

SEVENTH FRAMEWORK PROGRAMME
THEME 6: Environment (including climate change)

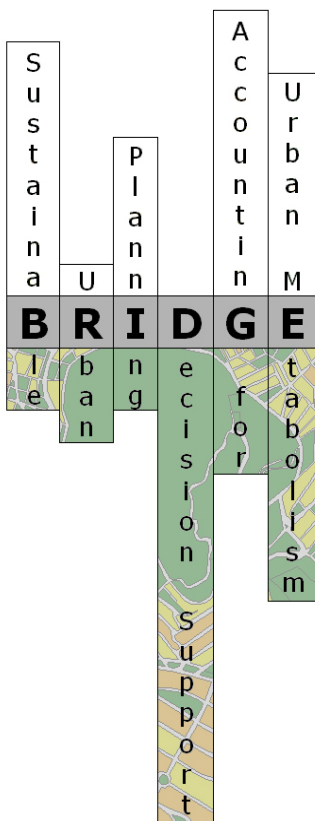


Contract for:

Collaborative Project

D.3.1.3

Datasets of air quality, energy, water, carbon and pollutants fluxes/concentrations



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1. Introduction

Urban communities consume material and energy and eliminate the wastes from the process. Energy and mass are exchanged by urban environments and fluxes are modulated by human activities, such as heating and air conditioning, vehicular traffic, changes in vegetative cover, waste production etc., in what has been termed "**urban metabolism**".

BRIDGE WP3 includes the Data Collection and Analysis activities in BRIDGE case studies, representing a unique attempt to collect and to analyse an integrated database suitable for the development and validation of models and methodologies for the analysis of fluxes between the city and its environment.

Task 3.1 – *in situ* data collection and analysis - applies established and newly developed methodologies aimed at collecting comprehensive data sets by means of in situ observations.

Specific objectives are the collection of meteorological data, trace gas emissions, mass, energy, and particle fluxes; assess the role and impact of city vegetation; identify the increase of the energy demand of buildings for cooling purposes; document the sensible heat flux and heat island characteristics of medium and large selected European cities.

1.1 Purpose of the document

Task 3.1 is aimed at monitoring the main fluxes, using in-situ observations, in the five BRIDGE case studies of Helsinki, Athens, London, Firenze and Gliwice. These cities were selected as European cities representative of different climates, sizes and socio-economic conditions and will be investigated for the above described drivers and flows.

The present document updates Deliverable number 3.1.2.

The following paragraphs will provide an overview of ongoing measurement work in the different case studies. Details concerning methods and instrumentation used and expected starting and closing date are provided in Annex.

An exhaustive report of methodologies and protocols adopted is to be provided in D.3.4 "BRIDGE observations report" and D.3.5 "BRIDGE observations protocol" due in month 30.

The BRIDGE Consortium decided that developing a project database hosting all data collected was unnecessary and hard to realize, due to the heterogeneity of information collected, in terms of time steps, structure of records etc. Moreover, it was pointed out that proper data exploitation could not be achieved without direct interaction between data providers on one side and modellers and DSS developers on the other.

Data sets were therefore not uploaded on the BRIDGE ftp Server, but will rather be obtained directly by providing institutions, however the location of the data is given in this report.

Contact details for data download are reported for each case study in the following sections.



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1.3 Definitions and Acronyms

Acronyms

CoP	Community of Practice
DSS	Decision Support System
CNR	Consiglio Nazionale delle Ricerche, Italy
KCL	King's College London
NKUA	National and Kapodistrian University of Athens
UHEL	University of Helsinki, Finland
IETU	Instytut Ekologii Terenów Uprzemysłowych, Poland
CMCC	Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy
UBAS	University of Basel
SOTON	University of Southampton

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Tretiach, M., Adamo, P., Bargagli, R., Baruffo, L., Carletti, L., Crisafulli, P., Giordano, S., Modenesi, P., Orlando, S., Pittao, E., 2007. Lichen and moss bags as monitoring devices in urban areas. Part I: Influence of exposure on sample vitality. *Environmental Pollution* 146 (2) 380-391.

Vesala T., Järvi L., Launiainen S., Sogachev A., Rannik Ü., Mammarella I., Siivola E., Keronen P., Rinne J., Riikonen A. and Nikinmaa E., 2008. Surface-atmosphere interactions over complex urban terrain in Helsinki, Finland, *Tellus* 60B, 188-199.

1.5 Project Overview

Urban metabolism considers a city as a system and distinguishes between energy and material flows. “Metabolic” studies are usually top-down approaches that assess the inputs and outputs of food, water, energy, etc. from a city, or that compare the metabolic process of several cities. In contrast, bottom-up approaches are based on quantitative estimates of urban metabolism components at local scale, considering the urban metabolism as the 3D exchange and transformation of energy and matter between a city and its environment. Recent advances in biophysical sciences have led to new methods to estimate energy, water, carbon and pollutants fluxes. However, there is poor communication of new knowledge to end-users, such as planners, architects and engineers.

BRIDGE aims at illustrating the advantages of considering environmental issues in urban planning. BRIDGE will not perform a complete life cycle analysis or whole system urban metabolism, but rather focuses on specific metabolism components (energy, water, carbon, pollutants). BRIDGE’s main goal is to develop a Decision Support System (DSS) which has the potential to propose modifications on the metabolism of urban systems towards sustainability.

BRIDGE is a joint effort of 14 Organizations from 11 EU countries. Helsinki, Athens, London, Firenze and Gliwice have been selected as case study cities. The project uses a “Community of Practice” approach, which means that local stakeholders and scientists of the BRIDGE meet on a regular basis to learn from each other. The end-users are therefore involved in the project from the beginning. The energy and water fluxes are measured and modelled at local scale. The fluxes of carbon and pollutants are modelled and their spatio-temporal distributions are estimated. These fluxes are simulated in a 3D context and also dynamically by using state-of-the-art numerical models, which normally simulate the complexity of the urban dynamical process exploiting the power and capabilities of modern computer platforms. The output of the above models lead to indicators which define the state of the urban environment. The end-users decide on the objectives that correspond to their needs and determine objectives’ relative importance. Once the objectives have been determined, a set of associated criteria are developed to link the objectives with the indicators. BRIDGE integrate key environmental and socio-economic considerations into urban planning through Strategic Environmental Assessment. The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of the above urban metabolism components. A Multi-criteria Decision Making approach has been adopted in BRIDGE DSS. To cope with the complexity of urban metabolism issues, the objectives measure the intensity of the interactions among the different elements in the system and its environment. The objectives are related to the fluxes of energy, water, carbon and pollutants in the case studies. The evaluation of the performance of each alternative is done in accordance with the developed scales for each criterion to measure the performance of individual alternatives.



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Several studies have addressed urban metabolism issues, but few have integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and extreme situations. The innovation of BRIDGE lies in the development of a DSS integrating the bio-physical observations with socio-economic issues. It allows end-users to evaluate several urban planning alternatives based on their initial identification of planning objectives. In this way, sustainable planning strategies will be proposed based on quantitative assessments of energy, water, carbon and pollutants fluxes.



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2. Summary

Task 3.1 is aimed at monitoring the main fluxes, using in-situ observations, in the five BRIDGE case studies – Helsinki, Athens, London, Firenze and Gliwice. These cities were selected as European cities representative of different climates, sizes and socio-economic conditions and will be investigated for the above described drivers and flows.

The following data will be provided:

- Time series and spatially extensive data sets of air quality and surface fluxes by participants KCL, CNR, IETU, UHEL, NKUA, CMCC.
- Turbulent fluxes and distribution of trace gas and particle concentrations by participants CNR, IETU, UHEL, SOTON, CMCC.
- Gas exchange of urban vegetation in relation to soil properties, by participants SOTON, CNR.
- Urban heat island characteristics and energy demand of buildings for cooling, by participants NKUA, IETU, CNR.
- Indoor environmental quality, by participants NKUA, CMCC.

An overview is given of ongoing measurement work in the different case studies. Details concerning methods and instrumentation used and expected starting and closing date are provided in Annex

Contact details for data download are also provided

2.1 Partners involved

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2. Case Studies

3.1 Helsinki

Description of study sites

Most of the measurements made under Task 3.1 are carried out at the urban measurement station SMEAR III. Measurements are carried out in two locations, Kumpula and Viikki, in Helsinki.

The air quality, turbulent flux and meteorological measurements are made at the Kumpula site (60°12'N, 24°57'E, 26 meters above sea level), which is located at the University of Helsinki campus area about five kilometers from the Helsinki city centre (Järvi et al. 2009). Measurements are carried out in a 31 meters high triangular lattice tower, which is equipped with meteorological instrumentation at several heights, and on the roof of one of the University of Helsinki buildings.

The surroundings in Kumpula are heterogeneous consisting of buildings, paved areas and vegetation, and three distinct areas of surface cover have been recognized in different wind directions (Vesala et al. 2008). In direction 320-40°, lays the urban sector with high fraction of buildings with mean height of 20 meters, and paved areas. One of the main road leading to the Helsinki city centre with 45 000 vehicles per workdays passes the road sector (40-180°) with a distance of 150 meters from the measurement tower. The area between is covered with deciduous forest. The vegetation sector is located in direction 180-320°, where the University Botanical garden and an allotment garden are located.

The multidisciplinary urban ecosystem and tree research lies in Viikki, seven kilometers from the Helsinki city centre. Viikki area consists of the University campus area, new residential areas build since early 2000's and extensive green areas. The measurements are done on two streets with south –west north-east direction. The streets are paved with local pillar type black alder and lime trees growing there. The streets have been build in 2002 using normal construction techniques, one street in normal modern residential area and one in an office area. Three different urban load bearing soil mixtures currently used in Helsinki are tested at the sites.

Collected data

Kumpula: Measurements include radiation components and profiles of the temperature and wind from levels 4, 8, 16 and 31 meters. The fluxes of momentum, sensible heat, water vapor, carbon dioxide and aerosol particle number are measured with the eddy covariance technique on top of the tower. Next to the tower is situated an air conditioned container where aerosol particle and gas concentration instrumentation is located. The weather station is situated on the roof of the University of Helsinki building.

CMCC is applying the ACASA model to simulate energy and mass fluxes over the Kumpula site. The period June-September 2008 was run and results were compared with flux measurements and presented at the 3rd Progress Meeting held in Athens (May 6-7, 2010) and at the Ninth Symposium on the Urban Environment (2-6 August 2010, Keystone, Colorado) (Marras et al. 2010). Also, data collected during the Project have been used to simulate energy, water, and carbon fluxes in Kumpula for a three months period (July-September 2010). Results will be presented in the Workshop on WP3-4 and in the 5th Progress Meeting that will be held in Gliwice (Poland) from May 23rd to May 25th 2011.

Viikki: Urban tree measurements cover campaignwise photosynthesis and transpiration measurements by chambers, continuous transpiration measurement with sapflow needles, stem diameters, soil temperature and humidity, soil CO₂ concentration, photosynthetically active radiation (PAR) and basic meteorological quantities. In addition to the measurements carried out at the SMEAR III station, stormwater quantity and quality are measured in three small catchments in Helsinki area.

Contact info:

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<http://www.atm.helsinki.fi/~ldapguest/HelsinkiEC/HelsinkiEC.HTML>

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3.2 Athens

Description of study sites

The Athens Case Study is focused on the municipality of Egaleo, which lies in Western part of Athens.



Figure 1. Egaleo in the greater Athens area (A). The case study site (B) [Source: Google Earth]

Five main road axes divide the area in four quarters. One of the quarters is an industrial degraded area (brownfield) called Eleonas. The total area of Egaleo is 650 ha and it is flat in general. The population is 74.046, although it is estimated that at least 120000 people, mostly medium and low income, live and work in the area. The level of education of the inhabitants is low to medium and the rate of unemployment high. The average density is estimated to be 225 inhabitants/ha. According to onsite observations and research it was found that most of the buildings in the area were built between 1950's – 1980's, with several of them built around 1950s. These buildings are made of reinforced concrete, and have one to three floors height. A small amount of houses were built in the 1920's and onwards. These residences are made of stone and are in poor condition. Finally, there are buildings built in the last decades made of reinforced concrete reaching a height of up to 6 floors. As it appears in the land use map of Egaleo, there very little free/ green spaces.

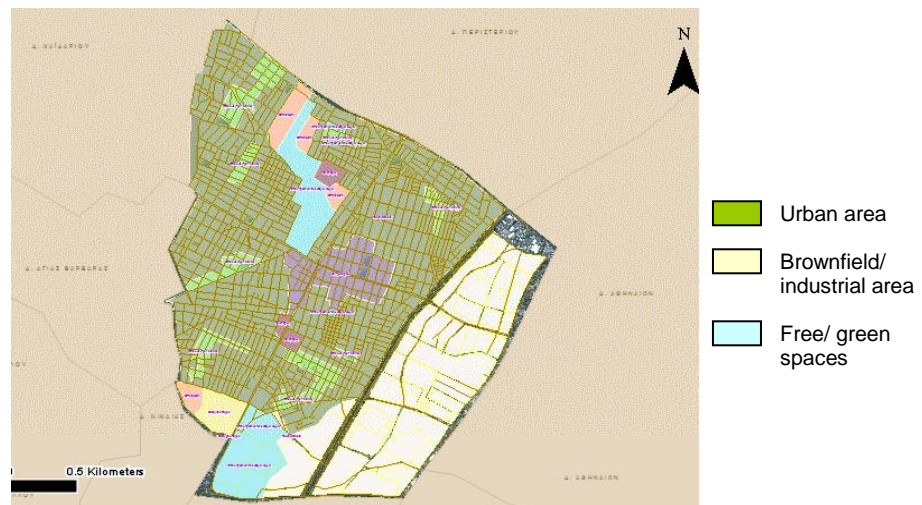


Figure 2. Land use map of Egaleo [Source: www.aigaleo.gr]

The in situ measurements that have been carried out focus on the area of Egaleo. Additionally NKUA is providing meteorological data from the National Observatory of Athens station “Thission” which is close to the case study area.

Collected data:

The following data have been collected and are available on the BRIDGE ftp server (<http://ftp.iacm.forth.gr/egroupware/>).

A. Meteorological parameters from “Thission” station

The folder “Meteo data Thission.rar” contains the following meteorological parameters:

1. Air temperature (C)
2. Relative humidity (%)
3. Wind direction and wind speed (m/s)
4. Precipitation (mm)
5. Diffuse solar radiation (W/m²)
6. Total solar radiation (W/m²)
7. Sunshine duration (hours)
8. Air pressure (hPa)

These data were taken from Thission meteorological station from the National Observatory of Athens, which is located near Egaleo, the Athens case study area (Latitude = 37°58.3/N, Longitude = 23°43/E and altitude = 107 m.). The station is located on a hill in the center of Athens characterized by some vegetation while it is surrounded by a dense urban area presenting a high anthropogenic heat, and some relatively open spaces. The data cover the whole year for 2008, 2009 and 2010. Measurements are ongoing.

B. In situ experimental measurements



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Another category of measurements are those that have been carried out at the case study area (Egaleo) during summer 2009. The following experiments have been carried out:

1. Indoor measurements

Ten residential buildings, representative of Egaleo's building stock, have been selected at the case study area and were monitored during the summer of 2009. Data collection includes:

- Information on the selected buildings (construction details, photos etc.)
- Distribution and collection of 320 questionnaires based on ASHRAE std 55 (long and short) from the residents assessing the indoor environment.
- Temperature recorded in the 10 residential buildings from May 2009 to Feb. 2010. Outdoor temperatures were also recorded.
- Measurements of particulate matter concentrations -PM1, PM2.5, PM10 -values of each residential building (units: mg/m³) during selected days.
- Indoor thermal comfort measurements: Air temperature (°C), relative humidity (%), Air velocity (m/s) and mean radiant temperature (°C), during selected days.

2. Outdoor measurements

The following measurements have been performed at the case study area to monitor the outdoor environmental conditions:

- Wind speed (m/s) and direction out of a selected canyon (by a cup anemometer placed on the top of the canyon in our area of investigation).
- Three components of the wind's speed-x,y,z (by 3xis anemometers which have been placed near to the facades of the canyon -dist:1.5m from the wall).
- PM1, PM2.5, PM10 (Units: mg/m³). Measurements taken with a portable instrument using the mobile station on several days during the reporting period.
- wind speed and direction by anemometers that have been placed in three different heights-3.5, 7.5, 15.5m – in the antenna of NKUA's mobile station.
- Air temperature (°C), Humidity (%), Air velocity (m/s) and Radiant temperature (C) at the height of 1.5m. Measurements taken with instruments mounted on the mobile station on several days during the reporting period.
- Measurements of the surface temperature of the urban fabric (building facades, roads and pavements) using an infrared thermometer (Cole Palmer) and infrared camera (Thermovision 570). Measurements taken with these portable instruments using the mobile station on several days during the reporting period

The measurements described above (air temperature, humidity, air velocity) were taken at different spots throughout the area (transect measurements).

C. Air quality measurements



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The files contain data on air pollutants (CO, NO₂, NO, SO₂, O₃, C₆H₆, PM10 -2.5) on several stations close to the case study area. Hourly values for a whole year period are given. The data are provided by the Ministry of Environment, Energy and Climate change from the Athens air quality network. Full data sets are provided for 2007, 2008, 2009 and 2010. Measurements are ongoing.

D. Heat island measurements

The file contains air temperature data from a network of 17 meteo stations set up by NKUA, in the greater Athens area including air temperature data for Egaleo and from a reference station in a suburban/rural area in order to calculate the heat island effect throughout the experimental period. Data sets are provided for 2009 and 2010.

E. Traffic data

Traffic Data for the years 2008 – 2009 have been collected from Ministry of Transport and Communication. More specifically, the following parameters are available:

1. Number of vehicles that have passed through specific measurement locations (per hour)
2. Average velocity (km/h) of the vehicles that have passed through specific measurement locations (per hour)
3. Percentage of time (%) that each measurement location is engaged (per hour)

F. Other data

Furthermore, NKUA has provided additional data according to specific requests of Bridge researchers (e.g. monthly natural gas consumption data for Egaleo, representative residential building description for the area of Egaleo)

The data collected for the Athens case study are being analyzed.

Contact info:

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3.3 London

Description of study sites

Physical Meteorology is collected at two sites on the KCL Strand campus: KSK (King's Strand King's) and KSS (King's Strand). The main site is KSS which became operational 1 November 2009.

Collected data:

1. **Physical Meteorological variables** and CO₂ are measured. Measurements are collected at 10 Hz and analysed into 15, 30 and 60 min periods. More details are provided at:

<http://geography.kcl.ac.uk/micromet/>

(KUMA Data Archive)

Air quality data: collected around London at 15 min time intervals. More details:

<http://www.londonair.org.uk/london/asp/default.asp>

Anthropogenic heat flux (all cities)

http://geography.kcl.ac.uk/micromet/wordpress/?page_id=436

2. Urban vegetation data for the Greater London Authority (GLA) has been extracted at each of the 33 London borough levels using ArcMap™ (ESRI® ArcMap™ version 9.3). The habitat classes extracted from the CEH Landcover 2000 data are : Class (1) Broad leaved trees, Class (2) Coniferous trees and Classes (5-8) Grasses.

The raster data-sets (25 m) were used to quantify the area of these land cover classes for each London borough.

Mean seasonal [PM10] data for 2006 has been extracted from the 20 m resolution London Atmospheric Emissions Inventory (LAEI 2006) for each borough. Using a buffer (~20 m) and a road network overlay the mean [PM10] associated with roads (street tree environment) is currently being established for selected boroughs.

Modelled [PM10] (LAEI 2006) has been used to extract [PM10] for each London borough

Urban green space capture of PM10 has been estimated for the following scenarios using the UFORE model approach:

- Borough level annual mean capture of PM10 by (i) blocks of green space (ii) street tree canopy cover.
- Selected borough level mean capture of PM10 by (i) blocks of green space (ii) street tree capture using mean of [PM10] extracted from the 20 m buffer around the roads (using literature derived deposition velocities to street trees).



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PM10 uptake by all trees in the GLA area has been estimated for current tree cover and for the year 2050 with greenspace cover increased to target values using five planting scenarios. These data are illustrated below:

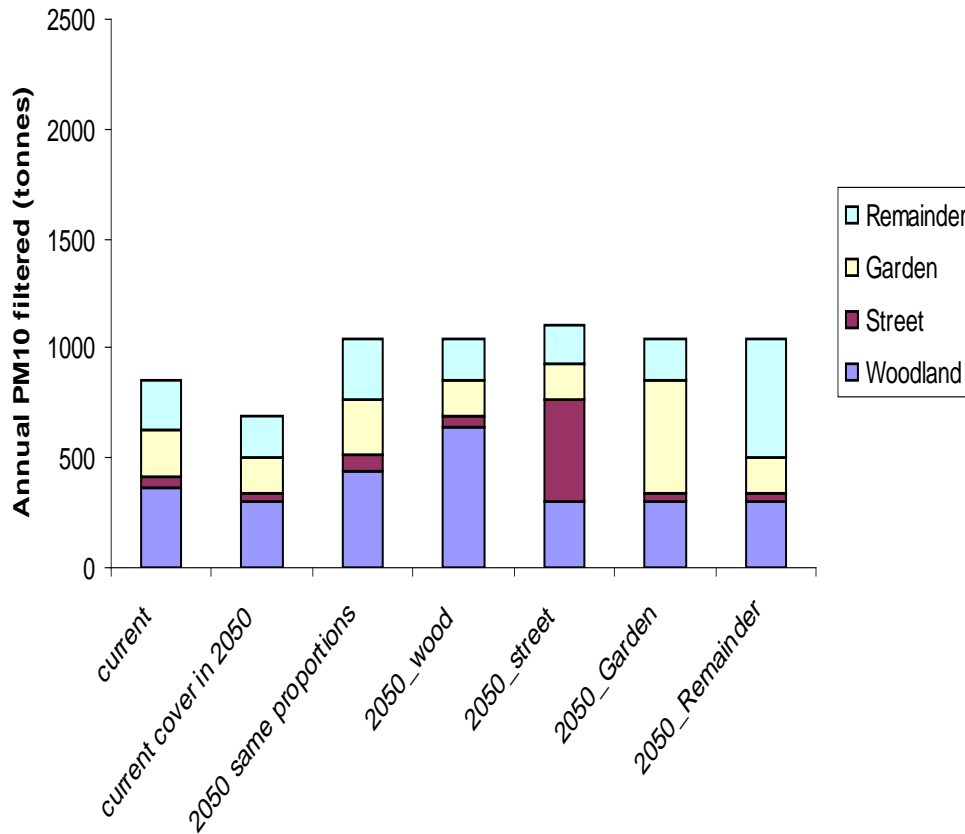


Figure 3. Annual PM10 in GLA

Relationships have been developed between atmospheric PM10 concentration and deposition to tree canopies (e.g. Annual mean PM10 capture in $\text{Kg ha}^{-1} \text{y}^{-1} = 1.257 \text{ Annual mean PM10 concentration in } \mu\text{g m}^{-3}$), and these relationships will be used to link greenspace data to urban air quality (using the URBAIR online model) to provide input to the BRIDE Decision Support System.



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air quality: <http://www.londonair.org.uk/london/asp/default.asp>

KCL micromet sites locations details: <http://geography.kcl.ac.uk/micromet/index.htm>

Operations password: monitoring_sg5035

2. SOTON

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3.4 Firenze

Description of study sites

Firenze (400.000 inhabitants) is located in the central part of Italy about 80 km east of the sea. The few big industries formerly present inside the town moved years ago from the centre; nevertheless the orographic configuration of the site (a closed basin) and its continental climate favor episodes with high atmospheric stability and heavy pollution. The city center of Firenze is characterized by small squares surrounded by a network of narrow streets linked to the ancient gates. According to the reconstruction plan of 1885, the city walls were demolished and were replaced by a ring of avenues surrounding the city center that are the busiest streets. There is almost no vegetation in the city-center area. The meteorological and micro-meteorological variables are measured at the Osservatorio Ximeniano located in the city center (43° 47' N, 11° 15' E) and is operating from 14 September 2005. Osservatorio Ximeniano founded in 1756, on the upper floor of the monastery of San Giovannino, is today an independent scientific body of measurement and research, which conducts scientific research in the geophysical and meteorological fields in collaboration with CNR-IBIMET and INGV.

Air quality datasets for a network of 5 air quality 'traffic-oriented' monitoring stations, including heavy and medium-traffic and urban-background sites, are available from 1 January 2003, sampling pollutant gases and total suspended PM₁₀.

Collected data:

- 1) A new instrumentation, the EOLO (Eddy cOvariance-based upLift Observation system) will be used to collect turbulent fluxes of dust in the Firenze case study. Size-segregated fluxes of mineral dust particles with aerodynamic diameters between 0.35 and 9.50µm are measured with this system. The system covers the largest portion of mineral dust mass subject to long range transport. The system is comprised of two main components: the wind system and the concentration system. The wind system consisted of an ultrasonic anemometer Metek USA-1, (Metek GmbH, Elmshorn, Germany), allowing fast and accurate measurements of the 3-D wind velocity and sonic temperature; this last parameter also provides a good estimation of the air temperature. The concentration system includes several parts. The most important are the OPC (CI-3100 series, Climet Instruments Co., Redlands, CA, USA) and the Multi-Channel Analyzers (MCA8000, Amptek Inc., Bedford, MA, USA). To minimize uncertainties, the inlet of the measuring system is directly attached to the anemometer. In our design, sampled particles are split in two channels: the so-called finer channel (Dopt from 0.26 to 0.54µm) and the coarser channel (Dopt from 0.54 to 7.00µm). The system simultaneously acquires data from the two channels through dedicated MCA devices. "Finer" and "coarser" particle number concentrations are stored every 30 min. An acquisition frequency of 5Hz is selected. The system is able to simultaneously record counts of particles falling in 18 size ranges. The number of particles per unit of sampled volume (number concentration) is then obtained.



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In the planning of this particular survey, the instrumentation has been modified to reinforce the housing and protection systems to cope variable and unforeseeable meteorological conditions. Moreover an Internet-based access point for a proper remote control of EOLO was set up. The EOLO post-processing software was then upgraded and largely extended to allow multiple output formats and to refine the raw data processing procedure to comply with recent achievements in the Eddy Covariance methodology, such as the spectral correction and coordinate framework rotation algorithms. The system was installed in the Florence BRIDGE site on June 2010, the 3rd, with the aim of carrying out a campaign of at least two months (June-July 2011). Data from the first three weeks have been analysed and used for tuning the acquisition setup (namely: air sampling flow rates, proportion of dilution, channels aggregation). After that (and due to the summer holidays) data have been downloaded again (through the internet) on early August and are presently under processing and quality screening. In September, an automatic raw data transfer has been established, in order to have the raw data in the laboratory in Viterbo on a continuous basis and allow a timely processing/screening. Starting September 2010, data are available for usage in the project and updated monthly.

2) ACASA (Advanced-Canopy- Atmosphere-Soil Algorithm) is a sophisticated model for estimating energy and mass fluxes between the surface and the atmosphere. ACASA was recently modified to simulate energy and mass fluxes in urban environment. It treats the surface and associated fluxes as an interconnected system, and the atmosphere, the urban surface and the soil are represented as a multilayer system. The model incorporates third-order closure principles for turbulent statistics to predict the effects that higher-order turbulent kinetic and thermodynamic processes have on the surface microenvironment and associated fluxes of heat, moisture, momentum, and carbon. Differently from other models, it allows counter-gradient transport that simpler models are unable to describe. The ACASA domain extends maximally to 100 m above the city and plant canopy elements to ensure applicability of the turbulence assumptions. Meteorological input data are taken from Eddy Covariance measurements collected in Firenze by CNR. So far, ACASA produced simulated fluxes, at half-hourly time step, of Net Radiation, Sensible and Latent Heat flux and Carbon dioxide turbulent flux. The investigated period covers January-April 2008. Local scale simulations of energy and mass fluxes were then produced and compared with observations. Results showed good agreement between simulated and observed fluxes and were presented at the 3rd Progress Meeting held in Athens (6th-7th May 2010) and at the Ninth Symposium on the Urban Environment (2-6 August 2010, Keystone, Colorado) (Marras et al. 2010). Also, energy, water, and carbon fluxes were simulated using data collected during the Project. The period covers three months in 2010 (July-September). Results will be presented in the Workshop on WP3-4 and in the 5th Progress Meeting that will be held in Gliwice (Poland) from May 23rd to May 25th 2011.

3) Physical Meteorological variables and turbulent fluxes are measured. A mast of 3 m was mounted on a typical tile roof of an ancient building of the Ximenian observatory at 33 m above the street level. Turbulent fluxes of CO₂, momentum, and sensible heat were collected using a sonic anemometer (Young/Metek) and an open-path CO₂/H₂O infrared gas analyzer (IRGA; Li-Cor 7500). The distance between the two sensors was approximately 0.4 m. The IRGA is calibrated every month using reference gas tanks and a portable dewpoint generator (Li-Cor 610). Raw data are collected at the frequency of 20 Hz. Half-hourly fluxes are derived. The weather station is situated on the same roof and data are available from 1 January 2005. 2BTECH 202 UV monitor for O₃ concentration was installed



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and data are available from 15 October 2009. Air quality data comprises Ozone (TwoBtech 202 UV analyzer) and CO (UNITEC ETL2000 thick film sensor) concentration.

Air quality datasets are available for FTP download. This data set contains PM10-PM2.5 (daily mean) and SO₂-NO₂-CO (hourly mean - solar time) for a network of 5 air quality monitoring stations. A map of air quality monitoring station is available in kmz (google earth) format.

An innovative microjoule lidar developed in cooperation with ENEA, will provide measurements of horizontal and vertical profiles of dust as well as the height of the planetary boundary layer. The Lidar has been designed to be a low-cost and an ultralow consumption instrument, suitable for airborne measurements. A GRIMM aerosolspectrometer, capable of analysing the distribution of dust particles in 20 spectral bands in the range between 0.23 µm to 20 µm, will complement remote observations of the Lidar with detailed *in situ* information on the nature of dust. Data are available starting in January 2010,

High Quality weather data are provided by a new automatic weather station that provide air temperature, air humidity, solar radiation short and long wave incoming and reflected, air pressure and infrared surface temperature of the roofs. Data are available from July 2010.

4) Biomonitoring activities in Florence are started as scheduled in the project.

The moss *Hypnum cupressiforme* has been used as a bioindicator for the estimation of atmospheric traces metal deposition in the urban area of Florence. Moss carpets have been collected in a forested area of central Sardinia (municipality of Bolotana – Nuoro) which is characterised by absence of air pollution. In laboratory, the moss material was cleaned from particles of soil, dead material and attached litter and was washed seven consecutive times with distillate water. After cleaning, moss samples were air dried. Moss bags have been prepared by weighing out 2 g air-dried weight, and packing it loosely in nylon nets of 25 cm in diameter with mesh of 4 mm². Moss bags have been located in the urban area of Florence close to three monitoring air quality stations of ARPAT (Agenzia Regionale Protezione Ambiente Toscana) located in Via Ponte alle Mosse, Viale Gramsci, and Viale Ugo Bassi. The first two stations are located in high traffic roads whereas the third one is located in a road characterised by less traffic density.

The first three campaigns of measurement relative to March-April, May-July, and August-October periods were completed. After exposure periods, the moss bags were removed and the moss samples were analyzed for As, Cr, Cu, Fe, Ni, Pb, V, and Zn by Inductively Coupled Plasma Atomic Emission Spectrometry.

The fourth bioaccumulation campaign relative to the autumn season is starting; the moss bags are going to be located in the three monitoring air quality stations of ARPAT at the end of October.

Any deviations between actual and planned activity has occurred.



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Land Use/Land Cover data, Road Networks, Buildings, Topography, Population, Administrative units and more, are available for FTP download at:

<ftp://149.139.16.152>
username: toscano
pwd: piero1980

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3.5 Gliwice

Description of study sites

Gliwice Monitoring Station, part of the Silesian Air Monitoring Network, is located 1 km from the Academic District (Politechnika). An eddy covariance (EC) flux station was installed in Gliwice (50°16'45'' N, 18°39'20'' E) in December of 2009 on the flat roof of a 15 m high building close to the Gliwice Monitoring Station. The source area in easterly directions is dominated by urban area, while towards westerly directions rural areas prevail.

Collected data:

Air pollution: SO₂, NO, NO₂, O₃, PM10

Meteo parameters: wind direction and velocity, air temperature, relative humidity, total radiation, atmospheric pressure, precipitation.

Additional measurements using the IETU equipment which can complete UBAS mast installed in the Politechnika District may be taken out:

Particle number Equipment: Particle counter (Profiler P212 –Met One) 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.5, 10.0 µm

PM10 concentration (or PM2.5) Equipment: Particulate Monitor, Model 5030 SHARP,

Soil moisture and temperature profiles 4 depths.

Turbulent flux measurements are carried out by UBAS starting from March 2010:

Variable	Frequency	Method	Equipment
The wind components (u,v, w)	10Hz	online	YOUNG 81000
Particle number	1Hz	Online (>0°C)	Particle counter (Profiler P212 –Met One) 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.5, 10.0 µm
PM10 concentration (or PM2.5)	1/h	online	Particulate Monitor, Model 5030 SHARP
Air humidity		online	
Air temperature		online	
Soil moisture profile 4 depths		online	
Soil temperature profile 4 depths		online	
Meteorological Mast 10 m		online	
Eddy covariance system			Logger CR1000
Wind vector	10 Hz		Young 81000
Conc. of H ₂ O and CO ₂	10 Hz		LiCor LI7500
Air Temp. and humidity	1 min		Vaisala HMP45
Components of net radiation	1 min		Kipp & Zonen CNR1

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Measurements averaged every 30 min/1hour are available on-line at:
<http://stacje.katowice.pios.gov.pl/iseo/>



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Annex:

Measurement details for the 5 case studies

Case study: Athens							
participant	National and Kapodistrian University of Athens Greece						
acronym	NKUA						
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	CO concentration	Infrared absorption		Athens air quality network	Jan. 2007	Ongoing	Hourly values
air quality	NO _x concentration	Chemiluminescent gas analyzer	Thermo Electron Corporation model 42i	Athens air quality network	Jan. 2007	Ongoing	Hourly values
air quality	O ₃ concentration	UV Photometric technology	Thermo Electron Corporation model 49i	Athens air quality network	Jan. 2007	Ongoing	Hourly values
air quality	Particle number size distribution	Beta radiation absorption		Athens air quality network	Jan. 2007	Ongoing	Hourly values
air quality	Principal outdoor pollutants (VOCs, contaminants, etc)	gas chromatography		Athens air quality network	Jan. 2007	Ongoing	Hourly values
air quality	SO ₂ concentration	Pulsed fluorescence gas analyzer	Thermo Electron Corporation model 43i	outdoor measurements	Jan. 2008	Ongoing	Hourly values
IAQ	CO ₂ concentration	online and sampling	TSI IAQ-CALC	indoor measurements	June 09	Sep 10	As requested
IAQ	Air infiltration	Blower door	Infiltec E3-A-DM4 Blower Door	indoor measurements	June 09	Sep 10	once in specified conditions
IAQ	PM1, PM2.5, PM10	sampling	Model 8520 DUSTTRAK™ Aerosol Monitor/ SKC	indoor measurements	June 09	Sep 10	10'
IAQ/ thermal comfort	Thermal comfort parameters (e.g. Air temperature (wet and dry bulb), air velocity, HR, black globe T)	Online and sampling	Tiny Tag temperature logger- Gemini Data Loggers + Delta OHMH/D230.70RTD Thermometer+Dantec low velocity flow analyser + Thermal Comfort Datalogger - INNOVA 1221(potentially)	indoor measurements	June 09	Sep 10	Hourly values of Tair/TC measurements on specific dates
meteo	Air pressure	Online	meteo data provided by the National Observatory of Athens		Jan 2008	Ongoing	hourly values
meteo	Air temperature	online-sampling	meteo data provided by the National	At the NOA meteo station	Jan 2008 (April	Ongoing	15'/ hourly values



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			Observatory of Athens (@Thission) & Tiny Tag temperature logger- Gemini Data Loggers+Therm T351-PX 1/3 DIN (@Egaleo)	and in situ at Egaleo (Bridge case study area)	2009 for Egaleo		
meteo	Air temperature (spatially)	online	Tiny Tag temperature logger- Gemini Data Loggers+Therm T351-PX 1/3 DIN	several stations in the greater Athens area for UHI assessment	April 2009	Dec. 2010	15'
meteo	Precipitation	Online	meteo data provided by the National Observatory of Athens		Jan 2008	Ongoing	hourly values
meteo	Relative Humidity	Online	meteo data provided by the National Observatory of Athens (@Thission) & Tiny Tag temperature logger- Gemini Data Loggers+Therm T351-PX 1/3 DIN (@Egaleo)	At the NOA meteo station and in situ at Egaleo (Bridge case study area)	Jan 2008 (April 2009 for Egaleo)	Ongoing	15'/ hourly values
meteo	Surface Temperature	infrared thermography	AGEMA Thermovision 570 + Cole -Palmer 08406		April 09	Dec 2010	During several days
meteo	Wind speed and direction	Online	meteo data provided by the National Observatory of Athens	At the NOA meteo station	Jan 2008	Ongoing	hourly values
meteo / radiation	Total and diffuse solar radiation	Online	meteo data provided by the National Observatory of Athens	At the NOA meteo station	Jan 2008	Ongoing	hourly values
meteo	Sunshine duration	Online	meteo data provided by the National Observatory of Athens	At the NOA meteo station	Jan 2008	Ongoing	hourly values
micromet	All three wind components (u,v and w)	Online	Young Model 81000 3-axis Ultrasonic anemometer (potentially)/or R M Young Company 27005T UVW ANEMOMETER	inside the main canyons near the facades of the canyon.	May 2009	Aug. 2009	
micromet	wind speed and direction	Online and sampling	A100K Pulse output Anemometer/ Anemometers W200 Porton Windwane, ±300°range / 12102 gill 3cup anemometer	inside the main canyons in the center of each canyon at different heights in the antenna of the mobile meteorological	May 2009	Aug. 2009	On selected days



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				station/ fixed out of a selected canyon			
Micromet	Air temperature, HR, radiant T	sampling	Thermal Comfort Datalogger - INNOVA 1221	At 1.5m height at several locations throughout the case study area	April 2009	Sept. 2009	On selected days
Micromet	Air temperature	sampling	T351-PX 1/3 DIN thermometers with PT100 sensor on mobile meteo station.	At 1.5m height at several locations throughout the case study area	April 2009	Sept. 2009	On selected days



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Case study: Firenze							
participant		Consiglio Nazionale delle Ricerche					
acronym		CNR					
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	H ₂ O and CO ₂ concentrations	online	Open-path infrared gas analyzer (LI-7500)	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average
air quality	NO _x concentration	online	thick film sensors UNITEC ETL2000	also measures CO	set-09	lug-11	hourly
air quality	O ₃ concentration	online	2BTECH 202 UV monitor		set-09	lug-11	hourly
air quality	Particle number size distribution	Lidar and particle counter	micro-Lidar Embedded devices; GRIMM 1109 particle counter	PBL profiles via Lidar; in situ size distribution by particle counter	dic-09	lug-11	hourly - campaigns
air quality	Principal outdoor pollutants (VOCs, contaminants, etc)	Bioaccumulation campaigns & lab spectrometry	"moss bags" & coupled plasma-atomic emission spectrometer (ICP-AES)		gen-10	lug-11	seasonal - campaigns
IAQ	PM1, PM2.5, PM10	online		5 air quality monitoring stations	Jan 03	end of BRIDGE project	daily
IAQ	Principal indoor pollutants (NO _x , VOCs, etc)	online		5 air quality monitoring stations	Jan 03	end of BRIDGE project	hourly
meteo	Air pressure	online	Digital barometer		Jan 05	end of BRIDGE project	hourly
meteo	Air temperature	online	Thermistors + Sonic T		Jan 05	end of BRIDGE project	hourly
meteo	Precipitation	online	Precipitation collectors		Jan 05	end of BRIDGE project	hourly
meteo	Surface Temperature	online	Thermistors	For the green area, only	ongoing	end of BRIDGE project	hourly
micromet	All three wind components (u,v and w)	online	Metek USA-1	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average



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micromet	Friction velocity, Sensible and latent heat fluxes and CO ₂ flux	Eddy covariance	Metek USA-1 + Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average
plant	Diurnal stem and bark diameter variation (6 trees)	online	Delta-T Devices Ltd, QS2	From 2 streets	ongoing	end of BRIDGE project	hourly
radiation	Up- and downward long- and short wave radiations + PAR	online	Net radiometer and photodiode sensor (Kipp&Zonen, CNR1 + PAR Lite)		ongoing	end of BRIDGE project	hourly
radiation	UVA & UVB radiation	Twin differential mobility parameter	Hauke-type DMA (10.9 cm) +CPC (TSI3025), Hauke-type DMA (28 cm) +CPC (TSI3010)		ongoing	end of BRIDGE project	hourly
participant							
Centro Euro-Mediterraneo per i Cambiamenti Climatici							
acronym		CMCC					
air quality	H ₂ O and CO ₂ concentrations	online	Open-path infrared gas analyzer (LI-7500);ACASA model for flux simulation	Istantaneous and 30-min average (optional, not mandatory for DiSAFRi); units: CO ₂ in mmol mol ⁻¹ H ₂ O in mmol mol ⁻¹ file format: ASCII, comma-separated values	nov-09	giu-11	10Hz and 30' average
air quality	Particle number flux (starting from 0.32 nm)	EC	Gill WindMaster + Optical Particle Counter (Climet CI-3100)	30-min average. approx. aerodyn. diameter ranges: ≈ 0.32-1.00 μm ≈ 0.32-2.50 μm ≈ 0.32-10.0 μm units: particle number fluxes: # cm ⁻² s ⁻¹ particle number concentration: # cm ⁻³ file format: ASCII, comma-	feb-10	giu-11	30'



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				separated values			
air quality	Particle number size distribution	post-processing of optical counting	custom particle sampling equipment	1-min average (customizable). Optical diameter range: 0.30 - 7.00 μm 17 size bins in this range units: particle number concentrations: # cm^{-3} (normalized by $d\text{Ln}(D)$) also available)	feb-10	giu-11	30'
micromet	All three wind components (u,v and w)	online	Gill WindMaster; ACASA model for flux simulation	Istantaneous and 30-min average; u,v,w: m s^{-1} file format: ASCII, comma-separated values	nov-09	giu-11	10Hz and 30' average
micromet	Friction velocity, Sensible and latent heat fluxes and CO_2 flux	Eddy covariance	Gill WindMaster + open-path infrared gas analyzer (LI-7500); ACASA model for flux simulation	30-min average; units: Friction velocity: m s^{-1} CO_2 fluxes: $\text{mmol m}^{-2} \text{s}^{-1}$ Latent/sensible heat fluxes: W m^{-2} file format: ASCII, comma-separated values	nov-09	giu-11	30'



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Case study: Gliwice							
participant		University of Basel					
acronym		UBAS					
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	H ₂ O and CO ₂ concentrations	Gas Analysis (open path)	Open-path infrared gas analyzer (LI-7500);		dic-09	dic-10	10Hz,30' average
air quality	NO _x concentration	on line	Silesian District Air Quality Network				
air quality	O ₃ concentration	on line	Silesian District Air Quality Network				
air quality	SO ₂ concentration		Silesian District Air Quality Network				
IAQ	CO ₂ concentration	sampling	Infrared gas analyzer (LI-7500)		dic-09	dic-10	10 Hz
meteo	Air pressure	sampling	LI-7500		dic-09	dic-10	10 Hz
meteo	Air temperature	sampling	Vaisala HMP 45		dic-09	dic-10	1'
meteo	air temperature (next to trees)	online	Silesian District Air Quality Network				
meteo	Precipitation	online	Silesian District Air Quality Network				
meteo	Relative Humidity	sampling	Vaisala HMP 45		dic-09	dic-10	1'
meteo	u, v components	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
micromet	All three wind components (u,v and w)	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
micromet	Friction velocity, Sensible and latent heat fluxes and CO ₂ flux	EC-Method	Young 81000 & LiCor 7500		dic-09	dic-10	10Hz,30' average
micromet	wind speed and direction	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
radiation	Up- and downward long- and short wave radiations + PAR	sampling	Kipp & Zonen CNR 1		dic-09	dic-10	1'
Weather station	temp, rain, etc	on line	Silesian District Air Quality Network				



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Case study: Helsinki							
participant		University of Helsinki					
acronym		UHEL					
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	H ₂ O and CO ₂ concentrations	online	Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)		2005/12/3 / 2007/6/28	end of BRIDGE project	10 Hz, 30' average
air quality	NO _x concentration	Chemiluminescence technique	TEI42S	detection limit 0.2ppb	nov-05	end of BRIDGE project	60 s, 30' average
air quality	O ₃ concentration	IR-absorption photometer	TEI49	detection limit 0.5ppb	nov-05	end of BRIDGE project	60 s, 30' average
air quality	CO concentration	Non-dispersive infrared absorption technique	Horiba APMA 370	detection limit 20ppb With special request from the Finnish Meteorological Institute	nov-05	end of BRIDGE project	60s
air quality	Particle number flux (starting from 6 nm)	EC	Metek USA-1 + Water-based Condensation particle counter (TSI-3781)		lug-07	end of BRIDGE project	10 Hz, 30' average
air quality	Particle number size distribution	Twin differential mobility particle sizer (3-950nm)	Hauke-type DMA (10.9 cm) +CPC (TSI3025), Hauke-type DMA (28 cm) +CPC (TSI3010)		ago-04	end of BRIDGE project	10'
air quality	Principal outdoor pollutants (VOCs, contaminants, etc)			With special request from the Finnish Meteorological Institute			
air quality	SO ₂ concentration	UV-fluorescence technique	Horiba APSA 360	detection limit 0.2ppb	set-06	end of BRIDGE project	60 s, 30' average
air quality	Soil gas profiles 3 depths	sampling	Gas Chromatograph	From 2 streets	giu-03	end of BRIDGE project	1/14days
IAQ	PM ₁ , PM _{2.5} , PM ₁₀	Aerodynamic Particle Sizer (0.5-20µm)	TSI-3321	With special request from the Finnish Meteorological Institute		end of BRIDGE project	
meteo	Air pressure	online	Silicon aneroid barometer (Vaisala DPA500)		gen-03	end of BRIDGE project	4'
meteo	Air temperature	online	Platinum resistance thermometer (Pt-100)		mag-05	end of BRIDGE project	60 s
meteo	air temperature (next to trees)	online	radiation shielded Pt100, IEC 751 class B	From 2 streets	giu-03	end of BRIDGE project	10'



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meteo	Precipitation	online	Precipitation collectors & weighing rain gauge		nov-04	end of BRIDGE project	1'
meteo	Relative Humidity	Online	Vaisala DPA500		mag-05	end of BRIDGE project	4'
meteo	Stormwater quality (Analyses of heavy metals, nutrients, organic pollutants etc)	Auto sampler	ISCO3700	at three measurement stations/sub-drainage basins	fall 09	end of BRIDGE project	rain event
meteo	Stormwater quantity	online	Labkoteck ultrasound device	see above	fall 09	end of BRIDGE project	continuous
meteo	u, v components	Online	2-dimensional sonic anemometer (Vaisala WXT510)	From four levels	nov-04	end of BRIDGE project	10 Hz
micromet	All three wind components (u,v and w)	online	Metek USA-1		mag-05	end of BRIDGE project	10 Hz, 30' average
micromet	Friction velocity, Sensible and latent heat fluxes and CO ₂ flux	Eddy covariance	Metek USA-1 + Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)		dic-05	end of BRIDGE project	10 Hz, 30' average
micromet	wind speed and direction	Online	Metek USA-1		mag-05	end of BRIDGE project	10 Hz, 30' average
plant	Diameter growth (6 trees)	online	Solartron (TM) displacement transducer	From 2 streets	giu-03	end of BRIDGE project	10'
plant	Diurnal stem and bark diameter variation (6 trees)	online	Solartron (TM) displacement transducer	From 2 streets	giu-03	end of BRIDGE project	10'
plant	Sapflow (6 trees)	online	Granier method	From 2 streets	giu-03	end of BRIDGE project	10'
radiation	PAR (next to trees)	online	Delta-T Devices Ltd, QS2	From 2 streets	giu-03	end of BRIDGE project	10'
radiation	Up- and downward long- and short wave radiations + PAR	online	Net radiometer and photodiode sensor (Zipp&Zonen, CNR1 + PAR Lite)		set-05	end of BRIDGE project	1'
soil	Soil moisture profile 3 depths	online	Thetaprobes	From 2 streets	giu-03	end of BRIDGE project	10'
soil	Soil temperature profile 3 depths	online	Thermistors	From 2 streets	giu-03	end of BRIDGE project	10'
Visual comfort	Light distribution				giu-03	end of BRIDGE project	10'
Meteo	Stormwater quality (Analyses of turbidity, conductivity and temperature of stormwater)	online	Labkotec-sond: turbidity, conductivity	see above	fall 09	end of BRIDGE project	continuous
Weather station	temp, rain, etc	Automatic		rainwise	Jan -03	end of BRIDGE project	continuous



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Case study: London							
participant		King's College London					
acronym		KCL					
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	H ₂ O and CO ₂ concentrations	Gas Analysis (open/close path)	Open/Closed-path infrared gas analyzer (Licor Li-7500 & Li-840)	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
air quality	NO _x concentration		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	O ₃ concentration		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	Particle number size distribution		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	Principal outdoor pollutants (VOCs, contaminants, etc)					ongoing	
air quality	SO ₂ concentration		London Air Quality Network		depend ds on site	ongoing	15 '
meteo	Air pressure	Capacitive silicon sensor	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
meteo	Air temperature	Capacitive ceramic sensor	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
meteo	Precipitation	tipping bucket	Vaisala WXT510 precipitation sensor & Campbell Scientific ARC100 Tipping Bucket			ongoing	
meteo	Relative Humidity	Capacitive thin film polymer	Vaisala WXT510			ongoing	
meteo	Surface Temperature	Infrared Thermometers	Raytek CI1A and CI2A		ago-08	ongoing	15 '
meteo	u, v components	2-dimensional sonic anemometer	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
micromet	All three wind components (u,v and w)	Sonic Anemometry	Campbell Scientific CSAT3	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
micromet	Friction velocity, Sensible and latent heat fluxes and CO ₂ flux	Eddy covariance (EC)	Campbell Scientific CSAT3 + Open path infrared gas analyzer (Li-7500)	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
radiation	Up- and downward long- and short wave radiations + PAR	Net radiometer and silicon photocell Sensor	Kipp & Zonen CNR1 & Skye Instruments SKP215	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '



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radiation	UVA & UVB radiation	Photodiode sensor	Skye Instruments SKU420 & SKU430	proper tower - Nov 1 2009	depend ds on site	ongoing	15'
University of Southampton							
SOTON							
air quality	PM1, PM2.5, PM10	EXCEL/GIS Information. Collation and analysis of existing met. Canopy cover and pollution data at two study sites (Firenze and London)	ArcMap, Matlab and UFORE based model.	Collation and analysis of existing data sets, and modelled / measured deposition velocities, supplemented by field sampling where necessary.	feb-09	ott-10	