CERES Surface Validation Update & Uncertainty Study

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• Show how to access validation data.
• Summarize SYN1Deg & EBAF – surface results.
• Describe a study determining sensitivity of uncertainty (RMS) to spatial variability of surface sites.

(All biases are based on Calculation – Observation)
CERES Data Access

https://ceres-tool.larc.nasa.gov/ord-tool

CERES_EBAF-Surface_Ed4.0 Subsetting and Browsing

Plot Type
- Time Series
- Scatter Plots

Temporal Resolution
- Monthly
- Daily
- 3-Hourly
- Hourly (Time Series only)

Time Range
From: 03 - 2000 (MM-YYYY) To: 06 - 2015 (MM-YYYY)

Save Data as ASCII File  Show Count Values  Hide CERES Calculations  Show Bias Values  Show Diurnal Values

Min Availability Filter (%): 0  replot
EBAF-surface & MERRA Validation Access

http://ceres-iprod.larc.nasa.gov/cave2
Longwave Surface Irradiance Down (SYN1Deg Ed4) (2000/02 - 2016/12)

Hourly

Land

Buoy

Monthly

Land

Buoy
Shortwave Surface Irradiance Down (SYN1Deg Ed4) (2000/02 - 2016/12)

**Hourly**

**Land**
- y-Mean: 355
- x-Mean: 357
- Bias(y-x): -2
- RMS: 84
- N: 1944978

**Buoy**
- y-Mean: 451
- x-Mean: 453
- Bias(y-x): -2
- RMS: 100
- N: 945978

**Monthly**

**Land**
- y-Mean: 182
- x-Mean: 183
- Bias(y-x): -1
- RMS: 11
- N: 5125

**Buoy**
- y-Mean: 233
- x-Mean: 234
- Bias(y-x): -1
- RMS: 10
- N: 2416
Surface Irradiance Down (EBAF-Surface Ed4)  
Land Sites (2000/02 - 2016/12)  

Shortwave Surface Bias (EBAF-Observation)

- Obs Mean: 183.4
- Bias EBAF Ed2.8: -0.87
- Bias EBAF Ed4: -0.80
- RMS Ed2.8: 11.51
- RMS Ed4: 11.54
- N: 4959.

Longwave Surface Bias (EBAF-Observation)

- Obs Mean: 317.9
- Bias EBAF Ed2.8: 0.82
- Bias EBAF Ed4: -0.04
- RMS Ed2.8: 10.00
- RMS Ed4: 9.75
- N: 5114.
Surface Irradiance Down (EBAF-Surface Ed4)

Land Sites (2000/02 - 2016/12)

SW Surface Down Deseasonalized Anomalies

LW Surface Down Deseasonalized Anomalies
Surface Irradiance Down EBAF-Surface Ed4 Buoys (2000/02 - 2016/12)

Shortwave Surface Bias (EBAF-Observation)

- Obs Mean: 230.2
- Bias EBAF Ed2.8: 3.53
- Bias EBAF Ed4: 4.68
- RMS Ed2.8: 11.37
- RMS Ed4: 11.61
- N: 3145.

Longwave Surface Bias (EBAF-Observation)

- Obs Mean: 393.4
- Bias EBAF Ed2.8: -0.80
- Bias EBAF Ed4: 0.74
- RMS Ed2.8: 5.74
- RMS Ed4: 5.55
- N: 1201.
Surface Irradiance Down EBAF-Surface Ed4 Buoys (2000/02 - 2016/12)

**SW Surface Down Deseasonalized Anomalies**

- Observations
- EBAF Ed4

Year/Month:
- 2000
- 2002
- 2004
- 2006
- 2008
- 2010
- 2012
- 2014
- 2016

SW Anomalies (Wm⁻²):
- -30
- -20
- -10
- 0
- 10
- 20
- 30

ρ Ed4 & Obs: 0.83
ρ Ed4 & #sites: 0.32

# Sites Used Per Month:
- 0
- 5
- 10
- 15
- 20
- 25
- 30

**LW Surface Down Deseasonalized Anomalies**

- Observations
- EBAF Ed4

Year/Month:
- 2000
- 2002
- 2004
- 2006
- 2008
- 2010
- 2012
- 2014
- 2016

LW Anomalies (Wm⁻²):
- -30
- -20
- -10
- 0
- 10
- 20
- 30

ρ Ed4 & Obs: 0.94
ρ Ed4 & #sites: 0.25

# Sites Used Per Month:
- 0
- 5
- 10
- 15
- 20
- 25
- 30

**Notes:**
- Buoy Group: 46 Possible Sites
- Path: /homedir/drutan/EBAF-val/pltebf4ts
- Date: Thu Jul  6 08:35:42 2017
### Monthly Mean Bias/RMS for SYN1deg & EBAF-Surface

<table>
<thead>
<tr>
<th>EBAF-surface</th>
<th>Longwave</th>
<th>Shortwave</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All in Wm(^{-2})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>Ed2.8</td>
<td>Ed2.8</td>
</tr>
<tr>
<td>Buoy</td>
<td>Ed4</td>
<td>Ed4</td>
</tr>
<tr>
<td>Observed Mean</td>
<td>318</td>
<td>396</td>
</tr>
<tr>
<td>Bias</td>
<td>0.8</td>
<td>-0.8</td>
</tr>
<tr>
<td>RMS</td>
<td>10.0</td>
<td>5.7</td>
</tr>
<tr>
<td>N (Months)</td>
<td>5114</td>
<td>1201</td>
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</table>

<table>
<thead>
<tr>
<th>SYN1Deg</th>
<th>Longwave</th>
<th>Shortwave</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All in Wm(^{-2})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>Ed3</td>
<td>Ed3</td>
</tr>
<tr>
<td>Buoy</td>
<td>Ed4</td>
<td>Ed4</td>
</tr>
<tr>
<td>Observed Mean</td>
<td>317</td>
<td>396</td>
</tr>
<tr>
<td>Bias</td>
<td>-3.1</td>
<td>-1.9</td>
</tr>
<tr>
<td>RMS</td>
<td>10.7</td>
<td>5.0</td>
</tr>
<tr>
<td>N (Months)</td>
<td>5125</td>
<td>943</td>
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</tbody>
</table>
Spatial Uncertainty Analysis of Surface Validation
At times assume a group of sites represent a larger area: drives down the RMS.

**Longwave Surface Bias (EBAF-Observation)**

- **EBAF**
- **Avg Sites 1st**

<table>
<thead>
<tr>
<th></th>
<th>EBAF</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>308</td>
<td>309</td>
</tr>
<tr>
<td>Bias</td>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>RMS</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>N</td>
<td>1283</td>
<td>192</td>
</tr>
</tbody>
</table>

**Shortwave Surface Bias (EBAF-Observation)**

- **EBAF**
- **Avg Sites 1st**

<table>
<thead>
<tr>
<th></th>
<th>EBAF</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>183</td>
<td>184</td>
</tr>
<tr>
<td>Bias</td>
<td>-4</td>
<td>-4</td>
</tr>
<tr>
<td>RMS</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>N</td>
<td>1289</td>
<td>192</td>
</tr>
</tbody>
</table>
Four South Polar Sites Represent Antarctica:

Longwave Surface Bias (EBAF-Observation)

- EBAF
- Avg Sites 1st

<table>
<thead>
<tr>
<th></th>
<th>EBAF</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>168</td>
<td>169</td>
</tr>
<tr>
<td>Bias</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>RMS</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>N</td>
<td>661</td>
<td>192</td>
</tr>
</tbody>
</table>

Shortwave Surface Bias (EBAF-Observation)

- EBAF
- Avg Sites 1st

<table>
<thead>
<tr>
<th></th>
<th>EBAF</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>132</td>
<td>133</td>
</tr>
<tr>
<td>Bias</td>
<td>-4</td>
<td>-5</td>
</tr>
<tr>
<td>RMS</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>N</td>
<td>597</td>
<td>191</td>
</tr>
</tbody>
</table>
Simply average over larger and larger groups of sites; randomly select groups 100 times number.

Do land and buoy sites separately.

\[
F_{\text{diff}}(\text{comp}, \text{obs}) (K) = \frac{1}{K} \sum_1^K F_{\text{diff}}(\text{comp}), \quad \Delta F_{\text{diff}}(K) = \Delta F_{\text{diff}}(\text{comp}) (K) - \Delta F_{\text{diff}}(\text{obs}) (K)
\]

\[
F_{\text{diff}, \text{RMS}}(K) = \left[ \frac{1}{N} \sum_1^N \frac{1}{L} \sum_1^L \left[ \Delta F_{\text{diff}} (K) \right]^2 \right]^{1/2}
\]

\(x = 100\) realizations
Plot RMS as a function of increasing group size.

\[ F_{\downarrow x, \text{RMS}}(K) \uparrow 2 \]

**Shortwave**

<table>
<thead>
<tr>
<th>Number of sites per group (K)</th>
<th>Ocean</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10^1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10^2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10^3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Longwave**

<table>
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<td></td>
<td></td>
</tr>
<tr>
<td>10^2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10^3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Plot RMS as a function of increasing group size.

\[ F_{\text{down}, \text{RMS}}(K) \uparrow 2 = \Delta F_{\text{down}, \text{bias}} \uparrow 2 + \Delta F_{\text{down}, \text{random}} \uparrow 2 / K \]

<table>
<thead>
<tr>
<th></th>
<th>Land (Wm(^{-2}))</th>
<th>Buoy (Wm(^{-2}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shortwave</td>
<td>Longwave</td>
</tr>
<tr>
<td>( \Delta F_{\text{down}, \text{bias}} \uparrow 2 )</td>
<td>3.2</td>
<td>3.1</td>
</tr>
<tr>
<td>( \Delta F_{\text{down}, \text{random}} \uparrow 2 )</td>
<td>9.6</td>
<td>7.9</td>
</tr>
</tbody>
</table>
Summary

- CERES EBAF & SYN1Deg along with surface observation can still be accessed at: 
  
  https://ceres-tool.larc.nasa.gov/ord-tool

- Overall the new EBAF-sfc Ed4 and SYN1Deg Ed4 surface validation shows little change (good thing).

- Uncertainty due to spatial variability in our surface validation sites shows:
  
  - Decrease is rapid for the land indicates higher spatial variability for these sites
  
  - Slower over ocean buoys:
    
    - Sites are primarily in tropics, less spatial variability in general
    
    - Fewer site with continuous time series adds to less reliable relationship.