Cloud structure anomalies over the tropical Pacific: CCM3 versus observations

Robert Cess
Marine Sciences Research Center
SUNY at Stony Brook

27th CERES Science Team Meeting
GFDL, Princeton, NJ

Objective

Compare the NCAR CCM3 to the ERBE/CERES observations of Cess, Zhang, Wang and Wielicki (2001) that include the strong 1997/98 El Niño and the weaker 1987 event.

Procedure

Employ output from a simulation with CCM3 employing prescribed SSTs, so that the two El Niños are imposed through the SST boundary condition.

Study Regions

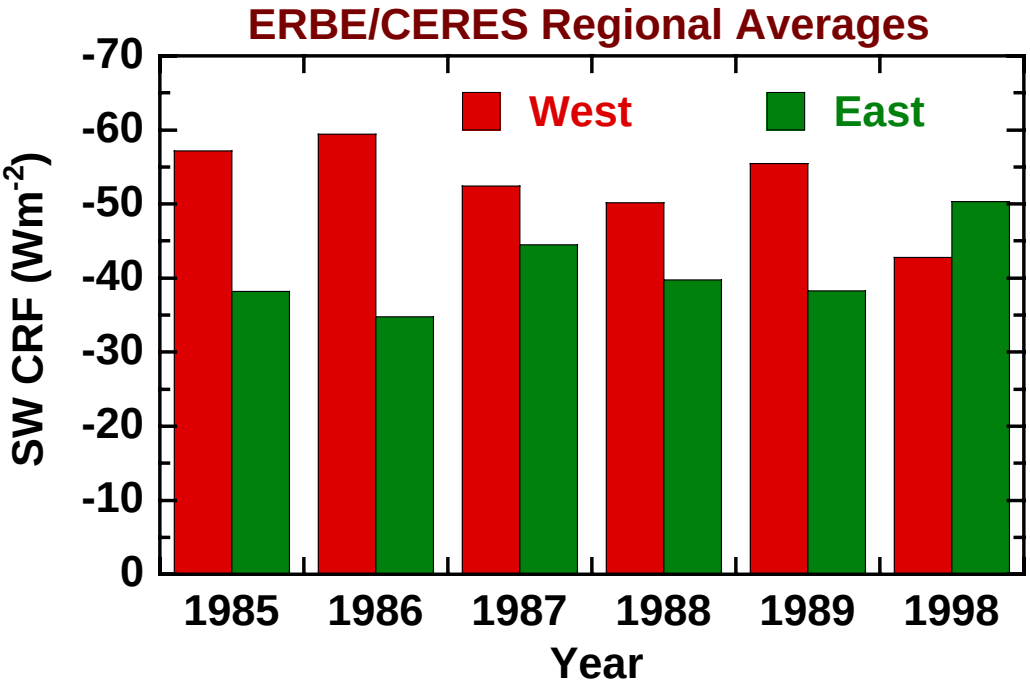
Western: 5°S to 10°N and 100°E to 170°E

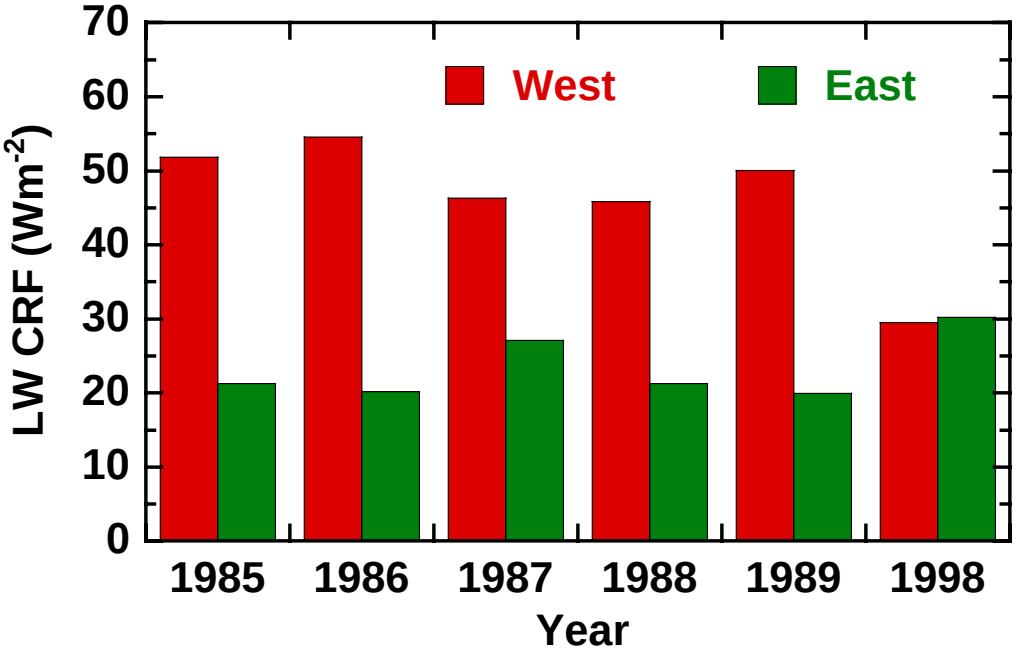
Eastern: 7.5^{o}S to 7.5^{o}N and 200°E to 280°E

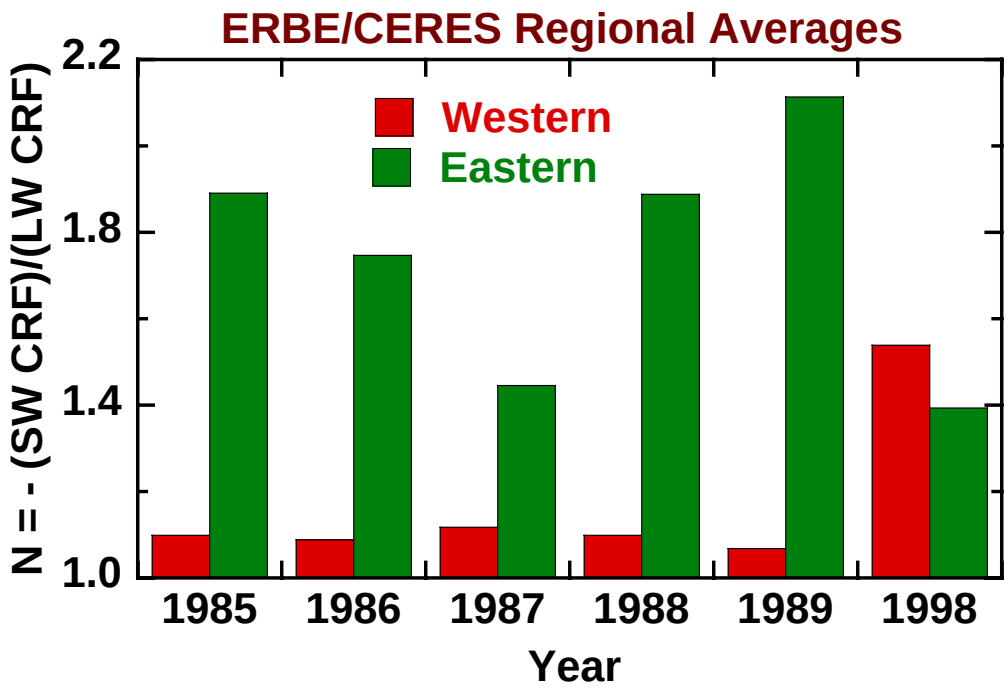
Data

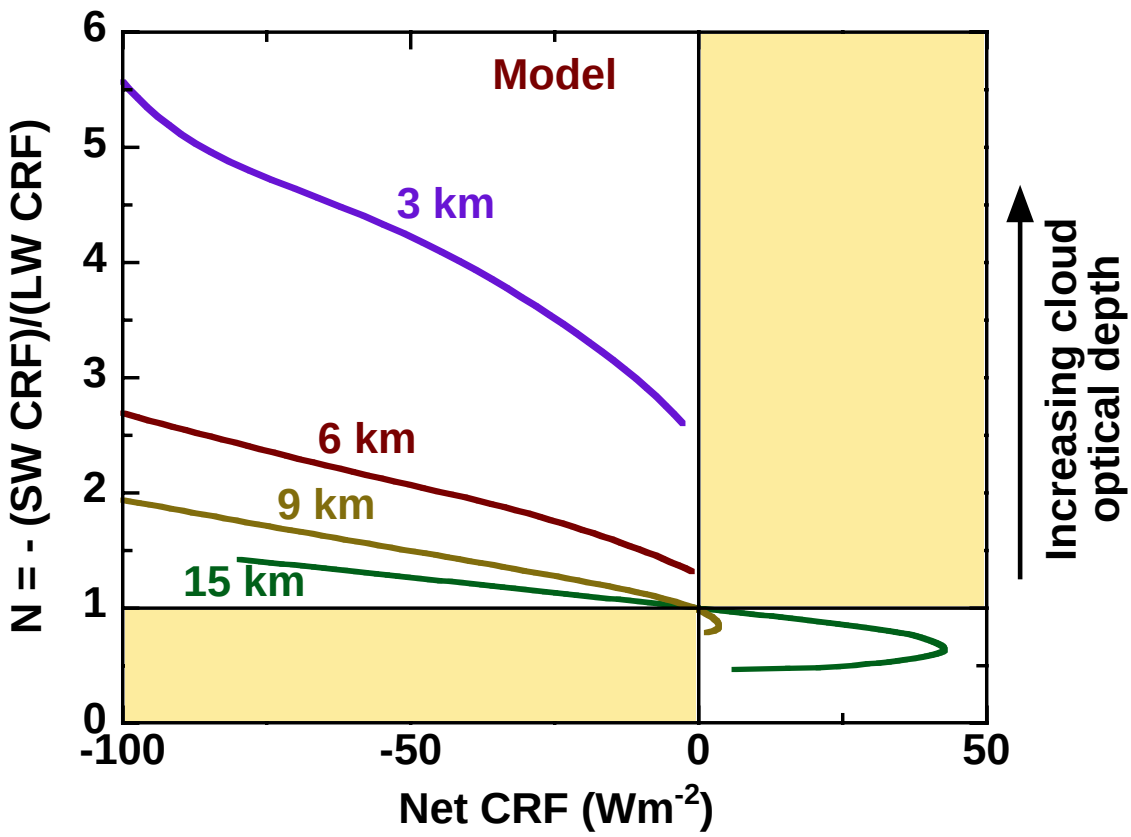
The data include the strong 1997/98 El Niño and the weaker 1987 event.

CRF at the top-of-the-atmosphere (TOA) from the Earth Radiation Budget Experiment (ERBE) for 1985 through 1989, and Cloud's and the Earth's Radiant Energy System (CERES) for the first four months of 1998. The ERBE data are likewise restricted to the first four months of each year.

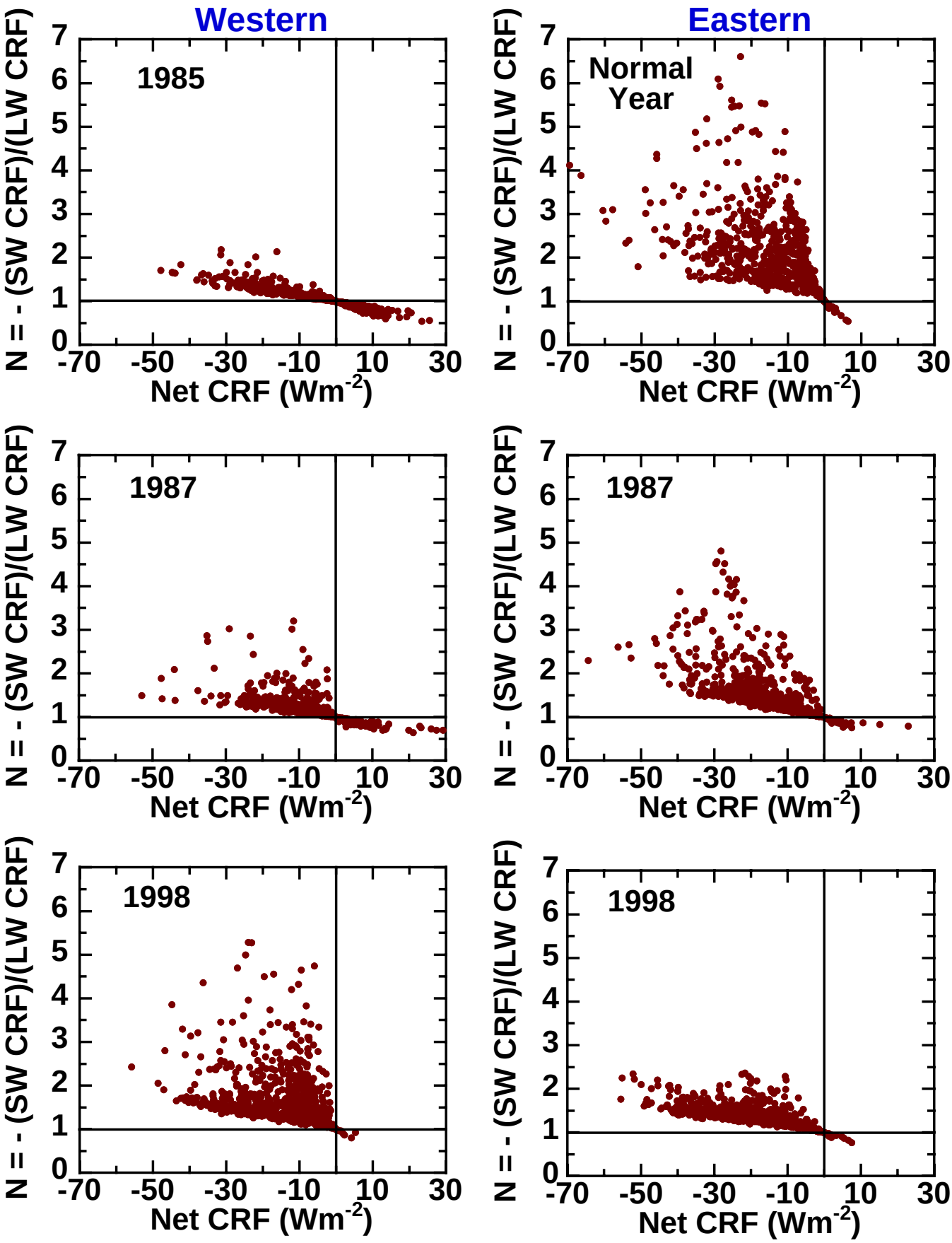

ERBE/CERES Regional Averages
West
East
SW CRF (Wm-2)
-70
-60
-50
-40
-30
-20
-10
0
1985
1986
1987
1988
1989
1998
Year


West
East
LW CRF (Wm-2)
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1998
Year

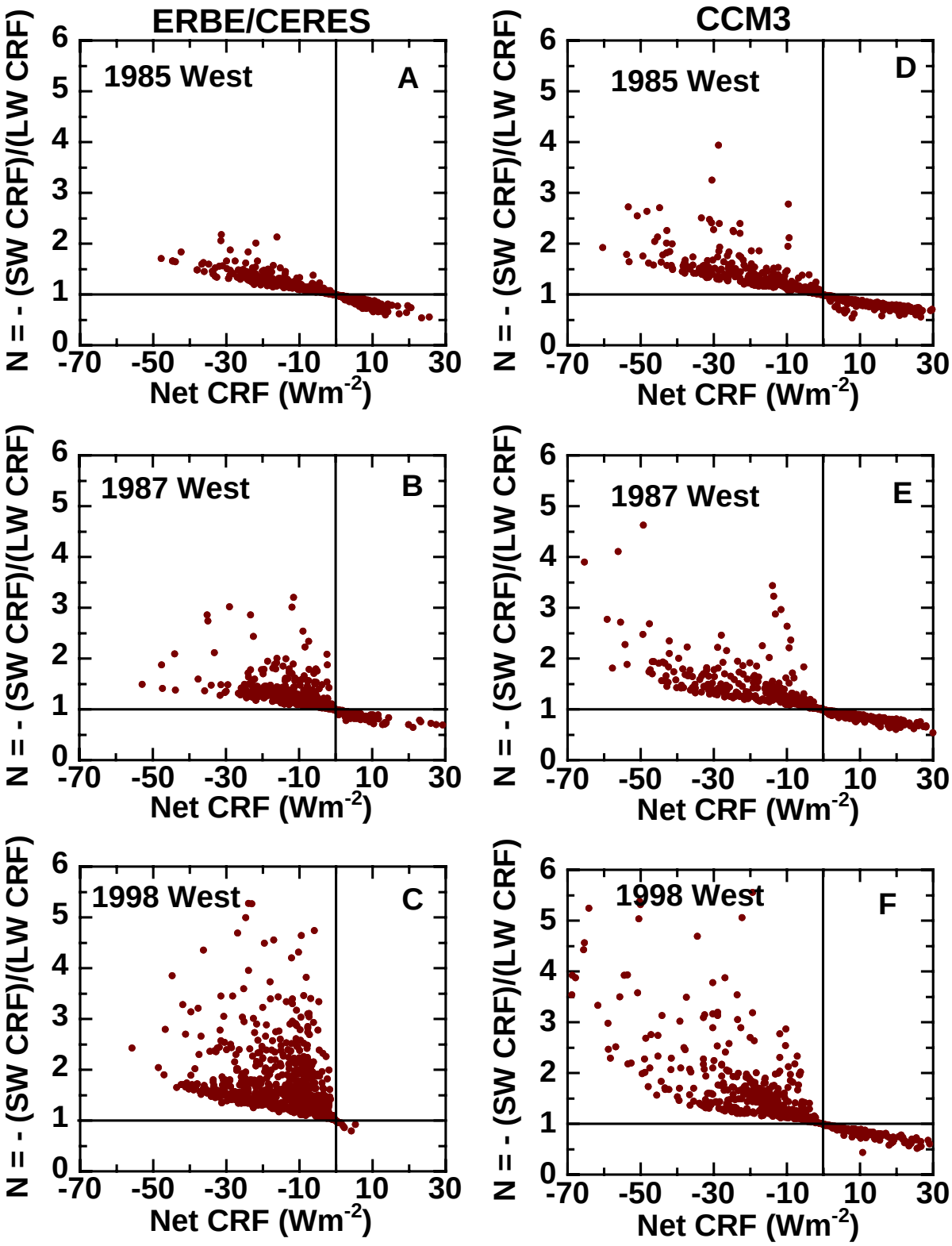

ERBE/CERES Regional Averages
Western
Eastern
N = - (SW CRF)/(LW CRF)
2.2
1.8
1.4
1.0
1985
1986
1987
1988
1989
1998
Year


Model
3 km
6 km
9 km
15 km
N = - (SW CRF)/(LW CRF)
6
5
4
3
2
1
0
-100
-50
0
50
Net CRF (Wm-2)
Increasing cloud optical depth

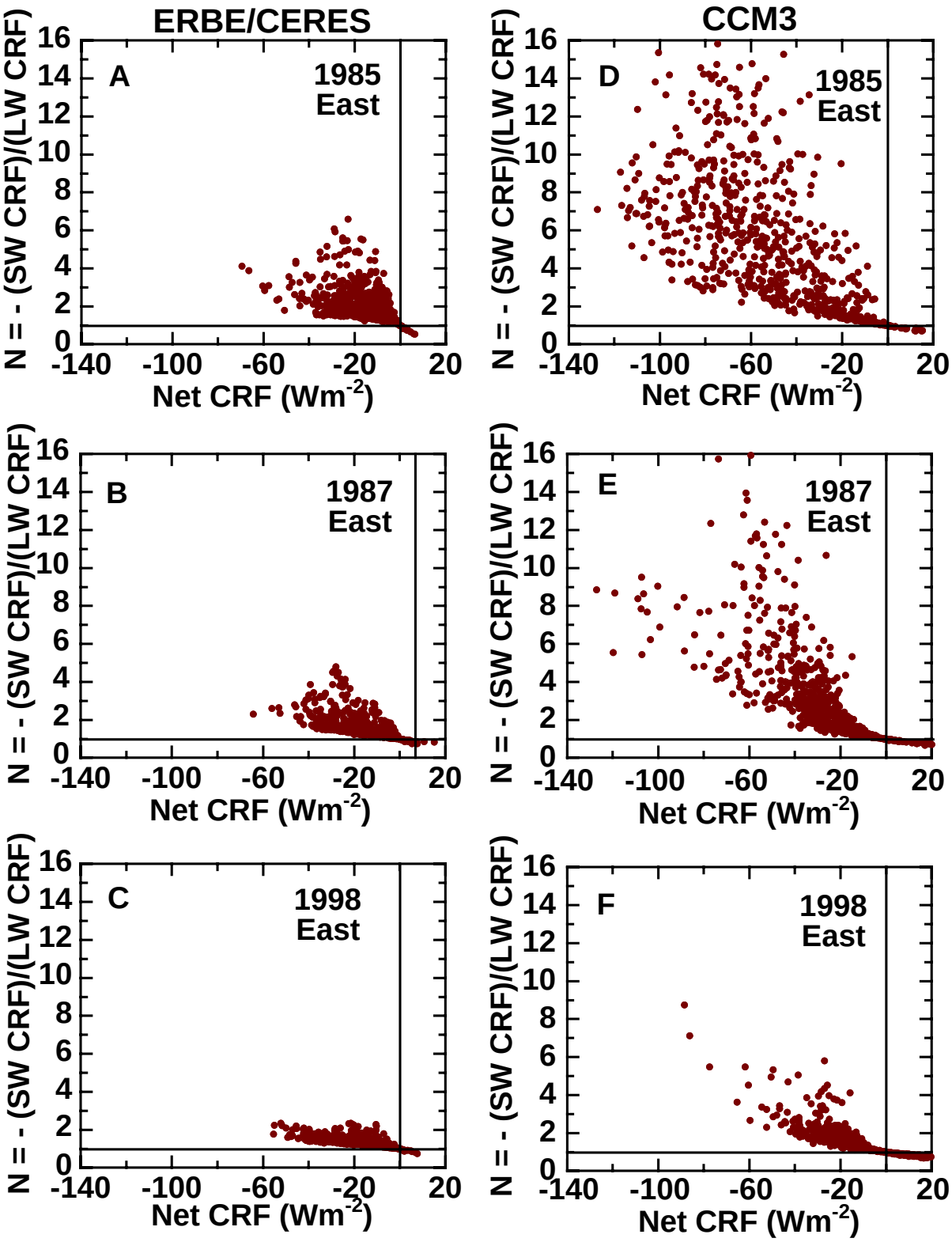
Monthly-mean Gridded Data

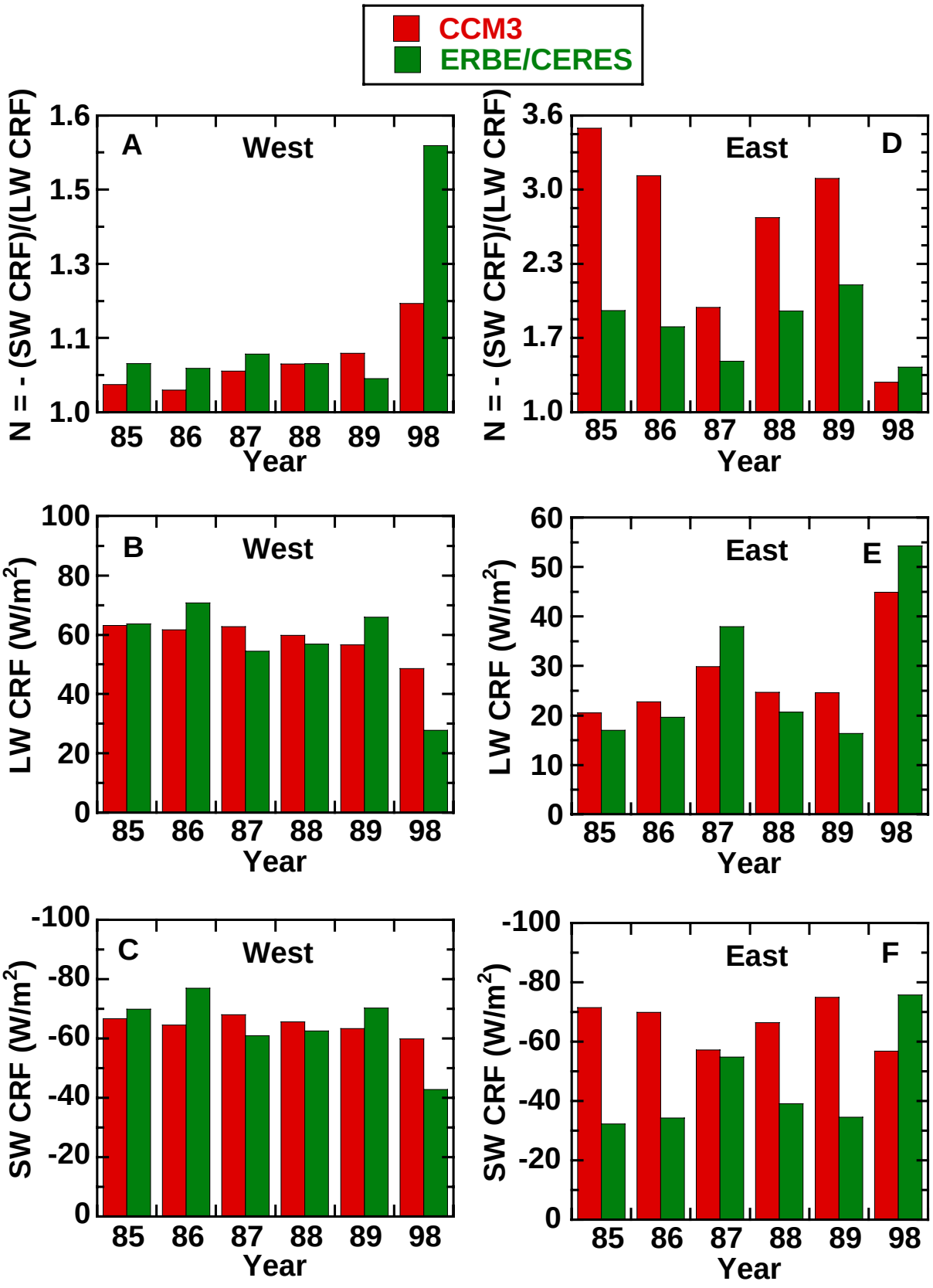


Monthly-mean Gridded Data



Monthly-mean Gridded Data




CCM3
ERBE/CERES
A
West
N = - (SW CRF)/(LW CRF)
1.6
1.5
1.3
1.1
1.0
85 86 87 88 89 98
Year
D
East
N = - (SW CRF)/(LW CRF)
3.6
3.0
2.3
1.7
1.0
85 86 87 88 89 98
Year
B
West
LW CRF (W/m2)
100
80
60
40
20
0
85 86 87 88 89 98
Year
E
East
LW CRF (W/m2)
60
50
40
30
20
10
0
85 86 87 88 89 98
Year
C
West
SW CRF (W/m2)
-100
-80
-60
-40
-20
0
85 86 87 88 89 98
Year
F
East
SW CRF (W/m2)
-100
-80
-60
-40
-20
0
85 86 87 88 89 98
Year

CONCLUSIONS

Western Region

CCM3 does an excellent job of replicating the observations of SW CRF, LW CRF and N, with the exception on 1998 for which it underestimates both the reduction in average cloud altitude and cloud amount as induced by the El Niño.

Eastern region

CCM3 does a poor job of replicating the observations of both SW CRF and N, with the best agreement coinciding with the two El Niños. For LW CRF, on the other hand, CCM3 does quite a good job, because of compensating errors in cloud amount and vertical structure.