Observing moisture and energy exchange of urban soils and the impact on local climate

Sarah Sandoval[1], Felix Ament[2] and Annette Eschenbach[3]

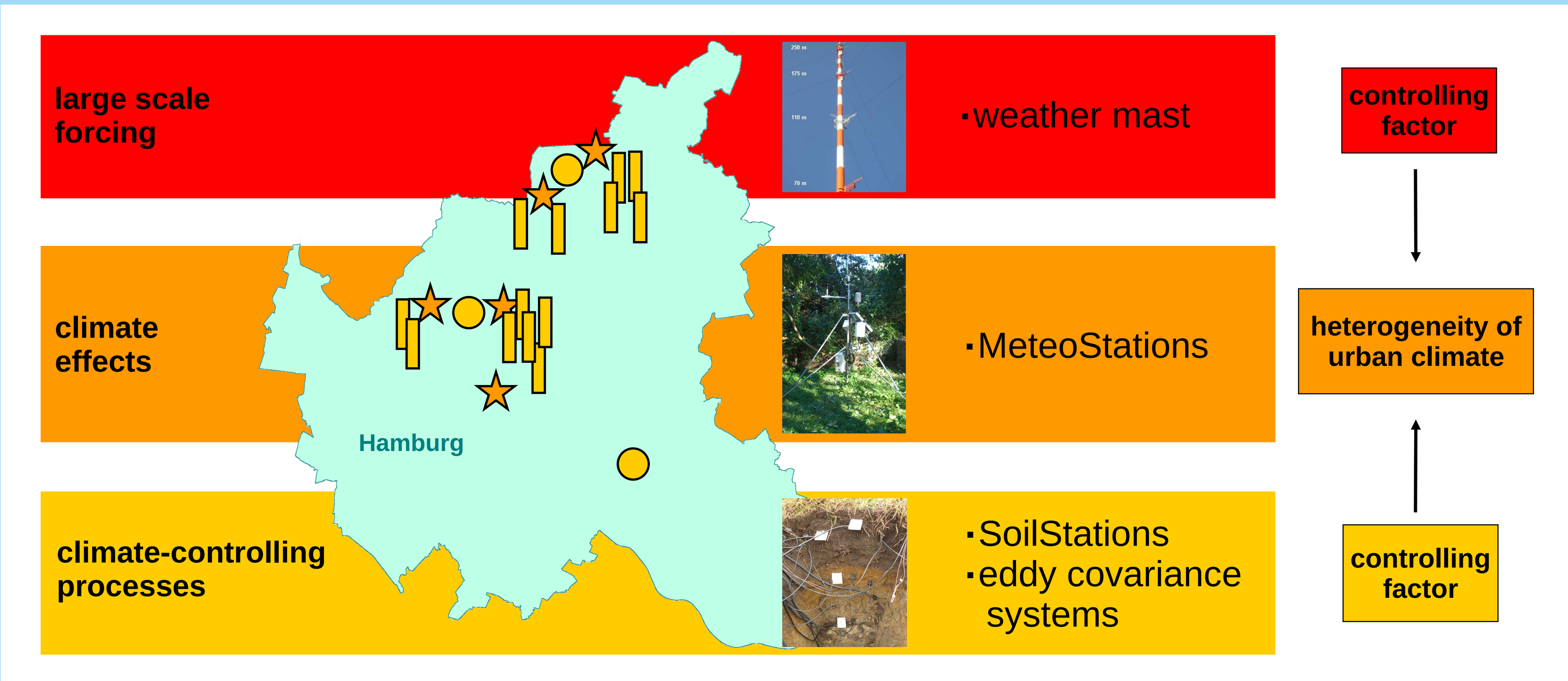


Fig. 1 *HUSCO concept*

Fig. 2a *SoilStation* ***Fig. 2b*** *MeteoStation* ***Fig. 2c*** *Weather mast*

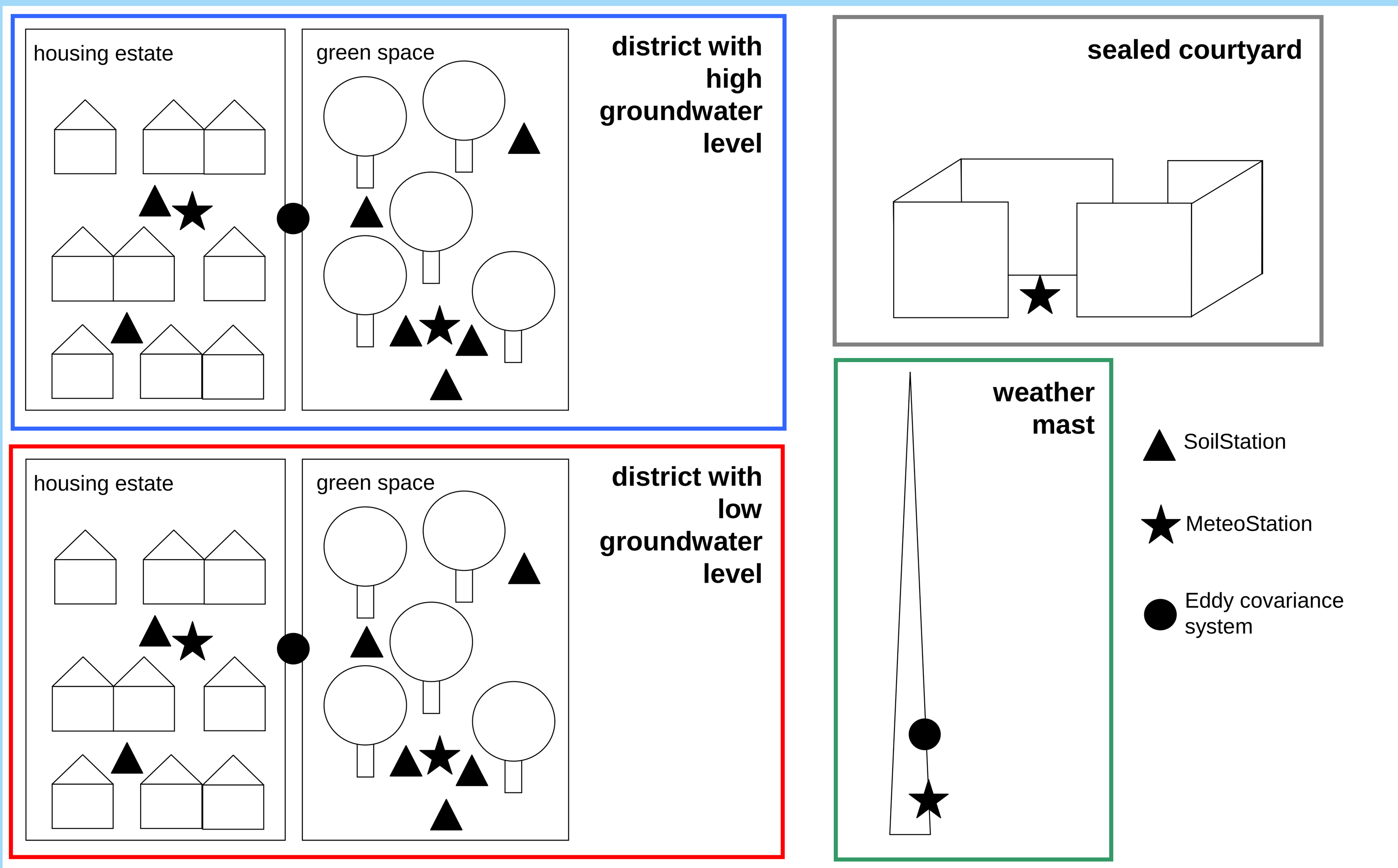


Fig. 3 *Scheme of measurement sites*

The project HUSCO

Soil as a storage and transmitter for water and thermal energy is able to influence and modify the local climate. The aim of the research project HUSCO (Hamburg Urban Soil Climate Observatory) is a more precise understanding of the interactions between pedosphere and atmosphere in urban environments.

HUSCO focuses on the impact of soil hydrology in different typical urban structural units. Main issues are:

- assessing the local effect of groundwater table depth and soil properties on meteorological variables in the urban environment
- determine the causative processes in the soil
- integrated flux measurements over urban districts

Methods

To detect the climate effects, namely the heterogeneity of temperature and humidity in urban areas, five “MeteoStations” have been set up at reference sites to analyze the core atmospheric parameters, e.g. temperature, relative humidity, precipitation and wind speed. (*Fig. 1 + 2b*)

To quantify the climate-controlling processes, like fluxes of water and energy, 13 “SoilStations” have been installed to analyze processes and seasonal variations in soil water balance and thermal properties in 5 depths up to 1.60 m (*Fig. 1 + 2a*). Furthermore, two Eddy covariance systems will collect data on turbulent fluxes.

In addition, data of the weather mast of Hamburg[a], a 300m radio communication tower equipped with meteorological sensors, will be used to evaluate the greater meteorological conditions. (*Fig. 1 + 2c*)

Measurement sites

Long-term measurements started in early summer 2010 in the city of Hamburg, Germany. The measurement reference sites were selected with regard to local groundwater table, type of housing estate, size and vegetation of the green space as well as soil properties (*Fig. 3*).

Two reference sites – i.e. two urban districts – with different groundwater table depths were chosen: a low groundwater table depth of < 2.5 m and a high groundwater table depth of > 5 m. Each site features two MeteoStations, one located in a housing estate and one in a green space. Another station is located inside a sealed courtyard.

In addition to the pedological sensors located at the MeteoStations, further SoilStations supplement these measurements to give information about the heterogeneity of the soil water balance within green spaces and housing estates.

Eddy covariance stations will be mounted at heights of about 30-40 m located in the housing estates. Temporarily, a mobile Eddy covariance station will be set up inside the green spaces to determine the local occurring fluxes.

First Data

The potential to interpret the collected data is manifold. Fig. 4 gives a first impression of the measurement's information content: exemplarily, the diurnal cycle of the air temperature of the five HUSCO MeteoStations is shown here, measured on a day with little clouds and high solar irradiation.

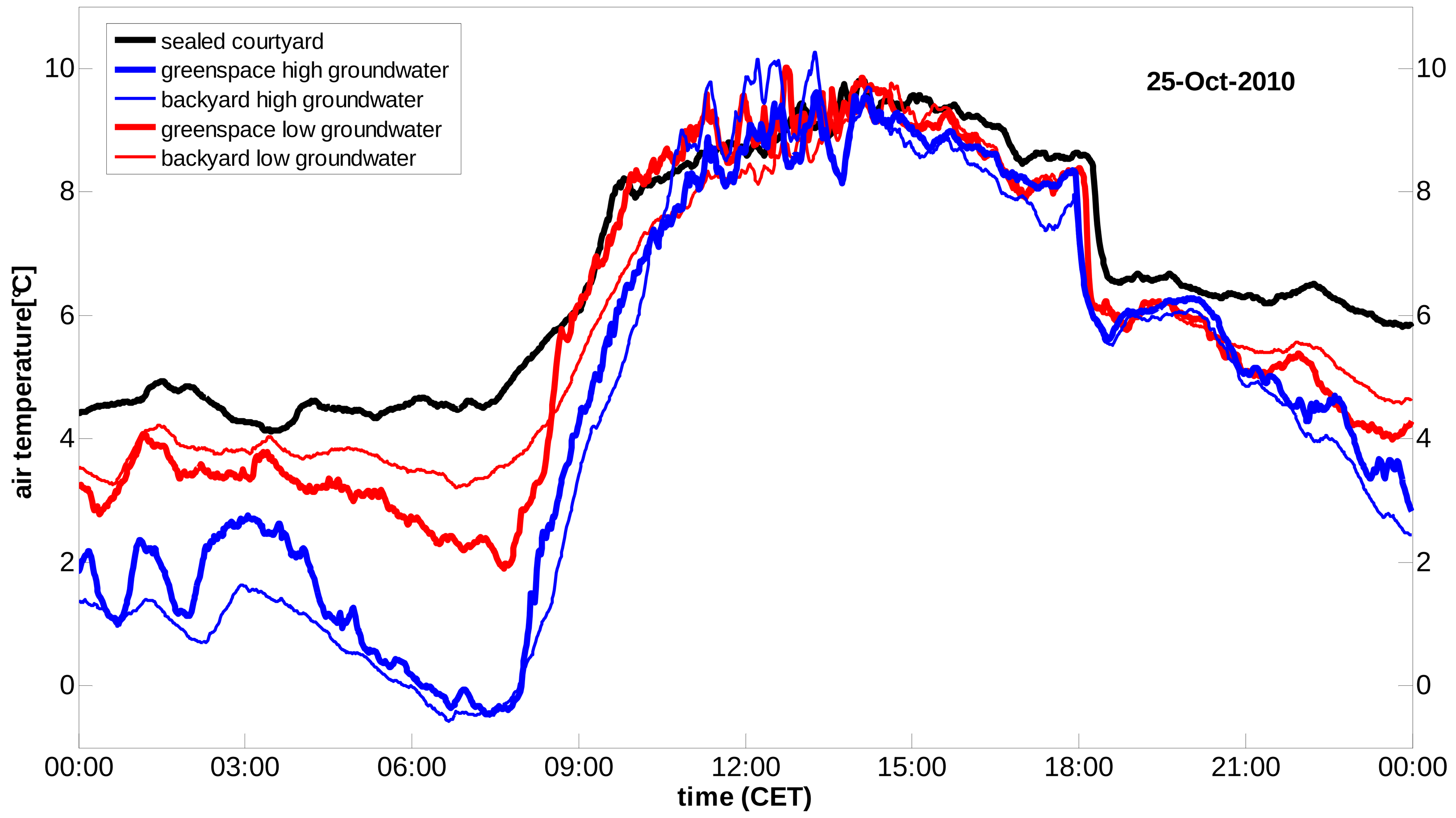
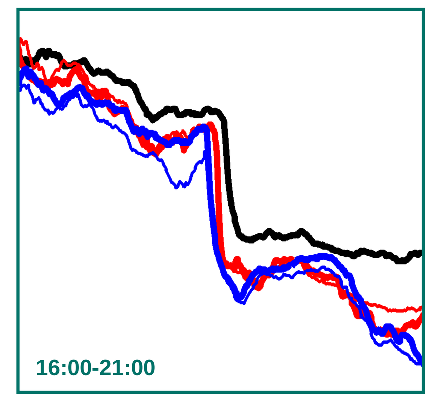


Fig. 4 *Diurnal cycle of the air temperature at the 5 MeteoStations on Oct. 25 2010.*

ZOOM

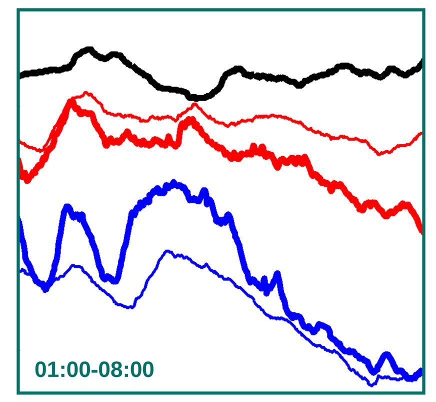
- **Large scale effects**

At about 6 p.m. a cold front approaches from the northwest and moves over Hamburg. It arrives at the district with high groundwater level first, followed by the low groundwater district and the inner city courtyard.



- **Local scale effects**

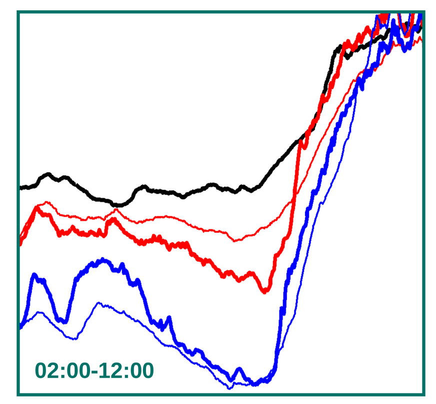
A clear regional distinction of the air temperature between the reference sites is visible, especially during night time. The temperatures within one urban district are quite similar, while there are significant differences between the three districts.



- **Micro scale effects**

Within one urban district areas with different land use show varying behavior:

After sunrise the green spaces warm up faster than the housing estates. In addition, during night time, the turbulent fluxes over the open green space cause more fluctuation in air temperature.



[a] *http://wettermast-hamburg.zmaw.de*

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

1) Sarah Sandoval
KlimaCampus, University of Hamburg
Bundesstraße 55
20146 Hamburg, Germany
sarah.sandoval@zmaw.de

2) Jun.-Prof. Felix Ament
Meteorological Institute, University of Hamburg
Bundesstraße 55
20146 Hamburg, Germany
felix.ament@zmaw.de

3) Prof. Dr. Annette Eschenbach
Institute of Soil Science, University of Hamburg
Allende-Platz 2
20146 Hamburg, Germany
a.eschenbach@ifb.uni-hamburg.de

supported by:
Hamburg Behörde für Stadtentwicklung und Umwelt
TIERPARK Hagenbeck
ISUF e.V.
Deutsche Telekom

KlimaCampus