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

\[ G_a = \varepsilon \sigma T_s^4 - OLR \]

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 \( G_a^* \).

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 = $\varepsilon\sigma T_s^4 - G_{a}^*$
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)
Inamdar & Ramanathan, 1997 (Tellus)
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

<table>
<thead>
<tr>
<th>BROADBAND</th>
<th>WINDOW</th>
<th>NON-WINDOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta G_a = 13.2$</td>
<td>$\Delta G_{a,\text{win}} = 3.7$</td>
<td>$\Delta G_{a,\text{nw}} = 9.5$</td>
</tr>
<tr>
<td>$\Delta R = -5.4$</td>
<td>$\Delta R_{\text{win}} = -7.4$</td>
<td>$\Delta R_{\text{nw}} = 2.0$</td>
</tr>
<tr>
<td>$\Delta G_a^* = 18.6$</td>
<td>$\Delta G_{a,\text{win}}^* = 11.1$</td>
<td>$\Delta G_{a,\text{nw}}^* = 7.5$</td>
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</tbody>
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$\Delta SST = 1.33 \text{ K}$

$\Delta w_{\text{tot}} = 9.3 \text{ kg m}^{-2}$

$17.3 \text{ kg m}^{-2}$
PLATFORM: CERES (TRMM), SSF EDITION 2B

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

[Map of temperature difference]

PRECIP. WATER DIFFERENCE, (JJA 98 - JF 98), (kg m⁻²)

[Map of precipitation water difference]
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$^{-2}$)