Study of satellite observations synergy in order to improve surface temperature in NWP

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OUTLINE

- Context of the study
- Satellite Land Surface Temperature (LST) comparison
- Comparison to in-situ data
- RTTOV simulations
- Conclusions and perspectives

Context of the study

- Importance of the Land Surface Temperature (LST) in surface analysis
- High dependence to surface characteristics and limits of its modelization
- Surface schemes use modeled LST

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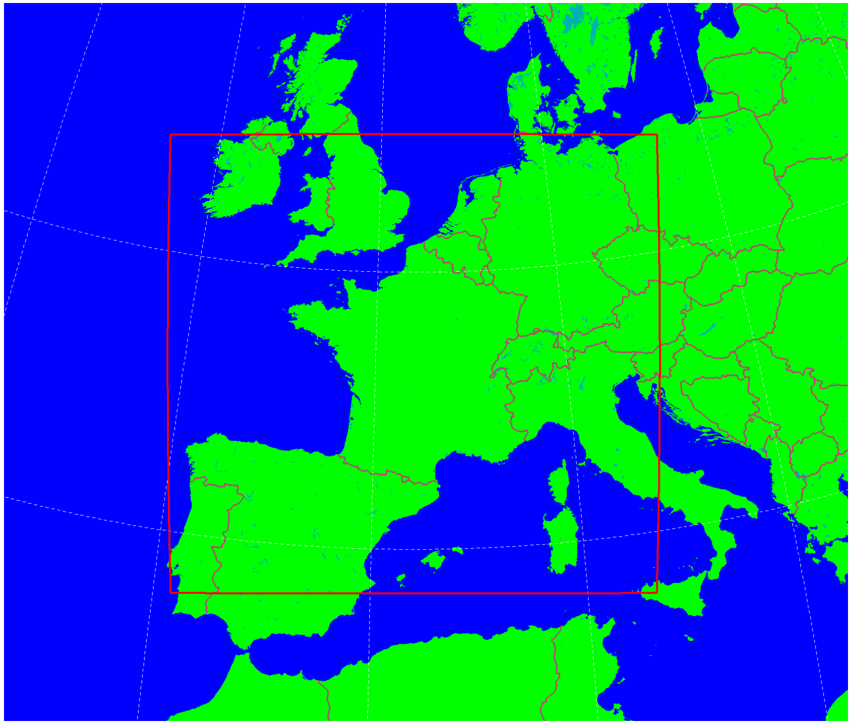
- **AROME-France 3D-Var** model :

→ Operational Meso-scale Non Hydrostatic model of Météo-France (Seity et al, 2011, Brousseau et al, 2016)

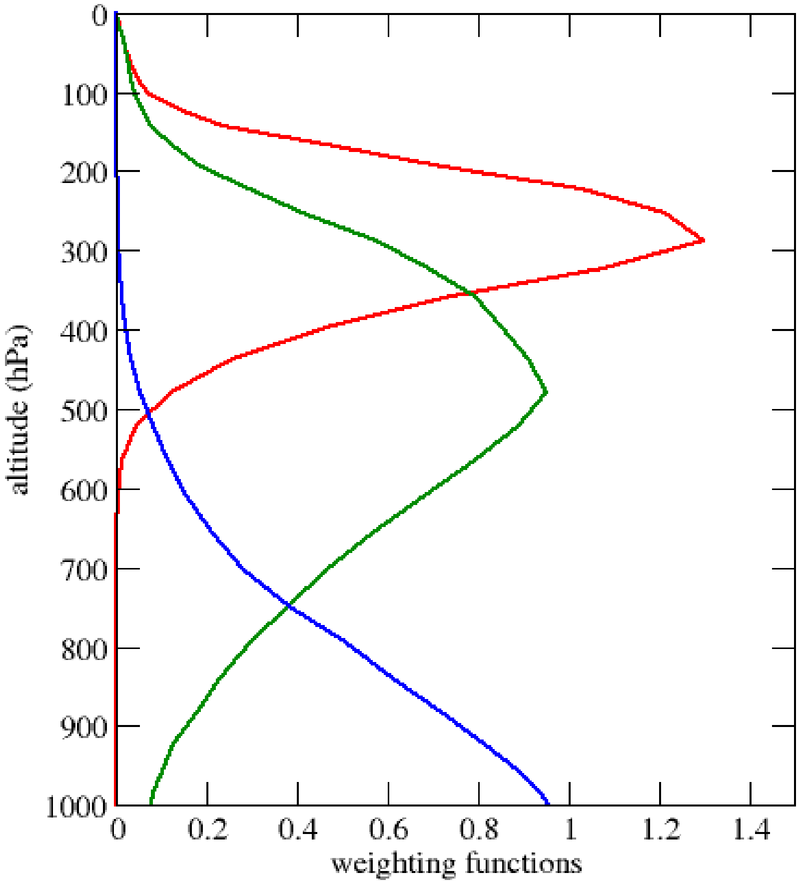
→ 1h 3D-Var cycle assimilating Conventional/Satellite/Radar observations



AROME-France domain (1.3 km)

Context of the study

- Realistic LST to replace modeled LST for satellite radiance assimilation
- Window channels for Satellites LST retrieval
- Further application of satellites LST in surface analysis



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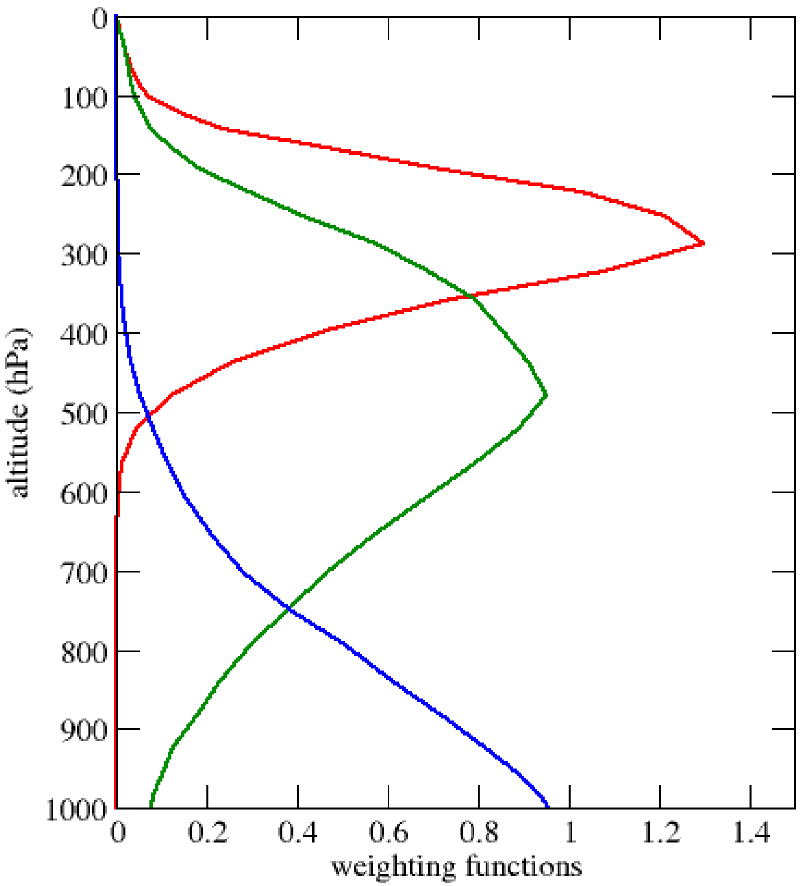
➡ Study of agreement between different sensors



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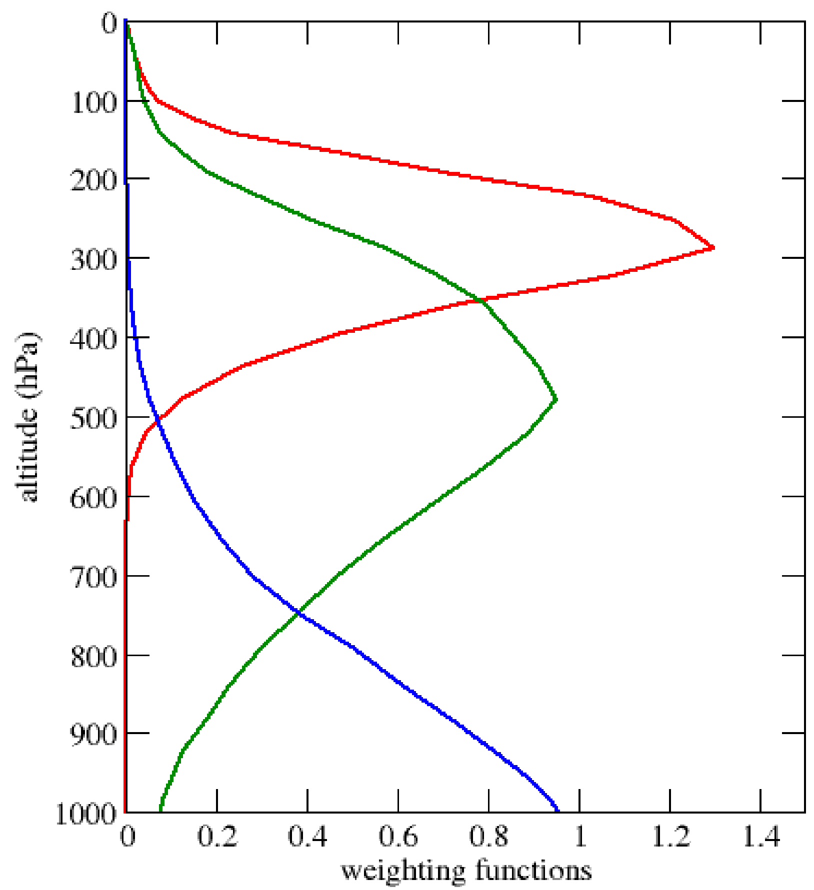
- Under clear-sky conditions
- Blacklisting cloud contaminated observations
- LST retrieved with the Mono-channel and known emissivity (IASI, SEVIRI, AMSU-A/MHS)
- RTTOV 11 and emissivity atlas
- Three covered periods of a month each:

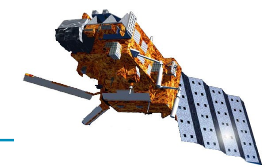
Summer: 16/06/2017 - 16/07/2017

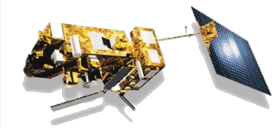
Autumn: 01/10/2017 - 31/10/2017

Winter: 15/01/2018 - 14/02/2018



Satellite LST comparison





Spinning Enhanced Visible and Infrared Imager SEVIRI

- On board MSG satellites
- Geostationary, 8 thermal Infrared channels
- 3 km of spatial resolution at nadir
- Emissivity Land-SAF atlas

→ **Channel 6 (7.3 μm) [*Guedj et al. , 2011*]**

Infrared Atmospheric Sounding Interferometer IASI

- On board Metop-A and Metop-B
- Polar orbit, 8461 channels
- 12 km of spatial resolution at nadir
- Emissivity atlas from University of Wisconsin

→ **Channel 1194 (10.6 μm) [*Boukachaba, 2017*]**

Advanced Microwave Sounding Unit AMSU-A

- On board Metop-A/B and NOAA satellites
- Polar orbit
- 15 microwave channels
- 48 km of spatial resolution at nadir
- Emissivity of CNRM MW atlas computed by F. Karbou 2015 and refined by F. Suzat

→ **Channel 3 (50.3 GHz) [*Karbou et al., 2006*]**

Advanced Microwave Sounding Unit AMSU-B

- On board Metop-A/B and NOAA satellites
- Polar orbit
- 5 microwave channels
- 16 km of spatial resolution at nadir
- Emissivity of CNRM MW atlas computed by F. Karbou 2015 and refined by F. Suzat

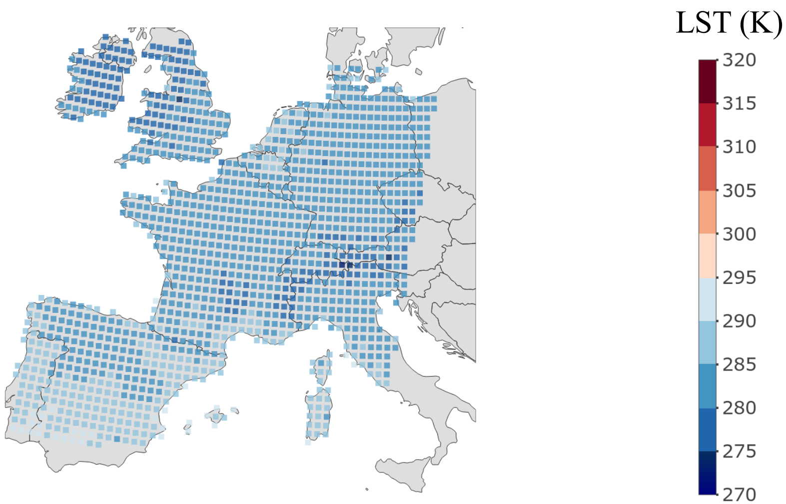
→ **Channel 1 (89 GHz) [*Karbou et al., 2006*]**

Different sensors LST compared to SEVIRI mean LST within 4.5 km +-30 min

Satellite LST comparison – IASI vs SEVIRI

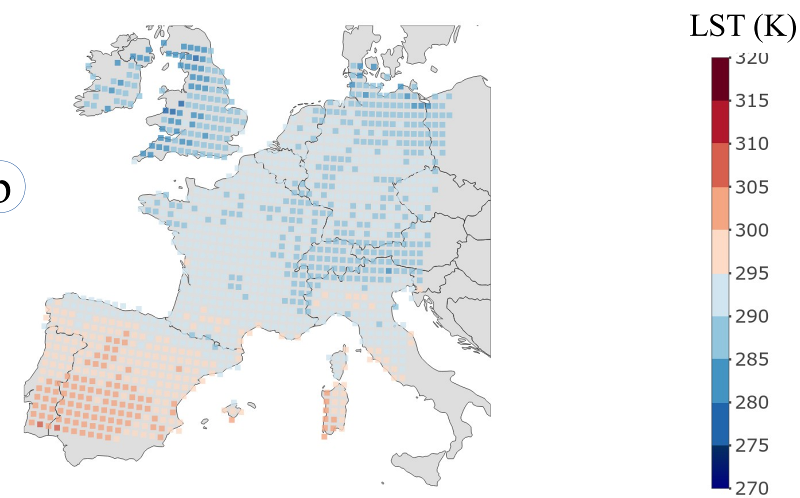
a

IASI LST – Night-time (October 2017)



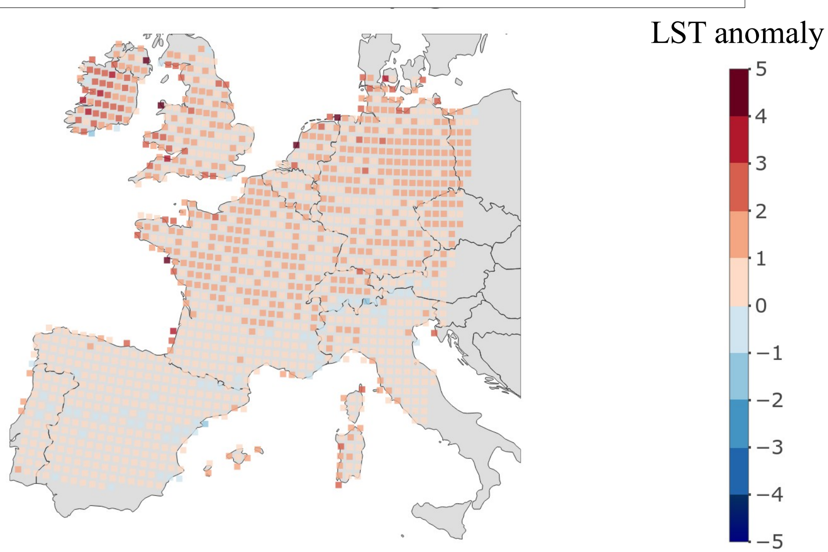
b

IASI LST – Daytime (October 2017)



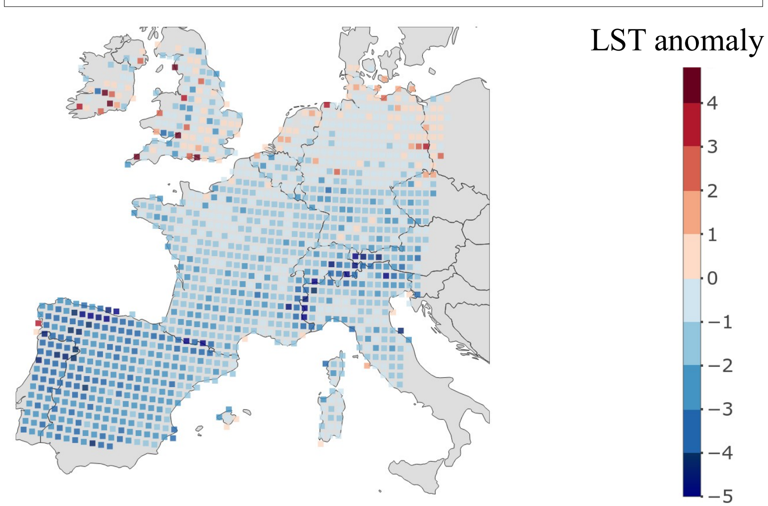
c

IASI - SEVIRI LST anomaly – Night-time (October 2017)

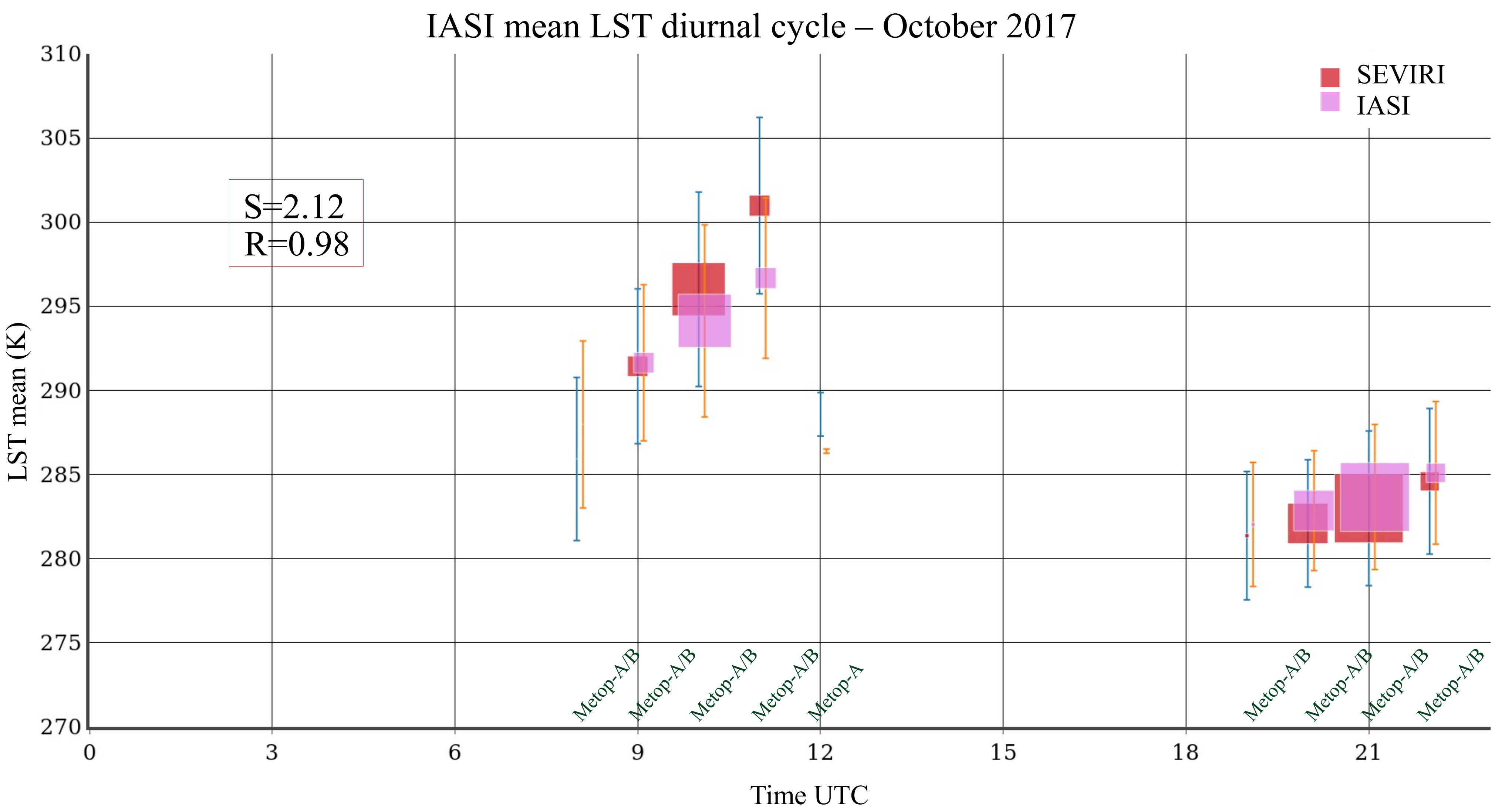


d

IASI - SEVIRI LST anomaly – Daytime (October 2017)



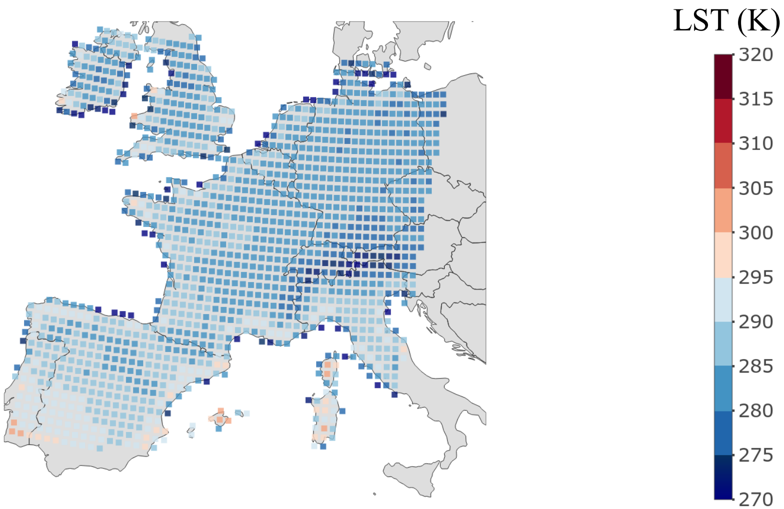
Satellite LST comparison – IASI vs SEVIRI



Satellite LST comparison - AMSU-A vs SEVIRI

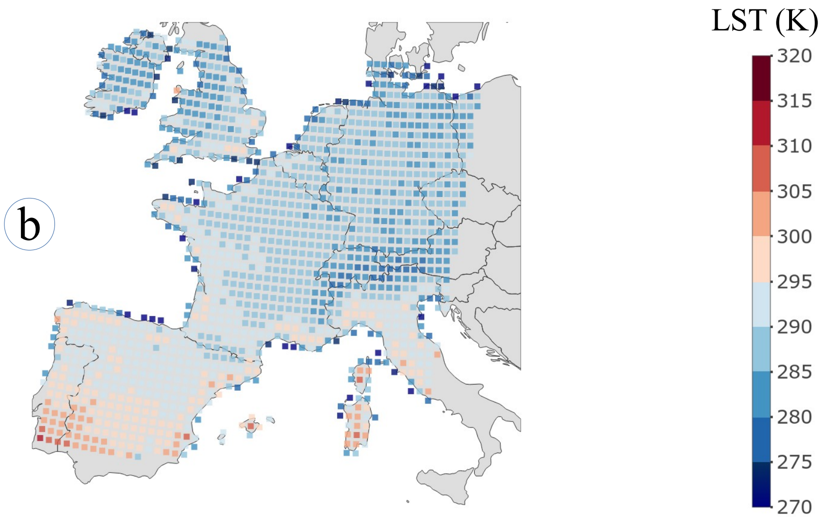
AMSU-A LST – Night-time (October 2017)

a



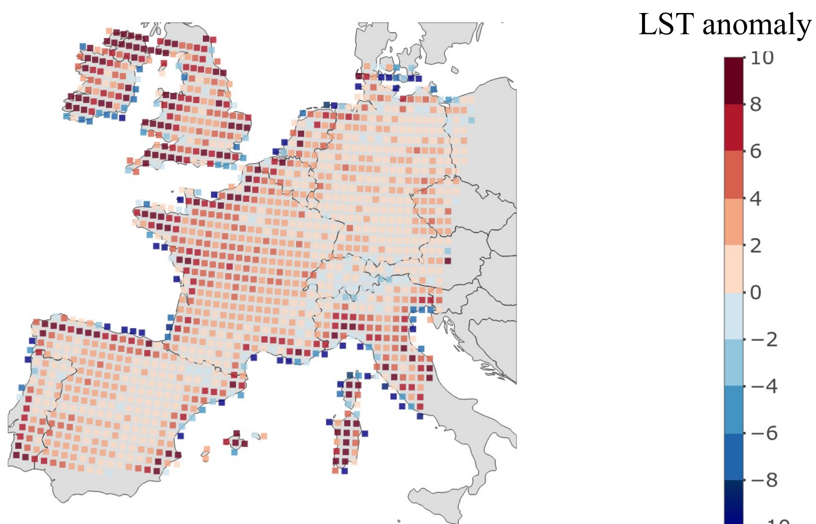
AMSU-A LST – Daytime (October 2017)

b



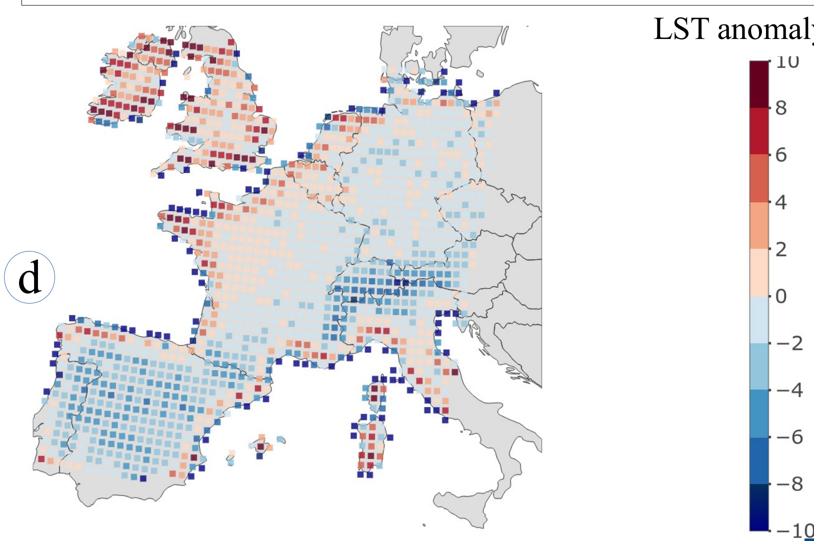
AMSU-A - SEVIRI LST anomaly – Night-time (October 2017)

c

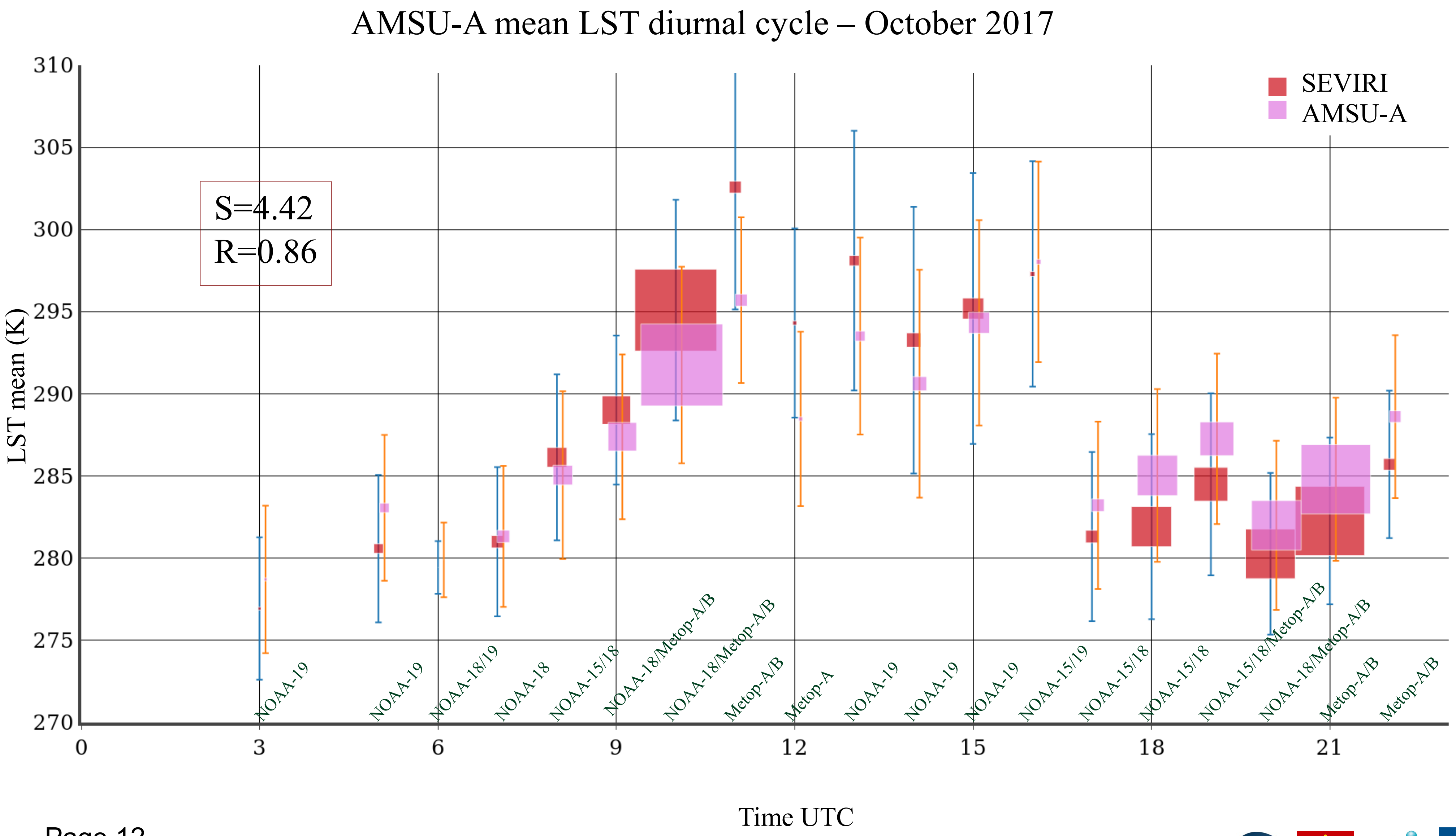


AMSU-A - SEVIRI LST anomaly – Daytime (October 2017)

d

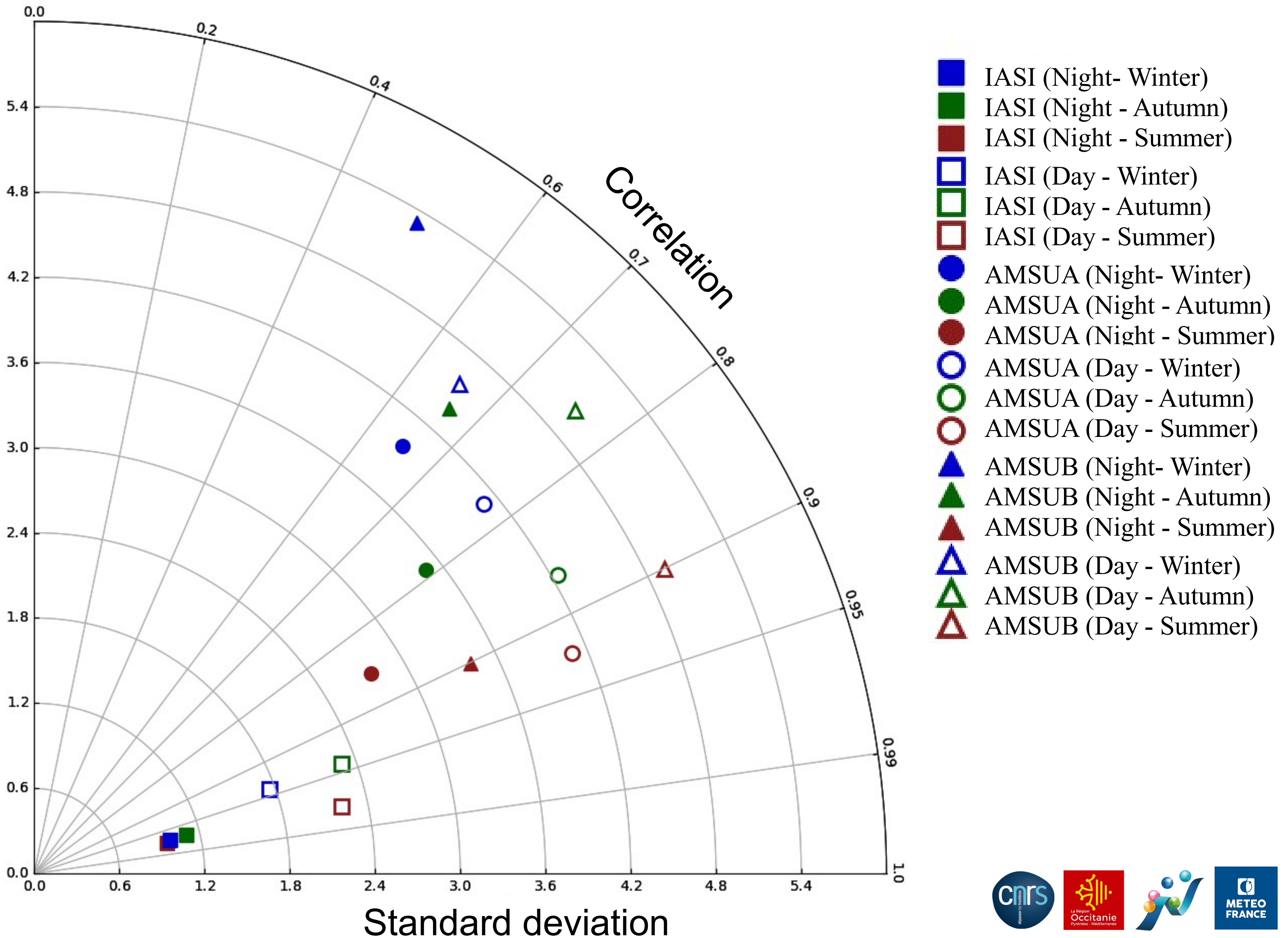


Satellite LST comparison - AMSU-A vs SEVIRI



Comparaison des LST – IASI/AMSU-A/B vs SEVIRI

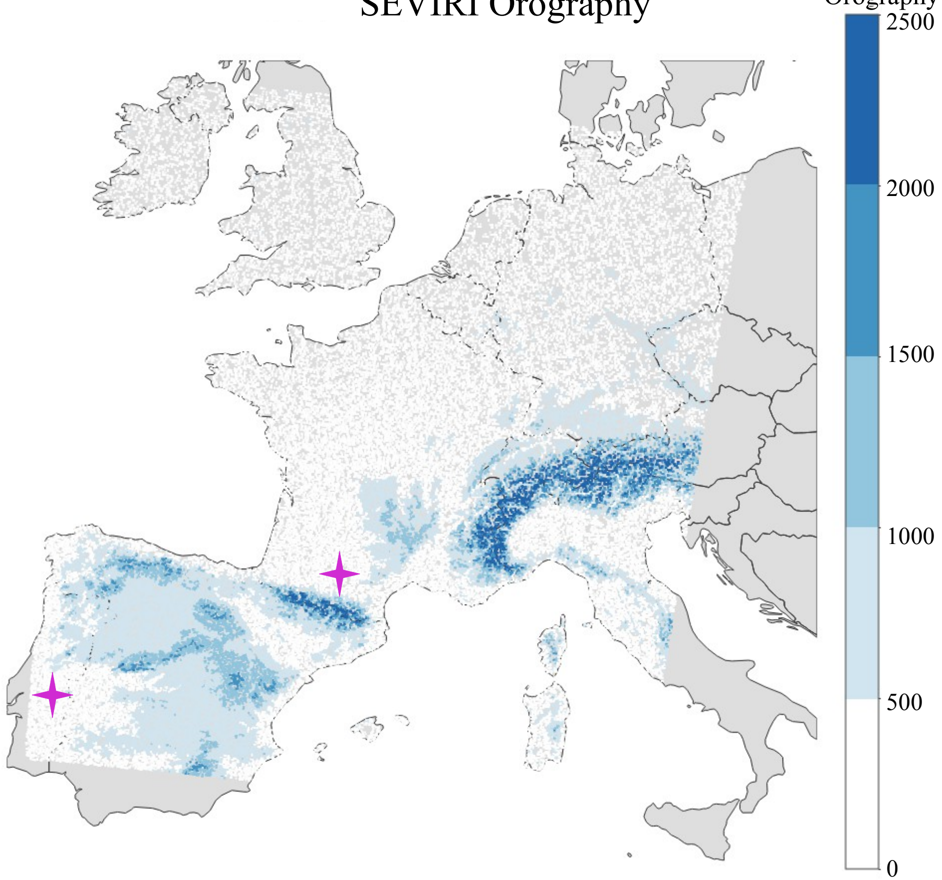
Statistics of differences : LST IASI/AMSU-A/B - LST SEVIRI

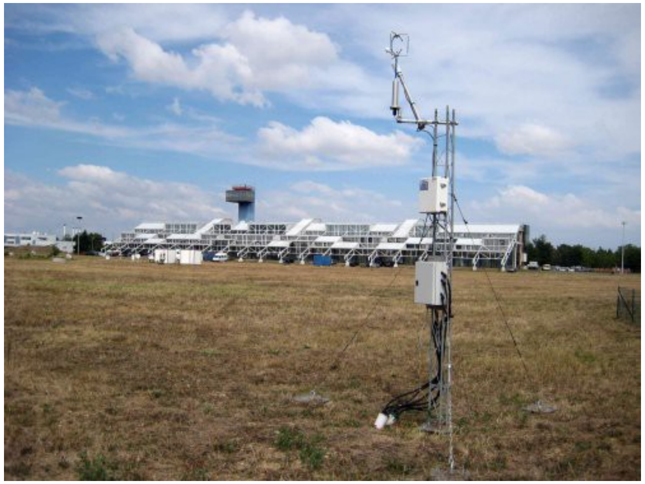


Comparison to in-situ data

- Météo-France Observation station at Toulouse, France.
- Karlsruhe Institute of Technology (KIT) Observation station at Evora, Portugal.

SEVIRI Orography

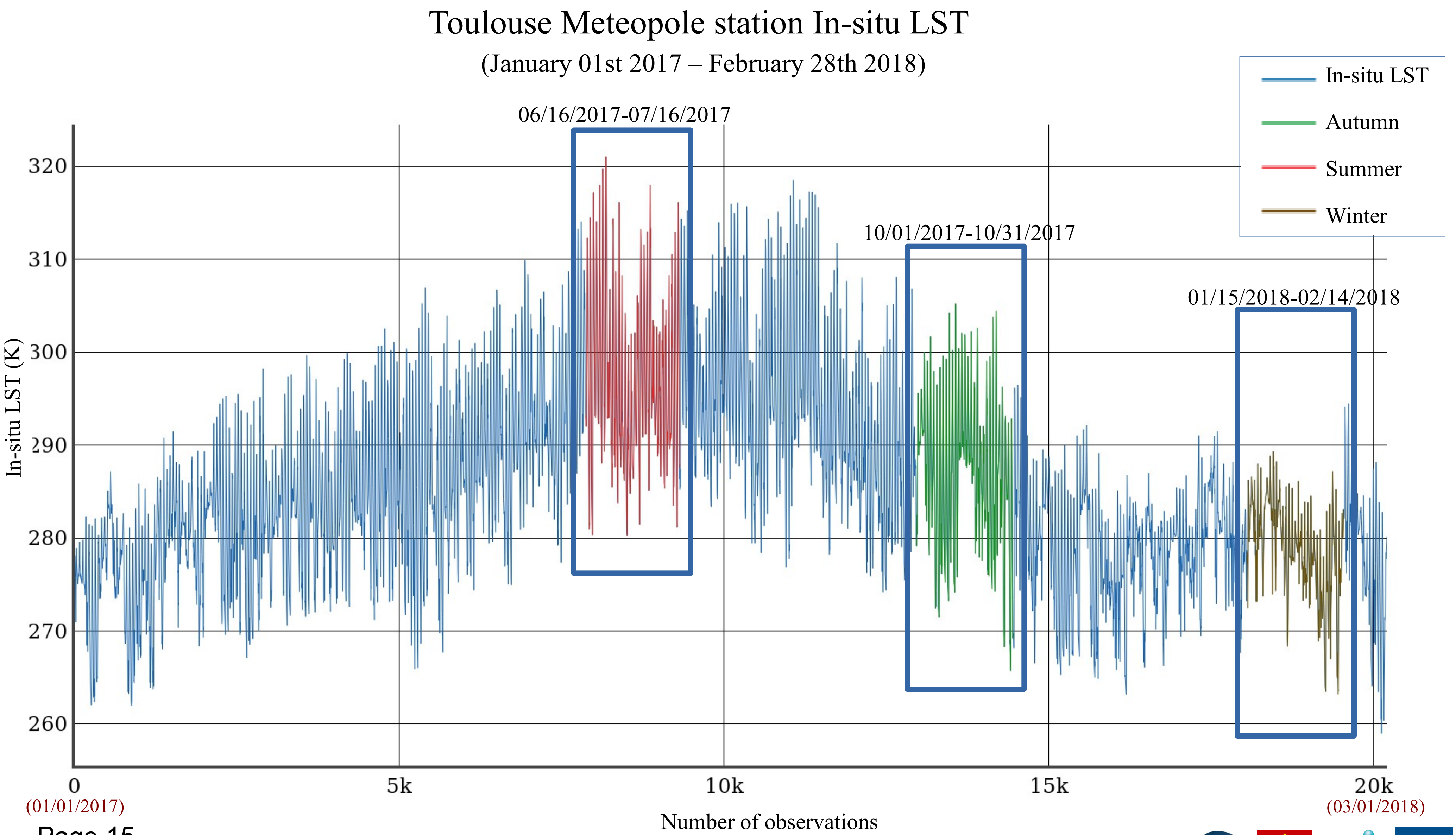




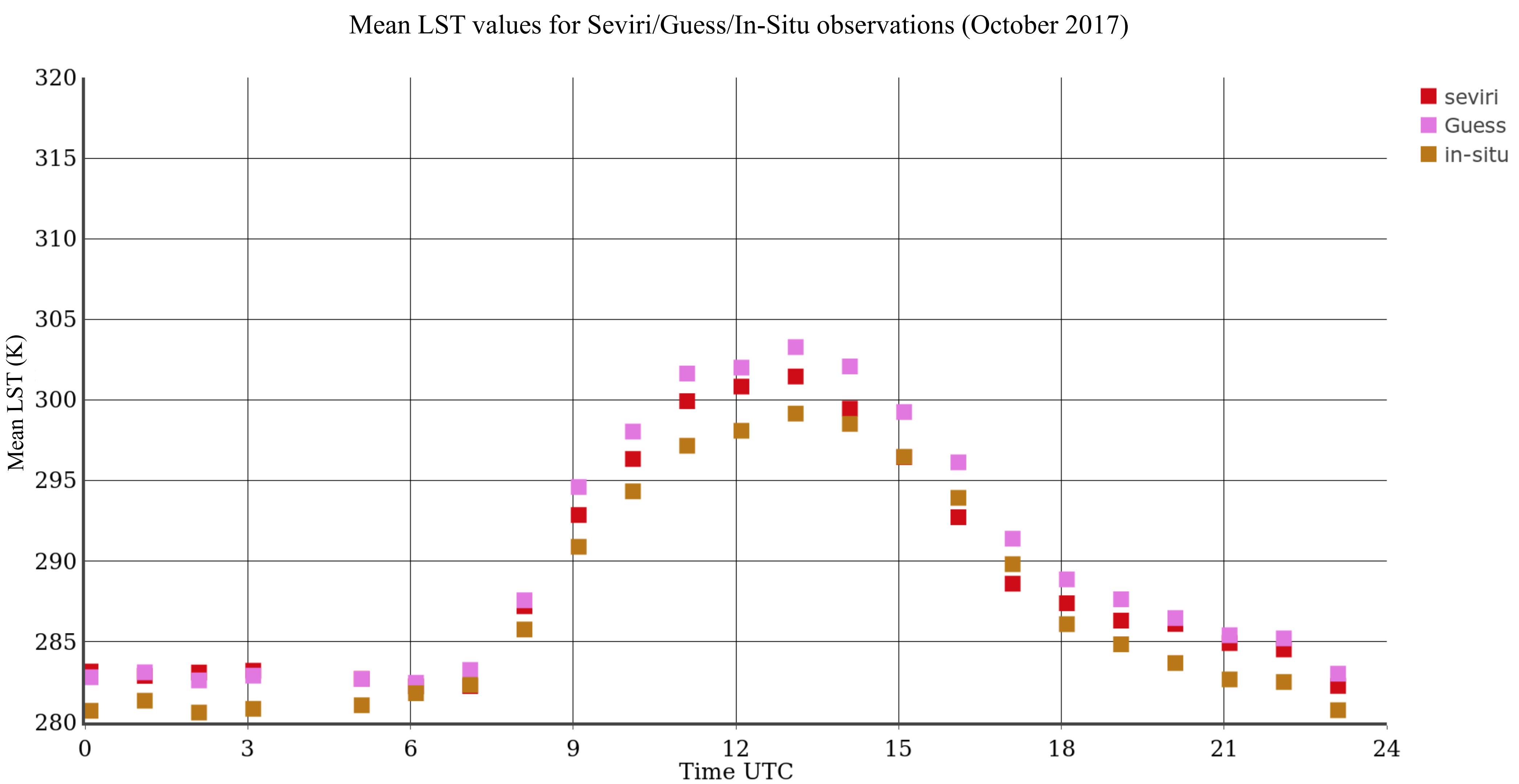
Meteopole-Flux observation station
(Thanks to William Maurel)

Evora observation station
(Thanks to Frank-Michael Göttsche and Maria Anna Martin)

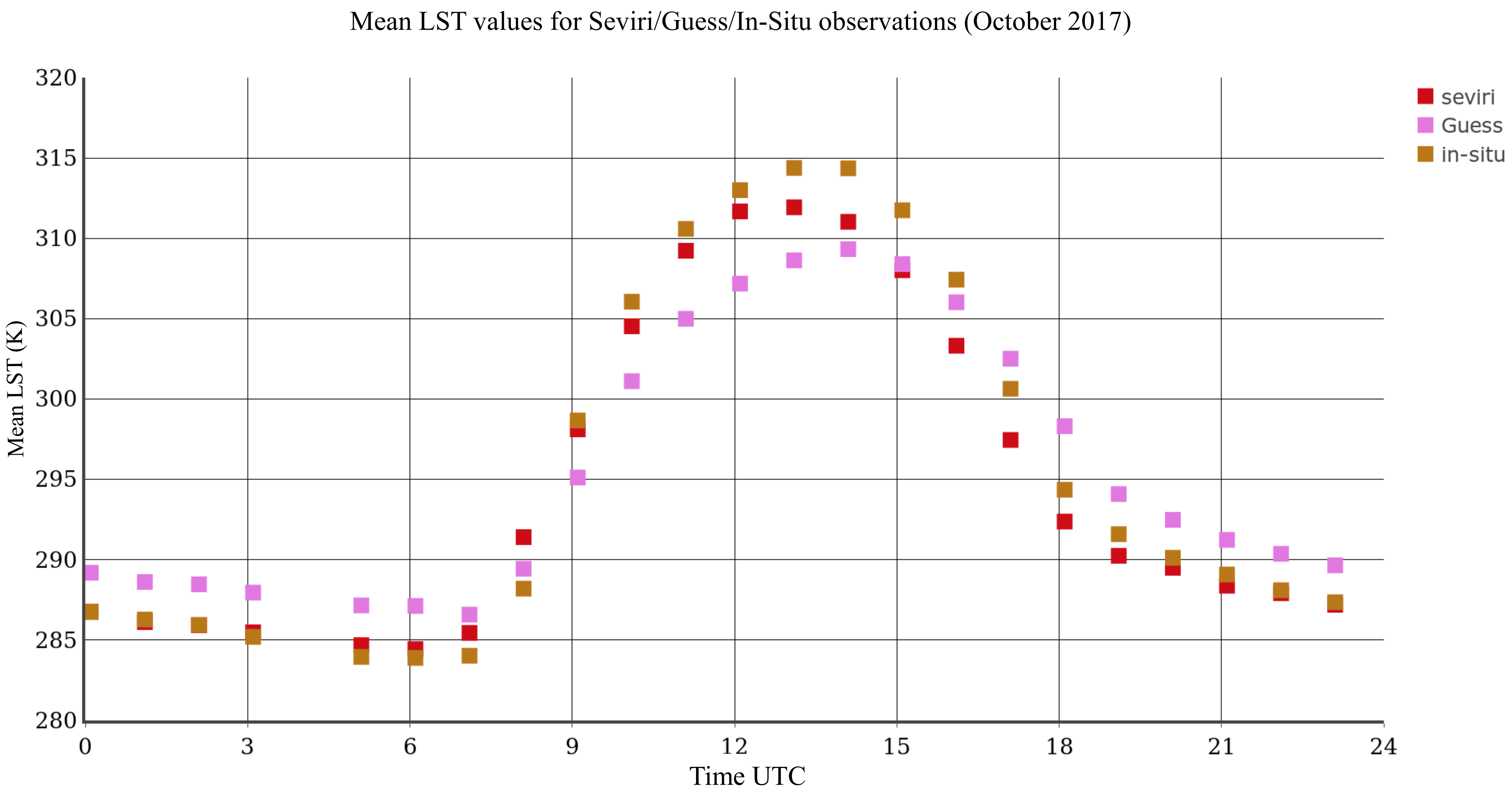
Comparison to in-situ data – Toulouse Meteopole



Comparison to in-situ data – Toulouse, France



Comparison to in-situ data – Evora, Portugal



RTTOV simulations (Radiative Transfer for TOVS)

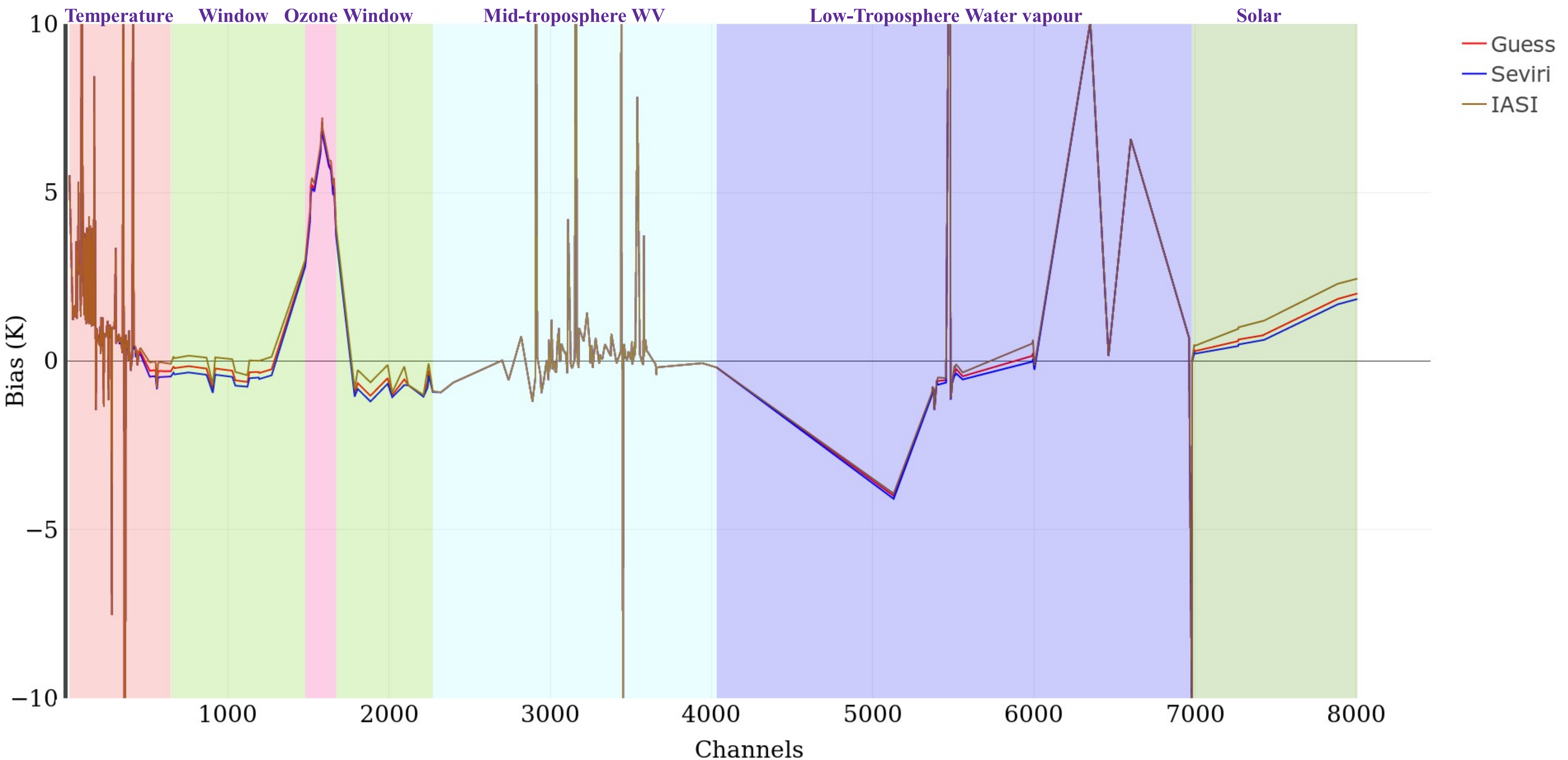
- RTTOV is a very fast radiative transfer model
- Use of RTTOV v12.2
- Use of emissivity atlas of University of Wisconsin
- Simulation of IASI 314 channels subset used at Météo-France
- Use of 740 vertical profiles from AROME model
- Simulations based on 3 values of surface temperature :

  - LST from the guess
  - LST from Seviri
  - LST from IASI

- Comparison with IASI observations

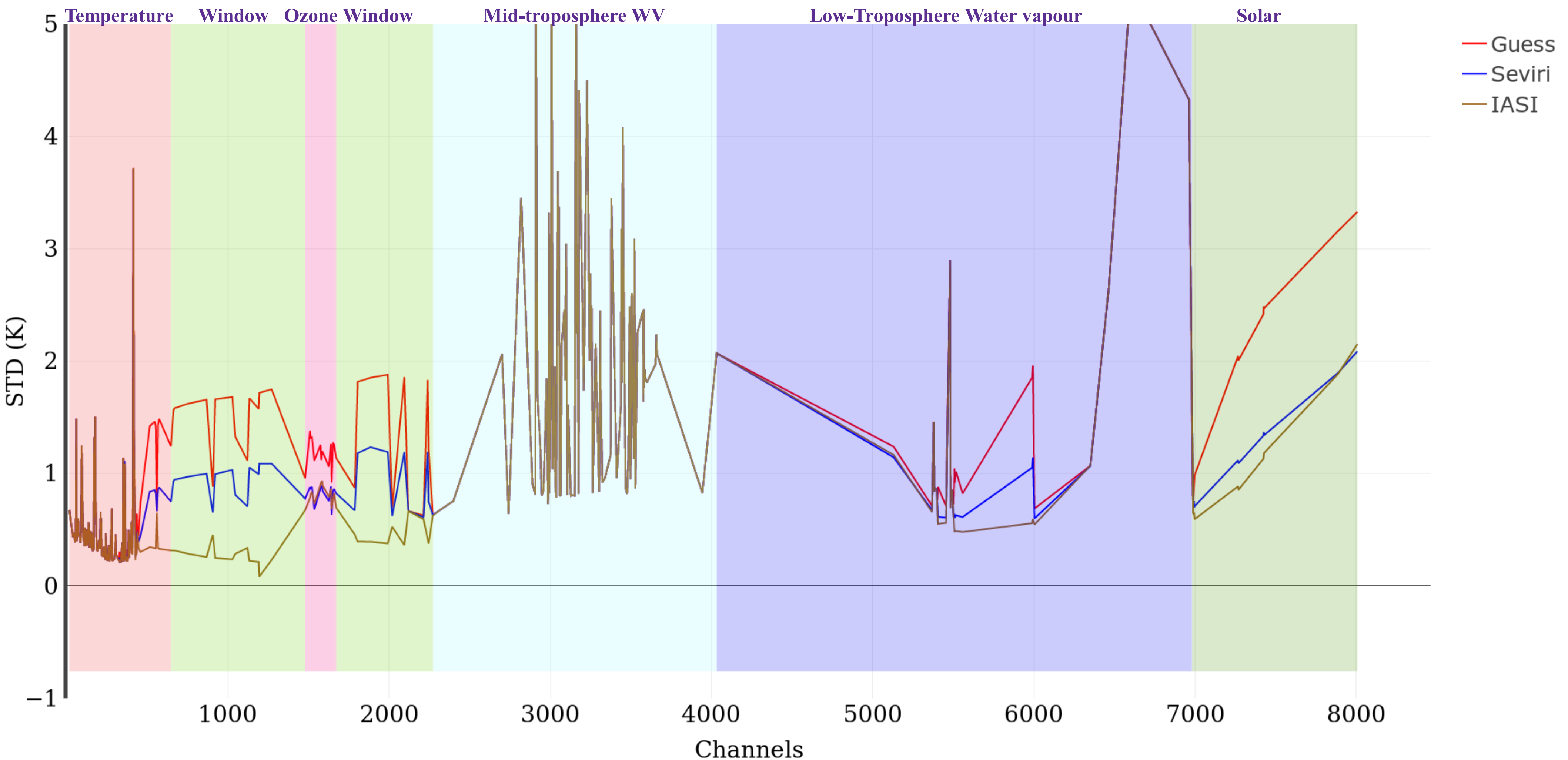
RTTOV simulations

IASI observations – simulation results Guess/Seviri/IASI LST (October 2017)



RTTOV simulations

IASI observations – simulation results Guess/Seviri/IASI LST (October 2017)



Conclusions and perspectives

- Global agreement between IASI/AMSU-A/B and SEVIRI over the three studied periods
- Better SEVIRI/IASI agreement especially on winter and night-time

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- Satisfying results from first simulations with RTTOV using SEVIRI LST

- Towards a synergy between sensors → Further use of SEVIRI LST for other sensors simulation
- Use of Satellite LST in surface analysis

Thanks for your attention

Satellite LST comparison - IASI vs SEVIRI

Bias and standard deviation of IASI to SEVIRI LST comparison

	ALL (K)			Night-time (K)			Daytime (K)		
	Bias	S	N° obs	Bias	S	N° obs	Bias	S	N° obs
90 days	0.117	2.027	142715	0.690	1.026	68237	-0.409	2.516	74478
Autumn	-0.418	2.123	55331	0.676	1.091	32252	-1.946	2.266	23079
Summer	0.803	1.958	53122	0.785	0.954	14113	0.809	2.212	39009
Winter	-0.008	1.630	34262	0.651	0.966	21872	-1.381	1.750	12390

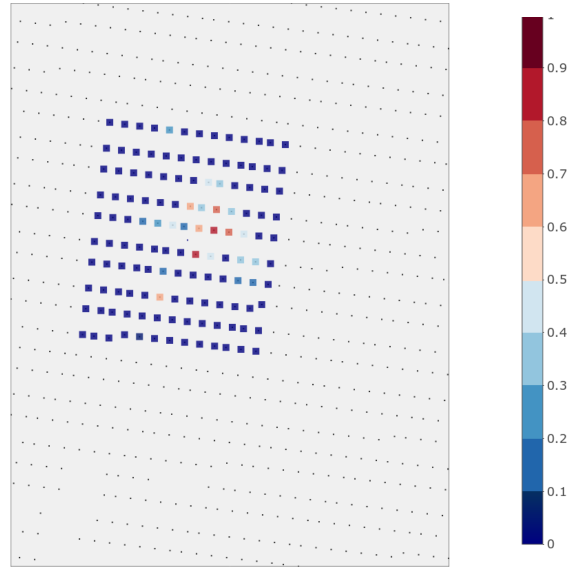
→ Global agreement between IASI and SEVIRI LST with some temporal variability:

- A better agreement during winter
- A better agreement during night-time

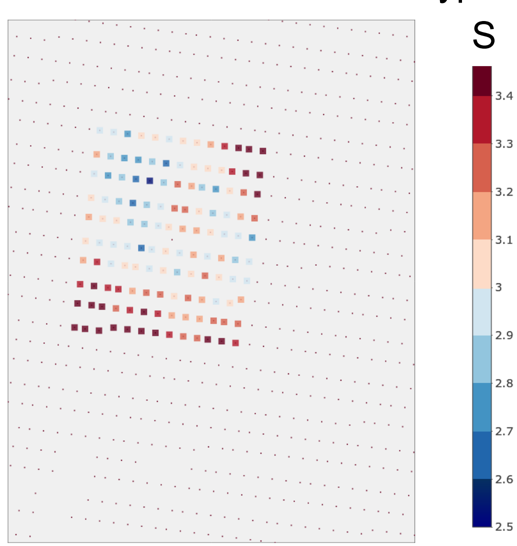
Comparaison aux données in-situ – Toulouse Météopole

Statistiques de différents pixels SEVIRI Vs In-Situ LST (Octobre 2017)

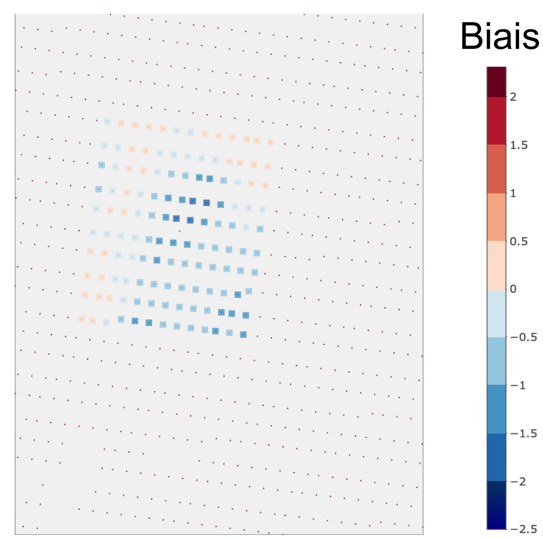
Fraction de Ville



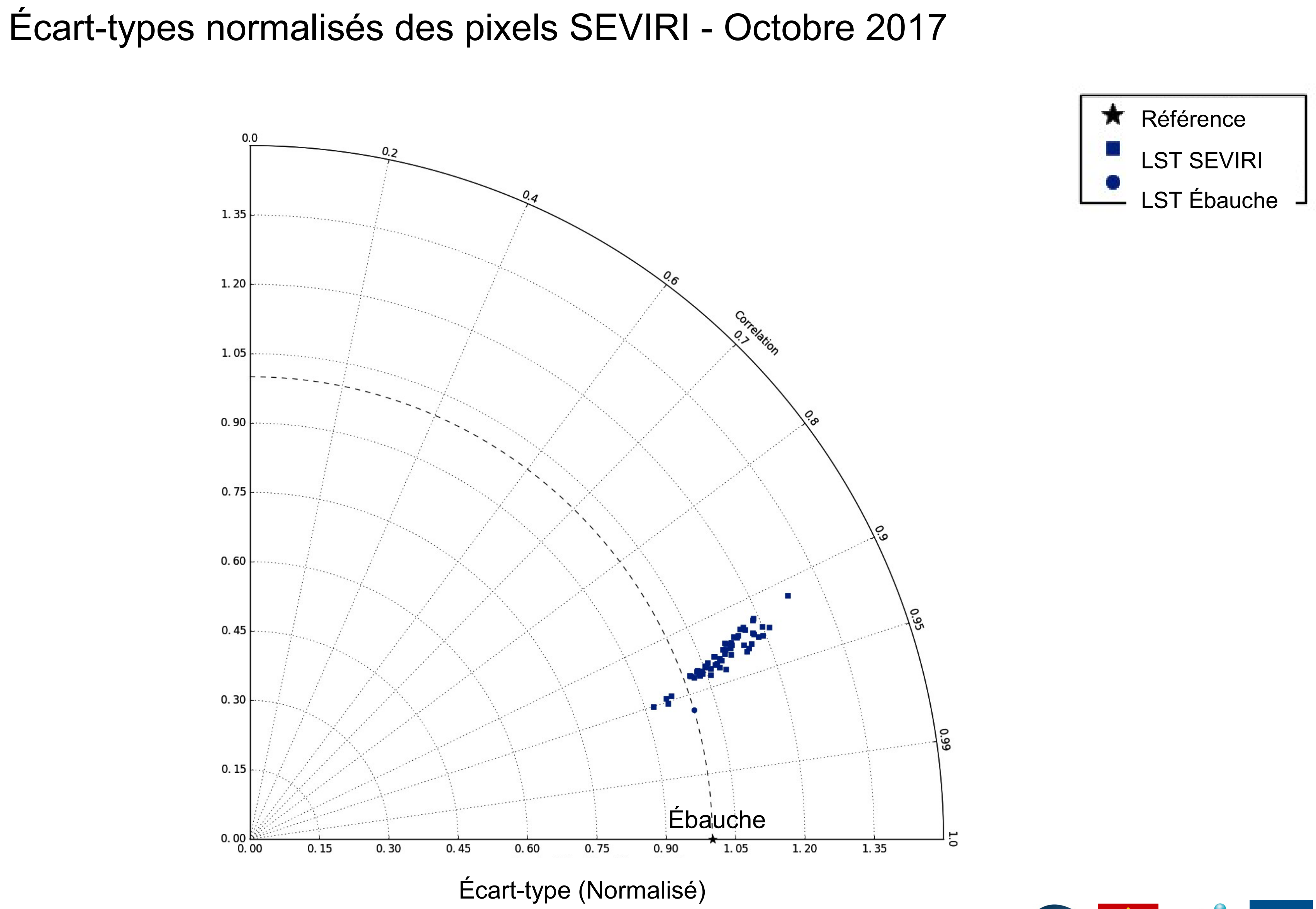
Obs – SEVIRI LST - Ecart-Type



Obs – SEVIRI LST - Biais



Comparaison aux données in-situ – Toulouse Météopole

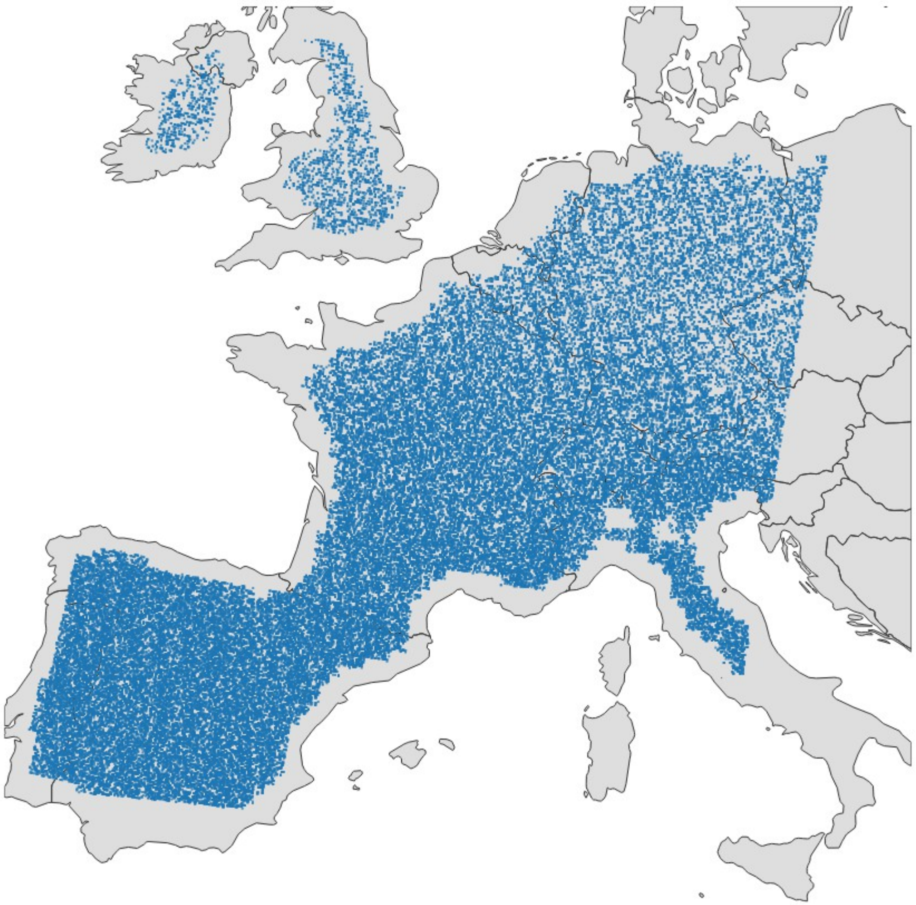


Satellite LST comparison - AMSU-A vs SEVIRI

Filtering coastal pixels in order to avoid contamination by oceans

→ Applying an emissivity threshold of 0.93 (October 2017)

Blacklisted observations



Considered observations

Satellite LST comparison – AMSU-A/B vs SEVIRI

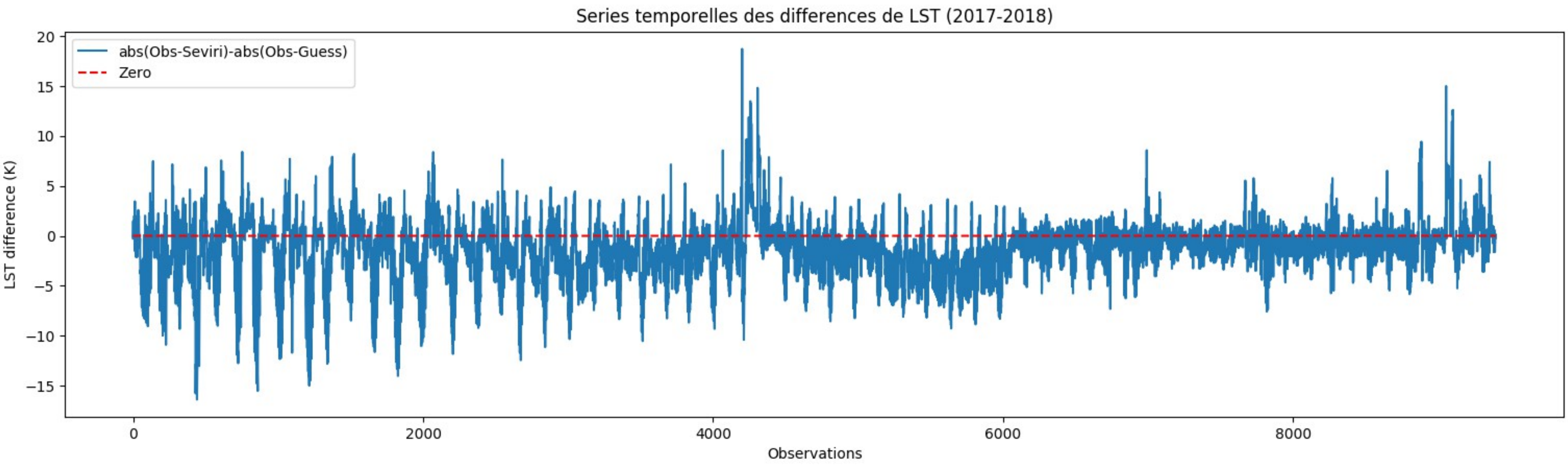
Bias and standard deviation of AMSU-A to SEVIRI LST comparison

	ALL (K)			Night-time (K)			Daytime (K)		
	Bias	S	N° obs	Bias	S	N° obs	Bias	S	N° obs
90 days	**0.424**	**4.306**	**273758**	**2.159**	**3.672**	**101984**	**-0.606**	**4.324**	**171774**

Bias and standard deviation of AMSU-B to SEVIRI LST comparison

	ALL (K)			Night-time (K)			Daytime (K)		
	Bias	S	N° obs	Bias	S	N° obs	Bias	S	N° obs
90 days	**-0.686**	**5.186**	**216644**	**0.762**	**4.790**	**92998**	**-1.775**	**5.206**	**123646**

Comparaison aux données in-situ – EVORA



Comparaison aux données in-situ – EVORA