Soil emissivity spectra for ground and remote sensing thermal calibration

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- ***Experimental Setup***
  - FTIR spectra
  - XRD diffraction analysis
  - WDXRF analysis
- Results and Comparisons
- Conclusions

EXPERIMENTAL SET-UP

Soil Samples

Storaged in special devices

Fourier Transform Infrared Spectroscopy (FTIR)

To retrieve hemispherical integrated reflectance / emissivity

X-ray Diffraction Analysis (XRD)

To retrieve crystalline mineralogical phase (Calcite, Quartz, etc.)

Wavelength Dispersive X-Ray Fluorescence (WDXRF)

To retrieve chemical compositions of soil samples

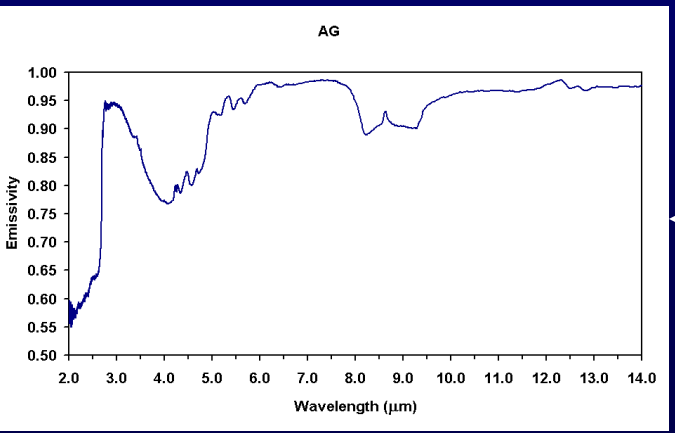
EXPERIMENTAL SET-UP (FTIR)

Soil Samples

Sample were Preprocessed follow Baldridge et al (2009)

FTIR+integrating sphere

Soil Emissivity spectra



dridge et al., 2009. The ASTER spectral library version 2.0. Remote Sensing of Environment 113 (4), 711–715.

EXPERIMENTAL SET-UP (XRD)

Soil Samples

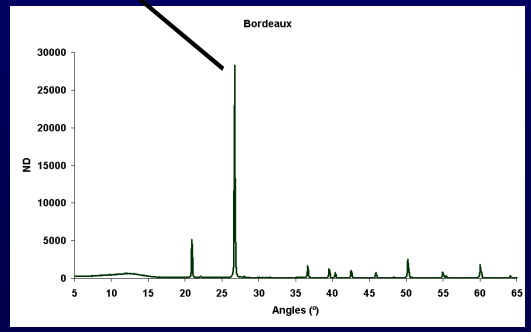
XRD

Bruker D5000 diffractometer

Quartz Peak

Oven driying
(to eliminate hymidity content)

Geologic mulling



Diffractogram

EXPERIMENTAL SET-UP (WDXRF)

Soil Samples

Press

Powder compounds

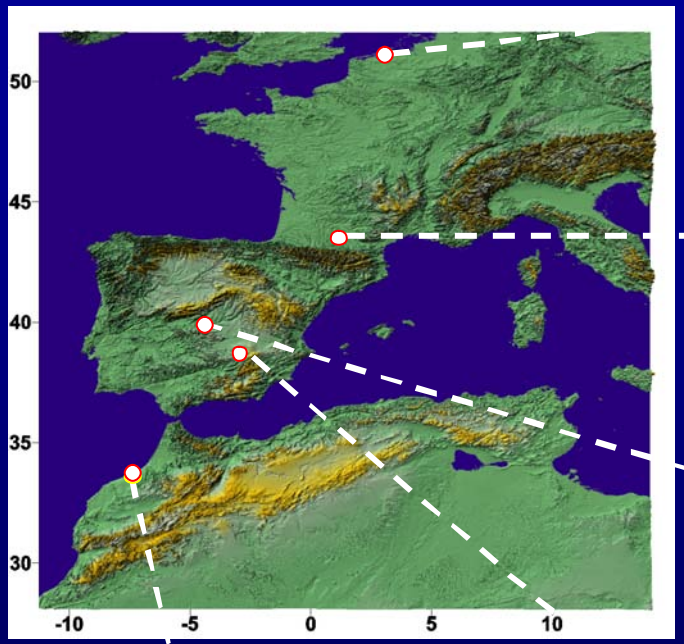
Oven driying
(to eliminate hymidity content)

Geologic mulling

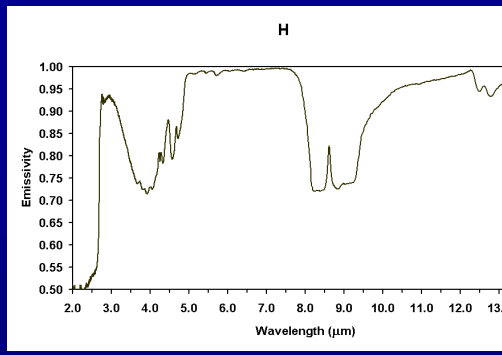
X-Ray Spectrometer (PW-240
to determine chemical composition

- Experimental Setup
  - FTIR spectra
  - XRD diffraction analysis
  - WDXRF analysis
- ***Results and Comparisons***
- Conclusions

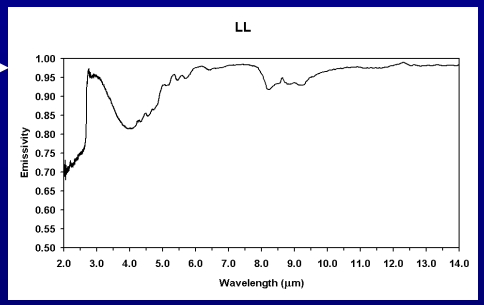
Soil emissivity Spectra



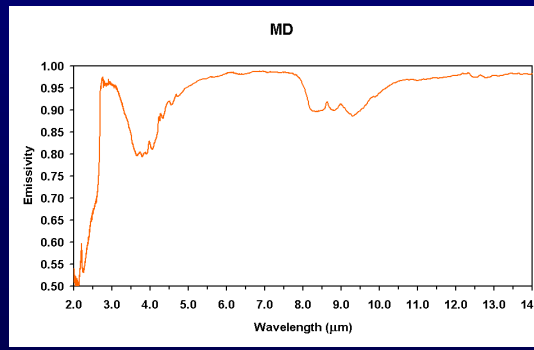
Noordwijk, EAGLE, 2006



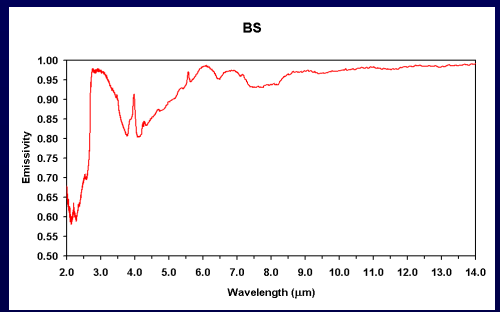
Les Landes, CEFLES-2 2007



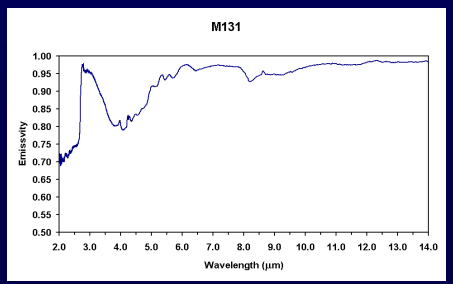
Madrid, DESIREX 2008



Barrax, SPARC 2004
SEN2FLEX,2005



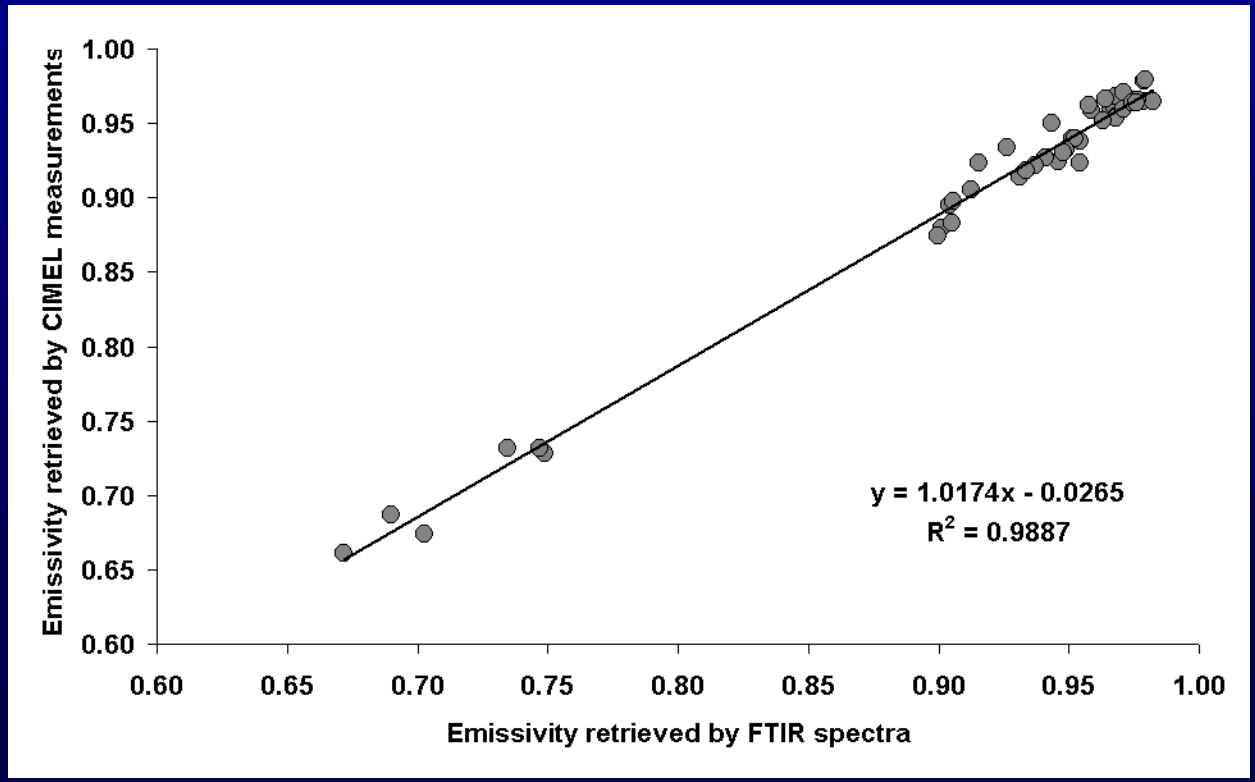
Marrakech, WATERMED 2002



Among others test site…

COMPARISONS with Ground measurements

inear relationship between emissivity values calculated from ground neasurements (applying TES method) and FTIR spectra for the whole set of oil samples.



COMPARISONS with Ground measurements

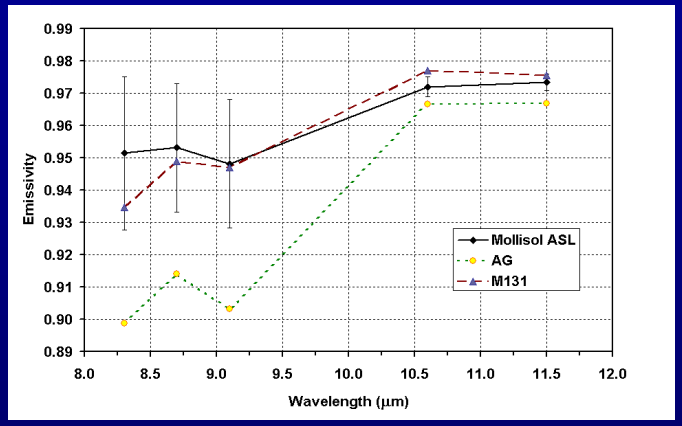
missivity comparison retrieved by radiometric measurements (TES method) nd the FTIR spectra

Soil Code	8.1 - 8.5	8.5 - 8.9	8.9 - 9.3	10.3 - 11.0	11.3 - 11.7	Bias	*s*	RMSE
AG	0.009	0.007	0.008	0.006	0.006	0.007	0.001	0.007
B	0.017	0.030	0.022	0.014	0.018	0.020	0.006	0.021
BS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D1	0.003	0.028	0.011	0.012	0.014	0.013	0.009	0.016
D2	-0.009	-0.007	-0.007	-0.002	-0.005	-0.006	0.002	0.006
H	0.003	0.020	0.016	0.013	0.014	0.013	0.006	0.015
M131	0.015	0.016	0.017	0.011	0.011	0.014	0.003	0.014
LL	0.018	0.016	0.015	0.011	0.012	0.014	0.003	0.014
MD	0.022	0.022	0.025	0.012	0.012	0.018	0.006	0.019
					TOTAL	**0.011**	**0.009**	**0.014**

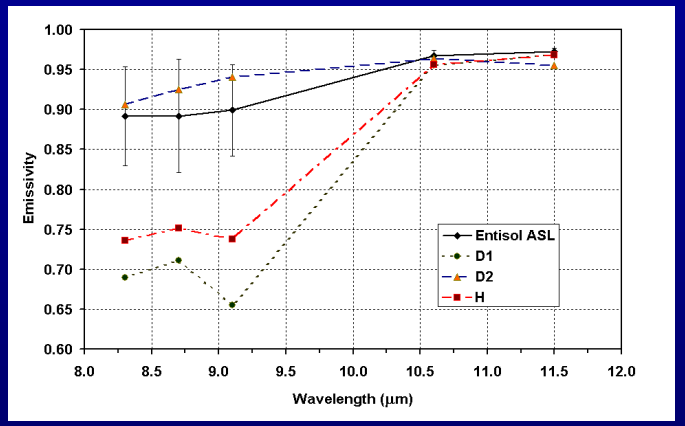
TES method overall accuracy = 0.015

COMPARISONS with other Spectral library

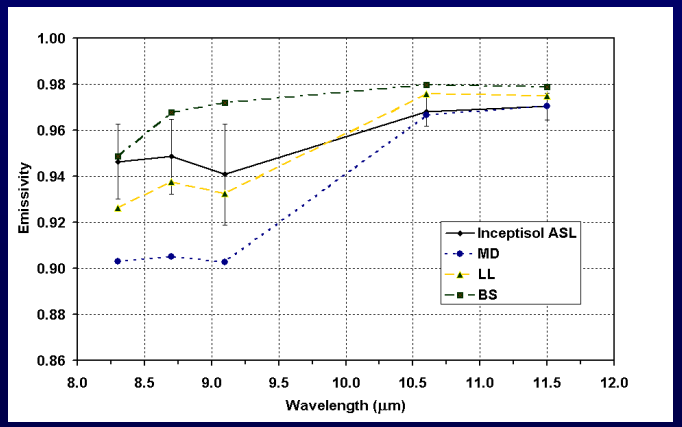
Comparison with others soil class available in the ASTER spectral library (ASL



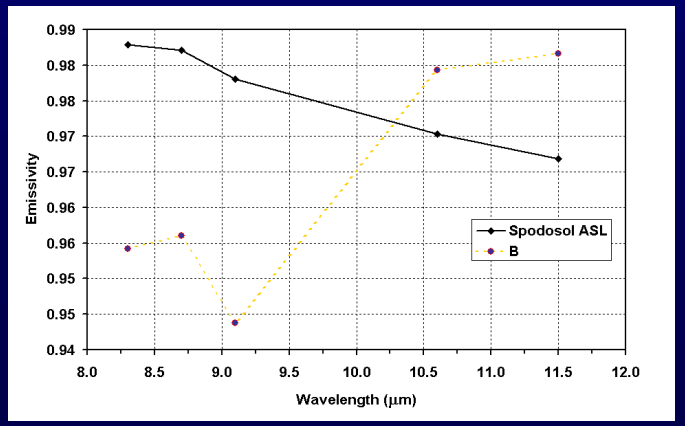
Mollisol ASL = 9 soil samples



Entisol ASL = 10 soil samples



Inceptisol ASL = 7 soil samples



Spodosol ASL = 1 soil samples with high content of amorphous material (87% glass)

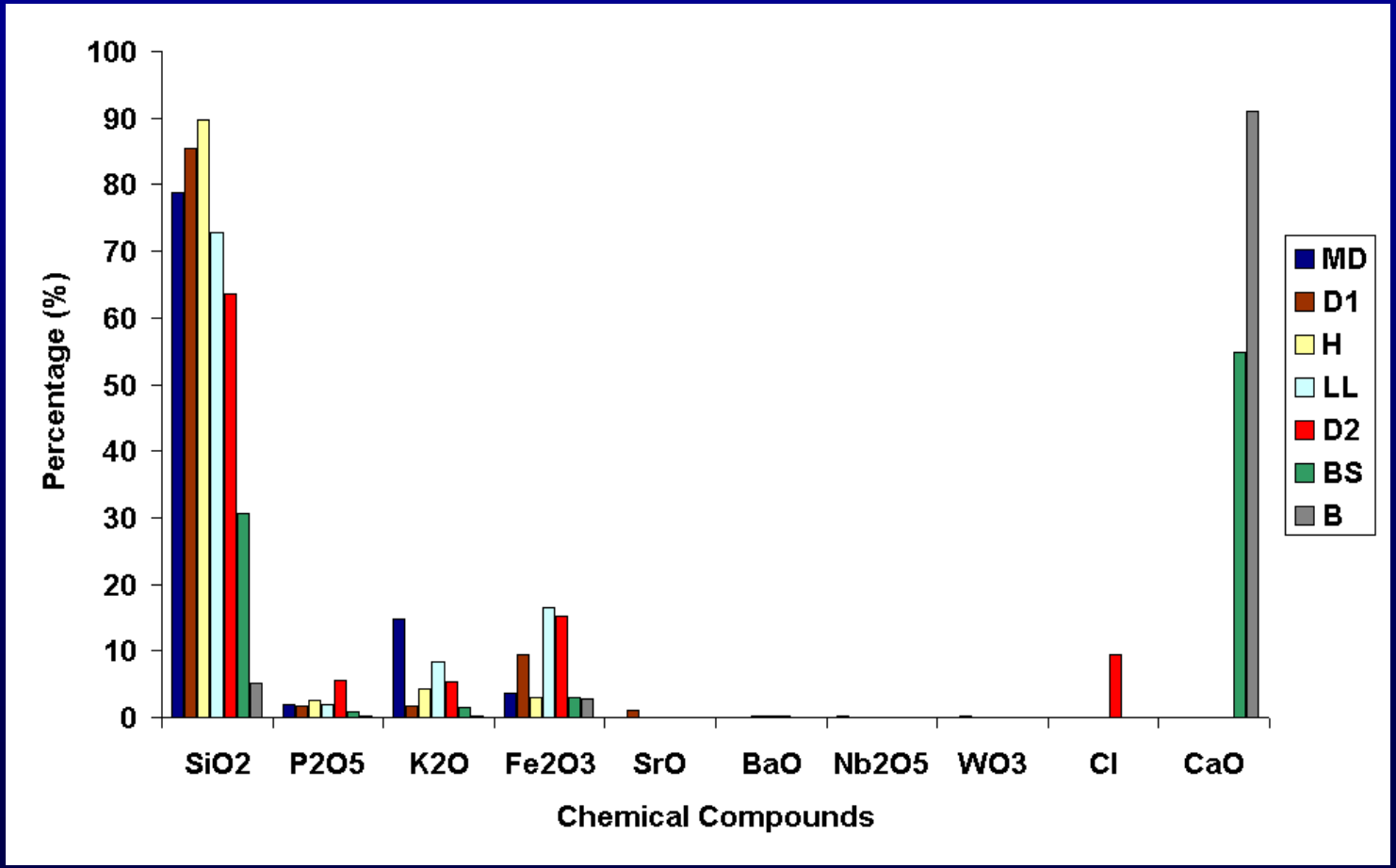
XRD

Mineralogical Phases Of some soil Samples Analyzed With XRD. (*X*) Main Phases, (·) Rest of Identified Minerals.

Soil code	Quartz	Calcite	Feldspar	Dolomite	Sheet-silicates
AG	*X*		·		
B	*X*		·		
BS	·	*X*			
CH	·		*X*	·	
D1	*X*				
D2	*X*	·			
H	*X*		·		
LL	*X*				·
M131	*X*	·	·		·
MD	*X*		·		
P	*X*				·

WDXRF

Chemical compounds in % for several soil samples analyzed using WDXRF. SiO and CaO are the predominant chemical compounds related with Quartz and Calcite.



- HYDRA 2008 – Doñana National Park (24-28 April)

Ground instrument

Land black body calibration

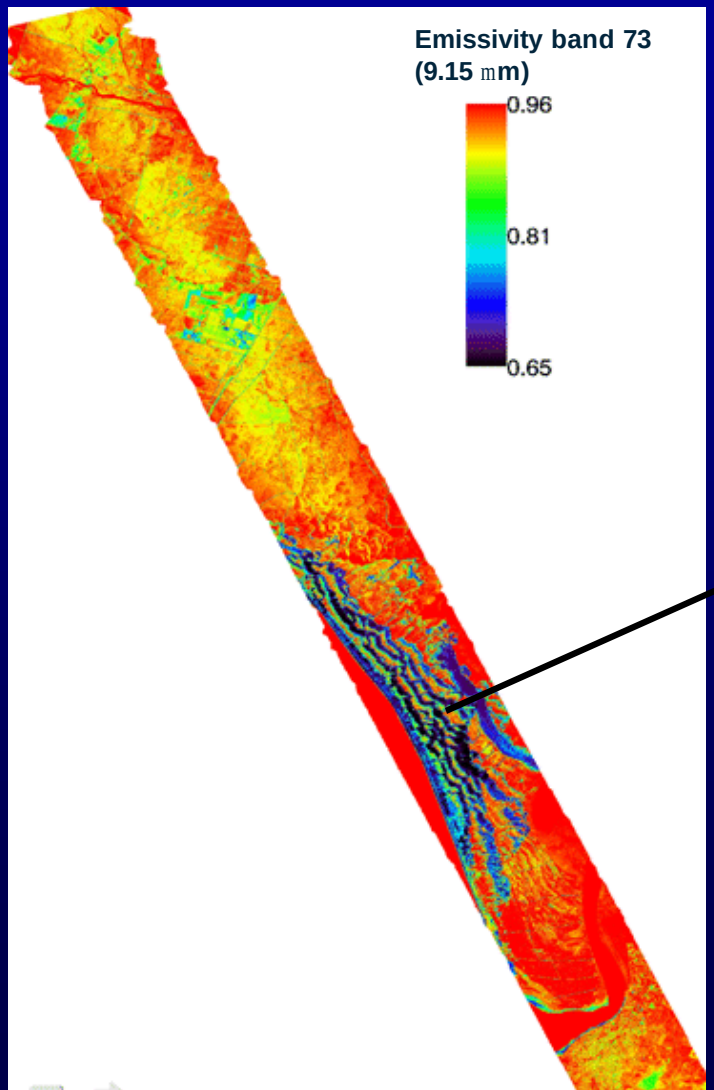
NEC TH9000 thermal camera (8-13 µm)

CIMEL CE 312-2 thermal radiometer (5 channels matching ASTER bands and 1 broad channel 8-13 µm)

Difusor Gold plate

- HYDRA 2008 – Doñana National Park (24-28 April)

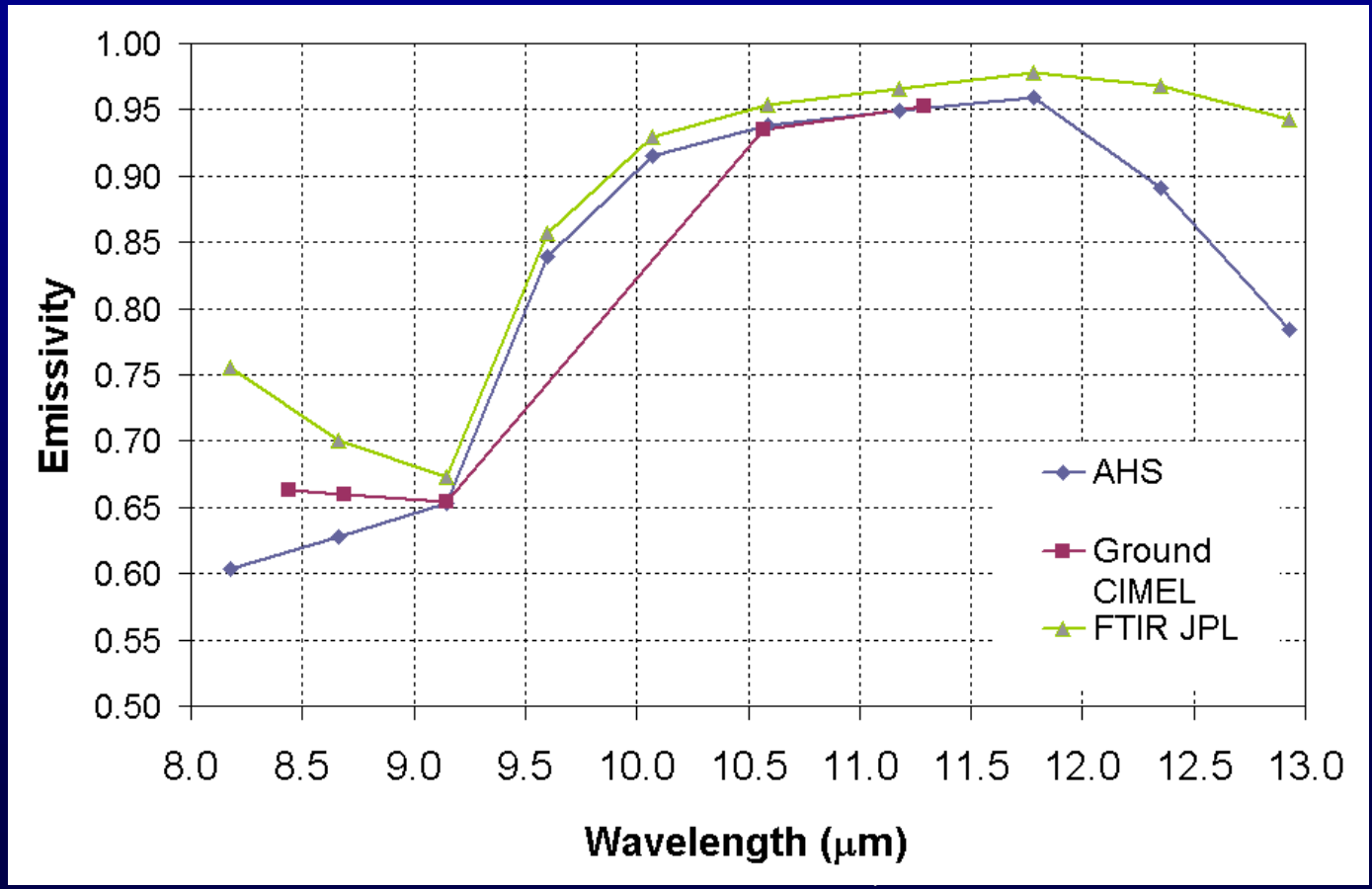
- HYDRA 2008 – AHS emissivity images



Sand Dunes measurements

- HYDRA 2008 Field campaign

Comparison Emissivity values retrieved from AHS images, ground measurements and FTIR JPL spectra



AHS – FTIR JPL total comparison

BIAS = -0.056
Sigma = 0.057
RMSE = 0.08

AHS – FTIR JPL (for bands 73 to 78)

BIAS = -0.017
Sigma = 0.002
RMSE = 0.017

- DESIREX 2008 - Madrid City (25 June – 4 July)

Ground instrument

Land black body

NEC TH9000 thermal camera

CIMEL CE 312-2 thermal radiometer

Car Transects

Väisälä RS-90 Radiosonde

Raytek Thermal Radiometer

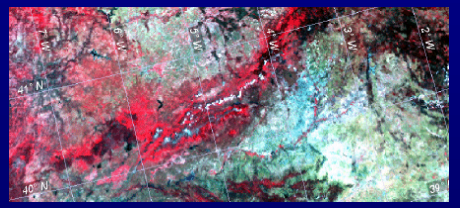
Difusor Gold plate

Apogee Thermal Radiometer

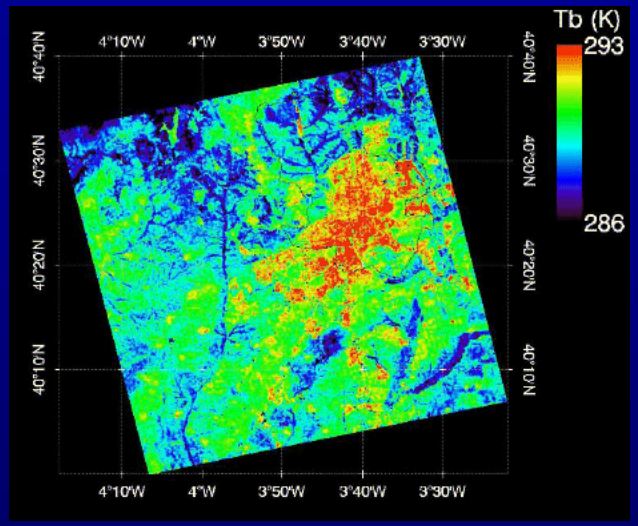
- DESIREX 2008 – Ground Measurements

DESIREX 2008 – Remote Sensing data

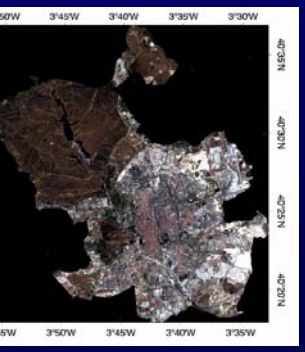
MSG2 - SEVIRI



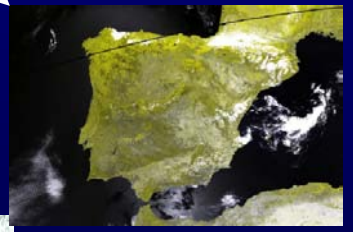
ENVISAT- AATSR



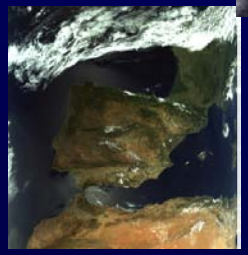
TERRA - ASTER



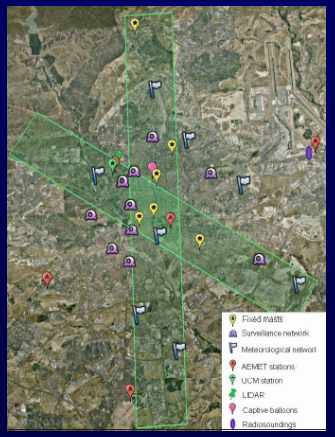
Landsat 5-TM

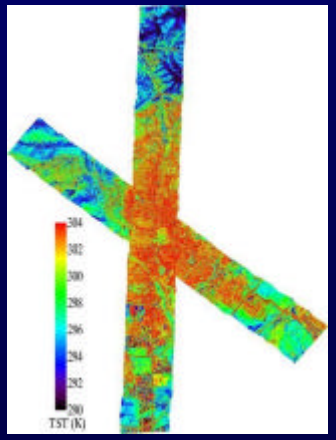


NOAA - AVHRR



TERRA - MODIS





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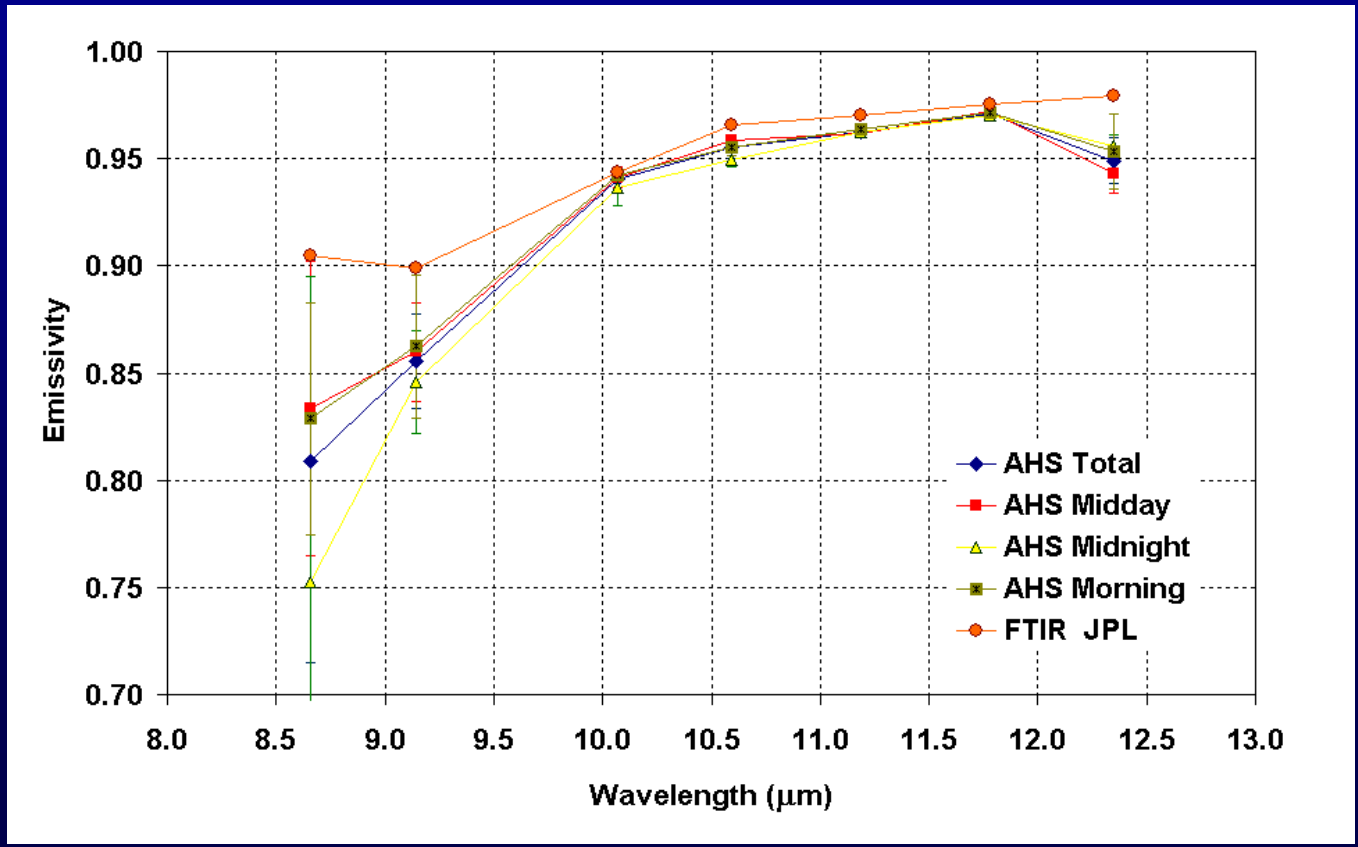
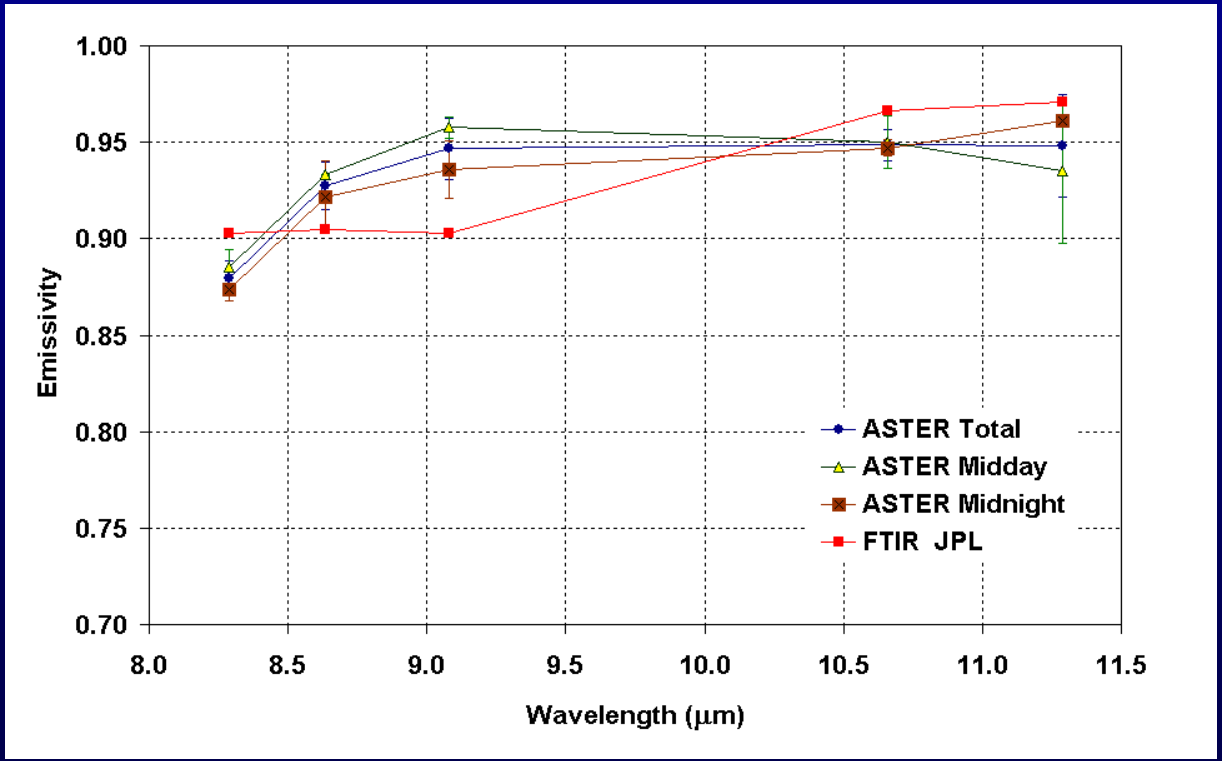
- DESIREX 2008 Bare soil site

Emissivity values retrieved by AHS images for the average of different day times and FTIR JPL spectra



- DESIREX 2008 Bare soil site

Emissivity values retrieved by ASTER images for the average of different day times and FTIR JPL spectra



CONCLUSIONS

- In this study we have provided the emissivity spectra for a variety of samples which could be used to evaluate land surface temperature algorithms for a variety of airborne and satellite sensors.

- Results indicated a good agreement between ground and FTIR emissivity measurements, with a RMSE bellow 0.015 and a high correlation coefficient (R^2 = 0.988).

- Error typically 1% between FTIR and AHS-ASTER emissivity estimated using TES in the 10-12 μm