Polar Record

www.cambridge.org/pol

Frozen data? Polar research and fieldwork in a pandemic era

Sophie Duveau

Centre Alexandre Koyré, École des Hautes Etudes en Sciences Sociales, Paris

Commentary

Cite this article: Duveau S. Frozen data? Polar research and fieldwork in a pandemic era. *Polar Record* **57**(e34): 1–5. https://doi.org/10.1017/S0032247421000541

Received: 10 June 2021
Revised: 26 July 2021
Accepted: 4 August 2021

Keywords:
Polar research; Svalbard; Fieldwork; Remote sensing; Covid-19 pandemic

Author for correspondence:
Sophie Duveau,
Email: Sophieamelia.duveau@ehess.fr

Abstract

Drawing on an ethnographic survey in Svalbard before and during the coronavirus outbreak, this commentary reflects on the multiple dimensions of fieldwork highlighted by the pandemic. Firstly, the cancellation of many field campaigns has revealed the decisive role of personnel inhabiting scientific bases in the maintenance of scientific activities in Svalbard. Automatic and remote-controlled instruments are autonomous only in appearance as the crucial phases of data acquisition often call for human presence. Secondly, airborne remote sensing can be perceived as a response to fill data gaps. Although embedded in a long history, the use of remote sensed data has taken on a new meaning in the context of the pandemic. Finally, the fact that several researchers endeavour to go to the field whatever the travel conditions underlines a certain need of being in Svalbard as well as limitations of science performed remotely.

While Sars-Cov-2 has spread to most countries in the world, only one Covid-19 case was reported in the Svalbard archipelago by the Norwegian Institute of Public Health (2020) by mid-2021. In this part of the Arctic, where health infrastructures remain very limited, early measures such as travel restrictions, isolation, school closures, social distancing and face covering were implemented for various time periods, in accordance with the national regulations (*Covid-19-forskriften nr. 470*, 2020). These responses might have contained intra-country transmission, whereas strict rules for entry to Norway might have slowed the progression of imported cases. However, travel restrictions affected, and still affect, economic activities associated with tourism as well as international research. The closing of Norwegian borders in 2020 and 2021 occurred as a fragmented process with a "window" of unrestricted freedom of movement through summer 2020 and successive governmental decisions which then made it more and more difficult for foreign nationals to travel to the Norwegian mainland and Svalbard. New rules on testing were introduced on 28 January 2021 (*Forskrift nr. 235 om endring i covid-19-forskriften*, 2021) to limit the transmitting of most infectious variants of the coronavirus. These tightened measures considerably lowered the accessibility to Svalbard for all kind of practitioners of science until the ease of certain measures from the end of June 2021, as a result of vaccination campaigns worldwide and the entry into force of the EU Digital COVID certificate.

This particular historical juncture brings to light polar research, through its social, political, environmental and technical conditions of possibility. Hughes and Convey (2020) have already drawn attention on the effects of the Covid-19 pandemic on scientific activity and logistics in Antarctica. In the Northern hemisphere, media commentators focused on the well-publicised expedition drifting in the Arctic ocean on board the German research vessel *Polarstern* since October 2019 (Hall, 2020; Vogel, 2020). Smaller scientific projects, field practices and actors' strategies to circumvent barriers to fieldwork did not receive the same attention. Redefining the contours of fieldwork may however enhance our understanding of what may be lost in the context of the global coronavirus outbreak. Covid-19 did not only have effects on multiple data series but also on social relations, institutions and geopolitics. The pandemic recalls that science is entirely embedded in society and so are data (Bigo, Isin, & Ruppert, 2019; Kitchin, 2014; Leonelli, 2015). At a time when the virus spreads the world, the circulation of human beings in the name of science and data can be debated. It seems therefore appropriate to ask whether the presence of scientists in the field is necessary and perceived as crucial or whether science can be performed remotely.

While ethnographic methods had long been imported into laboratories (Knorr-Cetina, 1981; Latour & Woolgar, 1979; Lynch, 1985; Traweek, 1988), this commentary investigates the nexus between the scientists and the field. Even though the "black box" of science is open, a closer examination of field practices will extend our knowledge on the "science in the making". The idea to document the discontinuity between the "lab" and the field was inspired by the literature on the spatiality and geographies of science (Kohler, 2002; Livingstone, 2010; Lynch, 1991), while building on issues arising from a long-term, intensive immersion in Svalbard.

CAMBRIDGE UNIVERSITY PRESS

Firstly, the cancellation and postponement of field campaigns in Svalbard has resulted in an underuse of scientific bases, underlining the role of the personnel and non-human entities in maintaining scientific activities. Secondly, remote sensing can be perceived as an alternative way to produce data without being in the field. While the pandemic is presented as disrupting datasets, airborne remote sensing aims at filling data gaps. Thirdly, data represent merely a part of fieldwork and the broad range of situations experienced by the practitioners of science during the pandemic reveals other motives than data collection. As evidenced by ethnographic material gathered before and during the coronavirus outbreak, remote sensing cannot fulfil all needs, and despite adverse conditions, several researchers still endeavour to ensure a human presence in the field.

Empty bases?

A significant number of scientific projects in Svalbard, including Norway-funded projects, have been cancelled or postponed as a direct consequence of the pandemic, even though diverse intertwined factors can be at play. On-site observations and interviews indicate that even when practitioners of science have been able to request entry into the Norwegian territory, the travel conditions, in particular the mandatory quarantine and the additional expenses arising from the quarantine or the testing, resulted in the cancellation of field campaigns. Cancellation and postponement of fieldwork may have been caused, less obviously, by the lack of housing, formalities and regulations at different and interconnected scales. Furthermore, the political rhythm did not systematically coincide with project rhythms, field seasons and environmental temporality.

Consequently, all of the scientific bases located in Svalbard were underused during the year 2020, while several closed throughout summer. During an immersion at the Polish research station in Hornsund, south of Spitsbergen, in September 2020, a member of the summer team confided that she had hosted very few researchers during the season. Similarly, the logistician of the Franco-German base in Ny-Ålesund, jointly managed by the Alfred Wegener Institute and the French Polar Institute Paul-Emile Victor (AWIPEV), argued that the exceptional circumstances under which the station employees worked changed the very nature and the meaning of his job. Whereas several employees can feel worthless, wintering personnel play a decisive role in maintaining scientific activities and monitoring, even though technicians were long made invisible in the history of science (Shapin, 1989). Prior to the closing of international borders, researchers entrusted the personnel of scientific bases with regular duties such as sampling, processing samples, checking devices or controlling data integrity. At the AWIPEV observatory in Ny-Ålesund, the case of radiosondes shows that global observing systems are fed by data produced locally by non-academics. By implementing protocols in printed form, the personnel here are able to calibrate the CFH and Ozone probes, release the balloons and thereby measure the water vapour as well as the vertical distribution of Ozone between the surface of the Earth and the stratosphere. Despite the cancellation of field campaigns, those who inhabit scientific bases for more or less extended periods continue to perform science on behalf of research professionals and hence contribute to data production.

Regardless of the work of the personnel, or with their occasional help, it may be feasible to bring the field home without the hassle of a trip to the Arctic and to act remotely by piloting an instrument. From weather stations to surface radiation measurements, automation has become a prominent driving force in data collection. For example, deployed near the old pier, in Ny-Ålesund, the remotely operated Ferrybox system and its underwater profiling sensor unit automatically transfer data to the Alfred Wegener Institute Computing Center in Bremerhaven (Fischer et al., 2017). From their "here" (or there, depending on the perspective one adopts), researchers monitor natural phenomena "over there" – the expression of this approach being accentuated by the installation of All-sky cameras allowing anyone to observe the sky remotely at all times and in all places on the sole condition of having an internet connection.

Nonetheless, data acquisition usually comes with problems (e.g. breakdowns, power cuts, errors in storing) and scientific instruments, automated or not, remotely controlled or not, require a human presence. Whether Svalbard permanent residents and bases' personnel can replace researchers in the field, the delegation of tasks to non-humans raises the question of the autonomy of such entities. Nowhere is the importance of human presence more evident than in the installation and the maintenance of scientific devices. At the time of the pandemic, these crucial phases of the scientific process could be delegated to the personnel on-site. Engineers from the Grenoble Institute of Planetology and Astrophysics who were unable to travel to Svalbard in 2020 thus dispatched the polarimeter which was to be installed at the Corbel base, a few kilometres from Ny-Ålesund, and then guided the French logistician remotely, through screens, in the steps of starting up the instrument. The same phenomenon occurred in Hornsund: a LF AWESOME low frequency wave receiver from Georgia Tech had been loaded on the ship Horyzont II and disembarked by Polish personnel in September 2020, the scientific team not having been able to leave the American continent.

In the context of the unprecedented global crisis, the on-site presence of personnel can therefore be seen as critical for pursuing research and environmental monitoring. The continuity, or the discontinuity, of the functioning of the scientific bases during the global coronavirus outbreak reveals inequalities in nations' capacities to maintain year-round or seasonal scientific activity in Svalbard. As research aligned with social studies of science point out, data are entangled in power relations and can be geopolitical, especially in polar regions where scientific activity has a particular status and reinforces sovereign claims (Dean, Naylor, Turchetti, & Siegert, 2008; Roberts & Paglia, 2016). Not all States can rely on the presence of their nationals in Svalbard, so cooperation appears to be decisive when travelling is no longer an option.

Filling data gaps with remote sensing

Among responses to the inability to travel, remote sensing may be depicted as a way to overcome "data gaps". The concept of gap in the data brings to light the narrative on the necessity of continuity and the crucial function of seriality, with established vocabulary like "time series", "data series" and "long-term monitoring", while suggesting a breakdown in the continuity. On 20 March 2020, the Svalbard Integrated Observatory System-Knowledge Center (SIOS-KC) issued a call for projects for access to remote sensed data through unmanned aerial vehicles (UAVs) and the new instrumented platform installed by the Norwegian Research Center on a Dornier 228NG. Operated by the Norwegian company Lufttransport, the manned aircraft performs regular passenger flights from Longyearbyen to Ny-Ålesund and Svea, thus offering

https://doi.org/10.1017/S0032247421000541 Published online by Cambridge University Press

the possibility of collecting data on these air routes. The Norsk Elektro Optikk hyperspectral imager (HySpex Classic VNIR-1800) mounted on the platform acquires two-dimensional images of the surface with a ground resolution of 30 cm with a swathe width of 600 m from 1000 m altitude, whereas the photographic sensor (PhaseOne IXU-180 RGB) on board the plane produces images with a ground resolution of 10 cm. The aircraft should soon be equipped with an L– and X–band synthetic aperture radar to overcome limited optical visibility due to low clouds. In 2020, SIOS-KC allocated one million Norwegian crowns to airborne remote sensing and promoted remote sensing as a response to Covid-19 pandemic.

The temporality of the project demonstrates, however, that the rollout of remote sensing means is not tied to the pandemic. Equipped with its sensors since 2018, the Do 228 NG carried out flights to acquire data as part of a test phase in September 2019. During this preliminary period, researchers were invited to target geographical areas for which they wish to get aerial photographs and hyperspectral images. In the peculiar context of the pandemic, remote sensed data acquisition has subsequently taken a distinct meaning and was heralded as a mean to fill data gaps by SIOS-KC. The description of the call for proposals encouraged project initiators who intend to fill data gaps to apply. While most field campaigns were cancelled, or postponed, researchers are thus given the opportunity to obtain new datasets as long as the announced requirements are fulfilled (data acquisition within a specific period, compliance with SIOS' data policy).

The use of airborne remote sensing during the pandemic is part of an ongoing process of field practices transformation partly related to technical evolution. Airborne remote sensing in Svalbard is embedded in a complex history that encompasses the development of aerial photography and its merchandising by the Norwegian Polar Institute since the early 20th century (Barr, 2003). Photogrammetric measurements on archive aerial images have taken on a renewed importance in long-term study of glacier systems (Brandt, Kohler, & Lüthje, 2008; Dowdeswell, 1986; Midgley & Tonkin, 2017).

More recently, unmanned vehicles have emerged as increasingly important technologies for field sciences in Svalbard, especially in regions where study sites can be difficult to access (Hann et al., 2021a). While an unmanned semi-submersible vehicle equipped with a water sampler and underwater sensors may sample and profile the water column close to the fronts of tidewater glaciers (Bruzzone, Ode, Caccia, & Ferre, 2020), digital cameras mounted on UAVs help researchers to map tidewater glaciers terminus and crevassed areas (Dachauer, Hann, & Hodson, 2021; Solbø & Storvold, 2013).

Presented as alternatives to satellite imagery whose usability depends on cloud cover, or much expensive manned aircraft, the UAVs are particularly acknowledged for their ease to use and their capability to monitor sudden events which might shape the landscape (Bernard, Friedt, Tolle, Marlin, & Griselin, 2017).

Not only UAVs may induce a new relationship to temporalities but they also intend to enlarge the perceived world of practitioners of science. Whereas satellite imagery already enabled the upscaling of field data for the mapping of plant groups, recent approaches used for studying the arctic tundra combine data derived from satellite with UAV multispectral imagery (Thomson et al., 2021). Aerial digital surveys which cover vast areas find multiple applications in terrestrial biology as well as in marine biology (Aniceto et al., 2018).

One may be tempted to assume that robots and remote sensing technologies have replaced human eyes, feet and arms, when in practice unmanned vehicles often require a human presence in the vicinity of the study site while a number of researchers link remote sensed data with *in situ* measurements. Digital elevation models, whether they are retrieved from aerial or satellite imagery, must be validated with ground control points (Błaszczyk et al., 2019). To be calibrated and validated, large-scale modelling of glaciers in Svalbard also builds on *in situ* observational data (van Pelt et al., 2019). The increased use of UAVs gives rise to both methodological and epistemological questions and entails solving practical problems (e.g. icing) under specific flight conditions in polar regions (Hann et al., 2021b).

Rather than a sudden shift, the scientific uses of UAVs in Svalbard reflect a trend which started before the pandemic and tends to be more regulated. In Europe, this is evidenced by the publication of a regulation by the European Commission, which lay down the rules and procedures for the operation of these technologies, whilst also defining the competency and age of remote pilots (2019).

Beyond data

Since March 2020, the "remote sensing" working group of SIOS has been carrying out a survey by questionnaire to assess the needs of scientists within the context of the pandemic. The survey could provide stakeholders with statistics on the impact of travel restrictions on scientific research related to Svalbard. The results of the survey will also offer meaningful data to compare with the open access "Research in Svalbard" database.

Even so, the main instrument of the survey, as any questionnaire, was elaborated in a certain context and has its limits. Although the survey aims at helping scientists filling data gaps, the questionnaire curiously ignores concrete constraints and factors that disrupted research and may lead to data gaps. Centering on Svalbard and travel restrictions, the questionnaire does not take the entanglement of local (e.g. institutes internal policies), national and international regulations into account, nor investigates the relationship between the laboratory and the field. Yet, experiments and data analyses after fieldwork have been postponed because of access restrictions and closure of laboratories as was the case in the scope of the large-scale scientific project Nansen Legacy (2018–2023). Relocating fieldwork in the whole process of knowledge production appears to be critical to handle interdependencies and cascading effects. In particular, the capacity for scientists to bring samples back to their country and hence to process them must be investigated thoroughly.

Most importantly, the questionnaire hardly addresses the broad range of situations experienced by the practitioners of science during the pandemic. Meant for the well-informed members of the SIOS community, the questionnaire has necessarily a limited scope and hence excludes undergraduate students and other invisible workers such as field assistants, trainees, technicians, temporary employees and administrative personnel. Given the diversity of actors and the heterogeneity of types of work encompassed by fieldwork, one can assume that the inability to go to the field has differentiated effects according to the objectives, interests and motives that lay behind fieldwork. Looking at academic pathways, young scholars and well-established researchers may be affected differently. Indeed, the field acts as a learning place, through an intimate interaction with the objects of knowledge, just as it contributes to build scientific legitimacy up throughout the

https://doi.org/10.1017/S0032247421000541 Published online by Cambridge University Press

whole career. The undergraduate students who were studying at the University Center in Svalbard in March 2020 were strongly encouraged to leave the archipelago. While the majority travelled back to their countries, some students stayed in Longyearbyen over the summer to undertake fieldwork and write their thesis. Fieldwork, in this particular context, served as a means to legitimise students' presence in Svalbard.

Students' trajectories also highlight the moral conditions in which fieldwork unfolds: the pressure on getting results, submitting the thesis and validating the school year. Concrete field practices and stories following the return from the field gathered at the student housing, finally shed light on another feature of fieldwork as a place of sociability. While some students lost the opportunity to go to the field, others joined field parties as field assistants.

The picture would be incomplete without mentioning friendship based on cooperation in the field, and vice versa. Even beyond friendship, the field is a crucial place for all practitioners of science to forge future collaborations. Specifically, Ny-Ålesund, as an international research station, allows the temporary gathering of researchers who are living and working in different locations (Ojala & Hautala, 2019).

Acknowledging social interactions as part of fieldwork, one should ask whether the teamwork was disrupted by the pandemic. Bringing members of an expedition together in a time of travel restrictions might become extremely difficult, if not impossible. While sharing a meal with a scientific party from the United States, in Longyearbyen, a researcher explained that their Russian counterpart had not arrived yet in Svalbard, but that his presence was imperative because he was bringing drilling equipment. However, collective work in the form of delegation of tasks was often observed as the way to circumvent barriers to fieldwork in Svalbard. Scientists self-organised and tended to help each other, cutting across boundaries of nations and institutions. Several institutions dedicated to fostering international scientific cooperation made attempts to enhance this phenomenon. For example, Svalbard Science Forum used social media to stimulate collaboration among scientists, while SIOS-KC launched a virtual platform alongside the deployment of remote sensing campaigns so that its members can either offer or request logistic support.

Re-enchanting the field

Science cannot be systemically practiced remotely and may require fieldwork in the strict sense, for instance to understand microbial life in snow, at the interfaces between snow and ice, and in ice.

Despite travel restrictions, a few scientists traveled to Svalbard in late 2020 and in spring 2021. Until mid-2021, only Norwegian citizens and foreign nationals residing in Norway were allowed entry. Nevertheless, several exemptions from the entry restrictions were made for practitioners of science to maintain activity and to conduct research or monitoring in Svalbard. However, they must contribute to the Norwegian disease detection and tracking system by registering prior to travel and undergo a quarantine period at a quarantine hotel on the mainland. In addition to mandatory testing prior arrival to Norway and at the border, they must present a certificate documenting a negative Sars-Cov-2 test result before departing for Svalbard. Interestingly, non-Norwegian scientists spent up to ten days in quarantine in Oslo and Tromsø to reach their field site.

As one British researcher explains, part of life escapes remote sensing and modelling requires, paradoxically, ground-based data:

> "You can't really detect microorganisms through remote sensing. I do some modeling work so I use existing data to inform a kind of numerical model of what is happening in the system . . . so in terms of carbon cycle, in terms of biological activity . . . but we definitely need data from the field to validate that model." (Interview's excerpt. February 2021).

Remote sensing technologies sometimes appear to be irrelevant. However, the fact that scientists go and keep going to Svalbard is often not solely motivated by scientific reasons. Affective dimensions of natural sciences should be particularly considered. The feeling of deprivation expressed by some informants during the pandemic invites us to reflect on the emotional component of field practices. At a time of reduced individual freedom, the symbolic meaning of fieldwork and the attachment to Svalbard are likely to be strengthened. As a French engineer, who had experienced two lockdowns in his country, phrases, "[he] is one of those people whose motivation for projects comes from the opportunity to travel abroad." (Interview's excerpt (translated). January 2021).

Field campaigns in Svalbard may form a benefit, bringing added value to the daily life within the laboratory. In that respect, damages induced by the pandemic should not be expressed only in terms of data loss.

The Covid-19 pandemic gives us the opportunity to study fieldwork through its conditions of possibility, while taking seriously the discourse of the actors on what, for them, constitutes the field. From the technician who was tasked to perform maintenance to the student who learns how to behave in the polar environment, practices differ and thus challenge the representation of fieldwork in terms of collecting things. Practitioners of science do not always go to Svalbard to collect data, or samples, and when they do so, they usually have many other motives which are not to be found in scientific publications.

Acknowledgments. The author wish to thank the Nicolaus Copernicus University, the Institute of Geophysics of the Polish Academy of Science, the Alfred Wegener Institute and the French Polar Institute for providing access to their research infrastructures in Svalbard and for logistic support. The author is grateful to the participants of this study for allowing her to conduct ethnographic observations during fieldwork and laboratory work.

Financial support. This study received no specific grant from any public funding agency, commercial or not-for profit sectors.

Conflict of interest declaration. The author declares no conflict of interest.

References

Aniceto, A. S., Biuw, M., Lindstrøm, U., Solbø, S. A., Broms, F., & Carroll, J. (2018). Monitoring marine mammals using unmanned aerial vehicles: Quantifying detection certainty. *Ecosphere*, *9*(3), e02122. doi: 10.1002/ecs2.2122

Barr, S. (2003). *Norway: A Consistent Polar Nation? Analysis of an Image Seen Through the History of the Norwegian Polar Institute*. Oslo: Kolofon AS.

Bernard, E., Friedt, J-M., Tolle, F., Marlin, C., & Griselin, M. (2017). Using a small COTS UAV to quantify moraine dynamics induced by climate shift in Arctic environments. *International Journal of Remote Sensing*, *38*(8–10), 2480–2494.

Bigo, D., Isin, E., & Ruppert, E. (2019). *Data Politics. Worlds, Subjects, Rights*. New York: Routledge.

Błaszczyk, M., Ignatiuk, D., Grabiec, M., Kolondra, L., Laska, M., Decaux, L., . . . Czapla, M. (2019). Quality Assessment and Glaciological Applications of Digital Elevation Models derived from Space-borne and Aerial Images over Two Tidewater Glaciers of Southern Spitsbergen. *Remote Sensing*, *11*, 1121. doi: 10.3390/rs11091121

Brandt, O., Kohler, J., & Lüthje, M. (2008). Spatial mapping of multi-year superimposed ice on the glacier Kongsvegen, Svalbard. *Journal of Glaciology*, *54*(184), 73–80.

Bruzzone, G, Ode, A., Caccia, M., & Ferre, R. (2020). Monitoring of Sea-Ice-Atmosphere Interface in the Proximity of Arctic Tidewater Glaciers: The Contribution of Marine Robotics. *Remote Sensing*, *12*(11), 1707. doi: 10.3390/rs12111707

Dachauer, A., Hann, R., & Hodson, A. J. (2021). Aerodynamic roughness length of crevassed tidewater glaciers from UAV mapping. *The Cryosphere Discuss*. [preprint]. doi: 10.5194/tc-2021-113

Dean, K., Naylor, S., Turchetti, S., & Siegert, M. (2008). Data in Antarctic Science and Politics. *Social Studies of Science*, *38*(4), 571–604.

Dowdeswell, J. A. (1986). Remote sensing of ice cap outlet glacier fluctuations on Nordaustlandet, Svalbard. *Polar Research*, *4*(1), 25–32.

European Commission. (2019) Commission Implementing Regulation no. 2019-947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. *Official Journal L 152*, 11.6.2019.

Fischer, P., Schwanitz, M., Loth, R., Posner, U., Brand, M., & Schröder, F. (2017). First year of practical experiences of the new Arctic AWIPEV-COSYNA cabled Underwater Observatory in Kongsfjorden, Spitsbergen, *Ocean Science*, *13*, 259–272.

Forskrift 27 mars 2020 nr. 470 om smitteverntiltak mv. ved koronautbruddet (covid-19-forskriften). [Regulation of 27 March 2020 no. 470 on infection control measures during the coronavirus outbreak] Retrieved from www.lovdata.no

Forskrift 28 januar 2021 nr. 235 om endring i covid-19-forskriften. [Regulation of 28 January 2021 no. 235 amending the Covid19 regulation] Retrieved from www.lovdata.no

Hall, S. (2020, April 24). Coronavirus shutdown forces research ship to break out of Arctic ice. *Nature*. Retrieved from https://www.nature.com/articles/d41586-020-01253-4 (accessed on 1 June 2021)

Hann, R., Altstädter, B., Betlem, P., Deja, K., Dragańska-Deja, K., Ewertowski, M., … Zagórski, P. (2021a). Scientific Applications of Unmanned Vehicles in Svalbard. In M. Moreno-Ibáñez, J. O. Hagen, C. Hübner, H. Lihavainen, & A. Zaborska (Eds.), *SESS report 2020. Longyearbyen: Svalbard Integrated Arctic Earth Observing System* (pp. 78–103). doi: 10.5281/ZENODO.4293283

Hann, R., Enache A., Nielsen M. C., Stovner B. N., van Beeck, J., Johansen, T. A., & Borup, K. T. (2021b). Experimental Heat Loads for Electrothermal Anti-Icing and De-Icing on UAVs. *Aerospace*, *8*(3), 83. doi: 10.3390/aerospace8030083

Hughes, K. A., & Convey, P. (2020). Implications of the COVID-19 pandemic for Antarctica. *Antarctic Science*, *32*(6), 426–439.

Kitchin, R. (2014). *The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences*. London: SAGE Publications.

Knorr-Cetina, K. (1981). *The Manufacture of Knowledge. An Essay on The Constructivist and Contextual Nature of Science*. Oxford: Pergamon Press.

Kohler, R. E. (2002). *Landscapes and Labscapes. Exploring the Lab-Field Border in Biology*. Chicago: The University of Chicago Press.

Latour, B., & Woolgar, S. (1979). *Laboratory Life: The Social Construction of Scientific Facts*. London: SAGE Publications.

Leonelli, S. (2015). What Counts as Scientific Data? A Relational Framework. *Philosophy of Science*, *82*(5), 810–821.

Livingstone, D. N. (2010). *Putting Science in its Place: Geographies of Scientific Knowledge*. Chicago: University of Chicago Press.

Lynch, M. (1985). *Art and Artifact in Laboratory Science. A Study of Shop Work and Shop Talk in a Research Laboratory*. London: Routledge & Kegan Paul.

Lynch, M. (1991). Laboratory Space and the Technological Complex: An Investigation of Topical Contextures. *Science in Context*, *4*(1), 51–78.

Midgley, N. G., & Tonkin, T. N. (2017) Reconstruction of former glacier surface topography from archive oblique aerial images. *Geomorphology*, *282*, 18–26.

Norwegian Institute of Public Health. (2020). *COVID19 Ukerapport - uke 31*. [Weekly report, week 31]. Retrieved from https://www.fhi.no/contentassets/8a971e7b0a3c4a06bdbf381ab52e6157/vedlegg/andre-halvar–2020/2020.08.05-ukerapport-uke-31-covid-19.pdf (accessed on 26 June 2021)

Ojala, M.-L., & Hautala, J. (2019). Knowledge creation rhythms of a science project, in and beyond remote Ny-Ålesund in the Arctic. *Polar Geography*, *42*(1), 1–17.

Roberts, P., & Paglia, E. (2016). Science as national belonging: The construction of Svalbard as a Norwegian space. *Social Studies of Science*, *46*(6), 894–911.

Shapin, S. (1989). The Invisible Technician. *American Scientist*, *77*(6), 554–563.

Solbø, S., & Storvold, R. (2013). Mapping Svalbard glaciers with the Cryowing UAS. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science*, XL-1/W2, 373-377. doi: 10.5194/isprsarchives-XL-1-W2-373-2013

Thomson, E. R., Spiegel, M. P., Althuizen, I. H. J., Bass, P., Chen, S., Chmurzynski, A., … Mahli, Y. (2021). Multiscale mapping of plant functional groups and plant traits in the High Arctic using field spectroscopy, UAV imagery and Sentinel-2A data. *Environmental Research Letters*, *16*(5), 055006. doi: 10.1088/1748-9326/abf464

Traweek, S. (1988). *Beamtimes and Lifetimes. The World of High Energy Physicists*. Cambridge: Harvard University Press.

van Pelt, W., Pohjola, V., Pettersson, R., Marchenko, S., Kohler, J., Luks, B., … Reijmer, C. (2019). A long-term dataset of climatic mass balance, snow conditions, and runoff in Svalbard (1957–2018). *The Cryosphere*, *13*, 2259–2280.

Vogel, G. (2020, March 16). Coronavirus concerns force Arctic mission to cancel research flights. *Science Magazine*. Retrieved from https://www.sciencemag.org/news/2020/03/coronavirus-concerns-force-arctic-research-mission-cancel-flights (accessed on 10 May 2021)