New Features

Winter-Release 2018/2019

ITS ALL ABOUT A GREEN FUTURE

Urban climate and its study are becoming more and more important as urban areas show significantly higher rates of population growth than rural areas. This rapid urbanization not only means that more people are exposed to the effects of urban microclimate but also that the already significant environmental challenges present in urban areas will increase even further.

During long-lasting heatwaves, such as this summer, everyone living in dense cities could feel the excess heat created by the urban environment. Although it is still discussed if the worldwide climate of 2018 can be considered a direct consequence of climate-change, there is broad agreement that developing urban green spaces is one of the most important principles for adapting to the climate of the future. Because of this, landscape-/architects are responding with new forms of green buildings, and many interesting new showcases can be found in this field.

However, for these adaptation strategies to be effective, the consequences of different measures need to be evaluated. In order to fulfill this need, the Winter Release 2018/2019 focuses on the implementation of Wall & Roof Greening with the new Green Façade module. This module grants the ability to simulate green wall and roof performances as a solution to sustainable urban development for the very first time.

Besides this new module in the field of green architecture, we developed the new editor MONDE and enhanced the possibility to provide user generated boundary conditions for various meteorological parameter by adding Full Forcing to our model.

Finally, there is now the option to convert ENVI-met Outputs to NetCDF and to use an ENVI-met plugin for Grasshopper that has been developed in the Ladybug Tools by Italian architect, Antonello di Nunzio, who developed components to connect Ladybug and Gismo to ENVI-met for urban microclimate analysis.

Daniela Bruse, CEO ENVI_MET
Prof. Dr. Michael Bruse, Director Innovations & Products

November, 2018

New Green Façade Module

1 IMPLEMENTATION OF NEW WALL AND ROOF GREENING

Wall and roof top greening have become an important tool in both green building design and urban planning to mitigate heat stress. Green walls and roofs are often referred to as the future of climate change adaptation tools in built-up areas as this approach can be applied even in densely built-up areas. Our new wall and roof greening model enables the user to simulate the complex interaction of vegetation, substrate layer, and fixation materials mounted on facades or roofs.

CURRENT STATE AND NEW DEVELOPMENT

In previous ENVI-met versions, non-vegetated walls and roofs were modeled very accurately using a 7-node model. Vegetated walls, however, are much more complicated to analyze. Vegetation is a living organism that reacts to the environment. The energy fluxes and thus, the energy balance is much more complicated due to the transpiration and evaporation within the leaves. In addition, in the presence of substrate layers, fluxes of heat and vapor become even more complex. Previously, it was not possible to accurately model green roofs and walls in their entire complexity. For this reason, a completely new model was developed to tackle these challenges. Using the new module, the effects of wall and roof greening on building energy performance as well as on the outdoor microclimate can be simulated, allowing the effects of climate change mitigation strategies to be quantified and evaluated.

The sophisticated new model does not only take into account the vegetation layer of the greening, but also the energy and humidity exchange with the substrate layer which can be even more important than the exchange with the vegetation layer.
In order to produce valid results, the module takes into account a multitude of parameters:

- The vegetation is treated as a living organism, due to the interaction of plants with their local environment (soil and air humidity, radiation, wind, air temperature) by opening and closing their stomata based on the sophisticated and validated ENVI-met plant model
- The effects of the greening are directly linked to the advanced IVS radiation scheme including the effects of multiple reflections and local infrared radiation
- Differentiation between climbing plants and different greening modules mounted on walls
- The substrate layer can be compose out of 3 layers of material including the option to model the planting substrate as well as the constructive technical materials.
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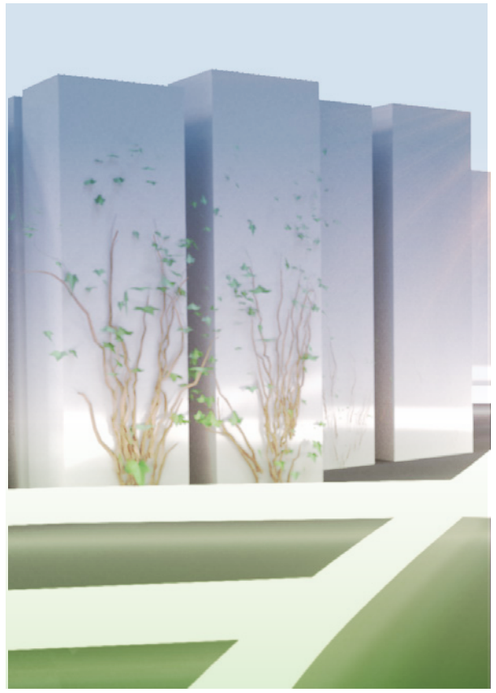
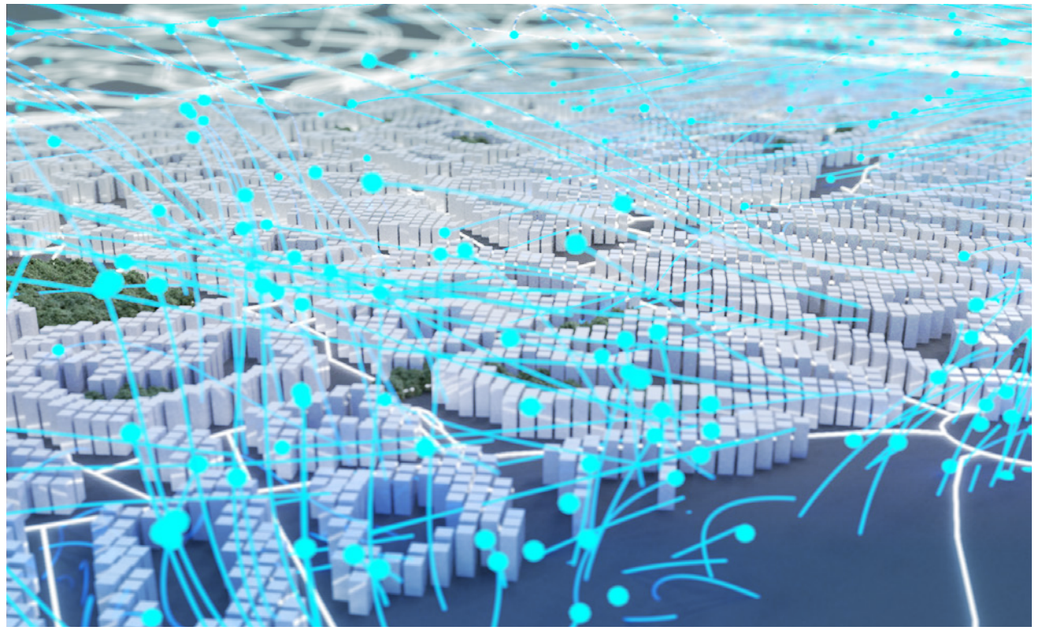


2 LINKING ENVI-MET METEOROLOGY WITH LARGER SCALE PROCESSES

With the new full forcing concept, it is now possible to set diurnal cycles of boundary conditions for various meteorological parameters such as radiation or cloud cover. Real measurement data of different heights can be entered, such as air temperature, air humidity, wind speed, and wind direction.

Introduction of Full Forcing



CURRENT STATE AND NEW DEVELOPMENT

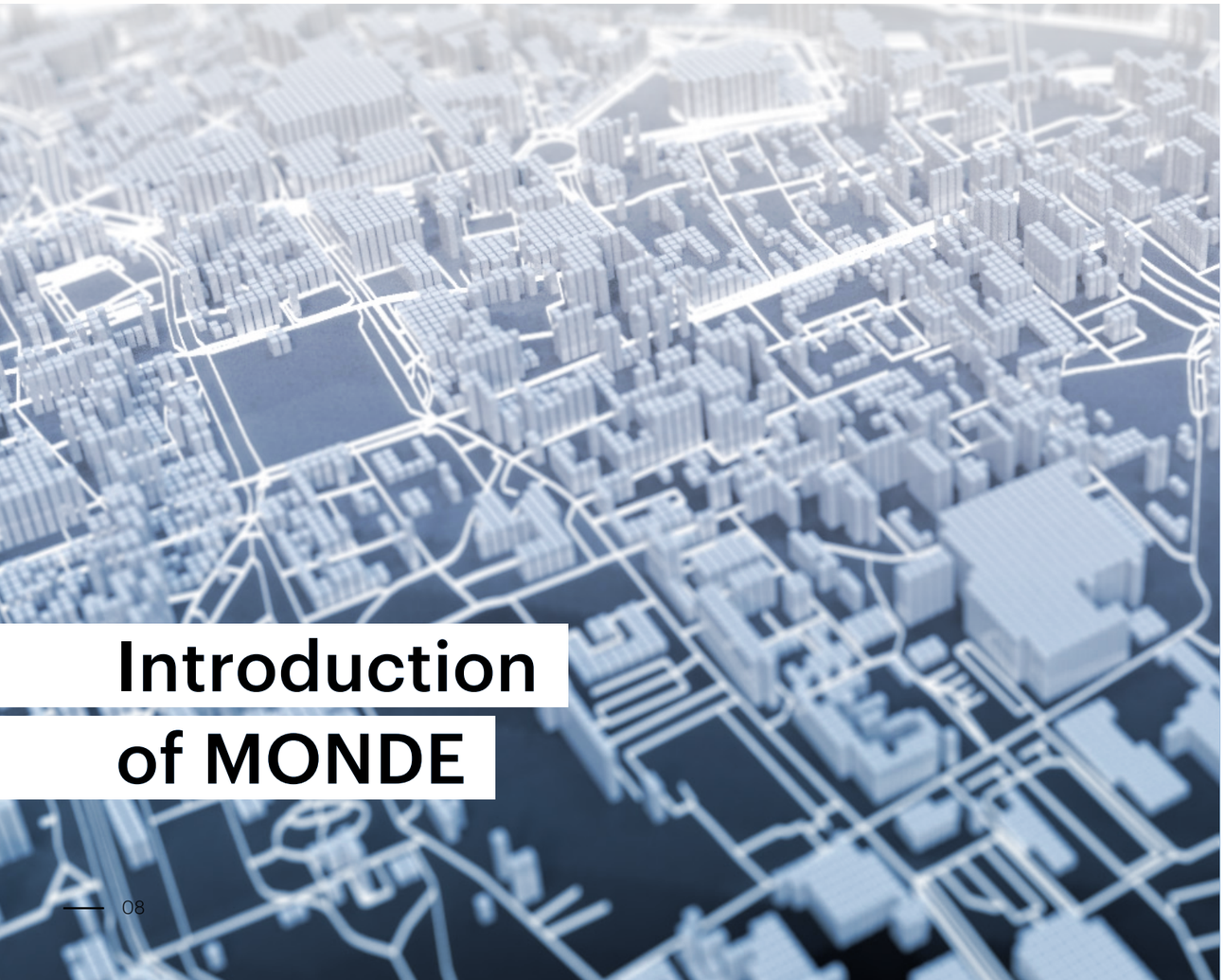
Because ENVI-met only simulates part of the spatial environment, boundary conditions are required for the lateral and vertical borders of the 3D model. Until now, ENVI-met offered three possibilities to provide boundary conditions to the model:

- Open lateral boundary conditions: The values of the next grid point close to the border are copied to the border each time step.
- Cyclic lateral boundary conditions: The values of the downstream model border are copied to the upstream model border.
  Simple forced lateral boundary conditions: a user-defined 24 hours cycle of air temperature and relative humidity that could be used to run the model

The open and the cyclic lateral boundary condition types allow users to start simulations with only a few initial parameters. However, with these lateral conditions it is not possible to reproduce specific scenarios like Sea and Land Breeze or weather phenomena, making it very difficult to compare the simulation output with a real situation and measured data. The simple forcing method, to some extent, goes a bit further: It allows users to import values for air temperatures and relative humidity for 24 hours. While the Simple Forcing is a viable option, there are some drawbacks: It is not possible to recreate a specific meteorology, as the Simple Forcing is limited to 24 hours of data and can only force air temperature and relative humidity at a height of 2 meters.
To evaluate the model using measured data or to simulate imaginary scenarios accurately, a new lateral boundary condition method has been developed. The new Full Forcing allows the definition of diurnal cycles of boundary conditions for various meteorological parameters such as radiation (subdivided into direct shortwave, diffuse shortwave, and longwave radiation) or cloud cover (low, mid, and high cloud cover) over a longer period of time. Additional profiles for air temperature, air humidity, wind speed, and wind direction can be entered for different heights depending on the measurement height of where they were obtained.

3 THE VECTOR-BASED WORLD EDITOR

ENVI-met MONDE opens a new chapter in generating and editing ENVI-met models: Moving away from the grid-by-grid editing, the new vector based approach makes it easy to generate models or to change resolutions with just one click. You can also import existing vector models or access the world-wide database of OpenStreetMap and OpenTopography to generate ENVI-met models. The digitizing process is now much faster and easier for the user and follows the intuitive steps from known programs such as CAD and GIS.



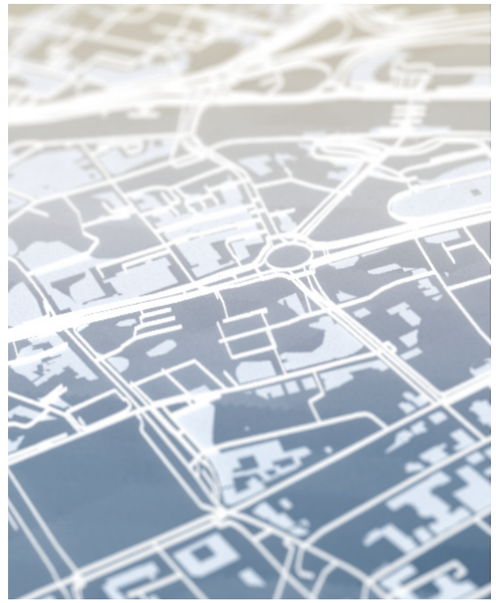
Introduction of MONDE

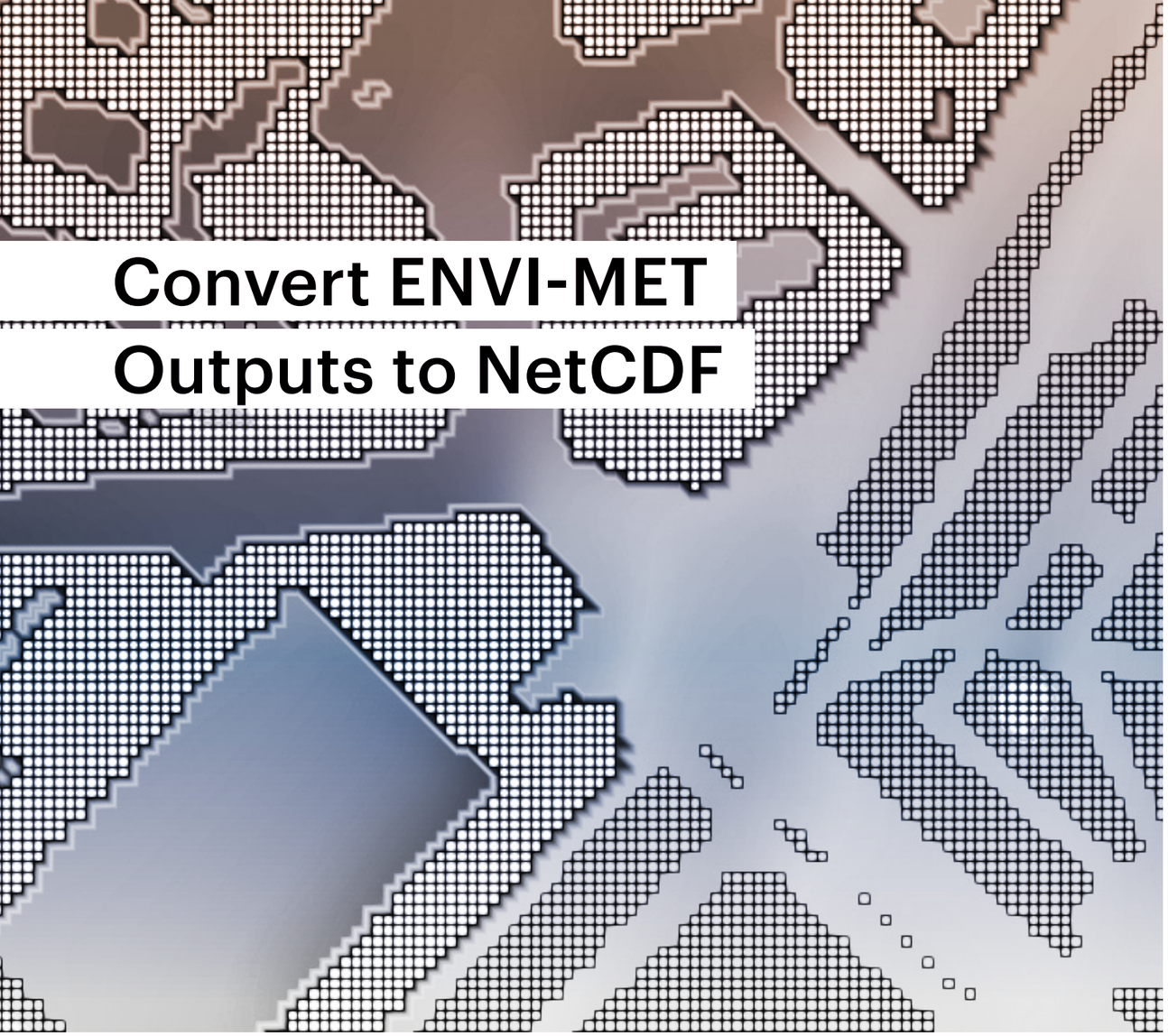
CURRENT STATE AND NEW DEVELOPMENT

In the ENVI-met system so far, the raster-based editor Spaces was needed to create model areas, which meant that every grid cell needed to be digitized click-by-click. This work was a labor-intensive, time-consuming, and tedious. In addition, the spatial resolution and size of the model area were determined at the very beginning of the digitizing process and could not be changed without a redrawing of the model.
With the new 64-bit and multicore support, model areas are not limited to city blocks anymore but can cover whole urban areas. In order to digitize such large areas, an easier and faster way was needed to create ENVI-met model areas.
ENVI-met now features a newly developed vector editor (MONDE), which enables the user to import existing geo-data in vector format and to edit the vector model using the established methods known from CAD and GIS. Vector data can easily be reshaped and rescaled, which saves time and effort compared with the raster-based click-by-click digitizing.
MONDE is able to import the following vector graphics (originating from institutions, planning agencies, architects, open source etc.):

- Shape files
- CAD-files
- OpenStreetMap data
- OpenTopography terrain data

MONDE supports all ENVI-met objects: buildings, profiles, simple plants, 3D vegetation, and terrain data. Since all objects in MONDE are based on vector information, the defined model area can be exported in every desired resolution with a single click. Furthermore, different scenarios of the same model area or multiple model areas within the digitized MONDE world can be exported independently. MONDE is a revolutionary tool allowing users to generate large ENVI-met model areas in a fast and easy way.





Convert ENVI-MET Outputs to NetCDF

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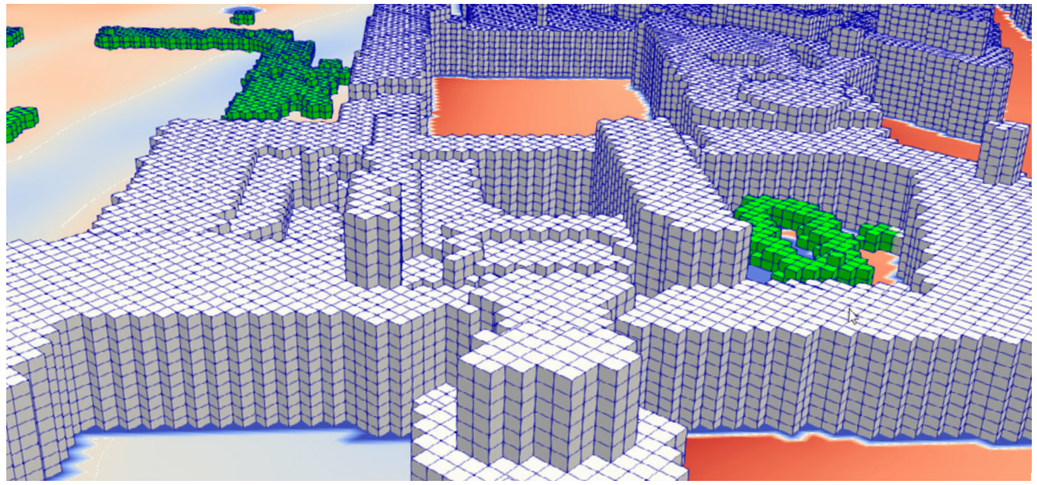
Since many of our users are already experts in their field of work and are acquainted with specific software, the new NetCDF converter allows users to visualize simulation results using a wide range of different visualization tools in addition to the well-known LEONARDO application.

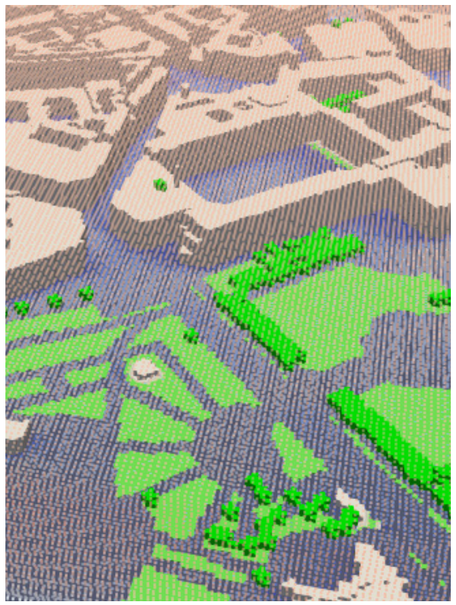


CURRENT STATE AND NEW DEVELOPMENT

ENVI-met stores its model outputs in a binary format that can only be read and visualized in the visualization tool LEONARDO. While LEONARDO offers a variety of features to analyze the data, the ENVI-met output scheme is not a common standard to store large three-dimensional data fields.

In order to provide our users with a standardized output format to visualize ENVI-met outputs, a converter tool is shipped with the next release: The NetCDF converter lets the user convert all simulation outputs after a simulation is run. This offers the possibility for the users to visualize the three-dimensional data using their preferred visualization tool e.g. Paraview.

Furthermore, since NetCDF is a machine-independent data format, the ENVI-met outputs can now be visualized on MacOS or Linux as well. This makes it an important contribution to widen the use of ENVI-met generated data.



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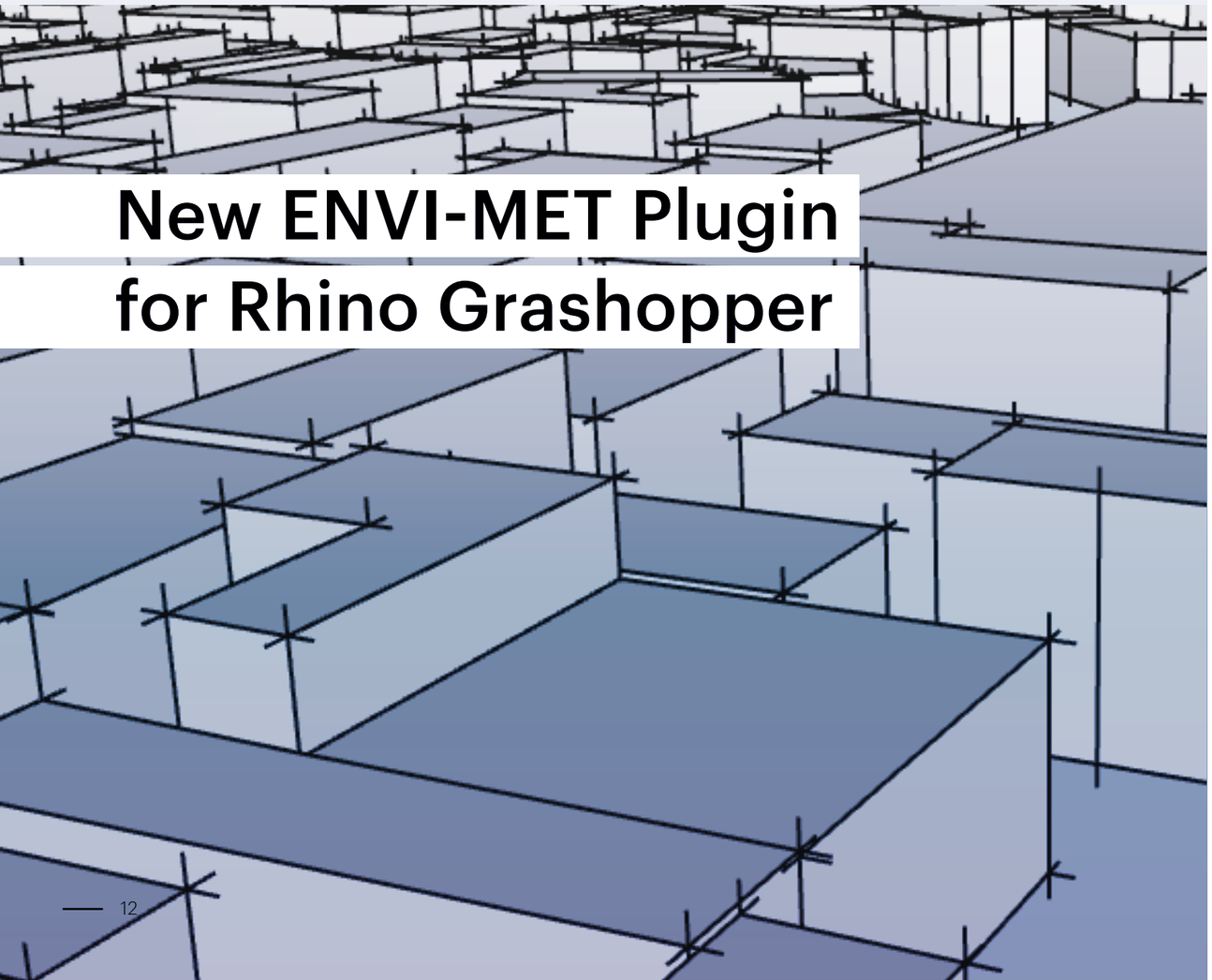
The new ENVI-met plugin for Rhino Grasshopper has been developed in the Ladybug Tools. By the use of this plugin, the user is able to convert Rhinoceros 3D designs to ENVI-met model areas and run ENVI-met simulations without even opening the ENVI-met software suite. This makes the usage, especially for architects who commonly utilize Rhinoceros 3D for their designs in the first place, much easier.



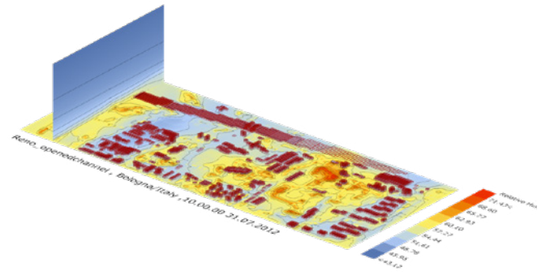
New ENVI-MET Plugin for Rhino Grashopper

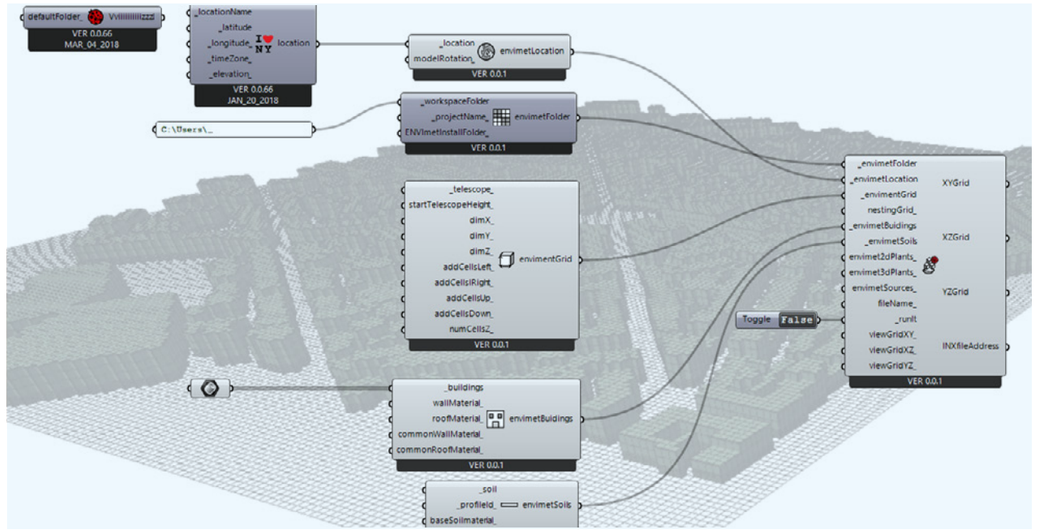
CURRENT STATE AND NEW DEVELOPMENT

In order to use ENVI-met, a multitude of programs have to be understood. Since our users are typically already experts in their core applications, learning to adequately use another complex application – like ENVI-met – can be seen as an obstacle. Furthermore, users, especially architects, often work with three-dimensional models of their buildings' designs already. In order to implement these to ENVI-met they would need to digitize them again thus producing twice the effort. A very common application used by architects to model and analyze their designs is Grasshopper for Rhinoceros 3D. Grasshopper is a graphical algorithm editor integrated with Rhinoceros 3D which offers the possibility to implement plug-ins of any kind.
Hence, to provide users the possibility to change their designs quickly and simulate the microclimatic impact of these new designs, an ENVI-met plugin for Grasshopper has been developed in the Ladybug Tools. The Ladybug Tools are an open-source plugin for Grasshopper for environmental and energy analysis. As part of these tools, the plugin, called "lb_envimet", is able to convert Rhinoceros designs to ENVI-met model areas and run ENVI-met simulations.

Currently the following features are available:

- Modeling 3D buildings with Rhinoceros and Grasshopper to generate ENVI-met model areas
- Integration with plugins of Grasshopper, such as Gismo (GIS plugin for Grasshopper)
- Using EPW file to feed your simulation file with weather data
- Generating SIM file with Grasshopper





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