Aerosols Absorption & Radiative Forcing

AeroCom Workshop
Virginia Beach

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California Institute of Technology

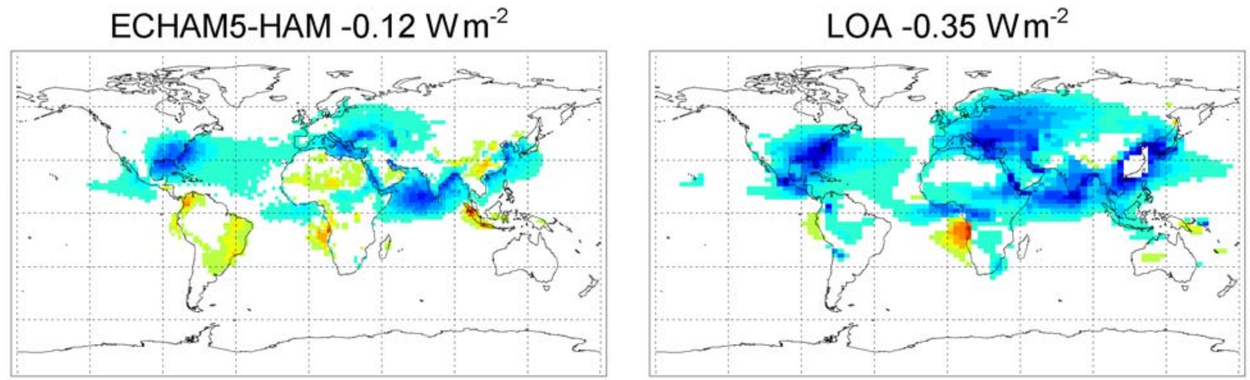
Motivation – Understanding Direct Aerosol Radiative Forcing

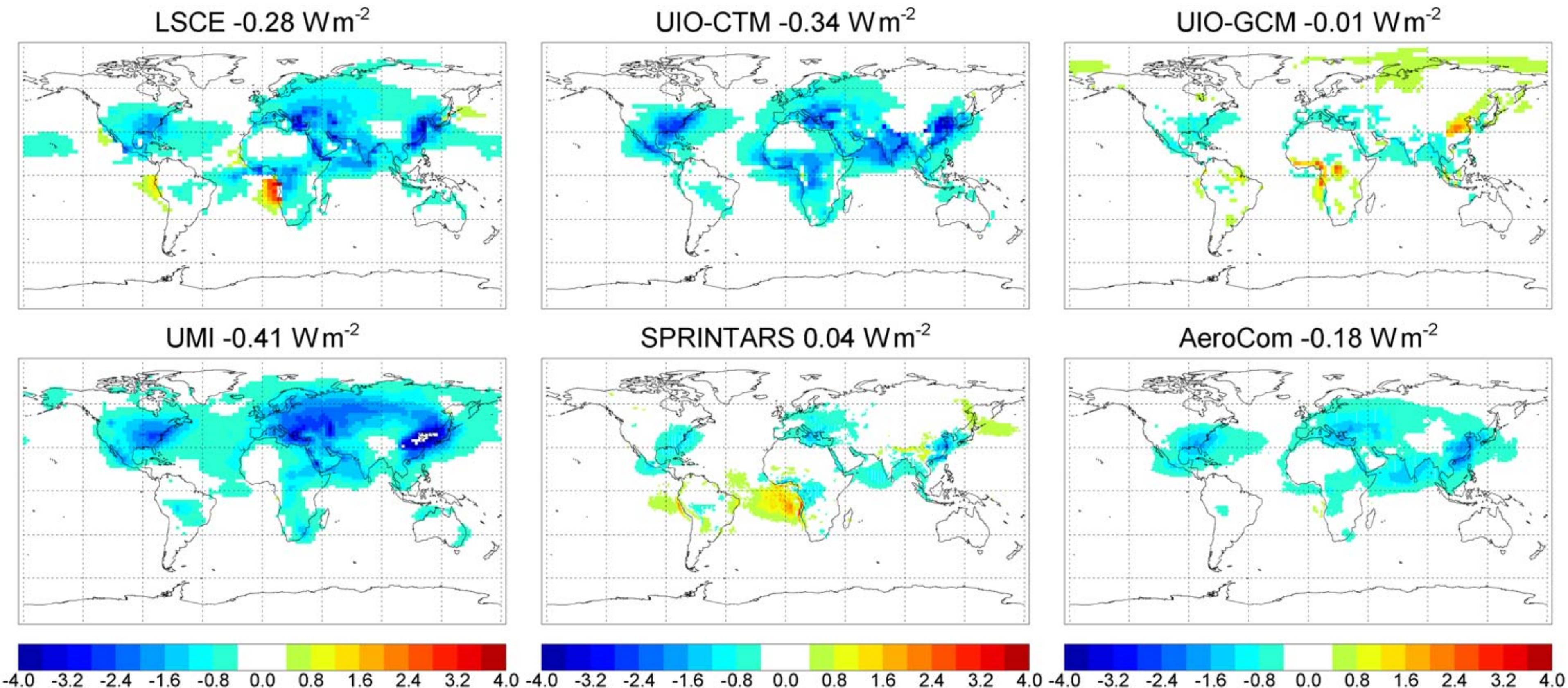
Annual-Mean

Top-Of-Atmosphere Total-Sky Anthropogenic

Direct Aerosol

Radiative Forcing

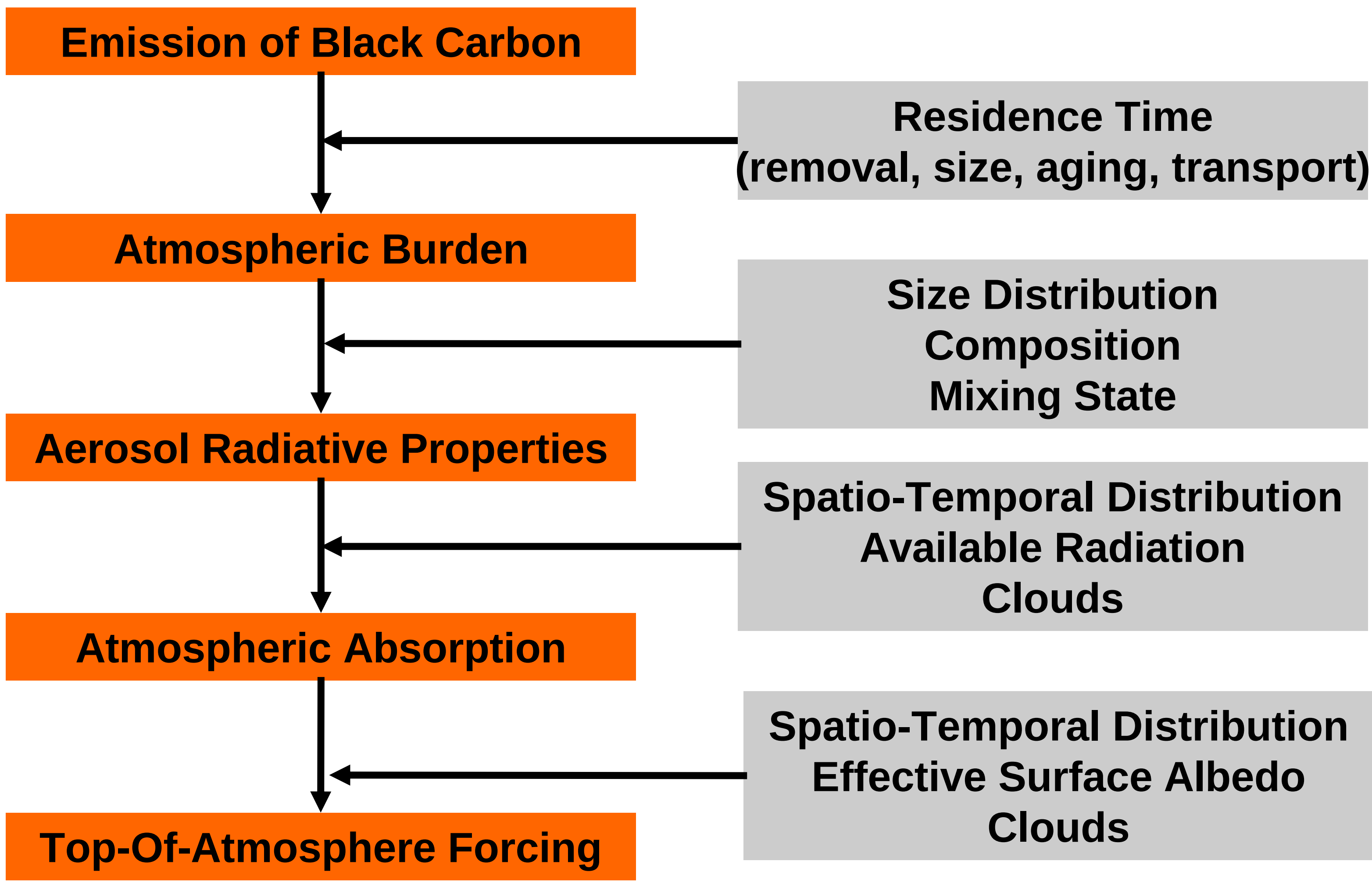




Objective

Positive contribution of absorption to Direct Aerosol Radiative Forcing

Increase understanding of link(s) between emissions and forcing



Method

Break down problem in individual steps

Traditionally:

Emission of Black Carbon

↓

Atmospheric Burden

Correlation for AeroCom Models:

$r \cong 0.29$

↓

Atmospheric Absorption

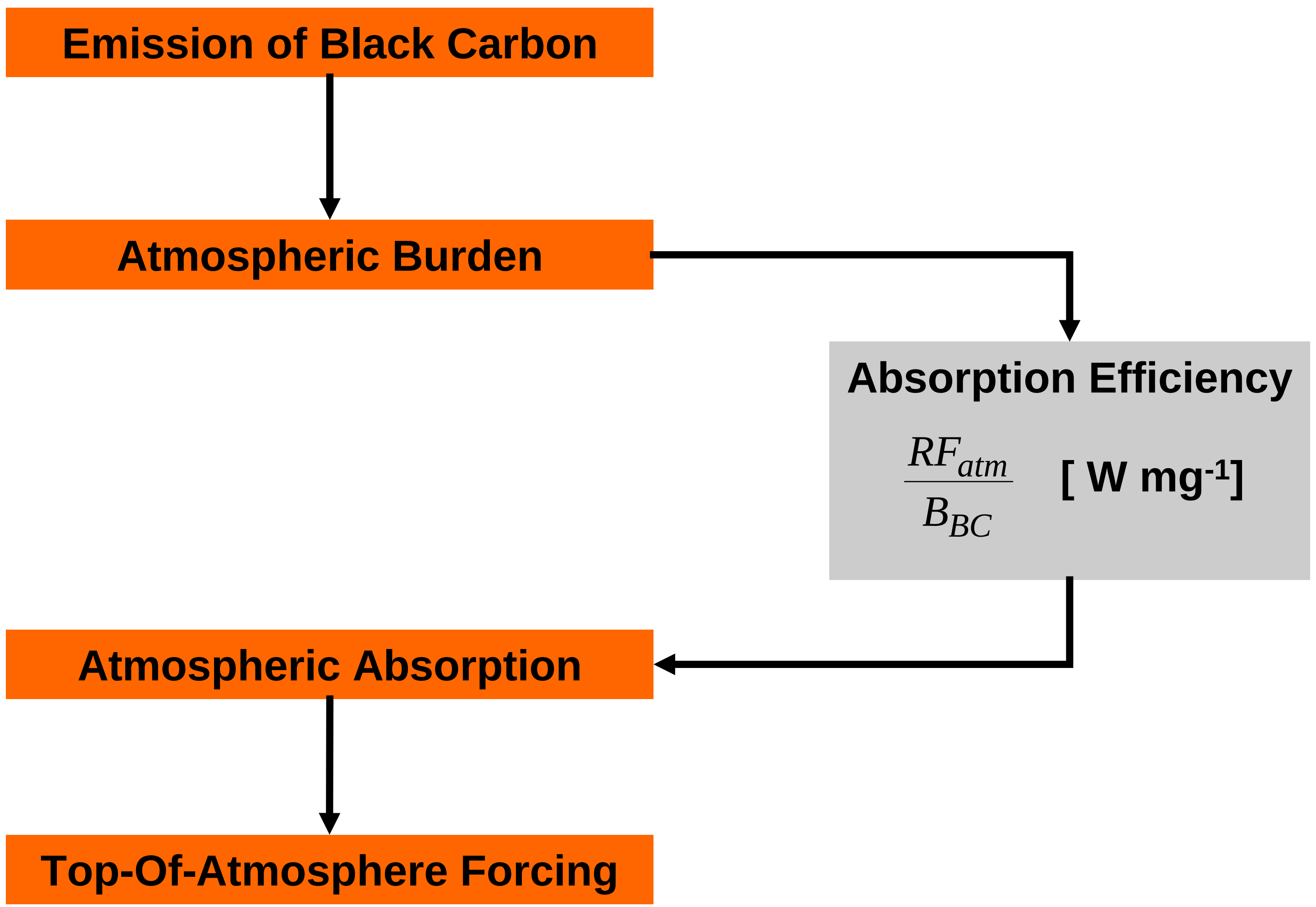
↓

Top-Of-Atmosphere Forcing

Method

Break down problem in individual steps

Traditionally:

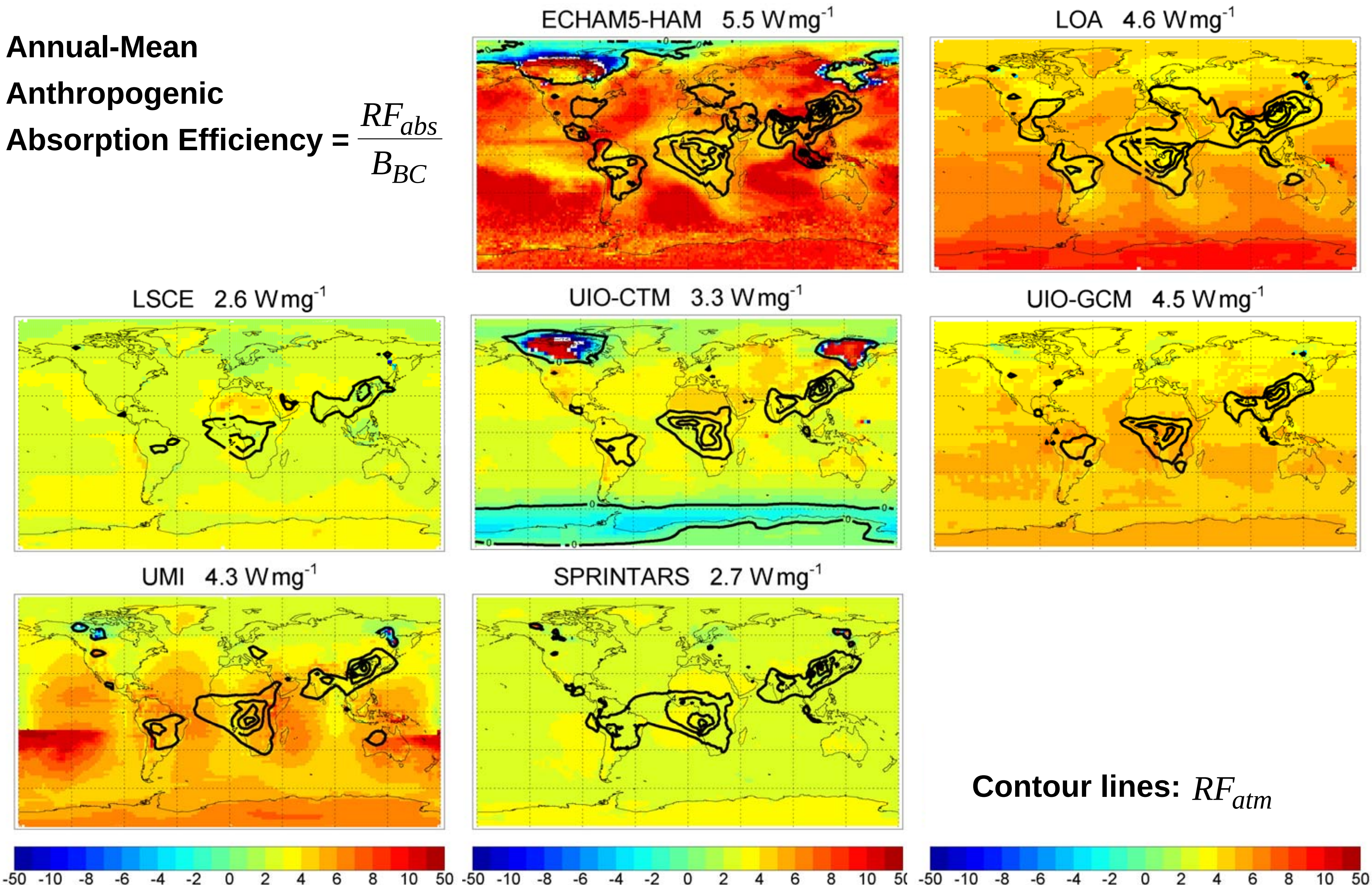


Aerosol Absorption Efficiency by Mass

Annual-Mean

Anthropogenic

Absorption Efficiency = $\dfrac{RF_{abs}}{B_{BC}}$

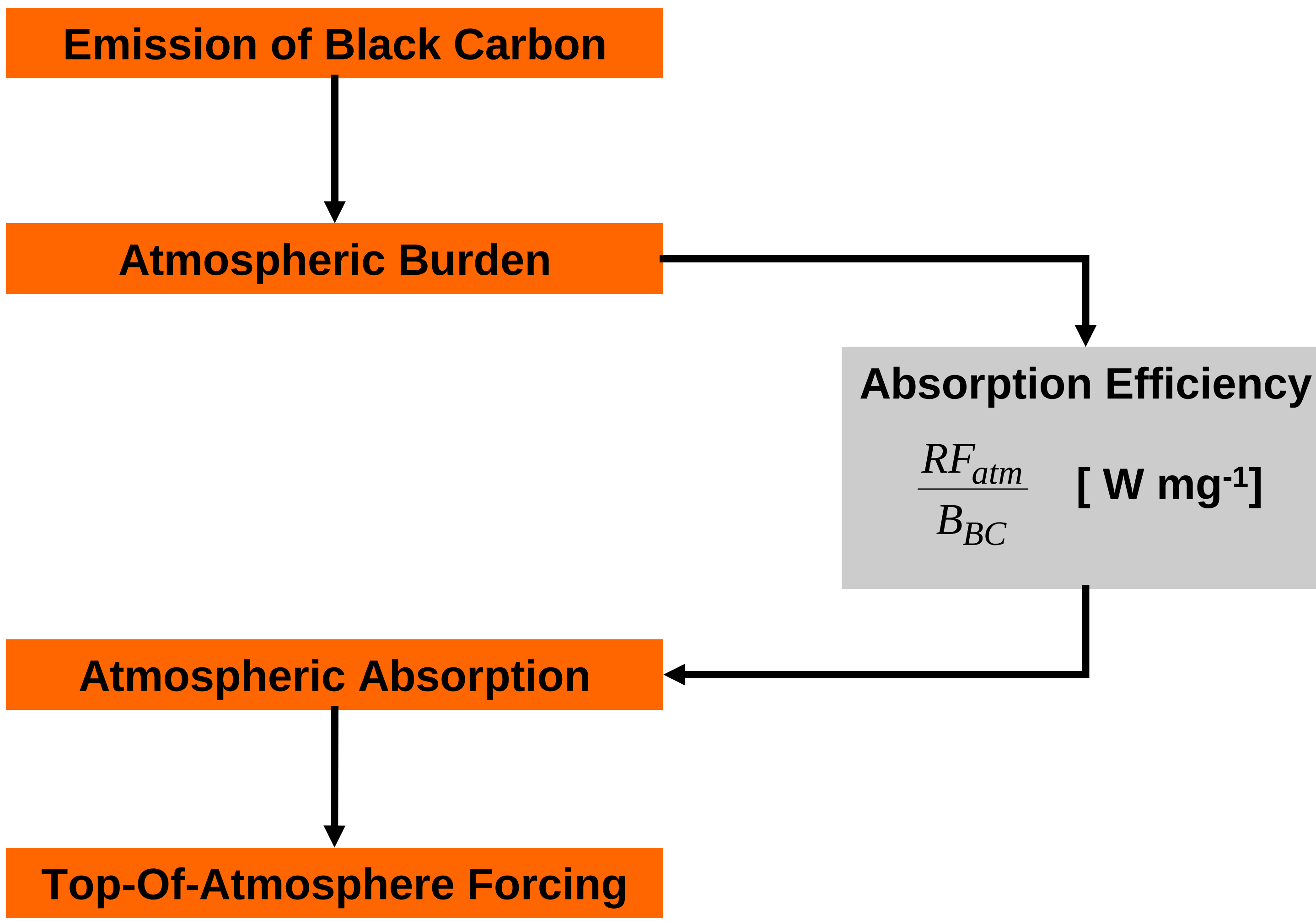


Contour lines: RF_{atm}

Method

Break down problem in individual steps

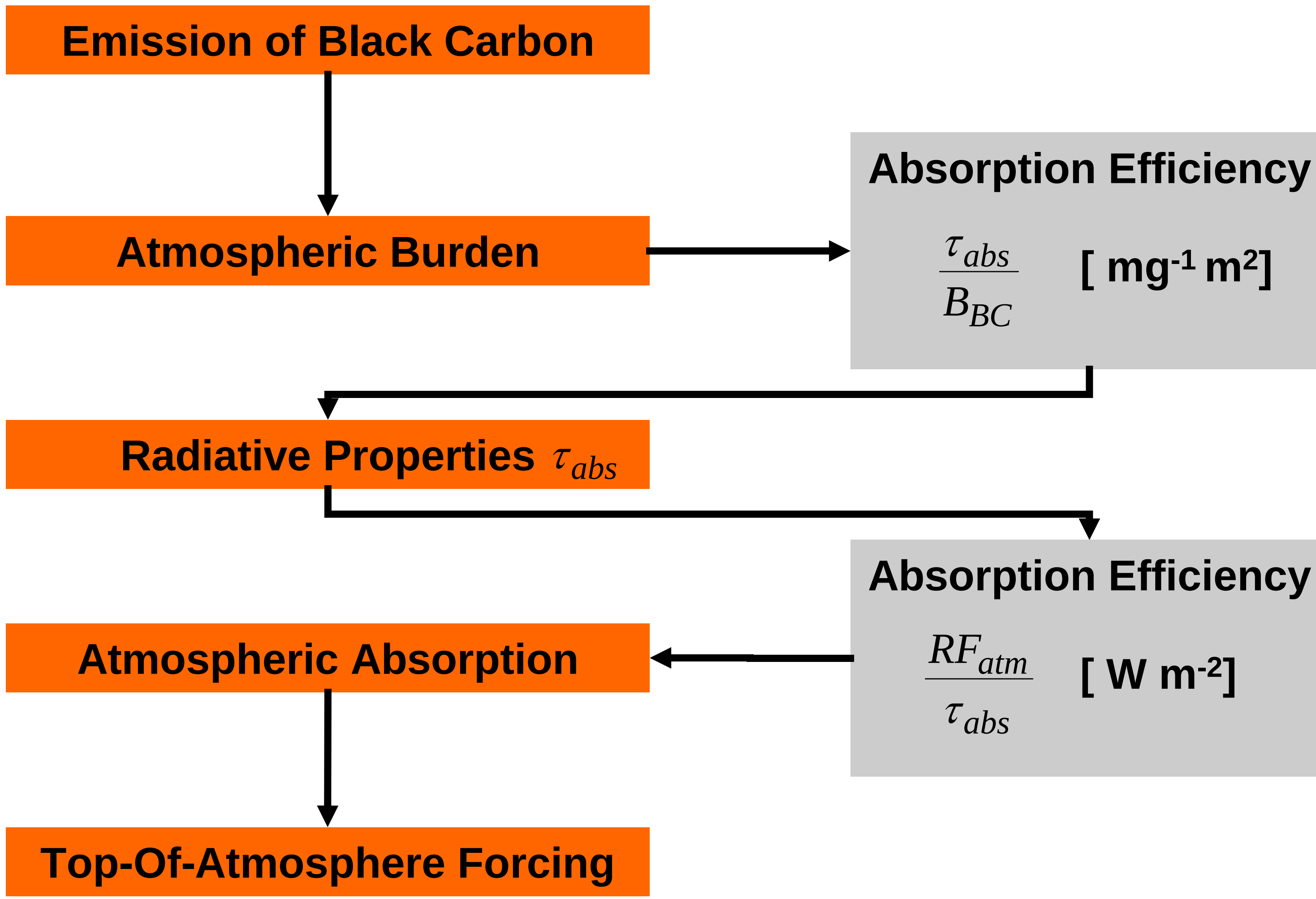
Traditionally:



Method

Break down problem in MORE individual steps

Establish physical connection – allows direct evaluation

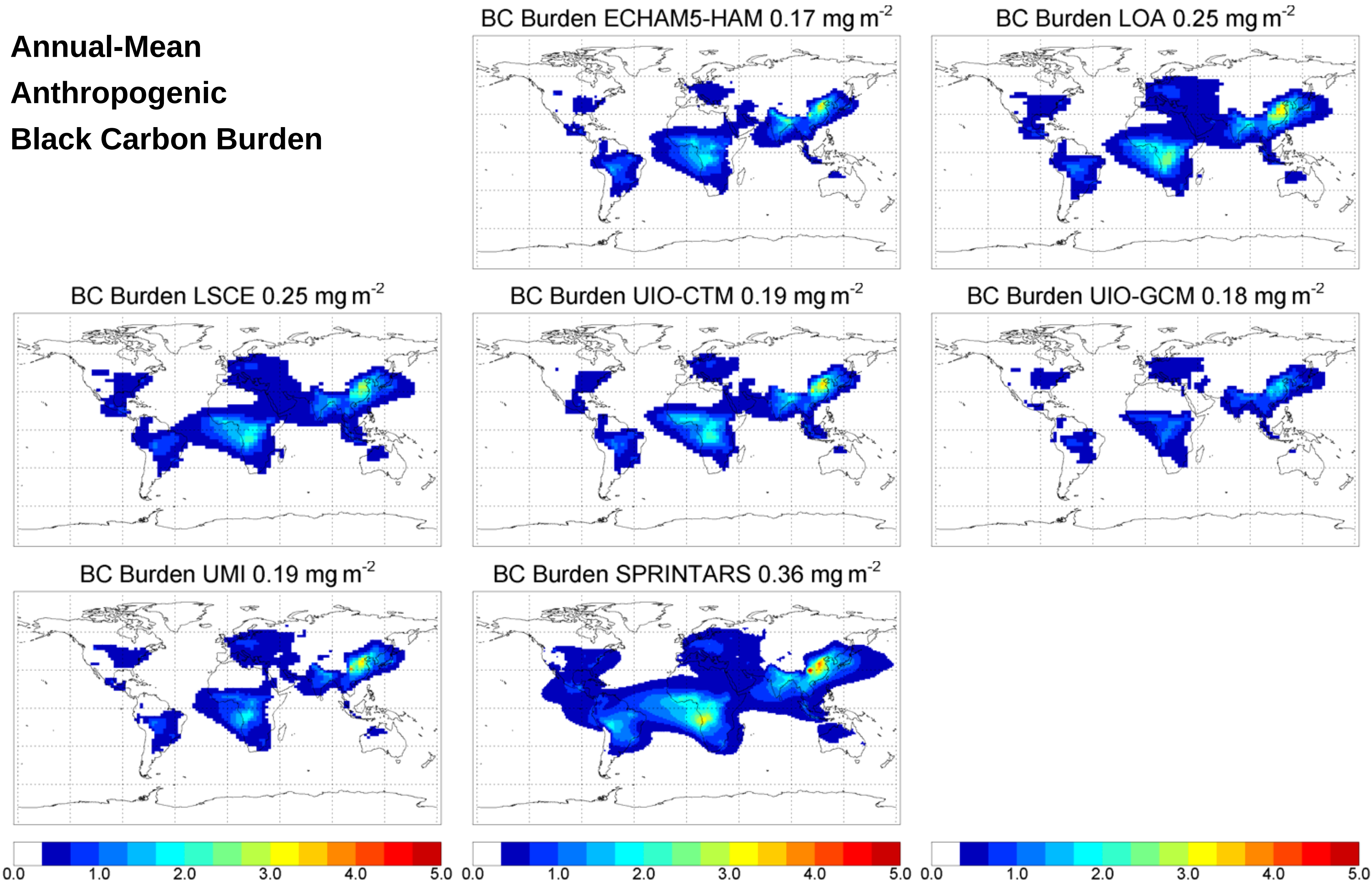


Black Carbon Burden

Annual-Mean

Anthropogenic

Black Carbon Burden



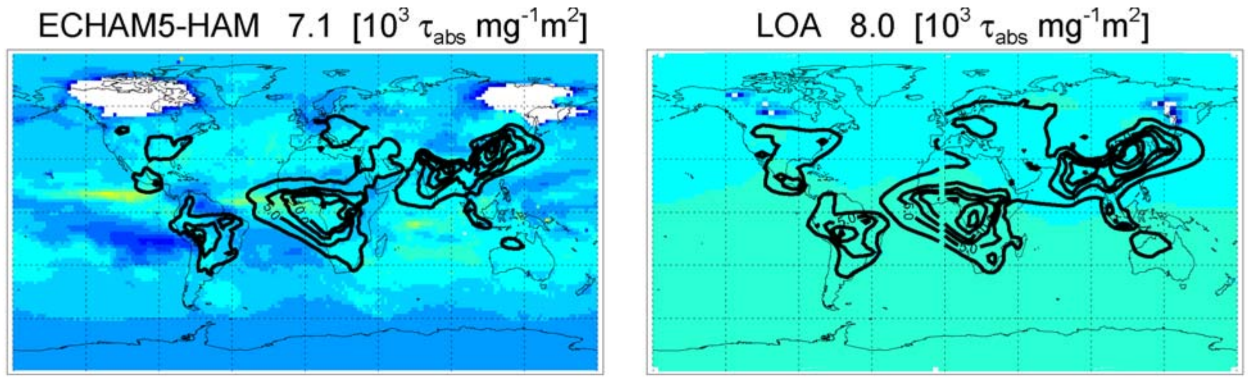
Aerosol Absorption Efficiency

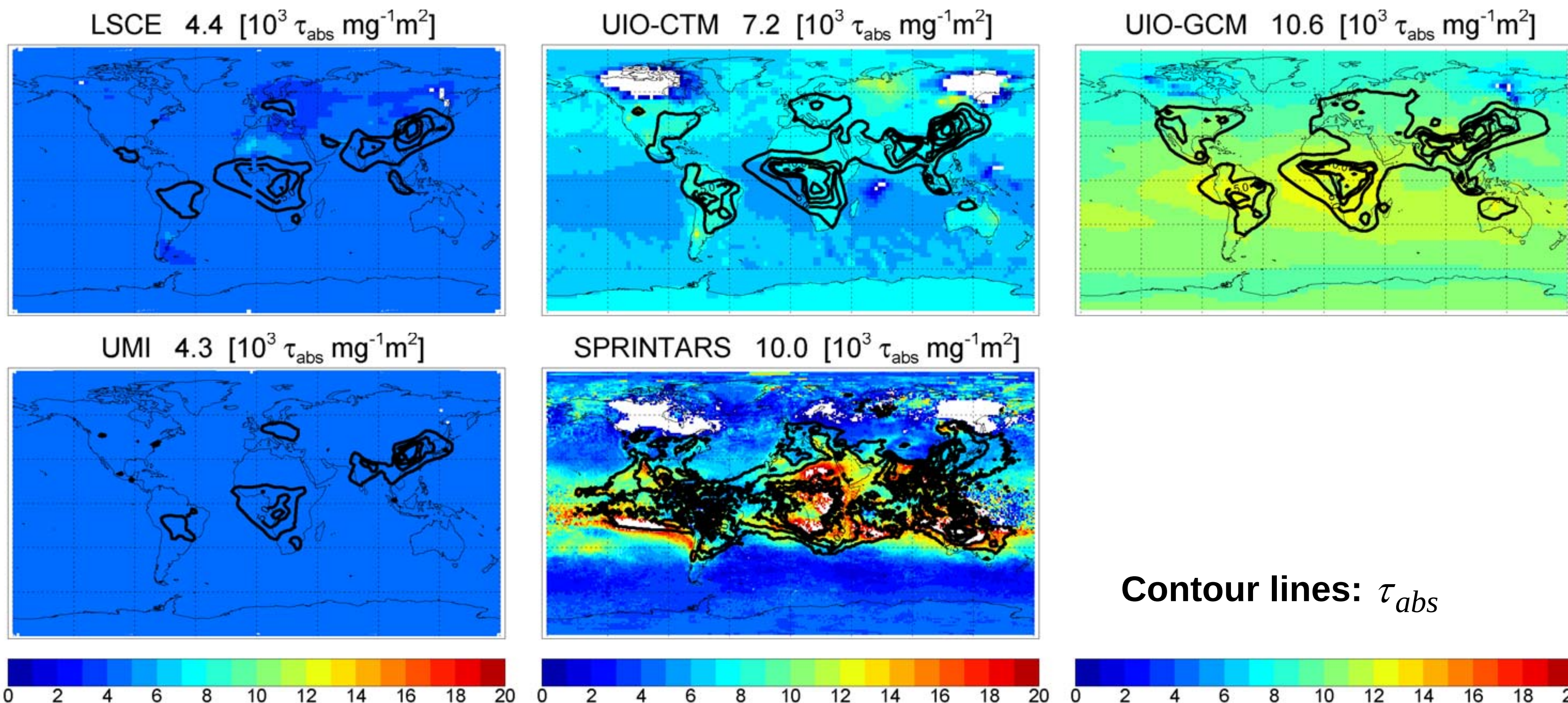
Annual-Mean

Anthropogenic

Absorption Efficiency = $\frac{\tau_{abs}}{B_{BC}}$

(τ_{abs}) at at λ=550 nm





Contour lines: τ_{abs}

Aerosol Absorption Optical Depth

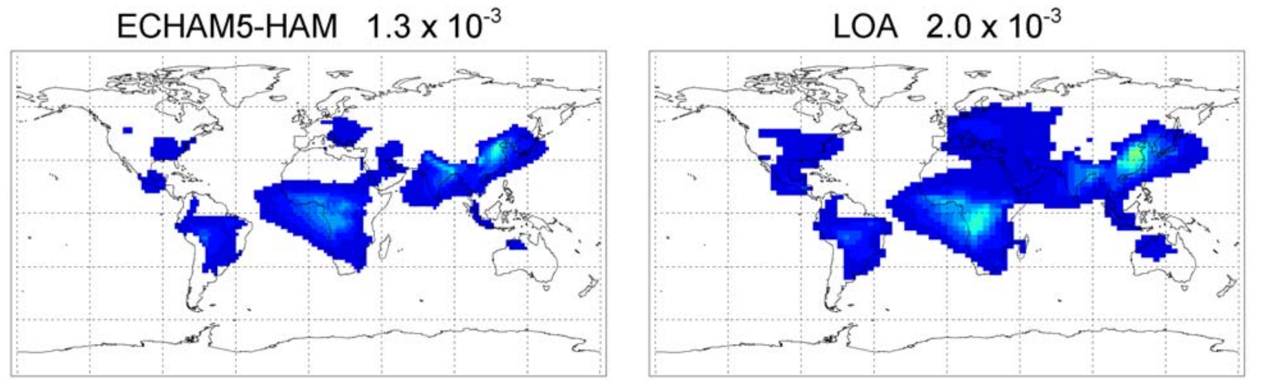
Annual-Mean

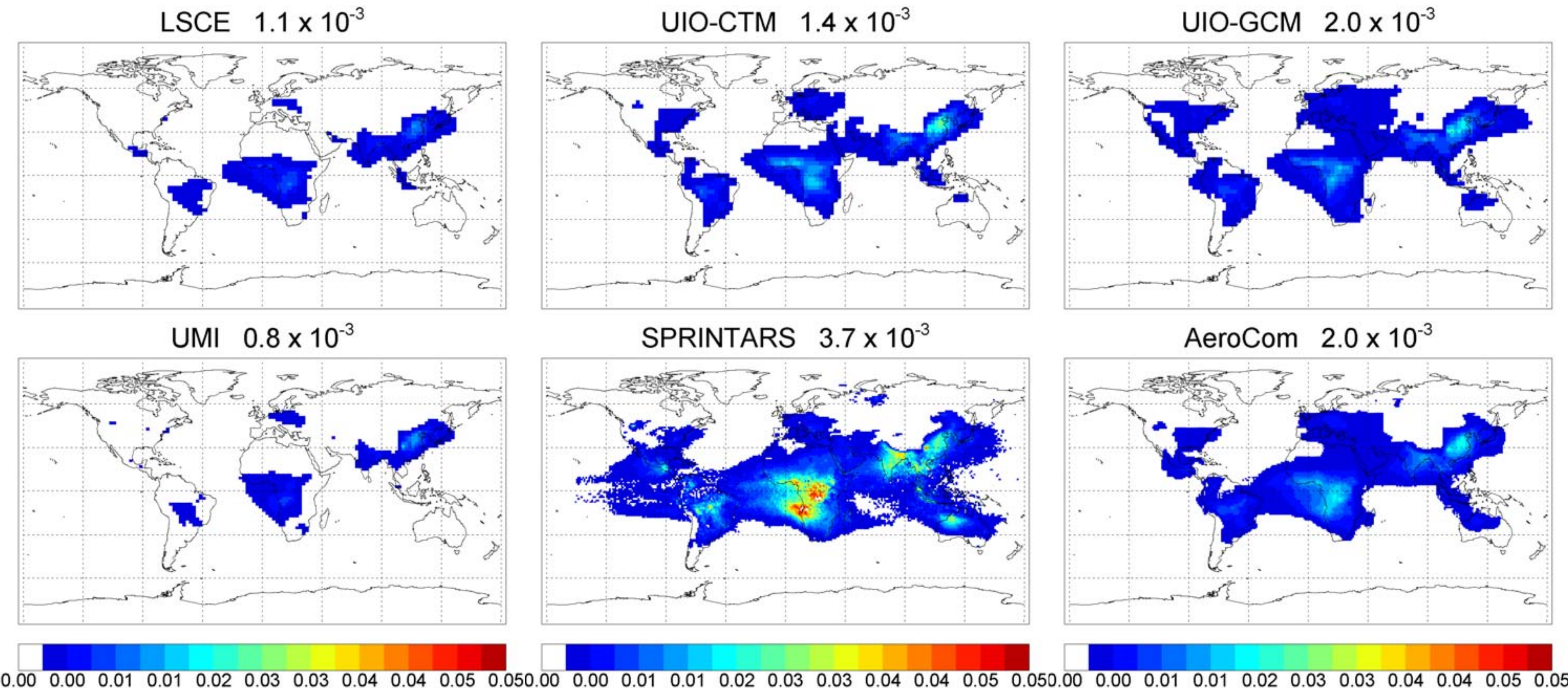
Anthropogenic

Absorption Optical Depth

at λ=550 nm

[x10^3]





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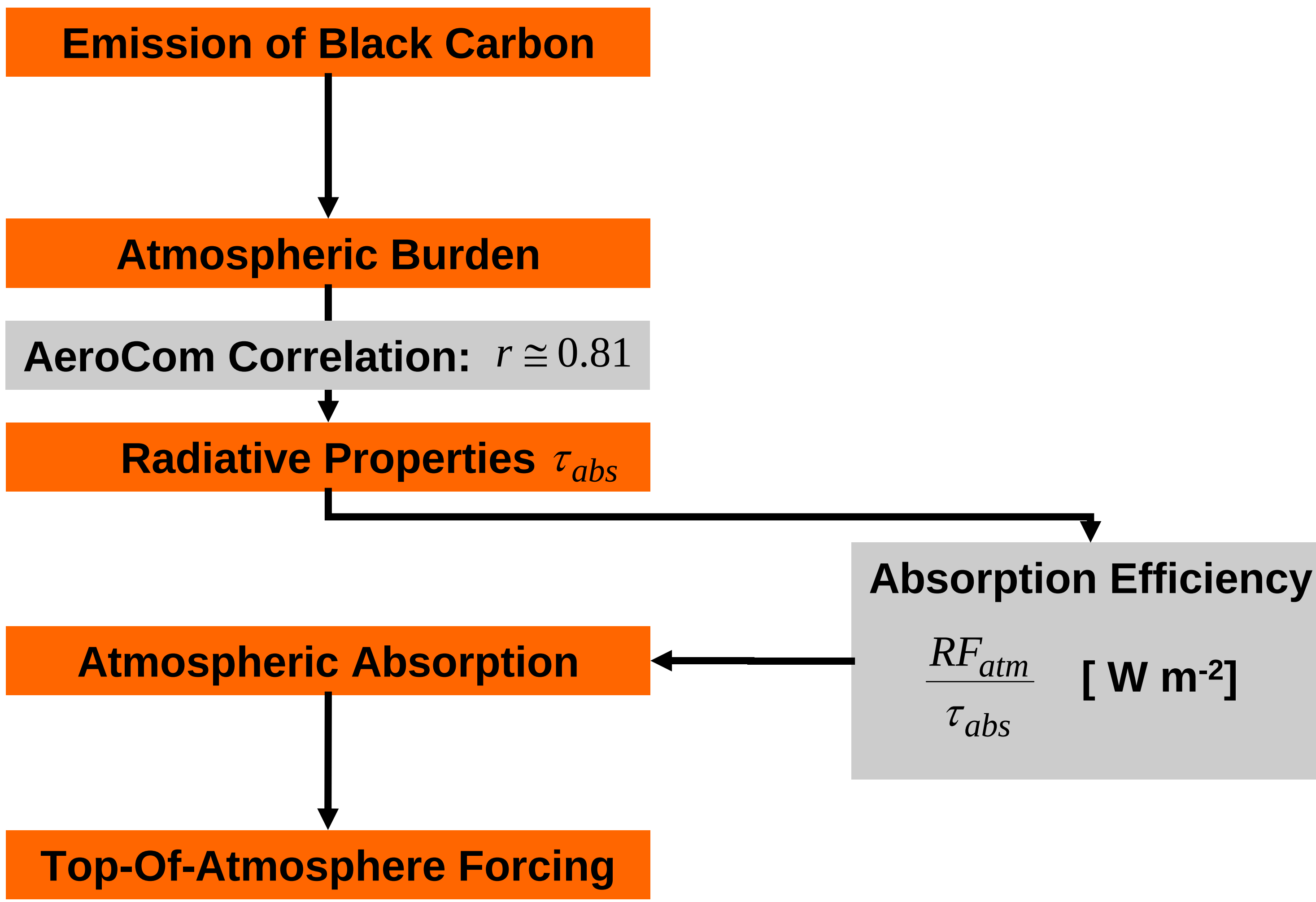


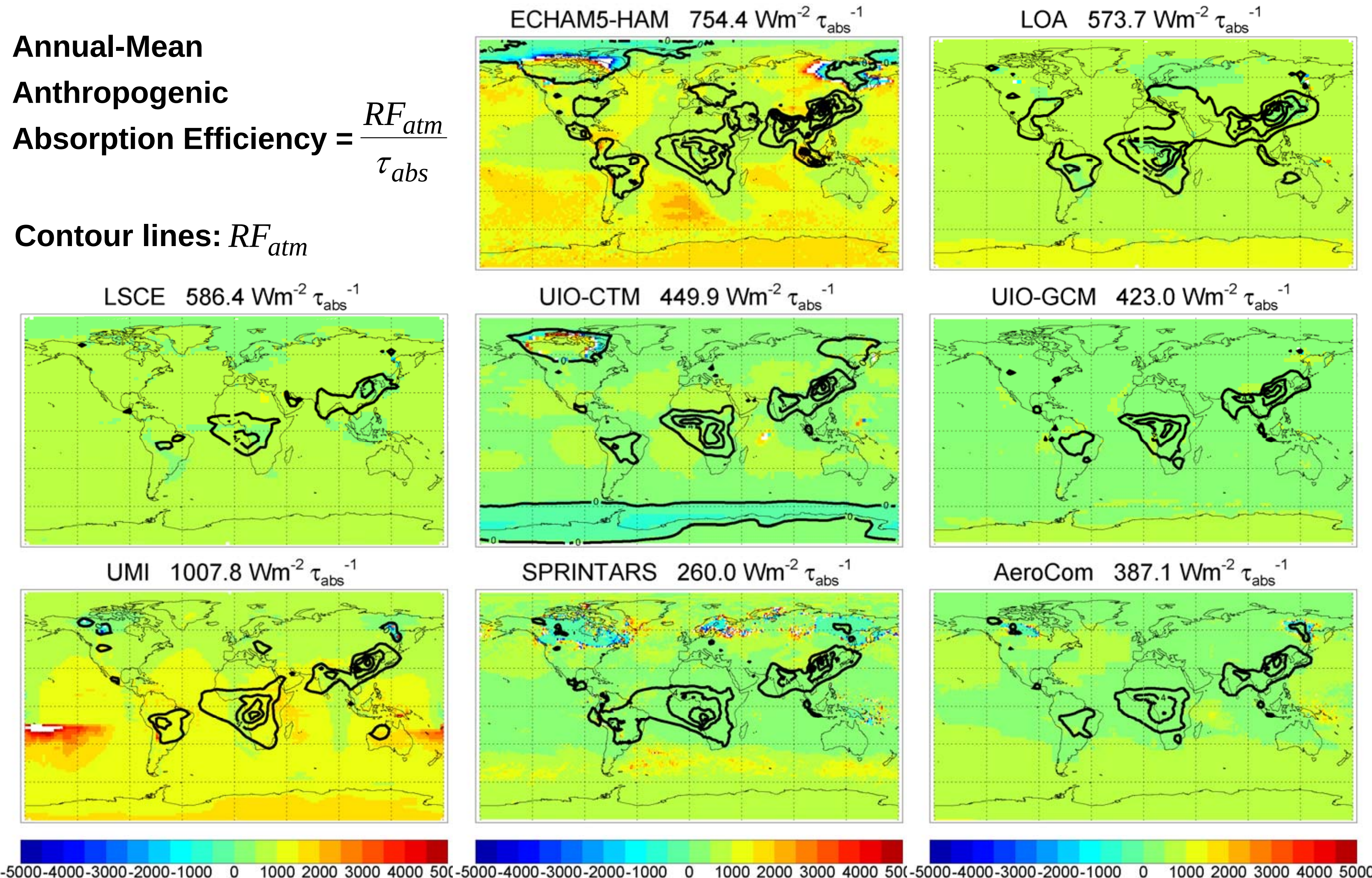
Aerosol Absorption Efficiency

Annual-Mean

Anthropogenic

Absorption Efficiency = $\frac{RF_{atm}}{\tau_{abs}}$

Contour lines: RF_{atm}



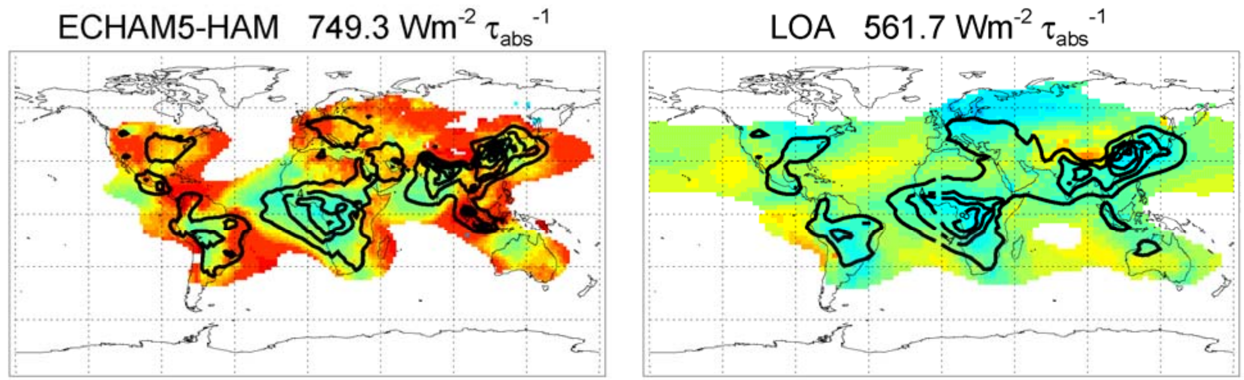
Aerosol Absorption Efficiency

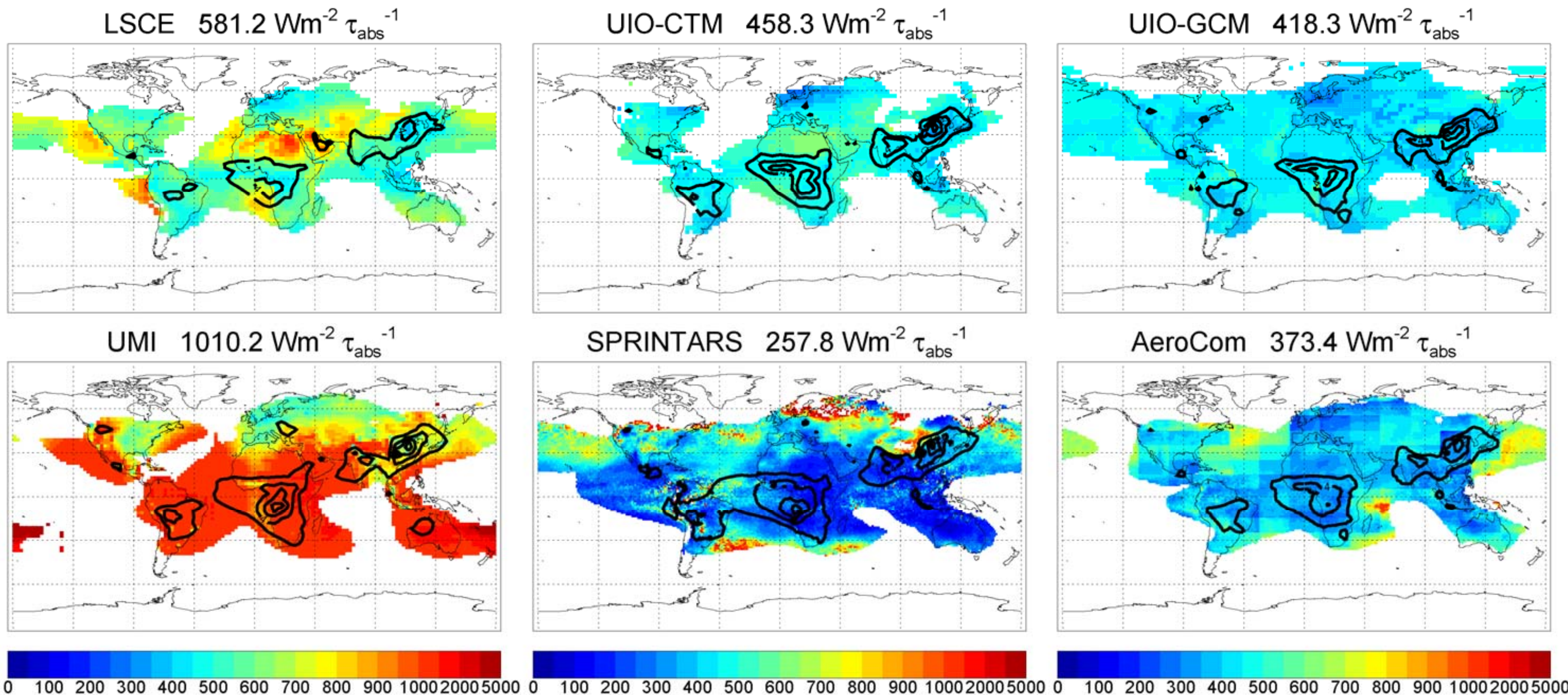
Annual-Mean

Anthropogenic

Absorption Efficiency = $\frac{RF_{atm}}{\tau_{abs}}$

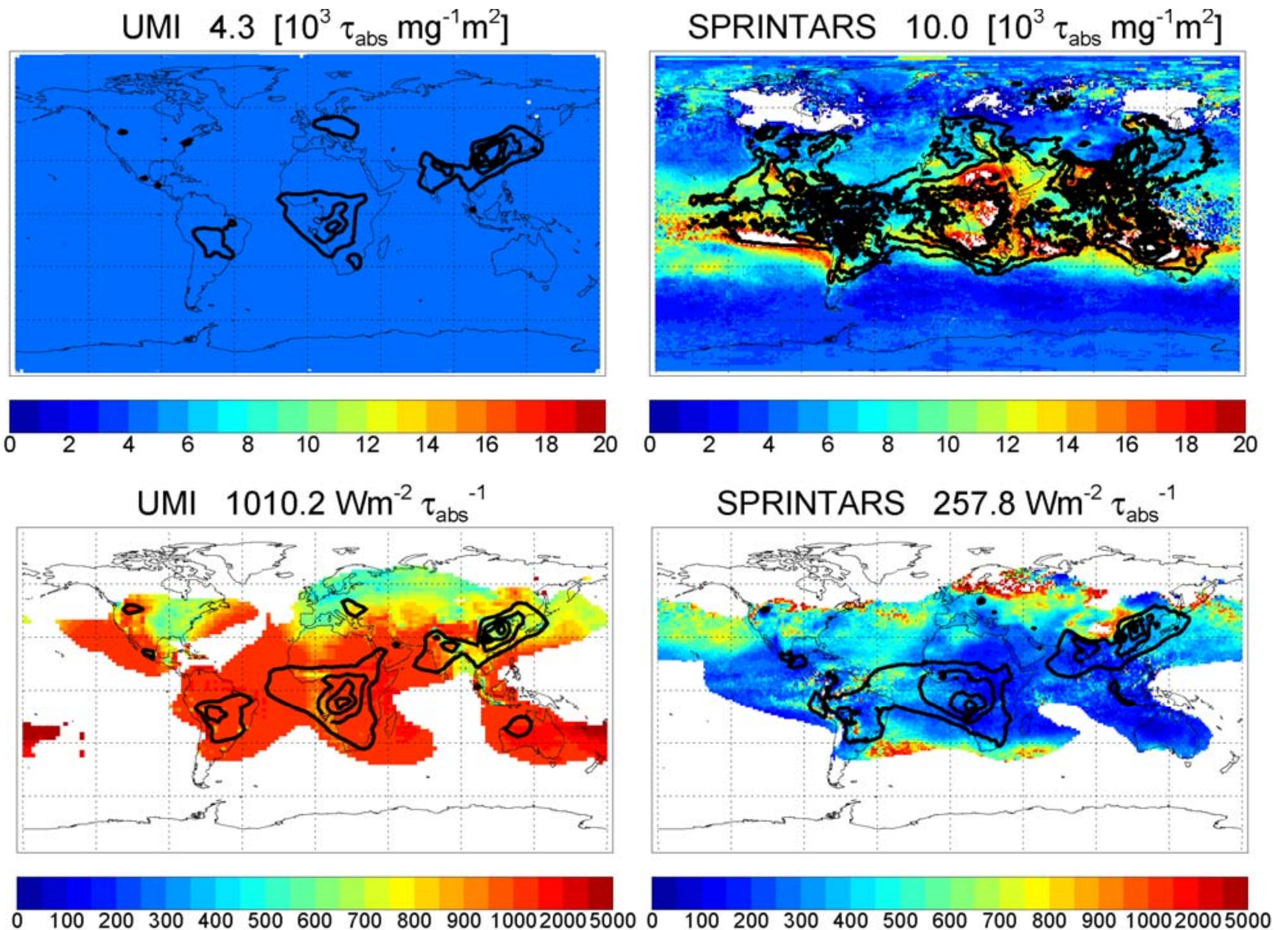
Mask $RF_{atm} < 0.5$ **[W m^{-2}]**





Aerosol Absorption Efficiency

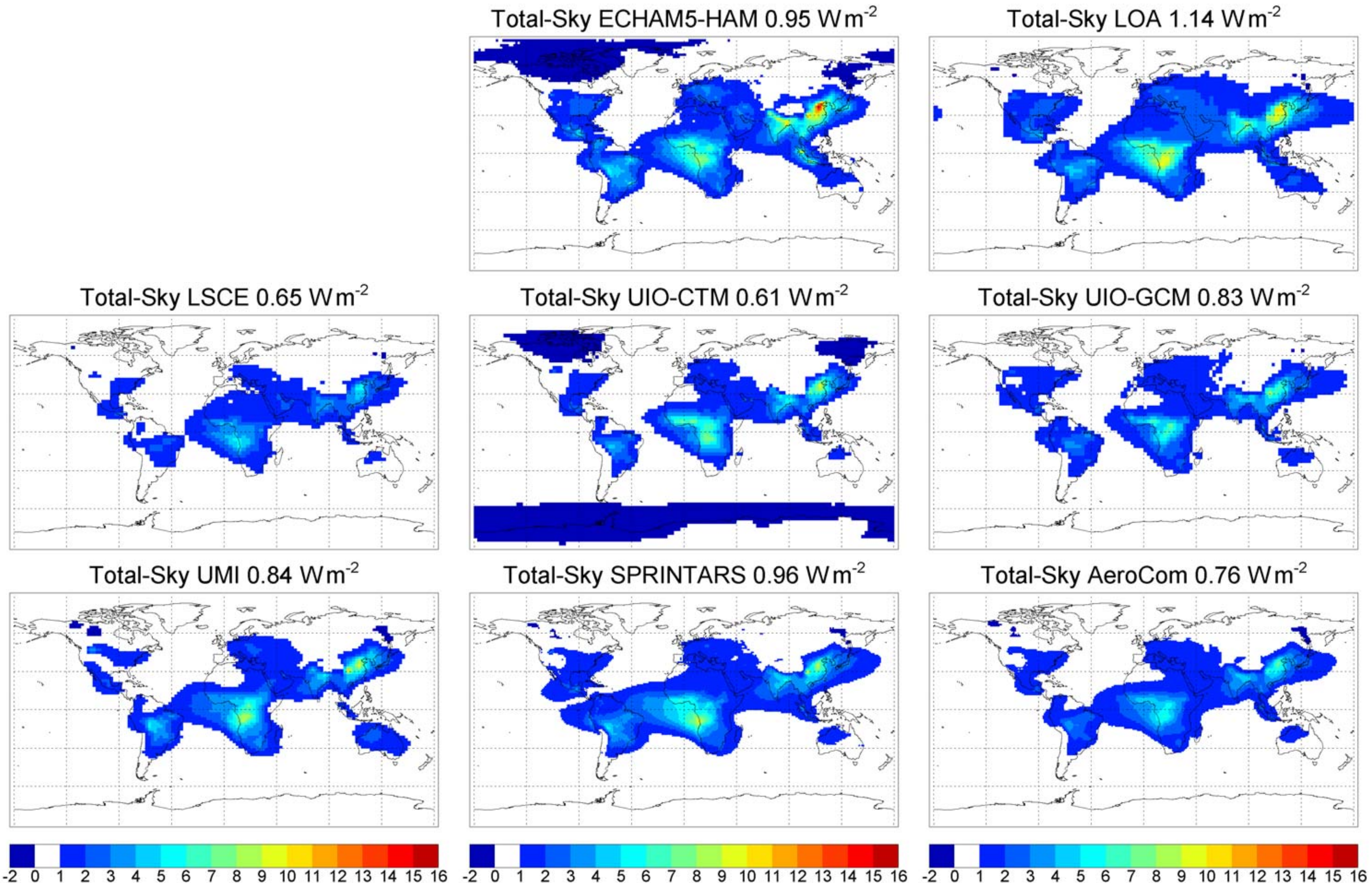
Compensating Effects:



$$\frac{\tau_{abs}}{B_{BC}}$$

$$\frac{RF_{atm}}{\tau_{abs}}$$

Direct Aerosol Radiative Forcing – Atmospheric Column



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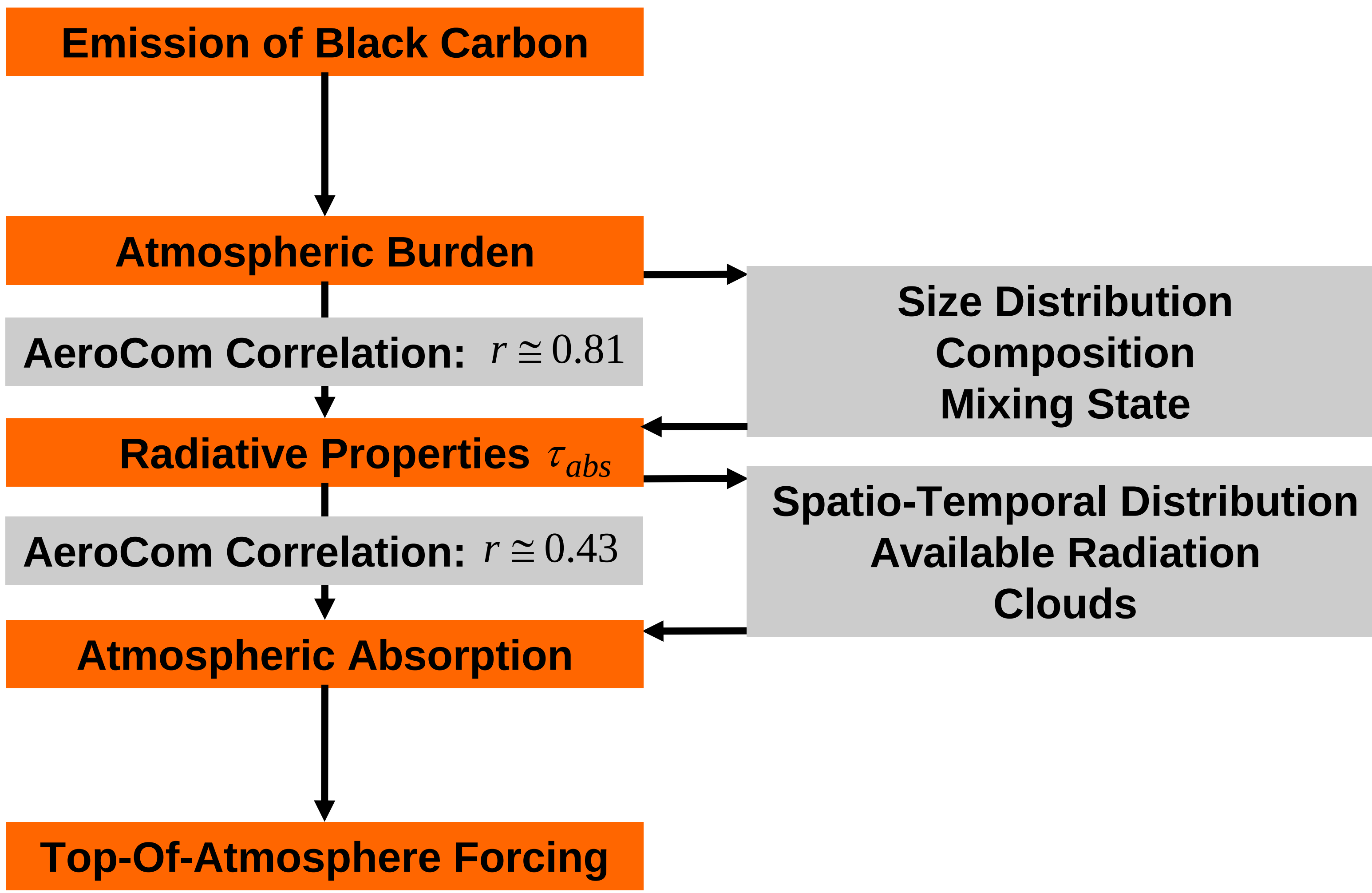
Establish physical connection – allows direct evaluation



Conclusions

Analysis of global annual mean radiative properties and effects creates little physical understanding

- Essential to break down the problem to a physical basis (This works only at the local scale)
- Reduction in complexity allows direct evaluation

Aerosol absorption important contribution to direct forcing

- Cloudy-sky contribution significant
- Additional diagnostics needed…

Uncertainty not limited to aerosol radiative properties

- Link to actual absorption and forcing equally important (and uncertain)
- AeroCom experiment could include forcing calculation with prescribed AOD / AAOD

This is work in progress…

Acknowledgements

- **AeroCom Modellers contributing to the forcing experiment**
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