Comparisons of CERES and ERA Interim TOA Radiative Fluxes

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Objective

- Compare the first decade of CERES EBAF TOA radiation budget data (March 2000 to February 2010) with ERA Interim Reanalysis Data
  - Longwave, shortwave, net (all-sky and clear-sky), solar incoming
  - Regional and global (90N to 90S) scale
  - 10-year climatology (average)
  - Interannual variability (2-sigma)
  - Deseasonalized time series (globe and tropics)
Data Sets

- **CERES EBAF Edition 2.6r 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

- **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/
  - ERA Interim has an error in solar incoming (~3 Wm⁻² too high)
    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 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 10-year Climatology (March 2000 to February 2010)**

<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>245.7</td>
<td>37.1</td>
<td>245.7</td>
<td>36.7</td>
</tr>
<tr>
<td>All-sky SW</td>
<td>99.8</td>
<td>16.5</td>
<td>99.8</td>
<td>15.8</td>
</tr>
<tr>
<td>All-sky Net</td>
<td>-1.3</td>
<td>61.5</td>
<td>-1.3</td>
<td>61.1</td>
</tr>
<tr>
<td>Clr-sky LW</td>
<td>264.0</td>
<td>40.9</td>
<td>264.0</td>
<td>40.4</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>70.0</td>
</tr>
</tbody>
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* 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 10-year Climatology (March 2000 to February 2010)

<table>
<thead>
<tr>
<th>ERA-Interim</th>
<th>Uncorrected Mean</th>
<th>Uncorrected 1-(\sigma)</th>
<th>Corrected Mean</th>
<th>Corrected 1-(\sigma)</th>
</tr>
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<tr>
<td>Solar Inc.</td>
<td>344.2*</td>
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<td>Clr-sky Net</td>
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<td>70.0</td>
<td>24.0</td>
<td>69.1</td>
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* ERA Interim has an error in the solar incoming (~ 3 Wm\(^{-2}\) too high)

(\url{http://www.ecmwf.int/research/era/do/get/index/QualityIssues})
All-sky TOA Climatology (3/2000 to 2/2010)

CERES EBAF Ed2.6r

ERA Interim

CERES EBAF Ed2.6r

ERA Interim
ERA Interim Minus CERES TOA Differences

ERA Interim Minus CERES EBAF Ed2.6r, 10-year Climatology
March 2000 to February 2010

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. 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>
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<tr>
<td>Solar Incoming</td>
<td>341.2</td>
<td>339.9</td>
<td>1.3 (0.4%)</td>
<td>0.01</td>
<td>0.23</td>
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<tr>
<td>Longwave</td>
<td>245.7</td>
<td>239.6</td>
<td>6.1 (2.5%)</td>
<td>0.80</td>
<td>0.52</td>
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<td>Shortwave</td>
<td>98.9</td>
<td>99.7</td>
<td>-0.8 (-0.8%)</td>
<td>0.74</td>
<td>0.46</td>
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<tr>
<td>Net</td>
<td>-3.4</td>
<td>0.6</td>
<td>-4.0 (-667%)</td>
<td>0.62</td>
<td>0.54</td>
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<tr>
<td>Clear Longwave</td>
<td>264.0</td>
<td>265.8</td>
<td>-1.8 (-0.7%)</td>
<td>0.48</td>
<td>0.53</td>
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<tr>
<td>Clear Shortwave</td>
<td>53.2</td>
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<td>0.7 (1.3%)</td>
<td>0.23</td>
<td>0.24</td>
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<tr>
<td>Clear Net</td>
<td>24.0</td>
<td>21.6</td>
<td>2.4 (11.1%)</td>
<td>0.40</td>
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- **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 Ed2.6r

ERA Interim
Clear-sky TOA Interannual Variability

CERES EBAF Ed2.6r

ERA Interim

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- 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.
Global Mean Deseasonalized Time Series

Global Mean (90N to 90S)

- **All-sky Longwave**
  - CERES
  - ERA

- **All-sky Shortwave**
  - CERES
  - ERA

- **All-sky Net**
  - CERES
  - ERA

Global Mean (90N to 90S)

- **Clear-sky Longwave**
  - CERES
  - ERA

- **Clear-sky Shortwave**
  - CERES
  - ERA

- **Clear-sky Net**
  - CERES
  - ERA
Tropical Mean Deseasonalized Time Series

Tropical Mean (30N to 30S)

- All-sky Longwave
- All-sky Shortwave
- All-sky Net

Clear-sky Longwave
Clear-sky Shortwave
Clear-sky Net
Summary

- ERA Interim has an error in the solar incoming; simple correction is developed to remove this error; which also affected SW and Net.

- ERA Interim uses a constant solar irradiance value. CERES EBAF uses a time varying solar irradiance from SORCE with a solar constant ~ 1361. This leads to differences in solar incoming fluxes for both mean and interannual variability.

- ERA Interim global mean all-sky longwave are much higher than CERES values (global mean by 6 Wm$^{-2}$). This contributed to the large difference in global mean Net when compared to CERES.

- ERA Interim 10-year global mean all-sky Net is negative (losing energy) while the corresponding CERES value is positive (gaining energy).

- 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; There are some differences in times series in the beginning and the ending of the 10-year period.