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Characterization of the Evapotranspiration flux on a Blue Green Solution (Blue Green Wave)

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The rapid growth of urban areas, jointly with the effects of climate change, is the major challenge to face the transition towards sustainable cities. Climate change leads to substantial modifications of the water cycle in cities, increasing the frequency of intense precipitation, drought and heat wave events. The replacement of natural surfaces by dark and impervious ones is the main cause of Urban Heat Islands (UHI) phenomenon. UHIs are microclimates characterized by significant temperature differences between inner cities and the surrounding rural areas. Part of a solution to tackle this issue is the re-naturalization of cities through the installation of Blue Green Solutions (BGS), such as green roofs, favoring the evapotranspiration (ET) process and thus reducing the air temperature.

To benefit BGS implementation, it is crucial to understand the thermo-hydric processes that govern them. For this purpose, the ET process of a 1 ha green roof implemented in front of the Ecole de Ponts ParisTech (France) called Blue Green Wave (BGW) was studied to determine its possible cooling effect to mitigate UHIs. Therefore, three methods were tested and compared to estimate ET: (i) the water balance during dry periods through the difference on the soil moisture content measured via a wireless sensors network, (ii) the absolute humidity measured by a dynamic transpiration chamber, and (iii) a scintillometer to assess the sensible heat flux, which allows to deduce the latent heat flux by computing the energy balance.

The wireless sensors demonstrated to assess correctly ET trends over long time periods, while the dynamic chamber allows to identify more precisely the ET behavior during shorter periods of measurement due to a better resolution. Indeed, ET computed via the water budget appeared significantly high compared to the values estimated by the dynamic chamber, and without showing an obvious daily pattern. In addition, ET trends estimated by both scintillometer and transpiration chamber methods were very close, but the corresponding values suffered from a significant difference. The divergence in ET flux computed by the three methods can be caused by: (1) errors in the sensible heat flux estimated by the scintillometer, leading overestimations of the latent heat flux; (2) noisy data of soil water content, induced by the rainfall events and the local soil characteristics where the sensors are implemented, and (3) modifications of the atmospheric conditions within the transpiration chamber.

More generally, ET appeared higher in spring season and during the first days of summer, when high temperatures were reached and soil water content was enough to support ET without inducing a deficit for plants. Conversely, despite significant temperatures at the end of summer, ET rate was lower due to the lack of water content in the soil. This suggests that during summer, when the UHI intensity is stronger and the cooling effects of the green roofs are needed, the ET potential could not be sufficient. To go further in the space-time characterization of ET flux, additional experiments and multi-fractal analysis will be carried out soon.