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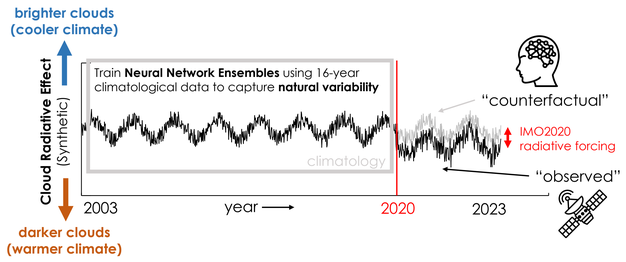
Radiative forcing from the 2020 shipping fuel regulation is **large** but hard to detect

The 2020 global cap on shipping fuel sulfur caused a **measurable warming effect** (~0.1 W m^{-2}, ~3.3 yr of CO_2 warming) by reducing cloud-seeding aerosols, but this signal is **largely masked by natural cloud variability**.

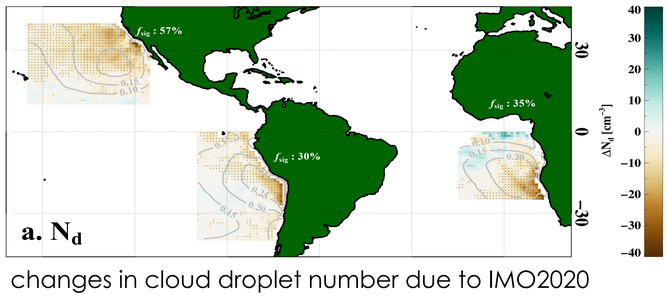
The Challenge: Cleaner Air, Warmer Planet?

IMO2020: Drastically cut sulfur in ship fuel (3.5% to 0.5%) for cleaner air.
Aerosols & Clouds: Sulfur emissions form aerosols that make clouds brighter, reflecting sunlight (cooling effect).
The Question: How did this global, abrupt event impact Earth's energy balance and is the change detectable?

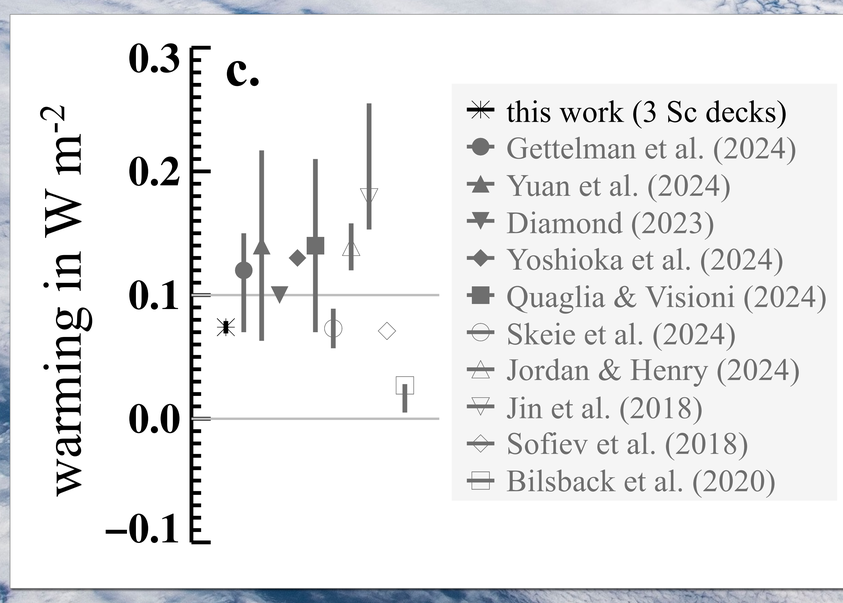


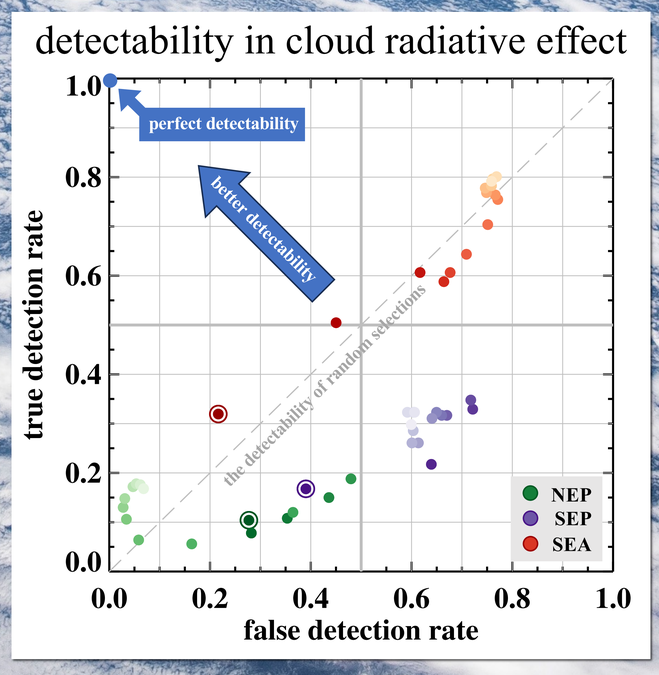
Our Approach: AI Mapping MET to Cld

Method: Trained neural network ensembles on 16 years of satellite & reanalysis data to capture the climatological relationship.
Counterfactual: Predicted what clouds would have looked like *without* IMO2020 during 2020-2022.



changes in cloud droplet number due to IMO2020





paper

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media coverage

Key Results:

Low Detectability: This significant climate impact is hard to distinguish from natural cloud variations.
Regional Hotspot: The southeast Atlantic showed the highest detectability due to wind patterns in the region.

Implications:

Accelerated Warming: Future aerosol reductions (for health/environment) will likely further unmask greenhouse gas warming.
Geoengineering Challenge: Proposed Marine Cloud Brightening (MCB) would need to be substantial to overcome the low detectability.