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Author(s): Sterken, Christiaan; Aspaas, Per Pippin; Dunér, David; Kontler, László; Neul, Reinhard;
Pekonen, Osmo; Posch, Thomas

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A Voyage to Vardø.

A Scientific Account of an Unscientific Expedition

Christiaan Sterken¹, Per Pippin Aspaas,² David Dunér,^{3,4} László Kontler,⁵
Reinhard Neul,⁶ Osmo Pekonen,⁷ and Thomas Posch⁸

¹*Vrije Universiteit Brussel, Brussels, Belgium*

²*University of Tromsø, Norway*

³*History of Science and Ideas, Lund University, Sweden*

⁴*Centre for Cognitive Semiotics, Lund University, Sweden*

⁵*Central European University, Budapest, Hungary*

⁶*Robert Bosch GmbH, Stuttgart, Germany*

⁷*University of Jyväskylä, Finland*

⁸*Institut für Astronomie, University of Vienna, Austria*

Abstract. After the “Venus Transit Conference” that took place at the University of Tromsø from June 2 to June 3, 2012, participants were given the opportunity to either stay in Tromsø until the night of June 5–6, or to participate in a voyage to Finnmark, where the historical sites Vardø, Hammerfest, and the North Cape were to be visited. This voyage culminated in the observation of the 2012 transit of Venus at Vardø.

This paper gives a detailed account of this voyage that lasted from June 3 to June 6, and emphasizes the historical, scientific, philosophical, educational and cultural involvement of the participants of the voyage and of the local population.

The paper concludes with reflections on the prime condition for success of any of the Venus transit expeditions of the past: the weather must cooperate in the first place – not only during the quarter of a day of the transit, but also during the preceding weeks and months in order to allow the explorers to rightly determine their geographic positions and correctly set their clocks. The latter factor is no longer an issue nowadays, but the weather aspect remains today a limiting factor as much as it was 250 years ago.

Despite the variable and partly clouded weather at Vardø during the time of the transit, the participants of this expedition were able to observe Venus in front of the Sun – with interruptions due to quickly moving clouds – between 4.30 a.m. and the fourth contact at 06:53:20 a.m. A large number of impressive, partly ‘dramatic’ photographs have been taken especially in this time interval.

1. Preamble

Sir David Gill (1842–1914), who served as H. M. astronomer at the Cape of Good Hope from 1879 to 1907, remarked that “A scientific expedition may be said to have two histories . . .”¹ Gill made this observation in the introduction of a book written by his wife Isobel Sarah Gill, née Black (–1920), entitled *Six Months in Ascension*.

¹Quoted on page 191.

An Unscientific Account of a Scientific Expedition (Black 1878, p. 130). The book deals with her “unscientific” account of her husband’s expedition to the island of Ascension to determine the solar parallax by measuring the parallax of Mars at the opposition of 1860.²

Gill’s thoughts were reformulated almost one century later by McMullin (1970), who distinguishes two principal senses of “science”:

1. either a collection of propositions, i.e., theories, data, and interpretations that he calls S_1 , or
2. a second body of information S_2 that he considers as the ensemble of the activities that affect the scientific outcome in any way.

S_2 contains S_1 , but is far broader and vaguer than S_1 . Evidently, scientists are primarily interested in S_1 , whereas S_2 is soon forgotten – except by historians of science.

Non-academic factors can influence science in various ways. When a rare event such as a transit of Venus takes place, low-profiled astronomers might find themselves in the limelight of popular media channels. Historians can find funding to host conferences and get books published that otherwise would be considered too narrow. Indeed, entire populations will sometimes be affected by events that are usually in the domain of the more than average interested academic and/or “nerd”, bringing new interchanges between academia and the general public. This is exactly what happened when a party of 11 Tromsø-conference participants of very different education, language and background, traveled together to see the 2012 transit on the Midnight Sun at the unique location of Vardø, where Maximilian Hell carried out his successful measurements in 1769.

This article tells the story of our unscientific expedition whose aim it was to commemorate the scientific expedition of Father Hell, who visited the same region nearly 250 years earlier. In the spirit of Sir Gill’s statement, we have undertaken to write the “second story” of our voyage. As such, this paper, as well as the two preceding papers in these Proceedings, exactly deals with S_2 . Whereas the scientific merit of ground-based observations of a Venus transit is virtually nil today, the present documentation of our voyage in the global context of the commemoration and re-enactment of historically significant observations – including the interest that such events are capable of raising among the general public – certainly has some scholarly value.

History of science can be important for both local and national identity. Three commemorative plaques on Vardø Town Hall, which is located at the site where Father Hell’s observatory once stood, illustrate this quite vividly (see Fig. 1). The lowest one, in Norwegian, explains that

Upon orders from His Majesty King Christian VII, Maximilian Hell built an observatory at this site in order to study the transit of Venus on June 3, 1769.

This plaque was unveiled during a solemn ceremony led by the vice-mayor of Vardø on June 3, 1979, i.e. exactly 210 years after Hell made his observation (there was only a small settlement, a church and a fortress at Vardø Island in 1769, not yet a proper town). Upper left is a plaque that was set up in 2006 by the *Občianske*

²Her “unscientific” account, though, gives an excellent description of the scientific principles that were at the basis of this voyage.

združenie Maximilián Hell (Maximilian Hell Civic Association), a group of Slovaks traveling by car all the way from Slovakia for this purpose.³ To the right is a plaque added by the *Norvégiai Magyarok Baráti Köre* (Circle of Friends – Hungarians in Norway) on June 5, 2012. The laurel with a band of Hungarian flag colors was attached on the same occasion. From the name forms (Slovak “Maximilián” and Hungarian “Miksa”) one notices that the Jesuit Hell⁴ – a child of German-speaking parents who wrote all his works in Latin or German and whose loyalties were with his order, the international republic of letters, the Habsburg dynasty, and the multi-ethnic kingdom of Hungary – is now somewhat anachronistically claimed for several national scientific canons.



Figure 1. Commemorative plates on the façade of the Vardø Town Hall. Photo courtesy Knut Ramleth.

2. The cast

Per Pippin Aspaas (PPA) is an academic librarian at the University Library of Tromsø. He received his degree in Classical Philology at the University of Oslo in 2001 and his PhD in History of Science at the University of Tromsø in 2012. PPA is the author (or co-author) of several articles in English, French, German, Swedish, Finnish and Norwegian on various aspects of early modern science. Since 2010 he is a co-editor of *Sjuttonhundratalet: Nordic Yearbook for Eighteenth-Century Studies*. He has recently co-edited a thematic issue on the history of research into the Aurora Borealis (in *Acta Borealia* vol. 29, issue 2, 2012) and an anthology on the history of Travels in the North (forthcoming on Wehrhahn Verlag, 2013).

³See hell.planetarium.sk/expedicia.php and hell.planetarium.sk/expedicia02.php

⁴Baptized Maximilianus Rudolphus Höll, he changed his surname to Hell at the age of 35 (in 1755), and from then on consistently named himself Maximilianus or Maximilian Hell. See also the discussion in Section 5.3 and Kontler’s article in these Proceedings.

David Dunér (DD) is associate professor of history of science and ideas at Lund University, Sweden. In 2010–2011 he was research leader for the research project *Astrobiology: Past, Present and Future* at the Pufendorf Institute for Advanced Studies, Lund University. He currently is a team member of *Centre for Cognitive Semiotics* at Lund University. He obtained his PhD in 2004 with a dissertation on the Swedish natural philosopher and theologian Emanuel Swedenborg. A revised English version *The Natural Philosophy of Emanuel Swedenborg*, was published in 2012 by Springer Verlag. He was guest editor for a special issue of *Astrobiology* (October 2012) on the topic *The History and Philosophy of Astrobiology*, and he is Editor-in-chief of *Sjuttonhundratalet: Nordic Yearbook for Eighteenth-Century Studies*. Besides his professional interests, David Dunér is an avid bird watcher.

Päivi Koivisto (PK) is a research scientist at the Technical Research Centre of Finland in Espoo. She received her degree of doctor of science in technology in 1995 from Helsinki University of Technology. Her field of interest is engineering applications of electromagnetic field theory and numerical solutions of inverse problems.

László Kontler (LK) is professor of history at Central European University in Budapest, Hungary. His academic interests focus on intellectual history, especially political and historical thought, intercultural communication and reception, and more recently the history of scientific knowledge production in the early modern period and the Enlightenment. He has written extensively (in English and in Hungarian) on Edmund Burke and William Robertson, on European and Hungarian political thought, on the Enlightenment in European and Central European contexts, and he is the author of *A History of Hungary* (Palgrave Macmillan Publishers 2002).

Detlev Lutz (DL) works as a Team Manager at Allianz Global Assistance, and assists worldwide Allianz and car-industry customers in the event of breakdown or malfunction of their vehicle. At Berlin's Freie Universität he obtained a M.A. degree in communication, politics and law. Astronomy first struck him in 1983, when he – as an exchange-student to the USA – joined William Russel Blacke's astronomy course at the Plymouth-Carver High-School Planetarium in Massachusetts. His first encounter with the Venus-transit phenomenon was thanks to the publication of a novel about Le Gentil's unfortunate journey by his former journalistic teammate Lorenz Schröter. Having missed his first chance for observation in 2004, he gladly joined this group for chasing this year's return of this rare cosmic configuration at the historical location of Vardø.

Reinhard Neul (RN) is senior scientist at Corporate Research of Robert Bosch GmbH in the field of microsystem technology, particularly micromechanical sensors for automotive and consumer electronics applications. He studied electrical engineering and obtained his Ph.D. degree in 1992 in technical cybernetics from the University of Stuttgart. Besides his professional occupation, he enjoys amateur astronomy and, specifically, eclipse chasing. He already had the chance to observe and photograph the entire 2004 transit of Venus at optimal weather conditions from Stuttgart.

Osmo Pekonen (OP) is a Finnish author, mathematician and historian of science. Besides his scientific papers, he has published numerous books in Finnish, for instance a popular science book on the history of the study of the planet Venus (Pekonen 2012). A landmark in humanities is his verse translation (the first ever in Finnish) of the Anglo-Saxon epic Beowulf that he accomplished in collaboration with Clive Tolley (Oxford University). OP wrote one doctoral thesis on differential

geometry and another one (in French) on the trip of Pierre Louis Moreau de Maupertuis to Lapland to measure the shape of the Earth in 1736–1737. The latter work received Prix Chaix d'Est Ange of Institut de France in 2012. OP is a corresponding member of four scientific academies in France.

Päivi Maria Pihlaja (PMP) holds a PhD in history at the University of Helsinki (2009). Subjects of interest include history of learning and ideas, in particular research targeted at the northern regions in the eighteenth and nineteenth centuries.

Thomas Posch (TP) is an astronomer, historian of science and writer working at the University of Vienna. He holds a PhD in astronomy and a PhD in philosophy, and participated in the expedition from Tromsø to Vardø primarily because of his interest in Maximilian Hell's 1768–1769 expedition.

Johan Stén (JS) is a research scientist at the Technical Research Centre of Finland (VTT) in Espoo. He received his degree of doctor of science in technology in 1995 from Helsinki University of Technology, where he is a docent in electromagnetic theory specializing in boundary value problems in scattering and radiation. He is also working in the field of history and philosophy of science.

Christiaan Sterken (CS) received his MSc in mathematics at the University of Ghent (1969), his PhD in astronomy at the University of Brussels (1976), and his Habilitation degree at the University of Liège (1988). He is Research Director at the Belgian Fund for Scientific Research, and works at the Department of Physics and Astronomy at the University of Brussels. His principal field of research is the photometry of variable stars (luminous blue variables, massive binaries, pulsating main sequence stars, and cataclysmic variables), and comets. He also teaches courses in observational astronomy, and on the history of natural sciences at the University of Brussels. In 2006 he was accorded the 21st *Sarton Chair for the History of Sciences* at the University of Ghent (Belgium). CS is the Editor of *The Journal of Astronomical Data* (JAD), an Open-Access on-line astronomical journal.

3. The voyage

3.1. Leaving Tromsø, en route for Vardø

On June 3, around 5 p.m., the group boarded the Motor Ship *Lofoten*, a 87-m long vessel (see Fig. 2) built in 1964 in Norway and operated by the Norwegian passenger and freight line *Hurtigruten* on voyages along Norway's western and northern coasts.

The MS *Lofoten* is the most traditional ship of the Coastal Voyage fleet, and is Norway's only floating national historic monument.⁵ The ship features cosy wood paneling, shining copper staircase grips, and a command bridge that invites for real marine navigation (see Fig. 3). The voyagers were to stay on board for more than 40 hours, a stay though interrupted by two short excursions on shore (see below, and also Figs. 3–5).

⁵<http://www.hurtigruten.co.uk/norway/Ships/Hurtigrutens-fleet/MS-Lofoten/>



Figure 2. MS *Lofoten* at the Tromsø wharf. Photo DL.



Figure 3. Command Bridge of MS *Lofoten*. Photo CS.



Figure 4. On board of *Lofoten*: Päivi Koivisto and Johan Stén looking at a Venus transit paper in the Swedish amateur astronomy magazine *Populär Astronomi* (photo OP).

3.2. Stopover at Hammerfest

Around 5 a.m. on June 4, the ship called at the port of Hammerfest, from which a short taxi drive took us to the site of the *Struve Geodetic Arc* monument at Fuglenes. The Arc is a chain of geodetic triangulations stretching from Hammerfest to the Black Sea, covering $25^{\circ} 20'$ (2822 km) and linking more than 250 measuring stations. The survey was carried out between 1816 and 1855 under the direction of the German-born Russian astronomer Friedrich Georg Wilhelm Struve (1793–1864) and Carl Friedrich Tenner (1783–1859) in a large Russian–Scandinavian geodetic measurement enterprise. This allowed Struve to determine the oblateness of the Earth with great precision: 1 : 294.73 (versus the hitherto accepted value 1 : 302.5, see Viik & Randjärv 2011). In other words: the *Struve Geodetic Arc* yielded the result that one degree of latitude was 359 meters shorter on the Black Sea than on the coast of the Barents Sea. Figure 6 shows the triangulation scheme in Finnmark.

The entire Arc is a *World Heritage Site* comprised of 40 points of measurement between the Barents Sea and the outlet of the Danube. One of its key monuments is located in Estonia, on the grounds of the old Tartu (Dorpat) Observatory, the first point of the Arc (see Fig. 7, where the meridian of Tartu appears as a vertical line in the middle). The Struve Geodetic Arc was added to the UNESCO World Heritage List in 2005, and became the first technical and scientific object to be accorded this prestigious status.



Figure 5. On board of *Lofoten*. *Top*: Reinhard Neul and Detlev Lutz, *bottom*: Thomas Posch and Detlev Lutz examining the geography of Norway. Photos CS.



Figure 6. Northernmost triangles of Struve's arc. Source: Struve (1857).



Figure 7. *Left*: the obelisk at Hammerfest is one of the geodetic points of measurement. The inscription reads $70^{\circ} 40' 12''$ N, $23^{\circ} 39' 48''$ E (photo CS). *Right*: Geodetic Arc map as displayed on site. Credit: National Land Survey of Finland.



Figure 8. Hammerfest harbor. Location of ship and of obelisk linked by a line of length 840 meter. North is up and East is right. Based on GoogleEarth.

The Hammerfest obelisk (Fig. 7) gives the geographic coordinates of the site: $70^{\circ} 40' 12''$ N, $23^{\circ} 39' 48''$ E. Figure 8 illustrates the formidable facilities that high-tech navigation puts at our fingertips: the Google-image shows a 123-meter long vessel – probably *MS Nordkapp* or *MS Nordnorge* moored at about the same position as our *MS Lofoten* was that day ($70^{\circ} 39'.899$ N, $23^{\circ} 40'.876$ E as recorded from the ship's GPS by CS). Starting from this position on a Google Earth map, the Struve Geodetic Arc monument is located at a distance of 842 m NNW, and its calculated coordinates are $70^{\circ}40'12''.8$ N, $23^{\circ}39'53''.57$ E, thus deviating less than 10 m from the inscription on the obelisk. Early navigators, geodesists and transit of Venus observers, by contrast, needed many days or nights of painstaking observation, calibration, and calculation (hand-based on logarithmic tables), only to determine their geographical position.

Hammerfest has a historical link to Rypeklubben, the site of one of the two northern British Venus transit expeditions (the one led by Jeremiah Dixon), as described by Nils Voje Johansen in these Proceedings.

3.3. Stopover at North Cape ($71^{\circ}10'21''$ N)

The North Cape on Magerøya – the northernmost accessible point of the European continent⁶ – offers three impressive artistic landmarks, viz.,

1. an array of seven sculptures (Fig. 9) created by boys and girls (aged 8–12 years) from different nations, symbolizing *Peace on Earth*. The nearby monument *Mother and Child* was created by sculptor Eva Rybakken (Oslo),
2. the North Cape *Globe* erected in 1978, to mark this northernmost point,
3. the Obelisk, erected in 1873 by King Oscar II of Norway and Sweden to commemorate his visit to the North Cape (Fig. 10) .

⁶Actually, the northernmost point is Cape Knivskjellodden; North Cape is located $50''$ or about 1.5 km to the south of Knivskjellodden.

We were specially lucky with the weather thanks to a favorable wind. On the guided bus tour, we passed by the area where British observers were stationed in 1769 (see Nils Voje Johansen's paper in these Proceedings).⁷



Figure 9. *Left:* the *Children of the Earth* monument on the Nordkapp plateau. *Right:* statue of mother and child. Photo CS.



Figure 10. *Left:* Per Pippin Aspaas, Thomas Posch, Reinhard Neul and Detlev Lutz in front of the metallic globe at Nordkapp. *Right:* Reinhard Neul at the hotel window in Vardø, hours before he observed the transit from that location. Photos CS.

⁷William Bayly's temporary observatory was near Honningsvåg Airport.

Later on the same day we passed by the abandoned settlement Kjelvik, which Father Hell visited twice on his voyage to and from Vardø, on October 3–7, 1768 and July 6–18, 1769, respectively. Thanks to the good weather, we had a very nice view of the village and its surroundings, clearly resembling the perspective on a beautiful copperprint by Maximilian Hell (Fig. 11).

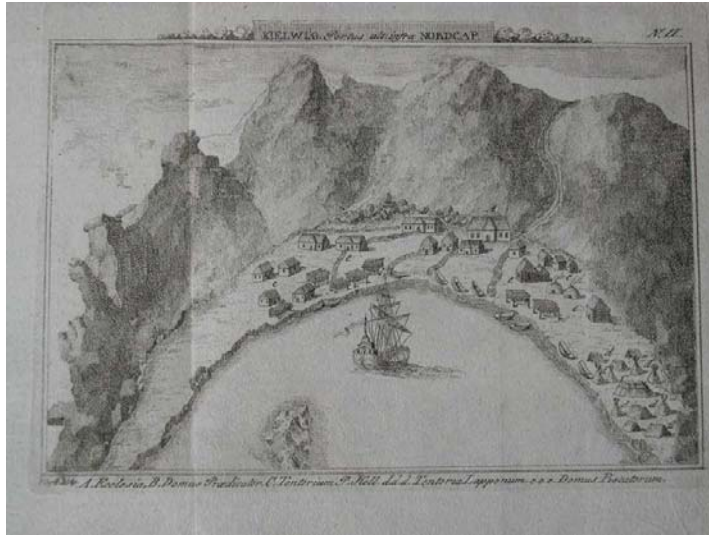


Figure 11. View of Kjelvik. From Hell's *Ephemerides Astronomicae ad Meridianum Vindobonensem Anni 1791* (1790).

4. Vardø

4.1. Arrival at Vardø

According to notes taken by Thomas Posch, our arrival was almost exactly at 4 a.m. on June 5 (i.e., 2 a.m. UT). Our voyage, therefore, had lasted 1.5 days, a duration that may be compared with that of Maximilian Hell and his colleagues from Tromsø to Vardø in 1768 – from September 26 to October 11: 15 days! The sky was completely overcast and there was little evidence for any imminent change of the weather because of the slow motion of the clouds. In fact, it would last almost exactly 24 hours until the Sun would become visible near the end of the transit. The majority of the team shared accommodation at the *Vardø videregående skole*⁸, whereas two participants (RN and CS) checked in at the Vardø Hotel.

Norway's easternmost town, now a municipality of approximately 2.200 inhabitants,⁹ evolved from a fishing village to a frozen-fish industry after 1945 (Finstad 2004), an industry that replaced traditional home-based fish processing in Vardø.¹⁰ Little is left these days of Vardø's fish-processing industry, and the city's emphasis

⁸The local high school, see <http://www.vardo.vgs.no/>

⁹The population peaked around 4200 in the 1968–1970, see the population statistics provided by <http://www.ssb.no/folkendrhist>.

¹⁰Balsvik (1989/2007) pp. 134–136 describes that unmarried daughters, widows and youths prepared the cod for the drying racks, see also Finstad (2004), p. 36.

has shifted towards tourism (in particular attracting birdwatchers to Hornøya and Finnmark County).¹¹

4.2. Vardøhus Festning

Vardø is the world's most northern fortress village, and its *Vardøhus Festning* is still in use – although not any more for military purposes: military operational presence is rather concentrated at the nearby US military radar installation operated by the Norwegian army. The first fortress on the site dates back to the early 14th century, and the present fortress dates from 1738. The square compound is surrounded by star shaped fortifications of earth walls, and houses the commander's residence and officer's quarters, powder storehouse, barrack, and prison (see Fig. 12). The fortress also functions as a museum facility, and acts as a flag and salute station.¹²



Figure 12. *Vardøhus Festning*. Photo courtesy Knut Ramleth.

4.3. Witches monument

The late artist Louise Bourgeois (1911–2010) and architect Peter Zumthor designed the *Steilneset Memorial* in Vardø to honor the alleged witches (77 women and 14 men) that were on trial – and even burned at the stake – as a result of the seventeenth-century witch hunts and the ensuing court trials, many of which were conducted at the *Vardøhus Festning*. The monument consists of two parts, of which

¹¹See www.gonorway.no/norway/counties/finnmark/vardoe/76378bfebb2bf20/index.html

¹²Historical details and diverse maps and drawings are available at www.verneplaner.no/?f=vardohus&id=107826&a=4.

the 100-m Zumthor wood-frame pavilion hides more history-of-science symbolism than any tourist leaflet dares to suggest. Inside the structure, visitors walk through a long corridor with 91 windows, each lit by a dim bulb that shines day and night (see Fig. 13).



Figure 13. Peter Zumthor's *Steilneset Memorial* pavilion, and one of the framed filament bulbs. Photos CS.

Besides the windows are texts displayed on black linen that document, for each individual woman and man, the details of the trial. These texts read as contemporary scientific posters – complete with date, value of the estate of the accused, the accusations, confessions, convictions and outcome of each case. The legal documents recording all the witch trials that took place in seventeenth-century Finnmark have recently been edited and published by Liv Helene Willumsen (2010), see also Willumsen (2011).

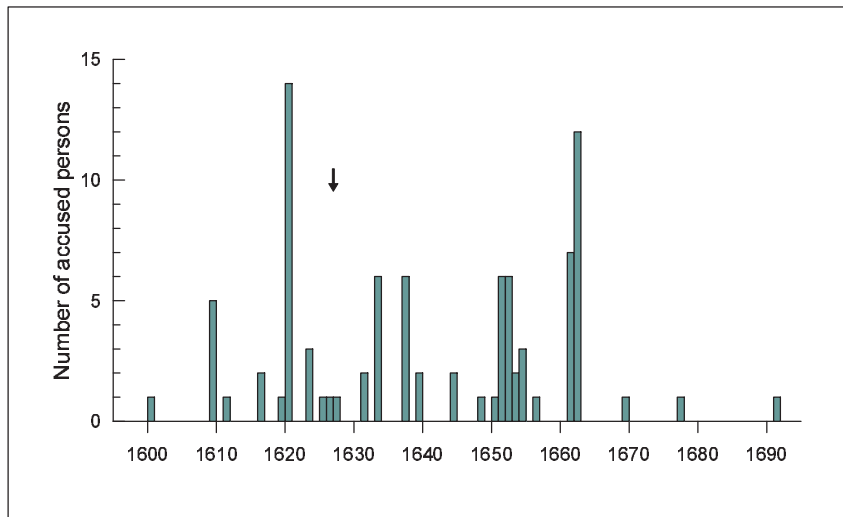


Figure 14. Histogram of number of persons accused of witchcraft as a function of time. The arrow represents the moment of Kepler's predicted first transit of Venus in 1631. Based on data collected at the Vardø *Steilneset Memorial*.

The first point to consider here is that the outcome of each case was very often based on "evidence" that came forth from a water ordeal, i.e., a *Judicium Dei* – a procedure based on the premise that God would help the innocent by performing a miracle on his behalf. Some of the cases are really telling: Anne, Laurits Pedersen's wife, was brought before the court in July 1610, a couple of months after Galileo published his *Sidereus Nuncius*. And Quiwe Baarsen, brought before the court in

May 1627, the year that Kepler published his *Tabulae Rudolphinae* that led to the very first prediction of a transit of Venus.

Figure 14 shows a histogram of the number of persons accused of witchcraft over the time period covered. The arrow represents the moment of Kepler's predicted first transit of Venus in 1631. The distribution is quite uneven, with irregular spells of several years, but also with peaks caused by series of linked witchcraft trials. Also Kepler's mother, Katharina Guldenmann (1546–1622), was accused of witchcraft in 1619 and put to prison one year later.¹³

The lesson to be learned from these facts is that at all times from Antiquity through the Age of Reason and into modern times, a bewildering conjugation of advanced scientific thought can coexist with retarded and brutal beliefs and convictions, and that such lack of insight and education always brings harm to many innocent people. This is true of all times and of all places, and this thought is perhaps the prime essence of the Vardø *Steilneset* monument. The close geographical link with an early-modern successful scientific expedition only illustrates the permanent need for ongoing teaching of the sciences and of their historiography.



Figure 15. Disembarkation at Vardø: David Dunér, Per Pippin Aspaas, Thomas Posch, Christiaan Sterken, Päivi Maria Pihlaja, Osmo Pekonen, Reinhard Neul, László Kontler, Päivi Koivisto and Johan Stén.

5. Living the transit

The Venus Transit Event in Vardø was a huge undertaking, the city being a *lieu de mémoire* for several groups, viz., Finno-Ugrianists, astronomers, historians of science, Catholics (and Jesuits in particular), Slovaks, Hungarians and Austrians, plus the Vardø population themselves.

¹³Voelkel (1999).



Figure 16. Per Pippin Aspaas (*right*) interviewed by the Norwegian Broadcasting Corporation reporter Per Olav Alvestad (*left*). Photo DL.

Members of the group (the Norwegian-speaking Per Pippin Aspaas and the Swedish-speaking Johan Stén) gave lectures at the local *Kulturhus*. Per Pippin Aspaas also made his debut on National TV for 900 000 spectators during the live program of NRK (Norwegian Broadcasting Corporation), see Fig. 16. Local school teachers explained the transit event to the public, see Fig. 17.



Figure 17. Vardø teacher Steinar Kristiansen explains the transit event to the local populace. The white circular disks are plastic fastfood plates: the rightmost one serves as a projection screen, the left ones are meant to prevent exposing the eye to direct sunlight. Note the low water level: at 00:51 a.m., when this photo was taken, the water level observed at Vardø was 22 cm above the tidal datum to which soundings on a chart are referred, i.e., just above the 2012 minimum of 19 cm (the 2012 maximum was 375 cm, see <http://vannstand.no/>). Photo RN.

Quite a number of official people traveled to Vardø for the transit celebration: several representatives of the churches, of the Norwegian army, and deputy heads of mission of the Austrian and Hungarian Embassies in Oslo (Fig. 18). The transit event was hosted against the background of a series of impressive cultural events.



Figure 18. Mr. Georg Schnetzer (*left*) of the Austrian Embassy in Oslo, and Mr. Tamás Vörös (*right*) of the Embassy of Hungary in Oslo in the lobby of Hotel Vardø. Photo CS.



Figure 19. Elisabeth Eikeland, Commander at Vardøhus Fortress poses in front of the gallery of her predecessors. Photo OP.

5.1. Concert at Vardøhus Fortress

On Tuesday June 5 we were offered a Baroque concert at Vardøhus Fortress under the motto *Where is Venus? A journey into the Habsburg dynasty music*, featuring compositions from the 1750–1830 timeframe. The arias were from Joseph Haydn's opera *Il mondo della luna*¹⁴ (1777). The soprano was Felicia Kaijser, the cembalo was played by Lars Henrik Johansen, and the presentation was by Anne-Lise Berntsen.

5.2. Dinner ceremony

The Mayor of Vardø, Lasse Haughom, hosted a dinner at the Vardø Hotel. The dinner was attended by several dignitaries, among whom Elisabeth Eikeland (Commander Vardøhus Fortress, Fig. 19) and Brigadier John Einar Hynaas (Commander of the History and Tradition Division of the Norwegian Armed Forces),¹⁵ who drank a toast to the health of King Harald V of Norway. The Mayor offered to each country representative a copy of Randi Rønning Balsvik's *Vardø – Grensepost og fiskevær*,¹⁶ a memorial book about the history of Vardø over the time span 1307–2007.

5.3. Religious service

A divine Service of ecumenical character comprising elements of Lutheran and Catholic eucharistic liturgy was conducted at the Vardø church. One of the participating priests was of Hungarian origin: Reverend János Kona is a Lutheran priest who settled in Northern Norway at Tana, a neighboring parish. The priest who gave the sermon was Catholic, and of Polish origin: Pater Dariuz Banasiak, O. Cist., superior of the Cistercian Monastery of Our Lady Queen of the Fjords, based in the Lofoten islands in Northern Norway. Rev. Cato Torsvik, the local Norwegian Lutheran priest, presided the service, which appropriately included a *Te Deum*, just as in 1769.

The music was mainly performed by *Vardø Bymusikk*, the local orchestra. Some of the music was profane, including *Bunch o'bones*, *Twinkling Flutes* and *Bugler's Holiday*. During the night, the same band played many other pieces, and marched in the street playing the *Transit of Venus March* by John Philip Sousa (Fig. 20).

The service emphasized the Hungarian origin of János Sajnovics and possibly also of Maximilian Hell. The Hungarian deputy head of mission Tamás Vörös spoke nicely, recalling the information from Sajnovics' work *Demonstratio Idioma Ungarorum et Laponum idem esse*,¹⁷ that the two Jesuits were able to recognize the Finno-Ugrian language relationship when hearing one of the local inhabitants reciting the Lord's Prayer. Besides astronomy, Hell and Sajnovics also engaged in the empirical study of the Lappish (Sami) language and confirmed earlier theories of its relationship with Hungarian, thereby seriously contributing to the development of

¹⁴ *The World on the Moon*, which features “the star Hesperus”: in Greek mythology, Hesperus (in Ancient Greek Hesperos) is the Evening Star, the planet Venus in the evening.

¹⁵ *Forsvarets avdeling for kultur og tradisjon*.

¹⁶ *Vardø, borderpost or fishing village*, (1989/2007).

¹⁷ Sajnovics (1770), pp. 14–15. This quotation actually refers to Maursund in present-day Troms County, and Sajnovics explicitly categorizes the reciter of the *Pater Noster* as a Carelian (i.e. Finnish) immigrant, not as a Sami native. Moreover, the episode is not even mentioned in the diary or in any of the numerous letters that Hell and Sajnovics wrote while in Vardø. It is only recorded in Sajnovics' treatise, which was written in Copenhagen about a year and a half after the visit to Maursund.



Figure 20. *Left: Vardø Bymusikk performing. Right: Thomas Posch setting up his equipment. Vardø church in the background. Photos OP.*

comparative Finno-Ugric linguistics. For linguists, Sajnovics is mainly known for his *Demonstratio* in which he addressed the topic (see the text on the white plaque in Fig. 1). He even launched a language reform, trying to introduce Sami words into Hungarian (see Kontler, in these Proceedings).



Figure 21. First day of issue cover commemorating the 2012 transit. Courtesy Steinar Borch Jensen.

5.4. The transit proper

A party tent had been erected on the place where Hell carried out his observations, i.e., the location of the present town hall, $70^{\circ}22'15''$ N, $31^{\circ}06'26''$ E.¹⁸ Artillery

¹⁸These GPS coordinates should not be directly compared to Hell's coordinates, because the latter refer to the plumb line and the local meridian, whereas the GPS data refer to the geoid model.

salutes were fired from Vardøhus Fortress at the beginning (and at the end) of the transit,¹⁹ but the main problem was that the sky was totally overcast, with not even a glimpse of the Midnight Sun. Fortunately, the weather in Tromsø was splendid (see Thorvaldsen's paper in these Proceedings) and we could enjoy the view on a giant TV screen (Fig. 22). The bad weather persisted for several hours, and when the majority of local inhabitants had chosen to return home, only a dozen of hard-core Venus-watchers kept vigil. Between 04:30 and 04:40, the Sun and Venus became visible through the heavy clouds, but to our disappointment, this short phase was followed by total obscuration, and even light rainfall at 05:04 a.m.



Figure 22. László Kontler, Päivi Maria Pihlaja, Reinhard Neul, David Dunér, Detlev Lutz, Osmo Pekonen and Per Pippin Aspaas looking in awe at the beautiful transit pictures broadcasted from Tromsø. Photo CS.

To illustrate the intensity of desperation, the following anecdote is worth telling. Around 03:30, Thomas Posch and Chris Sterken were looking for the other team members who had somehow disappeared, when the latter said that, from his life-long experience as an observer, it would just suffice to go to bed in order to see clear skies at wakeup. Thomas begged “Chris, you are the oldest, thus you should sacrifice yourself, please go to bed”. CS thus went for an alarm-clock assisted nap, and his belief system worked wonderfully well: the weather slightly improved around 5:30 – about 1.5 hours before egress – and Osmo Pekonen alerted the team lodged at the school (Fig. 23) and the positions indicated in Fig. 24 were taken. Osmo and Thomas walked from location O2 to place O3 between 05:04 and 05:25 a.m., and observed from there until the transit was entirely over. Thomas used viewing and imaging equipment, viz., a Canon EOS 550D digital camera (crop factor 1.6), a Canon EF 70-300mm 1:4.0–5.6 IS USM (used at $f = 300$ mm, corresponding to $f = 480$ mm due to crop factor) telelens, and a Carl Zeiss Mirotar T* 500 mm 1:8.0 (corresponding to $f = 800$ mm due to crop factor).

¹⁹That is, at 00^h04^m51^s and 06^s53^m20^s (GMT +2), respectively.



Figure 23. The very first minutes of actual observations of the transit: Per Pippin Aspaas, Päivi Maria Pihlaja, Osmo Pekonen, Johan Stén, Thomas Posch, and David Dunér. Per Pippin Aspaas and Osmo Pekonen are wearing the official T-shirts created for the event. Photo LK.

The most comfortable observing position, no doubt, was Reinhard Neul's (Figs. 10 and 25). As there were only thick clouds and no Sun visible from the beginning of the transit at midnight until 4 a.m., he decided to go to bed and set up the alarm clock at 5 and at 6. At 5 the sky was still completely covered, but before the alarm clock rang at 6, he woke up due to sunrays breaking through the windows. The sudden clearing of the patch of sky around the Sun confronted him with a dilemma: either move the equipment outside, and risk that viewing would be over by the time that the equipment was set up, or just "shoot" Venus from the hotel window. The latter option proved to be the better, and in so doing the situation already experienced in 1761 at the Copenhagen Rundetårn by the brothers Christian and Peder Horrebow – when "the phenomenon was already over"²⁰ by the time Peder Horrebow had finished the setup, was avoided.

Reinhard Neul used a telescope from William Optics, USA, with an apochromatic triplet lens made of SD glass by Lomo in Russia (aperture 80 mm and focal length 600 mm). The focal length was extended with an apochromatic Barlow lens: the Flat Field Converter from Baader Planetarium in Germany, which uses fluorite (CaF_2) as optical elements. As such, the effective focal length reaches about 1450 mm, large enough to fill the frame of the used DSLR Canon 1000D APS-C size sensor. For observing the Sun, he mostly applied a self-made filter using Baader AstroSolar film with density ND 5. He had tested the whole setup of the telescope in the hotel room the evening before the transit. The time recorded by his camera clock²¹ had been synchronized in Stuttgart with a radio controlled clock just before his departure, and was verified after returning home: the clock ran one second late in about one week.

²⁰Translation taken from Aspaas (2012), p. 273.

²¹Central European Summer Time MESZ = UTC + 2.

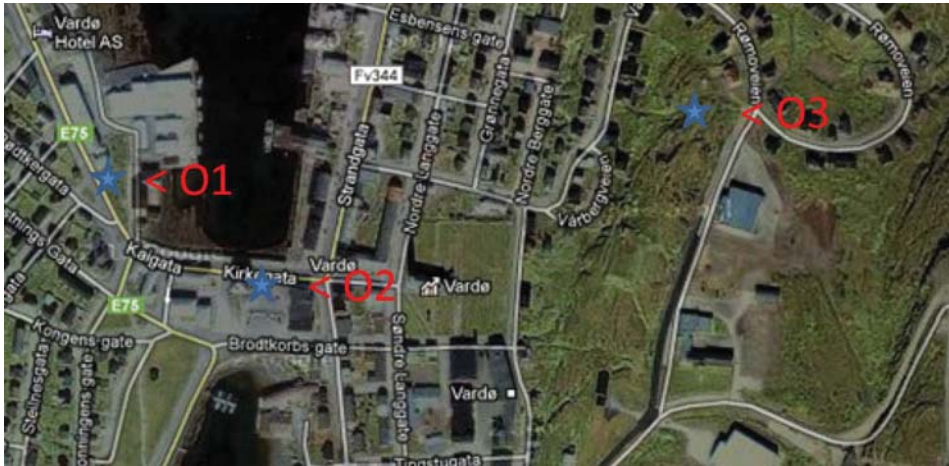


Figure 24. Map with observing locations prepared by TP. O1: PPA, DD, PK, LK, OP, PMP, TP and JS from 04:30 local (summer) time to 05:03. This position is very close to Hotel Vardø where RN and CS observed from around 5 a.m. till the end of the transit. O2: Original observing place of Maximilian Hell in 1769, and observing place of the successful and patient local observer Kai-Egil Evjen. O3: OP and TP from 05:25 until the end of the transit, location ~ 560 m East of Hotel Vardø.



Figure 25. Reinhard Neul's observing room at Hotel Vardø. Note the heavy books (Balsvik 1989/2007) that helped to stabilize the telescope mount. Photo RN.

Figure 26 shows the Venus trajectory across the solar disk in equatorial coordinates²² and in altazimuth coordinates (azimuth and elevation)²³. The calculated

²²Geocentric right ascension and declination – a coordinate system that refers to the celestial equator – derived from the orbital elements of the Sun and Venus at intervals of 1 minute in time.

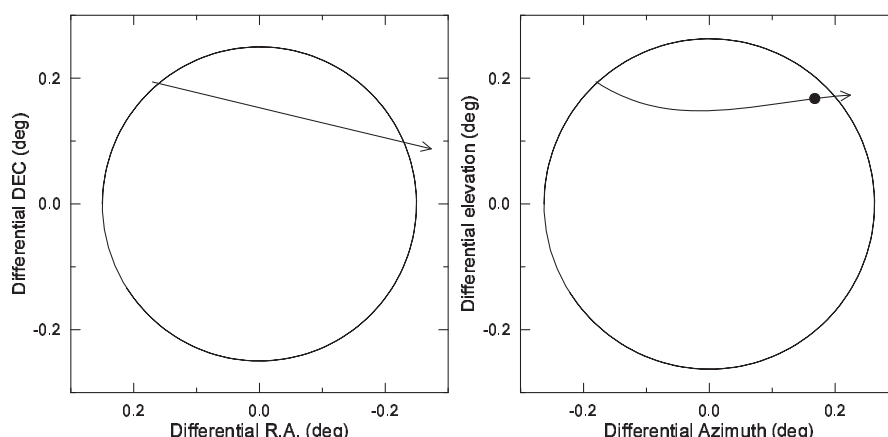


Figure 26. Venus trajectory across the solar disk. *Left*: trajectory in right ascension – declination (North is up and East is left). *Right*: the curved line is the trajectory as was to be seen in Vardø (North is up and West is left); the black dot represents Venus at 06:05:45 local time when Reinhard Neul took the picture shown in Fig. 28.

angular diameter of the Sun on June 6 was $31'.5$, and Venus had an apparent diameter of $57''.8$, and also the path of Venus as it was to be seen in Vardø. Figure 27 is a polar diagram showing azimuth and height (elevation above horizon) of the Sun on June 5–6. The thick segment represents that part of the trajectory during which Venus was on the solar disk for an observer at Vardø.

The Vardø observers missed the crucial stages of exterior and interior contacts at ingress, and also the exterior contact at egress, the Alta observers saw both ingress contacts, but entirely missed the egress, whereas the Tromsø observers got it all. The worst off was Detlev Lutz, who saw the clearing around the Sun when boarding the delayed *Hurtigruten* vessel *Midnattsol*. Once on deck, the Sun disappeared again only to reappear for one rare moment when he was looking from the inside of the upper deck, but the automatic window-cleaning destroyed all hopes for him to really spot the transit: Detlev's bad luck was almost worse than Le Gentil's in 1769.

Not to mention the Dutch visitor Steven van Roode,²⁴ who traveled from Vardø to Vadsø during the night, hoping for better weather because webcams had indicated partly blue skies over Vadsø during the time when we had bad weather in Vardø. Therefore, Thomas Posch even considered to leave Vardø for Vadsø together with Steven, but in the end he decided not to pursue that idea. As it turned out, it did clear up a bit in Vadsø towards the morning, but not enough to see the last phase of the transit, so van Roode deeply regretted having left Vardø.²⁵

Figure 28 shows two images taken by Reinhard Neul (at 06:05:45 MESZ) and by Thomas Posch. A keen observer will notice the basic difference between the

²³Azimuth and height were derived from right ascension and declination using transformation formulae from spherical astronomy.

²⁴Editor of the website www.transitofvenus.nl

²⁵van Roode (2012).

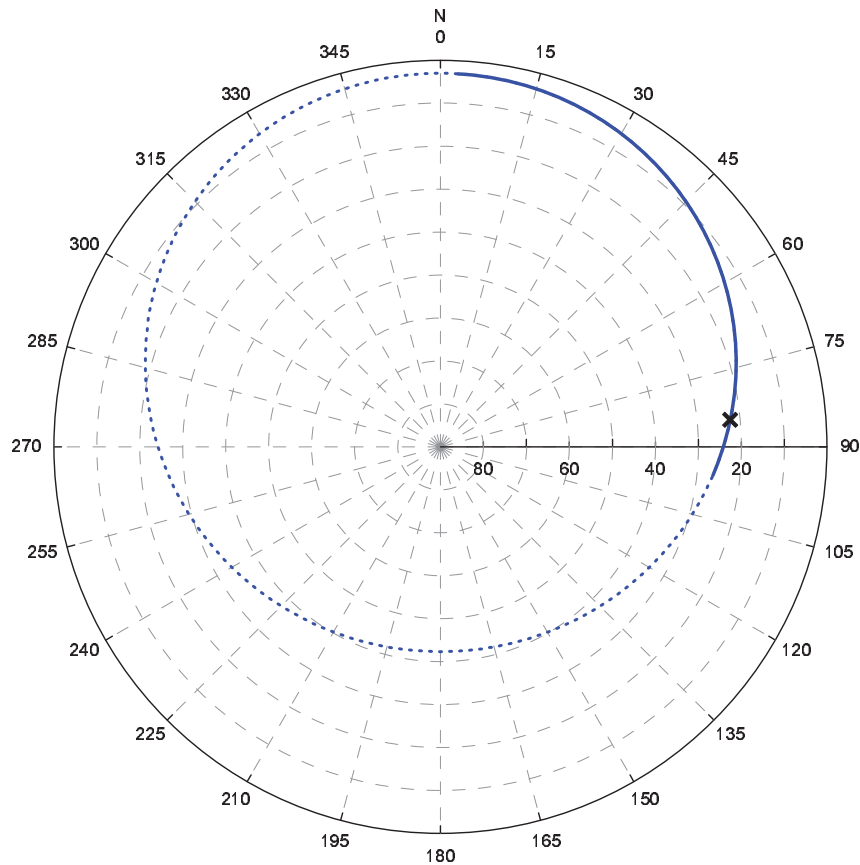


Figure 27. Venus trajectory across the solar disk: polar diagram with azimuth 0–360° (north is at top, the azimuth circle represents the local horizon), and height (elevation above horizon) is indicated along the radius axis. The dashed curve represents the trajectory of the Sun from 5:00 p.m. on June 5 till 5:00 p.m. on June 6. The thick segment represents that part of the trajectory during which Venus was on the solar disk for an observer at Vardø. The × symbol corresponds to the position of Venus at 06:05:45 MESZ (Fig. 28).

two pictures (except for the clouds): Neul used an equatorial mount,²⁶ whereas Posch used an altazimuth telescope mount (see Fig. 20). Comparison of both photographs using the positions of the sunspots reveals a rotation around the center of the field of view. This phenomenon, known as *Field Rotation*, arises from the fact that altazimuth telescope mounts are always aligned with respect to the local horizon with the camera always in the same position during a sequence of exposures. Human vision is also affected by this rotation, although we are not aware of this. The effect is dramatically illustrated in the movie of Misch & Sheehan (2004), that is based on photographic plates collected with a photoheliograph by David P. Todd at the 1882 Venus transit.

²⁶He aligned the polar axis as well as possible considering the local facilities, i.e., the axis of the mount was not star-adjusted but was aligned only by using a compass and an inclinometer, hence this photograph may also reveal an absolutely minor rotation effect.



Figure 28. Venus in transit. *Left*: photo Reinhard Neul. *Right*: photo Thomas Posch.

But even if weather had been cooperative, the differences in latitude and longitude between Tromsø and Vardø (a distance less than 500 km as the crow flies) would of course never yield an acceptable estimate of the solar parallax.



Figure 29. Venus in transit. *Left*: very first glimpse of the transit at 04:32:02, photo courtesy Kai-Egil Evjen (taken with a Sony A350 camera and a Minolta 300-mm APO/f2.8 lens). *Right*: photo courtesy François Moreau (taken at 06:10 a.m. through a density 5.0 filter with a Sanyo VPC-HD2000 digital camera mounted on an altazimuth tripod).

6. Departure from Vardø

In the early afternoon of June 6 the entire party left Vardø by plane and traveled back to Tromsø, where some of the participants continued their trip home the next morning (Figs. 30 and 31).

7. Closing remarks

The description of the Vardø weather conditions, in combination with the descriptions in the papers by Ratier and by Thorvaldsen in these Proceedings, vividly illus-



Figure 30. David Dunér and Chris Sterken board a Widerøe plane at Vardø airport. Photo RN.



Figure 31. Suzanne Débarbat admiring Reinhard Neul's imaging equipment at Tromsø airport. Photo CS.

trates the extreme impact of the weather on the outcome of a scientific enterprise of the magnitude of a Venus transit expedition today – despite our real-time weather evolution reports – and even more so in the past. The history of the pursuit of the Earth–Sun distance by the transit method is littered by laments of numerous desperate observers. One of Maximilian Hell's letters, for example, contains a telling note on the weather at Vardø in particular:

[...] I got my observatory ready to the extent that if the weather permits it, I will be able to make the necessary observations; however, the sky here at Vardø is truly not suitable for any astronomer. [...] Since the 19th of November, when we saw the Sun for the last time, I could see the Moon and the stars only twice, and only through clouds, while during all the other days and nights, the sky looked so dark that one should believe the Sun, Moon, Planets and Stars to be no longer in the sky at all, or else ourselves not to be on the Earth any longer.²⁷

Sajnovics' travel diary gives an idea of the suspense felt during the crucial moments of observation (here referring to the solar eclipse occurring the day after the transit):

4th [June], Sunday the 3rd after Pentecost. After mass for the Holy Trinity, the corresponding altitudes were recorded in the clearest of skies, with some wind from the North. During these operations, at 10:09 [a.m.] according to the Copenhagen clock, the eclipse of the Sun was noted to begin. Honourable Father Hell observed this moment; and I too observed the end. Then the meridian was recorded, and after lunch the corresponding altitudes of the Sun. As I take down the last of these altitudes, suddenly the entire sky is completely filled by the thickest of fog, falling down to the ground like dew or drizzle, covering everything in a darkness that is likely to last for a very long time. How bad if it had been like this yesterday!²⁸

It appears that really a miracle is needed, and this is what Sajnovics literally expressed to Father Splényi²⁹ in Tyrnavia, dated Vardø June 6, 1769, and quoted by Aspaas (2012) p. 306:

I for my part will cherish the magnitude of this miracle for as long as I live.

In 1769 Jacques-André Mallet and Jean-Louis Pictet also experienced overcast skies at their sites on the Kola Peninsula: Pictet could not see anything at all, whereas Mallet could observe part of the ingress. They shared this fate with other observers in northern Europe (Aspaas 2012, and references therein).³⁰ In the same

²⁷ *mein observatorium habe ich so weit in stande, daß wenn es der him[m]el zu lassen wird, meine [nöthige] observationes [werde] machen können, allein der him[m]el, der [hiesige] Wardöer him[m]el, dieser ist in wahrheit für keinen Astronom. [...] in wahrheit seit dem 19ten November da wir die Sonne das letztemahl sahen, sahe ich den Mond und [die] Sterne nur zwei mahl, und diese nur durch die wolken, alle übrige täge und nächte sichtet der him[m]el so finster aus, das mann glauben sollte Sonne, Monde, Planeten und Sterne seyen nicht mehr am him[m]el, oder wir selbstn wären nicht mehr auf Erden [...]* Translated by Thomas Posch, from a letter from Maximilian Hell to the County Prefect of Finnmark Eiler Hagerup in Talvik, dated Vardø 27 December 1768.

²⁸ Translation from Aspaas (2012) p. 305.

²⁹ Probably Ferenc Xavér Splényi (1731–1795), Bishop of Vác 1787–1795.

³⁰ It should be mentioned, however, that Anders Planman got excellent observations of both contacts at ingress in Kajaani. He also recorded the exterior contact at egress, though during less favorable weather conditions. Furthermore Stepan Rumovskii, along with two assistants, got quite accurate observations from Kola town. However, they made these observations through a thin layer of cloud, a circumstance which seems to have made Rumovskii doubtful regarding the accuracy of his observations. A Danish team led by Peder Horrebow at Dønnes in Nord-

year 1769, the secretary of the Danish Society of Sciences Henrik Hielmstjerne wrote to his colleague Johann Albrecht Euler in Saint Petersburg that Danish efforts to observe the transit of Venus from the Round Tower in Copenhagen, from the nearby Frederiksberg Palace, as well as from Trondheim and Nordland County in Norway

[. . .] have met with the same fate as that of the Englishmen situated at Nordkapp, as well as the Dutchmen, Germans, etc: either the sky has been cloudy or the light of the Sun has been too feeble for one to expect much from their observations; but, on the other hand, Professor Hill [sic] has had the best sunshine one could have hoped for; the acknowledged talents of this observer will guarantee the exactitude of his observations; we expect him to arrive here in two or three weeks, he will not hesitate to publish his findings and I shall not neglect to send them to You, in the meantime I have the honor to remain [etc.]³¹

Lomb (2011) gives multiple examples of failures of nineteenth-century British and French expeditions. And Jean-Charles Houzeau also had his share of bad-weather luck in 1882 when he lost about half of the transit at “his” Texas observing station, whereas his colleagues in Santiago de Chile had splendid weather (see Sterken in these Proceedings).

Mrs Gill concludes in her book (Black 1878) that

If any one desires to form an adequate idea of the difficulties of measuring the Sun's distance to a million of miles, *let him try to measure the thickness of a florin-piece, looked at, edge on, a mile off.*

This is a fair statement about the cutting-edge technology that is needed to succeed. That is, when the weather cooperates – not only during the quarter of the day of a transit, but in the preceding weeks and months so that the explorers could rightly determine their geographic positions and correctly set their clocks. The latter factor is no longer an issue today, but the weather aspect, as Fig. 32 vividly shows, remains a limiting factor as much as it was 250 years ago.

Nothing of this is surprising of course: in 1764 Nevil Maskelyne wrote of his experiences on Saint Helena in the southern Atlantic (Maskelyne 1764):

The almost continual cloudiness of the skies, at the Island of St. Helena, renders it a very inconvenient place for the making of astronomical observations, which I had the mortification to experience in losing the sight of the exit of the planet Venus, from the sun's disc, on the 6th of June 1761, to observe which was the primary motive of my going thither.

land Country only caught glimpses of the phenomenon; the Sun was totally covered by clouds during both ingress and egress. Swedish observers stationed at Pello (Fr. Mallet) and Torneå (Hellant) could not record any of the contacts of Venus with the limb of the Sun due to bad weather (see Widmalm and Pekonen, these Proceedings). Finally, the British observers Bayly and Dixon had similar problems in Honningsvåg and Hammerfest (see Voje Johansen, these Proceedings). No wonder Hell and Sajnovics considered their luck a miracle!

³¹Hielmstjerne to Euler, dated Copenhagen September 23, 1769, Translation from Aspaas (2012) pp. 260–261.



Figure 32. *Left*: last view of Venus on the Sun for more than a century to come. Photo RN. *Right*: simultaneously acquired view of the Sun above Vardø harbor. Photo CS.

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We dedicate this account of our voyage to the people of Vardø.

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