AGU23

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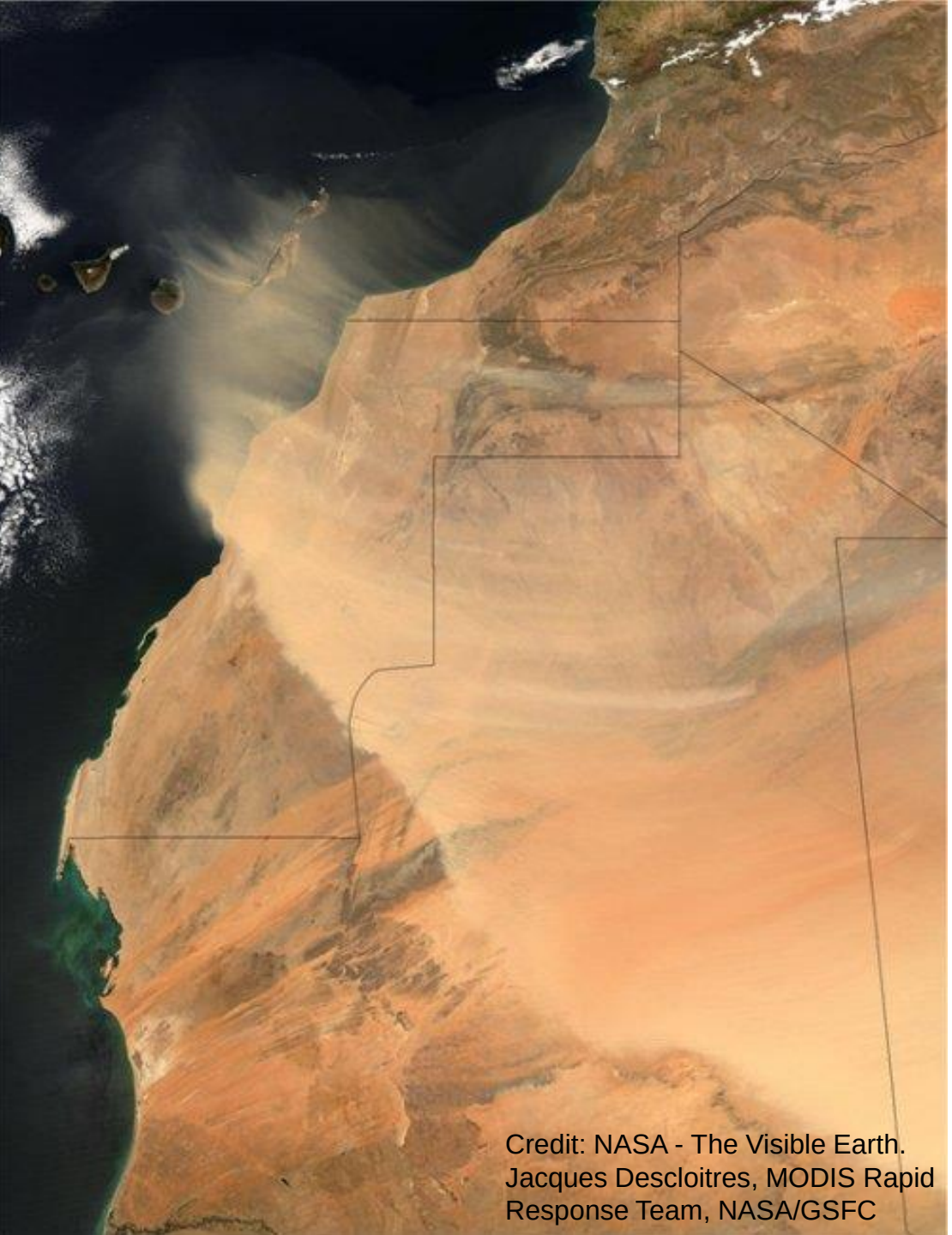
Linking source and emitted dust mineralogy: key aspects to improve the representation of airborne dust mineralogy in Earth System Models

María Gonçalves Ageitos

Vincenzo Obiso, Ron L. Miller, Oriol Jorba, Martina Klose, Yves Balkanski, Jan P. Perlwitz, Jerónimo Escribano, Luka Ilić, Longlei Li, Natalie M. Mahowald, Paul Ginoux, Qianqian Song, Samuel Remy, Jasper F. Kok, Philip G. Brodrick, David R. Thompson, Robert O. Green and Carlos Pérez García-Pando

Dust in a changing climate: From Small-Scale Insights to Large Scale Understanding. Abstract ID: 1394143

Climate, Aerosol, and Pollution Research



Credit: NASA - The Visible Earth.
Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

Challenges to represent mineralogy in Earth System Models:

… limited knowledge of the composition of parent soils

… and the resulting size-distributed mineralogy at emission

1) Current soil maps and limitations

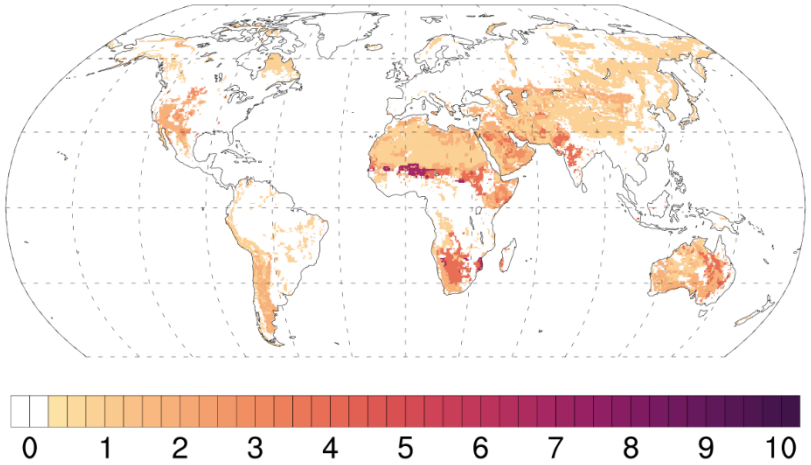
2) Size resolved mineral fractions at emission

3) Optical properties

4) EMIT and new perspectives

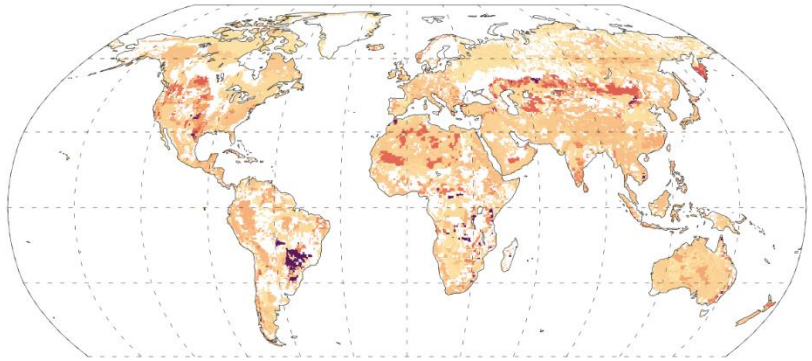
Soil mineralogy: iron oxides mass fraction (%w)

C1999 Hematite (%w) clay

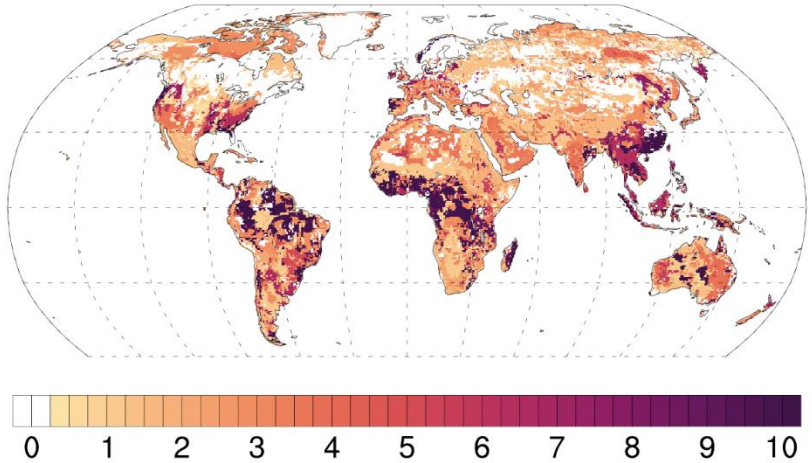


Claquin et al. (1999), Nickovic et al. (2012)

J2014 Hematite (%w) clay



J2014 Goethite (%w) clay

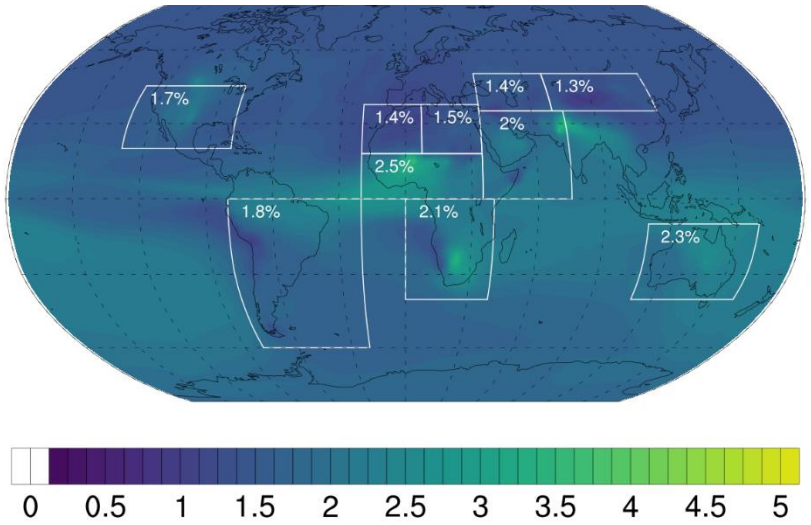


Journet et al. (2014)

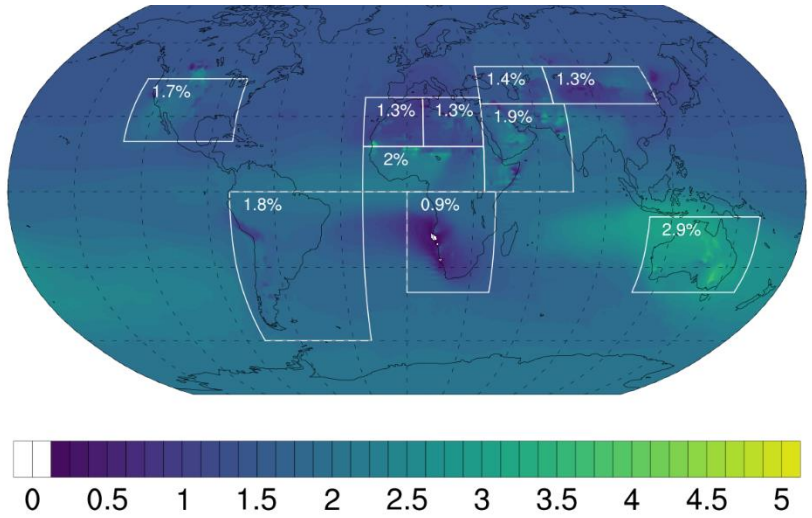
Li et al. (2021) multi-model study **attributes 97% of the uncertainty range** in **dust Direct Radiative Effect** to uncertainties in the abundance of **iron oxides**.

Iron oxides mass fraction (%w) at surface PM10 concentration

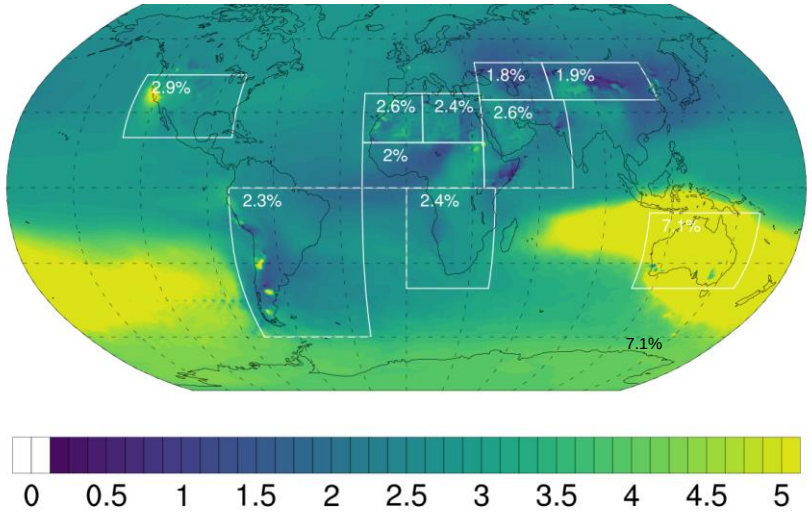
GISS-ModelE **C1999** (1.78%w)



MONARCH **C1999** (1.6%w)



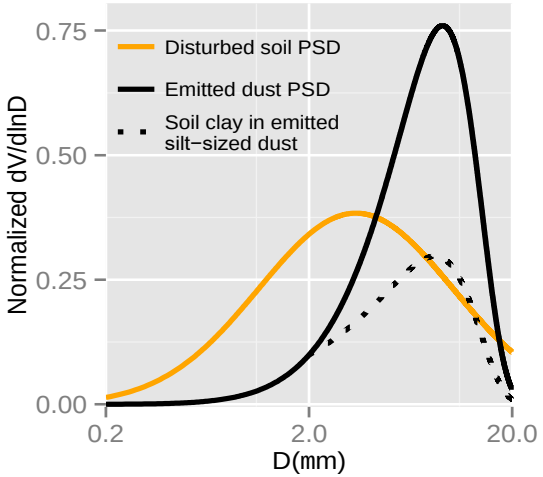
MONARCH **J2014** (2.3%w)



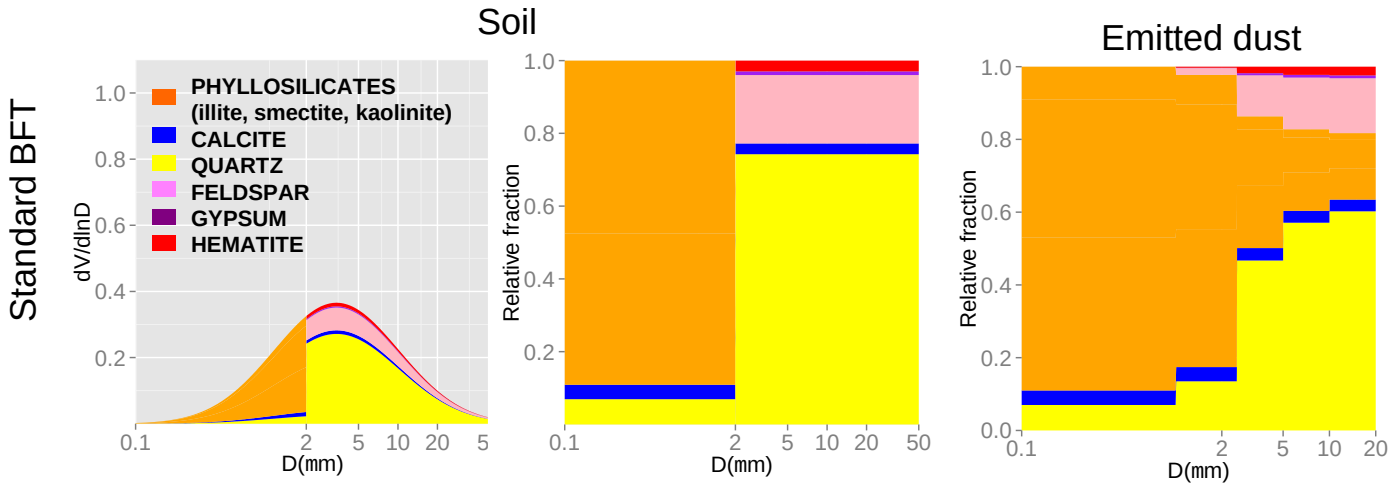
Same soil map, different model

Same model, different soil map

Size resolved mineral fractions at emission



Brittle Fragmentation Theory
(Kok, 2011)



Basic BFT

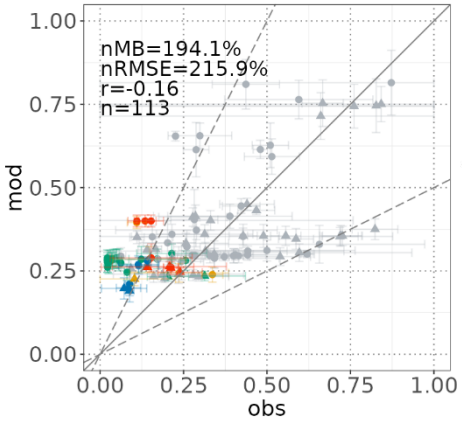
Perlwitz et al., 2015a,b; Pérez García-Pando et al., 2016;

Quartz mass fraction evaluation against in situ obs.

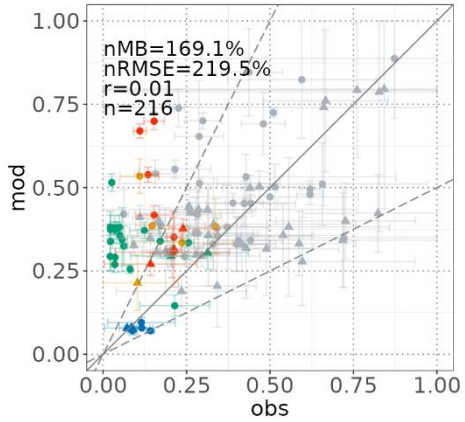
Multi-annual model experiments

C1999

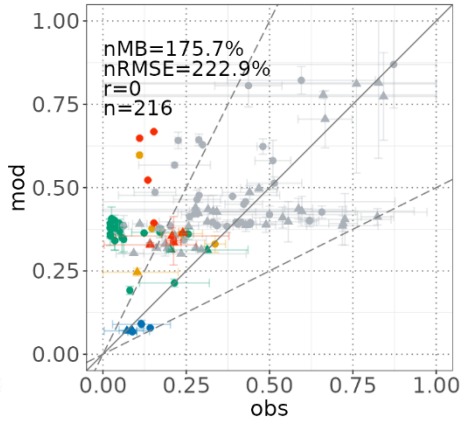
CESM-CAM6



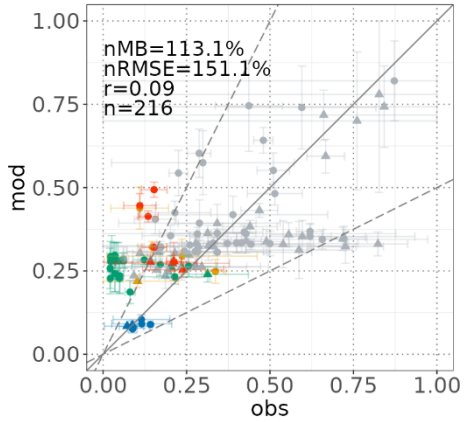
MONARCH



GFDL-AM4

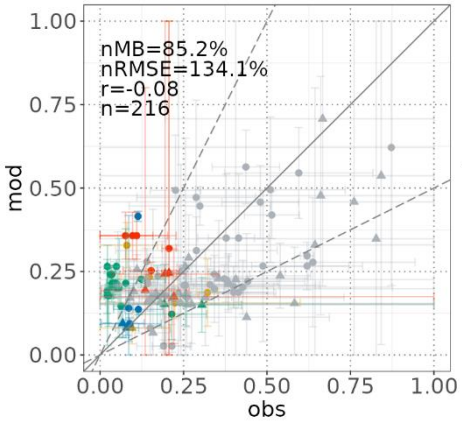


GISS-ModelE

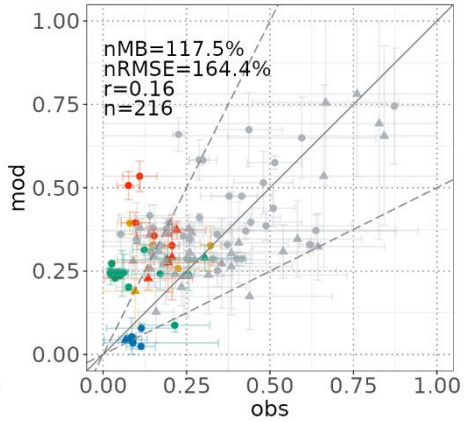


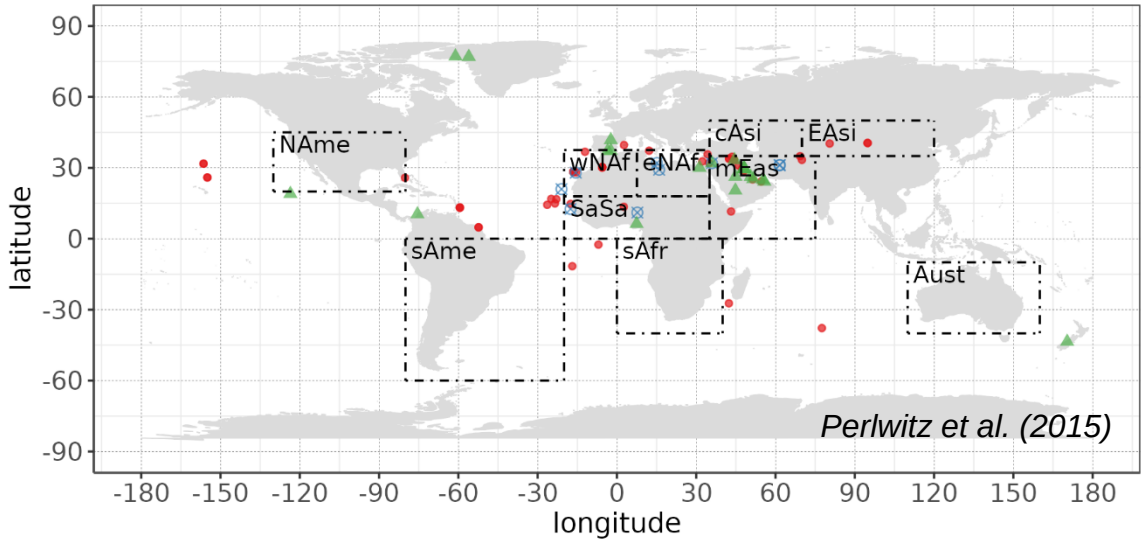
J2014

IFS-AER

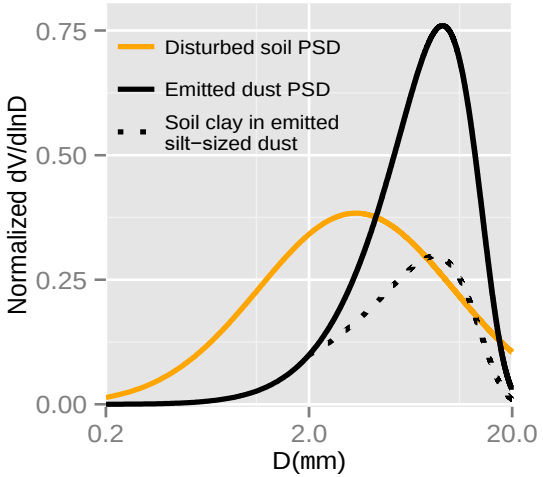


MONARCH





Refining the size-resolved mineral fractions at emission



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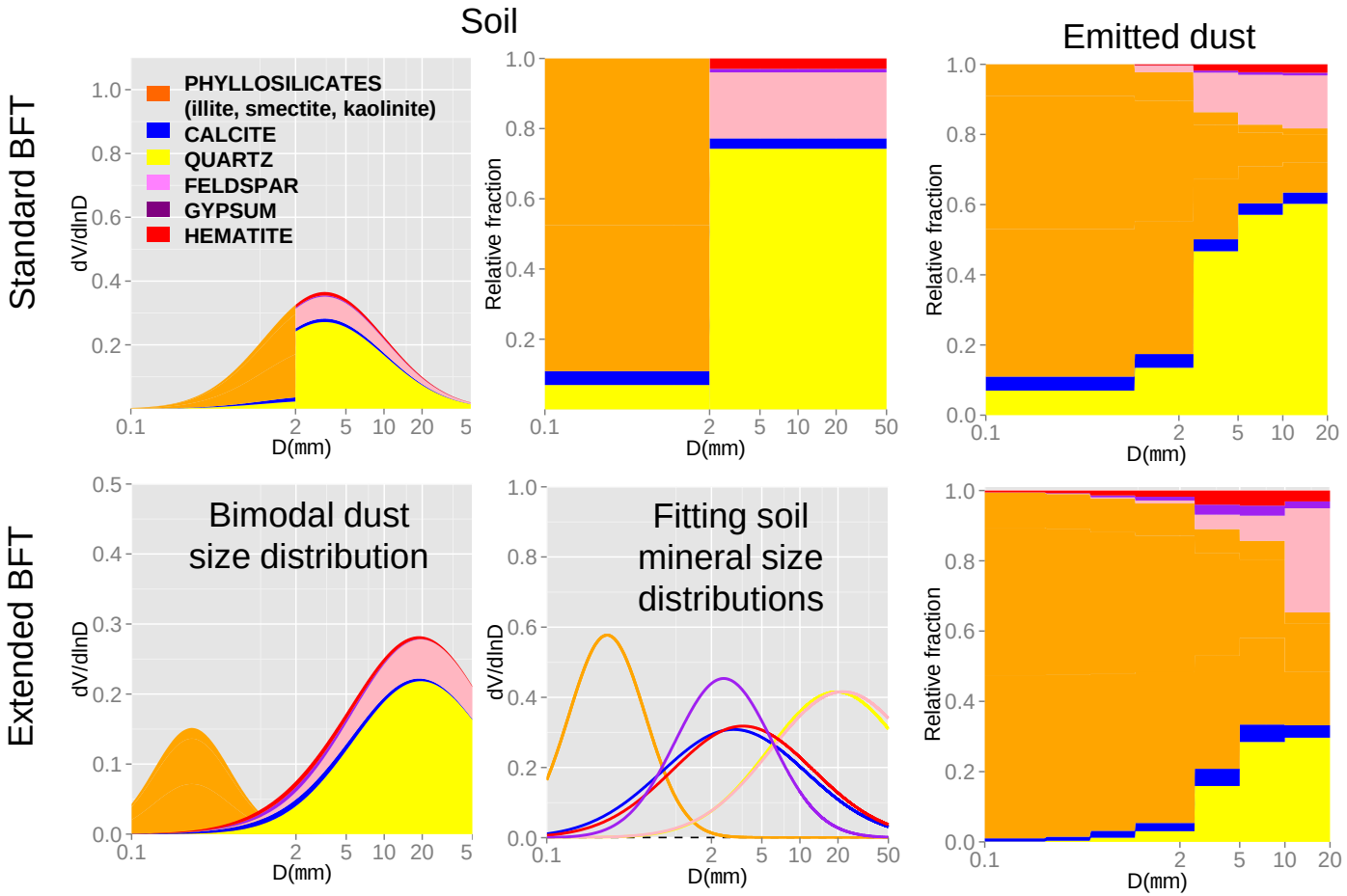


Basic BFT

Perlwitz et al., 2015a,b; Pérez García-Pando et al., 2016;

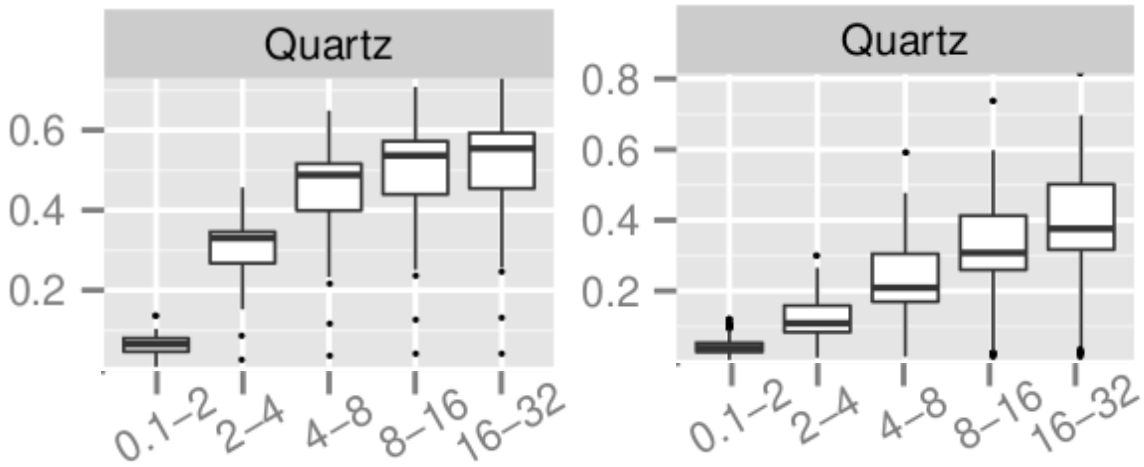
BFT with fitted mineral soil distributions

Pérez García-Pando et al., in prep.

Refining the size-resolved mineral fractions at emission: GISS-ModelE

Relative mass mineral fraction per size bin

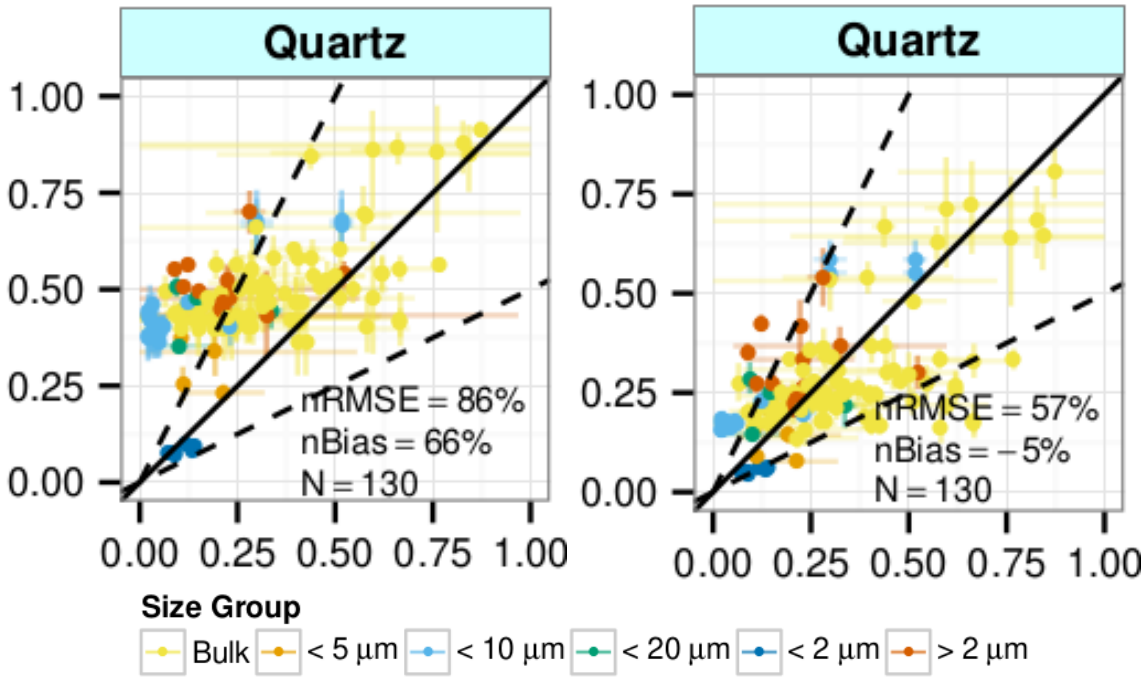
Basic BFT **BFT with fitted mineral soil distributions**



Bin size range (µm)

Evaluation against in situ measurements

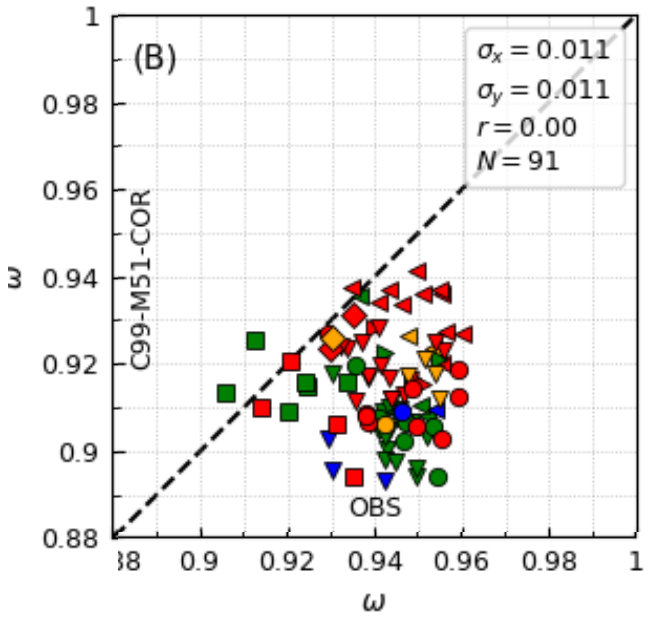
Basic BFT **BFT with fitted mineral soil distributions**

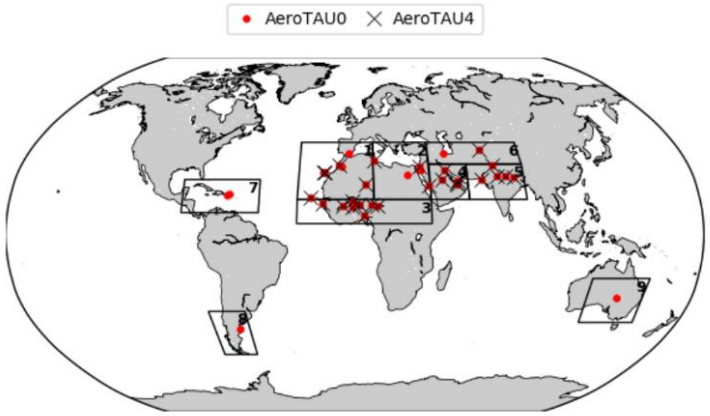


Pérez García-Pando et al., in prep.

Optical properties
Evaluation with AERONET SSA vis. filtered for dust events

MONARCH C1999

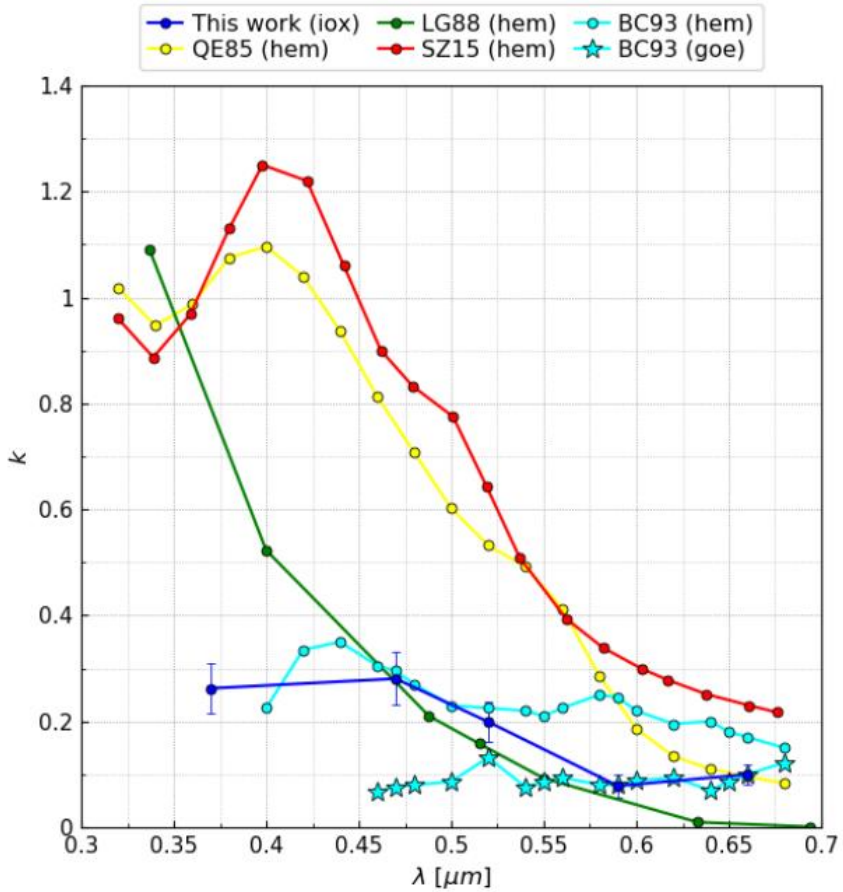




AERONETv3 Almucantar lev 2.0. Dust filters:

- Fine volume fraction lower than 0.1
- Sea salt filtered following Dubovik et al. (2002)
- BrC and BC filtered following Shuster et al. (2016)
- 2000-2020 monthly means produced only when at least 80 points are available

Imaginary part of the refractive index for iron oxides

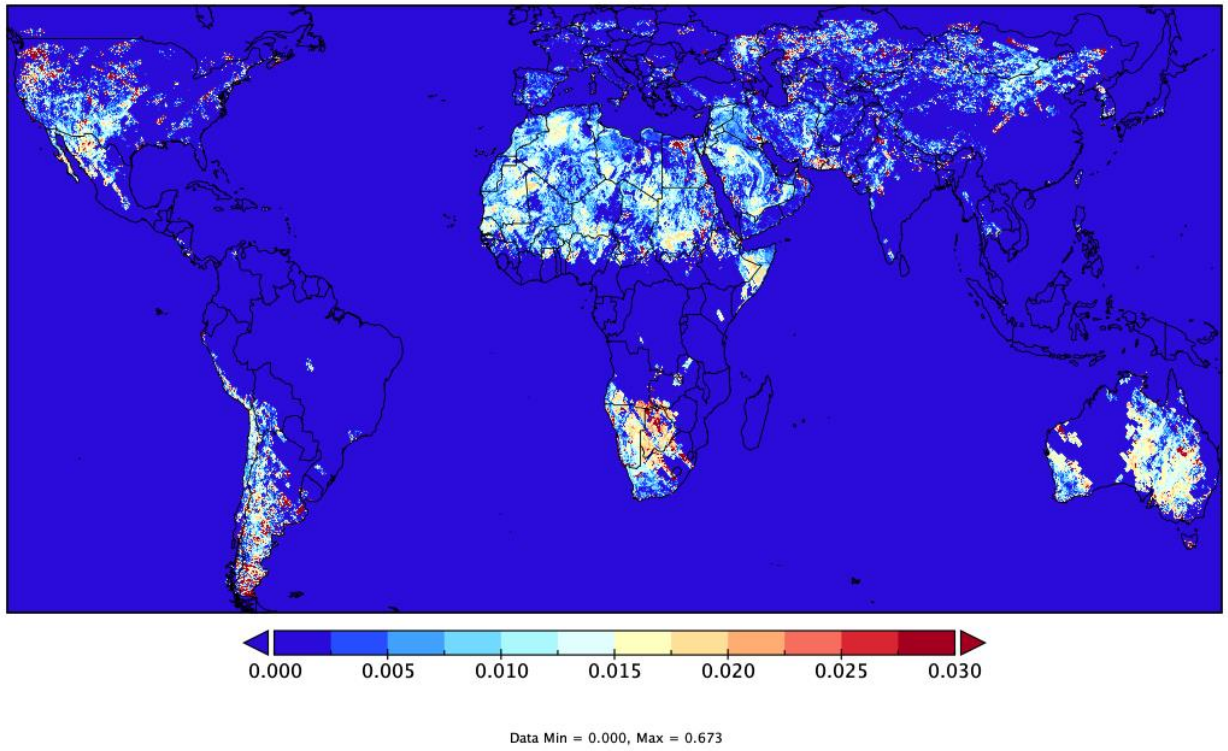


Obiso et al. 2023; egusphere 2023-1166

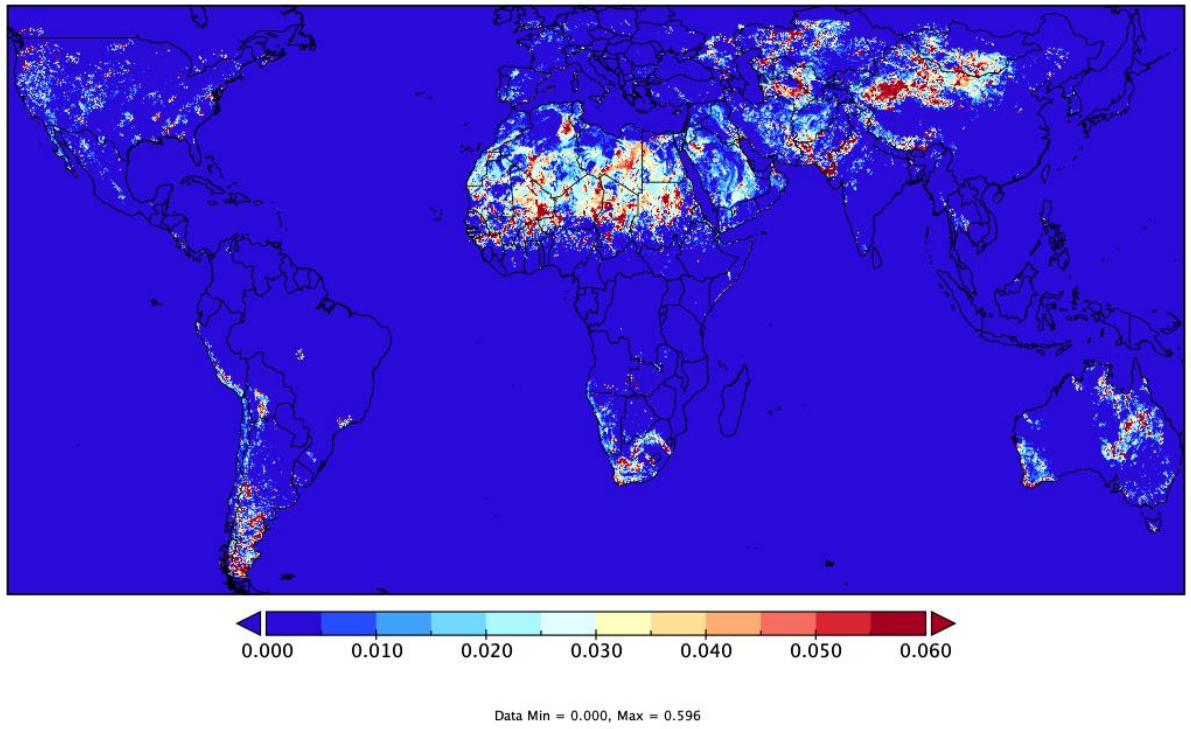
New EMIT soil maps: iron oxides mass fraction

PRELIMINARY RESULTS

Hematite mass fraction in clay EMIT



Goethite mass fraction in clay EMIT



(Green et al., 2020)

Summary and conclusions

- Soil mineralogy and size distribution at emission are key to represent the atmospheric cycle of minerals in Earth System Models.
- EMIT will bring in unprecedented constraints to the soil mineralogy at the global scale.
  - Transformation of mineral spectral abundances in soil mass fractions.
  - Limited information on the grain size of the minerals in the soil.
  - No direct retrievals for quartz and feldspars.
- Further development of methods to project soil to emitted mineral sizes.

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Thank you !

More about dust mineralogy modelling in:

Li et al. (2021), ACP
Gonçalves Ageitos et al. (2023), ACP
Obiso et al. (2023, in review), ACP
Song et al. (2023, submitted), ACP

STAY TUNED FOR EMIT UPDATES!

Open positions at BSC

Acknowledgments

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- We thankfully acknowledge the computer resources at Marenostrum4, granted through the PRACE project eFRAGMENT2 and the RES project AECT-2020-3-0020; the technical support provided by the BSC.
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