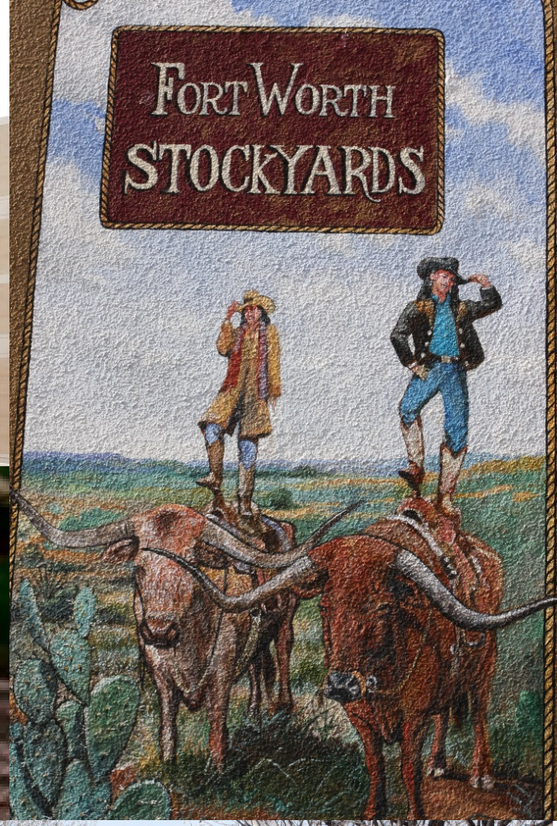

HOME OF THE 12TH MAN


FORT WORTH
STOCKYARDS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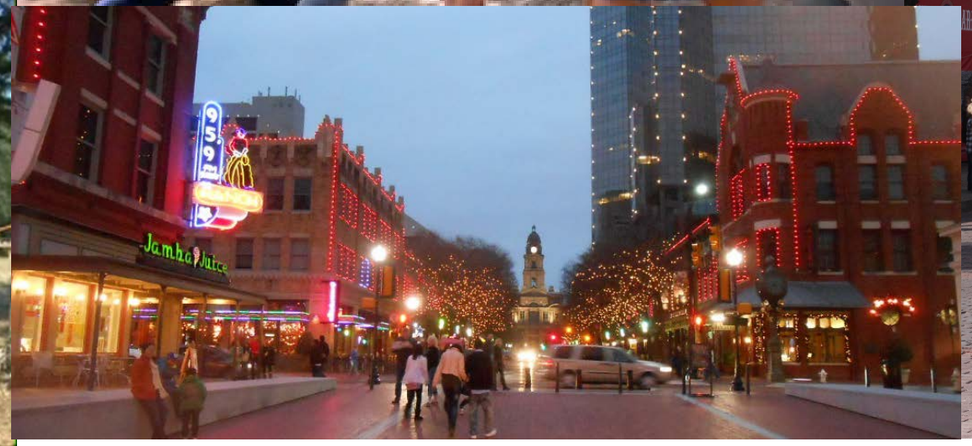
Jamba Juice


STOCKYARDS STATIO
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Importance of Calibration/Validation Traceability for Multi-sensor Imaging Spectrometry Applications

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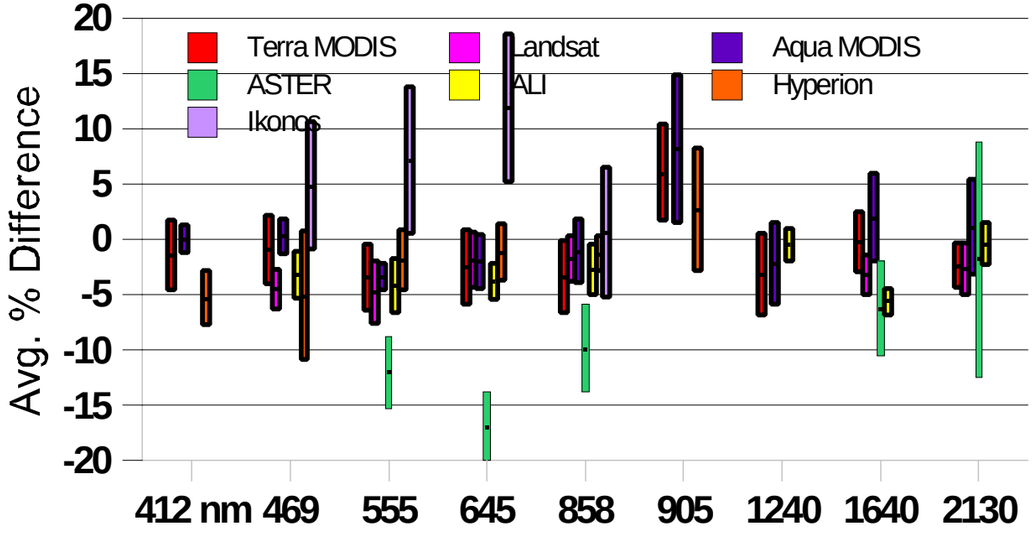
NASA Goddard Space Flight Center

Continue the push for SI-traceable, high accuracy data

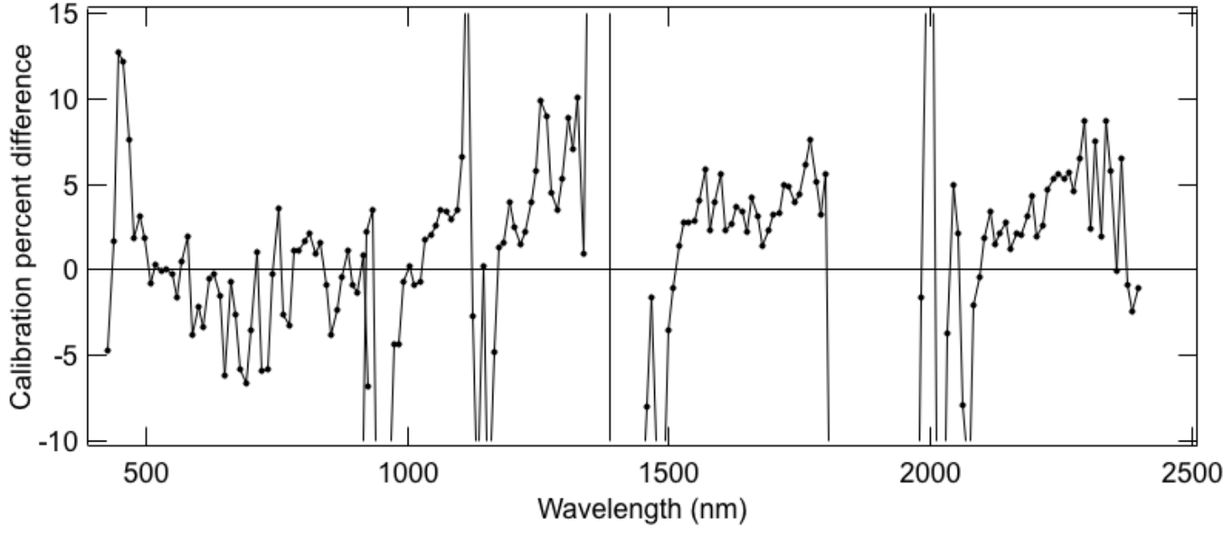
Especially important to maximize results from future imaging spectroscopy missions

- Current inter-consistency methods are not well suited for imaging spectroscopy's orbits and narrow swaths
- Interchangeable data sets from multiple sensors will require improved traceability and error budgets
- Need to ensure that techniques to reduce sensor radiometric uncertainty are applicable to field and airborne systems

How best to ensure compatibility of data sets?

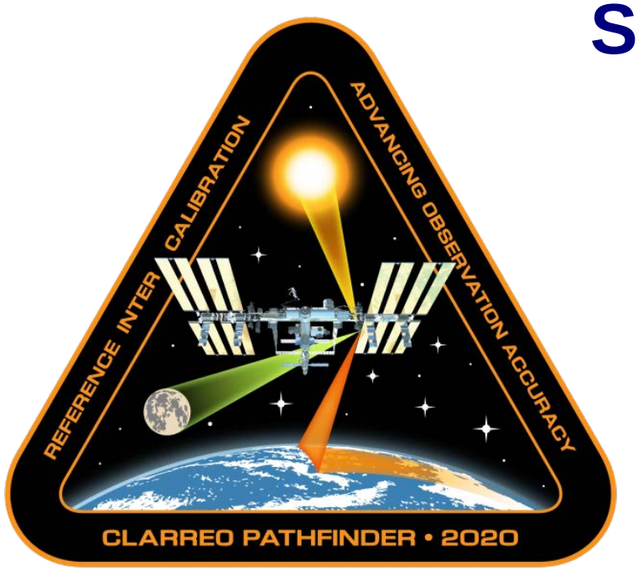


Correcting band-to-band differences will be more critical

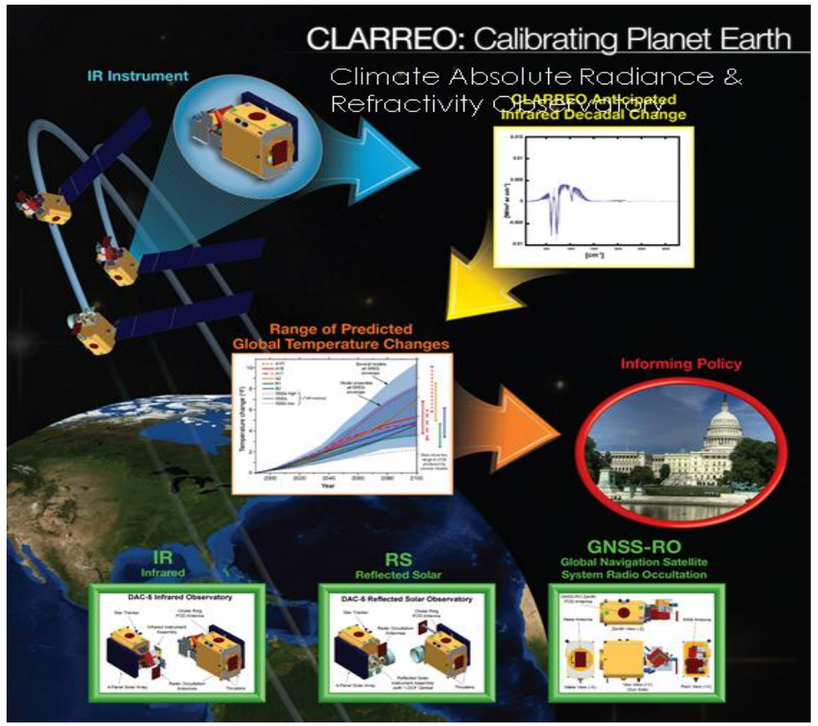


Use CLARREO Pathfinder work to illustrate benefits of traceability

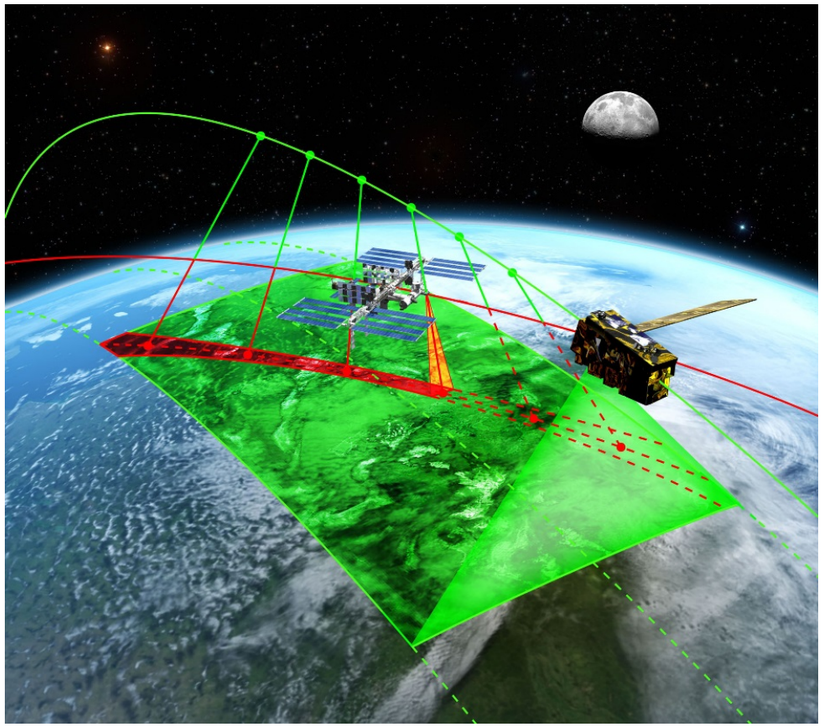
- CLARREO Pathfinder is a directed mission through the NASA Science Mission Directorate – Earth Science Division
- Targeted for launch in late CY2020 – early CY2021 to International Space Station for one-year mission



Demonstrate high accuracy SI-Traceable Calibration

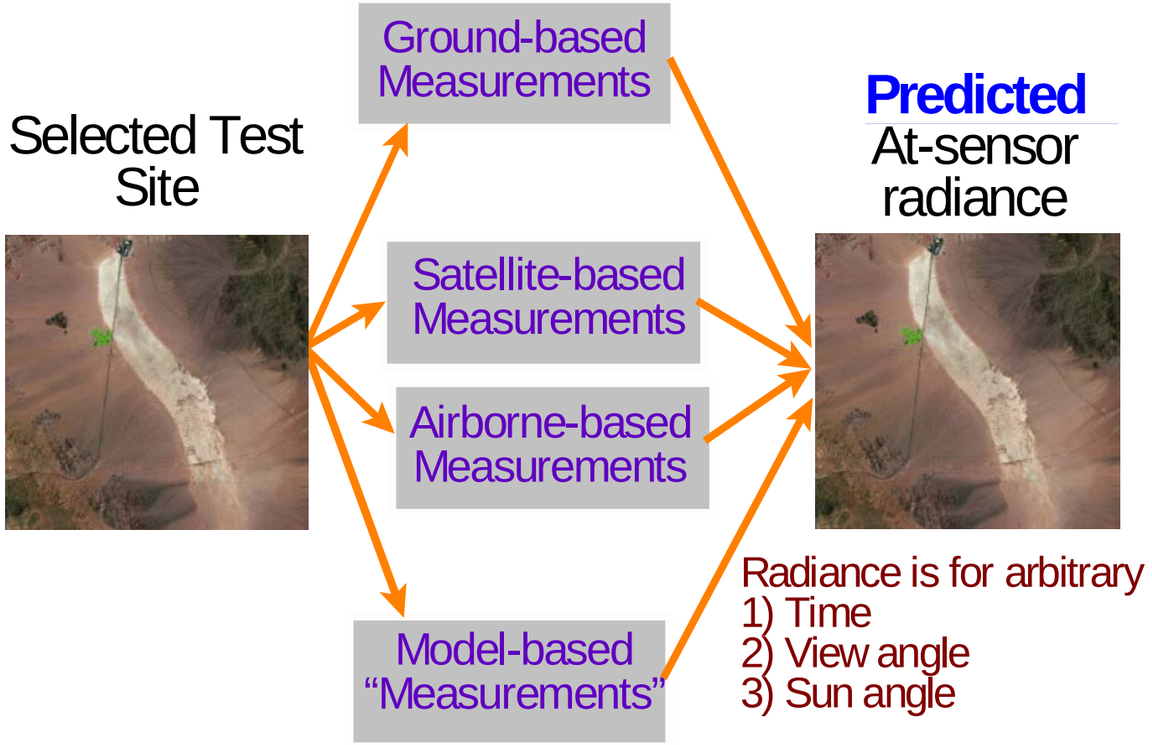


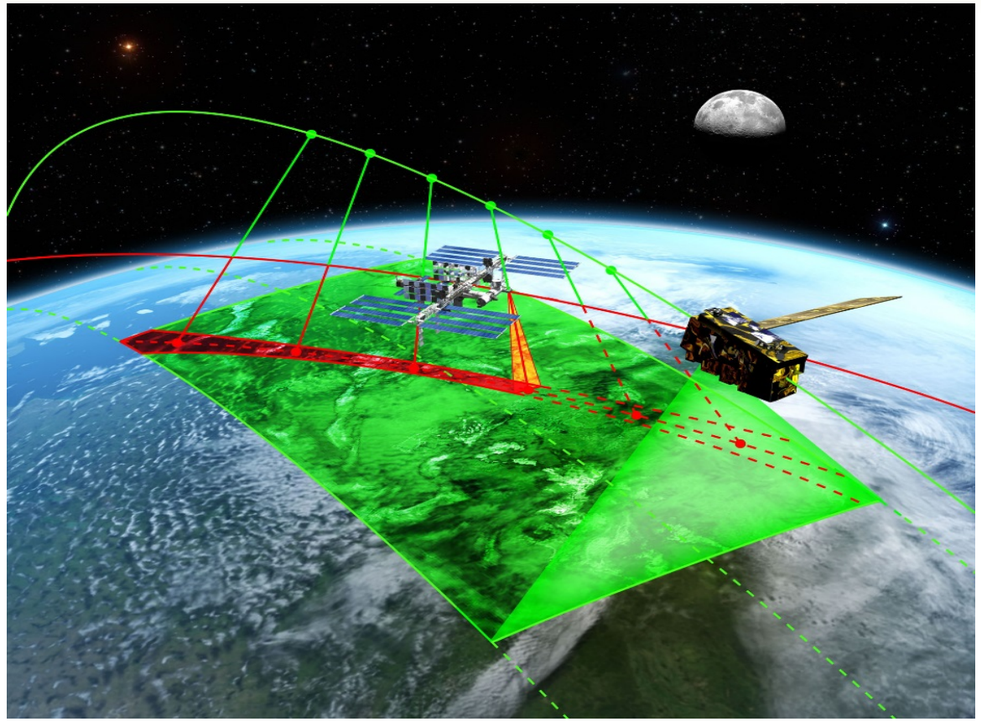
Demonstrate Inter-Calibration



Site characterization a part of CPF interconsistency

- CPF will concentrate on CERES and VIIRS
  - Demonstrate view and temporal matching
  - Show importance of imaging spectrometry
  - Use a full range of scene types





- Lunar views will improve knowledge of moon's calibration
- CPF will be tasked regularly to view a range of vicarious calibration sites
  - Characterize sites used by other sensors besides VIIRS and CERES
  - Simplifies tasking of CPF

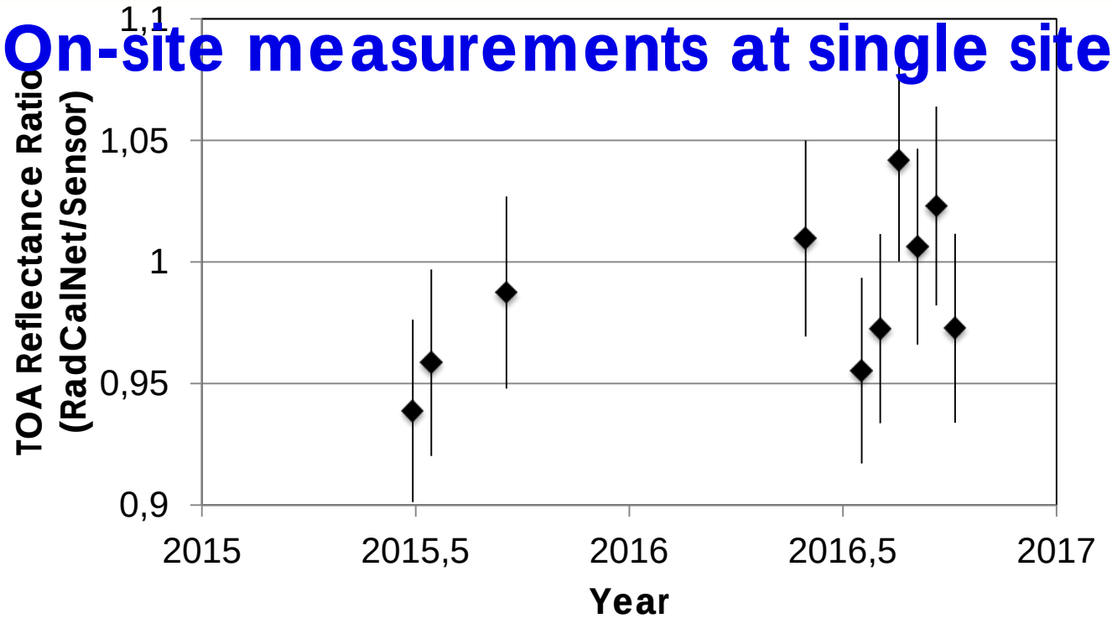
Why is CPF (or something similar) needed?

Results from desert sites show variability not explained by known uncertainties

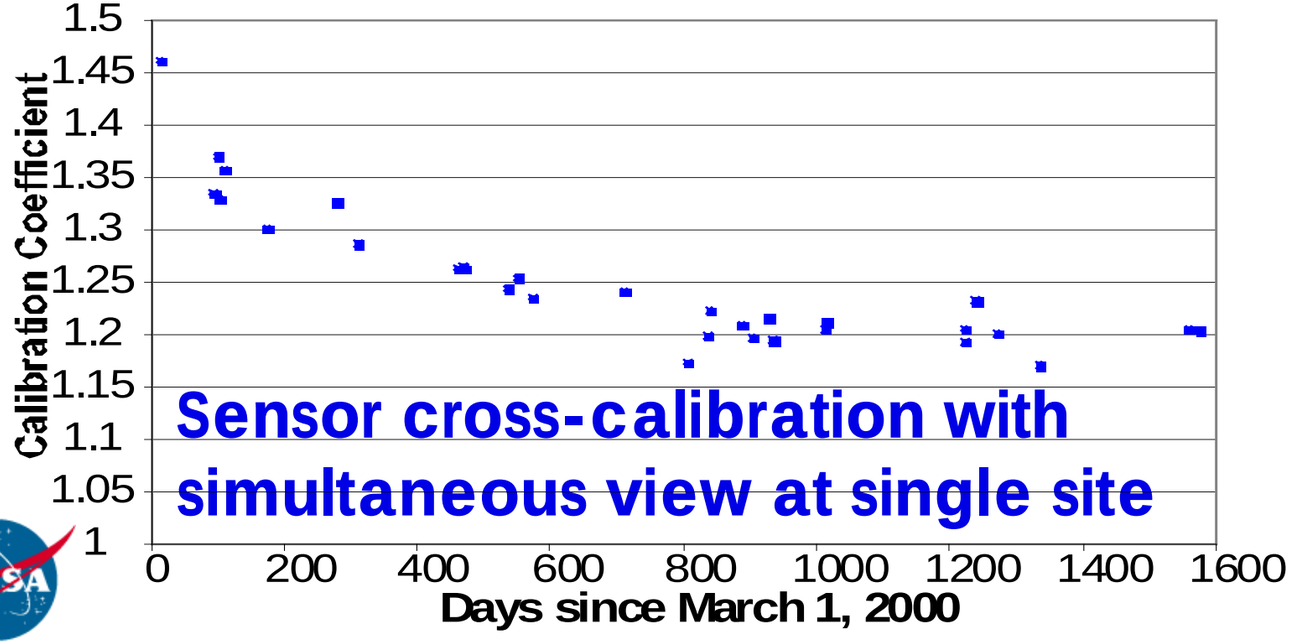
No singular cause for outlier data sets has been found

Either many small error sources, correlated errors, or unknown errors

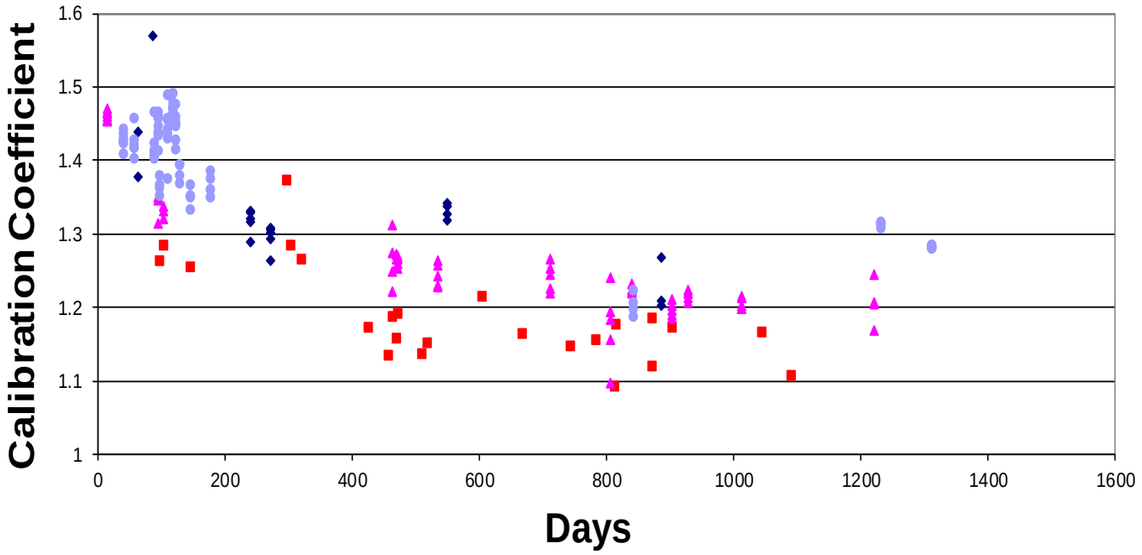
On-site measurements at single site



Multiple sites, simultaneous views

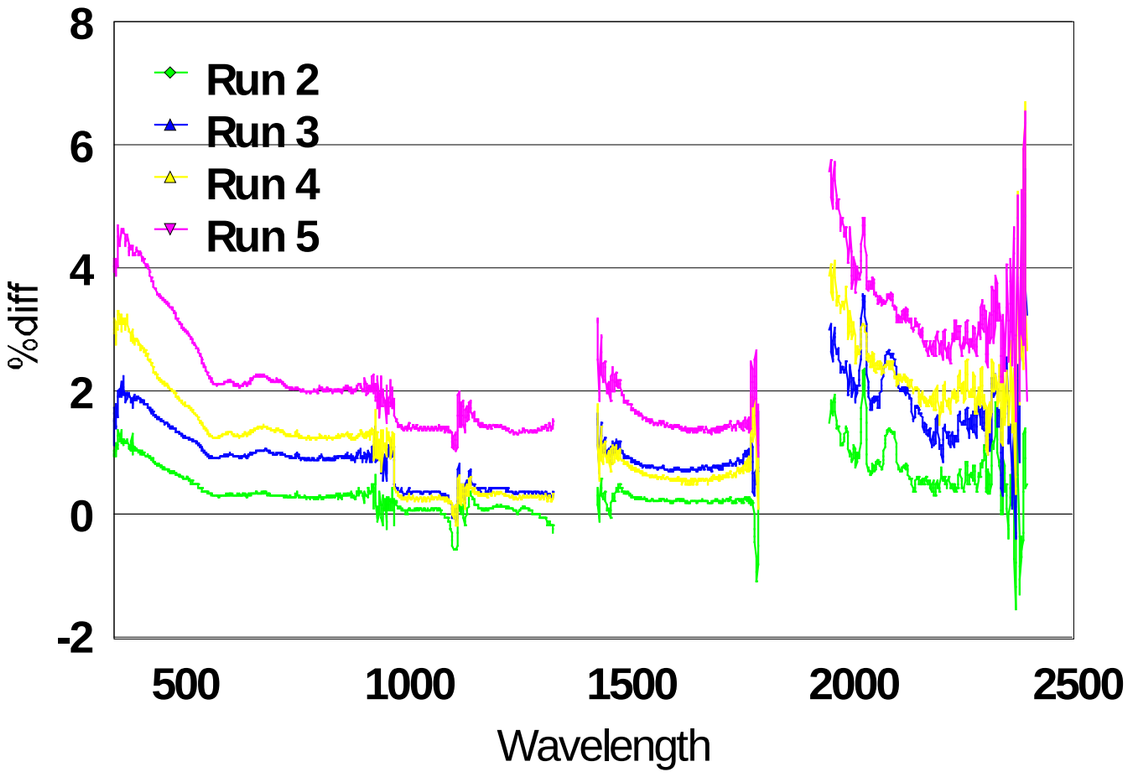


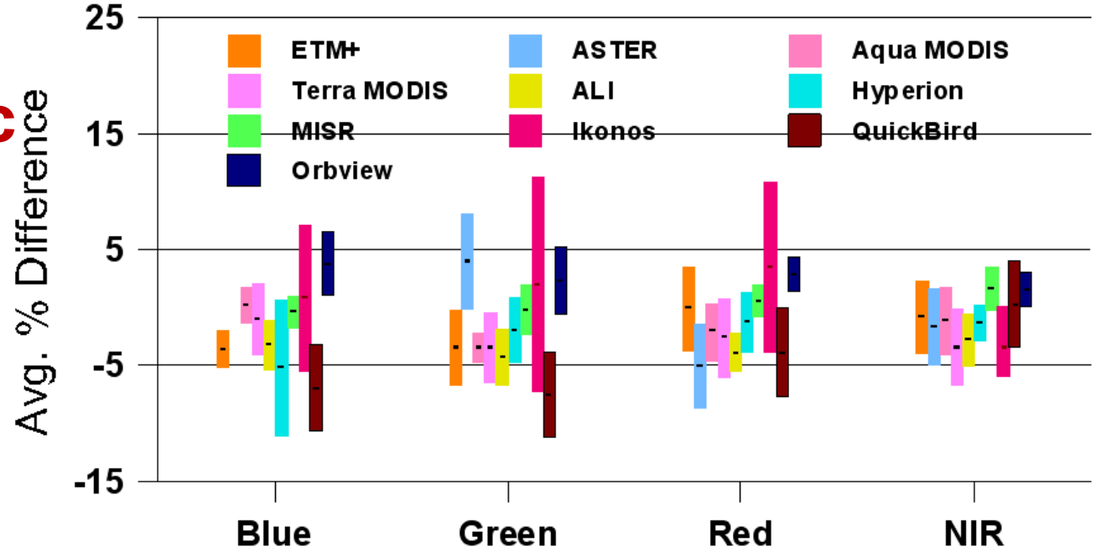
Sensor cross-calibration with simultaneous view at single site

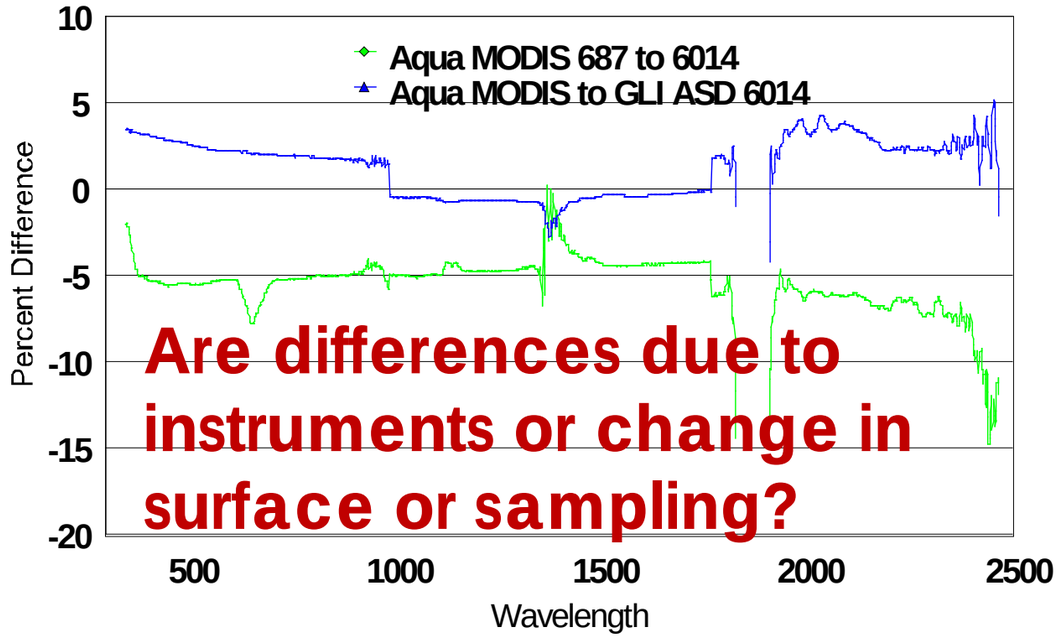


CPF's high accuracy will help to decouple uncertainties

Are differences and variability from the sensor under study, atmospheric or surface effects, or field instruments?





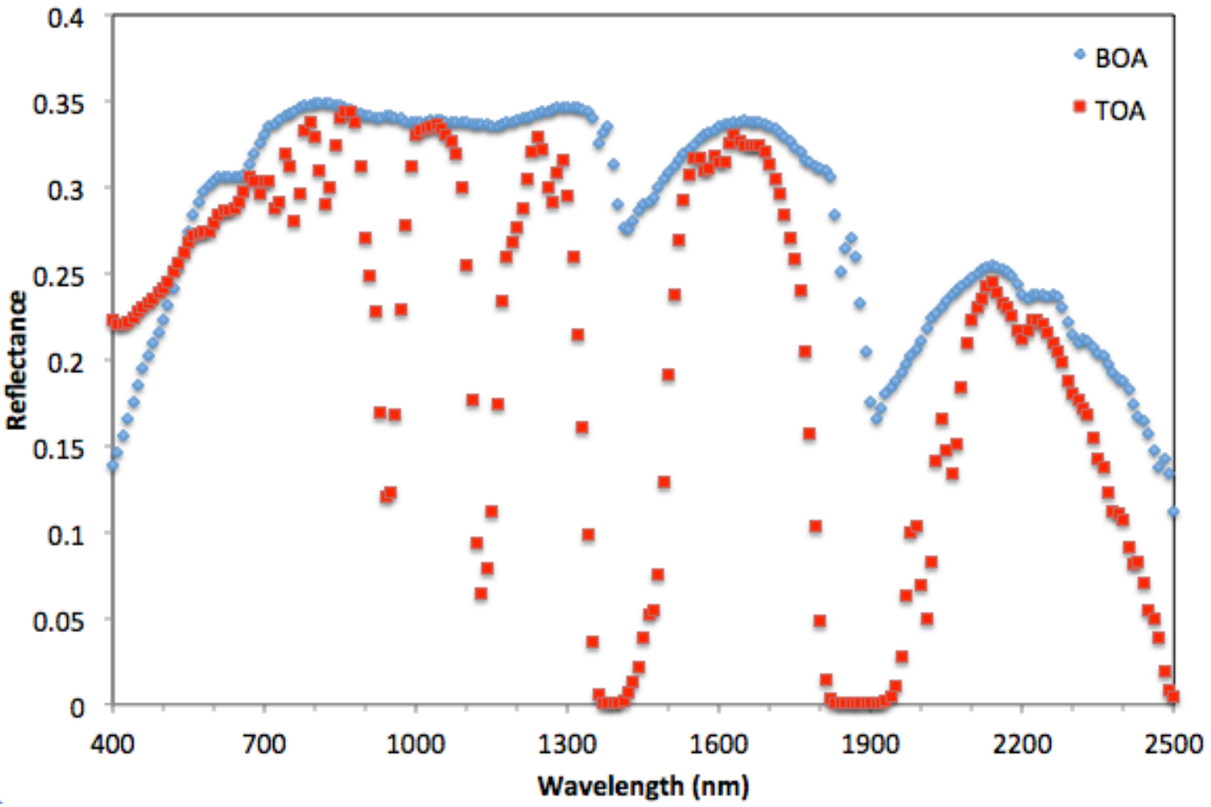


Are differences due to instruments or change in surface or sampling?

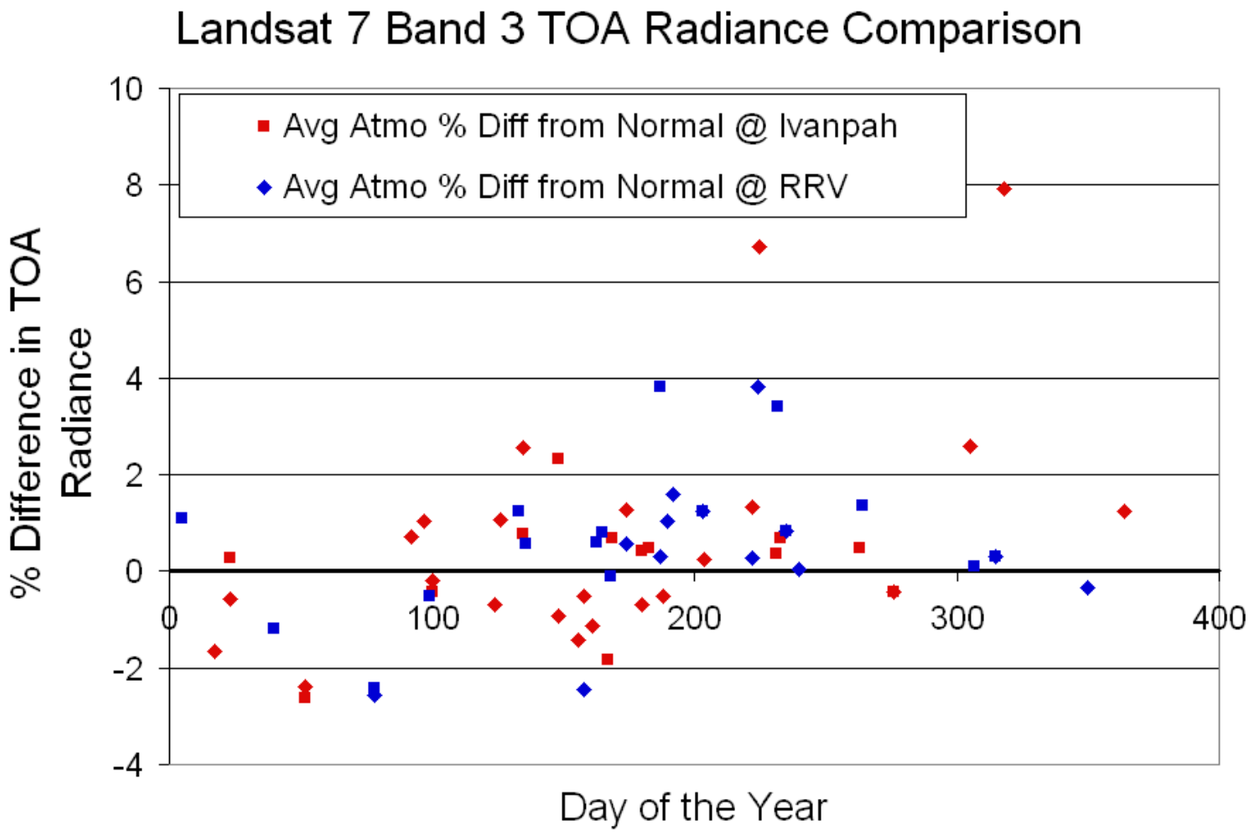
Increasing reflectance with time - BRDF or instrumental ?

Rely on modeling results to give insight

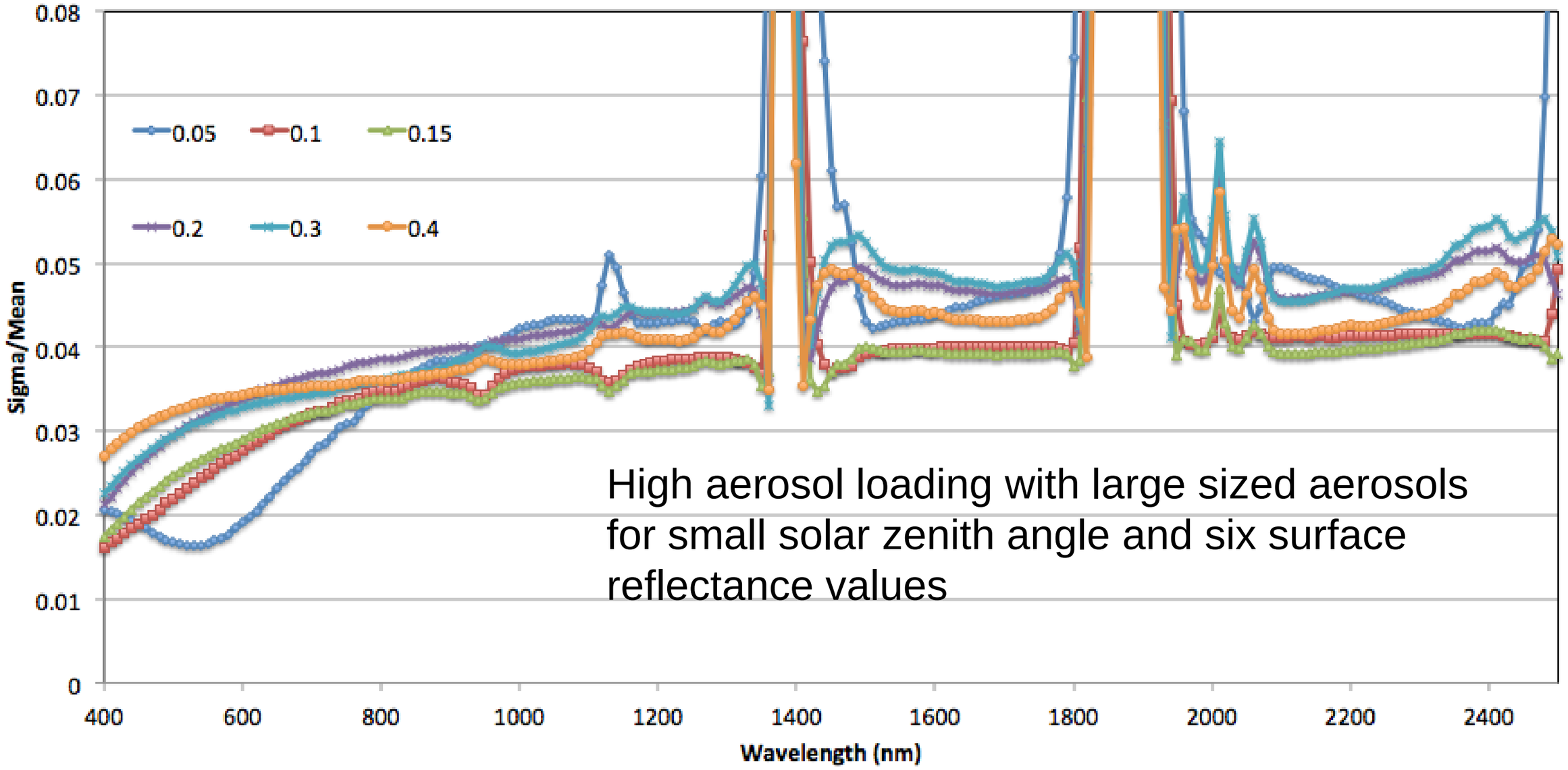
Atmosphere causes spectrally varying effects



But atmospheric effects do not appear to be the dominant uncertainty factor at some test sites



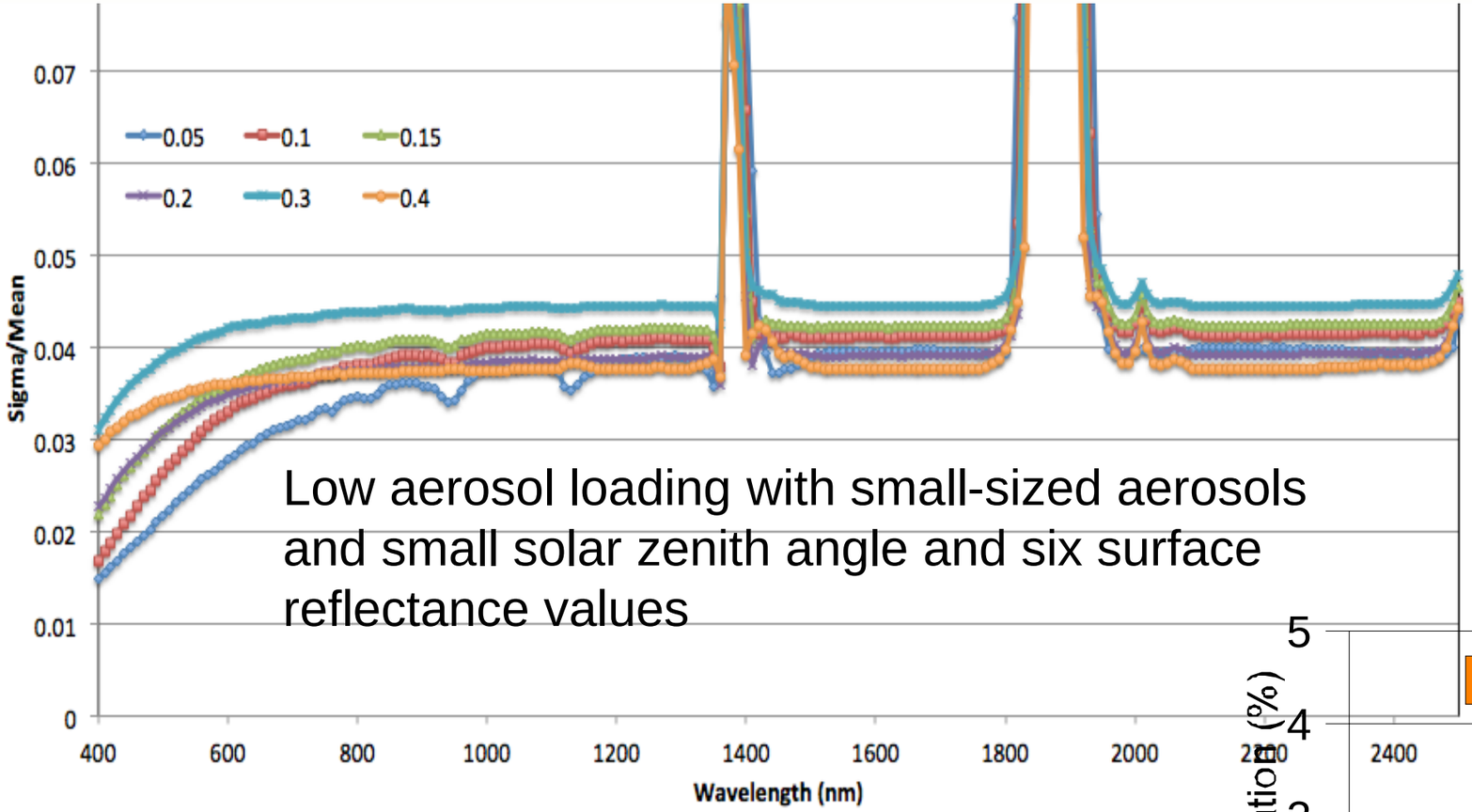
CPF work has led to improved modeling of uncertainties



High aerosol loading with large sized aerosols for small solar zenith angle and six surface reflectance values

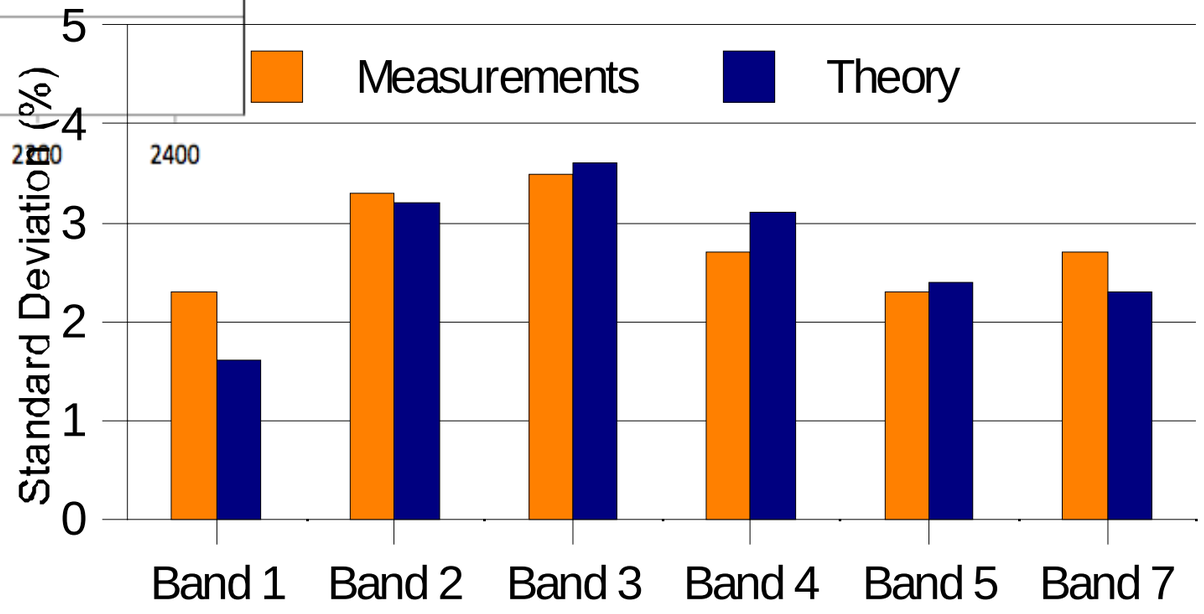
Monte Carlo results based on input uncertainties to radiative transfer code modeling of predicted top-of-atmosphere radiance

Modeling appears to match real life



Low aerosol loading with small-sized aerosols and small solar zenith angle and six surface reflectance values

Modeled uncertainties from a case typical of a desert calibration site

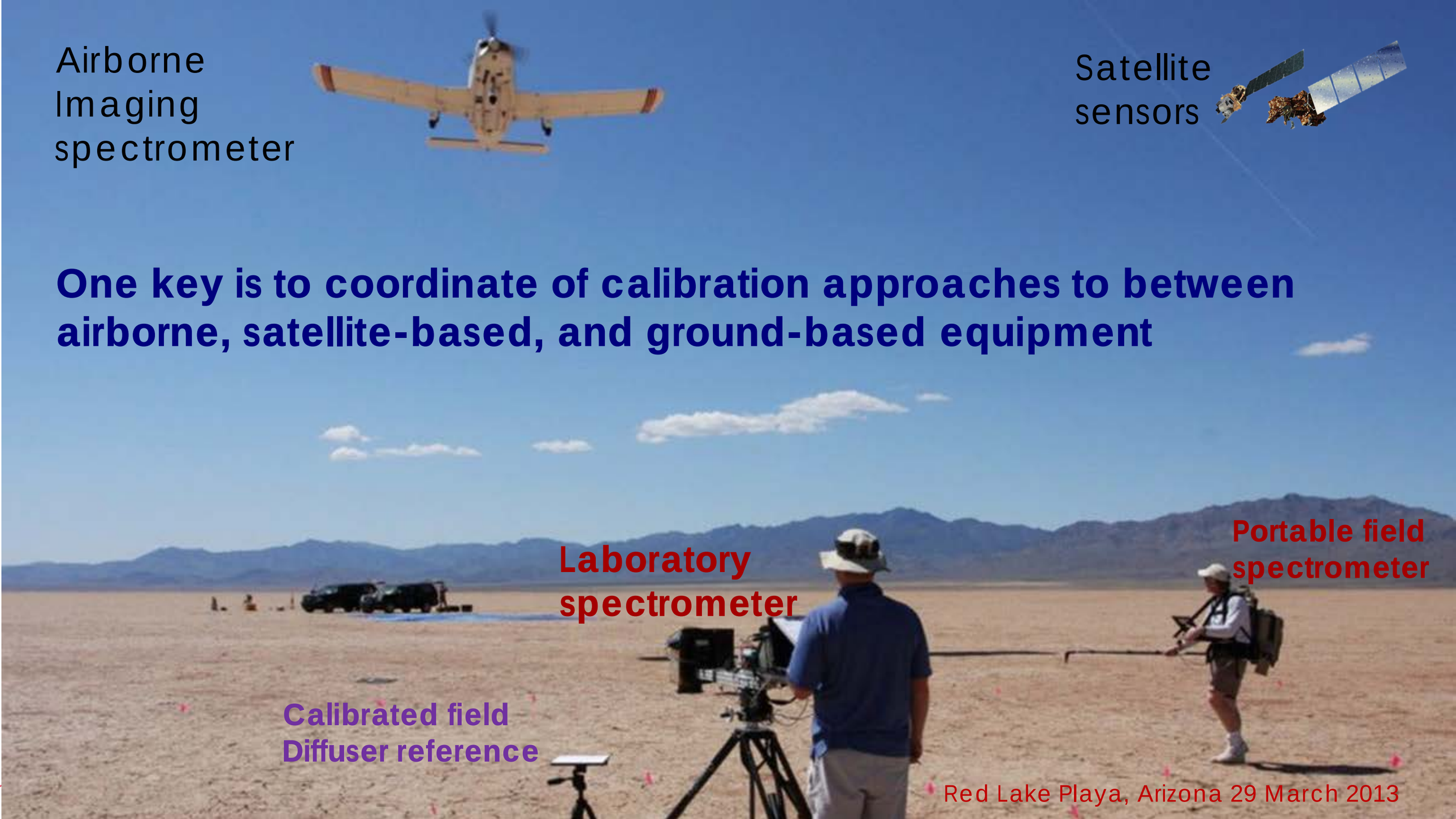


Compare the model results to those obtained by averaging calibration results from multiple dates

Airborne Imaging spectrometer

Satellite sensors

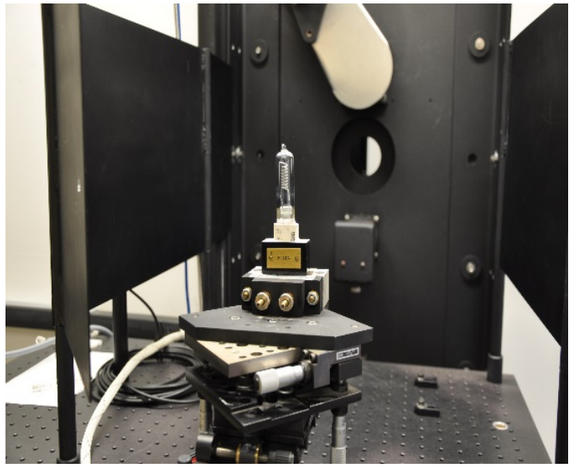
One key is to coordinate of calibration approaches to between airborne, satellite-based, and ground-based equipment



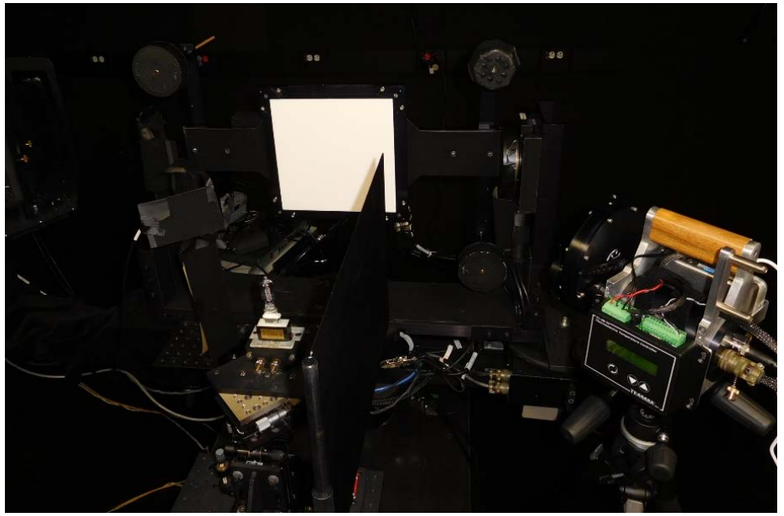
CPF will provide a link between the laboratory and the field

Source-based - **Absolute uncertainty (RSS, k =2) at 650 nm is <1.5%**

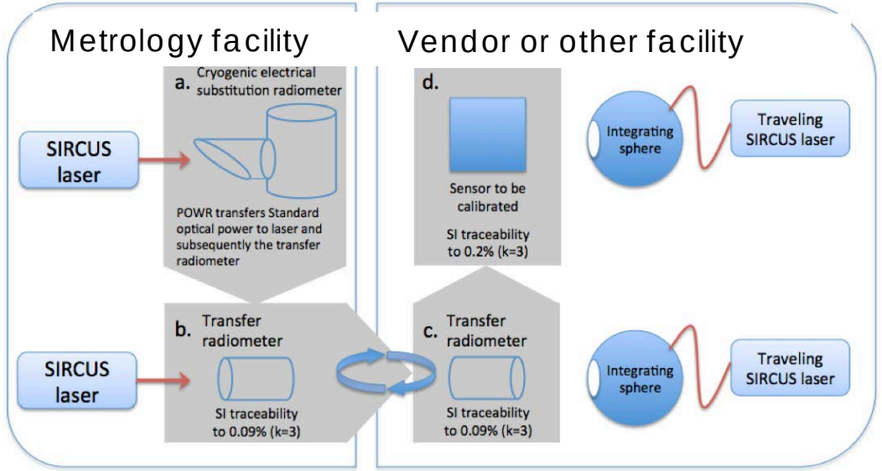
FEL lamp [1 kW quartz halogen lamp]

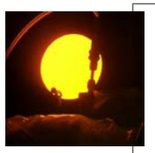


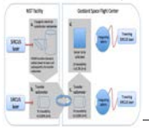
NIST calibrated 10'' Spectralon panel illuminated at 50 cm

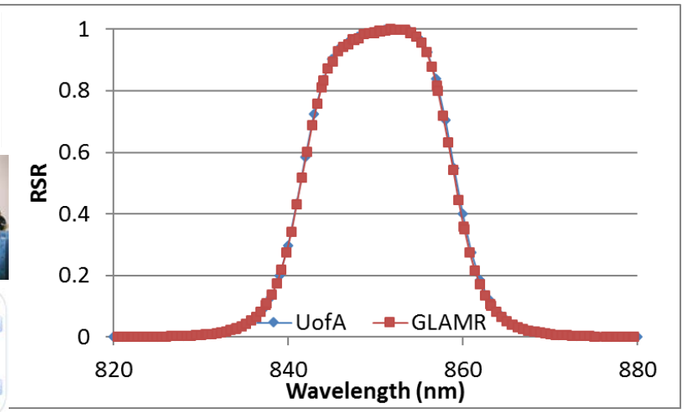


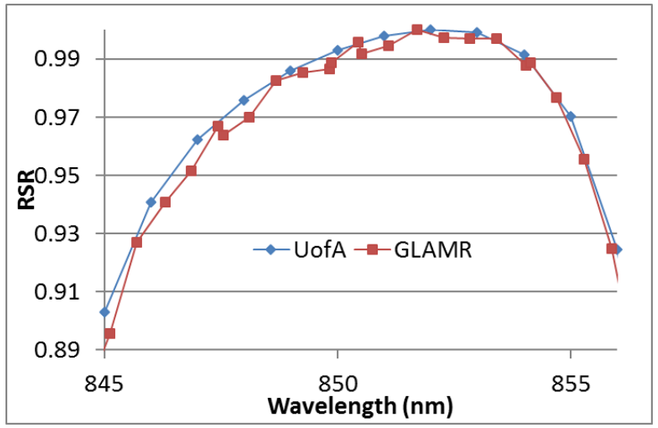
Detector-based - **Absolute uncertainty (RSS, k =2) <0.5%**





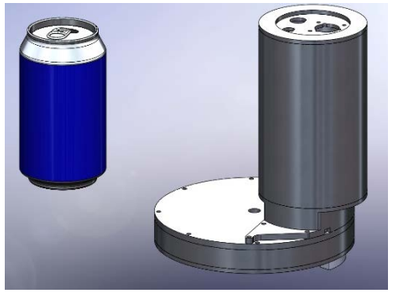




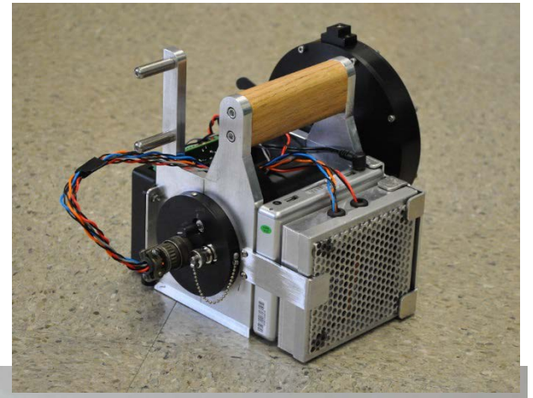


Portable, field transfer radiometers – multispectral to start

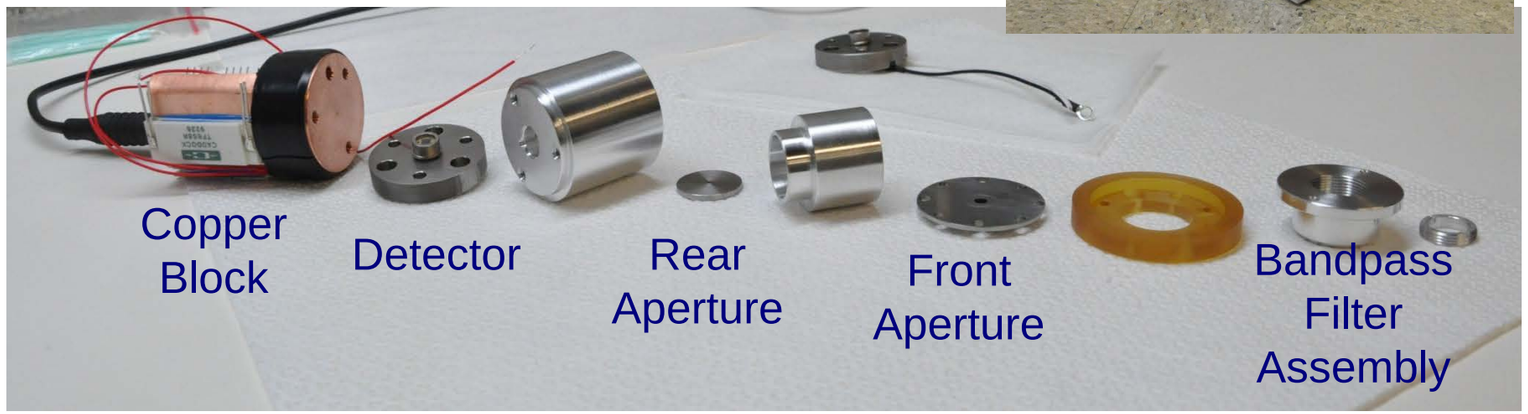
Response to a recommendation from CEOS Tuz Golu campaigns for a *standardised radiometer that can act as a transfer standard to link test-sites traceability*



Portability, size, and one-person operation were key design drivers



Primarily for on-site field calibration



Optical design follows that of field radiometer with electronic design relying on the University of Arizona transfer radiometer designs

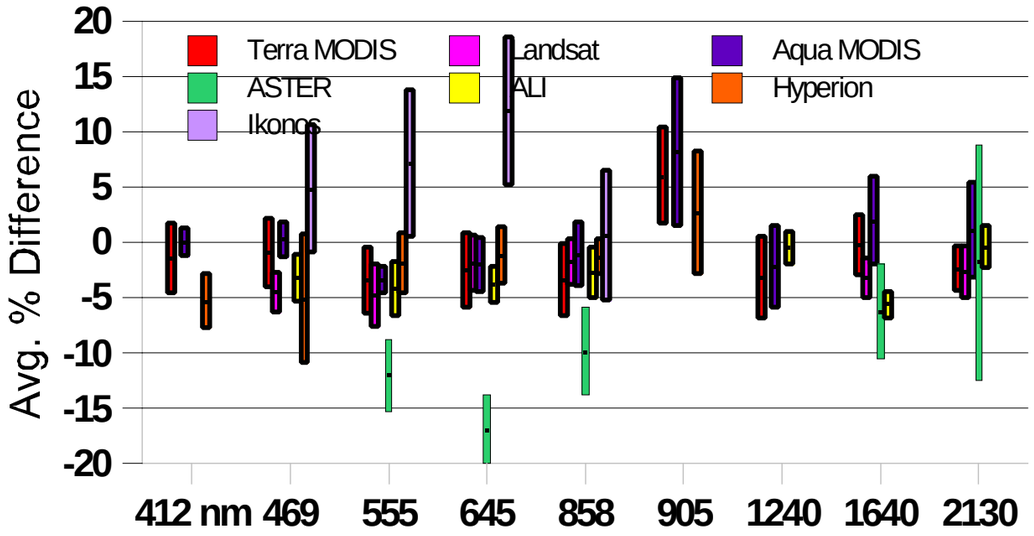
Lead to better calibration of field radiometers

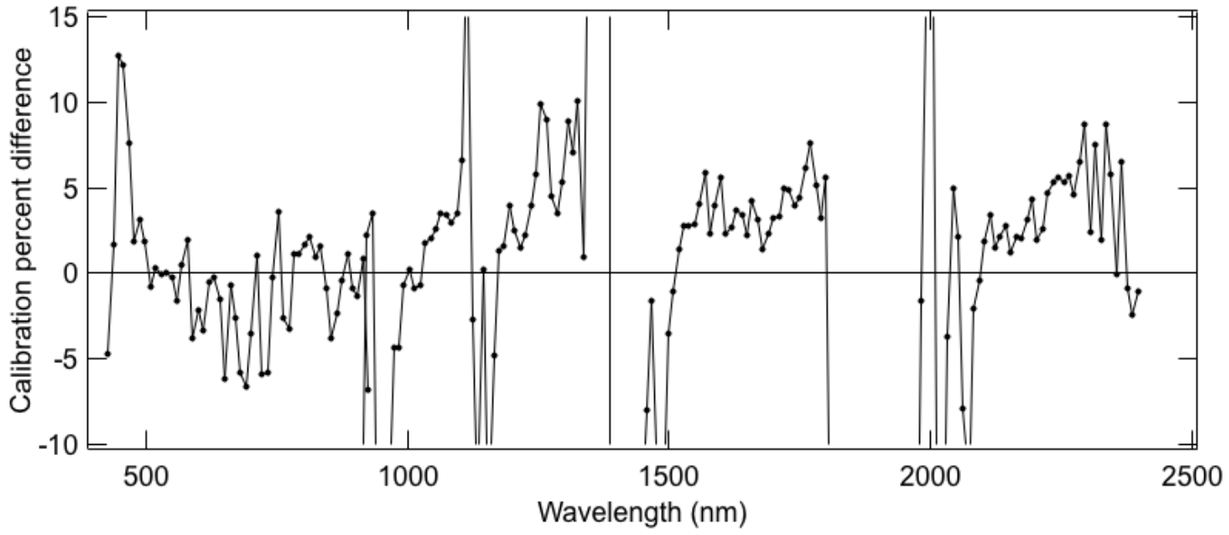
- Assess degradation of on-site radiometers without requiring returning instruments to laboratory
- Stability of transfer radiometer and radiance-based calibration provides a check on field radiometers used to assess surface properties

Summary

Development of well-understood, imaging spectrometers with high radiometric accuracy solves many issues

- Better radiometric accuracy implies better sensor quality
- Radiometric traceability allows use of data from multiple sensors without the need for on-orbit inter-comparisons
- On-orbit sensors with known absolute uncertainty and defensible traceability can act as transfer standards
- These are key concepts of CLARREO and CLARREO Pathfinder (CPF) mission





Conclusions

CLARREO Pathfinder will be an excellent tool for both direct interconsistency and for site characterization

- Will give another excellent example of the utility of imaging spectrometry
- Site characterization does not provide the same accuracy as direct interconsistency approaches
  - Fortunately, some sensors do not require full accuracy of CLARREO
  - Currently-used test sites will be understood to a level that should allow absolute calibrations rather than only trend analysis
  - Clearer understanding of Instrumented test sites and uncertainties caused by atmospheric and surface bi-directional effects
- Coordinated international efforts to understand ground sites will permit physically-based understanding leading to at-sensor radiance with absolute uncertainties <1%


ICE
COLD
BEVERAGE
TO GO!