Modeling the impact of Dust on Air Quality at BSC: From R&D to operations
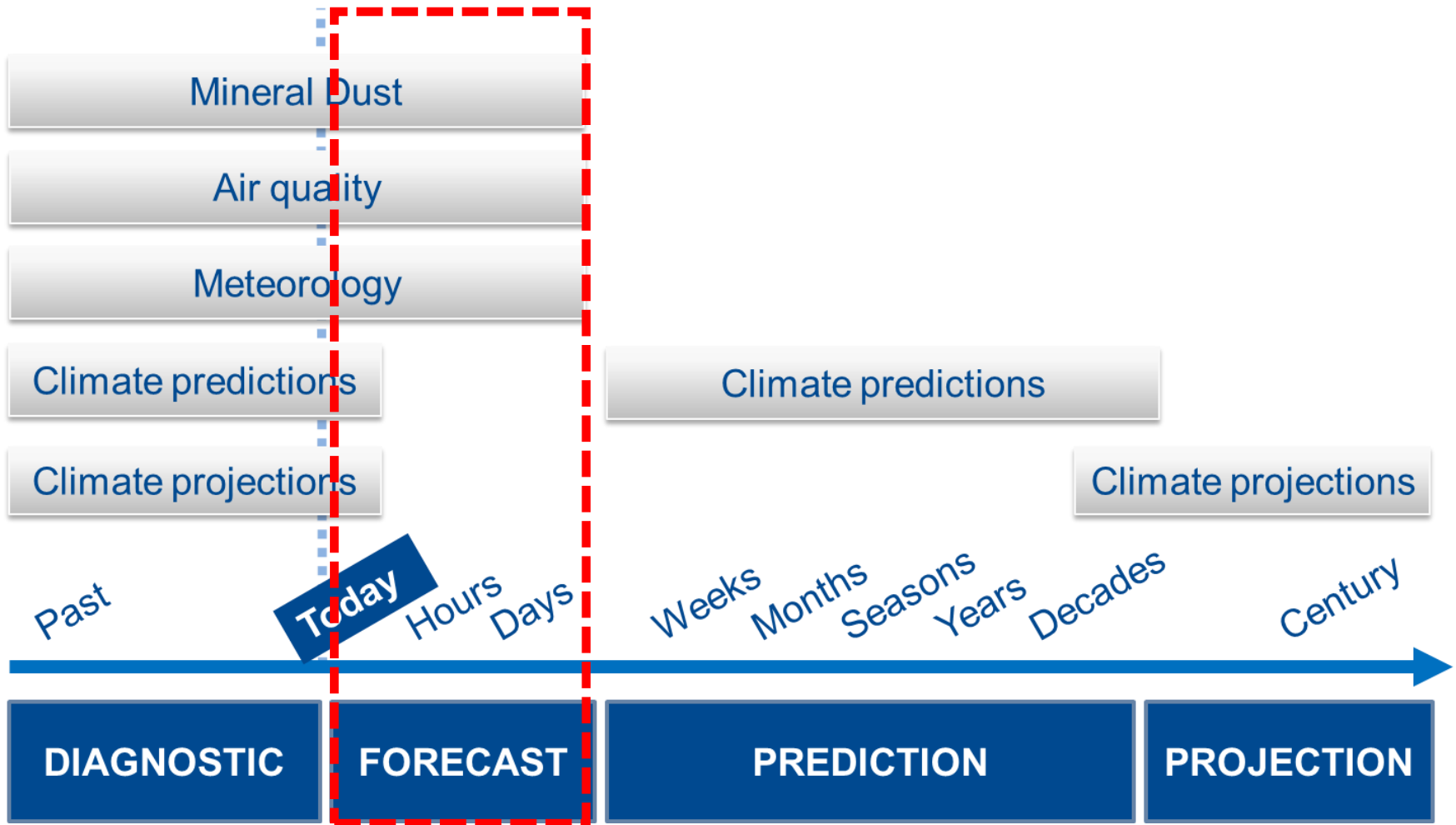
Sara Basart (sara.basart@bsc.es)

Atmospheric Composition Group, Earth Sciences Department

Barcelona Supercomputing Center (BSC)

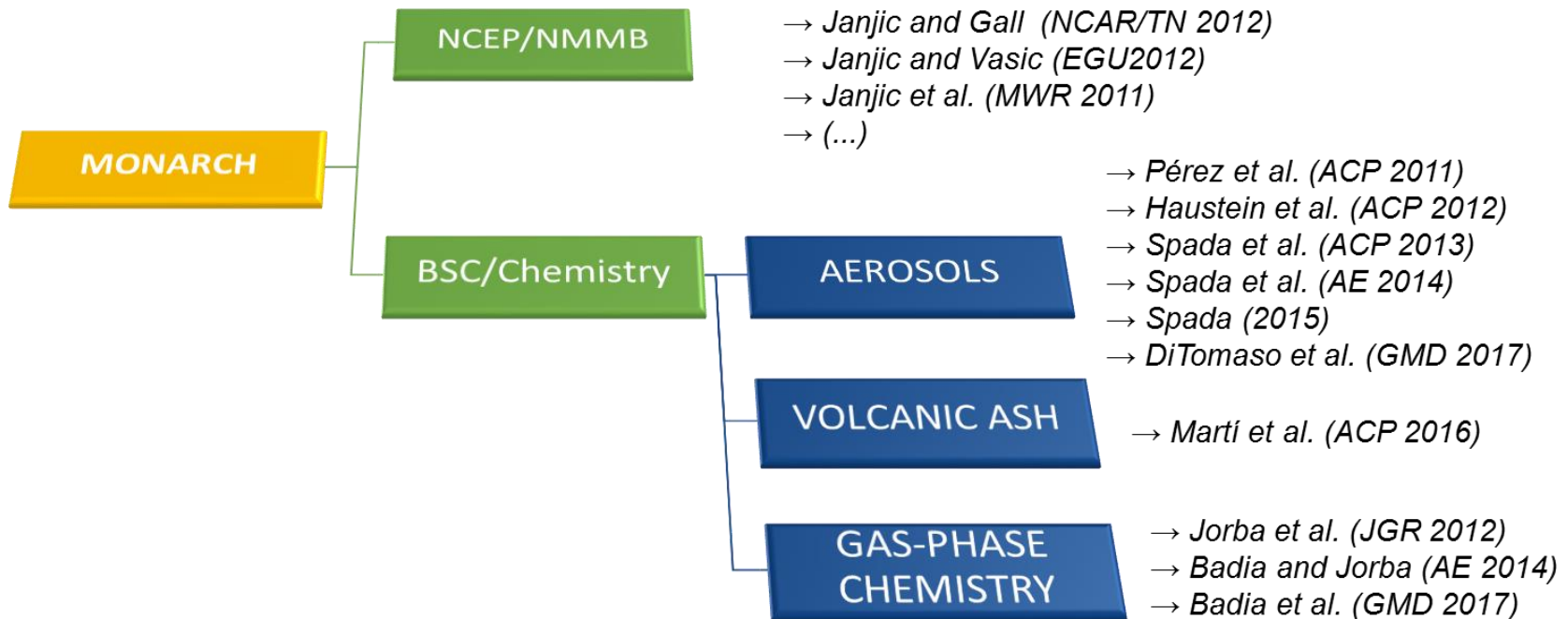*Seamless Prediction of Air Pollution for Africa: From Regional to Urban, 4-6 December, 2017, Pretoria, Sudafrica*

BSC Earth Sciences Department

Enviromental modelling and forecasting

Mineral Dust

Air quality

Meteorology

Climate predictions

Climate projections

Climate predictions

Climate projections

Past — Today — Hours — Days — Weeks — Months — Seasons — Years — Decades — Century

DIAGNOSTIC | **FORECAST** | **PREDICTION** | **PROJECTION**

Short-term forecast

2

The MONARCH model

· *Multiscale*: global to regional (up to 1km) scales allowed
· Fully *on-line* coupling: weather-chemistry feedback processes allowed
· Enhancement with a *data assimilation* system

→ *Janjic and Gall (NCAR/TN 2012)*
→ *Janjic and Vasic (EGU2012)*
→ *Janjic et al. (MWR 2011)*
→ *(...)*

→ *Pérez et al. (ACP 2011)*
→ *Haustein et al. (ACP 2012)*
→ *Spada et al. (ACP 2013)*
→ *Spada et al. (AE 2014)*
→ *Spada (2015)*
→ *DiTomaso et al. (GMD 2017)*

→ *Martí et al. (ACP 2016)*

→ *Jorba et al. (JGR 2012)*
→ *Badia and Jorba (AE 2014)*
→ *Badia et al. (GMD 2017)*

MONARCH - Emissions
HERMES 3.0: A multiscale emission modelling

- A **stand-alone tool** for simulating **emissions** on a **user-defined grid for global, regional and urban** air quality models.

- Users can **select, combine and scale multiple inventories** through a flexible configuration file to obtain **hourly gridded emissions**.

  ✓ *Spanish bottom-up emission inventory (street level emissions)*

Guevara et al., in preparation
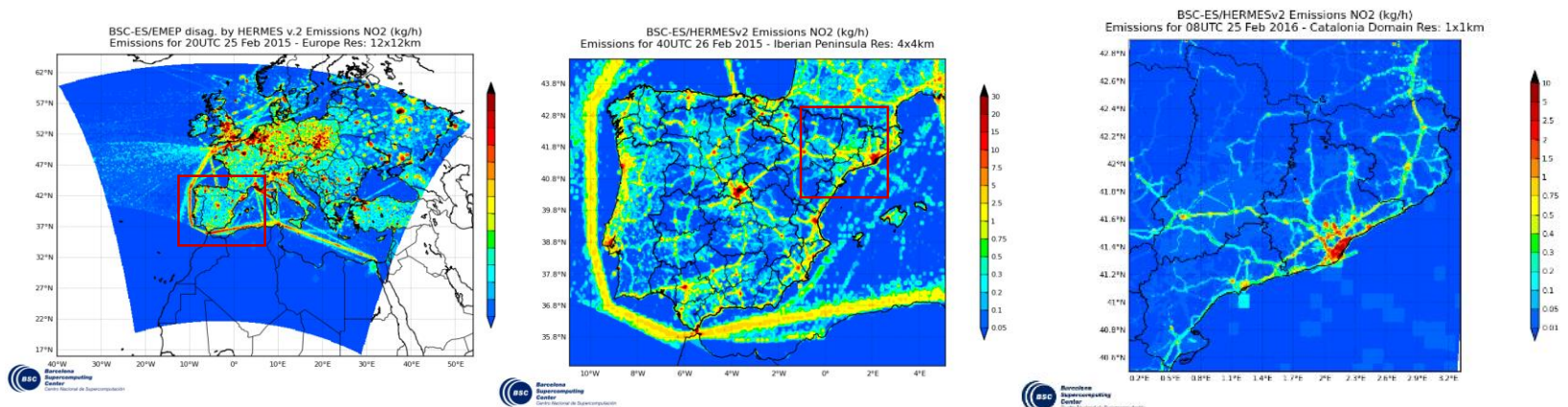
MONARCH - Dust Data Assimilation

MONARCH coupled with a Local Ensemble Transform Kalman Filter (**LETKF**) for the assimilation of aerosol optical depth observations
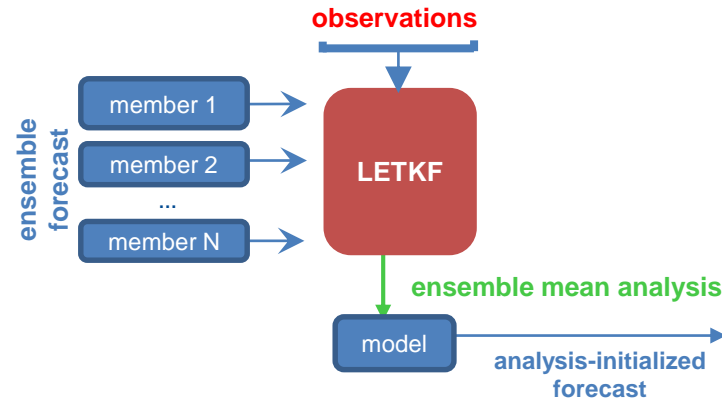
Mineral dust application
The ensemble forecast is based on uncertainties in the dust emission scheme

- vertical flux,
- size distribution at emission
- threshold on friction velocity
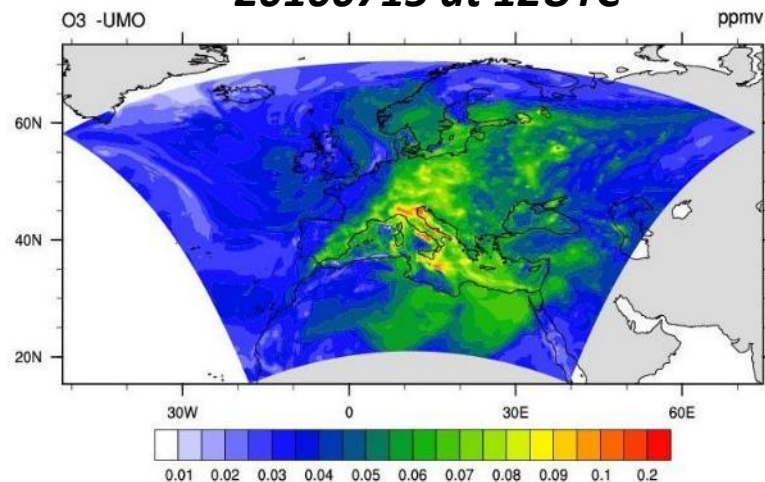
(Di Tomaso et al., GMD, 2017)

AERONET Validation
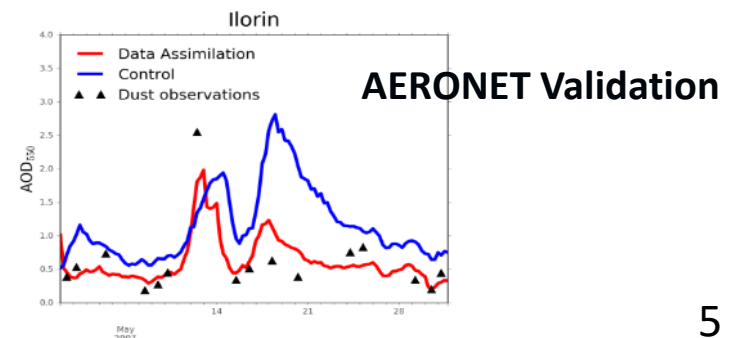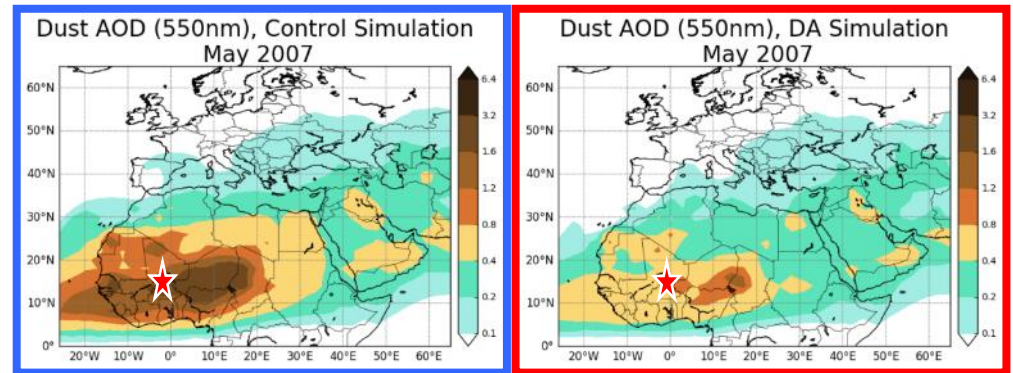
MONARCH - Operational forecasts

Global

NMMB-MONARCH-b015 AOD550
2015
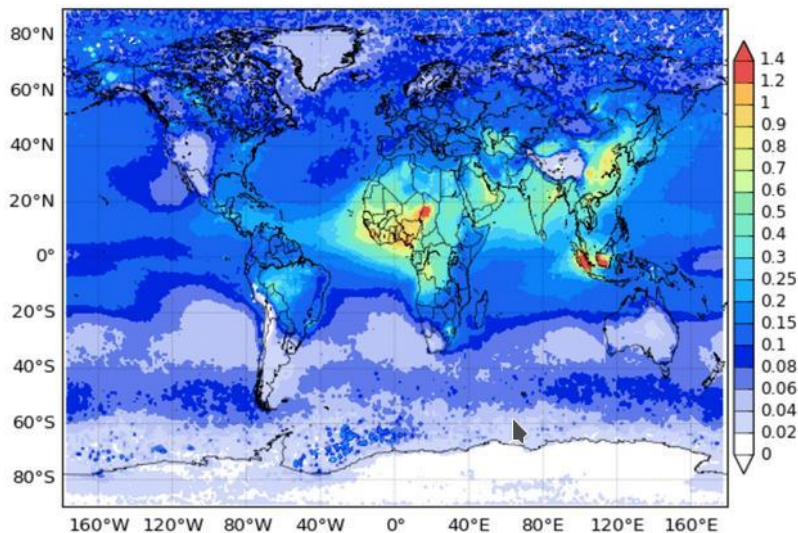
✓ *MONARCH contributes to the*
ICAP global operational
aerosol *multi-model ensemble*
http://icap.atmos.und.edu

Regional

20100715 at 12UTC

O3 -UMO   ppmv

Next year MONARCH
will be operational at
CALIOPE *(*www.bsc.es/caliope*)*
*AQ Forecast System for EU and **Spain***

Barcelona
Supercomputing
Center
Centro Nacional de Supercomputación

And more products in: http://www.bsc.es/ess/

WMO Dust Centers in Barcelona

SDS-WAS. North Africa, Middle East and Europe Regional Center.
*Started in 2010 – **Research***
http://sds-was.aemet.es

Barcelona Dust Forecast Center - *http://dust.aemet.es/*
NMMB/BSC-Dust   Res:0.1°x0.1°   Dust AOD
Run: 12h 11 MAY 2016   Valid: 12h 11 MAY 2016 (H+00)
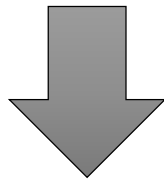
Barcelona Dust Forecast Center.
*Specialized WMO Center for mineral dust prediction. **Based on MONARCH***
*Started in 2014 - **Operations***
http://dust.aemet.es

@Dust_Barcelona

The WMO SDS-WAS project

OBJECTIVES:

- Identify and improve products to monitor and predict atmospheric 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 project

The SDS-WAS Regional Nodes and Centers
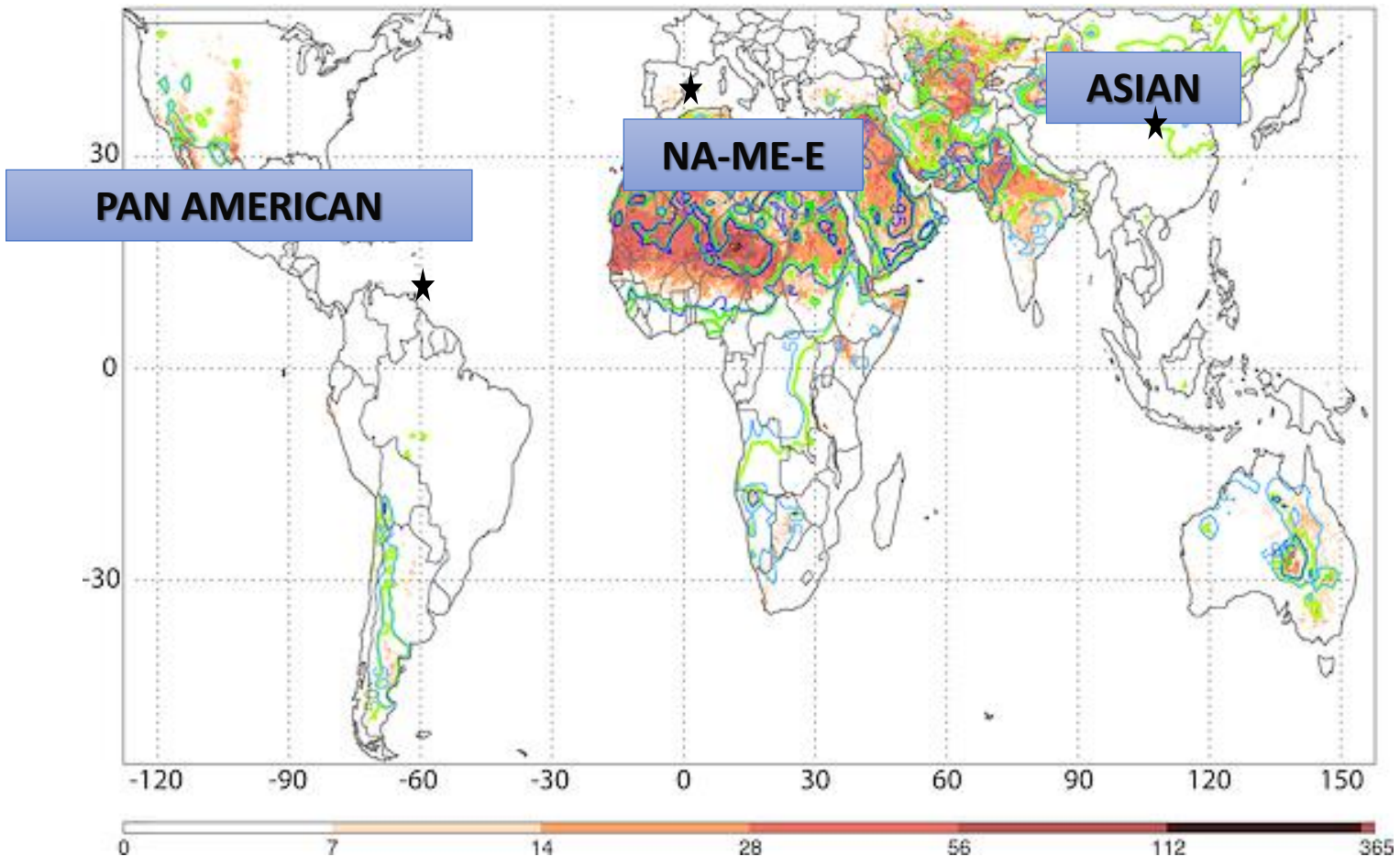
Annual mean frequency distribution of M-DB2 (2003–2009) DOD > 0.2 (red), TOMS (1980–1991) aerosol index ≥ 0.5 (blue), and OMI (2004–2006) aerosol index ≥ 0.5 (green). The isocontours of TOMS and OMI have been removed over oceans for clarity. Extracted from Ginoux et al. (2012, Rev. Geophys.)

SDS-WAS NAMEE RC
http://sds-was.aemet.es

SDS-WAS NAMEE: Dust Observations

7 March 2015
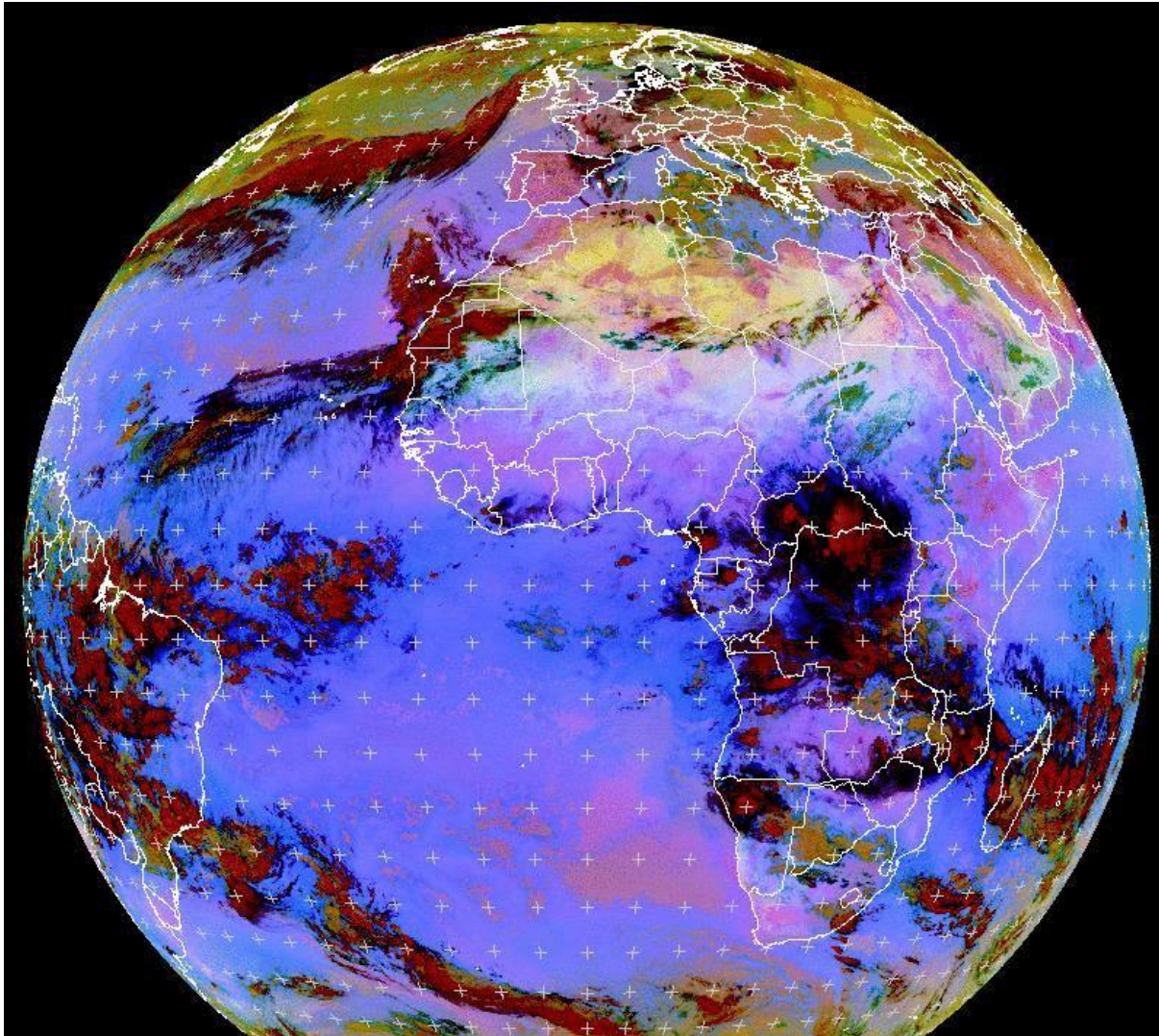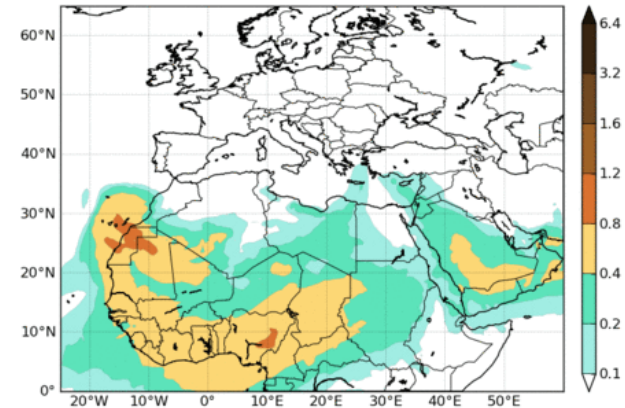

WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust AOD
Run: 12h 07 MAR 2015 Valid: 12h 07 MAR 2015 (H+00)

NOTE: There is available an historical archive of the MSG RBG dust products.

MET10 RGB-Dust 2015-03-07 23:00 UTC

Dust forecasts: SDS-WAS Multi-model

SDS-WAS product

12 Global – Regional models
(from ~ 100 to 10 km)

Barcelona
Supercomputing
Center
Centro Nacional de Supercomputación

Dust Surface Conc.
from 15-Oct-2017 12:00 to 18-Oct-2017 00:00

MEDIAN

http://sds-was.aemet.es/

Dust forecasts: SDS-WAS Multi-model

SDS-WAS product

12 Global – Regional models
(from ~ 100 to 10 km)

Barcelona
Supercomputing
Center
Centro Nacional de Supercomputación

AEMet
Agencia Estatal de Meteorología
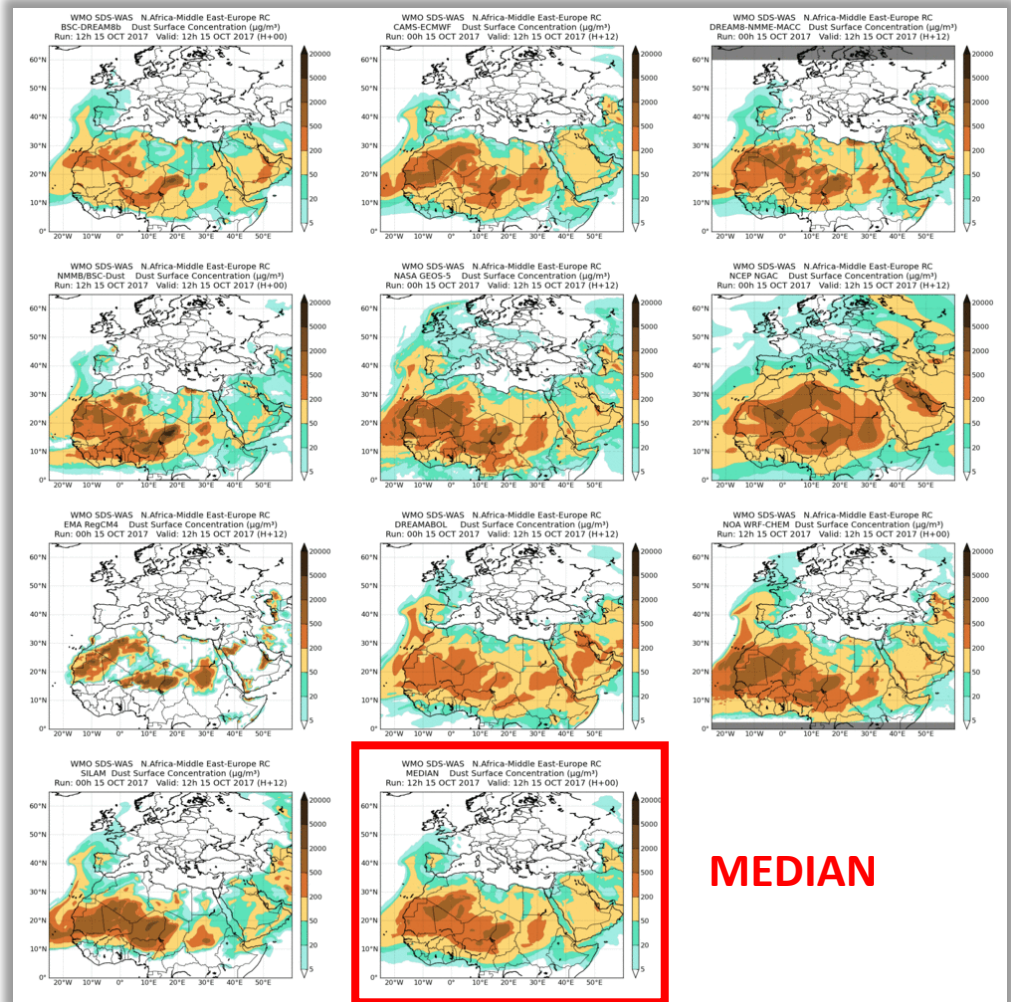
Dust Optical Depth at 550nm
from 15-Oct-2017 12:00 to 18-Oct-2017 00:00

MEDIAN

http://sds-was.aemet.es/
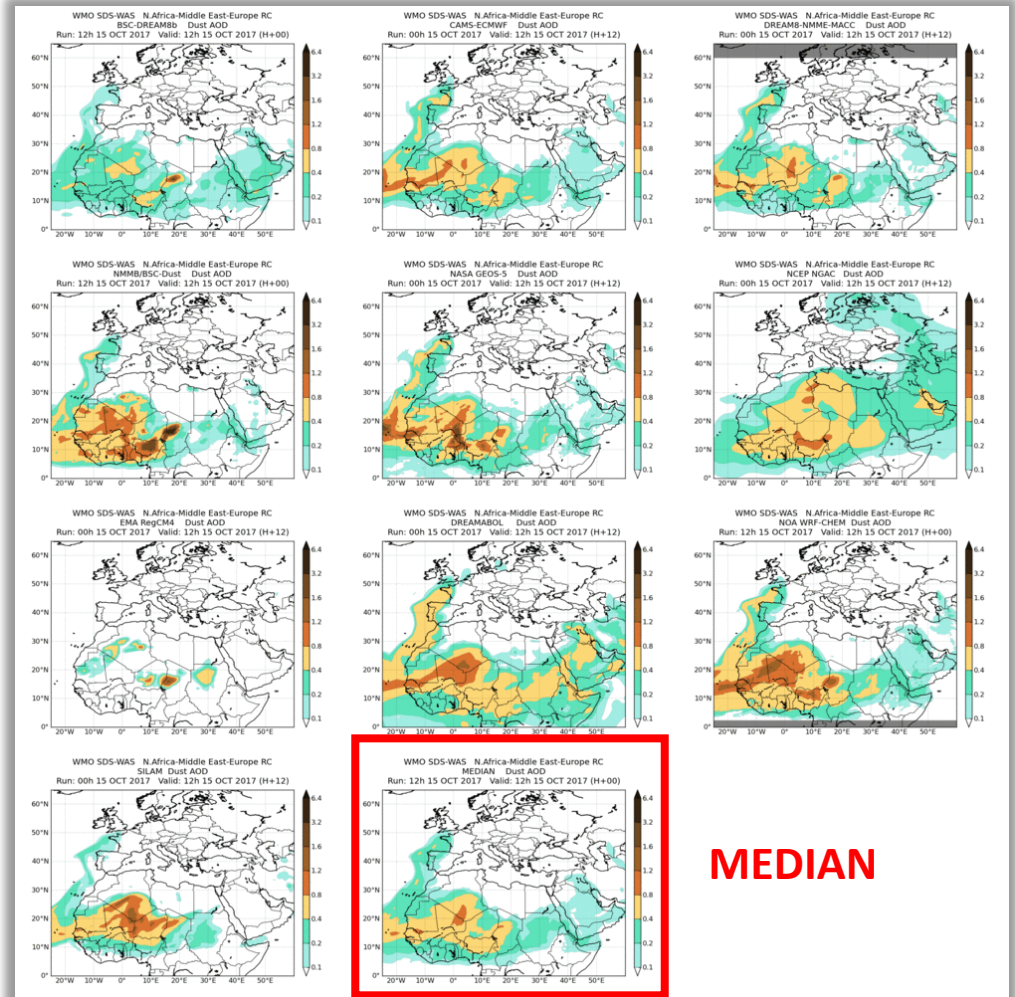
SDS-WAS NAMEE: DOD Model Evaluation

- **Evaluation with AERONET data**
  - Graphical NRT Evaluation by site
  - Evaluation scores monthly/seasonal/annual by regions and sites
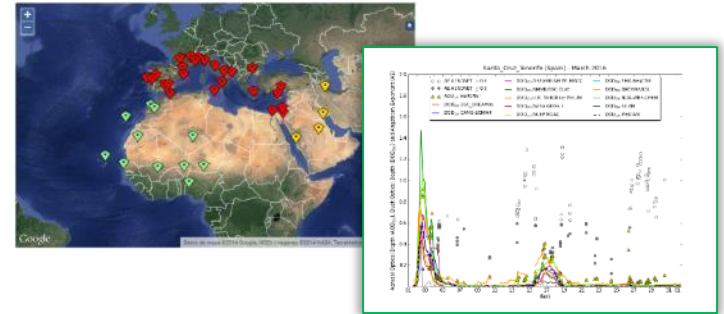
- **Evaluation with MODIS data onto the Atlantic**
  - Evaluation scores monthly/seasonal/annual

- **Evaluation of dust models with MODIS Deep Blue retrievals**
 - Evaluation scores monthly/seasonal/annual

http://sds-was.aemet.es/forecast-products/forecast-evaluation
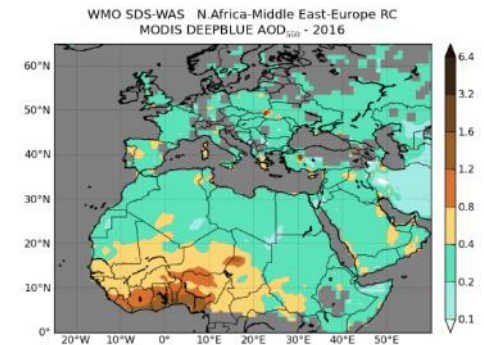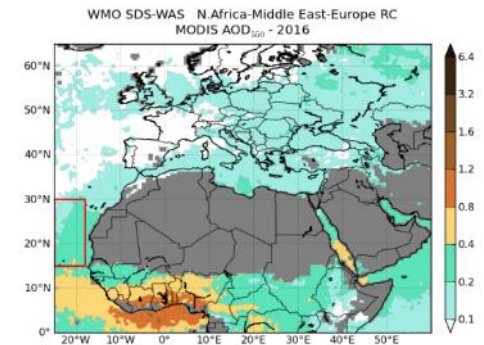
Ongoing research lines on dust modelling

Towards **better dust forecasts**:

- Identification of **dust sources**

  → *Natural vs Anthropogenic*

  → *Mineralogy*

- Predict **convective dust storms** - Haboobs

  → *Parameterized vs Explicit convection*

- **Data Assimilation**

  → *Reanalysis are essential to overcome the lack of observations in Africa and the Middle East*
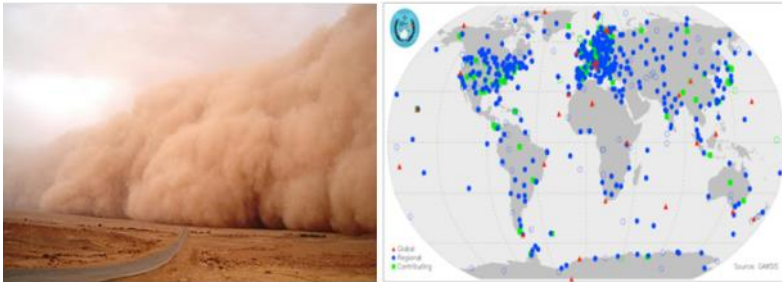
- **Multi-model ensembles**

(Ginoux et al., 2012)

Tehran, 2 June 2014

GAW stations
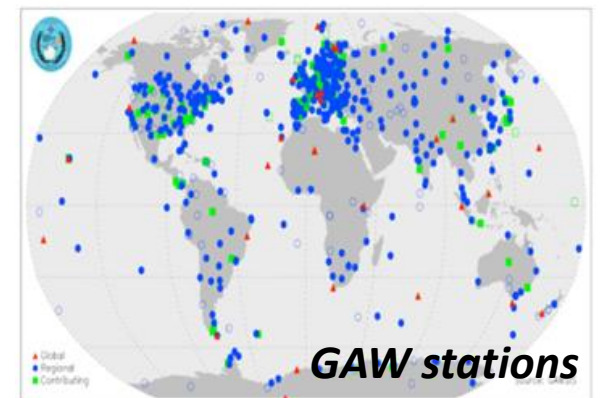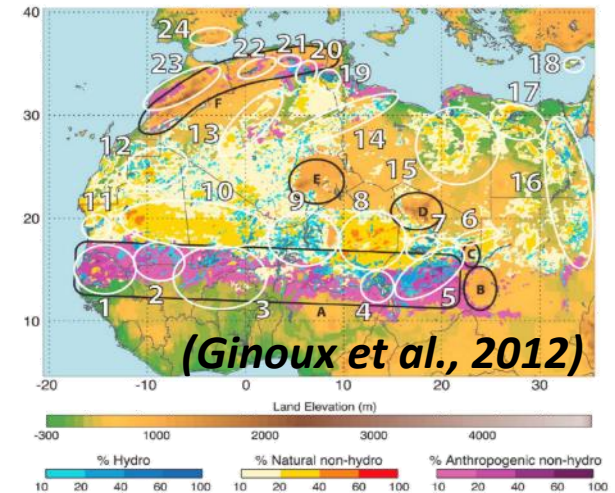
Ongoing projects to design dust services

DustClim

ERA4CS — European Research Area for Climate Services

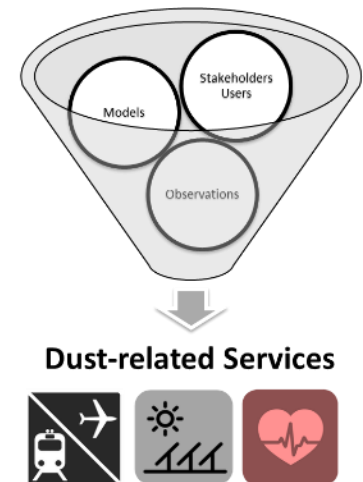- SDS is a serious hazard
- Lack of dust observations, particularly in Africa

GOAL: Develop **dust-related services** to specific socio-economic sectors based on an advanced **dust reanalysis**

InDust

COST — EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

INTERNATIONAL NETWORK TO ENCOURAGE THE USE OF MONITORING AND FORECASTING DUST PRODUCTS

http://www.cost.eu/COST_Actions/ca/CA16202

- 4-years project
- 30 participating countries
- Chair S. Basart / Vice-Chair S. Nickovic

Next dust events

Updated in the SDS-WAS website: ***http://sds-was.aemet.es/***

Thank you

Acknowlegde to Carlos Pérez García-Pando,, Francesco Benincasa, Enza Di Tomaso, Oriol Jorba, Marc Guevara, Maria Teresa Pay, Kim Serradell, Lluís Vendrell, Enric Terradellas, as well as AERONET, MODIS, U.K. Met Office MSG, MSG Eumetsat and EOSDIS World Viewer principal investigators and scientists for establishing and maintaining data used in the present contribution. Also special thank to all researchers, data providers and collaborators of the WMO SDS-WAS NA-ME-E Regional Node.

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