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First intercomparison between ATLID and Airborne Elastic Cloud Lidar during ECALOT campaign

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1st EarthCARE In-Orbit Validation Workshop – 14-17 Jan 2025

National Research Council Canada | Conseil national de recherches Canada

Environment and Climate Change Canada

esa

Canada

EarthCARE Commissioning Cal/Val Campaign in Ottawa (ECALOT)

Ottawa based aircraft/surface calibration/validation campaign: ECALOT

- During EarthCARE's commissioning phase

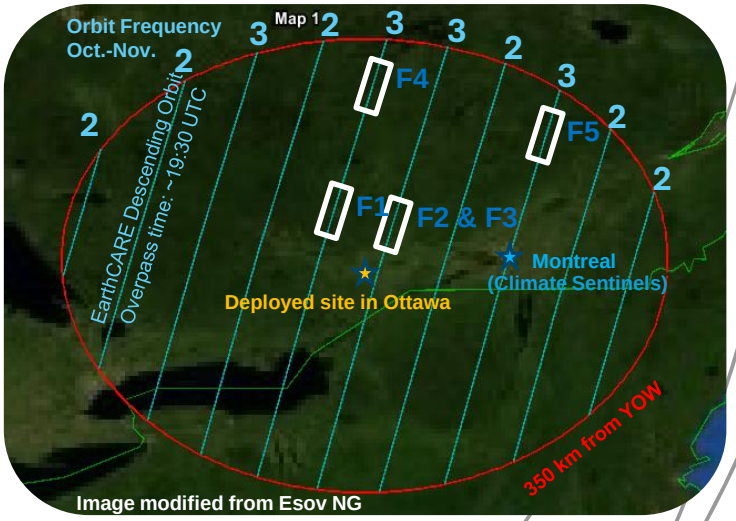
  Mid-latitude continental fall conditions with extension into winter

Surface observations

- Ottawa site (deployed by ECCC and McGill university) + Climate Sentinels: Downtown Montreal & Gault - East of Montreal (McGill & UQAM)
- Performed surface observations during each flights + orbits with no flight
- T & humidity (profile & surface), precipitation rate/type/profile, radiation (bb & spectral for IR), wind profile, etc.

Airborne observations

- ✓ Flight 1: Oct. 1st – Cu & Sc
- ✓ Flight 2: Oct. 10th – Sc + aerosols
- Flight 3: Nov. 4th – NS + large scale rain
- ✓ Flight 4: Nov. 20th – two-layer Sc + aerosols
- Flight 5: Nov. 22nd – Ci + Ns



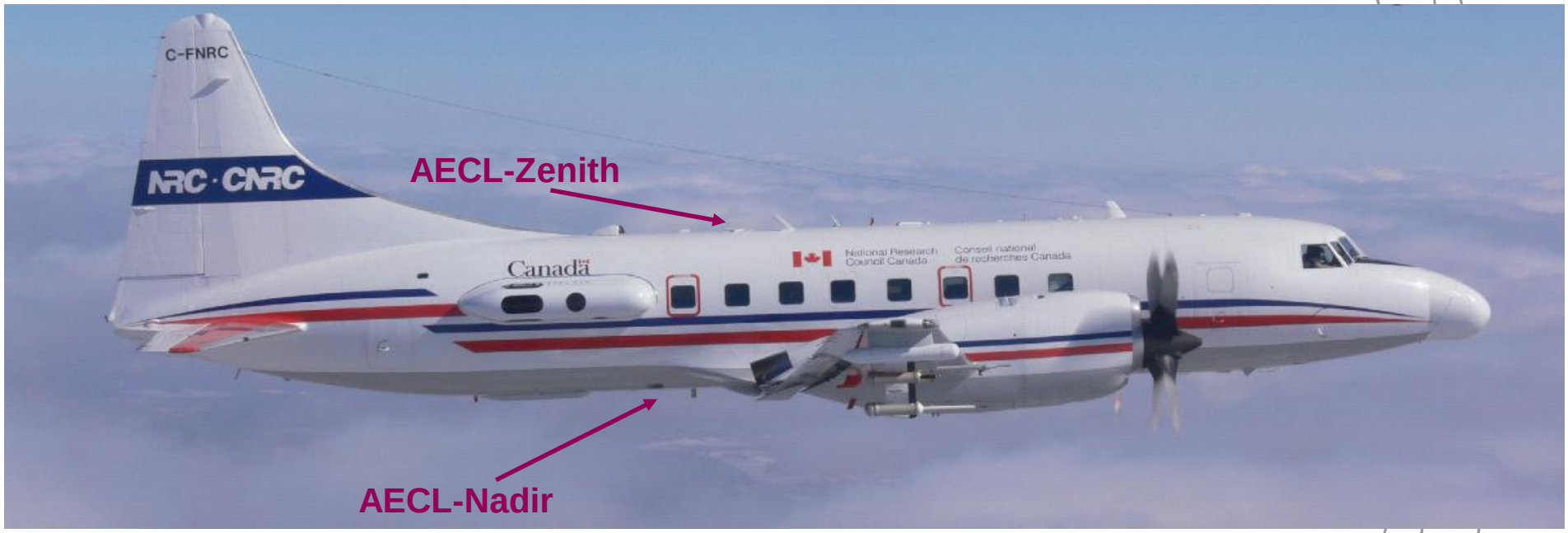
ECALOT Airborne & Surface Instruments

Airborne Instrument on Convair-580	Type
NAW (W-band radar) – zenith/side/nadir	Radar
NAX (X-band radar) – zenith/side/nadir	
Elastic cloud lidar (nadir and zenith)	Lidar
Nevzorov hot-wire	Cloud in situ probes
Small Droplets: CDP-2	
Cloud Particles Images: 2D-S (Stereo) Probe	
Precipitation Images: HVPS3	
CCNc-100	Aerosols probes
UHSAS-A	
RMNT Pressure Transducer	Atmosphere state
RMNT True Air Temperature	
RMNT 858 ADP	
Licor 848a or Licor 7000 H2O and CO2	
GPS	Geolocation

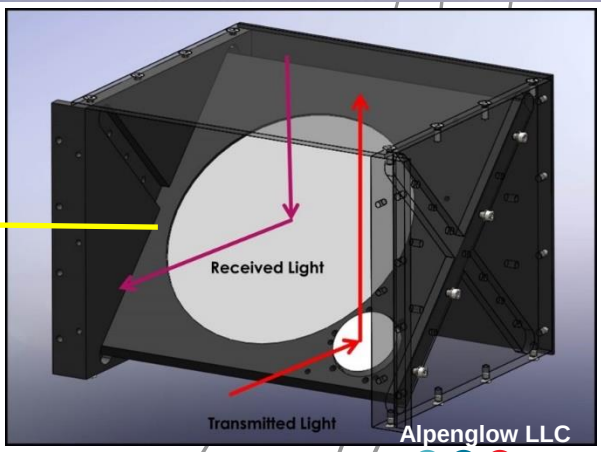
Surface Instrument Deployed at YOW	Deployment
HALO Doppler lidar	ECCC
DIAL water vapour lidar	
Micro rain radar	
Pluvio2 Rain Gauge	
Parsivel Disdrometer	
FD71p Visibility and Present Weather Sensor	
WXT520 Weather Sensor	
MP3000 radiometer (microwave)	
Atmospheric Emitted Radiance Interferometer (AERI)	McGill
NR01 Net Radiometer	
T, Humidity Sensors, Barometer & Anemometer	
Soil Humidity and T sensors	

Courtesy of Stephen Holden & Robert Reed

NRC Airborne Elastic Cloud Lidar (AECL)



- **Wavelength:** ***355 nm***
- **Sensitive to** ***small liquid drops*** **or** ***crystals***
- **Horizontal resolution:** ***20 profile per second***
- **Vertical resolution:** ***1.5 m***

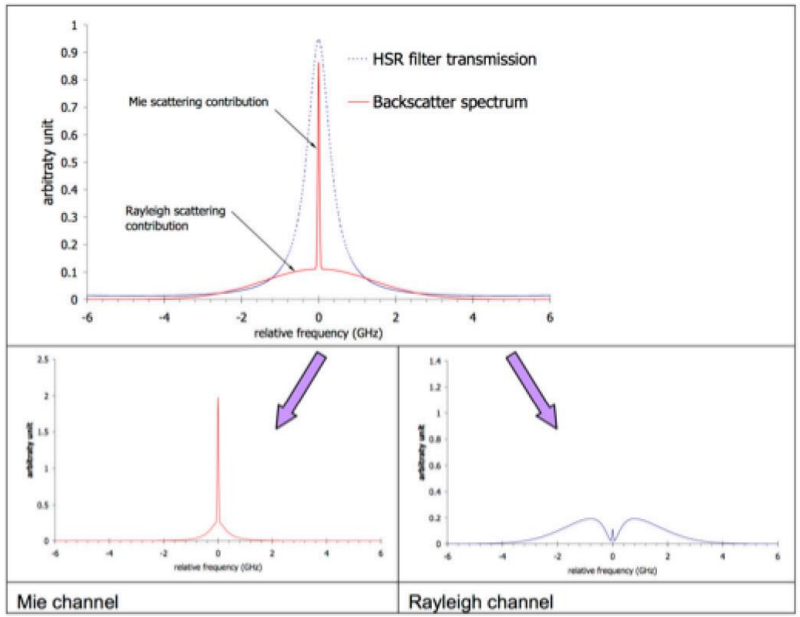


EarthCARE ATLID

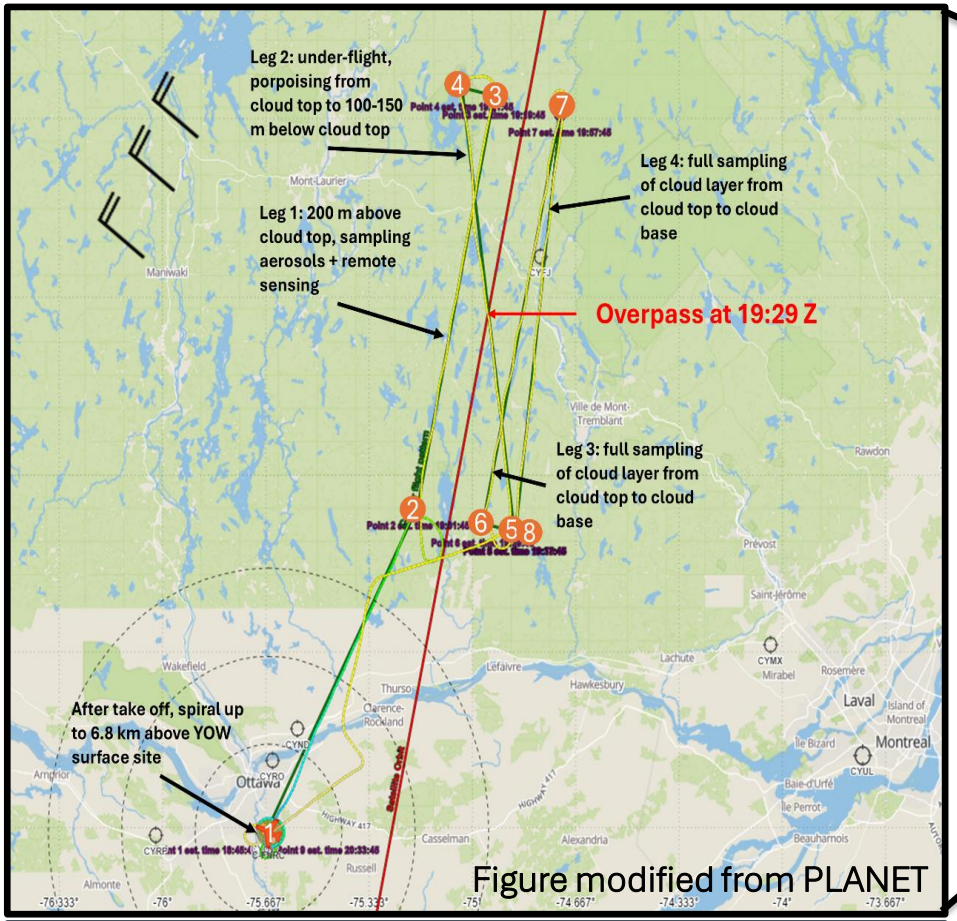
- The measurement principle uses the fact that interaction of light with molecules or aerosols lead to different spectra.

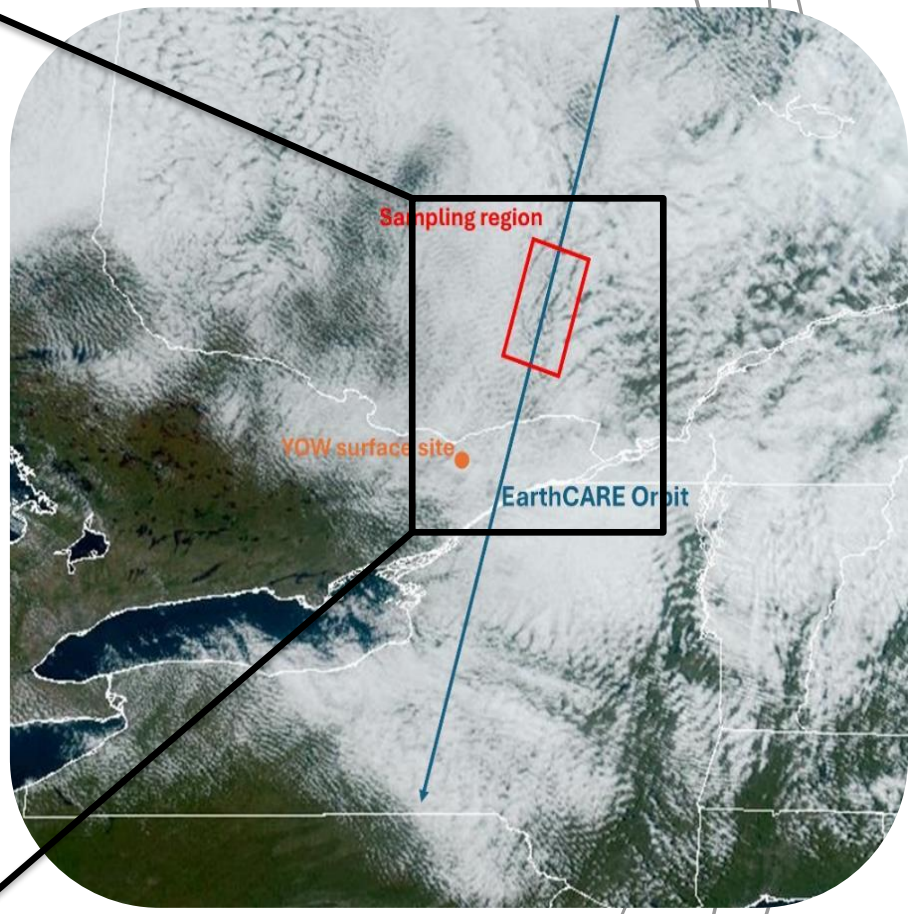
- After collection of the backscattered photons, the receiver chain uses a high spectral-resolution etalon filter to separate the particle and Rayleigh components.

  - Atmospheric profiles, in a direction close to the nadir (3 degrees shift along the satellite track)
  - Vertical resolution of about:
    - 100 m from ground to an altitude of 20 km
    - 500 m from 20 km to 40 km altitude.



ECALOT Flight 2 – 2024-10-10

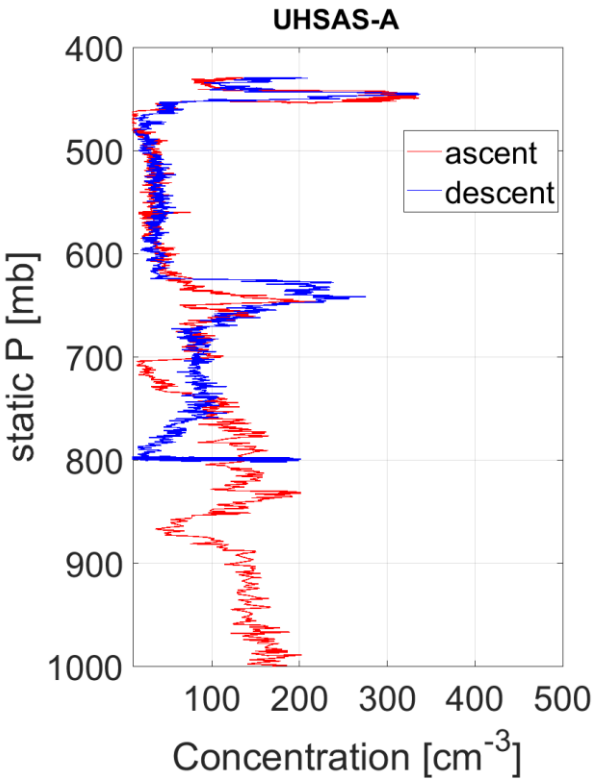


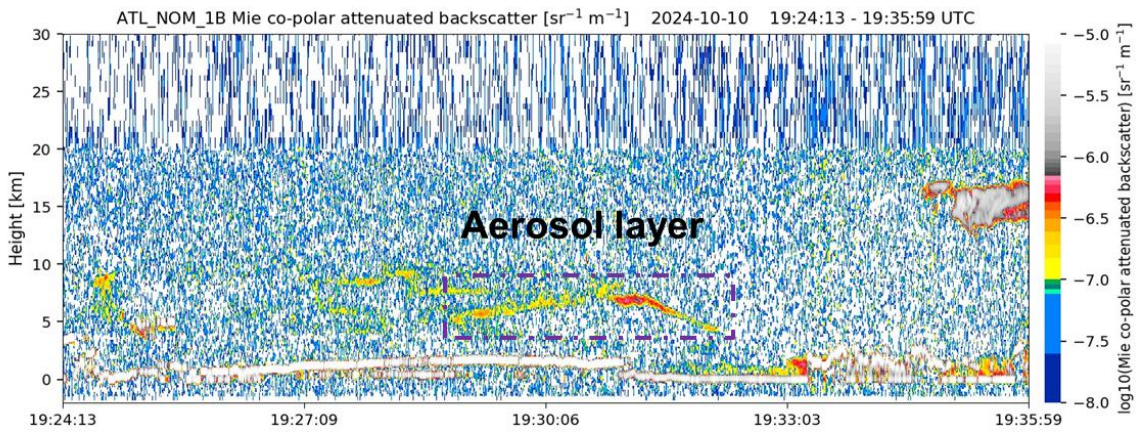


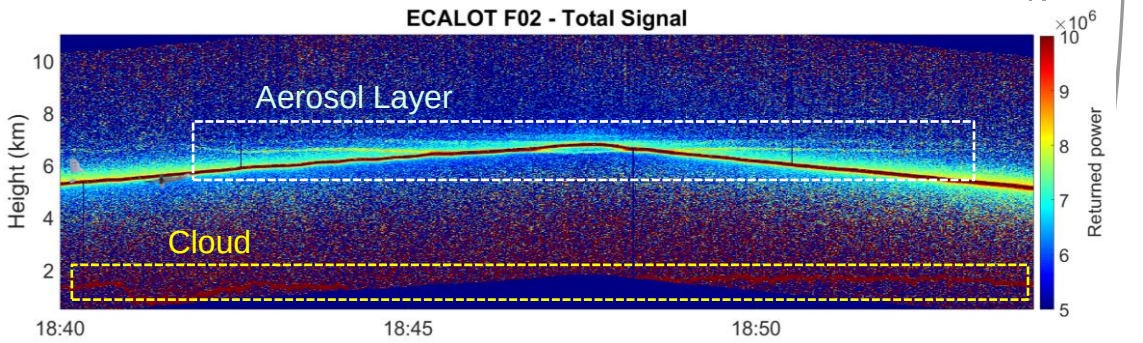
NOAA GOES-East GeoColor composite image at 19:30 UTC, 2024-10-10

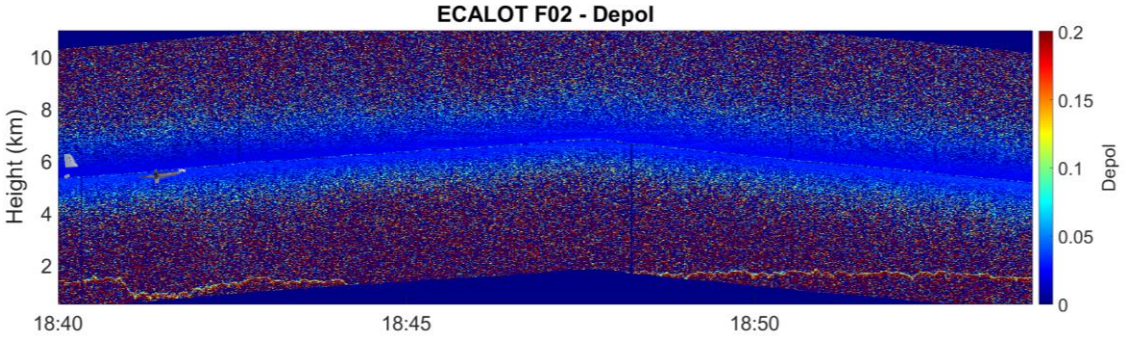
ECALOT Flight 2 – 2024-10-10

- **Aerosol layer at ~ 7km**
  - ***Moderately high signal return***
  - ***Low Depolarization ratio***
- **Liquid cloud at ~ 1.5 km**
  - ***High signal return***
  - ***Low Depolarization ratio***





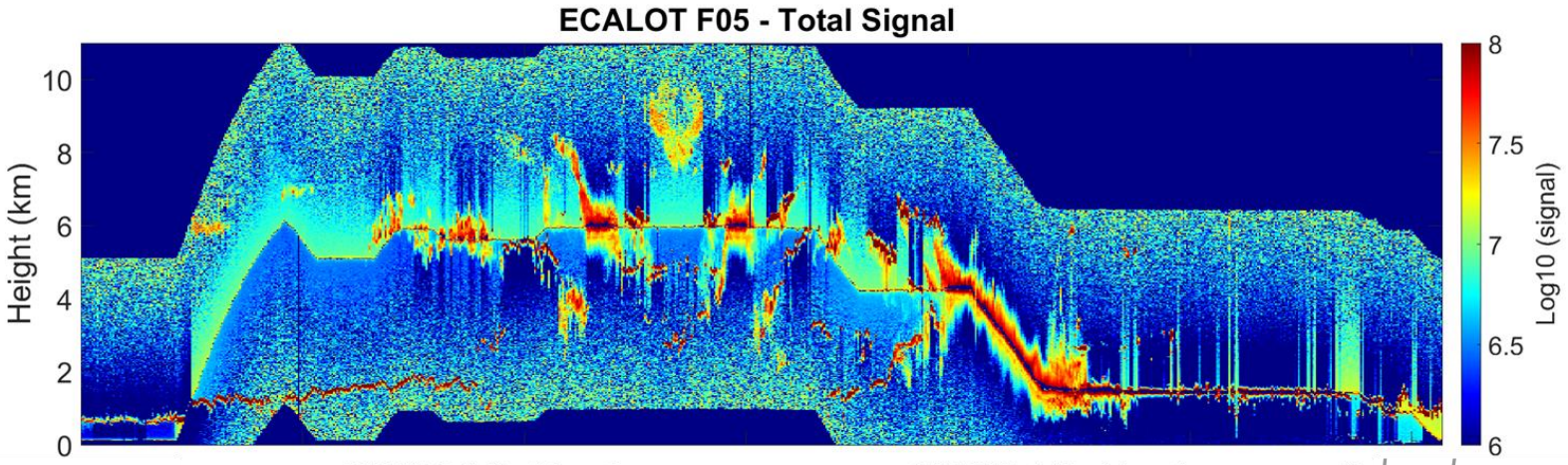


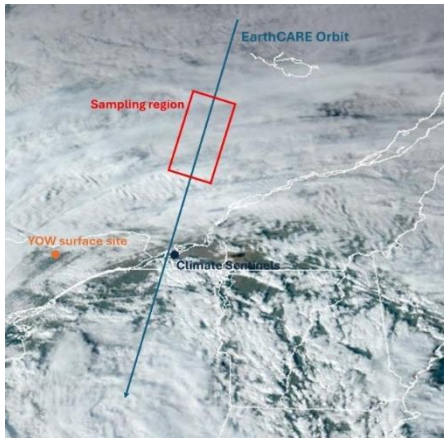


ECALOT Flight 5 – 2024-11-22

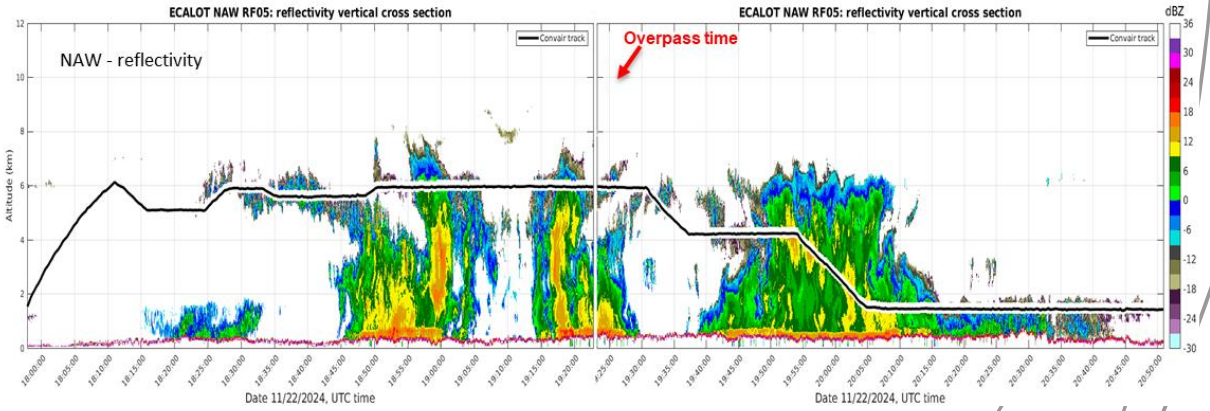
Targets:

- Multi-layer cloud
- Thin ice clouds ≻ 6 km
- Mixed-phase clouds ≻ 4 & 1.8 km
- Supercool liquid layers



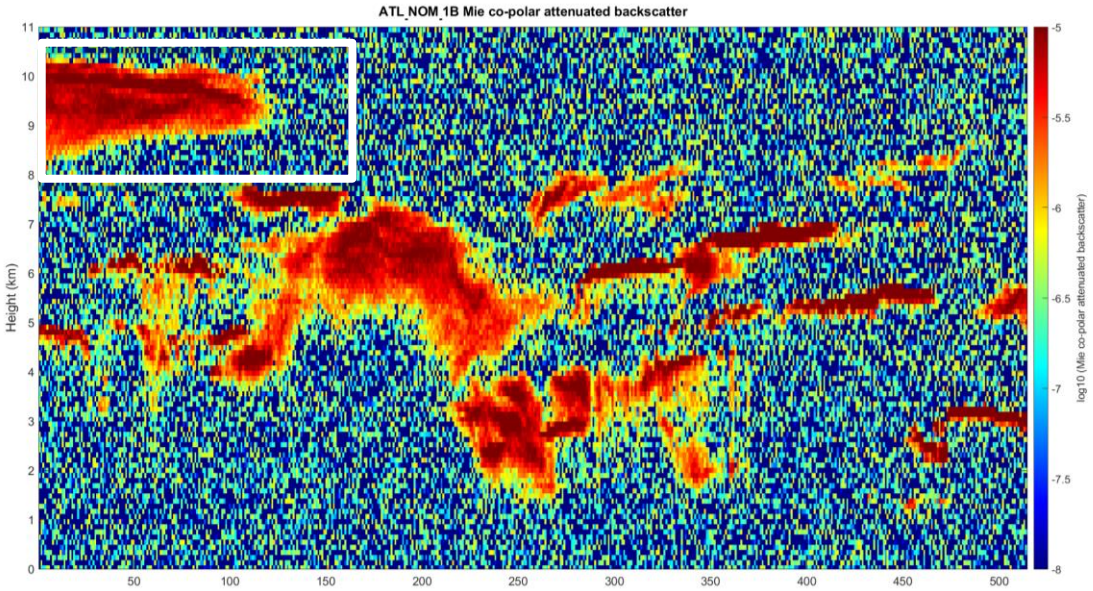


NOAA GOES geo-color image

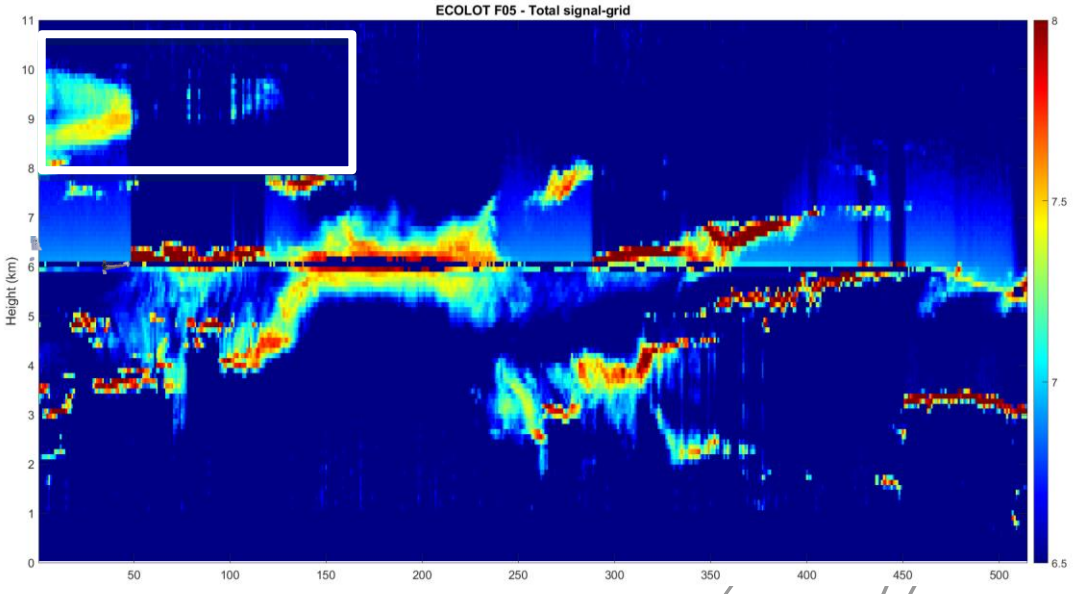


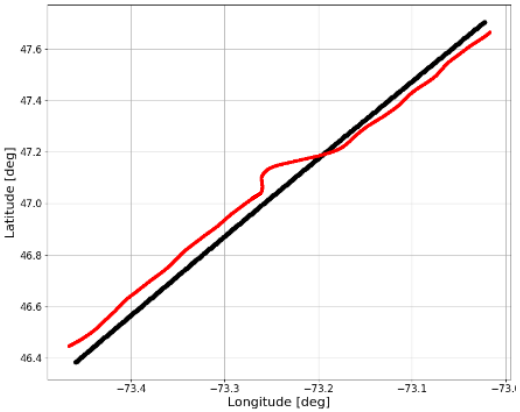
ECALOT Flight 5 – 2024-11-22

ATLID Mie co polar attenuated backscatter



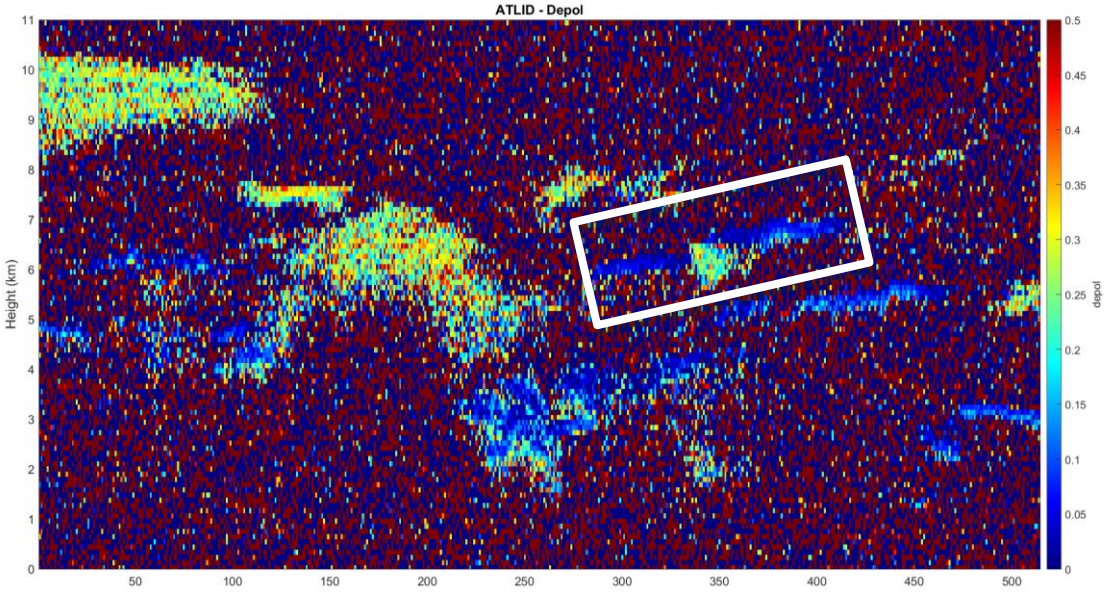
AECL total signal return



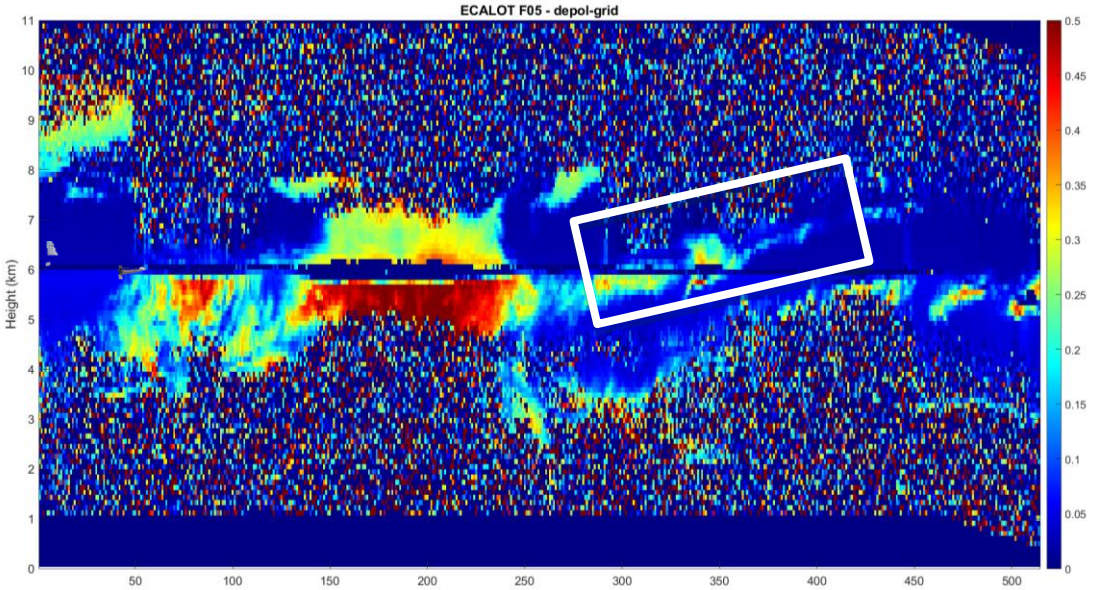


ECALOT Flight 5 – 2024-11-22

ATLID depolarization ratio (cross_pol / co_pol)

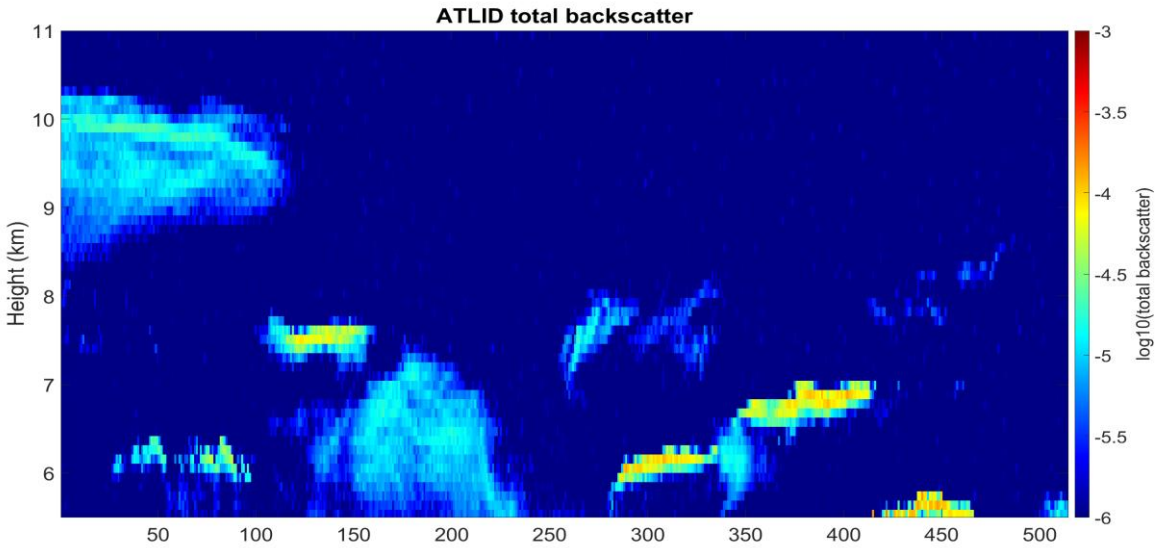


AECL depolarization ratio

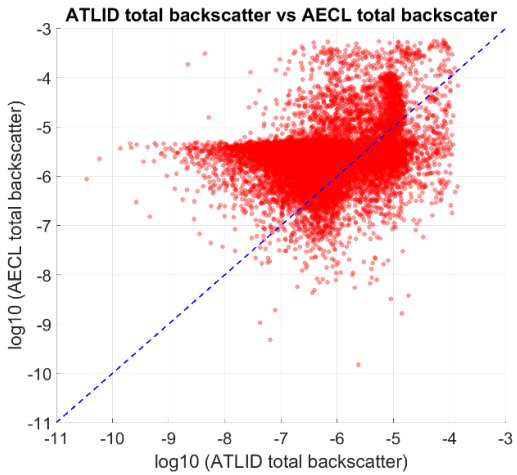


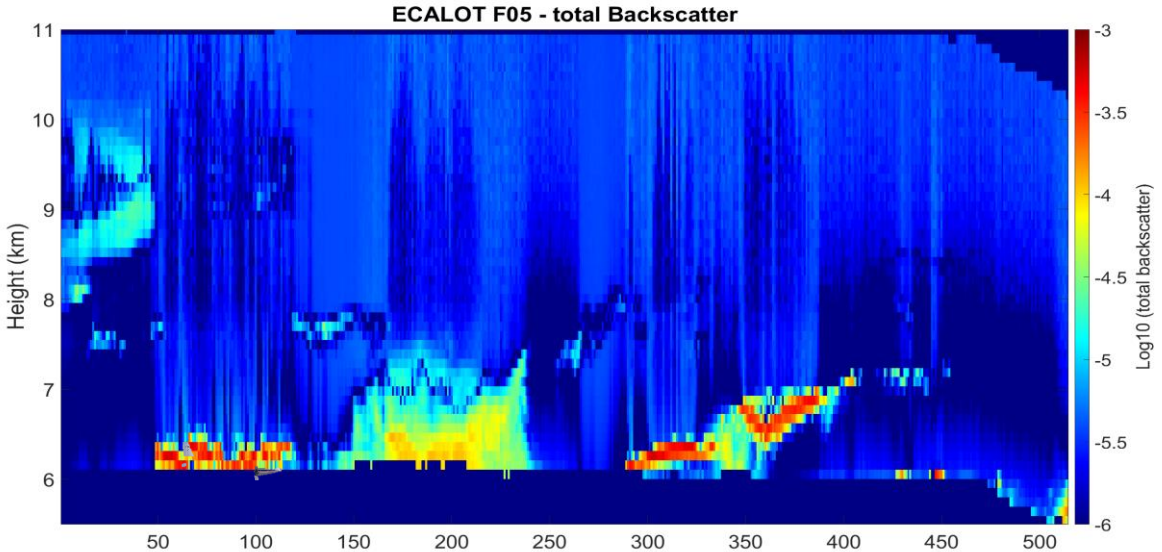
ECALOT Flight 5 – 2024-11-22

ATLID total backscatter



AECL total backscatter





Upcoming timelines

- ECALOT took place around the Ottawa region during Fall 2024 (extension into Winter 2025):
  - Aircraft/surface calibration/validation campaign in North America.
  - Provided good quality data for targeted flights to sample relevant mid-latitude continental weather to validate EarthCARE observations.
- Conducting one or two project flights in winter 2025
- Performing the nadir lidar calibration

Thanks!

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