Proposal for a new UArctic Thematic Network on High Latitude Dust

The Icelandic Aerosol and Dust Association (IceDust, https://icedustblog.wordpress.com/) is a scientific society committed to the support of research in the field of aerosol science focused on dust at high latitudes, with a main focus on Polar Regions. The IceDust is an international network of researchers, educators and innovators interested in understanding the climate and socio-economic impacts of High Latitude Dust (HLD) in the Arctic. The IceDust was established in 2016 and currently involves more than 110 scientists from 53 institutions in 21 countries, and is rapidly increasing in number. In 2022, IceDust became a member aerosol society of the European Aerosol Assembly, and also a contributing/associate member to the World Meteorological Organization Sand and Dust Storm Warning Advisory and Assessment System (WMO SDS-WAS) community. The Agricultural University of Iceland (AUI) has hosted the IceDust since 2014, first as a local dust society, while AUI became a member of UArctic in 2019, opening the opportunity for the IceDust as the HLD Network to become a UArctic thematic network, under the name: UArctic Thematic Network on High Latitude Dust. Working under the umbrella of UArctic as a new thematic network would help consolidate the HLD Network and promote further collaborations in research and education, focused on student, indigenous people and stakeholder involvement in the Arctic, and based on the collaboration with other thematic networks.

Thematic focus area of the network

The HLD Network is a collaborative initiative creating a dialog between scientists and educators from interdisciplinary backgrounds and focusing the interaction between diverse scientific disciplines, such as atmosphere, cryosphere, marine and terrestrial ecosystems, regarding the impacts of HLD on socio-economic sectors (air quality and wellbeing, road safety, human health, energy production, and more). Another main focus is to raise public awareness related to negative impacts of HLD to northern communities and provide them with tools to monitor dust storms (https://sds-was.aemet.es/forecast-products/dust-forecasts/icelandic-dust-forecast) and to be able to issue warnings.

High latitudes include active desert regions with at least 5 % production of the global atmospheric dust where 3% are calculated for the Arctic region, over 150 million tons of atmospheric HLD annually (Bullard et al., 2016; Groot Zwaafting et al., 2016; Böö et al., in review). Active HLD sources cover > 1,600,000 km^2 and are located in both the Northern (Iceland, Alaska, Canada, Greenland, Svalbard, North Eurasia, and Scandinavia - > 1,000,000 km^2) and Southern (Antarctica, Patagonia, New Zealand) Hemispheres (Meinander et al., 2022). Recent studies have shown that HLD travels several thousands of km inside the Arctic and > 3,500 km towards Europe (Crocchianti et al., 2021; Dordevic et al., 2019). In Polar Regions, HLD was recognized as an important climate driver in the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate in 2019 (IPCC, 2019). There are over 50 papers published under the IceDust umbrella on the impacts of Icelandic and HL dust on the atmosphere, cryosphere, marine and terrestrial environments, and society. HLD, once deposited for example, decreases albedo of both glacial ice/snow similarly as Black Carbon (BC), as well as albedo of mixed phase clouds via reduction in supercooled water content (Meinander et al., 2022). There is also evidence that volcanic dust particles scavenge efficiently SO_2 and NO_2 to form sulfites /sulfates and nitrous acid. In marine environments, Icelandic dust with high total Fe content (10-13 wt%) and the initial Fe solubility of 0.08-0.6%, can impact primary productivity and nitrogen fixation in the North Atlantic Ocean, leading to additional carbon uptake. In Iceland, ecosystem collapse was caused due to dust storms (Arnalds et al., 2016).

The HLD Network aims at serving as a gateway to expertise on HLD and a platform to facilitate research cooperation through the Arctic research community and broaden the scope of research based on previous experience from Iceland, Canada, Greenland, Svalbard, Scandinavian countries, and European countries. There have been several research projects lead by the IceDust members including field dust *in situ* measurements in the Arctic, cryosphere-atmosphere interactions due to light absorbing impurities (HLD, BC), cloud-aerosol interactions and atmospheric chemistry experiments, long-range transport of Arctic dust, and more (outcomes and project titles and numbers can be found in Meinander et al., 2022), including student projects.

There is a large group of UArctic thematic networks focusing on the most crucial and relevant environmental and societal topics in the Arctic. However, very few of them focus on atmosphere- and cryosphere-related issues and their interactions and impacts on society in the Arctic. Therefore, becoming a UArctic thematic network (TN) will strengthen scientific collaborations between the thematic networks and will bring new opportunities, especially in terms of training students, engaging local communities in raising awareness on HLD related issues and developing joint educational materials.

What are the goals and planned activities of the network?

The HLD Network goals are to: i. promote collaboration and communication in the field of aerosol research in the Arctic with an emphasis on local dust and its climate impacts; ii. open discussion and start collaboration with other thematic networks, for example the networks on Disasters and Natural Hazards, Arctic Geology, Permafrost, Arctic Plastic Pollution, Health and Well-being in the Arctic, Herbivory Network, Northern and Arctic Island Studies Research, and Arctic Transport and Logistics; iii. serve as a platform for communication between the Arctic and non-Arctic aerosol researchers, as well as provide missing information to other academic bodies from Arctic and abroad; and iv. give an easy-to-understand source of knowledge on aerosols for the general public and media, including topics such as air pollution, atmosphere-cryosphere interactions, volcanic ash resuspension, health and environmental effects of particulate matter, radiative forcing and ice nucleating properties of HLD, climate aspects of HLD, long-range transport of aerosol to high latitudes and HLD long-range transport towards the low latitudes, increased involvement of local communities, and more. The HLD Network is keen on promoting knowledge of basic aerosol processes and expanding the broader discipline of aerosol science and climate interactions in the Arctic. The Network encourages the implementation of collaborative research projects, the organization of scientific meetings such as HLD Workshop, the development of joint applications for funding, the training of students, sharing facilities and expertise. These events act not only in a collaborative way to communicate science, but art designed to build capacity within local communities on identifying the causes and effects of aerosols within the environment on the health of individuals.

The planned activities of HLD Network are:

Meetings. Members of the HLD Network have organized seven High Latitude Dust (HLD) Workshops in Reykjavik, Iceland since 2016 (https://icedustblog.wordpress.com/past-events/). Additionally, we have organized topical sessions focusing on cryosphere-atmosphere interactions at large scientific conferences, such as the EGU, IUGG, DUST. The next HLD Workshop is planned for 14-15 Feb 2024 in Reykjavik, Iceland, but IceDust members from Canada are keen to organize an additional HLD Workshop at Kluane Lake, Yukon, Canada, in 2025. The HLD Network is prepared to continue these annual workshops with participation of interested UArctic TNs members.

Scientific outputs. The HLD Network is based on scientific collaboration seeking to extend existing collaboration with the UArctic thematic networks. As a result of our joint efforts, we have already published over 50 scientific papers and conducted the largest HLD field campaign engaging 11 research institutions from 6 countries and a large number of students (https://icedustblog.wordpress.com/2021/08/17/dust-experts-meet-in-dyngjusandur-to-conduct-the-largest-field-campaign-in-iceland/). Several international research projects have been conducted and more are in the works or have been planned (details on the projects can be found in Meinander et al., 2022). The HLD Network emphasizes publishing of results in scientific papers and their science communication efforts through more accessible media.

Development of dust forecasts. One of the priorities of the HLD Network has been to develop an online dust forecast model for the public. The first HLD model was created for Iceland and it is part of WMO SDS-WAS. In the future, we believe that such a model is needed for the Arctic region, as well as implementation of new components to the existing model, such as dust darkness component on glacier surfaces and optical properties of HLD.

Mobility. The HLD Network will work with organizations, such as UArctic and IASC, including mobility programs such as Erasmus+, COST and INTERACT – International Network for Terrestrial Research and Monitoring in the Arctic - grant tools, to provide opportunities for the exchange of students and staff among institutions involved in the network.

Teaching and training. The HLD Network aims to expand its teaching and training activities, by contributing to specialized courses and involving students in field campaigns and in HLD workshop participation (especially those Arctic residents outside of Europe). Many HLD Network members teach and mentor graduate and undergraduate students and share their field experience. Their joint efforts for developing guidelines for the best practices to measure and observe HLD and its climate impacts are, therefore, needed.

How indigenous issues are included in TN's network's operation?

HLD affects large parts of the Arctic and researchers within the HLD Network are involved with the local communities. Citizen Science in terms of dust storm observations from the local people is an important part of the HLD Network activities. HLD impacts on the socio-economic sector are of importance and particular interest for our activities and we believe that we will strengthen the links between the HLD Network and other UArctic thematic networks focusing on social aspects and raising awareness in the North. The HLD Network will implement the activities so that it reflects UArctic's principles and values, including the key role of indigenous peoples for the development of the north.

Prior to conducting field work required for research, the communication with appropriate governing bodies and acquiring the correct permitting and adhering to the established conditions are sought. This includes clear communication of the nature, timing, and purpose of the research activities to be conducted, as well as a commitment to restoration, if needed. Communication with indigenous communities before, during, and after research has been done is also essential to harnessing collaborative and rewarding relationships. This communication can be event-based, such as research summits or open houses that are held to allow members of the community to see first-hand presentations of the results of research conducted in the region. Several projects within the existing network are co-led by indigenous communities to ensure a practice of collaborative research design, integrating indigenous knowledge and oral history, and providing platforms where science communication can be a conversation with the communities that are involved. The Greenland Science Week held in Nuuk and

Sisimiut, Greenland is another example of communicating research findings with communities. Through science talks, research images, movies, and various events, Greenland Science Week facilitates a collaborative platform to connect and learn from the work of citizens, managers, scientists, policymakers, and more.

Quality control at the network

How TN defines the quality on its own terms

The HLD Network provides a network of expertise on HLD and related climate impacts. HLD experts communicate through an email list, a website, annual workshops (some organized as an IASC event), joint field campaigns, joint student supervisions, the Facebook group Dust Storms in Iceland, Twitter, COST action tools, monthly dust seminars, joint projects, and other communication channels, to promote collaboration and share expertise. A majority of the work is published in scientific papers listed on the IceDust website (https://icedustblog.wordpress.com/publications/), contributions from the HLD Workshops are recorded and available online on the Workshop website (https://icedustblog.wordpress.com/2022/01/26/high-latitude-dust-workshop-2022/), science communication articles in media, and these are all advertised through the Facebook group and Twitter accounts. Meeting reports are generally produced in collaboration of several members and are circulated for internal review and stored at the network´s director facility.

How UArctic member organizations and institutions will benefit from the new TN, what is the added value in establishing such a network?

The new UArctic Thematic Network on HLD would mostly benefit and contribute to the UArctic thematic networks under the umbrella of the Natural Sciences, such as the Disasters and Natural Hazards, Arctic Geology, and Permafrost, as well as in terms of monitoring and understanding the sources of Arctic pollution and their impacts and awareness of local communities, the networks on the Arctic Plastic Pollution and Health and Well-being in the Arctic. Many HLD Network members represent the UArctic member organization, but the scope and importance of our research, including the interaction of different scientific disciplines, needs to be more emphasized and promoted to students, young researchers and local communities, to be engaged. This interdisciplinary approach is not only in natural sciences, but also includes socio-economic and health sciences, and interaction with stakeholders, such as municipalities, national parks, energy sector and transportation, and is definitely an added value of HLD research and networking. Additionally, Agricultural University of Iceland is part of NOVA network and supervises the Nordic Master program Environmental Changes at Higher Latitudes, in cooperation with Lund and Helsinki Universities and eleven partner institutions in Nordic Countries (https://www.lbhi.is/study-programmes/graduate-studies/environmental-change-in-the-arctic).

By becoming part of UArctic, the new UArctic Thematic Network on HLD will use the opportunities to interact with other UArctic thematic networks also within the Health and Social Sciences. As mentioned earlier, it would be especially interesting to facilitate collaboration with networks focusing on health/social sciences to raise awareness of dust impacts on human health, well-being, infrastructure, and potentially provide tools to predict extreme events, such as dust storms to northern communities. One of the main goals and benefits for the UArctic colleagues is to provide an understanding of the impacts of HLD in the Arctic and the role of HLD in Arctic air pollution and Arctic warming, which had been neglected until several years ago.

Additionally, with a changing climate and receding sea ice cover, interest has increased to access and exploit the rich mineral resources located in the Arctic. While the mining sector provides society with essential raw materials for a

wide range of industrial processes as well as forming the basis for the transition into a global green economy, it also has significant environmental pitfalls. Mobilization, transport, and deposition of mineral dust from mine sites is often significant at high latitudes which are regions susceptible to wind erosion because of the dry climate and lack of vegetation. Once dispersed into the environment, this mineral dust may impair important ecosystem functions due to its potential content of heavy metals and other trace elements, as well as cause concerns for public health. Such dust is particularly dangerous due to its high harmfulness for the health of workers and people in neighboring cities. Therefore the new UArctic Thematic Network on HLD will pay more attention to the study of impacts of technogenic dust storms and methods of combating dust pollution from such sources.

What kind of quality control has been already done in TN partner institutions' educational programs, courses etc (i.e. in accepting new program/course, student feedback and tutoring)

Developing joint teaching and training material and courses aimed at specialized Bsc/MSc/PhD students will be one of aims of the new UArctic Thematic Network on HLD that would be enabled by the thematic network status. Educational and training activities developed by HLD Network members have been quality-controlled by standardized procedures at the home universities, such as student evaluation and collecting student feedback. These procedures for quality control will continue to be implemented as part of the development of future activities of the UArctic Thematic Network on HLD.

Proposed UArctic TN on High Latitude Dust is recognized by the World Meteorological Organization as a contributing network to the WMO SDS-WAS and started closer collaboration with WMO and the United Nation Coalition for Combating SDS (Baklanov and Zhang, 2020). In the previous Report of the UN General Secretary for the UN General Assembly the activities and achievements of the High Latitude Dust network have been highlighted. Joint training workshops and courses are expected to be initiated.

Has the network already been awarded some funding? If so, for what activities?

The IceDust or HLD Network was established by cooperation of the first members under the funded project of the Top Research Initiative - Nordic Centre of Excellence for Cryosphere-Atmosphere Interactions in a Changing Arctic Climate (CRAICC, https://climate-adapt.eea.europa.eu/en/metadata/projects/cryosphere-atmosphere-interactions-in-a-changing-arctic-climate, currently CRAICC-PEEX Pan-Eurasian Experiment Programme, https://www.atm.helsinki.fi/peex). The development and successful completion of joint projects of the HLD members have shaped the network since 2018. Most of the projects focused on the dust *in situ* measurements and Light Absorbing Impurities impacts on cryosphere (see summary in Meinander et al., 2022). Funding has been also obtained to organize the annual HLD Workshops and mobility grants through the IASC, Ministry for Foreign Affairs of Finland, H2020 EU Interact, inDust COST Action, Icelandic Research Fund, National Power Agency of Iceland, Erasmus+, and other (https://iasc.info/news/iasc-news/472-workshop-report-iasc-workshop-on-effects-and-extremes-of-high-latitude-dust, https://www.rannis.is, https://www.landsvirkjun.is/orkurannsoknasjodur, https://en.ilmatieteenlaitos.fi/iba-project).

List the names of members and their home organizations and email address, name and contact information of the host organization and leader.

The HLD Network has more than 110 scientists from 53 institutions in 21 countries (for a list of current members and their affiliations see: https://icedustblog.wordpress.com/who-we-are/). Selected core group members and one student representative will be responsible for establishment of the HLD Network as a UArctic thematic network:

▪ Pavla Dagsson-Waldhauserova (leader), Agricultural University of Iceland (host institution). Department of Environmental and Forest Sciences, Árleyni 22, 112 Reykjavík, Iceland. Email: pavla@lbhi.is

▪ Outi Meinander, Finnish Meteorological Institute, Finland, outi.meinander@fmi.fi

▪ Alexander Baklanov, World Meteorological Organization (WMO/UN) and University of Copenhagen, Denmark, abaklanov@wmo.int and abaklanov@nbi.ku.dk

▪ James King, University of Montreal, Canada, js.king@umontreal.ca, student representative Arnold Downey, arnold.downey@umontreal.ca, please note that the University of Montreal is applying for the UArctic membership along with this application

▪ Christian Juncher Jørgensen, Aarhus University, Department of Ecoscience, Arctic Environment with research sites in Greenland, cjj@ecos.au.dk (+45 2087 1932)

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Reykjavík 22 Feb 2023

Letter of Support: Proposal for a new UArctic Thematic Network on High Latitude Dust

Dear Vice-President Kirsi Latola,

I would like to confirm the support of the Agricultural University of Iceland (AUI), UArctic member since 2019, to establish a new UArctic Thematic Network on High Latitude Dust (HLD). The HLD Network, known as IceDust Association, has been hosted at our University since 2014. The president of the IceDust Association, Dr. Pavla Dagsson-Waldhauserova, proposed leader of the Thematic Network on HLD, has dedicated her work to establish and lead the Association to become internationally recognized research network.

AUI as a host organization is committed to the work as a leader of the Thematic Network with providing the support for travels, activities related to maintaining the HLD Network and allocation of work hours for the leader of the Thematic Network.

Yours sincerely,

LANDBÚNAÐARHÁSKÓLI ÍSLANDS

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