An Overview of The May 2018 Railroad Valley (RRV) Field Campaign

Dave Case/NGA
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David.W.Case@nga.mil
(571) 557-5855
Brief’s Outline

• Campaign Site - Railroad Valley (RRV) Playa – Un. of Arizona Radiometric Calibration Test Site (RadCaTS)
  – RadCaTS/ is part of Radiometric Calibration Network (RadCalNet)
  – Overview of both RadCaTS and RadCalNet
• Campaign Goals
  – Evaluate the bidirectional reflectance distribution function (BRDF) of RRV Site
  – Evaluate a common reference material
  – Determine the radiometric uncertainties of RRV
  – Intercompare the top of atmosphere (TOA) satellite sensor calibration for various NASA, USGS and commercial sensors
• NGA’s Participation
• Summary
RadCATS and RadCalNet
Railroad Valley Playa, Nevada – Un. of Arizona Radiometric Calibration Test Site (RadCaTS)

**RRV Playa:**
- Located in north-central NV
- BLM manages the Playa, and several groups have permission to use a small area for radiometric calibration investigations
- Part of the Radiometric Calibration Network (RadCalNet)

**Playa is a suitable Calibration Site:**
- **High surface reflectance** (BRF > 0.3 reduces path radiance effects)
- **Spatially uniform** (minimizes misregistration)
- **Spectrally flat** (reduces uncertainty in cross calibration)
- **Fairly high altitude** (reduces uncertainty due to aerosols)
- **Large size** (reduces adjacency effects)
- **Arid region** (less clouds/rain)

Source: ASTER Science Team

Approved for public release, 18-917
RRV PLAYA and the Layout of RadCaTS

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Instruments of the RRV Site

2011: 8 channel Si & InGaAs detectors
2016: Wi-Fi and satellite uplink

Ground-viewing radiometer (GVR)
Cimel CE318 solar lunar photometer
Meteorological station
Satellite uplink, base station

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Routine RadCaTS Measurements Done Daily and Used to Supply Data to RadCalNet

• GVRs make point measurements every 2 min throughout day
• Cimel makes measurements based on AERONET protocol
• Data uploaded daily to Univ. of Arizona
• Multispectral BRF data converted to hyperspectral using library of data collected from 2000–2016 (~700 data sets)
• Spectral and temporal subset is supplied to RadCalNet
RadCaTS is One of the CEOS WGCV RadCalNet Sites

- RadCalNet is operational as of July 2018 (www.radcalnet.org)
- Currently four global sites
- RadCaTS bottom of atmosphere (BOA) data uploaded daily to NASA GSFC for further processing
RadCalNet Approach

- RadCalNet: Multiple automated in-situ measurement sites operated independently using same methodology and processing chain with known and documented uncertainties
  - Product provided to users:
    - TOA reflectance
    - 400-2500 nm (10 nm spectral sampling)
    - Defined for 50 m spatial area
    - Nadir view
    - 13 times per day: 9:00-15:00 local every 30 min
- CEOS Working Group on Calibration and Validation (CWCV) is managing this network from member’s agencies
Major Field Campaign Measurements
Surface BRDF Measurements

- Satellite Sensor data has shown there is a noticeable BRDF aspect to the Playa (see back up slide of MODIS data)
- For this field campaign, two instruments were used to measure the BRDF measurements
  - A goniometer developed by a researcher from the University of Lethbridge, Canada (ULGS)
  - NASA Jet Propulsion Laboratory’s (JPL) PARABOLA Instrument
Characterization of Tarp Material/Reference Panels – Attempting to Understand the Uncertainty of Arizona RadCaTS Daily Measurements

• Spectrometer measurements made of reference tarp sample (48% reflectance) using multiple spectrometers
• Measurements were done with up to six different radiometers/reference panels at different times during a single day
• One panel served as overall reference as did a very high reflectance panel (BaSO4 panel)
Gray Tarp Comparison

- Goal: Tarp sample measurements will isolate differences caused by the instruments or the reference
  - Effects from changing solar irradiance are limited because of short time between references and the gray sample
  - Short time between groups limits the BRDF effects of the sample
  - Limiting reflectance collection to a small sample area leads to teams measuring the same area
- Tarp is being evaluated as a traveling standard that would allow intercomparisons without the need for groups to gather in a single location
- One round of collections had all groups using the same reference standard
Barium Sulfate Panel Measurements

- Barium sulfate (BaSO$_4$) panel has a reflectance similar to those of the reference standard.
- Using the BaSO$_4$ panel reduces instrument effects such as those caused by non-linearity, lower SNR at lower reflectance, etc.
- Both BaSO$_4$ and gray tarp retrievals can be compared to laboratory-based predictions of reflectance allowing a check on the absolute uncertainty.
80 Meter (m) Transect Measurements

- **Goal:** Attempt to evaluate how much spatial sampling and collection methods affect retrieval of reflectance

- Transect approach limited the area that the groups were using to characterize (used a linear path approximately 80m in length)

- Equipment configuration, choice of reference, and sampling method for the 80m path was up to each group
  - Several groups walked while sampling the surface-leaving radiance
  - Others operated instruments in a stationary manner at several pre-determined spots along the path

- Should reduces differences caused by spatial heterogeneity of RRV
NGA’s Participation in the Field Campaign

- US government agencies and the international remote sensing community (e.g., NASA and CEOS) have extensive knowledge/experience in assessing radiometric calibration of EO Sensors
  - NGA is benefitting by learning the various techniques employed by these groups
  - Allows NGA scientists to understand the quality of the RadCaTS and RadCalNet Data
- NGA employs a variety of GEOINT sources to address its mission areas
  - It needs to be able to assess imagery quality of the various source material for non-literal exploitation
Summary

• A successful field campaign was done at the RRV Playa in May 2018
  - Extensive in situ spectral data was collected as well various satellite sensor data
  - This data should advance the knowledge about the uncertainty of the RadCalNet data publicly available
  - The field campaign lead believes results should be available in the first quarter of 2019
Back Up Material
RadCalNet Input Data

- **Surface Reflectance**
  - 30 minute intervals
  - 9 am to 3 pm local standard time
  - Nadir view
  - 10 nm intervals from 400 nm to 2500 nm

- **Atmospheric Data**
  - Pressure
  - Temp
  - Aerosol
  - Water Vapor
  - Ozone

- **Uncertainty**
  - Provided by site operators and evaluated by RadCalNet WG
RadCalNet Output Data

- **TOA Reflectance**
  - 30 minute intervals
  - 9 am to 3 pm local standard time
  - Nadir view
  - 10 nm intervals from 400 nm to 2500 nm

- **Uncertainty Information**
  - Will be available with the individual data points by 1st quarter of 2019
MODIS Data Showing a Potential BRDF Effect of the RRV Playa