ENVI
_MET
From One Click LCA

ENVI-met: Playground

BETTER
URBAN
LIFE

Contents

ENVI_MET From One Click LCA

Part 1 – Introduction

Welcome to the ENVI-met Playground

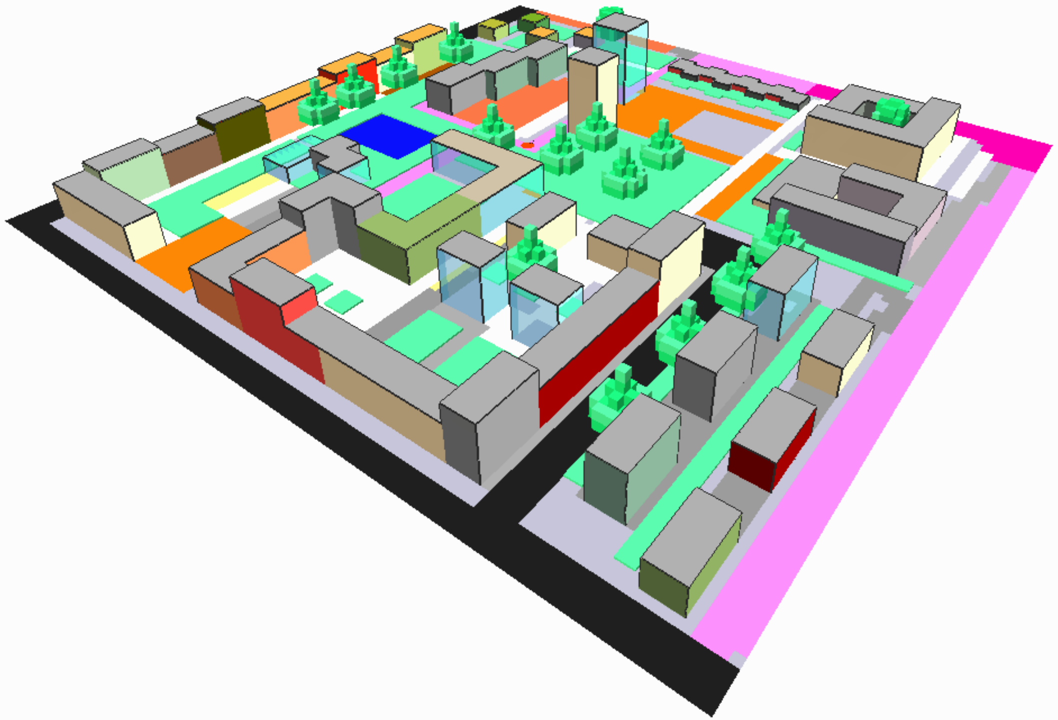
Part 1.1
Introduction to the Playground

The ENVI-met Playground is the place to work on your first project, test your skills, and learn about typical urban climate phenomena, as well as how to analyze, identify and tackle thermal hazards with ENVI-met. For that we have simulated two different scenarios for comparison. One representing a status quo and one containing measures to optimize thermal comfort.

With the Playground you will gain full access to the ENVI-met project data of both cases including:

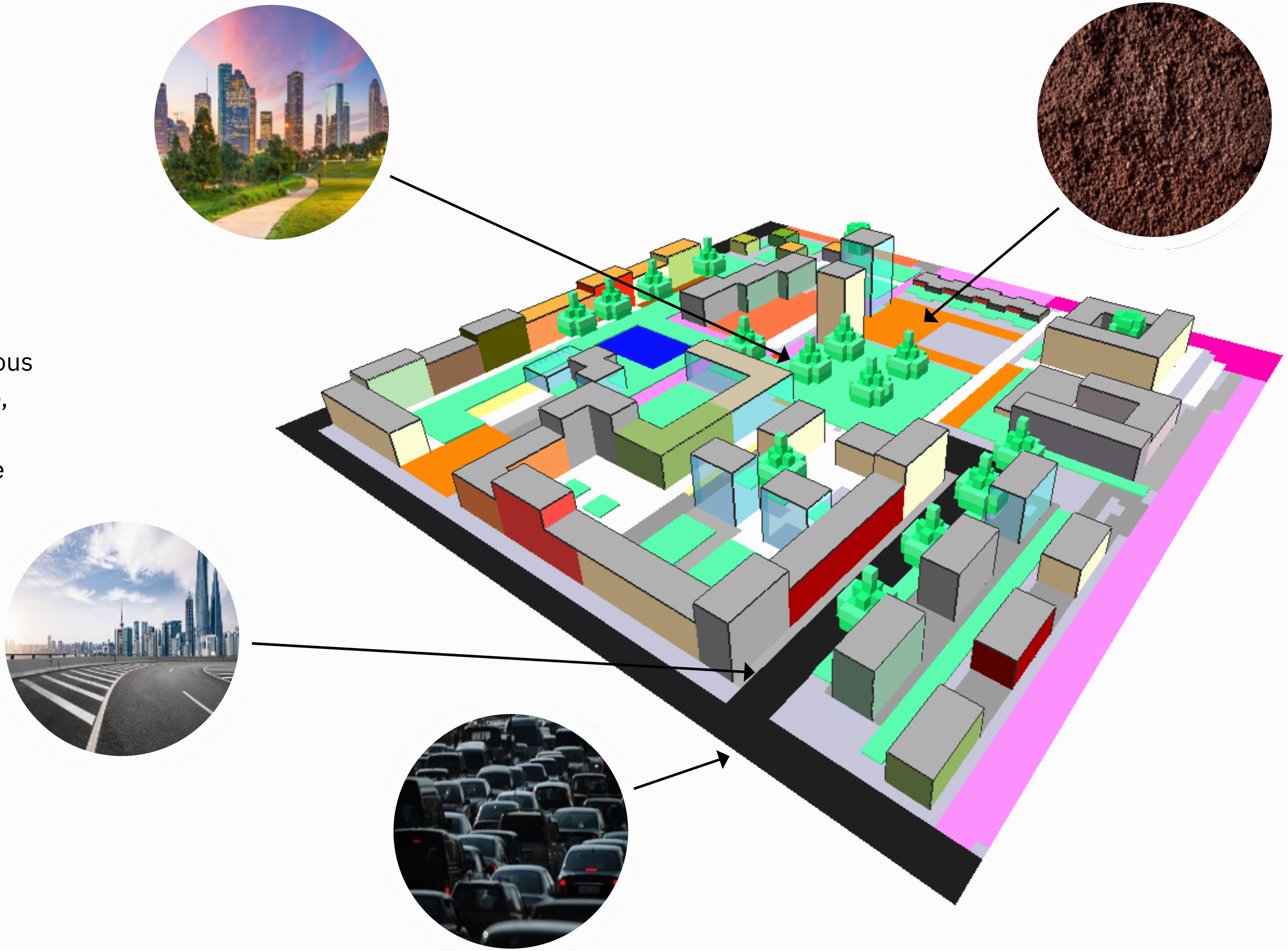
- project database (.edb)
- 2 model areas (.inx)
- 2 simulation settings files (.simx)
- weather conditions forcing file (.fox)

Feel free to edit them, create new database items, edit the model and change your simulation settings to your liking. We have also run simulations for you already, so you can directly dive into data analysis if you wish.



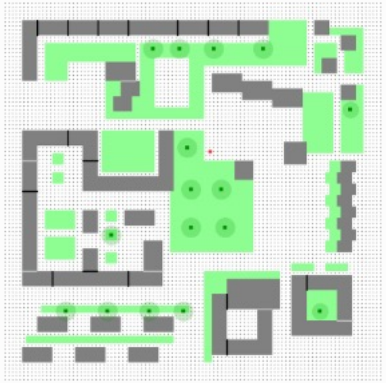
Playground\Playground_statusquo.inx

Part 1.2
The Status Quo Scenario



General Setup

Urban spaces are composed of diverse elements, including various types of vegetation, artificial materials like asphalt and concrete, both stationary and mobile pollution sources, as well as natural soils such as sand and loam. Our Playground integrates all these features into an urban environment model.



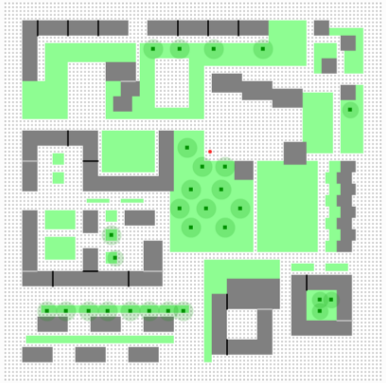
ENVI_MET
From One Click LCA

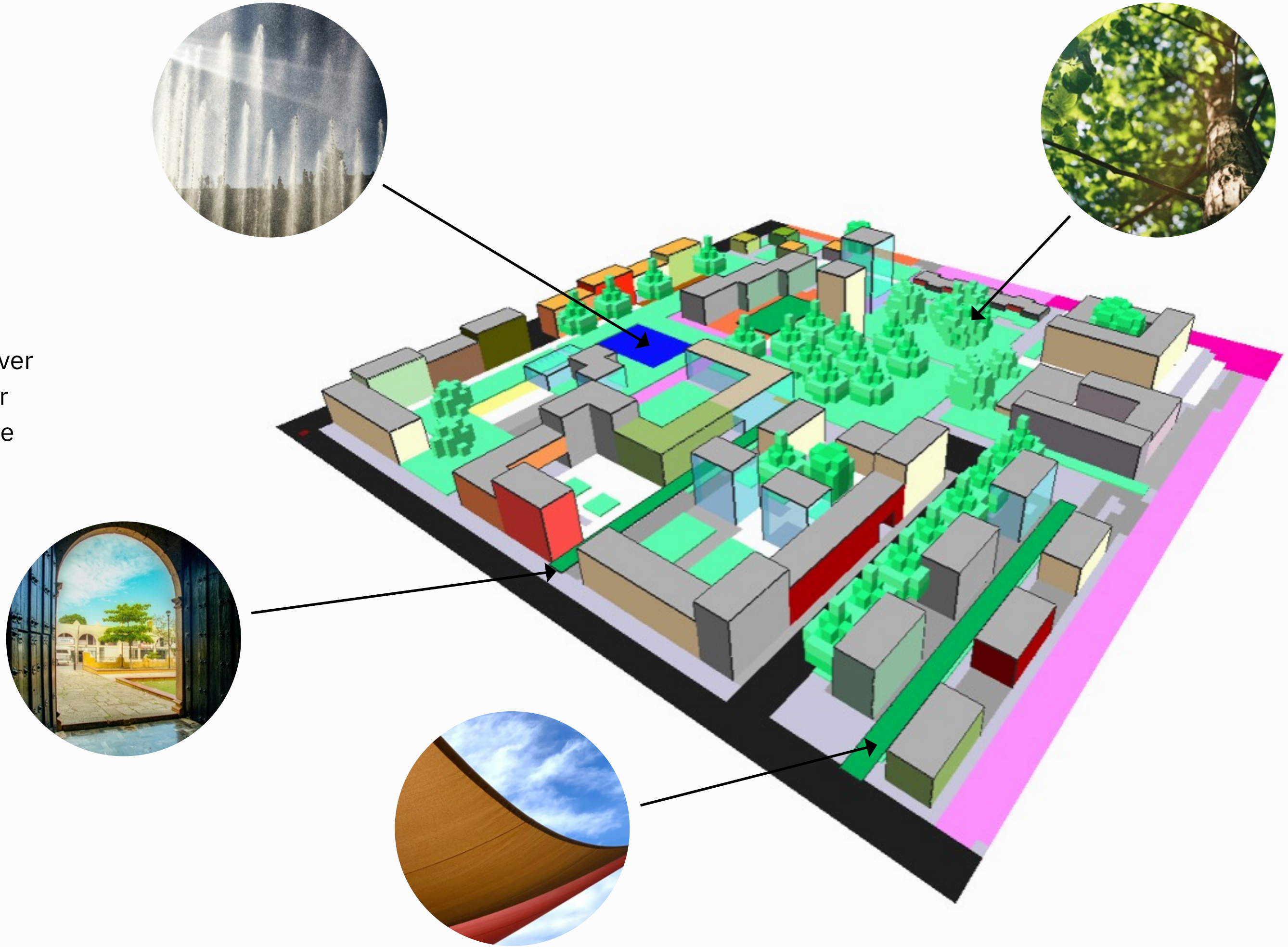
Playground\Playground_statusquo.inx

Part 1.3
The Optimized Scenario

General Setup

We have also implemented some optimizations, for you to discover their impacts. For example, we implemented trees, edited water features, placed shading structures and applied changes to some buildings.





ENVI_MET
From One Click LCA

Playground\Playground_optimized.inx

Part 2 – Thermal Comfort

How they us help to assess thermal comfort

ENVI
_MET
From One Click LCA

Part 2.1
Thermal Comfort Indices

Thermal comfort indices assess the human perception of heat

To assess human experience of heat, thermal comfort indices like the physiological equivalent temperature (PET) have been established. The PET translates complex outdoor conditions into an equivalent indoor temperature, making it easier to understand how people feel in different settings.

In contrast to air temperature, the PET considers multiple additional factors like air humidity, wind speed and solar radiation. Even individual factors like gender, size, weight, and metabolism can be considered.

Through this approach, we get more realistic assessments of human experience of heat or cold, than we would receive, just looking at air temperature.

Within the PET index there are several grades of physiological stress defined, which help to put your results into context. Slight heat stress is beginning above 23°C for example. With rising PET values this stress level increases up to extreme heat stress.

PET	Grade of physiological stress
4°C	Extreme cold stress
8°C	Strong cold stress
13°C	Moderate cold stress
18°C	Slight cold stress
23°C	No thermal stress
29°C	Slight heat stress
35°C	Moderate heat stress
41°C	Strong heat stress
>41°C	Extreme heat stress

ENVI_MET From One Click LCA

If you would like to know more about thermal comfort indices click here.

Part 2.2
Thermal Comfort and Air Temperature

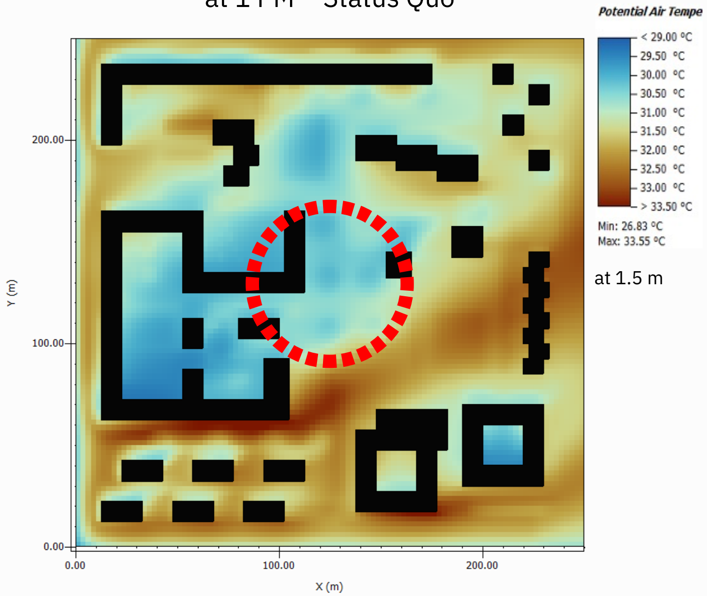
Thermal comfort can differ significantly to air temperature

To illustrate the difference between air temperature and PET, we've created two output maps: One showing the potential air temperature and one showing the PET at 1PM. Let's take a look at the tree vegetated area in the center:

While we can only see a small difference of less than 1°C in air temperature we can see drastic changes in thermal comfort depending on the exact location, i.e., if you are standing below or next to the trees' shadow.

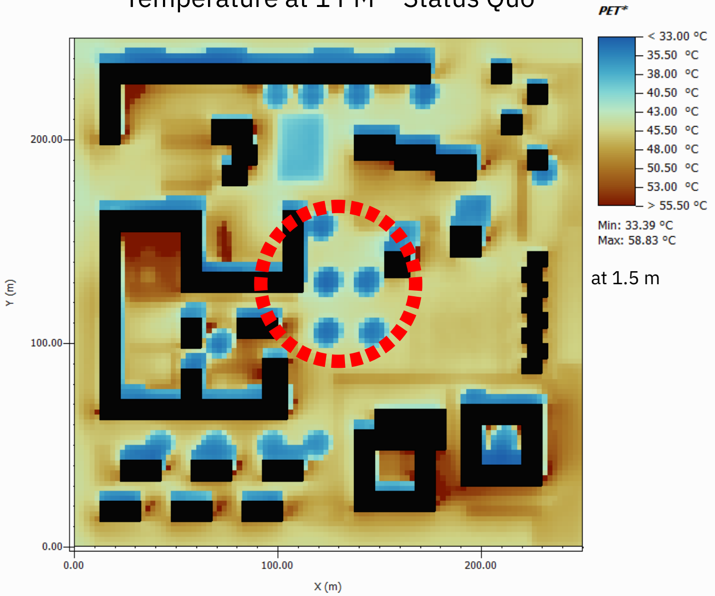
The combination of shading and transpiration of the trees' canopies increase thermal comfort by almost 10 K compared to non shaded areas. In our case this would mean a difference of moderate heat stress to extreme heat stress.

Potential Air Temperature at 1 PM – Status Quo



at 1.5 m

Physiological Equivalent Temperature at 1 PM – Status Quo



at 1.5 m

Playground\Playground_statusquo_output\atmosphere

Playground\Playground_statusquo_output\biomet\PET

ENVI_MET From One Click LCA

Part 3 – Heat Mitigation

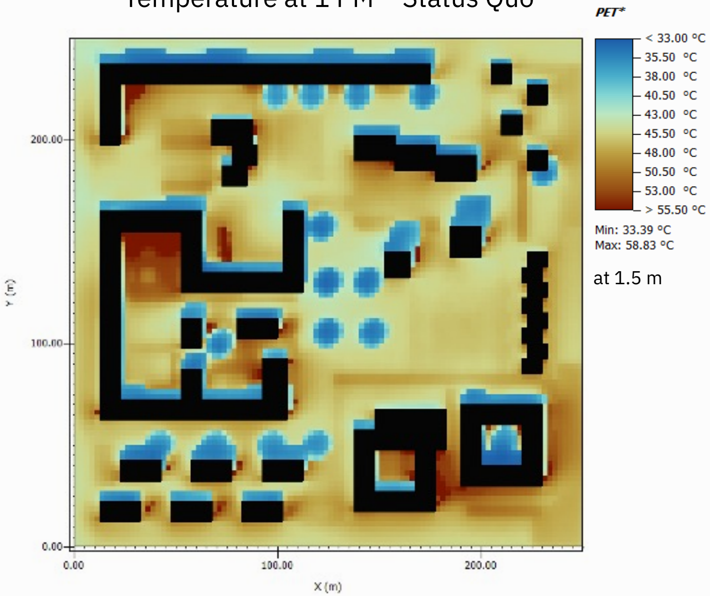
Analyzing impacts of heat mitigation measures

Part 3.1
Shading and Transpiration

Trees and shading sails can increase thermal comfort

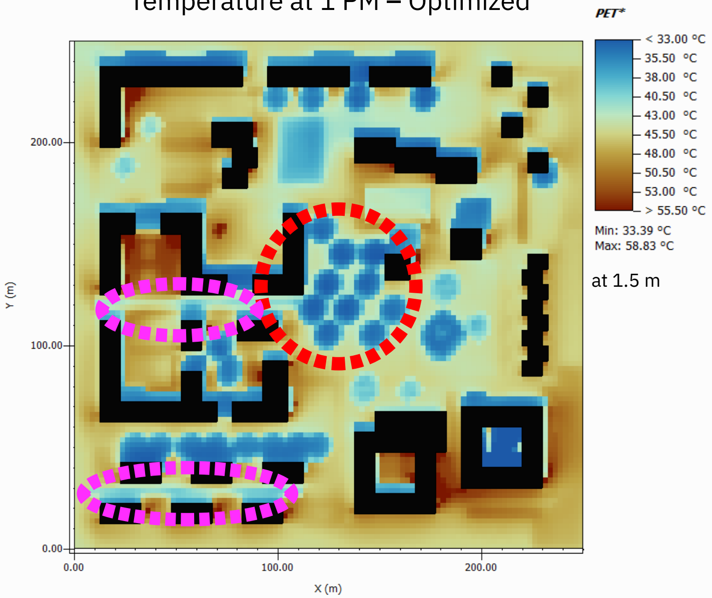
We hence find shading to be a crucial factor in improving outdoor thermal comfort. In our optimized scenario, we thus find lots of additional trees providing shading and cooling by transpiration. However, it is not always possible to plant more trees. A good option is then to add shade sails to at least provide shade.

Physiological Equivalent Temperature at 1 PM – Status Quo



Playground\Playground_statusquo_output\biomet\PET

Physiological Equivalent Temperature at 1 PM – Optimized



Playground\Playground_optimized_output\biomet\PET

ENVI_MET
From One Click LCA

Part 3.2
Different Surface Materials

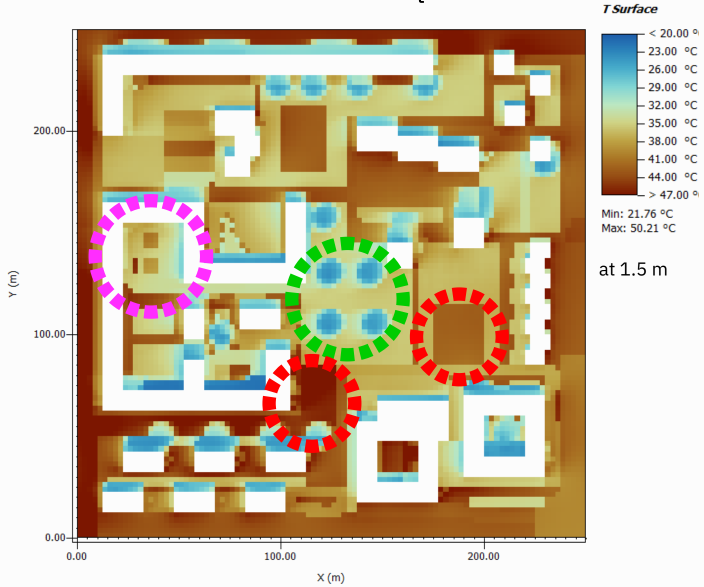
Artificial materials can affect nighttime cooling negatively

Asphalt or concrete pavements are usually darker materials with a low albedo (reflectivity), which can absorb a high amount of solar radiation. This causes them to heat up significantly during the day.

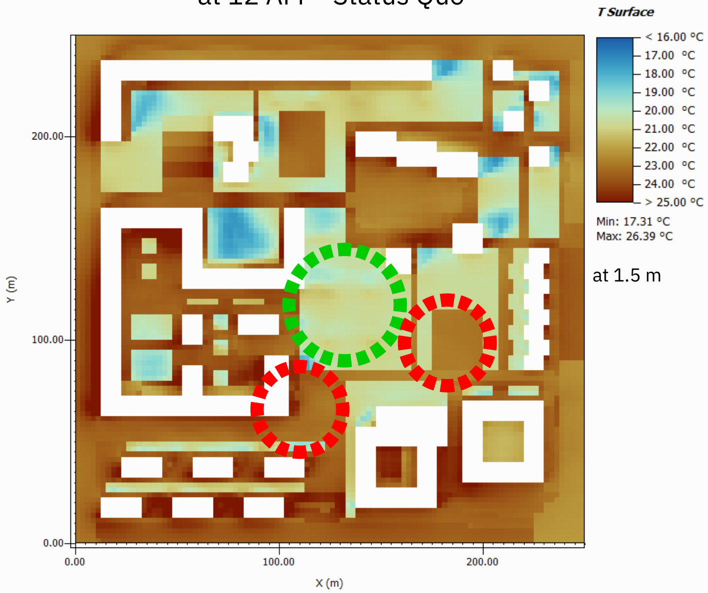
Looking at our simulated surface temperatures, we can see this effect quite clearly as our concrete and asphalt surfaces show significantly higher temperatures than the grass vegetated soil surfaces or the very bright surfaces.

Often the significant differences in surface temperature even remain until nighttime. At that time, the stored heat from the surfaces is slowly released into the air which reduces night-time cooling.

Surface Temperature
at 1 PM – Status Quo



Surface Temperature
at 12 AM – Status Quo



Playground\Playground_statusquo_output\surfaces

Playground\Playground_statusquo_output\surfaces

ENVI_MET From One Click LCA

Part 3.3
Different Roofing Materials

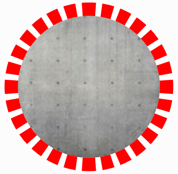
Façade materials warm up differently

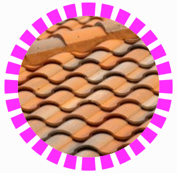
Taking a look at wall and roof temperatures of the buildings in our model area, we can also see large differences depending on the materials' physical properties.

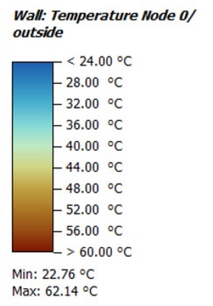
The terra cotta roofs for example heat up significantly less than those made of concrete.

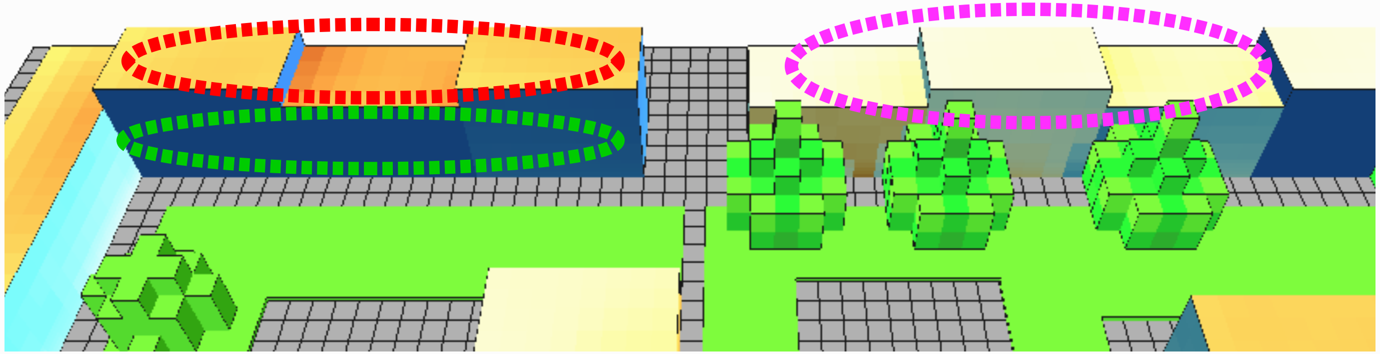
As you can see in SPACES, some buildings have wall greening, which can reduce outside wall temperatures strongly by around 20 Kelvin.

Wall & Roof Temperatures at 1 PM – Status Quo









Playground_statusquo_output\buildings\dynamic

ENVI_MET
From One Click LCA

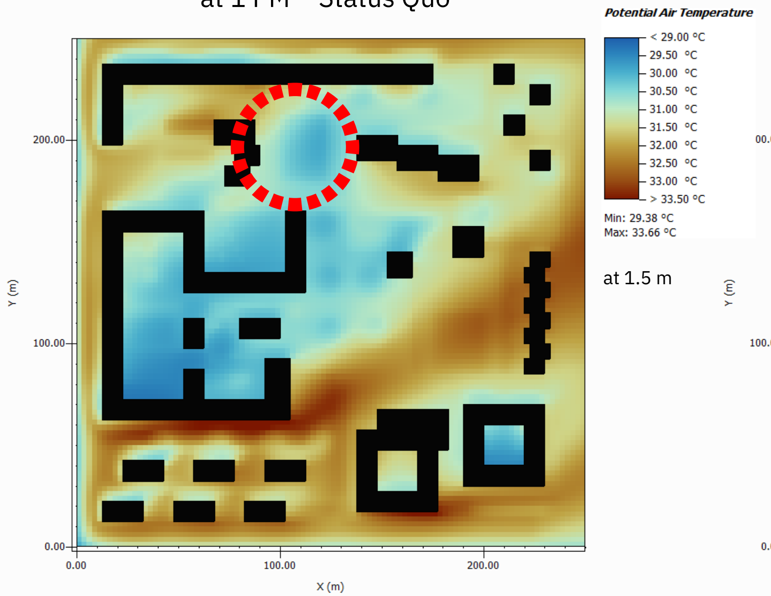
Part 3.4
Water

Different water features can have significant impact on microclimate

Water is able cool down the air by transforming sensible heat to latent heat. A water body alone, however, is not the most effective way to cool the surroundings.

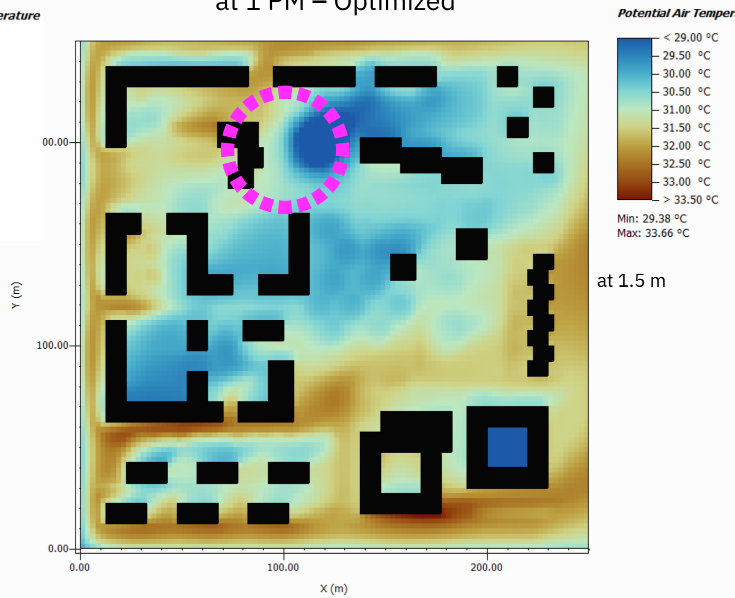
Water features like fountains or misting nozzles spray water dust into the air and by that can have an even stronger cooling effect, as shown by the air temperature reduction in the optimized scenario.

Potential Air Temperature
at 1 PM – Status Quo



at 1.5 m

Potential Air Temperature
at 1 PM – Optimized



at 1.5 m

Playground\Playground_statusquo_output\atmosphere

Playground\Playground_optimized_output\atmosphere

ENVI_MET From One Click LCA

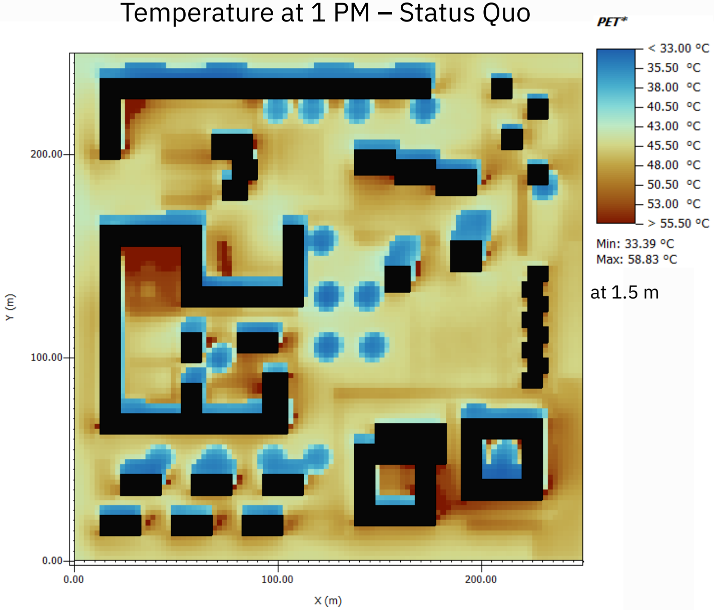
Part 3.5
Ventilation

Increasing ventilation can have a positive effect on thermal comfort

An important factor in determining thermal comfort is wind speed, as a good ventilation can help to transport heat away. This is why heat stress can become quite intense in a courtyard, where no wind exchange is present to cool down the human body.

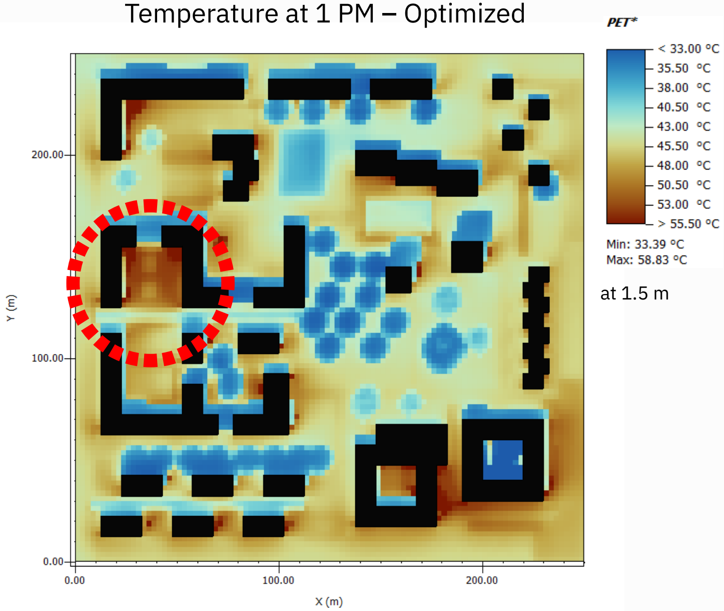
Opening up gates & wind channels in large building complexes can help to allow a free wind flow and hence higher wind speeds to improve thermal comfort conditions.

Physiological Equivalent Temperature at 1 PM – Status Quo



Playground\Playground_statusquo_output\biomet\PET

Physiological Equivalent Temperature at 1 PM – Optimized



Playground\Playground_optimized_output\biomet\PET

ENVI_MET
From One Click LCA

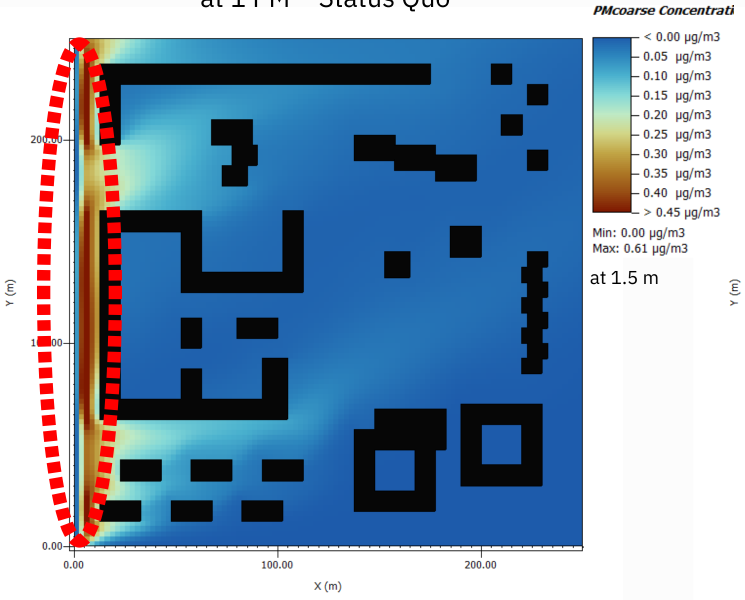
Part 3.6
Pollutants

ENVI-met can calculate the distribution of different pollutants

ENVI-met provides the option to simulate the distribution of emittants such as particulate matter (PM), ozone and nitric oxide. In our example we have assigned the asphalt street in the west to emit these pollutants representing an inner urban road with a daily traffic value of 8000 cars.

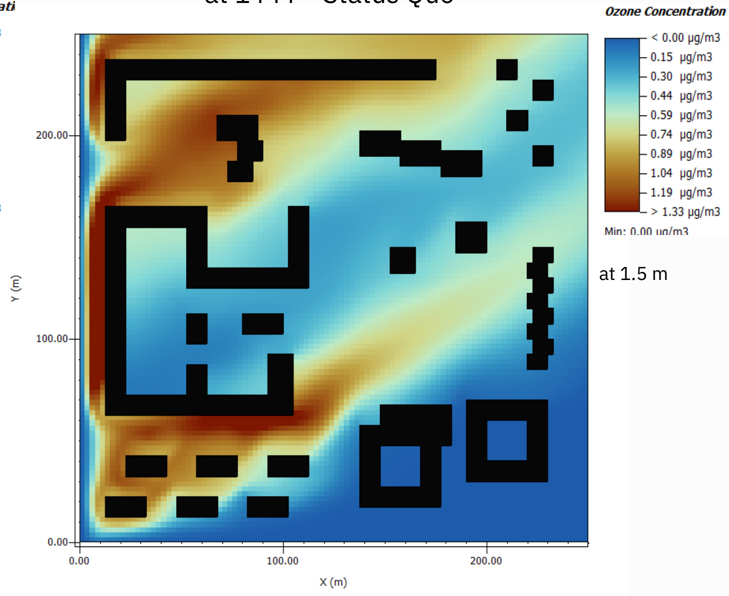
Looking at the results you can see how Ozone and PM10 particles are being emitted and transported through the model area by the wind affecting even relatively distant areas.

PM10 Distribution
at 1 PM – Status Quo



Playground\Playground_statusquo_output\pollutants

Ozone Distribution
at 1 PM – Status Quo



Playground\Playground_statusquo_output\pollutants

You have now seen some examples of how to analyze and compare ENVI-met simulation data.

However, there is a lot more to discover in ENVI-met. Maybe you want to create your own construction materials and assess their microclimatic performance, or you want to test out ways to strategically integrate vegetation to increase thermal comfort.

Whatever it is, feel free to test it out!

ENVI
_MET
From One Click LCA