Oral Presentation Subject 4

A meteorological monitoring network to investigate climate change in towns: six Mediterranean urban case studies

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Keywords: urban ecosystem, climate change, Mediterranean area

Urban meteorology and climatology are relevant research areas and have been considered more and more important because of worldwide growing urbanization. Several social and economical needs (e.g. health, energy, insurance, urban planning issues) have to be addressed and require more accurate and densely distributed measurements. Climate variability is the topic related to global warming that mostly concerns public opinion. More frequent and severe summer heat waves, winter cold waves, floods, drought and other extreme weather episodes have been getting more and more connected to climate change, which is object of media attention and international political agendas.
Historical temperature series referred to city centre alone can not be used to study the impact of global warming on towns. Progressive urban expansion and territorial anthropization have caused increase in energy consumption for building heating and cooling, road transport with consequent growth of urban air temperature. Furthermore urban geometry and texture, density of buildings, road asphalt, different cover material, radiation reflection by walls and windows, wind shielding and many other phenomena cause highly inhomogeneous meteorological field, both at ground and in altitude. The result is an urban microclimate somewhat complex to measure and characterize. The main microclimate phenomena in a big city is the so called Heat Urban Island (UHI): the city centre of the town is significantly warmer than its suburbs and surrounding rural areas due to human activities. These temperature differences are larger in stable atmospheric conditions with cloudiness and poor ventilation.
The study of urban climate change must therefore take into account two components: global warming and microclimate variability due to urban growth.
A preliminary investigation on urban climate change in Mediterranean area has been performed analysing historical temperature series measured in city centre and respective suburb airport of six Italian towns: Milano, Bologna, Roma, Napoli, Bari and Palermo. The Climatological Normals (CLINO) 1961-1990 and 1971-2000 have been compared with mean data of the last 15 years (2001-2015). A seasonal analysis have been performed too. Everywhere the mean temperatures have been higher in the city centre than in suburbs (UHI effect) and both have progressively raised over time. Conversely, the differences between city centre temperatures and suburb ones have decreased.
The availability of almost 5 years dataset by Climate Network® in Milano (8 weather stations) allows a quantitative spatial investigation of a strong and persistent Urban Heat Islands, as Milano is subject to atmospheric stability in almost 60% of days per year.
Climate Network® is a private professional network of Automatic Weather Stations (AWS) in Italy, currently accounting for 50 stations located in the main cities centres. It has been designed, set up and maintained according to rigorous quality and metrological criteria in order to correctly represent the Urban Canopy Layer (UCL) at the mean building top level. The network can be considered the technological evolution of the city historical meteorological observers, whose weather stations had been located on top of buildings, and it contributes to the continuity of urban historical climatological series. The network also supports business users, such as energy industries requiring continuous supply of comparable and high quality weather/climatic data in main Italian towns to bill energy consumption and evaluate thermal plants performances.
The current Milan UHI is presented here by showing spatial distribution of temperatures and Heating Degree Days (a unit used to determine the heating requirements of buildings, representing a fall of one degree below

a specified average outdoor temperature for one day). These data have also been compared to climatological series to infer UHI change in the last decades.
This work aims to provide a contribution to a deeper understanding of urban climate change. The authors believe that a specialised urban meteorological network is needful to assess current urban microclimate, its vulnerability and impacts of climate change.
Such a network would be functional for a lot of public, economical and social demands:

- health alerts;
- healts and civil protection management;
- climate adaptation and mitigation plan;
- urban planning and management;
- ex-post verification of the effectiveness of adaptation/mitigation actions;
- current climate data and climatological series for business (energy, insurance, finance, great distribution, building construction, etc.);
- smart building automation, energy smart grid, big data analytics.

Climate is an integral part of ecosystem functioning and human health is impacted directly and indirectly by results of climatic conditions and longer term changes in climate affect the viability and health of ecosystems.