Astrometeorological Weather Prediction at the Time of the Societas Meteorological Palatina

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Introduction

Astrometeorology was based on the idea that the position of the planets in relation to each other and to the signs of the zodiac would influence terrestrial weather. Due to this astronomers were asked to prepare "prognosticas" (weather predictions), which required comprehensive mathematical and astronomical knowledge. Astrometeorology had its heyday during the 16th century, when 213 authors demonstrably wrote 878 "prognostica" (Lüdecke 1999). In his great book of ephemerides, astronomer Johann Stöffler (1452-1531) had predicted a disaster for 2 February 1524, which was generally interpreted as a flood. Although this flood never came, faith in astrometeorology was not broken.

A new era began with the invention of reliable meteorological instruments in the first half of the 17th century in Italy, with the Florentine Accademia del Cimento being one of the centres at that time (Lüdecke 2003). In Magdeburg (Germany) Otto von Guericke (1602-1686) became famous for his air thermometer called "perpetuum mobile", which had only a rough calibration of seven scales ranging from "Magnus frigor" at the top to "Magnus calor" at the bottom. Guericke also constructed a water barometer, which also was a "semper vivum" (always living). Due to careful observations of both instruments, he got a very good feeling for the development of weather. In 1660 he could forecast a storm to reach Magdeburg within two hours. During the 18th century Tsar Peter I stimulated the newly founded Russian Academy of Science to take meteorological measurements all over the country. Especially he ordered scientific investigations in previously unexplored regions of Siberia during the Great Nordic Expedition (1733-1743) (Lüdecke 2002).

The modern world wide meteorological network of the Societas Meteorologica Palatina

In 1780 the Palatine Elector Karl Theodor (1724-1799) founded the Societas Meteorologica Palatina (Palatine Meteorological Society, 1780-1795) in Mannheim (Khrgian 1970, Cassidy 1985, Lüdecke 1997). The Society was designed to collect data on meteorological phenomena from all parts of the world. It became the first international operational meteorological network to fulfil approximately modern requirements. According to the instructions the measurements had to be taken at the same local time (7, 14 and 21 hours) and by the same instruments (barometer, thermometer and hygrometer), which were calibrated and provided by the Palatine Society free of charge. Observers were asked to construct additional instruments like a wind vane or a rain gauge. The measurements were recorded together on a uniform data sheet, also provided by the society. Symbols were defined to indicate precipitation, cloud cover, unusual phenomena and the state of the weather. Each year, between 15 and 33 stations, mostly at monasteries, sent their records to the "Museum Meteorologicum" at Mannheim. The data were analysed and mean daily, monthly and annual values were calculated. The results of the period 1781-1792 were published in Latin in the "Ephemerides Societatis Meteorologicae Palatinae" (1783-1795).

The local meteorological network of the Bavarian Academy of Science

Elector Karl Theodor also proposed a local observational network of the Bavarian Academy of Science in Munich to undertake more detailed studies. The Bavarian network (1781-1789) consisting of 16 to 21 stations and mostly run by Benedictine monasteries focussed on practical aspects. Four of them (Andechs, Hohenpeißenberg, Munich, Tegernsee) also belonged to the Palatine network. The results were published in a condensed form as mean and extreme values in "Der Baierischen Akademie der Wissenschaften in München meteorologische Ephemeriden auf das Jahr 1781" until 1789. Some papers on single meteorological or climatological aspects were included concerning yearly amount of rainfall, temperature inversion and the air pressure at different stations corresponding to their height above sea level.

A meteorological prize competition for the year 1780

One of the early results of that time showed that variations in pressure appeared quite regular over a large area. Due to this the Bavarian Academy of Science in Munich raised the subject of a prize competition: "Does the rising and falling of mercury in the barometer depend on accidental or periodically acting cause? If it is the later, what is the reason for this? Does the general weight of the heavenly body, especially of the moon and the sun contribute to that? May it be possible that the variation can be predicted with the same confidence with which an eclipse of the earth and the sun or ebb and flood are defined?" The deadline was the end of May 1782 and the prize would be 12 ducats (Lichtenberg 1781). Instead of granting a full or a half prize, Emmeran von Sutor from Rott am Inn received a gold medal to the value of six ducats for his paper on "Steigen und Fallen des Quecksilbers im Barometer"(Hammermayer 1983). But the Bavarian Academy of Science was not satisfied and expanded the deadline in 1782 with a prize of 50 ducats and a second time in the following year with a prize of 80 ducats.

The behaviour of the barometer – a matter of research in 1783

In the early 1780s the variations of pressure were a highly discussed matter of research. Two papers were published in the Ephemerides of the Societas Meteorologica Palatina. Johann Jakob Planer (1743-1789, professor of medicine, chemistry and botany) investigated the oscillation of the barometer at 2, 6, 10 am and 2, 6, 10 pm at Erfurt, Germany during a whole year from March 1782 until February 1783 (Planer 1783). His aim was to find a regular oscillation pattern between two observations of the day, but in the end he failed. Coelestin Steiglehner (1738-1819, professor of mathematics and physics at the University of Ingolstadt and observer of the meteorological station of the Palatine Society) published an excerpt from a paper on his observations of atmospheric pressure prepared in 1783 (Steiglehner 1784). He made up to 13 observations during single days. Like Planer, he wanted to find out if pressure changes at certain hours of the day. His case studies showed a constant falling or rising pressure in the morning as well as in the afternoon. He also compared the exact time of minimum pressure at London with the time when minimum pressure was observed at Regensburg on 15 days in 1777. The mean difference was 8 hours 36 minutes. For another comparison he used 24 measurements at Regensburg and Vienna in 1780. Between 22 March and 27 September (12 observations) he found a difference of 3 hours 37 minutes. His conclusion was that the movement of a depression took three times longer from London to Regensburg than from Regensburg to Vienna. But he did not notice that his results corresponded to the distance of these towns. Finally he showed a figure of pressure data from

London, Regensburg and St. Petersburg (1 Dec. 1775 until 9 Jan 1776) depicting the movement of a minimum from west to east very clearly.

Winners of the meteorological prize competition

Eberhard Schröter from St. Petersburg had submitted an astrometeorological paper to the Bavarian Academy in Munich (Schröter 1785). He had made meteorological observations four times a day during 34 years, which he combined with the aspects (conjunction, opposition, etc.) of the planets. His hypothesis was that places at the same meridian experienced the same weather due to the configuration of the planets. He underlined his ideas with two figures. The first showed totally different pressure graphs of St. Petersburg and Munich for October 1783, while the second figure gives similar graphs of four observatories in and around Munich in February 1784. Schröter provided advice on constructing of an astronomical-meteorological calendar. Finally he added his own calendar with a weather prediction for February 1784 in St Petersburg to his paper.

Franz Xaver Epp (1753-1789, organiser of the Bavarian meteorological network) reported that the Academy had tested Schröter's instructions of astrometeorological weather prediction. A calendar was prepared according to the astronomical aspects for Munich in February 1783 (Epp 1784). Meteorological observations had been made at 6 and 12 am and at 6 and 12 pm. Epp admitted that Schröter's prediction was true under certain configurations, but at other aspects it failed. Finally three papers were submitted, but the full prize was not conferred. Both astrometeorological explanations were preferred to the more realistic one.

Schröter received a gold medal to the value of 20 ducats, while the Jesuit Kaspar Sterr (1744-1844, professor of fine arts at Neuburg an der Donau) was honoured with a gold medal to the value of 12 ducats (Hammermayer 1983). A silver medal to the value of 12 ducats was given to Joseph Stark, professor at the secondary school at Straubing. Their papers were published in the forth volume of Neue Philosophische Abhandlungen der Baierischen Akademie der Wissenschaften (1785).

Sterr explained the periodic variations with the attraction of moon and sun (Sterr 1785). Pressure variations would be smaller towards the equator and bigger towards the poles. Observations showed that the deepest and the highest pressure occurred during wintertime. Accidental changes would be caused by atmospherical exhalations and by wind. Very often stormy weather was connected with falling pressure and westerly winds. But Sterr added that it would not be possible to predict time and power of the wind and where it would appear. Science would also not proceed to predict the variation of pressure for a couple of years as could be done for the eclipses of sun or moon. He verified his theory with an analysis of his observations for 1784. In 180 cases he found an agreement between observation and prediction of periodic variations, which could be expanded to nearly 2/3 of the cases, when accidental causes like exhalations, heat, wind and influence of human beings (!) could be added.

Stark made the most realistic contribution from the view of today. He showed that the power of attraction of neither the sun nor the moon and especially not of other planets had any influence on the variation of the barometer (Stark 1785). If this was the case, pressure variations could be calculated like the tides of the oceans according to Newton's law. Then pressure variations in Bavaria would result only in 1/32 lines of Parisian feet. According to his calculations barometric changes could not be compared with the tides at all. Stark also proved that the variations at the equator and on high mountains are smaller in summertime than at the poles, in lower regions, and in wintertime. In the last part of his paper, he presented three possibilities of weather prediction according to special astronomical constellations of moon and sun. He applied them to measurements of the first three months of the year to show that this only worked in single cases. His paper resulted in the final statement that the weather could not be predicted as reliable as the eclipse of the moon.

Falsification of the Schröter's method

After Schröter had received his prize for the best contribution in the contest, it became possible to verify his weather prediction for February 1784. The meteorological data of St. Petersburg for the year 1784 had been submitted to the Societas Meteorologica Palatina in Mannheim (Germany). The data of the very year were published not before 1786. If you compare Schröter's prediction with the observations, you will find out that eight predictions of rising or falling pressure occurred, but seven failed. This result is not very convincing and might have cost him the first prize. Due to a lack of a more sophisticated theory to explain the variation of the mercury in a barometer astrometeorology continued to be the preferred approach those days.

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