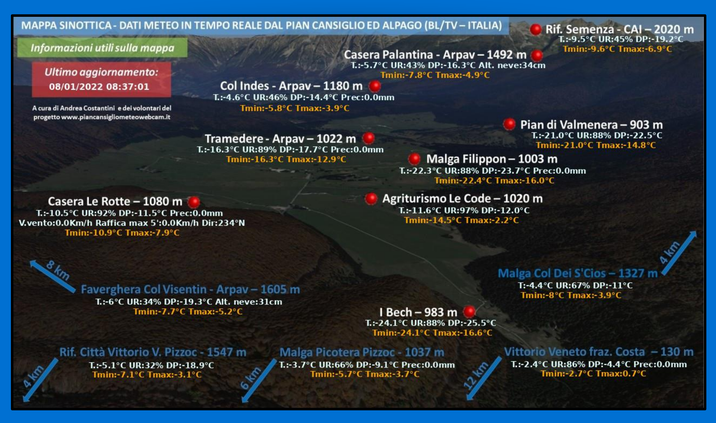
WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2022) (Paris, France, 10-13 October 2022)
SECTION «Topic 1: Innovative measurements, techniques and integration»

PO-22 - Development and use of LoRaWAN IoT technology for data acquisition and transmission in remote areas: the "case history" of the Experimental Meteorological Monitoring Project in the Pian Cansiglio Regional Forest - Italy

Dr. Andrea Costantini (Bachelor's degree in Atmospheric Physics and Meteorology, WMO 1083 Meteorologist Technician, creator and curator of the experimental and amateur, non-profit project **https://www.piancansigliometeowebcam.it/** **contact: costantini@meteoravanel.it**
Dr. Mauro Girotto (PhD in Electronic Engineering - Telecommunications, creator and developer of the "LoRa Weather Board")

The development of **LoRaWAN IoT** technology has led to an increasing availability of affordable nodes and gateways. This made it possible to install and **make available online** the data from some **remote and peculiar locations** in the area of the **Experimental Meteorological Monitoring Project in the Pian Cansiglio Regional Forest (north-east Italy region)** and offering the opportunity to detect accurate measurements from points which, in certain conditions, **can reach minimum values below -30°C** (such as **Pian di Valmenera**, a depression located **at only 903m a.s.l.**). The specificity of these places has forced the choice of suitable materials (manufactured by **Decentlab GmbH** based in **Dübendorf - Switzerland**), "spin off" of the "**Swiss Federal Laboratories for Materials Science and Technology**") and the installation of **professional solar screens according to WMO regulations** of recognized international standard (for example **Barani MeteoShield® Professional**).

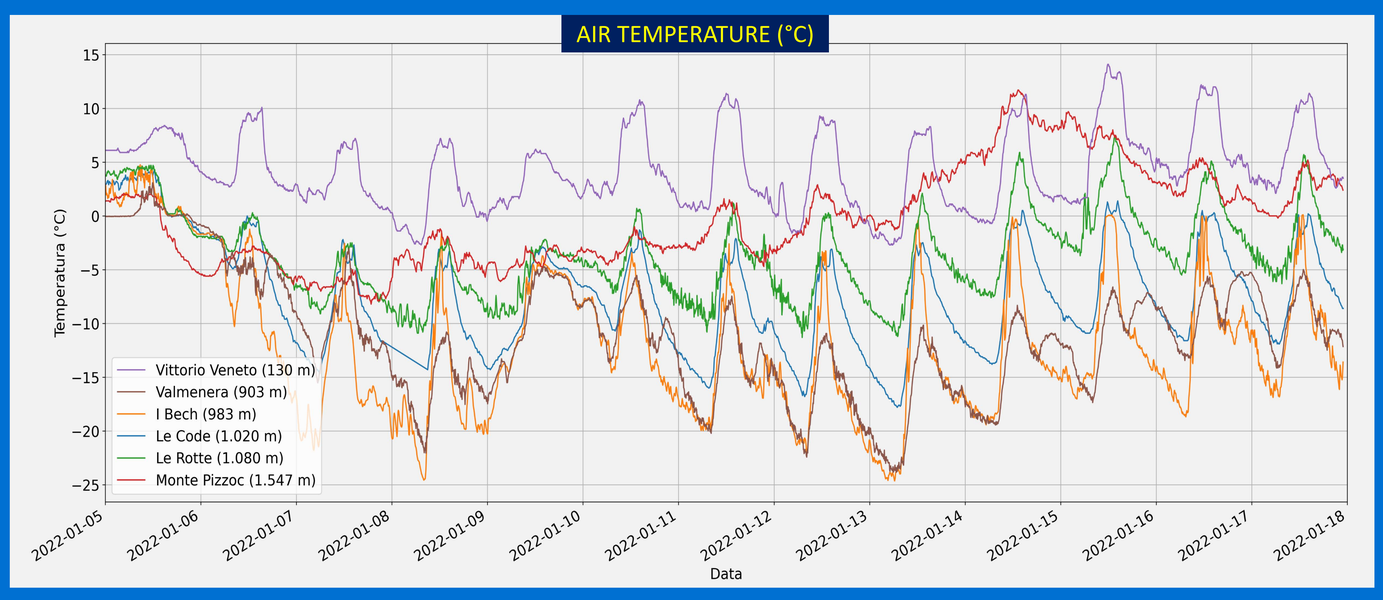


As a further **level of development in the IoT segment,** a self-built electronic board (called "**LoRa Weather board**") was implemented **by Dr. Mauro Girotto**, **based on LoRaWAN technology**, for the acquisition of meteorological/environmental quantities. The board has been designed for **battery-powered applications** and, at the hardware level, is designed for **mounting various sensors**, depending on the application, including **thermo-hygrometers, rain gauges and barometers**. As a **first field test**, **the board was installed at the beginning of January 2022 at two new measuring stations**, equipped with a **specific ultrasonic sensor** for **detecting the snowpack** and a **thermohygrometric sensor for compensation of the speed of sound**. The first data have started to flow into the database and the **extreme winter conditions** (-24.6° C on January 8th) will represent a **good test for the hardware** part in view of the subsequent stabilization of the measures for the future winters.

To acquire the data of the **LoRaWAN stations**, the low-power wide-area network infrastructure **of The Things Network** (TTN) was used which allows, **free of charge for educational and non-profit purposes**, to use the **MQTT protocol** to store the data in a time series database (**InfluxDB**). The data collected in this way, by means of simple scripts, are converted into the formats supported by the most well-known open-source and free monitoring networks, such as **Meteonetwork** and **Meteo4**. It is thus possible to compare and store all parameters.

The Experimental Project, to date, has **7 IoT LoRaWAN stations, 2 Davis VP2 semi-professional stations**, one amateur **PM2.5 and PM10 fine dust monitoring station** and more than **10 panoramic webcams with 4K resolution**, as well as data integration from other stations, including official **Arpa Veneto** network (Regional Authority). The territory is **thus covered by measurement points in the various locations** that are most significant for the acquired parameters.

The use of **LoRaWAN nodes** allows to acquire measurements from **remote locations,** which are **often inaccessible to other technologies** and thanks to the increasing availability of **low-cost gateways and transmitters**, as well as their **proven resistance to extreme operating conditions**, represents a sure example of **technical success. which will increasingly simplify the study of meteorological and climatic parameters**, easily combining other potential measures such as air quality, PM2.5, PM10 and similar measures.



Example of data layout from some stations of the network with comparison of the temperature parameter from 5th January to 17th January 2022. The daily periodic trend is evident, characterized by a large diurnal temperature range in the sites most subject to thermal inversion, while the station at high altitude di Monte Pizzoc (1547m, exposed to the Venetian plain), is much less affected by these variations, representing more directly the atmospheric circulation at an altitude of about 850hPa.

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Website references

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Environmental monitoring using LoRaWAN technology: experimental measurements and data analytics platform – *Dr. Luigi Laricchia - Laurea Magistrale in Informatica (Università degli Studi di Bologna) https://amslaurea.unibo.it/17312/1/laricchia_luigi_tesi.pdf*
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Arpa Veneto Regional Monitoring Network - *http://dati.ambienteveneto.it/*

We thank all the volunteers and enthusiasts of meteorology and Cansiglio who contribute to the growth and functional maintenance of the systems, together with the adequate scientific support for the technical choices: Bruno, Tobia, Mauro, Massimo, Matteo, Maura, Flavio and others. The stations are also located on regional property managed by the Veneto Agriculture Agency