

PRACE GEOGRAFICZNE, zeszyt 107

Instytut Geografii UJ
Kraków 2000

Leszek Kowanetz, Janina Trepieńska

METEOROLOGICAL INSTRUMENTS IN THE ASTRONOMICAL OBSERVATORY OF JAGIELLONIAN UNIVERSITY IN 18TH AND 19TH CENTURY

Abstract: The paper presents the short description of the meteorological instruments used at the station of Jagiellonian University and the photos of the old instruments in use by astronomers during 18th and 19th century in Cracow's Astronomical Observatory. The meteorological observations were carried out at the same place from 1792 and therefore we have the homogenous series of measurements of air temperature and air pressure. A very accurate description of the instruments has been written by the hand of Professor Jan Śniadecki in the first weather diary in 1792. The most interesting instruments: the mercury thermometer, the Fortin's mercury barometer, the thermometer by Jürgensen with three scales and the barograph, thermograph and anemograph were purchased in the early part of 19th century. Almost all instruments are at the Museum of Jagiellonian University to this day.

Key words: old instruments, beginning of meteorological measurements, first recorders.

Beginning of the meteorological station in Cracow is associated with the Astronomical Observatory of the Jagiellonian University. The first head of Observatory, Professor Jan Śniadecki, mathematician and astronomer began meteorological observation on 1 May 1792. That is the date since the station started to activity. Before this time, an ideas of weather observation were promoted by the Meteorological Society in Mannheim (Baden, Germany). Professor Śniadecki drew upon the recommendations of it and he brought first meteorological instruments such a mercury thermometer, mercury barometer – constructed by the Parisian firm, Fortin, and a hair hygrometer to measure the relative humidity. Location of the instruments is known and was described by Jan Śniadecki in 1792. A detail instruction how to take meteorological instruments, written in hand by Śniadecki, has been preserved in the first diary of meteorological observations kept in the Cracow Observatory (Trepieńska 1997). The later description of the instruments' location of the 19th century are much more laconic. It means that all subsequent observers obeyed the rules established

still in the 18th century and passed them to the future generations. Until (2000) the same site where the air temperature records were taken has been preserved. Putting down the records from this site provides continuity of the so called „Historical Station”. The new station, from 1958, is called „Station in the Botanical Gardens”.

Thermometers and Theromographs

Thermometers were placed on the frame of a window facing NNW, one opposite the other on the third floor of the building of the Astronomical Observatory. First used thermometer, produced by Fortin is calibrated in degrees Réaumur from -36 to +86°, with the scale cut onto a glass lamina. The construction of thermometer was like at present – the mercury in the bulb expands along the graduated thermometer stem. It is described by Professor Śniadecki in the first diary of meteorological observation. A thermometer by the same firm from 1786 with scale from -36 to +70°R, embossed on a brass plate in an exactitude 0.2° has not been kept. Different very interesting thermometer was kept in Observatory. With this instrument, by the firm Jürgensen, in Copenhagen were commenced on 11 April 1837. It is a metal thermometer with a round disk having three scales (Photo 1).

An August psychrometer, manufactured by the firm Greiner was introduced for measurements of air temperature and humidity in 1834. Vapour pressure and relative humidity were, in the beginning, determined from Dalton's Psychrometric Tables.

Later, in 19th century, Kämtz's Tables, Suhle's Tables and Jelinek's Tables were used.



Photo 1. Jürgensen's metal thermometer (1837).

In the 1840s, first self-recording instruments were introduced. From 1 April 1848 a Kreil thermograph operated at the Station. Its receptor was mercury, moving under the influence of heat from a laminated container to a glass rod. A light brass shaft, fastened to the rod, showed its motion on a paper tape, placed in a rectangular frame, through a pencil fixed to the shaft's end. It was controlled by a special clock mechanism which pressed the pencil against the paper in 5 minute intervals, indicating by points the values of air temperature. The number of points per day was 264. The accuracy of the thermograph readings approached 0.1°C. The Station possessed a Pfeiffer thermograph (1867), a Hipp electric thermograph (1874) and from 1886 a thermograph by Richard. Automatic

writing instruments by that well known Parisian firm were highly regarded at the Station (Trepínska 1982; Kowanetz 1997).

Barometers and Barographs

In the initial period of the station's activity two mercury barometers, constructed by the known Parisian firm, Fortin, were employed. One of them from the year 1788, had two tubes mercury, one vernier, and was portable. Its scale had a range of 30 Parisian inches (813.6 mm). Each inch divided into 12 lines and each line into 4 still smaller divisions. The use of the vernier made it possible to read the scale to an accuracy of 0.01 of a line. The barometer was equipped with a mercury thermometer. It was graduated in Réaumur degrees, from -15° to $+50^{\circ}$. The other barometer was similar in construction to the first, but it was permanently fixed to the wall (Photo 2). Its scale ranged from 19 to 30 inches (515 to 814 millimeters). Later various mercury barometers were in operation at the Station, as a Pistor 63 barometer (1826-1904, called „very good, excellent instrument”), a Halaszka portable U-tube barometer, a Greiner and a Fortin ones. One of the oldest barometers „modified by Magier” was transferred to the Technical School in Cracow in 1838. To check the divisions of the barometers the unit „etalon” was employed. From the beginning, each barometer was used with a correction for temperature, so the barometer readings were entered into the books after reduction to 0° (Réaumur, later Celsius).

In 1848 a barograph by Kreil came into use. Just it was called a „barometrograph”. The basis of the barograph was a mercury barometer. The level of mercury in the tube was marked every 5 minutes on a paper tape, held in vertical frame by a light brass rod with a pencil driven by a special clock mechanism. At every reading of the Pistor mercury barometer used then, the readings of the barograph were checked. In 1853 another type of barometer, namely aneroid, was bought. It was treated as auxiliary one. At the end of the nineteenth century the Station possessed an electric vacuum barograph (Photo 3), one of the first of this time (Trepínska 1982; Kowanetz 1997).



Photo 2. Fortin's mercury barometer (1788).

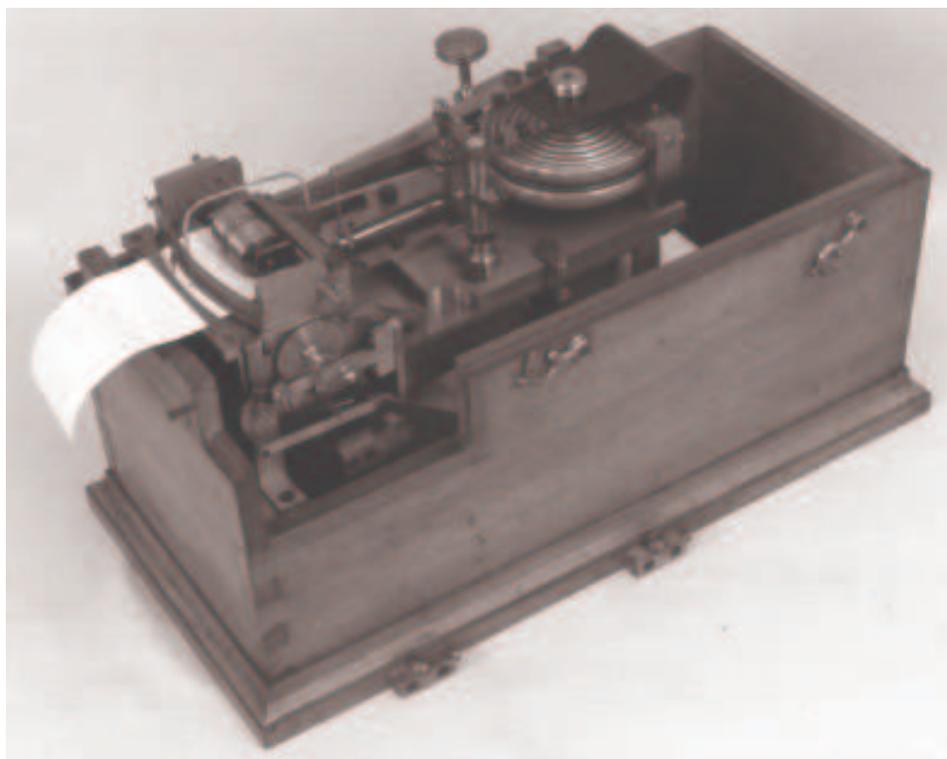


Photo 3. An electric barograph (end of the nineteenth century).

Hygrometers

Hair hygrometers have been used since the beginning of the Station existence. A Saussure hair hygrometer, described by Śniadecki, was a portable instrument (Photo 4). The main element of it was a human hair, fastened between two brass studs and confined by two plates. The lower plate was weighted down by small cylinder to which one end of the hair was tied. A 2.5 Parisian inch needle was attached to the cylinder with the weight and behind it was a percentage scale. The instrument stood on the table by a northern window. It was in operation until 1830.

Later, a Körner hygrometer was installed. An instrument of this type consists of two glass bulbs attached to the arms of a glass rod. One bulb contained a thermometer immersed in sulfuric ether ($C_2H_5OC_2H_5$). The other bulb was wrapped with a muslin covering, connected to a container. The entire instrument stands on a wooden platform with a thermometer, the range of the scale of which corresponds to that of internal thermometer. The larger bulb, with the ether is girdled by a silver band. If the muslin of the smaller bulb is moistened by the sulfuric ether, it evaporates into and out of

the device. This leads to a fall of the temperature, a consequence of the absorption of heat on evaporation down to the dew point. The moment of its occurrence is denoted by the appearance of drops of ether on the plated band. One must then read the air temperature on the thermometer. The value of the temperature of dew point permits one to calculate the vapour pressure and relative humidity. It was difficult to service and observations had to be performed on an open space (Trepieńska 1982; Kowanetz 1997). After 1 July 1834 the vapour pressure and relative humidity were measured by psychrometers. In later years, the Station always had a hair hygrometer serving for auxiliary or comparison purposes. Towards the end of the 19th century the Station possessed a hygrometer by the Swiss firm – Koppe and later one by the Berlin firm – Fuess (Kleinschmidt 1935).

Anemometers and Anemographs

In the last years of the 18th century the direction of the wind was observed with the aid of the wind vane, designed by Professor Śniadecki, devastated about 1858. It is known that the direction of wind was read on a special disk with the help of a wind indicator connected to a directional vane, fastened to a vertical rod „with gears and pinions”. The wind vane worked sufficiently well in strong winds. Wind directions were recorded



Photo 4. Saussure's hair hygrometer (1788).

according to an eight-directional, and after 1 January 1838 a sixteen-directional wind rose. Abbreviations denoting the corners of the Earth were taken from the Polish language and later from the German. After 1873 the use of English abbreviations was preferred.

A Kreil anemograph was installed after 1862 – a mechanical self-recording instrument. The special arrangement permitted the marking of the direction and speed of the wind through a pencil in contact with of the paper tape on a metal drum. That instrument did not give the best service, and already in 1875 the Robinson anemograph with a Osnaghi recorder began operation at the Station. The propeller of which was installed on a metal column on the roof of the building (Trepieńska 1982; Kowanetz 1997).

Raingauges and Pluviographs

Measurements of precipitation were initiated at the Station in August 1849. A Horner raingauge gives the quantity of water in Viennese lines or inches per square foot. After 1856 a rectangular raingauge, approximately 1055 cm² in area was employed. After 1863 the amount of precipitation was given in Parisian lines, later (after 1876 in millimeters). From 1 September 1887 a Rung „ombrograph” was used. A measurement of precipitation was made on the terrace of the building, 13.6 m above ground level. At the end of the 19th and beginning of the 20th centuries a Hellmann-Fuess recording ombrometer came into use at the Station (Twardosz 1997). Later pluviographs were constructed after its pattern.

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*Leszek Kowanetz, Janina Trepieńska
Institute of Geography
Jagiellonian University
Cracow
Poland*