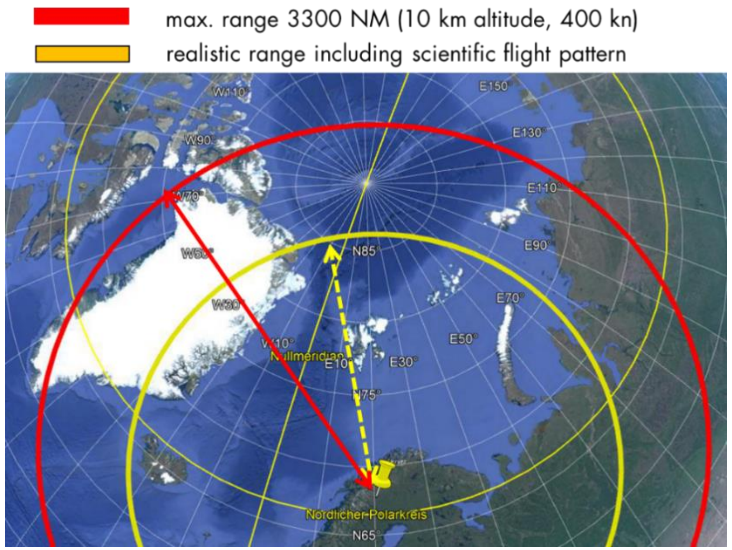
HALO during HALO-(AC)³

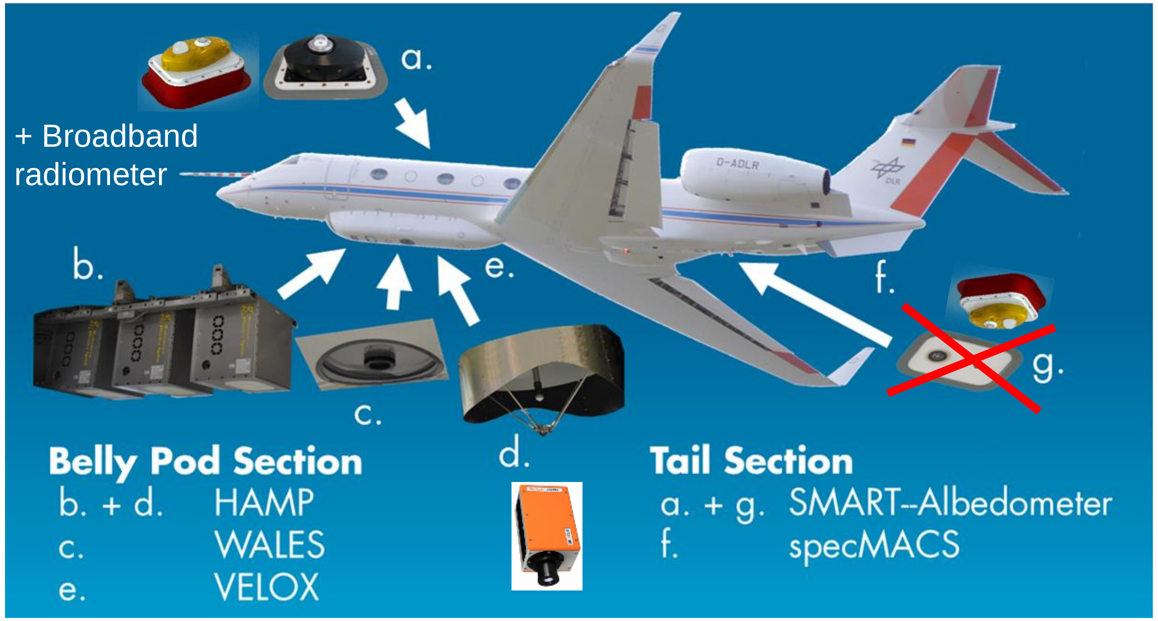
André Ehrlich, Susanne Crewell et al.

Kiruna: 5. March – 15. April 2022



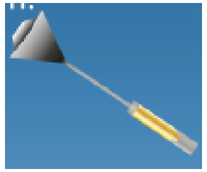
TRANSREGIO TR 172 | LEIPZIG | BREMEN | KÖLN

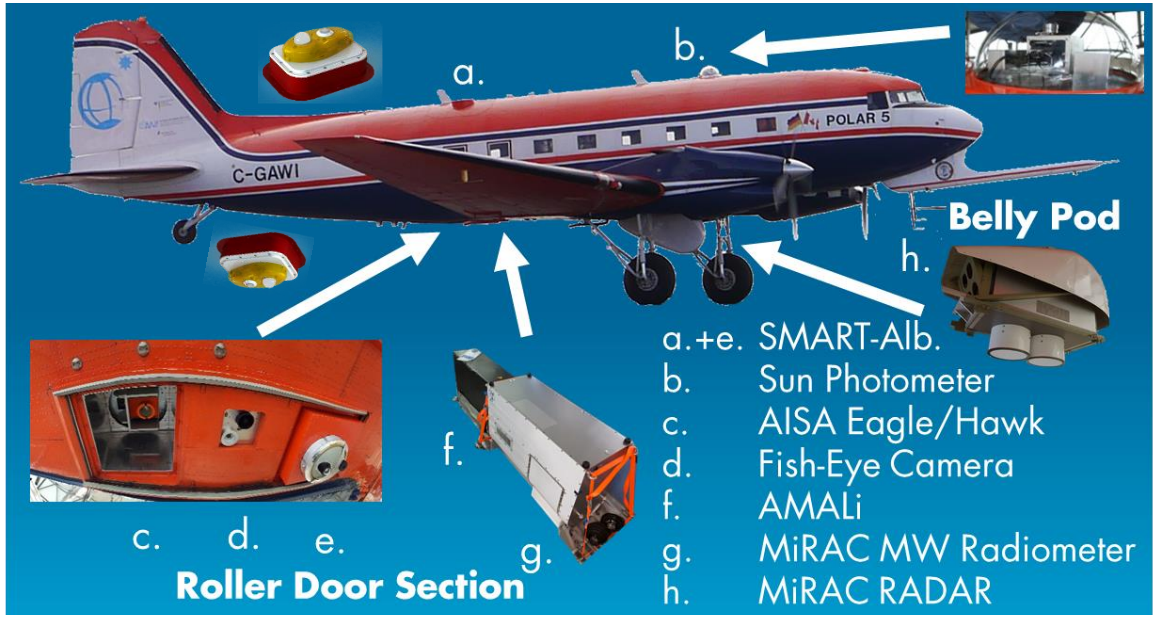
UNIVERSITÄT LEIPZIG
Universität Bremen
University of Cologne
TROPOS Leibniz Institute for Tropospheric Research



HALO

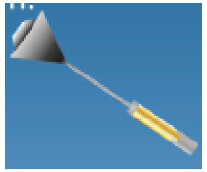
Remote sensing + Dropsonde





Polar 5

Similar remote sensing payload

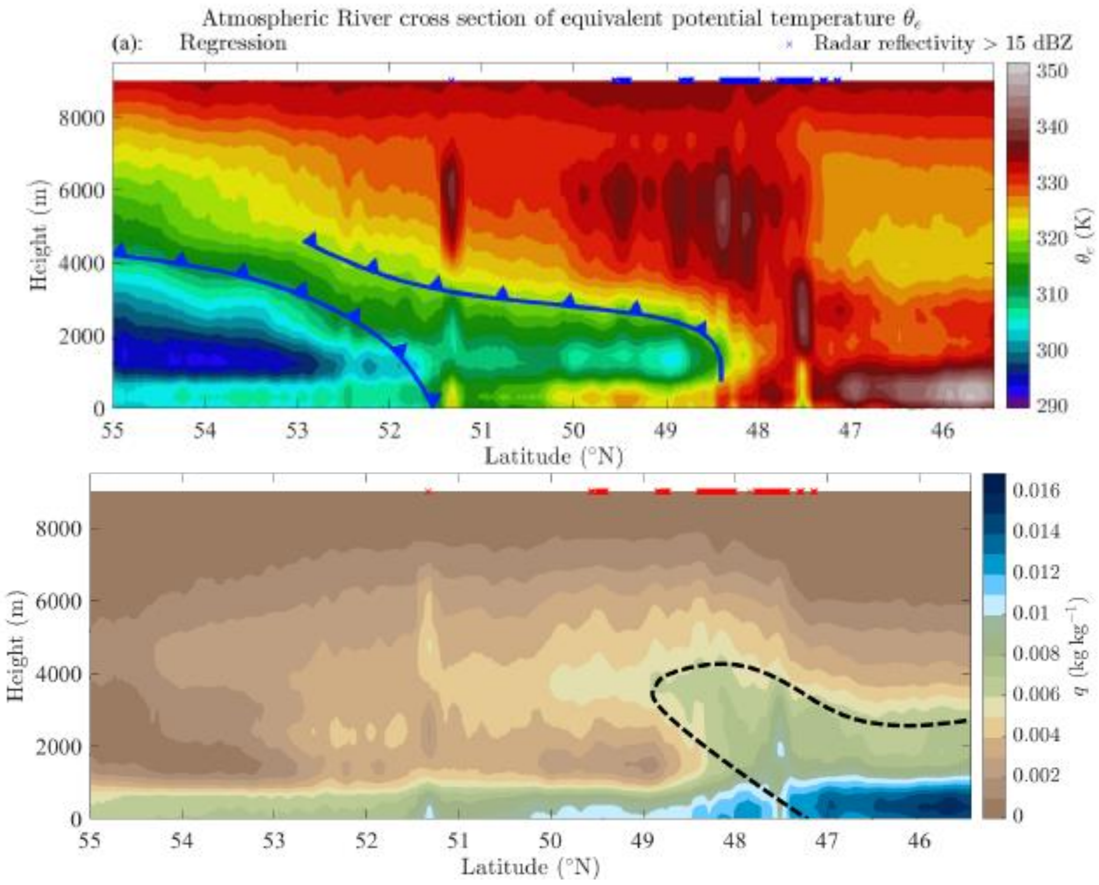


Scientific Payload of HALO-(AC)³

Names /Acronyms	Technique	Measured/Retrieved Quantities	Institution
HALO			
SMART-Albedometer	Passive Solar	Spectral Irradiance (Upward, Downward)	Uni Leipzig
		Spectral Radiance (Upward, *FOV* = 2.1°)	
specMACS	Passive Solar	Spectral Radiance (*FOV* = 34°, 1300 px / 320 px)	Uni München
WALES	Active Solar (Lidar)	Particle Backscattering Coefficient, Water Vapour Mixing Ratio, Cloud Top Height,	DLR
HAMP	Passive Microwave	Brightness Temperature	MPI Hamburg, Uni Hamburg, Uni Köln, DLR
	Active Microwave (Radar)	Radar Reflectivity Factor, Doppler Velocity, Doppler Spectra Width, Depolarization Ratio	
VELOX	Passive Terrestrial	Brightness Temperature (*FOV* = 44°× 35°, 640 px × 512 px)	Uni Leipzig, MPI Hamburg
BACARDI	Broadband radiometer	Solar and terrestrial irradiance (Upward, Downward)	DLR, Uni Leipzig
POLAR 5			
SMART-Albedometer	Passive Solar	Spectral Irradiance (Upward, Downward)	Uni Leipzig
		Spectral Radiance (Upward, *FOV* = 2.1°)	
Aisa Eagle/Hawk	Passive Solar	Spectral Radiance (*FOV* = 36°, 1028 px / 348 px)	Uni Leipzig
180° Fish-Eye Camera	Passive Solar	Spectral Radiance (*FOV* = 180° × 180°, 3908 px × 2600 px)	AWI/ Uni Leipzig
AMALi	Active Solar (Lidar)	Particle Backscattering Coefficient, Cloud Top Height, Particle Depolarization	AWI
MiRAC	Passive Microwave	Brightness Temperature	Uni Köln
	Active Microwave (Radar)	Radar Reflectivity Factor, Doppler Velocity, Doppler Spectra Width	Uni Köln
Sun Photometer	Passive Solar (direct Sun)	Spectral Aerosol Optical Depth (AOD)	AWI
Broadb. Radiometer	Broadband radiometer	Solar and terrestrial irradiance (Upward, Downward)	DLR, Uni Leipzig
Nose Boom	Five-hole probe	3D wind vector, temperature and humidity, turbulent fluxes	AWI

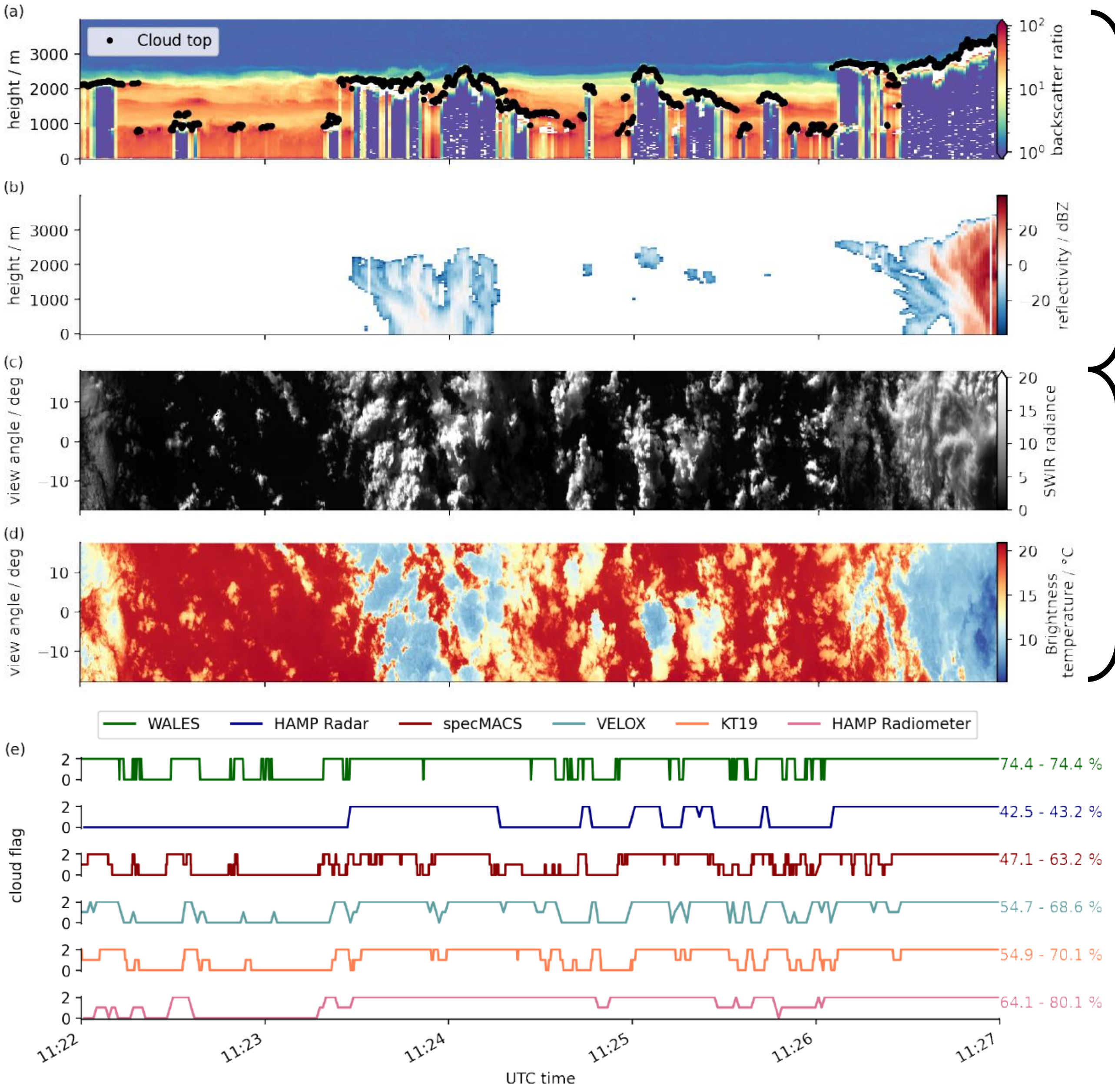
Payload differences HALO-(AC)³ vs Polar5

- Advanced lidar (**WALES**) with capability to derive water vapor profiles in cloud free regions
- Multi-channel (25) microwave radiometer (**HAMP**) compared to 7 high frequency channels (Polar 5) enable retrieval of thermodynamic state
- 35 GHz pulsed radar (**HAMP**) with slightly coarser vertical resolution as compared to FMCW system on (Polar 5) and similar sensitivity
- IR and polarization cameras



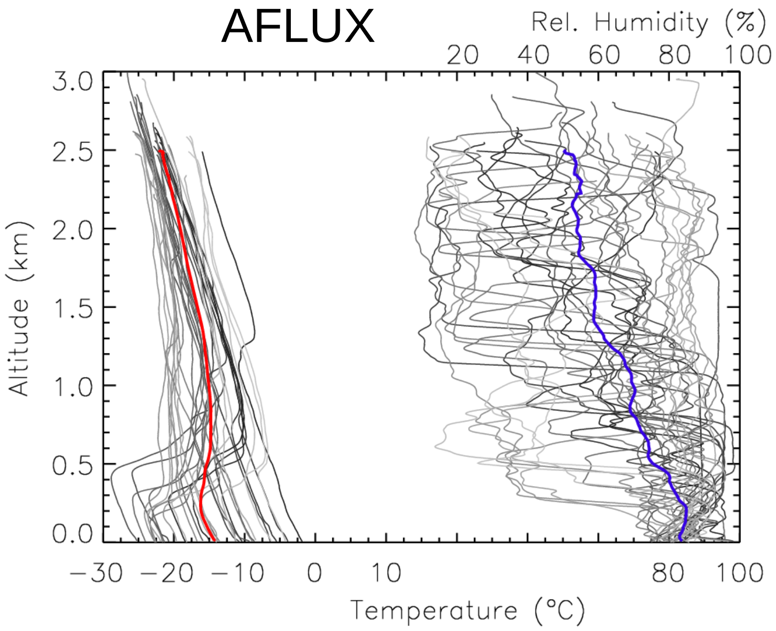
NAWDEX 27 Sep 2016, Andreas Walbröl,

Examples of Measurements



Vertical view

Horizontal view



+ passive radiometer = integrated view

See Stevens et al., BAMS, 2019
A High-Altitude Long-Range Aircraft Configured as a Cloud Observatory: The NARVAL Expeditions
https://journals.ametsoc.org/view/journals/bams/100/6/bams-d-18-0198.1.xml

Mission Aims for HALO

HALO = Remote sensing + Dropsonde

→ Only in high altitude: above/below cirrus

→ Provide a data set for:
- (A) detailed characterization of case studies
- (B) evaluation of numerical models + model experiments
- (C) evaluation of satellite products

→ Data to be expected:

Primarily measured quantities → !!!! → Derived quantities

→ Data missing = in situ → **Polar 5/6** + ATR-42 + FAAM

Mission Aims for HALO

To be discussed during the workshop

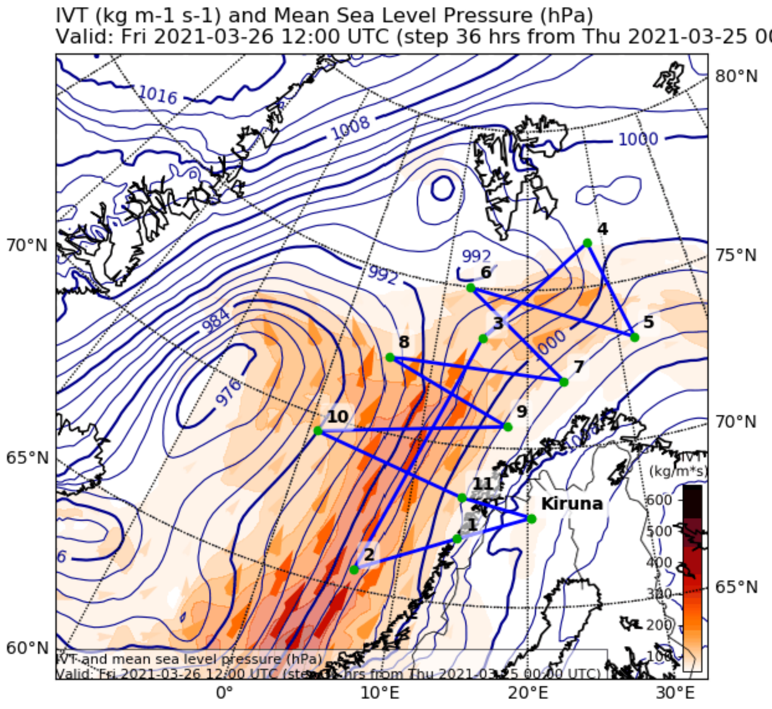
Objectives	Details	Instruments	Priority
Lagrangian sampling WAI	along trajectory	all	1
	across trajectory	all	1
Lagrangian sampling CAO	along trajectory	all	2
	across trajectory	all	2
Cirrus remote sensing	below/above cirrus	all	2
Large scale divergence		Drop sondes	1
Atmospheric rivers		all	2
Polar Low		all	3
Surface/Sea ice (cloud free)	cloud-free conditions	solar & IR imager	3

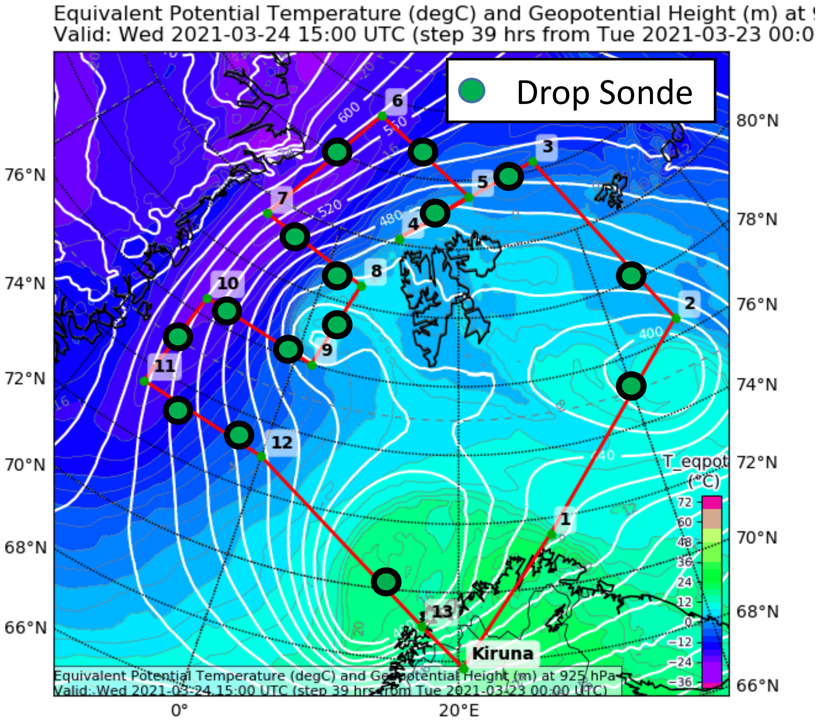
Examples from Dry Run

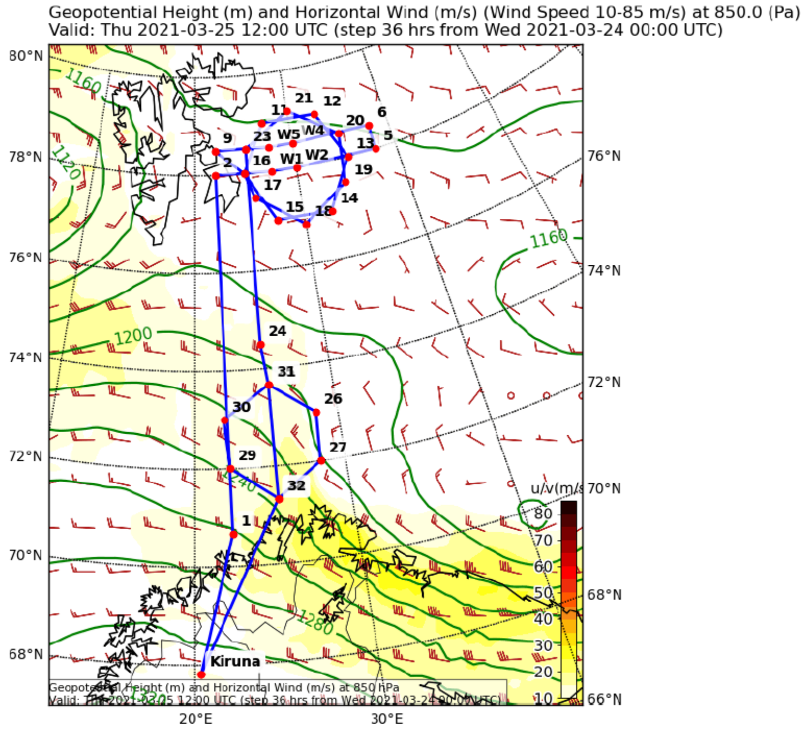
Flight planning:

→ identification of area of interest (4 day in advance)
→ lagrangian perspective
→ close collaboration with modelling demands
→ search link to Polar 5/6

Sufficient preparation time needed





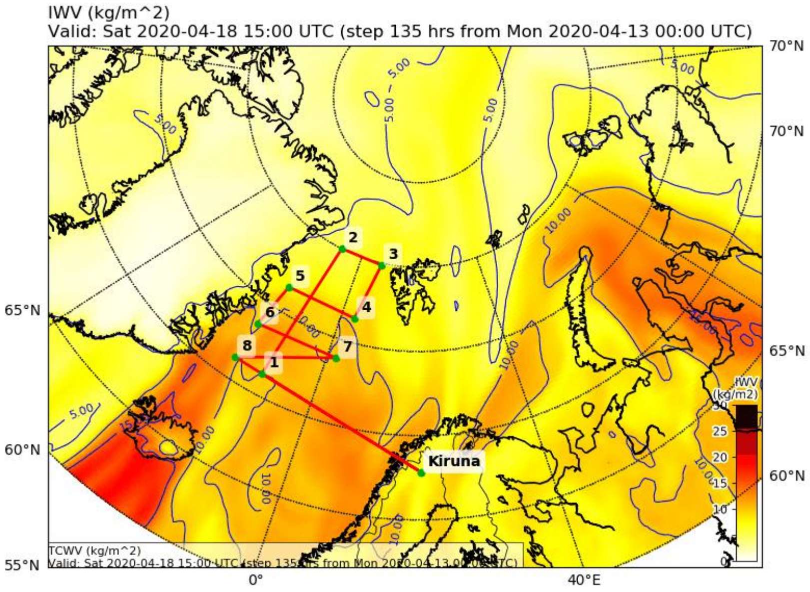


Examples from Dry Run

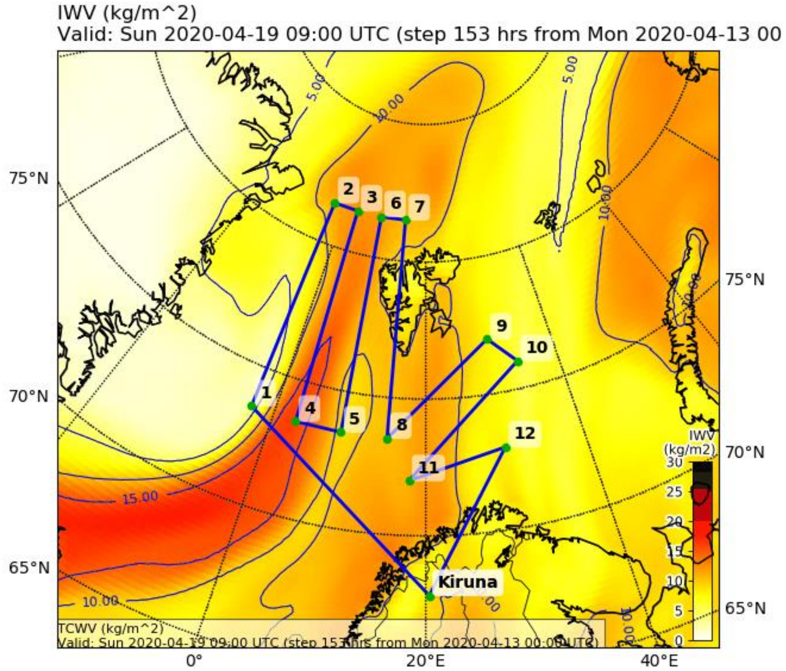
3 Flights on 3 consecutive days: maximize lagrangian perspective

- intense planning and operational effort → how to organize our self?
- sampling strategy → identify best flight pattern to make flights comparable?!

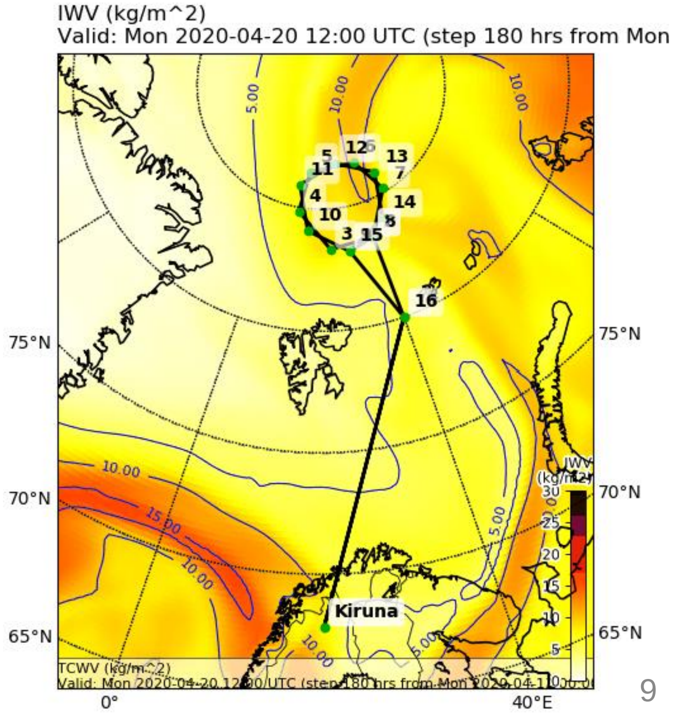
18. April



19. April



20. April



Other activities

ISLAS	– ATR-42	10 March - 30 March 2022 (or 1week later)
ACAO	– FAAM 146	07 March - 01 April 2022
MC^2	– INCAS King Air	09 March - 01 April 2022

© Claude Delhaye / Safire / CNRS Photothèque

Photograph courtesy of Adrian Court

Robert David

Activities parallel to HALO-$(AC)^3$ - Kiruna

ISLAS

Isotopic Links to Atmospheric Water's Sources Field Campaign 2022

Harald Sodemann

for the ISLAS team (Andrew Seidl, Aina Johannessen, Alena Dekhtyareva, Iris Thurnherr, Marvin Kähnert, Marius Jonassen, Lars R. Hole, Paul Voss, Sander Løklingholm, Lukas Papritz, Marina Dütsch, Patrick Chazette, Julien Delanoë, Alfons Schwarzenboeck)

BJERKNES CENTRE for Climate Research

erc European Research Council

UNIVERSITY OF BERGEN

FARLAB

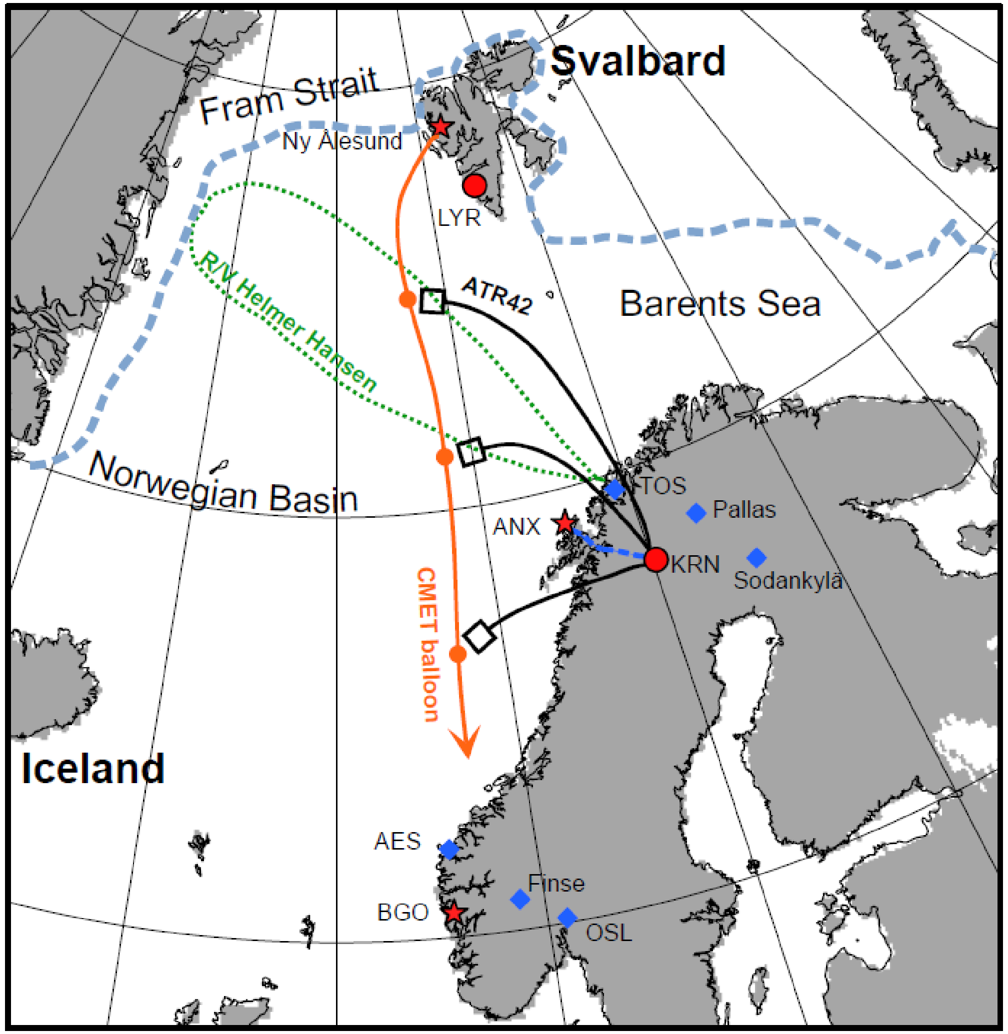
Activities parallel to HALO-(AC)³ - Kiruna

Plans (and wishes) for the ISLAS2022 campaign:

Lagrangian airmass sampling with water vapour isotope instrumentation

- Isotope meas. onboard ATR42
- Isotope meas. onboard R/V Helmer Hansen
- 5 CMET balloons from Ny Ålesund
- Supersite Andenes (ANX)
- Supersite Kiruna supersite
- Surface transect (ANX-KRN-Abisko)
- Special site overflights

- No more COVID restrictions!



ATR42 at Andenes

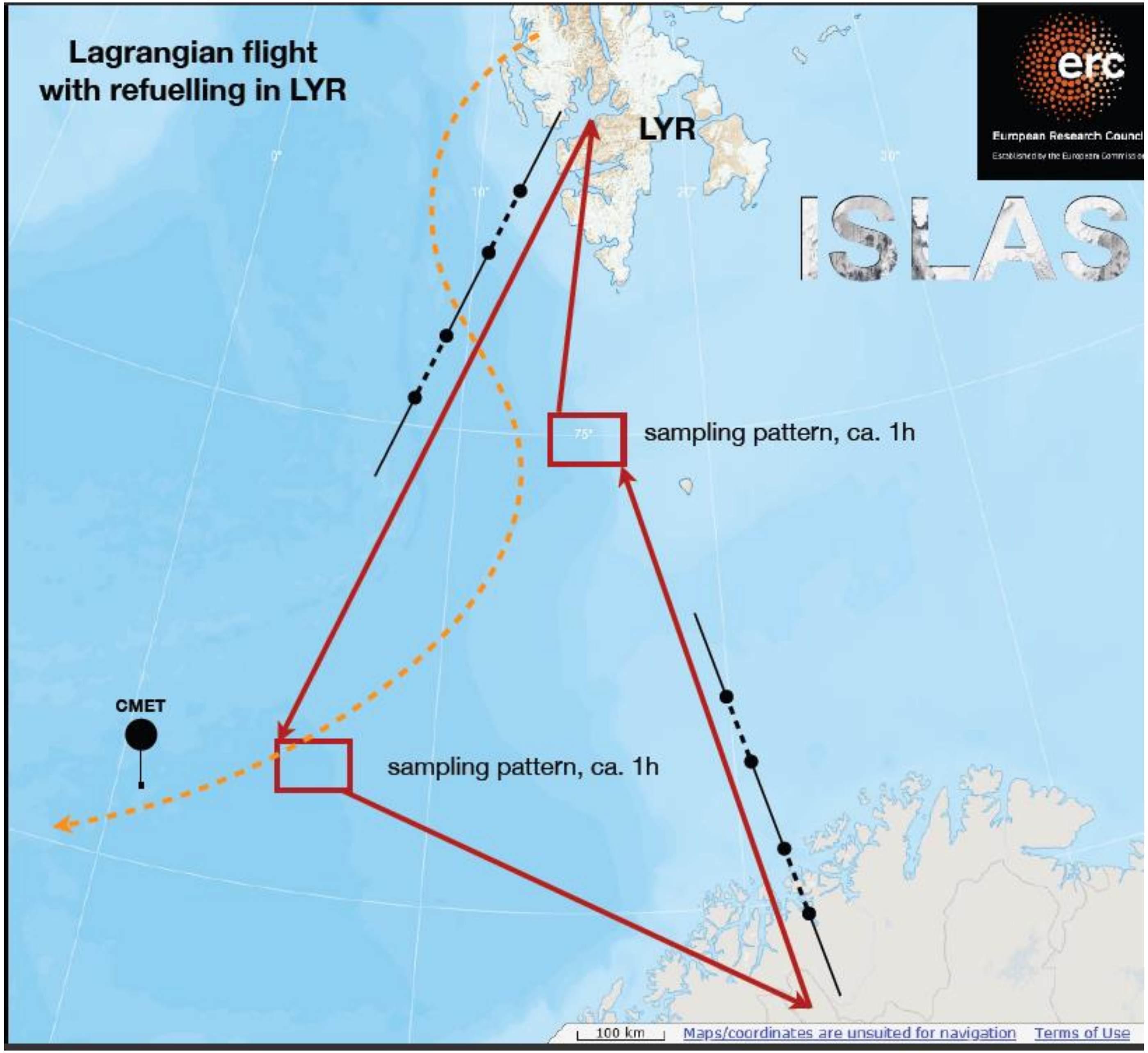
1. Internal instrumentation

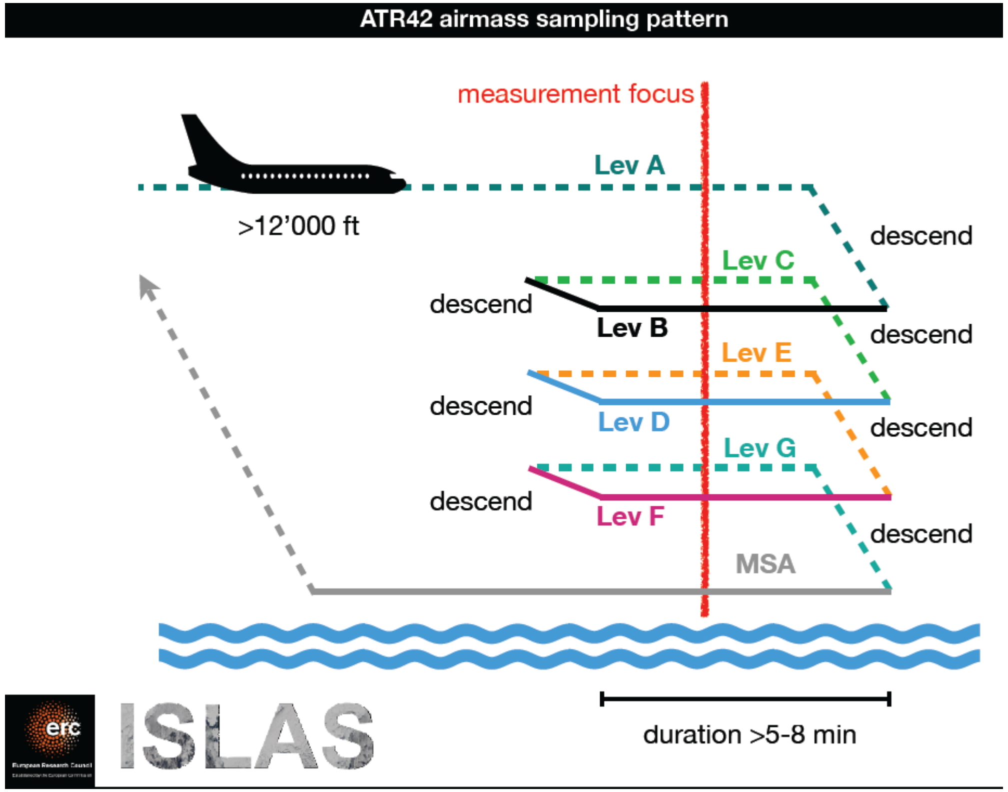
Picarro isotope rack
- according to specifications in DDI
- heated inlet backward position
- ALiAS looking sideways to the right
- ULICE looking downward (CNRS)
- BASTA looking sideways to the right

2. Microphysics and radiation
- CMP22 and CGR4 for radiation
- CIP
- PIP, Nephelometer (CNRS)
- PVM100, CDP
- Nevzorov probe
- SEA, LWC300
- UHSAS for aerosols
- FSSP300 for aerosols and droplets

3. Other instrumentation (SAFIRE)
- Thermodynamic standard package with fast/slow water vapour and temperature
- Aircraft dynamics standard package (winds)
- Licor 7500A
- G2401 for CO, CO2
- KH20
- Video cam at surface and to the right

Activities parallel to HALO-(AC)³ - Kiruna



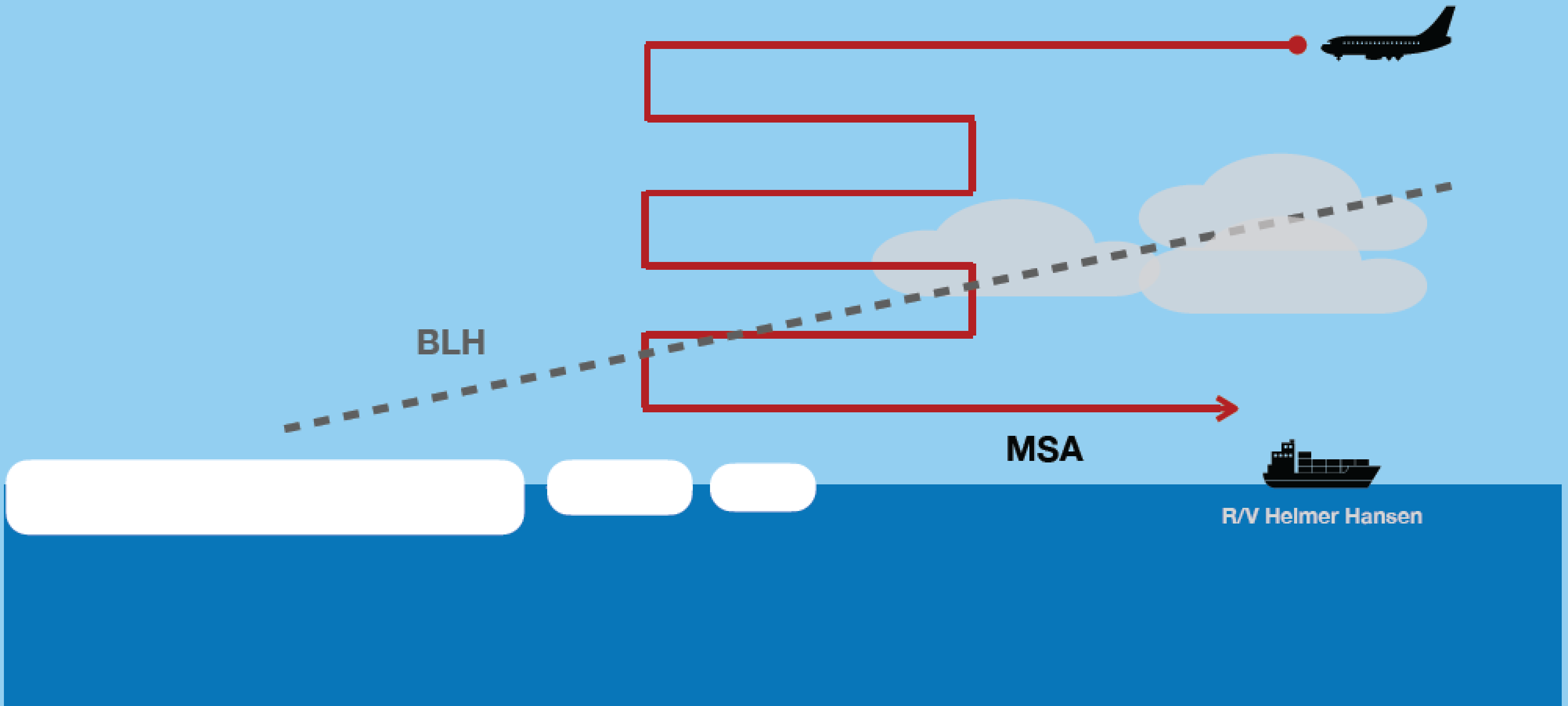


Purpose

- isotope composition of evaporation flux
- conservation of d-excess signal during BL growth
- ship intercomparison

Sequence: Box pattern with

1. horizontal legs above BLH
2. horizontal leg at entrainment height
3. horizontal legs within BL
4. horizontal leg(s) at MSA



Activities parallel to HALO-(AC)³ - Kiruna

Met Office
Steven Abel, Paul Field, Ben Murray, Tom Choularton
steven.abel@metoffice.co.uk

Arctic Cold Air Outbreaks (ACAO) experiment

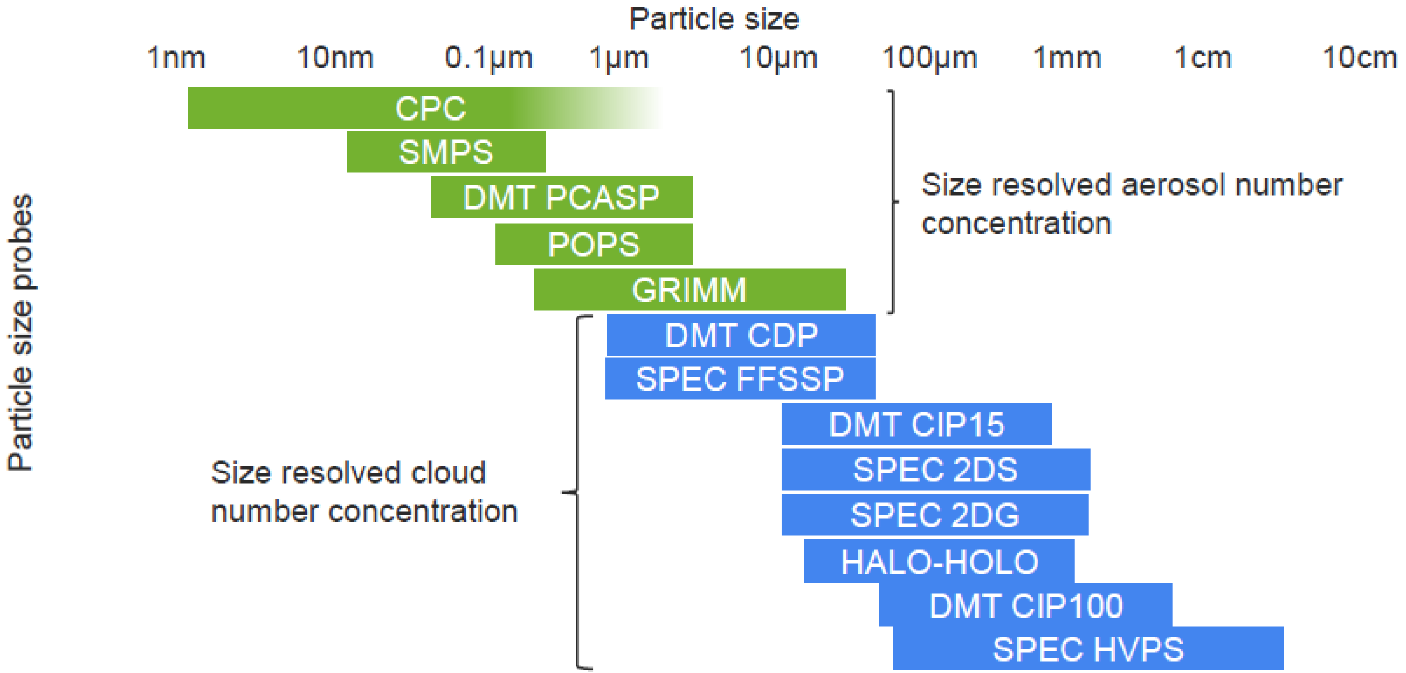
- Campaign status
- Motivation/objectives
- Proposed sorties
- Instrumentation
- Forecast support

NASA Worldview, 21st March 2021

UNIVERSITY OF LEEDS
MANCHESTER 1824 The University of Manchester
FAAM

Activities parallel to HALO-(AC)³ - Kiruna

Instrumentation for ACAO



Additional aerosol measurements
CCN concentration at 2 supersaturations
INP concentrations – CFDC and filters
Composition - SP2 and LAAPToF
CVI for drop residuals
Optical properties – nephelometer & TAP

Additional cloud measurements
Bulk liquid and ice water contents, 3V-CPI

Core chemistry

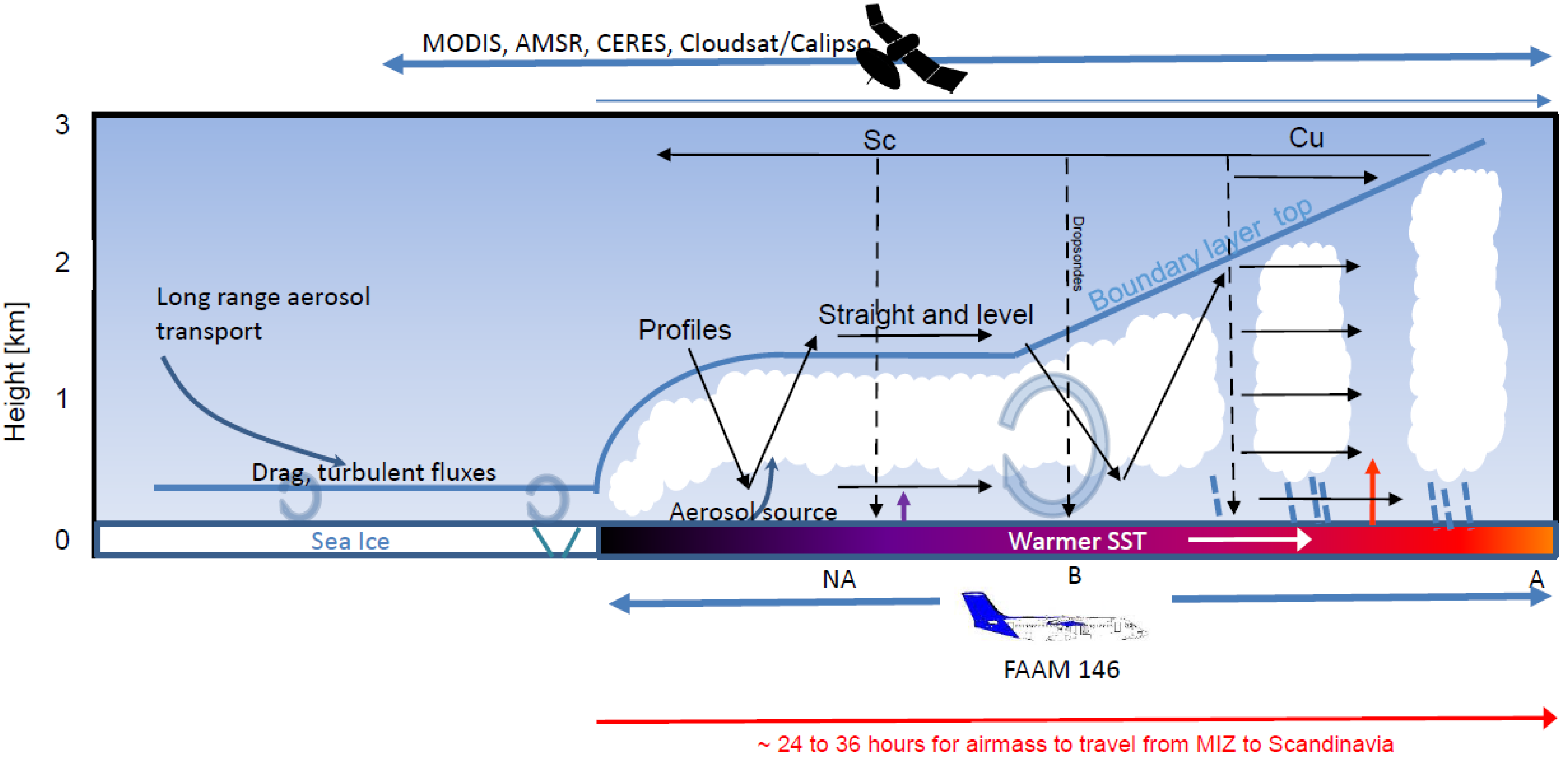
Thermodynamics
Dropsondes (T, RH, u, v)
Turbulence probes (u, v, w)
Water vapour (various incl. fast response)
Temperature (incl. fast response but not in-cloud)
Total water content (vapour + condensate)

Remote sensing
Broad band radiometers (vis and IR)
LIDAR (downward pointing)
Microwave radiometer for LWP/WVP
IR measurement of sea surface temperature

Activities parallel to HALO-(AC)³ - Kiruna

Study of the aerosol, cloud and boundary layer evolution from the MIZ to Scandinavia

Linking in with a wider regional network of observations (HALO-AC³, ISLAS, MC2)



UiO : University of Oslo

MC² 2022

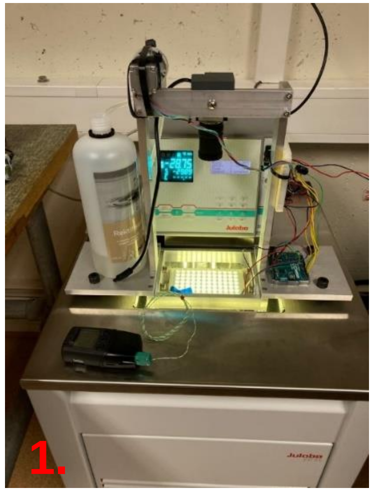
Robert David, Tim Carlsen, Franziska Hellmuth, Britta Schaefer, Astrid Bragstad Gjelsvik, Stefan Hofer, TRUDE STORELVMO

European Research Council

Activities parallel to HALO-(AC)³ - Kiruna

Scientific Objectives

1) Ice-nucleating particles
2) Improve precipitation estimates from radar in Arctic
3) Cirrus cloud property retrievals - In situ comparison
4) Cloud phase distribution



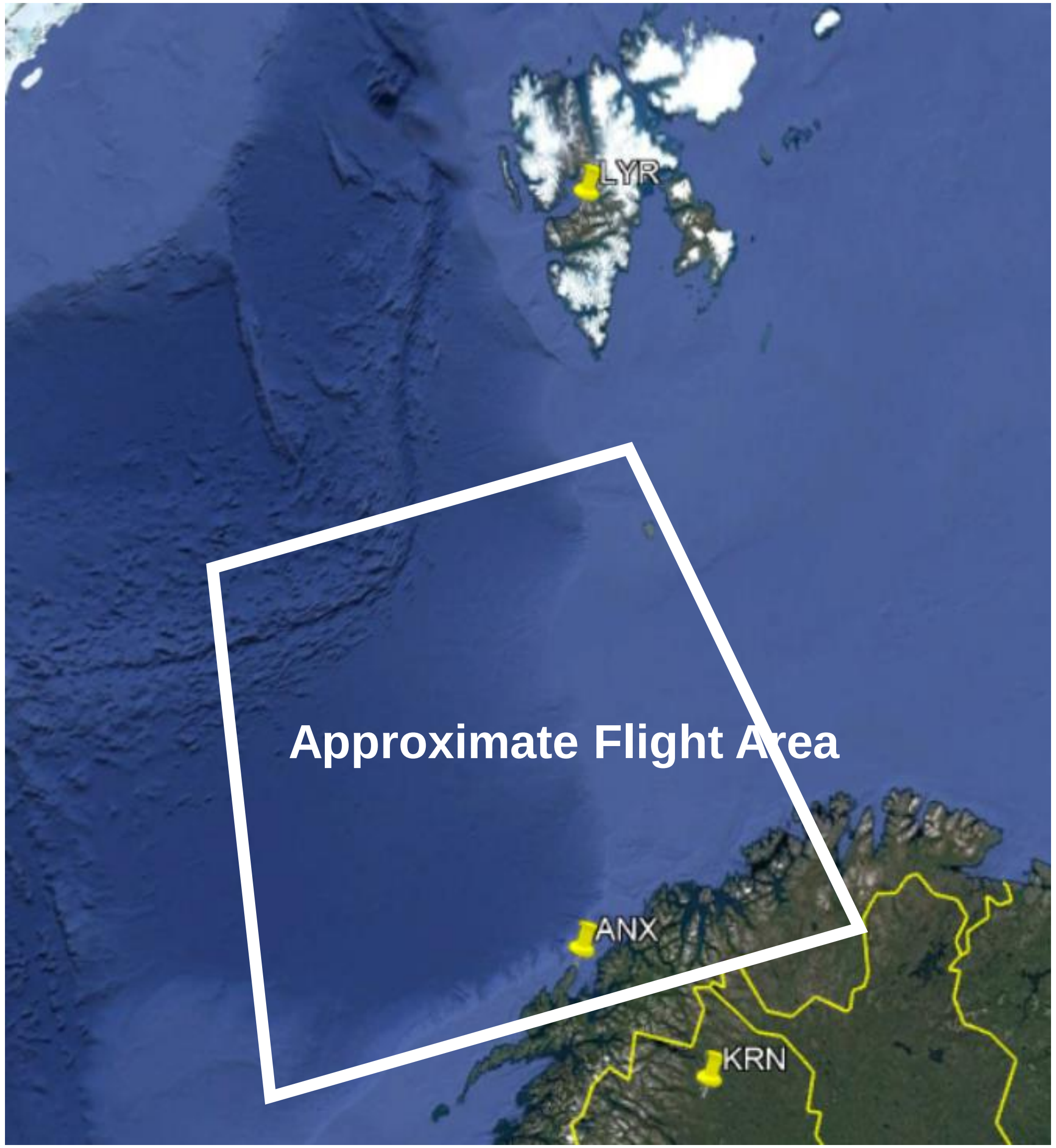
Measurement capabilities

1) Offline ice-nucleating particles (portable)
- Coriolis impinger for high resolution (200 L/min)
- PM10 filters for continuous monitoring (38 L/min)

2) Precipitation Measurements, Andenes, NO
- Multi Angle Snowfall Camera (U. of Utah)
- Precipitation Imaging Package (U. of Utah)
- Micro rain radar? (UiB)

3) Alomar Observatory, Andenes, NO
- Tropospheric Lidar
- Micro rain radar
- All-sky camera
- HaloCam and potentially, Polarization Cam (U. Leipzig)

4) INCAS King Air for co-located flights
- 2000 km range
- SPEC Hawkeye
- Holographic cloud probe (UiO/AS) or DMT CAPS



Flight patterns

1) Lagrangian Spiral descent over MRR (particle model)
2) Sawtooth (CGCs, SIP, cirrus)
3) Horizontal and stacked ladders (phase distribution, cirrus)

Questions?