AeroCom Working Group Direct Forcing

AeroCom Meeting 2007

Lille, France

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Assessment of aerosol direct radiative forcing

Progress

Current state of the art

- IPCC 2007 assessment confirms large remaining uncertainty

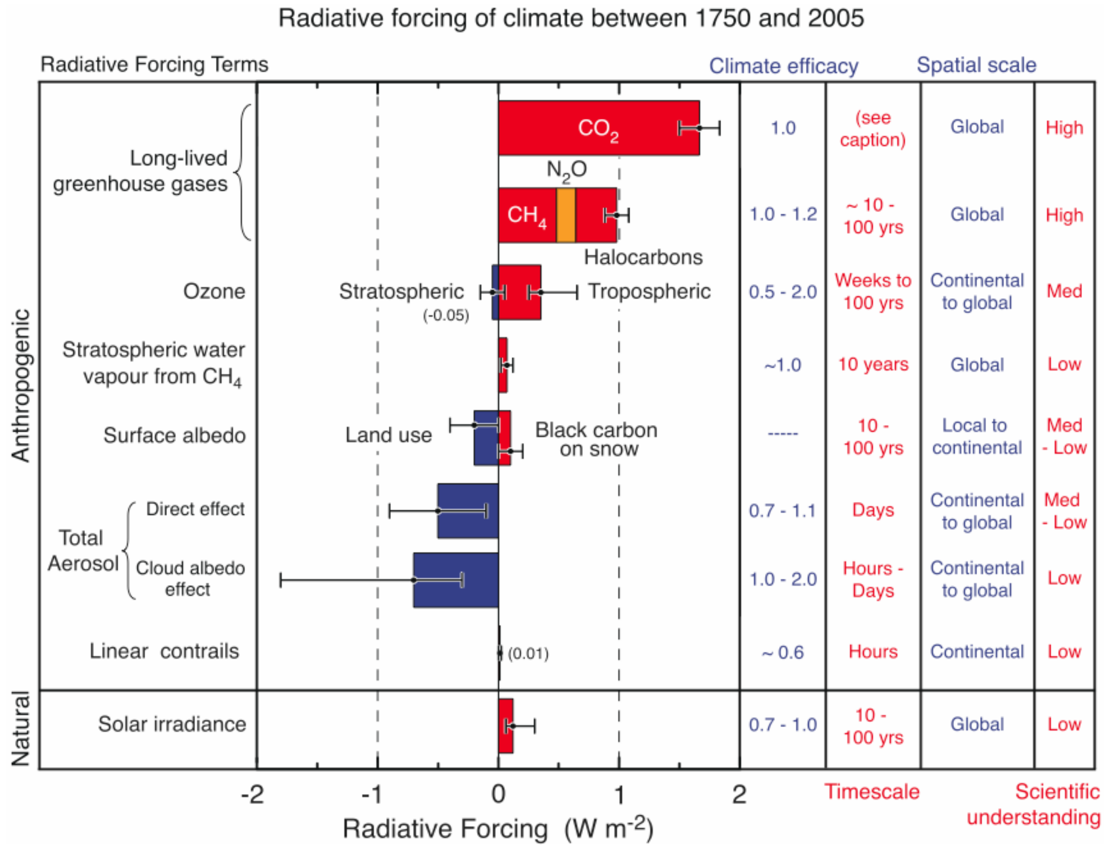

Figure: IPCC 2007 anthropogenic TOA direct radiative forcing by perturbation

Assessment of aerosol direct radiative forcing

Current state of the art

- IPCC 2007: Large error bar represents diversity in individual estimates

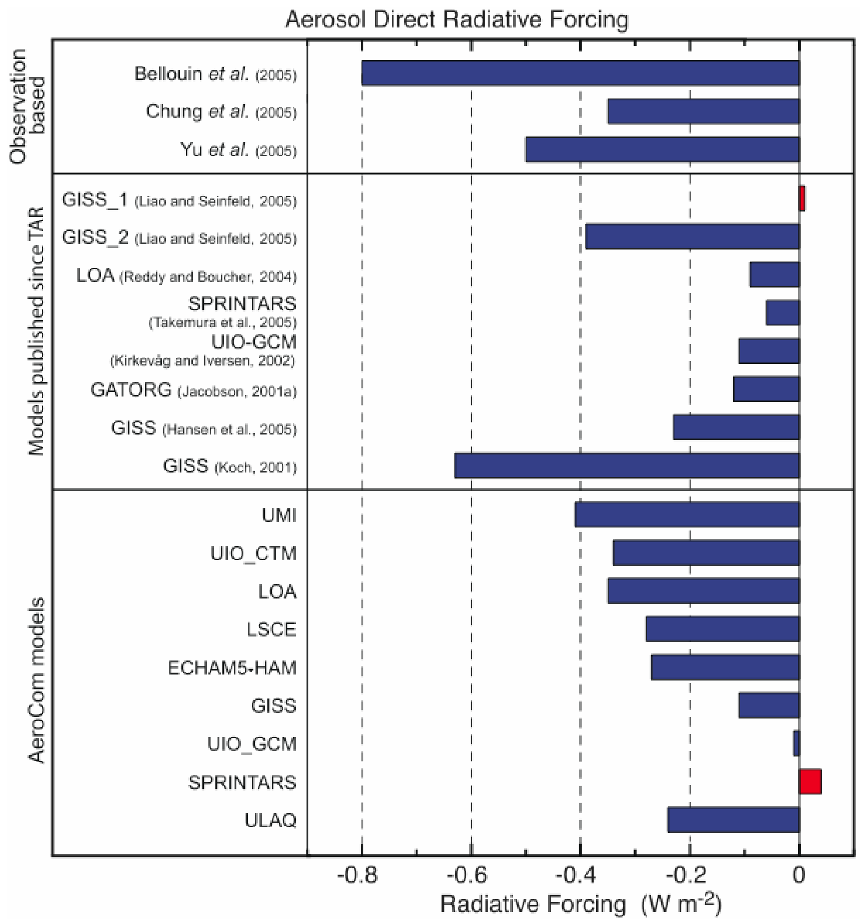

Figure: IPCC 2007 anthropogenic TOA direct radiative forcing by model

Progress

Assessment of aerosol direct radiative forcing

New developments since AeroCom 2006:

- Update of Bellouin et al. (2005) forcing estimate
- Work on secondary species by Gunnar Myhre et al.

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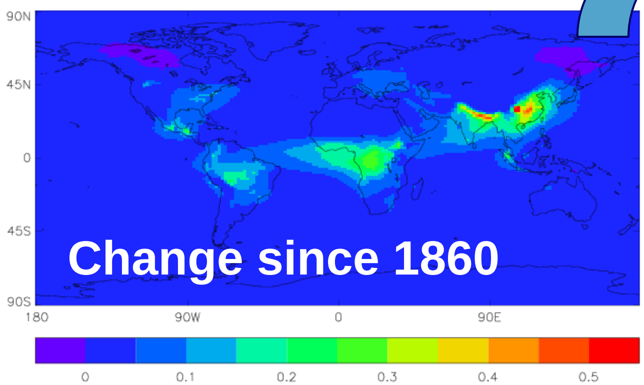
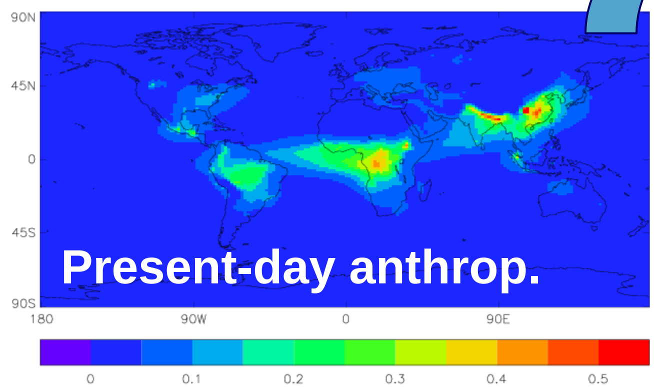
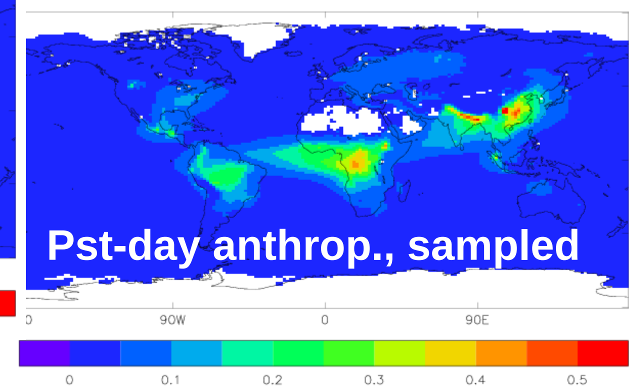
Making HadGEM2-A comparable to Bellouin et al.

Bellouin *et al.*: No pre-industrial observations, present-day natural aerosols used as a reference instead.

Bellouin *et al.*: MODIS sampling means NH continents better observed during summer



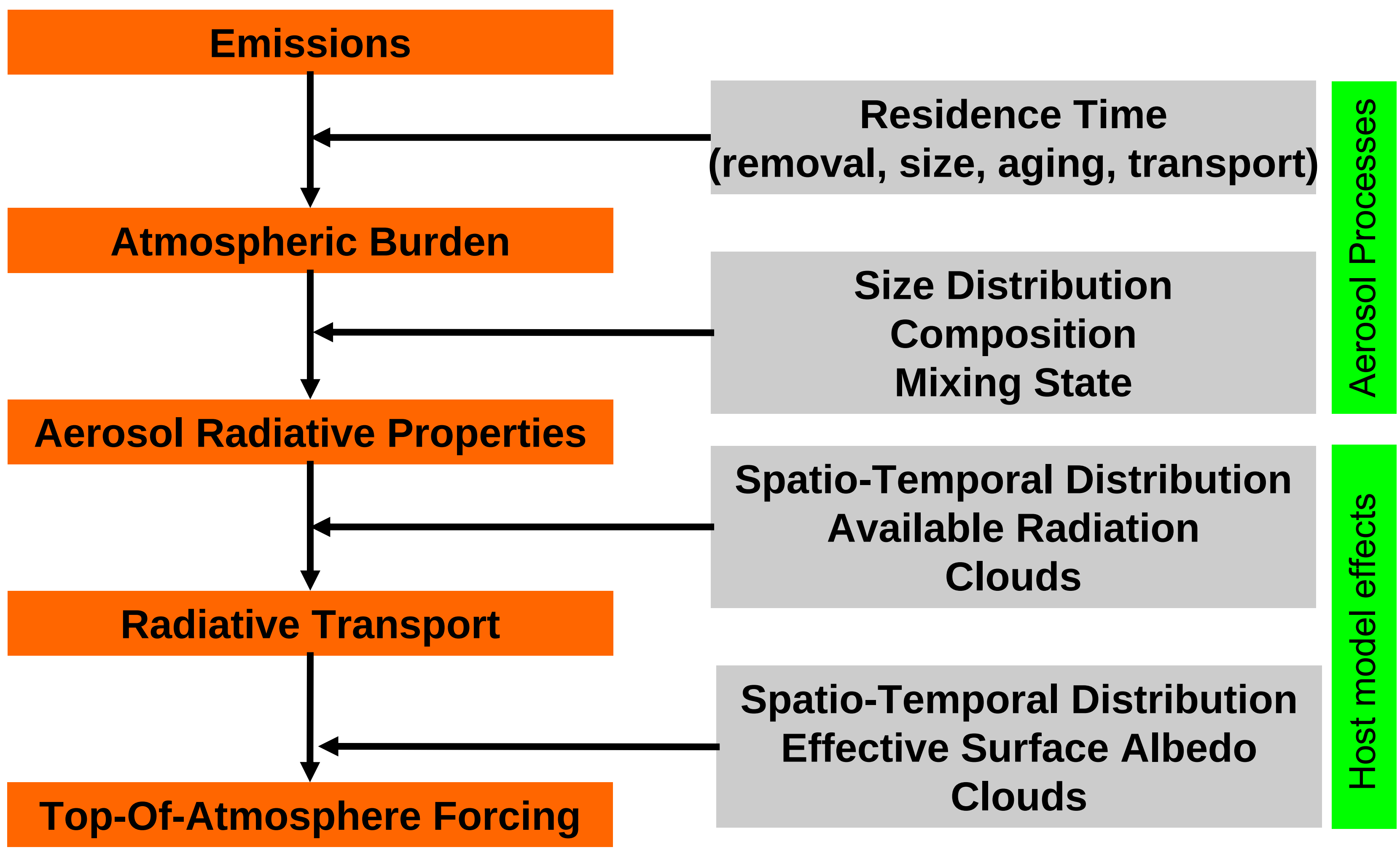




	Ocean		Land		Global	
	τ_{anthr}	DRF	τ_{anthr}	DRF	τ_{anthr}	DRF
Bellouin *et al.* on coll. 5	0.021	-0.60	0.107	-3.27	0.043	-1.30
HadGEM2-A	0.020	-0.51	0.054	-0.91	0.030	-0.63
HadGEM2-A w.r.t. natural, sampled	0.025	-0.67	0.081	-1.63	0.040	-0.91

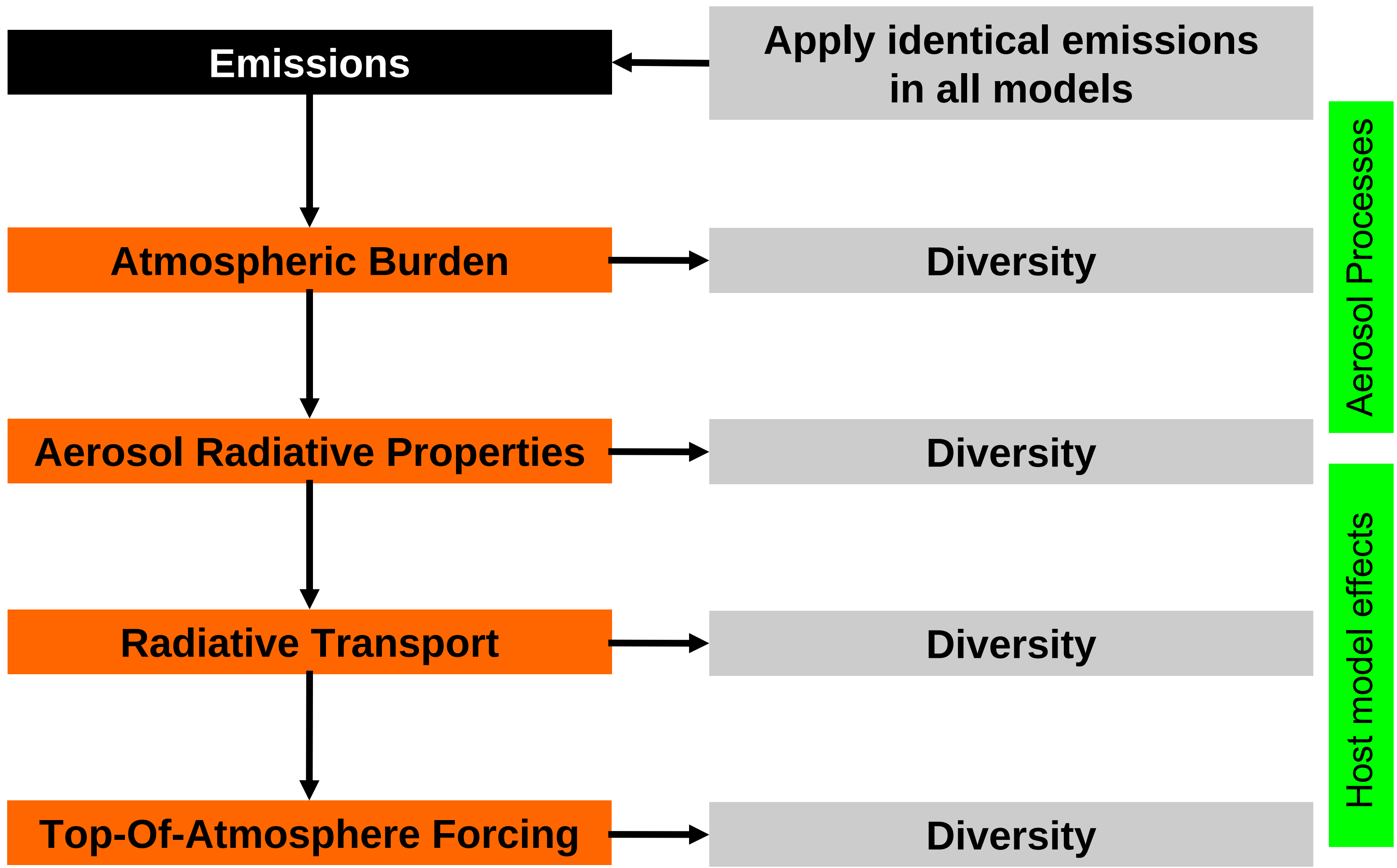
Assessment of aerosol direct radiative forcing

AeroCom: Intercomparison and assessment of the underlying process representations



Assessment of aerosol direct radiative forcing

AeroCom Stage 1: Facilitate inter-comparability through fixing emissions



AeroCom Radiative Forcing

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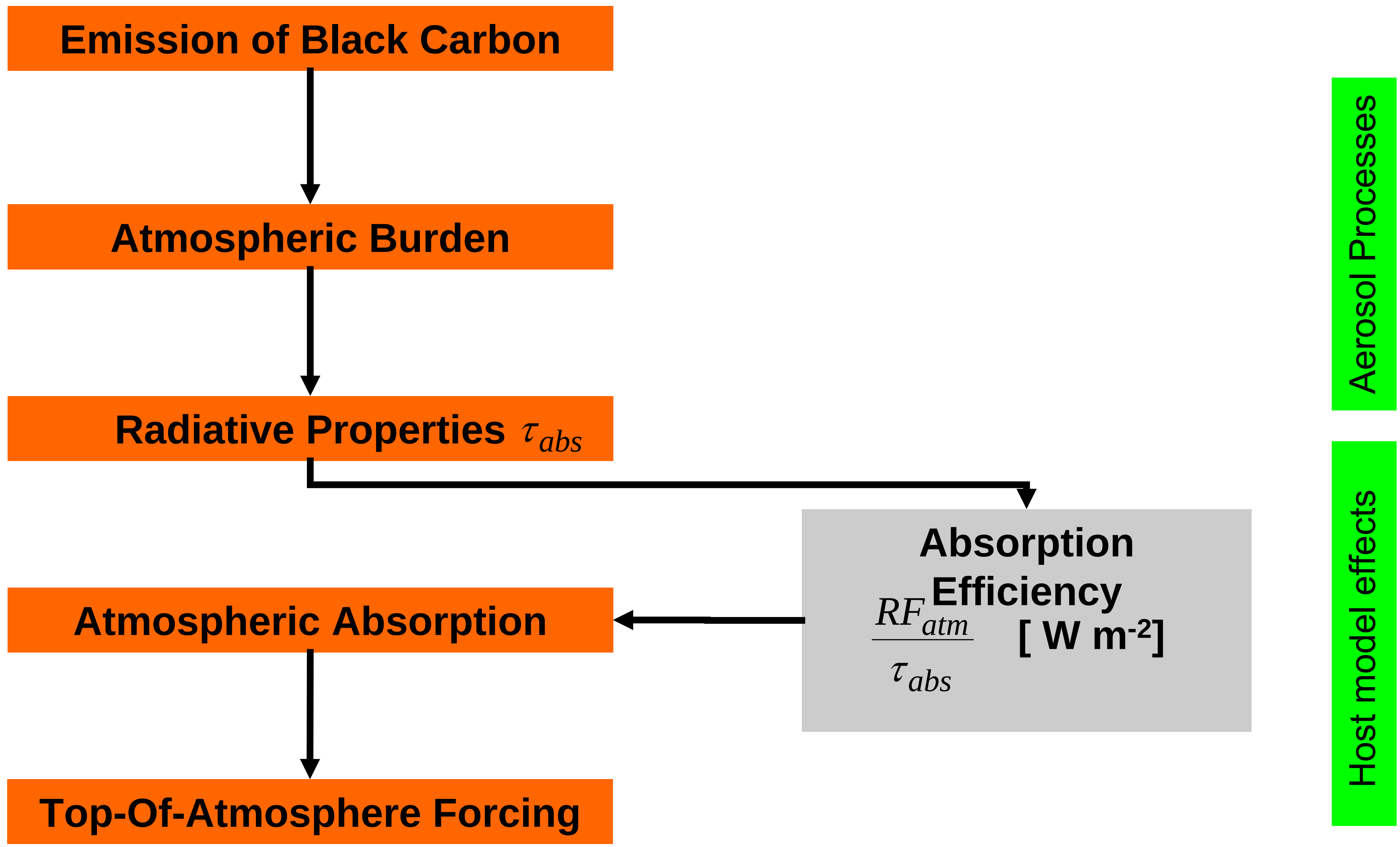
Assessment of aerosol direct radiative forcing

Analysis of AeroCom forcing experiment:

Large diversity in absorption efficiency from aerosol radiative properties:



AeroCom Radiative Forcing

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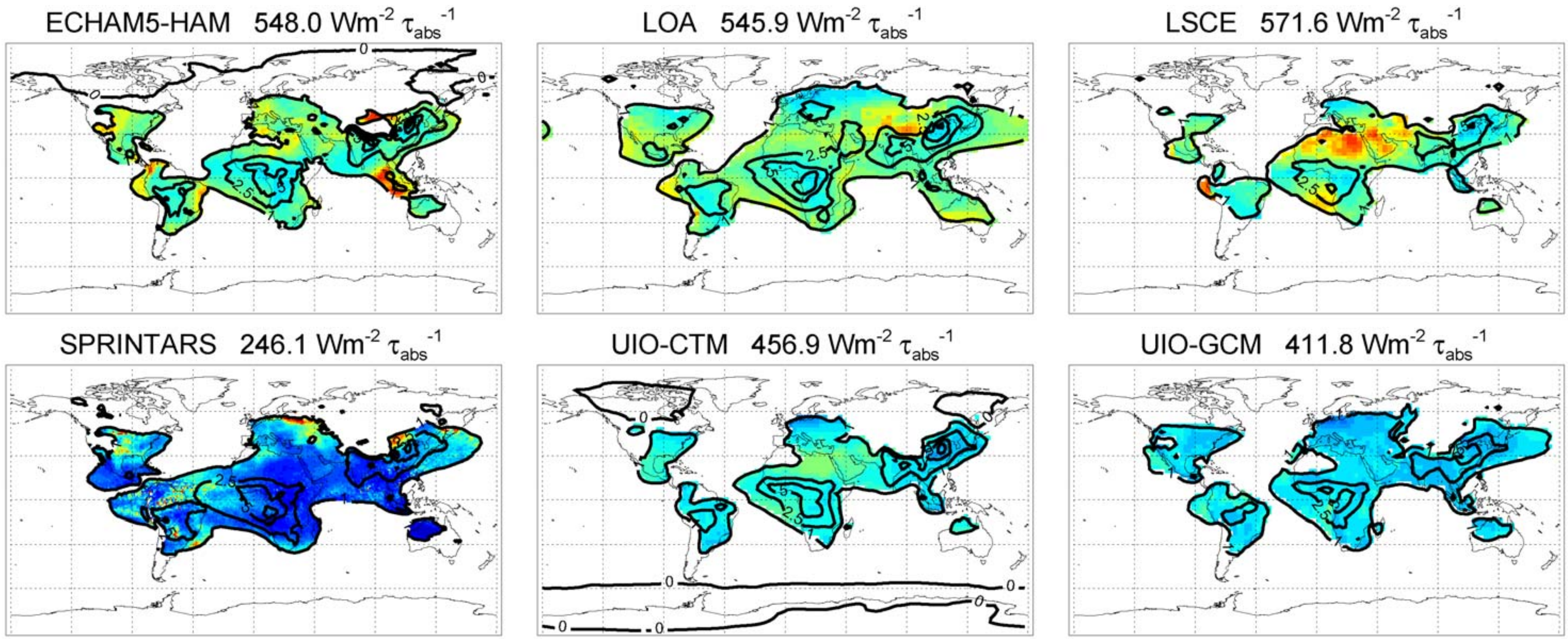
Analysis of AeroCom Forcing Experiment



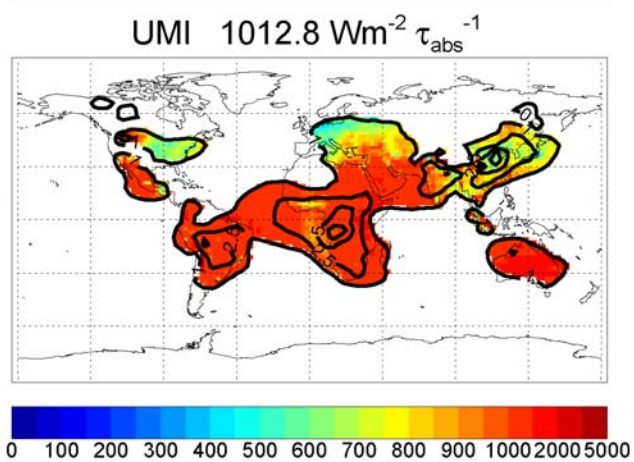


Figure: Annual-mean efficiency to generate all-sky atmospheric absorption from aerosol absorption optical depth: $\frac{RF_{abs}}{\tau_{abs}}$ [W m^{-2}]

Contour lines: RF_{abs} **Mask:** $RF_{abs} < 1.0$ [W m^{-2}]

Assessment of host model effects in AeroCom

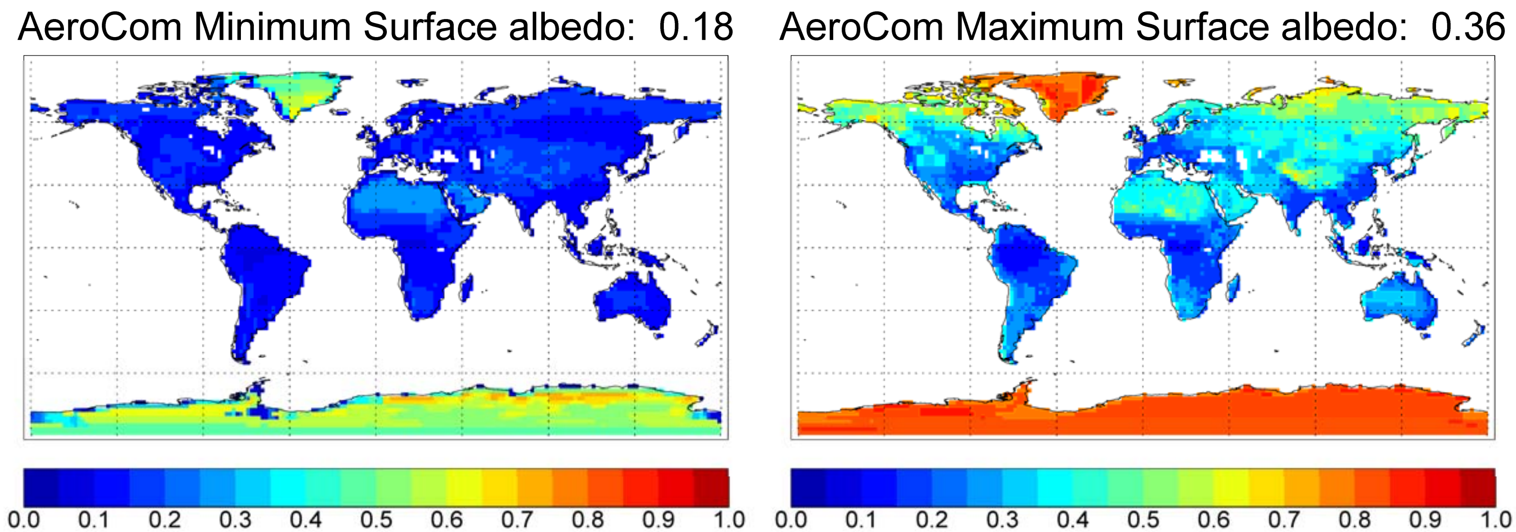


Figure: Annual-mean upper and lower bounds of broad-band shortwave land surface albedos derived from AeroCom submissions.

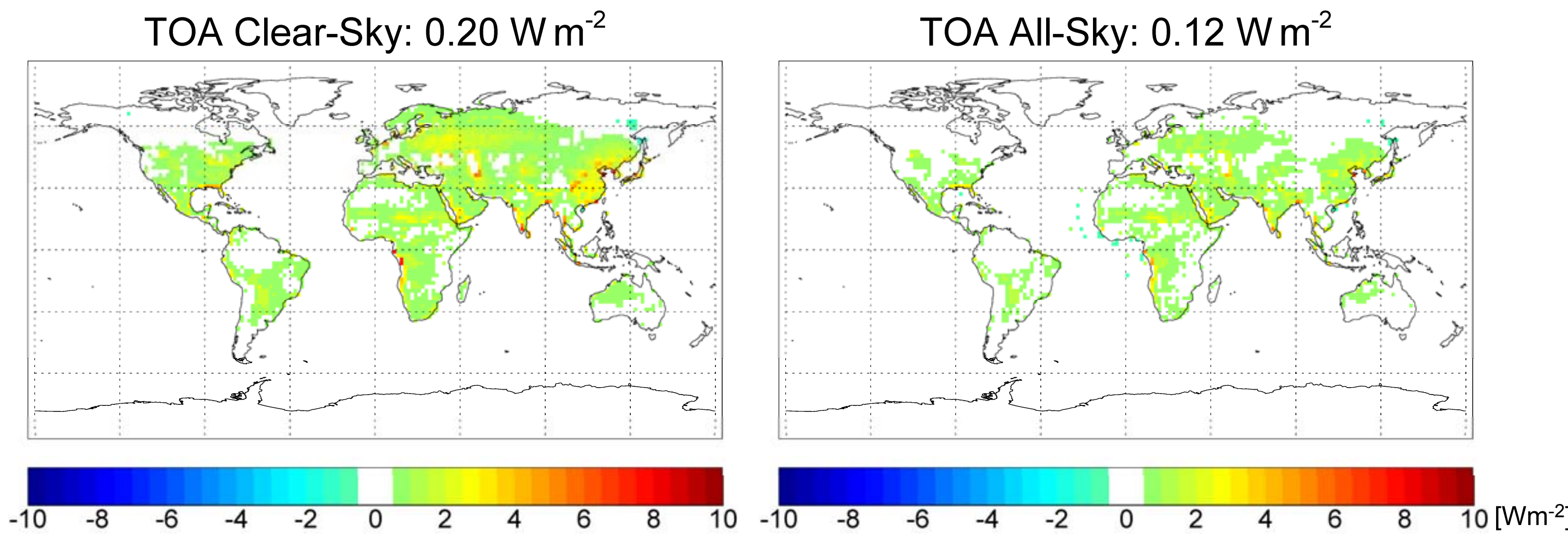
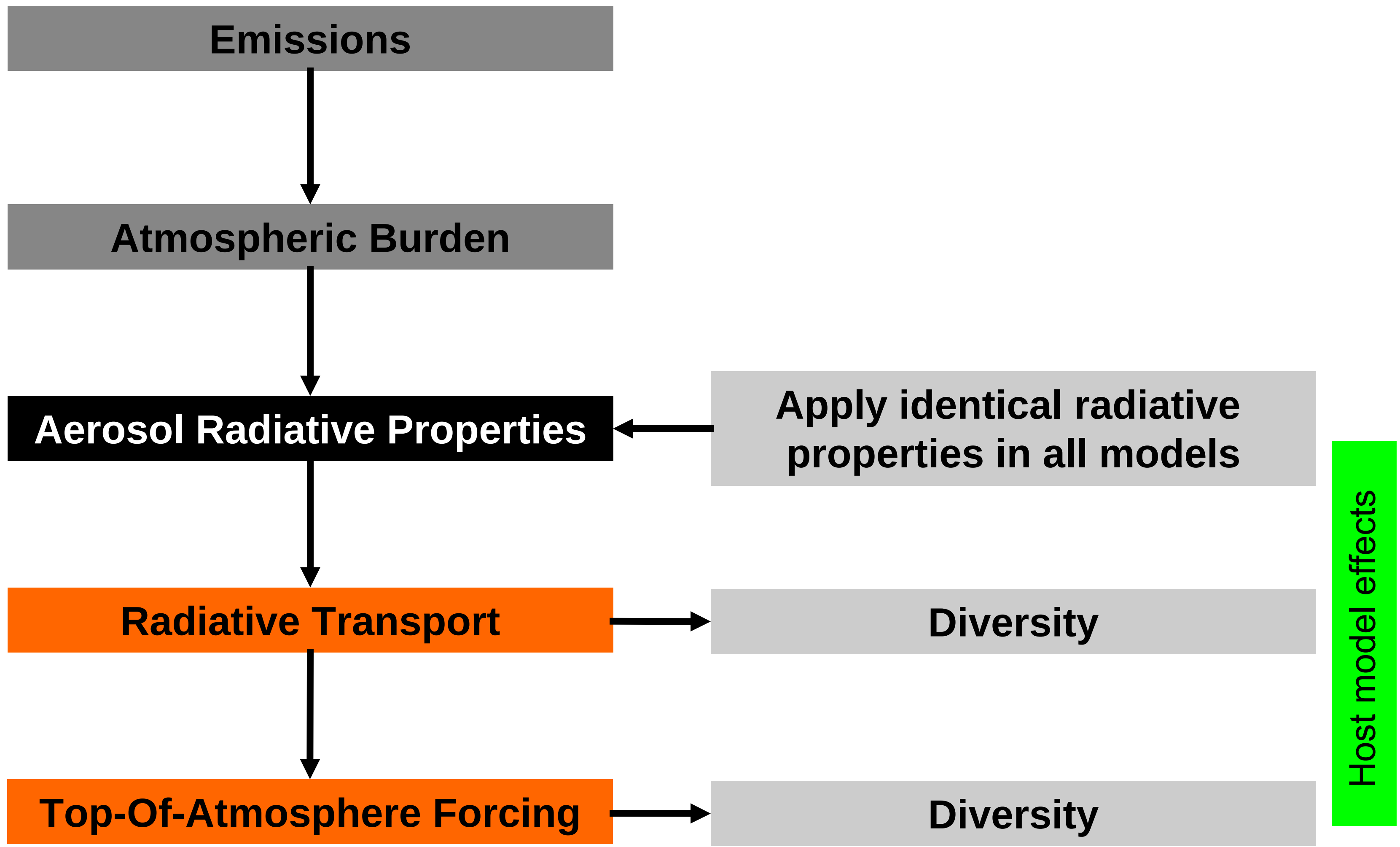


Figure: Annual-mean anthropogenic direct aerosol radiative forcing difference due to usage of upper minus lower bound of surface albedo (Stier et al., ACP, 2007).

Assessment of aerosol direct radiative forcing

AeroCom Prescribed

AeroCom Prescribed : Facilitate inter-comparability through fixing 3D aerosol radiative properties



AeroCom Prescribed - Set-up

Prescribe aerosol radiative properties identically in all models / satellite models:

- Extinction, Single Scattering Albedo, Assymetry Factor:
  - 3D distributions
  - 24 SW wavelengths
  - offline mapping tools to model resolution and radiation bands

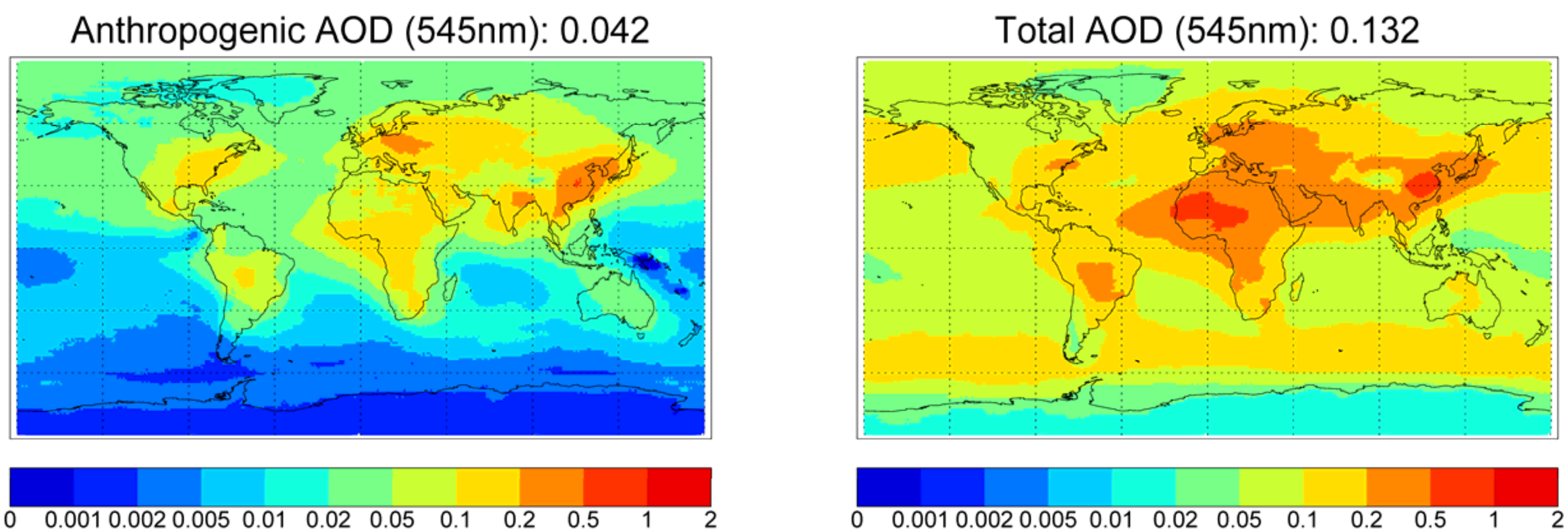


Figure: Annual-mean anthropogenic and total aerosol optical depth at 550 nm derived from AeroCom median model and AERONET.

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AeroCom Prescribed - Diagnostics

Aerosols

- 3D aerosol radiative properties as implemented
- Separate diagnostics for in-cloud and clear-sky radiative properties

Clouds

- 3D fractional cloud cover
- 3D cloud optical depth

Radiation

- AeroCom forcing protocol and additionally:
- Upwelling and downwelling clear-sky and all-sky radiative fluxes at TOA and surface
- Explicit cloudy-sky and clear-sky aerosol radiative properties as applied in the model
- Single column diagnostics at selected locations for benchmarking with reference radiation codes

Host model parameters

- Surface albedo / “effective” surface albedo

More information and discussion

- http://wiki.esipfed.org/index.php/AeroCom_Prescribed

AeroCom Prescribed - First results

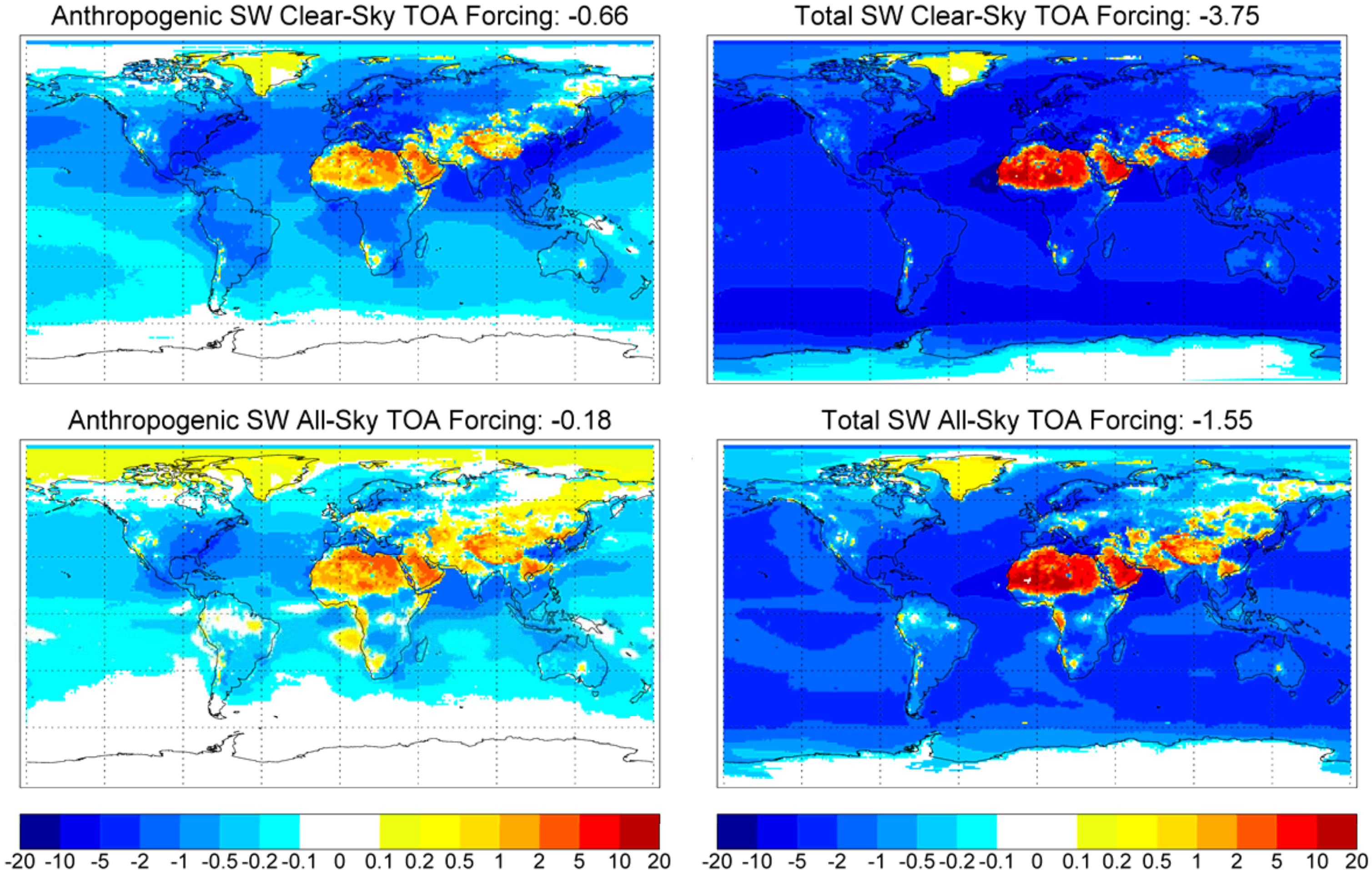

Figure: Annual-mean top-of-atmosphere anthropogenic and total aerosol direct aerosol radiative forcing [Wm^{-2}]. Offline model calculation by Stefan Kinne from the AeroCom Prescribed aerosol radiative properties.

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Discussion

AeroCom Prescribed experiment:

- Set-up / Diagnostics
- Timeframe
- Procedures
- Participation

AeroCom Forcing experiment:

- Re-iteration with updated and new models?
- Diagnostics?
- Additional species?

Additional evaluation data:

- Surface radiation measurements (ETH, Martin Wild)

Other suggestions:

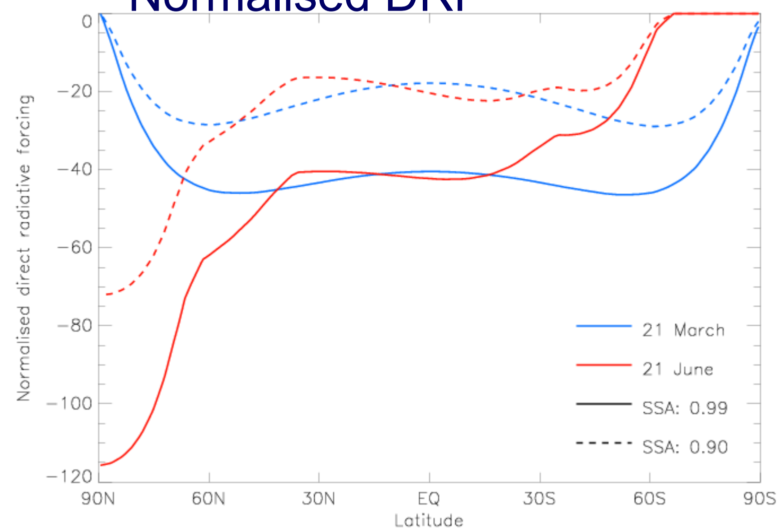
- ?

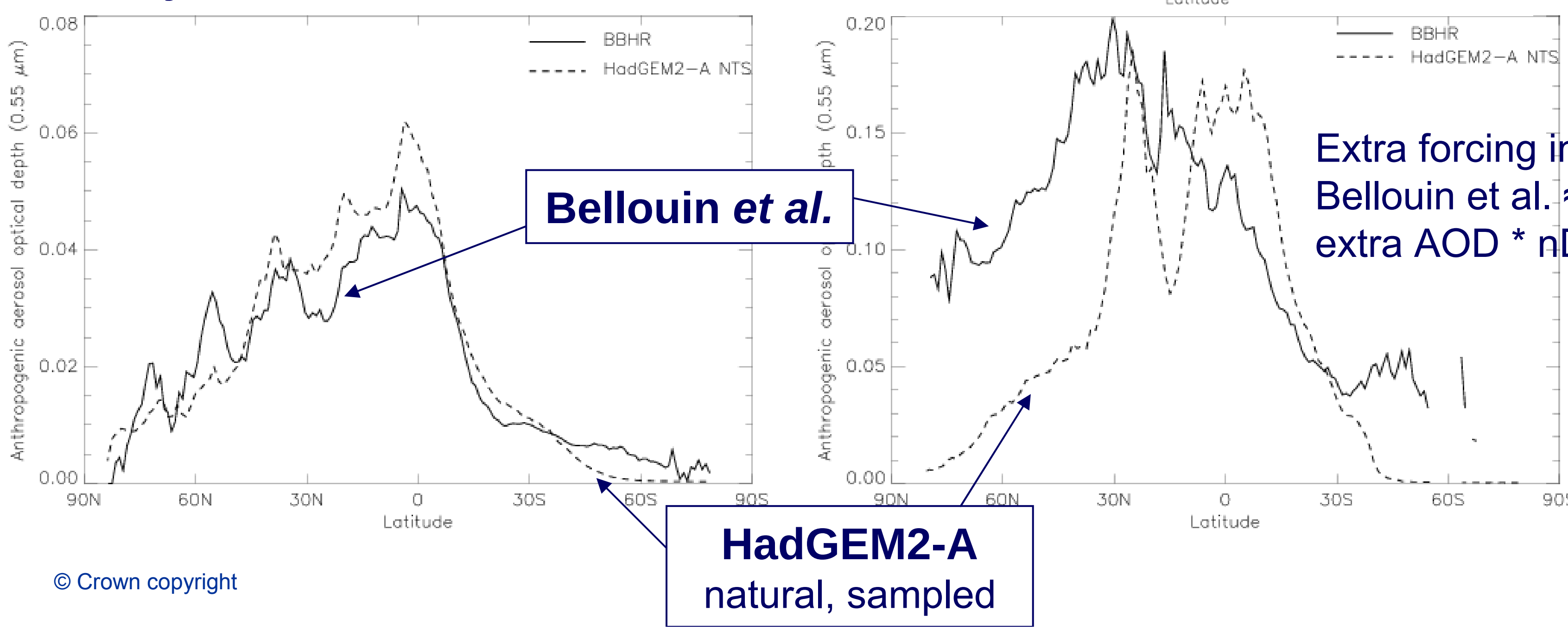
Remaining differences in clear-sky

More efficient at exerting a forcing:
- **Mid-latitude aerosols**
- **Scattering aerosols**

Aerosol location in Bellouin *et al*. and HadGEM2-A
- **Ocean: very similar**
- **Land: BBHR has much more aerosols where they are more efficient**

Normalised DRF





Extra forcing in Bellouin et al. ≈ extra AOD * nDRF

Assessment of aerosol direct radiative forcing

Myhre et al. investigated forcing of secondary species **nitrate** and SOAs:

Larger range than for most other aerosol components

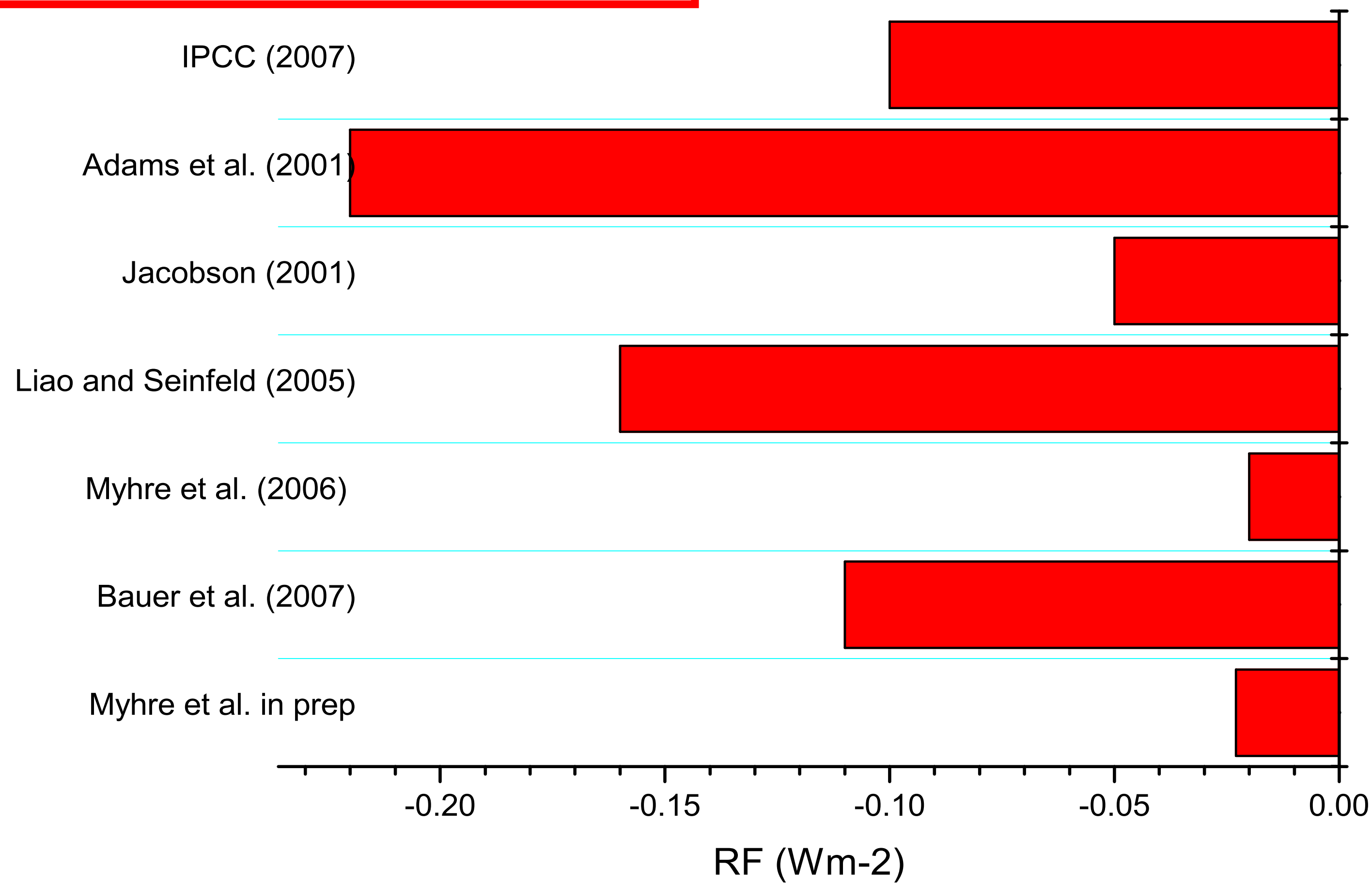


Figure: Comparison of TOA nitrate radiative forcing estimates

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Assessment of aerosol direct radiative forcing

Myhre et al. investigated forcing of secondary species nitrate and **SOAs**:

- ✓ Secondary organic aerosols (SOA) were treated simplified in Schulz et al. (2006) and only included as a natural component
- ✓ SOA is also important for the biomass burning aerosols

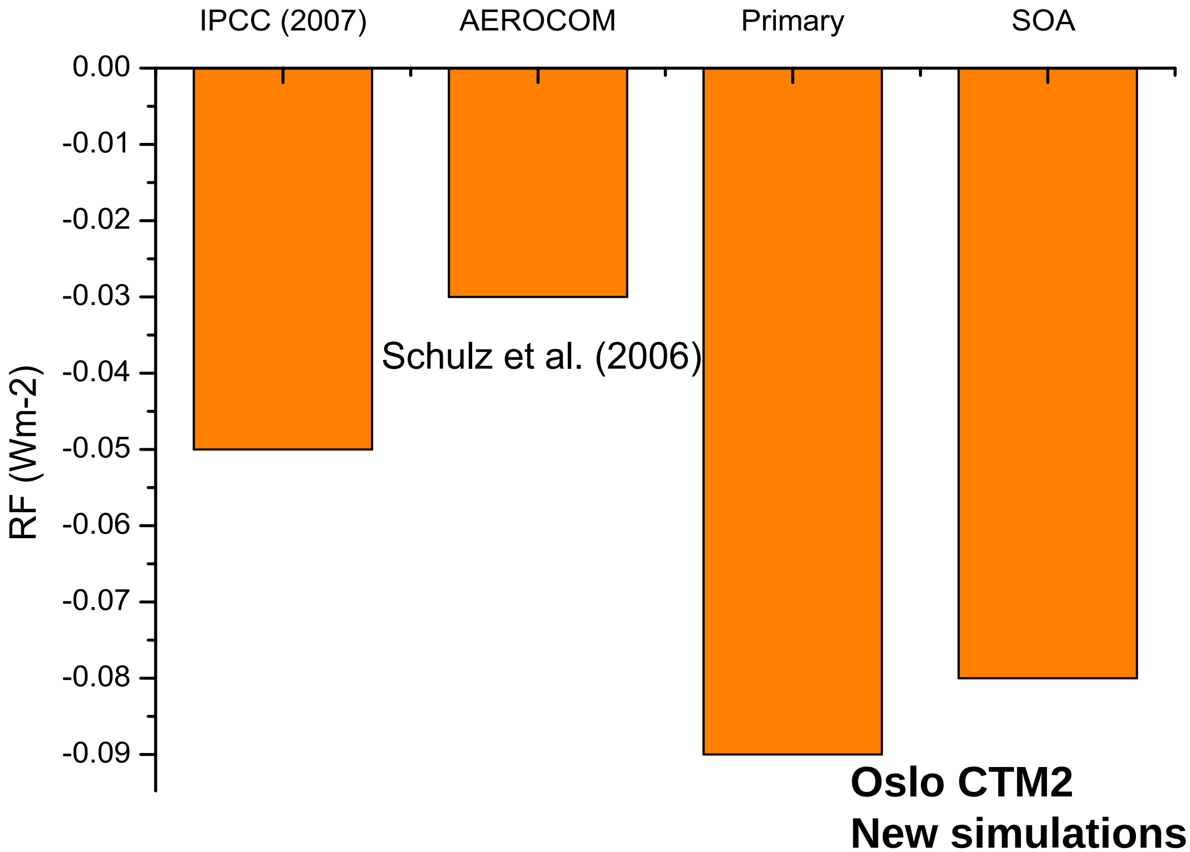

Figure: Comparison of secondary organic TOA radiative forcing estimates

Progress