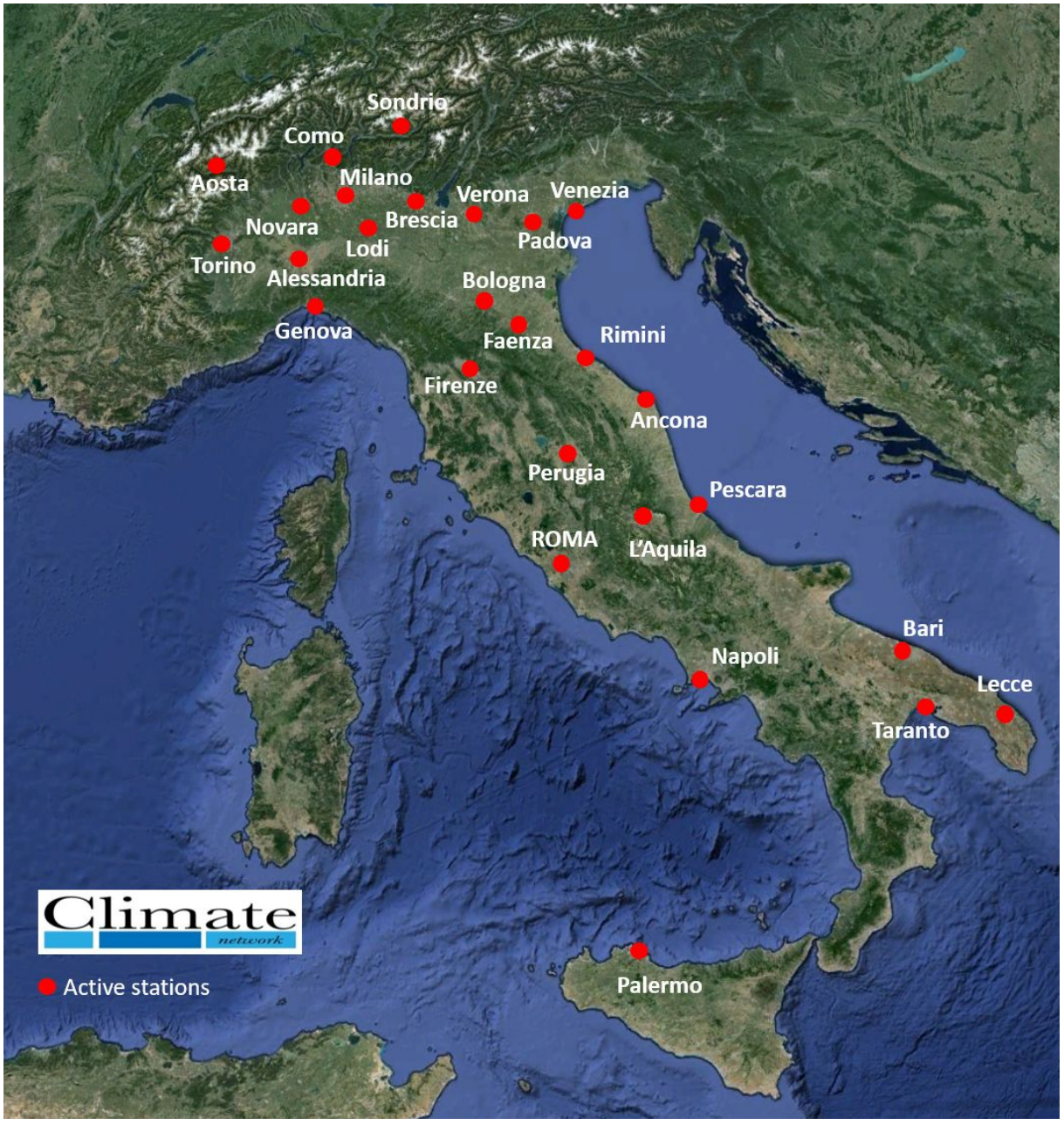
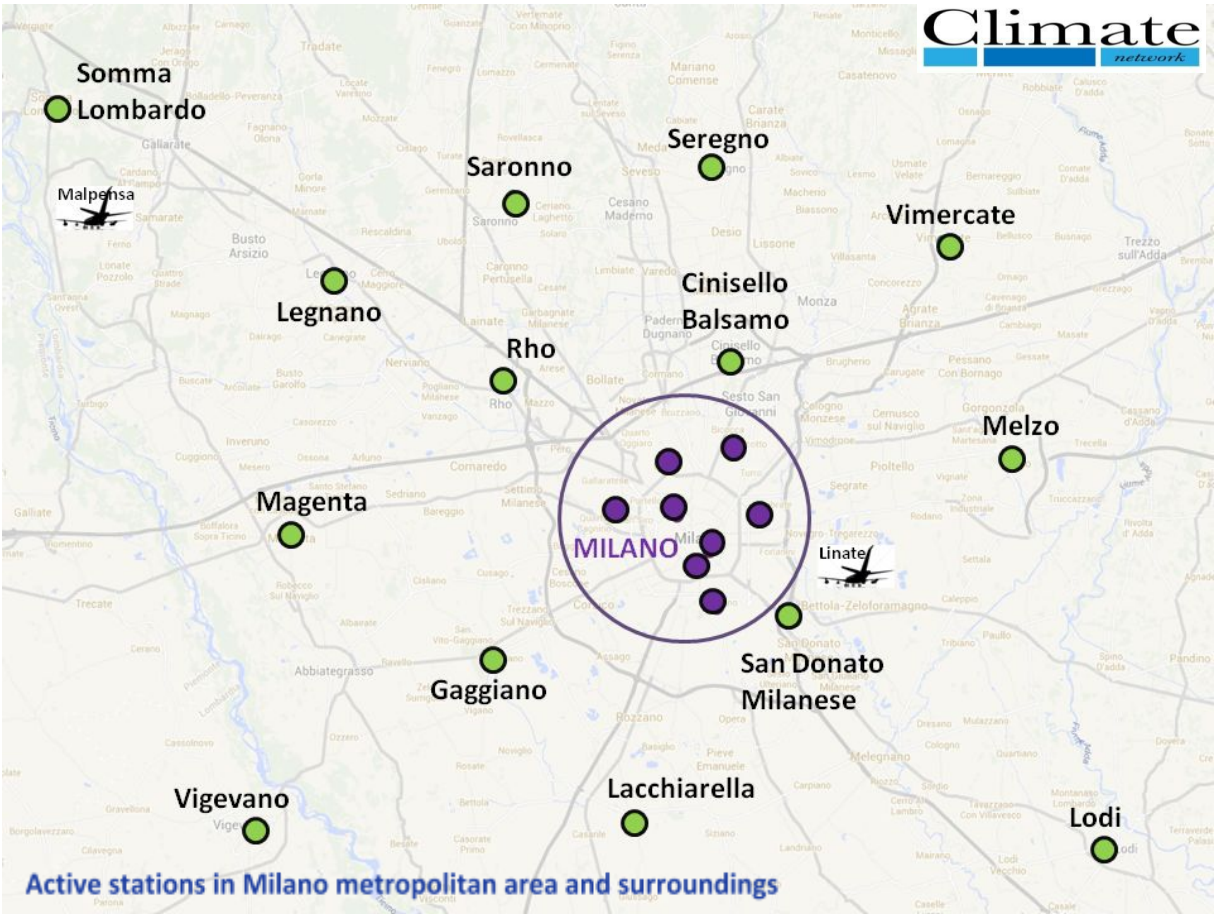
CLIMATE NETWORK® is a private and professional network of urban meteorological stations in Italy, internally designed and developed since 2010. Nowadays it consists of almost 50 weather stations located in most of the main Italian cities.



In very large cities, like Milano, Roma and Firenze, there are several stations installed on the same urban area.

In the metropolitan area of Milano and surroundings, the network accounts for about 20 weather stations. In Milano, the 8 stations are expressly located to well represent the difference in temperature between the downtown and the outskirts (i.e. Urban Heat Island).



Active stations in Milano metropolitan area and surroundings

The key-strengths of Climate Network® (CN) are **high quality** and **consistency of data** through:

(1) homogenous criteria to locate stations for energy application in the urban environment (measures at the top of the Urban Canopy Layer- UCL)

(2) same type of weather sensors with some redundant instrument

(3) full traceability of measures and reference to national metrological standards

(4) detailed Quality Control and Quality Assurance procedures

(5) automatic control and daily data validation by experienced meteorologists

(1) Same criteria to locate all stations

All CN weather stations are located in the city centres, with the same siting and exposure criteria that fulfil the WMO requirements for the correct representation of the Urban Canopy Layer (WMO/TD-No. 1250 2006, Tim R. Oke).
The stations are placed on building terraces or top roofs far from walls, other buildings and elements that could interfere with local meteorological fields. The selected rooftops all have a similar value of albedo (≈0,2).



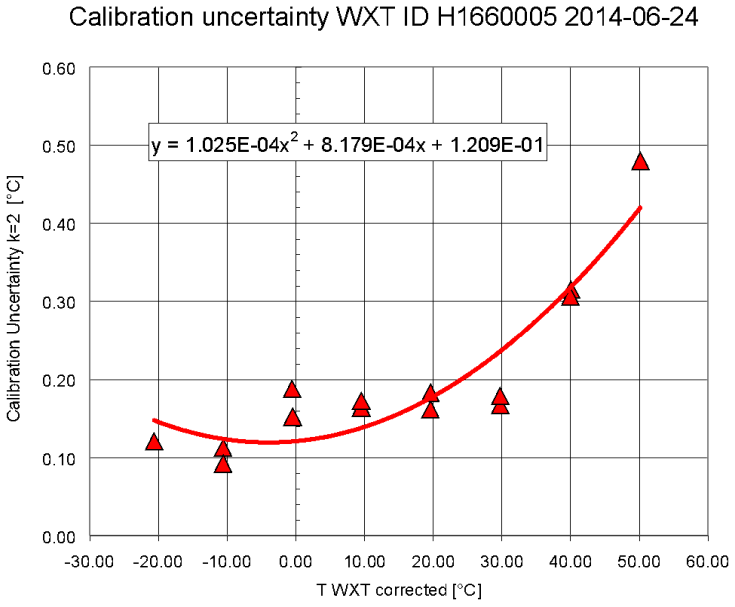
(2) Same type of weather sensors

The network is composed of advanced and solar-powered weather stations (multiparameter sensor: Vaisala WXT520), compact and easy to use, which implement an innovative technology without moving parts ensuring constantly reliable measures.
The available parameters measured are:

- **Temperature** (*2 thermometers, 1 redundant*)
- **Relative Humidity**
- **Atmospheric pressure**
- **Rain** (amount, intensity and duration)
- **Hail** (amount, intensity and duration)
- **Wind speed and direction**, gust included (*ultrasonic bi-axial sensor*)
- **Solar radiation** (global and diffuse) (*not in all stations*)

(3) Traceability of measures

Traceability is the most important requirement for the quality of CN measures. The need of measure reference standards and operative procedures led us to collaborate with INRIM (Italian Institute of Metrological Research) in MeteoMet Project. One of the main results of this collaboration has been our Internal Calibration Laboratory: a well documented traceability chain characterizes all measurements at any stage and the periodical calibration is managed in complete autonomy. We use the same standards and calibration methods for each sensor (temperature and humidity primary standards from INRIM).



In the framework of the EURAMET METEOMET Project, in collaboration with INRIM, Fondazione OMD has also studied the measurements uncertainty, taking into account the effect of ventilated or non-ventilated screens, the screen ageing and the minimum variability among identical thermometers.

CLIMATE NETWORK® MEASUREMENT UNCERTAINTY:
Temperature ≤ 0.2°C [-20°C, +50°C]
Relative Humidity = 3%

(4) Quality Control and Assurance procedures

CN design, developing and managing procedures were certified under ISO 9001:2008.
The QC/QA system aims at optimising the managing of a big meteorological network, widespread over national territory, ensuring high quality standards. The managing is performed trough periodic turnover of the sensors on field. All the procedures of cleaning, inspection and calibration of sensors are carried out at Internal Laboratory, i.e. a controlled environment, allowing the traceability of every maintenance operation. Once a year every sensor on field is substituted by a maintained and calibrated one.
As a consequence of QC/QA system, we can provide documentary evidence for each data on the sensor measuring it, calibration date and correction factors, raw value, etc.
This approach allows us to analyse the anomalies and take appropriate corrective actions.

(5) Automatic control and daily data validation by meteorologists

All data are subject to automatic control procedures of value reliability by means of sensor alert and mathematical algorithm.
Once a day our meteorologists check all data measured and perform a trend analysis to validate them.

A **key strength of CLIMATE NETWORK®** is the ability to compare data from different stations having the documented security of data homogeneity: if CN data show that the weather is colder in Roma than in Milano, it has been assured from a metrological point of view that the phenomena is true and it is not the consequence of different position criteria of sensors or calibration problems.

TECHNICAL INSIGHTS:

S. Curci, C. Lavecchia, S. Pilati, C. Paganelli, ***High quality sustainable monitoring in cities for climatological services***. The 2018 WMO/CIMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation "Towards fit-for-purpose environmental measurements" (CIMO-TECO 2018) - Amsterdam, (the Netherlands), 8-11 October 2018. Poster

G. Frustaci, C. Lavecchia, S. Pilati, C. Paganelli, ***Improvements in the observation of the Canopy Layer Urban Heat Island in Milano***. The 2018 WMO/CIMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation "Towards fit-for-purpose environmental measurements" (CIMO-TECO 2018) - Amsterdam, (the Netherlands), 8-11 October 2018. Poster

S. Curci, C. Lavecchia, G. Frustaci, R. Paolini, S. Pilati, C. Paganelli, ***Assessing measurement uncertainty in meteorology in urban environment***. Measurement Science and Technology - Vol. 28 - No. 10 Oct. 2017 - 104002 (8pp)
Paper, http://iopscience.iop.org/article/10.1088/1361-6501/aa7ec1

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Slides, Proceeding

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S. Curci, S.Pilati, S. Stucchi, M. Virlan, C. Lavecchia, S. Bellagarda, A. Merlone, ***Automatic Weather Station Traceability: an example of emerging need and calibration procedure***. "Metrology for Meteorology and Climate" MMC 2014 International Conference, Meteomet EU Project - Brdo, Slovenia, 15-17 Sep 2014. Slides

G. Lopardo, F. Bertiglia, S. Curci, G. Roggero, A. Merlone, ***Comparative analysis of the influence of solar radiation screen ageing on temperature measurements by means of weather stations***. International Journal of Climatology (2013) DOI: 10.1002/joc.3765. Paper