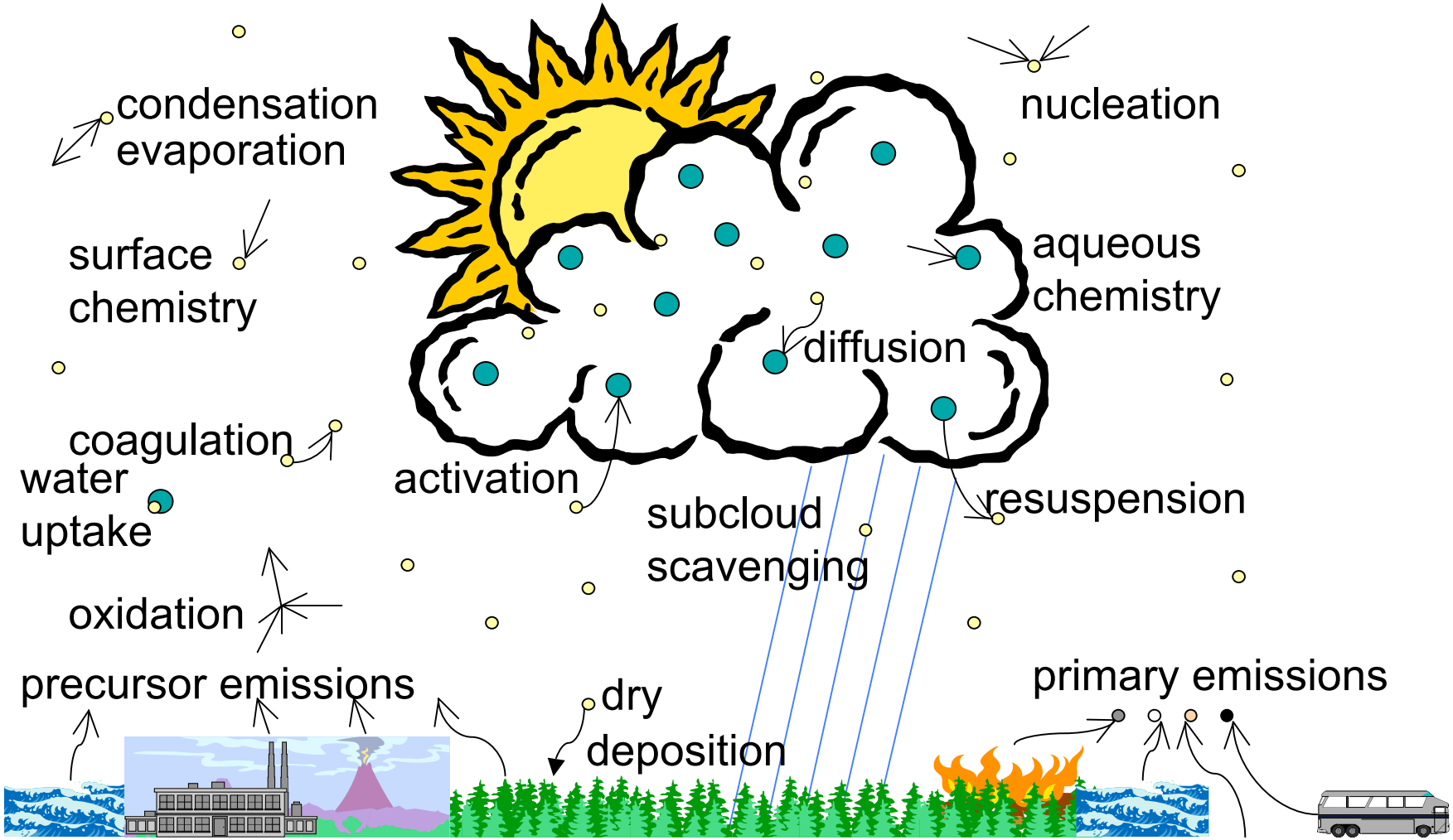
Sensitivity of Indirect Effects to Aerosol Treatment

Steven Ghan

Pacific Northwest National Laboratory



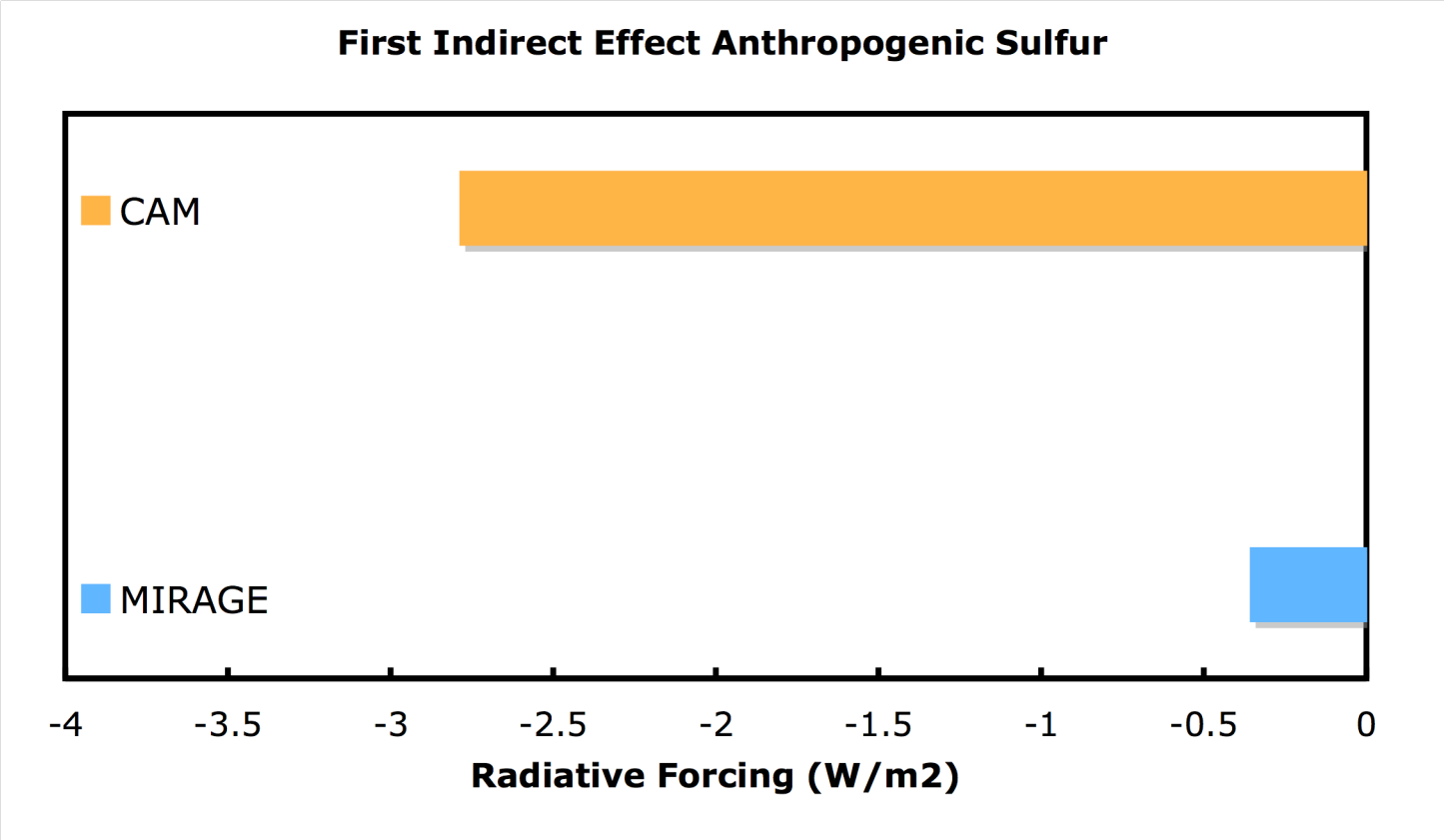
CAM and MIRAGE

- MIRAGE: PNNL aerosol physics applied to CAM2
- CAM: MOZART/Rasch aerosol applied to CAM3
- Similarities
  - All important aerosol species treated
  - Same treatment of prognostic droplet number
- Differences
  - Clouds
    - MIRAGE: single condensate, no droplet sedimentation
    - CAM: liquid, ice water, size-dependent sedimentation
  - Aerosols
    - MIRAGE: internal mixtures in 4 modes, variable size distribution
    - CAM: external mixtures, prescribed size distribution

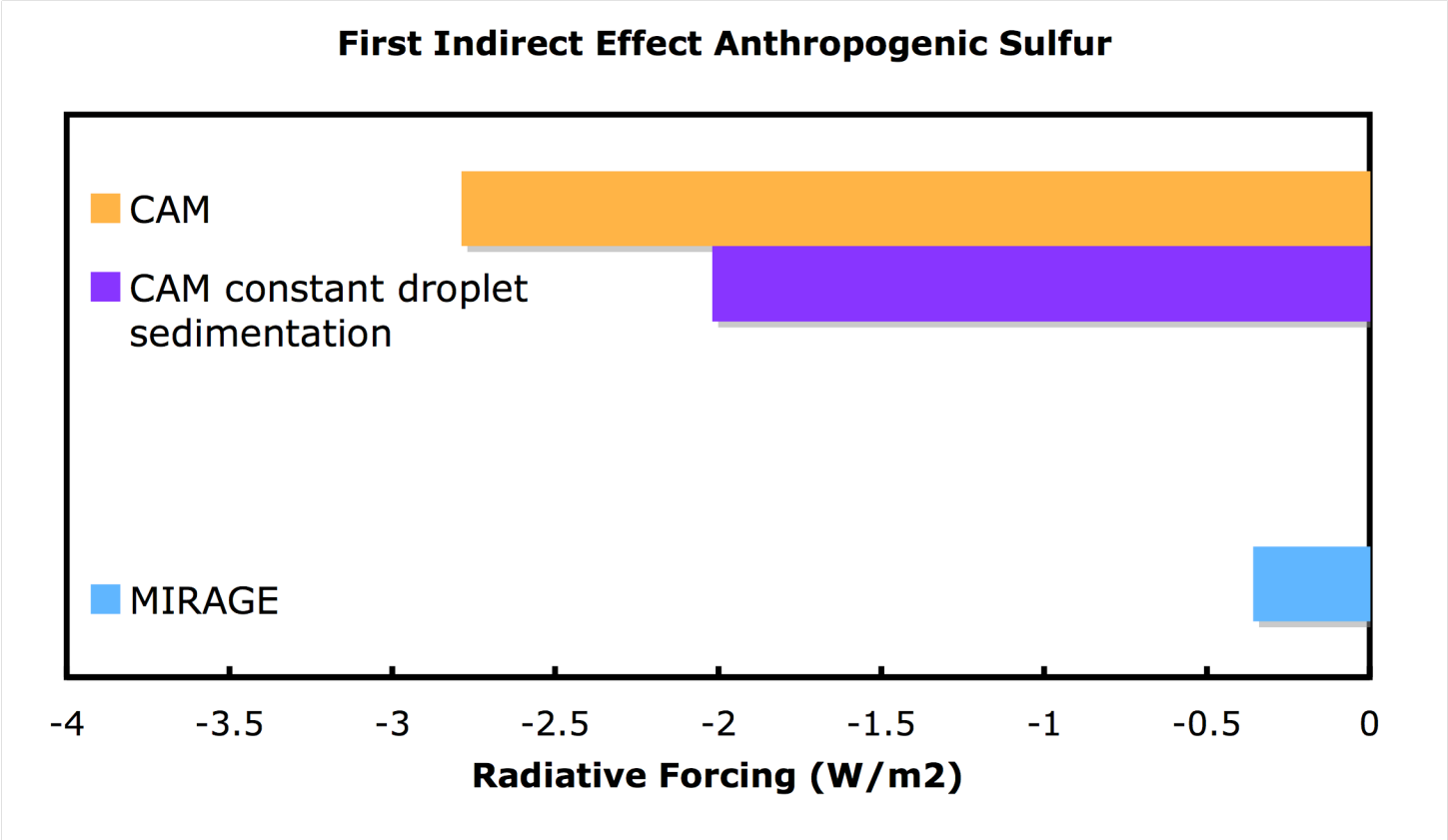
Experiment Design

- Simulations by CAM3 and MIRAGE
- 4x5xL26 resolution
- 3 year simulation after 4 month spinup.
- Simulations with, w/out anthropogenic sulfate.
- Droplet number influences droplet effective radius.
- Dependence of autoconversion on droplet number is neglected.

Indirect Effect



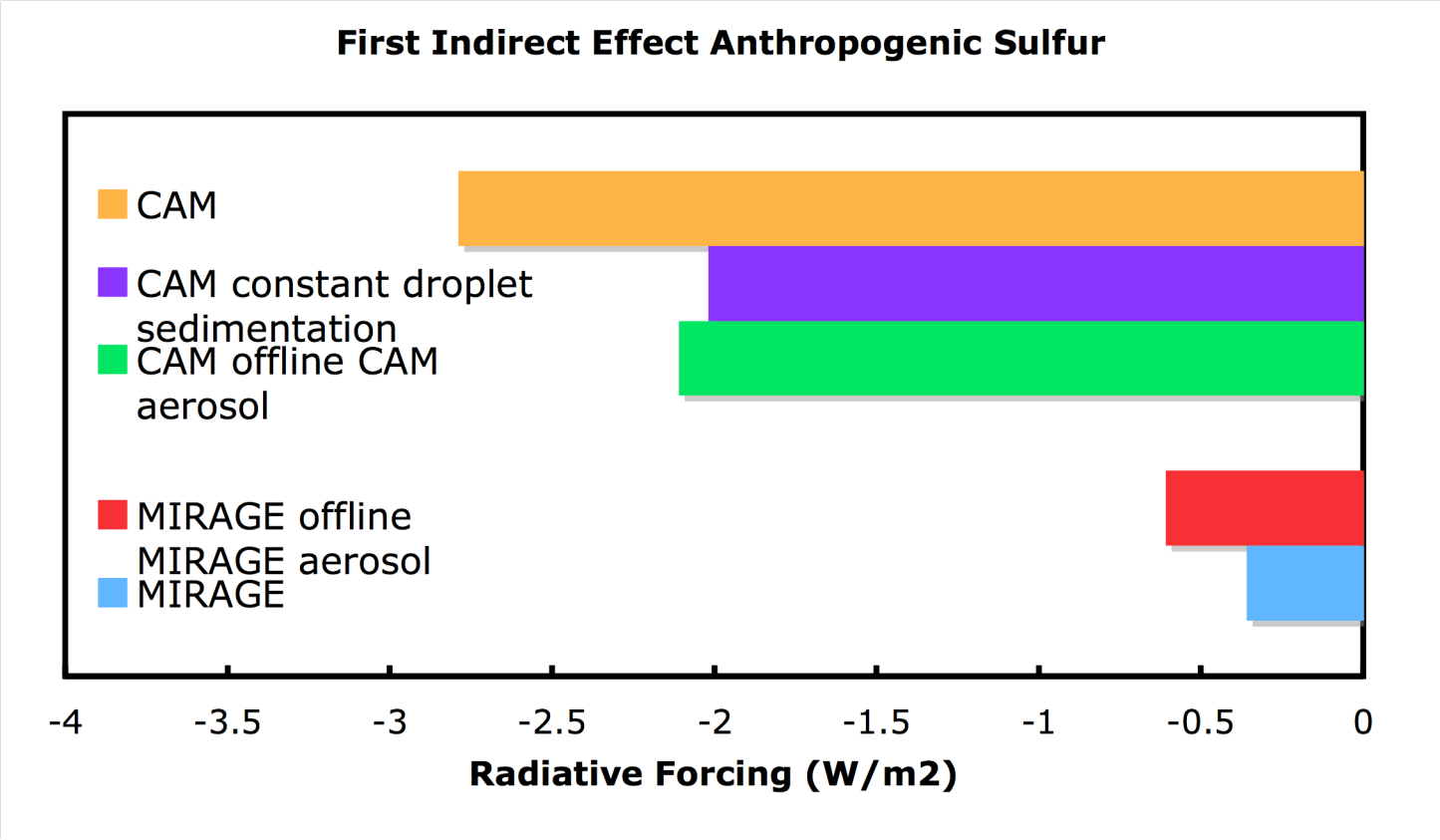
Indirect Effect



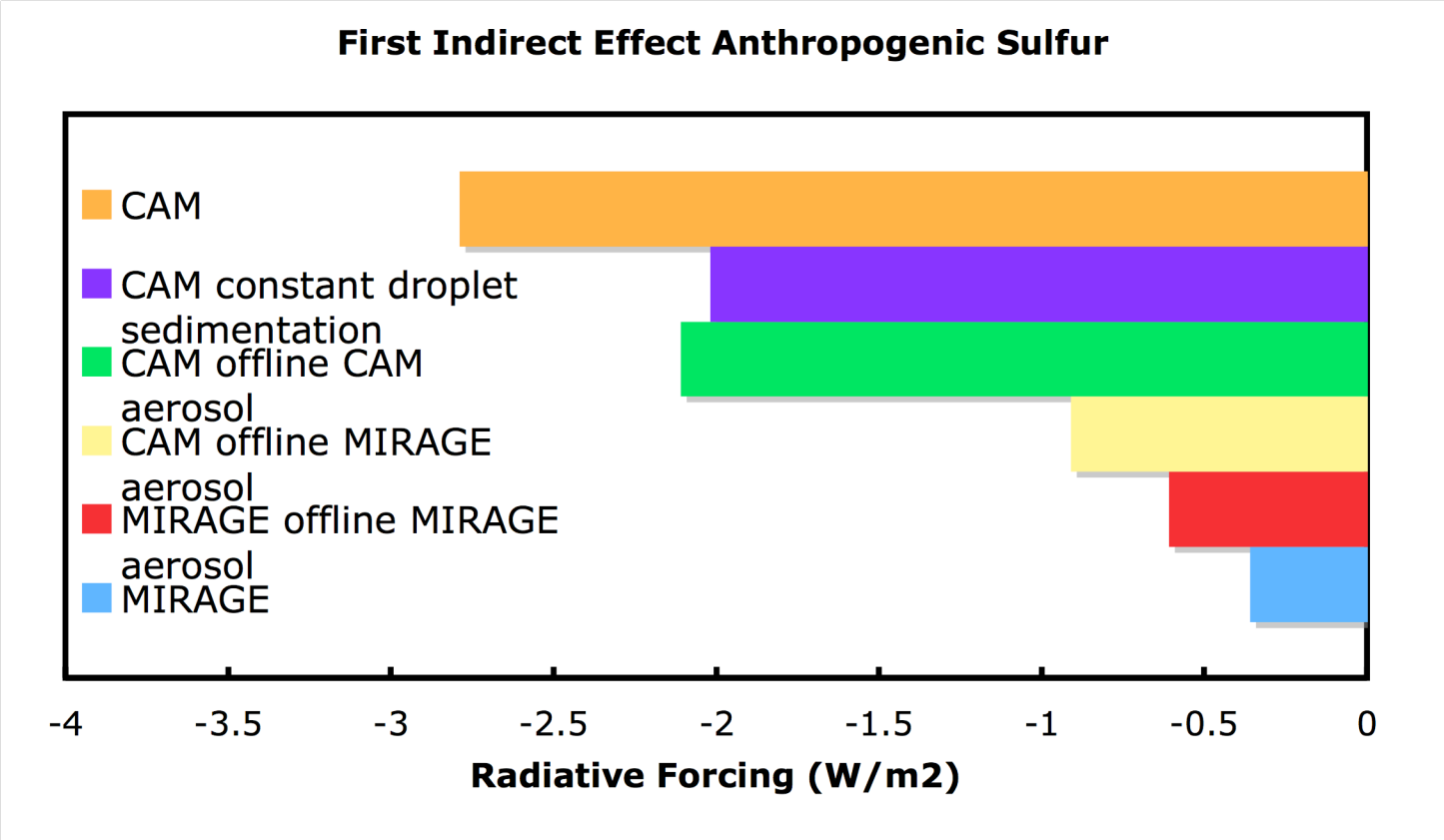
Isolating Aerosol Differences

- Run CAM with MIRAGE aerosol
- First run MIRAGE and CAM with offline aerosol:
  - MIRAGE with MIRAGE aerosol
  - CAM with CAM aerosol

Indirect Effect



Indirect Effect



Conclusions

- The first indirect effect simulated by CAM with CAM aerosol is large.
- The dependence of droplet sedimentation on droplet size contributes to the large magnitude.
- An aerosol treatment that allows aerosol size distribution to shift with increasing emissions is likely to produce a smaller indirect effect.
- Interactive aerosol produces a smaller indirect effect than offline aerosol.

Remaining Questions

- How will the second indirect effect change conclusions?
- Will adding MIRAGE aerosol physics online in CAM (which is what we are presently working on) reduce the magnitude of IE further?
- Can the benefits of MIRAGE aerosol physics be obtained without a high computational cost?