Atmospheric longwave cooling over the tropical oceans: The role of continuum and the water vapor Rotation and vibration-rotation bands inferred from CERES data

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Long-wave energy budget studies (Raval & Ramanathan, 1989; Stephens & Greenwald, 1991, etc) have focused on OLR & Ga, where

$$G_a = e\,s\,T_s^4 - OLR$$

Ability of the atmosphere to lose its excess energy and regulate its temperature depends also on G_a^*, LW radiation emitted by the atmosphere to the surface. Strength of greenhouse effect depends on both G_a and G_a^*

Microsoft
Equation 3.0

CERES data presently archives G_a^*

Net loss of Radiative energy from the atmospheric column expressed as,

Radiative Cooling, RC = $G_a - G_a^*$

RC is an important measure of the strength of the Earth's greenhouse effect and an indirect measure of the Earth's water vapor feedback.

Net Surface Cooling = $e s T_s^4 - G_a^*$

Data: CERES SSF Edition 2B

Imager-based skin surface temperature

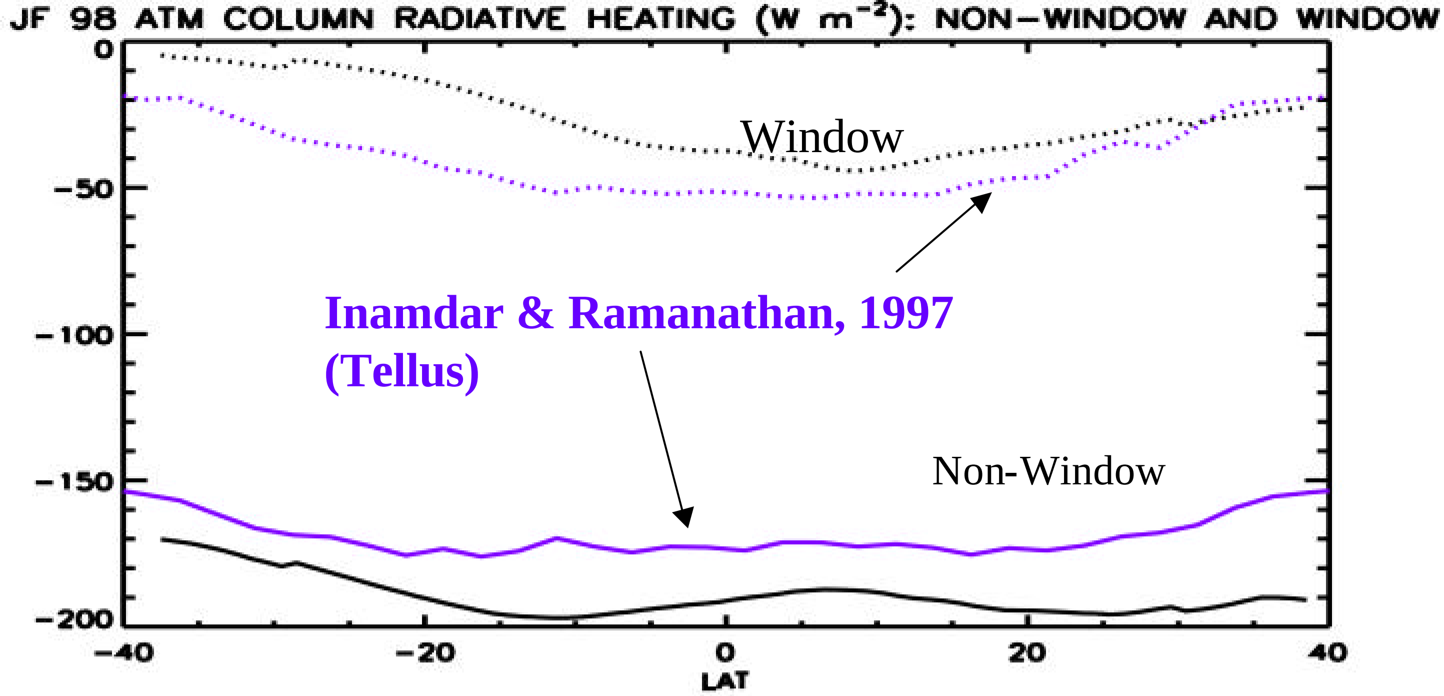
Microwave precipitable water over oceans

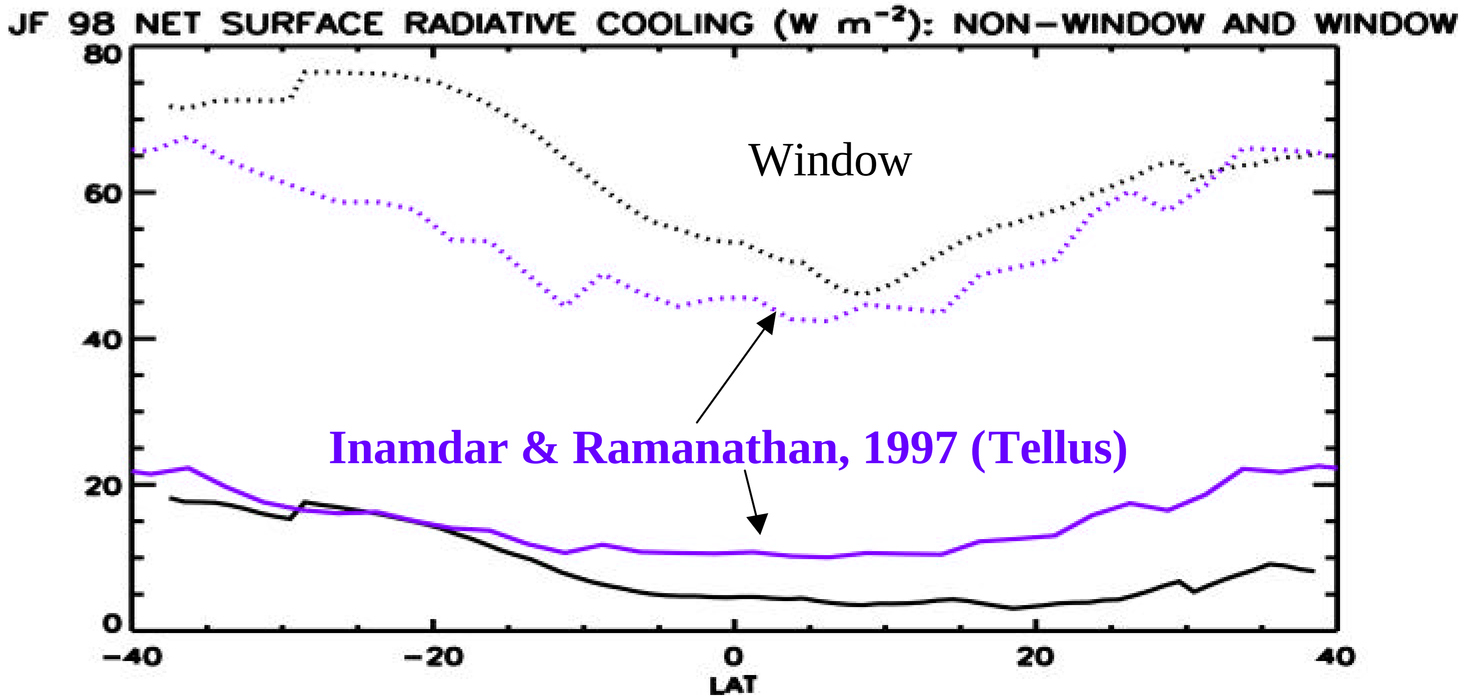
Upward LW flux

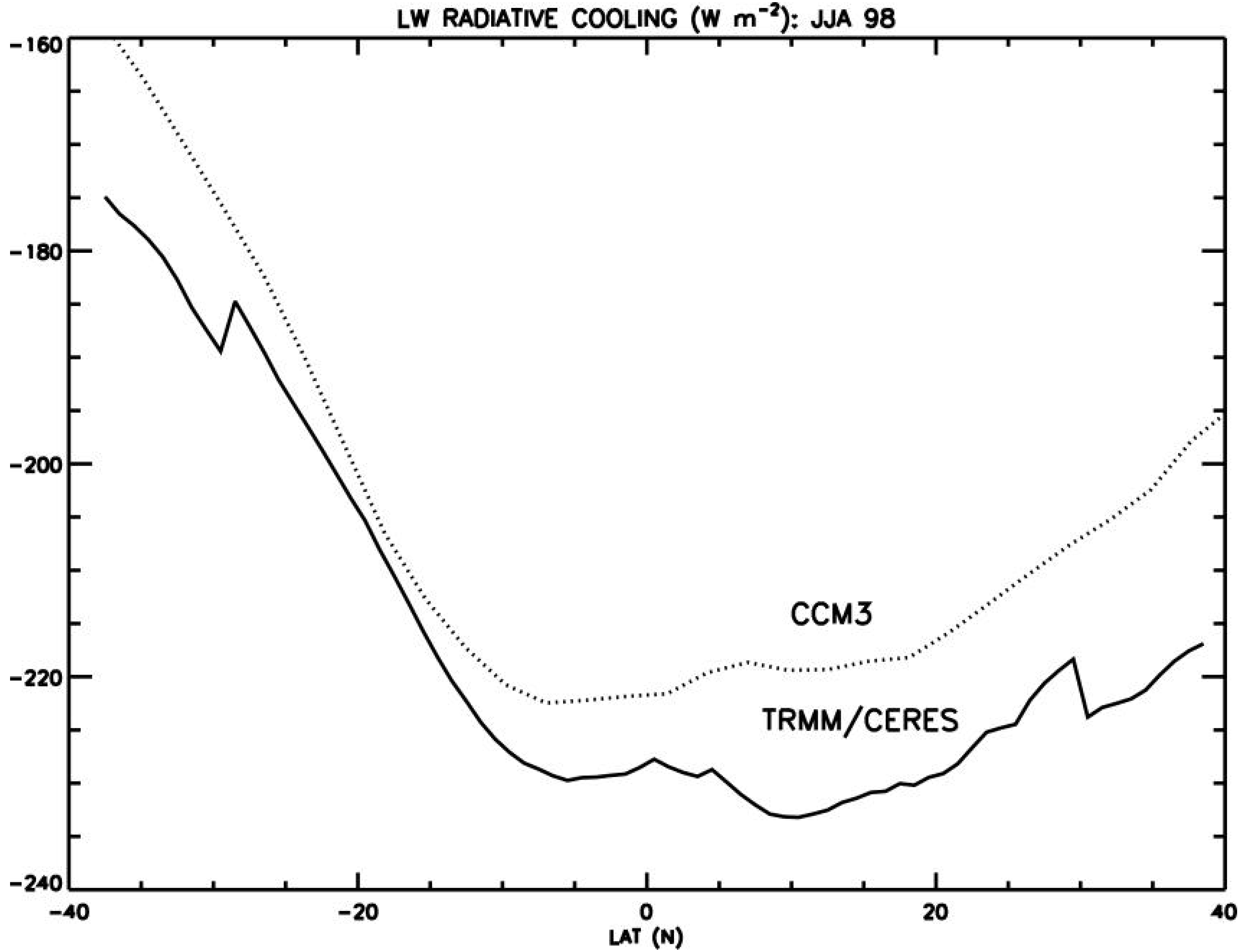
Upward WIN flux

Archived Downward LW Surface flux (Model A – Inamdar & Ramanathan)

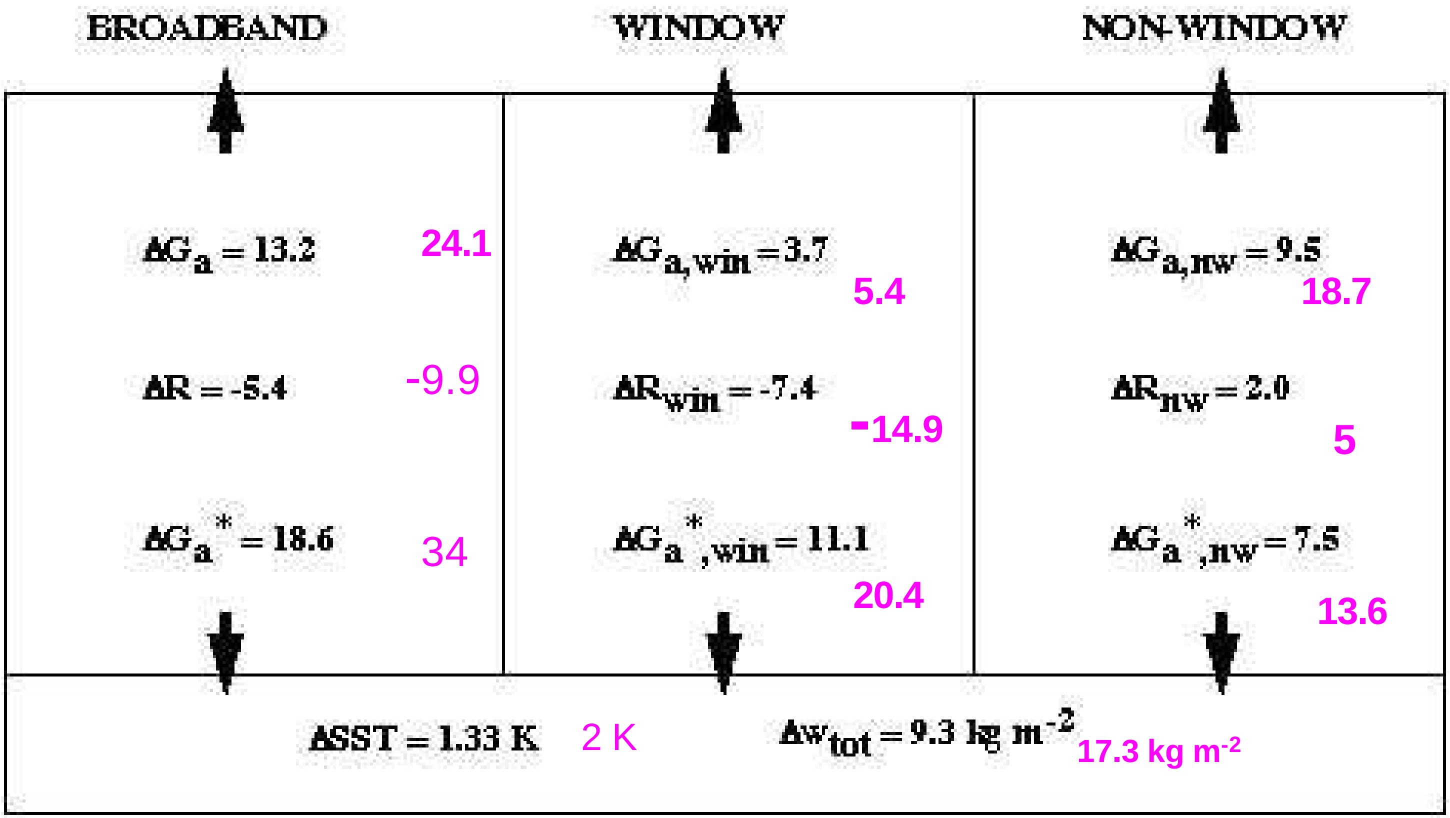
Downward WIN Surface flux (Model A)

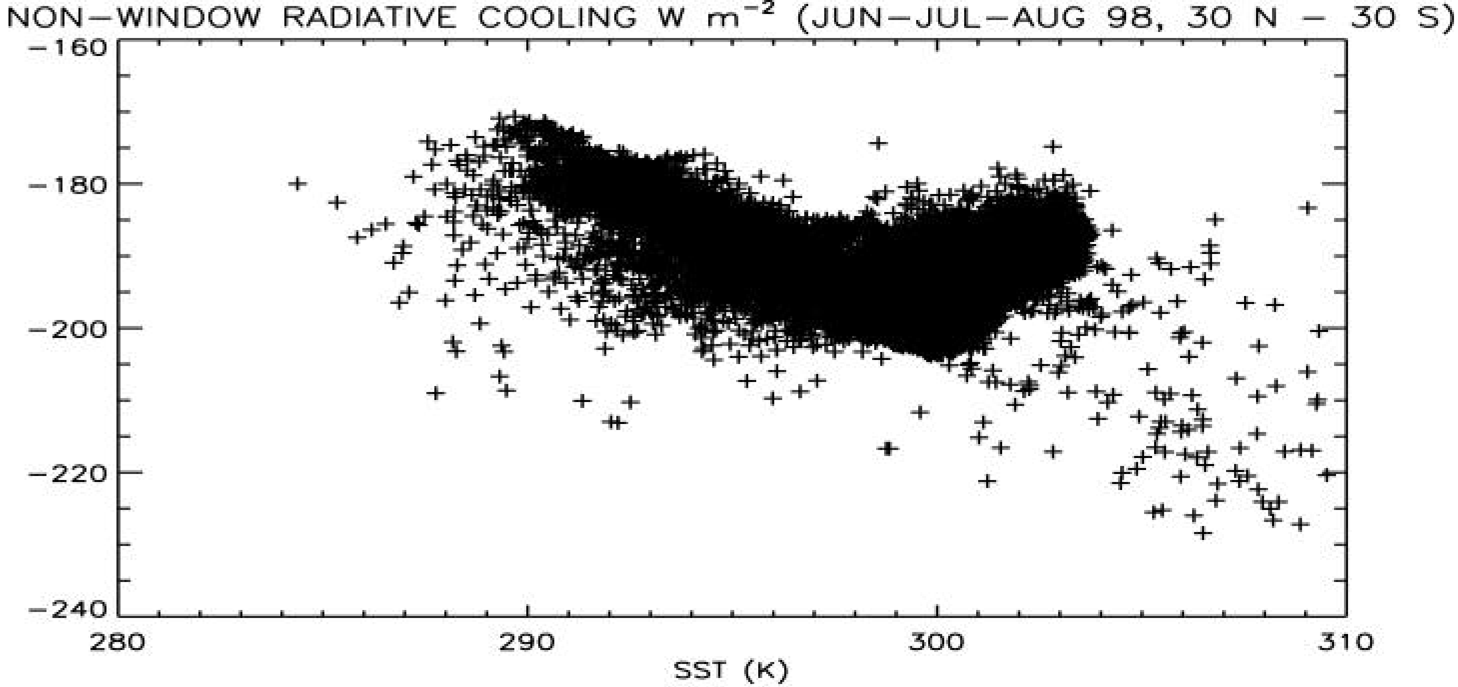

JF 98 ATM COLUMN RADIATIVE HEATING (W m⁻²): NON-WINDOW AND WINDOW
0
-50
-100
-150
-200
Window
Inamdar & Ramanathan, 1997
(Tellus)
Non-Window
-40
-20
0
20
40
LAT

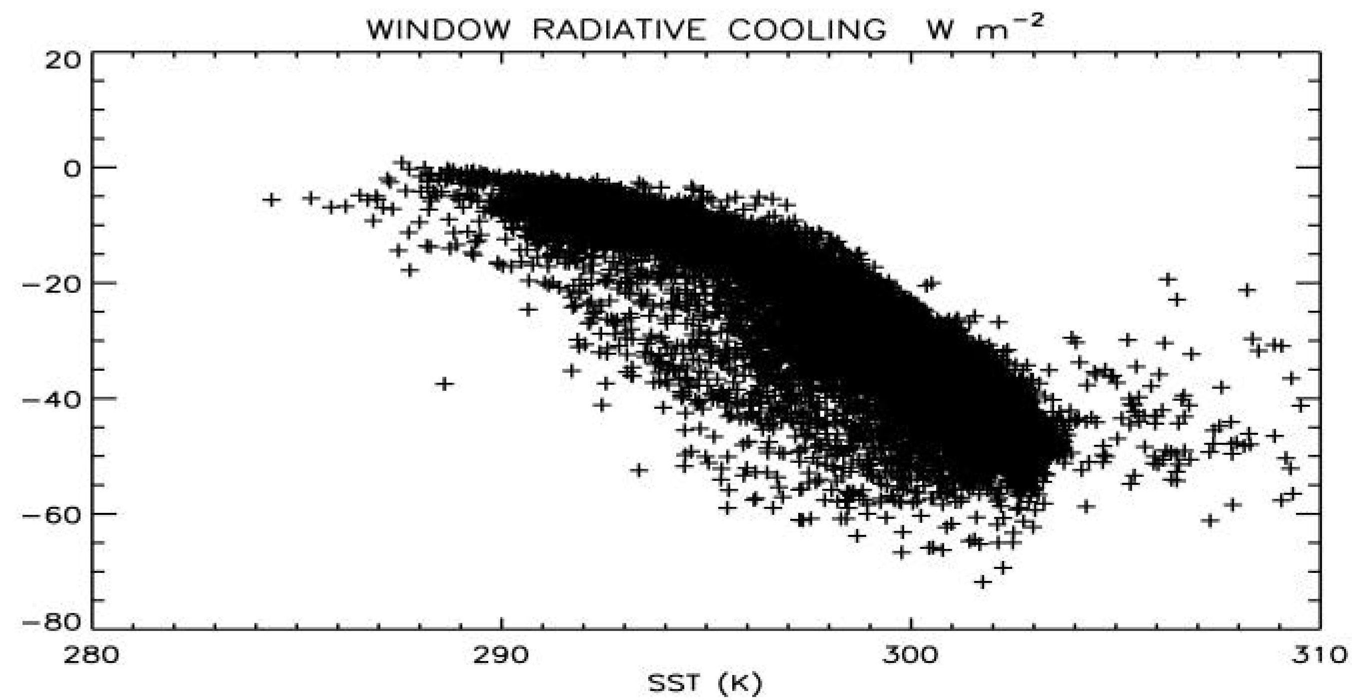

JF 98 NET SURFACE RADIATIVE COOLING (W m⁻²): NON-WINDOW AND WINDOW
80
60
40
20
0
Window
Inamdar & Ramanathan, 1997 (Tellus)
-40
-20
0
20
40
LAT

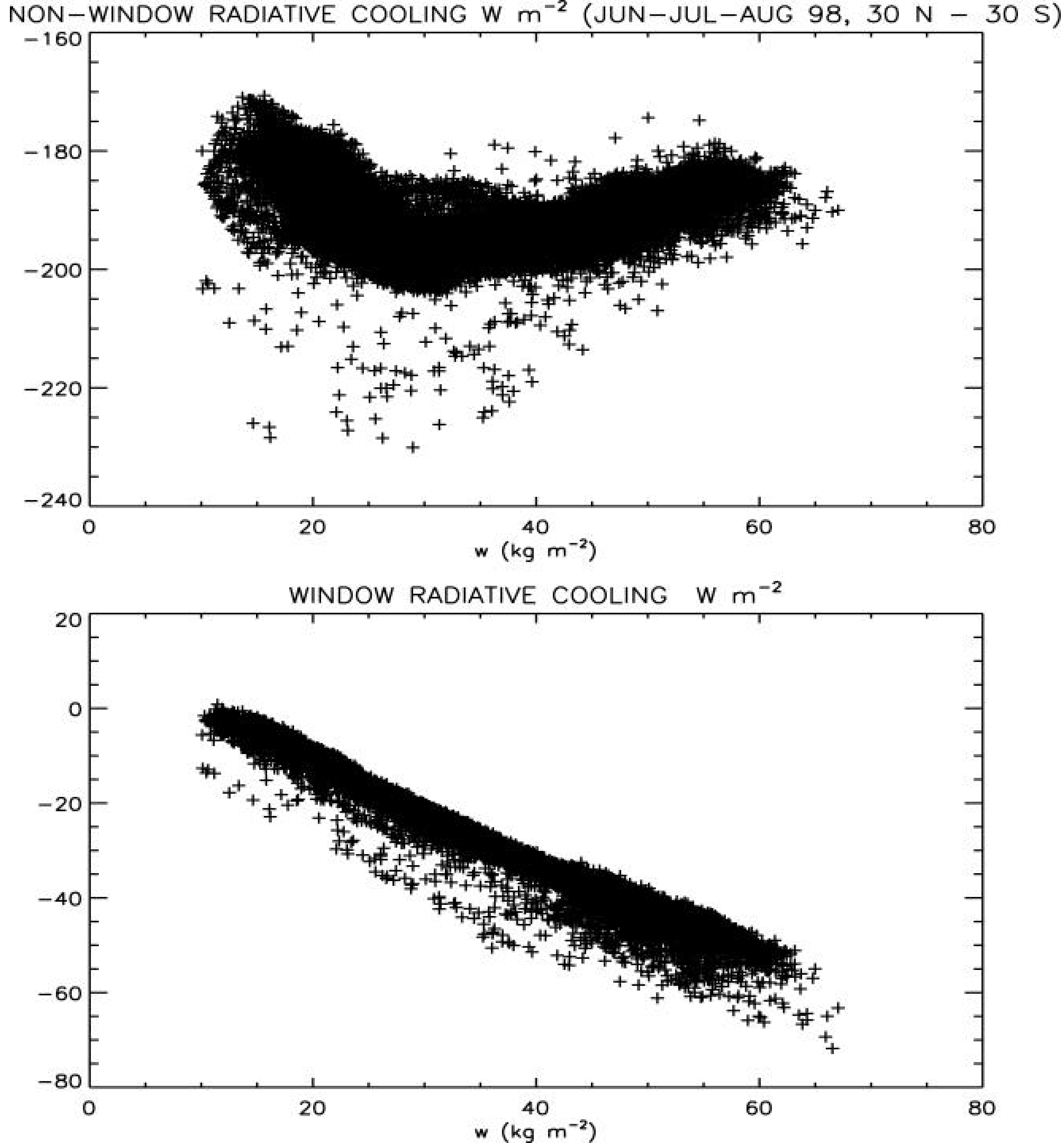

LW RADIATIVE COOLING (W m⁻²): JJA 98
-160
-180
-200
-220
-240
-40
-20
0
20
40
LAT (N)
CCM3
TRMM/CERES

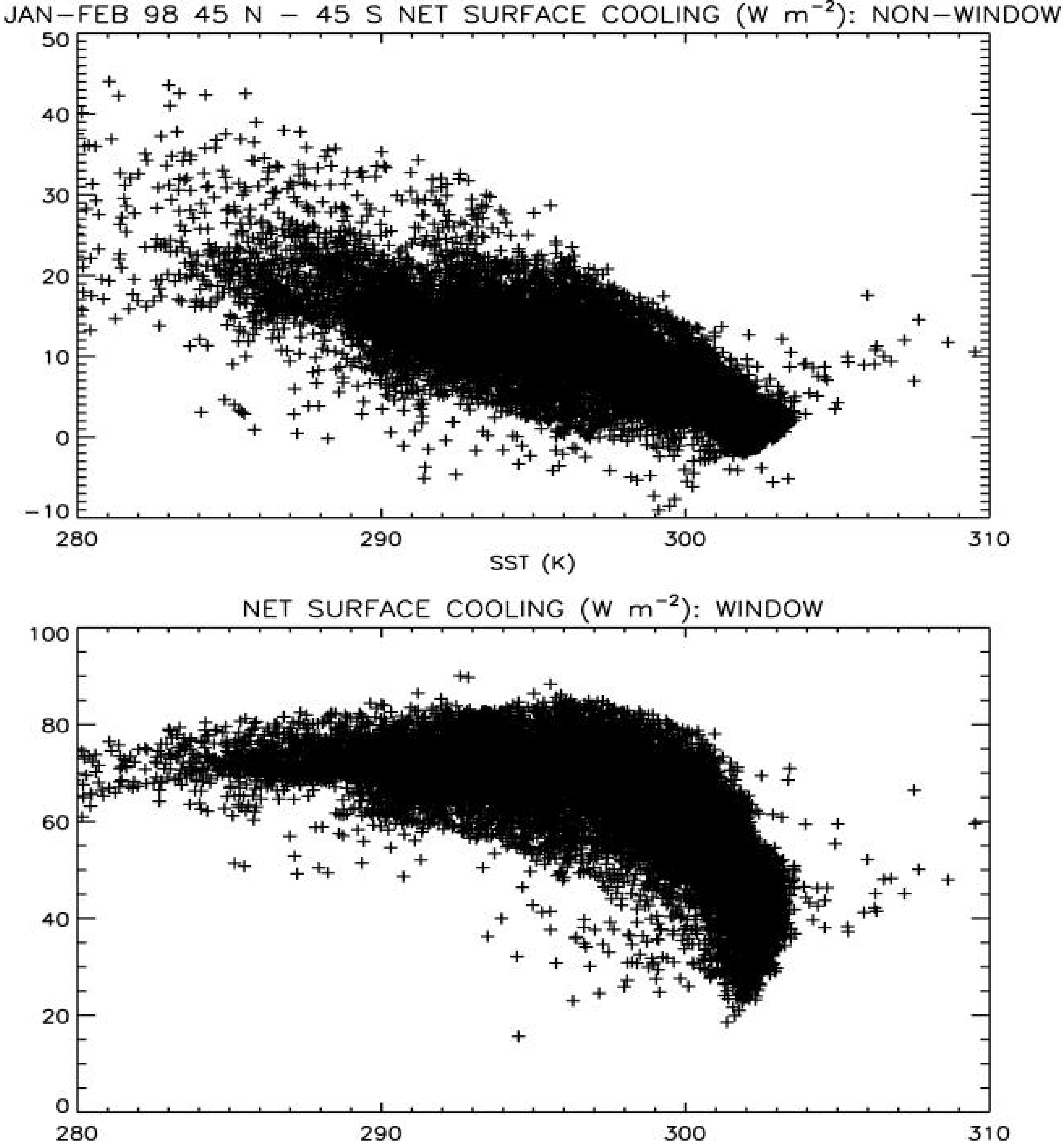
Changes in the atmospheric Ga, surface flux and column radiative cooling between JJA and DJF 98. The corresponding numbers for 19888-89 from ERBE & Model (Tellus 1997 paper) in Magenta

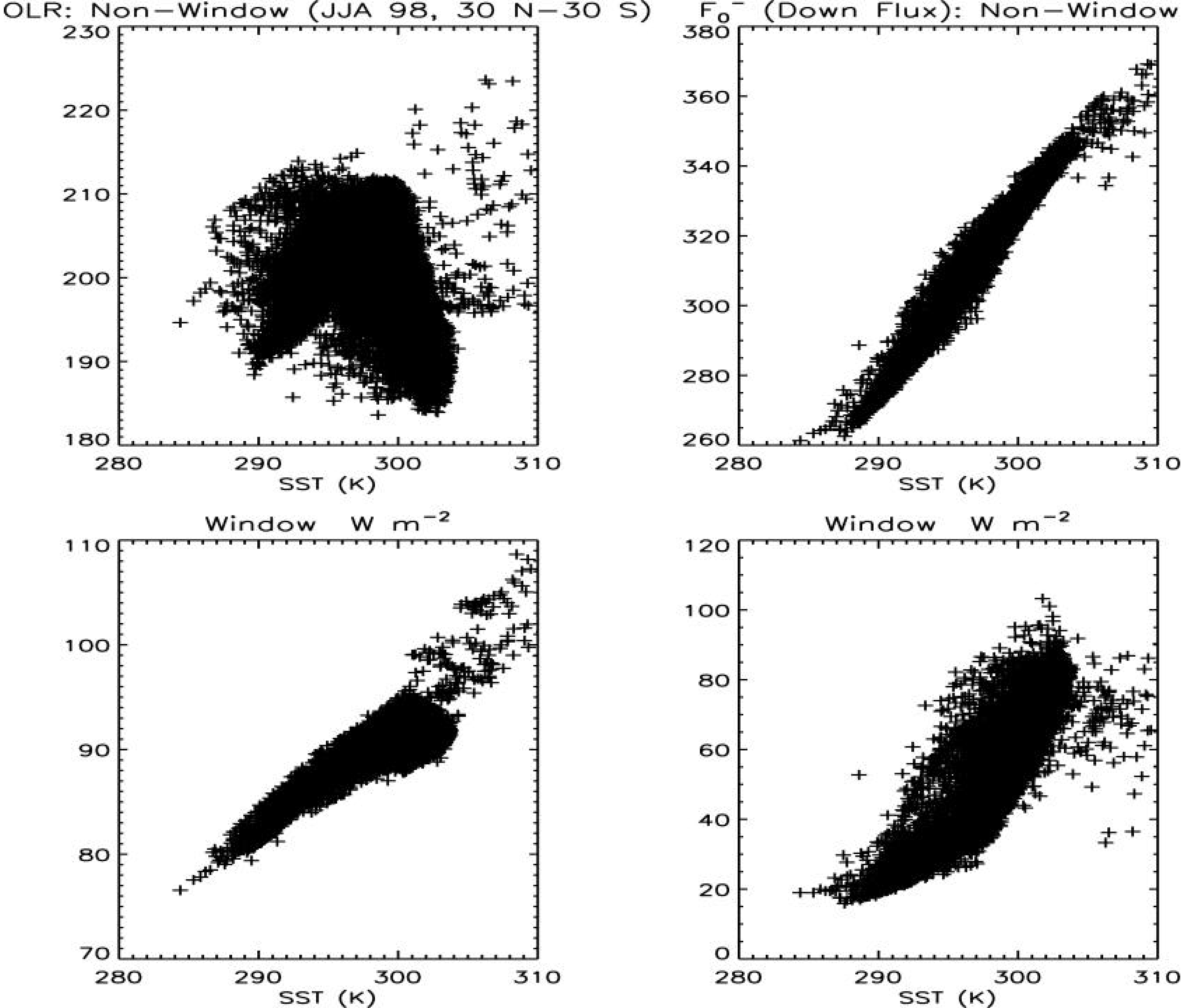



NON−WINDOW RADIATIVE COOLING W m^{-2} (JUN−JUL−AUG 98, 30 N − 30 S)
−160
−180
−200
−220
−240
280
290
300
310
SST (K)

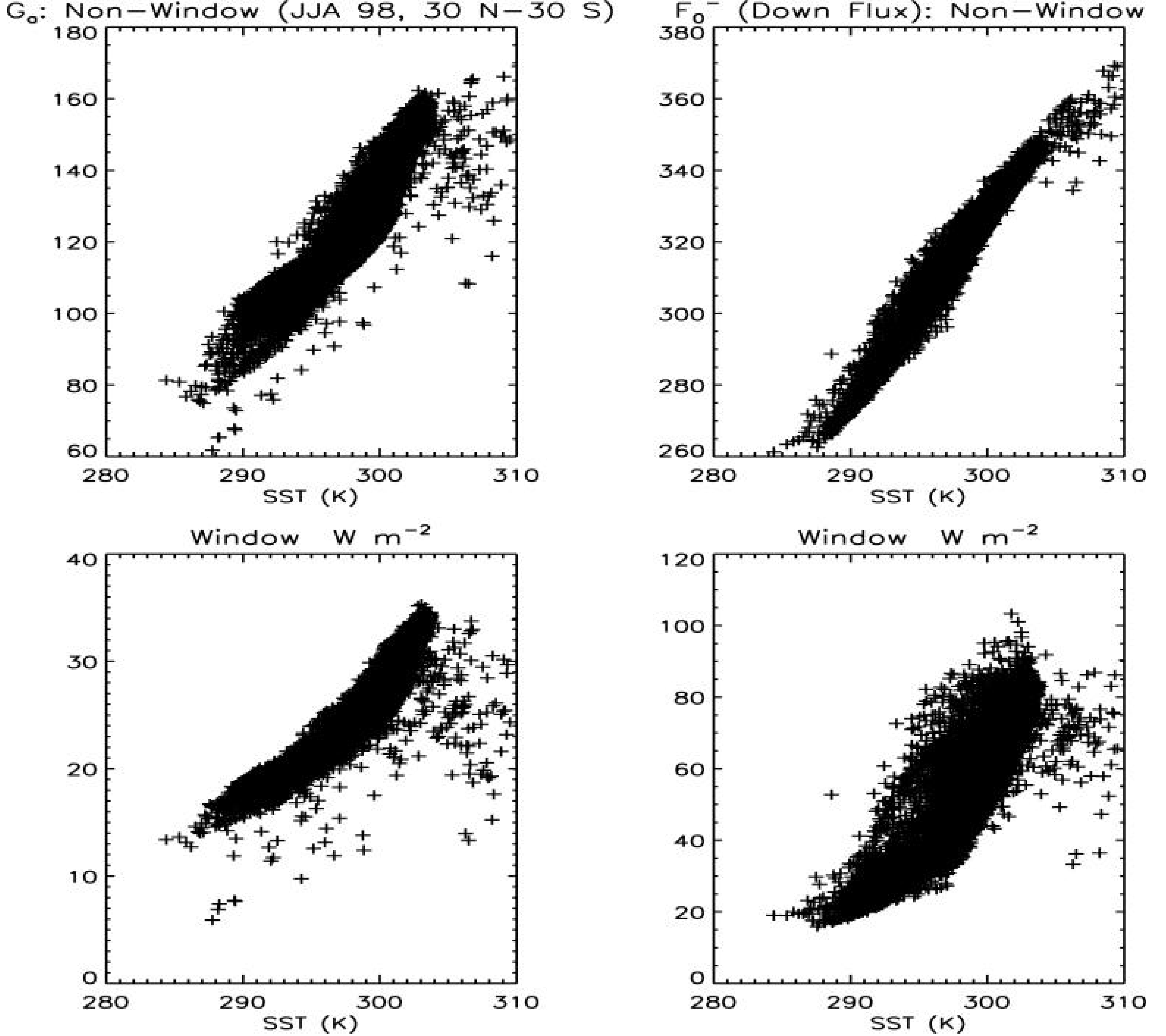

WINDOW RADIATIVE COOLING W m^{-2}
20
0
−20
−40
−60
−80
280
290
300
310
SST (K)


NON–WINDOW RADIATIVE COOLING W m^{-2} (JUN–JUL–AUG 98, 30 N – 30 S)
-160
-180
-200
-220
-240
0
20
40
60
80
w (kg m^{-2})
WINDOW RADIATIVE COOLING W m^{-2}
20
0
-20
-40
-60
-80
0
20
40
60
80
w (kg m^{-2})


JAN-FEB 98 45 N - 45 S NET SURFACE COOLING (W m^{-2}): NON-WINDOW
50
40
30
20
10
0
-10
280
290
300
310
SST (K)
NET SURFACE COOLING (W m^{-2}): WINDOW
100
80
60
40
20
0
280
290
300
310



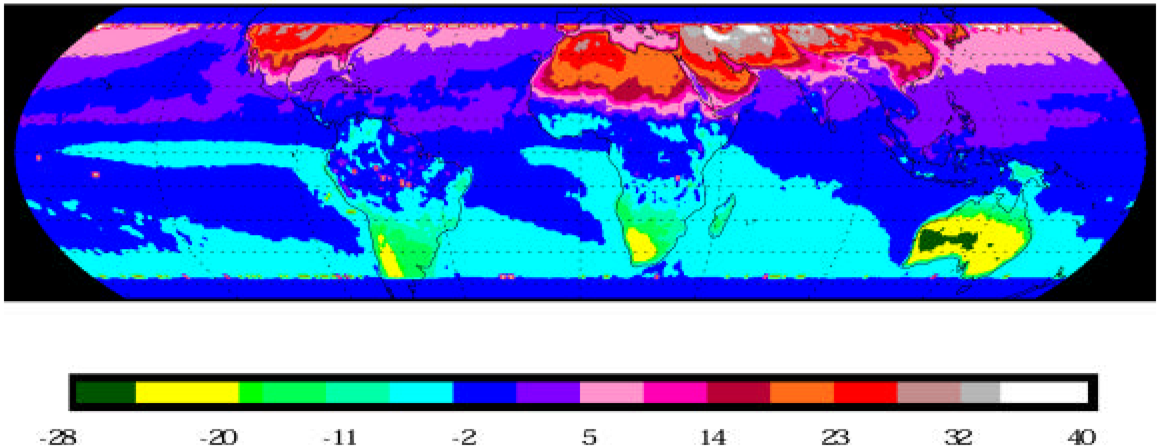
OLR: Non−Window (JJA 98, 30 N−30 S)
F_0^- (Down Flux): Non−Window
Window W m^{-2}
Window W m^{-2}
SST (K)



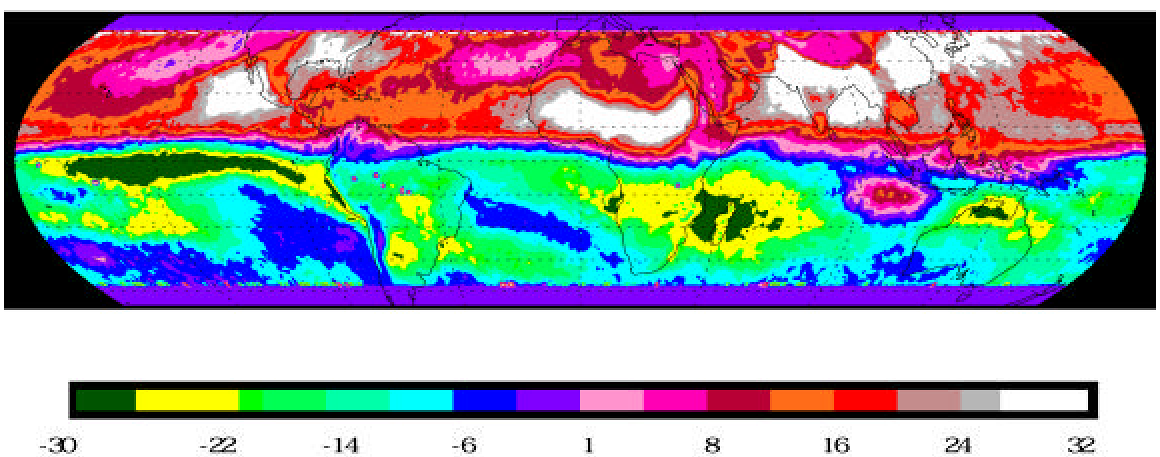
G_o: Non−Window (JJA 98, 30 N−30 S)
F_o^- (Down Flux): Non−Window
Window W m^{-2}
Window W m^{-2}
SST (K)
SST (K)
SST (K)
SST (K)

PLATFORM: CERES (TRMM), SSF EDITION 2B

SURFACE TEMPERATURE DIFFERENCE, (JJA 98-JF 98), (K)

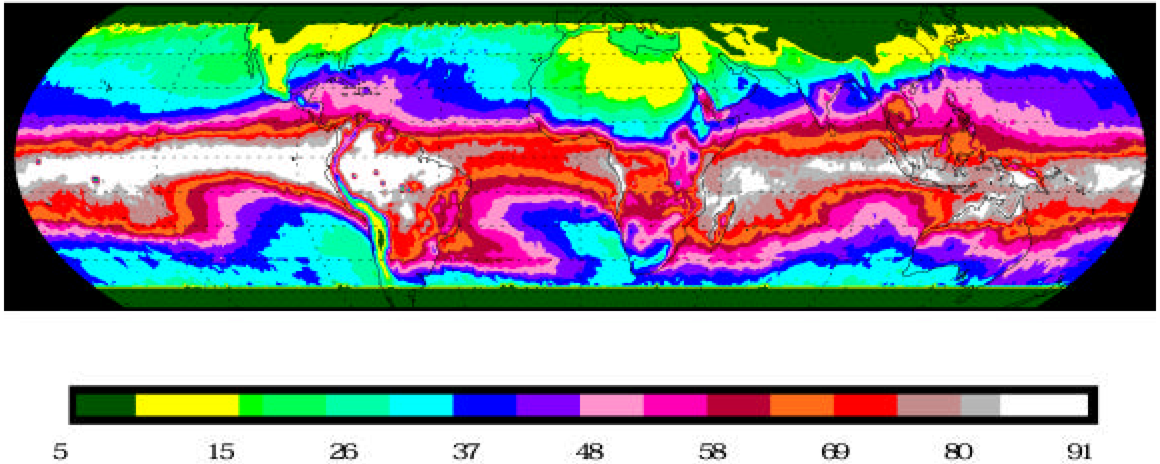


PRECIP. WATER DIFFERENCE, (JJA 98 - JF 98), (kg m^{2})

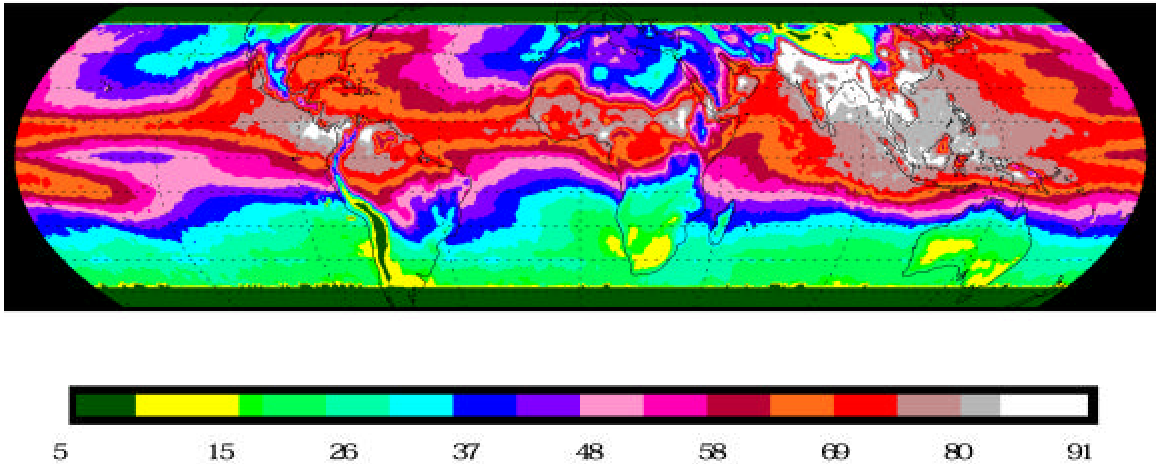


PLATFORM: CERES (TRMM), SSF EDITION 2B

SURFACE DOWN FLUX (WINDOW), JF 98, ($W\,m^{-2}$)

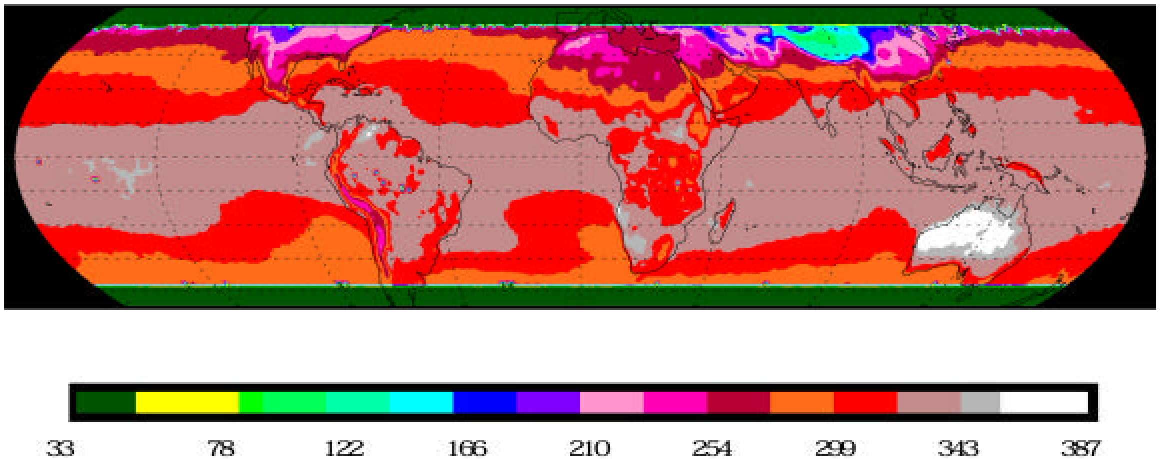


SURFACE DOWN FLUX (WINDOW), JJA 98, ($W\,m^{-2}$)

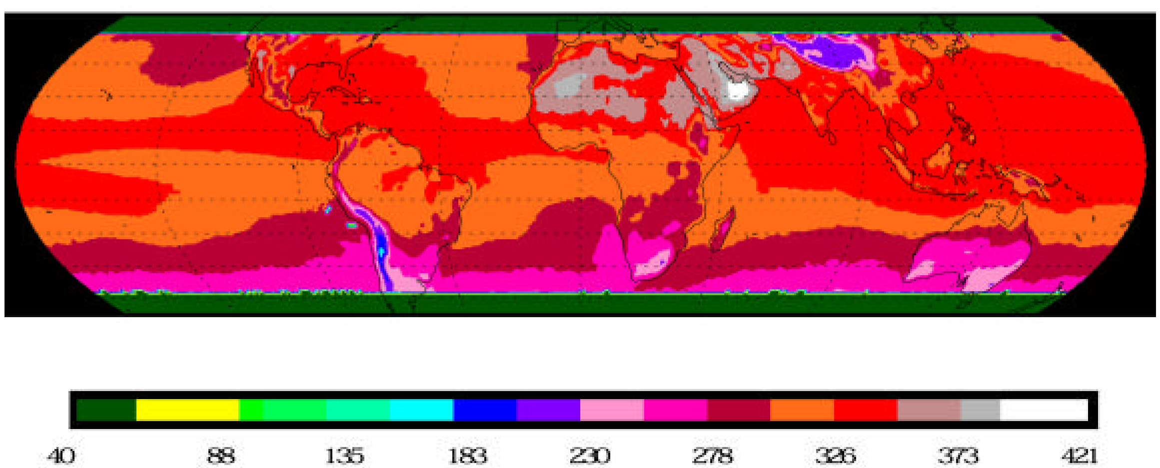


PLATFORM: CERES (TRMM), SSF EDITION 2B

SURFACE DOWN FLUX, W m^{-2}, NON-WINDOW (JF 98)

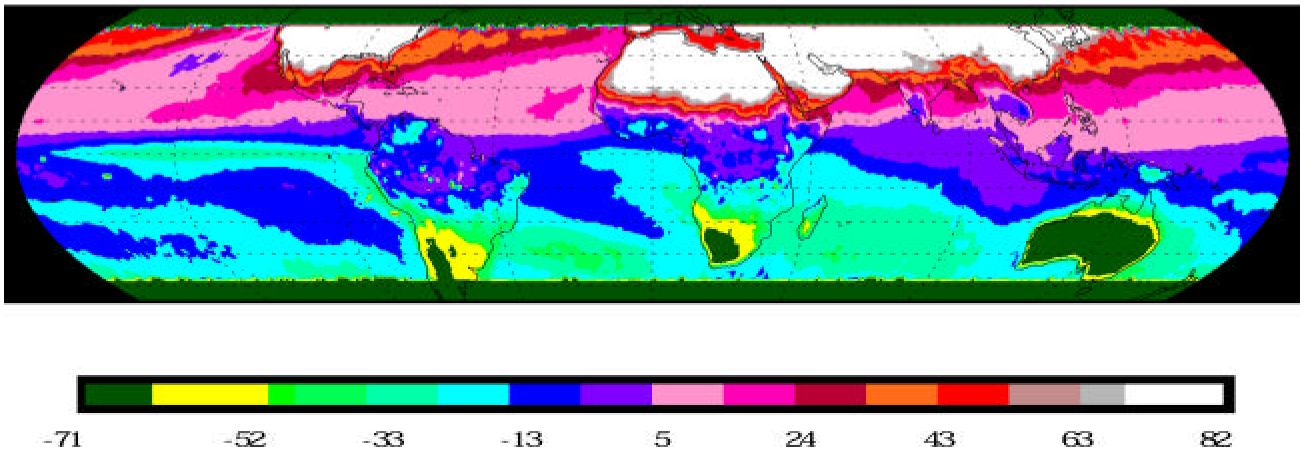


SURFACE DOWN FLUX, W m^{-2}, NON-WINDOW (JJA 98)

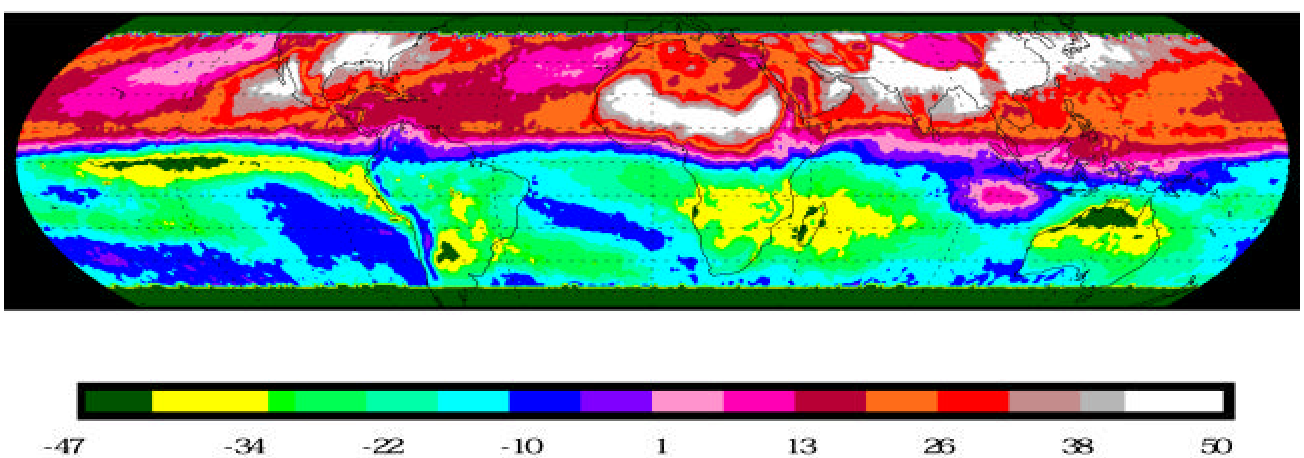


PLATFORM: CERES (TRMM), SSF EDITION 2B

SURFACE DOWN FLUX (NON-WINDOW), (JJA 98-JF 98), (W m^{-2})

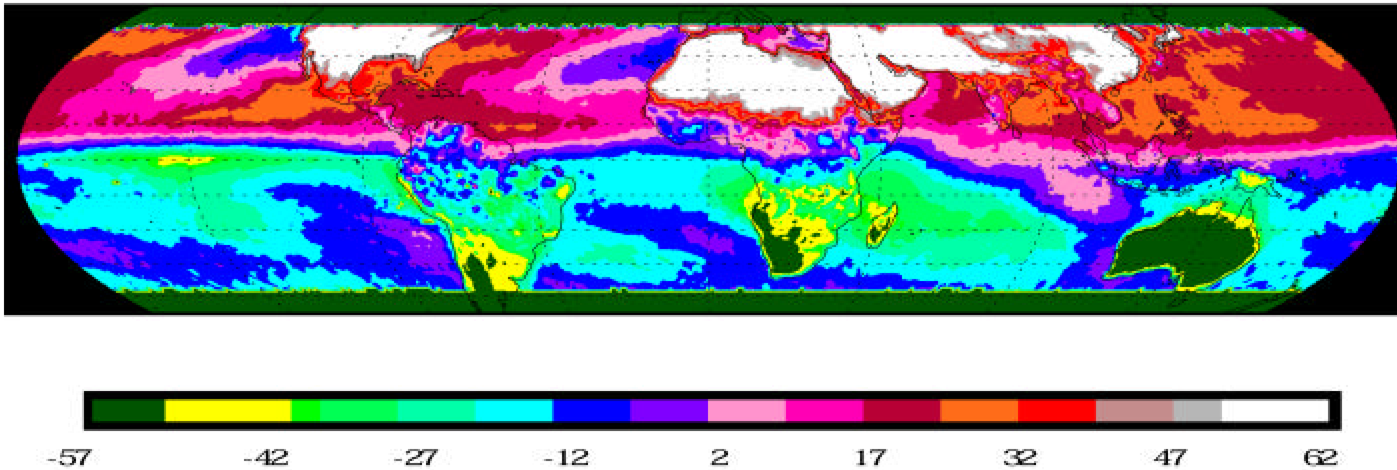


SURFACE DOWN FLUX (WINDOW), (JJA 98 - JF 98), (W m^{-2})

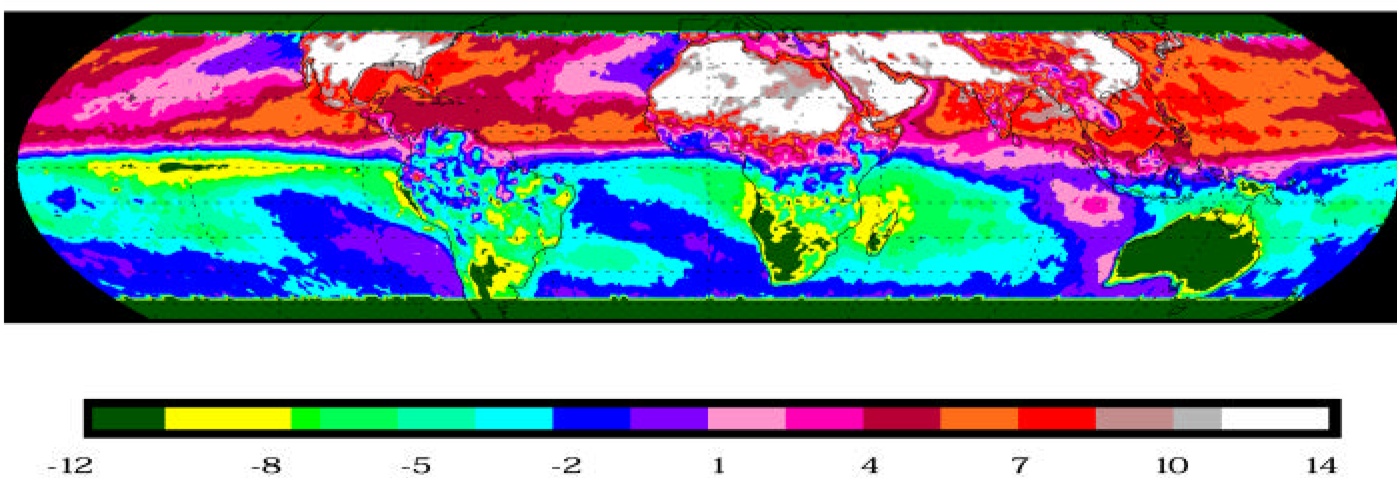


PLATFORM: CERES (TRMM), SSF EDITION 2B

ATM. GREENHOUSE EFFECT (NON-WINDOW), (JJA 98-JF 98), (W m^{-2})

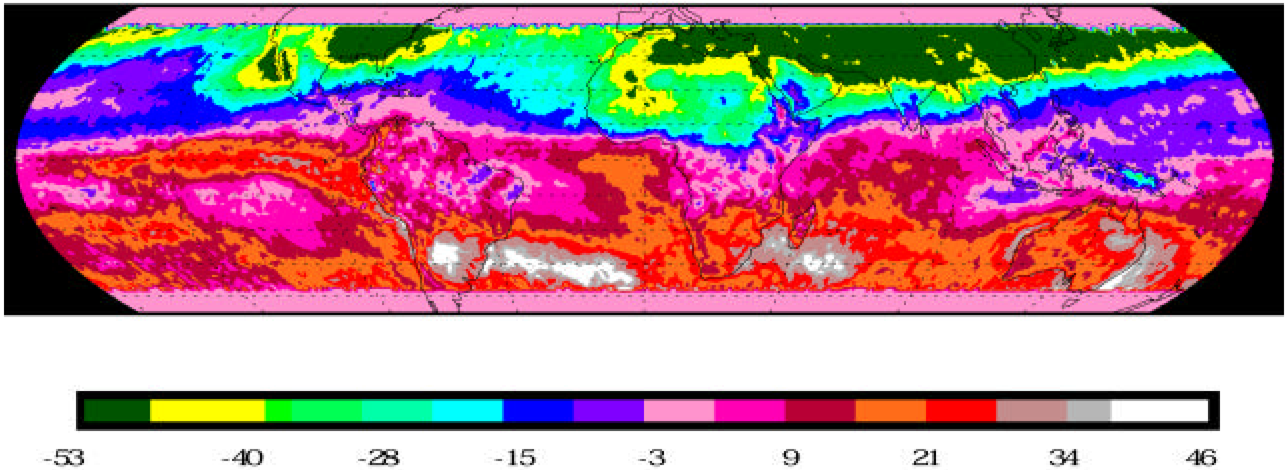


ATM GREENHOUSE EFFECT (WINDOW), (JJA 98 - JF 98), (W m^{-2})

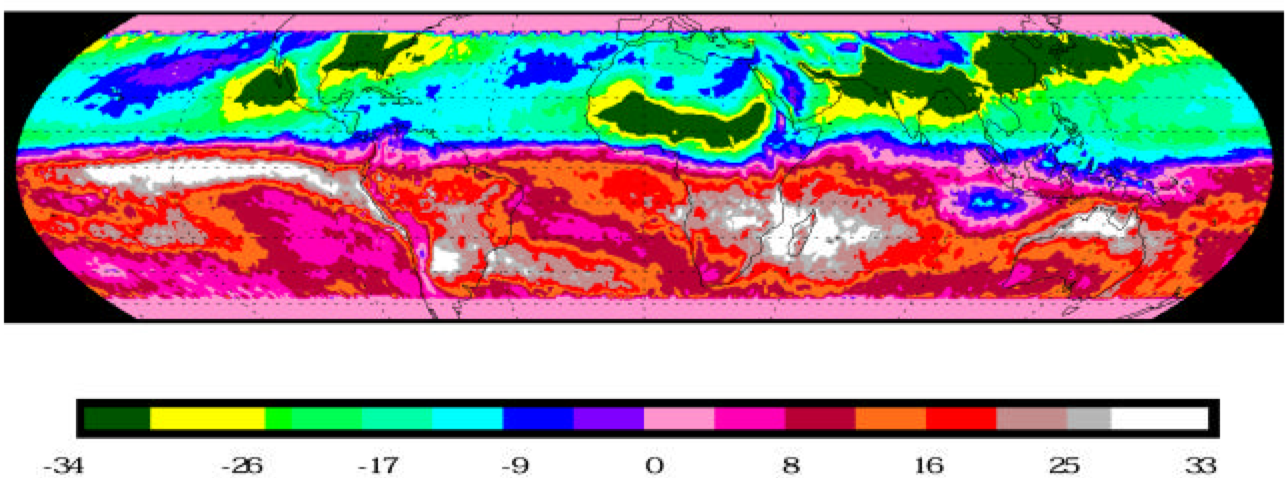


PLATFORM: CERES (TRMM), SSF EDITION 2B

ATM. COL. RADIATIVE COOLING, (JJA 98-JF 98), (W m^{-2})

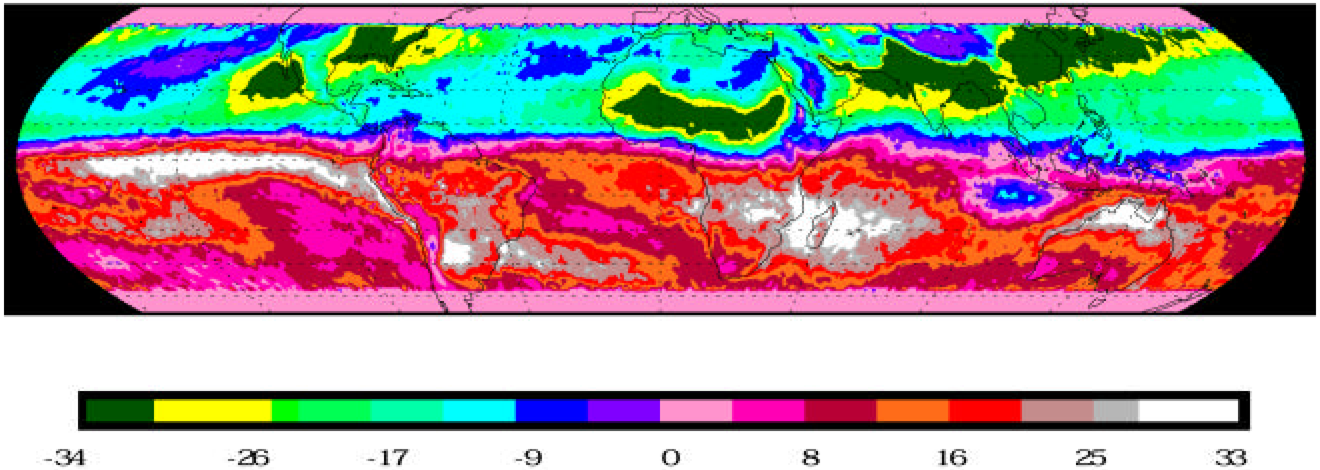


ATM COL. RADIATIVE COOLING (WINDOW), (JJA 98 - JF 98), (W m^{-2})

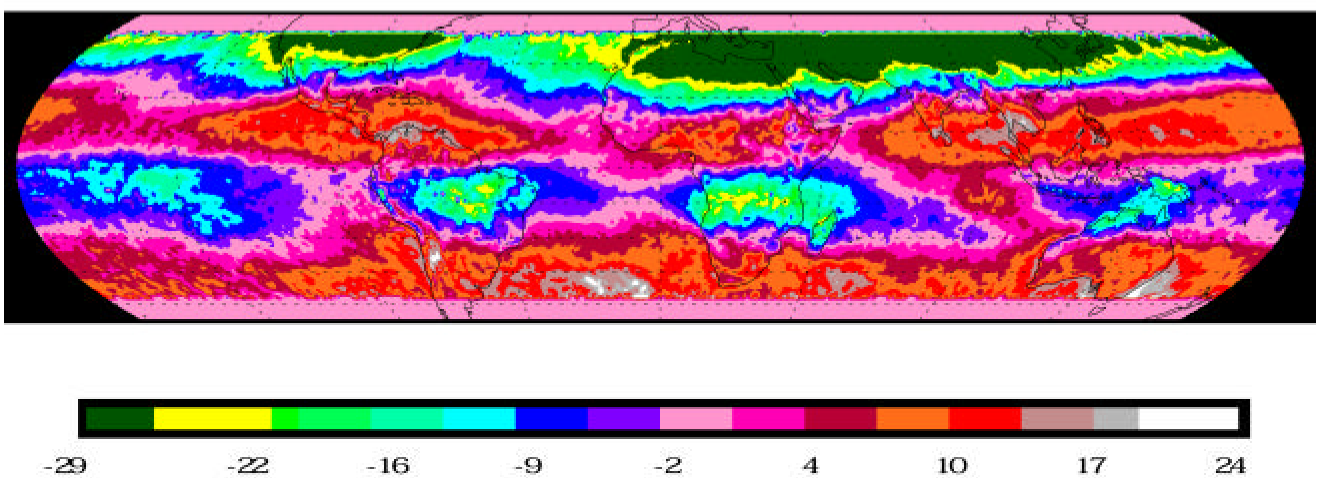


PLATFORM: CERES (TRMM), SSF EDITION 2B

ATM. COL. RADIATIVE COOLING (WINDOW), (JJA 98-JF 98), (W m^{-2})

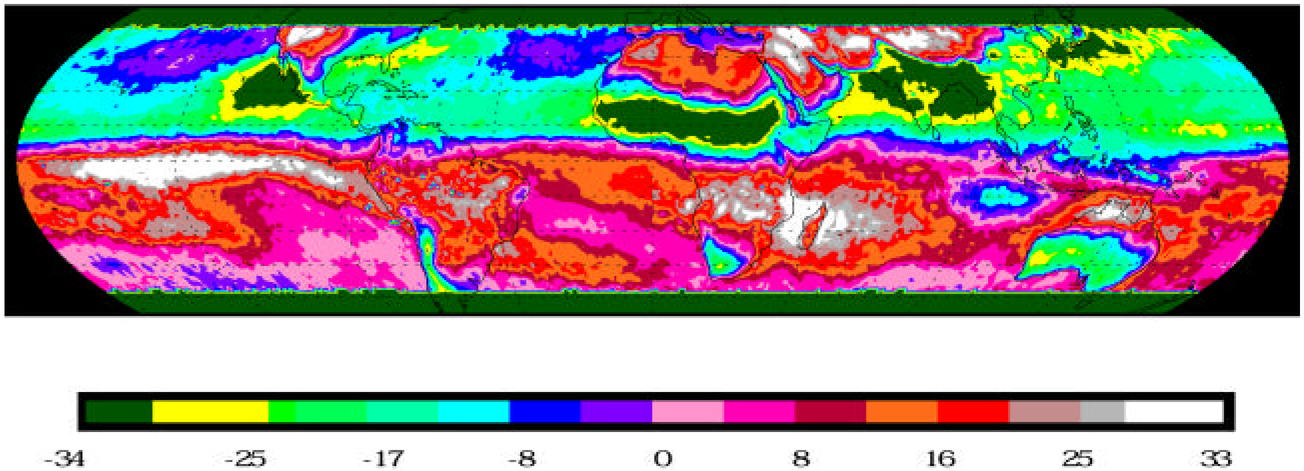


ATM COL. RADIATIVE COOLING (NON-WINDOW), (JJA 98 - JF 98), (W m^{-2})



PLATFORM: CERES (TRMM), SSF EDITION 2B

NET SURFACE COOLING (WINDOW), (JJA 98-JF 98), (W m^{-2})



NET SURFACE COOLING (NON-WINDOW), (JJA 98 - JF 98), (W m^{-2})