Environment and Climate Change Canada | Environnement et Changement climatique Canada

National Research Council Canada

Canada

Three Canadian aircraft cal/val campaigns in 14 months: ECALOT, WHAFFFERS, and PONEX

Zen Mariani[1], Alexei Korolev[1], Natalia Bliankinshtein[2], Zhipeng Qu[1], Kaley A. Walker[3], Michael Howorucha[3], Melissa Cholette[1], Raphaël Peroni[4], Cuong Nguyen[2], Keyvan Ranjbar[2], Paloma Borque[2], and the PONEX Team

[1]Environment and Climate Change Canada, Toronto, Ontario, Canada

[2]National Research Council Canada, Ottawa, Ontario Canada

[3]University of Toronto, Toronto, Ontario, Canada

[4]Université du Québec à Montréal, Montreal, Quebec, Canada

EarthCARE Workshop – June 10, 2026

ECALOT, WHAFFFERS, and PONEX

- **Ottawa, Canada aircraft campaigns:**
  - **ECALOT** (EarthCARE Commissioning Calibration/Validation Campaign in Ottawa):
    - **EarthCARE cal/val during its commissioning phase**
    - September 2024 – March 2025
    - 7 flights with National Research Council Canada (NRC) Convair-580 aircraft
  - **WHAFFFERS** (W-band, HiSRAMS, AERI, FIRR2, FINESSE and FIRMOS Experiment on Remote Sensing):
    - **Surface & aircraft infrared radiation measurements from multiple radiometers with simultaneous overpasses of PREFIRE**
    - January – February 2025
    - 6 flights with NRC Convair-580 aircraft

- **PONEX** (Polar Night Experiment) **Arctic Campaign**:
  - **Surface & aircraft cal/val of CSA HAWC satellite (pre-launch) & EarthCARE Arctic observations (cloud and aerosol)**
  - January 2026
  - Cross-country transit + 2 flights at Inuvik with NRC Convair-580 aircraft

Presentation Tomorrow at 14:18: Evaluation of NWP Simulations of Cold-Season Mixed-Phase Clouds Using EarthCARE and ECALOT Observations; **Zhipeng Qu (ECCC)**

Poster P018: Comparison of EarthCARE 3D Scene Reconstruction Products with Ice Cloud Retrievals from Side-Looking W-Band Polarimetric Airborne Radar Observations; **Cuong Nguyen (NRC)**

NRC Convair-580

Photo: Paul Loewen (U Sask)

POLAR NIGHT EXPERIMENT
PONEX
JANUARY 2026
ECCC-NRC CSA-ESA INUVIK N.W.T.

Inuvik

Canada

Canada

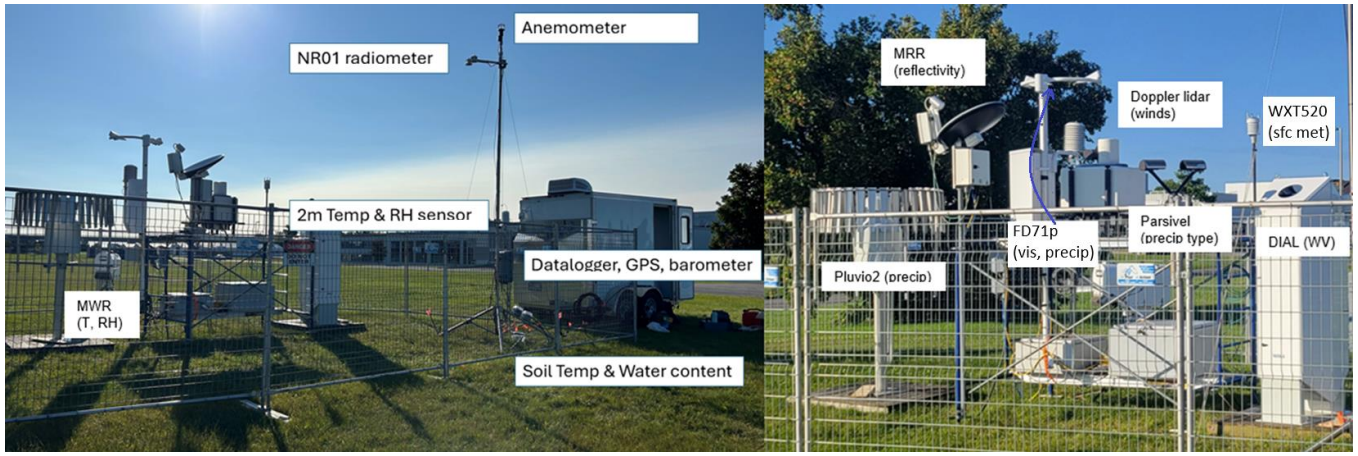
EarthCARE Commissioning Cal/Val Campaign in Ottawa (ECALOT)
Sep. 2024 – Mar. 2025
ECCC-NRC-ESA
McGill-UQAM-U Toronto

Ottawa

WHAFFFERS
Ottawa - 2025 - Gault

Ottawa surface site: results

- Observations used to **compare against EarthCARE, PREFIRE, surface radiometers, to calibrate NRC Convair-580 measurements and provide meteorological context**
- Thermodynamic profiling of the atmosphere (water vapour in particular) **crucial for radiative closure experiments underway (synergy with AERI, FIRR-2, FINESSE, and FIRMOS**)
- **X-MET:** defines atmospheric state (T, WV, and GHGs) used for radiative transfer calculations
  - ACM-RT processor for rad. closure assessment of the retrievals with the broadband radiometer measurements
  - **If there are biases in this information, it will affect the radiative closure**
  - Good agreement with winds and temperature below 6 km AGL; larger biases for water vapour (next slide)
- **Level2 Products:** C_TC (**hydrometer classification**) and AC-TC (**derived cloud base height, CBH**) compared against surface site for all nearby overpasses

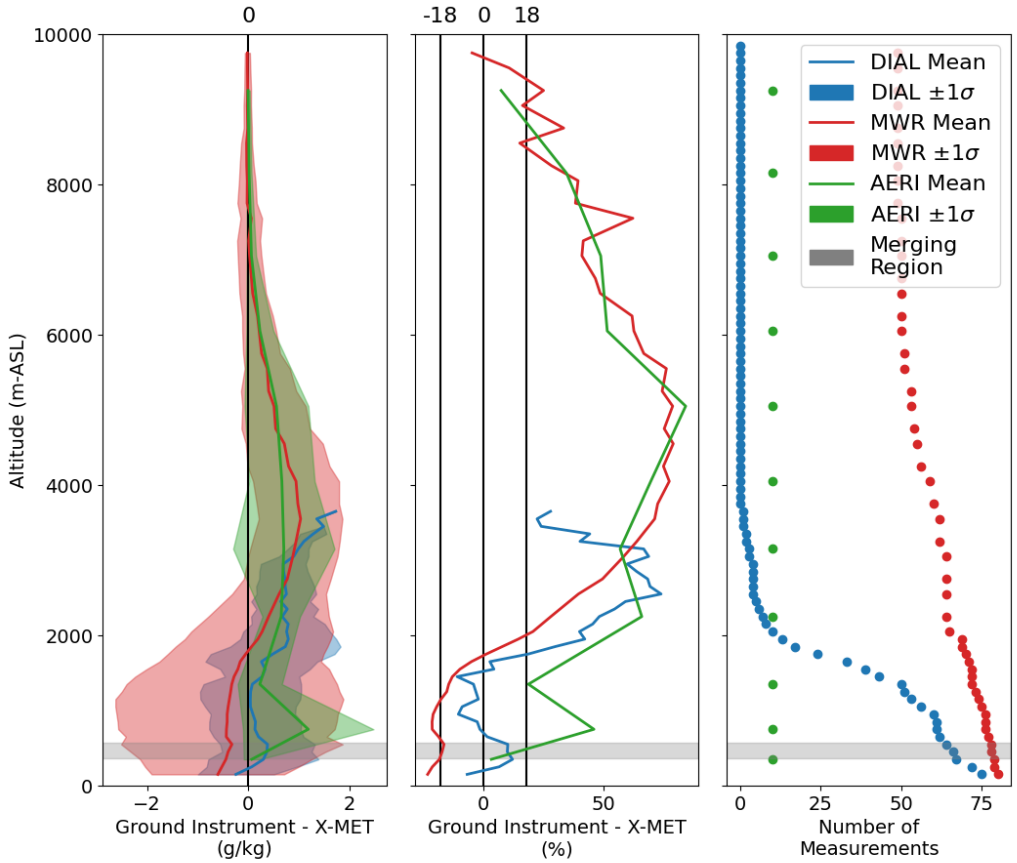


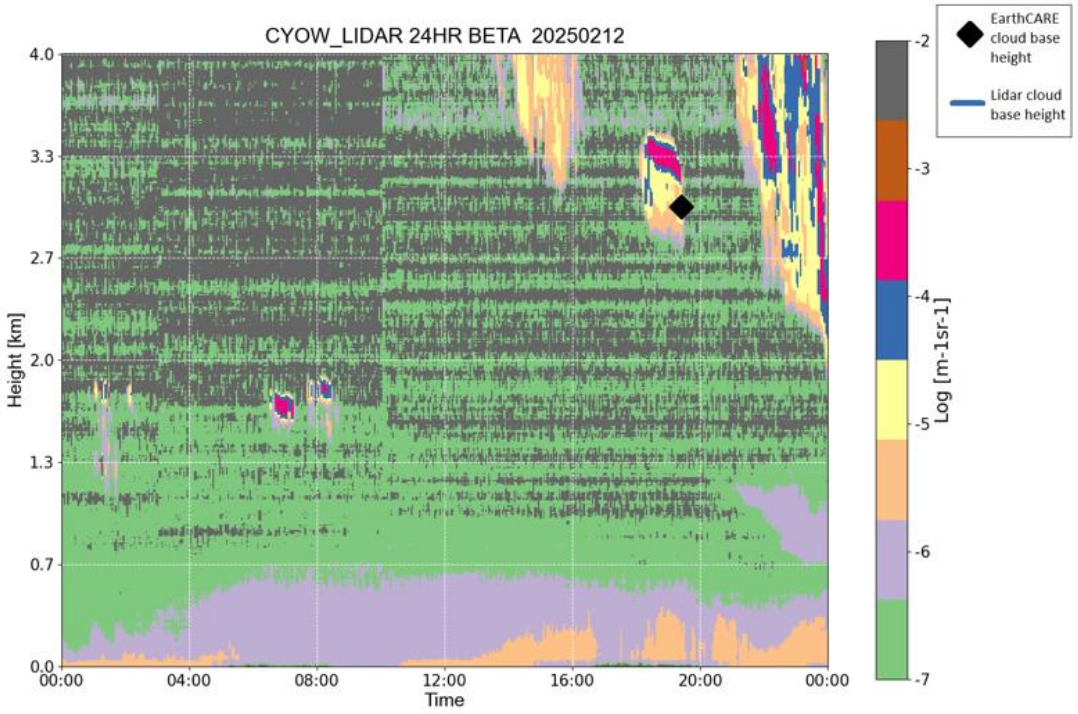
Two photographs of the Ottawa airport (CYOW) surface site including multiple lidars, radiometers, disdrometers, etc.

Canada

Comparisons with EarthCARE products

- X-MET water vapour (left) and AC-TC (**derived cloud base height (CBH),** right) compared against surface site





- DIAL water vapour lidar, MWR, and AERI vs. X-MET
- Mean bias is **not** within 10% error in XMET **specific humidity** quoted for lower troposphere (< 1600 m) but **is** within the 18% error quoted for the mid-upper troposphere

- **CBH** method: 1 km pixel resolution, scene construction index to reconstruct the cloud/aerosol field over the site. Target classification from CPR and ATLID (AC-TC) used based on this pixel value.
- The lidar-based **CBH** is estimated just above the EarthCARE CBH estimate; good agreement for several cases

Michael Howorucha (UofT): michael.howorucha@mail.utoronto.ca

Polar Night Experiment (PONEX) Surface & Aircraft Campaign

Overarching goal:

Acquire new knowledge needed to improve weather and climate forecasts in the polar regions through a better understanding of key physical processes and an improved representation of those processes within numerical weather and climate prediction systems.

PONEX Objectives:

Sub-orbital component

1. **HAWC** (preparatory phase)
   - testing performance of ALI & FIRR-2
   - algorithm development & simulators
2. **EarthCARE** cal/val: under-flights during post-launch phase
   - **validation of cloud and aerosol retrieval algorithms**
   - **assessment of calculated broadband radiative flux profiles & radiative closure assessment program**

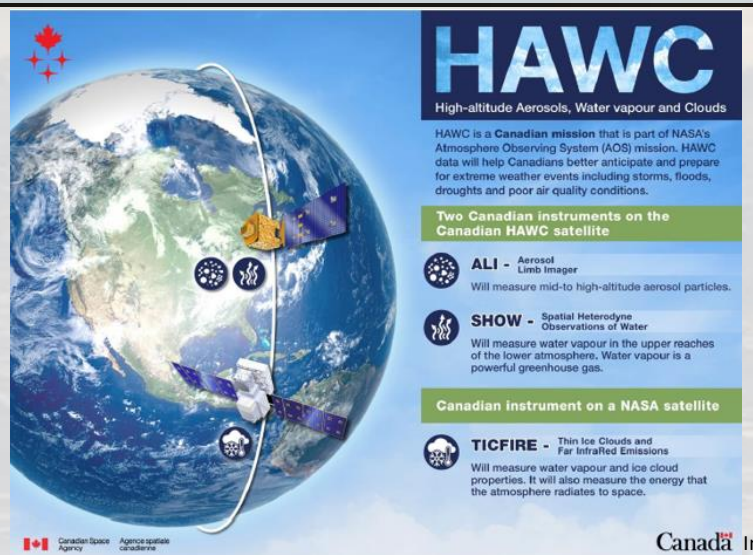


Image: CSA

Science component

1. Novel observations of Arctic surface emissivity and thermal profiles, radiative fluxes modulation by aerosol and clouds
2. New knowledge on the formation mechanism of optically thin ice clouds (OTIC) & its radiative properties in Arctic region. Explore the effect of OTICs on initiation of Arctic storms during polar night.
3. Statistical characterization of cloud microphysics and aerosol properties (sizes, chemical composition, concentration).
4. Free atmosphere and boundary layer dynamics during polar night.
5. Polar night atmospheric chemistry.
6. Explore transport of air pollutants and aerosol chemistry in Arctic regions during the polar night.
7. LONG TERM: Improve parameterizations suitable for numerical weather and climate prediction models & characterize the role of the polar regions in driving mid-latitude weather and global climate.

PONEX Team

ponex.hiwr.ca

Zen Mariani, Alexei Korolev, Zhipeng Qu, Jason Cole, Howard Barker, Daniel Michelson, Landon Rieger, Michael Wheeler, Michael Harwood, Melissa Cholette, Ivan Heckman, Robert Reed, Stephen Holden, Robert Crawford, Zane Dedekind (*Environment and Climate Change Canada*)

Natalia Bliankinshtein, Cuong Nguyen, Keyvan Ranjbar, Mengistu Wolde, Leonid Nichman, Paloma Borque, Kenny Bala, Anthony Brown, Reagh Sherwood, Eric Roux, Daniel MacDonald, Theodorus Van Westerop, Simone Baj, Jeremy Millett (*National Research Council of Canada*)

Kaley Walker, Kim Strong (*University of Toronto*)

Jean-Pierre Blanchet, Yann Blanchard, Julie Thériault, Raphaël Peroni (*Université du Québec à Montréal*)

Adam Bourassa, Paul Loewen (*University of Saskatchewan*)

Yi Huang, John Gyakum, Benjamin Riot-Bretecher (*McGill University*)

Rachel Chang, Xiaoli Zhou (*Dalhousie University*)

Aldona Wiacek (*Saint Mary's University*)

Philip Marsh (*Wilfirid Laurier University*)

Norm O'Neil (*University of Sherbrooke)*

Katherine Boggs (*Mount Royal University*)

Kerri Pratt, Vanessa Selimovic, Theo Severud (*University of Michigan*)

Glenn Diskin (*NASA*)

Daniel Knopf (*Stony Brook University*)

Alexander Laskin (*Purdue University*)

National Research Council Canada

CSA ASC

NASA

esa

UNIVERSITÉ DE SHERBROOKE

MOUNT ROYAL UNIVERSITY

UNIVERSITY OF SASKATCHEWAN

DALHOUSIE UNIVERSITY

McGill UNIVERSITY

UNIVERSITY OF TORONTO

UQÀM Université du Québec à Montréal

STONY BROOK UNIVERSITY OF NEW YORK

UNIVERSITY OF MICHIGAN

PURDUE UNIVERSITY

Environment and Climate Change Canada

Saint Mary's University

WILFRID LAURIER UNIVERSITY

Experimental Design


NRC Convair-580

Platform: NRC Convair-580
Location: Inuvik, NWT
Timeframe: (1) January 8 to 28, 2026 → *7 days earlier*
(2) ~11 flights, over 21 days → *2 flights + transit*

Research flight objectives:

Weather flights

1. polar night cloud microphysics (OTIC)
2. modulation of radiative fluxes by OTICS
3. mechanisms of ice initiation in polar night clouds
4. dynamics of the polar night troposphere

Clear sky flights

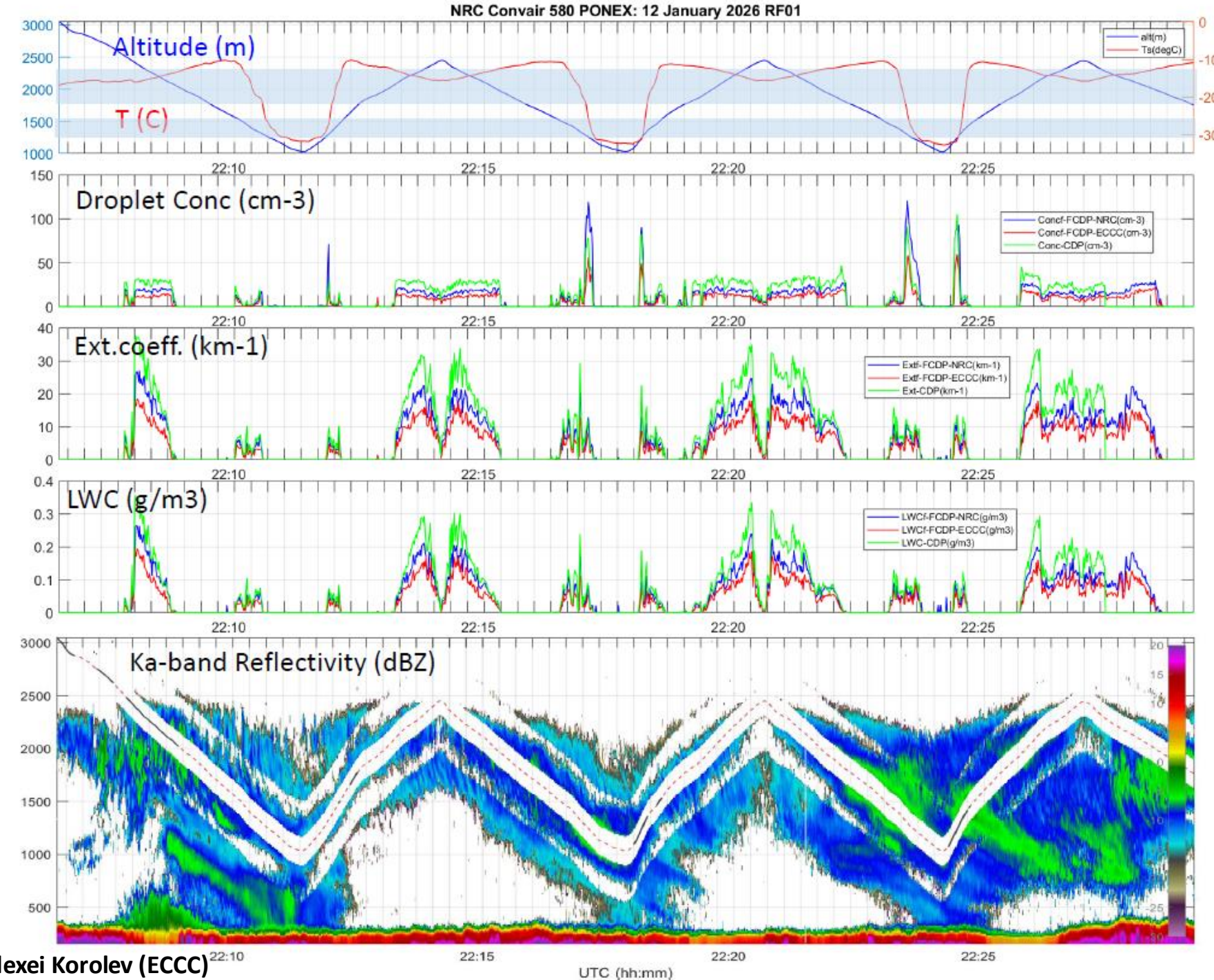
1. aerosol composition (natural and anthropogenic)
2. trace gases
3. surface emissivity

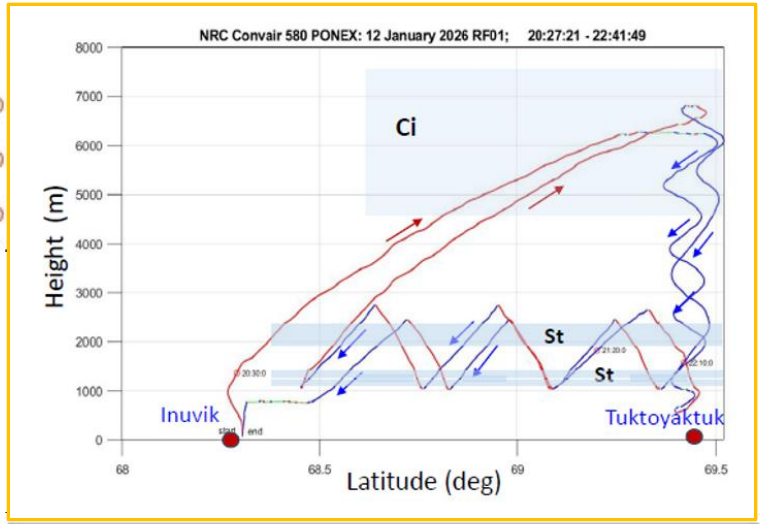
Suborbital flights:

1. HAWC remote sensing instruments (**ALI** and **FIRR-2**)
2. **Cal/val of EarthCARE Level2 products**

Aircraft instrumentation:

- Far-Infrared radiometer **FIRR-2** & aerosol limb profiler **ALI**
- Radars: X, W, Ka-band
- Elastic cloud lidar (355 nm)
- HiSRAMS (microwave sounder for T and RH)
- Aerosol Mass Spectrometer
- Aerosol size spectrometers, INP, CCN
- Trace gases (O_3, CH_4, CO_2, CO, H_2O)
- Cloud microphysical instrumentation





Two-three layer stratiform cloud system

T-inversion 20°C to 23°C !

Upper deck: above the T-inversion

- Clean => Conc ~10-20cm-3
- Generate sparce dendrites
- Ice Conc ~ 10-3 L-1

Lower deck: below T-inversion

- Coupling/decoupling
- polluted => Conc ~100-150cm-3
- Generate small ice particles
- Ice Conc ~ 10L -1

Alexei Korolev (ECCC)

FIRR-2 Analysis: PONEX January 12, 2026 [~2h] Research Flight

20:28 – 22:41 UTC

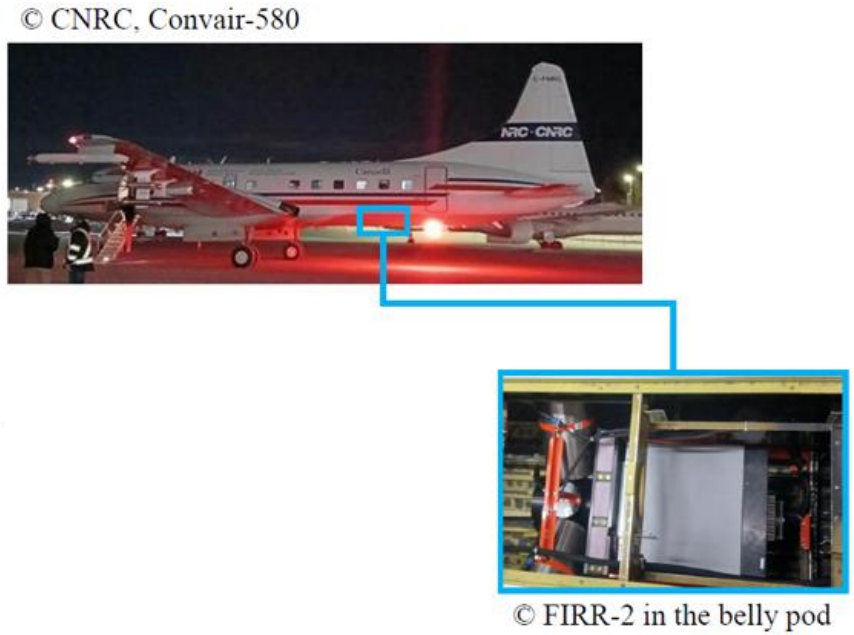
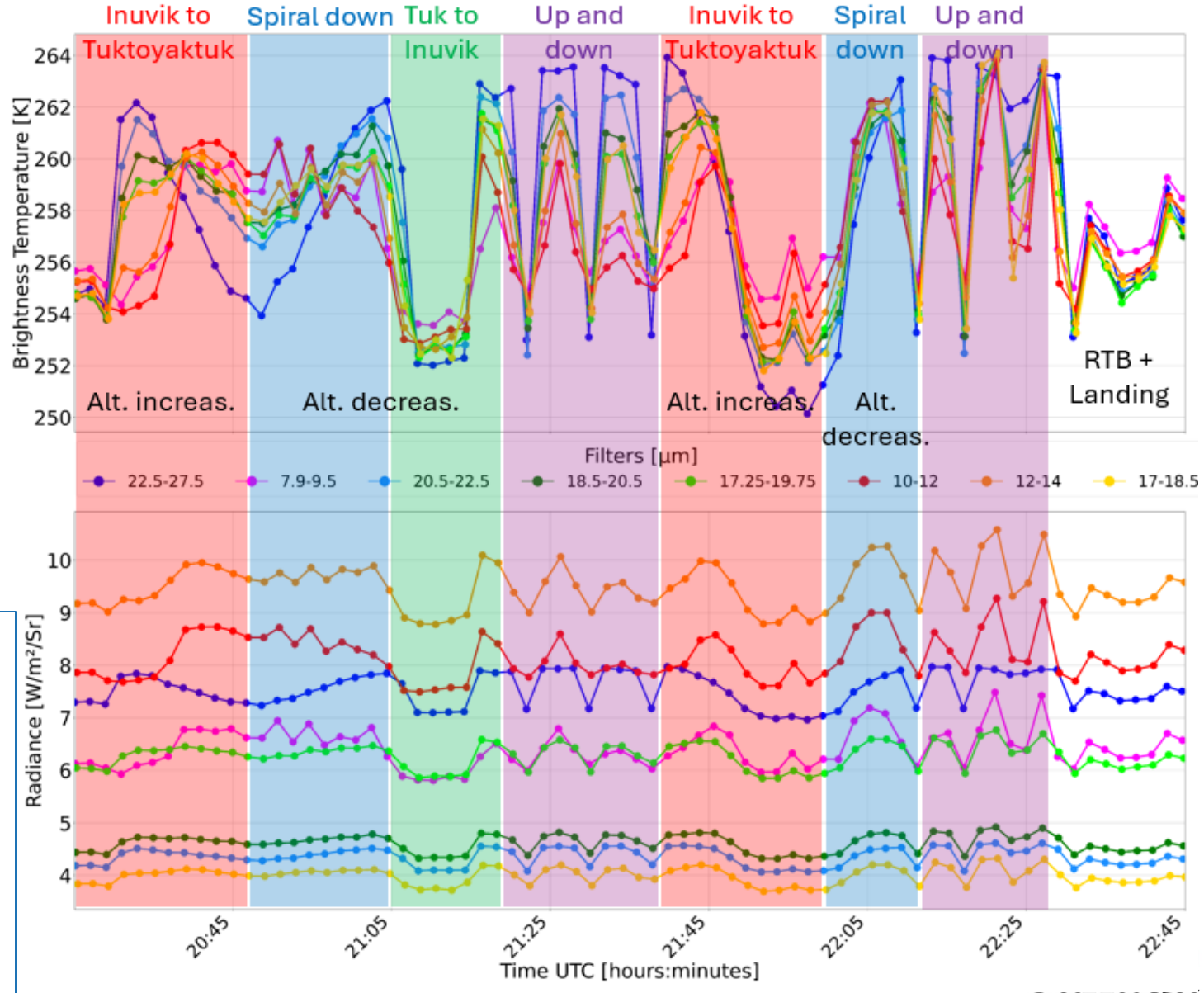


Figure: R. Peroni (UQAM)

Brightness temperature and radiance observations



Ongoing analyses:

Map changes in brightness temperatures with weather conditions (cloud conditions, type of surface below the aircraft, µ-physics, flight altitude)

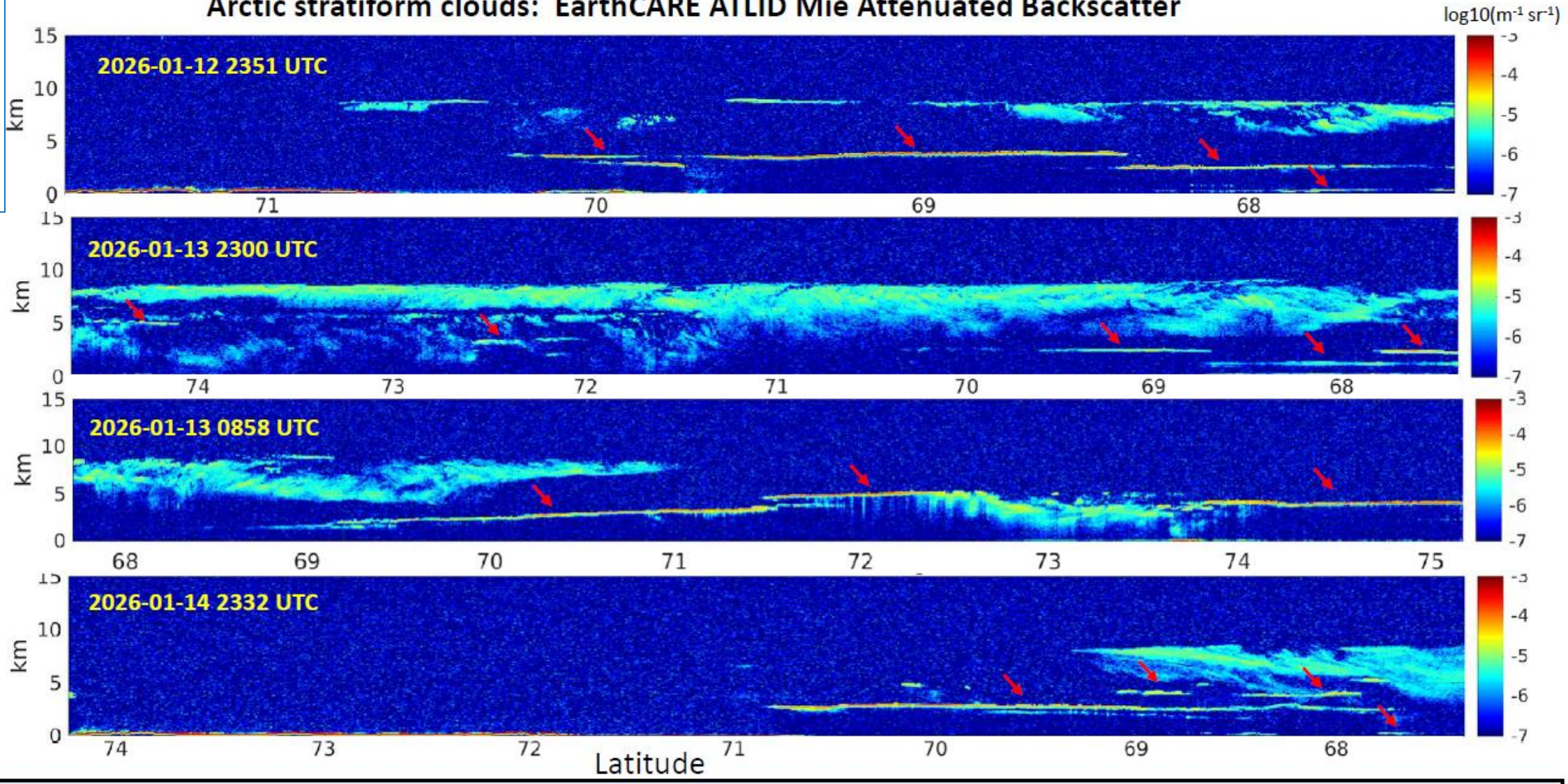
→ **Radiative closure study** (FIRR-2, MODTRAN, AERI) led by R. Peroni, J.-P. Blanchet (UQAM), and Z. Mariani (ECCC)

Poster P077: Radiative Closure Study in the Thermal and Far-Infrared Using Airborne FIRR-2 Measurements During the ECALOT Campaign;

Raphaël Peroni (UQAM)

Presentation Tomorrow at 14:18: Evaluation of NWP Simulations of Cold-Season Mixed-Phase Clouds Using EarthCARE and ECALOT Observations; **Zhipeng Qu (ECCC)**

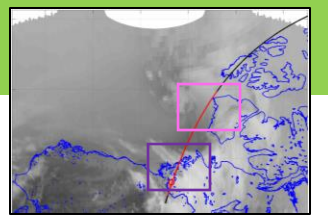
Arctic stratiform clouds: EarthCARE ATLID Mie Attenuated Backscatter



- Arctic stratiform clouds (St, Sc, As, Ac, As-Ns) can form in a wide range of altitudes (0<H<10 km) during the polar night.
- These clouds frequently extend horizontally over hundreds of kilometers throughout the Arctic polar night.
- Their extensive horizontal coverage and high optical thickness play a significant role in radiative transfer.
- The processes that contribute to their persistence and extended lifespan remain poorly understood.
- Current NWPs and climate models in most cases do not reproduce Arctic stratiform clouds due to their coarse vertical resolution.

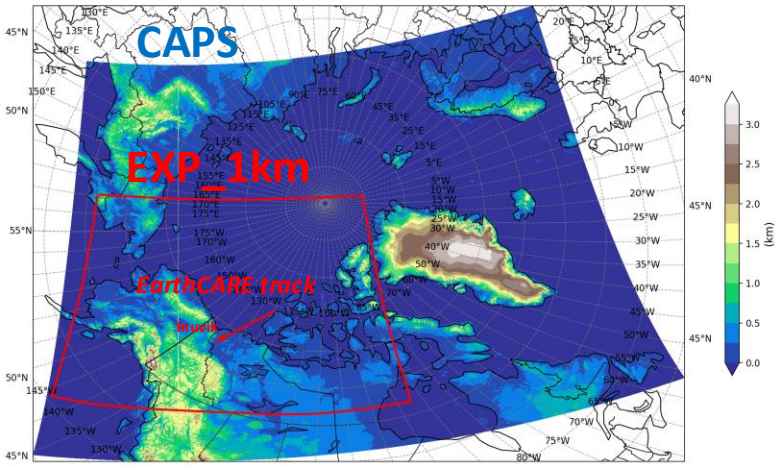
Z. Qu,
A. Korolev
(ECCC)

EarthCARE track on 00 UTC 20 Jan 2026 during PONEX



GEM[1]-based CAPS[2]-driven 1-km simulations during PONEX[3]

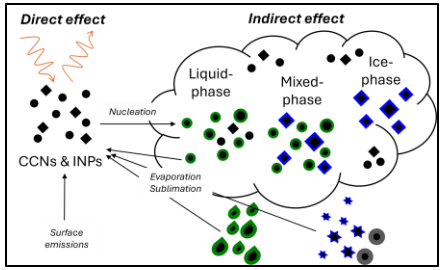
(Polar Night Experiment, Inuvik, 6-28 Jan 2026)



Setup	CAPS	EXP_1km
# runs/day	2	2 (for 4 configs)
Time step, period	1 min, 48 h	30 s, 24 h
dx, Nz	3 km, 62	1 km, 84

2 simulations:

- ***P3***: baseline configuration of the Predicted Particle Properties (P3) microphysics scheme[4-7]
- ***P3 aerosol aware***: P3 including the aerosol indirect effects



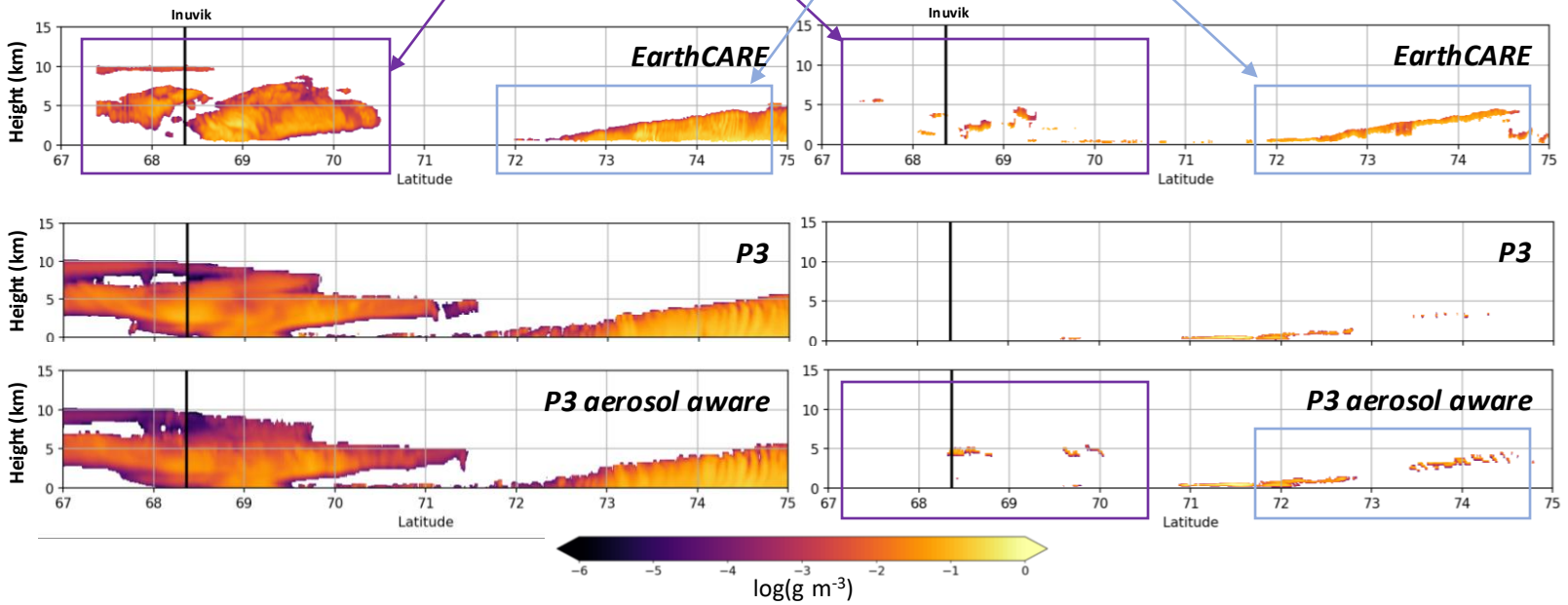
Arctic mixed-phase clouds

Ice water content

Associated with the post-frontal system located SE of Inuvik
Thin ice containing embedded supercooled liquid layers
Cloud top heights: 8 to 10 km

Cloud water content

Arctic stratiform mixed-phase cloud system
Embedded generating cells beneath a supercooled cloud top
Cloud top heights: 2 to 4 km



Layered mixed-phase clouds near Inuvik, sensible to the choice in the ice nucleation process, are simulated when prognostic aerosols are included in P3, which compares better to EarthCARE retrievals.

Lead: Melissa Cholette, ECCC (Melissa.Cholette@ec.gc.ca)

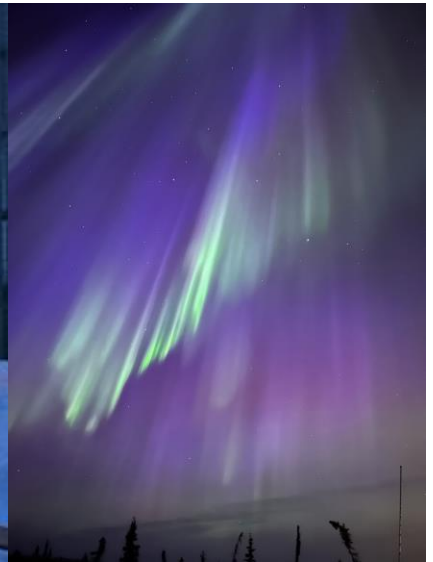
Canada

[1]Côté et al., (1998); [2]Casati et al., (2023); [3]https://hiwr.ca/ponex/; [4]Morrison & Milbrandt, (2015); [5-6]Cholette et al., (2019; 2023); [7]Morrison et al., (2025)

Hangar surface site analyses

- Surface suite of in-situ and remote sensing observations before, during, and after PONEX
  - September 23, 2025 – January 19, 2026
- Observations are the focus of several University research projects (CSA ROHSSA grant)

McGill U •	AERI:	(1) Clear-sky closure, FIR reconstruction, reconstructed FIRR-2 obs, H_2O and T retrievals (2) **EarthCARE Jan 19th overpass**: steady cloudy conditions captured by AERI
McGill U •	Sondes & met tower:	(1) Case study of the Jan 12, 2026, frontal passage (2) Prediction of mixed phase cloud frequency in cold surface temperatures (Jan 17-18)
McGill U •	HiSRAMS:	(1) Radiative closure on all-sky HiSRAMS spectra *(bottom right Fig.)*
U of Toronto •	DIAL:	(1) **Water vapour comparisons with microwave radiometer and EarthCARE X-MET product**
U of Toronto •	Doppler lidar:	(1) **Validate EarthCARE ATLID observations and X-MET wind fields**
Dalhousie U •	Microwave radiometer:	(1) Investigate liquid water path & integrated water path in mixed-phase clouds
Dalhousie U •	Surface met. Suite:	(1) Characterize wintertime precipitation & perform intercomparisons



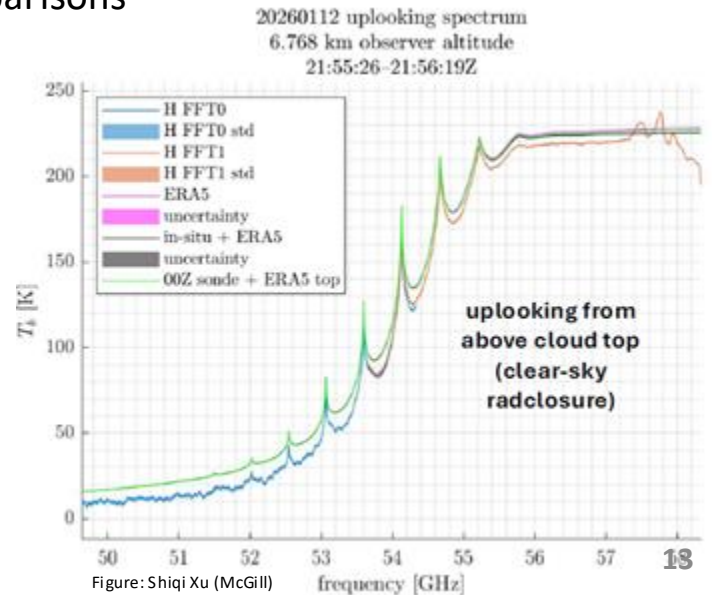


Figure: Shiqi Xu (McGill)

Conclusion

- **ECALOT and WHAFFFERS campaigns in Ottawa, Canada**
  - **Surface and aircraft cal/val campaigns in Ottawa and Montreal Sept 2024 – March 2025**
  - **13 research flights with NRC-Convair 580 aircraft**
  - **EarthCARE under-flights & rad. closure from several IR & FIR radiometers with simultaneous overpasses of PREFIRE**
  - **Thermodynamic profiling of the atmosphere crucial for radiative closure experiments (ongoing)**
  - **Surface observations support synoptic interpretation of cal/val flight results and comparisons with EarthCARE**
  - **Finalizing comparisons with X-MET: assess impact meteorological conditions have on agreement**
  - **Additional Level 2 products being compared: e.g., good agreement with hydrometeor_classification**

- **Polar Night Experiment (PONEX) Campaign in Canadian Arctic, January 2026**
  - **First aircraft campaign during Polar Night**
  - **Led by ECCC and NRC in collaboration with CSA, ESA, NASA, and University partners**
  - **Two EarthCARE overpasses undergoing analyses (observations & NWP model)**
  - **Cal/val synergy between CSA HAWC and EarthCARE satellites → more opportunities in the future**
  - **Deployment cut short due to insurmountable technical challenges**
  - **Focus on radiative closure, water vapor, temperature, & cloud microphysics analyses**
- **Possibility of follow-up ECALOT/PONEX 2.0 cal/val campaign in Ottawa (October 2026 - January 2027) - TBD**

Thank you!

zen.mariani@ec.gc.ca

Photo: Paul Loewen (U Sask)