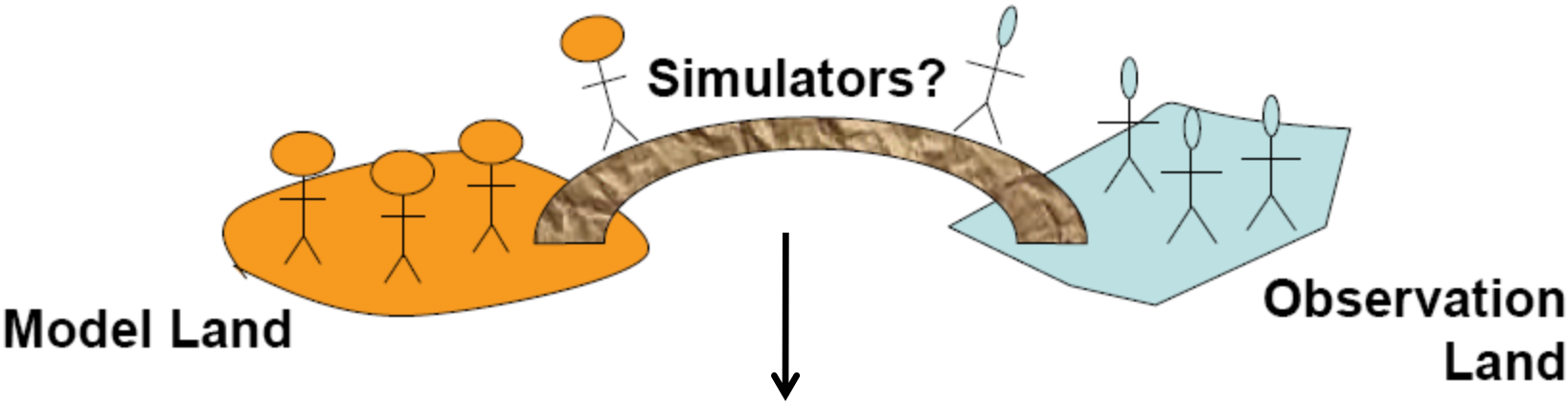
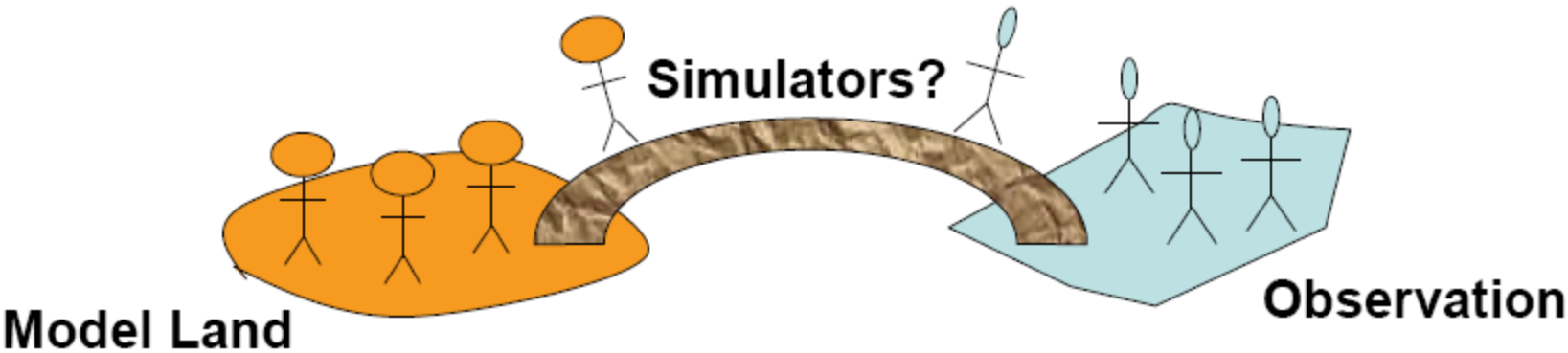
Validation of the ISCCP Simulator Using ARM Data

Jay Mace, Stephanie Houser, Sally Benson
Steve Klein

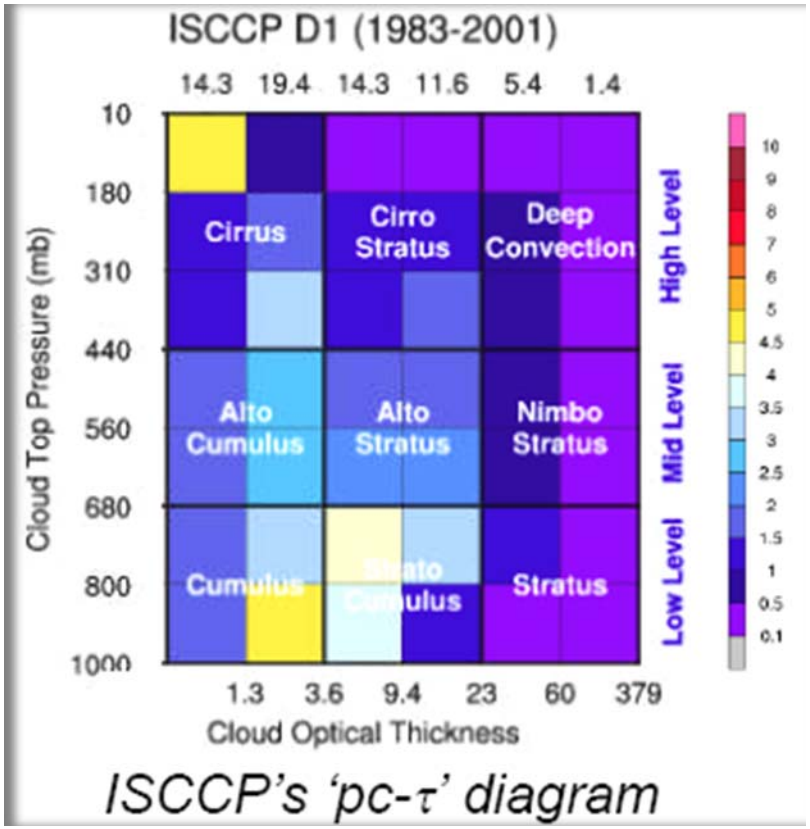


How Well Does the ISCCP Simulator Simulate ISCCP

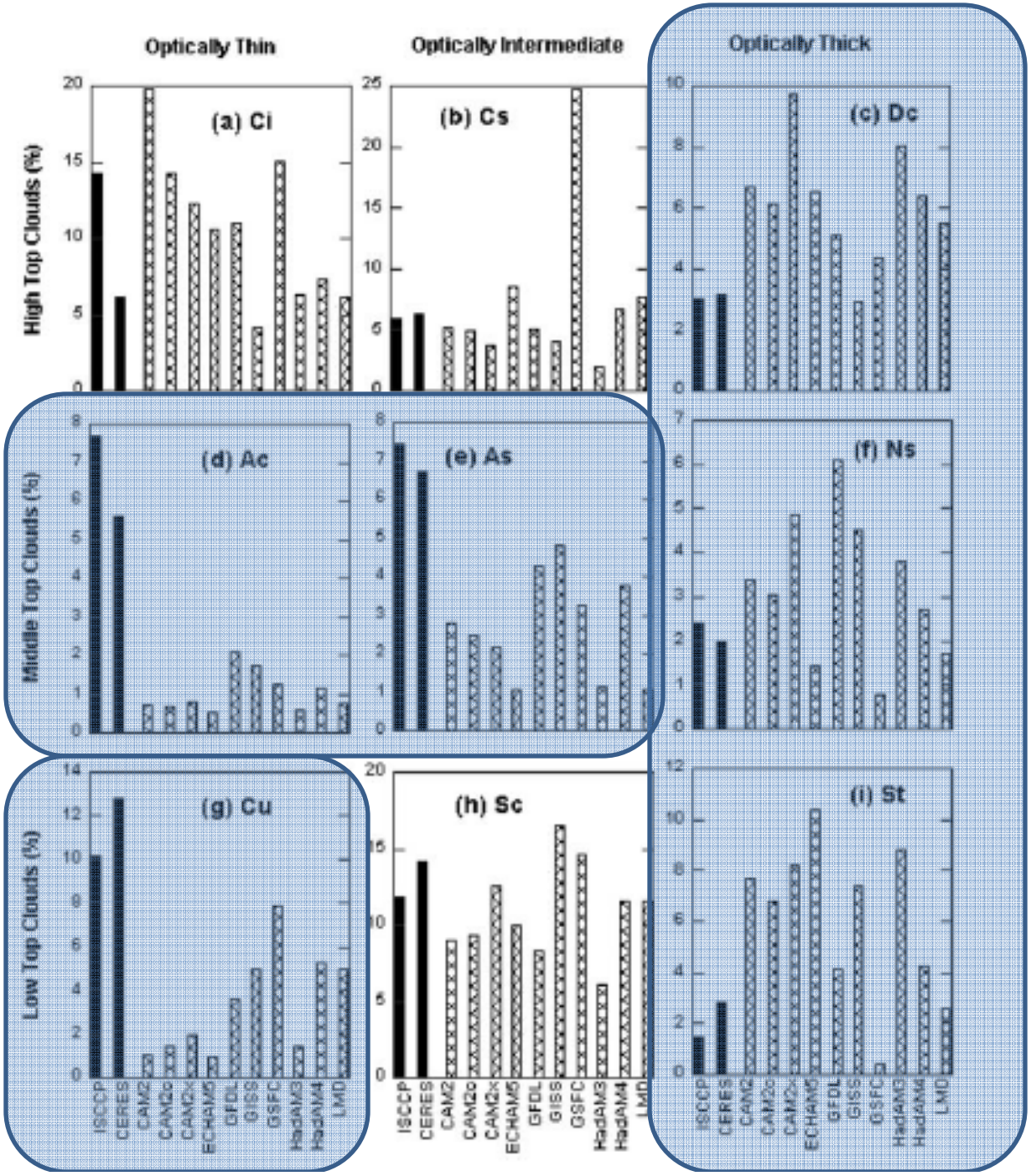


Model predicted
- cloud fraction profile,
- microphysical profile,
- radiative properties profile,
- thermodynamics

1. Parameterize the 10 micron Tb
2. Simulate ISCCP



ISCCP Simulator Results



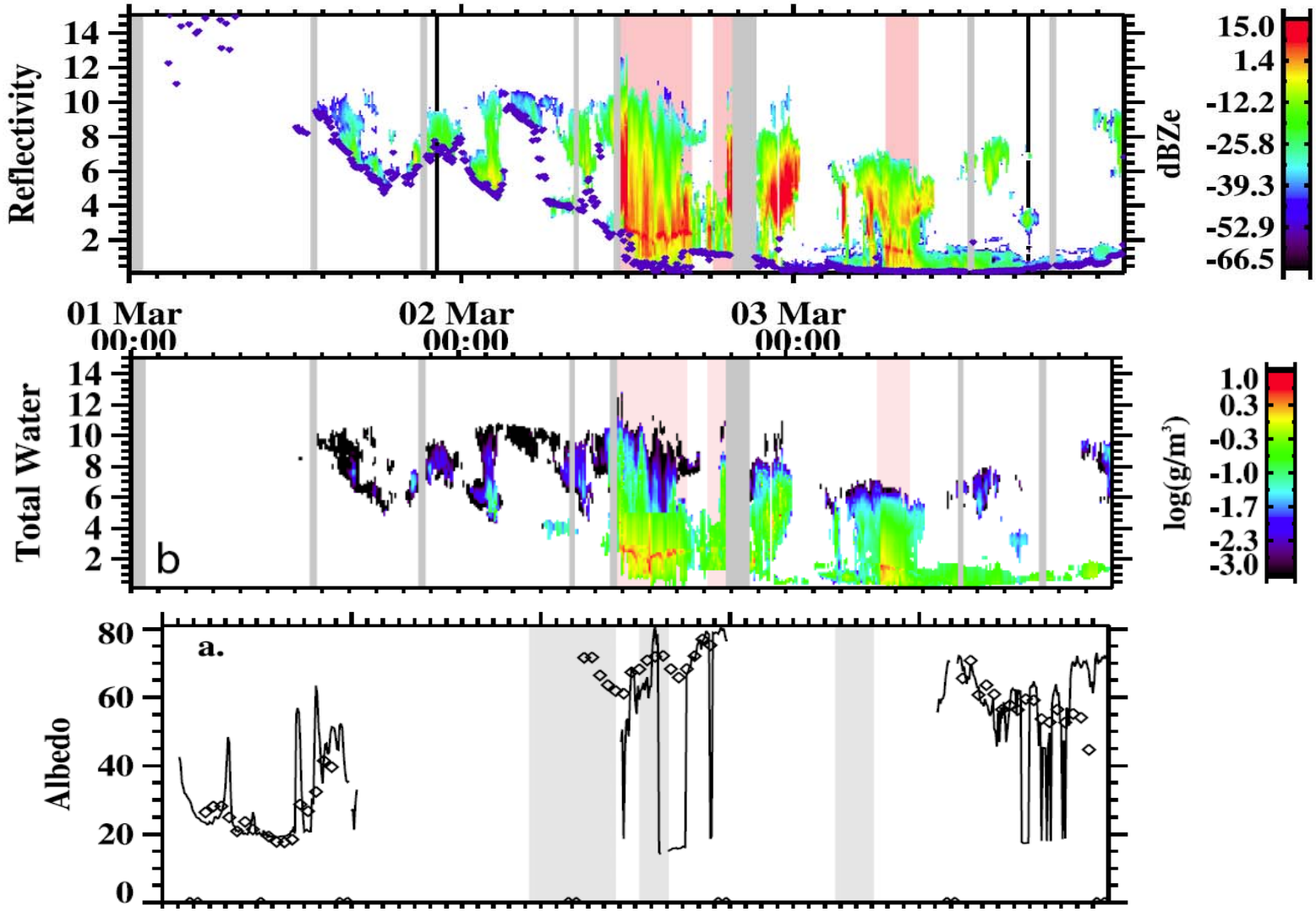
- Models produce too much optically thick clouds compared to ISCCP.

Models produce too little thin middle and low clouds compared to ISCCP.

From Zhang et al. (2005)

Using ARM Data to Test the ISCCP Simulator

First: ARM data to physical description (Mace et al., 2006a,b, 2008)



Using ARM Data to Test the ISCCP Simulator

Goal: To become one with ISCCP

The vertical profile of microphysics is input to ICARUS just as model output would be to produce CTP-Tau for a given profile.

If ….

1. The ARM data reasonably represent the atmosphere physical state,
2. The cloud field is sufficiently uniform so that spatial and temporal comparisons can be made
3. ICARUS is correctly simulating ISCCP,

Then, ISCCP and ARM should agree within uncertainty constraints

The Comparison Methodology

Other Details:

• We calculate the 10 micron radiance using MODTRAN and the MODTRAN radiance is then passed through the ISCCP simulation logic.

• Inversion problem with ICARUS has been fixed for this comparison.

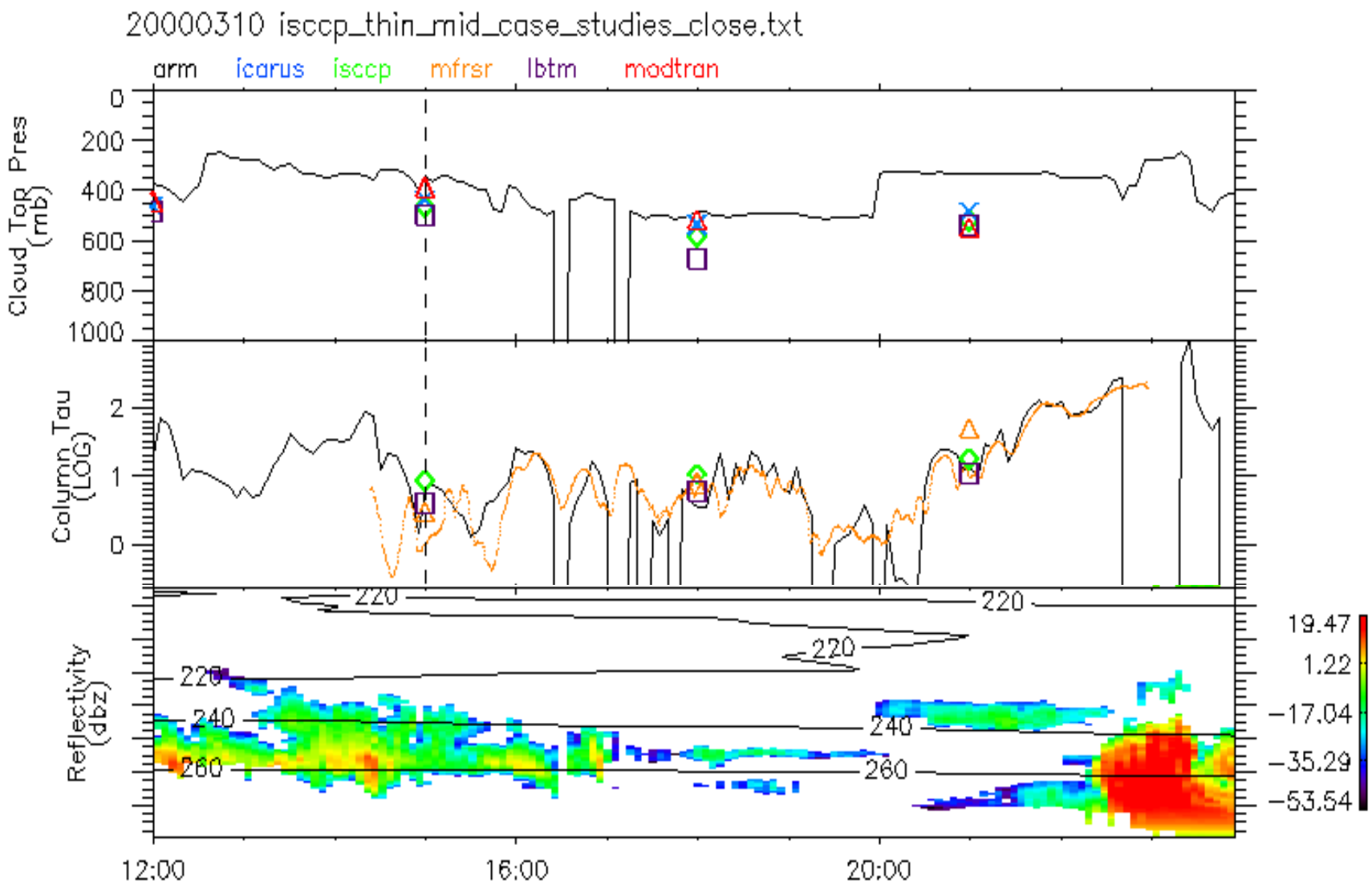
• We also compare with Minnis' LBTM nearest pixel to ARM

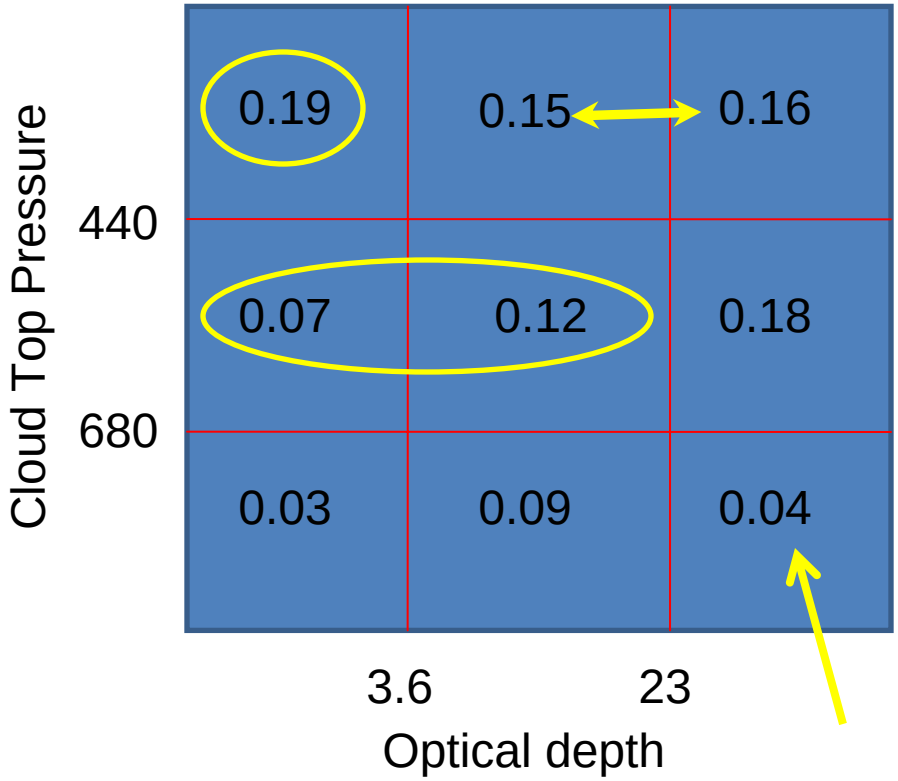
• Optical depths from Min's MFRSR retrieval is also used as an additional constraint on tau.

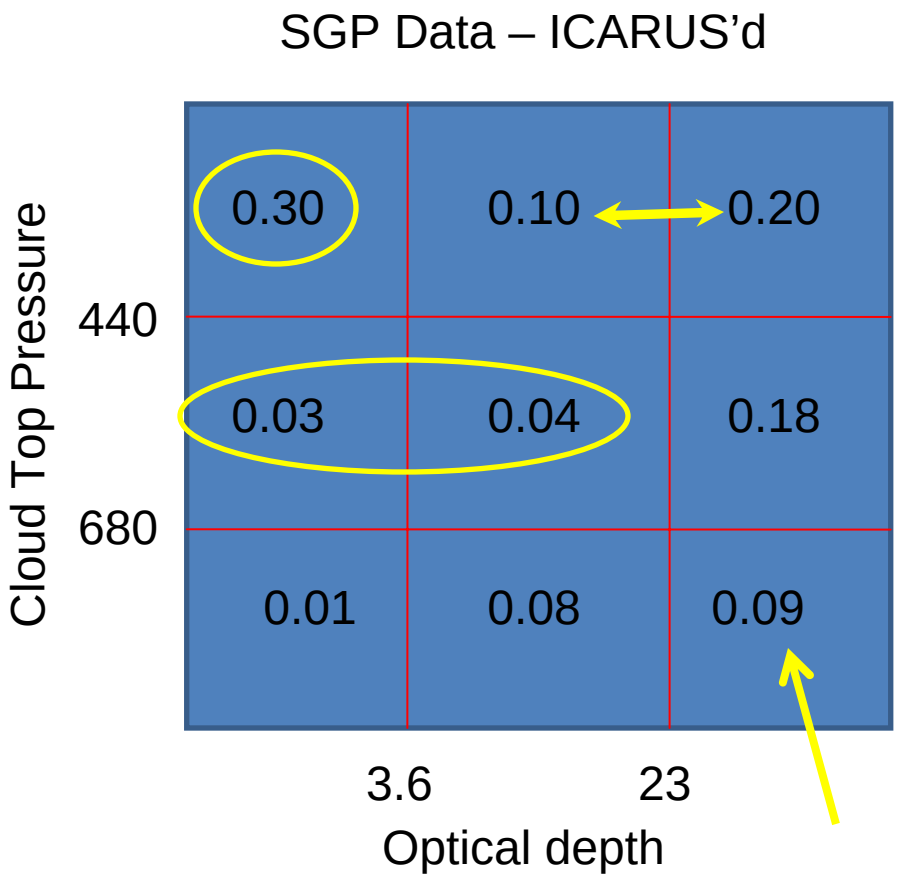
• Cases are filtered for highly variable cloud fields in the 100 km ISCCP averaging domain

• Data from SGP between 1997-2002.

A Banner Day!


20000310 isccp_thin_mid_case_studies_close.txt
arm
icarus
isccp
mfrsr
lbtm
modtran
Cloud Top Pres (mb)
0
200
400
600
800
1000
Column Tau (LOG)
2
1
0
Reflectivity (dbz)
220
240
260
19.47
1.22
−17.04
−35.29
−53.54
12:00
16:00
20:00





- Too much thin cirrus – yet cirrostratus+deep convection agree (note magnitude diff)
- Where did all the altostratus+altocumulus come from? (Yet nimbostratus agrees)
- Low clouds agree remarkably well although optical thickness distribution is shifted

Cloud Top Pressure

	ISCCP	ARM-ICARUS
High	0.50	0.60
Middle	0.36	0.24
Low	0.14	0.17

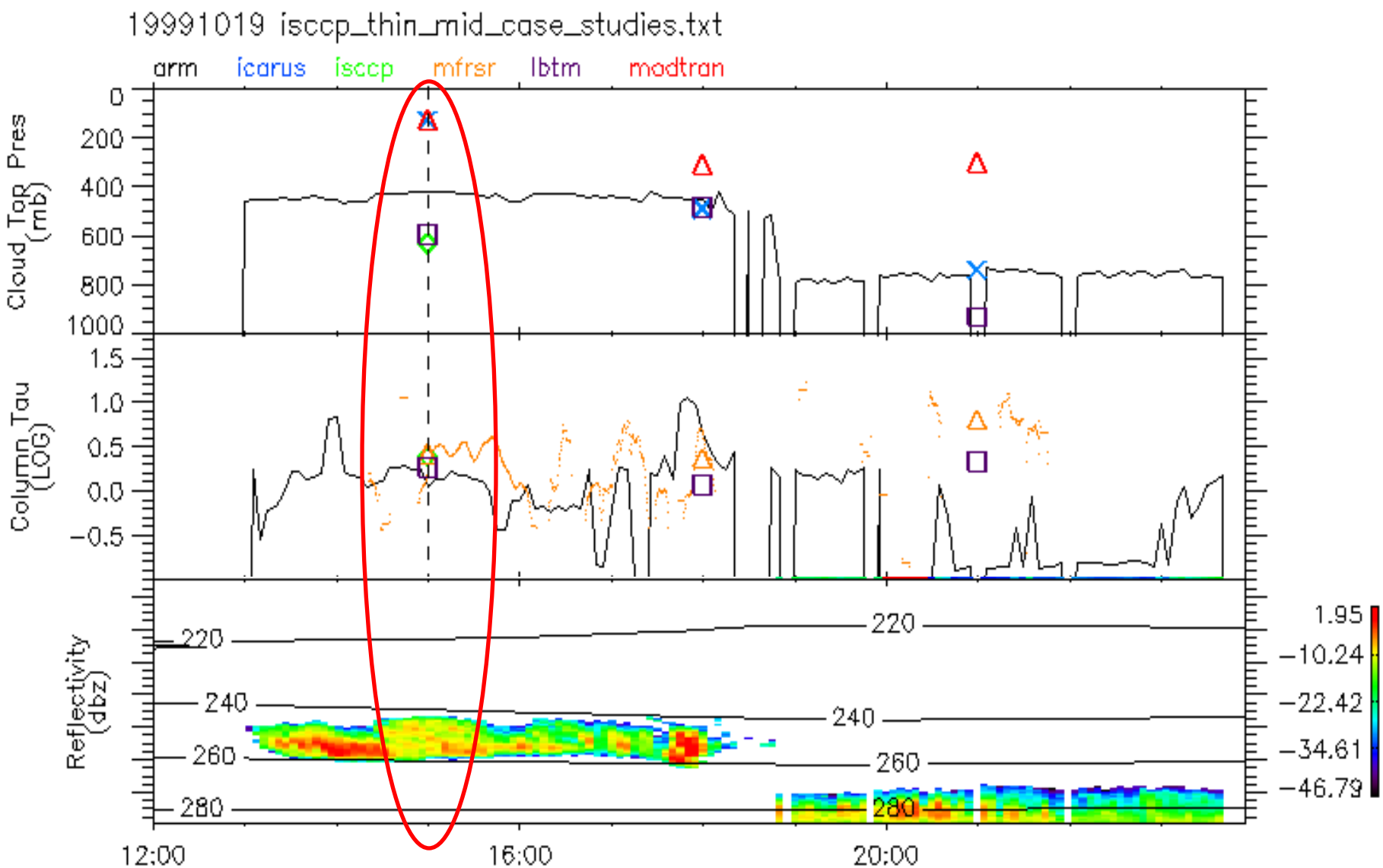
Optical Thickness

	ISCCP	ARM-ICARUS
Thick	0.37	0.47
Intermed	0.36	0.22
Thin	0.28	0.33

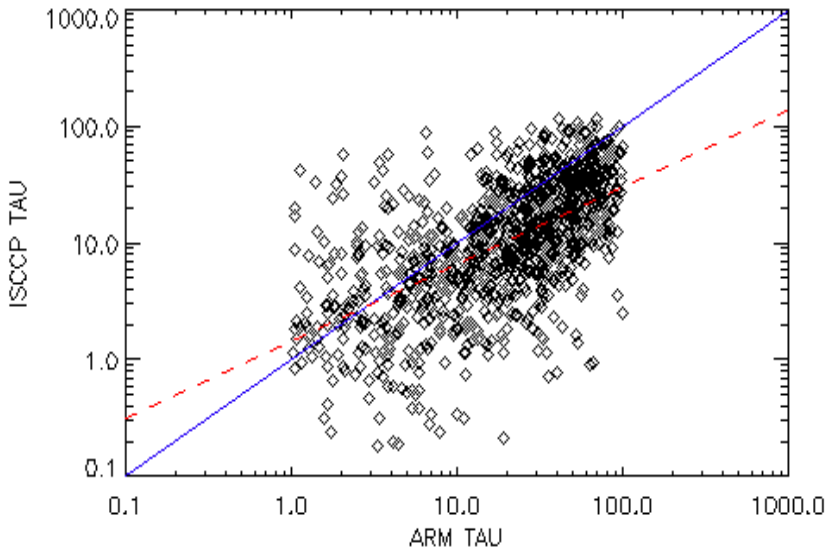
- Much of the middle level cloud derived by ISCCP is being placed in the high (thin) category by ICARUS.
- ARM analysis is finding much more optically thick cloud than ISCCP.

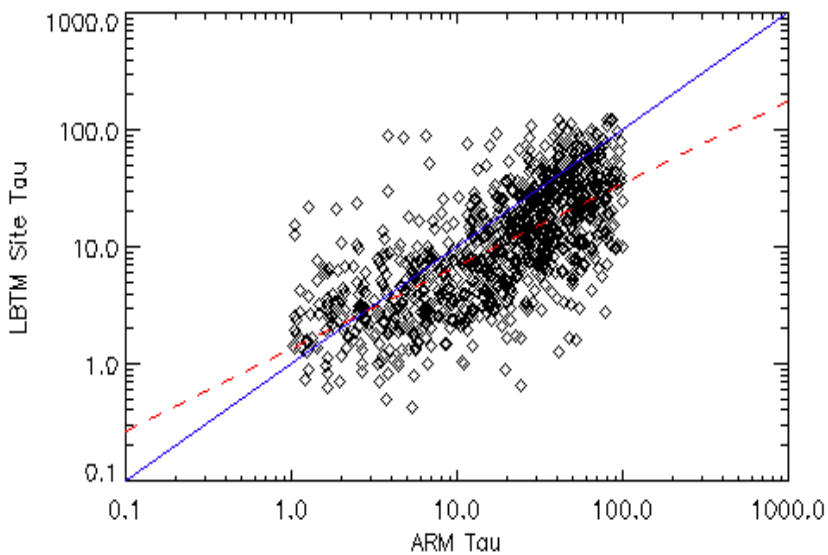
These issues are not totally unrelated….

An Example…


19991019 isccp_thin_mid_case_studies.txt
arm
icarus
isccp
mfrsr
lbtm
modtran
Cloud Top Pres (mb)
0
200
400
600
800
1000
Column Tau (LOG)
1.5
1.0
0.5
0.0
−0.5
Reflectivity (dbz)
220
240
260
280
1.95
−10.24
−22.42
−34.61
−46.79
12:00
16:00
20:00

Optical Depth Bias between Satellite (LBTM and ISCCP) and Surface-Derived.





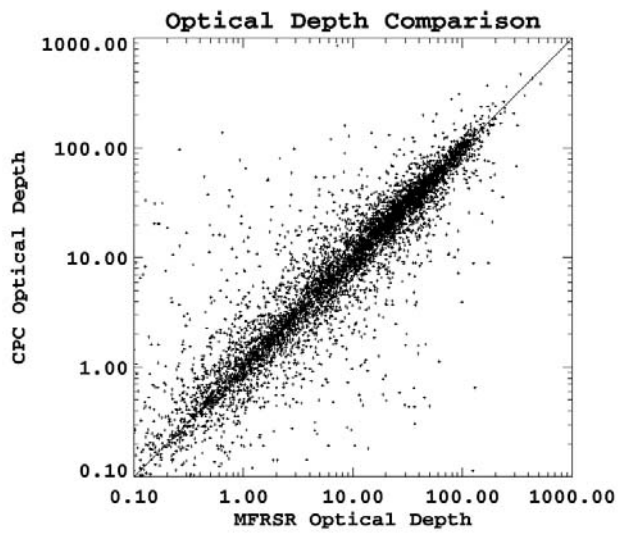
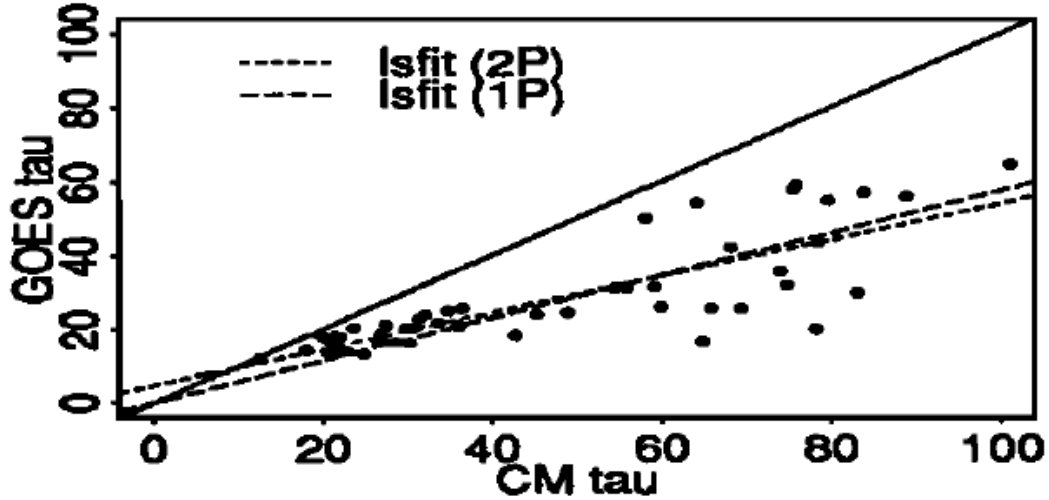


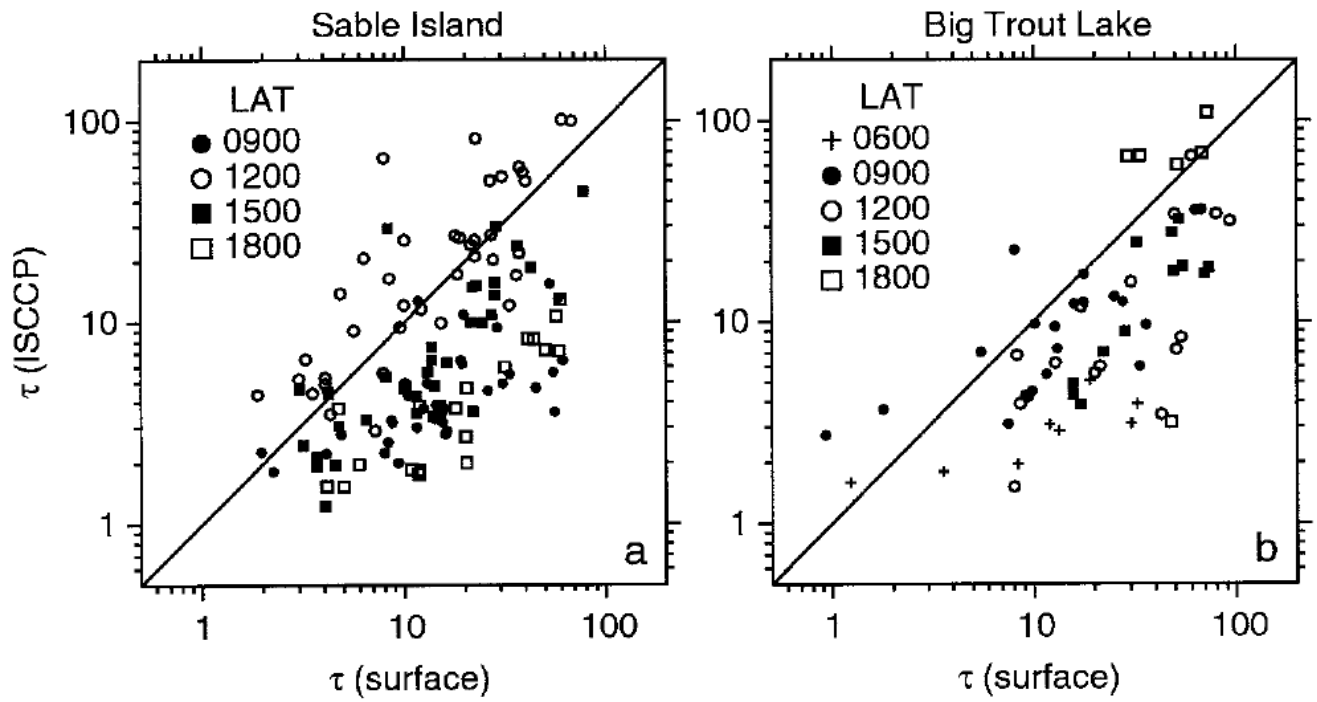
Figure 11. CPC optical depth compared to MFRSR optical depth for the period from March to December 2000. Only the period between 1700 UTC and 2100 UTC was considered for MFRSR optical depth less than 5.

This is not a new issue: Previously Published ISCCP Tau Comparisons

Comparison of Surface MFRSR-derived optical depth with ISCCP
Min and Harrison, 1996

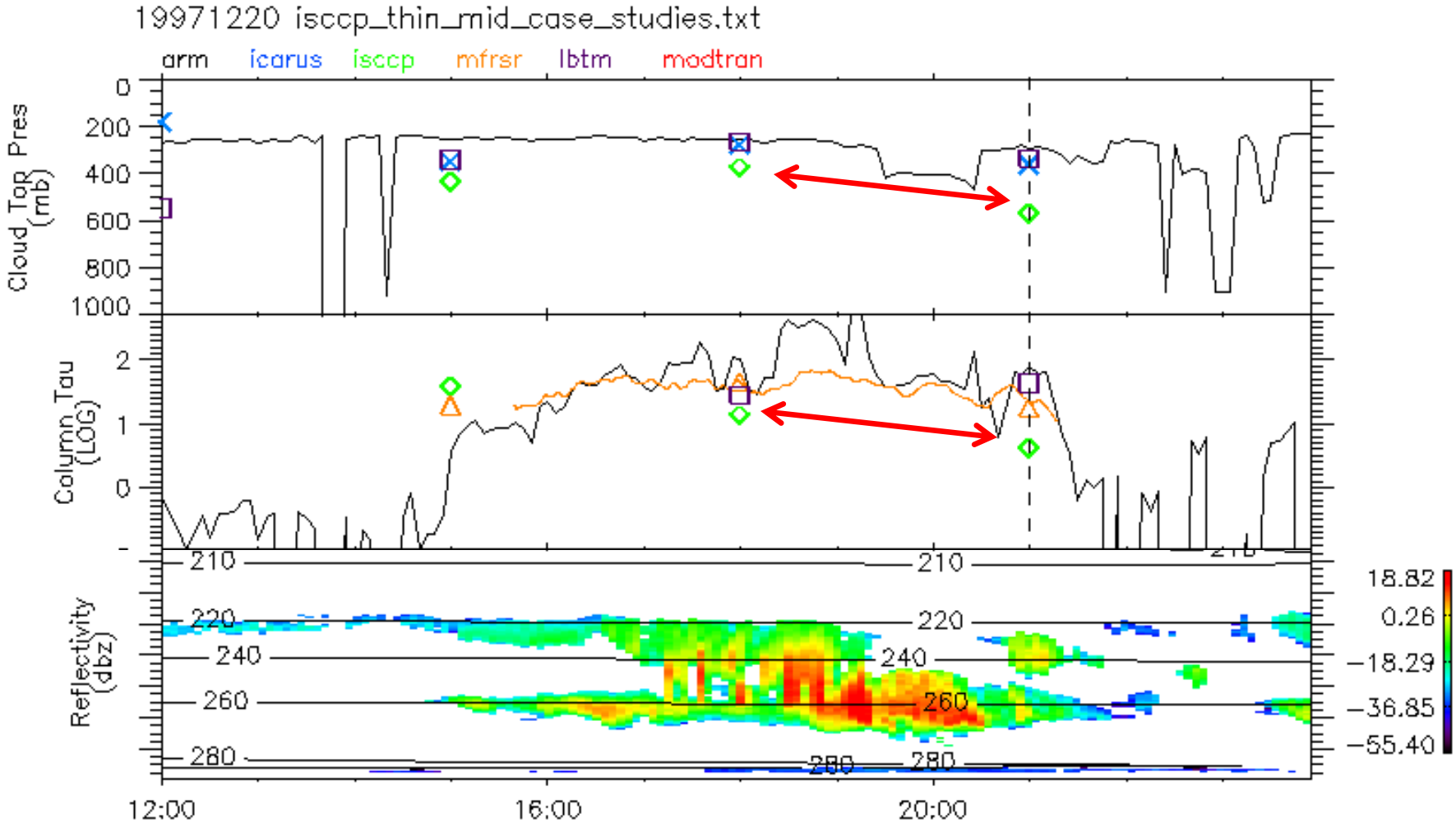


Comparison of Surface Pyranometer-derived optical depth with ISCCP
Barker et al., 1998

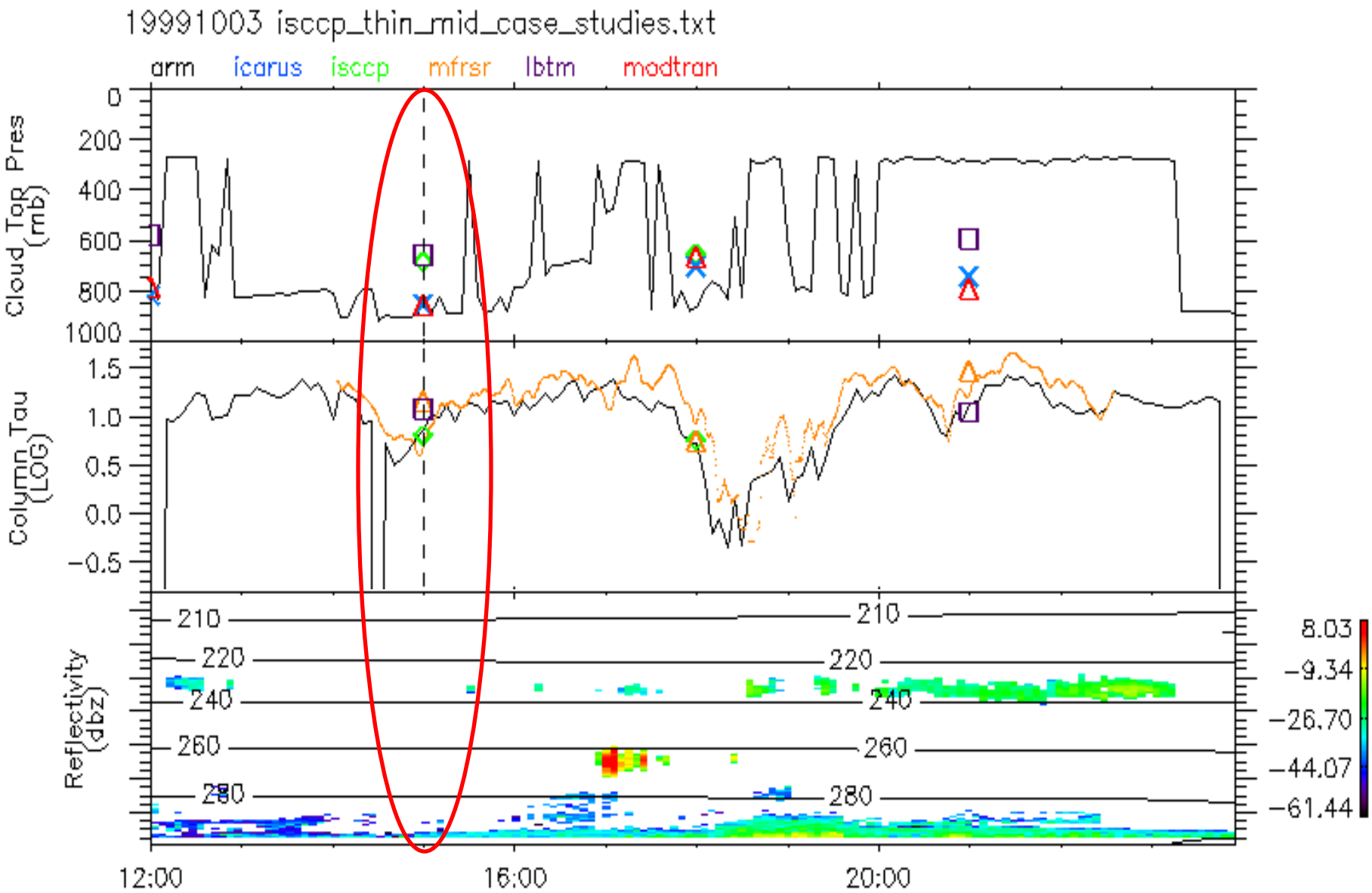


Examples of Tau Bias:

- ISCCP optical depth is lower than ARM
- Optical Depth Bias is NOT simulated by ICARUS
- It is therefore impossible for ICARUS to capture the middle troposphere CTP



Low Level Clouds Biased Into the Middle Trop Are Not Uncommon….



Summary:

ICARUS is not capturing a low bias in satellite-derived optical depth.

Therefore,

- Conclusions drawn from the ISCCP simulator that models create too little thin mid level clouds may be incorrect.

- Conclusions regarding the overprediction of optically thick clouds in models may be overstated

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Low	0.14	0.17

Optical Thickness

	ISCCP	ARM-ICARUS
Thick	0.37	0.47
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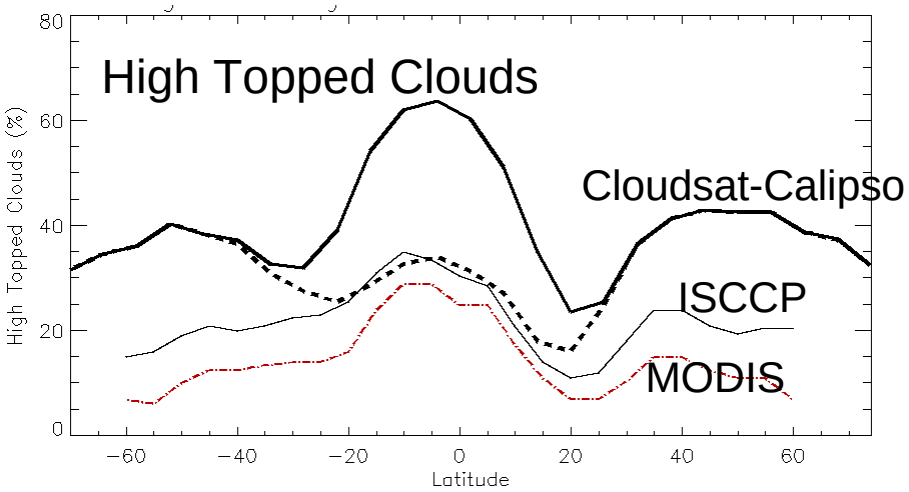
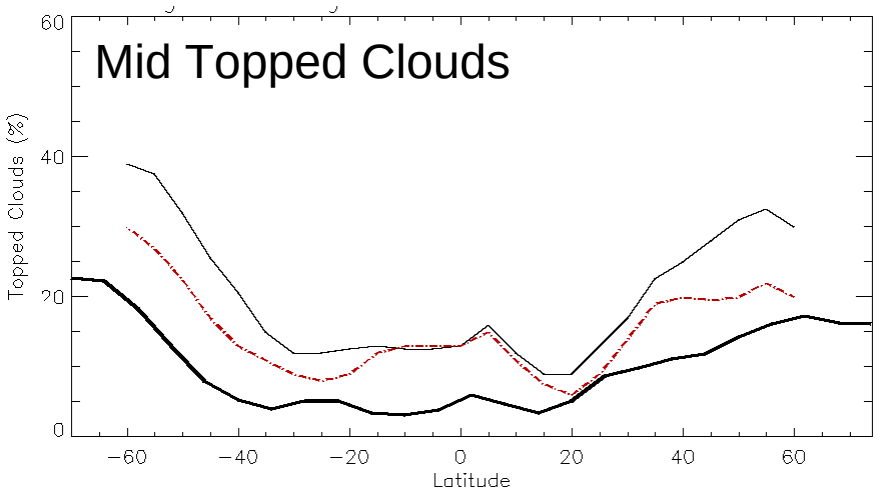
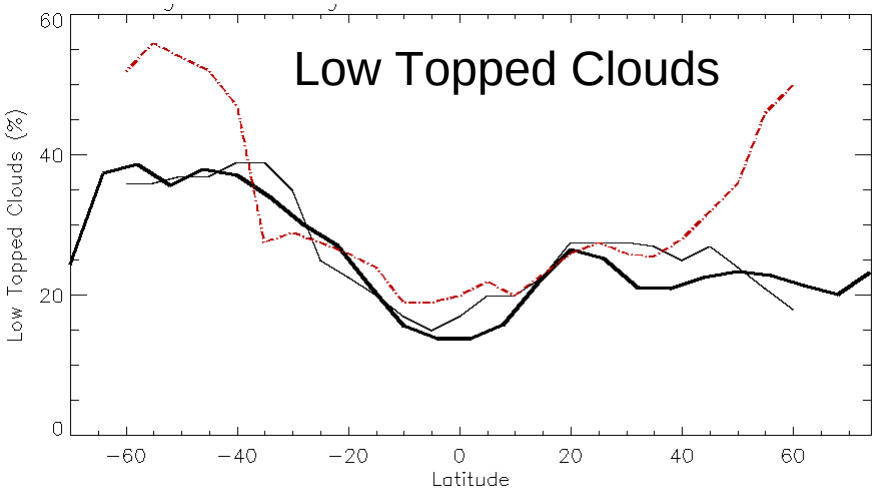
Comparison of Cloudsat-CALIPSO Clouds with ISCCP and MODIS-CERES (DJF)







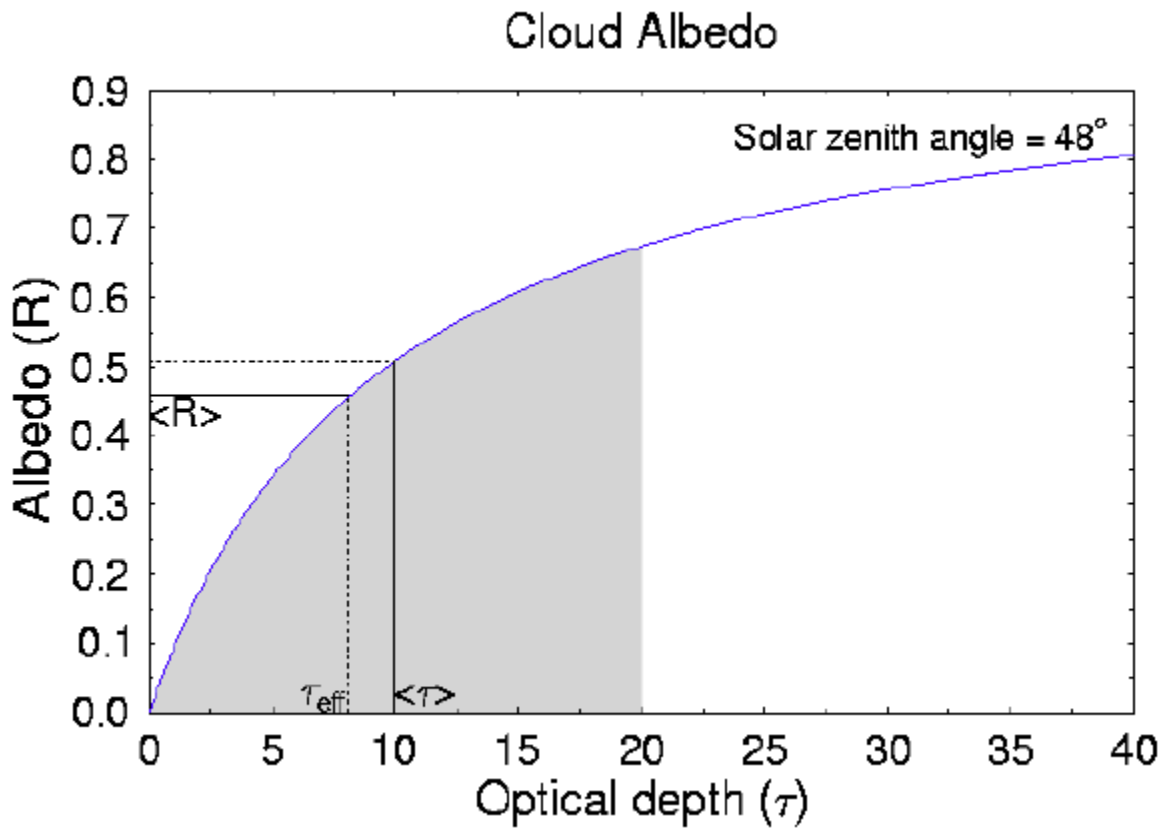
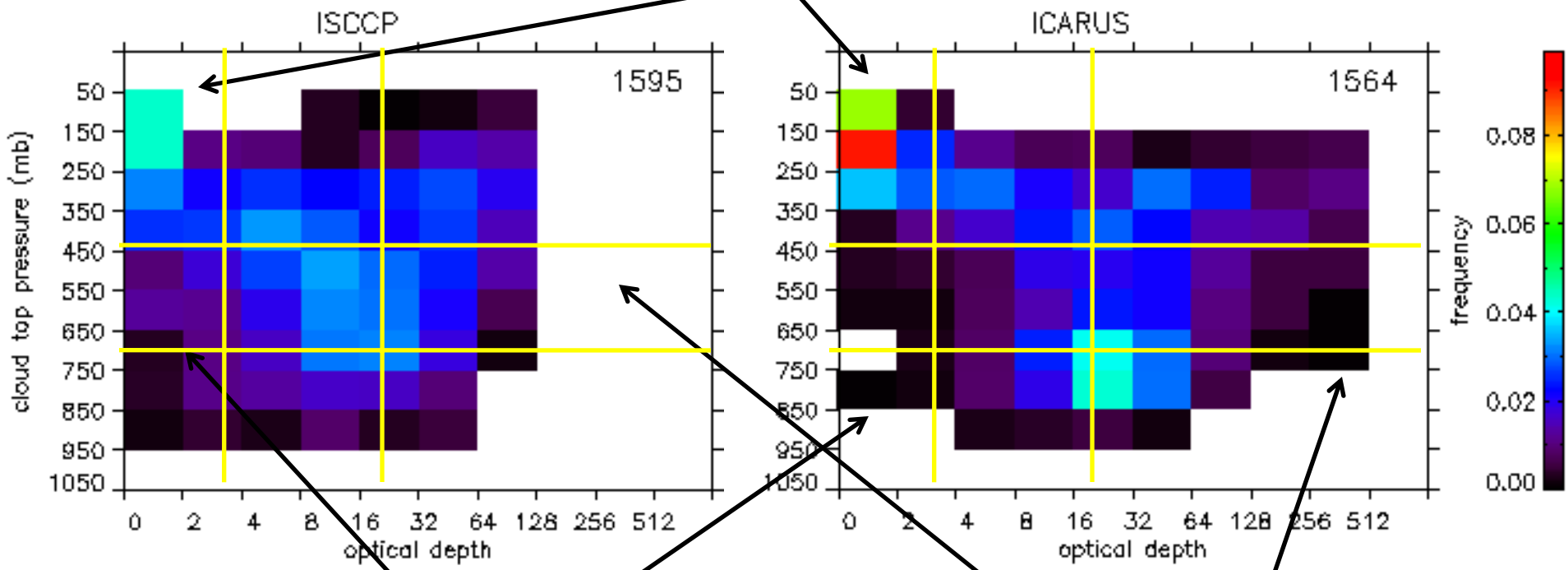


Figure lifted from Evans and McFarlane PDF found on line

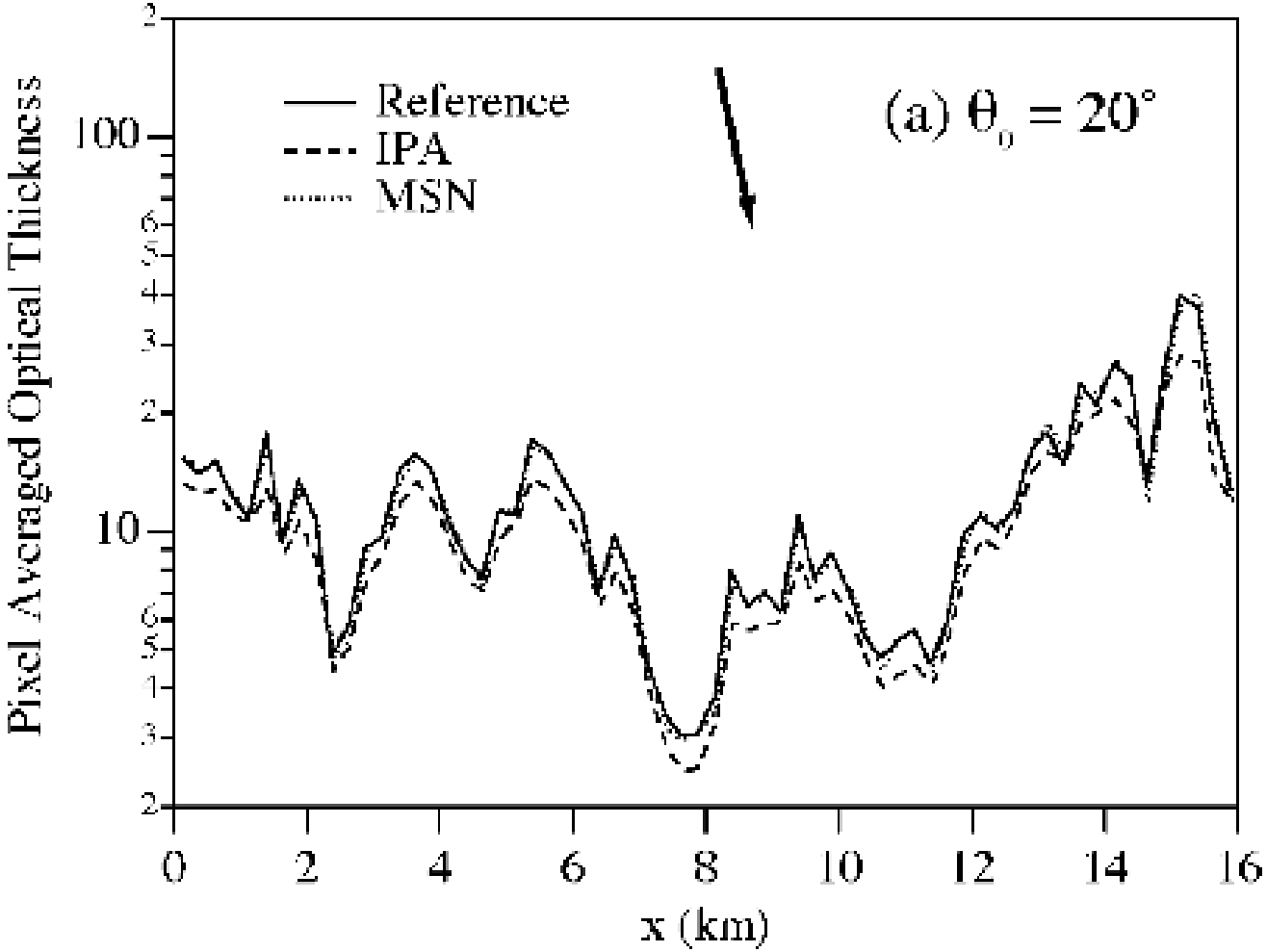
CTP Tau Histogram Comparison – ISCCP with ARM-ICARUS

“Too Much” Thin Cirrus

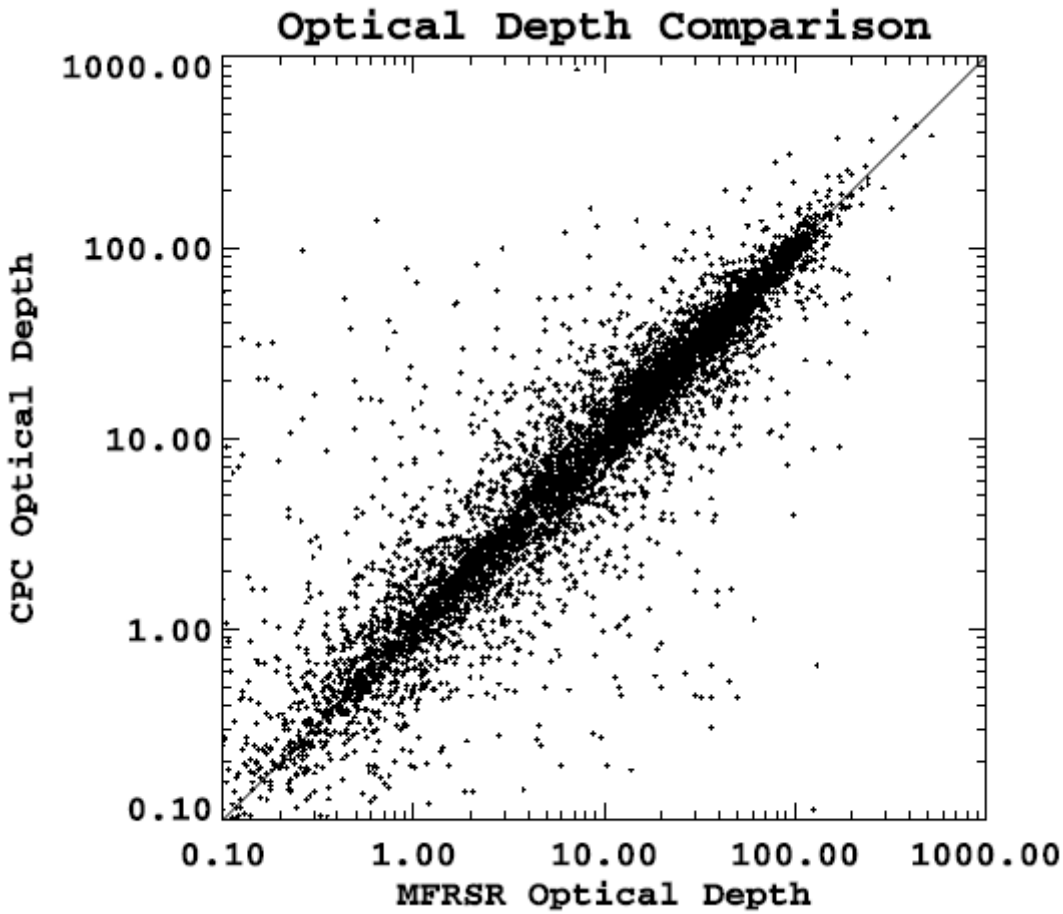


“Too Little” thin low and middle level cloud

“Too Much” Thick Cloud at all Level



Iwabuchi and Hayasaka (2003; figure 9c)


Optical Depth Comparison
1000.00
100.00
10.00
1.00
0.10
CPC Optical Depth
0.10
1.00
10.00
100.00
1000.00
MFRSR Optical Depth