Sand and Dust Storm (SDS)

SDS Workshop
4-7 Oct. 2016
İstanbul

SDS Analysis for the

Great Mediterranean Basin

Including West Asia (2003-2012)

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4 October 2016, Istanbul

METEOROLOJİ

Sand and Dust Storms (SDS)

T.C. Orman ve Su İşleri Bakanlığı

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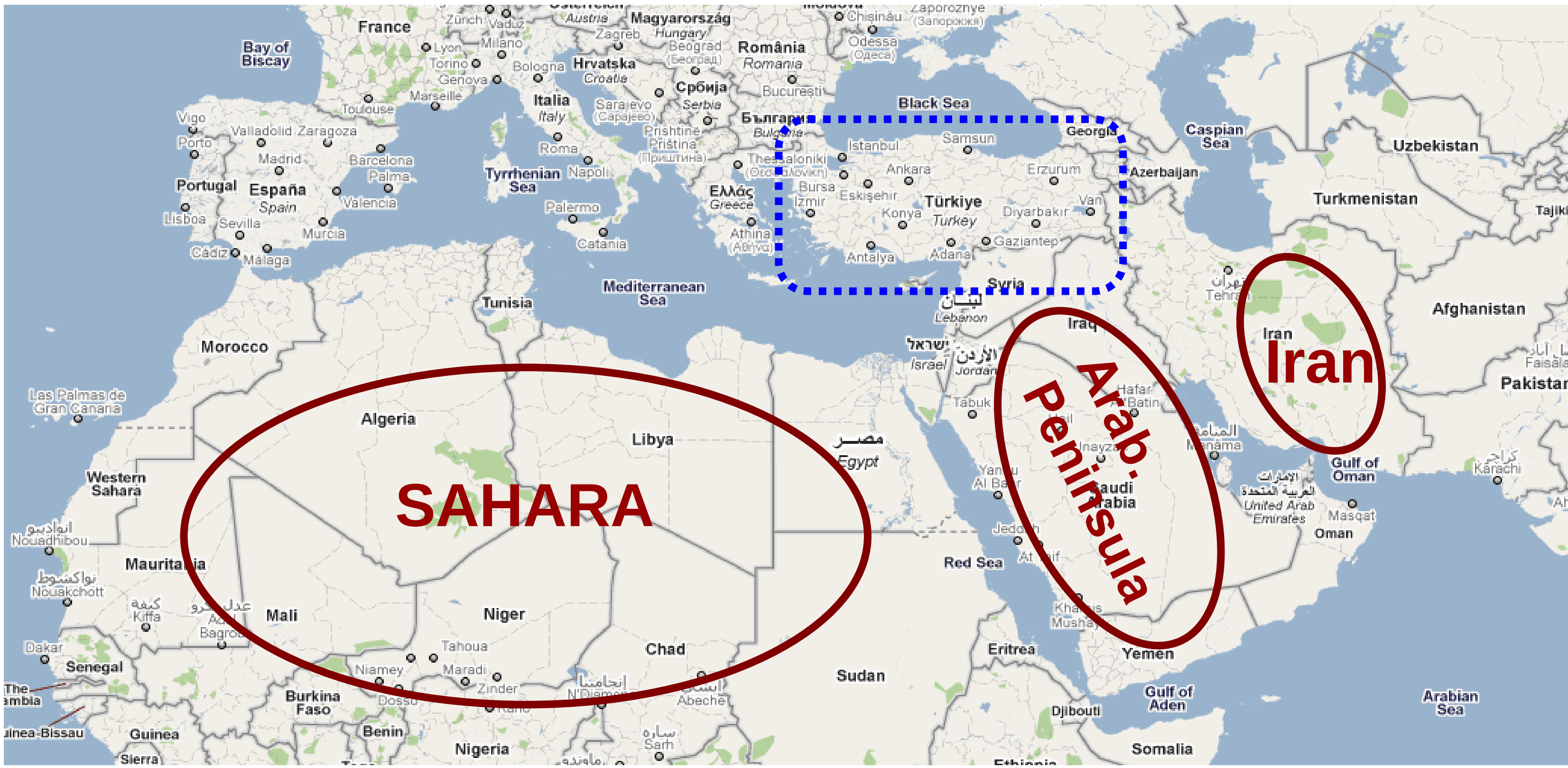
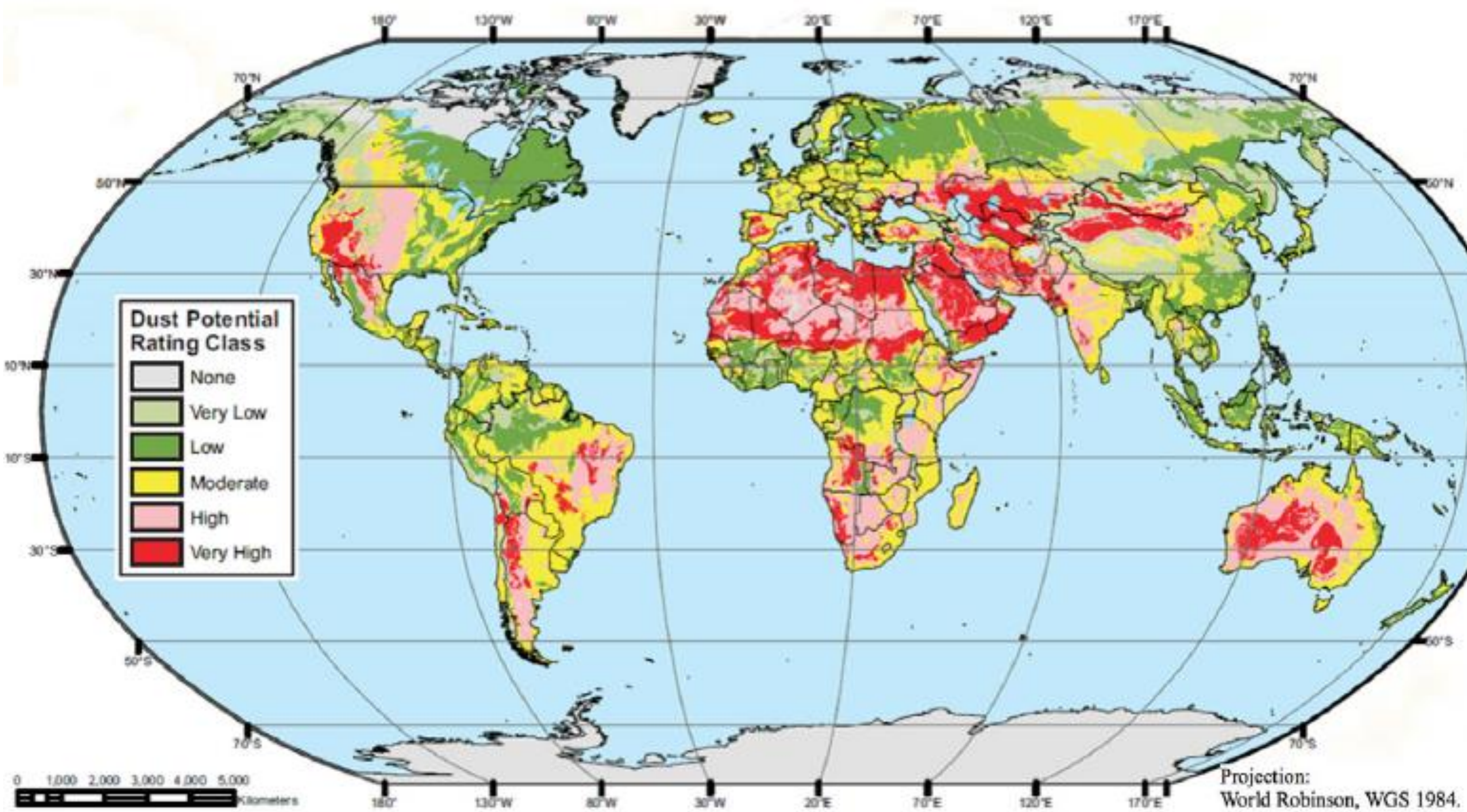
Dust transport is very important issue for the world ecosystem. Desert dusts could be transported for a long distances, by transferring the upper layers of the atmosphere.



Main dust source areas affecting Mediterranean region are known as Sahara, Arabian Peninsula and Iran.

Global Dust Potential Map



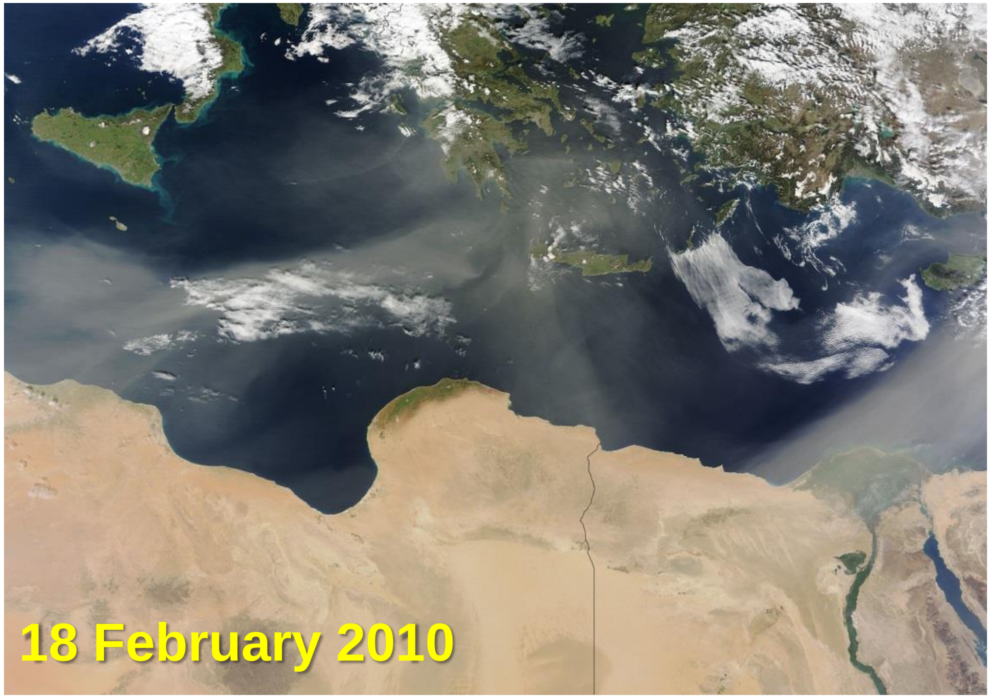
DTF (Integrated Desert Terrain Forecasting for Military Operations)

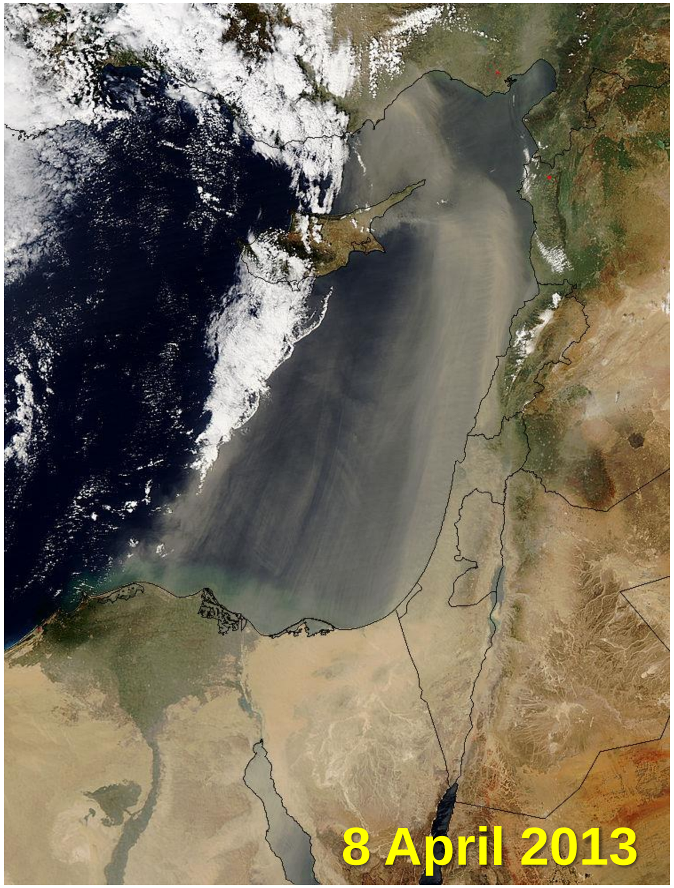
Varoujan K, S., Nadhir, A. A., & Sven, K. (2013). Sand and dust storm events in Iraq. Natural Science, 2013.

Dust sources affecting Mediterranean basin.

De Longueville, F., Hountondji, Y. C., Henry, S., & Ozer, P. (2010). ***What do we know about effects of desert dust on air quality and human health in West Africa compared to other regions?****. Science of the Total Environment, 409(1), 1-8.*

SDS over Mediterranean Basin

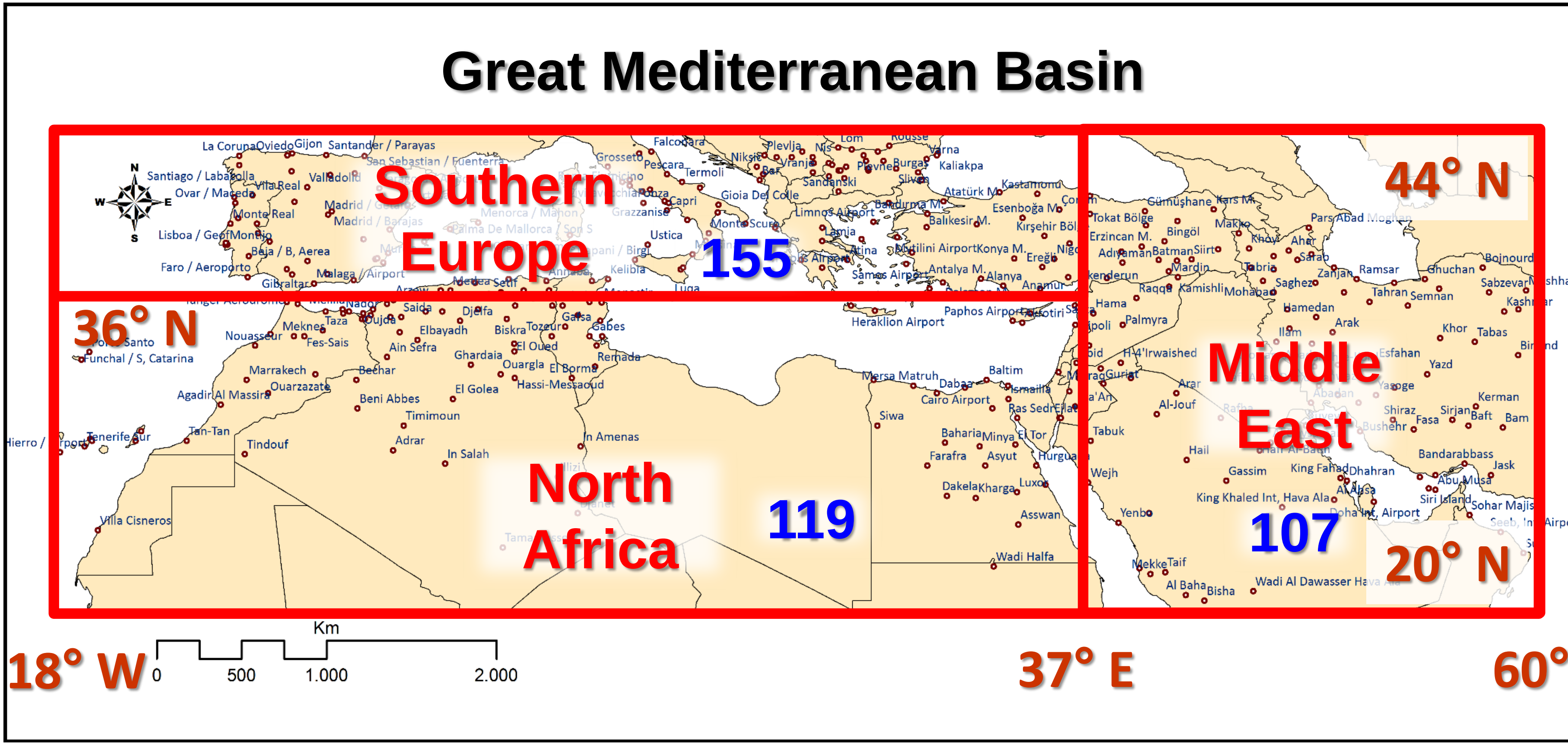




Countries within Eastern Mediterranean region are highly affected by dust storms.

Turkey is strongly effected from dust storms depending on its location. Dust sources from both Africa and Middle East are the most effective regions for sand and dust storms in Turkey.

Great Mediterranean Basin



Observations from 381 synoptic stations located on Great Med. Basin and MISR-Aerosol Optical Depth (AOD) data were used in this study.

The great Mediterranean Basin was divided into 3 sub regions.

Synoptic Data:

7wwWW -- Present and past weather

ww -- Present weather

• from 06 to 09	Haze, smoke, dust or sand
• from 30 to 35	Dust storm, sand storm, drifting or blowing snow
• 98	heavy thunderstorm with dust storm

The ratio of observed annual data for each station is more than 80 %.

This ratio is more than 90 % for every station for 10 years period.

The missing data is less than 1 % for all observations in study period.

Atmospheric Aerosols

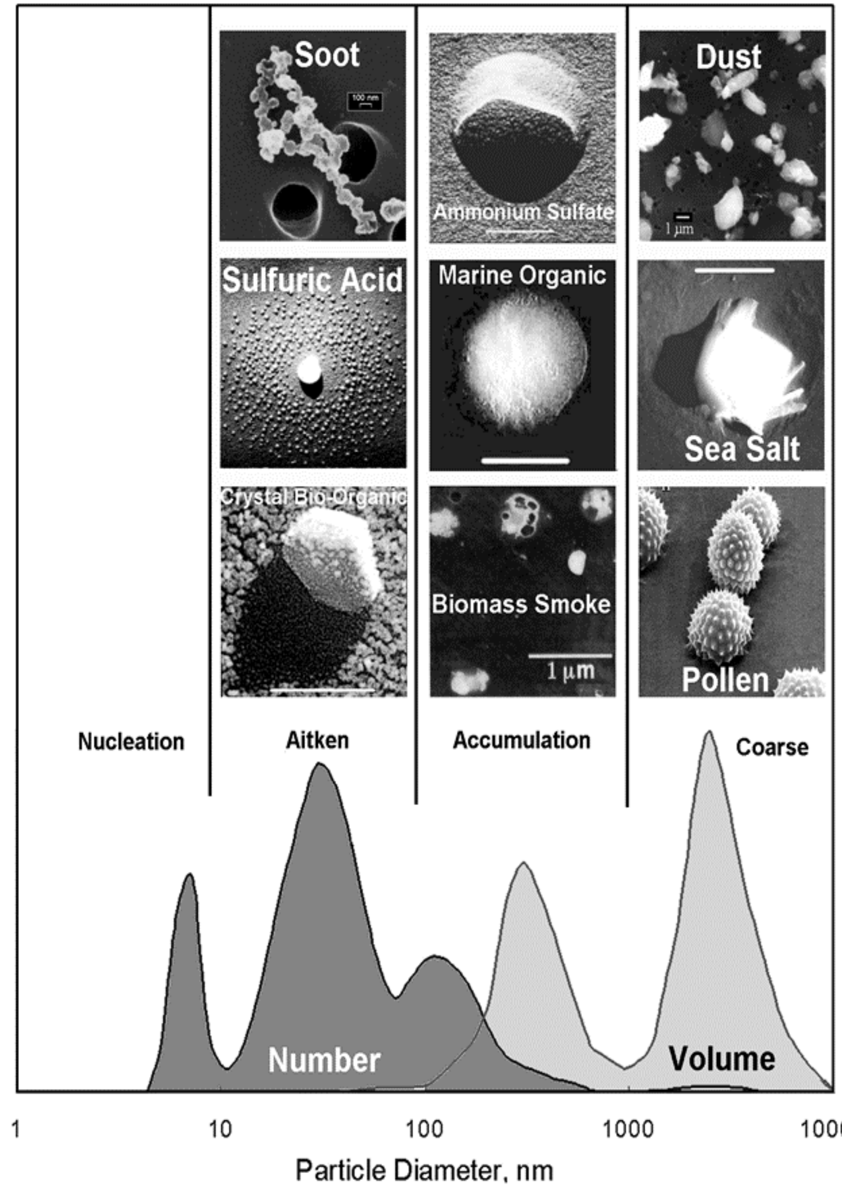
fine: particles (nucleation and accumulation) result from anthropogenic activities,

coarse: From mechanical processes like aeolian erosion (Dust).

Angstrom Exponent (AE)

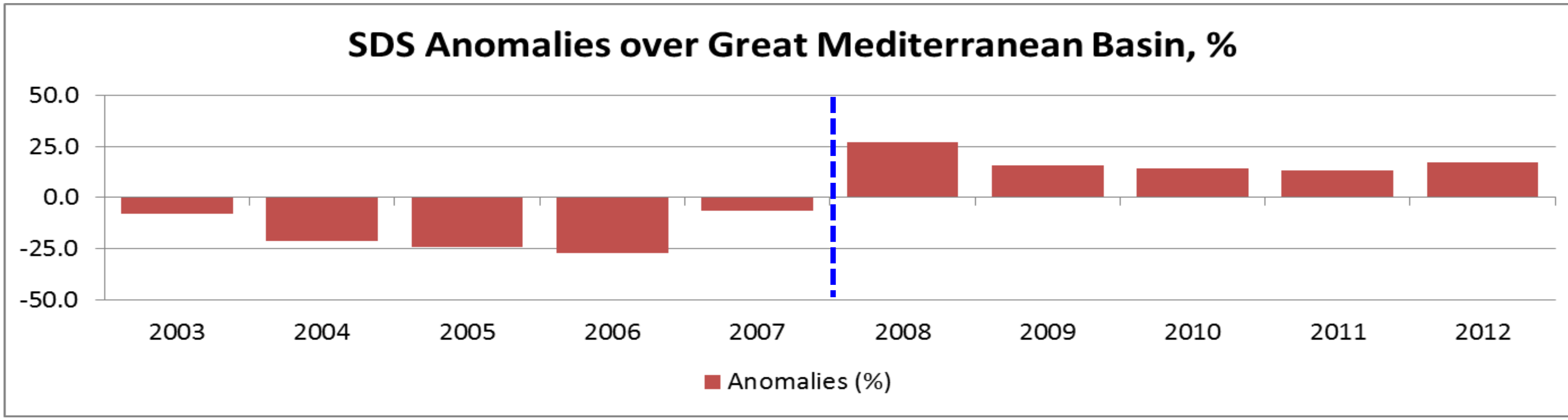
Angstrom Exponent is a good indicator for aerosol particle size.

Angstrom Exponent	Particle Size
Smaller numbers	Bigger size (coarse)
Bigger numbers	Smaller size (fine)

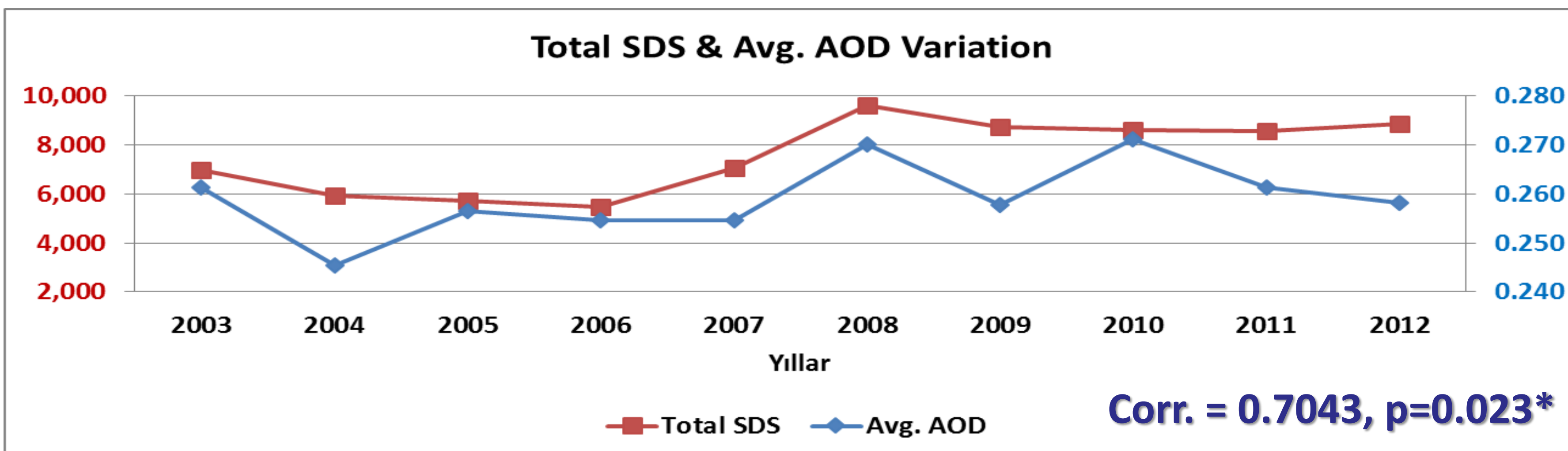


SDS Analysis over Mediterranean

➢Number of SDS in the second half of last 10 years shows strong increase compared to first half over Great Mediterranean Basin.



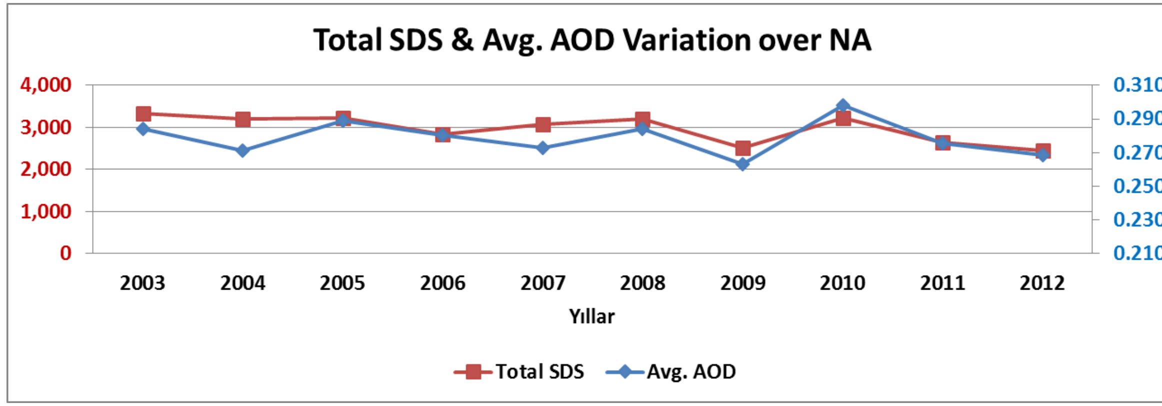
➢Good correlation between synoptic records and MISR AOD measurements is found.



SDS Analysis on Sub Basins

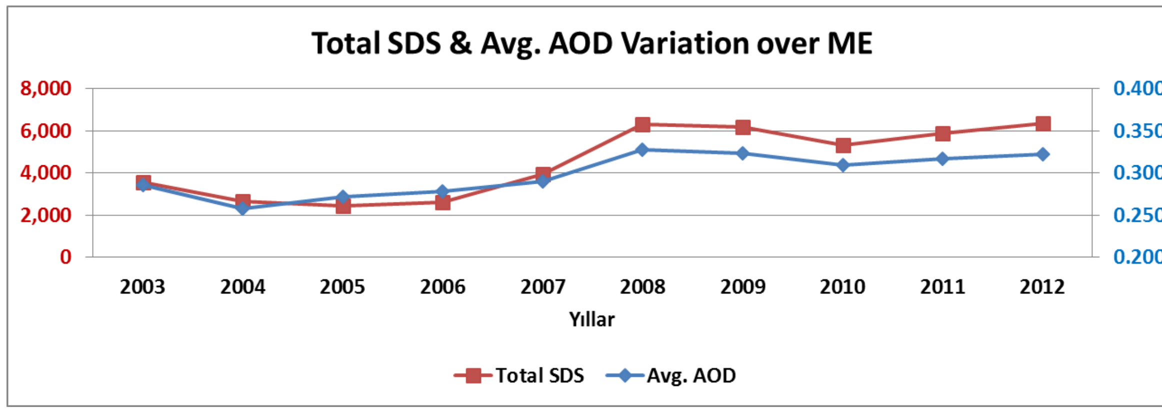
North Africa

Corr.: 0.72,
$R^2 = 0.4851$
$p = 0.018$*



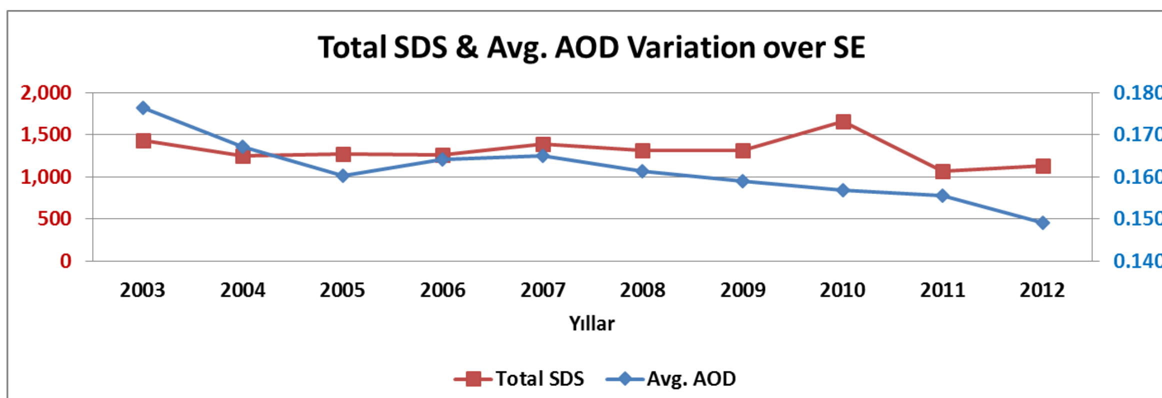
Middle East

Corr.: 0.98,
$R^2 = 0.9517$
$p = < 0.0001$*

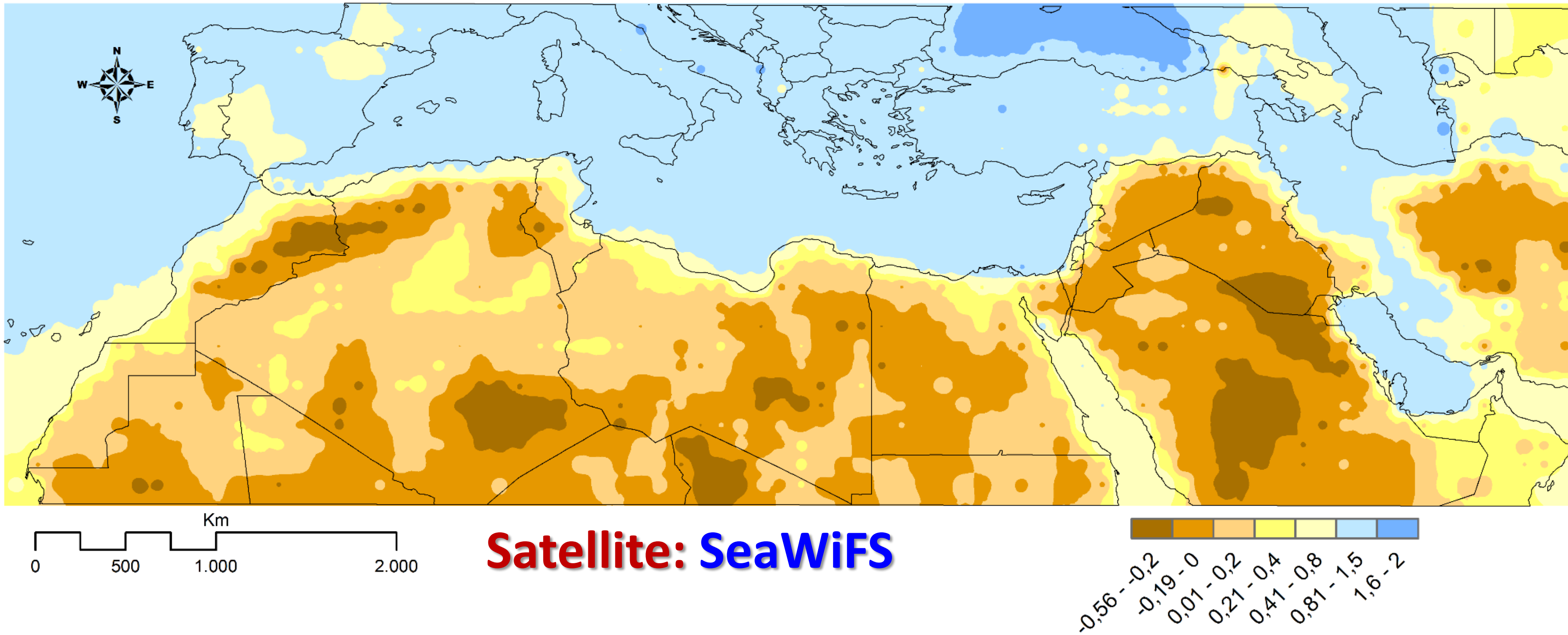


Southern Europe

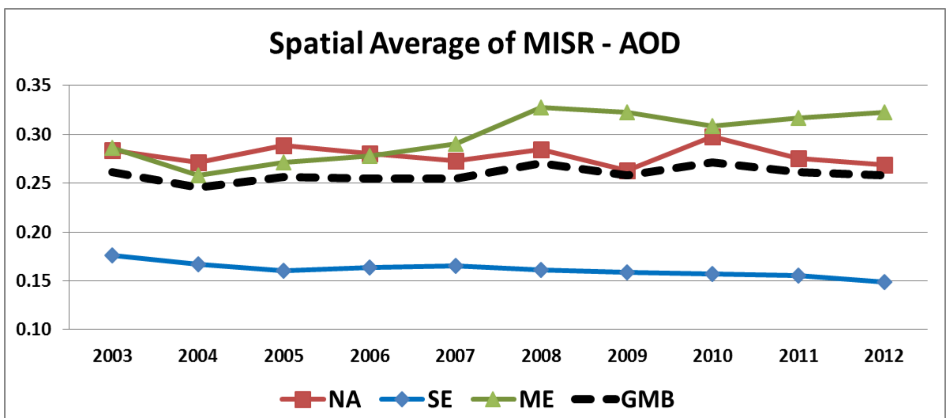
Corr.: 0. 35,
$R^2 = 0.1185$
$p = 0.326$

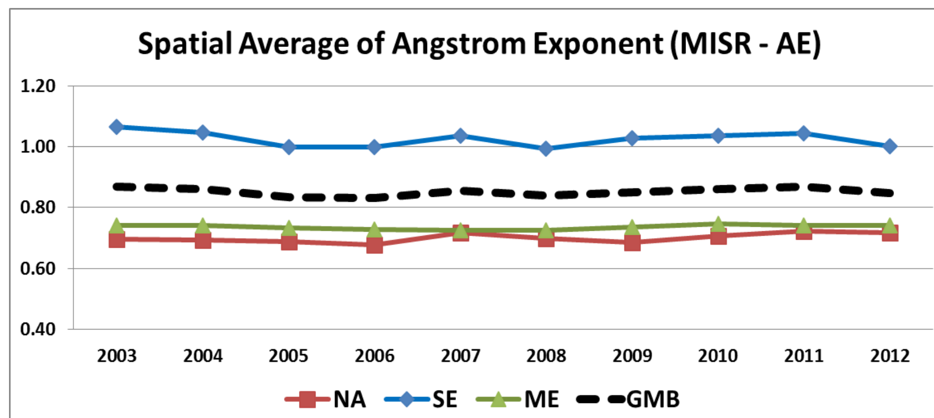


Angstrom Exponent (2002 – 2010)

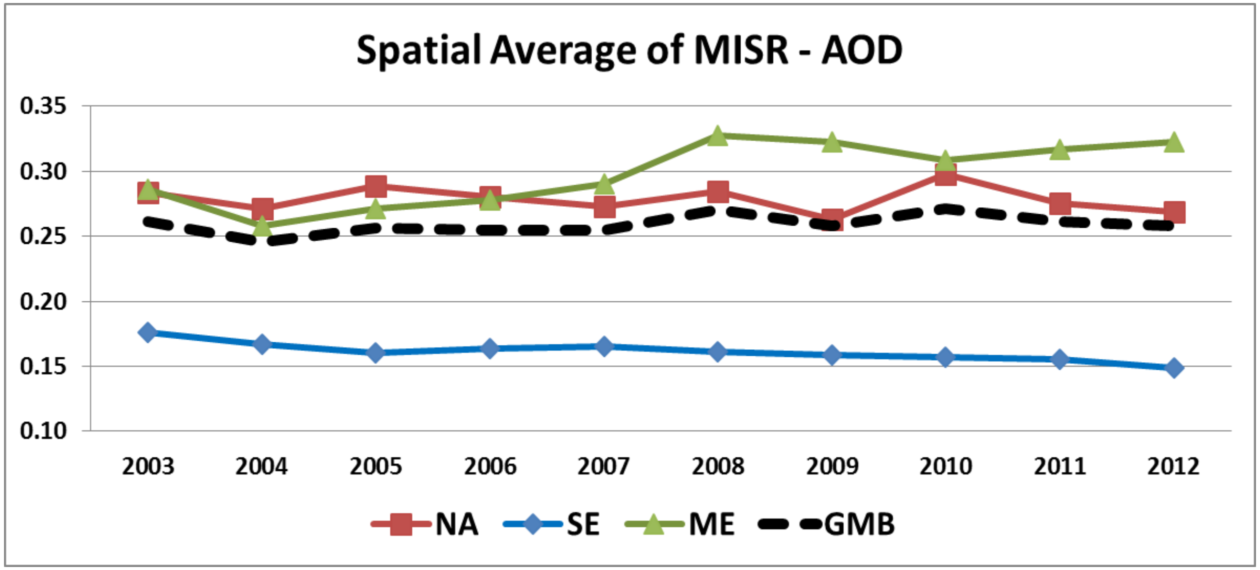


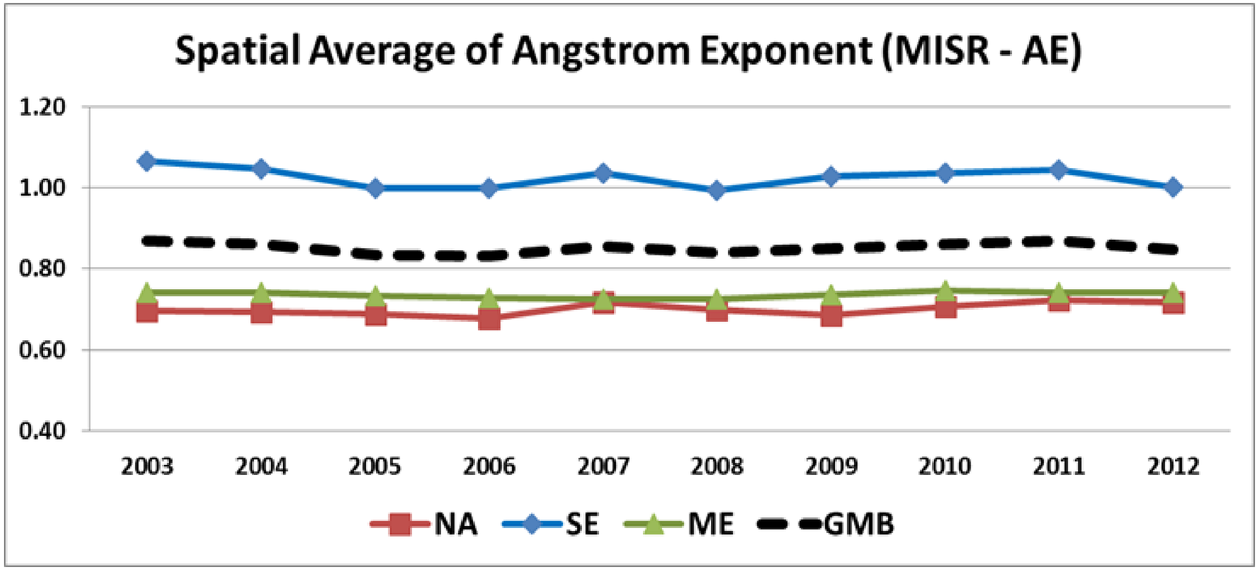
Satellite: SeaWiFS





SDS Analysis on Sub Basins





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SDS Analysis over Mediterranean

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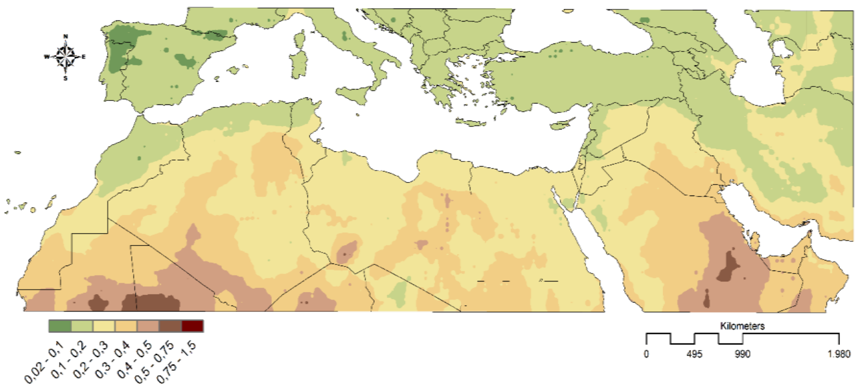
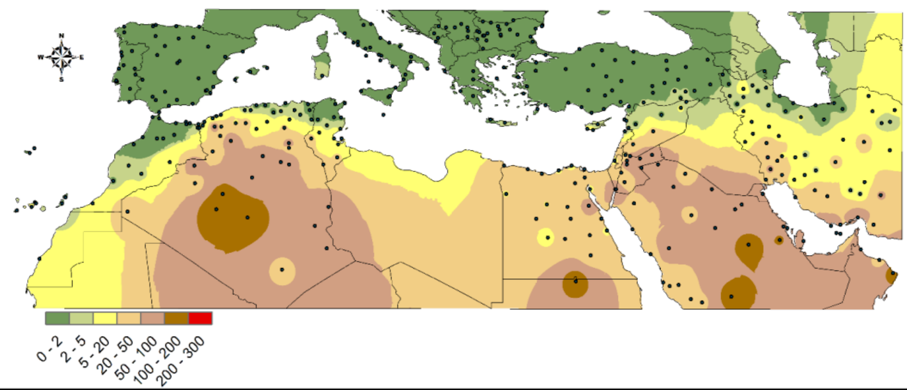
MISR AOD

Mean Annual SDS Events

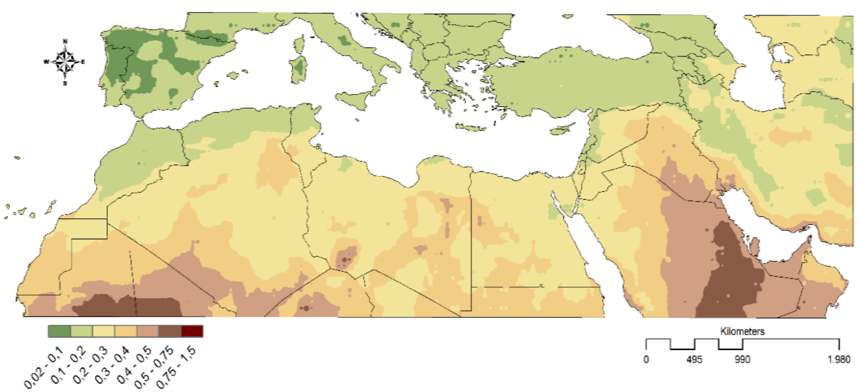
Mean MISR AOD values for the periods 2003-2007



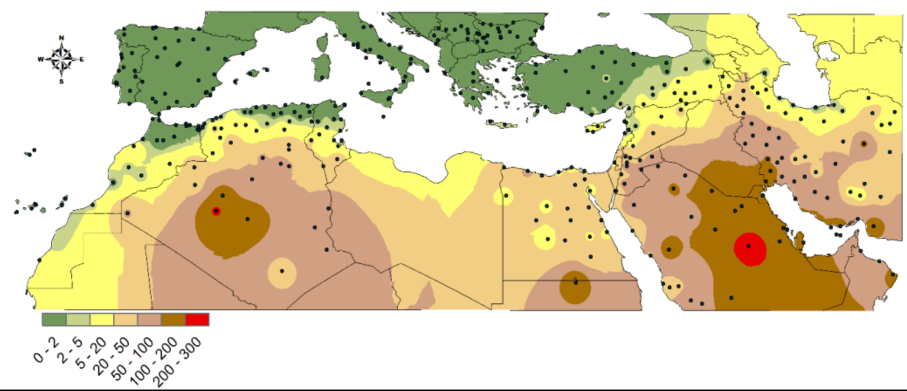
Mean Annual Synoptic SDS Events between 2003-2007



Mean MISR AOD values for the periods 2008-2012



Mean Annual Synoptic SDS Events between 2008-2012



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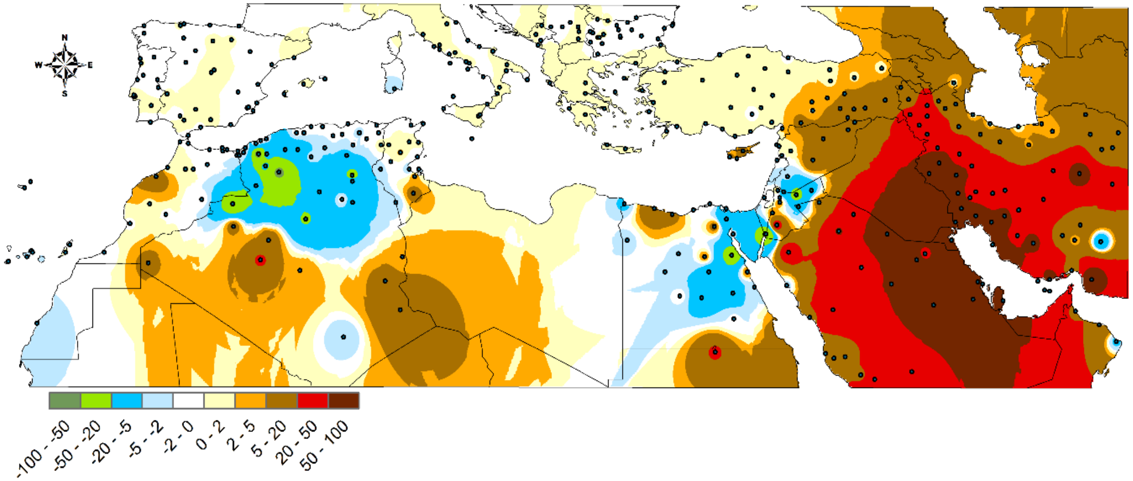
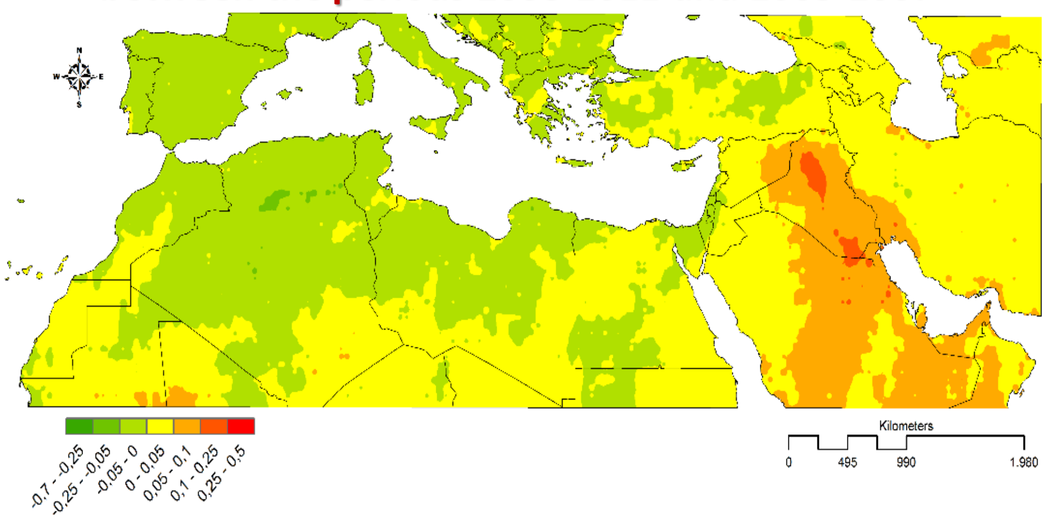
Mean SDS Count Difference between the periods 2008-2012 and 2003-2007



Mean MISR AOD Measurement Difference between the periods 2008-2012 and 2003-2007



It was found that SDS events at second period have increased significantly compared to first half over Middle East.

MISR AOD observations show same trend with observed SDS events.

SDS Trends over Mediterranean

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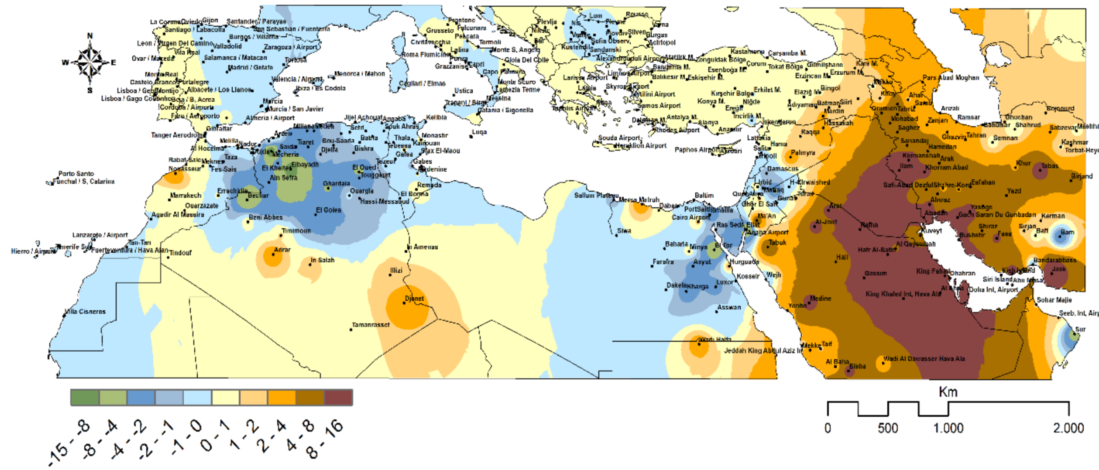
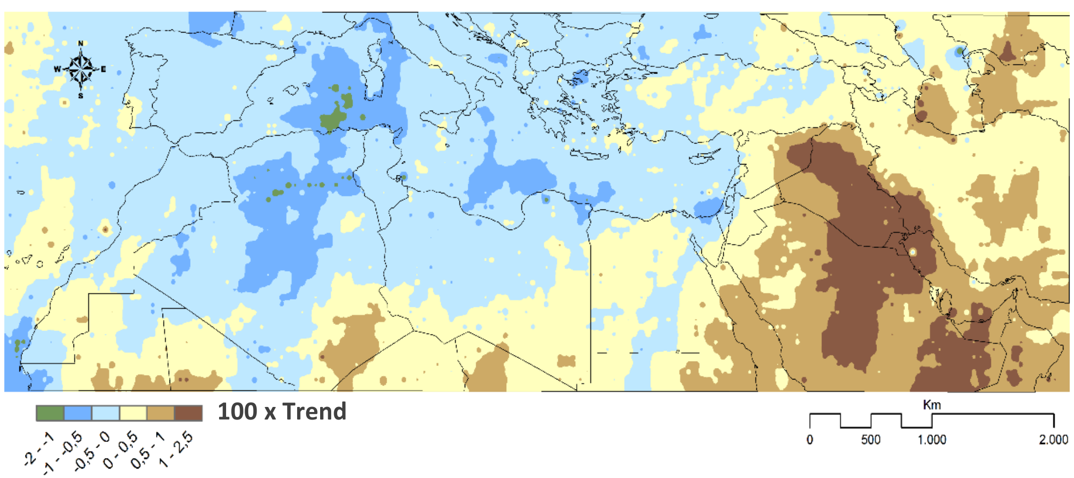
Both the number of SDS events and MISR AOD observations shows increasing trends over Middle East.

AOD Trends between 2003-2012 over Mediterranean



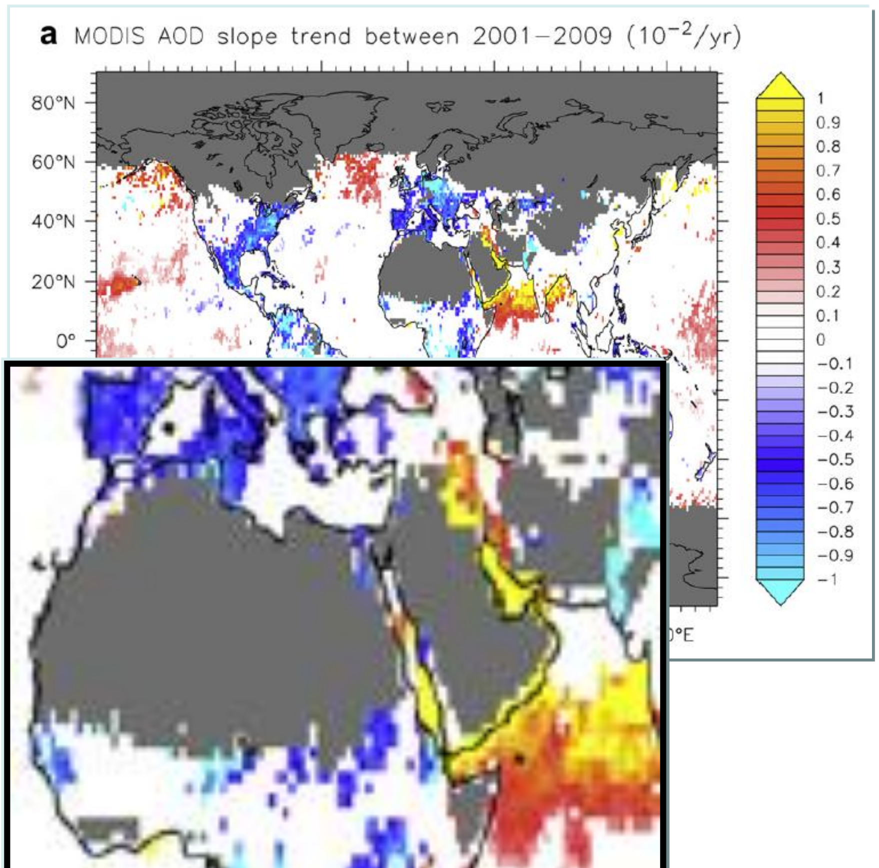
AOD Trends between 2003-2012 over Mediterranean

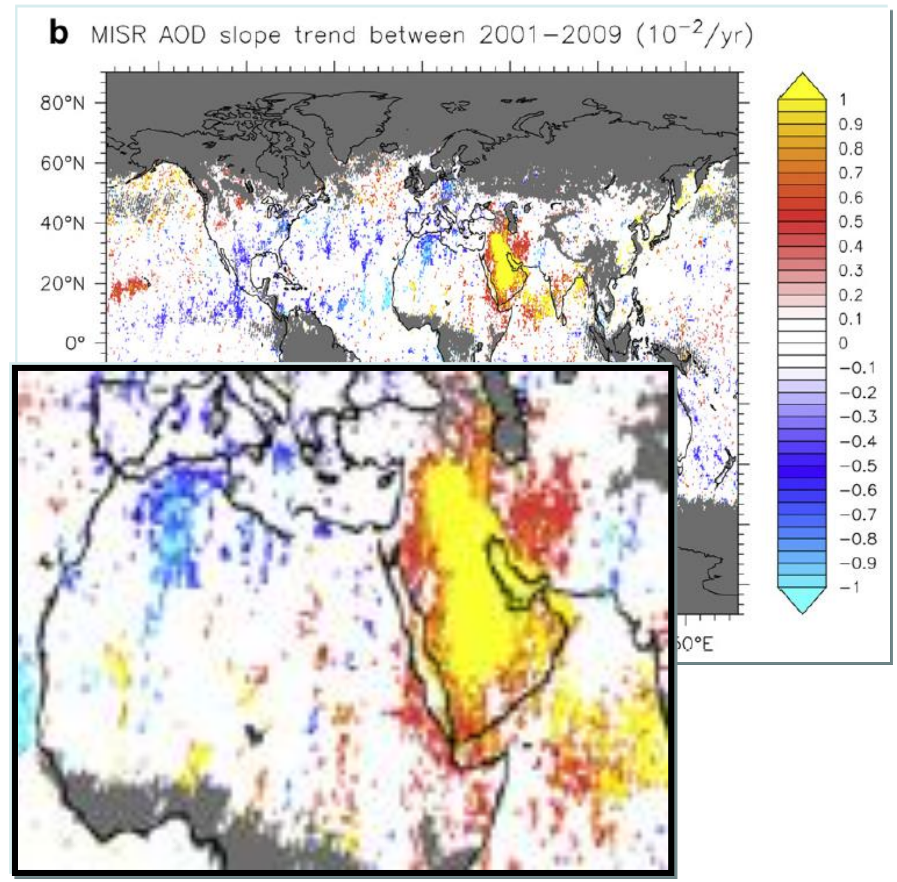


On the other hand there was no significant change over North Africa.

AOD Trends, 2000 - 2009

Studies made by de Meij et al (2012) also supported increasing aerosol trend over Middle East between years of 2000-2009. There was no important change over Africa





*de Meij, A.; Pozzer, A.; Lelieveld, J. (2012). "**Trend analysis in aerosol optical depths and pollutant emission estimates between 2000 and 2009**." Atmospheric Environment, Volume: 51 Pages: 75-85 DOI: 10.1016/j.atmosenv.2012.01.059.*

AOD Trends, 2000 - 2009

Zhang and Reid (2010) analyzed MODIS and MISR AOD data for the period 2000-2009 over the ocean both global and regional scale. They haven't found significant trend in global (0.003/decade).

On a regional scale the Bay of Bengal (0.07/decade), Asia's eastern coast (0.06/decade) and on the Arabian Sea (0.06/decade), significant increases were observed.

	Latitude (°)	Longitude (°)	Slope AOD/ per decade	$\lvert\omega/\sigma_\omega\rvert$		Corrected slope AOD/ per decade	MISR Slope AOD/ per decade
Global Oceans			0.010	3.60		0.003	−0.003
Africa (NW Coast)	8° N–24° N	60° W–18° W	−0.006	0.61	**- 0.013**	−0.013	−0.035
Africa (SE Coast)	27° S–15° S	32° E–45° E	0.017	2.12		0.010	−0.007
Africa (SW Coast)	23° S–7° S	20° W–15° E	0.016	1.35		0.009	−0.001
Arabian Sea	5° N–23° N	50° E–78° E	0.065	5.40	**0.058**	0.058	0.047
Central America	5° N–20° N	120° W–90° W	−0.016	1.73		−0.023	−0.030
Coastal China	20° N–40° N	110° E–125° E	0.069	4.06	**0.062**	0.062	0.038
Indian Bay of Bengal	10° N–25° N	78° E–103° E	0.076	5.63	**0.069**	0.069	0.035
Mediterranean Sea	30° N–45° N	0° E–40° E	−0.009	0.94	**- 0.016**	−0.016	−0.022
North America (E Coast)	30° N–45° N	80° W–60° W	−0.008	1.07		−0.015	−0.019
Southeast Asia	15° S–10° N	80° E–120° E	0.014	0.80		0.007	0.002

Zhang, J., & Reid, J. S. (2010). ***A decadal regional and global trend analysis of the aerosol optical depth using a data-assimilation grade over-water MODIS and Level 2 MISR aerosol products****. Atmospheric Chemistry and Physics, 10(22), 10949-10963.*

AOD Trends, 2000 - 2009

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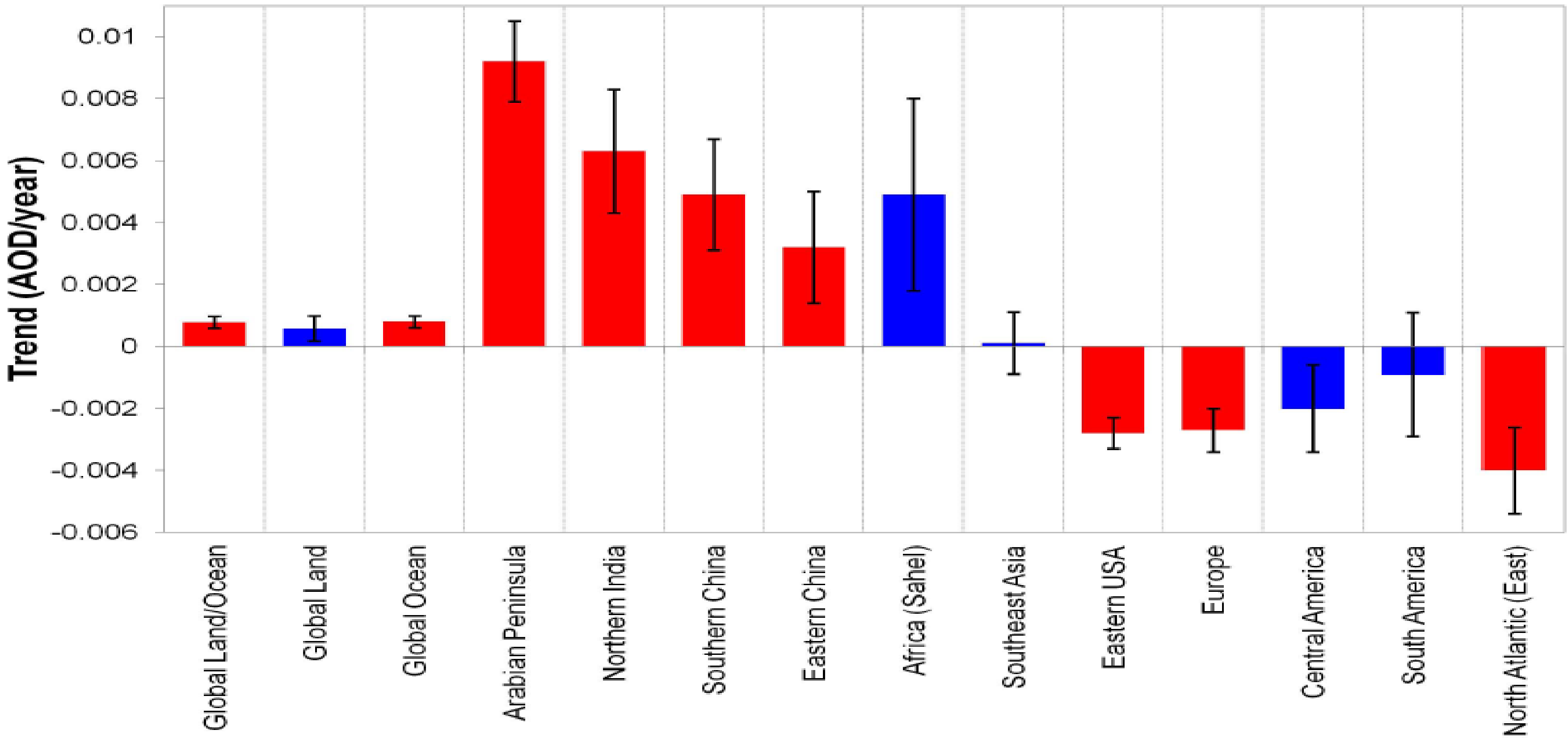
Hsu et al.: Aerosol optical depth over land and ocean.



Comparisons of global and regional annual trends based upon deseasonalised monthly anomaly of SeaWiFS AOD at 550 nm from January 1998 to December 2010. Units are AODyr−1. Red bars represent regions with AOD trend statistically significant (exceeding 90% confidence), while blue bars indicate regions where statistically significant trend are not found.

AOD Trends, 2000 - 2009

Hsu et al., Global and regional trends of AOD over land and ocean using SeaWiFS measurements from 1997 to 2010.

The resulting trend analyses based upon the SeaWiFS data from 1998 to 2010 show that the global annual trend of AOD during this period, although weakly positive (i.e. 0.00078 ± 0.00019 yr−1) and statistically significant at 95% level.

For the mineral dust-dominated parts of the world, strong positive trends are detected over the Arabian Peninsula and the adjacent waters. In contrast, a negative tendency is observed in the emission and export of Saharan dust over the western North Africa and the North Atlantic.

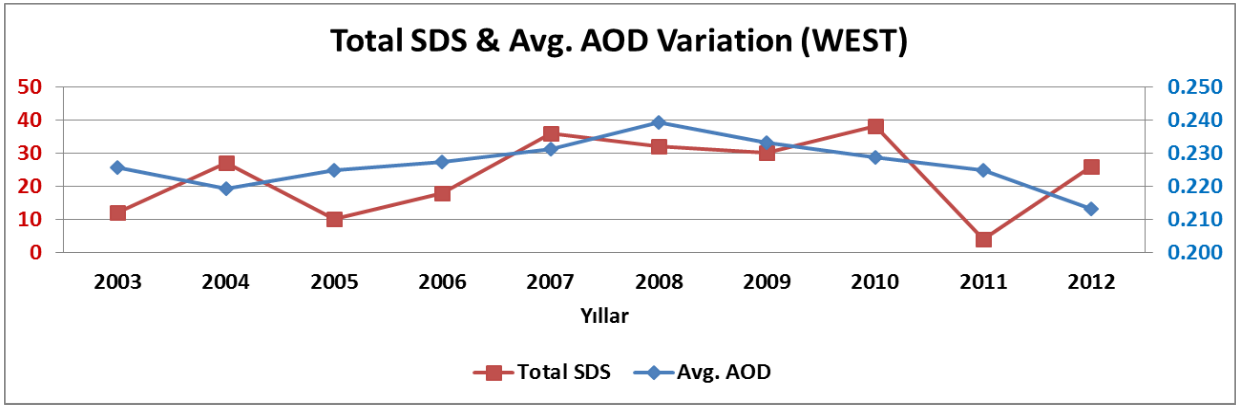
Hsu, N. C., Gautam, R., Sayer, A. M., Bettenhausen, C., Li, C., Jeong, M. J., Tsay, S.-C., and Holben, B. N.: ***Global and regional trends of aerosol optical depth over land and ocean using SeaWiFS measurements from 1997 to 2010****, Atmos. Chem. Phys., 12, 8037-8053, doi:10.5194/acp-12-8037-2012, 2012.*

SDS Analysis for Turkey

- Similar results were also found for Turkey.
- Depending on our analysis, SDS events are effective from south to north and increased at the second half of 10 year period.
- MODIS-AOD observations also confirm increasing SDS events.

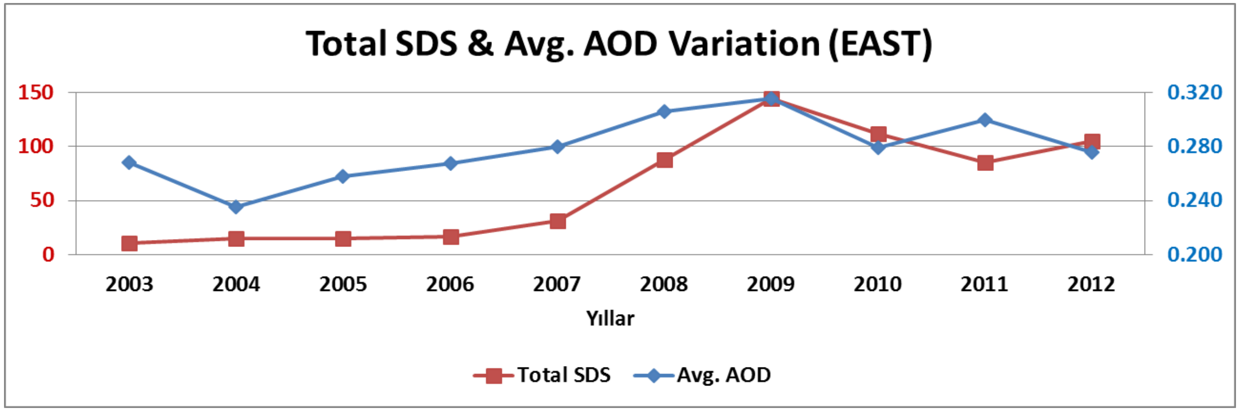
Turkey Western Part

Corr.: 0.3208
p: 0.366



Turkey Eastern Part

Corr.: 0.7649
p: 0.010*



Results

- Strong increase in SDS cases over Middle East for last 10 years.
- No significant change in North Africa (Sahara) for the same period.
- The aerosols over European Atmosphere have been slightly decreasing.
- Both Synoptic Observations and MODIS AOD Measurements confirms each other (High correlation).

What is the reason of SDS increase over Middle East during last decade?

Climate change???

Increase of desertification???

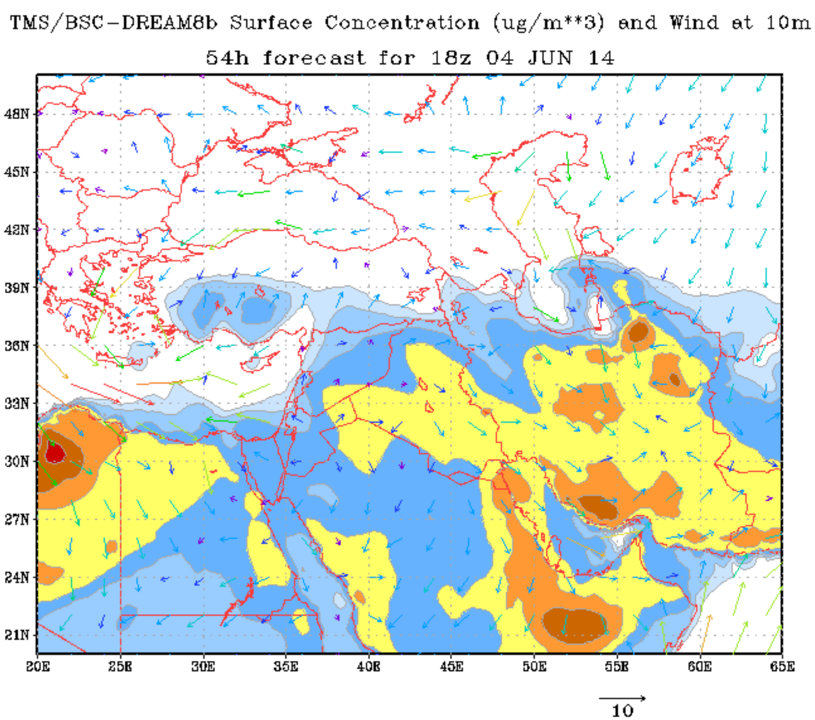
It is expected to increase at sand and dust storms with an expansion of arid regions depending on IPCC reports. Middle East is one of the most sensitive areas for climate change.

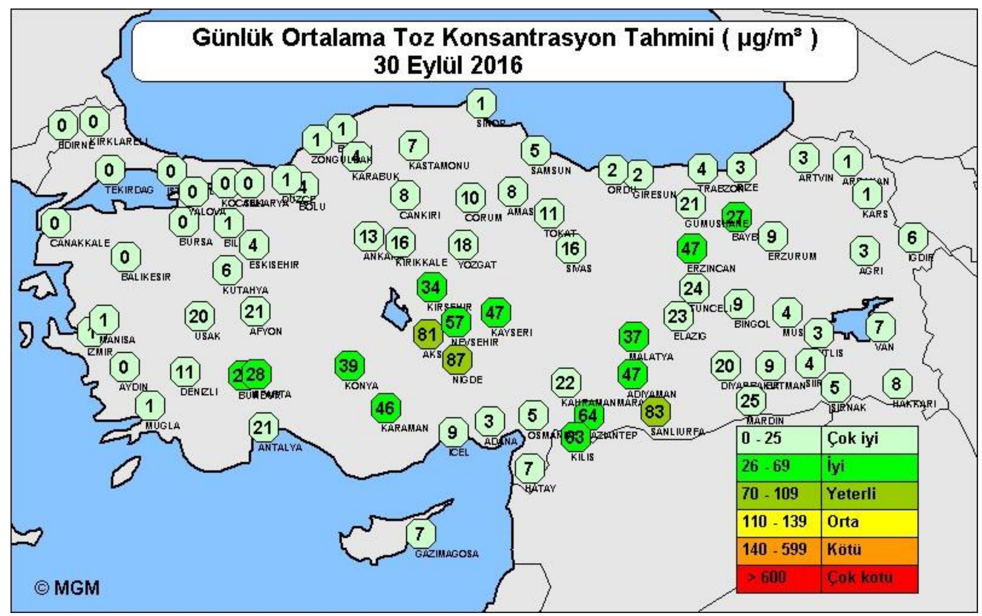
SDS Studies at TSMS

SDS Forecasts at TSMS

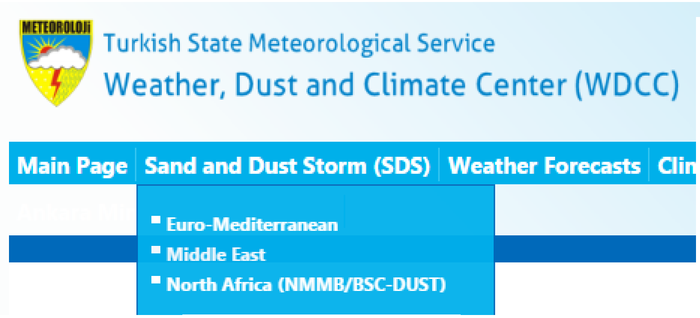
The BSC-DREAM8b dust transport model has been established at TSMS in cooperation with Spanish Met. Service under the EU TAIEX Small Grants Program.

The operational forecasts by BSC-DREAM8b have been started in June 2010. Forecasts are published at TSMS website.





WDCC - Weather, Dust and Climate Center



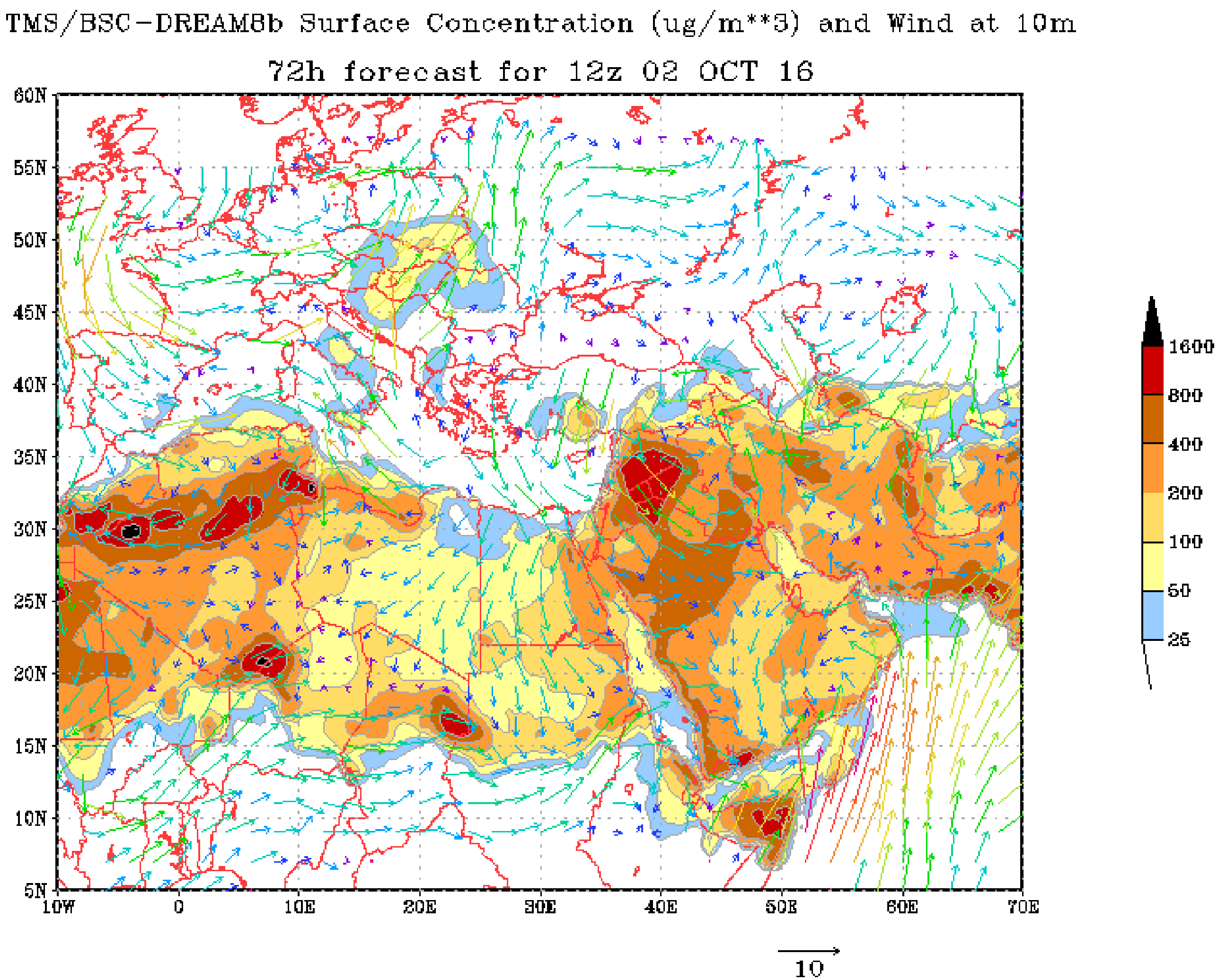
Regional Cooperation on Environment and Meteorology

between

Islamic Republic of Iran, Republic of Iraq, State of Qatar, Syrian Arab Republic, Republic of Turkey

www.wdcc.mgm.gov.tr

SDS Forecasts for the Middle East and Northern Africa



SDS Training Activities

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22-26 Feb. 2011, Istanbul

21-25 Nov. 2011, Antalya

26-28 Nov. 2012, Ankara

28-31 Oct. 2013, Istanbul


SDS Analysis for the Great Mediterranean Basin Including West Asia (2003-2012)
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Research Department
THANK YOU FOR YOUR KIND ATTENTION
4 October 2016, Istanbul