The ARMIP

Comparing Clouds And Their Seasonal Variations in 10 AGCMs With Satellite Measurements

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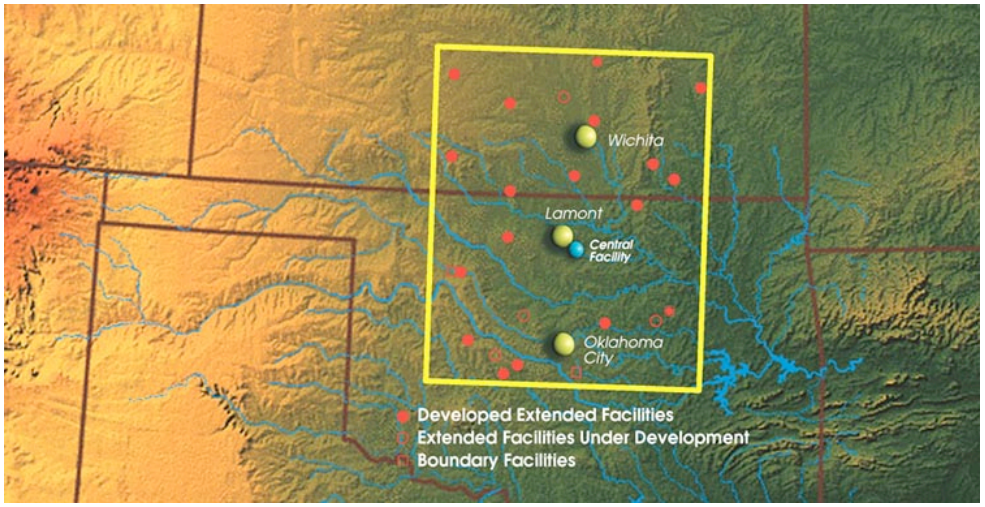
Norman Loeb and Patrick Minnis, NASA Langley

ARM SGP CART


Wichita
Lamont
Central Facility
Oklahoma City
Developed Extended Facilities
Extended Facilities Under Development
Boundary Facilities

ARM SGP CART

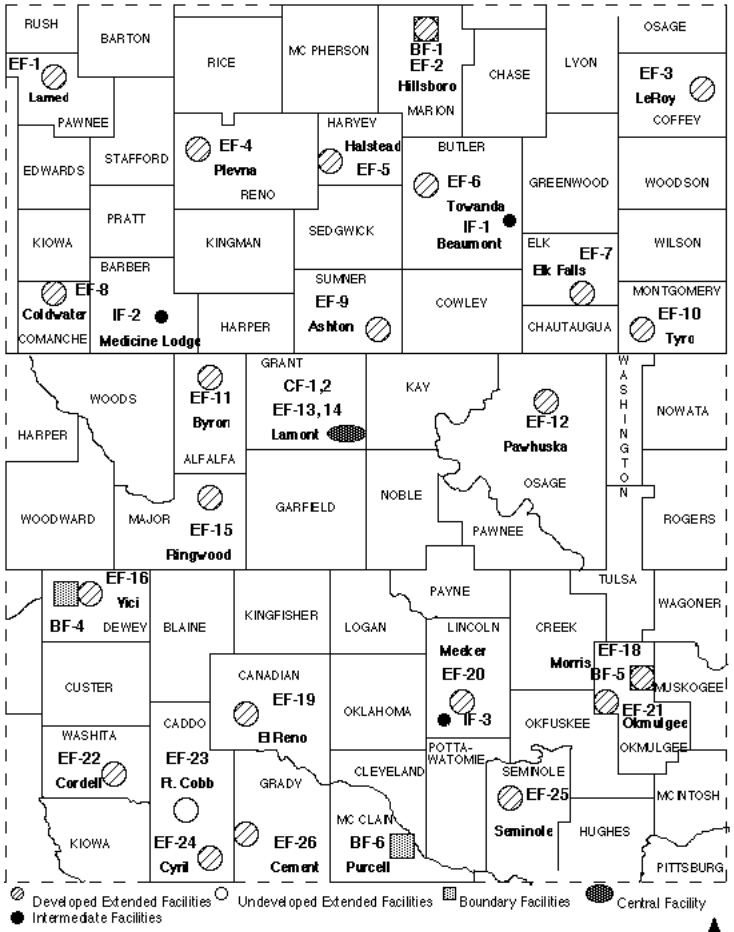
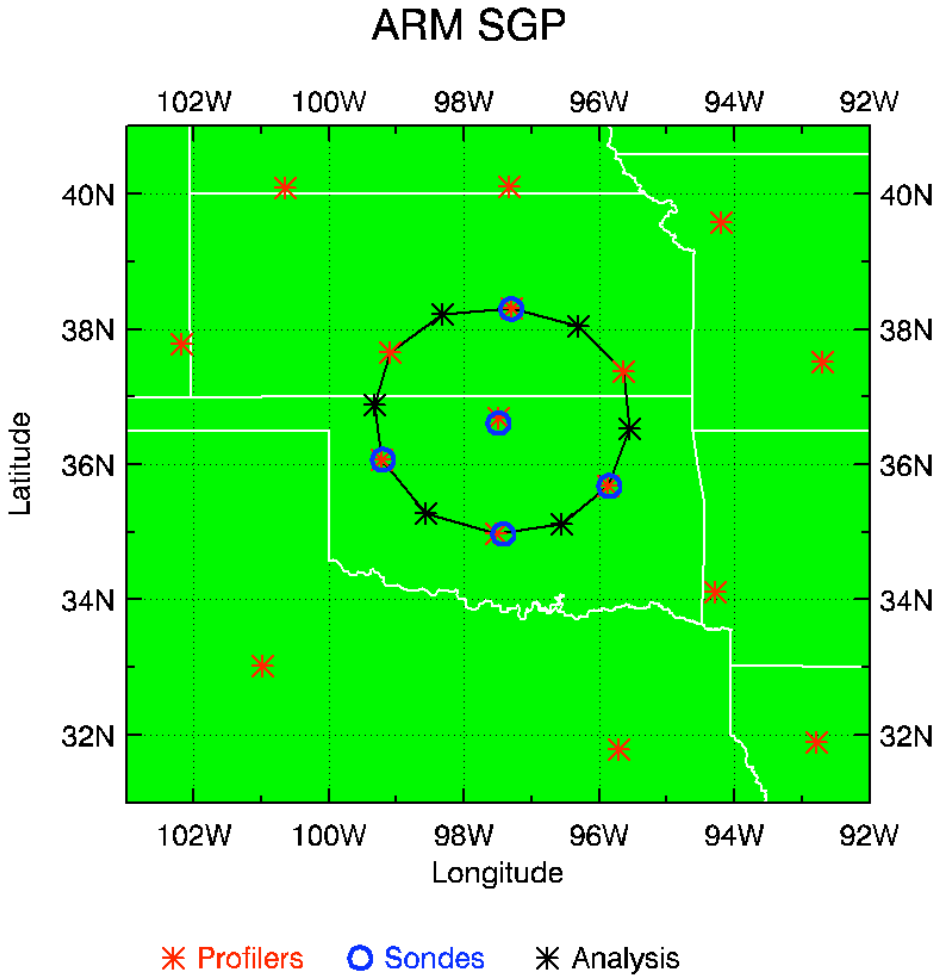


FIGURE 1 Overall View of the SGP CART Site (Approximate Scale: 50 km/in.)



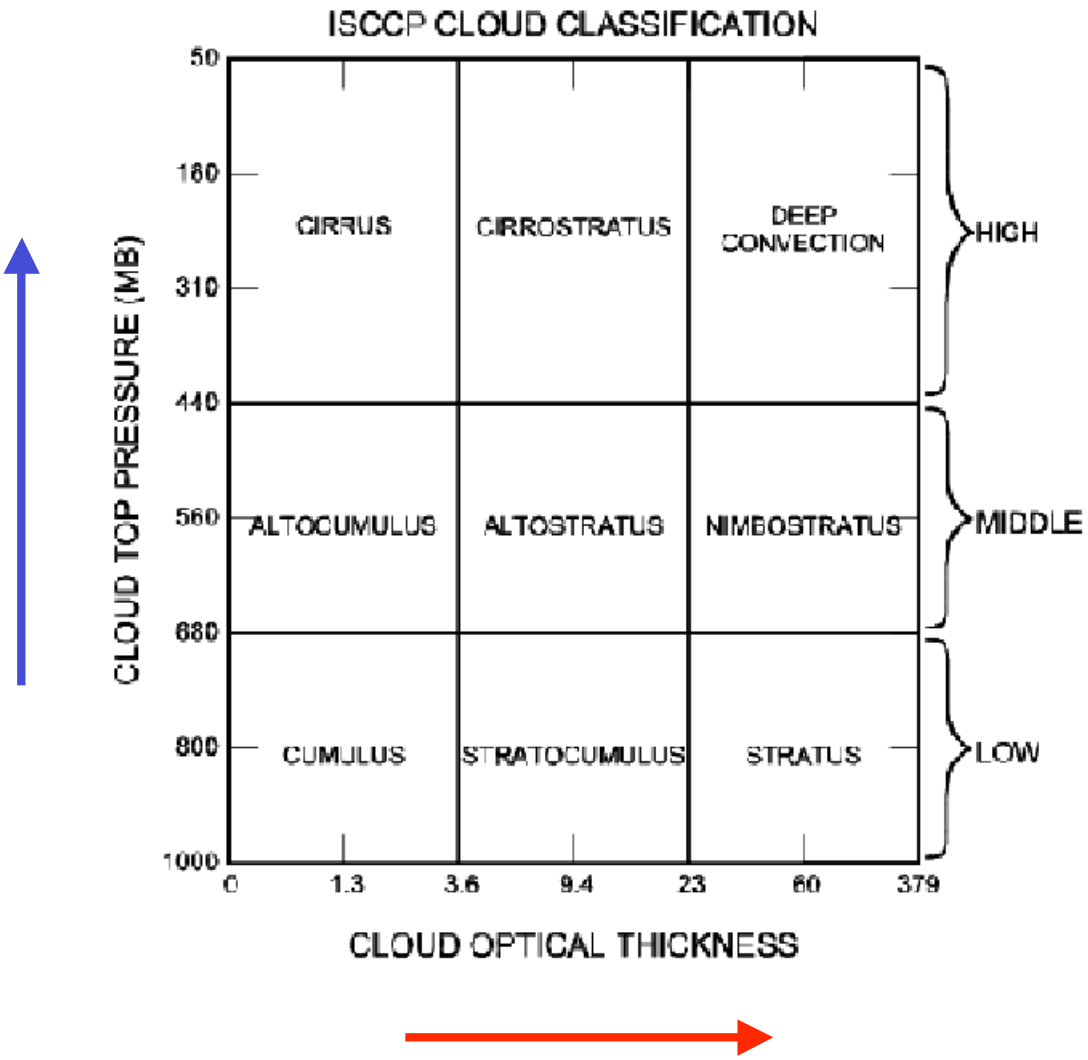
ARMIP Motivation:

- Identify systematic cloud biases in GCMs to relate ARM SCM, CRM and process studies to global models

- Document current status of clouds in GCMs to measure future progress

The ISCCP Simulator Is Used In All Models

(Steve Klein and Mark Webb)


ISCCP CLOUD CLASSIFICATION
CLOUD TOP PRESSURE (MB)
50
180
310
440
560
680
800
1000
CIRRUS
CIRROSTRATUS
DEEP CONVECTION
ALTOCUMULUS
ALTOSTRATUS
NIMBOSTRATUS
CUMULUS
STRATOCUMULUS
STRATUS
HIGH
MIDDLE
LOW
0
1.3
3.6
9.4
23
60
379
CLOUD OPTICAL THICKNESS

Observations:

ISCCP
CERES/MODIS

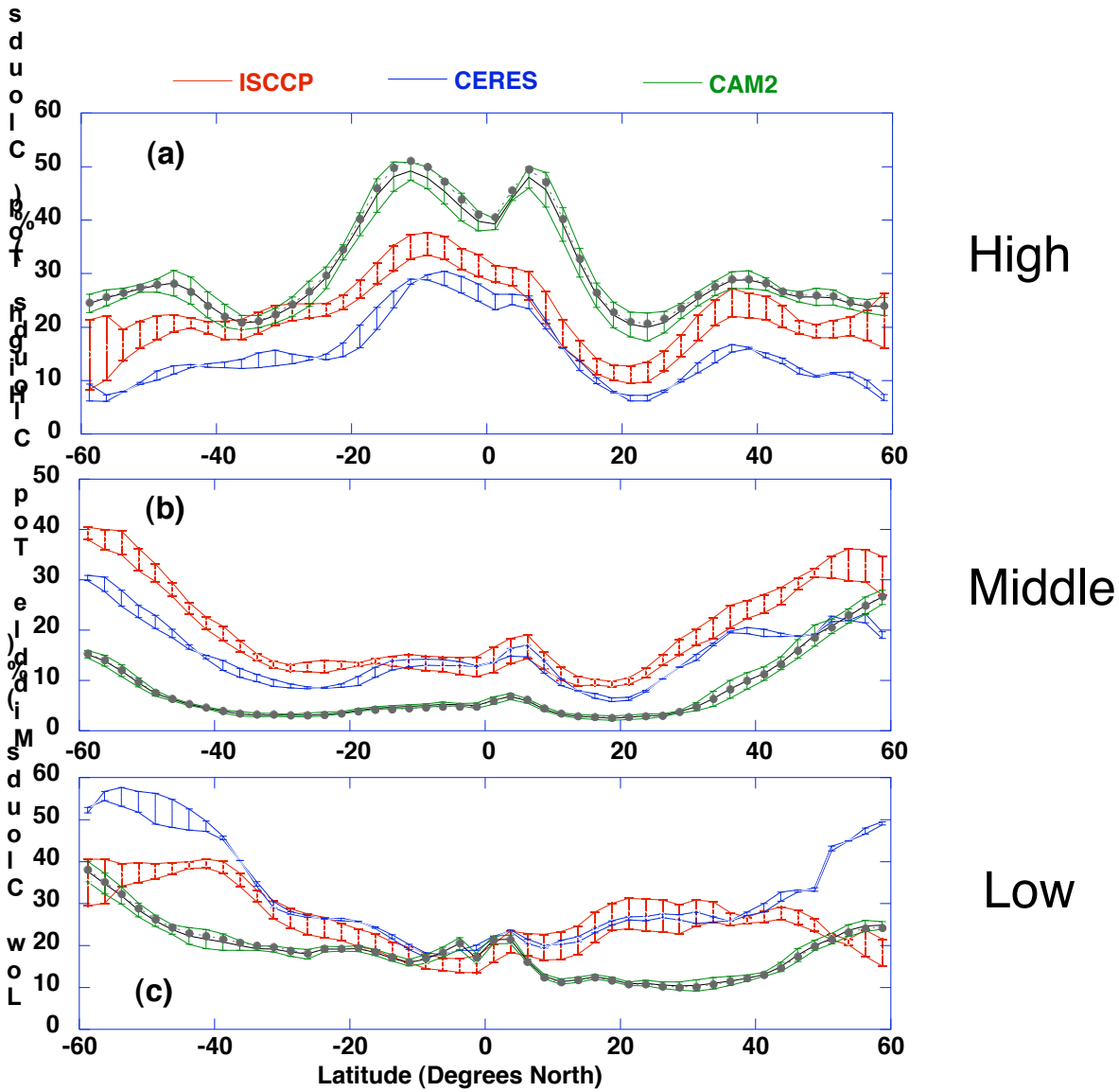
Models:

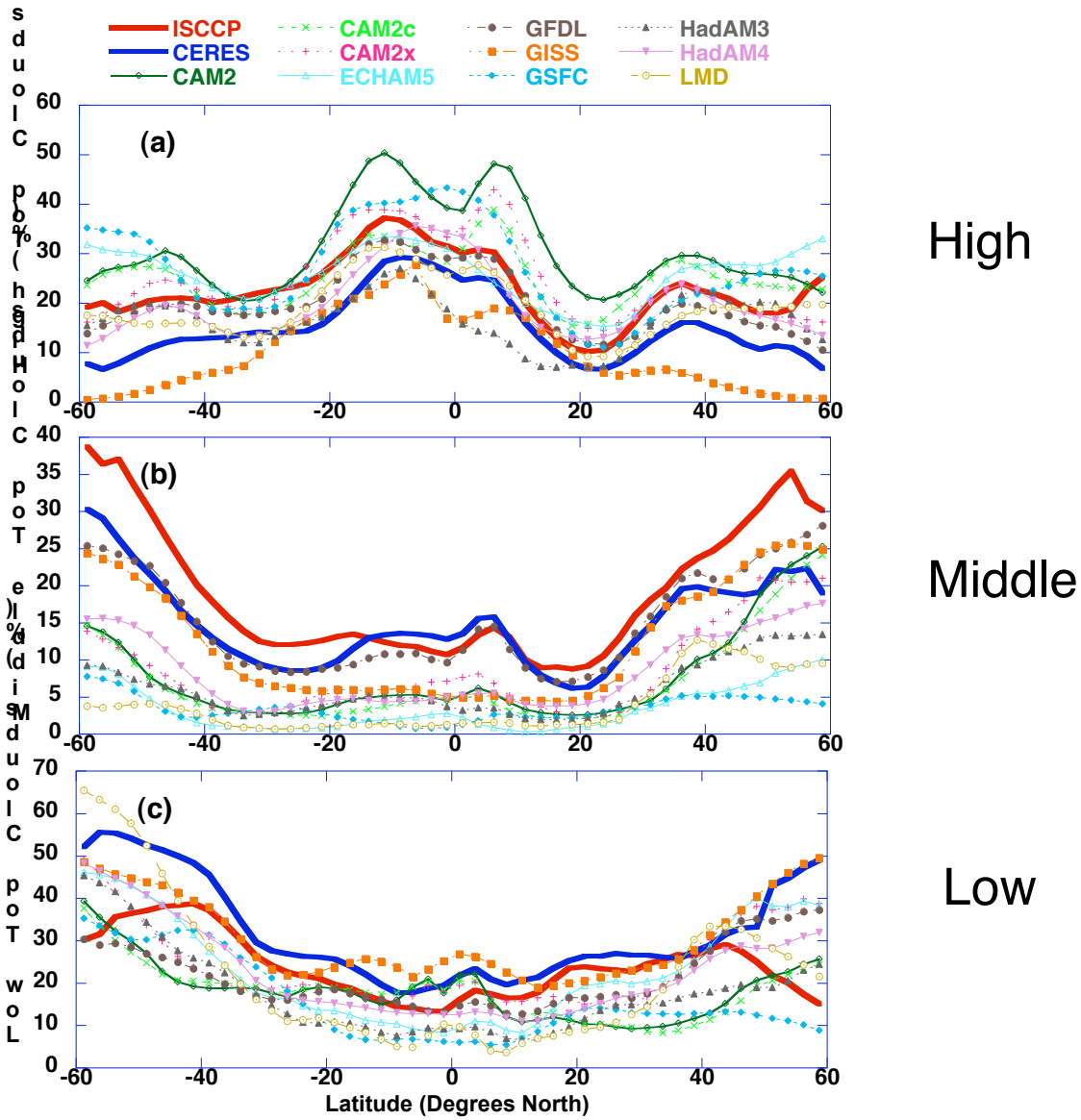
CAM2
CAM2c
CAM2x
GFDL
GISS
GMAO
HadAM3
HadAM4
LMD
ECHAM5

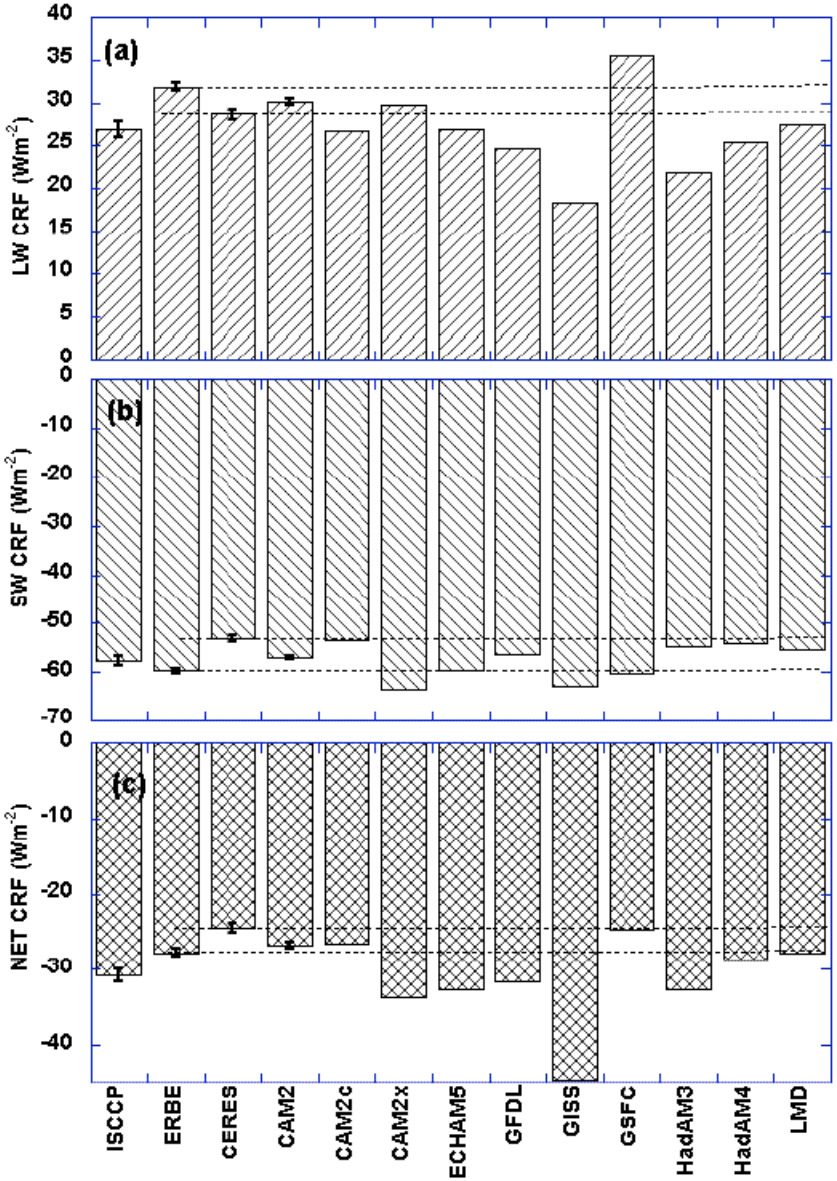
Check for

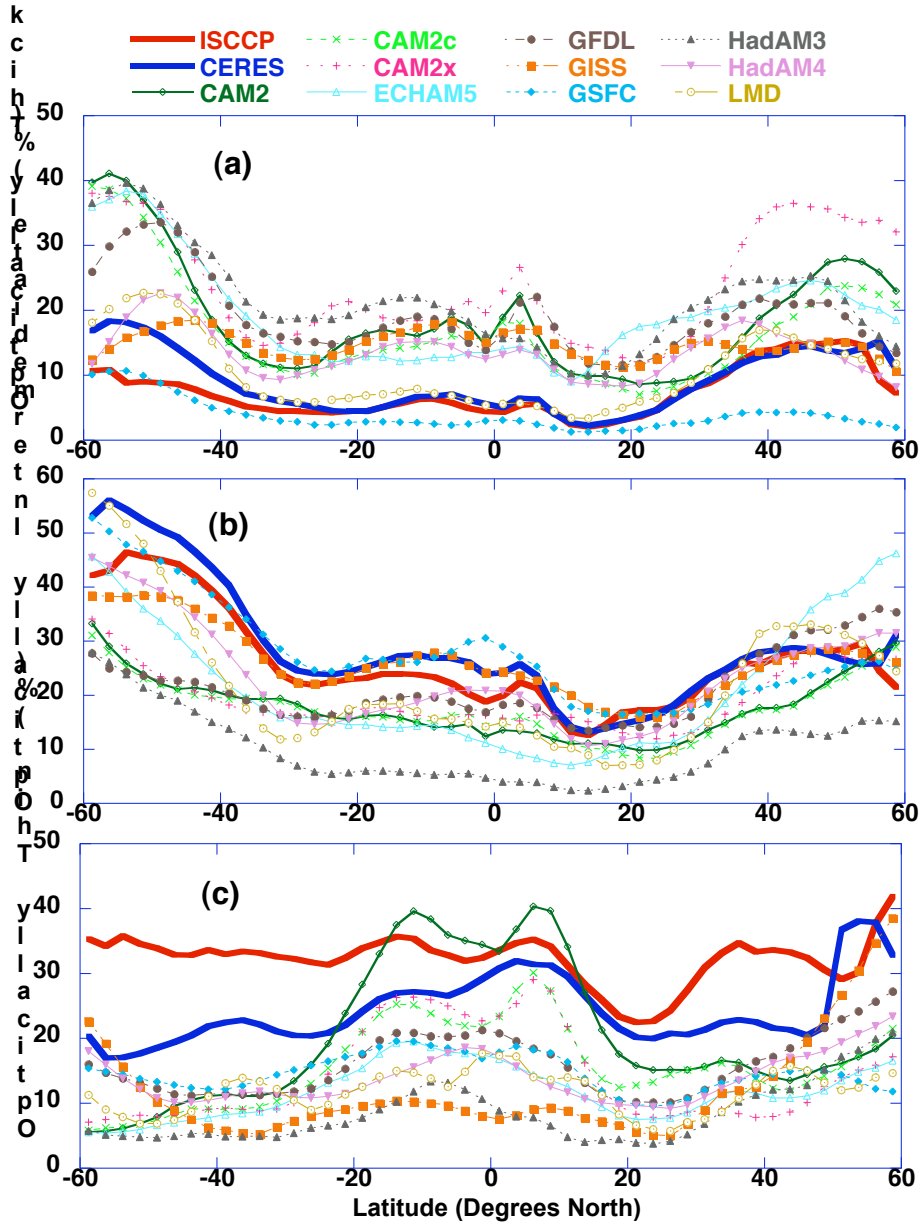
$$C_m > \max(C_{ISCCP}, C_{CERES}) + \delta_{\max}$$

$$C_m < \min(C_{ISCCP}, C_{CERES}) - \delta_{\min}$$


ISCCP
CERES
CAM2
(a)
(b)
(c)
High
Middle
Low
Latitude (Degrees North)


ISCCP
CERES
CAM2
CAM2c
CAM2x
ECHAM5
GFDL
GISS
GSFC
HadAM3
HadAM4
LMD
(a)
(b)
(c)
High
Middle
Low
Latitude (Degrees North)

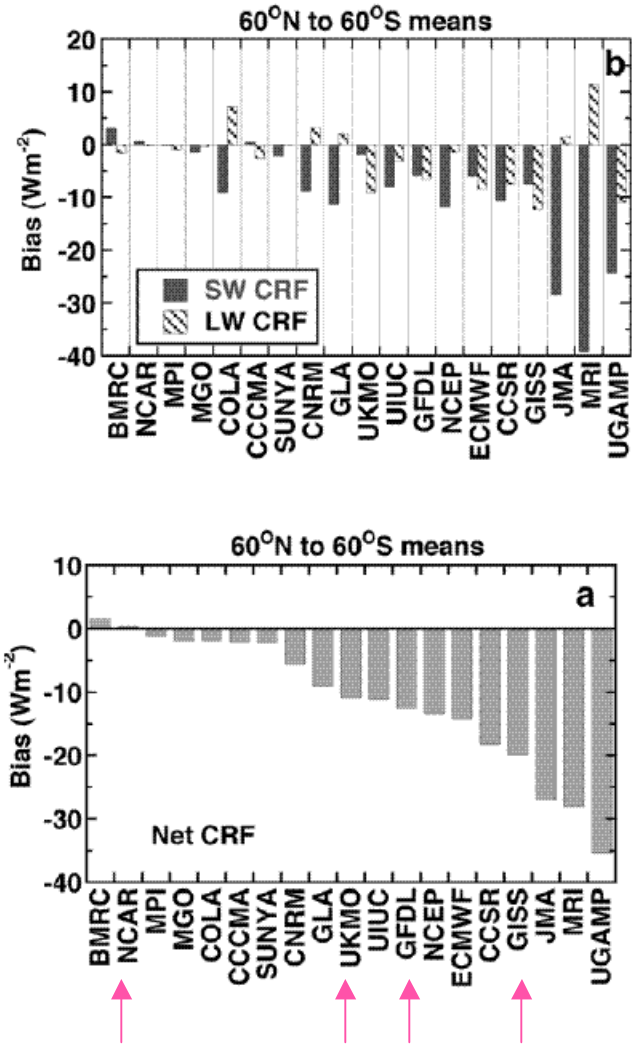

(a)
LW CRF (Wm-2)
40
35
30
25
20
15
10
5
0
(b)
SW CRF (Wm-2)
0
-10
-20
-30
-40
-50
-60
-70
(c)
NET CRF (Wm-2)
0
-10
-20
-30
-40
ISCCP
ERBE
CERES
CAM2
CAM2c
CAM2x
ECHAM5
GFDL
GISS
GSFC
HadAM3
HadAM4
LMD



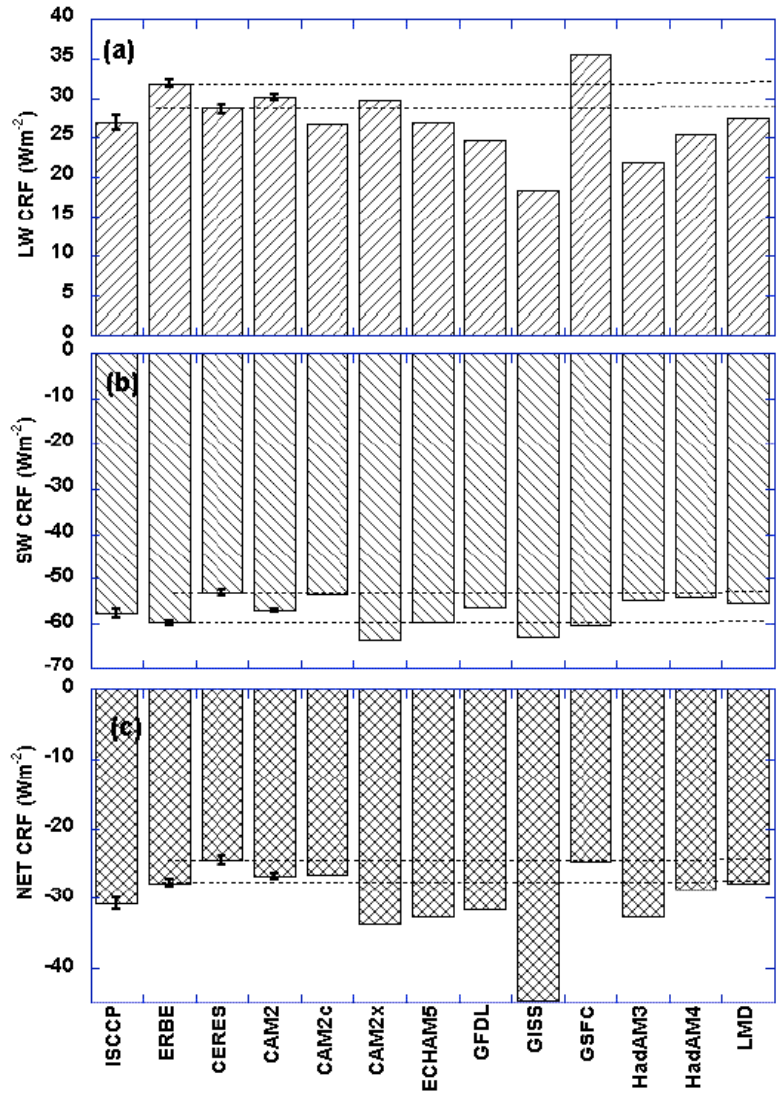
Thick

Intermediate

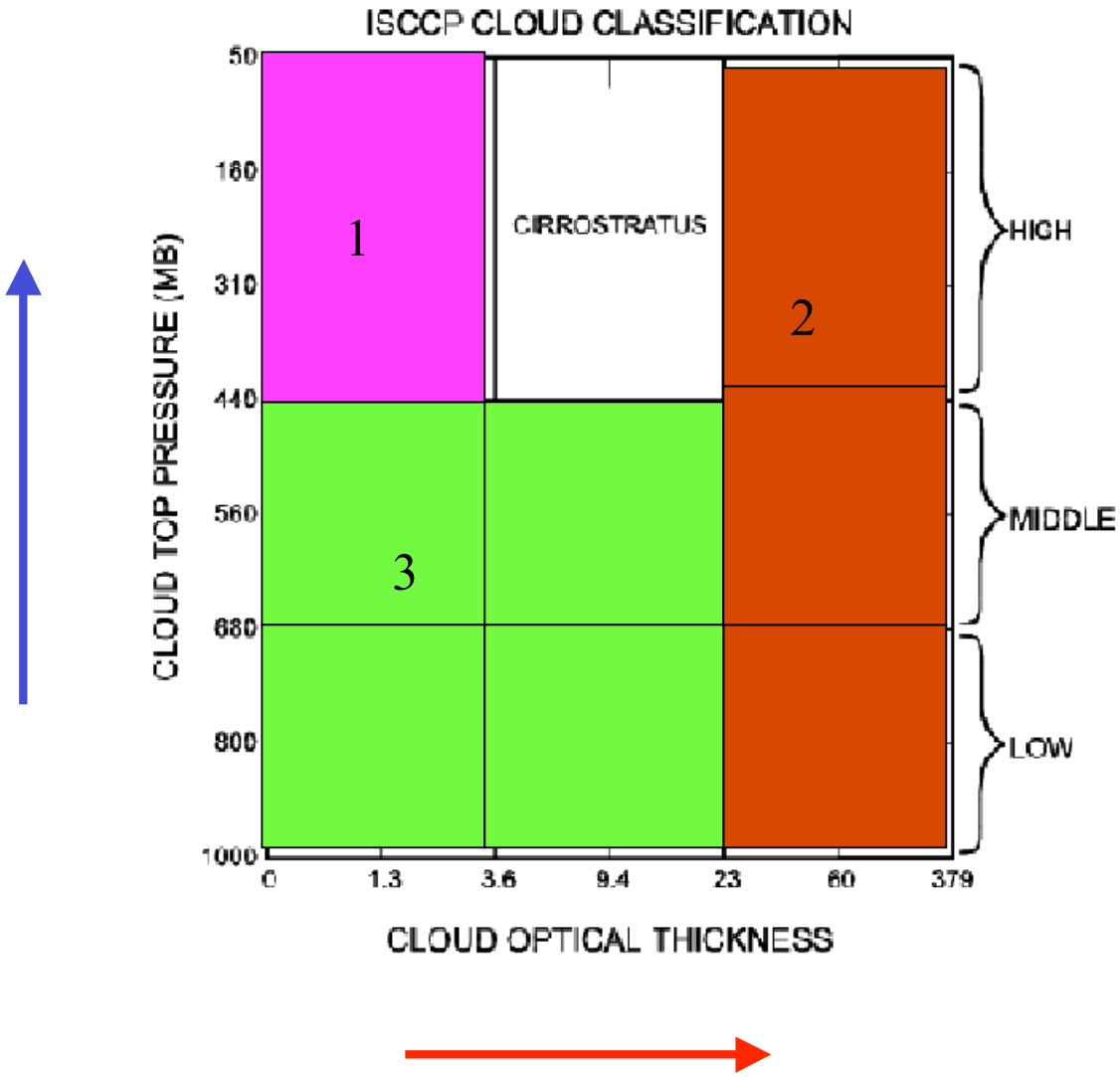
Thin

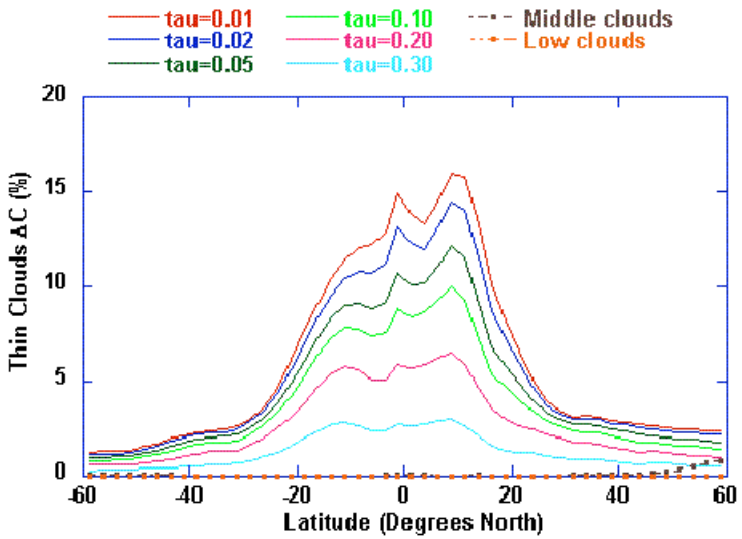


(Potter and Cess, 2004)



(Zhang et al.,2004)


ISCCP CLOUD CLASSIFICATION
CLOUD TOP PRESSURE (MB)
50
160
310
440
560
680
800
1000
1
CIRROSTRATUS
2
3
HIGH
MIDDLE
LOW
0
1.3
3.6
9.4
23
60
379
CLOUD OPTICAL THICKNESS

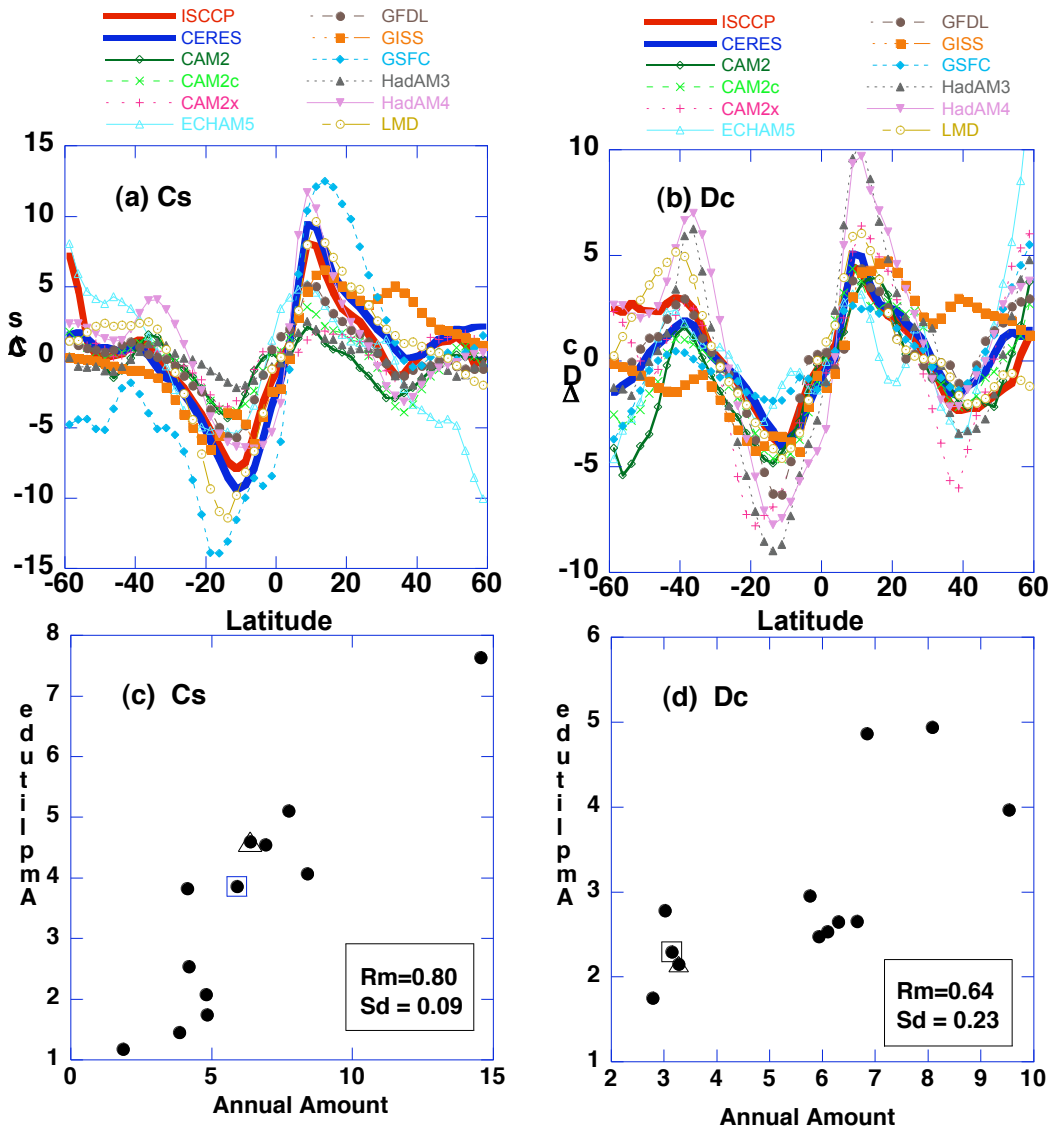

tau=0.01
tau=0.02
tau=0.05
tau=0.10
tau=0.20
tau=0.30
Middle clouds
Low clouds
Thin Clouds ΔC (%)
20
15
10
5
0
-60
-40
-20
0
20
40
60
Latitude (Degrees North)

1. Does This Matter?

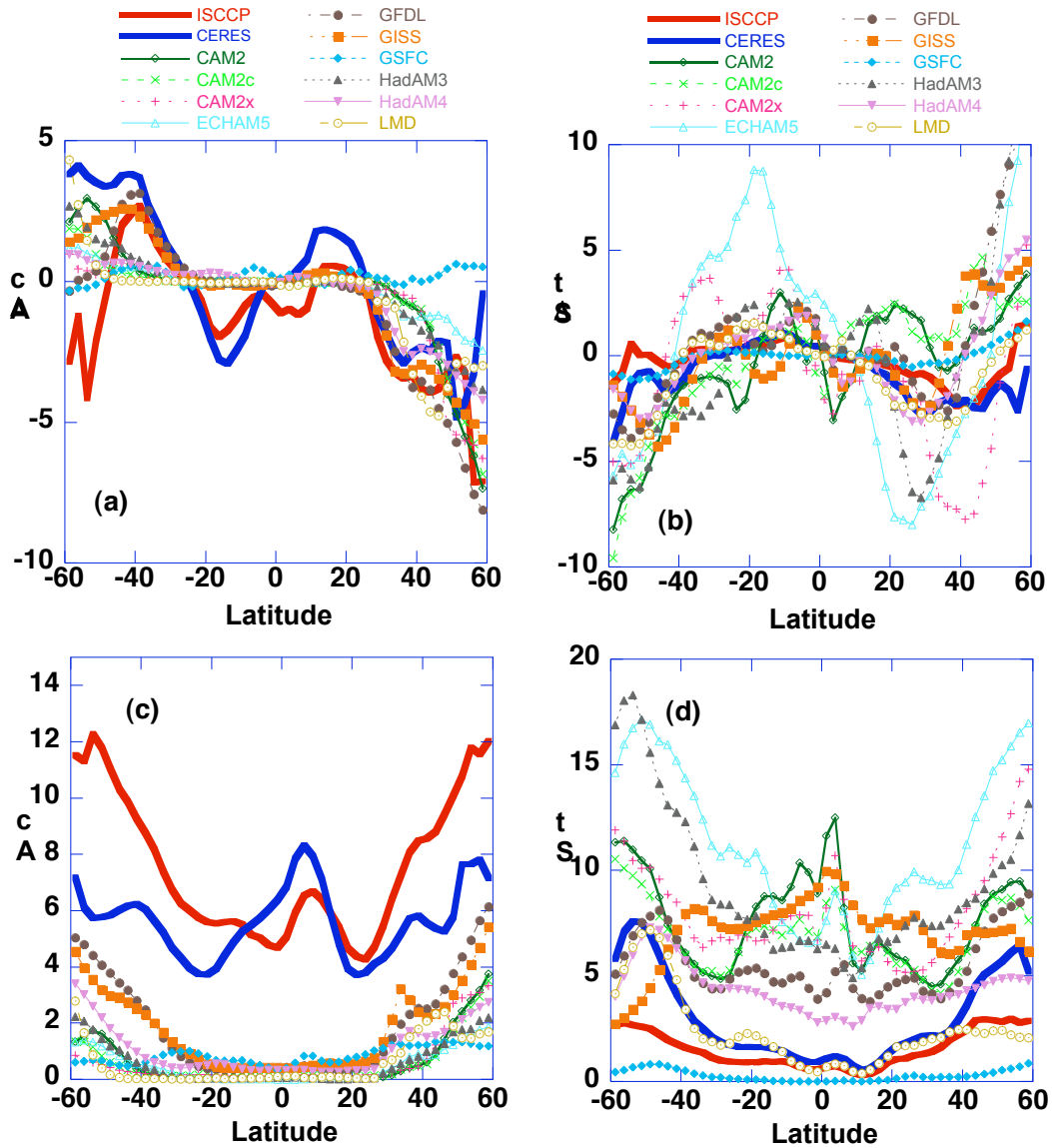
2. How Reliable Are the Data?

3. What Are the Physical Causes?

JJA Minus DJF



JJA Minus DJF



1. Does This Matter?

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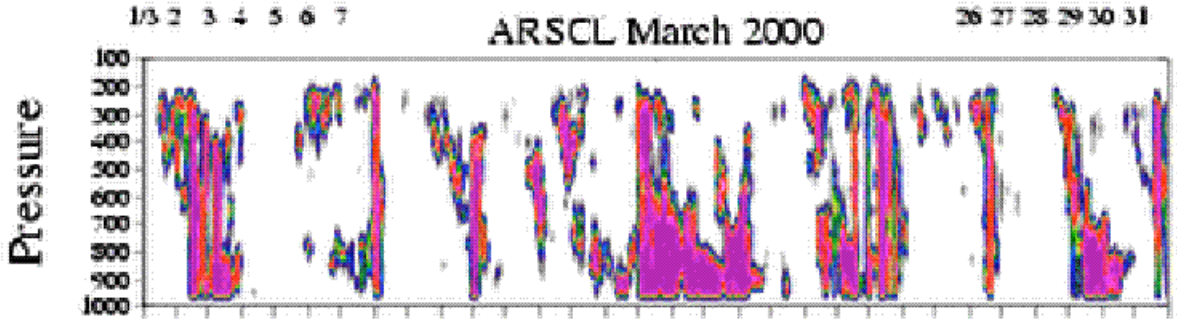
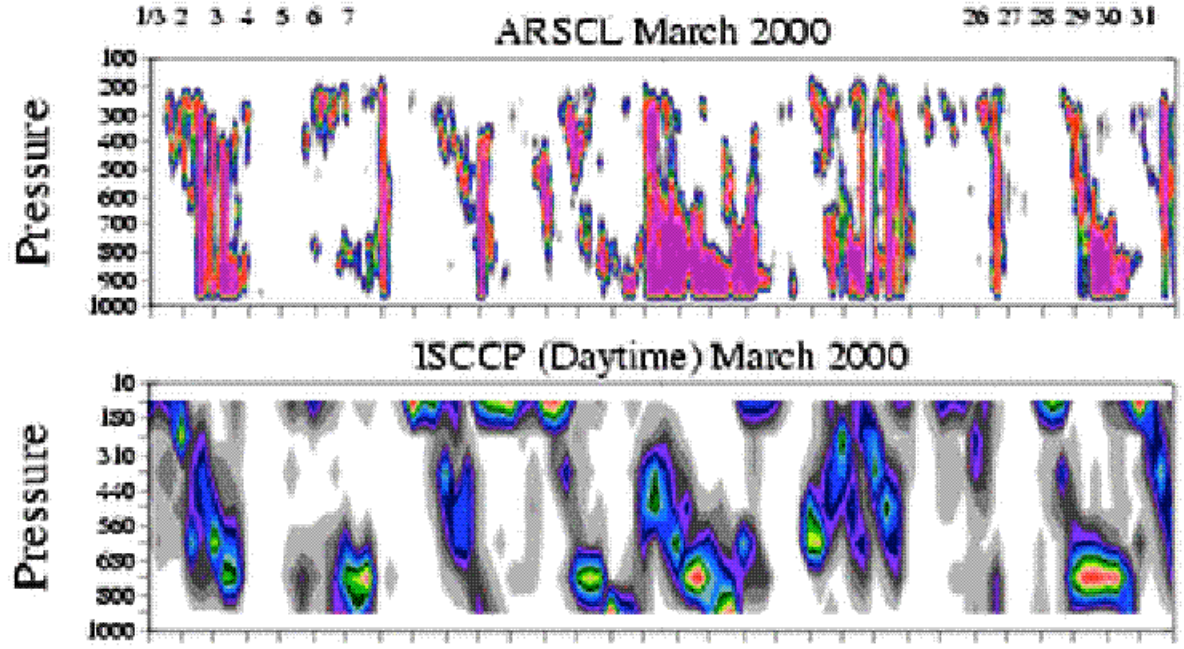
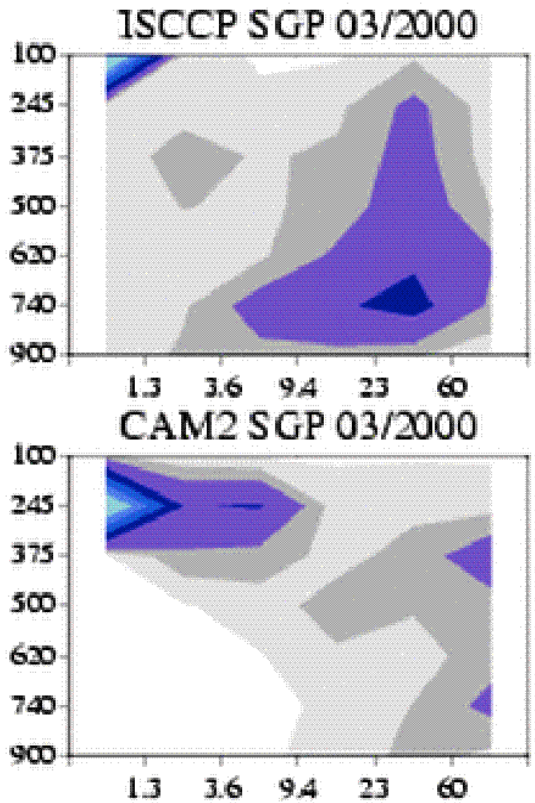
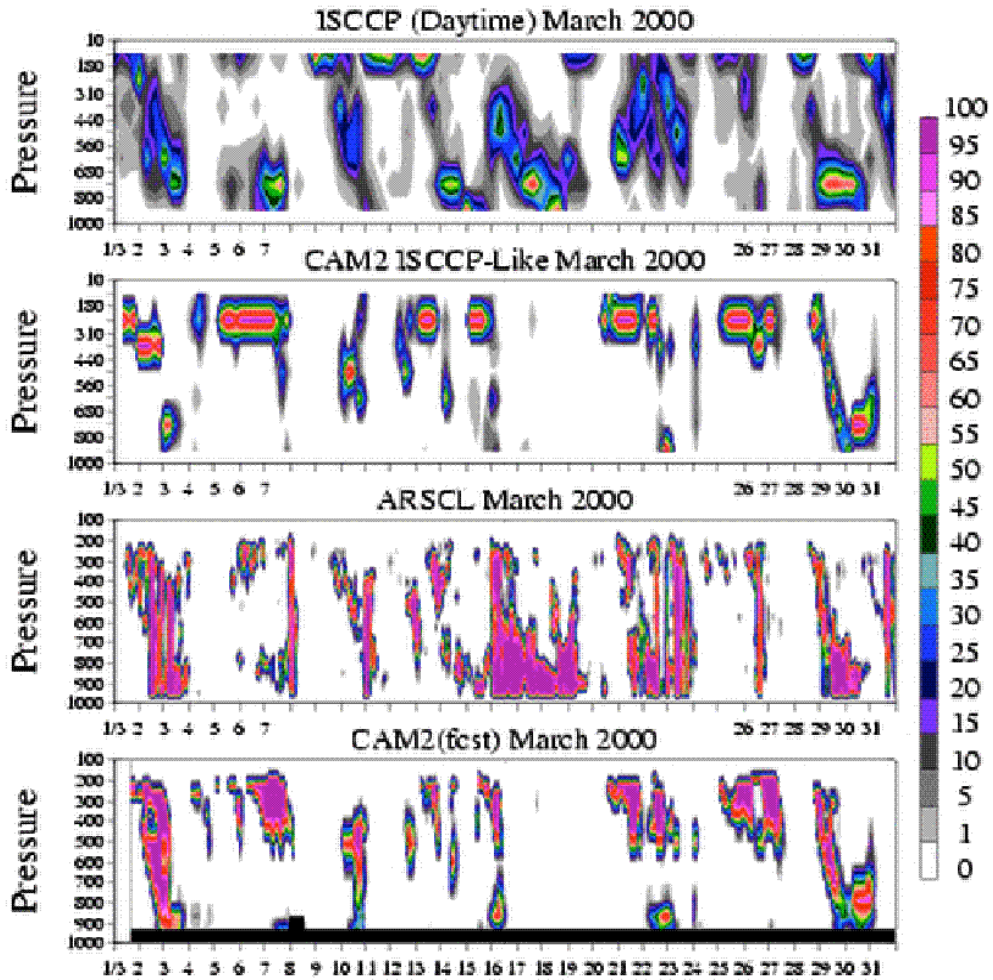

ARSCL March 2000
Pressure
1/3 2 3 4 5 6 7
26 27 28 29 30 31
100
200
300
400
500
600
700
800
900
1000


ARSCL March 2000
1/3 2 3 4 5 6 7
26 27 28 29 30 31
Pressure
100
200
300
400
500
600
700
800
900
1000
ISCCP (Daytime) March 2000
Pressure
10
150
310
440
560
680
800
1000

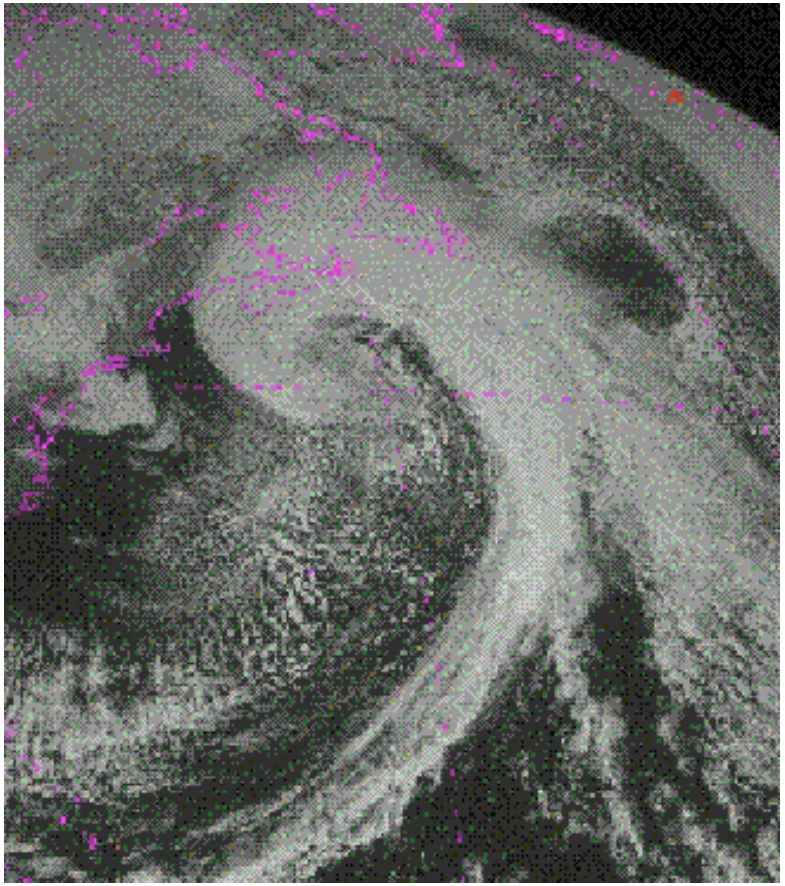

ISCCP SGP 03/2000
100
245
375
500
620
740
900
1.3
3.6
9.4
23
60
CAM2 SGP 03/2000
100
245
375
500
620
740
900
1.3
3.6
9.4
23
60


ISCCP (Daytime) March 2000
CAM2 ISCCP-Like March 2000
ARSCL March 2000
CAM2(fcst) March 2000
Pressure
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1
0

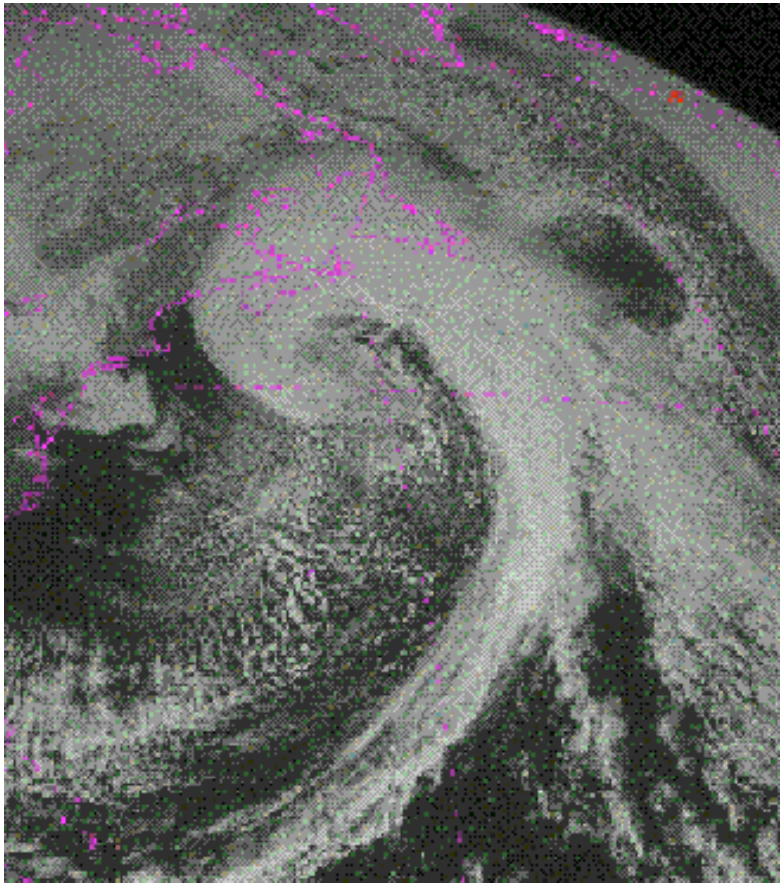
1. Does This Matter?

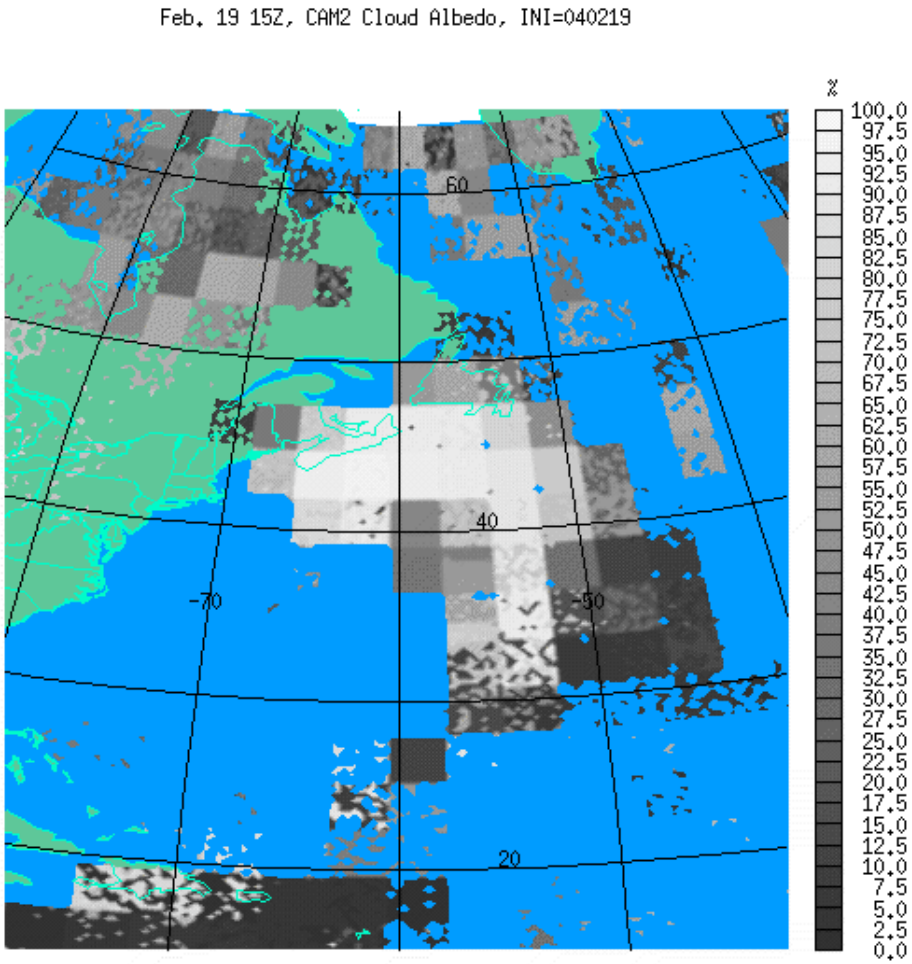
2. How Reliable Are the Data?

3. <u>What Are the Physical Causes</u>?

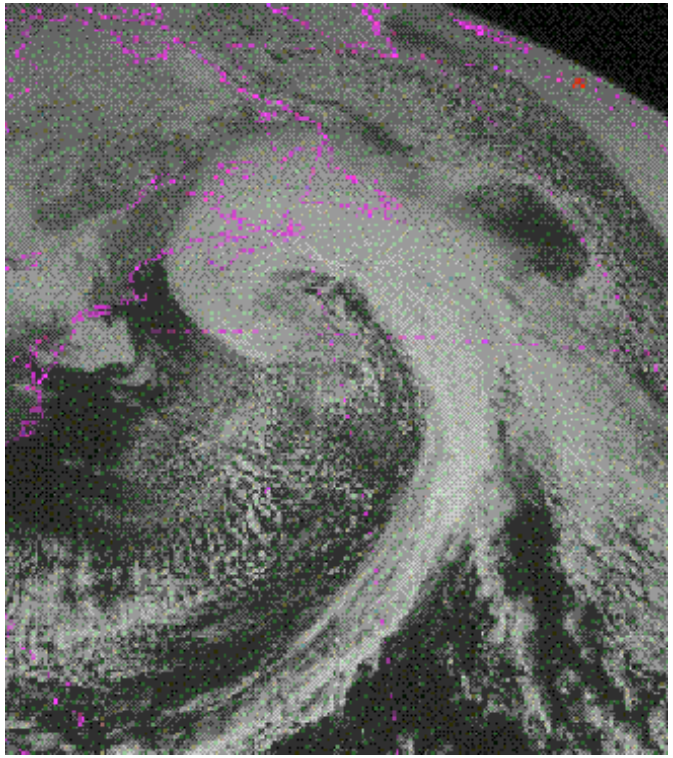


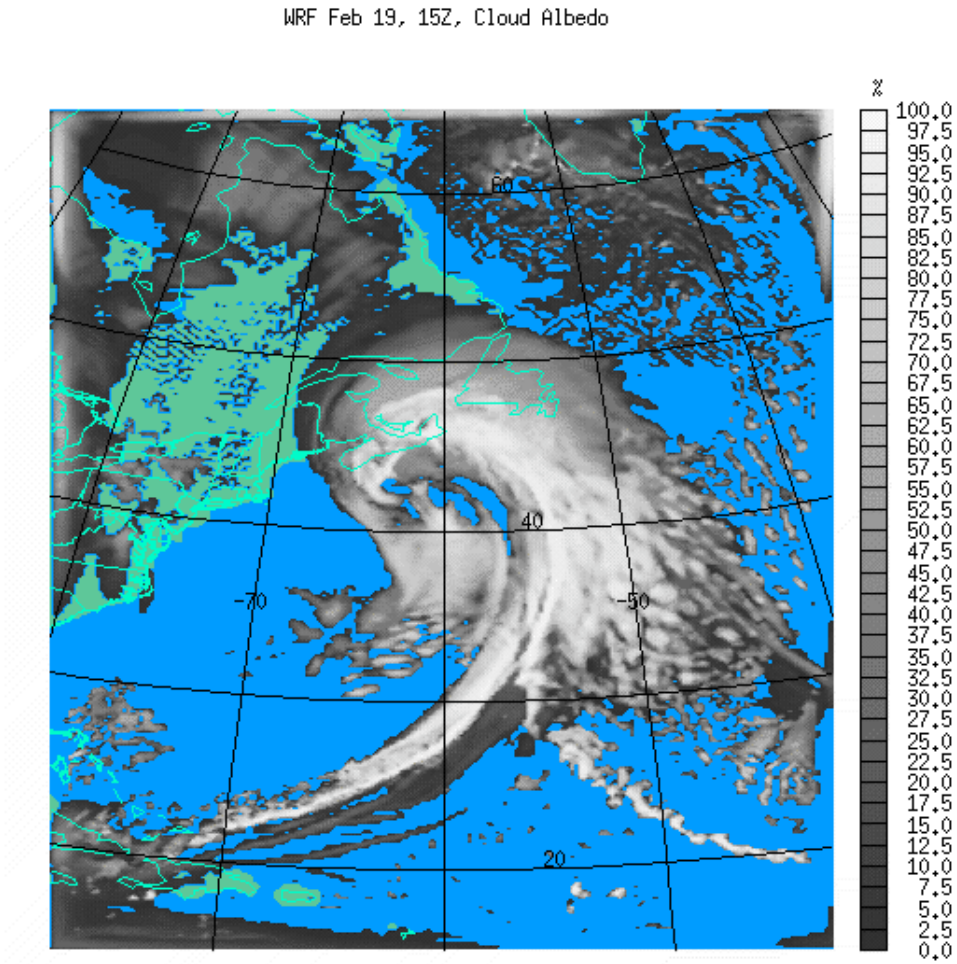
2/19/2004 15:00 Z




Feb. 19 15Z, CAM2 Cloud Albedo, INI=040219
60
40
20
-70
-50
%
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0

CAM2



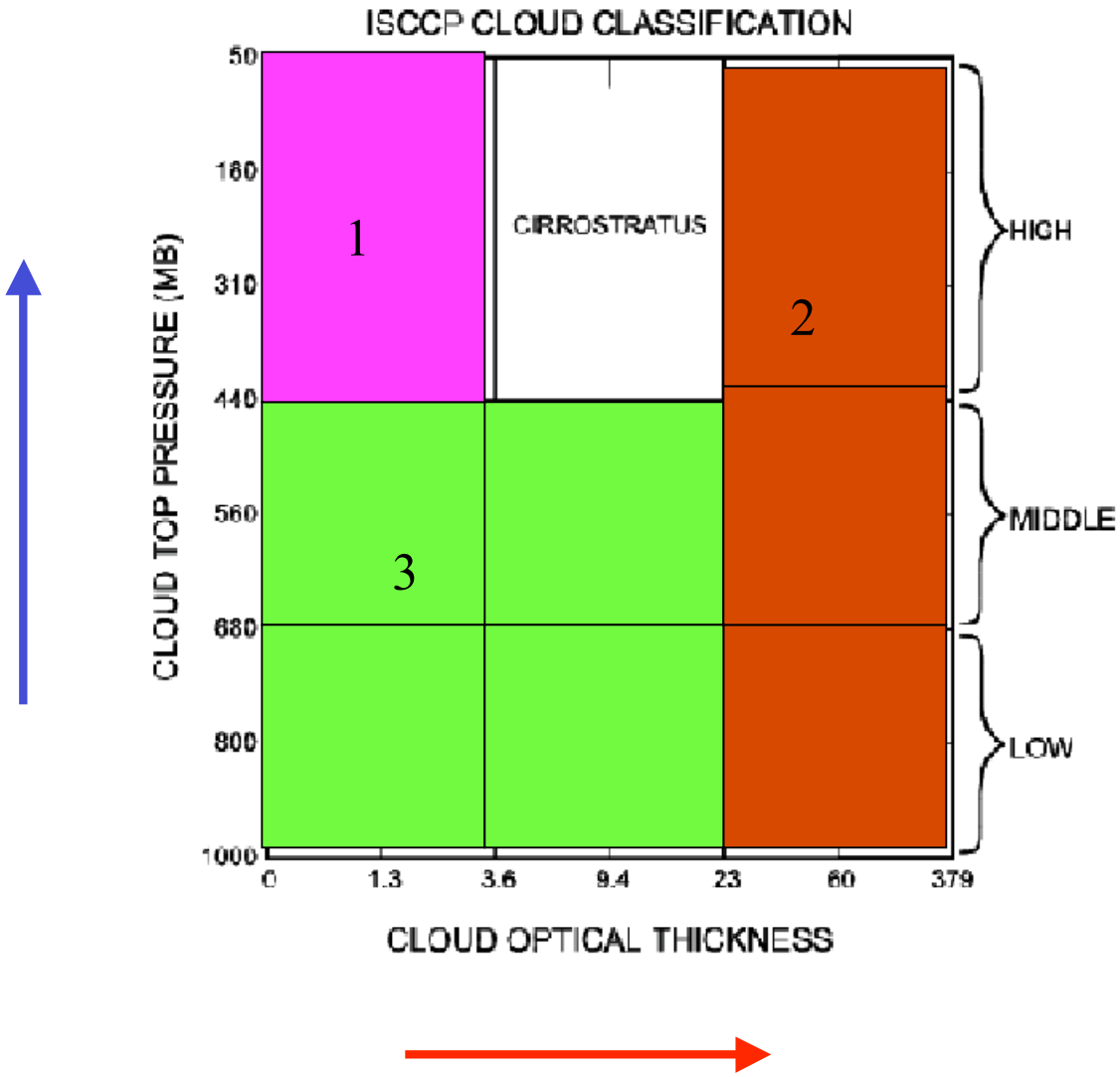

WRF Feb 19, 15Z, Cloud Albedo
%
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
60
40
20
-70
-50

WRF

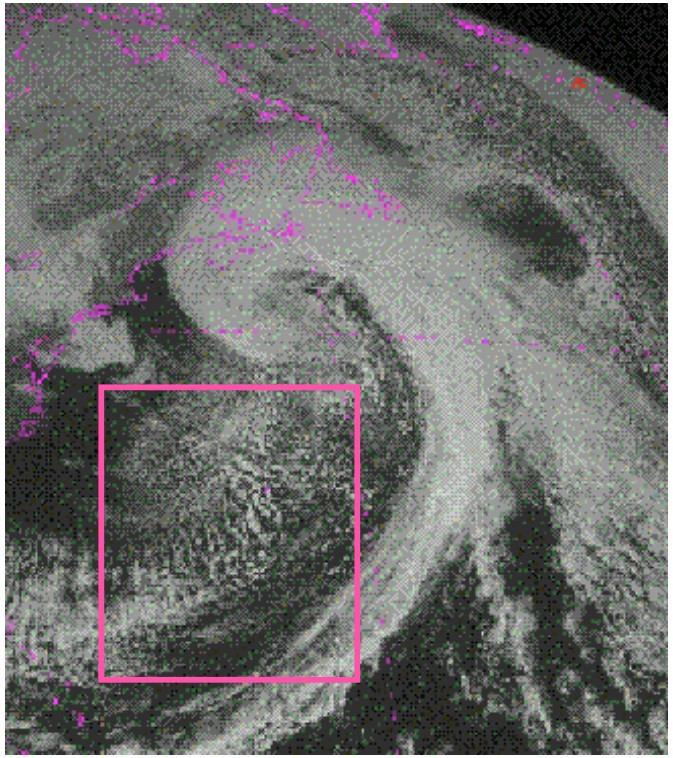
SUMMARY:

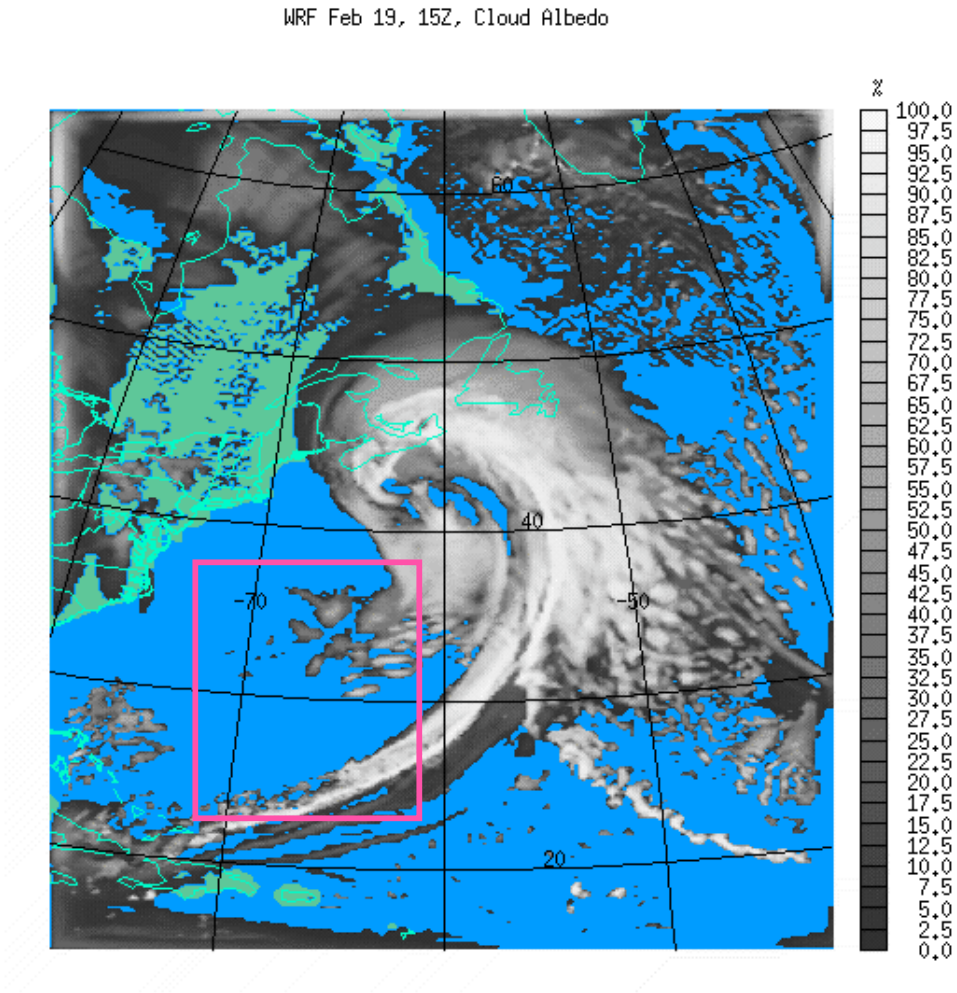
- **Model Cloud Biases In Altitudes**
- **Model Cloud Biases In Optical Thickness**
- **CRF**
- **Amplitude of Seasonal Variation**

- **Zhang et al. (2004) ARM CPM Special Issue of JGR**

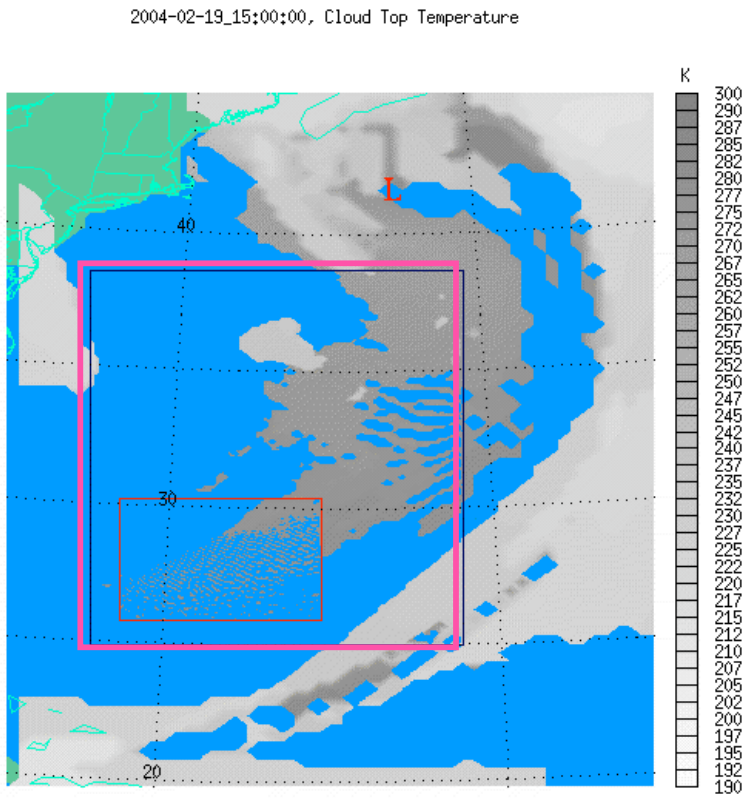

ISCCP CLOUD CLASSIFICATION
CLOUD TOP PRESSURE (MB)
50
160
310
440
560
680
800
1000
1
CIRROSTRATUS
2
3
HIGH
MIDDLE
LOW
0
1.3
3.6
9.4
23
60
379
CLOUD OPTICAL THICKNESS

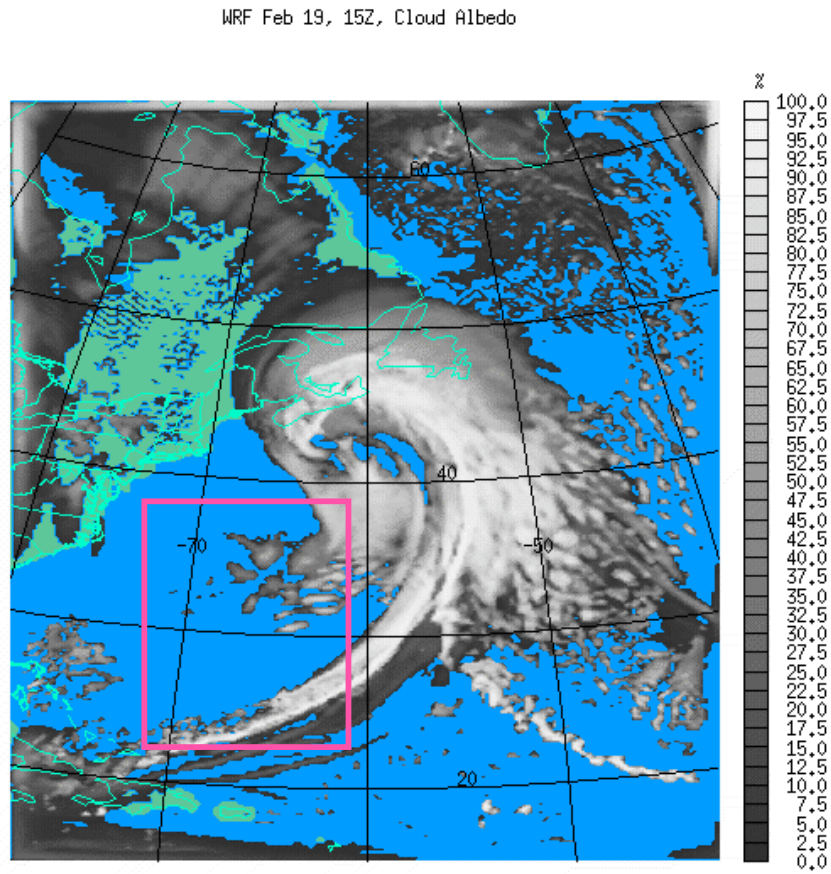
Zhang et al. (2004, ARM CPM Special Issue of JGR)



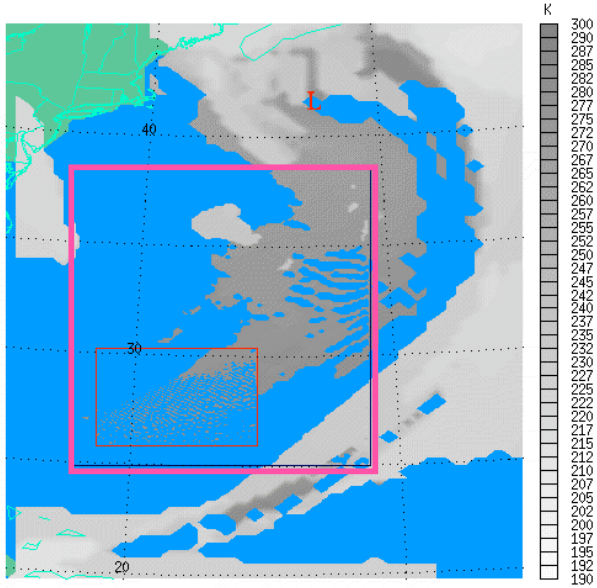
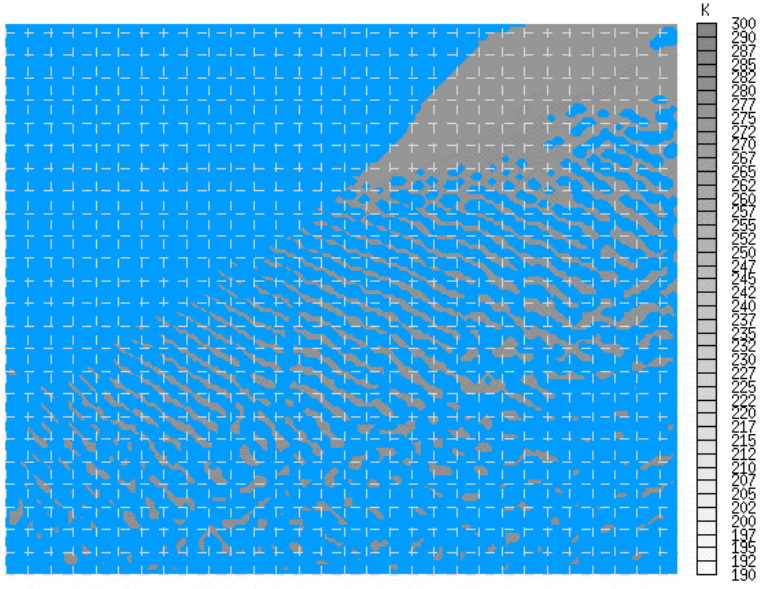
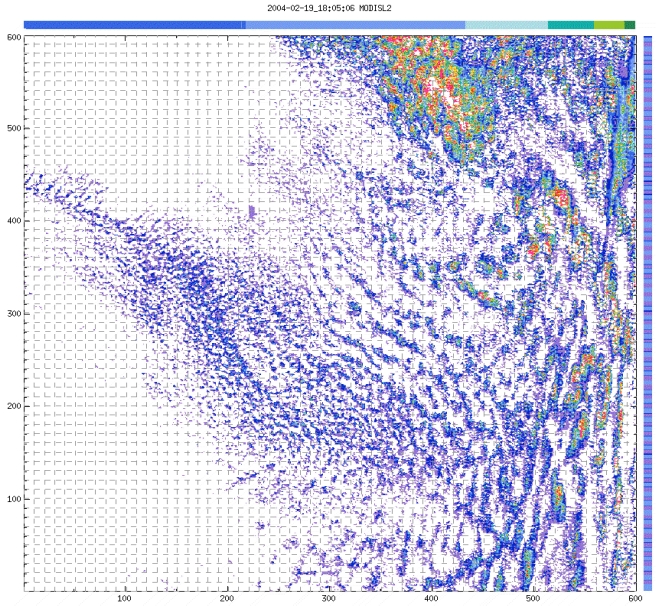

WRF Feb 19, 15Z, Cloud Albedo
%
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
60
40
20
-70
-50

WRF





20 km – 12 km – 4 km

2004-02-19_15:00:00, Cloud Top Temperature

2004-02-19_15:00:00, Cloud Top Temperature