



CERES and MODIS for direct and indirect forcings

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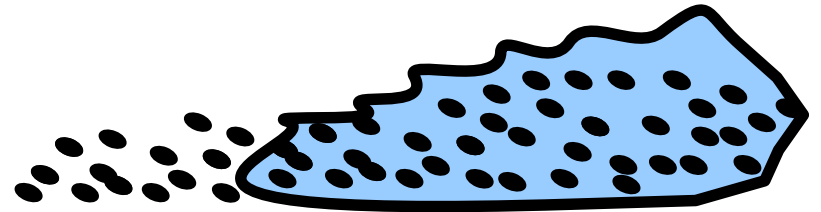
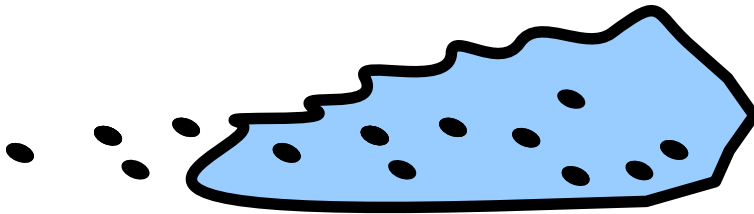
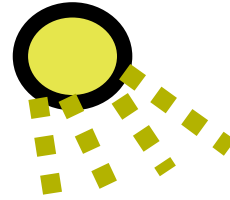
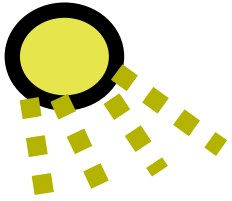


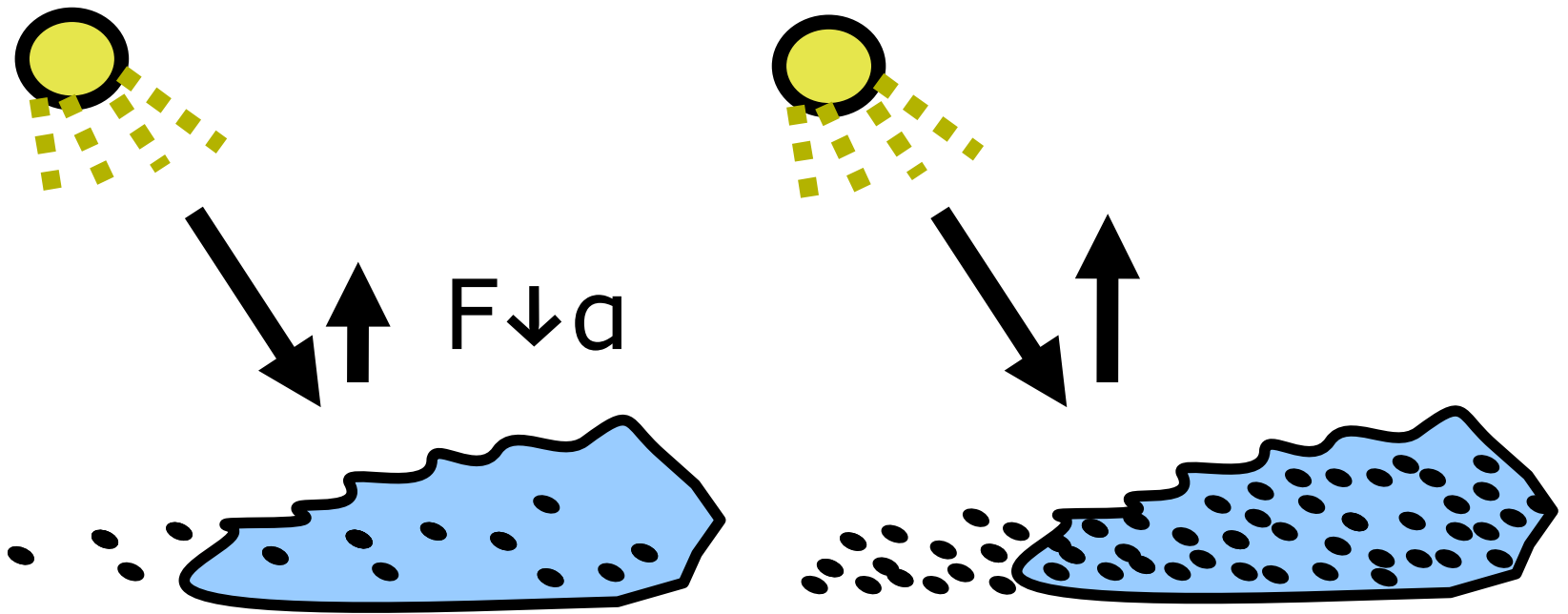
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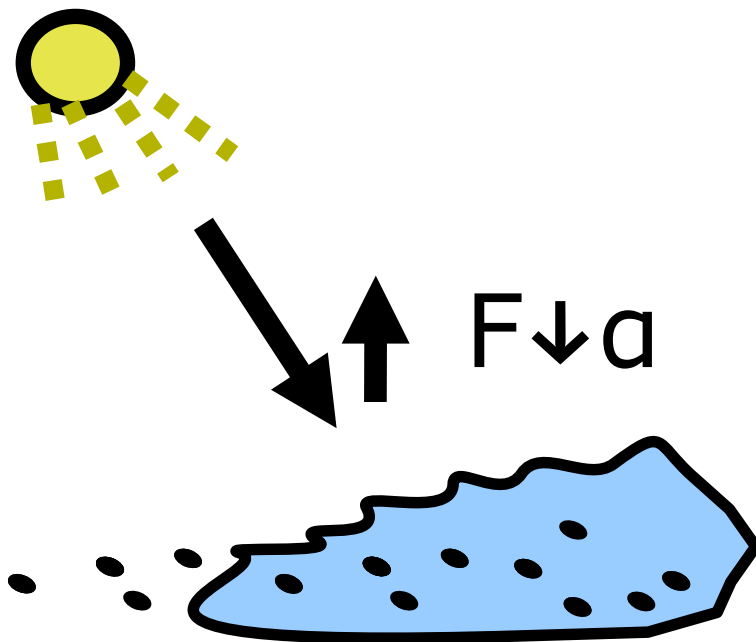


Introduction

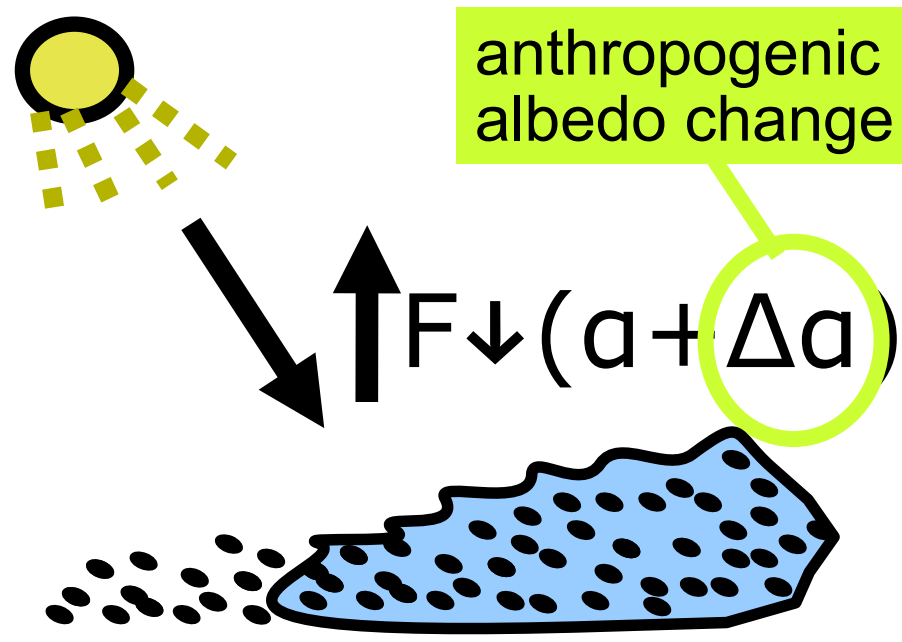




F_{\downarrow} : Incoming solar flux
 α : planetary albedo



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Forcing: $F_{\downarrow} \Delta\alpha$

Measurable at the top
of the atmosphere



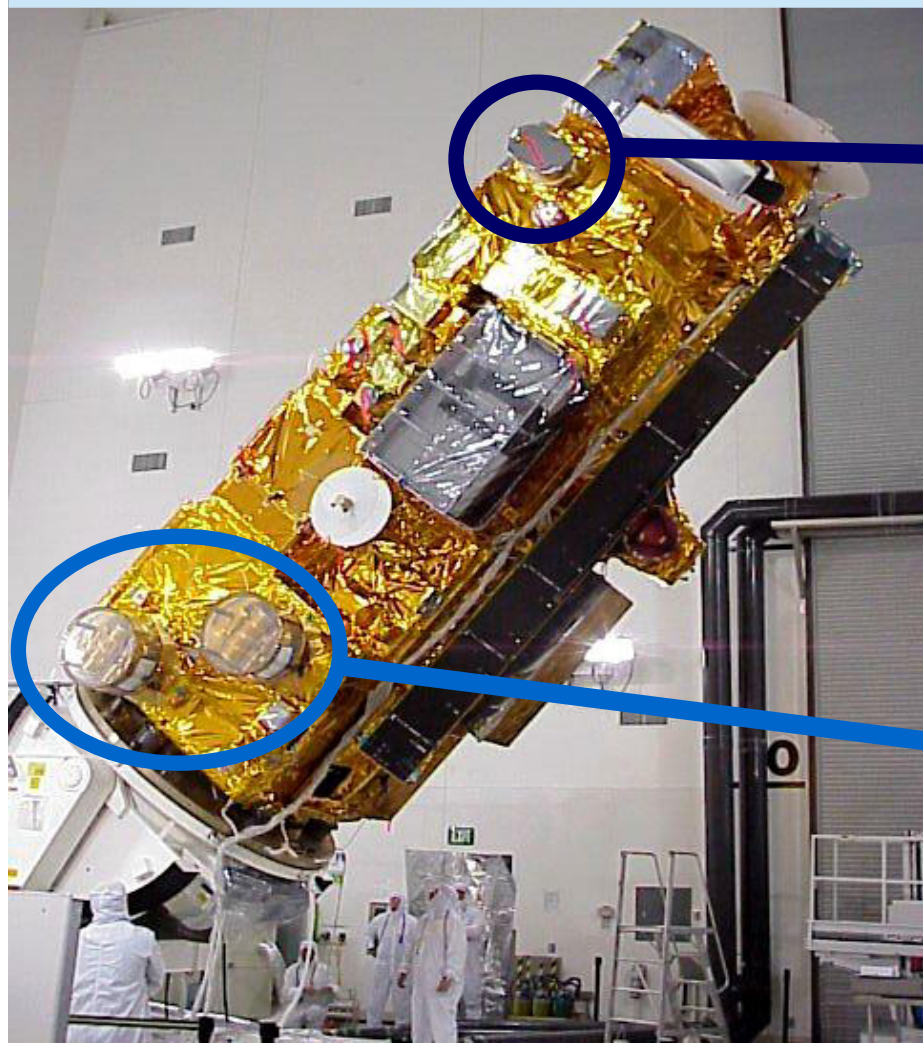
NASA's TERRA satellite



MODIS
- aerosols
- clouds

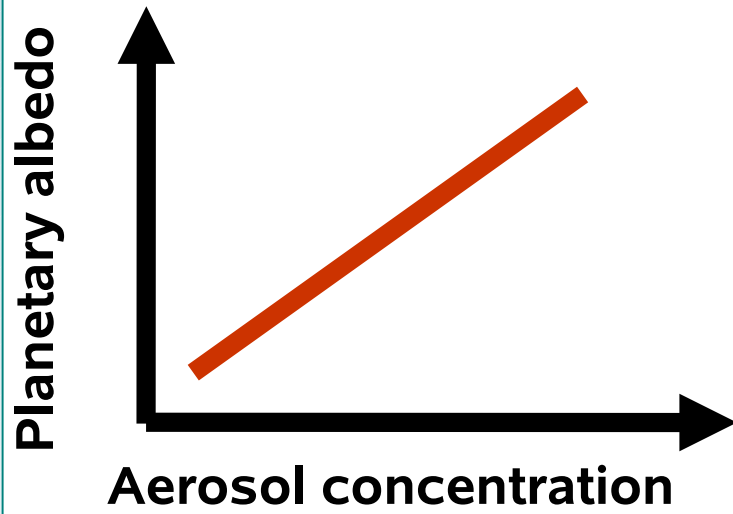


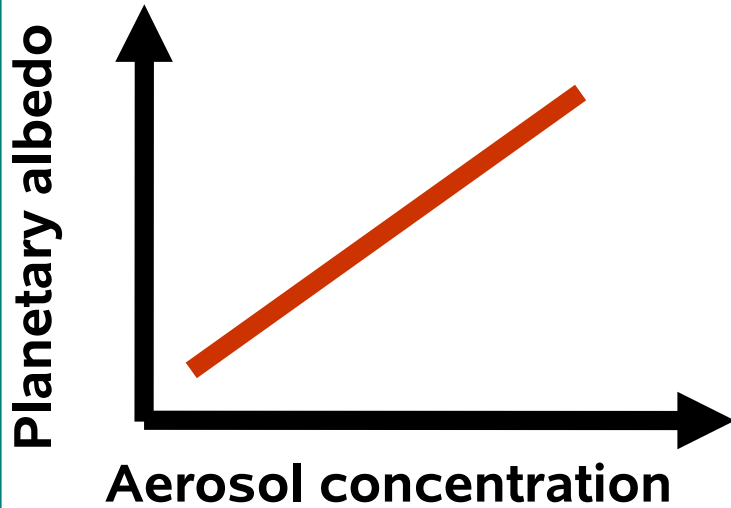
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MODIS
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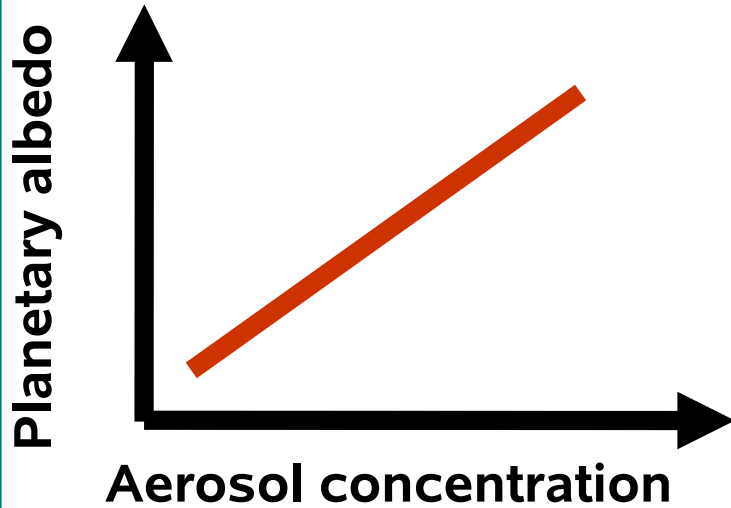
CERES
- radiative fluxes





CERES “ERBE-like” product:
Four cloud scenes:

- | | |
|-------------------|----------|
| 1.) Cloud free | < 5% |
| 2.) Partly cloudy | 5 – 50% |
| 3.) Mostly cloudy | 50 – 95% |
| 4.) Overcast | > 95% |



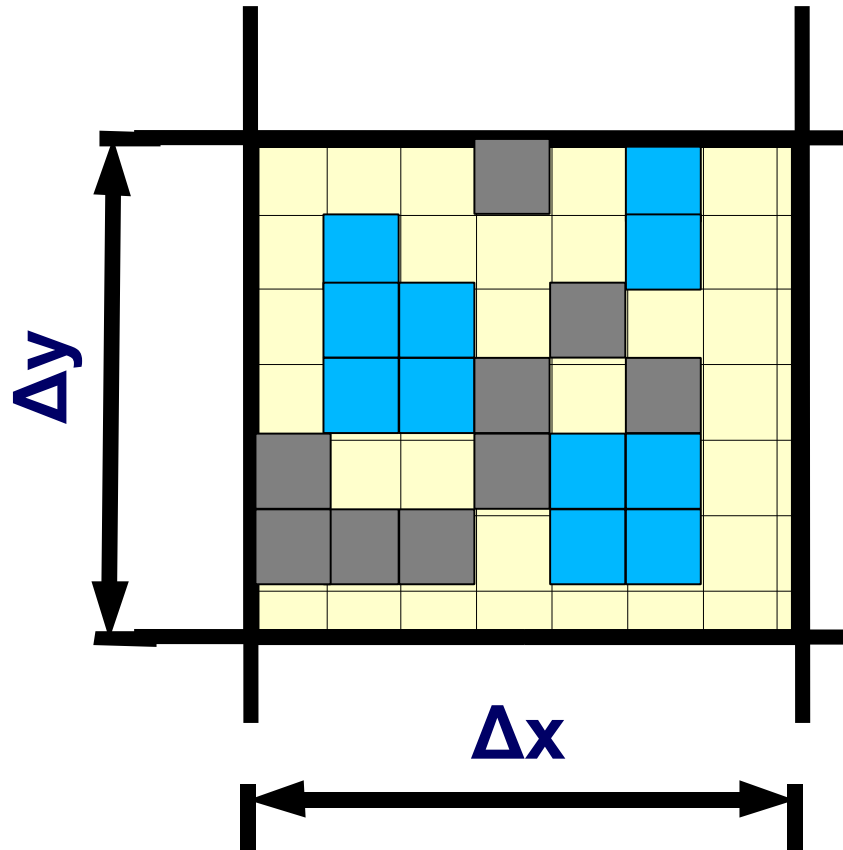
CERES “ERBE-like” product:
Four cloud scenes:




- | | |
|-------------------|----------|
| 1.) Cloud free | < 5% |
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Direct effect

Indirect effect*

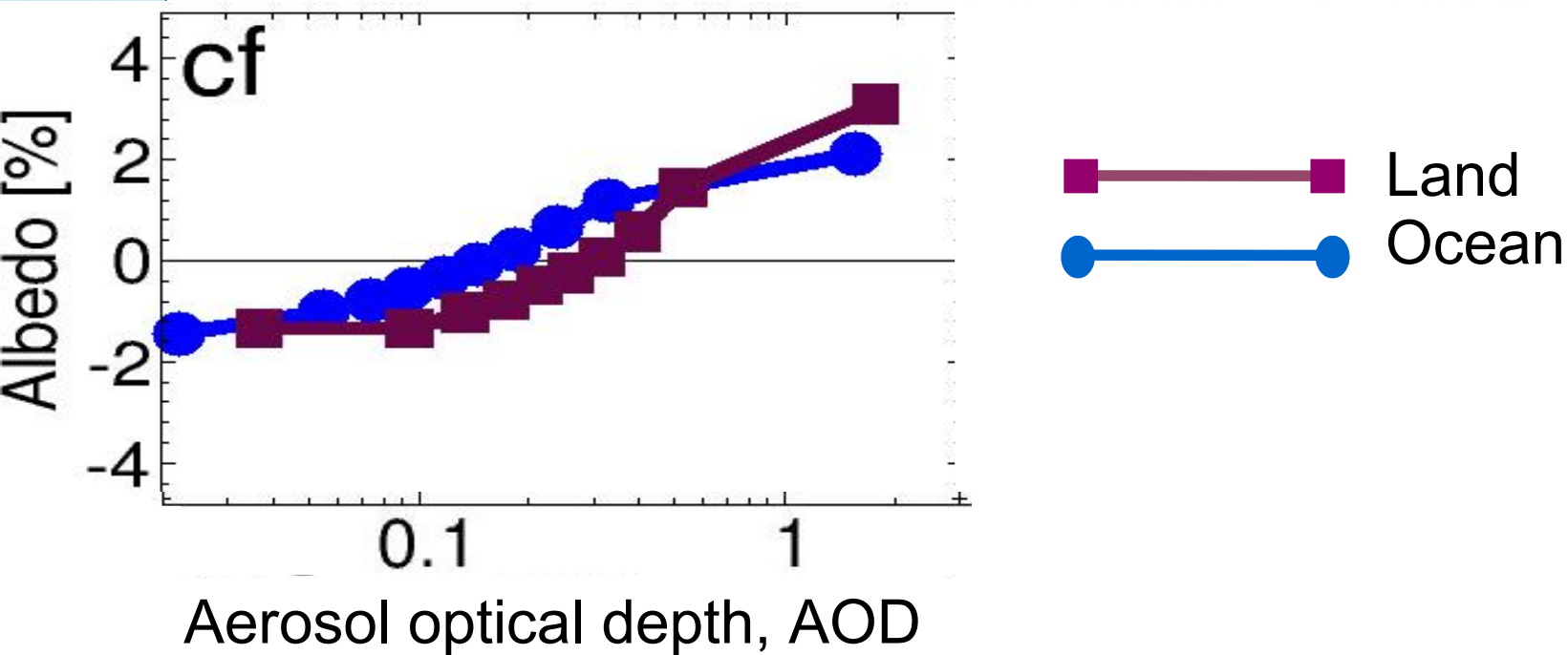
* No ice-cloud effects,
second indirect effect partially

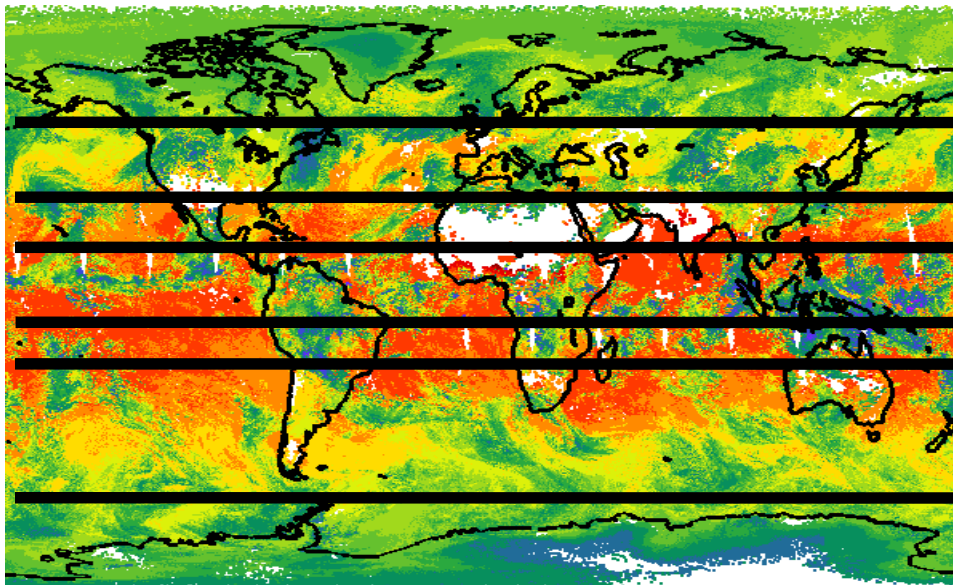
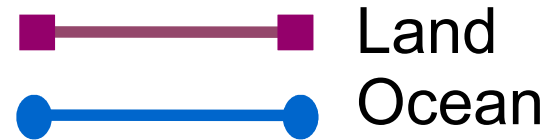
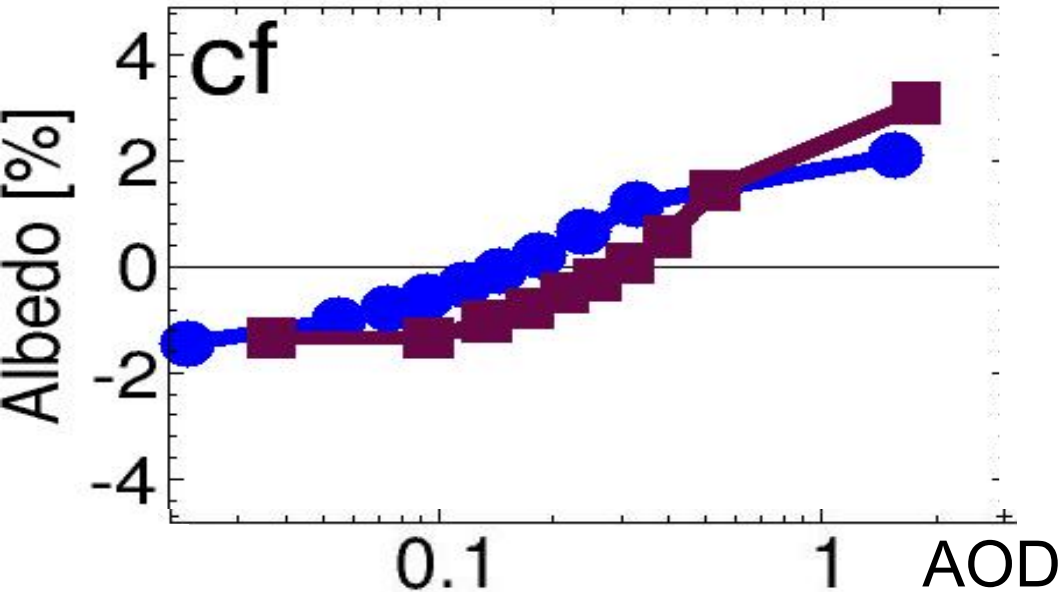


-  Aerosol measurements
-  Cloud measurements
-  No retrieval

Method adopted:

- > relate CERES planetary albedo to MODIS aerosol optical depth
- > daily values, $1^\circ \times 1^\circ$
- > five years of data March 2000 to February 2005

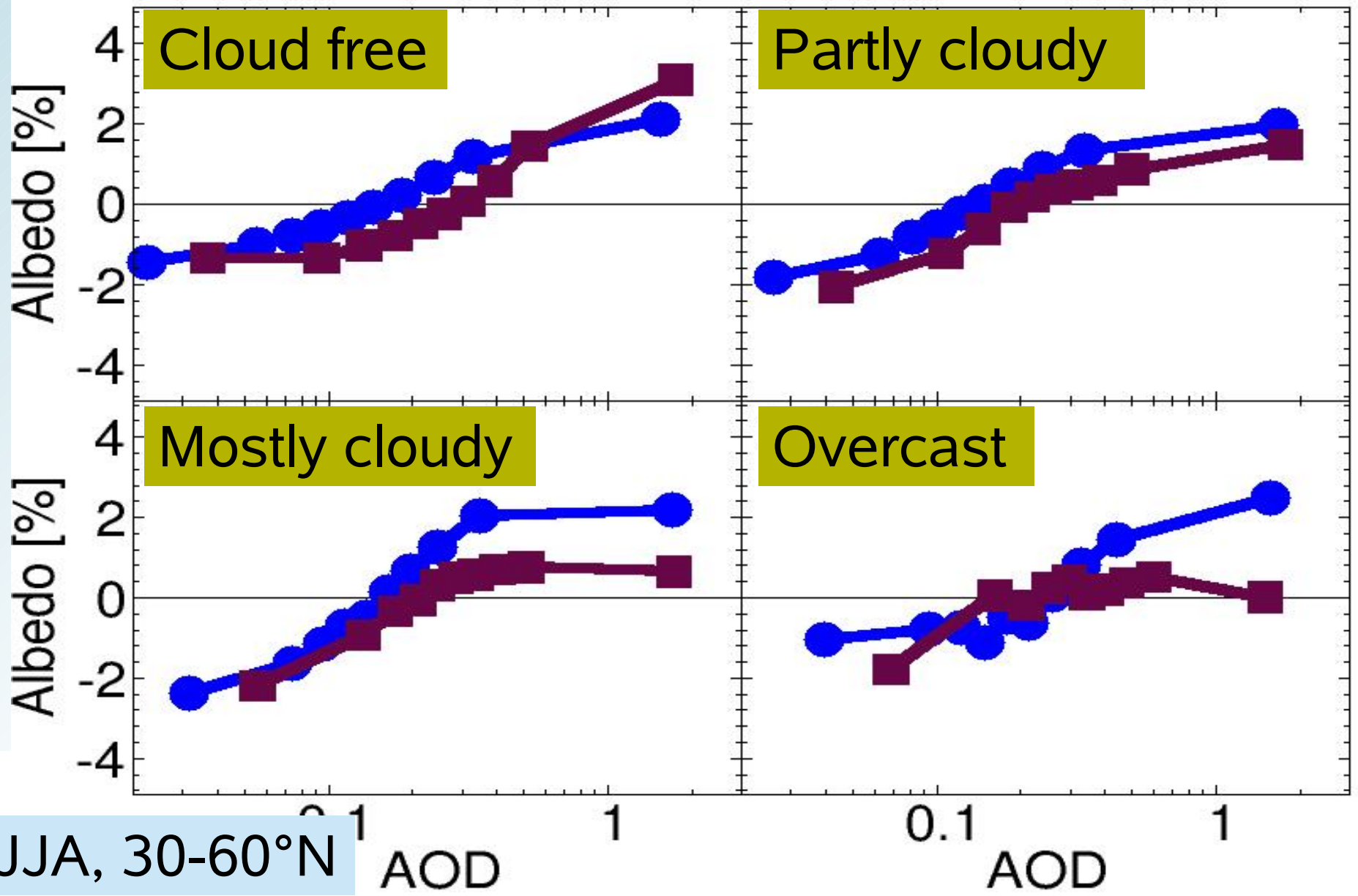




60°N
30°N
8°N
8°S
25°S
60°S

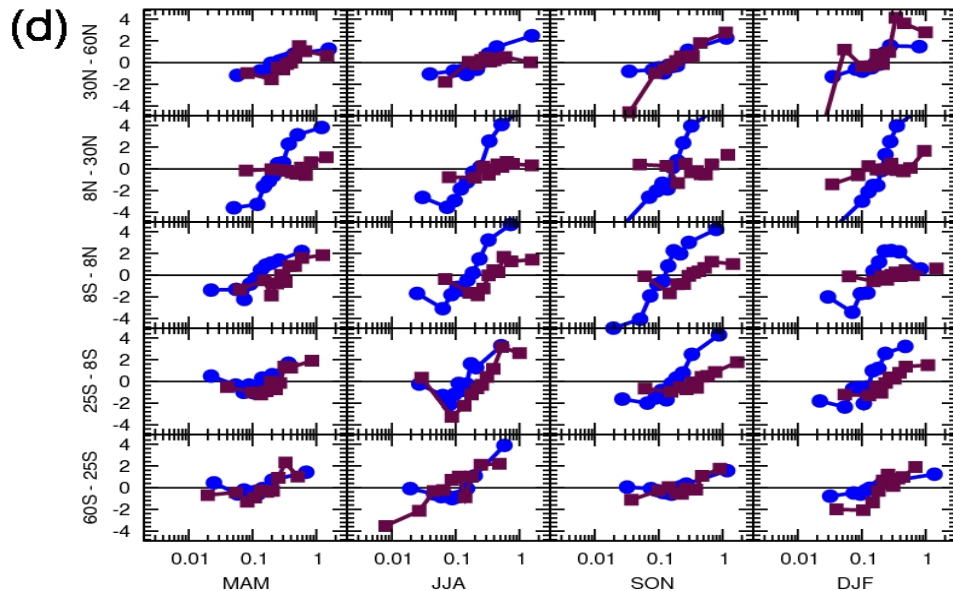
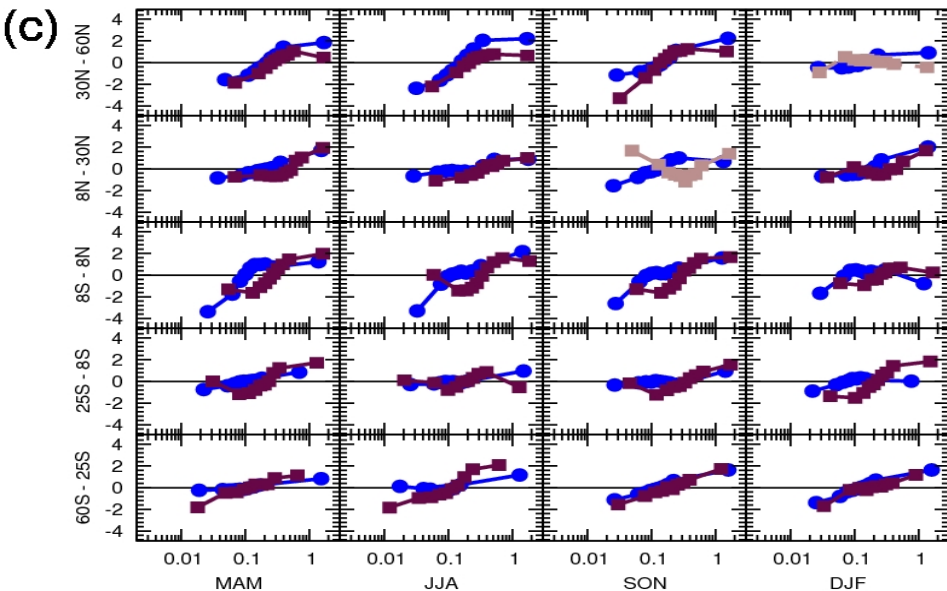
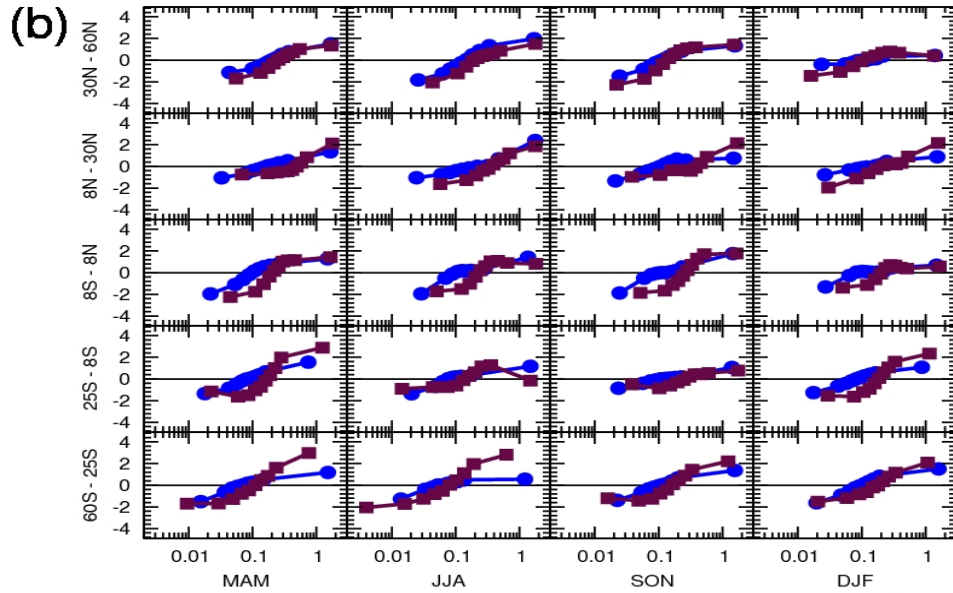
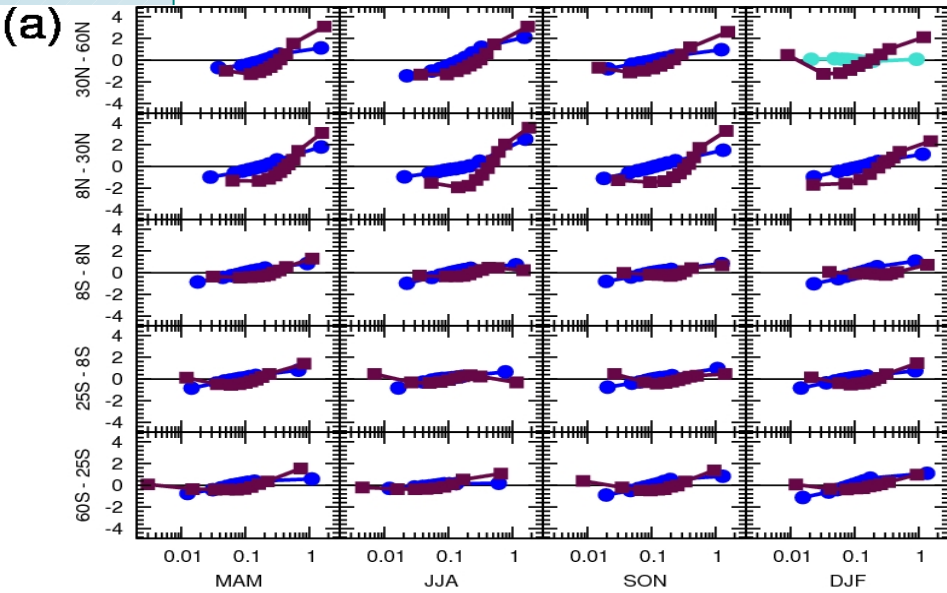
Relationship established for:

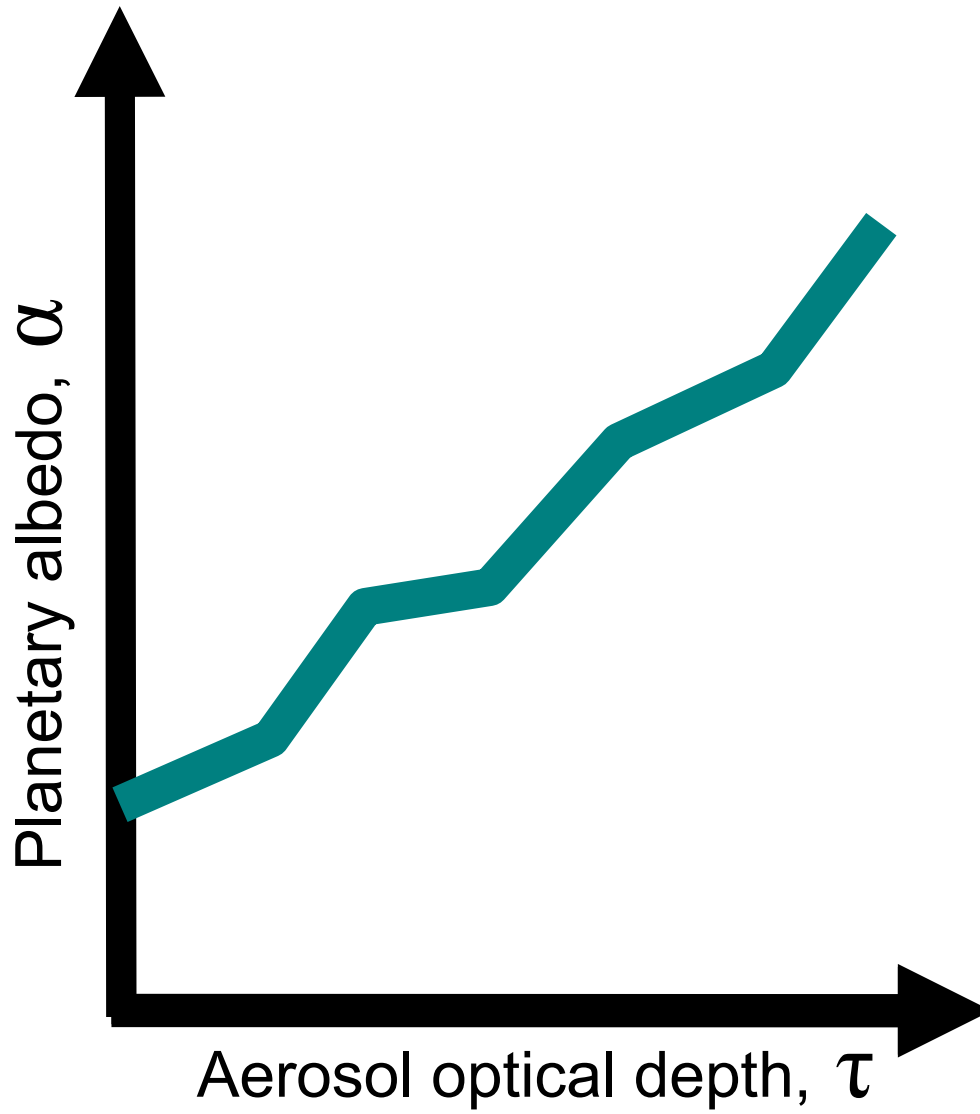
- Five regions
- Four seasons (MAM, JJA, SON, DJF)





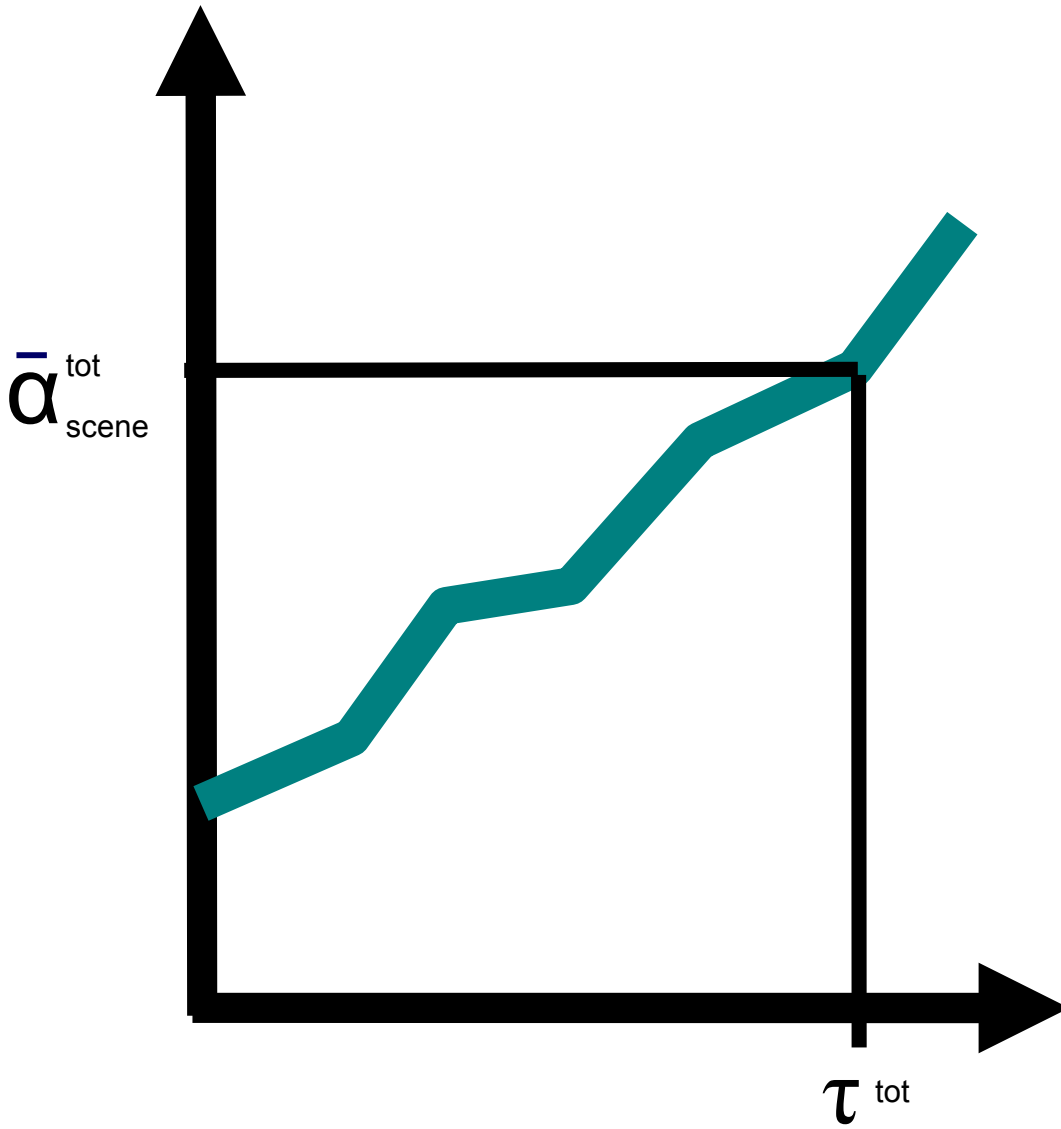
Results (2/5)

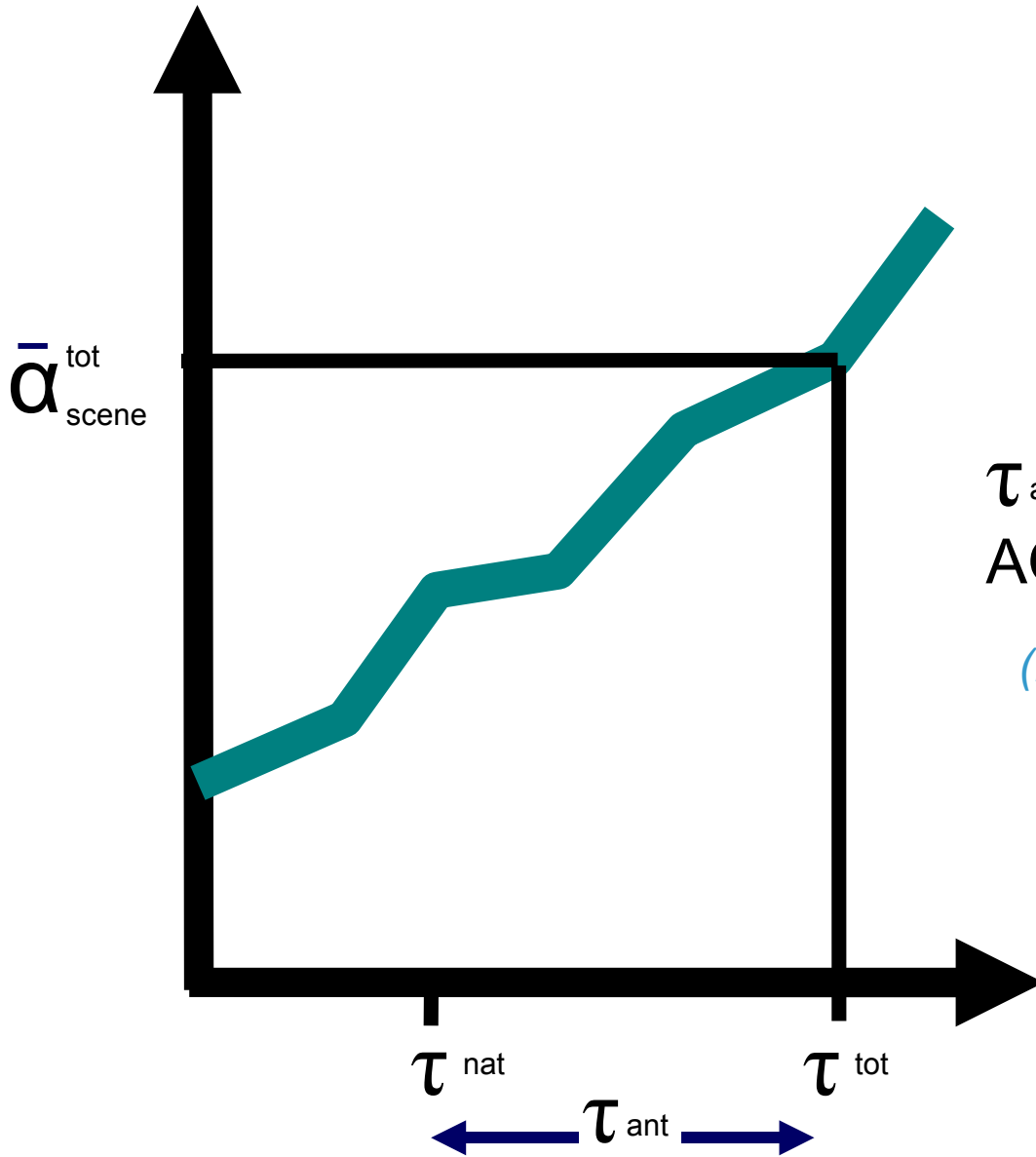






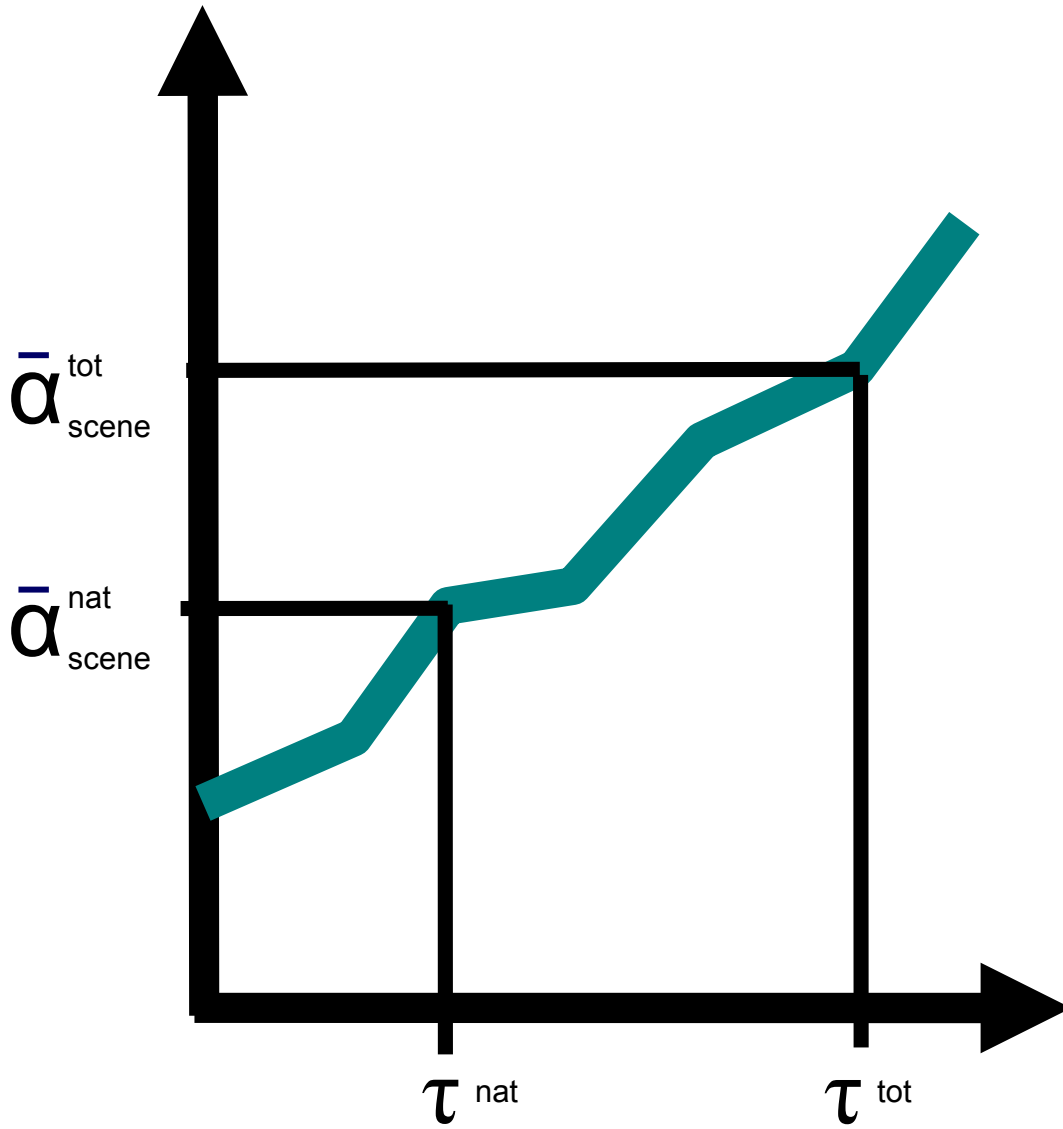
Results (3/5)





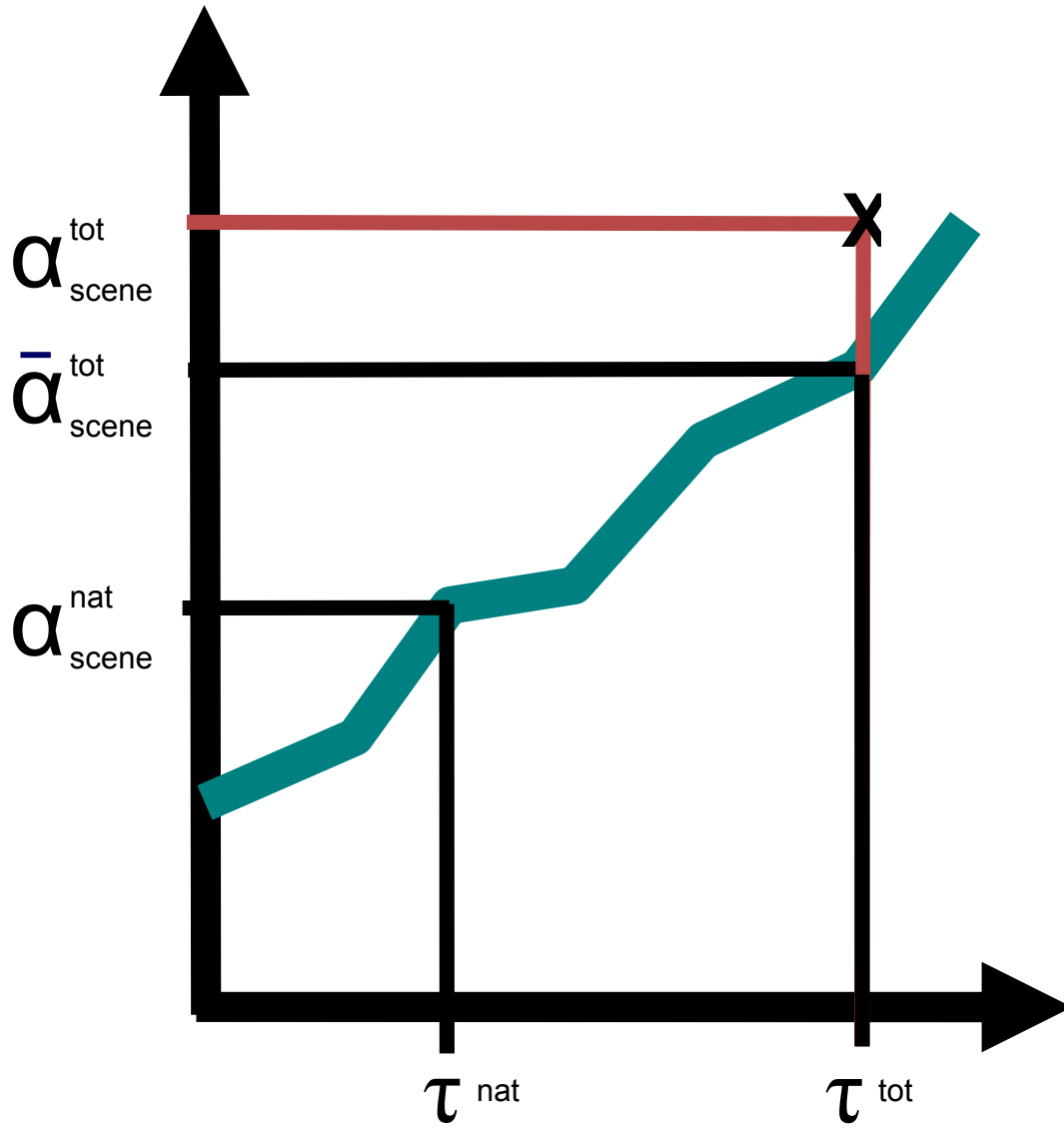
τ^{ant} : anthropogenic
AOD from MODIS

(Bellouin et al., Nature 2005)



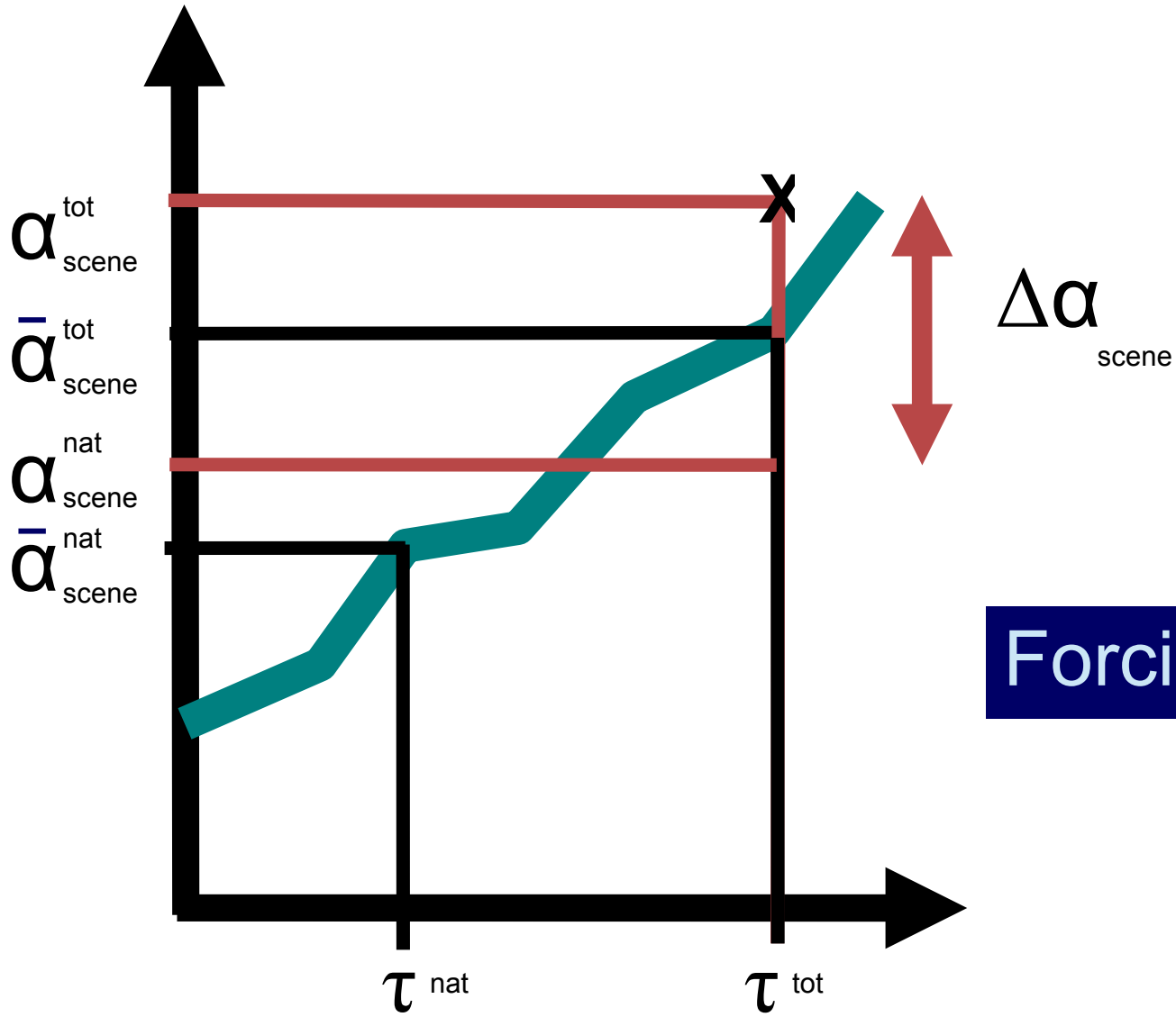


Results (3/5)



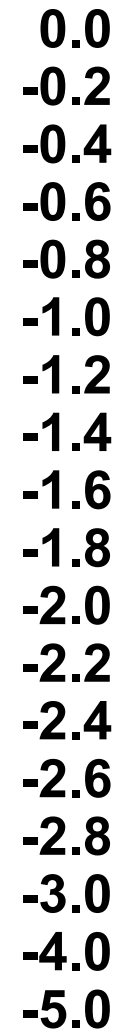
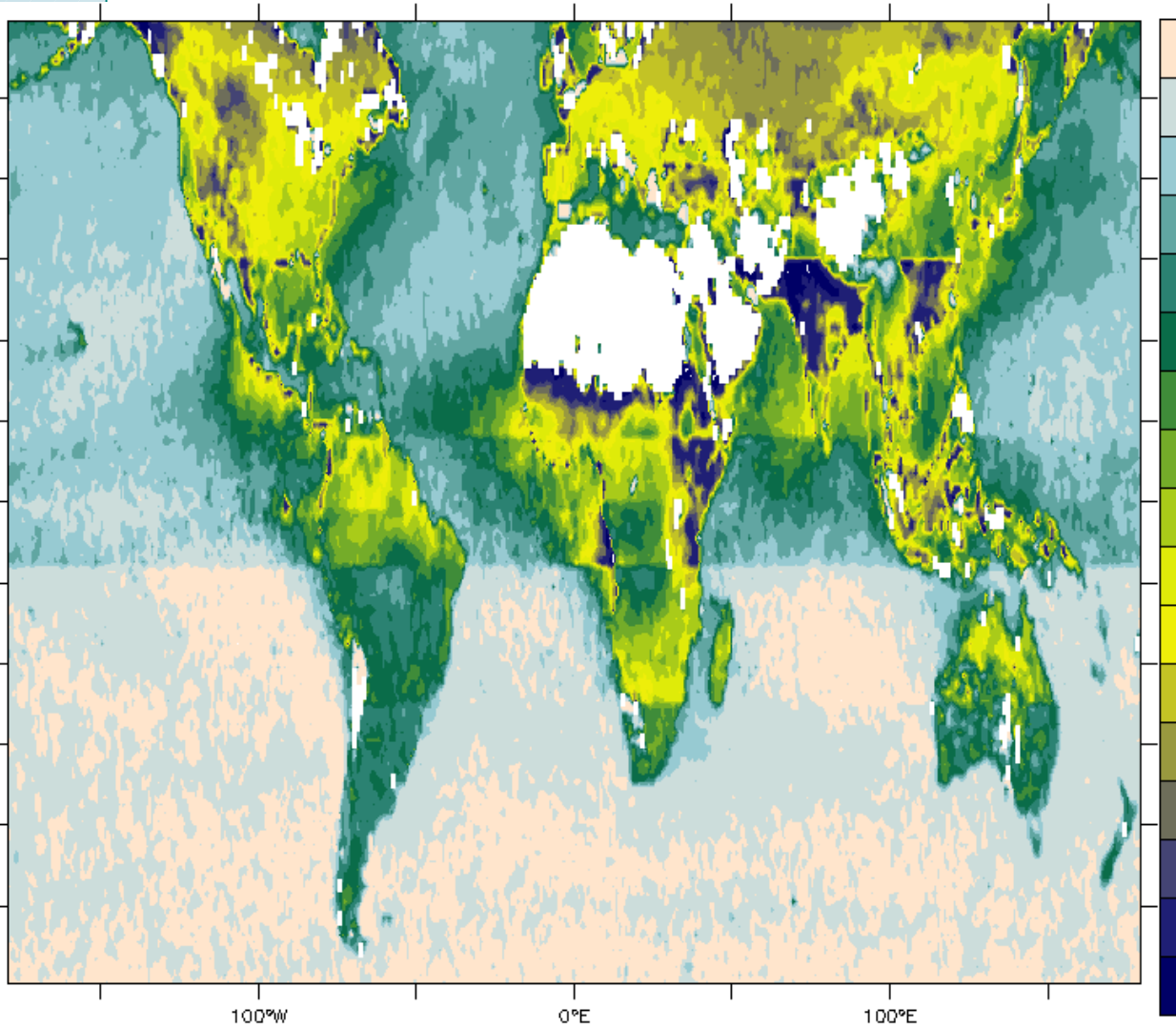


Results (3/5)



Forcing $F \downarrow \Delta\alpha$





**Global
annual mean:**

**direct effect:
-0.8 Wm⁻²**

**indir. effect:
-0.3 Wm⁻²**

**total:
-1.1 Wm⁻²**

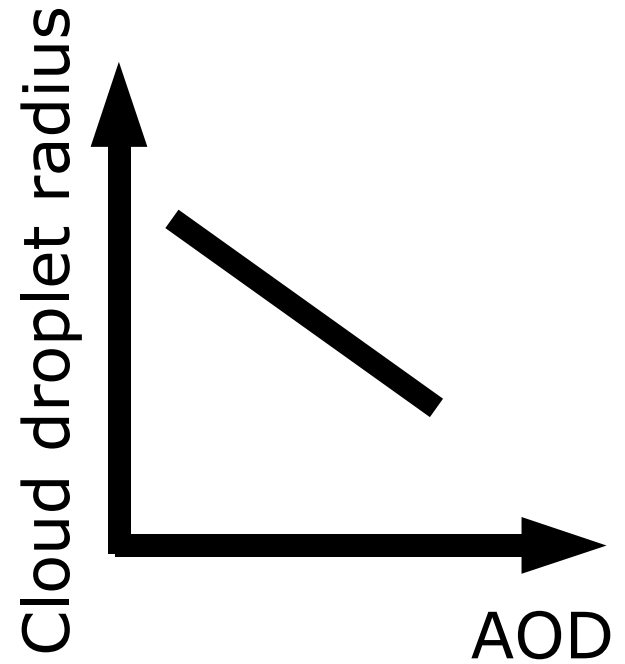
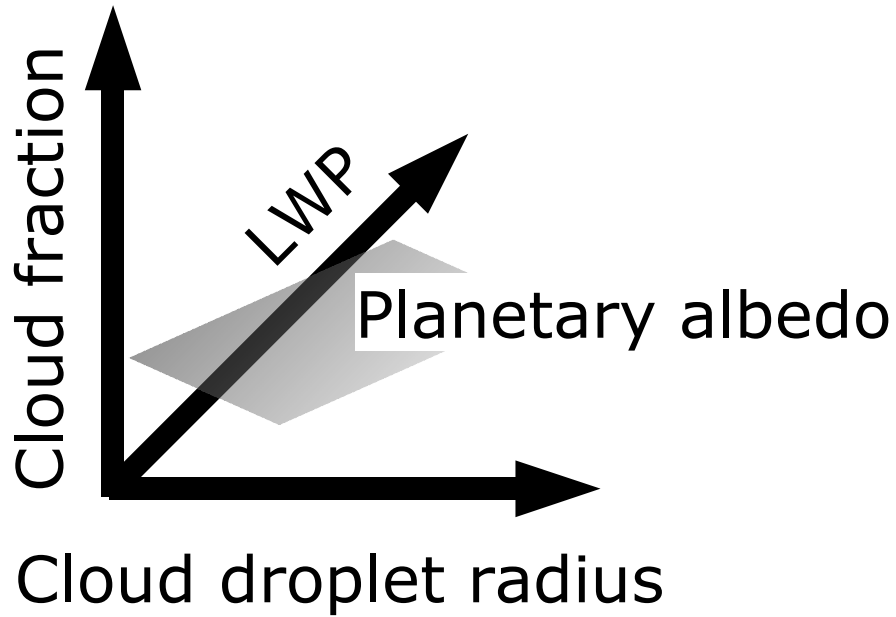




#	Description	Direct effect [Wm ⁻²]	Indirect effect [Wm ⁻²]
0	Baseline	-0.8	-0.3
1	Split time-series	-0.8 to -0.7	-0.3
2	Stratification by liquid water path	-0.5	-0.2
3	Different choice of seasons/regions	-0.8 to -0.7	-0.4 to -0.3
4	Different constraints on aerosol homogeneity / liquid cloud fraction	-0.7	-0.3 to -0.2
5	Aqua instead of Terra cloud data	-0.8	-0.3
6	Uncertainty on anthropogenic aerosol fraction	-0.9 to -0.6	-0.4 to -0.3
		-0.9 to -0.5	-0.4 to -0.2



Outlook



Single Scanner Footprint Data





1. Method

Significantly positive relationships CERES planetary albedo – MODIS aerosol optical depth



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2. Estimate of aerosol radiative forcings

a) Direct effect: -0.8 Wm^{-2}

b) Indirect effect: -0.3 Wm^{-2}



1. Method

Significantly positive relationships CERES planetary albedo – MODIS aerosol optical depth

2. Estimate of aerosol radiative forcings

a) Direct effect: -0.8 Wm^{-2}

b) Indirect effect: -0.3 Wm^{-2}

3. Uncertainty estimate

a) Direct effect: $\pm 0.3 \text{ Wm}^{-2}$

b) Indirect effect: $\pm 0.1 \text{ Wm}^{-2}$