Retrieving Infrared Land Surface Emissivity With AIRS Observations

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Outline

Sensitivity study for land surface emissivity

Sensitivity study for atmospheric and surface parameters

The retrieval method: MLEV

Case study

Future plan

Sensitivity Study for Land Surface Emissivity

Fast Model: SARTA（Stand-Alone Rapid Transmittance Algorithm）developed by L.L.Strow, S.Hannon, and H.Mottler
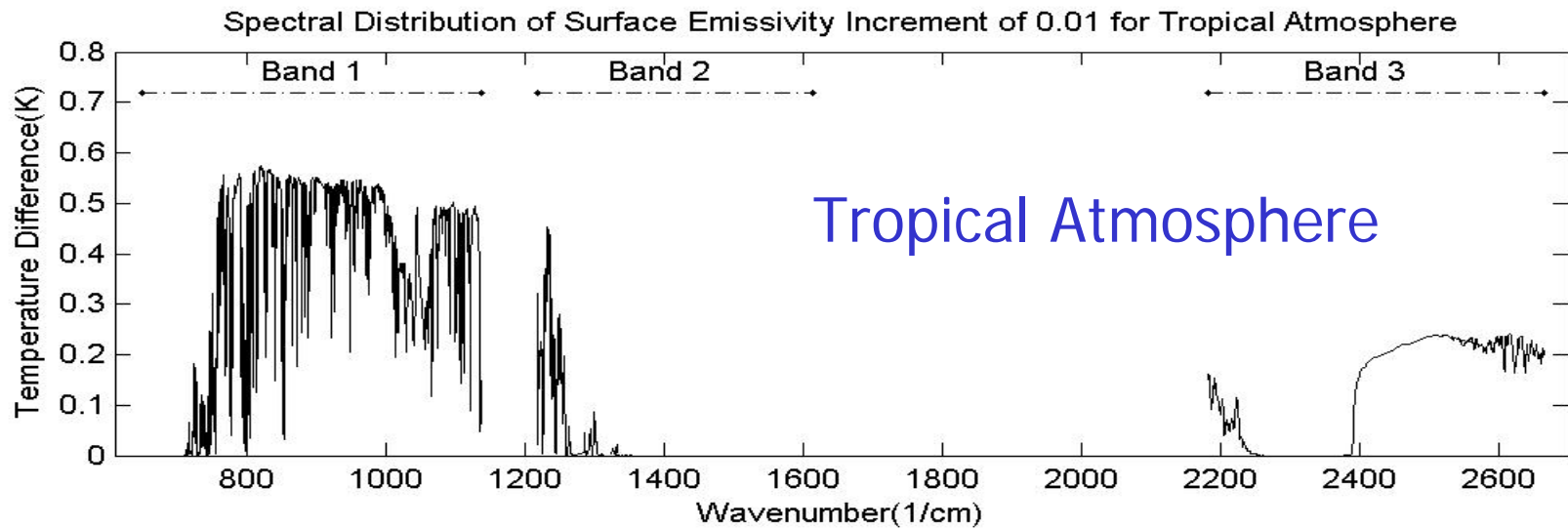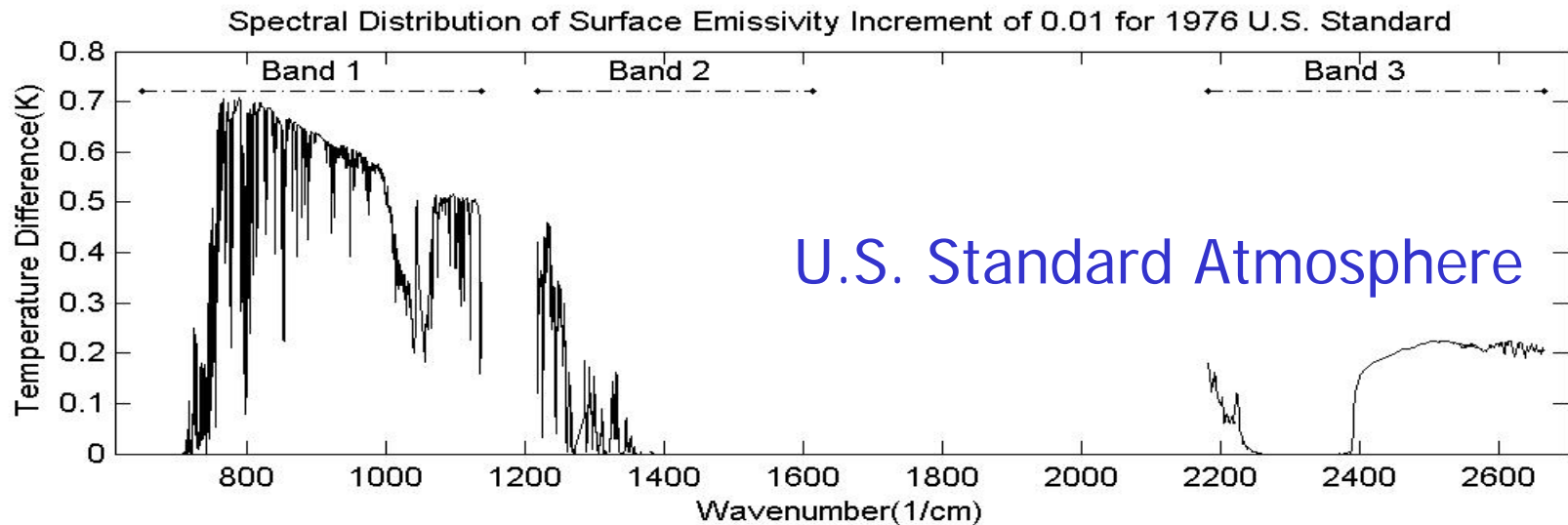
Profiles: six model profiles

Parameters: zero satellite angle
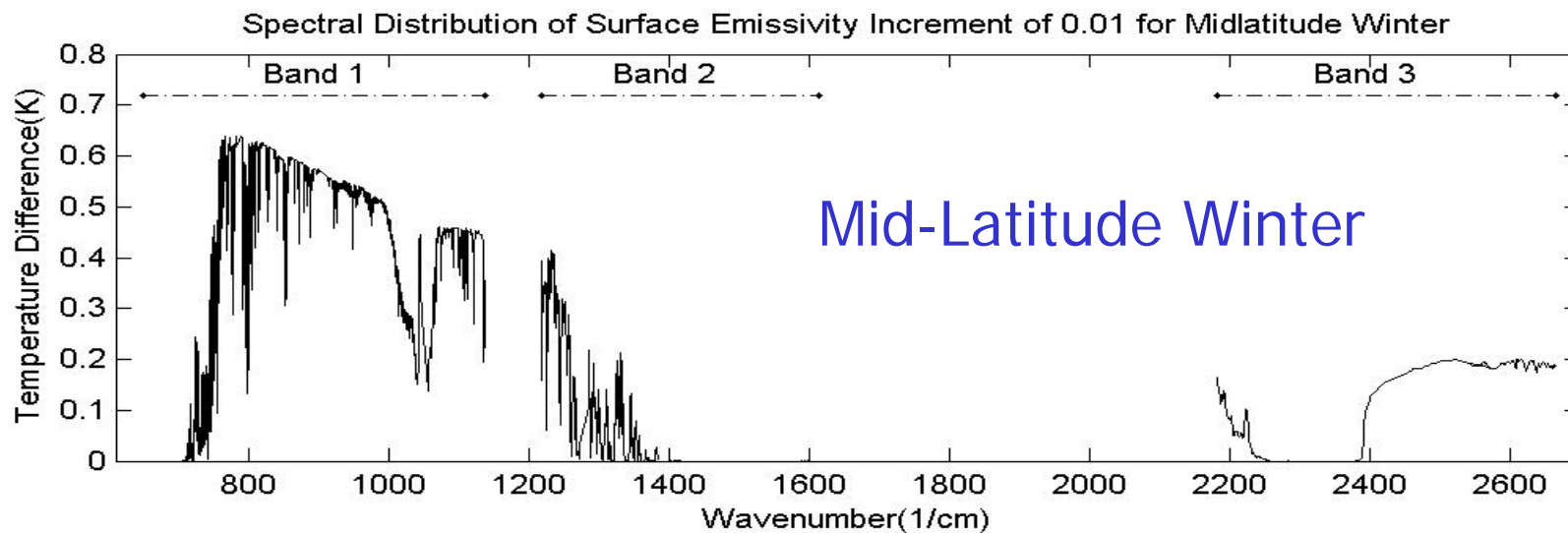
sea level surface for 6 model profiles

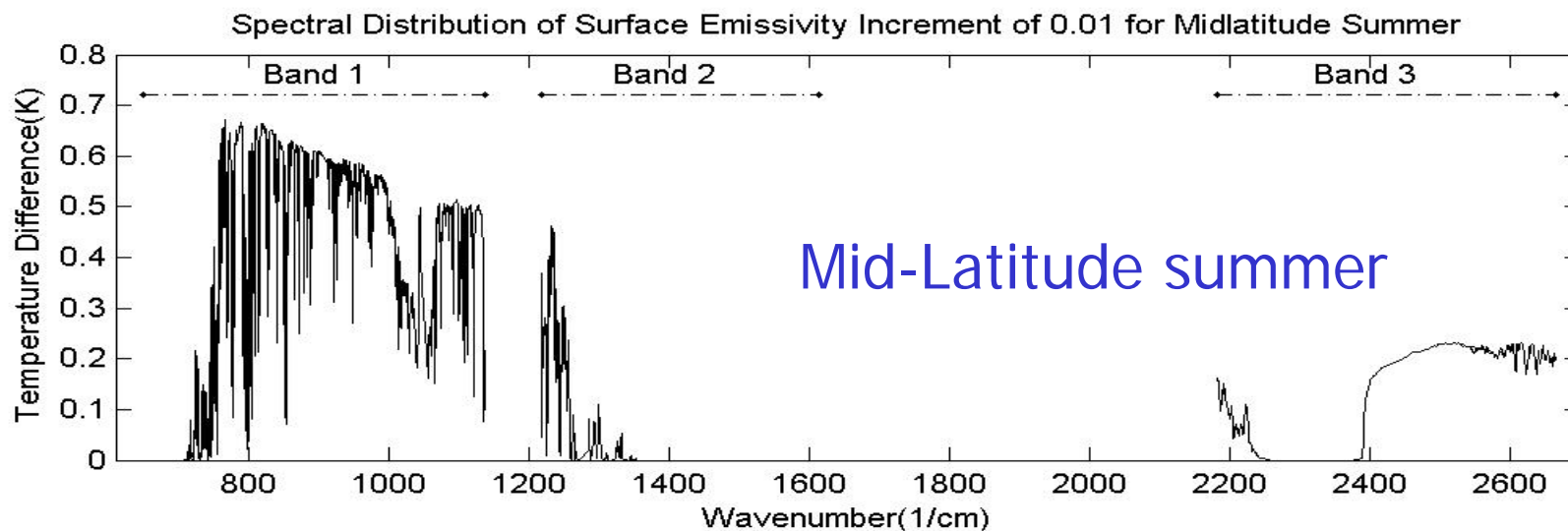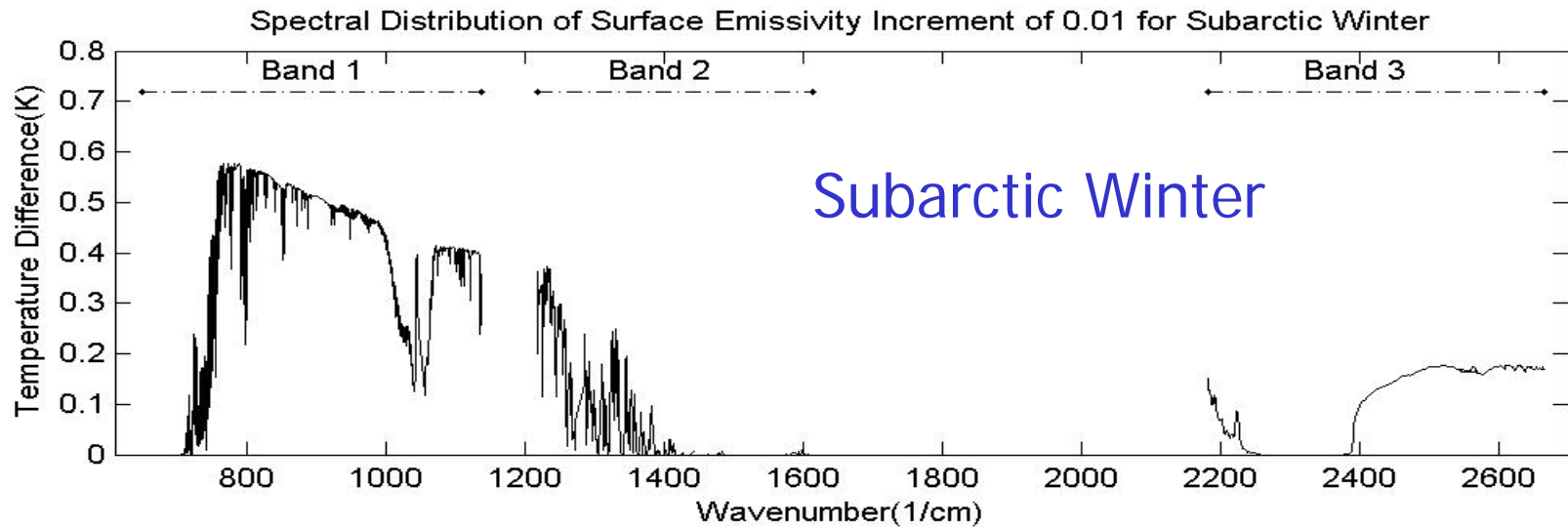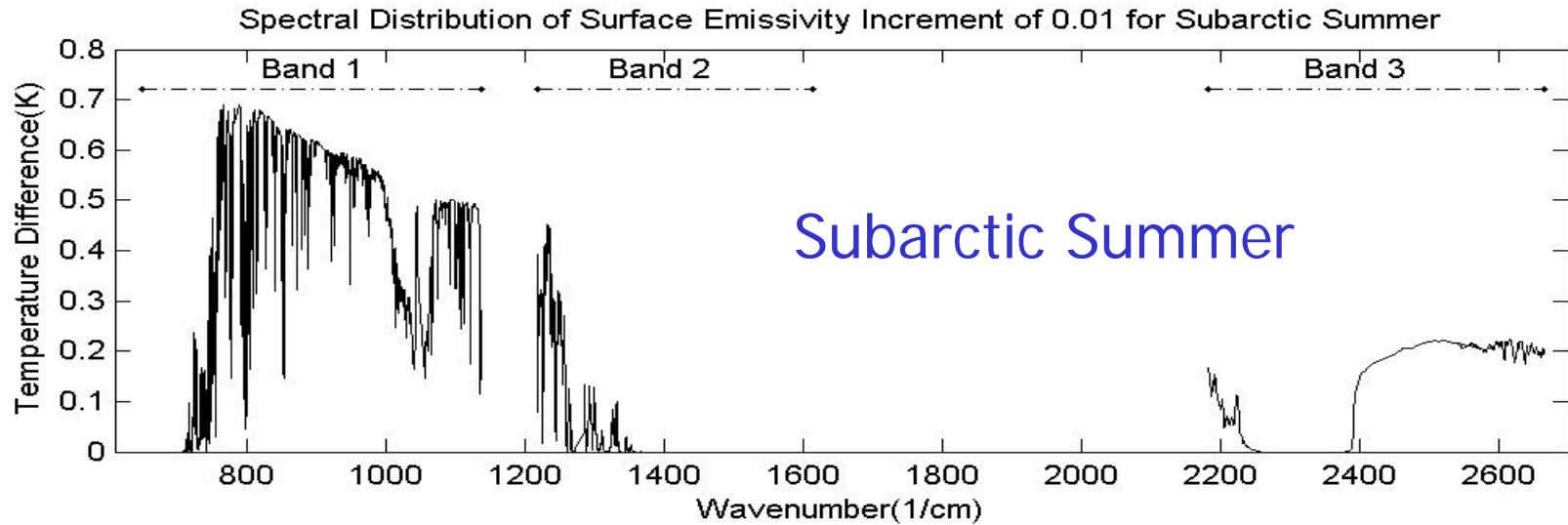increment of LSE from 0.97 to 0.98

others

Delta TB from Delta EMIS=0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for 1976 U.S. Standard

U.S. Standard Atmosphere

Spectral Distribution of Surface Emissivity Increment of 0.01 for Tropical Atmosphere

Tropical Atmosphere

Delta TB from Delta EMIS=0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for Midlatitude Summer

Mid-Latitude summer

Spectral Distribution of Surface Emissivity Increment of 0.01 for Midlatitude Winter

Mid-Latitude Winter

Delta TB from Delta EMIS=0.01

Spectral Distribution of Surface Emissivity Increment of 0.01 for Subarctic Summer

Subarctic Summer

Spectral Distribution of Surface Emissivity Increment of 0.01 for Subarctic Winter

Subarctic Winter

Sensitivity Study for Atmospheric and Surface Parameters

Fast Model: SARTA

Profiles: U.S. 1976 Standard Atmosphere

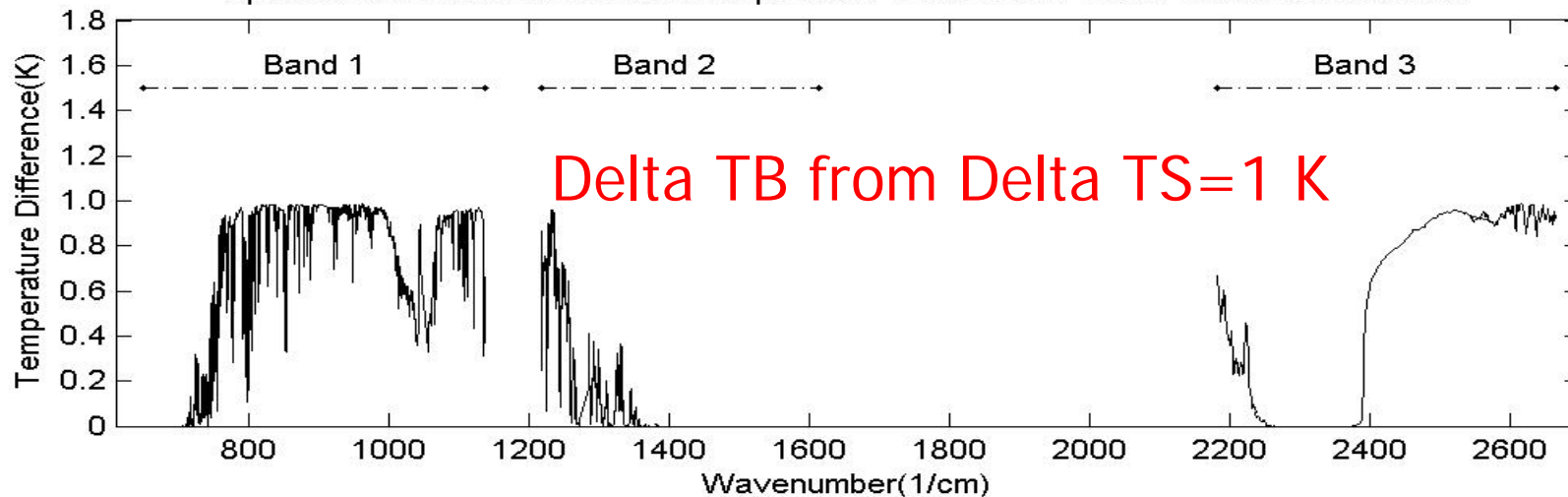**Increment/Decrement: (700hPa—1000hPa for Low Trop)**

Increase of surface temperature by 1K;

Increase of low troposphere temperature by 1K;

Decrease of low troposphere humidity by 15%;

Decrease of ozone by 10%.

Spectral Distribution of Surface Temperature Increment of 1K for 1976 U.S. Standard

Band 1   Band 2   Band 3

Delta TB from Delta TS=1 K

Temperature Difference(K)
Wavenumber(1/cm)

Spectral Distribution of Low Troposphere Temperature Increment of 1K for 1976 U.S. Standard

Band 1   Band 2   Band 3

Delta TB from Delta Tropospheric T=1 K

Temperature Difference(K)
Wavenumber(1/cm)
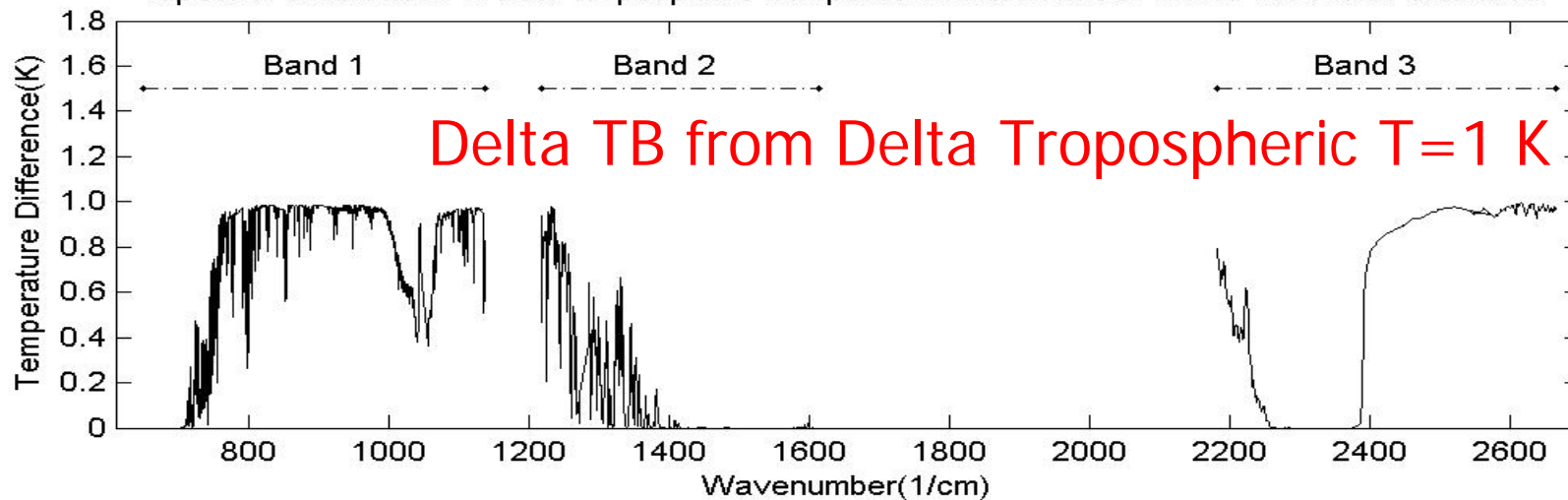
Spectral Distribution of Low Troposphere Humidity Decrement of 15% for 1976 U.S. Standard

Delta TB from Delta lnq=15%
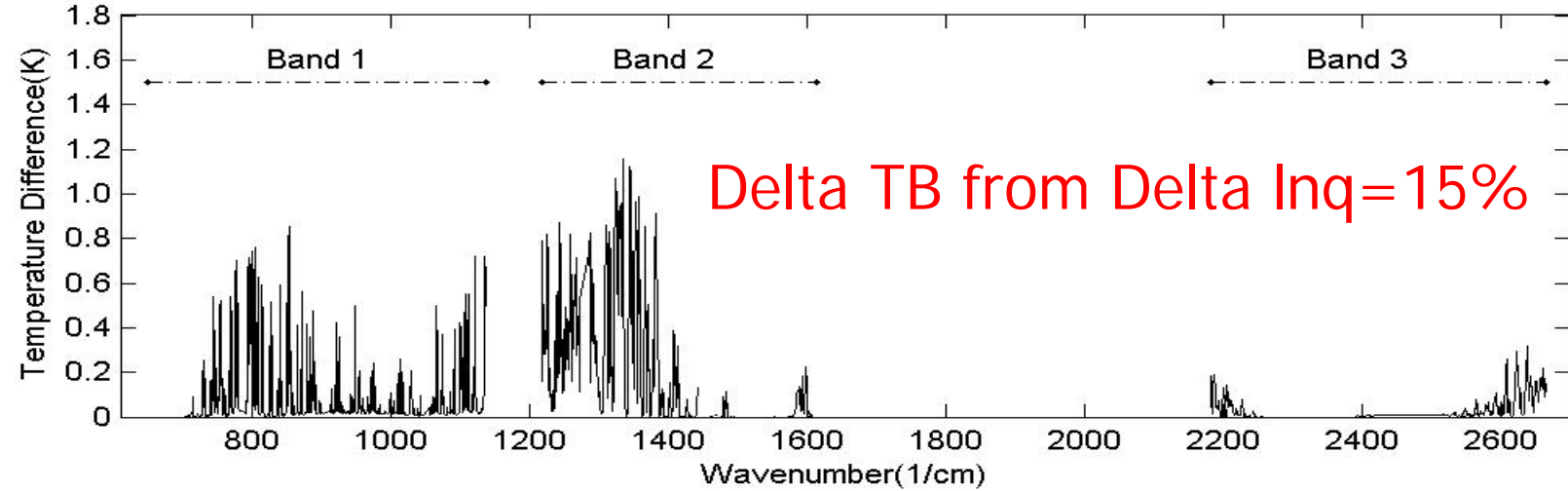
Spectral Distribution of Ozone Decrement of 10% for 1976 U.S. Standard
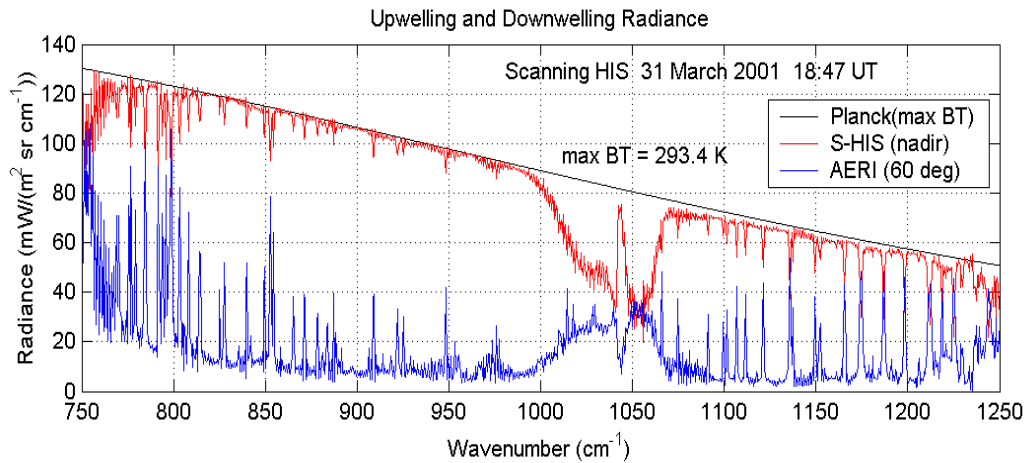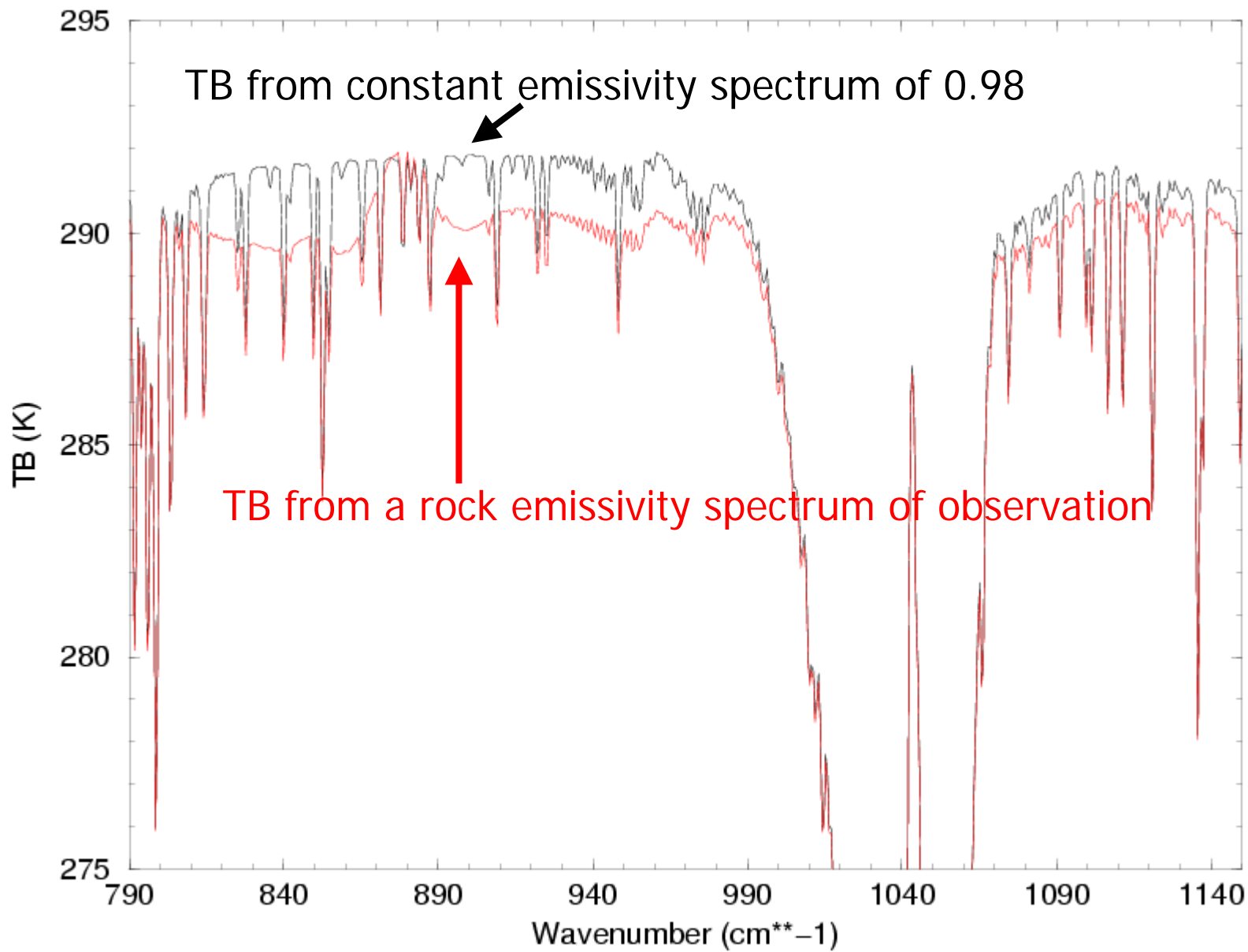
Delta TB from Delta lnO3=10%
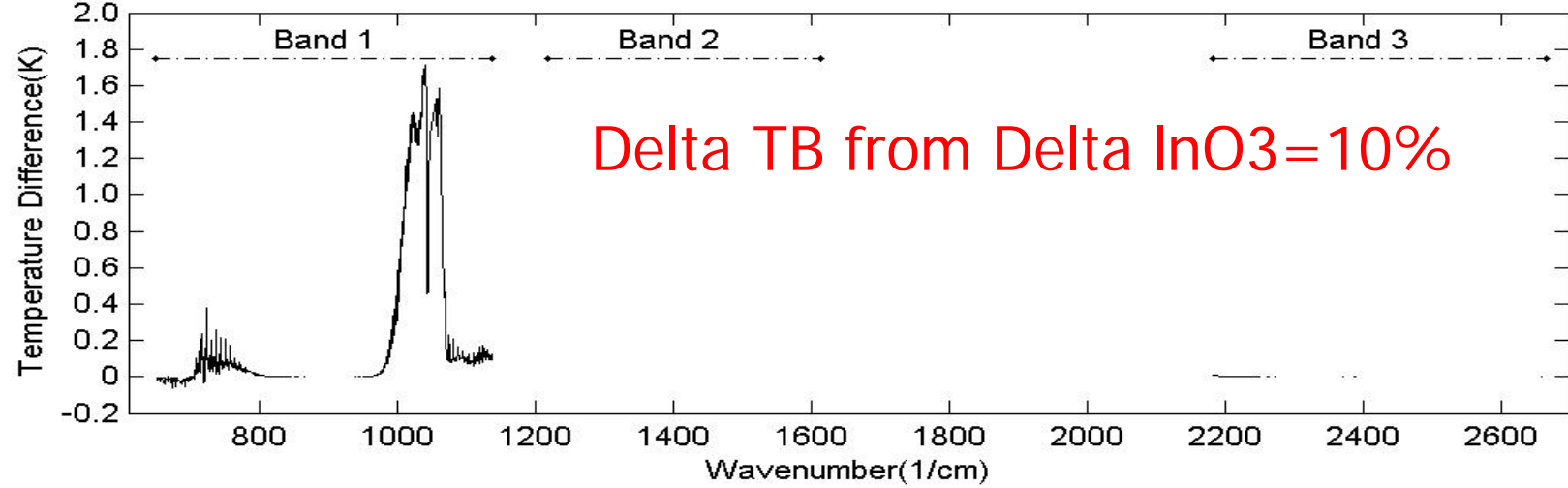
Retrieval LSE with LMEV Method

$$\varepsilon_\nu = \frac{R_\nu^{obs\uparrow} - R_\nu^{atm\uparrow} - \tau_\nu \overline{R}_\nu^{\downarrow}}{\tau_\nu \left(B_\nu(T_S) - \overline{R}_\nu^{\downarrow} \right)}$$

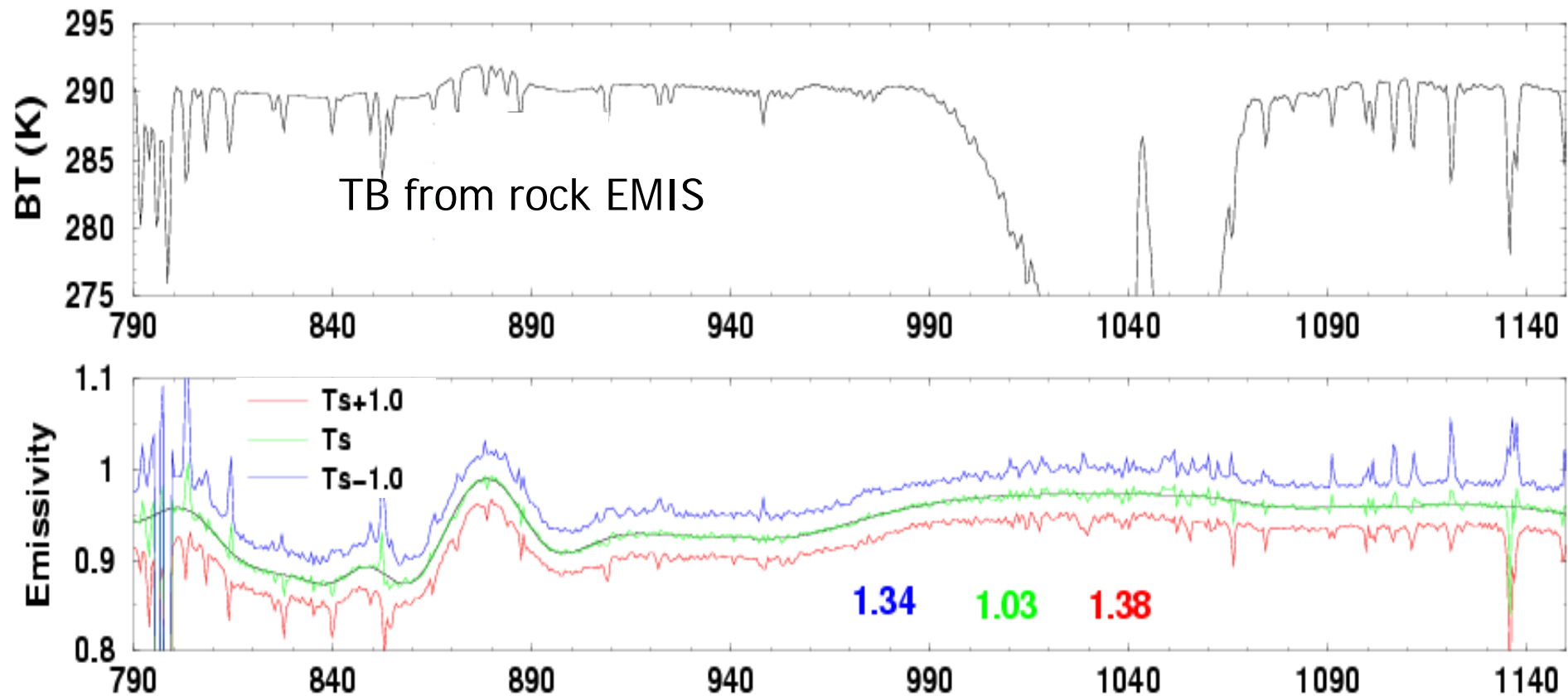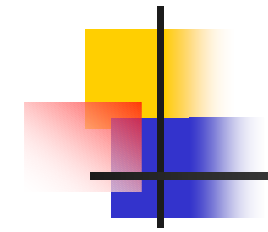# Best fit to LST/LSE when Local Spectral Variance in Emissivity is Minimum

(Robert Knuteson etc)
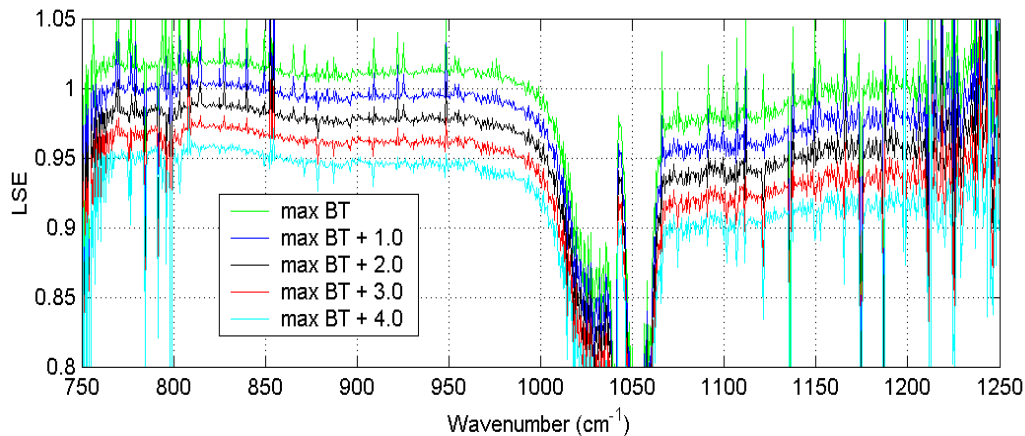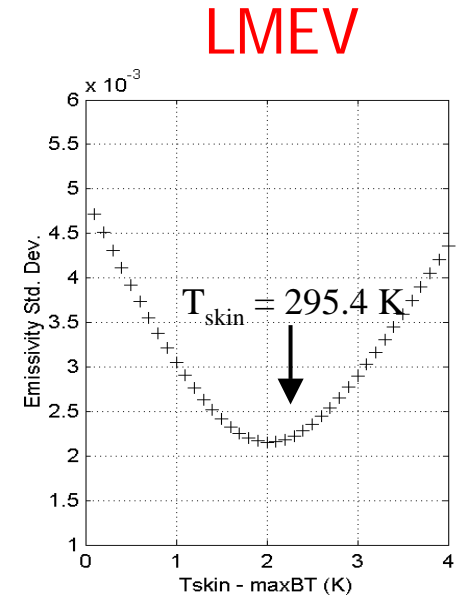
LMEV

$$\varepsilon_v = \frac{R_v^{obs\uparrow} - R_v^{atm\uparrow} - \tau_v \overline{R}_v^{\downarrow}}{\tau_v \left(B_v(T_S) - \overline{R}_v^{\downarrow} \right)}$$

TB from constant emissivity spectrum of 0.98

TB from a rock emissivity spectrum of observation

EMIS spectra derived with the correct/wrong Ts

TB from rock EMIS

Ts+1.0
Ts
Ts−1.0

1.34   1.03   1.38

A Case Study

Retrieval Algorithm: LMEV

AIRS Fast Model: SARTA

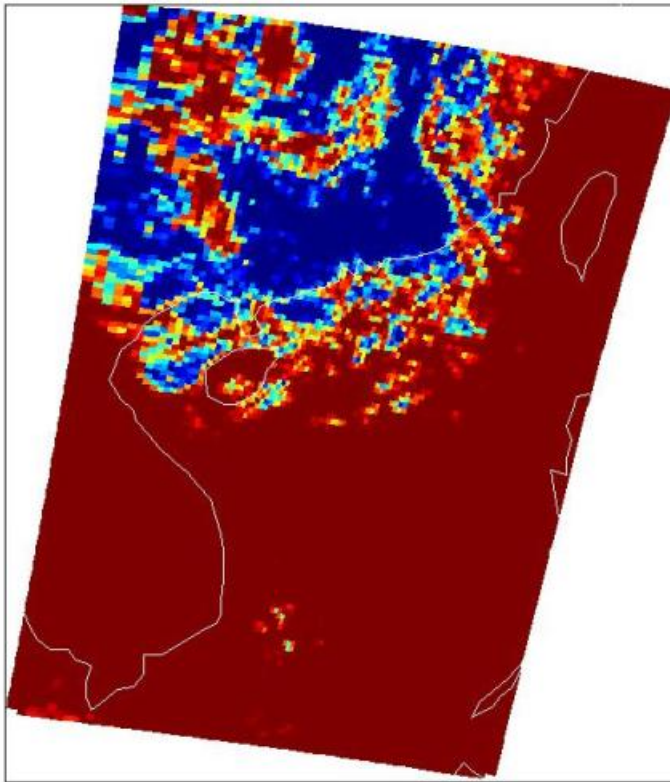**AIRS L1B Data:** Granule 182 （6mins, 118MB）

Sept.6,2002 18:11-18:17（GMT）

Atmospheric Profile: ECMWF profile of Sept.6,2002 at 18Z
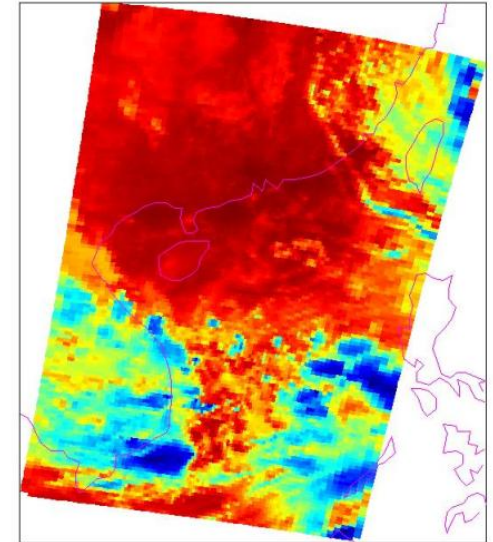
AIRS Clear Flag from MODIS Cloud Mask
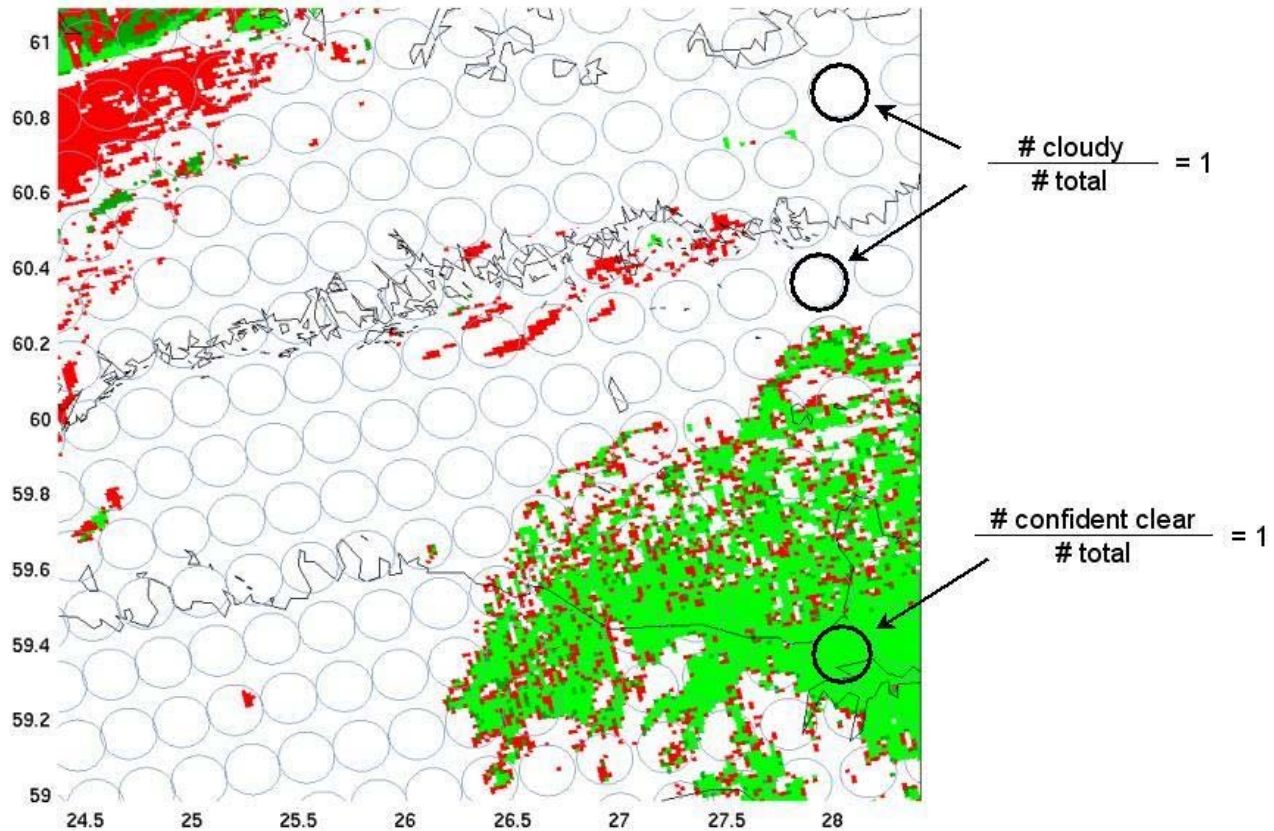
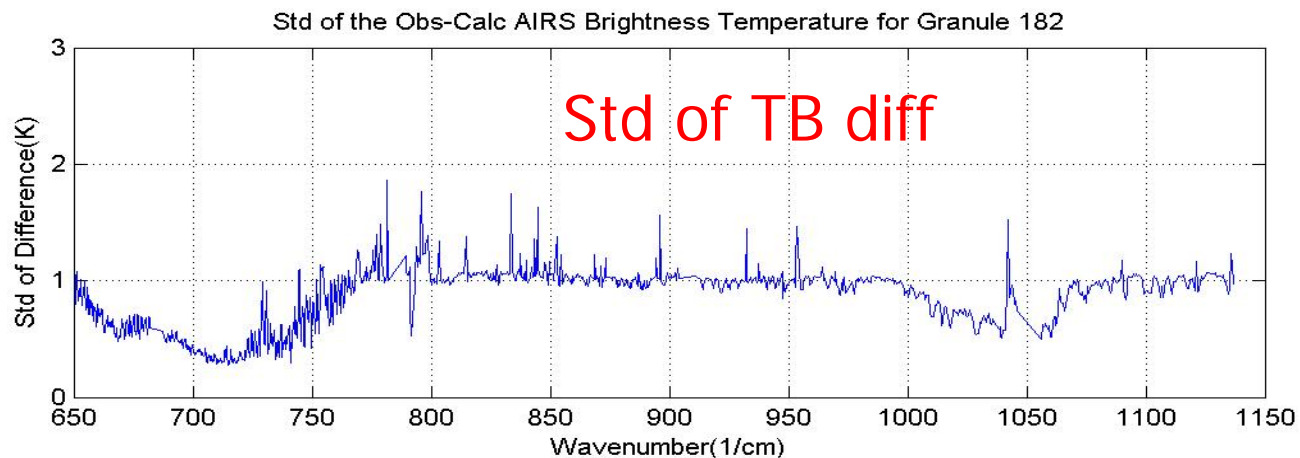# AIRS Clear Flag from MODIS Cloud Mask for G182

AIRS Cloud Flag from MODIS Cloud Mask
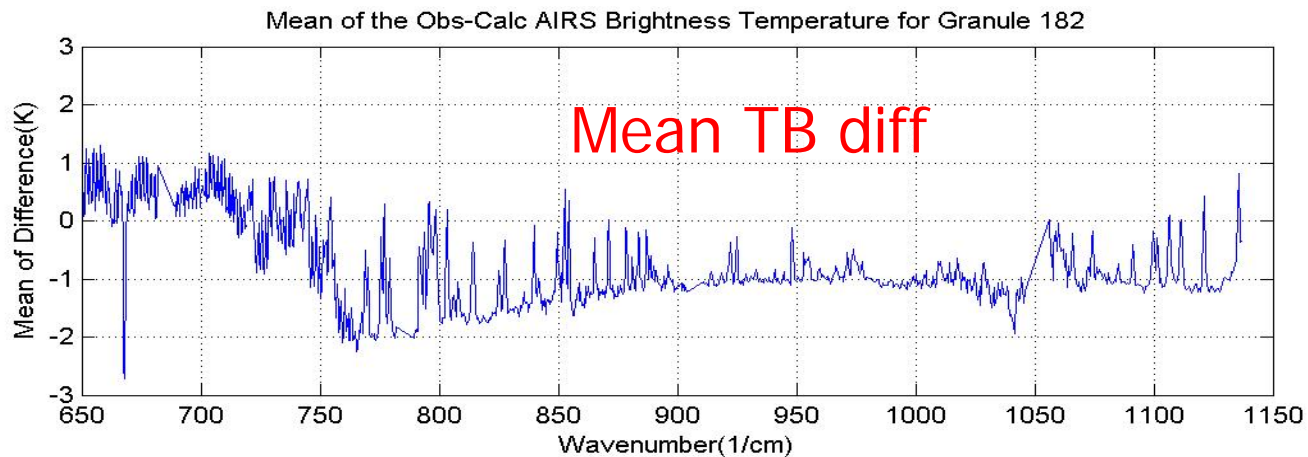

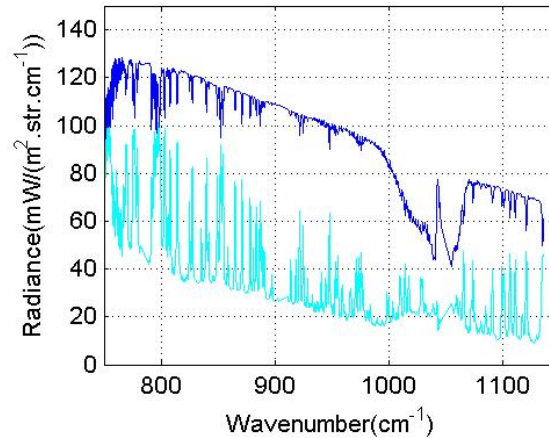AIRS Channel 560 (12.0047 µm)   Brightness Temperature

Mean and Std.of the Obs-Calc AIRS Brightness Temperature for G182

(1391 Clear FOVs/12150)

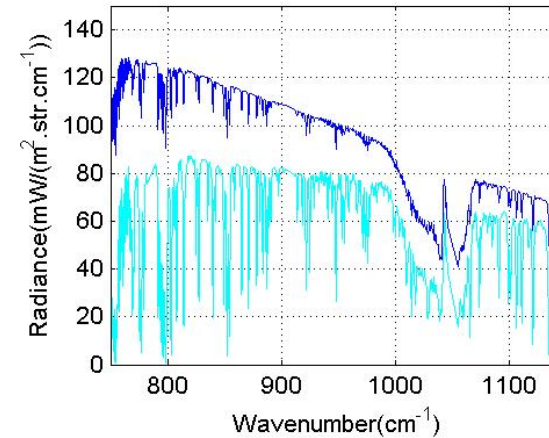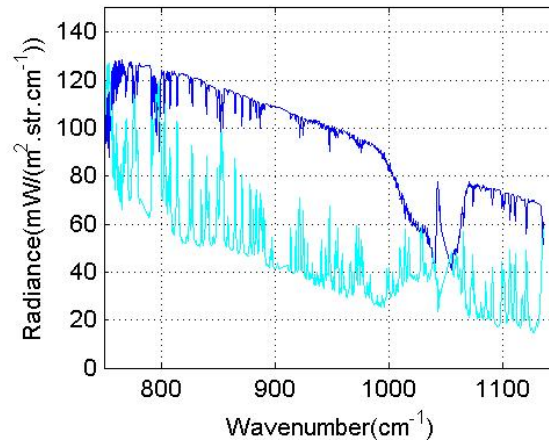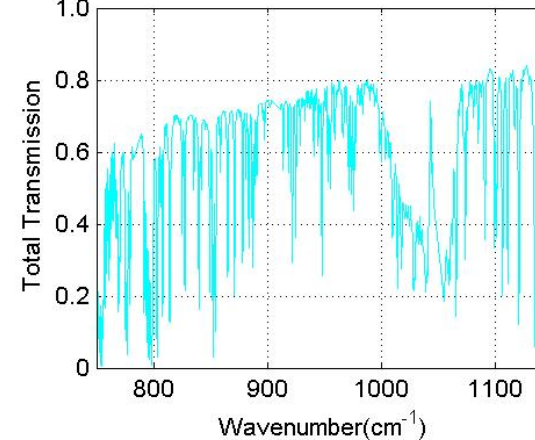# The Upwelling/Downwelling Radiance and Total Transmittance

The Retrieved LSE Spectral with MLEV

Minimum Std. Variance

Spectra of Land Surface Emissivity for a Clear FOV of Granule 182

A retrieved EMIS spectrum

Wavenumber (cm**-1)
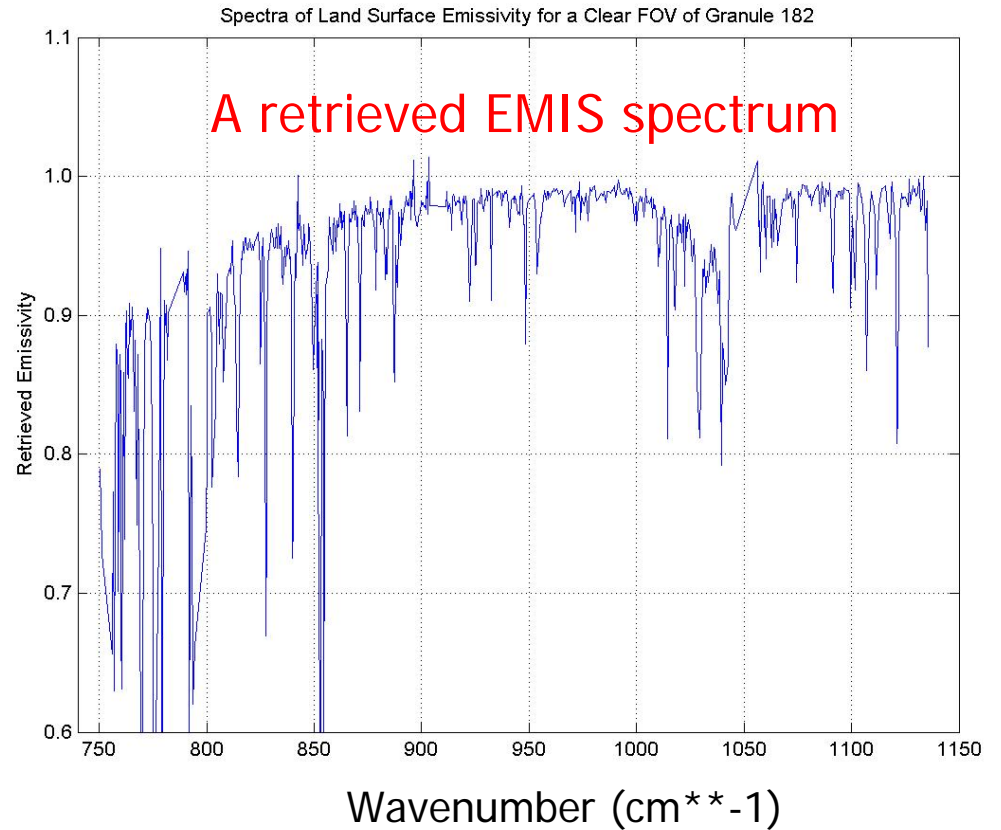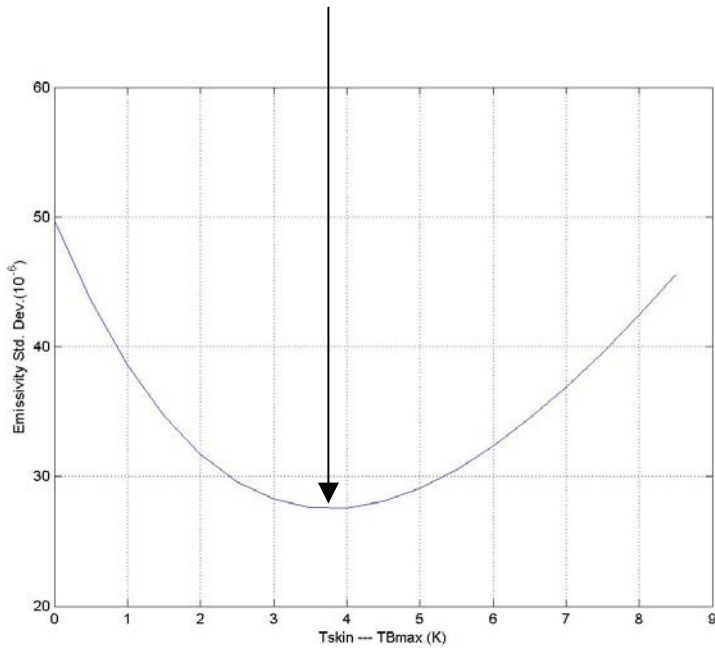
The Comparison Between Obs. and Calc. BT with Unit/Retrieved LSE

The Observed AIRS Brightness Temperature Minus the Calculated BT With Unit Emissivity

Obs – Calc with EMIS=1

The Observed AIRS Brightness Temperature Minus the Calculated BT With Retrieved Emissivity

Obs – Calc with LMEV retrieved EMIS
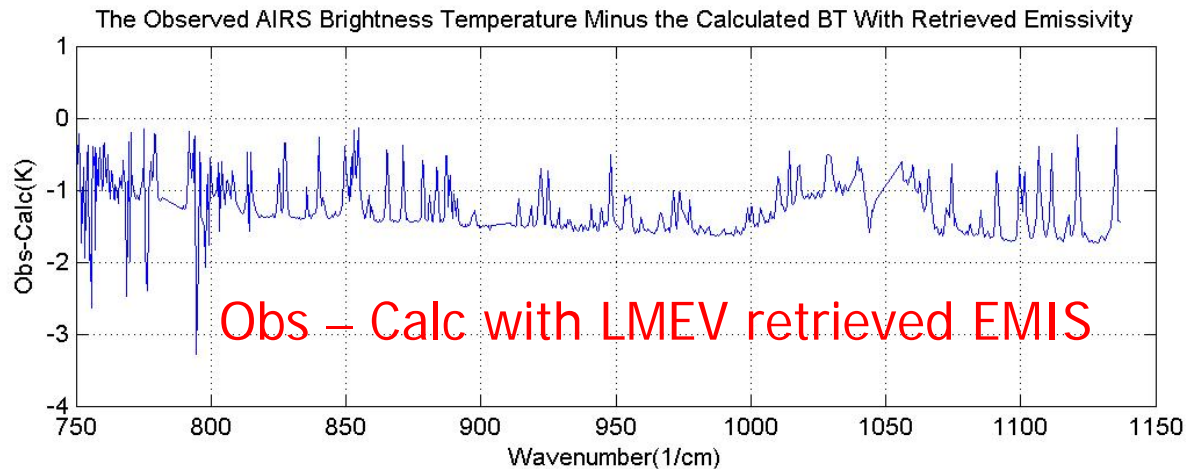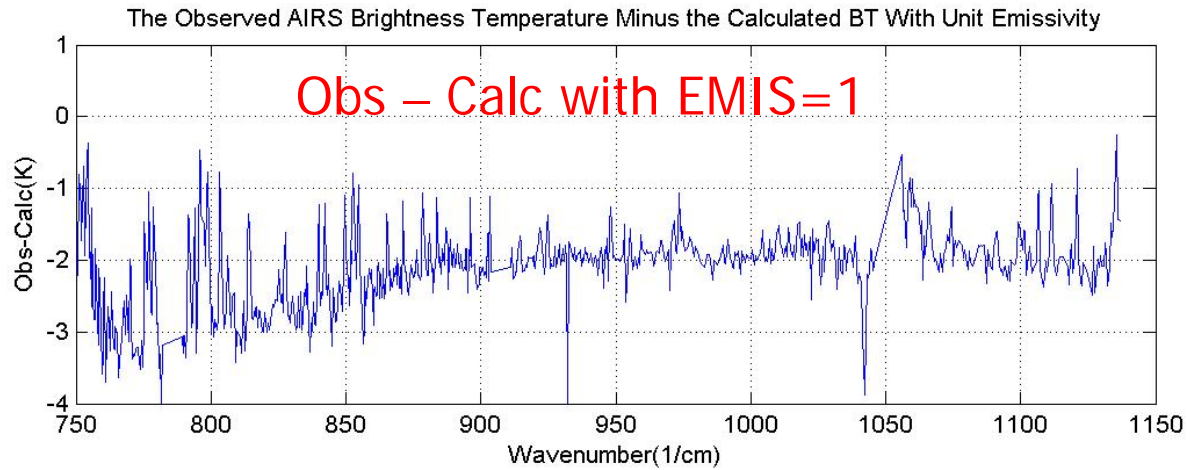
Future Plan

Update of model : Fast Model and Retrieval Algorithm
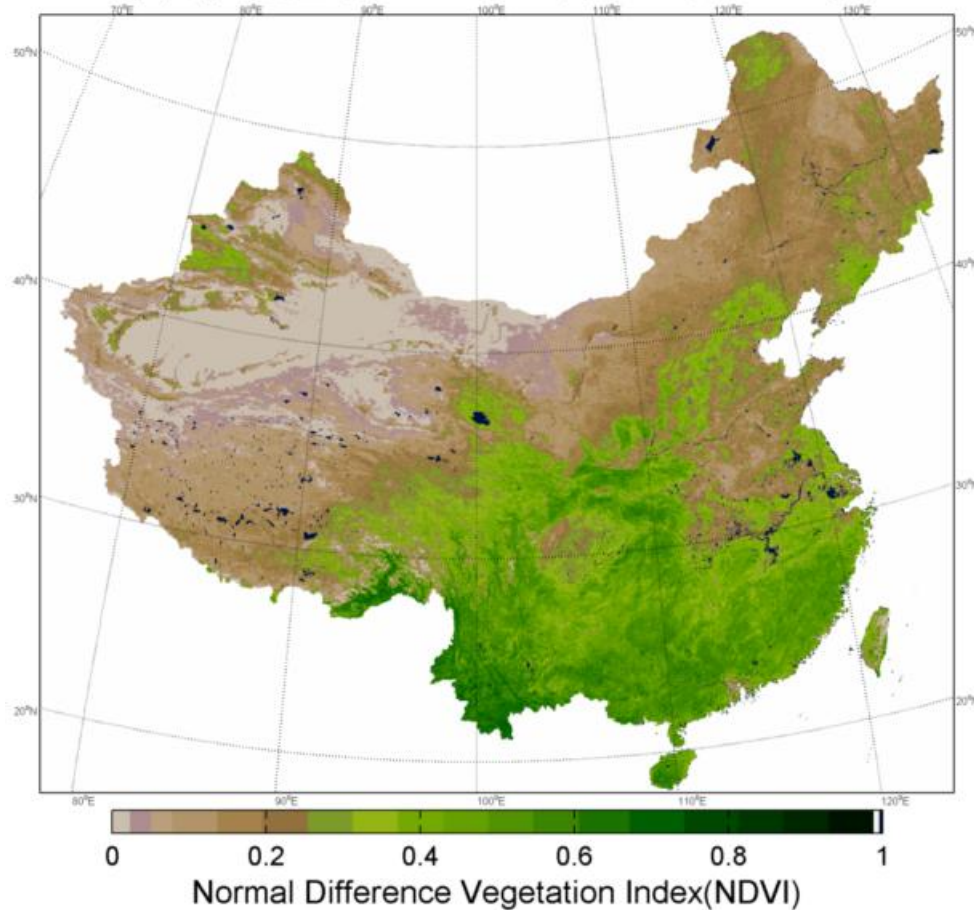
Initial Guess of LSE:

       1) in accordance with IGBP Atlas
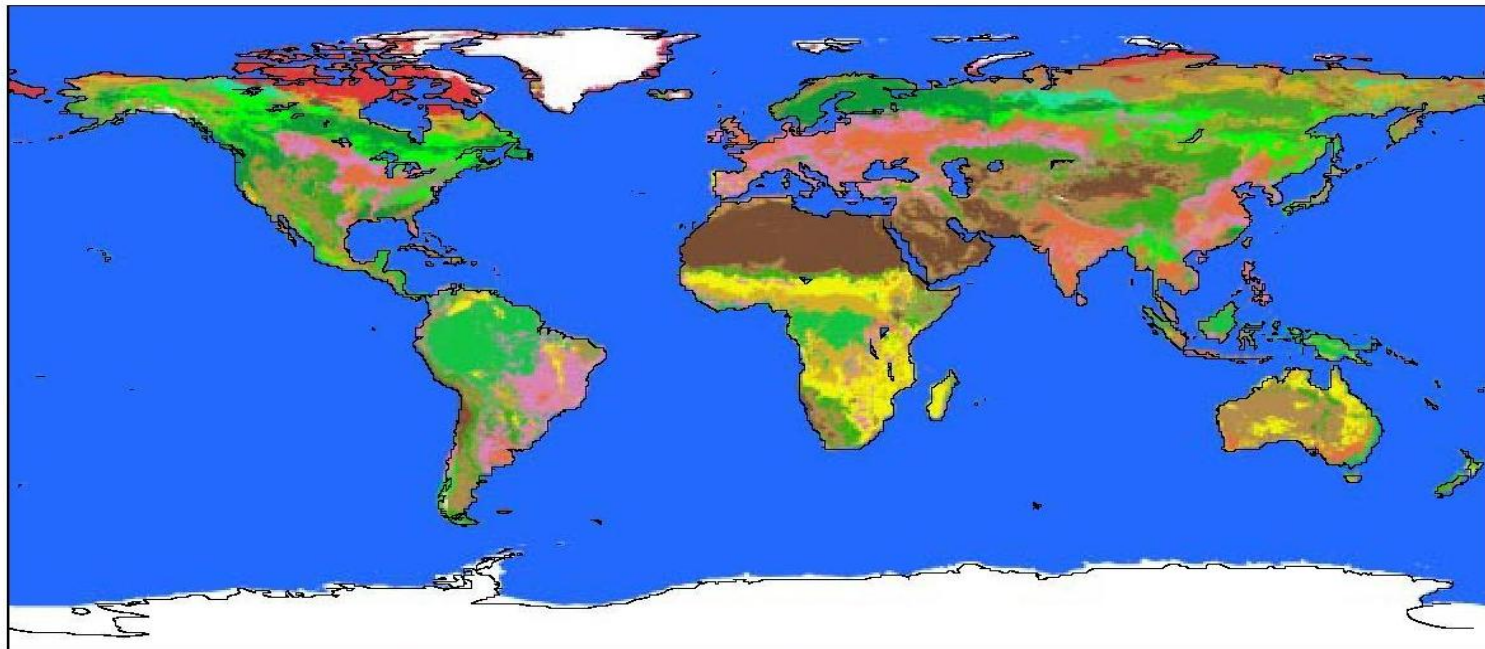
       2) in accordance with NDVI

Validation

NDVI Distribution Over China

中国陆地区域2002年10月1-10日NDVI图

Normal Difference Vegetation Index(NDVI)

18 Classes of IGBP Surface Type

Evergreen Needleleaf	Mixed Forests	Savannas	Urban	Water
Evergreen Broadleaf	Closed Shrubland	Grassland	Mosaic	Tundra
Deciduous Needleleaf	Open Shrubland	Wetlands	Ice/Snow	
Deciduous Broadleaf	Woody Savannas	Croplands	Barren	

Thanks!