RSG Vicarious Calibration Results and Automated Approach

Jeffrey Czapla-Myers
Remote Sensing Group ~ Optical Sciences Center
University of Arizona

Presented at
MODIS Science Team Meeting

Baltimore MD
22 Mar 2005

Topics

- Recent reflectance-based results for MODIS
- Summer 2004 field campaign
- Radiance calibration of MODIS and MISR
- MODIS/ASTER cross calibration
- Automated approach to ground-based vicarious calibration using LED radiometers
- Future work

RSG Field Campaigns at Railroad Valley, NV

- Successful collection

  2004

  - 2 Jul (A)
  - 4 Jul (A)
  - 9 Jul (A)
  - 10 Jul (T)
  - 11 Jul (A)
  - 26 Sep (T)
  - 13 Dec (T) +
  - 15 Dec (T) +

  2005

  - 12 Mar (T)
  - 13 Mar (A)
  - 14 Mar (T)
  - 15 Mar (A)

- Unsuccessful collection due to bad weather or site inaccessibility

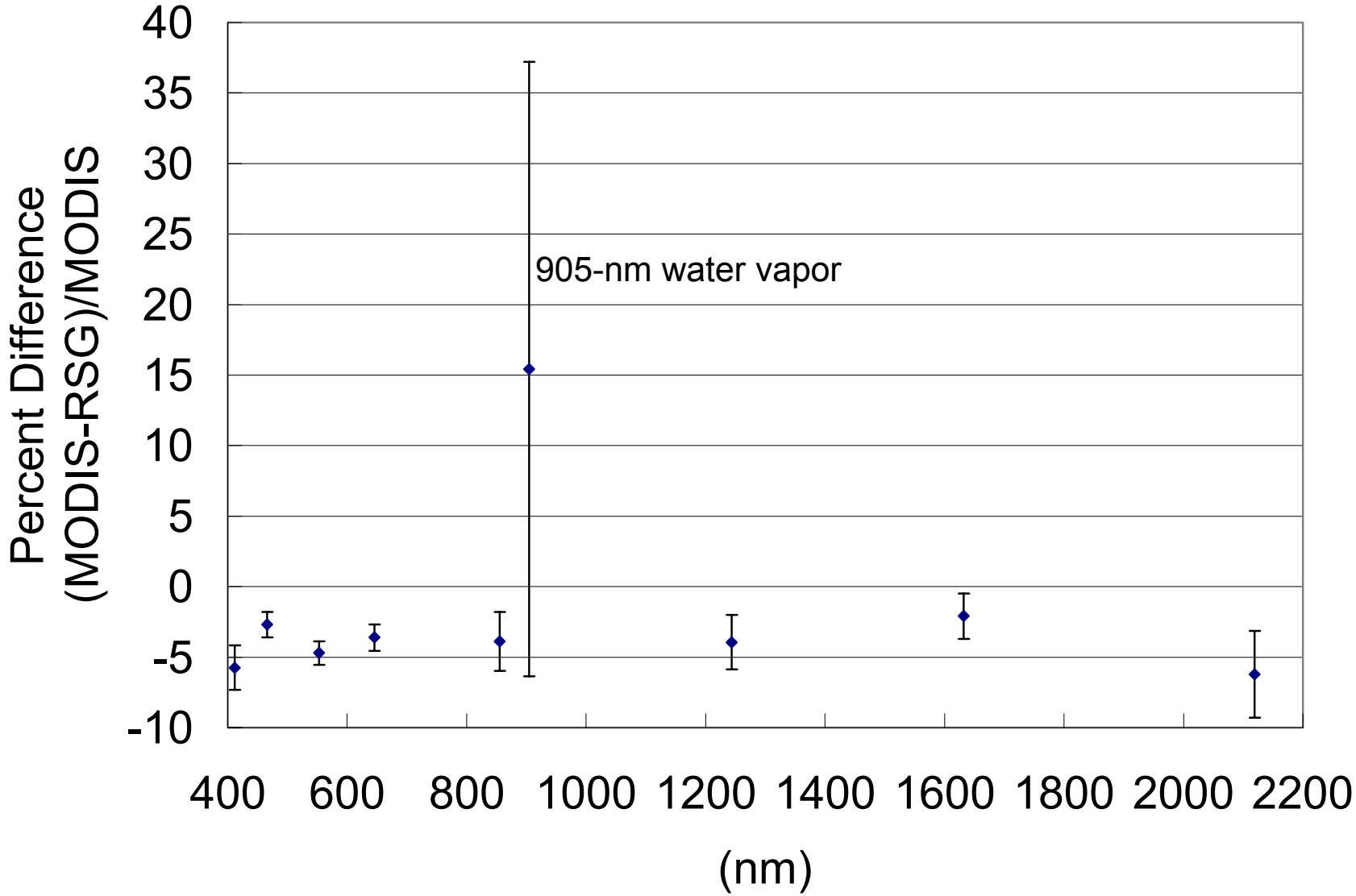
  2004

  - 6 Jul (T)
  - 8 Jul (T)
  - 9 Aug (T)
  - 18 Sep (A)
  - 22 Oct (A)
  - 24 Oct (A)
  - 26 Oct (T)
  - 13 Nov (T)
  - 9 Dec (A)

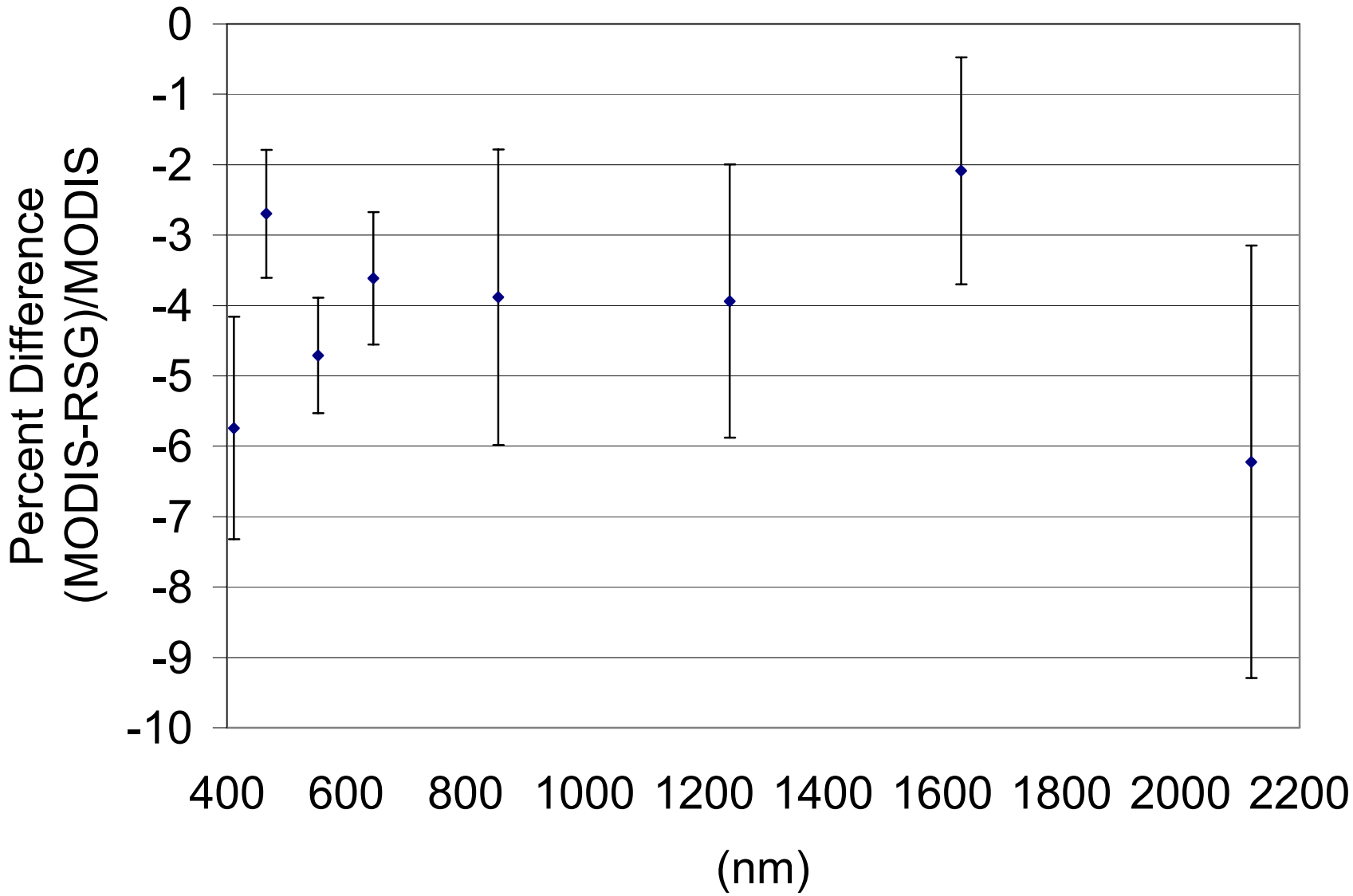
  2005

  - 10 Jan (A)
  - 16 Jan (T)
  - 17 Feb (T)
  - 5 Mar (T)

Updated MODIS Results



Updated MODIS Results



2004 Summer Campaign

- June-July dates were part of larger effort to understand equipment and playa
- RSG's mobile lab was in Nevada from 14 June to 11 July
- Four Aqua MODIS and one Terra MODIS data collections

Railroad Valley Marriott Hotel

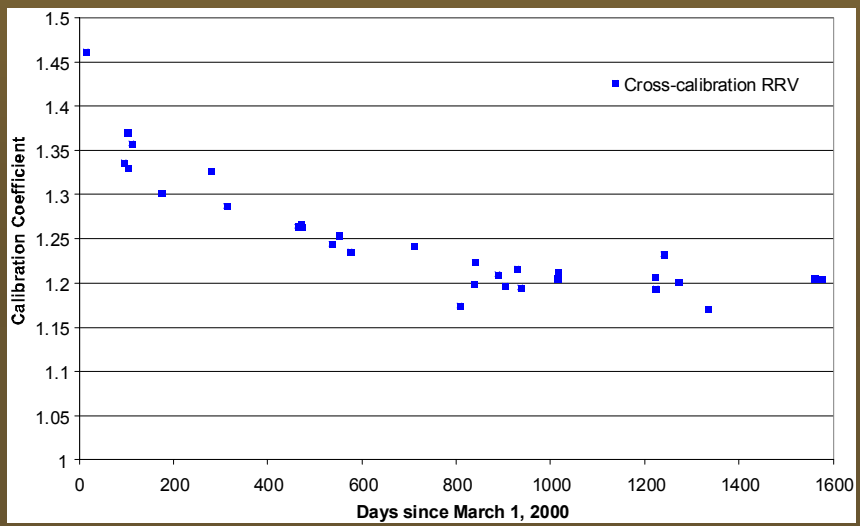
Field Measurements: Summer 2004

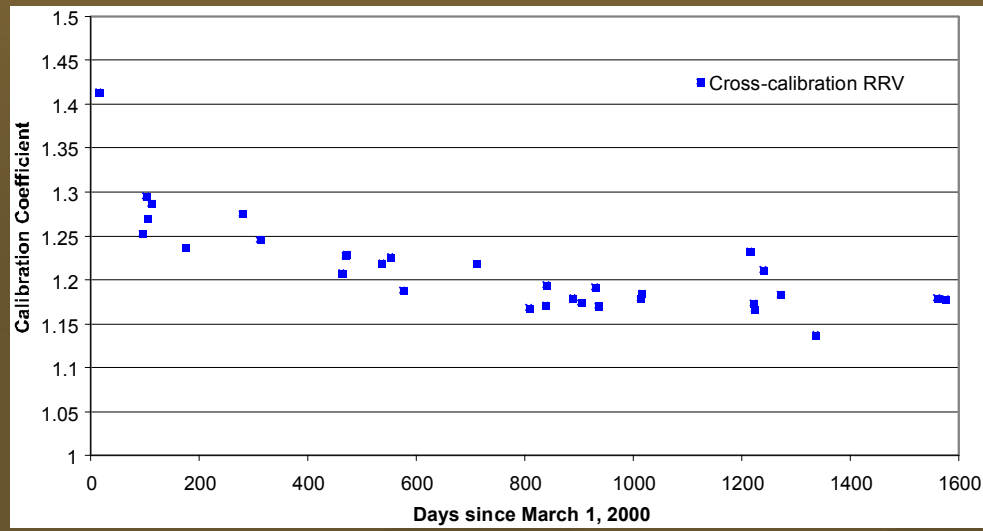
- Surface reflectance measurements at Ivanpah Playa, CA
  - Measure radiance from playa using transfer radiometer, and well-calibrated reference panel
  - Ratio these values to get surface reflectance
  - Compare to ASD measurements
  - Most bands agree very well except 666 nm
- Surface-leaving radiance at Ivanpah Playa, CA
  - Measure radiance with transfer radiometer just above ground
  - Compare to radiance calculated using radiative transfer code
  - Compare computed vs. measured band-averaged radiance
  - 163.69 vs. 162.96 W m^{-2} sr^{-1}, difference of 0.45% at 666 nm
- MODIS/MISR radiance comparisons of Railroad Valley, NV
  - Six dates between Jun & Dec 2004
  - Average percent difference between MODIS and MISR bands:
    - Blue: 1.5%
    - Green: 0.6%
    - Red: 1.1%
    - NIR: 0.2%

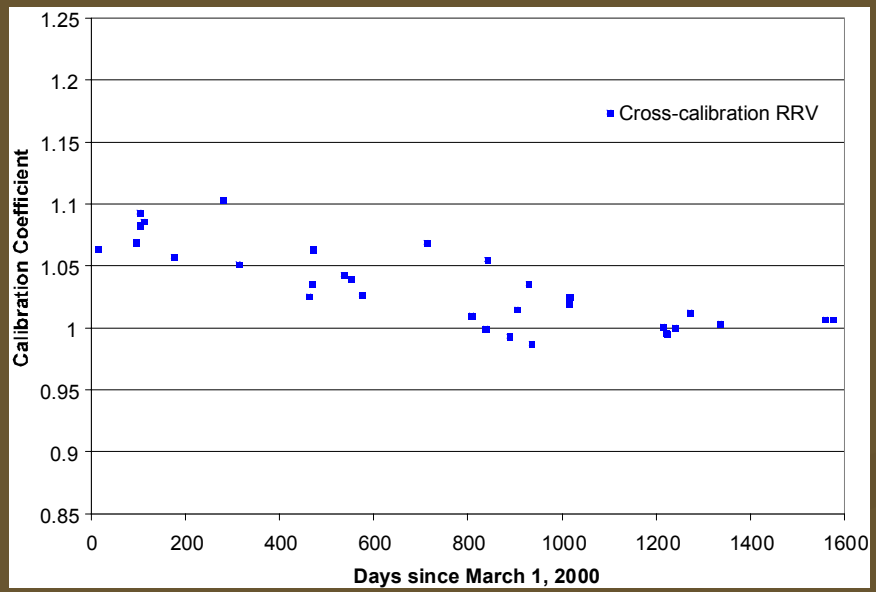
ASD studies

VNIR transfer radiometer

ASTER Cross Calibration Using MODIS



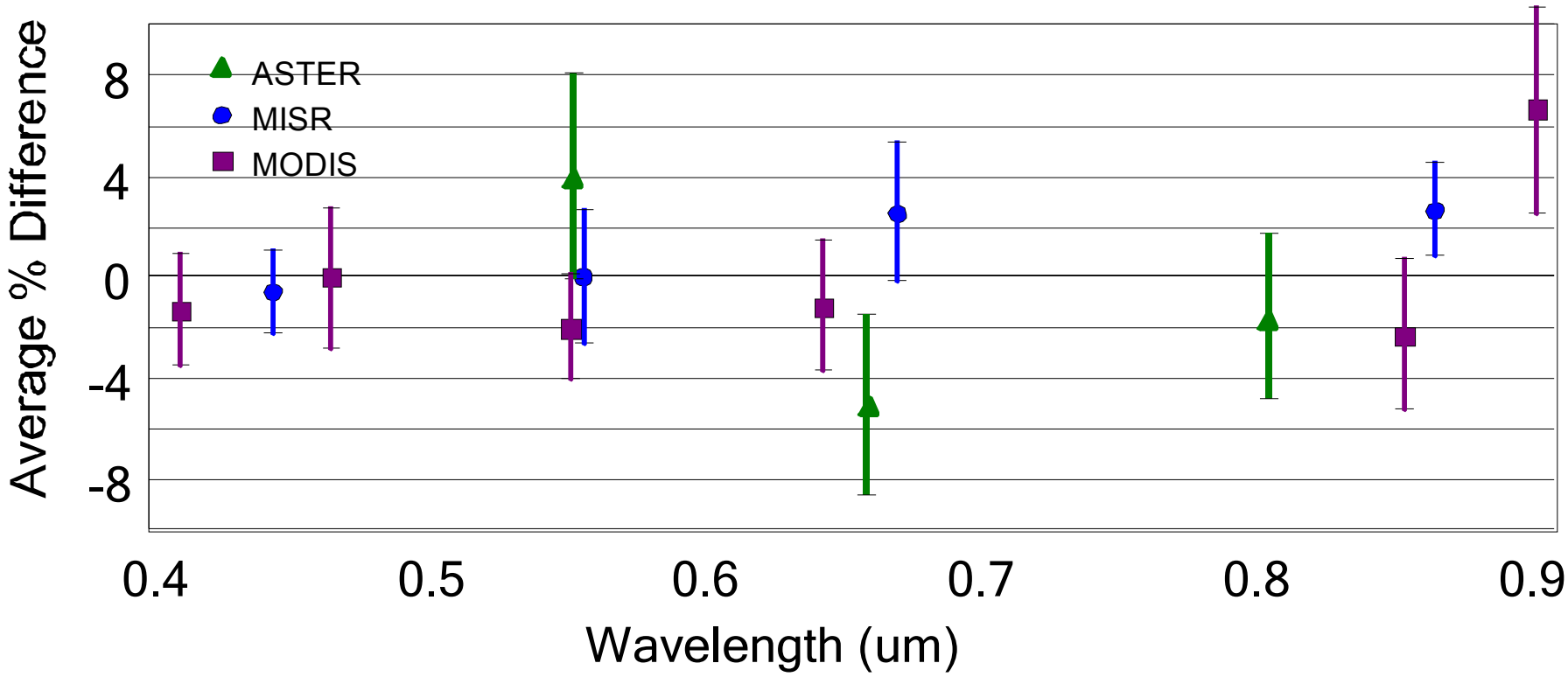




- Using MODIS to understand other sensors on Terra
  - Sensor geometries are equal
  - Viewing through same atmosphere
  - Surface reflectance the same for nadir view

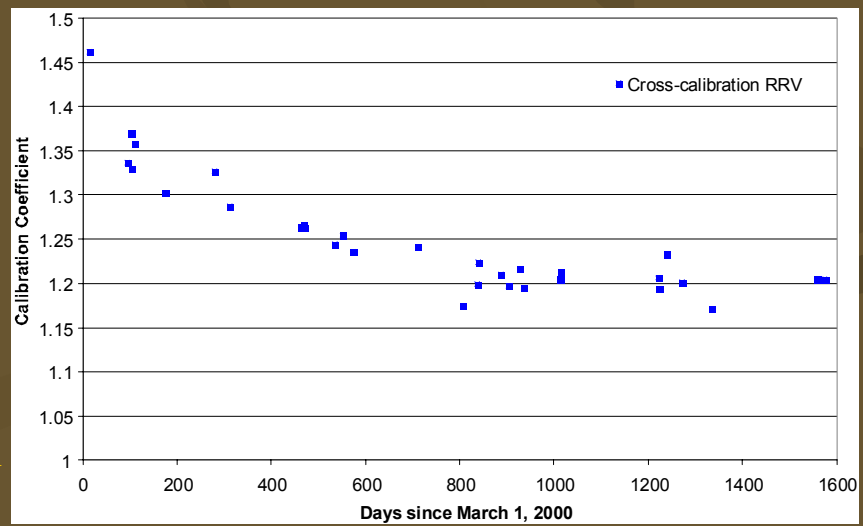
Comparison of MODIS with MISR and ASTER

- ASTER dates are after Aug 2002
- MISR and MODIS results use the same nine dates



Methodology for Automated Ground-Based Vicarious Calibration

- Would like fill in the gaps when we are not at test sites
  - MODIS and Landsat 7 ETM+ are always on
  - Would like additional points for trend line clarification
- Bad weather and equipment malfunction can limit data collection
- Based on the reflectance-based approach
- Requires different instruments to do the job without personnel
  - ASD → LED (surface reflectance)
  - ASR → Cimel sun photometer (atmospheric conditions)
- Elements that need to be accounted for:
  1. Surface reflectance of test sites
  2. Climate conditions
  3. Sky radiance



ASTER band 1

LED Radiometers

- Have been used before (e.g. GLOBE project)
- Critical element needed to measure surface reflectance
- Basically an LED used in reverse
- Readily available, inexpensive, robust, and built-in spectral selection
- Three bands: 522, 612, 837 nm
- Laboratory calibration
  - Spectral responsivity
  - Temperature stability
  - Field of view
- Five LED radiometers currently deployed at Railroad Valley
  - Four on MODIS site
  - One on corner of Landsat/ASTER sites

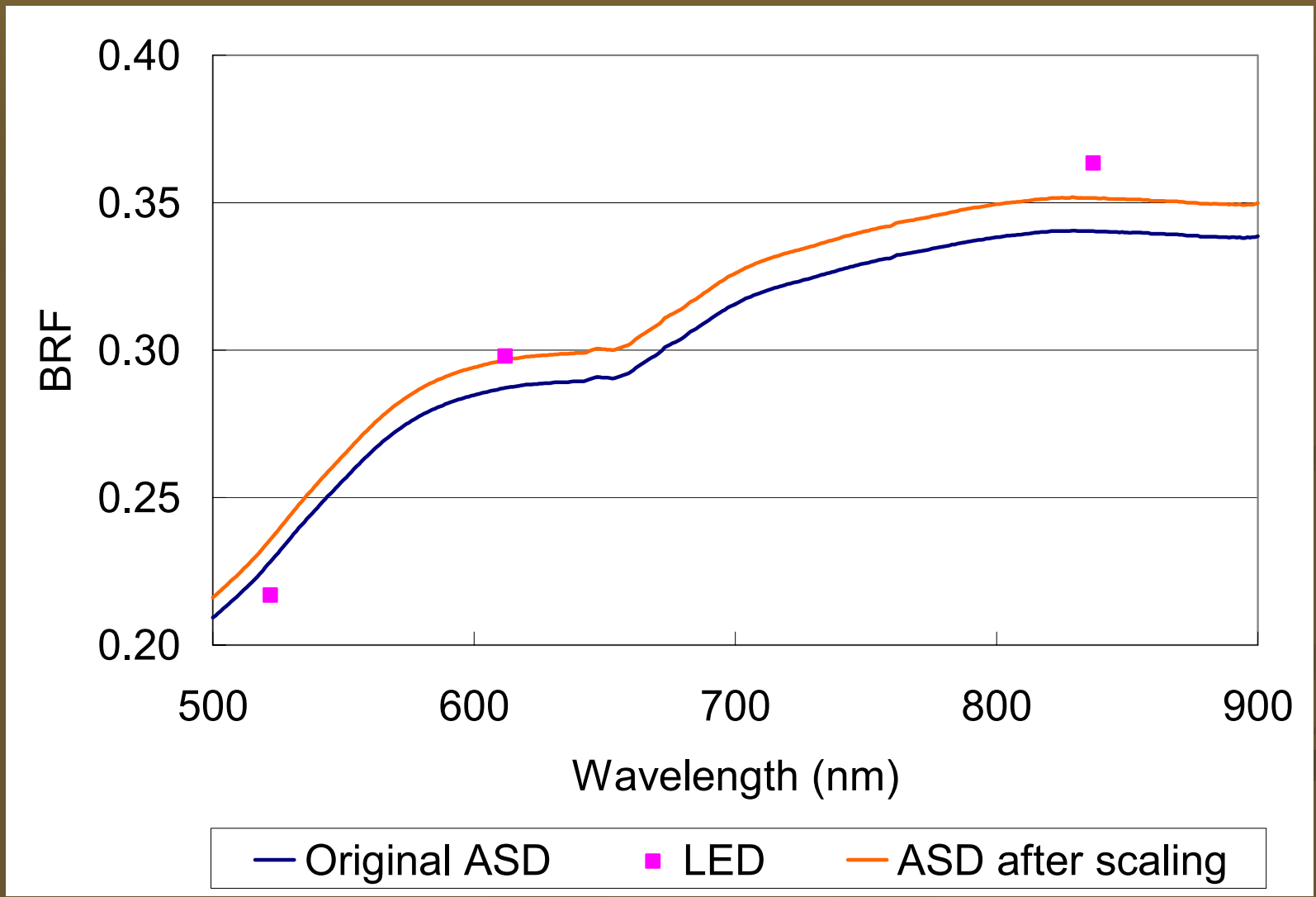
Deployment at Railroad Valley

AERONET

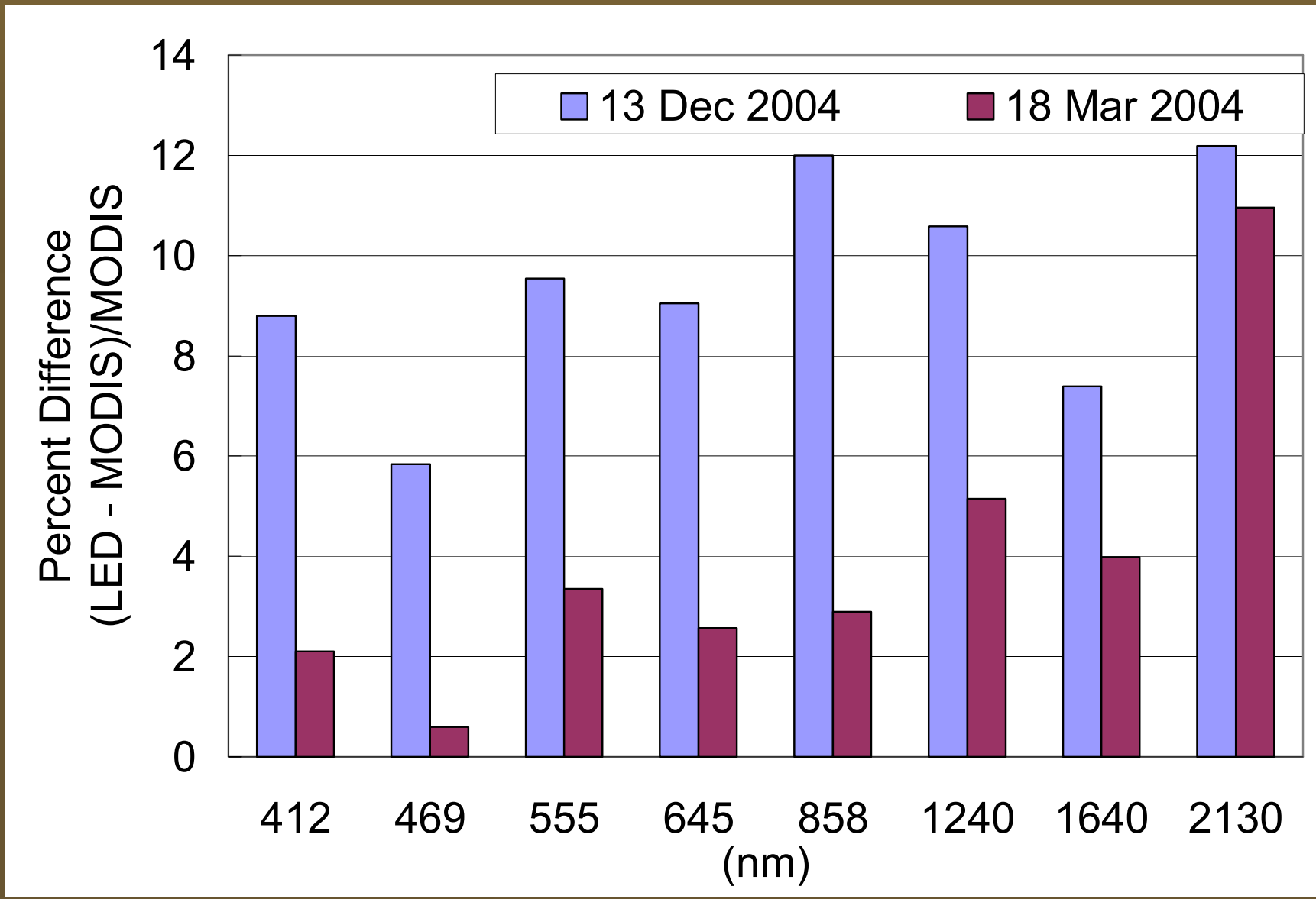
- Provides:
  - Atmospheric optical depth
  - Aerosol size distribution
  - Columnar water vapour
- Retrieved data used in RTC

Preliminary Results:
18 Mar 2004 & 13 Dec 2004

13 Dec 2004 ~ Railroad Valley



Results


Percent Difference
(LED - MODIS)/MODIS
14
12
10
8
6
4
2
0
13 Dec 2004
18 Mar 2004
412
469
555
645
858
1240
1640
2130
(nm)

Concerns

- Spectral calibration: required for each LED?
- Temperature-dependent spectral responsivity
- Quality control from batch to batch?
  - Same as Si detectors?
  - Will we have to measure each batch for responsivity vs. temperature? Not sure…
- Number of LEDs required on site?
  - Must account for spatial variations
  - Use of high-resolution imagery to determine locations of LED radiometers

Next Stage

- Process more MODIS data
  - Six dates in 2004
  - Four dates in 2005
- In the lab:
  - Build and test more LED radiometers
  - Test spectral responsivity of LEDs with varying temperature
- Data reduction
  - Integrate AERONET data
  - Compare results to those reported by MODIS