TIR CAL/VAL SITE AT LA CRAU, FRANCE

CEOS WGCV IVOS – TIRCALNET

28 Sept 2023

Arthur Dick[1], Sébastien Marcq[1], Delogu Emilie[1], Simon Hook[2], Gerardo Rivera[2], Mark Irvine[3], Yevgeny Derimian[4], Leo Delmas[1], Aimé Meygret[1]

[1]Centre National d'Etudes Spatiales (CNES), France;
[2]NASA Jet Propulsion Laboratory (JPL), United States;
[3]INRAE, Bordeaux, France;
[4]Université Lille, CNRS, UMR 8518 - LOA - Laboratoire d'Optique Atmosphérique, France;

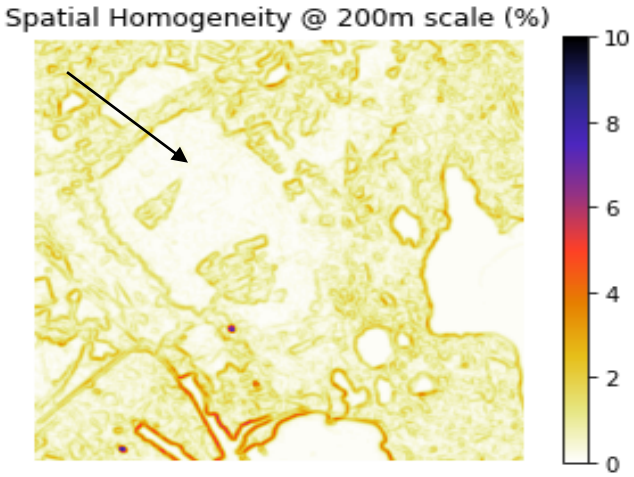
Outline

- La Crau site choice
- Available instrumentation
- First measurements
- Overall processing
- Comparison with ECOSTRESS and Landsat 9
- Perspectives

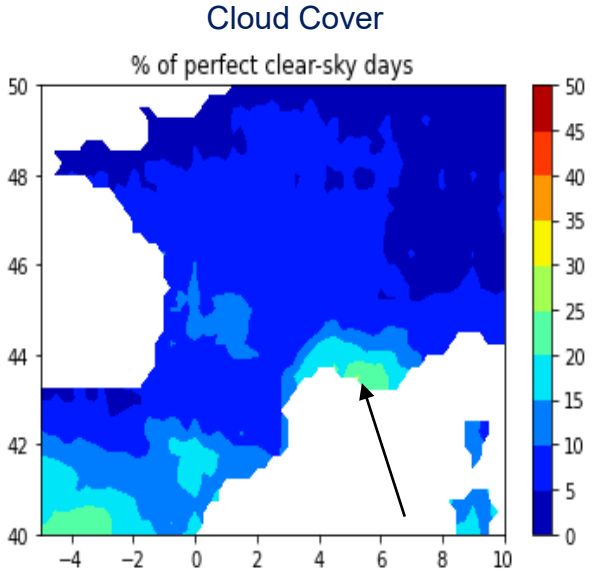
La Crau site choice

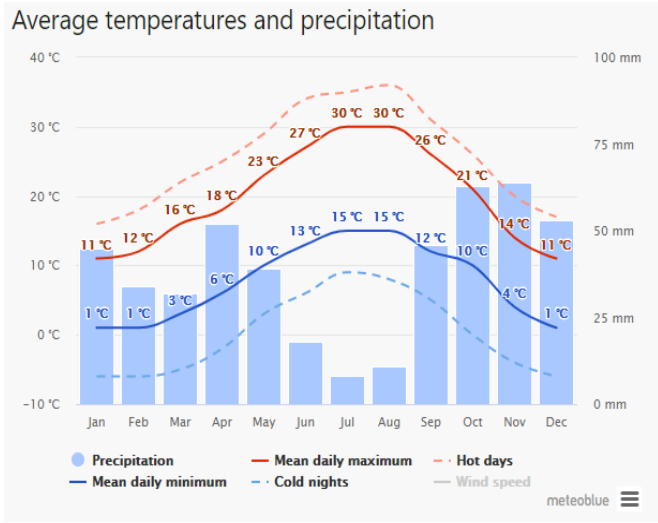
- To prepare the future CAL/VAL of TRISHNA and other TIR missions, it has been decided to develop an instrumented site with thermal infrared sensors
- Evaluation of the La Crau site, already used as VNIR automated calibration site (Radcalnet)

La Crau site location

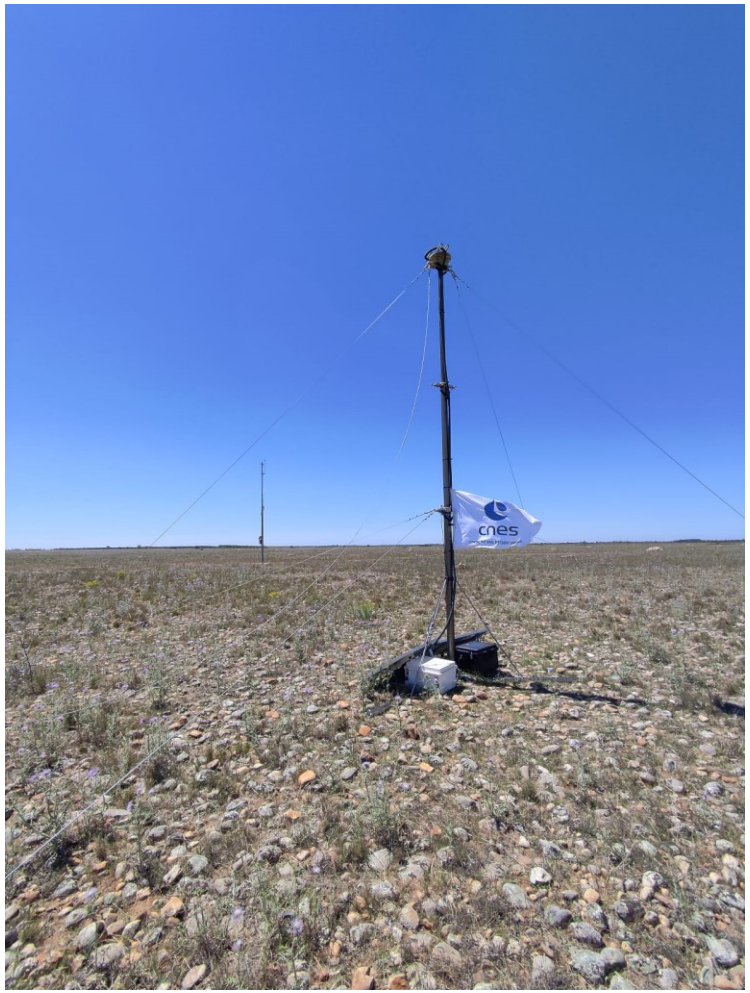


Estimation of spatial homogeneity on Landsat 8 TIR spectral band





La Crau CNES L1 Calibration / L2A Validation site



Installation of instrumentation in the TIR on a dedicated mast ~50m away from the VNIR-SWIR RADCALNET Station

Available instrumentation

- December 2022: Installation of a TIR radiometer loaned by NASA-JPL at the top of the mast + electrical facilities (solar panels and batteries)
- June 2023: Installation of a TIR radiometer loaned by LOA

JPL Radiometer key features
https://calval.jpl.nasa.gov/radiometers

- 143 x 102 x 133 mm
- 1,845 kg
- 1 large band (8-14µm)
- Active black body inside
- Brightness temperature measurement
- 5 zenithal angles of acquisition
- Day/Night acquisitions

LOA CIMEL CE312-N1 key features
https://www.cimel.fr/ce312/?lang=fr#specifications

- 250 x 80 mm (inst. only)
- 1 kg (inst. only)
- 1 large band (8-14µm)
- 3 narrow bands (8.2-9.2, 10.3-11.3, 11.5-12.5 µm)
- Passive black body separated
- Autonomous system

Speed x4

Future instrumentation

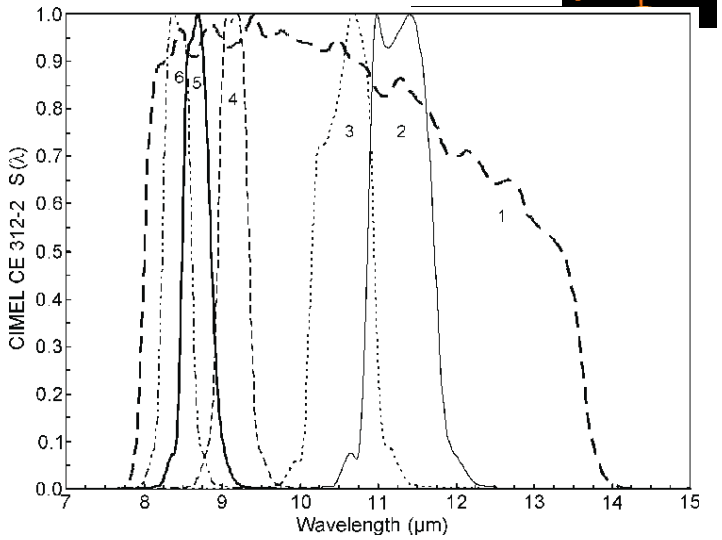
- **CIMEL CE312-N2 : CNES acquisition, 5+1 bands (ASTER) vs 3+1**
  - T4 2023/T1 2024

- **Thermo Buttons : small data logger for temperature validation,**
  - Site measurements in progress

- **Emissivity box : device for field emissivity measurement (Nerry et al 1990)**
  - Design in progress

- **Acquisition of 4 KT15.99 (Heitronics) with “TRISHNA-like” filters**
  - 8.65 µm, 9 µm, 10.6 µm, 11.3 µm
  - T4 2023

8.1-8.5 µm
8.5-8.9 µm
8.9-9.3 µm
10.3-11.0 µm
11.0-11.7 µm
8-13 µm

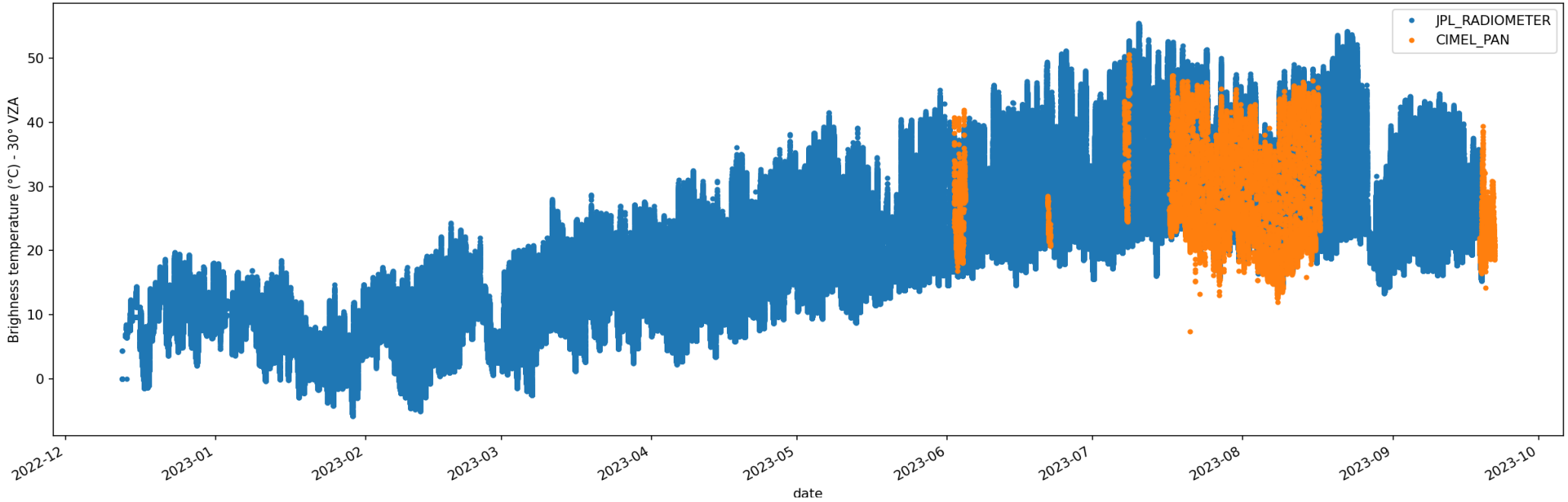


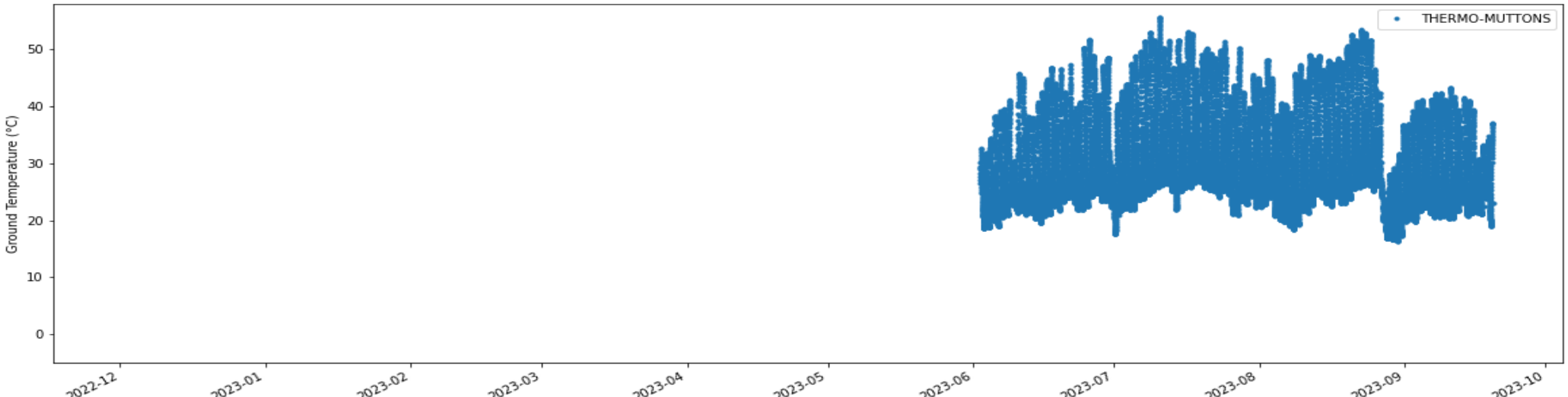
Soil Emissivity

Labed & Stoll 1991

First measurements

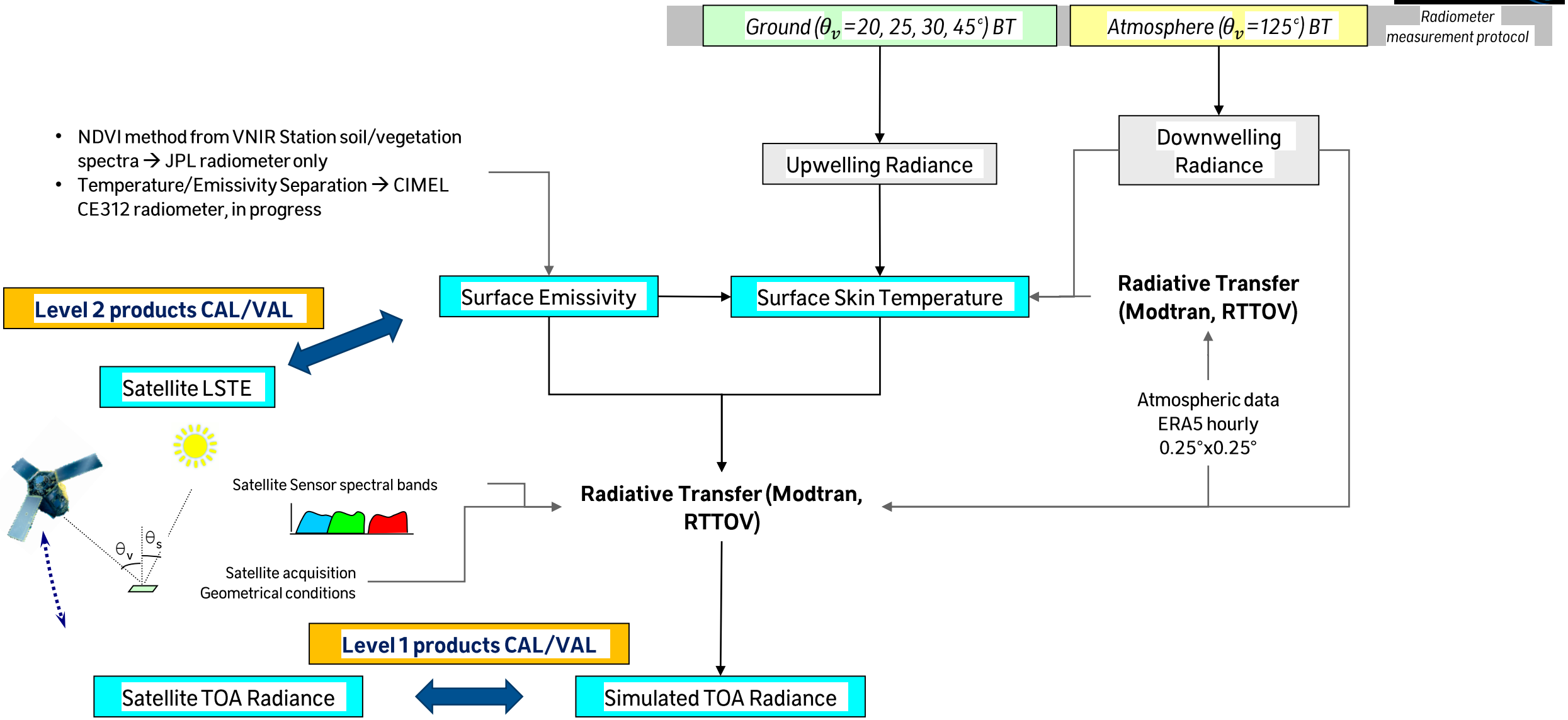
- Automatic measurement of JPL radiometer every 1’15”, CIMEL every 5’, thermo-buttons every 10’





La Crau TIR CAL/VAL station processing

- NDVI method from VNIR Station soil/vegetation spectra → JPL radiometer only
- Temperature/Emissivity Separation → CIMEL CE312 radiometer, in progress



Temperature and Emissivity Separation – current processing

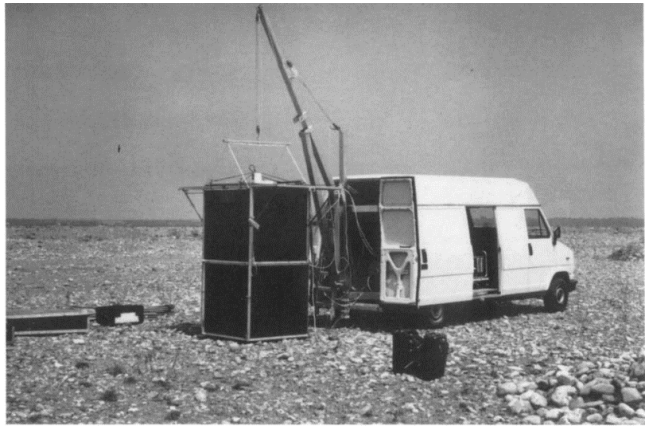
NDVI method

$$\epsilon = \epsilon_v P_v + \epsilon_s (1 - P_v)$$ Sobrino & Raissouni 2000

$$P_v = \frac{NVDI - NDVI_s}{NDVI_v - NDVI_s}$$ Carlson & Ripley 1997

ROSAS La Crau Station operating since 1997
12 filters in VNIR-SWIR

Soil Emissivity Spectra

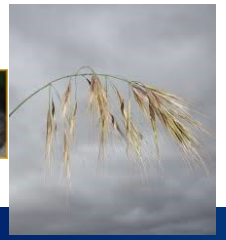


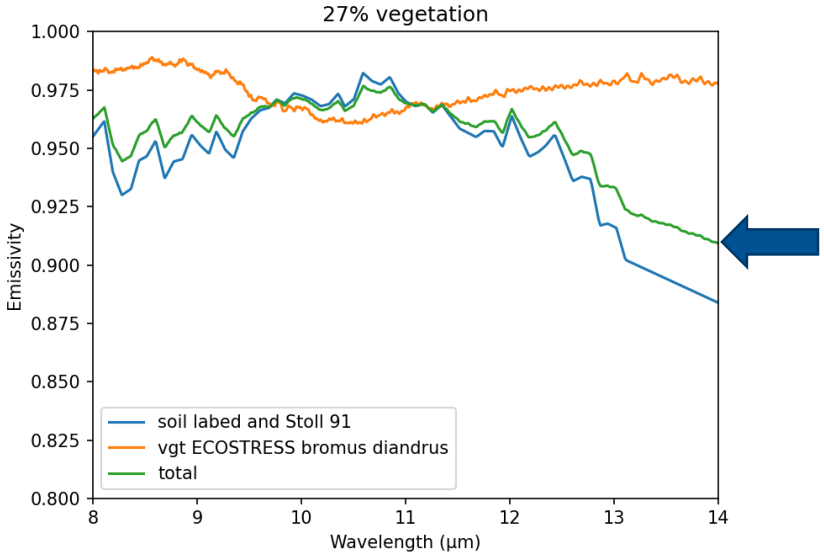
Labed & Stoll 1991

+ Emissivity measurements on la Crau samples (JPL, upcoming)

Vegetation Emissivity Spectra
Bromus diandrus

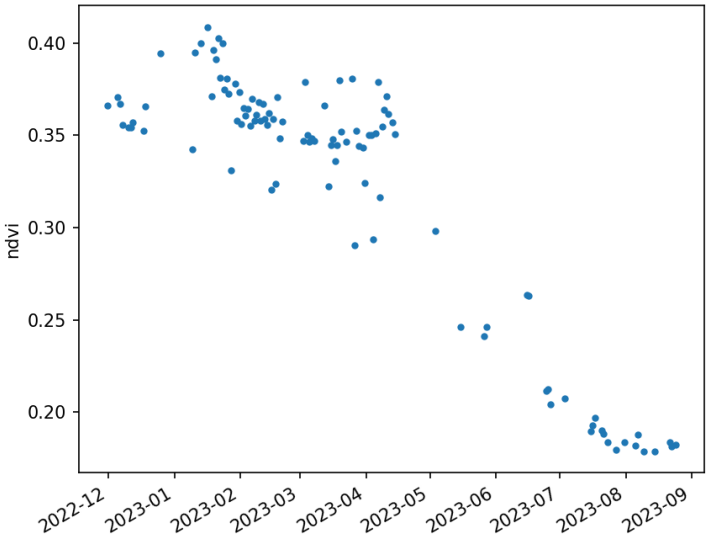
Meerdink et al 2019





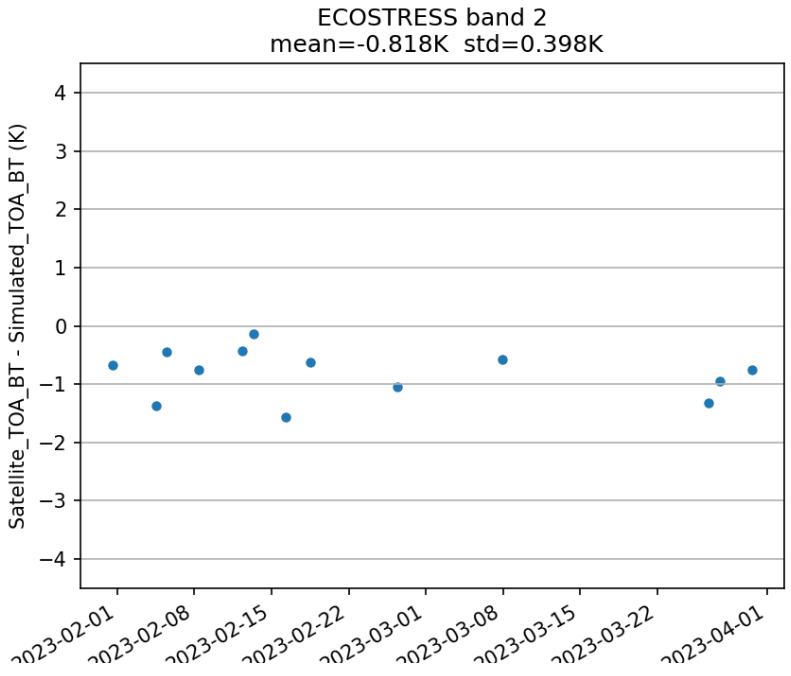
April 3rd 2023

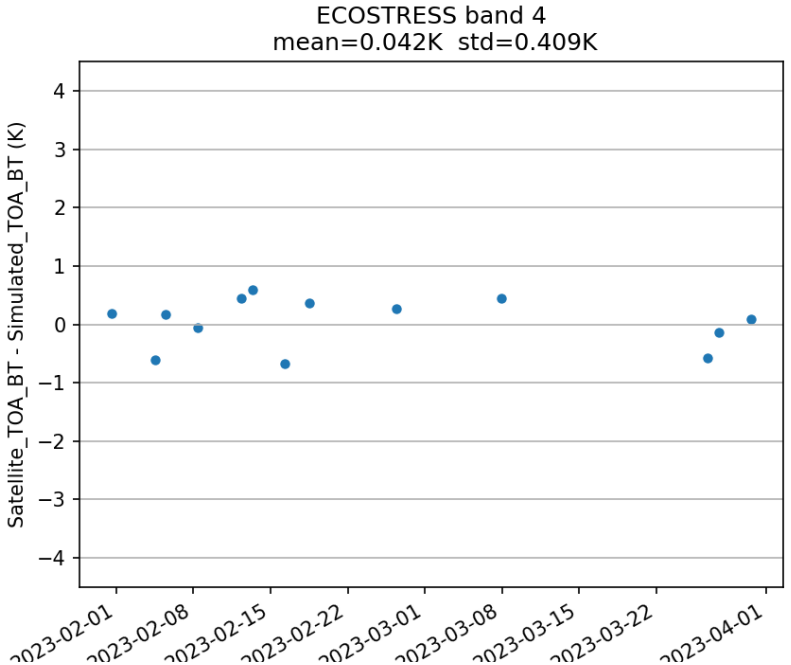
NDVI

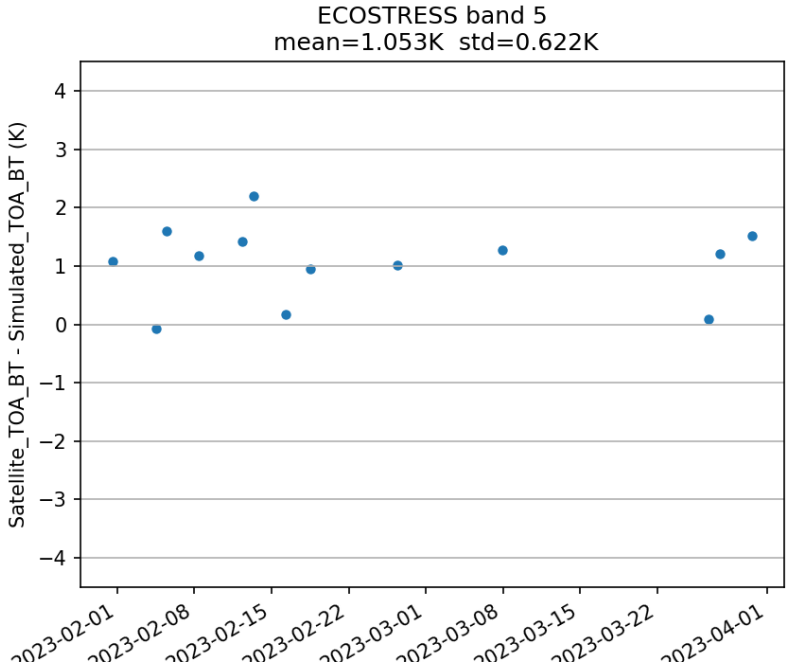


Evaluation for ECOSTRESS (collection 2)

Calibration coefficient validation : ECOSTRESS TOA measured BT - Simulation of TOA BT using the station

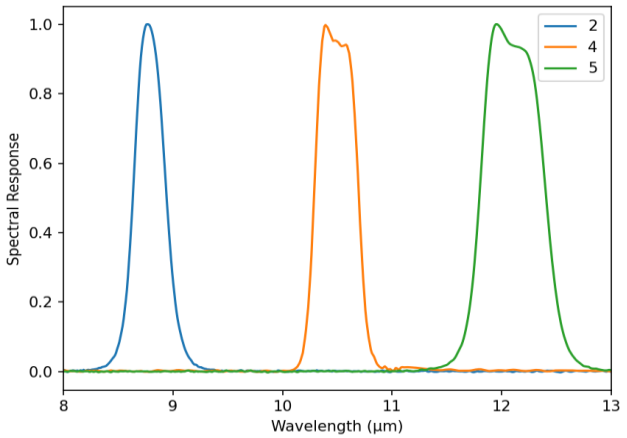






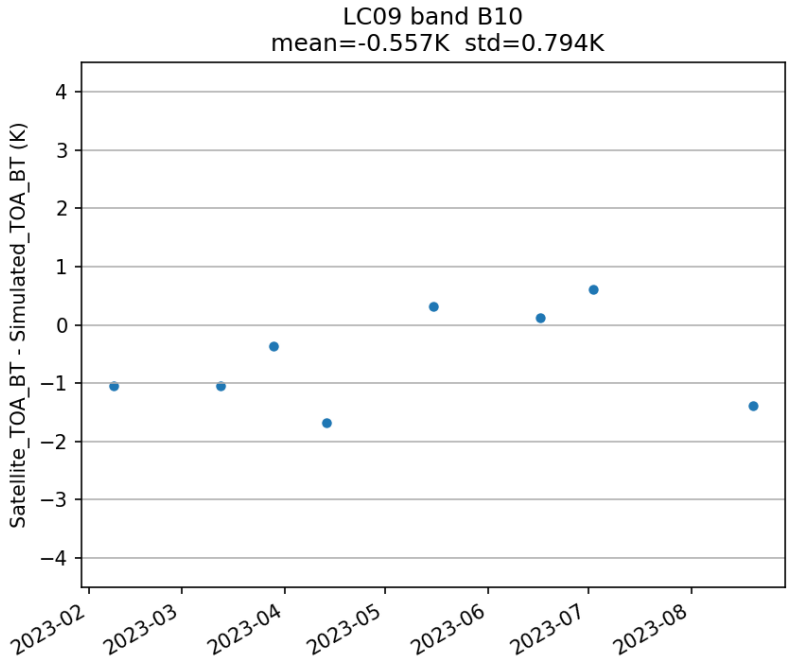
- Very good overall consistency!
- Slight interband differences

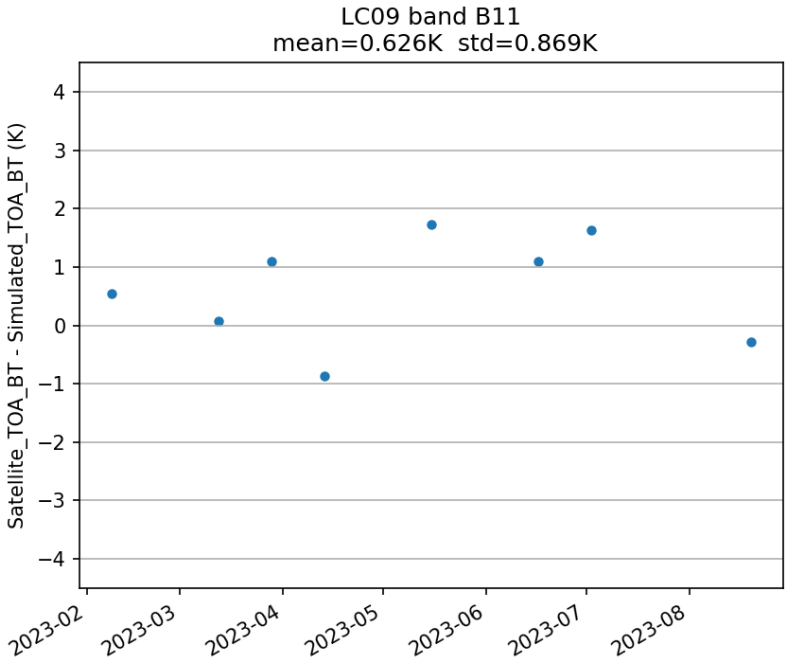
- To be updated with additional acquisitions



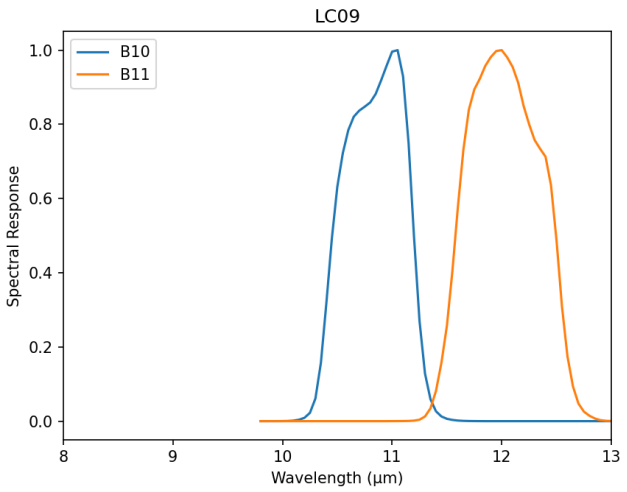
Evaluation for LANDSAT9

Calibration coefficient validation : LANDSAT9 TOA measured BT - Simulation of TOA BT using the station

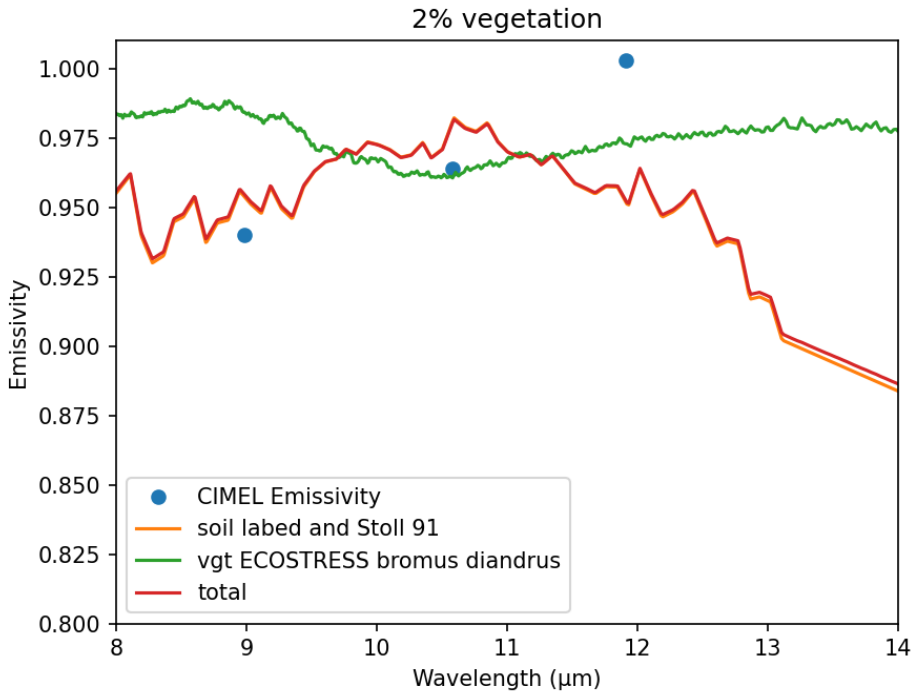




- Good consistency but slightly higher variability – potential effect of varying surface



Emissivity estimation



First estimation of the emissivity using the CIMEL CE 312 3+1 bands

Comparison with the NDVI method is good for 9µm and 10.5µm but not 12µm

→ To be investigated, suspicion of residual calibration issues

There were HYTES flights in July 2023 on the area
→ Spectral and spatial variations of emissivity

Emissivity measurements from samples (NASA/JPL)

Emissivity is the main focus of the future instrumentation : CNES CE312 5+1 bands, KT15, emissivity box

Perspectives

- Installation in 2022 and 2023 of permanent instrumentation in la Crau for TIR CAL/VAL

- First evaluation of L1 products for ECOSTRESS or LANDSAT9 show very good consistency with JPL radiometer measurements within 1 degree!
  - To be confirmed with additional data and with the upgrade of the processing

- This is the beginning… There is already plenty of different data to combine and some more to come
  - Coming installation of CNES CE312 and/or the 4 KT15 → potentially up to three instruments
  - Airborne campaign in 2023 : analyse the data when available + emissivity measurements from samples (JPL)
  - Potential field campaign in 2024 to characterize the surface emissivity