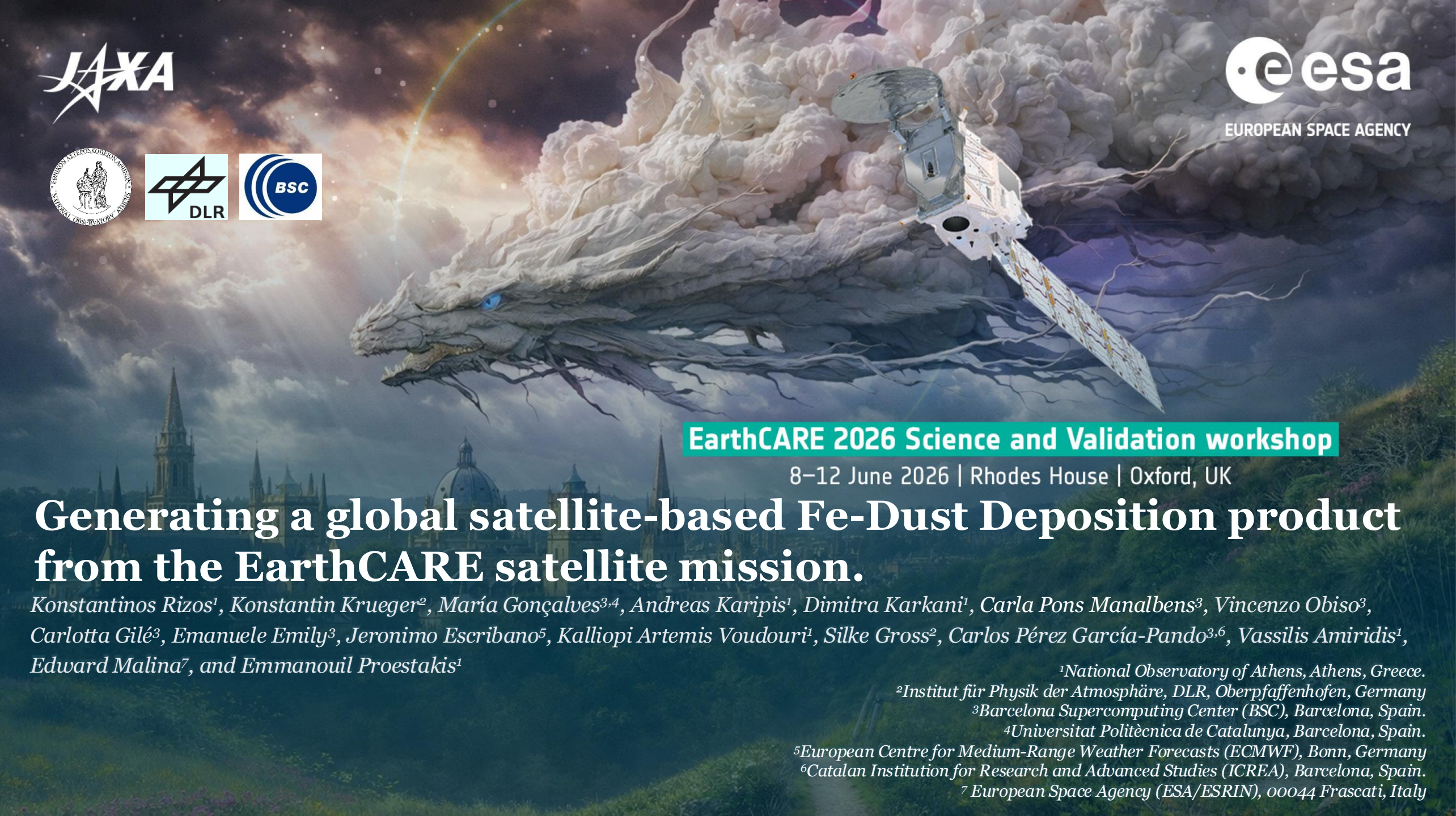


EarthCARE 2026 Science and Validation workshop

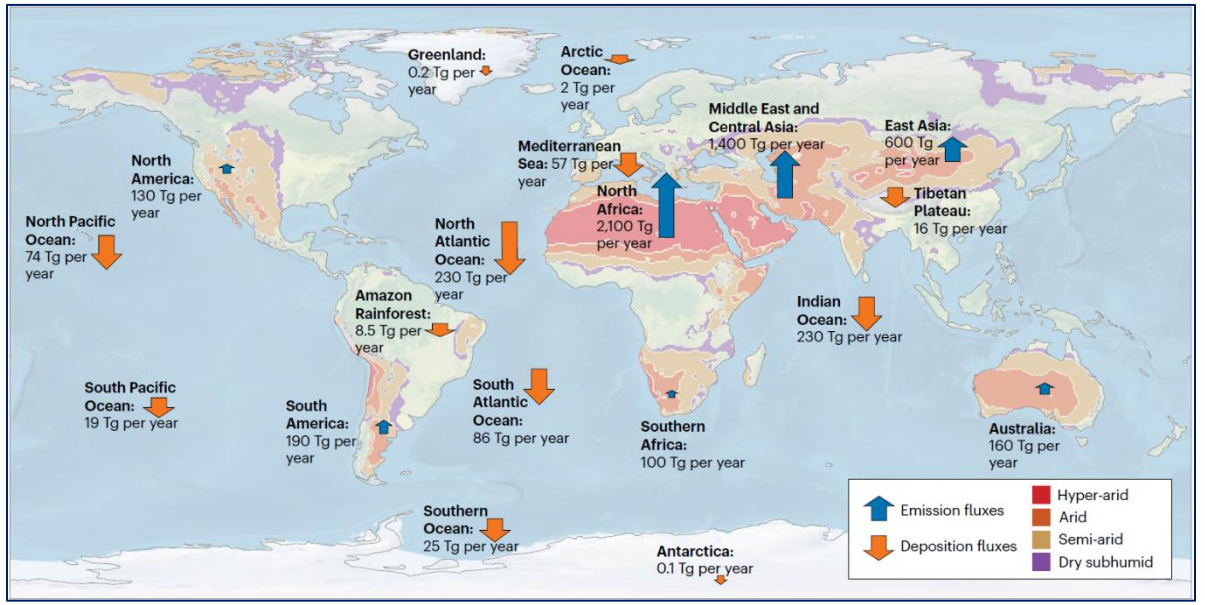
8–12 June 2026 | Rhodes House | Oxford, UK

Generating a global satellite-based Fe-Dust Deposition product from the EarthCARE satellite mission.

Konstantinos Rizos[1], Konstantin Krueger[2], María Gonçalves[3,4], Andreas Karipis[1], Dimitra Karkani[1], Carla Pons Manalbens[3], Vincenzo Obiso[3], Carlotta Gilé[3], Emanuele Emily[3], Jeronimo Escribano[5], Kalliopi Artemis Voudouri[1], Silke Gross[2], Carlos Pérez García-Pando[3,6], Vassilis Amiridis[1], Edward Malina[7], and Emmanouil Proestakis[1]

[1]National Observatory of Athens, Athens, Greece.
[2]Institut für Physik der Atmosphäre, DLR, Oberpfaffenhofen, Germany
[3]Barcelona Supercomputing Center (BSC), Barcelona, Spain.
[4]Universitat Politècnica de Catalunya, Barcelona, Spain.
[5]European Centre for Medium-Range Weather Forecasts (ECMWF), Bonn, Germany
[6]Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain.
[7] European Space Agency (ESA/ESRIN), 00044 Frascati, Italy

Background Overview



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Review Article | Published: 17 January 2023

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Jasper F. Kok, Trude Storelvmo, Vlassis A. Karydis, Adeyemi A. Adebiyi, Natalie M. Mahowald, Amato T. Evan, Cenlin He & Danny M. Leung

Nature Reviews Earth & Environment **4**, 71–86 (2023) | Cite this article

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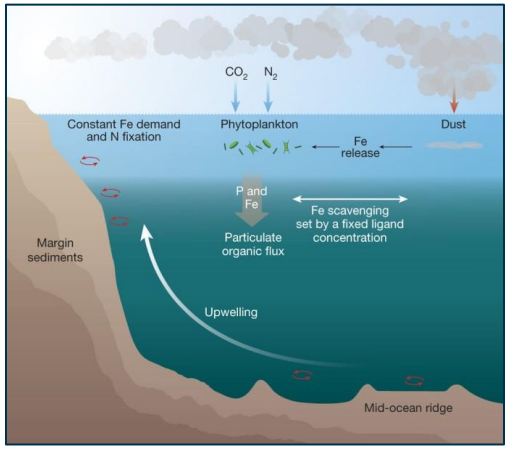
Review Article | Published: 02 March 2017

The integral role of iron in ocean biogeochemistry

Alessandro Tagliabue, Andrew R. Bowie, Philip W. Boyd, Kristen N. Buck, Kenneth S. Johnson & Mak A. Saito

Nature **543**, 51–59 (2017) | Cite this article



Biogeochemistry

Atmospheric deposited dust impacts ocean biogeochemistry: delivers essential nutrients such as iron, nitrogen, and phosphorus, fertilizes phytoplankton, thereby sustains marine productivity.

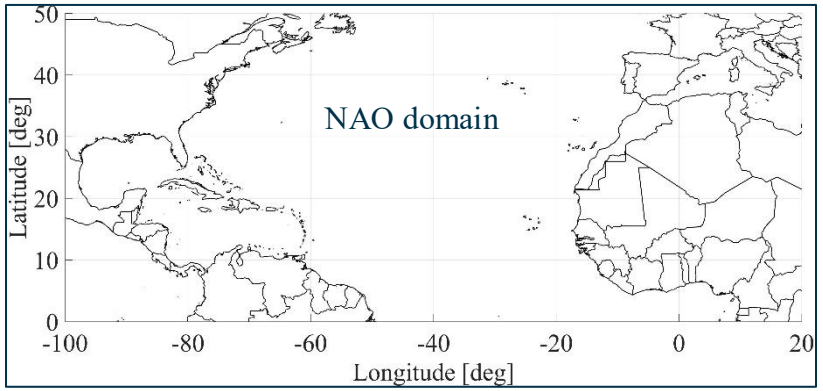
Climate

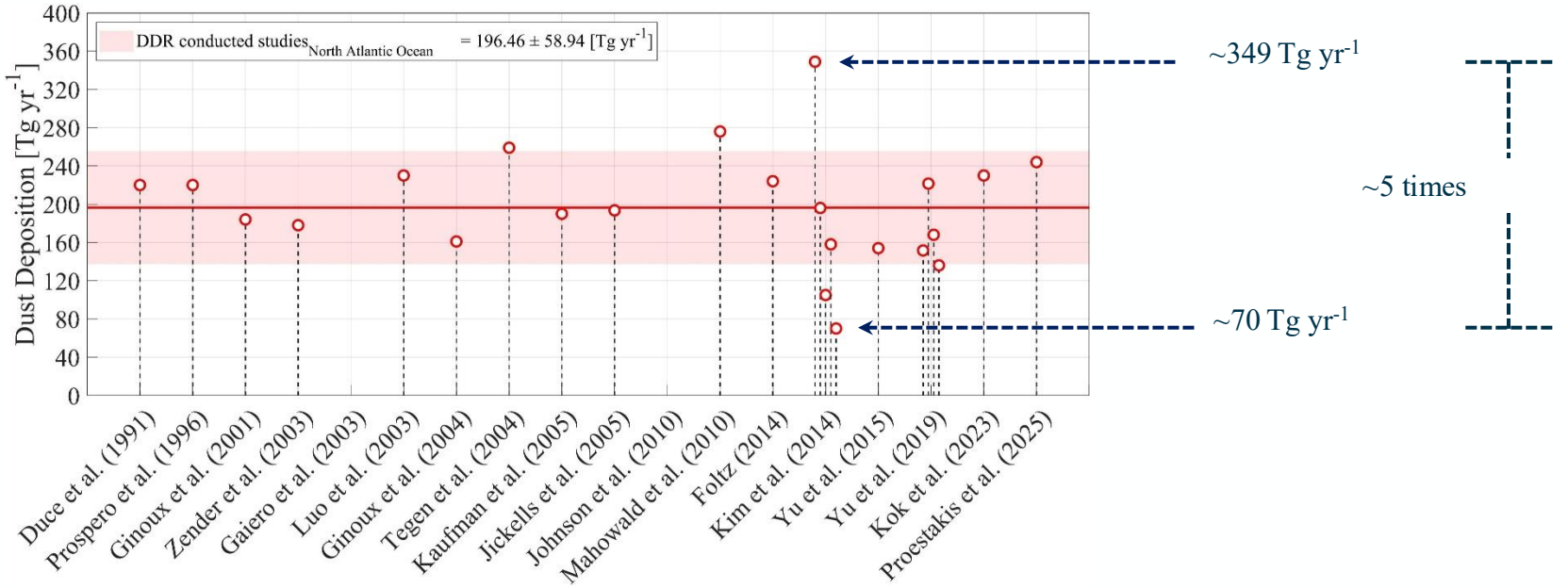
Atmospheric dust by supplying nutrients that stimulate phytoplankton growth, enhances the ocean's ocean role as a sink for greenhouse gases (i.e., facilitates the sequestration of atmospheric CO_2 into the deep ocean).

Weather

Atmospheric dust deposited into the ocean influences weather indirectly by modulating ocean color, affects heat absorption, sea surface temperature, and alters ocean–atmosphere feedbacks that shape weather patterns (i.e., such as tropical storm trajectories).

Dust Deposition variability in the reported values





- Dust deposition estimates are characterized by high variability.

(Different estimates, based on diverse methodologies, assumptions, parameterizations, meteorological inputs, temporal coverage, spatial domains, …)

- Improving our current state of knowledge on the quantification of atmospheric dust deposition across the ocean is essential for addressing unresolved questions about dust's biogeochemical impacts on marine ecosystems and climate.

Why EarthCARE…?

EarthCARE has the potential to facilitate significant breakthroughs in terms of EO-based estimates on dust deposition across the global ocean !

Main innovative advances of EarthCARE:

- First simultaneous depolarization (d355nm) and lidar-ratio (LR 355nm) aerosol measurements from space.
- Establish a 4-D atmospheric dust Climate Data Record
- Provide satellite-based global ocean dust deposition (and Dust-Fe) Climate Data Record

Scientific Questions (SQ):

SQ1: Can we quantify the atmospheric dust deposited across the global Ocean based on EarthCARE observations?

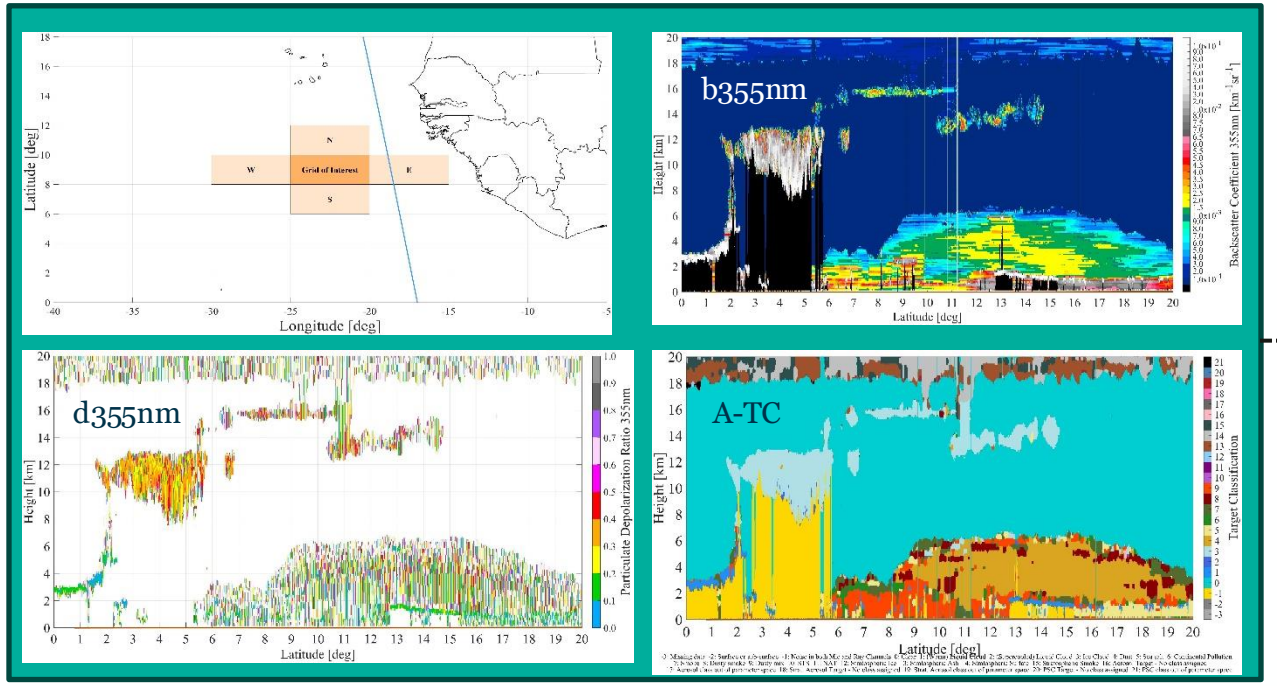
SQ2: What is the contribution of iron (Fe) in dust deposited into the ocean?

SQ3: What are the impacts of dust deposition on marine ecosystems?

EarthCARE-Based Atmospheric Dust Product

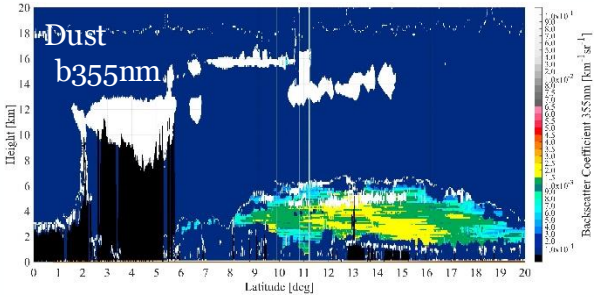
Conceptual approach

EarthCARE: 01380E

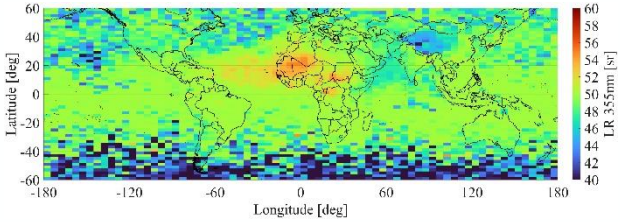


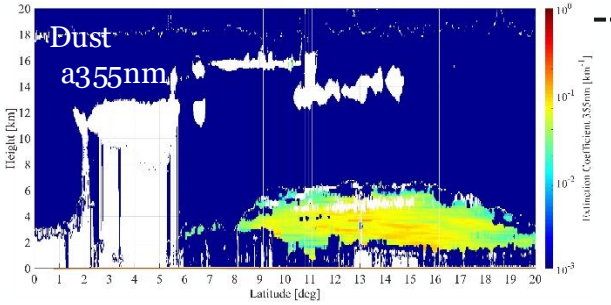
POLIPHON
Tesche et al., 2009; 2011
Ansmann et al., 2019
Floutsi et al., 2023

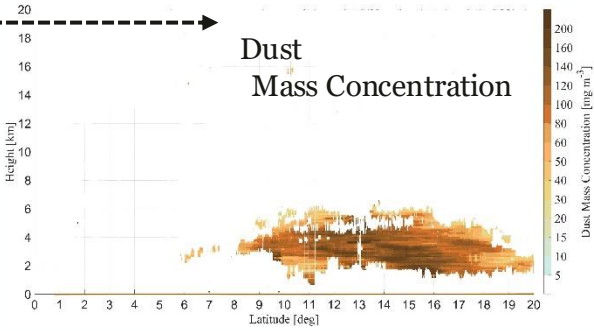
QA



EC-based Dust LR 355nm



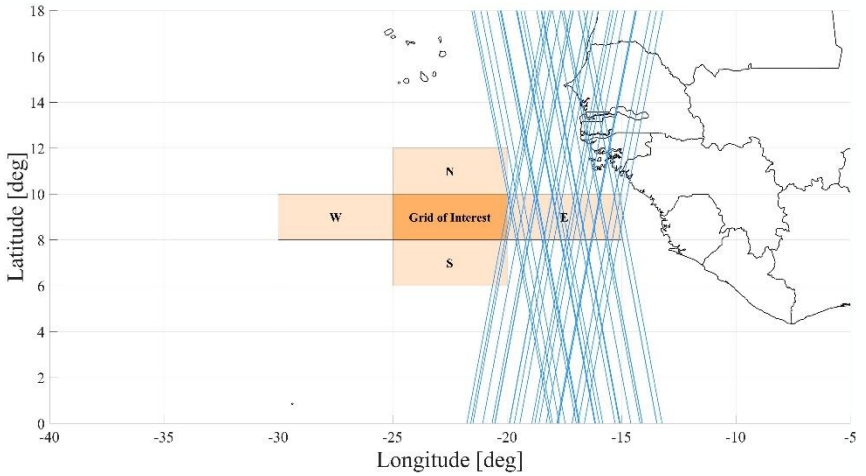




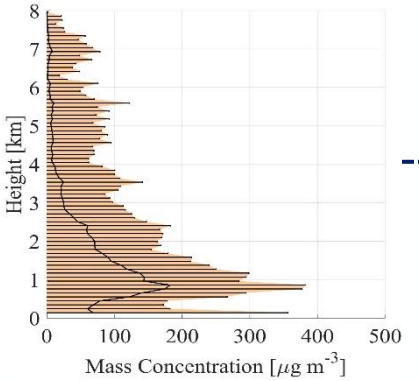
EarthCARE-Based Atmospheric Dust Product

Conceptual approach

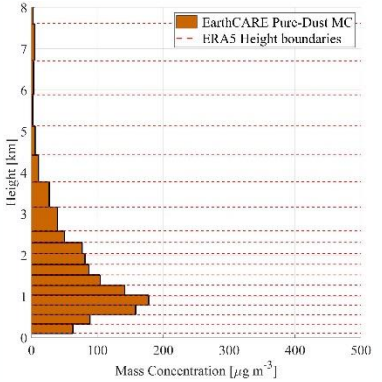
All EarthCARE overpasses
(SON 2024)



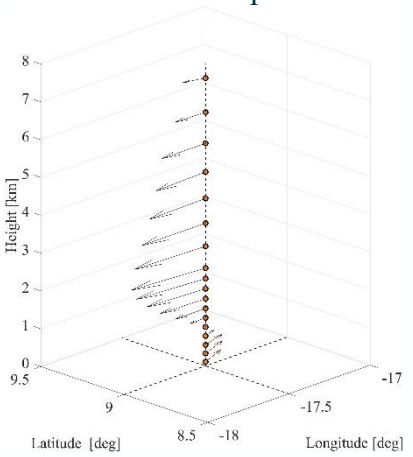
Dust mean MC profile
(SON 2024)



Dust mean MC profile in ERA5
vertical resolution (SON 2024)

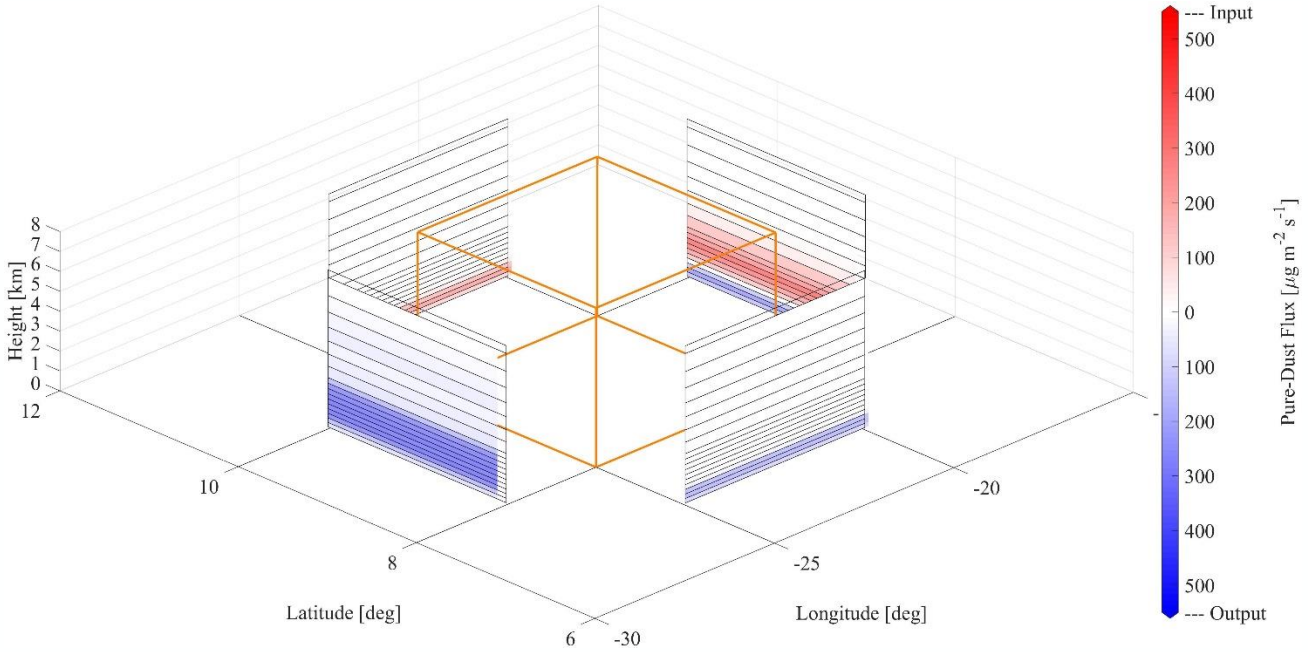


ECMWF ERA5
U/V wind components

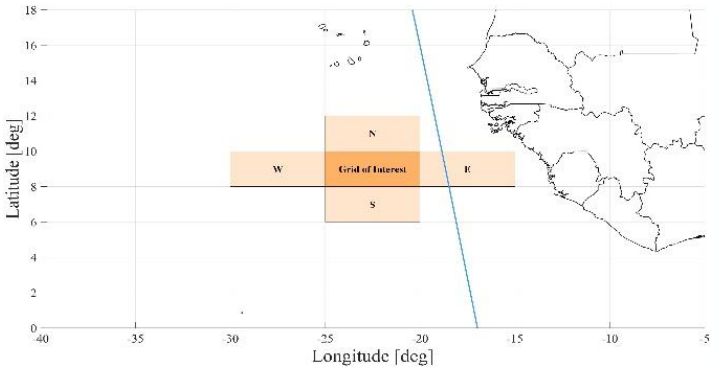


EarthCARE-Based Atmospheric Dust Deposition

- A 3D cuboid was defined over the Atlantic Ocean, and dust fluxes through its lateral boundaries were calculated.
- No dust sources, sinks, or transport above 10 km were assumed within the cuboid.
- Surface dust deposition was estimated as the residual between incoming and outgoing dust mass fluxes.



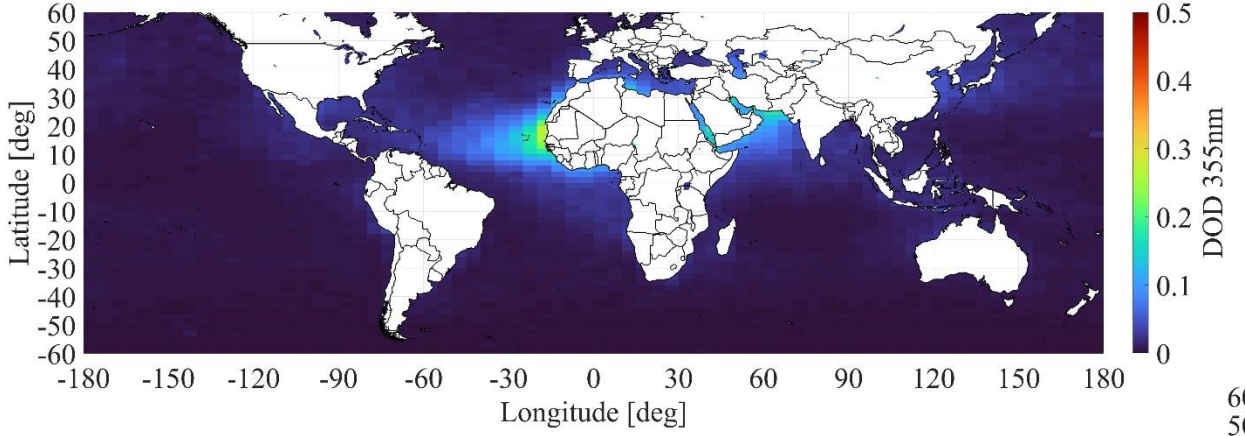
$$DDR = All\ input\ fluxes - All\ output\ fluxes \longrightarrow DDR = 71.1\ [\frac{mg}{m^2 d}]$$



EarthCARE-Based Atmospheric Dust Deposition

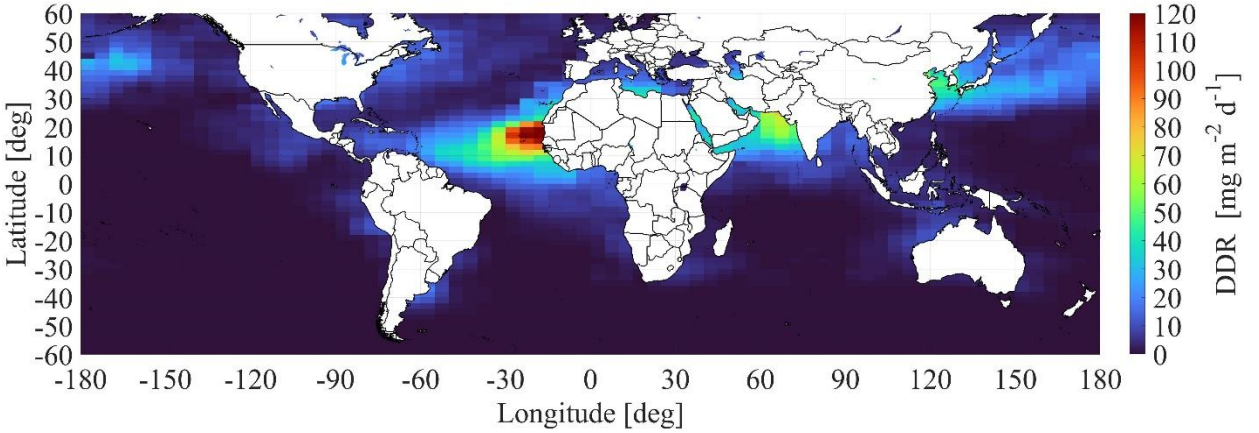
The figures presents the global annual-mean distribution of the atmospheric pure-dust aerosol component (left panel), expressed as dust optical depth (DOD at 355 nm), together with the corresponding pure-dust deposition rates over the oceans (right panel).

DOD 355 nm (09/2024-08/2025)



From atmospheric dust to deposited dust across the ocean

Dust Deposition Rate (09/2024-08/2025)



Validation of EC Dust Mass Concentration Profiles

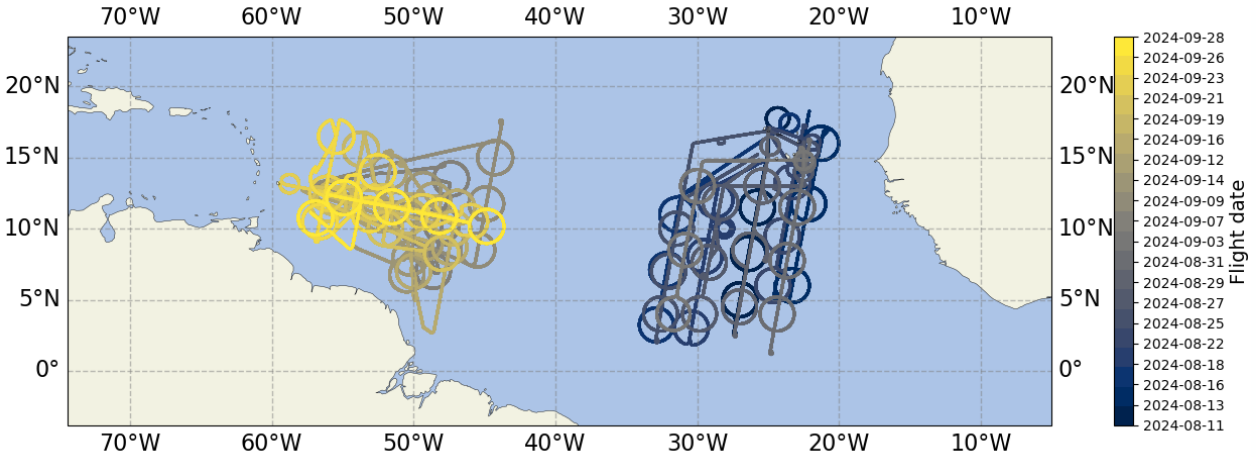
Evaluation of atmospheric dust

EarthCARE validation campaign **PERCUSION** with HALO

(**P**ersistent **E**a**R**th**C**are **U**nderflight **S**tudies of the **I**TCZ and **O**rganized convectio**N**)

Observations with HSRL WALES

- Cross sections of depolarization ratio, lidar ratio ⇒ aerosol typing!
- Generation of prototype-like products (e.g., atmospheric dust)



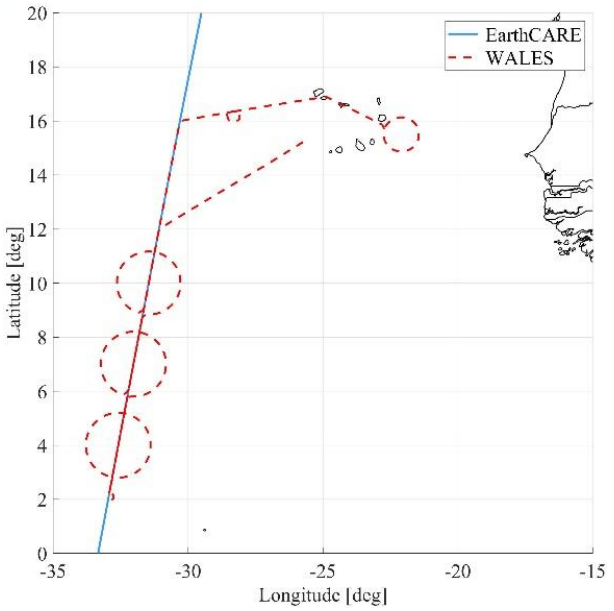
Silke Gross: Silke.Gross@dlr.de

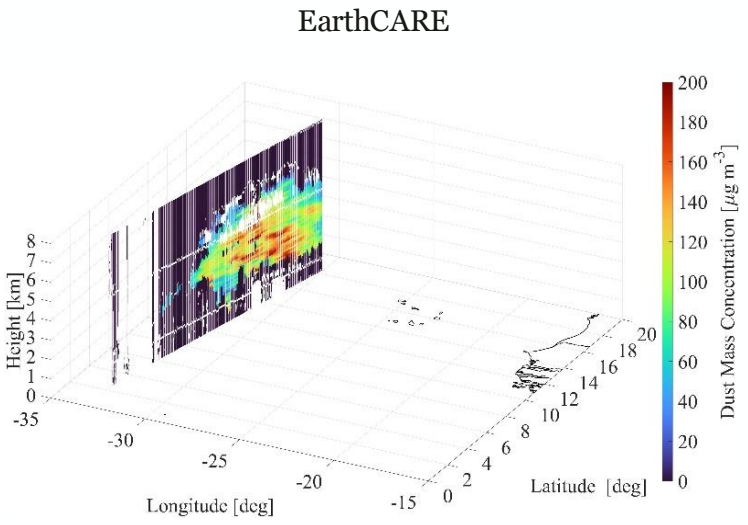
Konstantin Krueger: Konstantin.Krueger@dlr.de

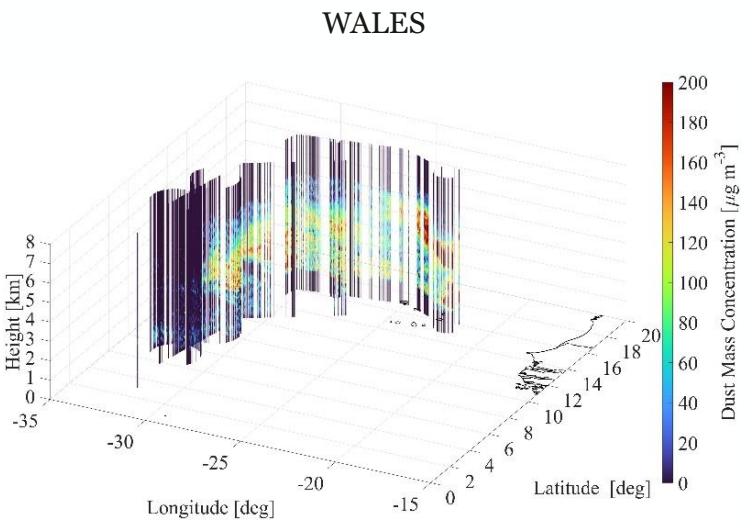
Validation of EC Dust Mass Concentration Profiles

Evaluation of atmospheric dust

Case study for EarthCARE orbit: 01380E

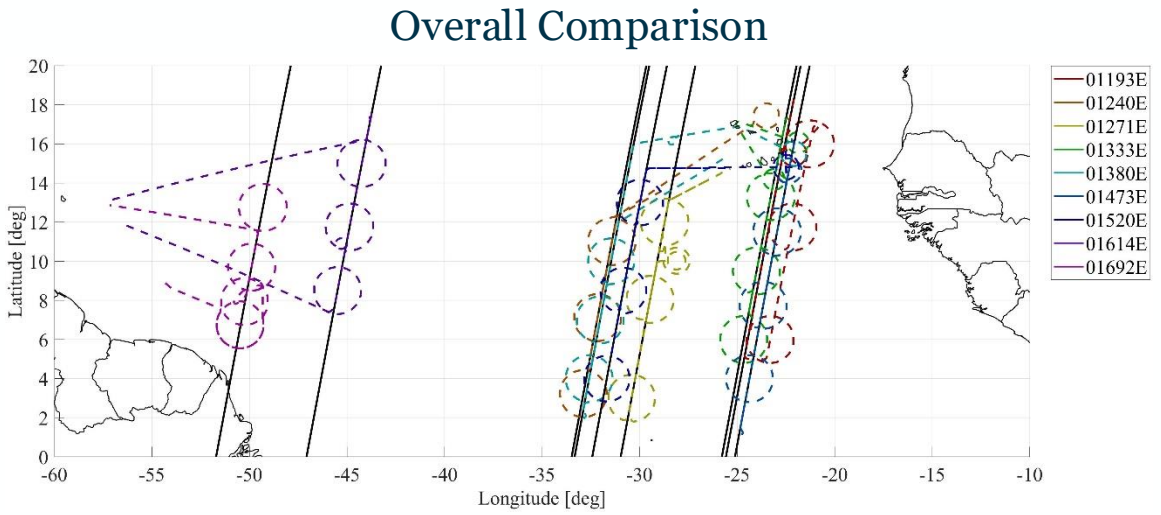


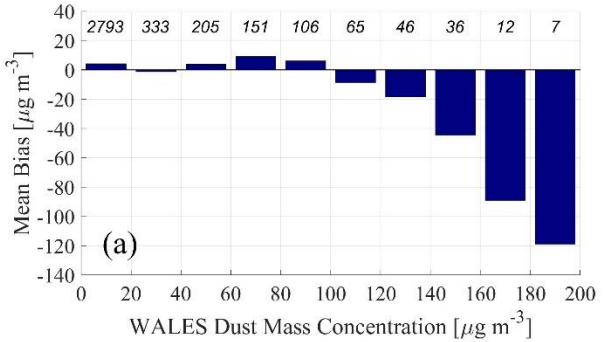


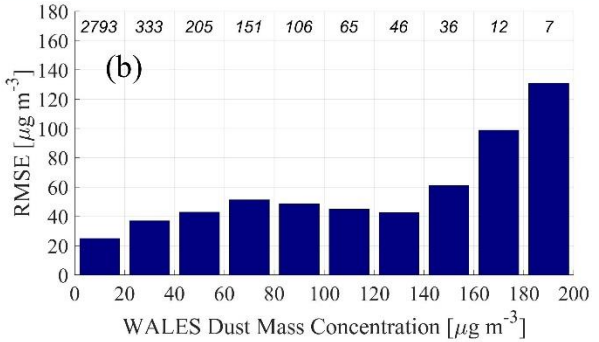


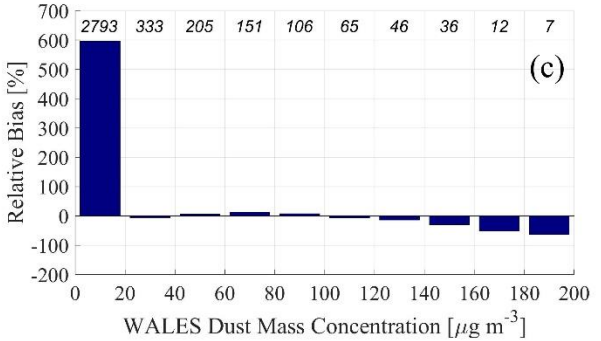
Validation of EC Dust Mass Concentration Profiles

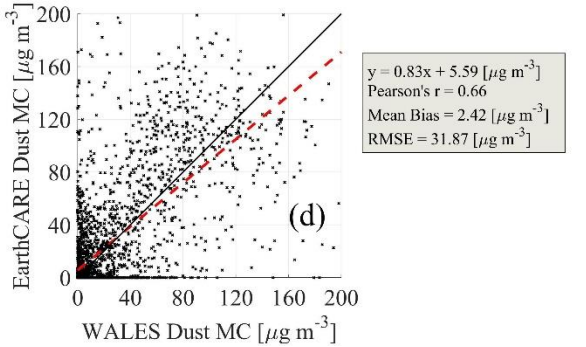
Evaluation of atmospheric dust





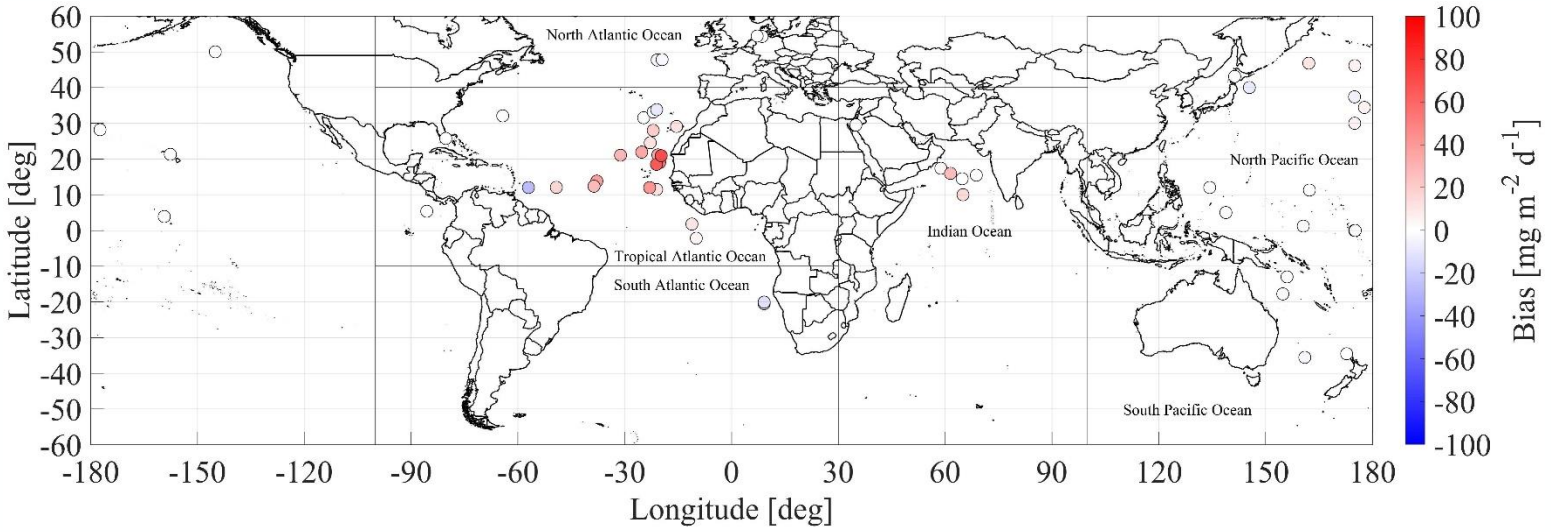


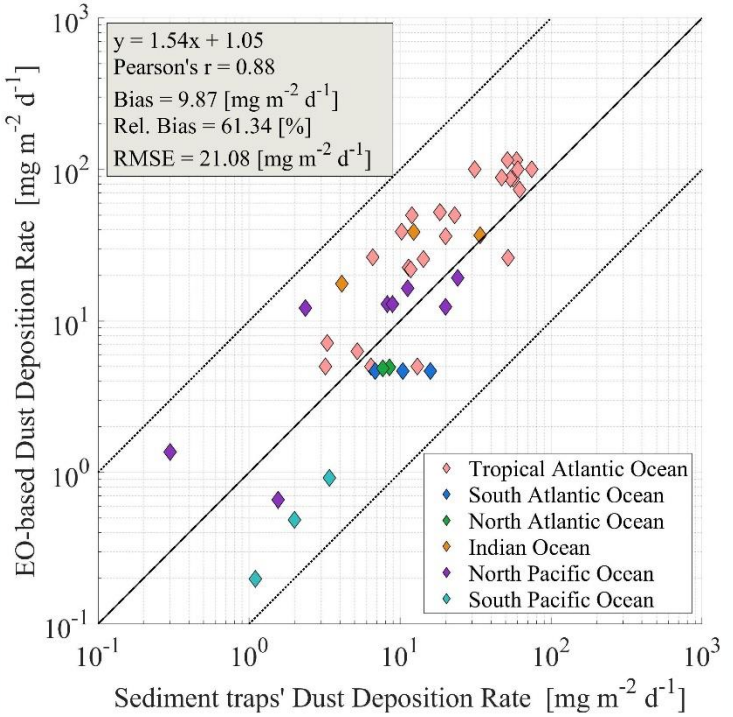




Estimation of Dust Fe deposited over the oceans

Evaluation of dust deposition rate outputs





In situ measurements of deposited lithogenic material.
Data records compiled by:
Huneeus et al. 2011 – "Global dust model intercomparison in AeroCom phase I".
Albani et al. 2014 – "Improved dust representation in the Community Atmosphere Model".

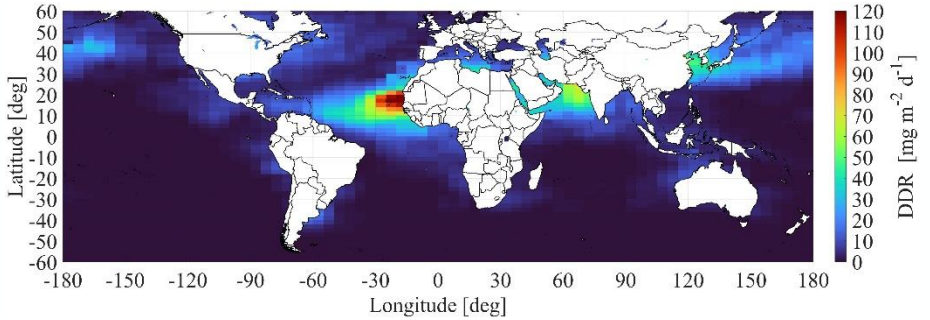
Estimation of Dust Fe deposited over the oceans

Dust-Fe deposition rate

EARTHCARE

ECMWF
ERA5 U/V

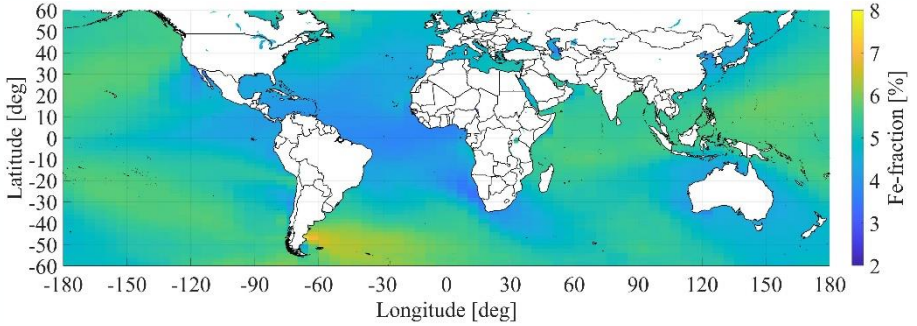
Dust Deposition Rate (09/2024-08/2025)



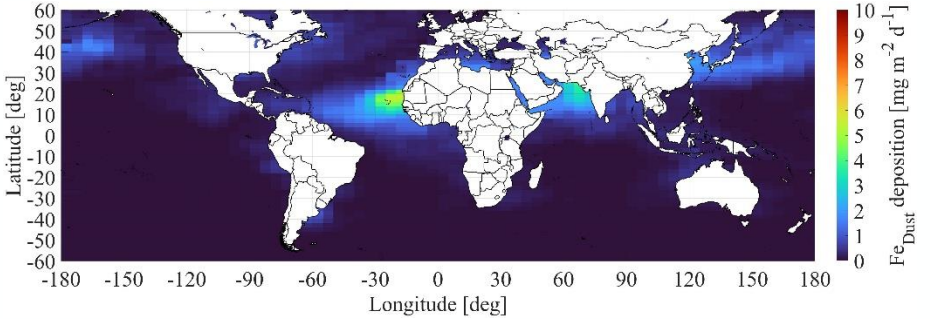
EMIT

MONARCH

Fe-fraction in dust



Dust-Fe Deposition Rate (09/2024-08/2025)



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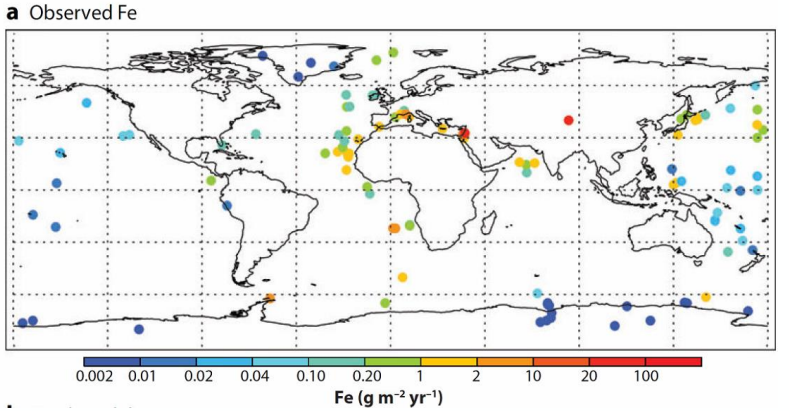
Carlos Pérez García-Pando: carlos.perez@bsc.es

Estimation of Dust Fe deposited over the oceans

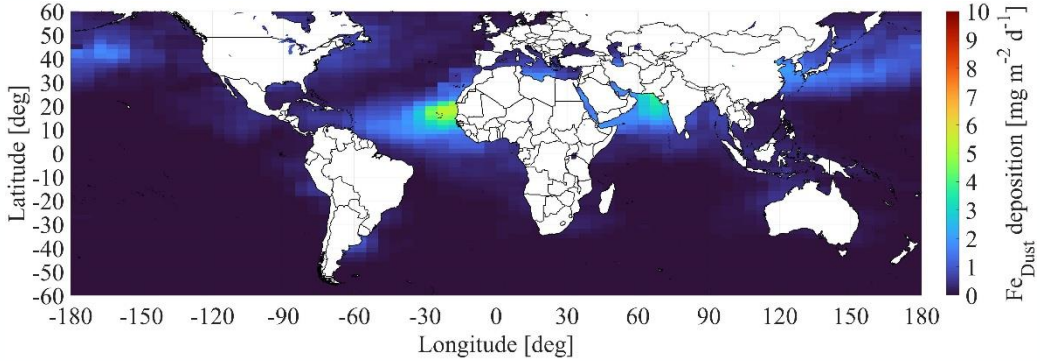
Next steps..

Dust-Fe evaluation



Source:
Mahowald et al., 2009

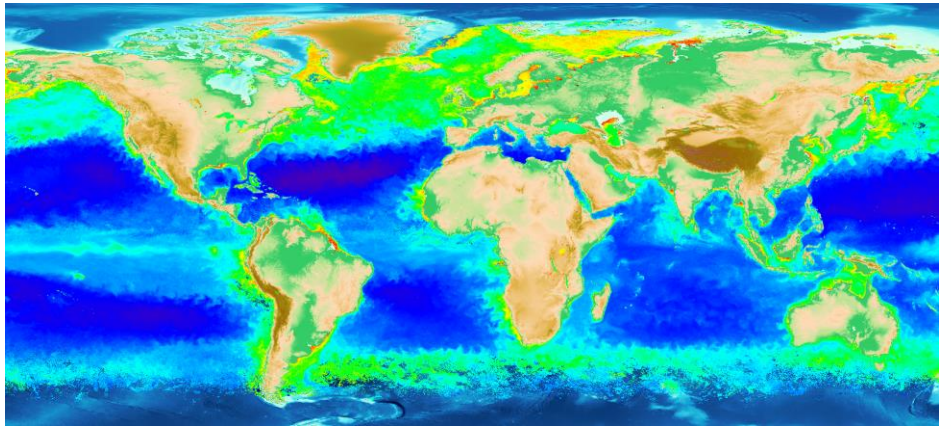
Dust-Fe Deposition Rate (09/2024-08/2025)



Impact on ocean ecosystems:

Intercomparison with Chl-*a*

ESA Ocean Colour CCI



Estimation of Dust Fe deposited over the oceans

Thank you for your:

1) time
2) interest
&
3) attention...

(...on behalf of OREO group)