Comparisons of CERES EBAF Ed2.7 TOA Fluxes with Reanalysis Data

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Objective

• Compare 13-year of CERES EBAF TOA radiation budget data (March 2000 to February 2013) with ERA Interim Reanalysis Data
  - Longwave, shortwave, net (all-sky and clear-sky), solar incoming
  - Regional and global (90N to 90S) scale
  - 13-year climatology (average)
  - Interannual variability (2-sigma)
  - Deseasonalized time series (globe and tropics)
Data Sets

- **CERES EBAF TOA Edition 2.7 Monthly Mean Data**
  - 1 degree by 1 degree equal angle global grid in NetCDF format
  - Obtained from CERES data website [http://ceres.larc.nasa.gov/order_data.php](http://ceres.larc.nasa.gov/order_data.php)

- **ERA Interim Reanalysis Monthly Mean Data**
  - 1.5 degree by 1.5 degree equal angle global grid in NetCDF format
  - Obtained from ECMWF ERA Interim data website [http://data-portal.ecmwf.int/data/d/interim_mnth/](http://data-portal.ecmwf.int/data/d/interim_mnth/)
  - ERA Interim has an error in solar incoming (~3 Wm^{-2} too high) [http://www.ecmwf.int/research/era/do/get/index/QualityIssues](http://www.ecmwf.int/research/era/do/get/index/QualityIssues)
Data Regridding

- CERES and ERA Interim data are regridded to a 3 degree by 3 degree grid to facilitate comparison of these data sets.
- Regridding is done using weighted-average procedure to minimize regridding noise (no interpolation) and to preserve the quality of the global mean values.
**Data Regridding (Continue)**

- Regridded data have the exact same global mean values as the original data; very similar but slightly smaller spatial variability.

**ERA Interim 13-year Climatology (March 2000 to February 2013)**

<table>
<thead>
<tr>
<th>ERA Interim</th>
<th>Original Mean</th>
<th>Original 1-σ</th>
<th>Regridded Mean</th>
<th>Regridded 1-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Inc.</td>
<td>344.2*</td>
<td>88.8</td>
<td>344.2*</td>
<td>88.4</td>
</tr>
<tr>
<td>All-sky LW</td>
<td>245.5</td>
<td>37.0</td>
<td>245.5</td>
<td>36.6</td>
</tr>
<tr>
<td>All-sky SW</td>
<td>100.2</td>
<td>16.4</td>
<td>100.2</td>
<td>15.7</td>
</tr>
<tr>
<td>All-sky Net</td>
<td>-1.5</td>
<td>61.4</td>
<td>-1.5</td>
<td>61.0</td>
</tr>
<tr>
<td>Clr-sky LW</td>
<td>264.0</td>
<td>40.9</td>
<td>264.0</td>
<td>40.3</td>
</tr>
<tr>
<td>Clr-sky SW</td>
<td>53.7</td>
<td>28.0</td>
<td>53.7</td>
<td>27.4</td>
</tr>
<tr>
<td>Clr-sky Net</td>
<td>26.5</td>
<td>70.4</td>
<td>26.5</td>
<td>69.9</td>
</tr>
</tbody>
</table>

* ERA Interim has an error in the solar incoming (~ 3 Wm\(^{-2}\) too high) ([http://www.ecmwf.int/research/era/do/get/index/QualityIssues](http://www.ecmwf.int/research/era/do/get/index/QualityIssues))
# ERA Interim Solar Correction

- Apply simple solar correction factor (1365/1377) to solar incoming and reflected SW; recalculate Net using these two new values

## ERA Interim 13-year Climatology (March 2000 to February 2013)

<table>
<thead>
<tr>
<th>ERA-Interim</th>
<th>Uncorrected Mean</th>
<th>Uncorrected 1-σ</th>
<th>Corrected Mean</th>
<th>Corrected 1-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Inc.</td>
<td>344.2*</td>
<td>88.4</td>
<td>341.2</td>
<td>87.6</td>
</tr>
<tr>
<td>All-sky LW</td>
<td>245.5</td>
<td>36.6</td>
<td>245.5</td>
<td>36.6</td>
</tr>
<tr>
<td>All-sky SW</td>
<td>100.2</td>
<td>15.7</td>
<td>99.3</td>
<td>15.6</td>
</tr>
<tr>
<td>All-sky Net</td>
<td>-1.5</td>
<td>61.0</td>
<td>-3.6</td>
<td>60.2</td>
</tr>
<tr>
<td>Clr-sky LW</td>
<td>264.0</td>
<td>40.3</td>
<td>264.0</td>
<td>40.3</td>
</tr>
<tr>
<td>Clr-sky SW</td>
<td>53.7</td>
<td>27.4</td>
<td>53.2</td>
<td>27.2</td>
</tr>
<tr>
<td>Clr-sky Net</td>
<td>26.5</td>
<td>69.9</td>
<td>24.0</td>
<td>69.0</td>
</tr>
</tbody>
</table>

* ERA Interim has an error in the solar incoming (~ 3 Wm\(^{-2}\) too high)

[http://www.ecmwf.int/research/era/do/get/index/QualityIssues](http://www.ecmwf.int/research/era/do/get/index/QualityIssues)
All-sky TOA Climatology (3/2000 to 2/2013)

CERES EBAF Ed2.7

ERA Interim

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ERA Interim Minus CERES TOA Differences

ERA Interim Minus CERES EBAF Ed2.7, 13-year Climatology
March 2000 to February 2013

All-sky Longwave

All-sky Shortwave

All-sky Net

Clear-sky Longwave

Clear-sky Shortwave

Clear-sky Net

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## Global (90NS) Mean Comparison

<table>
<thead>
<tr>
<th>Parameters (Wm⁻²)</th>
<th>ERA Int. 13y-avg</th>
<th>CERES 13y-avg</th>
<th>Mean Diff. ERA-Ceres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Incoming</td>
<td>341.2</td>
<td>339.9</td>
<td>1.3 (0.4%)</td>
</tr>
<tr>
<td>Longwave</td>
<td>245.5</td>
<td>239.6</td>
<td>5.9 (2.5%)</td>
</tr>
<tr>
<td>Shortwave</td>
<td>99.3</td>
<td>99.7</td>
<td>-0.4 (-0.4%)</td>
</tr>
<tr>
<td>Net</td>
<td>-3.6</td>
<td>0.6</td>
<td>-4.2 (-700%)</td>
</tr>
<tr>
<td>Clear Longwave</td>
<td>264.0</td>
<td>265.6</td>
<td>-1.6 (-0.6%)</td>
</tr>
<tr>
<td>Clear Shortwave</td>
<td>53.2</td>
<td>52.6</td>
<td>0.6 (1.1%)</td>
</tr>
<tr>
<td>Clear Net</td>
<td>24.0</td>
<td>21.7</td>
<td>2.3 (10.6%)</td>
</tr>
</tbody>
</table>

- **All-sky**: ERA Interim has higher global mean values of Solar incoming and outgoing LW; but lower values of SW and Net.
- **Clear-sky**: ERA Interim has lower global mean values of outgoing LW; but higher values of SW and Net.
All-sky TOA Interannual Variability

CERES EBAF Ed2.7

ERA Interim

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Clear-sky TOA Interannual Variability

CERES EBAF Ed2.7

Clear-sky Longwave

Clear-sky Shortwave

Clear-sky Net

ERA Interim

Clear-sky Longwave

Clear-sky Shortwave

Clear-sky Net
### Global (90NS) Mean and Interannual Variability

<table>
<thead>
<tr>
<th>Parameters (Wm⁻²)</th>
<th>ERA Int. 10y-avg</th>
<th>CERES 10y-avg</th>
<th>Mean Diff. ERA-Ceres</th>
<th>ERA Int 2-σ</th>
<th>CERES 2-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Incoming</td>
<td>341.2</td>
<td>339.9</td>
<td>1.3 (0.4%)</td>
<td>0.01</td>
<td>0.20</td>
</tr>
<tr>
<td>Longwave</td>
<td>245.5</td>
<td>239.6</td>
<td>5.9 (2.5%)</td>
<td>0.96</td>
<td>0.47</td>
</tr>
<tr>
<td>Shortwave</td>
<td>99.3</td>
<td>99.7</td>
<td>-0.4 (-0.4%)</td>
<td>1.26</td>
<td>0.42</td>
</tr>
<tr>
<td>Net</td>
<td>-3.6</td>
<td>0.6</td>
<td>-4.2 (-700%)</td>
<td>0.66</td>
<td>0.58</td>
</tr>
<tr>
<td>Clear Longwave</td>
<td>264.0</td>
<td>265.6</td>
<td>-1.6 (-0.6%)</td>
<td>0.40</td>
<td>0.67</td>
</tr>
<tr>
<td>Clear Shortwave</td>
<td>53.2</td>
<td>52.6</td>
<td>0.6 (1.1%)</td>
<td>0.24</td>
<td>0.31</td>
</tr>
<tr>
<td>Clear Net</td>
<td>24.0</td>
<td>21.7</td>
<td>2.3 (10.6%)</td>
<td>0.40</td>
<td>0.68</td>
</tr>
</tbody>
</table>

- ERA Interim has slightly higher interannual variability of all-sky fluxes; but slightly lower interannual variability of clear-sky fluxes
- ERA Interim uses a constant solar irradiance value while CERES uses a time varying solar irradiance observations from SORCE
Tropical Mean Deseasonalized Time Series

Tropical Mean (30N to 30S)

- All-sky Longwave
  - CERES
  - ERA

- All-sky Shortwave
  - CERES
  - ERA

- All-sky Net
  - CERES
  - ERA

Tropical Mean (30N to 30S)

- Clear-sky Longwave
  - CERES
  - ERA

- Clear-sky Shortwave
  - CERES
  - ERA

- Clear-sky Net
  - CERES
  - ERA
Summary

• ERA Interim has an error in solar incoming (~3 Wm\(^{-2}\) too high)

• ERA Interim uses a constant solar irradiance value. CERES EBAF uses a time varying solar irradiance from SORCE with a solar constant ~ 1361; leads to differences in solar incoming between these two datasets

• ERA Interim global mean all-sky longwave are much higher than CERES values (by 6 Wm\(^{-2}\)); leads to large differences in global mean all-sky net fluxes

• Larger regional (land vs. ocean) differences are found in all-sky shortwave, all-sky net and clear-sky shortwave flux.

• Globally, ERA Interim has slightly higher interannual variability of all-sky fluxes; but slightly lower interannual variability of clear-sky fluxes than CERES

• Global mean time series are very similar. However, there are some larger differences in all-sky SW and LW times series after 2010