Uncertainty quantification for aerosol radiative forcing

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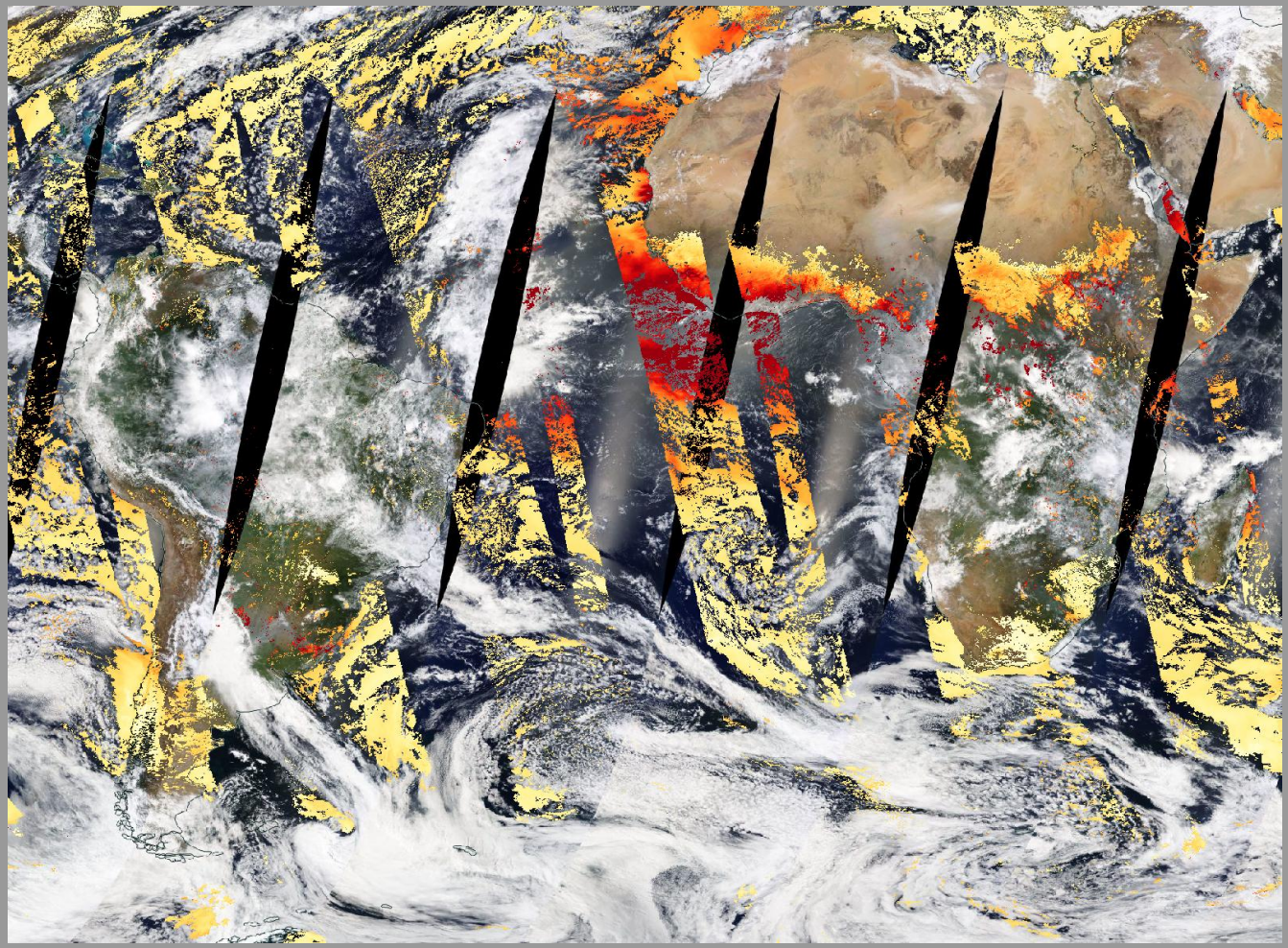
Aerosols have a global cooling effect

- **More clouds** $\rightarrow$ less ultraviolet radiation
- **Aerosol radiative forcing (ARF)**:

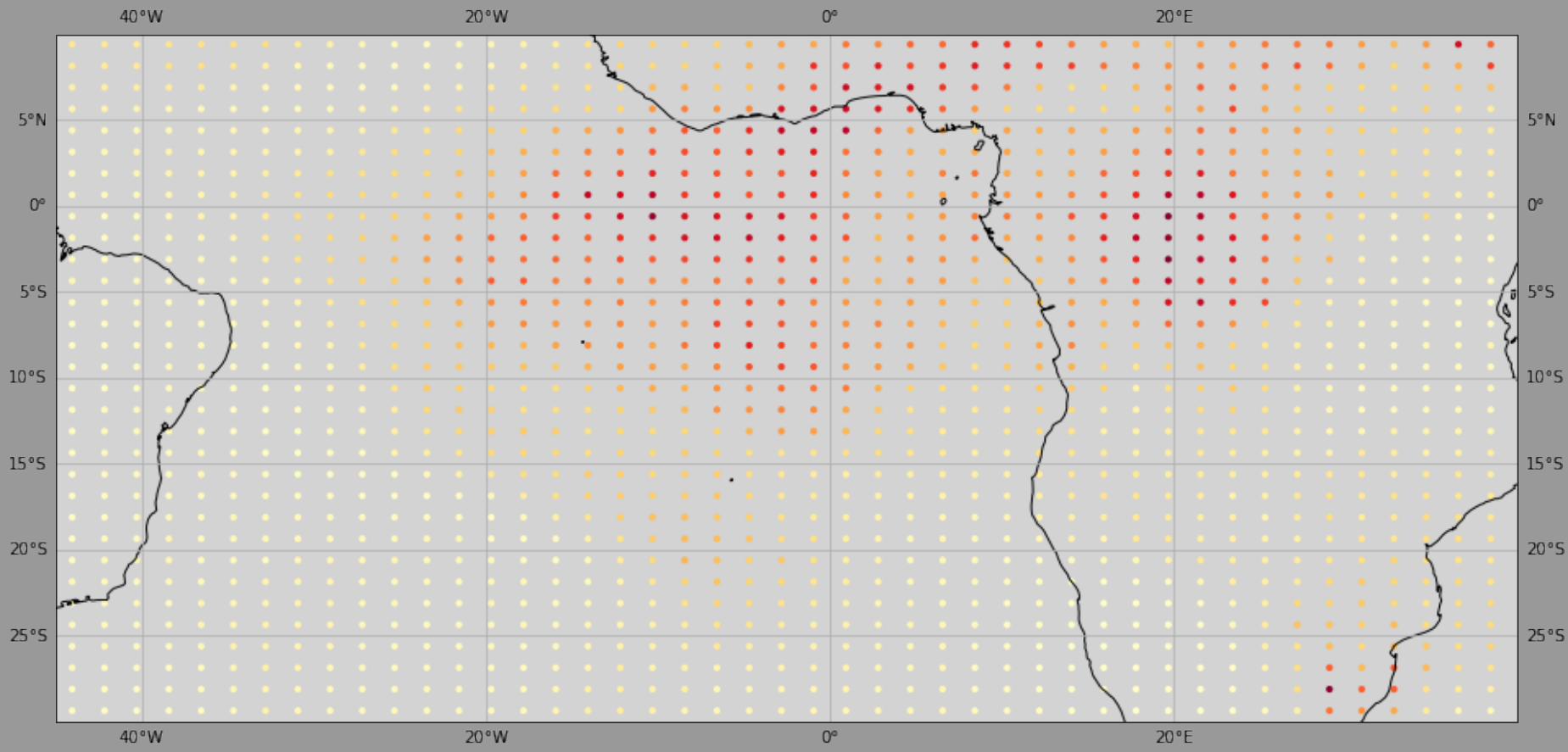
  (radiative energy balance today) $-$ (pre-industrial balance)

Aerosol optical depth via satellite shows missingness



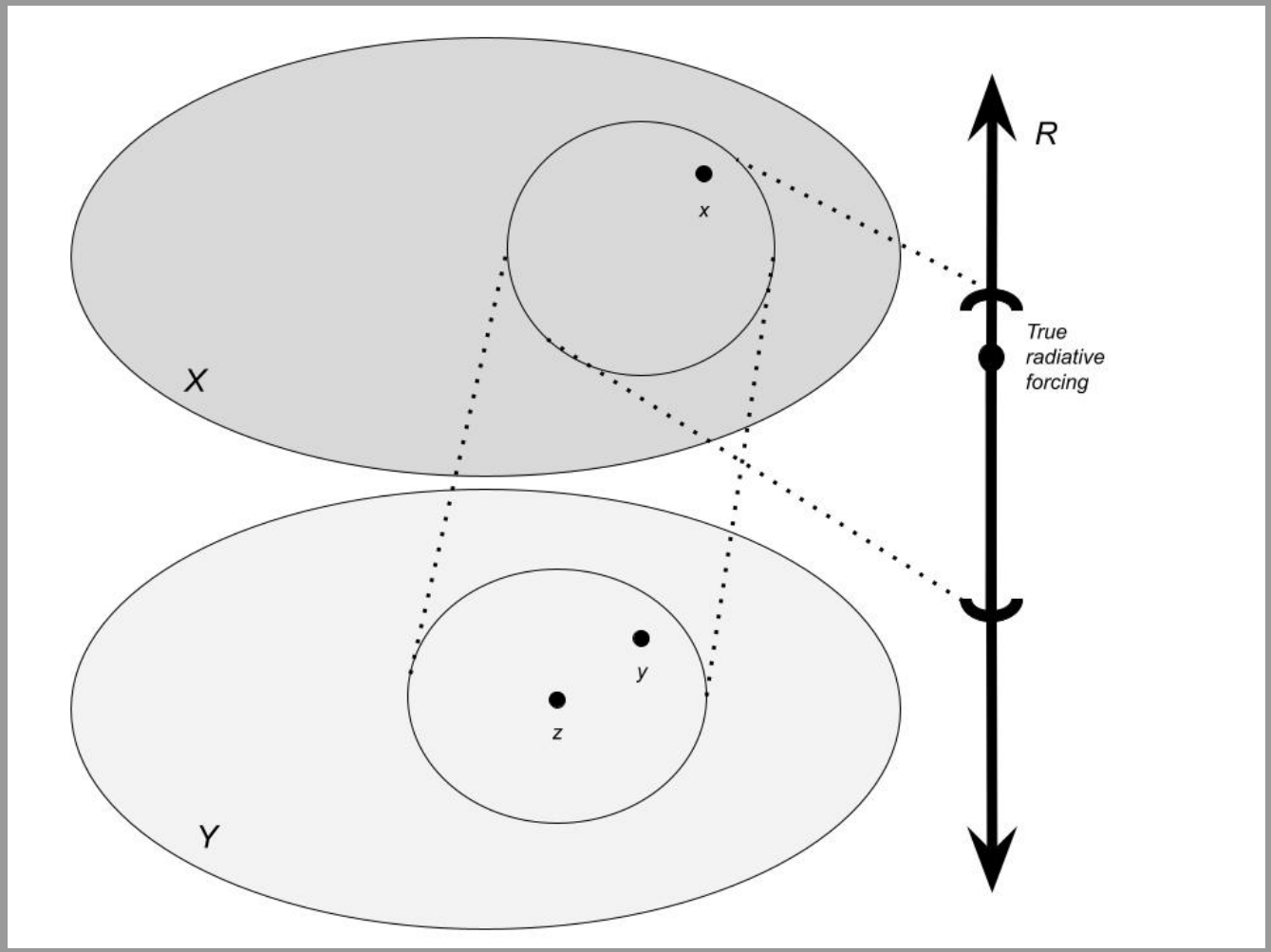
(Image source: worldview.earthdata.nasa.gov)

Aerosol optical depth via simulation looks similar



(Data source: University of Leeds)

UQ = nonlinear inverse problem



History matching is the usual approach

- **"Non-implausible" region** (Bower, et. al. 2010; Johnson, et. al. 2020):

$$\Xi_{HM} \approx F^{-1}\left[B_z(3, \|\cdot\|_\infty)\right]$$

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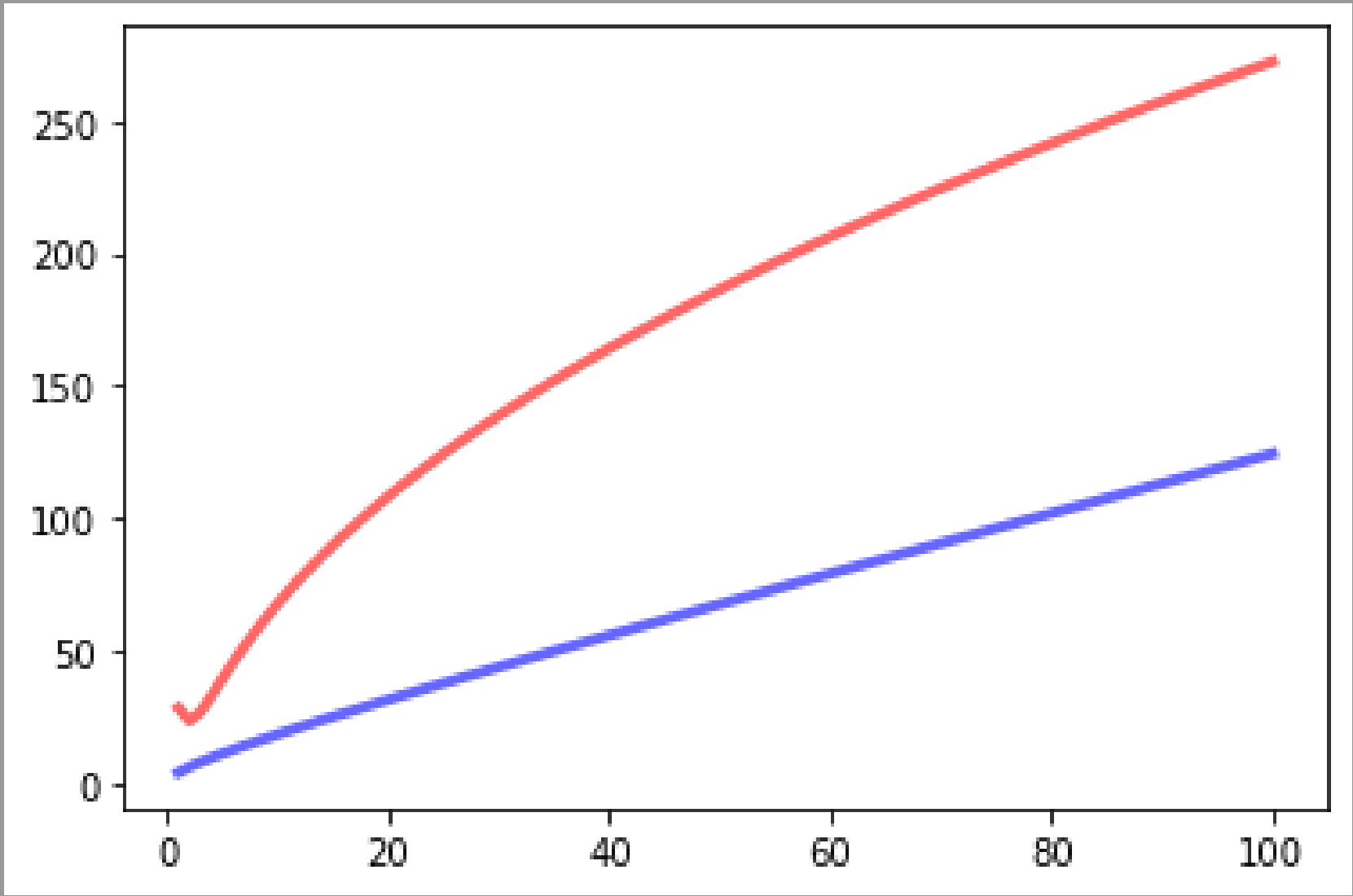
- **Question:**

$$\text{Vol}(\Xi_{UQ}) \overset{?}{\ll} \text{Vol}(\Xi_{HM}) \qquad (d \text{ large})$$

Our radius is smaller than their radius



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- **Aerosol radiative forcing** $\rightarrow$ global cooling effect
- **Smaller** the confidence set $=$ **better**!
  - Previous work: **"non-implausible" region**
  - Our work: **confidence set**
- Remaining **challenges**:
  - **Missing** satellite data
  - **Small datasets** $+$ many variables
  - **Non-linear** inverse problem