Land Surface Emissivity Derive from Suomi NPP CrIS

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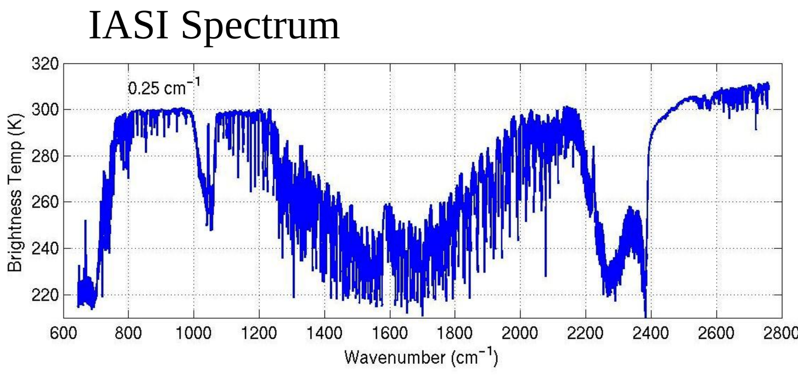
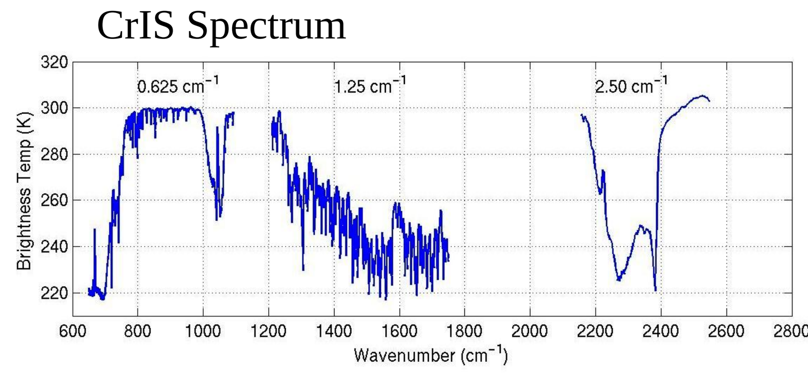
Introduction & Summary

Presented here is the land surface IR spectral emissivity retrieved from the Cross-track Infrared Sounder (CrIS) measurements. The CrIS is aboard the Suomi National Polar-orbiting Partnership (NPP) satellite launched on October 28, 2011. We describe the retrieval algorithm, demonstrate the surface emissivity retrieved with CrIS measurements, and inter-comparison with the Infrared Atmospheric Sounding Interferometer (IASI) emissivity. We also demonstrate that surface emissivity from satellite measurements can be used in assistance of monitoring global surface climate change, as a long-term measurement of IASI and CrIS will be provided by the series of EUMETSAT MetOp and US Joint Polar Satellite System (JPSS) satellites. Monthly mean surface properties are produced using last 5-year IASI measurements. A temporal variation indicates seasonal diversity and El Niño/La Niña effects not only shown on the water but also on the land. Surface spectral emissivity and skin temperature from current and future operational satellites can be utilized as a means of long-term monitoring of the Earth's environment. CrIS spectral emissivity are retrieved and compared with IASI. The difference is small and could be within expected retrieval error; however it is under investigation.

IASI Spectrum



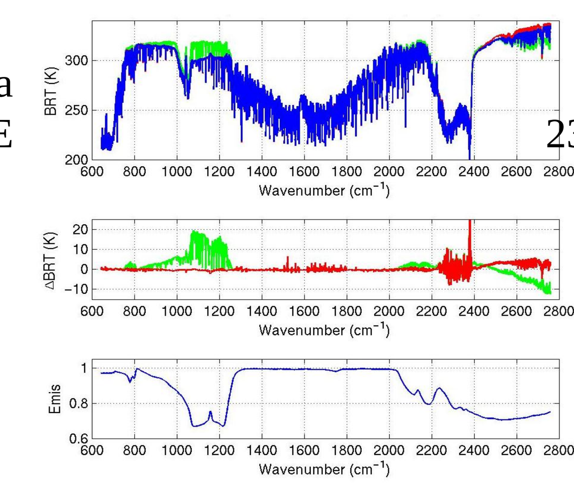
CrIS Spectrum



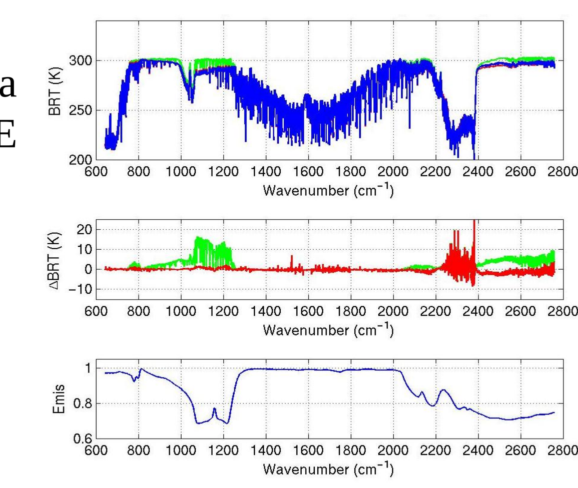
Retrieval AlgroritHm

The retrieval algorithm only relies on 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. A multi-stage statistical regression retrieval algorithm is to derive IR ultraspectral emissivity and skin temperature from the CrIS instrument on Suomi NPP satellite. The algorithm details are found elsewhere (*Zhou et al.*, 2011, *IEEE TGRS* **49**, 1277–1290). Retrieval samples are shown.

2007.08.01 Sahara
23.38° N; 24.41° E
SZA=30.5°
T_s=322.6K



2007.08.01 Sahara
23.41° N; 24.83° E
SZA=120.6°
T_s=303.2K



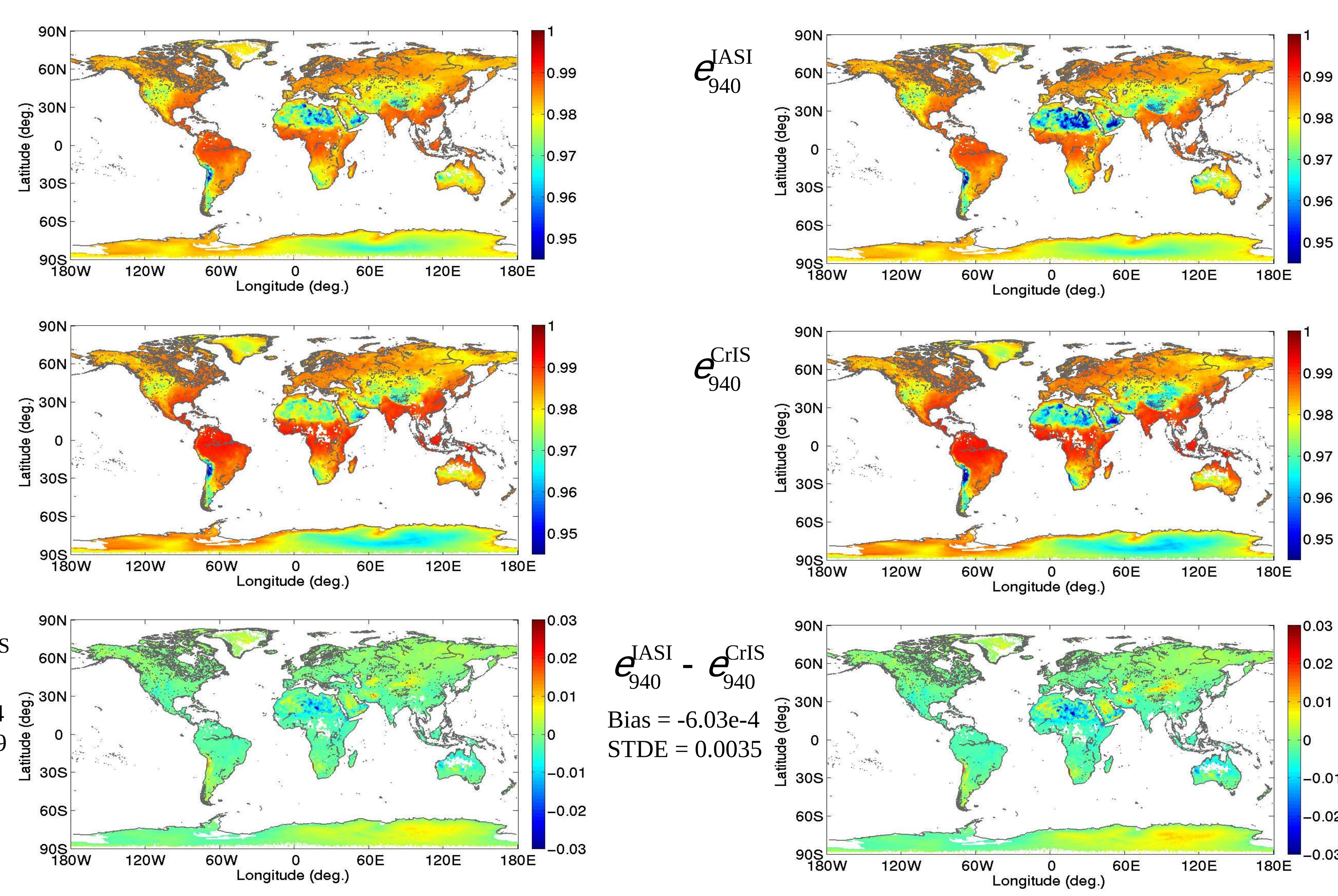
First CrIS Retrieval Samples and Inter-Comparison with IASI (2012 Sept. Mean)

e^{IASI}_{890} e^{IASI}_{940}

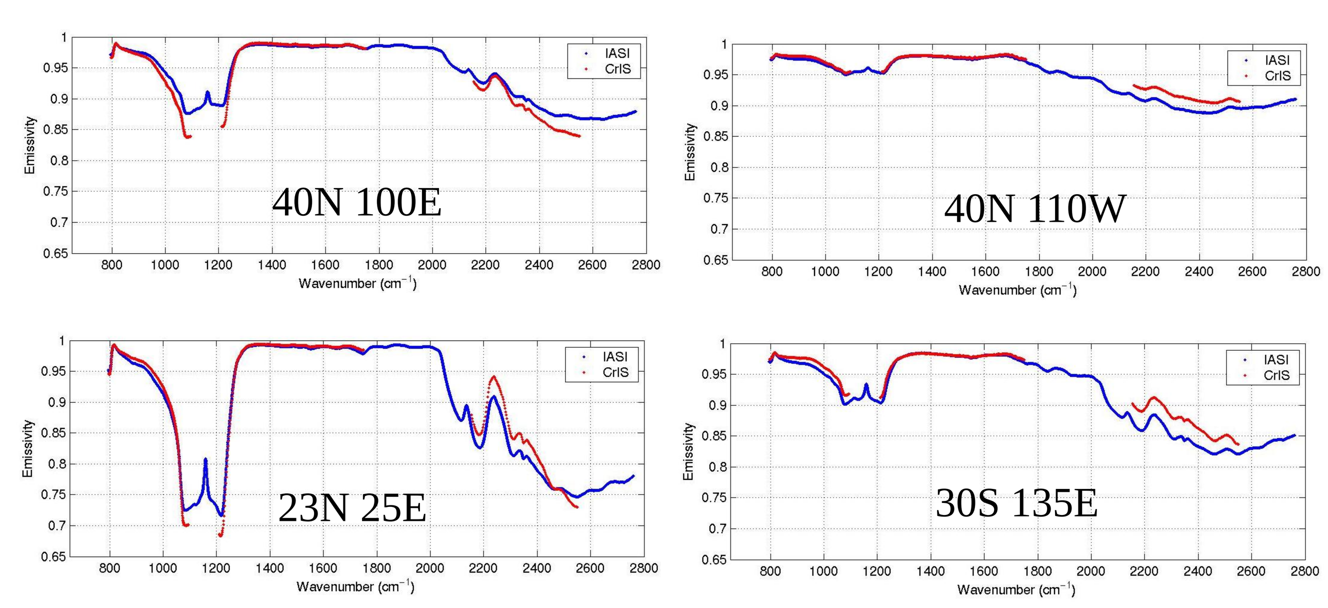
e^{CrIS}_{890} e^{CrIS}_{940}

e^{IASI}_{890} - e^{CrIS}_{890}
Bias = -4.40e-4
STDE = 0.0029

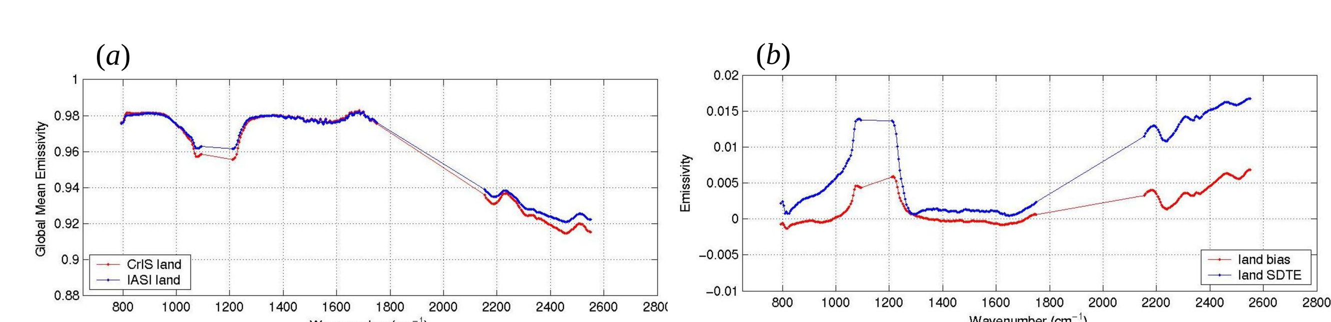
e^{IASI}_{940} - e^{CrIS}_{940}
Bias = -6.03e-4
STDE = 0.0035



IASI and CrIS monthly mean continental surface emissivity at 890 cm^{-1} and 940 cm^{-1}; and the differences between IASI and CrIS.



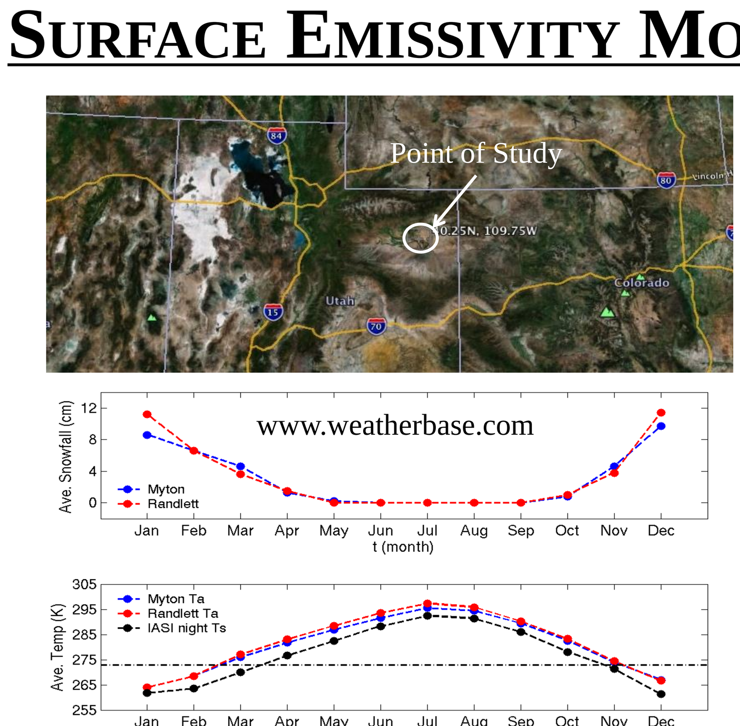
IASI and CrIS monthly mean emissivity comparison samples



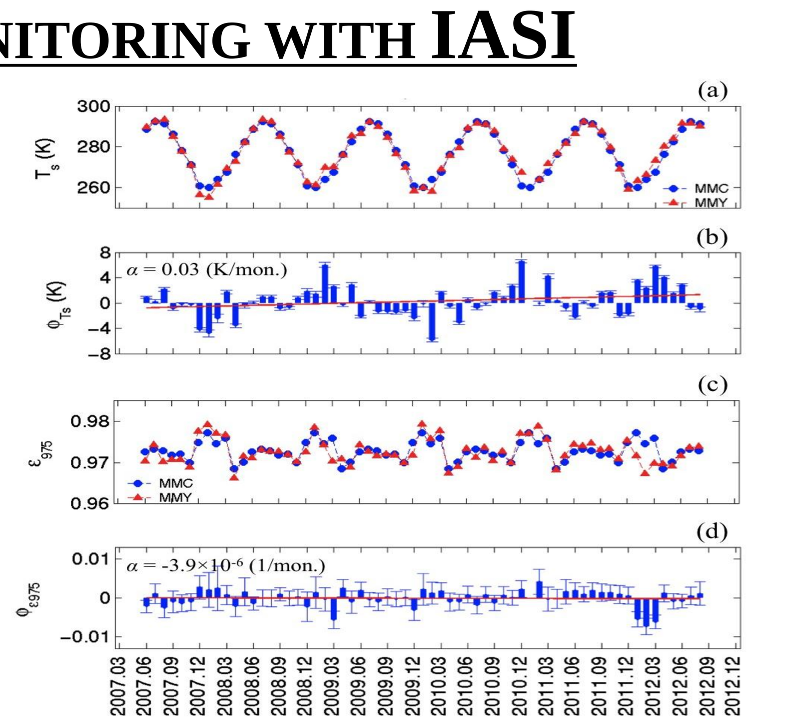
From Sept. 2012 monthly mean global land surface emissivity: (*a*) Global mean land emissivity of IASI (in blue) and CrIS (in red). (*b*) The mean bias between IASI and CrIS (in red) and STDE (in blue).

Relatively large difference is shown in the quartz reststrahlen bands (1000-1250 cm^{-1}) where CrIS band gap exists.

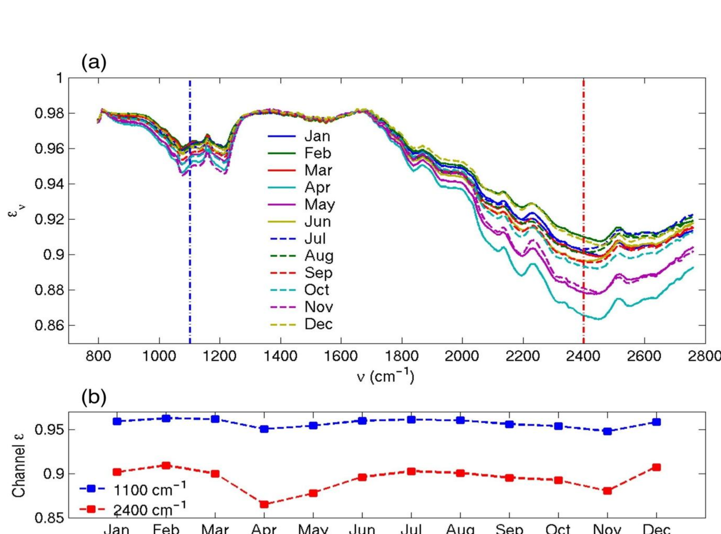
Surface Emissivity Monitoring with IASI

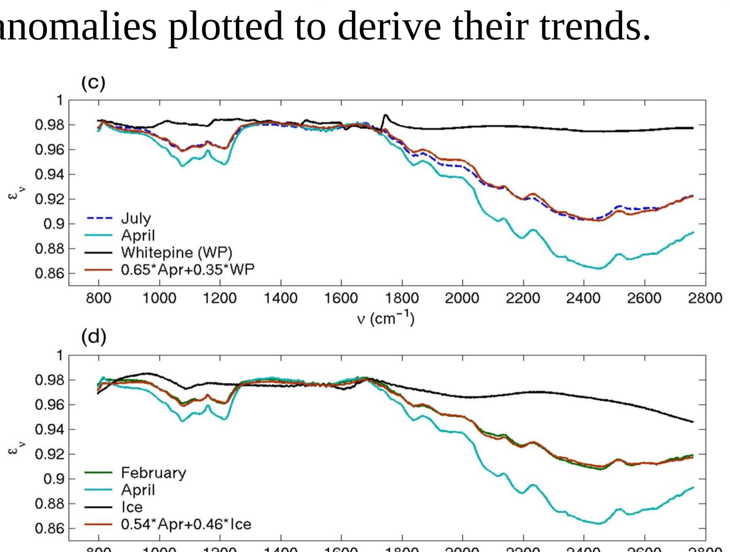


Weather stations Myton and Randlett are within the area, climate snowfall and air temp. plotted in color; IASI nighttime skin temp. plotted in black.

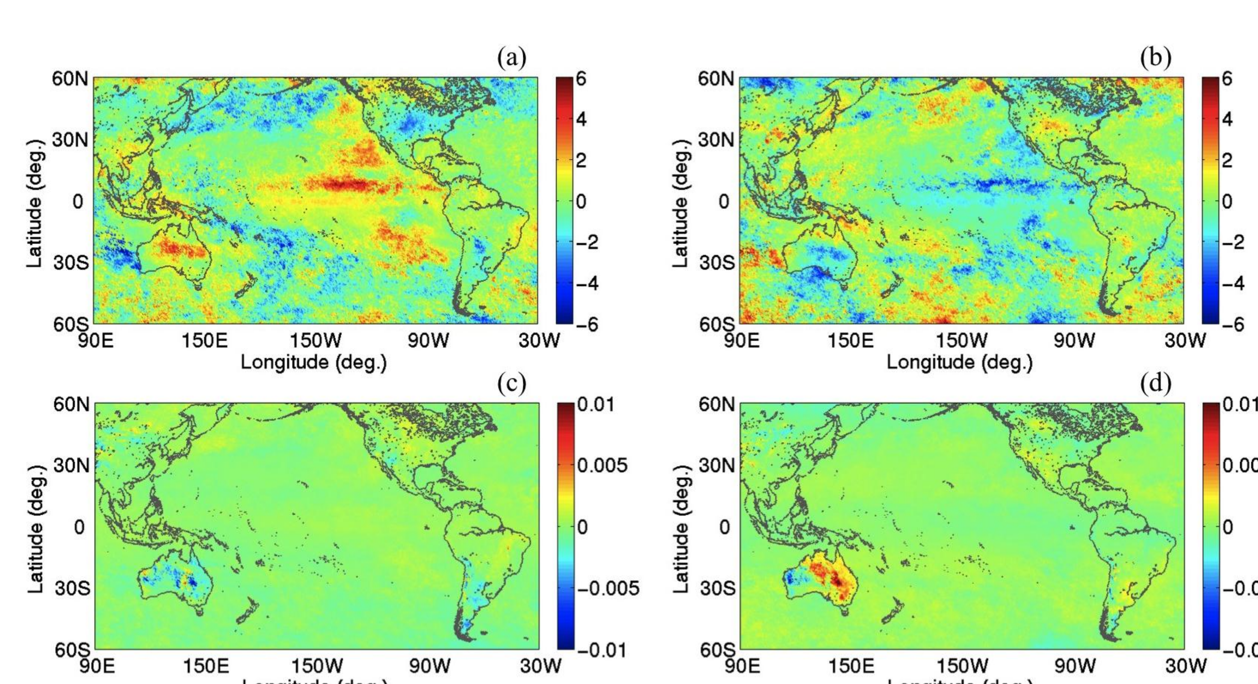


Sample from 40.0-40.5° N Lat. and 109.5-110.0° W Long.: Illustration of monthly mean (a) T_s and (c) ε_{975} against their monthly mean climatology, (b) T_s anomalies and (d) ε_{975} anomalies plotted to derive their trends.

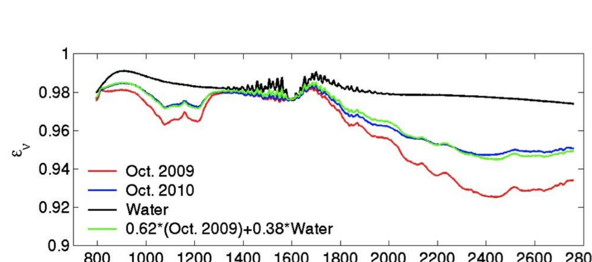




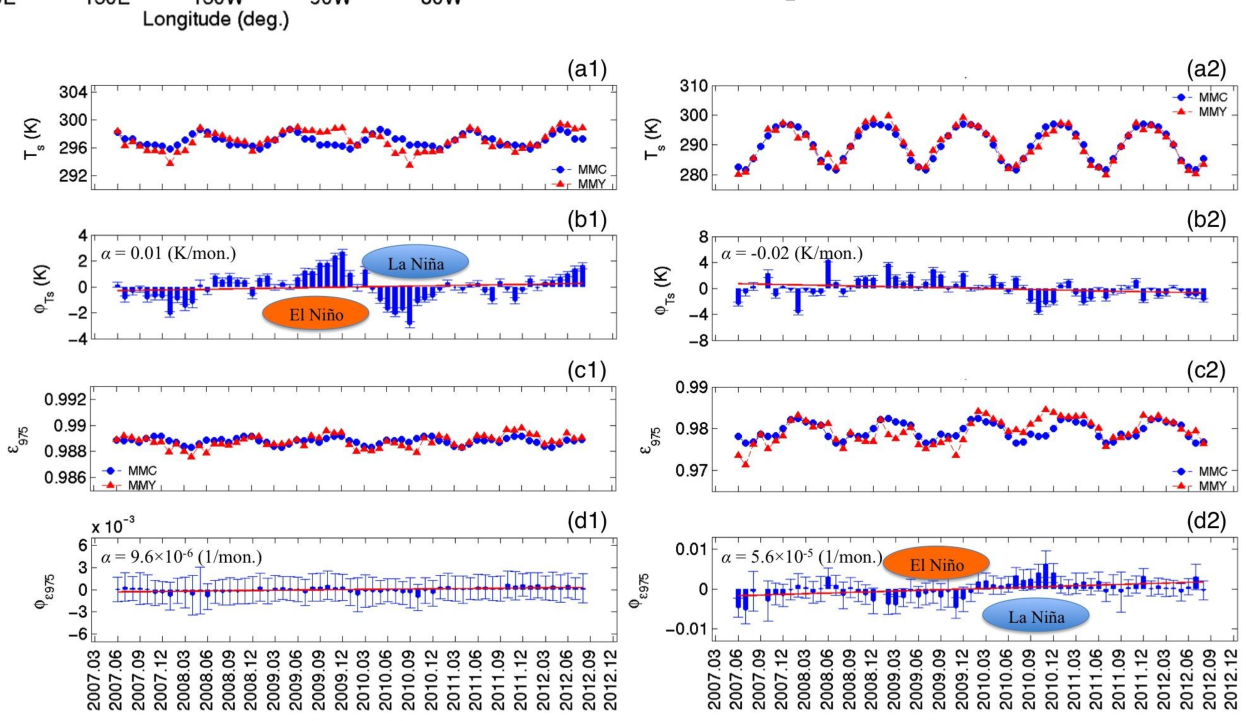
(a) Monthly mean climatology ε_ν; (b) Channel emissivity at 1100 and 2400 cm^{-1} as a function of month. (c) Vegetation increasing from April to July, and (d) Snow/ice cover decreasing from February to April.



(a) and (b) show skin temperature anomalies for October 2009 and October 2010, respectively; and associated emissivity anomalies (at 975 cm^{-1}) are plotted in (c) and (d) for October 2009 and October 2010, respectively. During the October 2009 El Niño period, droughts happened in Australia and the land was drier, which causes a lower emissivity, while during October 2010 La Niña period, great rainfalls made the land wet and increased emissivity in the northeastern part of Australia.



From Australia 24.5-25.0° S Lat. and 145.0-145.5° E Long., monthly mean ε_ν of the October 2009 El Niño (in red) and the October 2010 La Niña (in blue). October 2010 ε_ν is roughly reproduced (in green) by a linear combination of October 2009 ε_ν and laboratory-measured water ε_ν.



As El Niño plays the largest role in tropical drought occurrence, a location in Australia is chosen (right-column of the figure: 24.5-25.0° S Latitude; 145.0-145.5° E Longitude) to illustrate ε_ν variation associated with the drought during the El Niño years and greater rainfall during La Niña events.