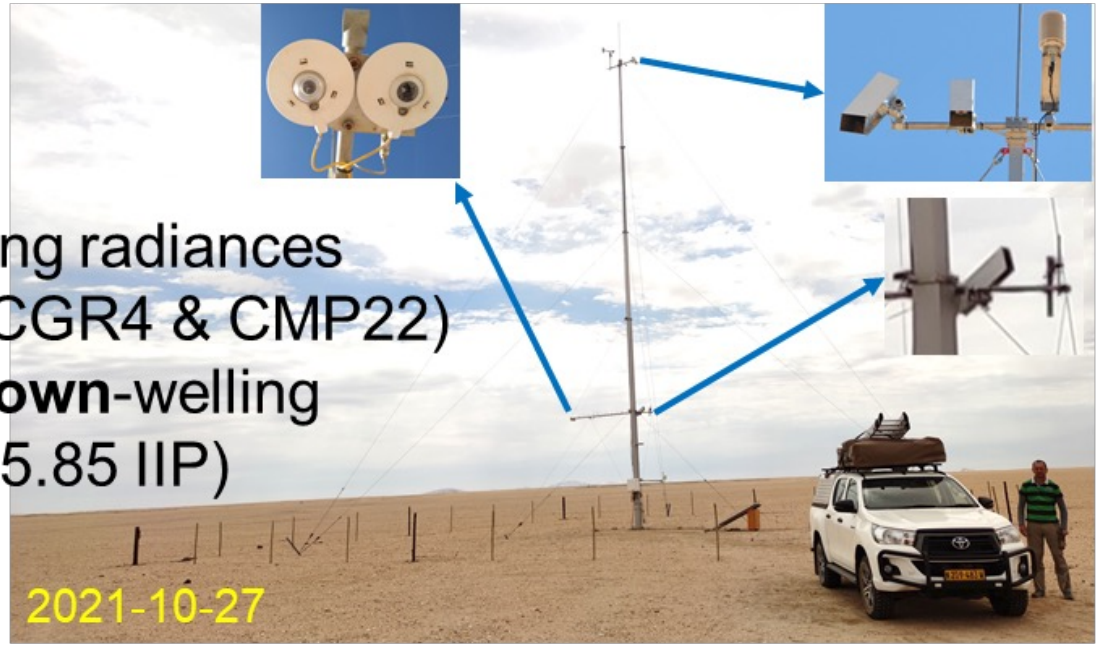
LST & Emissivity (1/16)

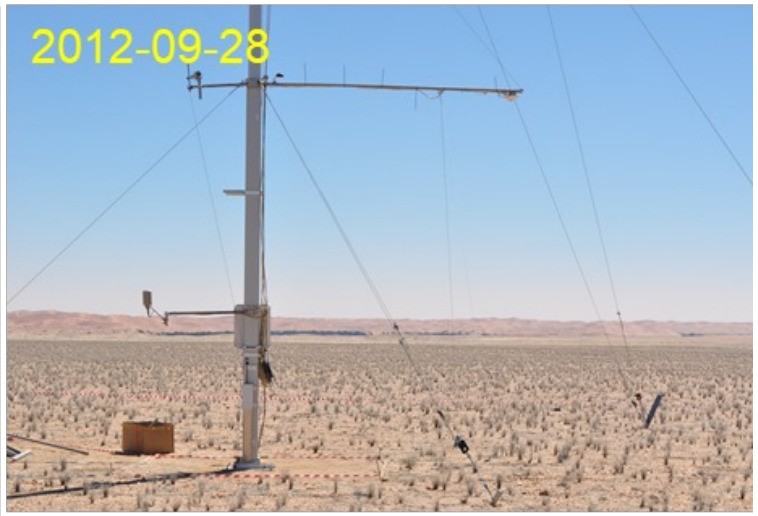
In-situ LST from broadband hemispherical and narrowband directional radiances

University of Basel

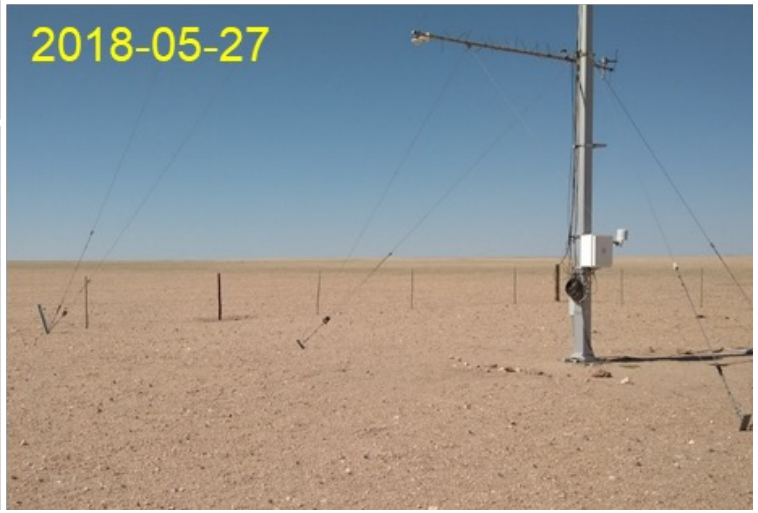
Karlsruhe Institute of Technology

GBB Plains
BSRN: **up**-welling radiances
(Kipp & Zonen CGR4 & CMP22)
LST: **up- and down**-welling
(Heitronics KT15.85 IIP)





GBB Rocks (7 km from Plains)
BSRN: **down**-welling radiances
(Kipp & Zonen CGR4 & CMP22)



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LST & Emissivity (2/16)

KIT's validation instrument: Heitronics KT15.85 IIP

- **chopped**, precision radiometer: stability better than **0.12% per year**
- field of view: 8.5°
- narrow band: 9.6µm - 11.5µm
- absolute uncertainty **< 0.3K**
- Brightness temp.: Planck law
- LST with channel-effective emissivity

LST & Emissivity (3/16)

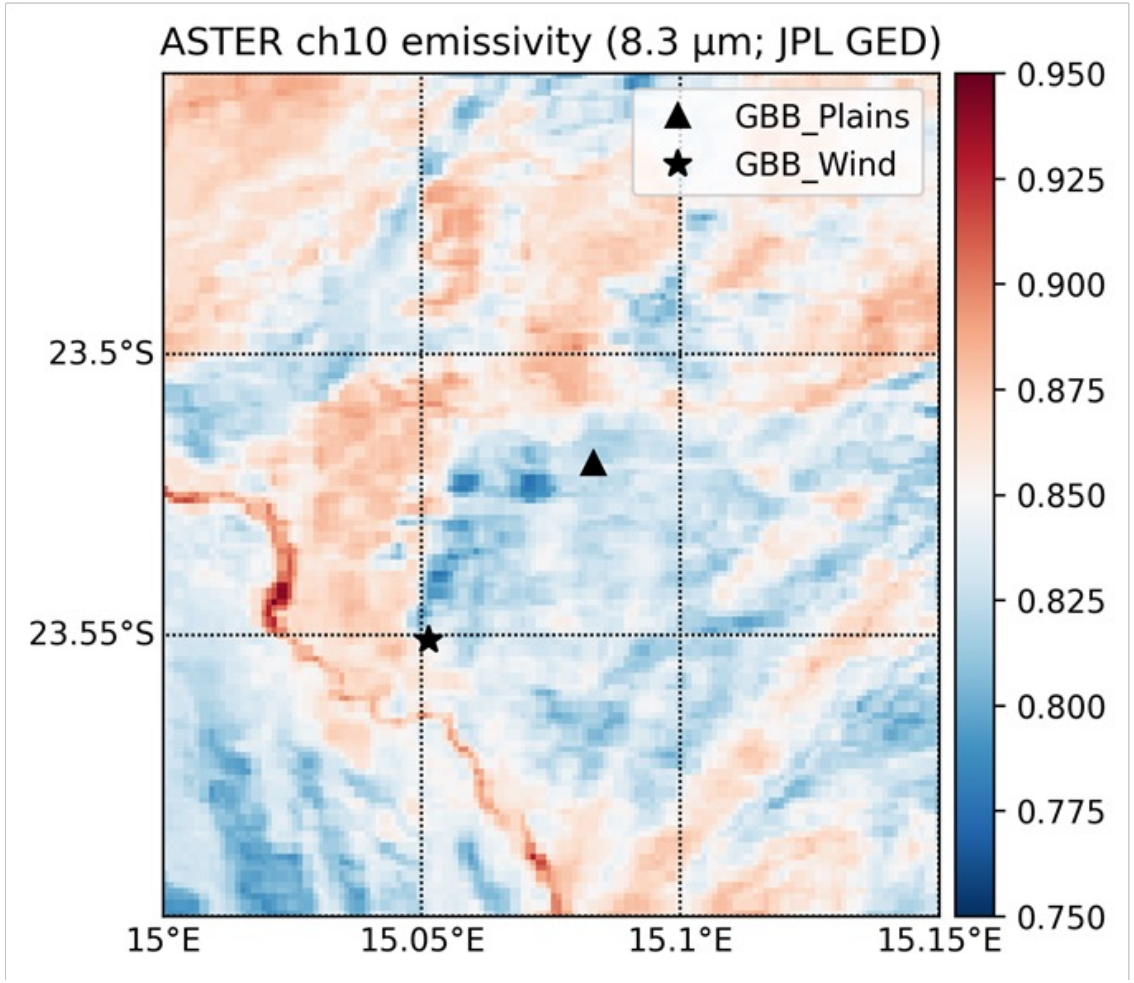
BSRN* longwave sensor: Kipp & Zonen CGR4

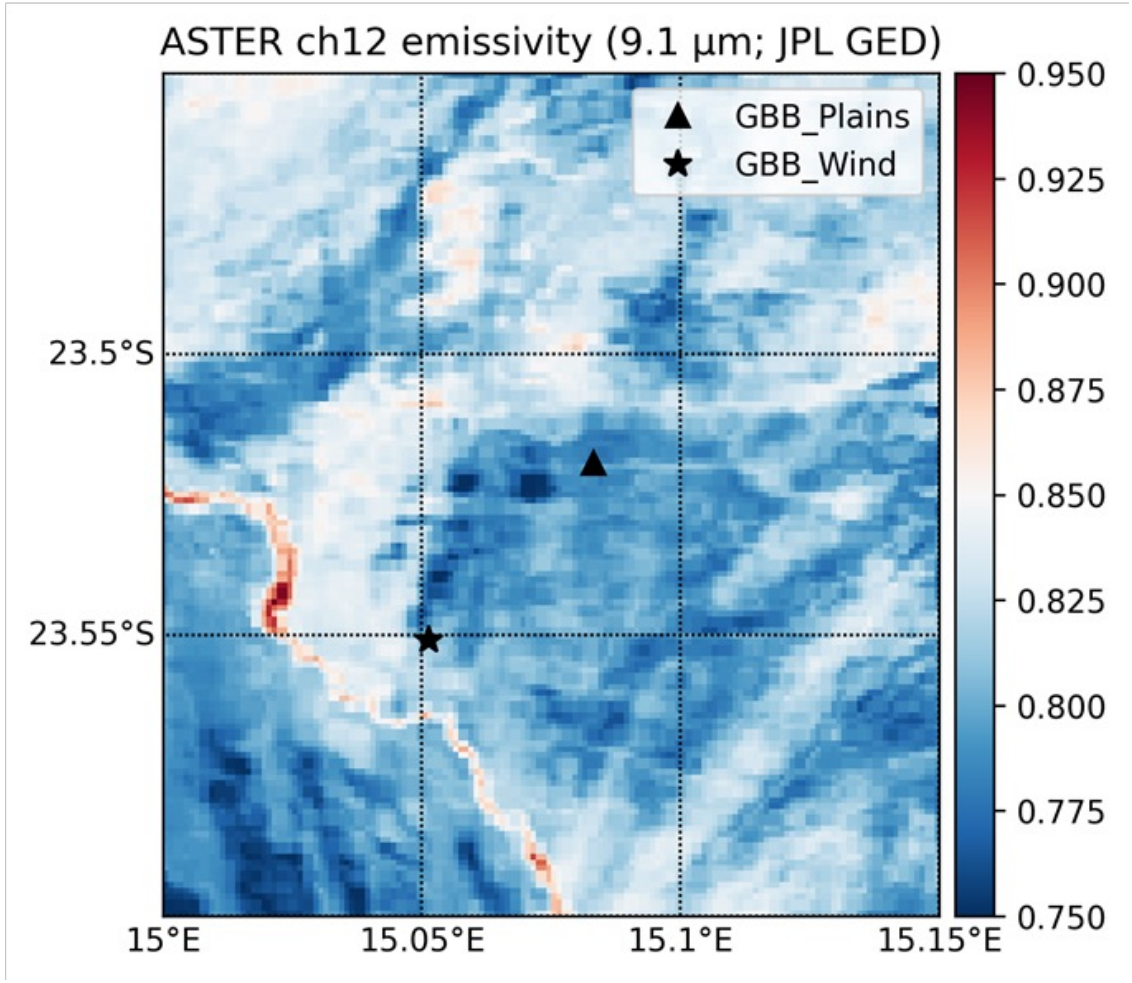
*Baseline Surface Radiation Network

- pyrgeometer: thermopile & solar blind silicon dome & temperature sensor
- field of view: 180°
- broad band: 4.5µm - 42µm
- uncertainty in **daily total** < 3%
- Brightness temp.: Stefan-Boltzmann law
- LST with **broadband** emissivity

LST & Emissivity (4/16)

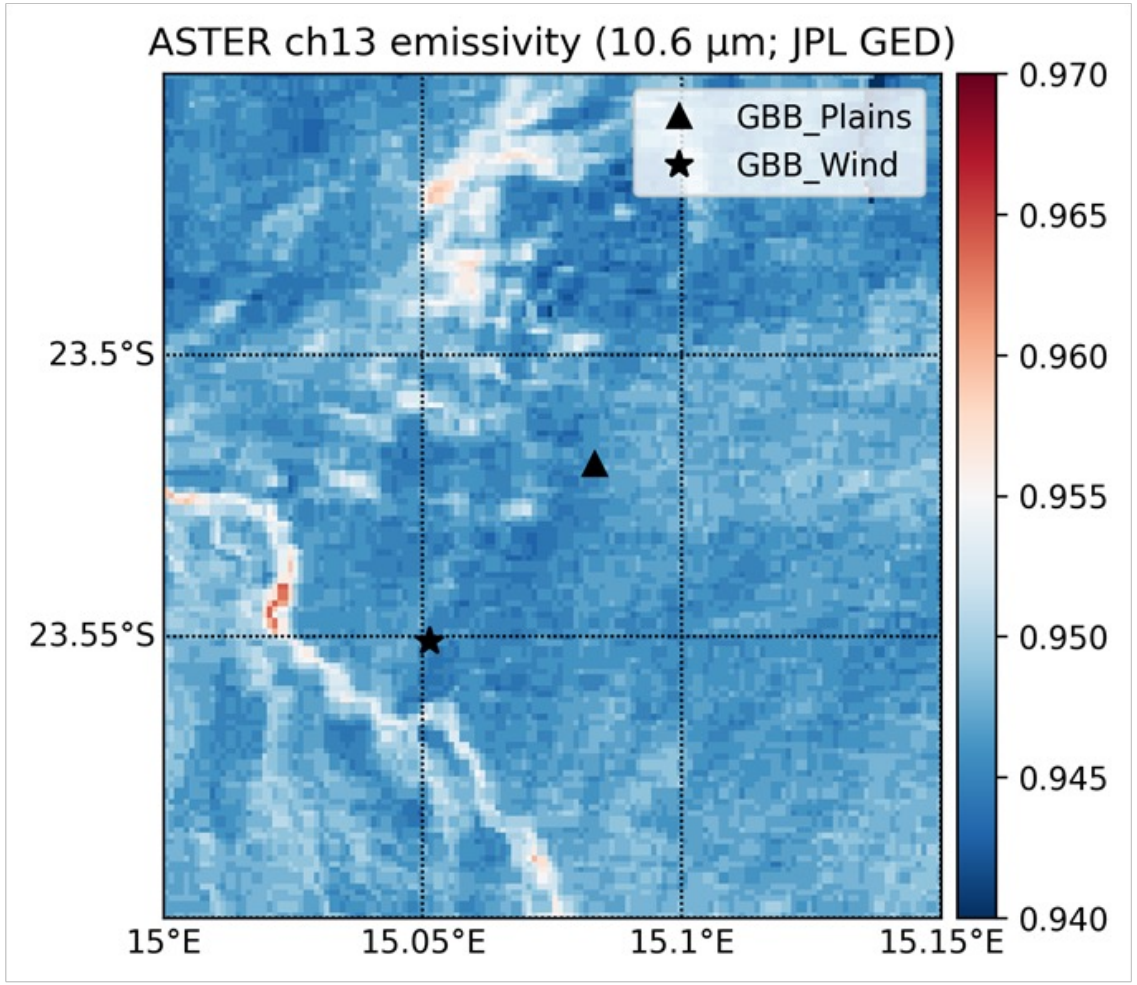
ASTER ch10 & ch12 emissivity (TES)

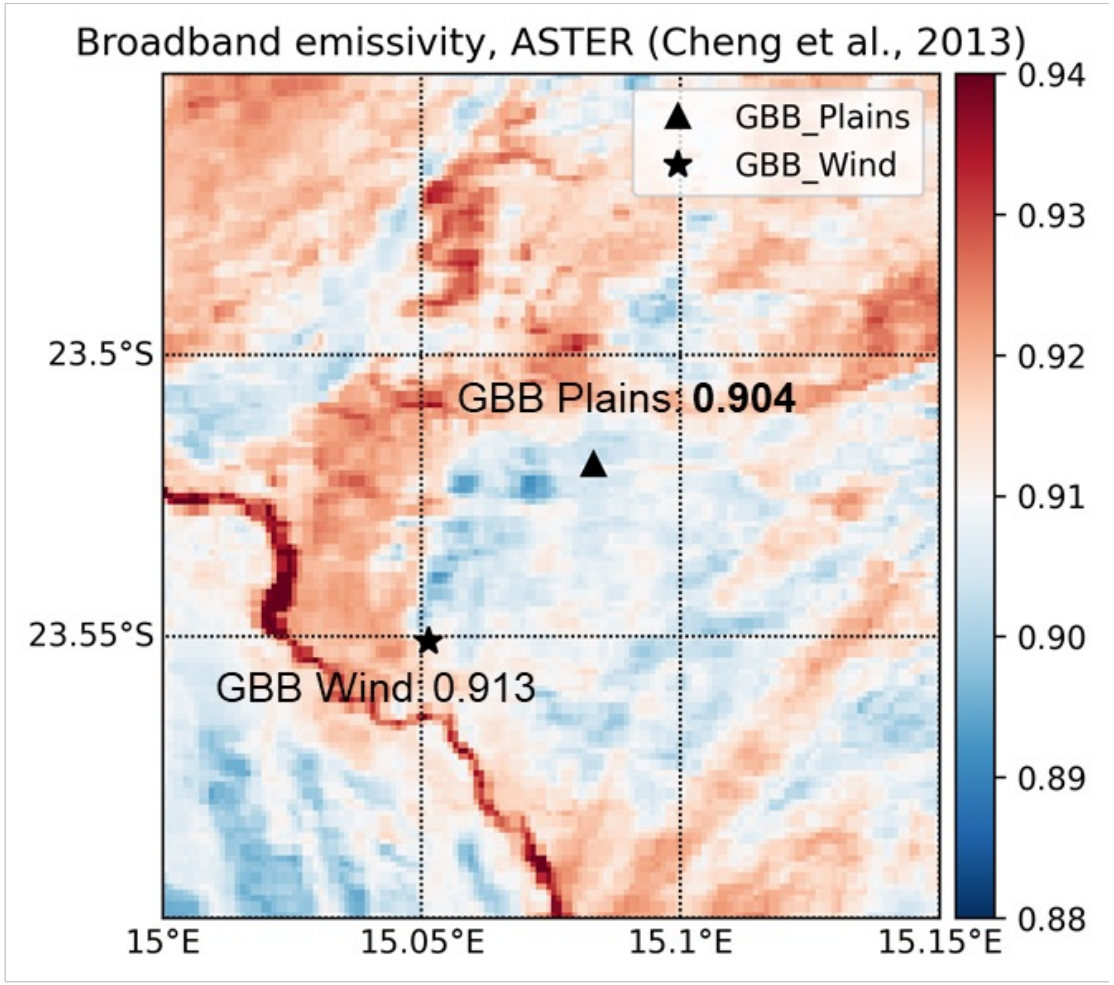




LST & Emissivity (5/16)

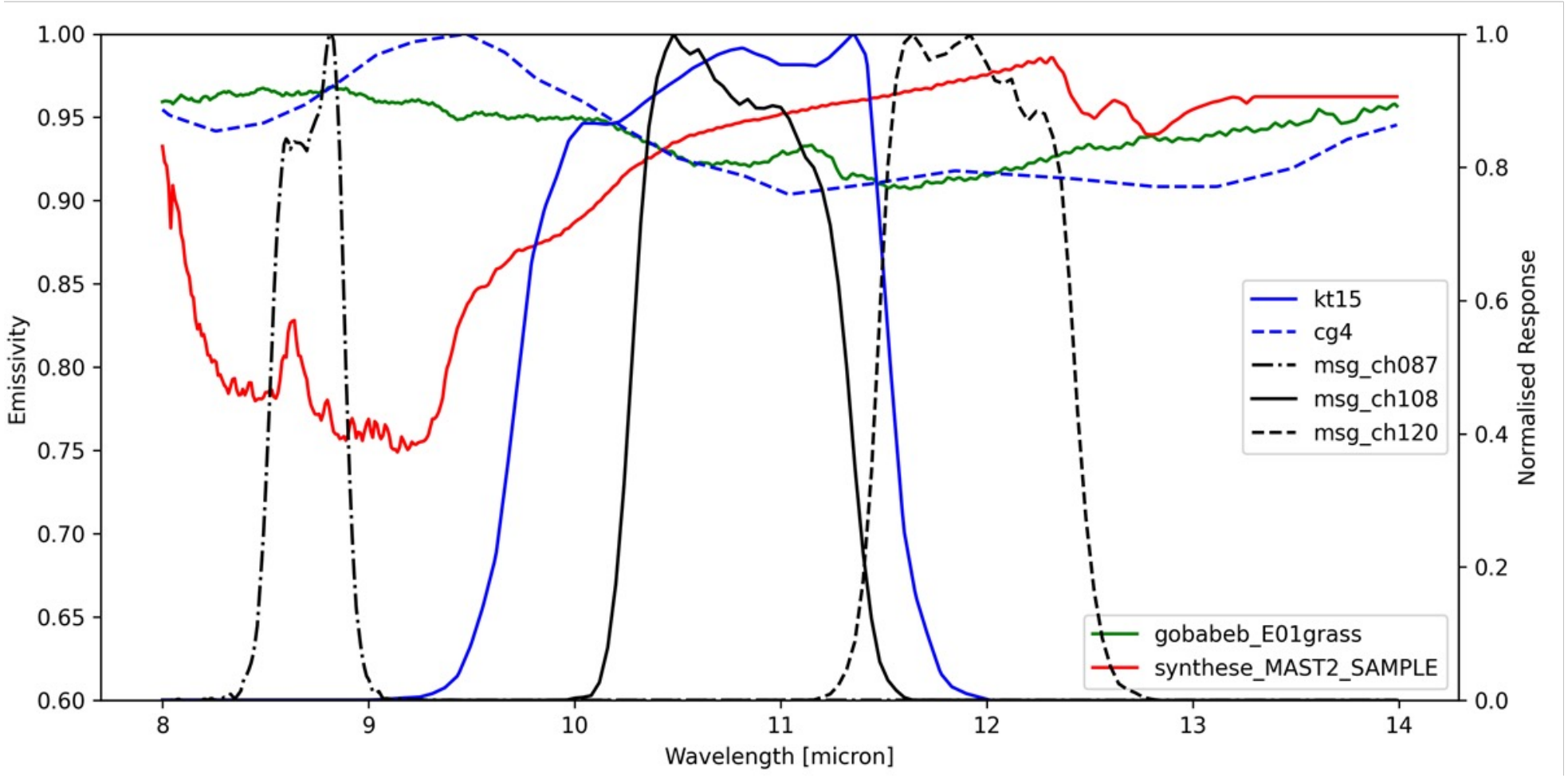
ASTER ch13 & broadband emissivity





LST & Emissivity (6/16)

In-situ emissivity spectra (GBB_Plains)



LST & Emissivity (7/16)

Channel-effective in-situ emissivities (GBB_Plains)

Karlsruhe Institute of Technology

Instrument / channel	gobabeb_E01grass*	synthese_MAST2_SAMPLE (gravel)
Heitronics KT15.85 IIP	0.931	**0.930**
Kipp & Zonen CG4	0.941 ('broadband')	**0.901** ('broadband')
MSG/SEVIRI ch087	0.965	0.785
MSG/SEVIRI ch108	0.926	0.944
MSG/SEVIRI ch120	0.916	0.972

*spectra obtained in laboratory (dry grass sample spread out on flat surface)

NASA JPL Jet Propulsion Laboratory

ONERA THE FRENCH AEROSPACE LAB

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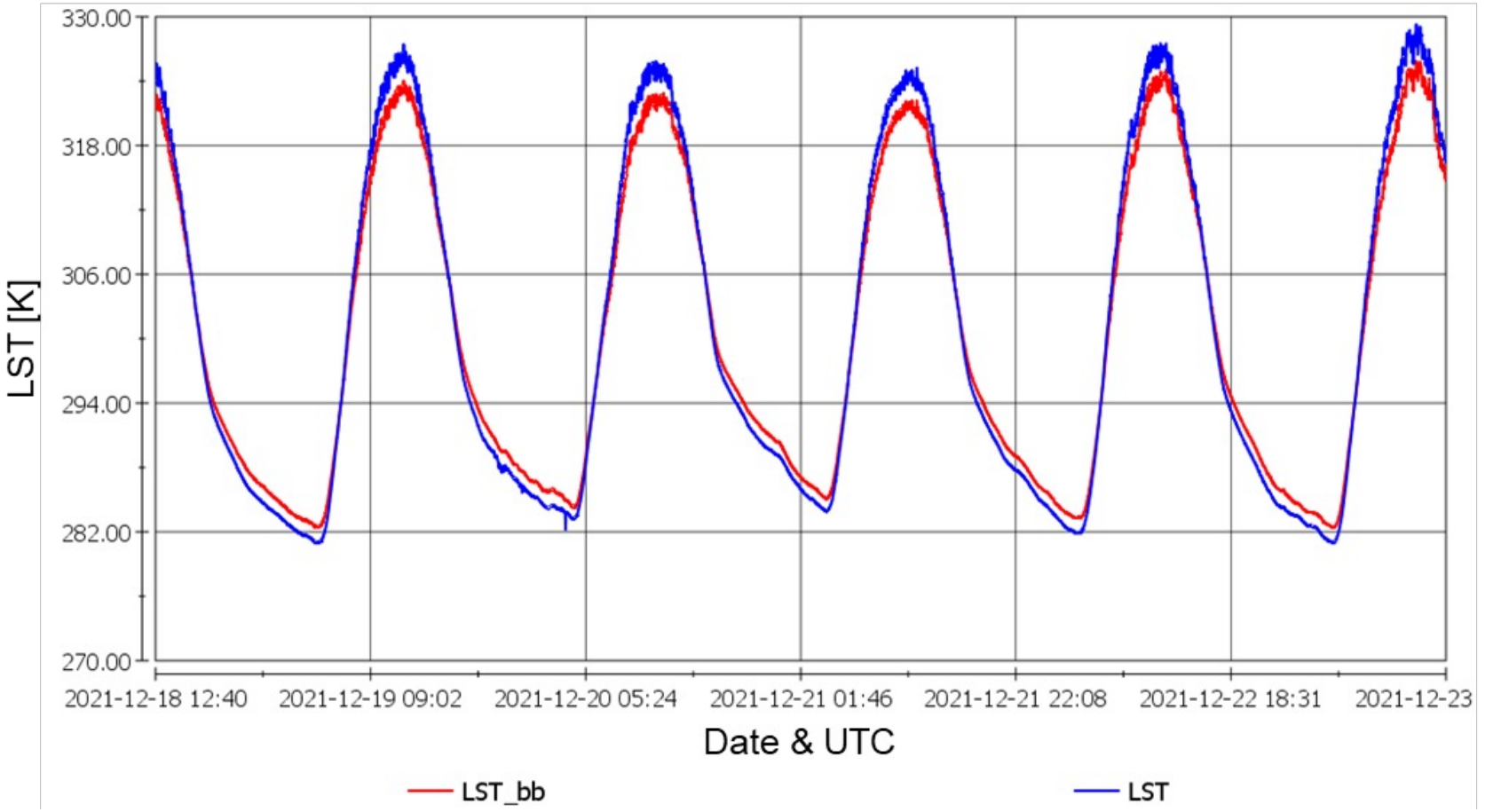
LST & Emissivity (8/16)

In-situ LST from CGR4 (LST_bb) & KT15.85 IIP (LST)

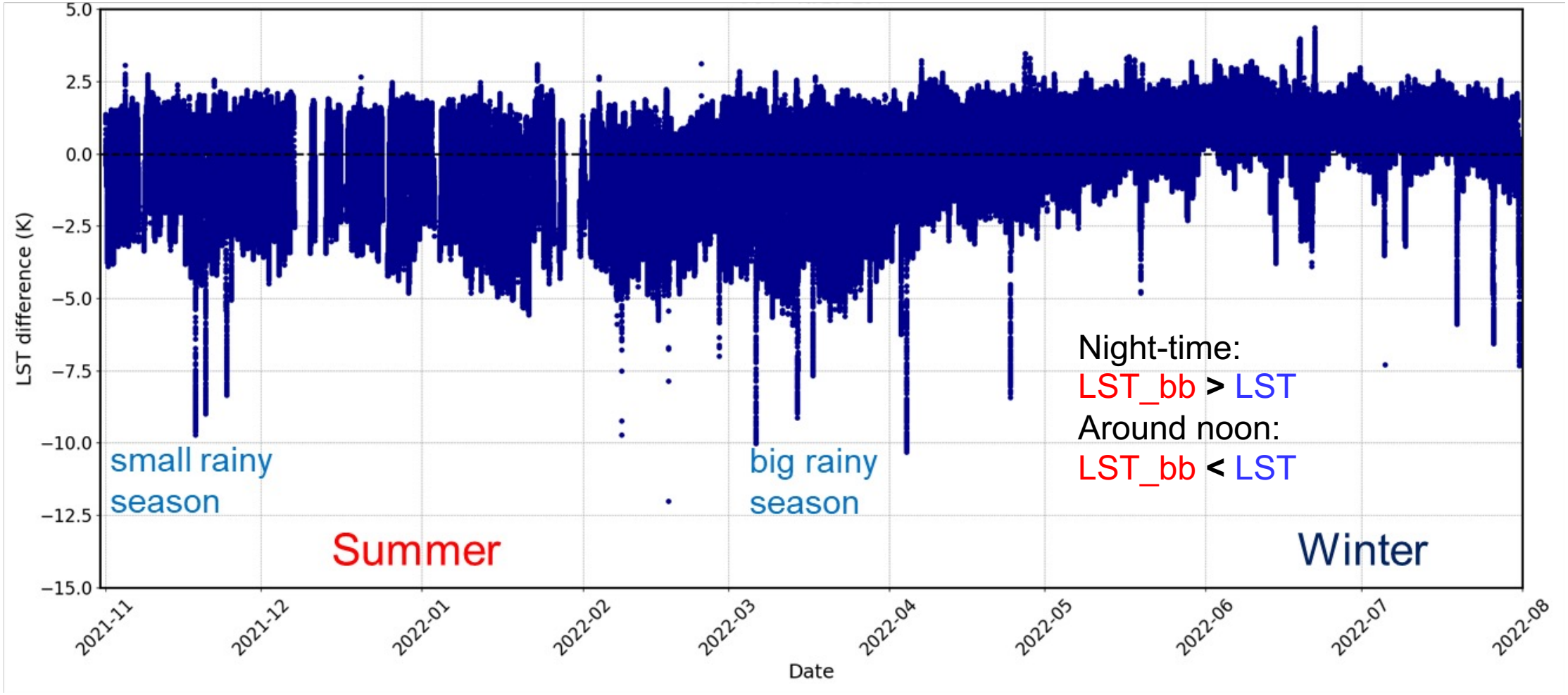


Sensor emissivity
KT15 : 0.930
CGR4: 0.901

Night-time:
LST_bb > LST
Around noon:
LST_bb < LST

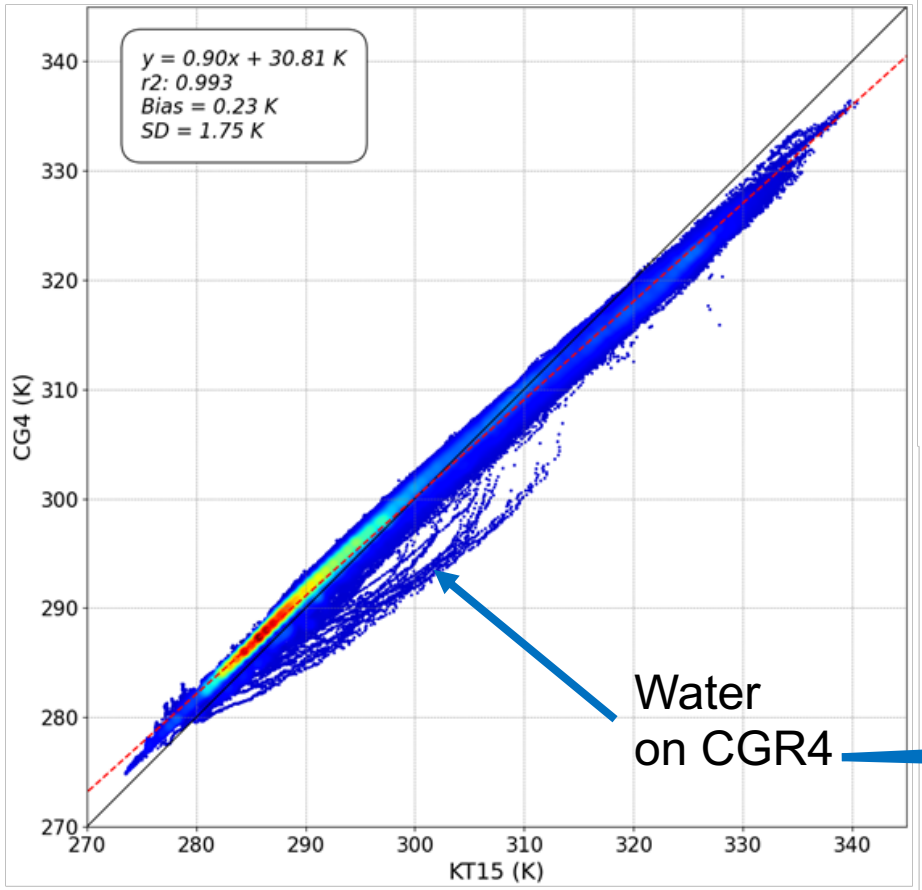
LST & Emissivity (9/16)

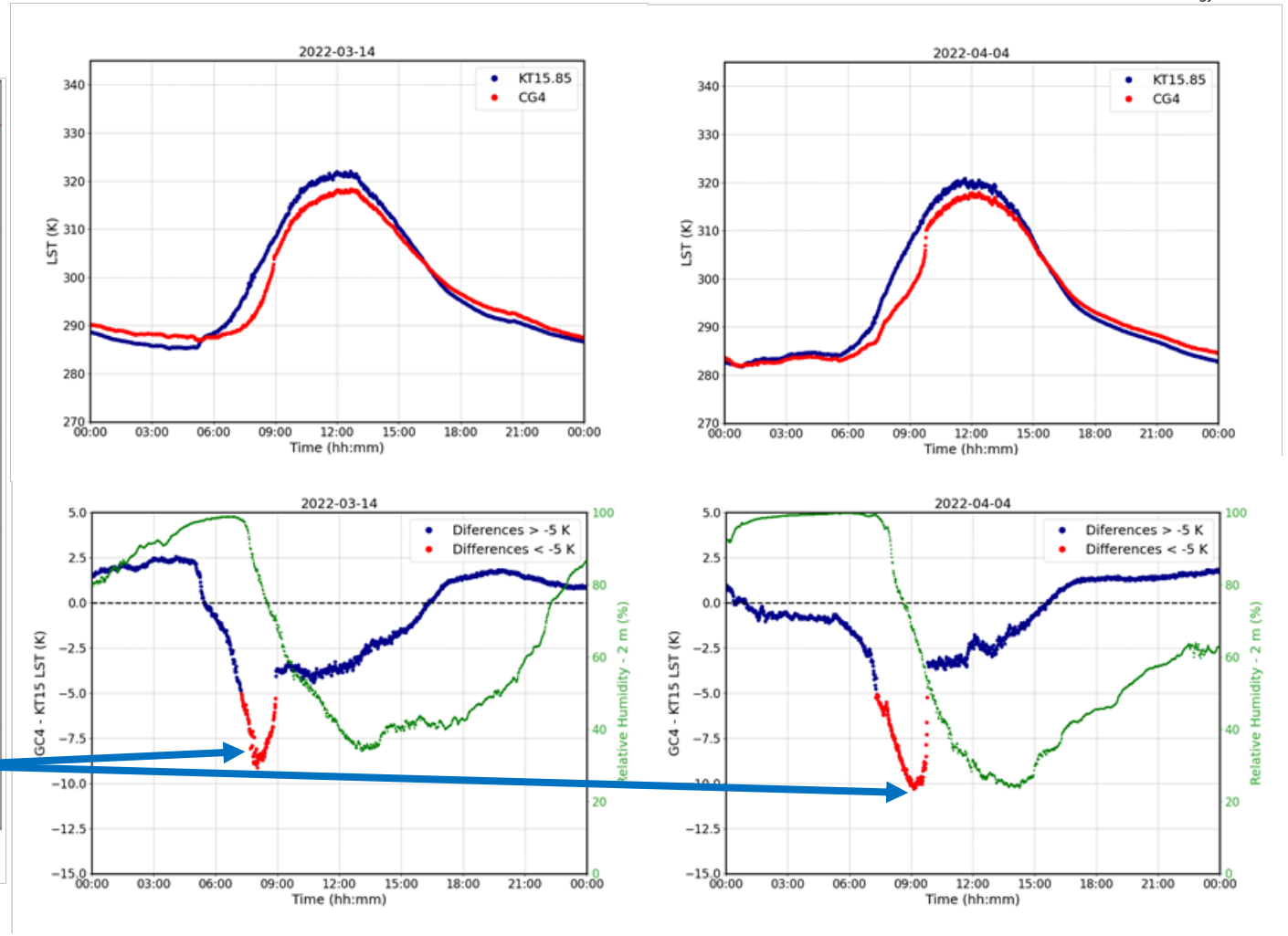
In-situ LST Difference: CGR4 – KT15.85 IIP



LST & Emissivity (10/16)

CGR4 LST versus KT15.85 IIP LST





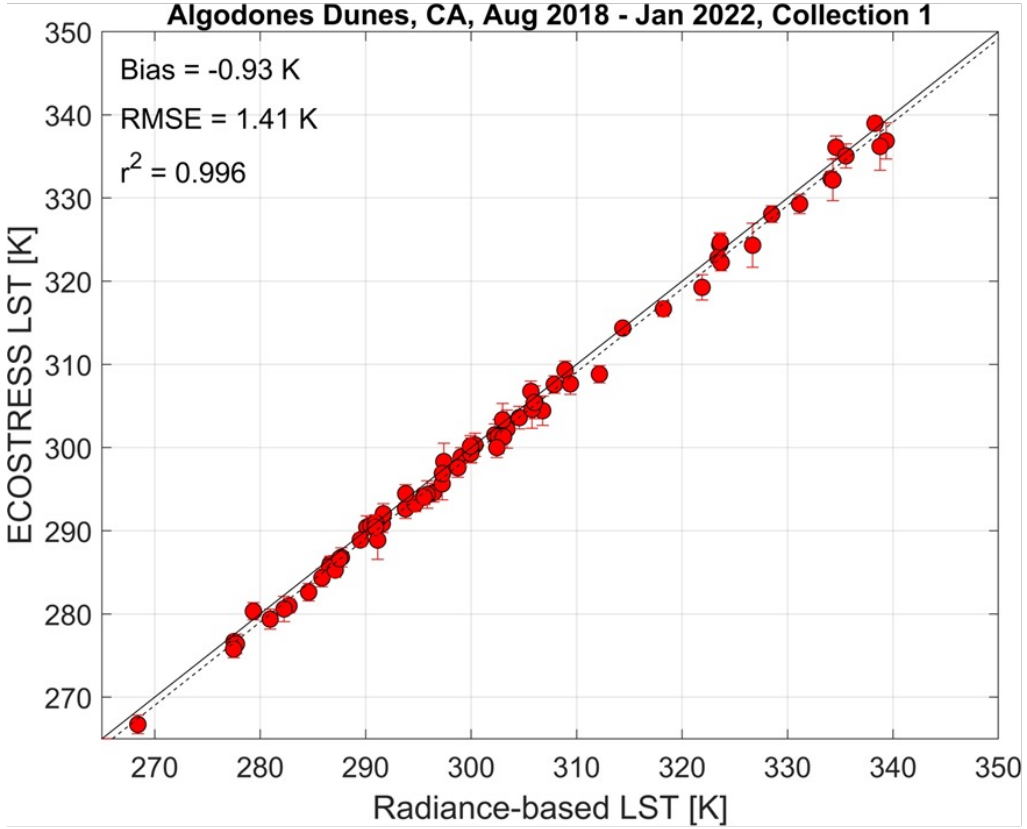
LST & Emissivity (11/16)

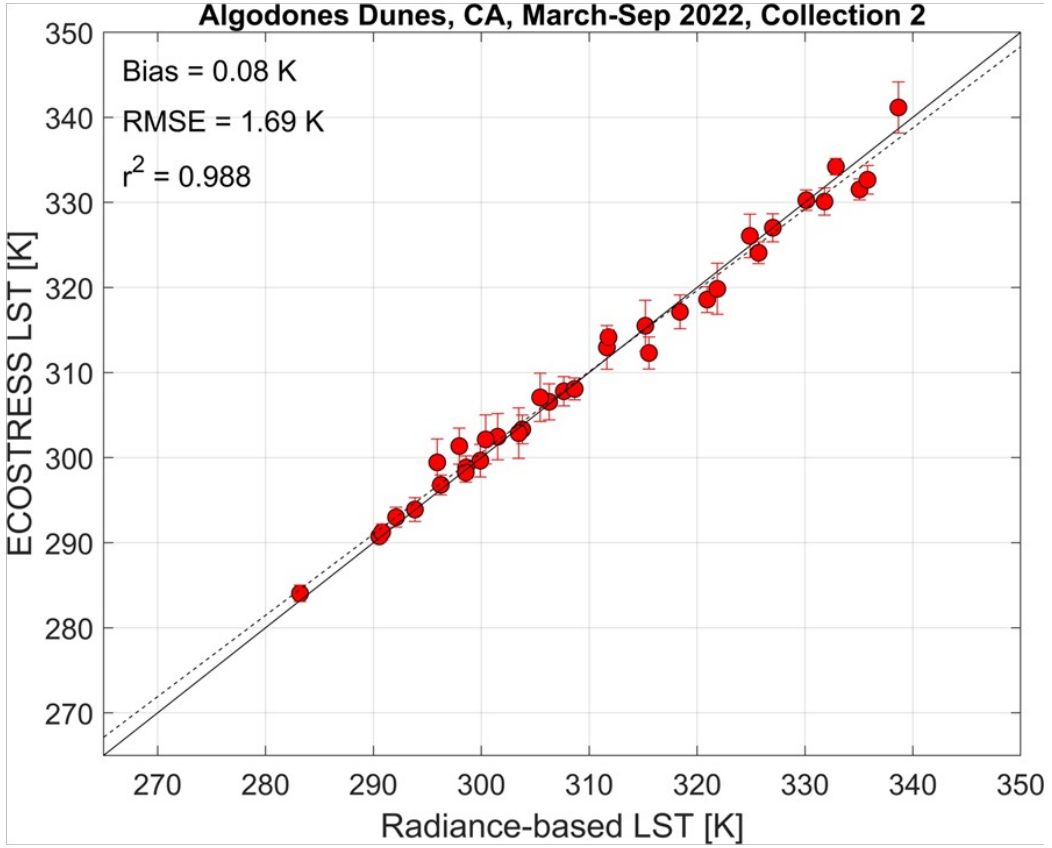
Lessons from CGR4 and KT15.85 IIP in-situ LST comparison:

- Broadband emissivities obtained from ASTER GED and in-situ emissivity spectra agree to better than 0.5%
- Around noon, CGR4 LST is generally lower than KT15 LST (1-5K)
- At nighttime, CGR4 LST is higher than KT15 LST (1-2K)
- After precipitation events, water clings to the CGR4 sensor and causes LST underestimation of up to 10K
- **Avoid** using broadband hemispherical TIR sensors for LST validation, even over flat, homogenous surfaces (e.g. Namib gravel plains)

LST & Emissivity (12/16)

ECOSTRESS collection 2 calibration update

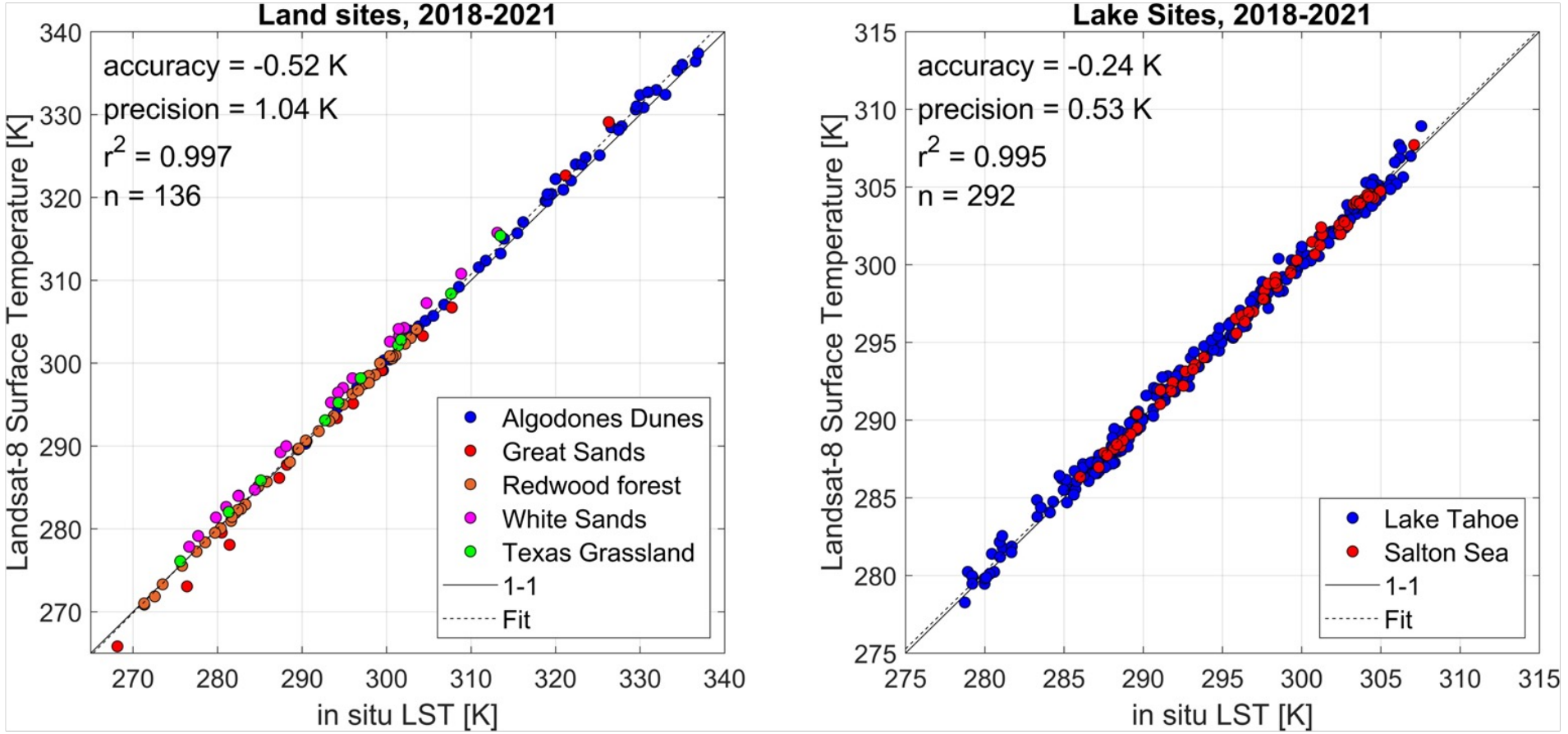




Previous cold bias of ~1 K in Collection 1 has been reduced to near zero in Collection 2

LST & Emissivity (13/16)

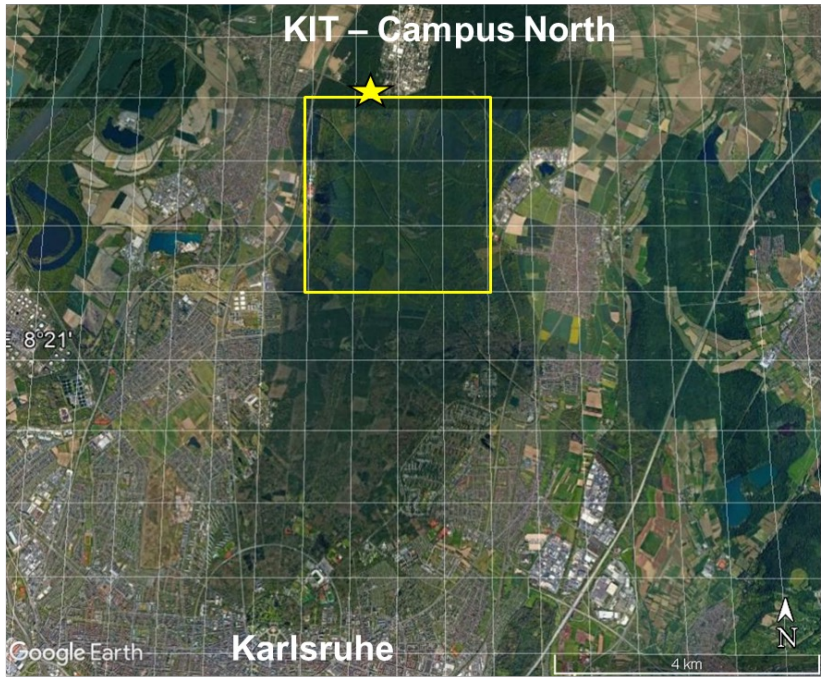
Landsat 8 collection 2 LST validation update

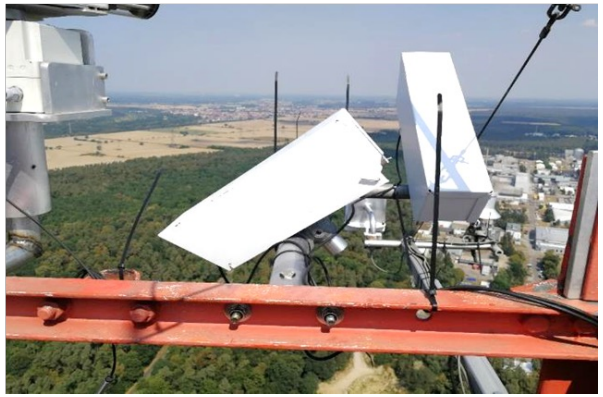


Landsat 8 collection 2 surface temperature product has consistent accuracy and precision of ~1 K across a wide variety of different land cover types over land and water

LST & Emissivity (14/16)

Validation of satellite LST products over KIT-Forest Site (Copernicus LAW)



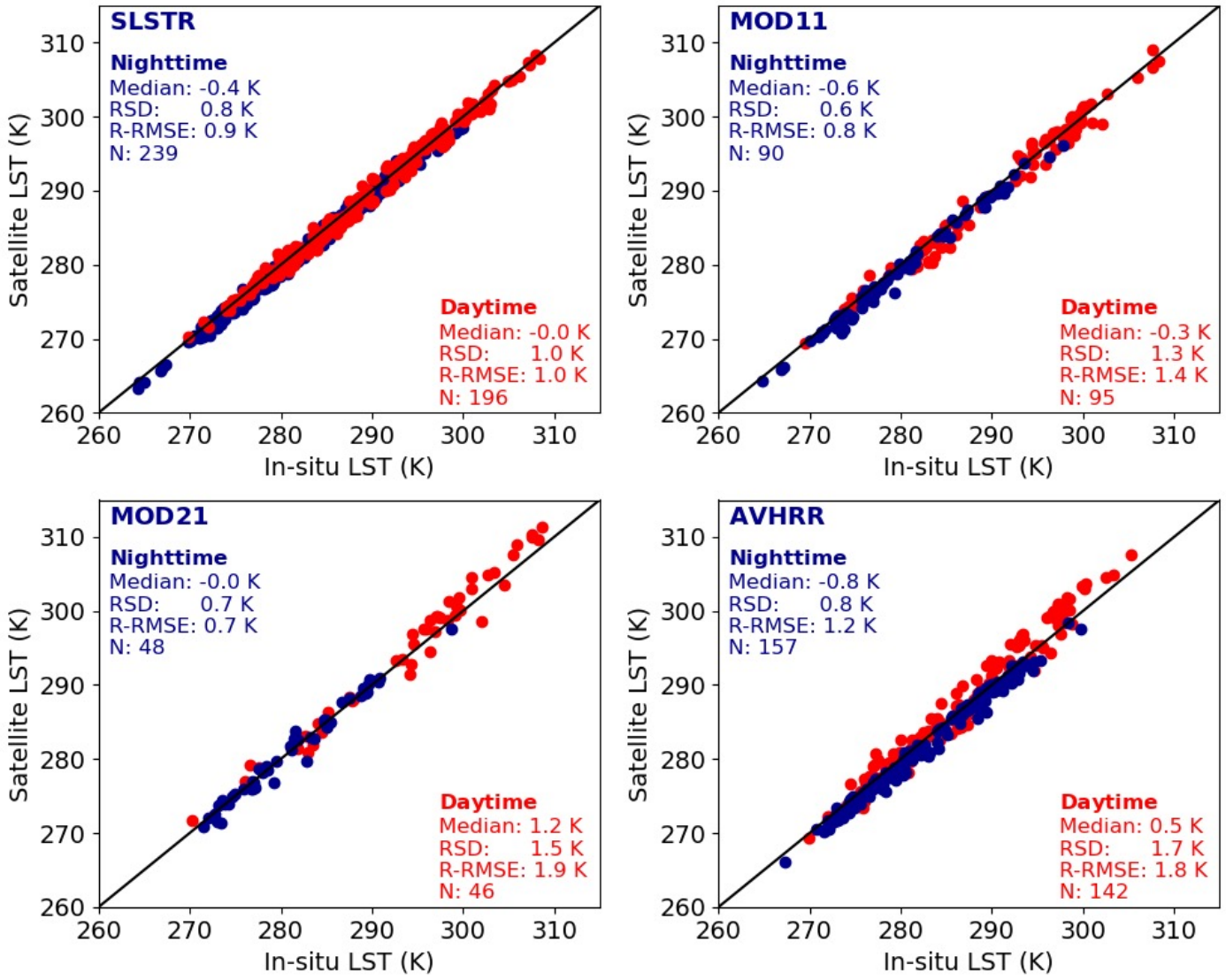


The KIT Forest Site (49.091 N, 8.425 E; since Aug 2020) covers about 6 x 3 km^2 of mixed forest dominated by pinus sylvestris (pine tree) & fagus sylvativa (beech tree).

Two Heitronics KT15.85 IIP radiometers are mounted at 200 m height (meteorological tower, star symbol).

More information about the Copernicus LAW project and its sites can be found in: ***https://law.acri-st.fr/sites***

LST & Emissivity (15/16)



In-situ validation over KIT-Forest (Aug–Mar 2022) for LST from SLSTR, MODIS (MOD11 & MOD21) and AVHRR (cloud free & high-quality retrievals).

Remaining outliers (e.g. undetected clouds) were reduced with a 3σ (SLSTR: 2σ) Hampel filter.

Robust statistics for all data:

Product	Median (K)	RSD (K)	RRMSE (K)
SLSTR	-0.3	0.9	1.0
MOD11	-0.5	0.8	1.0
MOD21	0.3	1.1	1.2
AVHRR	-0.4	1.2	1.2

LST & Emissivity (16/16)

Conferences

- EUMETSAT Meteorological Satellite Conf.: **Sep 19-23, 2022, Brussels, Belgium**
- 6th Recent Advances on Quantitative Remote Sensing (RAQRS) Conf.:
  Sep 19-23, 2022, Valencia (Torrent), Spain
- ESA Land Surface Temperature CCI (LST_cci) 2022 User workshop: **Sep 27-29, 2022**
  https://climate.esa.int/en/events/lst_cci-2022-user-workshop/
- 2022 Dragon 5 Mid-term Symposium: **Oct 17-21, 2022, online**
  https://dragon5.esa.int/event/2022-dragon-5-mid-term-symposium/
- AGU Fall Meeting (AGU#22): **Dec 12-16, 2022, Chicago (IL), USA & online**
  https://www.agu.org/Fall-Meeting