Test of the Iris Hypothesis Using CERES SSF Data

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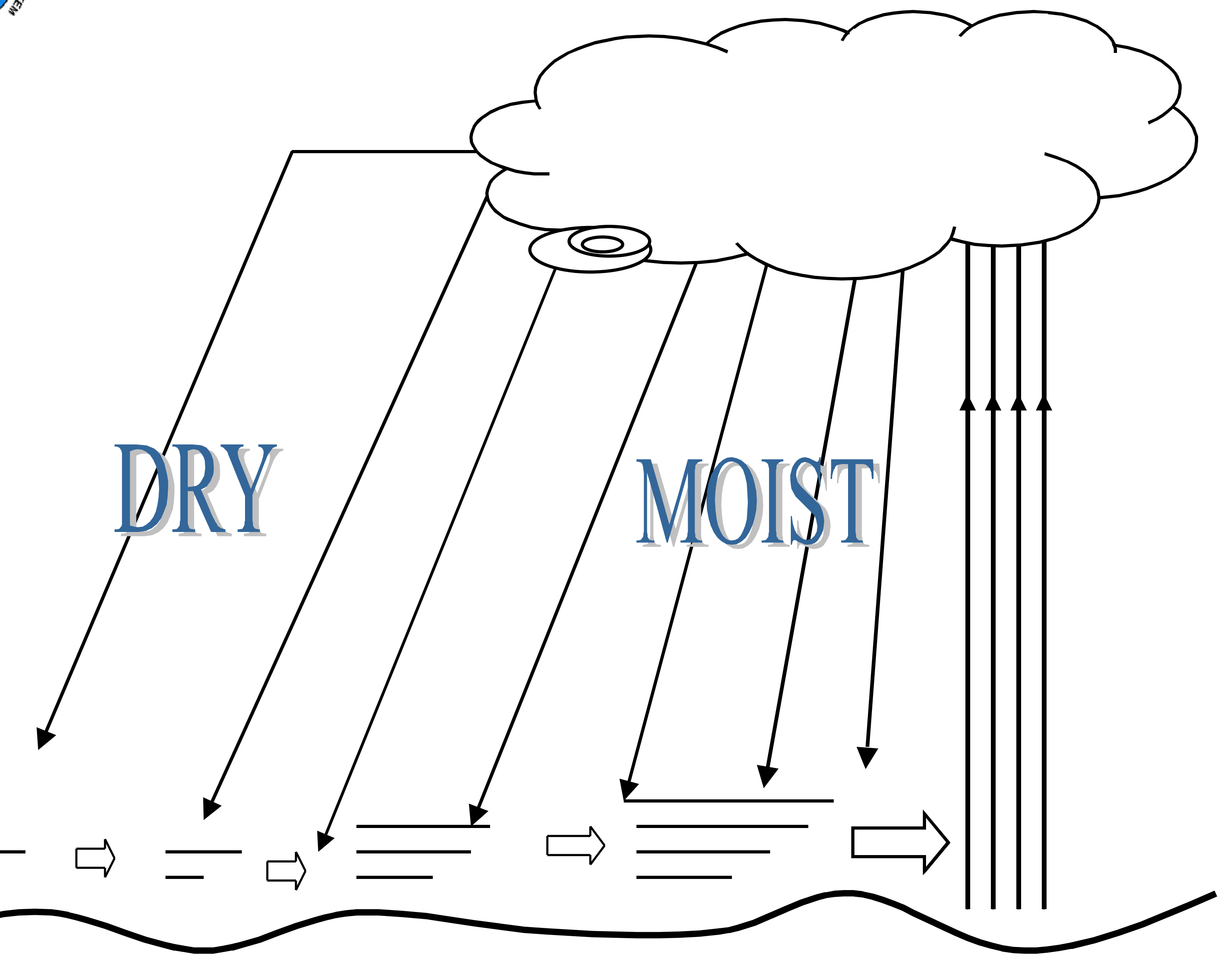
Outline

1. Background

    Lindzen et al.' (2001) climate feedback: observation & model

2. CERES Data
3. 3.5-box Model Calculation
4. Discussions: cirrus
5. Summary



Atmospheric Moisturization

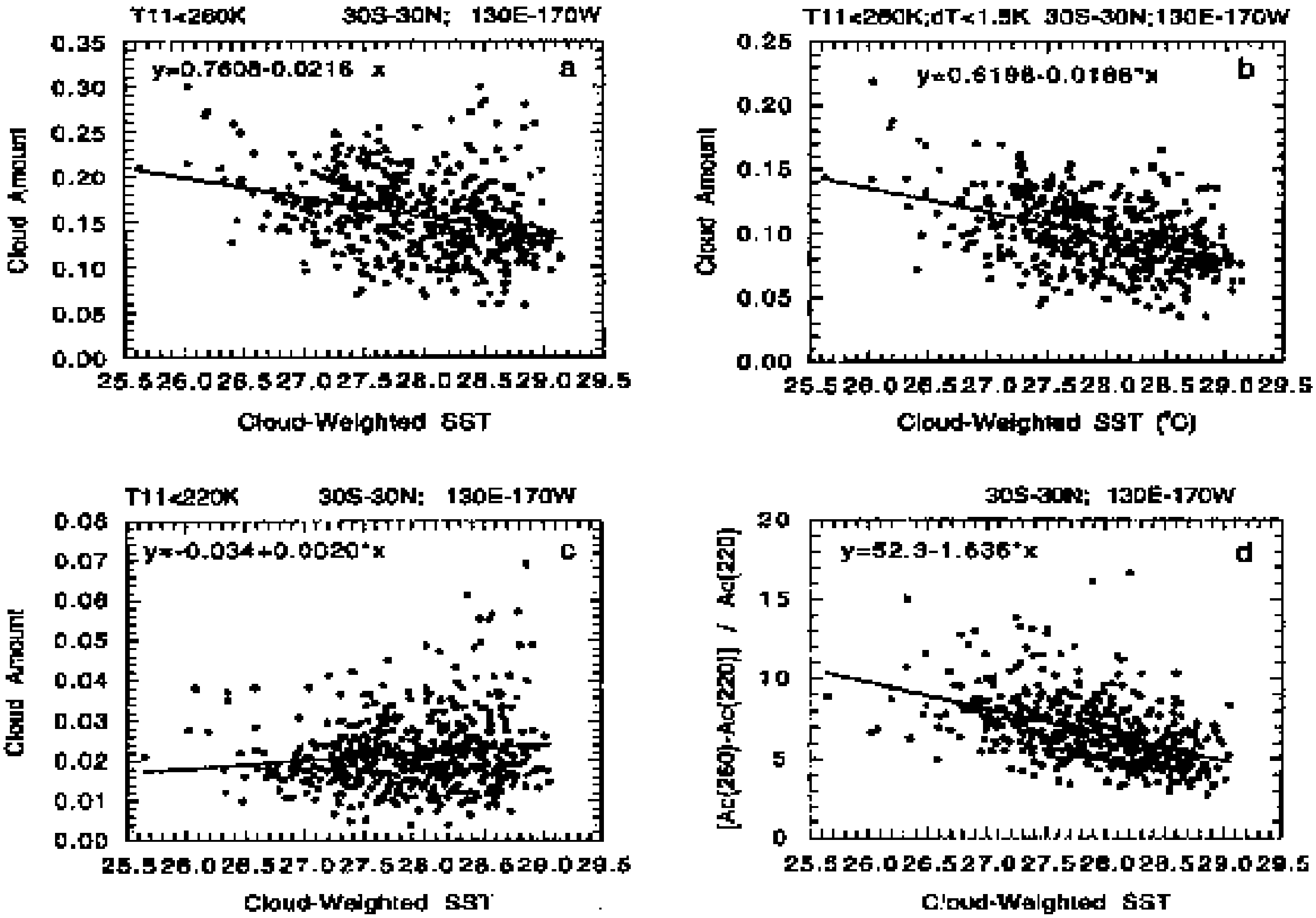
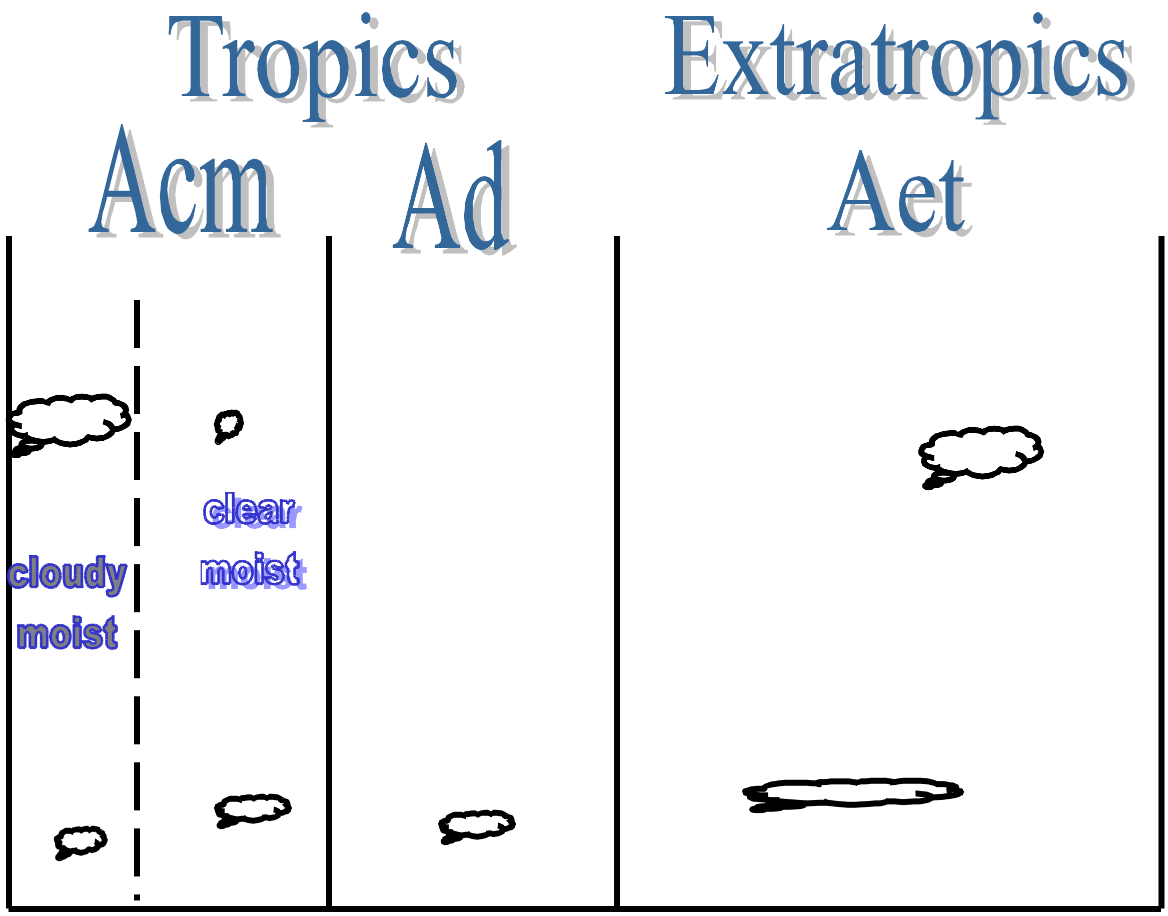


FIG. 5. Scatterplots showing how cirrus coverage varies with cloud-weighted SST for both "all" (a) upper-level clouds and (b) thick clouds. Also shown is (c) the variation of cumulus area with cloud-weighted SST and (d) the variation of cirrus coverage normalized by cumulus coverage. Data points correspond to daily averages. (See text for details.)



Tst = Ts + 10K   Tset = Ts – 10K

1. Background (cont.)

Based on the anvil variations with SST observed from GMS data and 3.5-box greenhouse model, Lindzen et al. (2001) proposed a very strong negative radiative feedback of the clouds on climate change (–0.45 ~ –1.1K/K; or **IR Iris**).

1. Background (cont.): main points

Q: Do CERES data show the similar cloud change with SST, and feedback processes?

(Since we do not know where many values in Lindzen et al. come from)

2. CERES TRMM Data

Definitions of clouds & climate regimes:

convective clouds: Tb(10.8) < 220K

cloudy moist: Tb(10.8) < 260K (anvil+DCC)

or other cloudy definitions

dry area: broadband LW↑ > LW50

LW50: 50% percentile of 8-month LW↑ statistics

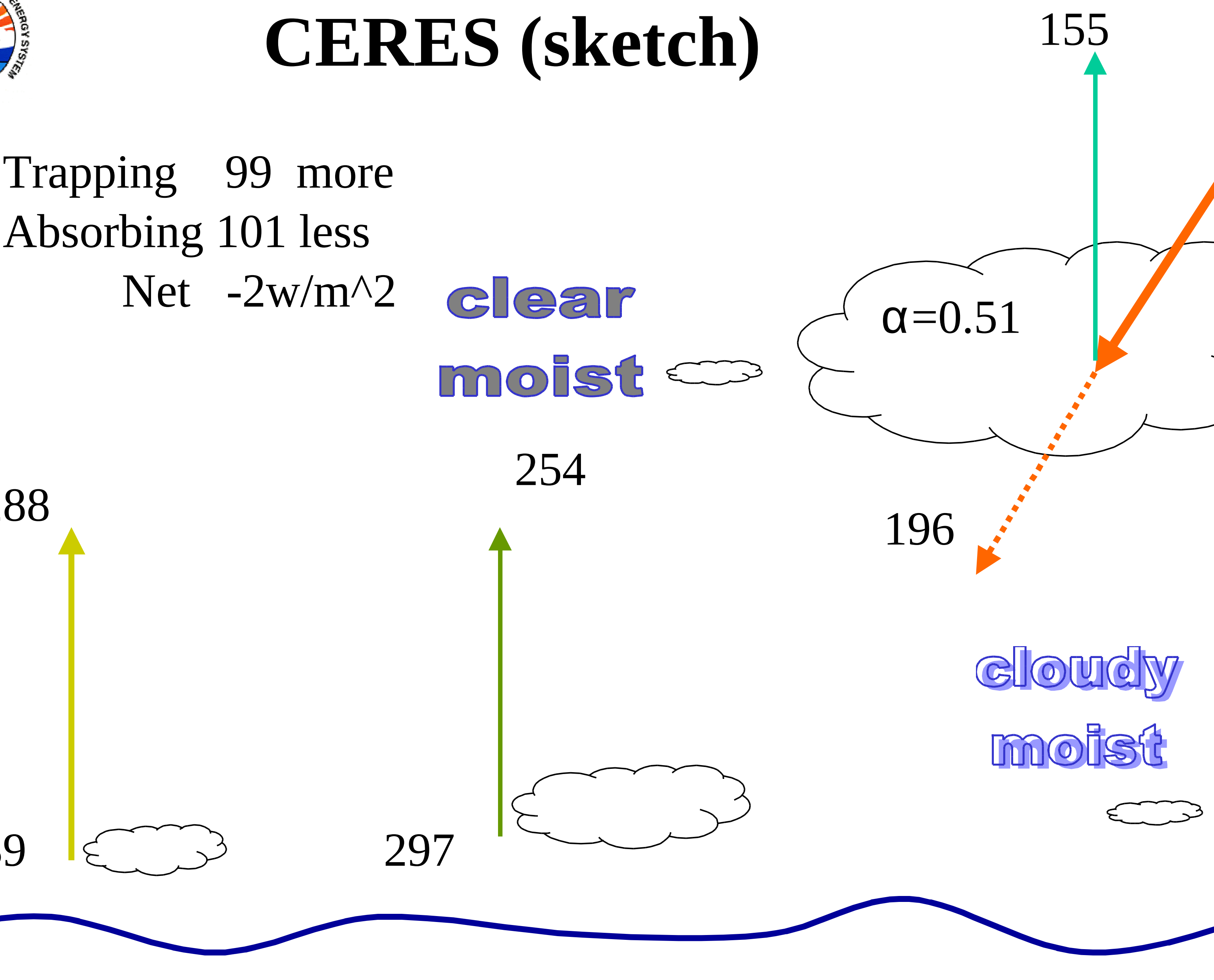
CERES Estimates

clear moist: all other pixels

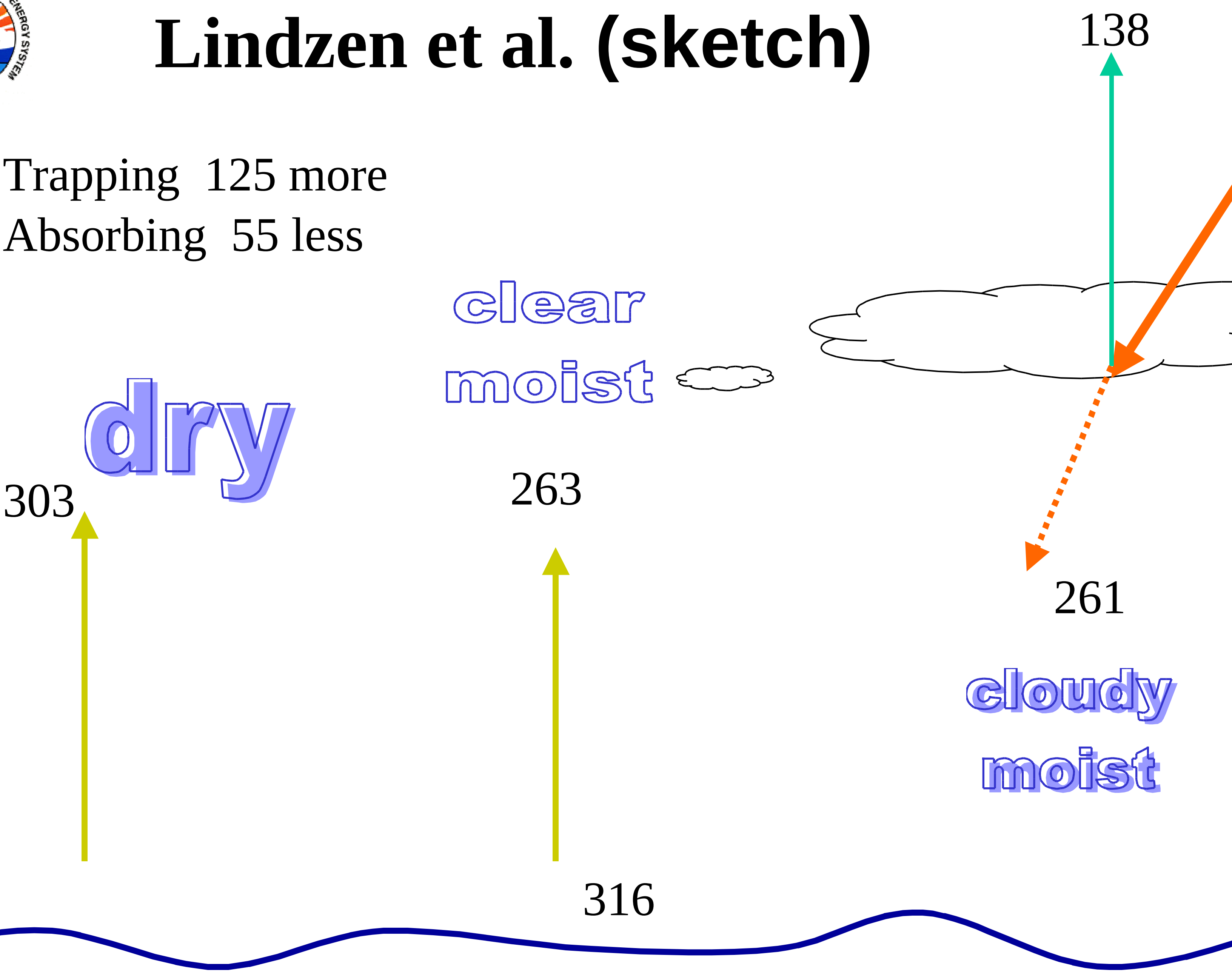
	LaRC ¾ CERES			Lindzen et al.		
	dry	clear moist	cloudy moist	dry	clear moist	cloud moist
q	0.5	0.4	0.1	0.5	0.28	0.22
edo	0.154	0.258	0.510	0.211	0.211	0.349
↓	338.7	297.1	196.2	315.9	315.9	260.6
↑	287.7	253.9	154.8	303.1	263.1	137.7

CERES (sketch)

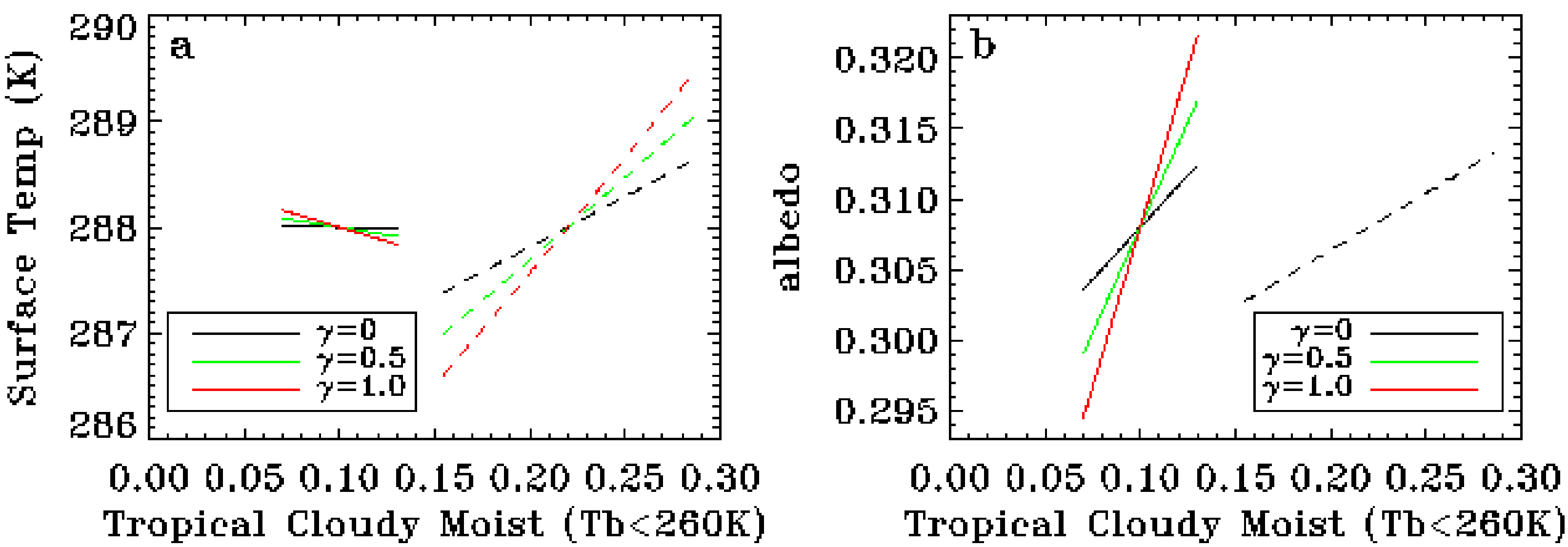
Trapping 99 more
Absorbing 101 less
Net -2w/m^2



Lindzen et al. (sketch)



Model cloud feedbacks



Solid lines: CERES; Dashed lines: Lindzen et al.

4. Discussions

LCH points:

1. Edge effects: increasing SST & keeping a constant Tb threshold (260K)

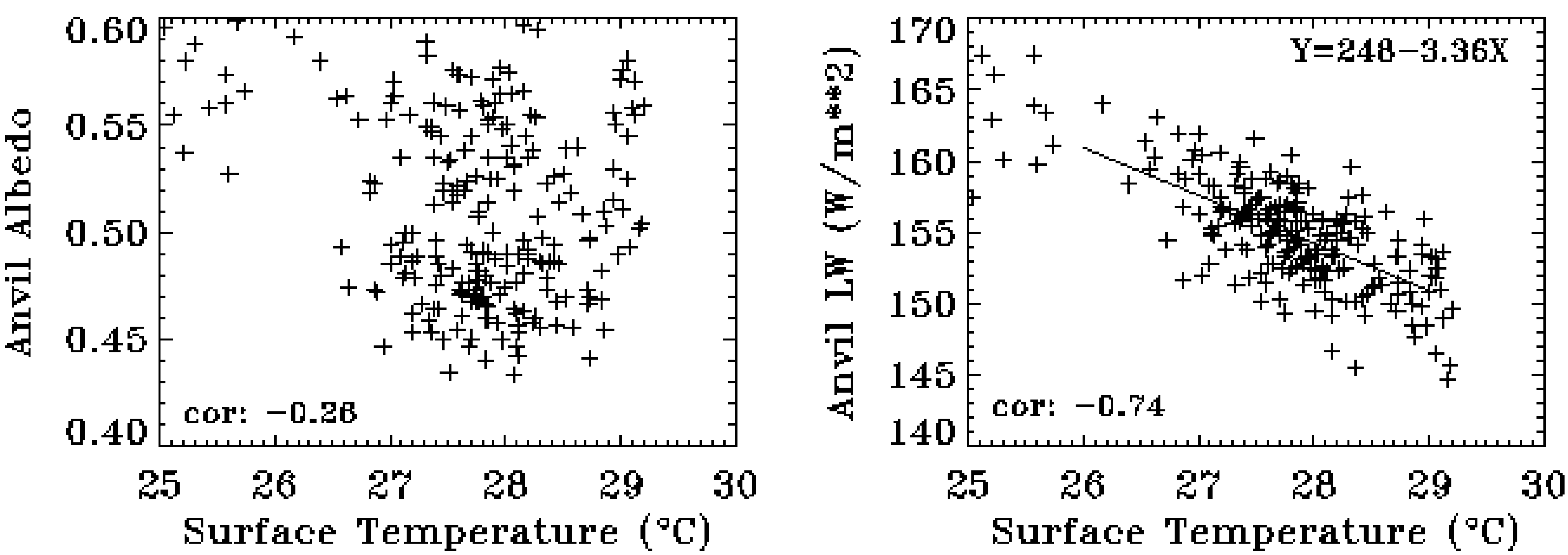
   cutting out radiative warming thin cirrus

2. ‘LCH specified subjectively the ORL and albedo for the three regions while requiring that the mean OLR and albedo of the tropics are consistent with the ERBE inferred values’.

Discussions (cont.)

3. ‘LCH inferred areal coverage of high-level clouds using a threshold temperature of 260K…… This areal coverage of high-level clouds is **merely an index** for ……It is **not meant to be** the total areal coverage of high-level clouds……’
4. 4. ‘If we **assume** that their estimates of OLR in the three tropical regions **are appropriate** for studying the climate sensitivity, the feedback factors of high-level clouds should remain negative as suggested by LCH although the magnitudes are somewhat smaller, …….’

CERES Albedo and LW



a) ISCCP Cloud Fraction in West Pacific (%)

H (km) \ Optical Depth	0–1	1–4	4–9	9–23	23–60	60–380
13–24	14.9	5.1	0.9	0.8	1.8	0.7
9.5–13	0.7	8.5	5.0	4.2	3.4	0.6
7–9.5	1.9	6.4	2.3	1.0	0.4	0.1
5–7	2.2	1.4	1.2	1.0	0.3	0.1
3.5–5	1.0	1.4	1.3	0.5	0.1	0.0
2–3.5	0.5	1.1	1.0	0.3	0.1	0.0
0–2	0.4	1.6	1.1	0.2	0.0	0.0

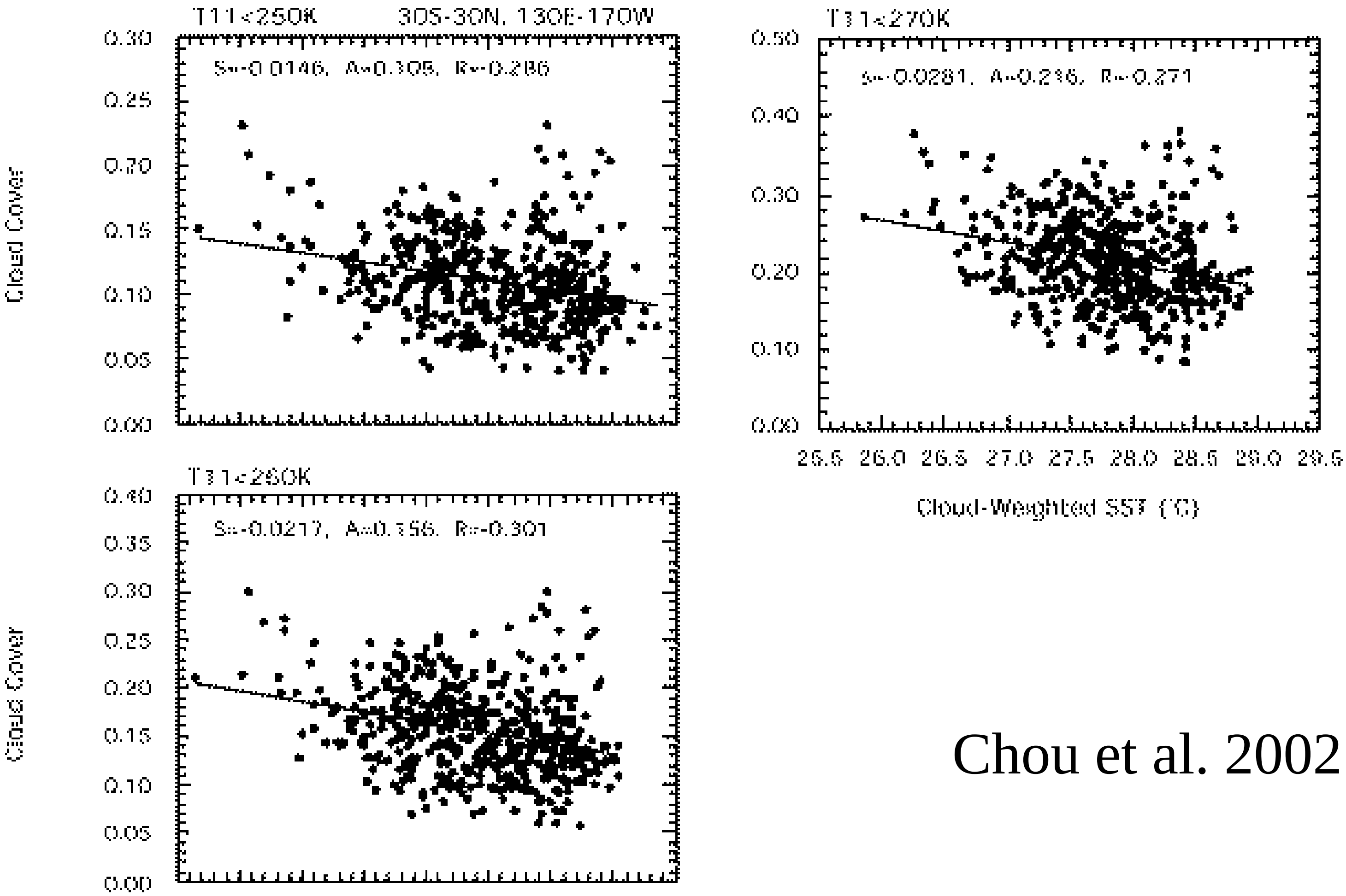
Fu et al. 2001

b) Cloud Radiative Forcing (W m^{-2})

H (km) \ Optical Depth	0–1	1–4	4–9	9–23	23–60	60–380
13–24	+8.1	+4.0	+0.4	-0.1	-1.0	-0.5
9.5–13	+0.1	+1.7	-1.1	-3.2	-4.1	-0.9
7–9.5	+0.1	-0.7	-1.4	-1.2	-0.7	-0.1
5–7	-0.1	-0.5	-1.0	-1.4	-0.5	-0.1
3.5–5	-0.1	-0.4	-1.9	-0.9	-0.2	-0.1
2–3.5	-0.1	-0.4	-0.9	-0.5	-0.1	0.0
0–2	0.0	-0.6	-1.0	-0.3	-0.1	0.0

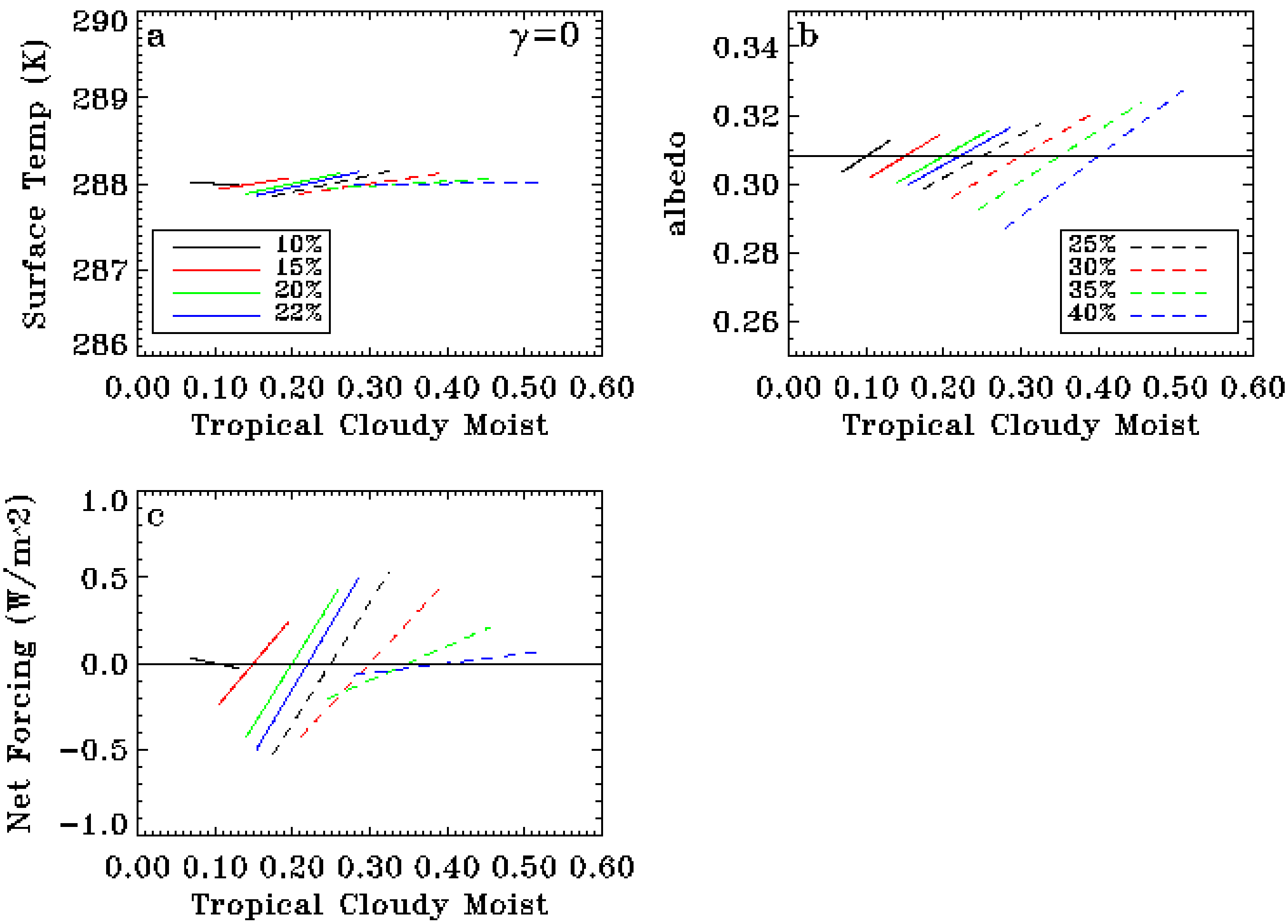
High cloud radiative forcing = -1 W/m^2

Tb threshold versus CC

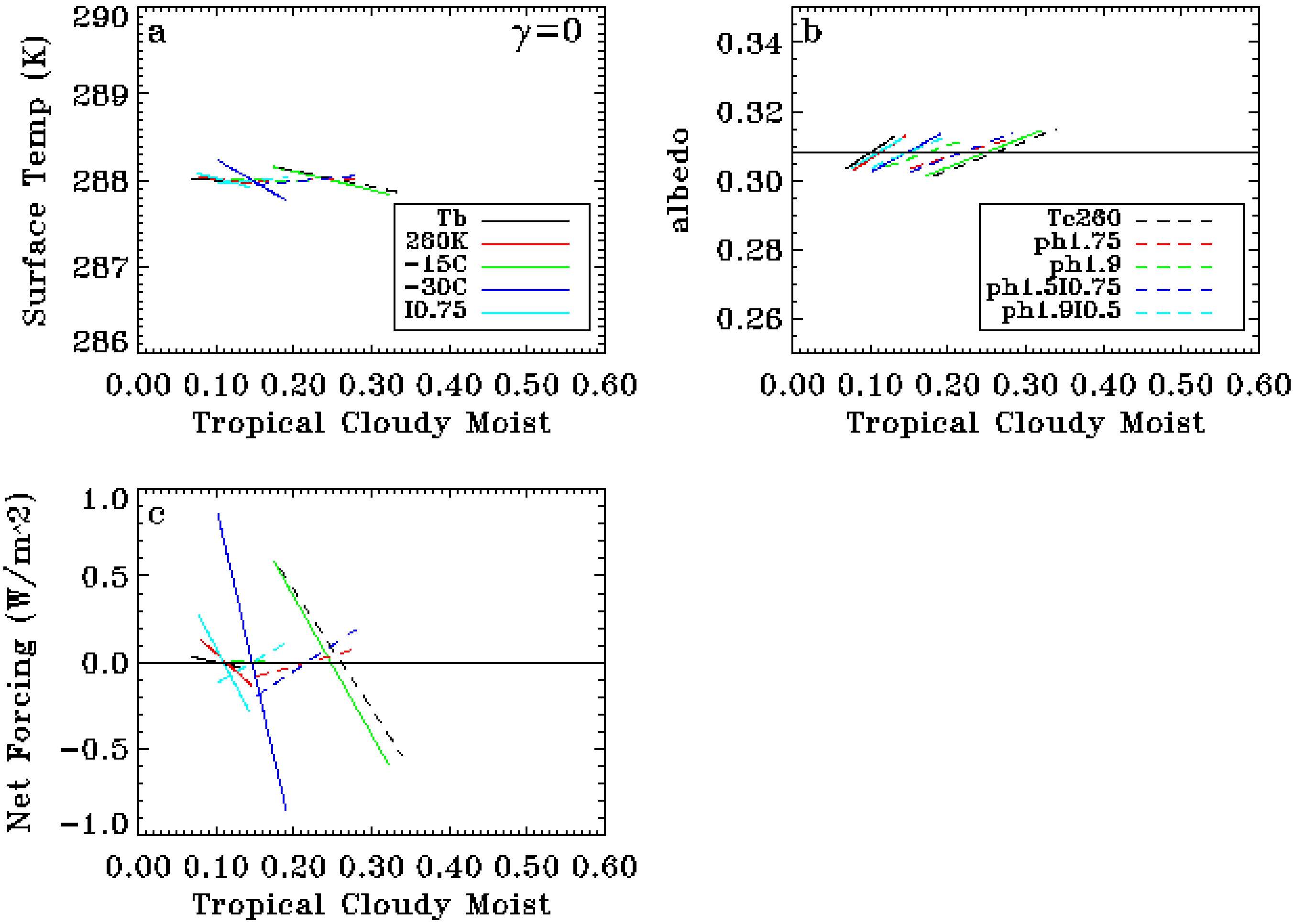


Chou et al. 2002

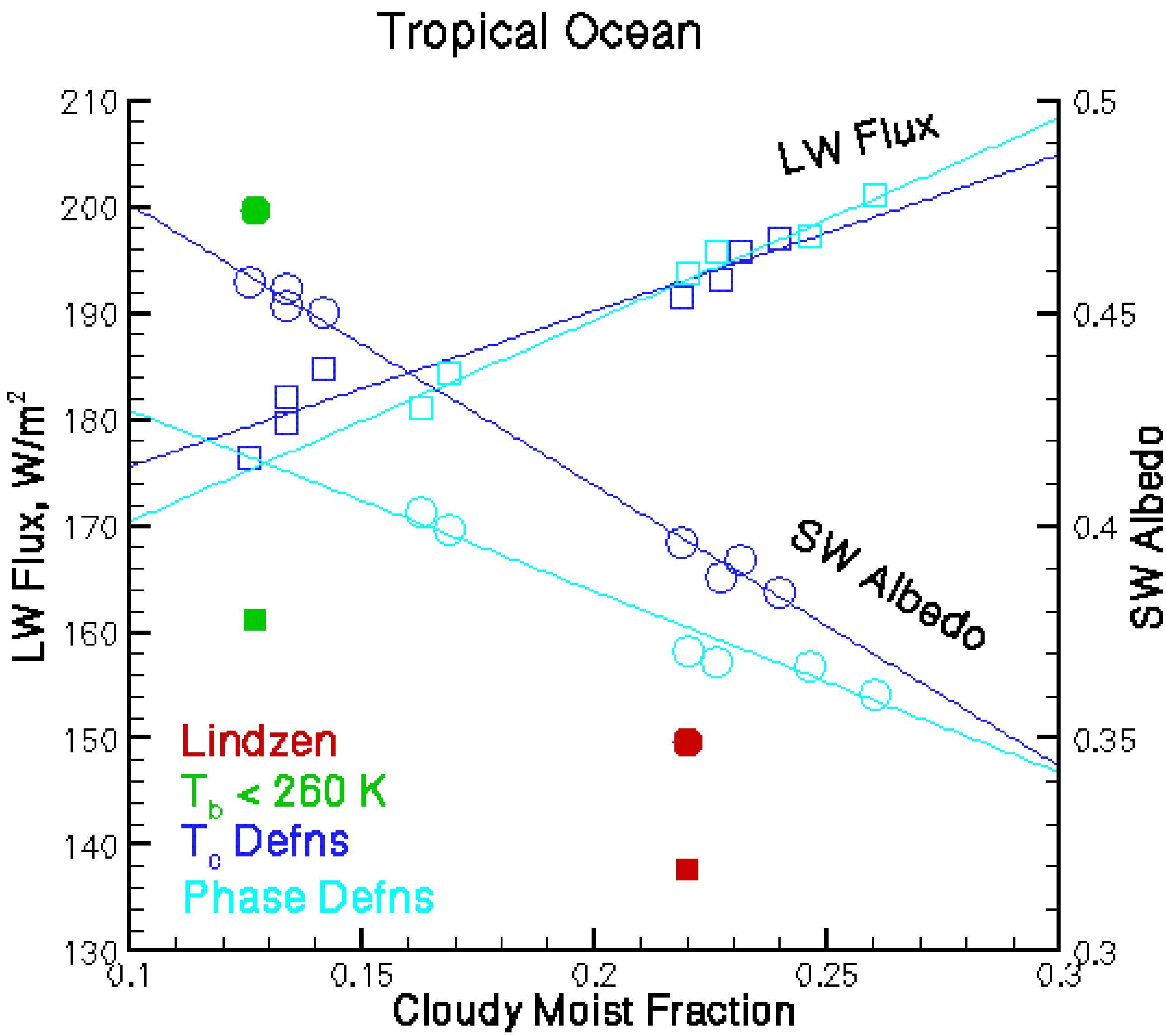
Effects of Tb threshold



Effects of ice cloud amount



LW & alb vs high clouds



Summary

1. Based on observations, eliminating cirrus clouds in the edge of extent anvil clouds will not change the net radiative forcing much (within ~2W/m^2).
2. 2. Although change Tb threshold for cloudy-moist regions leads to different areal coverage and albedo of the clouds, the radiative feedback of the clouds is still small due to corresponding change in longwave radiation.
3. For all kinds of cirrus clouds (or cloudy-moist regions) we tested, the feedback factors of high-level clouds are only ~1/10 of LCH.

Acknowledgement

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