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IMPROVING SUBKILOMETER MODELLING WITH GEM : CASE OF PARIS

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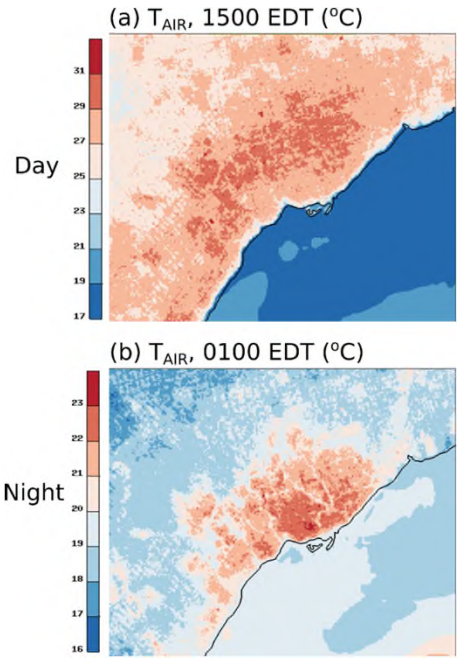
INTRODUCTION

Current status at ECCC for urban-scale prediction

- Urban canopy represented for short-range NWP over Canada (2.5 km)
- Higher resolution is needed for high-impact weather, and urban-scale services including air quality and public safety, adaptation science

- **ECCC-PASS project for the PanAmerican/Para-PanAmerican Games inToronto 2015, Canada,**
  - Realtime experiments, grid spacing=250 m, PanAm Games, Toronto, 2015,
  - Reused during summer 2017 in support of products to face lasting high-water levels and flooding, storm surge, in the Great-Lakes region

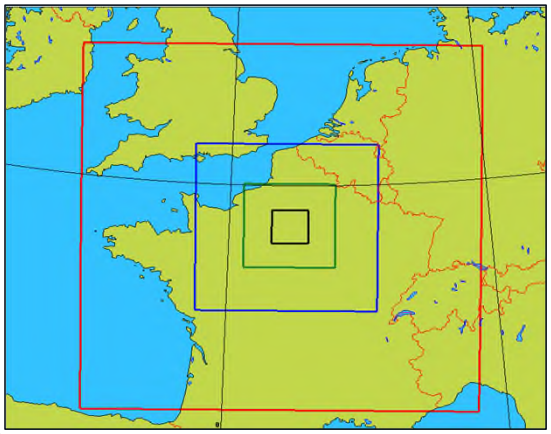
- **Research and Demonstration Project Paris Olympics (2020-2024)** (**S5**)
  (World Weather Research Program – WMO)
  - Paris as a testbed for model intercomparison at subkilometer/ hectometric scales
  - Services in the context of sport event
  - Realtime simulations
- **Objectives : Explore the sensitivity of the system to multiple factors to guide further systems**

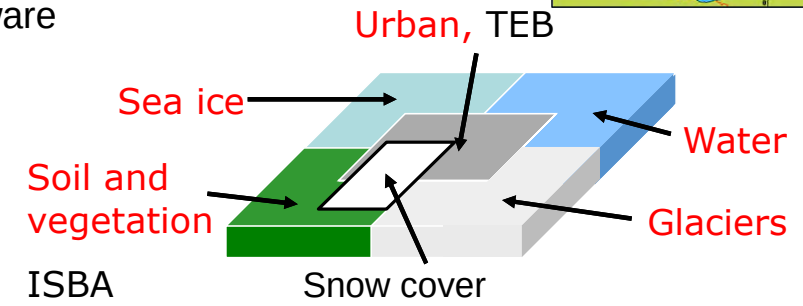


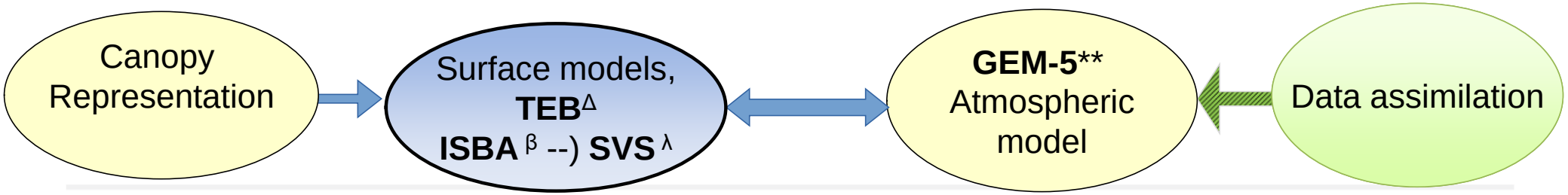
Leroyer et al. 2022

OVERVIEW OF GEM NWP SYSTEM FOR PARIS

- Driving data from the global Deterministic ECCC model (15 km)
- Dynamical downscaling
  - 15km → **2.5km** → **1km** → **250m** → **100m (**Starting 00Z)
  - ~100 km x 100 km, Prognostic levels : 10 m wind / 5 m T
- For 250m and 100m:
  - **Land-surface schemes :** TEB, ISBA
  - **Land cover:** ESA CCI v1.6, Soil texture: SOILGRIDS
    - Urban cover: OpenStreetMap, in-house software
  - **Physics parametrizations**
    - P3 microphysics scheme
    - Kuo-Transient for shallow convection
    - Boundary-layer clouds





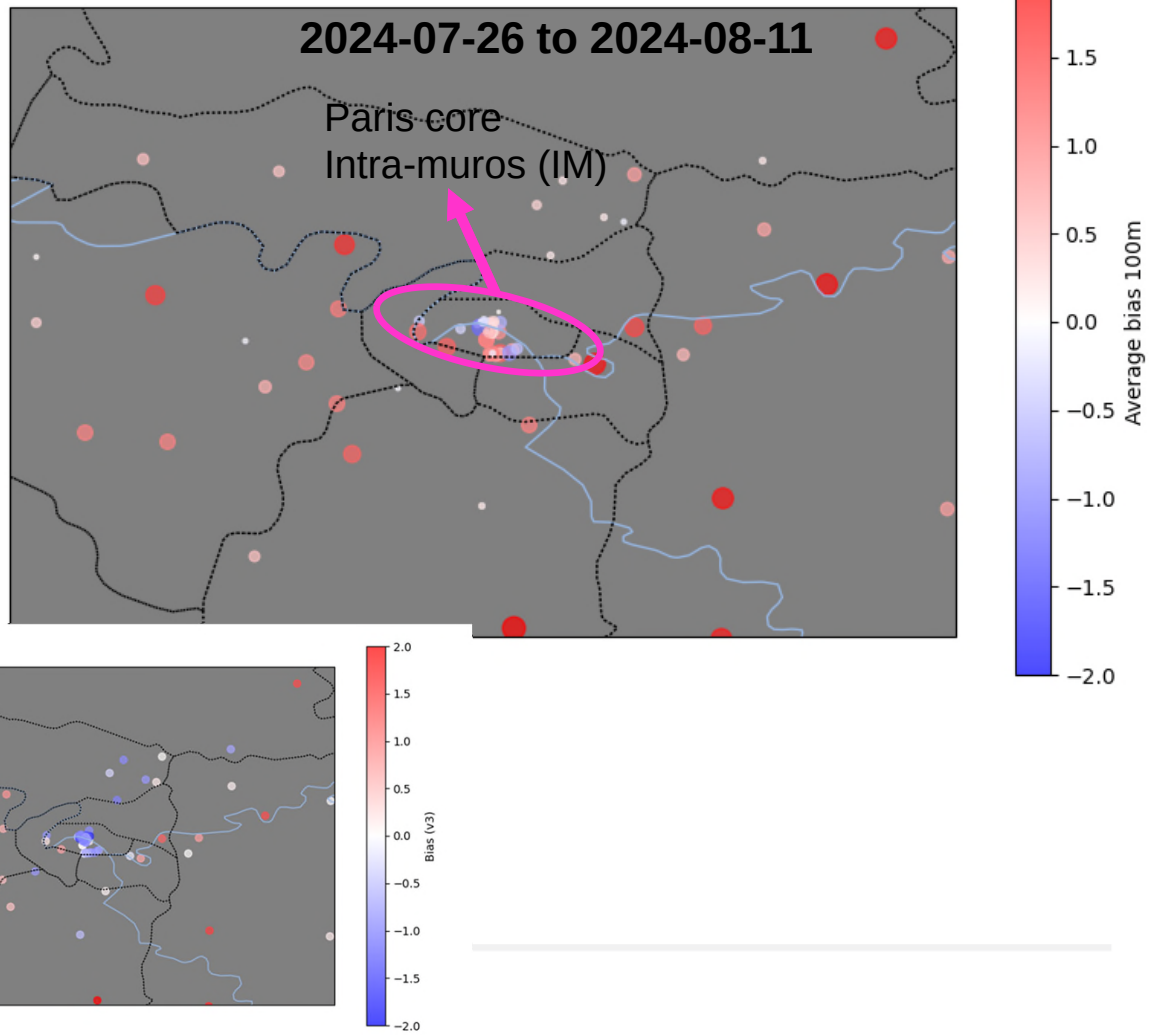


Δ *Town Energy Balance* **Global Environmental Multiscale model*

β *Interaction between the Soil and Biosphere and the Atmosphere* λ *Soil Vegetation and Snow*

100-M PERFORMANCE DURING OLYMPICS GAMES

- *Simulations 36 h*
  - *00-12h removed as considered a spinup*
  - ***Analysis of 12-36h***
- Mean 2m temperature bias over the period at the available stations
- Relatively accurate in downtown Paris
- <u>Some</u> too warm countryside areas during realtime, tends to attenuate at the end of summer (land cover and/or soil moisture)

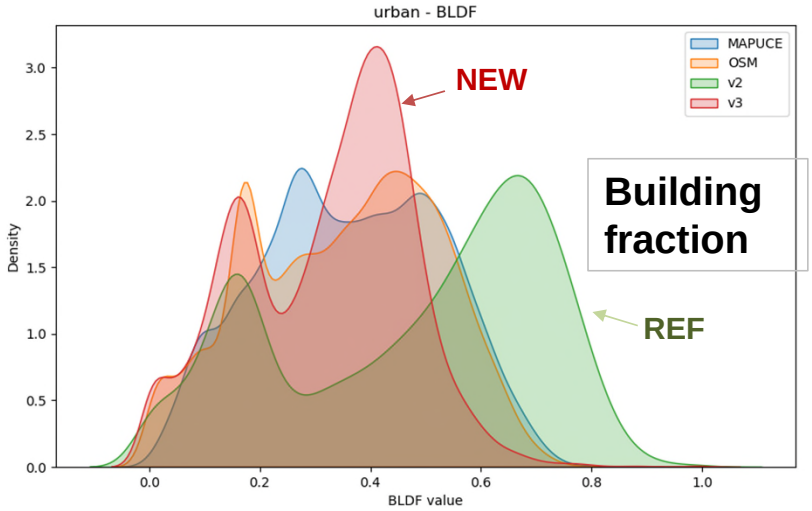


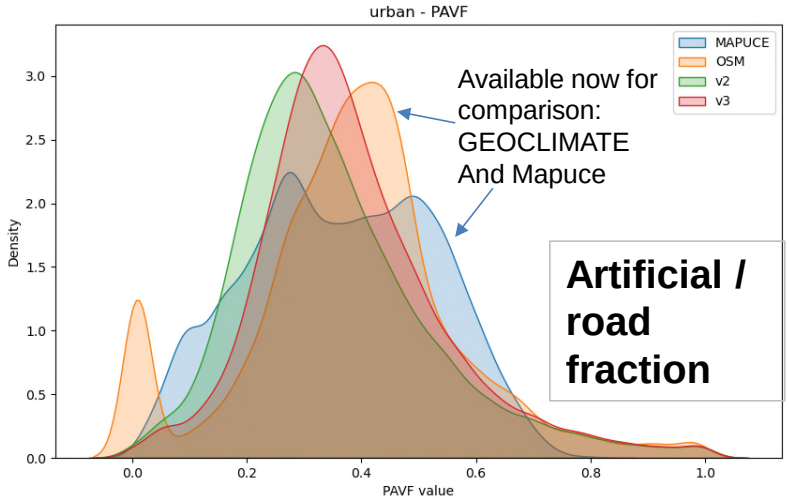
Mean bias for Aug. 2024

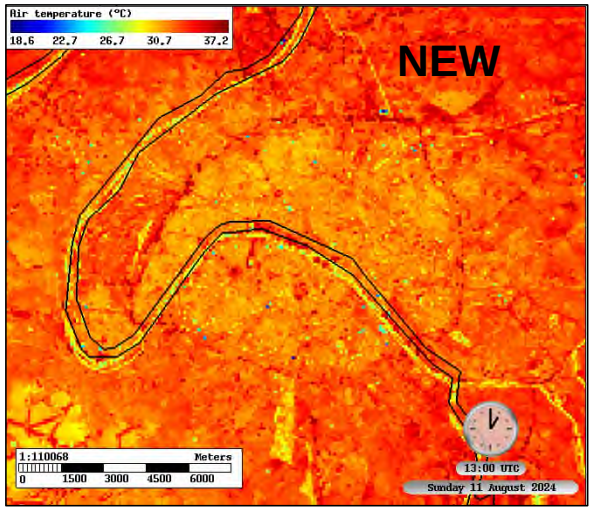
SENSITIVITY TO URBAN FABRIC REPRESENTATION

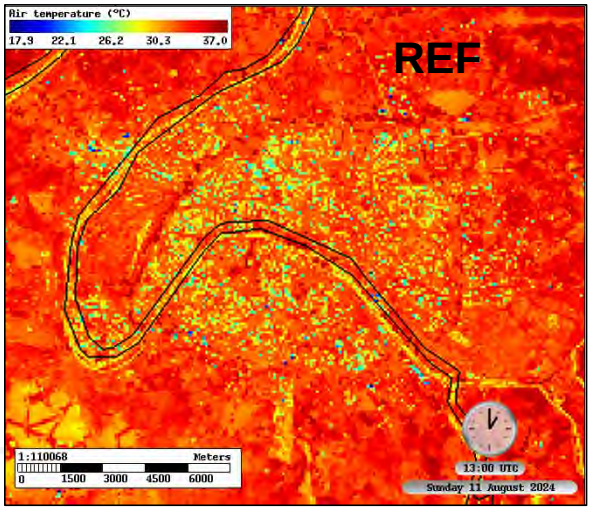
NEW : correct OSM @OpenStreetMaps with Mapuce (Meteo-France)
Eg : less building in building blocks

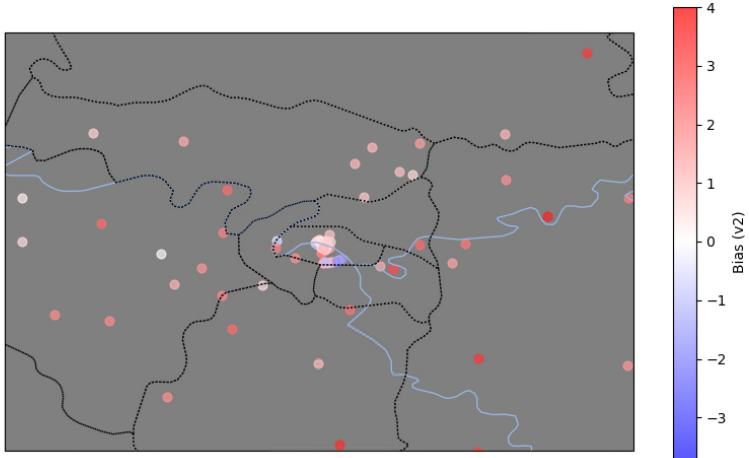
Distribution for Paris Intra-Muros

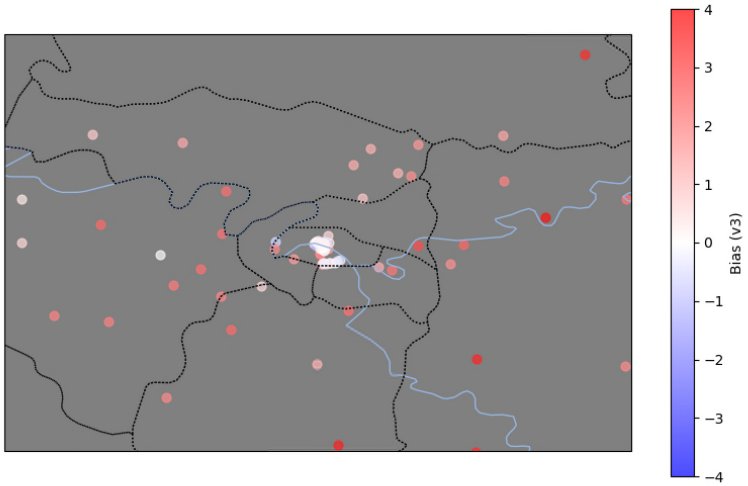




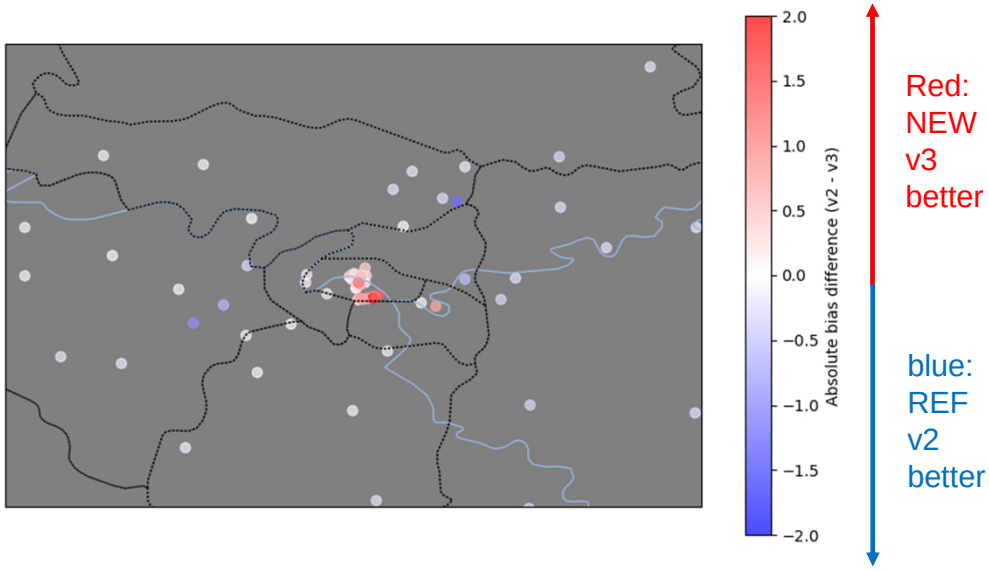








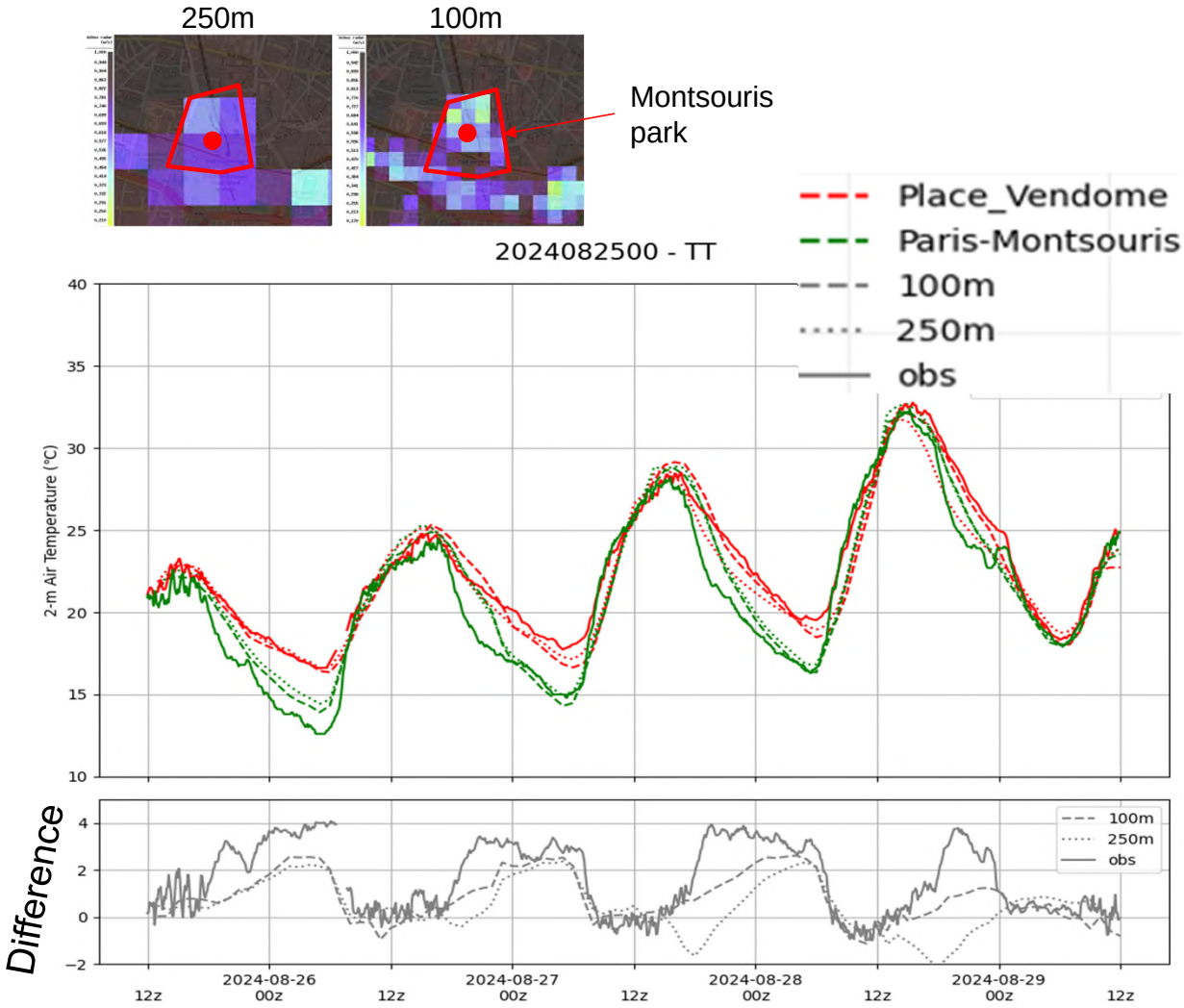
- Statistics for the 3 days period from 2024-08-10 to 2024-08-12
- Temperature bias at stations and difference between the absolute bias
- Changes between v2 and v3 are mostly in the central area. V3 has almost no temperature bias for that period



INTRA-URBAN VARIABLITLY (SELECTED WARM PERIOD)

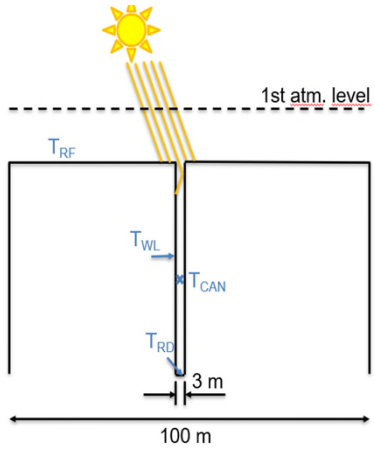
- Comparison of air temperature at
  - **very urbanized (Place Vendome)** and
  - **central medium size park (Paris-Montsouris)**

- With 100 m and 250 m grid spacing :
  - Delimitation of the small park effect on clear days
  - similar response at Paris-Montsouris (park big enough) but with **too slow evening cooling** (surface-atmosphere coupling to investigate)
- 100 m versus 250 m :
  - Evening cooling closer to observations (impact of canopy details)

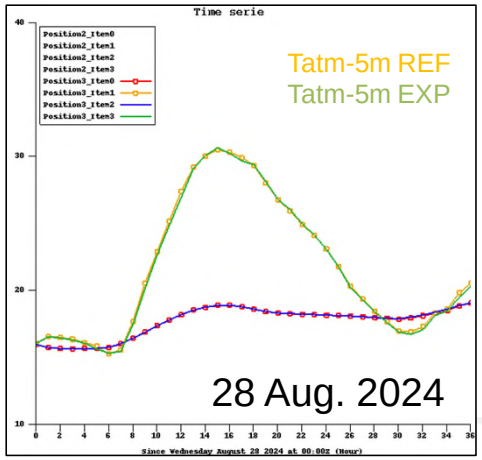


2M AIR TEMPERATURE IN A NARROW STREET

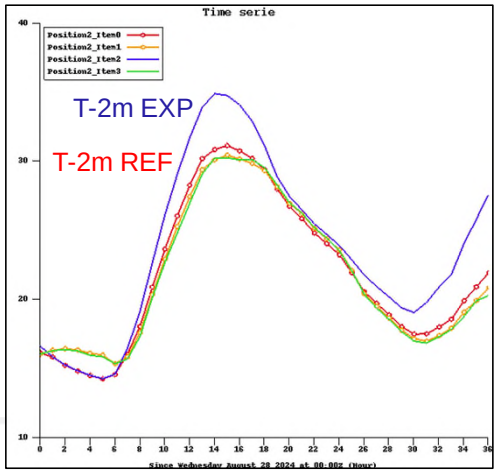
- T2m improved with NEW ancillary dataset
- But this sensitivity experiment has highlighted a problem of **cold grid points**
  - Less grid points concerned with NEW ancillary data, or at 250 m res
  - Still obvious for specific grid points at 100 m for Paris Downtown
    - Grid points with very narrow streets
  - Experiment EXP : Thermal roughness lenght decreased for the canyon-atmosphere resistance



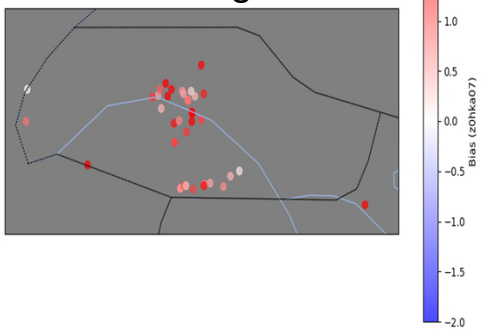
‘cold’ grid point



Regular grid point



Mean bias EXP
26-28 Aug. 2024



For cold grid point, no sensitivity to canyon-atmosphere resistance

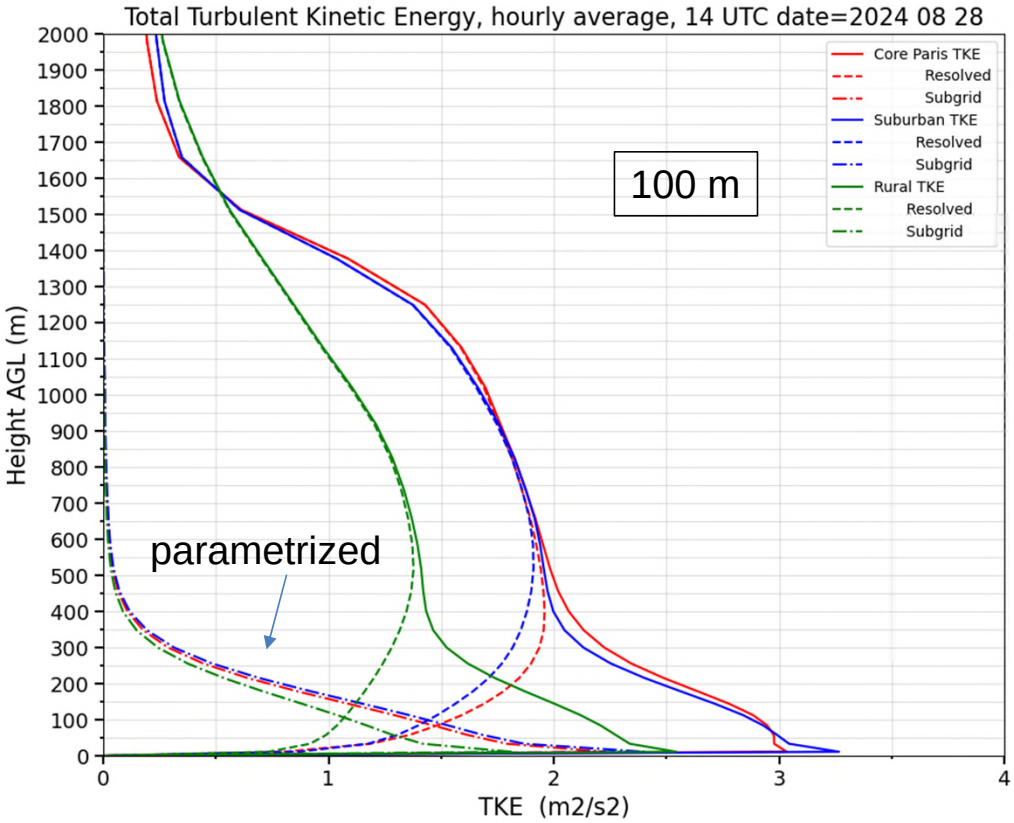
Warming elesewhere (too much)

- ➢ Not retained
- ➢ Next focus:

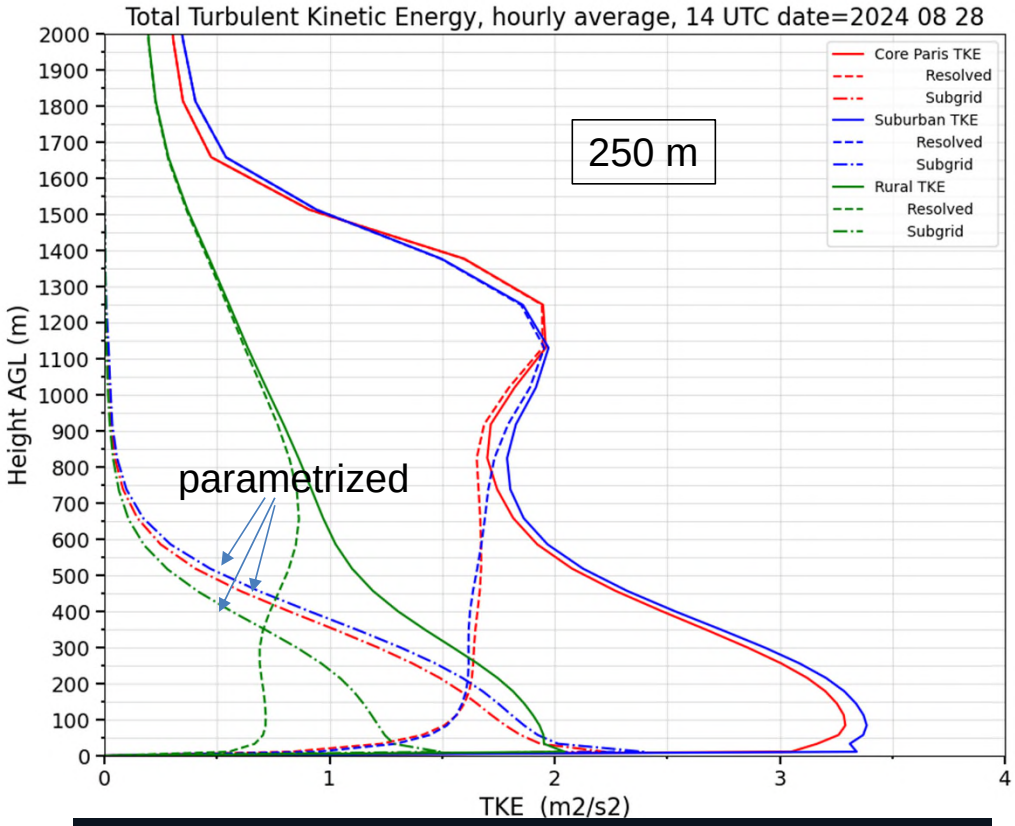
- Resistances for the walls; morphometric parameters…

TURBULENCE AT DIFFERENT SCALES (A WARM DAY)

TKE(——) = TKE subgrid, parametrized (-.-.-) + TKE resolved at the grid scale (---)



Near-surface: parametrized still important



100 m versus 250 m :
total TKE with similar value near the surface

TURBULENCE AT DIFFERENT SCALES (A WARM DAY)

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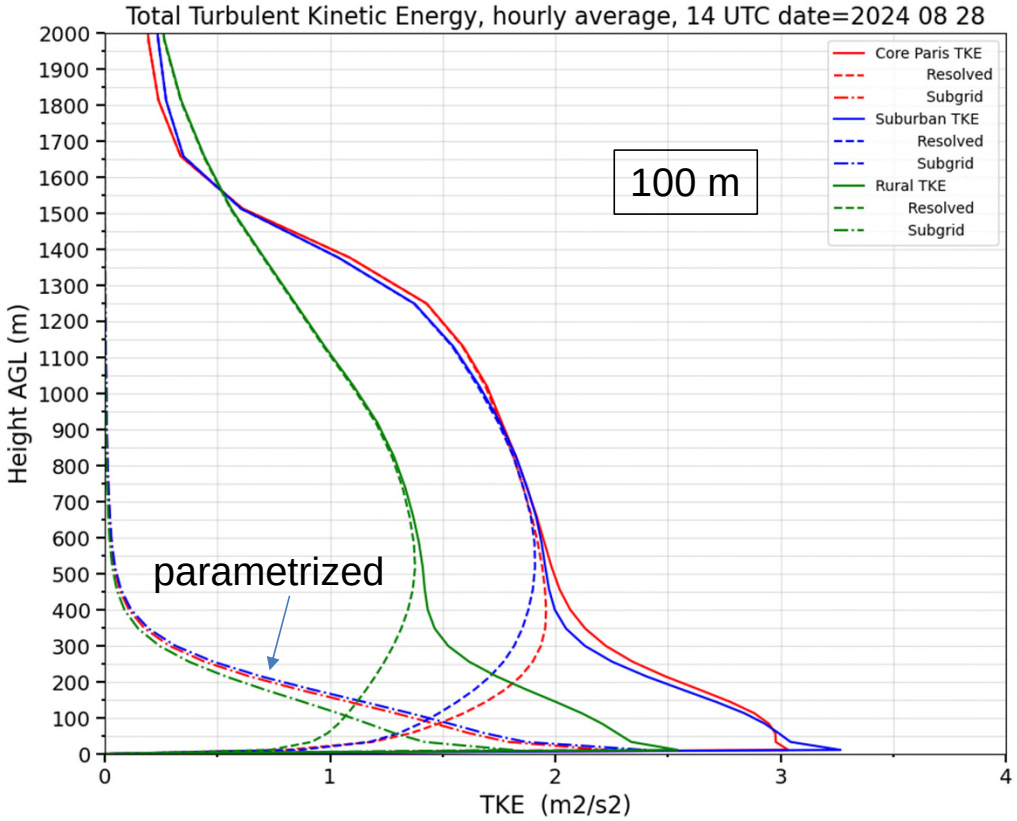
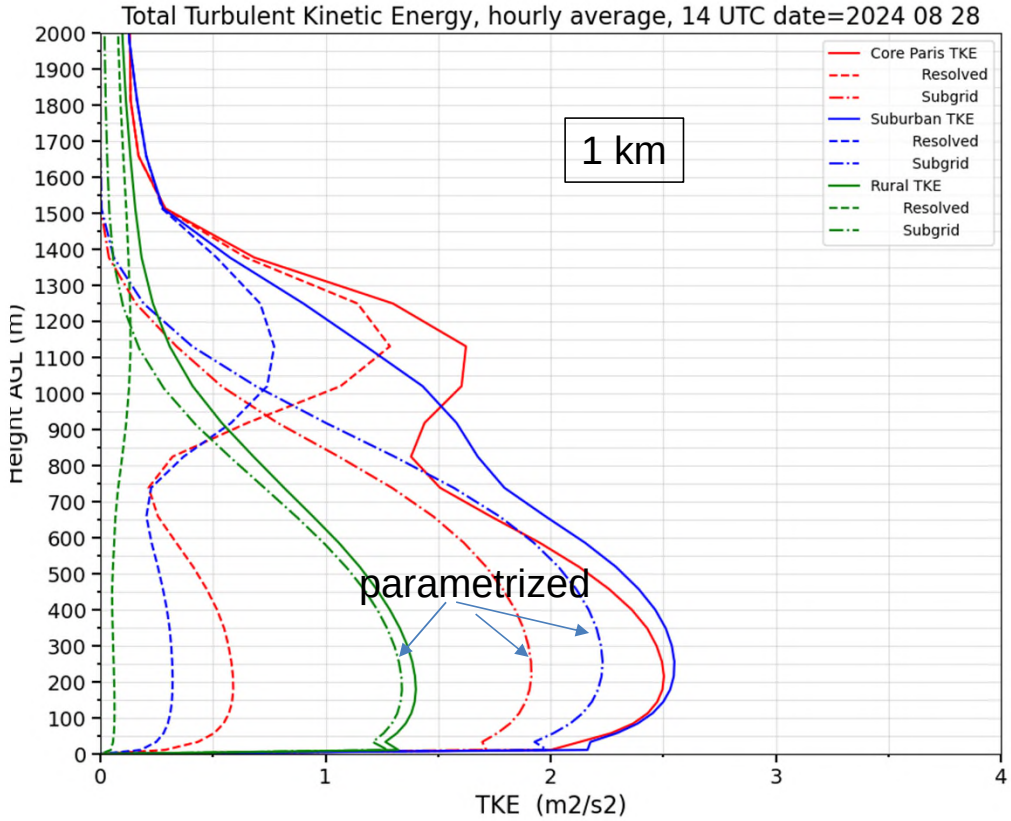
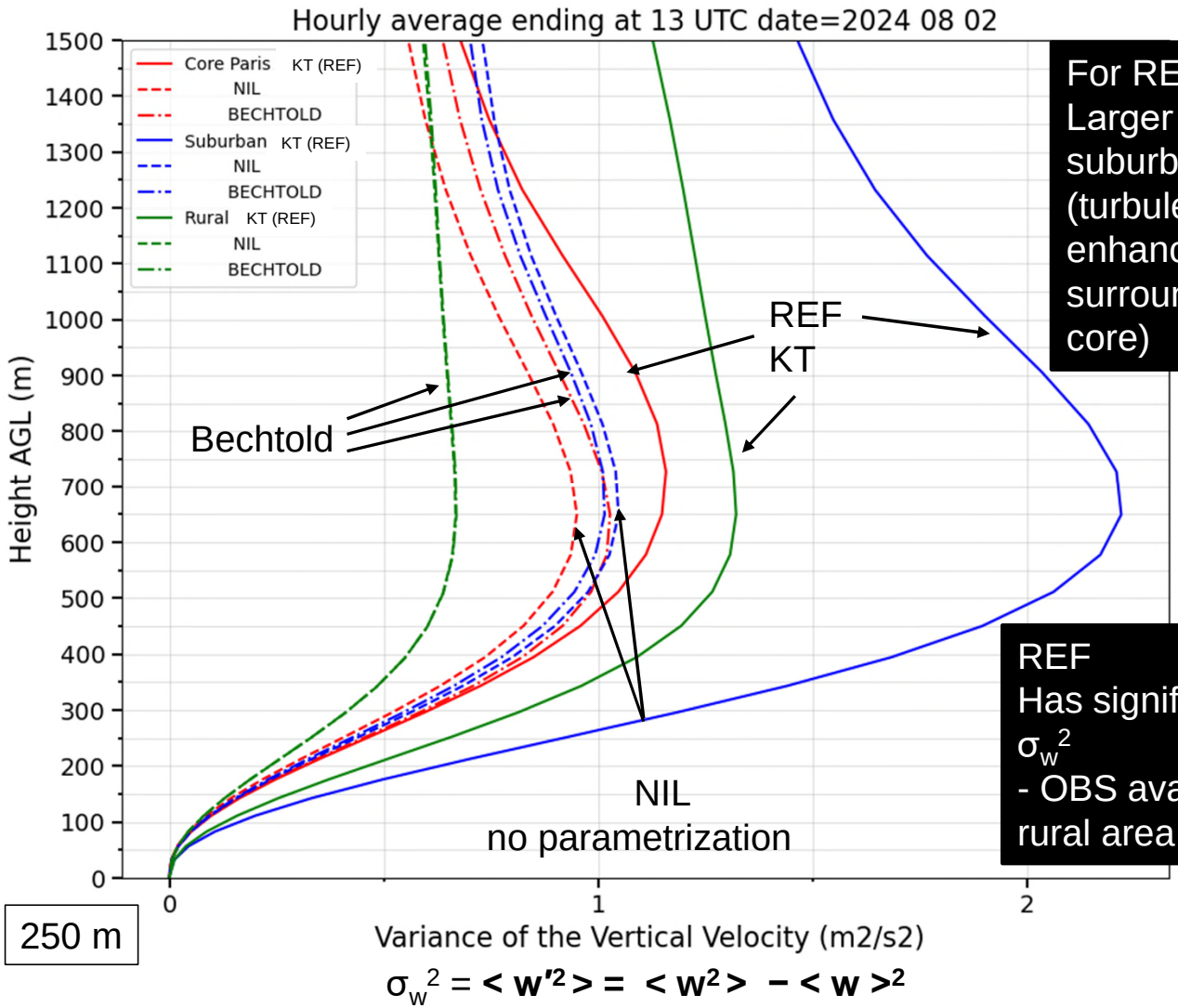




Parametrized dominates, lower total values

SENSITIVITY TO SHALLOW CONVECTION

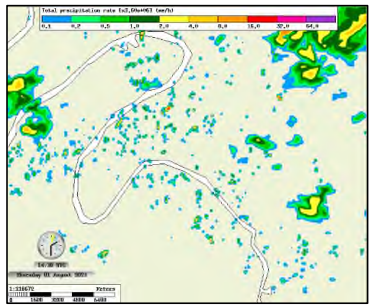


$\sigma_w^2 = \langle w'^2 \rangle = \langle w^2 \rangle - \langle w \rangle^2$

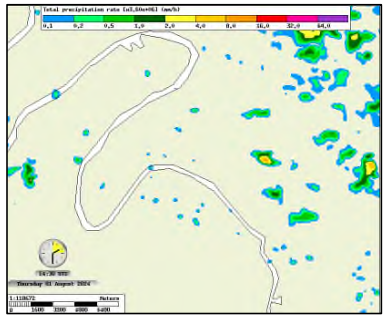
For REF and NIL
Larger σ_w^2 for the suburban region (turbulent enhancement for the surrounding of the city core)

REF
Has significant larger σ_w^2
- OBS available in rural area only…

Kuo Transient (REF)



No parametrization



Still tiny showers…

CONCLUSIONS

- NWP system to refine the prediction of the urban environment down to 100 m – 250 m applied to the Paris region as part of the WWRP / WMO Paris 2024 has proven value.

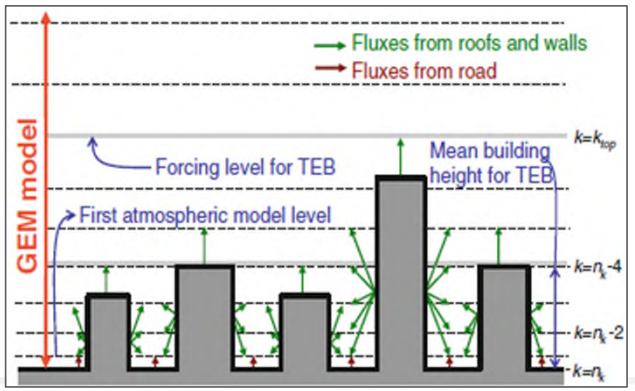
- Understanding of the model behavior by necessary diagnostics : weights of different factors (surface process or atmospheric parametrizations) in issues identified :

- **Ancillary data impact is dominant for T2m**

- ***Is it relevant to use a single-layer canopy model, or is it mandatory to use muti-levels in the canopy ?***
  - Future work: update with CaM-TEB

Husain et al. (2013)

- ***Is it relevant to forecast at hectometric scale without full 3D atmospheric processes (turb, rad…) ?***



➢ Definitely, work in progress…

**** THANKS FOR YOUR ATTENTION ! ****

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Paris from space #T. Pesquet