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EXCELENCIA SEVERO OCHOA 2023 - 2027

NASA

24rd AeroCom / 13th AeroSat workshop, Institut Pascal, Université Paris-Saclay, France, 13–17 October 2025

Dust Absorption Sensitivity to Mineralogy in the MONARCH Model

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Introduction and Aim

Significant uncertainties related to dust radiative effect (DRE) in atmospheric models with typically homogeneous mineralogy

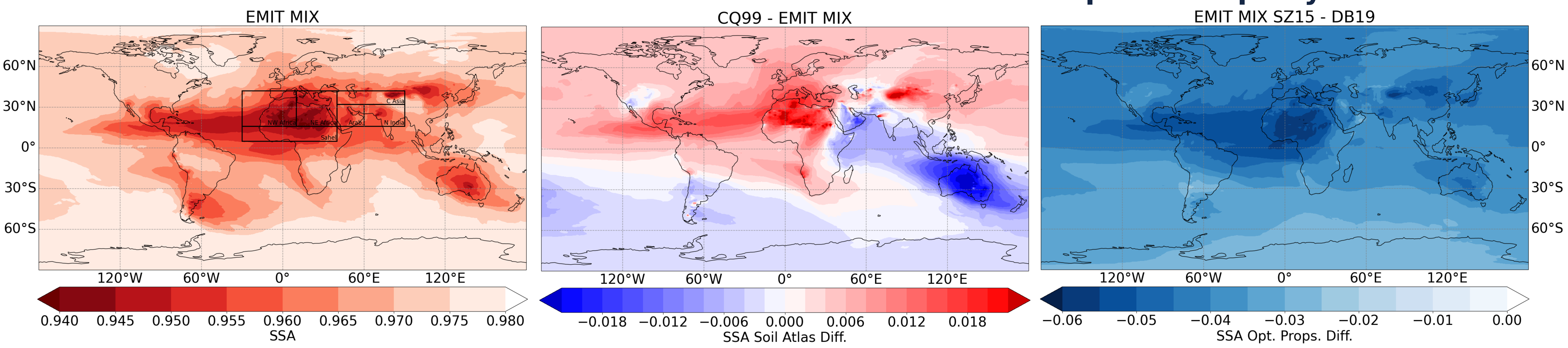
To examine the sensitivity of dust single scattering albedo (SSA) and DRE to mineralogical variability and optical property representations

Experimental Set-up

MONARCH coupled with RRTM for 18 global experiments of 1 year smiulations set up based on the following:

3 Soil atlases	CQ99 (Claquin 1999)	JN14 (Journet 2014)	EMIT
	one iron oxide mineral category	hematite and goethite represented as separate minerals	
2 Sets of complex refractive indices (CRIs)	SZ15 (Scanza 2015)	DB19 (Di Biagio 2019)	
3 Particle mineralogy assumptions	BLK Homogeneous dust, average mineralogy from a global simulation	BIN Average mineralogy for each bin from a global simulation, constant in time	MIX Dyanmic mineralogy, varying in time, explicit atmospheric cycle of all minerals

Global SSA and SSA Differences Between Soil Atlases and Optical Property Datasets

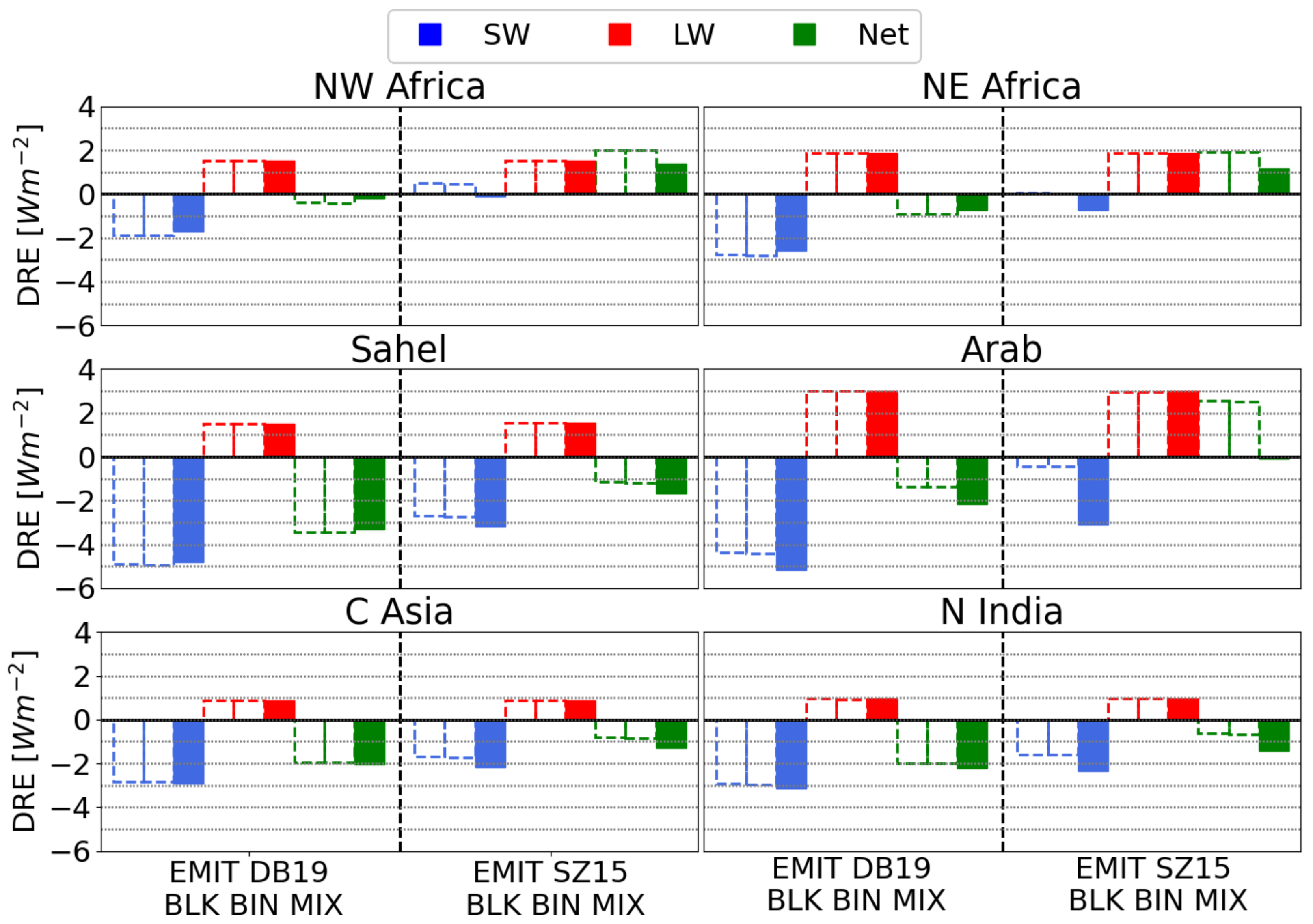


Global SSA distribution reflects the iron-content in the dust sources, as seen by EMIT and the main dust transport pathways.

EMIT and CQ99 differences highlight the different parent soil distribution of iron.

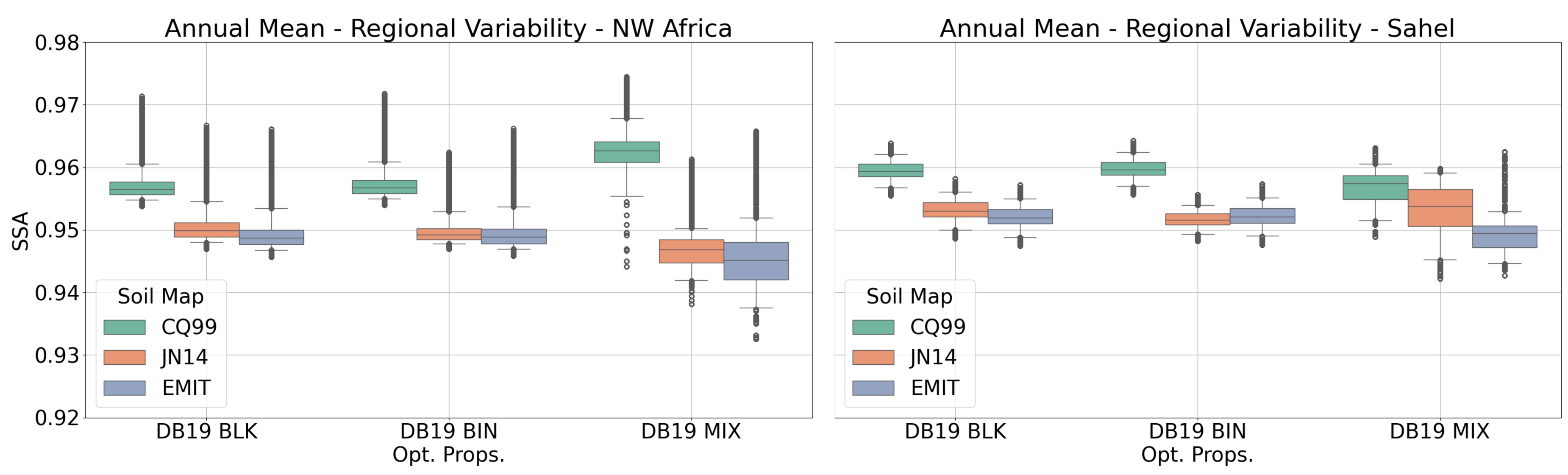
SZ15 CRIs show a more absorbing dust globally. Positive variations represent more scattering in DB19.

Regional Direct Radiative Effect at TOA of EMIT with DB19 and SZ15 CRIs



- SZ15 shows smaller DRE and can produces positive net DRE at TOA
- SZ15 accentuates the difference between mineralogy representations
- BLK and BIN mineralogy configurations similar regionally

Regional SSA Variability



- CQ99 more scattering due to one iron oxide category as opposed to both hematite and goethite in JN14 and EMIT
- JN14 BIN size-dependent mineralogy counters the effect of size, leading to a less variable SSA than in BLK experiment
- Different relationship in BIN JN14 and EMIT in two regions driven only by the size-distribution
- Regional differences in soil mineralogy propagating to SSA in MIX variability in the MIX case

Highlights and Future Work

- Homogeneous dust typically the most scattering, with some size-dependent differences in JN14
- MIX with the most degrees of freedom shows the most variability and regional differences
- Regional DRE fairly consistent across soil atlases
- DRE depends strongly on the CRI dataset
- Next steps:
  to explore the seasonal variabilities and the DRE efficiency

Acknowledgments

This project has received funding from Juan de la Cierva Fellowship JDC2022-049038-I funded by MICIU and by European Union NextGenerationEU and AEI, HEAVY: Grant PID2022-140365OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by ERDF, EU. FRAGMENT: ERC Consolidator Grant No. 773051. EMIT: NASA Earth Venture Instrument program, under the Earth Science Division of the Science Mission Directorate. AXA Research Fund through the AXA Chair on Sand and Dust storms at the Barcelona Supercomputing Center (BSC). CERTAINTY: Horizon Europe programme, under Grant Agreement No. 101137680.

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