MAKING SENSE OF THE AURORA: A RESEARCH PROJECT

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In this presentation I provide a brief thematic orientation about the project "Making Sense of the Aurora," a multi-disciplinary Nordic research network based at University of Tromsø that brings humanists and natural scientists together to study the history of efforts to comprehend the northern lights. I begin with some irreverant reflections regarding the aurora borealis and Norwegian identity. I will then provide an all-too brief outline of the history of scientific and cultural fascination with the aurora, before touching upon some thematic problems that we seek to address in our studies.

As we well know, landscape is frequently a constitutive element in forging national, regional, and local identity. But so too are the characteristics of the sky, be these arrays of particular types of clouds or a distinctive light. Such sky-scapes also enter into the cultural-political processes of creating shared identity. In high northern latitudes the appearance of the sky, when dark, commonly includes nightly displays of the aurora borealis. It might seem at first glance that nothing can be more natural than Norway claiming the aurora as icon and subject matter for research. Afterall, the hemispheric oval, a geographic ring, of the statistical maximum occurrence of the northern light skirts the northern coast of Norway. But of course historical realities are rarely natural. At Oslo airport, for example, postcards can be purchased offering photographs of the northern light including the caption: "Norway – The Aurora Borealis," yet few of the tourists purchasing such cards actually witness this natural spectacle. Similarly for persons who reside in Oslo, Bergen, and other urbanized centres characterized by light-pollution and obscurred horizons. Contingent cultural politics rather than geographic determinism provide insight into how and why features of land- and skyscape become emblematic for a region or nation (Shama, 1996; Daniels 1997; Friedman 2010).[1]

Norwegians, for example, tend to consider the aurora borealis to be a particularly national natural phenomenon: websites and publications imply, if not proclaim, Norway to be *the* nation for northern light, both with respect to tourism and to scientific research. But a quick round of Googling on the internet, or even reading published sources, reveals that competition for attracting auroral tourism and for claiming leadership in auroral research is actually quite keen. Alaska, Canada, Finland, Iceland, Russia, and Sweden all boast special roles for themselves. Just as in Norway, postcards are readily available in Finland with alluring photographs of *revontulet* and text: "Aurora Borealis – Finland", or "Lapland". Similarly for Canada and Alaska. Although disputes break out in the media occasionally between Norway and Finland with respect to "of course" the proper home to these northern icons. Similar displays of chauvinism can be found in chronologies of significant

[1] References to literature in this paper are merely representative and do not aim at comphrehensiveness.

names and events in the history of the scientific study of the aurora; these are rarely the same from one nation to another.

Yes, during the first half of the twentieth century Norway did produce significant contributions to the study of the aurora: Kristian Birkeland, Carl Størmer, and Lars Vegard were certainly pioneers (Brekke & Egeland, 1994; Friedman 1995). By the 1920s Norway could certainly consider itself as the leading nation in this field (Chapman, 1926). A number of Norwegians continued to be part of the research front in the postwar era. But popular literature generally fails to mention that after World War II and especially during the Cold War, when polar geophysical research assumed military strategic significance, the United States and Soviet Union entered these sciences with huge research budgets and massive numbers of scientists. Their researchers came to dominate auroral research. Although Norwegians remained active and provided important contributors in auroral studies, to claim a unique leading role is problematic. Indeed the same can be said for any other single nation or region that seeks priveledged status in an era of multi-national collaboration and interdependence.

How then is the myth of the aurora as being particularly Norwegian, or Canadian, or Alaskan maintained? Part of the answer entails the role of story-telling; legends and images prove to be valuable resources, both for researchers and for heads of tourist bureaus. Promotional efforts with regard to being the home of the aurora is achieved, in part, by ignoring other northern nations' claims and accomplishments.
In contrast, the project, "Making Sense of the Aurora", embraces a multi-national comparative perspective that will respect the trans-national character of scientific inquiry and fascination with the northern light. It is a topic moreover that invites Nordic collaboration while also demonstrably able to attract attention of international scholars, as both the topic and the historical problems it generates transcend regional parochial interest.

Indeed, the aurora borealis has status in the history of science as one of the great enigmas. Beginning in the early 1700s when the emerging European republic of learning embraced the aurora as a topic of considerable interest and well into the 1900s, the nature and cause of the aurora defied consensual explanation. The project seeks to contribute to the study of the history of scientific, cultural, and political interest in the northern light in the Nordic nations, while extending comparative perspectives to include European and more generally northern circumpolar frameworks.

The subject matter and perspectives intersect with several research specialities that is sensitive to local contexts, including environmental history, historical geography, far-northern history, history of polar politics, as well as science- and cultural studies. Our aim is internationally-oriented, contextually-sensitive, history of science that also actively engages with other humanistic fields as well as seeks dialogue with natural sciences.

Attempting to comprehend the aurora: A brief historical overview

Following a number of exceptionally brilliant displays of the aurora in the early 1700s that were visible over most of Europe, even as far south as Italy and Spain, natural philosophers attempted to make sense of the perplexing and widely-witnessed

public spectacle. They accepted the challenge of transforming the aurora from a Natural Wonder associated with superstition and fear of God's wrath into a phenomenon able to be comprehended through rational inquiry and brought into the domain of a mechanically-based natural philosophy. But, was the aurora a chemical or electrical effect; the result of sun- or moonlight reflected and refracted by polar ice; an indication of extreme vulcanic activity in the Arctic? Even the aurora's location in the sky, including its height, totally baffled everyone (Eather 1980; Aspaas & Hansen 2007; Briggs, 1967; Brundtland 2009; Lindqvist 1993).

Investigators in the Nordic countries quickly learned to appreciate the value of claiming a privileged status because of their geographic proximity to, and therefore greater experience in observing, the northern lights in all its forms and colors. Patriotic Nordic natural philosophers and later professional scientists assumed that the riddle would be solved by their own nationals, which in turn would bestow prestige and honour to themselves, their patrons, and their nations (Fara, 1996; Widmalm, 2009). Yet, others from mid-latitude centres of learning developed their own strategies for making authoritative claims about the aurora. Efforts to create proxies that seemed to replicate auroral phenomena in the form of laboratory simulation or drawing analogically upon other sources of insight less dependent upon geographic proximity. Moreover, considerable interest among scholars and diletante also arose early in non-Nordic countries possessing far-northern territory where aurora frequently could be witnessed, such as Russia, Canada, Scotland, and the United States.

By mid-nineteenth century many of the earlier fanciful explanations for the aurora had been eliminated through experiment and advances in physical theory, but researchers and commentators still could not agree upon its nature or cause. Debate ensued whether these lights were the result of local electrical discharges from friction between ice crystals high in the atmosphere, a form of atmospheric electricity arising from hemispheric air currents similar in some respects to lightning, a discharge from the earth, or even the consequence of some form of space dust. Increasingly investigators found connections between the aurora and rapid fluctuations in the earth's magnetic field, so called magnetic storms, which played havoc on maritime compasses. These two phenomena were themselves associated with the appearance of large numbers of sunspots. Both gross statistical correlations and dramatic observation, as in the case of the massive solar explosion arising near a large sunspot in 1859 and the hemispheric auroal and magnetic storms that soon followed suggested some linkeage (Fritz, 1881; Lemström 1886; Tromholt, 1885; Angot 1896). But neither the state of physical theory nor the development of scientific instrumentation could bring any secure insight. Moreover, the great uncertainties on almost all aspects of the aurora allowed for discounting solar influences – merely coincidence – and like pre-Copernican theories of the celestial sphere, ad hoc explanations could be summoned to save favorite explanatory schemes.

By the mid-1800s and accelerating thereafter, the aurora was also increasingly 'visible' as a result of heightened curiosity about Arctic nature in the wake of sensational polar expeditions. The aurora was becoming a recognized icon of the far-north and polar wilderness. Britain, France, United States, Germany, Sweden, and Austro-Hungary sent expeditions into the ice with much fanfare and celebrating or

mourning the results. Much of Europe and North America caught the polar bacillus resulting in broad circulation of images and literary description of Arctic nature, including the aurora. Travel literature to northern-most Europe, such as exotic "Lapland", further added to the aurora's prominence as a feature of the Arctic and sub-Arctic and with that endowed with a spectrum of cultural meanings and symbolism (Drivenes 1992; Fara 1996; Schimanski & Spring 2009, Spring 2009).

During the last third of the century a new round of 'peaceful' scientific-cultural competition began that sought to win national honour by clarifying the as yet puzzling aurora. The great advances in electro-magnetic and chemical theory as well as new instruments such as the spectroscope, coupled with efforts to coordinate simultaneous observations across national or local boundaries, seemed to promise a means to attain closure on the never-ending debate about the aurora. American, Austro-Hungarian, Danish, Finnish, German, Swedish, and Swiss researchers led the way; Norway played a relatively marginal and sporadic role. Publications in the1880s and 1890s that aimed at compiling accepted knowledge about the aurora revealed a bewildering degree of contradiction; to some, it seemed that it may yet be the case that the aurora borealis actually entailed at least two completely different phenomena arising from differing causes: the allegedly locally-arising far-northern brilliant displays and the more diffuse lights seen further south on a continental or hemispheric scale.[2]

Norway entered the field of auroral studies prominently in the early 1900s. Following Fridtjof Nansen's and the *Fram*'s triumphant return from the Arctic in 1896, physicist Kristian Birkeland capitalized on the national embrace of polar research and exploration to launch a school of Norwegian auroral research. Birkeland, Størmer, Krognes, and Vegard brought Norway into a dominant international position during the first three decades of the century. Birkeland set in motion a definitive link between solar activity and the aurora and magnetic storms. Drawing upon an analogy with the new scientific sensation, the cathode-ray tube, he postulated a solar source of charged particles that are caught in the Earth magnetic field and pulled down into the atmosphere in a narrow zone in far northern magnetic latitudes. Through expeditions to collect magnetic, atmopsheric electric, and auroral observations as well as laboratory models, he developed a highly suggestive theory that commanded international attention, but not necessarily consensual acceptance. His early efforts attracted the attention of his mathematician colleague at the university in Oslo, Carl Størmer. Although his painstaking calculations showing the trajectories of charged particles in a dipole magnetic field gave considerable plausibility to features of Birkeland's theory, Størmer's yet greater achievement entailed developing auroral photography. Beginning in 1910 Størmer and his assistants took hundreds of coordinated photographs of the aurora againt a background of stars from specific locations which then allowed, using triangulation, an undisbutable determination of the height and locatgion of the aurora in the sky. Fixing the lower limit to ca. 100km above the ground, Størmer, together with Krogness and Vegard, provided significant stability to auroral studies. Claims, such as Birkeland's and many others, that intimate relations exist between aurora and

[2] The rhetoric logic of Angot 1996 is structured by the author's desire to further his claim of two different phenomena.

weather phenomena were largely, but not entirely, swept aside as no clear mechanism could link phenomena separated vertically by some 90 km of atmosphere (Friedman 2012). Of much greater scientific value was the use of the aurora, together with spectroscopic measurments, to study the physical and chemical nature of the as yet inaccessible upper-most regions of the Earth's atmosphere (Kragh 2009).

By the mid-1900s, however, Norwegian investigators' claims for hegemony in this field were challenged as new disciplinary-specializations emerged related to the study of the upper atmosphere and solar-terrestrial interactions. Although a solar-terrestrial linkage was secure, critical features, such as the nature of the solar discharge and the processes of interaction between charged particles and the Earth's magnetic field. Moreover the discovery in the 1920s of a charged-layer in the Earth's atmosphere – the ionosphere –which is critical for long-distance radio transmission brought this region in which the aurora occurs into greater focus. After World War II when the physical environment of the Arctic assumed military strategic importance in East-West national security (Doel 2003). The Super Powers invested heavily in auroral and related topics, not the least because of the importance of trans-polar communications that are influenced by strong ionozation of the upper atmosphere, accompanying geophysical storms associated with powerful aurora. Auroral and related research was being conducted with sophisticated and expensive technologies based on large, well-staffed institutions including massive graduate-training programs. Also the high-energy collisions between charged particles and molecules in the upper atmosphere were able to provide insight into atomic processes scarcely able to be reproduced in laboratories. Many significant centres of research on the aurora emerged in places such as Texas and Colorado, where nobody sees aurora in the night sky. New highly-complex models of solar-terrestrial interactions emerged after the 1957-58 International Geophysical Year and the start of satellite and rocket measurements in near-space around Earth. Using a range of new instrumentation and coordinated observations shared by many nations, scientists transformed our understanding of the aurora and the broader interconnections between solar and terrestrial magnetic fields.

Norway no longer enjoyed a unique status in this field. Norwegian and other Nordic researchers nevertheless creatively carved out disciplinary niches for themselves and sought innovative collaborative arrangements within the massive international research endeavours. NATO's well-endowed basic research programs allowed European researchers, including Norwegians, to gain access to expensive technologies while also stimulating multi-national European networks of space and near-space investigators. Moreover sophisticated laboratories could now not just allow creating model analogies to phenomena associated with the aurora, but could study the physical features of plasma – the state of extremely energized charged matter such as emitted in the so-called solar wind – so that theories of how the terrestrial and solar magnetic fields interact could receive greater accuracy. Nordic scientists also found new ways to take advantage of their geographical location, especially once Sweden, Norway, and Finland developed institutions for research in the far north. Installations such as EISCAT offer evidence of how small northern nations can maintain significant positions in international endeavors as this advanced radar system for studying near-space plasma and magnetic disturbances with which

aurora is associated expanded to include not just other European nations, but also Japan and China.

Making sense of efforts to make sense of the aurora

This sketch points to a number of themes and perspectives that the history of efforts to comprehend the aurora poses for the history of science. Clearly for most of this history the aurora could not be brought into the laboratory for scrutiny. Nor could the aurora readily be 'disciplined' by skillful observing, with or without instruments. Still beginning in the 18th century, instruments and experiments were used in efforts to view, measure, position, allegedly replicate, simulate, and explain the marvel. These claims were supported and contested by direct observations of the aurora, which themselves often proved contradictory and confusing.

A key theme for the project then, from the 1700s, and continuing in different forms well into the 1900s, is that of constituting the object of inquiry: how did investigators try to stabilize this fleeting, frequently rapidly changing phenomenon? Agreement as to the aurora's appearance and visual characteristics was difficult to achieve for over two hundred years, thus making the task of achieving an international discourse on the aurora's nature and cause even more problematic. Nineteenth-century means of reproducing artists's renditions of the aurora could provide some basis for common discussion; similarly for the emergence of a descriptive vocabulary. Still, the often rapidly changing auroral forms, usually not visible to most investigators working in mid-latitudes, made basic discussion of the aurora a challenge. Prior to the achievement of a photographic atlas in 1930 of auroral forms, no single consistent classificatory schemes could be agreed upon. The project seeks to study how investigators attempted, with varying degrees of success, to construct the aurora as an object able to be described, discussed, and theorized through any number of different strategies; such as systematized field observations, illustrative and narrative textual strategies, laboratory proxies and analogies, and theoretical modelling.

"Making Sense of the Aurora" entails not only how the the aurora was established as an object for scientific study, but also how the right to make authoritative claims about this phenomenon changed over time and national context. Whose evidence counted – and why? How did participants in local and trans-national discussions negotiate the relative validity of statements about the aurora? A broad range of amateur and professional scientists; polar explorers and 'Lapland' travelers; dilitantee, popular-science writers, and professors all engaged in an on-going discourse or discourses about the aurora in the 18th and 19th centuries. Discussion about the aurora seems not to have had clear, fixed sharp boundaries defining who could contribute trustworthy observations and insight to the task.

The project therefore also necessarily includes the varied and changing interactions between amateur and professional science, popular culture and academic learning. By avoiding a-historical definitions of 'science' and 'popular culture' the project will contribute to analyzing how over time these realms changed configuration as well as how strategies for asserting authority varied and changed.

Such processes of so-called boundary-work between 'science' and 'non-science' also arose within institutionalized science. It was not always clear what type of scientific specialist was best qualified to investigate the polar aurora. Was it a chemical, astronomical, electromagnetic, and so forth phenomena? As the nineteenth-century disciplinary order of learning developed and mutated over time, the aurora could be found as a topic in several academic fields, as well as those sciences largely institutionalized on the margins of academic institutions, such as magnetic and meteorological observatories. In the twentieth century we can witness at times disciplinary specialists competing to assert privileged theoretical and methodological resources for explaining the aurora, while also attempting to discredit insights won through other disciplinary resources.

Efforts aiming to comprehend the aurora intersected with broader cultural and scientific interests. Why did investigators in different times and contexts consider the aurora an important phenomenon to study or write about? Why invest one's career or life to explain such a puzzling and ephemeral phenomon? There is nothing natural, or inevitable, in creating national traditions for the study of the aurora. Even for Norway, geographic location was by no means causal for the rise – comparatively late – of a national research effort focussed on the aurora or for the aurora to assume iconic *national* rather than just regional status.

Our various sub-projects then will contribute to the growing number of contextual studies of science that link practices in various sites for research, such as field stations and academic laboratories, with broader disciplinary or institutional dynamics embedded in societal realities. They will contribute to the historiography of experimentation which now transcends the role of instruments in the development of theories and laboratory practices to exploring how instruments confer authority, as well as determine what and how things can be observed, measured, and replicated, and therefore, also what can be thought. Instruments are not always strictly neutral. In many cases, the results are subjectively interpreted according to expectations, which was common especially in 18th century efforts to simulate the aurora in vacuum tubes or chemical-filled flasks.

Similarly new studies on science in the field sheds insight and raises questions related to social and cognitive practices in making knowledge outside of laboratories and seminar rooms. Scientists' interactions with local populations or with non-academic members of expeditions often proved crucial for success. Reliable observational practices in the field, and especially in harsh terrain, required specialised skills, which could not be learned from textbooks. How were such skills acquired and communicated; how did they serve as sources of authority and power? This growing literature that problematizes field work and its relation to science in the lab or observatory will be drawn upon – and contributed to – in the project.

In drawing to a close, I would underscore how historical study of the aurora is of value for gaining deeper understanding of the Nordic nations' changing identities with respect to polar and 'Northernly' cultures. Differences among the nations are clear, both with respect to when and why Northern identity was emphasized as well as willingness to engage in polar activities. For example, Denmark's long and changing engagement with Greenland and Iceland as well as polar exploration, Sweden's rise as a leading polar nation in the nineteenth century and decline after

World War I, Norway's polar turn in the aftermath of Nansen's expeditions as a means of declaring her right to be considered a sovereign '*kulturnasjon*', and Finland's nineteenth-century efforts to define its own cultural specificity including its 'northerness'. How national interests in studying and appropriating the aurora as a national 'specialty', as cultural icon, and as research subject within European context changed over these three hundred years.

Literature list

Alfred Angot, *The Aurora Borealis*. London: Kegan Paul, Trench, Trübner & Co. 1896.

Asgeir Brekke and Alv Egeland, *The Northern Lights: The Heritage and Science*, trans. James Anderson. Oslo, Gyldendal 1994.

Aspaas, P.P. and T.L. Hansen, "Geomagnetism by the North Pole, anno 1769: The Magnetic Observations of Maximilian Hell during his Venus Transit Expedition", i: *Centaurus*, 49, 2 (2007), 138-164.

Briggs, J.M. (1967). "Aurora and Enlightenment: Eighteenth-century explanations of the aurora borealis", in *Isis,* 58, 4 (1967), 491-503.

T. J. Brundtland, "Instrumenter under nordlyset". Foredrag holdt ved workshop, *Understanding the Aurora: Nordic Research into the Northern Light 1716-1917*, Alta 2009.

Sydney Chapman, "The Aurora Borealis as observerd from Norway", in: *Nature*, 118 (1926), 797-98.

Stephen Daniels, *Fields of Vision: Landscape Imagery and National Identity in England and the United States*. Oxford: Polity 1997.

R. E. Doel, "Constituting the postwar earth sciences: The military's influence on the environmental sciences in USA after 1945", in: *Social Studies of Science*, 33, 5 (2003), 635-66.

E.-A. Drivenes, "*La Recherche* – forskningsekspedisjonen Frankrike glemte", i *Historisk tidsskrift* 71, 1 (1992), 11-35.

R. H. Eather, *Majestic Lights: the Aurora in Science, History and Arts*. Washington D.C.: American Geophysical Union 1980.

Patricia Fara, "Northern possession: Laying claim to the aurora borealis", in: *Historians. Workshop* 42 (1996), 37-57.

R. M. Friedman, "Civilization and national honour: The rise of Norwegian geophysical and cosmic science", in *Making Sense of Space: A History of Norwegian Space Activities*, ed., J. P. Collett. Oslo: Universitetforlaget 1995, 3-39.

Friedman, "Making the aurora Norwegian: Science and image in the making of a tradition", in: *Interdisciplinary Science Reviews* 35, 1 (2010), 52-70.

Friedman, "Birkeland, Krogness, and the quest for a magnetic meteorology, 1898-1918: Stabilizing the aurora as a discipline-building strategy". Mss. in progess (2012).

Hermann Fritz, *Das Polarlicht*. Leipzig: Brockhaus, 1881.

Helge Kragh, "The spectrum of the aurora borealis: From enigma to laboratory science", in: *Historical Studies of the Natural Sciences*, 39, 4, (2009), 377-417.

Sem Lemström, *L'Aurore Boréale.* Paris: Authier-Villars 1886.

Svante Lindqvist, "The spectacle of science: An experiment in 1744 concerning the aurora borealis", in: *Configurations* 1 (1993), 57-94.
Simon Schama, Landscape and Memory London: Fontana, 1996.
Johan Schimanski and Ulrike Spring, "Explorers' bodies in arctic mediascapes: Celebrating the return of the Austro-Hungarian polar expedition in 1874", in: *Acta Borealia* 26 (2009), 53-79.
Spring, "Mellom vitenskap og under". Foredrag holdt ved den første nordisk nordlys-nettverk workshop: *Understanding the Aurora: Nordic Research into the Northern Light 1716-1917*, Alta, Februar 2009.
Sophus Tromholt, *Under the Rays of the Aurora Borealis: In the Land of the Lapps and Kvæns,* ed. Carl Siewers. London: Sampson Low, Marston, Searle, and Rivington 1885, Vol. I, 192-288.
Sven Widmalm, "The discovery of the aurora's effect on the magnetic needle: A case study on the creation of scientific authority in mid 18th-century Sweden". Paper presented at the 2nd Nordic aurora-network workshop, November 2009, Tromsø.

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Summary:
The article provides an introduction to a on-going research project based at University of Tromsø that seeks to analyze the history of efforts to make sense of the aurora borealis from the early 1700s through to the Cold War. Following brilliant displays of the northern lights in the early eighteenth century, natural philosophers strove to explain this phenomenon that evoked widespread fear and superstition. It was not until well into the twentieth century that consensual explanation emerged for this, one of the great enigmas in the history of science. From the start, the quest to explain the aurora borealis became enmeshed with patriotic science and nationalist sentiments. The history of efforts to understand the nature and cause of the aurora poses a number of thematic problems. Being a fleeting and at times rapidly changing phenomenon, only occasionally seen south of far-northern latitudes, the aurora needed to be constituted as an object able to be brought into the domain of rational science. Observational accounts of the aurora came most often from by persons living or travelling in the far north or in the Arctic, but these persons were generally

not trained scientists: Whose witnessing counted and how was authority negotiated among professional scientists and amateurs?

Keywords:
Aurora borealis, science in the far north, polar research, history of science

