

# Radiative Forcing Working Group

**AeroCom Workshop**

**02/10/2014**

**Steamboat Springs**

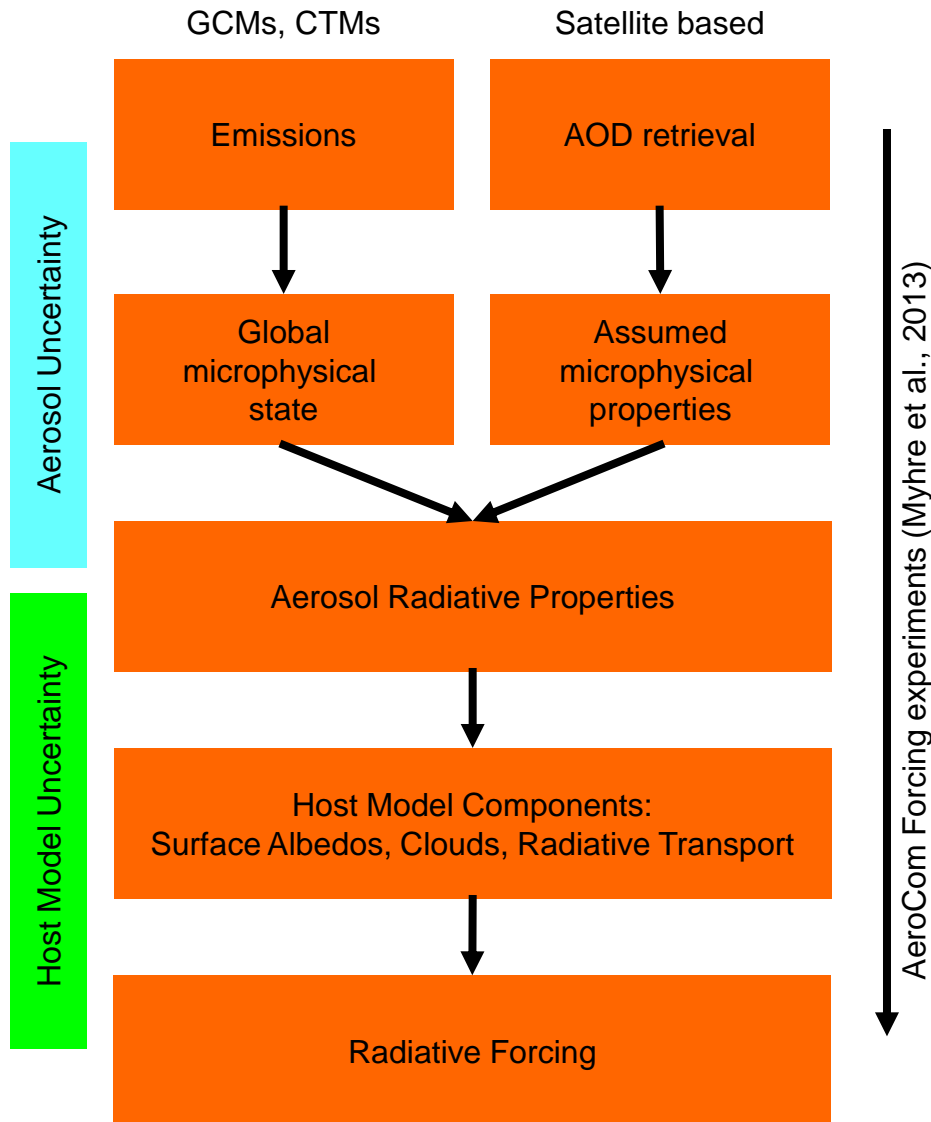
Philip Stier

Climate Processes Group

Department of Physics

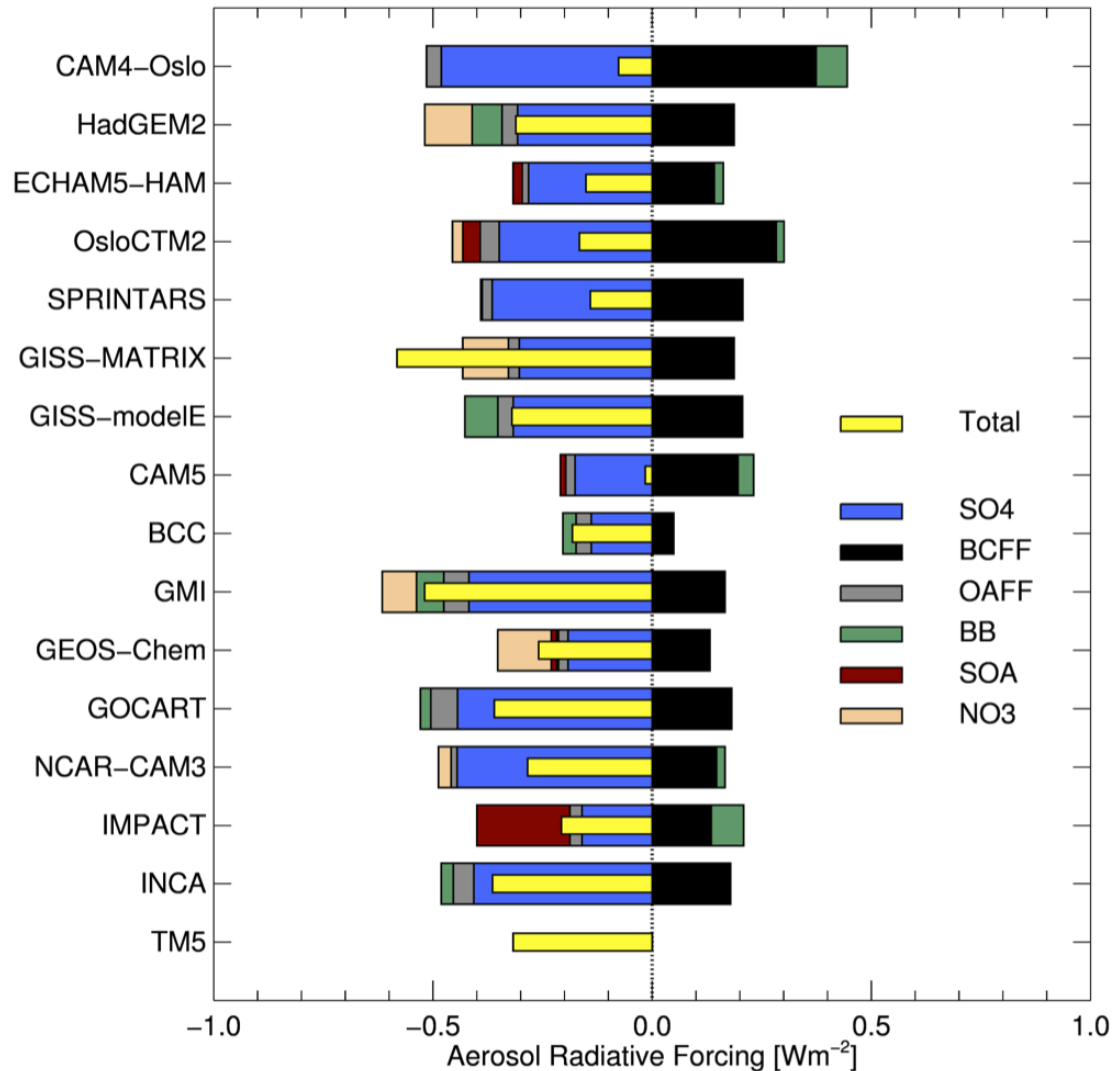
University of Oxford

# AeroCom Radiative Forcing Assessments

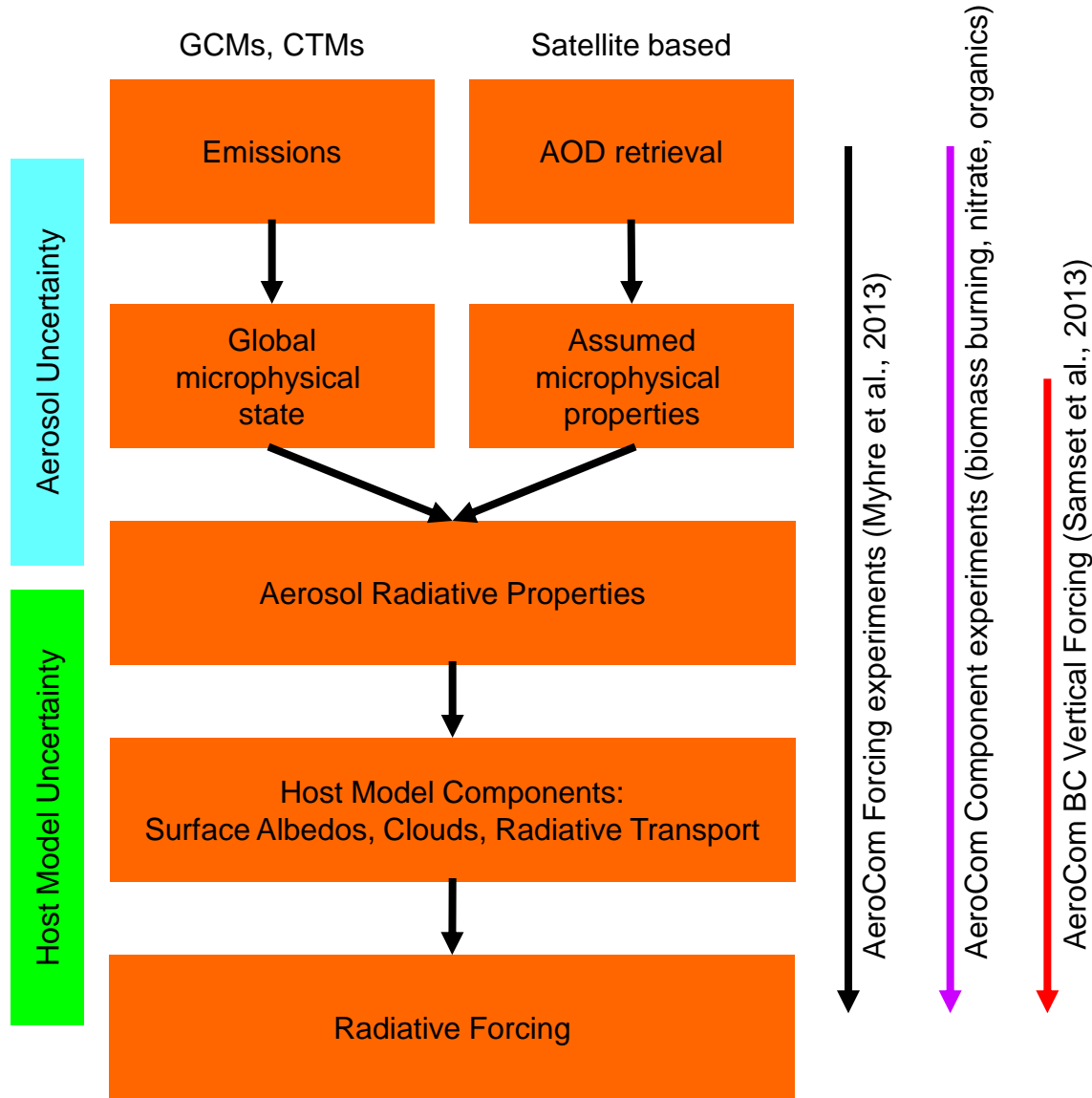


# AeroCom Radiative Forcing Experiments

AeroCom Phase II radiative forcing (Myhre et al., 2013):



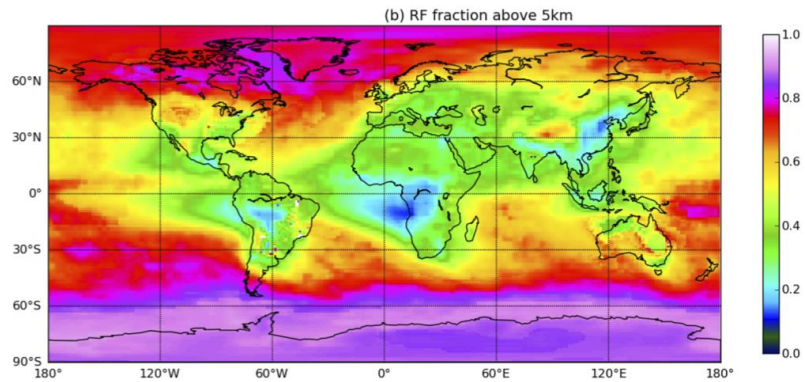
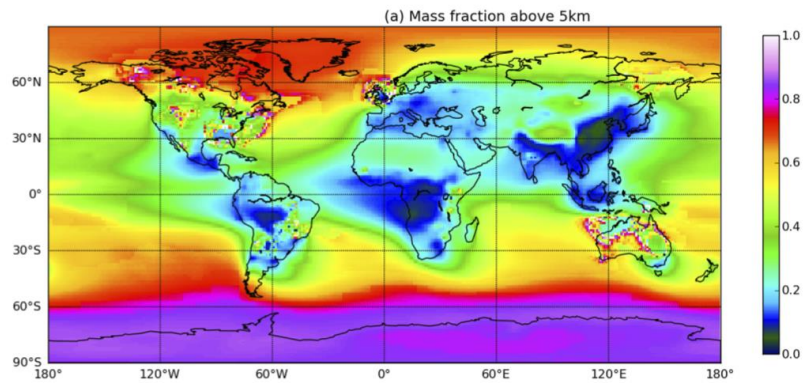
# AeroCom Radiative Forcing Assessments



# AeroCom Process Studies

AeroCom sensitivity of BC forcing to height (Samset et al., 2013):

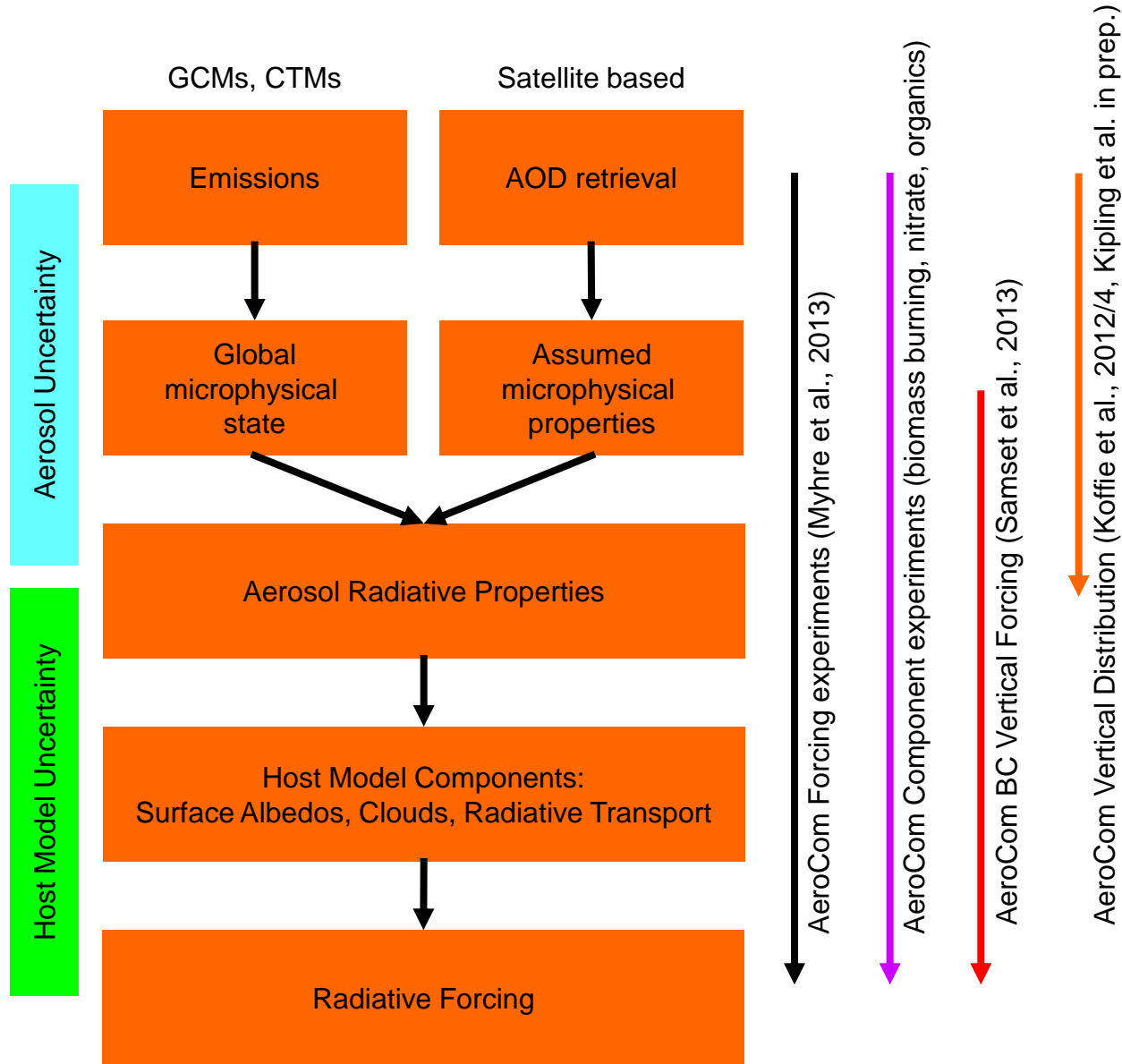
## BC mass fraction > 5km



## BC forcing fraction > 5km

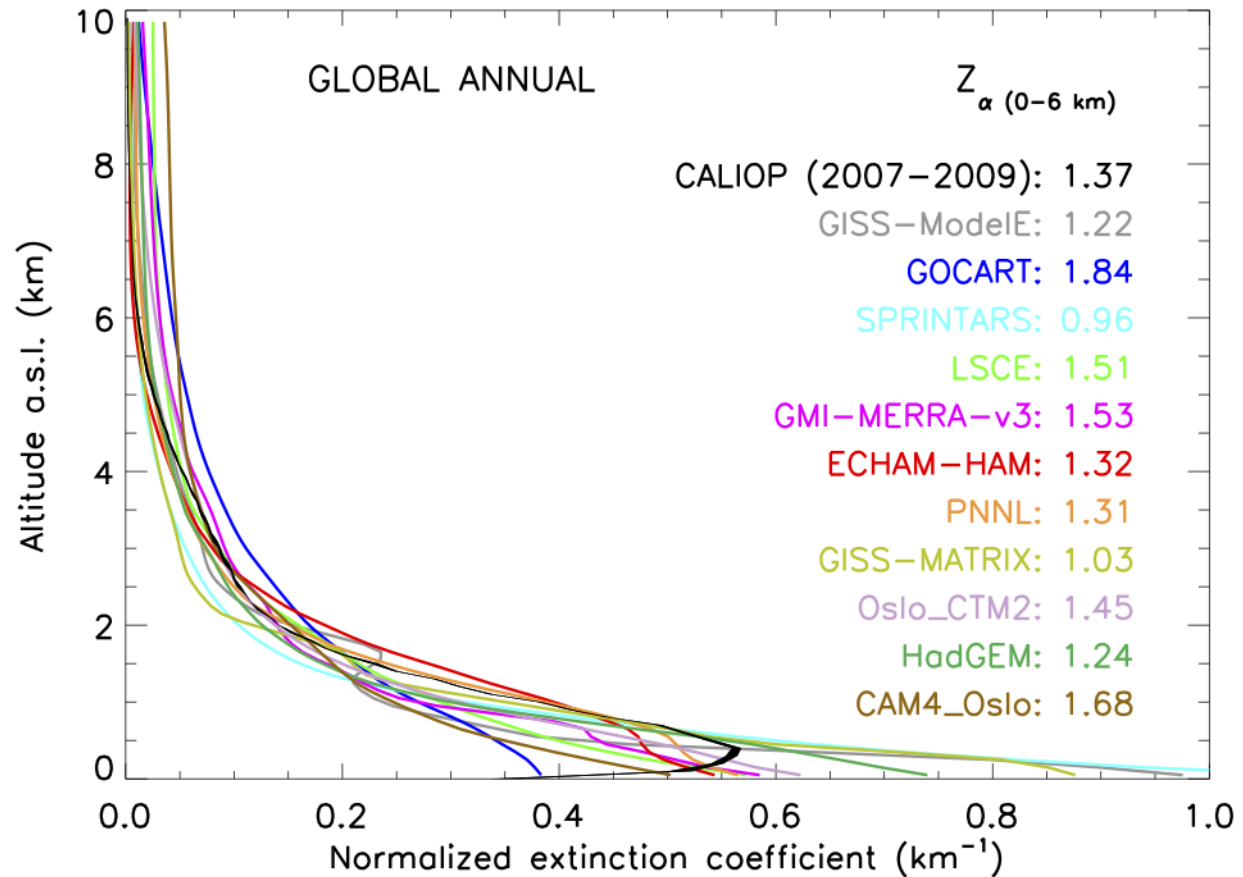


# AeroCom Radiative Forcing Assessments



# AeroCom Process Studies

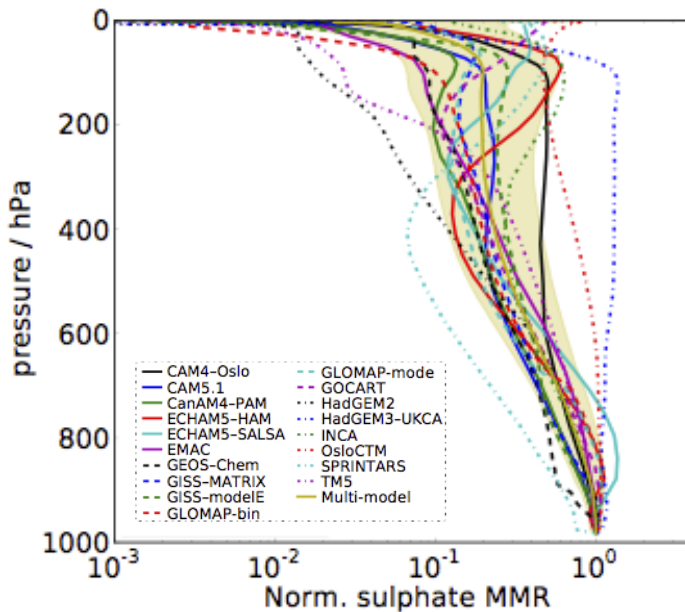
Evaluation of AeroCom vertical distribution:  
(Koffie et al., 2012, in prep.)



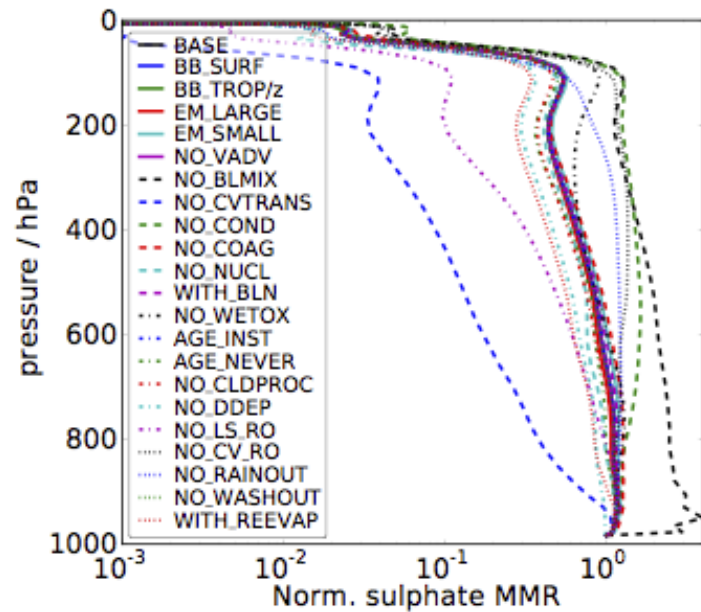
# AeroCom Process Studies

Understanding AeroCom vertical distribution (Kipling et al., in prep.):

AeroCom vertical distribution  
sulfate **mass mixing ratio**



HadGEM-UKCA perturbed  
physics ensemble

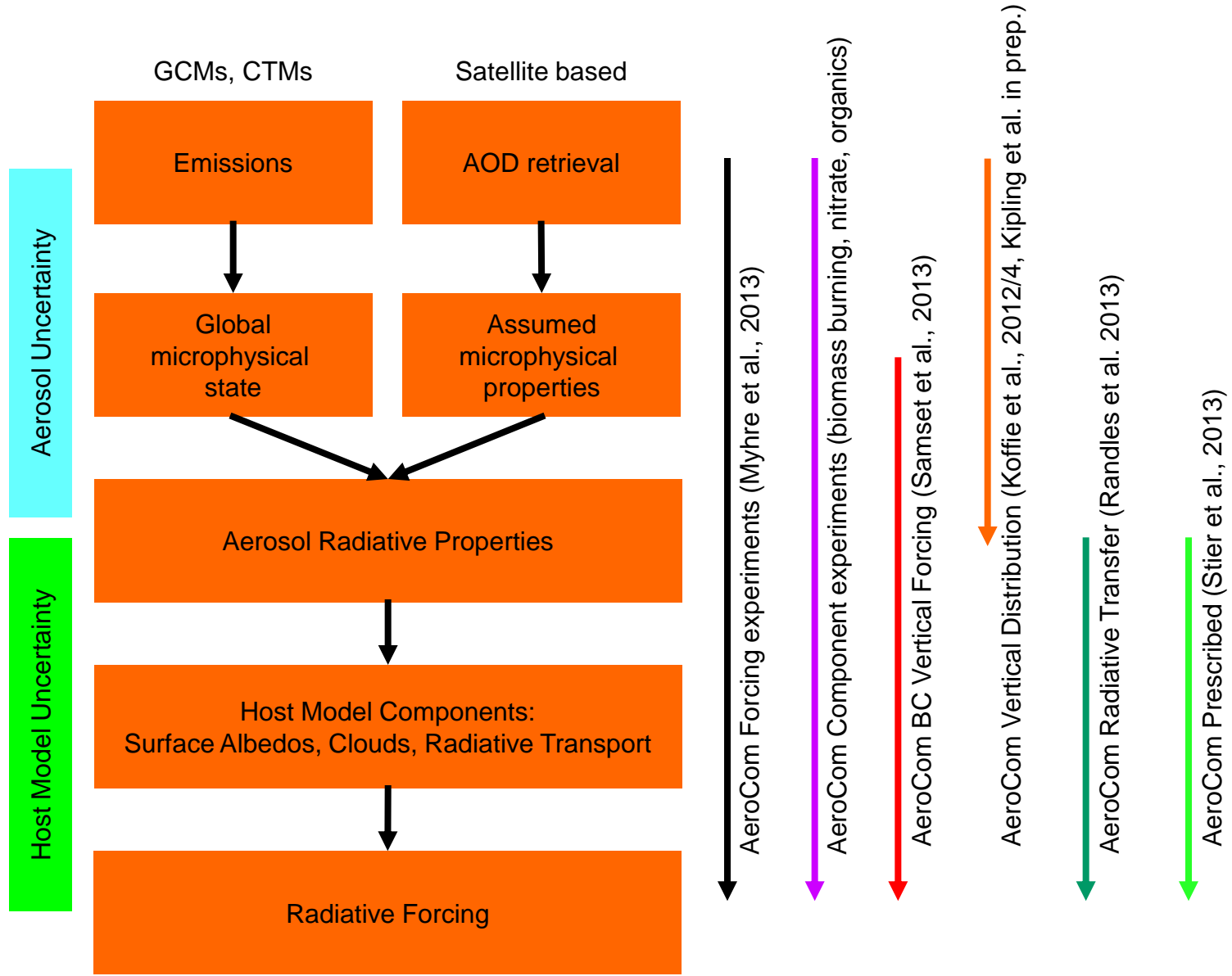


Revised paper draft to be circulated in next few weeks

*Full AeroCom perturbed physics experiment in planning for 2015  
(Carslaw & Lee, ...)*

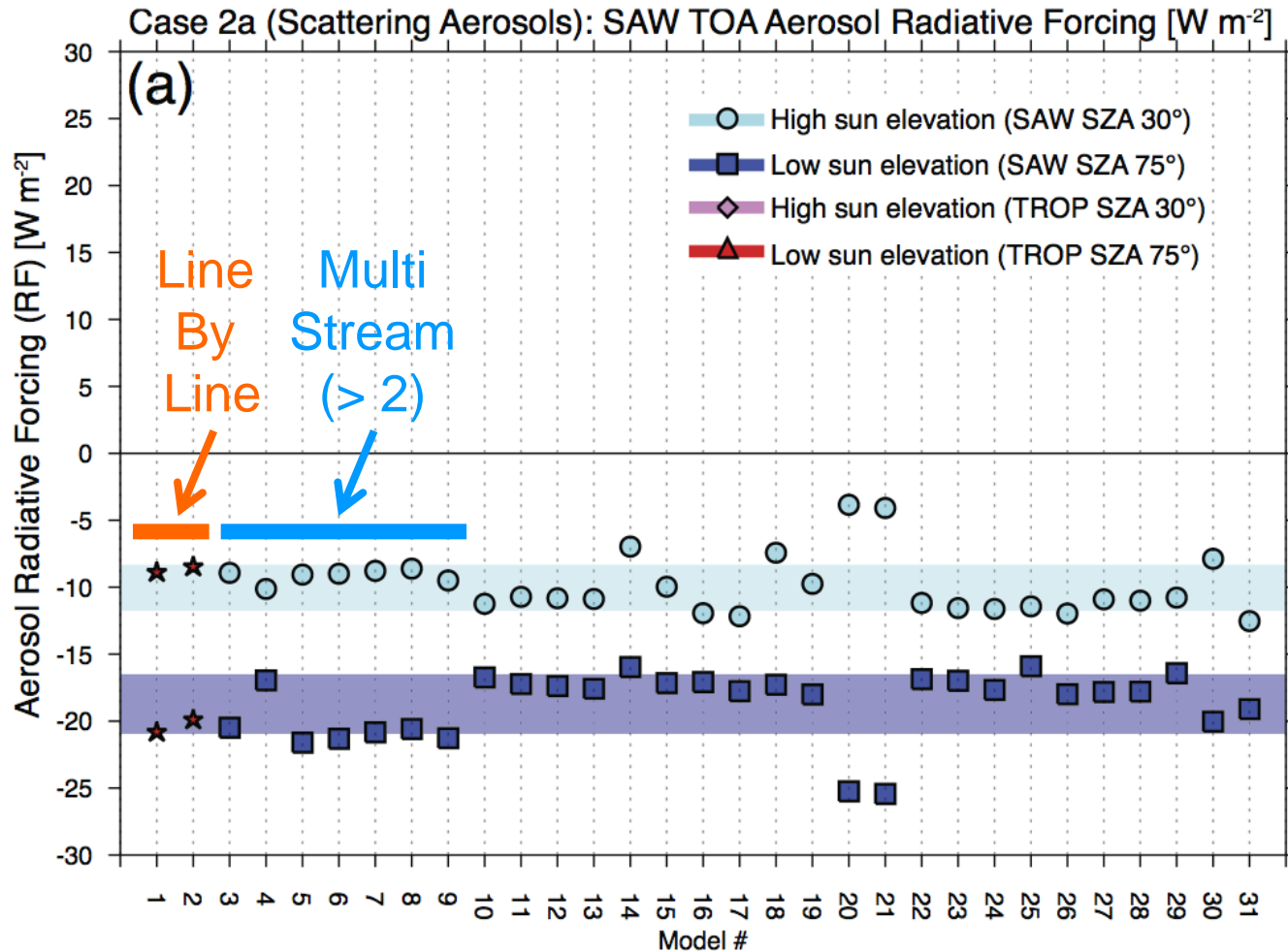


# AeroCom Radiative Forcing Assessments

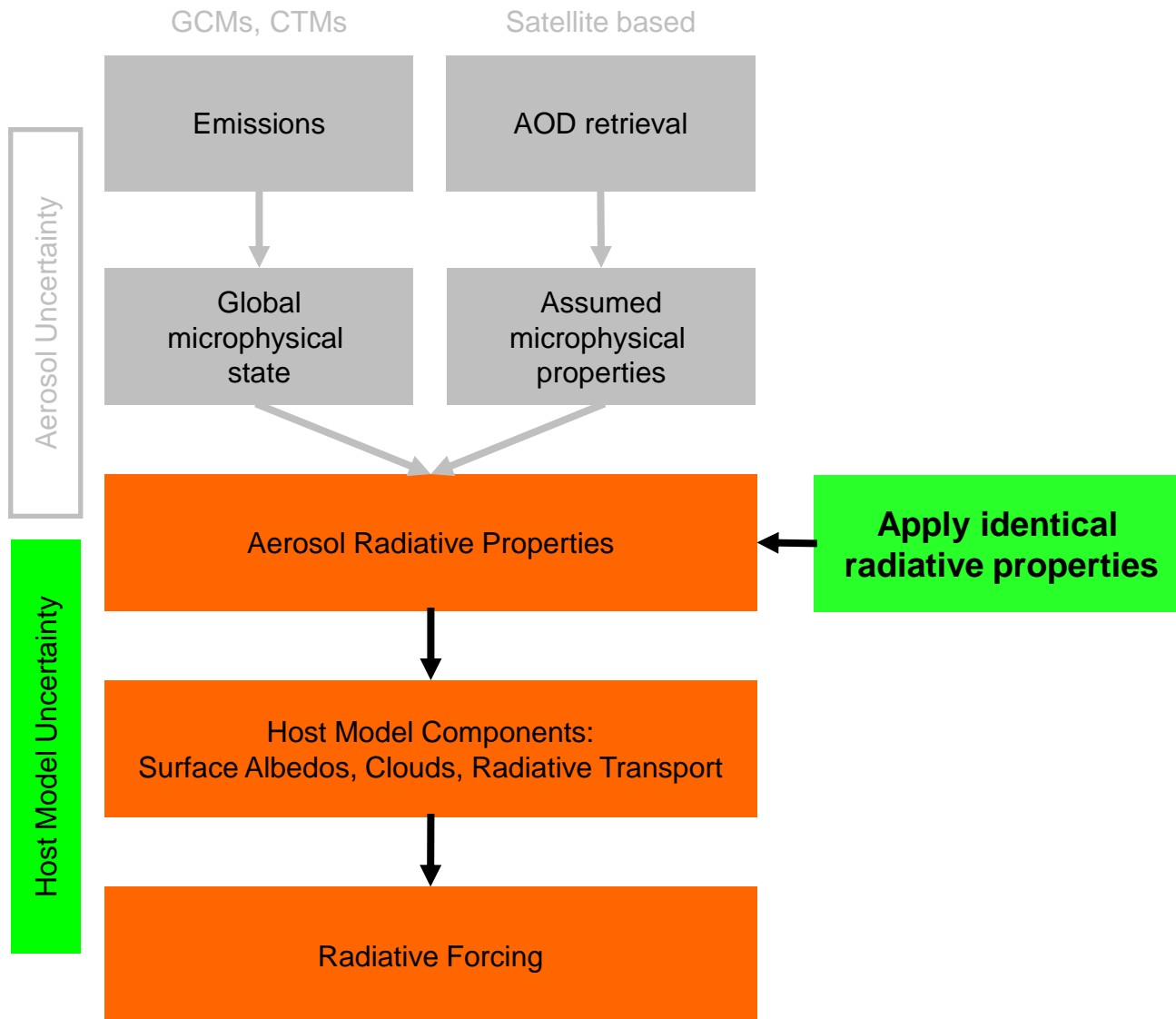


# AeroCom Radiative Forcing Experiments

AeroCom offline radiative transfer experiment (Randles et al., 2013):



# AeroCom Prescribed



# AeroCom Radiative Forcing Experiments

## Attribution of inter-model forcing variability to host model effects

AeroCom Prescribed: constant aerosol radiative properties (Stier et al., 2013)

$$\Delta RF_{TOA}^{all} = \underbrace{\frac{\overbrace{\partial RF_{TOA}^{all}}^{\text{Sensitivity}}}{\partial A_{sur}} \Delta A_{sur}}_{\text{Surface albedo}} + \underbrace{\frac{\overbrace{\partial RF_{TOA}^{all}}^{\text{Sensitivity}}}{\partial A_{cld}} \Delta A_{cld}}_{\text{Clouds}}$$

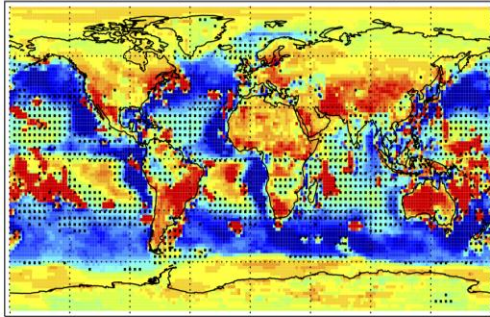
# AeroCom Prescribed: Attribution to Host Model Effects

Absorbing Case: FIX3-FIX0

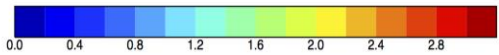
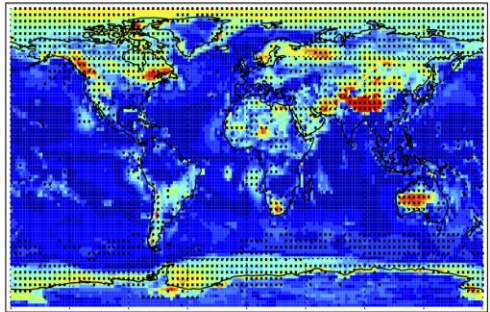
$$\frac{\partial RF_{TOA}^{all}}{\partial A_{sur}}$$

Surface Albedo

Slope [Wm<sup>-2</sup>] All-Sky RF vs surface albedo (FIX3-FIX0)



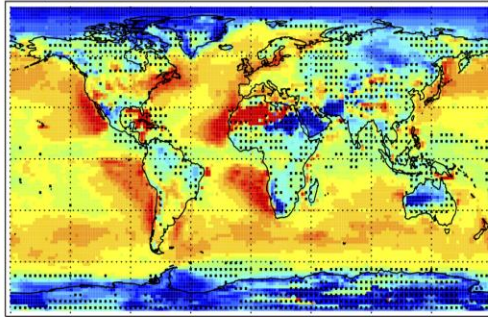
Error [Wm<sup>-2</sup>] All-Sky RF due to surface albedo (FIX3-FIX0)



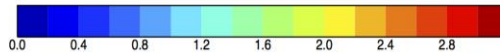
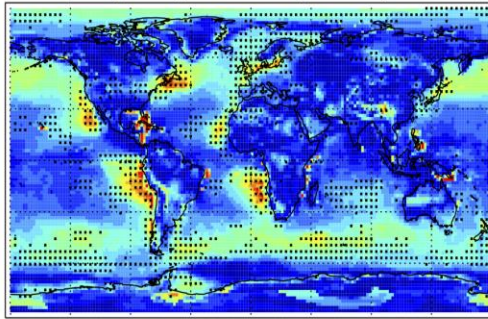
$$\frac{\partial RF_{TOA}^{all}}{\partial A_{cld}}$$

Cloudy Albedo

Slope [Wm<sup>-2</sup>] All-Sky RF vs cloudy albedo (FIX3-FIX0)

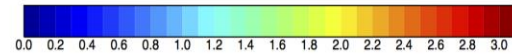
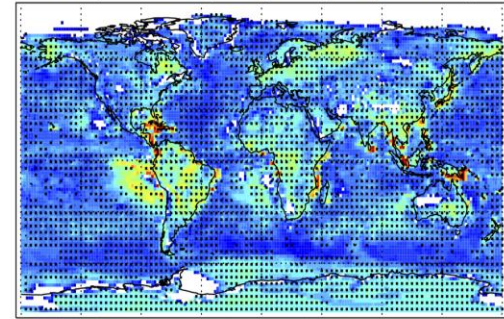


Error [Wm<sup>-2</sup>] All-Sky RF vs cloudy albedo (FIX3-FIX0)



Unexplained

Unexplained error [Wm<sup>-2</sup>] All-Sky RF (FIX3-FIX0)

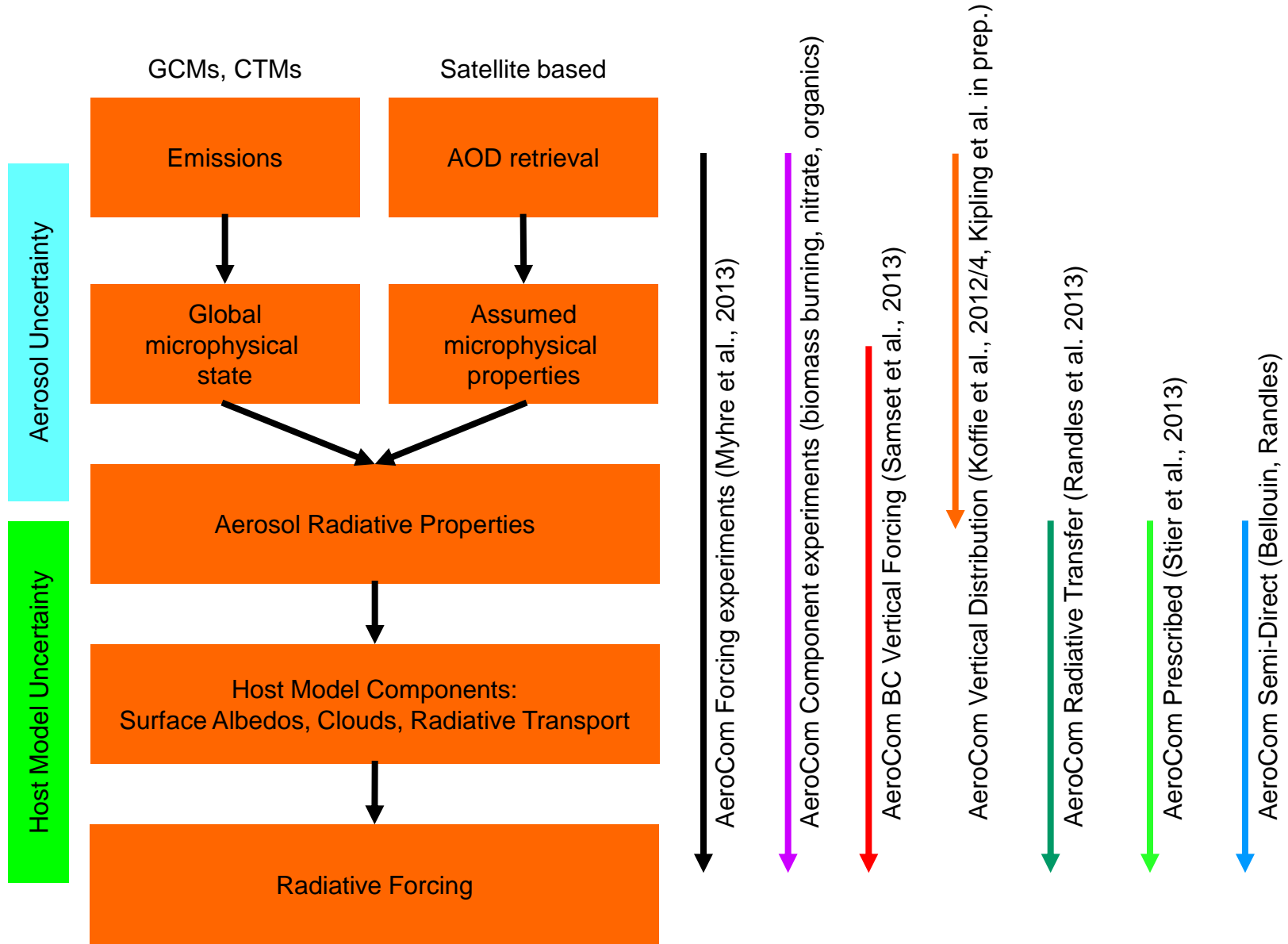


$$\frac{\partial RF_{TOA}^{all}}{\partial A_{sur}} \Delta A_{sur}$$

$$\frac{\partial RF_{TOA}^{all}}{\partial A_{cld}} \Delta A_{cld}$$



# Hierarchy of AeroCom Radiative Forcing Assessments

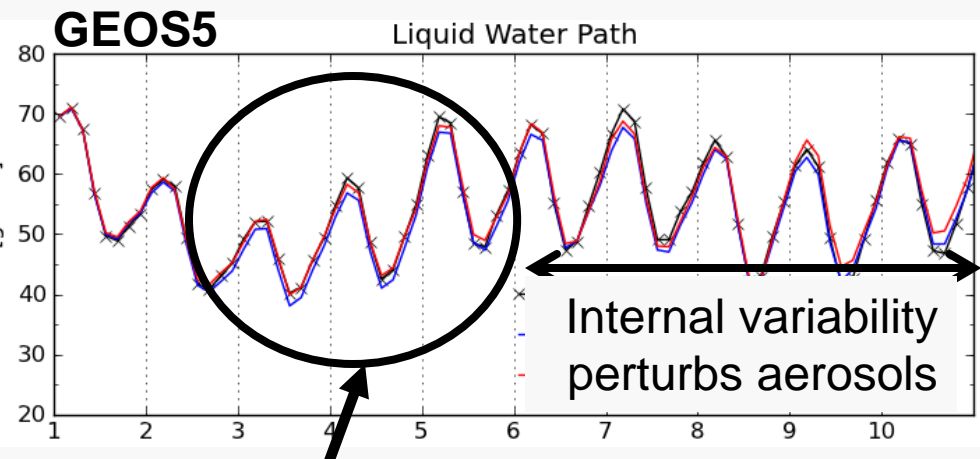
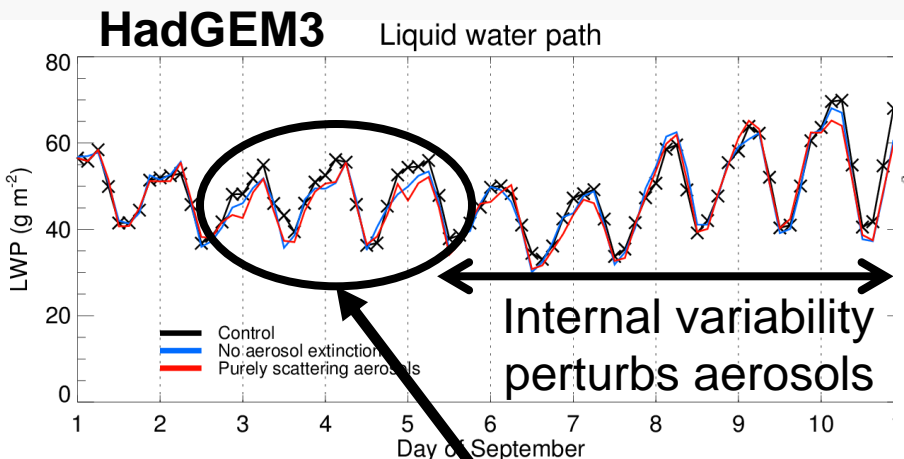


# Semi-direct effect

Nicolas Bellouin  
Cynthia Randles



- Hypothesis: The semi-direct effect of absorbing biomass-burning aerosols above stratocumulus clouds off Namibia maintains liquid water path at larger values.
- Experiments: Three 10-day simulations starting 1 September - **control**, then **no aerosol extinction**, then **purely scattering aerosols**.
- In HadGEM3 and GEOS5, no-extinction and purely-scattering simulations show decreased regional LWP after about 2 days.



Signature of semi-direct effects?

# AeroCom Radiative Forcing Experiments

## Discussion

- Will we learn from the past?
  - *Will models resolve “easy” issues, such as land surface albedo?*
  - *How do we pull through information across experiments?*  
*(proposal: required core diagnostics)*
- We may want to consider to merge future experiments  
*At least consider common baseline*
- Need for more evaluation
  - *Proposed analysis of 3-hourly co-located radiative properties*  
*(Nick Schutgens)*
  - *Evaluation paper of Phase II runs (Michael Schulz)*
- The AeroCom data is underexplored  
*Potential for many follow up studies*



# Hierarchy of Radiative Forcing Assessments

