

# Heat wave in urban environments – connecting vertical layers



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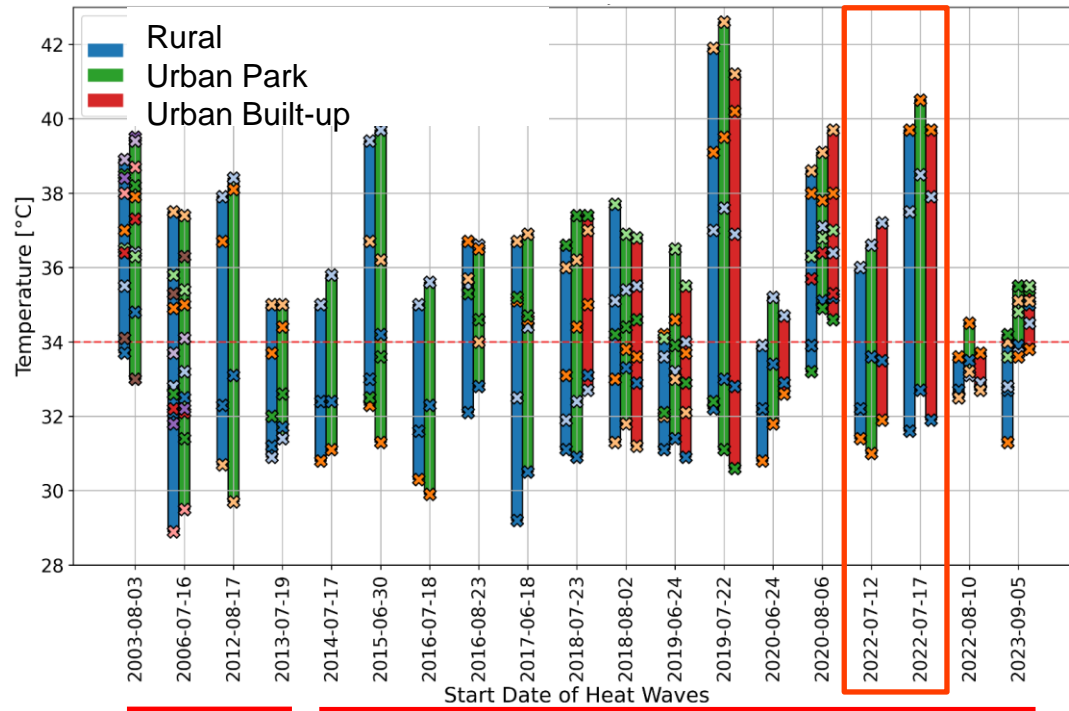


Science conference 2026, Oslo



# Motivation: 19 heat waves in 20 yrs

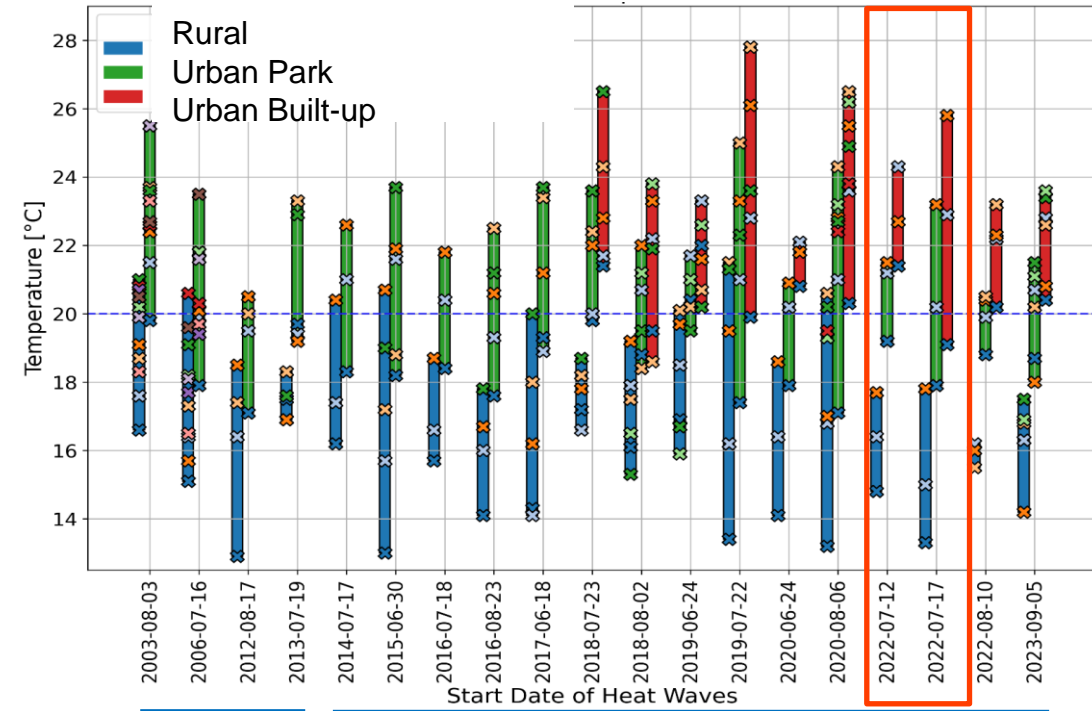
## Daytime Maximum Air Temperatures



2003 – 2013 (4)

2014 – 2023 (15)

## Night time Minimum Air Temperatures



2003 – 2013 (4)

2014 – 2023 (15)

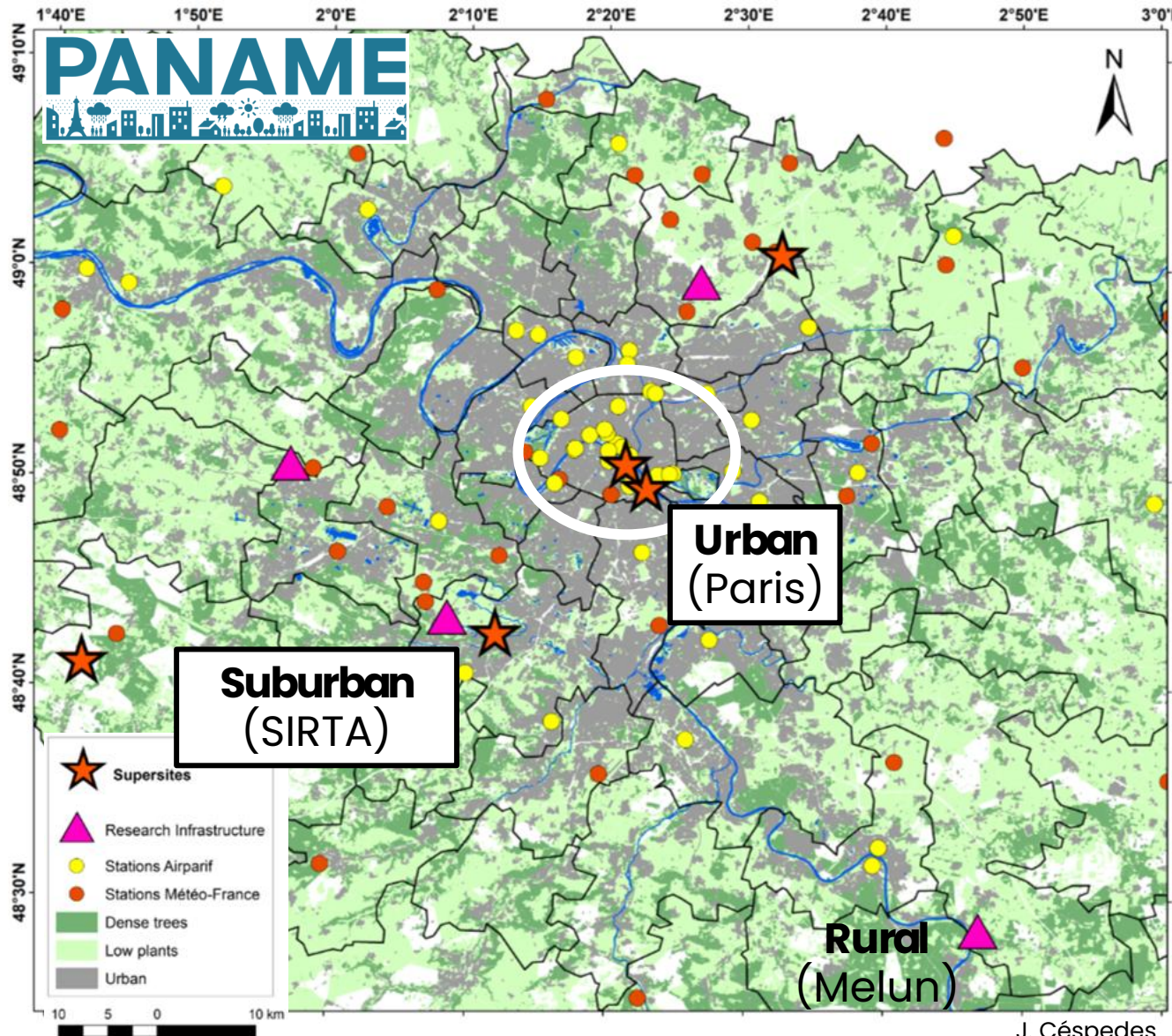
- Heatwave detection based on observations at urban park
- Daytime:  $T_{\max}$  spatially uniform across Paris region, large temporal variability
- Night-time:  $T_{\min}$  strong urban increment

**What causes this variability ?**

Cespedes et al. (2024) and Haeffelin et al (2024)  
demonstrated the important role of  
stability and mixing in the urban atmospheric boundary layer  
on nocturnal cooling

→ Here, we investigate the role of atmospheric stability on both  
night time minimum and daytime maximum temperature

# Profile observations



J. Céspeles

## Atmospheric remote sensing

MWR



Microwave Radiometer

Temperature

DWL



Doppler wind lidar

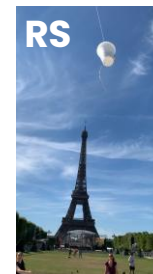
Wind + turbulence

ALC



Automatic lidar ceilometer

Aerosols + clouds

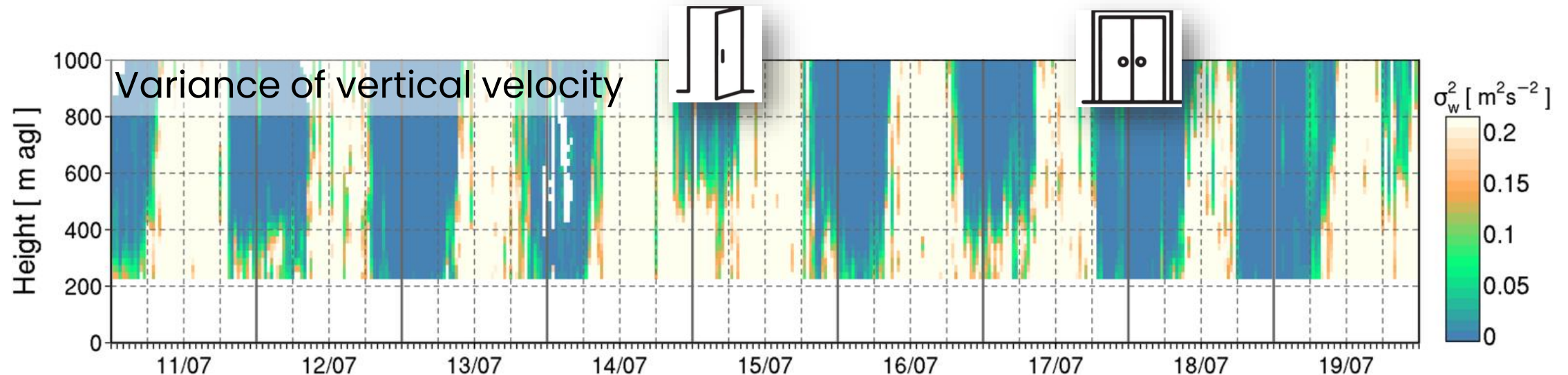
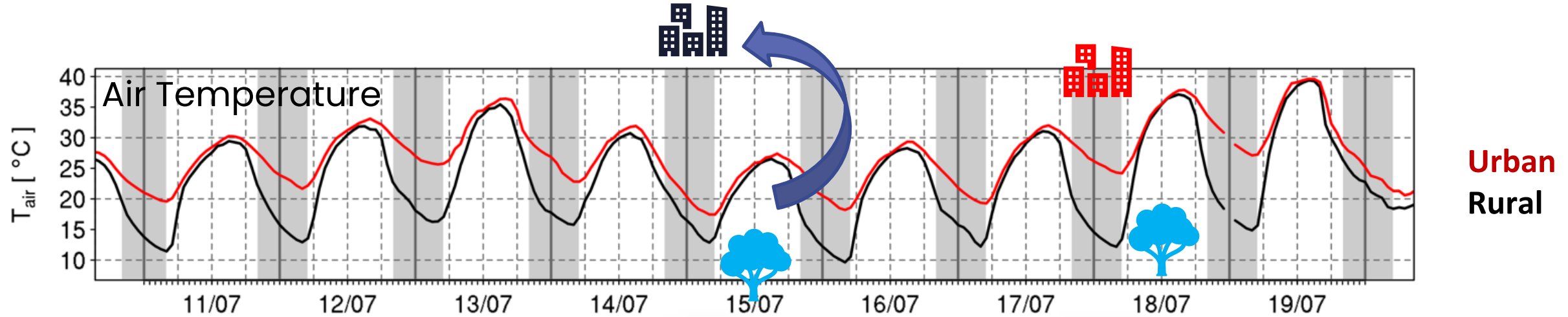


+ Paris city:  
Lightweight radiosondes

+ Surface weather station network (Météo-France)

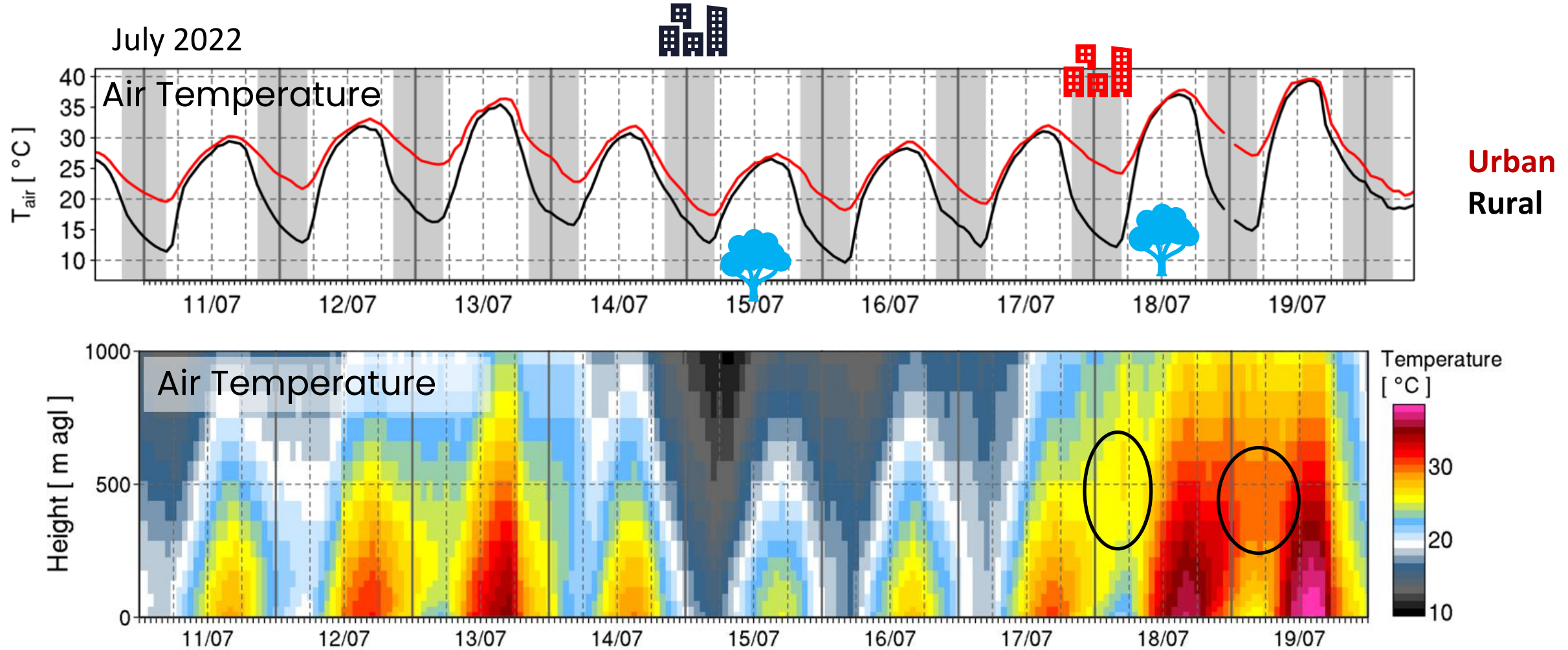
# Night time temperature variability

# Nocturnal transport and mixing

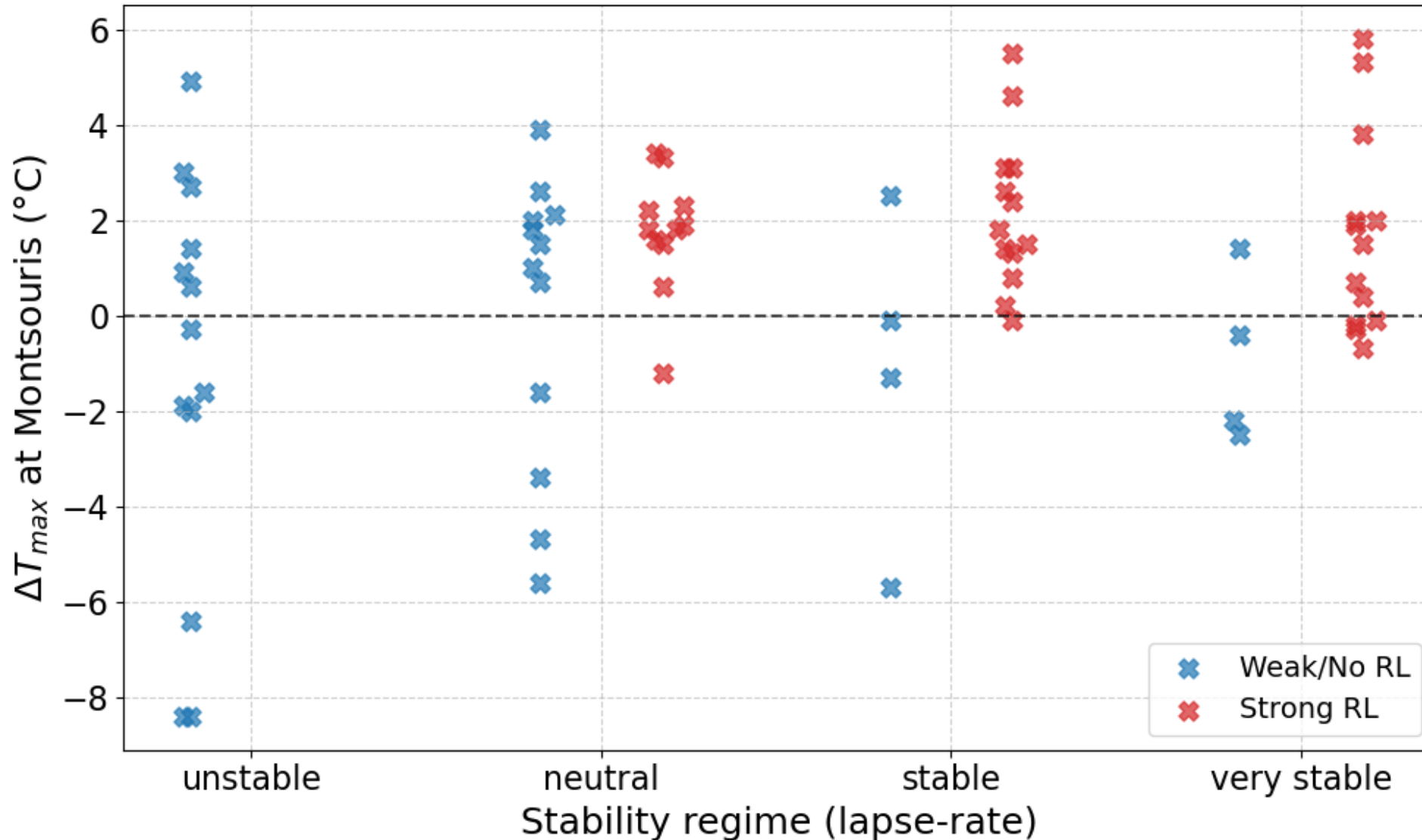


July 2022

# Heat stored in residual layer at night



# Heat stored in residual layer at night

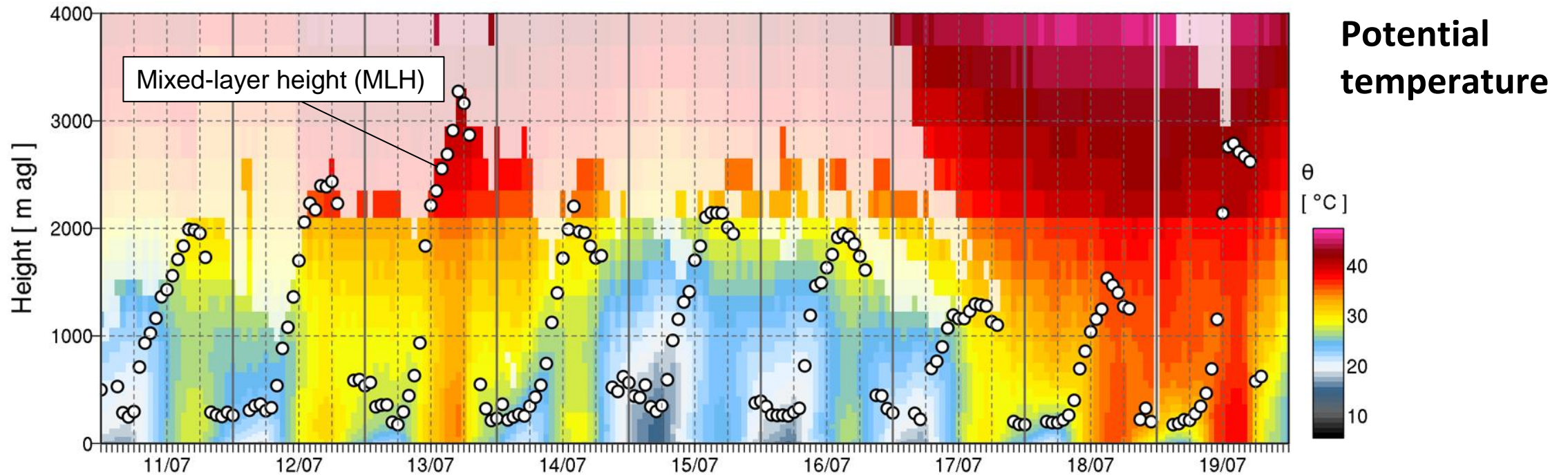


# Daytime temperature variability

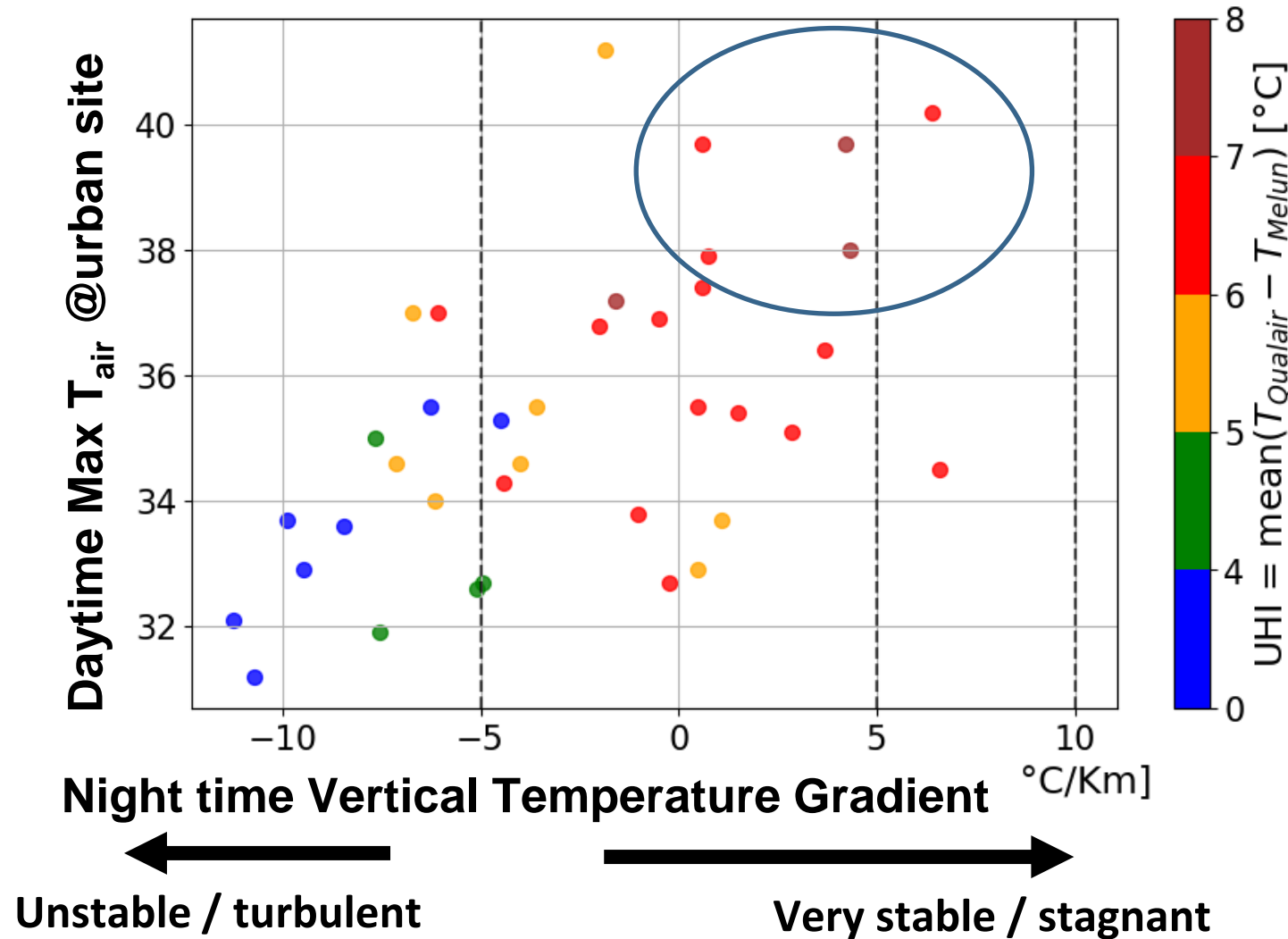
# Entrainment of elevated heat

## Air temperature in central Paris

July 2022



# Daytime Maximum Temperatures



Highest daytime maximum  $T_{air}$  :  
after **nights** with very stable conditions (weak mixing)  
+ hot air from long-range transport in upper layers

# Conclusions

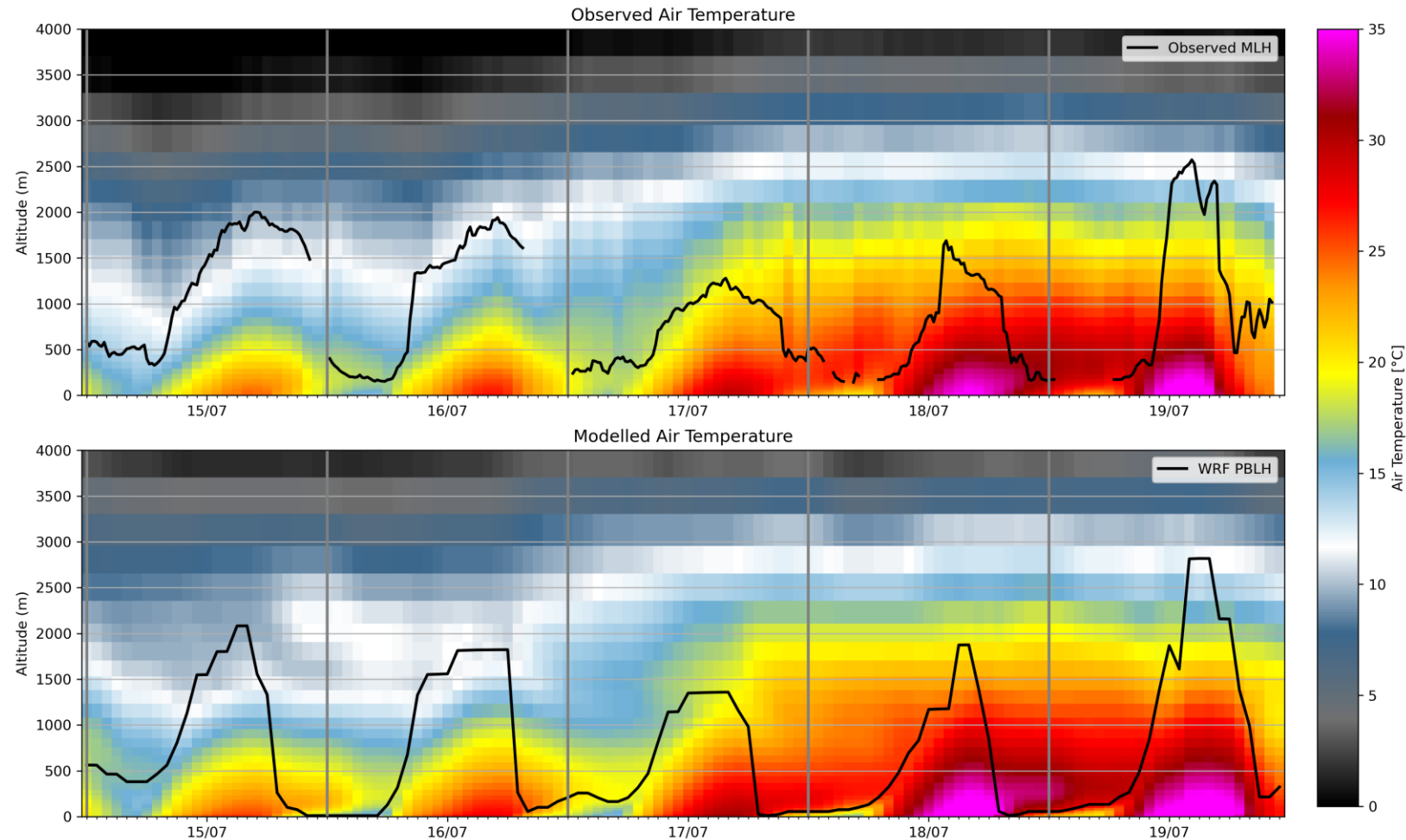


- Heat waves becoming more frequent in Paris region
- Temporal evolution with heat accumulation
  - ✓ Heat reservoir at night in residual layer
  - ✓ Long-range transport of hot air in upper layers  
→ Entrainment
- Stable stratification during heat waves intensifies urban heat island
- Peak daytime temperatures usually following nights with strong urban heat island intensity → **cumulated heat hazard**

# Perspectives

- **InteGREEN project:** Which vegetation strategy to maximise the ecosystemic services?

→ Simulations @ 1km resolution or less with urban scheme including vegetation (Segura-Barrero post-doctoral position)



# Acknowledgements

