Compatibility of field campaign experiments and RadCaTS results on ASTER vicarious calibration

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Hirokazu Yamamoto*, Jeffrey Czapla-Myers**, and Satoshi Tsuchida***

(My name is displayed as “山本浩万” (KANJI) on MS Teams.)

*1 Digital Architecture Research Center (DigiARC), AIST
*2 Wyant College of Optical Sciences, UArizona.
*3 Geological Survey of Japan (GSJ), AIST

(Contents in this material have been partially presented on IGARSS2022)
ASTER instrument

[Image of the ASTER instrument]

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Band No.</th>
<th>Spectral Range (µm)</th>
<th>Spatial Resolution, m</th>
<th>Quantization Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNIR</td>
<td>1</td>
<td>0.52-0.60</td>
<td>15</td>
<td>8 bits</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.63-0.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3N</td>
<td>0.78-0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3B</td>
<td>0.78-0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWIR</td>
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<td>1.60-1.70</td>
<td>30</td>
<td>8 bits</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.145-2.185</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>2.185-2.225</td>
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</tr>
<tr>
<td></td>
<td>7</td>
<td>2.235-2.285</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2.295-2.365</td>
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<td></td>
<td>9</td>
<td>2.360-2.430</td>
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</tr>
<tr>
<td>TIR</td>
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<td>8.125-8.475</td>
<td>90</td>
<td>12 bits</td>
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<td></td>
<td>11</td>
<td>8.475-8.825</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>8.925-9.275</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>10.25-10.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>10.95-11.65</td>
<td></td>
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</tr>
</tbody>
</table>

- ASTER is a cooperative effort between NASA, Japan's Ministry of Economy, Trade and Industry (METI), and Japan Space Systems (JSS). AIST has been involved in ASTER project from the development stage.
- ASTER is the instrument aboard the NASA's Terra satellite, which was launched on Dec. 18 1999.
- The ASTER VNIR bands are evaluated radiometrically by reflectance-based various calibration methods for more than 20 years.

[Links to ASTER instrument and Terra spacecraft information]
Vicarious Calibration for ASTER sensor

• Sites
  – Alkali Lake (US)
  – Railroad Valley (US)
  – Ivanpah Playa (US)
  – Lake Lefroy (Australia)
  – Coyote Lake (US)
  – Roach Lake (US)
  – Primm Valley (US)
AIST ASTER vicarious calibration area at Railroad Velley

ASTER imagery Captured on 8 Aug., 2021

OCO-GOSAT joint team (JPL and JAXA)
**Instruments**

ASD FieldSpec FR, 3, 4

PREDE POM02 (or CE318-T)

MicroTops-II (Model 540, 521)

Labsphere Spectralon SRT-99-100

TR-73U

https://www.monotaro.com/

Nikon CP4300
RICOH THETA m15 etc.

ASTER degradation curve (Dec, 1999 ~ Dec, 2019)

Band1 (Green)

Band2 (Red)

Band3N (NIR)

Band3B (NIR)
Article

Radiometric Degradation Curves for the ASTER VNIR Processing Using Vicarious and Lunar Calibrations

Satoshi Tsuchida 1,*, Hirokazu Yamamoto 1,1, Toru Kouyama 2,2, Kenta Obata 1,3, Fumihiro Sakuma 4, Tetsushi Tachikawa 4, Akihide Kamei 5, Kohei Arai 6, Jeffrey S. Czapla-Myers 7, Stuart F. Biggar 7 and Kurtis J. Thome 8

1 Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Central 7, Higashi 1-1-1, Tsukuba 305-8567, Japan; hirokazu.yamamoto@aist.go.jp (H.Y.); obata@ist.aichi-pu.ac.jp (K.O.)
2 Artificial Intelligence Research Center, National Institute of Advanced Industrial Science and Technology, 2-4-7 Aomi, Koto-ku, Tokyo 135-0064, Japan; t.kouyama@aist.go.jp
3 Department of Information Science and Technology, Aichi Prefectural University, 1522-3 Ibaragabasama, Nagaute, Aichi 480-1198, Japan
4 Research and Development Division, Japan Space Systems, Tokyo, 3-5-8 Shibakoen, Minato-ku, Tokyo 105-0011, Japan; fsakuma@jcom.home.ne.jp (F.S.); Tachikawa-tetsushi@jspacesystems.or.jp (T.T.)
5 National Institute for Environmental Studies, Tsukuba 305-8506, Japan; kamei.akihide@nies.go.jp
6 Saga University, Saga City 840-8502, Japan; arai@is.saga-u.ac.jp
7 Remote Sensing Group, College of Optical Sciences, University of Arizona, Tucson, Arizona, 1630 E University Blvd, Tucson, AZ 85721, USA; jscc@optics.arizona.edu (J.S.C.-M.); biggar@optics.arizona.edu (S.F.B.)
8 NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; kurtis.thome@nasa.gov

* Correspondence: s.tsuchida@aist.go.jp; Tel.: +81-29-861-3947

Remote Sens. 2020, 12, 427
AIST ASTER measurement area at Railroad Valley and Radiometric Calibration Test Site (RadCaTS)

A ground-viewing radiometer (GVR)

https://wp.optics.arizona.edu/rsg/resources/radcats/
Validation of ASTER VNIR radiometric performance using the reflectance-based vicarious calibration experiments and RadCaTS data (2013(2014) - 2021)

RadCaTS data are available from March 2013 to present, and ASTER ViCal experiments has not been conducted after 2020 due to the impact of COVID-19, so RadCaTS and ASTER ViCal data obtained from 2014 to 2019 are used in this research (There are no ASTER ViCal data in 2013).
Result 2

Table. ASTER acquisition date, time, and VNIR pointing angle [deg] at the time of RadCaTS and AIST ViCal simultaneous measurements.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (UTC)</th>
<th>VNIR pointing Angle [deg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 6, 2014</td>
<td>18:39:04</td>
<td>-0.019</td>
</tr>
<tr>
<td>Jun 26, 2017</td>
<td>18:38:41</td>
<td>-0.019</td>
</tr>
<tr>
<td>Jul 28, 2017</td>
<td>18:38:55</td>
<td>+0.019</td>
</tr>
<tr>
<td>May 3, 2018</td>
<td>18:45:42</td>
<td>+8.586</td>
</tr>
<tr>
<td>Jul 15, 2018</td>
<td>18:40:06</td>
<td>-0.017</td>
</tr>
<tr>
<td>Aug 19, 2019</td>
<td>18:38:28</td>
<td>-0.019</td>
</tr>
</tbody>
</table>

Fig. A summary of the ASTER ViCal and RadCaTS simultaneous measurement results

Table. Mean and standard deviation results of ASTER TOA spectral radiance ratio

<table>
<thead>
<tr>
<th></th>
<th>ViCal (Mean)</th>
<th>ViCal (Standard Deviation)</th>
<th>RadCaTS (Mean)</th>
<th>RadCaTS (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band1</td>
<td>1.03</td>
<td>0.02</td>
<td>1.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Band2</td>
<td>1.01</td>
<td>0.02</td>
<td>1.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Band3N</td>
<td>1.01</td>
<td>0.03</td>
<td>1.05</td>
<td>0.01</td>
</tr>
</tbody>
</table>

RadCalNet RVUS data results agree with our vicarious calibration results.
Conclusion

- The latest ASTER L1T radiometric performance was evaluated using ASTER ViCal and RadCaTS data.
- The results derived from RadCaTS data are mostly agree with ASTER ViCal experiments conducted for the period 2014 to 2019.
- ViCal results are closer to ASTER L1T TOA radiance processed by the latest radiometric DB Ver5 than RadCaTS results.
- This results make sense because the latest radiometric DB reflects AIST ViCal results.
- Evaluation of current ASTER radiometric DB (ver5) shows that ASTER Band1, Band2, and Band3N percent difference are within 5%.
- The results of this research indicate that RadCaTS data can be used instead of ASTER vicarious calibration experiments.