

Development and implementation of a compact, non-intrusive water surface temperature monitoring station for river ecosystem

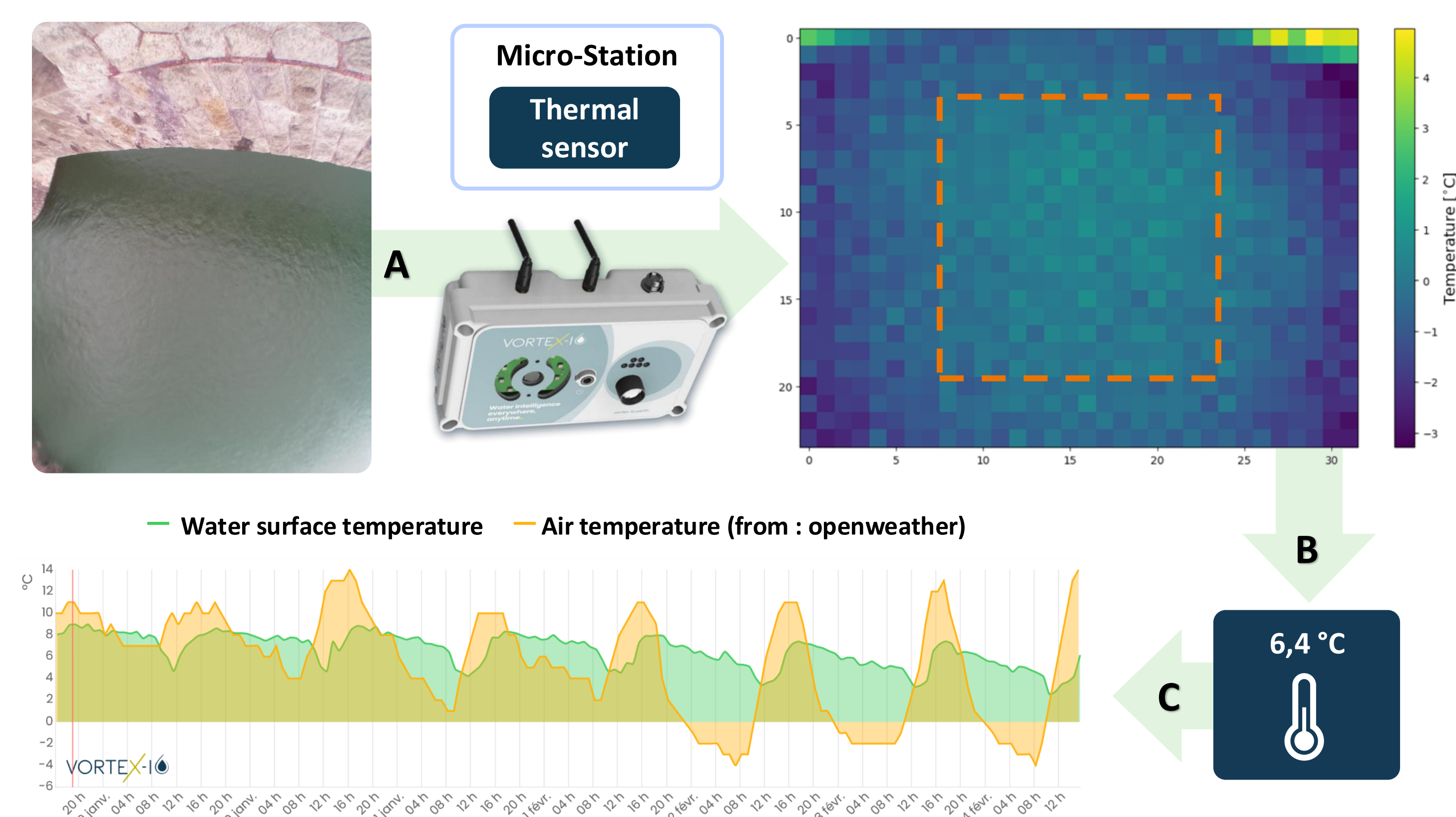
The project

Water temperature analysis is a **critical challenge**, as water plays a key role in a wide range of sectors—from agriculture (such as aquaculture and crop irrigation) to industrial applications like the cooling of nuclear reactors. To improve **real-time water temperature monitoring** and estimation, Agence de l'Eau Adour-Garonne has partnered with vortex-io to **significantly enhance existing systems in terms of reliability, deployment simplicity, spatial coverage, and measurement frequency**.

vortex-io operates a dense network of micro-stations originally developed to measure parameters such as water level. As part of this research and development project, new methods were designed to enable these stations to measure **water surface temperature using dedicated sensors**. Those stations are **fully autonomous**, use GSM network to send their measurements and solar panel to charge their batteries.

Nowadays, the project has raised several **years of data** and allows us to conclude about measurement reliability and sustainability.

Water surface temperature measurement



The measurement occurs at least once per hour.

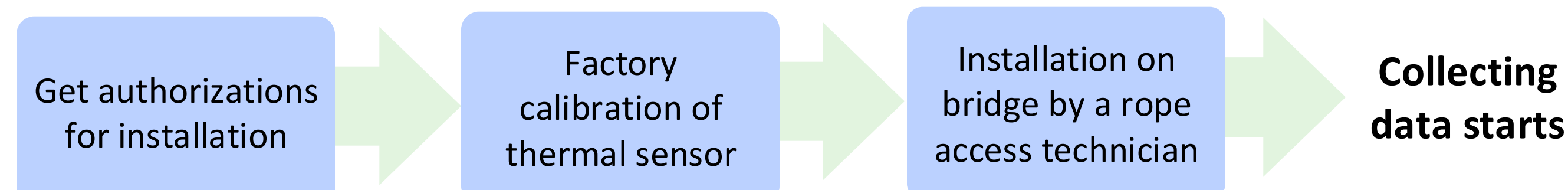
A — At this step, the thermal sensor gets a thermal image (infrared) from the water surface. We can see some hot corners which are parts of the bridge where the micro-station is installed. This thermal matrix is about twice as small as the usual camera view.

B — Then, the average value of pixels contained in the orange dotted rectangle is computed (area where the accuracy is the best, according to the sensor manufacturer)

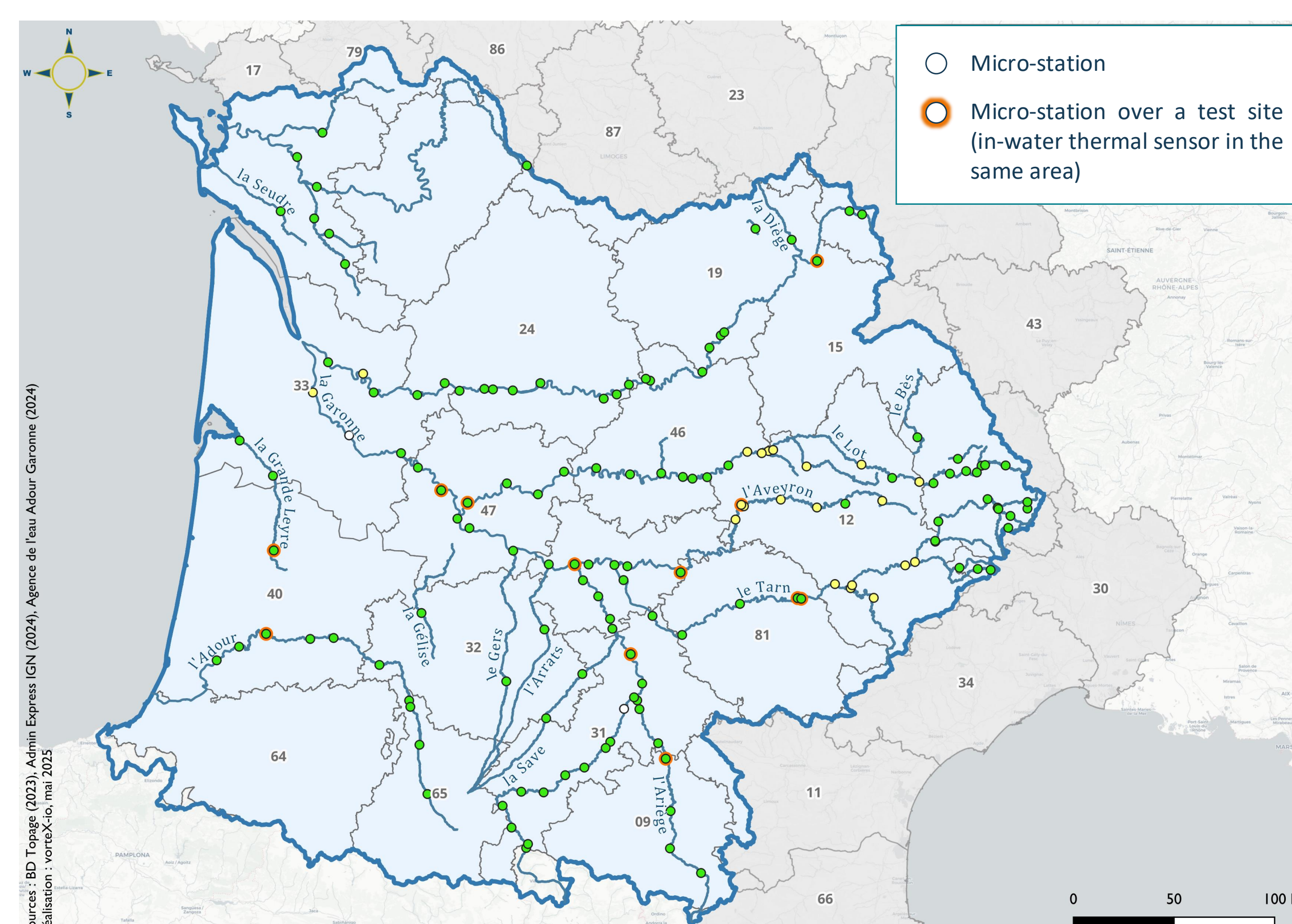
C — Finally, the acquired temperature value is checked by comparison with previous values, and the temperature bias (calibration part in Manufacturing and installation process) is removed. If the sent surface temperature is valid, the new value is made available through the vortex-io App.

This global process takes only a few minutes.

Manufacturing and installation process

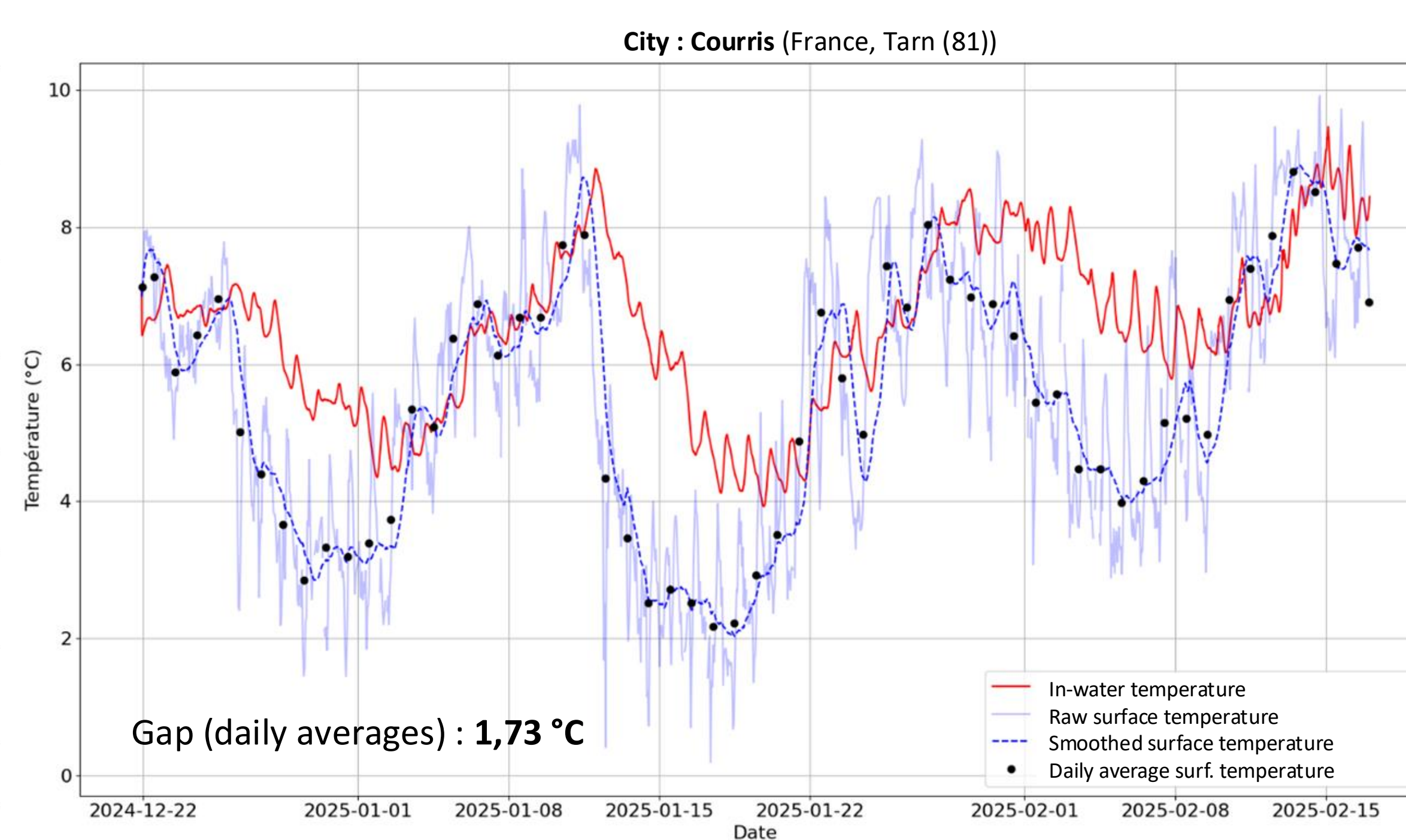
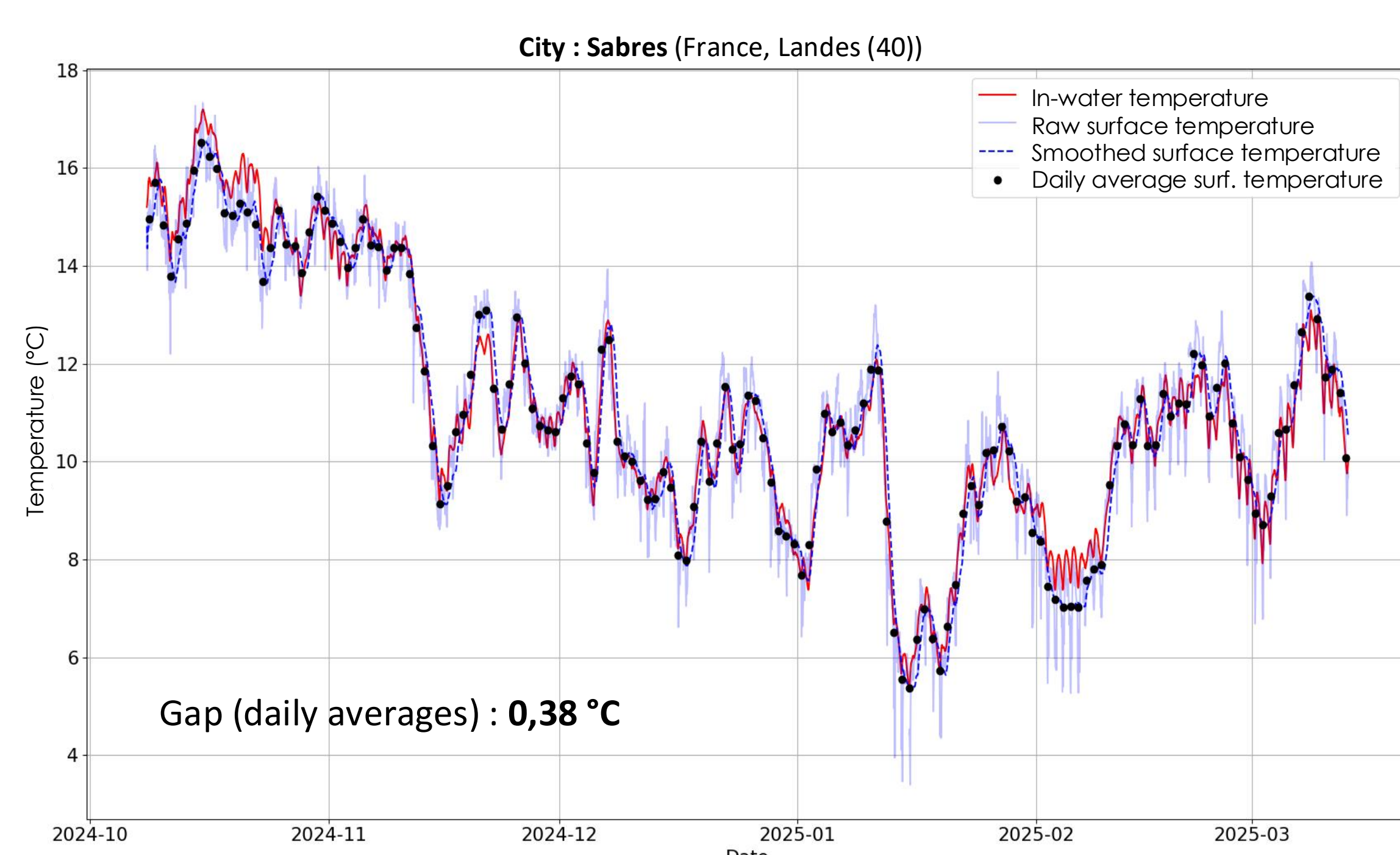


Stations across Adour-Garonne basin



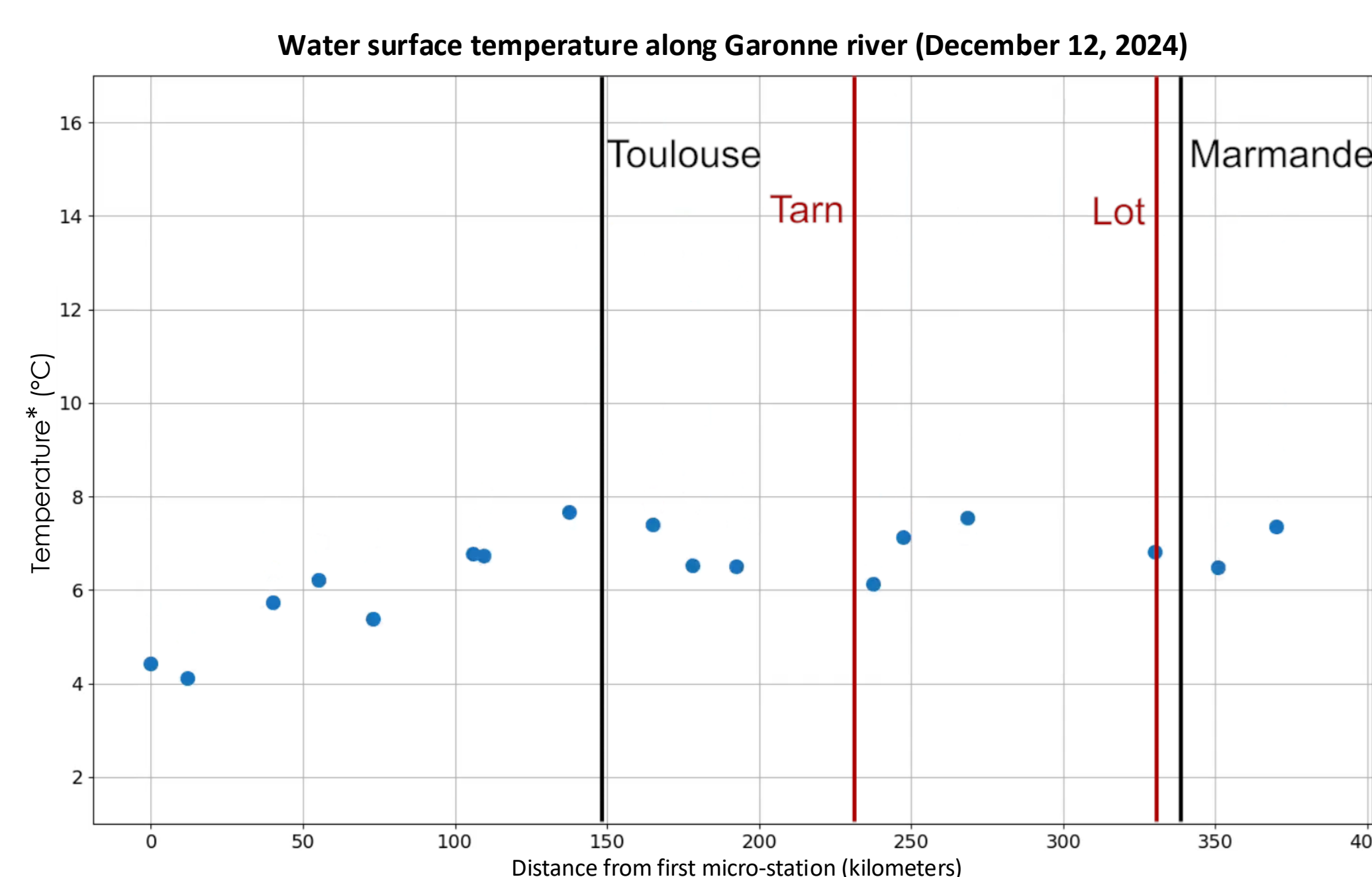
The Adour-Garonne basin is the main place where stations have been deployed (but not limited to). At some sites, we added an in-water (~10 cm deep) thermal sensor to have a reference value do some studies about the system's reliability.

Results and conclusions



It appears that different sites exhibit **varying correlations** between surface temperature and in-water temperature. This reflects the **fundamental difference between surface temperature and deep average temperature**. Surface temperature can approximate deep average temperature **under certain conditions**:

- The river is **well-mixed**;
- The river is sufficiently small;
- There are **no local disturbances** (such as factory cooling water discharge).



Conclusions

The vortex-io station **measures water surface temperature**. Some specific conditions, where the temperature in a section of the river is well mixed and uniform allows the station to measure the average temperature of the water course.

The large micro-station network, with high time resolution, **opens the way to a large-scale monitoring of water surface temperature**, useful to follow the health of river species, especially.

Plus, with the Trishna satellite (supposed to be launched in 2026), **the vortex-io micro-stations represent a way to cover the lack of both spatial and temporal resolution of a satellite measure**: the system is simple to deploy and designed to be installed in various and complex situations.

References

- « Modeling and Experimental Investigation of the Evolution of Surface Temperature Fields in Water Bodies » Feiyang Luo, Changgeng Shuai, Yongcheng Du et Chengzhe Gao
- « Rising water temperature in rivers: Ecological impacts and future resilience » Matthew F. Johnson, et. al.