Barcelona Supercomputing Center
Centro Nacional de Supercomputación

AXA Research Fund

EXCELENCIA SEVERO OCHOA

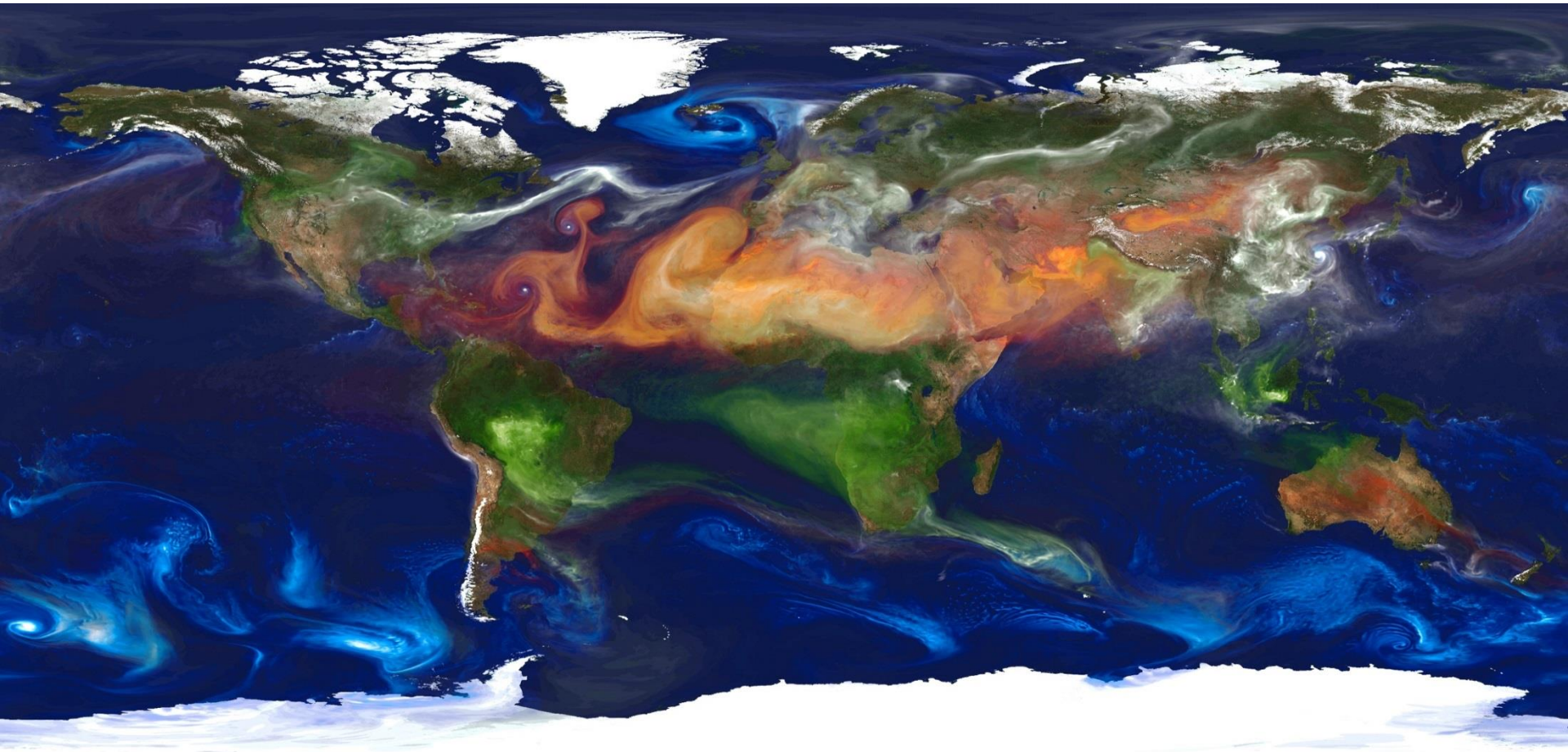
Towards the development of a dust observational database

Sara Basart (BSC, sara.basart@bsc.es), Lucia Mona (CNR-DTA), Vassilis Amiridis (NOA), Slobodan Nickovic (SEVCCC), Paola Formenti (CNRS)

and all the researchers that are contributing through SDS-WAS Regional Center, inDust and DustClim

INDICES Summer School , Saclay, France, 5th June 2019

Motivation – Dust impacts and its extension



Organic Carbon + Elemental carbon
Dust
Sulfate
Sea salt

NASA | GEOS-5 Aerosols

Motivation – Dust impacts

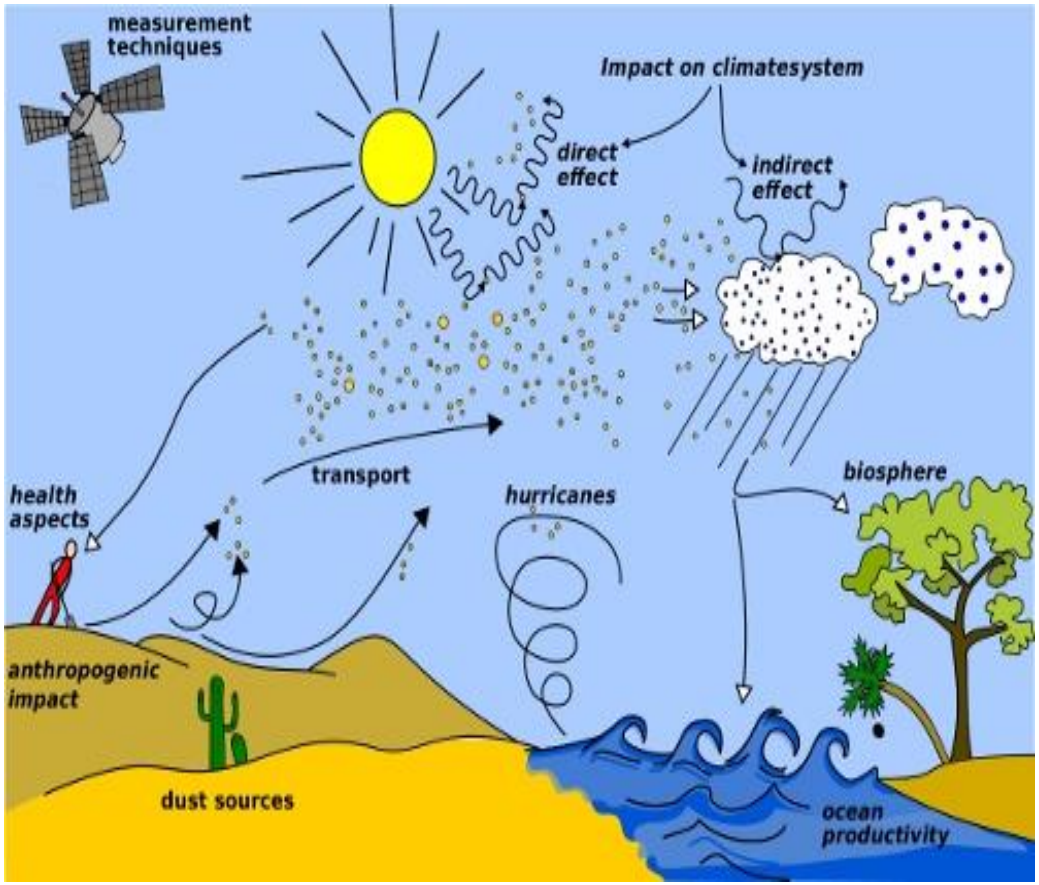


Image from WMO website (http://www.wmo.int/pages/prog/arep/wwrp/new/hurricanes.html)

Ecosystems, meteorology and climate

Air Quality and Human Health

Aviation and Ground Transportation

Energy and industry

Agriculture and fishering

Astrophysics

A piece of SDS history

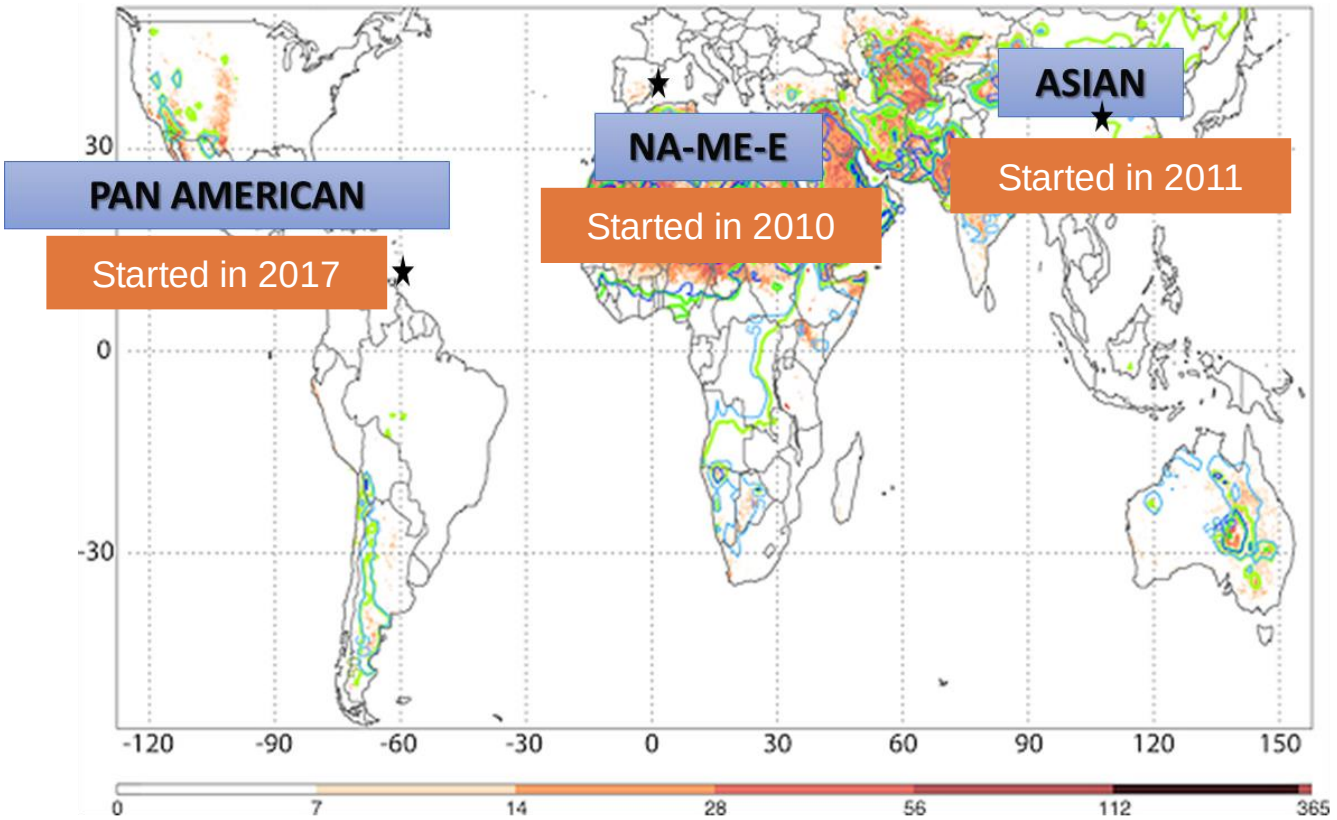
- Late 80'es:
  - First demonstration that SDS dynamic simulations are possible
- 90'es:
  - First satellite products capable to detect SDS
  - First successful daily SDS forecast test
  - First long-term daily SDS forecasts
- **2000's:**
  - Fast growth in **dust observations** and forecasting models
- 2010's:
  - Fast growth in user-oriented applications

WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

- Objectives:
  - Identify and improve products to monitor and predict dust by working with research and operational organizations, as well as with users.
  - Facilitate user access to information.
  - Strengthen the capacity of countries to use the observations, analysis and predictions provided by the WMO SDS-WAS.

WORLD METEOROLOGICAL ORGANIZATION

SDS-WAS and the Regional Nodes/Centers



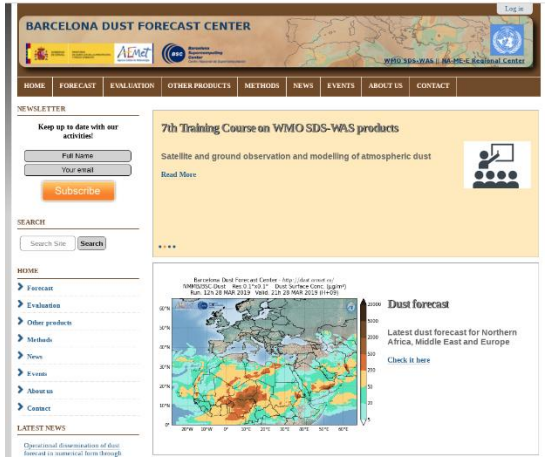
Annual mean frequency distribution of M-DB2 (2003–2009) DOD > 0.2 (red), TOMS (1980–1991) aerosol index ≥ 0.5 (blue), and OMI (2004–2006) aerosol index ≥ 0.5 (green). The isocontours of TOMS and OMI have been removed over oceans for clarity.

Extracted from Ginoux et al. (2012, Rev. Geophys.)

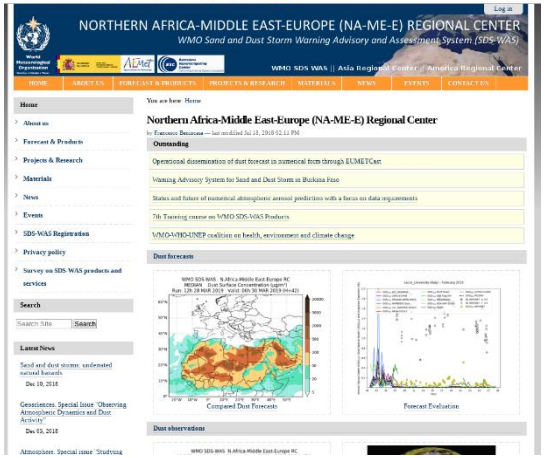
WORLD METEOROLOGICAL ORGANIZATION

WMO Dust Centers at Barcelona

Barcelona Dust Forecast Center.
Unique specialized WMO Center for mineral dust prediction in Europe
http://dust.aemet.es
started in 2014 - **Operations**
MONARCH is the reference model

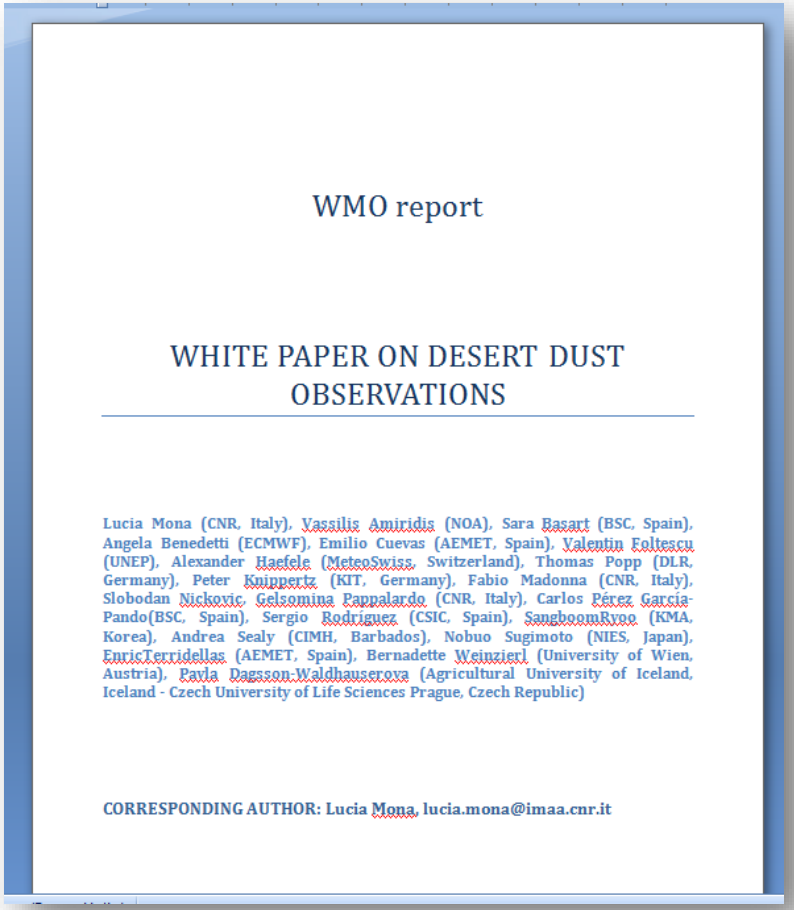


SDS-WAS. North Africa, Middle East and Europe Regional Center.
http://sds-was.aemet.es
started in 2010 – **Research**
MONARCH is contributing to the model ensemble



WMO White paper report for dust observations

- Near surface characterization
- Photometer measurements
- Lidar measurements
- Lidar +Photometer
- Satellite observations
- Networks
- Gaps and Needs



WMO report

WHITE PAPER ON DESERT DUST OBSERVATIONS

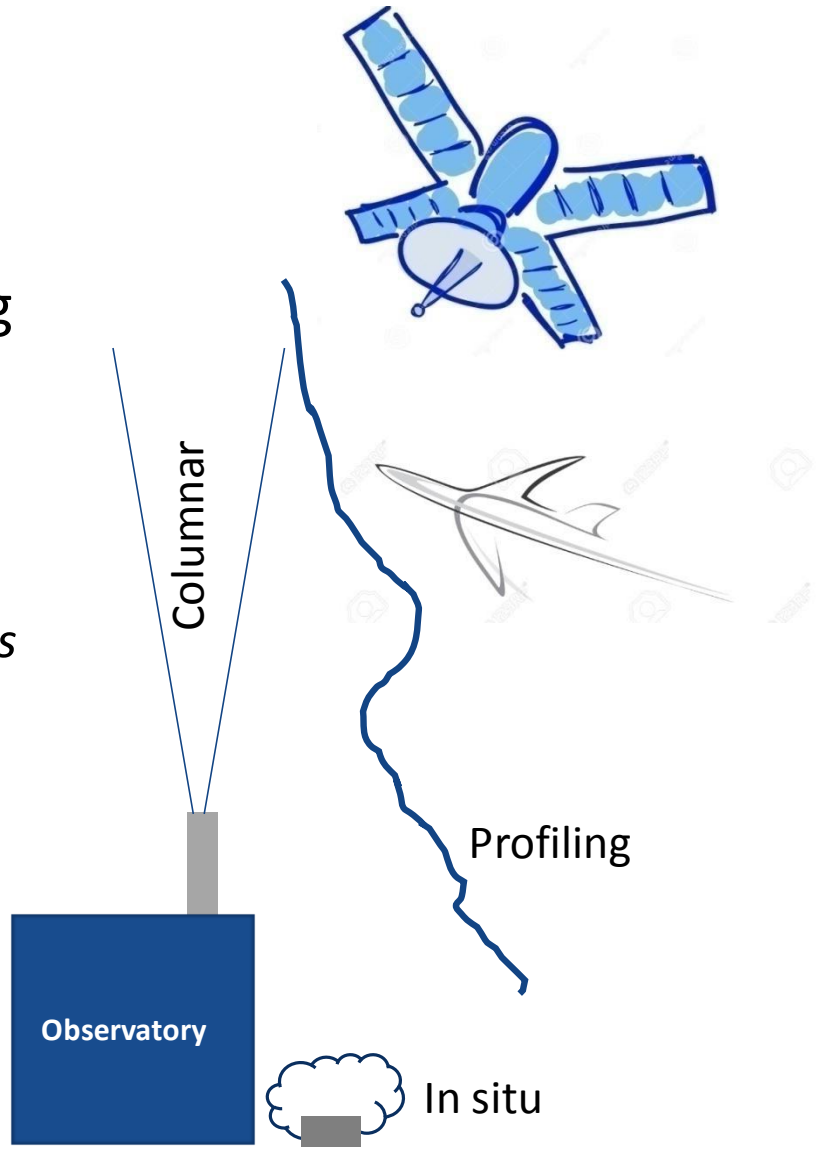
Lucia Mona (CNR, Italy), Vassilis Amiridis (NOA), Sara Basart (BSC, Spain), Angela Benedetti (ECMWF), Emilio Cuevas (AEMET, Spain), Valentin Foltescu (UNEP), Alexander Haefele (MeteoSwiss, Switzerland), Thomas Popp (DLR, Germany), Peter Knippertz (KIT, Germany), Fabio Madonna (CNR, Italy), Slobodan Nickovic, Gelsomina Pappalardo (CNR, Italy), Carlos Pérez Garcia-Pando(BSC, Spain), Sergio Rodriguez (CSIC, Spain), SangboomRyoo (KMA, Korea), Andrea Sealy (CIMH, Barbados), Nobuo Sugimoto (NIES, Japan), EnricTerridellas (AEMET, Spain), Bernadette Weinzierl (University of Wien, Austria), Pavla Dagsson-Waldhauserova (Agricultural University of Iceland, Iceland - Czech University of Life Sciences Prague, Czech Republic)

CORRESPONDING AUTHOR: Lucia Mona, lucia.mona@imaa.cnr.it

WORLD METEOROLOGICAL ORGANIZATION

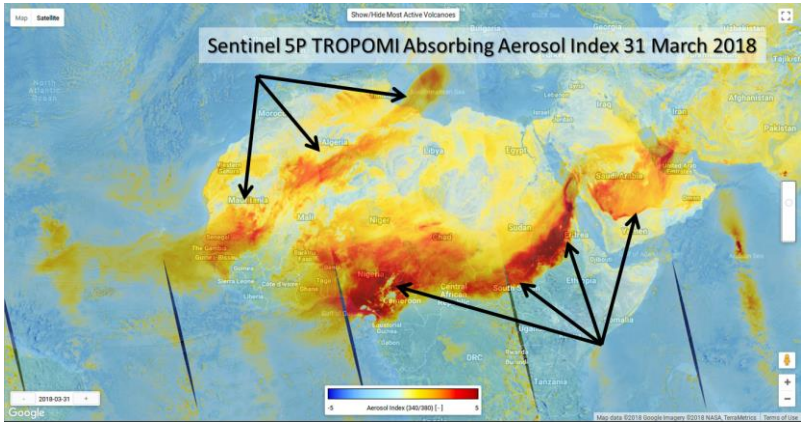
State of art for particle characterization

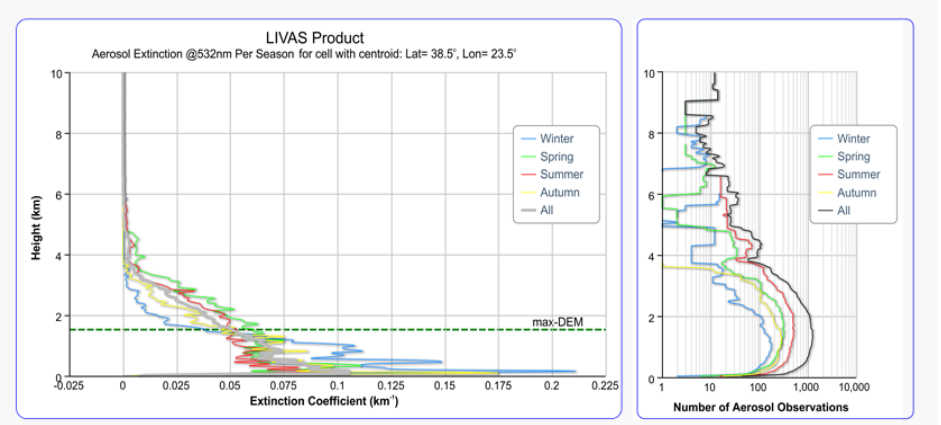
- Satellite measurements
- Ground based remote sensing
- Near surface characterization
- Measurement campaigns
  - *developing and testing methods*



Looking dust from space

- Satellite can detect dust pattern:
  - MODIS visible, SEVIRI RGB, AI (TROPOMI, OMI, TOMS)
- Satellite can provide dust component (big particles)
  - MODIS, MISR, OMI, IASI, POLDER, SeaWIFS, SEVIRI, AATSR…
- Satellite can provide dust 4D path
  - CALIOP, LIVAS





Looking dust from the ground

- Columnar aerosol information – optical properties:
  - GAW (https://www.gaw-wdca.org/) – Global
  - AERONET (https://aeronet.gsfc.nasa.gov/) – Global
  - SKYNET (https://www.skynet-isdc.org/) - Global
- Profiling capability (backscattering and extinction)
  - GAW (https://www.gaw-wdca.org/) – Global
  - EARLINET/ACTRIS (https://www.earlinet.org/) – Europe
    - Ongoing algorithms that provide mass concentration (GARRLIC, LIRIC)
  - e-PROFILE (https://e-profile.eu/) – Global
    - Ceilometers are useful for NRT validation
  - MPLNet (http://mplnet.gsfc.nasa.gov/) – Global
  - PolyNet/ACTRIS - Europe

Looking dust from the ground

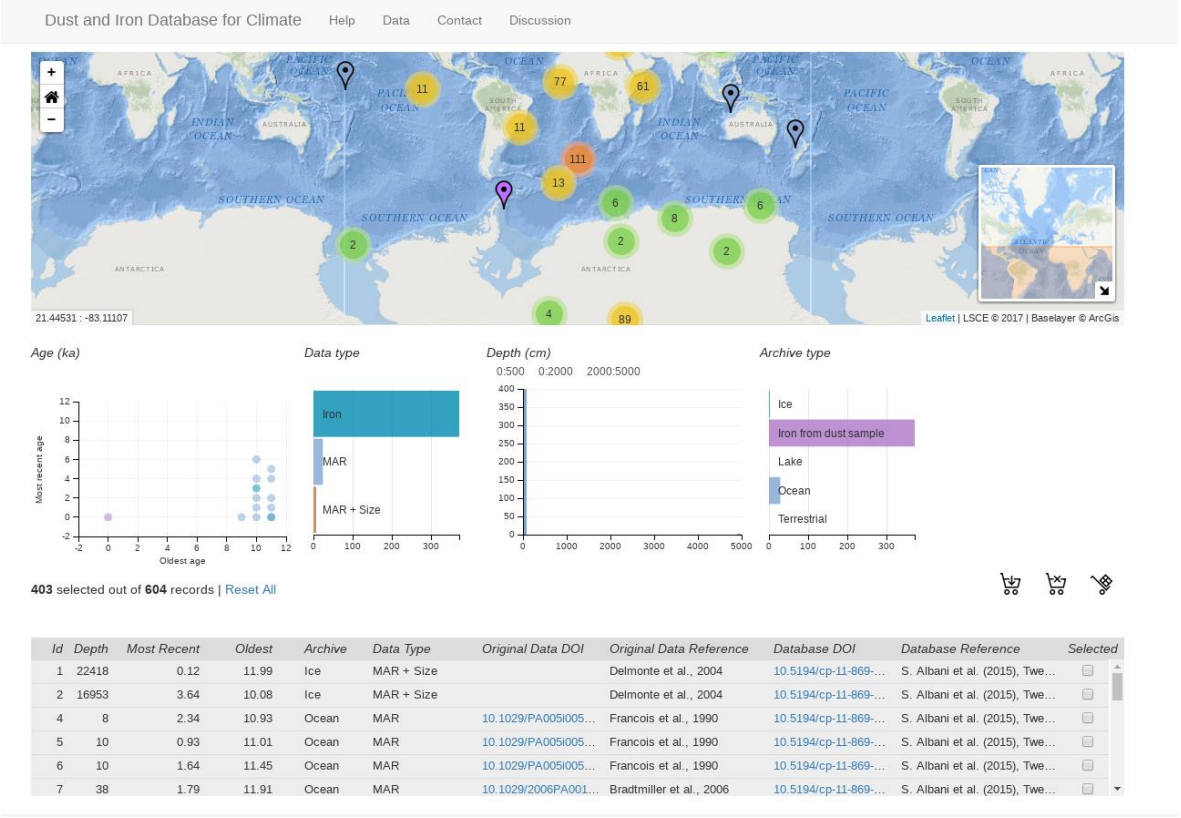
- Surface concentration (PM10 and PM2.5)
  - GAW (https://www.gaw-wdca.org/) – Global
  - EMEP (http://ebas.nilu.no/) – Europe
  - INDAAF (https://indaaf.obs-mip.fr/) – Sahel
  - Regional Air Quality networks (EIONET, IMPROVE…)
- Chemical composition
  - GAW (https://www.gaw-wdca.org/) – Global
  - EMEP (http://ebas.nilu.no/) – Europe

Looking dust from the ground

- Size distribution
  - GAW (https://www.gaw-wdca.org/) – Global
  - EMEP (http://ebas.nilu.no/) – Europe
- Visibility
  - METAR and SYNOP weather reports (https://www.ncdc.noaa.gov/isd)
- Deposition
  - INDAAF (https://indaaf.obs-mip.fr/) – Sahel
  - CARAGA (http://mistrals.sedoo.fr/Database-Content/?project=ChArMEx) – Europe

Climatologies based on multiple studies

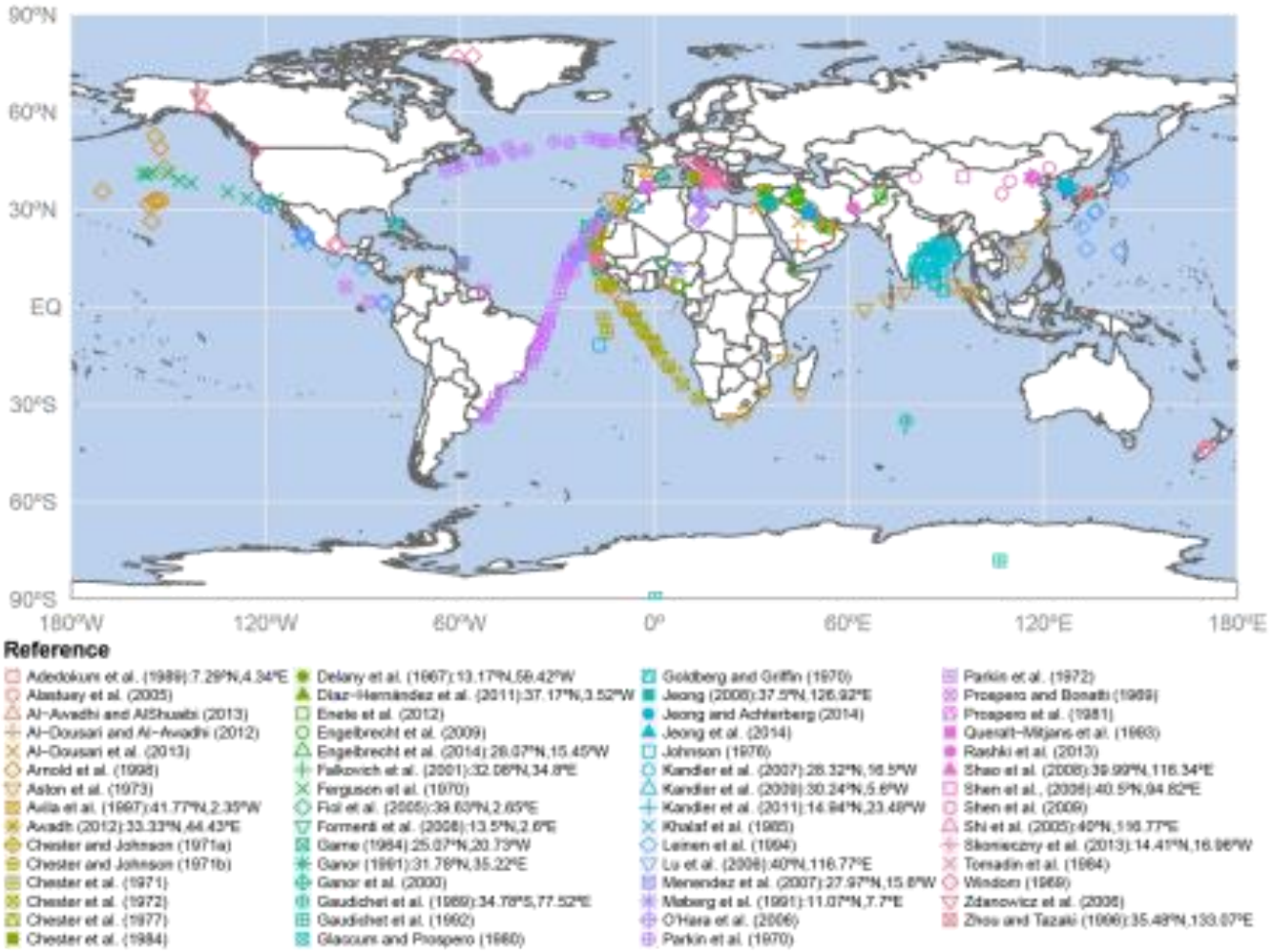
- Deposition of dust: DIRTMAP
  - Two period: present and LGM (http://www.ncdc.noaa.gov/data-ccess/paleoclimatology-data/datasets/loess-eolian-dust)
- Dust and iron database for climate (http://dustironclimate.lsce.ipsl.fr)



Id	Depth	Most Recent	Oldest	Archive	Data Type	Original Data DOI	Original Data Reference	Database DOI	Database Reference	Selected
1	22418	0.12	11.99	Ice	MAR + Size		Delmonte et al., 2004	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	
2	16953	3.64	10.08	Ice	MAR + Size		Delmonte et al., 2004	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	
4	8	2.34	10.93	Ocean	MAR	10.1029/PA005i005...	Francois et al., 1990	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	
5	10	0.93	11.01	Ocean	MAR	10.1029/PA005i005...	Francois et al., 1990	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	
6	10	1.64	11.45	Ocean	MAR	10.1029/PA005i005...	Francois et al., 1990	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	
7	38	1.79	11.91	Ocean	MAR	10.1029/2006PA001...	Bradtmiller et al., 2006	10.5194/cp-11-869-...	S. Albani et al. (2015), Twe...	

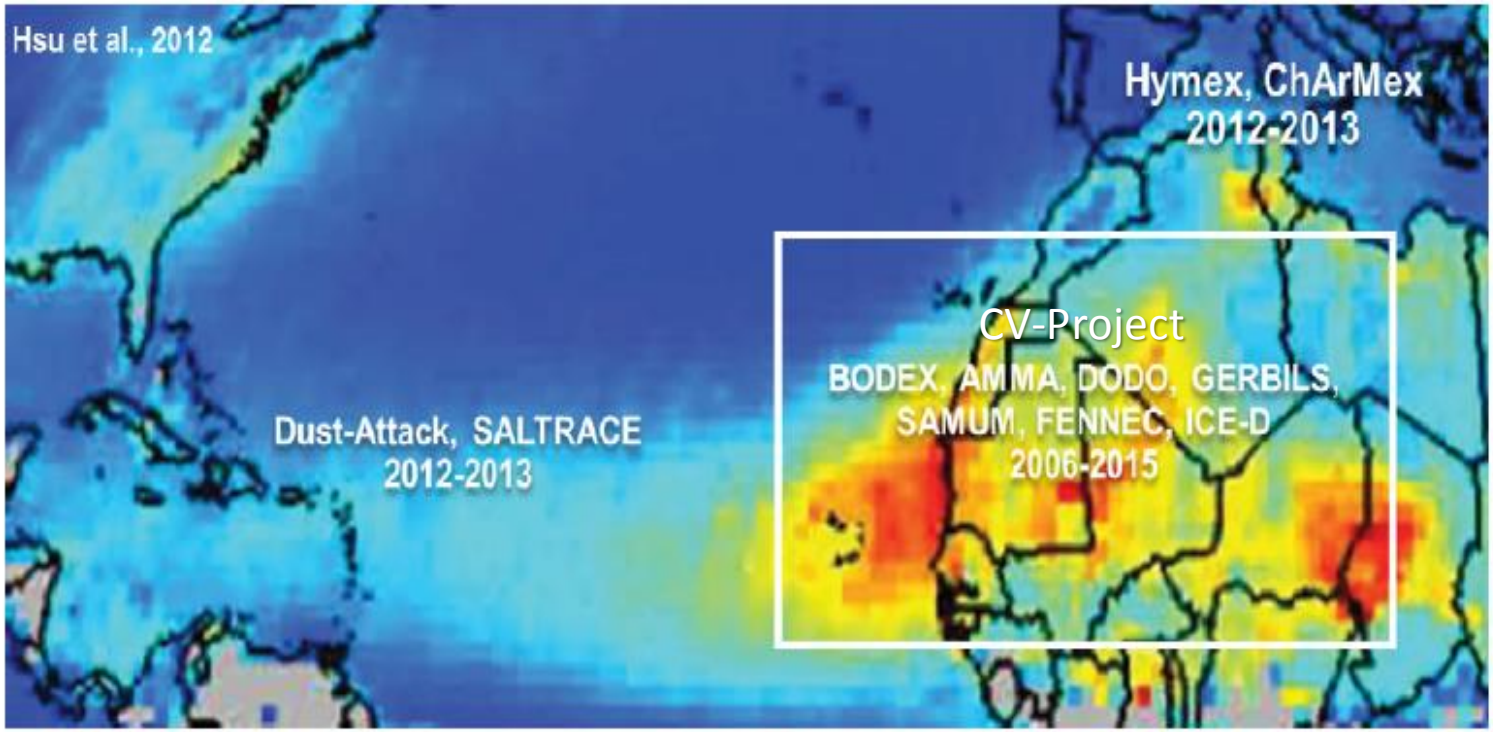
Climatologies based on multiple studies

- Mineralogy (Perlwitz et al, ACP, 2015)



Experimental campaigns

- Exceptional set of synergistic measurements for a limited period of time



Upcoming experimental campaign - ASKOS

Upcoming ESA/Aeolus Airborne Cal/Val

Upcoming experimental campaign - ASKOS

Projects and participants engaged

inDust
COST Action CA16202

erc D-TECT

DUSTUP – DUSt Transport – Understanding Processes

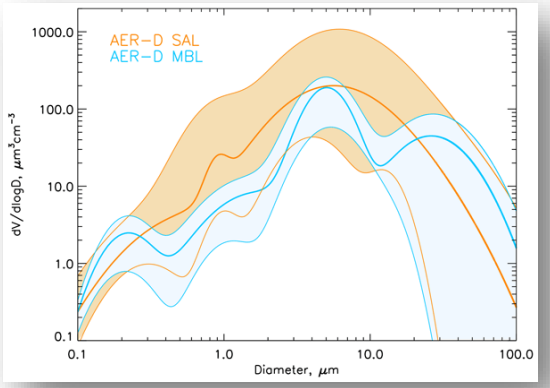
Upcoming experimental campaign - ASKOS

Aerosol-related science questions to be addressed

- What determines the structure of the SAL and its spatial coherence?
- What is the role of electrification in the long-range transport of dust?
- What is the role of Saharan dust in Ice Nuclei (IN) formation and more in general on cloud-processes?
- Can the uncertainties in dust typing be identified to support development of improved satellite products?
- What is the value of the Aeolus backscatter product for dust detection?

Gaps identified

- Spatio-temporal gaps
  - Good spatial coverage with satellites
  - In-situ have important gaps in Africa, Australia and **ocean**
- Size gaps
  - **Dust Giant** and **Ultragiant** particles have been observed often in the Mediterranean but also up to 3500 (ultragiant) and 10000 km (giant) far from the source (e.g. van der Does et al., 2018; Marenco et al., 2018; Renard et al., 2018; Ryder et al., 2018)
  - Synergistic use of different techniques could fill the gaps and avoiding not accounting the impact on radiation budget of giant particles acting as CCN



Gaps identified - Semantics

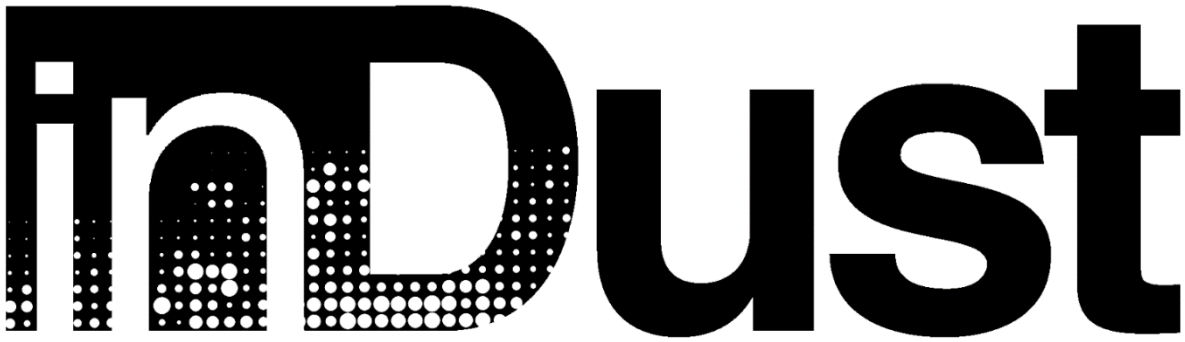
- Typing/speciation procedures - Needs for a typing baseline
  - Even if different the aerosol typing procedures typically classify aerosol in 4-6 types. Never exceeding 8 components.
  - Confusing and misleading nomenclature
  - Remote-sensing can provide optical constraints interpreted as particle size, shape, and indices of refraction
  - A further interpretative step, entailing additional assumptions, reports particle Source/Chemical Composition
  - Validation Data for aerosol type are very limited
  - Model simulations and in situ measurements can help

The inhomogeneity among satellite (and not only) aerosol typing schemes decreases fundamental long-term datasets (multi sensors) consistency

www.cost-indust.eu

#COSTinDust

International Network to Encourage the Use of Monitoring and Forecasting Dust Products



COST Action CA16202

Chair: Sara Basart (Spain, sara.Basart@bsc.es)
Vice-Chair: Slobodan Nickovic (Serbia)

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación

Our goals

- To establish a network involving research institutions, service providers and potential end users of
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- T
by the presence of high concentrations of airborne mineral dust.

inDust is looking for dust user-oriented services

inDust

COST Action CA16202

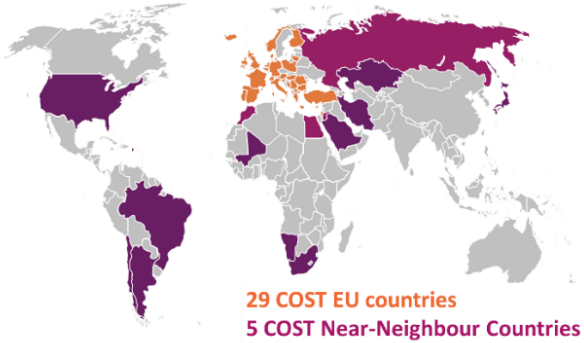
How

Build capacity to promote the use of the delivered dust products and to enhance the availibitiy appropriate products to assist affected socio-economic sector.

Train al staff to properly use the available observational and forecast products to design and implement preparedness and mitigation measures.

Enhance the cooperation with institutions from near-neighbouring and international partner countries in Northern Africa and the Middle East.

Network



29 COST EU countries
5 COST Near-Neighbour Countries
13 International Partner countries
2 International Organisations (WMO and ECMWF)

Researchers on:

- Satellite products
- Ground observations
- Dust forecasting models
- Climate
- Socio-economic impacts

Users:

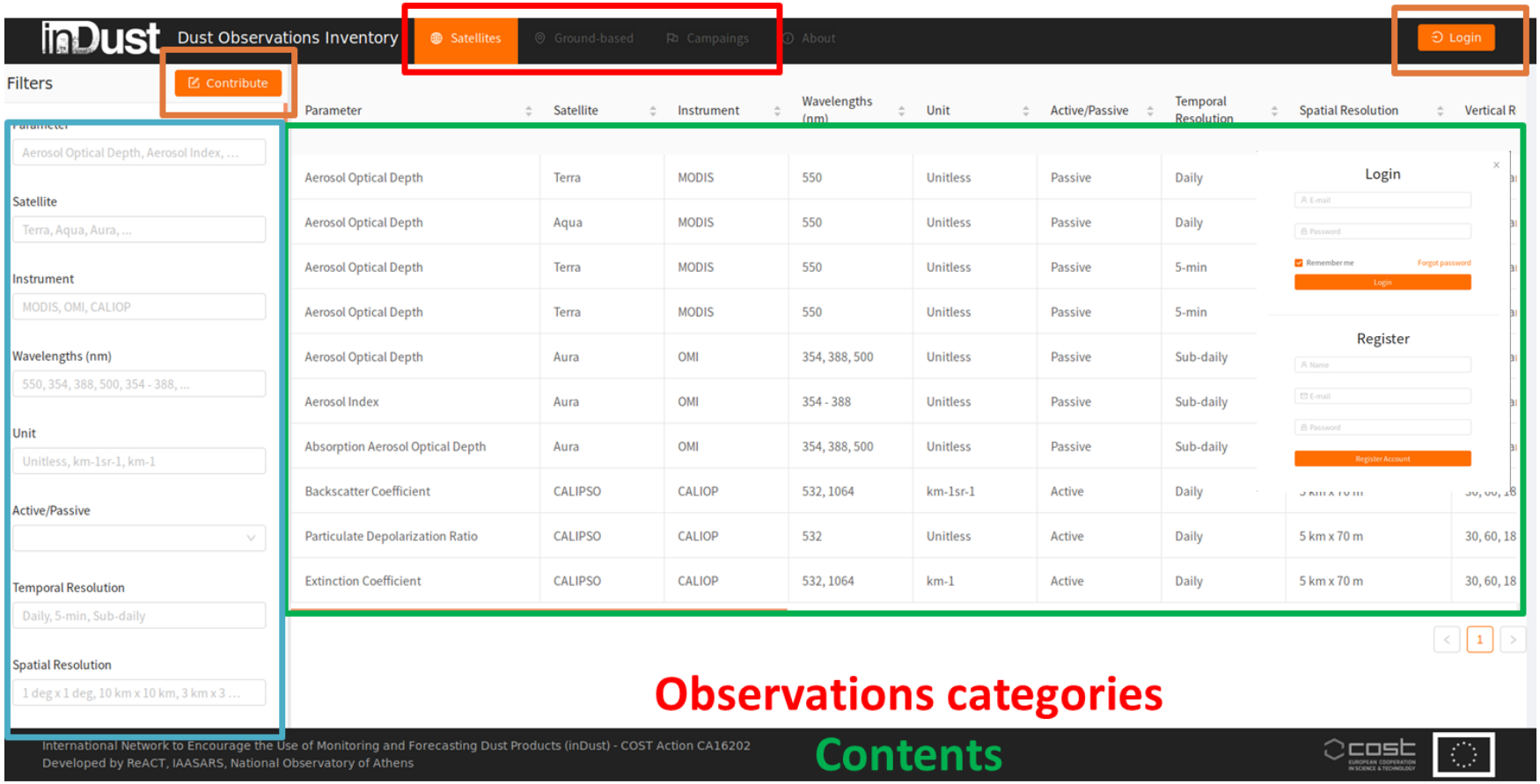
- Solar energy
- Aviation
- Air Quality
- Health
- International bodies (WMO, UNCCD, …)

Joint to us! http://www.cost-indust.eu/ #COSTinDust

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon H2020 Framework Programme of the European Union

Interactive catalogue



Observations categories

Contents

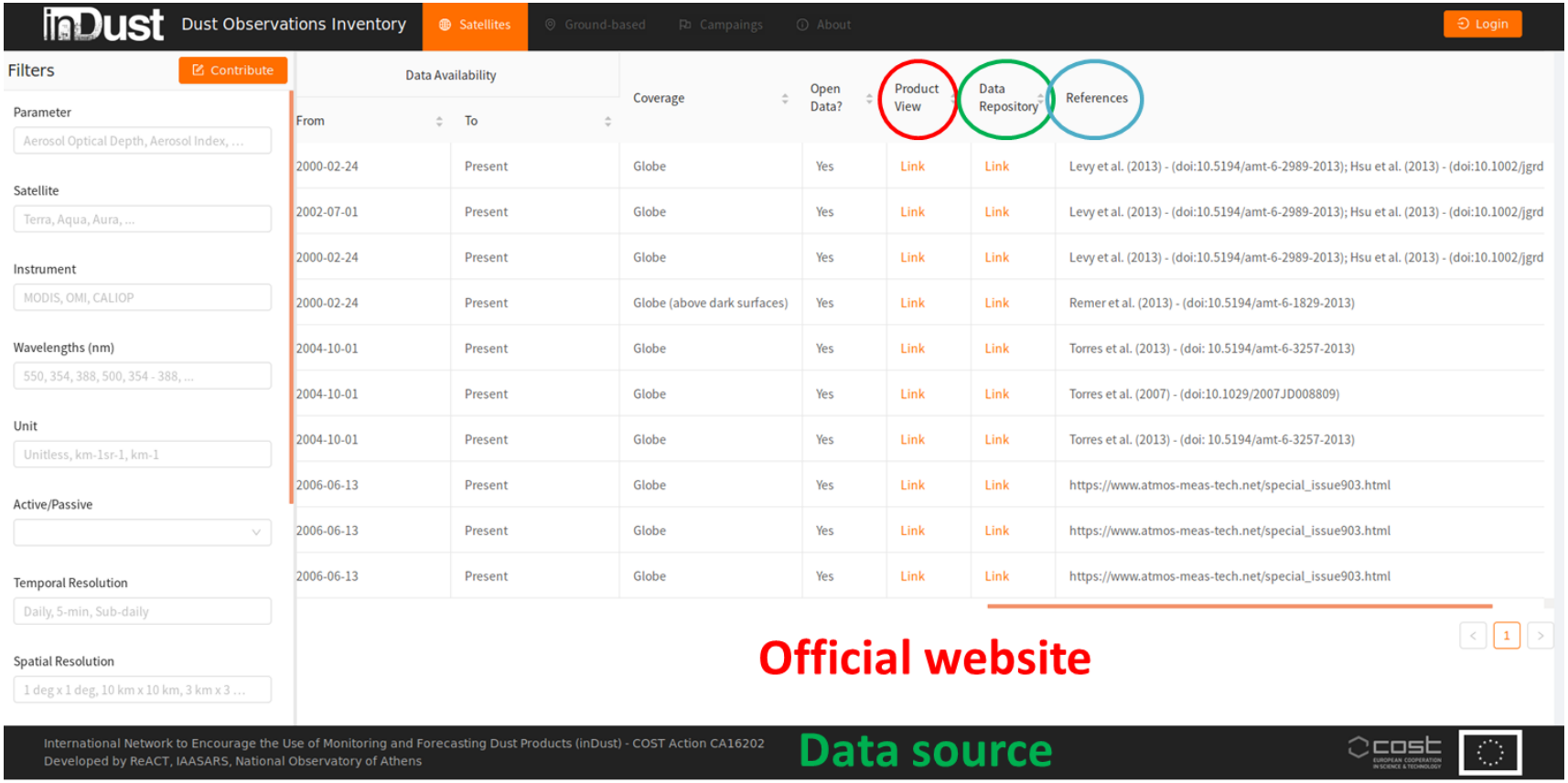
Search

New entry

http://react.space.noa.gr/indust

ReACT Remote sensing of Aerosols, Clouds and Trace gases

Interactive catalogue



Official website

Data source

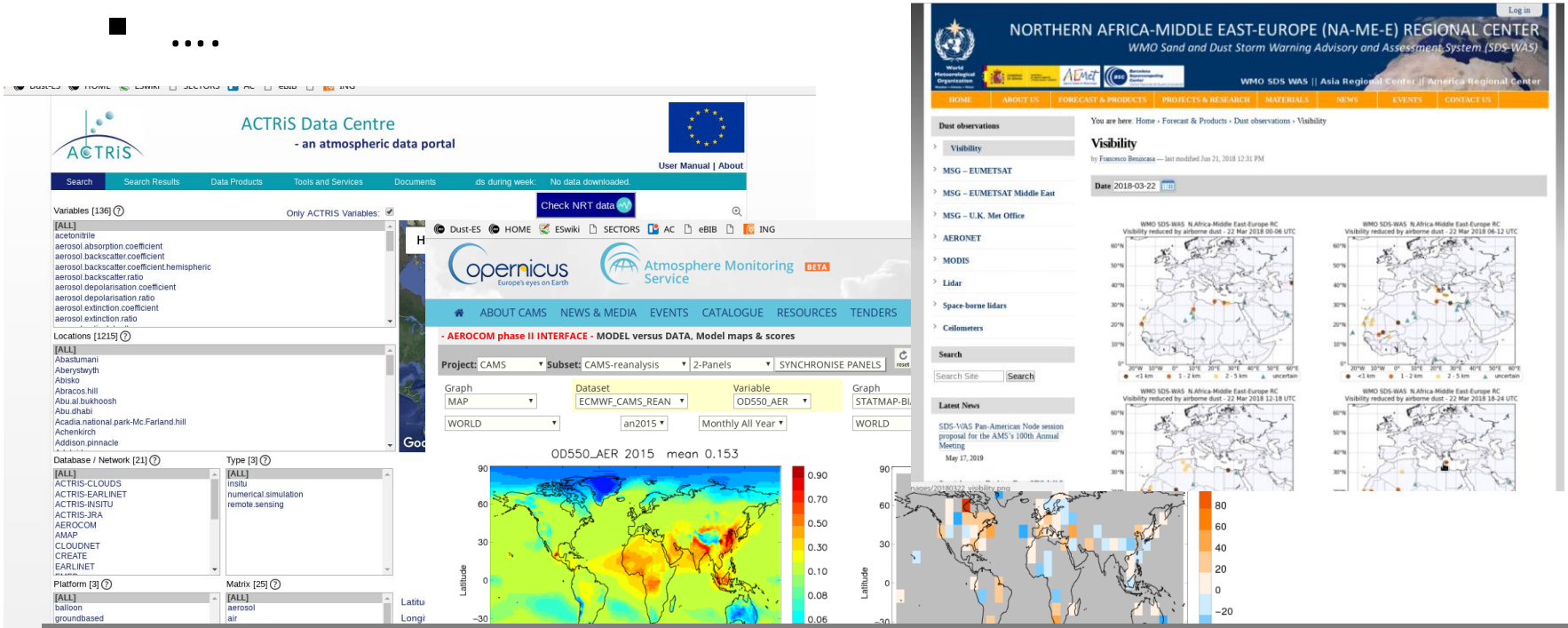
Literature

http://react.space.noa.gr/indust

ReACT Remote sensing of Aerosols, Clouds and Trace gases

Harmonised databases

- SDS-WAS NAMEE RC (https://sds-was.aemet.es/)
- AEROCOM (https://aerocom.met.no/)
- ACTRIS (http://actris.nilu.no/)
- ….



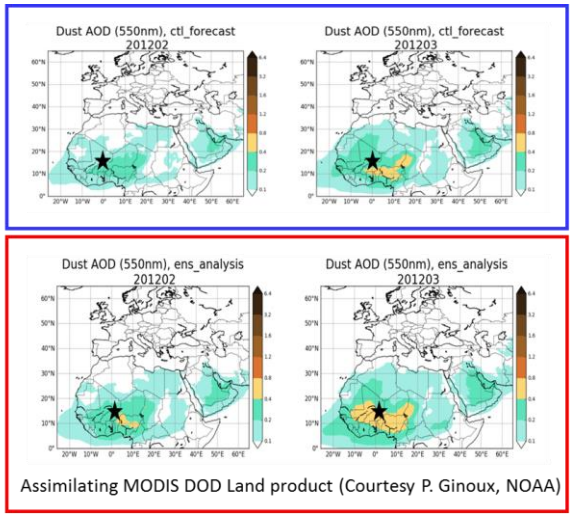
WMO has not any Vtable for aerosols

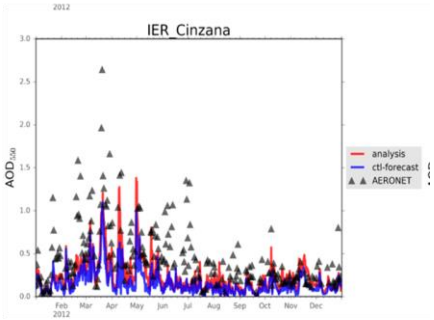
DustClim

ERA4CS European Research Area for Climate Services

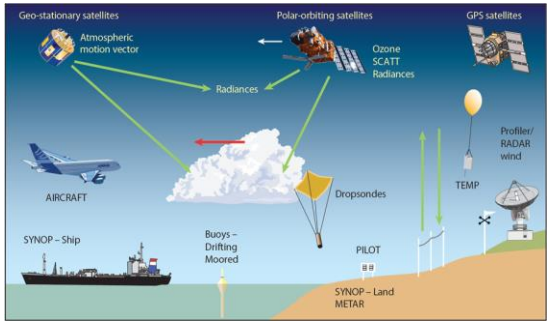
Dust Storms Assessment for the development of user-oriented **Clim**ate Services in Northern Africa, Middle East and Europe

REANALISYS based on the NMMB-MONARCH model: Climatology (2002-2016) of sand and dust storms (SDS) in high spatial-temporal detail (10km, 3-hourly)





(Courtesy E. Di Tomaso, BSC)



OBSERVATIONS: Our simulations, predictions and services are enhanced by/verified with an intensive use of in-situ and satellite filtered-dust observations

BSC AEMet Agencia Estatal de Meteorología cnrs

Harmonised databases

DustClim

Catalog http://earth.bsc.es/thredds_dustclim/catalog.html

Dataset

- eea/
- nasa-aeronet/
- earlinet/
- nasa/
- nmmb-bsc-ctm/
- nilu/
- noaa/

Initial TDS Installation at My Group see Info
THREDDS Data Server [Version 4.6.11 - 2017-12-04T16:22:46-0700] Documentation

Needs

- Long-term databases that includes information on:
  - Dust-cloud interactions (radiation budget, precipitations…)
  - IN and CCN measurements
  - Mineralogy
  - Dust and thunderstorms ….
- Typing/speciation procedures:
  - Making clear the variety of typing meanings, names, procedures
  - Review the differences and try to explain them
  - Identify gaps and further needs
  - Comparing algorithms
  - Overcoming limitation in reference datasets
- Harmonized information
  - Common standards and definitions
  - Include non-atmospheric communities

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EXCELENCIA SEVERO OCHOA

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DustClim

ERA4CS
European Research Area for Climate Services

Thank you

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