Observation-oriented CCN modification over the Southern Ocean using the CAM6

Qing Niu[1,2,3], Christina McCluskey[3], Greg McFarquhar[1,2], Gerald Mace[4], Danny Leung[3], Simone Tilmes[3], Susannah Burrows[5], Naser Mahfouz[5], Katherine Calder[3]..

University of Oklahoma, NCAR (visitor)

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Intro: Simulated Antarctic Clouds “bright” enough?

Simulation - Observation:

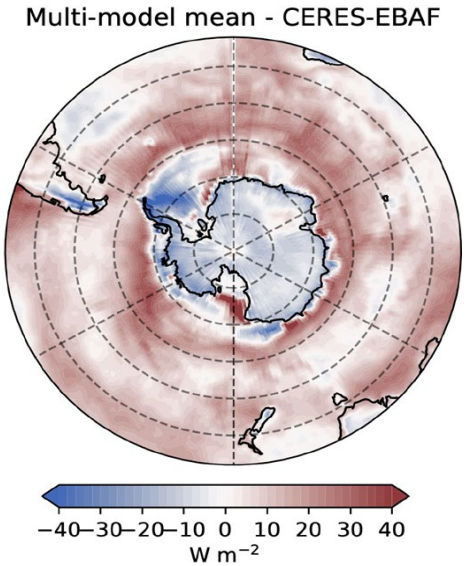


Fig 1. **Surface incoming shortwave radiation** bias during **Austral summertime**[1]. Mallet, et al.,(2023)

Intro: Natural Marine Cloud Brightening

Simulation - Observation:

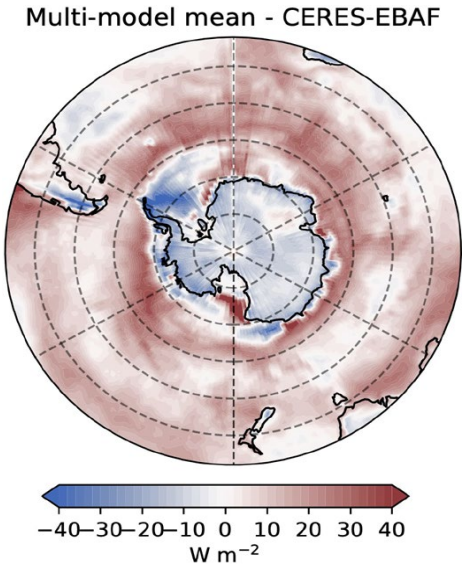


Fig 1. **Surface incoming shortwave radiation** bias during **Austral summertime**[1]. Mallet, et al.,(2023)

Observation:

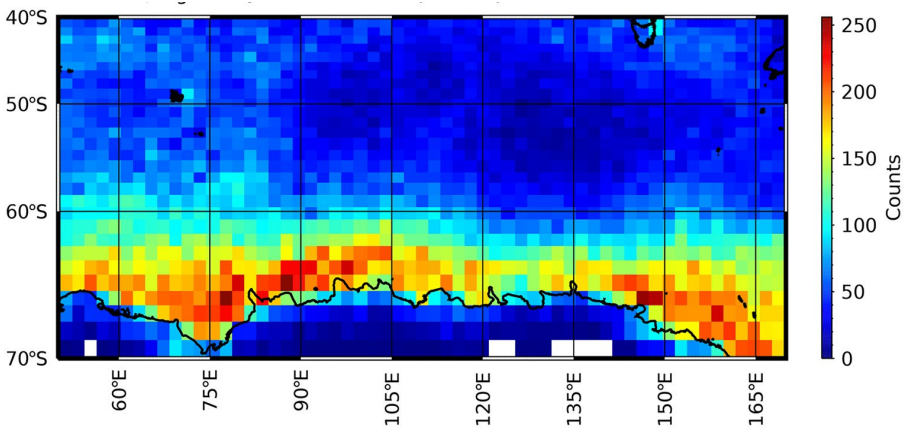
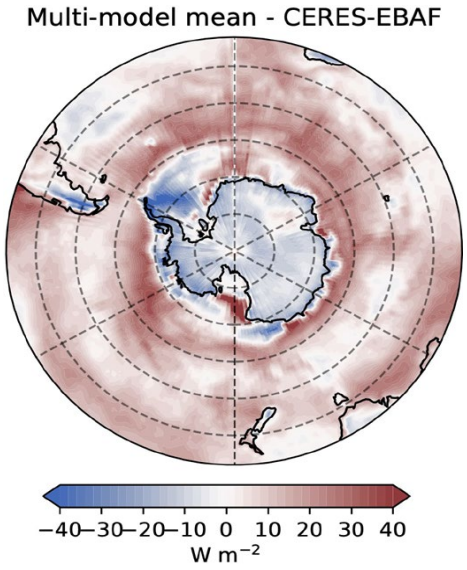
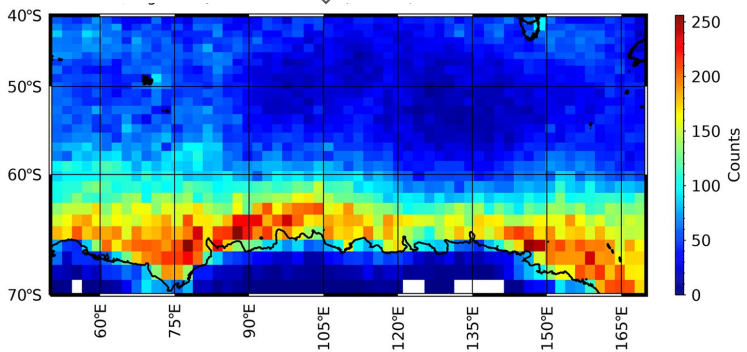


Fig 2. Geographic distribution of the high-Nd-quartile scenes during **Austral summertime,** Mace et al., (2021)

Bias of reflected solar radiation



Bias of cloud droplet number



Bias of Cloud Condensation Nuclei number

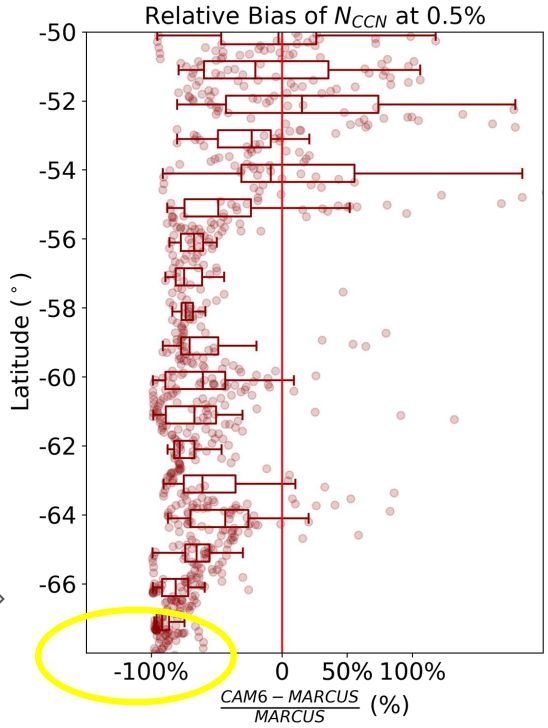
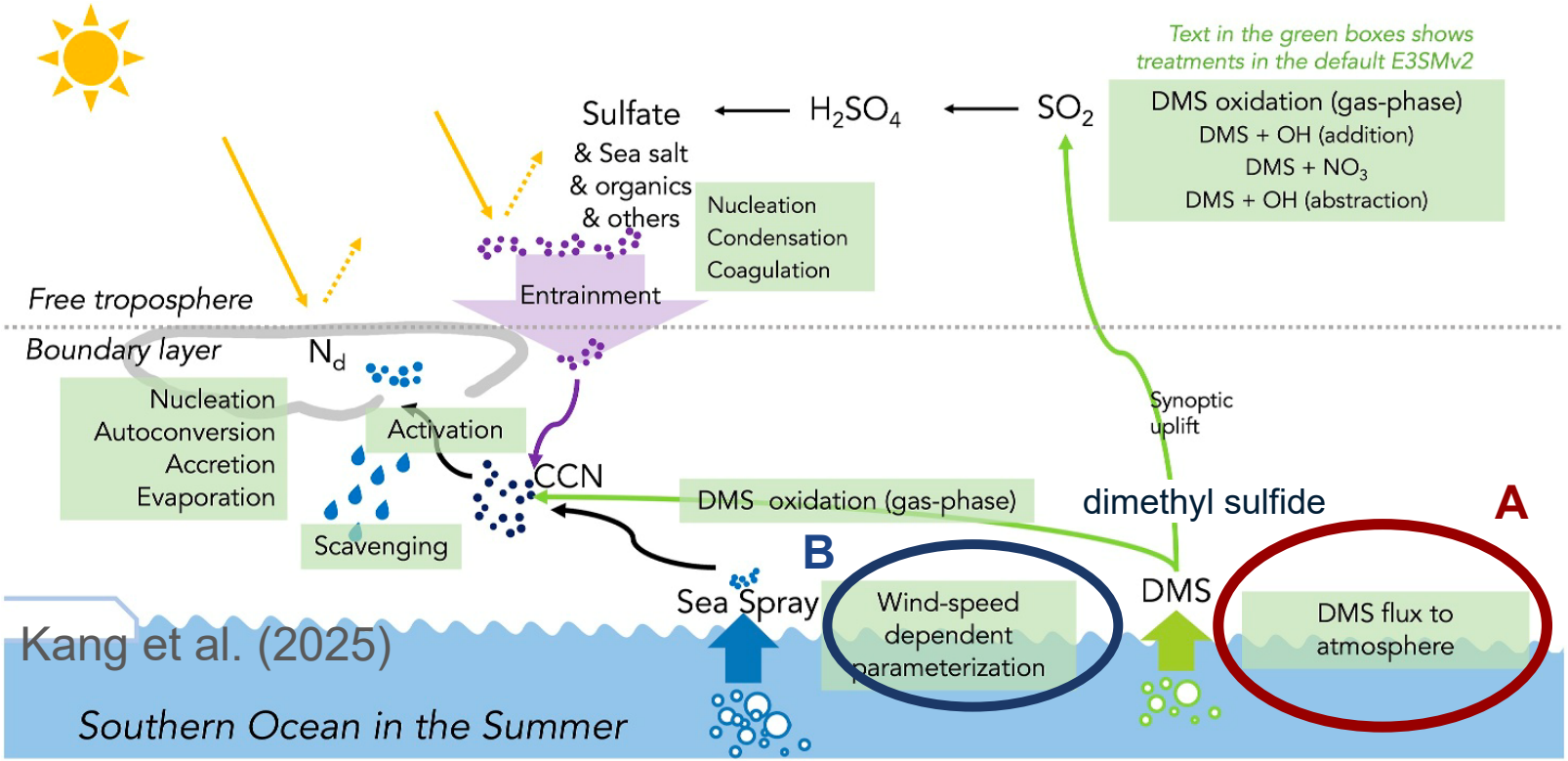


Fig 3. Latitudinal distribution of relative bias of CCN population

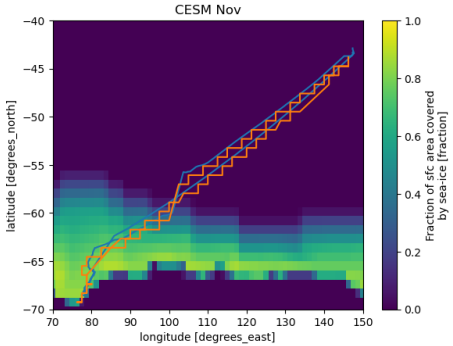
Over the Summertime Southern Ocean



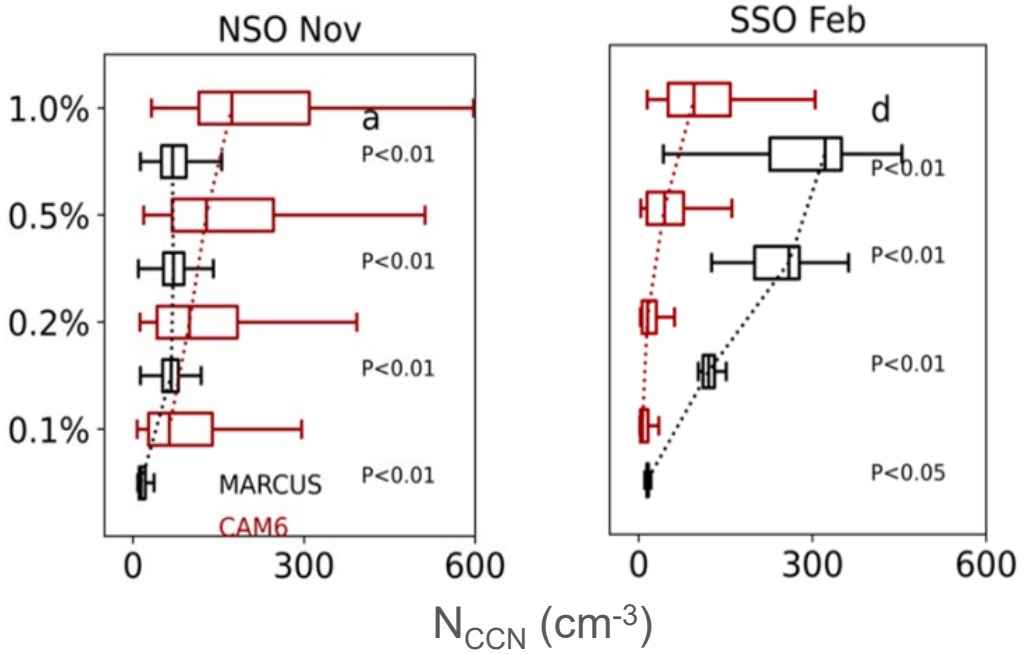
Intro: CAM6 CCN Seasonal Bias

Niu et al. 2025 JGR-A:
(doi 0.1029/2024JD042734)

A. Sometimes overestimate sea- salts
B. CAM6 missing small sulfates



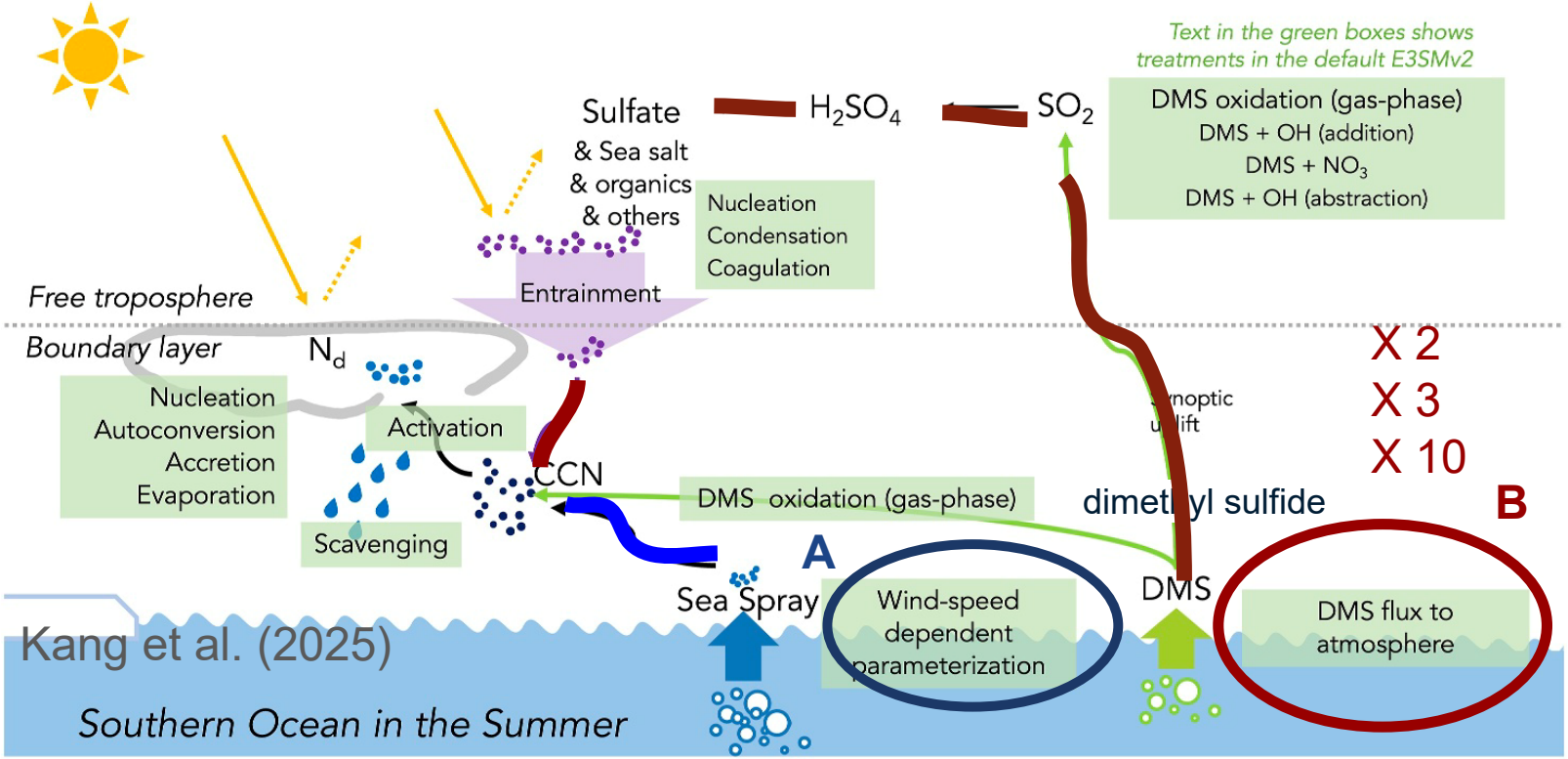
SSw



To do list:

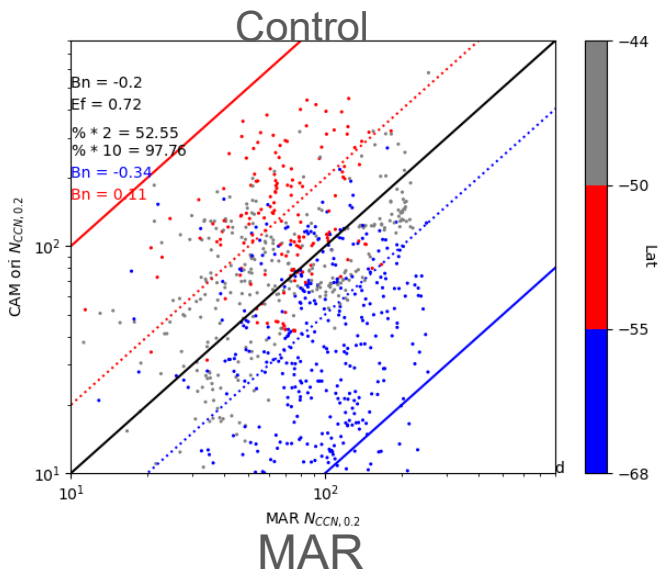
A. Tuning up sea salts↓
B. Tuning down sulfates ↑

A Reduced sea-salt emission flux from $U_{10}^{3.41}$ to $U_{10}^{2.8}$

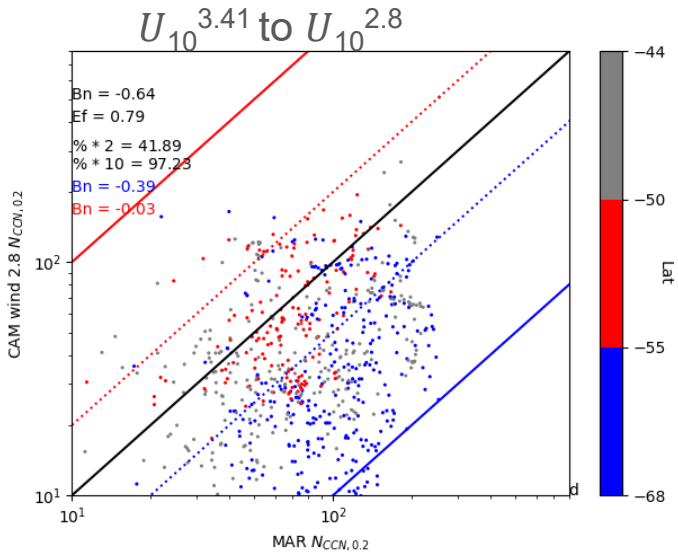


A. Tuning down sea-salt emission

CAM



MAR



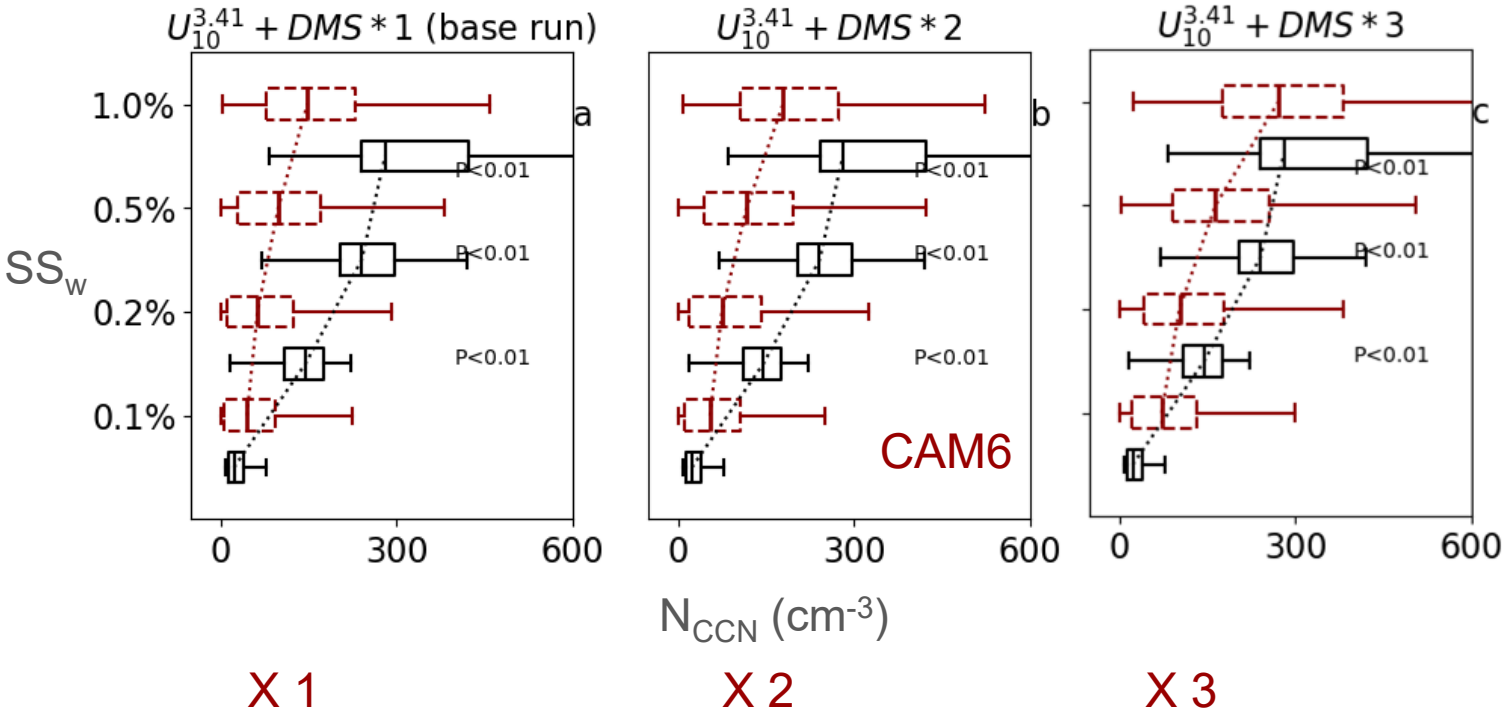
MAR

- ✅ Largely improve the N_{CCN} between 45°S -55°S (grey and red)
- ❌ Not for south of 55°S

- ⇒ maybe caused by substantial SO_4 south of 55°S

B. Tuning up sulfates

2018 Jan, Voyage from Hobart to Mawson



Influence on Clouds

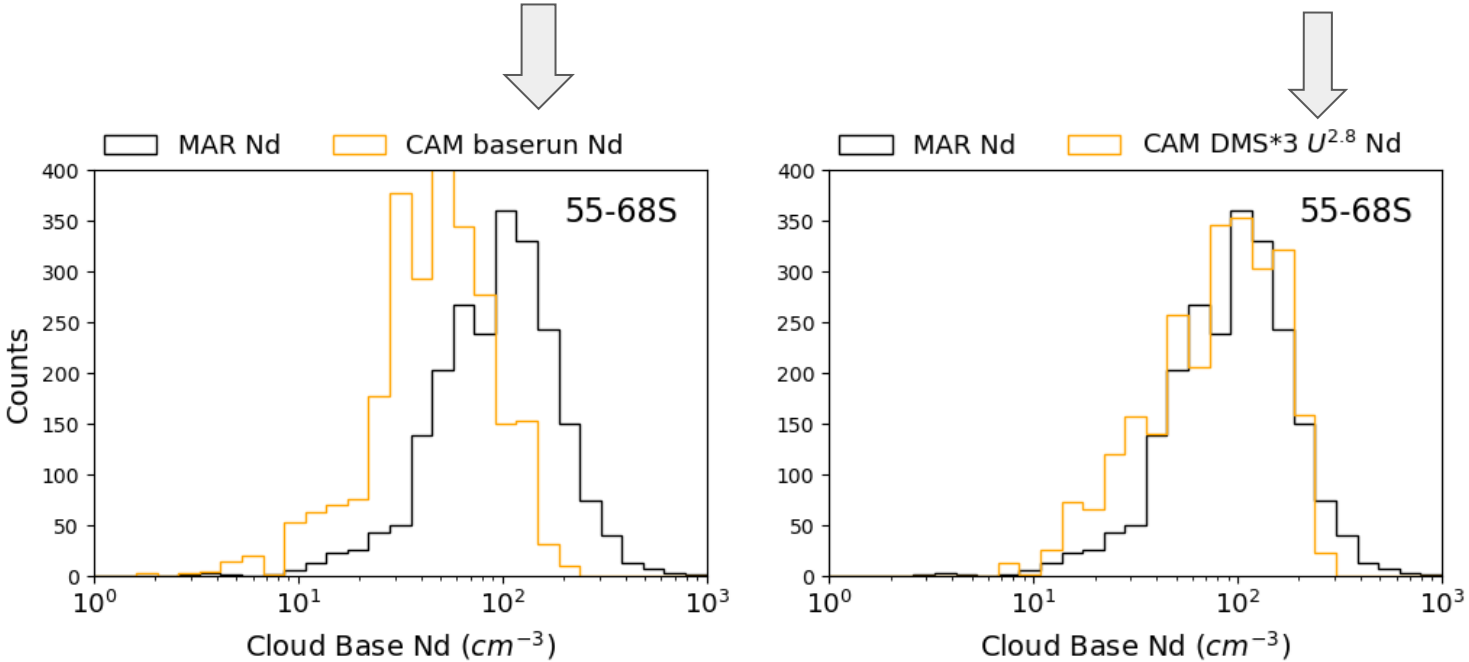


Fig 4. Histogram of N_d from **observation** and CAM6

Influence on Radiation: become more reflective

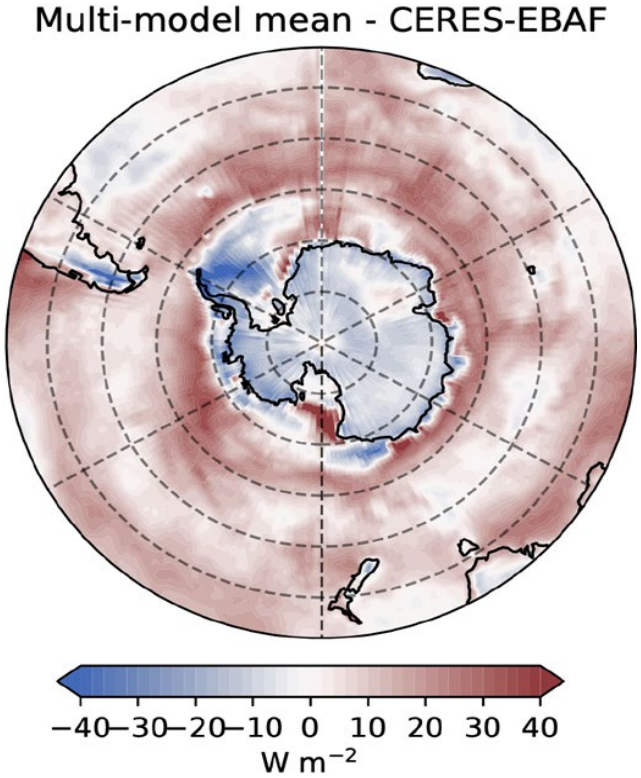


Fig 1. **Surface incoming shortwave radiation (W m^{-2})** bias during **Austral summertime**[1]. Mallet, et al.,(2023)

DMS X 3+ $U^{2.8}$ - baserun

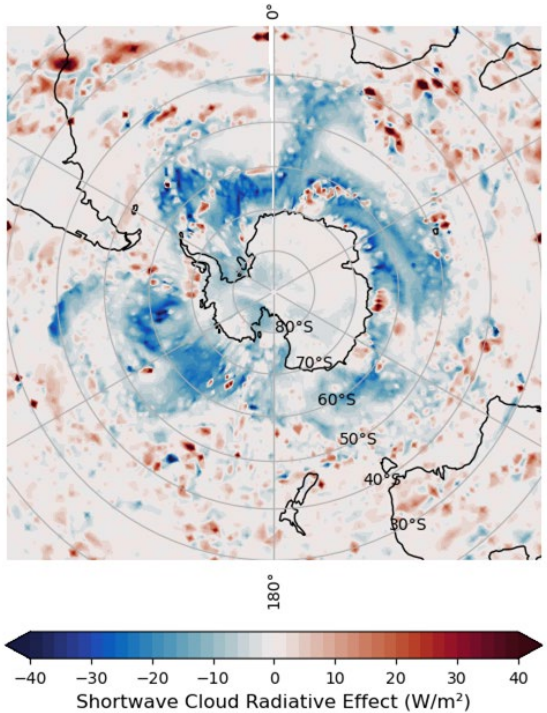


Fig 2. **TOA Shortwave Cloud Radiative Forcing (W m^{-2})** during **2018 Jan**.

1. University of Oklahoma (OU)
2. Cooperative Institute for Severe and High-Impact Weather Research and Operation
3. NSF National Center for Atmospheric Research (NCAR)
4. University of Utah
5. Pacific Northwest National Laboratory (PNNL)

Over the Summertime Southern Ocean: