



DigitalGlobe

# Results from DigitalGlobe's participation in the Inter-Agency Campaign at Railroad Valley in May 2018

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Joint Agency Commercial Imagery Evaluation  
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# Railroad Valley (RVUS) Importance to DigitalGlobe



- Railroad Valley Playa is in south-central Nevada
  - ~ 1.5 hour drive from the town of Ely, NV
  - ~ 4-5 hour drive from Las Vegas, NV (e.g. middle of nowhere)
- Is a well known absolute radiometric calibration site
- Readily available data:
  - RadCalNet (Radiometric Calibration Network) Site – almost daily nadir surface reflectance available
  - AERONET Site – almost daily atmospheric measurements of ASD, SSA and asymmetry parameter
  - University of Arizona and JPL have on-site laboratory equipment – folks with eyes on the site several times per year
- What makes Railroad Valley a good calibration site?
  - Desert climate – low aerosol loading
  - Relatively high altitude (less atmosphere to measure and model)
  - Relatively large (averaging over lots of pixels can occur)
  - Homogeneous
  - Relatively bright target



- Sharing methodologies
- Inter-comparison of measurement methodologies and cross-calibration of sensors
  - Sensors: Landsat 8, Sentinel 2B, Sentinel 2A, ASTER, S-NPP and Terra, WorldView-4, WorldView-3; WorldView-2, and GeoEye-1
  - Agencies present: DigitalGlobe, AIST (Japan ASTER team), NASA/GSFC, NASA/JPL, NGA, Univ. Arizona, and Univ. Lethbridge (Canada)



# Railroad Valley Campaign Goals for DG



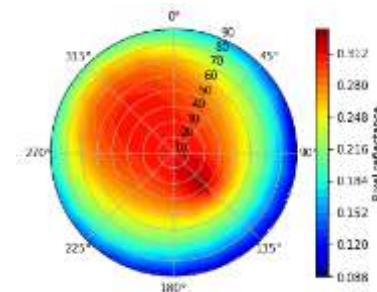
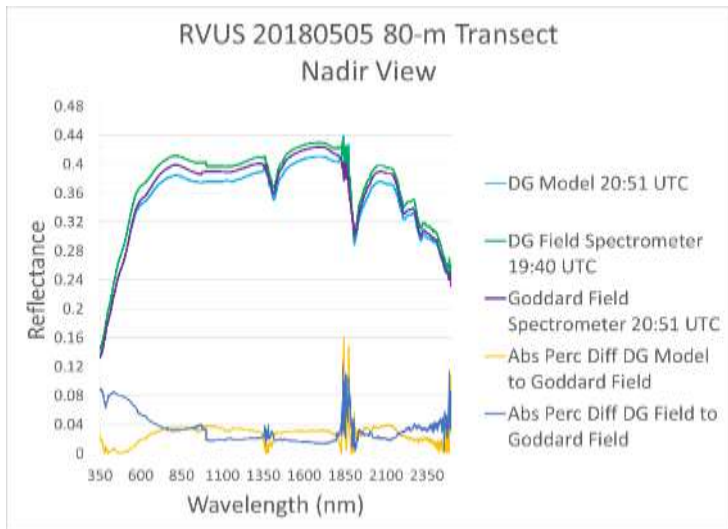
- Build a model of Railroad Valley surface reflectance using on-site measurements
- Compare our vicarious results to on-site RadCalNet results, and understand the uncertainties of higher off-nadir collects
- Compare our surface reflectance measurements and TOA radiance/reflectance calculations via ongoing collaborations with other agencies
- Scout additional nearby sites: Lunar Lake and Black Rock Lava flow are natural white and black tarps



# Field Measurements and BRDF Model Results



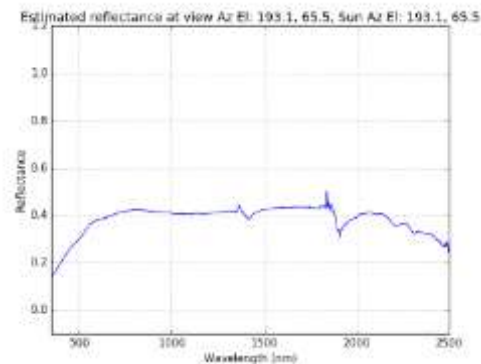
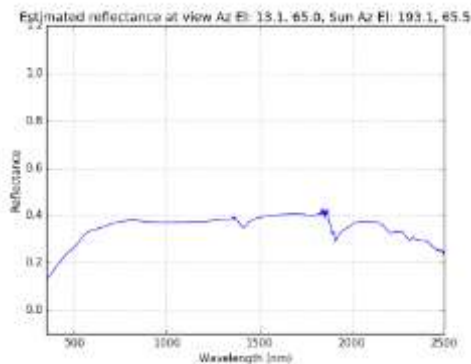
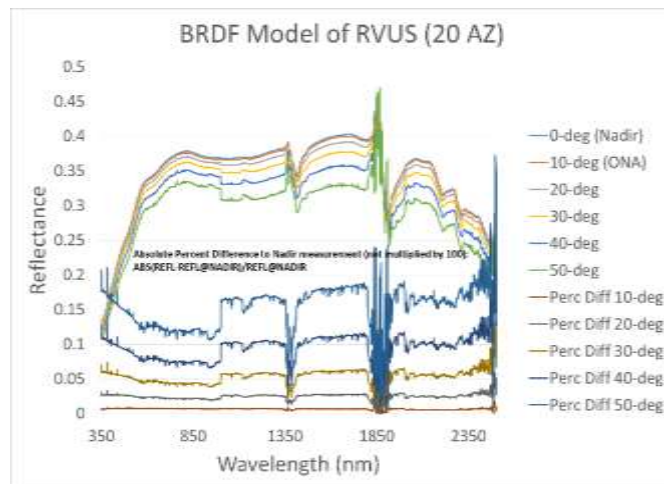
- Comparison of data collected over an 80-m transect on-site
- 4% difference btw Goddard Field Spectrometer measurements and DG BRDF Model of RVUS @ nadir
- Same for Goddard Field to DG Field excepting for blues - DG field at different time than others, so could be effect of different solar angles and/or all the clouds. Maybe we didn't get back to reference panel enough for that measurement!
- Also our notes say “super sketchy cloud in front of sun” for our 80-m transect walk.



Output of our surface reflectance model of Railroad Valley at 550 nm (Sun @ 137 AZ, 61 EL). *Empirical Bi-directional Reflectance Distribution Function Model for Absolute Radiometric Calibration Sites*, given by T. Ochoa on Wednesday.

# Results change with view angle

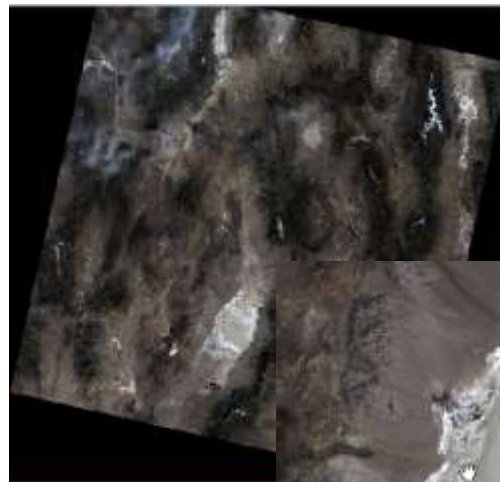
- Surface reflectance decreases with off-nadir angle
- ONA < 25-deg within 5% of a nadir measurement
- Azimuthal differences exist as well due to hot spots and other non-homogeneities
- This is important because our sensors look at all the angles



# Calibrating Satellites During the Campaign

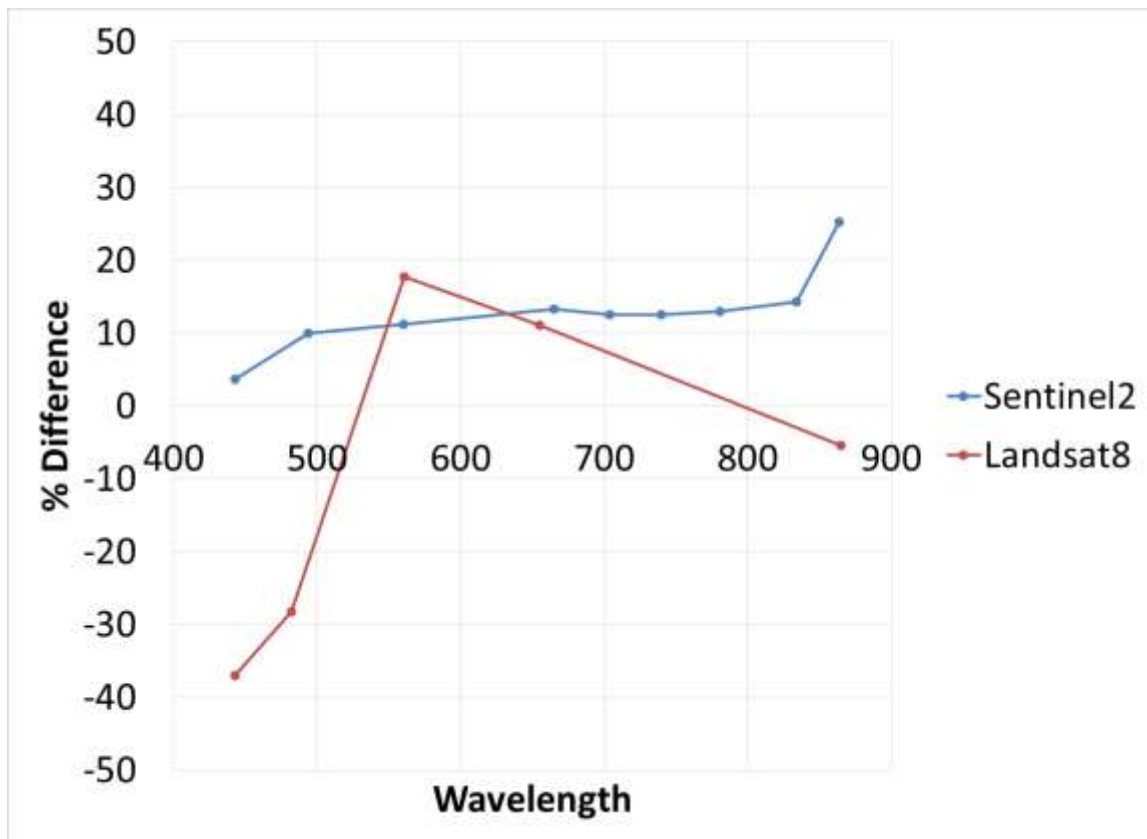


- Same methodology that we use for our calibration tarps in Longmont, CO, USA:
- Take ASD data of surface at the angles the satellite will be at for overpass
- We also took an entire set of angles at sampled azimuths and elevations for our BRDF model
- Get atmospheric data from weather station (temperature and pressure) and AERONET (AOD, column water vapor, SSA and asymmetry parameter)
- Run inputs through MODTRAN to model TOA Radiance
- Compare to Sensor TOA Radiance



Landsat 8 R-G-B image of Railroad Valley on May 4, 2018

# Initial DG-MODTRAN TOA Radiance Comparison to Sentinel 2B and Landsat 8 on May 4, 2018



Surface reflectance measurements taken on 5/4/2018 under lots of cirrus clouds.



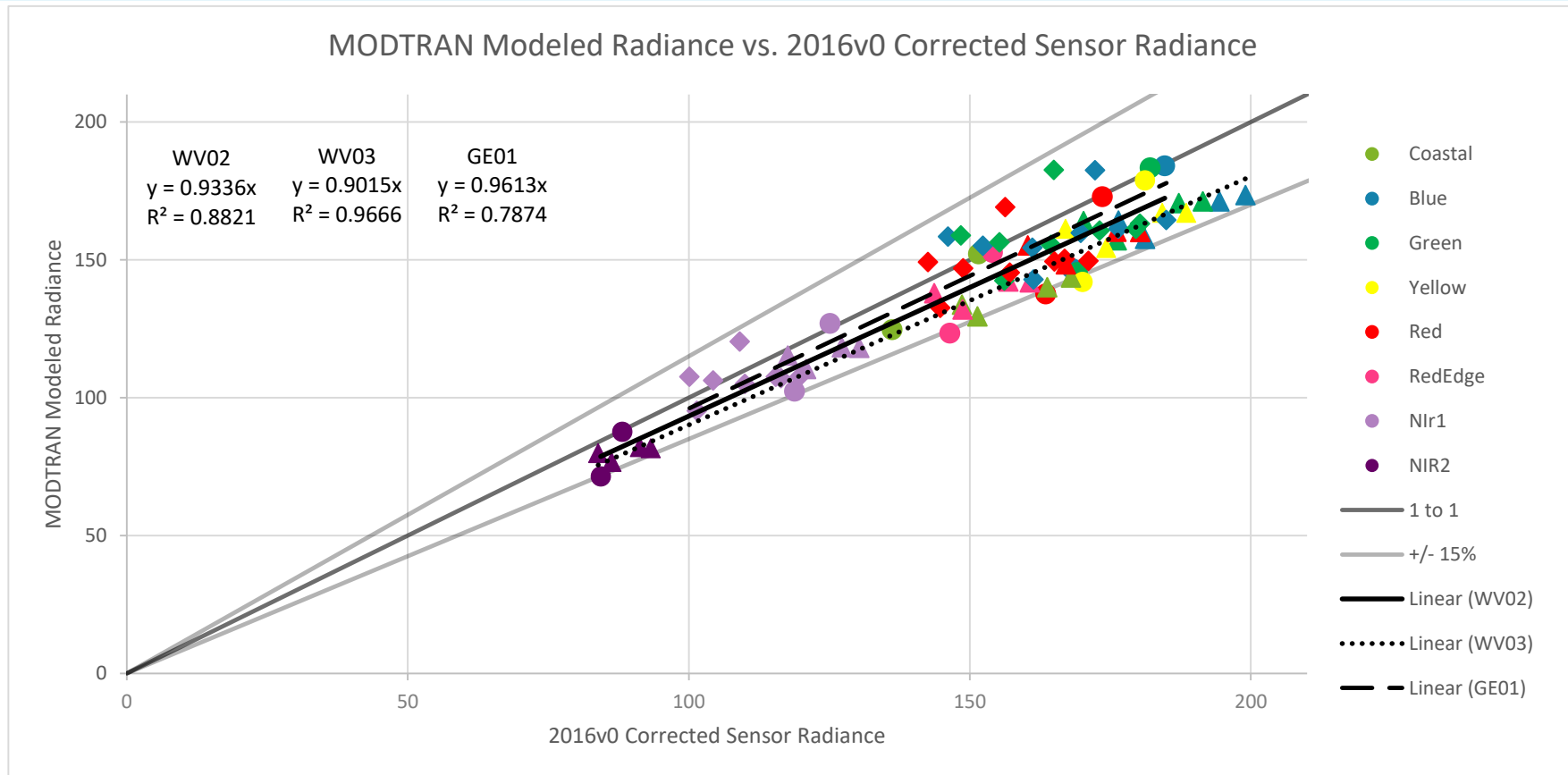
# Images collected by DigitalGlobe



- WorldView-2, WorldView-3, and GeoEye-1 images collected on May 5, 2018
- A good collection of varying view angles
- Weather was not ideal this campaign - partial clouds over site for all images collected
- Very thick cirrus clouds on this day, so we used BRDF model developed from measurements used on May 4, 2018

DigitalGlobe Collects on May 5, 2018					
Sensor	meanSunAz	meanSunEl	meanSatAz	meanSatEl	ONA
WV02	143.3	64.1	113.8	69	21
WV03	155.4	66.4	184.1	82.4	7.6
WV03	155	66.3	16.2	70.8	19.2
WV03	155.2	66.4	20.8	81.6	8.4
WV03	155.6	66.4	190	68.5	21.5
GE01	139.4	63	47.1	59	31
GE01	139.9	63.1	130.9	68.4	21.6
GE01	139.7	63.1	94.3	70.8	19.2

# Initial Look at DG TOA Radiances – Current 2016v0 calibration vs MODTRAN pushed by in-situ measurements



# A Cloudy Campaign

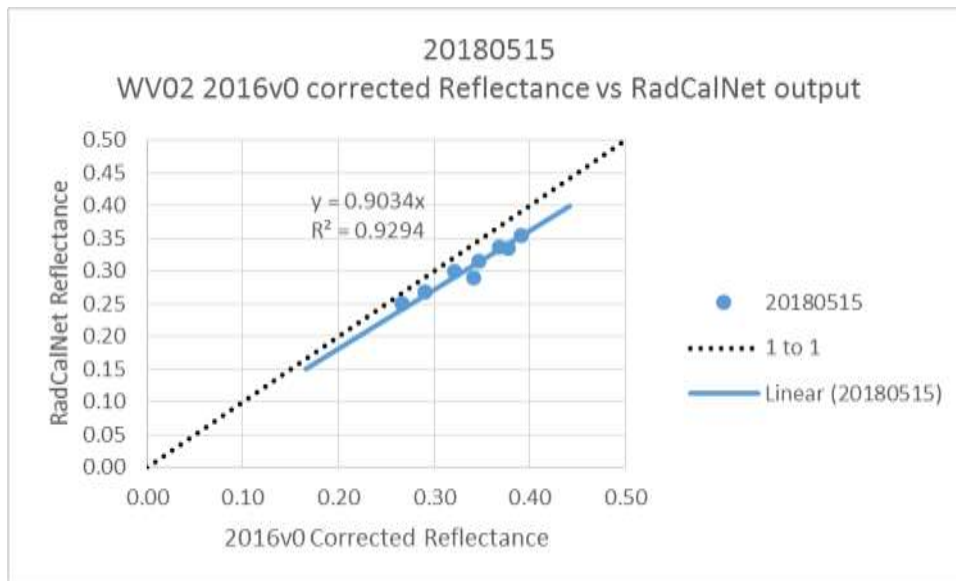


WorldView-2 image on May 5, 2018 shows clouds and their shadows partially covering the calibration site

# Comparisons to RadCalNet



- Closest date of available RadCalNet data to May 5<sup>th</sup> DG sensor collects is May 15
- Used modeled surface reflectance and AERONET to calculate TOA Reflectance
- ONA = 21°



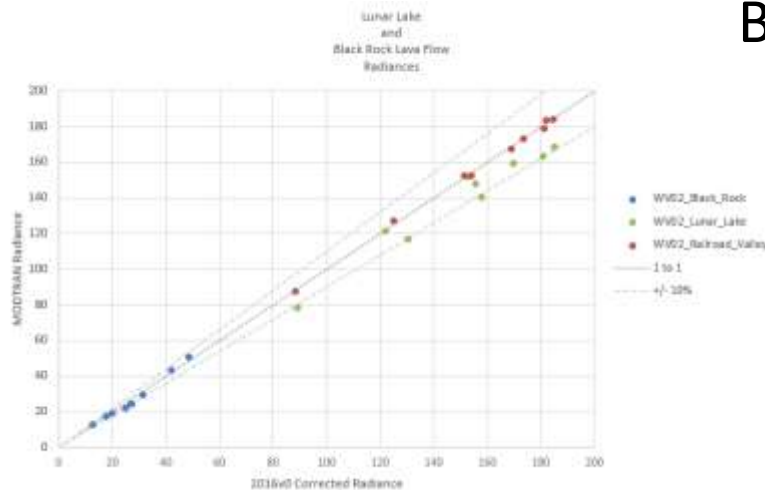
# A Natural Version of our White and Black Tarps



## Lunar Lake Playa



## Black Rock Lava Flow



- Lots of cirrus clouds
- Initial surface reflectance sampling at nadir only and not over a very large area
- Still results are promising at +/- 10%

# We got a lot out of this campaign (even if the weather wasn't the best)



- Involvement in the remote sensing calibration arena brings validation to our methodologies and the radiometric accuracy of our sensors
- Onsite science discussions and inter-agency sharing of methodologies helps the absolute radiometric calibration community and the science to grow
- A greater understanding of a major secondary site through ground reflectance measurements and on-site observations
- Ready for next year!



# Questions?





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