Landsat Radiometric Calibration: Towards a 20-Year Record of Calibrated Thematic Mapper Class Data for Carbon Cycle Studies

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http addresses:
http://ltpwww.gsfc.nasa.gov/IAS/handbook/handbook_htmls/chapter13/chapter13.html
http://landsat.gsfc.nasa.gov
http://Landsat7.usgs.gov/

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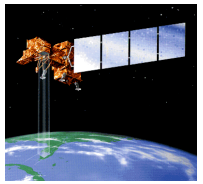
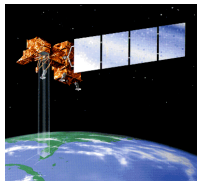


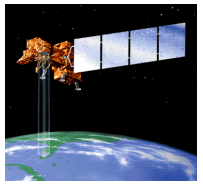
Introduction

- Questions:
  - This investigation best fits under question a) what are the changes in land cover and/or land use (monitoring/mapping activities). Although the investigation is not considering land use or land cover change, it is developing techniques and parameters by which a Landsat data set can be generated that is devoid of sensor degradation effects and therefore more readily useable for detecting land use/land cover changes.
- Goals
  - Contribute to maintenance of Landsat-7 ETM+ and Landsat-5 TM radiometric calibration through vicarious calibration campaigns and regular meetings with Landsat-5/7 personnel
  - Reconstruct Landsat-5 (and 4) Thematic Mapper calibration based on analyses of on-board calibration system and historically acquired vicarious calibration data



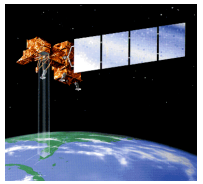
Introduction (continued)

- Approach
  - Supplement and complement USGS Image Assessment System (IAS) and NASA/GSFC Land Cover Project Science Office(LPSO) efforts
  - Conduct redundant multiple vicarious calibration campaigns for the Landsat-7 ETM+ (and Landsat-5 TM) reflective and thermal bands
  - Analyze historical internal calibrator and earth image data to reconstruct lifetime calibration records for L5 and L4 TM's
  - Share and integrate results with IAS and LPSO, updating processing algorithms and parameters to improve calibration

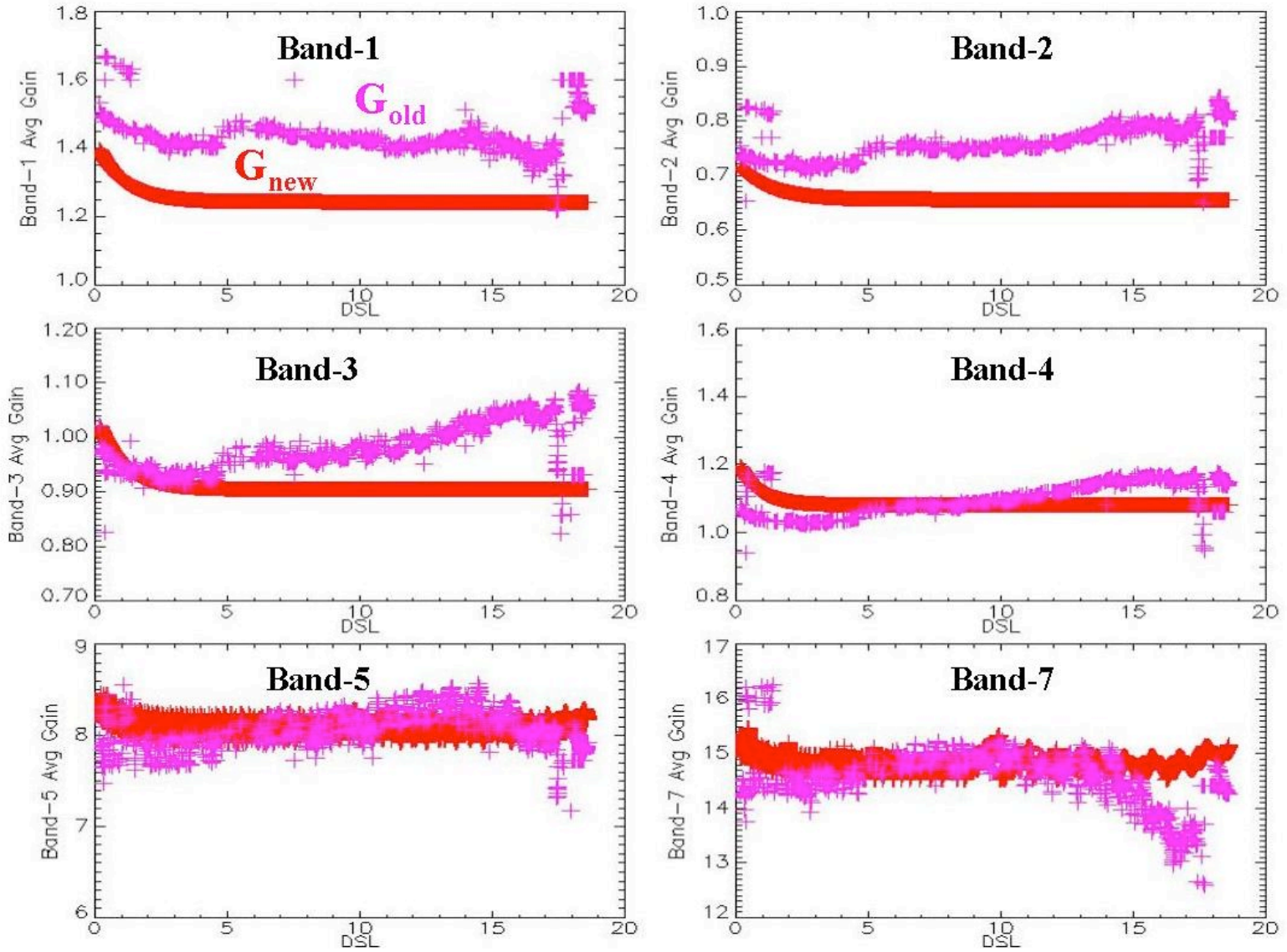


Results

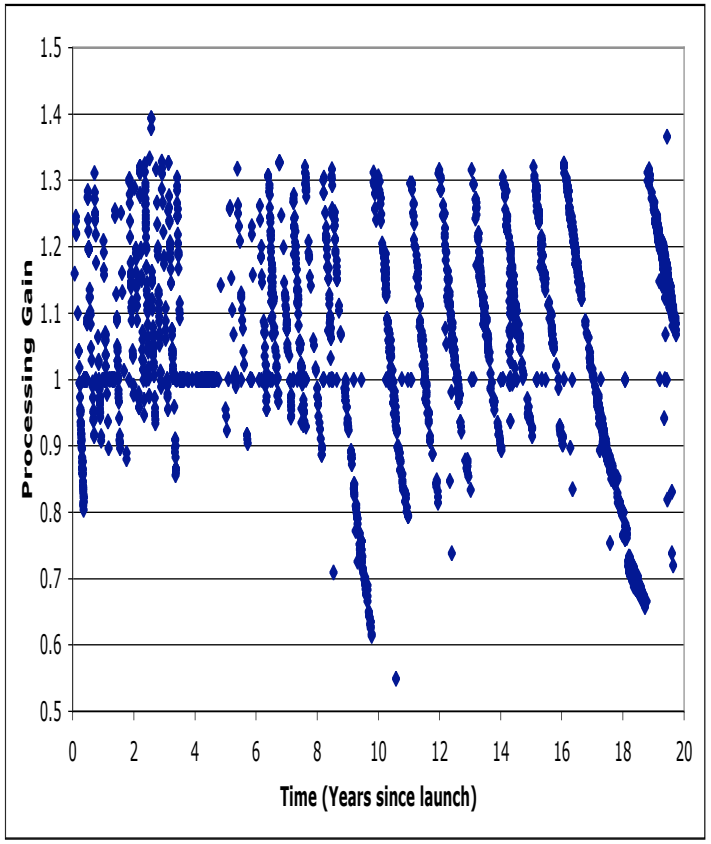
- Most significant results
  - Improved operational calibration procedure implemented by EDC for Landsat-5 TM processing in May 2003 (SDSU)
    - Consistently calibrated data sets
    - Cross calibrated to Landsat-7 ETM+
  - Current Landsat-5 TM thermal band calibration generally accurate to 2% (JPL, RIT)
    - Some scenes fail to process and calibrate correctly
      - Probable origin of bad rap for L5 TM thermal calibration
  - Landsat-7 ETM+ stable to within 0.5%/year; calibration accurate to 5% (UAz)
    - Some biases apparent relative to vicarious calibration
  - Landsat-7 ETM+ thermal band calibration generally consistent with vicarious calibration to ~1% (JPL, RIT)
    - Changed temperature regime since SLC failure--current results not definitive - accuracy probably affected
  - Thermal band atmospheric correction model implemented

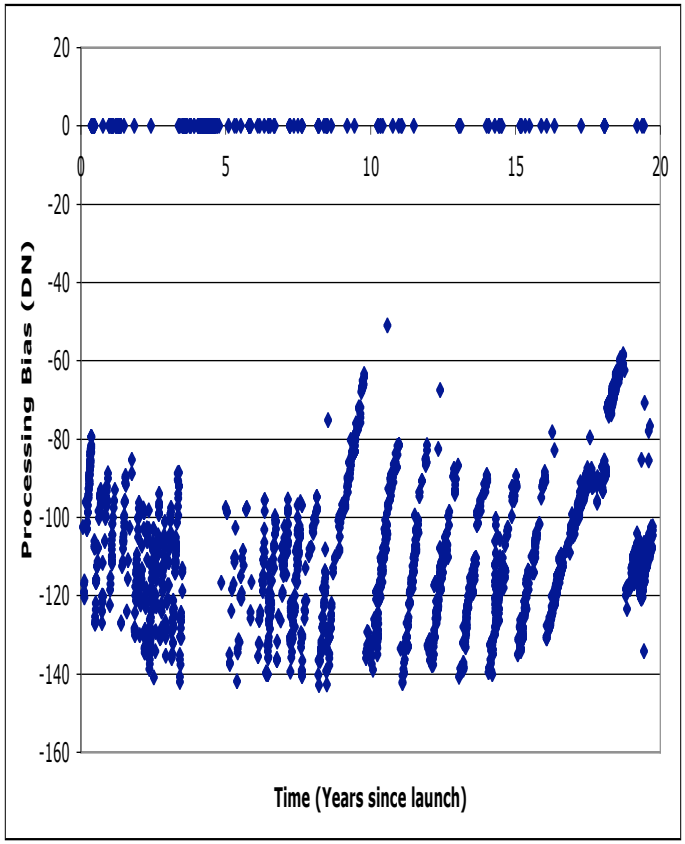


Landsat-5 TM Operational Calibration Changes

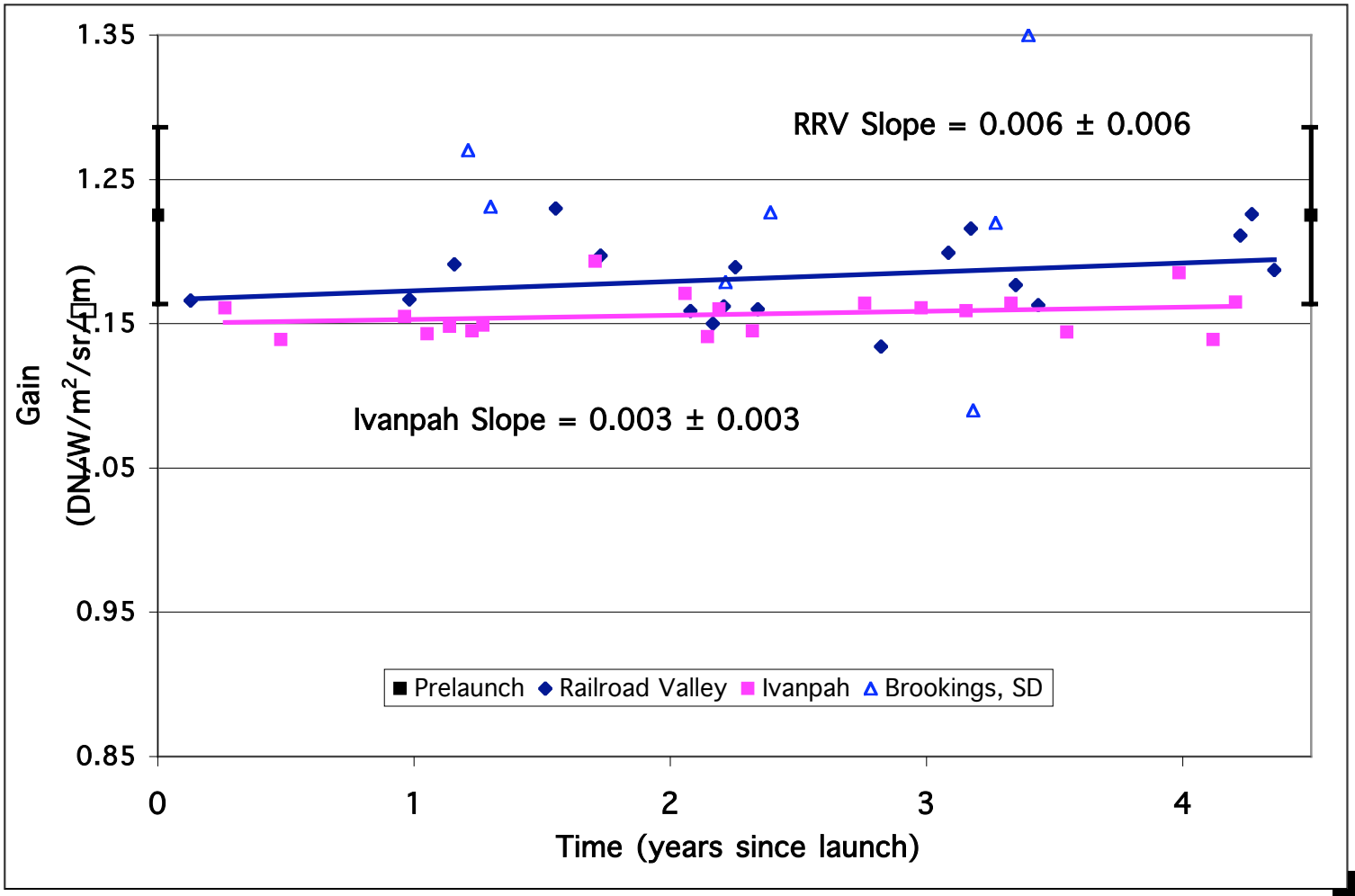


Landsat-5 Thermal Band Calibration History

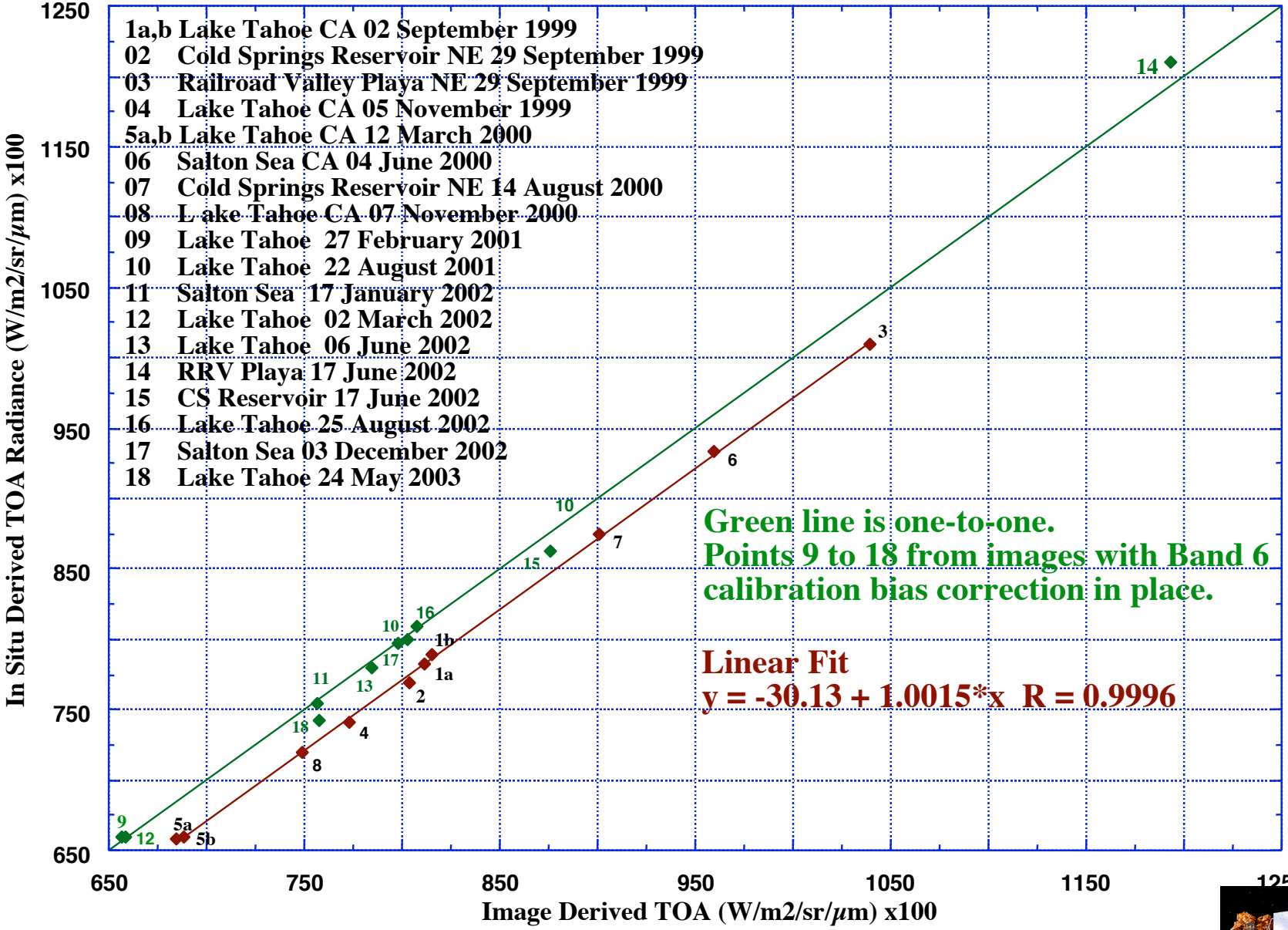




Landsat-7 ETM+ Reflective Band Calibration

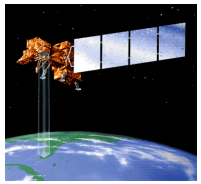


ETM+ Band 6 Comparison: In Situ Derived Versus Image Derived Top Of The Atmosphere Radiance



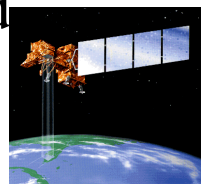
Thermal Band Atmospheric Correction Parameter Calculator

- Uses National Centers for Environmental Prediction (NCEP) modeled atmospheric global profiles for a particular date, time and location
- Uses commercially available MODTRAN software
- Web based- Emails parameter results to user
- Works for L7 and L5; Currently atmospheric data from 1/2003- present
- http://tightrope.gsfc.nasa.gov/atm_corr/atm_corr.html

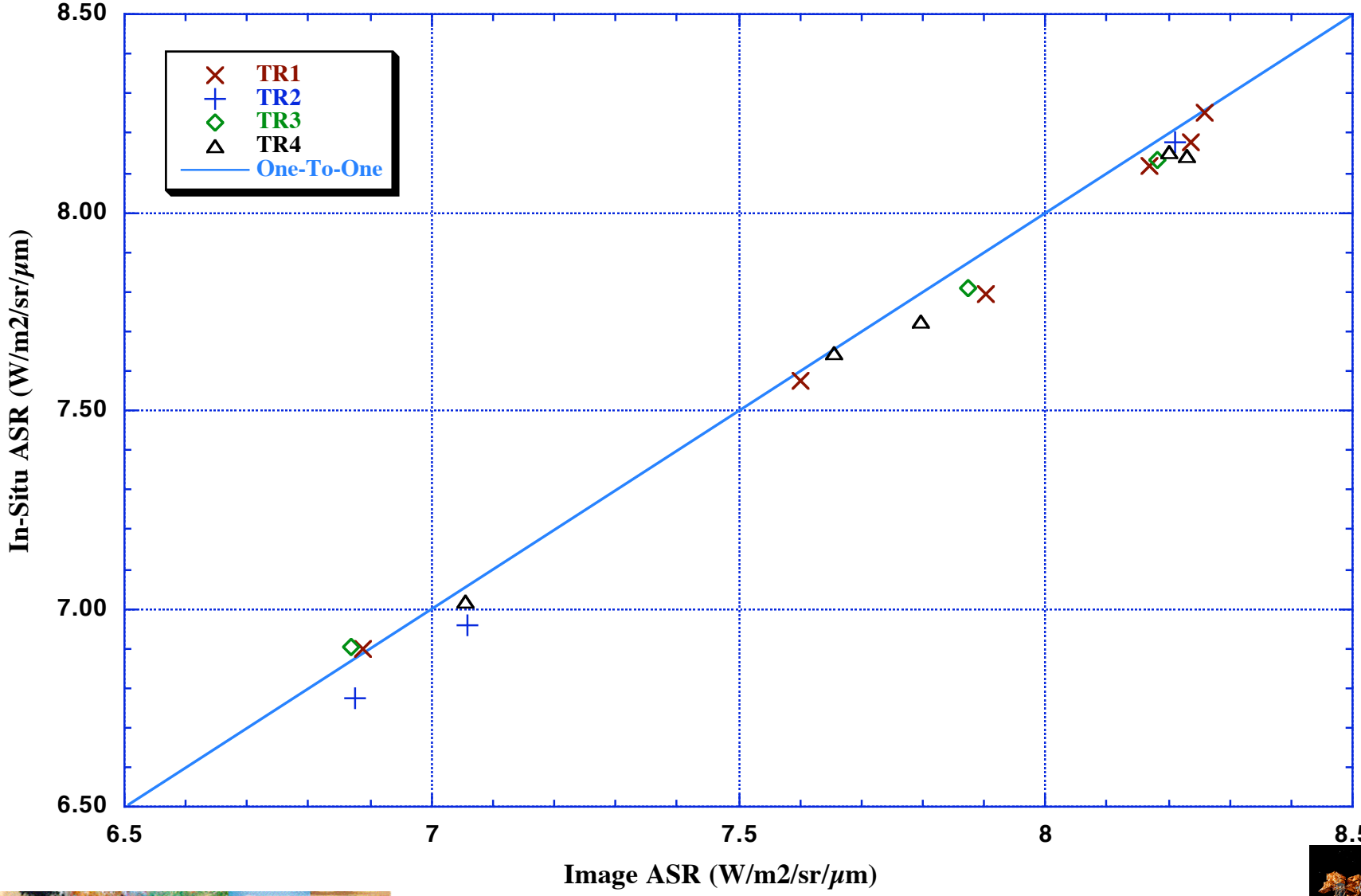


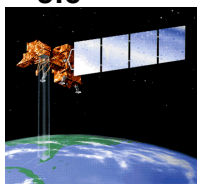
Results (continued)

- Future Steps
  - Continue L5/L7 reflective and thermal band calibration campaigns
  - Complete L4 TM calibration history reconstruction/ cross calibration
  - Evaluate impact of SLC-off thermal regime change on Landsat-7 thermal band calibration
  - Resolve mid-life crisis on Landsat-5 TM calibration
  - Resolve origin of occasional Landsat-5 TM thermal band calibration failure
  - Reassess historical Landsat-5 TM thermal band calibration
  - Refine/expand thermal atmospheric correction method



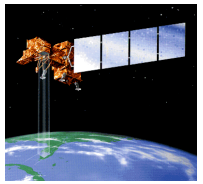
In-Situ vs Image Derived At Sensor Radiance For ETM+ Band 6 For 7 Dates From 9 June Thru 2 December 2003 For Lake Tahoe Rafts





Conclusions

- L7 ETM+ continues to be well radiometrically calibrated and stable
  - Vicarious efforts contributing significantly to effort as on-board calibration systems have limitations
- L5 TM calibration significantly improved, though some issues remain
  - Largely because L5 calibration was ignored for significant portions of its life



Publications--published

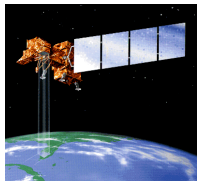
1) Barsi, J.A., J.R. Schott, F.D. Palluconi, D.L. Helder, S.J. Hook, B.L. Markham, G. Chander and E.M. O'Donnell, Landsat TM and ETM+ thermal band calibration, Canadian Journal of Remote Sensing, 29: 141-153, 2003.

2) Chander, G. and B. L. Markham, Revised Landsat 5 TM radiometric calibration procedures and post-calibration dynamic ranges, IEEE Transactions on Geoscience,41,2674-2677, 2003.

3) Thome, K. J., S. F. Biggar, W. T. Wisniewski, Cross-comparison of EO-1 sensors and other Earth Resources Sensors to Landsat-7 ETM+ Using Railroad Valley Playa, IEEE Trans. On Geoscience and Remote Sensing, 41, pp. 1180-1188, 2003.

4) Biggar, S .F., K. J. Thome, W. T. Wisniewski, Vicarious radiometric calibration of EO-1 sensors by reference to high-reflectance ground targets, IEEE Trans. On Geoscience and Remote Sensing, 41, pp. 1174-1179, 2003.

5) Bryant, R., M. S. Moran, S. A. McElroy, C. D. Holifield, K. J. Thome, T.Miura, S. F. Biggar, "Data continuity of Earth Observing 1 (EO-1) Advanced Land Imager (ALI) and Landsat TM and ETM+," IEEE Trans. On Geoscience and Remote Sensing, 41, pp. 1204-1213, 2003.



Publications- In Progress

1) Teillet, P.M., D.L. Helder, T. Ruggles, R. Landry , F.J. Ahern , N.J. Higgs , J. Barsi , G. Chander , B.L. Markham , J.L. Barker[7], K.J. Thome , J.R. Schott , and F.D. Palluconi, A Definitive Calibration Record for the Landsat-5 Thematic Mapper Anchored to the Landsat-7 Radiometric Scale, Canadian Journal of Remote Sensing, in press

2) ~10 papers submitted to special Landsat performance issue of IEEE Trans. On Geoscience and Remote Sensing, currently scheduled for December 2004.