Results of sensor comparisons using RR Valley and White Sands

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Background

Sensor calibration and characterization is essential in order to **compare** data **between** sensors

- Biases between sensors need to be removed
  - Different sensors on the same platform
  - “Same” sensors over time
  - Different sensors across platforms
- Relative calibration is sufficient in some cases
  - Data from single sensor for change analysis
  - Multiple sensors for which significant overlap exists
- Absolute calibration needed for temporal studies between multiple sensors with little to no overlap
- Vicarious methods are an excellent means to do relative and absolute radiometric cross-calibration

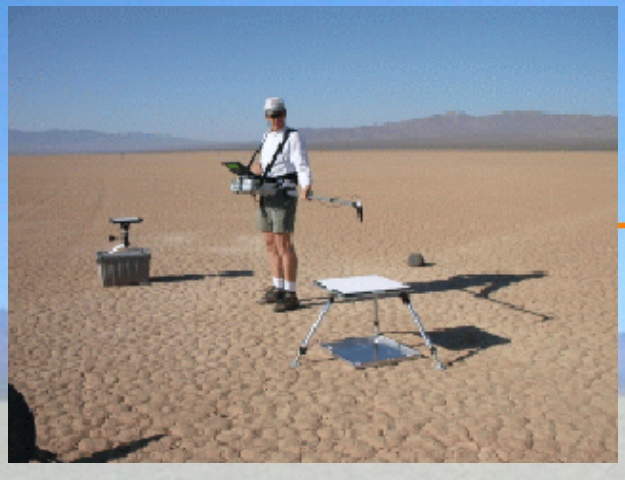
Talk outline

Rely on the reflectance-based method for cross calibration

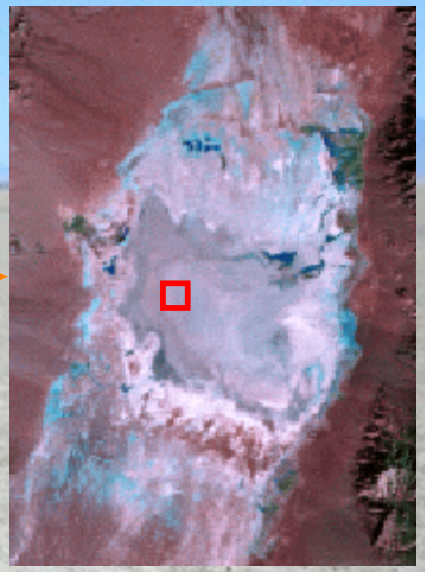
- Does not require coincident views
- Works for various spatial and spectral resolutions
- Talk overview
  - Description of reflectance-based approach
  - Example results
  - Cross-calibration results
  - Accuracy and precision discussion
  - Summary

Reflectance-based approach

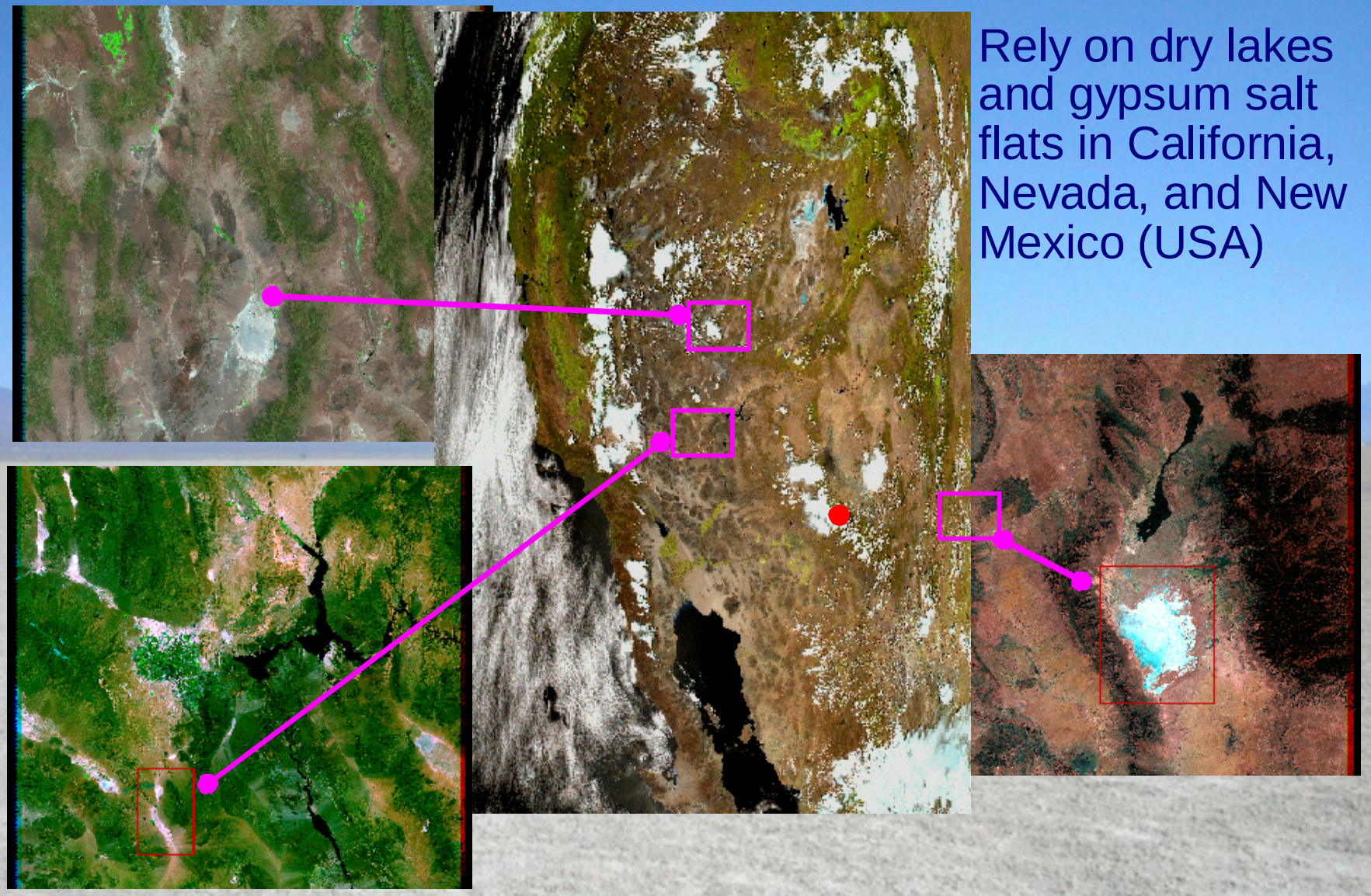
Method relies on atmospheric and surface characterization at the time of sensor overpass



Radiative Transfer Code



UofA test sites

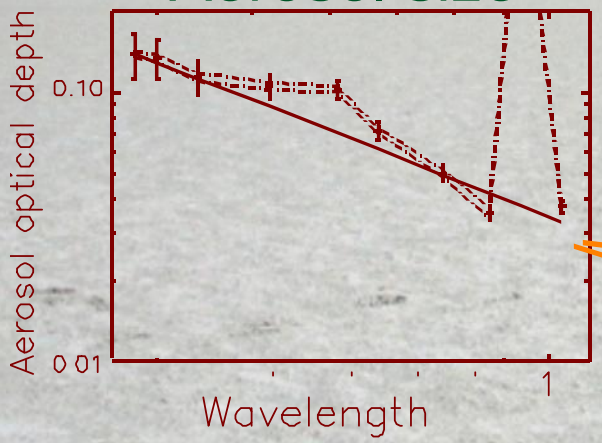


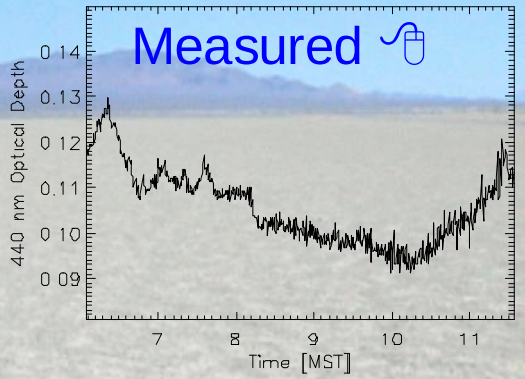
Rely on dry lakes and gypsum salt flats in California, Nevada, and New Mexico (USA)

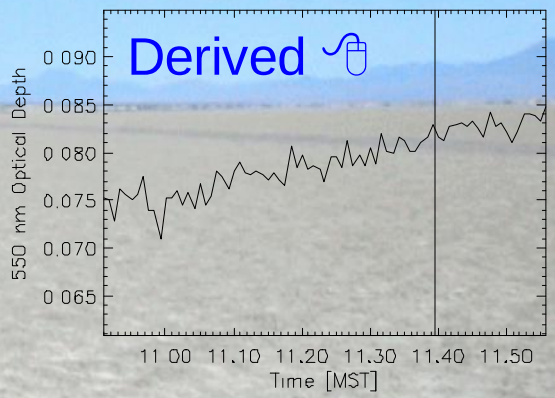
Aerosol parameters

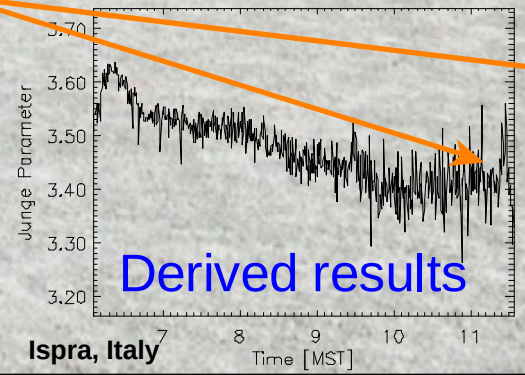
Primary parameter is spectral transmittance which is used to derive spectral and temporal results

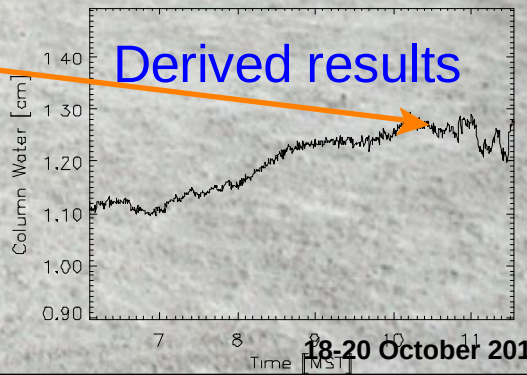
- Convert transmittance to optical depth
- Spectral optical depth used to retrieve
  - Column absorbers
  - Concentration
  - Aerosol size



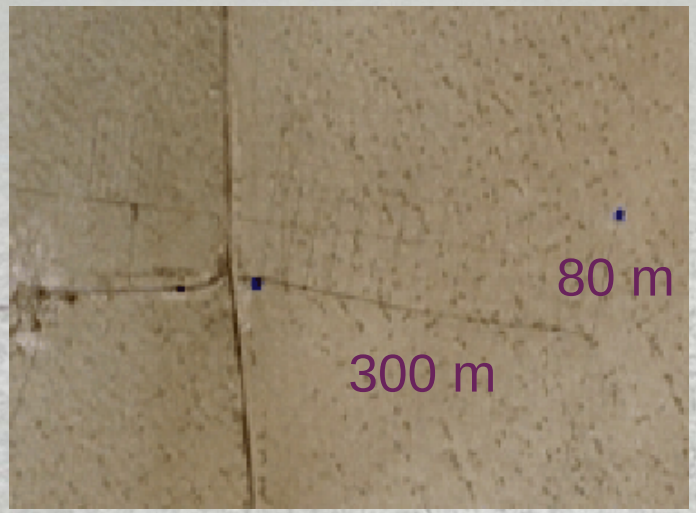


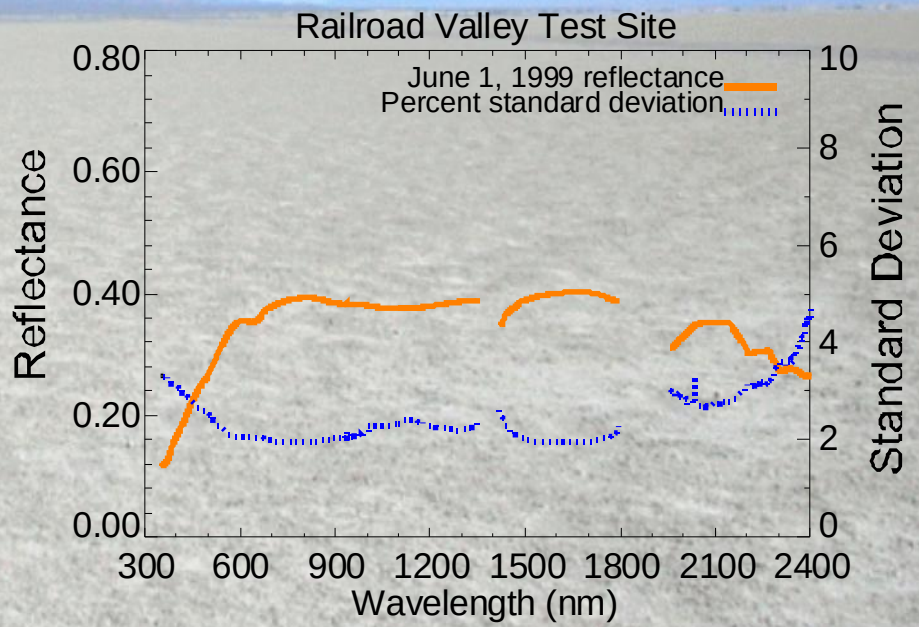






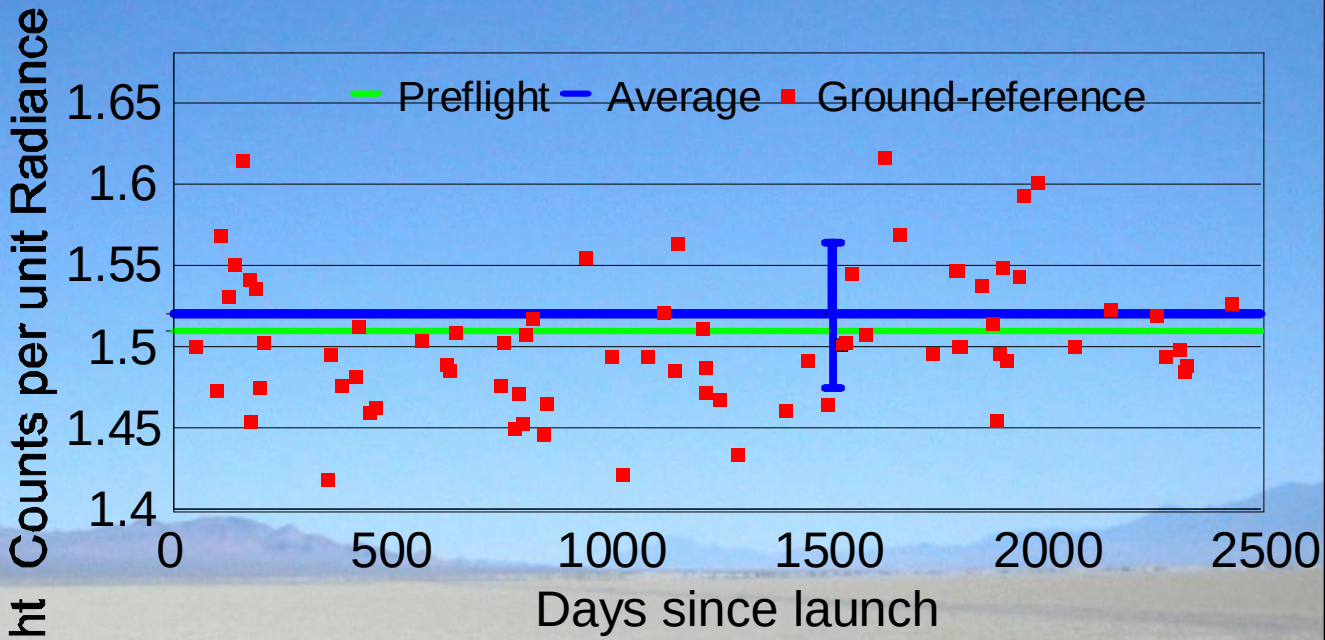
Surface reflectance retrieval

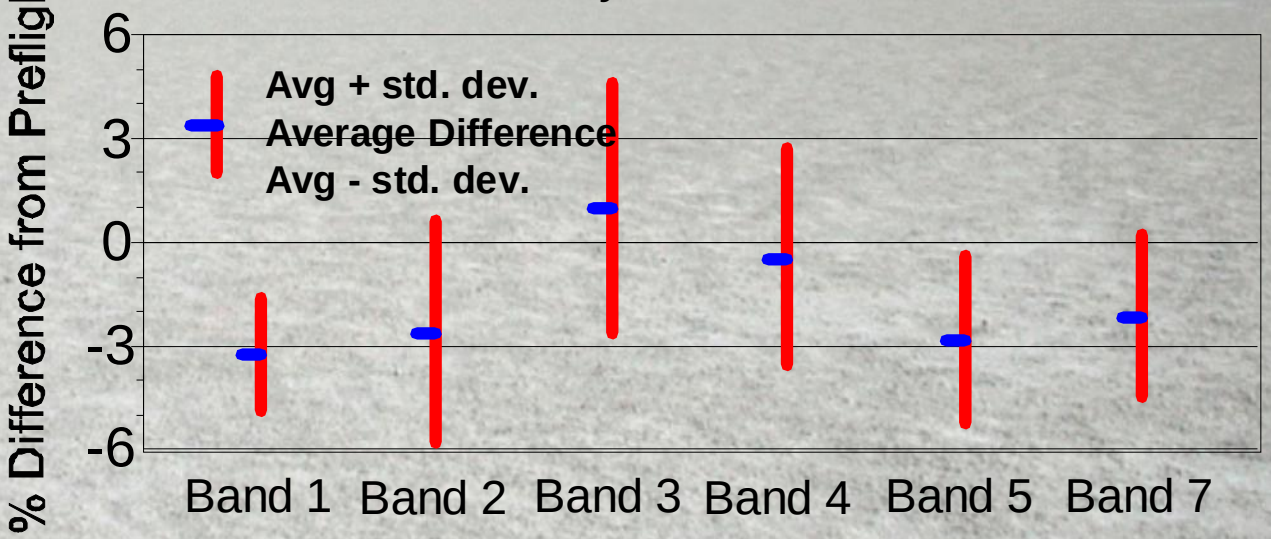




Typical Results

Results from Band 4 of ETM+ as a function of time and average for all bands compared to preflight

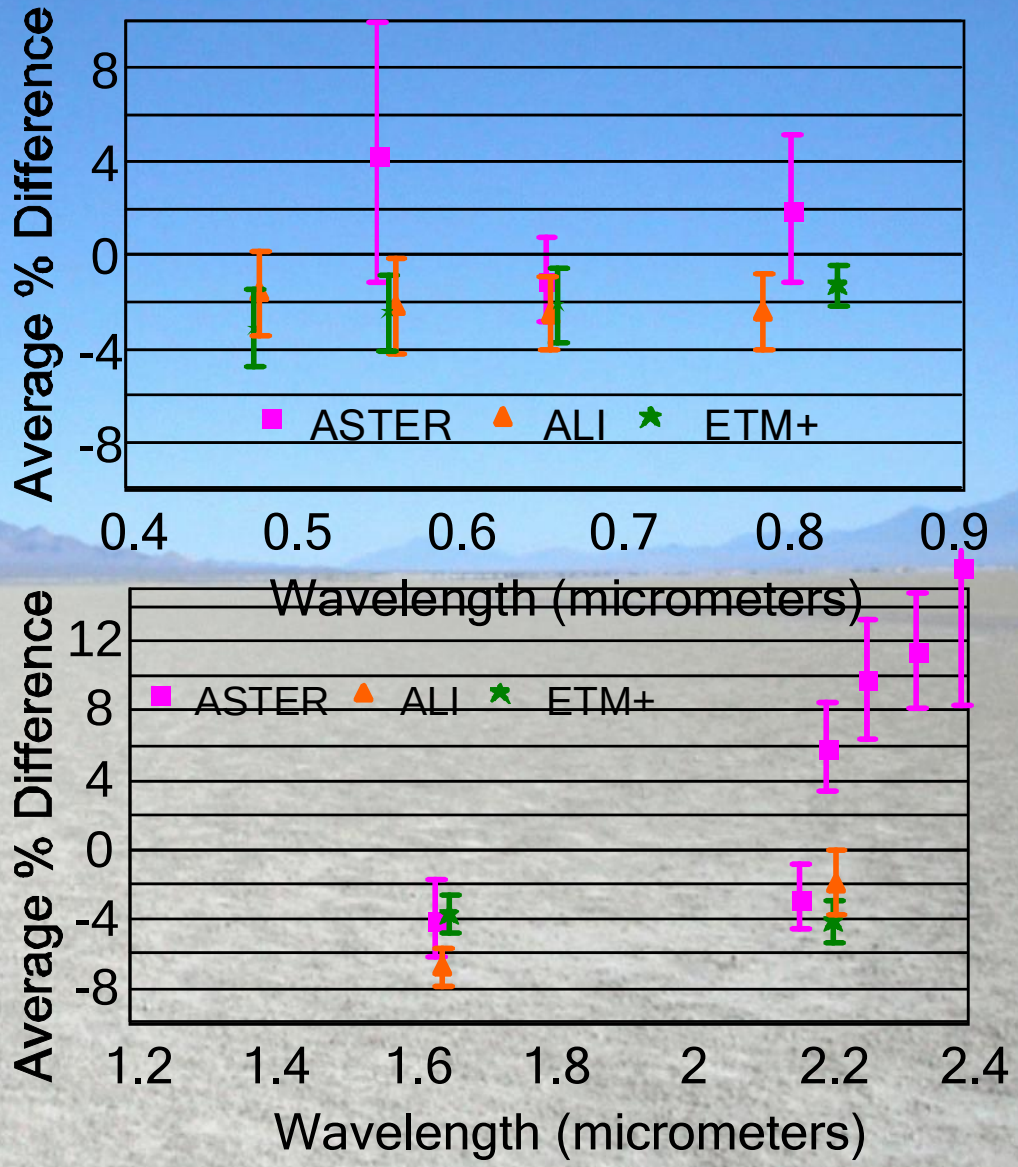




Intercomparison results

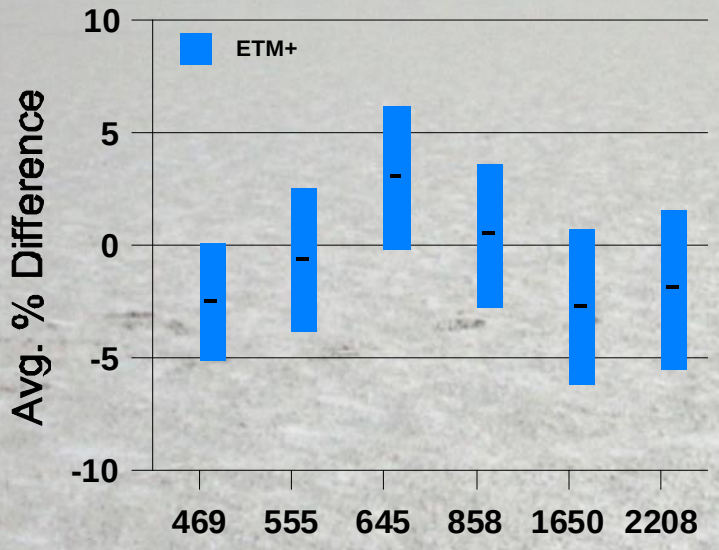
Comparison of moderate resolution sensors

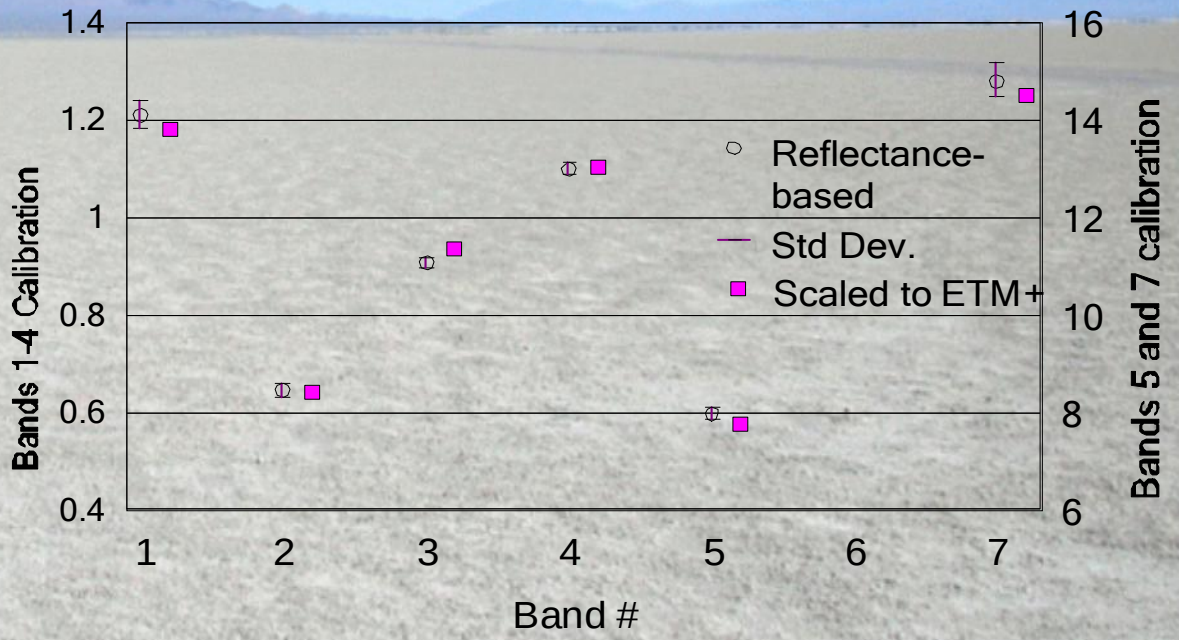
- Percent difference from accepted calibration for a given sensor
- Comparisons of percent differences and standard deviations gives information about the calibration
- Sensors here see test sites on same day



ETM+ and TM averages

- ALI orbit eventually shifted
  - Not on same day as ETM+
  - % difference results remained the same
  - Confidence to apply method to non-coincident sensors
- Calibrate TM relative to ETM+ (eight days out of phase with each other)





TM/ETM+ cross calibration

Approach was applied to ETM+ for the same time period & scale TM values to match ETM+ preflight

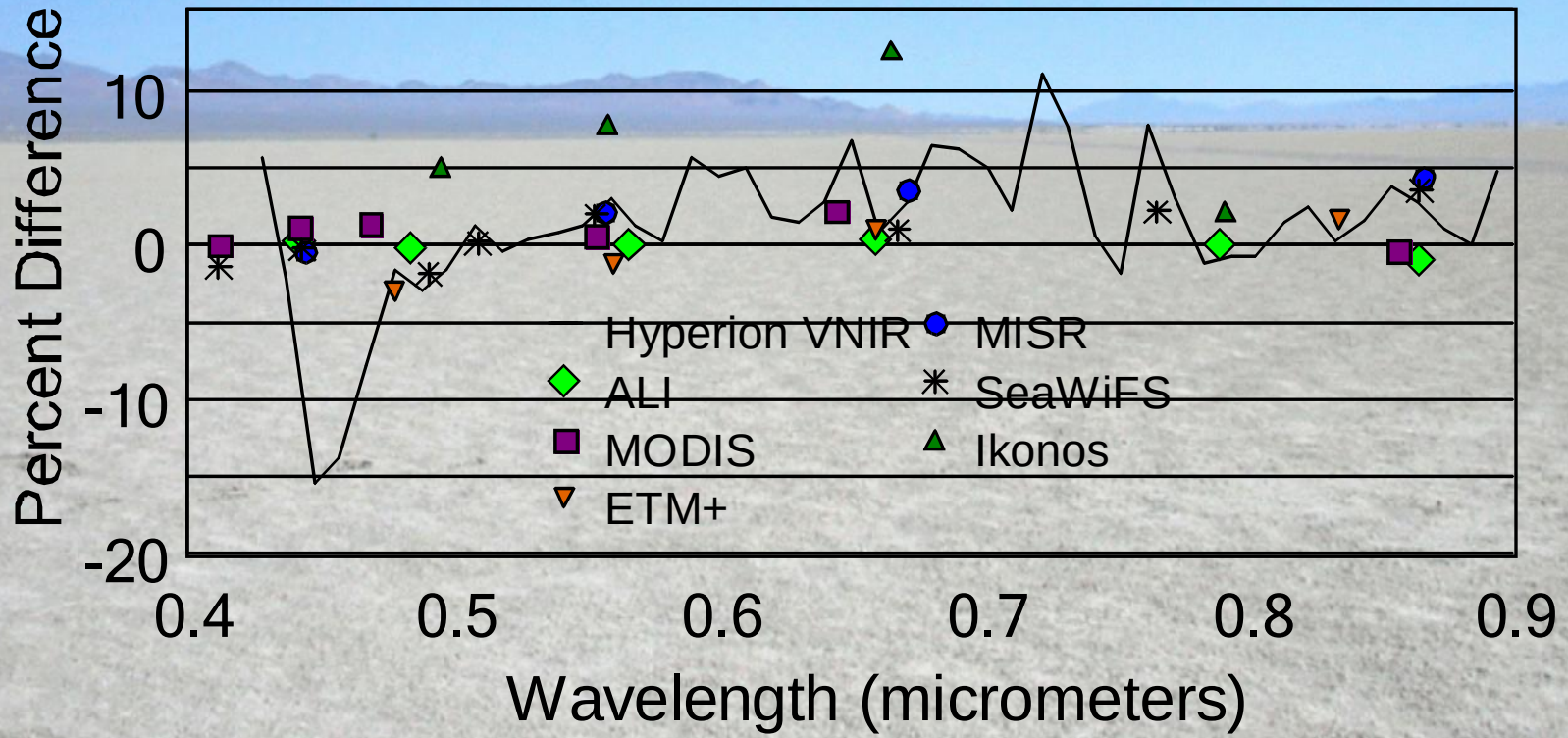
- Started with 17 data sets during the period
- Downselected to 7 data sets
- Resulting TM coefficients based on this approach match well with ETM+/TM underflight results

Band #	ETM+ Avg. select dates	ETM+ std. dev. select dates (%)	TM Avg. select dates	TM std. dev. select dates (%)	TM cross cal. result	TM cross cal std. dev. (%)
1	1.19	0.6	1.21	1.4	1.25	1.5
2	1.17	0.7	0.642	0.9	0.650	1.1
3	1.55	0.0	0.909	0.0	0.884	---
4	1.51	0.8	1.09	0.9	1.10	1.2
5	7.39	0.8	8.06	1.5	8.13	1.7
7	21.2	0.8	14.9	2.0	15.0	2.2

Single day cross-comparison

July 16, 2001 provided seven different sensor viewing RRV Playa within 30 degrees of nadir

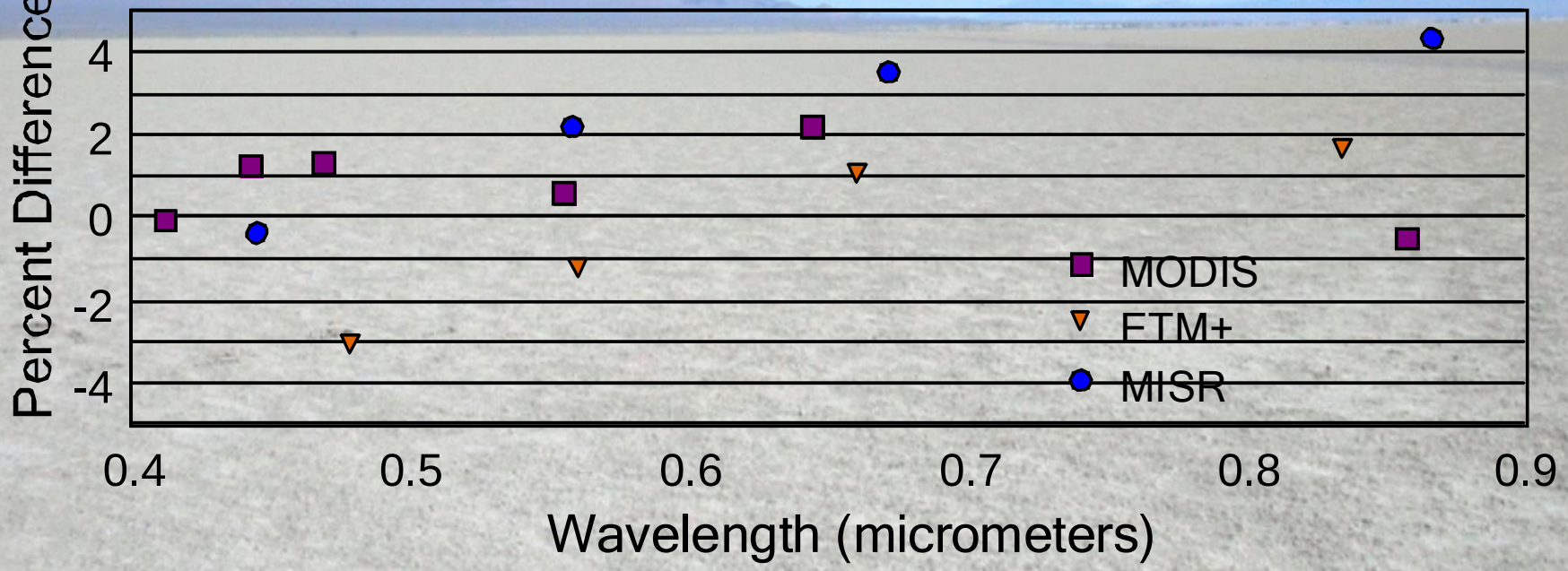
- % difference relative to each sensors accepted calibration at that time
- Reflectance-based predictions is 0% difference



Single day comparison

More typical cross-comparison using coincident sites

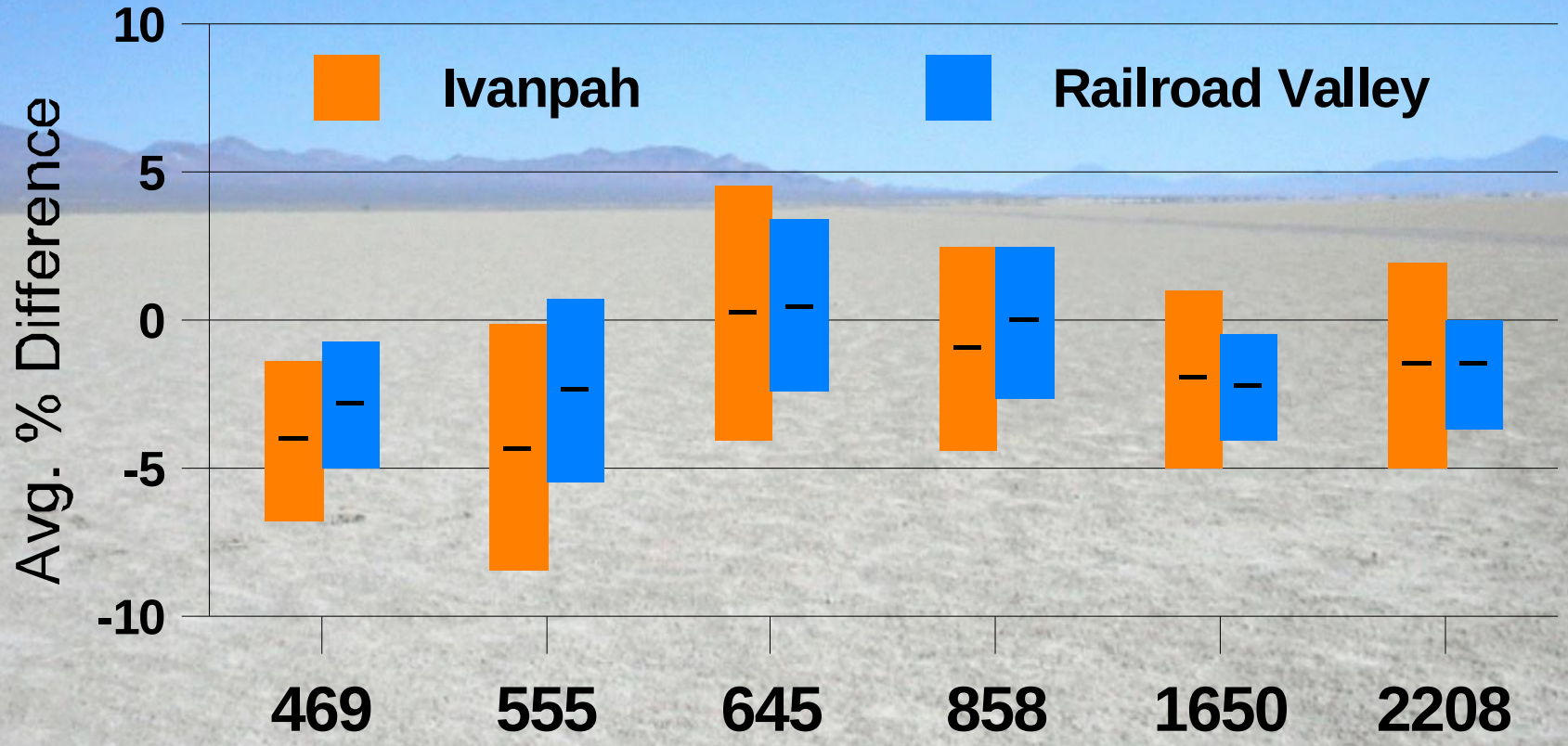
- Method used reference to Landsat-7 ETM+ derived surface reflectance
- Show ETM+, MISR, MODIS results here
- ETM+ data points shown derived from reflectance-based calibration



Site dependence

Results from two test sites show that the approach is site independent

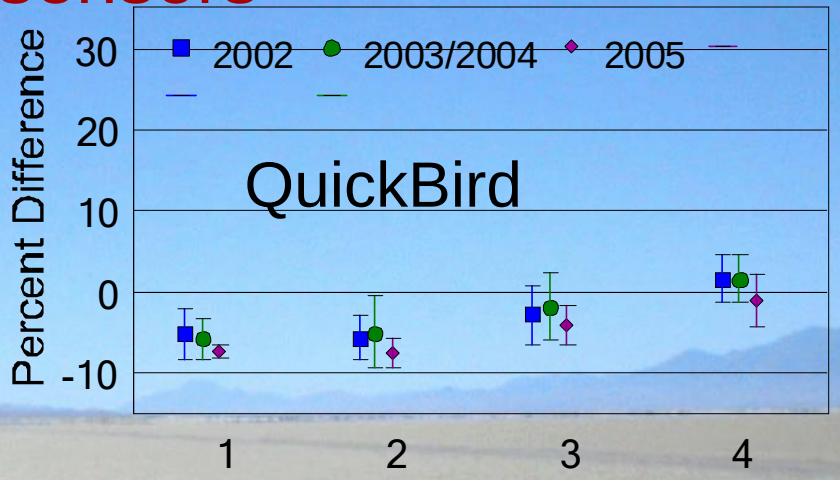
- Differences are within statistical variations
- Standard deviations are statistically different

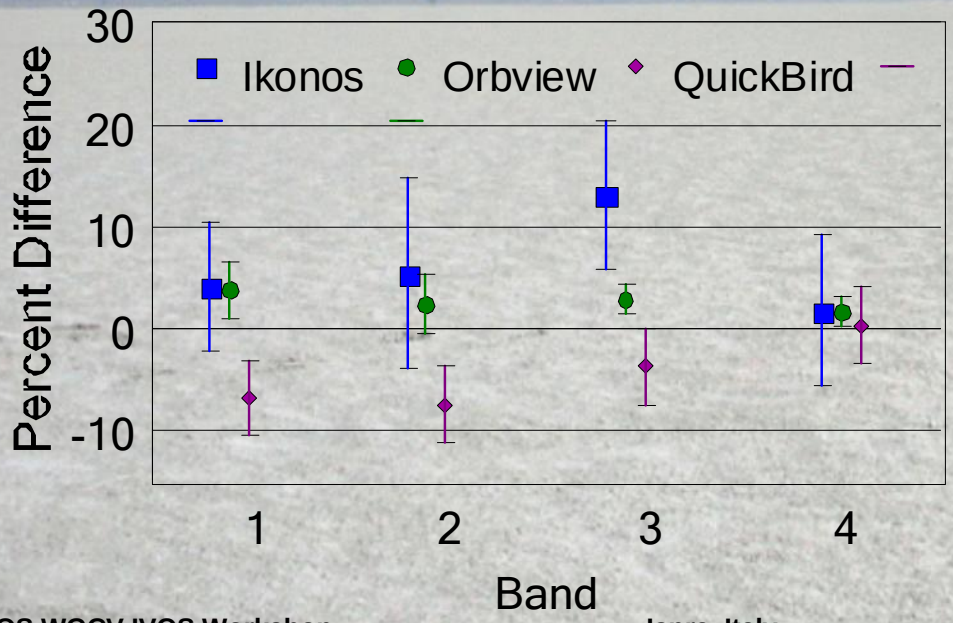


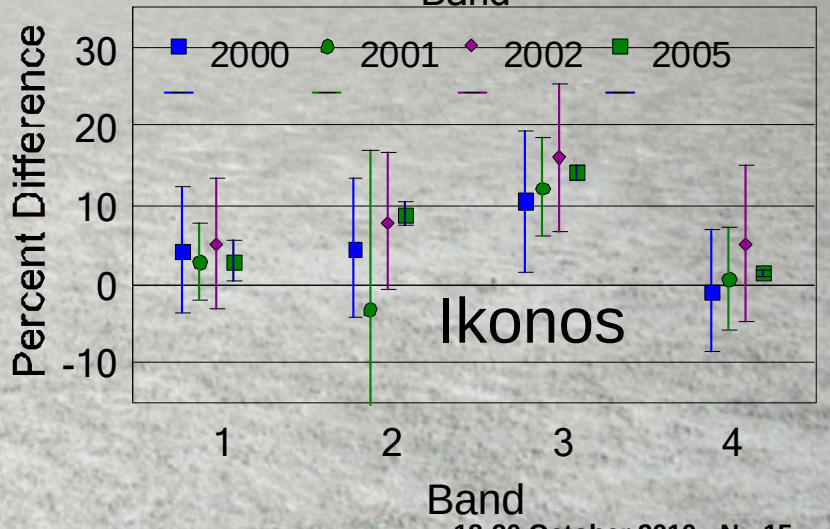
High resolution sensor calibration

Combined results from four desert sites for calibration of high resolution sensors

- Comparing year to year
- Comparing standard deviations
- Sensor to sensor comparisons

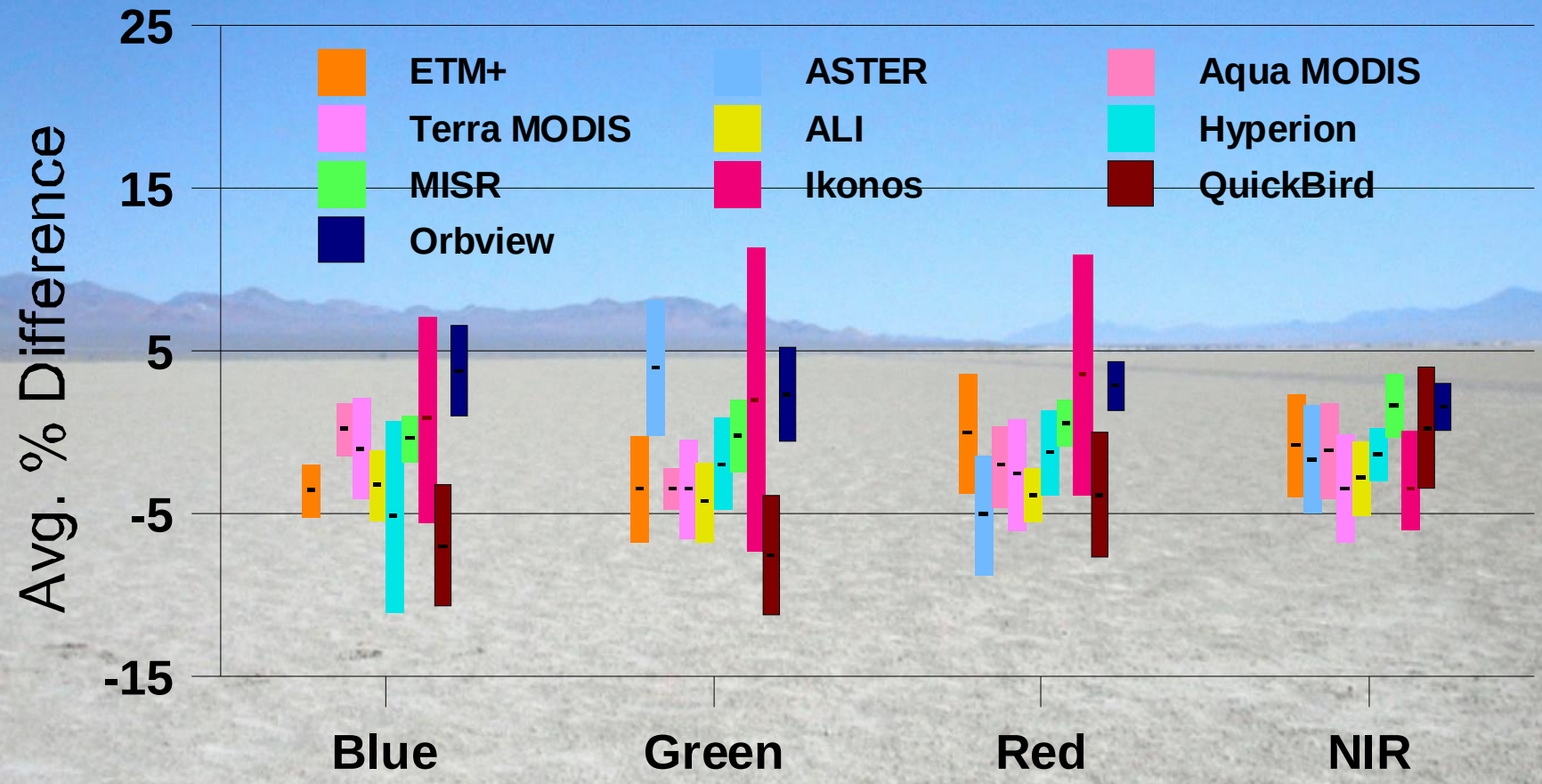






Overall results

Comparisons can then be made amongst other sensors of varying spectral and spatial resolution



Summary

Cross-calibration approach shown here is suitable for varying spatial and spectral resolutions

- Spectral effects are taken into account in the ground measurements
- Other work shows that footprints as large as 1-km can be used
  - Requires large-sized sites such as RRV Playa
  - Geolocation between ground data and sensor is an issue
  - Site-to-site and season-to-season biases are not significant
- Combination of methods shown here should allow cross-calibration relative to a given sensor to approach levels of 0.7% combined uncertainty