# Monitor Surface with Its Emissivity and Skin Temperature

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## Introduction

Surface emissivity and skin temperature derived from the current and future operational satellites can and will reveal critical information on the Earth's ecosystem and land surface type properties. Satellite ultraspectral data have been shown to be significant to atmospheric research and monitoring the Earth's environment. Long-term and large-scale observations needed for global change monitoring and other research can only be supplied by satellite based remote sensing. Surface emissivity retrieved from satellite ultraspectral IR measurements can be greatly beneficial but not limit to the assimilation of ultraspectral resolution IR radiances in numerical weather prediction models, climate simulation.

Presented here is the global surface IR emissivity retrieved from IASI measurements under "clear-sky" conditions. We demonstrate the surface skin temperature and emissivity retrieved with IASI satellite global measurements in conjunction with some initial retrieval analyses. IASI is a Michelson interferometer with spectral coverage between 3.6 and 15.5 µm. At nadir, the instrument samples data at intervals of 25 km along and a cross track, each sample having a maximum diameter of about 12 km. We are to demonstrate that surface skin temperature and emissivity from satellite measurements can be used in assistance of monitoring global change. Global surface properties with a spatial resolution of 0.5×0.5 degrees of latitude-longitude are produced with temporal variation to indicate seasonal diversity of global surface properties. Surface monitoring over last 4-year IASI measurements is under investigation; it is to attempt deriving a long-term trend as the measurements continuously provided.

Surface spectral emissivity and surface skin temperature from current and future operational satellites can and will reveal critical information about the Earth's ecosystem and land-surface-type properties, which might be utilized as a means of long-term monitoring of the Earth's environment and global climate change

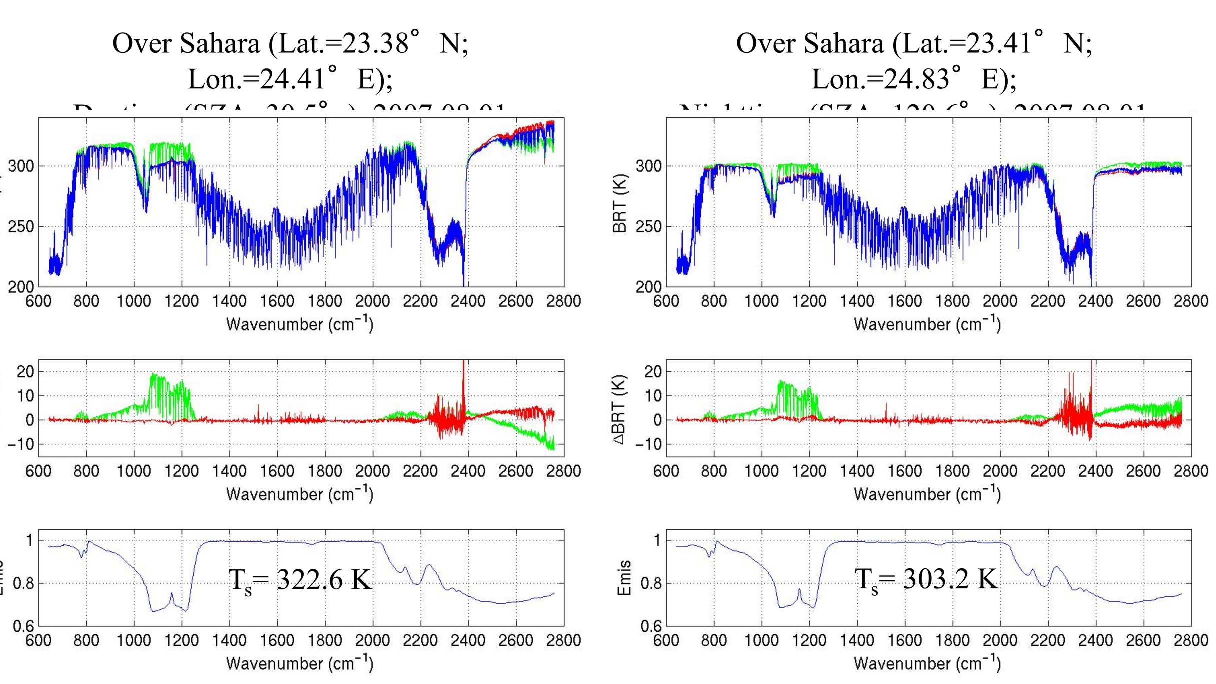
## Retrieval Algrorithm

The retrieval algorithm used here for demonstration only uses measured radiance and instrument noise; no other "truth" data from satellite or surface-based instruments or from numerical weather analysis/prediction models is utilized in assisting or constraining the retrieval products. The fast transmittance model used herein is a combination of the Stand-alone AIRS Radiative Transfer Algorithm (SARTA) Version 1.07 and the physically-based cloud RTM is based on the DIScrete Ordinate Radiative Transfer (DISORT) calculations performed for a wide variety of cloud microphysical properties. An all-season, global EOF regression database is used. The regression coefficients are classified with respect to cloud-free and cloudy conditions. The algorithm and details are found elsewhere. A multi-stage statistical regression retrieval algorithm is used to derive IR ultraspectral emissivity and skin temperature from the IASI instrument on METOP-A.

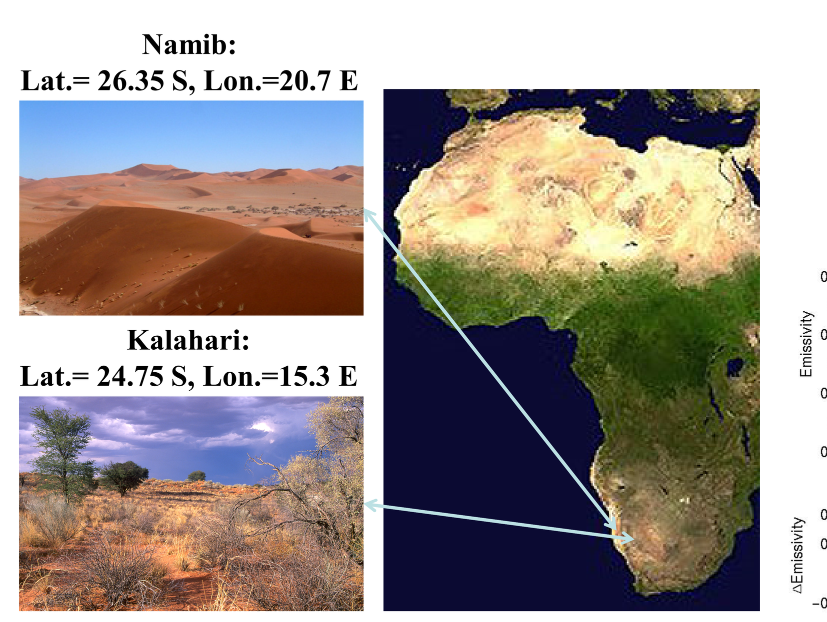
**Reference**:

1.Strow et al., "An overview of the AIRS radiative transfer model," *IEEE Trans. Geosci. Remote Sens*., **41**, 303–313 (2003).
2.Yang et al., "Radiative Properties of cirrus clouds in the infrared (8-13 µm) spectral region," *J. Quant. Spectros. Radiat. Transfer*, **70**, 473–504 (2001).
3.Zhou et al., "Thermodynamic and cloud parameters retrieval using infrared spectral data," *Geophys. Res. Lett*., **32**, L15805 (2005).
4.Zhou et al., "Physically retrieving cloud and thermodynamic parameters from ultraspectral IR measurements," *J. Atmos. Sci*., **64**, 969–982 (2007).
5.Zhou et al., "Global land surface emissivity retrieved from satellite ultraspectral IR measurements," *IEEE Trans. Geosci. Remote Sens.*, **49**, 1277–1290 (2011).

## Retrieval Demonstration and Validation




IASI samples of surface emissivity retrieved over Sahara Desert from both day and night. BRT simulations with retrievals (red with rtv ε and green with ε=1) are compared with the measurements (blue).




The quartz-doublet region from the Namib to the Kalahari site, is well captured by retrievals, due to the different sand mineralogy at these 2 sites.

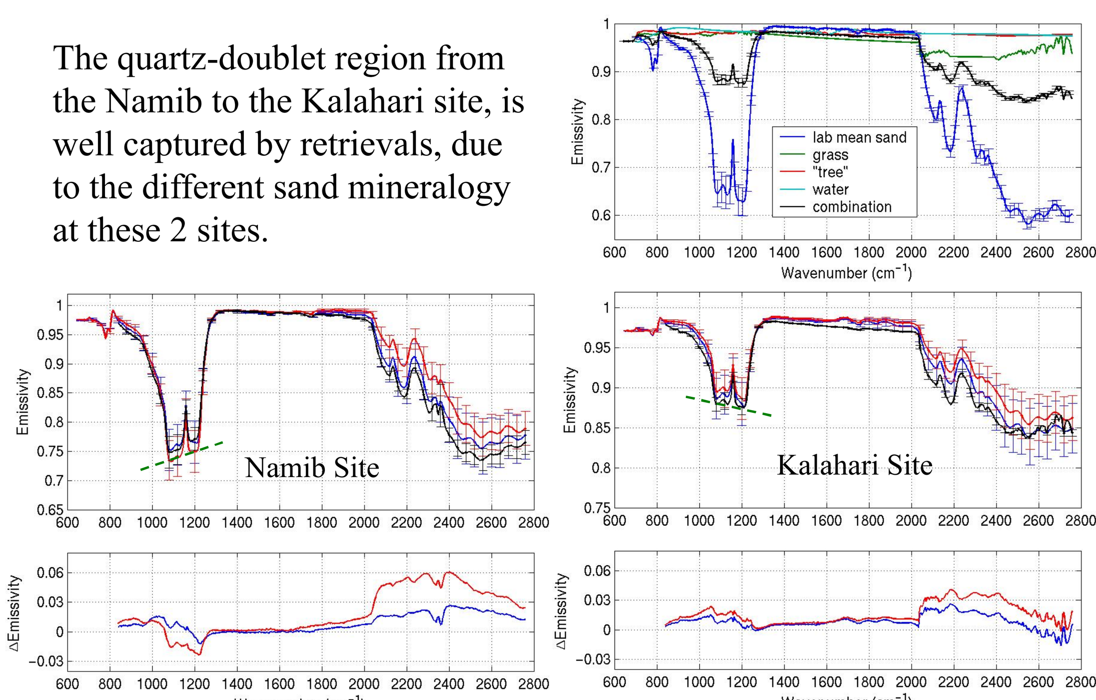
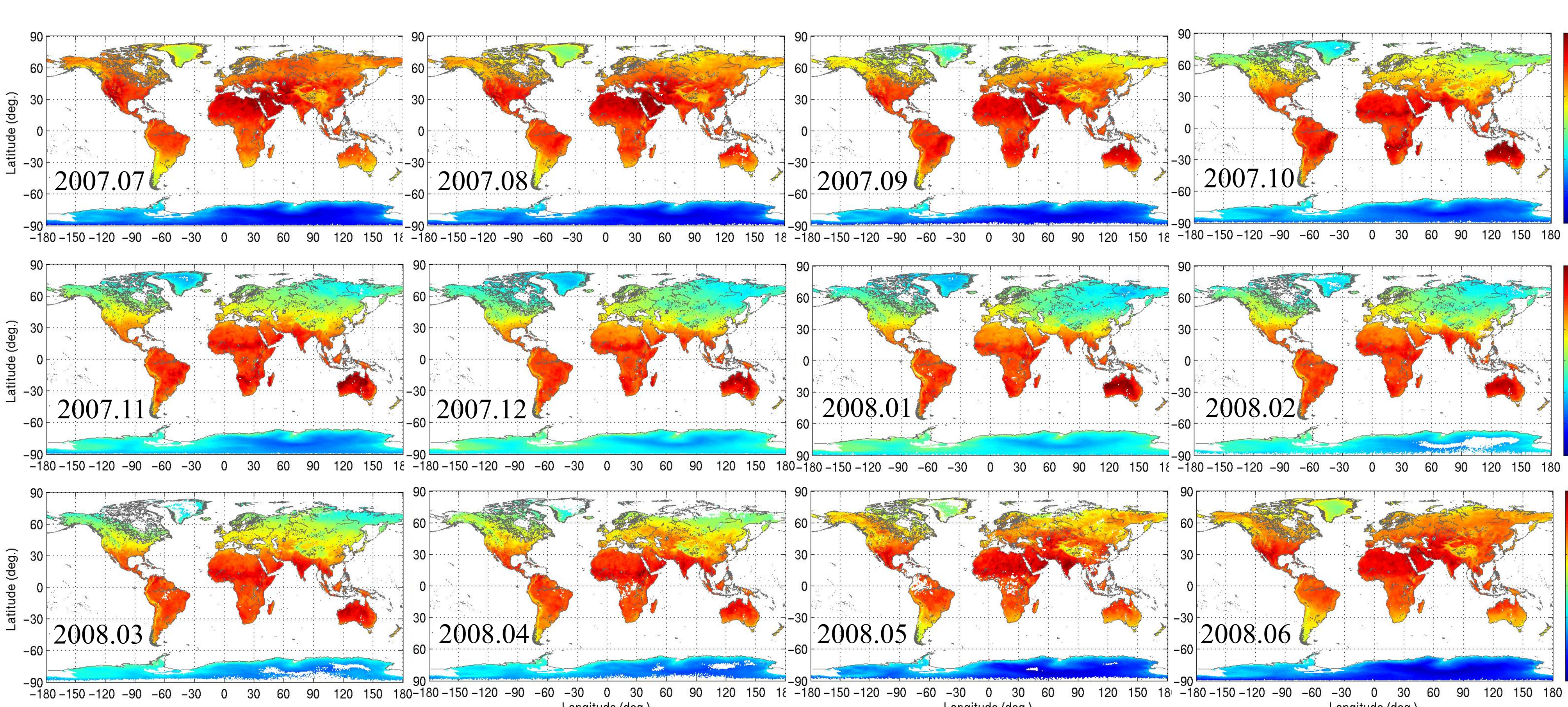



**Table 1.** Summary of the Major Characteristics of the Kalahari and Namib Validation Sites Including Locality, Elevation, Surface Area, Dune Height, Grain Size, Sand Source and Bulk Mineralogy

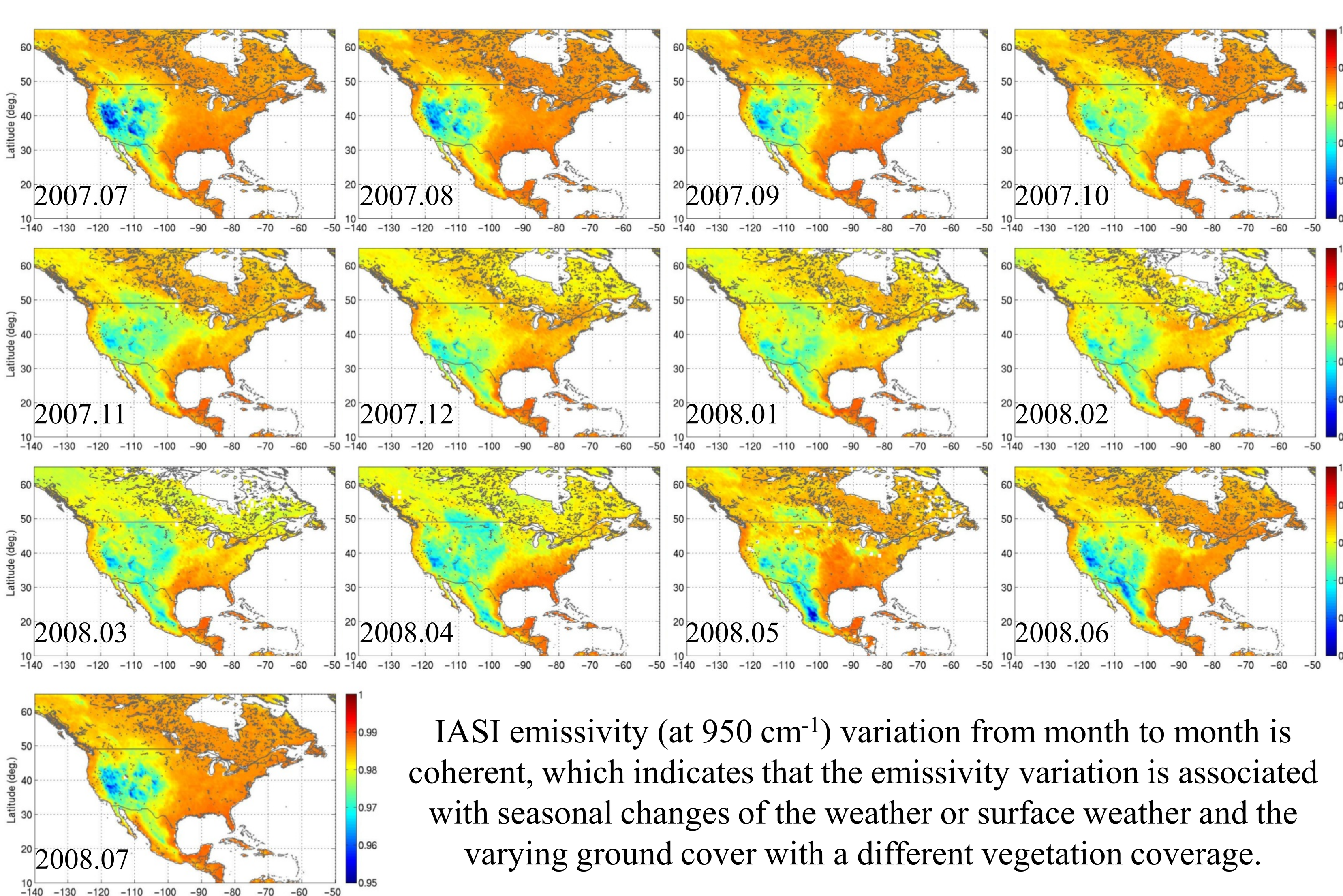
| | Kalahari | Namib |
|---|---|---|
| Locality | covers most of Botswana, including northwestern South Africa and southeastern Namibia | western coast of Namibia |
| Approximate surface area (km$^2$) | 100,000 | 34,000 |
| Elevation (m) | 1,000 | 0–500 |
| Maximum dune height (m) | 30 | 300 |
| Percent of grain size of sand | | |
| >500 µm | 0% | 1% |
| 250 500 µm | 30% | 53% |
| 125–250 µm | 68% | 40% |
| <125 µm | 2% | 6% |
| Sand source | aeolian deposited, fluvial | littoral, fluvial, weathered tsondab sandstone |
| Mineralogy | | |
| Major | Quartz | quartz |
| Minor | | feldspar, magnetite |

Desert validation: July 2007 monthly-mean IASI daytime (red) and nighttime (blue) compared with the mean laboratory result (black). Sample STDs are shown in vertical bars; the green dashed-line is added on to indicate sand mineralogy character. The difference between laboratory result mean and monthly-mean IASI daytime (red), nighttime (blue), respectively.

## Surface Temporal Variation

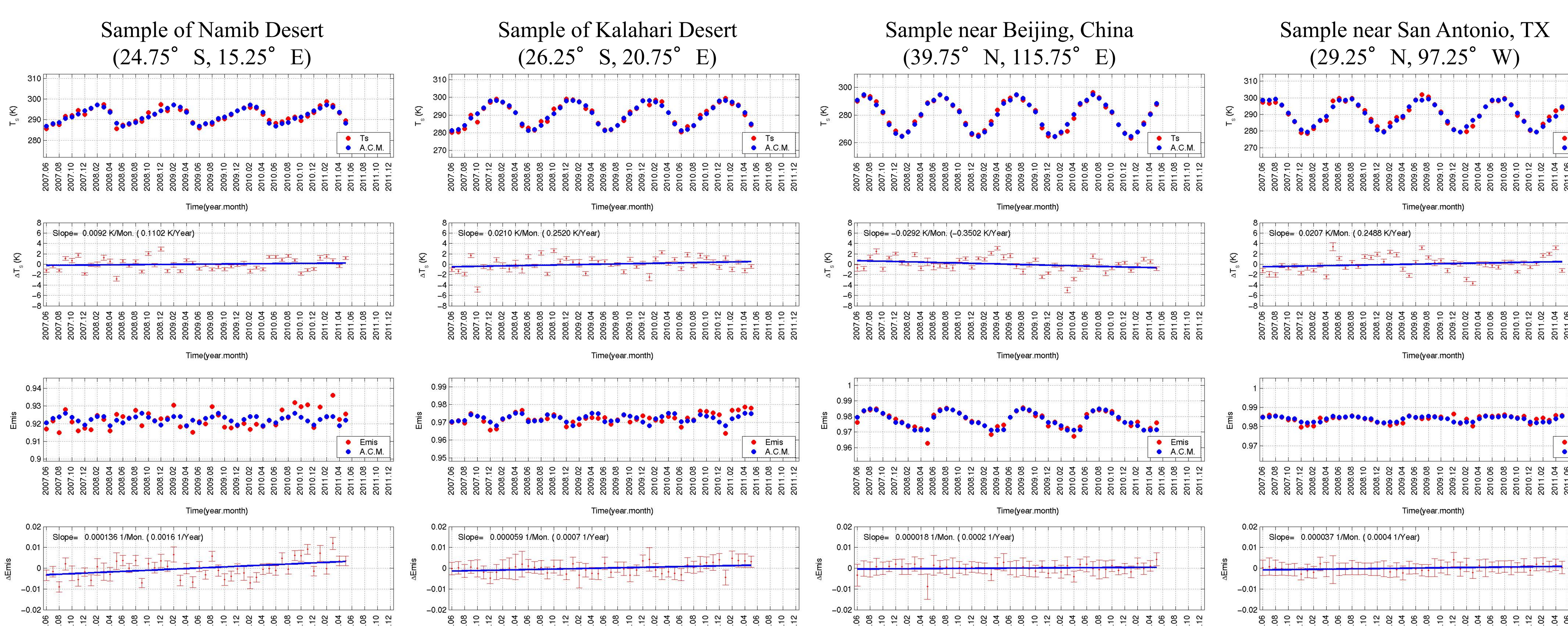



Seasonal variation of IASI monthly-mean global land surface skin temperature (K) at a spatial resolution of 0.5° ×0.5° in latitude-longitude.

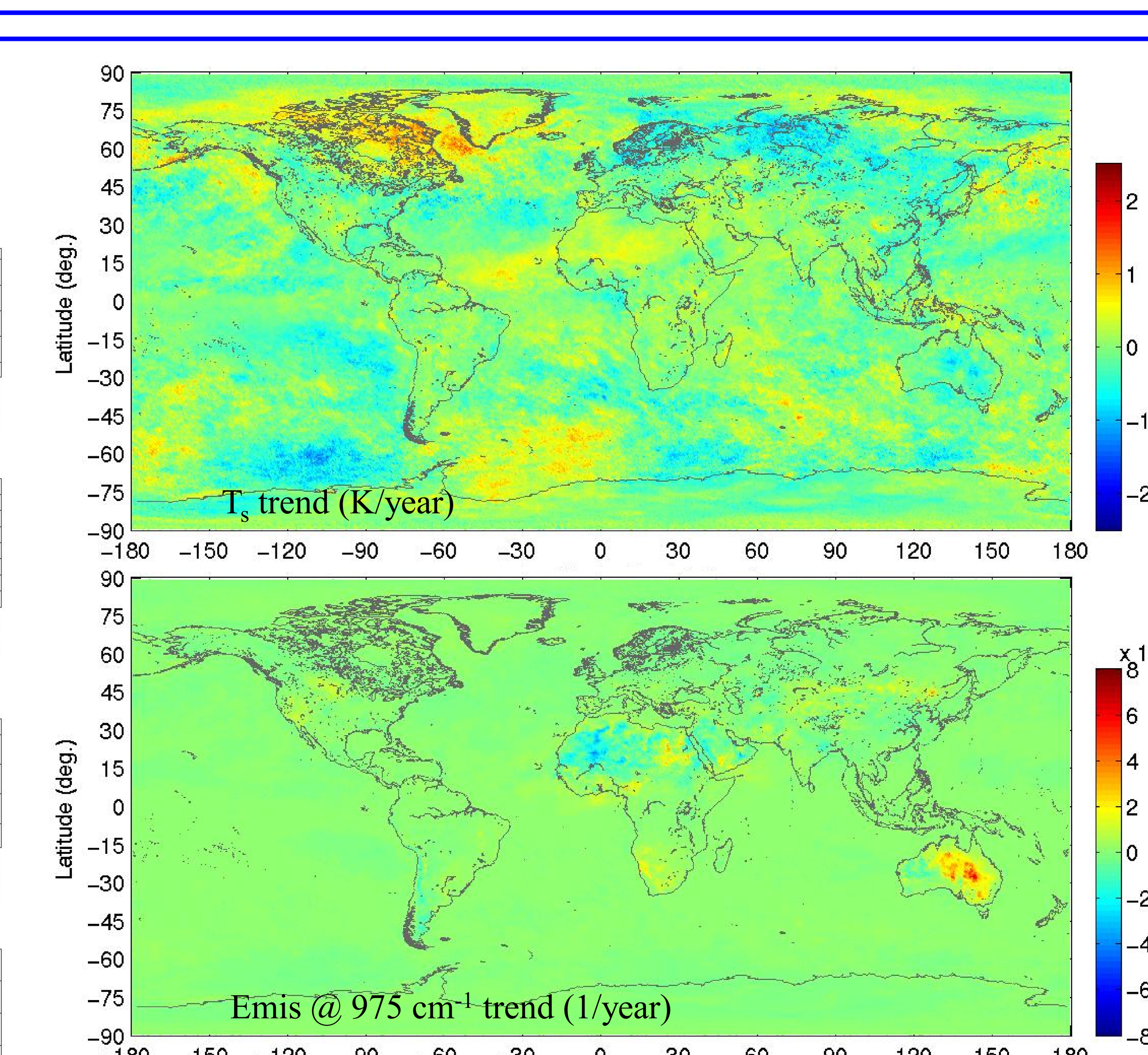



IASI emissivity (at 950 cm$^{-1}$) variation from month to month is coherent, which indicates that the emissivity variation is associated with seasonal changes of the weather or surface weather and the varying ground cover with a different vegetation coverage.

## Grobel Surface Monitoring




Trend analysis over surface skin temp. and emis. (at 975 cm$^{-1}$) anomalies (deviation from annual cycle mean). Vertical error bars on the anomalies are estimated as STDE/(Sample #)$^{1/2}$; bias error is minimized in the anomalies.




Monthly mean IASI global surface skin temp. (emis.) anomalies from last 4 years are used to generate a short-term global map of surface temp trend in K/year (emis. in 1/year) with a relatively higher spatial resolution of 0.5° ×0.5° in latitude-longitude