



LST Validation and Analysis

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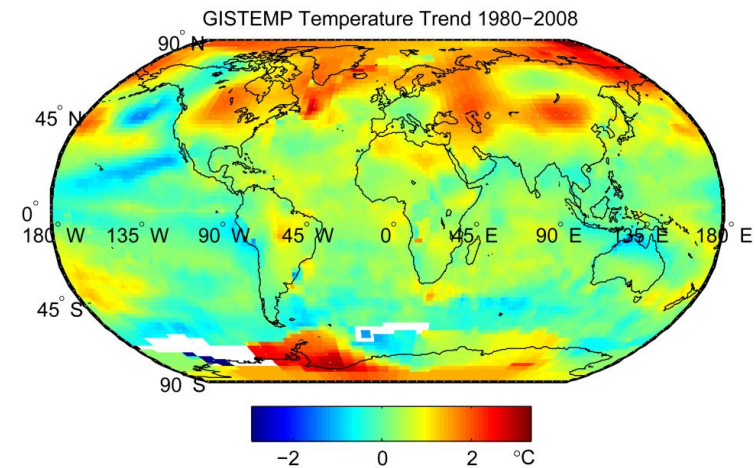
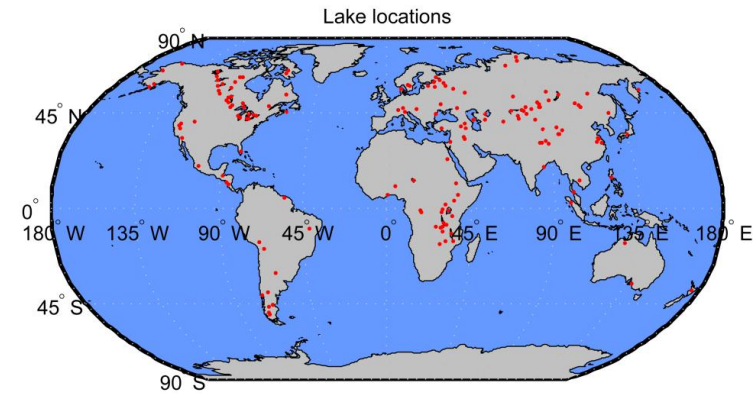
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Outline

- Inland Water Studies
- Validation Studies
- New 1km T/E product
- Summary and Conclusions

Introduction

- The Idea
 - Temperatures of lakes and reservoirs have potential as good indicators of climatic trends
 - Existing in situ data is insufficient in space and time
 - Nearly 30-year record of satellite thermal infrared imagery available
- Project Objectives
 - Use satellite derived water surface temperatures to characterize the temporal thermal behavior of lakes and inland water bodies worldwide
 - Relate changes in the thermal behavior of the water bodies to global and regional climate change as indicated by surface air temperature data
 - Study sites: 165 large lakes worldwide
 - Case study: 6 lakes in California and Nevada

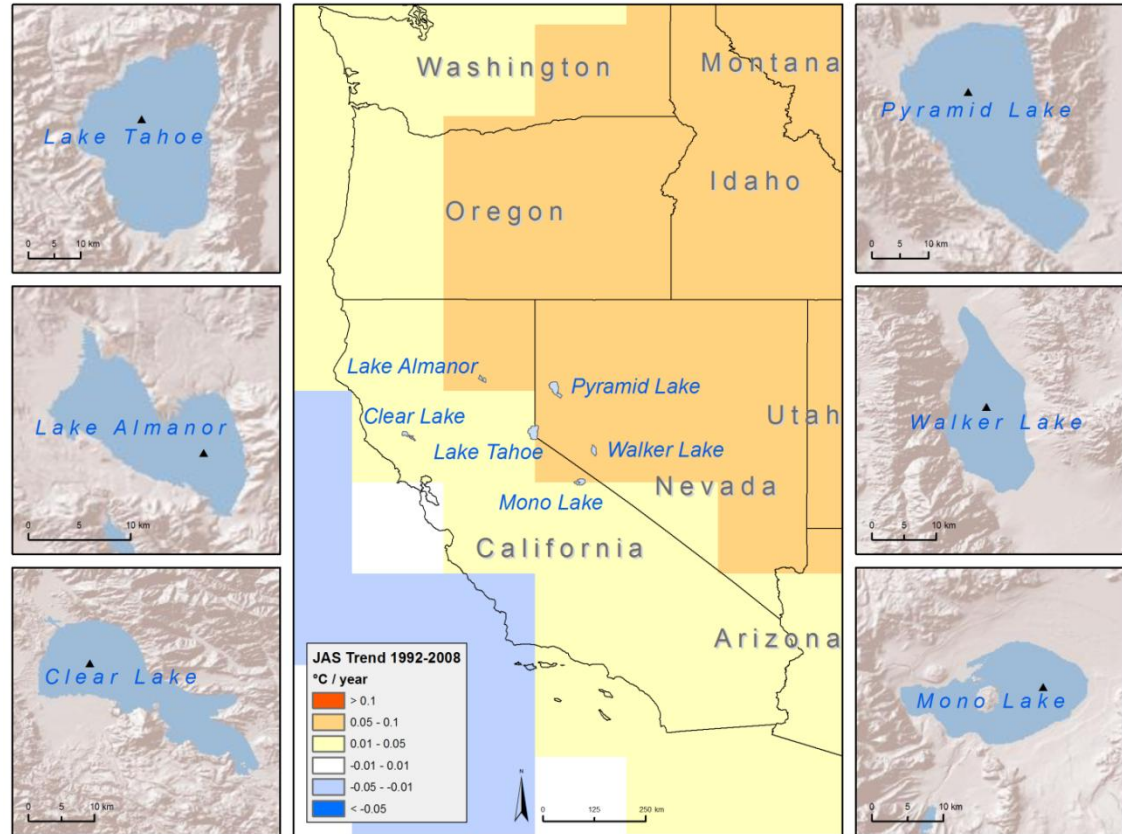


California/Nevada case study

To develop the methodology, a preliminary case study was carried out for six lakes in California and Nevada.

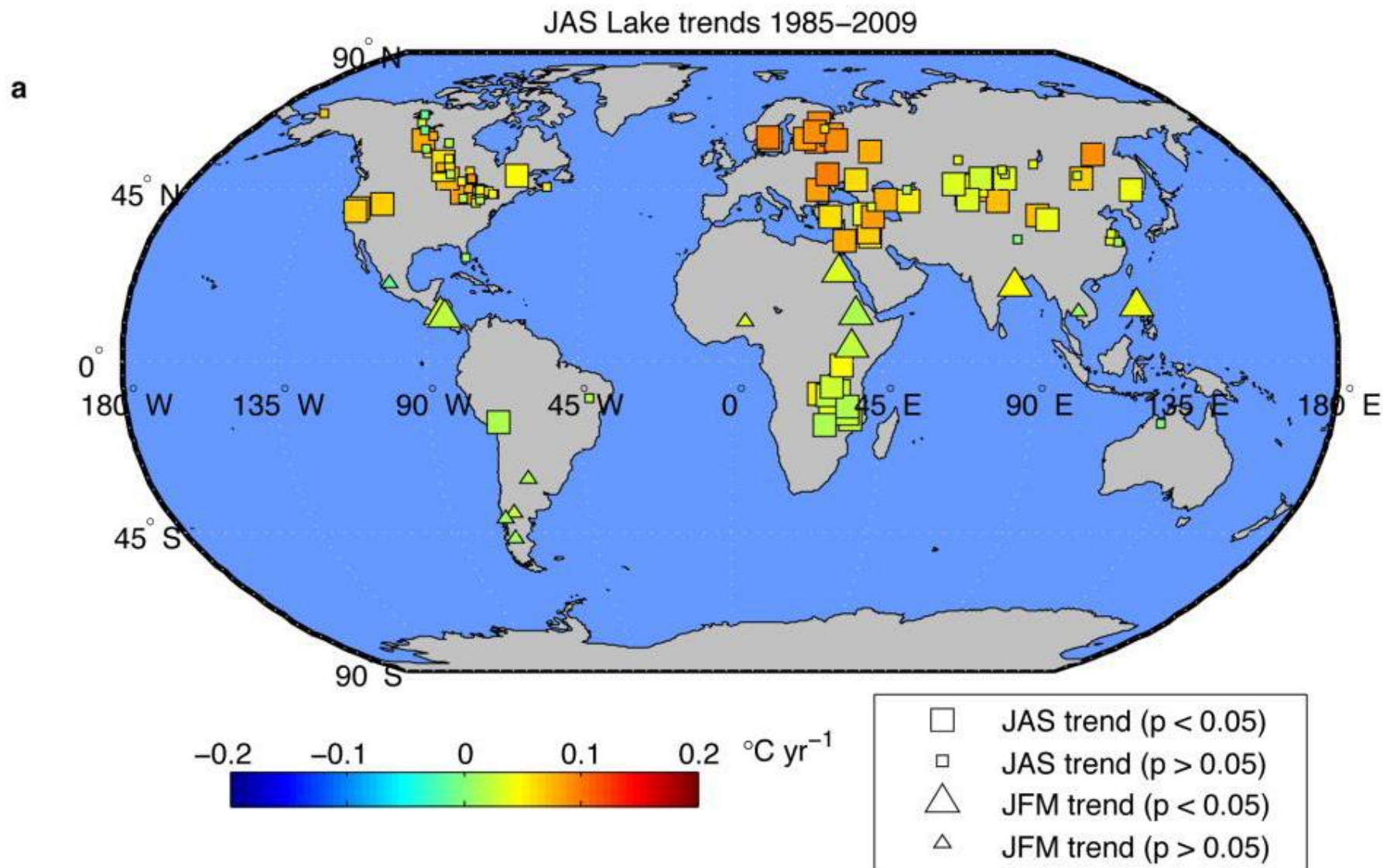


In situ measurements at 4 buoys at Lake Tahoe were used to develop algorithms and validate the results



The location of the six test sites for the case study. The center panel shows the spatial lake locations and the GISTEMP (Hansen et al., 1999) summertime temperature change between 1991 and 2008.

Global satellite-derived seasonal (July, August, September (JAS) and January, February, March (JFM)) nighttime lake surface temperature trends between 1985 and 2009



From Schneider and Hook, 2010

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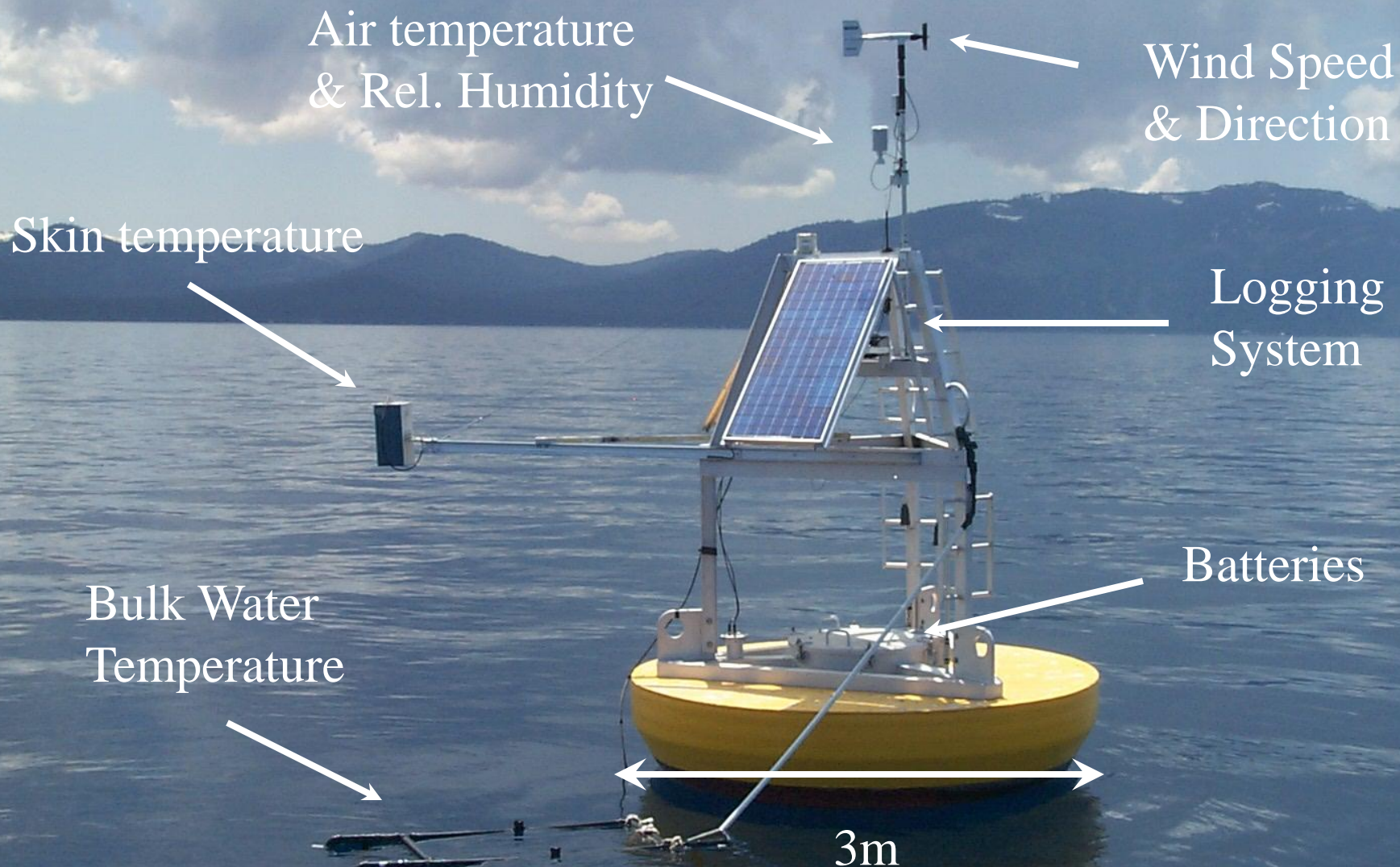


2000-09-20-D

- Large 35 km x 16 km
- High 2 km
- Available year round (does not freeze in winter).
- Homogenous compared with land.
- Large annual temperature range 5-25 C.
- Freshwater (kind to instruments!)
- Good infrastructure and easy access.

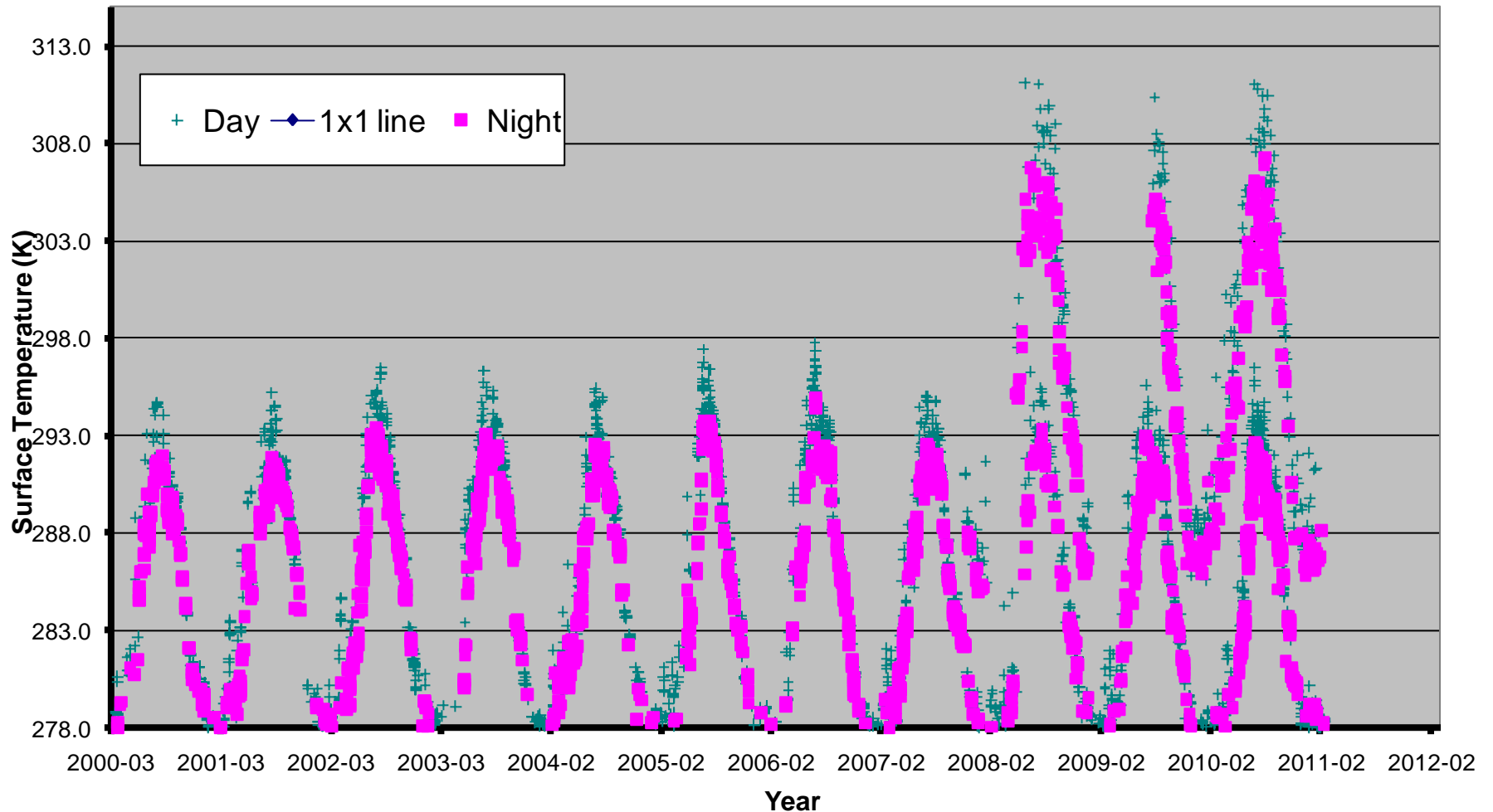
0 35 km

TB3 Installed 11-04-2002

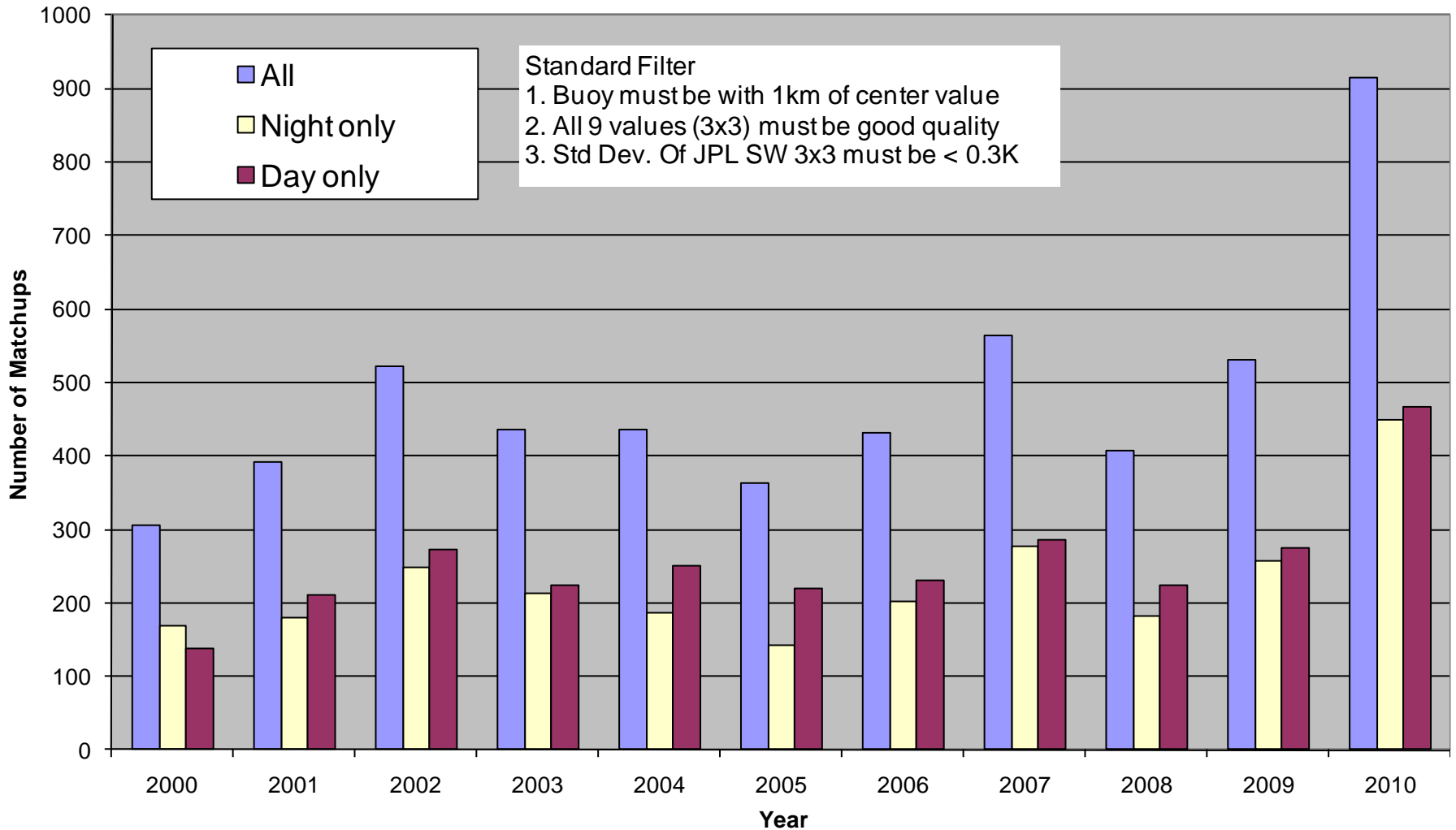


6/17/2003 1:20pm

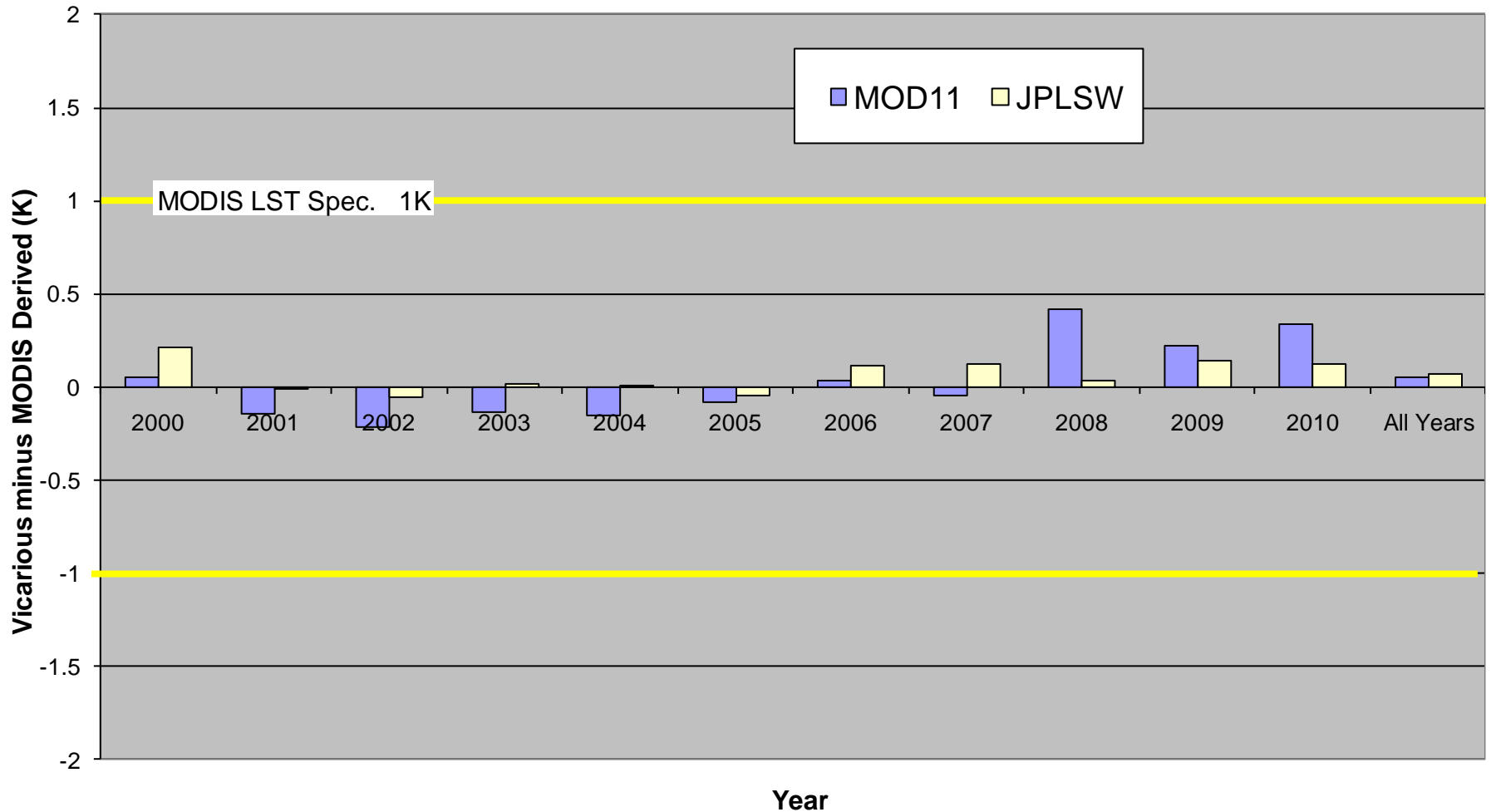
MODIS Terra Split Window Day and Night Surface Kinetic Temperatures at Lake Tahoe and Salton Sea CY2000-2010 v5.x



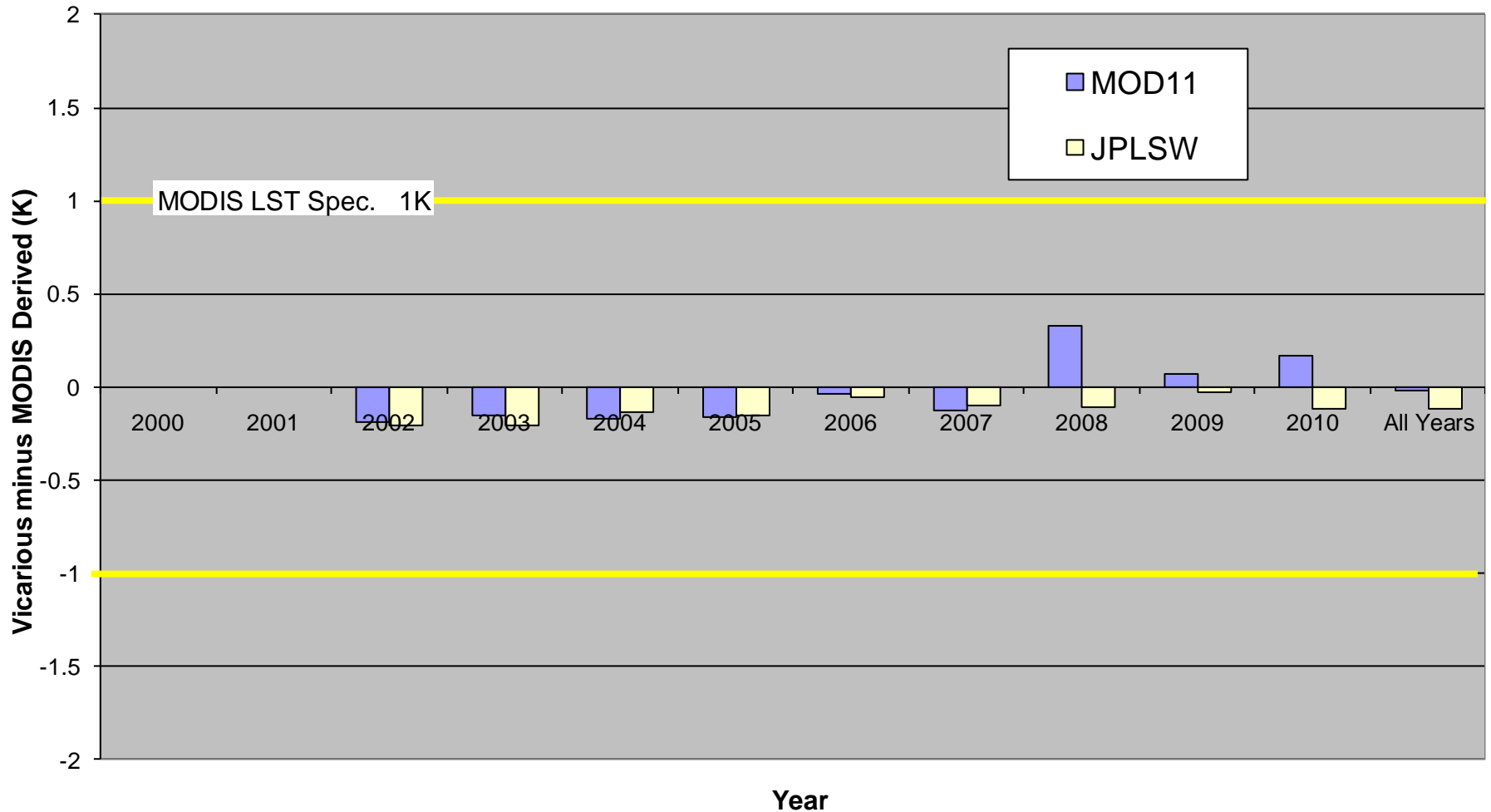
Cloud Free Filtered Statistics for MODIS Terra LST Products at Lake Tahoe and Salton Sea CY2000-2010, All Angles v5.x



Delta Temperature between Vicarious and MODIS Terra LST Products at Lake Tahoe and Salton Sea CY2000-2010, All Angles v5.x



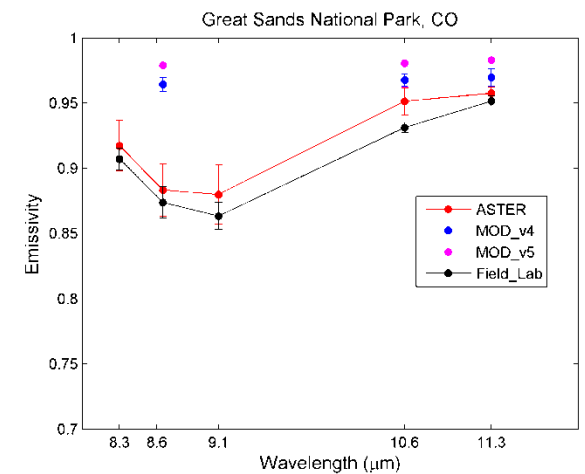
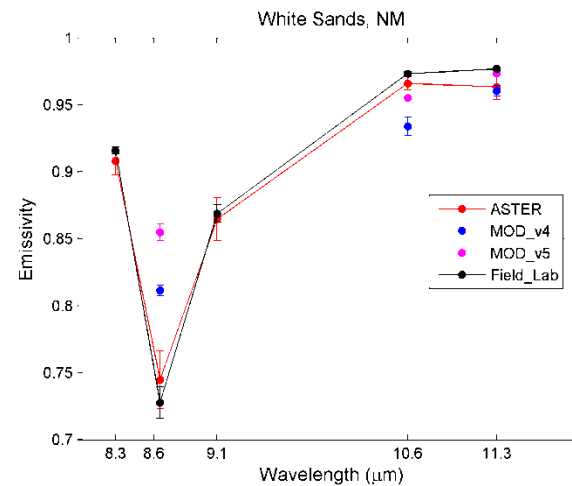
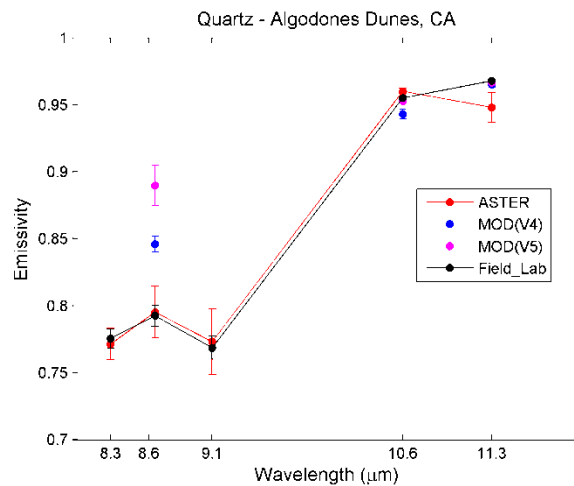
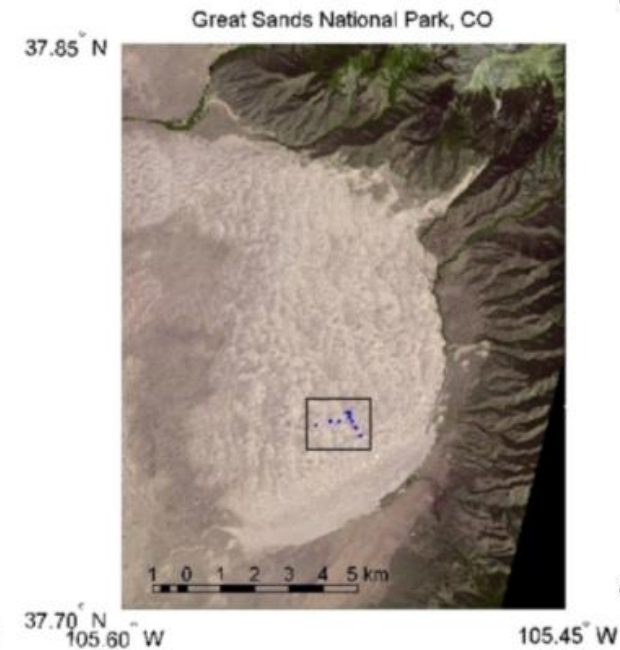
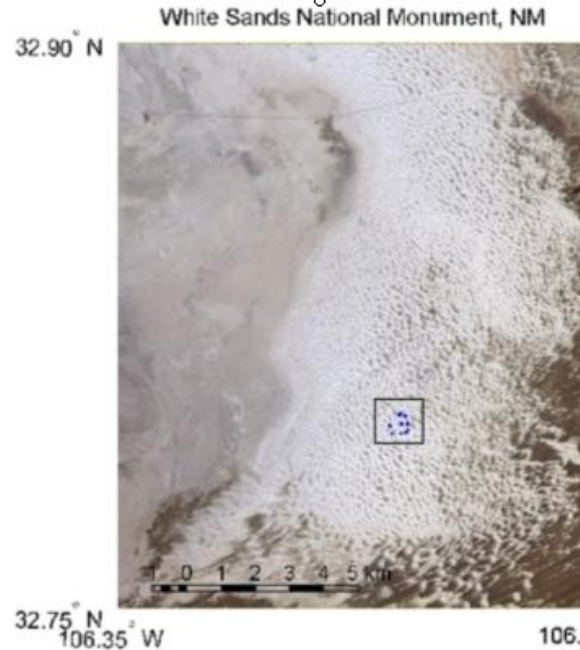
Delta Temperature between Vicarious and MODIS Aqua LST Products at Lake Tahoe and Salton Sea CY2000-2010, All Angles v5.x



Outline

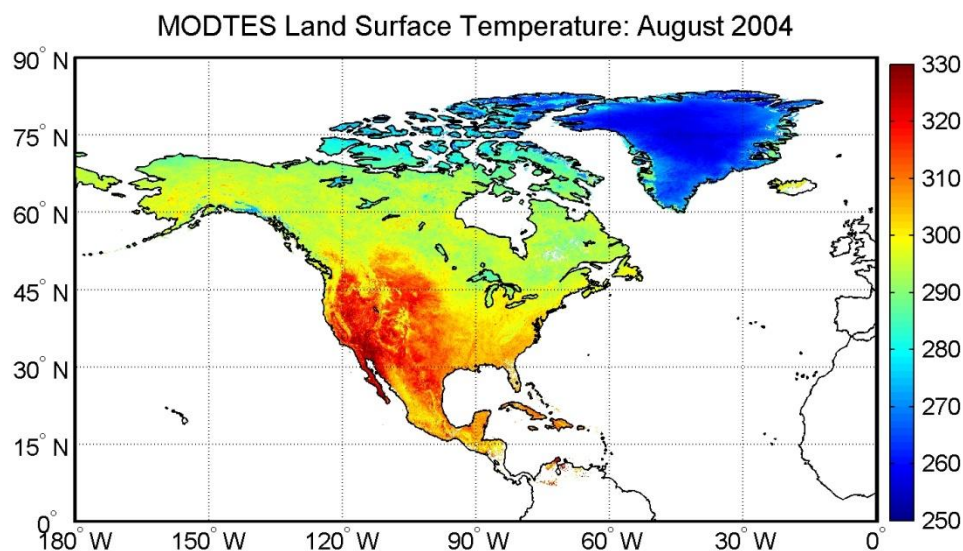
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MODIS Emissivities are over-estimated





Generating a 1km MODIS Land Surface Temperature/Emissivity Products using the ASTER TES Algorithm



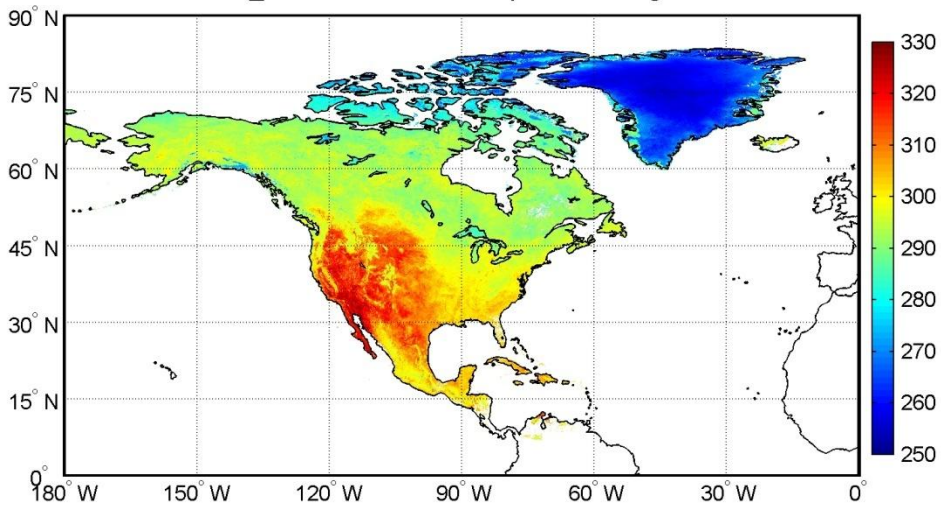
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Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

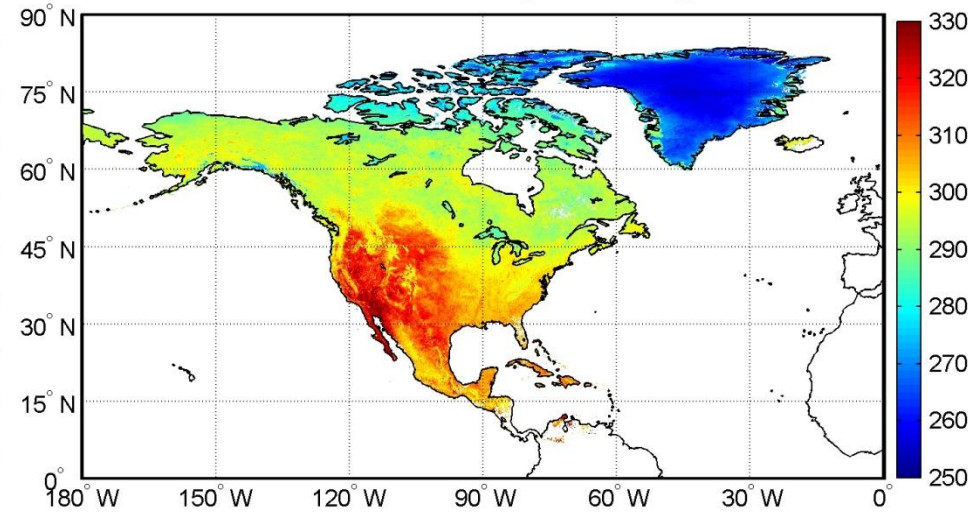
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LST Comparisons

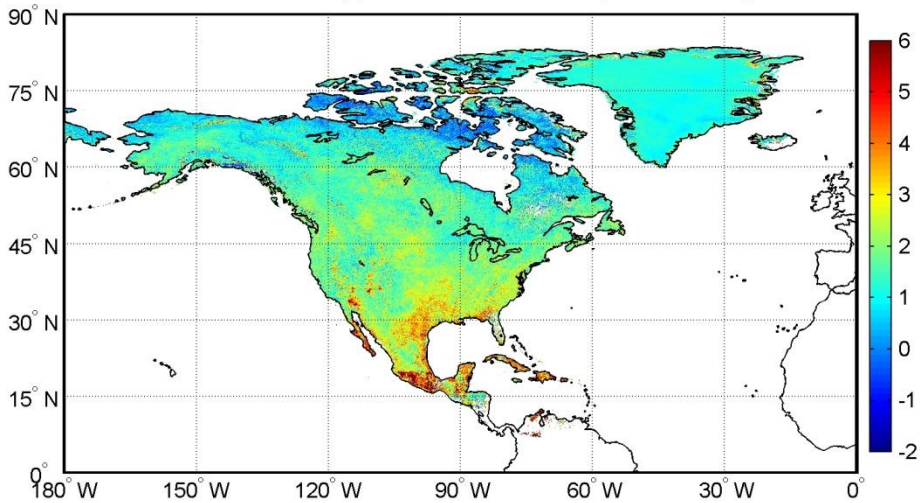
MOD11_L2 Land Surface Temperature: August 2004



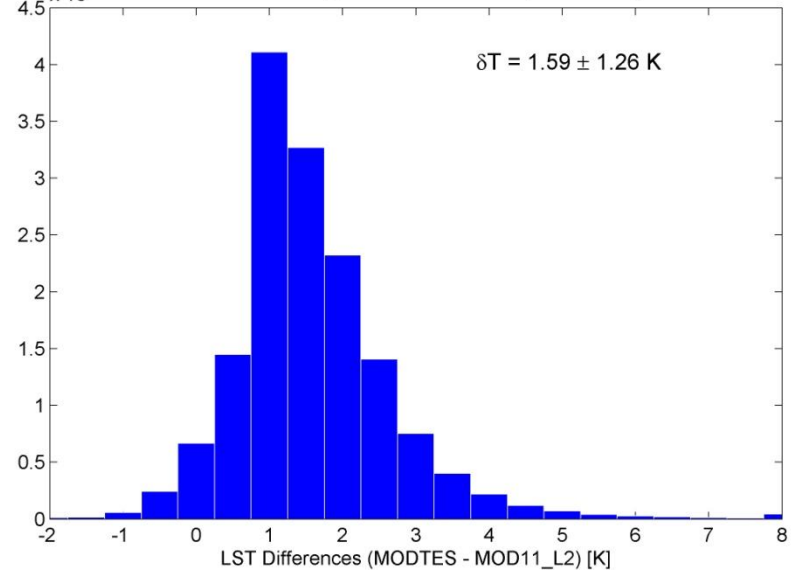
MODTES Land Surface Temperature: August 2004



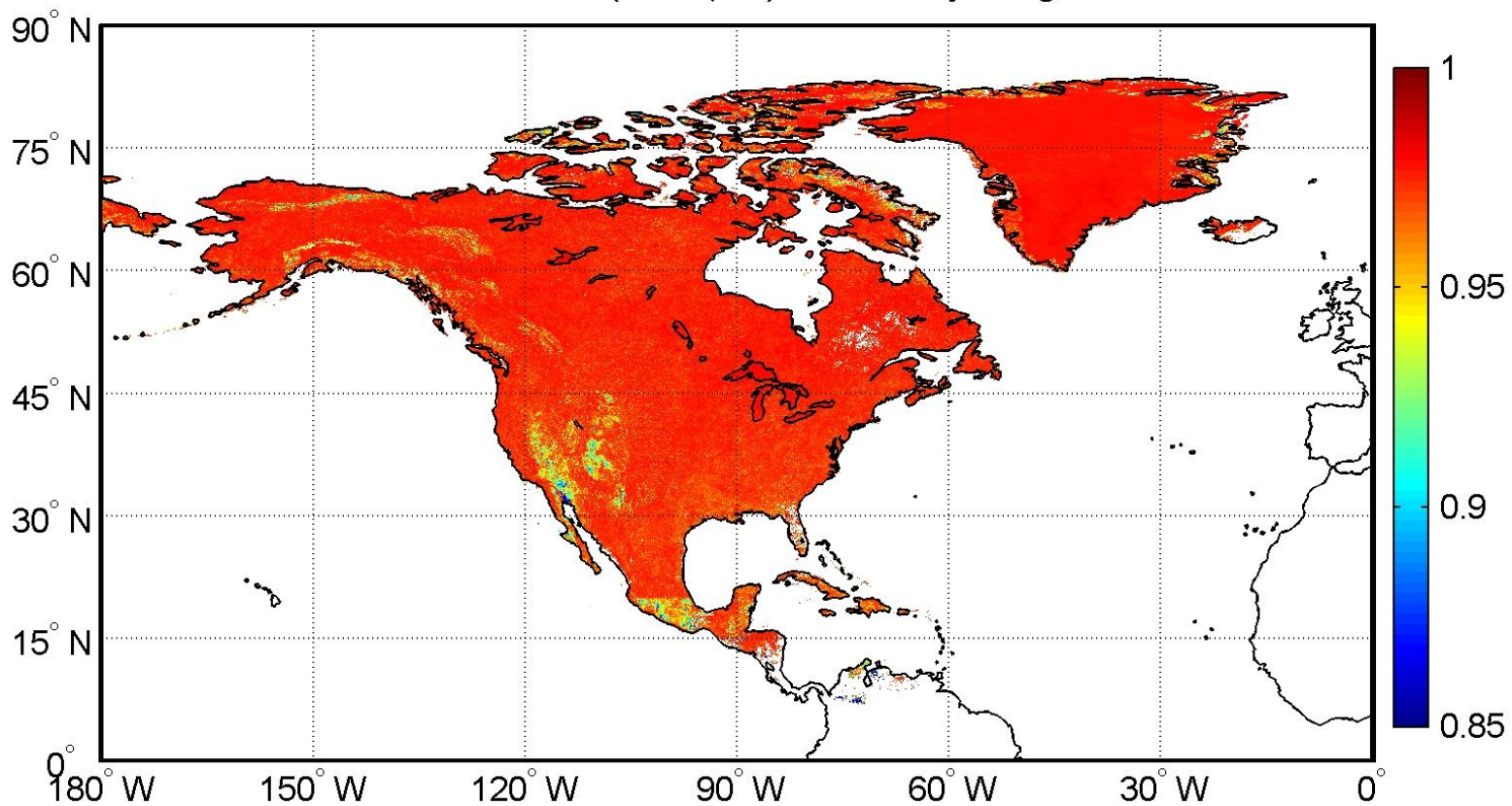
MODTES minus MOD11_L2 Land Surface Temperature: August 2004



$\times 10^5$ MODTES minus MOD11_L2 Land Surface Temperature: August 2004

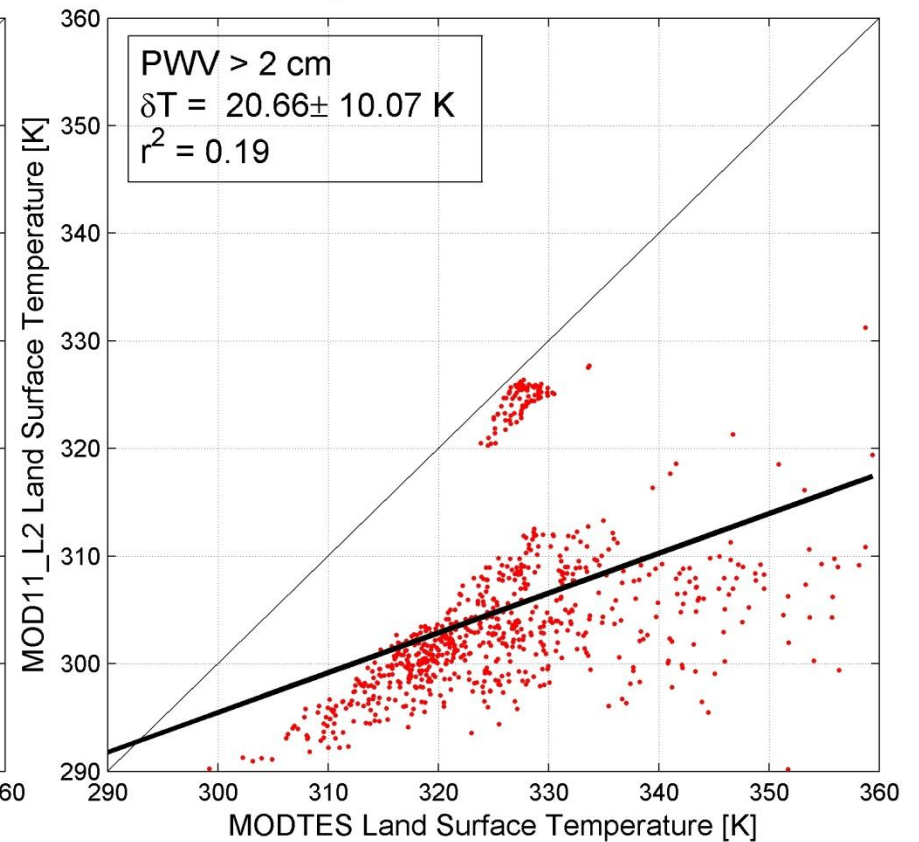
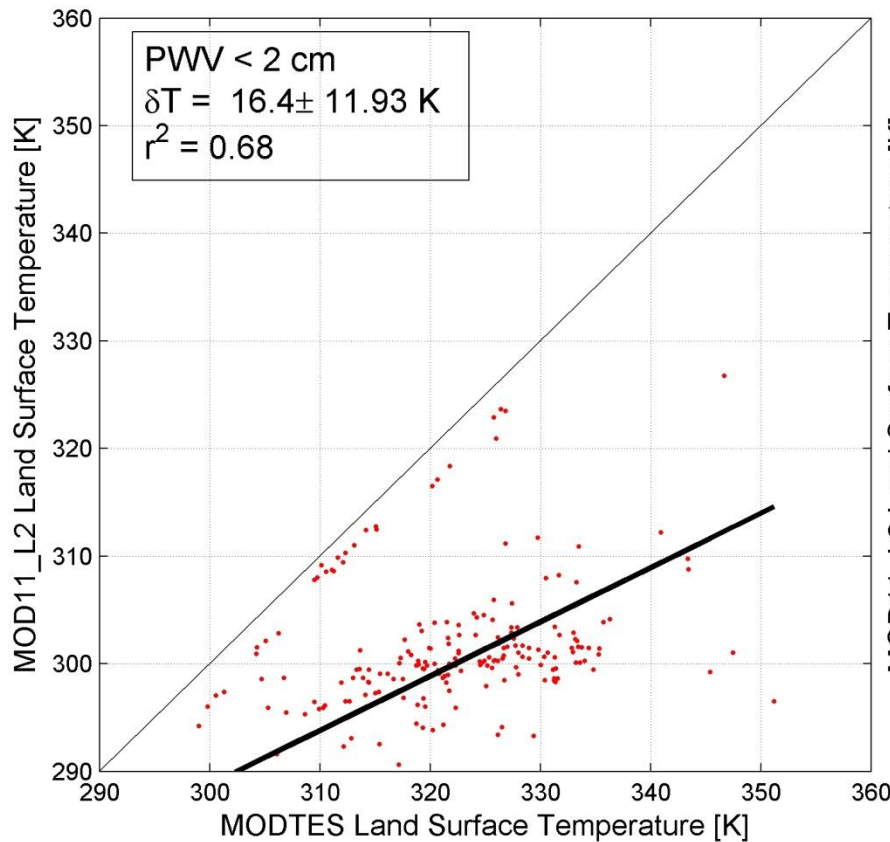


MODTES Band 29 (8.52 μm) Emissivity: August 2004



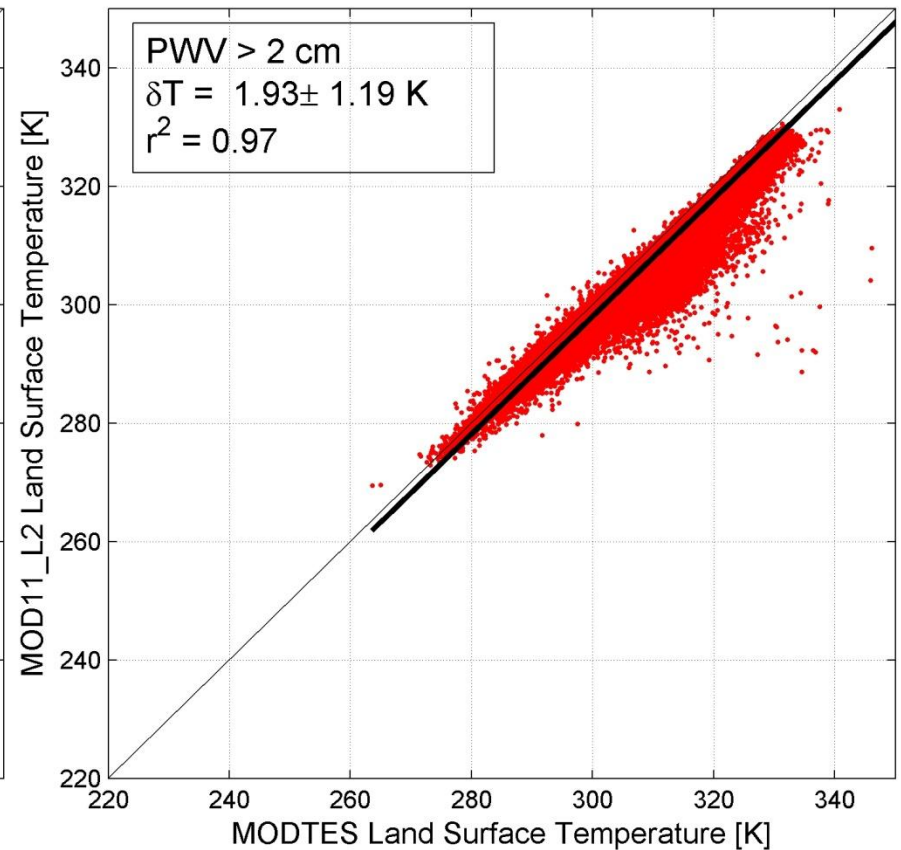
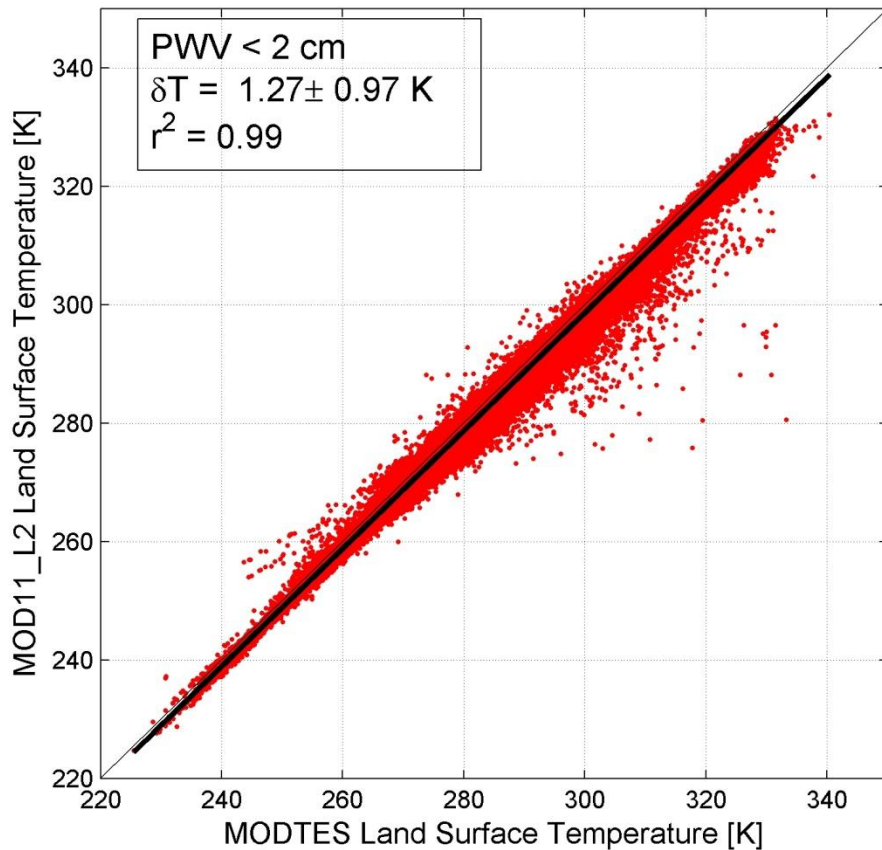
LST Comparisons over Bare Regions

Bare Surfaces: Band 29 MODTES Emissivity < 0.85



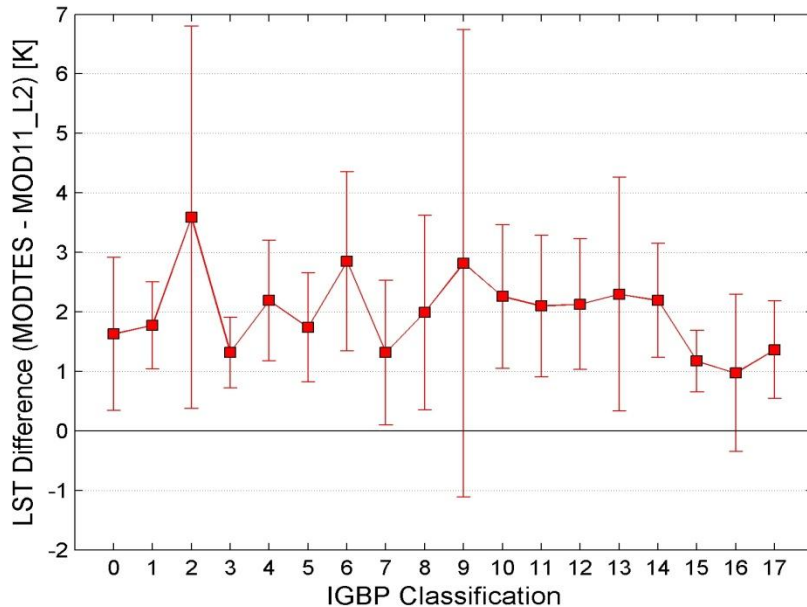
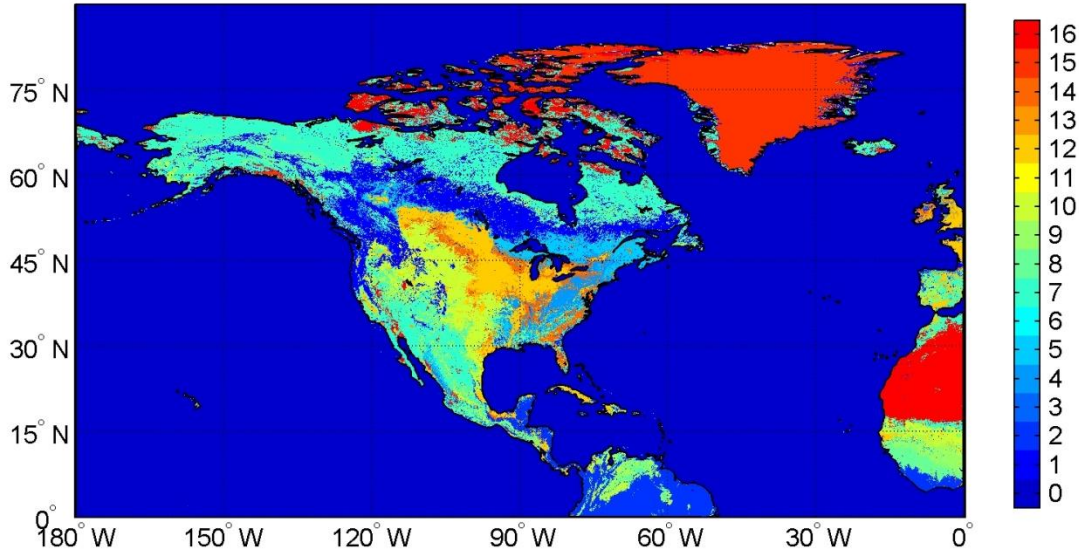
LST Comparisons over Vegetated Regions

Mixed and Vegetated Surfaces: Band 29 MODTES Emissivity > 0.85



IGBP Analysis

MOD12 IGBP Classification



IGBP CLASS ID	IGBP CLASS Description
0	Water Bodies
1	Evergreen Needleleaf Forest
2	Evergreen Broadleaf Forest
3	Deciduous Needleleaf Forest
4	Deciduous Broadleaf Forest
5	Mixed Forest
6	Closed Shrublands
7	Open Shrublands
8	Woody Savannas
9	Savannas
10	Grasslands
11	Permanent Wetlands
12	Croplands
13	Urban and Built-Up
14	Cropland/Natural Vegetation Mosaic
15	Snow and Ice
16	Barren or Sparsely Vegetated
17	Missing Data

Summary and Conclusions

- Established automated sites for validating thermal infrared data at Lake Tahoe CA/NV and Salton Sea CA. Lake Tahoe Site has been operating since 1999.
- Measurements made at the site include skin- bulk- air- temperature, wind speed, wind direction and net radiation at multiple locations every 2 minutes. Multiple locations (4 buoys) allow validation of several points within a scene.
- Validated data from multiple instruments including, AATSR, ASTER, MODIS (Terra, Aqua), Landsat 5 and Landsat ETM+, MTI.
- Results so far for MODIS indicate:
 - MODIS algorithm works extremely well over water
 - MODIS algorithms have some issues over arid and sem-arid areas. Version 4.1 better than 5.0
 - MODIS algorithms have some issues over wet surfaces. Version 4.1 better than 5.0
 - Developing an experimental 1km LST product using ASTER algorithm which provides emissivity and temperature

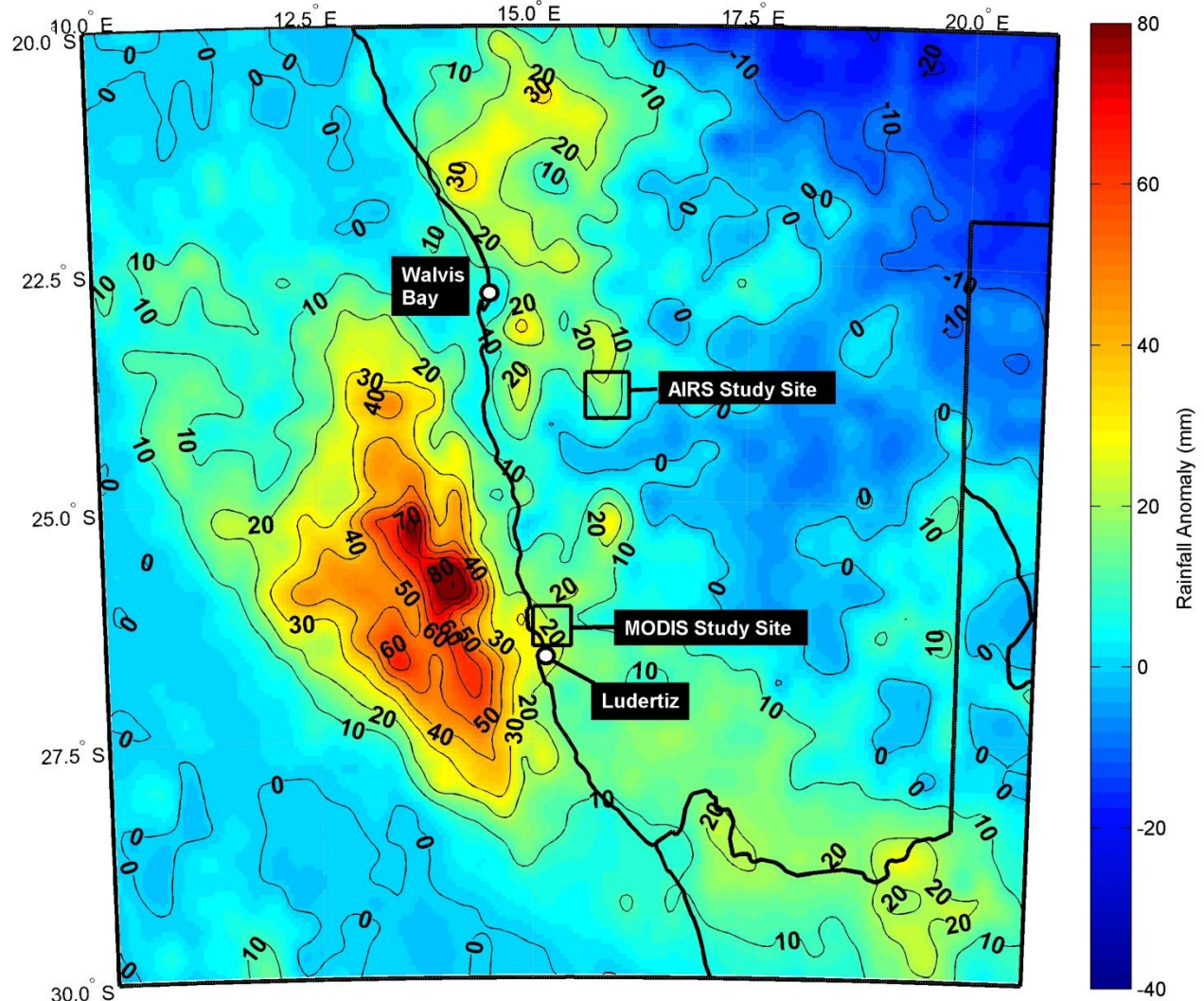
Backup

Namib Desert Rainfall event during April 2006

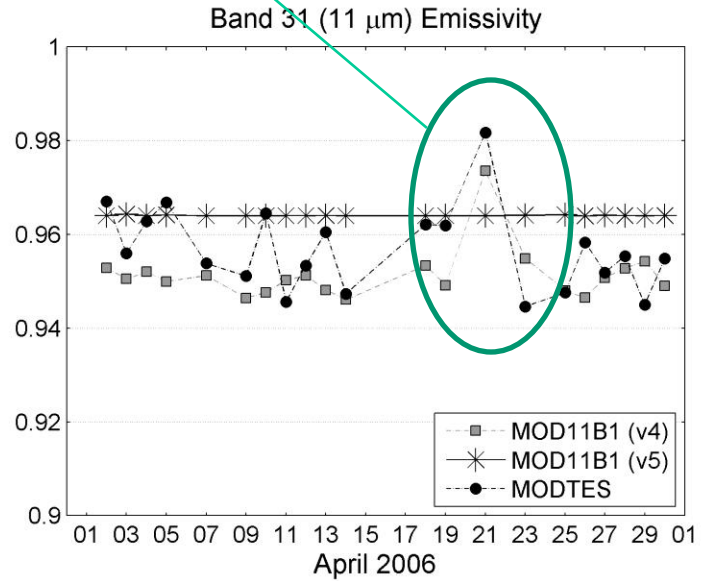
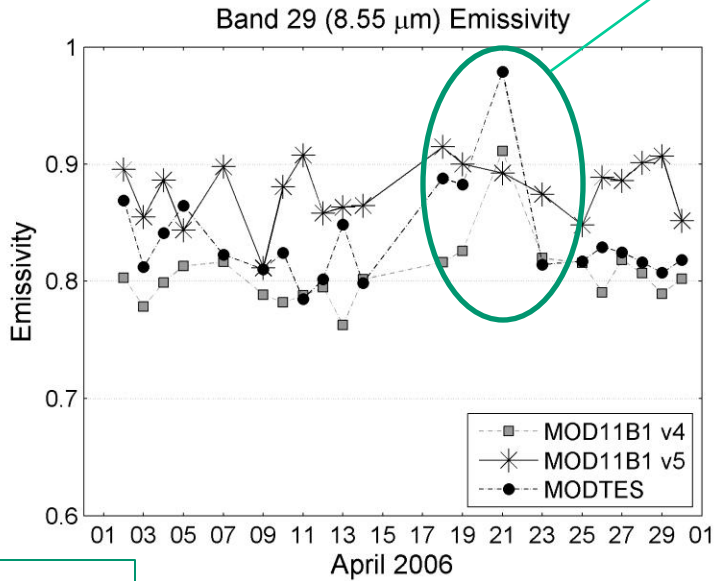
TRMM rainfall anomaly for April, 2006 (mm)

From 16-22 April 2006, almost **100 mm** rain was recorded at Luderitz – **6 times the long-term annual rainfall average!**

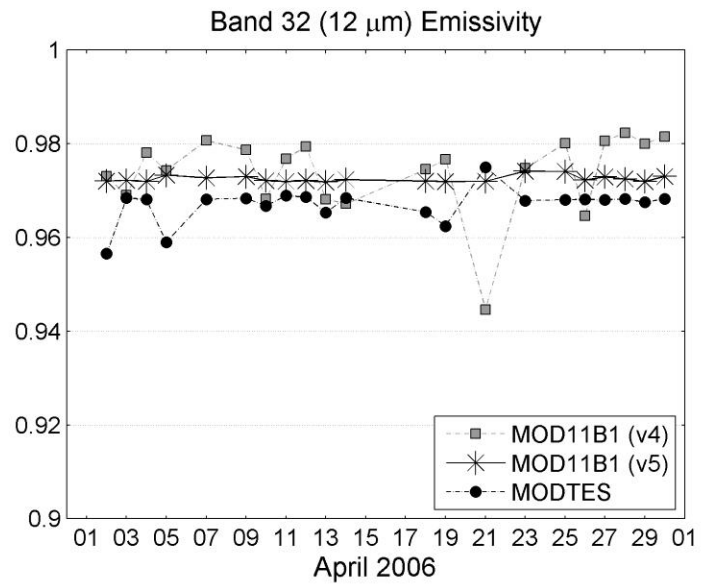
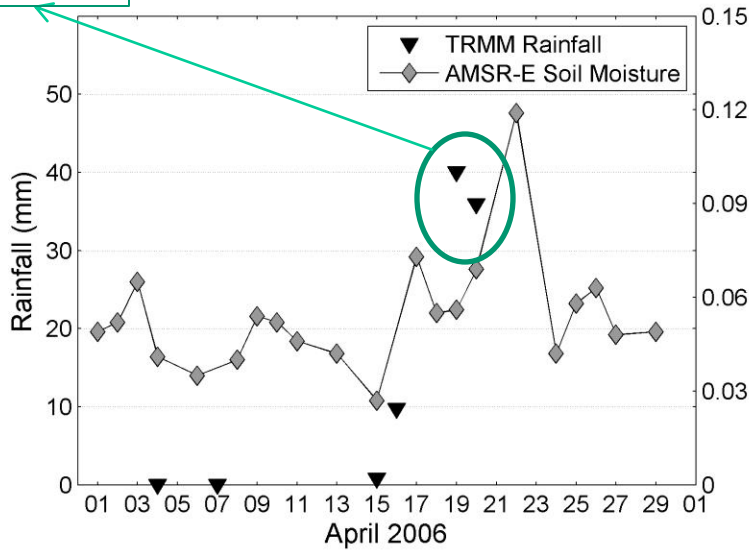
Muller et al. (2008) found that wet conditions over Southern Africa during this time resulted from a combination of La Niña event and warming of the southeast Atlantic Ocean.



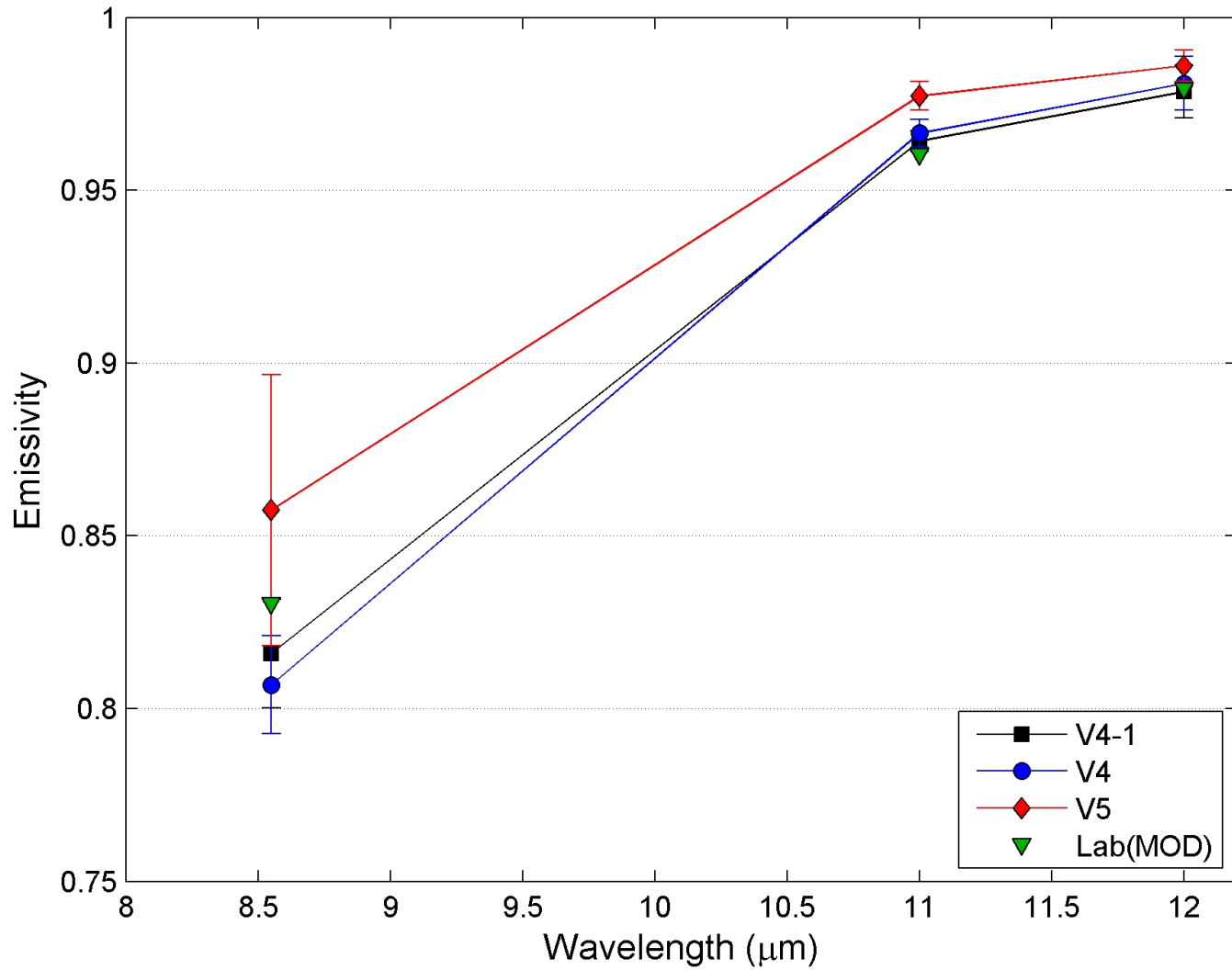
Increase in Emissivity



TRMM Rainfall



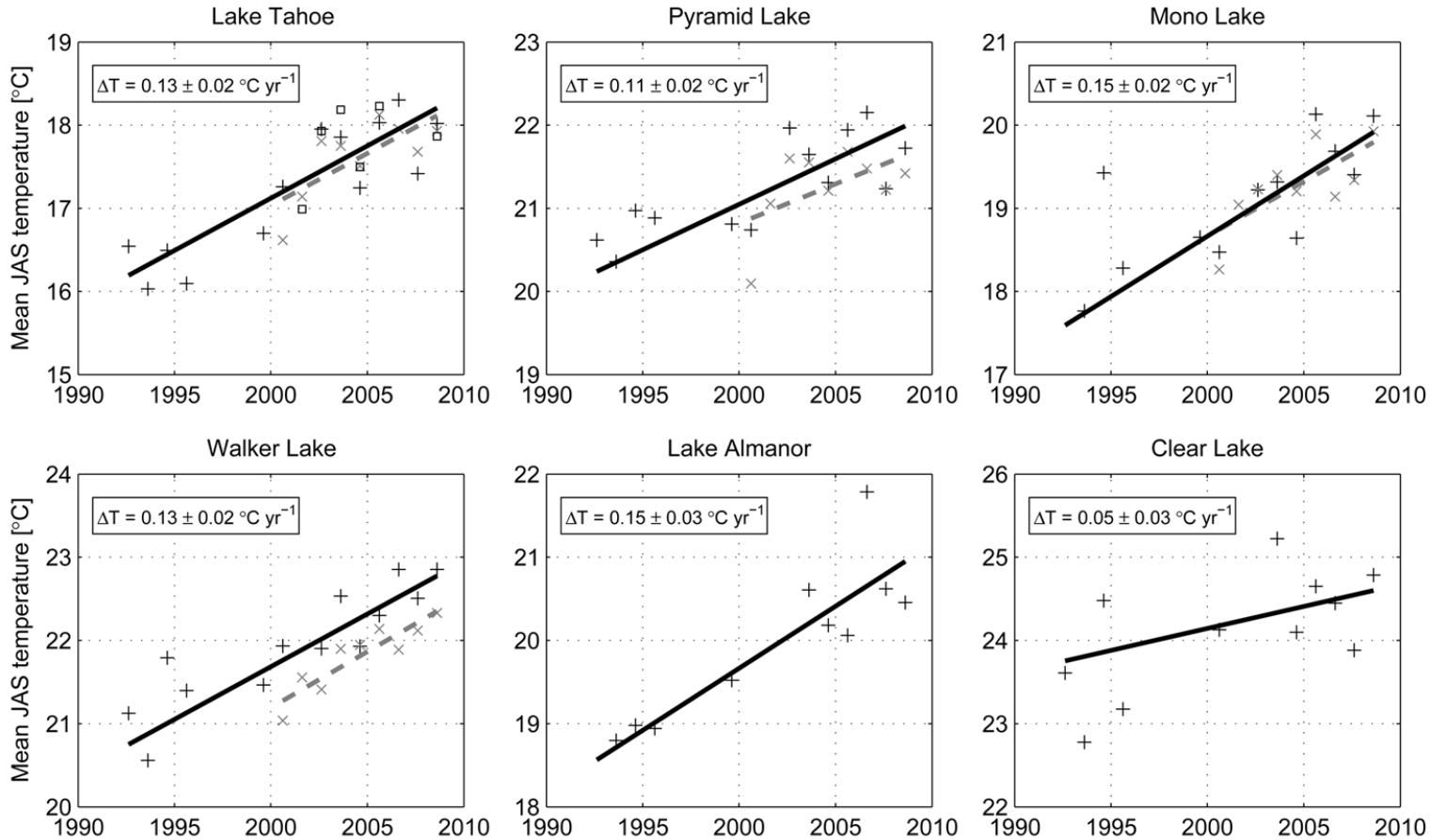
Namib Desert



Results:

Summertime (JAS) trends since 1991

+ ATSR × MODIS □ In situ — Trend (ATSR) - - - Trend (MODIS)



Schneider et al. (2009), Satellite observations indicate rapid warming trend for lakes in California and Nevada. *Geophys. Res. Lett.*, 36, L22402, doi:10.1029/2009GL040846.

Validation of North American ASTER Emissivity Database (NAALSED)

