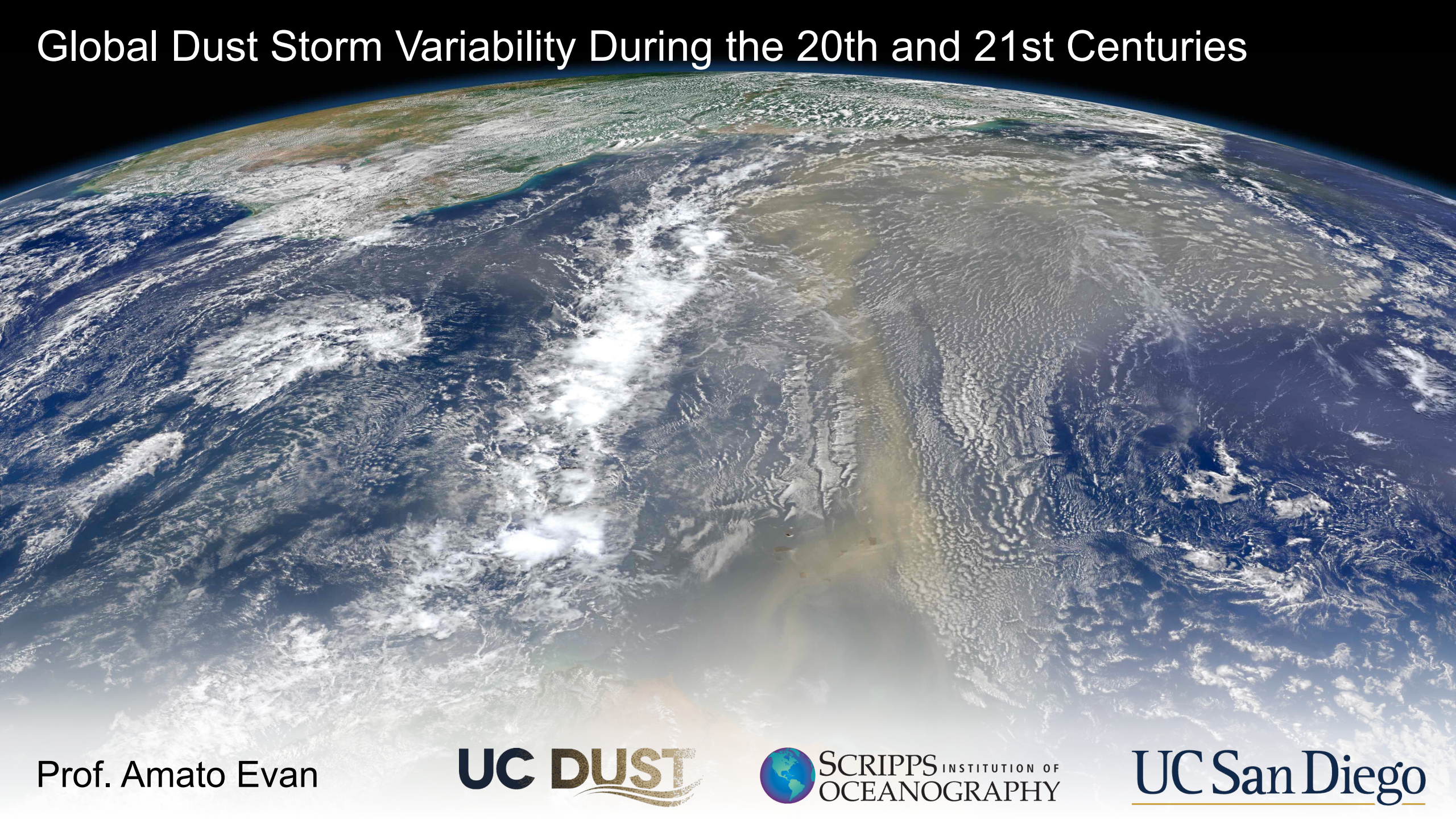
Global Dust Storm Variability During the 20th and 21st Centuries



Prof. Amato Evan

UC DUST

SCRIPPS INSTITUTION OF OCEANOGRAPHY

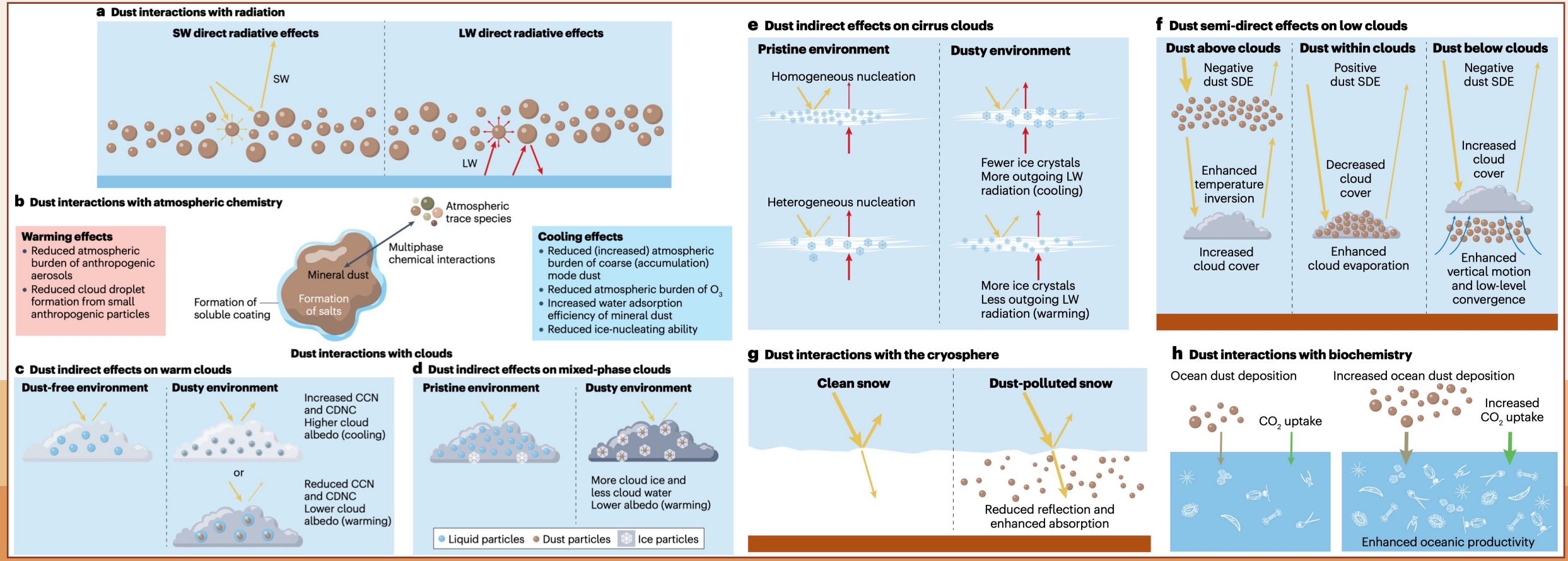
UC San Diego

Why do we care about dust?



Evan et al. (2026, *Drylands*)

Dust in the Climate System: Coupling and Feedbacks



Kok et al. (2023, *Nature Reviews*)

Dust in the Climate System: Coupling and Feedbacks

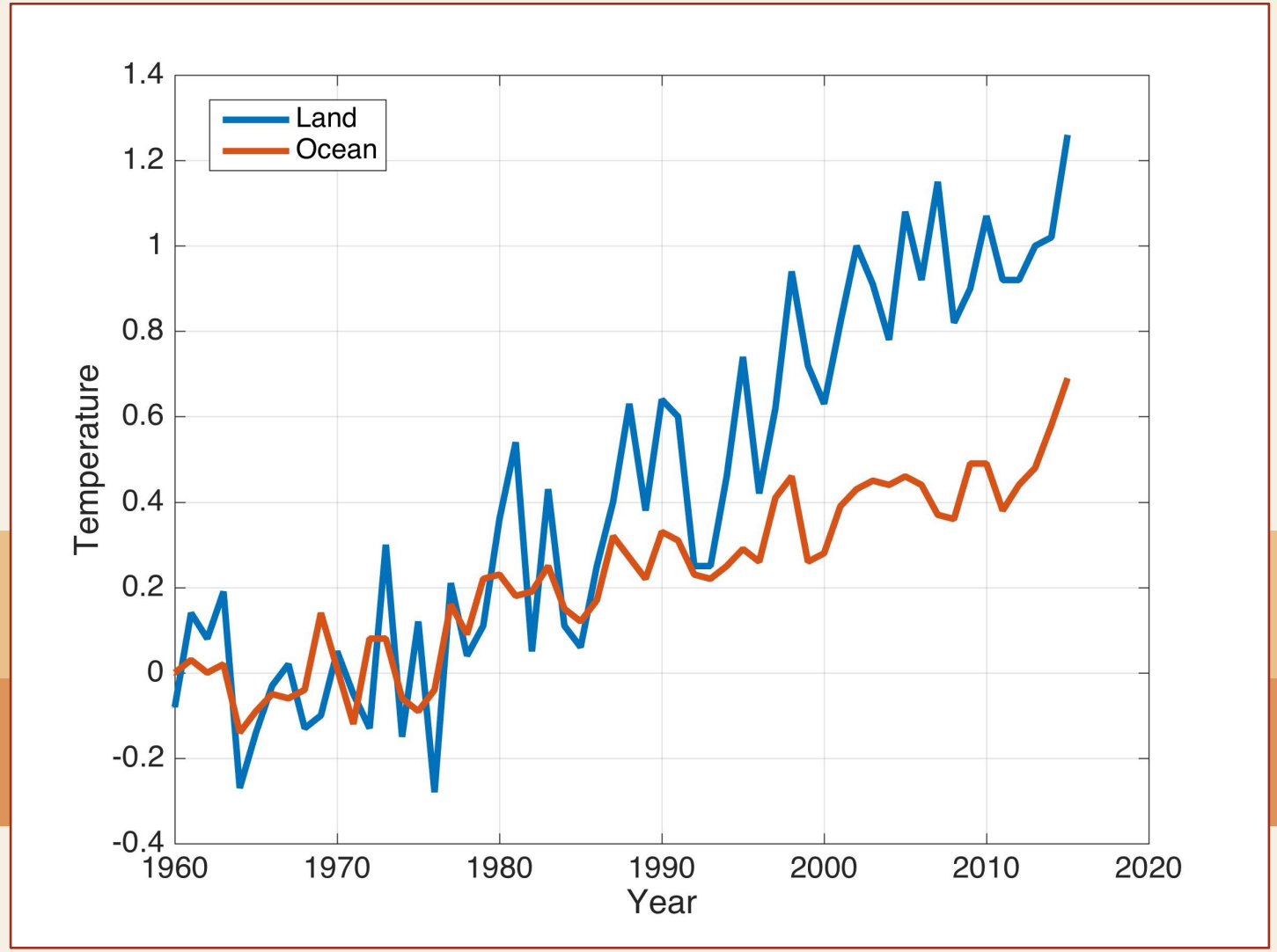






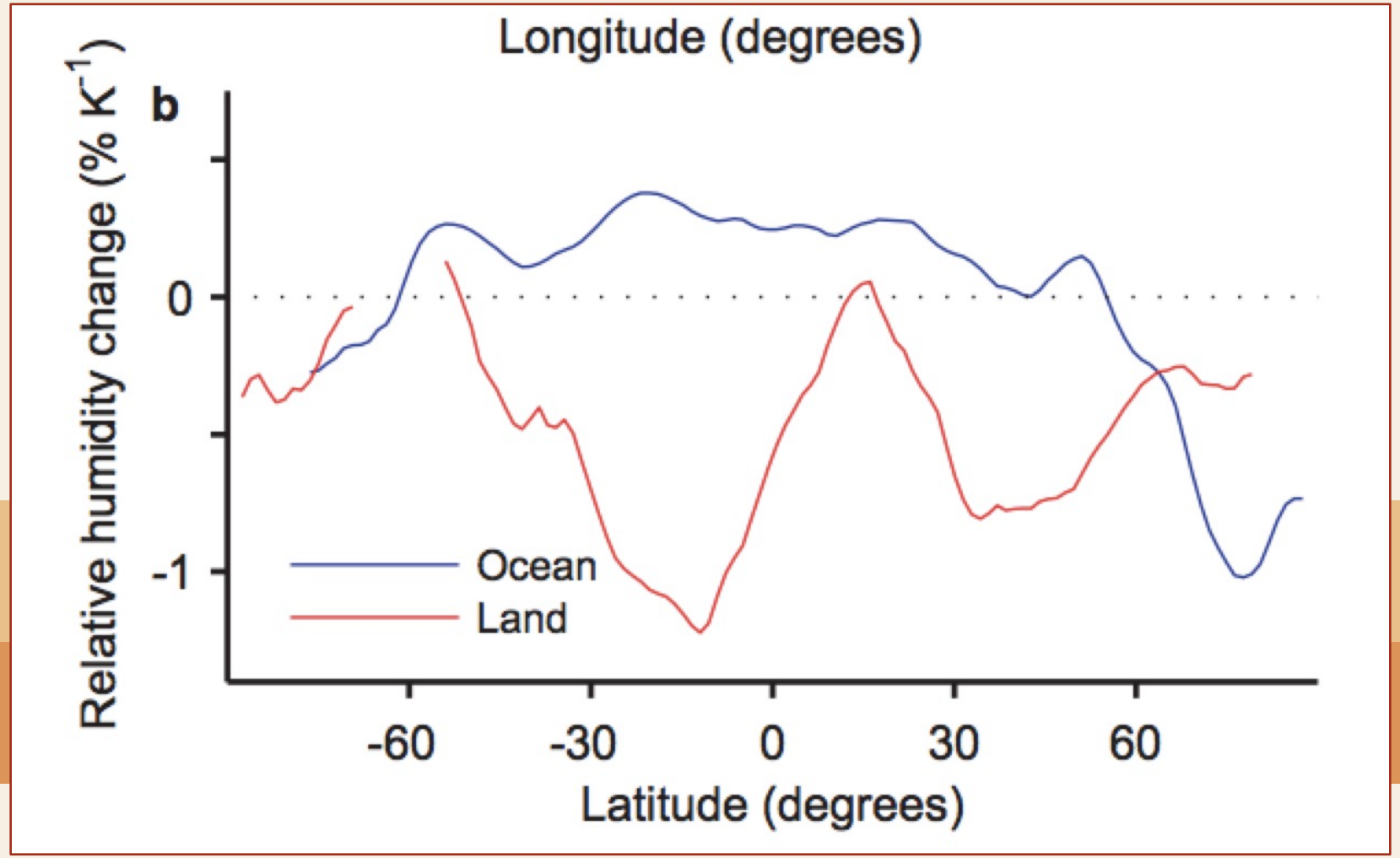


What Dust Trends Should We Expect?



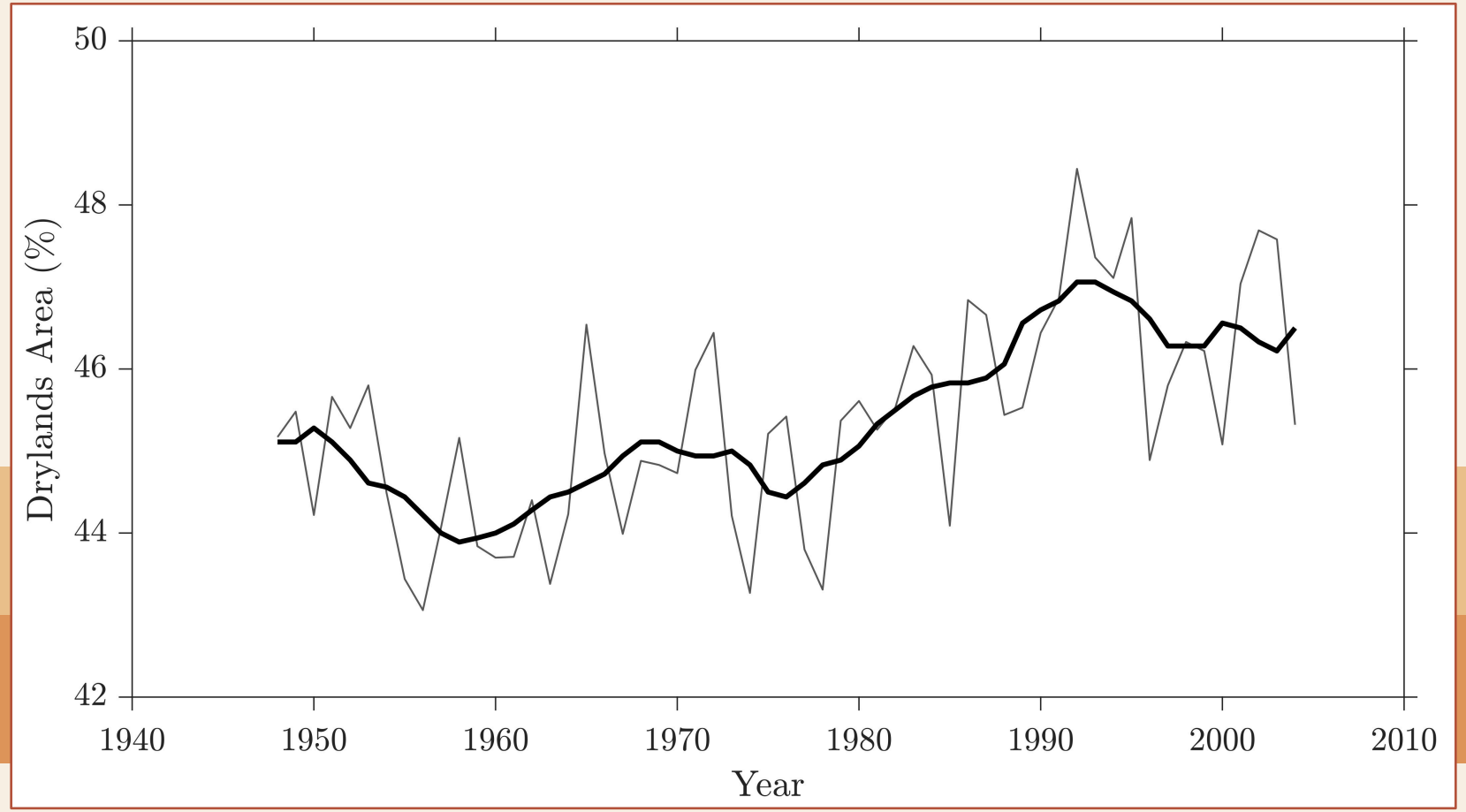
Source: NASA GISS // GHCN v3

Land Surfaces are Becoming More Arid



Byrne & O'Gorman (2016, *J. Clim*)

Global Drylands are Growing as Earth Warms



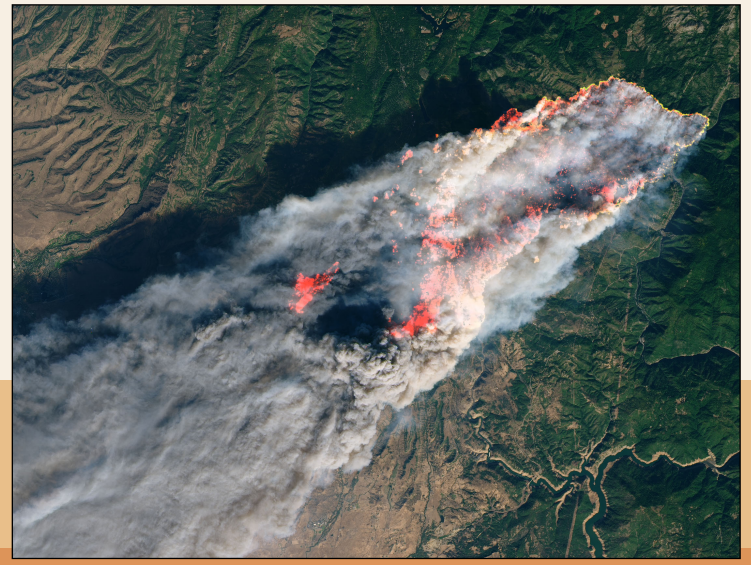
Huang et al. (2015, *Nature Clim Chg*)

Reasons to Expect Increasing Dust Emission

Surface drying and degradation



Wildfire



Changes in precipitation and erosion



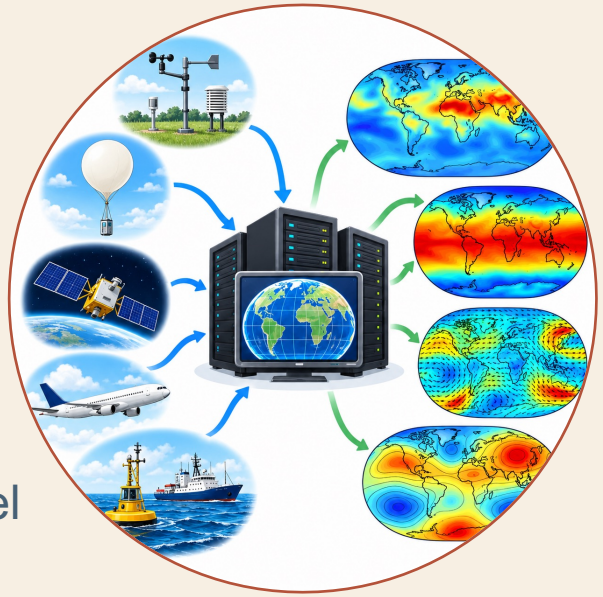
Zender and Kwon (2005, *J Geophys Res*); Cheng et al (2016, *J Clim*); Yu and Ginoux (2022, *Nature Geo.*)

Multidecadal Global Records of Dust



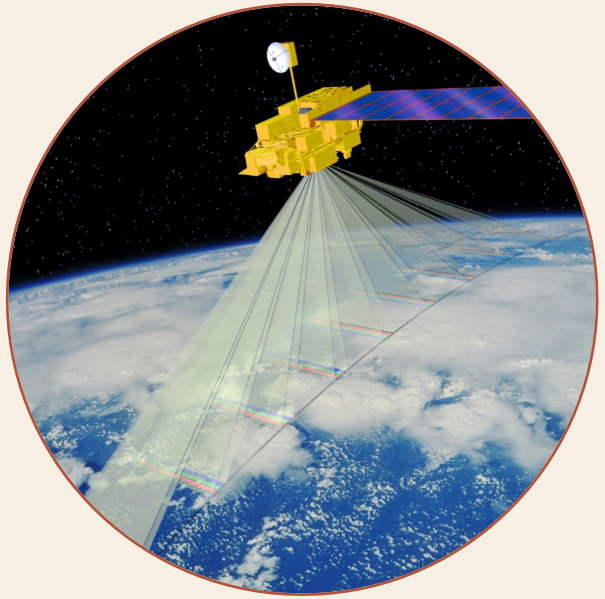
Visibility

1. Observer dust classification
2. Methods change over time
3. Scattered Locations
4. Few desert observations



Assimilation System

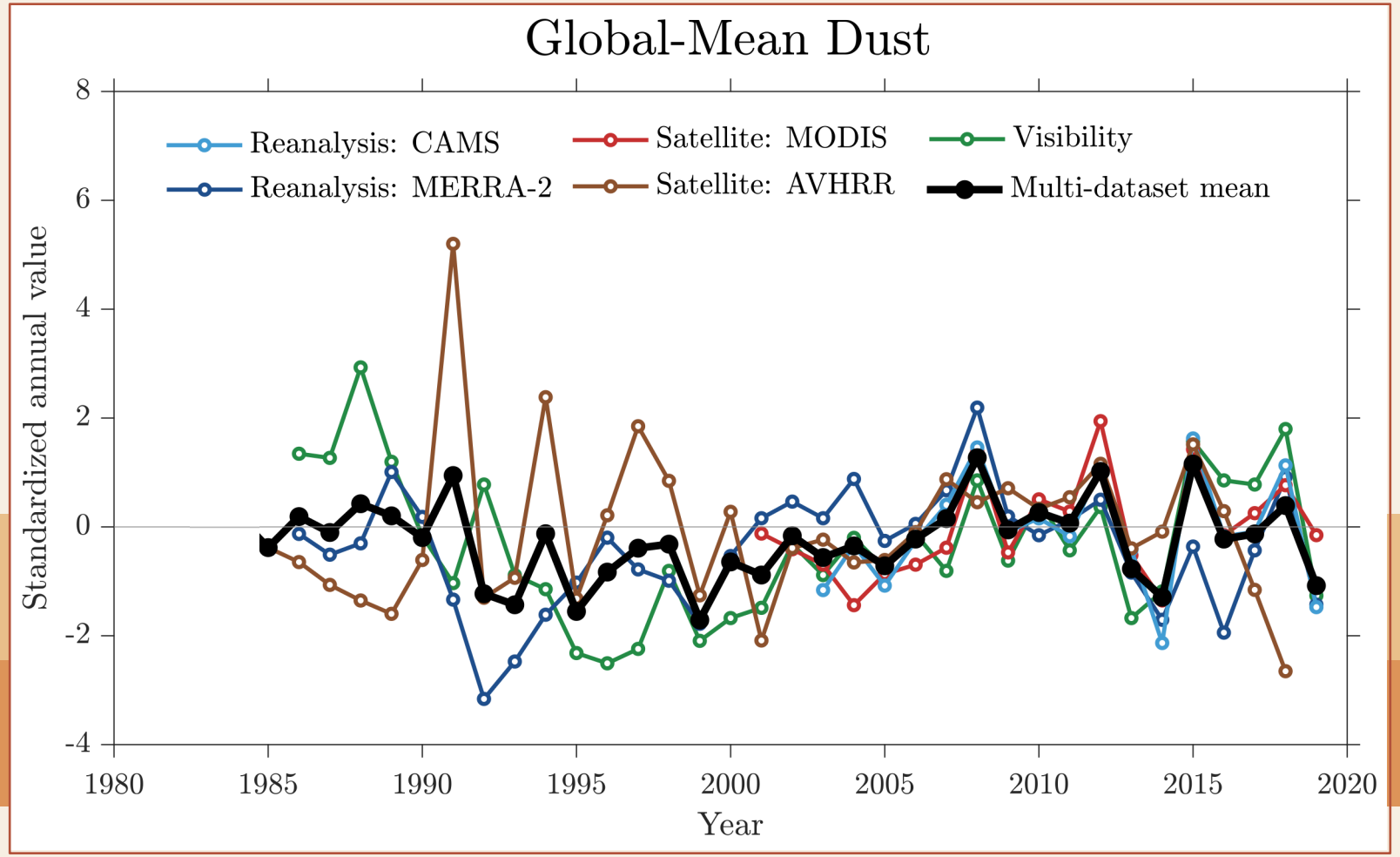
1. Not an observation
2. Only as good as the model
3. Inconsistent observations



Satellites

1. Doesn’t work when cloudy
2. Temporal sampling bias
3. Subject to retrieval uncertainty
4. Satellite drift

Recent Global Dust Variability



Xi (2021, *JGR*); Song et al. (2021, *ACP*); Voss & Evan (2020, *JAMC*)

Longer Historical Dust Records - Cores

Sediment



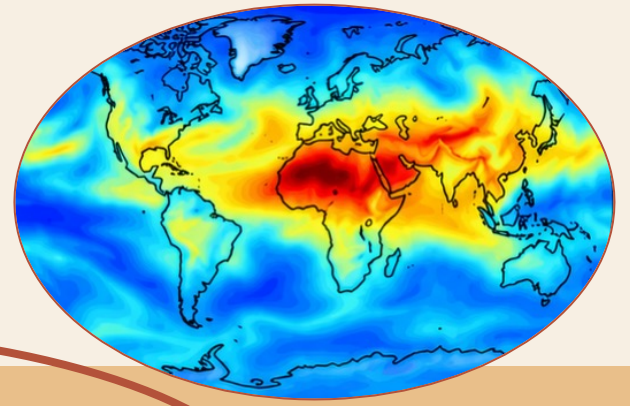
Coral

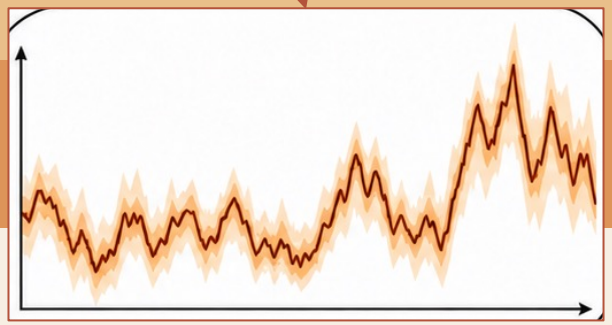




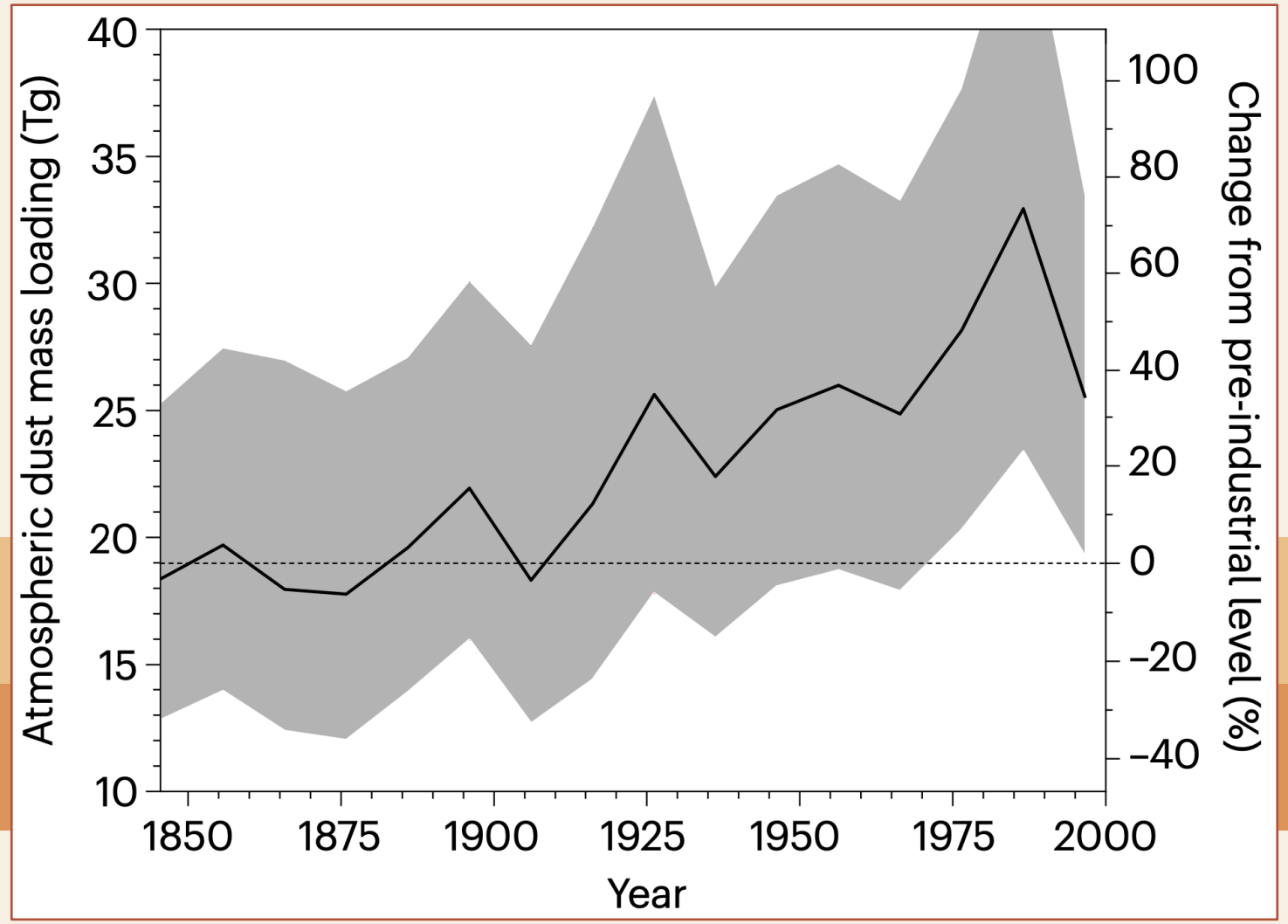
Ice

Model-based constraints



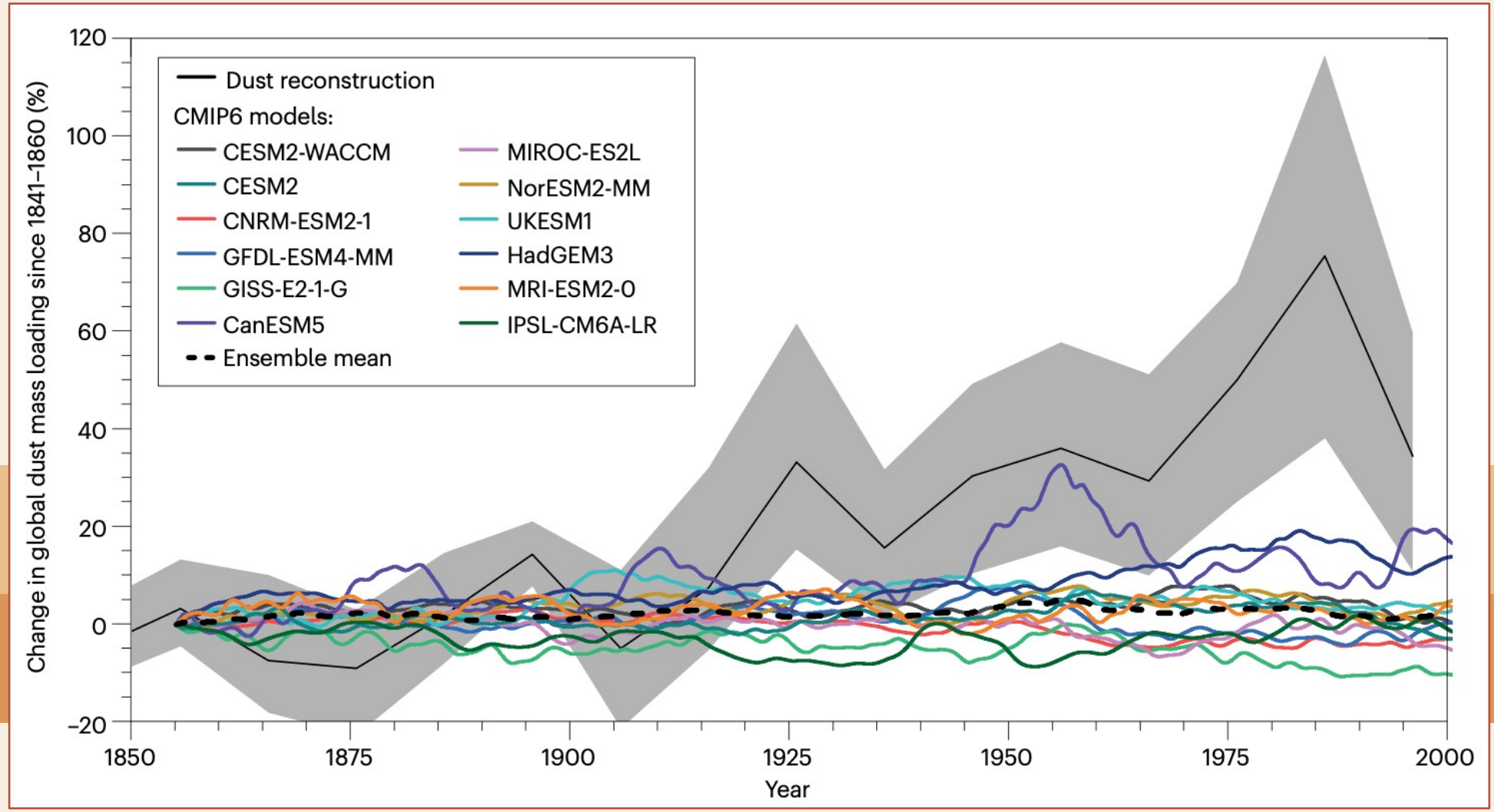


20th Century Global Dust Variability



Kok et al. (2023, *Nature Rev.*)

Models Do Not Reproduce The Trend



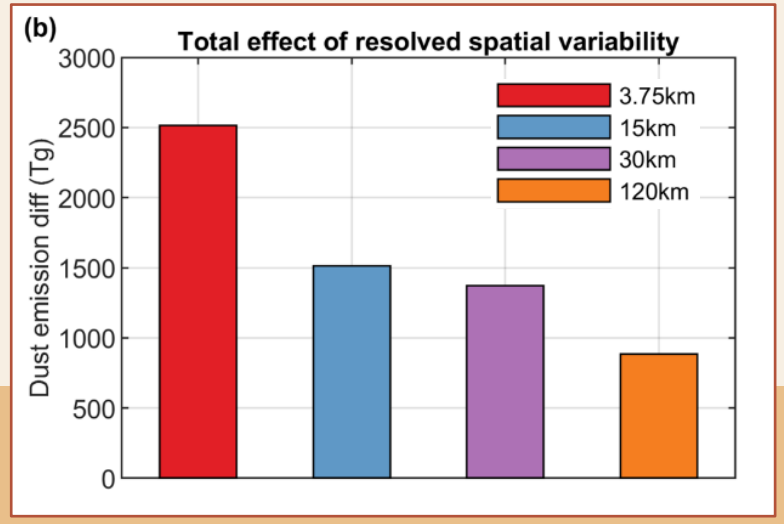
Kok et al. (2023, *Nature Rev.*)

Why do Models and Observations Diverge?

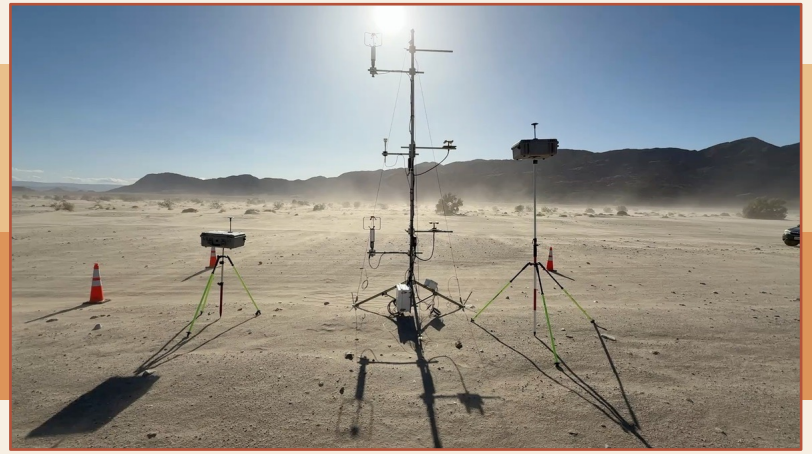
Land Use Change?



Too Coarse?



Incomplete Physics?



Summary

- There are compelling physical reasons why global warming should cause an uptick in dust storms
- Difficult to measure/retrieve/infer dust storms at the global scale, even with modern measurements
- Recent trends (1980's onward) are inconclusive
- A reconstruction of 20th century dust variability does show an upward trend, but this is not reproduced by models
- Future agreement between models and observations is needed to have confidence observed in trends and physical understanding of causes.

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