State of CERES

Norman G. Loeb
NASA Langley Research Center, Hampton, VA

CERES Science Team Meeting, October 6-10, 2014
Toulouse, France
CERES Meeting & Workshop Objectives

1) CERES Meeting:
- Status of NASA & CERES Project
- CERES Terra, Aqua and SNPP SW/LW/TOTAL Channel Calibration Update
- CERES FM6 and RBI Update
- CERES SNPP SSF Edition-1: VIIRS Cloud Algorithm & Validation Status
- CERES GEO Cloud Algorithm Status
- CERES ADM, SOFA, SARB and TISA Working Group Reports
- Data Management Team & Atmospheric Sciences Data Center (ASDC) Updates

2) Workshop:
- Calibration intercomparison between CERES, ScaRaB and GERB.
- Evaluation of CERES time-space averaging using temporal information from ScaRaB and GERB.
- Towards synergistic scientific use of CERES/ScaRaB/GERB.
CERES Team Leads

- Principal Investigator: Norman Loeb
- Project Scientist: Kory Priestley

CERES Working Groups:
- Instrument: Kory Priestley
- ERBElke: Takmeng Wong
- Clouds: Pat Minnis (Lead); Bill Smith Jr., (Deputy)
- Inversion: Wenying Su
- SOFA: David Kratz
- SARB: Seiji Kato
- TISA: David Doelling
- FLASHFlux: Paul Stackhouse & David Kratz
- Data Management: Jonathan Gleason
- ASDC: John Kusterer
- Five CERES instruments on 3 satellites (Terra, Aqua, SNPP) are flying.
- FM6 will be fly on JPSS-1 in 2016 and the CERES Follow-on (RBI) will fly on JPSS-2 in 2021.
TOA Radiation Changes (March 2000 – June 2014)

Absorbed Solar

Emitted LW

Net Radiation

Multivariate ENSO Index
CERES Journal Publication and Citation Counts
(For Papers Between 1993-2014; Updated September 1, 2014)

- Total number of peer-reviewed journal articles: 892
- Total number of citations to CERES papers: 26,467

Compiled by Anne Wilber & Dave Kratz
CERES Data Processing Flow

CERES Level-0 Measurements
- Ephemeris & Attitude
- Snow & Ice Coverage
- Imager Radiances & Aerosol Retrievals

Ephemeris & Attitude
- TOA Radiances (BDS)
- Determine TOA Fluxes

Determine Cloud Properties & TOA Fluxes
- Solar Irradiance
- Meteorological & Ozone Analysis (MOA)
- Aerosol Assim.

GEO Data
- Derive GEO Clouds and TOA Fluxes

L2
- Stratify by ISCCPD2 Cloud type
- Grid Cloud Properties & TOA Fluxes

ISCCPD2-Like (Clouds; Fluxbycloudtype)
- Grid Cloud Properties & TOA Fluxes
- Cloud and Fluxes (SSF 1deg-Hour)
- Computed Fluxes & Cloud Property Footprints (CRS 1deg-Hour)

L3
- Solar Irradiance
- MOA
- Snow & Ice Coverage
- Aerosol Assim.

Compute SFC & ATM Fluxes
- Time Interpolate

L3
- Daily and Monthly Cloud Properties & TOA Flux Averages (SSF 1deg-Day, -Month)
- SSF Stream (CERES+Imager TOA & SFC Fluxes and Clouds)

L3b

SYN Stream (CERES+Imager+GEO TOA, ATM, SFC Fluxes and Clouds)
- EBAF

Data Product Level
- Level-1
- Level-2
- Level-3
- Level-3b
- Algorithm
- Ancillary Data Set
## Update on CERES Data Use – Number of Unique Users by Product

<table>
<thead>
<tr>
<th>Products</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBAF-TOA</td>
<td>72</td>
<td>146</td>
<td>234</td>
<td>381</td>
<td>407</td>
</tr>
<tr>
<td>EBAF-Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESG</td>
<td>14</td>
<td>130</td>
<td>151</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>SYN1deg</td>
<td>61</td>
<td>315</td>
<td>285</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYN1deg-lite</td>
<td>41</td>
<td>126</td>
<td>133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSF1deg-lite</td>
<td>46</td>
<td>106</td>
<td>93</td>
<td>138</td>
<td>136</td>
</tr>
<tr>
<td>ISCCP-D2like</td>
<td>17</td>
<td>12</td>
<td>45</td>
<td>62</td>
<td>37</td>
</tr>
<tr>
<td>SSFlevel2</td>
<td>84</td>
<td>77</td>
<td>138</td>
<td>192</td>
<td>167</td>
</tr>
<tr>
<td>BDS</td>
<td>11</td>
<td>9</td>
<td>14</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>ES4</td>
<td>59</td>
<td>36</td>
<td>11</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>ES8</td>
<td>22</td>
<td>20</td>
<td>18</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>ES9</td>
<td>21</td>
<td>12</td>
<td>5</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>SFC</td>
<td>31</td>
<td>20</td>
<td>14</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>NEWS</td>
<td>31</td>
<td>32</td>
<td>33</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>MISR-MODIS</td>
<td>9</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>FLASH_SSF</td>
<td>25</td>
<td>8</td>
<td>15</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>FLASH_TISA</td>
<td>17</td>
<td>18</td>
<td>20</td>
<td>11</td>
<td>3</td>
</tr>
</tbody>
</table>
CERES Terra and Aqua Edition 4

- Instrument gains and SRFs: Delivered.
  - Improvement to Aqua SW part of TOT SRF.

- CERES Clouds code: Delivered. Several years of Terra and Aqua processed SSF Edition 4-beta2.
  - Increased cloud fraction (more consistent with CALIPSO).
  - Decreased cloud optical depth (more thin clouds).
  - Significant improvements to polar cloud mask.

- Inversion (ADMs and SOFA) code: Delivered.
  - 2nd generation CERES ADMs; Improved parameterized surface fluxes.

- SARB and TISA code deliveries within next few months.
  - Use of 5-channel 1-hourly GEO cloud retrievals.
  - Consistent reanalysis and MODIS calibration throughout.
  - SYN1deg to be released 1-hourly, 3-hourly, daily and monthly.
  - Consistent non-GEO and GEO TISA products (all GMT).
  - Improved to Fu-Liou RT code and ancillary inputs (e.g., Ed4 clouds+overlap, surface albedo, MATCH aerosols).
**Terra Lunar Deep Space Calibration (LDSC) Maneuver**

- In August 2013, the ASTER Team requested the Terra FOT to review the previous Deep Space Calibrations (DSC) in 2003 and determine steps for possible future DSC.

- ASTER Science team made an official request with the Terra Project Scientist for a LDSC maneuver.

- A DSC maneuver is an accelerated 240 degree pitch-over (360 relative to local horizon) during S/C night that provides observations of the cold background of deep space and an option for a lunar viewing.

- Two previous DSC maneuvers were executed in 2003:
  - March 26 maneuver was a deep space calibration (DSC)
  - April 14 maneuver was both deep space and a lunar calibration (LDSC).

- A LDSC provides the Terra instrument teams observations that can be compared against the LDSC in 2003.
  - Can be used to verify calibration changes from onboard calibration sources over the lifetime of the mission.
- Blue block on S/C is instrument deck
Terra Lunar Deep Space Calibration (LDSC) Maneuver: Timeline

- LDSC proposal will need to be presented to and approved by
  - Terra Project Scientist
  - Terra Science Teams
  - GSFC management
  - NASA HQ
  - Prior to approval an Updated Risk Analysis may be required

- FOT could support a LDSC near End of Mission if desired and approved

- The FOT has been able to identify potential opportunity dates based on desired phase angles 2017 - 2020
  - Preliminary opportunities are in line with Lunar Phasing (approximately one opportunity per month)
  - As desired dates get closer it will become easier to determine opportunities that meet all LDSC requirements

- At August 2014 interface meeting ASTER IOT has indicated to the FOT a LDSC on July 18, 2016 may be most desirable for science and budget considerations
  - FOT will follow up on investigating 2016 opportunity dates
  - Allows for less time to get required consensus and approvals prior to LDSC execution
- CERES FM5 time-varying gains and beginning of mission SRFs to be used in SSF Edition 1.

- Receiving Collection 1.1 calibrated VIIRS radiances from GSFC Land PEATE (Xiong).


**Longer-Term Plans**

- Work with GMAO on next generation meteorological assimilation used in CERES processing.
  - Kickoff meeting at GSFC November 19, 2014.
  - Hope to have GMAO representation at spring CERES meetings.

- Production code modernization effort.
  - Some subsystems rely on routines that go back 20 years or longer, with varying programming styles and standards.
  - Revision and modification of the CERES production code where necessary will ensure long-term maintainability and scalability of code, and ultimately improve efficiency (simplify code updates, smoother transition to next generation of programmers and scientists, etc.).


- Work with Jack Xiong (GSFC) to place VIIRS radiances on same radiometric scale as MODIS Aqua.

- Work towards ensuring a seamless transition between ERB data products on different satellites (e.g., Aqua -> S-NPP -> JPSS-1 -> JPSS-2).

- Prepare production codes for CERES FM6 on JPSS-1.

- Evaluate impact of upcoming high spatial/temporal resolution operational geostationary imagers on CERES Level 3 products. (e.g., GOES-R ABI, HIMAWARI ABI, etc.).
**Arctic Radiation–IceBridge Sea-Ice Experiment (ARISE)**

- Field experiment over Arctic Ocean to study Arctic sea-ice, clouds and radiation during late summer to early autumn 2014.

- Consists of airborne polar geophysical project called Operation IceBridge.
  - Goal of IceBridge is to characterize annual changes in thickness of sea ice, glaciers, and ice sheets. Uses LVIS laser altimeter (1064 nm backscatter).
  - Bridges gap between ICESat satellite missions.

- Radiation science goals: Evaluate CERES clouds and radiation products for coincident Terra, Aqua and Suomi NPP satellite overpasses.

- Base of operation: August 27-Sept 2: Thule Air Base, Greenland. Sept 4-Oct 2: Fairbanks, AK.

- Aircraft: Wallop’s C-130

- Instruments: BBR (Bucholtz), SSFR (Schmidt), 4STAR (Redemann), NAST-I (Noe), LVIS + Digital Camera (Blair), in-situ Probes (Anderson)

**Personnel:**

a. Hal Maring – HQ Program Manager, Radiation Sciences  
b. Tom Wagner – HQ Program Manager, Cryospheric Sciences  
c. Bruce Tagg – HQ Program Manager, Airborne Sciences  
d. Christy Hansen – NASA Goddard, IceBridge Project Manager, and Radiative Balance Project Manager  
e. Bill Smith – NASA Langley, Science Team Lead
ARISE MISSION STATUS – 10/3/14
WEEK 5

Flight Map Summary: shows 17 ARISE science flights completed

“Days” Breakdown
✓ 33 days in field
✓ 2 transit flts complete
✓ 17 sci flts complete
✓ 1 planned maint.
✓ 6 reqd hard down days
✓ 1.5 wx. days
✓ 7 unplanned maint. no-fly days

Flight Hours
✓ 149 used
✓ 80 hours left

Asset Coordination
✓ TERRA
✓ AQUA
✓ CALIPSO
✓ CLOUDSAT
✓ METOP-A,B
✓ SUOMI NPP
✓ NOAA 15,18,19
✓ CryoSat-ESA
✓ Mable
✓ SIZRS 140/150

ARISE Science Reports:
https://espo.nasa.gov/missions/arise/mission-flight-docs

Courtesy of Christy Hansen
COVE

• DOE purchased Chesapeake Lighthouse (CLT) to create RFORE -- Reference Facility for Offshore Renewable Energy.

• Goal was to construct a 100 m tower for wind research.

• However, cost of 100m tower is higher than $10M DOE cap ($15M).

• Thus, DOE is returning CLT to GSA for auction.

• In parallel, they are evaluating the suitability of CLT and other sites for a downscaled project that will last 2-3 years.

• Safety is still an issue for DOE, though.
  • A 3-year project at CLT will likely require more structural inspections of the housing level ($??), paint ($0.5-1M), and a hazmat cleanup ($300k).

• Meanwhile, the COVE project is still collecting data.

• COVE MPLNET will move to CAPABLE site at LaRC, pending LAFB approval.
Future Earth Radiation Budget Missions

• Responsibility for sustained climate measurements transferred from NOAA to NASA.

• CERES FM6 to launch on JPSS-1 in Nov 2016.
  - CERES team to produce Earth Radiation Budget Climate Data Records using CERES FM6, closely following FM5/SNPP approach.

• Radiation Budget Instrument (RBI) Status:
  - Draft RFP released in April, 2013
  - Industry-Day April 30, 2013
  - Official RFP release: June 14, 2013
  - Award: Spring 2014
  - RBI delivery date: Spring 2019.
Upcoming Conferences & Meetings of Interest

The Climate Symposium 2014
- October 13–17, 2014, Darmstadt, Germany

Fall American Geophysical Union
- December 15–19, 2014, San Francisco, CA

3\textsuperscript{rd} International A-Train Symposium 2015
- March 4–6, 2015, Southern California

EGU General Assembly 2015
- April 12–17, 2015, Vienna, Austria

Spring CERES Science Team Meeting
- April 28-30 (Tentative), 2015, Hampton, VA

Gordon Research Conference
- July 26–31, 2015, Bates College, Lewiston, ME

International Radiation Symposium 2016
- April 17-23, 2016, Auckland, New Zealand
Other News

• SORCE successfully transitioned to a new “hybrid” operating mode on Monday, Feb. 24th, 2014.

• The hybrid mode allows SORCE to take solar measurements again after an approximate 6-month hiatus due to the loss of another battery cell.

• “Hybrid” Mode: Every orbit SORCE makes solar observations during the daylight part of the orbit, and then put itself into safe-hold every eclipse (to conserve power during nighttime).

• Goal is to operate SORCE until after the TSIS launch in 2017 (likely on ISS).

• Total Solar Irradiance Calibration Transfer Experiment (TCTE) launched November 19, 2013. Mission duration: 18 months.

• Successful SORCE/TCTE cross-calibration campaign occurred between Dec 22-Dec 28, 2013.

• CERES team is switched to V15 SORCE TIM for Feb03-Jun13.

• For July 2013 onwards, RMIB TSI composite (mainly DIARAD/VIRGO instrument on SOHO) is being used (anchored to SORCE TIM V15).
Other News

• CALIPSO – Functioning nominally

• CloudSat – Returned to the A-Train. Nominal Daylight Only Operations (DO-Op) continue.

• Global Precipitation Measurement (GPM) - GPM Core Observatory satellite launched on February 27th, 2014.

• Deep Space Climate Observatory (DSCOVR) – Launch in January 2015.
  - LaRC received grant to generate NISTAR fluxes (Minnis/Su Co-Pis).

• Cloud-Aerosol Transport System (CATS) launch to the ISS (December 2014).
End