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 Regional Meeting
Thursday, 25th May, 2017

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

Hesham El-Askary

Center of Excellence in Earth Systems Modeling and Observations
Schmid College of Science and Technology, Chapman University
CEDARE

Cairo, Egypt

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

Description of the pilot T4.1 ACC

ACC Partners: NOA, CEDARE, CUT, INOE, IPB, AOA

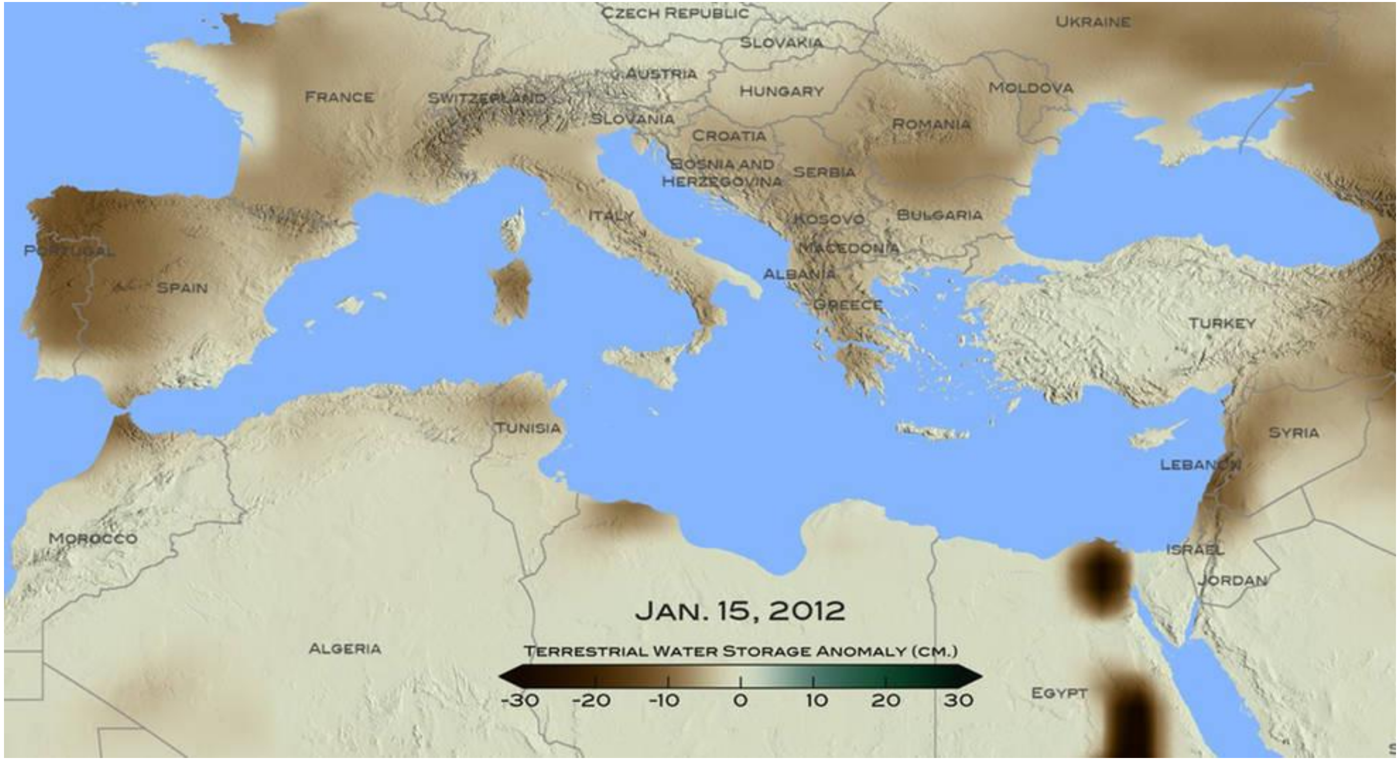
Initial ACC objectives:

- To collect, homogenize and integrate ground-, air- and space-based EO data with emphasis on the atmosphere, weather and climate.
- To utilize the consolidated datasets in support of the provision of accurate services related to atmospheric hazard forecasting and climate projections.
- To assess the regional climate change impacts based on region-optimized projections and establishment of a climate data hub for supporting decision makers on mitigation and adaptation policies.

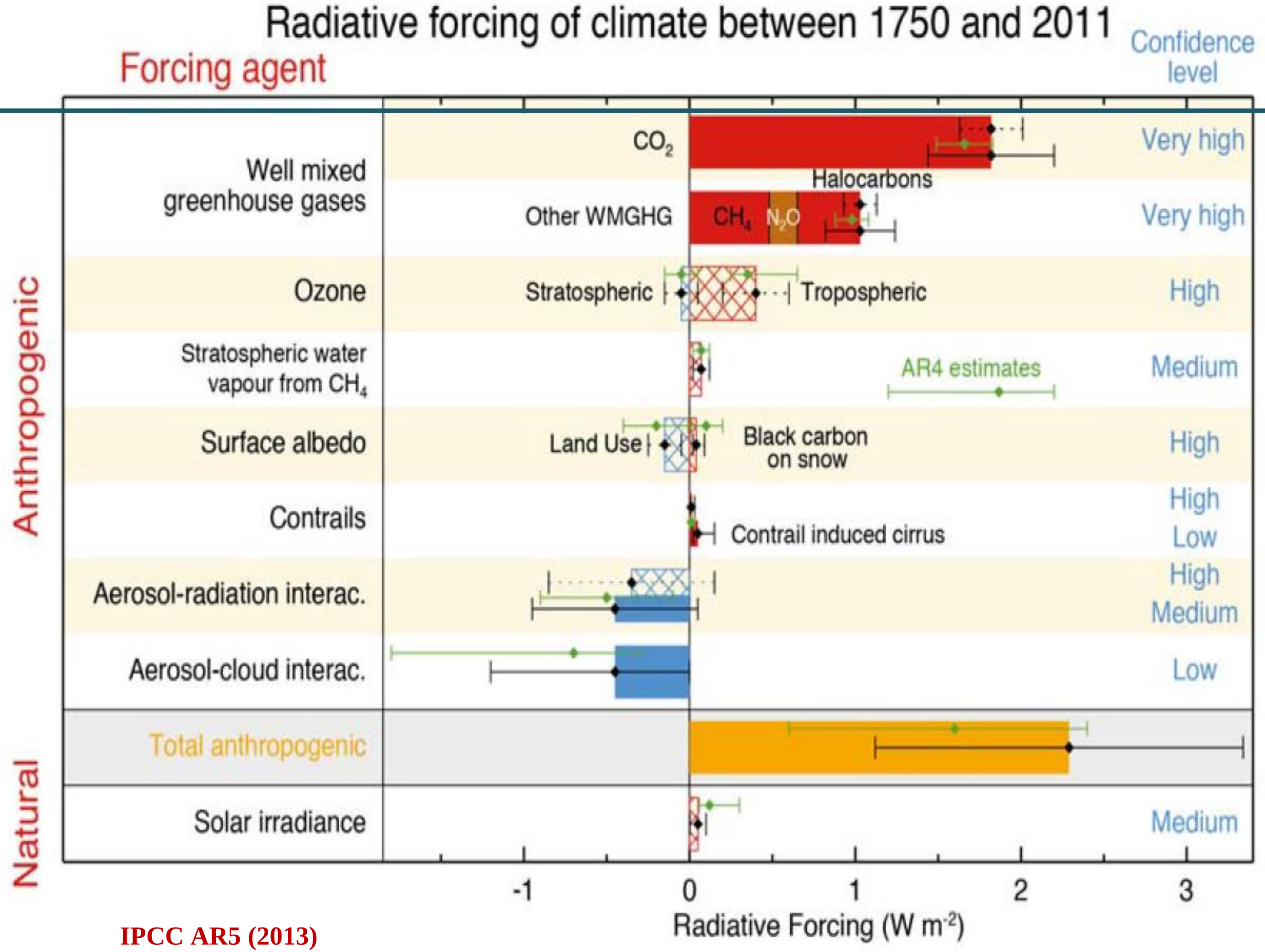
Sand-and dust storms in North Africa and Gulf: opportunities to better monitor and prediction

- 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.
- 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.
- Saharan dust also plays an important role in climate and weather due to their direct (radiative forcing) and indirect (clouds, precipitation)
- 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.

NASA Finds Drought in Eastern Mediterranean 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.

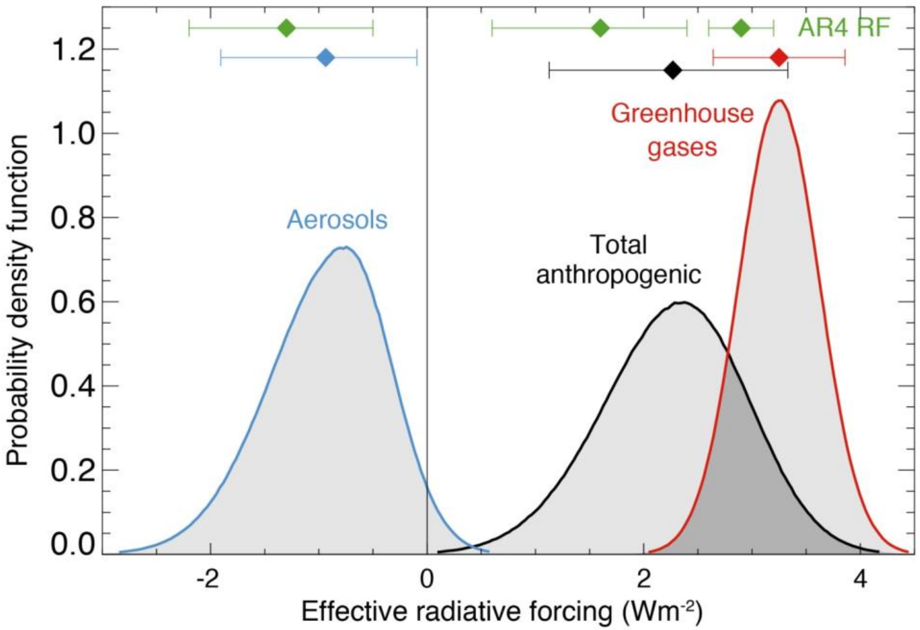


IPCC AR5 (2013)

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)



ACC desert dust forecasting pillar motivation

Mineral dust is a very important atmospheric component

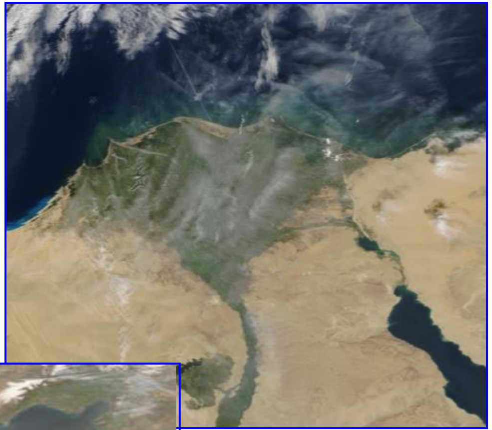
- Affects climate change (radiation and clouds)
- Affects ocean and land biogeochemistry (fertilization from dust depositions)
- Health impacts
- It is a real hazard threat (e.g. for aviation) in Africa and Middle East (haboobs)

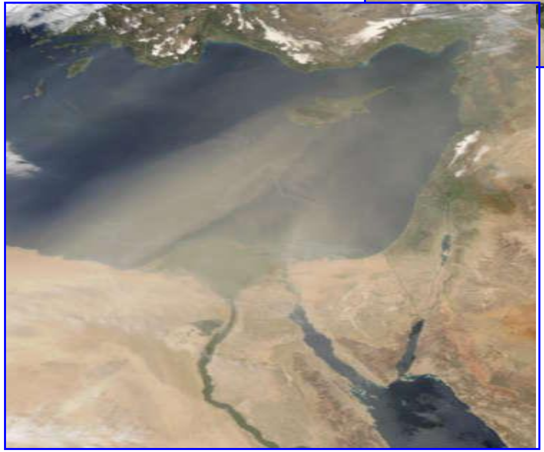
- Resolving of small scale phenomena (e.g. Low Level Jets, haboobs, land-use changes) improves dust simulations for research and case studies.
- Such runs require high resolution grids and advanced modeling schemes not commonly available at operational mode.
- Need to represent these processes in the coarser operational dust models so as to improve the forecasts.
- **Remote sensing can be the key towards this direction through assimilation and evaluation techniques.**

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.

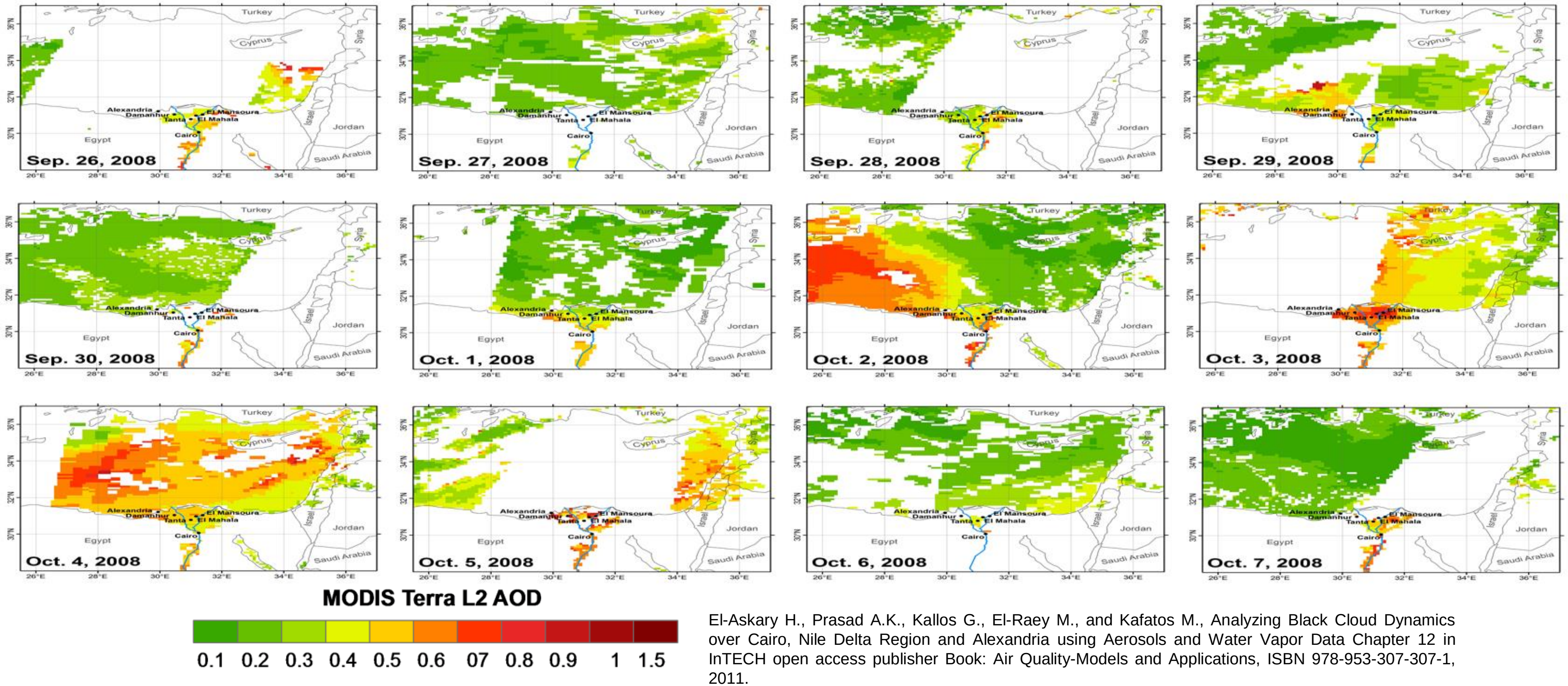
Black cloud covers Cairo and greater Delta region





Dust blows across the north and northeast directions towards the Mediterranean

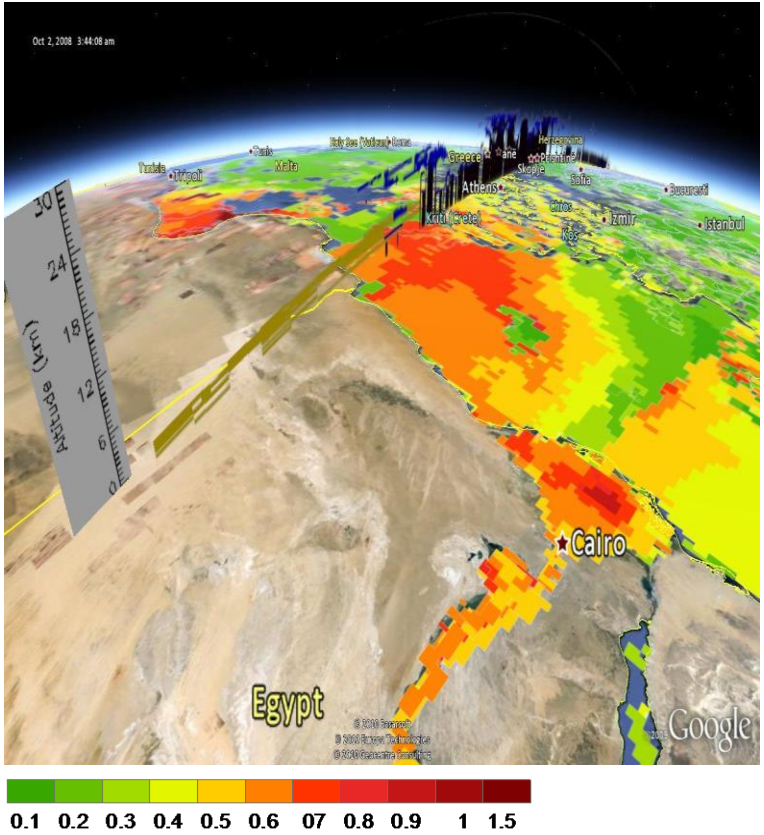
High AOD LOADINGS over Mediterranean Sea During Sep. & Oct. 2008



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.

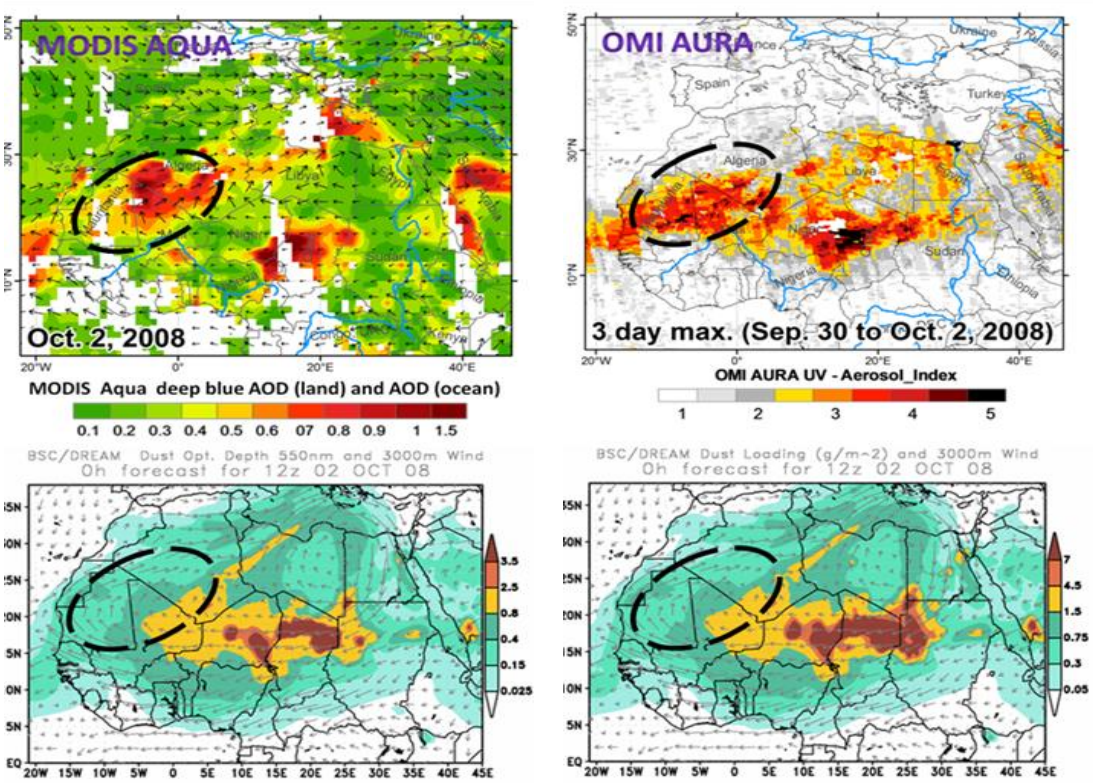
CHAPMAN UNIVERSITY

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



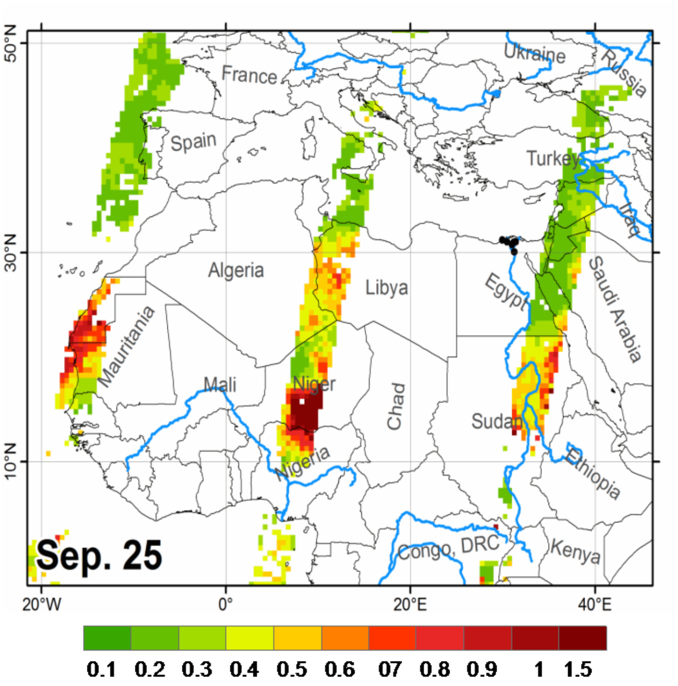
MODIS Terra level-2AOD

Observations Versus Modelling

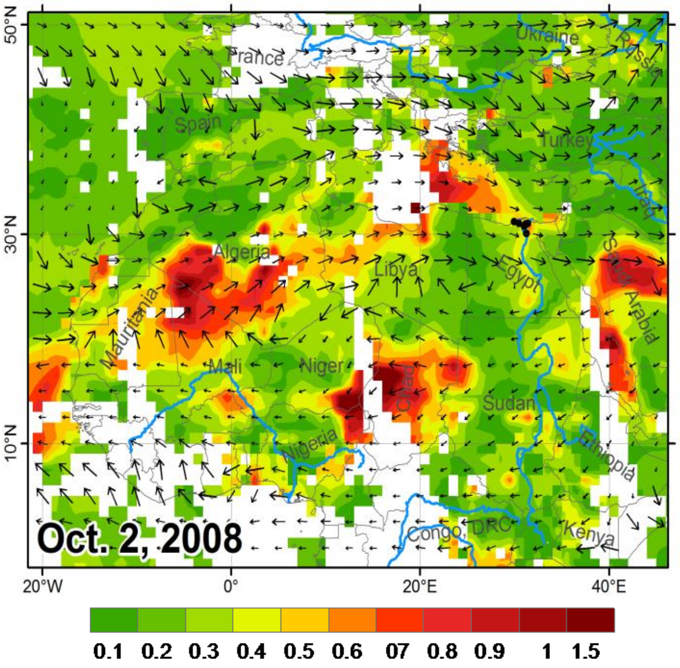


Prasad A. K., El-Askary H., and Kafatos M., “High altitude dust transport over Nile Delta during biomass burning season”, Environmental Pollution, 158, 3385-3391, 2010 doi: 10.1016/j.envpol.2010.07.035

Multi Sensor Detection



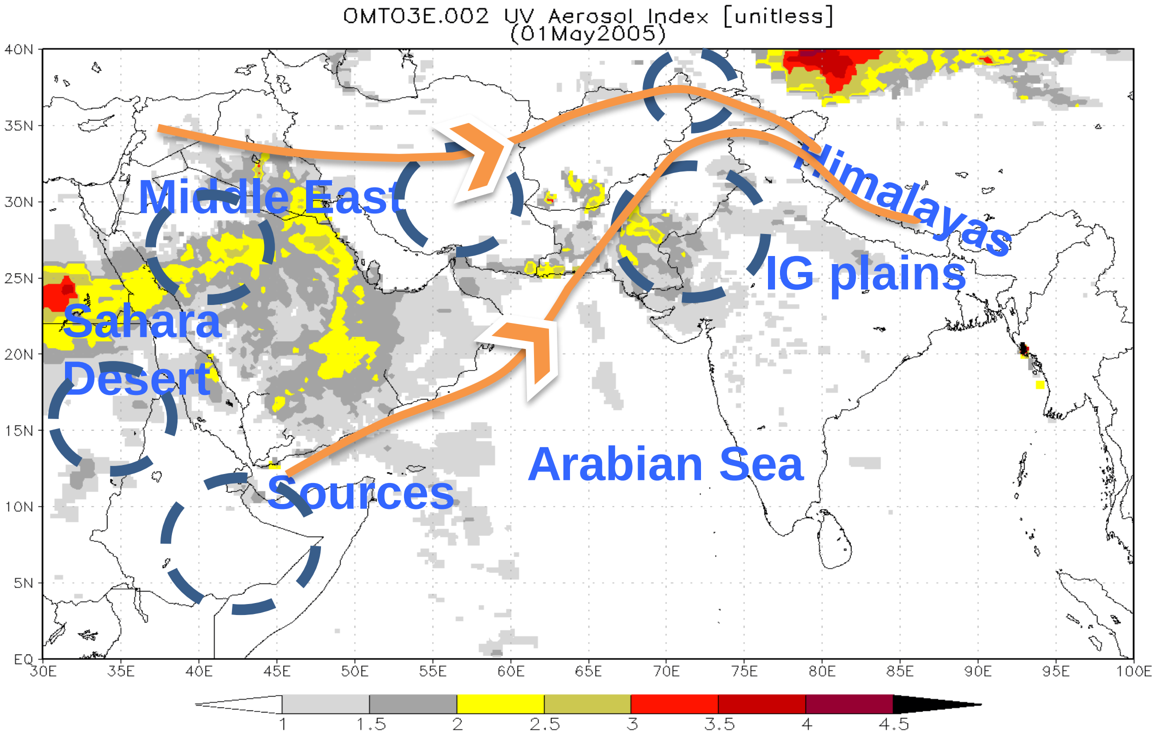
MISR AOD (individual overpass)



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

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

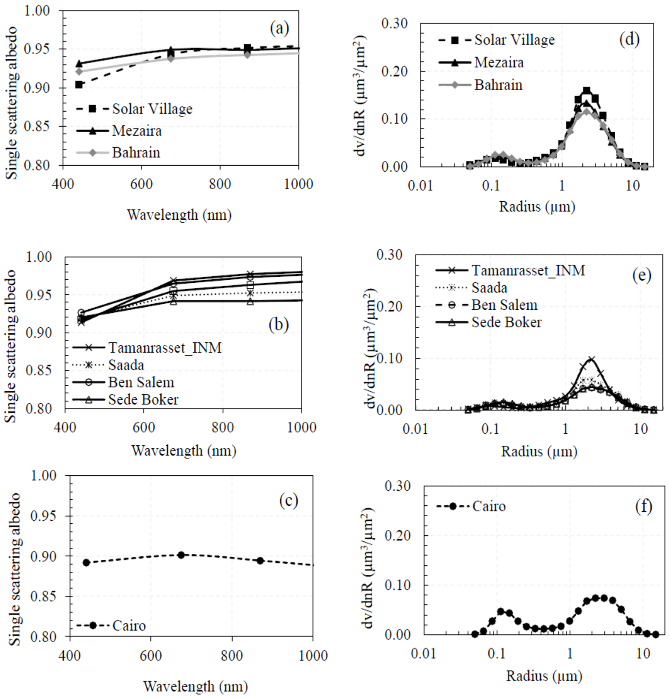


Characterization of the aerosol types over KSA (36 - 55°E, 17 - 30°N), for selected dates where the bold days represent great variations associated with the specified atmospheric scenario during Mar – May of 2003-2010.

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

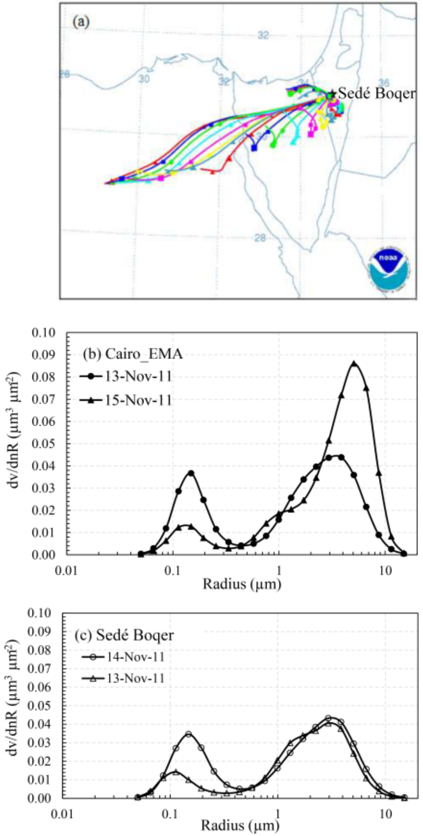
Ashraf Farahat, Hesham El-Askary, Peter Adetokunbo and Abu Tharr Fuad, "Analysis of aerosol absorption properties and transport over North Africa and the Middle East using AERONET data", Annales Geophysicea, (In Press 2016).

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).



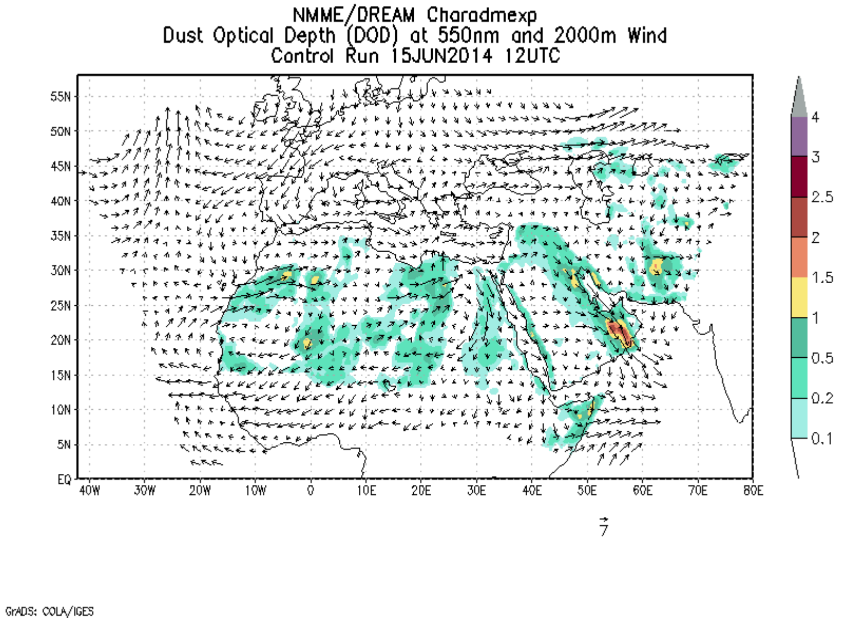
Characteristics of the Single Scattering Albedo (SSA) a) Solar Village, Bahrain, and Mezaira; b) Tamanrasset INM, Sada, Ben Salem, and Sede Boker; c) Cairo, and Volume Size Distribution at the eight sites d) Solar Village, Bahrain, and Mezaira; e) Tamanrasset INM, Sada, Ben Salem, and Sede Boker; f)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

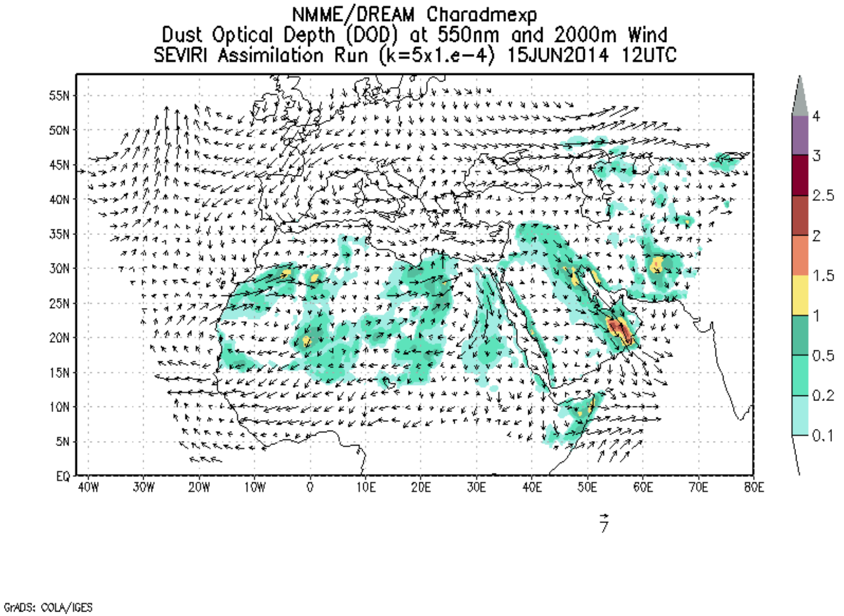
Ashraf Farahat, Hesham El-Askary and Umran Dogan, "Aerosols size distribution characteristics and role of precipitation during dust storm formation over Saudi Arabia", Aerosol and Air Quality Research, vol. 16, No.10: 2523-2534, doi: 10.4209/aaqr.2015.11.0656.



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.

Desert dust modeling and forecasting



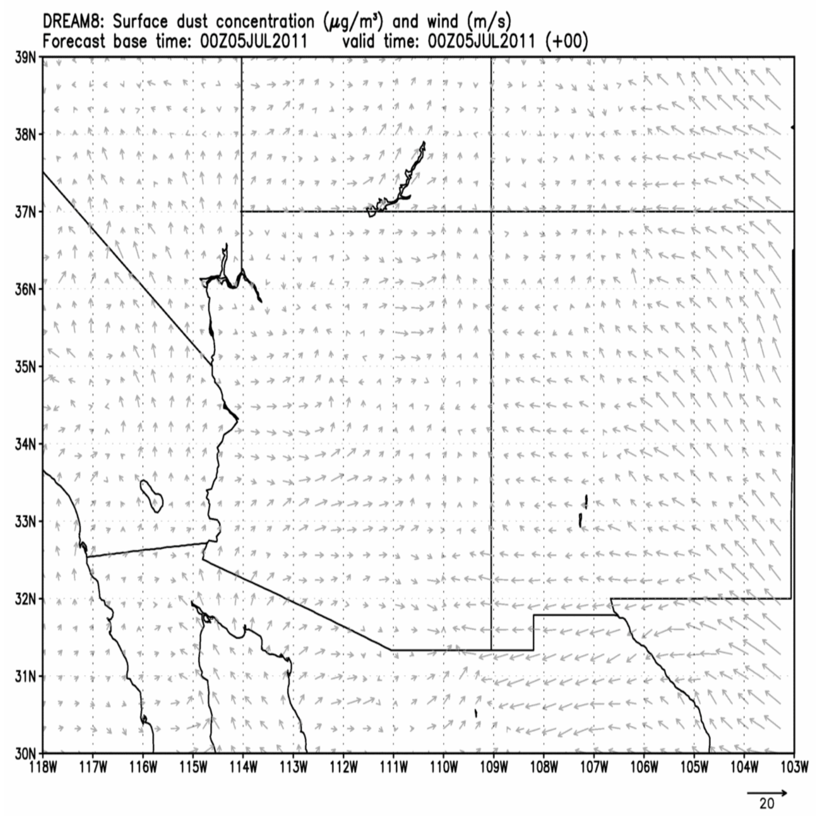


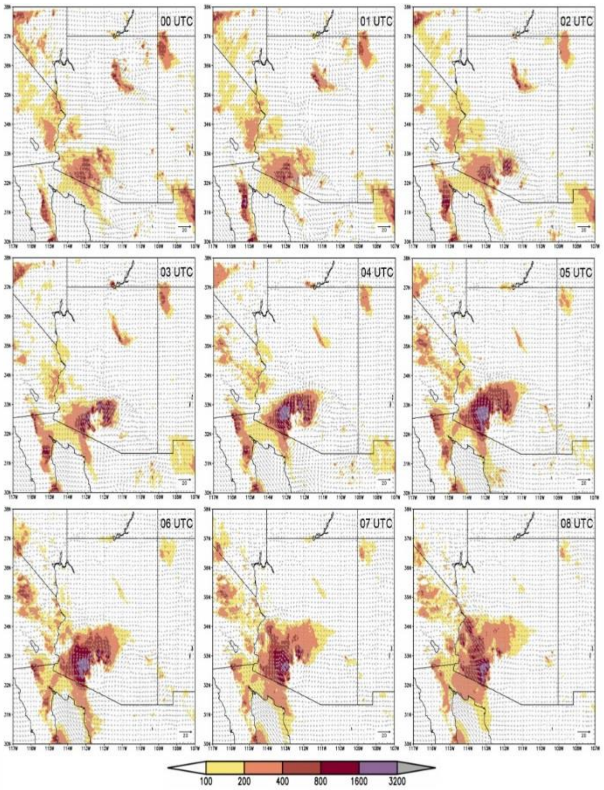
Assimilation Effects

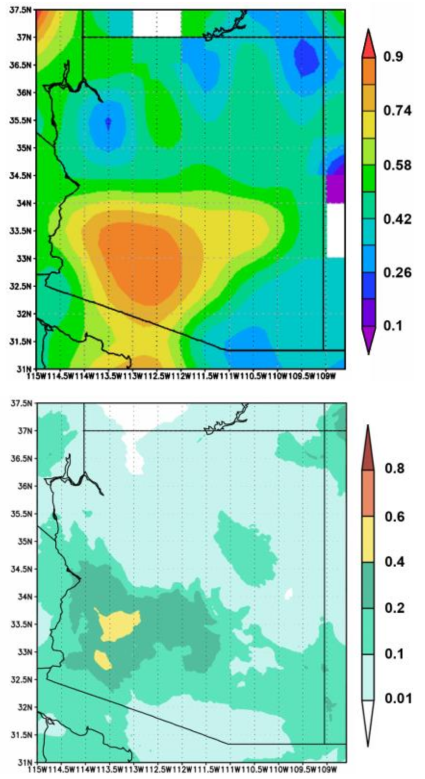
- Cuts dust production over Arabian Peninsula
- Saharan dust sources are represented in finer detail
- Dust increases over Iberian Peninsula
- Sahel sources may be too strong

Credit: with Vassilis Amiridis and Slobodan Nickovic

Numerical simulation of "An American Haboob"



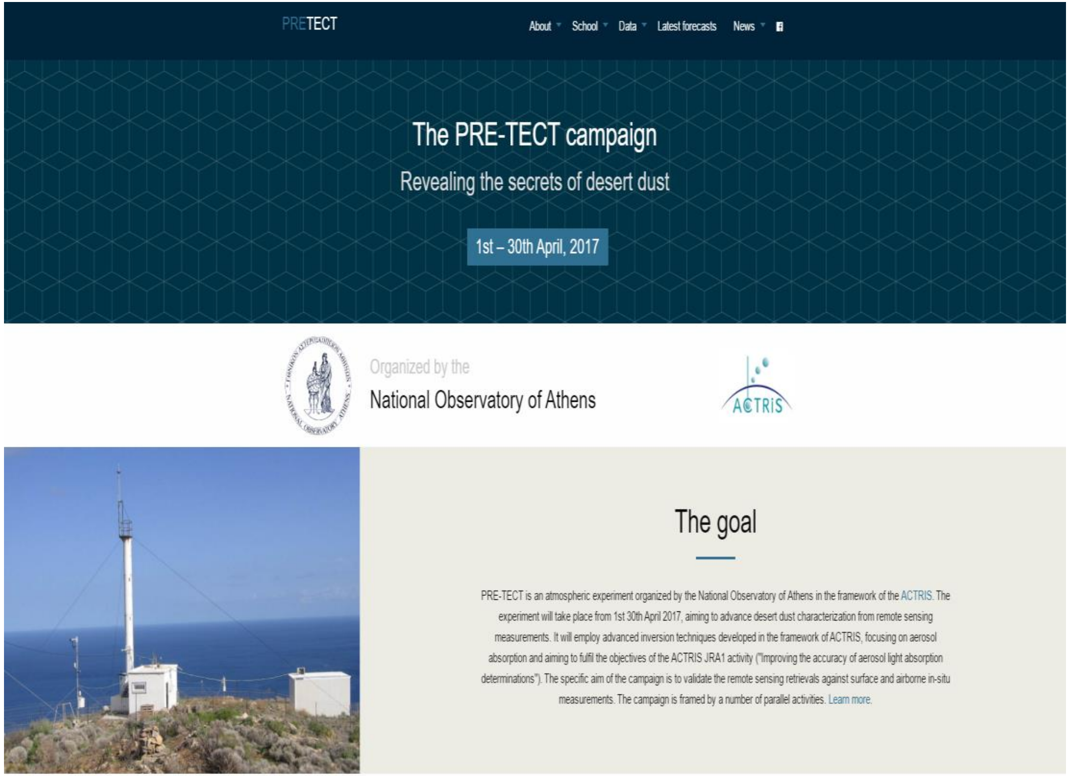




A. Vukovic, M. Vujadinovic, G. Pejanovic, J. Andric, M. J. Kumjian, V. Djurdjevic, M. Dacic, A. K. Prasad, **H. M. El-Askary**, B. C. Paris, S. Petkovic, W. Sprigg, and **S. Nickovic**, "Numerical Simulation of "An American Haboob"", Atmos. Chem. Phys. Discuss., 13, 26175-26215, 2013.

In collaboration: Hesham El-Askary and Slobodan Nickovic

ACC desert dust forecasting in PRE-TECT



GEO-CRADLE provides the **modeling support** for PRE-TECT campaign

PRE-TECT observations and measurements

- Remote sensing (ground lidars, cloud radar, satellites) and
- In-situ (ground based and airborne)

Will be used to fine tune and evaluate the dust model simulations

PRE-TECT measurements

News

HOME / NEWS / CLOUD RADAR INSTALLATION COMPLETED

Cloud Radar installation completed

March 30, 2017, 1:07 p.m.

Cirrus clouds observation at Finokalia site.

The installation of the Cloud Radar at Finokalia site is finished.

Cloud Radar is fully operational.

← PollyXT lidar installation completed

News

HOME / NEWS / POLLYXT LIDAR INSTALLATION COMPLETED

PollyXT lidar installation completed

March 29, 2017, 8:18 a.m.

Autonomous measurements of PollyXT at Finokalia atmospheric station.

PollyXT lidar is fully operational.

The installation of the PollyXT lidar to the atmospheric research station of Finokalia is finished.

All quality tests and calibration procedures are completed.

News

HOME / NEWS / EUFAR AWARDS DOGMA AND CLIMA RESEARCH PROJECTS TO PERFORM 16 HOUR FLIGHTS DURING I

EUFAR awards DoGMA and CIIMA research projects to perform 16 hour flights during PRE-TECT

+++ ESA flights

March 9, 2017, 11:42 a.m.

EUFAR awards the two rPRE-TECT related research projects with a total of 16 aircraft flight hours (8+8) of the FA20 – DLR aircraft and 5K euros (2.5K + 2.5K) to cover Travel & Subsistence expenses:

1. Evaluating Dust forecasting over the eastern Mediterranean Area (DoGMA)

NICKOVIC Slobodan (Project leader),AMIRIDIS Vassilis, CVETKOVIC Bojan, ILIC Luka, PEJANOVIC Goran, PETKOVIC Slavko, SOLOMOS Stavros, WEINZIERL Bernadett

2. Evaluation of ground-based lidar methodologies for continuous profiling of Cloud condensation and Ice nuclei concentrations in the Mediterranean (CIIMA)

AMIRIDIS Vassilis (Project leader), BINIETOGLOU Ioannis, GERASOPOULOS Evangelos, KOKKALIS Panagiotis, KOTTAS Michael, MAMOURI Rodanthi, MARINOU Eleni, NENES Athanasios, PAPAYANNIS Alexandros, PROESTAKIS Emmanouil, TSEKERI Alexandra, WEINZIERL Bernadett, KANAKIDOU Maria, KALIVITIS Nikos

PRE-TECT measurements

Sunphotometric station:
- CIMEL lunar/sunphotometer (AERONET)
- PREDE-POM sunphotometer (SKYNET)
- PSR sunphotometer
- Pyranometers

ENIGMA Magnetometer http://enigma.space.noa.gr/

PRE-TECT measurements

INOE ACC activities in PRE-TECT field campaign

- Gas monitors (SO2, O3, NOx, THC, CO)
- Black carbon monitor
- Aerosol particle sizer
- Weather station
- Remote sensing lidar

EGYPTAIR - ACCIDENT CAUSED BY DUST STORM

http://edition.cnn.com/2002/WORLD/africa/05/07/tunis.crash/index.html

TUNIS, Tunisia (CNN) 7 May, 2002, 17:44 GMT -- An EgyptAir jet crashed on a hillside outside Tunisia's capital Tuesday as the pilot attempted to make an emergency landing, killing at least 18 people, a government official said…

…Weather was foggy and rainy at the time, with **sandstorms** blowing in from the Sahara Desert. ...

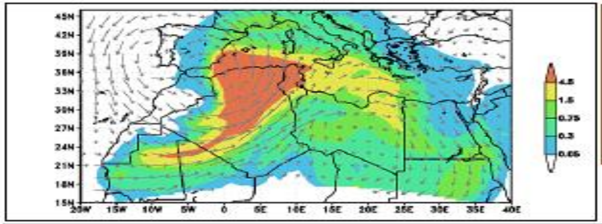
EGYPTAIR ACCIDENT AGAIN: ROUTINE PREDICTION OF THE DUST STORM

Predicted dust load ($\mu g\ m^{-2}$)

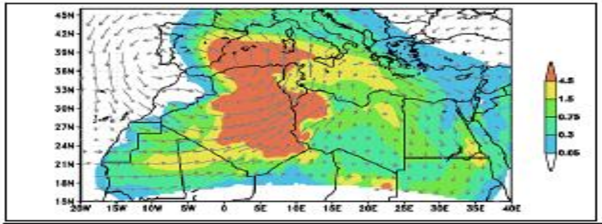
Predicted cross-section dust concentration ($\mu g\ m^{-3}$)

Features of the case:
- Major Mediterranean dust storm
- Fast moving system
- More than 5 mg m^{-3} in the elevated dust cloud core!

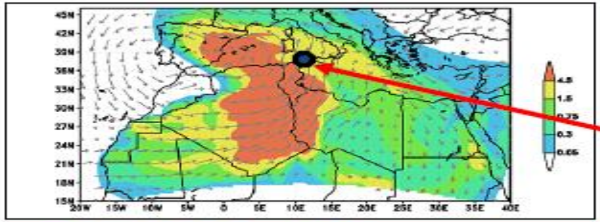
dust



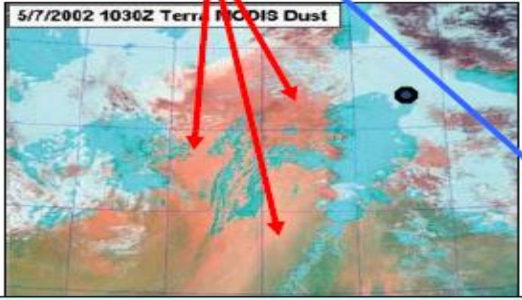
06 UTC, 7 May 2002 18-hr forecast



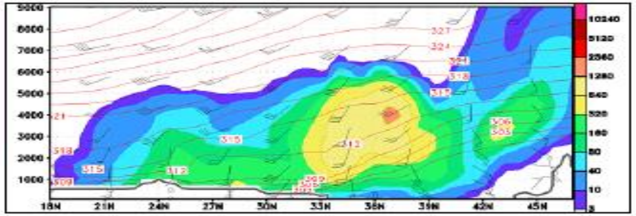
12 UTC, 7 May 2002 24-hr forecast



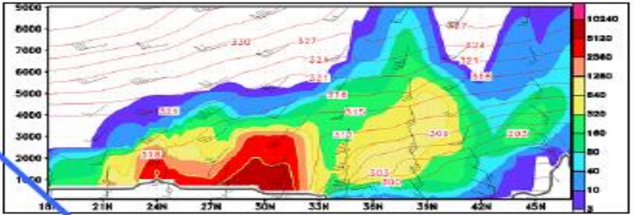
18 UTC, 7 May 2002 30-hr forecast



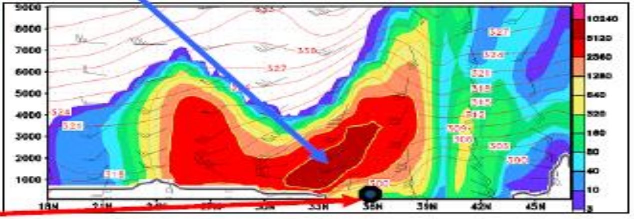
Tunisian dust storm captured by MODIS
Source: Steven D. Miller, NRL, Monterey



06 UTC, 7 May 2002 18-hr forecast

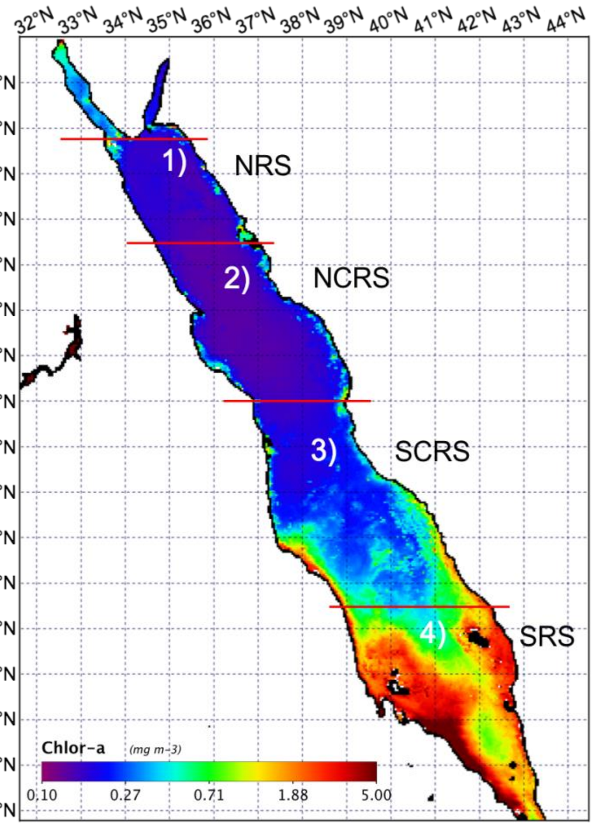


12 UTC, 7 May 2002 24-hr forecast

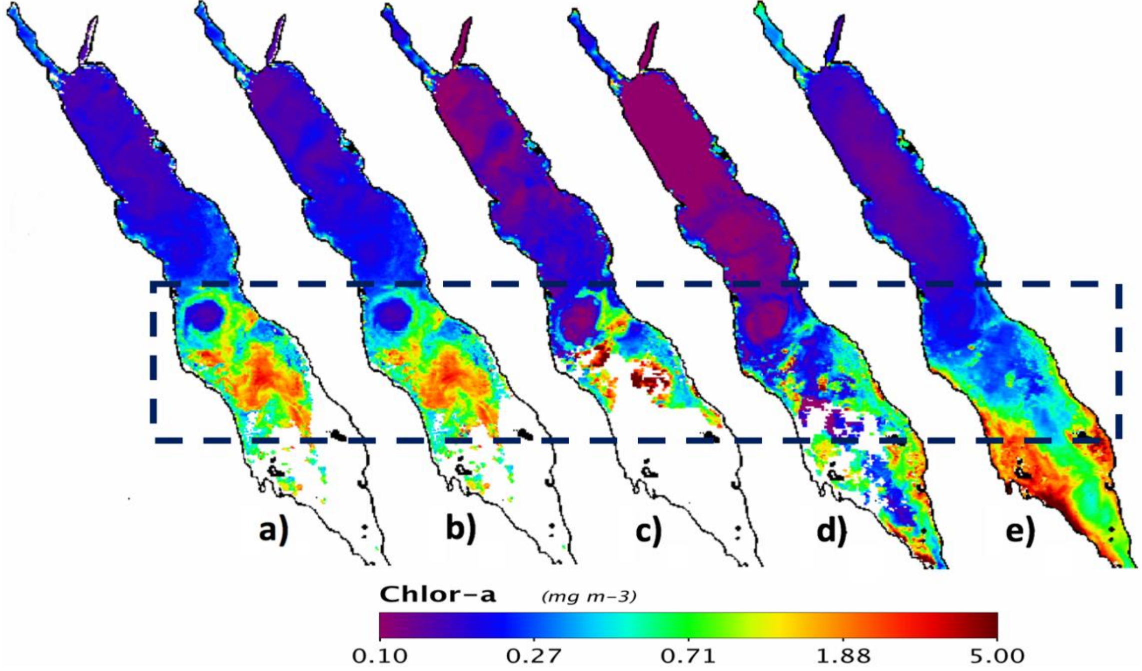


18 UTC, 7 May 2002 30-hr forecast

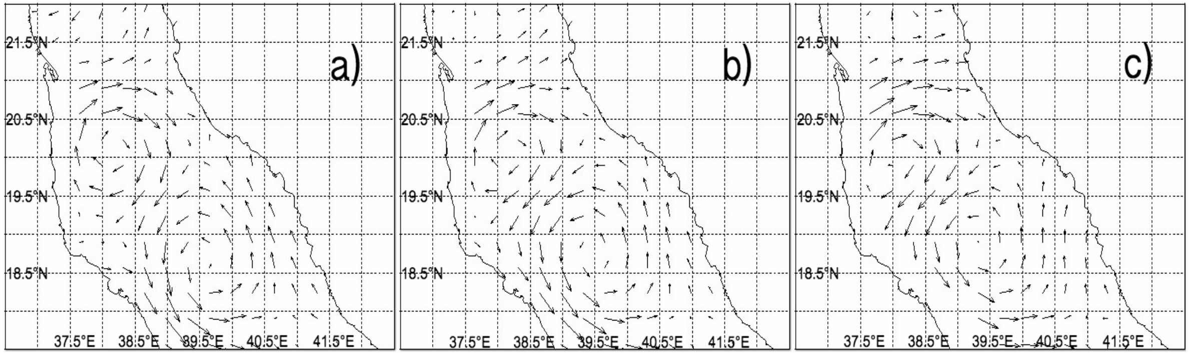
Site of the accident



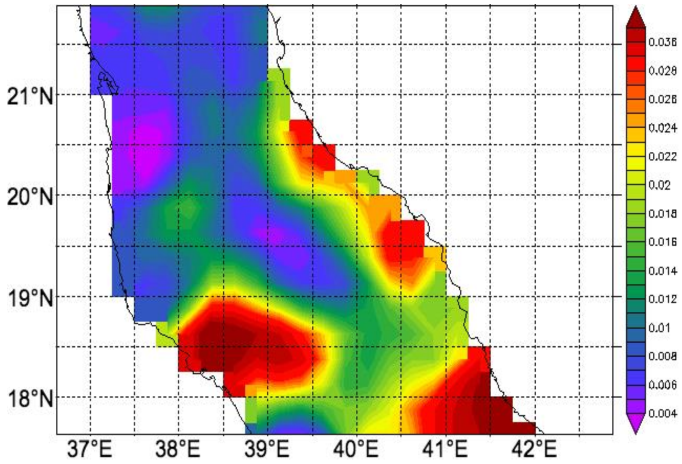
32°N 33°N 34°N 35°N 36°N 37°N 38°N 39°N 40°N 41°N 42°N 43°N 44°N
29°N 28°N 27°N 26°N 25°N 24°N 23°N 22°N 21°N 20°N 19°N 18°N 17°N 16°N 15°N 14°N 13°N
1) NRS
2) NCRS
3) SCRS
4) SRS
Chlor-a (mg m-3)
0.10 0.27 0.71 1.88 5.00

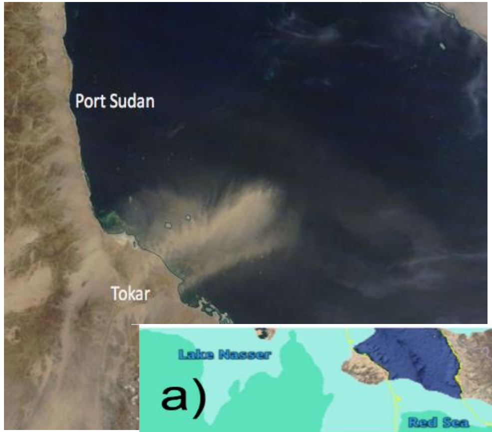


a)
b)
c)
d)
e)
Chlor-a (mg m-3)
0.10 0.27 0.71 1.88 5.00



a)
b)
c)
21.5°N
20.5°N
19.5°N
18.5°N
37.5°E 38.5°E 39.5°E 40.5°E 41.5°E





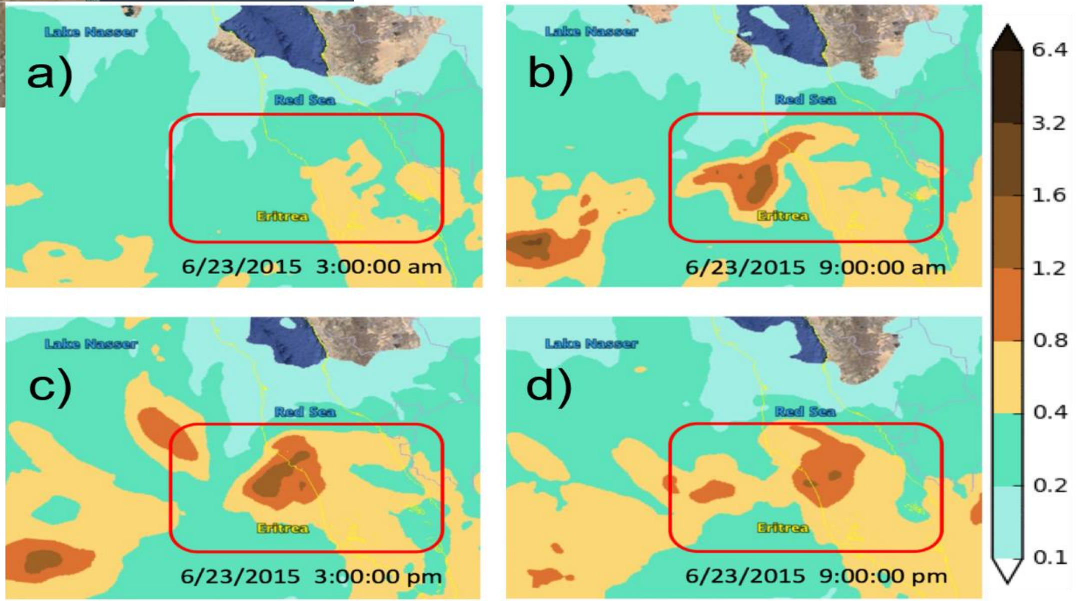


Figure 9. Aerosol Optical Depth (AOD) of a dust event in June 23, 2015 simulated by NMMB/BSC-Dust model

2014
Hurghada
water
treatment plant
Giftun Island
Sekala
mangroves
al-Hadabah
airport
Red Sea
2 km

Show only left image | Show only right image

download large image (1 MB, JPEG, 1362x1362 - left) — acquired January 28, 1985
download large image (943 KB, JPEG, 1362x1362 - right) — acquired November 28, 2014

VIEW BOTH IMAGES

Growth of Hurghada, Egypt

January 15, 2015

Hurghada first emerged as a settlement of significance in 1909, when British geologists discovered oil reserves nearby. For decades oil—as well as fishing—drove the small Egyptian town's economy. Today, it is a major resort city, part of a transformation along the Red Sea coast.

As recently as the 1980s, only 12,000 people lived in Hurghada. It was around that time that hotels started to spring up, as the region's spectacular coastal views, perpetually sunny skies, mild winters, and extensive network of coral reefs proved an appealing combination for developers. By 2014, Hurghada's population had swollen to more than 250,000 people, and the city had become a haven for tourists—fueled by some of the best diving and snorkeling opportunities in the world. More than one million tourists, mainly Europeans and Russians, visit Hurghada each year.

Image Location

More Images of the Day

Related Images


A Better Eye on Reefs
April 20, 2013


Coral Reefs


Coral Reefs in the Persian Gulf
July 3, 2002


Coral Reefs of Southwest Madagascar

As Hurghada has grown, satellites have observed dramatic changes to the landscape. The two natural-color images above were captured by the Thematic Mapper (TM) on Landsat 5 in 1985 and the Operational Land Imager (OLI) on Landsat 8 in 2014.

Aside from the airport and the modest cluster of buildings that made up Hurghada, the region was undeveloped in 1984. The town appears gray in comparison to the tan desert. Offshore, shallower water appears turquoise; deeper water is dark blue. By 2014, hotels and other residential and commercial developments crowd the landscape. In addition to expansion around the core of Hurghada, buildings and infrastructure now hug the coasts, particularly in the neighborhood of Sekala, the center of the city's nightlife.

Development has been particularly dense just east of Hurghada International Airport in a neighborhood called Al-Hadabah. The airport, now Egypt's second busiest, has undergone several expansions and serves several million people each year. In another sign of urban expansion, a large water treatment planet was built to the northwest.

While the tourist traffic boosts the Egyptian economy, the resorts have come with a cost for the local environment, particularly the coral reef ecosystems that make the area so appealing. Construction of hotels and other infrastructure often involved the destruction of fringing reefs along the coastlines, caused by the dredging or dumping of large amounts of sediment. Offshore coral reefs have suffered damage from careless snorkelers and scuba divers. Meanwhile, wastewater runoff from the land has fueled the growth of harmful algae.

While it is not possible to distinguish between reefs, underwater sand, sea grass, and algae in natural-color Landsat imagery, some scientists have used other wavelengths to track changes in Hurghada's corals. The findings indicate the reefs may be in serious trouble. According to one study, corals near Hurghada have declined by as much as 50 percent over three decades.

"What is happening to the coral reef around Hurghada is extremely sad," said Hesham El-Askary, the study's author and an associate professor at Chapman University. "In addition to the effects of climate change, Hurghada's coral reefs are damaged, displaced, polluted, and stepped on."

References

El-Askary H. *et al*, (2014, March 11) Change detection of coral reef habitat using Landsat-5 TM, Landsat 7 ETM+ and Landsat 8 OLI data in the Red Sea (Hurghada, Egypt). *International Journal of Remote Sensing*, 35 (6), 2327-2346.
Kamh, S. *et al*, (2012, January 10) Evaluating urban land cover change in the Hurghada area, Egypt, by using GIS and remote sensing. *International Journal of Remote Sensing*, 33 (1), 41-68.
Red Sea Governorate Hurghada. Accessed January 14, 2014.
Vanderstraete, T. *et al*, (2007, February 22) The use of multi-temporal Landsat images for the change detection of the coastal zone near Hurghada, Egypt. *International Journal of Remote Sensing*, 27 (17), 3645-3655.

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