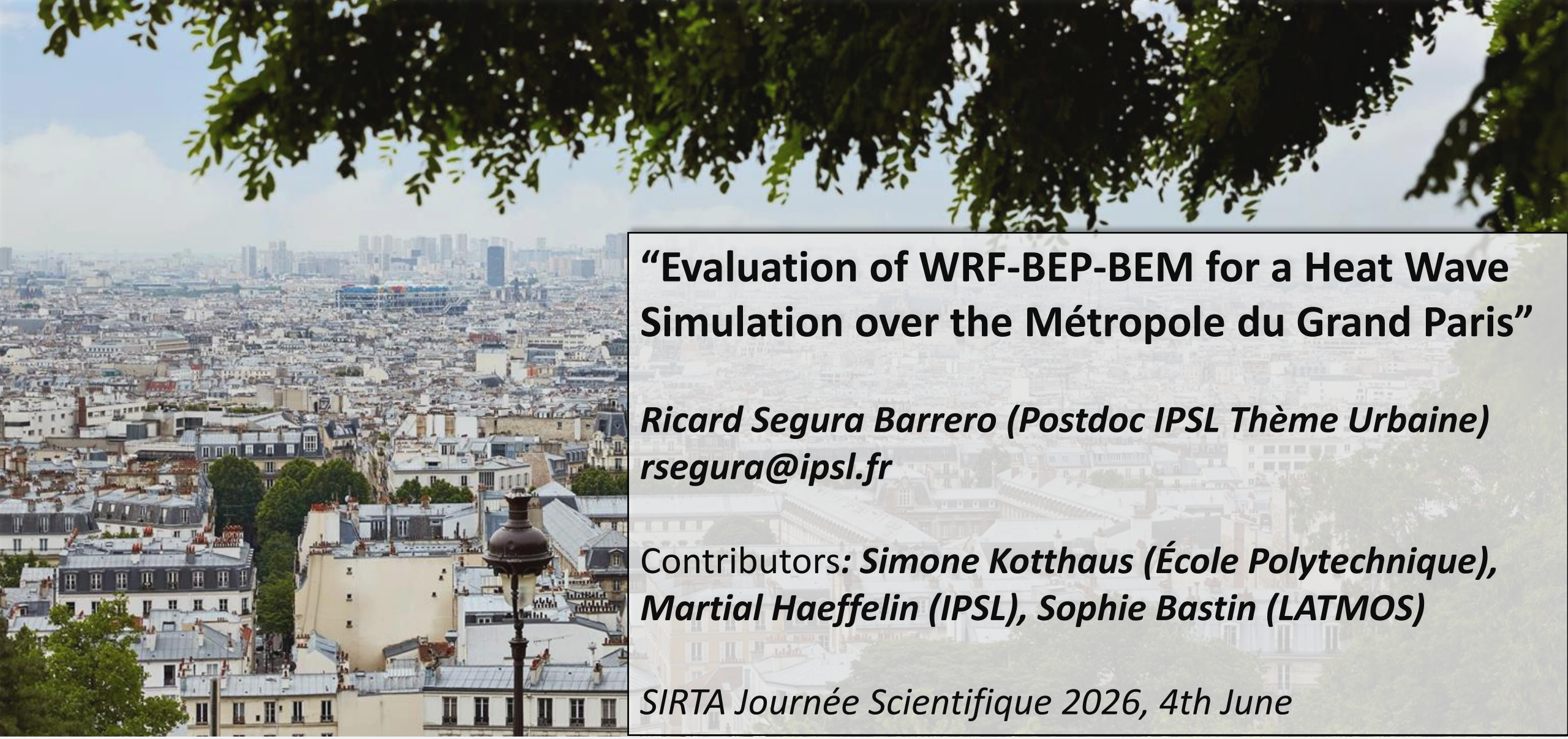

“Evaluation of WRF-BEP-BEM for a Heat Wave Simulation over the Métropole du Grand Paris”

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Contributors***: Simone Kotthaus (École Polytechnique), Martial Haeffelin (IPSL), Sophie Bastin (LATMOS)***

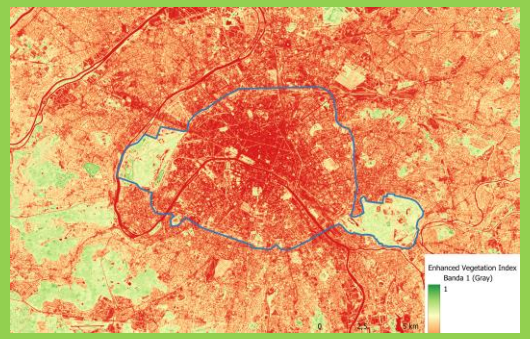
SIRTA Journée Scientifique 2026, 4th June

SIRTA LMD inteGREEN IPSL SORBONNE UNIVERSITÉ FRANCE 2030 PROGRAMME DE RECHERCHE VILLE DURABLE

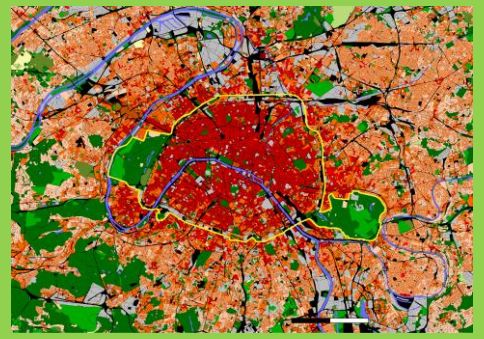
Context

Vegetation health and growth indicators

Sentinel-2 Derived Vegetation Indices

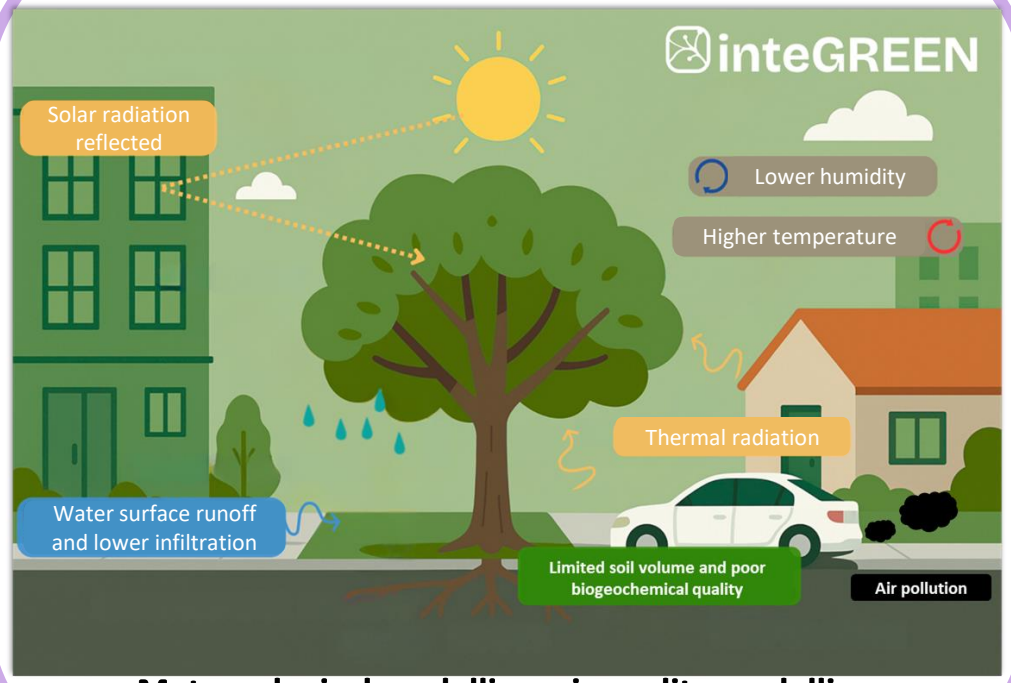


Vegetation Characterisation



2018-2025

Abiotic stress indicators



Meteorological modelling, air quality modelling, Soil measurement campaigns, tree management surveys

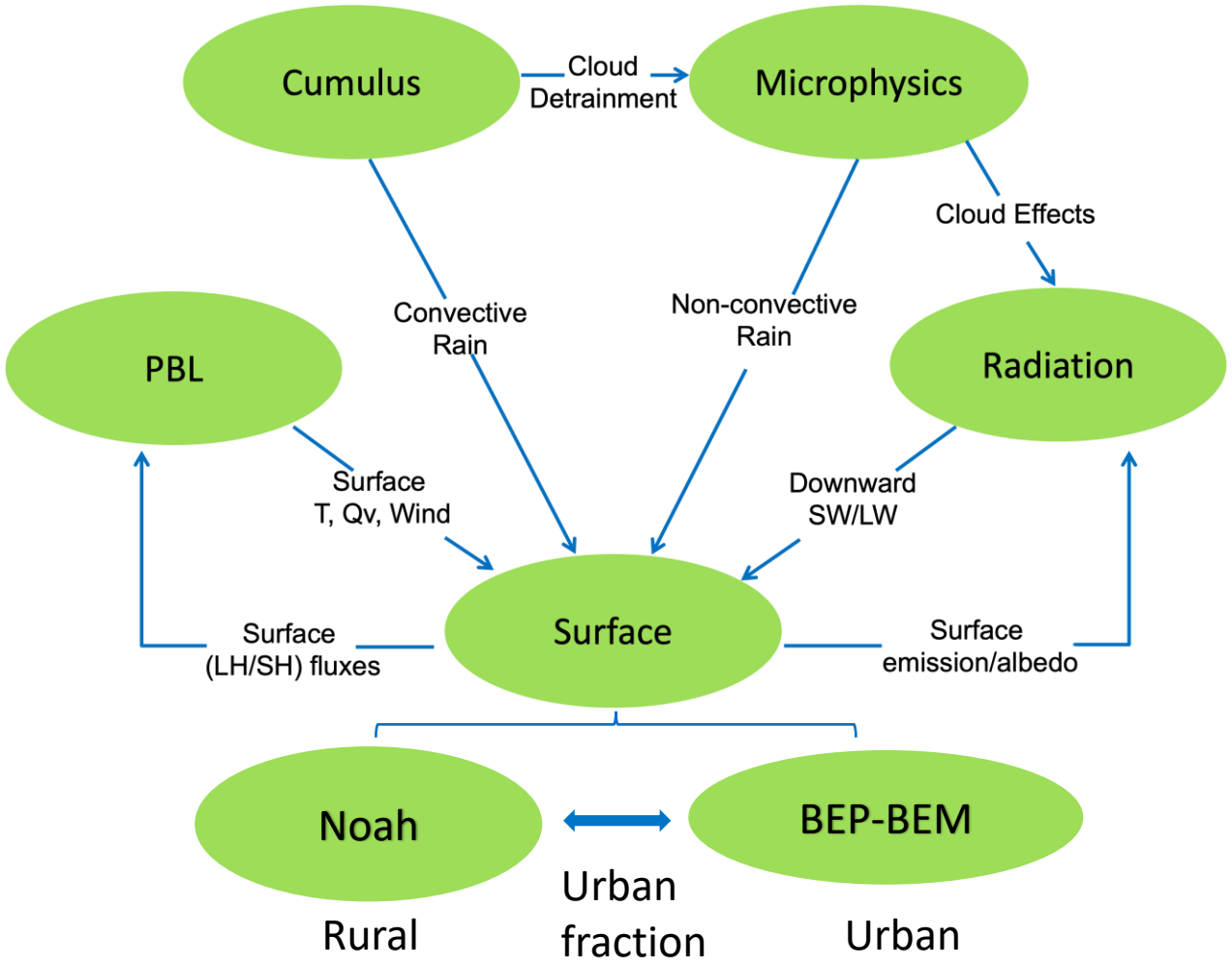
Statistical Attribution of Vegetation Stress
Best urban greening practices

IPSL SIRTA

inteGREEN

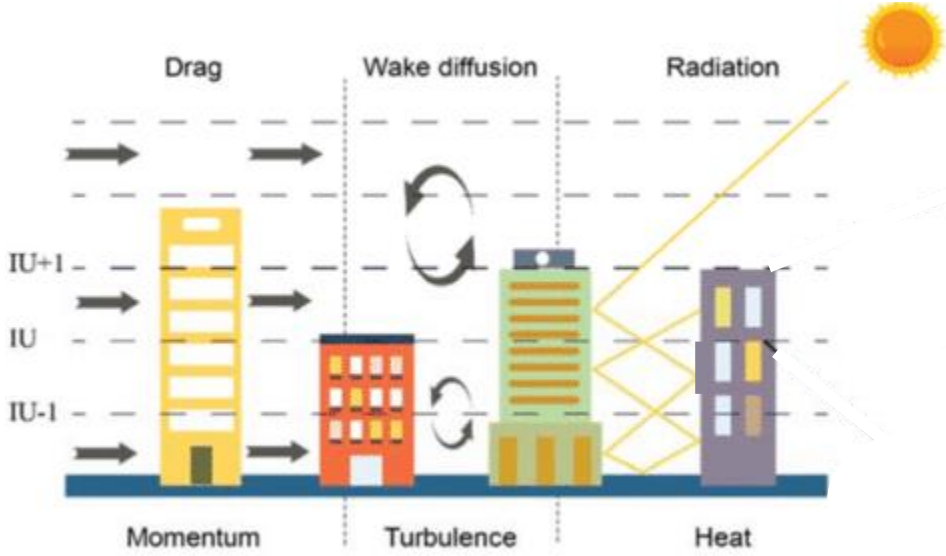
WRF-BEB-BEM model

Weather Research and Forecasting (WRF) physical parameterizations

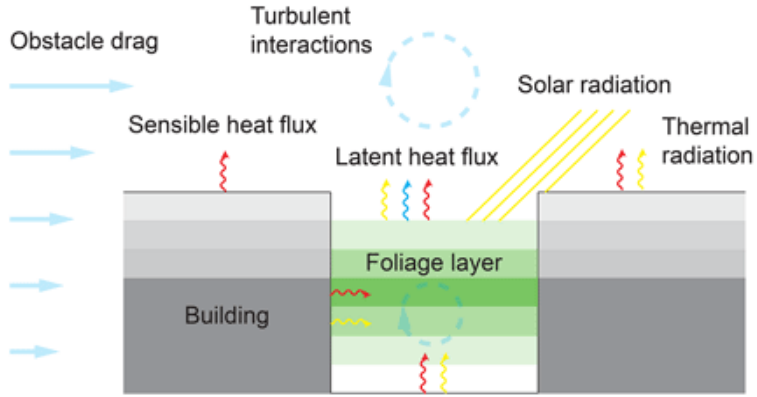


Building Effect Parameterisation and Building Energy Model (BEP-BEM)

Current model



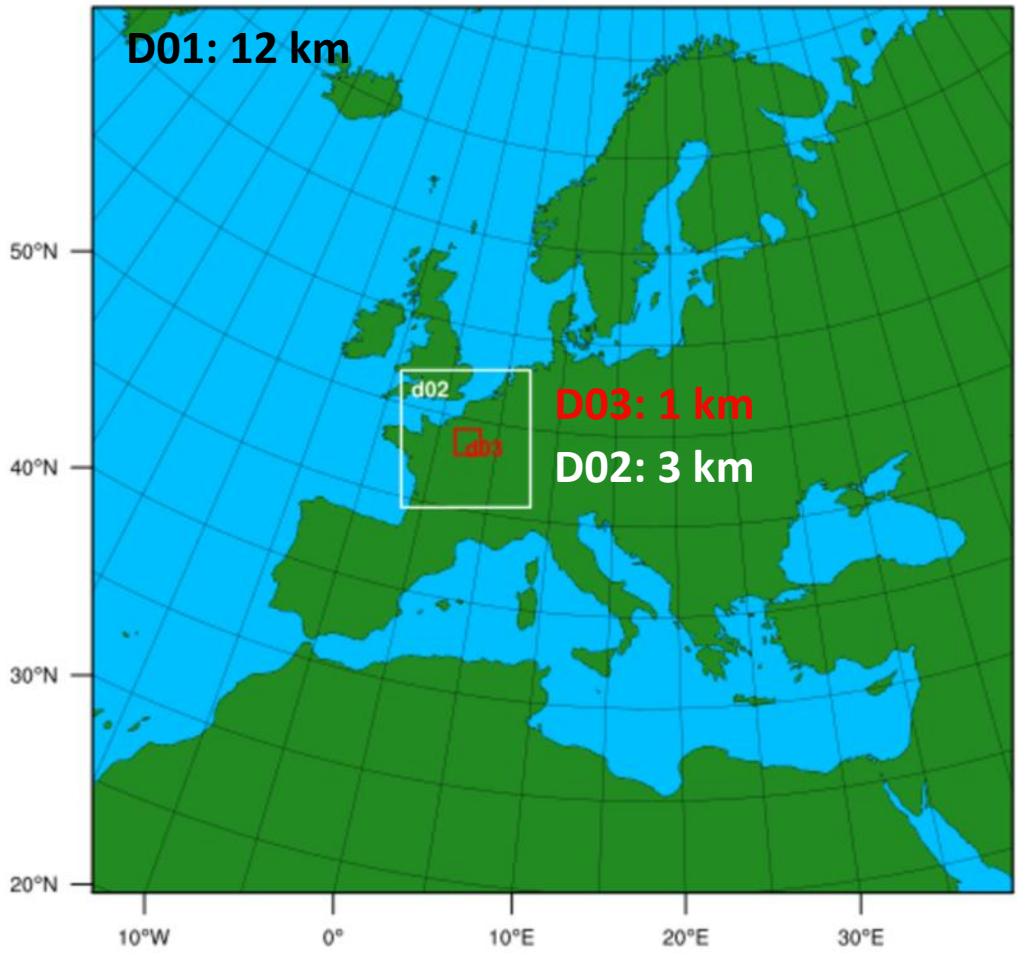
Future desired model



BEP-Tree

Methodology

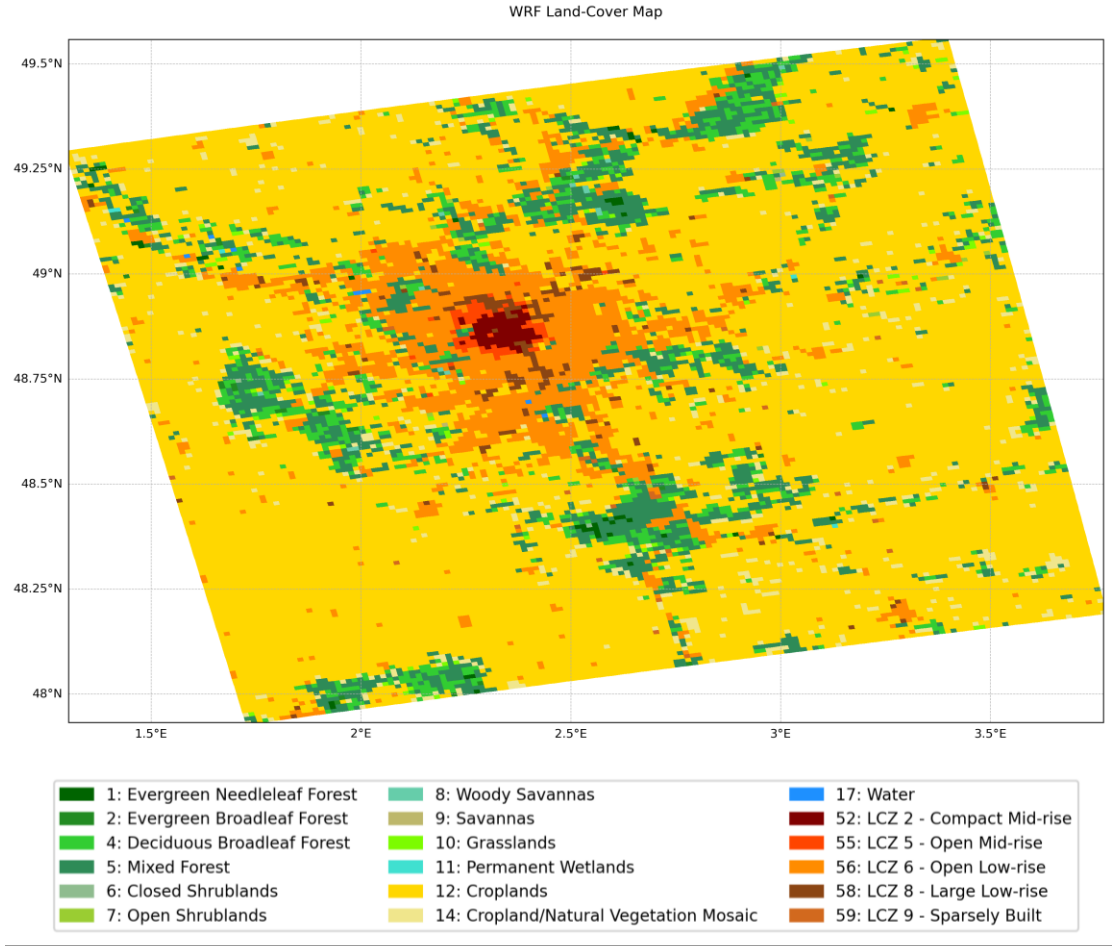
WRF domains



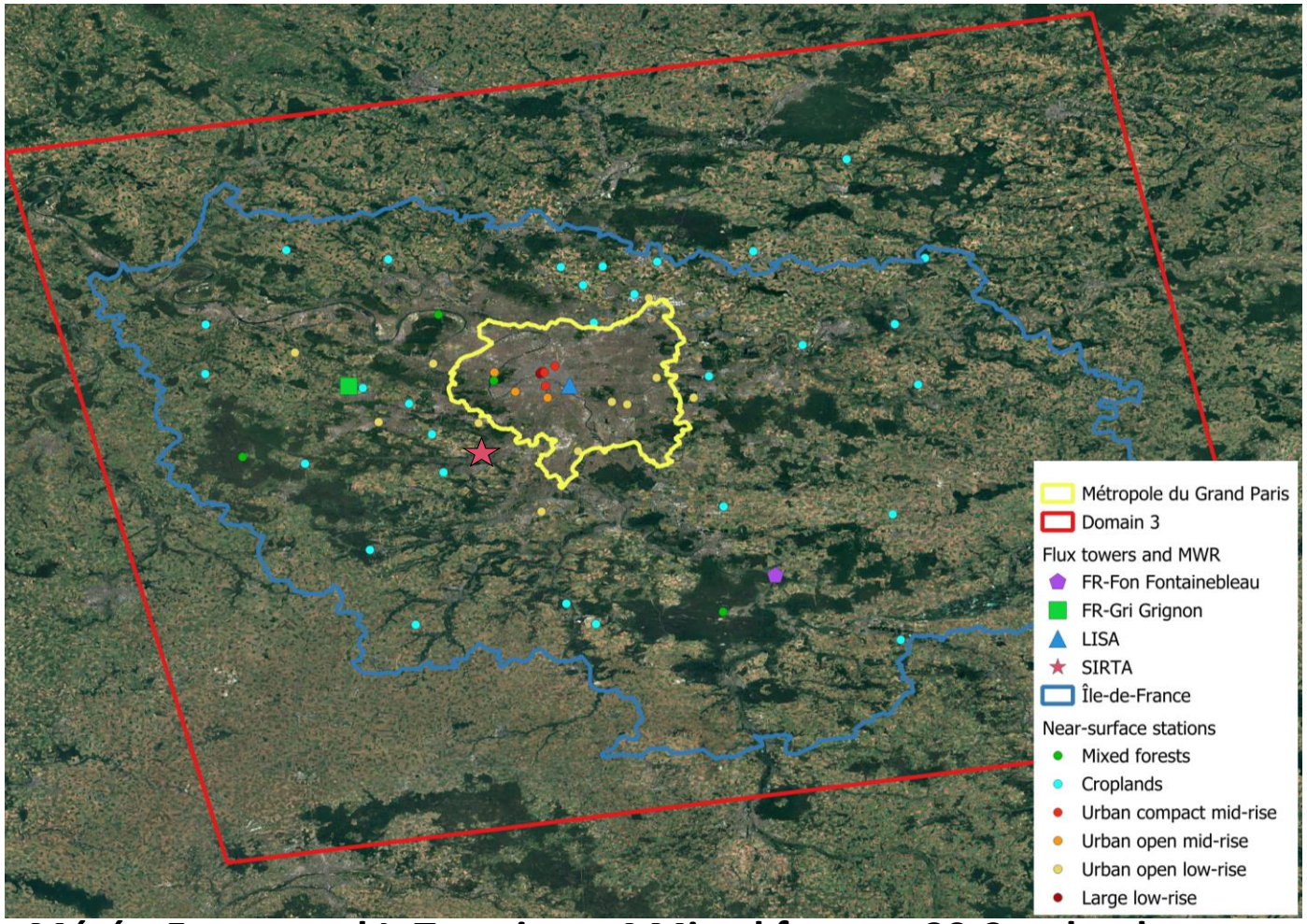
Period of study: 2 July 2022 to 23 July 2022 (+1 day of model spin-up)

Methodology

WRF Domain 3 Land-cover map



Near-surface meteorological stations for model evaluation

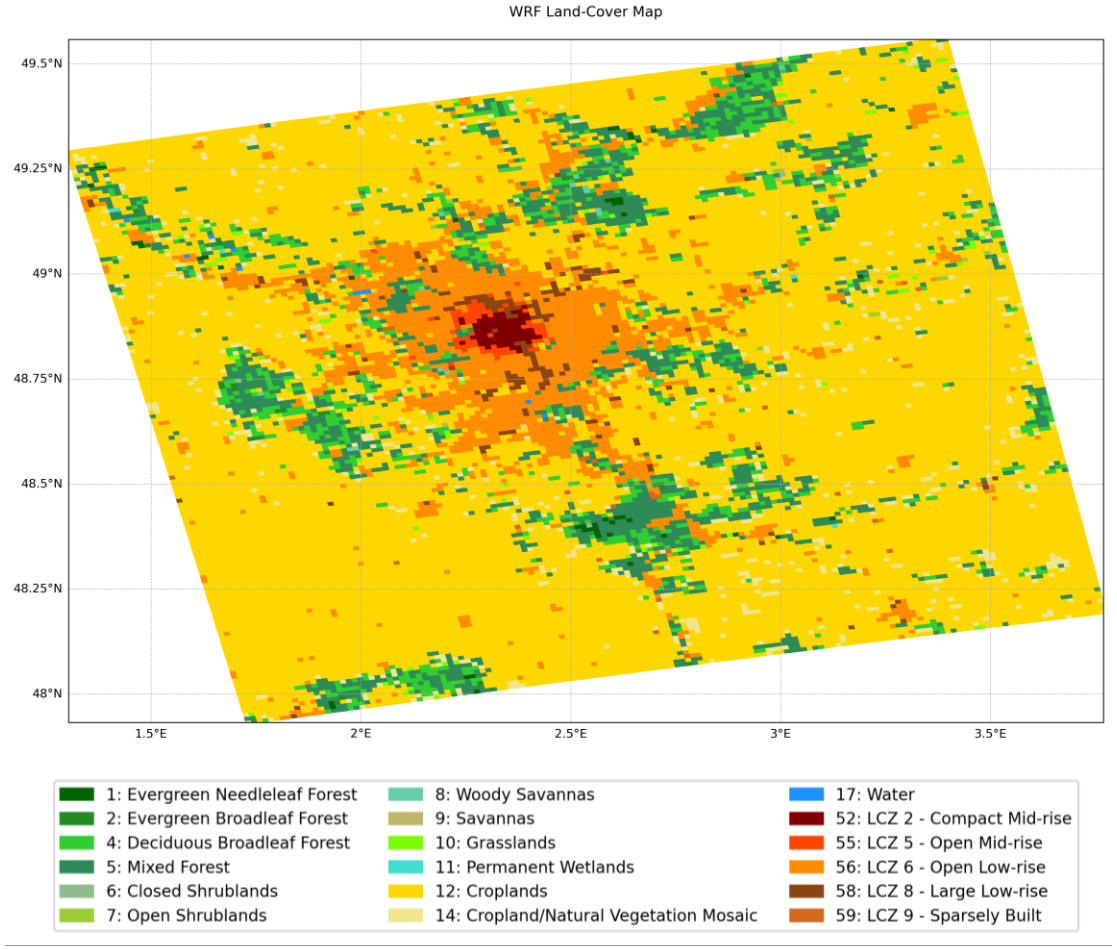


Météo-France and IoT stations: 4 Mixed forests; 29 Croplands

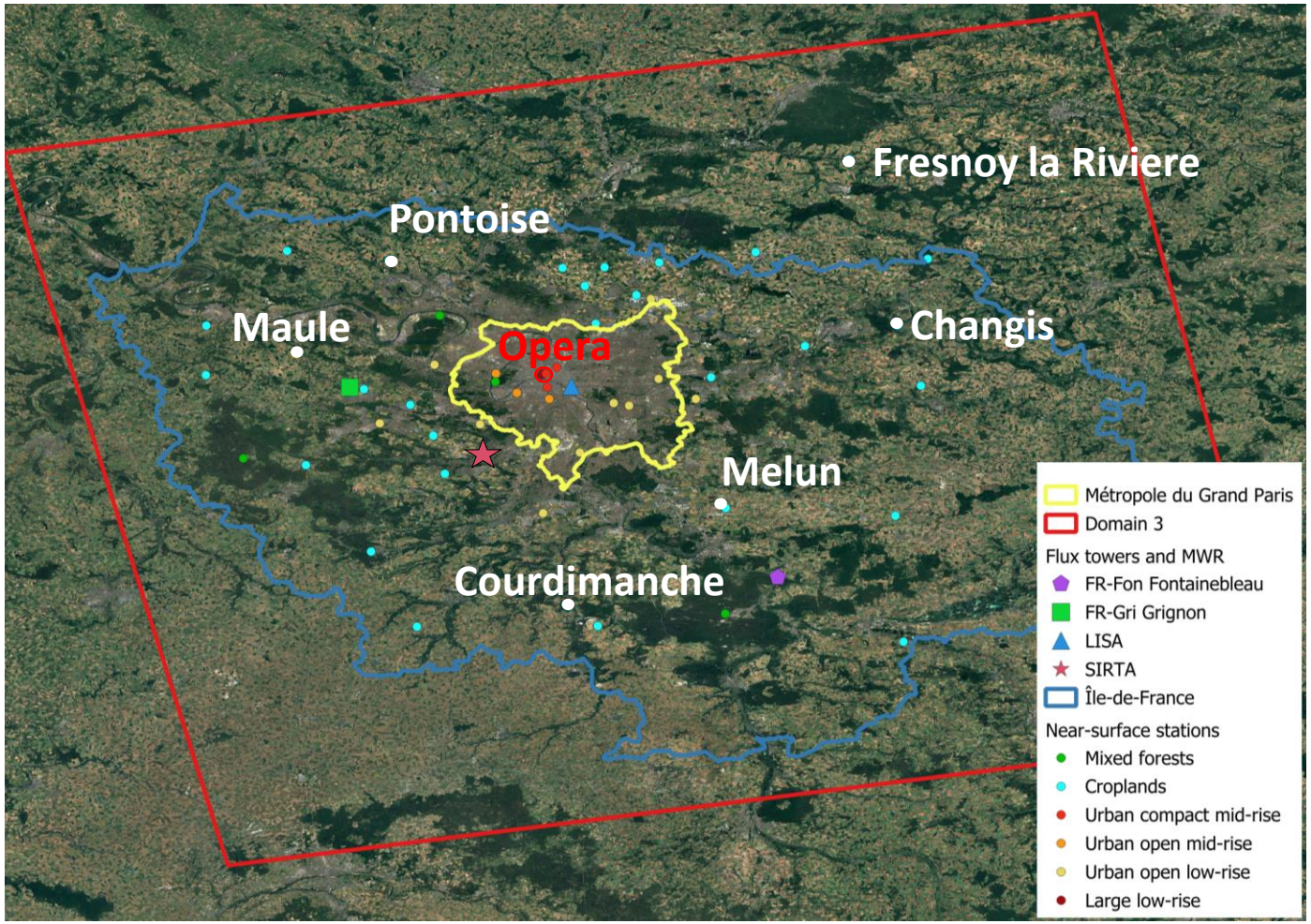
4 Urban Compact mid-rise; 4 Open mid-rise; 11 Open low-rise; 2 Large low-rise

Methodology

WRF Domain 3 Land-cover map



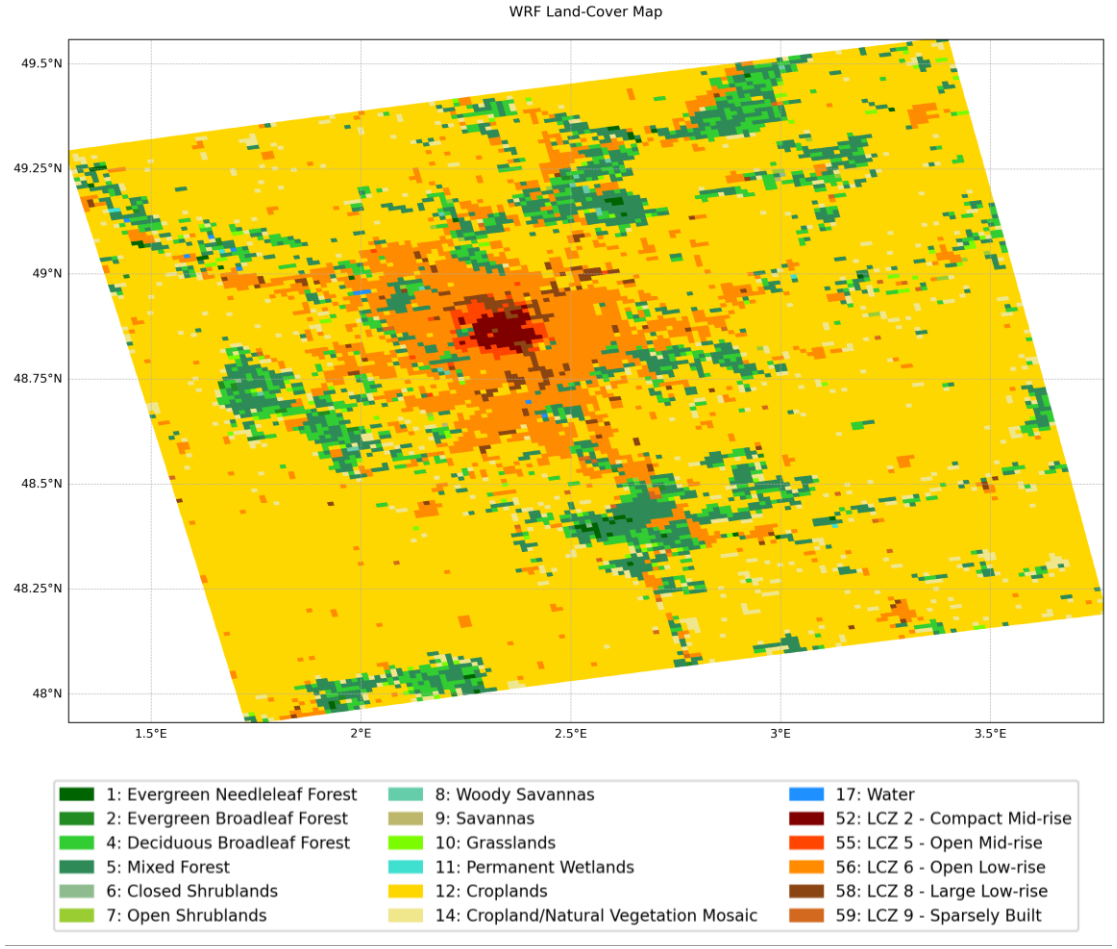
Near-surface meteorological stations for model evaluation



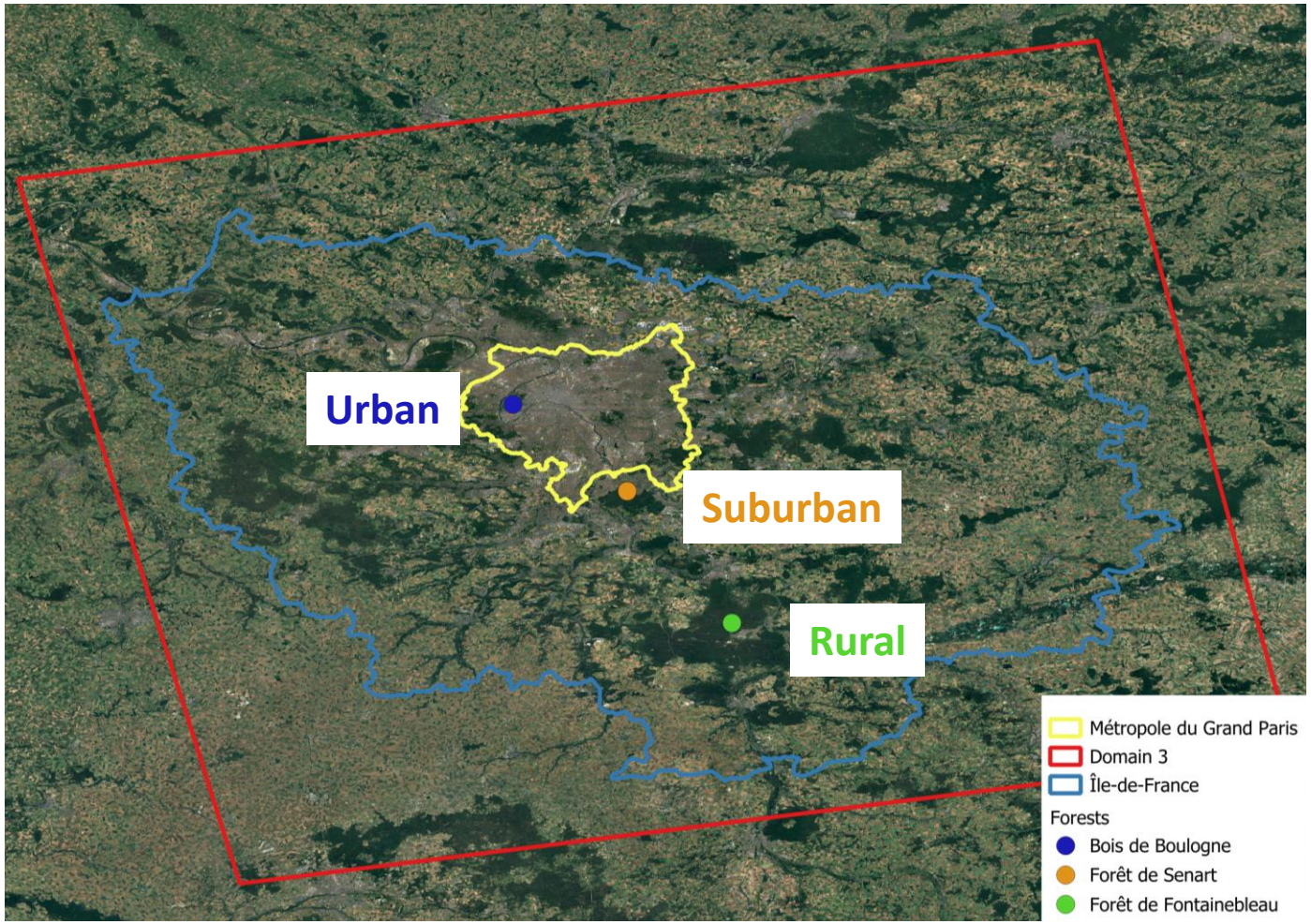
Urban Heat Island (UHI) = Tair (urban average) – Tair (rural average)

Methodology

WRF Domain 3 Land-cover map



Forests grid cells

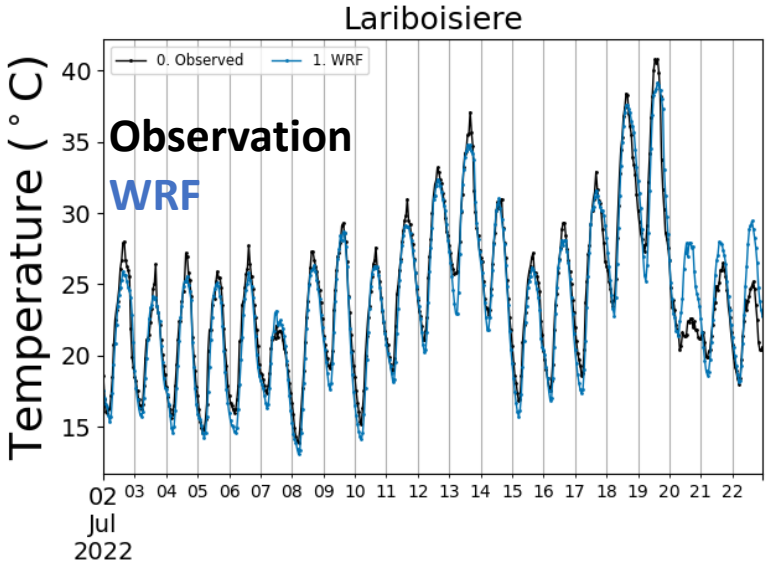


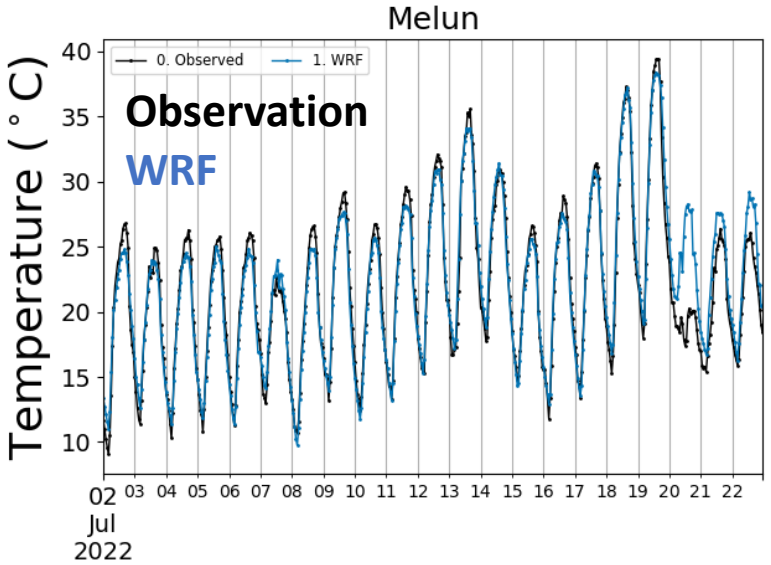
Near-surface evaluation of temperature and humidity

URBAN

RURAL

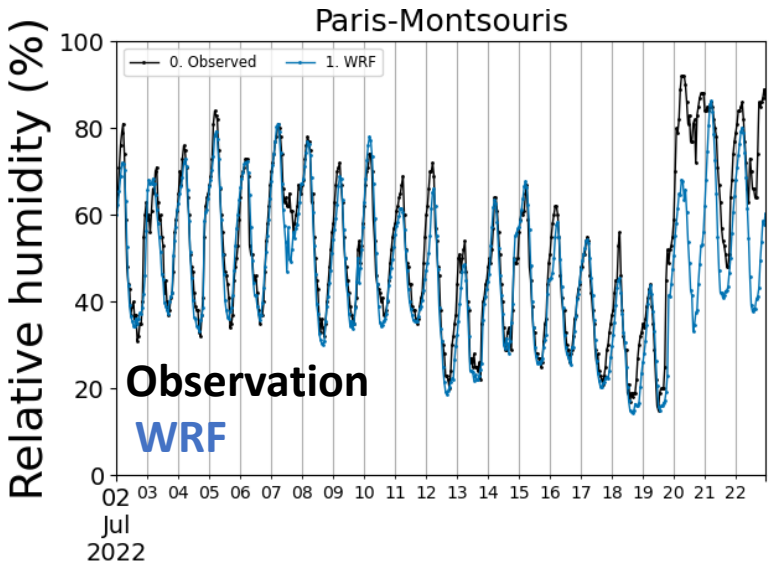
Overall:
RMSE = 1.87 ^{o}C
MB = 0.05 ^{o}C
Night-time:
RMSE = 1.72 ^{o}C
MB = -0.01 ^{o}C
Daytime:
RMSE = 1.90^{o}C
MB = -0.27 ^{o}C

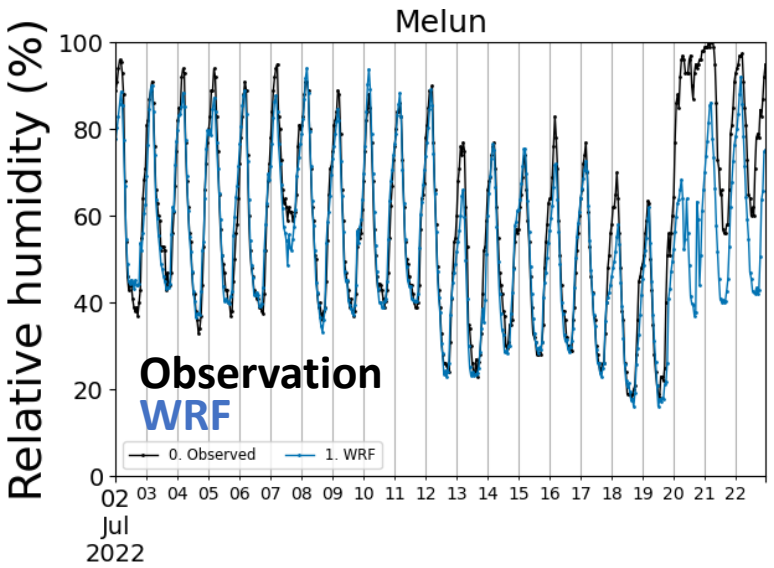




Overall:
RMSE = 1.86 ^{o}C
MB = 0.30 ^{o}C
Night-time:
RMSE = 1.80 ^{o}C
MB = **0.84 ^{o}C**
Daytime:
RMSE = 1.89^{o}C
MB = -0.04 ^{o}C

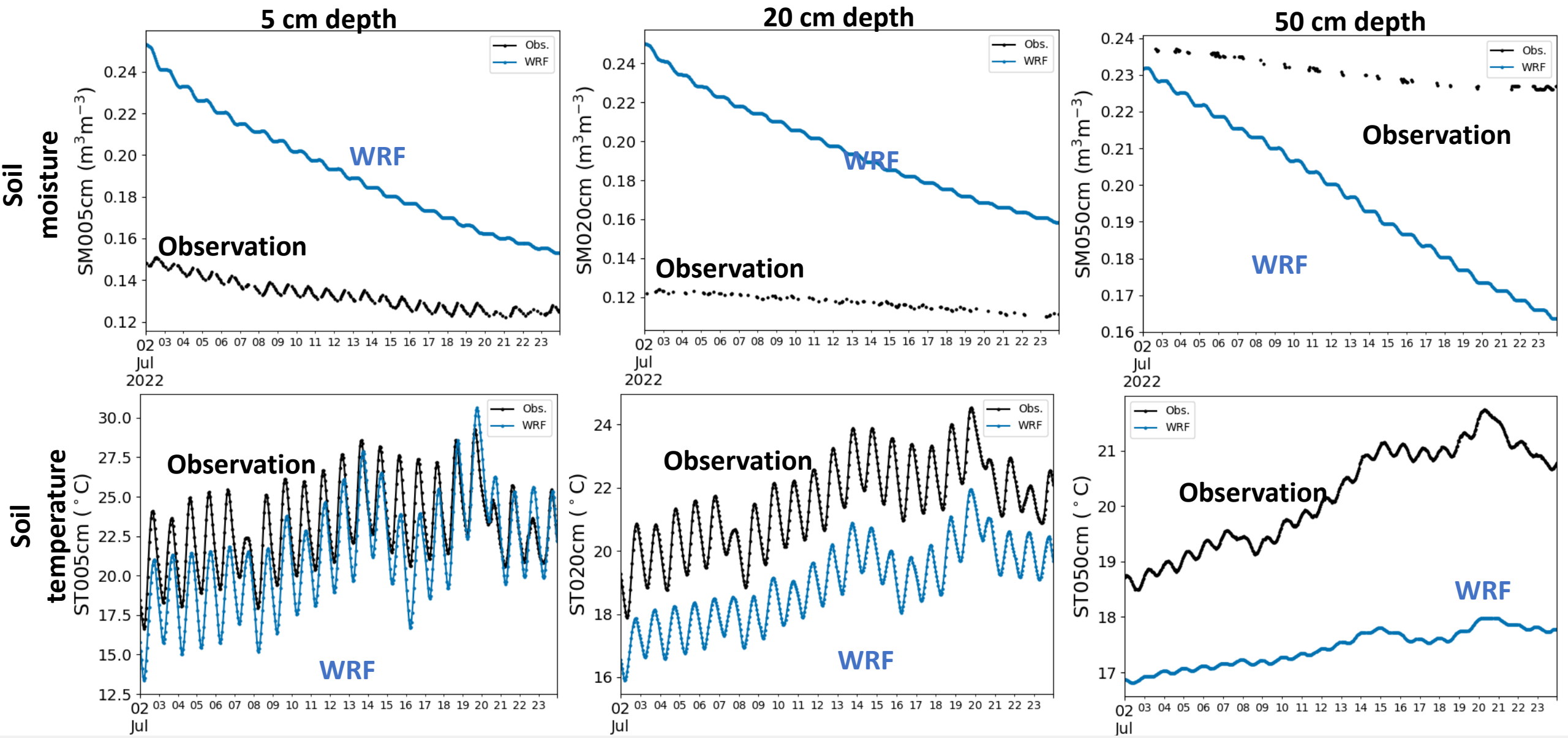
Overall:
RMSE = 13.5 %
MB = 3.5 %





Overall:
RMSE = 10.7 %
MB = -2.8 %

Soil properties evaluation at SIRTA

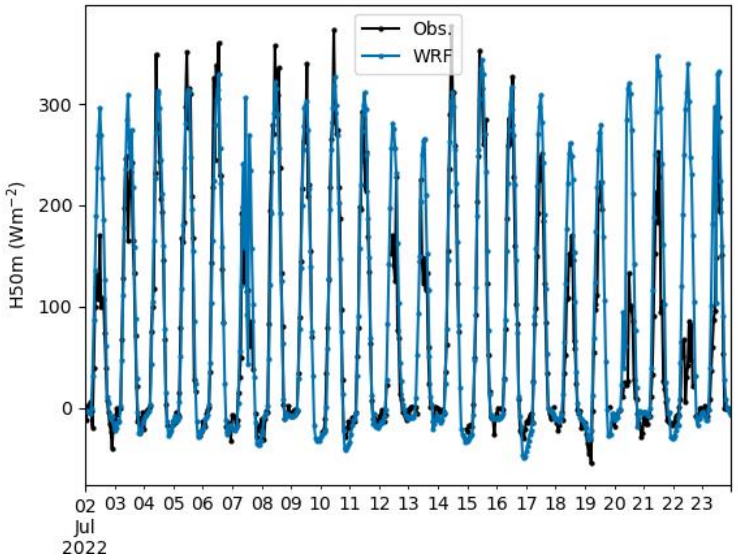


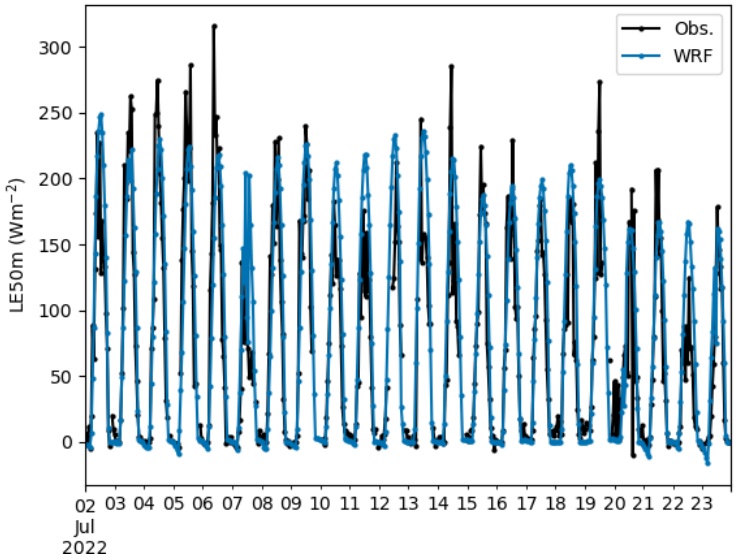
Evaluation of heat fluxes: SIRTA, Fontainebleau and Grignon

Sensible heat flux

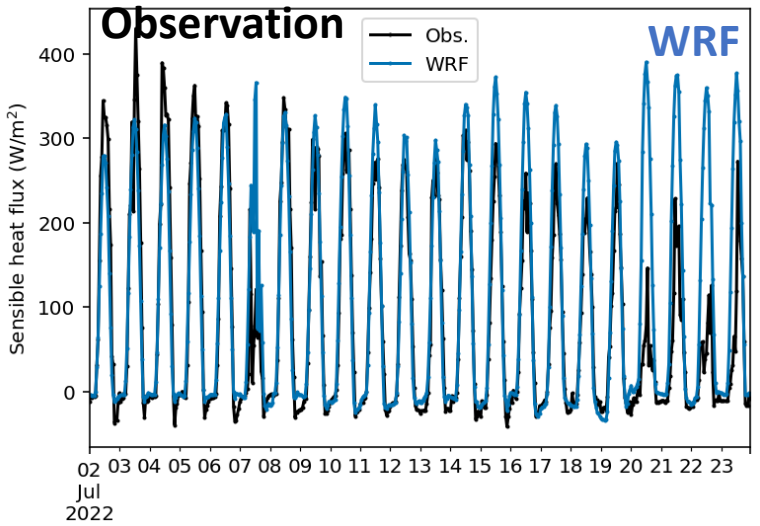
Latent heat flux

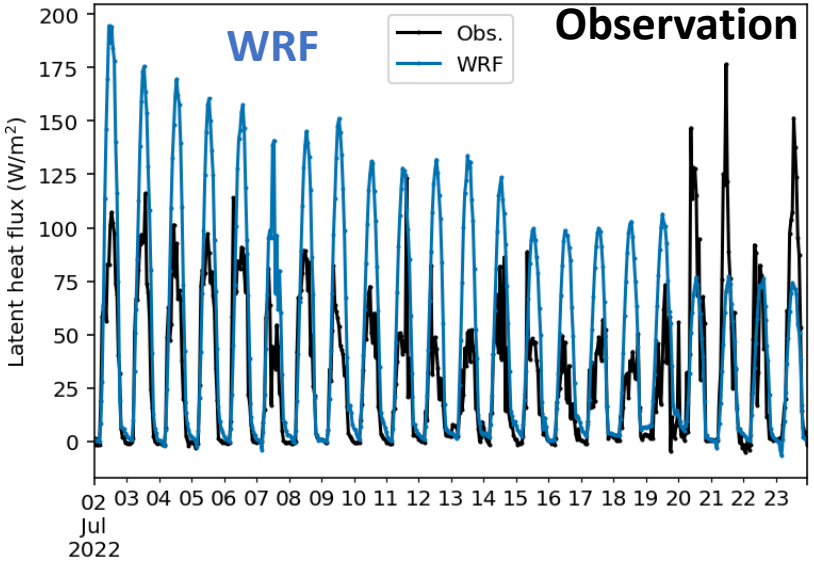
SIRTA (heterogeneous land-cover)



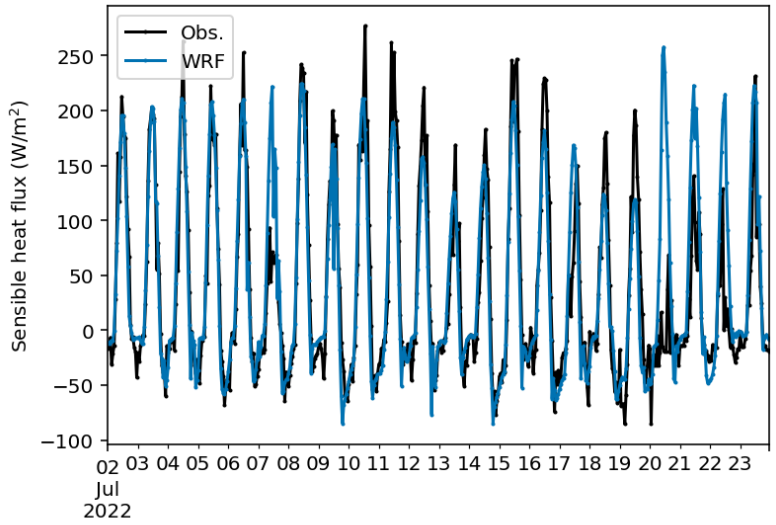


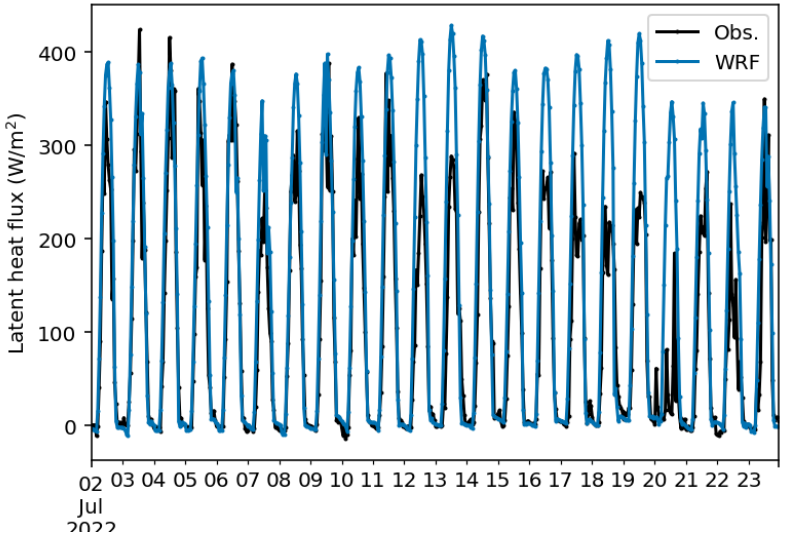
Grignon (Cropland)





Fontainebleau (Forest)



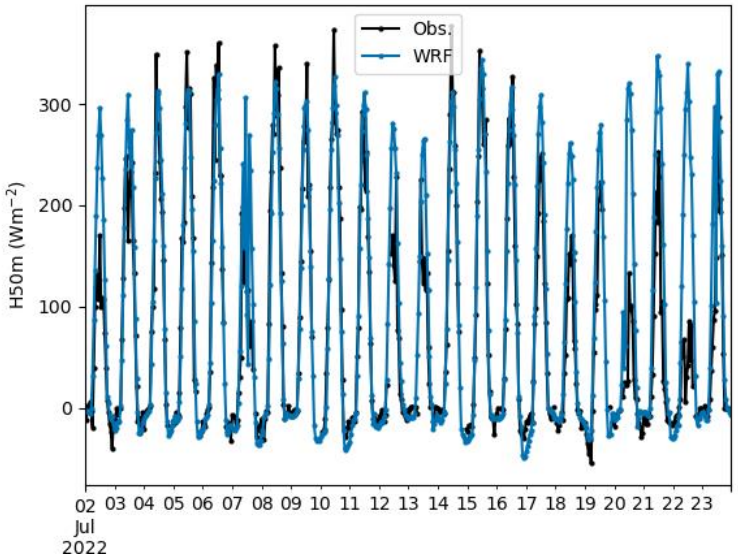


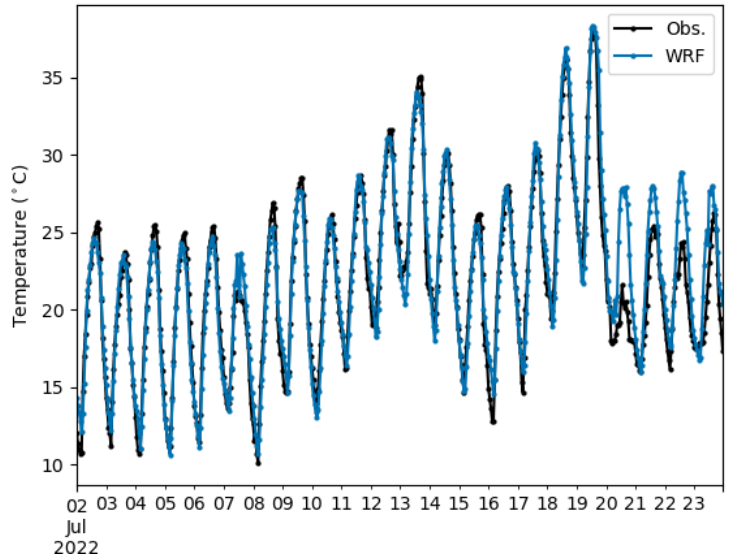
Evaluation of heat fluxes: SIRTA, Fontainebleau and Grignon

Sensible heat flux

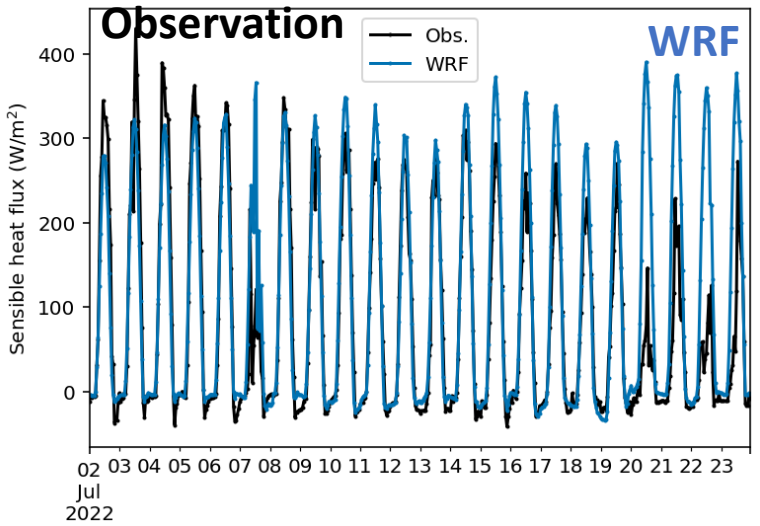
Air temperature

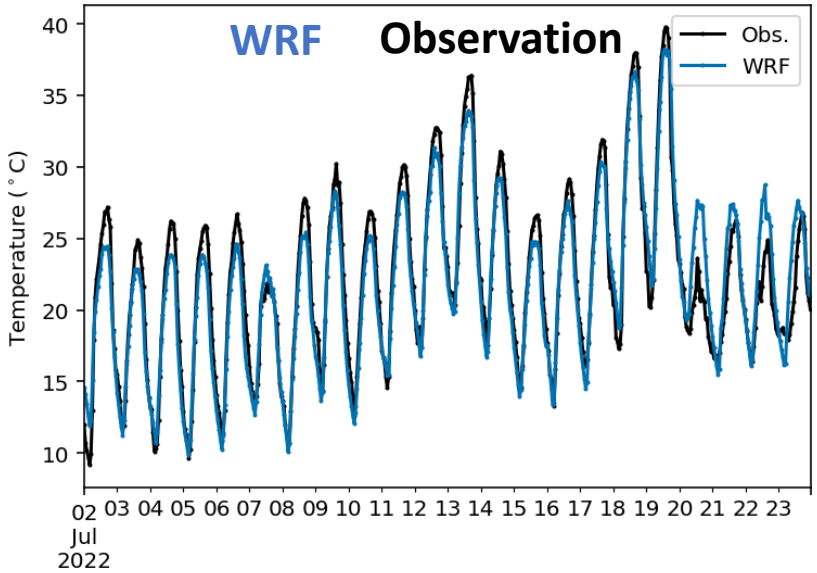
SIRTA (heterogeneous land-cover)



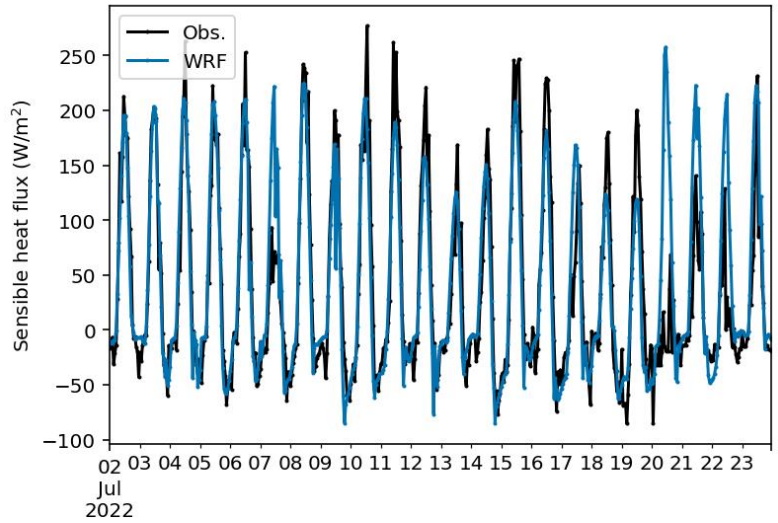


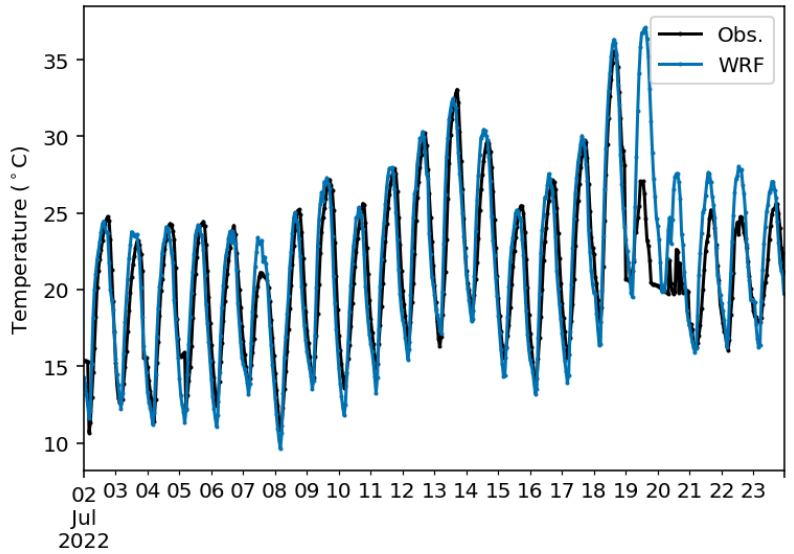
Grignon (Cropland)



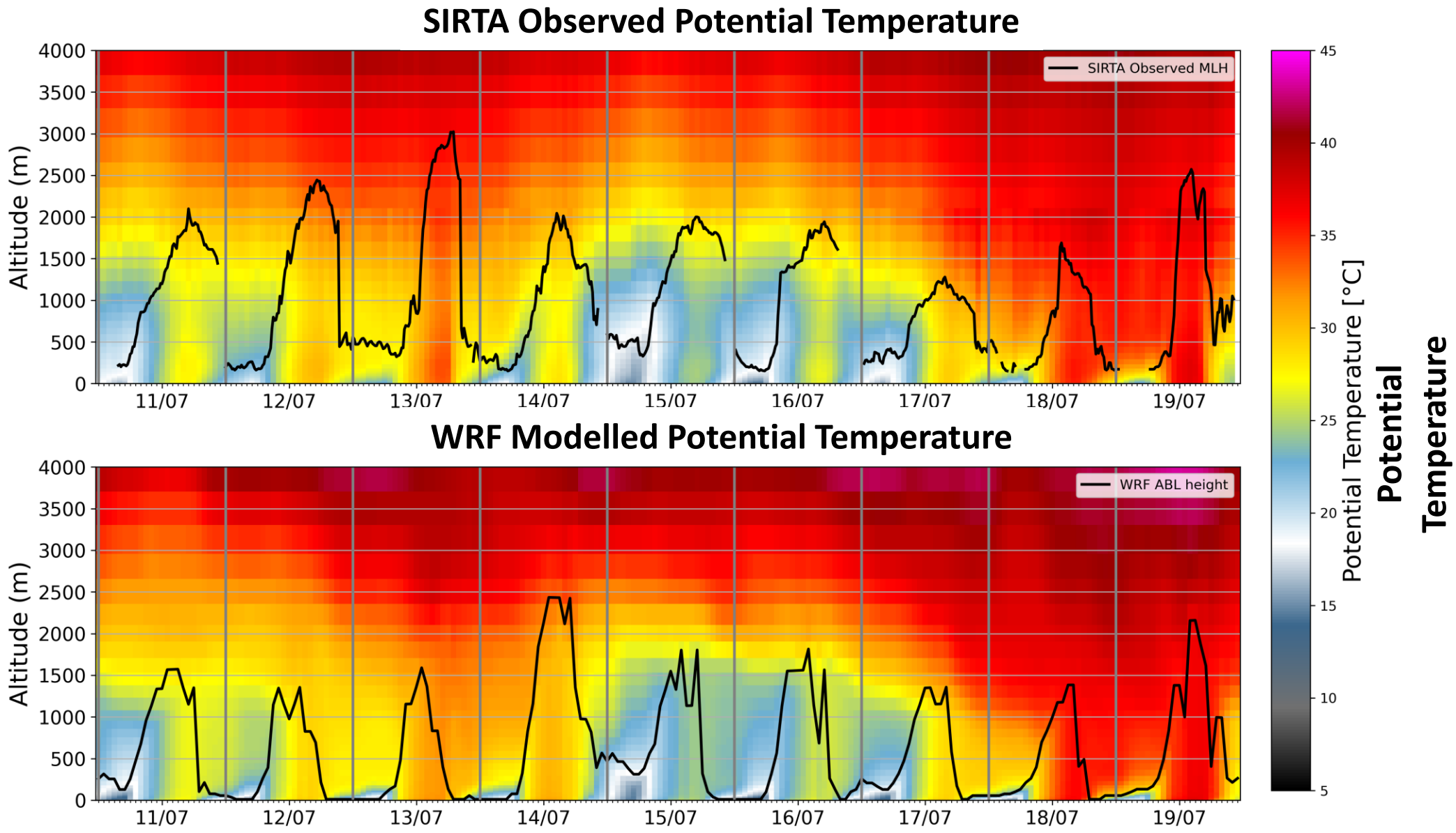


Fontainebleau (Forest)

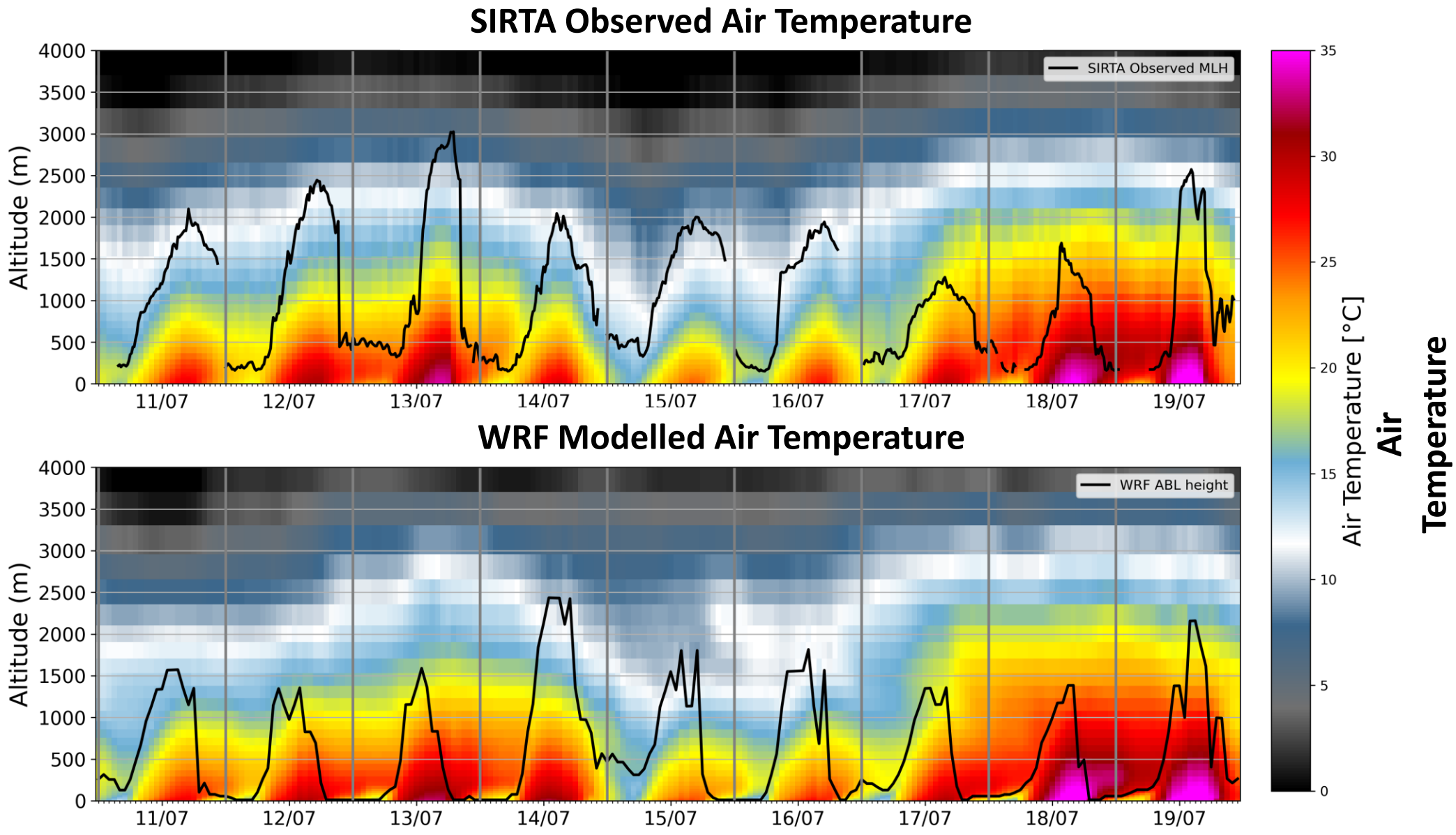




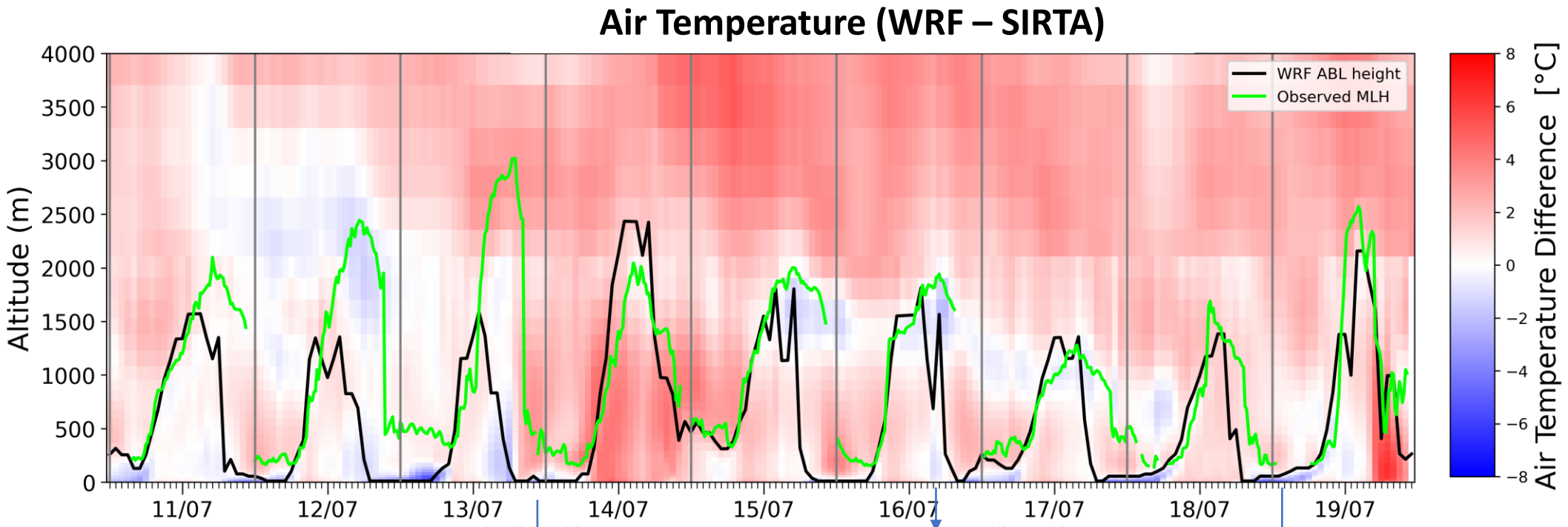
PBL dynamics during the July 2022 Heat Wave

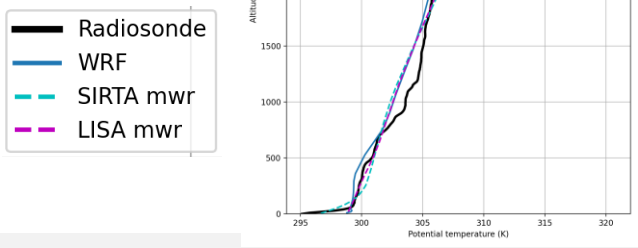


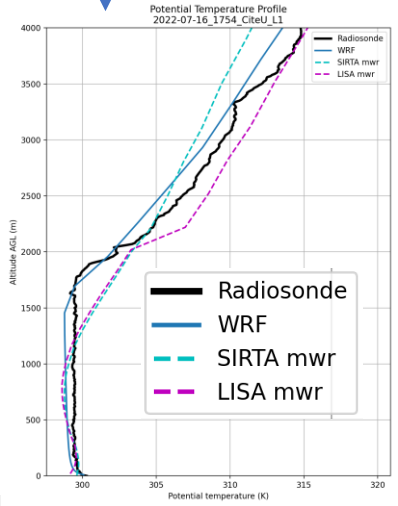
PBL dynamics during the July 2022 Heat Wave

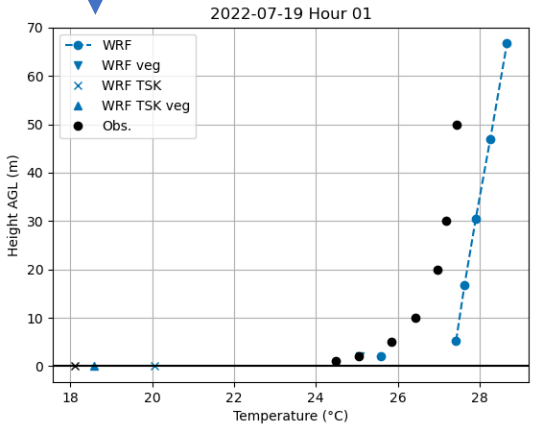


PBL dynamics during the July 2022 Heat Wave

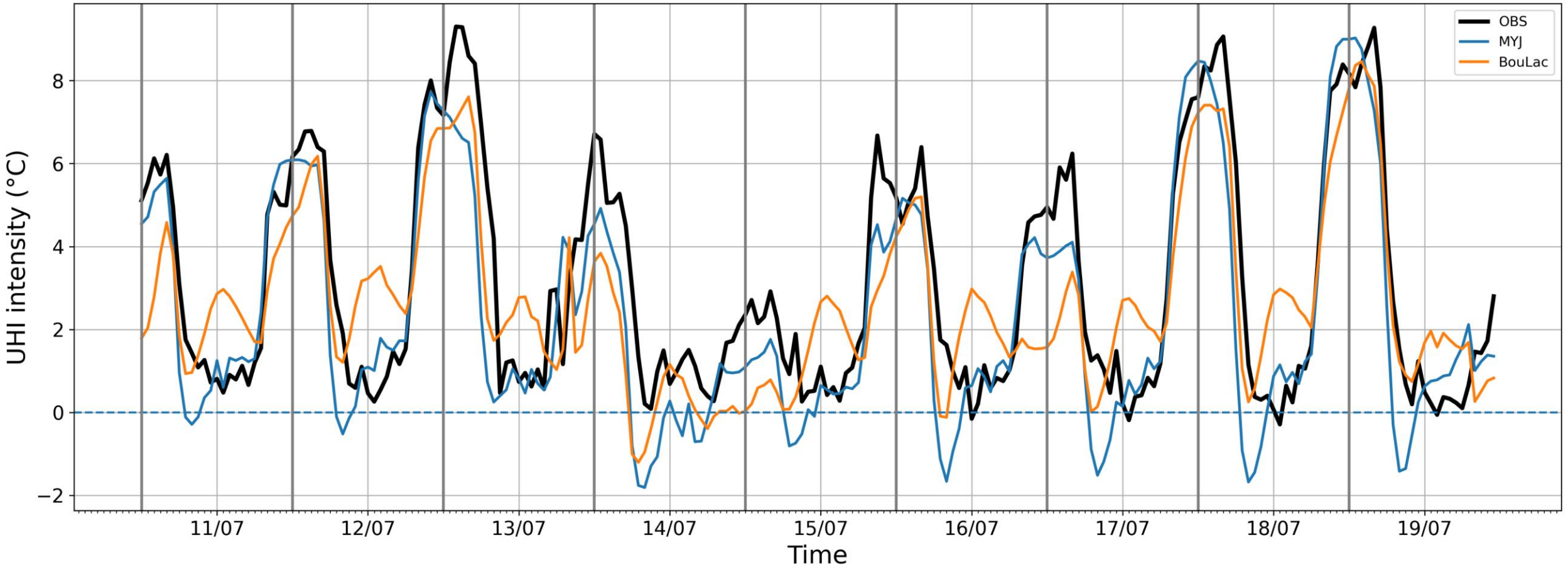








Urban heat Island effect

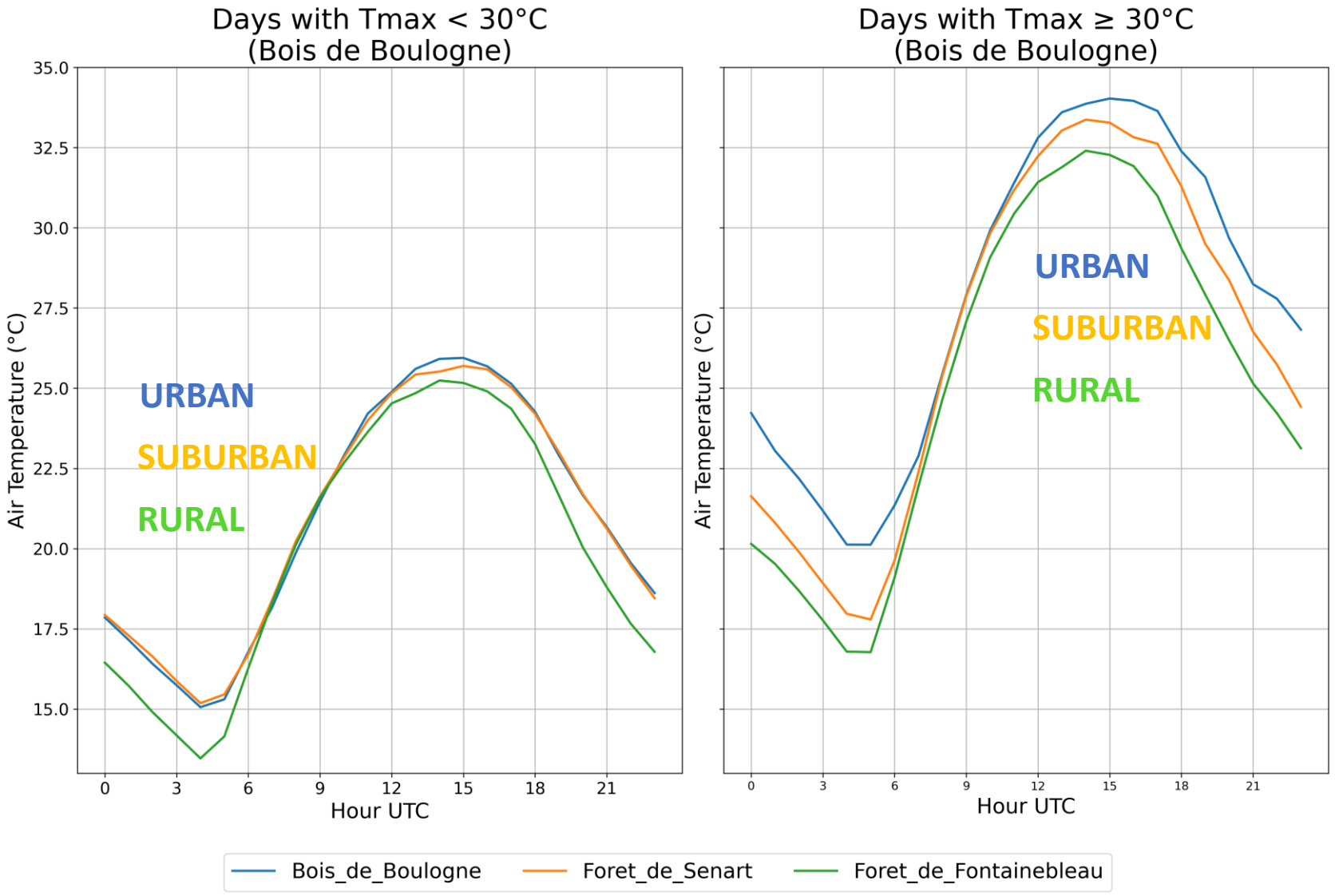


Urban Heat Island (UHI) = Tair (urban average) – Tair (rural average)

Urban Woods vs Rural Woods

Heat wave exacerbates night-time temperature differences from 1.7 °C to 3.5 °C,

And daytime differences from 0.6 °C to 1.8 °C.



Conclusions and perspectives

Good overall model performance

- Accurate simulation of **urban and rural air temperature and relative humidity**.
- Slight **night-time warm bias in rural areas** → Underestimation of the simulated **Urban Heat Island intensity**.

Land-surface processes remain challenging

- Soil moisture and soil temperature differ from observations at the SIRTA Observatory.
- However:
  - Surface heat fluxes are well represented across different land-cover types.

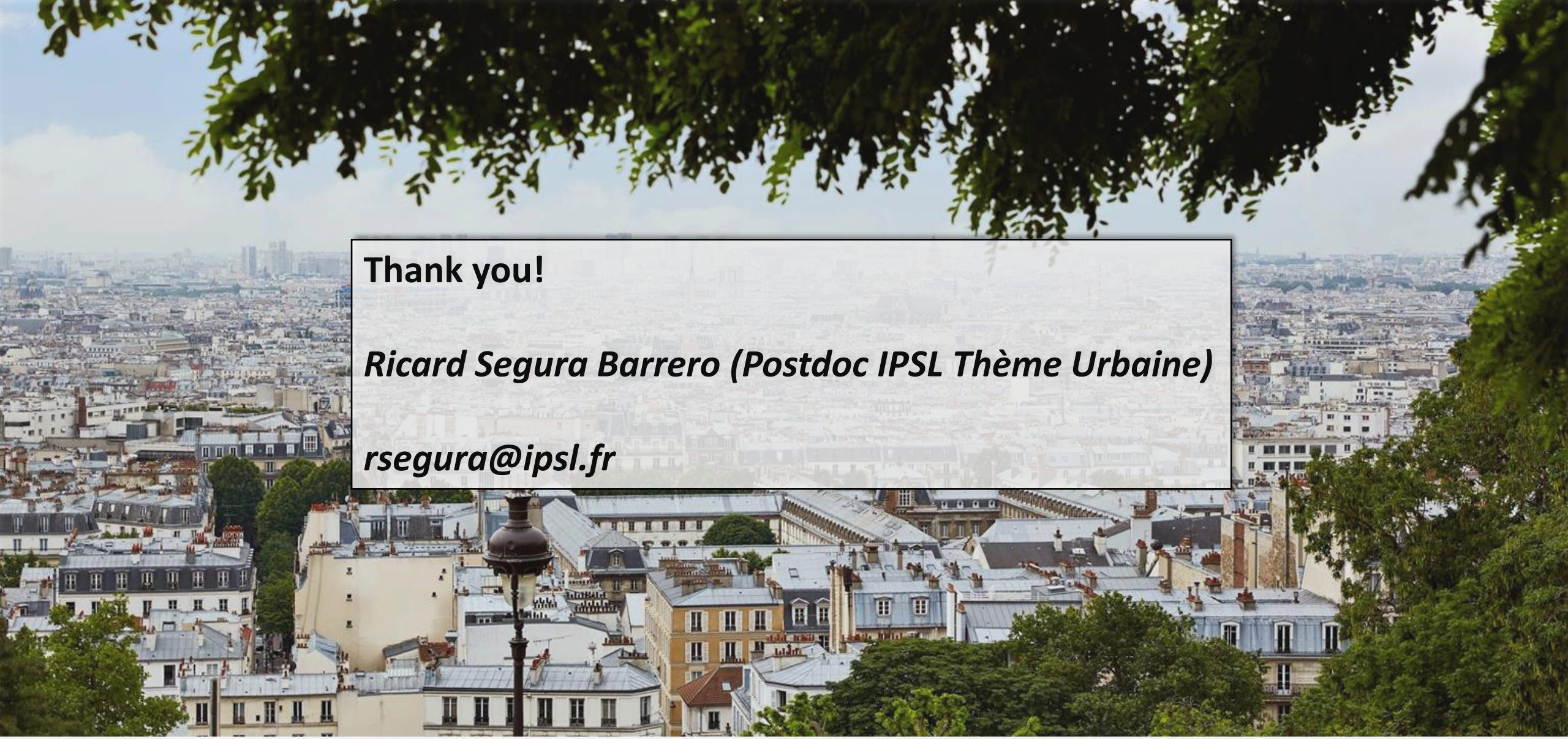
Accurate representation of boundary layer dynamics

- Good simulation of the heat wave episode
- Strong agreement with observed vertical air and potential temperature profiles
- Performance comparable to, or better than, microwave radiometer retrievals

Urbanisation and heat wave impacts on woodlands are captured

Next step

Include and analyse the representation of street trees in the Urban Canopy Model and their impact on the atmosphere.



Thank you!

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