Meteorology in Mannheim: The Palatine Meteorological Society, 1780–1795

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On September 15, 1780, *Karl Theodor*, Elector Palatine of the southern German state of Palatinate-Bavaria (Kurpfalzbayern), chartered a permanently funded international network of meteorological observers known as the "Societas Meteorologica Palatina." At the same time he appointed a three-man "meteorological class" in the Mannheim Academy of Sciences to organize and direct the society and to publish and analyze its copious data. The newly endowed class invited observers at 27 selected academies, monasteries and universities to join the planned endeavor and generously supplied the enthusiastic respondents with precisely calibrated instruments, detailed instructions and data forms at state cost. The forms were gathered annually, compared, abstracted, translated and published in elaborate quarto *Ephemerides* by Mannheim's meteorological class until the project collapsed in 1795.[1] At its greatest extent the society encompassed 31 simultaneously recording stations, and a total of 37 stations, stretching from the Urals to North America, participated for at least one year in the endeavor (see Appendix).

Such an extended, coordinated and functioning network realized many of the aims of previous and contemporary efforts to achieve an empirical basis for exact meteorology. Attempts at concerted recording of data were always hampered by the vagaries of communication and instrumentation. The Palatine Society achieved a control of its members and a standarization of their readings unparalleled until the advent of state weather bureaus over half a century later. The reliability of the extensive data that it produced proved equally outstanding and of use to meteorologists ever since. They served not only as the last impetus to the emancipation of meteorology from its Aristotlean origins, but also as the basis for the first synoptic weather charts constructed by Humboldt, Buch and Brandes early in the next century.

Yet, while decades ahead in its operations, the Palatine Society remained firmly anchored conceptually and institutionally in its era. It thus affords unique insights into the nature and context of late eighteenth-century science. In a recent study *Theodore S. Feldman* found that eighteenth-century meteorology displayed elements of the transition then occurring in many physical sciences from random observation and hypothesis to "exact experimental physics," the joining of physical laws and applied mathematics into an experimental science.[2] This occurred most rapidly in the improvement and use of chemical-meteorological instruments, such as the thermometer and barometer, during the last third of the century. But organized

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[1] Ephemerides Societatis Meteorologicae Palatinae. Mannheim 1783–1795. 12 volumes for the years 1781–1792. Earlier histories of the Palatine Society include *Friedrich Traumüller*: Die Mannheimer meteorologische Gesellschaft (1780–1795). Ein Beitrag zur Geschichte der Meteorologie. Leipzig 1885; and *A. Kh. Khrgian*: Meteorology. A historical survey. Vol. 1. Trans. Ron Hardin. Jerusalem 1970. Chapter 6.

[2] *Theodore S. Feldman*: The history of meteorology, 1750–1800. A case study in the development of experimental physics. Dissertation. University of California, Berkeley 1983.

networks, including the Palatine Society, continued to emphasize the contemporary virtues of pure empiricism, practical applications and local conditions to the exclusion of experimental climatology. The latter required the concepts of climate and its evolution over time and space and both were inventions of the nineteenth century. Only after decades of gathering and publishing reliable data at numerous locations, it was thought, could serious studies of the weather at each location begin.

The Palatine Society equally reflected its social origins: the rising influence of science and scientists within the southern German Catholic enlightenment. While several valuable studies have been devoted to science and learning in enlightenment Germany and Prussia, little attention has been directed specifically to the Catholic south.[3] The aim of this paper is to outline these distinguishing but little explored features of the Palatine Society. In particular I hope to show how the creation of this scientific project may be seen in relation to larger cultural and social trends at that time, how these larger trends affected the scientific aims of the project, and how these aims led to contributions to the science of meteorology.

The scientific background

After the invention of meteorological instruments and the start of systematic observations during the seventeenth century, observers sought a basis for exact predictions of the local weather by comparing observations made at numerous locations. The new empirically-based predictions would replace the long tradition of unsubtantiated farm rules and folk sayings. Because of the seasonal cycle of the weather and, especially, because of the association of meteorology with astronomy in Aristotlean science, it was often thought that the new meteorology would be primarily observational and even reducible in large part to astronomy. Many observers expected to find exact periodicities in the local weather and to relate them directly, as Aristotle had done, to celestial motions. Such overly optimistic statements as the following attest to the astronomical analogy: "Just as incomprehensible as it seems to every stranger to astronomy how one is able to predict solar and lunar eclipses and similar celestial phenomena in calendars with so much exactness, just as little will the stranger to natural science be able to convince himself that one day a time will come when one will be able to forecast with the same reliability rain and snow, thunder and lightning – and even several years before their occurrence."[4]

Among the most elaborate of the early attempts to gather concerted observations were the project sponsored by the Accademia del Cimento from 1654 to 1667 and the Royal Society's call for meteorological readings in 1724. But after the Royal Society ended its call in 1735 no major efforts to gather dispersed data occurred until the last third of the century, despite the inclination to international cooperation displayed by such projects as the observations of the transits of Venus.[5] The reason was the perceived necessity of tighter control of the observers, central coordination of a long-term project and precise comparability of the instruments.

Although the barometer was well researched and improved standard thermometer scales with likely fixed points for calibration were available by the last third of the century, construction and materials still caused wide variations. In a comparison of the best English

[3] For example, *Charles McClellan*: State, society and university in Germany (1700–1914). Cambridge 1980. *Karl Hufbauer*: The formation of the German chemical community (1720–1795). Berkeley 1982.

[4] *Johann Heinrich Voigt*: Etwas von des Herrn Hofrath Gatterers meteorologischen Grundjahre. Magazin für das Neueste 1,1 (1781), 1–11.

[5] *Harry Woolf*: The transits of Venus. A study of eighteenth-century science. Princeton 1959.

thermometers in 1776, Cavendish found a variation in the boiling point of water of more than 2 1/2 °F. Lavoisier and co-workers obtained a similar result when they dipped 38 thermometers simultaneously into a bucket of ice water.[6]

In response to such obvious imprecision (and with an eye to their national instrument trades), the academic meteorological committees under Cavendish and Lavoisier set themselves the task of standardizing thermometer construction. With data compiled by a "multiplication" of observers equipped with new precision instruments, the Paris Academy declared in 1776, "we are to hope that physics will soon be augmented by a new science."[7] Toward that end *Père Louis Cotte* began compiling data recorded at various locations for the Société Royale de Médecine in Paris, and recommended the new Paris instruments to observers. Van Swinden, Lambert, Toaldo and other "meteorologists" called for the establishment of coordinated observations, and in 1778 Lavoisier set up a small network of precisely calibrated barometers in France. A year later he wrote Blondeau that he planned "to extend them not only throughout the kingdom but even throughout Europe, if it is possible."[8] With instrument makers newly capable of manufacturing large numbers of identical instruments in collaboration with physical scientists, such networks were indeed possible.

Paralleling and stimulating these scientific and instrumental advances was a growing governmental concern for exact meteorology as essential to economic prosperity. Because of the influence of the weather on agriculture, husbandry and health, meteorology was always closely associated with economics. The connection became explicit during the late eighteenth century when mercantilistic states began to appreciate the economic value of a healthy, growing population and thriving agriculture. The point was driven home after the destructions of the Seven Years War (1756–1763) were followed by over a decade of cold and wet summers that decreased agricultural productivity and population throughout Europe.[9] Some absolute governments, influenced by Physiocratie and worried about a recurrence of the notoriously unfruitful years at the turn of the century – and the attendant social unrest – encouraged their scientists to make comparisons and predictions. While scientists quickly recognized the need for more reliable data, instruments and comparative techniques, nearly every new study and network after 1770 originated from or sought to assist the economics of agriculture and health. Père Cotte's project for the Société Royale de Médecine, the first and largest state-supported network before Mannheim's, is a prime example.[10] In 1774 a persistent cattle plague indueed Turgot, the physiocratic Comptroller-General of French finances, to establish a network of veterinarians and country doctors to record "medico-meteorological" data. Two years later the network expanded into a "medical society" and Cotte, known for his tedious compilation

[6] *Henry Cavendish*: An account of the meteorological instruments used at the Royal Society's house. Royal Society of London, Philosophical Transactions 66 (1776), 375–401. *Bézout, Lavoisier, Vandermonde*: Expériences faites par ordre de l'Académie, sur le froid de l'année 1776. Académie Royale des Sciences, Mémoires 1777, 505–526.

[7] Sur le froid de 1776. Académie Royale des Sciences, Histoire 1776, 1–14. P. 9.

[8] Lavoisier to Blondeau, 16 November 1776. In: Oeuvres de Lavoisier: Correspondance. Vol 3. Ed René Fric. Paris 1964. P. 658.

[9] *Hans von Rudloff*: Die Schwankungen und Pendelungen des Klimas in Europa seit dem Beginn der regelmäßigen Instrumenten-Beobachtungen (1670). Braunschweig 1967. Pp. 102–137. *Emmanuel LeRoy Ladurie:* Times of feasr, times of famine. A history of climate since the year 1000. Trans. Barbara Bray. London 1971. Pp. 90–94.

[10] *Caroline C. Hannaway*: The Société Royale de Médecine and epidemics in the Ancien Régime. Bulletin of the history of medicine 46 (1972), 257–273.

of medico- and botanico-meteorological data from archival sources,[11] began an extensive correspondence with widely dispersed observers of botanical, medical and meteorological readings. Cotte annually assembled and published their readings in the memoirs of the Medical Society until the Convention suppressed all learned societies in 1793.

Cotte's project was equally indicative of the state of pre-Palatine meteorology. True to the Baconian inclinations of the era, Cotte insisted upon pure empiricism to the exclusion of all hypothesis. His only analysis of the assembled data involved the extraction of monthly highs, lows and averages of instrument readings. Moreover, as in all previous networks, Cotte's extensive data were supplied by volunteer correspondents located in randomly distributed sites. Nearly all were amateur observers and some were unfamiliar with the instruments. Even worse, despite Cotte's recommendations, most of the instruments were incomparable with each other, poorly constructed and unreliable. In 1783 Cotte complained publicly: "The majority employ defective instruments supplied by traveling barometer peddlers. It is not possible to establish comparisons among observations with such disparate instruments."[12]

The Palatine Meteorological Society remedied many of these defects with its own instruments, carefully selected locations and observers, and standard instructions and data forms. Nevertheless its science remained, like Cotte's, largely empirical and circumscribed by the practical needs of its enlightened state.

Palatine culture

Attention to the practical value of meteorology in the Palatinate (Pfalz), and to the need for coordinated research, occurred within the complicated social and cultural transformations occurring in that realm after 1760.[13] As Dreyfus pointed out for the Electorate of Mainz, the Catholic enlightenment displayed a new self-consciousness: a liberation from Rome in religious matters, a philosophical rationalism imported from northern Pietistic provinces, and a "nationalistic," patriotic sentiment.[14] This was accompanied in the social sphere by the rising influence of non-landed nobles, lower clerics and professional bureaucrats, all skilled in obtaining and administering new scientific, technical and cultural knowledge for state benefit. Rulers welcomed the rising status of these technical "cameralists," whom they could use against such entrenched opponents of state absolutism as the Roman Church. At the same time cameralist scientists, including those in the Palatinate, never tired of proclaiming the usefulness of their science for the economic and cultural benefit of their absolute state and for the "happiness" and "perfection" of their fellow subjects.[15]

Unlike the ecclesiastic Electorate of Mainz, the Palatinate was ruled by a secular Elector, but the political alignments of state, Church and Pope were nearly identical until 1774. Like

[11] *Louis Cotte*: Traité de météorologie. Paris 1774.

[12] *Louis Cotte*, in: Société Royale de Médecine, Histoire 1782–1783, 245f. Cited by *Feldman* (note 2), p. 214.

[13] Since many of these developments are unfamiliar to non-specialists and since most of the literature (primary and secondary) is obscure, obsolete and often unavailable outside of Germany, I offer this brief but essential summary.

[14] *F. G. Dreyfus*: Sociétés et mentalités à Mayence dans la seconde moitié de XVIIIe siècle. Paris 1968.

[15] Palatine examples include *Freiherr von Semmingen*: Von dem Einfluße, den eine Akademie auf den Geist der Nation haben sollte. Rheinische Beiträge zur Gelehrsamkeit (Mannheim) 2,1 (1778), 12–25; *Friedrich Casimir Medicus*: Ueber die blos praktischen Beispiele. Physikalisch-Ökonomische und Bienengesellschaft zu Lautern, Bemerkungen 1773, 210–259; *Georg Adolph Succow*: Von dem Nuzzen der Chymie zum Behuf des bürgerlichen Lebens, und der Oekonomie. Mannheim 1775.

the Febronian bishop-electors of the Rhein provinces, Karl Theodor adhered increasingly to an anti-papal stance and to a policy aimed at achieving state control of the Church. This brought him into conflict after 1770 with the powerful ruling Archbishop of Speyer, for whom the pampered Elector proved no match. Dominated in secular affairs by inaugural directives[16] and in spiritual affairs by his Jesuit confessor, Karl Theodor and his realm remained in the grip of traditional authorities and under the influence of the Jesuit order. But even before his confessor's death in 1769, Karl Theodor displayed an urge to independence. Enlightened culture and its purveyors served his immediate need. In 1763 the Elector made an obvious jesture of support to the non-Jesuit lower clergy and intellectuals of his realm by establishing an Academy of Sciences in Mannheim for the express purposes of promoting local secular history and the status of non-Jesuit scholars; all Jesuits were excluded from academy membership by electoral decree. This prohibition, zealously sought by the academy, applied even to Karl Theodor's favorite scientist, court astronomer *Father Christian Mayer, S. J.*, best known for his discovery of double stars.

The dissolution of the Jesuit order in 1773 brought matters to a head, causing a brief power struggle between the Elector and Archbishop over the disposal of Jesuit property. Karl Theodor's eager subjects turned out the real winners as they moved into the sudden cultural vacuum. Still politically weak, but financially unfettered, the Elector fully implemented the policy encouraged by his enlightened subjects of gaining internal influence through the generous patronage of secular arts, German culture and useful sciences, all opposed by the Archbishop. In 1775 Karl Theodor gladly endowed a culturally patriotic "German Society" (Deutsche Gesellschaft) instituted by his newly influential subjects. In the society's charter he declared: "We have always considered the sciences and arts to be the foundations of the prosperity of a state and therefore, as the true means to make the happiness of our loyal subjects – which is continually our first and last concern – blossom out, and to give them the desired degree of permanence, have taken the same under our especial protection."[17] The grateful subjects responded by referring to their Elector as "a well-meaning godhead among men" and as "the father of his people." To complete the image, his nuturing government became "the mother of sciences."[18]

Although Mannheim never attained the brilliance of Weimar, Berlin or Vienna, no effort or expense was spared in attempting to enliven its culture. Besides the Academy and German Society, a highly respected German Theatre opened in Mannheim and such luminaries of Protestant enlightenment as Mozart, Lessing and Klopstock settled briefly in the realm before being driven out by the Church.[19] In science, construction of an astronomical observatory for Father Mayer was begun in 1774 and stocked with the best English instruments. A year later a

[16] *(Marquis d'Ittre)*: Karl Theodors Initiation zum regierenden Churfurst von der Pfalz. Göttingisches Historisches Magazin 1 (1787), 648–682.

[17] "Die Wissenschaften und Künste haben wir stets als die Grundfeste der Wohlstand eines States betrachtet, und deswegen selbe, als das wahre Mittel die Glückseligkeit unserer getreuen Unterthanen, welche unsere ununterbrochene erste und letzte Sorge ist, aufblühen zu machen, und ihr den wünschten Grad von Beständigkeit zu geben, in unseren ganz besonderen Schutz aufgenommen." *Karl Theodor*, Stiftungsbrief, 13 October 1775 (Badisches Generallandesarchiv Karlsruhe, Abteilung 77, Faszikel 6397. Hereafter: GLA 77/6397).

[18] *Friedrich Casimir Medicus*: Nicht das Clima, sondern eine glückliche bürgerliche Regierung ist die Mutter der Wissenschaften. Mannheim 1775. *Stefan von Stengel*: Eröffnungsrede. Deutsche Gesellschaft, 29. Brachmonat (June) 1778. Rheinische Beiträge zur Gelehrsamkeit 2,1 (1778), 3–11.

[19] Documents in GLA, Karlsruhe.

physical cabinet with lectures and experiments was established in the Residence under the direction of Karl Theodor's non-Jesuit court priest, *Father Johann Jakob Hemmer.*[20]

Such generous patronage continued after Karl Theodor inherited Bavaria at the end of 1777 but did not spread to the latter. Not only did Karl Theodor's strategy for taming the episcopally inclined bishops of his dispersed realm now shift to a pro-papal stance, but Karl Theodor entertained little interest in Bavaria, which he tried to trade to Austria for the Netherlands. After a brief battle with Austria, Frederick II of Prussia forced the Elector to accept his inheritance and to move to Munich, where he and most of his unhappy officials lived nearly as exiles.

The economic importance of agriculture, population and applied physical sciences was forcefully propagated in the Palatinate by another patriotic assembly, the "Physical-Economic and Bee Society" (Physikalisch-Ökonomische und Bienengesellschaft), which also ran a three-year college of cameralistic studies (Germany's first) in the rural town of Kaiserslautern.[21] Karl Theodor's repeated confirmations of the Society's independent public school against the claims of the Catholic professors in Heidelberg to preside over all higher education served to confirm the independent social status of the Physical-Economic Society and its school cameralists.[22] This independent status enabled them to dominate Palatine economic policy with their practical mixture of mercantile and physiocratic economics and to spread their chief economic and scientific teaching derived from it: agriculture and population were the bases of economic prosperity and applied physical sciences were the key to their growth.[23] The Physical-Economic Society made itself useful by researching "economic" (applied) sciences and teaching them to future "clever administrators." It also made some of the earliest demographic studies, while Dr. Franz Anton Mai, member of both the Academy and the Physical-Economic Society, developed an extensive public health policy, the leading medical "police" program in Germany at that time.[24]

Although the Physical-Economic Society and its teachings were influential, most its members were not. Judging from the members' religions, the Society was mainly a Protestant movement, and Protestants were excluded by law from Karl Theodor's service. This left the field to Father Hemmer and his noble Catholic colleague *Stefan von Stengel.* Hemmer and Stengel, both members of the Physical-Economic Society, soon conceived, initiated and ran the Palatine Meteorological Society, and both individuals were obvious representatives of the culture that spawned it.

[20] Palatine patronage is described more fully by *Friedrich Walter:* Mannheim in Vergangenheit und Gegenwart. Vol. 1. Mannheim 1907. *Adolf Kistner:* Die Pflege der Naturwissenschaften zur Zeit Karl Theodors. Mannheim 1930.

[21] *Heinrich Webler:* Die Kameral-Hohe-Schule zu Lautern (1774–1784). Speyer 1927. Contemporary arguments for the cameral school include *Ludwig Benjamin Martin Schmid:* Briefe über die hohe Kameralschule zu Lautern. Erster Brief (31. Juli 1776). Der Teutsche Merkur 8 (1776), 163–172. *Friedrich Casimir Medicus:* Erster Beweiß, daß die Kameralwissenschaft auf einer besonders hierzu gestifteten Hohen Schule vorgetragen werden müsse. Zum Nutzen der Staaten und der Bürger erörtert. Sammlung kleiner Schriften der Kameral Hohen Schule zu Lautern 1 (1781), 163–188.

[22] Documents in Universitätsarchiv Heidelberg, III 6a, Nr. 1.

[23] This is explored by *Martin Joseph Funk:* Der Kampf der merkantilistischen mit der physiokratischen Doktrin in der Kurpfalz. Neue Heidelberger Jahrbücher 18 (1914), 103–200. The practical economics of the cameral school may be found in such textbooks as *Ludwig Benjamin Martin Schmid.* Lehre von der Staatswirtschaft. 2. volumes. Mannheim 1780. *Johann Heinrich Jung:* Lehrbuch der Finanz-Wissenschaft, Leipzig 1789.

[24] *Friedrich Casimir Medicus:* Zustand der Bevölkerung und Cultur der Unter-Pfalz für das Jahr 1771. Göttingisches Historisches Magazin 1 (1781), 520–524. *George Rosen:* From medical police to social medicine. Essays on the history of health care. New York 1974.

Hemmer and Stengel

Like other sons of impoverished peasants in Catholic lands, Father Hemmer had risen socially through the Church. He was named a court priest in 1760 and in 1768 he joined the Academy of Sciences. Despite any scientific interests, his early activities centered on a radical reformation of Germany orthography, about which he lectured, argued and wrote into the middle 1770s.[25] This placed him squarely among the rapidly rising lower clergy of the realm and in direct opposition to waning authorities. Hemmer's orthographic reforms, which got him into the anti-Jesuit Academy, were bitterly opposed by *Father Anton Klein, S. J.*, teacher at the Jesuit School in Mannheim, the leading Latin school for noble boys. But in 1768 the Jesuits drove Klein from the school and even the country when, succumbing to enlightened reform, he tried to introduce German instruction and a library of contemporary authors to the school.

By 1774 cultural patriotism had prevailed, the Jesuits were disbanded and Klein returned to a court professorship in German literature, personally conferred upon him by Karl Theodor. One of the Elector's French speaking subjects complained to Voltaire: "Our court has suddenly become German; it has renounced French and Italian productions and today it has only German comedies."[26] The shifting cultural winds were certainly obvious to Hemmer after Klein's appointment. In addition Stengel probably informed him of the Elector's motive for seeretly departing for Rome upon the Pope's death in 1774: to insure that the Vatican could not or would not interfere in his internal affairs. Stengel's father, the Elector's closest councilor, aceompanied him to Rome.

Stengel's father was also the Elector's cultural minister, which brought young Stengel, then in his early twenties, into contact with Hemmer. While the Elector visited the Vatican, Hemmer and Stengel embarked upon a joint study of the highly rationalistic philosophy expounded by Christian Wolff, professor at the Pietistic university of Halle. It was not long before they conceived the idea of the aforementioned German Society for the promotion of German language and culture in opposition to the predominance of French culture, Church Latin and Klein's professorhip. Upon his return the Elector was only too happy to support "these patriotic endeavors . . . of several loyal and clever men," who, like Hemmer and Stengel, turned out to be the non-ruling lower clergy and middle level nobles.[27]

Although Hemmer helped to initiate the German Society, he left its organization to young Stengel, who operated with his tactical advice and approval, particularly regarding Klein. Hemmer turned instead to science. The Elector's awakened interest in secular culture included natural science after his return from Rome, and Hemmer immediately founded his physical cabinet. With Mayer now occupied at the observatory, Hemmer's scientific interests blossomed to take on the task. In his inaugural lecture at the physical cabinet he displayed the usual altruism and enlightened intellectuality. "No science is more useful, none more pleasant

[25] *Hemmer*: Abhandlung über die deutsche Sprache zum Nutzen der Pfalz, in öffentlicher akademischer Versammlung vorgelesen. Mannheim 1769. Deutsche Rechtschreibung. Mannheim 1775. A sample of his orthography is found in note 35.

[26] *Cosmo Collini* to Voltaire, 1 January 1777. In: The complete works of Voltaire. Vol. 124. Oxford 1976. P. 126.

[27] "Wir haben daher mit besonderem höchsten Wohlgefallen ersehen, daß in unserer Residenzstadt Mannheim sich einige vertraute und geschickte Männer zu gemeinschaftlicher Bearbeitung der deutschen Sprache verbunden haben." *Karl Theodor*, charter of German Society, 13 October 1775 (GLA 77/6397). A list of members is also in GLA 77/6397.

and stimulating than natural science." As the basis for both natural law and new technology, "one can justly regard it as the richest source of the happiness of the human race."[28]

Also typical of the era, in which new electrical marvels abounded, Hemmer's physics was both electrically unified and medically useful. During the 1770s he examined the electricity of flames, the deposit of dew on conductors, and formulated theories of air electricity and the lightning rod. At Hemmer's behest the Elector overrode the Church's theological objections in becoming the first German ruler to order the erection of lightning rods on public buildings.[29] In the medical realm, Hemmer researched the death of an unfortunate maiden struck by lightning, he cured a half-paralyzed man by electric shocks, and, for clues to human fertility, he carefully examined the off-spring of electrified pregnant dogs.[30]

By 1780 Hemmer had added agronomy to his repertoire. In his speech to the Mannheim Academy upon the founding of the Palatine Society, Hemmer proclaimed agriculture and medicine to be the primary motives for the project. "What greater need is there for man than food and health?" he asked. Since both were subject to the "vicissitudes" of the atmosphere, the carrier of diseases and the provider of beneficial conditions for plants and humans, both would benefit from a precise understanding of the weather gained through the concerted gathering of meteorological readings.[31]

While Hemmer's scientific interests and aims may thus be seen in close relation to his social and cultural milieu and to his standing in it, Hemmer's meteorology and its applications were most influenced by the semi-empirical electrical meteorology offered by *Giuseppe Toaldo*, professor of astronomy in Padua. In his prize-winning treatise for the Montpelier Academy in 1774 on how weather physically affects agriculture, and the practical lessons to be learned from this, Toaldo offered an electrical physics of plants and weather from which he extracted a series of useful, predictive rules based upon his analysis of 48 years of data compiled in Padua.[32]. Since the Abbé Nollet had discovered that electrified plants grow faster, Toaldo associated plant growth with heat and electricity, which thinned out sap, causing growth. Water, accumulated in clouds by electrical attraction, provided the raw material for growth. Precipitation was induced by combinations of air temperature and pressure, measured by the appropriate instruments.

Toaldo derived long-term regulariities in the local weather, which made forecasts possible, from his version of "astro-meteorology": he associated variations in instrument readings with his revival of the hypothesis that the atmosphere, like the ocean, should exhibit tides caused by the gravitational attraction of the moon and sun. Toaldo tentatively confirmed the hypothesis by comparing lunar and solar periodicities with meteorological readings for each day of the

[28] Auszug aus der Rede, womit Herr Abt Hemmer ... seine Vorlesungen den 10. Windmonat 1778 eröffnet hat. Rheinische Beiträge zur Gelehrsamkeit 2,1 (1778), 143–147.

[29] *Hemmer*: De electricitate flammae. Historia et commentationes Academiae Electoralis Scientiarum et Literarum Theodoro-Palatinae. Physikum 6 (1790), 23–46. Nachricht von den in Kuhrpfalz angelegten Wetterleitern. Ibid. 4 (1780), 21–86. Versuche über den Thau. Pfalzbaierische Beiträge zur Gelehrsamkeit 1782, part 2, 424–430.

[30] *Hemmer*: Einige merkwürdige Wetterschläge. Hist. comment. Academ. Elect. Physikum 4 (1780), 87–94, delivered September 1776. Glückliche Wirkung des elektrischen Feuers bei einer vieljährigen Lähmung. Ibid., 116–138. Elektrische Versuche mit belegten Thieren. Ibid. 5 (1784), 158–165, delivered 2 December 1781.

[31] Speech published in: Historia Societatis Meteorologicae Palatinae. Ephemerides 1781 (publ. 1783), 1–54, on pp. 18–23.

[32] *Giuseppe Toaldo*: Essai sur la météorologie, appliqué à l'agriculture. Montpelier 1775. German: *Joseph Toaldo*: Witterungslehre für den Feldbau. Trans. Johann Gottlieb Steudel. Berlin 1777.

year, averaged over 48 years. The resulting correlations and frequencies of readings for each day led to statistical predictions.

Toaldo's advanced analysis and his confirmation of the oft repeated notion of atmospheric tides caused a brief sensation.[33] They became known in the Palatinate upon the Elector's return from Rome. The Academy prize for 1775, submitted by Hemmer, called for a calculation of lunar and solar effects upon barometer variations. But, except for an essay review of the German translation of Toaldo's book in 1778, that is the only surviving reference to the useful science until four years later.[34] By then Karl Theodor was displaying a personal interest in meteorology applied to agriculture and a willingness to fund multiple observations to further the subject. Hemmer's enthusiasm for Toaldo and agriculture abounded. In May 1779 he wrote the Elector: "Weather observations have nowadays become one of the most important branches of natural science after Toaldo showed so convincingly their great influence on farming and the growth of plants, and set the same on a scientific footing. One now works in all ways with doubled diligence in order to give this new structure the suitable solidity and completeness through multiple observations made with all possible exactness and agreement. I also am disposed to contribute my share to this so useful work."[35]

If prompted by utility, Hemmer was nevertheless sincere. During the 1780s he personally researched gravitational effects using a newly invented, automatically recording barograph. As the organizer and director of the Palatine Society, he required his correspondents to record the daily zodiacal position and phase of the moon. He also asked them to record the entire range of non-meteorological cameralistic data, such as the growth of crops and the migration of birds, as well as monthly mortality, medical, fertility and deomgraphic data. All of these data could then be compared directly with one another and any regularities perceived.

Foundation and function

The coincidence and mutual encouragement of interests occurring between Karl Theodor and his subjects throughout the 1770s were directed toward the institution of a large-scale meteorological network by events in neighboring Baden, combined with the actions of Hemmer and Stengel. In the introduction to the German translation of his book, Toaldo had

[33] *Louis Cotte*: Mémoires sur la météorologie. Vol. 1. Paris 1788, pp. x and 624. *Samuel Horsley*: An abridged state of the weather at London in the year 1774, collected from the meteorological journal of the Royal Society. Royal Society of London, Philosophical Transactions 65 (1775), 167–193. *M. de la Place*: Suite des recherches sur plusieurs points du Système du Monde. Académie Royale des Sciences, Mémoires 1776, 525–552, on p. 541f. *J. H. van Swinden*: Résultats des observations météorologiques faites en l'année 1778 à Franeker en Frise. Académie Imperiale et Royale de Bruxelles, Mémoires 3 (1780), 401–500. In reality there was no significant tidal effect of the moon on the atmosphere. It amounts to only 0.025 mm of mercury at the equator and decreases with latitude.

[34] (Unsigned): Neue Witterungslehre, mit ihrer Anwendung auf das 1778te Jahr. Rheinische Beiträge zur Gelehrsamkeit 1 (1777), 289–299.

[35] "Di wetterbeobachtungen sind heutiges tages zu einem der wichtigsten zweige der naturlehre geworden, nachdem Toaldo iren grosen einfluß in den Feldbau und den wakstum der pflanzen so überzeugend dar getan, und di selben auf einen wißenschaftlichen fus gesezet hat. Man arbeitet nun aller arte mit verdoppeltem fleise, um disem neuen gebäude durch merere, mit aller möglichen genauigkeit und übereinstimmung gemachte beobachtungen, di gehörige festigkeit und vollkommenheit zu geben. Auch ich bin gesonnen, das meinige zu disem so nützlichen werke beizutragen." *Hemmer* to Karl Theodor, circa 1 May 1779 (GLA 77/6400).

called upon cameralist administrators to help improve agriculture by substantiating and expanding his semi-empirical rules through the organization of networks of observers.[36] While Hemmer and Stengel thereafter displayed a greater awareness of the utility of meteorology, Toaldo's suggestion generated no response. In Baden, however, *Johann Lorenz Böckmann,* teacher of physics in Karlsruhe and privy councilor to Margrave Karl Friedrich, was moved to action. He had little trouble convincing the physiocratic Margrave in 1778 of the agricultural benefits of meteorology, nor of the benefits of setting up a "weather institute" of 16 coordinated observers throughout Baden. Echoing Toaldo in his *Wünsche und Aussichten,* Böckmann called upon his colleagues in other lands to do the same for the sake of health and agriculture.[37] Encouraging responses poured in, according to Böckmann, including letters of active interest from Hemmer, Mayer, Stefan's father Georg von Stengel and Kaiserslautern's cameral school. In early 1779 Hemmer wrote a warm review of Böckmann's booklet.[38]

The move to meteorology in Mannheim had already accelerated upon Karl Theodor's inheritance of Bavaria a year earlier. Stefan and Georg von Stengel began exchanging data between Mannheim and Munich. After joining his father in Munich, Stefan obtained data from an engineer in Mannheim, compared them with his own, and presented the results regularly to the Elector who, Stengel reported, "gradually expressed more interest in the subject."[39] His interest was soon such that Stengel was ordered to render reports every ten days.

Stengel also remained in touch with Hemmer in the Mannheim residence. Immediately after the appearance of Böckmann's booklet, Stengel wrote Hemmer of the idea of "an extended society of diligent observers" throughout the realm equipped with comparable instruments in order to research the meteorological influence of the moon for agricultural purposes. Hemmer responded, wrote Stengel, "immediately full of delight and encouraged me to carry out the matter if possible with the support of the Elector." They nearly reenacted the founding of the German Society; Stengel, now privy councilor, carried out the ground work at court with tactical advice from Hemmer. The Elector was already sufficiently prepared when Stengel presented the idea to him orally. "Thus he too immediately took up the idea with pleasure, approved on the spot," and asked Stengel to draft a charter for the project.[40]

With encouraging responses to his project in hand, Böckmann traveled to Mannheim in 1779 to discuss developments there. A collision of interests apparently occurred, probably over the possibility of subsuming one project under the other. Böckmann curiously reported only an encounter with Mayer, who so far had nothing to do with the Hemmer-Stengel plan. When Böckmann's efforts failed later that year, due, he wrote cryptically, "to external hindrances of various kinds," the Mannheim Academy immediately called his instrument maker, *Carlo Artaria,* to Mannheim to work with Hemmer on producing instruments for its

[36] *Toaldo*: Witterungslehre (note 32), p. 9.

[37] *Böckmann*: Wünsche und Aussichten zur Erweiterung und Vervollkommung der Witterungslehre. Karlsruhe 1778.

[38] *Hemmer*: Wünsche und Aussichten. . . Rheinische Beiträge zur Gelehrsamkeit 2,1 (1779), 457–470. *Böckmann*: Beyträge zur neuesten Geschichte der Witterungslehre. Erster Versuch. Karlsruhe 1781. P. 11n. Böckmann to Ildephons Kennedy, 31 October 1780 (Archiv, Bayerische Akademie der Wissenschaften, Munich. Hereafter: BAW).

[39] *Stephan (sic) von Stengel*: Denkwürdigkeiten. P. 150. Typescript prepared from several versions of his manuscript (Stadtarchiv Mannheim, kleine Erwerbungen 114). *Friedrich Walter*: Das Tagebuch des Ing.-Maj. F. Denis. Mannheimer Geschichtsblätter 16 (1915), 52–65.

[40] *Stengel*: Denkwürdigkeiten (note 39). P. 150f.

project.[41] But Karlsruhe and Baden were not invited to join, and absented themselves from, the later Palatine Society.

The decision to extend the network beyond Palatinate-Bavarian borders may have derived from the Böckmann encounter, but it was made months later and with little ado. As late as May 1780 Hemmer noted in a letter to Karl Theodor that their instruments "are, on highest order, to be finished as soon a possible and sent throughout all electoral lands."[42] In the founding charter four months later, the international dimension sounded like an insertion in Stengel's draft. Daily observations with comparable instruments were to be made "at several notable places of all the electoral lands, also in other regions of Europe and the remaining parts of the world."[43] In subsequent references Karl Theordor's subjects never failed to congratulate the Elector for his international recognition gained through his patronage of their project.[44]

By the time that Karl Theodor signed the Society's charter in 1780, the Stengels had obtained and, where necessary, trained observers among Italian clerics and Bavarian monasteries, Artaria and Hemmer had prepared a large stock of identical instruments, Hemmer had composed explicit instructions for the observers, invented standard recording symbols and data forms, and began inviting foreign locations to participate. The locations were carefully selected to insure geographic distribution. Preferance was given to academies, universities and monasteries since they could best insure continuity beyond the death of the initial observers.

Hemmer insisted that every location accepting his invitation or volunteering its services agree in writing to follow his instructions, his "Monitum ad observatores," before he sent them any instruments. The instrument packages, dispatched by special courier, contained a barometer, two Reaumur mercury thermometers, a hygrometer made from an expanding goose feather, and, for selected locations, a magnetic declination needle.[45] The bulb barometers and thermometers, each consisting of uniform cylindrical glass tubes filled with mercury, were thrice heated to remove all dissolved air from the mercury. The barometer was mounted on a vertical plank next to a scale in Paris inches and next to one of the thermometers, used to correct the barometer readings for thermal effects. Because of recent improvements in thermometer construction, Hemmer was especially explicit in describing its careful construction. Following DeLuc's prescriptions for mercury thermometers, Hemmer calibrated the 80 °Reaumur scale using the two fixed points of melting ice (0 °R) and boiling water (80 °R) at a barometer reading of 27 Paris inches. The second thermometer, mounted on

[41] *Böckmann*: Carlsruher meteorologische Ephemeriden vom Jahr 1779. Carlsruhe 1780. P. 33f. No mention of the Mannheim developments or of the "external hindrances" appears in Böckmann's correspondence with Kennedy (BAW) or with Markgraf Karl Friedrich von Baden (GLA 48/536).

[42] ". . . da ich mit einem besonders berufenen künstler unaufhörlich an den maschinen arbeite, die auf höchsten befehl bald möglichst verfertiget und durch alle kurfürstliche länder verschiket werden sollen" *Hemmer* to Karl Theodor, 9 May 1780 (GLA 213/3118).

[43] ". . . daß an mehreren merkwürdigen Standt-Orten sämmtlicher kurfürstlicher Erbstatten, auch in andern Gegenden Europens, und der übrigen Welttheile künftig nach möglichst gleichlaufenden auf höchste Kosten verfertigten Werkzeugen tägliche Beobachtungen gemacht und zusammen gebracht werden sollen." *Karl Theodor*, charter of Palatine Meteorological Soceity, 15 Herbstmonat (September) 1780 (GLA 77/6400).

[44] For example, Hemmer to Karl Theodor, 18 Weinmonat (October) 1781 (GLA 213/3118). Academy to Elector, 15 Christmonat (December) 1783 (GLA 77/6400).

[45] *Hemmer*: Monitum ad observatores Societatis Meteorologicae Palatinae. In: Historia Societatis (note 31). Pp. 8–17. One of Hemmer's thermometers survives in the Deutsches Museum, Munich. *Traumüller* (note 1) provides an extensvie description of the instruments.

a wooden plank, was intended to record air temperature while suspended outside in the shade away from buildings. Other instruments, such as a wind vane, rain gauge and an air electricity device, were described in the *Ephemerides* for local construction.

Each station received annually twelve data forms, one for each month. Observations of the instruments, placed according to Hemmer's instructions, were to be recorded on the forms thrice daily: at 7 AM, 2 PM and 9 PM, and Hemmer's symbols were to be used throughout. All of these very explicit instructions, which nearly all observers followed – with or without prodding from Hemmer – insured the remarkable standardization and reliability achieved by the project.

Hemmer, Father Mayer and Mayer's assistant, *Karl König*, constituted the new meteorological class of the Mannheim Academy. The Stengel's preferred to remain councilors. Mayer's main contribution was to obtain the participation of the Marseills Observatory and the St. Petersburg Academy. The latter lined up two other Russian stations, manned by German émigrés. Mayer was apparently supposed to provide supplemental astronomical readings and to help with the analysis of data. But, excluded from the Academy until 1773, Mayer never got along well with it. He had also ruined his health by moving into his observatory before it was finished. When he died in 1783 "with having hardly laid a hand on the work," as the Academy put it, a replacement was neither sought nor funded, and Hemmer and König thereafter ran the project alone and without complaint.

The project and annual publication of the *Ephemerides* continued smoothly until Hemmer's unexpected death in 1790, the result of his continual inhaling of mercury fumes while working on the instruments.[46] Since Hemmer had not designated a successor, the entire project fell to his unwilling medical colleague *Johann Melchior Güthe, M. D.*, who tried to give it to the academy secretary, Andreas Lamey. The personal nature of the project was obvious, even to Stefan von Stengel. "I am surprised that this business at the academy is not transferred to a special member," he wrote Lamey.[47] Observations and the publication of incoming data continued in Mannheim, but Hemmer's organization and control of the project obviously died with him.

Even if its members had little to do with the project, the Academy was heavily involved financially. Although Artaria's salary and the costs of materials for the instruments were borne directly by the state treasury, the project devoured such a sizeable fraction of the academy's annual budget that it was ordered to start saving paper in 1784. Of its approximately 10,000 Gulden per year, it paid out 1500 Gulden for the *Ephemerides* and related literature and 800 Gulden for the new class and its salaries.[48] In 1785 Hemmer concluded a large, ten-year publishing contract for the *Ephemerides* in order to relieve the academy of annual payments.[49] The contract, which insured publication after Hemmer's death, was barely fulfilled. Already

[46] Diagnosed from Hemmer to Karl Theodor, 18 Weinmonat (October) 1781 (GLA 213/3118), and Ferdinand Denis to Stefan von Stengel, 3 May 1790 (Stengel-Sammlung, Bayerisches Hauptstaatsarchiv, Geheimes Hausarchiv, Munich).

[47] "Es wundert mich daß dieses Geschäft bey der Akademie nicht einem besondern Mitgliede übertragen ist." *Stefan von Stengel* to Andreas Lamey, 10 Weinmonat (October) 1793 (GLA Sammlung Kremer-Lamey, Nr. 157).

[48] Academy accounts for 1783 (GLA 77/6400). Academy budget for 1782, in: *Ludwig Bergsträsser*: Der Briefwechsel zwischen Stengel und Lamey. Mannheimer Geschichtsblätter 8 (1907), 122–133, on p. 132f.

[49] Contract mit dem Buchhandler M. Fontaine die Ephemerides Meteorolog. betreffend, 1785 (BAW, I 261).

limping after 1790, the project collapsed when the French army crossed the Rhein. Mannheim was besieged and occupied in 1795, the academy was temporarily disbanded and Hemmer's physical cabinet destroyed. The French got all the way to Munich where they routed Karl Theodor from his Nymphenburg residence. The last volume of *Ephemerides*, for 1792, appeared in 1795 with data compiled at 15 perseverant stations.

Participation and effect

Since meteorology was widely recognized as economically useful and in need of empirical research, the announcement of Mannheim's project met with widely favorable responses. "That is without doubt the true means of guiding the meteorological science soon to its perfection," Louis Cotte exclaimed.[50] Yet participation in the project, though considerable, was less than expected then, or now.[51] The reasons included difficulties in communication, the shipment of fragile instruments and personal and political differences. That the project succeeded and survived as long as it did is a tribute to Hemmer's organization and perseverance.

The object of the Palatine Society was to assemble reliable, long-term readings from which, after years of data gathering, patterns and regularities could be perceived. The society thus sought and accepted the participation of those most inclined to observation rather than to analysis. Practically no interaction occurred between the organizers of the project and those constructing an "experimental physics" of the weather through detailed studies of individual phenomena, instrument readings and geophysical hypotheses. Since such studies often involved other sciences, especially chemistry and hydrodynamics, some of the leading members of those sciences – Cavendish, Lavoisier, Dalton, DeLuc and the Lichtenbergs – constituted the community of non-participating "meteorologists."

The selection of participants according to devotion to observation is reflected in the occupations of those who did participate (see Appendix). The heaviest representation was by clerics and professors of astronomy and physics. No chemists have been detected. That Kaiserslautern's professor of "economic chemistry," Georg Adolph Succow, like his school colleagues, had nothing to do with the project, owed more to religious segregation than to scientific selection.

That communication was a problem is indicated by the circumstance that of the 37 stations that delivered data, only 8, and only 4 outside Palatinate-Bavaria, participated for the entire twelve years of the project. Moreover, of the 27 foreign locations initially invited there is no recorded response from 11, including every station in the British Isles. The Royal Society of London received its invitation but never responded. In this case the reason was, again, personal. The society's president, Joseph Banks, claimed that he could find noone to do the observations, which did coincide with a lapse in meteorological readings at the Royal Society's house and a turn to experiments on the freezing and latent heat of thermometer mercury.[52] But Banks had fallen into conflict with most members of the Royal Society's former meteorologi-

[50] *Cotte*: Mémoires (note 33), p. 3.

[51] A combined total of about 250 systematic observers at that time are listed by *Cotte*: Extraits et résultats des observations météorologiques faites en differentes villes. In: *Cotte:* Mémoires (note 33). Vol. 2. Pp. 189–616; and *Gustav Hellmann*: Die Entwicklung der meteorologischen Beobachtungen in Deutschland von den ersten Anfängen bis zur Einrichtung staatlicher Beobachtungsnetze. Preussische Akademie der Wissenschaften, Math.-Physikal. Klasse, Abhandlungen 1926, Nr. 1.

cal committee. Not even Mayer's very good relations with Nevil Maskelyne, astronomer royal and former committee member, could be turned to Mannheim's favor.

Besides Baden, all of Austria absented itself from the project. The university of Vienna was invited to participate and Father Maximilian Hell, professor of astronomy, was enthused enough about coordinated observations and applied meteorology to have Böckmann's *Wünsche und Aussichten* reprinted in Vienna at his own expense.[53] But in 1778 Father Hell suffered defeat at the Paris Academy of Sciences in a dispute with Mayer over the existence of double stars.[54] A year later Austria suffered defeat at the hands of Prussia in the conflict over Karl Theodor's inheritance. Both defeats probably discouraged Vienna and other active Austrian locations from accepting, or even responding to, Mannheim's call.

The shipment of fragile instruments was another major problem. As far as can be determined every station required the shipment of at least two parcels, since the first invariably arrived in more pieces than it was sent. This was a particular problem in France where participation was much less than expected. Cotte complained to Lavoisier: "The extreme difficulty in delivering their instruments in France discourages these gentlemen. Of the three cases that have been sent to me, only one has reached me, and the instruments were broken by the negligence of the officials, who have ransacked and disordered the instruments."[55] While this probably explains why Cotte, though accepting his invitation, never delivered any data, Mannheim's difficulties in France were compounded by the coincidence of its project with Cotte's. There were no simultaneous particpants in the two endeavors.

Whenever the instruments did get through, they were immediately compared with the local devices. The comparisons indicated the need for improvements in some instruments, such as the hygrometer, but often the barometers and thermometers displayed excellent accord, an indication of generally improved construction. In at least two instances, the Dijon and St. Petersburg academies, the instruments were judged in such excellent accord that the project data were obtained with the old devices.[56]

True to the empirical aims of the project, all of the data received from each location appeared in extenso in the *Ephemerides*. Any supplementary studies, analyses or curiosities reported by the participants were also published without prejudice. Among the latter were ten years of tidal readings recorded by Toaldo's assistant, a report of the phenomenal volcano outburst on Iceland in 1783, sightings of an apocalyptic "blood red" cloud that settled over a terrified Europe that summer, and a brief tabulation of a cold wave that winter.[57]

All of the voluntary analyses of data concentrated during the first three years upon barometer variations and their possible cause. Some of the earliest graphical representations of

[52] *Cavendish*: Observations on Mr. Hutchins's experiments for determining the degree of cold at which quicksilver freezes. Royal Society of London, Philosophical Transactions 73 (1783), 303–328. *Charles Blagden*: History of the congelation of quicksilver. Ibid., 329–397.

[53] *Böckmann*: Beyträge (note 38), p. 11n.

[54] *R. (?)*: Aus der Sternkunde. Rheinische Beiträge zur Gelehrsamkeit 2,1 (1779), 473–480.

[55] Cotte to Lavoisier, 20 February 1782. In: *Lavoisier*: Correspondance (note 8), p. 710. Hemmer complained, too, in: Historia Societatis (note 31), p. 45f.

[56] *Hughes Maret*: Histoire météorologique de 1783. Académie des Sciences, Dijon, Nouveaux Mémoires 1783, part 1, 204–230. (*Johann Albrecht Euler*): Comparison des instrumens météorologiques envoyés par l'Académie Electorale de Mannheim avec ceux de l'Académie Impériale des Sciences. Acta Academiae Scientiarum Imperialis Petropolitanae 1782, part 2, 25–27 (separate paging).

[57] Unknown to the reporters, these events were all related.

data and the notion of mean variation appeared in these studies.[58] Most attention focussed on the hypothesis of lunar influence. Hemmer carried the search for such influence the farthest in his annual studies of Mannheim's data; he compared the lunar phases with everything he could find: barometer, thermometer, wind and weather readings, numbers of births and deaths, the migration of insects and the spread of diseases. Such comparisons appeared in simple tabular form, followed by qualitative remarks about apparent correlations. In 1783 Hemmer employed a more reliable method: his automatic barograph, bought directly from its inventor, Changeux. Analysis of the plentiful data that it delivered was significant yet disappointing. Hemmer could report only that the barometer dipped briefly for a small fraction of a line as the sun crossed the meridian at noon and midnight.[59] Otherwise there were no astronomical correlations, and all such studies gave way to pure empiricism in the *Ephemerides* after 1784. One of the motivations of the project, a realization of the lingering hope that detailed weather forecasts could be easily derived in advance from celestial motions, met its final empirical refutation. Primarily as a result of this and of independent studies of individual phenomena, by the early nineteenth century meteorology had finally separated itself entirely from its ancient association with astronomy and was turning increasingly to geophysics for definition.

The comparative tables constructed by Karl König and published as appendices to the *Ephemerides* displayed the non-astronomical meteorological conceptions of the organizers of the Palatine Society. If one might indulge briefly in "whiggism," a comparison with nineteenth-century presentations indicates that the organizers indeed entertained little conception of climate as a temporal and spatial phenomenon. The most obvious difference from later reports is the lack of a single map in the entire 12 volumes of *Ephemerides*. Inundated with data and deprived of hypotheses, König held to traditional static and local conceptions of the weather and to empirical methodology. In the appendices he or the local reporter provided monthly extrema, means and variations for each instrument at each location. König then extracted the annual extrema and variations for a "Tabula generalis observatium annua," in which the date of the annual extremum was noted for each location, listed by latitude. For two consecutive years the annual tables were joined into one big table, "Comparatio annorum collectorum," but without comment or conclusion. The apparent intent was to facilitate perceptions of patterns and regularities in the monthly and annual readings, extending over the entire duration and extent of the network. Although more grandiose than local, static conceptions, the aim was still far removed from later notions of climate and even from a contemporary proto-conception of a zone, published in the *Ephemerides*.[60] Yet König's empiricism precisely satisfied the needs of the day and the more modest aim of providing data for future research. When scientists turned early in the next century to geophysical hypotheses concerning the causes of instrument variations and their

[58] *Vincent Chiminello*: De diurna nocturnaque oscillatione barometri monitum. Ephemerides 1784, 230–233. *Anton Strnadt*: Observationes meteorologicae unius lunarius synodici factae pragae bohemorum 1785. Ibid. 1785, 596ff. *Hemmer*: Tabula barometrica II. Ibid. 1783, 62f. *Johann Jacob Planer*: Observatio oscillationis mercurii in tubo torricelliano erfordiae instituta. Ibid., 250–257.

[59] *Hemmer*: De Solis in Barometrum influxu. Hist. et comment. Academ. Elect. Physikum 6 (1789), 50–64. Abridged translation: "Vom Einfluss der Sonne auf das Barometer. Journal der Physik (ed., F.A.C. Gren) 1,2 (1790), 218–229.

[60] *Cölestin Steiglehner*: Excerpta ex dissertatione: Atmosphaerae presso varia observationibus baroscopicis propriis et alienis quaesita. Ephemerides 1782, 444–457. Analyzing pre-project dara from London, Regensburg and Moscow, Steiglehner found that certain low-pressure readings were correlated so as to indicate the movement of low presure across the continent.

correlations over geographical distances, the extensive and reliable data of the Palatine Society were, as its participants had hoped, readily available and conducive to the ultimate creation of modern climatology.[61]

This rather "whiggish" comparison between König's tables and their successors is intended to cast the nature of the Palatine Society's science and achievements in sharper relief. The confluence of the scientific interests and soical aims of enlightened Palatine intellectuals with those of their absolute state helped to make such an extensive, well-supported and open-ended project as the Palatine Society possible and helped to encourage the kind of science that it sought and obtained.

Zusammenfassung

Der Aufsatz befaßt sich mit der Gründung, dem Betrieb und den Auswirkungen der "Pfälzer Meteorologischen Gesellschaft" (Societas Meteorologica Palatina). Die Gesellschaft, die von 1781 bis 1792 durch die Mannheimer Akademie der Wissenschaften geleitet wurde, war in der Tat ein internationales Netzwerk für die Sammlung genauen meteorologischer Beobachtungen, die auf vergleichbaren, aus Mannheim gelieferten Instrumenten abgelesen wurden. Die Gesellschaft wird in Zusammenhang mit den kulturellen, sozialen und wirtschaftlichen Entwicklungen während der katholischen Aufklärung in der Kurpfalz untersucht. Ihre wissenschaftlichen Ziele und Ergebnisse werden vor dem Hintergrund der Entwicklung der Meteorologie als exakte Naturwissenschaft im späten achtzehnten Jahrhundert betrachtet.

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Appendix

Locations

Years of participation in the project are indicated after each location. (If no years are given, the location did not participate.) I = foreign location initially invited. National identifications are modernized.

Berlin, I, 81–88
Bologna, I, 82–84, 87-92
Brussels, I, 82–92
Budapest (Ofen), I, 81–92
Cambridge, Mass., USA, 82–87
Copenhagen, I, 82–88
Delft, 84–85
Den Haag, 82–83
Dijon, 83–84
Dublin, I
Düsseldorf, I, 82–84
Edinburgh, I
Eidsberg, Norway, 87
Erfurt, 81–88
Franeker, Netherlands, I
Geneva, I, 82–89
Godthaab, Greenland, 87
Göttingen, I, 83–85, 87
Hohenpeissenberg, Bavaria, 81–91
Ingolstadt, 81–82

[61] For example, *Ludwig Friedrich Kämtz*: Lehrbuch der Meteorologie. 2 Vols. Halle 1831.

La Rochelle, France, I, 82–90
Lemberg (Ukraine), I
Lisbon, I
London, I
Madrid, I
Mannheim, 81–92
Marseilles, 82–92
Middelburg, Netherlands, 82–88
Montmorency, France, I
Montpelier, France, I
Moscow, 83–89, 91–92
Mounr St. Andex, Bavaria, 81–92
Mount St. Gotthard, Switzerland, 81–92
Münster, I
Munich, 81–92
Padua, I, 81–92
Paris, I
Prague, I, 81–87, 89–91
Pyshmen (Urals), 90–91
Regensburg, 81–91
Rome, 82–92
St. Petersburg, I, 83–92
St. Zeno, Bavaria, 81
Sagan, Poland, I, 81–92
Spydeberg, Norway, 83–86
Stockholm, I, 83–92
Tegernsee, Bavaria, 81–89
Turin, I
Vienna, I
Würzburg, 81–88

Participants

The names and most of the occupations are taken from the *Ephemerides*. Institutional affiliations are designated simply academy or monastery, unless a more exact specification is required. Professors are at the institution in the designated location. A number after a name indicates the year he started reporting.

Berlin:	Nicholas de Beguelin, academy member; Franz Karl Achard, same (88)
Bologna:	Petronio Metteuci, professor of astronomy and mathematies and director of observatory
Brussels:	Abbé Théodore Augustin Mann, academy member and church canon
Budapest:	Franz Weis, professor of astronomy and director of observatory in Ofen; Franz Xaver Bruna, successor to Weis (85)
Cambridge, Mass.:	Edward Wigglesworth, professor of theology; Samuel Williams, professor of mathematics and physics (83); Isaac Rand, M. D. (assisted 85)
Copenhagen:	Thomas Bugge, professor of astronomy and mathematics, director of observatory
Delft:	Simeon Peter van Swinden, jurist, brother of J. H. van Swinden
Den Haag:	idid.
Dijon:	Hughes Maret, M. D. and perpetual secretary of academy
Düsseldorf:	Mathias Phennings, professor
Eidsberg:	Jacob Nicolaus Wilse, professor of theology and pastor in Spydeberg
Erfurt:	Johann Jakob Planer, professor of public health and member of academy
Geneva:	Jean Senebrier, naturalist, director of city library
Godthaab:	Andreas Ginge, missionary to Greenland
Götringen:	Johann Christoph Gatterer, Jr., historian and member of academy
Hohenpeissenberg:	Guarinus Schloegel, member of monastery in Rottenbuch; Herculanus Schwaiger, same (82); Albino Schwaiger, same (86)
Ingolstadt:	Cölestin Steiglehner, professor of physics and mathematics
La Rochelle:	Pierre Seignette, M.D. and pharmacist, perpetual secretary of academy
Mannheim:	Johann Jakob Hemmer, court priest, head of physical cabinet and member of academy; Capt. Ferdinand Denis, military engineer; Johann Melchior Güthe, M. D. and academy member (90)
Marseilles:	St. Jacques de Silvabelle, director of observatory
Middelburg:	Van de Perre
Moscow:	Engel, M. D. and correspondent of St. Petersburg Academy; Johann Gotthilf Stritter, archivist and ibid. (85)
Mount St. Andex:	Kettel, member of monastery; Edmund Hochholzer, same (90)
Mount St. Gotthard:	Onuphrius, member of monastery; Laurentius Mediolansia, same (84)
Munich:	Huepauer, reader in theology at hermitage; Maximus Imhof, teacher of physics, mathematics and philosophy in hermitage (89)
Padua:	Giuseppe Toaldo, professor of astronomy, geography and meteorology

Prague:	Anton Strnadt, astronomer royal and professor of mathematics and physical geography
Pyshmen:	Benedict Franz Johann von Hermann, engineer in Russian service
Regensburg:	Joseph (Placidus) Heinrich, teacher of philosophy in St. Emmeram monastery; Dominus Winckler, same (recorded deaths)
Rome:	Giuseppe Calandrelli, professor of mathematics in Collegium Romanum and director of observatory
St. Petersburg:	Johann Albrecht Euler, perpetual secretary of academy
St. Zeno:	monastery members
Sagan:	Preuss, canon in monastery
Spydeberg:	Jacob Nicolaus Wilse, see Eidsberg
Stockholm:	Henric Nicander, astronomer and perpetual secretary of academy
Tegernsee:	Gotthardus, member of monastery; Donaubauer, same (83); Maurus Magold same (85)
Würzburg:	Ambrosius Egell, professor of experimental physics