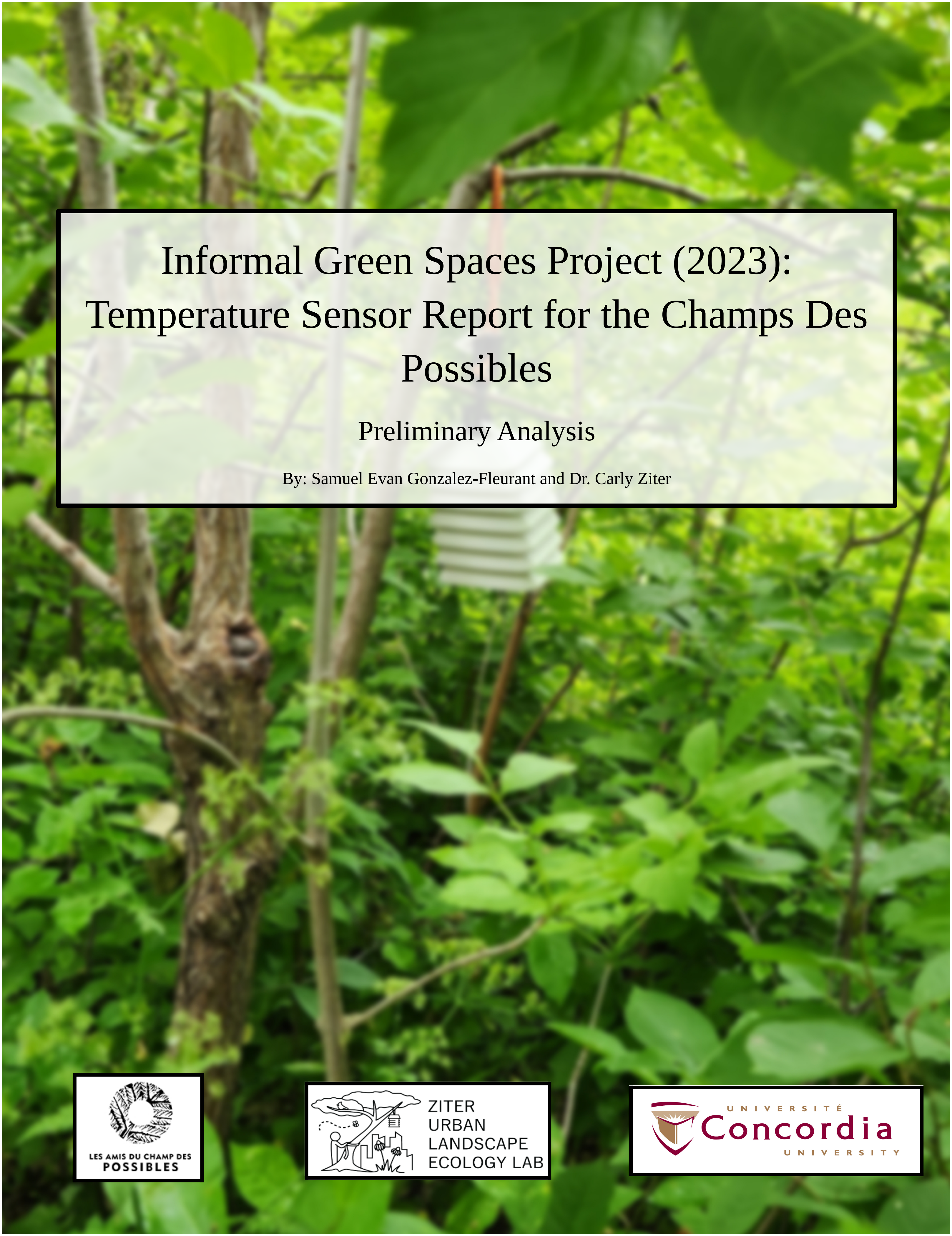
Informal Green Spaces Project (2023): Temperature Sensor Report for the Champs Des Possibles

Preliminary Analysis

By: Samuel Evan Gonzalez-Fleurant and Dr. Carly Ziter



LES AMIS DU CHAMP DES POSSIBLES

ZITER URBAN LANDSCAPE ECOLOGY LAB

UNIVERSITÉ Concordia UNIVERSITY

Table of Contents **Page**

Introduction:

Map of Sensor Locations

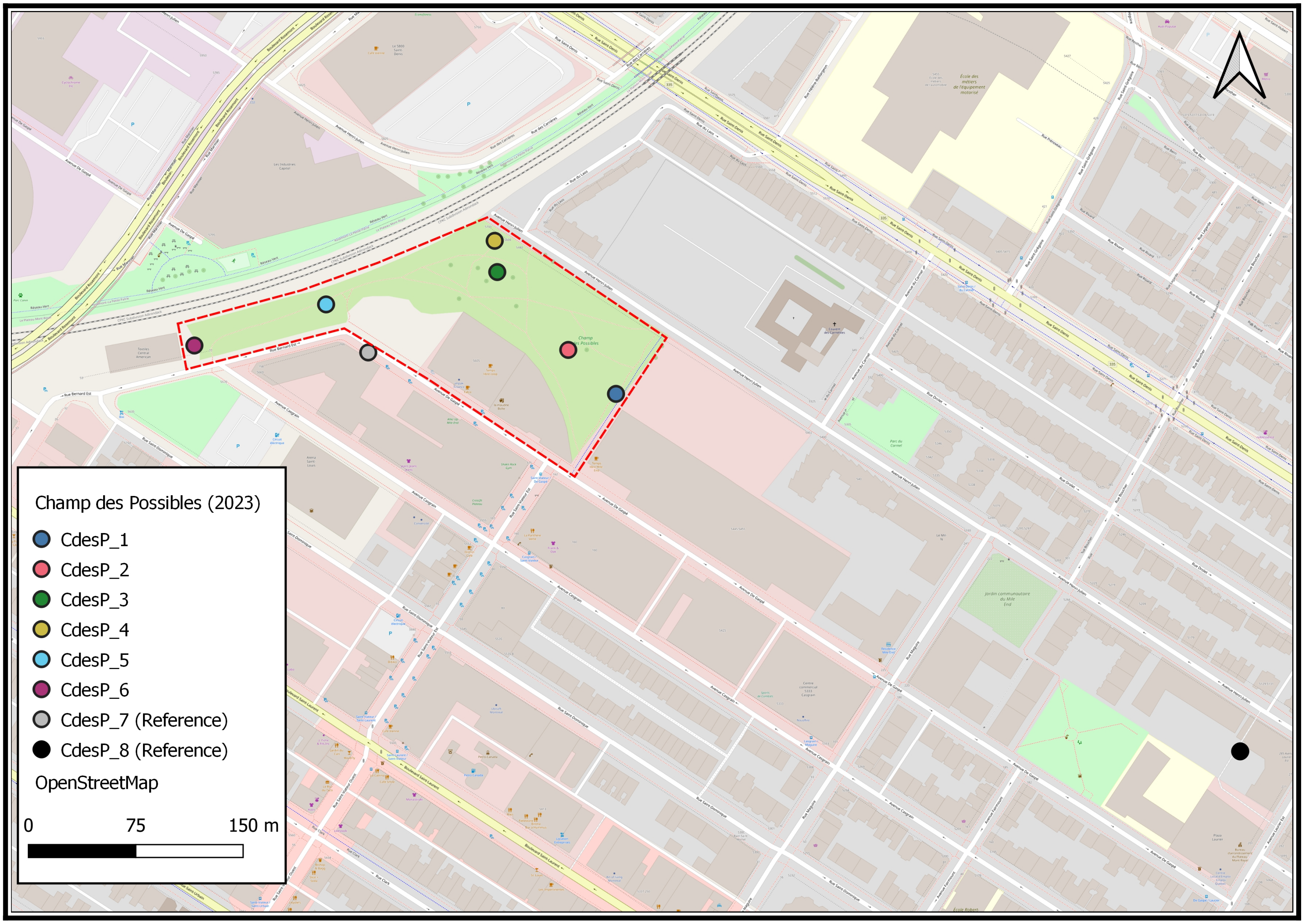


Figure 1: A high-resolution map created in QGIS. CdesP_1 was hanging over pavement on a lamp post close to the park and next to a bike path.CdesP_2,3,&4 were all forested sensors surrounded by trees and/or bushes next to small trails. CdesP_5&6 were in a forested section about 10m from an open walking trail. CdesP_7, the first reference sensor, is at a minimum distance of 50m to the green space and is hung on a lamp post on Av. de Gaspé. CdesP_8, the second reference sensor, is at a minimum distance of 500m to the green space and is hung on a fence on the premise of the apartment complex at 283 Laurier Ave E.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 Champ des Possibles. To learn more about heat islands in Montreal and about those who are impacted, **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 16th to September 4th; 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. Furthermore, CdesP_2 was unfortunately lost July 14th, but it was replaced 10 days later on July 24th. Finally, 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

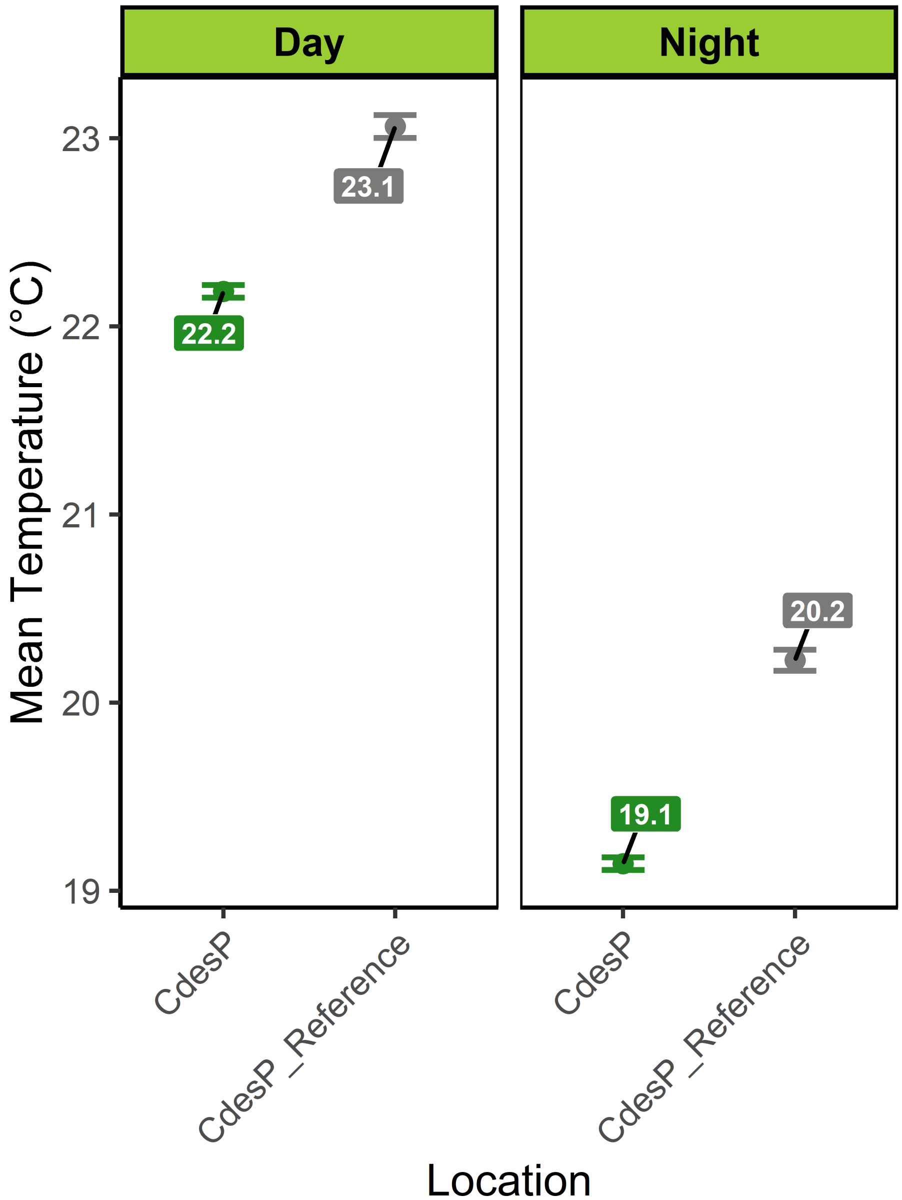


Figure 3: An average comparison graph showing the average temperature, day and night, in the Champs des Possibles and that of the reference sensors for the summer. The values displayed are these averages.

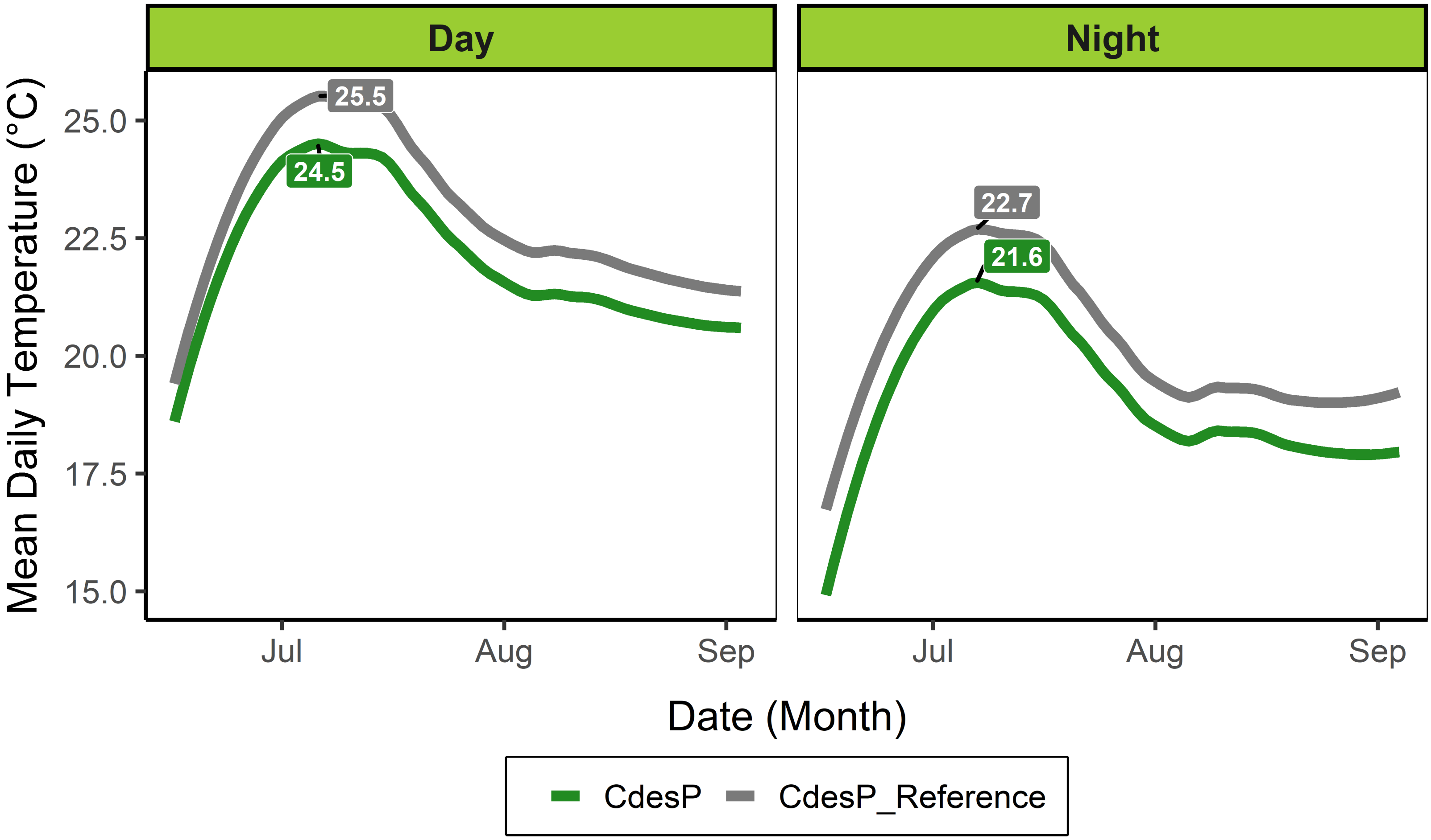


Figure 4: A smooth graph showing the average daily temperature, day and night, in the Champs des Possibles and that of the reference sensors over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 3 demonstrates that the average temperature of the Champ des Possibles for the whole summer was lower than the reference sensors. On average, the temperature difference was 0.9°C during the day, and 1.1°C at night.

Figure 4 delves deeper into the temperature trend, showing us that the average daily temperature of the Champ des Possibles was always below that of the reference sensor. During the day, the temperature difference between the Champ des Possibles and the reference grew steadily from the beginning of data collection until it reached its maximum in early July. At this time it was also the peak temperature of the summer, where the Champ des Possibles was 1°C cooler than the reference sensors. After the temperature peak, the temperature difference decreased slightly and remained fairly constant until the end of the data collection period. The trends were very similar at night. At the temperature peak of the summer, the Champ des Possibles was 1.1°C cooler than the reference sensors.

Figures 5 and 6

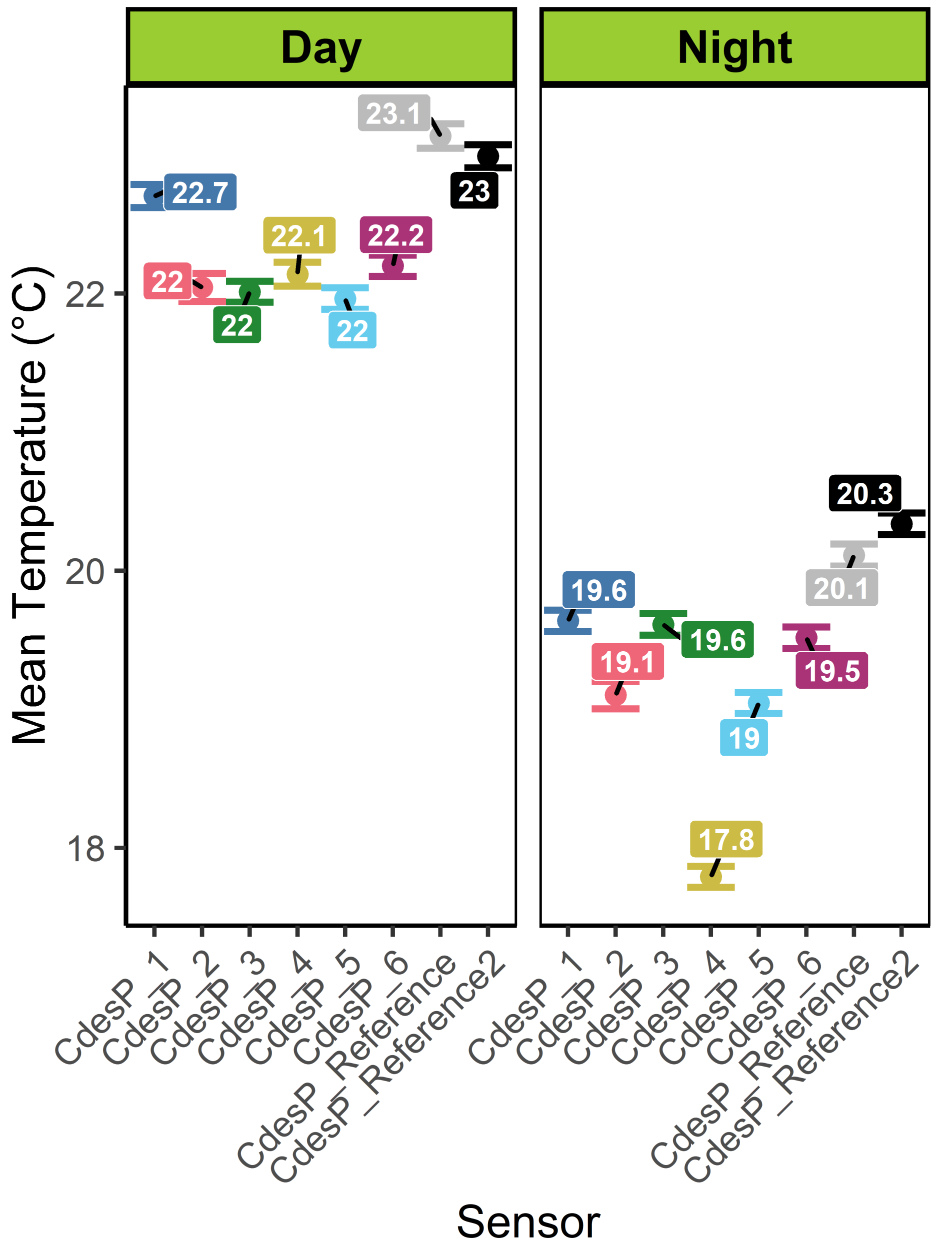


Figure 5: An average comparison graph showing the average temperatures, day and night, of each sensor location in the Champs des Possibles and that of the reference sensors for the summer. The values displayed are these averages.

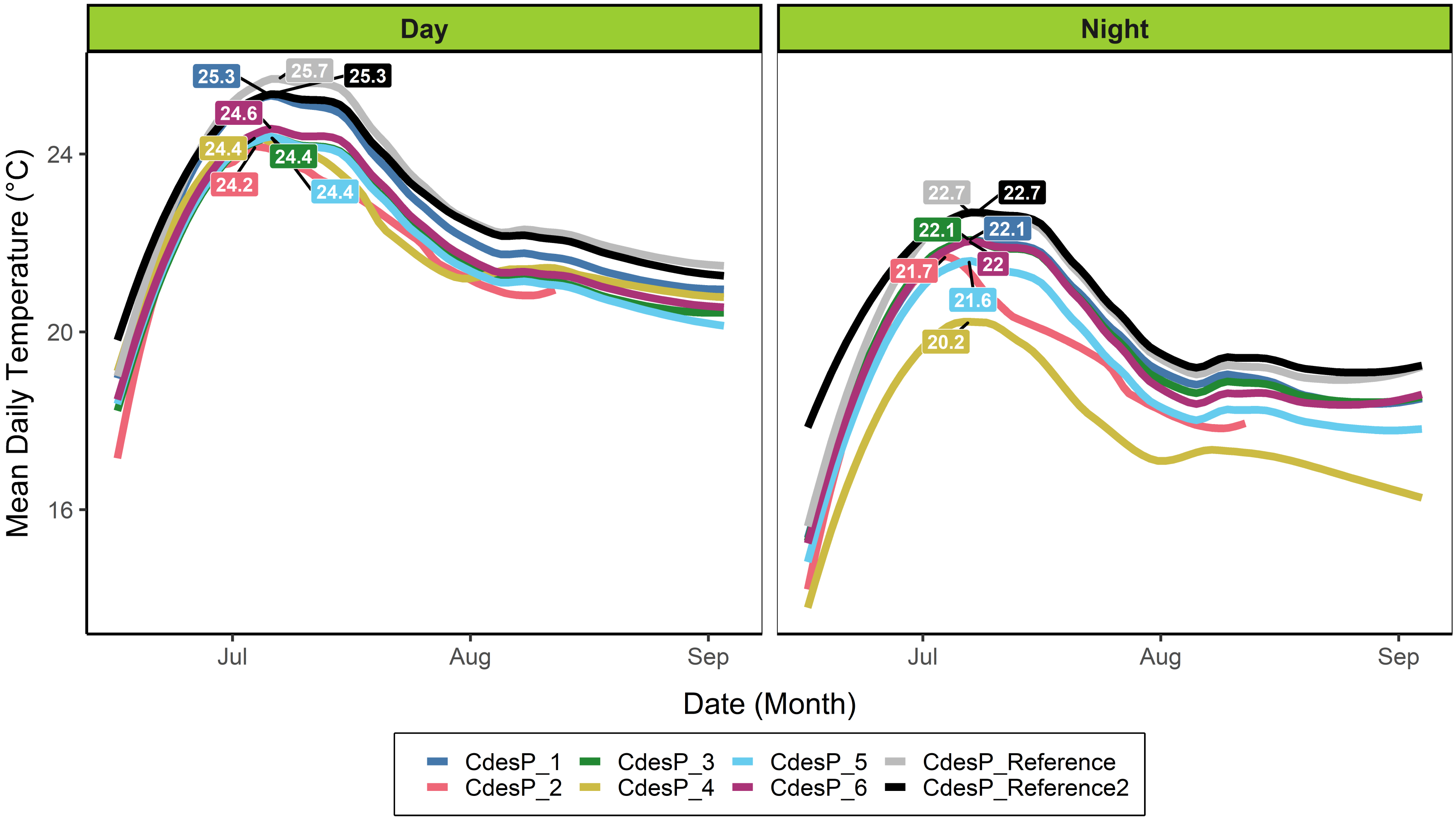


Figure 6: A smooth graph showing the average daily temperature, day and night, of each sensor location in the Champs des Possibles and that of the reference sensors over the summer. The values shown are the maximum temperature values for their respective lines.

Figure 5 shows us that all individual sensors last summer were, on average, cooler than the reference sensor. Additionally, we can see that the temperature in the green space was very homogeneous during the day. The only sensor that deviated was CdesP_1, the only park sensor not placed under vegetation. Averaging sensors CdesP_2,3,4,5,&6 we see that they were approximately 1°C cooler–while CdesP_1 was 0.3°C cooler–than the reference sensors. Comparatively, at night the temperatures were more variable. CdesP_1,3,&6 were extremely close to each other (approximately 0.6°C cooler than the reference sensors averaged), CdesP_2&5 were also very close (approximately

1.2°C cooler than the references averaged), and finally CdesP_4 was alone being 2.4°C cooler than the reference sensors.

Figure 6 shows us that each sensor in the Champs des Possibles was nearly always cooler than the reference sensor throughout the summer, with the exception of CdesP_1. During the day CdesP_1 followed reference sensor 2 extremely closely until mid July, after which the differences between the two steadily grew until the end of the data collection period. The other sensors began extremely close to each other, and their respective temperature differences to the reference sensors steadily increased until the temperature peak of the summer (between early to mid July). During the peak, the in-park sensors (CdesP_2,3,4,5,&6) were 1.1°C cooler than the reference sensors, while CdesP_1 was 0.2°C cooler than the reference sensors. After the peak, the in-park sensor's respective temperature differences to the reference sensors dropped and remained fairly constant until the end of data collection.

At night the trends were very similar; however, unlike during the day, CdesP_1 was always cooler than the reference sensors. All the in-park sensors, except CdesP_4, were very close at the beginning of data collection. Once in early July however, the sensors started splitting up. Sensors CdesP_1,3,&6 stayed close to each other and their temperature differences to the reference sensors remained fairly constant. Sensors CdesP_2&5's temperatures dropped, eventually joining up in late July, and their temperature differences to the reference sensors were variable. At the temperature peak (early to mid July) CdesP_1,3,&6 and CdesP_2&5 were, respectively, 0.6°C and approximately 1.1°C cooler than the reference sensors averaged. CdesP_4 was much cooler and also experienced more variability compared to most of the other sensors. At the temperature peak, CdesP_4 was approximately 2.5°C cooler than the reference sensors.

Discussion and conclusion:

As shown by figures 3 and 4, there was a clear temperature difference (0.9°C during the day on average, and 1°C during the day at the peak summer temperature) between the Champs des Possibles and the urban reference sensors–showing us that the green space is cooling its environment. Furthermore, figures 3 and 4 show us that almost all of the park sensors were always cooler than the reference sensors, and that most sensors were consistently close to each other in temperature. The two exceptions were CdesP_1 and CdesP_4. CdesP_1 was on average always warmer than the other park sensors, this was likely due to it being out in the open and not under tree cover. That being said, this sensor is interesting as it shows the cooling effect of the park since even though it lacked cover, it was still cooler than the reference sensors on average (figure 5). Moreover, as the temperature decreased in the later part of the data collection period, the temperature difference between the reference sensors and CdesP_1 actually increased to the point where it was nearly as cool as CdesP_4 (figure 6, day). CdesP_4 had an interesting change in trend where during the day it was as cool as the other sensors, but at night it became significantly cooler (figures 5&6, night). This sensor, unlike the others, was mostly surrounded by bushy plants and only a few large trees. It is possible that the trees surrounding the other sensors were retaining some of the daytime heat at night–a phenomenon that can be observed in urban green spaces. Whereas trees can potentially "trap" daytime heat around (which can take longer to dissipate at night), open spaces can allow for more efficient night-time cooling. Such a phenomenon suggests that it is important that green spaces be heterogeneous, as different habitat and vegetation types within parks can contribute to differing cooling (and ecosystem) benefits. As such, it is important that we preserve the heterogeneity of green spaces such as the Champ des Possible 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 Champs des Possibles 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 Champ des Possibles are cherished by those who live near them, evidenced by the hard work and actions of community groups such as *Les Amis du Champs* 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.