

METEOROLOGICAL NETWORK, ARCHIVES AND DATA MANA- GEMENT

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Meteorological network

Slovenia's meteorological network covers an area of over 20,000 square km. Our climate regime is very complex and demands a dense meteorological network.

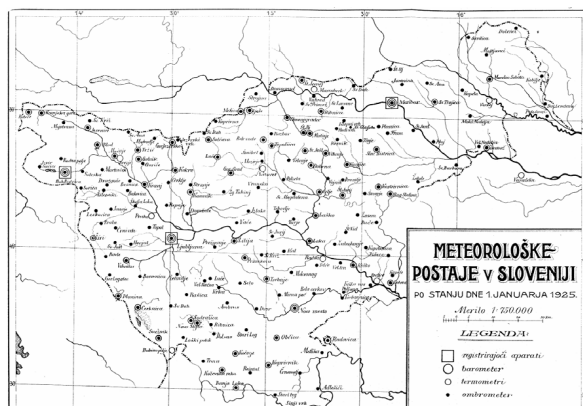


Figure 1. The Slovenian meteorological network in 1925

The first preserved series of meteorological measurements started in 1850 in the capital city Ljubljana. The meteorological network

in Slovenian territory expanded to 85 stations at the end of the 19th century. In 1940 there were 183 stations, in 1950 already 200. The 1971-2000 period started with 339 stations and ended with 276 stations.

The data are generated from stations of different types: fully automatic stations, automatic stations with an observer and stations without any automatic data registration. Thirteen synop stations, including 4 airports (24 obs/day), still have professional observers. All other stations are automatic or involve volunteers. The maximum (108) of climate stations was noted in 1973 and the maximum (245) of precipitation stations was recorded in 1978. Our highest location of a synop station is at Kredarica with an elevation of 2514 m, while the lowest location of a synop station is at Portorož Airport near the Adriatic coast with an elevation of 2m. The Slovenian meteorological network also contains 38 mechanical pluviographs, 22 heliographs and some other special devices, redundant mechanical instruments (thermographs, hygrographs). The automatic network encompasses: 27 meteorological stations, 8 automatic hydrological stations with meteorological instruments, 17 automatic ecological stations with meteorological

instruments, 1 automatic oceanic buoy with meteorological instruments.

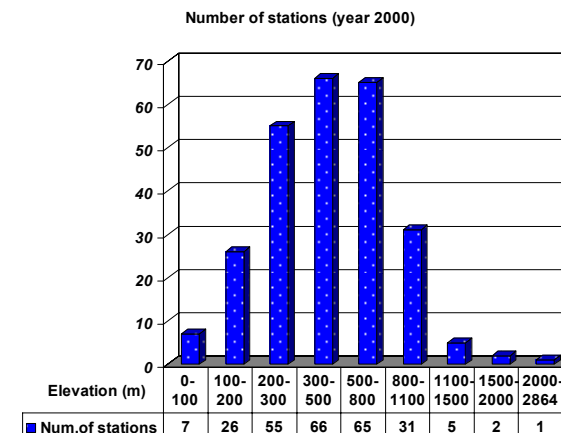


Figure 2. The elevation distribution of stations in 2000

At the precipitation stations observers measure precipitation only once a day at 7:00 am, they also measure the depth of snow cover and the depth of fresh snow, during the day they note the weather phenomena (fog, frost, dew, stormy weather – wind, thunder, hail and other forms of precipitation). All the observers have to fill in a form on paper– a meteorological diary. In 2006, the density of the precipitation network is 8.7 items per 1000 km².

At climate stations observers measure precipitation only once a day at 7:00 am, they also measure the depth of snow cover and the depth of fresh snow, during the day they note the weather phenomena (fog, frost, dew, stormy weather – wind, thunder, hail and other forms of precipitation). Most observers have to measure the following three times (at 7:00, 14:00 and 21:00 in CET): temperature, maximum and minimum temperature, humidity, visibility, cloudiness, condition of the soil, wind, some observers also send the synop messages to the Global Telecommunication System (GTS). All observers have to fill in a form on paper – a meteorological diary. In 2006 the density of the climate network is 2.0 items per 1000 km².

Synoptic stations involve the same procedure as classical climatological stations, but observers take measures more frequently during the day, at the airport this occurs over 24 hours. They certainly send the synop messages to the GTS and have to fill in a form on paper – a meteorological diary. Most synoptic stations use a classical Hg barometer for pressure. In 2006 the density of the synop network is 0.6 items per 1000 km².

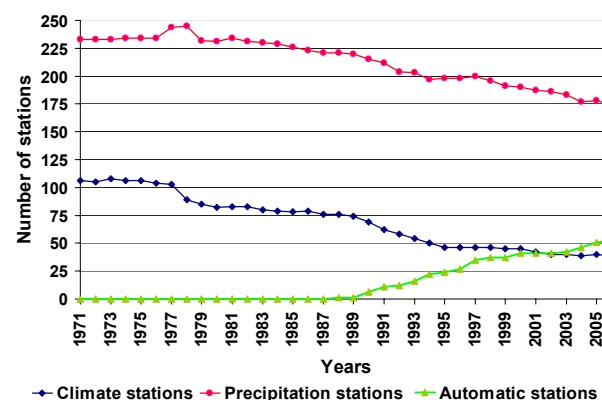


Figure 3. Number of meteorological stations by types in the 1971-2006 period

Remote sensing

Another part of our meteorological network involves remote sensing. We collect satellite products from Meteosat Second Generation (MSG) and radar measurements from the Lisca Meteorological Radar Centre. MSG is a joint project involving the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). MSG has 12 channels and receives spectral bands from 0.4 µm to 14.40 µm, the horizontal sampling distance is 1 km in the 12th high resolution visible (HRV)

channel and 3 km in other channels, while the time resolution is 15 minutes.



Figure 4. The Lisca Meteorological Radar Centre on Mount Lisca at an elevation of 948 m

The radar on Mount Lisca, at an elevation of 948 m, emits 5 cm long electromagnetic waves, the average radiated power is 250 watts, the antenna's frequency is 3 revolutions per minute, the inclination angles are between 0 and 30 arc degrees, the area resolution is 1 km, the time resolution is 10 minutes, while the measuring distance is

about 200 km. The latest project is the assimilation of daily radar precipitation regarding the vertical profile. The Slovenian Meteorological Office once a day sounds the atmosphere from the LJUBLJANA station, synop number 14015, position: 46.06583 N, 14.51722 E, elevation 299 m.

Meteorological data processing and quality control

We undertake a validation every day for automatic data (only for a few parameters for half-hour aggregations) and every month for classical climatological data on daily aggregations. At the moment the validation for the synop data is very simple.

We have some programmes in fortran, pascal and we are now moving on to new tools (postgres base, php and other web procedures, OpenSource tools).

First we use tests to check the hard limits (temperature T is within the interval -50 , $+50$ degrees etc.), then the soft limits (temperature T is within local extremes etc.), then inner consistency tests (the T_{min} cannot be higher than the T_{max} etc.), then we test if the values are within a time series, look for any big jumps, run variability tests, spatial consistency tests (values of the same parameter measured at the same time at

nearby stations may not differ too much from each other).

We also make comparisons with redundant measurements if they exist. Our tests for the automatic stations are still not as sophisticated as the tests for the classical data. We use some objective and subjective methods for interpolations. All data have quality flags.

Archive and the Meteorological database (MDB)

Our meteorological database system has a twofold nature at the moment because there are both the old ASCII file system database and a new relational database system for easy access in Postgres. In the MDB two types of tables exist – **input tables with original data** and **user tables with controlled data** for clients. In the MDB there are also relational tables with derived data (monthly data, e.g., mean, extreme, sum, number of days with, ...).

Data rescue activities in the Meteorological Office include the preservation of all climate data and corresponding metadata collected in the national meteorological network in the territory of Slovenia and their transfer from paper records to a digital form in order to be

imported into a relational database for easy access. The automatic data are routinely imported into the relational database. The data in the user tables have quality flags.

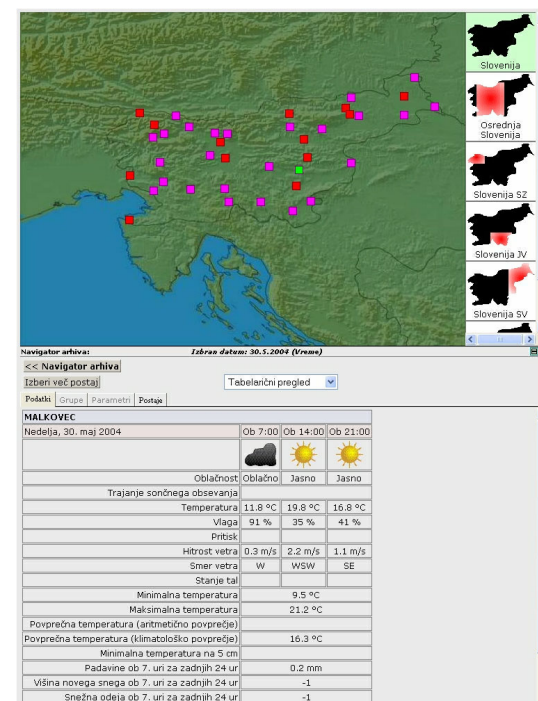


Figure 5. In 2006 we have developed web services to access meteorological data directly from the MDB – user-friendly Internet connections between client and the MDB

All data, historical data coming from the old time series archive as well as actual data collected from the operational station

networks, are processed and put into the database using the same software system.



Figure 6. In 2001 all paper records were moved to an appropriate archive where the temperature-humidity conditions correspond to the requirements of such premises

Climate data records in a paper form are stored in the Meteorological archive dating back to 1850. All data since 1961 have been digitised. The older historical data are in the process of being digitised. In the archive there are some gaps in the climate records due to loss, destruction or dissemination over various organisations or countries.

Figure 7. The first preserved meteorological measurements started in 1850 in the capital city Ljubljana

Long meteorological data time series have a global climate and national value – archives are a future asset for humans.

Plans for the future

The automatic stations cannot measure all atmospheric phenomena and can be damaged by thunderstorms. We propose to keep the classical meteorological measurements with a paper bulletin together with the automatic stations, remote sensing and to retain the paper and digital archives.