
Annual report 2020

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WP 0, Management

Task 0.2, D 0.2.4

Version 1

Work Package 1

Publications

Publications – peer-reviewed articles

Beck, L., Sarnela, N., Junninen, H., Hoppe, C., Garmash, O., Bianchi, F., Riva, M., Rose, C., Peräkylä, O., Wimmer, D., Kausiala, O., Jokinen, T., Ahonen, L., Mikkilä, J., Hakala, J., He, X., Lampilahti, J., Leino, K., Kangasluoma, J., Korhonen, F., Siivola, E., Aalto, P., Cappelletti, D., Mazzola, M., Viola, A., Vitale, V., Jang, S., Lee, K., Vakkari, V., Krejci, R., Zieger, P., Lange, R., Massling, A., Skov, H., Petäjä, T., Ehn, M., Worsnop, D., Kulmala, M., Kerminen, V.-M., Sipilä, M. (2020) Aerosol formation is closely linked to changes in the Arctic ecosystem, *Geo. Res.Lett.*, DOI: 10.1029/2020GL091334.

Petäjä, T., Duplissy, E. M., Tabakova, K., Schmale, J., Altstadter, B., Ancellet, G., Arshinov, M., Balin, Y., Baltensperger, U., Bange, J., Beamish, A., Belan, B., Berchet, A., Bossi, R., Cairns, W. R.L., Ebinghaus, R., El Haddad, I., Ferreira-Araujo, B., Franck, A., Huang, L., Hyvarinen, A., Humbert, A., Kalogridis, A. C., Konstantinov, P., Lampert, A., MacLeod, M., Magand, O., Mahura, A., Marelle, L., Masloboev, V., Moisseev, D., Moschos, V., Neckel, N., Onishi, T., Osterwalder, S., Ovaska, A., Paasonen, P., Panchenko, M., Pankratov, F., Pernov, J. B., Platis, A., Popovicheva, O., Raut, J. C., Riandet, A., Sachs, T., Salvatori, R., Salzano, R., Schroder, L., Schon, M., Shevchenko, V., Skov, H., Sonke, J. E., Spolaor, A., Stathopoulos, V. K., Strahlendorff, M., Thomas, J. L., Vitale, V., Vratolis, S., Barbante, C., Chabrillat, S., Dommergue, A., Eleftheriadis, K., Heilimo, J., Law, K. S., Massling, A., Noe, S. M., Paris, J. D., Prevot, A. S. H., Riipinen, I., Wehner, B., Xie, Z. Y., Lappalainen, H. K. (2020) Integrative and Comprehensive Understanding (iCUPE): concept and initial results, *Atmos. Chem. and Phys.*, 20 (14), 8551-8592.

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Alexander Kokhanovsky, Claudio Tomasi, Alexander Smirnov, Andreas Herber, Roland Neuber, André Ehrlich, Angelo Lupi, Boyan H Petkov, Mauro Mazzola, Christoph Ritter, Carlos Toledano, Thomas Carlund, Vito Vitale, Brent Holben, Tymon Zielinski, Simon B elanger, Pierre Larouche, Stefan Kinne, Vladimir Radionov, Manfred Wendisch, Jason L Tackett, David M Winker (2020), "Remote Sensing of Arctic Atmospheric Aerosols", In In: Kokhanovsky A., Tomasi C. (eds) *Physics and Chemistry of the Arctic Atmosphere*. Springer Polar Sciences. Springer, pp. 505-589

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Ohata, S., Mori, T., Kondo, Y., Sharma, S., Hyvärinen, A., Andrews, E., Tunved, P., Asmi, E., Backman, J., Servomaa, H., Veber, D., Eleftheriadis, K., Vratolis, S., Koike, M., Kanaya, Y., Yoshida, A., Moteki, N., Zhao, Y., Tobo, Y., Matsushita, J., and Oshima, N.: Estimates of mass absorption cross sections of

black carbon for filter-based absorption photometers in the Arctic, *Atmos. Meas. Tech. Discuss.* [preprint], <https://doi.org/10.5194/amt-2021-166>, in review, 2021.

Conference abstracts

Pernov, J. B., Beddows, D., Skov, H., Harrison, R. M., Dall'Osto, M., Massling, A. (2020) Decade trend analysis of k-means clustered aerosol types in High Arctic, European Aerosol Conference, online: hosted in Aachen, Germany, e-poster.

Pernov, J. B., Beddows, D., Skov, H., Dall'Osto, M., Harrison, R. M., Massling, A. (2020) Trend analysis of aerosol particle physical properties at Villum Research Station, Northern Greenland, Arctic Change conference, 7th – 10th December, Platform presentation.

Stratmann, F., Skov, H., Massling, A., Wex, H. (2020) Biogenic origin of Ice Nucleating Particles in the Arctic, European Aerosol Conference, online: hosted in Aachen, Germany, Poster.

Torseth, K., Andrews, E., Asmi, E., Eleftheriadis, K., Fiebig, M., Herber, A., Huang, L., Kylling, A., Lupi, A., Massling, A., Mazzola, M., Nojgaard, J. K., Popovicheva, O., Schichtel, B., Schmale, J., Sharma, S., Skov, H., Stebel, K., Vasel, B., Vitale, V., Whaley, C., Yttri, K. E., Zannata, M. (2020) Review of Observation Capacities and Data Availability for Black Carbon in the Arctic Region, European Polar Science workshop, 26th – 30th October, Copenhagen, Talk.

Thomas, D. C., Skov, H., Beddows, D., Harrison, R. M., Pernov, J. B., Dall'Osto, M., Massling, A. (2020) Optical properties of different aerosol types in the High Arctic using k-means clustering, European Aerosol Conference, online: hosted in Aachen, Germany, Platform presentation.

Whaley, C. H., von Salzen, K., Mahmood, R., Weiss-Gibbons, T., Winter, B., Saunders, L., Eckhardt, S., Arnold, S., Chien, R.-Y., Christensen, J., Faluvegi, G., Flanner, M., Fu, J., Gauss, M., Huang, L., Im, U., Klimont, Z., Kuhn, T., Langner, J., Law, K., Onishi, T., Oshima, N., Peng, Y., Plummer, D., Popovicheva, O., Pozzoli, L., Raut, J.-C., Sand, M., Schmale, J., Sharma, S., Skov, H., Taketani, F., Thomas, M., Tsigaridis, K., Tsyro, S., Massling, A., Watson-Parris, D. (2020) Model simulations of short-lived climate forcers in the Arctic, 16th International Global Atmospheric Chemistry, 14th – 18th September, Manchester, UK, Poster.

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Christian Lanconelli, Fabrizio Cappucci, Bernardo Mota, Nadine Gobron, Amelie Driemel, Angelo Lupi, Long-term trends of surface reflectance derived from models, satellite and in-situ observations over polar areas, EGU2020, EGU General Assembly Conference Abstracts, pag.5830.

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Other Publications

Pernov, J.B., Hjorth, J. L., Bossi, R., Lebourgeois, T., Nøjgaard, J. K., Thomas, D. C., Massling, A., Skov, H. (2020) Source Apportionment of VOCs in the High Arctic, 3rd VRS workshop, 27th – 28th January, Copenhagen, Denmark, Poster.

Massling, A., Vitale, V., Eleftheriadis, K., Wehner, B., Haddad, I. E. and collaborators (2020) Ground-based component for short lived climate forcers, Eraplanet annual meeting, 3rd December, platform presentation.

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Sang-bum Hong, Young Jun Yoon, Silvia Becagli, Yeontae Gim, SD Chambers, Ki-Tae Park, Sang-Jong Park, Rita Traversi, Mirko Severi, V Vitale, Joo-Hong Kim, Eunho Jang, J Crawford, AD Griffiths (2020), " Seasonality of aerosol chemical composition at King Sejong Station (Antarctic Peninsula)", Atmospheric Environment, pp. 117185, Vol. 223.

Conference presentations (talks and posters)

Pernov, J. B., Beddows, D., Skov, H., Dall'Osto, M., Harrison, R. M., Massling, A. (2020) Trend analysis of aerosol particle physical properties at Villum Research Station, Northern Greenland, Arctic Change conference, 7th – 10th December, Platform presentation.

Torseth, K., Andrews, E., Asmi, E., Eleftheriadis, K., Fiebig, M., Herber, A., Huang, L., Kylling, A., Lupi, A., Massling, A., Mazzola, M., Nojgaard, J. K., Popovicheva, O., Schichtel, B., Schmale, J., Sharma, S., Skov, H., Stebel, K., Vasel, B., Vitale, V., Whaley, C., Yttri, K. E., Zanatta, M. (2020) Review of Observation Capacities and Data Availability for Black Carbon in the Arctic Region, European Polar Science workshop, 26th – 30th October, Copenhagen, Talk.

Thomas, D. C., Skov, H., Beddows, D., Harrison, R. M., Pernov, J. B., Dall'Osto, M., Massling, A (2020) Optical properties of different aerosol types in the High Arctic using k-means clustering, European Aerosol Conference, online: hosted in Aachen, Germany, Platform presentation.

Pernov, J. B., Beddows, D., Skov, H., Harrison, R. M., Dall'Osto, M., Massling, A. (2020) Decade trend analysis of k-means clustered aerosol types in High Arctic, European Aerosol Conference, online: hosted in Aachen, Germany, e-poster.

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Whaley, C. H., von Salzen, K., Mahmood, R., Weiss-Gibbons, T., Winter, B., Saunders, L., Eckhardt, S., Arnold, S., Chien, R.-Y., Christensen, J., Faluvegi, G., Flanner, M., Fu, J., Gauss, M., Huang, L., Im, U., Klimont, Z., Kuhn, T., Langner, J., Law, K., Onishi, T., Oshima, N., Peng, Y., Plummer, D., Popovicheva, O., Pozzoli, L., Raut, J.-C., Sand, M., Schmale, J., Sharma, S., Skov, H., Taketani, F., Thomas, M., Tsigaridis, K., Tsyro, S., Massling, A., Watson-Parris, D. (2020) Model simulations of short-lived climate forcers in the Arctic, 16th International Global Atmospheric Chemistry, 14th – 18th September, Manchester, UK, Poster/Talk.

Workshops

3rd Villum Research Station workshop with international cooperation, 27th – 28th January, Copenhagen, Denmark.

Work progress and achievements

- Continuation of monitoring of short-lived climate forcers at Villum Research Station in North Greenland.
- Model development of air-snow exchange of POPs to improve description of multi-media transport of POPs to the Arctic environment.

Task 1.1

During 2020 the activities in Task 1.1 were aimed at (i) completing the framework of long-term observations of short lived climate forcers (SLCFs) and ancillary measures necessary to be able to understand the processes that involve them and the changes in place, and (ii) work to fill the gap of columnar aerosol measurements during polar night thanks to the new technique of lunar photometry.

With respect to (i), particular attention was paid to the Arctic in consideration of the MOSAIC campaign and work was done in collaboration and synergy with initiatives promoted by AWI. We also worked to obtain an accurate picture of the measured parameters and the instrumentation/methods used. In addition, through a cooperative work coordinated by Marco Zanatta (at that time at AWI), detailed information was collected and grouped into 4 categories: in-situ measurements, gas measurements (both of trace gases and of possible aerosol precursors), vertical sounding measurements, measurements of the atmospheric column with remote sensing techniques from the ground.

With respect to (ii), during 2020 two inter-comparison campaigns devoted to assessing performances and capabilities of existing lunar photometry instrumentation were performed: (i) in winter 2020 in Ny-Alesund and (ii) in summer 2020 in Lydenberg, despite pandemic situation. Both campaigns included a day of workshops to discuss the results and experiences that emerged. During the first inter-comparison campaign in Ny-Alesund new tools and techniques such as CLIDAR were tested.

Task 1.2

During 2020 and 2021 monitoring of aerosol absorption coefficient and Equivalent black Carbon continued at the Zeppelin Research station, Ny Aalesund, Svalbard. Work continued on the state of mixing for black carbon containing particles and the evaluation of data from multi-instrument datasets for absorption coefficient and refractory carbon so that the mass absorption cross sections (MAC) is determined for arctic aerosol. This work is documented in the article by Ohata et al., 2021 AMTD (accepted) under the title “Estimates of mass absorption cross sections of black carbon for filter-based absorption photometers in the Arctic” <https://amt.copernicus.org/preprints/amt-2021-166/>

During 2021 after the partial lifting of restrictions for traveling to Svalbard, we have reestablished measurements by means of a tandem volatility Differential mobility classifier for the study of the physicochemical mechanisms governing new particle formation. New particle formation is extensively investigated due to its strong variability, nonlinear dependence on anthropogenic or natural precursors and the potential effect on climate in a regional and global scale. The focus is on investigating whether newly formed particles are volatile at temperatures between 250-300 0C as it should if it consisted of sulphuric acid or sulphate or whether it contains a solid core.

Task 1.3

In 2020 vertical aerosol measurements were performed within the MOSAiC campaign. A tethered-balloon system was deployed on the ice flow during the summer period. In total, 38 profiles of aerosol parameters (number concentration in different size ranges and mass concentration of eBC) are available. Most measurements were done under cloudy conditions and show distinct aerosol layers. Temperature inversions prevent vertical mixing of aerosol particles and most pollution is caused by long-range transport connected with warm-air intrusion. In addition, measurements of radiation, cloud droplet, meteorological parameters and turbulence were performed and will be analyzed in connection with the

aerosol data. This unique combination will provide new insights into particle sources and transport processes in the Arctic.

Task 1.4

During 2020-2021, we have analyzed 350 (bi-)weekly composite samples from filters collected at eight observatories across all sectors of the Arctic, at roughly overlapping periods in 2014-2019, resulting in unique annual cycles including the periods of winter darkness and summer daylight. This has been achieved by the measurement of major inorganic ion, EC/OC and WSOC. The WSOC was also measured by offline aerosol mass spectrometry (AMS) for the quantification of the natural and anthropogenic sources of OA. We have submitted two papers based on these measurements. In the first, we investigate how the major Arctic aerosol components behave relative to each other, how they change over a seasonal cycle and between stations in relative terms. We discuss the assets of the presented pan-Arctic aerosol dataset for simulating future Arctic climate. In the second, we determine the anthropogenic and natural sources driving the mass of primary and secondary OA in summer and winter. Finally, the same filter set has been analyzed for water soluble iodine, an important species involved in aerosol formation. We are currently preparing a manuscript based on these measurements.

Work Package 2

Publications

Publications – peer-reviewed articles

Feltracco, M., Barbaro, E., Spolaor, A., Vecchiato, M., Callegaro, A., Burgay, F., Vardè, M., Maffezzoli, N., Dallo, F., Scoto, F., Zangrando, R., Barbante, C., and Gambaro, A.: Year-round measurements of size-segregated low molecular weight organic acids in Arctic aerosol, *Sci Total Environ*, 763, 142954, 2021.

Petäjä, T., Duplissy, E. M., Tabakova, K., Schmale, J., Altstädter, B., Ancellet, G., Arshinov, M., Balin, Y., Baltensperger, U., Bange, J., Beamish, A., Belan, B., Berchet, A., Bossi, R., Cairns, W. R. L., Ebinghaus, R., El Haddad, I., Ferreira-Araujo, B., Franck, A., Huang, L., Hyvärinen, A., Humbert, A., Kalogridis, A. C., Konstantinov, P., Lampert, A., MacLeod, M., Magand, O., Mahura, A., Marelle, L., Masloboev, V., Moisseev, D., Moschos, V., Neckel, N., Onishi, T., Osterwalder, S., Ovaska, A., Paasonen, P., Panchenko, M., Pankratov, F., Pernov, J. B., Platis, A., Popovicheva, O., Raut, J. C., Riandet, A., Sachs, T., Salvatori, R., Salzano, R., Schröder, L., Schön, M., Shevchenko, V., Skov, H., Sonke, J. E., Spolaor, A., Stathopoulos, V. K., Strahlendorff, M., Thomas, J. L., Vitale, V., Vratolis, S., Barbante, C., Chabrillat, S., Dommergue, A., Eleftheriadis, K., Heilimo, J., Law, K. S., Massling, A., Noe, S. M., Paris, J. D., Prévôt, A. S. H., Riipinen, I., Wehner, B., Xie, Z., and Lappalainen, H. K.: Overview: Integrative and Comprehensive Understanding on Polar Environments (iCUPE) – concept and initial results, *Atmos. Chem. Phys.*, 20, 8551-8592, 2020.

Spolaor, A., Moroni, B., Luks, B., Nawrot, A., Roman, M., Larose, C., Stachnik, Ł., Bruschi, F., Koziół, K., Pawlak, F., Turetta, C., Barbaro, E., Gallet, J.-C., and Cappelletti, D.: Investigation on the Sources and Impact of Trace Elements in the Annual Snowpack and the Firn in the Hansbreen (Southwest Spitsbergen), *Frontiers in Earth Science*, 8, 664, 2021a.

Spolaor, A., Varin, C., Pedeli, X., Christille, J. M., Kirchgeorg, T., Giardi, F., Cappelletti, D., Turetta, C., Cairns, W. R. L., Gambaro, A., Bernagozzi, A., Gallet, J. C., Björkman, M. P., and Barbaro, E.: Source, timing and dynamics of ionic species mobility in the Svalbard annual snowpack, *Sci Total Environ*, 751, 141640, 2021b.

Mercury and persistent organic pollutants in polar areas, annual deposition and their long-term variability. Presenter: Andrea Spolaor. The European Network for Observing Our Changing Planet, ERA-PLANET Annual Virtual Project Meeting 3-4 December 2020

Saiz-Lopez, A., Travnikov, O., Sonke, J. E., Thackray, C. P., Jacob, D. J., Carmona-García, J., Francés-Monerris, A., Roca-Sanjuán, D., Acuña, A. U., Dávalos, J. Z., Cuevas, C. A., Jiskra, M., Wang, F., Bieser, J., Plane, J. M. C. and Francisco, J. S.: Photochemistry of oxidized Hg(I) and Hg(II) species suggests missing mercury oxidation in the troposphere, *Proceedings of the National Academy of Sciences*, <https://doi.org/10.1073/pnas.1922486117>, 2020.

Chuxian Li, Jeroen E. Sonke, Gaël Le Roux, Natalia Piotrowska, Nathalie Van der Putten, Stephen J. Roberts, Tim Daley, Roland Gehrels, Maxime Enrico, Dmitri Mauquoy, François De Vleeschouwer (2019) Unequal anthropogenic enrichment of mercury in Earth's northern and southern hemispheres. *ACS Earth & Space Chemistry*. <https://pubs.acs.org/doi/abs/10.1021/acsearthspacechem.0c00220>

Lim, A. G., Jiskra, M., Sonke, J. E., Loiko, S. V., Kosykh, N. and Pokrovsky, O. S.: A revised northern soil Hg pool, based on western Siberia permafrost peat Hg and carbon observations, *Biogeosciences*, 2020, 1–35, doi:10.5194/bg-2019-483

Zhiyong Xie, Zhen Wang, Olivier Magand, Alban Thollot, Ralf Ebinghaus, Wenying Mi, Aurelien Dommergue (2020): Occurrence of legacy and emerging organic contaminants in snow at Dome C in the Antarctic. *Science of the Total Environment*, 741, 140200. <https://doi.org/10.1016/j.scitotenv.2020.140200>

Work progress and achievements

Task 2.1

In 2020 activities of CNR was focused in finalized the analysis of snow samples collect during the 2018-2019 snow season (October 2018 – May 2019) from the Ny-Alesund site and complete additional analysis related to the WP. The samples have been measured for organic contaminants, trace elements, halogens and mercury. The dataset are under preparation and when ready will be summited and available in the iCUPE website. We are currently working on three scientific publications associated to this dataset,

one focusing on organic contaminants, once regarding the trace elements and once regarding the water stable isotopes. During the 2020 the filed campaign was extremely limited due to the COVID restriction and only part of the proposed activities were performed. Only daily surface snow sample were collected in Ny-Alesund during the snow season (Oct 2019 – May 2020) and the analysis of the collect samples are schedule in February 2021. In addition to the filed activities we continue with the data interpretation collect within the iCUPE project and we publish the following papers and presented new results in the iCUPE annual meeting. Other three manuscripts related with the iCUPE activities are submitted and currently under review.

Task 2.2

In 2020 CNRS has finalized all atmospheric reactive mercury concentration and gaseous mercury isotope measurements at VRS and ZEP research stations for the periods Spring 2018 - Summer 2019. The datasets delivered a available on the iCUPE website. We are currently working on three scientific publications associated to the data. The results show that previous atmospheric reactive mercury observations, using commercial automated analysers, have been underestimated. We also find that the summertime maximum in atmospheric elemental mercury in the Arctic is the result of snow re-emissions, and not marine or river re-emissions. Additional findings were published on mercury in Siberian permafrost soil profiles, leading to a new circum-polar soil mercury budget (Lim et al., 2020). We also reviewed mercury enrichment in sediment and peat archives of atmospheric mercury deposition in both Earth's hemispheres, including polar environments. The results suggest that the northern hemisphere is far more polluted than the southern hemisphere. Finally, we revisited atmospheric mercury redox dynamics, by providing new rate constants for gas phase oxidized mercury photolysis. The new redox scheme was tested in the GLEMOS mercury chemistry and transport model, finding an unusually long atmospheric mercury residence time that suggests a missing oxidation pathway.

Task 2.3

We have submitted a paper on modeling halogen activation in the Arctic and impacts on surface ozone in WRF-Chem. We sent this paper to JAMES - Journal of Advanced Modeling Earth Systems. We have made this code public, on GitHub through the account of Louis Marelle. We have the reviews for the paper and will have some updates to the code following the reviews.

Task 2.4

Together with Olivier Magand and Aurélien Dommergue, we have published some results of emerging organic contaminants in the snow from Dome C, which is a contribution for iCUPE. By analyzing the levels and component characteristics of organophosphate esters (OPEs), perfluoroalkylated substances (PFASs) and polycyclic aromatic hydrocarbons (PAHs) in the snow collected at Dome C, we found that these organic contaminants can be transported to the Antarctic inland. Relatively high concentrations of chlorinated OPEs, e.g. Tris(1-chloro-2-propyl) phosphate (TCPP) and tris-(2-chloroethyl) phosphate (TCEP) were detected. Perfluorooctanoic acid (PFOA) was the dominant compound of PFASs, followed by current-used short-chain PFAS, e.g. perfluoro-n-hexanoic acid (PFHxA), perfluoro-n-heptanoic acid

(PFHpA) and perfluoro-n-pentanoic acid (PFPeA). Surprisingly, GenX (2-(heptafluoropropoxy) propanoic acid, HFPO-DA) was determined in the Antarctic for the first time. HFPO-DA will follow the example of PFOA and become a new problem for the polar environment. Both global distillation and cold trapping may play significant roles to convey these chemicals from the Southern Ocean to the Antarctic inland. Scavenging and remobilization of organic contaminants by snow deposition and melting under the global climate change may enhance the essential impact on driving the exchange processes between environmental media.

Work Package 3

Publications

Publications – peer-reviewed articles

Hochreuther, P.; Neckel, N.; Reimann, N.; Humbert, A.; Braun, M. Fully Automated Detection of Supraglacial Lake Area for Northeast Greenland Using Sentinel-2 Time-Series. *Remote Sens.* 2021, 13, 205

Schröder, L.; Neckel, N.; Zindler, R.; Humbert, A. Perennial Supraglacial Lakes in Northeast Greenland Observed by Polarimetric SAR. *Remote Sens.* /doi.org/10.3390/rs12172798, 2020, 12, 2798

Neckel N, Zeising O, Steinhage D, Helm V and Humbert A (2020) Seasonal Observations at 79°N Glacier (Greenland) From Remote Sensing and in situ Measurements. *Front. Earth Sci.* 8:142. doi: 10.3389/feart.2020.00142

Petäjä T., Duplissy E.M., Tabakova K., Schmale J., Altstädter B., Ancellet G., Arshinov M., Balin Y., Baltensperger U., Bange J, Beamish A., Belan B., Berchet A., Bossi R., Cairns W. R. L., Ebinghaus R., Haddad I. E. , Ferreira-Araujo B., Franck A., Huang L., Hyvärinen A., Humbert A., Kalogridis A.C., Konstantinov P., Lampert A., MacLeod M., Magand O., Mahura A., Marelle L., Masloboev V., Moisseev D., Moschos V., Neckel N., Onishi T., Osterwalder O., Ovaska A., Paasonen P., Panchenko M., Pankratov M., Pernov J.B., Platis A., Popovicheva O., Raut J.C., Riandet A., Sachs T., Salvatori R., Salzano R., Schröder L., Schön M., Shevchenko V., Skov H., Sonke J.E., Spolaor A., Stathopoulos V., Strahlendorff M., Thomas J.L., Vitale V., Vratolis S., Barbante C., Chabrillat S., Dommergue A., Eleftheriadis K., Heilimo J., Law K.S., Massling A., Noe S.M., Pari J.D., Prévôt A., Riipinen I., Wehner B., Xie Z., and Lappalainen H.K, 2020. Overview – Integrative and Comprehensive Understanding on Polar Environments (iCUPE): the concept and initial results ,Environments (iCUPE), DOI: 10.5194/acp-20-8551-2020

Humbert A., Schröder L, Schultz T. , Müller R, Neckel N.Helm V., Zindler R., Eleftheriadis K., Salzano R., Salvatori R. 2020- Dark glacier surface of Greenland's largest floating tongue governed by high local deposition of dust, *Remote Sens.* 2020, 12, 3793; doi:10.3390/rs12223793

Salzano, Aalstad K., Boldrini E., Gallet J.C., Kępski D., Luks B., Nilsen, Salvatori R., Westermann S, 2021, Terrestrial Photography Applications on Snow cover in Svalbard (PASSES), SESS report 2020-The State of Environmental Science in Svalbard– an annual report, DOI: <https://doi.org/10.5281/zenodo.4294084>

Salzano R., Killie M.A, Luks B., Malnes E., 2021, A multi-scale approach to snow cover observations and models (Snow Cover), SESS report 2020-The State of Environmental Science in Svalbard– an annual report, <https://doi.org/10.5281/zenodo.4294092>

Salzano R, Lanconelli C, Esposito G, Giusto M, Montagnoli M, Salvatori R (2020) On the Seasonality of the Snow Optical Behaviour at Ny Åle-2sund (Svalbard Islands, Norway). Under review

Jawak SD, Andersen BN, Pohjola V, Godøy Ø, Hübner C, Jennings I, Ignatiuk D, Holmén K, Sivertsen A, Hann R, Tømmervik H, Kääb A, Błaszczyk M, Salzano R, Luks B, Høgda AK, Storvold R, Nilsen L, Salvatori R, Krishnan KP, Chatterjee S, Lorentzen DA, Erlandsson R, Lauknes TR, Malnes E, Karlsen SR, Enomoto H, Fjæraa AM, Zhang J, Marty S, Nygård KO, Lihavainen H (2020). SIOS's Earth Observation (EO), Remote Sensing (RS), and operational activities in response to COVID-19. Under review

Conference abstracts

Salzano R., Salvatori R., Valt M. 2020, Snow cover analysis integrating satellite and terrestrial imageries over a decade, SnowHydro Conference, Bolzano/Bozen (Italy) - 28th to 31st January, 2020

Salzano R., Aalstad K., Boldrini E., Gallet JC, Kępski D., Luks B., Nilsen L., Salvatori R., Westerman S. 2020. Terrestrial photography applications for snow cover monitoring: implementation of a shared approach, SIOS Online Conference on Remote Sensing (RS) and Geoinformation (GI) applications in Svalbard -abstract- SIOS's Conference 4th - 5th June 2020

Di Franco S., Salvatori R., Salzano R. 2020. The metadata profile for a snow-ice spectral library, SIOS Online Conference on Remote Sensing (RS) and Geoinformation (GI) applications in Svalbard -abstract- SIOS's Conference 4th - 5th June 2020.

Salvatori R., Salzano R., Lanconelli C., Esposito E., Giusto M., Montagnoli M. 2020. Ground-based monitoring of snow spectral reflectance, SIOS Online Conference on Remote Sensing (RS) and Geoinformation (GI) applications in Svalbard -abstract- SIOS's Conference 4th - 5th June 2020.

Workshops

Salvatori R., Salzano R., Di Franco S., Fontinovo G., Plini P. 2020. Snow-Ice Spectral library (SISpec) 2.0, -9th Workshop Remote Sensing of Land Ice and Snow of the European Association of Remote Sensing Laboratories (EARSeL), Bern 3rd - 5th February 2020, abstract, pg.42

Angelika Humbert, Niklas Neckel, Ludwig Schröder, Veit Helm, Robin Zindler. Supraglacial Hydrology at 79°N Glacier, Greenland – Lessons learned and Challenges. -9th Workshop Remote Sensing of Land Ice and Snow of the European Association of Remote Sensing Laboratories (EARSeL), Bern 3rd - 5th February 2020

Greenland ice sheet, Angelika Humbert, AASCO - Arena for Gap Analysis & Arctic Science Workshop, 2nd-3rd Nov 2020

Master thesis:

Robin Zindler (supervisor A. Humbert): Supraglaziale Hydrologie am 79°N Gletscher Nordost-Grönland, 2020

Work progress and achievements

- Preparation of the H2020 call entitled iARCDEV
- Preparation of the ESA ITT call entitled CLUSTER
- Contribution to the State of Environmental Science in Svalbard (SESS) report.
- Completion of PolSAR algorithm for lake drainage and classification of wet snow
- Acquisition of optical imagery for further study of supraglacial lake drainage
- Development of a concept for the combination of remote sensing surface characterization and modelling of dust deposition

Work Package 4

Publications

Publications – peer-reviewed articles

Ancellet, G., Penner, I. E., Pelon, J., Mariage, V., Zabukovec, A., Raut, J. C., Kokhanenko, G., and Balin, Y. S.: Aerosol monitoring in Siberia using an 808 nm automatic compact lidar, *Atmos. Meas. Tech.*, 12, 147–168, <https://doi.org/10.5194/amt-12-147-2019>, 2019.

Mason, S. L., Hogan, R. J., Westbrook, C. D., Kneifel, S., Moisseev, D., and von Terzi, L.: The importance of particle size distribution and internal structure for triple-frequency radar retrievals of the morphology of snow, *Atmos. Meas. Tech.*, 12, 4993–5018, <https://doi.org/10.5194/amt-12-4993-2019>, 2019.

Schoger, S., D. Moisseev, Dmitri, A. von Lerber, Annakaisa, S. Crewell, Susanne and K. Ebell, Snowfall rate retrieval for K- and W-band radar measurements designed in Hyytiälä, Finland, and tested at Ny-Ålesund, Svalbard. *Journal of Applied Meteorology and Climatology*. 10.1175/JAMC-D-20-0095.1, 2020.

Zhao, F., Riipinen, I., and M.A. MacLeod, A steady-state mass balance model for predicting gas-particle concentration ratios of PBDEs, *Environmental Science & Technology* (in press).

Conference presentations (talks and posters)

Identification of Aerosol Sources in Siberia and Study of Aerosol Transport at Regional Scale by Airborne and Space-Borne Lidar Measurement, Zabukovec A., Ancellet G., Pelon J., Penner I., Kokhanenko G., Balin Y., EPJ Web of Conferences, EDP Sciences, 2020, 237, 02014 (4 p.). <10.1051/epjconf/202023702014> - hal-02399661

Integrating in-situ and satellite data components, Law et al (WP4 partners), ERA-Planet annual meeting, 3 December 2020.

Aerosol monitoring in Siberia using an 808 nm automatic compact lidar Ancellet G., Penner I., Pelon J., Mariage V., Zabukovec A., Raut J.-C., Kokhanenko G., Balin Y., *Atmospheric Measurement Techniques*, European Geosciences Union, 2019, 12, pp.147-168. <10.5194/amt-12-147-2019> - insu-01857969

Work progress and achievements

Task 4.1

Proxies were derived for aerosol condensation sink as a function of carbon monoxide concentrations and temperature and for mixing-layer height as a function of radiation and wind speed using in-situ surface data. Parameters to represent a proxy for gross primary production were also investigated. Results show that additional data sources are needed to better constrain proxies. A pilot aerosol re-analysis (2005-2019 SMEAR II data) providing detailed information on new particle formation events was produced and will be available at <https://avaa.tdata.fi/>.

Task 4.2

Cloud radar measurements and falling snow microphysical properties were used to evaluate cloud and precipitation satellite retrieval algorithms including CAPTIVATE, proposed for upcoming ESA EarthCARE mission, and NASA GPM precipitation retrievals. Improved snowfall intensity retrievals were also estimated over Ny-Ålesund (Schoger, et al., in review).

Task 4.3

In-situ (surface, aerosol lidar), airborne (YAK), satellite data (CALIOP, VIIRS) and modelling (FLEXPART, WRF-Chem) were used to evaluate emissions of short-lived climate forcers. Deficiencies in BC and CH₄ emission inventories were identified over Siberia in particular from gas flaring (BC) and

wetland (CH₄) sources. iCUPE partners are contributing to the Arctic Council AMAP SLCF climate assessment 2020-2021.

Law, K., J.-P. Paris, T. Onishi, J.-C. Raut, L. Marelle, A. Riandet, M. Arshinov, B. Belan, M. Panchenko, D. Chernov, Evaluation of local pollution sources in the Eurasian Arctic based on integrated data analysis and modeling ; iCUPE deliverable report 4.3.2, submitted November 2020.

Task 4.4

Using the global contaminant fate model (BETR Global) coupled to a human exposure model (ACC-HUMAN), an improved sub-model for gas-particle partitioning of low-volatility organic pollutants (e.g. PBDEs) was developed. The new BETR Global v4.0 model was used to simulate Arctic exposure for PCBs and PBDEs from 1970 to 2050.

Zhao, F.; MacLeod, M., iCUPE Deliverable 4.4.2, submitted June 30, 2020.

Work Package 5

Publications

Publications – peer-reviewed articles

Barreira, L. M. F., Ylisirniö, A., Pullinen, I., Buchholz, A., Li, Z., Lipp, H., Junninen, H., Noe, S. M., Krasnova, A., Krasnov, D., Kask, K., Talts, E., Niinemets, Ü., Ruiz-Jimenez, J., and Schobesberger, S.: The importance of sesquiterpene oxidation products for secondary organic aerosol formation in a spring-time hemi-boreal forest, *Atmos. Chem. Phys. Discuss.* [preprint], <https://doi.org/10.5194/acp-2021-8>, in review, 2021.

Nigul, K.; Padari, A.; Kiviste, A.; Noe, S.M.; Korjus, H.; Laarmann, D.; Frelich, L.E.; Jõgiste, K.; Stanturf, J.A.; Paluots, T.; Pöldveer, E.; Kängsepp, V.; Jürgenson, H.; Metslaid, M.; Kangur, A. The Possibility of Using the Chapman–Richards and Näslund Functions to Model Height–Diameter Relationships in Hemiboreal Old-Growth Forest in Estonia. *Forests* 2021, 12, 184. <https://doi.org/10.3390/f12020184>

Kulmala, M., Ezhova, E., Kalliokoski, T., Noe, S., Vesala, T., Lohila, A., Liski, J., Makkonen, R., Bäck, J., Petäjä, T., & Kerminen, V-M. (2020). CarbonSink+: Accounting for multiple climate feedbacks from forests. *Boreal Environment Research*, 25, 145-159.

Petäjä T., Duplissy E.M., Tabakova K., Schmale J., Altstädter B., Ancellet G., Arshinov M., Balin Y., Baltensperger U., Bange J, Beamish A., Belan B., Berchet A., Bossi R., Cairns W. R. L., Ebinghaus R., Haddad I. E. , Ferreira-Araujo B., Franck A., Huang L., Hyvärinen A., Humbertl A., Kalogridis A.C., Konstantinov P., Lampert A., MacLeod M., Magand O., Mahura A., Marelle L., Masloboev V., Moisseev D., Moschos V., Neckel N., Onishi T., Osterwalder O., Ovaska A., Paasonen P., Panchenko M., Pankratov M., Pernov J.B., Platis A., Popovicheva O., Raut J.C., Riandet A., Sachs T., Salvatori R.,

Salzano R., Schröder L., Schön M., Shevchenko V., Skov H., Sonke J.E., Spolaor A., Stathopoulos V., Strahlendorff M., Thomas J.L., Vitale V., Vratolis S., Barbante C., Chabrillat S., Dommergue A., Eleftheriadis K., Heilimo J., Law K.S., Massling A., Noe S.M., Pari J.D., Prévôt A., Riipinen I., Wehner B., Xie Z., and Lappalainen H.K, 2020. Overview – Integrative and Comprehensive Understanding on Polar Environments (iCUPE): the concept and initial results ,Environments (iCUPE), DOI: 10.5194/acp-20-8551-2020

Kitz, F., Spielmann, F. M., Hammerle, A., Kolle, O., Migliavacca, M., Moreno, G., et al. (2020). Soil COS exchange: A comparison of three European ecosystems. *Global Biogeochemical Cycles*, 34, e2019GB006202. <https://doi.org/10.1029/2019GB006202>

Timmusk, S.; Nevo, E.; Ayele, F.; Noe, S.; Niinemets, Ü. Fighting Fusarium Pathogens in the Era of Climate Change: A Conceptual Approach. *Pathogens* 2020, 9, 419. <https://doi.org/10.3390/pathogens9060419>

Noe SM and Niinemets Ü (2020) Impact of Gall-Forming Insects on Global BVOC Emissions and Climate: A Perspective. *Front. For. Glob. Change* 3:9. doi: 10.3389/ffgc.2020.00009

[Conference presentations \(talks and posters\)](#)

Datapilots, services and interoperability (iCUPE final meeting, 9-10. June 2021)

Overview on SMEAR Estonia developments and data (Physics seminar, Tartu University, 7. April 2021)

SMEAR Estonia: Concepts, Data and Services (Centre of Excellence ENVIRON workshop, 15. Oct. 2020, Järvselja, Estonia)

SMEAR Estonia: Metsa ökosüsteemi ja atmosfääri vastastikmõju ja metsandus (Estonian Forest Conference, 13. Dec. 2019)

Work Package 6

[Publications](#)

[Publications – peer-reviewed articles](#)

Petäjä T., Duplissy E.M., Tabakova K., Schmale J., Altstädter B., Ancellet G., Arshinov M., Balin Y., Baltensperger U., Bange J, Beamish A., Belan B., Berchet A., Bossi R., Cairns W. R. L., Ebinghaus R., Haddad I. E. , Ferreira-Araujo B., Franck A., Huang L., Hyvärinen A., Humbertl A., Kalogridis A.C., Konstantinov P., Lampert A., MacLeod M., Magand O., Mahura A., Marelle L., Masloboev V., Moisseev D., Moschos V., Neckel N., Onishi T., Osterwalder O., Ovaska A., Paasonen P., Panchenko M., Pankratov M., Pernov J.B., Platis A., Popovicheva O., Raut J.C., Riandet A., Sachs T., Salvatori R.,

Salzano R., Schröder L., Schön M., Shevchenko V., Skov H., Sonke J.E., Spolaor A., Stathopoulos V., Strahlendorff M., Thomas J.L., Vitale V., Vratolis S., Barbante C., Chabrillat S., Dommergue A., Eleftheriadis K., Heilimo J., Law K.S., Massling A., Noe S.M., Pari J.D., Prévôt A., Riipinen I., Wehner B., Xie Z., and Lappalainen H.K, 2020. Overview – Integrative and Comprehensive Understanding on Polar Environments (iCUPE): the concept and initial results ,Environments (iCUPE), DOI: 10.5194/acp-20-8551-2020

Petäjä, T., Ganzei, K. S., Lappalainen, H. K., Tabakova, K., Makkonen, R., Räisänen, J., Chalov, S., Kulmala, M., Zilitinkevich, S., Baklanov, P. Y., Shakirov, R. B., Mishina, N. V., Egidarev, E. G., & Kondrat'ev, I. I. (2021). Research agenda for the Russian Far East and utilization of multi-platform comprehensive environmental observations. *International Journal of Digital Earth*, 14(3), 311-337. <https://doi.org/10.1080/17538947.2020.1826589>

Conference abstracts

Altimir, N., Mahura, A., Petäjä, T., Lappalainen, H. K., Borisova, A., Bashmakova, I., Noe, S., Duplissy, E.-M., Haapanala, P., Bäck, J., Pankratov, F., Schevchenko, V., Konstantinov, P., Vavrentsov, M., Chalov, S., Baklanov, A., Ezau, I., Zilitinkevich, S., and Kulmala, M. and the SMEAR Measurement Concept: Arctic Datasets as Part of PEEEX International Collaboration, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-13244, <https://doi.org/10.5194/egusphere-egu2020-13244>, 2020.

Buenrostro Mazon, S., Borisova, A., Altimir, N., Mahura, A., and Lappalainen, H. K.: Communication channels to build a stronger PEEEX network, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-15881, <https://doi.org/10.5194/egusphere-egu2020-15881>, 2020.

Lappalainen, H., Kerminen, V.-M., Altimir, N., Mahura, A., Ezhova, E., Vihma, T., Uuotila, P., Chalov, S., Konstantinov, P., Archinov, M., Qui, Y., Ezau, I., Kukkonen, I., Melnikov, V., Ding, A., Baklanov, A., Kasimov, N., Guo, H., Bondur, V., and Petäjä, T. and the Hanna Lappalainen: Pan-Eurasian Experiment (PEEX) Programme – Overview on the recent results , EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-7740, <https://doi.org/10.5194/egusphere-egu2020-7740>, 2020.

Work progress

- Organized special session Pan-Eurasian EXperiment (PEEX) – Observation, Modelling and Assessment in the Arctic-Boreal Domain at EGU General Assembly 2020, 08 May
- Arctic Urbanization under Environmental Change Workshop, 14-15 Jan 2020, Helsinki, Finland, https://www.atm.helsinki.fi/peexold/images/Arctic_Urbanization_under_Environmental_Change_WS_List_of_participants.pdf
- Organized the #HackTheArctic hackathon took place on the weekend of 12.-14.March. The event used open data portals to design new digital solutions for society, policy-making or research. www.HackTheArctic.com
- PEEEX Special Session at EGU2021 (29 April) and PEEEX HQ online meeting 28 April 2021

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- Online Research Seminar on “Holistic multi- and interdisciplinary approach in supporting the Arctic sustainable development” (19 Feb 2021), number of participants: about 50 researchers from Austria, Czech Republic, Denmark, Finland, Norway, Russia, and Switzerland
 - https://www.atm.helsinki.fi/peex/images/PEEX_19Feb2021_ResSeminar-KSC-UHEL_agenda.pdf
 - PEEEX research collaboration online meeting (12 Nov 2020), audience: Finnish and Russian researchers (from UH-INAR and Kola Science Center RAS), https://peexqhome.files.wordpress.com/2020/12/peex_12nov2020_meet-ksc-uhel_agenda.pdf
 - Participation in the Horizon Results Booster, Module A.
 - Contributing to the Data Task Group and Communication Task Group of EU Polar Cluster.