The AeroCom multi-model perturbed physics ensemble (MMPPE)

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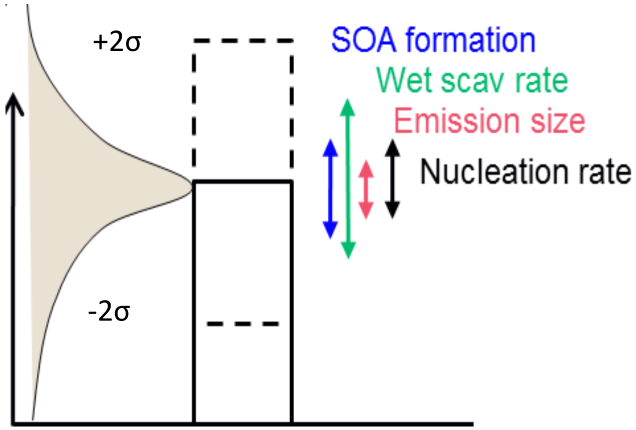
N8 Research Partnership | High Performance Computing

Identifying causes of uncertainty



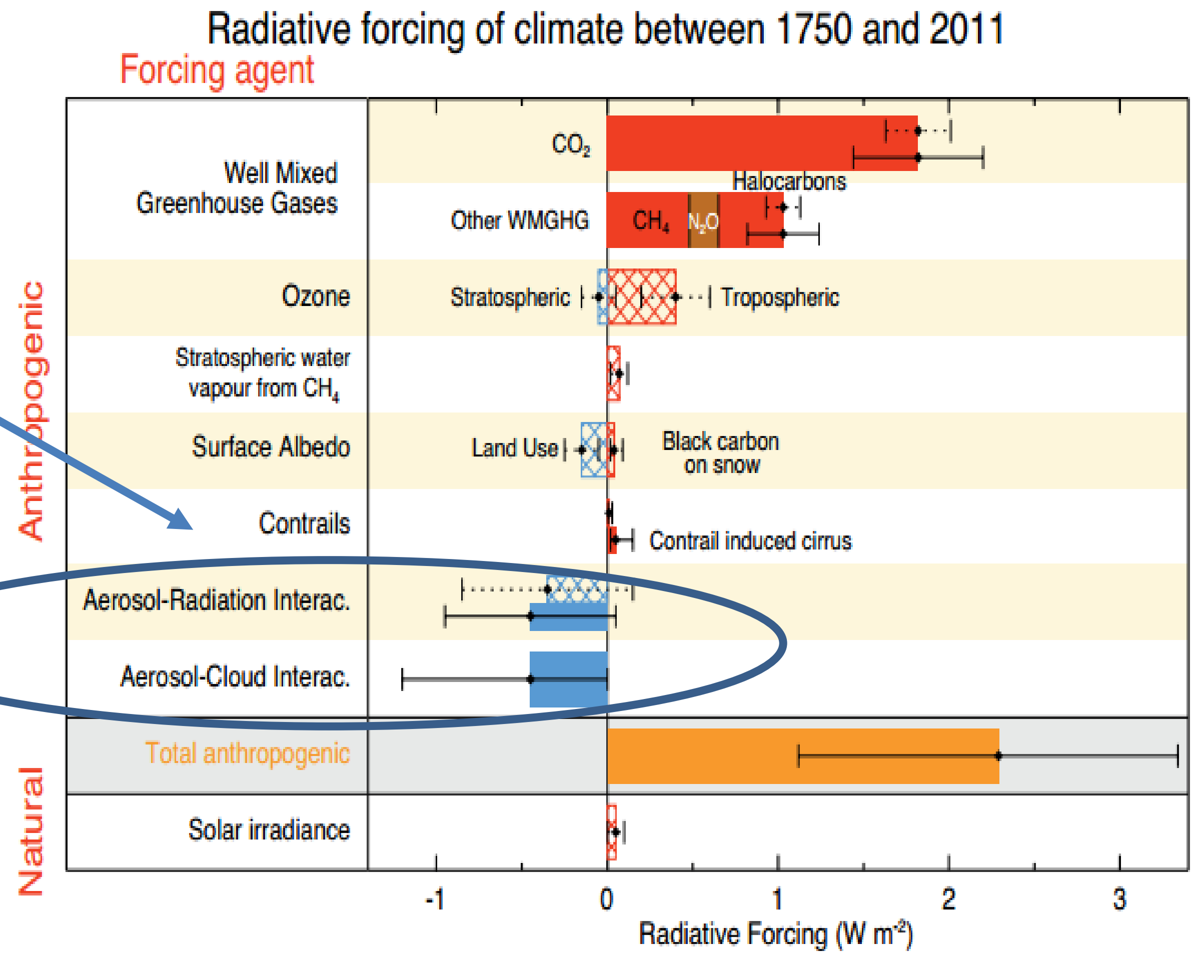


Figure 8.15 | Bar chart for RF (hatched) and ERF (solid) for the period 1750–2011, where the total ERF is derived from Figure 8.16. Uncertainties (5 to 95% confidence range) are given for RF (dotted lines) and ERF (solid lines).

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The approach, following ACP 2011

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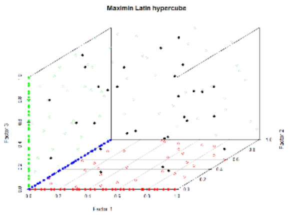
Define key model outputs

↓

Expert elicitation of parameter uncertainties

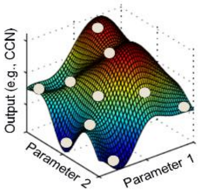
↓

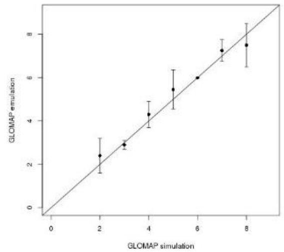
Design sample of parametric combinations for emulation



→ Run global aerosol model

→ Build and validate emulators of the key model outputs





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Sample from emulator for variance-based sensitivity analysis

↓

Observationally constrain the key model outputs

Extending to MMPPE

- Require consistency in perturbations
  - Without consistency in process representation

Begin with two 3-parameter MMPPEs:

Direct radiative effect
and
Aerosol-cloud interaction

Multi-model experiments

- Time period
  - 2008 and some pre-industrial year
- Simulations
  - 39 simulations + AeroCom baseline

To be consistent between models

- Emissions
  - Current emissions
- Nudging
  - Nudging such that radiation effects can be determined
- Chemistry
  - Offline but not CTM

Model dependent

The black carbon experiment

Direct radiative forcing
+0.71 [+0.08,+1.27]

Atmospheric BC burden

1. Aerosol number

Scale BC number flux, at emission, with fixed radius

[X*0.5, X*2]

2. Wet deposition

Scale removal tendencies

[X*0.3, X*3]

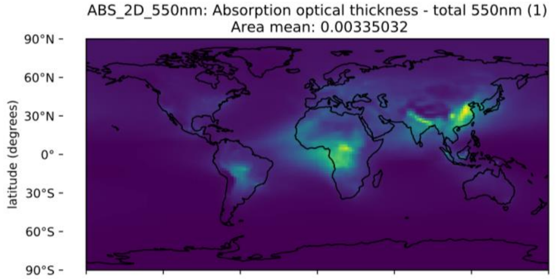
Radiative properties

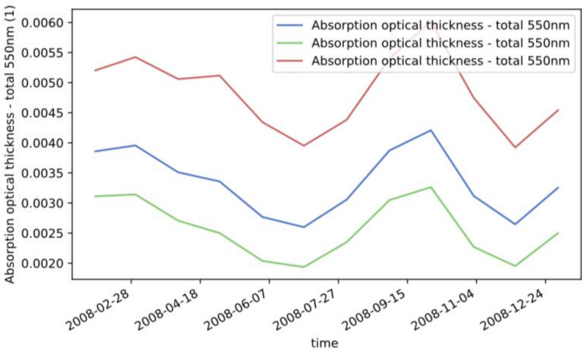
3. Radiative properties

Scale imaginary part of refractive index

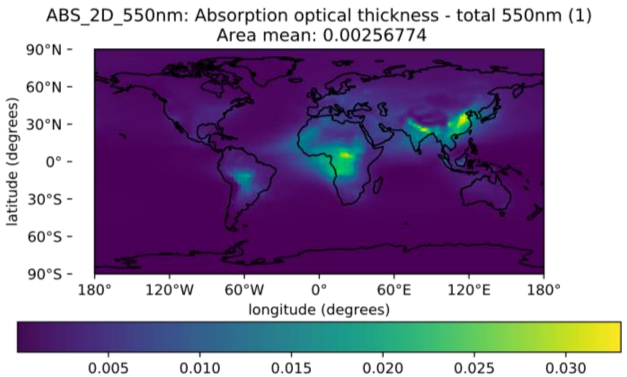
[0.2, 0.8]

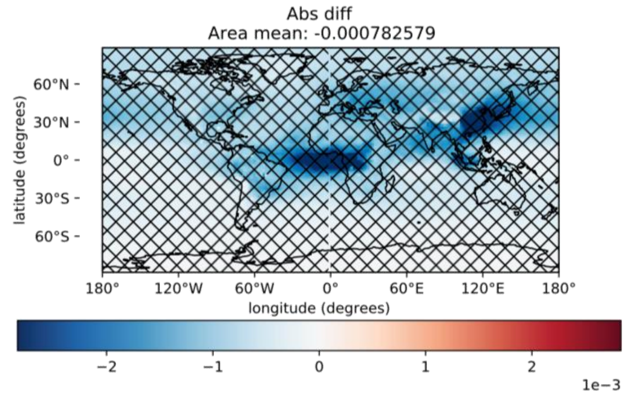
Initial sensitivity runs



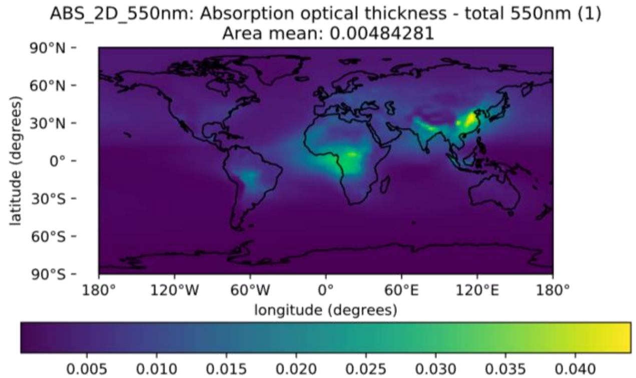


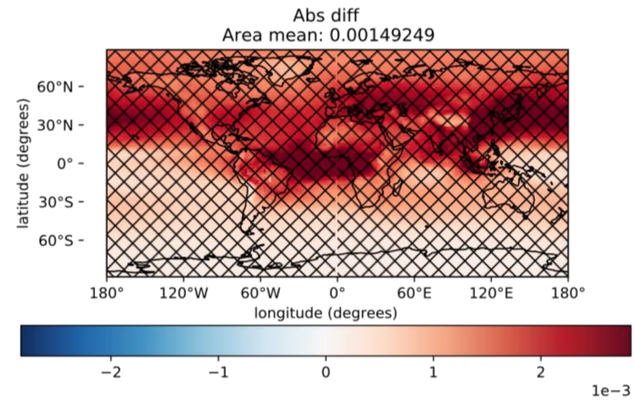
High Wet dep.





Low Wet dep.





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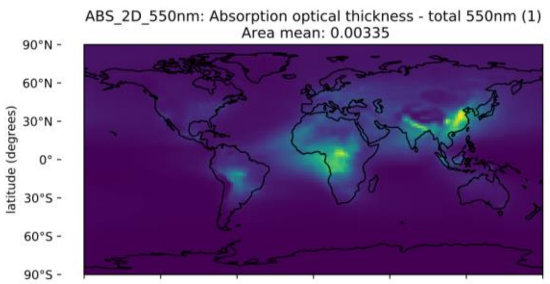
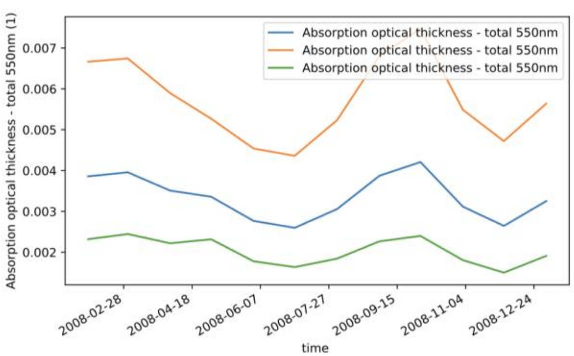
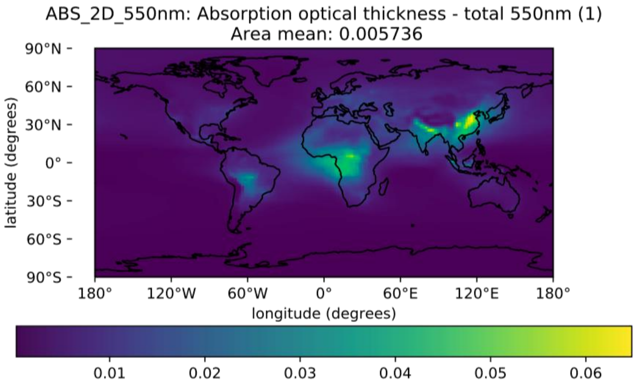
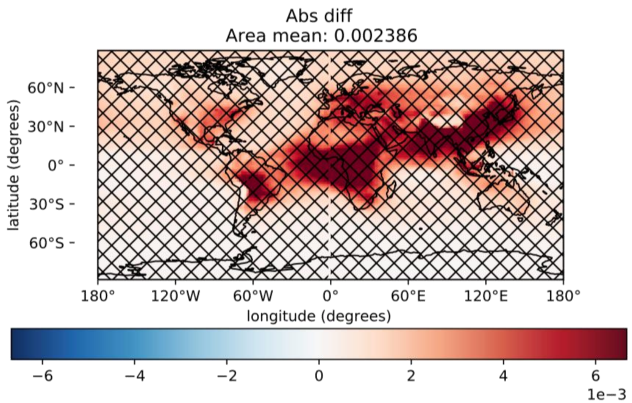
Initial sensitivity runs



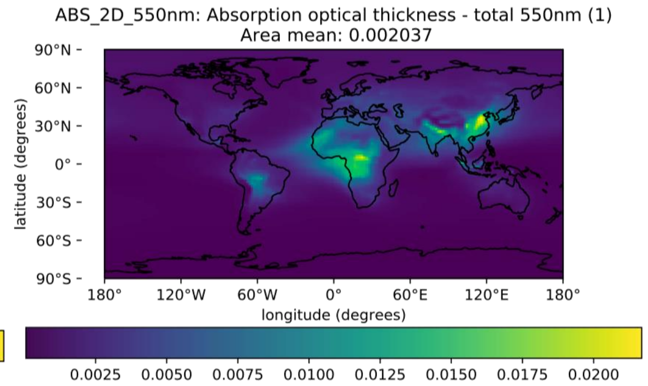


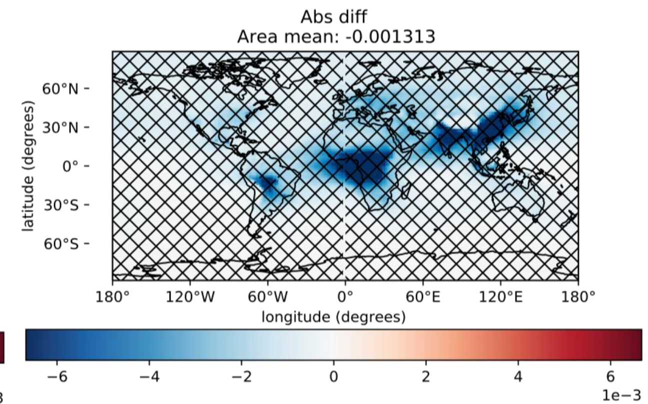
High BC n_i



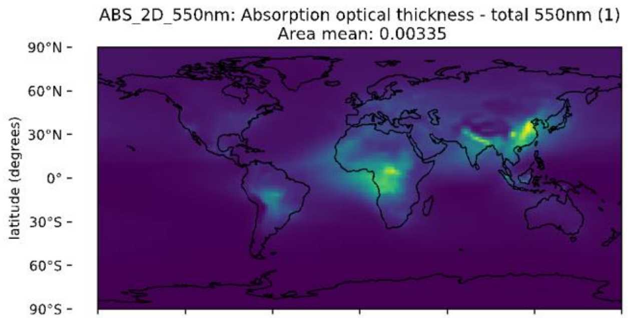


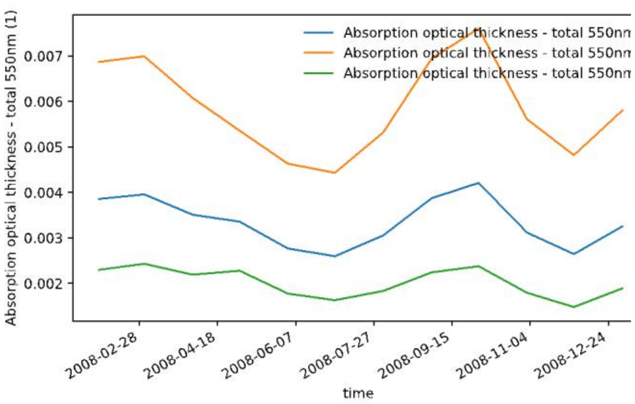
Low BC n_i



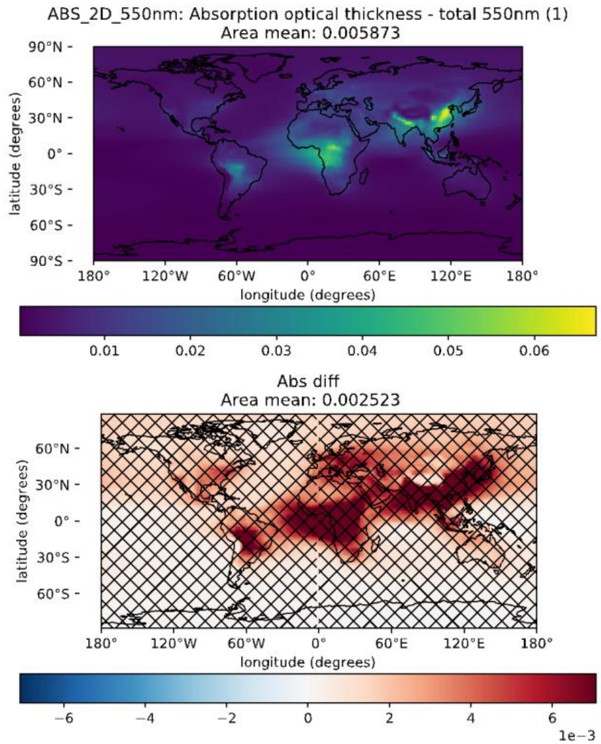


Initial sensitivity runs

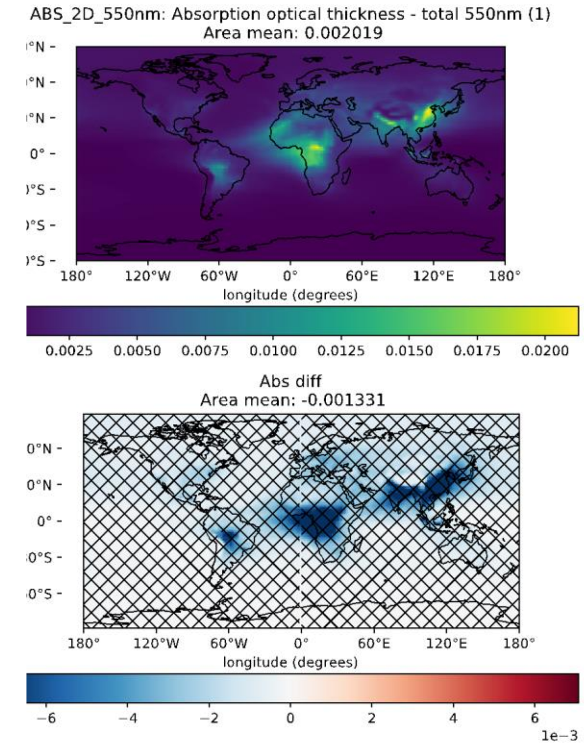




High BC emissions



Low BC emissions



The cloud experiment

Aerosol-cloud interaction
- the largest historical forcing

Atmospheric aerosol → CCN	Aerosol → droplets	Loss via precipitation
1. CCN Scale DMS number flux [X*0.5, X*2]	2. Activation Scale updraft velocities in participating scheme [X*0.2, X*5]	3. Autoconversion Change exponent in autoconversion scheme KK: [-2, -1]

Diagnostics

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6. Diagnostics

Global, 3d field, monthly
N50, N3, PM2.5, BC
Global, 2d field, monthly
AOD (550nm), TOA fluxes, BC dry deposition flux, BC wet deposition flux, Emission fluxes, BC burden
3hr Station
BC, AOD (440 and 870nm), AAOD
To be defined
Aerosol mass, Aerosol number, Size distribution, Drop size, CDNC, CCN, LWP, Cloud mass, Cloud fraction, Surface fluxes, Rain and snow fluxes, others...

- **Compare model to observations**
- **Compare models to each other**

Selected references

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