



CAMAERA

DESERT DUST

A.Uppstu, R.Hänninen, R.Kouznetsov, O.Meinander, M.Sofiev



PROGRAMME OF
THE EUROPEAN UNION



IMPLEMENTED BY



1





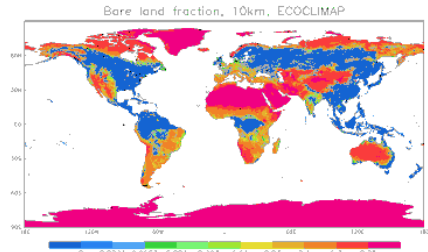
FMI STATUS OVERVIEW

- Introduction
- Dust source
- Applications
 - SILAM reanalysis
 - Lancet Countdown
- Summary

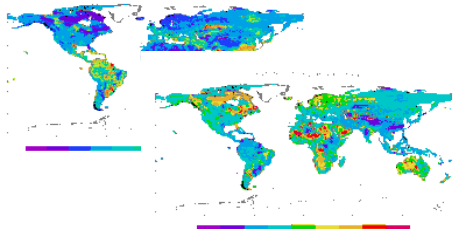


SILAM DUST SOURCE: FROM SOPHISTICATED ...

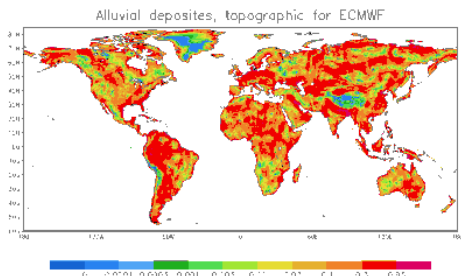
Bare land area



Soil composition

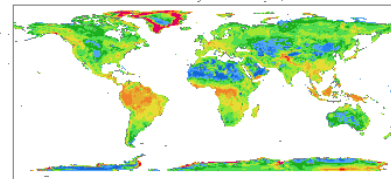


Alluvial deposits



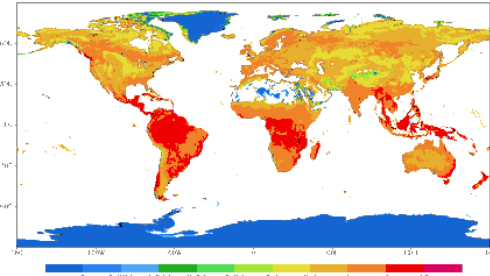
$\tilde{u}_{crit}^*$

Roughness z_0



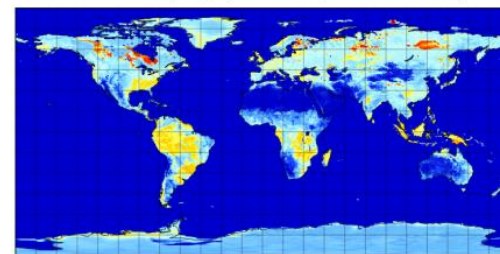
LAI(t)

Leaf area index, month 1, ECOCCLIMAP



Water in soil

Volumetric soil water layer 1 @ Layer between 2 depths below land surface layer



Volumetric soil water layer 1 @ Layer between 2 depths below land surface layer (m**3 m**3)

u_{crit}^*

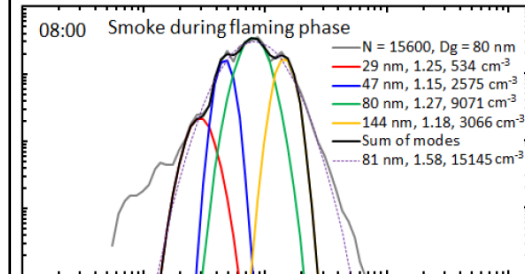
Pmsl and hourly prec. (mm) green:rain blue:snow
initial: 00Z13APR2006 valid: 05Z15APR2006



Meteo:
wind speed
gustiness
turbulence
stability
temperature
precipitations

Entrainment

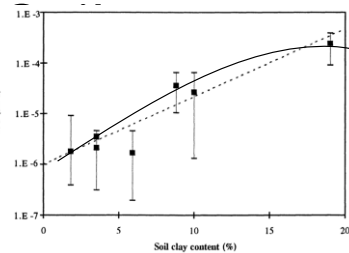
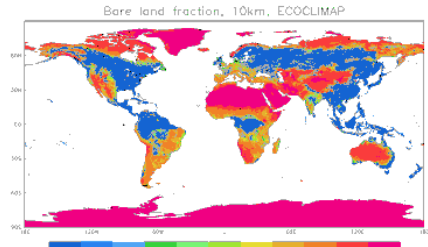
Fine PM:
4 modes





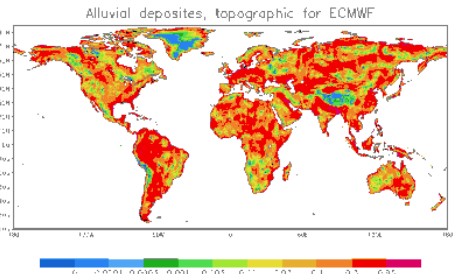
SILAM DUST SOURCE: FROM SOPHISTICATED ...

Bare land area

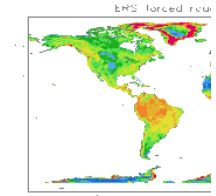


crusty soils
Gillette's obs

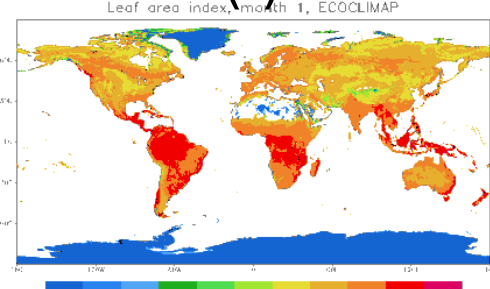
Alluvial deposits



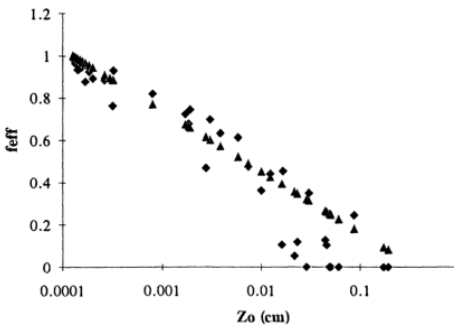
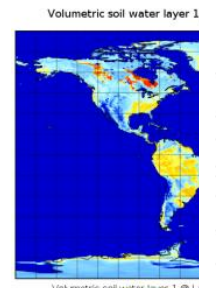
Roughness



LA

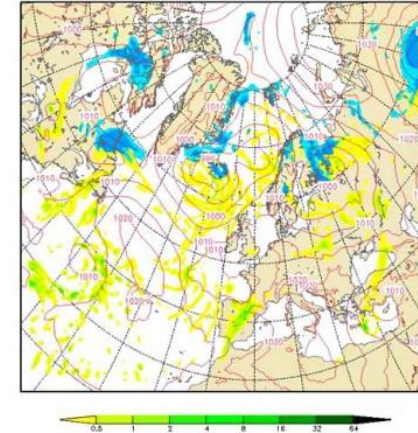


Water in soil



u_{crit}^*

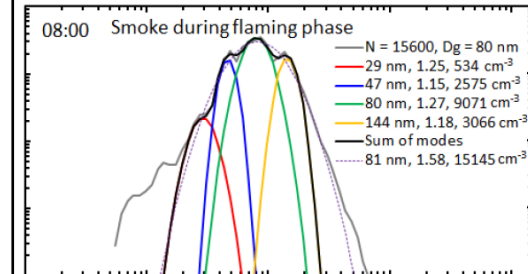
Pmsl and hourly prec. (mm) green:rain blue:snow
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Meteo:
wind speed
gustiness

Entrainment

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4 modes

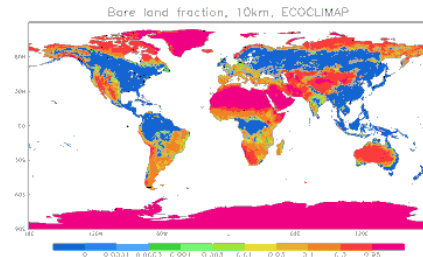


Measurements

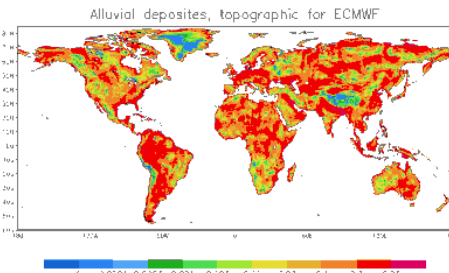


...TO SIMPLE

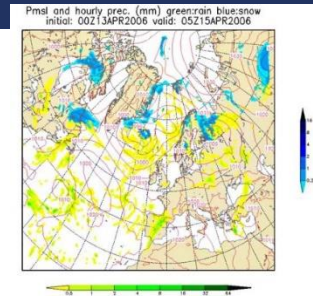
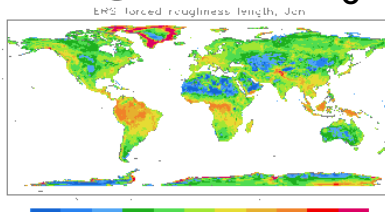
Bare land area



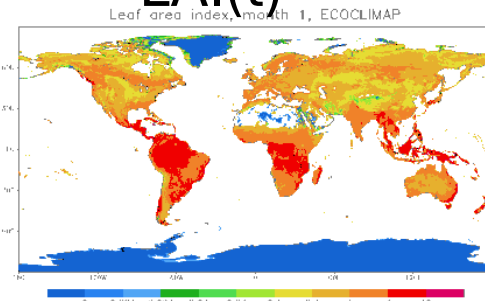
Alluvial deposits



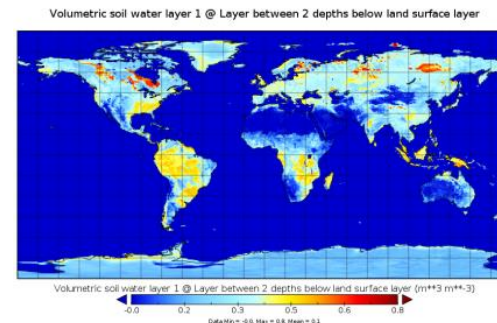
Roughness z_0



LAI(t)



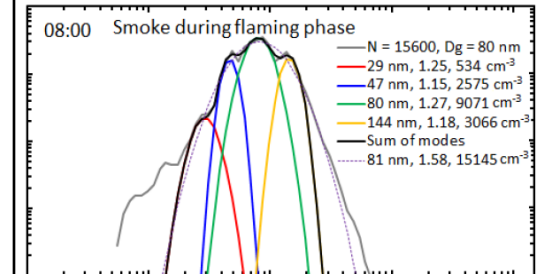
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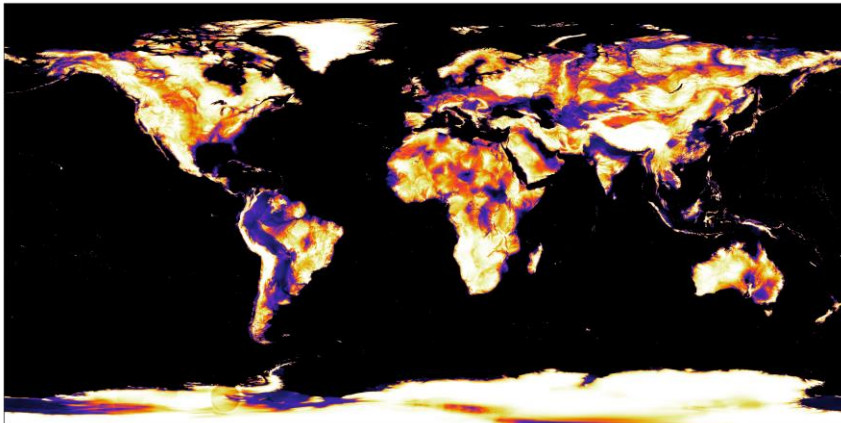
U10m
crit



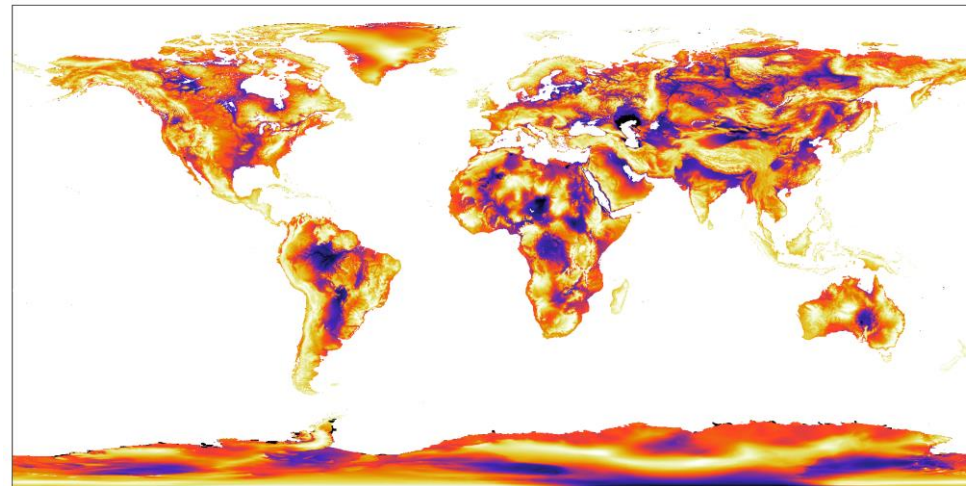
IMPROVING THE GINOUX SHAPE FUNCTION FOR ALLUVIAL DEPOSITS

- Ginoux et al. (2001) developed shape function approach to alluvial deposits
- some major emission areas are filtered out
- the map is full of artifacts
- Better: a fraction of land within a given radius (~1500 km) at an elevation higher than the given point

$$(h-h_{\max})^5/(h_{\max}-h_{\min})^5$$

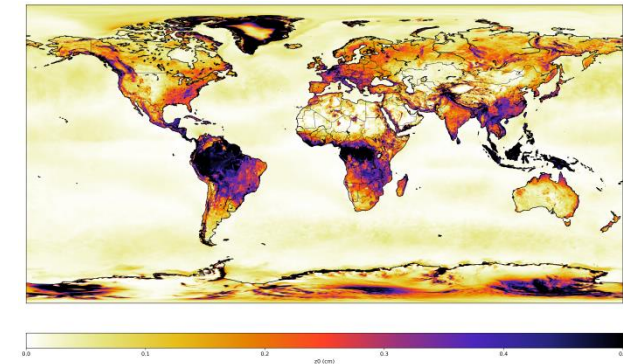


$$(\text{fraction of land elevated higher than } h)^5$$

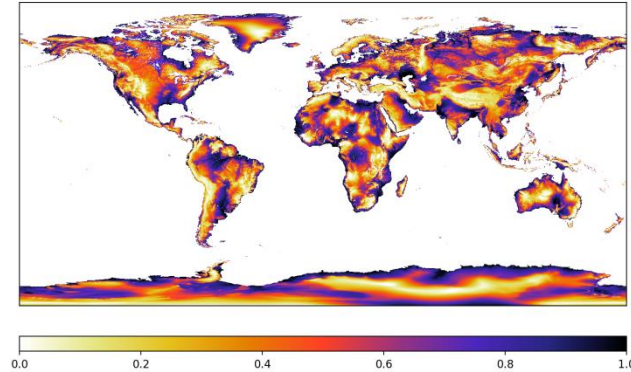




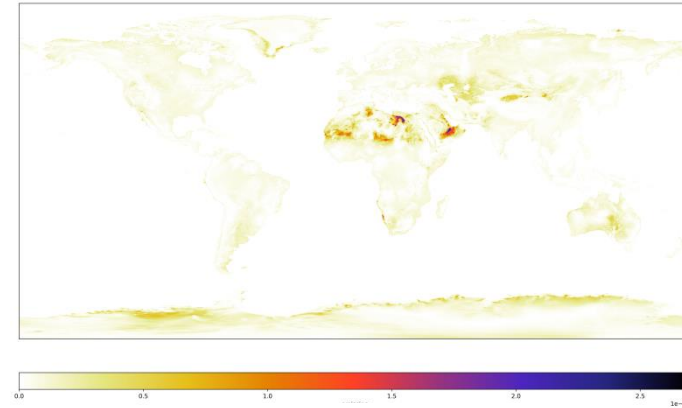
DUST EMISSION MAP



roughness



proxy for alluvial deposits

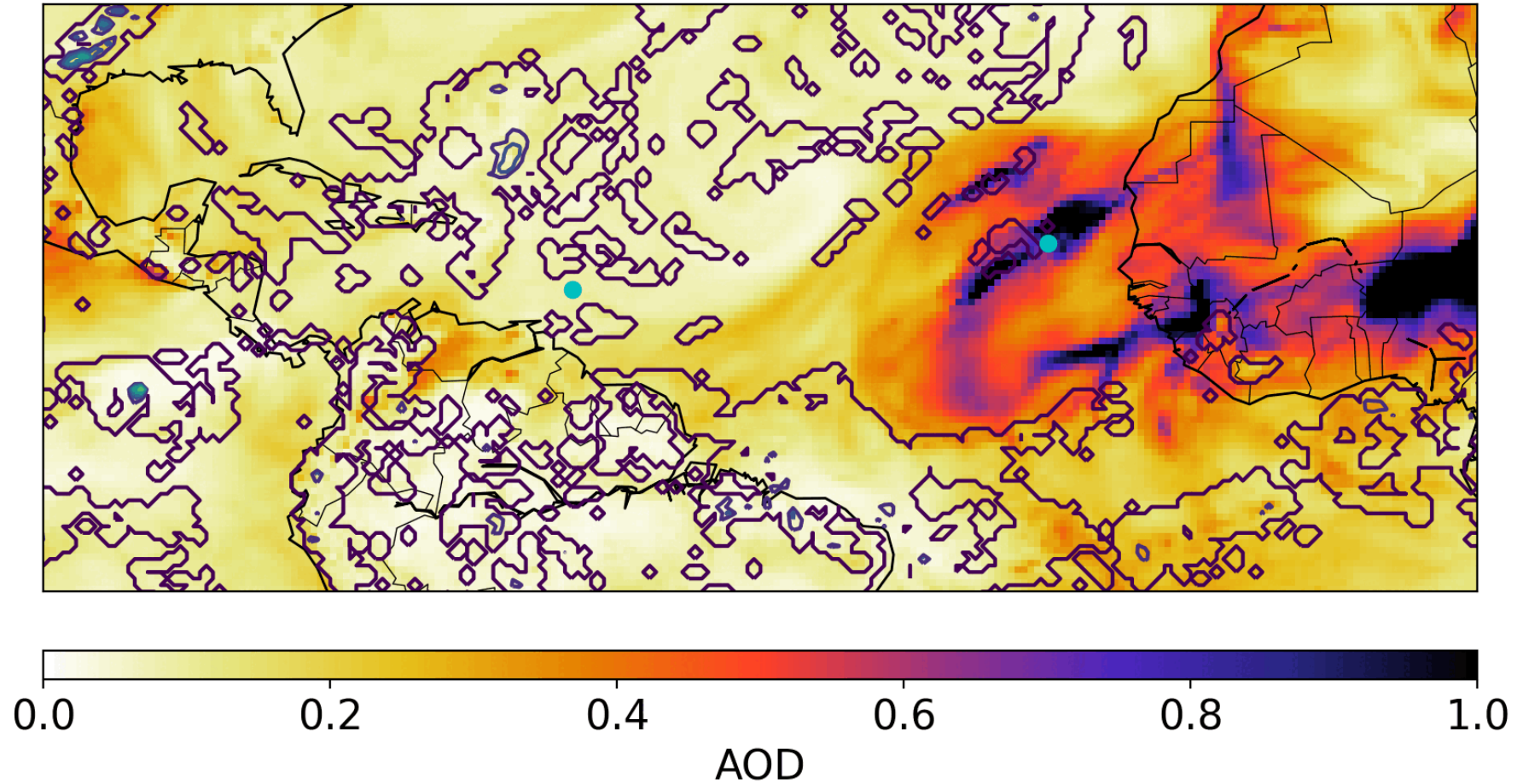


Base map for emission



FOR ALL SPECIES: LIMITED SCAVENGING

limited scav 2017-04-11 00:00:00





EVALUATION WITHIN SDS-WAS

Right variable?
Nope...

Browser address bar: <https://dust.aemet.es/products/daily-dust-products?tab=evaluation§ion=statistics>

Network: Aeronet v3 lev1.5 | Models: 16 models | Statistics: 2 statistics | Timescale: Monthly | Selection: April 2025

APPLY VIEW MAP

r											
Station	MULTI-MODEL	Monarch	Cams	Dream8-Macc	Nasa-Geos	Metoffice	Ncep-Gefs	Ema-Regcm4	Silam	Lotos-Euros	Icon-Art
Europe	0.44	0.41	0.39	0.36	0.39	0.34	0.40	0.01	0.31	0.37	0.53
Mediterranean	0.75	0.68	0.75	0.67	0.74	0.66	0.67	0.14	0.51	0.68	0.69
MiddleEast	0.75	0.63	0.70	0.64	0.69	0.64	0.65	-0.00	0.60	0.56	0.70
NAfrica	0.85	0.68	0.74	0.72	0.86	0.79	0.74	0.07	0.75	0.71	0.78
Total	0.82	0.73	0.75	0.71	0.81	0.75	0.74	0.12	0.71	0.71	0.77
RMSE											

DOWNLOAD

Explore related products

The WMO Barcelona Dust Regional Center offers a wide range of dust products that serve the need for detailed dust information on a regional scale. We encourage you to explore other dust-related products.



SILAM DUST, FIRE, AQ REANALYSIS

- Global spin-up 1900-1980, $2^\circ \times 2^\circ$
- Main period, target: 1980-2024, $0.5^\circ \times 0.5^\circ$
available: dust & fire PM, 1980-2024, $0.5^\circ \times 0.5^\circ$
AQ 1980-2024, $2^\circ \times 2^\circ$
- Troposphere and stratosphere
- AQ, PM, GHG, ozone depleting species
pollen (Europe only, 1980-2024, $0.1^\circ \times 0.1^\circ$)
- Special period: 2003-2024, MODIS era



LANCET COUNTDOWN DUST

- Ensemble of dust models
 - CAMS-RA (Copernicus Atmosphere Monitoring Service Reanalysis)
 - NAAPS-RA (Naval Research Laboratory Navy Aerosol Analysis and Prediction System Reanalysis)
 - NASA MERRA-2 (NASA Modern-Era Retrospective analysis for Research and Applications, Version 2)
 - SILAM (Finnish Meteorological Institute System for Integrated modelling of Atmospheric composition)
- 2003-2023
- Population exposure



POPULATION WEIGHTED DAYS OF HIGH EXPOSURE TO DUST

- Picture under embargo for a peer-review in The Lancet. To appear in (Romanello et al, The Lancet, 2025)

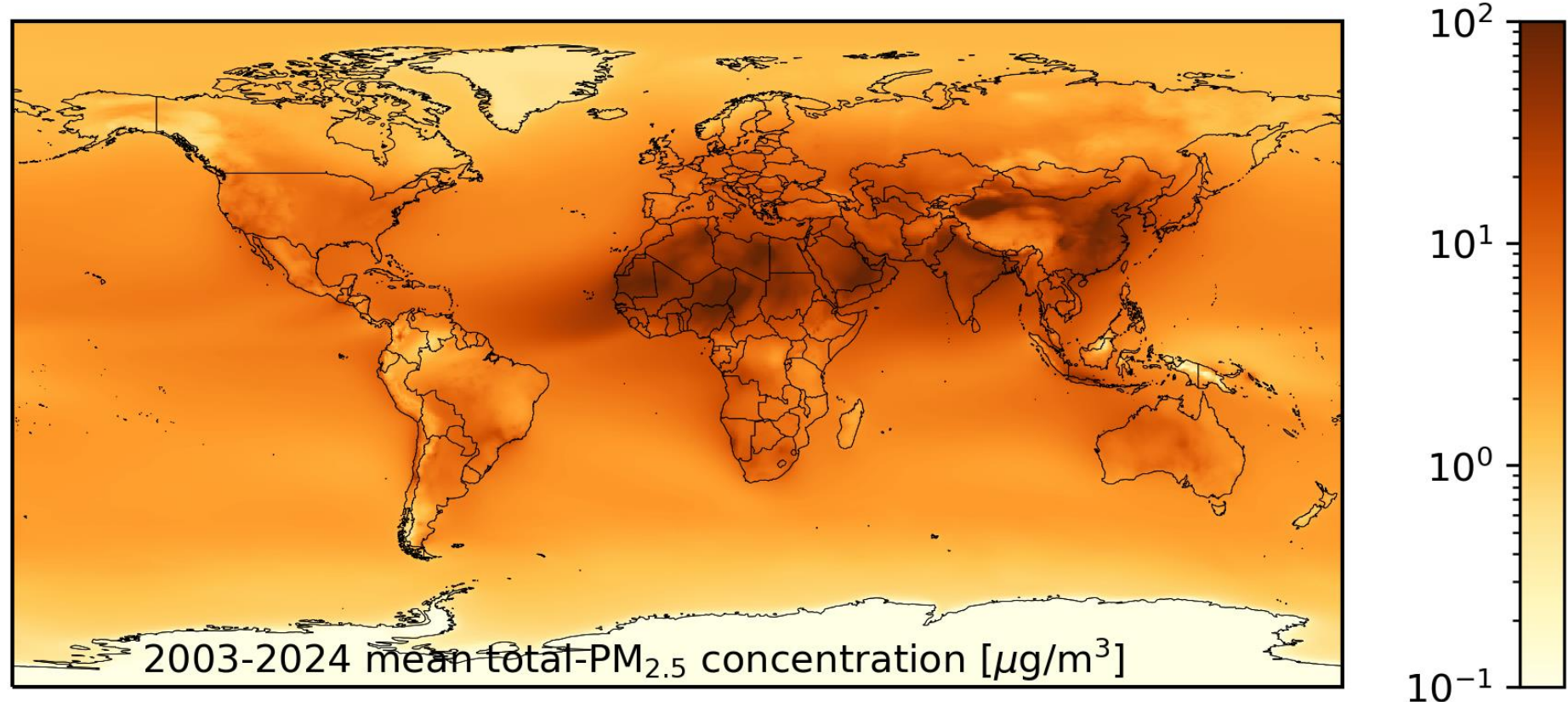
Population-weighted days of exposure to desert dust PM10 above 45 $\mu\text{g}/\text{m}^3$ for 2003-2023

Under review. Not for sharing



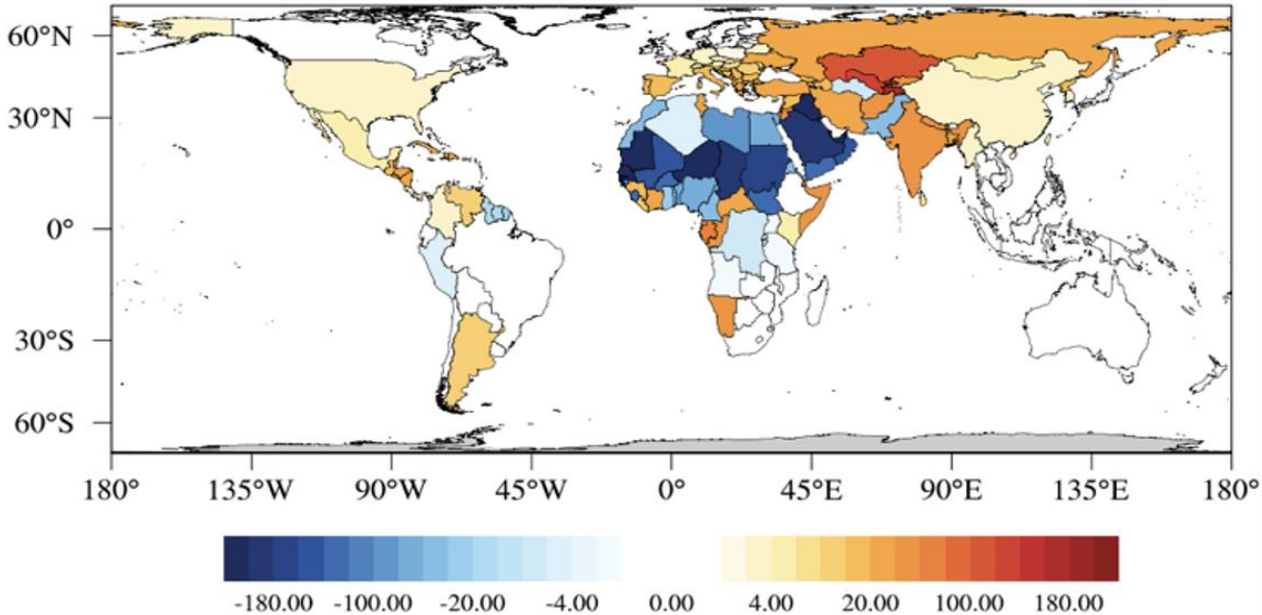
...AND TOTAL PM

- Exposure to total PM_{10} ; Figure: mean total $\text{PM}_{2.5}$ 2003-2024
- SILAM reanalysis
- Country-wise exposure and trend





LC-2024 VS 2025, DUST ENSEMBLE



LC 2024. Figure 5: Change in population-weighted days of exposure to dust-PM₁₀ higher than 45 µg/m³ from 2003–2007 to 2018–2022. (Romanello et al, The Lancet, 2024)

Picture under embargo for a peer-review in The Lancet. To appear in (Romanello et al, The Lancet, 2025)

LC2025. Figure 38: Change in mean annual days per person of exposure to desert dust higher than 45 ug/m³ from 2003-12 to 2019-23 (unit: days yr⁻¹ per person).

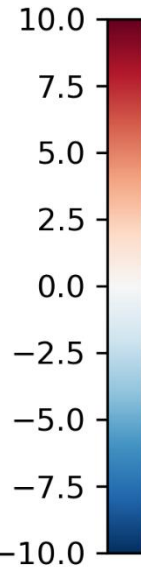
Under review. Not for sharing



PM_{2.5} ANNUAL ANOMALIES: DRIVEN BY DUST AND FIRES

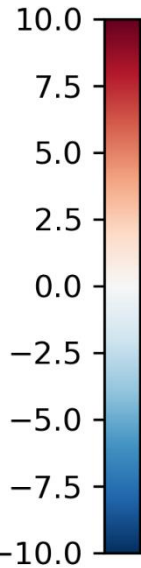
2003

2003 total-PM_{2.5} anomaly from 2003-2024 mean [$\mu\text{g}/\text{m}^3$]



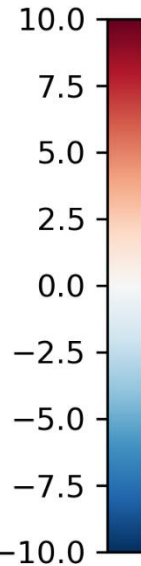
2010

2010 total-PM_{2.5} anomaly from 2003-2024 mean [$\mu\text{g}/\text{m}^3$]



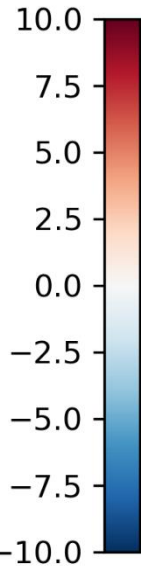
2009

2009 total-PM_{2.5} anomaly from 2003-2024 mean [$\mu\text{g}/\text{m}^3$]



2023

2023 total-PM_{2.5} anomaly from 2003-2024 mean [$\mu\text{g}/\text{m}^3$]





SUMMARY

- The desert dust source with optimized set of parameters has been made, evaluated and implemented in IFS
- Several presumably meaningful dependencies proved deteriorating the model skills
 - noise in the data is more significant than added value
- Application over MODIS time suggested some reduction of dust release from Northern Africa
 - ...with simultaneous increase of the number of days with high concentrations