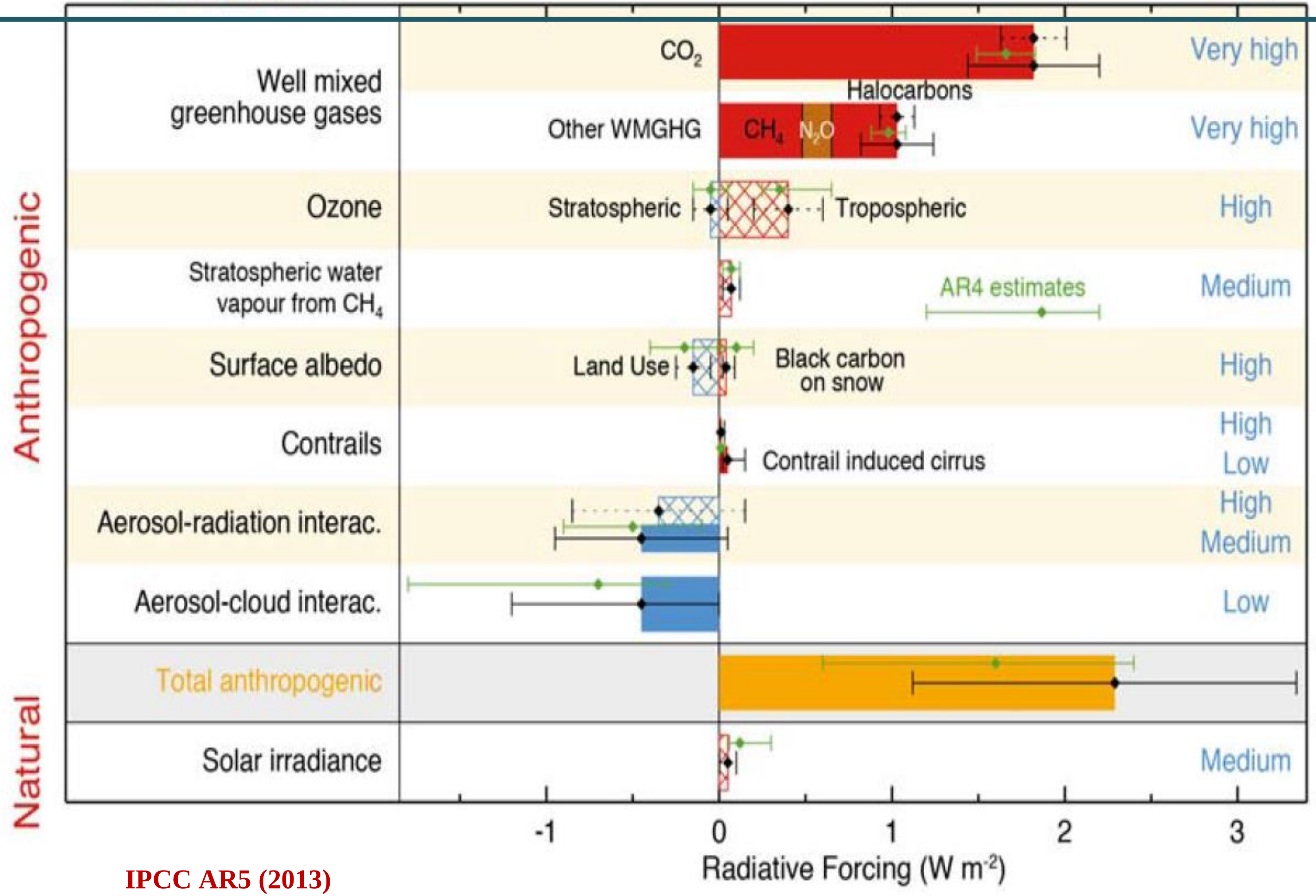




a)
Zone_4
Zone_5
Zone_6
Days
b)
Zone_4
Zone_5
Zone_6
Days
c)
October 9
October 10
October 11
October 12
October 13
October 14
October 15
October 16
d)
October 20
October 21
October 22
October 23
October 25
October 26 (Fine mode data missing)
October 27
AOT



Radiative forcing of climate between 1750 and 2011

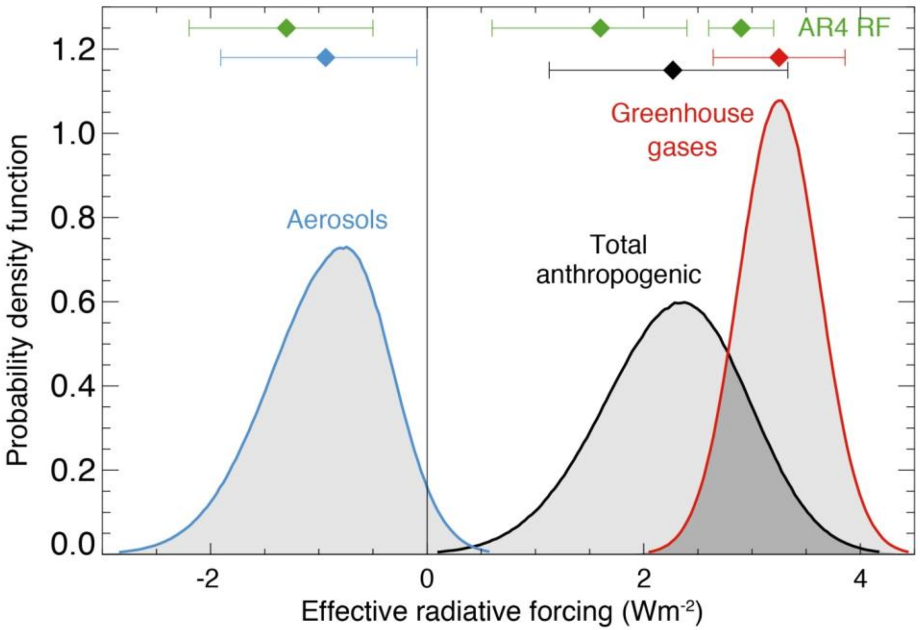


IPCC AR5 (2013)

Climate Sensitivity, λ

$$\lambda \equiv \frac{\Delta T_S}{RF} \equiv \frac{\Delta T_S}{RF_{CO2} + RF_{Aerosols}}$$

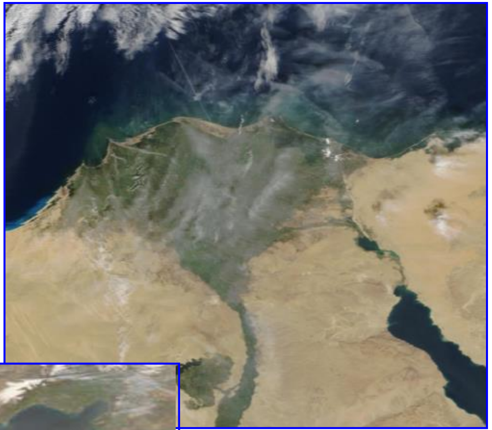
$\Delta T_S =$ **The change in equilibrium surface temperature due to radiative forcing (RF)**

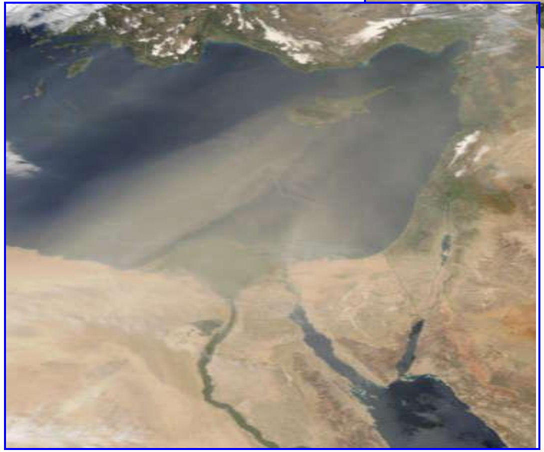


Dust and Black cloud episodes over Egypt (Nile Delta)

- Previous studies have attributed the increased pollution levels during the black cloud season only to the bio-mass or open burning of agricultural waste, vehicular, industrial emissions, and secondary aerosols.
- However, new multi-sensor observations (column and vertical profiles) from satellites, dust transport models and associated meteorology present a different picture of the autumn pollution.

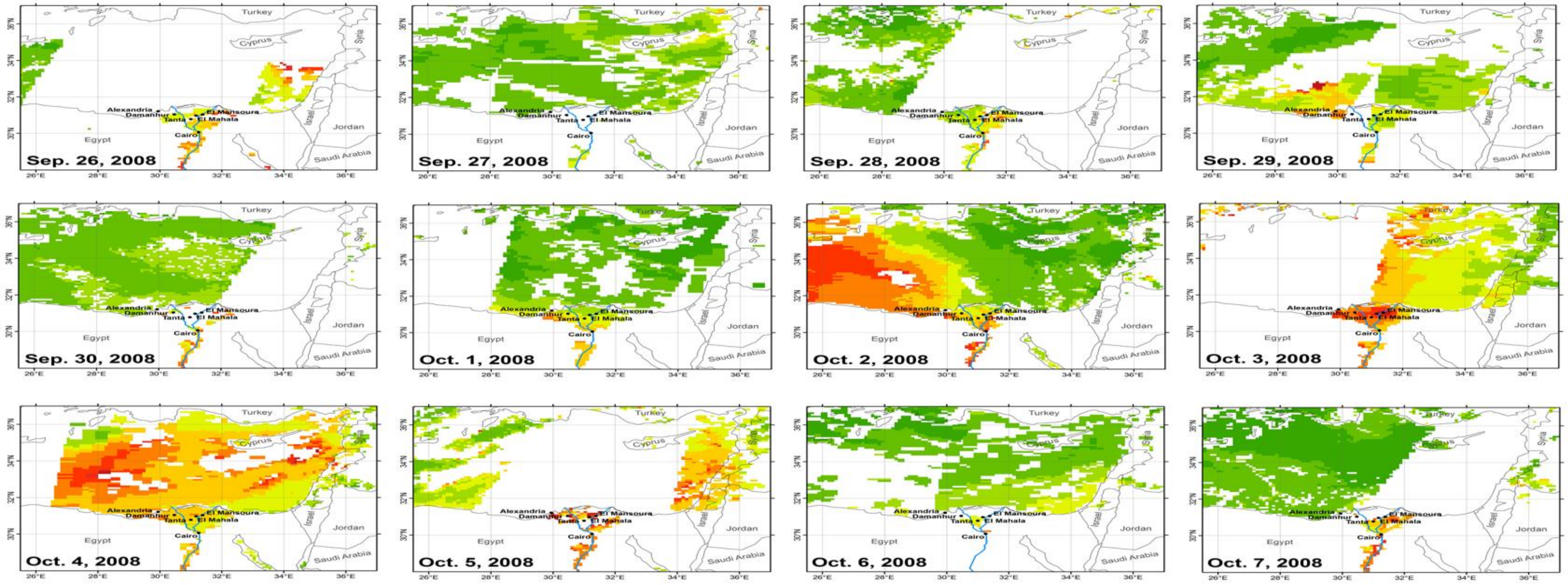
Black cloud covers Cairo and greater Delta region

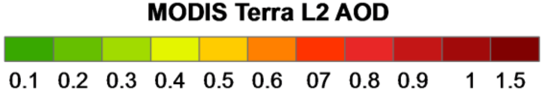




Dust blows across the north and northeast directions towards the Mediterranean

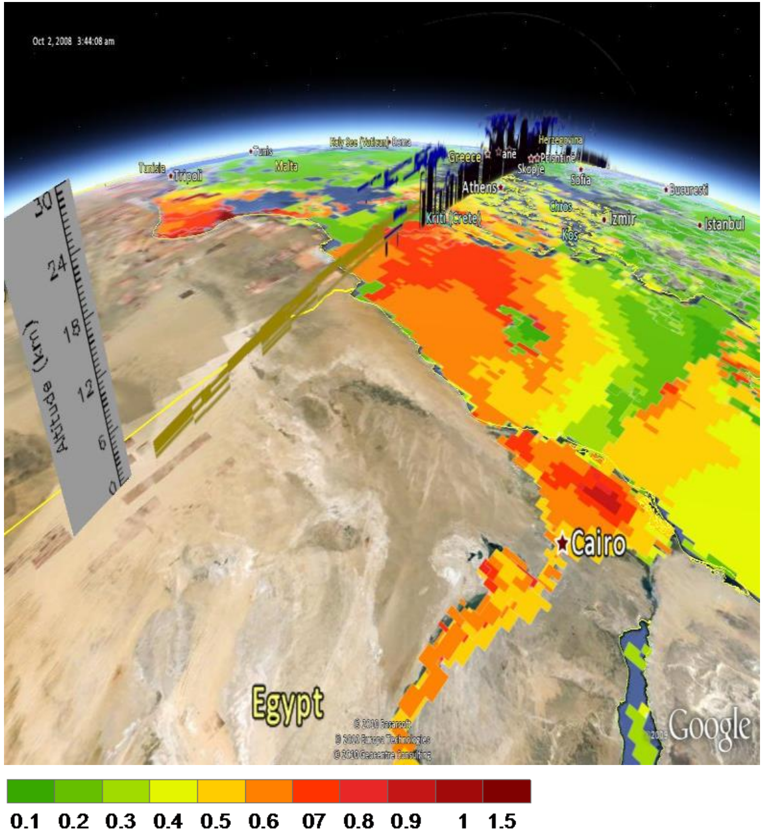
High AOD LOADINGS over Mediterranean Sea During Sep. & Oct. 2008





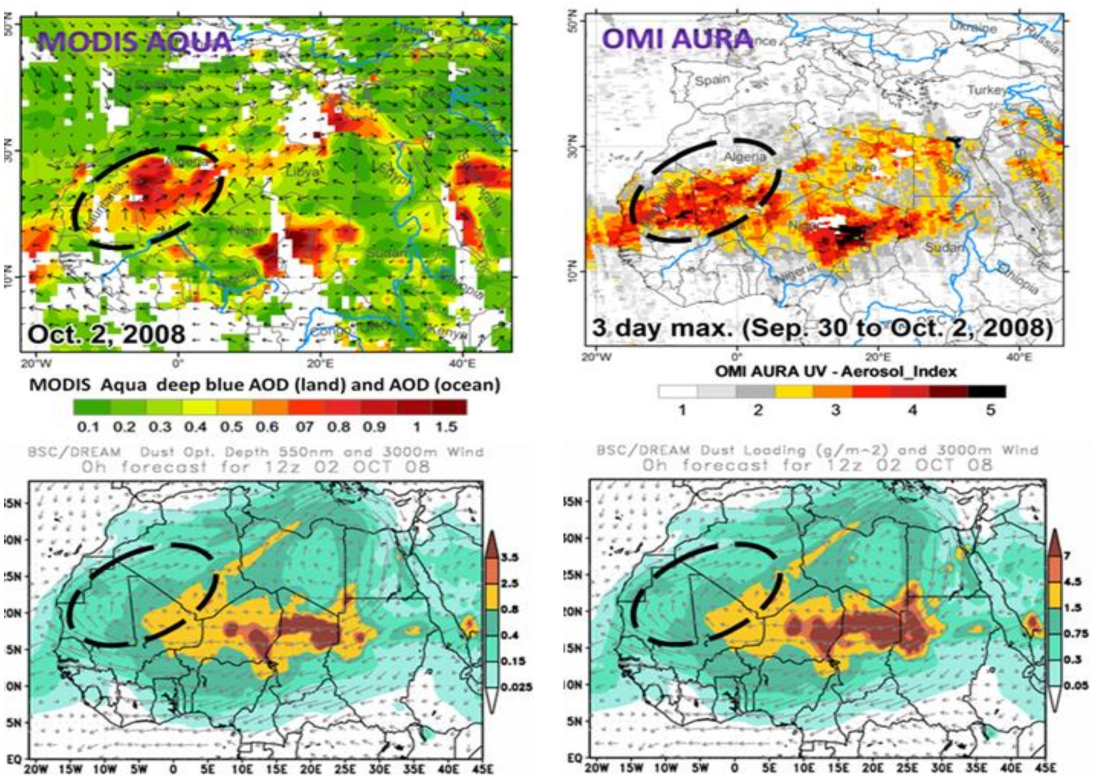
El-Askary H., Prasad A.K., Kallos G., El-Raey M., and Kafatos M., Analyzing Black Cloud Dynamics over Cairo, Nile Delta Region and Alexandria using Aerosols and Water Vapor Data Chapter 12 in InTECH open access publisher Book: Air Quality-Models and Applications, ISBN 978-953-307-307-1, 2011.

Long range transport of High altitude dust over Nile Delta and surrounding region



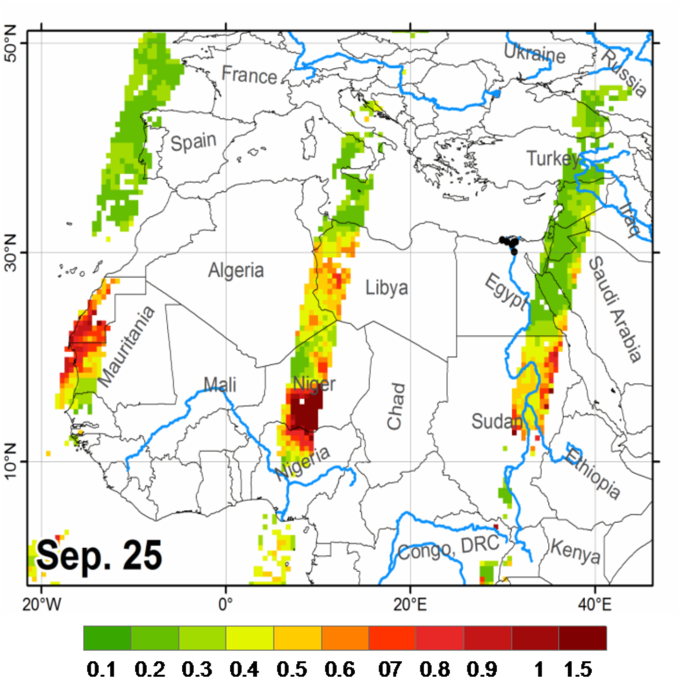
MODIS Terra level-2AOD

Observations Versus Modelling

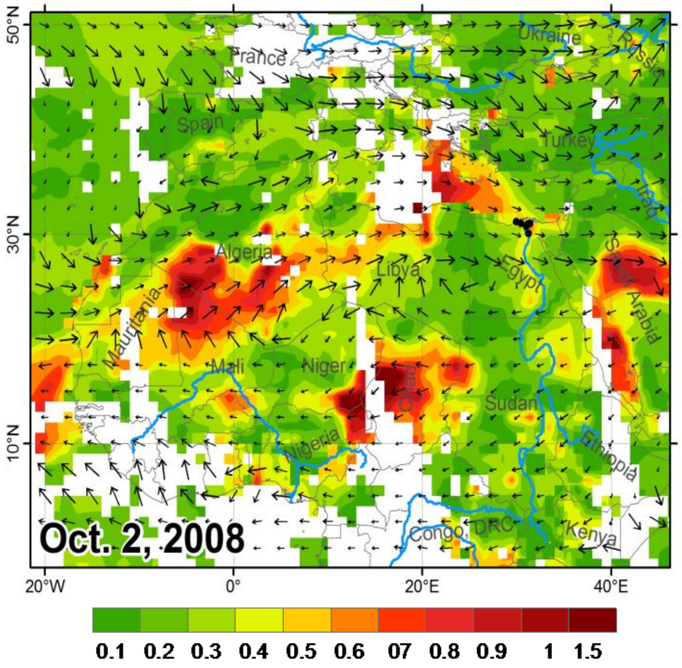


Prasad A. K., El-Askary H., and Kafatos M., "High altitude dust transport over Nile Delta during biomass burning season", Environmental Pollution, 158, 3385-3391, 2010 doi: 10.1016/j.envpol.2010.07.035

Multi Sensor Detection



MISR AOD (individual overpass)



MODIS Aqua DB_AOD over Land (transport pathway!)

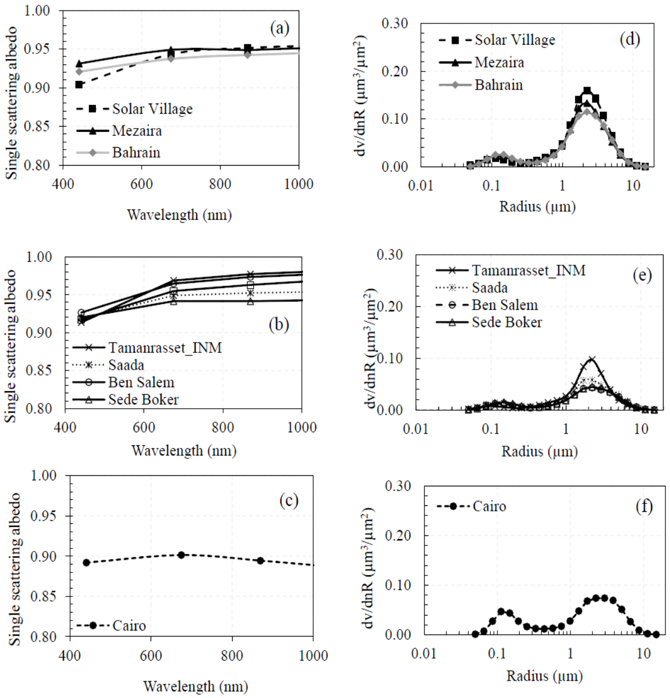
Prasad A. K., El-Askary H., and Kafatos M., "High altitude dust transport over Nile Delta during biomass burning season", Environmental Pollution, 158, 3385-3391, 2010 doi: 10.1016/j.envpol.2010.07.035

Characterization of the aerosol types over KSA (36 - 55°E, 17 - 30°N), for selected dates where the bold days represent great variations associated with the specified atmospheric scenario during Mar – May of 2003-2010.

Date	AE	AOD
Pollution		
2 May 2003	1.01	0.69
23 Sep 2003	1.18	0.29
18 April 2004	1.02	0.69
19 Apr 2005	1.81	0.49
7 Mar 2006	1.81	0.25
9 Sep 2008	1.81	0.37
3 Jan 2009	1.81	0.49
15 Mar 2009	1.22	0.35
14 Feb 2010	1.23	0.27
30 Apr 2010	1.81	0.51
Dust		
18 May 2003	0.54	0.64
5 Aug 2003	0.49	0.71
4 Aug 2008	0.48	0.57
17 Aug 2009	0.48	0.67
19 Jul 2010	0.49	0.70
11 Aug 2010	0.47	0.59
Mixed		
19 Jan 2003	0.66	0.19
5 Mar 2003	0.61	0.39
4 Apr 2004	0.61	0.30
4 Apr 2005	0.63	0.31
27 Apr 2006	0.63	0.28
7 Apr 2007	0.61	0.29
23 Jan 2008	0.83	0.18
24 Apr 2008	0.51	0.51
14 Jan 2009	0.62	0.27
25 May 2009	0.60	0.33
3 Mar2010	0.61	0.25
28 Sep 2010	0.63	0.27
Clean		
6 Jan 2003	0.87	0.09
2 Jan 2005	0.80	0.08
3 Oct 2005	0.81	0.07
29 Dec 2009	0.73	0.10
5 Jan 2010	0.67	0.10
9 Jan 2010	0.87	0.10

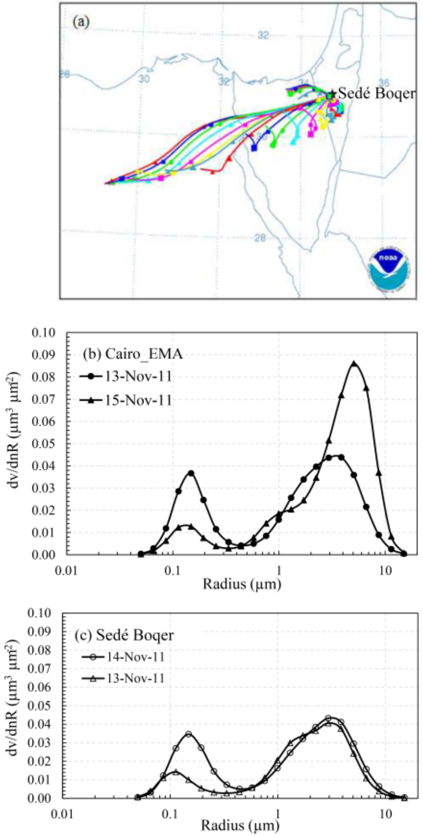
Ashraf Farahat, Hesham El-Askary, Peter Adetokunbo and Abu Tharr Fuad, "Analysis of aerosol absorption properties and transport over North Africa and the Middle East using AERONET data", Annales Geophysicea, (In Press 2016).

Aerosol Type –Region(s)	AERONET Sites	References
Biomass – North Africa	Cairo	El-Askary and Kafatos, (2008); Marey et al., (2010&2011); El-Metwally et al., (2008)
Mixed – Middle East	Sede Boker	Derimian et al., (2006); Eck el. (2010)
Dust – Middle East	Solar Village, Bahrain, Mezaira	Dubovik and King, (2000); Dubovik et al., (2002)
Different aerosols types	All Sites	Holben et al., (2001)
Mixed – North Africa	Saada, Tamanrasset_INM, Ben-Salem,	Basart et al., (2009); Abdi et al., (2012).



Characteristics of the Single Scattering Albedo (SSA) a) Solar Village, Bahrain, and Mezaira; b) Tamanrasset INM, Sada, Ben Salem, and Sede Boker; c) Cairo, and Volume Size Distribution at the eight sites d) Solar Village, Bahrain, and Mezaira; e) Tamanrasset INM, Sada, Ben Salem, and Sede Boker; f) Cairo.

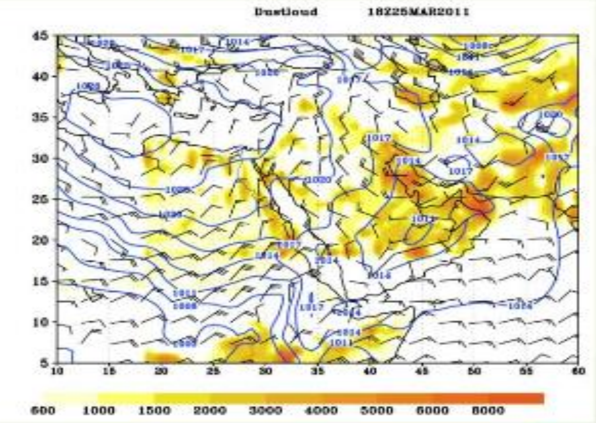
Ashraf Farahat, Hesham El-Askary and Umran Dogan, "Aerosols size distribution characteristics and role of precipitation during dust storm formation over Saudi Arabia", Aerosol and Air Quality Research, vol. 16, No.10: 2523-2534, doi: 10.4209/aaqr.2015.11.0656.



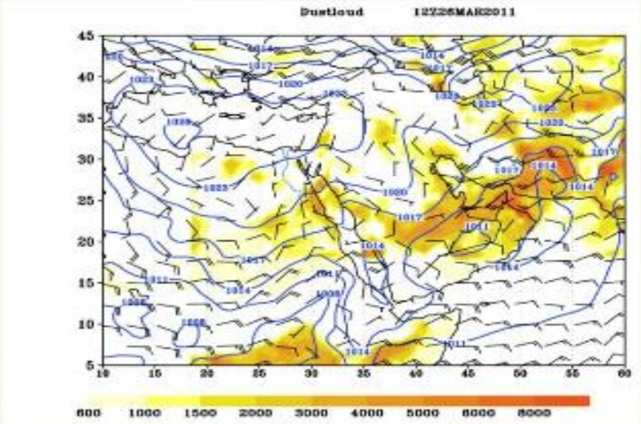
a) HYSPLIT backward trajectory on November 14, 2011 at Sede Boker site showing aerosols possible transport from Cairo site b) Volume size distribution at SEDEE_BOKER site during November 13 and 14, 2011 c) Volume size distribution at EMA_Cairo site during November 13 and 15, 2011.

Forecasting of Dust storms

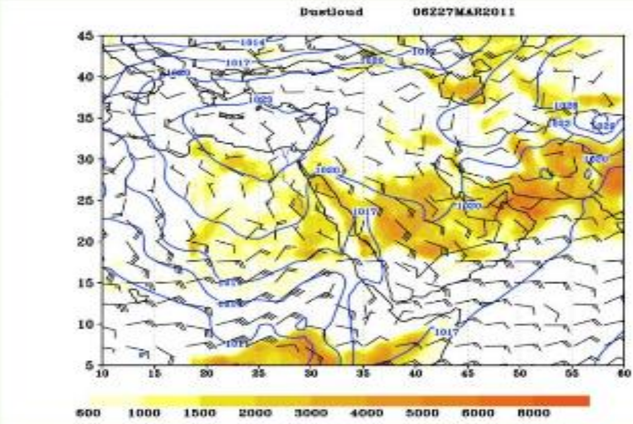
18Z 25MAR 2011



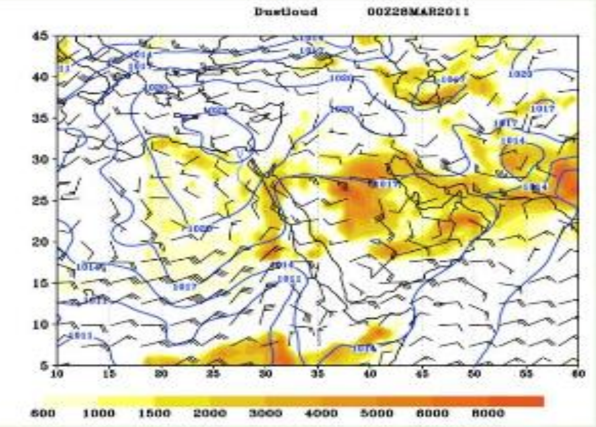
12Z 26MAR 2011

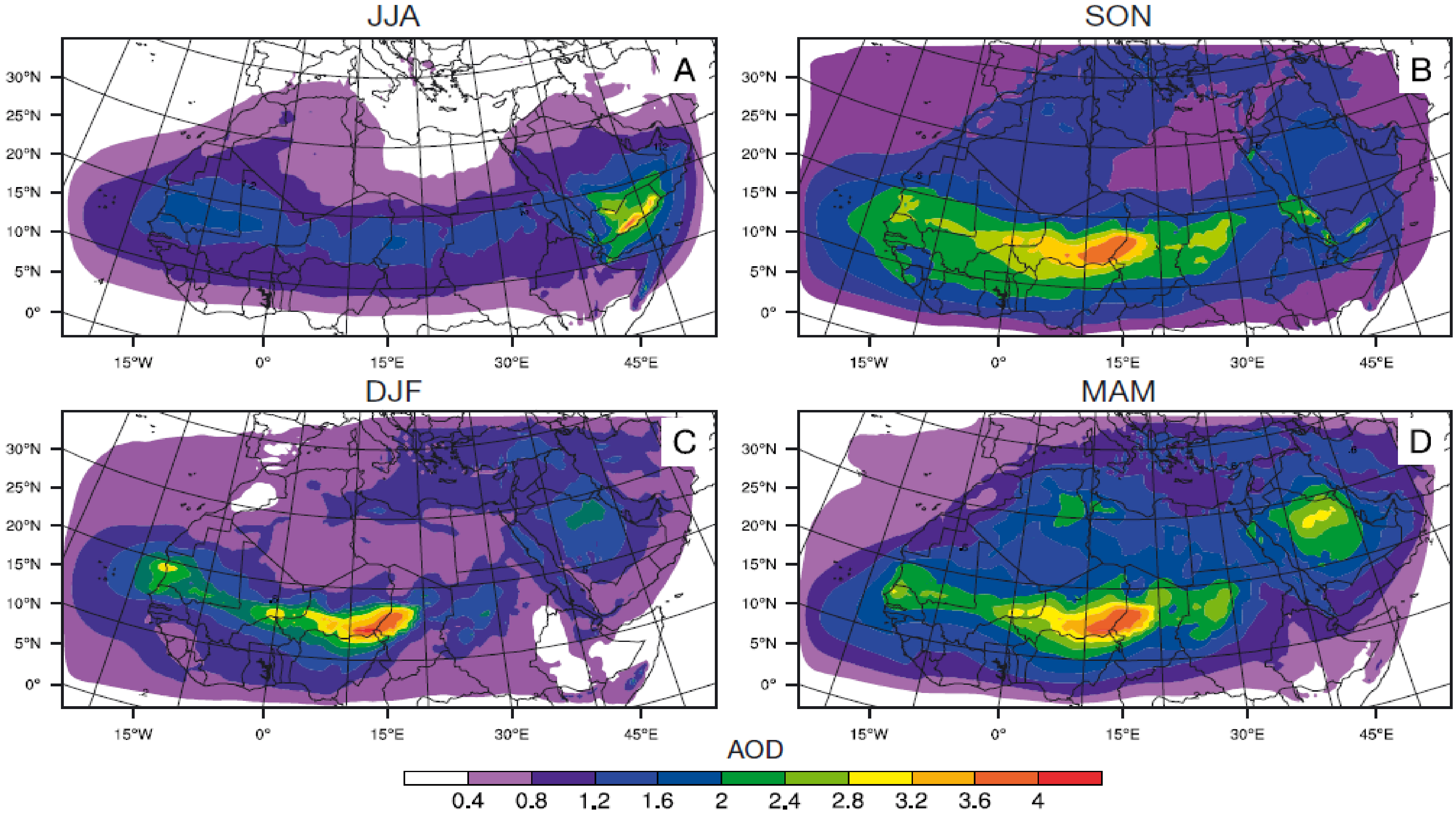


06Z 27MAR 2011



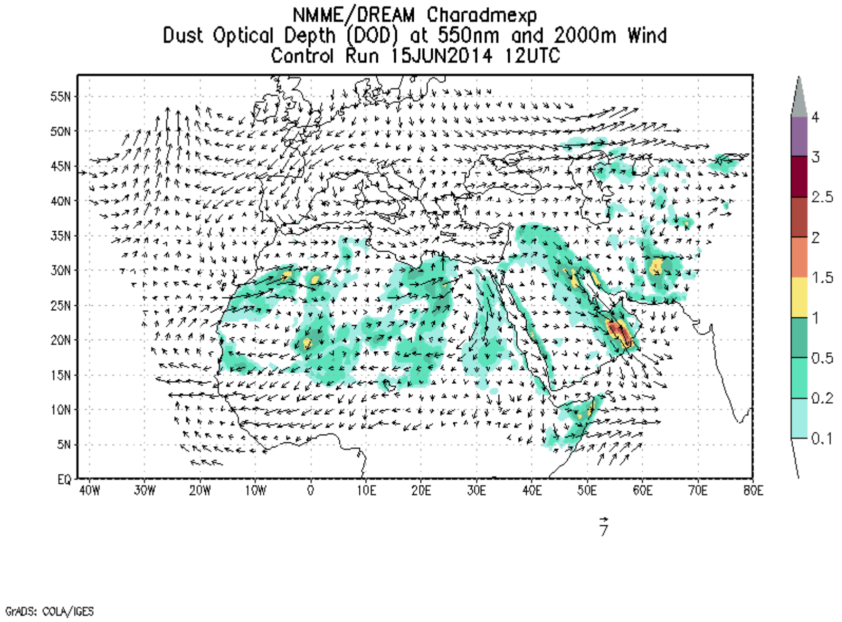
00Z 28MAR 2011

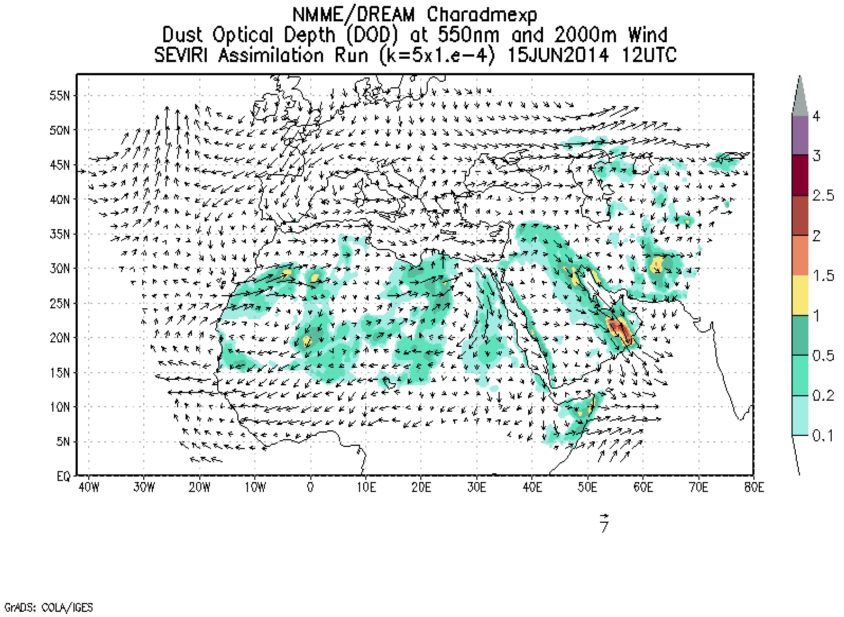




Modeled climatological aerosol optical depth (AOD) (unitless) for the period 1998–2006 for (A) JJA, (B) SON, (C) DJF, and (D) MAM.

Desert dust modeling and forecasting



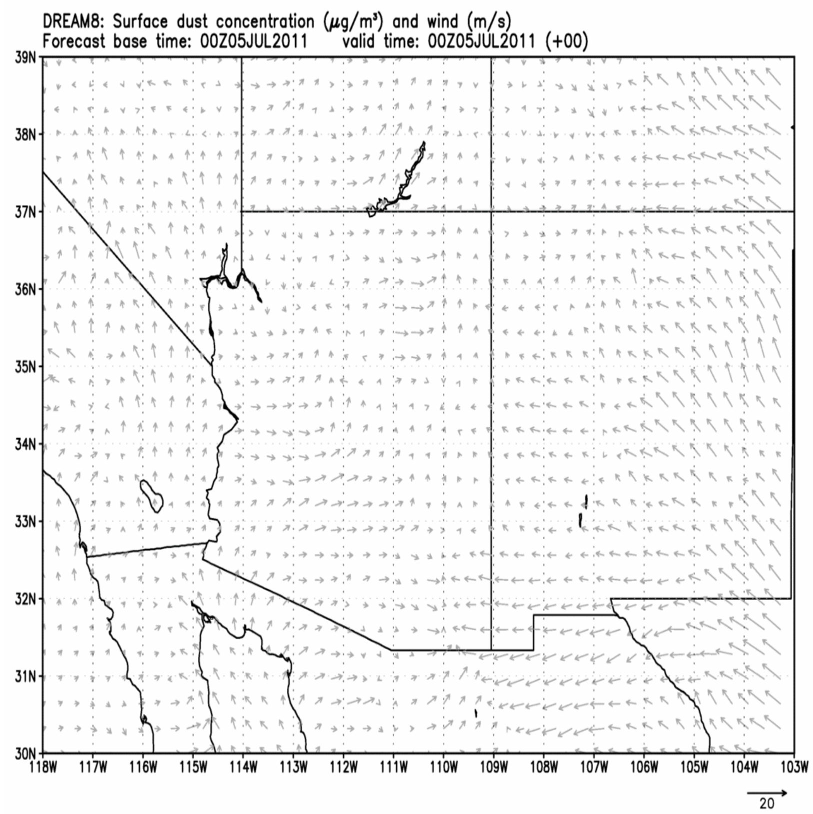


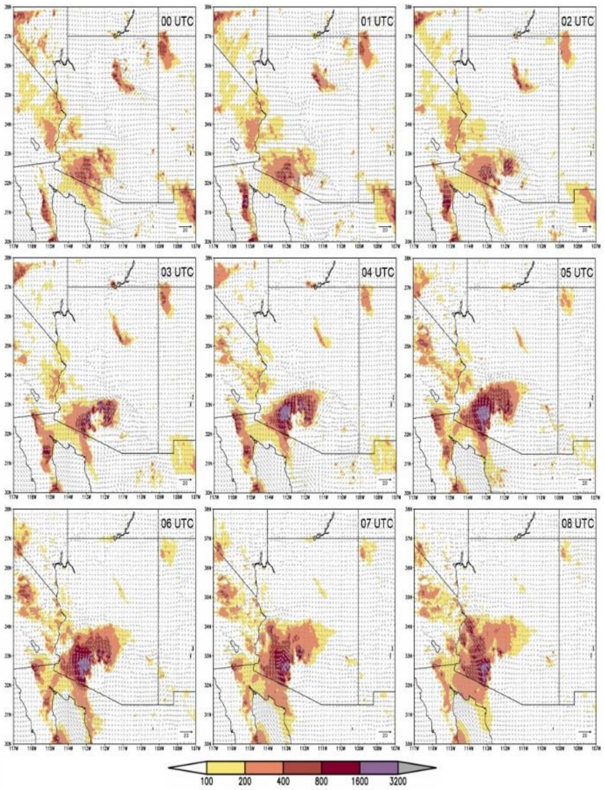
Assimilation Effects

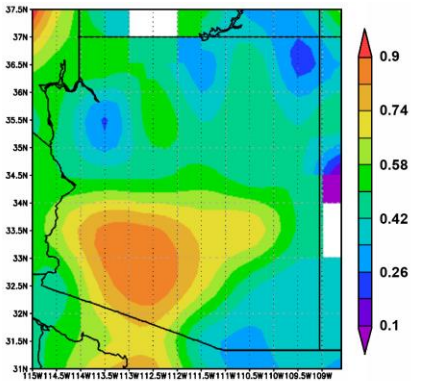
- Cuts dust production over Arabian Peninsula
- Saharan dust sources are represented in finer detail
- Dust increases over Iberian Peninsula
- Sahel sources may be too strong

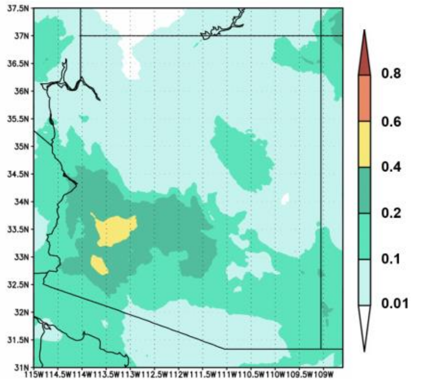
Credit: with Vassilis Amiridis and Slobodan Nickovic

Numerical simulation of "An American Haboob"







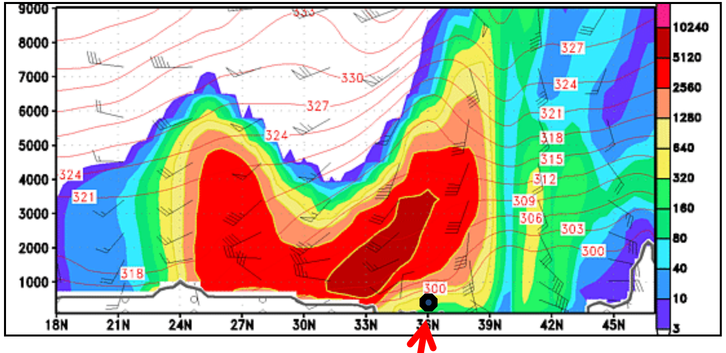


A. Vukovic, M. Vujadinovic, G. Pejanovic, J. Andric, M. J. Kumjian, V. Djurdjevic, M. Dacic, A. K. Prasad, **H. M. El-Askary**, B. C. Paris, S. Petkovic, W. Sprigg, and **S. Nickovic**, "Numerical Simulation of "An American Haboob"", Atmos. Chem. Phys. Discuss., 13, 26175-26215, 2013.

In collaboration: Hesham El-Askary and Slobodan Nickovic

AVIATION

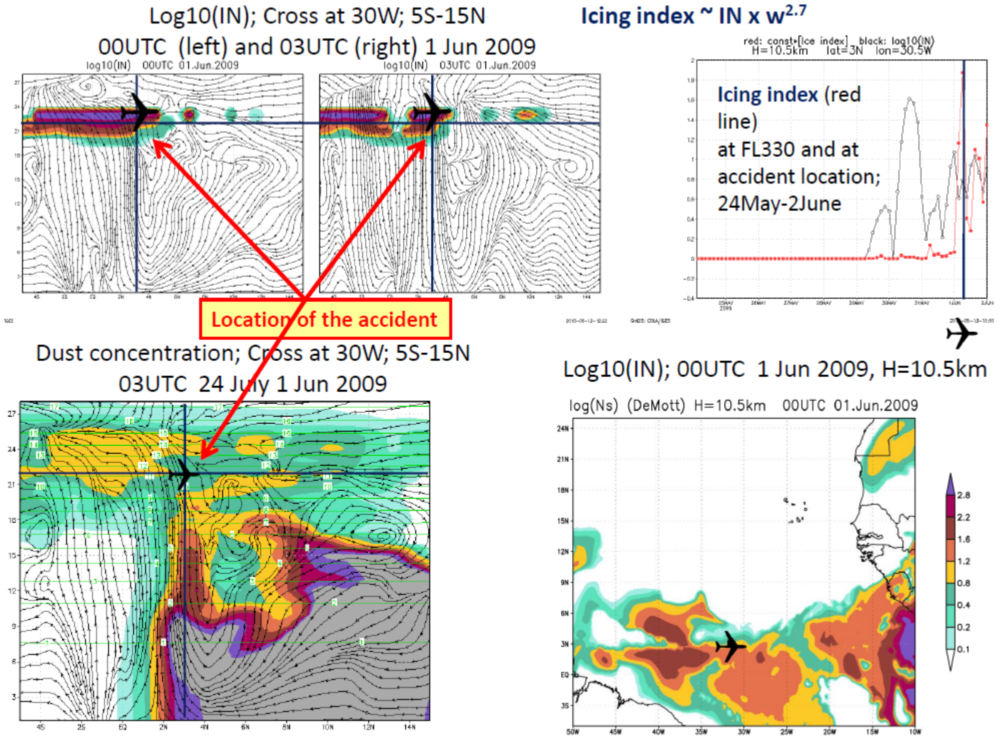
Egypt Air 2002 accident
Extreme dust loads



TUNIS 7 May, 2002
DREAM dust prediction

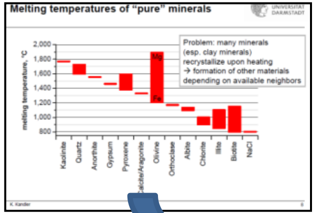
AVIATION

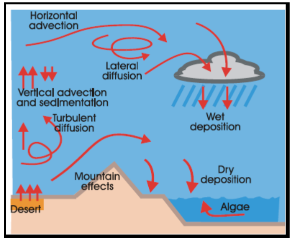
AirFrance 2009 accident
Hypothesis on dust influence: dust-icenucleation

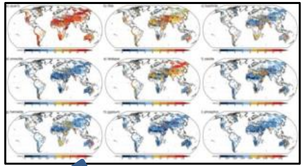


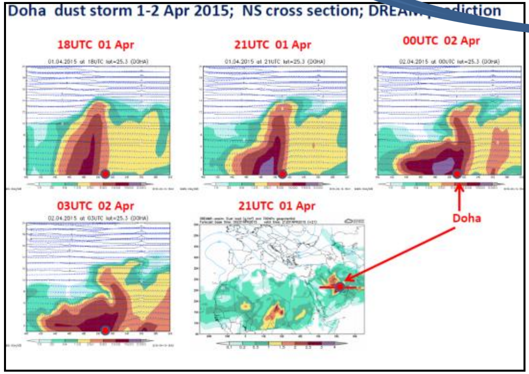
AVIATION

Dust melting on aircraft engines
(new turbines higher working T)
Predicting conditions for expected dust melting using mineralogy









Engine damage

Image: Eric Moody, British Airways

Concluding Remarks

- Fifteen countries in the region have shown interest in improving their capabilities to forecast and understand the dust process resulting in launching the Sand and Dust Storm Warning, Advisory and Assessment System (SDS-WAS) as a joint project of the World Weather Research Programme (WWRP) and the Global Atmospheric Watch (GAW) under the WMO Commission for Atmospheric Sciences.
- In terms of the climate variability; it is more relevant to the application of remotely sensed data and models for understanding the aerosols and its relation with the air quality that negatively impact the human health.

Open Discussion