

# **Spectral surface emissivity for use in assimilation of IR radiance data over land**

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## Objectives

- ◆ **High spectral resolution sounders IASI and AIRS**
- ◆ **Background informations for Ts and SSE**
- ◆ **Validation of new emissivity maps**
- ◆ **Retrieval and assimilation of atmospheric profiles and surface parameters - preparations**

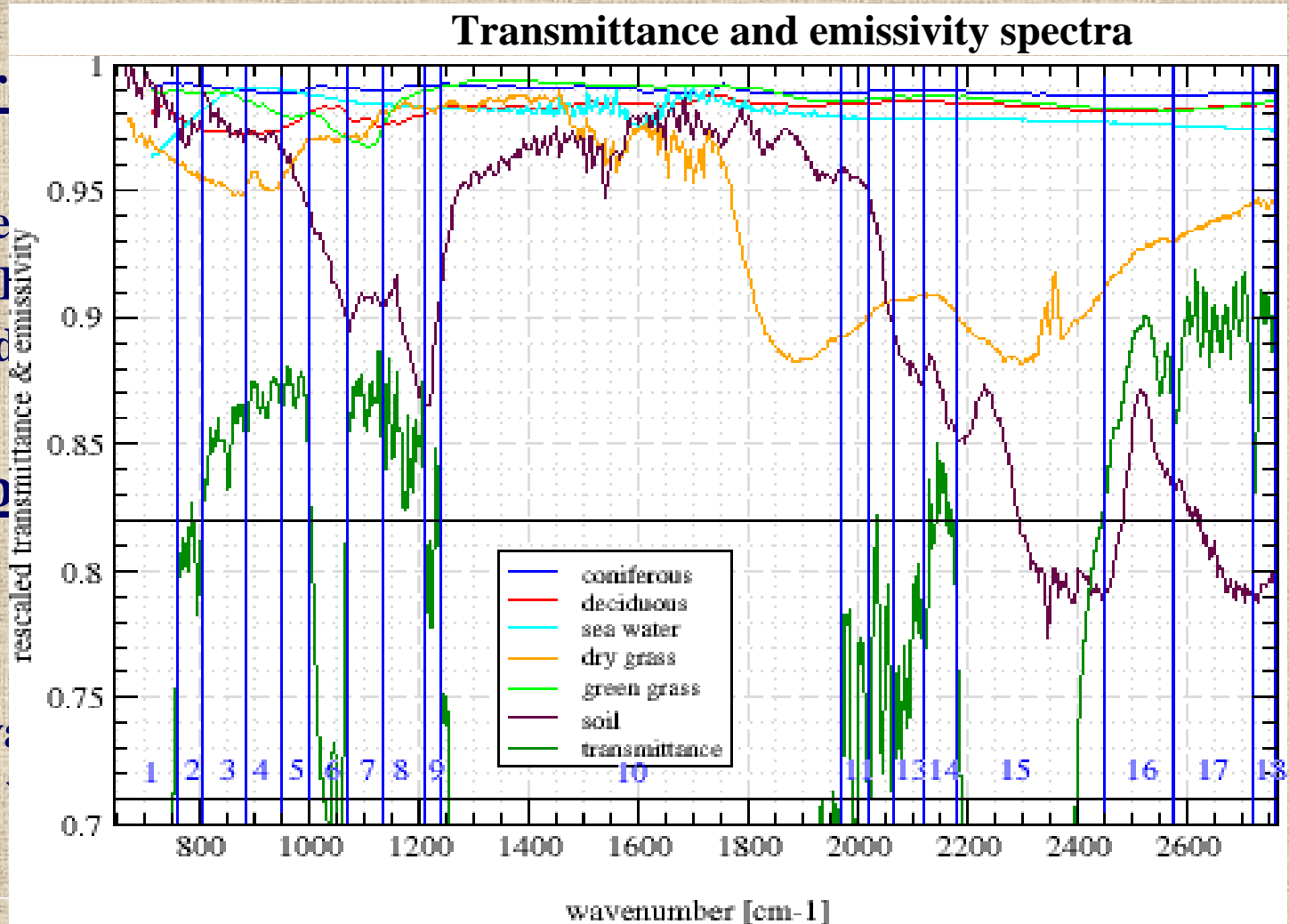
# Emissivity data

## Main sources

- MODIS spectral emissivity
- ASTER-JPL emissivity
- Snyder model

## New wavebands

- usefulness for
- narrower and
- to follow the vegetation
- for validation





# Land cover types

## ◆ ECOCLIMAP:

a complete surface parameter global dataset derived from:

- existing land cover maps and climate maps
- Normalised Difference Vegetation Index (NDVI) from AVHRR observations
- FAO database of soil texture

215 ecosystems combined from 12 vegetation types (pure ecosystems)

## ◆ New land cover types:

bare soil	rocks	permanent snow and ice
crops type C3	crops type C4	irrigated crops
nat. herbaceous (temp.)	nat. herbaceous (tropics)	wetland
needleleaf trees	ev. broadleaf trees	deciduous broadleaf trees
urban	water	



## Use of IASI/AIRS data over land

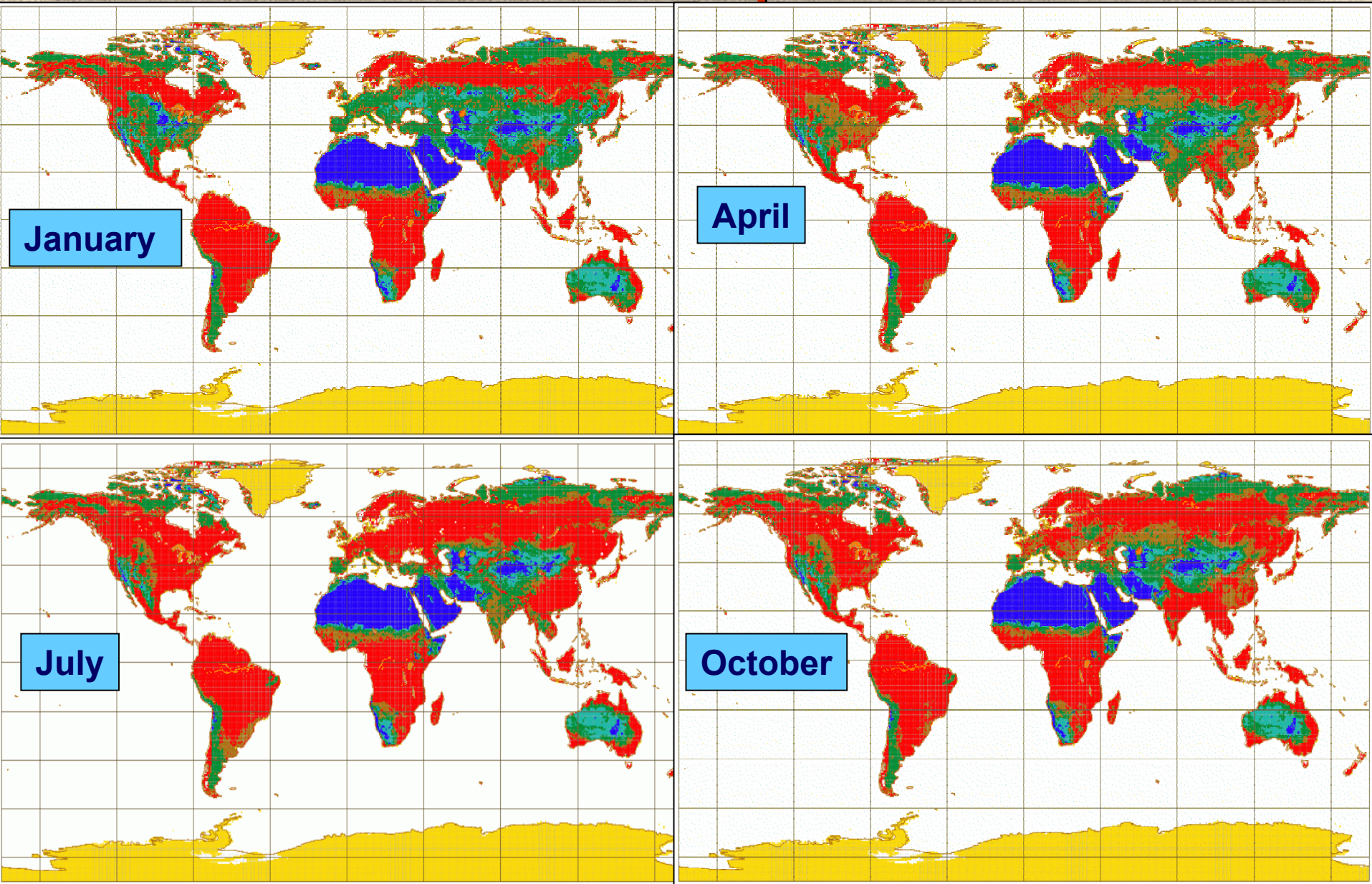


January

April

July

October



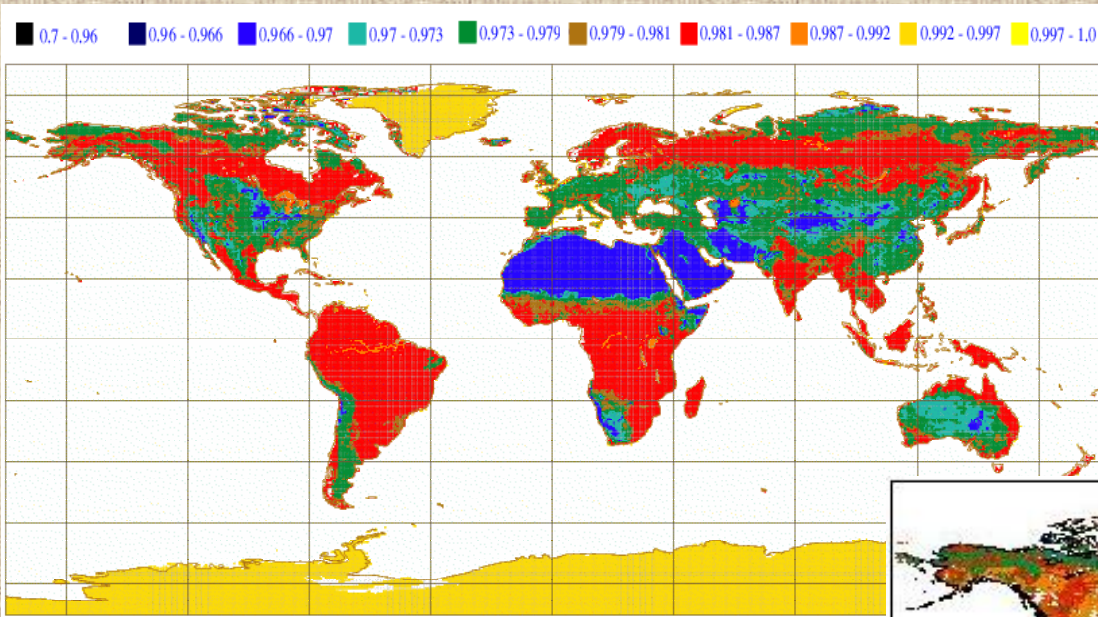


# **Emissivity maps validation with MODIS**

- ◆ **MODIS – Moderate Resolution Imaging Spectroradiometer**
  - retrieval of land surface products
  - 'split window' technique for SSE in MODIS bands 31 and 32
  - 1km spatial resolution
  - temporally: individual swath data, 1-day average, 8-day average
  
- ◆ **Maps used here were MODIS SSE composites of individual swaths**

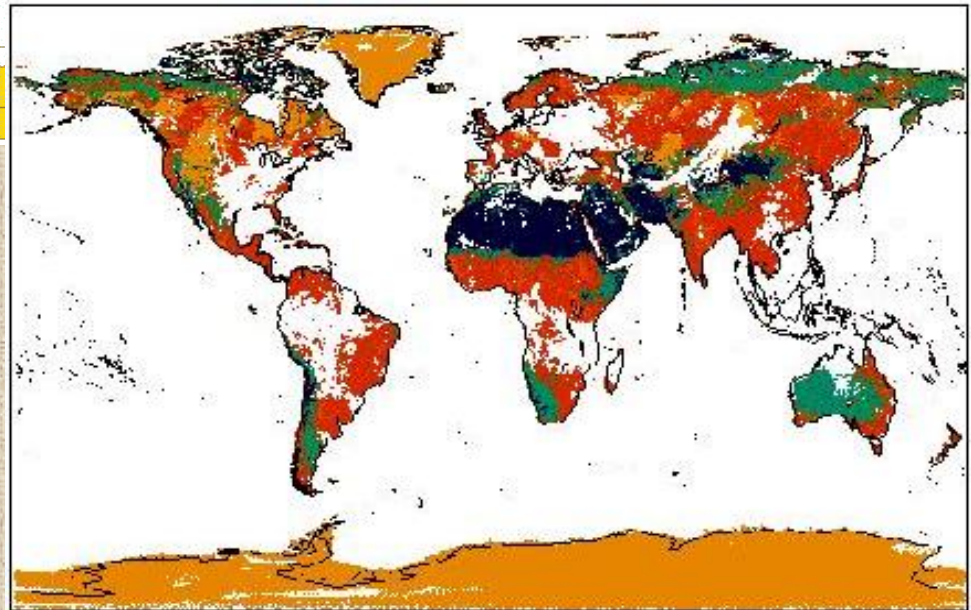


# Validation with MODIS



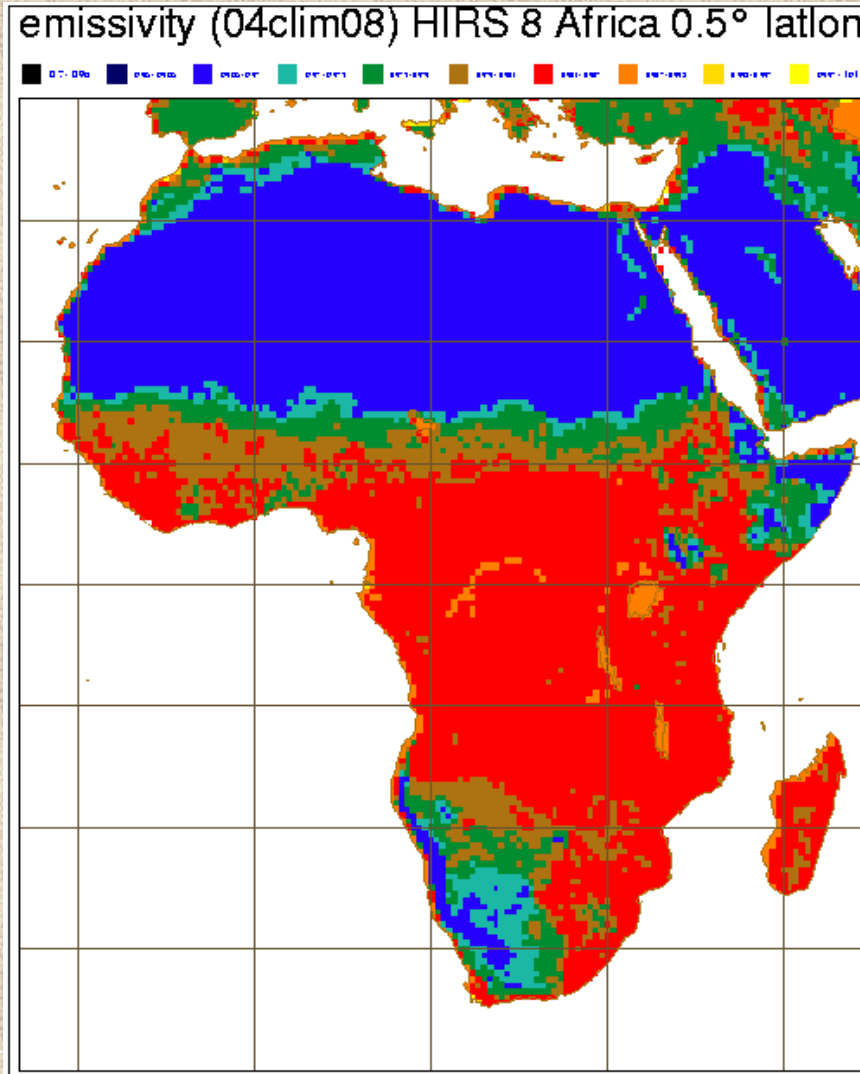
← map of SEE for January

SSE composite map, MODIS  
channel 31, January 2001  
(courtesy of P. Francis)



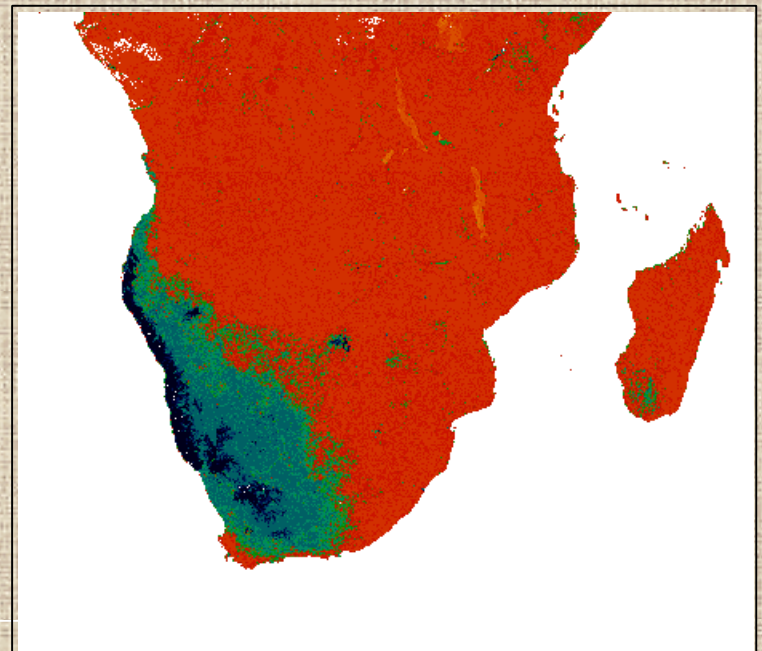


# Validation with MODIS



← map of SEE for August

SSE composite map, MODIS ch. 31  
August 2000





# Validation with MODIS

SSE map for August

emissivity (03clim08) HIRS 8 S Amer 0.5° latlon



SSE composite map, MODIS ch. 31  
August 2000



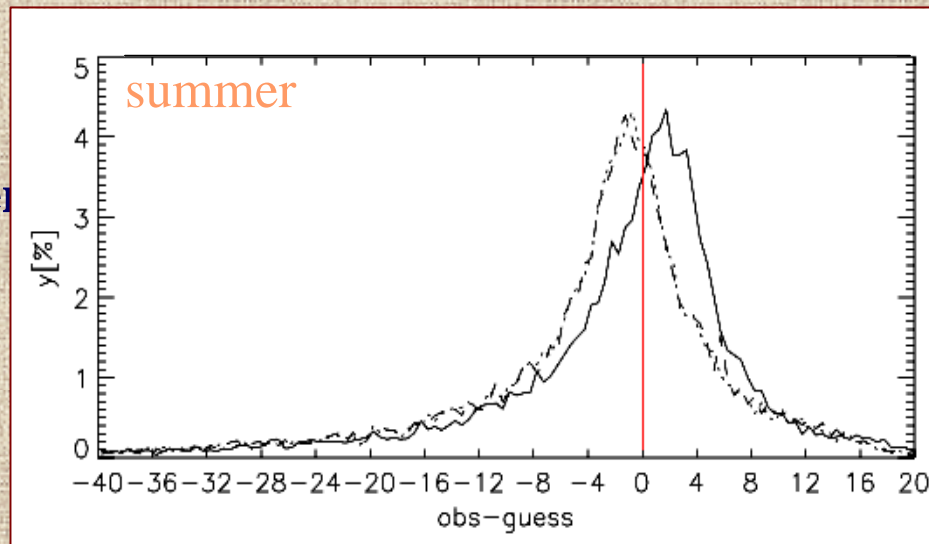
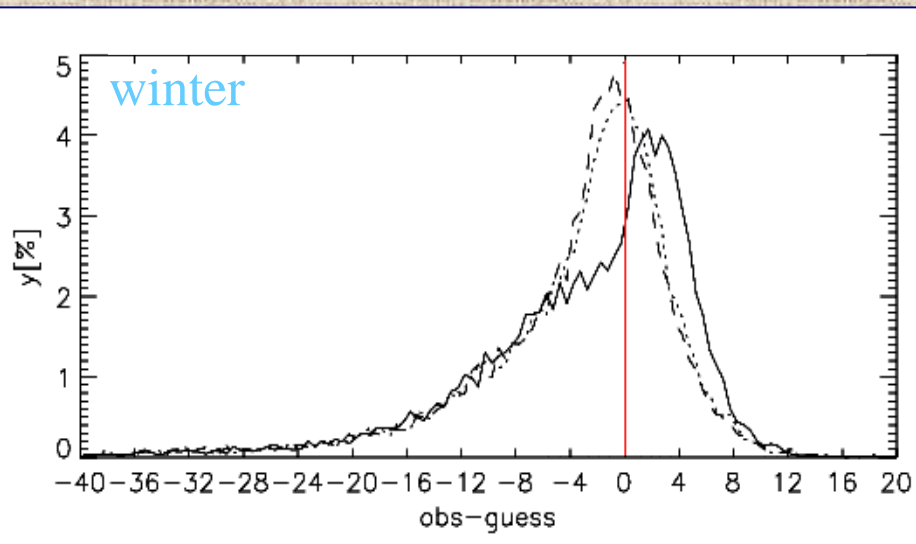


## **Validation HIRS-8**

- ◆ **HIRS** – High-resolution Infra-Red Sounder
  - channel 8 - very sensitive to surface parameters
    - can be used to detect cloud contamination
    - waverange almost equal to MODIS ch. 31 and waveband 4
  
- ◆ **Tests on differences between measured and forecasted Tb (obs-guess)**
  - forecasted Tb = Tb calculated in RTTOV-7 from atmospheric profile  
(6hour ARPEGE model forecast)
  - 1<sup>st</sup> reference run – SSE from ARPEGE
  - 2<sup>nd</sup> reference run – SSE from RTTOV-7
  - experimental run – closest SSE value from new maps to the observation point
  - 'good points'      -1K < (obs-guess) < 2K
  - no bias correction on (obs-guess)



## Validation HIRS-8



dom ref	globe	Europe	N Am	S Am	Africa	Austral	Asia	Antarct
<b>RTTOV</b> <sub>(0.98)</sub>	2.9%	1.7%	2.2%	-3.1% *	10.8%	4.3%	3.7%	0.7%
<b>ARPEGE</b>	16.5%	12.8%	11.6%	-2.4% *	30.3%	50.3%	12.9%	0.3%



# Validation AIRS

◆ The same methodology as for HIRS-8 except:

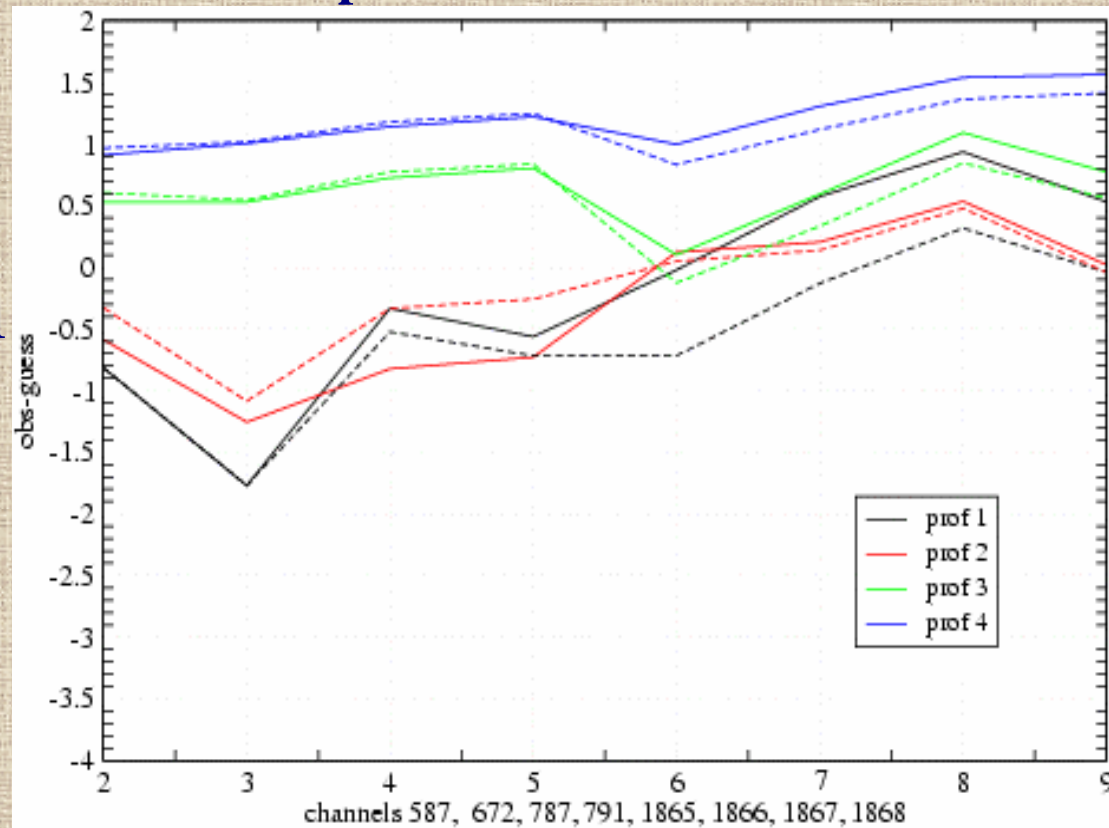
- channel selection
- cloud detection

◆ Chosen channels:

band (3+4): 587, 672, 787, 791  
band 15: 1865-1868

◆ New SEE tests:

4 randomly chosen points

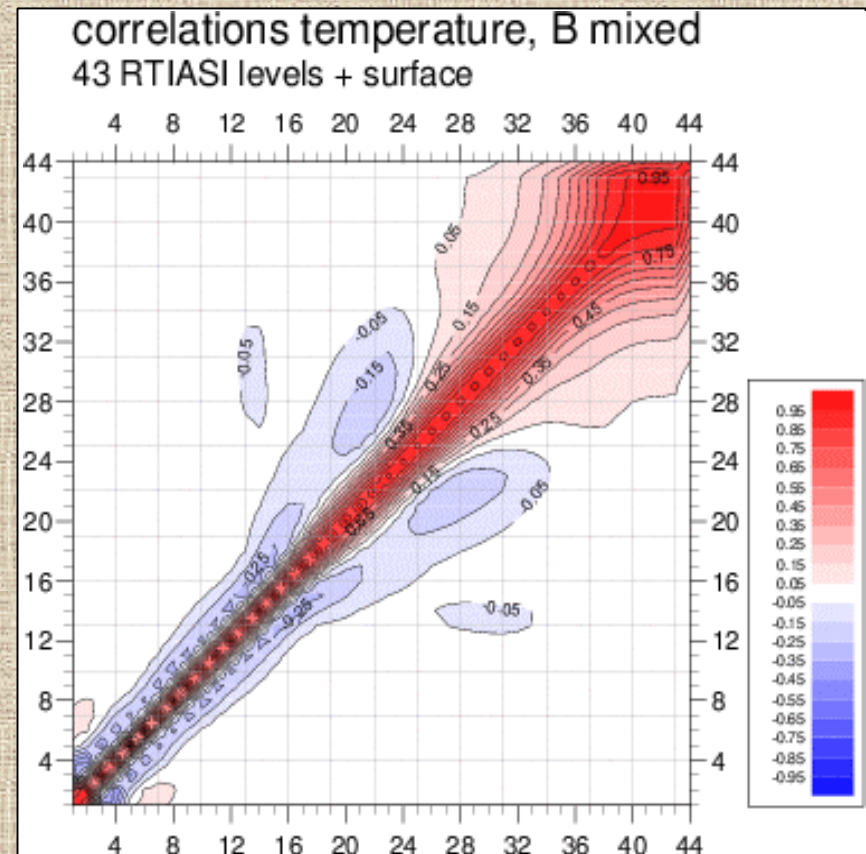




# Background errors statistics for temperature

## ➤ Temperature

- ensemble method  
(10 members, 1 month)
- vertical correlations with surface temperature
- separated statistics for land



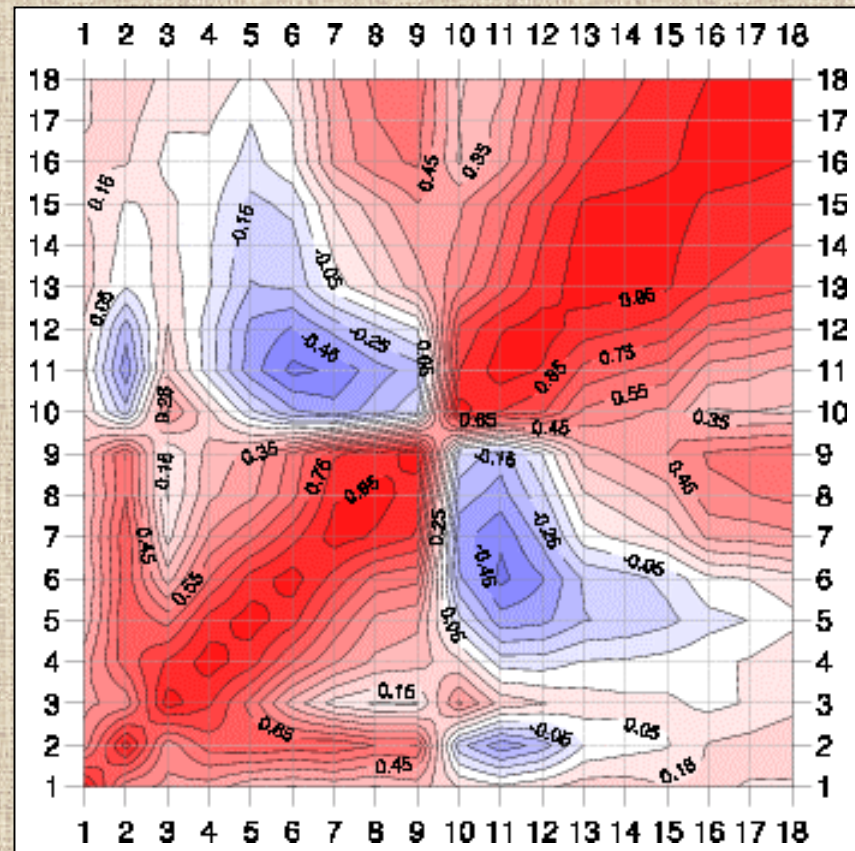


# Background errors statistics for surface spectral emissivity

## ◆ Emissivity

- just for 5 land cover types
- arithmetic average
- weighted average

BARE SOIL





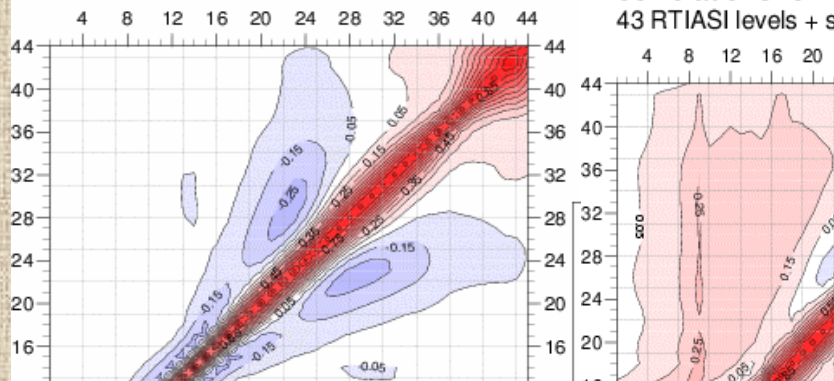
## Conclusions

- ◆ **New emissivity maps are consistent with MODIS SSE maps**
- ◆ **Usage of the new SSE in RTTOV-7 with HIRS-8 data gave usually better results than with SSE currently used in ARPEGE or in RTTOV (with some exceptions)**
- ◆ **Preliminary tests for AIRS data showed we could expect improvement of simulated Tb values in RTTOV**
- ◆ **Work on 1D-Var on the inversion of radiances and retrieval of emissivity and Ts**

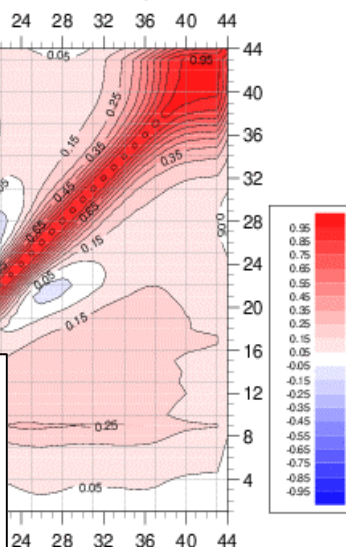


# Background errors statistics for temperature

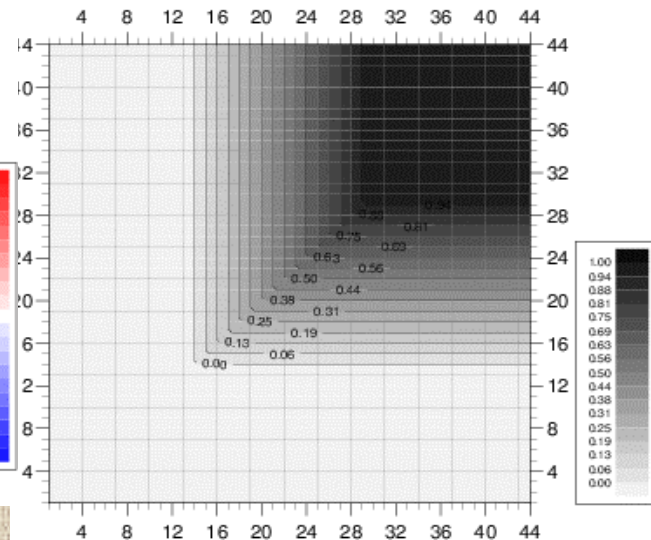
correlations temperature, B from ECMWF  
43 RTIASI levels + surface



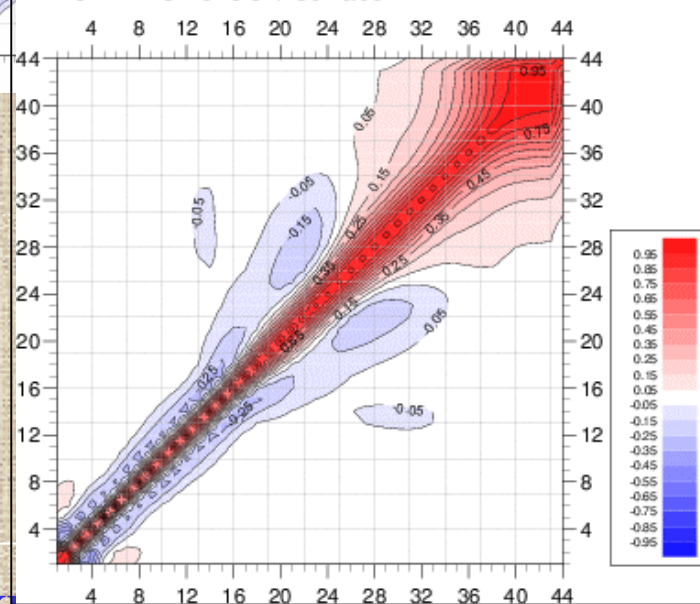
correlations for T over LAND - sumcov  
43 RTIASI levels + surface, all days



matrix to combine 2 B matrices  
1.0 - just my values, 0.0 - just Nadia



correlations temperature, B mixed  
43 RTIASI levels + surface



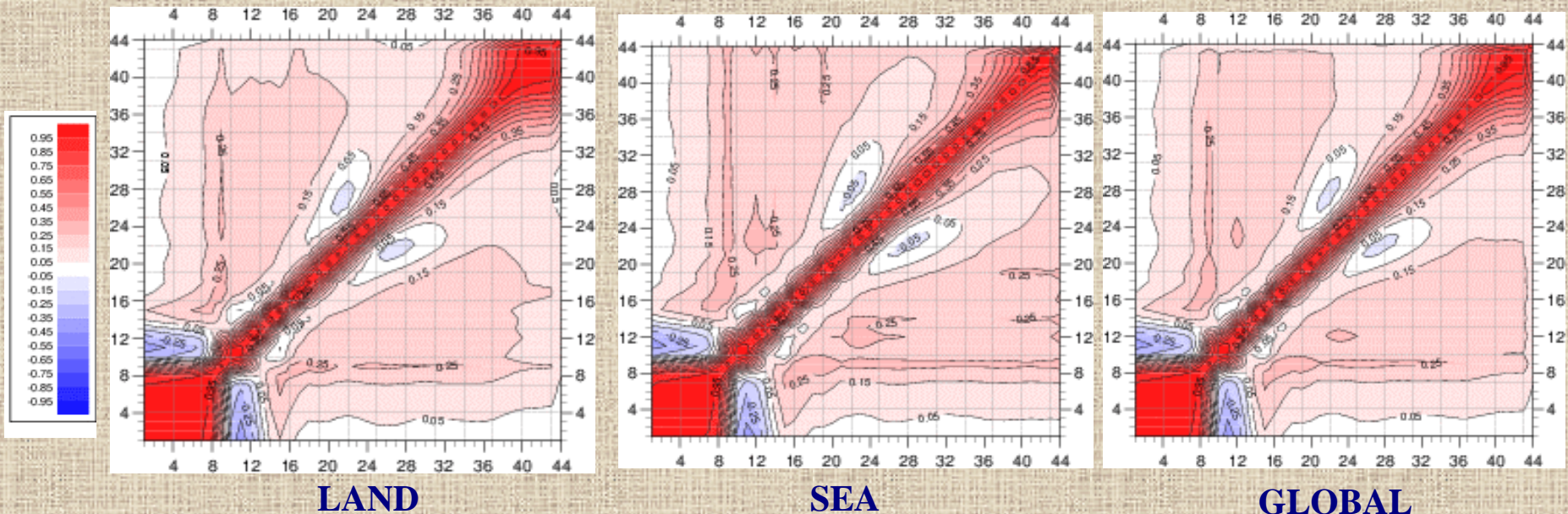
**B MIXED**



# Background errors statistics for temperature

## Temperature

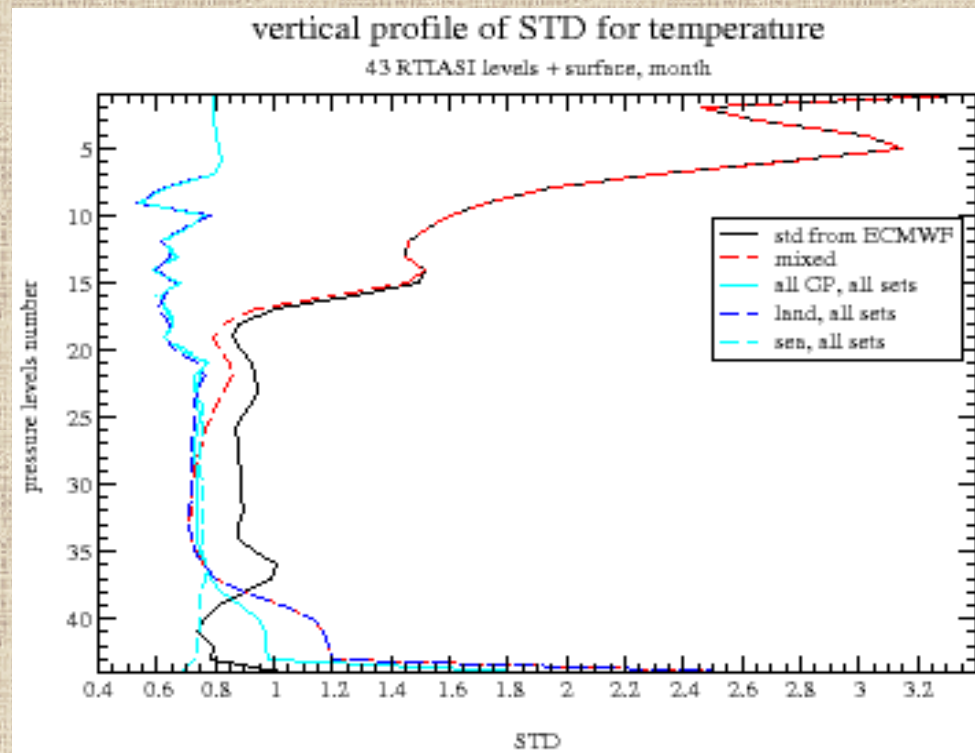
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- vertical correlations with Ts
- separated statistics for land





# Background errors statistics for temperature

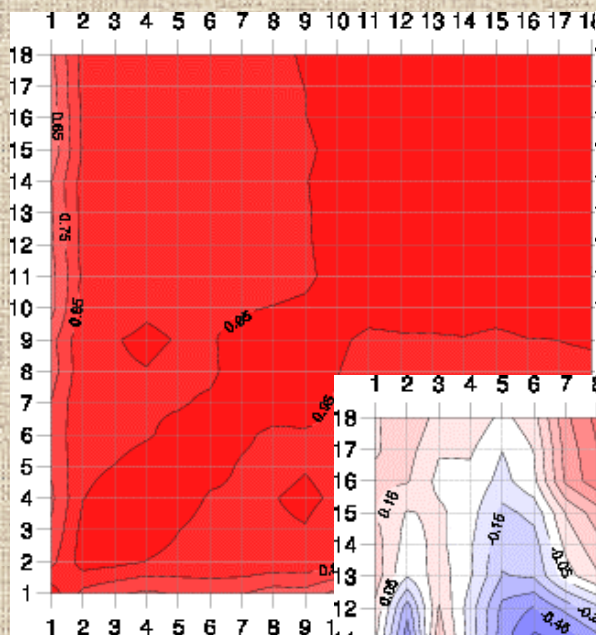
## Vertical profile of T standard deviation



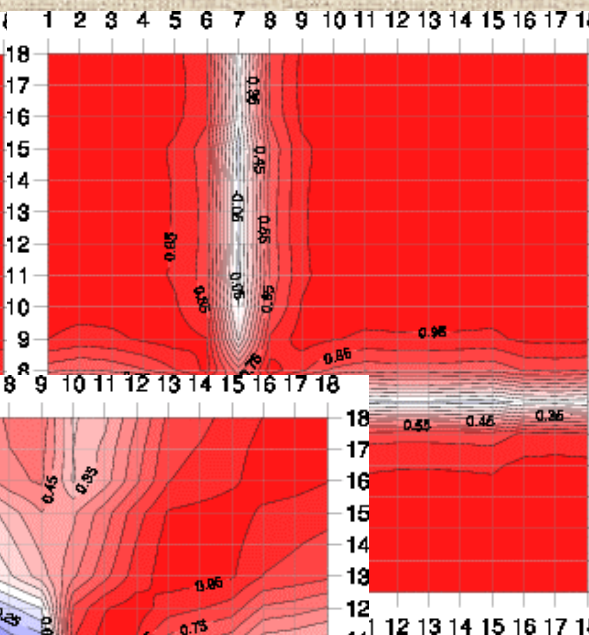


# Background errors statistics for surface spectral emissivity

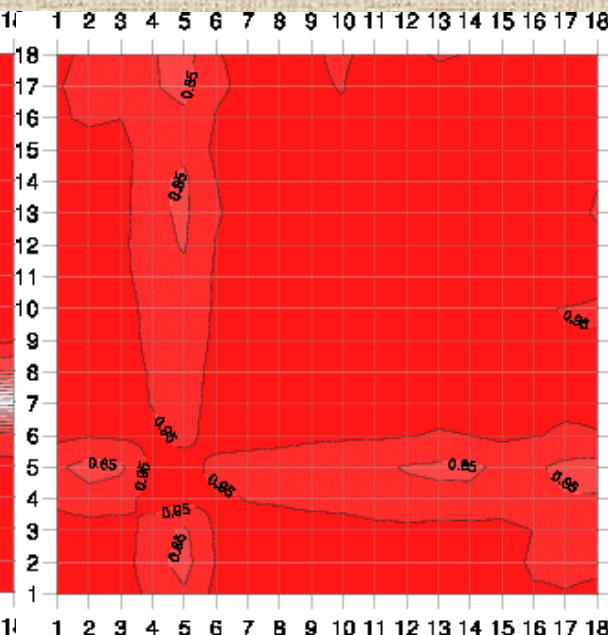
**HIGH VEGETATION**



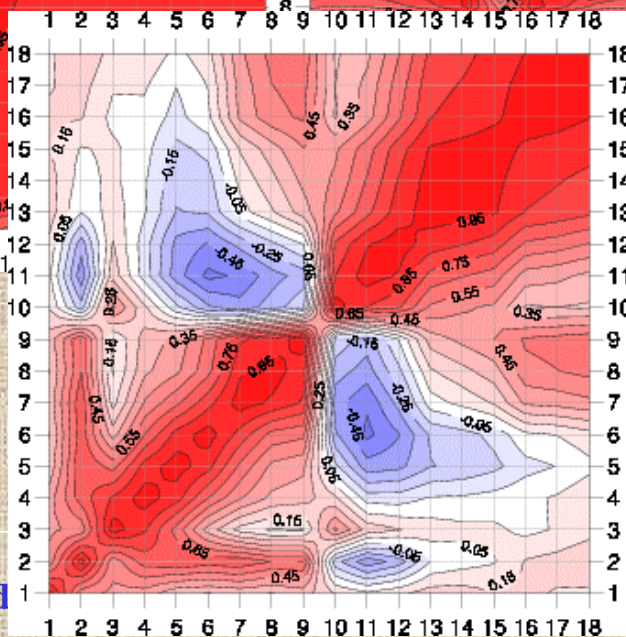
**LOW VEGETATION**



**ICE / SNOW**



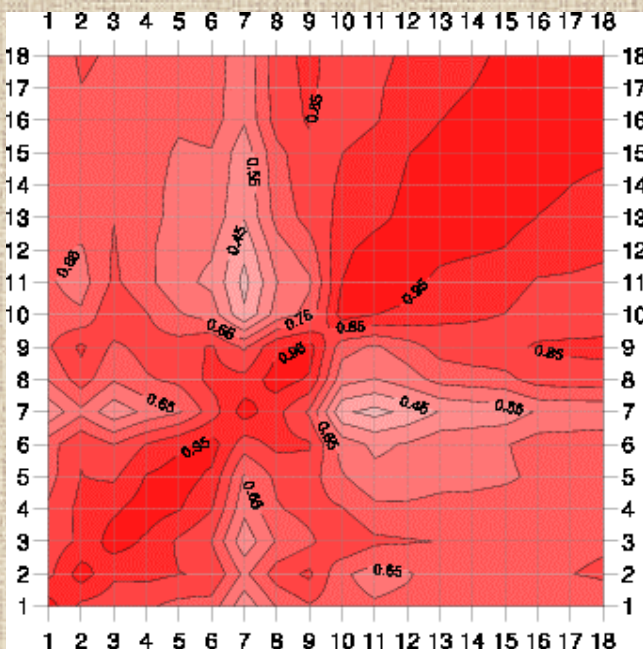
**BARE SOIL**



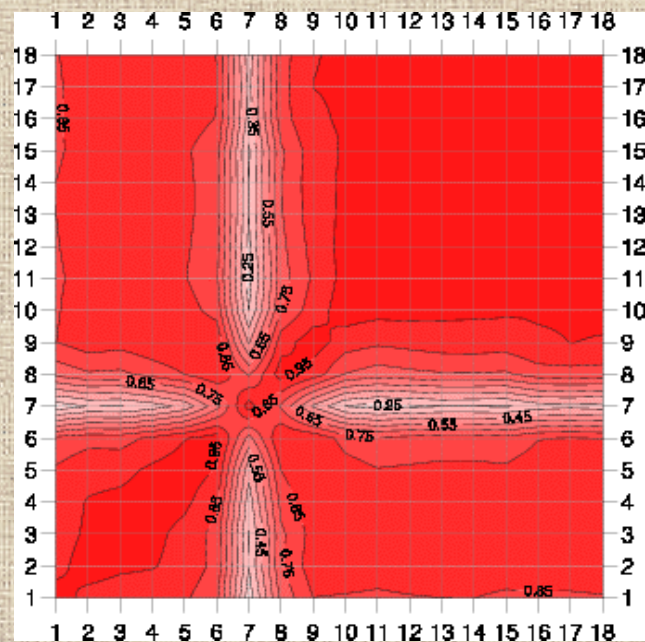


# Background errors statistics for surface spectral emissivity

## ◆ Averages



arithmetic average



weighted average



International TOVS Study Conference, 13<sup>th</sup>, TOVS-13, Sainte Adele, Quebec, Canada, 29  
October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and  
Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.