Calibration and Cross-Calibration of MODIS using Railroad Valley

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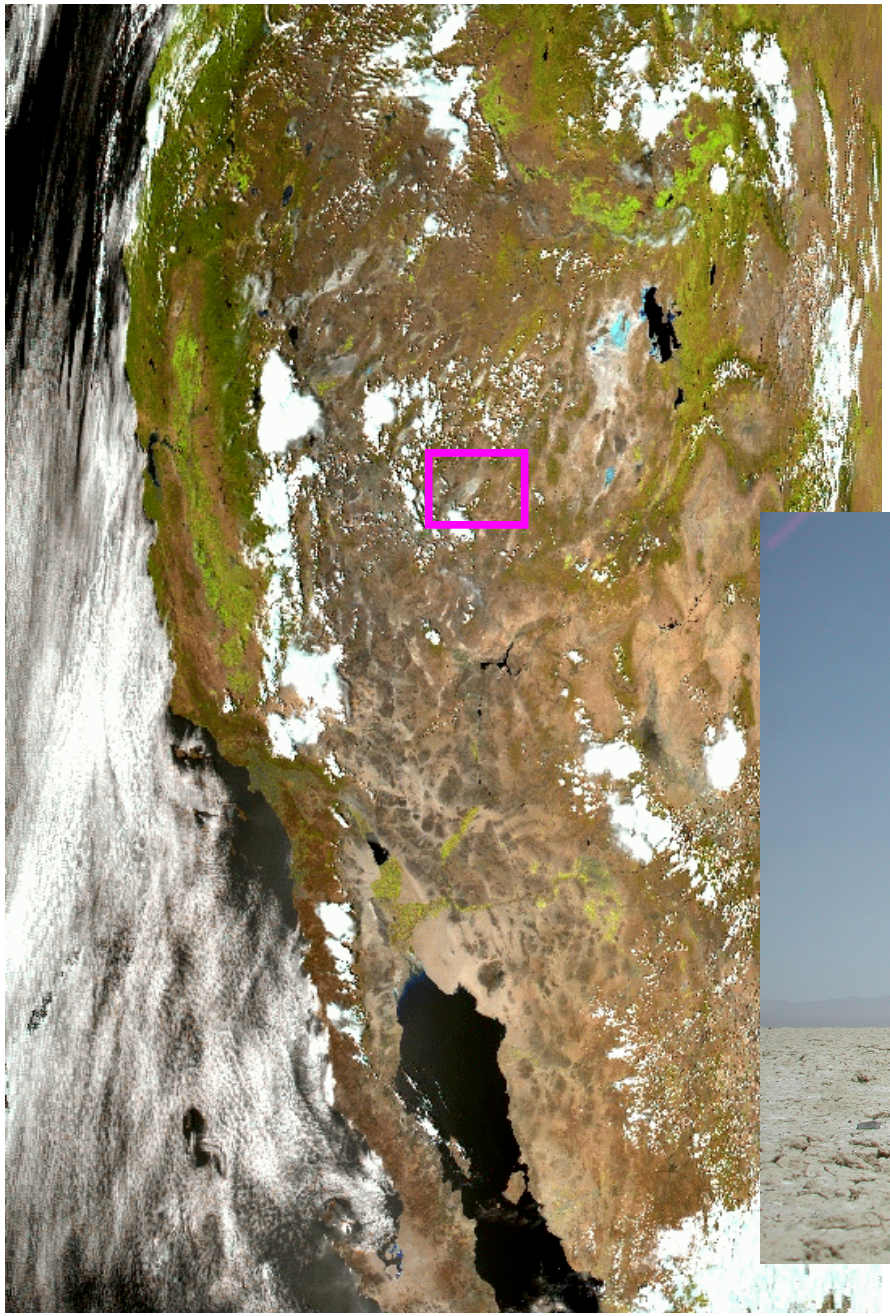
Introduction

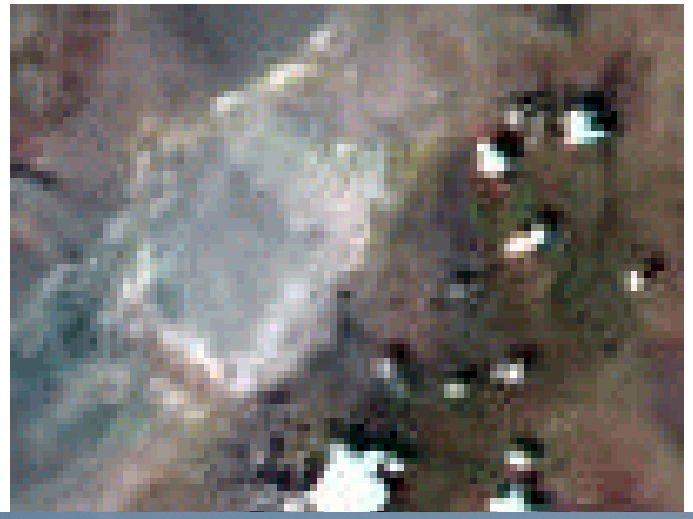
- Vicarious calibration results of the Remote Sensing Group at the University of Arizona
- Reflectance-based method
  - Surface reflectance measurements and atmospheric transmittance data are used as input to a radiative transfer code
  - Surface reflectance is collected over a 1-km^2 area
  - Radiative transfer code used to predict at-MODIS radiances
  - Compare predicted radiances to MODIS radiances from Level 1B
- Cross-calibration to ETM+
  - ETM+ data are used to determine the surface reflectance
  - This reflectance is used in an approach that is identical to the reflectance-based approach
  - Reduces effects due to inadequate sampling of the surface reflectance over a 1-km^2 area
  - Using ETM+ because of the high quality of the data and confidence in the sensor's calibration
  - Conversion to reflectance allows for easier correction of band-to-band differences, temporal differences, and different solar models

Data sets

- Have added four reflectance-based data sets for Terra MODIS since last meeting
  - May 14, 2002
  - May 16, 2002
  - June 15, 2002
  - June 17, 2002
  - Cloudy weather ruined six other attempts between November 2001 and July 2002 and equipment limits prevented a seventh data set
- Added one cross-calibration data set
  - February 9, 2002
  - Other dates will be added as the ETM+ data are obtained
- In addition, we attempted our initial calibrations of Aqua MODIS
  - July 11 - cloudy skies
  - July 13 - Successful collection and MCST supplied the imagery
  - July 15 - Cloudy skies

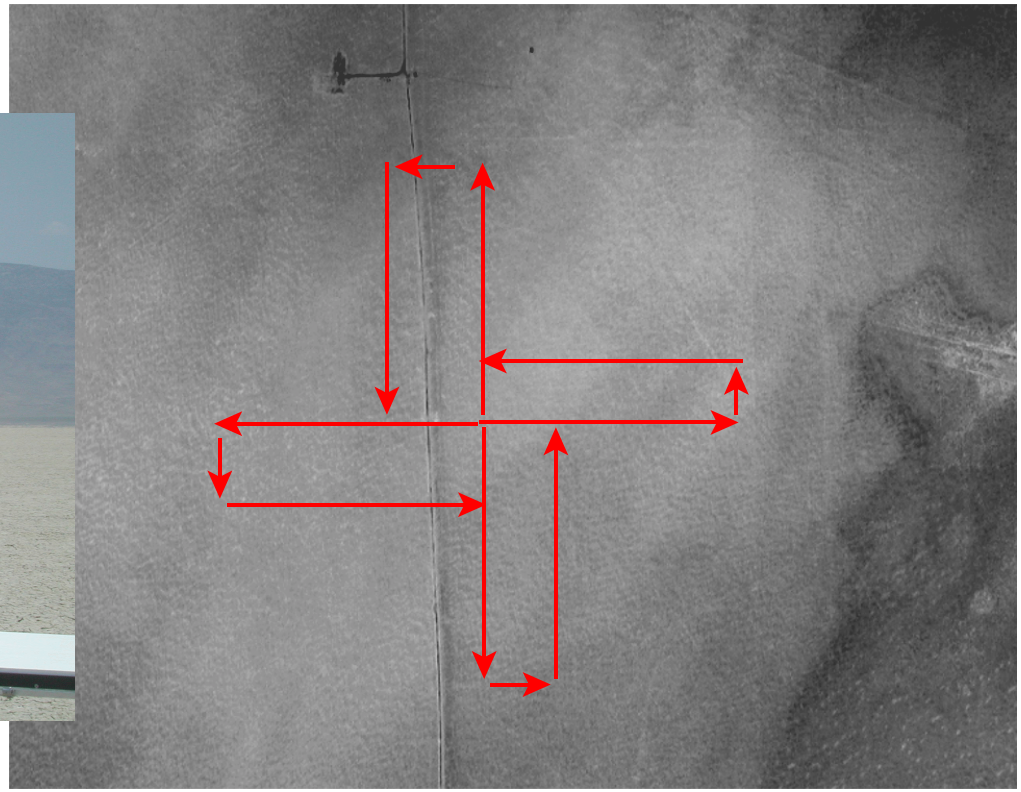
Railroad Valley test site - Images from Aqua



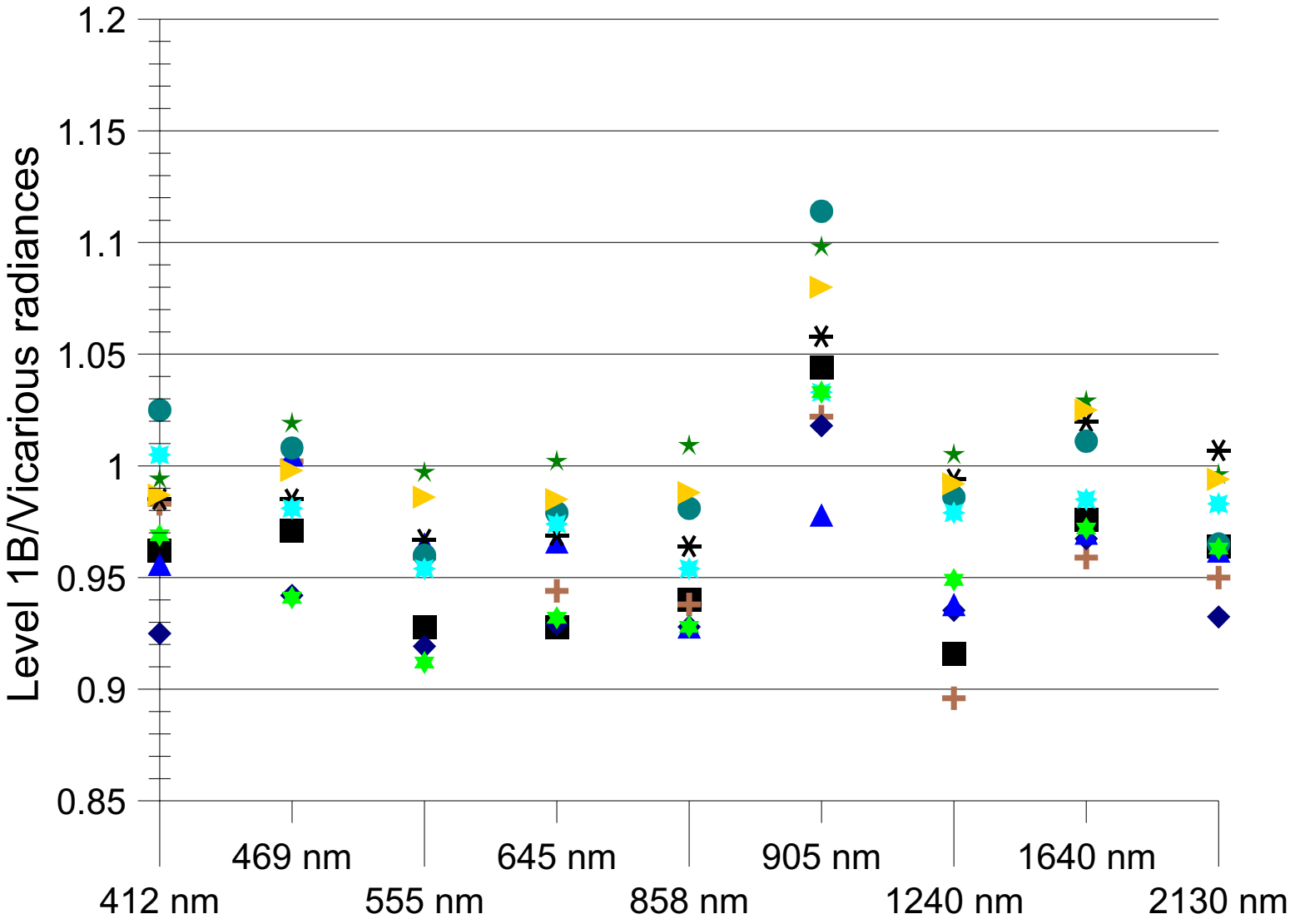


Surface reflectance retrieval

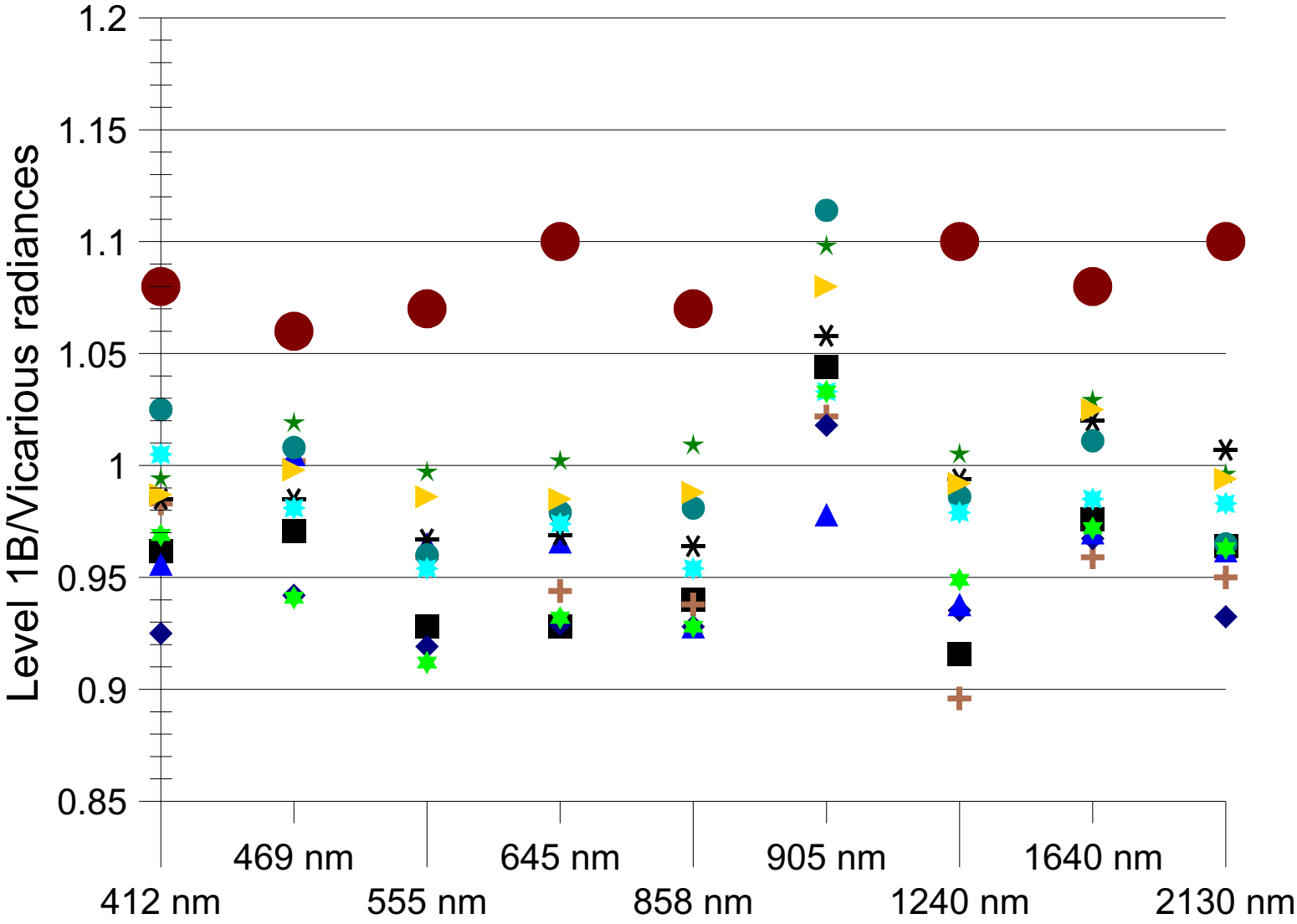
- Surface reflectance is found by referencing measurements of upwelling radiance from the test site to those of a panel of known reflectance
  - Reference panels are Spectralon
  - Radiometer reports data at 1-nm intervals from 350 to 2500 nm
- Directional reflectance effects are ignored (assume lambertian surface which is good to 2% for view angles out to 20 degrees and solar incident angles)
- Sampling strategy has 8 paths of 500 m in length separated by 100 m



Reflectance-based Results

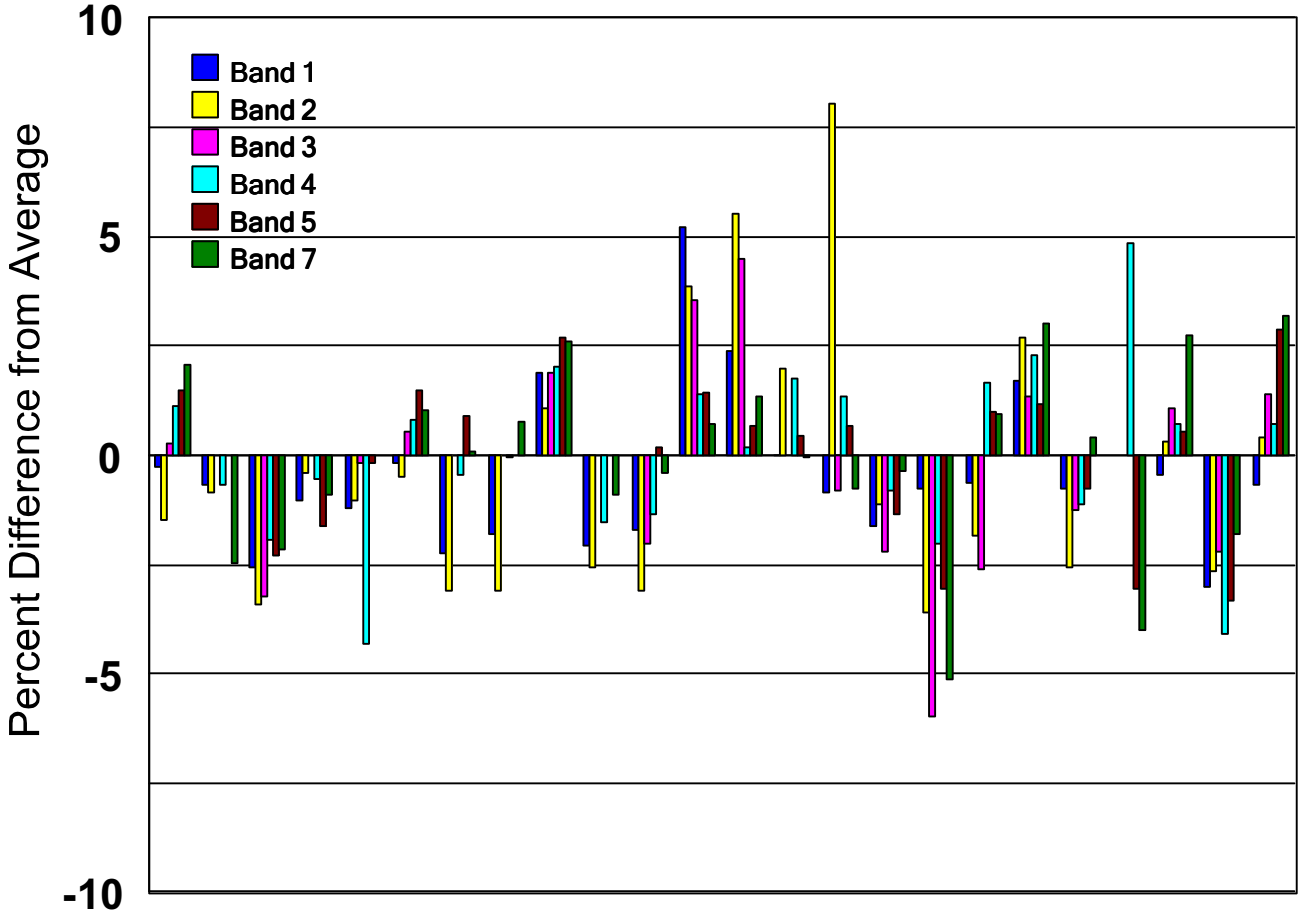


Reflectance-based Results

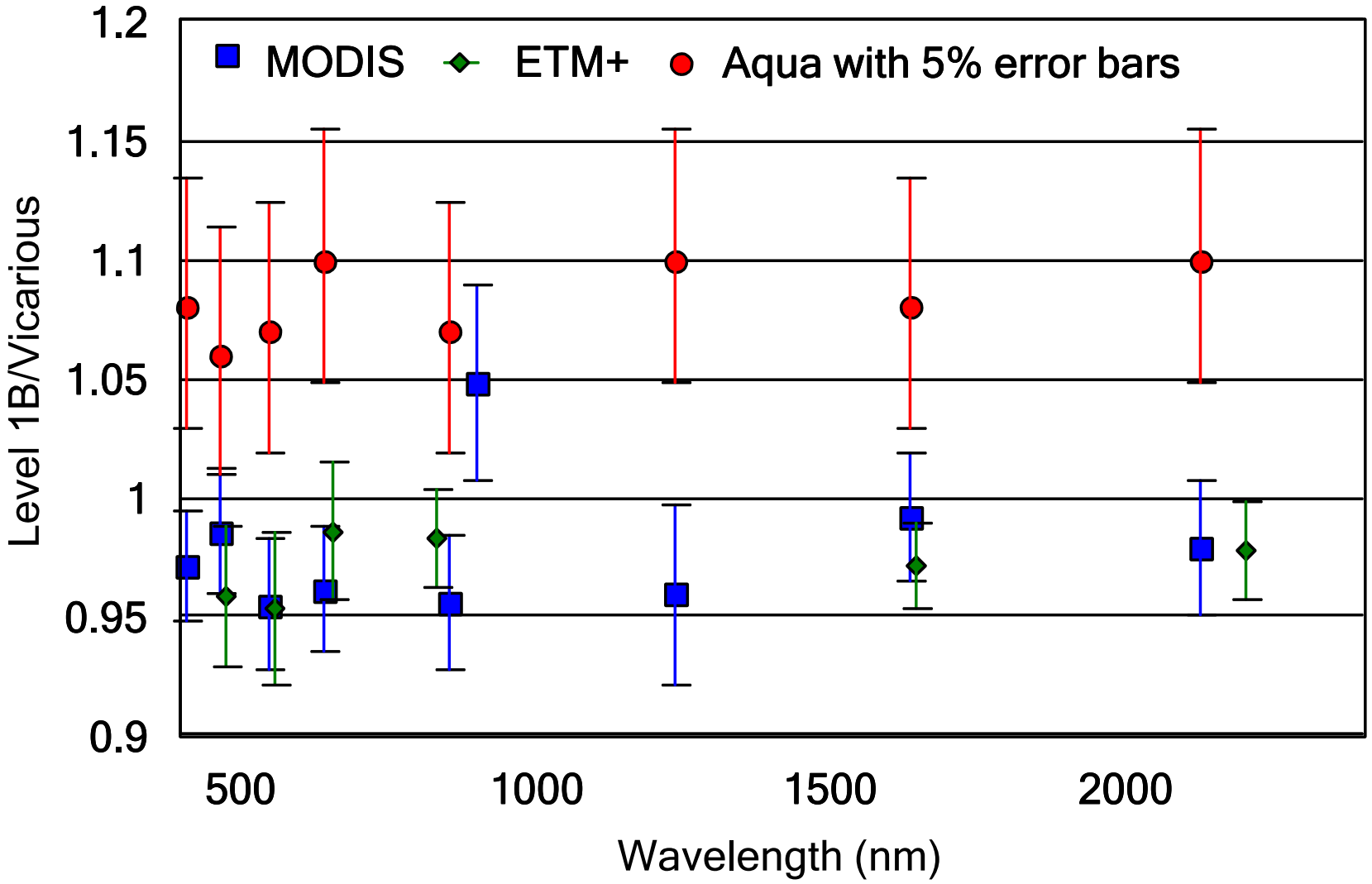


Probability of outliers

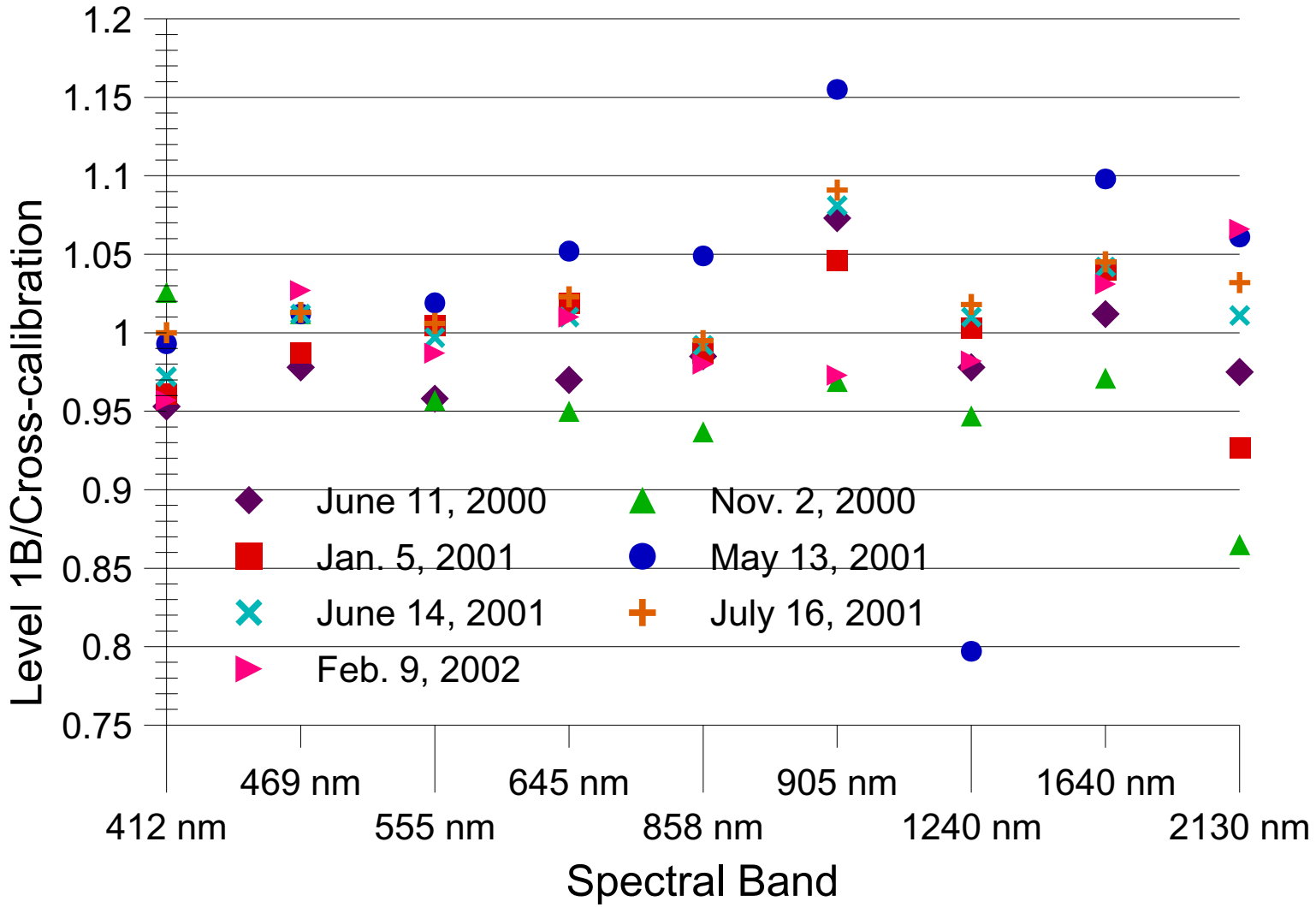
- Vicarious work can still suffer from periodic outliers
- Trying to understand the cause of these, but they are becoming rarer
  - Graph below shows 24 data sets for ETM+
  - Standard deviation of the average is 2.2%
  - 37 out of 155 points exceed the standard deviation and 7 exceed 2-σ (barely)



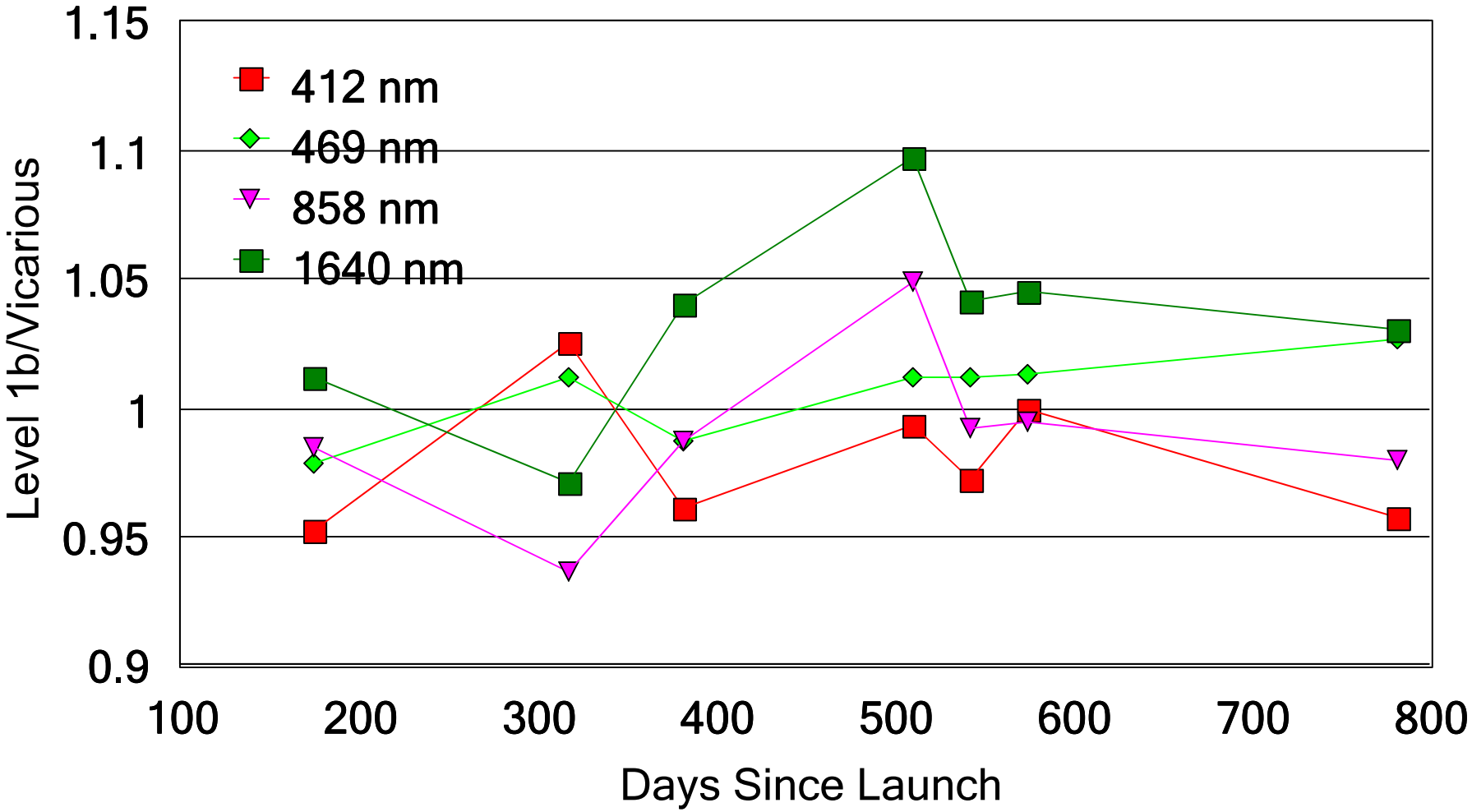
Comparison with ETM+ results



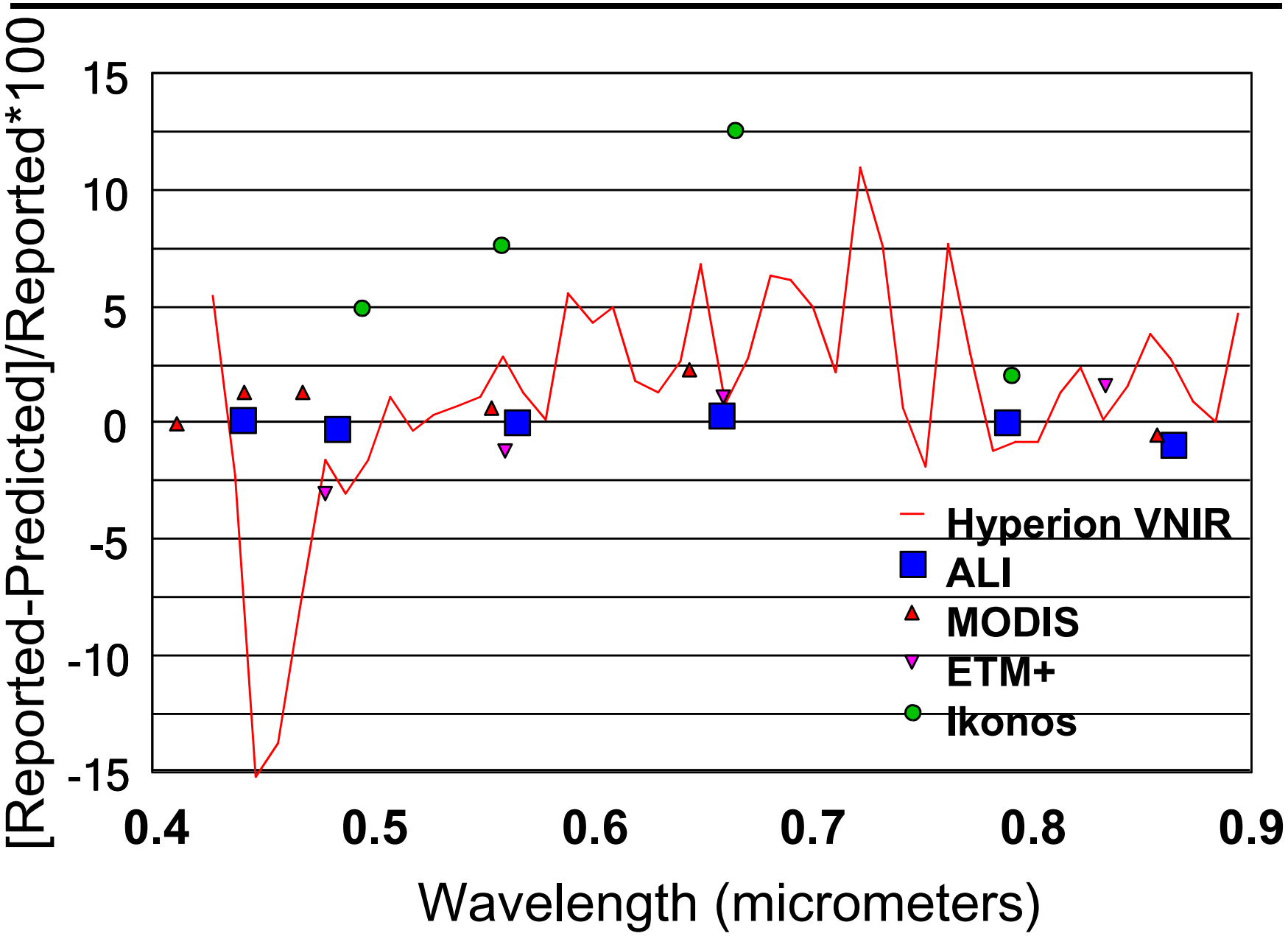
Cross-comparison to ETM+



Cross-comparison results



Cross-comparison to ETM+ - July 16, 2001



Conclusions and Future Work

- Agreement between Terra and Aqua is encouraging at this point in the mission
  - However, need to better understand the differences between the vicarious and Aqua MODIS
  - Reflectance-based accuracy is approaching 3% in visible and near infrared and precision is near 2% [1-σ]
  - Experience with Terra MODIS and Landsat-7 ETM+ gives confidence that these differences between Terra and Aqua are real
- Still, the vicarious data have been known to produce outliers
  - Had hoped for multiple days to mitigate this effect
  - Results from Terra on July 12 would have also given us further confidence in the results
  - Afternoon overpass increases odds of clouds thus reduces the probability of a successful ground comparison
- Upcoming work planned for August 11-22
  - 5 overpasses of Aqua with view angles <30 degrees will be attempted at Railroad Valley over a two week period
  - Includes at least three attempts at Terra
  - So, at this point it is a wait and see attitude
- Thanks to Jack Xiong and Junqiang Sun for taking the time to get us the Aqua MODIS imagery