RadCalNet

Radiometric Calibration Network of Automated Instruments

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Outline

• Motivation: why a network rather than independent instrumented sites for radiometric calibration?
• Context and objectives
• Who is involved in establishing RadCalNet?
• The shared vision of RadCalNet
• What are the RadCalNet building blocks
• Summary and future work
Why RadCalNet (formerly Landnet) ?

Why a new network of instrumented sites dedicated to the radiometric calibration of EO optical sensors?

- To collect surface and atmospheric data necessary to calibrate EO sensors
- To increase the number of matchups between *in situ* measurements and space sensor observations
- To ensure Système International (SI) traceability
- To support the establishment of the Global Earth Observation System of Systems
  - Provide ground-based measurements
  - Verify the radiometric consistency between EO space sensors

Landsat 8 OLI results from Railroad Valley for first 2 years

Illustrates additional data from automated collections, need for more data, lessons learned regarding instrument requirements, and site conditions
QA4EO established at the request of GEO

- **Key principle:** “all Earth observing (EO) data and derived products should have associated with them a quality indicator based on a documented quantitative assessment of its traceability to internationally-agreed-upon reference standards (e.g. SI units)”

- **Accuracy of EO instruments and data products:** critical for study of global environmental issues

- **Calibration and characterization of EO instruments:** vital to develop integrated GEOSS for coordinated Earth observations

- **Intercalibration between instruments:** has become central in cal/val strategies of national and international organizations

- **Proper traceability:** enables interoperability of data from EO systems
RadCalNet has been on the CEOS WGCV IVOS WG agenda for years

Inherits from earlier concepts such as GIANTS (Phil Teillet’s approach to site characterization)

2013: CEOS/IVOS WG decides that sufficient resources are available to produce momentum. It was agreed to set up RadCalNet WG.

13–14 Jan 2014: first RadCalNet meeting at ESTEC
RadCalNet objectives and members

**Objectives:**
- Define the detailed architecture of RadCalNet
- Demonstrate RadCalNet operational concept with currently-available infrastructure and resources
- Provide recommendations to CEOS/WGCV/IVOS and CEOS/WGCV for evolution of RadCalNet towards an operational network

**RadCalNet WG members:**
- Academy of Opto-Electronics (C. Li, L. Ma, L. Tang)
- Centre National d’Etudes Spatiales (P. Henry, A. Meygret)
- European Space Agency (M. Bouvet, P. Goryl)
- National Aeronautics Space Administration (K. Thome)
- University of Arizona (J. Czapla-Myers)
- National Physical Laboratory (N. Fox, E. Woolliams)
The shared vision of RadCalNet

L0: raw instrument data
L1: instrument data in physical unit
L2: surface or atmosphere parameters retrieved from L1
RadCalNet building blocks

• **Currently:** 3 instrumented sites
  - Baotou (China)
  - La Crau (France)
  - Railroad Valley (USA)

• CNES has defined a methodology for the identification of the best locations for RadCalNet sites on a global scale
Current RadCalNet sites with instrumentation

- Lat, lon, (elevation)          WRS-2 path/row
- Railroad Valley: 38.497°, -115.690°, (1435 m)  40/33
- La Crau: 43.559°, 4.864°, (18 m)  196/30
- Baotou: 40.852°, 109.629°, (1307 m)  127/32
Instrumentation example: Railroad Valley

- Radiometric Calibration Test Site (RadCaTS)
- Surface reflectance
  - 4 ground-viewing radiometers (GVRs)
  - 8-channel multispectral instrument
  - Temperature controlled
  - Full laboratory calibration

Atmosphere
- AERONET Cimel
- Meteorological station

GVR channels
Example of results: Landsat 8 and RadCaTS

- Period: Mar 2013 – Mar 2015 (~2 years on orbit)
- Railroad Valley

**TOA Spectral Radiance**

**TOA Reflectance**
Other examples of RadCaTS results

- MODIS and VIIRS: automated RadCaTS (2012–2014)
  - Terra MODIS
  - Aqua MODIS
  - SNPP VIIRS

TOA Spectral Radiance Comparison

 MODIS land bands (1–7)
Other examples of RadCaTS results

- MODIS, VIIRS and Landsat 8 OLI surface reflectance validation: automated RadCaTS (2012–2014)

**Surface Reflectance Comparison**

![Graphs showing surface reflectance comparison between different sensors.]
What are the RadCalNet building blocks?

• **ESA issued an ITT (now closed) to:**
  • Identify, characterize, and equip a 4\textsuperscript{th} site that is operated jointly by ESA and CNES
  • Define protocols for RadCalNet in situ data quality control (QC) and harmonization
  • Collect, QC, and harmonize all data coming from RadCalNet sites
  • Demonstrate the operation of RadCalNet

• **NASA:** process all data to TOA reflectance in 30-min intervals for a nadir view (9:00–15:00 local time)

• **NPL:** provide support across RadCalNet sites
  • Harmonization
  • Traceability of measurement protocol
  • Instrument calibration
Development of 4th RadCalNet site

- Global study of potential locations (Chile, Australia, Namibia on short list)
- 4th site has been chosen to be Gobabeb, Namibia
  - Karlsruhe Institute of Technology research centre
  - Site being set up by NPL, CNES, and Magellium on behalf of ESA/CNES
  - Instrumentation will be similar to La Crau site: Cimel with extra ground channels, rotation to measure BRDF
- Gobabeb site will be characterized during field campaign led by CNES, and involving NPL personnel
  - Field equipment (ASDs, Spectralon panels, Cimel) have been characterized at NPL
  - Field campaign (Oct–Nov 2015) after Sentinel-2A commissioning phase
Gobabeb site

- Following field campaign, Cimel will be installed on a permanent tower
- Magellium responsible for data transfer
- CNES will process data (same as La Crau)
- NPL has operational responsibility
- Planned to be operational by end of 2015
RadCalNet after inclusion of 4th site

- Lat, lon, (elevation)
  - Railroad Valley: 38.497°, −115.690°, (1435 m)
  - La Crau: 43.559°, 4.864°, (18 m)
  - Gobabeb: −23.501°, 15.095°, (470 m)
  - Baotou: 40.852°, 109.629°, (1307 m)

- WRS-2 (path/row)
  - 40/33
  - 196/30
  - 179/76
  - 127/32
Instrument characterization for Gobabeb campaign

Cimel sun photometer and ASD spectroradiometer:
- Stability
- Temperature sensitivity
- Absolute calibration
- Spectral response, wavelength check
- FOV, solid angle check

GRASS
Construction tests:
- positioning stability
- pointing accuracy
Stability of optical components:
- spectrometer
- reference source

BRDF calibration of reference reflectance targets
Instruments used for in situ measurements at Gobabeb

Ground reflectance at nadir view

BRDF

BRDF and atmosphere
• Development of new GVRs (GVR 25 and 26)
• Wireless link installed in 2015
• Analysis of diffuse irradiance retrieval
• Automated processing interface with NASA
• RadCaTS will continue to be used to cal/val:
  • Landsat 8 OLI and Landsat 7 ETM+
  • Terra and Aqua MODIS, MISR, and ASTER
  • RapidEye
  • SNPP VIIRS
  • Sentinel-2A
  • WorldView-3
• Continued participation in RadCalNet
RadCalNet summary

• In the context of GEOSS/GEO and within the QA4EO framework, CEOS WGCV IVOS is developing a concept for global calibration traceable to SI
  • RadCalNet is a key element of this concept
  • It will provide a network of instrumented sites for cal/val of sensors
• Working group created under the auspice of CEOS WGCV IVOS
• A period of prototyping will demonstrate the feasibility of the concept
• Four sites have been chosen (China, France, Namibia, USA)
• Following the prototyping period, RadCalNet will be an operational network for calibration, intercalibration, and validation for the benefit of GEOSS (interoperability)
• Group is working on the data circulation, processing, and web portal
Thanks!

- Questions?