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

Preliminary Analysis

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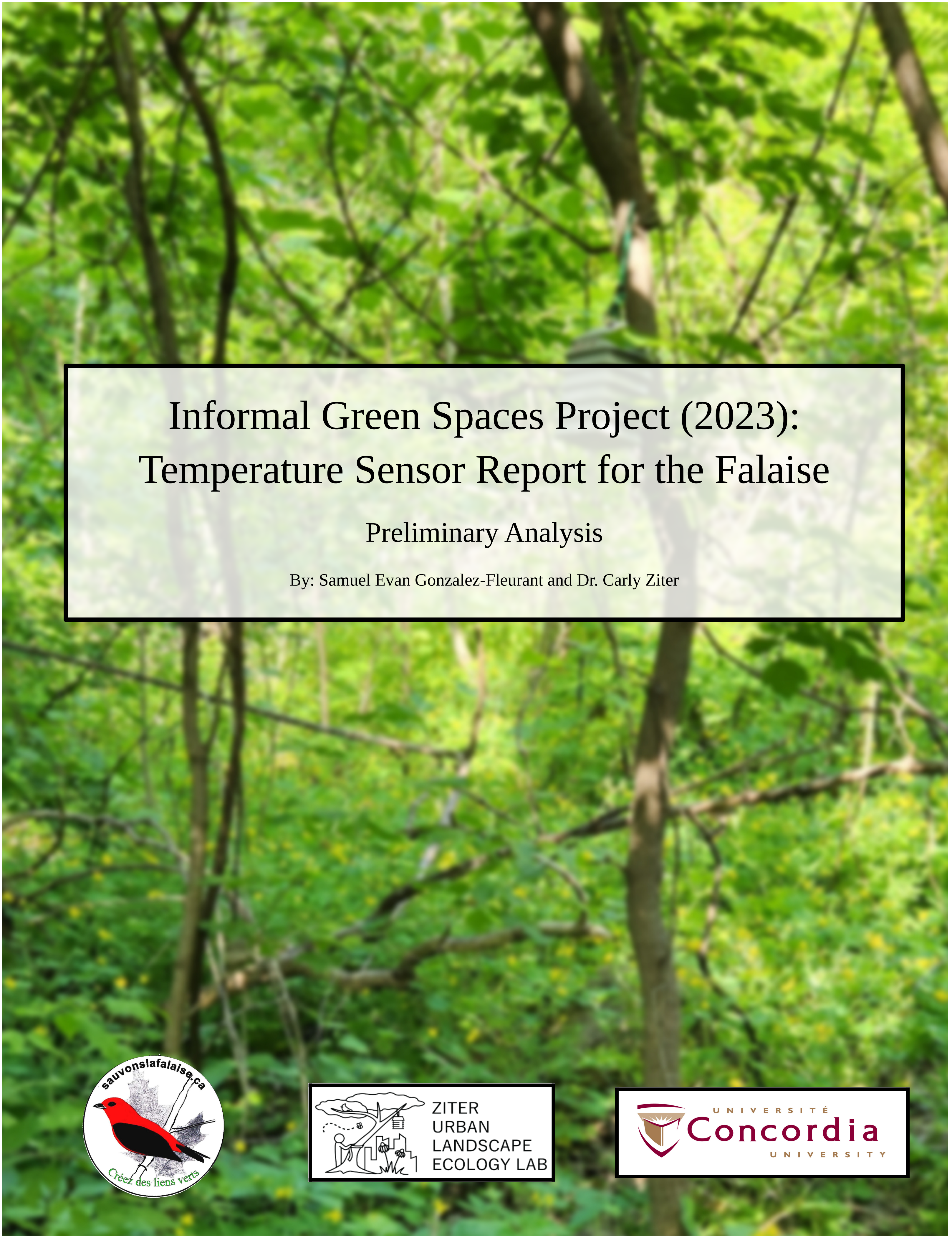

sauvonslafalaise.ca
Créez des liens verts

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Introduction:

Map of Sensor Locations

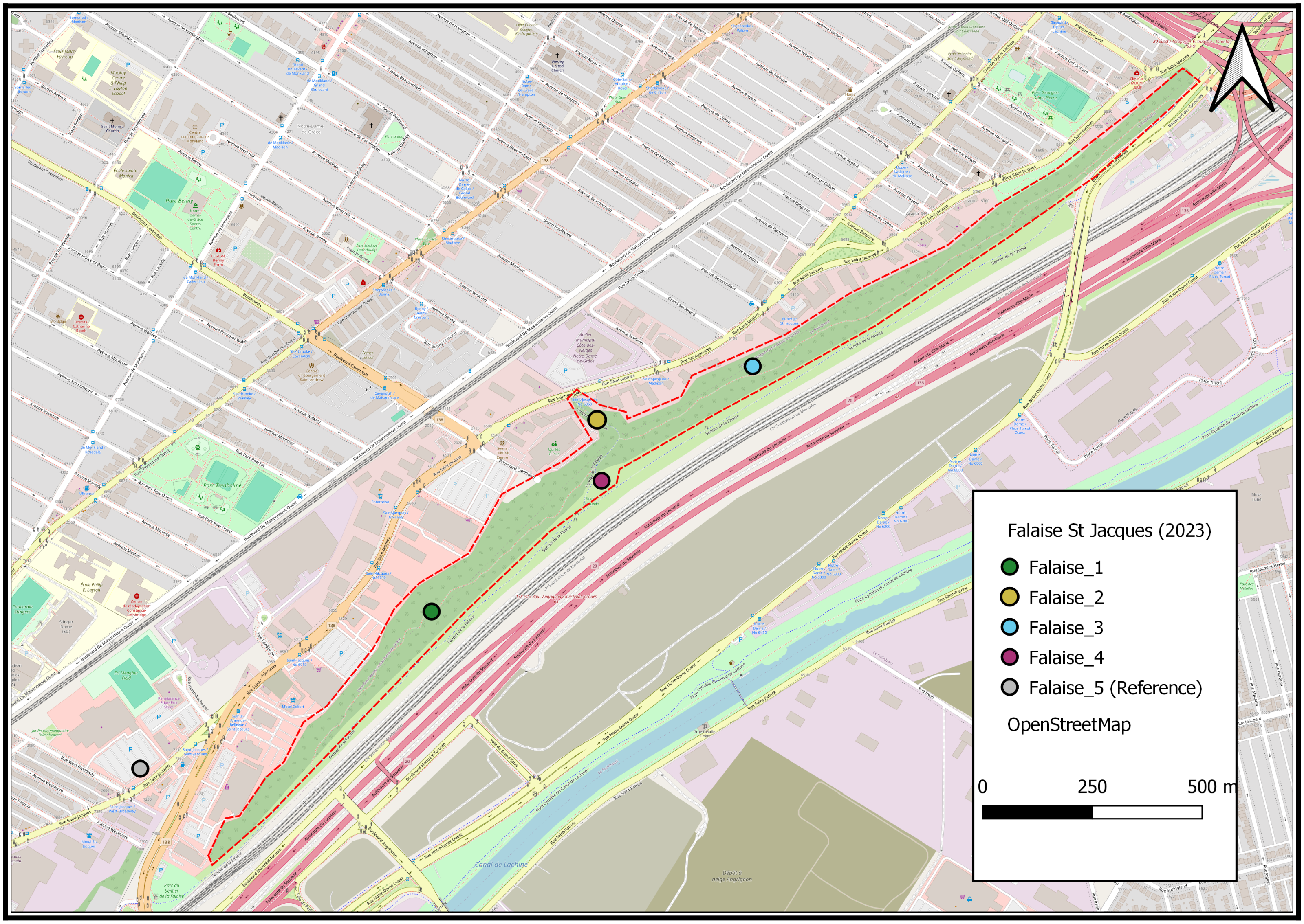

Figure 1: A high-resolution map created in QGIS. Falaise_1&3 are in heavily forested areas, while Falaise_2 is in a forested area next to asphalt, and Falaise_4 is in an open/wetland area at the base of the Falaise. The reference sensor was placed at a minimum distance of 300 meters from the Falaise, in the parking lot of the nearby RONA on St-Jacques. 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 Falaise. 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

The data spans June 1st to August 22nd; however, some sensors died earlier than other due to battery loss. Because of this, data used for analysis was adjusted such that each sensor starts and ends at approximately the same time for easier comparison. Additionally, 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

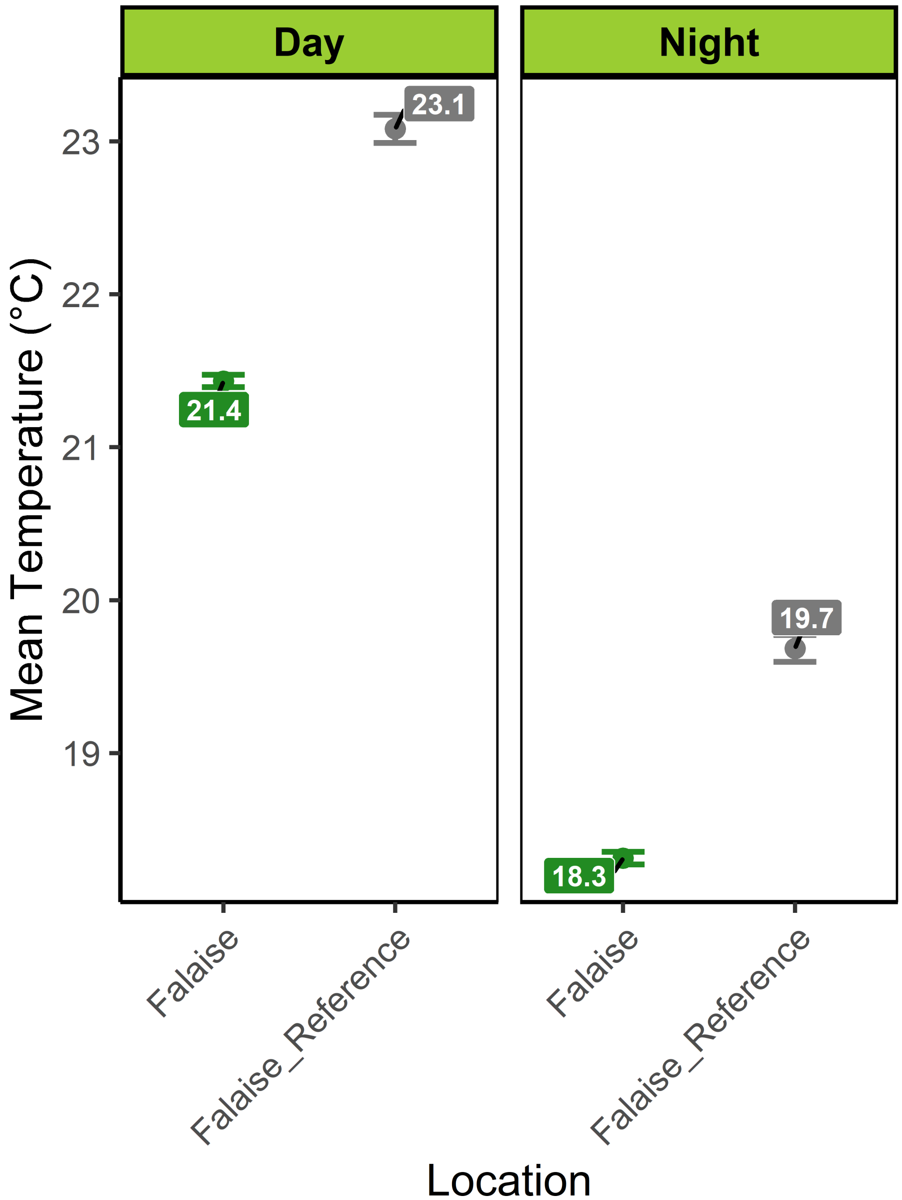

Figure 3: An average comparison graph showing the average temperature, day and night, in the Falaise and that of the reference sensors for the summer. The values displayed are these averages.

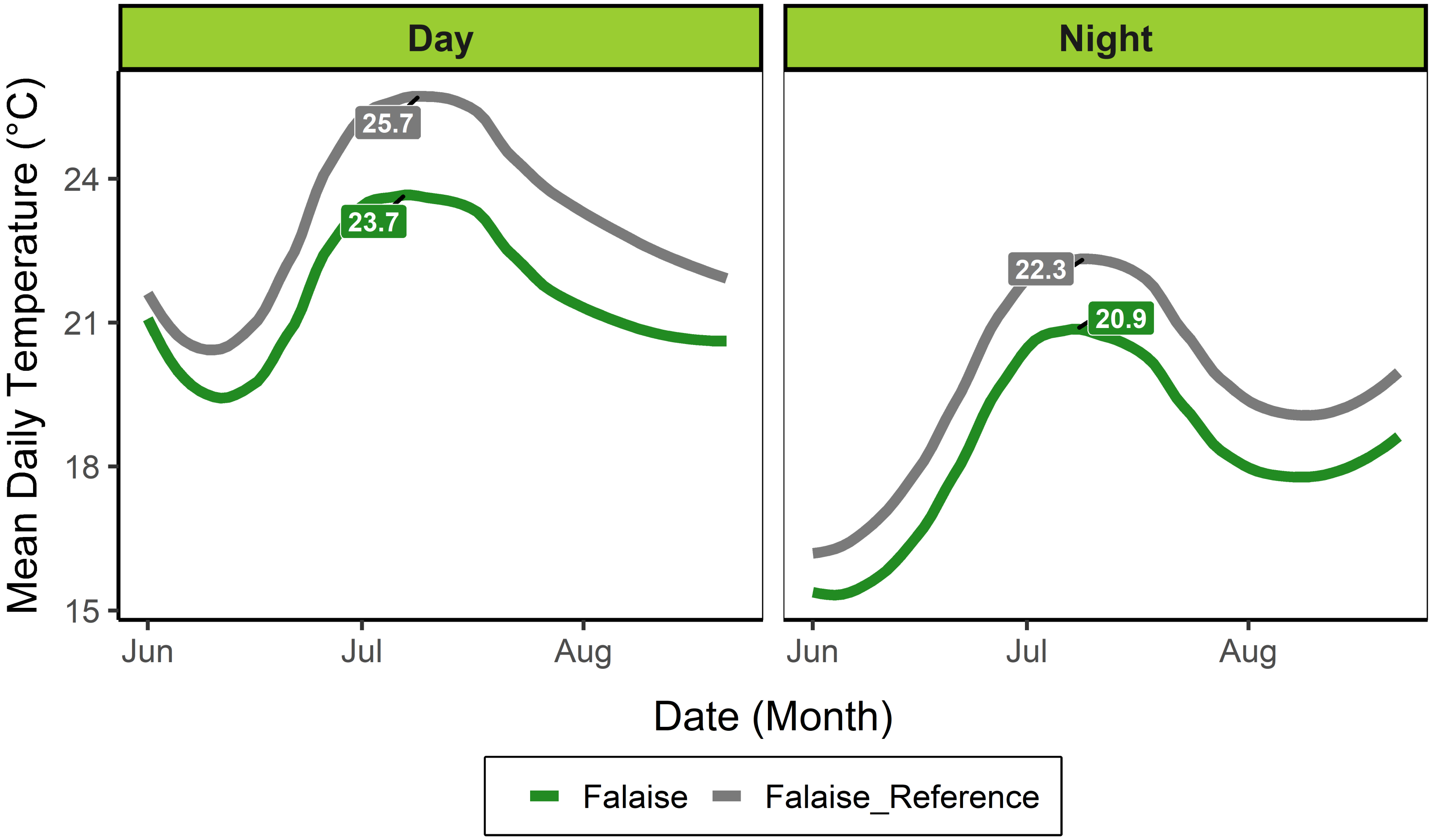

Figure 4: A smooth graph showing the average daily temperature, day and night, in the Falaise and that of the reference sensors over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 3 demonstrates that the average temperature of the Falaise for the whole summer was lower than the reference sensor. On average, the temperature difference was 1.5°C during the day, and 1.3°C at night.

Figure 4 (smooth) delves deeper into the temperature trend showing us that the average daily temperature of the Falaise was always below that of the reference sensor; however, the trend over the summer was variable. During the day, and the start of data collection, the temperature difference between the reference sensor and the Falaise was small and increased significantly before the middle of June. After this, it decreases and remains stable until the temperature peak of the summer (late June to mid July), where it grows significantly. At this peak, the Falaise is 2°C cooler than the reference. After the temperature peak the difference between the reference and the Falaise dropped slightly and stayed somewhat constant. At night the temperature difference was much more constant. At the temperature peak (late June to mid July) the Falaise was approximately 1.5°C cooler than the reference sensor.

Figures 5 and 6

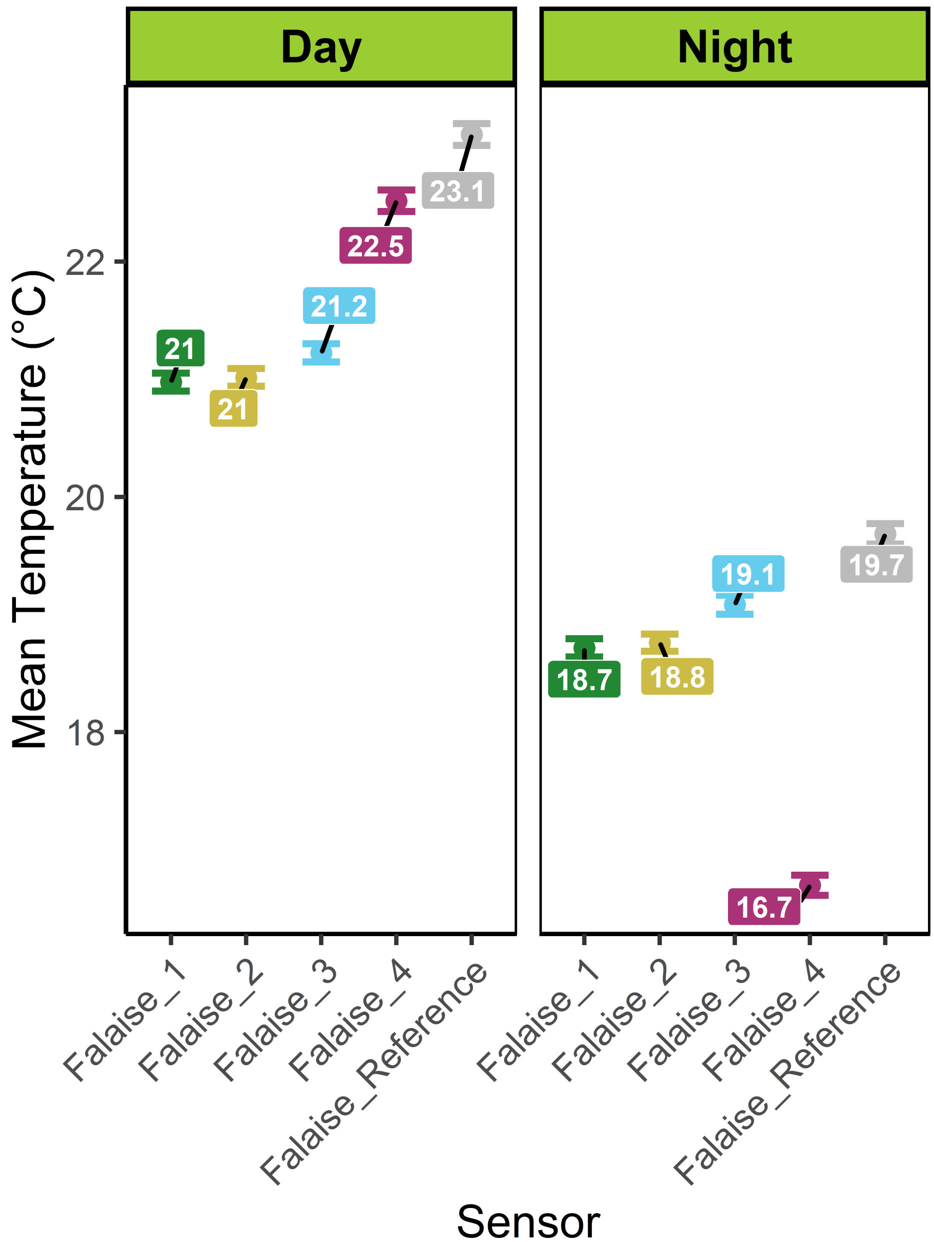

Figure 5: An average comparison graph showing the average temperatures, day and night, of each sensor location in the Falaise and that of the reference sensors for the summer. The values displayed are these averages.

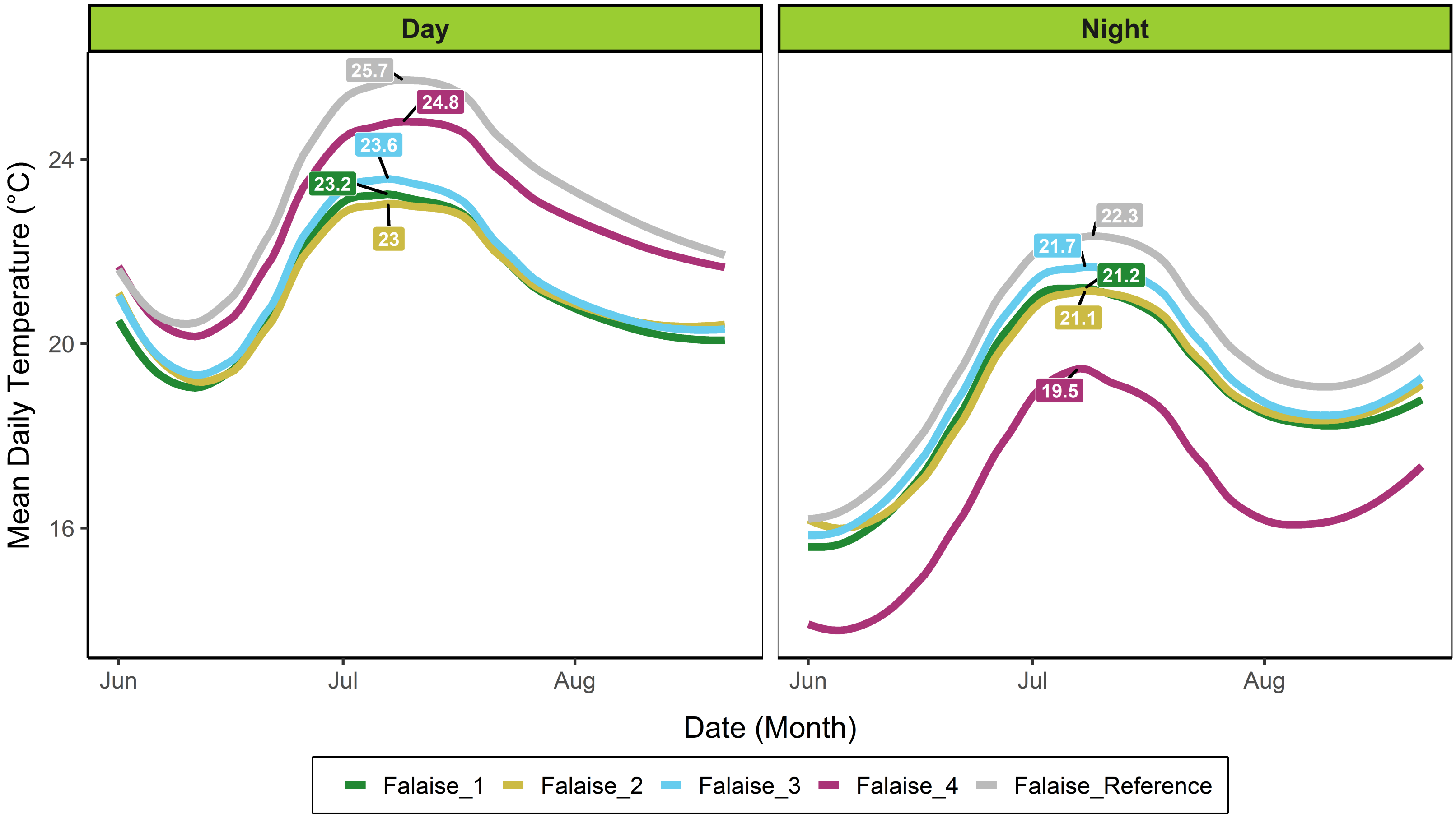

Figure 6: A smooth graph showing the average daily temperature, day and night, of each sensor location in the Champs des Possibles and that of the reference sensors over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 5 takes a look at the temperature in the different sensor locations within the Falaise and shows us that all individual sensors last summer, on average, were cooler than the reference sensor. Furthermore, all the wooded areas (Falaise_1,2, &3) were very close to each other. Averaging these three sensors, we see that they were approximately 2°C cooler than the reference sensor. Additionally, Falaise_4 was much warmer than the forested sensors during the day; it was 0.6°C cooler than the reference sensor. At night however, the trends inverted and Falaise_4 got to be 3°C cooler than the reference (approximately 2.2°C cooler than the forested sensors), while the forested sensors were 0.8°C cooler than the reference.

Figure 6, shows us that each sensor in the Falaise was nearly always cooler than the reference sensor throughout the summer. Notably Falaise_4 was, at certain points during the day, quite close to the reference. For example, right at the beginning of data collection (early June) Falaise_4 is nearly equal to the reference sensor (or even warmer); however this is a single instance and not maintained. After the beginning of June, the difference between Falaise_4 and the reference grew steadily until the temperature peak of the summer (late June into mid July) where Falaise_4 was 0.9°C cooler than the reference. After the peak, the difference steadily decreased until the end of data collection. Furthermore, we see that all the wooded areas (Falaise_1,2,&3) were consistently very close to each other throughout the summer, day and night. During the day, their respective differences to the reference sensor remained relatively constant before and after the temperature spike. During the peak, averaged, these three sensors were approximately 2.5°C cooler than the reference sensor. At night, we once again saw inverted trends. Falaise_4 became the coolest sensor while the forested sensors were grouped up and warmer. For all sensors their respective temperature differences to the reference were relatively constant over the summer. At the peak Falaise_4 was 3°C cooler than the reference, and the forested sensors averaged were approximately 1°C cooler than the reference.

Discussion and conclusion:

As shown by figures 1 and 2, there is a clear temperature difference (1.5°C during the day on average, and 2°C during the day at the peak summer temperature) between the Falaise and the urban reference sensor–showing us that the green space is cooling its environment. Furthermore, figures 3 and 4 show us that during the day forested environments will be generally cooler than those which are open and less shaded–such as the environment of Falaise_4. 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. Falaise_4 from figures 5 and 6 is a perfect example of this phenomenon; it was 3°C cooler both on average, and at the summer temperature peak. As such, it is important that we preserve the heterogeneity of green spaces such as the Falaise 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 Falaise 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 Falaise are cherished by those who live near them, evidenced by the hard work and actions of community groups such as *Sauvons La Falaise,* 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.