Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

Multi-instrument observations of prolonged stratified wind layers at Iqaluit, Nunavut

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Environment and Climate Change Canada, Government of Canada

AMS 2018 Conference

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Overview

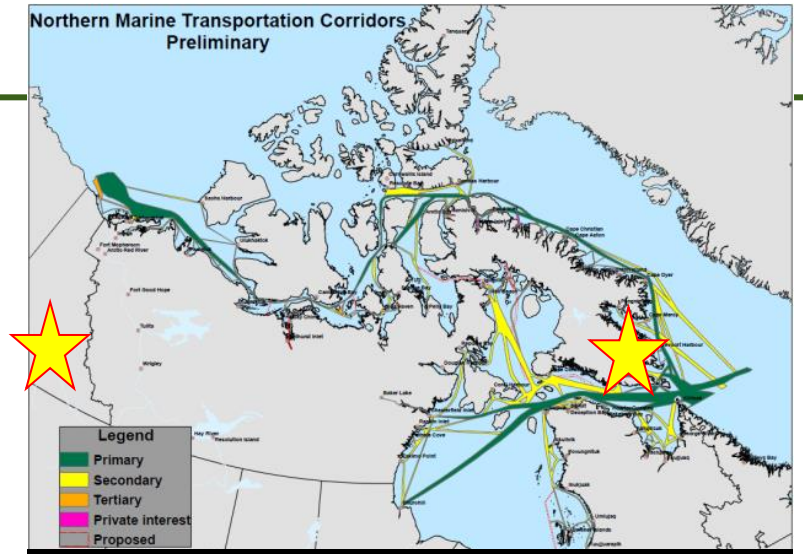
Environment and Climate Change Canada

- The Iqaluit supersite
- Instrumentation
- Observations of stratified wind layer events
- Summary

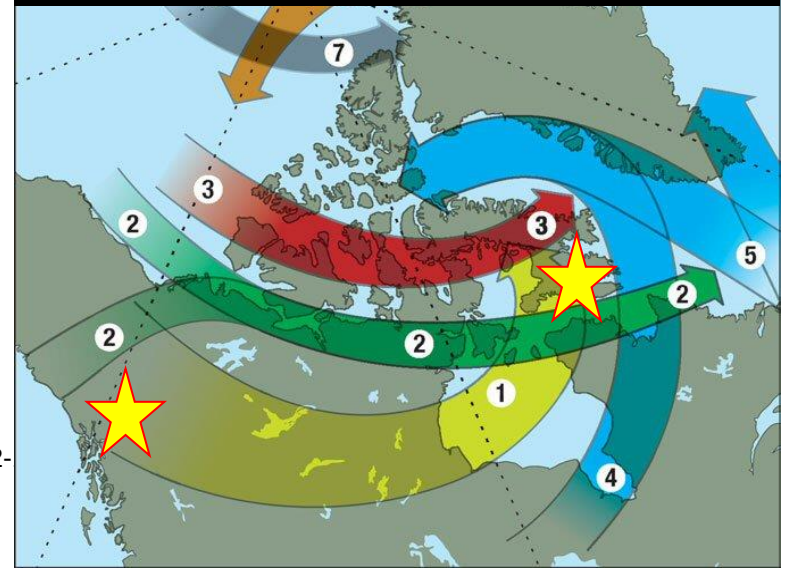
Photo: M. Harwood

Canadian Arctic Weather Science (CAWS) Project

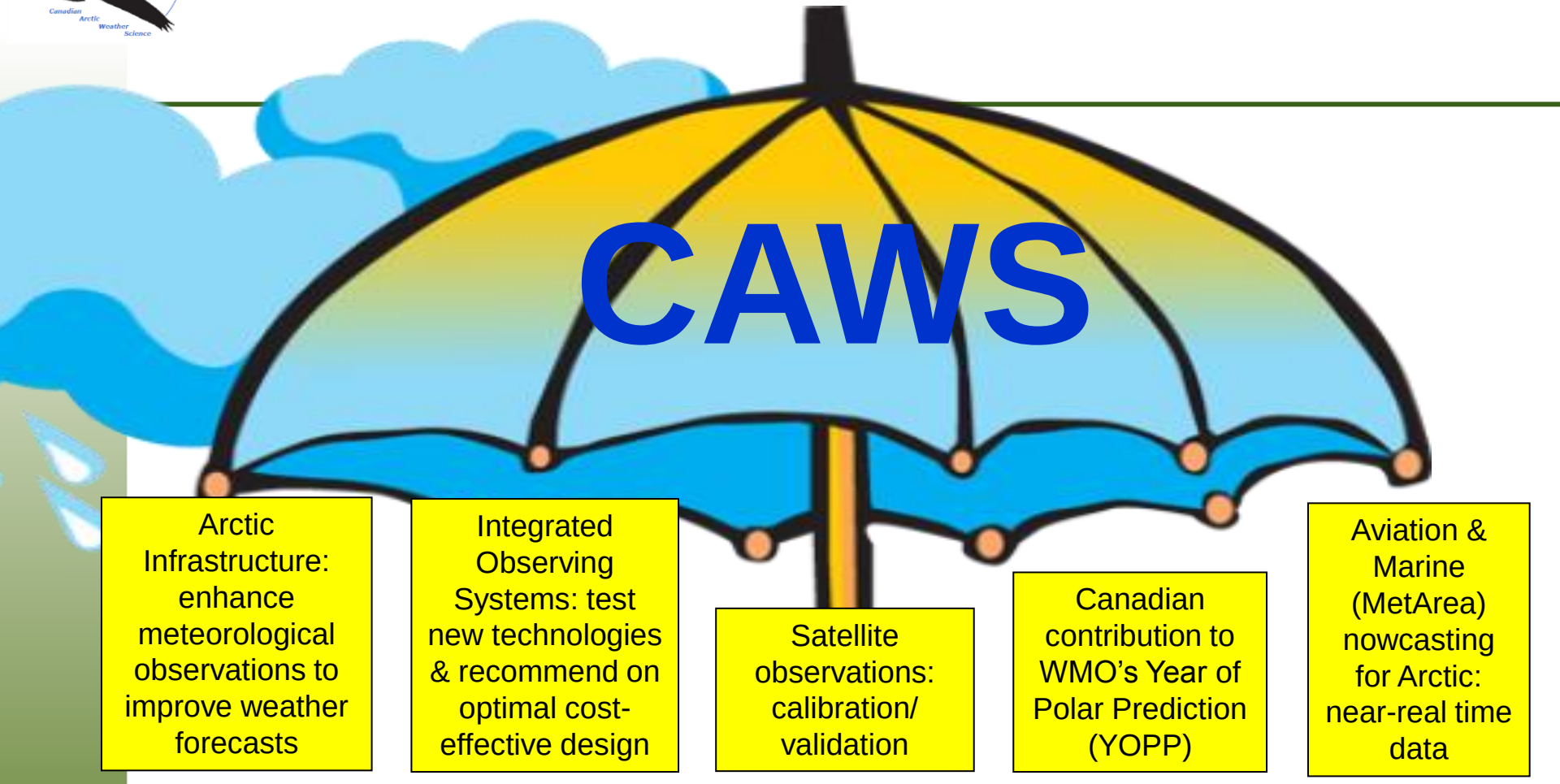
- Weather is a safety issue for the Arctic: why is it a challenge to **forecast**?
- What is the required cost-effective **observation system**?
- How to provide reliable and relevant weather information to the **local communities**?
- What can we learn from **Traditional knowledge**?



Iqaluit & Whitehorse are weather and transportation hot spots



CAWS
Canadian Arctic Weather Science



Arctic Infrastructure: enhance meteorological observations to improve weather forecasts

Integrated Observing Systems: test new technologies & recommend on optimal cost-effective design

Satellite observations: calibration/ validation

Canadian contribution to WMO's Year of Polar Prediction (YOPP)

Aviation & Marine (MetArea) nowcasting for Arctic: near-real time data

Iqaluit Supersite

ECCC site

CAAAL water vapour Lidar

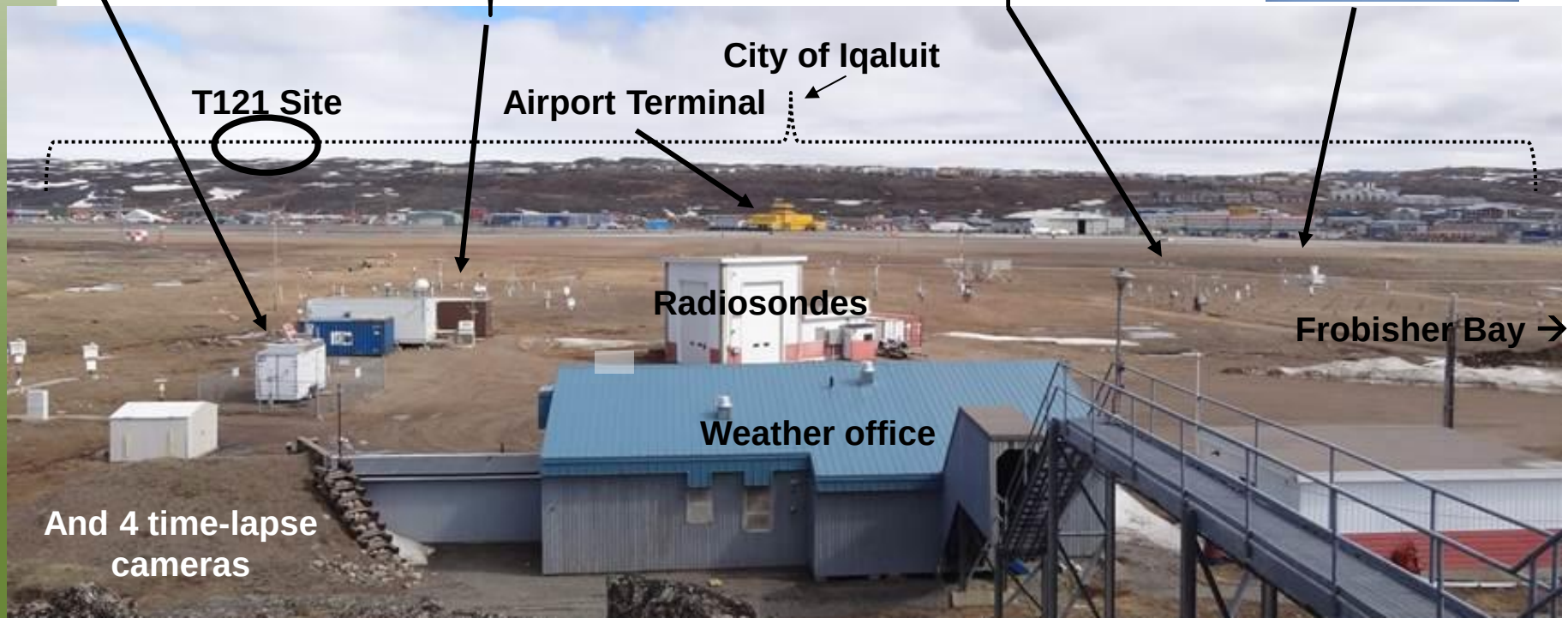
Doppler Lidar

Precipitation Imaging Package

Ceilometer

Present weather detection

Ka-Band weather radar



Ka-Band Doppler Radar

- Automated scanning radar for measuring winds, clouds, and precip during different environmental conditions (clear sky, light precipitation, fog, clouds)
- Operates at 35-GHz using a 30 kW pulsed laser at 10 kHz with a range resolution of 30 m

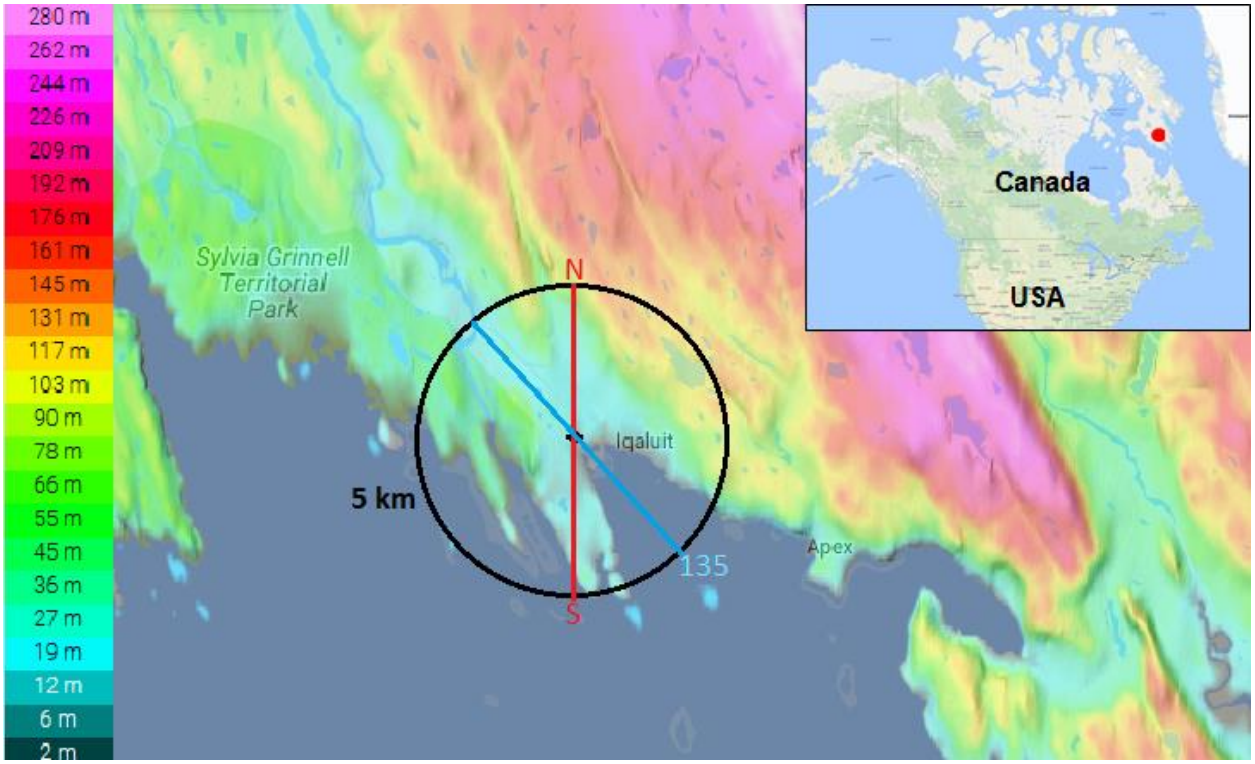
Essential Parameters	
Manufacturer	METEK
Measurement products	Doppler velocity, backscatter, cloud/fog/precipitation, depolarization ratio
Range resolution	30 m
Maximum range	~ 25 km (depending on atmospheric conditions)
Scan sequence	10 minutes (Vertical stare, 3x PPI, RHI)

Scanning Doppler Lidar

- Modular, autonomous, pulsed Doppler lidar system
- Operation is similar to radar (scanning)
- Operates at 1.5 µm using a 15 µJ pulsed laser at 10 kHz
- Applications include boundary layer wind profiling, plume dispersion, analysis of complex flows, cloud studies, etc.

Essential Parameters	
Manufacturer	HALO Photonics Ltd.
Measurement products	Doppler velocity, wind profiles, backscatter, depolarization ratio
Range resolution	3 m overlapping gates (range gate length of 60 m)
Maximum range	~ 3 km (depending on atmospheric conditions)
Scan sequence	8 minutes (Vertical stare, PPI, 2x RHI, VAD, DBS)

The Iqaluit supersite: topography



All observations are delivered in **near-real time** to ecpass.ca (publically-accessible)

ecpass.ca/protected/iqaluit.html

CAWS: CANADIAN ARCTIC WEATHER SCIENCE

Contact Us: zen.mariani@canada.ca

- Iqaluit Observations
- External Products
- Surface Meteorological Observations
- Vertical Profiles (Clouds, T, P, RH)
- LIDAR Wind (VR) and Aerosol (Beta) Products
  - Lidar Product Info
  - Depolarization Ratio
  - PPI (Latest)
  - VAD
  - DBS Wind Profile
  - Vertical Stare
  - RHI VR
- KaBand Radar Products
- CIMEL Sun Photometer
- Publications
- Animations
- CAWS Products
- OBRS Products
- Original ECPASS Site

IQALUIT (YFB) OBSERVATIONS PAGE

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Iqaluit (YFB) Observations

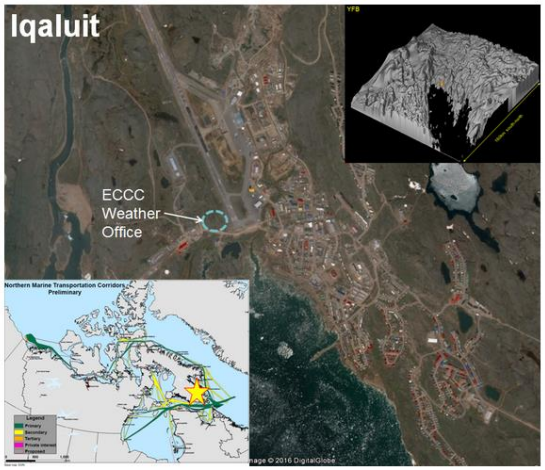
THIS IS THE IQALUIT OBSERVATIONS PAGE

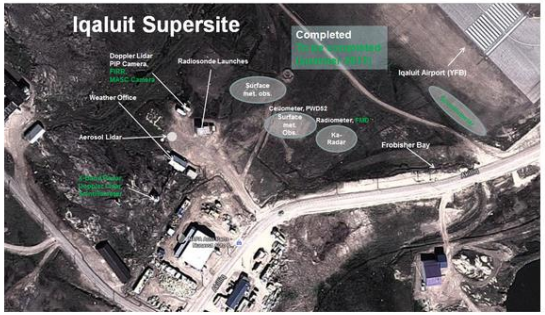
For request of raw or processed data files, please contact zen.mariani@canada.ca

General Information on the Iqaluit Meteorological Observation Site

Click here for more information on the Iqaluit site, including all instrumentation deployed to the site

The Iqaluit meteorological site is located West of the Iqaluit airport (YFB) at the Environment and Climate Change Canada (ECCC)'s Weather Office site. New instruments for near-real time meteorological observations and research have been installed to complement the existing surface and upper air meteorological measurements taken at the site.

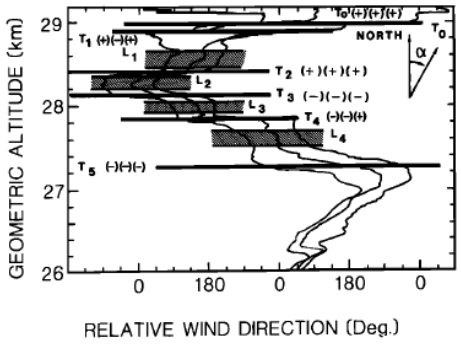




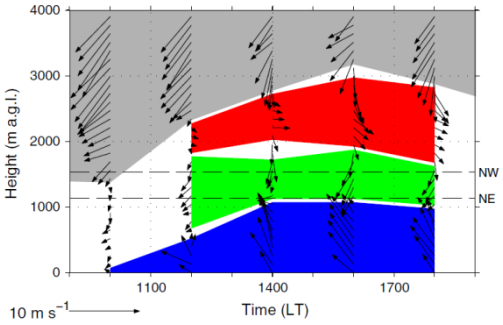
Previous observations of stratified wind layers

- A vertically-stratified structure in the atmosphere can have large impacts on aerosols, air quality, trace gas distributions, and vertical mixing
  [e.g., Holton, 1983; Newell et al., 1996; Sofiev et al., 2009]

- Sidi and Barat, JGR (1986)
  - Radiosonde observations in the stratosphere
  - Related to dissipation of an internal gravity wave



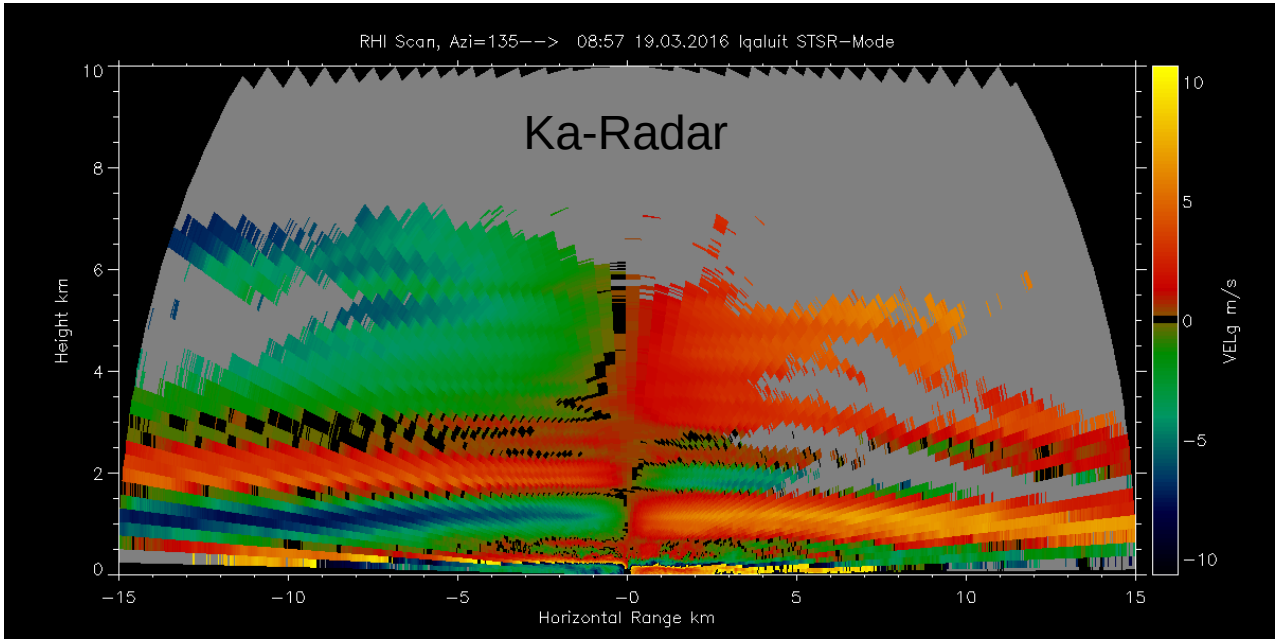
- Adler and Kalthoff, Boundary-Layer Meteorol (2014)
  - Radiosonde and wind lidar observations in the troposphere
  - Wind layer events over complex (mountainous) terrain



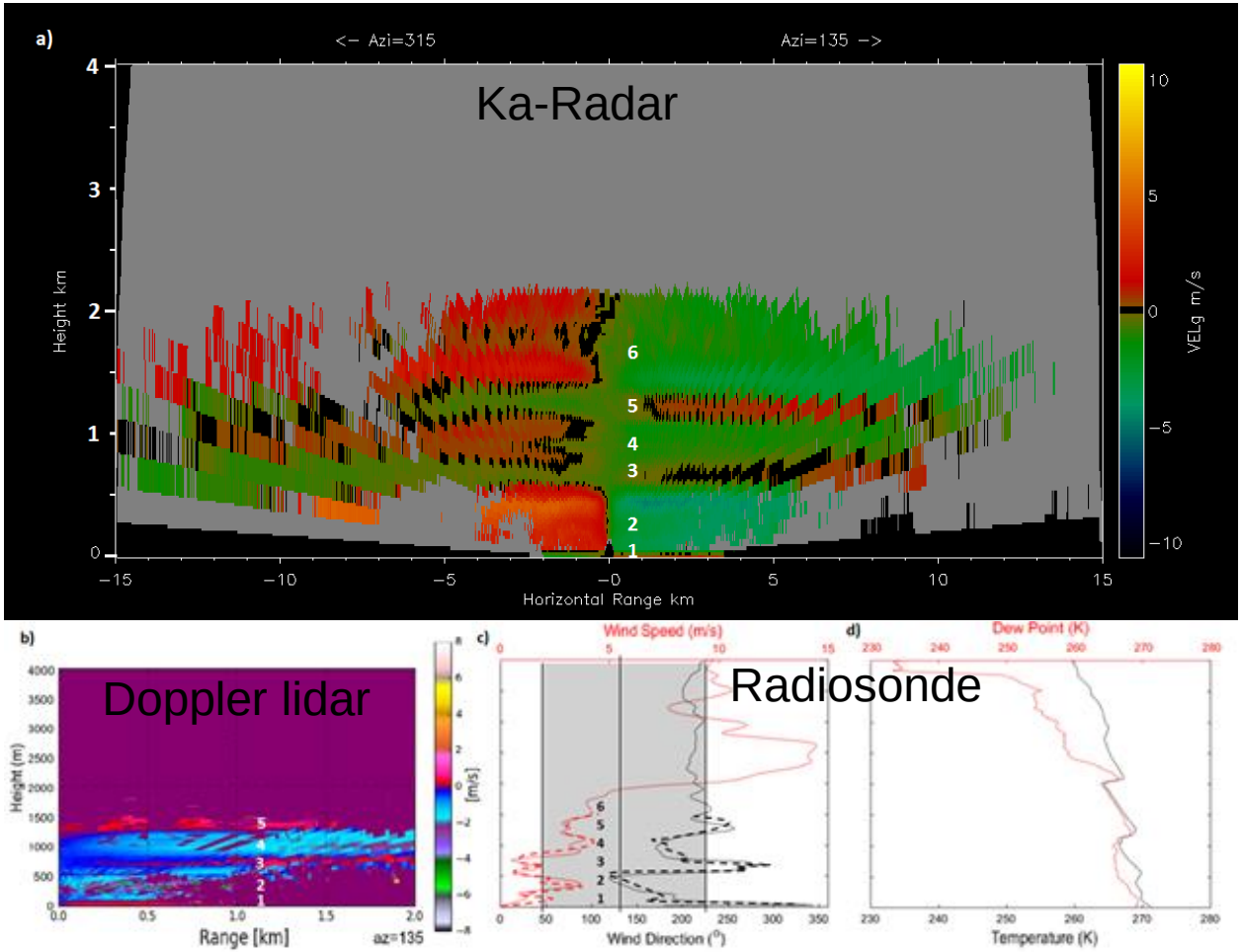
- A continuous observation of a stratified vertical wind structure has yet to be documented and thoroughly characterized

Example stratified wind layer event over Iqaluit March 18-20, 2016

- Event = lasting at least two hours in duration with at least four layers



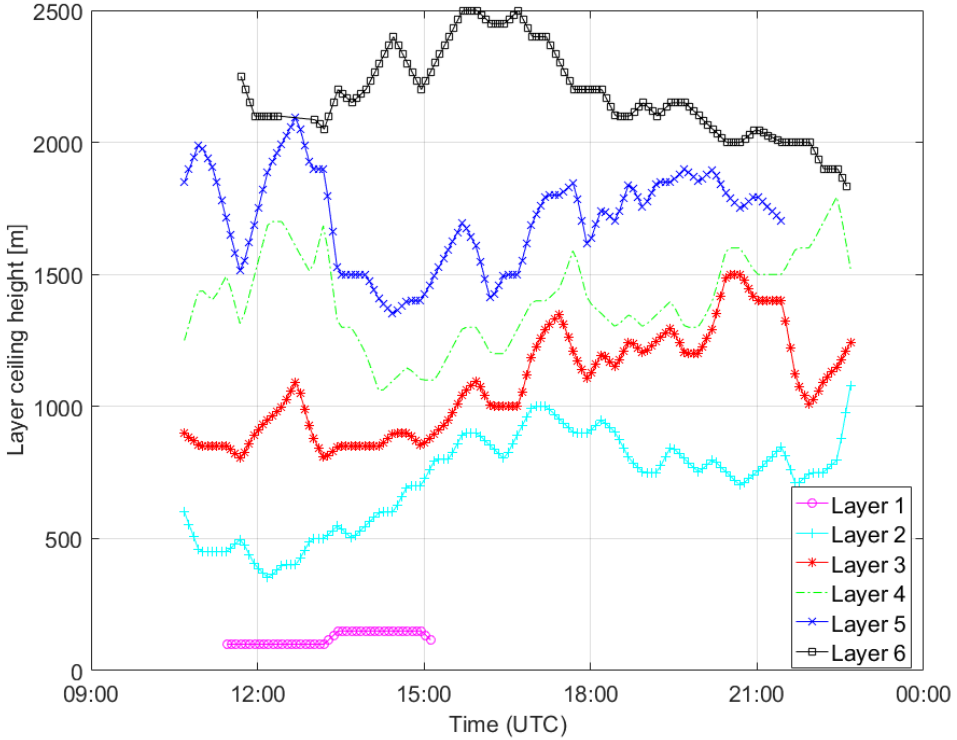
May 12, 2016 case



Mariani et al. (2017), GRL; under review

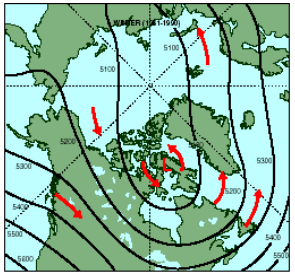
Temporal evolution of layers
May 12, 2016 case

- Altitudes and vertical widths of the layers were highly variable in time
- Most layers appear to be coupled as they change altitude together
- Negative correlation among layers (e.g., layers 2 and 3 at 12:00 to 13:00) and merging (layers 5 and 6 at 12:27) was also observed

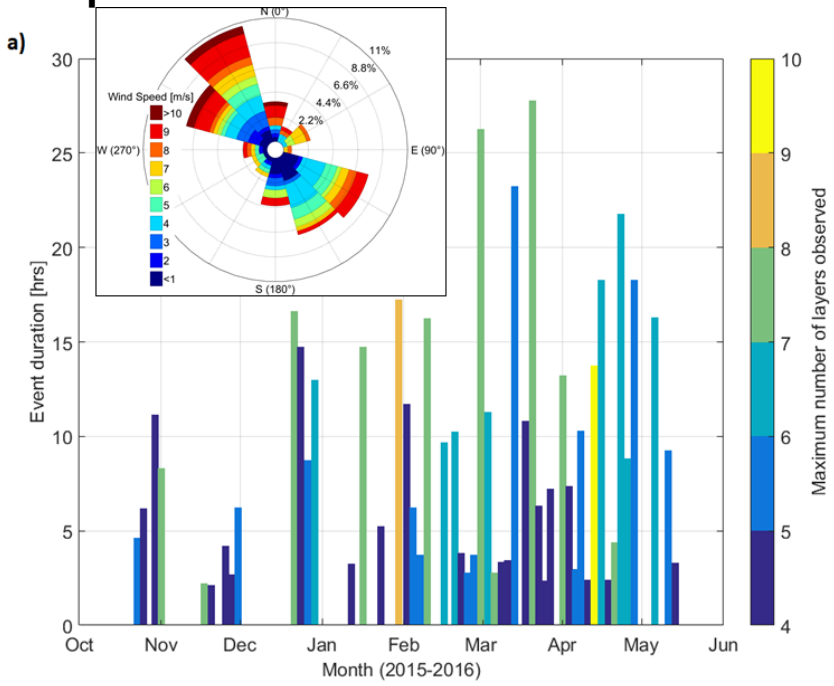


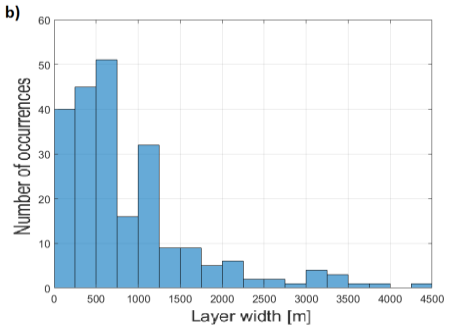
All observed wind layer events

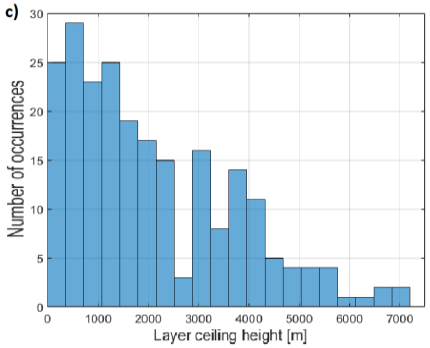
- Doppler lidar, radar, radiosonde, and water vapour lidar observations detected stratified layers 0.1 to 4.4 km thick up to 7.2 km a.s.l. and lasting up to 27.5 hr
  - High frequency (**40% daily occurrence**): 64+ observed events
  - Most (70%) wind layers **occurred in the free troposphere**
  - 80% occurred while Iqaluit was east of a longwave trough/upper low
  - 81% of events **occurred during light precipitation**



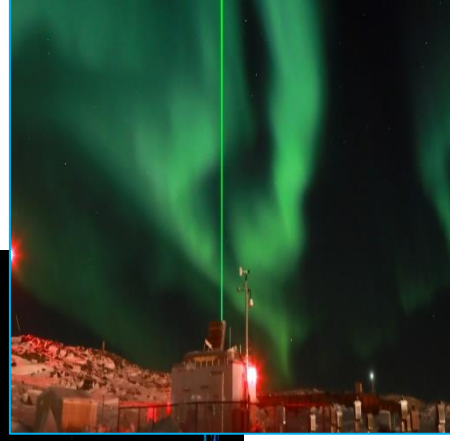
- Underrepresented in numerical weather prediction (NWP) forecast model: **forecast bias was amplified or reversed**

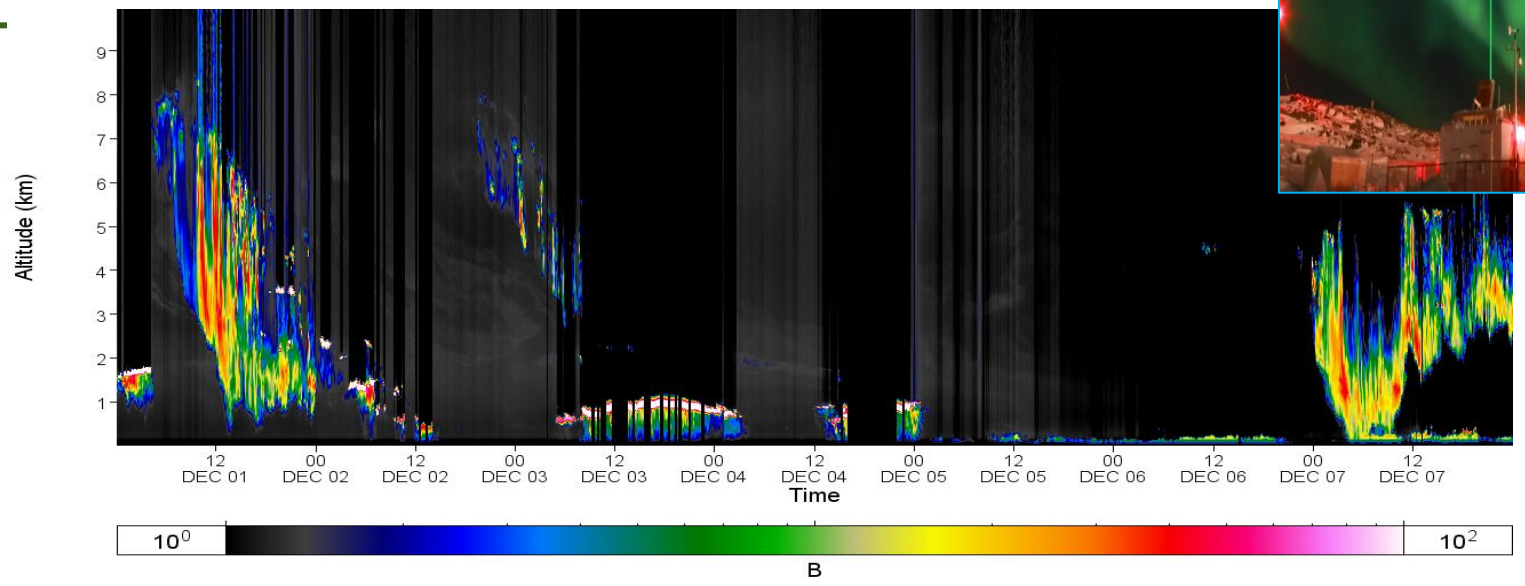


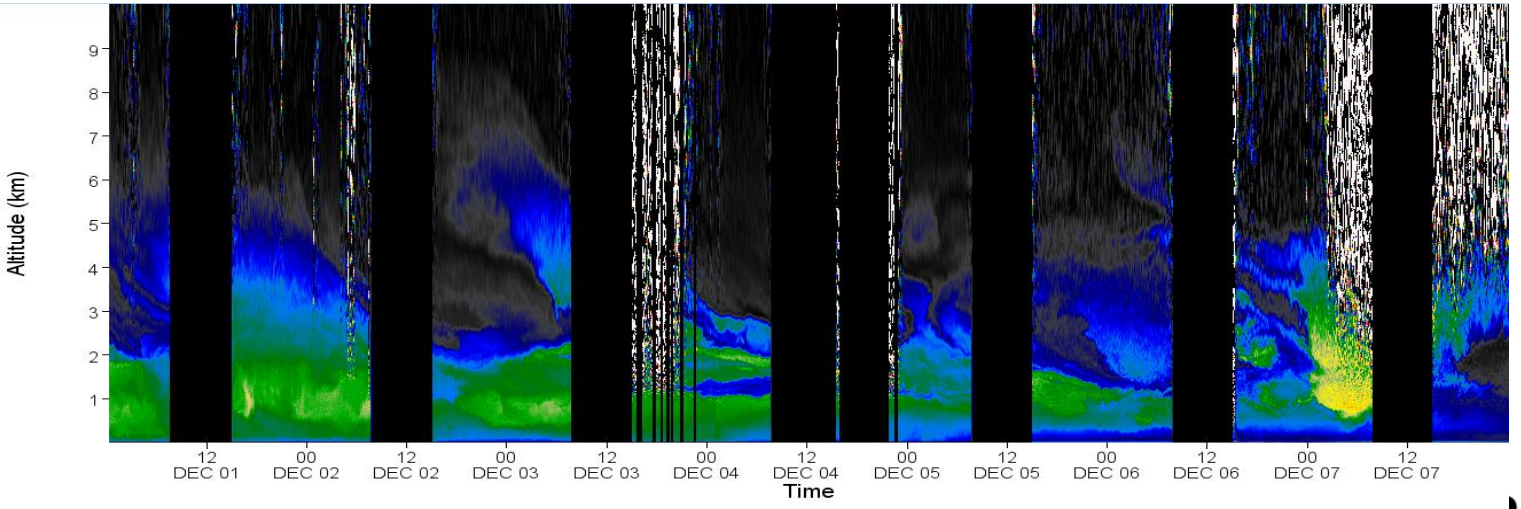




CAAAL Observations – Dec 1-7



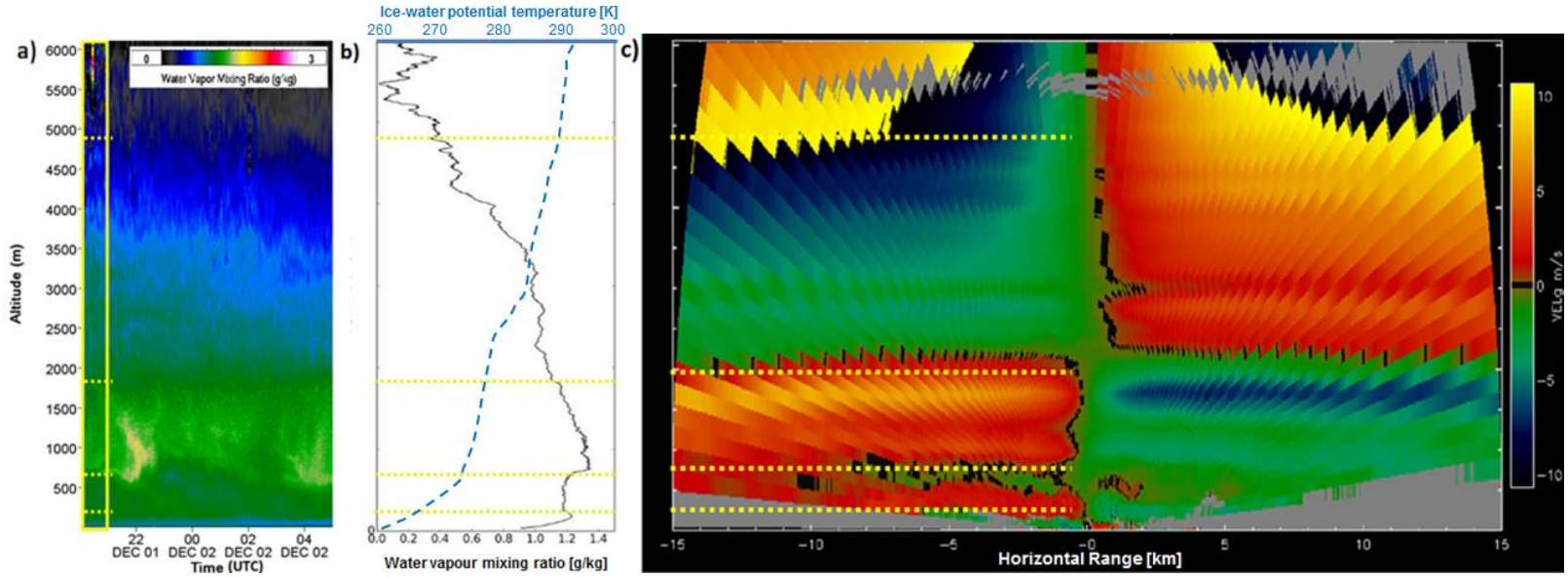




K. Strawbridge, ECCC

Stratified water vapour and wind layers: Dec 1, 2016 case

- Relationship between stratified wind layers and temperature/humidity layers remains uncertain
- Transition zones with significant changes in water vapour mixing ratio occurred at the same altitude as transitions between wind layers



Summary

- Iqaluit supersite:
  - Provides near-real time data made available to the public and researchers via ecpass.ca
  - Enables enhanced evaluation of new remote sensing technologies and Arctic forecasts
  - Uniquely equipped to characterize the atmospheric structure and study layering events
  - Radiosondes observed layer events on only 33% of event days
- Characterization of long-lasting vertically-stratified wind layers (40% obs days)
  - May be related to a similar layered water vapour structure indicating different air masses
- Layered structure phenomenon is tied to the thermal structure and dynamics of the atmosphere
- Preliminary results indicate stratified wind layer events affect NWP forecast skill by increasing biases
  - Evaluation of the ability of ECCC's High Resolution Deterministic System to represent these layered structures over Iqaluit
  - Installation of new radiation flux sensors: radiative budget

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