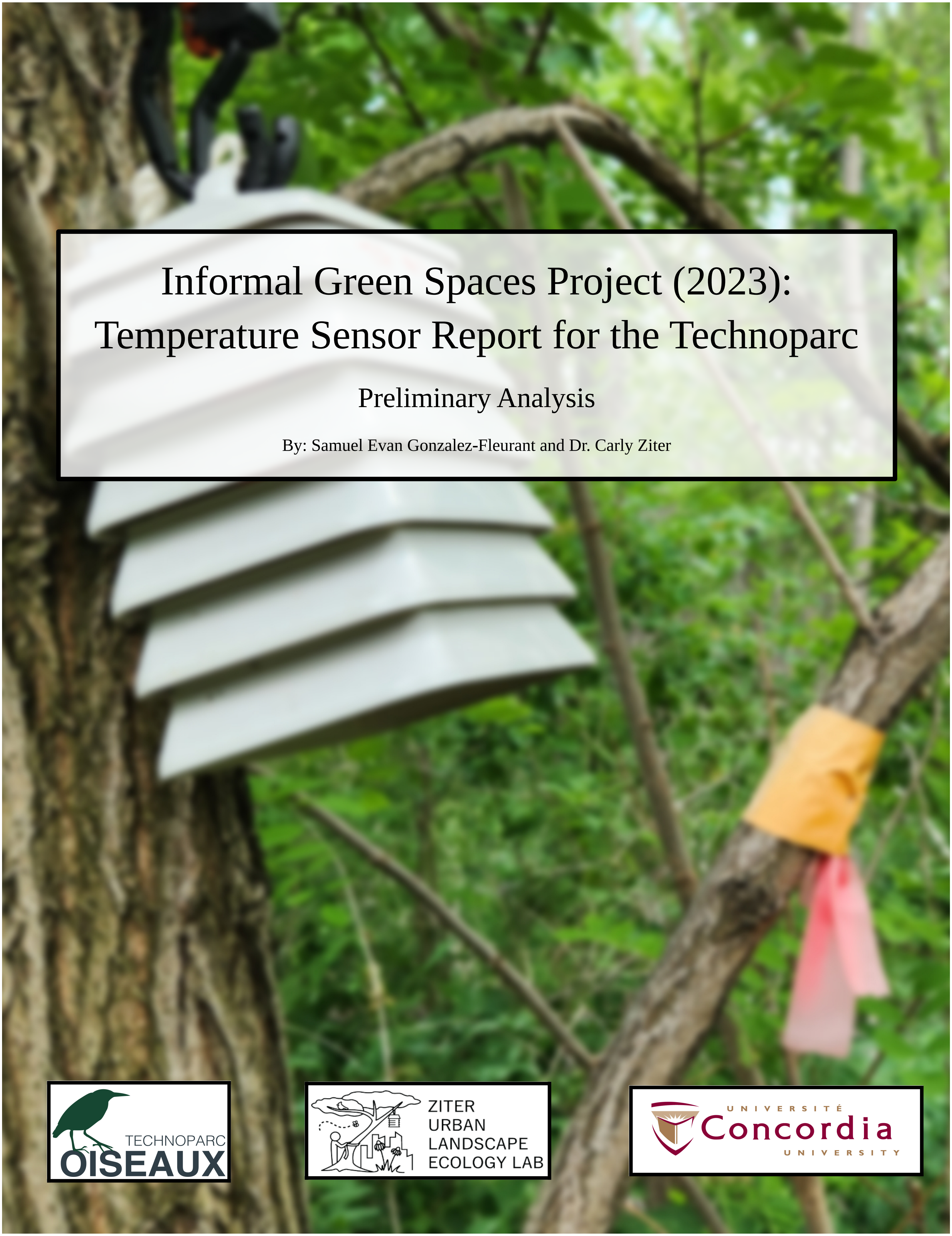

Informal Green Spaces Project (2023): Temperature Sensor Report for the Technoparc

Preliminary Analysis

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Introduction:

Map of Sensor Locations

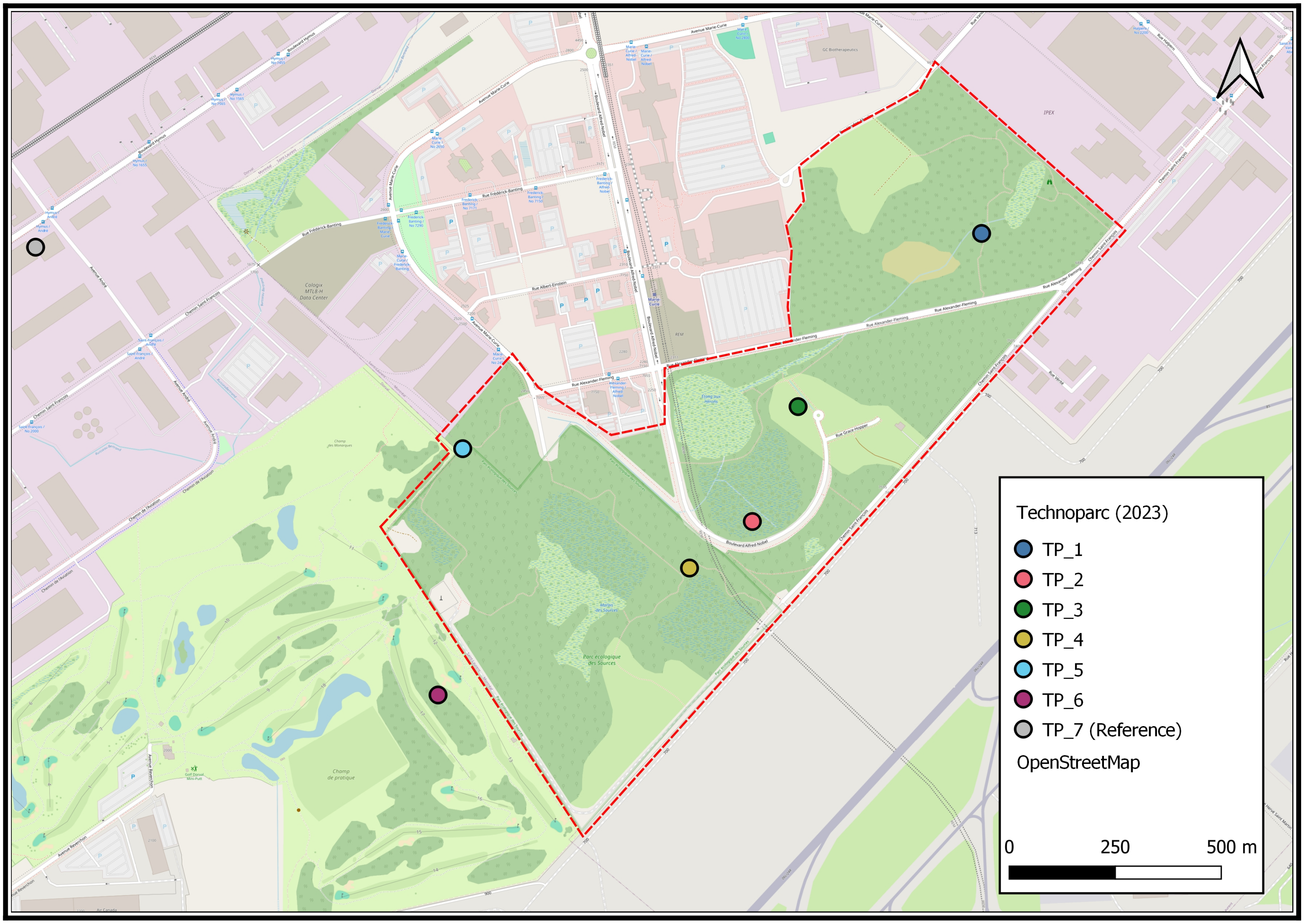

Figure 1: A high-resolution map created in QGIS. TP_1&2 were in heavily forested areas next to wetland, TP_3 was in an open field, TP_4&5 were in heavily forested areas, and TP_6 was in a small patch of forest surrounded by mowed lawn. The reference sensor TP_7 was placed at a minimum distance of 1km from the Technoparc, in the parking lot of CrossFit de l'Ouest. For the interactive version **click here**.

Objective of the Study:

Green spaces are invaluable to us, they are not only important in promoting biodiversity in cities, but also provide urban residents with a multitude of services. One such service is temperature regulation. Cities create “urban heat islands”, or areas of increased temperature that occur when vegetation is replaced by buildings and paved surfaces, among other factors. These urban heat islands have significant consequences for health and well-being of urban residents; across Canada, immigrants and people with lower incomes are also disproportionately likely to live in the hottest urban areas. Past studies have found that green spaces provide cities with temperature regulation through shade and evaporative cooling, offsetting the urban heat island and providing spaces for urban residents to cool off. In this study we investigate the temperature regulation of green spaces in Montreal, as part of a broader assessment of the social and ecological benefits provided by “informal green spaces” such as the Technoparc. To learn more about heat islands in Montreal **click here**.

Information on the Sensors

The temperature sensors themselves were Kestrel DROP D2 Wireless data loggers. They were protected from direct solar radiation by an AcuRite plastic shield to best record ambient temperature. The temperature sensors were placed approximately 2 m above the ground and were in the field from early June to early September, taking a reading every 30 minutes. The sensor locations were chosen based on two factors; (1) general interest from the partner group for its study, and (2) the habitat types present in the green space. The goal was to capture the heterogeneity of the green spaces in the data, to better understand how its regulatory temperature service.

Figure 2: Example of the AcuRite solar shield (Left), and a Kestrel DROP D2 (right) temperature sensor .

Information on the Data

For the Technoparc, the data spans June 2nd to August 22nd. Luckily no sensors were lost or damaged; however, some sensors died earlier than others as a result of battery loss. Because of that, data used for analysis was adjusted such that each sensor starts and ends at approximately the same time for easier comparison.. Furthermore, due to potential differences in the effects of vegetation on urban heat during daytime and nighttime, the data was split into day and night. Day is defined as the time between 6:00 am and 8:30 pm and night as the time between 8:30 pm and 6:00 am, based on approximate sunset and sunrise times.

Information on the Graphs

Two different kinds of graphs were created for this report. The first kind (figure 3 and 5) I will refer to as a ‘comparison of means’ plot, which shows us the average temperature for the **whole** time range. The second kind (figures 4 and 6) I will refer to as a ‘smooth’ plot, which looks at the change in temperature **over time**. Simply, it uses a formula to create a trendline over the data (the line shown) that helps us visualize how the data changes over time. In short, they both use the same data; however, at different time scales.

Additionally, variations of the two graphs mentioned above were made. These variations (figures 5 and 6) look at each sensor location within the site. This was done to investigate how environmental composition impacts temperature regulation of green spaces.

Results

Figure 3 and 4

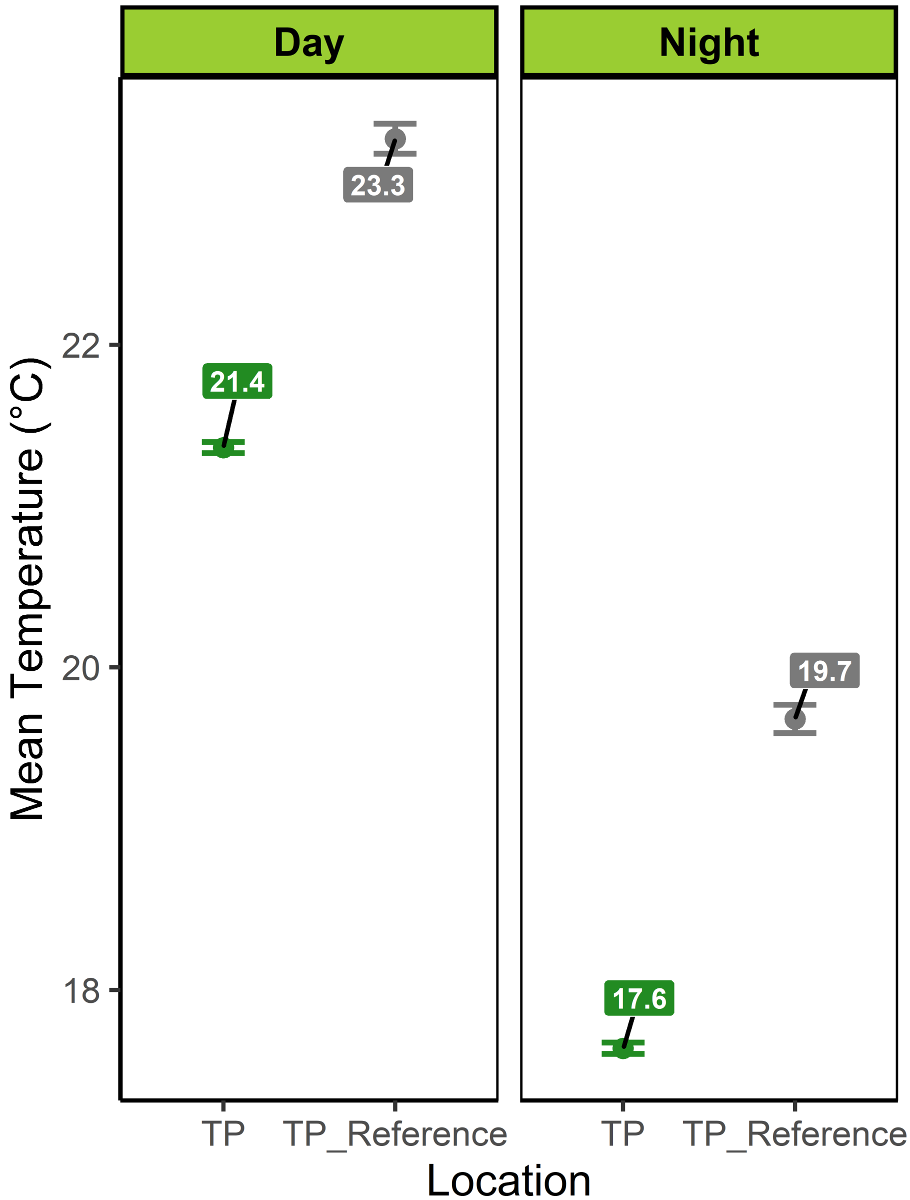

Figure 3: An average comparison graph showing the average temperature, day and night, in the Technoparc and that of the reference sensor for the summer. The values displayed are these averages.

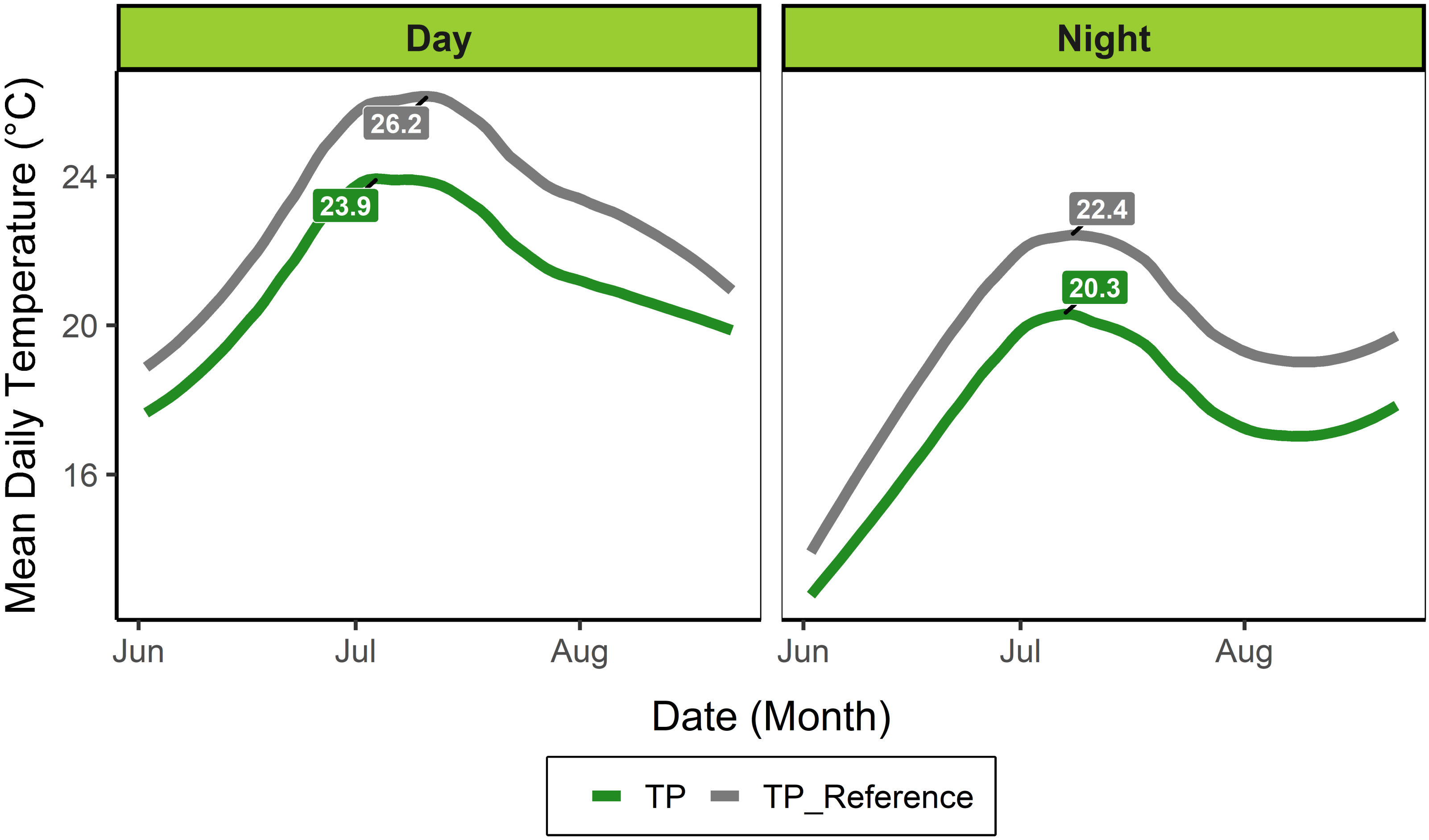

Figure 4: A smooth graph showing the average daily temperature, day and night, in the Technoparc and that of the reference sensor over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 3 demonstrates that the average temperature of the Technoparc for the whole summer was lower than the reference sensor. On average, the temperature difference was 1.9°C during the day, and at night the difference was 2.1°C.

Figure 4 delves deeper into the temperature trend, showing us that the average daily temperature of the Technoparc was always below that of the reference sensor; however, the trend over the summer was variable. For example, during the day, the temperature difference between the Technoparc and the reference remained constant between early and late June, but in early to mid July it became increasingly larger. At night, the difference in the temperature grew steadily from early June to the peak of the summer which occurred again in early to mid July. The difference in temperature at the peak of the summer was 2.3°C during the day and 2.1°C at night. After the peak of the summer, the temperature difference during the day remained relatively consistent as the overall temperature dropped until the end of the experiment. At night the temperature difference decreased until late July, but then increased as temperatures increased until the end of the experiment.

Figures 5 and 6

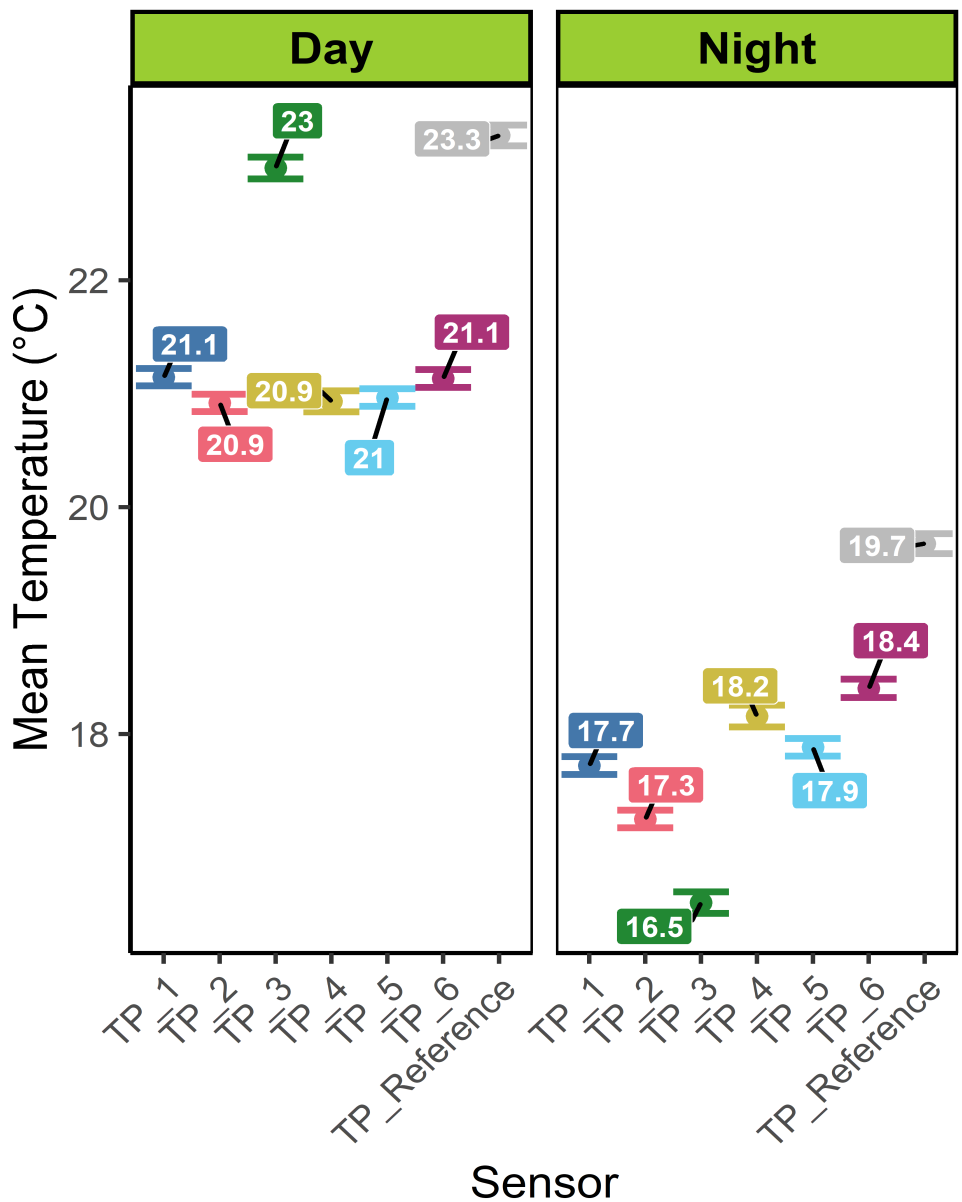

Figure 5: An average comparison graph showing the average temperatures, day and night, of each sensor location in the Technoparc and that of the reference sensor for the summer. The values displayed are these averages.

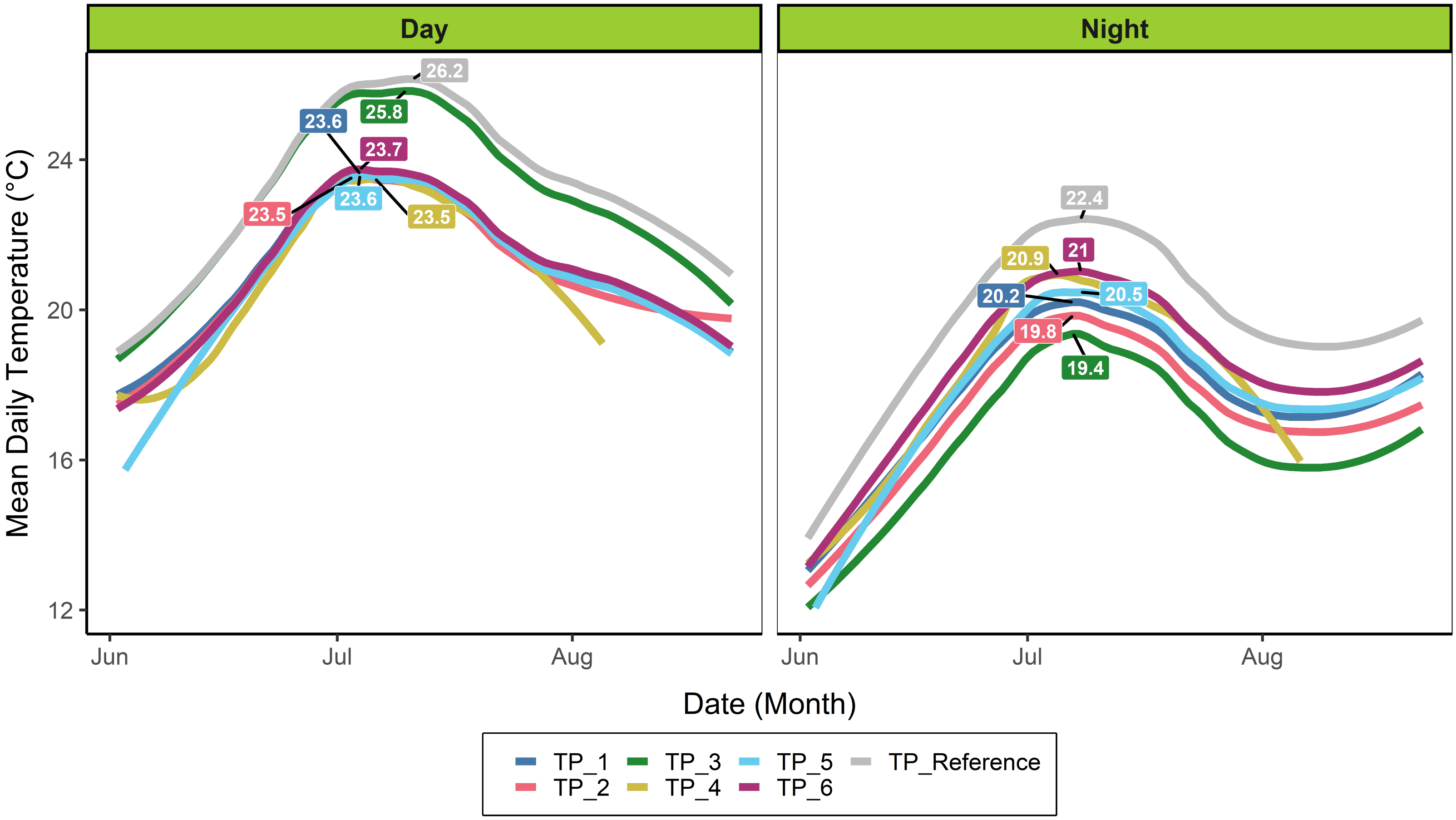

Figure 6: A smooth graph showing the average daily temperature, day and night, of each sensor location in the Technoparc and that of the reference sensor over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 5 shows us that all individual sensors last summer, on average, were cooler than the reference sensor. Furthermore, all the forested sensors (TP_1,2,4,5,&6) were extremely close to each other during the day. Averaged, these 5 sensors were 2.3°C cooler than the reference. In comparison, TP_3 was only 0.3°C cooler than the reference sensor, and 2°C warmer than the other Technoparc sensors. At night however, we can see that this trend was inverted. TP_3 becomes the coolest sensor by being 3.2°C cooler than the reference, followed by the two forest/marshy sensors TP_1&2 (2.2°C cooler than the reference averaged), and finally the forested sensors TP_4,5,&6 (1.5°C cooler than the reference averaged).

Figure 6 shows us that each sensor in the Technoparc was nearly always cooler than the reference sensor throughout the summer, with the exception of sensor 3. Unlike in figure 5, figure 6 better illustrates the trend of TP_3 over the summer. During the day, we can see that from June to July TP_3 and the reference sensor were nearly identical in temperature. Once the temperature peaked in early July however, TP_3 became cooler and that difference slowly increased until the end of the experiment. At the peak, TP_3 was 0.4°C cooler than the reference sensor and 2.2°C warmer than the forested sensors. Comparatively, all the other sensors (TP_1,2,4,5,&6) were constantly extremely close to each other for most of the summer. At their peak, they were approximately 2.6°C cooler on average compared to the reference. A night we see the same trends as in figure 5: TP_3 was practically always the coolest sensor (3°C cooler than the reference at the peak), followed by the two marshy/forested sensors TP_1 and 2 (2.4°C cooler than the reference at the peak averaged), and finally the forested sensors TP_4,5,&6 (1.6°C cooler than the reference at the peak averaged).

The difference between the reference and most of the sensors remained fairly constant before and after the temperature peak of the summer (early July to mid July). The only sensor that behaved abnormally was TP_4. In the lead up to the death of the sensor the temperature readings dropped, and it is uncertain if it was because of natural causes or due to a malfunction.

Discussion and conclusion:

As shown by figures 3 and 4, there is a clear temperature difference (1.9°C during the day on average, and 2.3°C during the day at the peak summer temperature) between the Technoparc and the urban reference sensor–showing us that the green space is cooling its environment. Furthermore, figures 5 and 6 show us that during the day forested environments will be generally cooler than those which are open and less shaded. Importantly however, we see that at night the trends can invert; open areas can actually become cooler than forested sensors. These results indicate that it is important that these green spaces be heterogeneous, as different habitat and vegetation types within parks can contribute to differing cooling (and ecosystem) benefits. Although open areas may be much warmer during the day, they may be much more efficient at night-time cooling than forested areas. This is the case because trees can potentially “trap” daytime heat, which takes longer to dissipate at night. Comparatively, open areas allow the green space to cool down at night and thus allow surrounding urban areas to cool off and reach lower temperatures–TP_3 from figures 5 and 6 being a perfect example of this phenomenon. As such, it is important that we preserve the heterogeneity of green spaces such as the Technoparc as variety in habitat type can provide differing cooling benefits at different times leading to more effective temperature control.

Informal green spaces such as the Technoparc have a demonstrable cooling effect, as such they become a tool cities **must** use to combat urban heat island effects, which is increasingly important in a warming climate. Moreover, green spaces have a plethora of other co-benefits; for example, they support biodiversity, contribute to reducing air pollution, and positively impact human well-being and health, among many other equally valuable benefits. As such, if the goal is to create cities that can combat the effects of climate change, preserving remaining green spaces should be a priority;

especially in areas that are lacking in access to green spaces—such as in particularly densely packed and/or vulnerable populations.

Finally, green spaces such as the Technoparc are cherished by those who live near them, evidenced by the hard work and actions of community groups such as *Technoparc Oiseaux*, who play an important role in defending them. However it cannot just be community groups with the burden of defending these spaces, academic institutions also have a responsibility and a role in this. Scientific evidence demonstrating the ecological value of these spaces can be vital for community groups (and decision-makers). Scientists and academic institutions can play an important role in collecting, examining, and explaining scientific evidence, such that decisions can be made with science in mind with how green spaces play a role in combating increasing environmental challenges faced by our cities.