

# Properties and challenges of mineral dust aerosol modelling in the latest Earth System Models

AS3.7/CL3.16 Natural Aerosols in Climate Change

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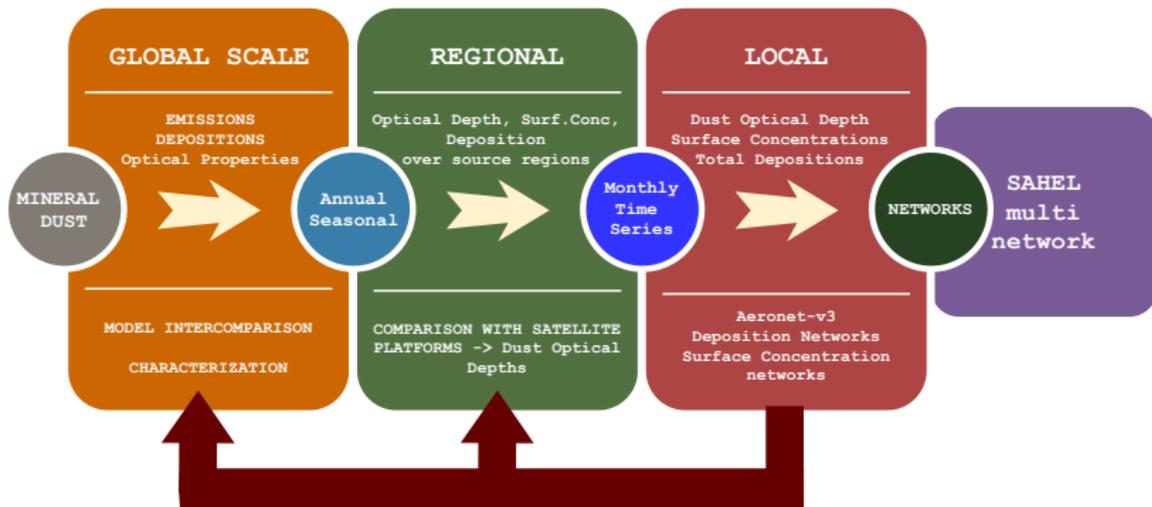
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## Overview: scales, methods, datasets

# Overview: Scales and Methods of Analysis



# Datasets and their scales

## Comparisons

Overview of the comparison done of the CRESCENDO-ESMs models against observations on several scales. For Loadings and Mass Extinction Efficiency (MEE) only inter-comparisons between model are possible. L=local, N=Network, G=Global, R=Regional, A=Annual, M=Monthly, CM=Monthly-Climatology, CA=Annual-Climatology, TS=Time-Series

Diagnostic	Dataset	Scales	Time	Reference	Comments
Aerosol Optical Depth	AERONET	(L, N)	(A, M, TS)	[Giles et al., 2019]	Aeronet v3
	MODIS	(G, R)	(A, M)	[Sayer et al., 2014]	DeepBlue-v6
	MISR	(G, R)	(A, M)	[Diner et al., 2002]	
Angstrom Exponent	AERONET	(L, N)	(A, M, TS)	[Giles et al., 2019]	Aeronet v3
	MISR	(G)	(A, M)	[Diner et al., 2002]	
Dust optical depth	AERONET dusty	(L, N)	(A, M, TS)	[Giles et al., 2019]	Subset of AERONET
	MODIS DOD	(G, R)	(A, M)	[Pu and Ginoux, 2018]	See Supplementary
	IASI dust	(G, R)	(A, M)	[Peyridieu et al., 2013]	Near-Infrared
Surface concentration	UMOAC	(L, N)	(CA, CM)	[Prospero and Nees, 1986]	Filter Collectors
	Mahowald et al.	(L, N)	(CA)	[Mahowald et al., 2009]	
	LISA-Sahel	(L)	(TS, CA)	[Marticorena et al., 2017]	
Dust deposition flux	Network-H2011	(N)	(CA)	[Huneus et al., 2011]	Compilation dataset
	Network-SET-B	(N)	(CA)	[O'Hara et al., 2006, Vincent et al., 2016]	Compilation dataset
Wet/dry deposition flux	LISA-Sahel	(L)	(TS)	[Marticorena et al., 2017]	



## Dust cycle: mean values and spatial patterns



# Global dust cycle: mean values

## Global Inter-model comparison

Global dust mass balance, loading, dust optical depth (DOD), mass extinction efficiency (MEE) and lifetime for each model. PD and PDN scenarios. The units for emissions and depositions tendencies are [Tg/yr], for Load is Tg, for MEE is m<sup>2</sup>/g and life in days.

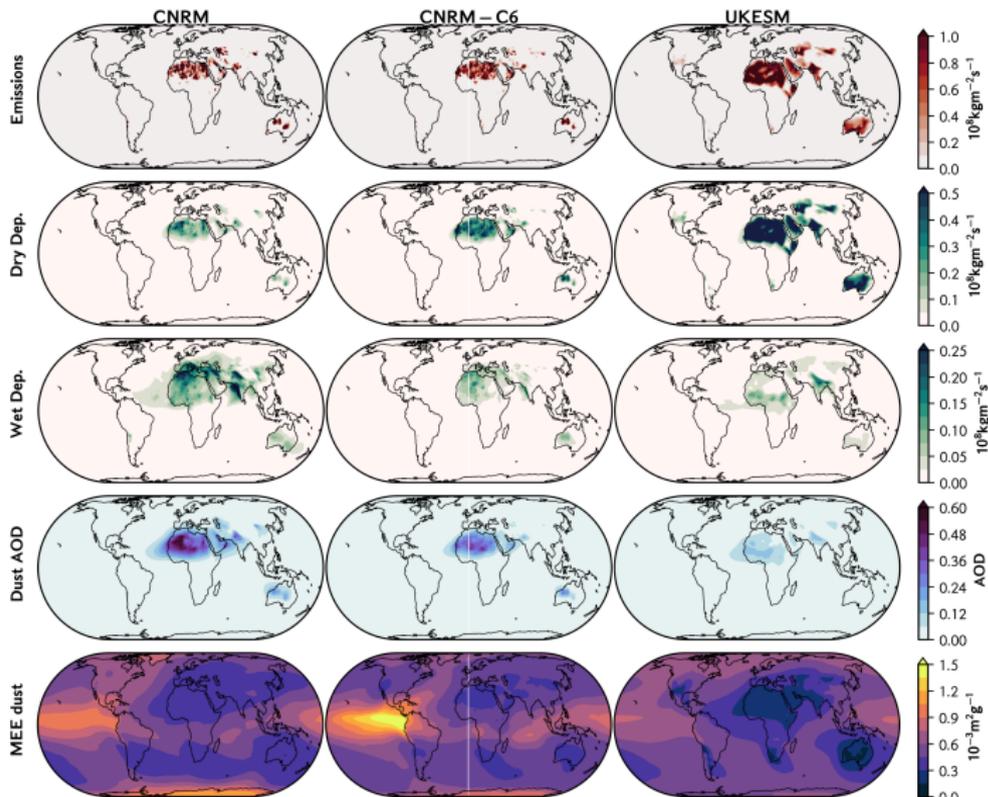
Model	Exp.	Eml. [Tg/yr]	Dep. [Tg/yr]	Net [Tg/yr]	$\Delta$ %	Dry Dep. [Tg/yr]	Wet Dep. [Tr/yr]	Sedim. [Tg/yr]	DOD -	Load [Tg]	MEE* [m <sup>2</sup> /g]	MEE [m <sup>2</sup> /g]	Life [Day]
CNRM	PD	3542.2	3392.8	149.41	4.24	542	2108.9	741.9	0.023	32.6	0.55	0.36	3.4
CNRM C6	PD	2605.2	2461.9	143.29	5.5	1490.3	753.8	217.8	0.011	13.3	0.63	0.44	1.9
ECv3	PD	1126.6	1126.7	-0.12	0.01	367.8	493.2	265.7	0.029	11.7	1.86	1.27	3.8
IPSL	PD	1557.5	1558.9	-1.44	-0.1	329.3	968.3	261.3	0.026	16.4	0.82	0.82	3.8
NorESM	PD	1368.2	1368.3	-0.09	-0.01	84.0	275.7	1008.6	0.023	7.2	2.86	1.63	1.9
UKESM	PD	7524.4	7527.6	-3.21	-0.04	6566.3	949.8	-	0.011	18.1	0.5	0.31	0.9
CNRM	PDN	1278.4	1216.3	62.09	4.85	208.6	716.8	290.9	0.011	15.2	0.56	0.38	4.3
CNRM C6	PDN	1812.1	1725.7	86.41	4.77	1126.5	435.1	164.0	0.011	11.6	0.63	0.46	2.3
IPSL	PDN	1295.3	1297.1	-1.77	-0.13	268.8	813.1	215.2	0.024	14.8	0.82	0.82	4.2
NorESM	PDN	1733.6	1733.4	0.12	0.01	115.7	345.5	1272.2	0.029	9.1	2.87	1.61	1.9

### Notes

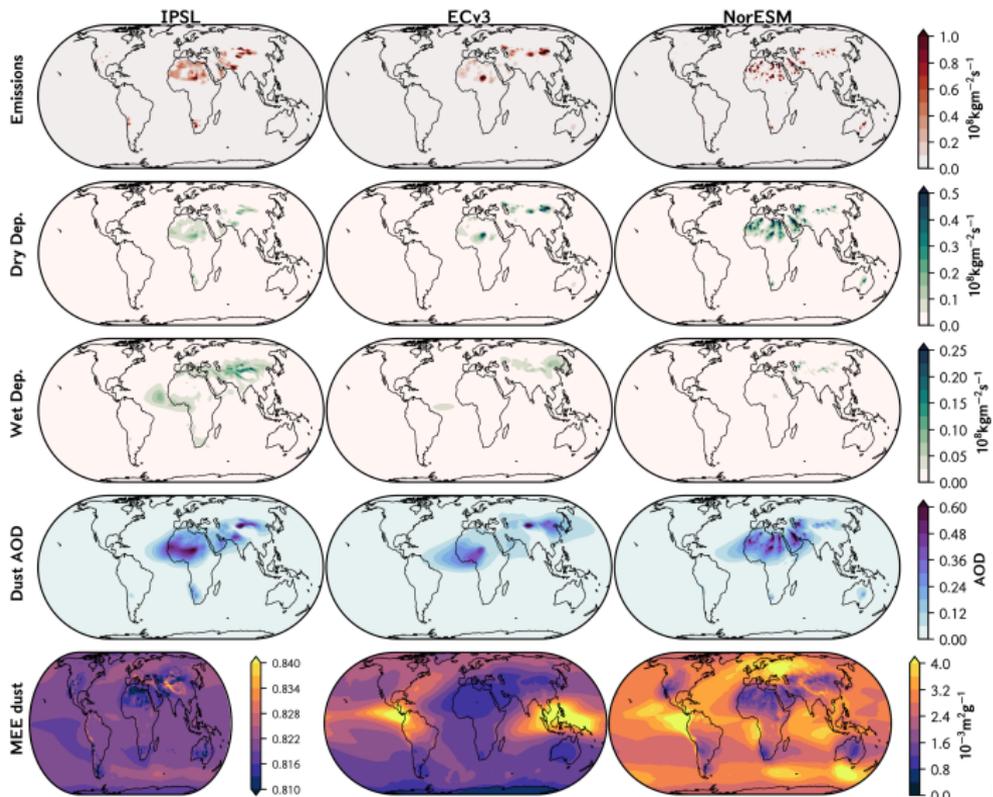
- Simulations from 2000-2014. PD (Present-Day forcings), PDN (Present-Day forcings with nudged winds).
- CNRM C6 -> same model configuration that CMIP6 simulations
- CNRM -> new ESM specifications.
- MEE\* field as the ratio of dust optical depth to loadings fields before the mean.
- MEE ratio of mean of the fields of dust optical depth and loadings.



# Spatial patterns: sectional dust modelling



# Spatial patterns: modal dust modelling

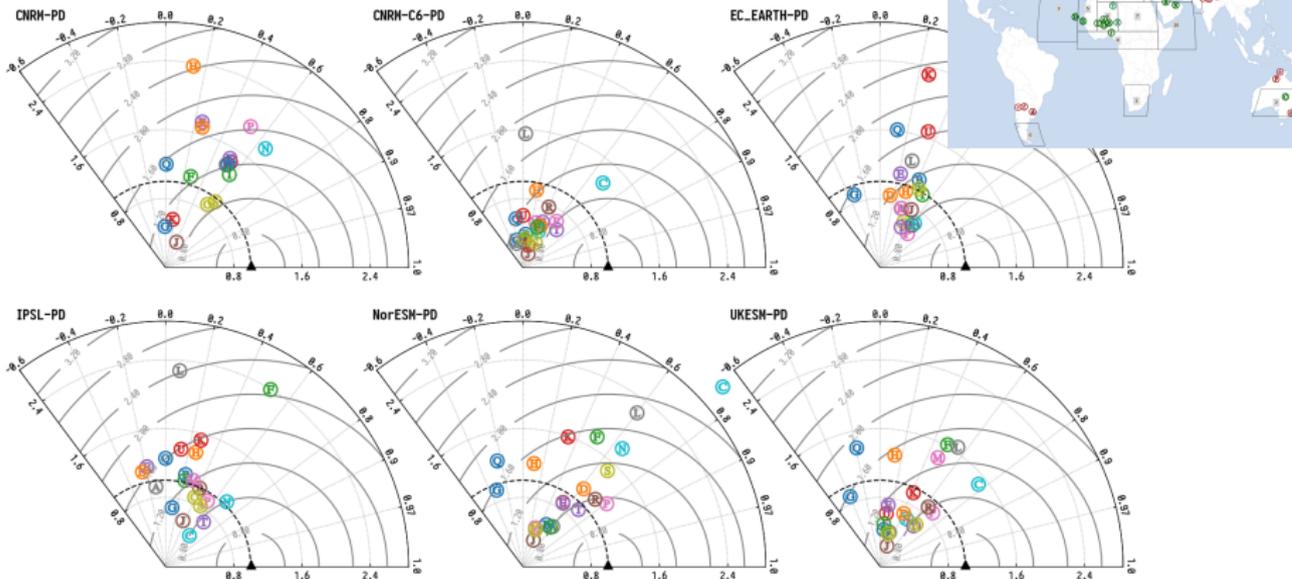


## Instrumental Networks: optical depths, surface concentrations and dust depositions



# Instrumental Network: AERONETv3. Normalized Taylor Diagram.

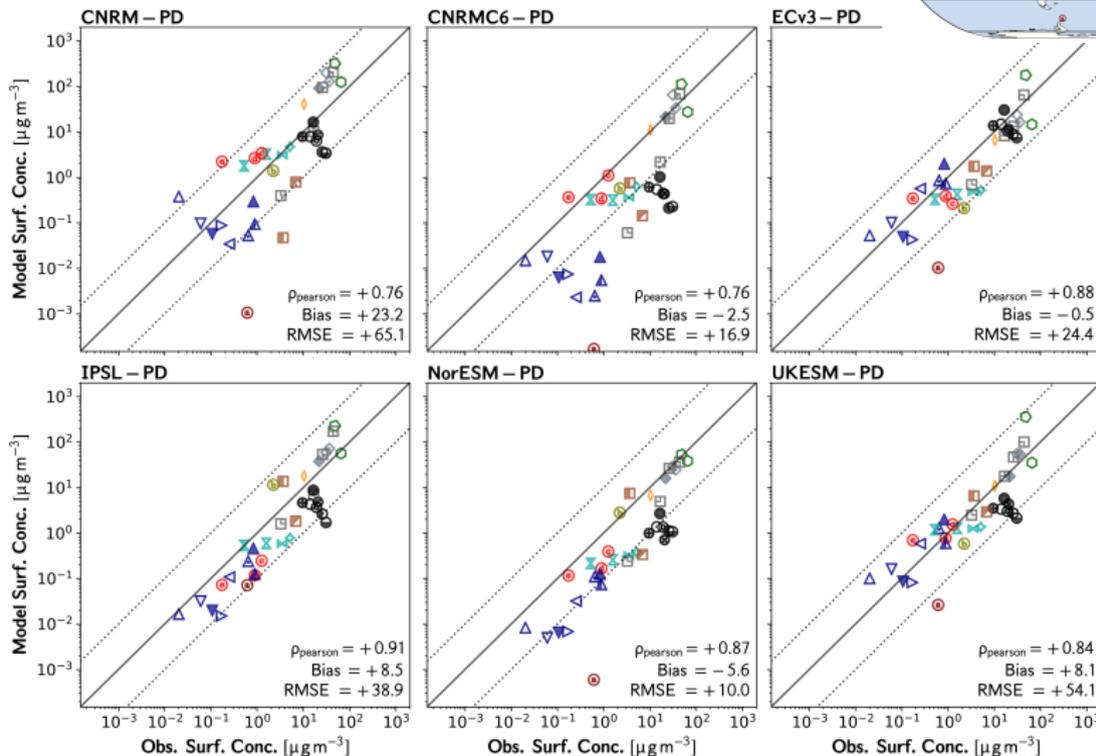
Exp: PD

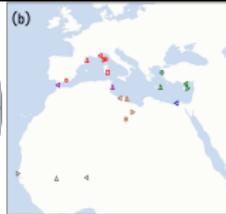
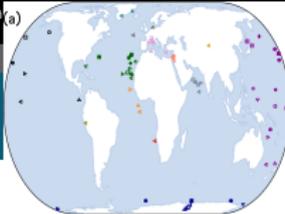


We compare total aerosol optical depths at 440 nm

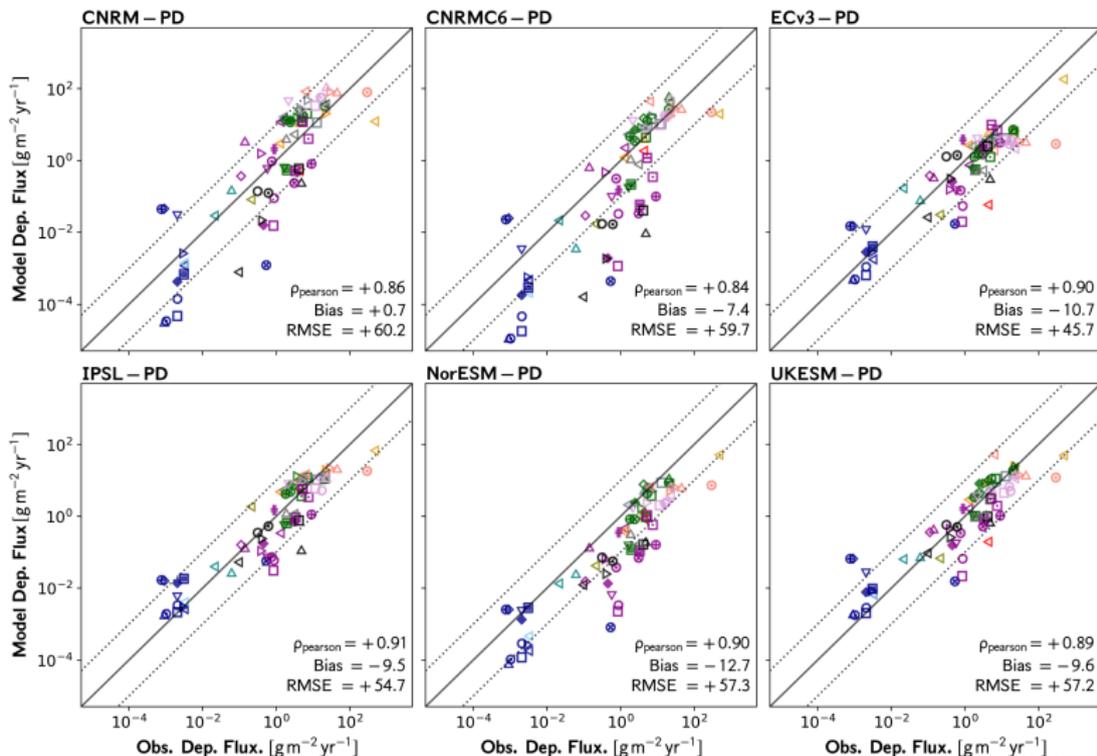


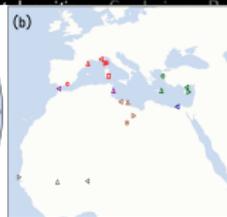
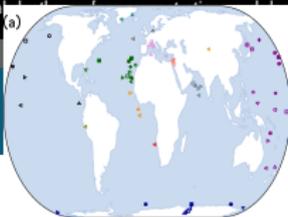
# Instrumental Network: Surface Concentrations



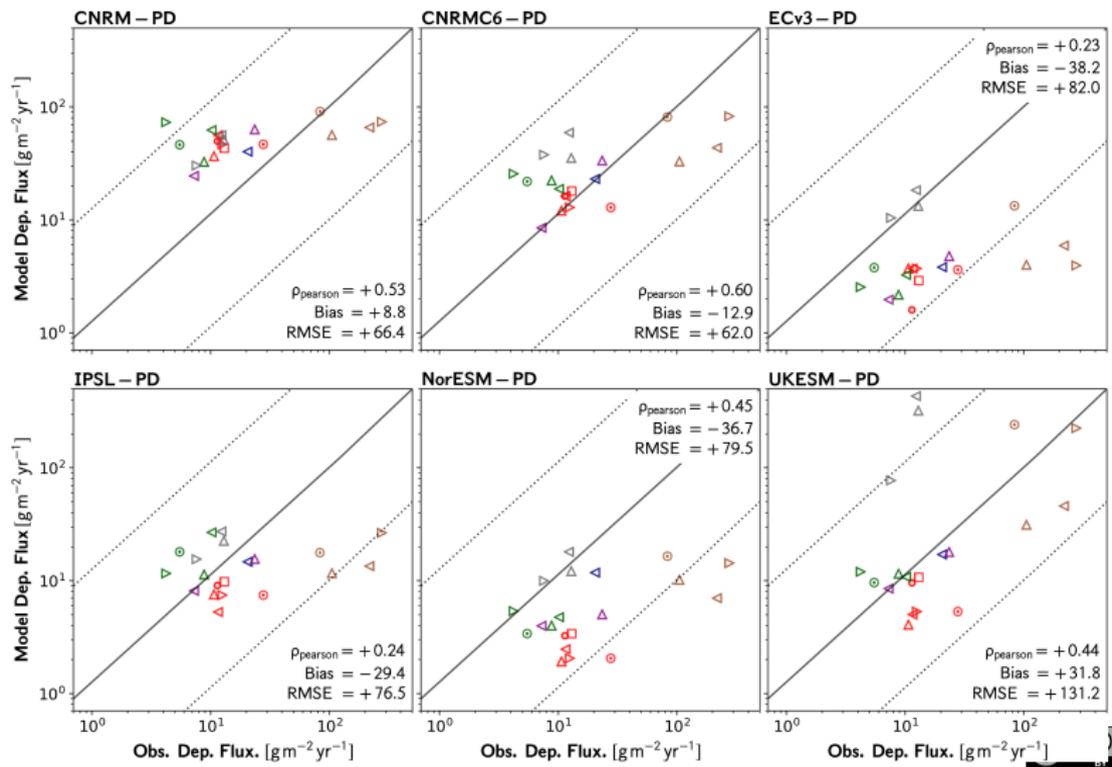


# Instrumental Network: Dust Depositions (a)





# Instrumental Network: Dust Depositions (b)



## Conclusions



# Discussion and Conclusions

## Remarks

- Important differences due to large particles ( $> 10\mu m$ )
- Consistency in general emission properties: north vs south, sahara as main source region.
- Differences in emissions over Asian deserts.
- Reasonable comparisons with surface concentrations networks.
- Comparison with deposition similar to previous studies.
- Comparison with AERONET needs additional hypothesis regarding dusty stations.

## Open questions about mineral dust

- Role of large particles and how to model them.
- Refractive index (mineral composition).
- ESMs with coupled vegetation and land use.
- Comparison with same PSD at emission.

## Prospective Publication

Includes additional studies: regional and seasonal comparisons, detailed study at Sahel, normalized emission comparisons, ocean depositions, Direct radiative effects.

Thanks for your attention!



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