DustClim

ERA4CS European Research Area for Climate Services

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BSC Barcelona Supercomputing Center
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A 10-year regional reanalysis of desert dust aerosol at high spatial resolution

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EGU21-11644 vPICO: Fri, 30 Apr, 09:00–12:30 (CEST)

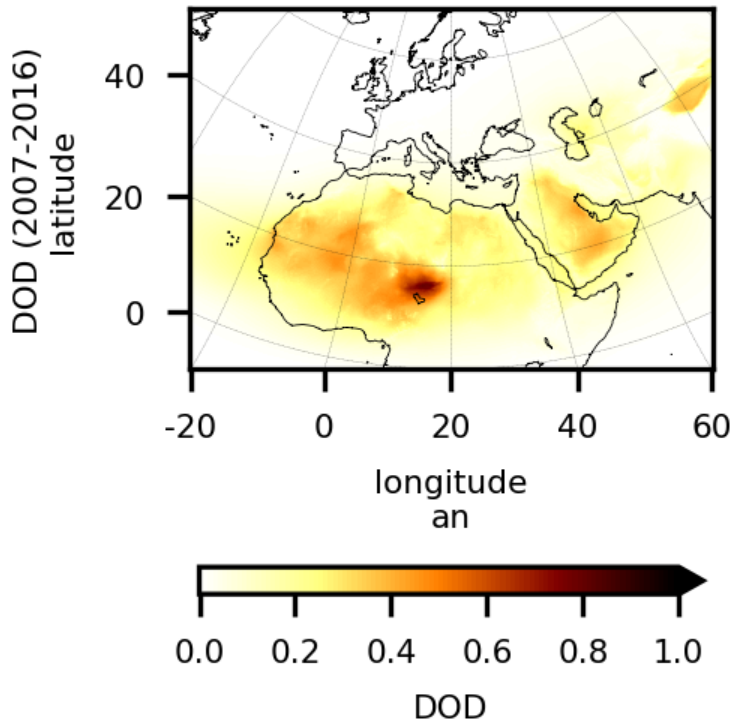
A novel regional desert dust reanalysis

We have produced a complete and consistent, four dimensional, regional reconstruction of desert dust in a recent decade

10-year published

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

- ✓Unprecedented **high resolution**
- ✓Specific **dust observational constraint**
- ✓**Uncertainty estimates** in the reanalysis output
- ✓Linked to specific **air quality and climate services**



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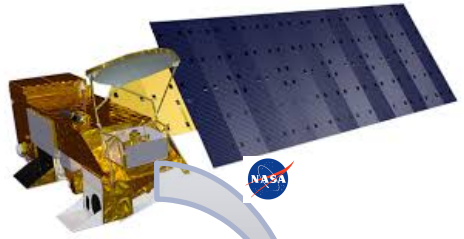
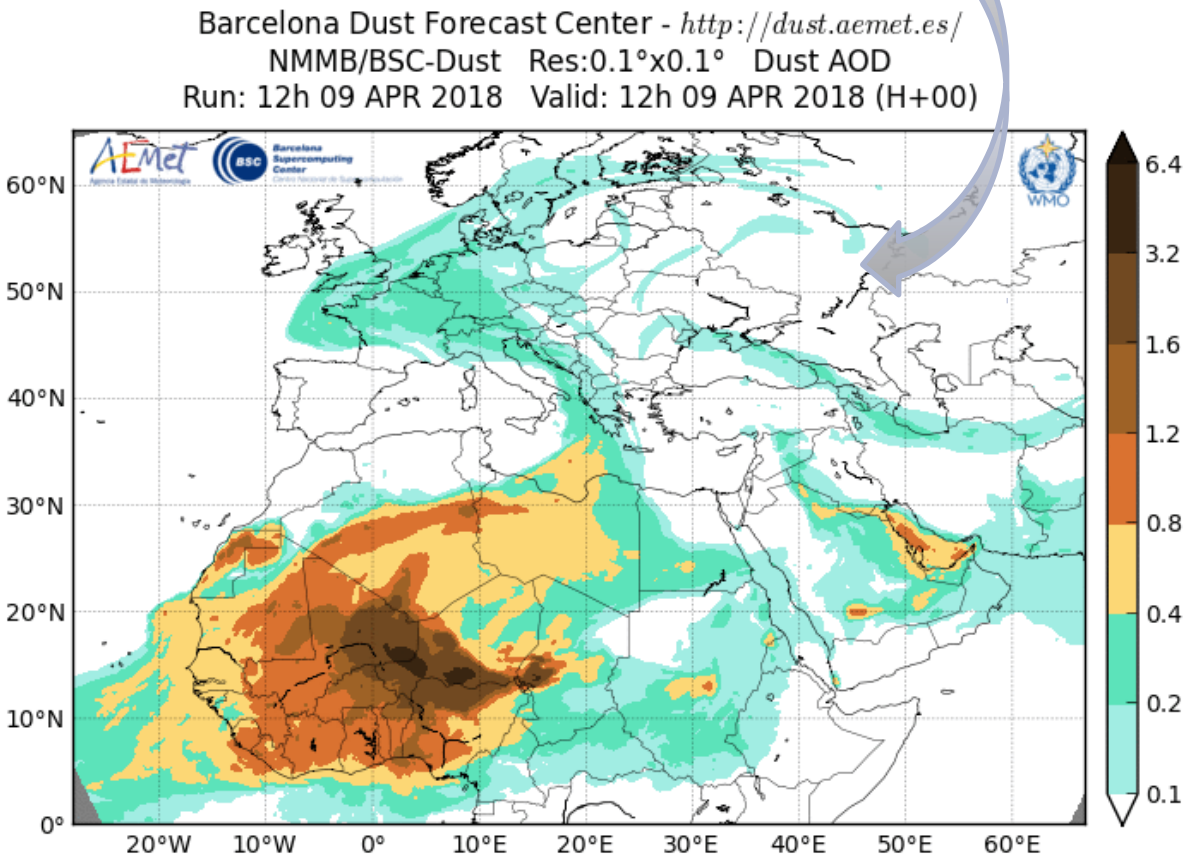
Reanalysis production: the methodology



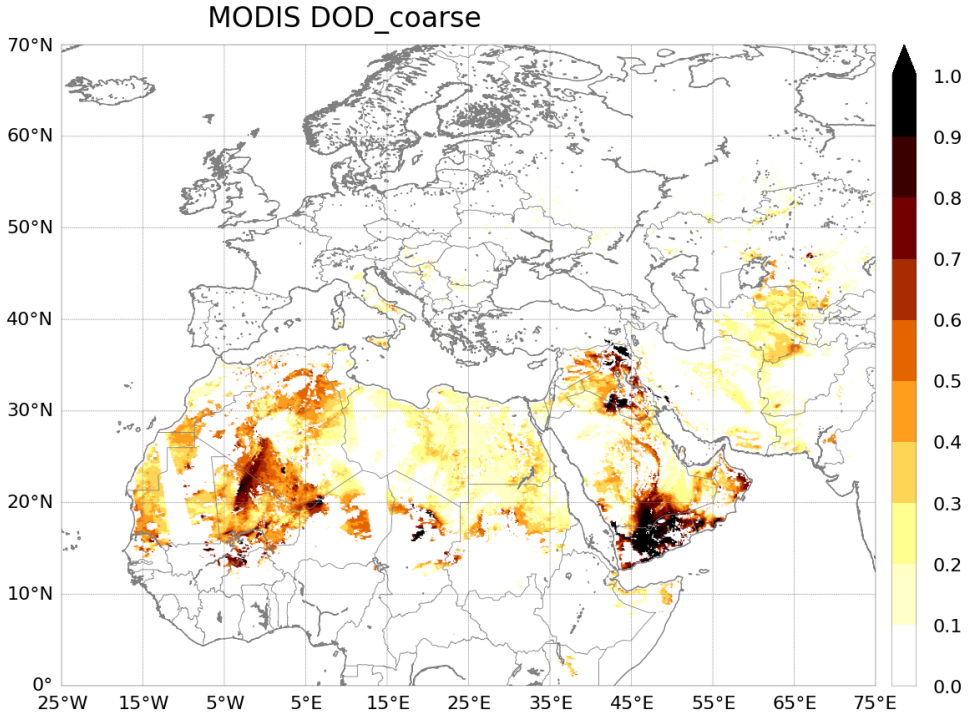


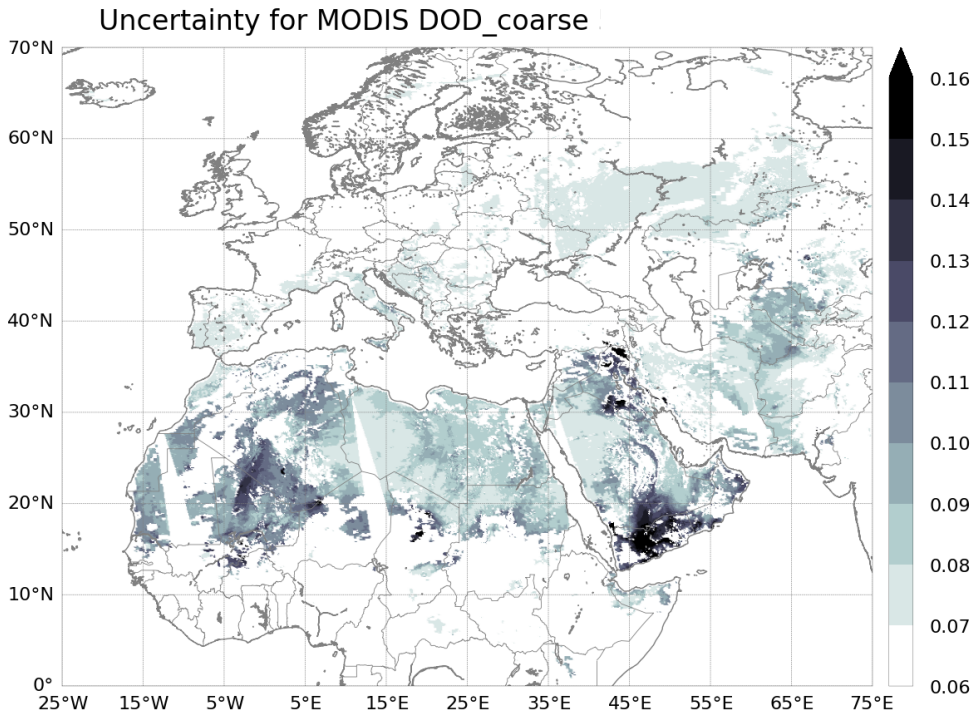
Assimilated observations:
satellite retrievals of coarse dust optical depth

Assimilation scheme:
Local Ensemble Transform Kalman Filter

Chemical weather modelling system:
Multiscale Online Non-hydrostatic AtmospheRe Chemistry (MONARCH) ensemble forecast

Assimilated observations: a daily sample





- coarse-mode dust optical depth retrieved from MODIS Deep Blue L2 aerosol products (Ginoux et al. 2010, 2012; Pu and Ginoux 2016)
- observation uncertainty estimated using a prognostic approach (Sayer et al. 2014)

~120,000 observations assimilated daily (after quality control)

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Characteristics of the reanalysis data set

Data set length: 10 years (**2007-1016**)

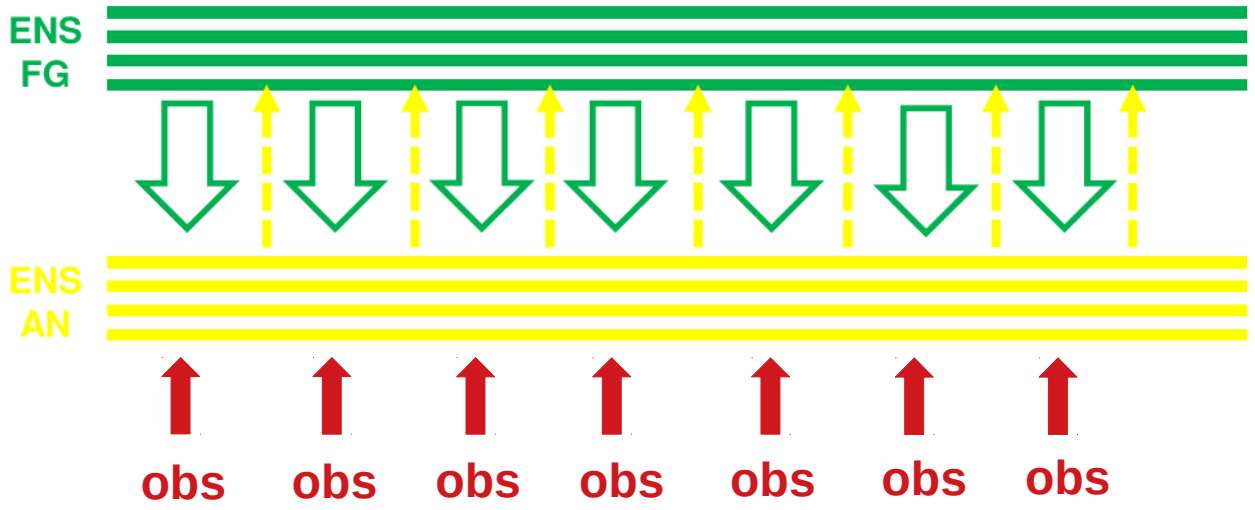
Geographical domain: regional (**Northern Africa, the Middle East and Europe**)

Horizontal resolution: **0.1°** lat × **0.1°** lon

Output frequency**: 3-hourly** and climatology values (**monthly, seasonal, annual**)

Type of fields: **analysis (AN)** and/or **first-guess (FG)**

Ensemble statistics: ensemble (ENS) **mean, max, median, std**



The first-guess is an analysis-initialized forecast

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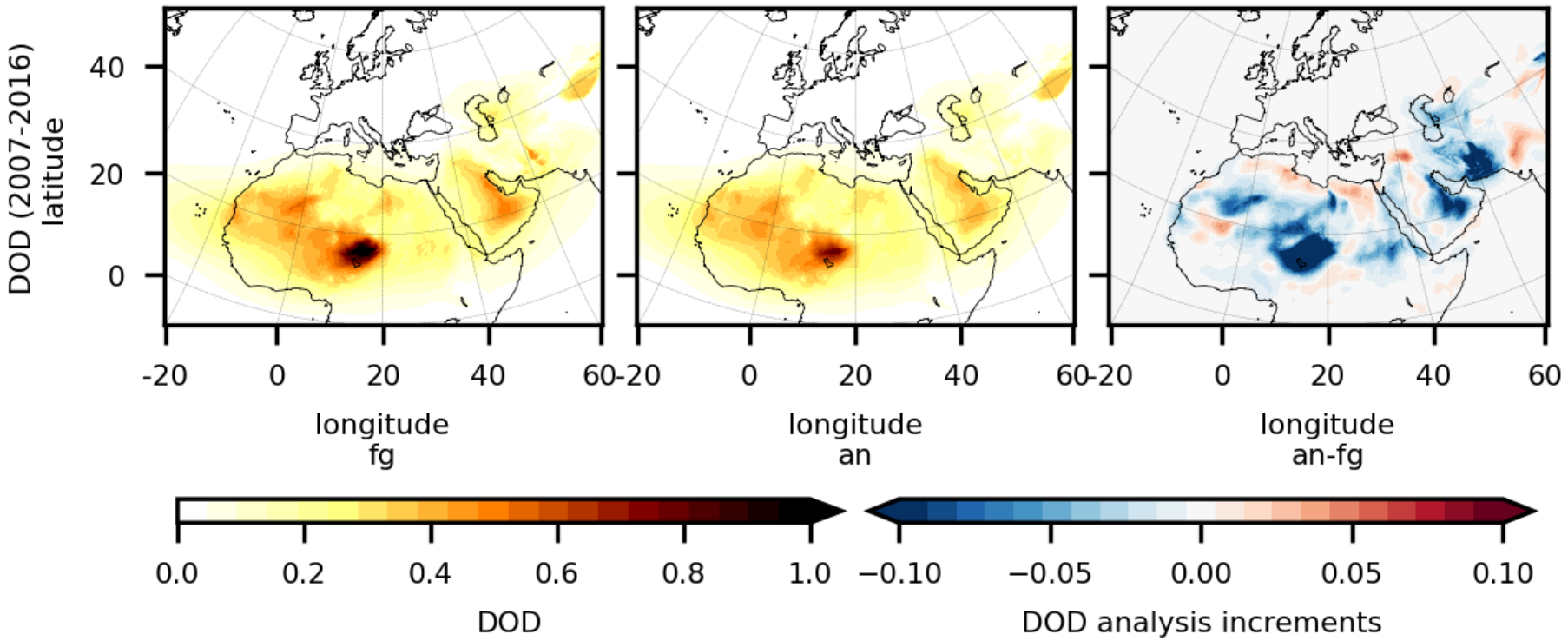
Reanalysis data set

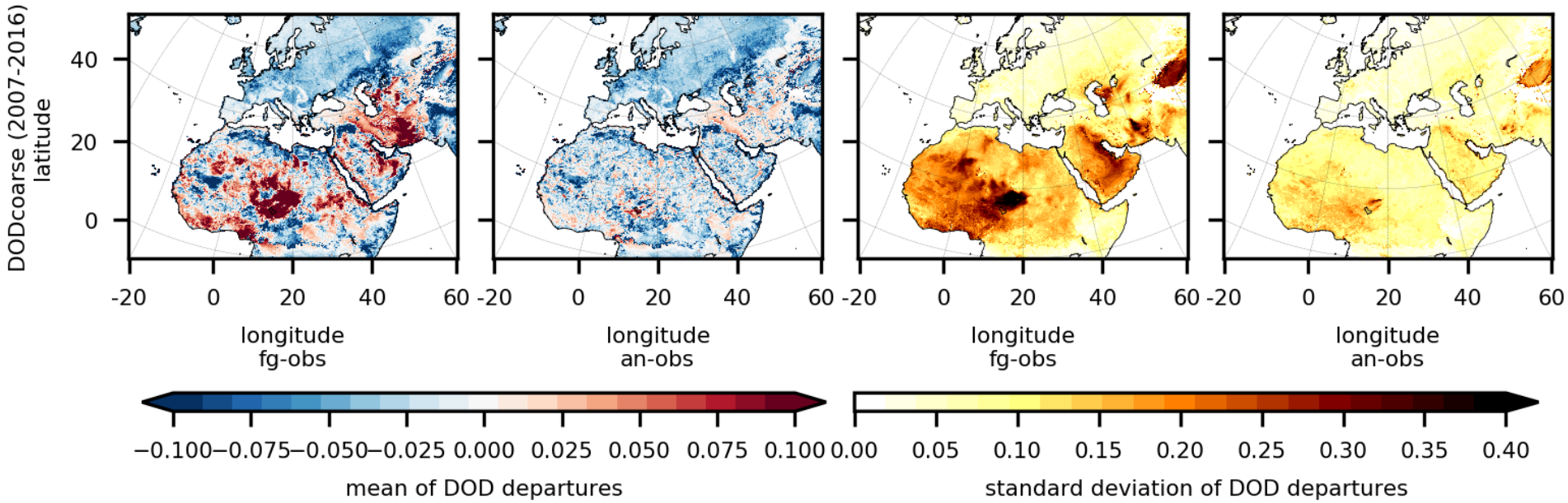
variable description	unit	spatial dimension	description of dust particle size	first-guess	analysis
dust mass concentration	$kg\ m^{-3}$	3D	8 bins	x	x
dust extinction coefficient	m^{-1}	3D	total	x	x
mid-layer height	m	3D	NA	x	
dust dry deposition flux	$kg\ m^{-2}\ s^{-1}$	2D	8 bins	x	
dust wet deposition flux	$kg\ m^{-2}$	2D	8 bins	x	
dust mass surface concentration	$kg\ m^{-3}$	2D	8 bins	x	x
dust loading	$kg\ m^{-2}$	2D	8 bins	x	x
dust optical depth	*unitless*	2D	total	x	x
coarse dust optical depth	*unitless*	2D	total	x	x
dust surface extinction coefficient	m^{-1}	2D	total	x	x
direct normal irradiance	$W\ m^{-2}$	2D	NA	x	
global horizontal irradiance	$W\ m^{-2}$	2D	NA	x	

Observation increments



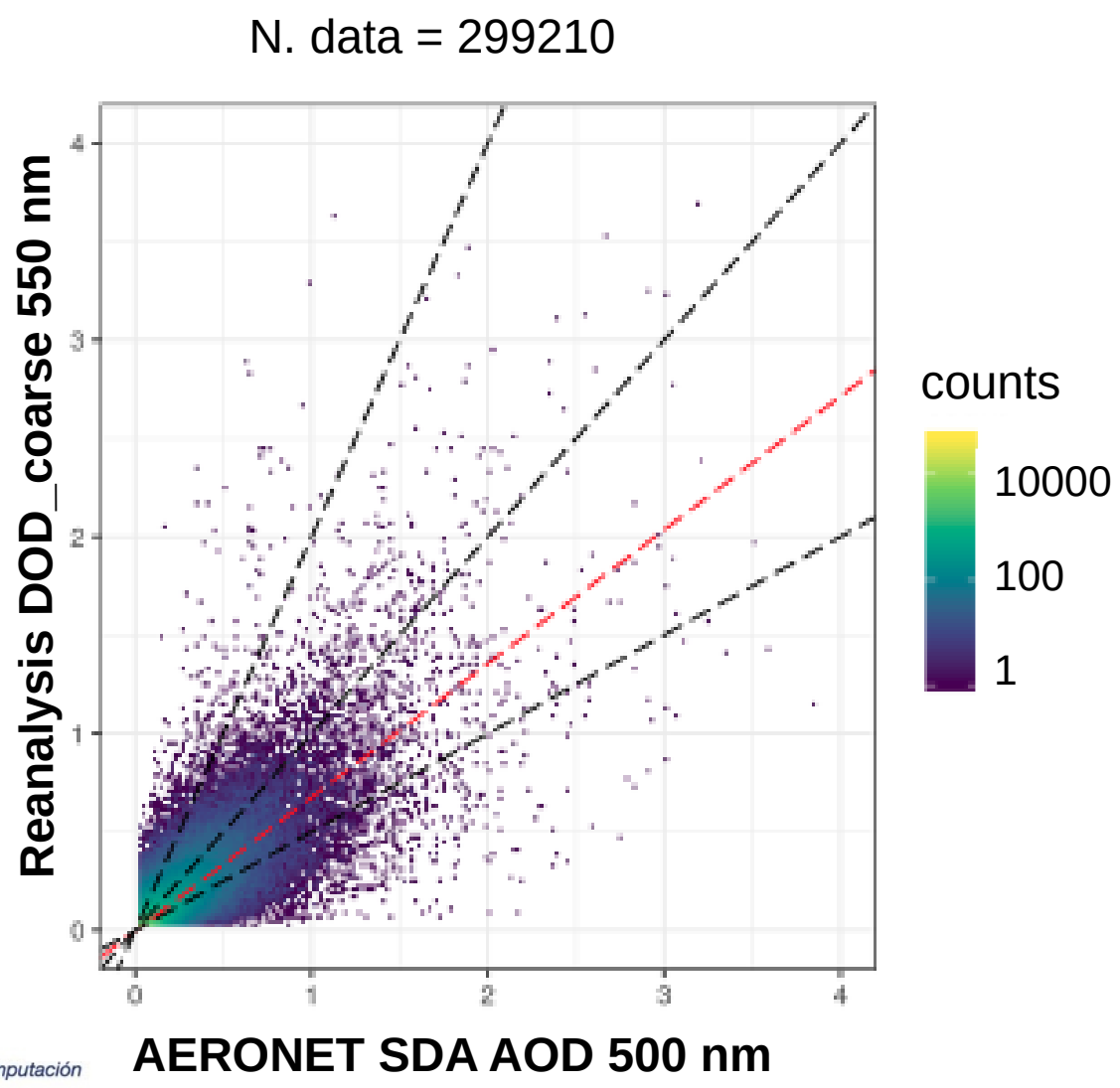
- **Systematic negative corrections** linked to overestimation of the major sources' strength in Africa and the Middle East (the Bodélé depression in Chad, in the Saudi Arabia lowlands and in the Balochistan region of south-western Asia)
- **Positive mean increments** over the Thar desert, in the north part of Syria, inland from the Mediterranean sea in the north of Africa, and between Mauritania and Mali might indicate an underestimation of source strength or issues with the the transport downwind from the sources

Departures from assimilated observations



- The **reduction of the standard deviation** of the analysis departures compared to the first-guess proves the consistency of our assimilation procedure
- The **positive mean departures decrease** considerably in the analysis compared to the first-guess
- Some of the **negative mean departures** remain unchanged: lower DOD not analyzed efficiently or contamination of other aerosols than dust in the observations

Validation against independent observations



Reference data set:
AERONET v3
SDA retrievals
Level 2.0

Bias = -0.05

RMSE = 0.12

Pearson coef. = 0.81

Pilot services based on the reanalysis

The reanalysis variables have been used to produce dust-relevant information for different sectors and related validation exercises:

- **EGU21-14490: vPico Mon 26 Apr 15:43–15:45**

AS1.27 Convective and Volcanic Clouds (CVC) and possible impact on aviation management

Sara Basart et al.: *Operating in risky sand and dust storm environments in Northern Africa, the Middle East and Europe: a portfolio of aviation climate services*

- **EGU21-12819: vPico Thu 29 Apr 11:24–11:26**

CL2.1 Climate Services - Underpinning Science

Athanasios Votsis et al.: *Addressing the impacts of sand and dust storms in North Africa, the Middle East and Europe for air quality, aviation and solar energy: the DustClim approach to climate services*

Acknowledgments

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Thank you

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