The Radiation Budget Instrument (RBI): Instrument Overview and Calibration Features

Ronald Glumb, Christopher Lietzke, Jay Overbeck, Merritt Webb

Harris Space and Intelligence Systems
Fort Wayne, Indiana USA
Agenda

• RBI Mission
• Key requirements for RBI Mission
• Instrument design
• On board calibration sources
• RBI predicted performance
Radiation Budget Instrument

- Collects upwelling earth radiance over a wide spectral range
  - Ultraviolet to far-infrared (100um)
  - Continuous cross-track scans
- Three spectral bands
  - Shortwave: reflected solar energy
  - Longwave: emitted earth energy
  - Total: independent check of the other two bands
  - One telescope per band simplifies detectors and operations
- Very precise calibration
  - Extensive ground calibration program sets the calibration
  - Multiple onboard targets hold calibration over mission life
RBI’s Mission: Earth’s Radiation Budget Measurement Continuity
Key Requirements Drive Calibration and Traceability to CERES

- Radiometric Uncertainty (SW, LW and Total channels)
  - Long Term Uncertainty (within 1-month) --- Repeatability
  - Relative Spectral Response by channel
    • SW: 200nm – 5 µm; LW: 5 µm – 50 µm; Total: 200nm – 100 µm
  - Point Spread Function (PSF) 95% match to CERES
  - Channel to channel registration of 98%
  - Calibration sources for SW, LW and solar calibration
Instrument Channels and Targets

- Earth Limb -62.3°
- NADIR 0° (+Z)
- Earth Limb +62.3°
- Space Look -70°
- Space Look +70°

Infrared Cal Target (ICT)
Visible Cal Target (VCT)
Solar Cal Target (SCT)
Optical Module Designed to Control Straylight and Provide Stable Thermal Environment

- Telescope Mirrors
- Filter
- Fore-Baffles
- JPL Thermopile Detector
Visible Calibration Target Provides SW and Total Calibration Standard

- The VCT provides 6 active sources
  - 375, 405, 445, 660, 915, 1470 nm
- Si and InGaAs photodiode provides quick reference of radiance
- ESR (Electrical Substitution Radiometer) provides stable absolute measurement traceable to NIST
  - Used monthly to calibration Si and InGaAs photodiode along with SW and Total channels
- Neutral density filters in filter wheel provide adjustment for flux level
- Laser diodes remotely located, fiber coupled, providing thermal stability of diodes and sphere
SCT and ICT

• ICT
  – Provides for IR calibration (LW and Total)
  – Flight heritage design from CrIS and AHI-8
  – Trap design provides >0.995 emissivity
  – Design provides the capability to raise the temperature to provide the opportunity to perform linearity measurements while on-orbit

• SCT
  – Three Spectralon® panels provide opportunities for solar or lunar calibration
    • Diffuser 1 used Bi-Weekly
    • Diffuser 2 used Quarterly
    • Diffuser 3 used Yearly
    • Cover fills opening when SCT not in use
  – Used as a cross check with legacy CERES data
  – Solar calibration target is not used to meet radiometric uncertainty requirements
**RBI 30 day Calibration Timeline**

- **ICT Linearity TOT/LW**
- **Lunar TOT/SW**
- **ICT Linearity TOT/LW**
- **Lunar TOT/LW**
- **Solar Target TOT/SW**
- **Daily VCT – NIR Laser TOT/SW**
- **Nominal Earth Scan**

- **VCT Spectral TOT/SW**
- **VCT Linearity TOT/SW**

**Day 1**
- ICT only requires 7 – 13.2 second looks during this period

**Day 8**
- Solar view takes about 10 mins

**Day 15**
- Multiple orbits necessary

**Day 22**
- VCT Linearity takes about 18 min using ESR per wavelength per channel – should be done over poles to minimize impact

**Day 28**
- Daily VCT is 13.2 sec

- VCT spectral is done after linearity – no ESR

**ICT view performed once per orbit**
Predicted Performance Demonstrates Margin on Radiometric Uncertainty Requirements

Performance margin on Radiometric Uncertainty requirements on closest approach

<table>
<thead>
<tr>
<th>Channel</th>
<th>Repeat</th>
<th>LongTerm</th>
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<tbody>
<tr>
<td>Tot</td>
<td>36.69%</td>
<td>31.20%</td>
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<tr>
<td>LW</td>
<td>16.87%</td>
<td>31.58%</td>
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<tr>
<td>SW</td>
<td>41.07%</td>
<td>156.36%</td>
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RBI Calibration Traceability

- LW Channel RSR Characterization @ SDL
- ICT Paint Sample emissivity
- PRTs Calibrated with Standard PRT cal traceable to ITS-90 Scale
- Total Channel RSR Characterization @ SDL
- Total Channel RSR Characterization @ SDL
- RBI VCT Photodetector
- RBI VCT ESR @ L-1
- NIST Reference Detector

RBI Calibration
- LW Channel
- SW Channel
- Total Channel

NIST Reference Detector
RBI Programmatic

• SRR was held Dec 2014
• PDR planned for Q1 – 2016
• CDR planned for Q1 – 2017
• Flight delivery date November 2018
• Instrument flies on JPSS-2, launch 2021

• RBI will carry on the important ERBE and CERES data records
  – PSF and spectral coverage traceable to CERES
  – RBI has an enhanced shortwave calibration source providing accurate multi-wavelength sources with a NIST-traceable reference detector

• Thanks to the NASA LaRC RBI program team

Program is on Track for Successful Delivery of RBI FM1
Summary

• RBI will carry on the important ERBE and CERES data records
  – PSF and spectral coverage traceable to CERES
• RBI includes several new calibration features
  – Stable NIST traceable IR calibration source
  – Visible calibration target (VCT) provides accurate multi-wavelength source with NIST-traceable reference detector
  – Solar calibration target provides cross check with VCT