National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

AIRS v6 Land Surface Temperature (LST) and Emissivity Assessment

Glynn Hulley

Thanks to: Evan Manning, John Blaisdell

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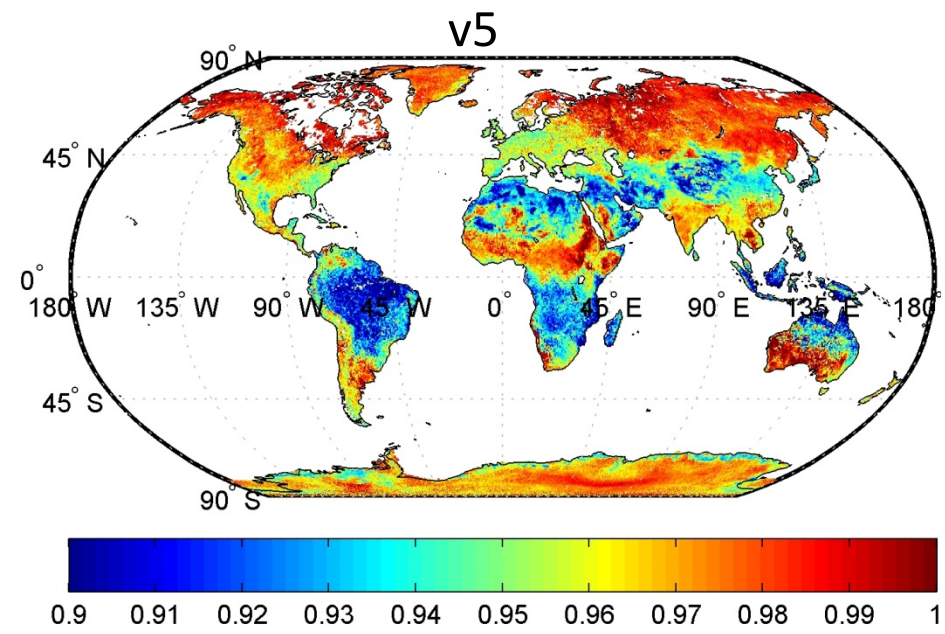
Outline

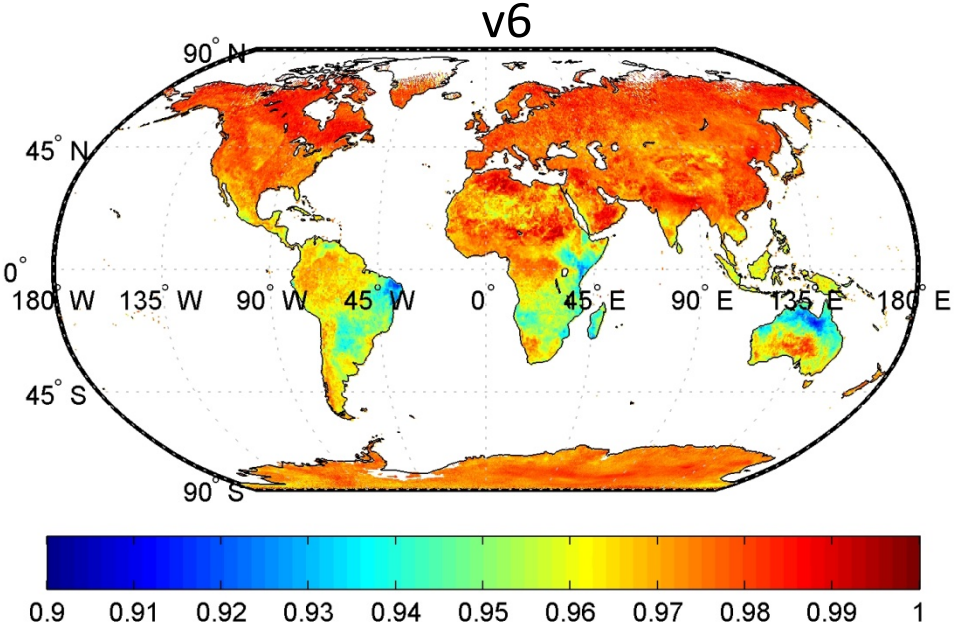
- Summary of changes in V6 surface retrieval
- Global V5 vs V6 emissivity comparisons
- Diurnal emissivity differences
- ASTER Emissivity climatology
- Radiance-based LST validation results

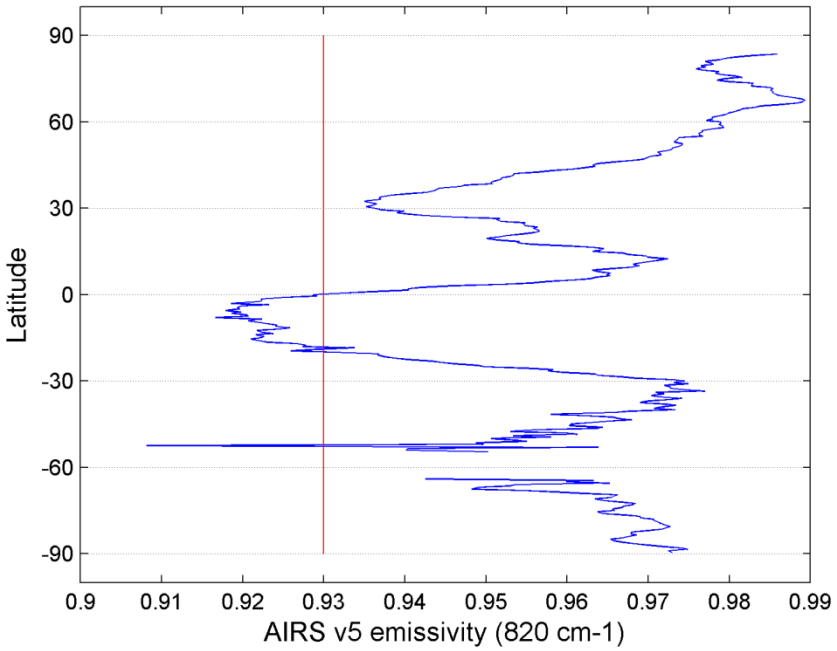
Modification	Version 5	Version 6	Justification
Emissivity Perturbation Function	$\varepsilon_{\nu} = \varepsilon_{o,\upsilon} \sum_{i} A_i F_i(\upsilon)$	$(1-\varepsilon_{\nu}) = (1-\varepsilon_{o,\upsilon})\,[1+\sum_{i} A_i F_i(\upsilon)\,]$	Eliminates unphysical Values with $\varepsilon_{\nu} > 1$
Reflectance Perturbation Function	$\rho_{\nu} = \rho_{o,\upsilon} \sum_{i} B_i G_i(\upsilon)$	$\rho_{\nu} = \rho_{o,\upsilon}\,[1+\sum_{i} B_i G_i(\upsilon)\,]$	Eliminates unphysical Values with $\rho_{\nu} < 0$
Initial Reflectance Guess	$\rho_{o,\upsilon} = 1-\varepsilon_{o,\upsilon}/\pi$	$\rho_{o,\upsilon} = d(1-\varepsilon_{o,\upsilon}/\pi)$	Accounts for attenuation of solar radiation by clouds from sun to observation point.
Channels	15 longwave: (758-1228 cm^{-1}) 10 shortwave: (2456-2658 cm^{-1})	57 shortwave: (2396 - 2660 cm^{-1})	Reduced cloud clearing errors, minimizes day/night emissivity differences, shortwave independent of incorrect longwave emissivity.
Emissivity first guess	NOAA surface regression	MODIS Baseline-Fit Emissivity (UW-Madison, Seemann et al. 2003)	Using a physical-based, coincident emissivity retrieved from MODIS improves shortwave spectral shape and LST accuracy

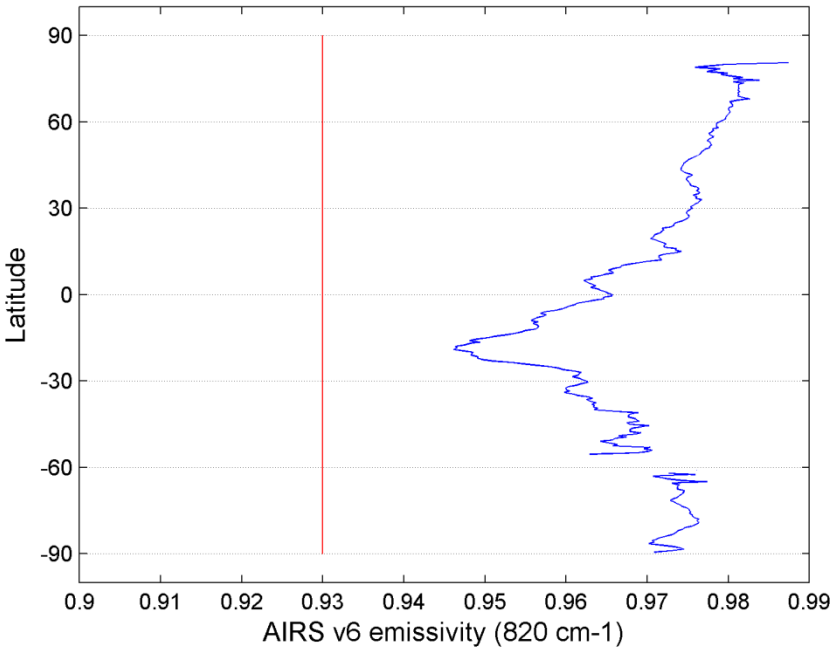
Jan 2007

820 cm-1 (12 µm) Emissivity





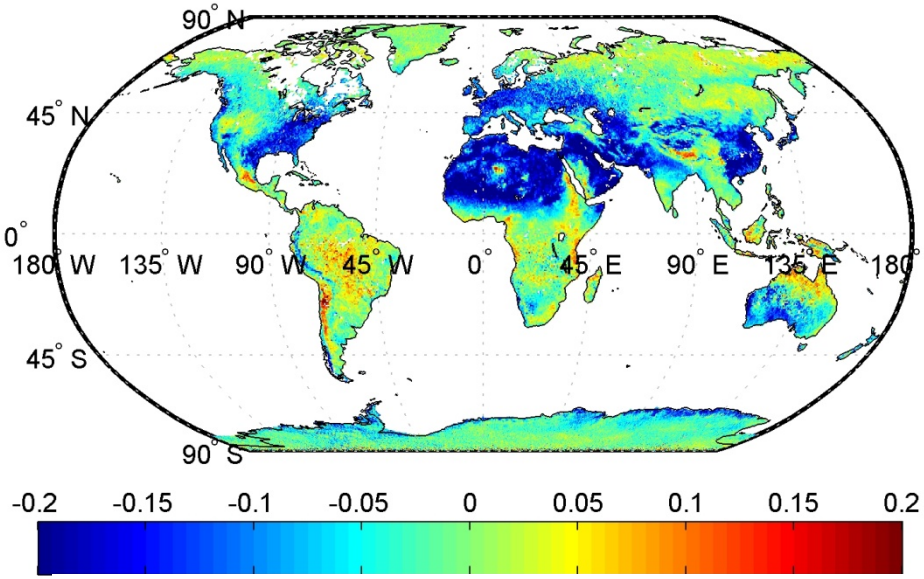


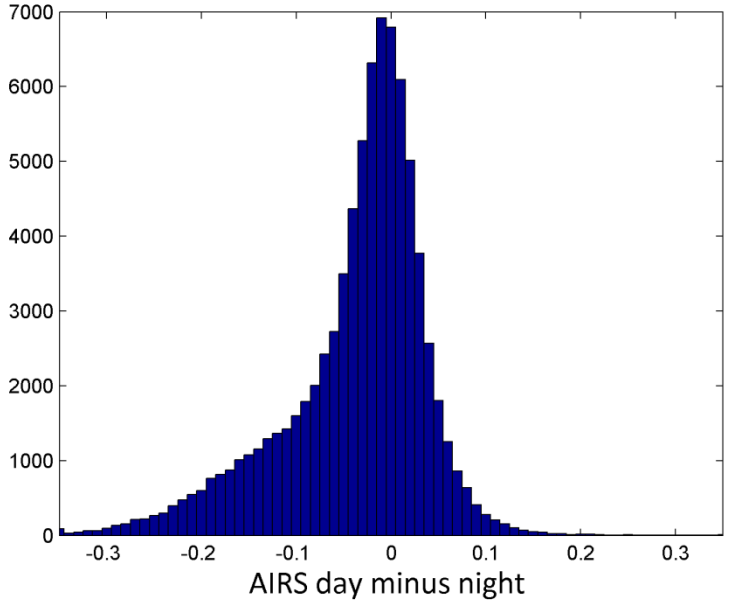


Jan 2007, 2564 cm-1

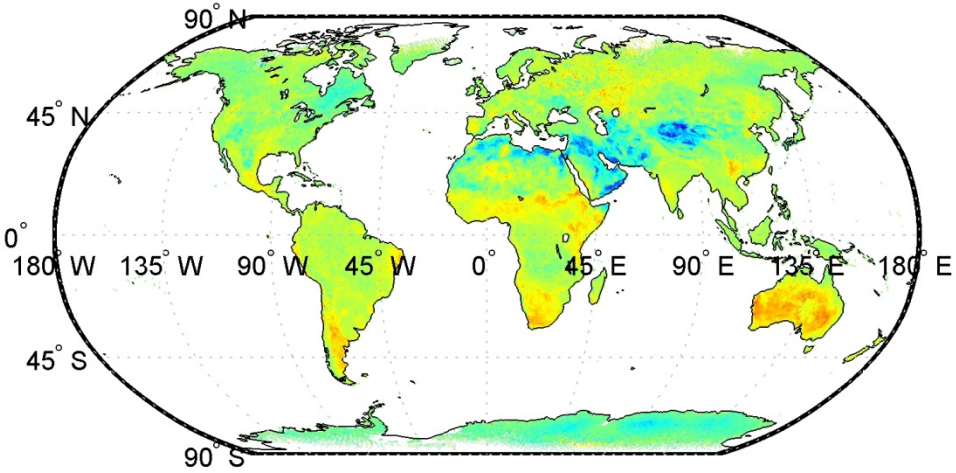
Emissivity Day-Night differences

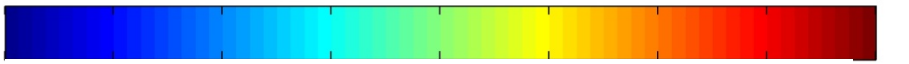
V5

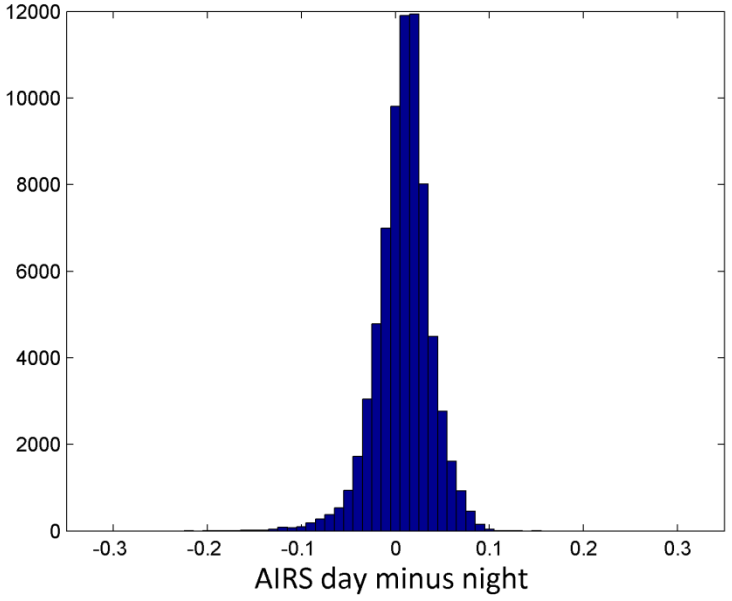




V6



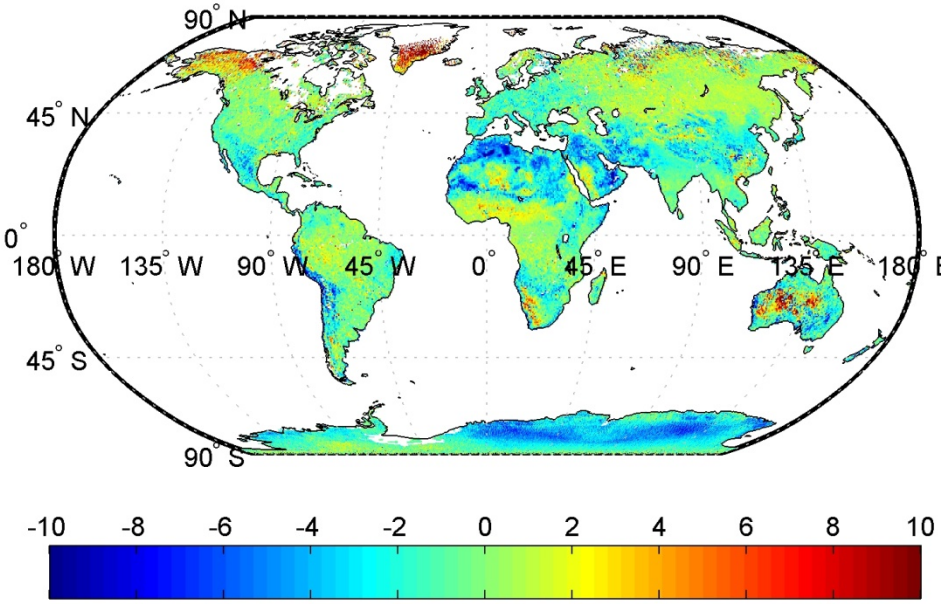




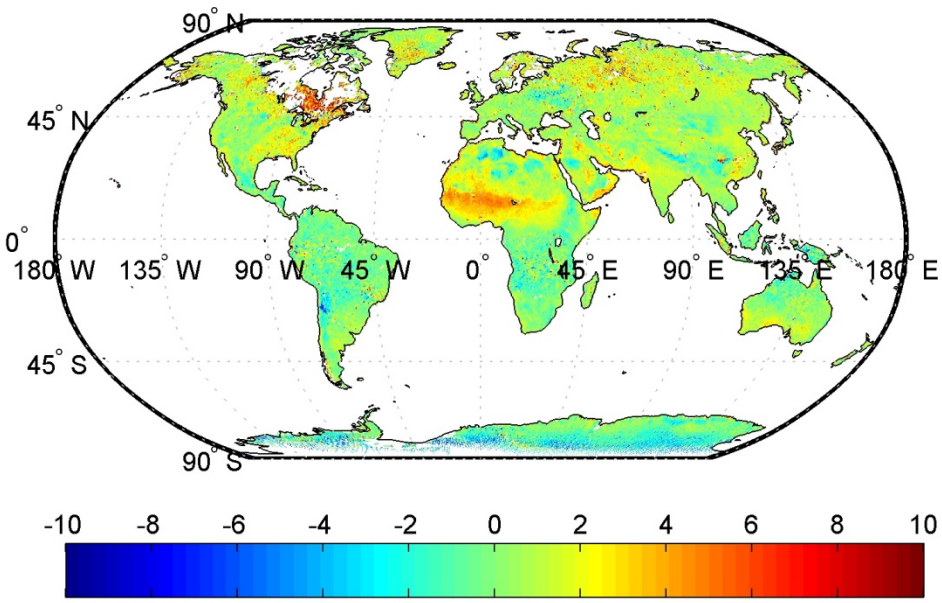
Jan 2007, TSurf

Surface Temperature

Day: v6 – v5 (K)



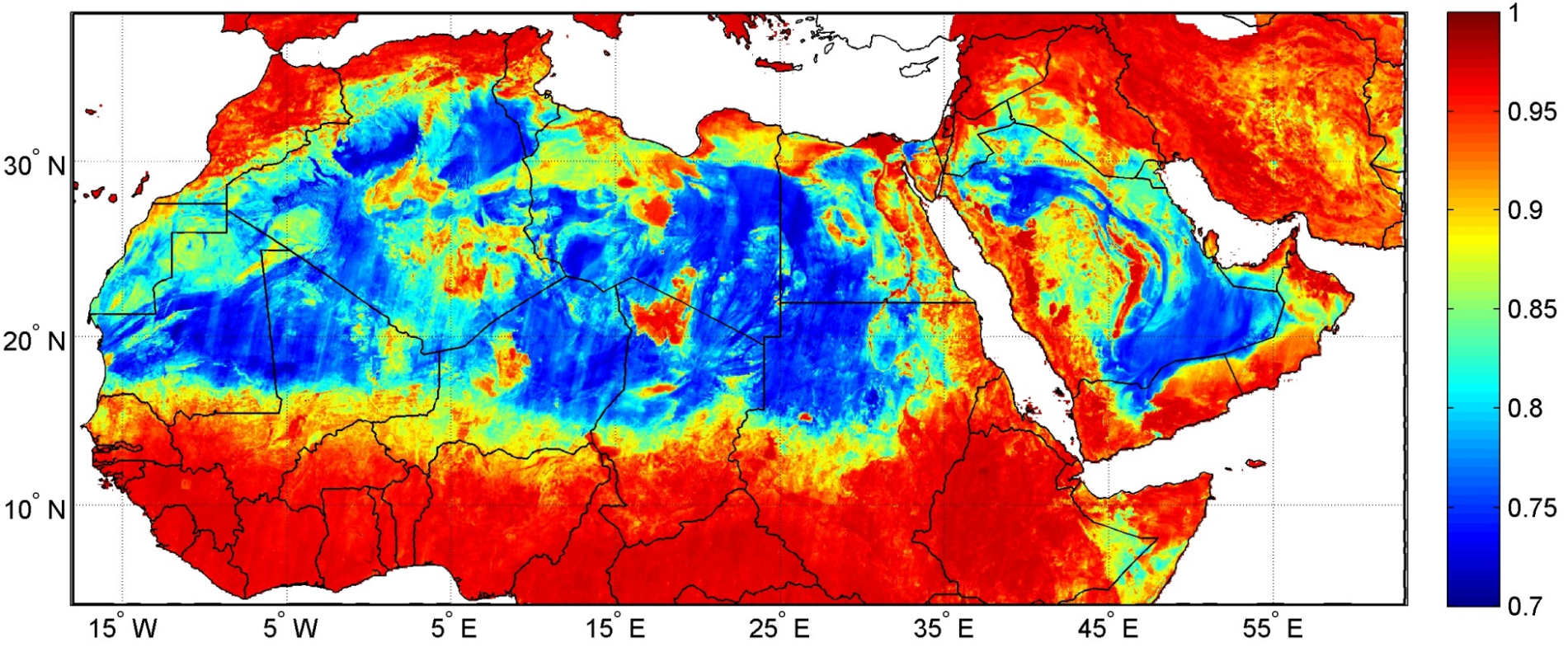
Night: v6 – v5 (K)



ASTER Emissivity Climatology

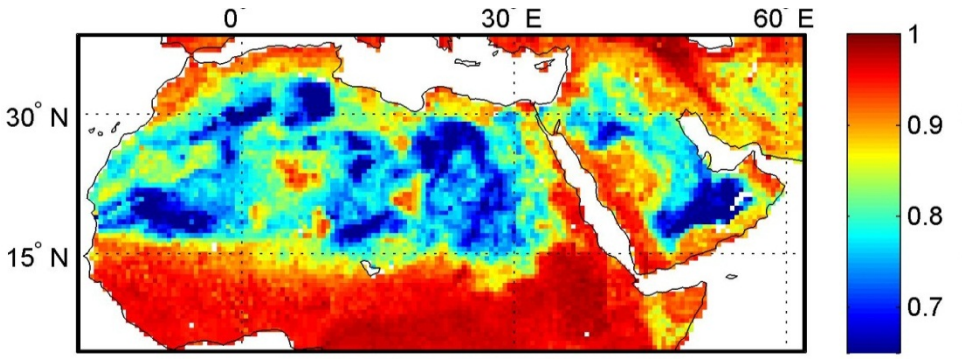
- 16 day repeat, ‘On-demand’
- 90m spatial, 60x60 km scene
- 5 TIR bands (8-12 μm)
- LST, emissivity produced using TES algorithm

Band 10 emissivity (8.3 μm,1205 cm-1): 5km: 2000-2010 (~112,000 scenes)

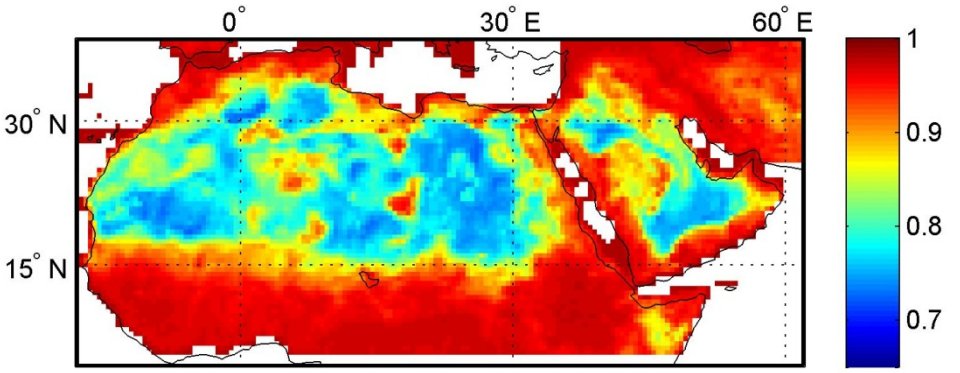


AIRS v5 vs ASTER (8.6 μm, 1163 cm-1)

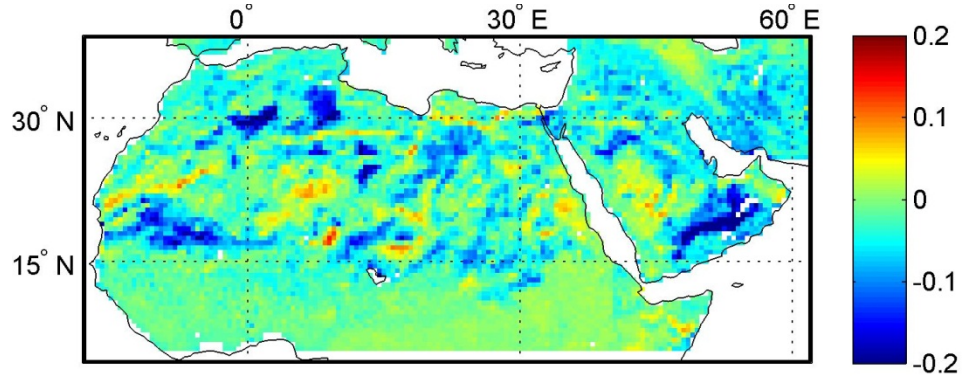
AIRS v5 Emissivity

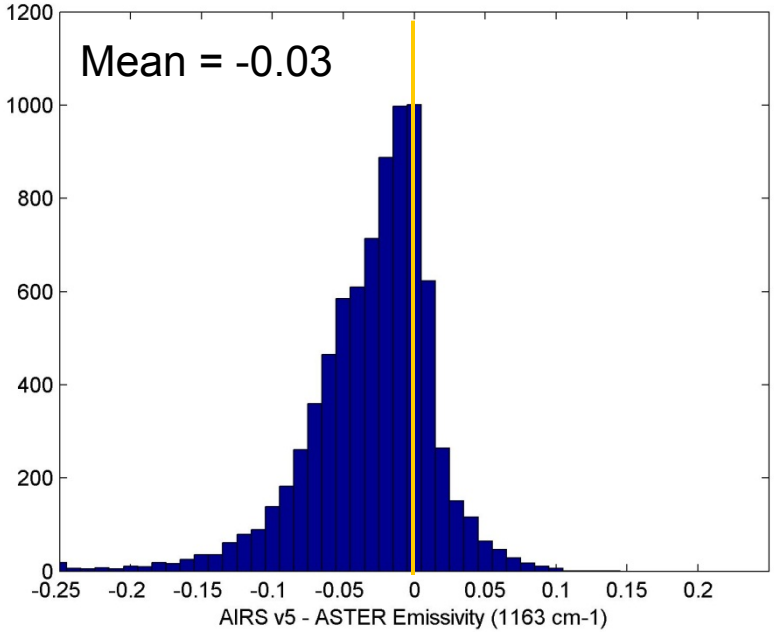


ASTER



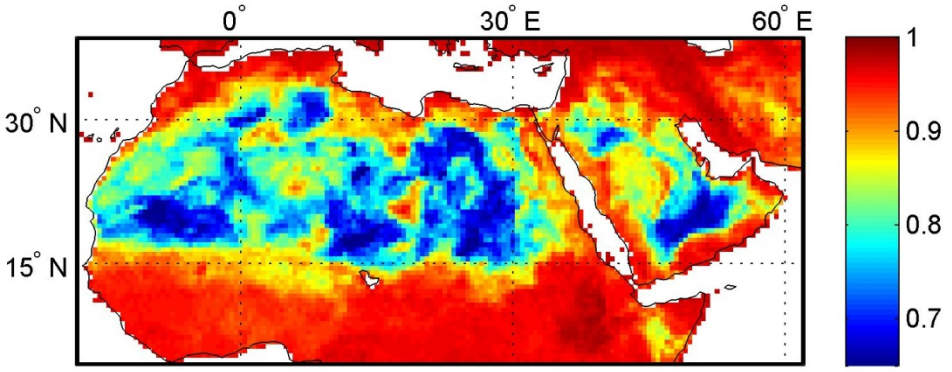
AIRS v5 minus ASTER



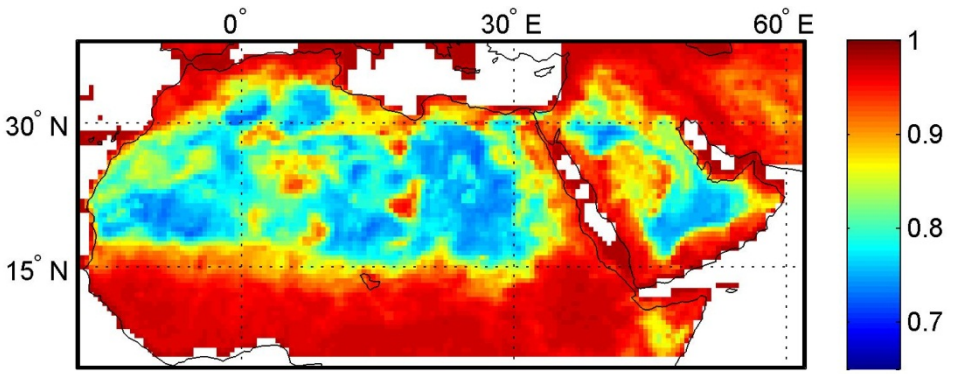


AIRS v6 vs ASTER (8.6 μm, 1163 cm-1)

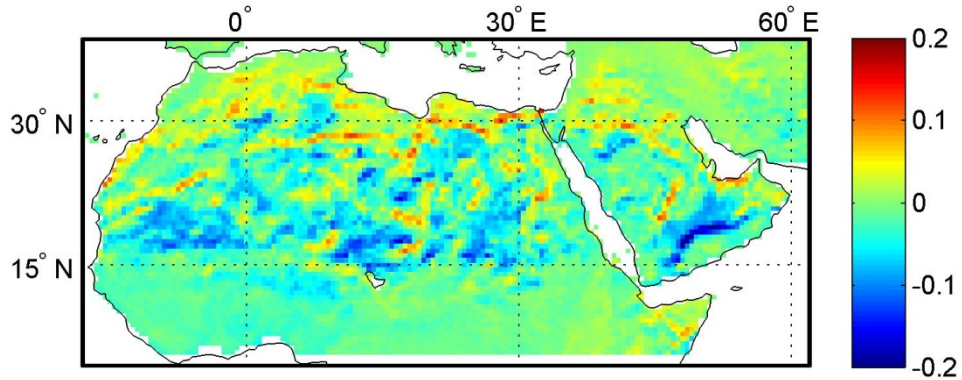
AIRS v6 Emissivity

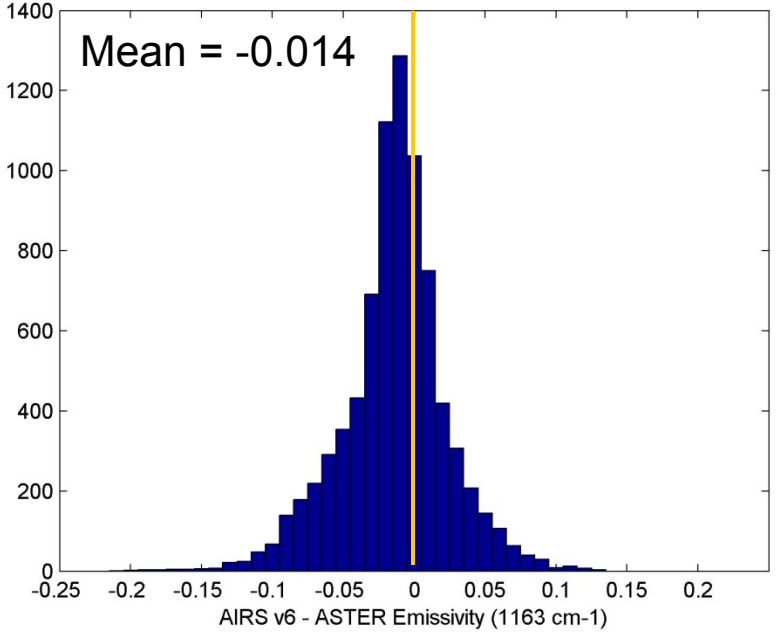


ASTER



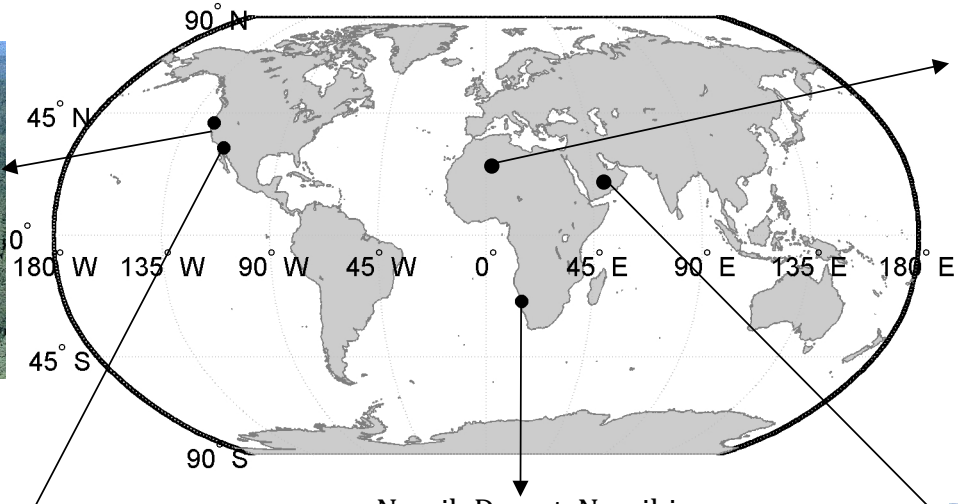
AIRS v6 minus ASTER



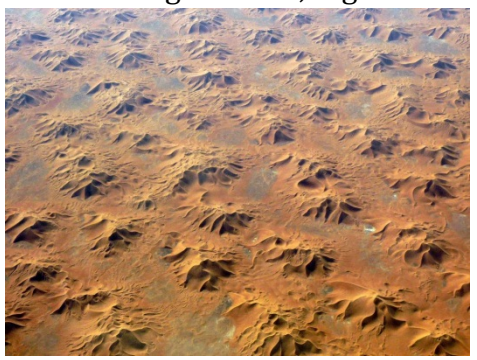


Radiance-based LST Validation Sites

Redwood National Forest, CA

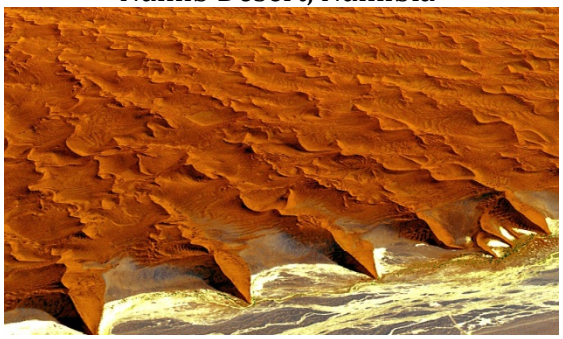


Grand Erg Oriental, Algeria

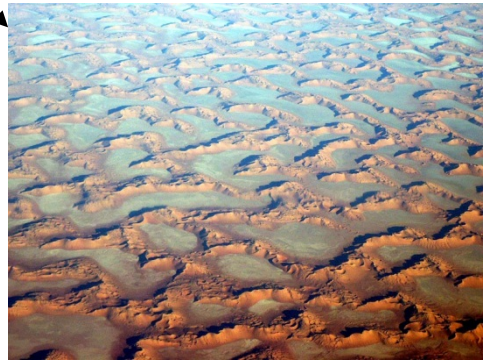


Gran Desierto, Mexico

Namib Desert, Namibia



Rub' Al Khali, Saudi Arabia



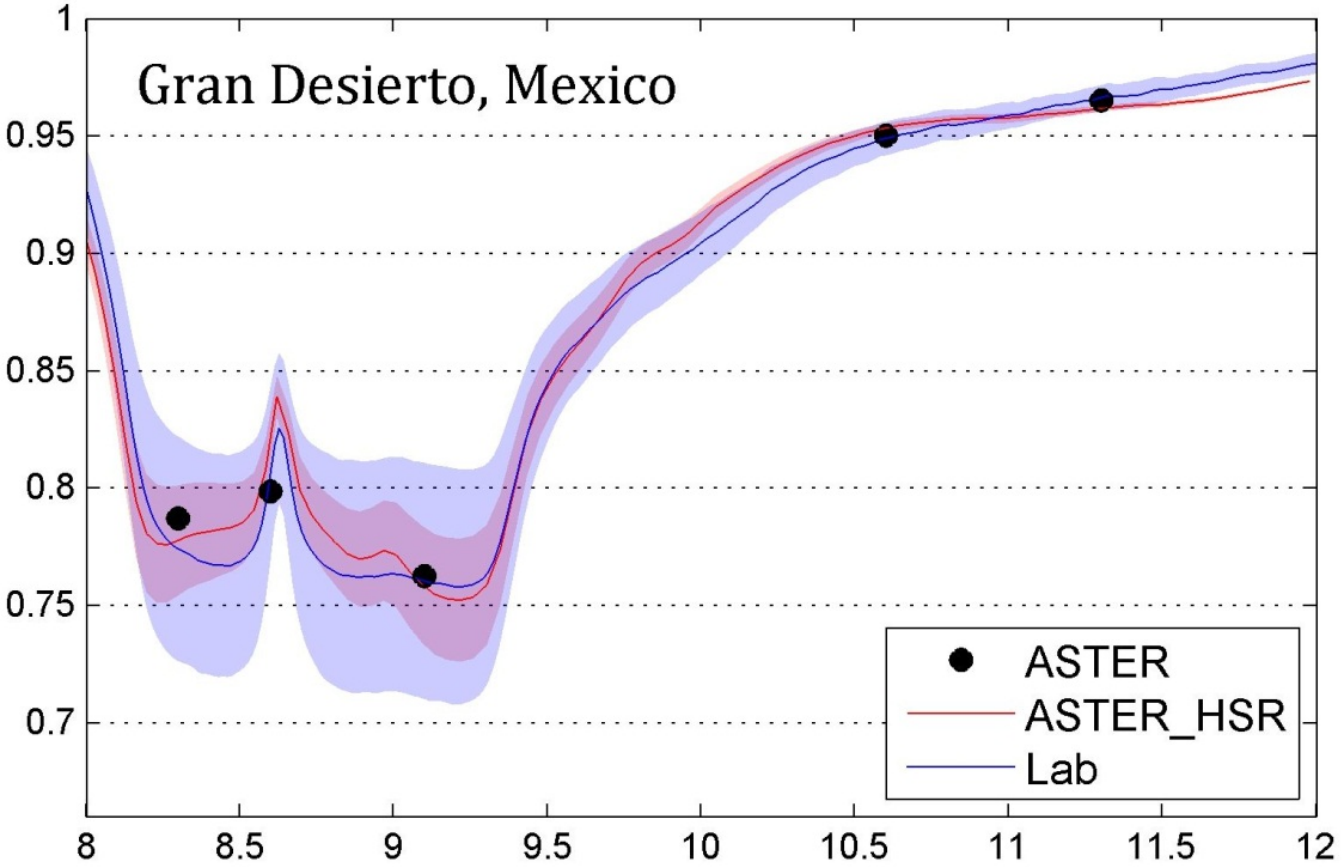
Radiance-based LST validation (Radiative closure) 11 µm

- Input: retrieved LST
- Accurate surface emissivity (e.g. Lab, ASTER)
- External profiles (e.g. NCEP, ECMWF)
- SARTA to get TOA BT) → Vary LST until obs = calc BT

High Spectral Resolution (HSR) ASTER Emissivity

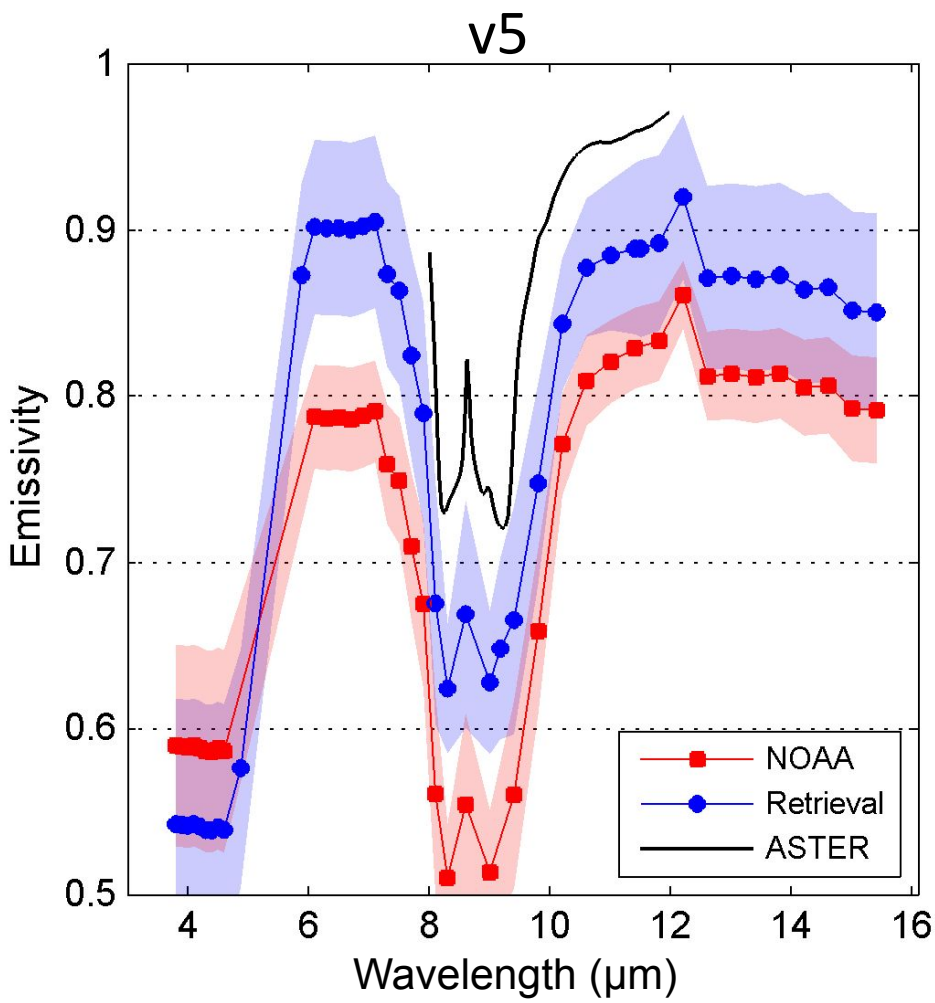
Principal Component Analysis (PCA) regression (UW-Madison, Eva Borbas)

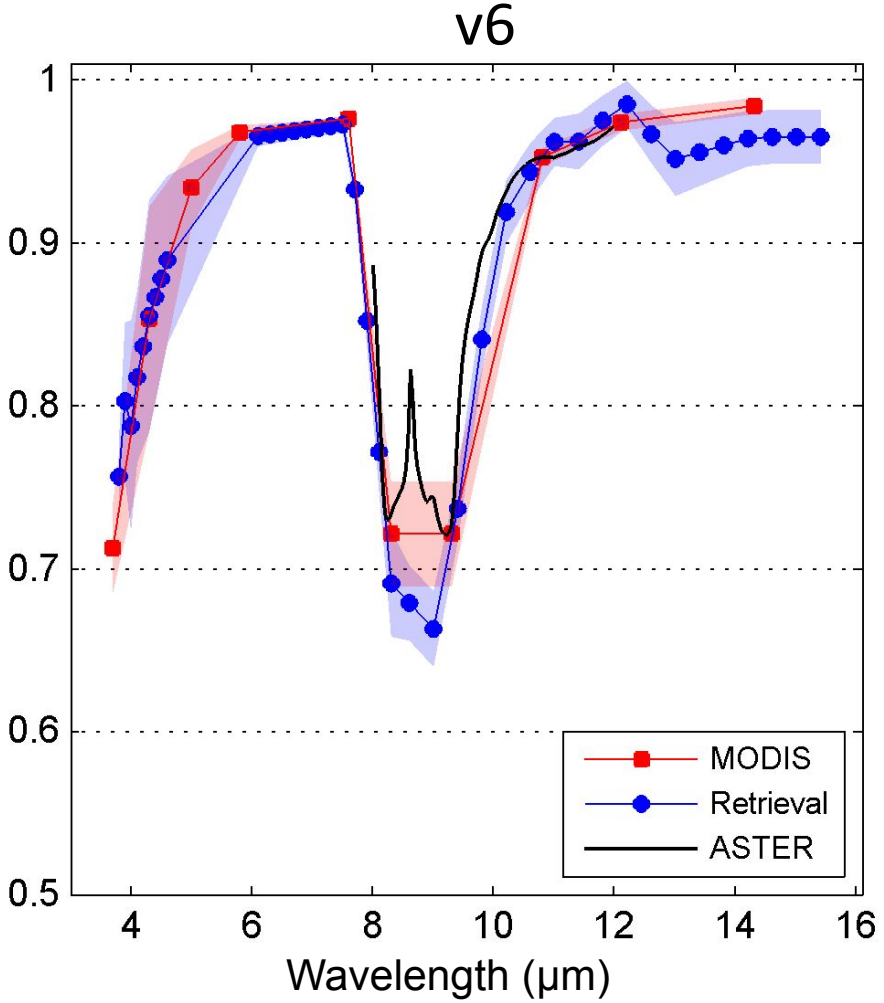
- PCs, eigenvectors generated from 142 lab spectra
- 84 wavenumbers from 835-1250 cm^{-1}
- $\varepsilon = c \cdot U$



Grand Erg Oriental, Algeria

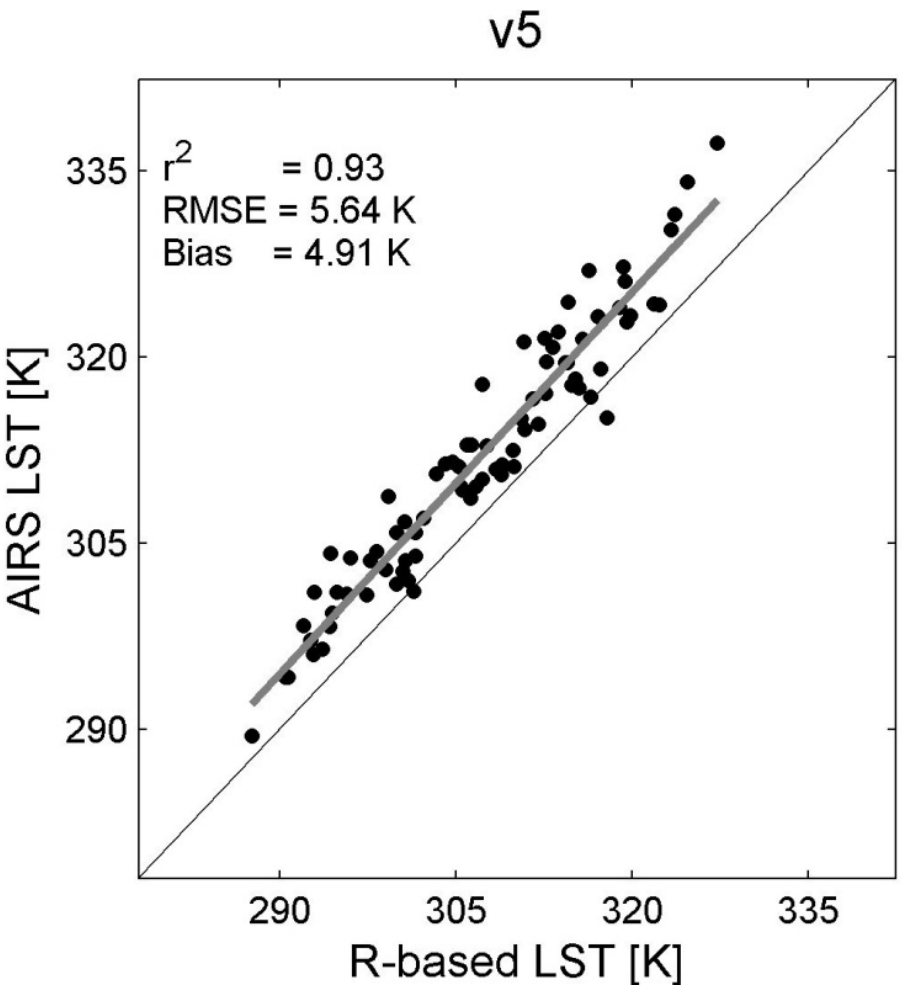
- Day
- 2003-2010
- Cldfrac<0.5
- View <45
- QA {0,1}

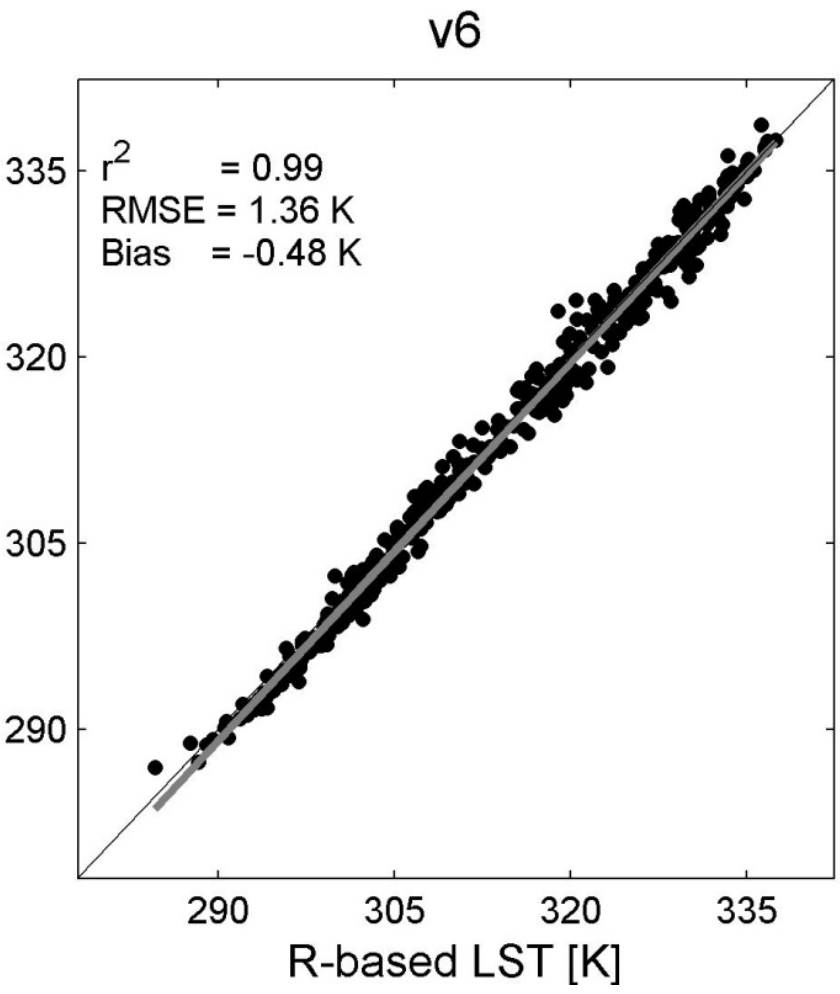




Grand Erg Oriental, Algeria

- Day
- 2003-2010
- Cldfrac<0.5
- View <45
- QA {0,1}

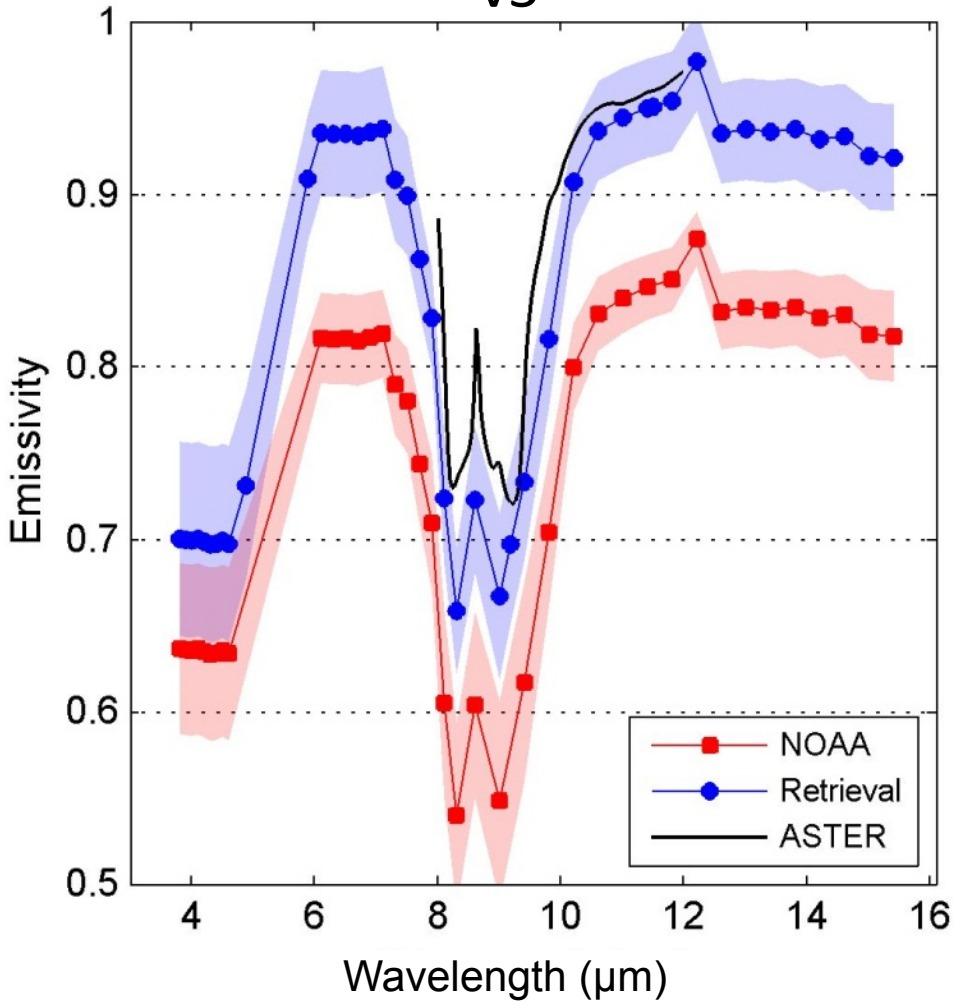




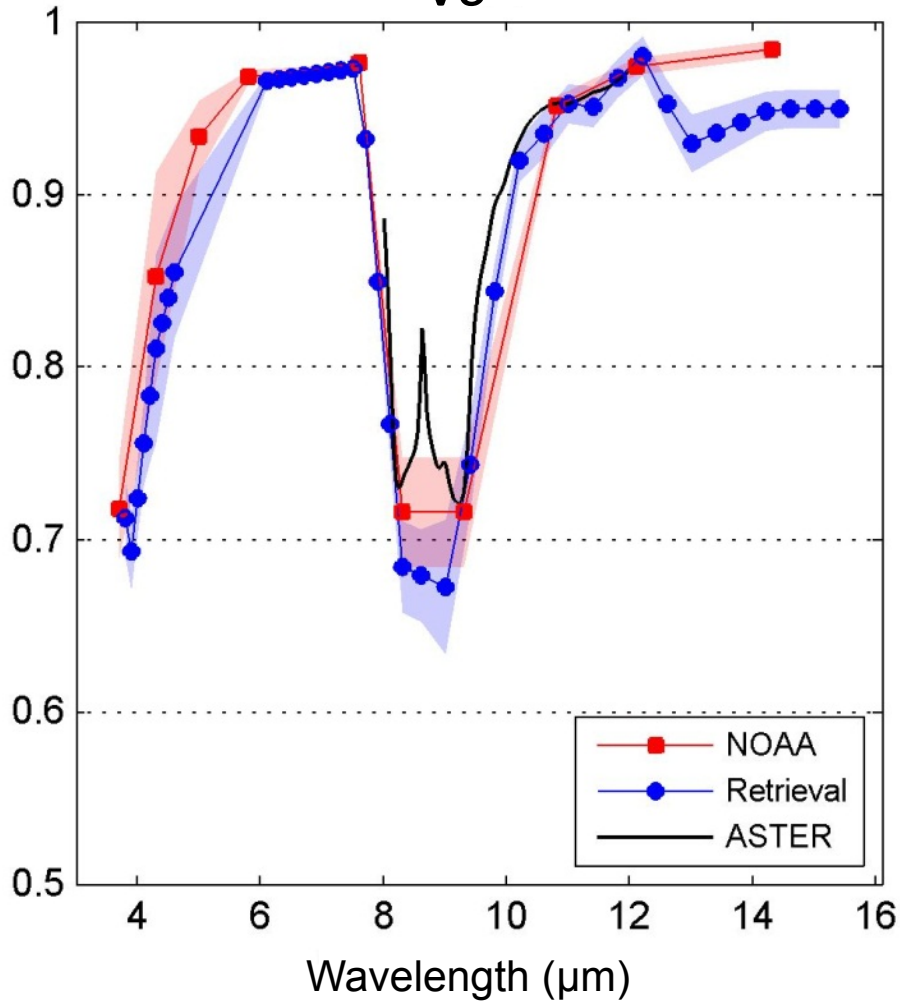
Grand Erg Oriental, Algeria

- Night
- 2003-2010
- Cldfrac<0.5
- View <45
- QA {0,1}

v5

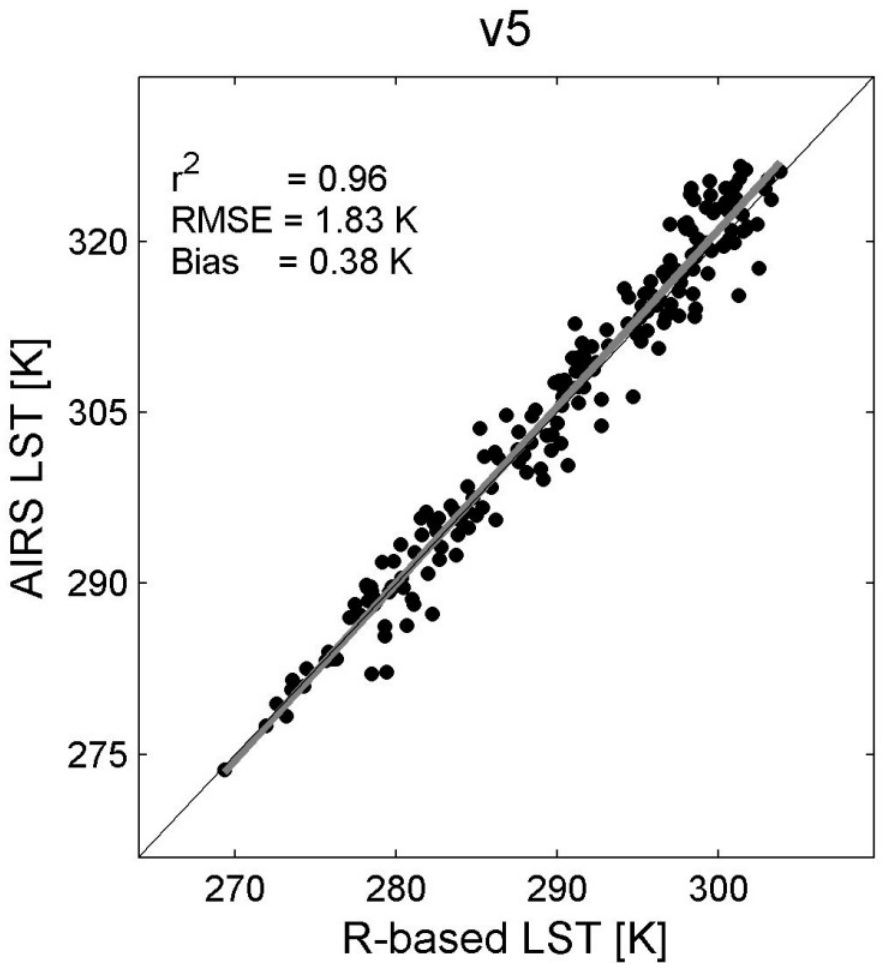


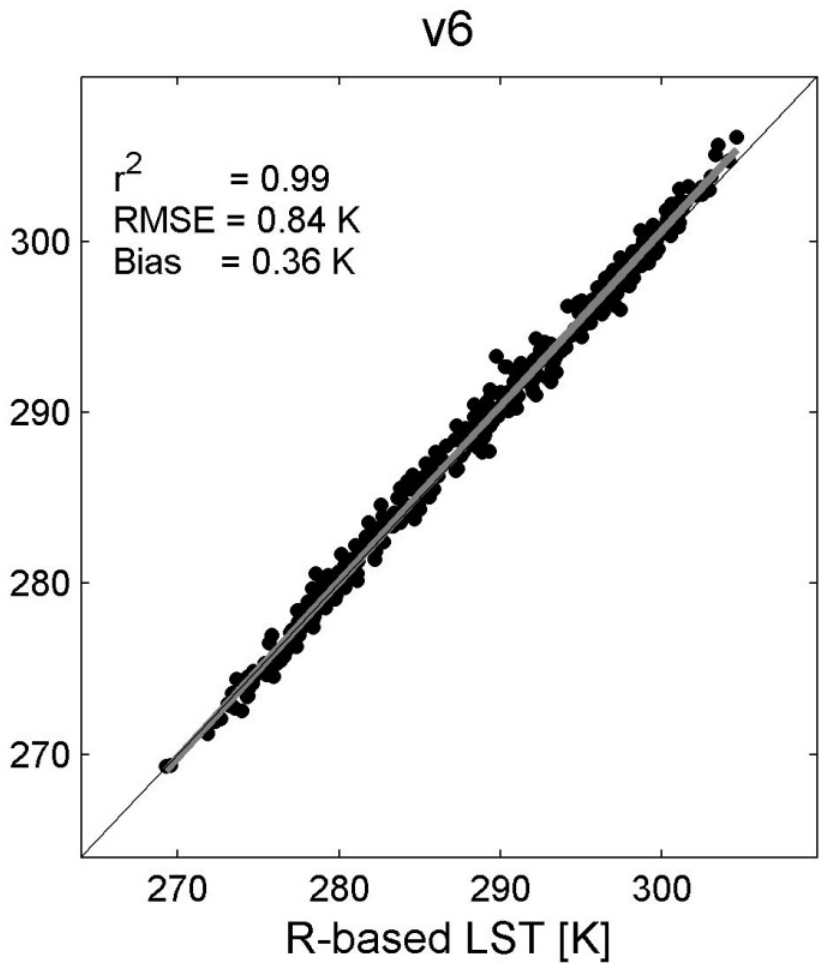
v6



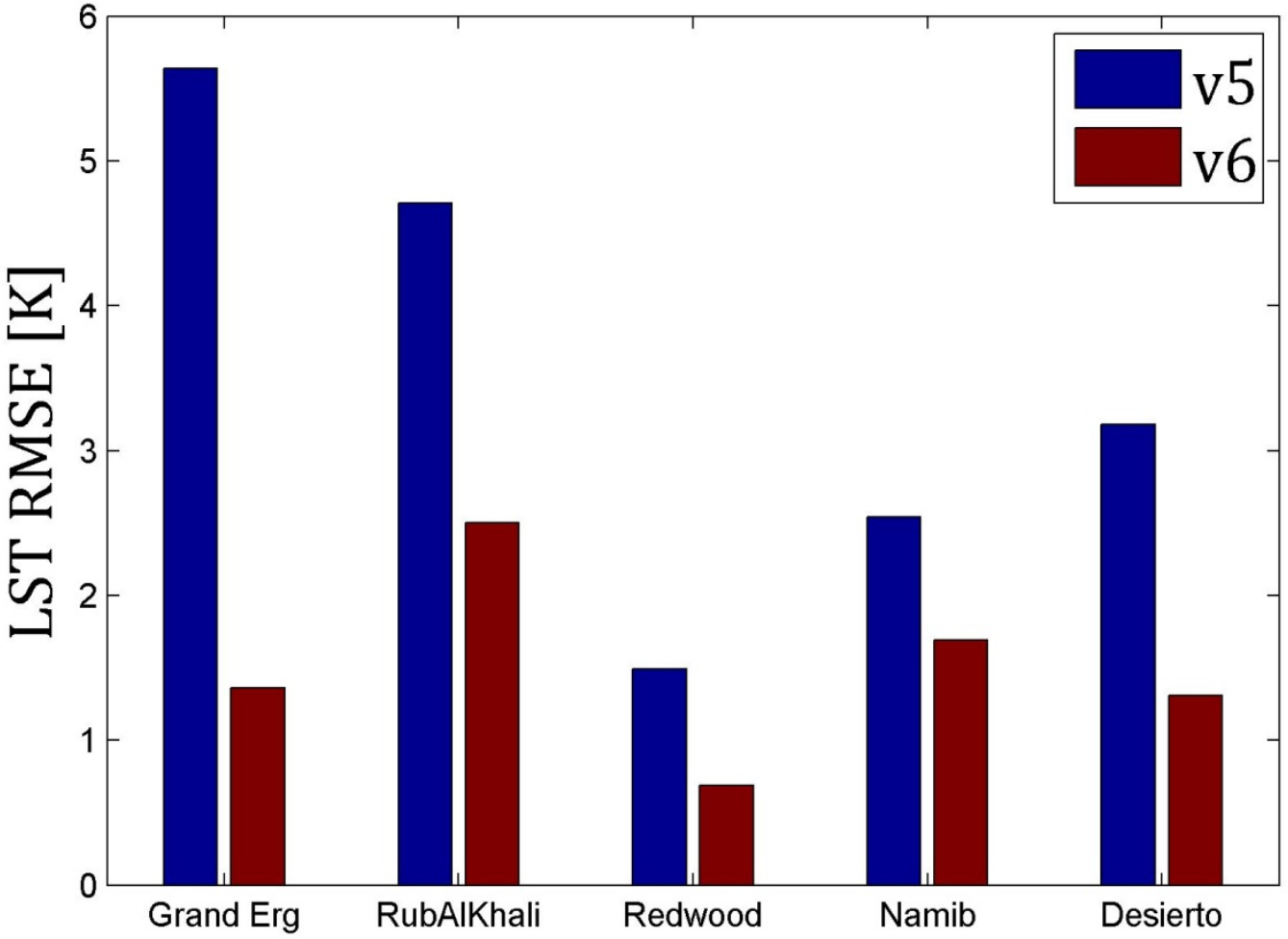
Grand Erg Oriental, Algeria

- Night
- 2003-2010
- Cldfrac<0.5
- View <30
- QA {0,1}

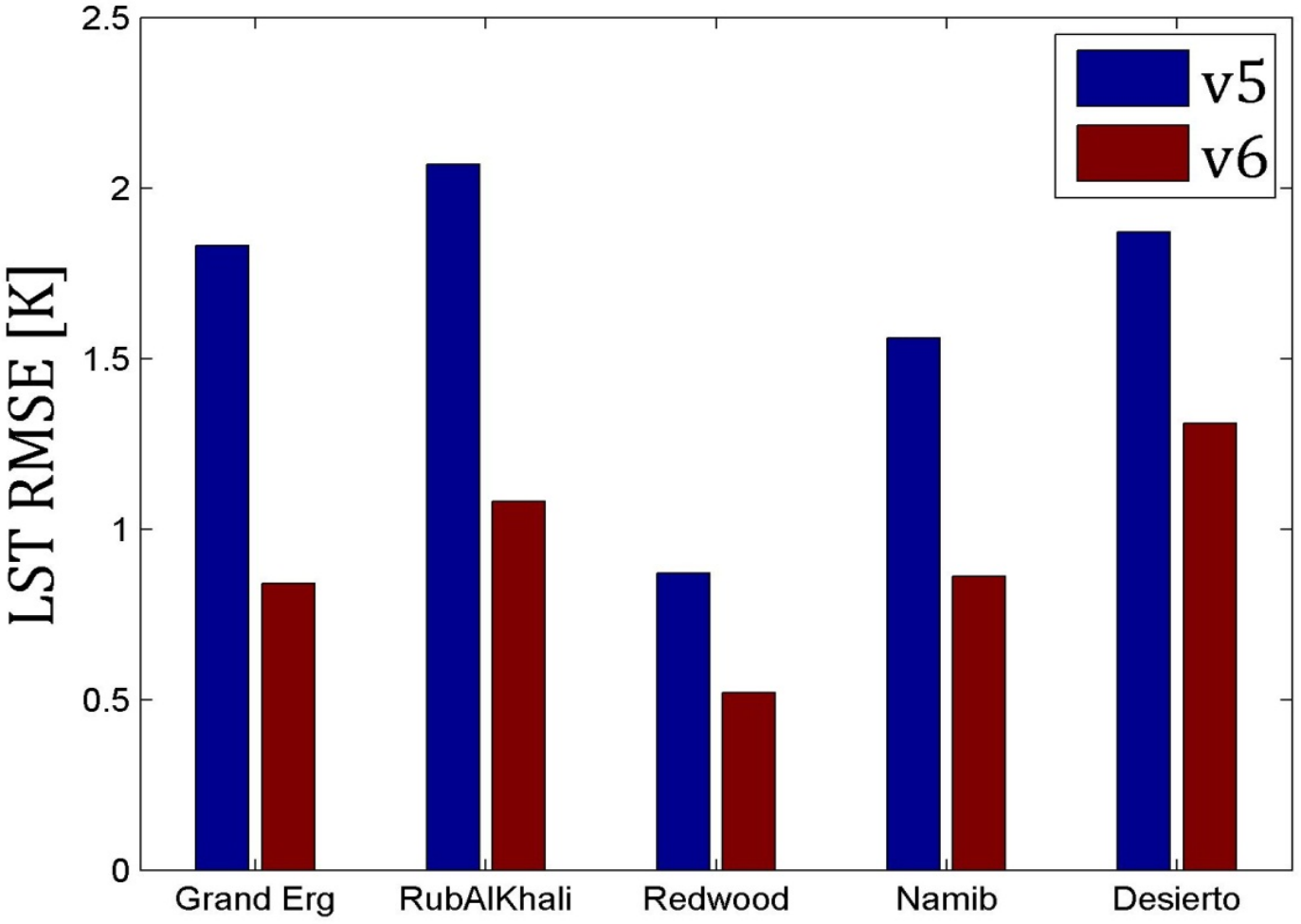




RMSE statistics for LST daytime (vs R-based LST)



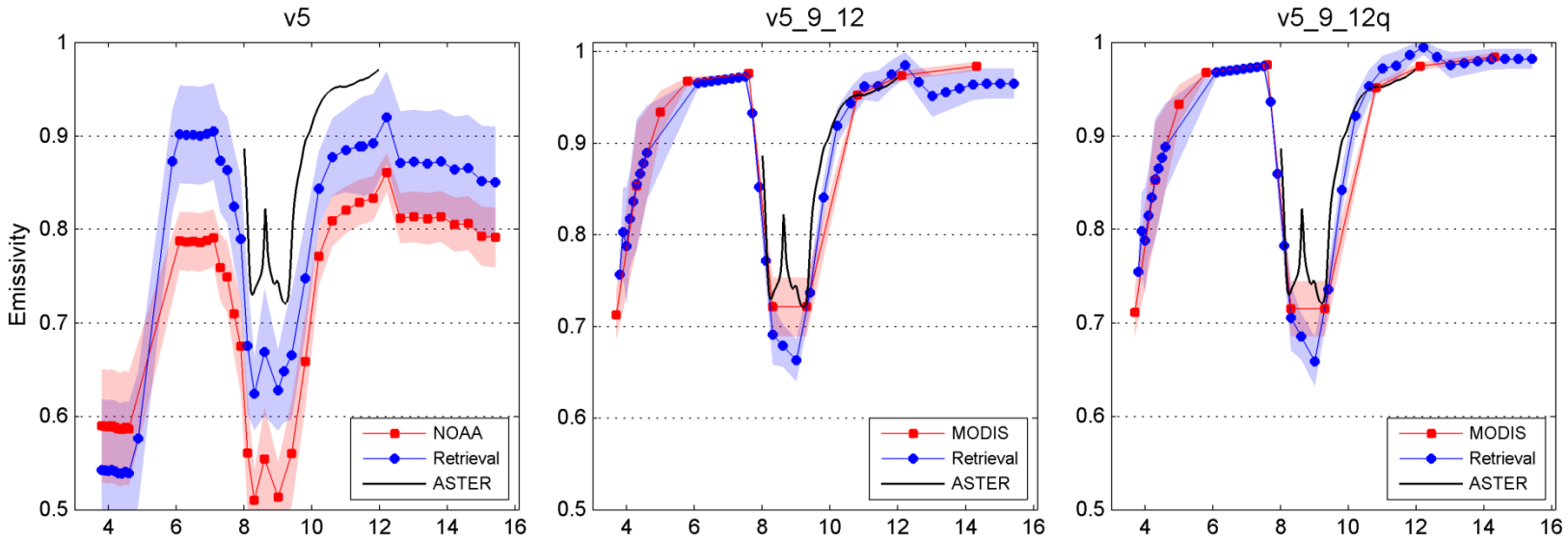
RMSE statistics for LST nighttime (vs R-based LST)



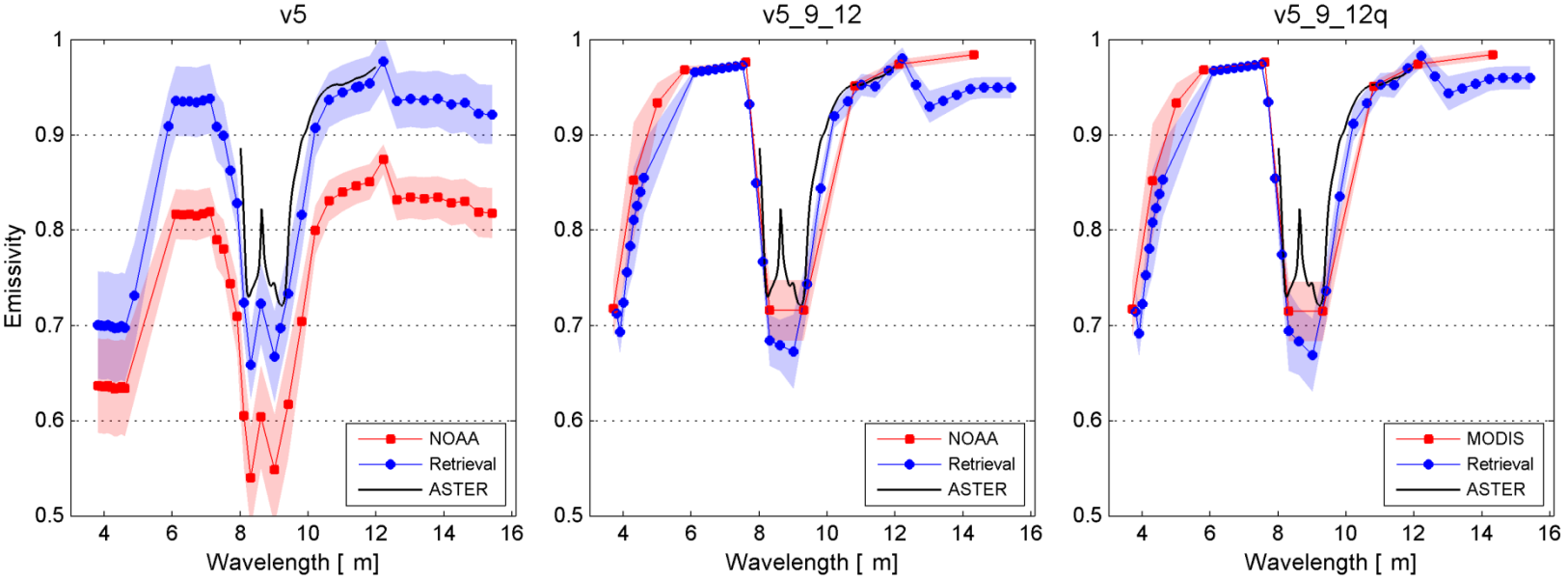
Summary

- Improved surface retrieval methodology and new MODIS emissivity first guess in V6.
- V6 emissivities more accurate and stable than V5 in short and longwave.
- Diurnal emissivity differences are smaller but still exist.
- V6 emissivities compare better than V5 with ASTER climatology
- RMSE in V6 LST's reduced by factor of 2 compared to V5 at radiance-based validation sites.

Day


v5
v5_9_12
v5_9_12q
Emissivity
NOAA
Retrieval
ASTER
MODIS
Retrieval
ASTER
MODIS
Retrieval
ASTER

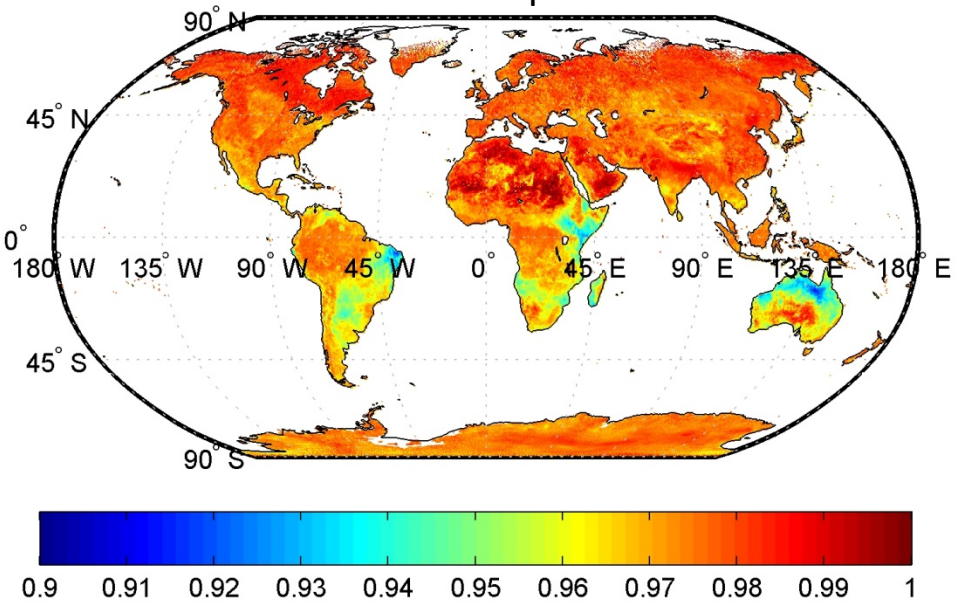
Night


v5
v5_9_12
v5_9_12q
Emissivity
NOAA
Retrieval
ASTER
NOAA
Retrieval
ASTER
MODIS
Retrieval
ASTER
Wavelength [m]
Wavelength [m]
Wavelength [m]

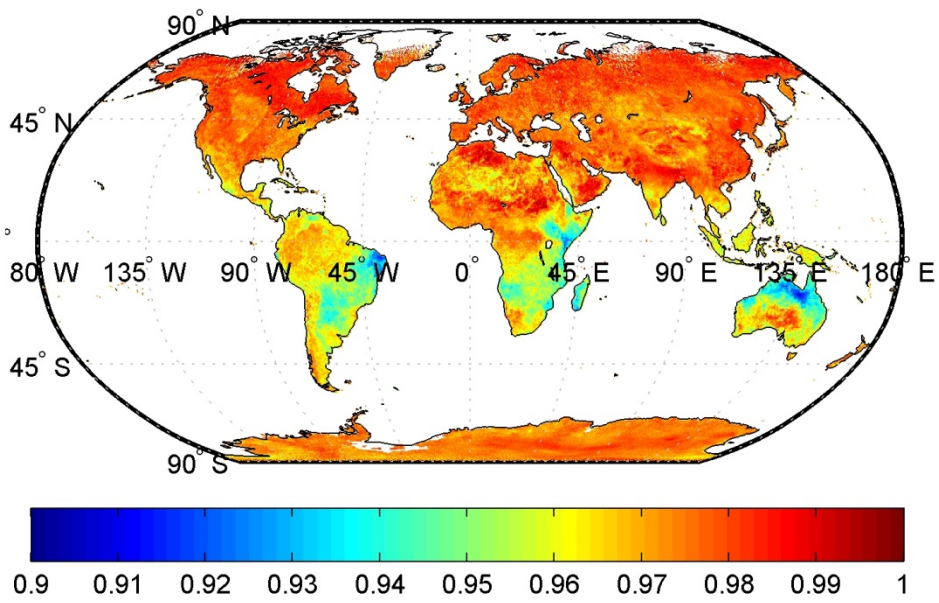
Jan 2007, 820 cm-1

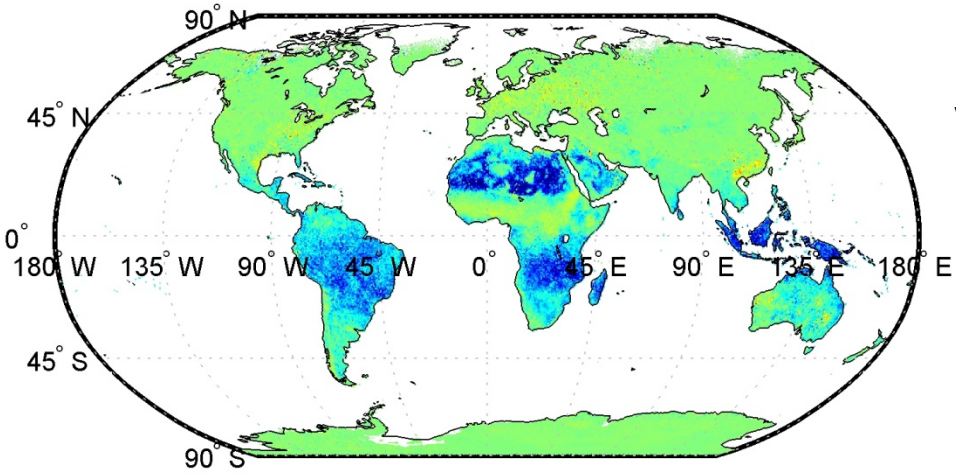
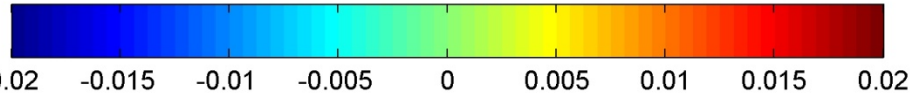
Emissivity

v5.9.12q



v5.9.12





v5.9.12 – v5.9.12q