Surface Flux Estimations over Tropical Oceans Using TRMM Data

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Outline

Background

4DDA model results:

~40W/m² heat transport over land

Method: TRMM satellite

SW & LW: Model B of CERES SSF

Gupta et al. (2001); Gupta et al. (1992)

bulk formula: SST, Qa, WS,

Ts – Ta, Qs - Qa, WS_{AIR} - WS_{OCEAN}

TOGA COARE algorithm

3. Results

4. Summary
The Energy Cycle:

From Kiehl and Trenberth, BAMS 97
Atmospheric Energy Transport

\[ \nabla \cdot \mathbf{F}_A = R_T + F_S \]

\[ F_A = g^{-1} \sum (h+k) \partial h \partial \rho \]
Energy Balance over Land
retrieval method

**surface radiation:** model B of CERES SSF

SW : Gupta et al. (2001); LW : Gupta et al. (1992)

**surface turbulence:** bulk formula: SST, Qa, WS

Ts - Ta, Qs - Qa, WS_{\text{AIR}} - WS_{\text{OCEAN}}

**TOGA COARE algorithm** (Fairall et al. 1996)

\[
H_{\text{LAT}} = \rho L \; C_L (U_a - U_s)(Q_s - Q_a) \quad (1a)
\]

\[
H_{\text{SEN}} = \rho C_p C_S (U_a - U_s)(T_s - T_a) \quad (1b)
\]

\[
\text{NSF} = H_{\text{SW}} + H_{\text{LW}} - H_{\text{LAT}} - H_{\text{SEN}} \quad (2)
\]

data analysis:

CERES – surface radiation; TMI – bulk parameters
CERES sfc SW

980101–980228

980301–980531

980601–980831

w/m²
CERES sfc LW

980101–980228

980301–980531

980601–980831

w/m^2
in situ ship vs satellite
# ship vs satellite: LH

<table>
<thead>
<tr>
<th></th>
<th>Ship Covariance</th>
<th>Ship inertial-Dissipation</th>
<th>Ship bulk</th>
<th>Satellite Bulk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship Covariance</td>
<td>101.48 W/m²</td>
<td>0.542</td>
<td>0.604</td>
<td>0.142</td>
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<tr>
<td>Ship inertial-dissipation</td>
<td>6.53 (43.04)</td>
<td>108.01 W/m²</td>
<td>0.665</td>
<td>0.333</td>
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<tr>
<td>Ship bulk</td>
<td>12.46 (29.39)</td>
<td>5.93 (38.38)</td>
<td>113.94 W/m²</td>
<td>0.506</td>
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<tr>
<td>Satellite bulk</td>
<td>-1.91 (40.88)</td>
<td>-8.47 (49.45)</td>
<td>-14.37 (30.79)</td>
<td>99.57 W/m²</td>
</tr>
</tbody>
</table>
## ship vs satellite: SH

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Ship Covariance</td>
<td>4.72 W/m²</td>
<td>0.450</td>
<td>0.584</td>
<td>0.106</td>
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<tr>
<td>Ship inertial-dissipation</td>
<td>0.93 (7.55)</td>
<td>5.65 W/m²</td>
<td>0.243</td>
<td>0.050</td>
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<tr>
<td>Ship bulk</td>
<td>-0.62 (4.30)</td>
<td>-1.55 (7.55)</td>
<td>4.10 W/m²</td>
<td>0.372</td>
</tr>
<tr>
<td>Satellite bulk</td>
<td>-1.64 (6.31)</td>
<td>-2.57 (8.58)</td>
<td>1.02 (3.98)</td>
<td>3.08 W/m²</td>
</tr>
</tbody>
</table>
TRMM: solid
SSMI: dashed
Fig. 5. Meridional profiles of zonal average of latent heat flux: (a) mean values, (b) values for the northern winter season (Dec–Jan–Feb), and (c) values for the northern summer season (Jun–Jul–Aug).
Intercomparison: difference

Fig. 6. Meridional profiles of the zonal average of the difference between J-OFURO and HOAPS, and J-OFURO and GSSTF. Those between original J-OFURO and J-OFURO using the HOAPS wind and the GSSTF specific humidity are also shown.

Kubota et al. 2003, JC
TRMM: solid
SSMI: dashed
net zonal mean
summary

• TRMM: CERES, VIRS and TMI – heat balance over ocean surfaces. The data could be used for model validations.

• Instantaneous bias (rms) errors are approximately -1.9 (40.88) W/m², and -1.64 (6.30) W/m² for surface LH and SH fluxes, respectively, when directly compared to in-situ ship measurements.

• Compared to Goddard SSM/I product: LH and SH biases are 10 to 30 W/m² and 6 to 8 W/m², respectively.

• Tropical oceans generally gain 46, 52, and 26 W/m² heat from the atmosphere for northern hemispheric winter, spring, and summer seasons, respectively.
TOA radiation
TRMM 199801

Albedo

Outgoing LW (W/m²°C)

LW
sensitivity test

Graphs showing the relationship between wind speed and various environmental parameters, including Sensible Heat, Latent Heat, Surface Temperature, Surface Specific Humidity, Air Temperature, and Air Specific Humidity. The graphs display bias and standard deviation values for each parameter.
monthly tropical net
Diurnal SW & LW fluxes