TISA Products/Validation/Status

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Outline

- SRBAVG-daily product status
- ISCCP-D2like products status, M Sun
- GSFC GEOS5 vs GEOS4 differences
- Adjusted CERES SRBAVG dataset, N. Loeb
- SYN/AVG/ZAVG status and validation
- G GEO (MTSAT calibration) status
- TISA Edition3 Improvements
- Edition number madness explained
- Products and schedules

- TISA objective is to time and space average all parameters thrown our way
  - Use linear interpolation as a default
  - Use SW directional models to estimate daily flux
  - Incorporate GEO retrieved cloud and fluxes to estimate diurnal signal
SRBAVG Daily
SRBAVG-Daily on Ed2E

- Provide daily fluxes and cloud properties
  - SRBAVG-daily1 is the GEO (GEO & CERES) TOA, surface fluxes and clouds
  - SRBAVG-daily2 is the nonGEO (CERES-only) TOA fluxes and MODIS clouds
- SRBAVG-daily2: also includes the MODIS product aerosols
  - 0.65μm and 1.6μm (Ignatov aerosols) in SRBAVG1 product
  - Monthly zonal incoming solar flux
  - Daily Snow/Ice coverage maps (snow+ice+IGBP permanent)
- Include Model B Terra based TOA clear-sky albedo map
- Corrects the RAPS mode G GEO/CERES SW normalization error
- SRBAVG product delayed in order to expedite SYN/AVG/ZAVG product
SRBAVG-daily temporal averaging validation

- Make sure all the daily parameters average to the monthly mean
  - To test, compute monthly mean flux from daily means from stand alone IDL HDF read code
  - Compare to monthly mean on SRBAVG files

- Overall consistency between daily and monthly
  - LW and cloud properties are linearly averaged
  - Daily twilight correction is applied to TOA SW daily fluxes
  - Surface Model A and B SW flux parameterization fail with SZA >80°
    - Estimate failed SW surface fluxes by interpolating transmission for SW down and surface albedo for SW up
  - Weight by daily flux SW flux to derive monthly mean flux

- Outstanding Issues
  - nonGEO clear-sky TOA LW, which is based on half-sine fit on monthly hourly fluxes, due to lack of clear-sky observations
  - Daily clear-sky TOA LW will be computed from daily half-sine fit
    - the average of the daily means will not equal the monthly mean
# of nonGEO clear-sky LW measurements during Jan 2001
Averaged daily - monthly mean clear-sky LW flux
Jan 2001

GEO SRBAVG4-1 (W/m²)

SRBAVG5  262.78
SRBAVG1  262.27
Bias      0.51
reg RMS   2.27
Total-sky SFC Net SW flux
daily derived - SRBAVG monthly means

SRBAVG4-1 Total-sky Sfc Net SW Flux - Mod B
Terra_FM1  July 2002

SRBAVG4-1 (W/m²)
-2.4  -1.6  -0.8  0.0  0.8  1.6  2.4
G5-G4 Comparison
G5 impact on the CERES flux product

- How does the GSFC G5 product impact the CERES fluxes?
  - G5 atmospheric profiles could change the ADM scene ID
    - Changes in MODIS derived cloud properties
    - Changes in clear-sky identified MODIS pixels
- How does the G5 profiles impact the GEO derived fluxes?
  - GEO cloud properties more sensitive to G5 profile than MODIS
    - 2 channel retrieval, at night clear-sky determined from predicted TOA clear-sky temperature
    - GEO derived BB fluxes are normalized to CERES fluxes
      - Normalization should work no matter the change in GEO cloud properties
      - Good test of the TISA SW regional normalization algorithm
      - Expect to see minimal global flux difference
- Procedure:
  - Process 3 months of SSF, SFC, GGEO and SRBAVG products using existing algorithms, with G5 input
    - Terra Jan06, Aqua Jan06, and Terra Jul04
- Compare with results SRBAVG Ed2D monthly mean product
## TOA Flux G5-G4 Comparison Table

<table>
<thead>
<tr>
<th>Bias (Wm⁻²)</th>
<th>Aqua Jan06</th>
<th>Terra Jan06</th>
<th>Terra Jul04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear-sky SW nonGEO</td>
<td>0.01</td>
<td>-0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>50.5</td>
<td>1.17</td>
<td>1.35</td>
<td>1.45</td>
</tr>
<tr>
<td>Clear-sky LW nonGEO</td>
<td>-0.01</td>
<td>-0.04</td>
<td>-0.11</td>
</tr>
<tr>
<td>~263</td>
<td>1.64</td>
<td>1.59</td>
<td>2.00</td>
</tr>
<tr>
<td>Clear-sky LW GEO</td>
<td>-0.06</td>
<td>-0.11</td>
<td>-0.20</td>
</tr>
<tr>
<td>~259</td>
<td>2.01</td>
<td>1.97</td>
<td>2.40</td>
</tr>
<tr>
<td>All-sky SW GEO</td>
<td>0.03</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>~101</td>
<td>0.73</td>
<td>0.76</td>
<td>0.77</td>
</tr>
<tr>
<td>All-sky LW GEO</td>
<td>0.06</td>
<td>-0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>~234</td>
<td>0.36</td>
<td>0.51</td>
<td>0.55</td>
</tr>
</tbody>
</table>

- Note biases < 0.1 Wm⁻² except for clear-sky LW
- GEO SW regional normalization algorithm is working
• LW surface fluxes are decoupled from the TOA and depend only on the lower atmosphere and are sensitive to skin temperature differences
• Very similar differences for the clear-sky SFC LW
G5-G4, All-sky SFC Down LW, Model B

Terra Jul04

G5 = 347.30
G5-DAO = 3.38
reg RMS 90N-90S = 9.12

Terra Jan06

G5 = 326.20
G5-DAO = 0.50
reg RMS 90N-90S = 8.49

Aqua Jan06

G5 = 326.20
G5-DAO = 0.50
reg RMS 90N-90S = 8.48
### SFC Flux G5-G4 Comparison Table based on land statistics

<table>
<thead>
<tr>
<th>Land Bias</th>
<th>ModelB Land RMS</th>
<th>Aqua Jan06</th>
<th>Terra Jan06</th>
<th>Terra Jul04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear-sky Net SW ~212</td>
<td>0.94</td>
<td>0.92</td>
<td>0.00</td>
<td>2.23</td>
</tr>
<tr>
<td>All-sky Net SW ~170</td>
<td>0.80</td>
<td>0.78</td>
<td>-0.02</td>
<td>1.96</td>
</tr>
<tr>
<td>Clear-sky DN SW ~240</td>
<td>0.94</td>
<td>0.92</td>
<td>0.02</td>
<td>2.22</td>
</tr>
<tr>
<td>All-sky DN SW ~192</td>
<td>0.80</td>
<td>0.79</td>
<td>0.01</td>
<td>2.04</td>
</tr>
<tr>
<td>All-sky Net LW ~ -53</td>
<td>-4.24</td>
<td>-4.22</td>
<td>-3.86</td>
<td>7.57</td>
</tr>
<tr>
<td>Clear-sky DN LW ~322</td>
<td>0.85</td>
<td>0.95</td>
<td>4.22</td>
<td>8.39</td>
</tr>
<tr>
<td>All-sky DN LW ~ 346</td>
<td>0.50</td>
<td>0.60</td>
<td>3.38</td>
<td>8.48</td>
</tr>
</tbody>
</table>

- Some Land SFC SW flux differences are ~ 1Wm\(^{-2}\).
- SFC Land LW flux differences are ~ 4Wm\(^{-2}\).  

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**Note:**

- Land SFC SW flux differences are significant for clear-sky conditions.
- Land SFC LW flux differences are notable for all-sky conditions.

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**References:**

- CERES Team and Data Set
- Atmospheric Sciences Team
• Differences are mainly over land, especially over Africa and tropics

NASA Langley Research Center / Atmospheric Sciences
G5-G4 MODIS(CERES) cloud property differences

Cloud amount

July 2004 day

July 2004 night

Jan 2006 day

Jan 2006 night

Eff Pressure

Infrared Emissivity

July 2004 day

July 2004 night

Jan 2006 day

Jan 2006 night
Adjusted SRBAVG fluxes
Net Flux Optimal Global Closure

- **Objective** is to close the net flux imbalance by adjusting SW & LW TOA fluxes according to known uncertainties.
  - Norm will address topic in following presentation
  - Mainly instrument uncertainty
  - Apply instantaneous uncertainty adjustments to Norm’s SSF-daily database to derive monthly mean regional adjustment
  - Apply regional adjustments to the SRBAVG GEO product as final output
  - Able to sidestep CERES production, process 5 years in 1 day

- **Opportunity to validate TISA temporal averaging**
  - Compare monthly means from Norm’s daily SSF database with SRBAVG nonGEO fluxes
  - SSF database comprised of (GMT) daily gridded day and night flux means from SSF
  - Norm first derives SSF daily SW fluxes and then averages all footprint daily fluxes for the day including regions with multiple measurement times
  - SRBAVG first spatially averages the footprint fluxes and then uses the mean cloud property directional model to interpolate between gridded measurements
  - SSF database averages all LW footprints for the day regardless of multiple overpasses, SRBAVG interpolates between measurement times
SSFdaily - nonGEO TOA SW flux

SSFdaily - nonGEO All-sky SW flux, July 2002

SSFdaily - nonGEO All-sky global SW flux timeline

<table>
<thead>
<tr>
<th>All-sky TOA SW Rev1</th>
<th>Difference</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERES</td>
<td>96.91</td>
<td></td>
</tr>
<tr>
<td>nonGEO</td>
<td>96.71</td>
<td>0.20</td>
</tr>
</tbody>
</table>

SW flux difference (W/m²)
5-Year Annual Flux Means

<table>
<thead>
<tr>
<th>60 month mean</th>
<th>SSF-daily</th>
<th>nonGEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear LW</td>
<td>linear</td>
<td>267.26</td>
</tr>
<tr>
<td></td>
<td>half-sine</td>
<td>266.68</td>
</tr>
<tr>
<td>All-sky LW</td>
<td>linear</td>
<td>238.33</td>
</tr>
<tr>
<td></td>
<td>half-sine</td>
<td>237.65</td>
</tr>
<tr>
<td>Clear SW</td>
<td></td>
<td>51.35</td>
</tr>
<tr>
<td>All-sky SW</td>
<td></td>
<td>96.91</td>
</tr>
</tbody>
</table>

- Two independent approaches giving similar global means
SYN/AVG/ZAVG products
• Beta4 Code delivered to the DAAC
  – Code deliveries now required work both on SGI and cluster
  – TSI (Dec07), SYN (Dec07), SYN/AVG/ZAVG (Feb08)
  – TSI code has not been promoted, Magneto environment issues
  – SYN/AVG/ZAVG takes ~ 3 days to process, working on optimizing the code
  – If no other major problems allow six weeks for testing (mid June)
• Beta4 process all the seasonal months for both Aqua (Jul02-Oct05) and Terra (Apr00-Oct05) to monitor any long-term artifacts
  – Make sure that SRBAVG = ZAVG global monthly means
  – Best case scenario, 1.5 months, evaluate 1 month, (end Aug)
• Should be an Edition2 product by the end of 2008 in order to meet Terra/Aqua senior review funding requirements
  – Given no show stoppers, 4 months to process entire record, (end Dec)
Comparison of SYN/AVG and SURFRAD PAR fluxes, Terra July 2002 product

PAR: Monthly Mean  Diurnal Cycle
Table Mountain, CO  2002/07

- Sfc Observation
- Sfc Obs 3Hr Mean
- SARB AVG Model Value
- Sfc Obs 24 Hr Average
- SARB AVG 24 Hr Average
- SYNI 24 Hr Average

PAR: Monthly Mean  Diurnal Cycle
Desert Rock, NV  2002/07

- Sfc Observation
- Sfc Obs 3Hr Mean
- SARB AVG Model Value
- Sfc Obs 24 Hr Average
- SARB AVG 24 Hr Average
- SYNI 24 Hr Average
Comparison of SYN/AVG and SURFRAD PAR monthly 3-hourly fluxes, Terra July 2002 product

- Surfrad sites: Bondville, IL; Desert Rock, NV, Fort Peck, MT; Goodwin Creek, MS; Penn State, PA; Table Mountain, CO
GGEOL MTSAT status
MTSAT issues delaying G GEO processing

- MTSAT cloud properties matched at Terra times were vastly different than for GOES-9 or GMS-5
  - Increase in clear-sky amount for regions with large SZA
  - Noticed that many regions near the terminator had counts or radiances=0 even though the SZA<90°
  - Noticed a nonlinear response that resulted in negative radiances for low count scenes.
    - Working with Don Garber to either use a dual linear or hyperbolic fit when regressing coincident ray-matched Terra/MTSAT radiances
    - Applying lessons learned with Terra and Aqua to VIRS/MTSAT matches to make sure that all SZA are well calibrated

- MTSAT images were reformatted
  - McIDAS ingested MTSAT images from Nov05-Aug07 using the GMS-5 receiving equipment
  - Used JPEG compression to reduce resolution from 4 to 5km and from 10bit linear to 8bit squared visible count to radiance relationship
  - From Sep07 to present receiving nominal resolution images
  - Develop calibration technique with 10bit data and then apply to 8bit
• Note that many terminator MTSAT pixels have counts of 0 when the SZA < 90°
MTSAT 10bit visible calibration, Sep 2007

MTSAT/Terra

MTSAT/Aqua

MTSAT/GOES11
Edition 3 improvements
Edition 3 improvements

- LW NB-BB and ADM improvements
  - Develop LW NB-BB model using ADM binning and LW 5° regional normalization similar to GEO derived BB SW
  - Currently using one global parameterization using NB flux and column RH humidity and instantaneous normalization
- LW cubic spline interpolation over land
  - To estimate peak daytime flux using 3-hourly sampling
- Improvements in the clear-sky GEO mask
  - Clear-sky scene identification weakest part of GEO cloud retrieval algorithm
  - Derive clear-sky albedo maps from GEO (now using monthly MODIS clear-sky maps)
  - Mitigate effects of dark cold scenes being classified as clear-sky in GEO algorithm
LW land cubic spline interpolation

- Truth are 1-hourly GERB measurements
- Interpolation performed on 3-hourly measurements
- Cubic spline captures the daytime heating peak given 3-hourly fluxes
- Linear always underestimates the truth near noon
Comparison of monthly hourly GEO LW flux bias

Linear

06 LST

Bias Linear – GERB Truth
July 2004 LST 06
INPUT FILE bias_linear_06.out

Cubic spline

12 LST

Bias Cubic Spline – GERB Truth
July 2004 LST 12
INPUT FILE bias_cubic_12.out

July 2004
GEO clear-sky monthly mean LW is computed from days with CERES measurements only, same days as the nonGEO product.

- Right panel difference plots shows the effect of using all GEO measurements days instead of only the CERES measurement days.
- Greatest difference occurs in very cloudy regions.
- GEO clear-sky retrievals not as robust as MODIS using only a VIS and IR channel.
# Terra CERES Edition Products

- **CERES Edition table** *(link in the TISA DQS)*

<table>
<thead>
<tr>
<th>Edition2</th>
<th>Terra SSF</th>
<th>Terra SFC</th>
<th>Terra SRBAVG</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Edition2</th>
<th>Terra SSF</th>
<th>Terra CRS</th>
<th>Terra FSW</th>
<th>Terra SYN/AVG/ZAVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SSF_Edition2A</td>
<td>CRS_Edition2A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* projected products are consistent across an Edition2 letter or row in the table
  
  code= refers to the product code used to process the named Edition2 product
# Aqua CERES Edition Products

- **CERES Edition table** *(link in the TISA DQS)*

<table>
<thead>
<tr>
<th>Edition2</th>
<th>Aqua SSF</th>
<th>Aqua SFC</th>
<th>Aqua SRBAVG</th>
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<tbody>
<tr>
<td></td>
<td>Error in Model B SW sfc fluxes</td>
<td>code=Terra_SFC_Edition2C</td>
<td>code=Terra_SRBAVG_Edition2D</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SRBAVG Edition2A Cautions</td>
</tr>
<tr>
<td></td>
<td>Corrected Model B SW sfc fluxes</td>
<td>code=Terra_SFC_Edition2C</td>
<td>code=Terra_SRBAVG_Edition2E</td>
</tr>
<tr>
<td></td>
<td>MODIS collection 5</td>
<td>code=Terra_SFC_Edition2C</td>
<td>code=Terra_SRBAVG_Edition2E</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Edition2</th>
<th>Aqua SSF</th>
<th>Aqua CRS</th>
<th>Aqua FSW</th>
<th>Aqua SYN/AVG/ZAVG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrected Model B SW sfc flux</td>
<td>CRS improvements</td>
<td>code=Terra_FSW_Edition2C</td>
<td>code=Terra_AVG_Edition2C</td>
</tr>
</tbody>
</table>

* projected products are consistent across an Edition2 letter or row in the table

code= refers to the product code used to process the named Edition2 product

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**NASA Langley Research Center / Atmospheric Sciences**
CERES spatially gridded and temporally averaged (level 3) products

- ERBE-like
  - TOA Fluxes based on ERBE (scene id, ADM) algorithms and output format
  - Instantaneous, daily, monthly hourly (ES-9), monthly means (ES-9, ES-4)
  - Terra Ed2 (Mar00-Dec06), Ed1CV (2 month lag)
  - Aqua Ed2 (Jul02-Dec06), Ed1CV (2 month lag)
- SFC
  - Instantaneous gridded (SSF) CERES footprint TOA and surface fluxes, clouds and aerosols, output in local time
  - Terra Ed2 (Mar00-Dec06)
  - Aqua Ed2 (Jul02-Dec06)
- FSW
  - Instantaneous gridded (SSF & CRS) radiative transfer modeled profile fluxes consistent with CERES TOA fluxes, clouds and aerosols, output in GMT time
  - Terra Ed2 (Mar00-Dec06)
  - Aqua Ed2 (Jul02-Dec06)
- Extend ERBE-like, SFC and FSW, datasets to Dec07
  - First to Aug07, processing takes 6-9 months after instrument coefficient delivery
  - Second to Dec07, currently no plans for 2008, Use GEOS-5 in 2008
CERES spatially gridded and temporally averaged (level 3) products

- ISCCP-like-MODIS (new)
  - Pc-Tau stratified (SSF) MODIS retrieved cloud properties
  - Similar to ISCCP-D2 output of monthly GMT 3-hourly and means
  - Terra Ed2 (process Mar00-Dec06, due Fall 2008)
  - Aqua Ed2 (process Jul02-Dec06, due Fall 2008)
  - Extend to Dec07 on same schedule as SFC

- ISCCP-like-GEO (new)
  - Pc-Tau stratified 5-geostationary imager retrieved cloud properties
  - GEO (process Mar00-Oct05, due Dec 2008)

- SRBAVG
  - Temporally averaged gridded, zonal and global TOA and surface fluxes, clouds and aerosols, output in local time as monthly hourly and monthly means
  - nonGEO product contains CERES fluxes and clouds only
  - GEO product contains both CERES and GEO fluxes and clouds
  - Terra Ed2 (Mar00-Oct05)
  - Aqua Ed2 (Jul02-Oct05) (New)
CERES spatially gridded and temporally averaged (level 3) products

- **SRBAVG Ed2E Daily means (new)**
  - Same as SRBAVG except for daily output
  - Terra Ed2 (process Mar00-Oct05, due Nov 2008)
  - Aqua Ed2 (process Jul02-Oct05, due Dec 2008)

- **SYN/AVG/ZAVG (new)**
  - Temporally averaged synoptic radiative transfer modeled profile fluxes consistent with CERES and GEO TOA fluxes, clouds and aerosols
  - GMT 3-hourly (SYN), monthly 3-hourly and monthly means (AVG), and zonal and global means (ZAVG)
  - Terra Ed2 (process Mar00-Oct05, due Dec 2008)
  - Aqua Ed2 (process Jul02-Oct05, due Feb 2009)
  - Terra Beta3 (Mar00-Sep04)

- **Extend SRBAVG, ISCCP-like-GEO and SYN/AVG/ZAVG to Dec07**
  - First to Dec06, late 2008 SRBAVG, mid 2009 SYN/AVG/ZAVG
  - Second to Dec07 ~ 1 year after SFC