The Bureau of Meteorology

Assessing sub-km models for a heatwave event over Paris

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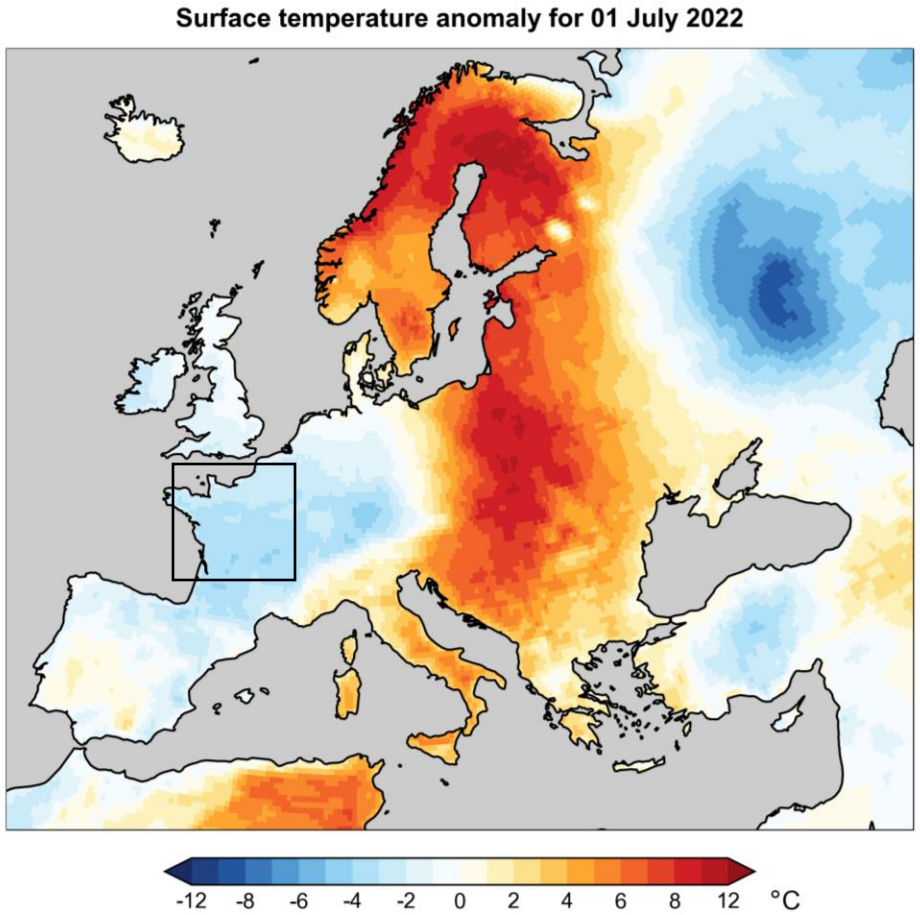
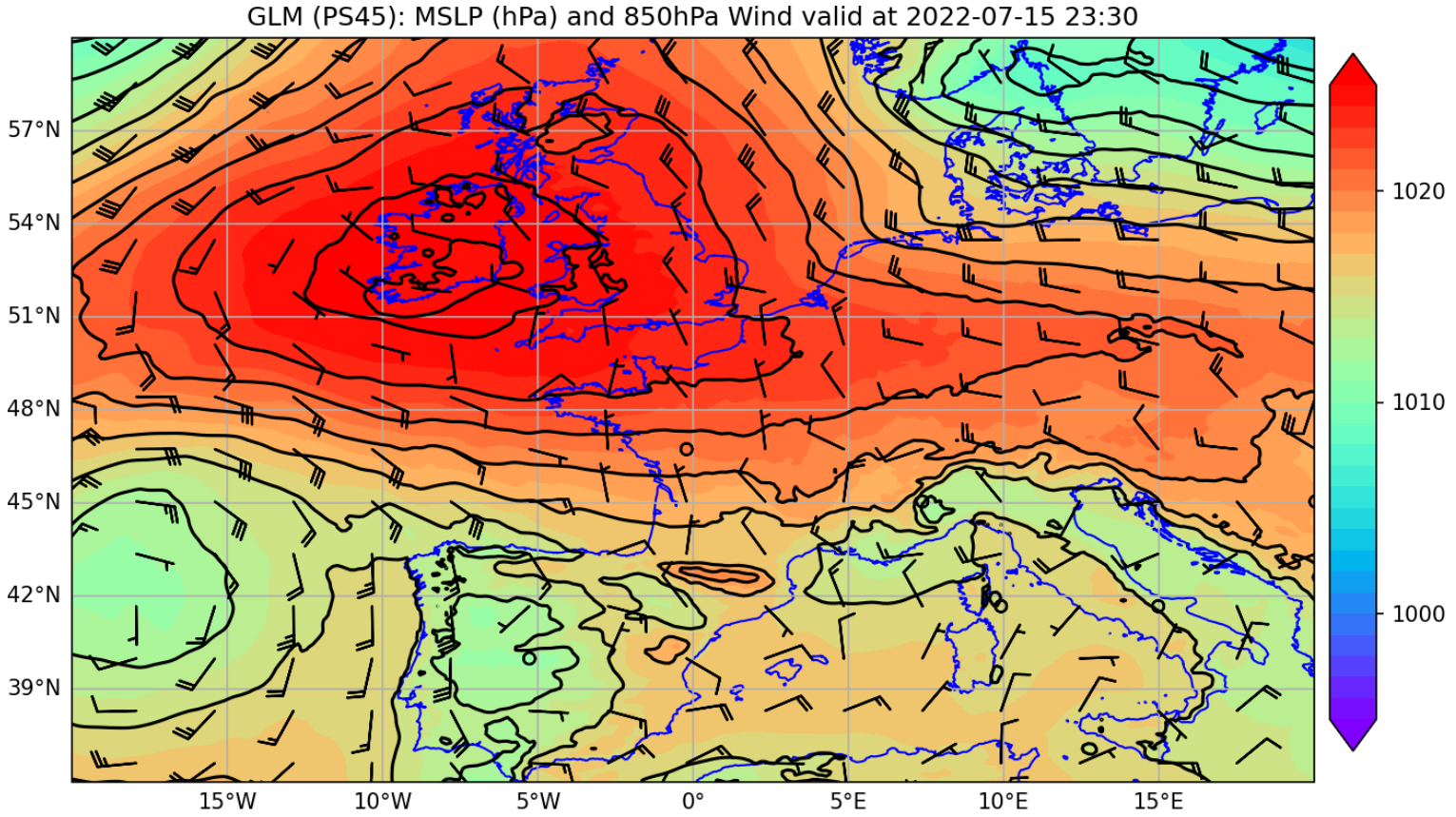
To advance research on the (future) meteorological forecasting systems at ~100m resolution for urban areas

Institutes from: France, Canada, USA, China, Sweden, Japan, Germany, Netherlands, Korea, UK, Australia etc.

2019	Endorsement of the RDP by WWRP, Identification of the research questions by the partners
2020	Kick off meeting, scientific collaborations, identification of funding and project opportunities
2021	Modelling exercises at sub-km scale
2022	Research activities continue; observation campaign kick-start
2023	Research activities continue; observation campaign continues model intercomparison started
2024	Routine running of sub-km scale NWP systems for the Olympic Games

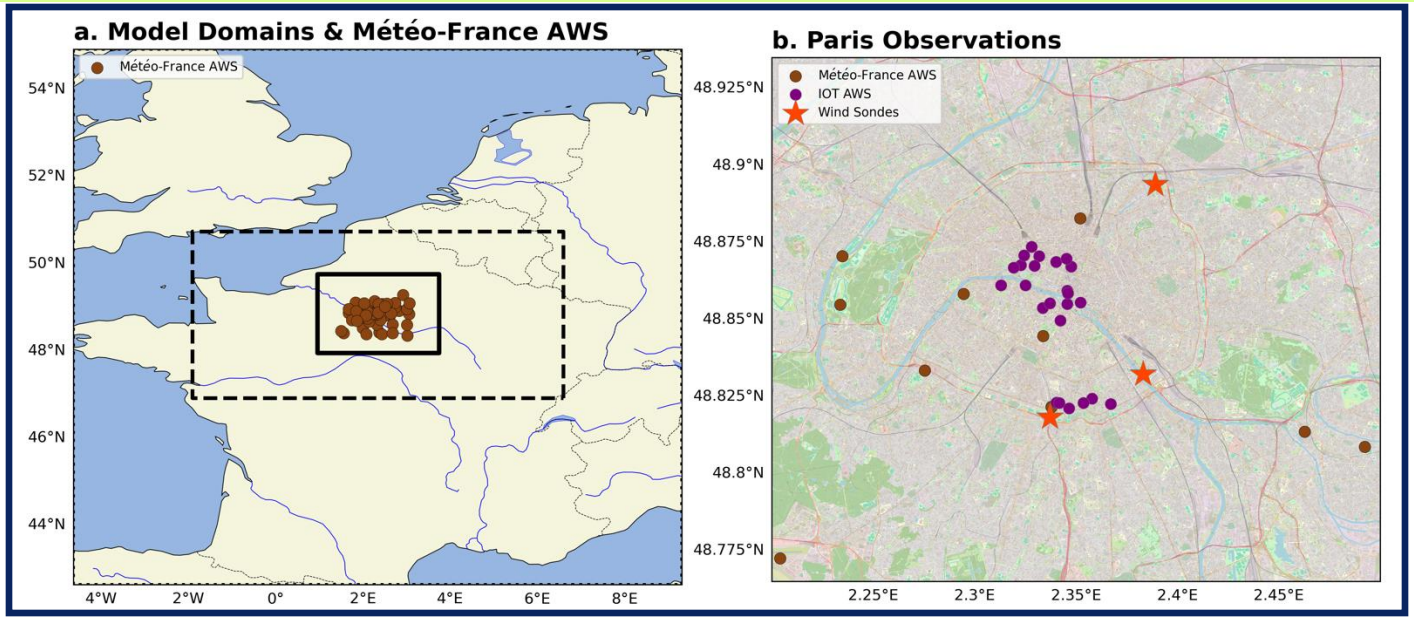
July'22 European Heatwave





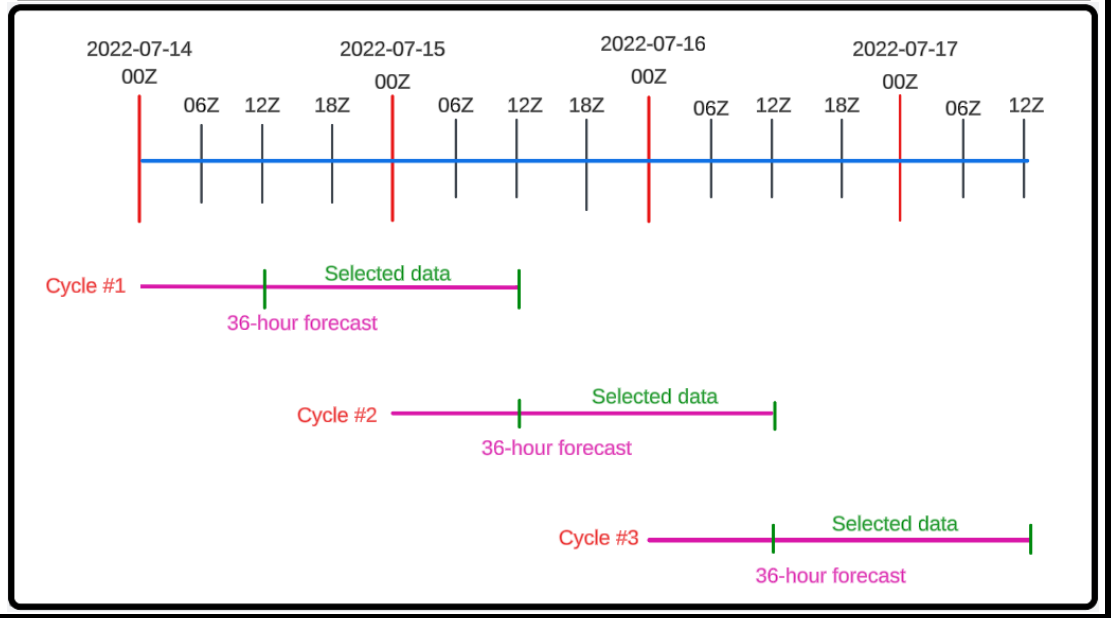
Courtesy: Copernicus

Experiments, Data & Methodology



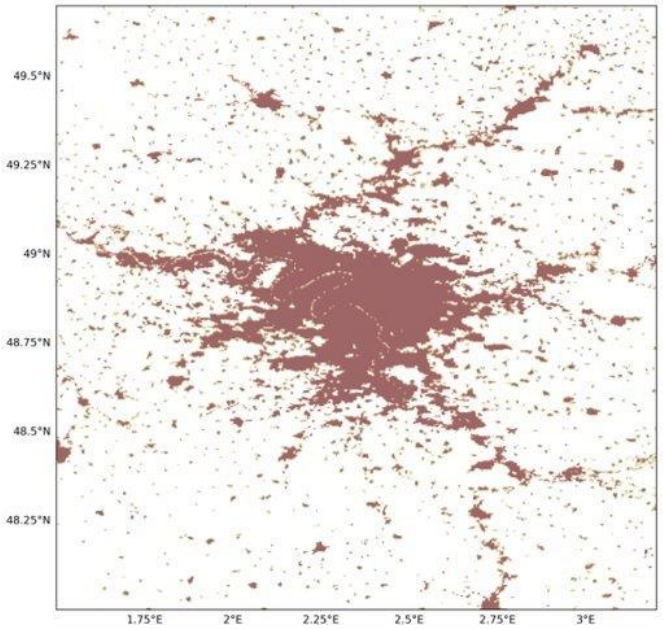
- Regional Nesting Suite (**RAL3.1**) + **MORUSES.**
- UKMO global model (PS45) analysis start dumps.
- 1.5km: L70/40km, 900 x 600 grid
- 333m: L140/40km, 1800 x 1200 grid
- 100m: L140/40km, 2000 x 2000 grid

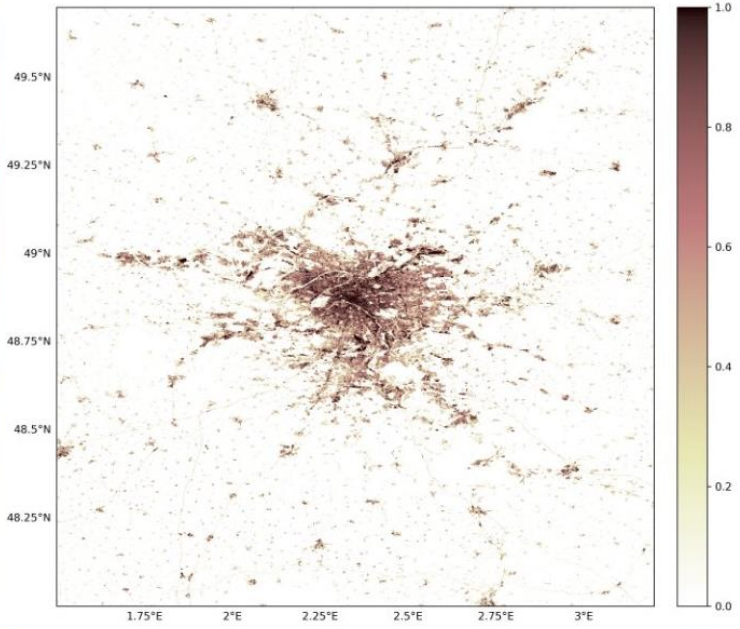
$$Discrepency, D = F - O,$$
$$\text{Bias} = < D >,$$
$$\text{RMSE} = \sqrt{< D^2 >},$$
$$RMSE^2 = var(D) - Bias^2,$$
$$var(D) = cMSE$$



Updated Urban Fractions

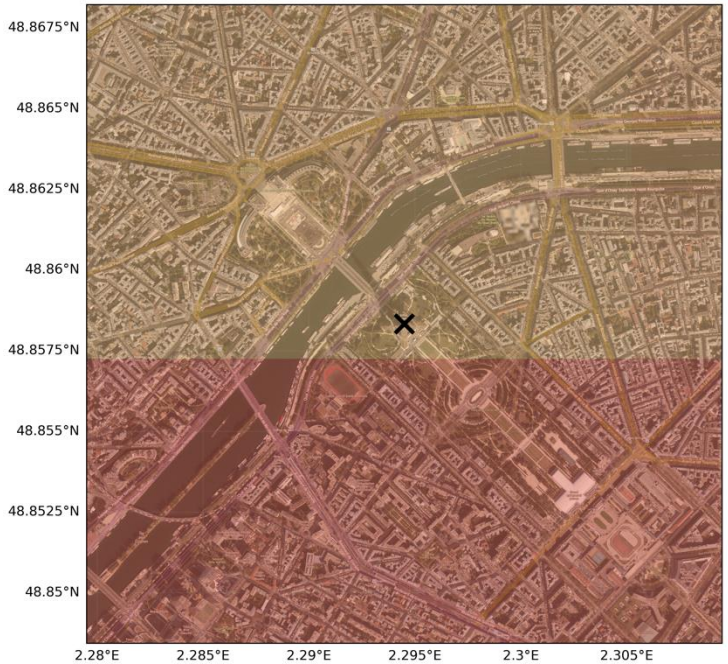
CCI v1.0 (default)

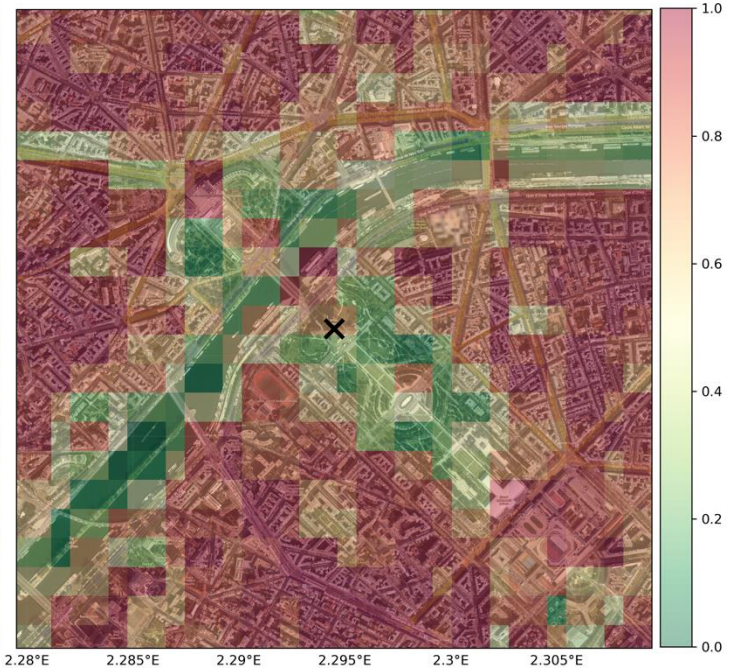




ESA World-cover

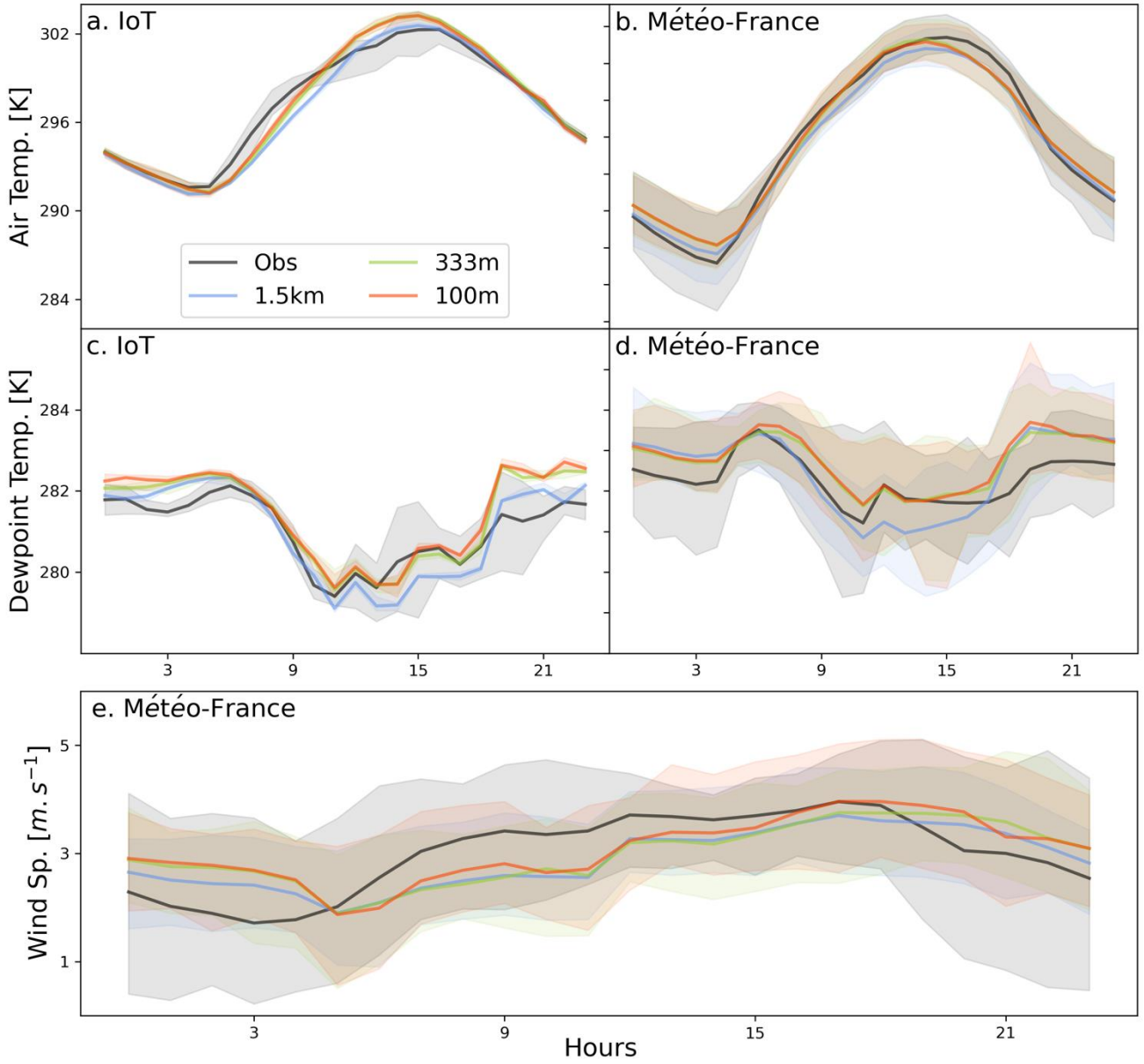
ESA WC mapped to 1.5km grid





ESA WC mapped to 100m grid

Model screen-level (site average and range)



Urban Fractions:

SIRTA (Suburban)

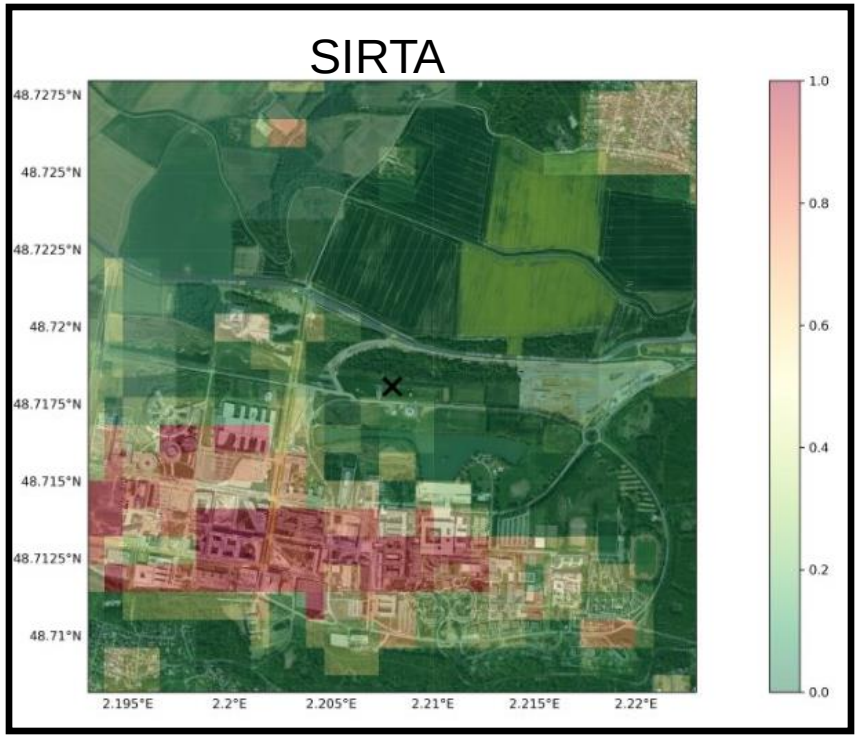
1.5km: 0.18, **333m**: 0.00, **100m**: 0.00

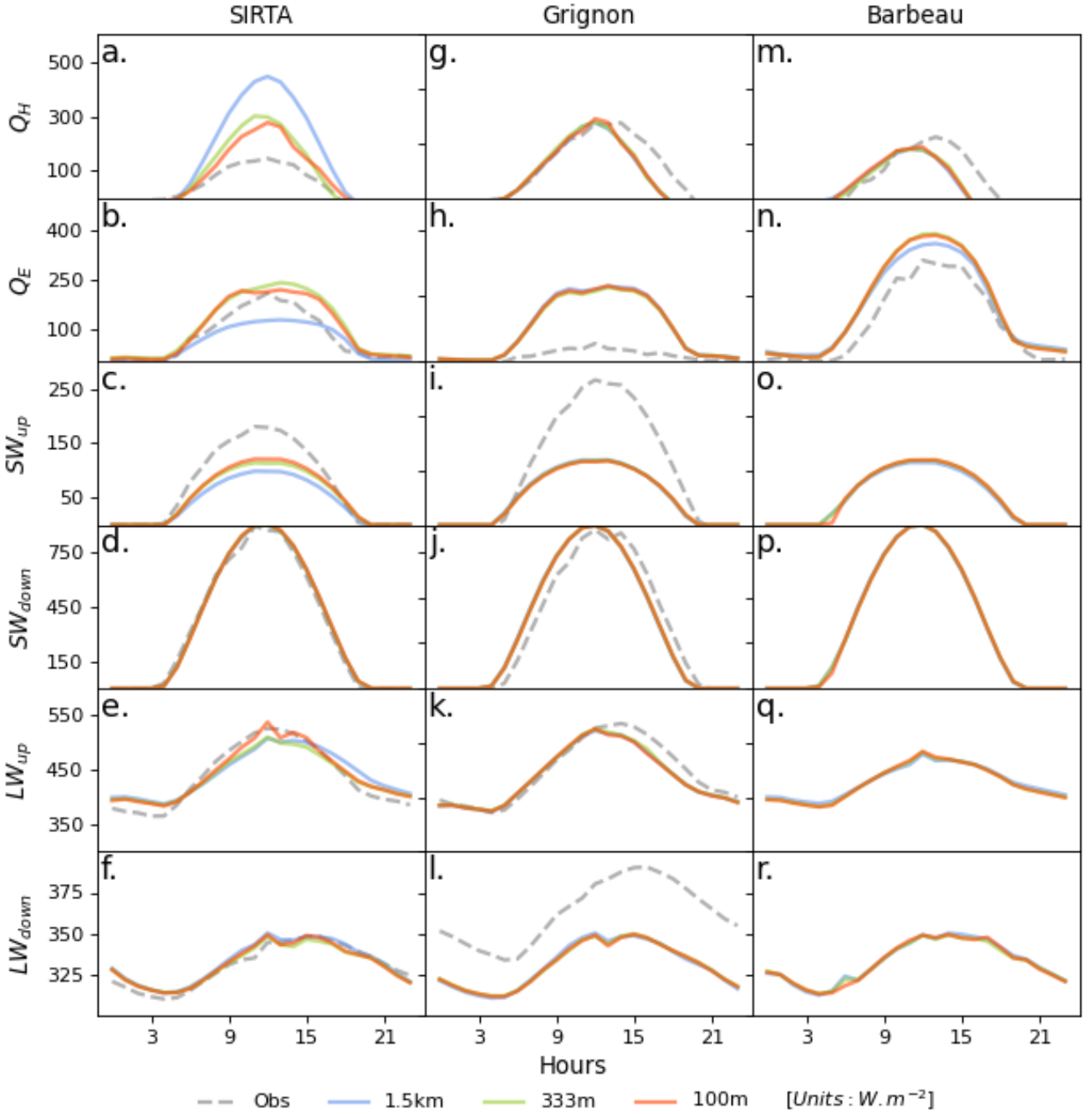
Grignon (Cropland)

1.5km: 0.10, **333m**: 0.00, **100m**: 0.00

Barbeau (Broadleaf Forest)

1.5km: 0.01, **333m**: 0.00, **100m**: 0.00

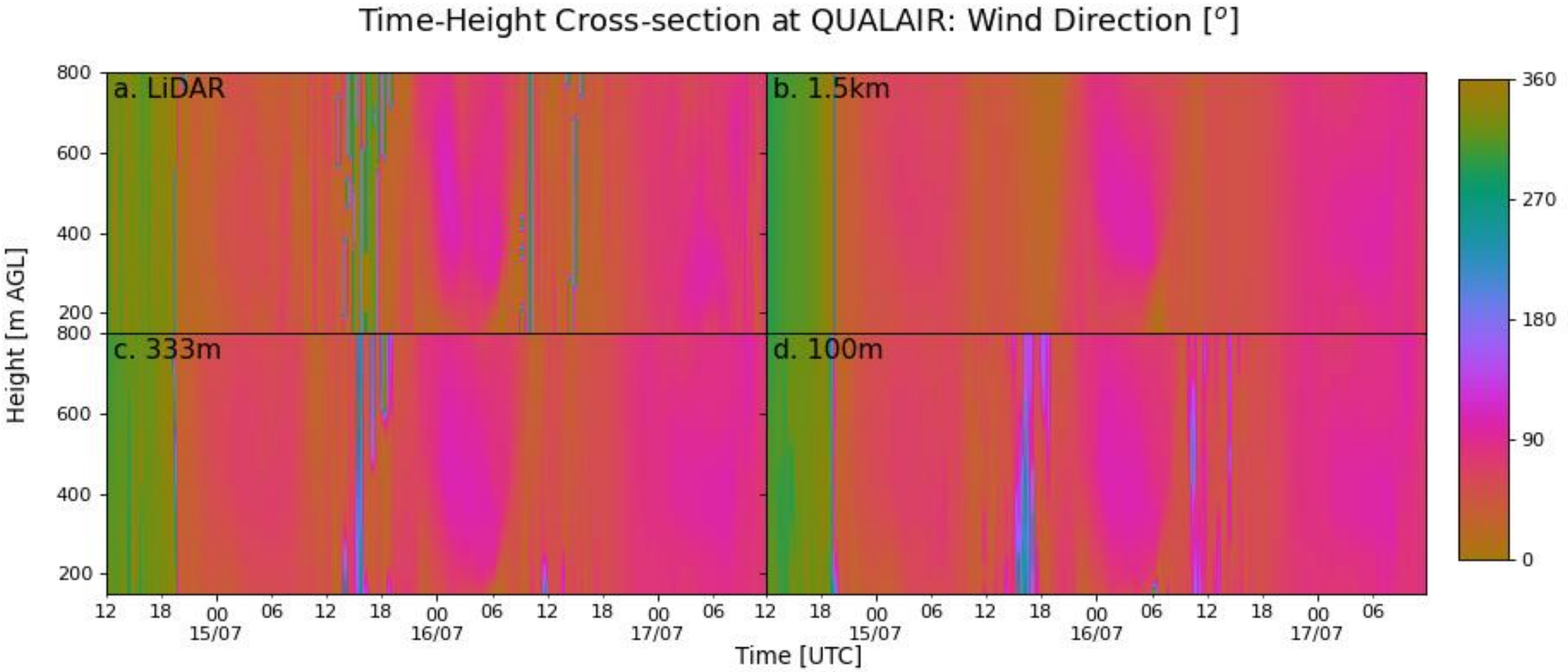




LLJ Core Statistics

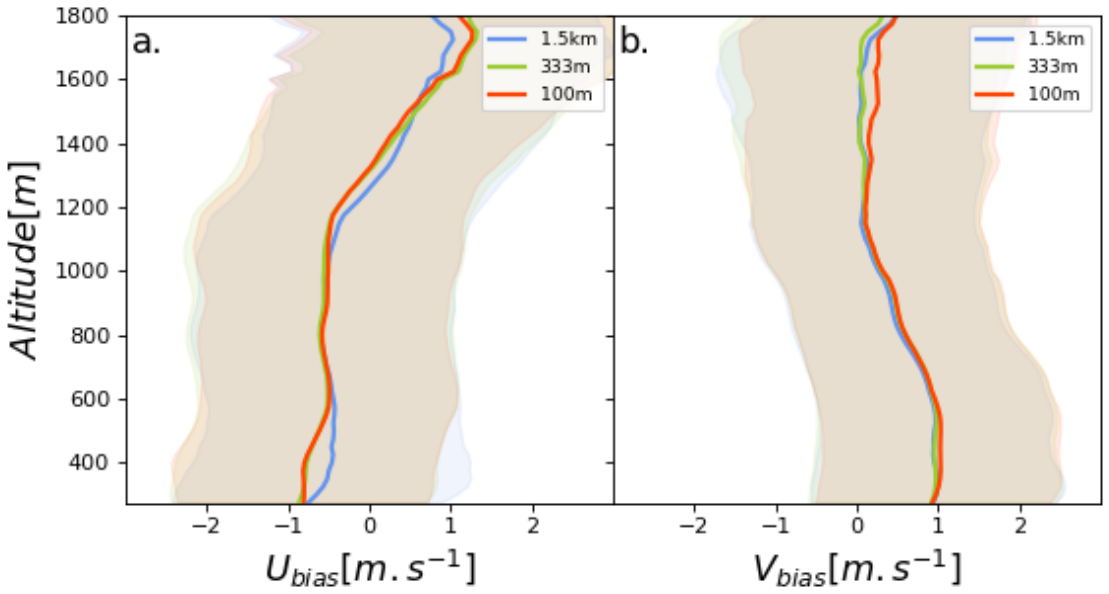
Model	Bias	S.D.	cRMSE
1.5km	-10.24	275.22	266.99
333m	63.92	285.77	277.72
100m	-11.35	113.14	109.96

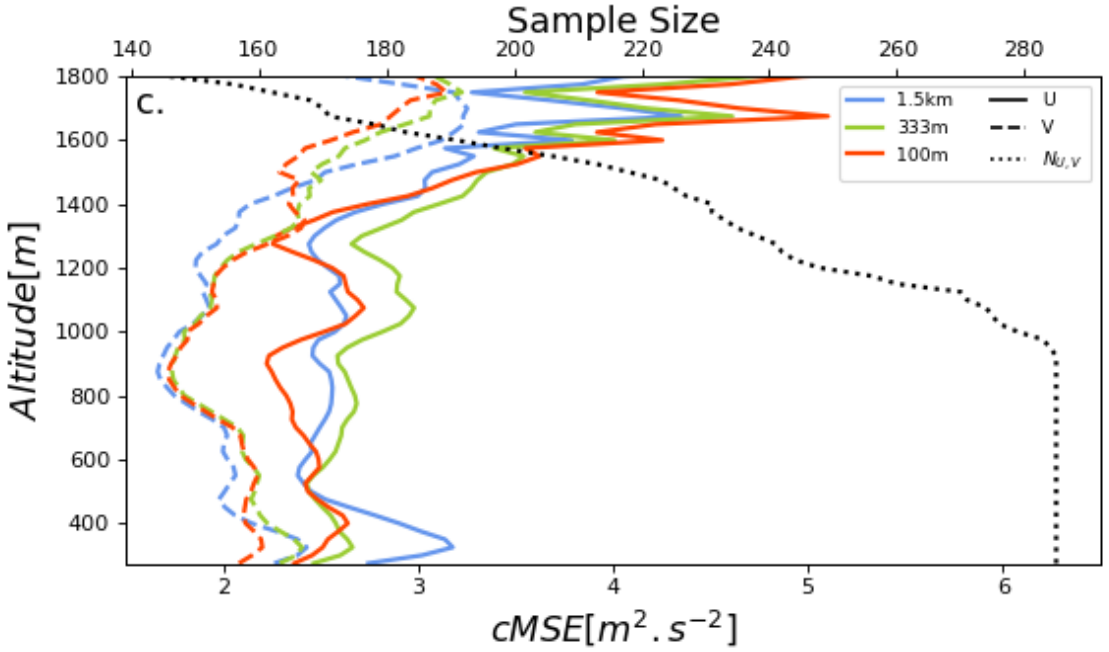
Low Level Jet (LLJ) event detection: height > 300m; wind speed > 4 $m.s^{-1}$; over the course of 2 h; difference in core wind speed < 20%; difference in core wind direction < 45°


Time-Height Cross-section at QUALAIR: Wind Direction [^{o}]
a. LiDAR
b. 1.5km
c. 333m
d. 100m
Height [m AGL]
800
600
400
200
800
600
400
200
360
270
180
90
0
12
18
00
15/07
06
12
18
00
16/07
06
12
18
00
17/07
06
12
18
00
15/07
06
12
18
00
16/07
06
12
18
00
17/07
06
Time [UTC]

Skill against LiDAR

- A more prominent easterly bias at lower-levels in sub-km models compared to the 1.5km model
- Similar mean flow and the larger-scale turbulence in both the 333m and 100m models.
- The cMSE profiles indicates the characteristic difference in turbulent flows simulated by each model.





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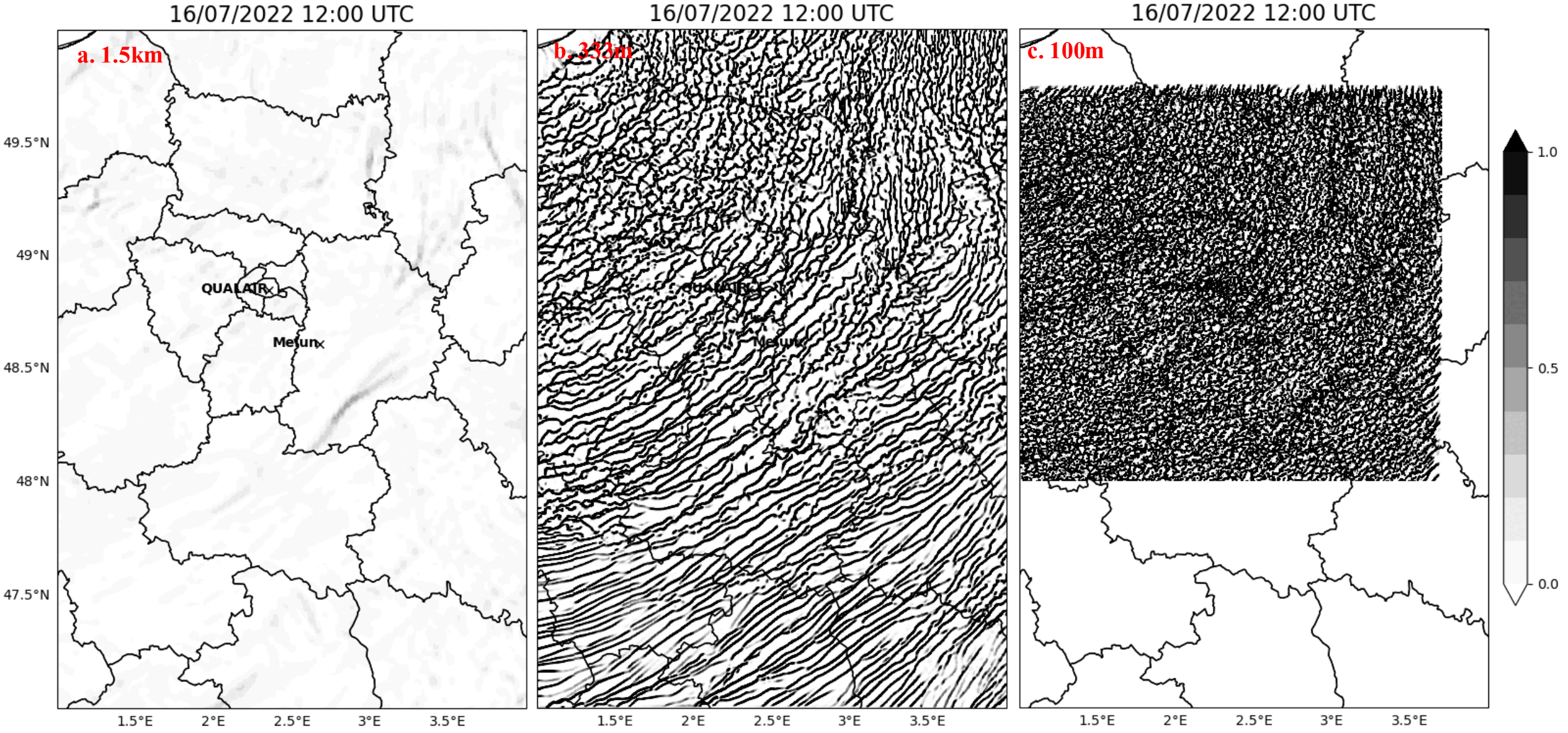
Vertical Velocity (m.s^{-1}): ~450m



Remarks

1. **Screen-level**
   - There are a range of model biases, seems to be dominated by the land surface
     - Thermal inertia
     - Soil moisture
   - May also be influenced by the atmospheric heterogeneity.
2. **Fluxes**
   - Drier and warmer air over SIRTA in the 1.5km model.
     - Due to SW_{up} and Q_e being too low, leading to warming of the surface and high sensible heat flux.
   - SW_{up} is generally underestimated.
     - Suggests that the albedo is too low in the different models
     - Water limited environment? Incorrect parameter specification?
3. **BL Winds:**
   - All models capture the nocturnal LLJ albeit with varying intensity and height.
   - More prominent urban signature in 100m vertical velocity field compared to the 1.5km and 333m models.
   - Convective rolls aligned to the mean flow.
4. **Roadmap:** Possibility to do a case each from 2023 and 2024 depending on the observation availability.

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Thank you

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