Simpler Surface Radiative Fluxes

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Simpler Surface Radiative Fluxes

- Downwelling clear-sky and all-sky, SW and LW surface fluxes derived from TOA-to-Surface transfer algorithms and radiation parameterizations
- Each component currently computed with two models

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SW</strong></td>
<td></td>
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<tr>
<td>Clear</td>
<td>Li et al.</td>
<td>LPSA</td>
</tr>
<tr>
<td>All-sky</td>
<td>-</td>
<td>LPSA</td>
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<tr>
<td><strong>LW</strong></td>
<td></td>
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<tr>
<td>Clear</td>
<td>Inamdar and Ramanathan</td>
<td>LPLA</td>
</tr>
<tr>
<td>All-sky</td>
<td>-</td>
<td>LPLA</td>
</tr>
</tbody>
</table>

- LPSA/LPLA = Langley Parameterized SW/LW Algorithm
Simpler Surface Radiative Fluxes

- CERES Science Team strongly recommended that several model-based methods be used concurrently for ensuring high accuracy in surface fluxes.
- Surface-only algorithms should also try to make as much use of TOA measurements as possible.
- Surface-only algorithms are simple, computationally fast and allow quick testing of time averaged and interpolated data products such as SRBAVG.
- Surface-only algorithms establish links with other project: NASA/GEWEX SRB Project (SW and LW Models B).
Simpler Surface Radiative Fluxes

- **SW Model A:**

- **SW Model B (LPSA/Staylor Algorithm):**

- **LW Model A:**

- **LW Model B:**
Simpler Surface Fluxes: Validation

- Validation on instantaneous/footprint level using ground-measured fluxes from different climate regimes
- Validation criteria:
  - ±20 Wm\(^{-2}\) for instantaneous/footprint level fluxes
- Validation data sources:
  - ARM/SGP Central and Extended Facilities
  - BSRN Sites: Alice Springs (Australia), Tateno (Japan), and Florianopolis (Brazil)
- Gridded monthly average results: Part of SRBAVG
Shortwave Clear-sky Comparison

Central Facility       TRMM2B

1 minute data

Npoints = 55

Model A
Bias = 8.89 W m\(^{-2}\) (1.65 %)
RMSD = 26.07 W m\(^{-2}\) (4.83 %)

Model B
Bias = -18.00 W m\(^{-2}\) (-3.33 %)
RMSD = 26.97 W m\(^{-2}\) (4.99 %)
Surface-only Fluxes

Shortwave Clear-sky Comparison

Extended Facilities   TRMM2B

1 minute data

Npoints = 815

Model A
Bias = 13.99 W m\(^{-2}\) (2.57 %)
RMSD = 28.10 W m\(^{-2}\) (5.16 %)

Model B
Bias = -12.02 W m\(^{-2}\) (-2.21%)
RMSD = 24.13 W m\(^{-2}\) (4.43%)
Surface-only Fluxes

Shortwave Clear-sky Comparison

CMDL       TRMM2B

Npoints = 31

Model A
Bias = 49.60 W m\(^{-2}\) (6.46%)
RMSD = 61.84 W m\(^{-2}\) (8.06%)

Model B
Bias = 11.29 W m\(^{-2}\) (1.47%)
RMSD = 39.45 W m\(^{-2}\) (5.14%)

1 minute data
Surface-only Fluxes

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Shortwave Clear-sky Comparison

BSRN       TRMM2B

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias</td>
<td>1.14 W m(^{-2}) (0.23%)</td>
<td>-26.74 W m(^{-2}) (-5.47%)</td>
</tr>
<tr>
<td>RMSD</td>
<td>47.24 W m(^{-2}) (9.67%)</td>
<td>45.96 W m(^{-2}) (9.40%)</td>
</tr>
</tbody>
</table>
## SW Clear-Sky Comparisons (Summary Statistics)

### SW Model A - TRMM Edition 2B

<table>
<thead>
<tr>
<th>Sites</th>
<th># Points</th>
<th>Mean Bias, Wm(^{-2}) (%)</th>
<th>RMS Diff., Wm(^{-2}) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM/CF</td>
<td>55</td>
<td>8.9 (1.7)</td>
<td>26.1 (4.8)</td>
</tr>
<tr>
<td>ARM/EF</td>
<td>815</td>
<td>14.0 (2.6)</td>
<td>28.1 (5.2)</td>
</tr>
<tr>
<td>CMDL</td>
<td>31</td>
<td>49.6 (6.5)</td>
<td>61.8 (8.1)</td>
</tr>
<tr>
<td>BSRN</td>
<td>108</td>
<td>1.1 (0.2)</td>
<td>47.2 (9.7)</td>
</tr>
</tbody>
</table>

### SW Model B - TRMM Edition 2B

<table>
<thead>
<tr>
<th>Sites</th>
<th># Points</th>
<th>Mean Bias, Wm(^{-2}) (%)</th>
<th>RMS Diff., Wm(^{-2}) (%)</th>
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<tbody>
<tr>
<td>ARM/CF</td>
<td>55</td>
<td>-18.0 (-3.3)</td>
<td>27.0 (5.0)</td>
</tr>
<tr>
<td>ARM/EF</td>
<td>815</td>
<td>-12.0 (-2.2)</td>
<td>24.1 (4.4)</td>
</tr>
<tr>
<td>CMDL</td>
<td>31</td>
<td>11.3 (1.5)</td>
<td>39.5 (5.1)</td>
</tr>
<tr>
<td>BSRN</td>
<td>108</td>
<td>-26.7 (-5.5)</td>
<td>46.0 (9.4)</td>
</tr>
</tbody>
</table>
Shortwave All-sky Comparison

Model B Extended Facilities  TRMM Edition 2A (LPSA)

1 minute data

Npoints = 2226
Bias = 12 Wm^{-2}
RMS = 109 Wm^{-2}
Shortwave All-sky Comparison

Model B Extended Facilities  
TRMM Edition 2A

(LPSA)

60 minute data

Npoints = 2138
Bias = 13 Wm\(^{-2}\)
RMS = 72 Wm\(^{-2}\)
Shortwave All-sky Comparison

Central Facility       TRMM2B

Ground Measured DSW (W m\(^{-2}\))

Model B
Bias = -8.70 W m\(^{-2}\) (-1.85\%)
RMSD = 49.08 W m\(^{-2}\) (10.46\%)

Npoints = 149

60 minute average
Surface-only Fluxes

Shortwave All-sky Comparison

Extended Facilities vs TRMM2B

60 minute average

Model B
Bias = 9.64 W m\(^{-2}\) (2.04%)
RMSD = 61.93 W m\(^{-2}\) (13.11%)

Npoints = 2087
Shortwave All-sky Comparison

Surface-only Fluxes

CMDL        TRMM2B

60 minute average

Npoints = 353

Model B

Bias = 35.41 W m$^{-2}$ (8.98%)
RMSD = 93.79 W m$^{-2}$ (23.80%)
Shortwave All-sky Comparison

BSRN       TRMM2B

60 minute average

Npoints = 321

Model B
Bias = 6.28 W m\(^{-2}\) (1.69%)
RMSD = 72.20 W m\(^{-2}\) (19.46%)
# SW All-Sky Comparisons (Summary Statistics)

**SW Model B - TRMM Edition 2B**

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<tr>
<th>Sites</th>
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<th>RMS Diff., Wm(^{-2}) (%)</th>
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<td>149</td>
<td>-8.7 (-1.9)</td>
<td>49.1 (10.5)</td>
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<tr>
<td>ARM/EF</td>
<td>2087</td>
<td>9.6 (2.0)</td>
<td>61.9 (13.1)</td>
</tr>
<tr>
<td>CMDL</td>
<td>353</td>
<td>35.4 (9.0)</td>
<td>93.8 (23.8)</td>
</tr>
<tr>
<td>BSRN</td>
<td>321</td>
<td>6.3 (1.7)</td>
<td>72.2 (19.5)</td>
</tr>
</tbody>
</table>
Longwave Clear-sky Comparison

Central Facility       TRMM2B

1 minute data

Model A
Bias = -2.03 W m\(^{-2}\) (-0.64 %)
RMSD = 18.62 W m\(^{-2}\) (5.92%)

Model B
Bias = -1.65 W m\(^{-2}\) (-0.53%)  
RMSD = 17.35 W m\(^{-2}\) (5.52%)

Npoints = 129
Surface-only Fluxes

Longwave Clear-sky Comparison

Extended Facilities   TRMM2B

1 minute data

Npoints = 1932

Model A
Bias = -3.04 W m\(^{-2}\) (-0.92%)
RMSD = 24.11 W m\(^{-2}\) (7.34%)

Model B
Bias = -4.86 W m\(^{-2}\) (-1.48%)
RMSD = 20.76 W m\(^{-2}\) (6.32%)
Surface-only Fluxes

Longwave Clear-sky Comparison

Extended Facilities       TRMM2B       Daytime

1 minute data

Model A
Bias = 9.11 W m^{-2} (2.54 %)
RMSD = 22.98 W m^{-2} (6.41%)

Model B
Bias = -9.53 W m^{-2} (-2.66%)
RMSD = 17.64 W m^{-2} (4.92%)

Npoints = 854
Surface-only Fluxes

Longwave Clear-sky Comparison

CMDL TRMM2B

1 minute data

Npoints = 97

Model A
Bias = -10.37 W m\(^{-2}\) (-2.71%)
RMSD = 16.65 W m\(^{-2}\) (4.35%)

Model B
Bias = -10.65 W m\(^{-2}\) (-2.78%)
RMSD = 17.49 W m\(^{-2}\) (4.57%)
Surface-only Fluxes

Longwave Clear-sky Comparison

BSRN   TRMM2B

1 minute data

Model A
Bias = -0.55 W m$^{-2}$ (-0.18%)
RMSD = 25.57 W m$^{-2}$ (8.22%)

Model B
Bias = -12.46 W m$^{-2}$ (-4.01%)
RMSD = 19.47 W m$^{-2}$ (6.26%)

Npoints = 209

Ground Measured DLF (W m$^{-2}$)

CERES Modeled DLF (W m$^{-2}$)
## LW Clear-Sky Comparisons (Summary Statistics)

### LW Model A - TRMM Edition 2B

<table>
<thead>
<tr>
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<td>1932</td>
<td>-3.0 (-0.9)</td>
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<tr>
<td>CMDL</td>
<td>97</td>
<td>-10.4 (-2.7)</td>
<td>16.7 (4.4)</td>
</tr>
<tr>
<td>BSRN</td>
<td>209</td>
<td>-0.6 (-0.2)</td>
<td>25.6 (8.2)</td>
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### LW Model B - TRMM Edition 2B

<table>
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<tr>
<th>Sites</th>
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<td>129</td>
<td>-1.7 (-0.5)</td>
<td>17.4 (5.5)</td>
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<tr>
<td>ARM/EF</td>
<td>1932</td>
<td>-4.9 (-1.5)</td>
<td>20.8 (6.3)</td>
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<tr>
<td>CMDL</td>
<td>97</td>
<td>-10.7 (-2.8)</td>
<td>17.5 (4.6)</td>
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<td>BSRN</td>
<td>209</td>
<td>-12.5 (-4.0)</td>
<td>19.5 (6.3)</td>
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Surface-only Fluxes

Longwave All-sky Comparison

Central Facility     TRMM2B

Ground Measured DLF (W m$^{-2}$)

CEFES Modeled DLF (W m$^{-2}$)

1 minute data

Npoints = 317

Model B

Bias = 0.05 W m$^{-2}$ (-0.01%)

RMSD = 18.84 W m$^{-2}$ (5.55%)
Surface-only Fluxes

Longwave All-sky Comparison

Extended Facilities  TRMM2B

1 minute data

Npoints = 4470

Model B
Bias = -2.30 W m\(^{-2}\)  (-0.67%)
RMSD = 20.92 W m\(^{-2}\)  (6.09%)
Longwave All-sky Comparison

Surface-only Fluxes

CMDL         TRMM2B

1 minute data

Npoints = 790

Model B

Bias = \(-7.20\, \text{W m}^{-2}\) (1.85%)

RMSD = \(18.53\, \text{W m}^{-2}\) (4.78%)
Longwave All-sky Comparison

BSRN       TRMM2B

CERES Modeled DLF (W m$^{-2}$)

Ground Measured DLF (W m$^{-2}$)

1 minute data

Npoints = 574

Model B

Bias = -9.76 W m$^{-2}$ (-2.87%)

RMSD = 18.75 W m$^{-2}$ (5.51%)
## LW All-Sky Comparisons (Summary Statistics)

**LW Model B - TRMM Edition 2B**

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<td>18.8 (5.6)</td>
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<td>4470</td>
<td>-2.3 (-0.7)</td>
<td>20.9 (6.1)</td>
</tr>
<tr>
<td>CMDL</td>
<td>790</td>
<td>-7.2 (-1.9)</td>
<td>18.5 (4.8)</td>
</tr>
<tr>
<td>BSRN</td>
<td>574</td>
<td>-9.8 (-2.9)</td>
<td>18.8 (5.5)</td>
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Summary

- Simple and efficient algorithms used to derive surface SW and LW fluxes for CERES/SSF.
- SSF fluxes complement CRS results; Provide redundancy, intercomparison, and quick results.
- Models A provide clear-sky fluxes only; Models B provide all-sky fluxes.
- SSF fluxes validated against ground-based measurements from many different climate regimes.
- LW fluxes close to meeting accuracy criteria for climate research.