Deciphering the role of desert-dust aerosols in the next phase of CMIP

Stephanie Fiedler
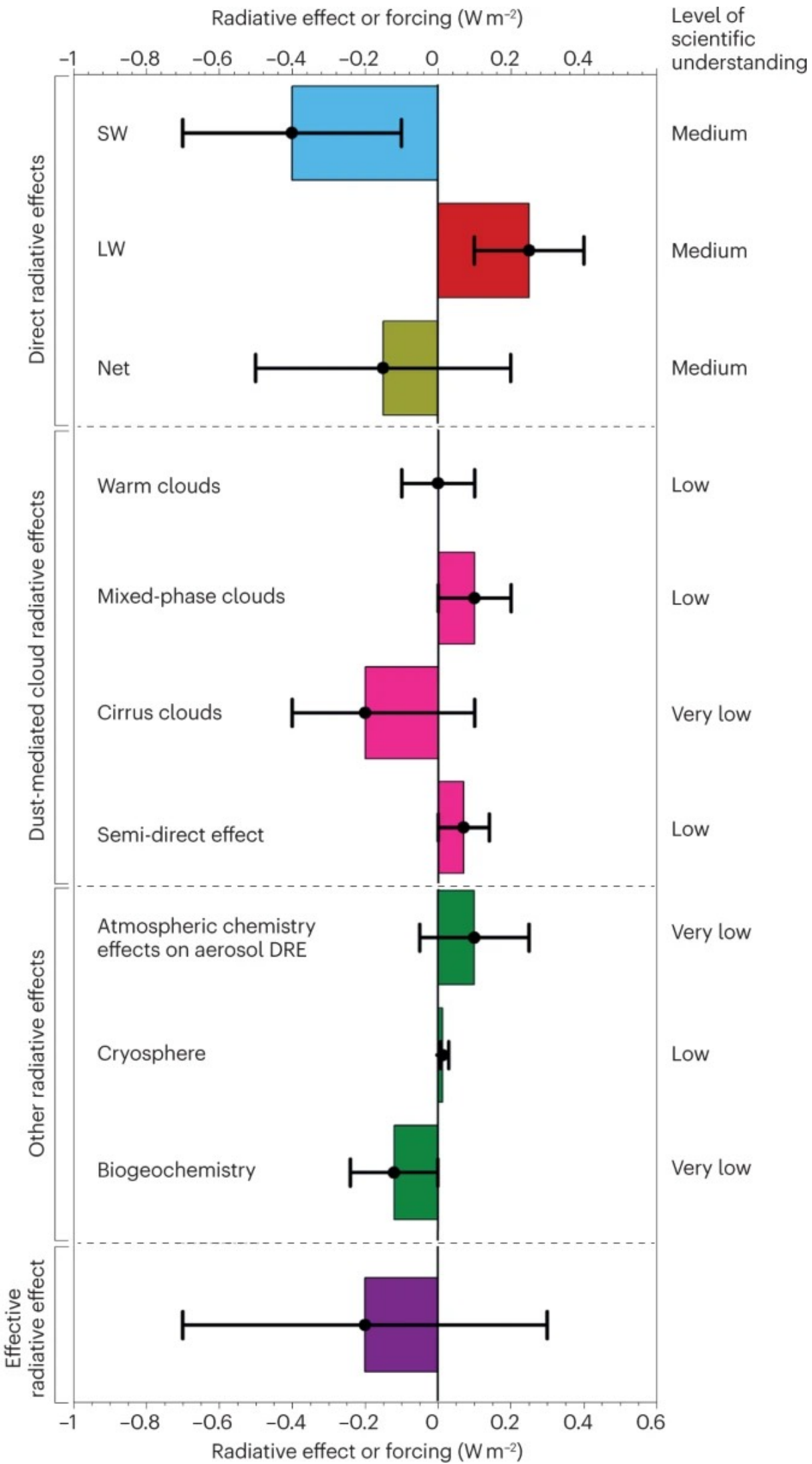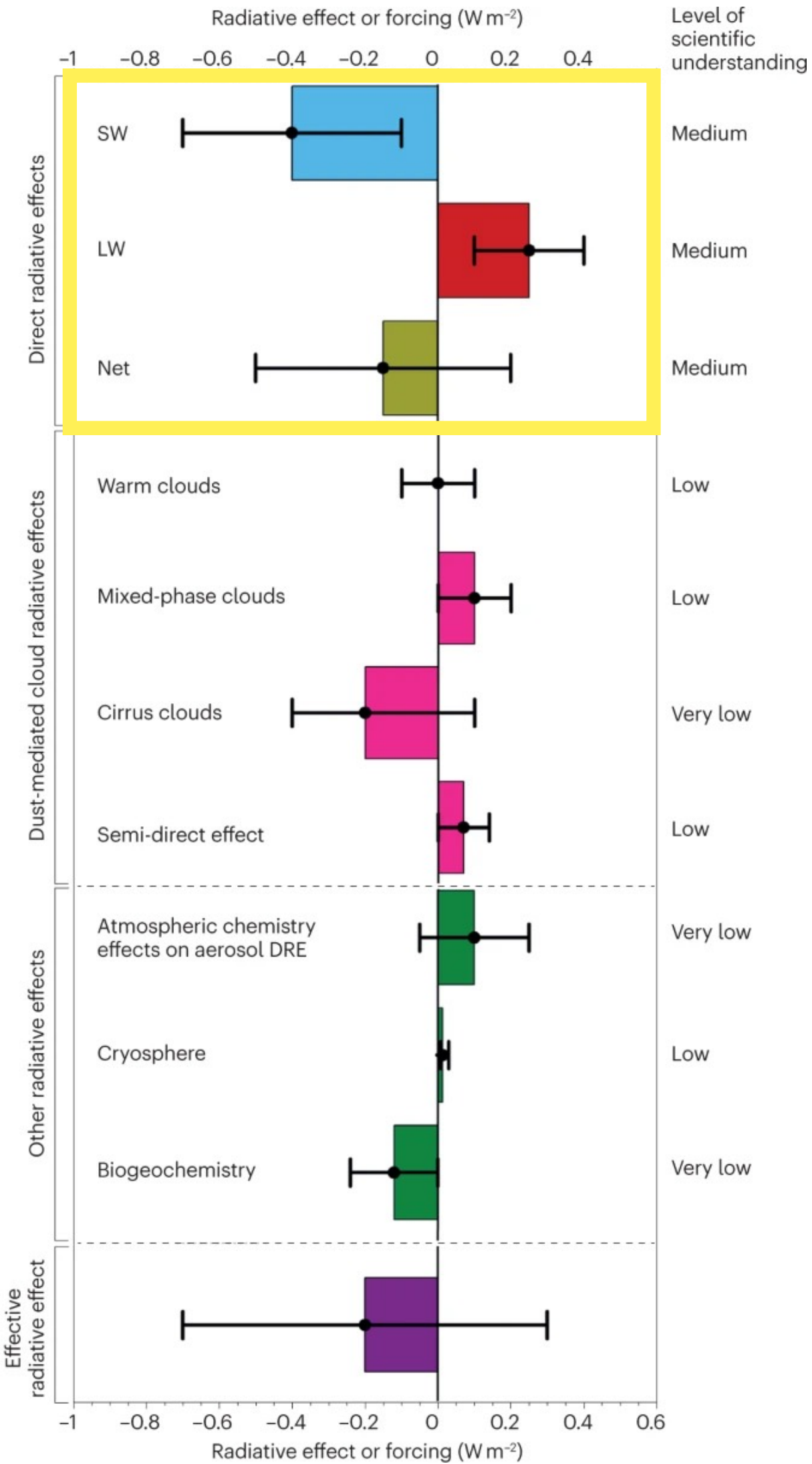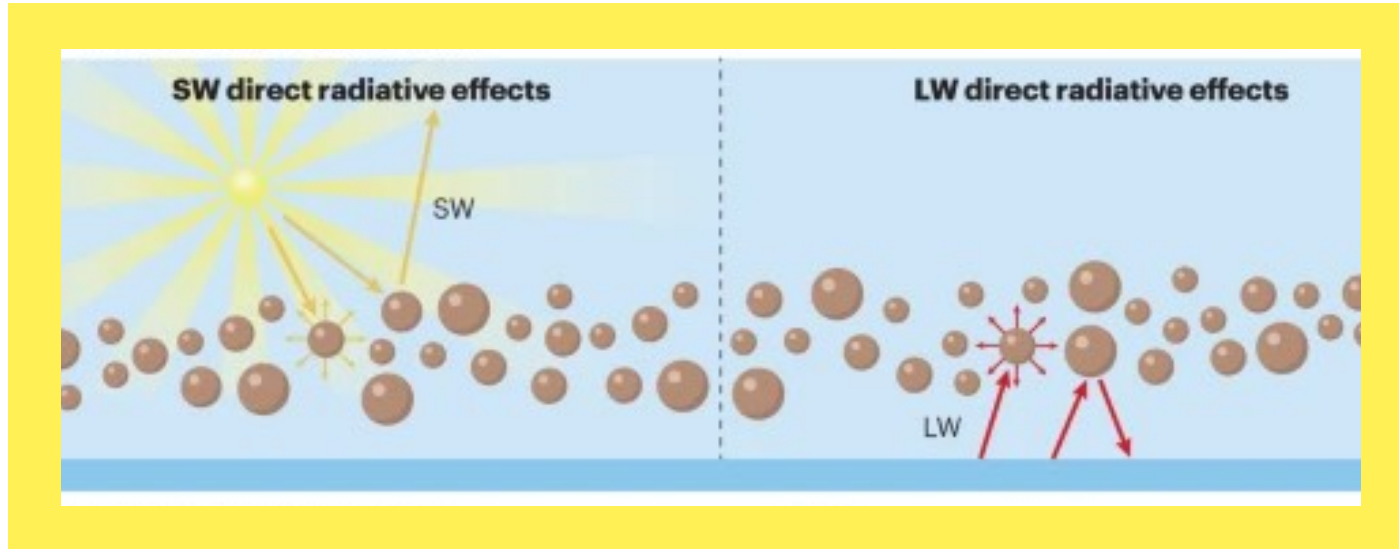

CMIP Forcings Workshop, ECMWF Reading
29 October 2024

GEOMAR · UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

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Desert-dust aerosol effects

Desert-dust aerosol effects

Kok et al. (2023)

Desert-dust aerosol effects

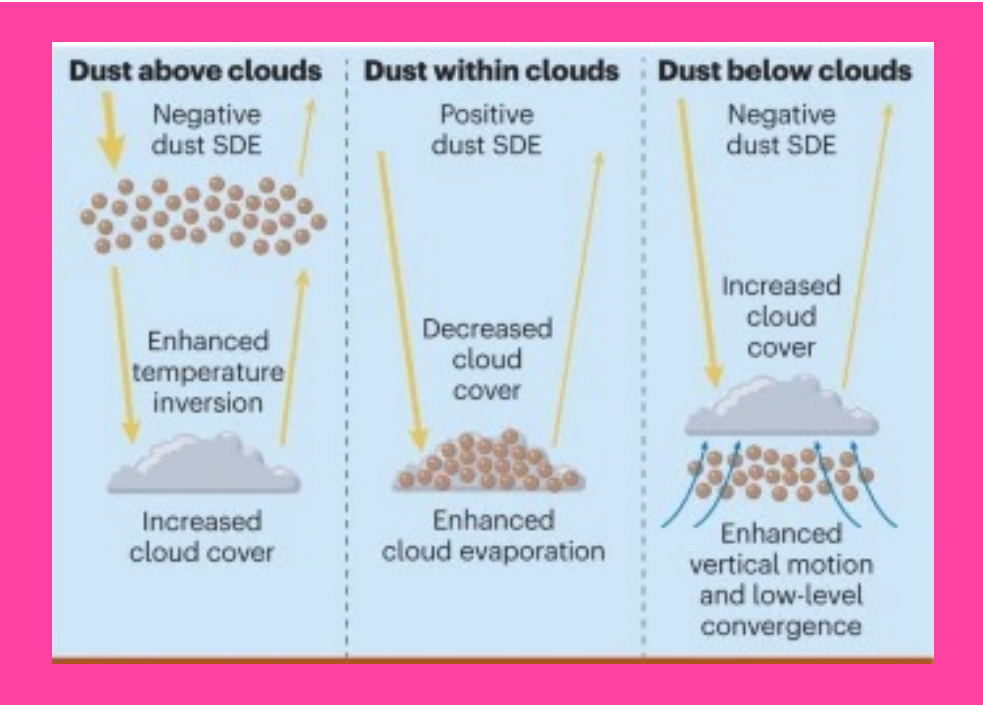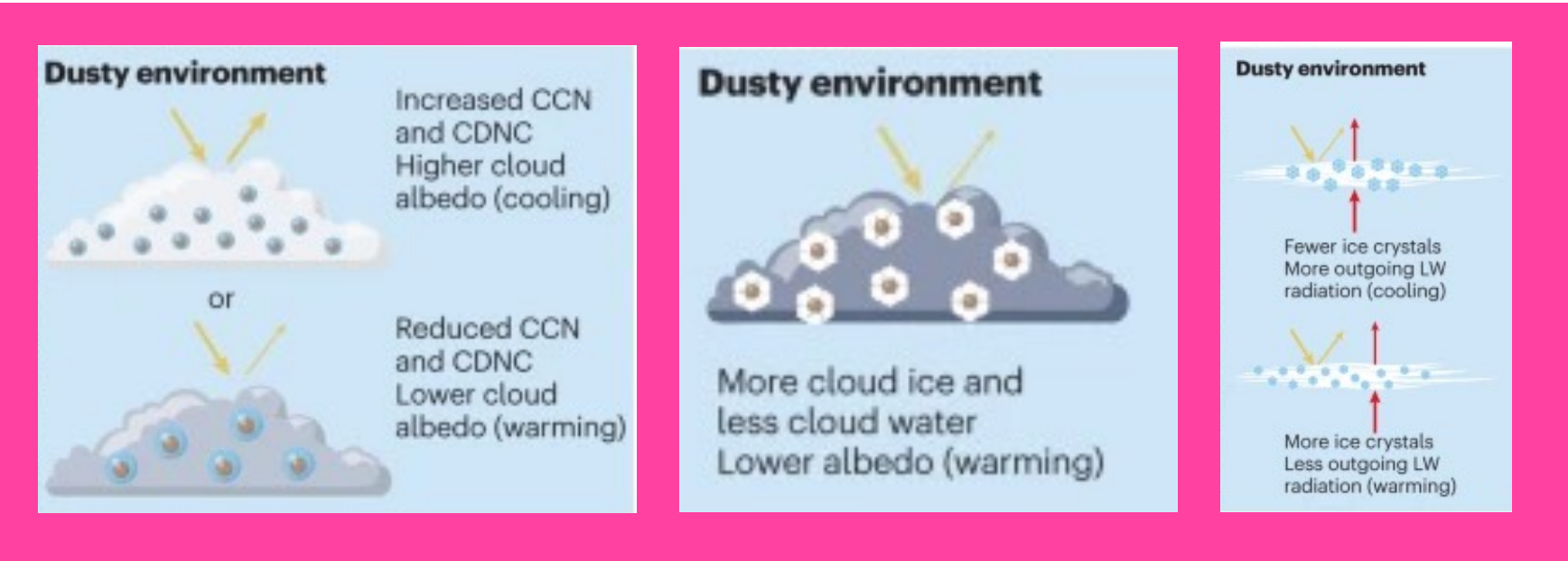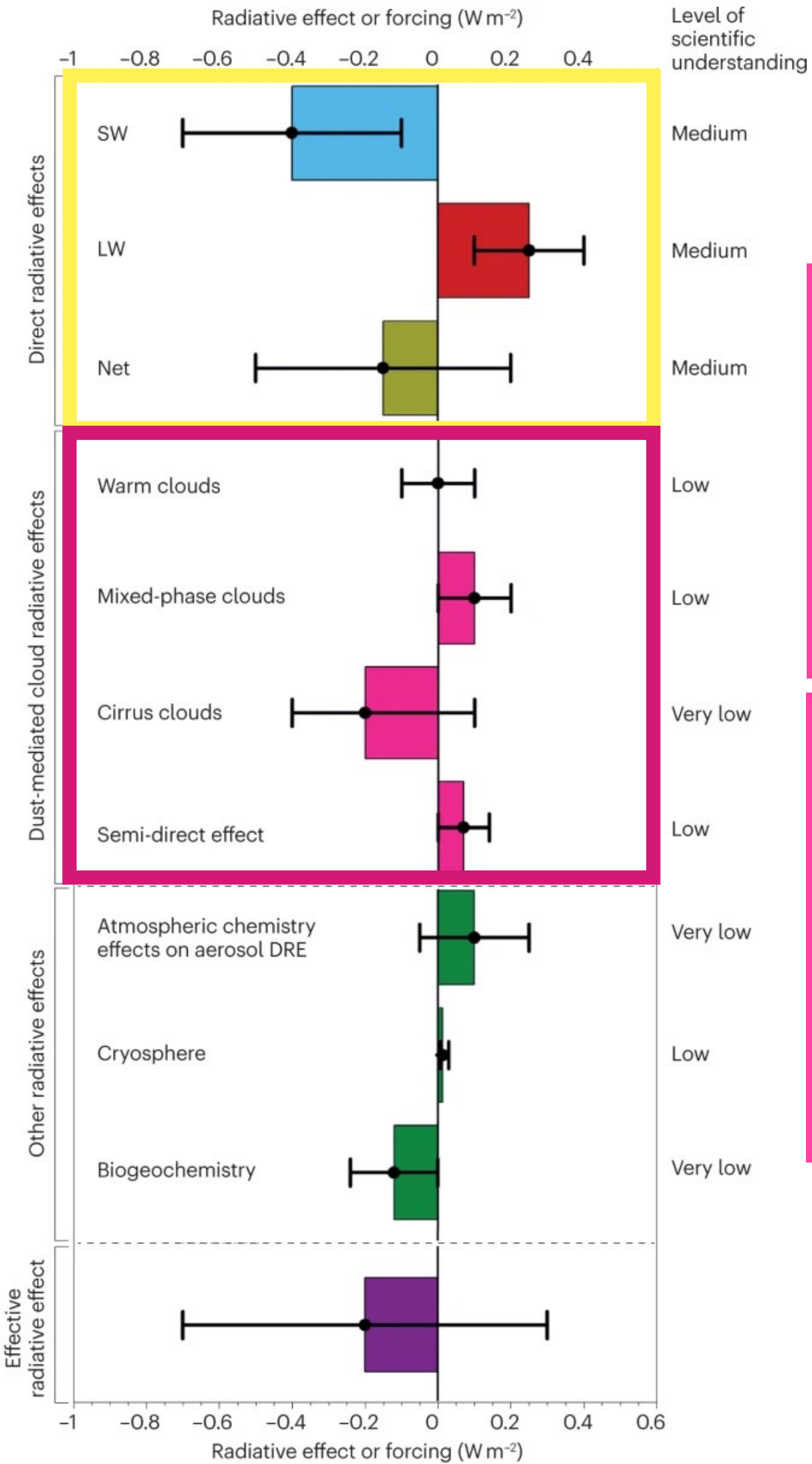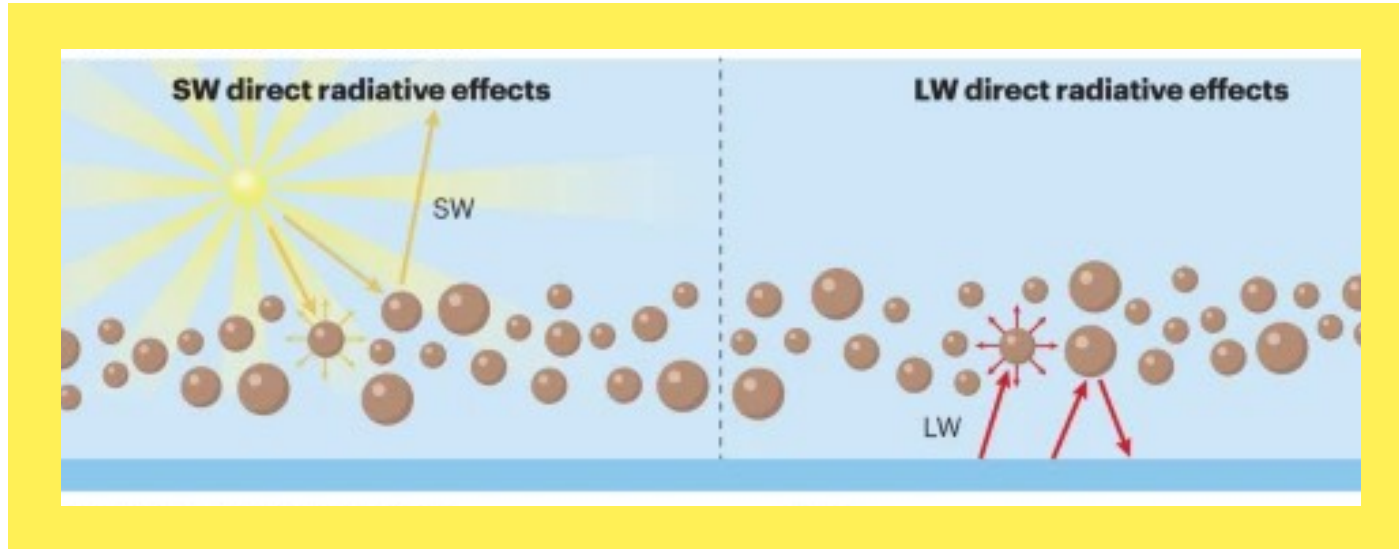Kok et al. (2023)

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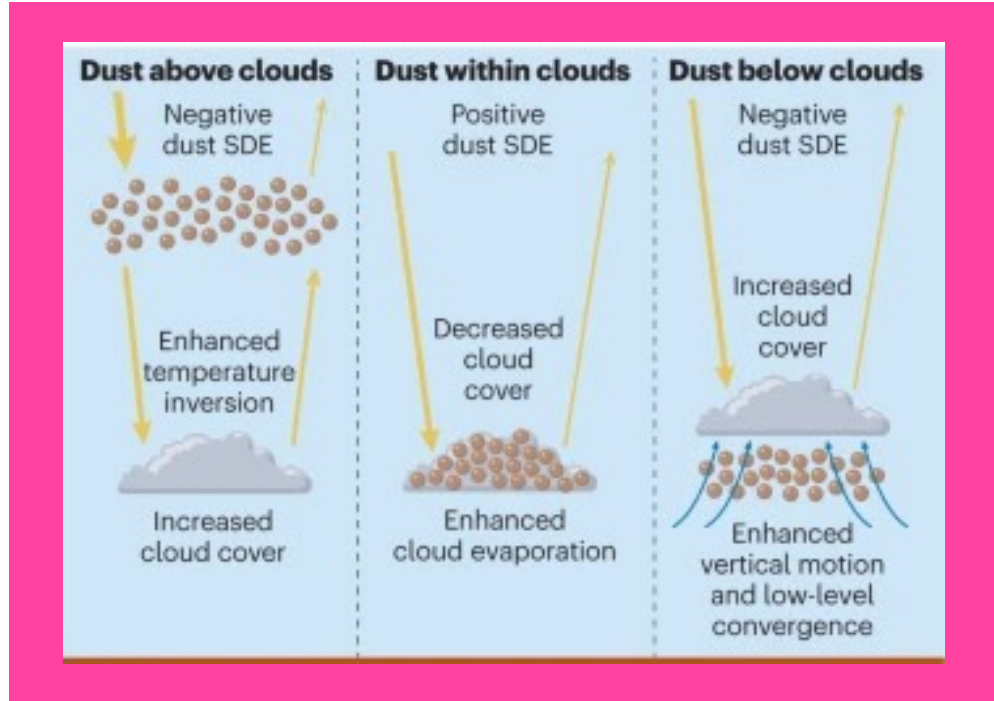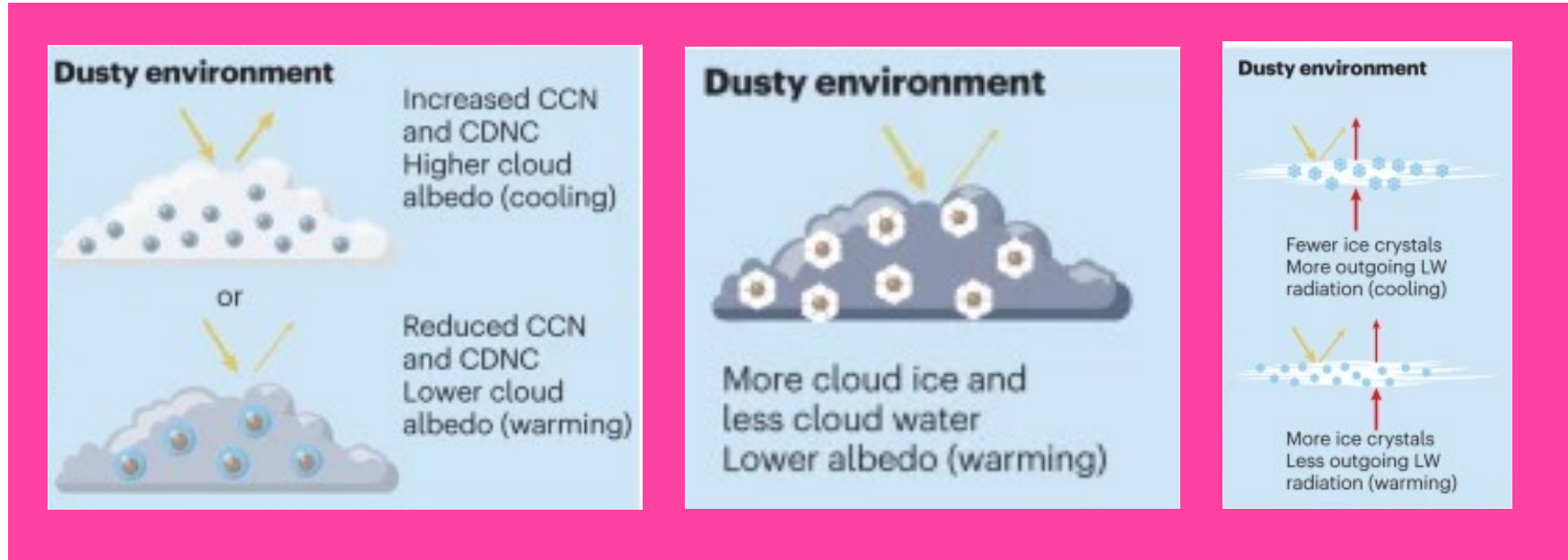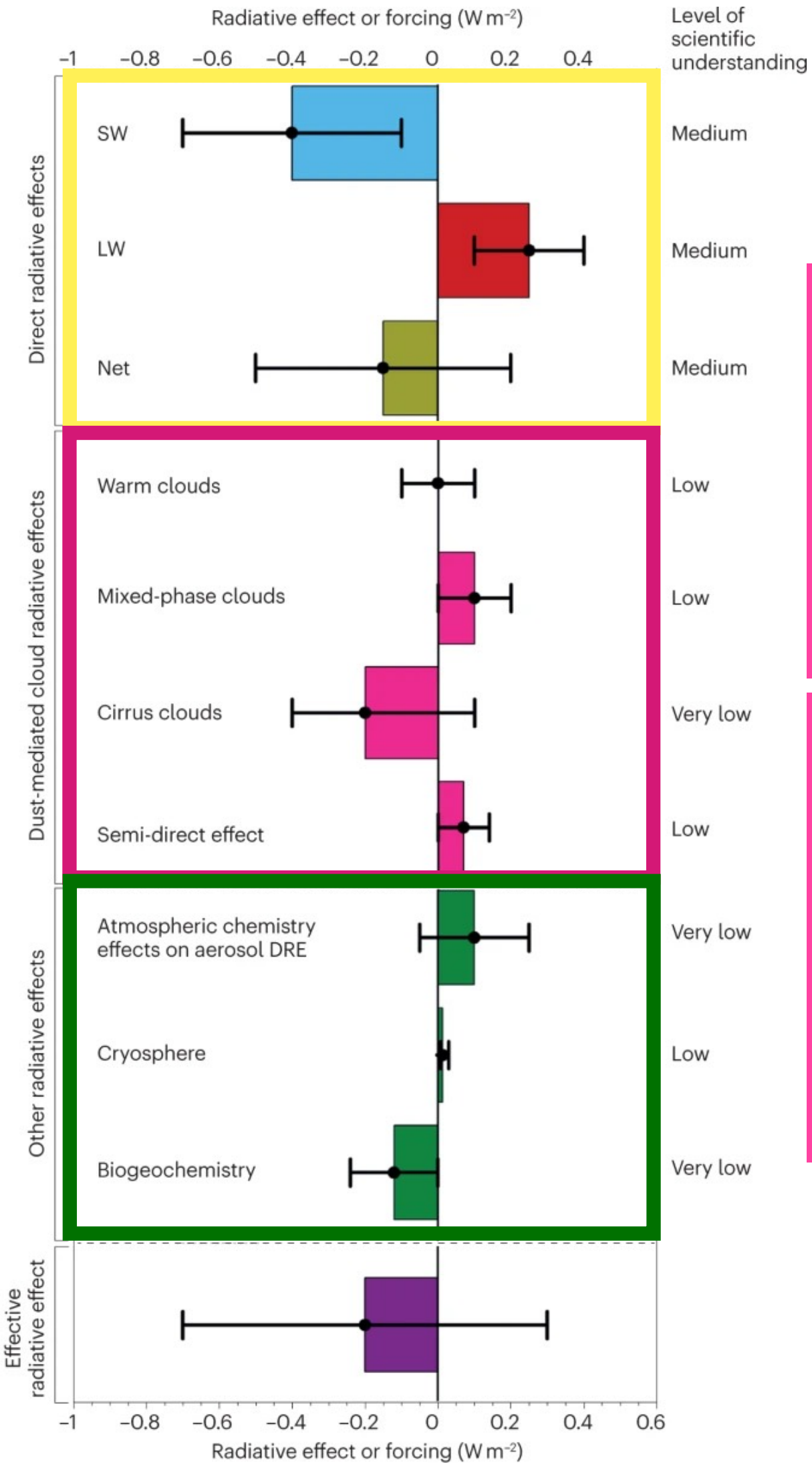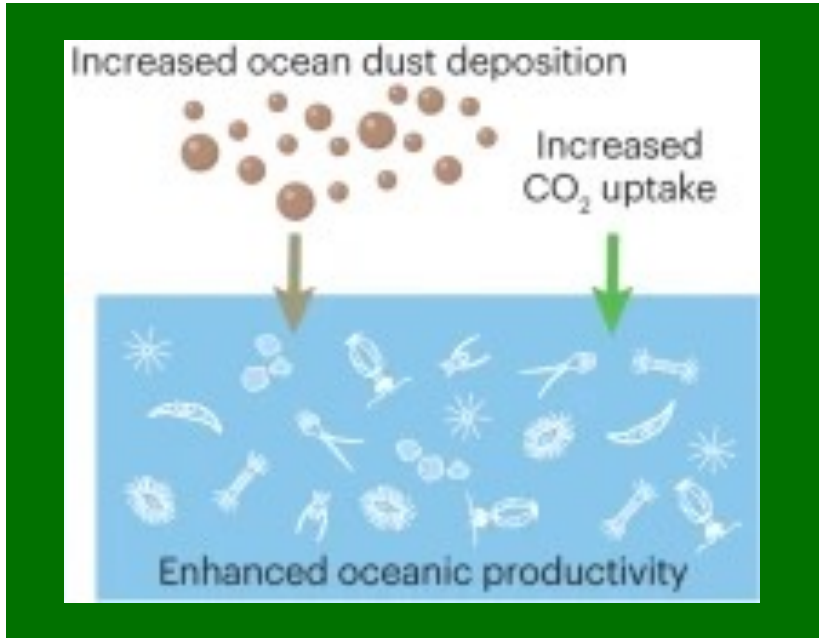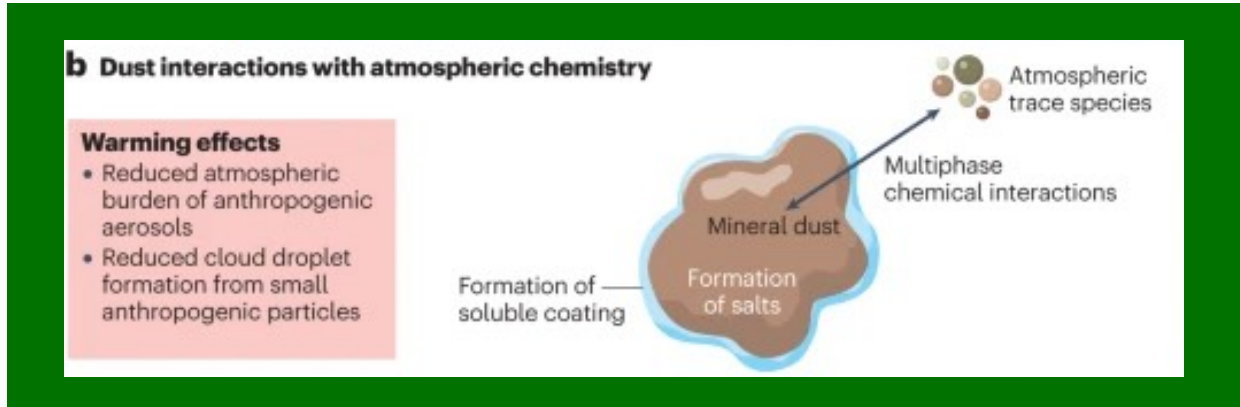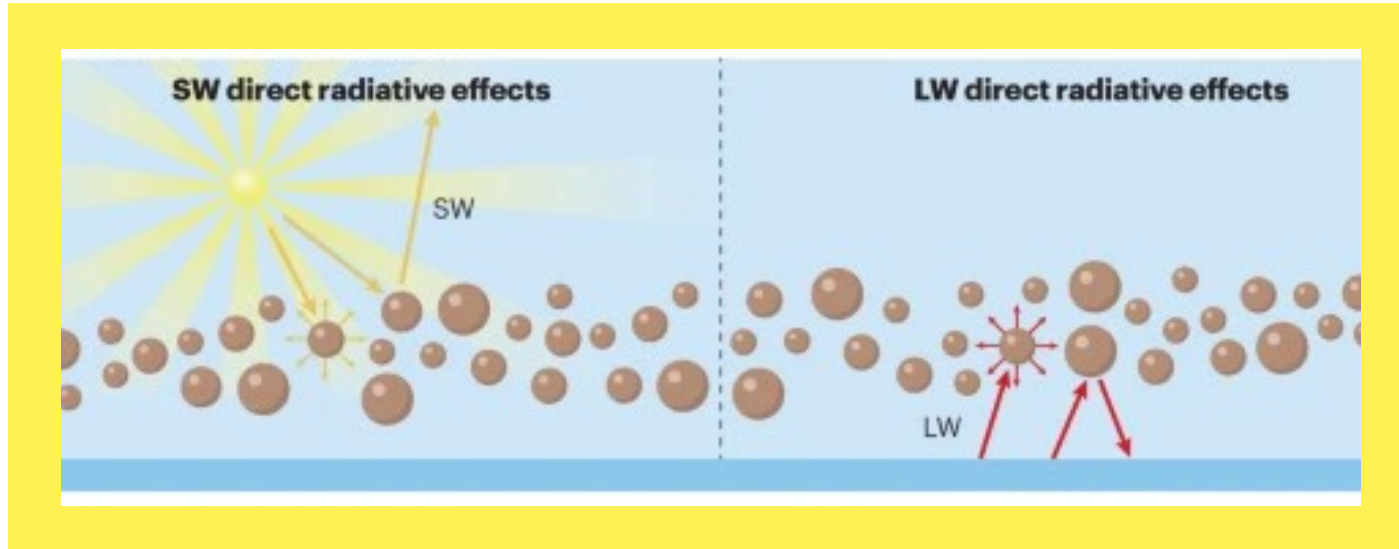
Dust aerosols
Small particles with large impacts

Dust aerosols

Small particles with large impacts

Weather risk, traffic disruptions, soil erosion

Dust aerosols

Small particles with large impacts

Weather risk, traffic disruptions, soil erosion

Impact on human health

Dust aerosols

Small particles with large impacts

Weather risk, traffic disruptions, soil erosion

Fertilisation of eco-systems & influence on carbon cycle

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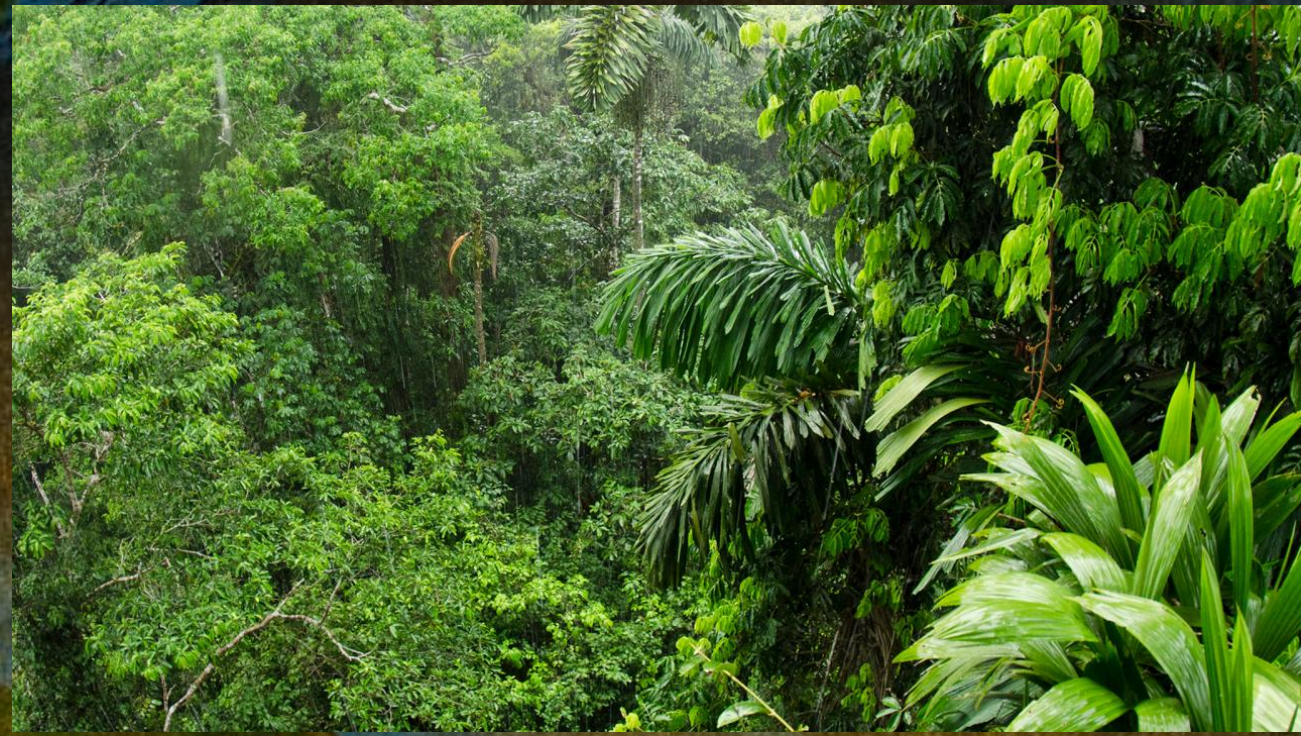
Fertilisation of eco-systems & influence on carbon cycle

Impact on human health

Impact on PV power production

Emission and deposition of desert-dust aerosols

Kok et al. (2023)
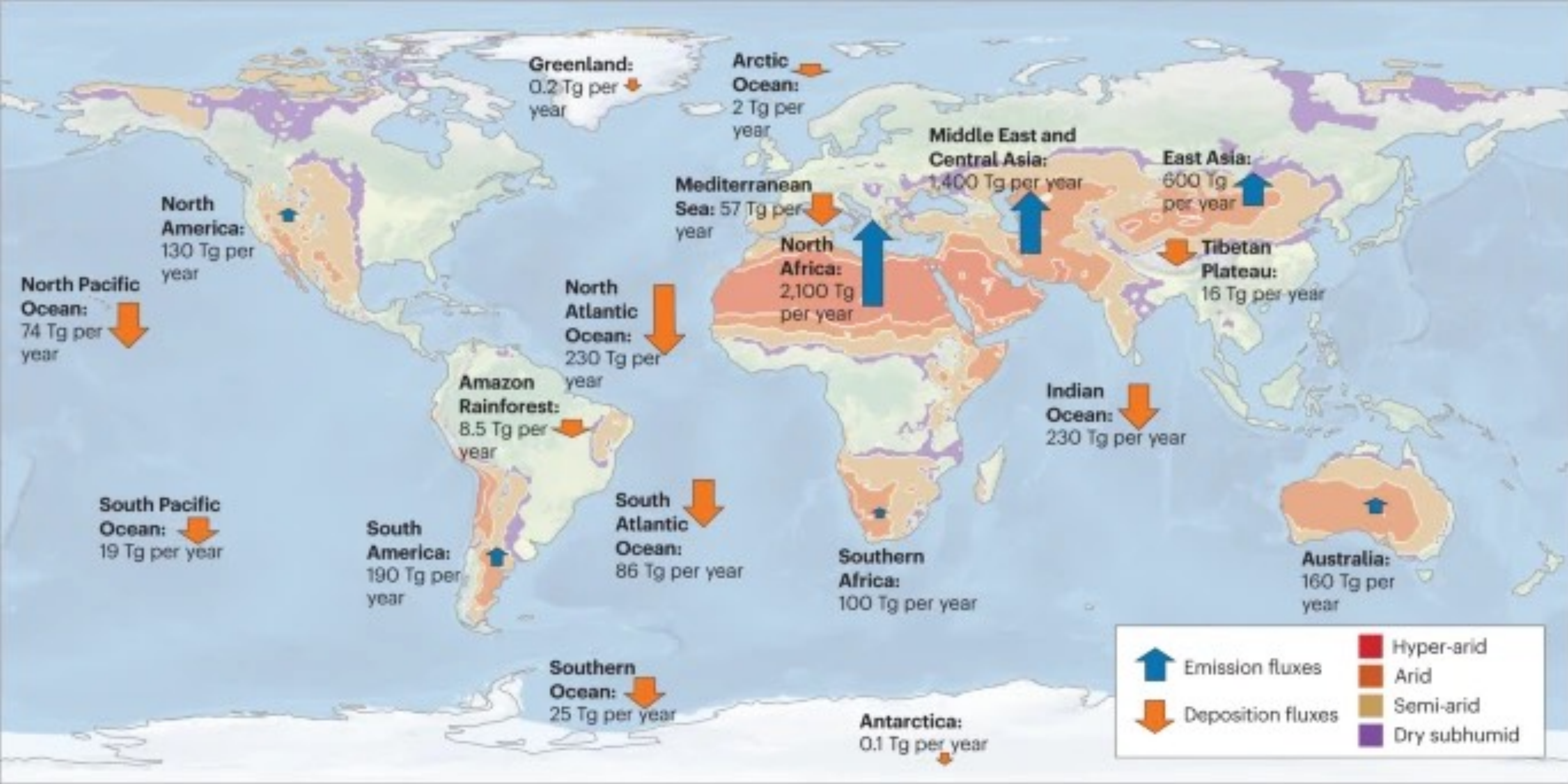
Models miss reconstructed increase in natural dust-aerosol burden since pre-industrial
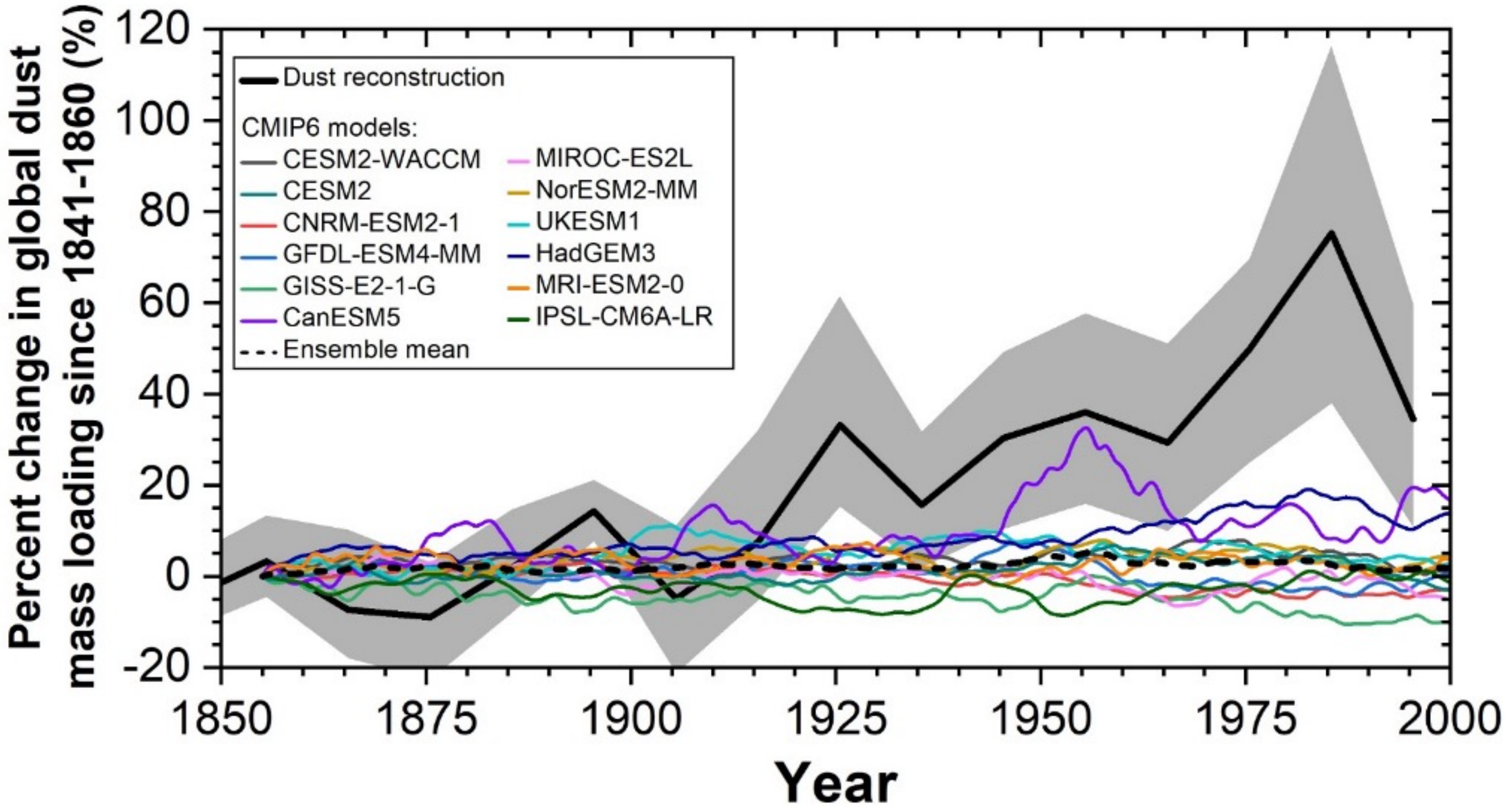
New DustCOMM dust emission inventory for 1841-2000

Gridded dust emission inventory

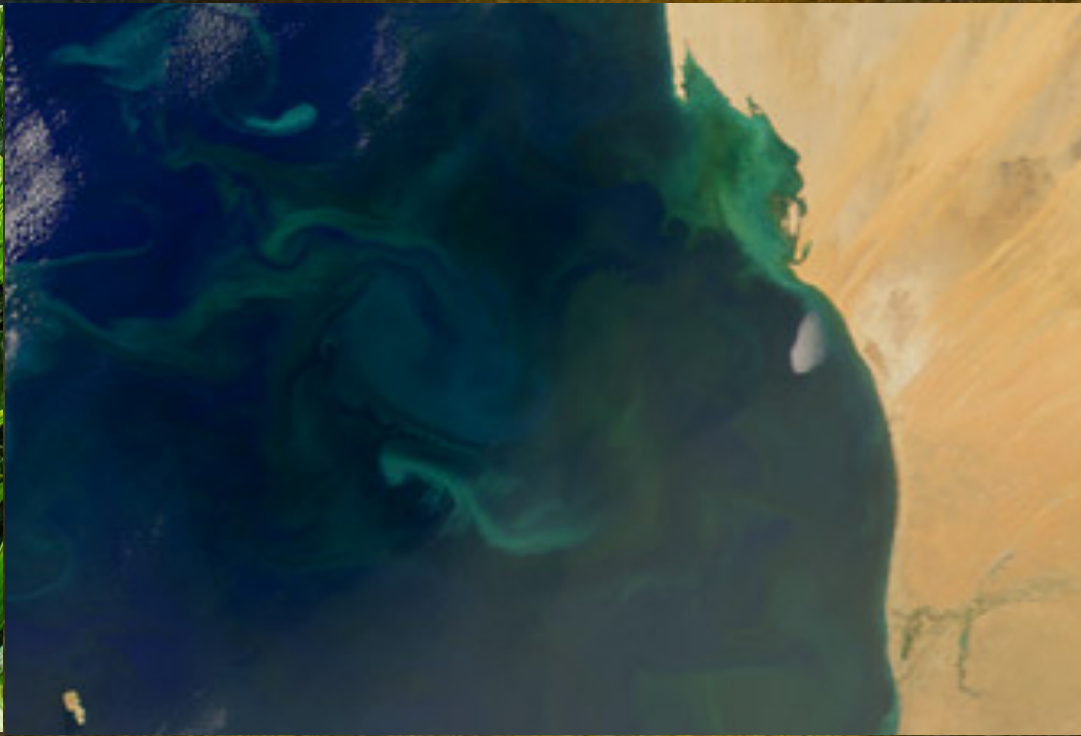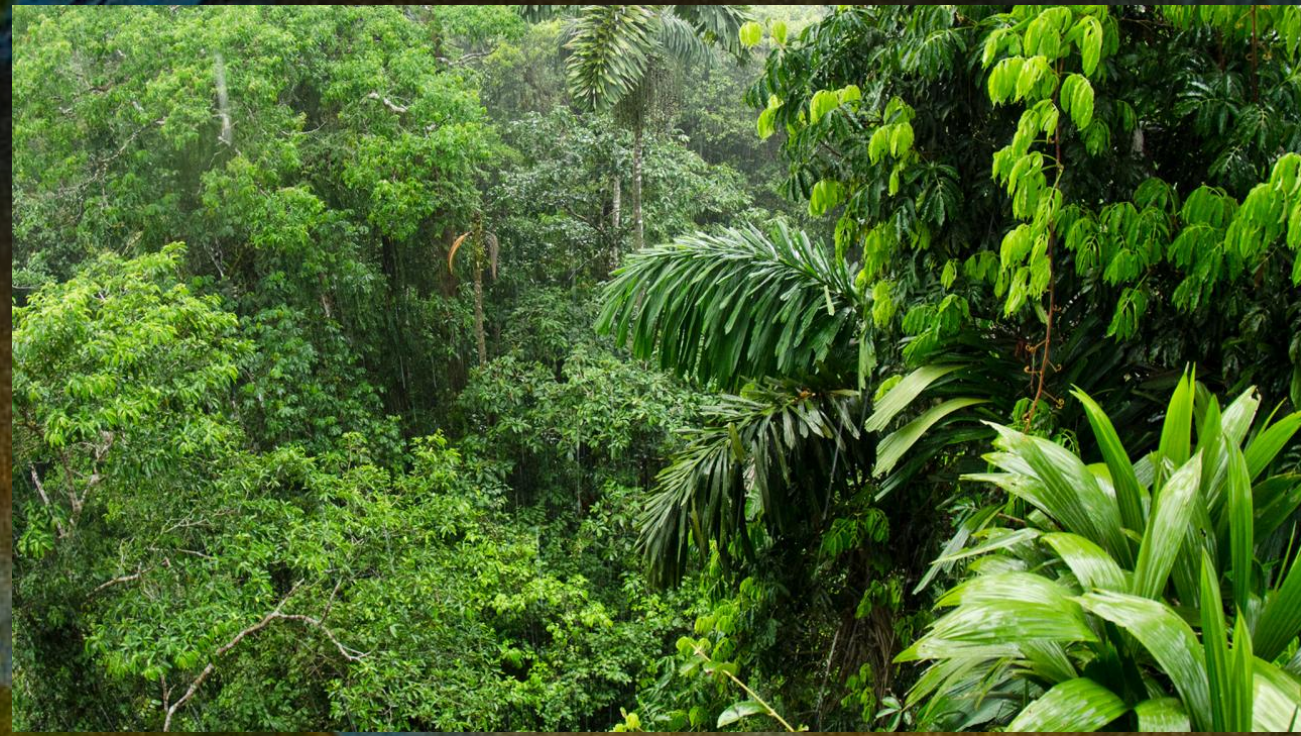- Most accurately simulates historical dust changes
- Loses dependence of dust emissions on climate

Decadally varying regional or global scaling factors

- Reproduce regional and global dust trends
- Preserves dependence of dust emissions on environmental conditions
- Dust spatial distributions less accurate

Decadally varying 2D dust optical depth fields

- Computationally fast
- Enables models without dust-aerosol schemes to account for historical dust changes

Manual describing these options is available here:

Jasper Kok: jfkok@ucla.edu

Leung et al. (2024)
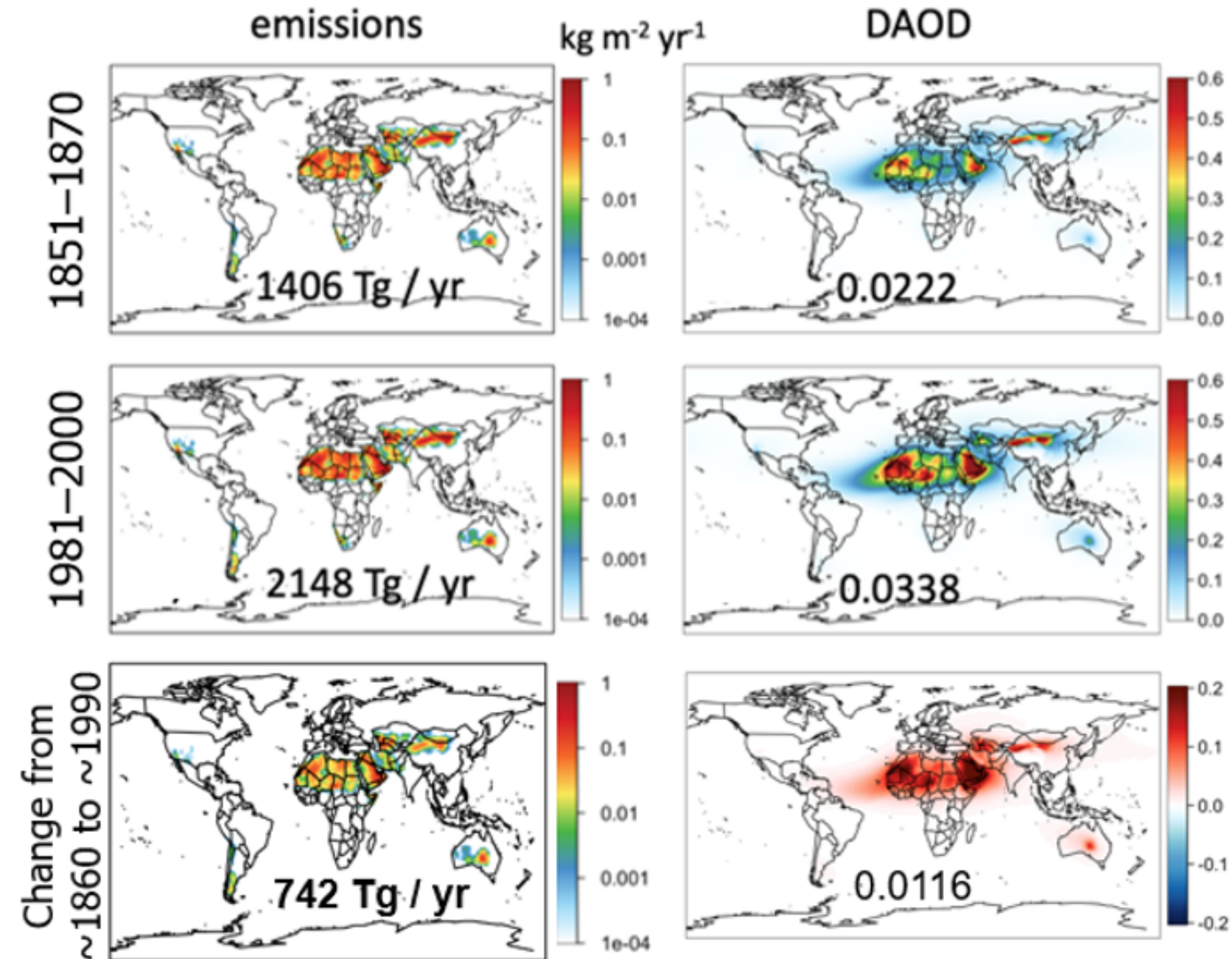
Model using dust-aerosol emission inventory reproduces reconstructed dust aerosols optical depth

Leung et al. (2024)
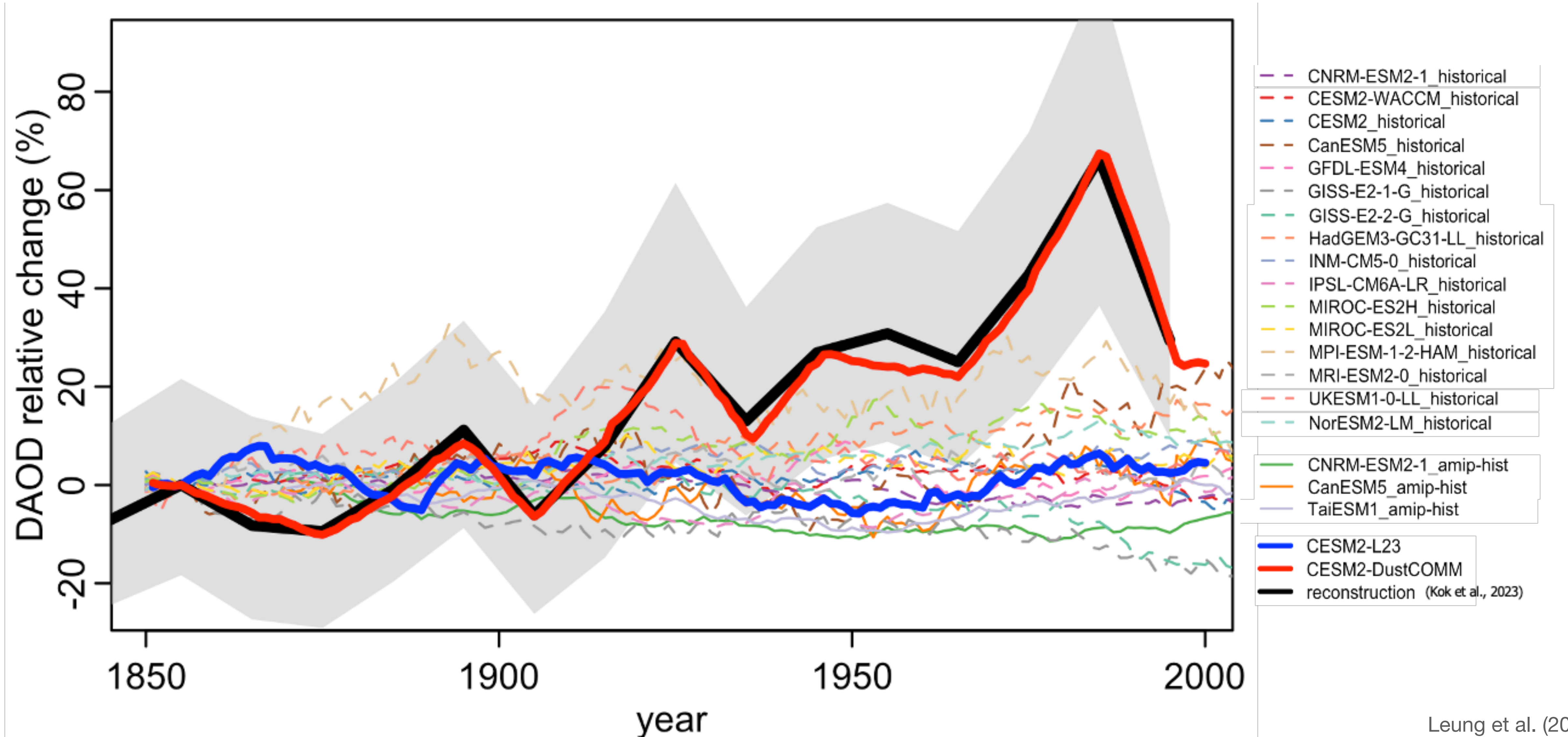
Proof of concept of DustCOMM from AeroCom

- Experiments with prescribed sea-surface conditions for 1850 – 2000 to diagnose dust direct radiative effects
- 8 participating models: EC-Earth, GISS ModelE, ECHAM/MESSy, NorESM, CESM, CAM-ATRAS, IPSL/INCA, and UKESM

Courtesy: Jasper Kok
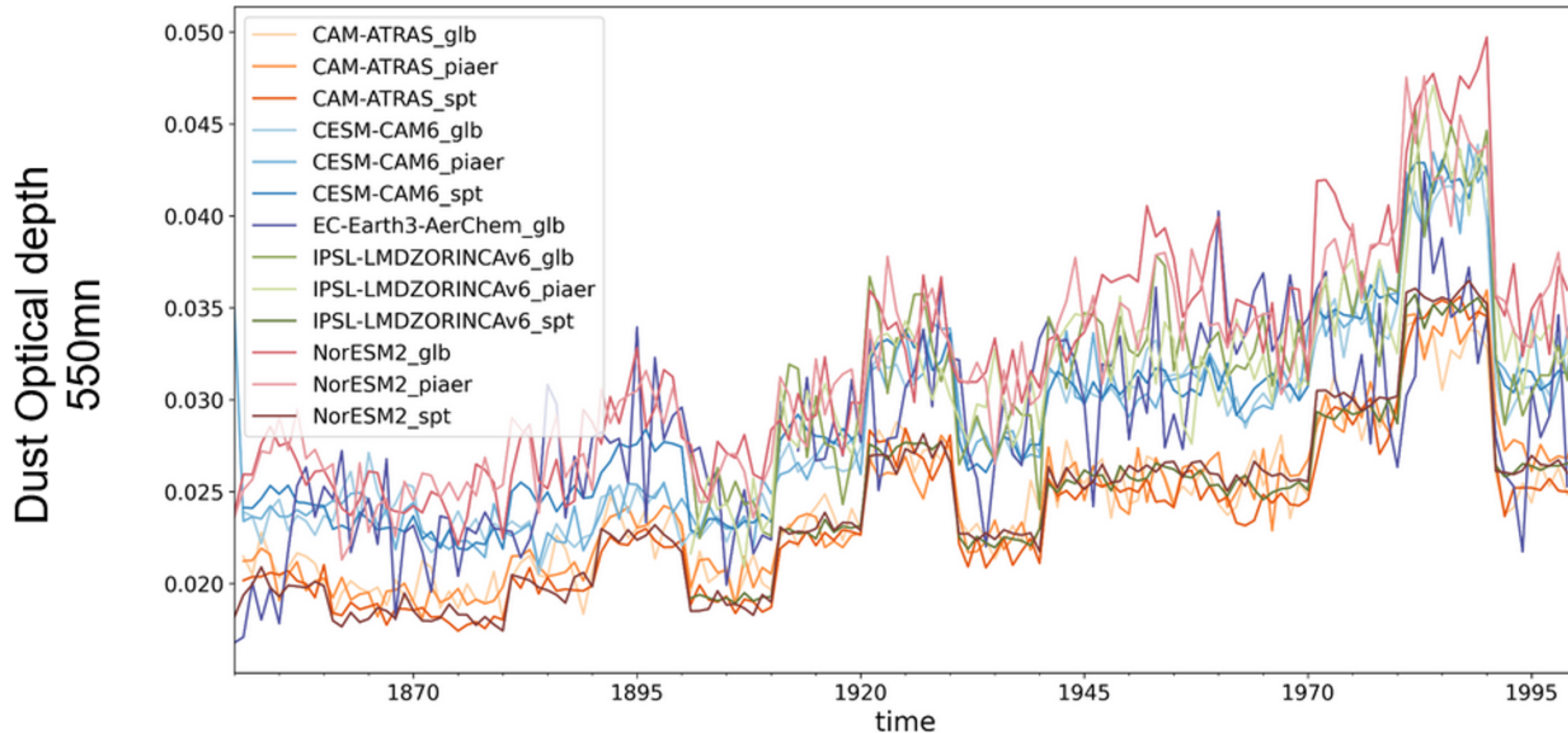
Science Questions of AerChemMIP2

AerChemMIP2 Co-chairs

Stephanie Fiedler (Germany)
Fiona O'Connor (UK)
Duncan Watson-Parris (USA)

1. Process Understanding:
How has our process understanding advanced for global and regional atmospheric composition changes, radiative forcing, and climate responses?

2. Feedbacks:
How important are climate feedbacks to natural SLCF emissions, atmospheric composition, and radiative effects?

3. Air quality:
What is the relative importance of climate change and emissions of SLCFs for atmospheric composition and air quality?

4. Sustainability:
What future climate penalties are expected from improving air quality and what are the climate trade-offs arising from policies for improved sustainability (if any)?

AerChemMIP2

MIP LONG NAME

Aerosol Chemistry Model Intercomparis...

Fiedler et al. (in prep.)

Deciphering the role of desert-dust aerosols in the next phase of CMIP

DustCOMM dust emission inventory for 1841-2000
- Data extension to 2023 in prep.
- Different boundary data types
- 3 simple future scenarios

Stephanie Fiedler
sfiedler@geomar.de

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AerChemMIP2 experiment on dust
- Historical and future experiments with prescribed dust
- Boundary data will be available via input4MIPs
- Support will be provided
- Simple dust plumes are in prep

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New opportunity to fill gaps in our knowledge
- To better understand the composition, climate, and air quality responses to dust aerosol emissions
- To quantify the role of the missing representation of dust changes for radiative forcing

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