Models evaluation

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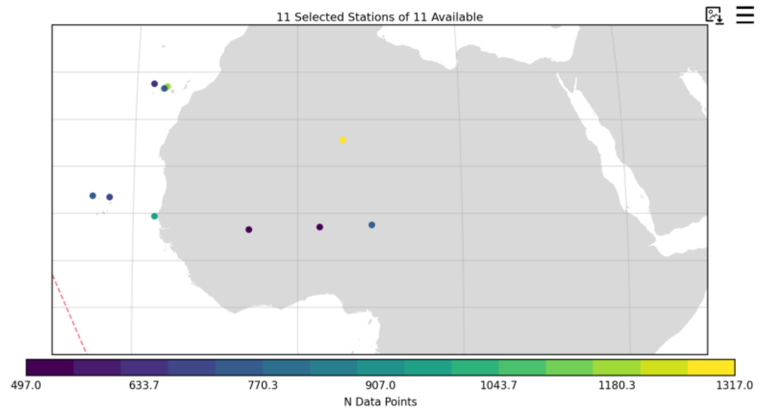
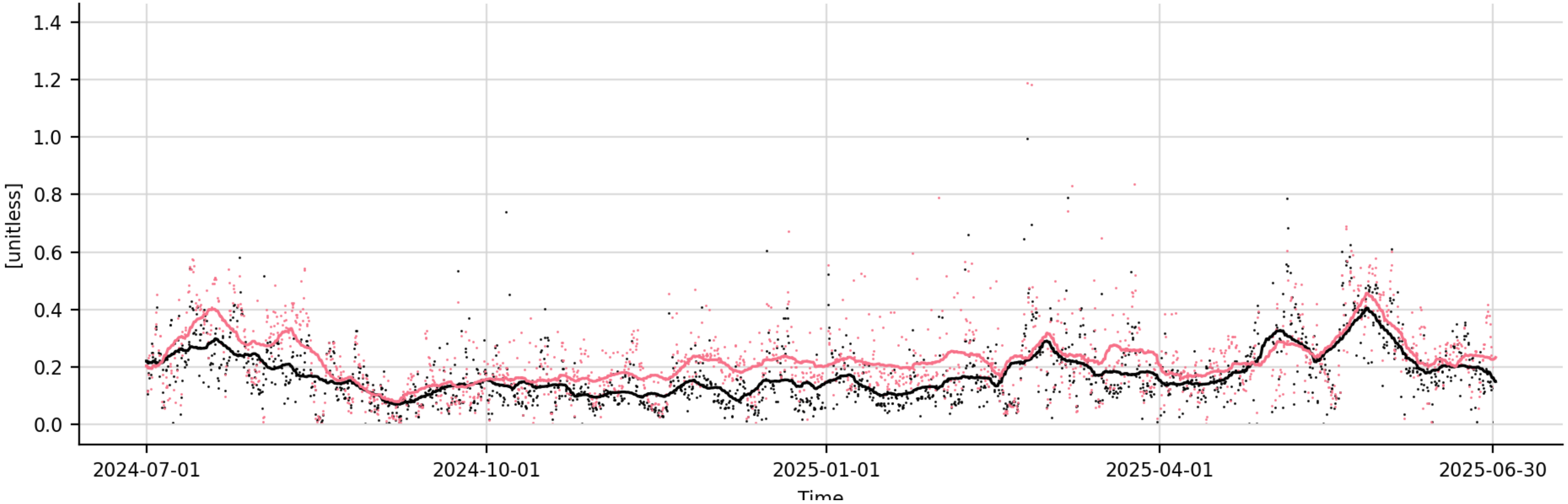
Eyeball verification





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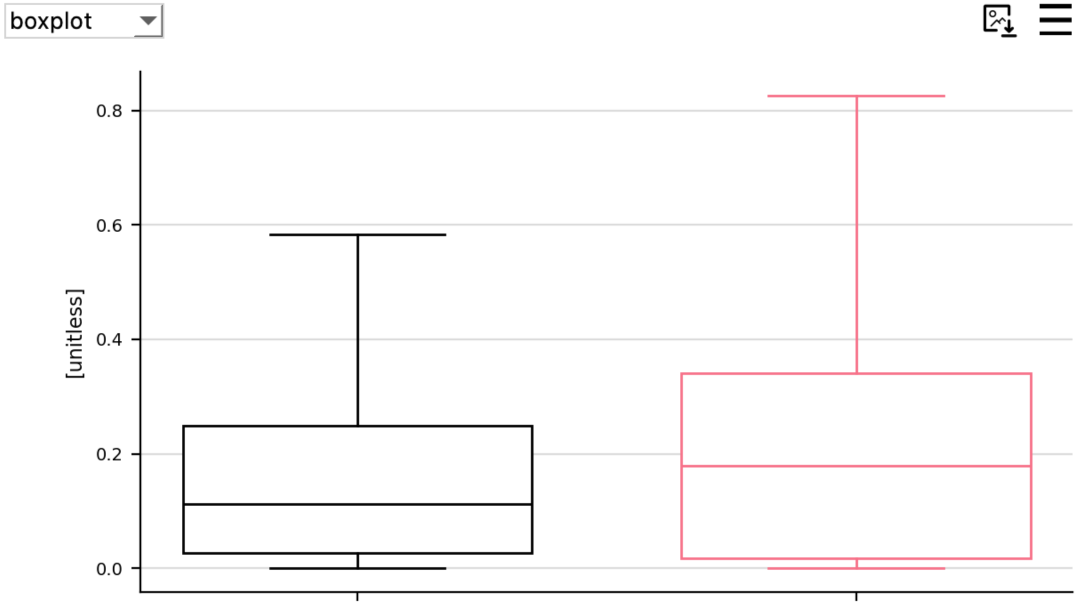
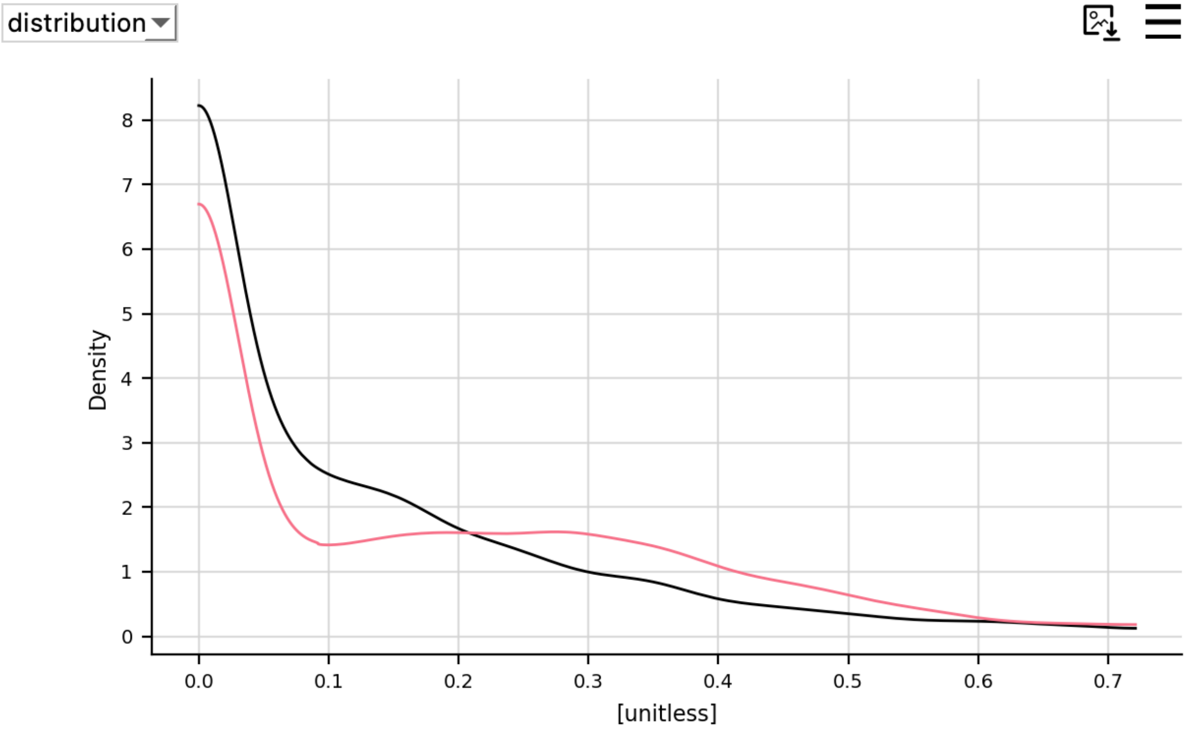
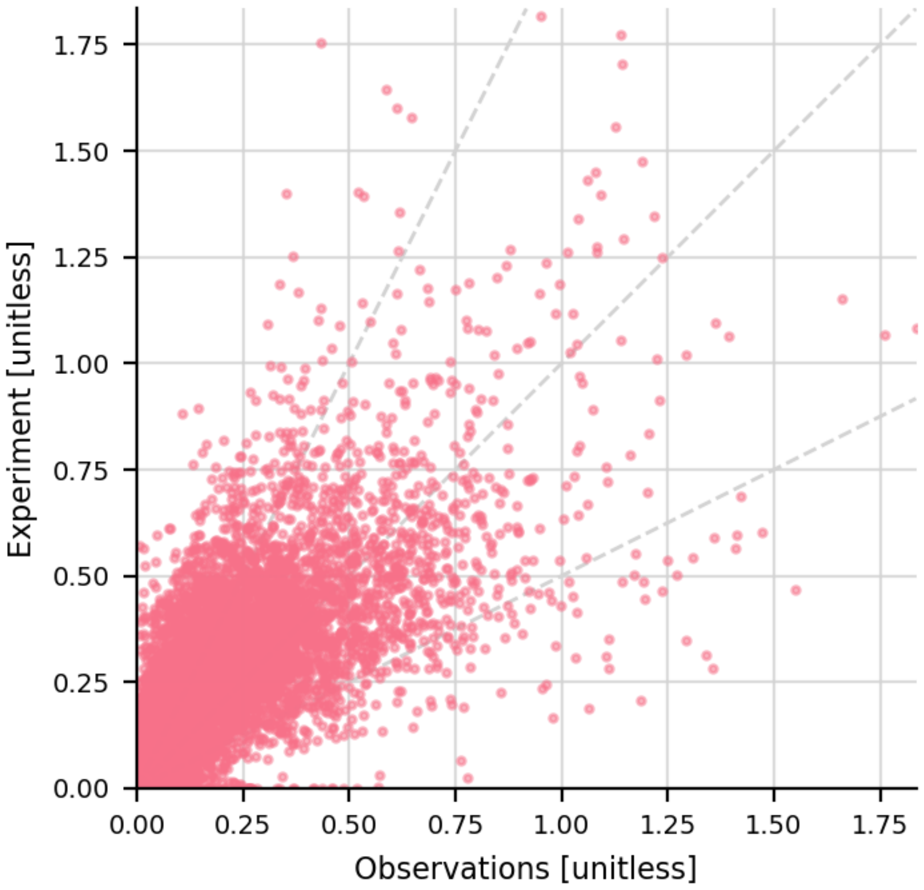
Statistical distribution





Scatter plots



Basic error statistics

Mean error - $Mean\ Error = \frac{1}{N}\sum_{i=1}^{N}(F_i - O_i)$

Answers the question: *What is the average forecast error?*

Range: -∞ to ∞. **Perfect score:** 0.

Correlation coefficient - $r = \frac{\sum(F-\bar{F})(O-\bar{O})}{\sqrt{\sum(F-\bar{F})^2}\sqrt{\sum(O-\bar{O})^2}}$

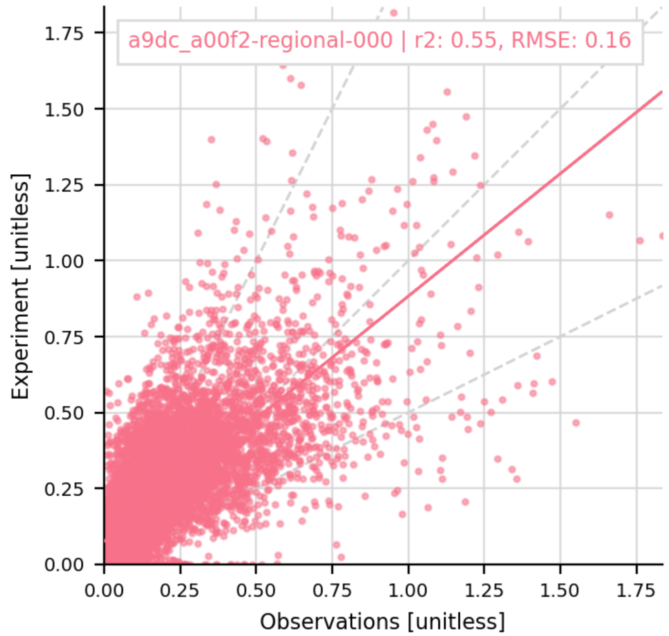
Addresses the question: *How well did the forecast values correspond to the observed values?*

Range: -1 to 1. **Perfect score:** 1.

Root mean square error - $RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(F_i - O_i)^2}$

Answers the question: *What is the average magnitude of the forecast errors?*

Range: 0 to ∞. **Perfect score:** 0.



Normalized error statistics

- **NMB (Normalized Mean Bias)**: NMB captures the average deviations between two datasets. On this website it is reported in units of percent. Values near 0 are the best, negative values indicate underestimation and positive values indicate overestimation.

$$\mathrm{NMB} = \frac{\sum_{i=1}^{n}(m_i - o_i)}{\sum_{i=1}^{n} o_i}$$

- **MNMB (Modified Normalized Mean Bias)**: MNMB is a normalization based on the mean of the observed and forecast value. It ranges between –2 and 2 and when multiplied by 100 %, it can be interpreted as a percentage bias.

$$\mathrm{MNMB} = \frac{2}{n}\sum_{i=1}^{n}\left(\frac{m_i - o_i}{m_i + o_i}\right)$$

Normalizing the RMSE facilitates the comparison between datasets or models with different scales.

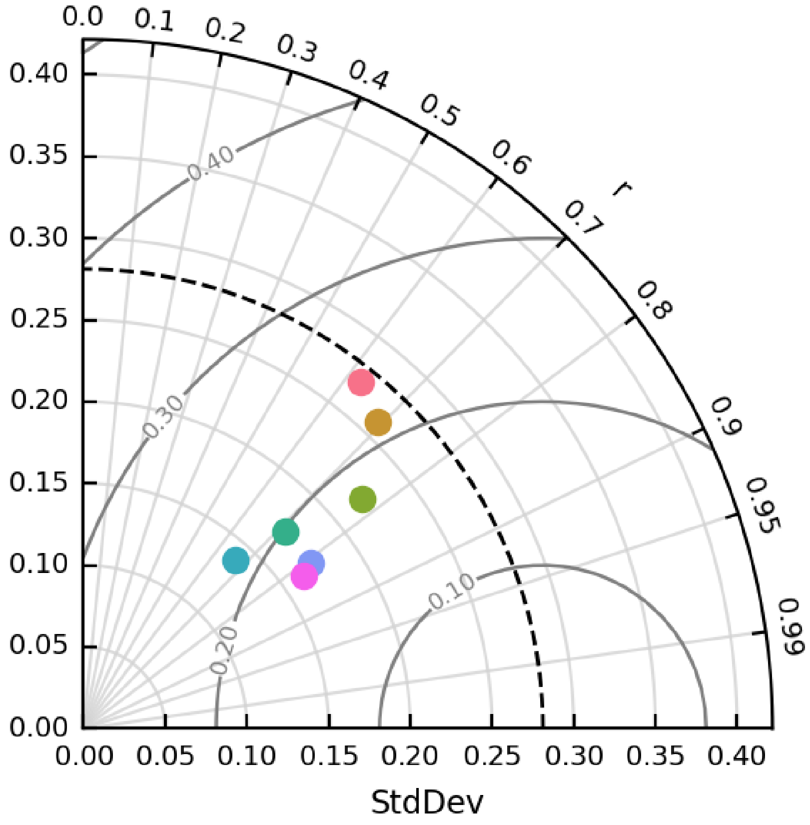
$$\mathrm{NRMSE} = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(o_i - m_i)^2}}{\overline{o}}$$

- **FGE (Fractionnal Gross Error)**: FGE is a measure of model error, ranging between 0 and 2 and behaves symmetrically with respect to under- and overestimation, without over emphasizing outliers.

$$\mathrm{FGE} = \frac{2}{n}\sum_{i=1}^{n}\left|\frac{m_i - o_i}{m_i + o_i}\right|$$

	RMSE	r	NRMSE	MFB	MFE	SLOPE	MB	NMB
a9dc_a00f2-regional-000	0.16	0.74	88.98	-4.95	84.14	0.81	0.04	24.00

Taylor diagrams

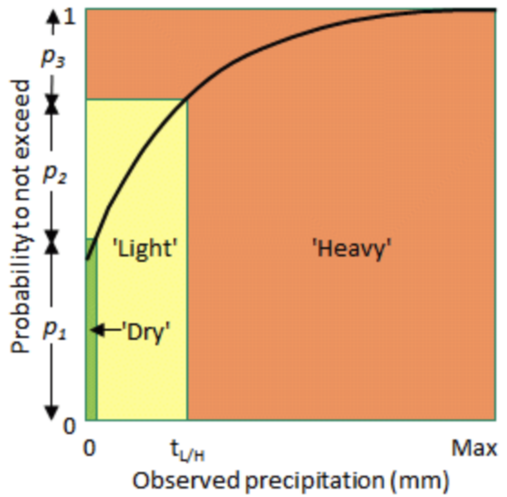


SEEPS

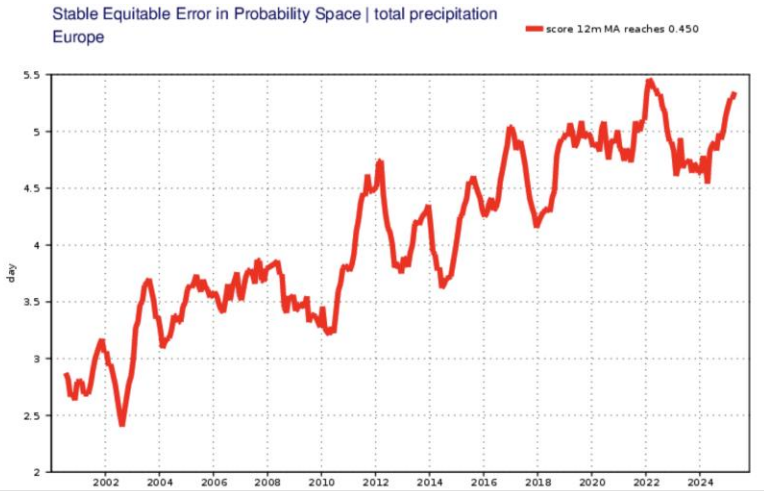
Stable equitable error in probability space (SEEPS) - $SEEPS = \frac{1}{N}\sum_{i=1}^{3}\sum_{j=1}^{3} n(F_i, O_j)\, s_{ij}$

where $n(F_i, O_j)$ is the joint occurrence of forecast category i and observed category j in the 3x3 contingency table, and the scoring matrix is given by

$$s = \begin{bmatrix} 1 & 1-\frac{1}{2(p_2+p_3)} & 1-\frac{1}{2p_3}-\frac{1}{2(p_2+p_3)} \\ 1-\frac{1}{2p_1} & 1 & 1-\frac{1}{2p_3} \\ 1-\frac{1}{2p_1}-\frac{1}{2(p_1+p_2)} & 1-\frac{1}{2(p_1+p_2)} & 1 \end{bmatrix}$$



Like LEPS, SEEPS measures the error in probability space as opposed to measurement space. It was developed to assess rainfall forecasts, where $(1-p_1)$ is the climatological probability of rain (i.e., accumulation exceeding 0.2 mm, following WMO guidelines), and $p_2=2p_3$ divides the climatological cumulative rainfall distribution into "light" (lower 2/3 of rain rates ≥0.2 mm) and "heavy" (upper 1/3 of rain rates ≥0.2 mm). Refer to diagram at right, where $t_{L/H}$ is the threshold delineating "light" and "heavy" rain.



Categorical verification

YES/NO forecasts (dichotomous)

Contingency Table

		Observed yes	Observed no	Total
Forecast	yes	***hits***	***false alarms***	***forecast yes***
	no	***misses***	***correct negatives***	***forecast no***
Total		***observed yes***	***observed no***	***total***

hit - event forecast to occur, and did occur
miss - event forecast not to occur, but did occur
false alarm - event forecast to occur, but did not occur
correct negative - event forecast not to occur, and did not occur

Categorical verification

Accuracy (fraction correct) - $Accuracy = \frac{hits + correct\ negatives}{total}$

Answers the question: *Overall, what fraction of the forecasts were correct?*

Range: 0 to 1. **Perfect score:** 1.

Bias score (frequency bias) - $BIAS = \frac{hits + false\ alarms}{hits + misses}$

Answers the question: *How did the forecast frequency of "yes" events compare to the observed frequency of "yes" events?*

Range: 0 to ∞. **Perfect score:** 1.

Probability of detection (hit rate) - $POD = \frac{hits}{hits + misses}$ (also denoted *H*)

Answers the question: *What fraction of the observed "yes" events were correctly forecast?*

Range: 0 to 1. **Perfect score:** 1.

False alarm ratio - $FAR = \frac{false\ alarms}{hits + false\ alarms}$

Answers the question: *What fraction of the predicted "yes" events actually did not occur (i.e., were false alarms)?*

Range: 0 to 1. **Perfect score:** 0.

Probability of false detection (false alarm rate) -

$POFD = \frac{false\ alarms}{correct\ negatives + false\ alarms}$ (also denoted *F*)

Answers the question: *What fraction of the observed "no" events were incorrectly forecast as "yes"?*

Range: 0 to 1. **Perfect score:** 0.

GERRITY score

Gerrity score - $GS = \frac{1}{N}\sum_{i=1}^{K}\sum_{j=1}^{K} n(F_i, O_j)\, s_{ij}$

where s_{ij} are elements of a scoring matrix given by

$s_{ii} = \frac{1}{K-1}\left(\sum_{r=1}^{i-1} a_r^{-1} + \sum_{r=i}^{K-1} a_r\right)$ $(i = j$, diagonal$)$, $s_{ij} = s_{ji} = \frac{1}{K-1}\left(\sum_{r=1}^{i-1} a_r^{-1} - (j-i) + \sum_{r=j}^{K-1} a_r\right)$ $(i \neq j$, off-diagonal$)$, and $a_i = \left(1 - \sum_{r=1}^{i} p_r\right) \Big/ \sum_{r=1}^{i} p_r$

with the sample probabilities (observed frequencies) given by $p_i = N(O_i) / N$.

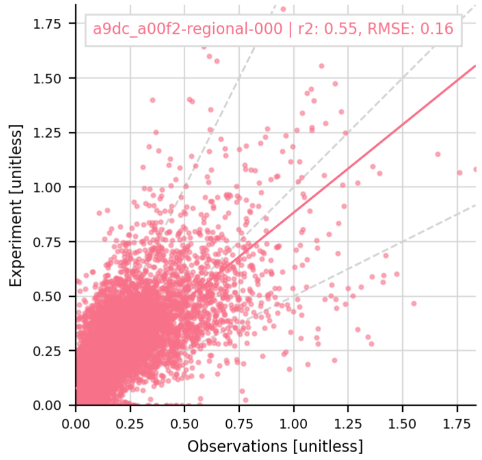
Answers the question: *What was the accuracy of the forecast in predicting the correct category, relative to that of random chance?*

Range: -1 to 1, 0 indicates no skill. **Perfect score:** 1

Categories:

[0, 0.1, 0.4, 0.8]

$$GS = \begin{bmatrix} 0.42 & -0.28 & -0.66 & -1.00 \\ -0.28 & 0.34 & -0.03 & -0.37 \\ -0.66 & -0.03 & 2.86 & 2.52 \\ -1.00 & -0.37 & 2.52 & 23.3 \end{bmatrix} \bullet \begin{bmatrix} 3272 & 1067 & 61 & 0 \\ 282 & 2753 & 814 & 34 \\ 11 & 331 & 519 & 69 \\ 0 & 18 & 82 & 50 \end{bmatrix} = 0.52$$



Routine dust forecasts evaluation

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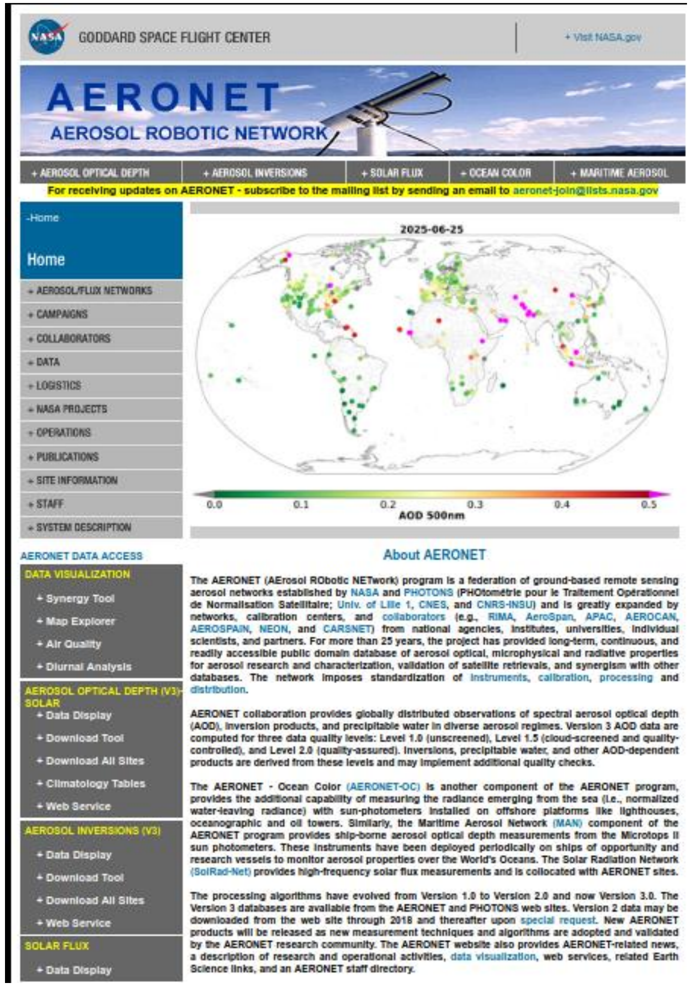
AERONET



- Direct Sun :
  - AOD
  - Angstrom Exponent
  - SDA: coarse and fine

- Inversions:
  - SSA
  - Complex refractive index (real and imaginary)
  - Absorption AOD
  - Asymmetry parameter
  - Phase function
  - Size distribution

ATARRI

Colocation/representativity errors

temporal

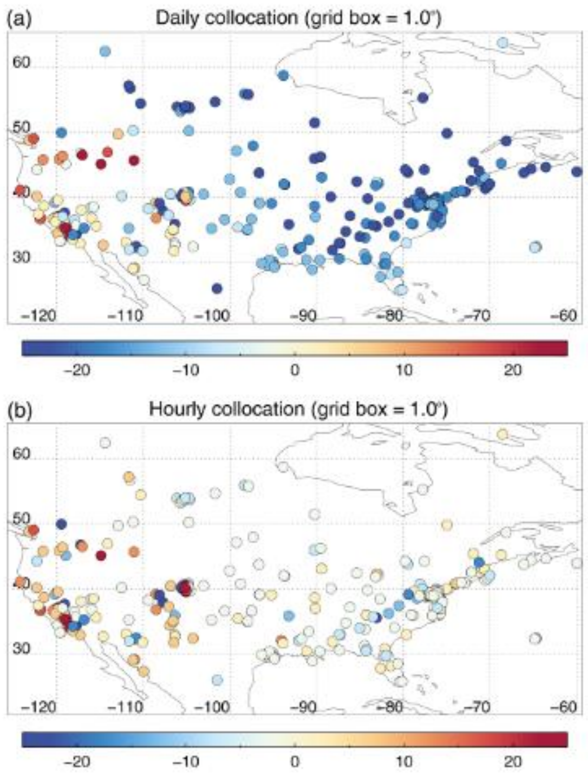


Figure 5. Yearly representation errors (%) for AOT from AERONET direct sun L2.0 in North America, for two different collocation protocols (**a** daily; **b** hourly) and a model grid-box size of 1°.

spatial err.

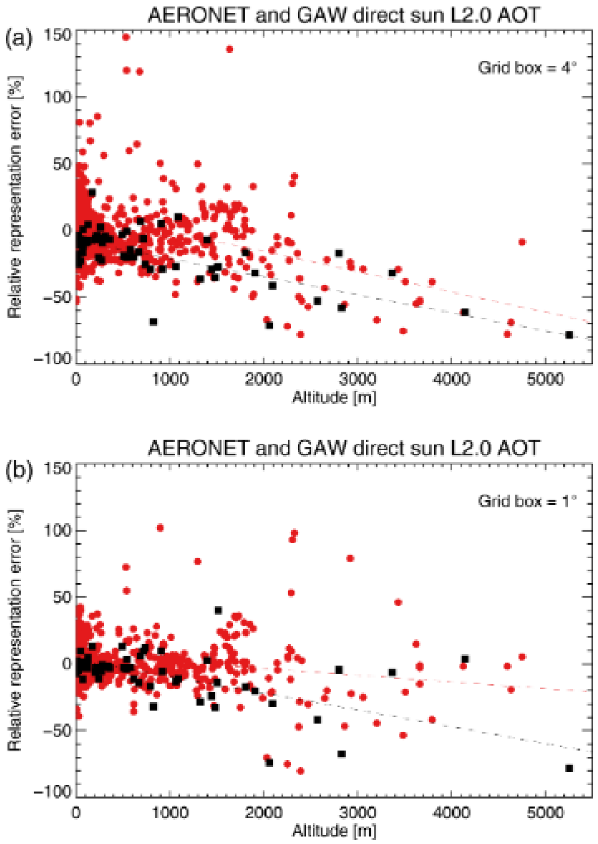


Figure 8. Yearly representation errors for AOT from AERONET direct sun L2.0 (red circles) and GAW (black squares) as a function of site altitude, for a model grid-box size of either 4° or 1°, using hourly collocation.

temporal + spatial

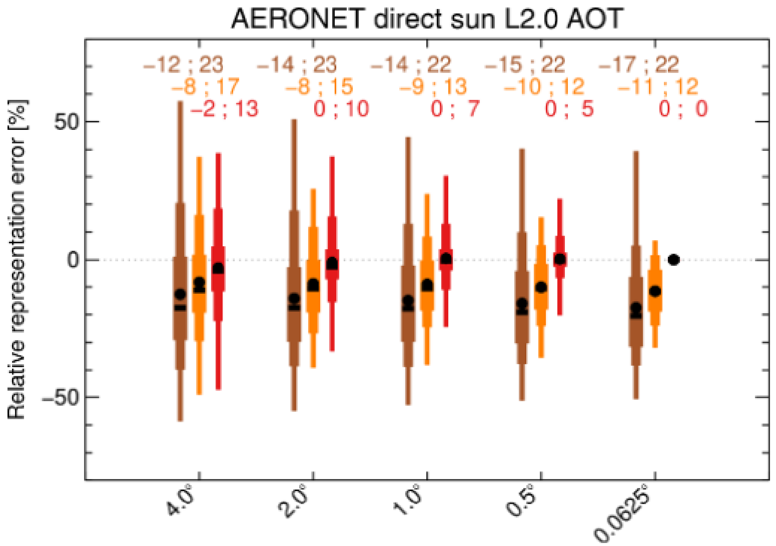
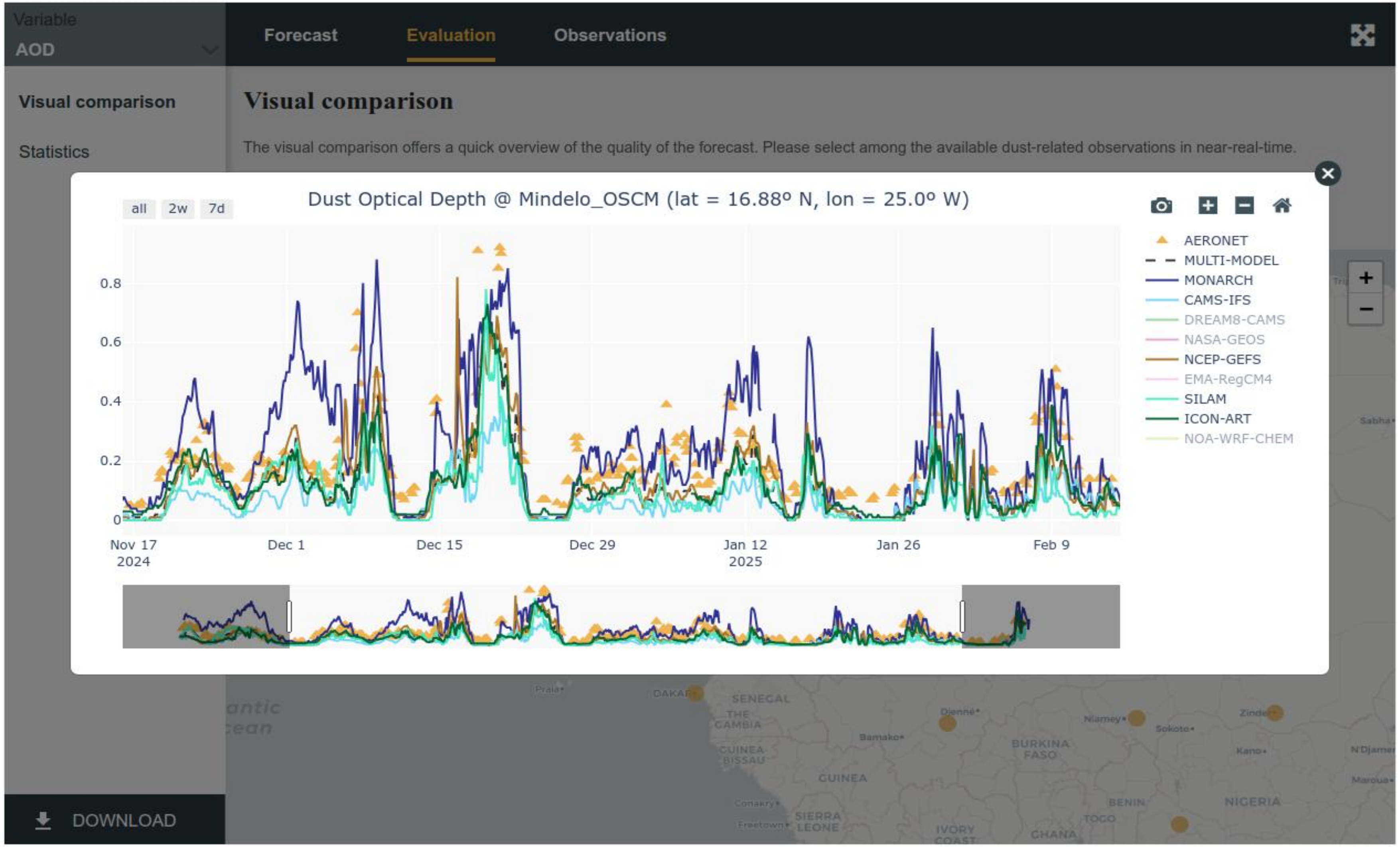


Figure 4. Yearly representation errors for AOT from AERONET direct sun L2.0 for different model grid-box sizes. The colours indicate different collocation protocols: yearly (brown), daily (orange) and hourly (red). Numbers on top are the means of the errors and means of the signless errors.

Schutgens (2020)

BDRC



Variable
AOD
Forecast
Evaluation
Observations
Visual comparison
Statistics
Visual comparison
The visual comparison offers a quick overview of the quality of the forecast. Please select among the available dust-related observations in near-real-time.
Dust Optical Depth @ Mindelo_OSCM (lat = 16.88º N, lon = 25.0º W)
all
2w
7d
0.8
0.6
0.4
0.2
0
Nov 17
2024
Dec 1
Dec 15
Dec 29
Jan 12
2025
Jan 26
Feb 9
AERONET
MULTI-MODEL
MONARCH
CAMS-IFS
DREAM8-CAMS
NASA-GEOS
NCEP-GEFS
EMA-RegCM4
SILAM
ICON-ART
NOA-WRF-CHEM
DOWNLOAD

Dust identification

AERONET measures all-aerosol optical depth, but dust predominant scenes can be identified :

1- Selection of sites

2- Optically coarse: low Angstrom exponent

- AE<0.6: coarse particles
- AE<0.3: coarser particle (capturing dust events)
- should be compared with AOD

3- Use the Spectral Deconvolution Algorithm (SDA) coarse AOD:

- should be compared with coarse AOD
- other coarse aerosols can be present (eg. sea salt)

4- Use almucantar inversions (Obiso et al 2024)

- constraints on the spectral SSA, fine mode fraction, refractive index
- few points-> climate Applications

Wavelengths:

Almucantar (standard) : 440, 675, 870, and 1020 nm

AOD at 550 can be interpolated using angstrom exponent

Others: 340, 380, 500, and 1640 nm,

Products (QA)

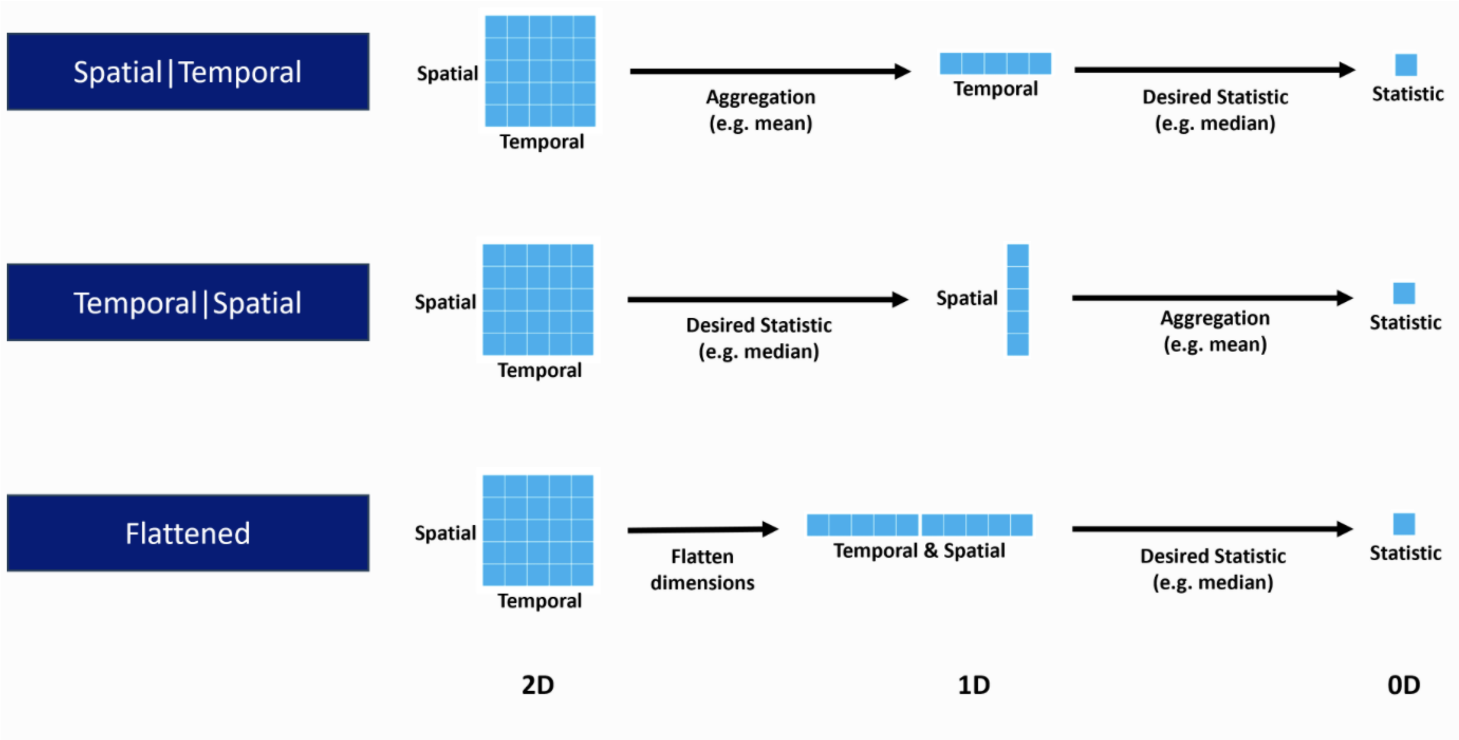
Level 1: Raw data

Level 1.5: cloud-screened

Level2: calibrated (pre and post)

Preliminary steps

- Compute modeled optical depth $H(\boldsymbol{x}) = \sum_i \sum_a \sum_d m_d^a(z_i)\, C_{ext}^{a,d}(\lambda)$
- Colocate in time (linear interpolation) and space (bilinear interpolation) with measurements
- (Aggregate data points over a region)
- Compute evaluation statistics
- Remember that we never observe only dust!



BDRC – Model comparison

Statistics

Network: Aeronet v3 lev1.5 | Models: 6 models | Statistics: 4 statistics | Timescale: Annual | Selection: 2024 | VIEW MAP

MBE

Station	MULTI-MODEL	Monarch	Cams	Nasa-Geos	Metoffice	Ncep-Gefs
Europe	-0.12	-0.12	-0.12	-0.10	-0.09	-0.12
Mediterranean	-0.10	-0.09	-0.10	-0.08	-0.04	-0.11
MiddleEast	-0.13	-0.12	-0.13	-0.12	0.03	-0.17
NAfrica	-0.12	-0.06	-0.15	-0.08	-0.04	-0.13
Total	-0.11	-0.10	-0.12	-0.09	-0.05	-0.12

r

Station	MULTI-MODEL	Monarch	Cams	Nasa-Geos	Metoffice	Ncep-Gefs
Europe	0.47	0.43	0.47	0.49	0.55	0.40
Mediterranean	0.80	0.68	0.76	0.78	0.80	0.71
MiddleEast	0.73	0.59	0.62	0.71	0.66	0.61
NAfrica	0.77	0.61	0.71	0.78	0.76	0.73
Total	0.77	0.66	0.72	0.78	0.74	0.72

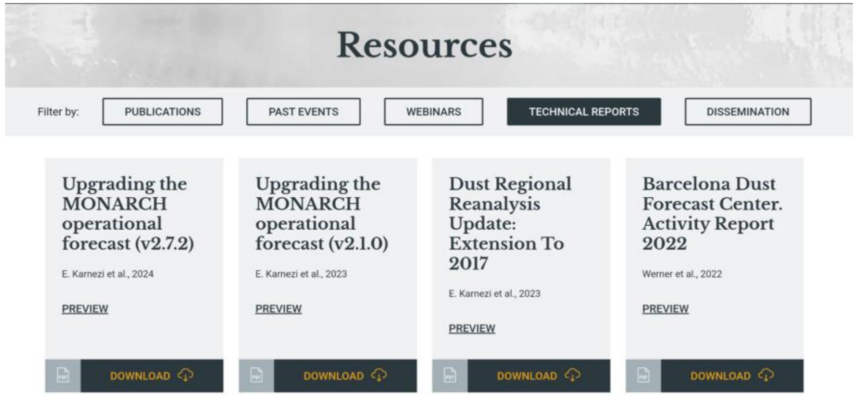
RMSE

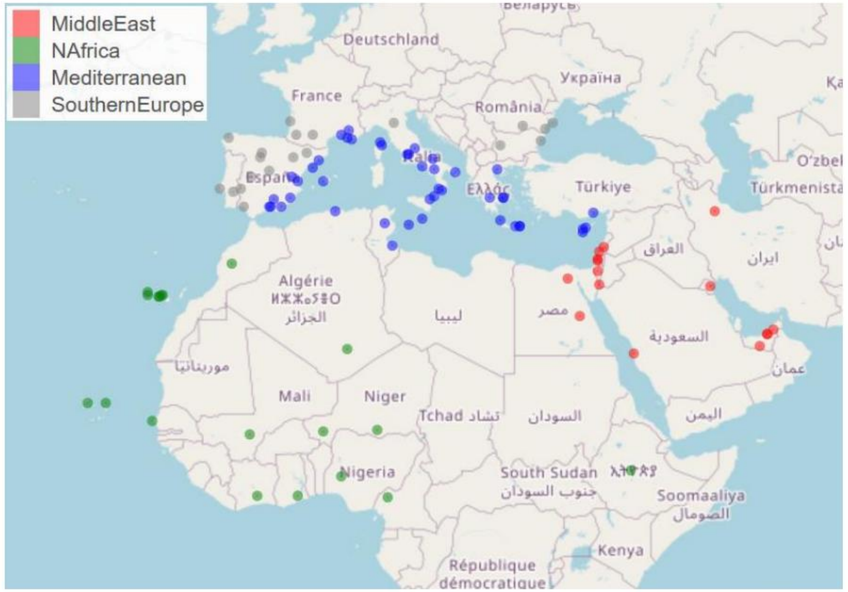
Station	MULTI-MODEL	Monarch	Cams	Nasa-Geos	Metoffice	Ncep-Gefs
Europe	0.15	0.15	0.15	0.13	0.12	0.15
Mediterranean	0.14	0.14	0.14	0.12	0.10	0.15
MiddleEast	0.17	0.18	0.19	0.17	0.15	0.22
NAfrica	0.26	0.27	0.28	0.22	0.22	0.26
Total	0.17	0.18	0.18	0.15	0.14	0.18

FGE

Station	MULTI-MODEL	Monarch	Cams	Nasa-Geos	Metoffice	Ncep-Gefs
Europe	1.71	1.77	1.78	1.26	1.07	1.76
Mediterranean	1.40	1.46	1.50	1.01	0.64	1.54
MiddleEast	0.90	0.93	1.01	0.81	0.45	1.24
NAfrica	0.79	0.90	0.93	0.58	0.55	0.88
Total	1.35	1.41	1.44	1.00	0.74	1.47

BDRC – MONARCH forecasts upgrades





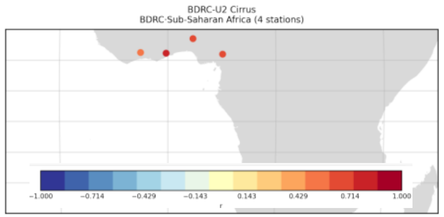
AERONET SDA coarse AOD at 500nm compared to modeled coarse Dust Optical Depth (DODcoarse) at 550nm

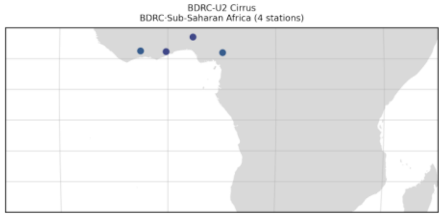
		Mean	RMSE	r	MFB	MFE
Selected_BDRC_2021	Operational	-0.02	0.11	0.74	-89.37	112.67
	Upgrade	0.01	0.13	0.74	-70.66	106.95
Mediterranean	Operational	-0.03	0.08	0.80	-110.14	122.28
	Upgrade	-0.01	0.09	0.81	-91.84	114.13
NorthAfrica	Operational	-0.00	0.20	0.61	-26.62	89.60
	Upgrade	0.05	0.22	0.63	-5.47	91.06
MiddleEast	Operational	-0.02	0.11	0.70	-36.67	62.79
	Upgrade	0.01	0.12	0.71	-13.29	58.66
SouthernEurope	Operational	-0.02	0.05	0.81	-142.71	149.53
	Upgrade	-0.02	0.06	0.82	-128.65	140.89

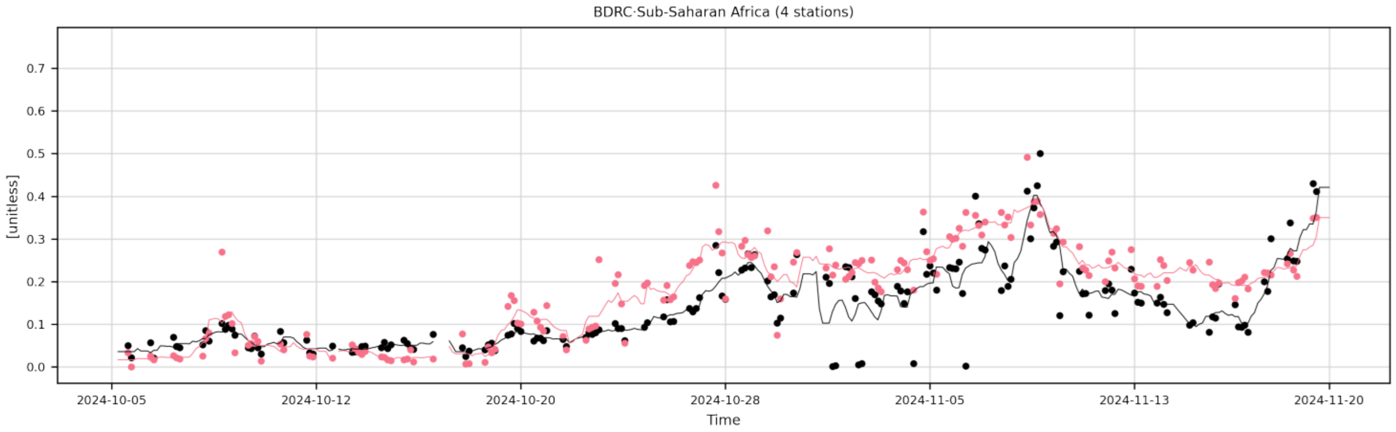
BDRC – MONARCH NRT evaluation

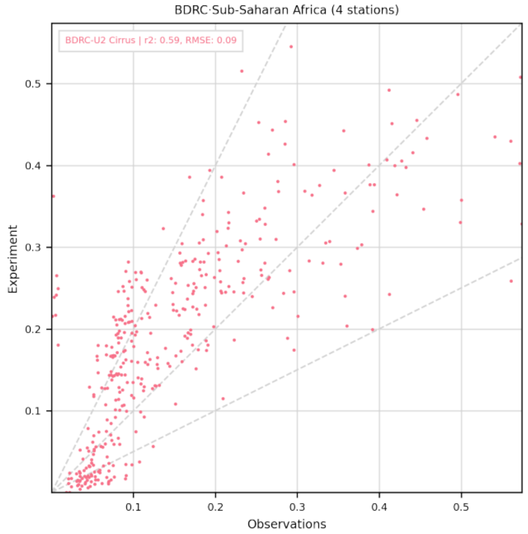
- The website evaluation tool provide either very granular and interactive evaluation or automatic but monthly-yearly statistics

- Established a new bi-weekly automatic reporting with Providentia to regularly monitor MONARCH dust forecasts (internal usage)









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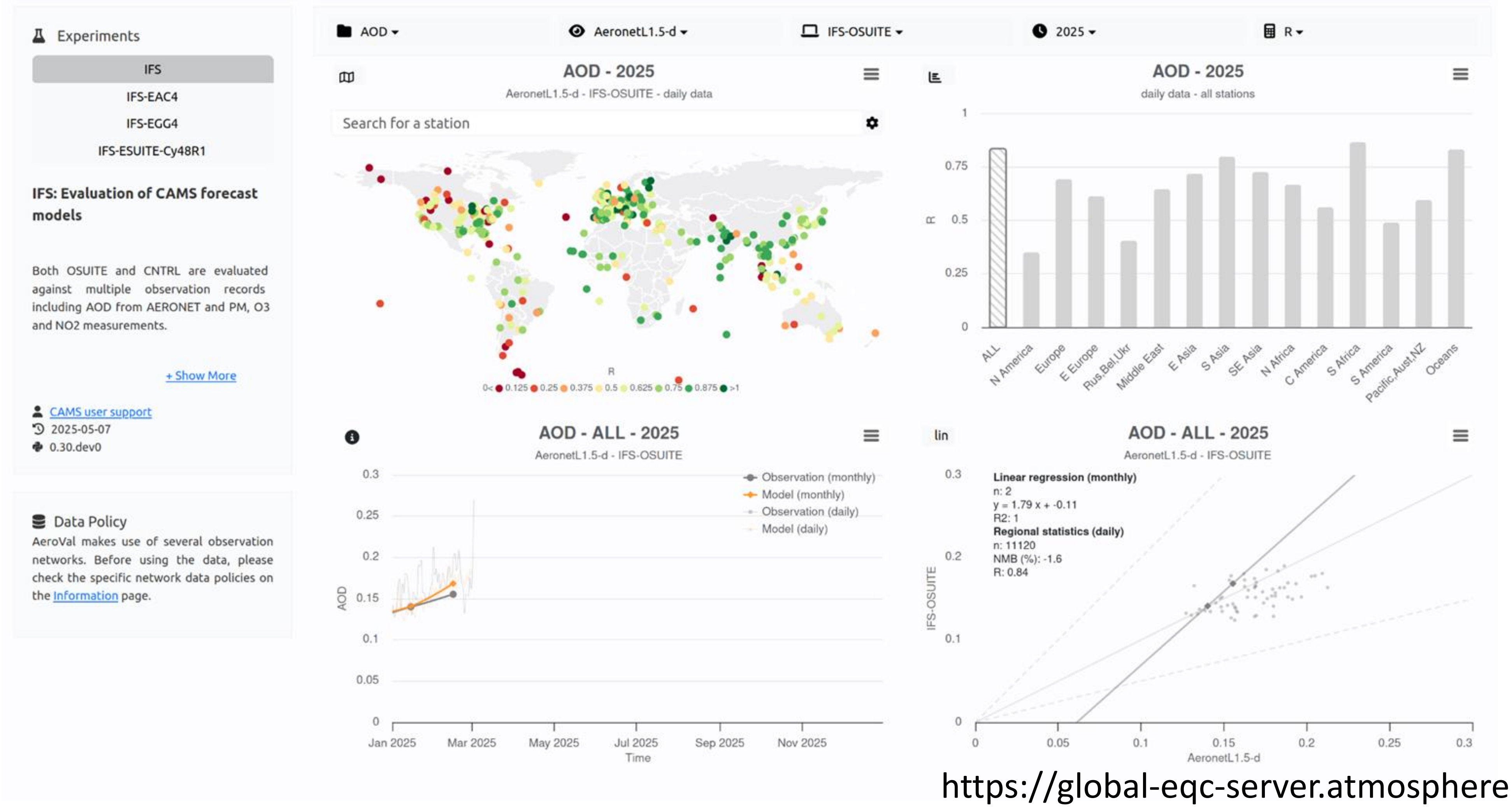
Aeroval



https://global-eqc-server.atmosphere.copernicus.eu

Aeroval

Heatmap | Time Series | Taylor Diagram

AODc ▾ | AeronetSDAV1.5-d ▾ | Middle East ▾ | 2013-2025 ▾ | MNMB ▾

Experiments

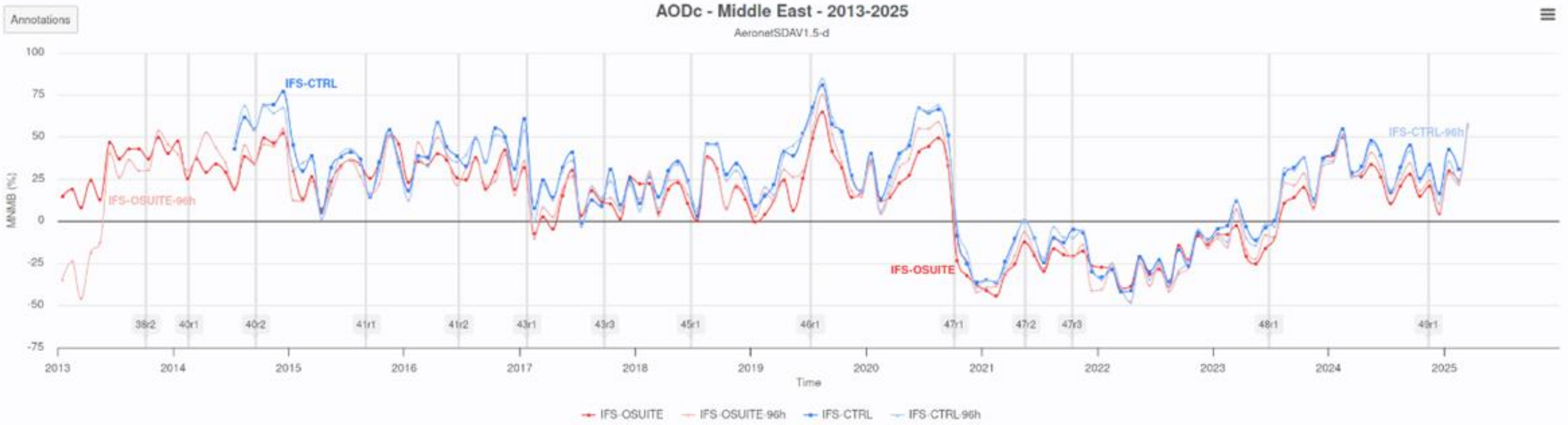
- IFS
- IFS-EAC4
- IFS-EGG4
- IFS-ESUITE-Cy48R1

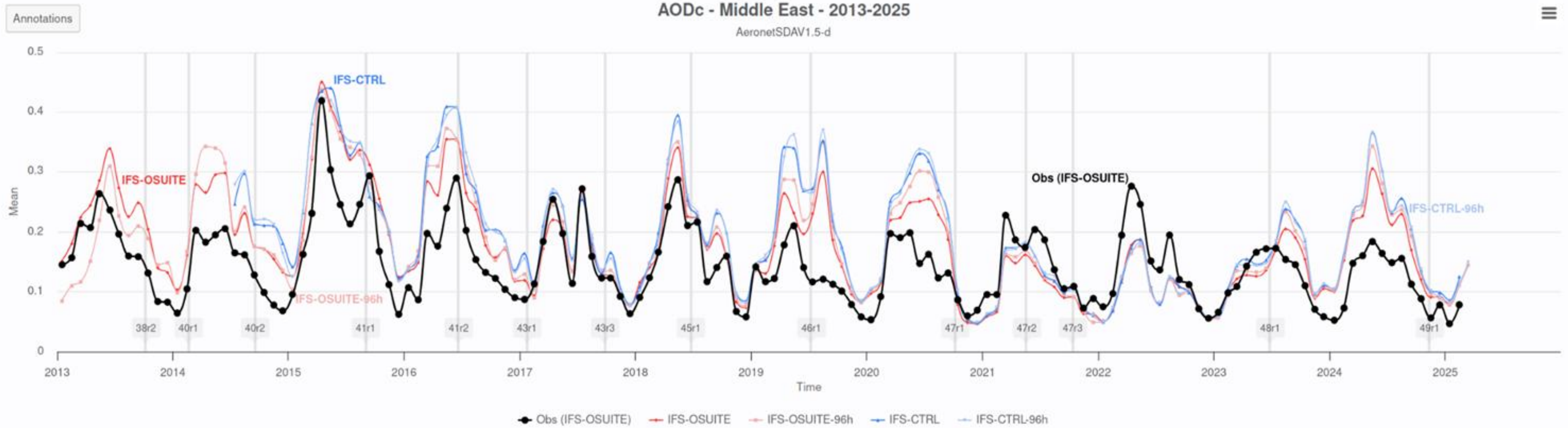
IFS: Evaluation of CAMS forecast models

Both OSUITE and CNTRL are evaluated against multiple observation records including AOD from AERONET and PM, O3 and NO2 measurements.

+ Show More

CAMS user support
2025-05-07
0.30.dev0

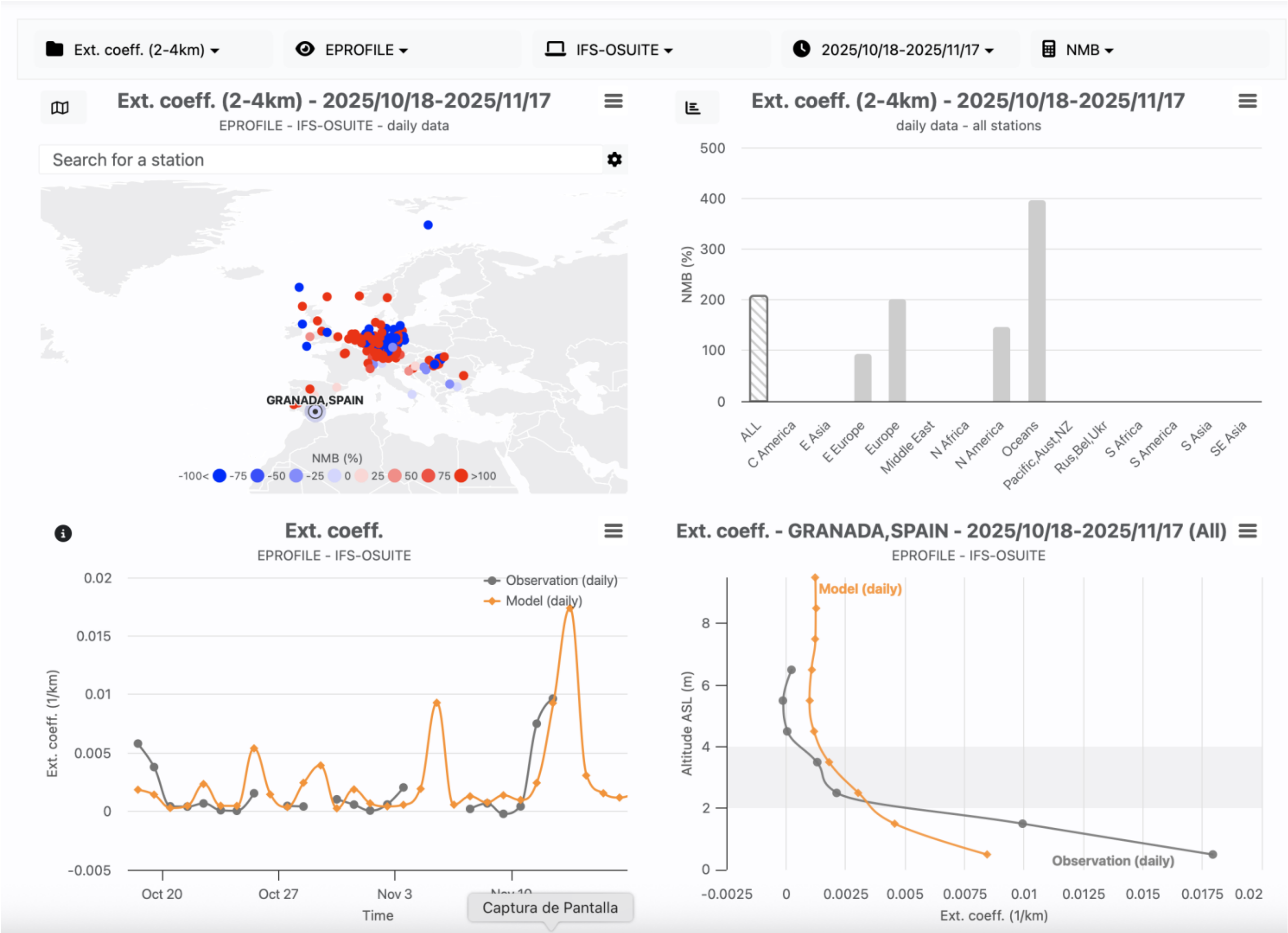




Data Policy

AeroVal makes use of several observation networks. Before using the data, please check the specific network data policies on the Information page.

Aeroval: e-profiles



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CAMS82

ECMWF COPERNICUS REPORT

Copernicus
Europe's eyes on Earth

Copernicus Atmosphere Monitoring Service

Validation report of the CAMS near-real-time global atmospheric composition service

Period December 2024 - February 2025

Issued by: KNMI

Date: 02 June 2025

Ref: CAMS2_82_2023SC2_D82.1.1.14-DJF2025

Table S.1: Performance of o-suite for a 0-24h and 72-96h as well as for GHG 25km and 9km experiments for the period DJF-2025. REF[1] Average statistics of AirNow, EEA and CNEMC REF[2] Average statistics of GAW, IASOA and ESRL. REF[3] Average statistics of ACE-FTS, SAGE-III/ISS, OMPS-LP, Aura MLS and ozonesondes. REF[4] From a network of stations that were collected from FMI. IAGOS Global statistics consider all airports but Frankfurt and Madrid. The color scale legend, units and type of statistics used in each case is provided below.

Species	Reference	Type	Region	tres	*Bias*		*Error*		*R*	
CAMS for Reactive Gases & Aerosol					00-24h	72-96h	0-24h	72-96h	0-24h	72-96h
AOD	AERONET	COL	Global	daily	13%	8%	39%	41%	0.83	0.78
	AERONET	COL	N. America	daily	27%	14%	45%	41%	0.37	0.33
	AERONET	COL	Europe	daily	3%	9%	36%	39%	0.70	0.60
	AERONET	COL	E. Asia	daily	13%	6%	39%	43%	0.70	0.62
	AERONET	COL	N. Africa	daily	-25%	-17%	50%	52%	0.59	0.43
	AERONET	COL	S. America	daily	27%	6%	47%	36%	0.51	0.55
	AERONET	COL	Oceans	daily	19%	17%	34%	37%	0.81	0.76
	AERONET SDA	COL	Europe	3h	-120%	-118%	140%	140%	0.17	0.17
	AERONET SDA	COL	Middle East	3h	-26%	-25%	76%	78%	0.44	0.40
	AERONET SDA	COL	N. Africa	3h	-51%	-45%	84%	89%	0.70	0.67
AE	AERONET	COL	Global	daily	0.09	0.09	0.09	0.09	0.56	0.55
	AERONET	COL	N. America	daily	0.13	0.14	0.13	0.14	0.36	0.33
	AERONET	COL	Europe	daily	-0.00	-0.00	0.00	0.00	0.64	0.61
	AERONET	COL	E. Asia	daily	0.04	0.05	0.04	0.05	0.24	0.19
	AERONET	COL	N. Africa	daily	-0.10	-0.09	0.10	0.09	0.76	0.73
	AERONET	COL	S. America	daily	0.28	0.28	0.28	0.28	0.20	0.19
	AERONET	COL	Oceans	daily	0.10	0.10	0.10	0.10	0.59	0.58

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CAMS82

Validation report of the CAMS near-real-time global atmospheric composition service

Period December 2024 - February 2025

Issued by: KNMI

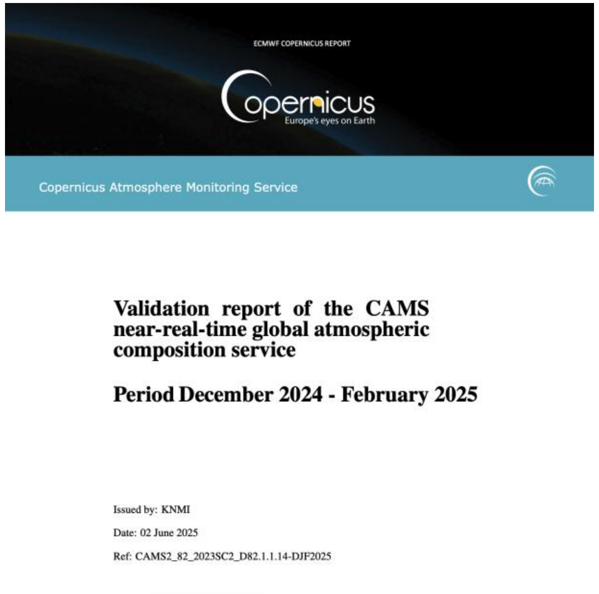
Date: 02 June 2025

Ref: CAMS2_82_2023SC2_D82.1.1.14-DJF2025

Table S.5: Improvement or deterioration of o-suite 0-24h forecast due to Data Assimilatation (DA) is calculated by the difference of performance statistics for o-suite and the control experiment. The improvement or deterioration of the Current Year Quarter (CYQ) compared to the Previous Year same Quarter (PYQ) is calculated by the difference of performance statistics for CYQ and the PYQ experiment. The color scale legend, units and type of statistics used in each case is provided below.

Species	Reference	Type	Region	tres	*DA improvement?*			*CYQ to PYQ improvement?*		
CAMS for Reactive Gases & Aerosol					Bias	Error	R	Bias	Error	R
AOD	AERONET	COL	Global	daily	-11%	-1%	0.04	-3%	4%	0.04
	AERONET	COL	N. America	daily	-22%	-10%	-0.01	-4%	4%	0.05
	AERONET	COL	Europe	daily	0%	1%	0.07	1%	6%	0.07
	AERONET	COL	E. Asia	daily	-13%	2%	0.06	-5%	5%	0.14
	AERONET	COL	N. Africa	daily	-3%	-1%	-0.02	-9%	5%	0.18
	AERONET	COL	S. America	daily	-15%	-7%	0.03	1%	-1%	-0.09
	AERONET	COL	Oceans	daily	-15%	-1%	0.04	-9%	5%	0.08
	AERONET SDA	COL	Europe	3h	-6%	-2%	-0.01	1%	7%	-0.10
	AERONET SDA	COL	Middle East	3h	-10%	-2%	0.02	-3%	-3%	-0.22
	AERONET SDA	COL	N. Africa	3h	-10%	-3%	0.04	-45%	-2%	0.20
AE	AERONET	COL	Global	daily	-0.02	-0.02	-0.02	0.11	0.11	0.01
	AERONET	COL	N. America	daily	0.00	0.00	-0.04	0.14	0.14	0.03
	AERONET	COL	Europe	daily	0.02	0.02	0.01	0.15	0.15	0.08
	AERONET	COL	E. Asia	daily	0.01	0.01	0.01	0.15	0.15	0.05
	AERONET	COL	N. Africa	daily	0.03	0.03	-0.02	0.04	0.04	0.04
	AERONET	COL	S. America	daily	0.01	0.01	-0.07	0.18	0.18	-0.18
	AERONET	COL	Oceans	daily	-0.04	-0.04	-0.04	0.09	0.09	-0.02

CAMS82



ECMWF COPERNICUS REPORT

Copernicus
Europe's eyes on Earth

Copernicus Atmosphere Monitoring Service

Validation report of the CAMS near-real-time global atmospheric composition service

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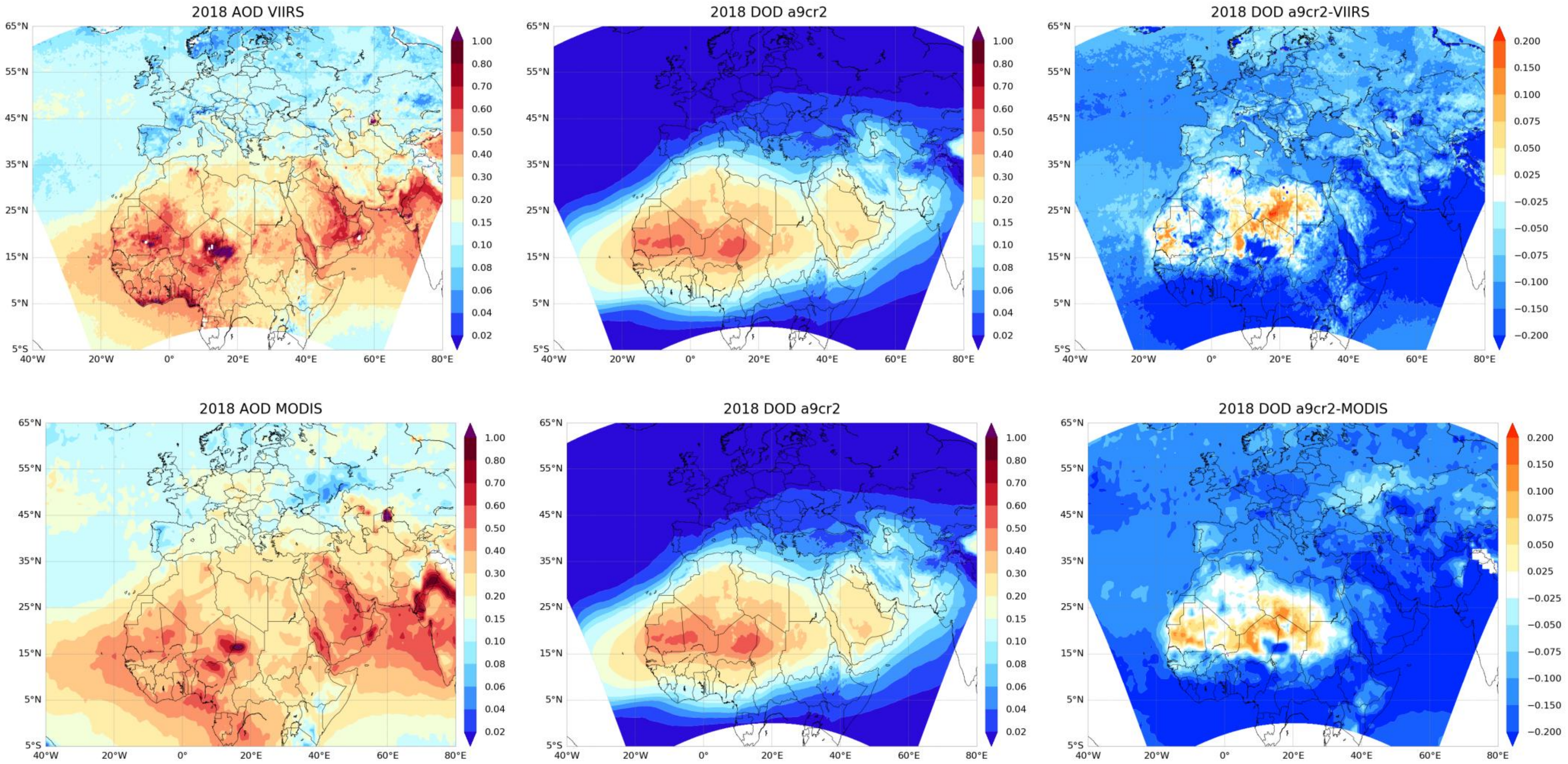
	o-suite	cntrl	SDS-WAS	ICAP
Forecasts 00-24 hours				
COR	0.67	0.65	0.80	0.84
MB	-0.03	-0.02	-0.01	-0.02
RMSE	0.10	0.10	0.08	0.07
MNMB	-87.21	-80.45	-65.36	-44.85
Forecasts 48-72 hours				
COR	0.66	0.66	0.77	0.78
MB	-0.03	-0.02	-0.01	-0.02
RMSE	0.10	0.10	0.08	0.08
MNMB	-85.56	-80.79	-60.88	-46.11
Forecasts 96-120 hours				
COR	0.65	0.65	NaN	0.74
MB	-0.03	-0.02	NaN	-0.02
RMSE	0.10	0.10	NaN	0.09
MNMB	-85.00	-81.15	NaN	-46.30

Table 9.1.1: Skill scores (MB, MNMB, RMSE, and r) of 0-24 hours, 48-72 hours and 96-120 hours forecasts (on a 3-hourly basis) for CAMS o-suite, CAMS control and SDS-WAS multi-model median, and ICAP multimodel mean for DJF-2025 NAMEE region. DOD (AODcoarse SDA product) from AERONET is the reference.

Non-routine dust evaluation

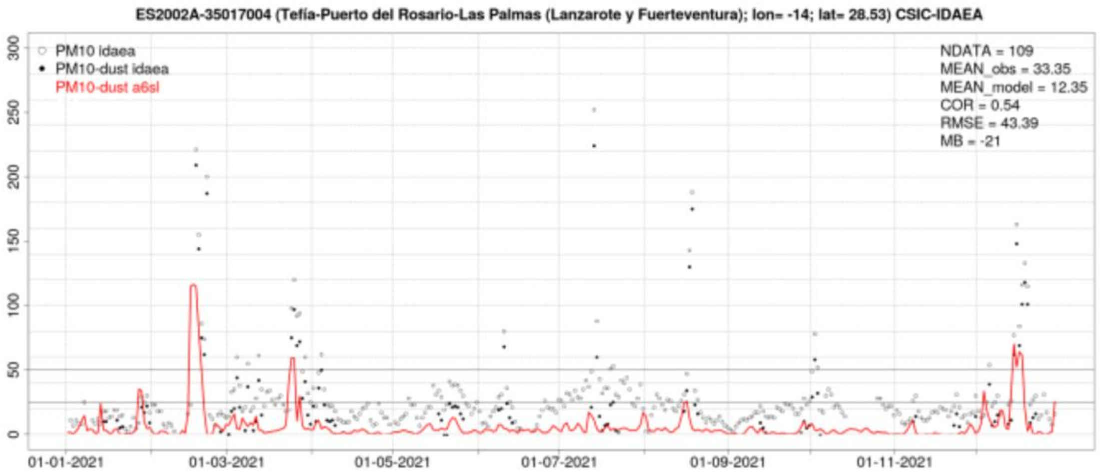
Satellites evaluation

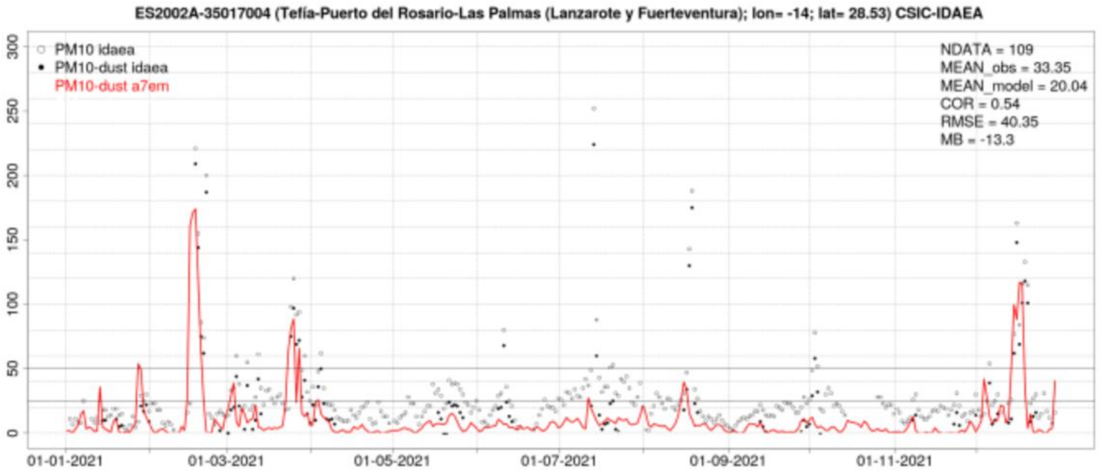
Courtesy of E. Karnezi



Surface PM

Courtesy of E. Karnezi





PM10 dust contribution from Escudero et al. (2007)

	Hit rate	False alarm rate
MONARCH v2.1.0	13.4%	0.6%
MONARCH v2.7.2	19.6%	1.4%

LIDAR

Uses the linear depolarization ratio:

PLDR = 0 for spherical particles
PLDR ≳ 30 for dust
and computes dust and non-dust contributions

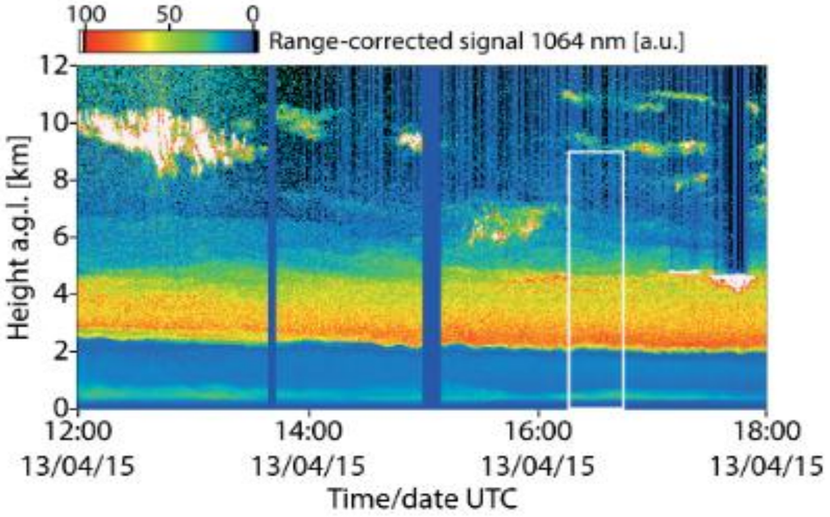


Figure 8. Dust layering over the central Asian AERONET site of Dushanbe, Tajikistan, on 13 April 2015 observed with Polly lidar at 1064 nm (range-corrected signal). The densest layer from 2 to 5 km height a.g.l. (above ground level) contained dust particles from Iran, Afghanistan, and Oman according to the backward trajectories in Fig. 9. With increasing height, dust was advected from the Arabian peninsula and the Sahara. The polluted boundary layer reached up to about 2 km height and contained traces of local dust and dust from Kazakhstan. Above 6.5 km height (and temperatures < −20 °C) ice clouds developed triggered by dust particles, which are favorable ice-nucleating particles. POLIPHON results in Figs. 10–12 are derived for the height–time range indicated by the white rectangle.

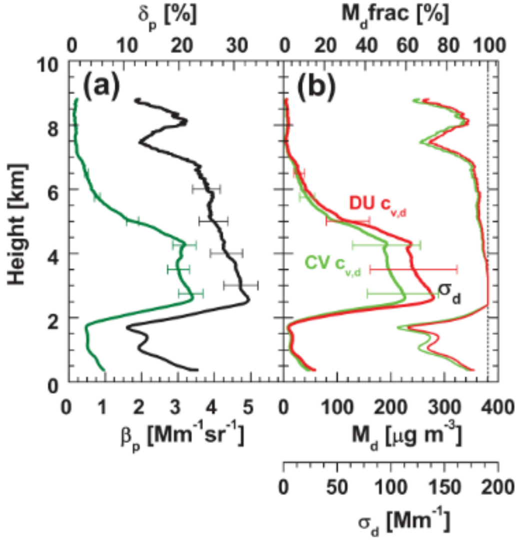


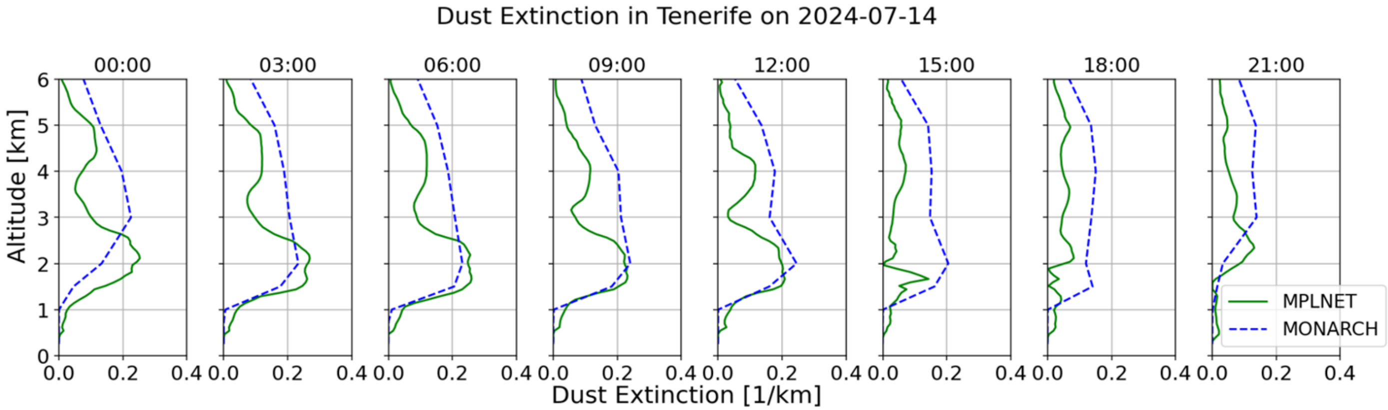
Figure 10. Retrieval of dust mass concentration. From profiles of the particle backscatter coefficient β_p (green curve in **a**, 532 nm) and particle linear depolarization ratio δ_p (black curve in **a**, 532 nm), the profile of the dust backscatter coefficient β_d is determined and then converted into the dust extinction coefficient σ_d (red curve in **b**) by means of a lidar ratio of 40 sr. The σ_d profile is then converted into mass concentration M_d (shown in **b** as thick lines) by means of volume conversion factors $c_{v,d}$ of 0.64×10^{-12} Mm for Sal, Cabo Verde (CV, green M_d profile; see Table. 4), and 0.79×10^{-12} Mm for Dushanbe (DU, red M_d profile) and dust particle density $\rho_d = 2.6\ g\ cm^{-3}$. Respective profiles of M_d fraction (thin red and green curves in **b**) are also shown. The Polly lidar observation was performed at Dushanbe on 13 April 2015, 16:15–16:44 UTC (white rectangle in Fig. 8). The temporally averaged lidar signal profiles were smoothed with 750 m before the computation of β_p and δ_p. Error bars indicate **(a)** 10 % and **(b)** 30 % uncertainty (typical uncertainty according to Table 1).

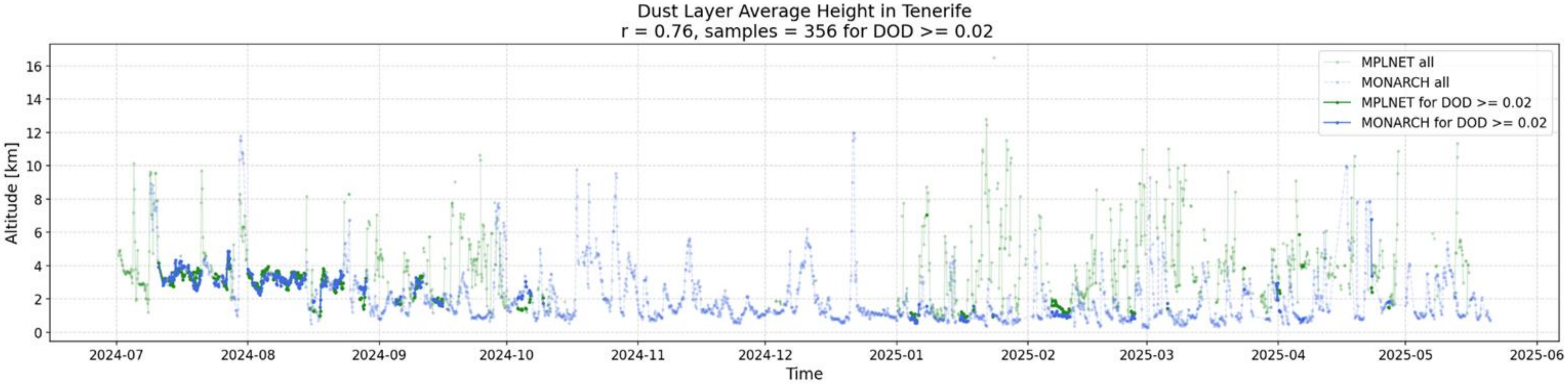
Ansmannn et al (2019)

LIDAR: MPLNET

Courtesy of C. Gilé

- Fair agreement of profile shapes (as seen by ρ)
- Overestimation of MONARCH DOD
- Fair agreement in the mean altitude of the dust mass for dust events



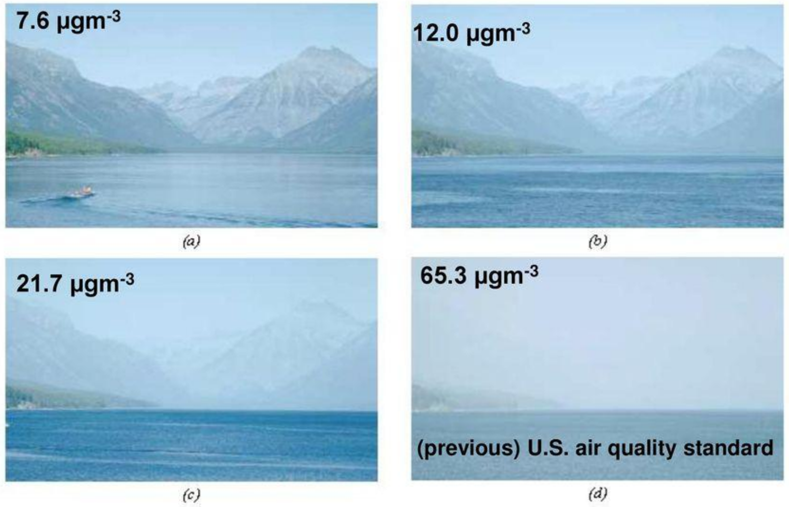


https://dust.aemet.es/resources/evaluation-of-vertical-profiles-of-dust-concentrations

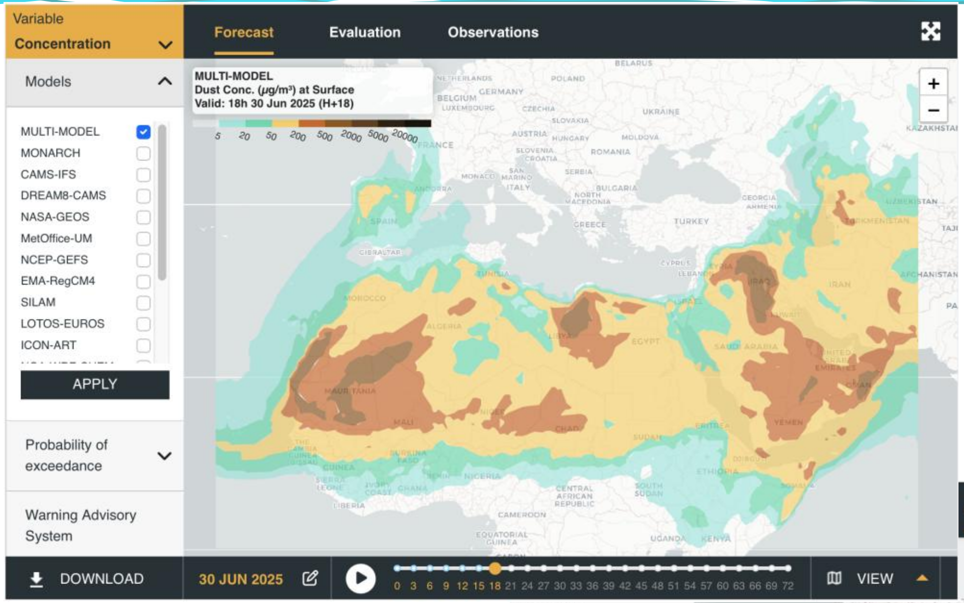
Visibility

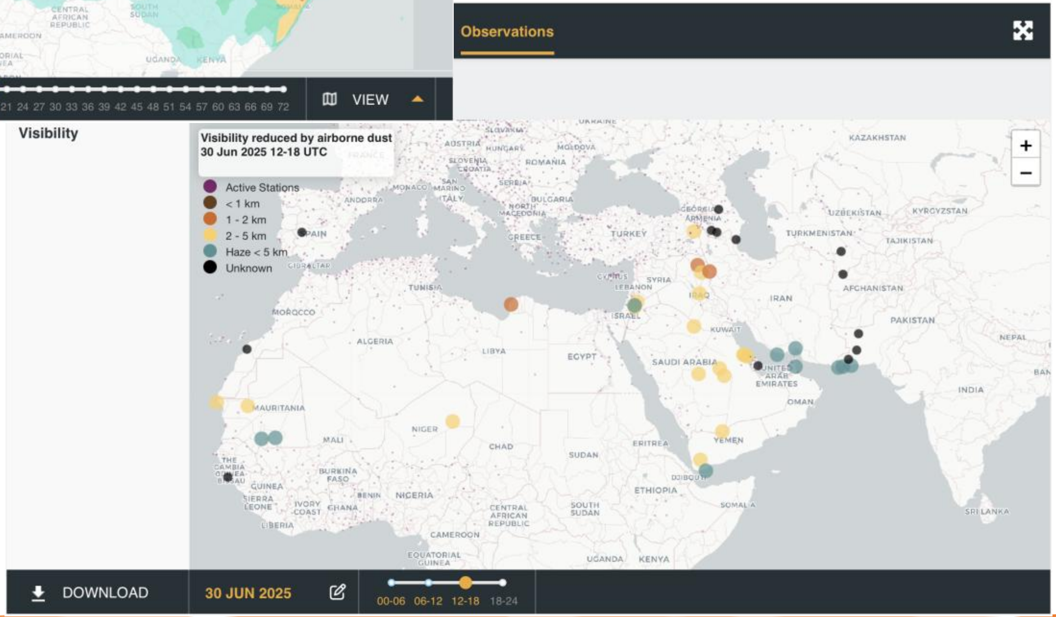
AEROSOL IMPACTS ON VISIBILITY

Visibility degradation by aerosols at Glacier National Park, Montana



Natural aerosol concentrations are typically less than 2 $\mu g\ m^{-3}$





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Reanalysis evaluation

CAMS EAC4 evaluation

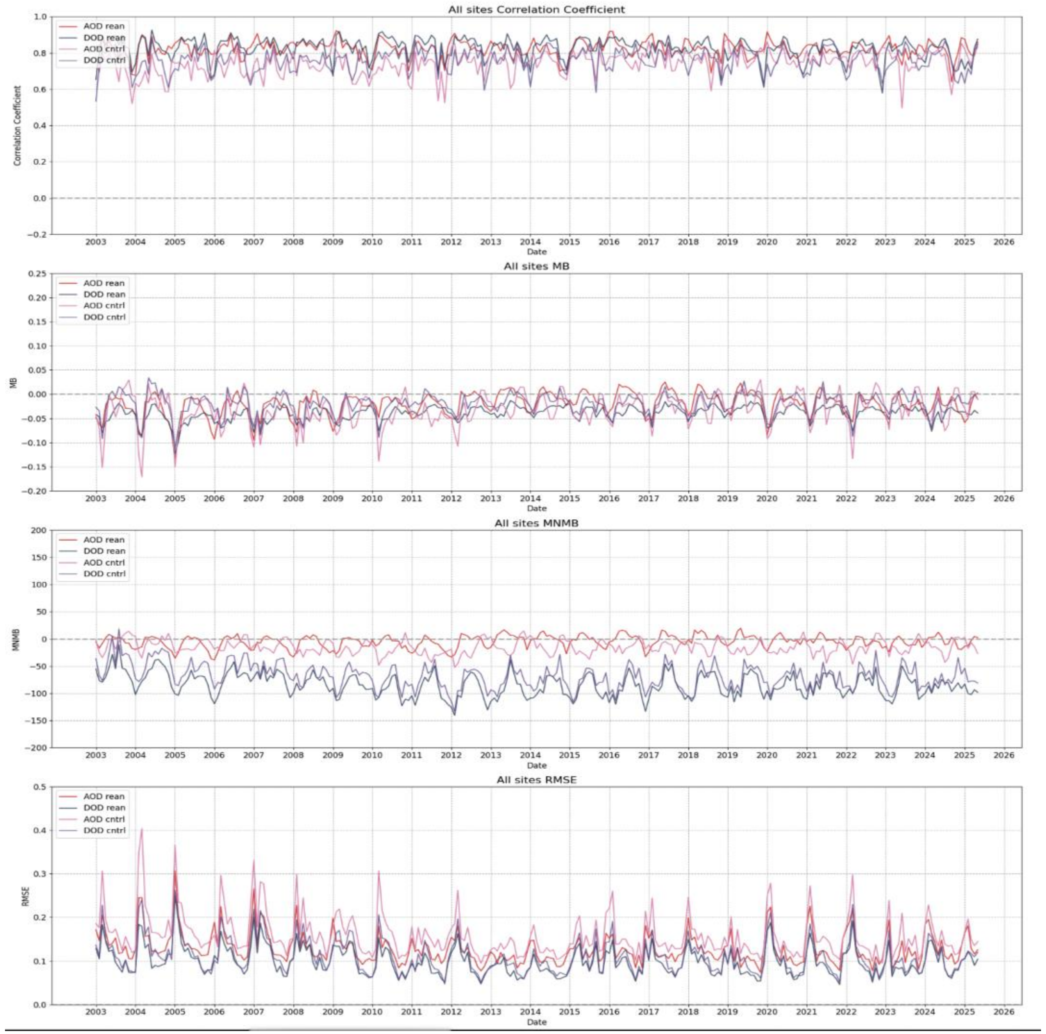
Courtesy of T. Vintimilla

Correlation

Mean bias

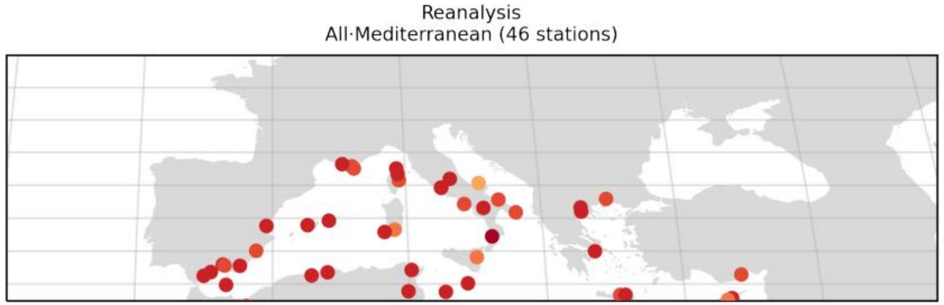
MNMB

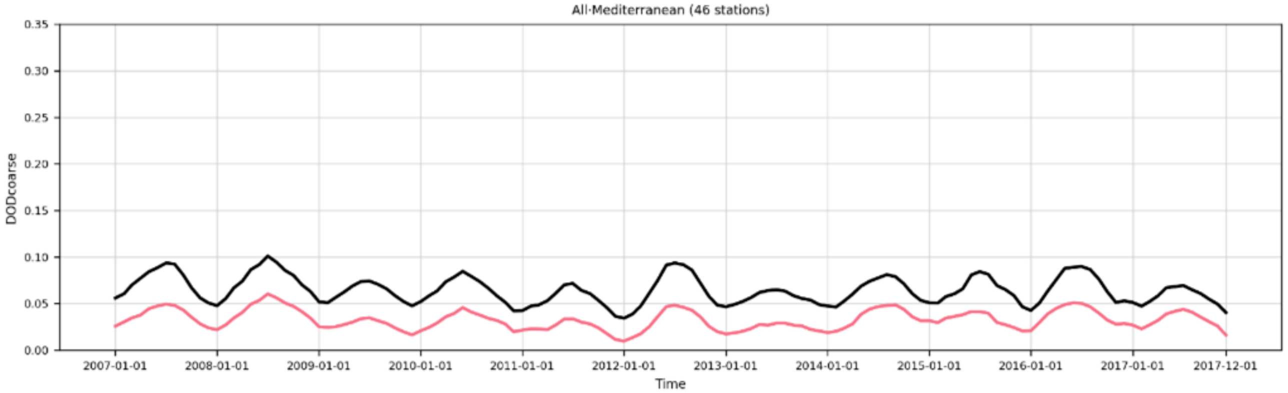
RMSE

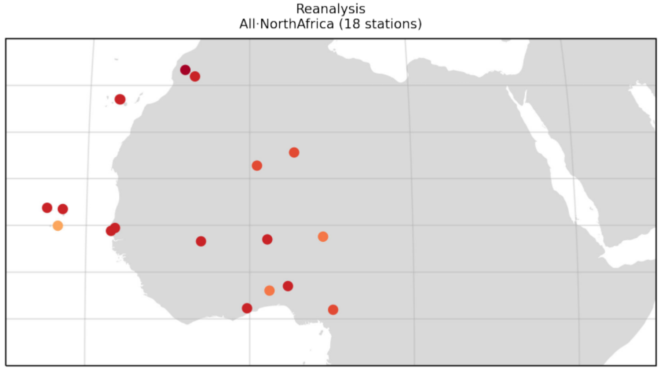


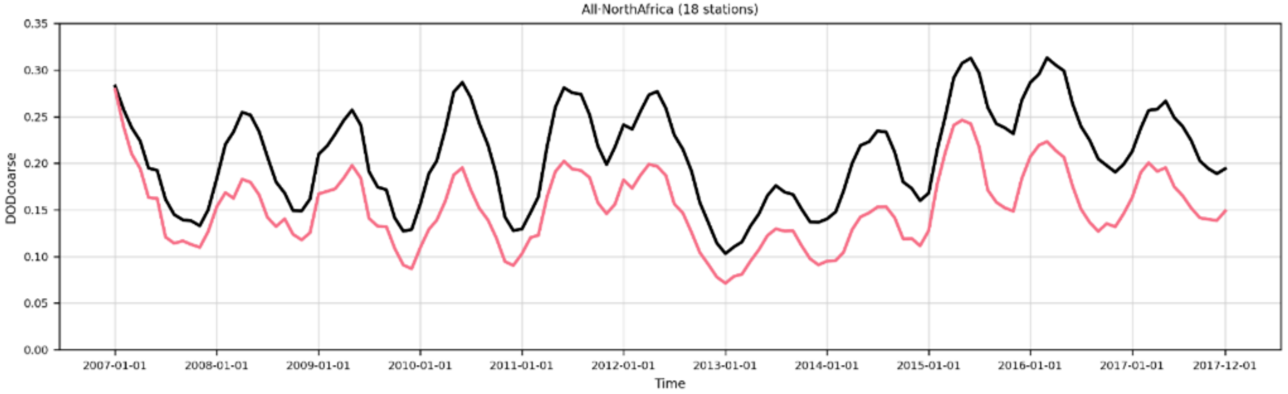
Dustclim evaluation

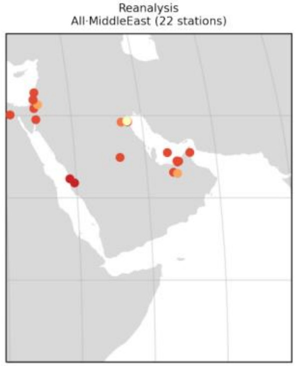
Evaluation against AERONET coarse AOD (O'Neill)

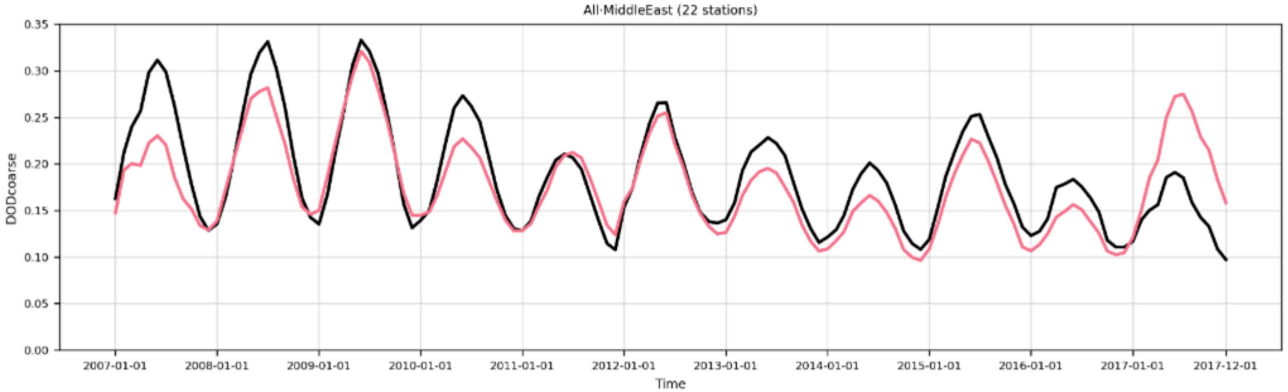












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Dustclim evaluation report

[DustClim: ERA4CS] DELIVERABLE D2.4

ERA4CS European Research Area for Climate Services

Report on reanalysis evaluation results and associated uncertainties

Michail Mytilinaios (CNR-IMAA), Lucia Mona (CNR-IMAA), Serena Trippetta (CNR-IMAA), Francesca Barnaba (CNR-ISAC), Sara Basart (BSC), Enza Di Tomaso (BSC), Jeronimo Escribano (BSC), Carlos Pérez García-Pando (BSC), Oriol Jorba (BSC), Beatrice Marticorena (CNRS), Paola Formenti (CNRS), Claudia Di Biagio (CNRS), Juan Cuesta (CNRS)

Abstract

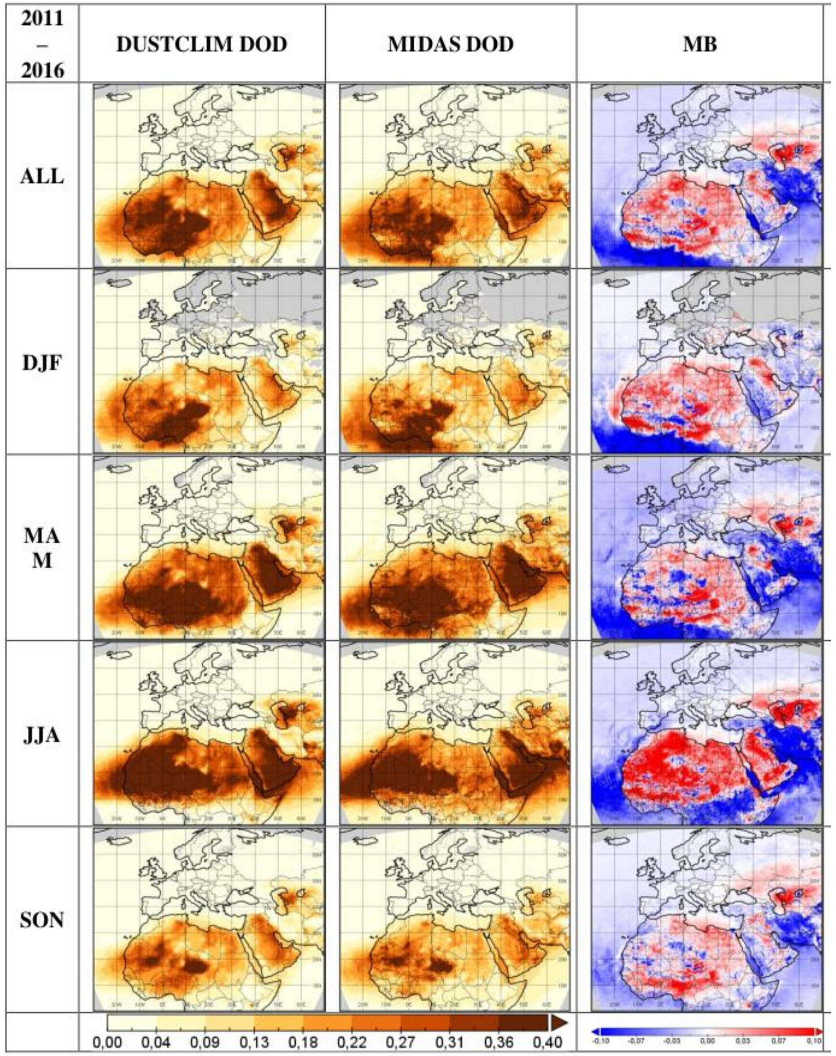
A decadal dust reanalysis for Northern Africa, Middle East and Europe has been produced in the framework of the DustClim project, using the mineral dust module of the MONARCH chemical weather system and by assimilating satellite observations of aerosol optical depth (AOD) with specific observational constraints for dust. As a second step, the evaluation of the MONARCH model reanalysis performance has been carried out using independent datasets grouping observations of variables that are included in the model outputs and are relevant for its scoring. This deliverable describes the approach used to evaluate the reanalysis products and provides a discussion of the first results obtained.

DustClim is supported by the European Commission under the ERA4CS action - Joint Call on Researching and Advancing Climate Services Development, Grant Agreement no. 690462 – ERA4CS – H2020-SC5-2014-2015/H2020-SC5-2015-one-stage

Dustclim evaluation: DOD

MIDAS dataset

Gkikas et al. (2021)



Dustclim evaluation: vertical

LIVAS dataset

Amiridis et al. (2015)

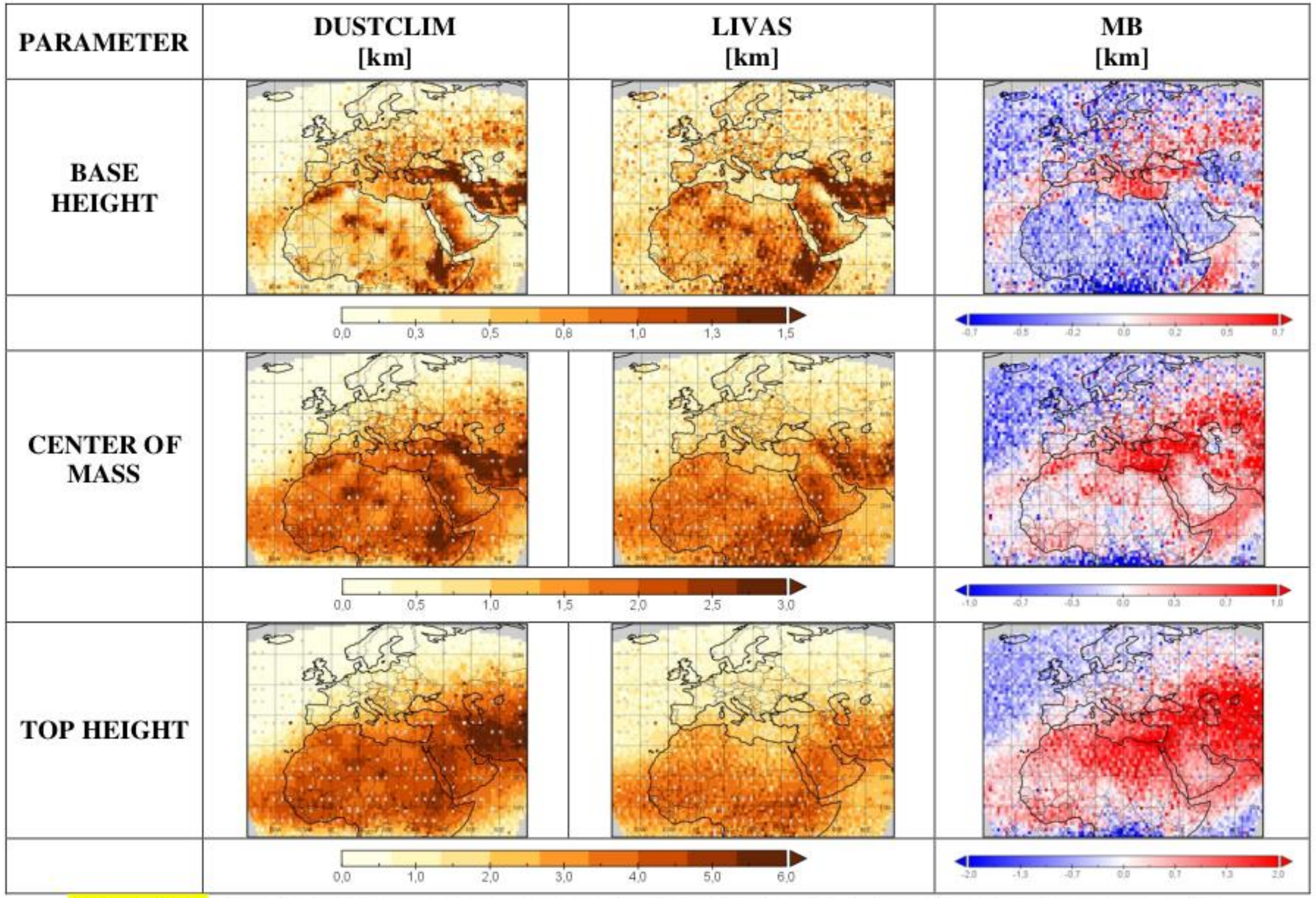


Figure 3.17 Base height (upper row), center of mass (middle row) and top height (lower row) of the dust layer, in km a.s.l., over the DustClim domain, for the period 2011–2016

Dustclim evaluation: surface

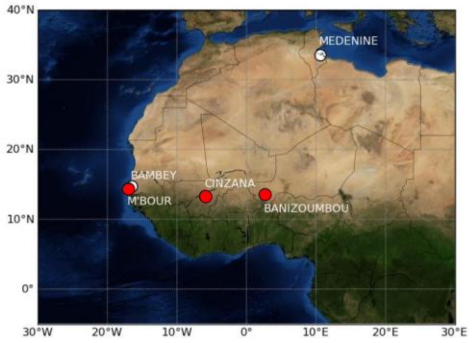
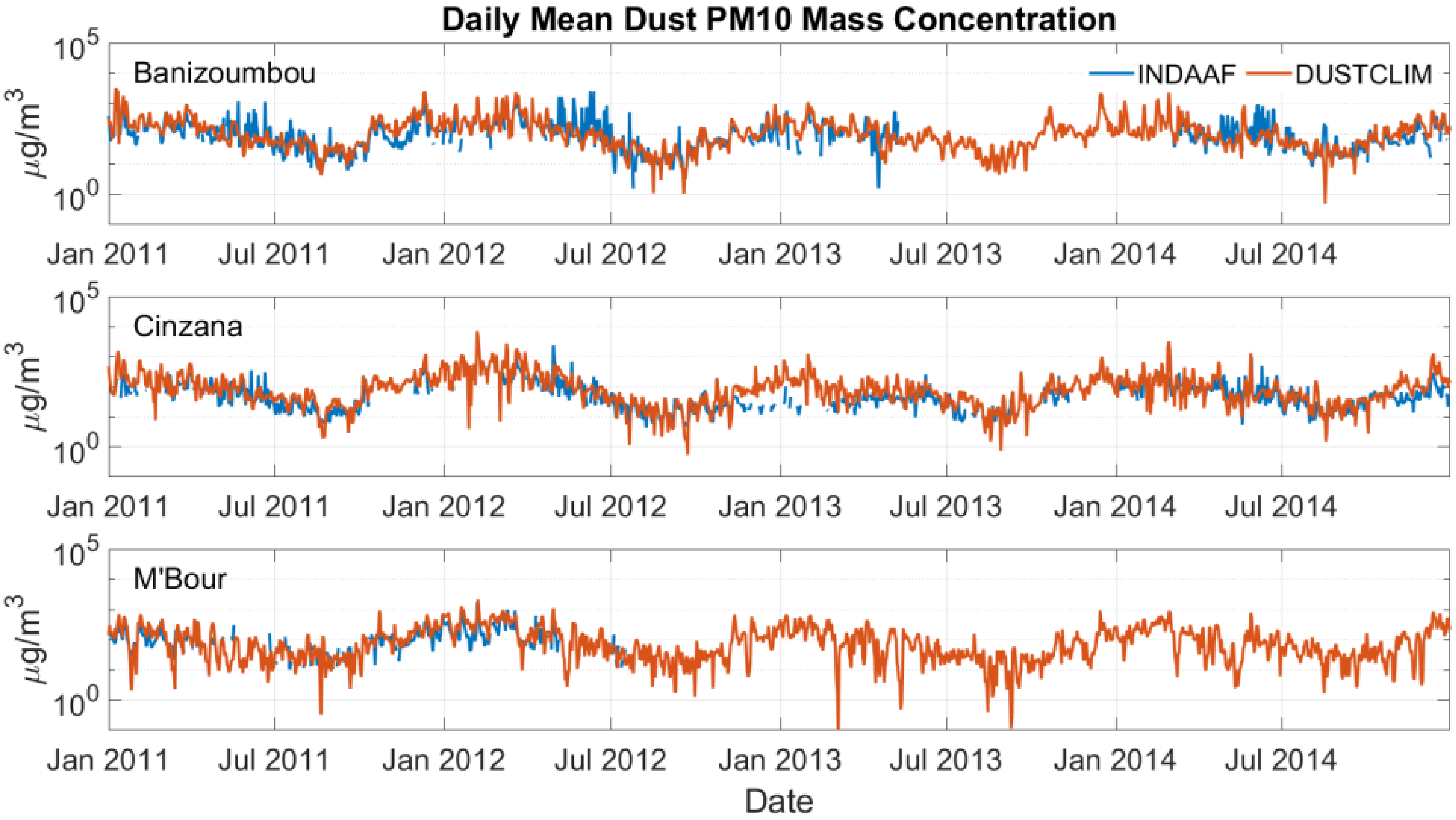


Figure 3.29 The 5 INDAAF/SDT monitoring stations (www.lisa.u-pec.fr/SDT/). The stations used for the DustClim reanalysis evaluation are marked with red dots



Dustclim evaluation: surface

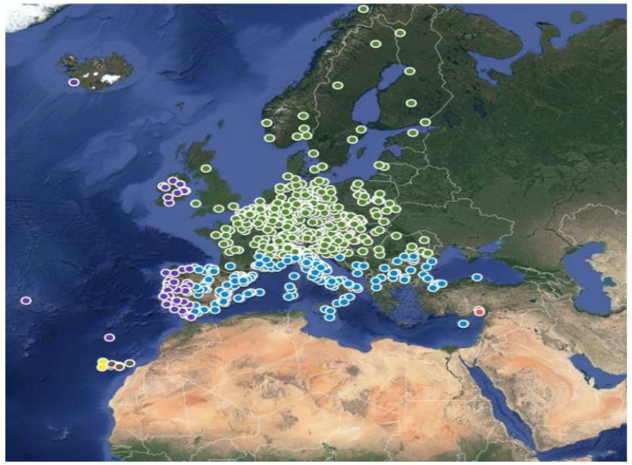
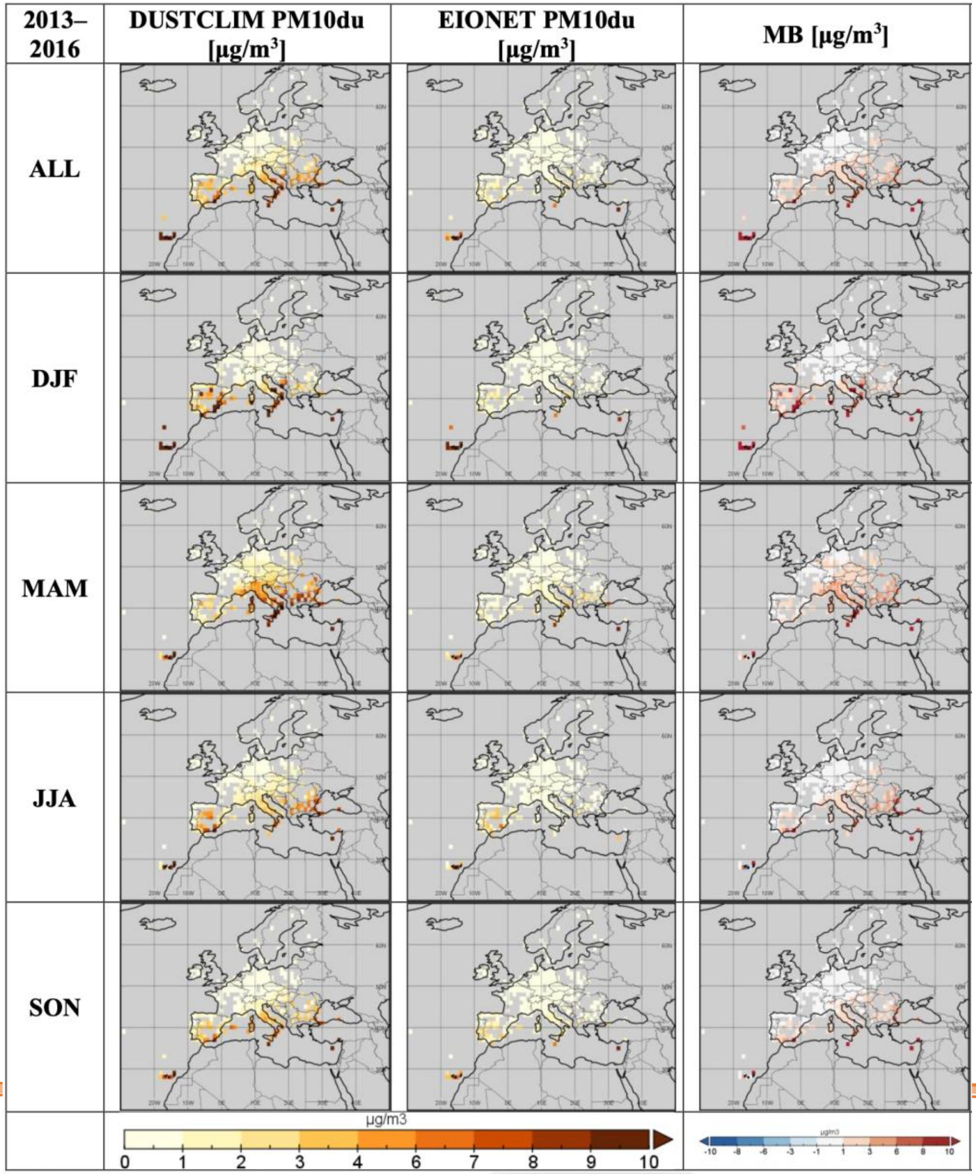


Figure 3.33 EIONET stations indicated with different colors according to the regional division of the DustClim domain (Figure 2.1): Blue for Mediterranean Sea, green for Northern Europe, purple for Subtropical Atlantic, yellow for Tropical Atlantic, brown for Western Africa and red for Western Asia stations.

PM10 dust contribution from Barnaba et al. (2017)



Dustclim evaluation: deposition

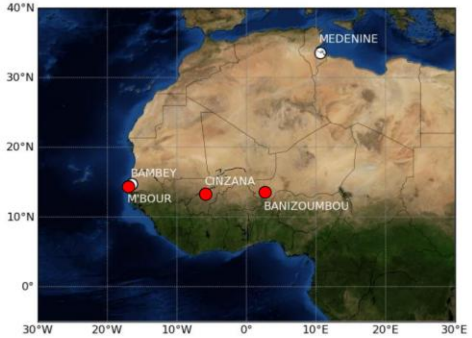


Figure 3.29 *The 5 INDAAF/SDT monitoring stations (www.lisa.u-pec.fr/SDT/). The stations used for the DustClim reanalysis evaluation are marked with red dots*

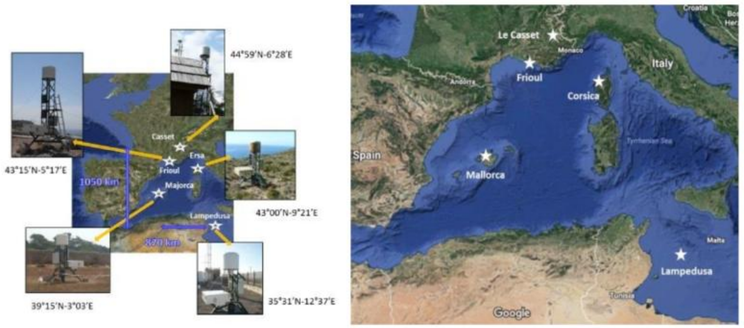


Figure 3.40 *Location of the CARAGA samplers constituting the deposition network deployed in the western Mediterranean basin and southern of France*

	Model				Measured 2012				Measured 2006-2012			
INDAAF	Dry	Wet	**Total**	Wet/Tol	Dry only	Wet	**Total**	Wet/Tot	Dry only	Wet	**Total**	Wet/Tot
Banizoumbou (Niger)	114	107	**221**	49%	39	97	**183**	53%	48	72	**135**	53%
Cinzana (Mali)	137	98	**235**	42%	39	97	**130**	75%	36	79	**119**	66%
M'Bour (Senegal)	108	70	**179**	39%					65	7	**92**	7%
CARAGA									**Measured 2014**			
Medenine (Tunisia)	108	153	**261**	59%							**60**	
					Measured 2012-2013							
Lampedusa (Italy)	17	102	**119**	86%			**7**					
Mallorca (Spain)	1	27	**28**	95%			**6**					
Ersa (Corsica)	1	17	**18**	95%			**2**					

Table 3.21 *Deposition fluxes produced by the reanalysis with the same quantities recorded at INDAAF and CARAGA ground-based stations. The unit in the deposition files are kg m^{-3}. It was assumed that it corresponds to the loss by the surface level and that it corresponds to surface deposition in km m^{-2}.*

Final remarks

- Quantitative evaluation of mineral dust models not straightforward because
  - we never measure only dust!
  - dust amounts vary strongly temporally and geographically
  - ground-truth observations are very sparse in main dust sources regions
- Wide consensus on DOD evaluation not yet there, in the meanwhile we prefer using AERONET coarse optical depth and compare it with coarse dust DOD (but with some care on which error statistics to look at)
- Near real time and extensive evaluation of forecasts and reanalyses of dust is common practice and publicly available
- Mineral dust forecasts generally provide skillful predictions up to 3 days in advance
- Hourly to interannual dust variability well reproduced by reanalyses
- Evaluation strategy should be adapted based on the objective (modeling improvements, air-quality forecasting, solar energy application etc.)

References

1. https://www.cawcr.gov.au/projects/verification/
2. To be updated …

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Funded by the European Union

THANK YOU

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