CAMAERA

A NEW WIND-BLOWN DUST SOURCE IN SILAM: SIMPLE APPROACH WORKS BEST

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PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Coordinated by HYGEOS

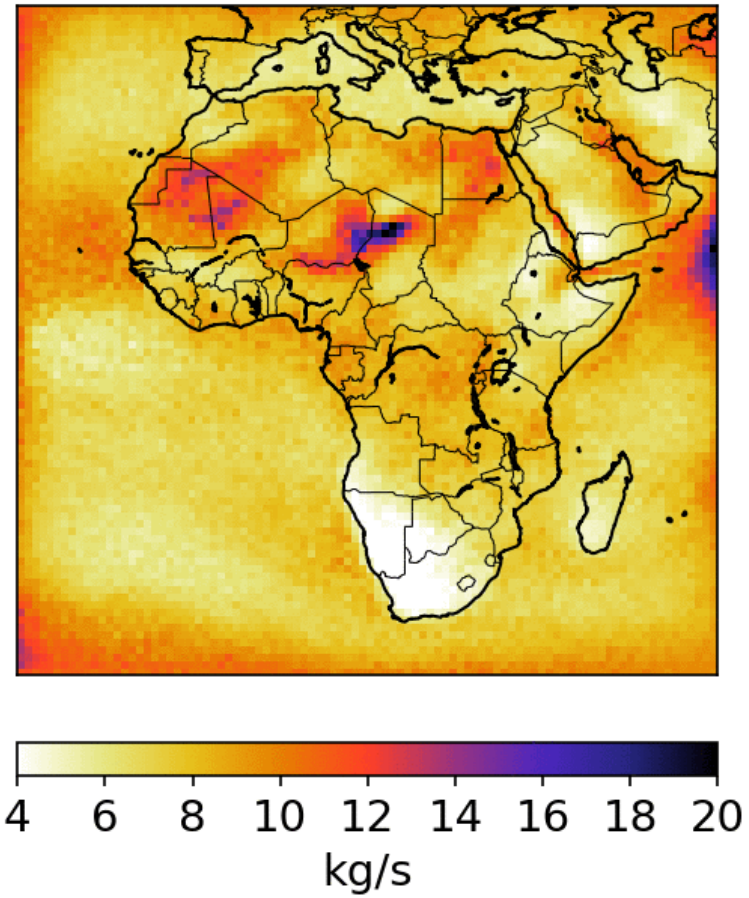
BACKGROUND

- SILAM had a complex dust emission model, but performance against AERONET observations was not particularly good
- The model was based on a multitude of parameters, and it was very difficult to tune them for better performance
- Emission assimilation of MODIS AOD was performed to get a basic idea about the correct dust emission

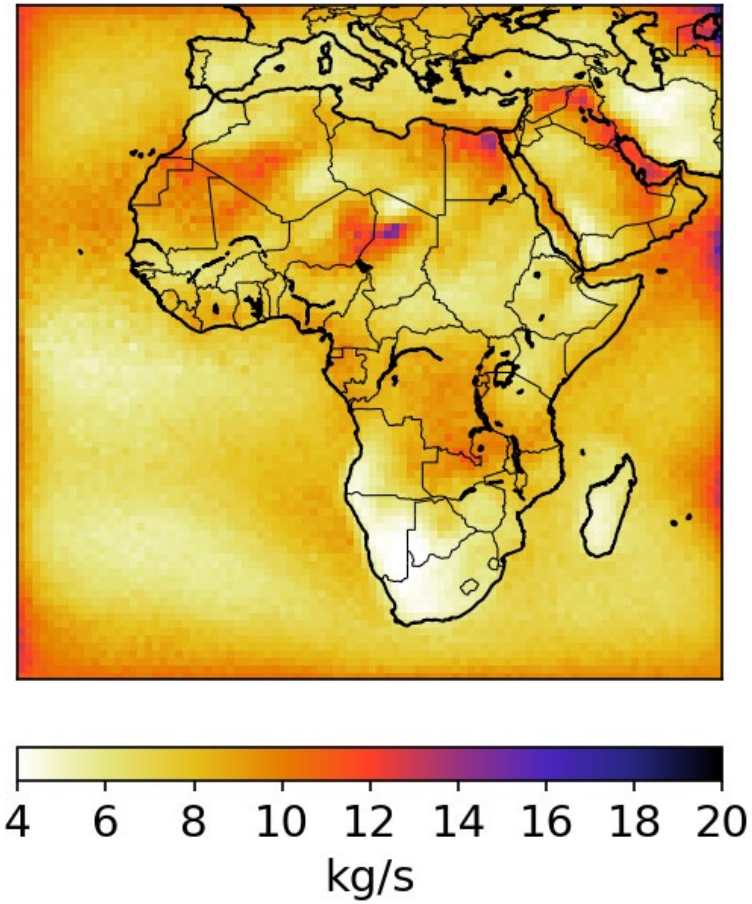
RESULT OF ASSIMILATION

Emission by time

Jan 01

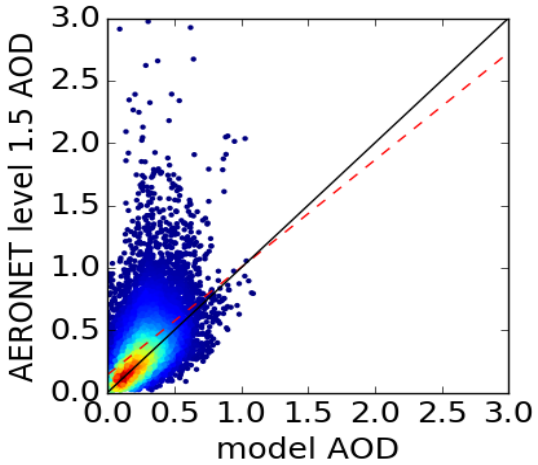


Average full year emission

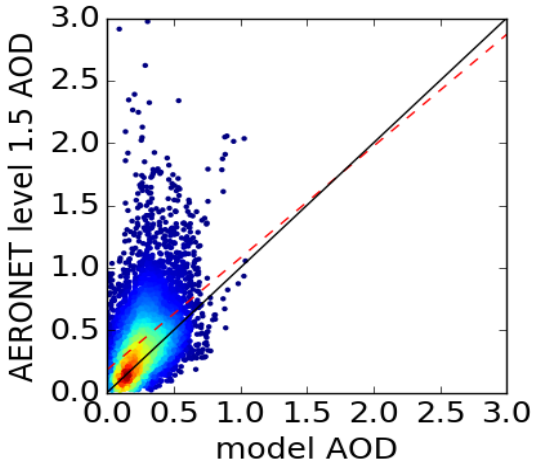


COMPARISON AGAINST AERONET

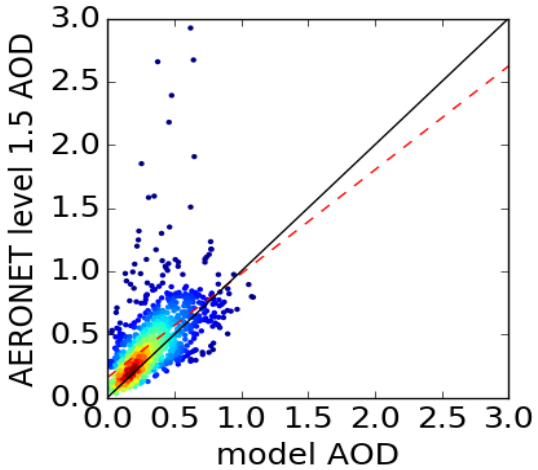
All points



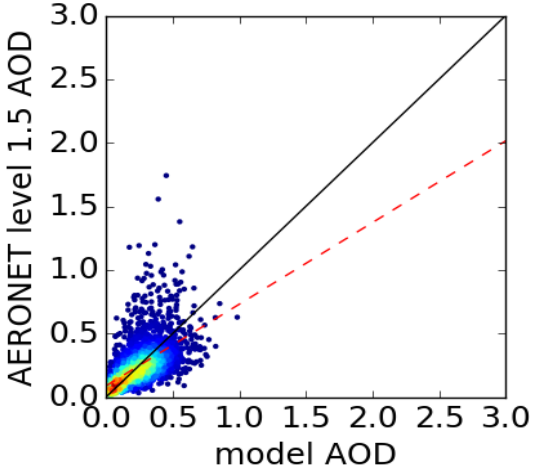
Sahara/Sahel



Middle East



Mediterranean



RMSE

	SILAM old	SILAM test	SDS-WAS median
Sahel/Sahara	0.39	0.34	0.31
Middle East	0.42	0.27	0.33
Mediterranean	0.20	0.15	0.15
All regions	0.35	0.29	0.28

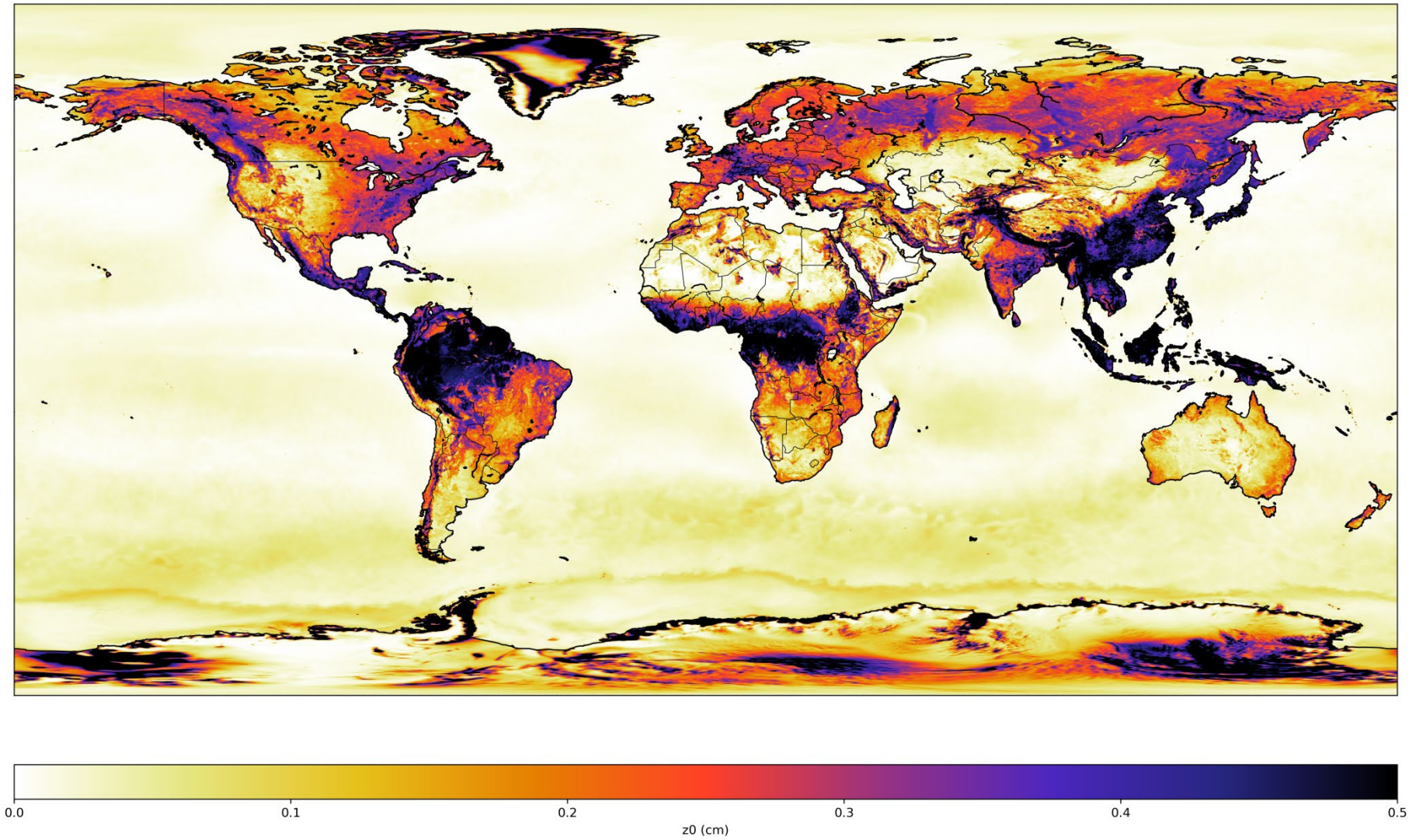
Correlation coefficient

	SILAM old	SILAM test	SDS-WAS median
Sahel/Sahara	0.39	0.42	0.75
Middle East	0.13	0.56	0.52
Mediterranean	0.60	0.57	0.72
All regions	0.44	0.47	0.74

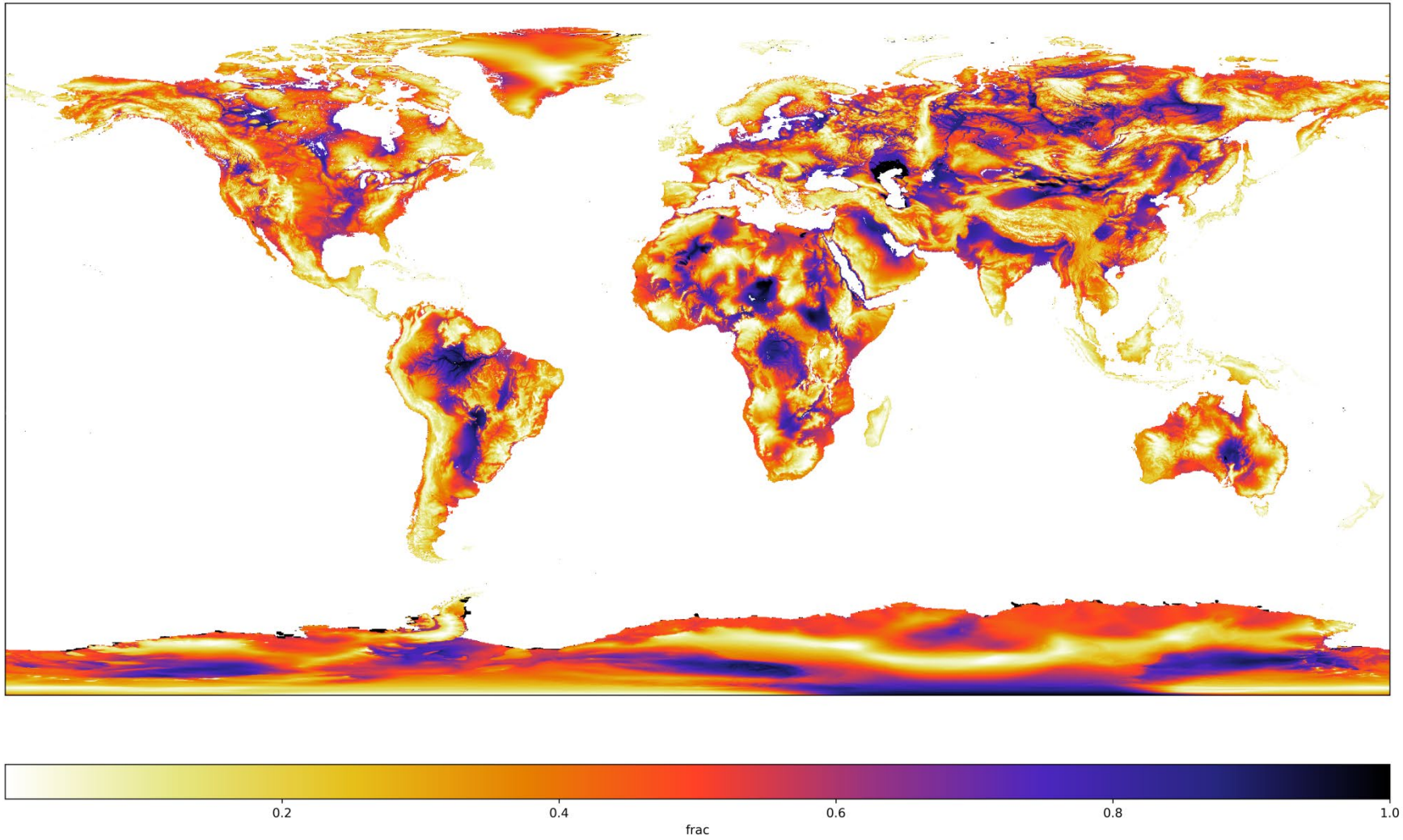
HOW TO FIND A BASIC EMISSION MAP

- Now we know that even with crude climatological emissions, we can beat some dedicated dust emission models
- Can we obtain a similar average emission using non-assimilated data?
  - Surface roughness from satellites
  - Ginoux shape function
- With a dynamic component, the performance would likely be still much better

RETRIEVED SURFACE ROUGHNESS FROM THE ADVANCED SCATTEROMETER (ASCAT) JULY 2022



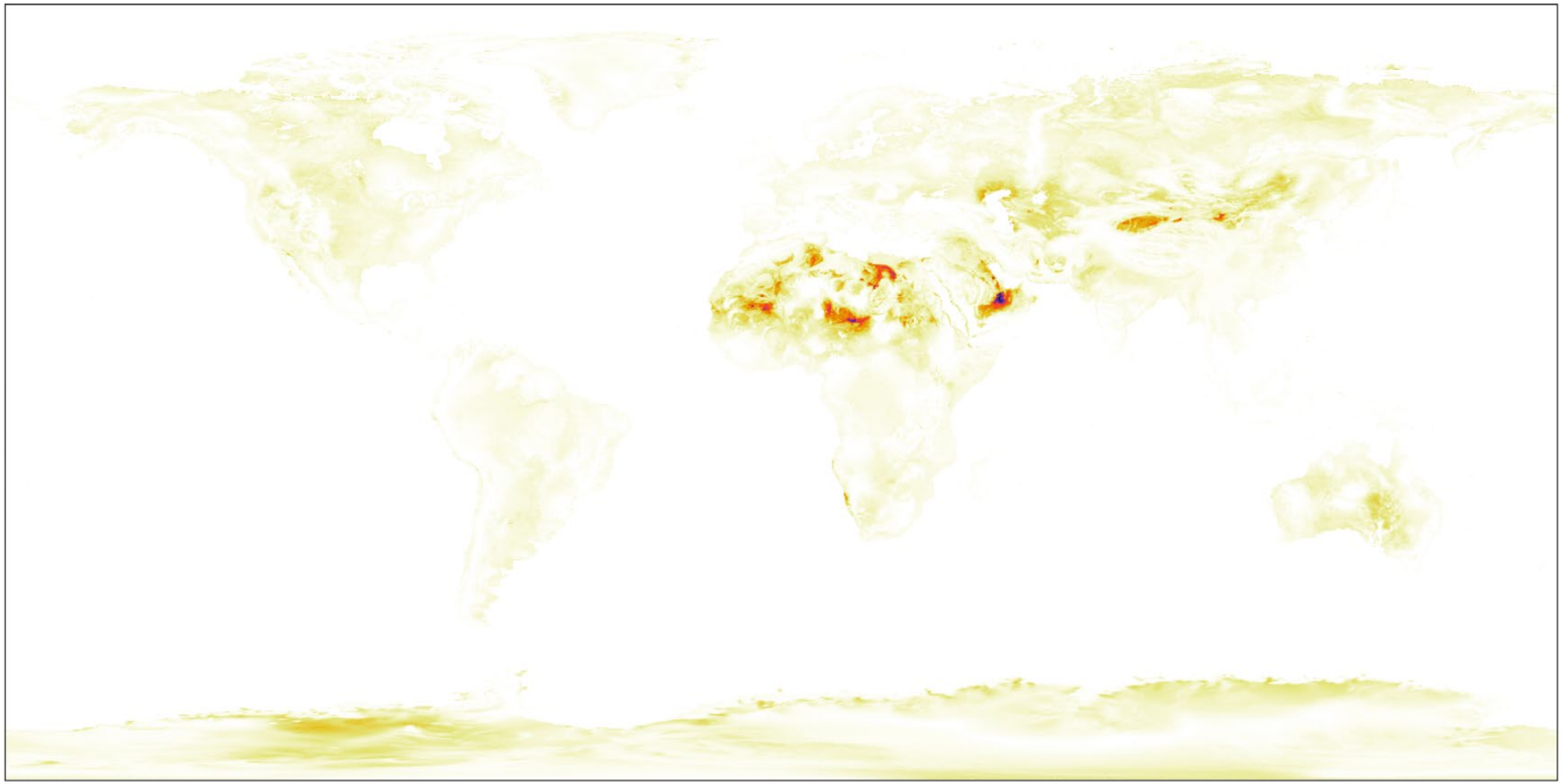
MODIFIED GINOUX FUNCTION



- Fraction of land within a 10 degree radius at a higher elevation than the current point
- Original Ginoux shape function leads to a map full of artefacts and misses the El Djouf depression

RESULTING EMISSION MAP

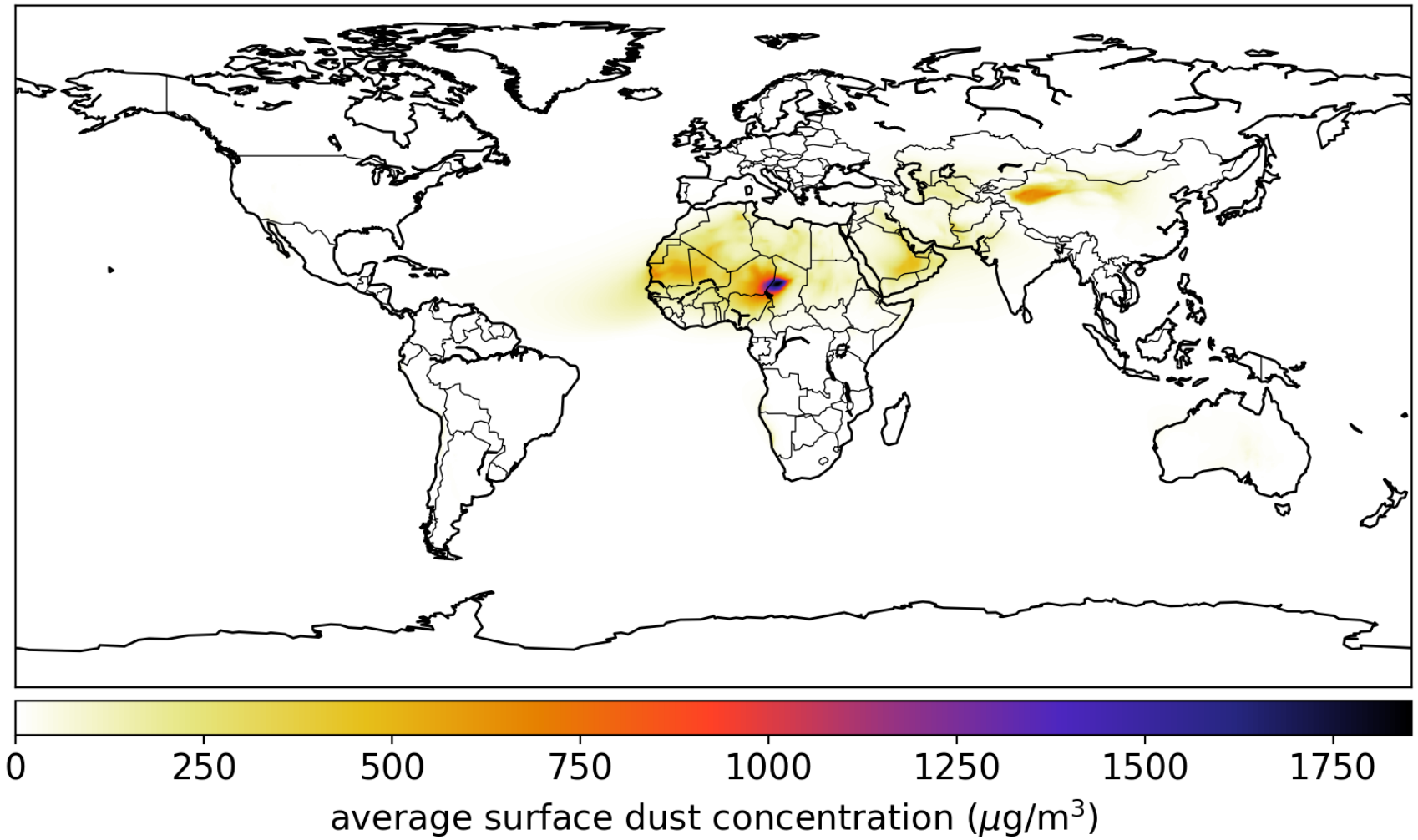
deposit_map / roughness$^{0.5}$

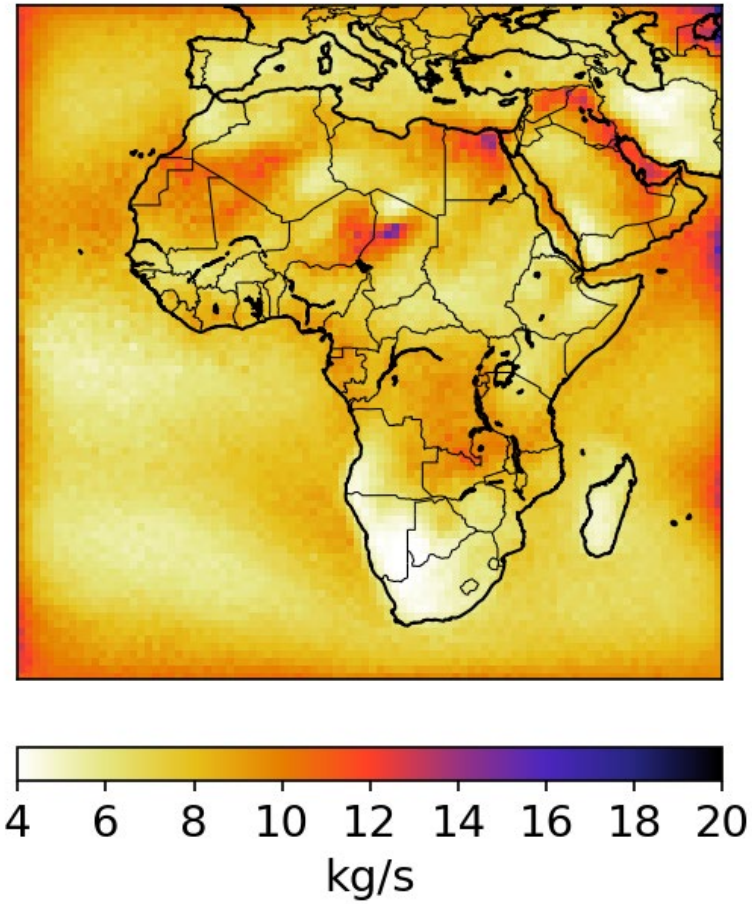


SILAM DUST EMISSION MODEL

- Dust emission ~ deposit_map / roughness$^{0.5}$ • max($U_{10m} - U_0$, U_{min})^3
- V_{min} = 1.4 m/s
- v_0 = 5 m/s + constant • soil_moisture
- Leaf area index and snow depth are used to turn off the emission
- deposit_map / roughness$^{0.5}$ acts as a base emission map, that can in principle be tuned through assimilation
- The emission may be scaled with an alluvial deposit map
- No soil data (such as clay or sand fractions) are used
  - The impact of clay on the emission of dust is complex, as there are subcell scale correlations with the clay fraction and other features impacting the dust emission (such as vegetation cover and soil moisture)
  - Soil data maps seem to be of questionable quality in the major emission areas of dust
  - Clay can form a crust, strongly reducing dust emission

AVERAGE SURFACE CONCENTRATION





PERFORMANCE AGAINST AERONET (2017)

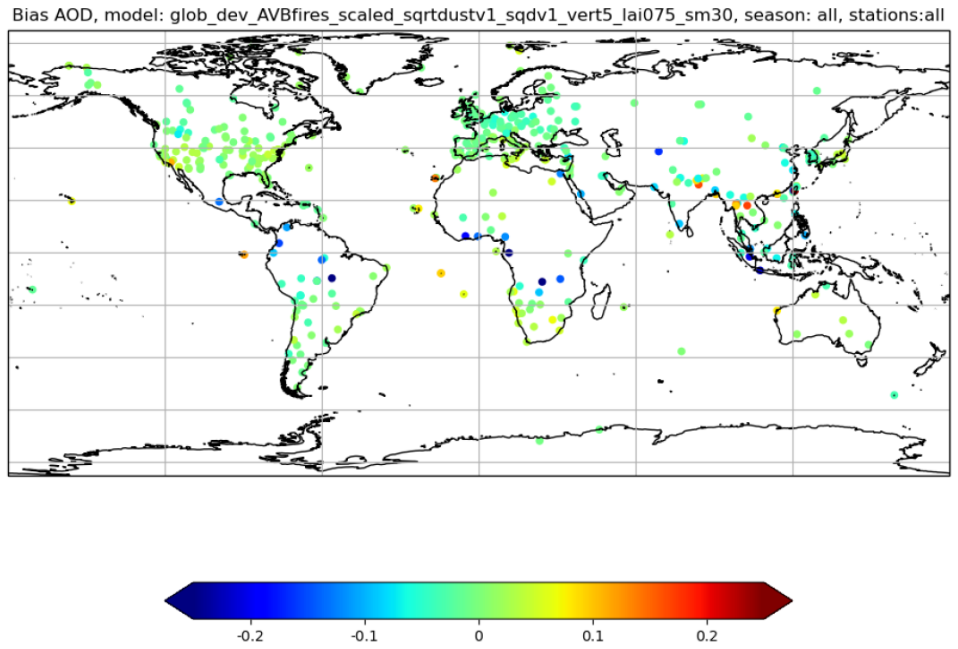
Mean model: 0.158
Mean obs: 0.163

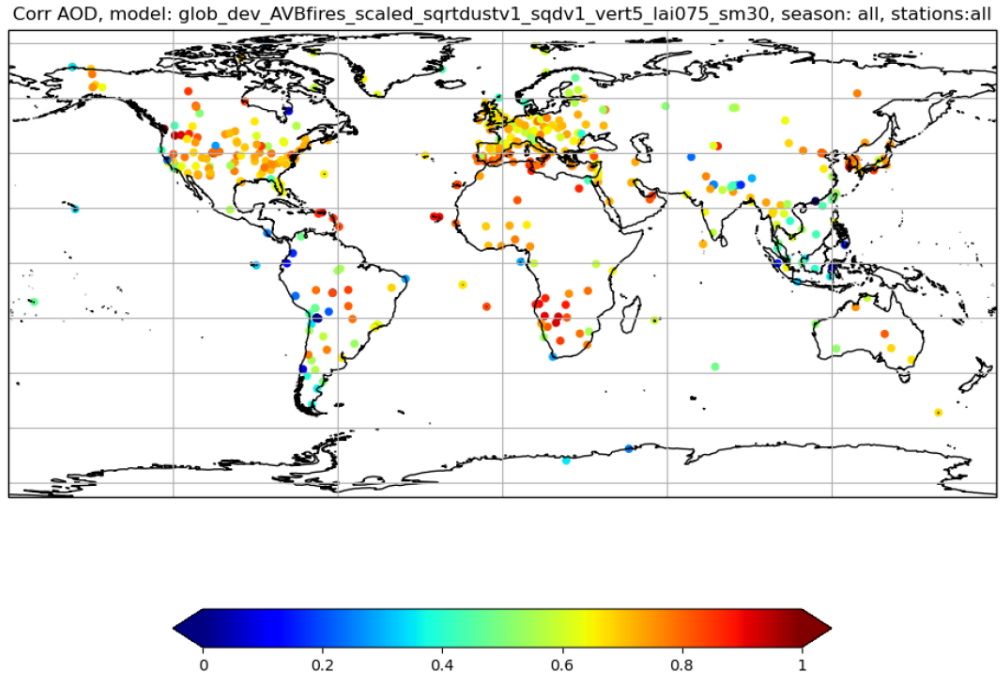
Median model: 0.121
Median obs: 0.122

Mean RMSE: 0.104
Median RMSE: 0.077

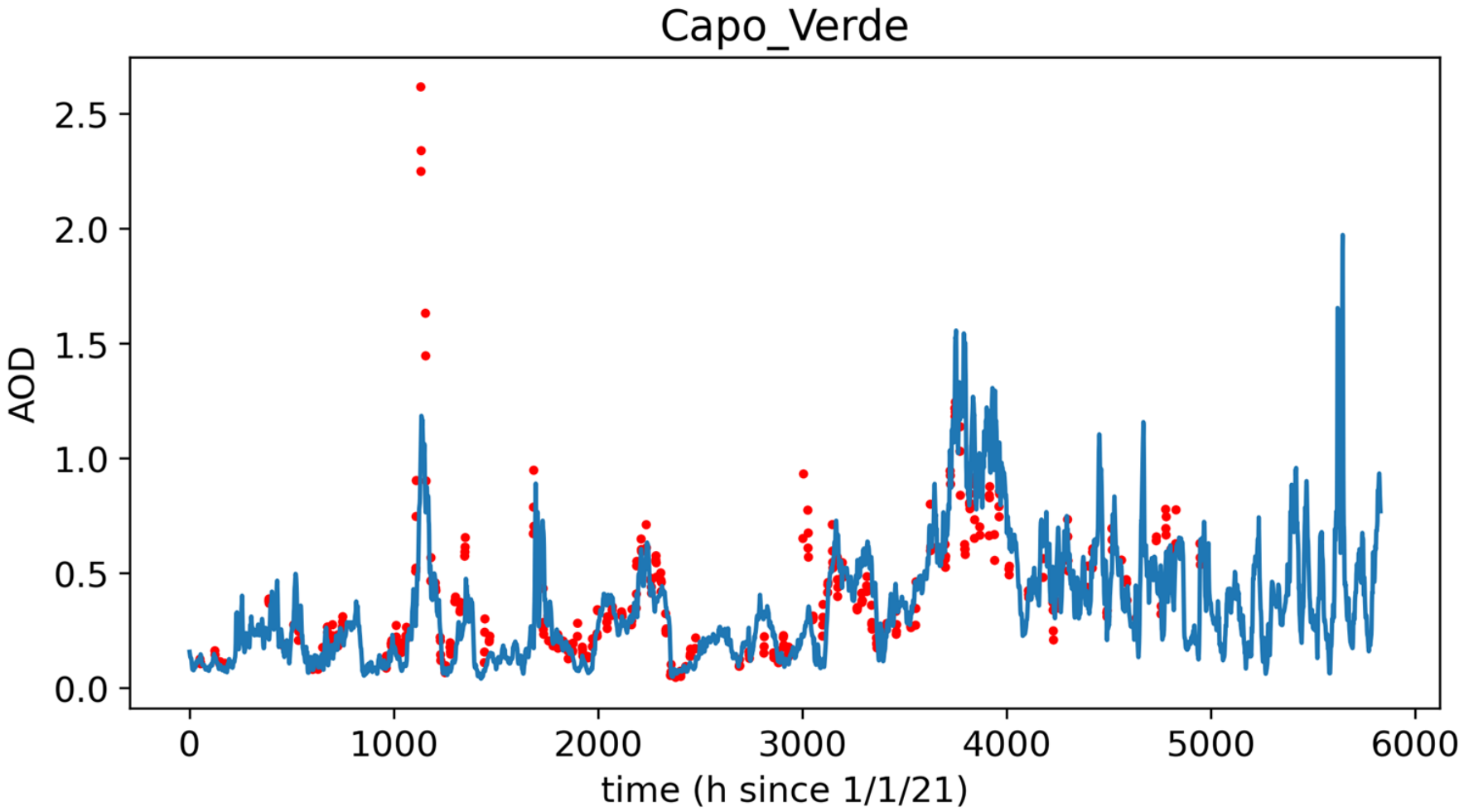
Mean corr: 0.642
Median corr: 0.685

Full corr: 0.80
Full RMSE: 0.126
Mean obs: 0.183
Mean model: 0.159





SILAM VS AERONET AT CAPE VERDE (2021)



SDS-WAS EVALUATION FOR 2022

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	MULTI-MODEL	SILAM	CAMS-IFS
Europe	0.72	0.68	0.65
Mediterranean	0.76	0.70	0.66
MiddleEast	0.70	0.62	0.62
NAfrica	0.75	0.75	0.40
Total	0.77	0.74	0.54

RMSE			
	MULTI-MODEL	SILAM	CAMS-IFS
Europe	0.15	0.18	0.16
Mediterranean	0.17	0.22	0.18
MiddleEast	0.26	0.32	0.32
NAfrica	0.29	0.31	0.38
Total	0.23	0.27	0.29

FURTHER DEVELOPMENT

- Replace the soil moisture with a simpler expression, hopefully more suitable for the wetness of a sandy surface
- Assimilation of the base emission map using MODIS AOD and/or IASI dust optical depth
- Still try to find a parametrization for the constant emission part?
- We can gradually move toward more complexity, if comparison against observations support it