Measurement based assessment of aerosol radiative forcing

MODIS level 3 (1°x1°) daily, monthly, measures:
- aot (550 nm)
- distribution of the AOT among 8 models:
R_{eff}= 0.10, 0.15, 0.20, 0.25 µm - fine aerosol
R_{eff}= 1.0, 1.5, 2.0 µm for sea salt
R_{eff}= 1.5, 2.5 µm for dust

Consistent calculations of solar reflected flux at TOA

Aerosol Models_"Didier2"

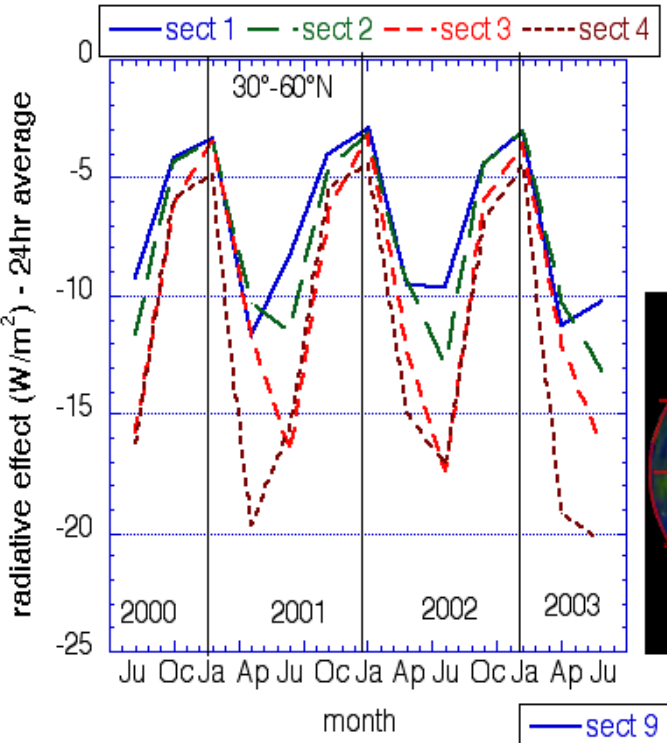
Small particles:

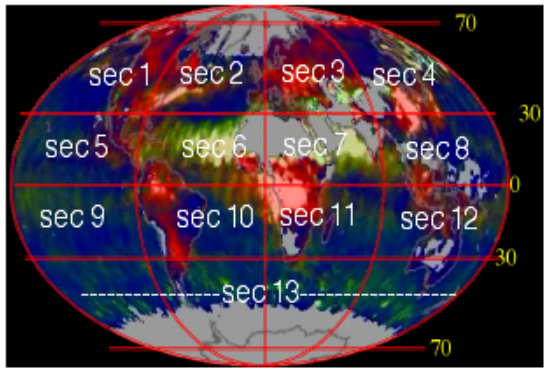
	l=0.47-->0.86mm	l=1.24mm	l=1.64mm	l=2.13mm	r_g	s	r_{eff}	comments
1	1.45-0.0035i	1.45-0.0035i	1.43-0.01i	1.40-0.005i	0.07	0.40	0.10	Wet Water Soluble type
2	1.45-0.0035i	1.45-0.0035i	1.43-0.01i	1.40-0.005i	0.06	0.60	0.15	Wet Water Soluble type
3	1.40-0.0020i	1.40-0.0020i	1.39-0.005i	1.36-0.003i	0.08	0.60	0.20	Water Soluble with humidity
4	1.40-0.0020i	1.40-0.0020i	1.39-0.005i	1.36-0.003i	0.10	0.60	0.25	Water Soluble with humidity

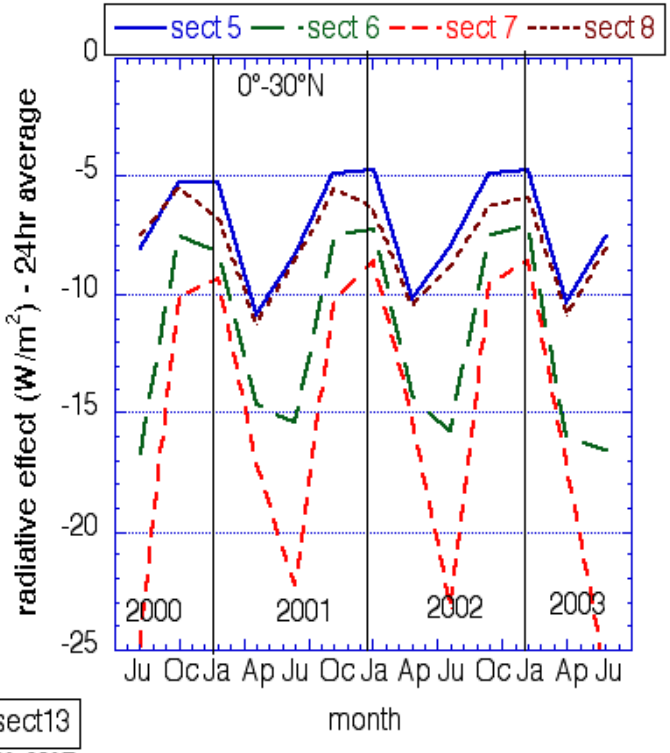
Large particles:

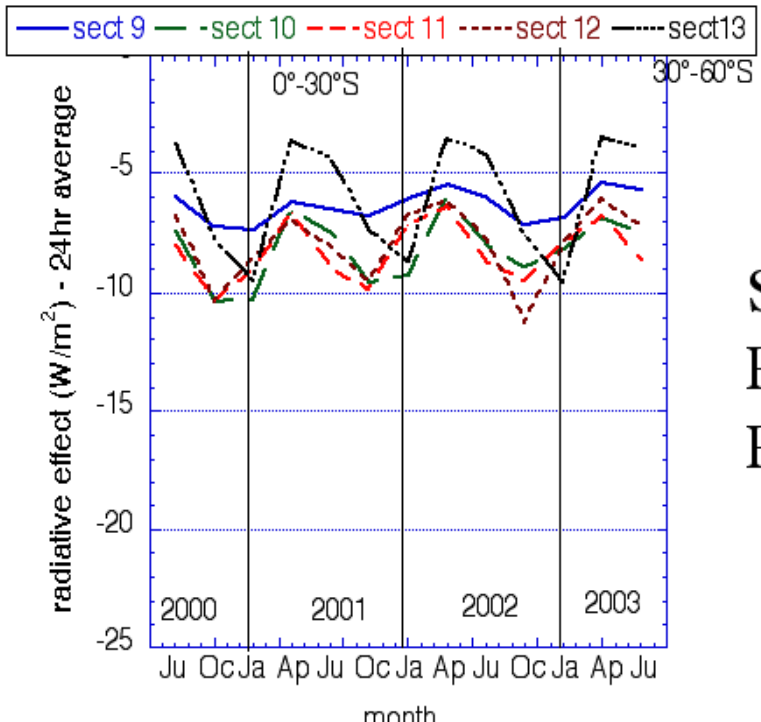
	l=0.47-->0.86mm	l=1.24mm	l=1.64mm	l=2.13mm	r_g	s	r_{eff}	comments
5	1.45-0.0035i	1.45-0.0035i	1.43-0.0035i	1.43-0.0035i	0.40	0.60	0.98	Wet Sea salt type
6	1.45-0.0035i	1.45-0.0035i	1.43-0.0035i	1.43-0.0035i	0.60	0.60	1.48	Wet Sea salt type
7	1.45-0.0035i	1.45-0.0035i	1.43-0.0035i	1.43-0.0035i	0.80	0.60	1.98	Wet Sea salt type
8	1.53-0.003i (0.47) 1.53-0.001i (0.55) 1.53-0.000i (0.66) 1.53-0.000i (0.86)	1.46-0.000i	1.46-0.001i	1.46-0.000i	0.60	0.60	1.48	Dust-like type
9	1.53-0.003i (0.47) 1.53-0.001i (0.55) 1.53-0.000i (0.66) 1.53-0.000i (0.86)	1.46-0.000i	1.46-0.001i	1.46-0.000i	0.50	0.80	2.50	Dust-like type

Radiative effect over the oceans from MODIS





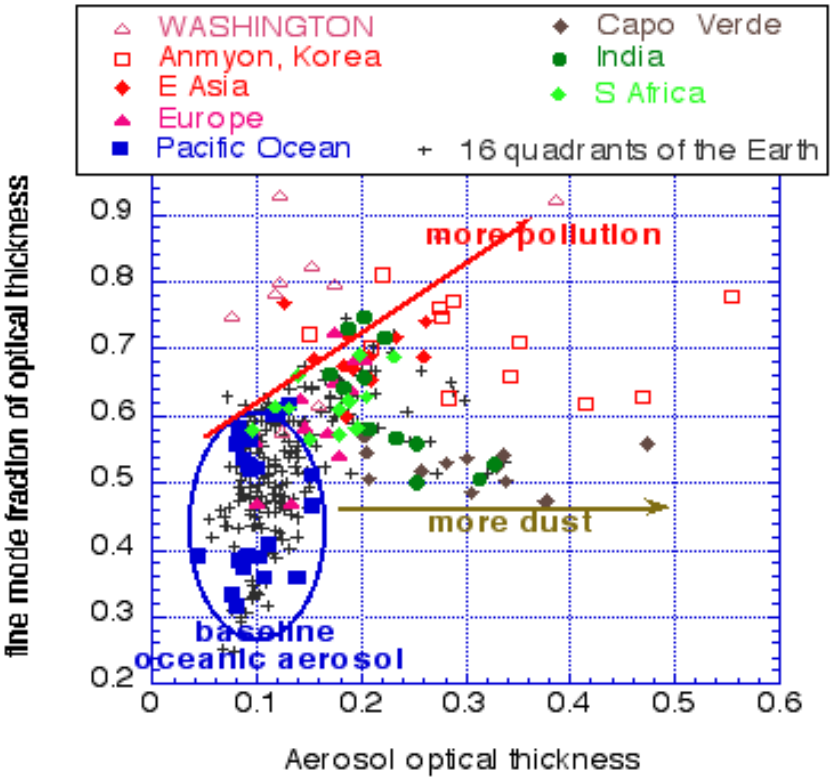




Seasonal aerosol Radiative effect at TOA
Remer et al., 2004

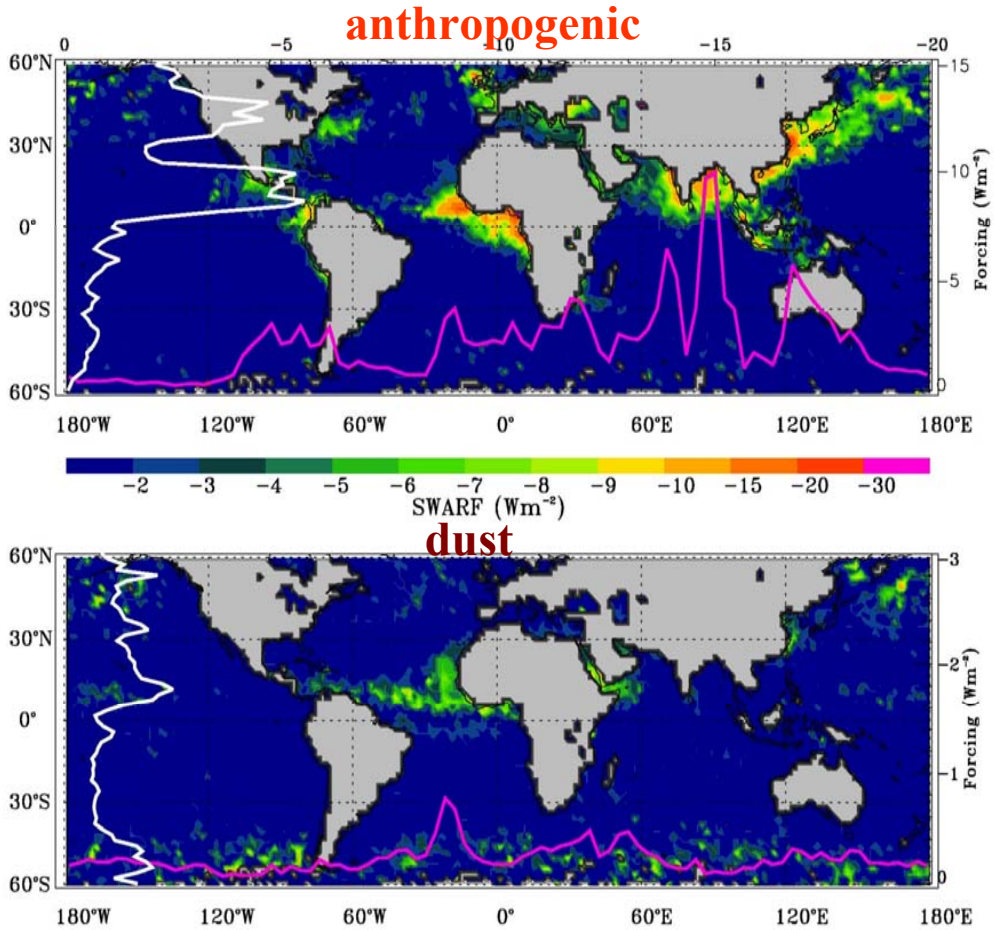
Aerosol direct radiative forcing

Classification of aerosol to natural and anthropogenic



Kaufman et al 2004 ?

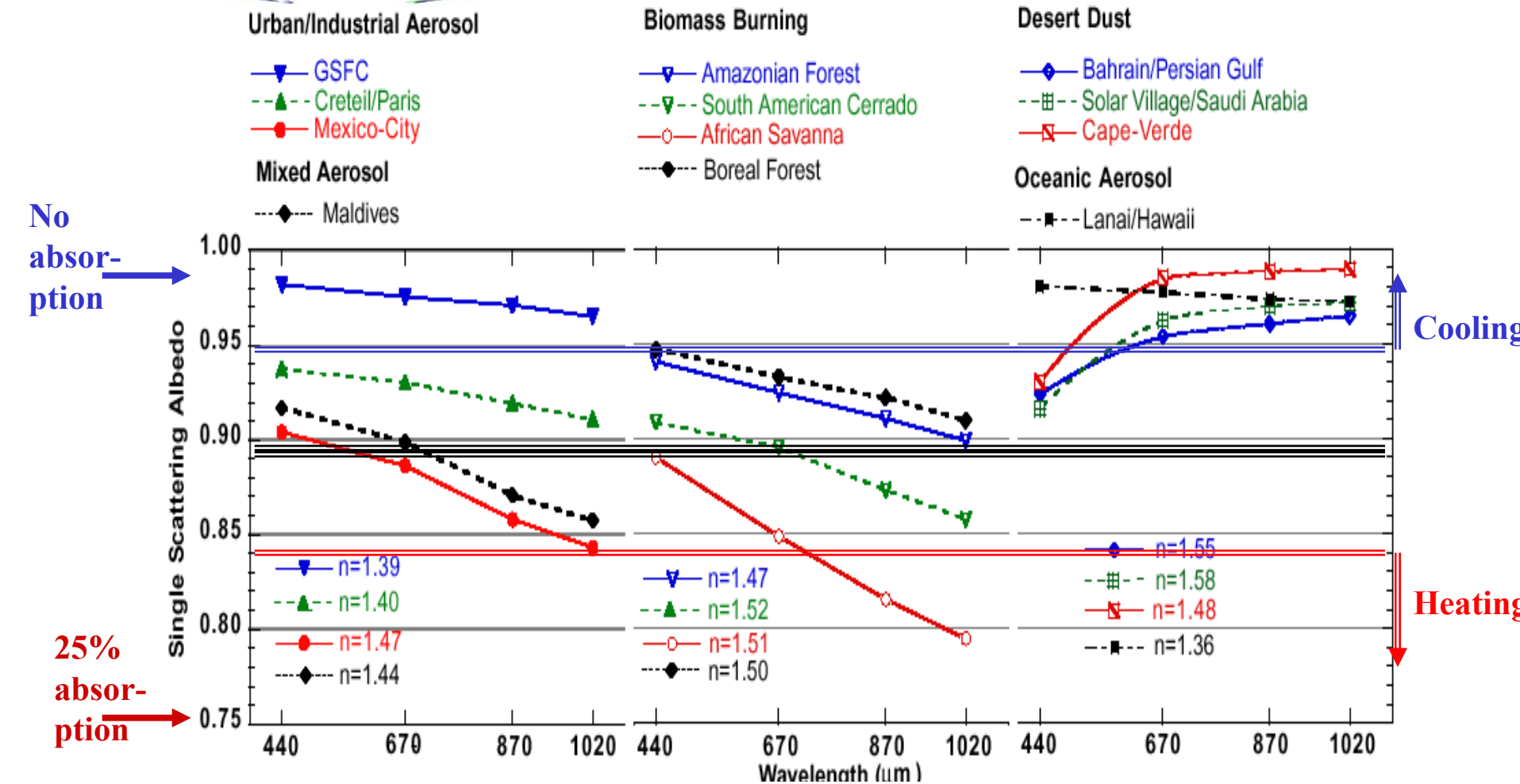
Instantaneous aerosol anthropogenic forcing and dust radiative effect

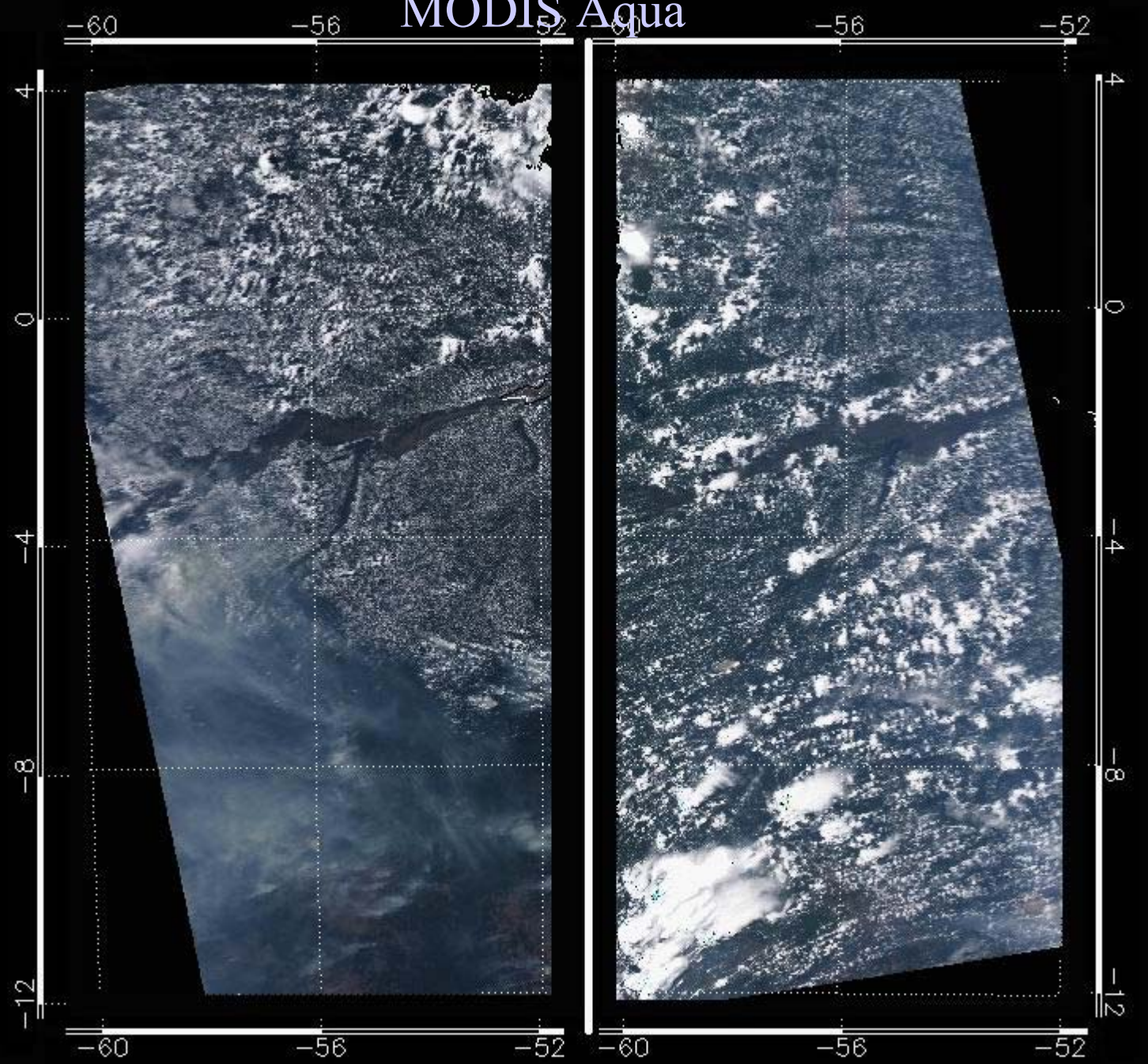


Christopher et al 2004

Opportunity from AERONET

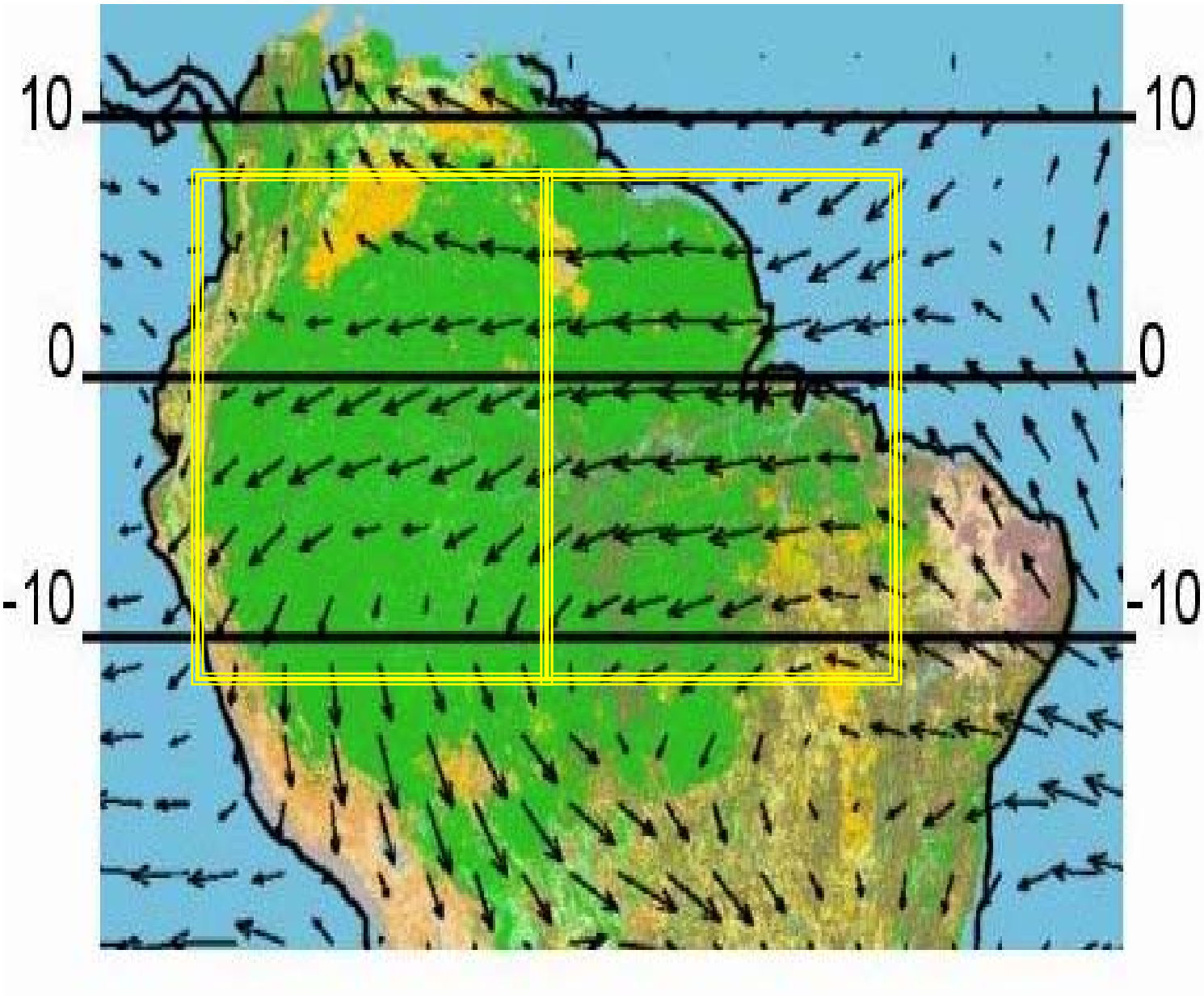
Dubovik et al.,2002

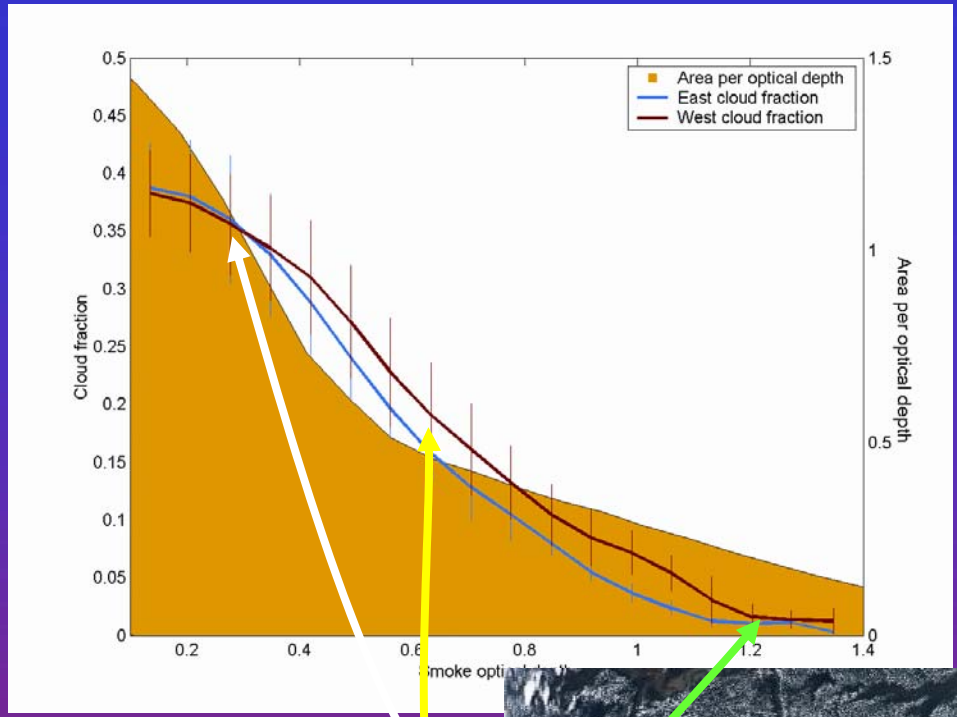




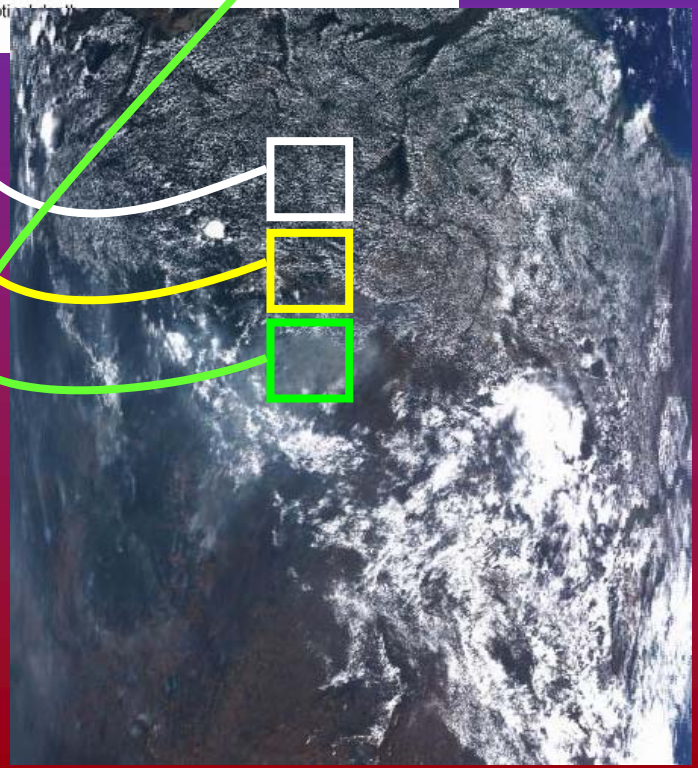
Aerosol Semi-direct effect - Koren et al 2004

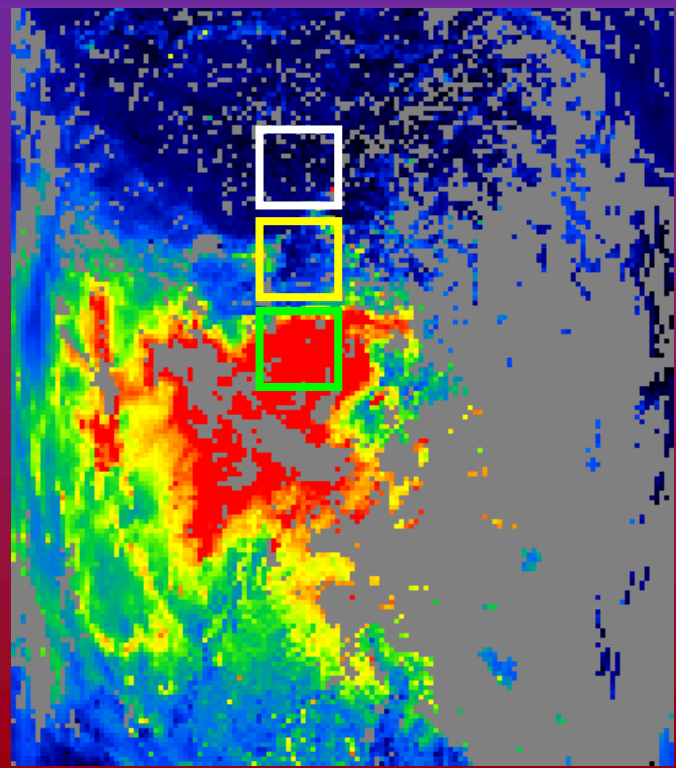
Selection of meteorological conditions



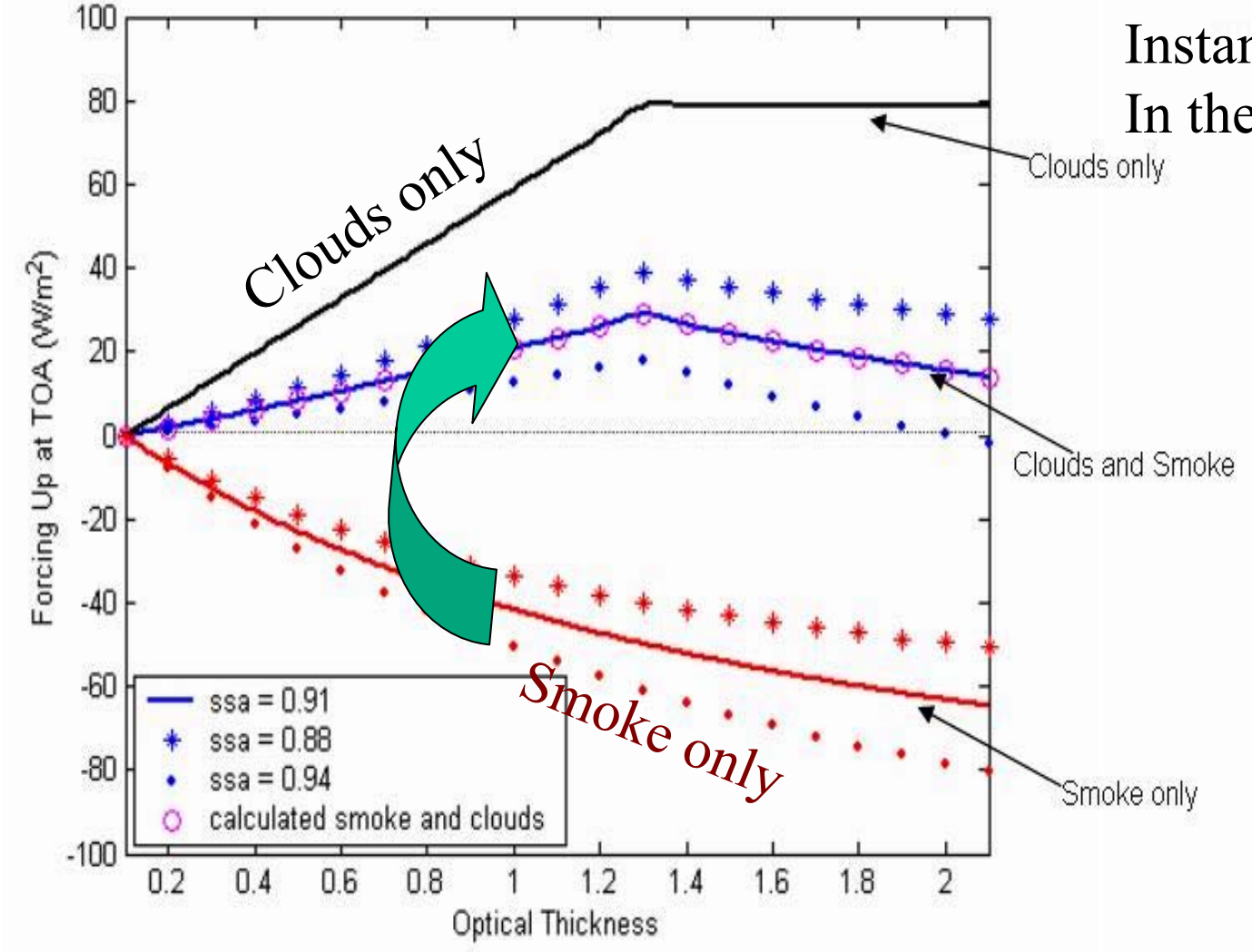


Cloud fraction as function of aerosol optical depth (OD). The cloud fraction decreases almost linearly with increasing OD.



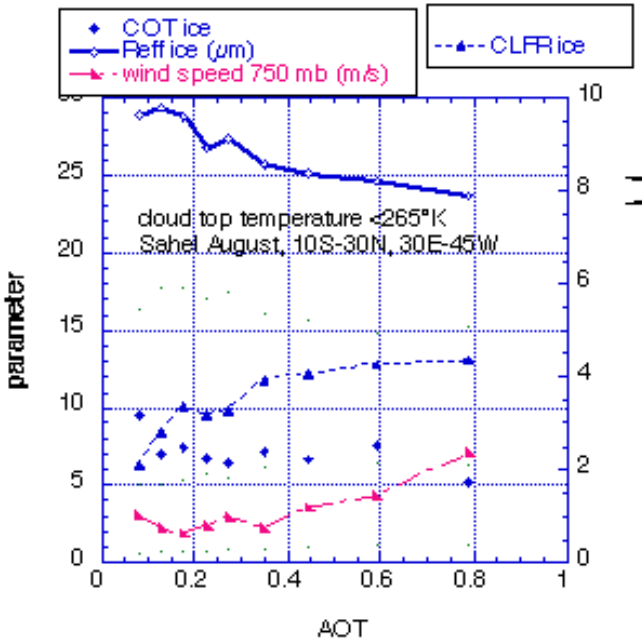


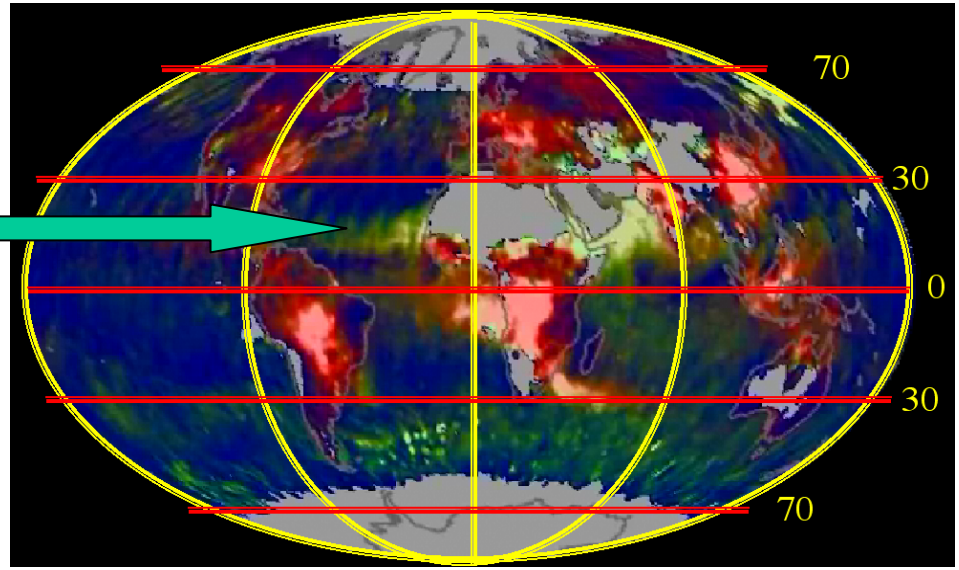
Instantaneous forcing
In the afternoon

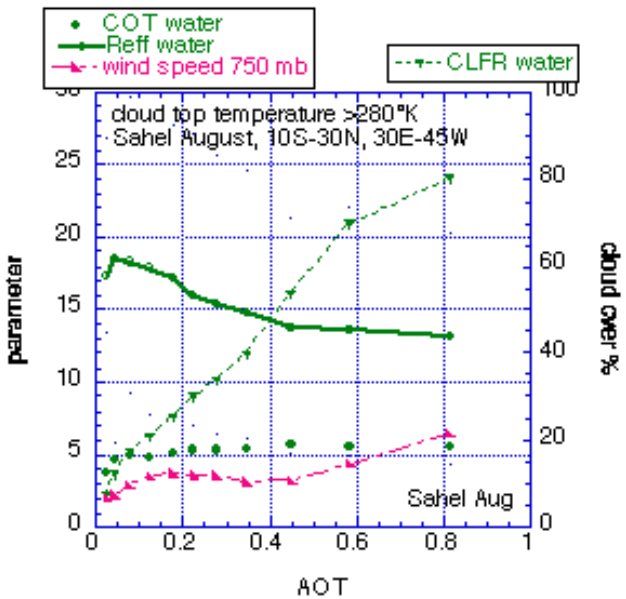


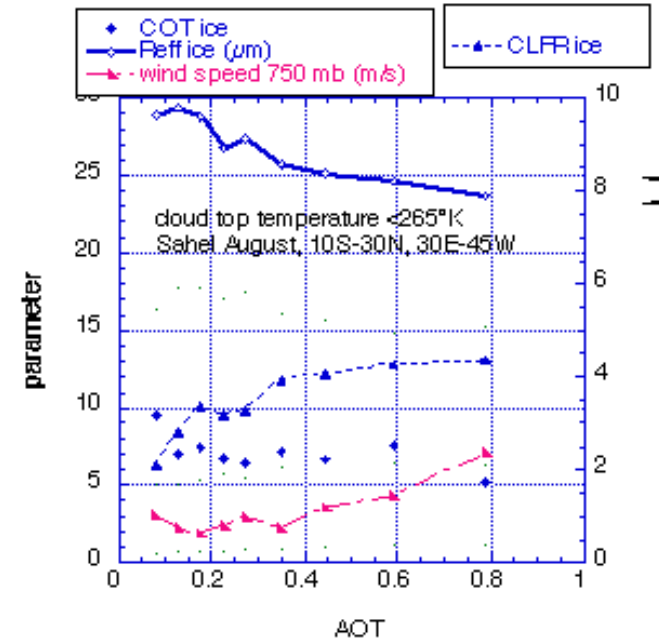
Impacts:

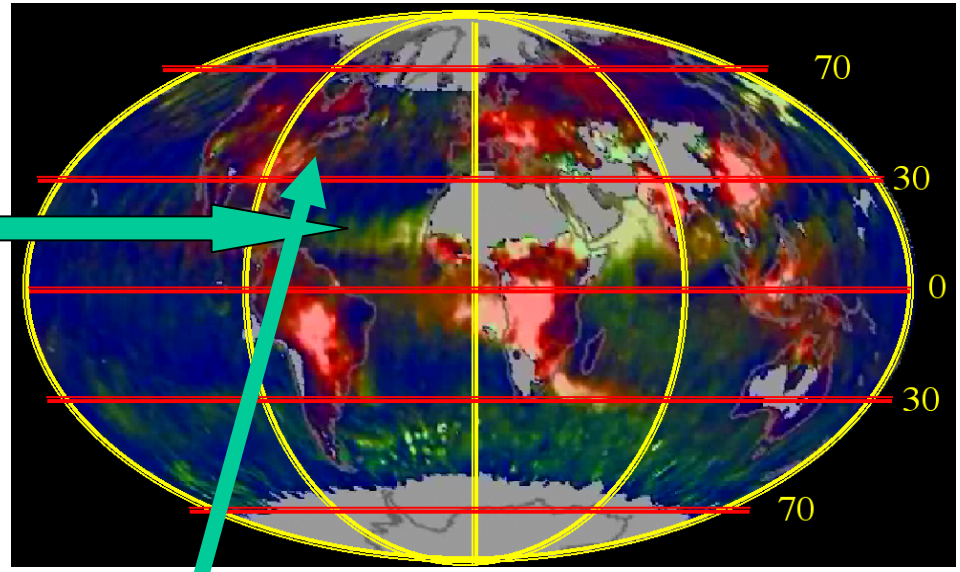
- slowing Greenhouse warming of the surface
- warmer, higher, more stable boundary layer
- smaller boundary layer cloud fraction

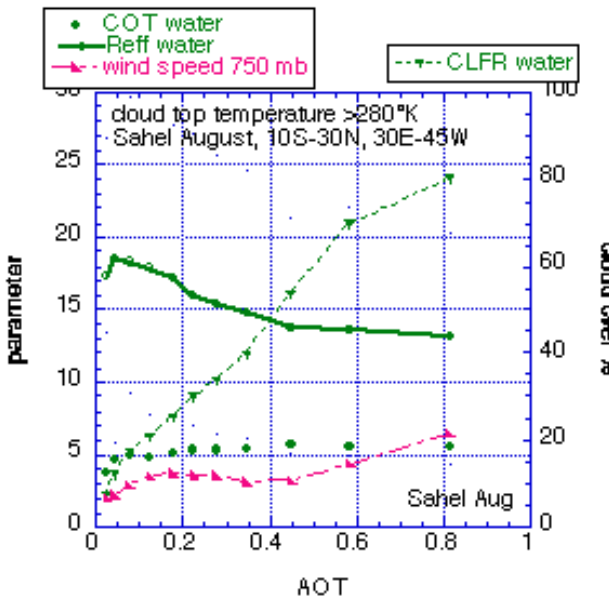

COT ice
Reff ice (μm)
wind speed 750 mb (m/s)
CLFR ice
cloud top temperature <265°K
Sahel August, 10S-30N, 30E-45W
parameter
cloud cver %
AOT

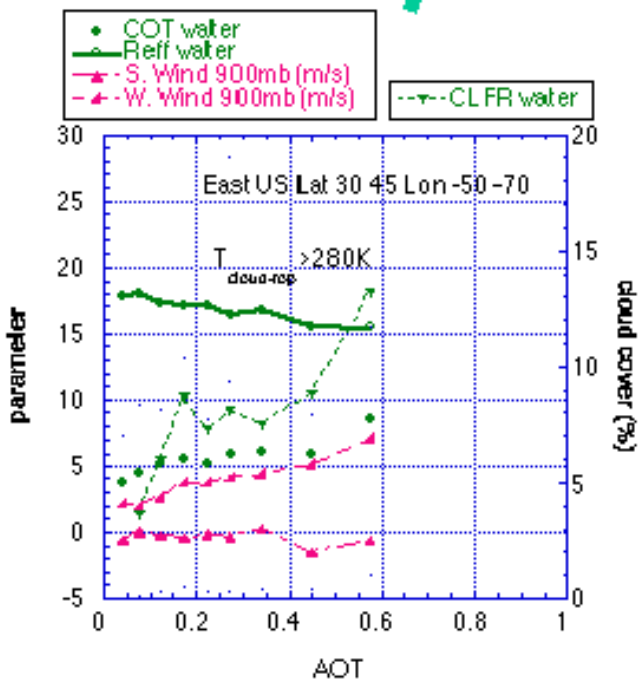

70
30
0
30
70

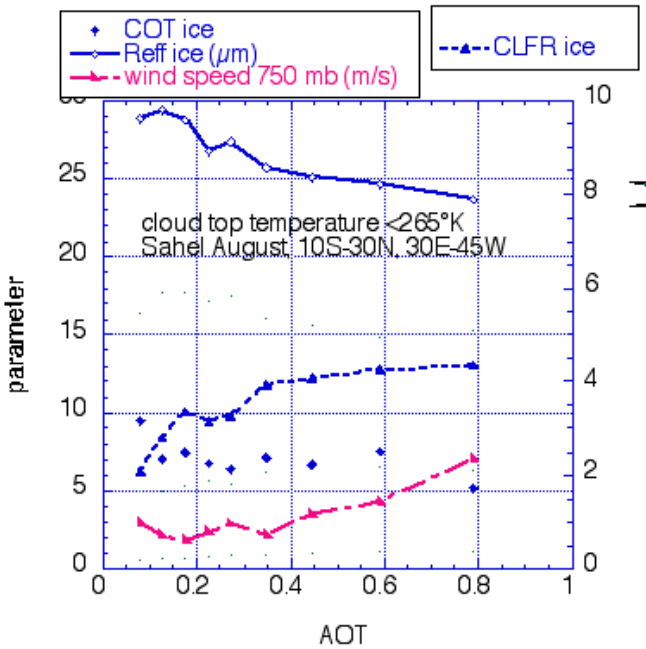

COT water
Reff water
wind speed 750 mb
CLFR water
cloud top temperature >280°K
Sahel August, 10S-30N, 30E-45W
Sahel Aug
parameter
cloud cver %
AOT

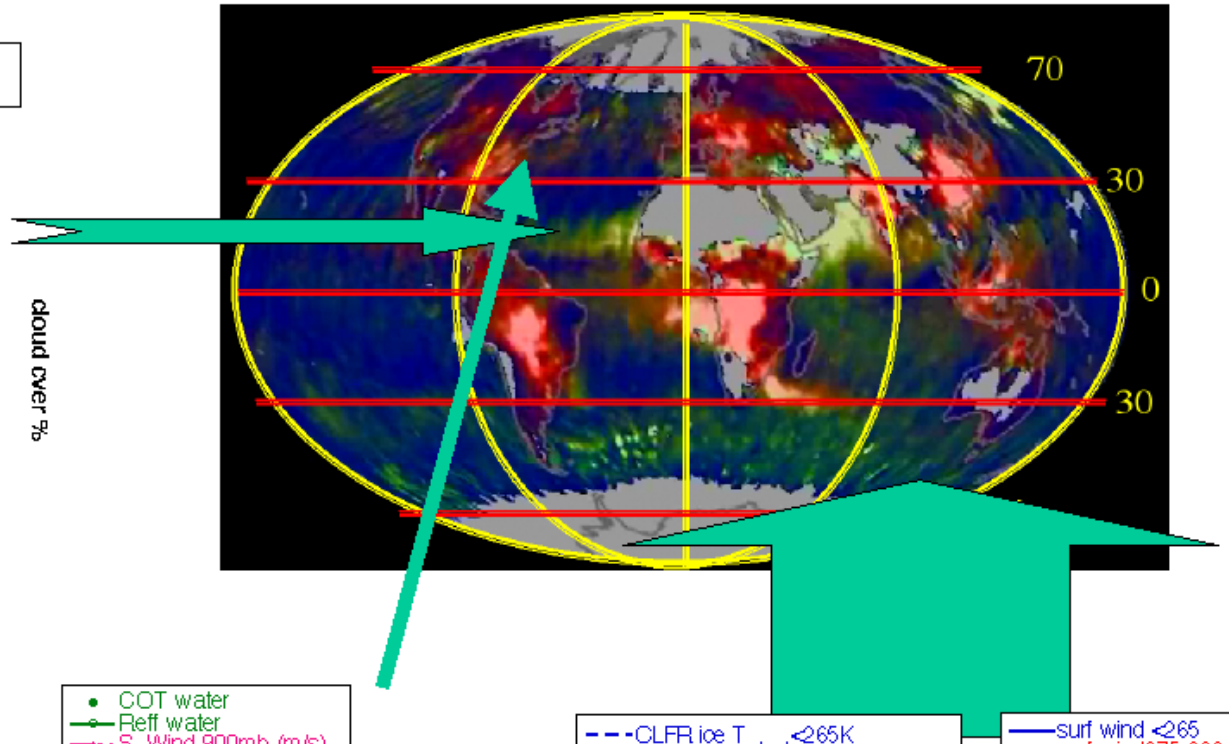

COT ice
Reff ice (μm)
wind speed 750 mb (m/s)
CLFR ice
cloud top temperature <265°K
Sahel August, 10S-30N, 30E-45W
parameter
cloud cover %
AOT

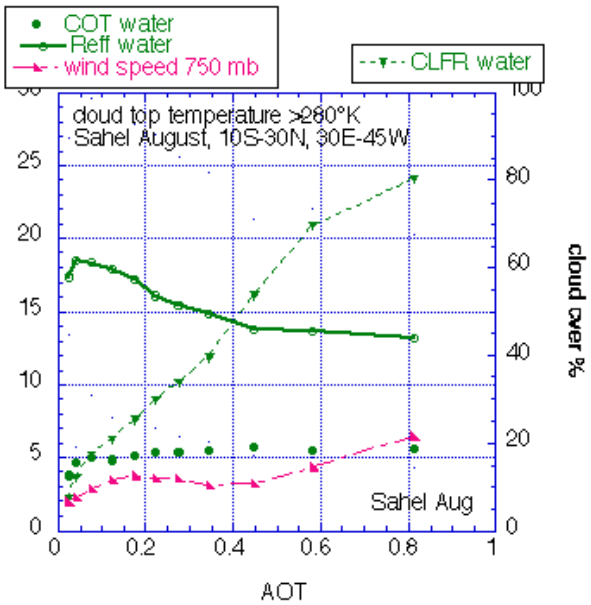

70
30
0
30
70

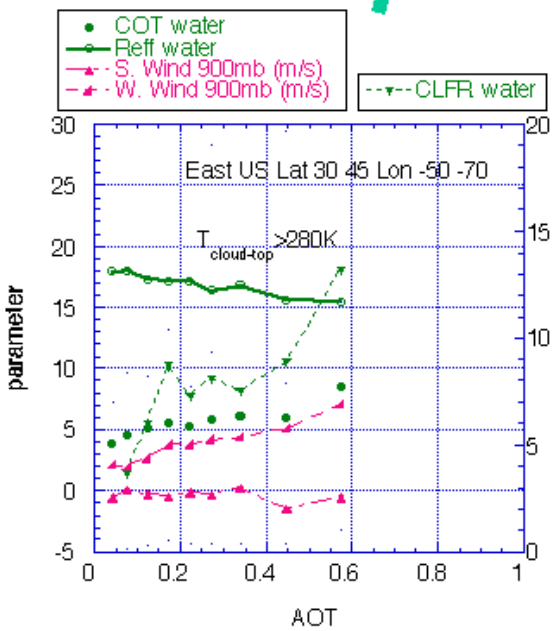

COT water
Reff water
wind speed 750 mb
CLFR water
cloud top temperature >280°K
Sahel August, 10S-30N, 30E-45W
Sahel Aug
parameter
AOT

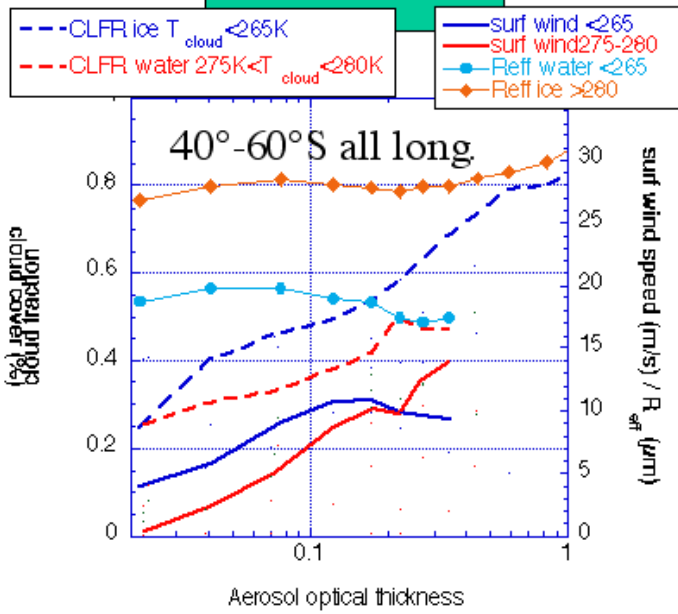

COT water
Reff water
S. Wind 900mb (m/s)
W. Wind 900mb (m/s)
CLFR water
East US Lat 30 45 Lon -50 -70
T cloud-top >280K
parameter
cloud cover (%)
AOT


COT ice
Reff ice (μm)
wind speed 750 mb (m/s)
CLFR ice
cloud top temperature <265°K
Sahel August, 10S-30N, 30E-45W
parameter
cloud over %
AOT


70
30
0
30


COT water
Reff water
wind speed 750 mb
CLFR water
doud top temperature >280°K
Sahel August, 10S-30N, 30E-45W
Sahel Aug
parameter
cloud over %
AOT


COT water
Reff water
S. Wind 900mb (m/s)
W. Wind 900mb (m/s)
CLFR water
East US Lat 30 45 Lon -50 -70
T cloud-top >280K
parameter
cloud fraction (%)
AOT


CLFR ice T cloud <265K
CLFR water 275K<T cloud <280K
surf wind <265
surf wind275-280
Reff water <265
Reff ice >280
40°-60°S all long.
surf wind speed (m/s) / R eff (μm)
Aerosol optical thickness

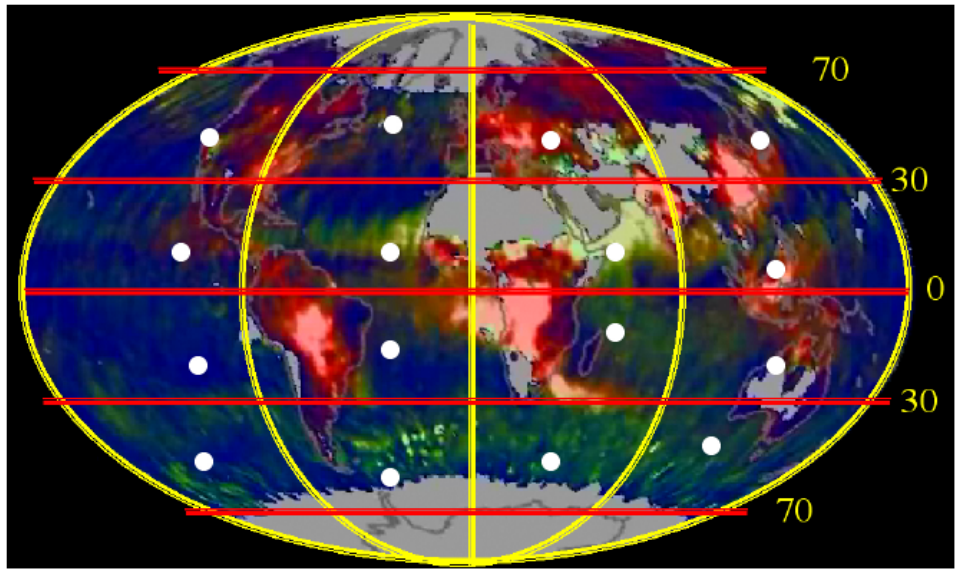
Ocean - August 2003

AOT

0.15	0.18	0.20	0.23
0.11	0.23	0.42	0.11
0.09	0.13	0.17	0.11
0.10	0.12	0.13	0.11

Broken Cloud fraction

0.52	0.47	0.34	0.49
0.42	0.40	0.52	0.39
0.34	0.44	0.43	0.38
0.54	0.56	0.58	0.55



Correlations with aerosol AOT

CORRELATION of ice cloud cover

<265	0.84	0.87	0.96	0.80
0.8	0.91	0.57	0.64	0.73
	0.90	0.85	0.49	0.80
	0.90	0.90	0.94	0.94

CORRELATION Reff ice cloud

<265	0.75	0.79	-0.24	-0.92
-0.1	-0.81	-0.96	-0.94	-0.94
	0.84	-0.88	-0.93	-0.54
	0.92	0.82	0.37	0.65

CORRELATION of water cloud cover

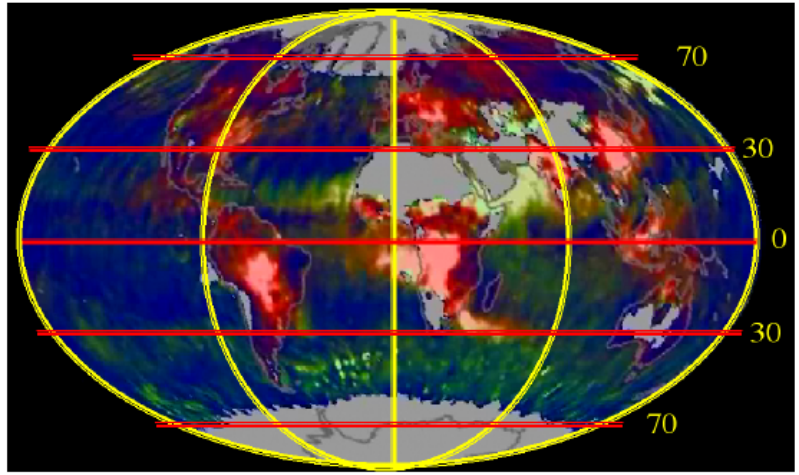
>280	0.71	0.89	0.86	0.63
0.9	0.98	0.98	0.99	0.99
	0.99	0.99	0.98	0.81
	0.96	0.95	0.96	0.97

CORRELATION Reff water cloud

>280	-0.78	-0.83	0.26	-0.60
-0.5	-0.76	-0.97	-0.93	-0.93
	0.83	-0.85	-0.92	-0.95
	0.64	-0.87	-0.97	0.87

Correlation of 0.2 is 95% significant, 0.55 is 99% significant

Change in cloud properties for a change in AOT from background (0.06) to the average value



Range of cloud top temperature (K)

<265 Aerosol OT				
0.19	0.23	0.24	0.22	0.25
	0.16	0.26	0.35	0.14
	0.13	0.15	0.18	0.13
	0.15	0.16	0.18	0.15

>280 Aerosol OT				
0.15	0.09	0.16	0.22	0.2
	0.1	0.22	0.47	0.09
	0.08	0.13	0.17	0.11
	0.09	0.1	0.11	0.08

<265 % change in Reff ice cloud				
-1.1	2	1	0	-1
	-1	-4	-8	-1
	2	-3	-5	-1
	1	1	0	1

>280 % change in Reff water clo				
-2.9	-2	-2	0	-3
	0	-4	-18	-1
	0	-4	-6	-2
	0	-3	-3	1

<265 % change in ice cloud OT 9				
0.5	0	5	-2	2
	5	-7	17	-1
	1	7	7	-4
	-5	-4	-5	-6

>280 % change in water cloud O				
2.6	2	5	-4	6
	2	3	2	2
	4	1	3	4
	4	5	1	3

<265 % change in ice water				
-0.6	1	6	-3	1
	4	-11	9	-2
	2	4	2	-5
	-5	-3	-5	-5

>280 % change in liquid water				
-0.3	0	3	-4	3
	2	-2	-16	1
	4	-3	-3	2
	4	2	-2	4

Correlation between the aerosol effect on cloud ice size and optical thickness for 0-70°N Oct. 2003