VILLUM RESEARCH STATION

Henrik Skov, Lise Lotte Sørensen, Andreas Massling, Ulrich bay Gosewinkel,
Carsten Ambela Skjøth, Jesper Christensen and Ulas Im

VILLUM RESEARCH STATION, GREENLAND 81° 36'N 16°39' W, OPENED IN 2015 AN ARCTIC CLIMATE STATION

Next slide:
Continuous measurement plane text
Italic instrument operated in campaigns
(Parenthesis indicate external operator.)

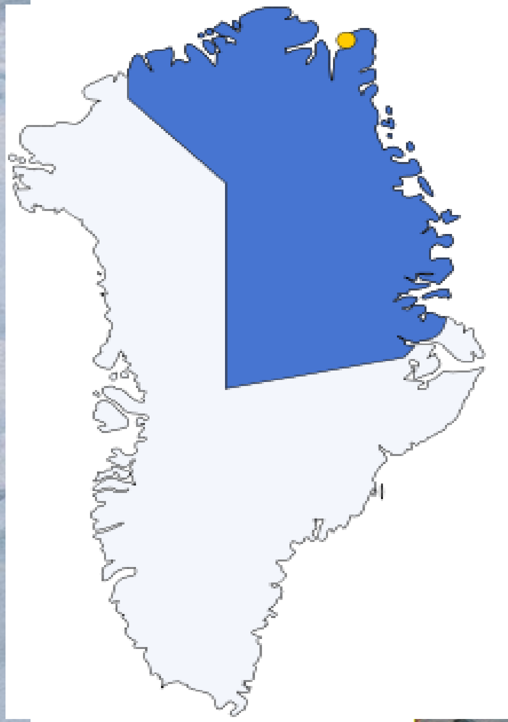
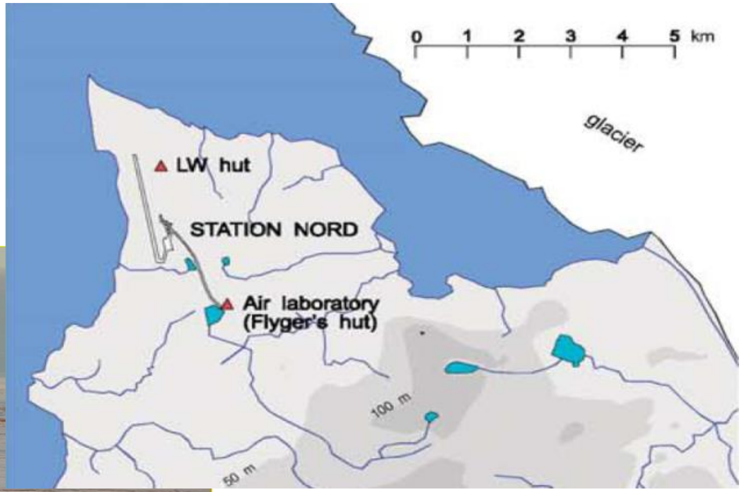


Photo: Bjarne Jensen



www.villumresearchstation.dk

Atmospheric Parameters measured at Villum Research Station

Meteorology (AU-ENVS, DMI, and Asiaq)

- Temperature
- Relative humidity
- Wind direction & Wind speed
- Precipitation & Snow depth
- Radiation

Particle physics (AU-ENVS)

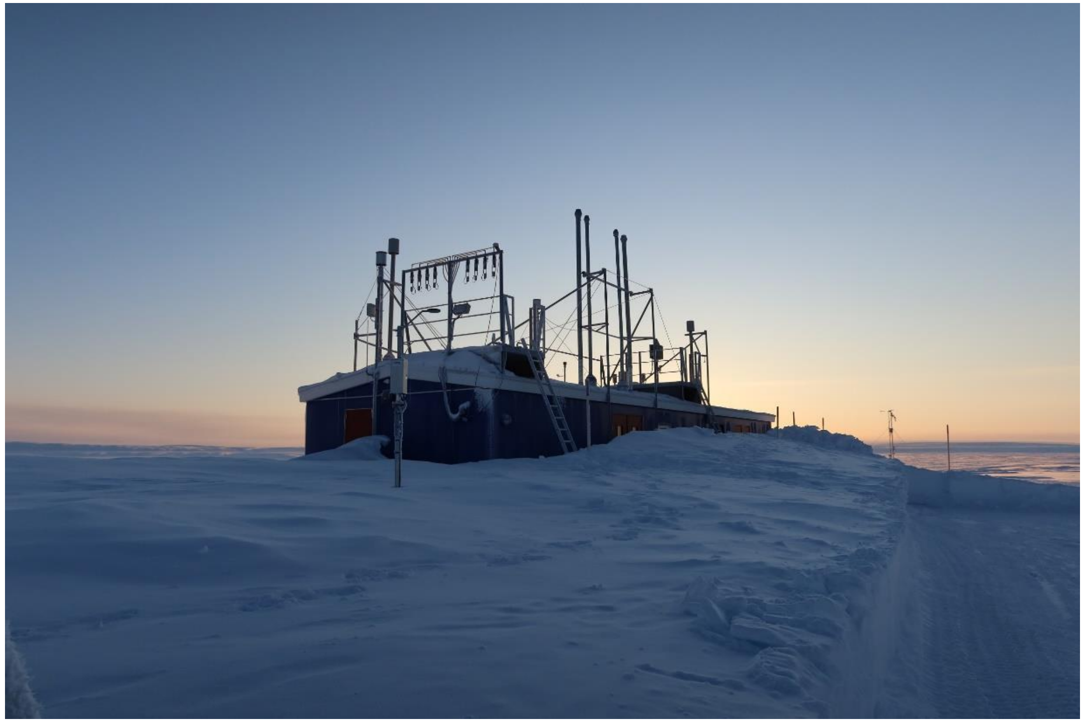
- Submicron PNSD (10 – 900 nm, SMPS)
- Supermicron PNSD (0.3 – 10 µm, OPC)
- Scattering coefficient (Nephelometer)
- Absorption coefficient (BC mass, Aethalometer)
- Particle number concentration (>10nm, CPC)

Particle physico-chemical parameters (AU-ENVS), campaign-wise

- *Subsaturated hygroscopic growth of submicron aerosol (HTDMA)*
- CCN activity of submicron aerosol (CCN counter) (by TROPOS)

Remote sensing (DTU)

- Boundary layer height (Ceilometer)
- Vertical profile of wind speed and direction (Wind LIDAR)
- *Max-DOAS (by CSIC)*



Atmospheric Parameters measured at Villum (Continued)

Particle chemistry (by AU-ENVS) – weekly time res. Started in 1990

- Filter Pack Sampler
  - (Elements by ICP-MS: Sb, Ba, Ga, Zn, As , Se, Co, Pb, Na, Mg, Al, K, Ca, Ti, Rb, Sr, Mo, Cd, V, Cr, Mn, Ni, Cu, Fe)
  - (Inorganics by IC: Na, Br, Cl, NH_3, HNO_3, SO_2, SO_4^{2-}, NO_3^-, NH_4^+)
- High Volume Sampler (EC/OC and Persistent Organic Pollutants)

Gases (by AU-ENVS)

- Gaseous Elemental Mercury (GEM), $\mathbf{O_3}$, (NO_2), CH_4, $C^{14}H_4$, CO_2
- *Volatile Organic Compounds (PTR-ToF-MS)* ***in campaigns***
- Water isotopes (University of Alaska Anchorage)

Particle Chemistry (AU-ENVS), campaign-wise

- On-line Particulate matter (PM_1) including organic aerosols, SO_4^{2-}, NO_3^- , rBC, OC and NH_4^+
- *SP-AMS (Soot Particle - Aerosol Mass Spectrometer)*
- ACSM (Aerosol Chemical Speciation Monitor)
- INP (by TROPOS)
- NAIS (by HU)

DRONES, TETHERED BALLOONS AND SMALL RESEARCH AIRCRAFT

VILLUM
RESEARCH STATION

PROGRAMMES AND PROJECTS

AMAP, EMEP, WMO-GAW, IASOA, Interact, ACTRIS, ICOS, GIOS

AMAP CORE Atm. SLCF, ICOS;

Upgrate of Villum Research Station; a bead ruptor (OMNI Bead ruptor Elite MIII Homogenizer), Freeze dryer (Martin Crist ALPHA 1-2 LDplus) and cylinders with special reducing valves to providing liquid CO_2 snow

PRODUCTION IN 2022

We have published 18 articles in 2022 in atmospheric chemistry and physics where 10 is related to “ACTRIS - in situ particle measurements”

3 AMAP Assessment Reports

2 PhD student finished their thesis (Jacob Boyd Pernov and Daniel Charles Thomas)

Dan's Defense is the 16 February 1:00 PM. (I will send a TEAMs link)

PLANS FOR 2023 AND 2024 (ATMOSPHERE)

AMAP CORE Atmosphere, SLCF, ACTRIS and ICOS continuous

2023: AU will have activities April 15-30; AWI?

2024: April-May AU; EPFL; TROPOS, AWI (AC3); ARCSIX (NASA)

(Lauren Samora, Sebastian Schmidt among others)

MAIN OBJECTIVE AND HYPOTHESIS

Main Objective is to determine the changes in the atmospheric composition in high Arctic due to climate change and how it in turn feeds back on climate in a post fossil fuel word.

We hypothesis that the anthropogenic induced climate change course irreversible changes in atmospheric composition and processes now and in the year to come.

MAJOR RESEARCH SUBJECTS IN A POST FOSSIL FUEL WORLD

1. Turbulence at more heights; CH_4 and O_3 peaks at ground level
2. Changes in dust concentration
3. Anthropogenic induced changes in natural sources of aerosols and potential impact of them
4. The importance of biogenic aerosols for INP
5. Changes in the fundamental chemical and physical processes of O_3 and particles dynamics (formation, growth and removal) as function of height
6. The frequency and extension of warm air intrusion both direct and latent.

1. TURBULENCE AT MORE HEIGHTS; CH_4 AND O_3 PEAKS AT GROUND LEVEL

Reseponsible. Lise Lotte Sørensen; LLS@envs.au.dk

Often the atmosphere is stable in cold areas like the Arctic, and stable atmospheres are suppressing the vertical mixing, however new studies indicate that Low Level Jets (LLJs) can enhance the vertical mixing.

We hypothesize LLJ will become more frequent due to increasing temperature gradients in the Arctic coastal areas

How do the LLJs affect the atmospheric mixing and vertical transport of GHG and particles?

ICOS | National Network Denmark

Tubing to sample air at 3 heights is installed at an 85 meter mast with inlet in 20 m, 50 m and 85 m. A PICARRO G2301 is used to measure CO_2, CH_4 and H_2O. Turbulence is measured at different heights.

2. CHANGES IN DUST CONCENTRATION

Responsible: Andreas Massling; ANMA@envs.au.dk

1. Emission of dust particles from soils might be changing as more surfaces in Arctic regions are exposed (retreating glaciers, snow- and ice-free areas, etc.)
2. Soil dust has an absorbing component and can be deposited on snow- and ice-covered areas and thus impact albedo
3. Soil dust is known to have ice-nucleating potential compared to homogenous freezing of cloud droplets
4. A monitoring network to measure dust particle concentrations in the Arctic is proposed (AMAP recommendation)
5. This could potentially be realized within a simple set up without an expensive infrastructure (fully equipped measurement stations) and would demand a reasonable spatial distribution

3. FEEDBACK MECHANISMS: THE ROLE OF ARCTIC WARMING ON NATURAL AEROSOL EMISSIONS AND TRANSPORT

Responsible: Henrik Skov; hsk@envs.au.dk and Andreas Massling; ANMA@envs.au.dk

1. Arctic warming is impacting on the source strength of aerosol precursors in the Arctic as more open waters increase biogenic emissions
2. Simultaneously, air mass transport in the Arctic changes impacting on the spatial distribution of aerosol particle populations at higher latitudes
3. An increase of nucleation events and the number of smallest particles is e.g. observed at Villum
4. While having high number concentrations during summer these particles can affect the radiation balance of the Arctic atmosphere
5. Can these particles after substantial ageing and growth be involved in cloud formation and affect cloud properties that in turn are key for the indirect aerosol effects?

4. THE IMPORTANCE OF BIOGENIC AEROSOLS FOR INP

Responsible: Carsten Ambela Skjøth; CAS@envs.au.dk

There are well above 1 million different bacteria and fungi in the atmosphere. 75% or more cannot be classified at the species or family level! An unknown fraction escape traditional detection methods! Bioaerosols are known for their importance as INP. Their presence and abundance dramatically responds to a warming world.

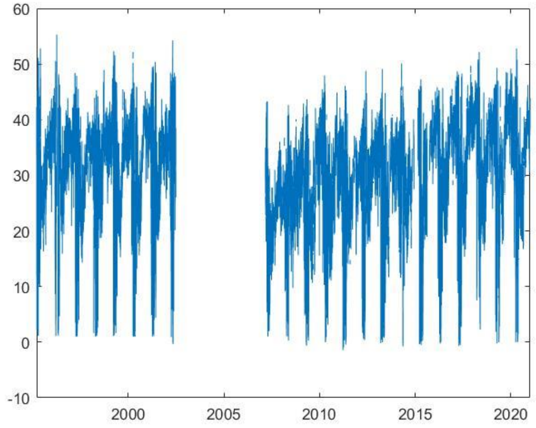
▶ Research Questions

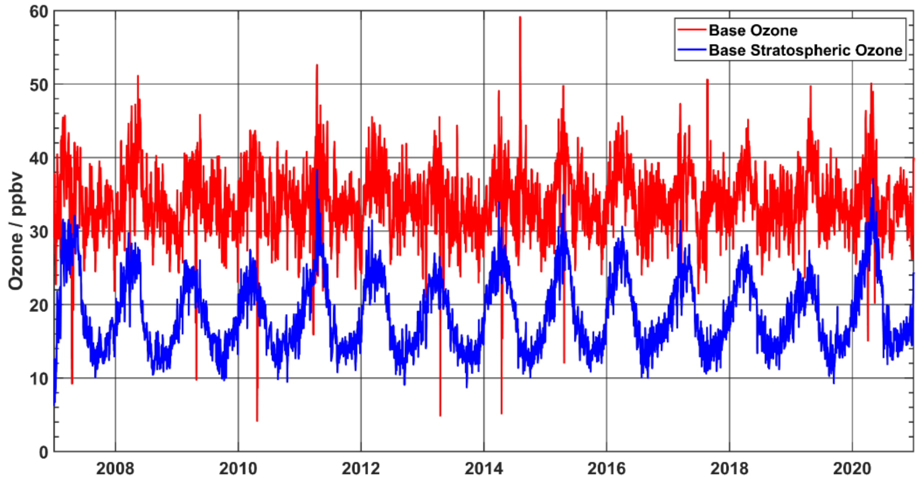
1. How does the Arctic bioaerosol look today?
2. How large a fraction of the Arctic bioaerosol is unknown to mankind and where does it come from?
3. What is the impact of the Arctic bioaerosol on physical environment?
4. Which bioaerosols can we expect in the Arctic atmosphere in a post fossil fuel world – diversity, abundance and their INP capability?
5. Will bioaerosols be the dominating component in the physical hydrological cycle (as INP) in a post fossil fuel world?

5. CHANGES IN THE FUNDAMENTAL CHEMICAL AND PHYSICAL PROCESSES OF O_3 AND PARTICLES DYNAMICS

Responsible: Henrik Skov; HSK@envs.au.dk; Jesper Christensen; JC@envs.au.dk

Main aim is to determine the special Arctic processes that is responsible for tropospheric ozone deletion and how high it is reaching and the connection between IO, IO_3^- and aerosol formation as function of height





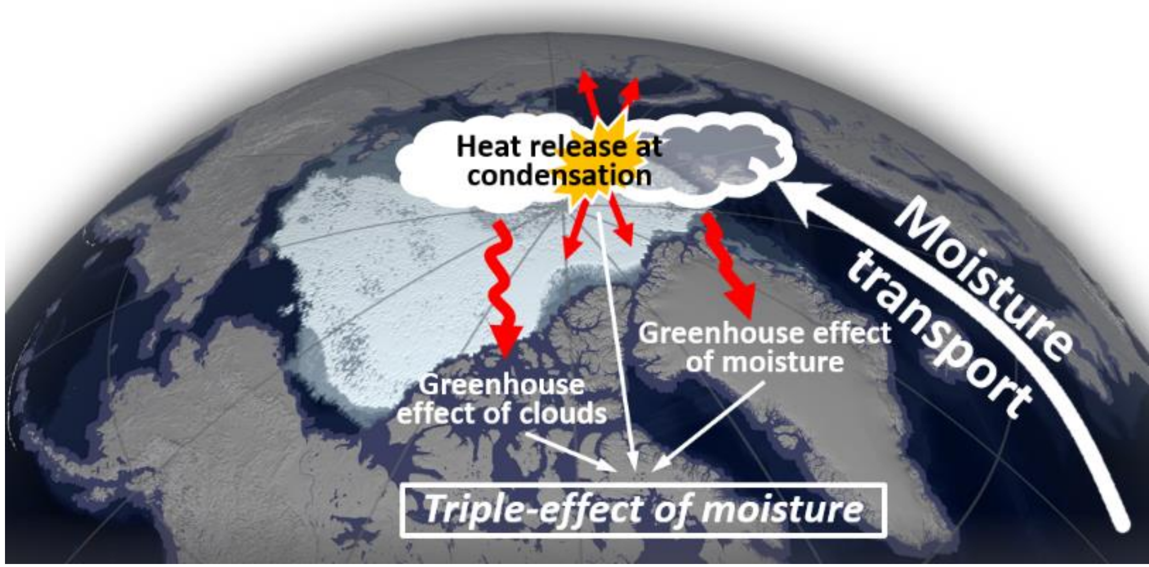
Jesper Christensen, work in progress

6. IMPACT OF AEROSOLS DURING WARM AIR INTRUSION EVENTS

Responsible; ULAS@envs.au.dk

- When the transported moisture condenses to clouds, large amounts of heat is released. This condensation energy from **the moisture transport is augmented to a triple-effect** by increases in humidity as well as in clouds that both enhance the Arctic greenhouse effect and boost the warming from moisture transport
- A hitherto overlooked aspect of this interaction is that the **intrusion events likely also bring aerosols from mid-latitudes into the Arctic**.
- **We hypothesize here that aerosols turn the triple-effect of moisture transports into a quadruple-effect** via their modulating effects on clouds, making cloud formation more efficient exactly at times when moisture is available for cloud formation.

VRS is located where the moisture intrusion events occur, thus a perfect spot to study these interactions



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- Villum Foundation is acknowledged for the large grant making it possible to build the new research station at Station Nord
- Interact
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- The Royal Danish Air Force is acknowledged for providing free transport to Station Nord, and the staff at Station Nord is especially acknowledged for excellent support
- Last but not least PhD. and master students


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