

How Satellites Power SDS Early Warning Systems

~~Dust effects and the impact of geomeasurements on their forecasting~~

Sara Basart, sbasart@wmo.int

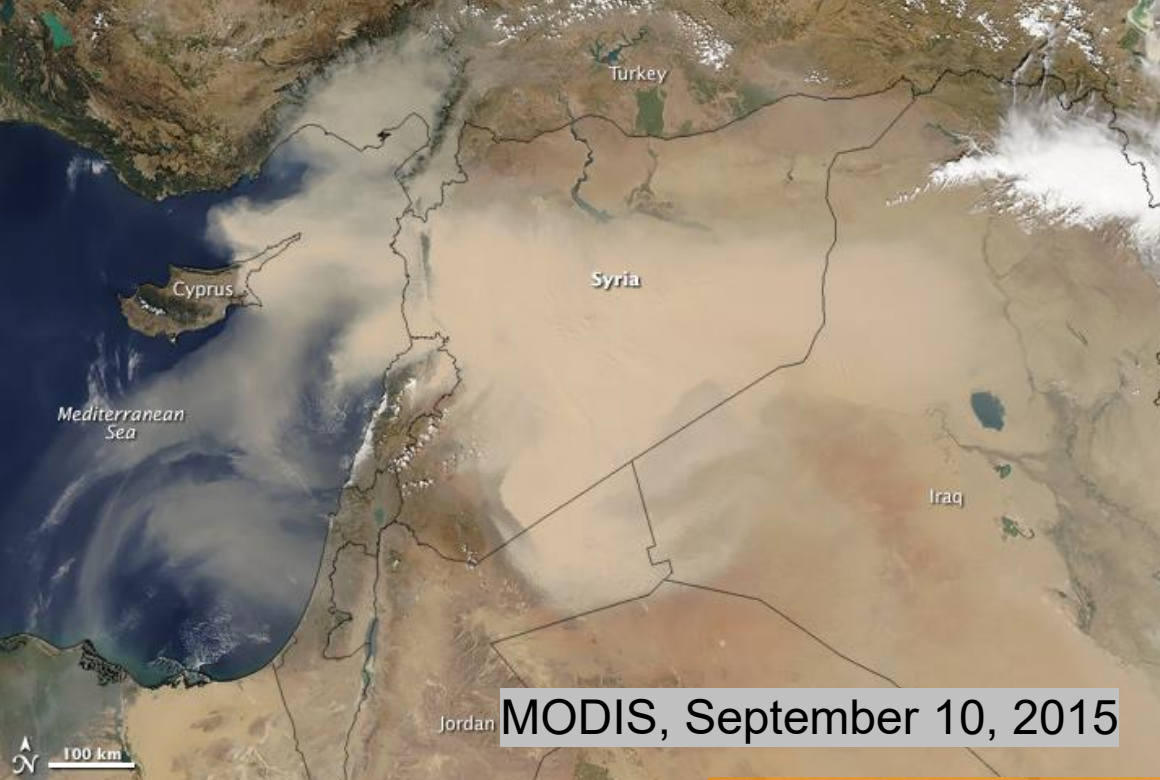
Scientific Officer

WMO Science, Services and Capacity Building Department

Global Atmosphere Watch (GAW) Programme

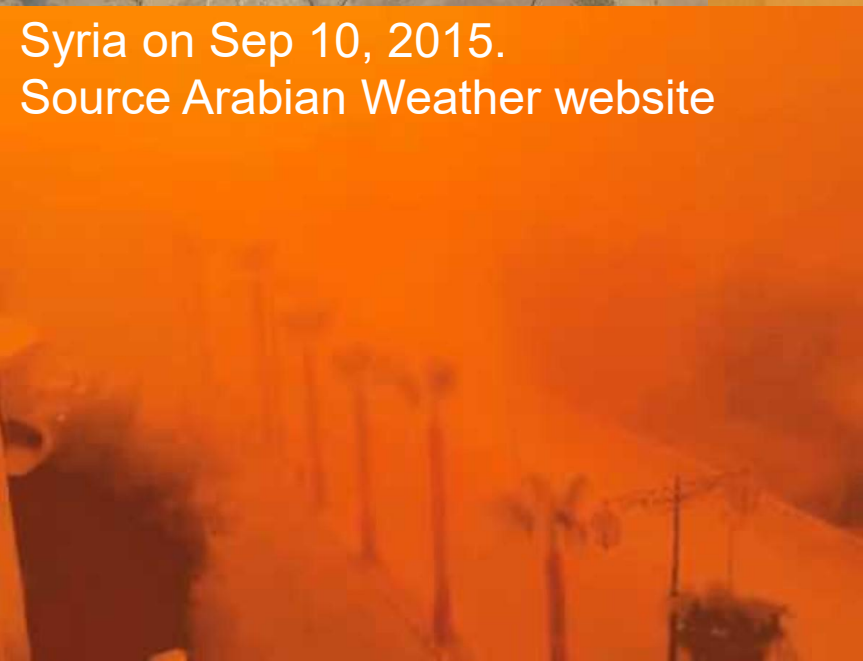


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MODIS, September 10, 2015

Al-Jawf region, KSA, March 14, 2023
Source Arabia weather website



Syria on Sep 10, 2015.
Source Arabian Weather website



Kuwait City on May 16, 2022.
Source Arab News



Baghdad, Iraq, on May 16, 2022.
Photo/Hadi Mizban

Almería, Spain, 2022



Switzerland, 2022



Crete, 2018



Türkiye, 2020



Paris, 2021



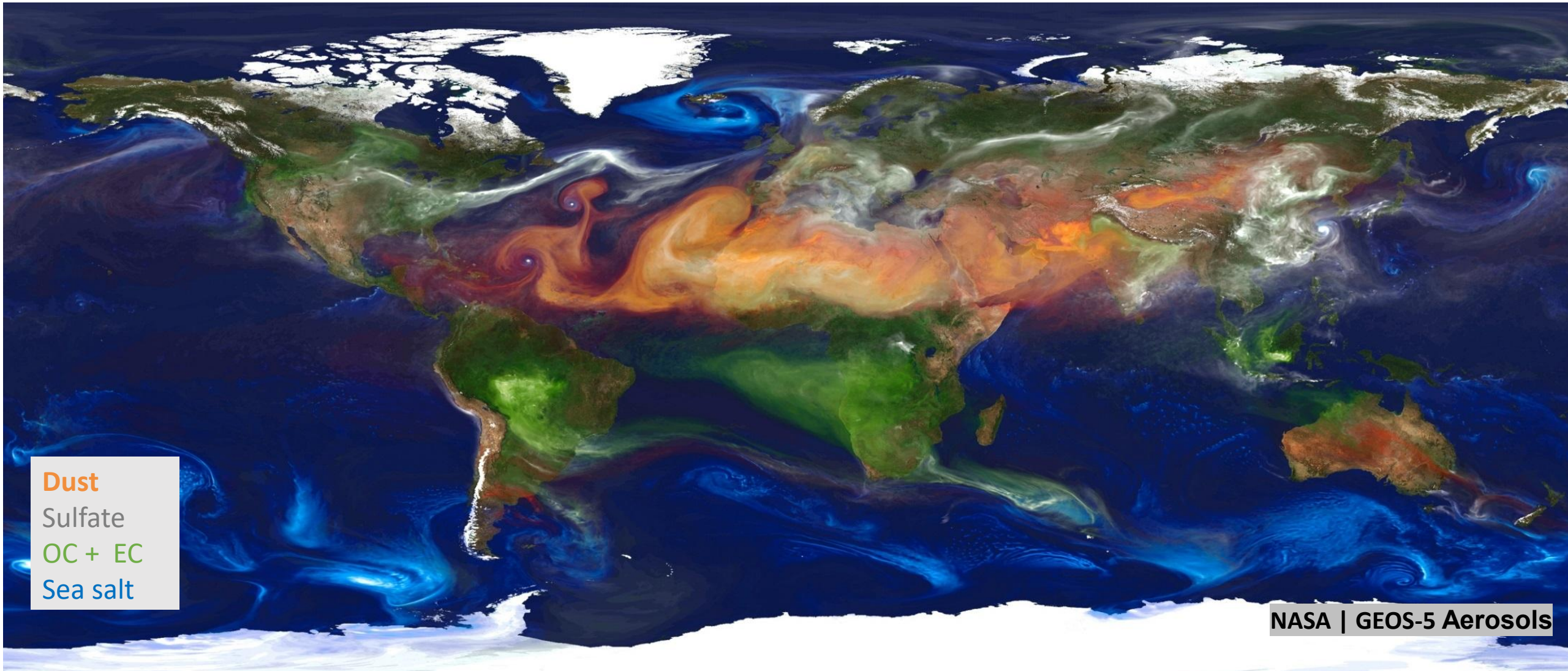
SAND AND DUST STORMS



LAND CONDITIONS

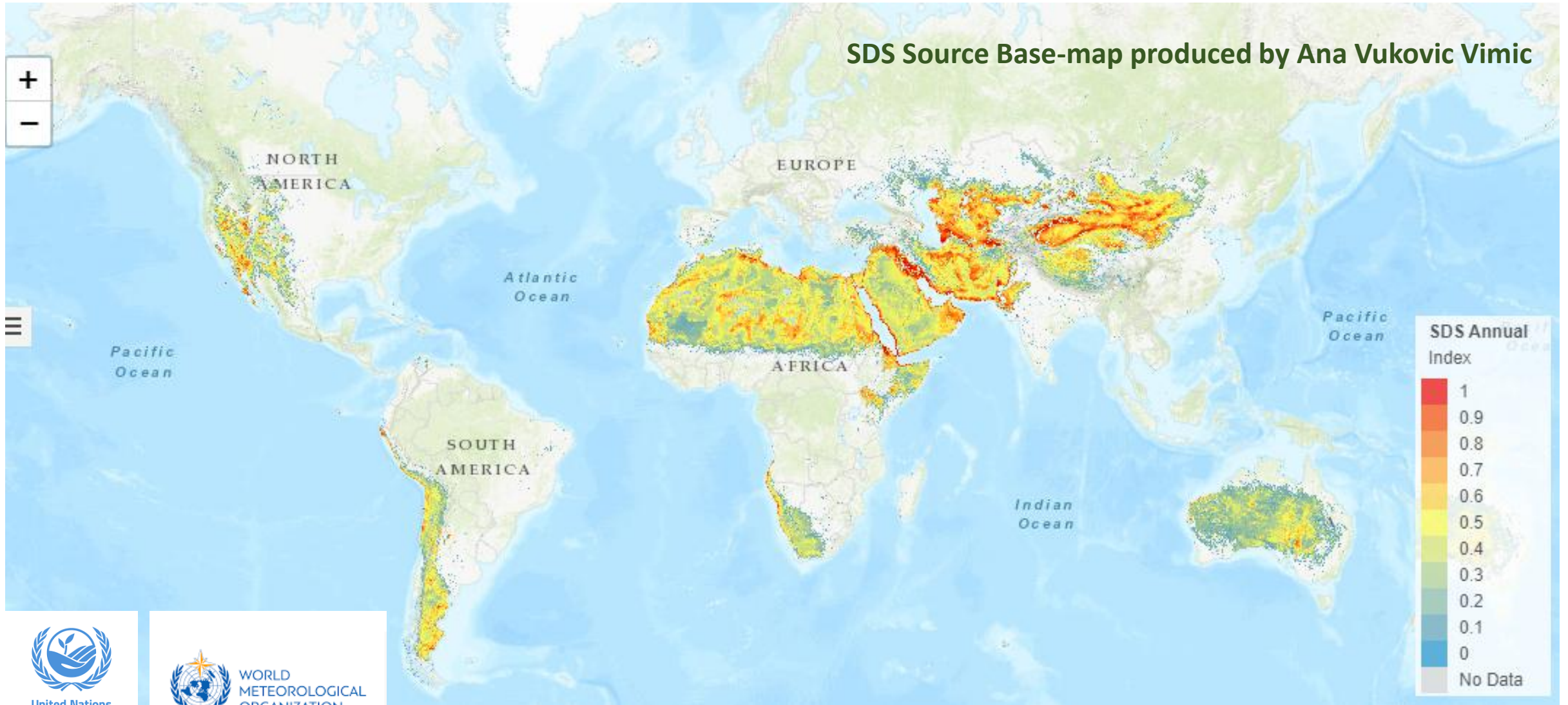


ATMOSPHERIC DRIVERS



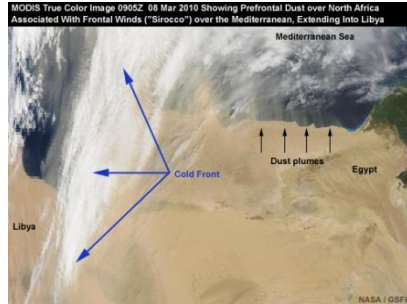
Dust transport is a global phenomenon. However, **dust emission** is a threshold phenomenon, sporadic and spatially heterogeneous, that is locally controlled on small spatial and temporal scales.

Sand and Dust Storms - Sources

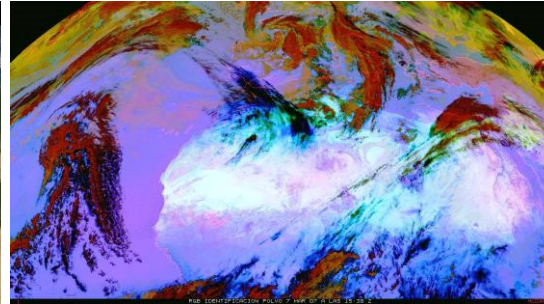


Sand and Dust Storms - Types

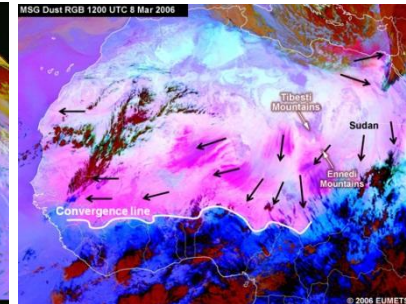
Synoptic SDS (large scale weather systems) *(Extended)*



Pre-frontal winds

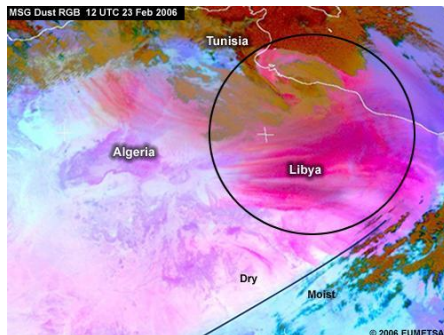


Post-frontal winds

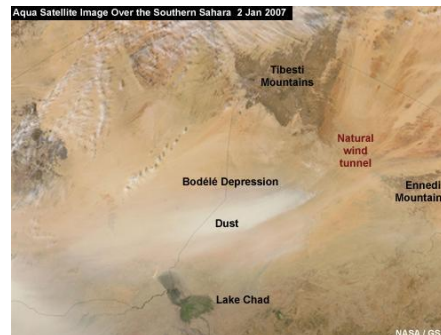


Large-scale trade winds

Mesoscale SDS *(Localised)*



Downslope winds



Gap flow

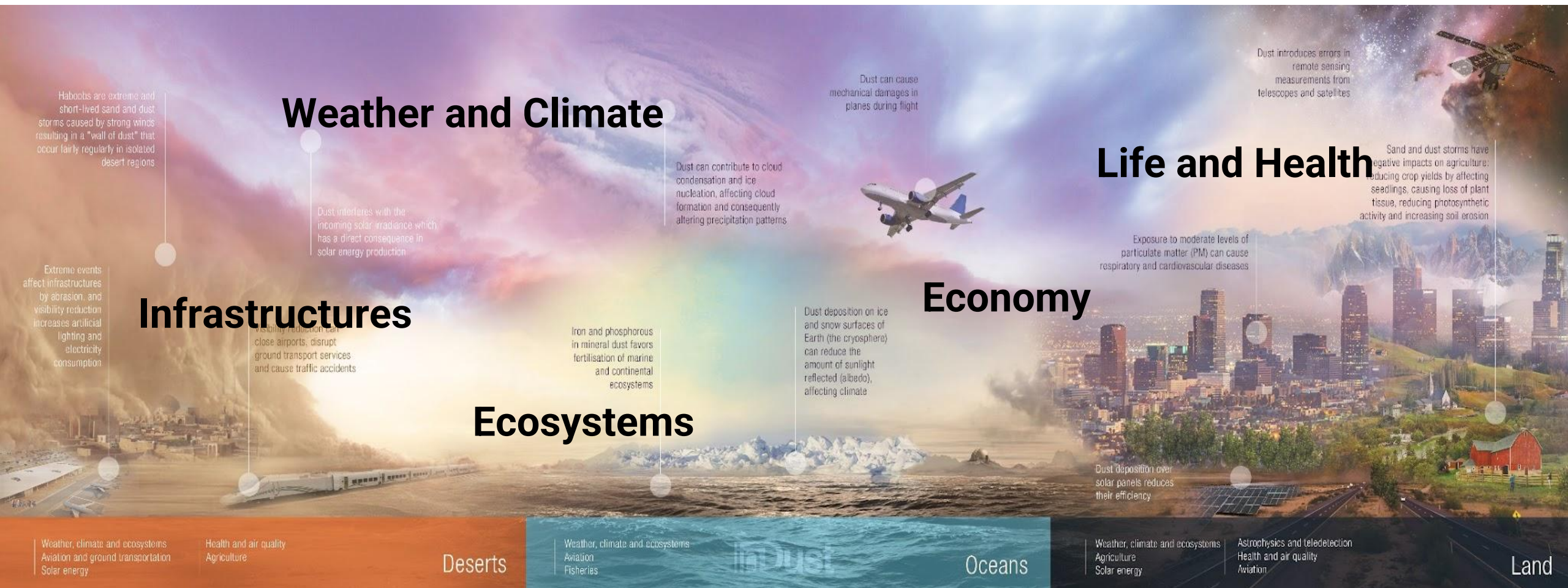


Dust devils



Haboobs

Sand and Dust Storms - Impacts



inDust Leaflet available in www.cost-indust.eu/media-room

**UN General Assembly
Proclaimed 12 July
International Day of
Combating Sand and Dust
Storms, Aiming to Raise
Awareness about
Importance for Health,
Sustainability**



UN Coalition for
Combating Sand
and Dust Storms

<https://unsdscoalition.org/>

UN declared **2025 to 2034 the
decade to combat increasing SDS
from Africa to China**

WMO launched in 2007 the international research programme on Sand and Dust Storms, the SDS-WAS



● WMO Dust Regional Centers

<https://wmo.int/topics/sand-and-dust-storms>

The WMO SDS-WAS Science for Services



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International coordination of researchers, providers and users

Identification and assessment of SDS impacts

Promoting the use of current available products (observations and forecasts)

Building capacity and facilitate access to the available services

Dissemination and awareness

The World Meteorological Organization spearheads a Sand and Dust Storm Warning Advisory and Assessment System.



Early
Warnings
to All

Godzilla, June 2020

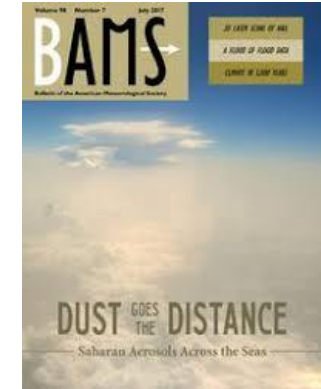
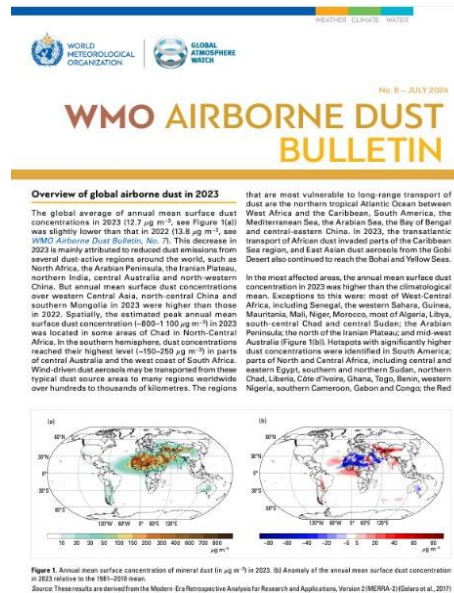


Source NASA

Scientific Assessments

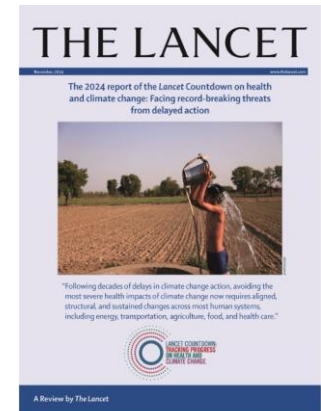
- Publish community assessment reports and high-level scientific papers
- Provide technical recommendation for monitoring atmospheric composition
- Contribute to international reports

WMO publications
Available at: <https://library.wmo.int/>



AVIATION
IMPACT
REVIEW

(Scherllin-Pirscher et al., BAMS, 2024)



HEALTH
CLIMATIC
INDICATOR

(Romanello et al., Lancet, 2024)

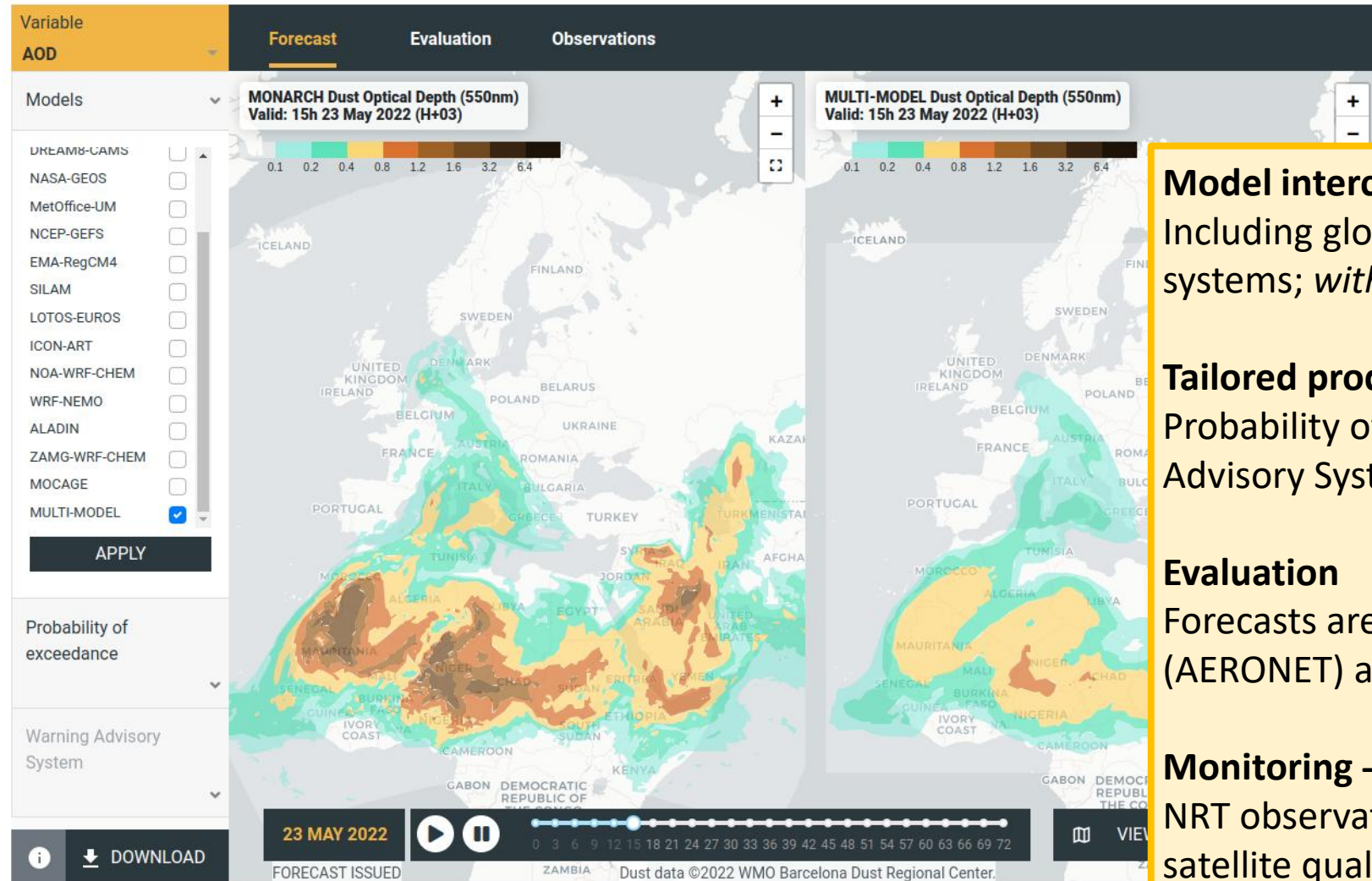
Advancing on Early Warning Systems (EWS) for SDS

	Temporal Focus	Primary Data Sources	Main Objective
Reanalysis	Past (Historical decades)	Satellites , networks, Chemical Transport Models (CTMs) and Numerical Weather Prediction with assimilation of satellites and networks.	Map long-term dust source regions and frequency trends of SDS.
Monitoring	Present (Real-time tracking)	Satellites , networks (including visibility sensors), and camaras	Track the current location, size, and intensity of an active dust plume.
Nowcasting <i>(less developed)</i>	Immediate Future (0 to 6 hours)	Weather radar, satellites , and wind-extrapolation algorithms	Provide hyper-local, fast warnings for rapidly advancing dust walls (e.g. haboobs).
Forecast	Future (1 to 5 days)	Chemical Transport Models (CTMs) and Numerical Weather Prediction (in some cases with assimilation of satellites and networks)	Predict the path, arrival time, and intensity of a dust storm days in advance.

WMO Barcelona Dust Regional Center

<https://dust.aemet.es/>

@Dust_Barcelona



Model intercomparison

Including global and regional forecasting systems; *with and without Data Assimilation*

Tailored products:

Probability of exceedance and Warning Advisory System

Evaluation

Forecasts are compared with networks (AERONET) and satellites (MODIS)

Monitoring - Observations

NRT observations includes visibility and satellite qualitative products

Dust Products Catalogue

www.dust.aemet.es

[< BACK TO PRODUCTS](#)

Dust Catalogue

Satellites

Ground-based

Campaigns

Dust Models

Marine Environments

Admin Login

Filters

Contribute

Parameter

Aerosol Optical Depth, Aerosol Index, Absorp...

Satellite

Terra, Aqua, Aura, ...

Instrument

MODIS, OMI, CALIOP, ...

Spectral Range

Parameter	Satellite	Instrument	Data Availability		Spectral Ra...	Unit	Active/Pass...	Temporal R...
			From	To				
Absorption ...	PARASOL	POLDER	2005-03-01	2013-11-30	443, 490, 5...	Unitless	Passive	Seasonal
Absorption ...	PARASOL	POLDER	2005-01-01	2013-12-31	443, 490, 5...	Unitless	Passive	Yearly
Absorption ...	PARASOL	POLDER	2005-03-22	2013-10-11	443, 490, 5...	Unitless	Passive	Daily
Absorption ...	PARASOL	POLDER	2005-03-01	2013-10-31	443, 490, 5...	Unitless	Passive	Monthly
Absorption ...	PARASOL	POLDER	2005-03-01	2013-11-30	443, 490, 5...	Unitless	Passive	Seasonal
Absorption ...	PARASOL	POLDER	2005-01-01	2013-12-31	443, 490, 5...	Unitless	Passive	Yearly
Absorption ...	Aura	OMI	2004-10-01	Present	354, 388, 500	Unitless	Passive	Sub-daily
Absorption ...	ERS-2	ATSR-2	1995-06-01	2003-06-30	550	Unitless	Passive	Monthly
Absorption ...	ENVISAT	AATSR	2002-05-01	2012-04-30	550	Unitless	Passive	Monthly
Absorption ...	ERS-2	ATSR-2	1995-06-01	2003-06-30	550	Unitless	Passive	Monthly

International Network to Encourage the Use of Monitoring and Forecasting Dust Products (inDust) - COST Action CA16202

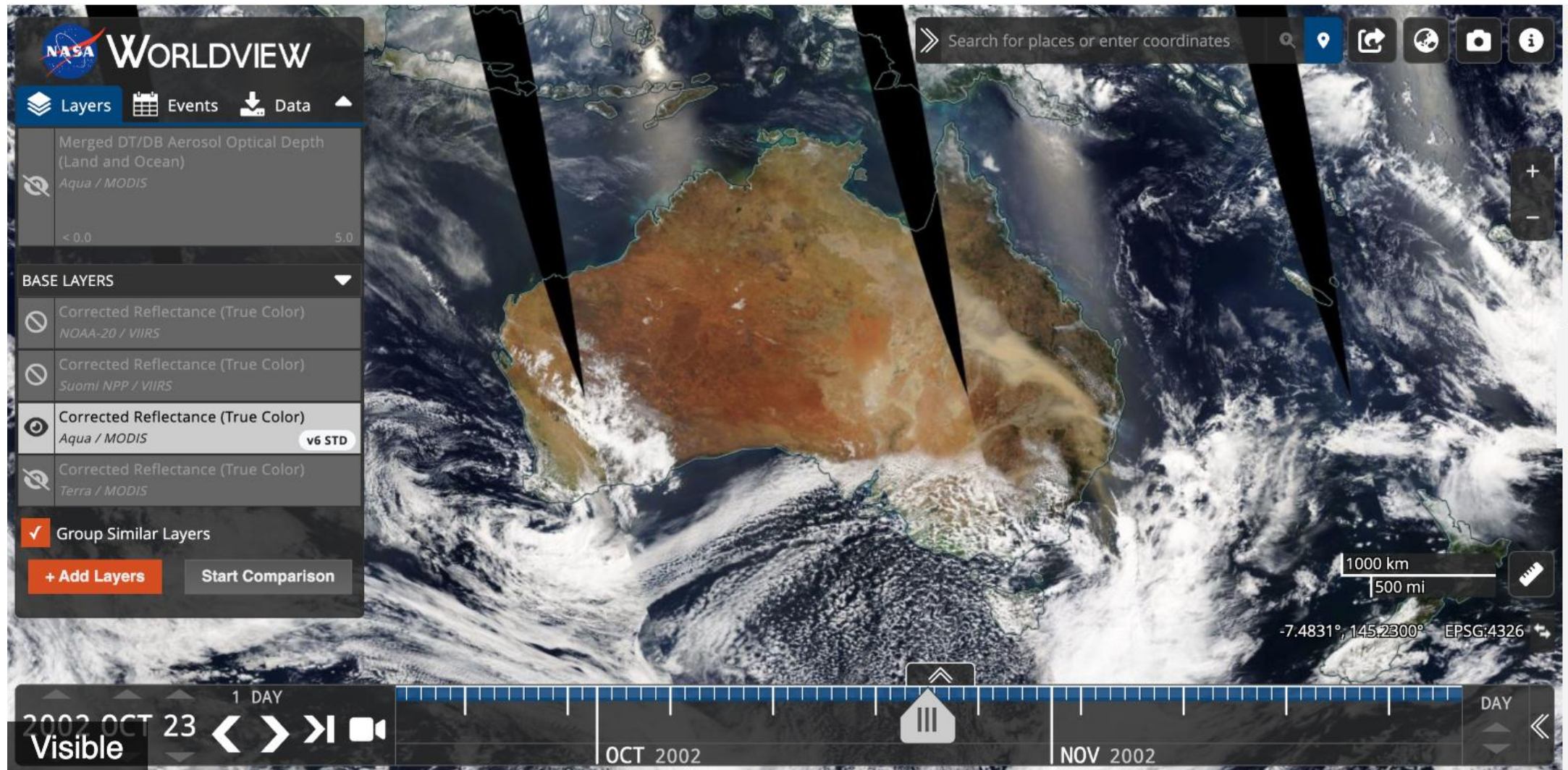
Developed by ReACT, IAASARS, National Observatory of Athens

inDust

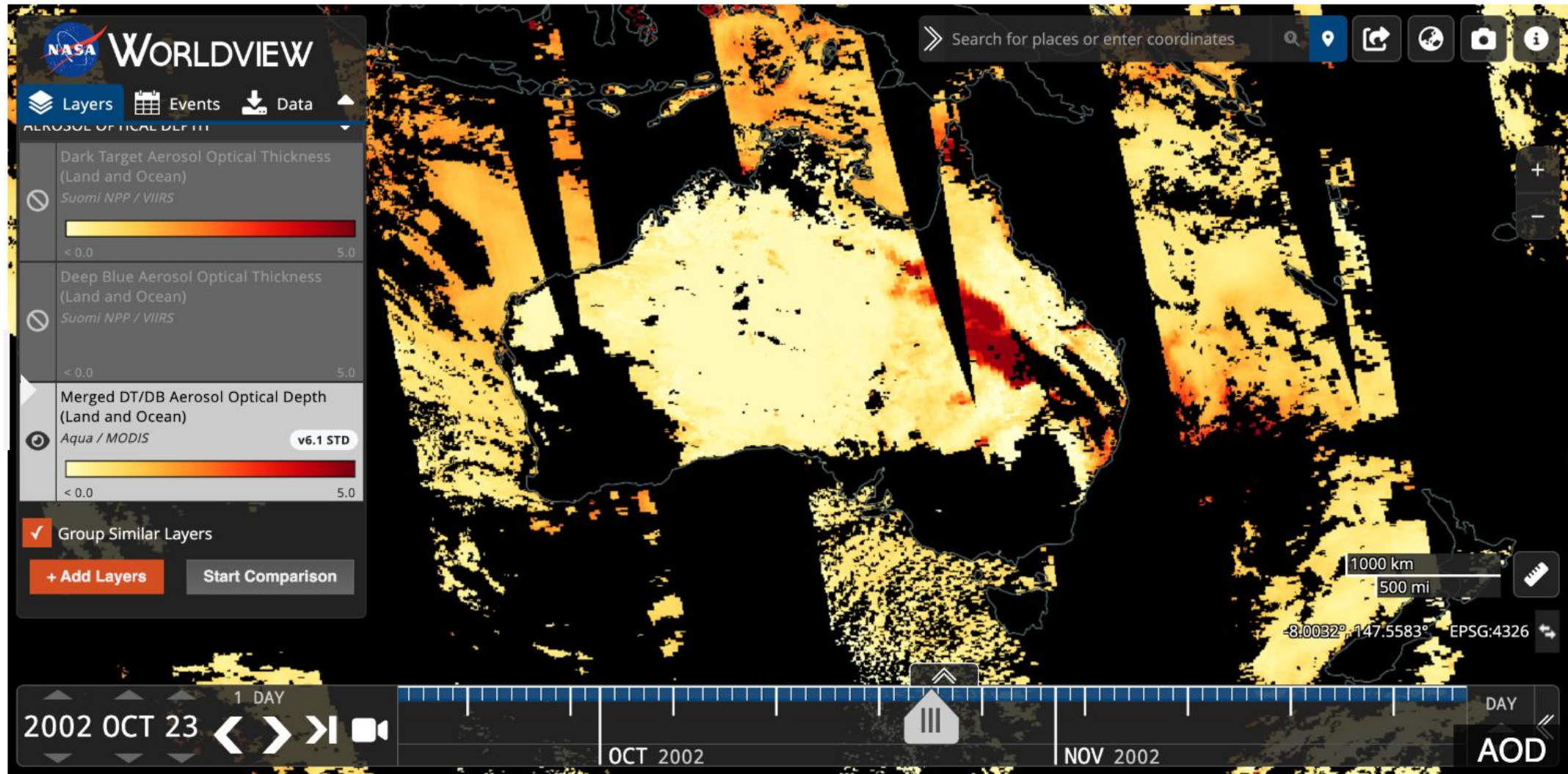
COST
EUROPEAN COOPERATION
IN SCIENCE & TECHNOLOGY

Mona et al., 2023, Observing Mineral Dust in Northern Africa, the Middle East, and Europe: Current Capabilities and Challenges ahead for the Development of Dust Services, BAMS, <https://doi.org/10.1175/BAMS-D-23-0005.1>

Sand and Dust Storms - Satellites

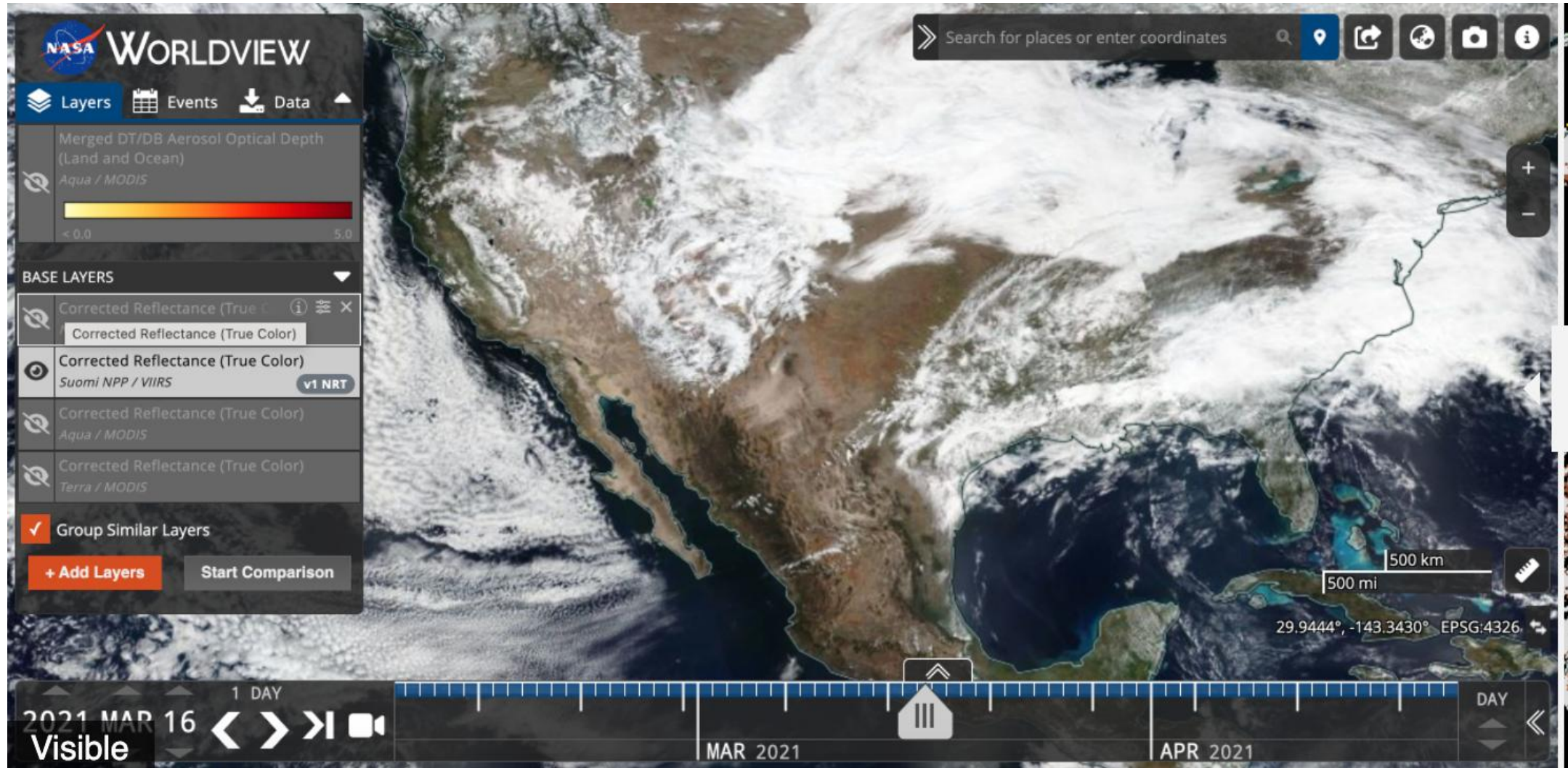


Sand and Dust Storms – Satellites (Aerosol Content)



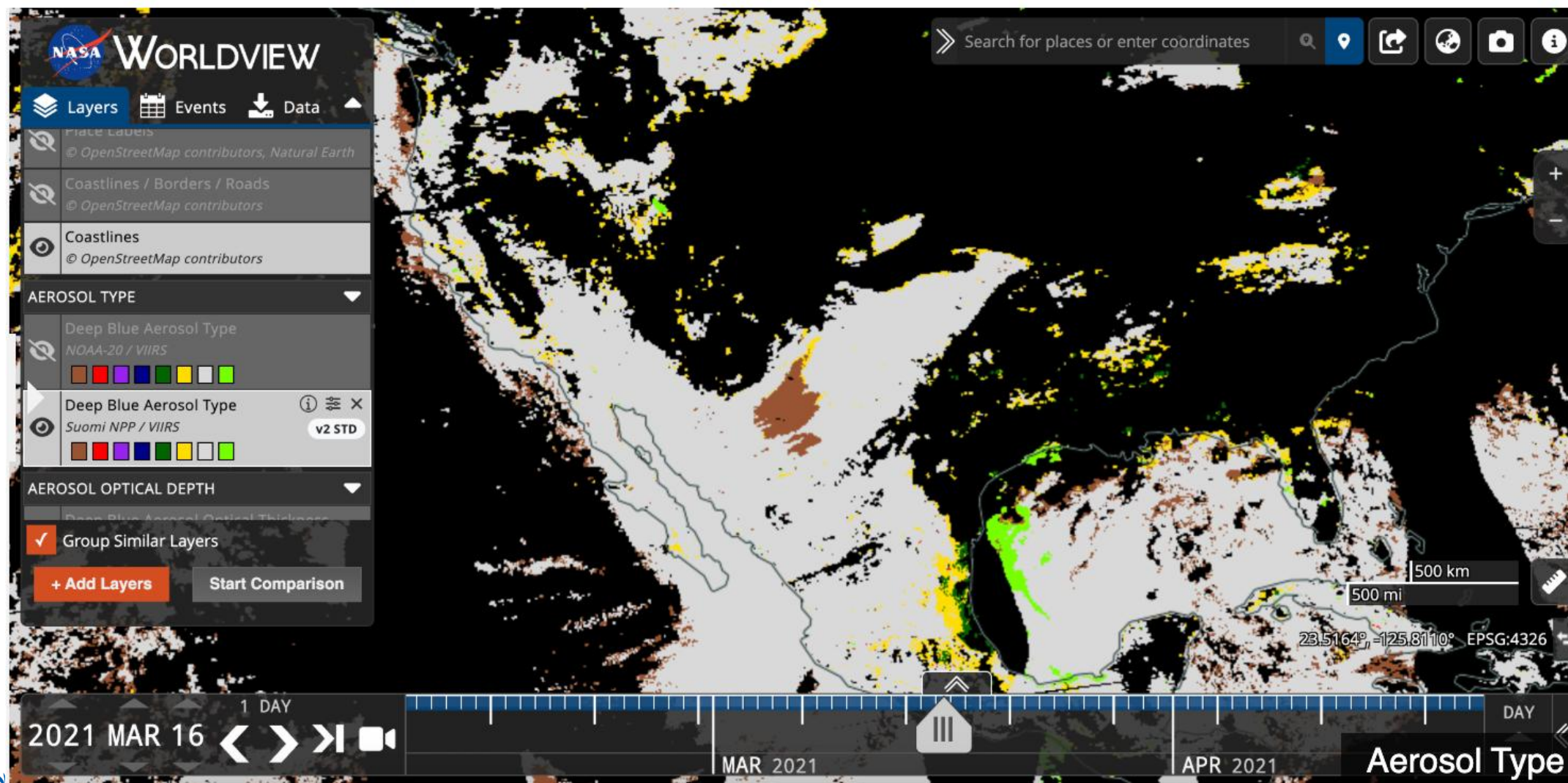
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Sand and Dust Storms - Satellites



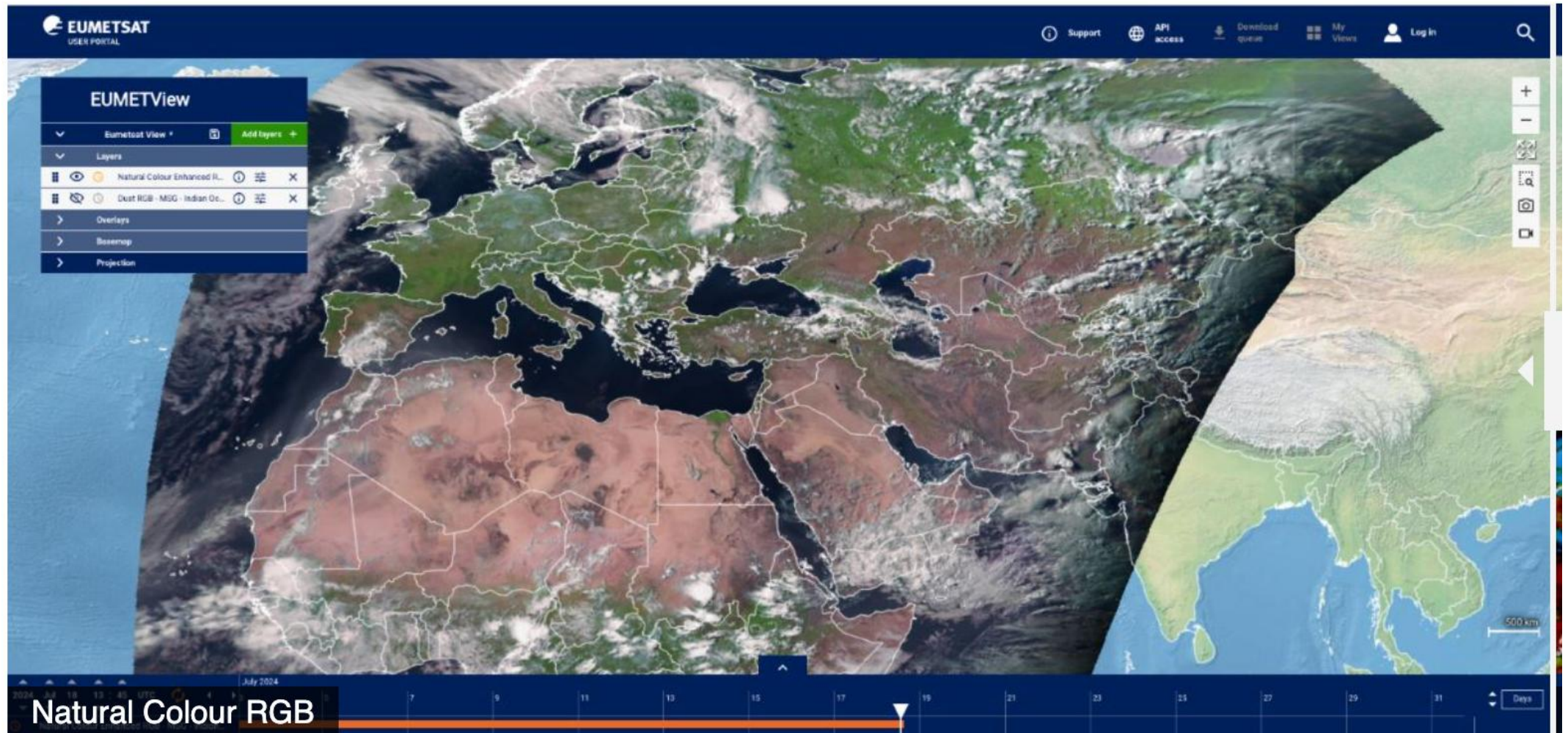
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Sand and Dust Storms – Satellites (Aerosol Typing)

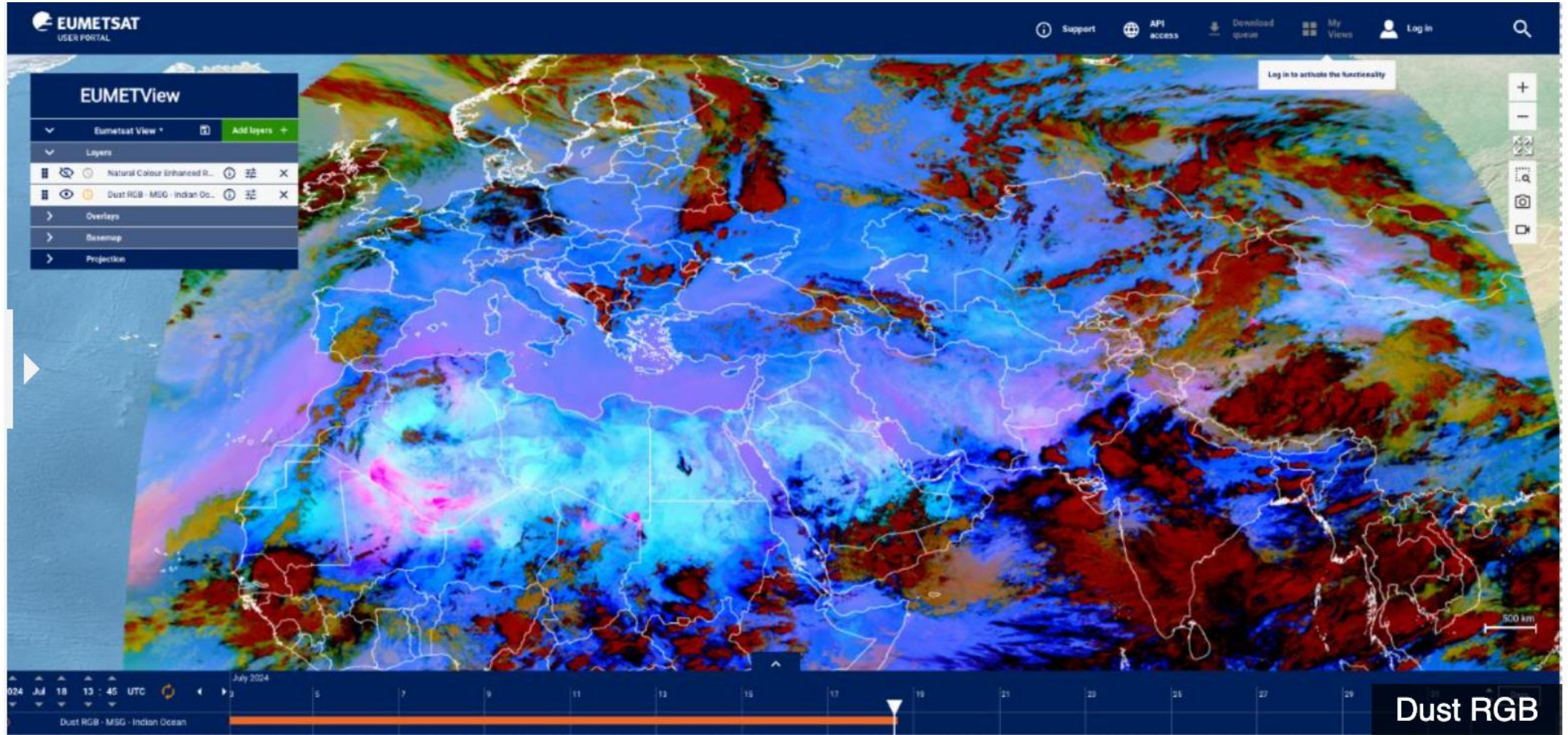


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Sand and Dust Storms - Satellites



Sand and Dust Storms – Satellites (Haboobs monitoring)



Final remarks

- **Sand and Dust Storms (SDS)** play a significant role in different aspects of weather, climate and atmospheric chemistry and represent a **serious hazard** for life, health, property, environment and economy.
- Satellites provide the **critical spatial coverage** needed to detect, track, and model unpredictable dust sources.
- Effective Early Warning Systems require all four dimensions—using **Past** data to prepare, **Present** data to track, and **Immediate/Future** data to protect.
 - *Geostationary satellites are key over sources, during short and intense SDS*
- WMO, through its research activities as SDS-WAS and its associated **Dust Regional Centers**, is key to **provide information and guidance** on how to assess and address the risks posed by SDS by building effective EWS.

<https://community.wmo.int/en/activity-areas/gaw>



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Stay up to date on our core and related activities through our Newsletter

Thank you.

Sara Basart (sbasart@wmo.int)

*Special thanks to the WMO-GAW experts in all regions
that make the WMO SDS-WAS successful*



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