AIRS v6 Land Surface Temperature (LST) and Emissivity Assessment

Glynn Hulley, Evan Manning

Jet Propulsion Laboratory, California Institute of Technology

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Outline

1. UW MODIS Baseline-fit (MODBF) Emissivity Database

2. Radiance-based Land Surface Temperature (LST) validation method

3. AIRS land validation targets

4. LST and Emissivity evaluation for v6 baseline versions:
   1. v5_7_5_ModisEmis (2-Regression)
   2. v5_7_5_Clim (Climatology)
   3. v5_7_5_SCCNN (Neural Net)

The UW Global IR Land Surface Emissivity Database: Baseline Fit Method

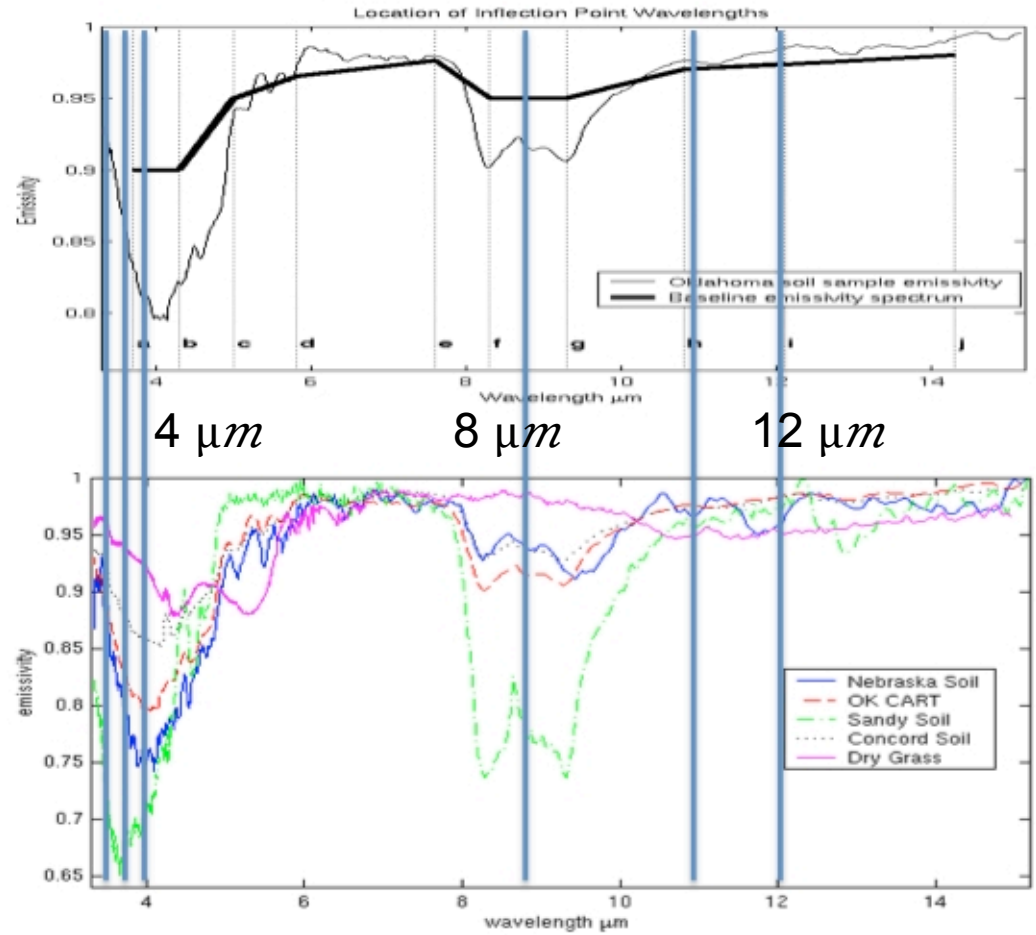
* Slide courtesy of Eva Borbas, UW

•Based on a **conceptual model** developed from **laboratory measurements** (UCSB) of surface emissivity is applied to fill in the spectral gaps between the six emissivity wavelengths available from **MYD11**

•**10 hinge points** were chosen between 3.7 and 14.3 μm

•Adjust a laboratory-derived "baseline emissivity spectra" based on the MOD11 values for every global latitude/longitude pair

•**Result:** a monthly global emissivity database at 10 wavelengths with 0.05 degree spatial resolution

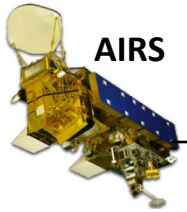


Reference:
Seemann et al., 2008: JAMC, 47, 108-123.

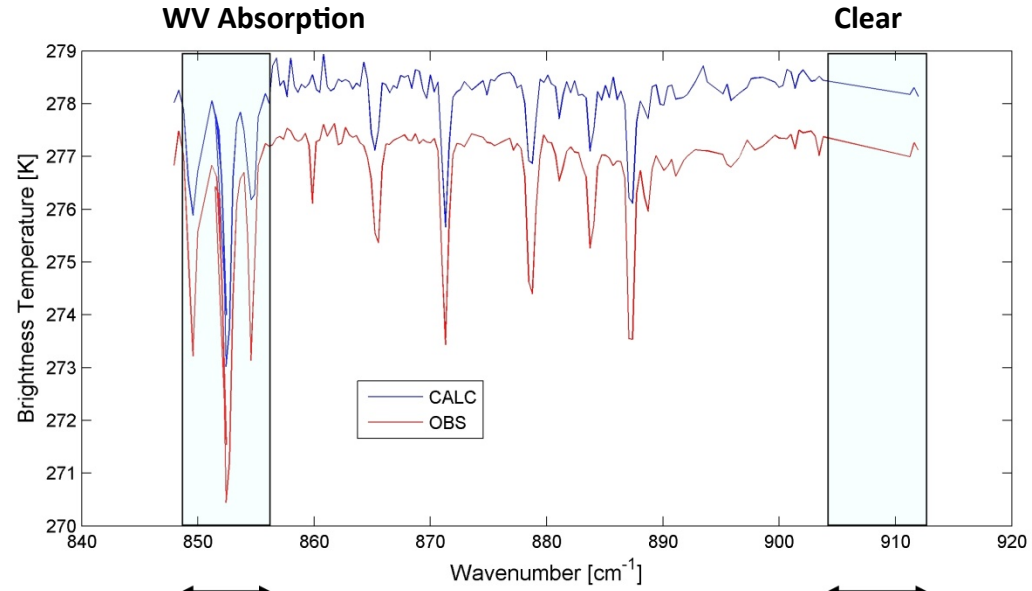
Radiance-based (R-based) Land Surface Temperature (LST) Validation

- LST notoriously difficult to validate
- R-based method adopted from MODIS to validate AIRS LST
- Accurate radiative transfer model and emissivity measurements required.
- ***<u>Advantages</u>***: - Application to many sites
  - Day and night observations
  - Can be used for coarse resolution sensors (granted you have large, homogenous site)

Radiance-based LST Validation



T_b(obs)
CCR's



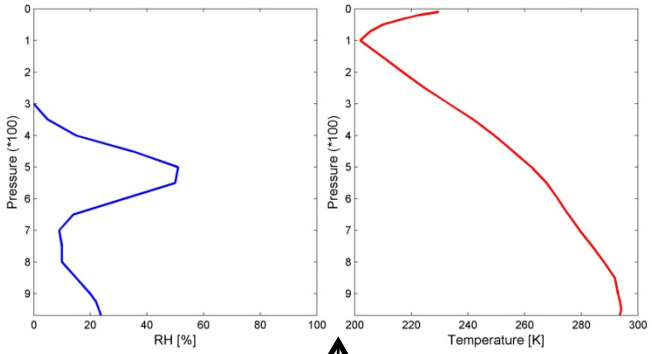
27 Channels (~12 μm)
848 – 856 cm^{-1}

3 Channels (~11 μm)
904 – 912 cm^{-1}

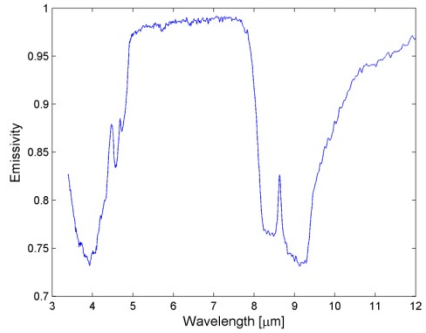
SARTA

T_b(calc) + NEΔT

NCEP (GDAS) Profiles



Lab Field Emissivity



Surface

T_s(AIRS retrieved)

NCEP Profile Quality Test

ΔT_b (obs) = T_{b11}(obs) - T_{b12}(obs)

ΔT_b (calc) = T_{b11}(calc) - T_{b12}(calc)

$\Delta T_b = \Delta T_b(\text{obs}) - \Delta T_b(\text{calc})$

$-0.5\text{ K} < \Delta T_b < 0.5\text{ K}$

YES → $T_{s'} = T_s \pm 2K$ → SARTA

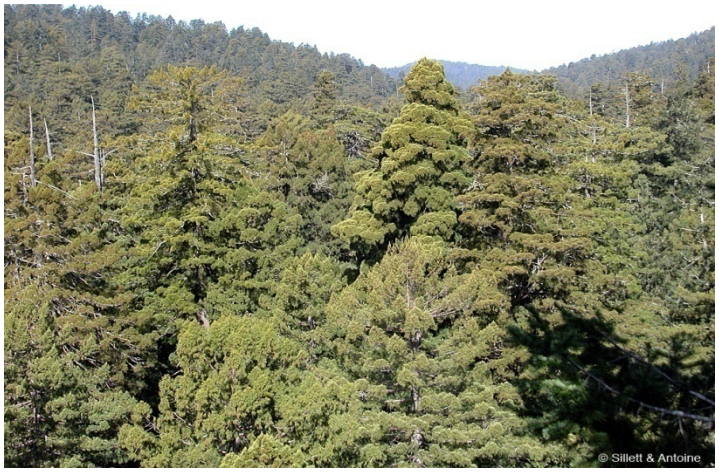
NO → **QUIT!**

SARTA → $T_{b'}$(calc) → T_{rad} = interp([T_s $T_{s'}$],[$T_{b'}$ T_b],T_b)

Theoretically Correct Surface Temperature

AIRS Land Validation Sites

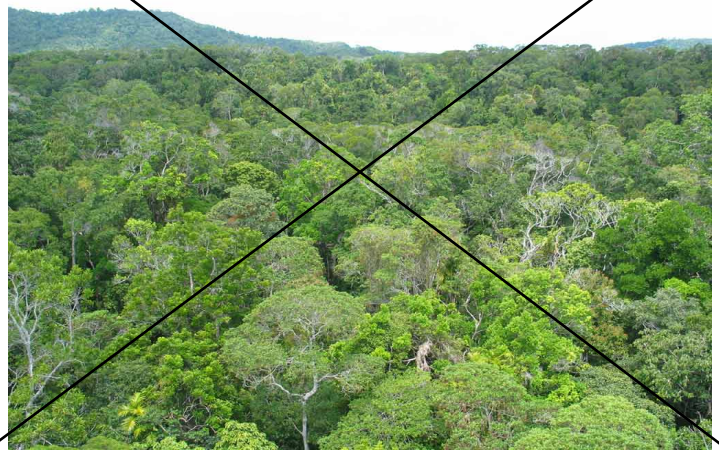
Redwood National Forest, California



Dry Atmosphere

Namib Desert, Namibia

Chinizuia Forest, Mozambique

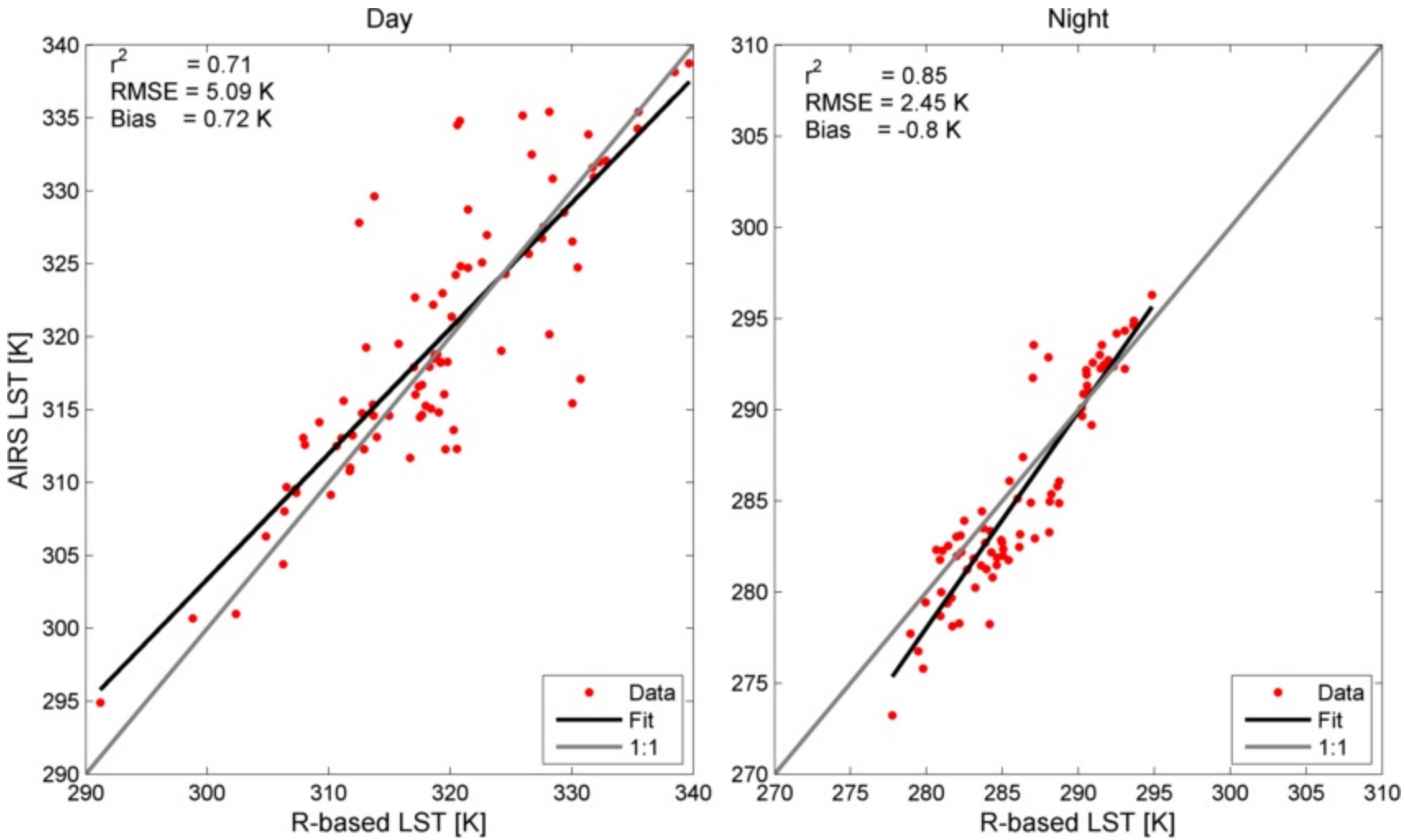


Humid Atmosphere

Gran Desierto, Mexico

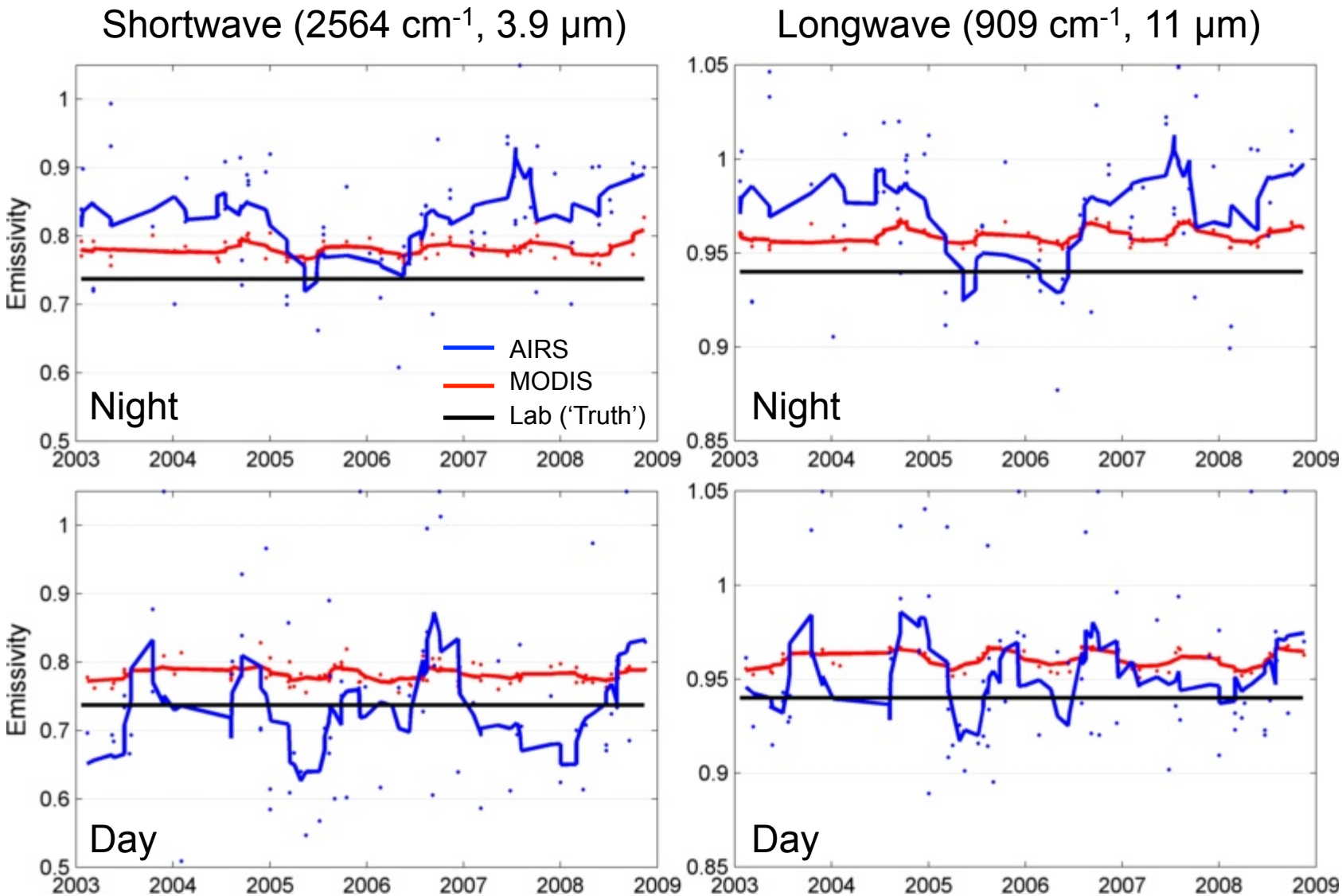
v5

Namib Desert
2003-2009



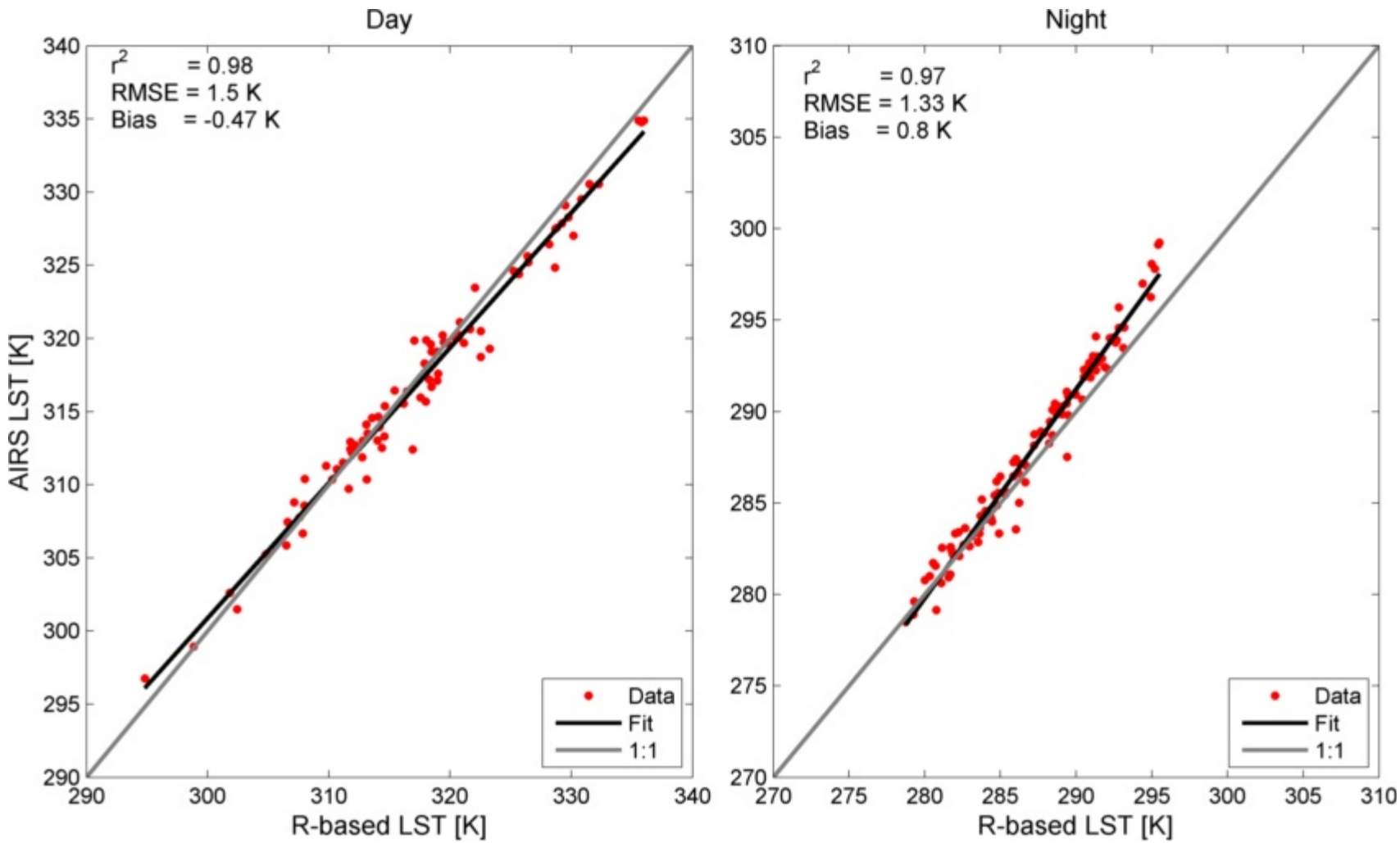
v5

Namib Desert



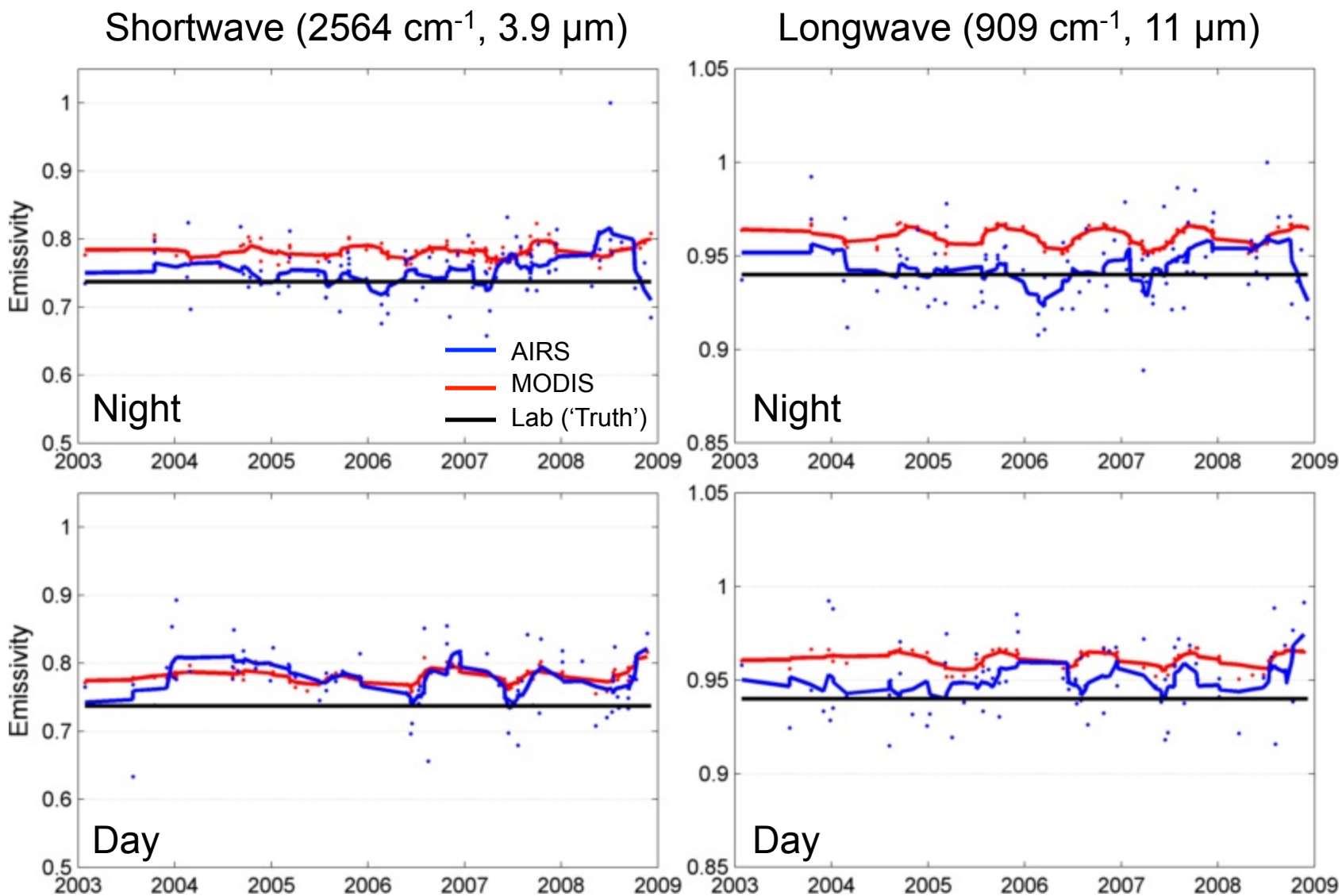
v5_7_5_ModisEmis

Namib Desert
2003-2009



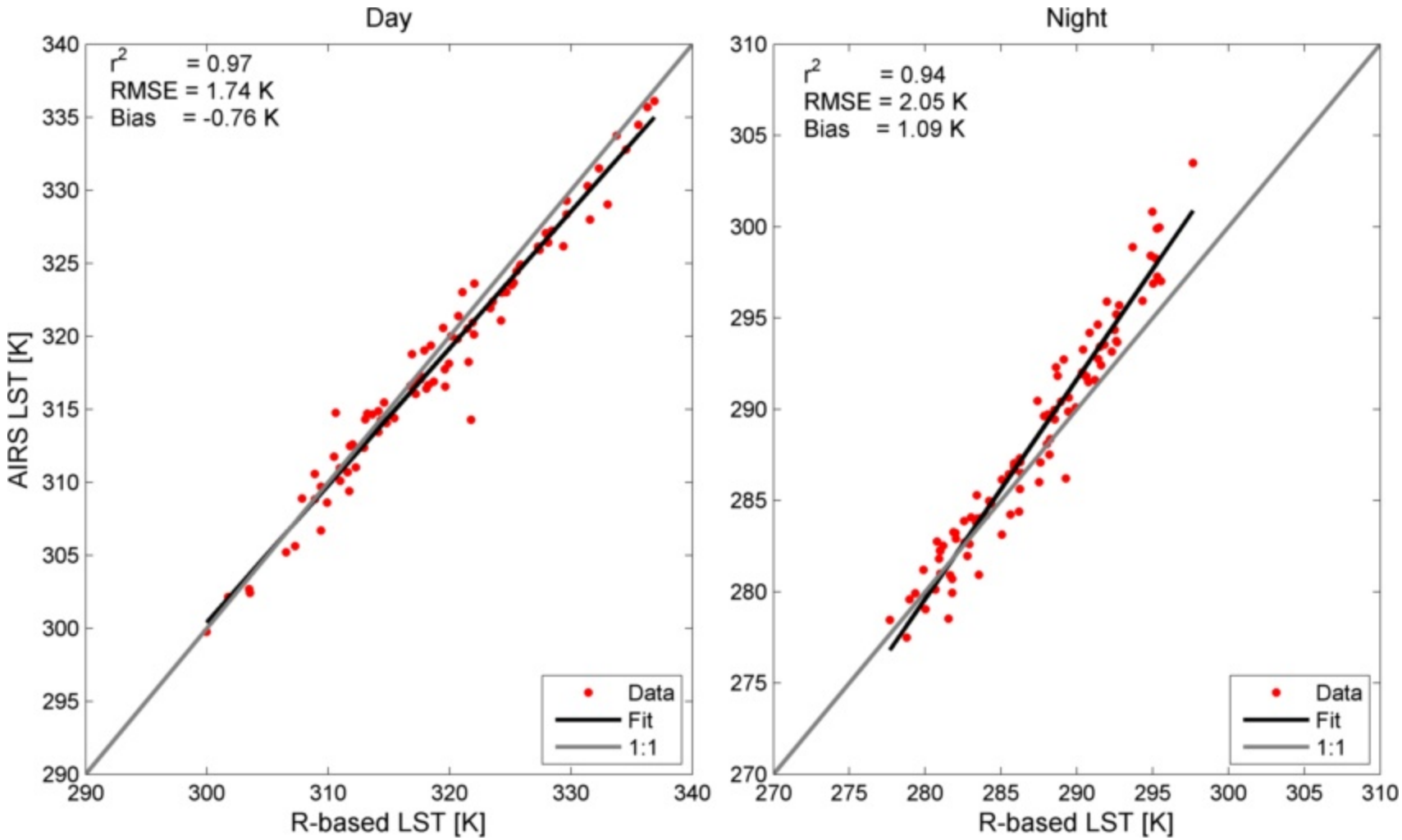
v5_7_5_ModisEmis

Namib Desert



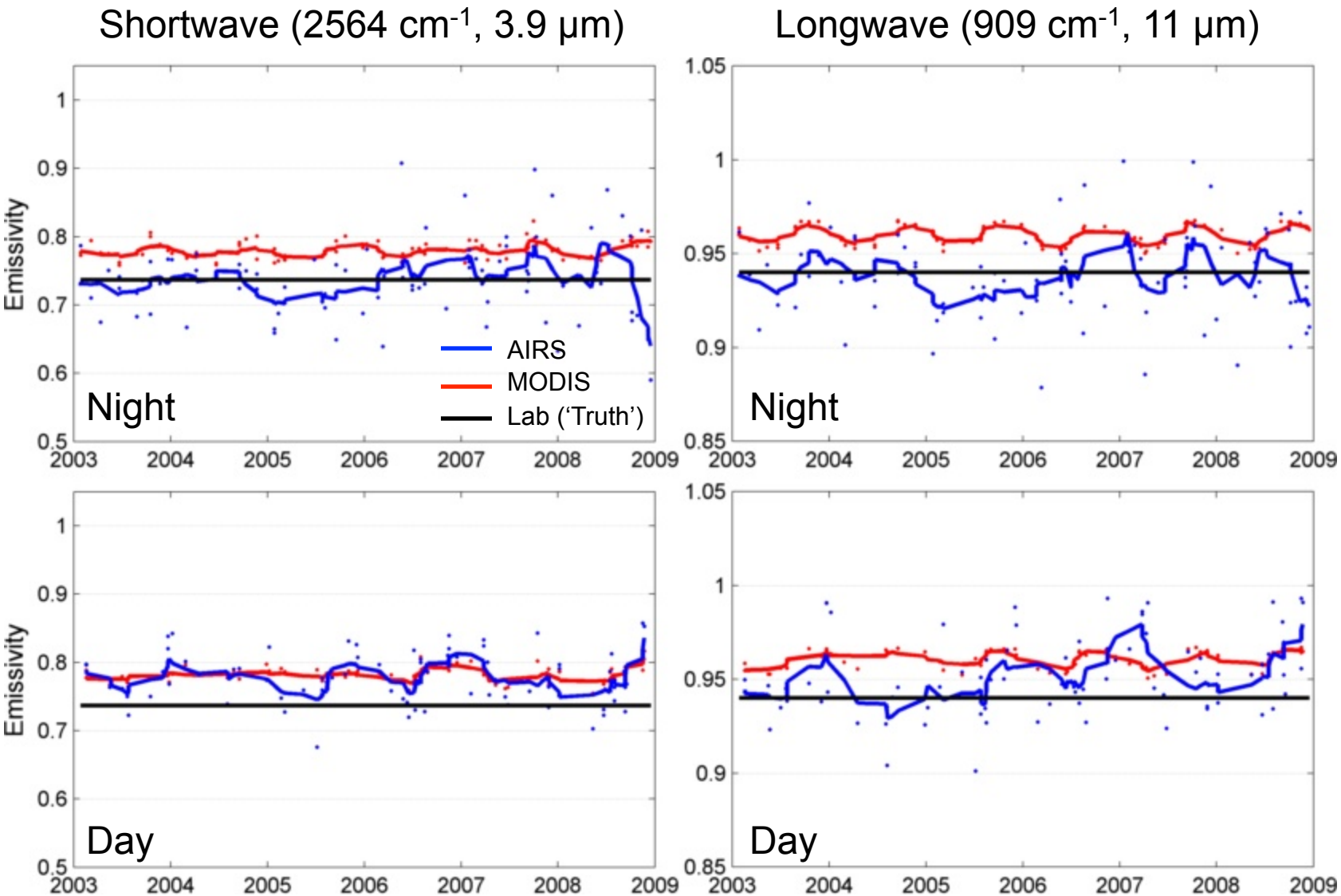
V5_7_5_Clim

Namib Desert
2003-2009



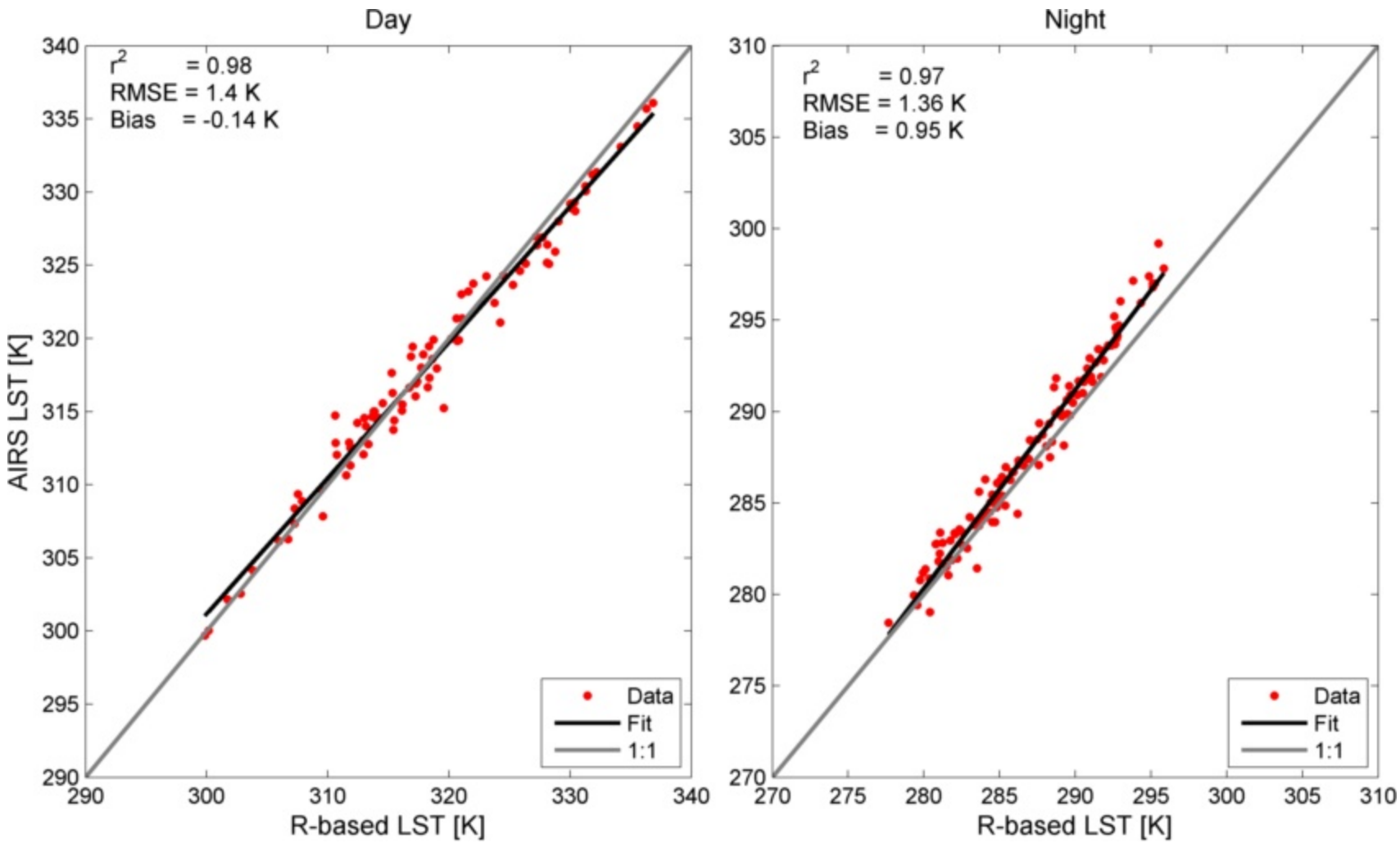
v5_7_5_Clim

Namib Desert



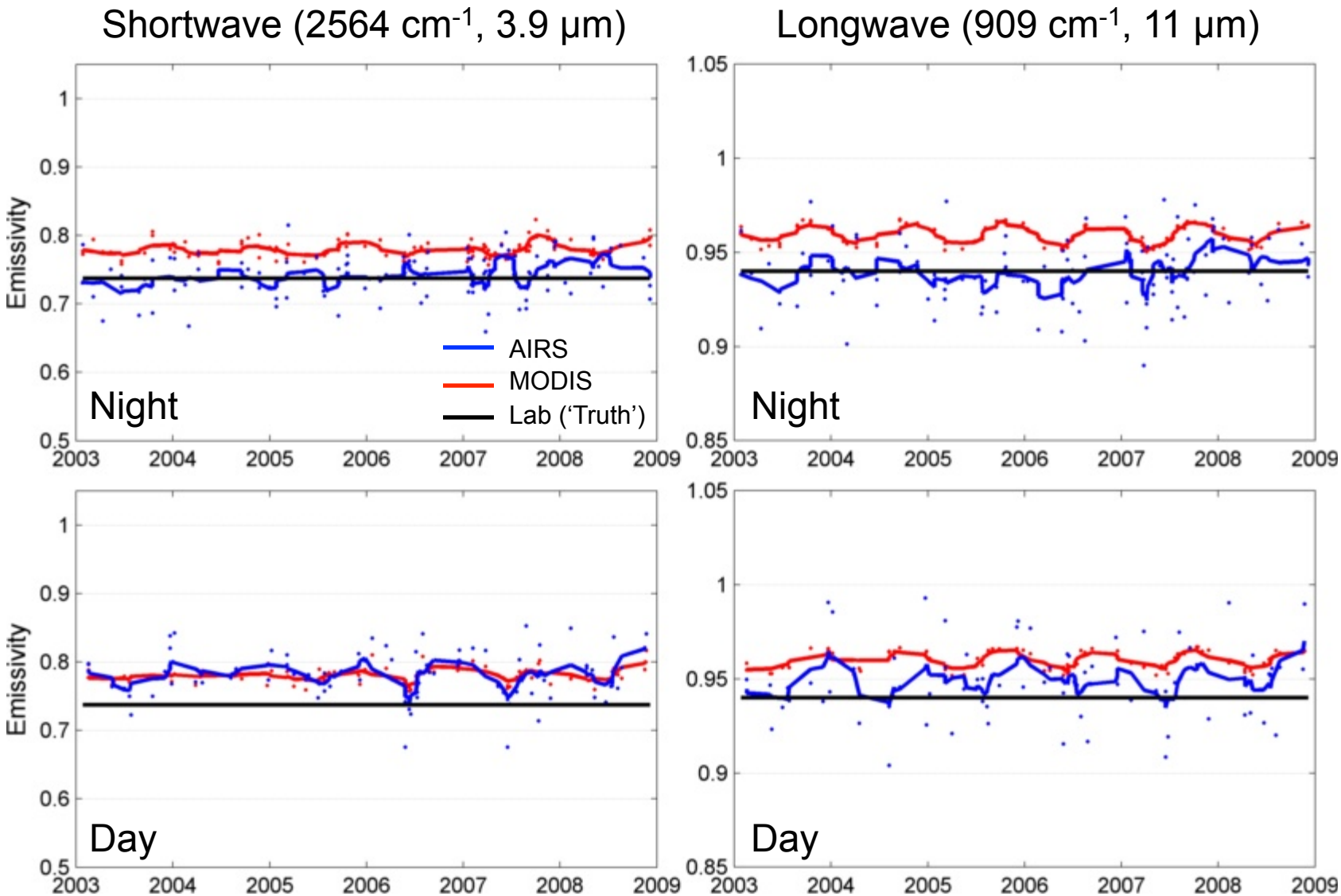
V5_7_5_SCCNN

Namib Desert
2003-2009



v5_7_5_SCCNN

Namib Desert



Rankings – Day LST

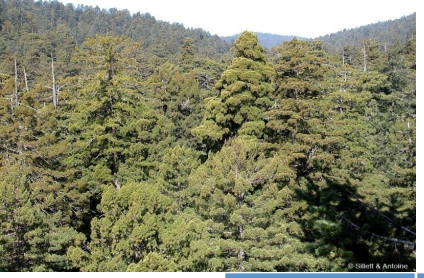
Namib Desert
2003-2009

Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_SCCNN	1.42	-0.14
2	v5_7_5_ModisEmis	1.53	-0.47
3	v5_7_5_Clim	1.74	-0.76
4	v5	5.09	0.72

Rankings – Night LST

Namib Desert
2003-2009

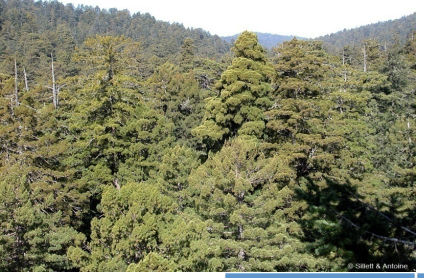
Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_ModisEmis	1.33	0.80
2	v5_7_5_SCCNN	1.36	0.95
3	v5_7_5_Clim	2.05	1.09
4	v5	2.45	-0.8



Rankings – Day LST

Redwood Forest
California
2003-2009

Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_SCCNN	0.72	0.20
2	v5_7_5_ModisEmis	0.95	0.09
3	v5_7_5_Clim	1.02	-0.05
4	v5	1.66	0.42



Rankings - Night LST

Redwood Forest
California
2003-2009

Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_ModisEmis	0.73	-0.02
2	v5_7_5_SCCNN	1.00	-0.54
3	v5	1.11	-0.36
4	v5_7_5_Clim	1.16	-0.09

Rankings - Day LST

Gran Desierto
Mexico
2003-2009

Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_SCCNN	1.64	-0.31
2	v5_7_5_ModisEmis	1.92	0.26
3	v5_7_5_Clim	2.22	-0.22
4	v5	5.26	0.72

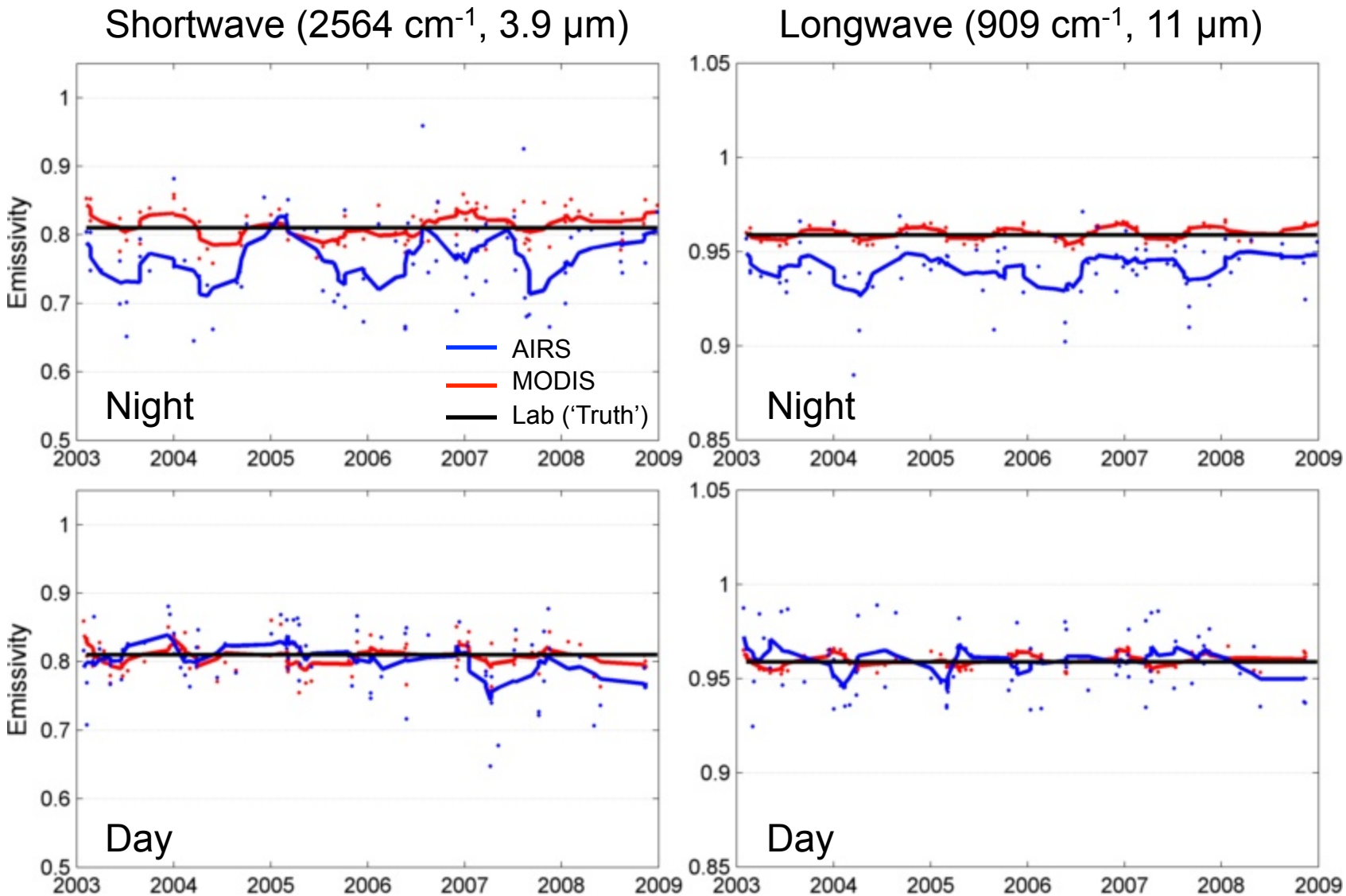
Rankings - Night LST

Gran Desierto
Mexico
2003-2009

Rank	Version	RMSE [K]	Bias [K]
1	v5_7_5_ModisEmis	1.61	1.08
2	v5_7_5_Clim	1.88	1.24
3	v5	2.08	-0.48
4	v5_7_5_SCCNN	2.81	1.91

v5_7_5_SCCNN

Gran Desierto



Conclusions/Future Work

- Radiance-based Land Surface Temperature (LST) val method has been developed for AIRS surface product evaluation.
- MODIS emissivity leads to improved LST accuracy, most noticeable over desert regions.
- SCCNN has improved accuracy in terms of RMSE during daytime observations at all sites, but issues at night.
- ModisEmis (2-regression) has most consistent results at all sites.
- Include more sites in evaluation, using ASTER emissivity over desert regions for the LST simulations.

The End

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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Land Surface Temperature (LST) Validation Methods

- Improved accuracy of surface products ***should*** directly affect accuracy of atmospheric parameters, e.g. T and especially Water Vapor in boundary layer
- Currently very difficult to validate coarse resolution sounder products (AIRS, IASI)
  - High variability in LST, particularly during daytime
  - Large thermally homogeneous areas required for LST
  - Large compositionally homogeneous areas required for emissivity
- Evaluation over long time periods, different land cover types, and varying atmospheric conditions