On climates and disciplines in Norway in the 1870s

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In the 1870s there were two scientific experts on climate in Norway. Their climates shared space, but not time, and the knowledge about them was produced from different scientific objects: the atmosphere and the flora.[1] This paper discusses how these bodies of knowledge about climate were formed in different emerging disciplines, and how they represent distinctive views of what constituted scientific knowledge about climate. Formed within the same small scientific institution in Christiania, and influenced by the political agendas of an emerging nation-state, they show both the political significance and the semantic diversity of the scientific concept 'climate' in Norwegian science in the 1870s.

The first expert was Axel Blytt (1843-1898), botanist at the Botanical Garden in Christiania (now Oslo) from 1862, and professor of botany at the University from 1880.[2] It was the *history* of the Norwegian flora that caught Blytt's interest and turned his attention towards climate. Throughout history, varying climate had produced plant distribution patterns in Norway, manifested as separate layers in peat bogs. From the study of these patterns and layers, Blytt produced knowledge about Norway's climate in the past.

The other expert, working at the same institution, was Henrik Mohn (1835-1916), who was appointed first director of the Norwegian Meteorological Institute and professor of meteorology at the University in Christiania by the Norwegian Parliament in 1866.[3] Unlike Blytt, Mohn was interested in the directly observable climate and not its history.

This article will discuss differences and similarities in Blytt's and Mohn's climate studies, including their relationships to objectivity, to historization, and to ideological or political aspects of their work. In Blytt's theory, the immigration of plants was an element with strong nationalistic connotations and relevance for contemporary historicizations of the Norwegian people. His theory is an illuminating example of Katherine Anderson's argument that climate ideas originated *outside* meteorology.[4] In Andersons view, meteorology was a "test case" where speculation challenged "disciplined, Baconian observation" in the claim for authority. While the botanist Blytt was a free speculator, the climatologist and meteorologist Mohn put considerable effort into balancing between the objective observer and the creative craftsman.

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[1] The historicity and epistemological roles of scientific objects is discussed in Daston, Lorraine (ed.). *Biographies of Scientific Objects*. Chicago and London, 2000.
[2] For a biography of Axel Blytt, see: Nordhagen, Rolf. "Axel Blytt. En norsk og internasjonal forskerprofil". *Blyttia* 1/1943, vol. 1: 21-55.
[3] For a biography of Henrik Mohn, see: Engelbrethsen, Per. "Professor Mohn og det norske meteorologiske institut". *Naturen* 4, 1895: 97-104.
[4] Anderson, Katherine. *Predicting the Weather. Victorians and the Science of Meteorology*. Chicago, 2005: Introduction.

I will start with presenting and discussing Blytt and his studies of the flora and the climates in the past that formed it. Moving over to Mohn, I will present his climatology and how his type of knowledge about the atmosphere shaped his ideas of climate. In the end I will discuss how these two sets of scientific knowledge about climate both were formed by emerging international scientific disciplines, by aspirations of a yet unsovereign nation, and by the little community at a small university. I will argue that both Blytt and Mohn negotiated between different *disciplinary objectivities*, or different consensuses regarding what constituted truth, in their research.[5]

The botanical climate

As the son of the University professor of botany and director of the Botanical Garden Mathias Numsen Blytt (1789-1862), Axel Blytt took over his father's work on a three-volume Norwegian Flora in 1862.[6] He received a scholarship from the University in Christiania in 1873 and a professorship of botany in 1880. The second and third volumes of the Flora were published in 1874 and 1876. In the latter year, he also published *Essay on the immigration of the Norwegian Flora during alternating rainy and dry periods*, which presented his theory of the origin and history of the Norwegian Flora.[7] While *Norges Flora* was a descriptive work with purely textual descriptions and no theories or hypotheses, the *Essay* was a discussion rather than a description.

In the *Essay*, Blytt argued that two parameters in the natural condition of Norway were decisive for the distribution of plants: the humidity of the climate, and the hardness of the bedrock (substratum) on the spot. These two parameters decided which types of plants would be able to grow on a certain place, Blytt argued. "The hard substratum has a uniform flora poor in species (…), on looser substrata the covering of vegetation is more dispersed, the number of individuals is less, but that of the species is greater…".[8] Further, some plants thrived in a wet climate, others in a dry. Some plants were "general", meaning that they thrived in either of the conditions. Blytt made the basic assumption that the plants in Norway had immigrated as the ice pulled back and that they had been distributed according to their preferences for wet or dry climate and hard or loose bedrock.[9] Blytt did not see temperature as decisive in itself.[10]

To explain how the climate affected the distribution of the Norwegian flora, Blytt used a simple climate model with three main agents: the ocean, the mountains and the wind.[11] The ocean produced moist air, which was blown into Norway by the prevailing south-westerly winds. The mountains were an obstacle to these winds, and provided shelter from them on

[5] Porter, Theodore M. *Trust in Numbers. The Pursuit of Objectivity in Science and Public Life*. Princeton, 1995: Introduction.
[6] Blytt, Mathias Numsen. *Norges Flora eller Beskrivelse over de i Norge vildtvoxende Karplanter tilligemed Angivelser af de geographiske Forholde under hvilke de forekomme*. Christiania, 1861.
[7] This text was first published in Norwegian as an article under the title "Forsøg til en Theori om Indvandringen af Norges Flora under vexlende regnfulde og tørre Tider" in the Norwegian journal *Nyt Magazin for Naturvidenskaberne* in 1876. The English title refers to the book that was published in Christiania in the same year as a response to the great attention that the article and its theory had received. In the following, I will refer to the English version.
[8] Blytt 1876: 26.
[9] Blytt's studies of plant distribution was inspired by Edward Forbes, who had described types of distribution of flora and fauna in 1846. Nordhagen 1943: 26.
[10] Blytt 1876: 19-20.
[11] Blytt 1876: 15ff.

their north-eastern side.[12] Plants close to the ocean, or in a place inland where these winds blew, were called *insular*. Plants that were far inland or behind mountains, protected from the moist air, were called *continental* plants. In this way, Blytt made his own climatic-geographical classification system based on a simple climate model and a theory of plant immigration.

One observation that sat uneasy with the assumption of immigration was that the distribution of some alpine plants had large gaps that did not fit into the picture. For instance, some plants were found only in single spots in Norway and then on other continents.[13] Despite a long discussion of how Norwegian plants were transported, he could not explain the patchwork pattern in this distribution. He concluded that this was not a result of the agency of the plants themselves, but of the agency of long-term changes in their living conditions. Of his two parameters, hardness of the soil and humidity of the climate, the latter was clearly the most likely to have changed since the Ice Age. Blytt therefore had to superimpose *time* on his classification system, which is how he ended up in a discussion on the history of the Norwegian climate.

To find out more about this history, Blytt followed the recommendation of the Scottish geologist James Geikie to excavate *peat bogs*.[14] Containing different layers of plants and other material from different periods, peat bogs were seen as archives of natural history. Using his categorization of plants as a tool, Blytt established a chronology of climate types since the Ice Age. He found that the same type of plants dominated different layers, indicating repeated periods of similar climate.

Not all peat bogs could be assumed to contain material from the whole postglacial period. Since the Norwegian land mass had risen continually after the withdrawal of the ice, only peat bogs at altitudes more than 600 feet above the present sea level would contain the oldest bottom layers. Blytt saw this as essential for their interpretation. It not only informed the chronology of the immigration of plants, it also removed incompatibilities between his own results and those from similar investigations of peat bogs in Denmark, where Blytt argued that no land rise had occurred.[15]

Blytt's conclusion was that the climate in Norway had gone through several wet and dry periods since the Ice age. He tried to connect this theory to natural phenomena that were subject to astronomical laws. The theories of James Croll, which Blytt had mentioned only briefly at the end of his *Essay*, turned out to be a useful way to structure the history of the Norwegian flora and climate.[16]

Croll's theories, presented in the book *Climate and Time* in 1875, highlighted the earth's position in relation to the sun as the key to understanding many large-scale processes in nature.[17] The sun was the source of heat on earth, and wind patterns in the atmosphere and

[12] In the 1960s, climatologists Theodor Hesselberg and Bernt Andreas Birkeland calculated the effect of the mountain ranges in southern Norway on precipitation and wind based on large data sets of meteorological observations. See Vollset's paper in this issue.

[13] Blytt 1876: 22-23.

[14] Axel Blytt's draft of testimonial of James Geikie, 19.12.1881. National Library of Norway, Collection of Letters 66. On Geikie see also: Hamlin, Christopher. "James Geikie, James Croll, and the Eventful Ice Age". *Annals of Science* 39/6 (1982): 565-583.

[15] Blytt 1876.

[16] Blytt 1876: 87-88. James Geikie was perhaps the one who introduced Croll's ideas to Blytt. On Geikie and his influence from Croll, see: Hamlin 1982.

[17] Croll, James. *Climate and Time in their Geological Relations. A Theory of Secular Changes of the Earth's Climate*. 1875. On Croll see also: Fleming, James R. "James Croll in Context: The Encounter Between Climate Dynamics and Geology in the Second Half of the Nineteenth Century". *History of Meteorology* 3 (2006): 43-54. Fleming describes Croll's ideas between cosmic and terrestrial physics and geology, placing him in a position between emerging disciplines.

current patterns in the ocean were among the most important factors deciding how this heat was distributed on its surface. Croll's argument was that the earth's elliptic path around the sun, as well as the inclination of its rotational axis, went through regular variations with vast consequences for the quantity and distribution of heat – that is, for climate on earth. Through a long chain of causes and effects these variations explained the phenomenon of ice ages. Hence, according to Croll, ice ages could be astronomically calculated – both those of the past and those of the future. Croll's theories provided Blytt with a connection between the history of the Norwegian flora, climate and astronomical laws. In a number of publications in the following decades, Blytt expanded his grand theory on the history of the Norwegian flora and climate and worked Croll's ideas into it.[18]

Seeking communities from other disciplines

The style of writing in the Essay and in later papers from Blytt's hand embraced ideals from geology rather than from botany. In 1882 the geologist Amund Helland described Norway as "the country of geological discussion", referring to the legacy of the grand old man of Norwegian geology, Theodor Kierulf.[19] Kierulf was a friend of the Blytt family and had had a significant influence on the young Axel Blytt.[20] At the end of his career, Blytt threw himself into the core of geological debate and advocated revisions in the established periodization.[21] In his correspondence with Blytt, James Geikie especially valued the "suggestive" character in the publications.[22] Charles Darwin also wrote to Geikie about Axel Blytt, and praised the deed of being "a good theoriser".[23] To geologists, being suggestive and theorising were important epistemic virtues.

This was not necessarily the case among botanists. The problem was not Blytt's theory in itself, but the method by which it had been produced. In several letters to Blytt, the botanist Johan Emanuel Zetterstedt called for caution when making hypotheses. Geology was young, he wrote, and consisted more or less of "guesses". However, proving was better than guessing: "Hypotheses give life to questions, they turn out not to be true, and science

[18] On the upheaval of the Norwegian land mass, see: Blytt, Axel. "Om vexellagring og dens mulige betydning for tidsregningen i geologien og læren om arternes forandringer". *Christiania Videnskabsselskabs Forhandlinger* No. 9 1883. Published in German as "Ueber Wechsellagrung und deren mutmaasliche Bedeutung für die Zeitrechnung der Geologie und Für die Lehre von der Veränderung der Arten" in *Biologisches Centralblatt* III No. 14-15: 418-434 et 449-461. Erlangen, 1883. On the history of ocean currents and on the distribution of land and ocean in the northern hemisphere through times, see: Blytt, Axel. "Om den sandsynlige årsag til den periodiske ændring af havstrømmenes styrke". *Archiv for Mathematik og Naturvidenskab* Vol. 9, 1884. Published in German as "Ueber die wahrscheinliche Ursache der periodischen Veränderungen in der Stärke der Meeresströmungen" in *Biologisches Centralblatt* IV No. 2: 33-48. Erlangen 1884. On the history of the Earth and its crust and previous changes in its spherical form, see: Blytt, Axel. "Om den sandsynlige årsag til strandliniernes forskyvning. Et forsøg på en geologisk tidsregning". *Nyt Magazin for Naturvidenskaberne* XXXI, Vol. 11, 1886. Published in English as "The probable cause of the displacement of beach-lines. An attempt to compute geological epochs". *Christiania Videnskabs-Selskabs Forhandlinger* No. 1, 1889. On geological periodization see: Blytt, Axel. "Til forsvar for mit Forsøg på en geologisk Tidsregning". *Arkiv for Mathematik og Naturvidenskab* 14 B (1890): 197-219.

[19] "…den geologiske Diskussions Land". "By thoroughly discussing problems, misunderstandings are often removed, and new light is thrown over the matter". Kierulf quoted by Helland, Amund. *Forsøg paa en geologisk Diskussion.* 1882: 1-2. (My translation).

[20] Axel attended Kjerulf's lectures as a student. Nordhagen argues that Kierulf's theories about the Ice Age had a profound influence on the natural sciences in Norway in the 1860s. Nordhagen 1943: 10.

[21] Blytt 1890.

[22] Letters from James Geikie to Axel Blytt 18.07.1881, 18.12.1881, and 27.12.1888. National Library of Norway, Special collections, Letter collection no. 66.

[23] Letter from Charles Darwin to James Geikie 16.11.1876. Darwin, Francis (ed.). *The Life and Letters of Charles Darwin* Vol III, 1889: 244.

advances threefold".[24] Even though hypotheses were necessary, in Zetterstedt's opinion, they were something scientists turned to only when they were desperate.[25] Since geology was a science without disciplinary borders, and without a fully developed method, Zetterstedt recommended sticking to undisputable facts, rather than producing grand theories based on speculation.

Immigration theories and the nation

As Deborah Coen has shown, climatology could serve to unify an empire.[26] In the 1880s, climatologists participated in consolidating the Austrian-Hungarian Empire in by describing natural regions that matched with political boundaries. Blytt's historicism could be interpreted as having similar political overtones when seen in the light of contemporary theories about the history of the Norwegian land and people.

In 1873, three years before Blytt's *Essay*, the Norwegian historian Johan Ernst Sars (1835-1917) published the first volume of his history of Norway, in which he presented Norwegian history as a dialectic process from golden age to crisis and then to the "synthesis" of Sars' own time. This dialectic history was governed by natural laws, dictated by natural surroundings and taking place through "organic" change. Norwegian farmers represented the continuity of this history, as bearers of the Norwegian identity.[27]

The similarities between Blytt's theory of the origin of the Norwegian Flora and Sars' history of the Norwegian people are striking. First, as Sars, Blytt had a holistic view in which the scientific object was reduced to a singular long history. Second, the dialectic process in Sars' history was reflected in Blytt's alternations between rainy and dry periods. Finally, the development from origin to the present was embedded in natural conditions governed by laws.[28]

Also other elements in Norwegian historical theory had similarities with Blytts's theory. Theories of immigration were well-established in Scandinavian historical writing at the time, most famously the theories of historians Peder A. Munch (1810-1863) and Rudolf Keyser (1803-1864) in the 1840s and 1850s.[29] Keyser and Munch, like Blytt and Mohn professors at the University in Christiania, argued that Norwegians had immigrated from the North. This gave the Norwegian people an origin distinguishable from those of the Swedes and the Danes, and a position among the oldest peoples in Europe. This was significant in a nation where there was a strong and growing wish for ending the union with Sweden which had begun in 1814, on the back of a a 400 year period under Danish rule. By bringing an

[24] Letter from Johan E. Zetterstedt to Axel Blytt 21.10.1877. National Library of Norway, Special collections, Letter collection no. 66.
[25] Letter from Johan E. Zetterstedt to Axel Blytt 02.01.1877. Ibid.
[26] Coen, Deborah. "Climate and Circulation in Imperial Austria". *The Journal of Modern History* 82, 2010; Coen, Deborah. "Imperial Climatographies from Tyrol to Turkestan". *Osiris* 26/1, 2011.
[27] Sars, Johan Ernst. *Udsikt over den norske historie*. 4 volumes. 1874-1894. See also: Melve, Leidulf. *Historie. Historieskriving frå antikken til i dag*. Oslo 2010: 151-154; Andresen, Astri, Sissel Rosland et al. *Å gripe fortida. Innføring i historisk forståing og metode*. Oslo 2012: 183-186. With the first volume of his *Udsigt*, Sars positioned himself as the leading Norwegian historian. It also led to considerable debate at the University and in Parliament around the proposal of an extraordinary professorship for him at the University in 1874. Kyllingstad, Jon and Tor Arne Rørvik. "Vitenskapenes universitet" in Collett, John P. (ed.). *Universitetet i Oslos historie*, Vol. 2, 2011: 97-100, 362-366.
[28] Naomi Oreskes compares how today's geologists and historians understand the past. Oreskes, Naomi. "Why I Am a Presentist". *Science in Context* 26/4 2013: 595-609.
[29] Keyser, Rudolf. "Om Nordmændernes Herkomst og Folkeslægtskab". *Samlinger til det Norske Folks Sprog og Historie*, Vol. 6, 1839: 259-462; Munch, Peder Andreas. *Det norske folks historie*. 8 volumes. 1853-1863. For more about the works of Keyser and Munch in historiographical context, see: Dahl, Ottar. *Norsk historieforskning i det 19. og 20. århundre*. 1970 (1990).

immigration theory into botany, Blytt had given the Norwegian flora a set of political connotations.

Henrik Mohn, climate, and how the atmosphere worked

Meteorologist Henrik Mohn also saw the Norwegian climate as a distinguishable entity. Climatology was what had earned his Meteorological Institute a place within the University in Christiania. "Climatology is the statistics of the meteorological elements", Mohn wrote in his 1872 textbook *Om Vind og Vejr*.[30] Mohn's strategy for producing knowledge about the atmosphere was two-fold. First, it was about quantification, in line with other studies of nature and society at the time.[31] Second, it was about analysing the observations and formulating what he called "laws" (lover), a process in which personal judgement, experience and skill had a significant part. The "laws" were more like rules of thumb, characterized by exceptions as they had been for centuries.[32] To Mohn, producing weather forecasts was a craft based on scientific observations.

Mohn saw climate as the property of place. To *describe* the climatic conditions of the whole globe or even a single country was a matter of making maps based on an immense amount of observations. However, "to fully *understand* the climatic conditions would require knowledge about the movements in the atmosphere and their attributed phenomena in detail".[33] Mohn's study of the mechanisms of the atmosphere reflected his dual ambitions of both being able to predict storms and eventually weather, and to understand climate.

One of the results of these studies was a model of atmospheric movement that he called "hvirvel" – whirl.[34] The whirl described large air masses rotating counter-clockwise around barometric minima, and there would be a number of whirls in the atmosphere at any time, Mohn explained. They would move not only by rotation, but also linearly, following certain paths. In a whirl there would be winds of all directions, but those in its southern half would usually be the strongest. The storms that Mohn and his staff tried to warn the Norwegian population about in the late 1860s and early 1870s were most often the southern half of a whirl passing over some part of Norway. The paths they followed were essential for estimating the damage or potential danger that the winds would represent for Norwegian fishermen and seafarers. Whirls were the mechanism of the weather, and the machinery of the climate. The whirl model was a mathematical and physical construction developed as a tool for thinking theoretically about motion in gases, and thus objects that physicists could discuss. Processes in whirls could be described by equations and calculated, most often by people who took no interest in weather forecasting specifically. By identifying whirls on daily weather maps, Mohn introduced a theoretical scientific object into the craft of weather forecasting.

In the foreword to his textbook *Om vind og vejr*, Mohn explained that he had been constantly concerned with maintaining "a sharp distinction between the field of secure

[30] Mohn, Henrik. *Om Vind og Vejr*. Christiania 1872. The book was translated into seven languages: German, French, Italian, Spanish, Polish, Russian, and Finnish.
[31] Porter, Theodore. *The Rise of Statistical Thinking 1820-1900*. 1986; Lie, E. and H. Roll-Hansen. *Faktisk talt. Statistikkens historie i Norge*. Oslo 2001.
[32] Daston, Lorraine. "Unruly Weather: Natural Law Confronts Natural Variability" in Daston, Lorraine and Stolleis, Michael (eds). *Natural Law and the Laws of Nature in Early Modern Europe: Jurisprudence, Theology, Moral and Natural Philosophy*. 2008: 233-248.
[33] Mohn 1872: 280-281. (My italics).
[34] His whirl model was most thoroughly presented in two publications on storms: Mohn, Henrik. *Stormenes Love*, Christiania 1868 and Mohn, Henrik. *Det Norske Meteorologiske Instituts Storm-Atlas*. Christiania 1870. The *Storm-Atlas* was published with Norwegian and French parallel texts. On Mohn's whirl model, see also: Kutzbach, Gisela. *The Thermal Theory of Cyclones. A History of Meteorological Thought in the Nineteenth Century*. American Meteorological Society, Historical Monograph Series. 1979: 76-84.

conclusions and the field of guesses". Even though this had given the book a somewhat fragmented character, he continued, "...both the reader and science would benefit from a clear distinction between what is known and what is not known".[35] Numbers representing measured observations were known. What they could tell about future weather, however, was not known. As a meteorologist and weather forecaster, Henrik Mohn operated in the zone between "secure" knowledge and educated guesses. The events around the British meteorologist Robert Fitzroy, including the questioning of his scientific authority and the resulting discontinuation of weather forecasting after his death, clearly demonstrated the tension that could be displayed in this zone.[36]

Hence, the thick volumes of climatological records in the annual *Meteorologisk Årbog* series from 1866 onwards, were what Mohn considered secure knowledge.[37] Originally, this activity was the part of meteorology that was regarded as scientific, and what made meteorology deserve its place at the University. From the climatological records, one could calculate whatever average was needed: averages of a period (monthly, annual), of a geographical entity (cities, counties, regions, or the whole country) or of both. Like the *Flora* to Blytt, climatological records were collections of facts which could serve the theorizer.

In 1868 Mohn presented the following law: the center of a whirl, that is, the barometric minimum, has an oval shape oriented in the direction that the whole whirl is moving.[38] While some laws of whils and storms were universal, some depended on place. For instance, whirls were not a priori the same in Europe as in America. In his textbook from 1872, Mohn pointed out that the laws governing the weather in America had been found to be "quite the same" as those in Europe.[39] Mohn clearly saw his laws as something non-absolute, dependent of place, and not fully "secure knowledge".

Choosing between "knowing" and "guessing"

With time, the whirl model became a factor in the larger equation defining whether and how the institute's resources should be spent on storm warnings. After a few optimistic years, in 1872 Mohn argued that the storm warnings were not sufficiently useful. The problem was not that the warnings were wrong, but that many storms came without any warning. Fishermen and sailors could trust the storm warnings, but they could not trust their absence.[40]

In Mohn's opinion, there were two ways to improve this. One was to follow the quantification strategy through increasing the number of observations and improving the means of dissemination: establishing more stations along the coast, and a storm warning center positioned among the stations on the western coast of Norway. The other way, which was the one he recommended, was to devote more time and resources to the scientific study of

[35] Mohn 1872: iv. (My translation).
[36] Anderson 2005: ch 3. Mohn received the report from the Committee headed by Francis Galton that stated that Fitzroy's forecasts were unscientific. The report was sent to the institute, and is now in the DNMI library store, Forskningsparken, Oslo.
[37] Mohn, Henrik (ed.). *Norsk Meteorologisk Aarbog*, Det Norske Meteorologiske Institut. 1868. Published in Norwegian, German and French.
[38] Mohn 1868: 18. According to Gisela Kutzbach, meteorologists were not eager to communicate theories in the 1860s and 1870, due to a lack of estimation for theories about the atmosphere among physicists. Buchan did not allow himself to call his ideas theories, because theories should be firmly anchored in facts. Referring to F. Rosenberger. *Die Geschichte der Physik*, Vol 2. 1884: 327, Kutzbach describes this as an attitude which was spreading among meteorologists in this period. Kutzbach 1979: 75.
[39] Mohn 1872: 233-234.
[40] For more on the history of weather reports and its significance to the Norwegian fisheries and population along the coast, see: Fulsås, Narve. *Havet, døden og véret. Kulturell modernisering i Kyst-Noreg 1850-1950*. 2003.

whirls, and less to observation.[41] This strategy of analysis relied considerably on his personal accumulated experience.

Mohn's Danish colleague, the director of the Danish meteorological institute Niels Hoffmeyer, strongly advocated for forecasting based on personal skill. In Hoffmeyer's opinion, weather forecasting relied on individual experience from drawing isobars on maps. Hoffmeyer pointed to himself as the best example: "It would be quite unnatural of me to say that I believe someone else could draw better curves than myself, because there is hardly any meteorologist who has as long experience within this sport as I".[42] Weather forecasting was simply "unscientific": "…We must not hide our ignorance, but simply confess it", he argued.[43] The Danish Meteorological Institute had been established separately from the University of Copenhagen precisely because its tasks were regarded to be more "practical" than "scientific".[44]

Concluding remarks – shorelines

Representing separate disciplines whose contours were only emerging, Blytt and Mohn applied different "objectivities".[45] To use Theodore M. Porters concept, Blytt acquired *disciplinary objectivity* – a consensus within a discipline of what was or made truth – from *geology*.[46] He applied an analytic approach to the *origin* of what constituted a new scientific object: the Norwegian flora as a whole. His interest in origins made *time* just as essential as *order*. The *Essay* represented a shift not only of scientific object, but also of method and of epistemic virtue, from the traditional botanical truth-to-nature that focused on categories, to a holistic approach to the history of the flora of a nation.[47] It was a historicizing turn which produced the first history of the Norwegian climate. This deep-time perspective was unfamiliar in traditional botany, but was about to become a standard perspective in geology.

Mohn, on the other hand, swore to the authority that fact-producing instruments could give him, and that lay in expressing facts in numbers. Climate could be studied as sets of measurements of weather in certain places.[48] The disciplinary objectivity of climatology lay in the numbers and the methods for producing them. Contrary to contemporary climate studies based on archival records, Mohn showed little interest in the climate of the past. However, in his laws of whirls we see negotiations of the disciplinary objectivity of *meteorology*. For instance, while Heinrich Dove's classical *Winddrehungsgesetz* was considered old-fashioned by most meteorologists of the 1870s, Mohn did his best to implement it in his model. The *Winddrehungsgesetz* was a rule of meteorology through which one could use single-point observations to predict changes in wind direction at that point.[49] The rule was considered to be imprecise and to be applicable only in certain conditions and only in certain parts of the world, limitations that also characterized Mohns own rules. Mohn presented his new whirl

[41] The Norwegian Meteorological Institute. *Annual Report.* 1872.
[42] Letter from Niels Hoffmeyer to Henrik Mohn, 17.02.1876. National Archive of Norway, Archive of the Meteorological Institute. Correspondence 1876. RA/S-1570/D/Dc/L0003/0002.
[43] Letter from Niels Hoffmeyer to Henrik Mohn, 17.12.1875. RA/S-1570/D/Dc/L0003/0001.
[44] *Meteorologisk institut gennem hundrede aar. 1872-1972*. Det Danske Meteorologiske Institut. Copenhagen, 1972: 20-24.
[45] The emergence of climatology between disciplines is also discussed in Philipp N. Lehmann's paper in this issue.
[46] Porter 1995: Introduction.
[47] Lorraine Daston and Peter Galison points to botany as a discipline in which the epistemological virtue "truth-to-nature" existed as an ideal up to the late 19th century. Daston, Lorraine and Peter Galison. *Objectivity*. 2007: 197.
[48] Mohn, Henrik. *Oversikt over Norges Klimatologi*. 1870; Mohn, Henrik. *Norges Vind- og Stormstatistik*. 1870.
[49] Dove, Heinrich Wilhelm. *Meteorologische Untersuchungen*. Berlin 1837.

and the rules that governed it as the surroundings of the single point of observation from which Dove described a wind shift.[50] In this way, Mohn's ideas of atmospheric movement, fundamentally different from Dove's, were presented as a continuation, not a rejection, of older ideas.

What were the similarities between Blytt's and Mohn's climate studies? Prediction, whether of the future or of the past, was an important part of their scientific work.[51] This brought both of them to the borders of "secure knowledge". Both worked within the frames of a national scientific enterprise where the flora, the weather, the climate, and history had distinct Norwegian identities.[52] Although they were internationally oriented scientists, Blytt studied the Norwegian Flora and Mohn the Norwegian weather. They were also colleagues at an institution which had only a handful of scientific staff in this period, whose humanistic "culture of unity" had long been threatened by a growing gap between natural and human sciences.[53] Defenders of this culture considered Darwinism, positivism, and the growing belief in the significance of measuring as threats to the University as a scientific institution. In their eyes, producing knowledge was inseparable from producing meaning.[54] Both Blytt's Darwinism-inspired focus on the past and Mohn's insistence on numerical facts can be interpreted as parts of this new threat to the University.

The only object of study that Mohn and Blytt shared was shorelines.[55] Shorelines are linear marks in the bedrock along the Norwegian coast in different heights above the present sea level. They were believed to be traces of previous sea levels, thus demonstrating the different stages in the rise of the Norwegian land mass. Both Blytt and Mohn wrote an article on this phenomenon, with radically different approaches. Blytt's article *Om den sandsynlige aarsag til strandliniernes forskyvning* ("Probable causes of the displacement of beach lines") was a long discussion where his own hypothesis was connected to a wide range of existing theories, starting with Immanuel Kant from 1754. His own hypothesis was focused on the origin of mountain ranges in the Northern hemisphere. Blytt was aware of his very hypothetical approach, and asked for "patience for the many deficiencies and imperfections connected to such an attempt". He hoped "that the hypothesis at least will be found worthy of a closer examination".[56]

Mohn's article on shorelines was the result of a documentary project in which he presented his observations, measurements, drawings and statistical analysis of shorelines between Bergen and Vardø. Of 53 pages in his article *Bidrag til Kundskaben om gamle Strandlinier i Norge* ("Contributions to the Knowledge about Old Beach-Lines in Norway"), only the last four were devoted to a discussion of the possible *origin* of the shorelines. "To theorise on the creation of shorelines," Mohn concluded, "the present material and knowledge

[50] Mohn. *Storm-Atlas*. 1870: 23. On Mohn's alignment with Dove's theory, see Kutzbach 1979: 78-79. On the status of Dove's theory among meteorologists, see Kutzbach 1979: 88-93.

[51] On the concept of prediction of the past, see Anderson 2005 and Stanley, Mathew. "Predicting the Past: Ancient Eclipses and Airy, Newcombe and Huxley on the Authority of Science". *Isis* 103/2 2012: 254-277.

[52] Deborah Coen discusses climate studies as a part of political and cultural projects in Austria-Hungary in the 1880s in Coen 2010 and Coen 2011.

[53] While Blytt occasionally refers to Mohn's work in his publications, I have not seen any references to Blytt by Mohn. I have not found any correspondence between them in the personal collection of letters after Blytt (National Library in Oslo) or in Mohn's correspondence in the archive of the Norwegian meteorological institute (National Archives in Oslo). On the threat against the "culture of unity", see: Kyllingstad and Rørvik 2011 and Phillips, Denise. *Acolytes of Nature*. *Defining Natural Science in Germany 1770-1850.* Chicago 2012.

[54] Among the fiercest defenders of this culture of unity were the philosophy professor Marcus Monrad (1816-1897) and professor of medicine Ferdinand Lochmann (1820-1891). Kyllingstad and Rørvik 2011: 27-41.

[55] Blytt 1886. In the English version of his article, Axel Blytt used the term "beach lines". Mohn, Henrik. "Bidrag til Kundskaben om gamle Strandlinier i Norge". *Særtryk af Nyt Magazin for Naturvidenskaberne.* Christiania 1876.

[56] Blytt 1888: 240.

about their nature and topographical conditions is still far too poor".[57] Axel Blytt disagreed, and this contrast between him and Mohn illustrates the difference between their approaches to climate as well. The botanist practicing geology was free to speculate, while the meteorologist could rely only on direct observations.

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[57] Mohn. *Strandlinier*. 1876: 53.