

# QuickBird Radiometric Characterization

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# Introduction

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- Background
  - Reflectance-based vicarious calibration
  - Test sites
- Results
  - 2003 data sets
  - Comparison to previous results
- Error/precision discussion
  - Use of reflectance-based method as cross-calibration approach
  - Comparisons with multiple other sensors
- Conclusions and future work

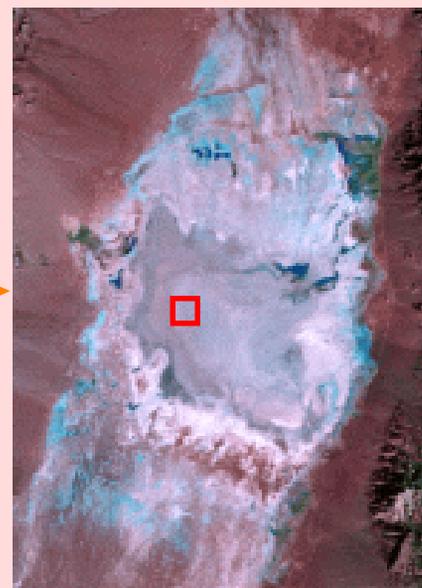


# Reflectance-based Approach

Combine surface reflectance and atmospheric transmittance data to predict at-sensor radiance



Radiative Transfer Code



# QuickBird Datasets

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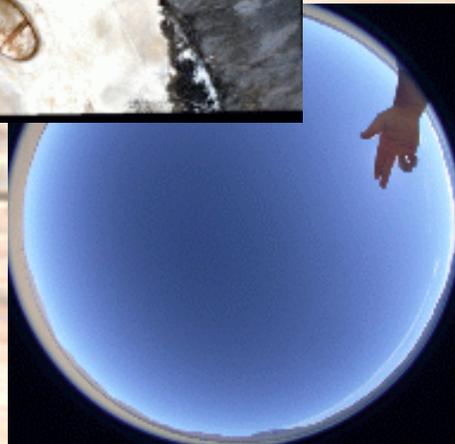
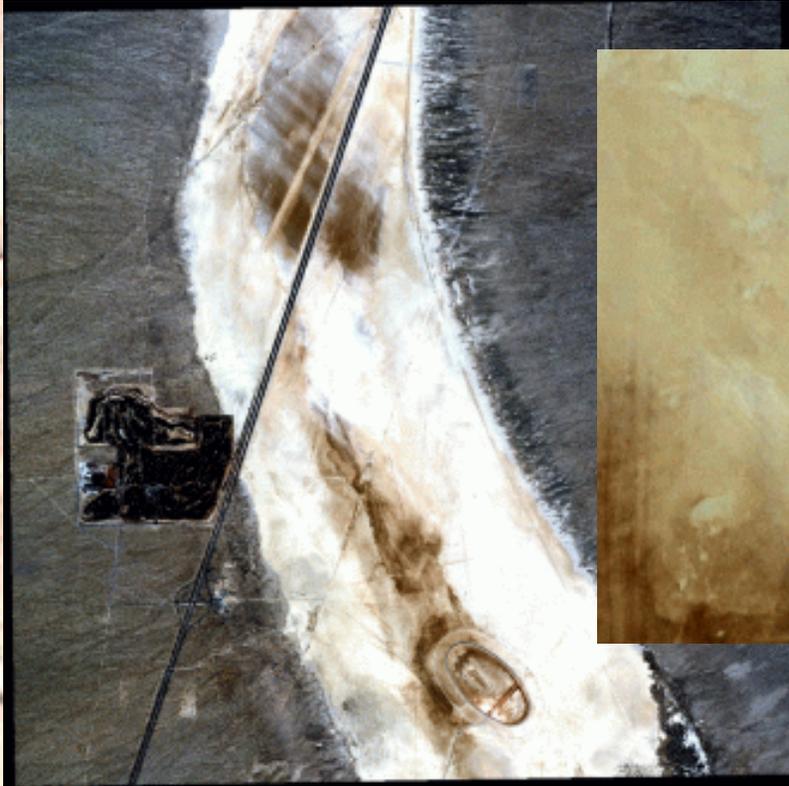
A total of three Quickbird scenes were acquired for the current evaluation

- August 22, 2003
  - White Sands Missile Range
  - High reflectance and high sun angle leading to high radiance
- December 15, 2003
  - Ivanpah Playa
  - Lower sun angle gives nearly factor of two lower radiance
- January 7, 2003
  - Railroad Valley Playa
  - Snow-covered test site



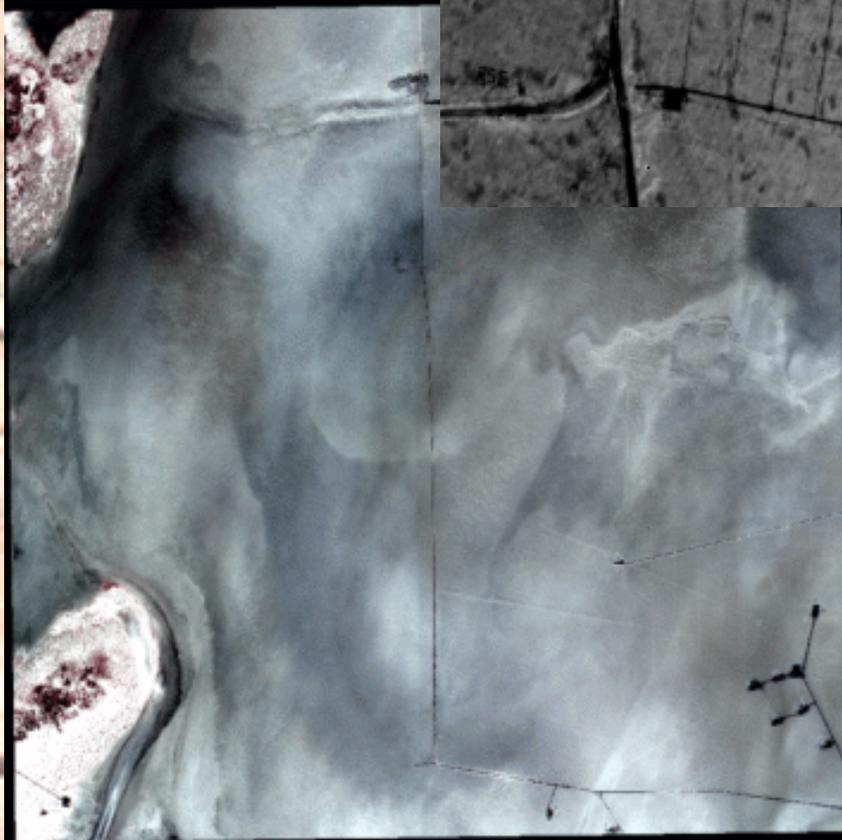
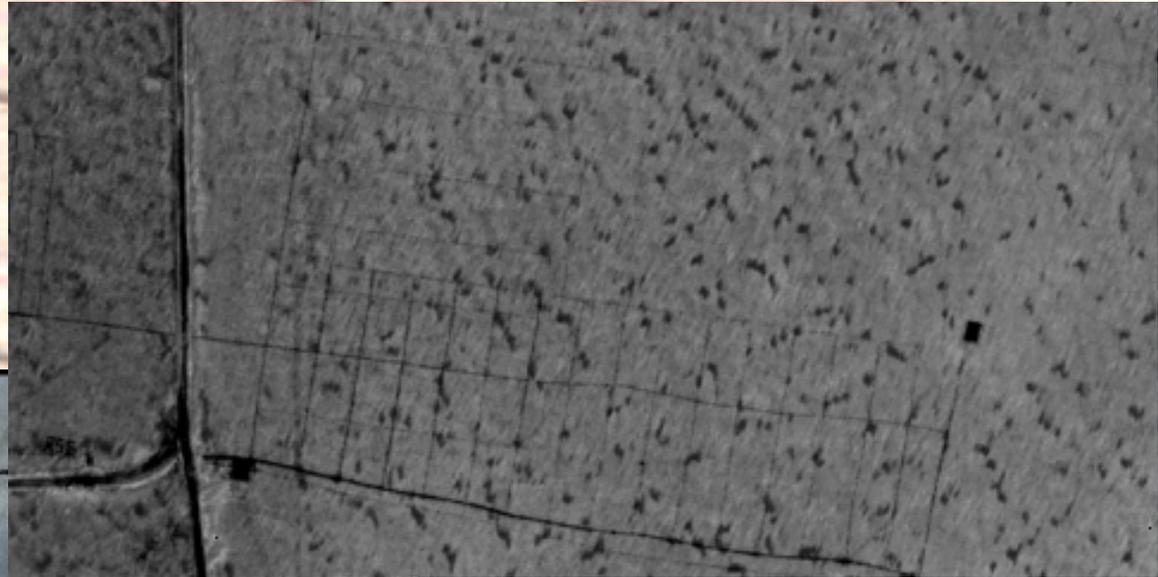
# Ivanpah Playa test site

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# Railroad Valley Test Site

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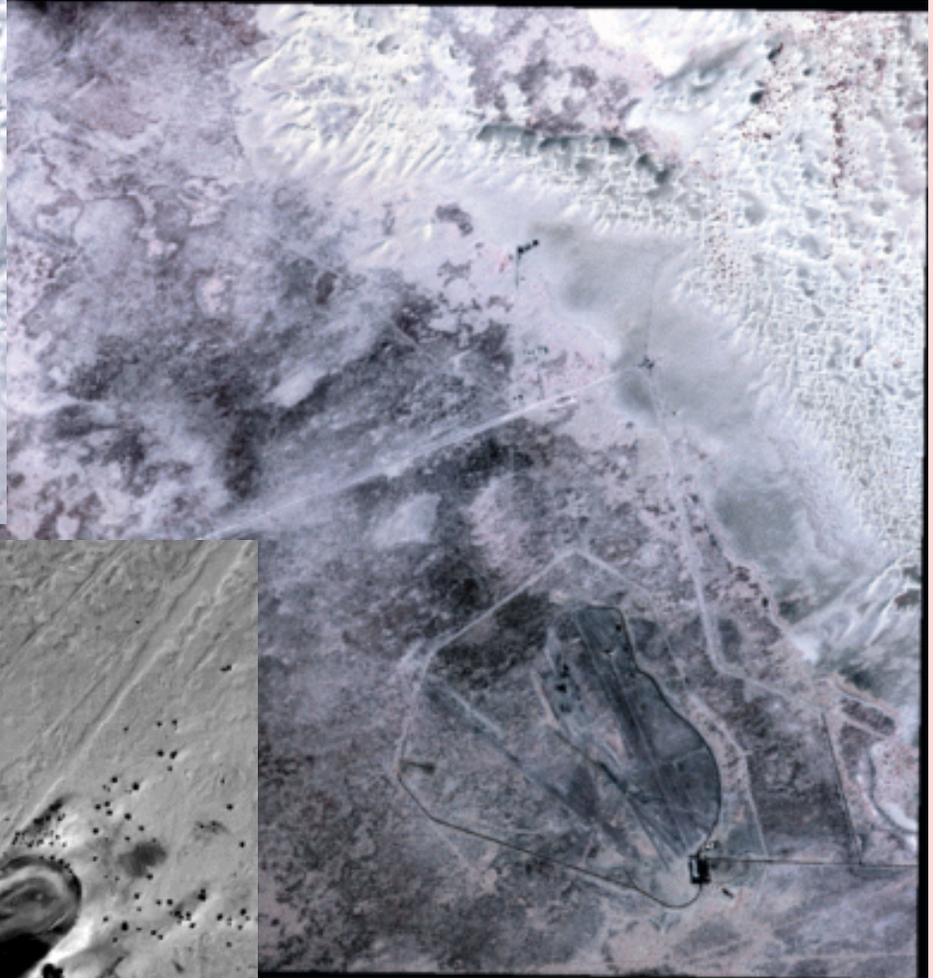
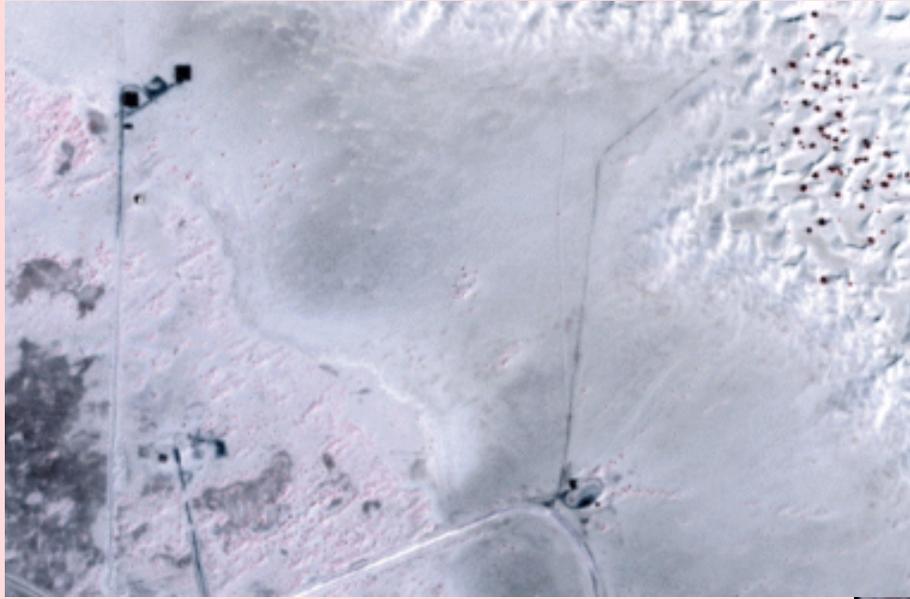
# Railroad Valley Test Site - Jan. 2004

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# White Sands Missile Range

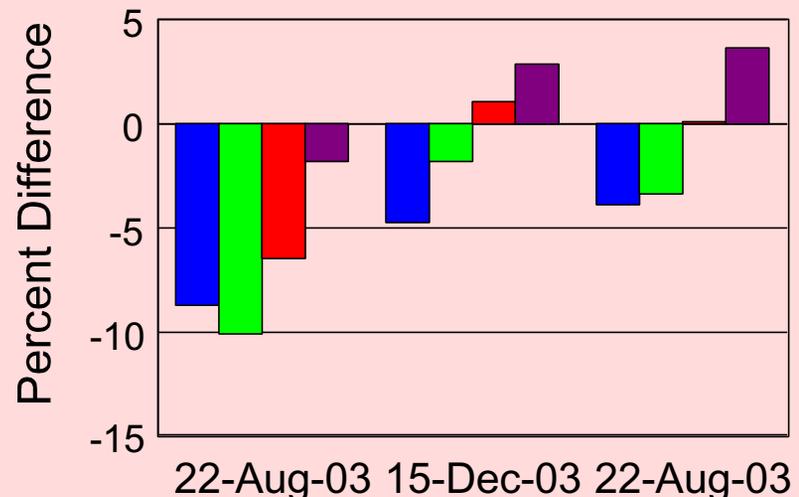
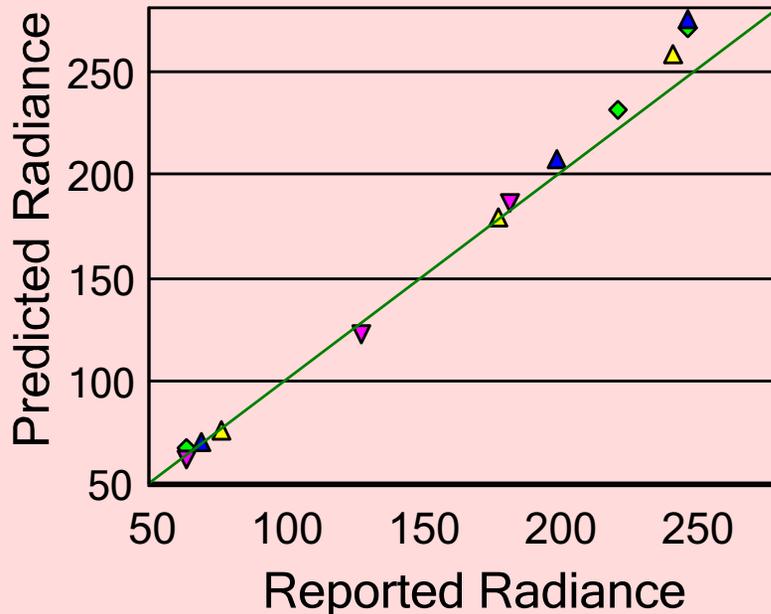
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# Results

Ground-based data from the three data sets were used to predict at-sensor radiance

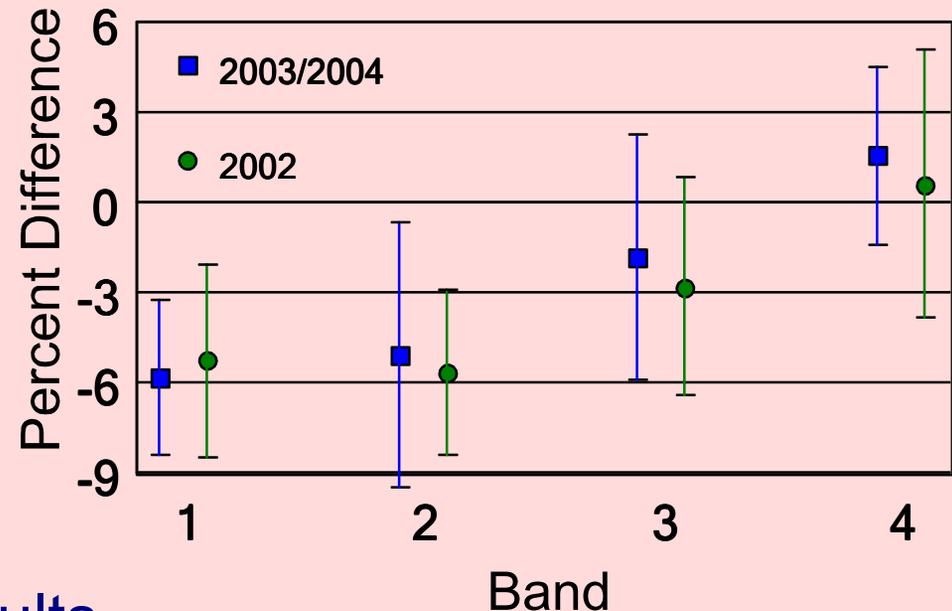
- At-sensor radiance also determined from the QuickBird imagery and supplied coefficients
- August 22 data set appears anomalous relative to other two
  - Similar behavior seen in the past
  - Possible error in aerosol parameterization



# Results - Comparison to 2002

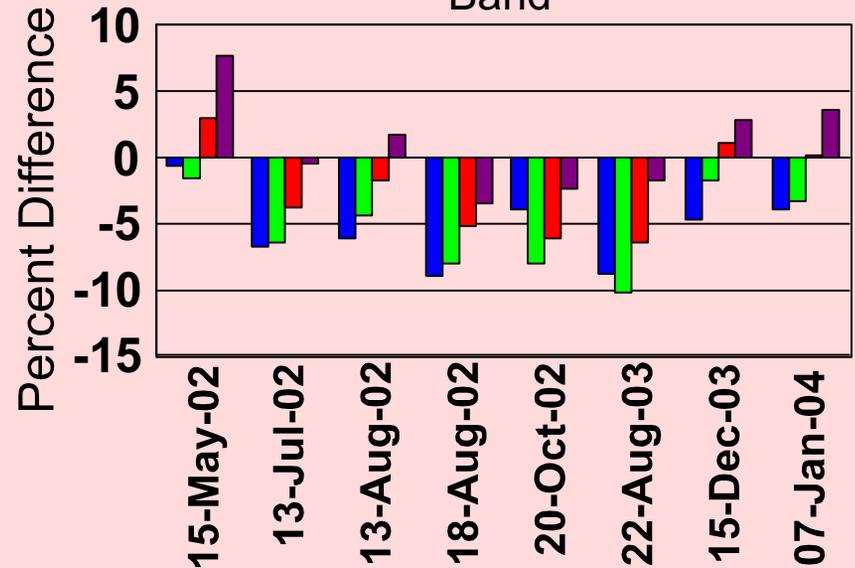
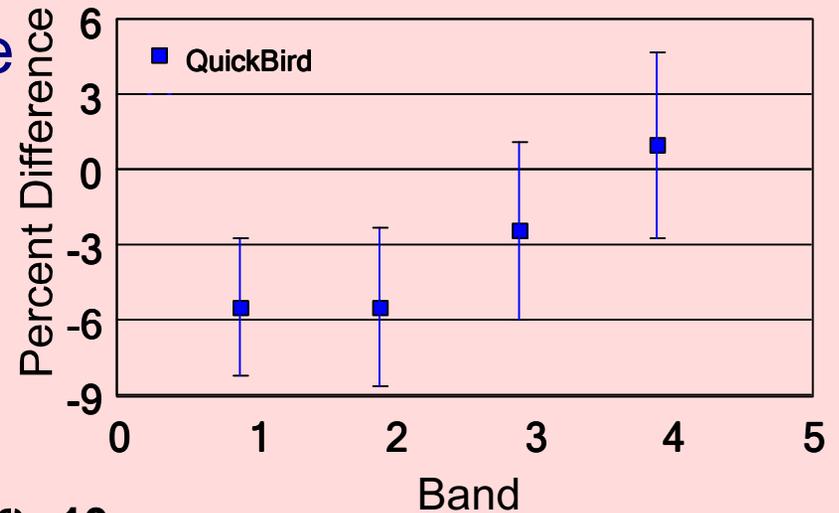
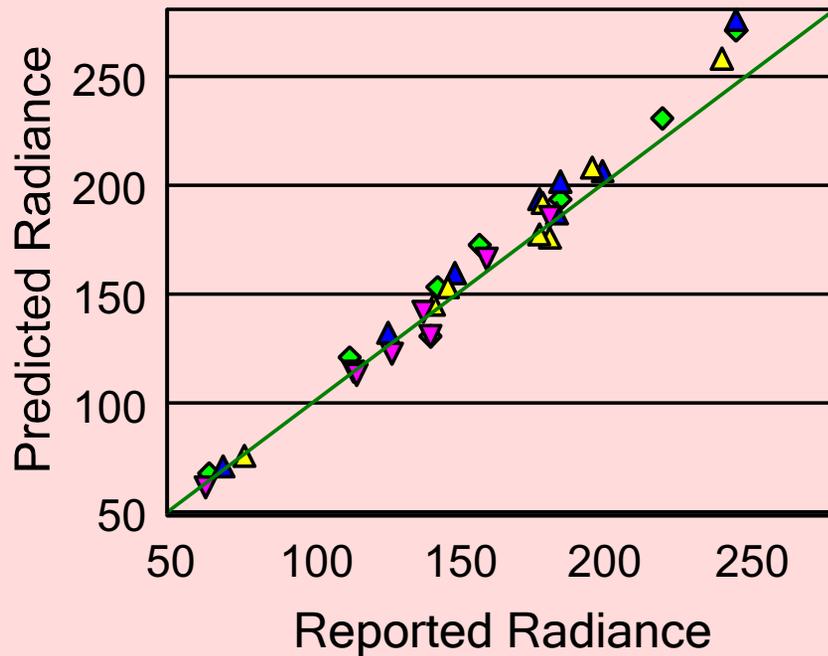
Computed average percent difference between ground-based predictions and image-based reported radiance

- Also computed standard deviation of this average
- Three current data sets comprise the 2003/2004 data set
- Five data sets comprised the 2002 work
- Averages are effectively identical between years
  - Sensor not changing
  - Vicarious results are repeatable
- Standard deviations are similar
- Biases from vicarious results are apparent



# All data

- Bias as a function of radiance is not readily apparent
- Standard deviations are between 2.8 and 3.7%
- Results are similar to those seen for other sensors

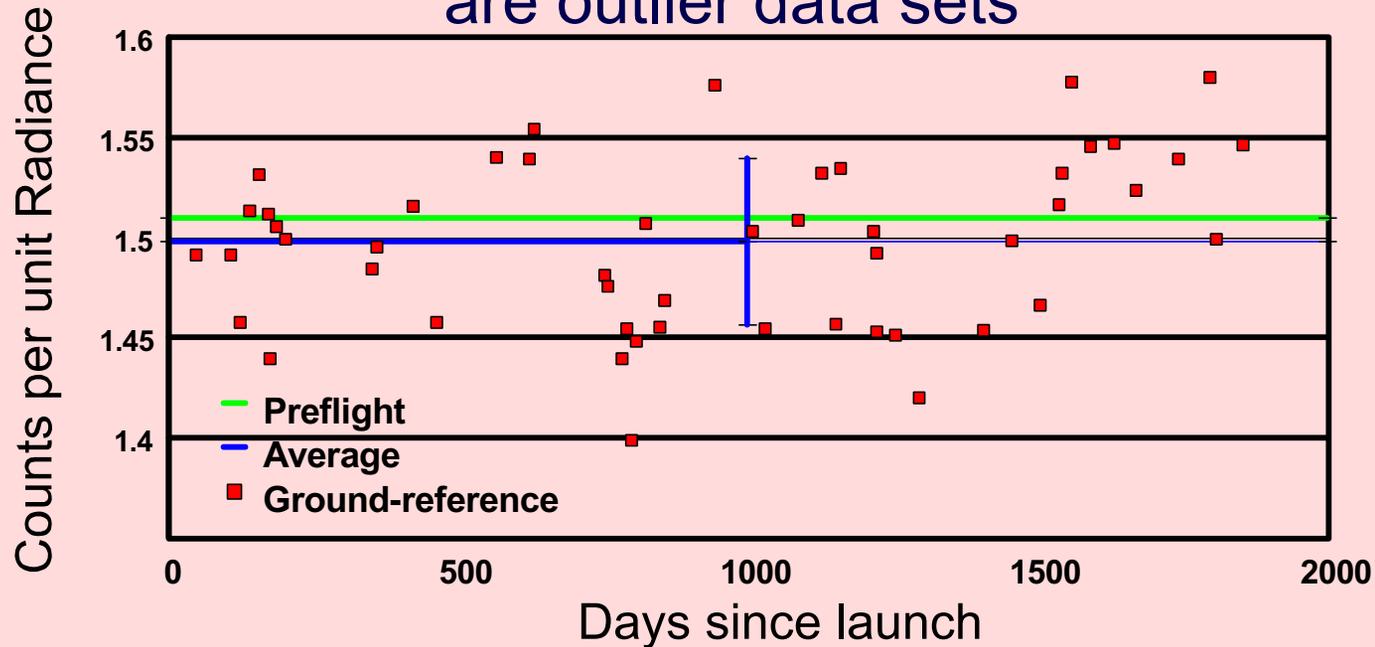


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# Errors in reflectance-based results

One major drawback of the reflectance-based approach are outlier data sets



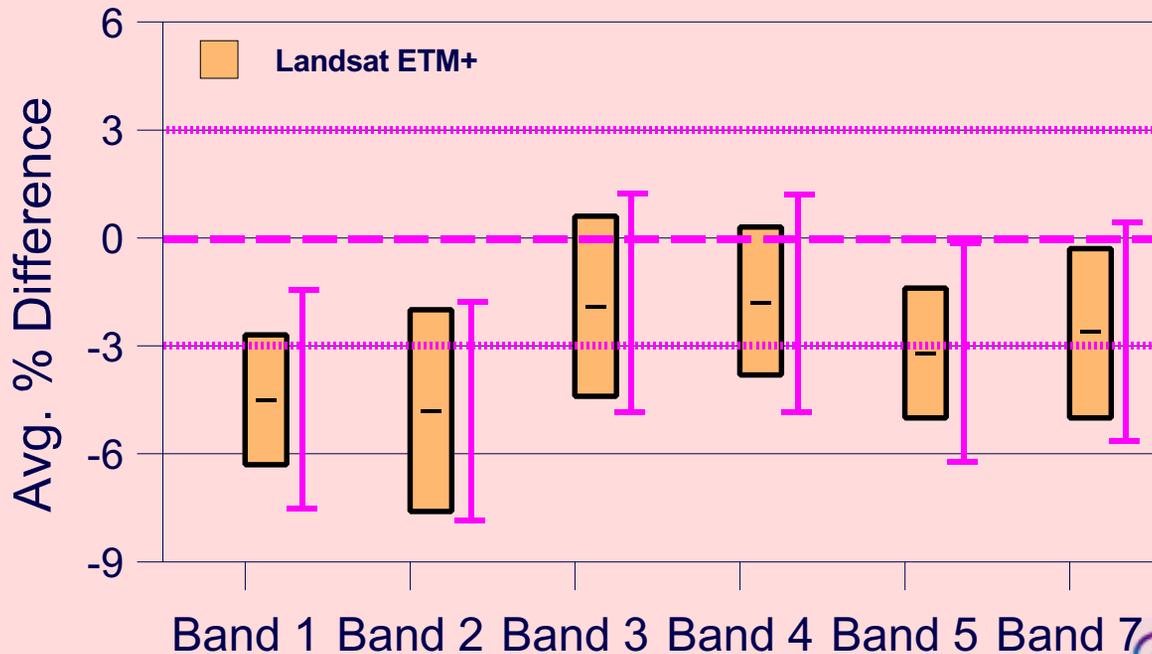
- ETM+ band 3 results shown above
- Examination of results does not show obvious cause
  - Some scatter likely from “errors” in surface reflectance
  - Outliers also due to anomalous atmospheres



# Repeatability

The repeatability of the reflectance-based method still provides an equivalent 2-3% precision

- Reflectance-based results from more than 40 ETM+ data sets
- Shows average and standard deviation along with 3% error bars



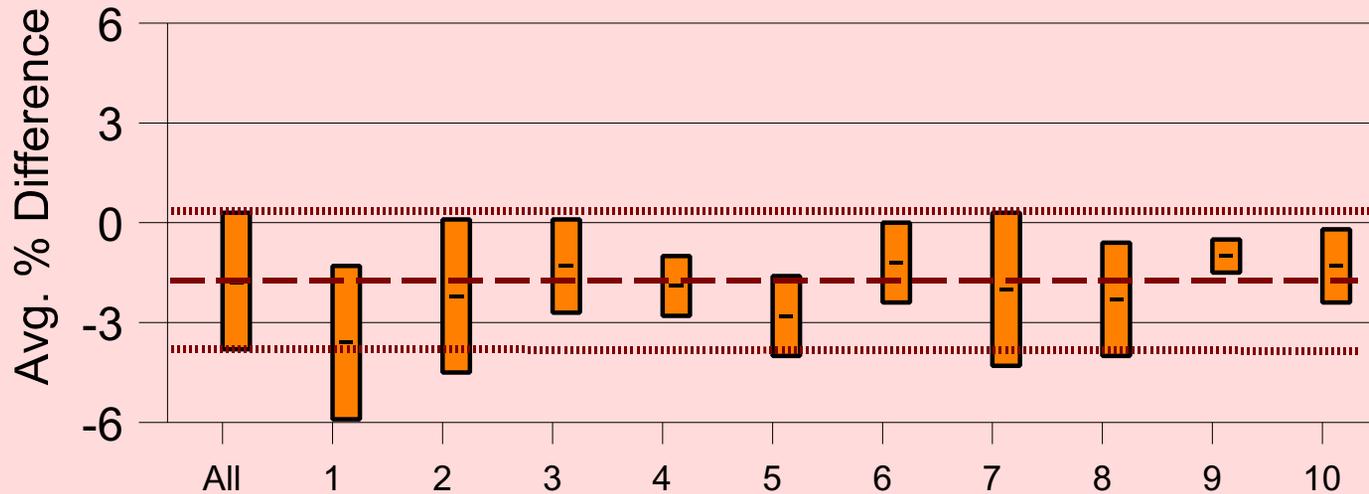
Biases are still an issue

Trending is still not a trivial proposition



# How many data sets is enough

Analysis of the ETM+ data set implies that as few as five reflectance-based data sets is sufficient to characterize the radiometric calibration



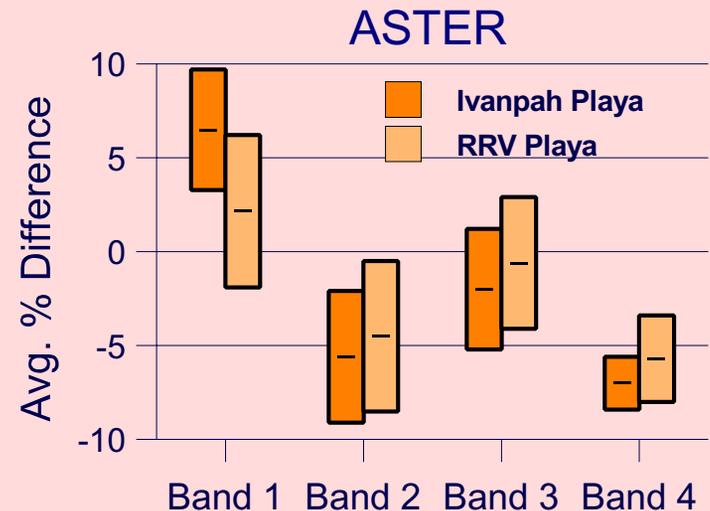
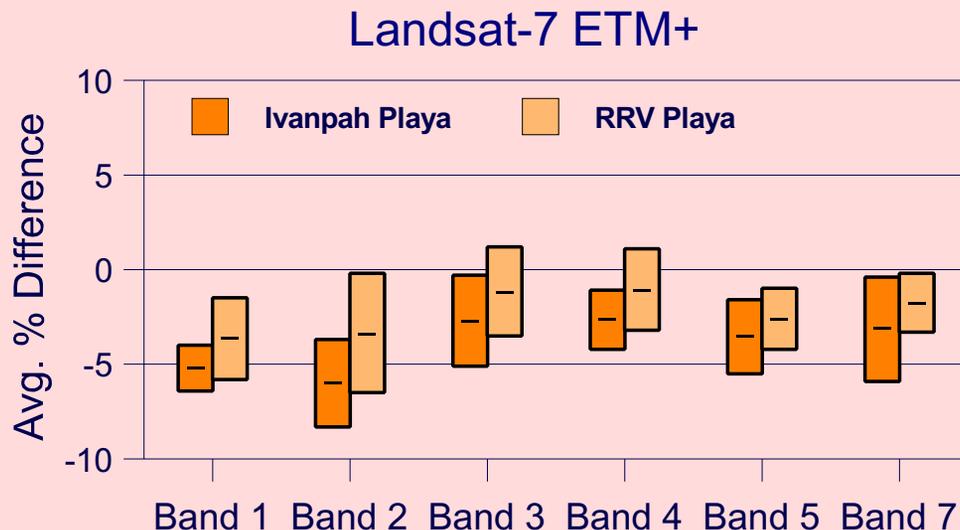
- Above are average and standard deviation from five randomly sampled data sets from full set of dates
- All of the data sets fall within 3% of original average
- These data sets included all test sites



# Repeatability by site

Differences between sites have been noted for several sensors

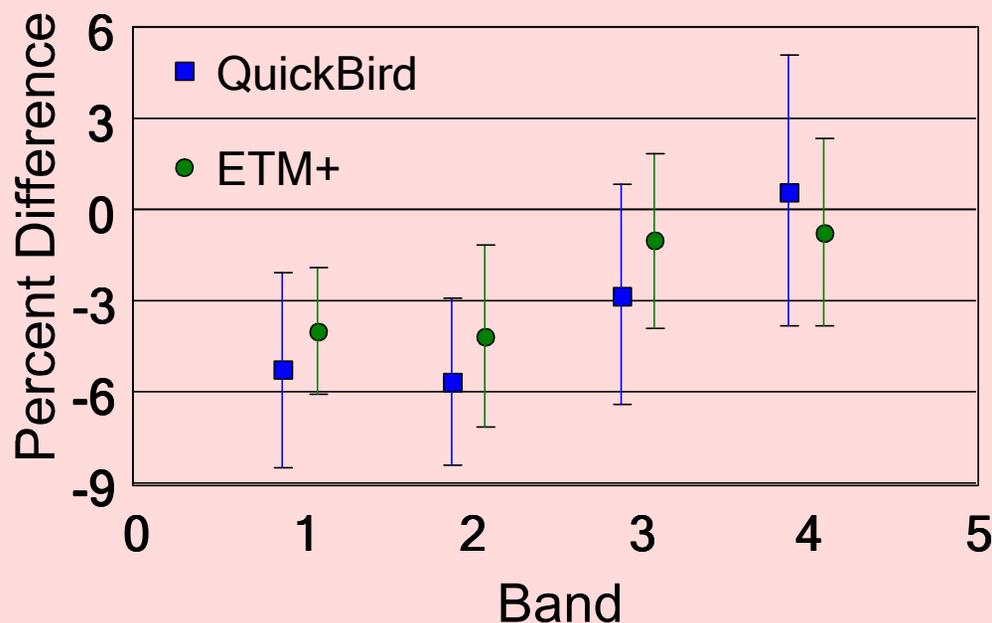
- Differences indicate possible site biases
  - Aerosol parameterization
  - Atmospheric adjacency effects
- Can also indicate instrumental effects
  - Stray light
  - Size of source effects



# When a bias is not a bias

The bias in the QuickBird data is repeatable

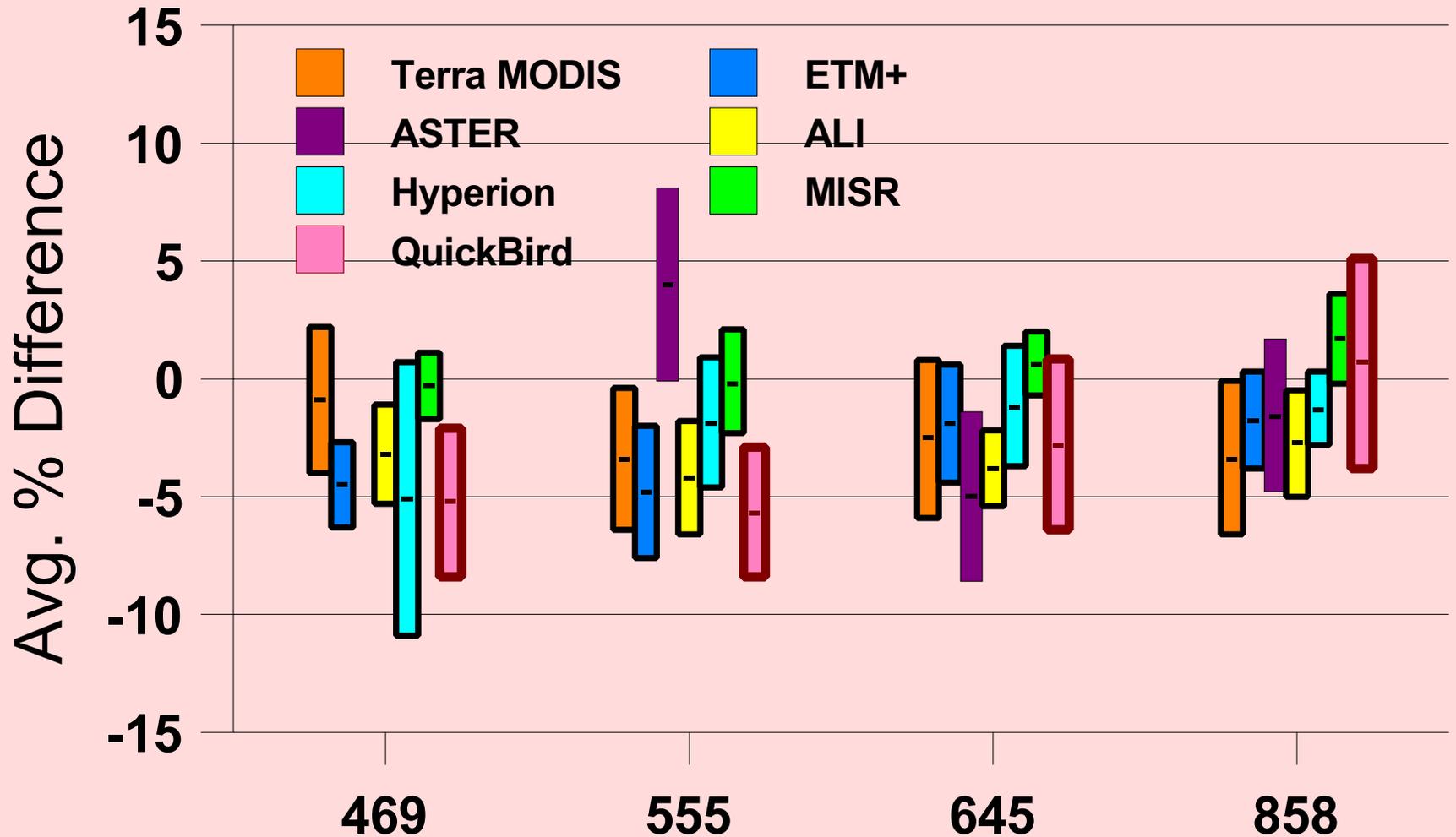
- As shown, there are also similar biases seen in the ETM+ data
- Biases seen for both ETM+ and QuickBird are similar
- Infer that ETM+ and QuickBird give similar results radiometrically



The two sensors agree to better than 2%

Current data sets agree to better than 1%

# Comparison with other sensors



# Conclusions and Future work

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QuickBird remains stable radiometrically since launch

- Current calibration coefficients provide agreement with Landsat-7 ETM+ to within 2% in all four bands
- Absolute agreement with vicarious results is within the combined uncertainties of the two methods
- The 3-5 data sets per group acquired to assess the radiometric calibration is sufficient to produce results at the 2-3% level of repeatability
  - Only true for stable sensors
  - Data sets should be from a single group
  - Results point to the use of a single site as well
- Plans are in place to repeat this work for QuickBird and Orbview-3 during 2004
  - Multiple sites
  - Joint with other projects

