DEPARTMENT OF PHYSICS

Introduction of old & new experiments Radiative Forcing Working Group

AeroCom Workshop

23/09/2013

Max Planck Institute for Meteorology

Hamburg

Philip Stier

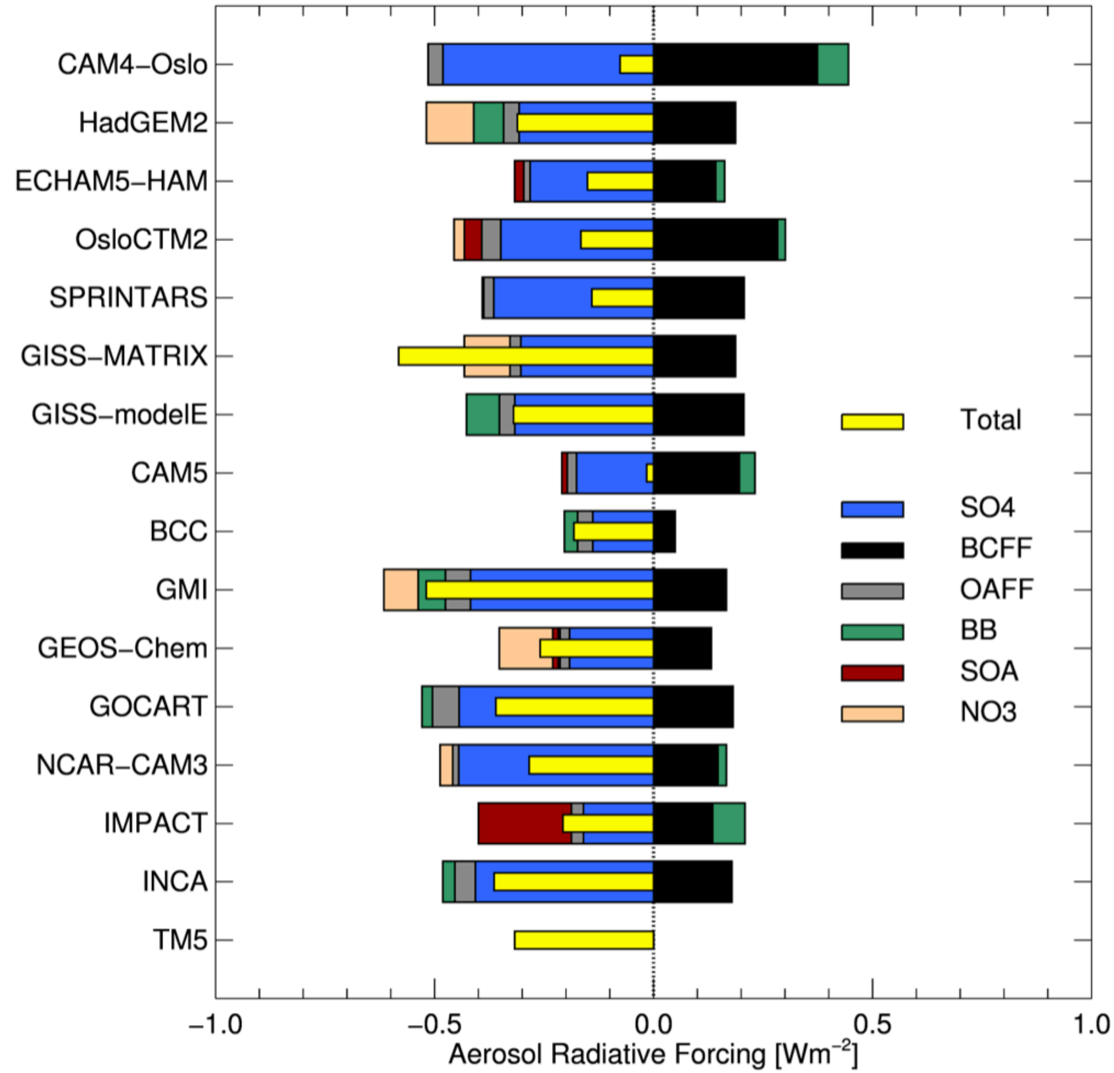
Climate Processes Group
Department of Physics
University of Oxford

UNIVERSITY OF OXFORD

Radiative Forcing Experiments

The old…

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



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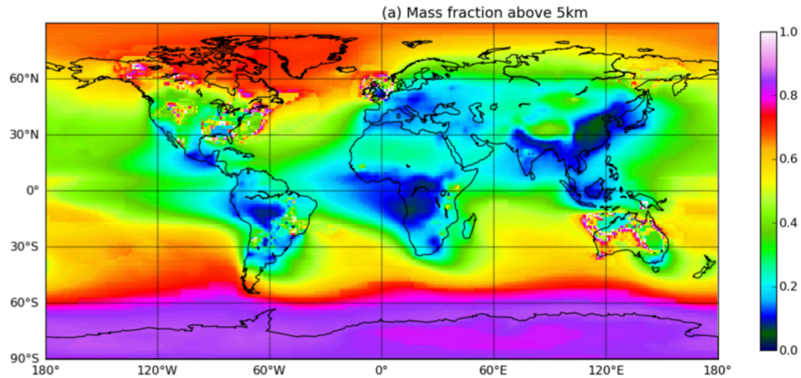
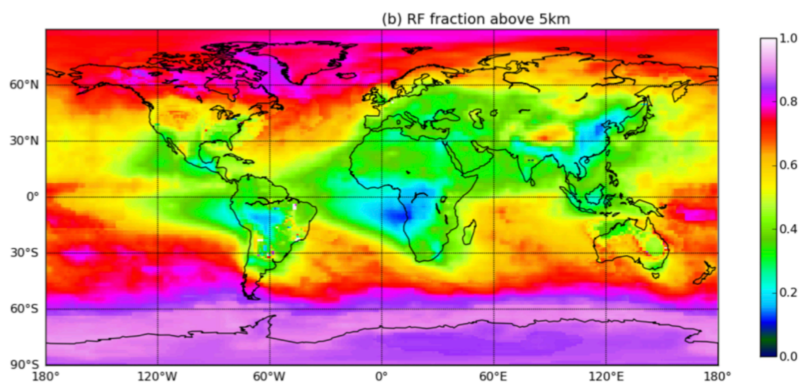
Radiative Forcing Experiments

The old…

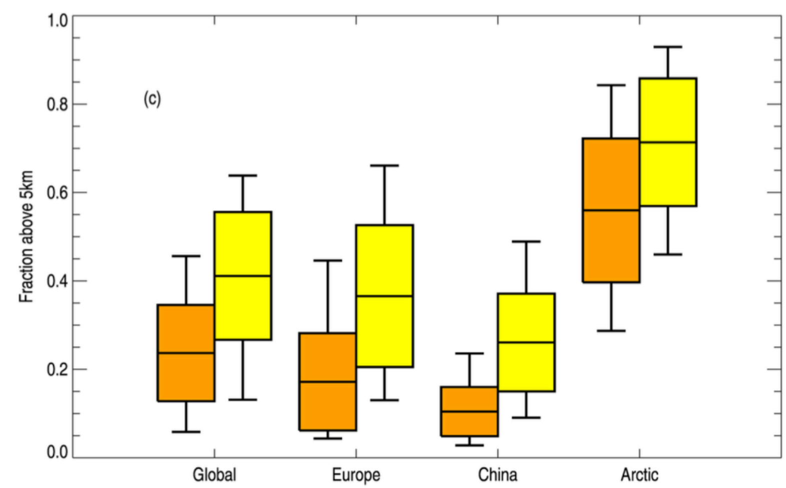
AeroCom sensitivity of BC forcing to height (Samset et al., 2013):

BC mass fraction > 5km





BC forcing fraction > 5km



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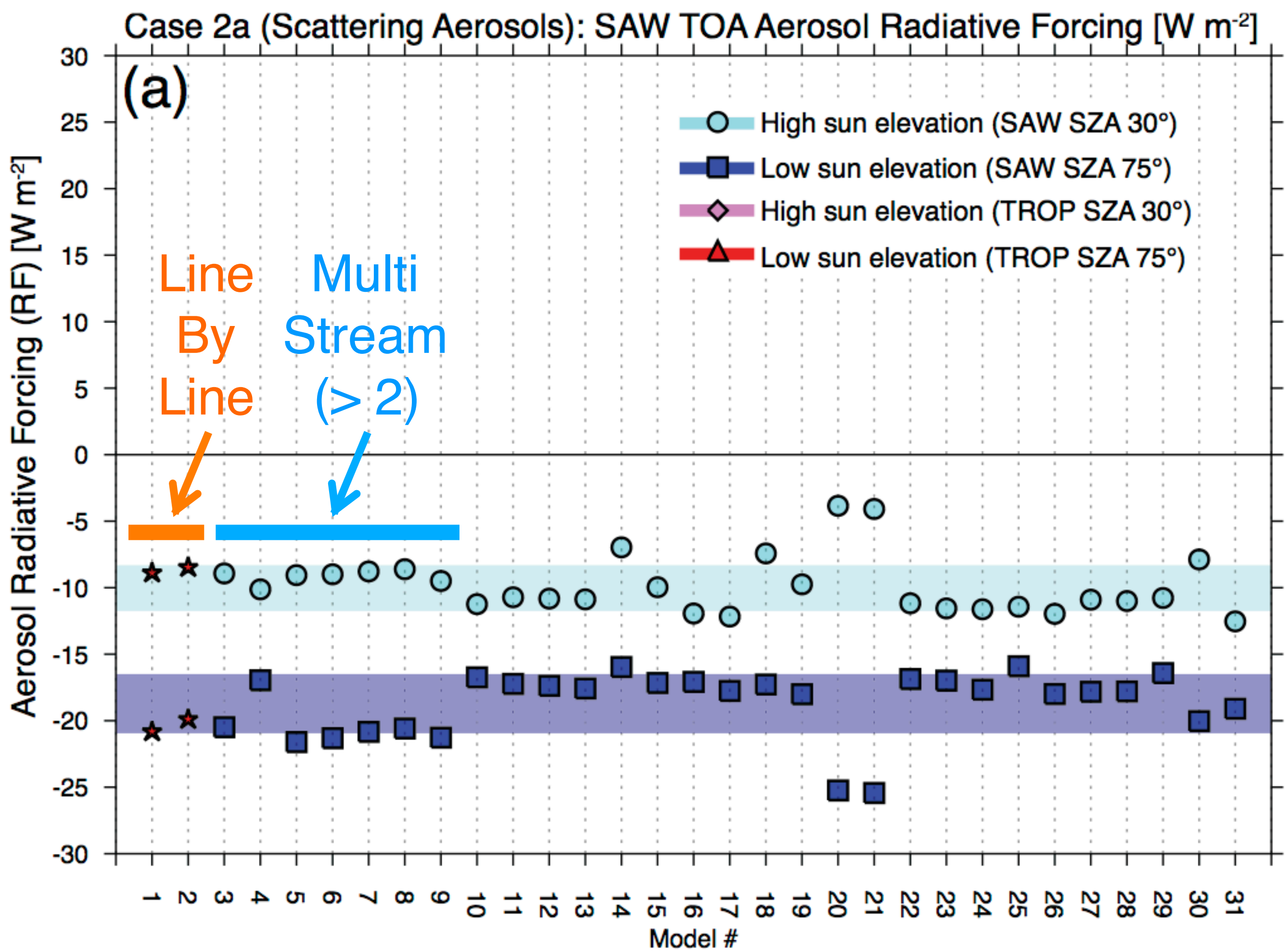
Radiative Forcing Experiments

The old…

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



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Radiative Forcing Experiments

The old…

Attribution of inter-model forcing variability to host model effects

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

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

AeroCom Prescribed: Attribution to Host Model Effects

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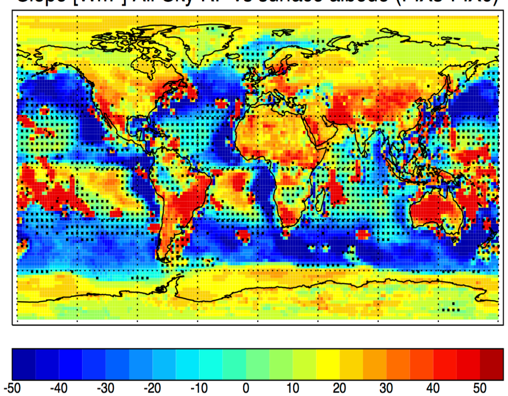
Absorbing Case: FIX3-FIX0

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

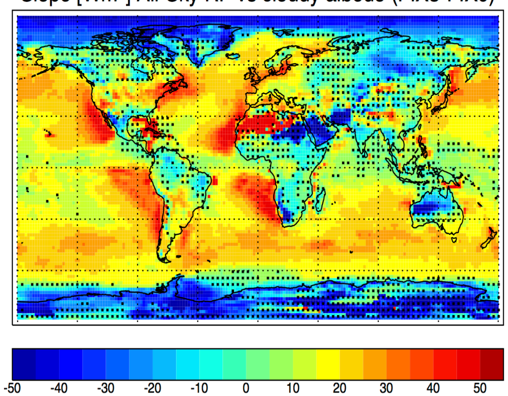
Surface Albedo	Cloudy Albedo	Unexplained

Sensitivity

Slope [Wm^{-2}] All-Sky RF vs surface albedo (FIX3-FIX0)

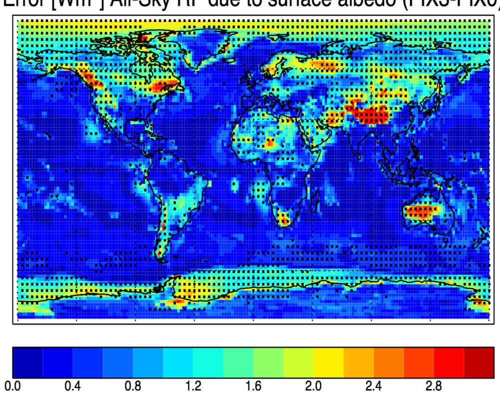


Slope [Wm^{-2}] All-Sky RF vs cloudy albedo (FIX3-FIX0)

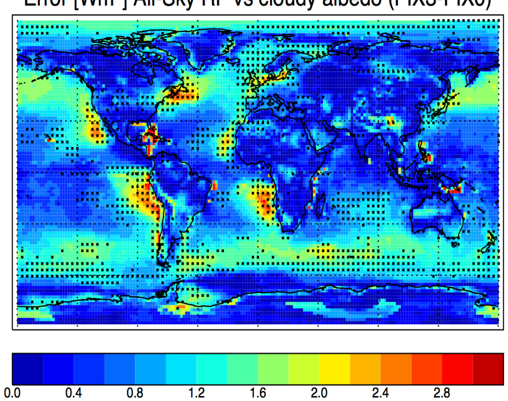


Forcing Error

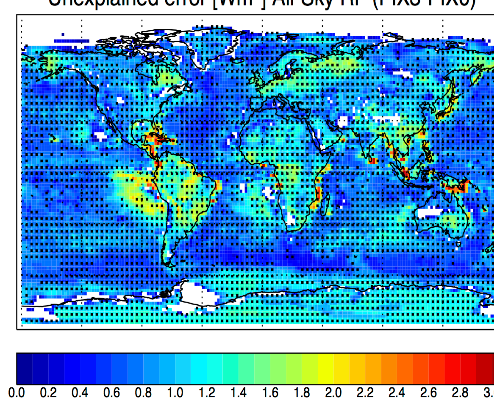
Error [Wm^{-2}] All-Sky RF due to surface albedo (FIX3-FIX0)



Error [Wm^{-2}] All-Sky RF vs cloudy albedo (FIX3-FIX0)



Unexplained error [Wm^{-2}] All-Sky RF (FIX3-FIX0)



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

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Radiative Forcing Experiments

The new…

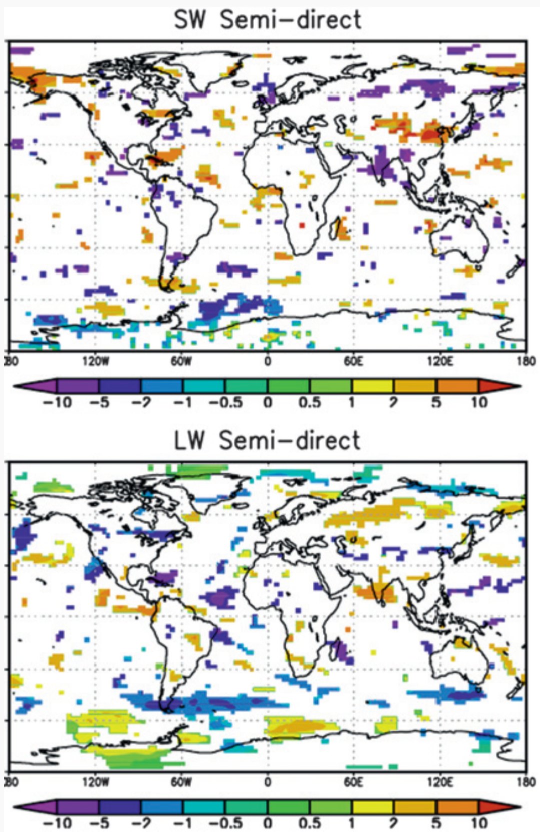
Ongoing and proposed work on radiative forcing:

- Semi-direct effects (Nicolas Bellouin)
- Black carbon forcing efficiency from HIPPO1-5 (Bjorn Samset)
- Effect of RH on sulfate radiative forcing (Bjorn Samset)

Fast adjustments to aerosol-radiation interactions
(semi-direct effect)

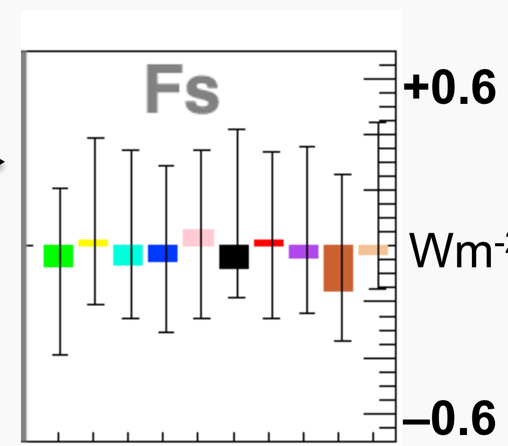
University of Reading
Nicolas Bellouin

- Previous estimates as residual: ERF – RFari – RFaci
- But the signal is small compared to internal variability.



Ghan et al. (2012). White areas are not significant at the 95% confidence level.

Bauer and Menon (2012) Global average, green bar is for all aerosol sources, error bars indicate interannual variability



Fast adjustments to aerosol-radiation interactions
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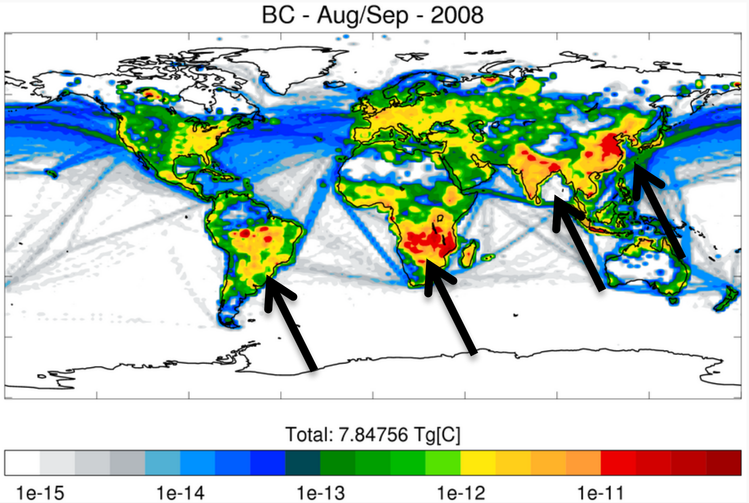
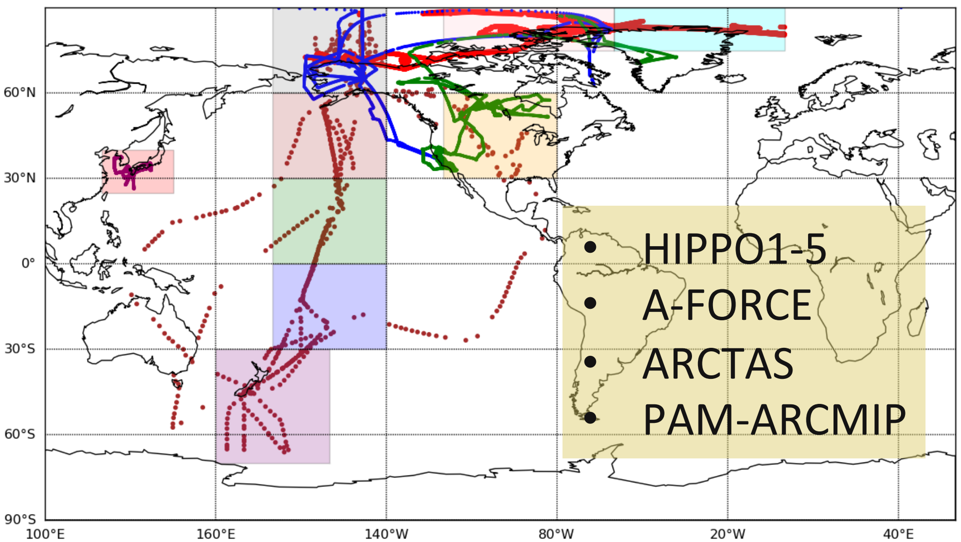
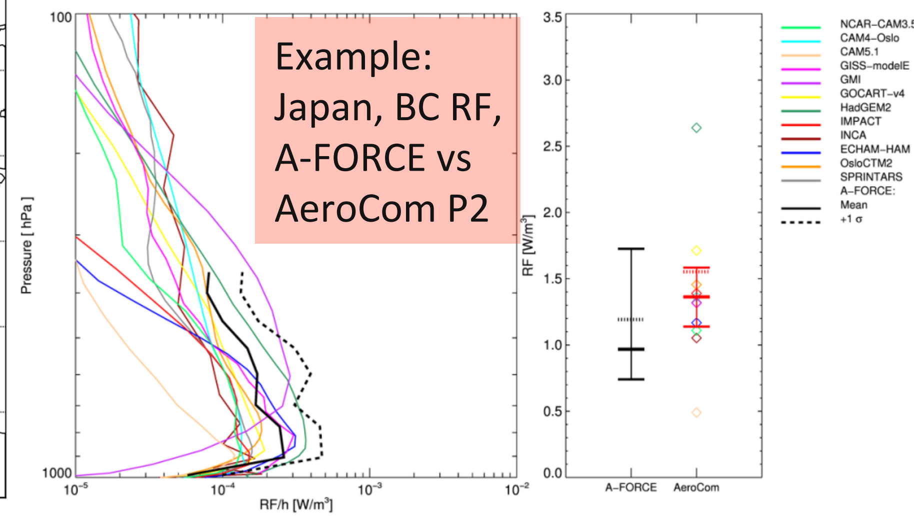


- Proposition: Dedicated GCM simulations
- **Short** simulations
  - Spin up model to **1 September** to produce initial aerosols/clouds.
  - Then run for **15 days** with:
    - 1. Control aerosols;
    - 2. Aerosol scattering and absorption efficiencies set to zero;
    - 3. Aerosol single-scattering albedo set to 1.
- Diagnostics focused on the **fast** response
  - Diagnostics on radiation timesteps;
  - Vertical distributions of thermodynamics, aerosols, clouds.
- Allow comparison against LES/CR modelling, and aircraft observations of biomass-burning aerosols overlying stratocumulus (2015: ORACLES, ONFIRE, CLARIFY)

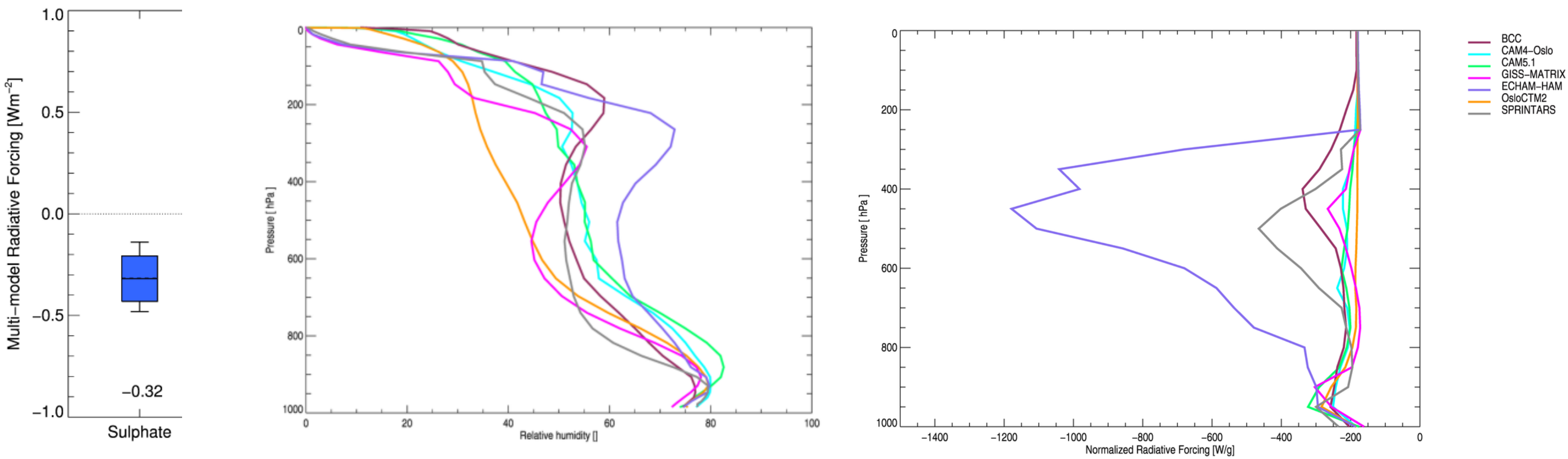
Comparison of industrial and remote region BC RF between AeroCom and flight campaigns





Ongoing study (see talk by B. Samset Thursday): Schwarz et al. 2010 showed that AeroCom Phase 1 overestimates the HIPPO1 BC MMR Pacific dataset. A submitted paper updates this to AeroCom Phase 2 and HIPPO1-5. In this study we use BC forcing efficiency profiles to estimate BC RF from four flight campaigns in both industrial and remote regions, and evaluate both the absolute burden and RF representation and their vertical profiles.

Effect of model variability in relative humidity on sulphate RF



(a) **(b)** **(c)**

Ongoing study: What drives the multimodel variability in sulphate RF? (**a**, from Myhre et al, ACP, 2013) AeroCom models have significant differences in relative humidity (**b**), which can influence the forcing efficiency of sulphate (**c**), significantly increasing the impacts of burden variations.

We aim to quantify this effect, using methods similar to those employed for BC in Samset et al., ACP, 2013.

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Radiative Forcing Experiments

The new…

Discussion

- Will we learn from the past?

  Low(er) hanging fruit: surface albedo

- Views on new experiments?

  General feedback and suggested timelines

- We may want to consider to merge experiments

  At least consider common baseline

- The AeroCom Phase II data is underexplored

  Potential for many follow up studies

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