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P-type Processes and Predictability:

Initial results from the Winter Precipitation Type Research Multiscale Experiment (WINTRE-MIX)

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2 McGill University

3 University of Wyoming

4 University of Colorado Boulder

5 Environment and Climate Change Canada / Environnement et Changement climatique Canada

6 FARM Flexible Array of Radars and Mesonets

7 UQÀM Université du Québec à Montréal

8 NRC·CNRC

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NCAR UCAR EOL Earth Observing Laboratory

https://www.eol.ucar.edu/field_projects/wintre-mix

NYS Mesonet University at Albany

NSF AGS-2113995

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Project Overview

Minder, J. R., and Coauthors, 2023: P-type Processes and Predictability: The Winter Precipitation Type Research Multiscale Experiment (WINTRE-MIX). *Bull. Amer. Meteor. Soc.*, https://doi.org/10.1175/BAMS-D-22-0095.1.

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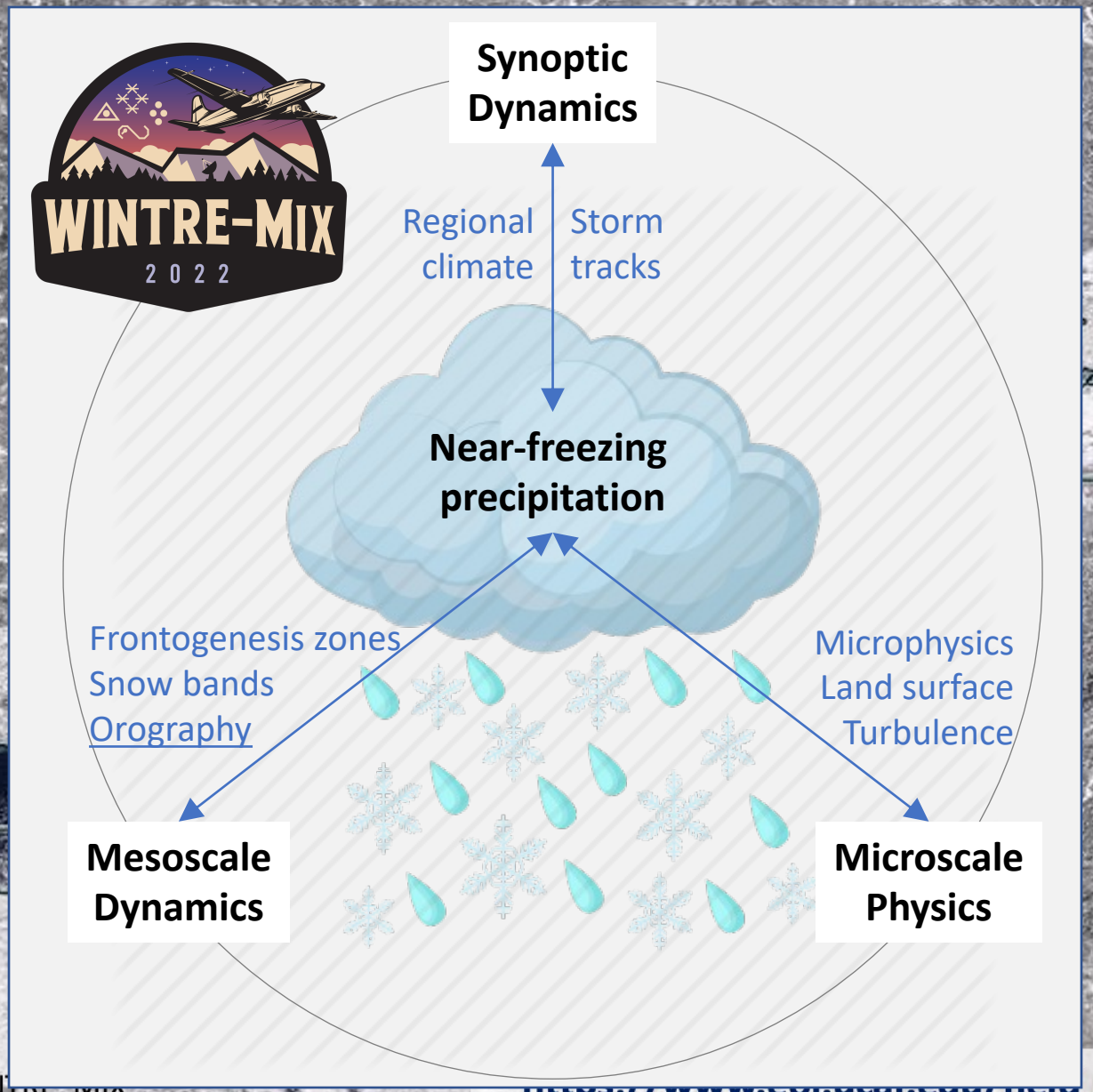
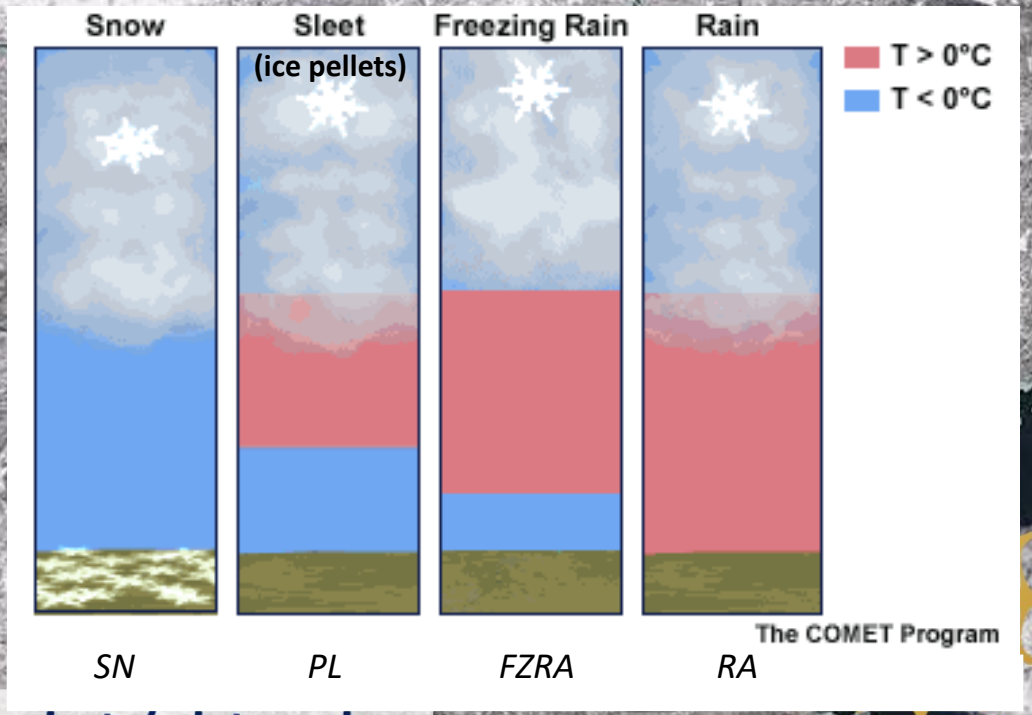
Winter Precipitation Type Research Multi-scale Experiment



Focus & Goal

To better understand how multi-scale processes influence the variability and predictability of precipitation type and amount under near-freezing surface conditions.



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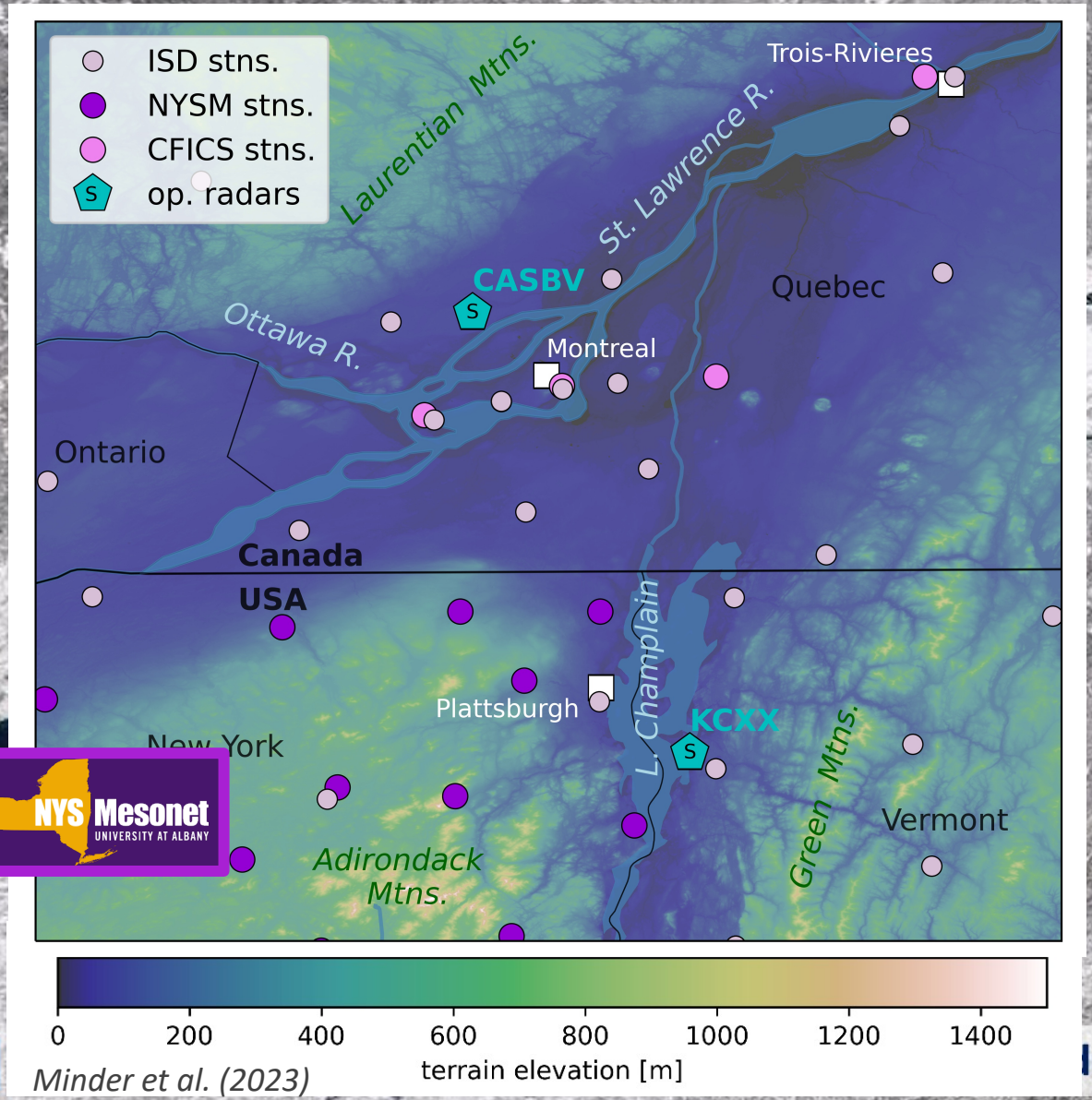
Project Overview: *Where & When?*



Minder et al. (2023)

- US (NY) – CAN (QC) boarder region
- St. Lawrence / Champlain Valleys
- Excellent backbone of existing observations
- Plentiful & diverse near-freezing winter precipitation

- 1 February – 15 March 2022
- 11 intensive observing periods (IOPs)

lu/field_projects/wintre-mix

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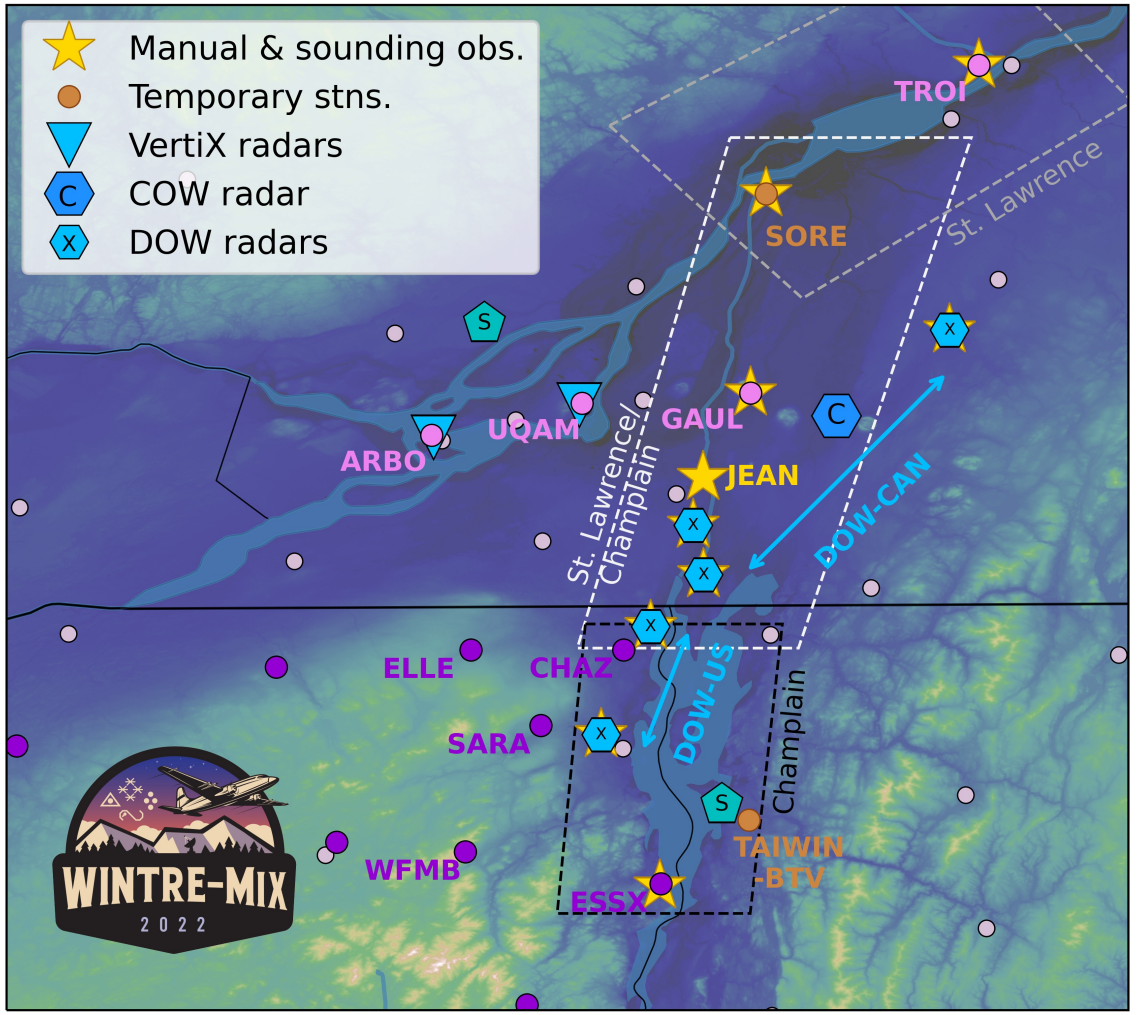
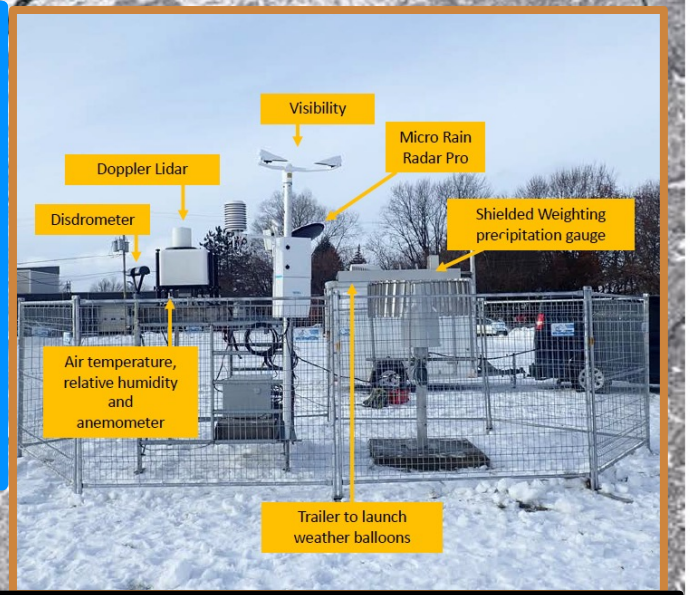
Project Overview:
Deployment strategy



Minder et al. (2023)



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Results:

Example case study

Intensive observing period #5 (IOP5)

- 22–23 February 2022
- Warm air advection over persistent shallow cold air in St. Lawrence Valley
- (PL to) FZRA to RA transition

WINTRE-MIX 2022

Minder, J. R., and Coauthors, 2023: P-type Processes and Predictability: The Winter Precipitation Type Research Multiscale Experiment (WINTRE-MIX). *Bull. Amer. Meteor. Soc.*, https://doi.org/10.1175/BAMS-D-22-0095.1.

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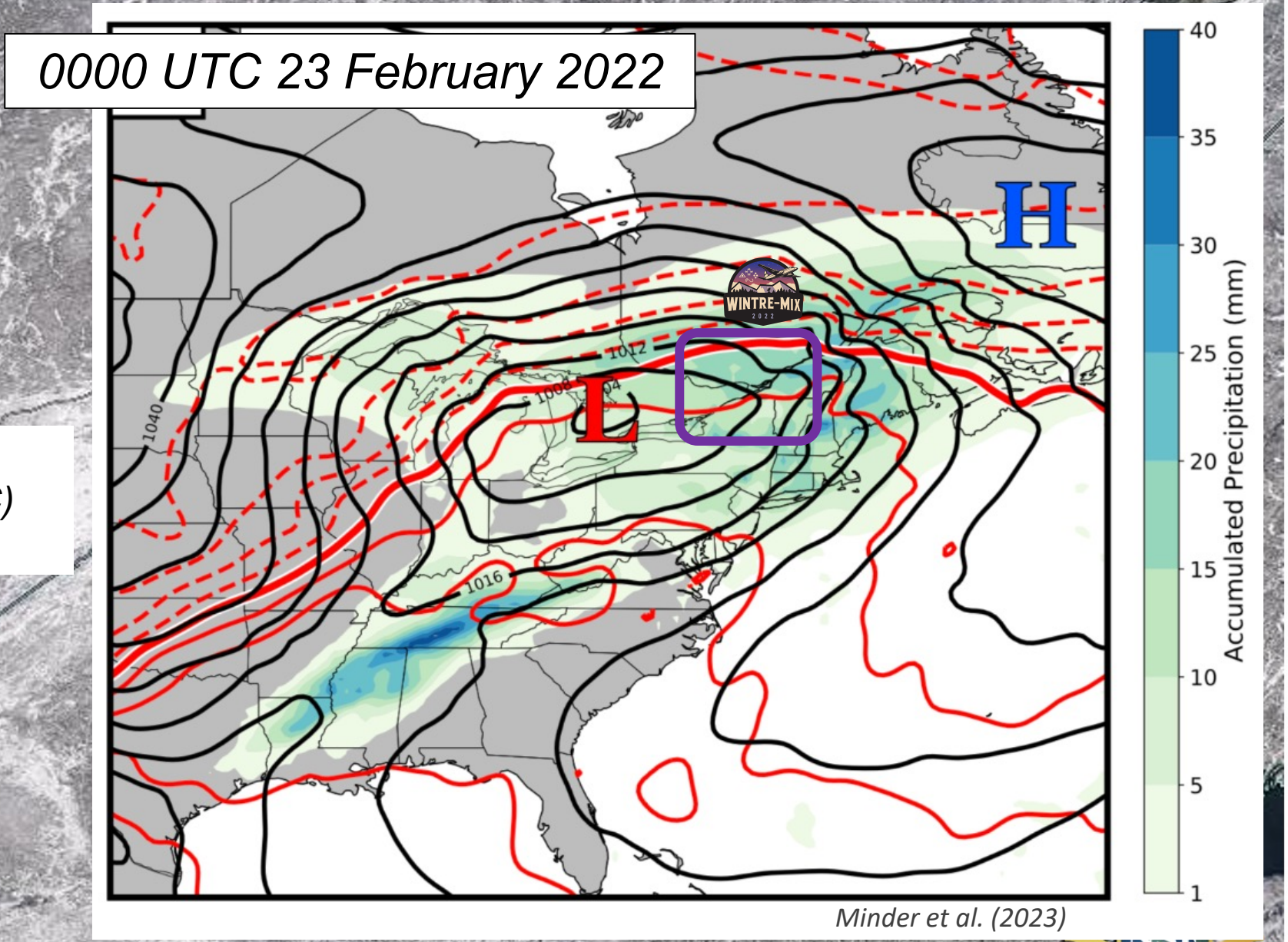
IOP5:
Synoptic environment (ERA-5)

SLP (black contours)
850-hPa T (red, dashed where <0°C)
Event-total precipitation (shaded)



Minder et al. (2023)

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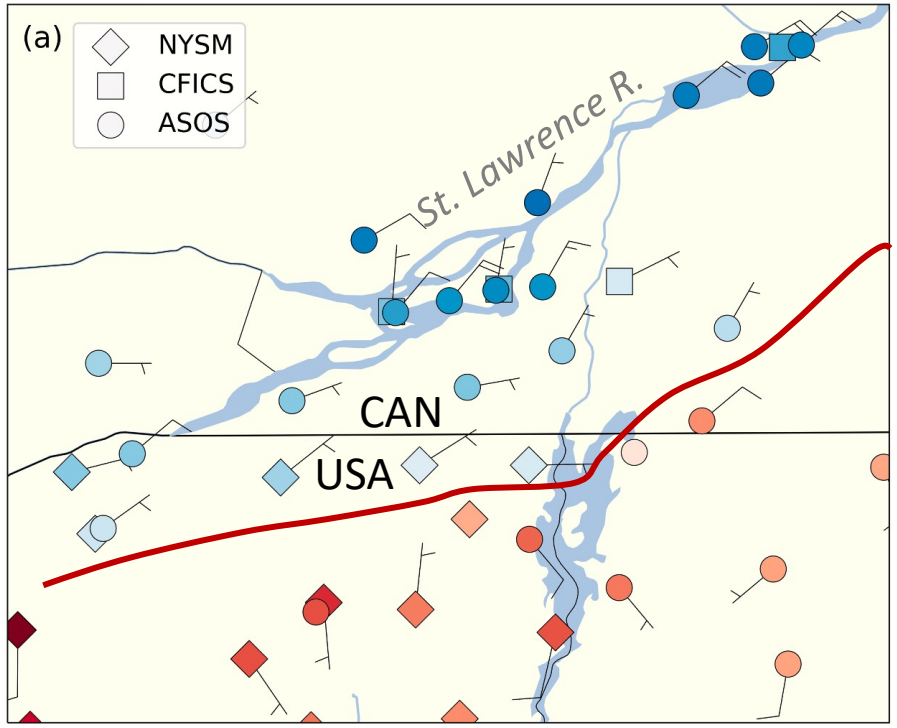
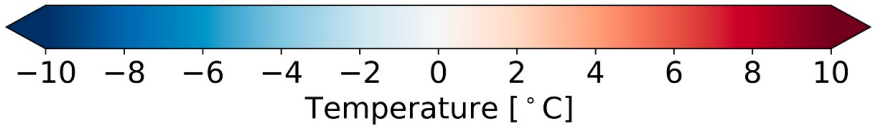
IOP5: *Mesoscale overview*

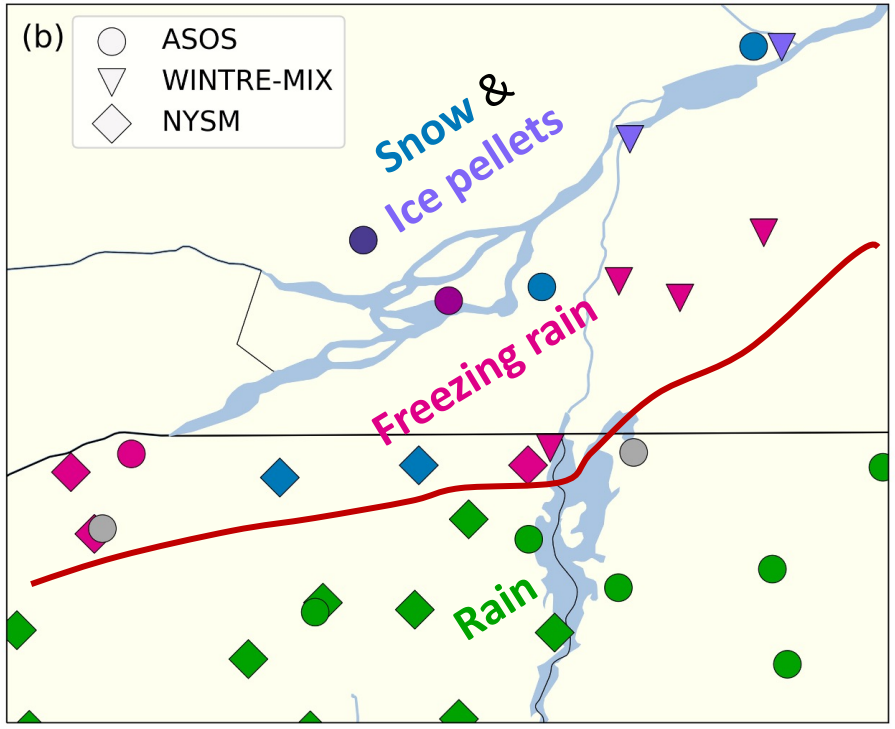
0000 UTC 23 February 2022

2-m Temperature
10-m winds (full barb = 5m/s)





Observed/diagnosed p-type



Minder et al. (2023)

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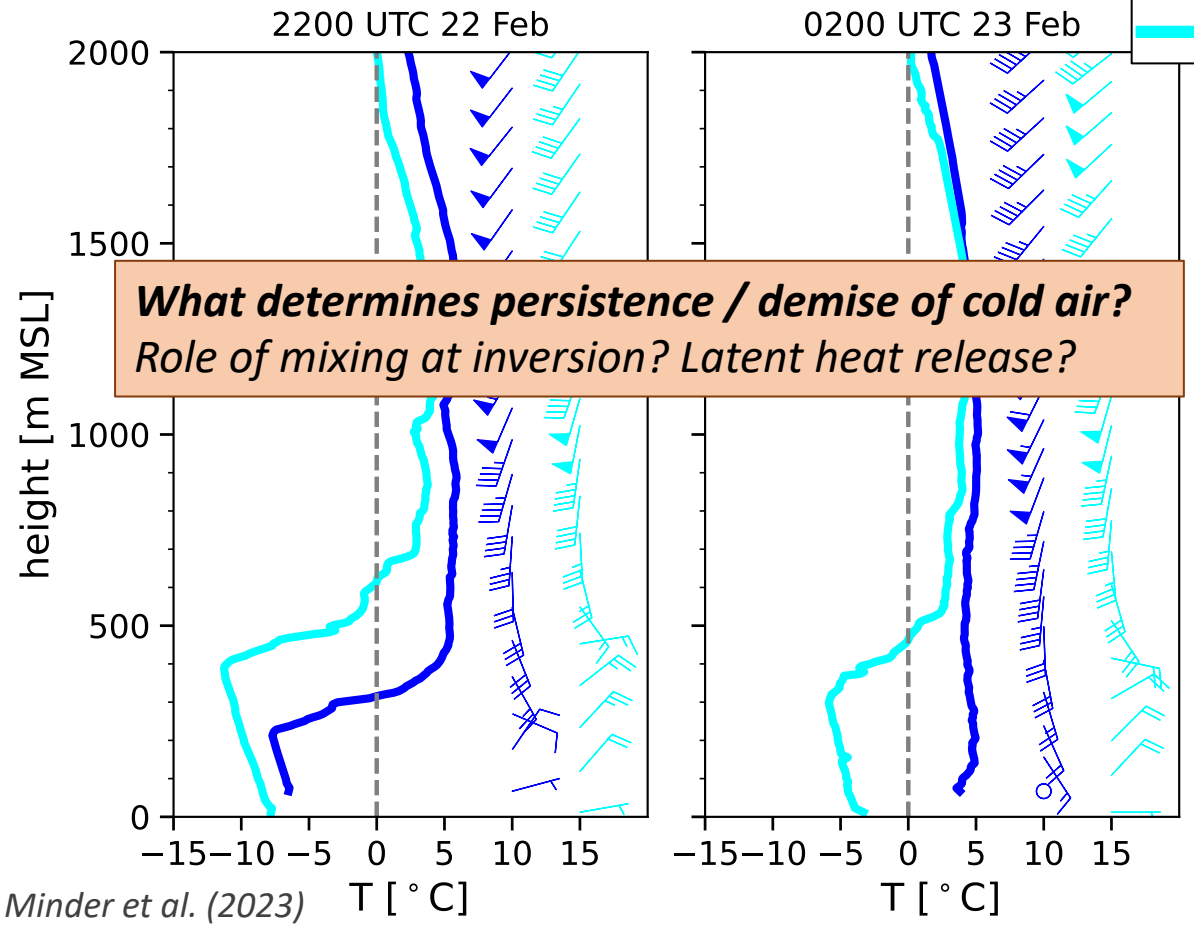
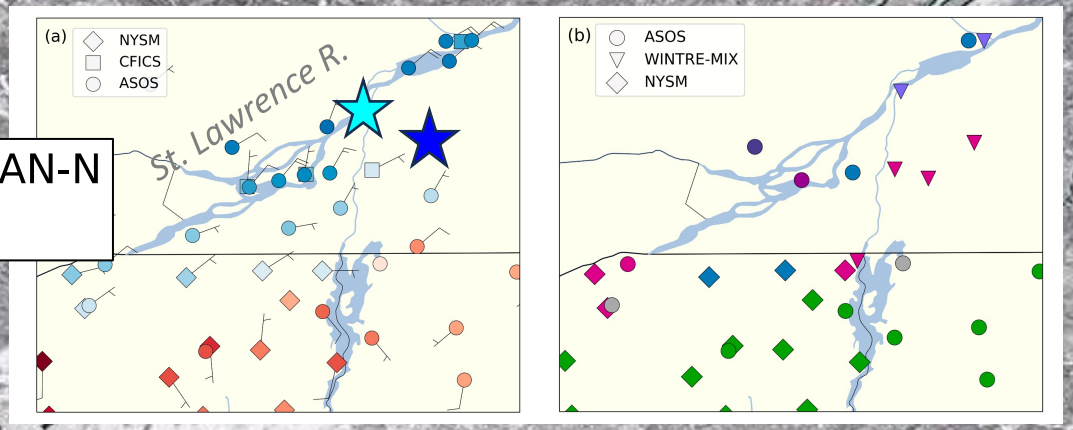
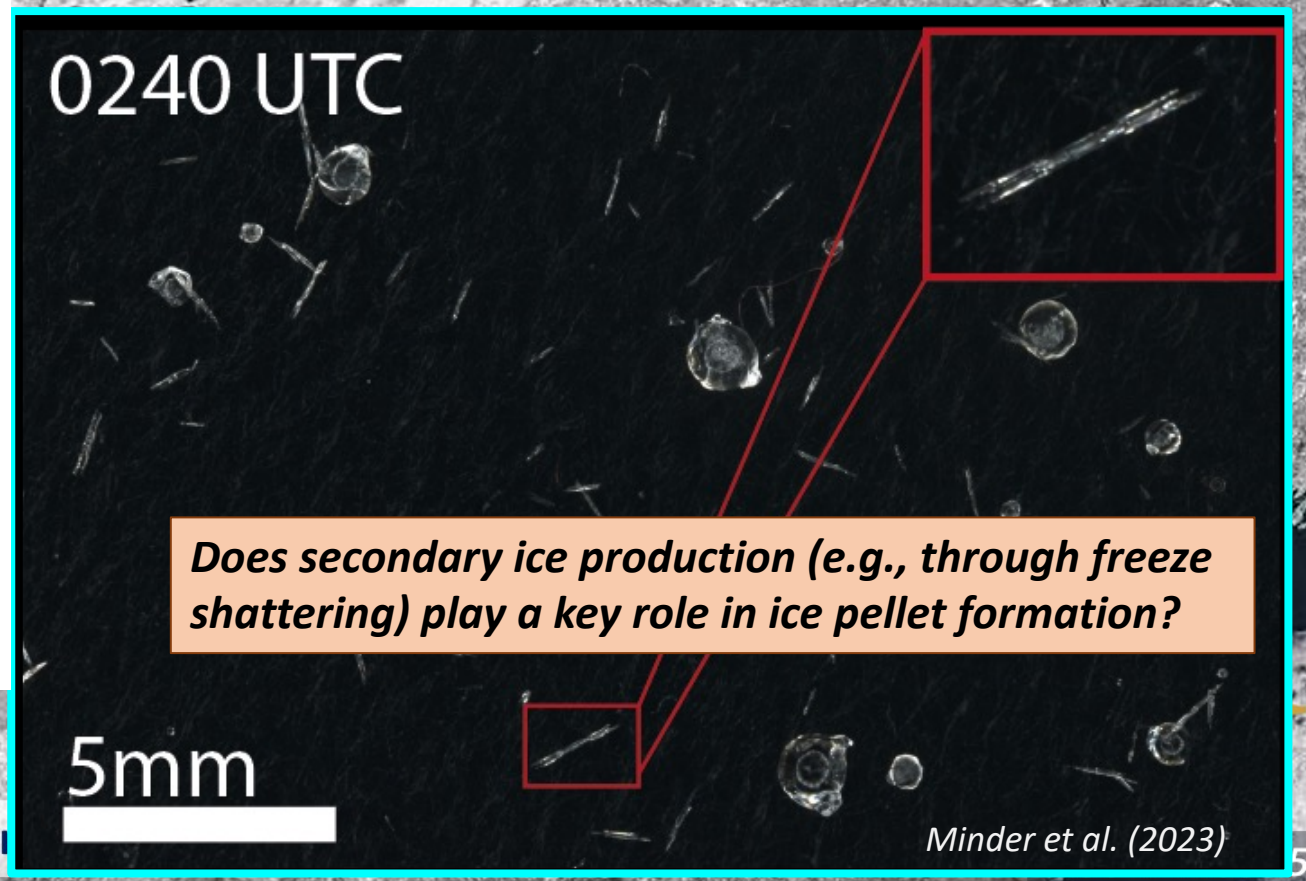
IOP5: *Soundings & hydrometeor obs.*



What determines persistence / demise of cold air?
Role of mixing at inversion? Latent heat release?

Minder et al. (2023)





Does secondary ice production (e.g., through freeze shattering) play a key role in ice pellet formation?

Minder et al. (2023)

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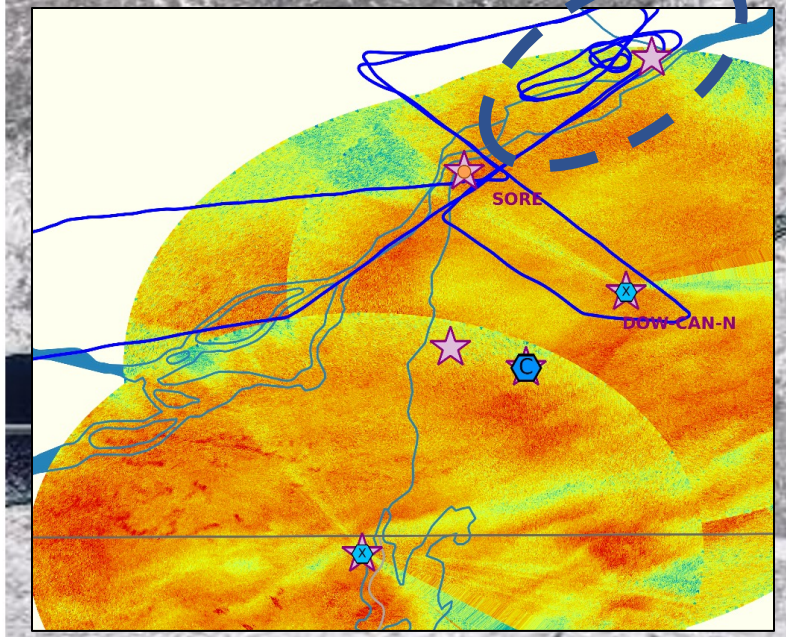
Observations:
Research aircraft

Data from missed approach at Trois-Rivieres



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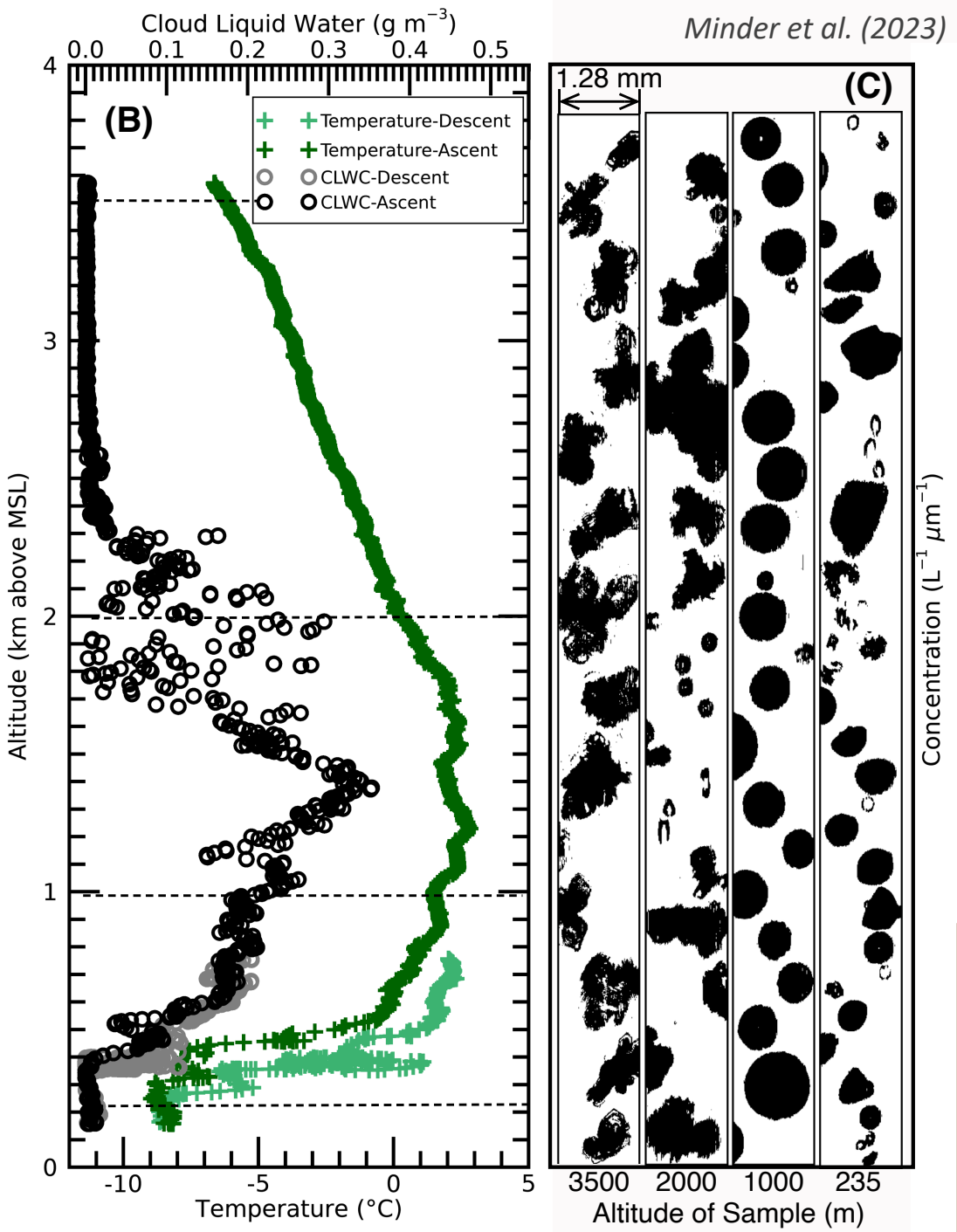
Minder et al. (2023)



What is the mechanism for ice pellet freezing?

What determines persistence / demise of surface cold air?

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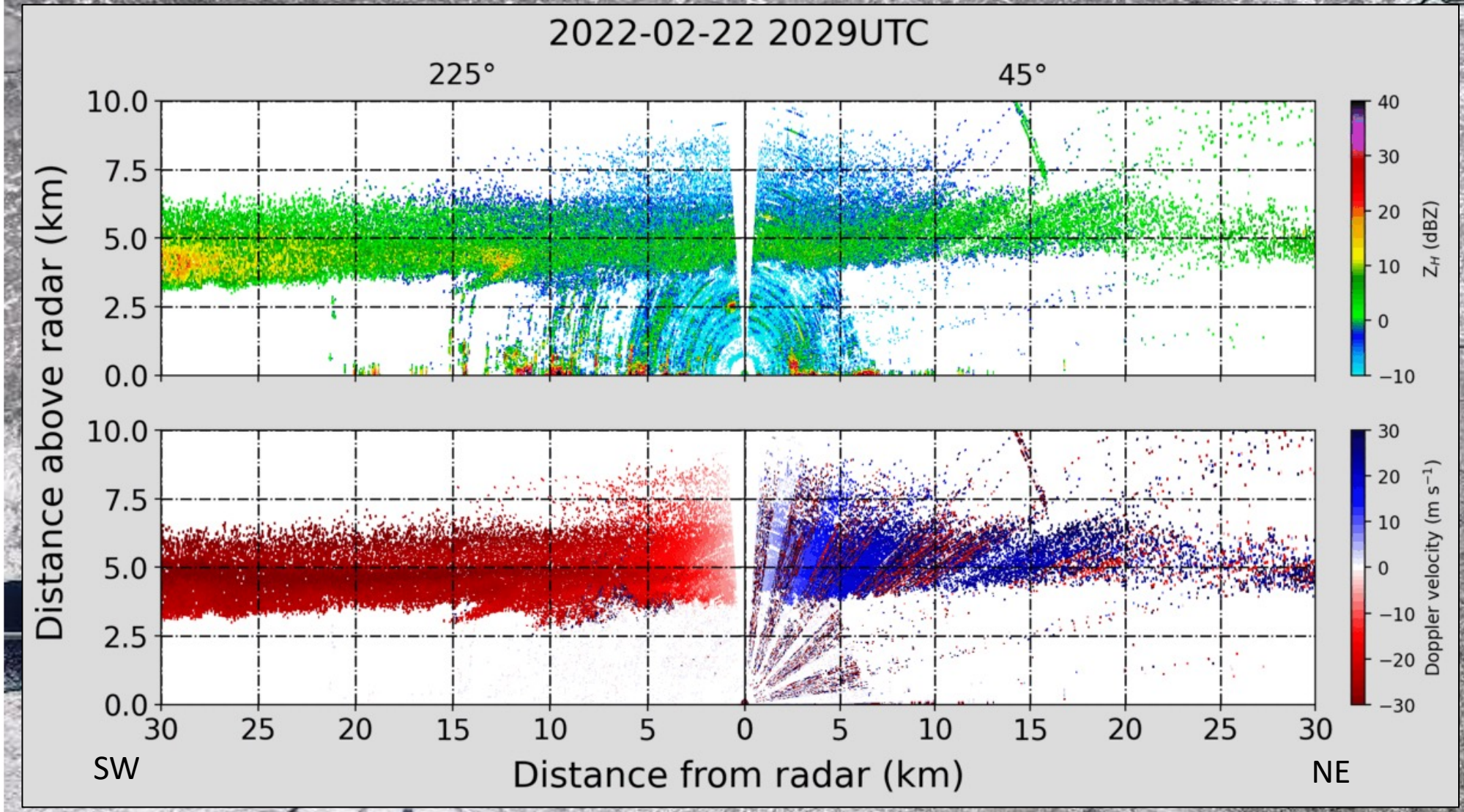
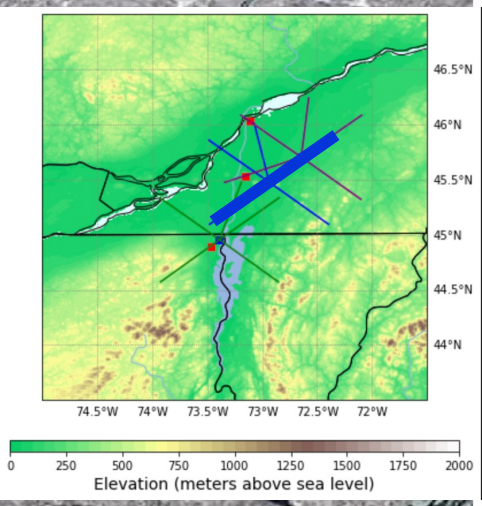
IOP5: *COW radar – along-valley RHIs*





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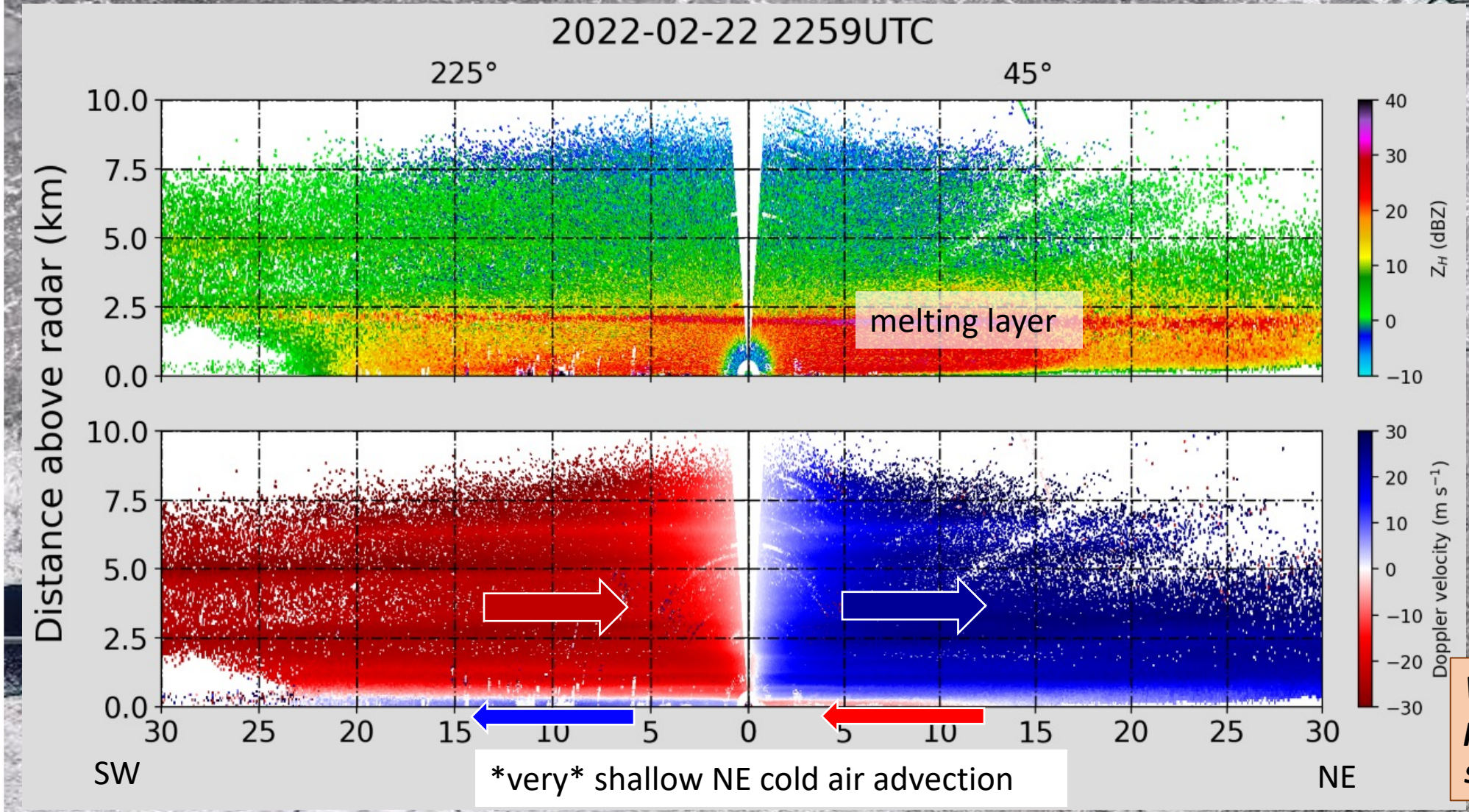
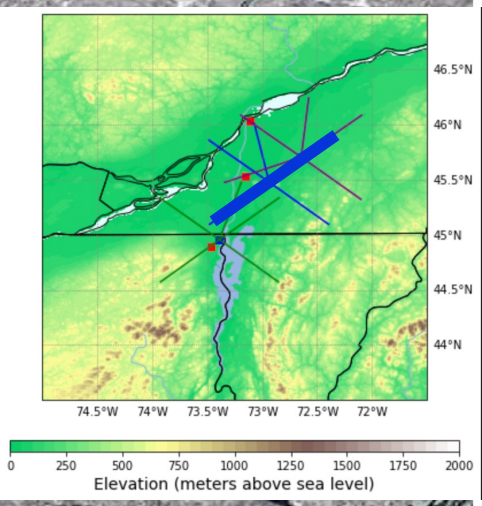
IOP5: *COW radar – along-valley RHIs*





What determines persistence / demise of surface cold air?

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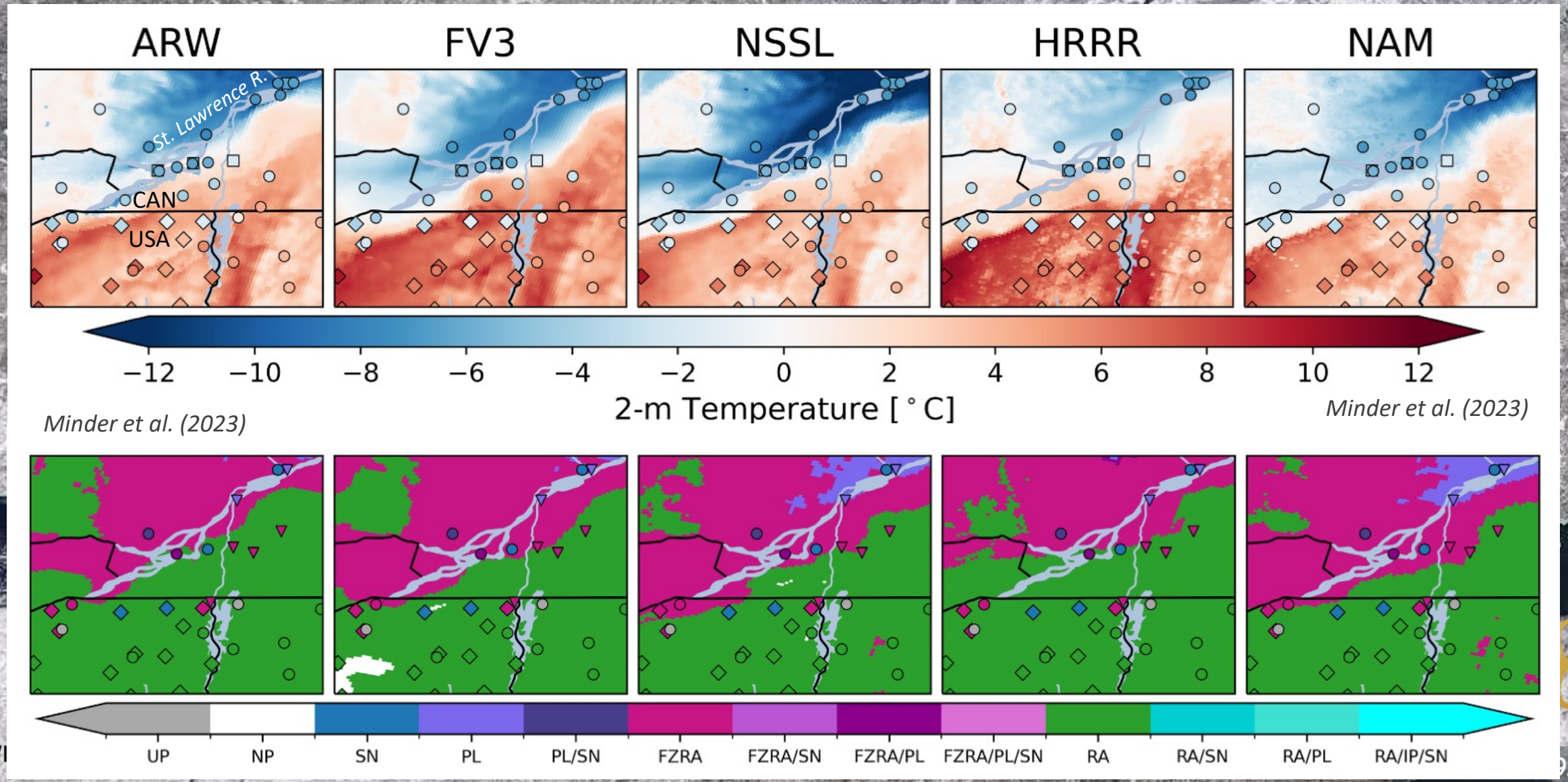
IOP5: ***High-res. Model evaluation***

0000 UTC 23 February 2022

Sources of temperature and p-type biases in the St. Lawrence Valley?
Inadequate vertical resolution? Biases in PBL? Biases in microphysics?
Dependence on synoptic regime?



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Results:

Ongoing work

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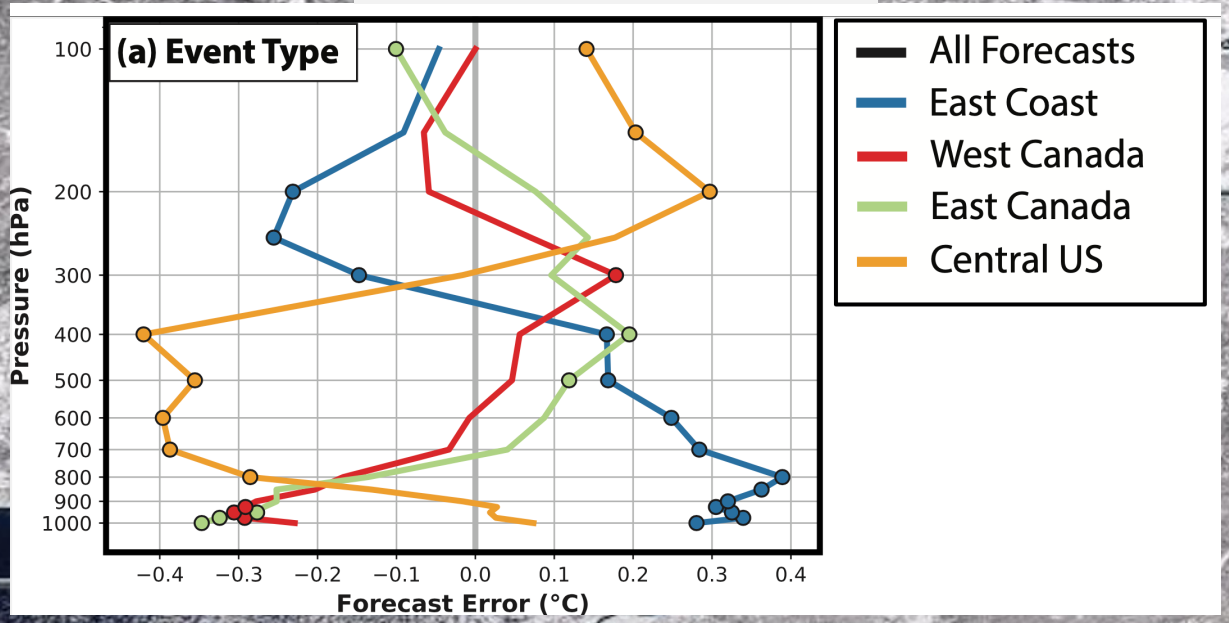
Synoptic-scale controls on p-type predictability

Andrew Winters

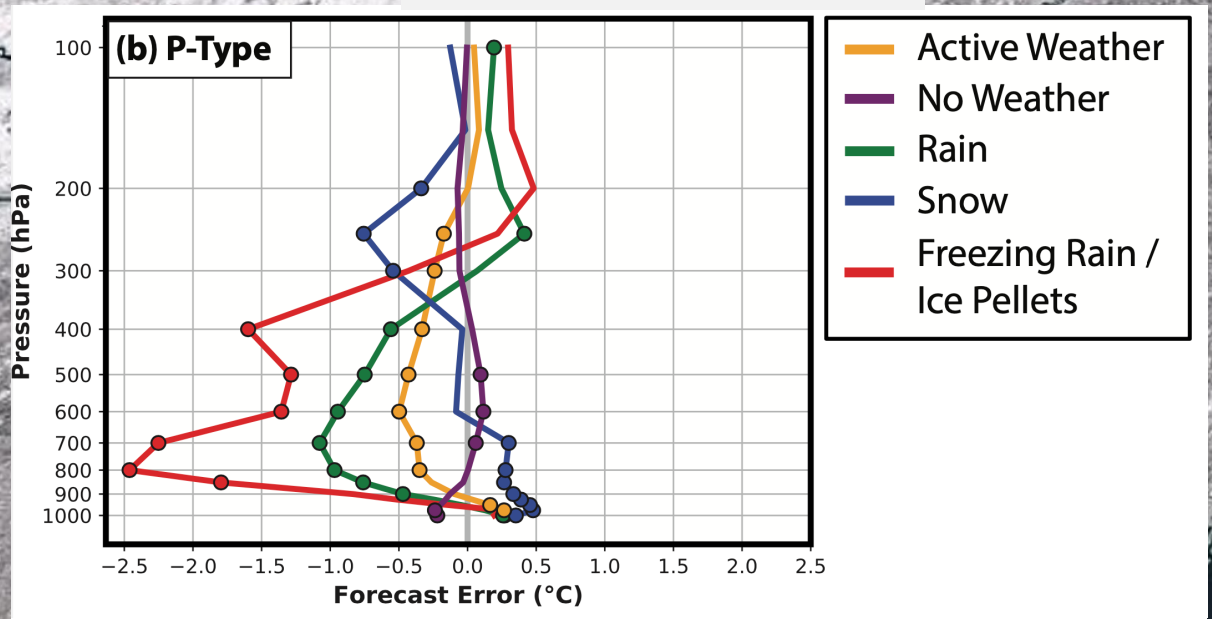
University of Colorado Boulder

Mean 120-h GEFSv12 reforecast errors

… by cyclone track



… by observed p-type



Near-surface temperatures are biased warm during East Coast events relative to West Canada and East Canada events

Lower-tropospheric temperatures are biased cold, and **near-surface temperatures are biased warm** during periods of rain freezing rain, and ice pellets relative to periods of other weather types

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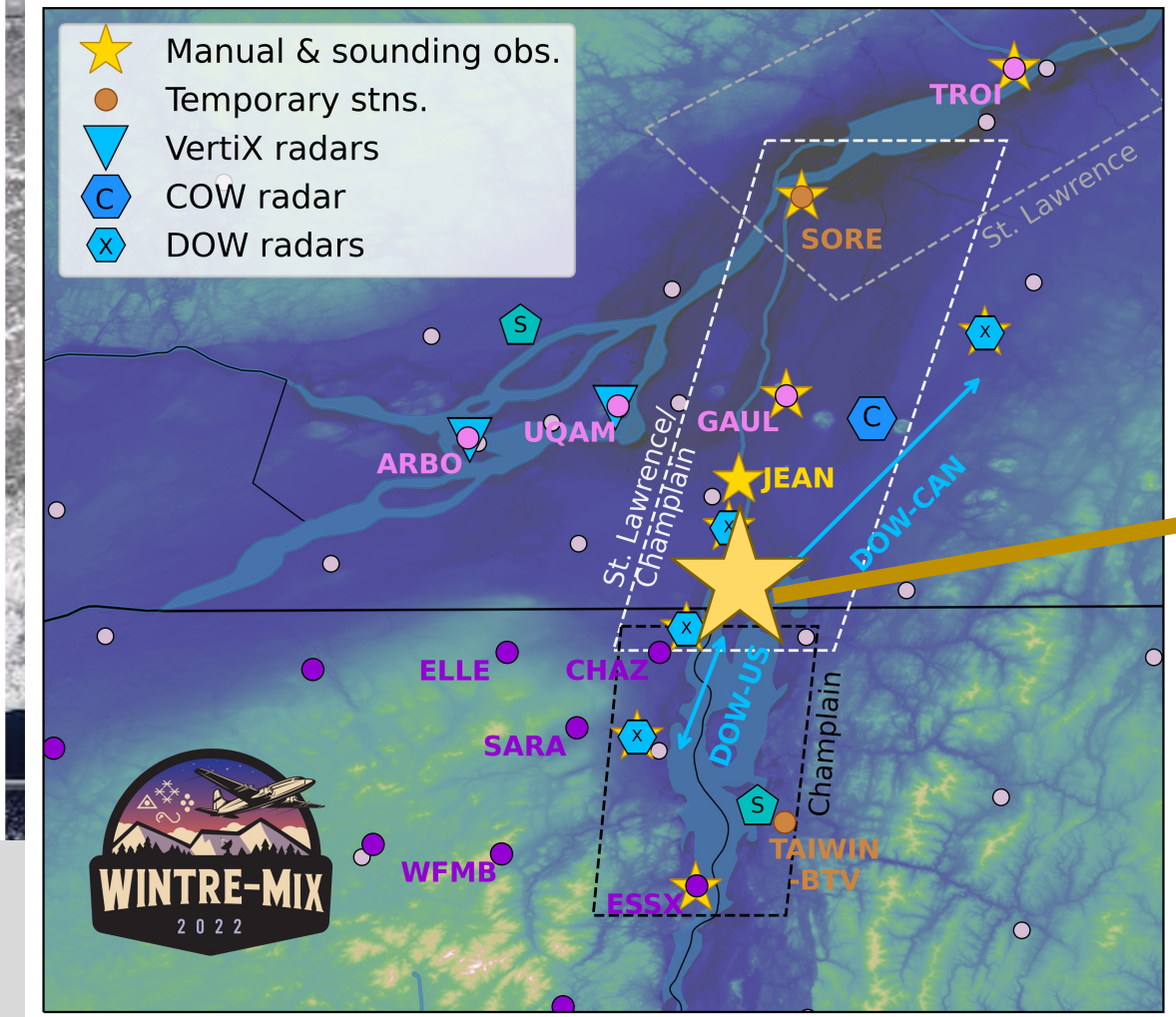
Frontal structures over the St. Lawrence River Valley

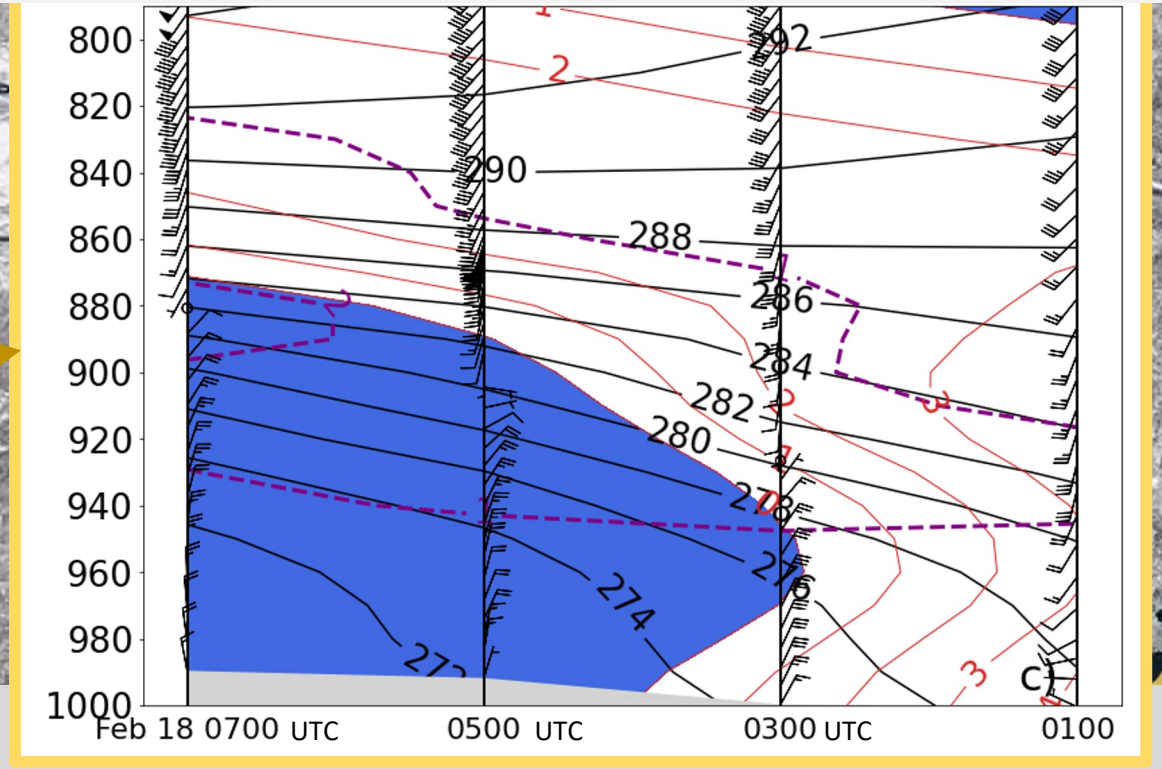
Juliann Wray

John Gyakum

McGill UNIVERSITY



Frontal evolution from soundings at DOW-CAN site



IOP 4 Vertical Cross-Section with Time (UTC):
θ (K, black), winds (kt), T (°C, blue shading < 0, red contours > 0), PV (PVU, purple dashed)

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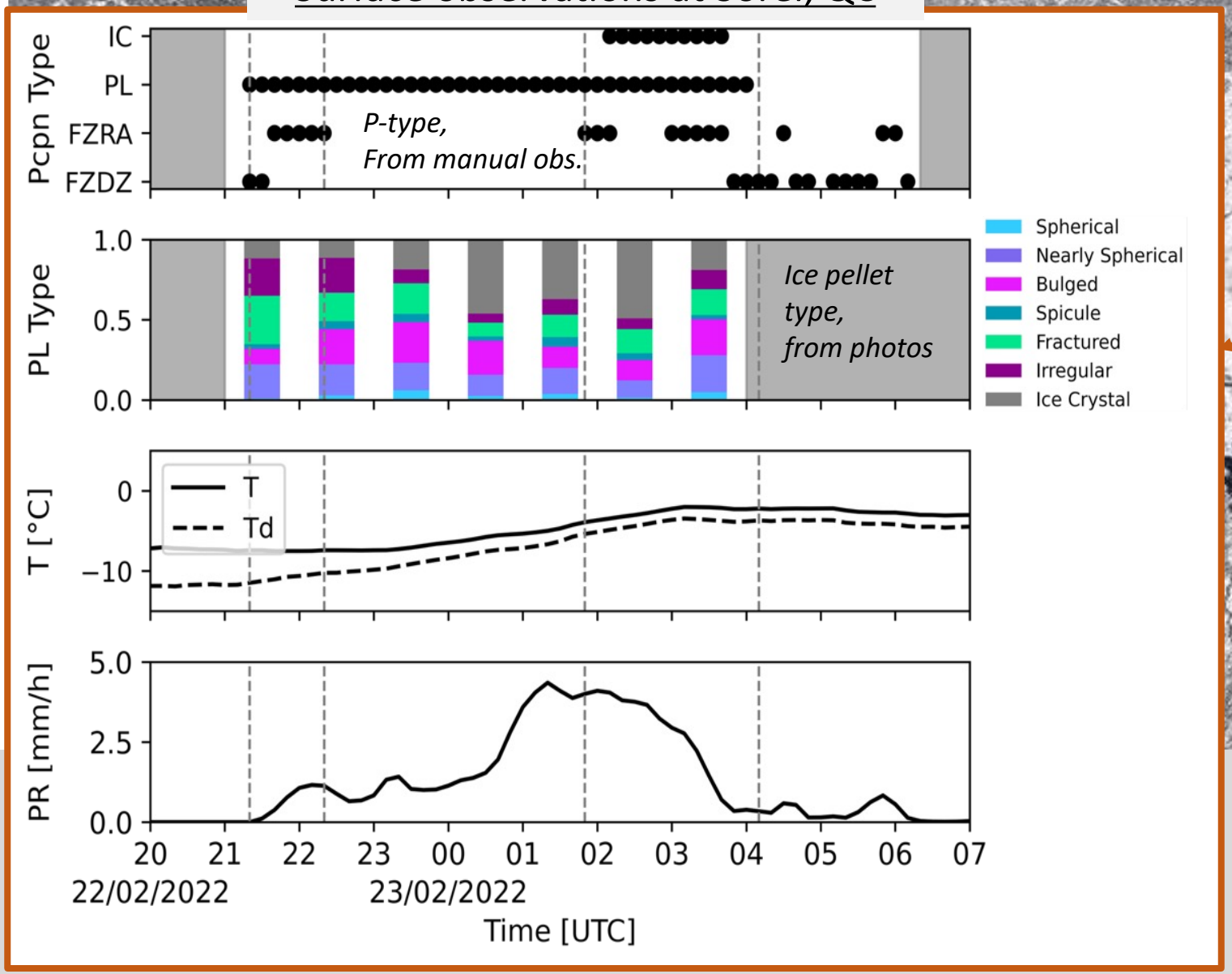
Microphysics of FZRA / Ice Pellet transitions



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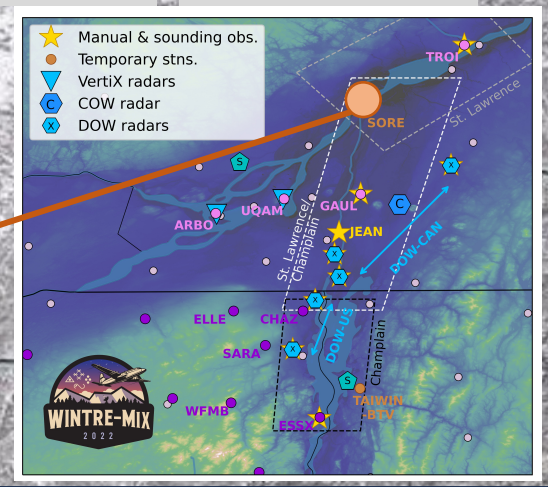

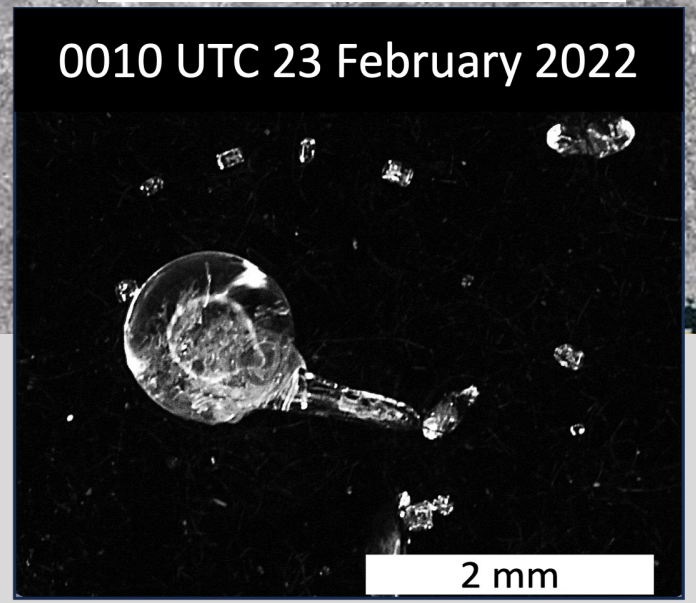

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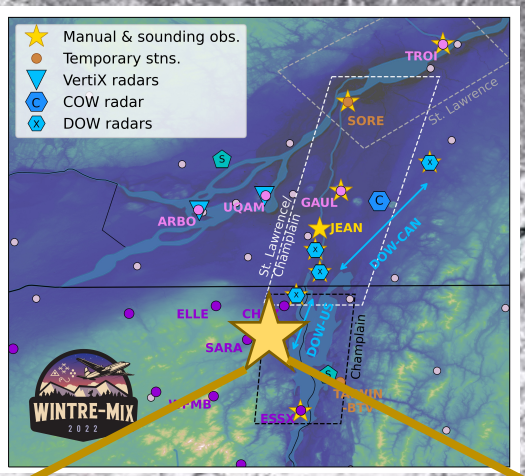
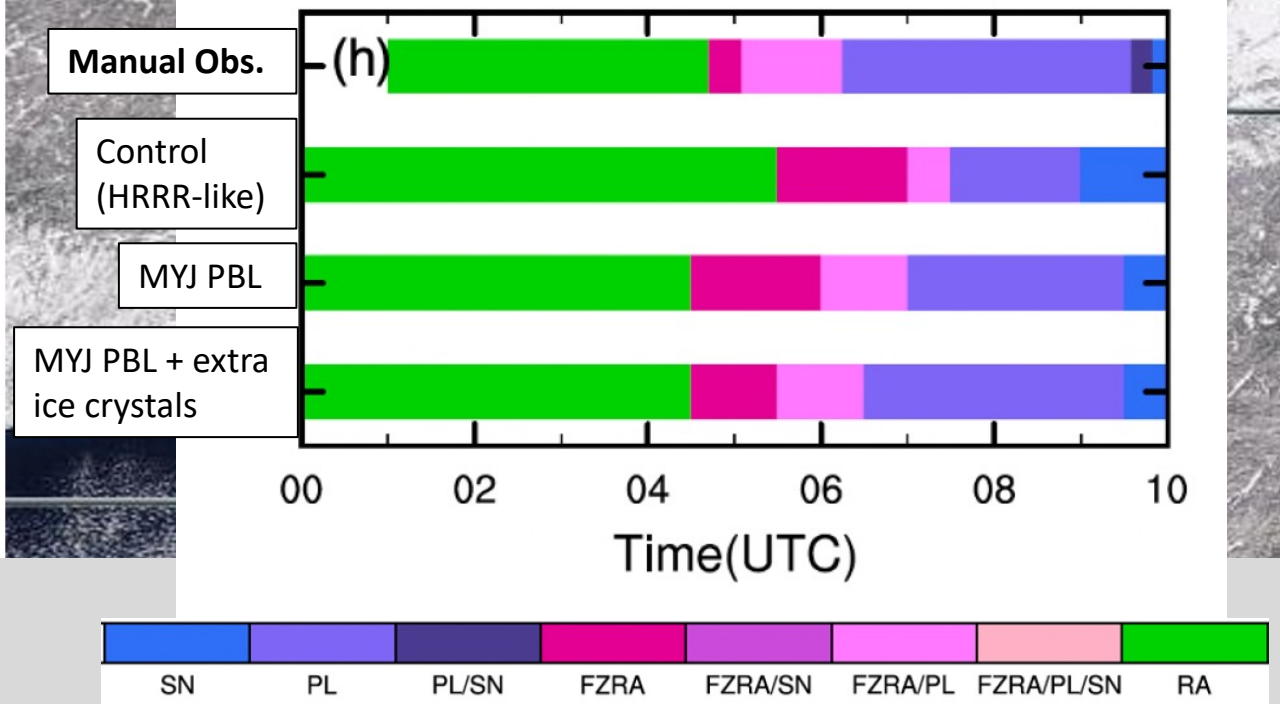
Simulating FZRA / Ice Pellet transitions

Bin Han

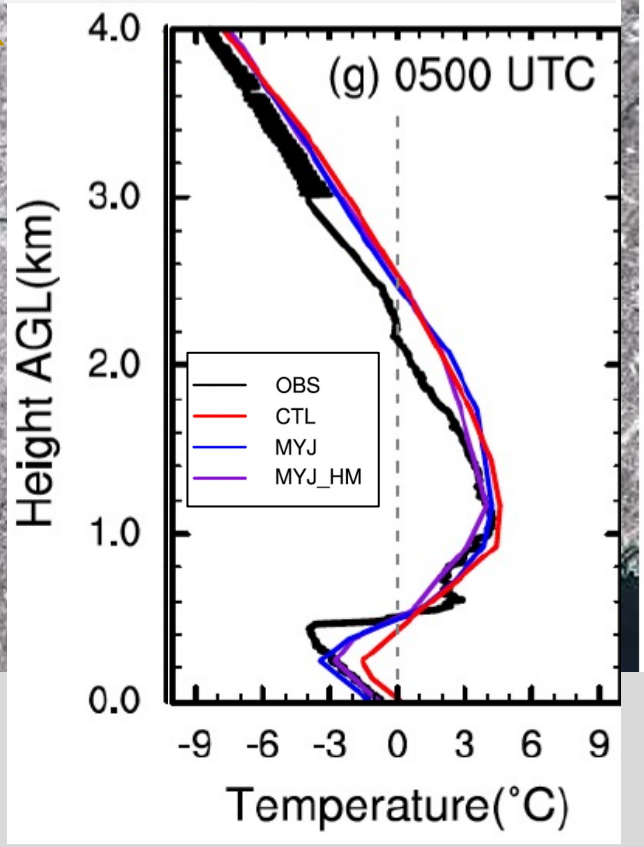
UNIVERSITY AT ALBANY
State University of New York



Observed and WRF-simulated p-type



Obs. & simulated temp. profile



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Airborne perspectives on p-type transitions

Eden Koval

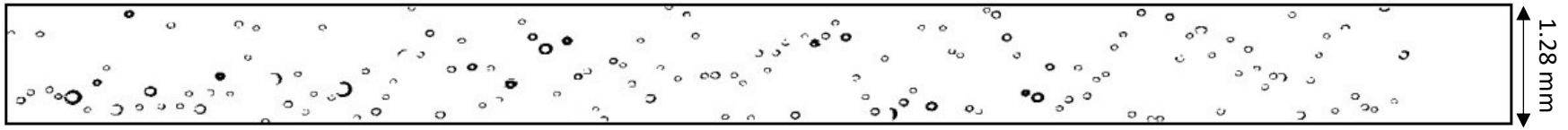
Jeffrey French

University of Wyoming

Select 2DS particle images during IOP 9

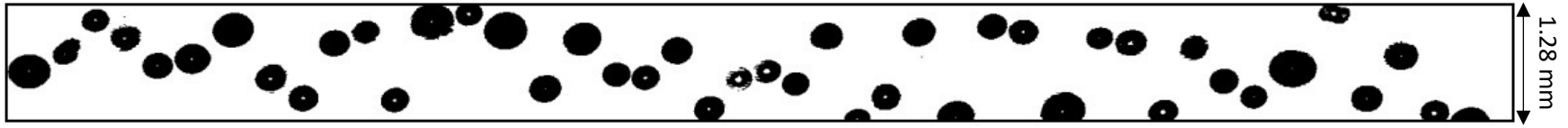
Small, supercooled liquid droplets near cloud top (despite cold temps)

4.6km -12°C



Supercooled drizzle drops (hazardous for aircraft icing!)

4.1km -10°C



Ice crystals (secondary ice production?)

3.6km -4.4°C

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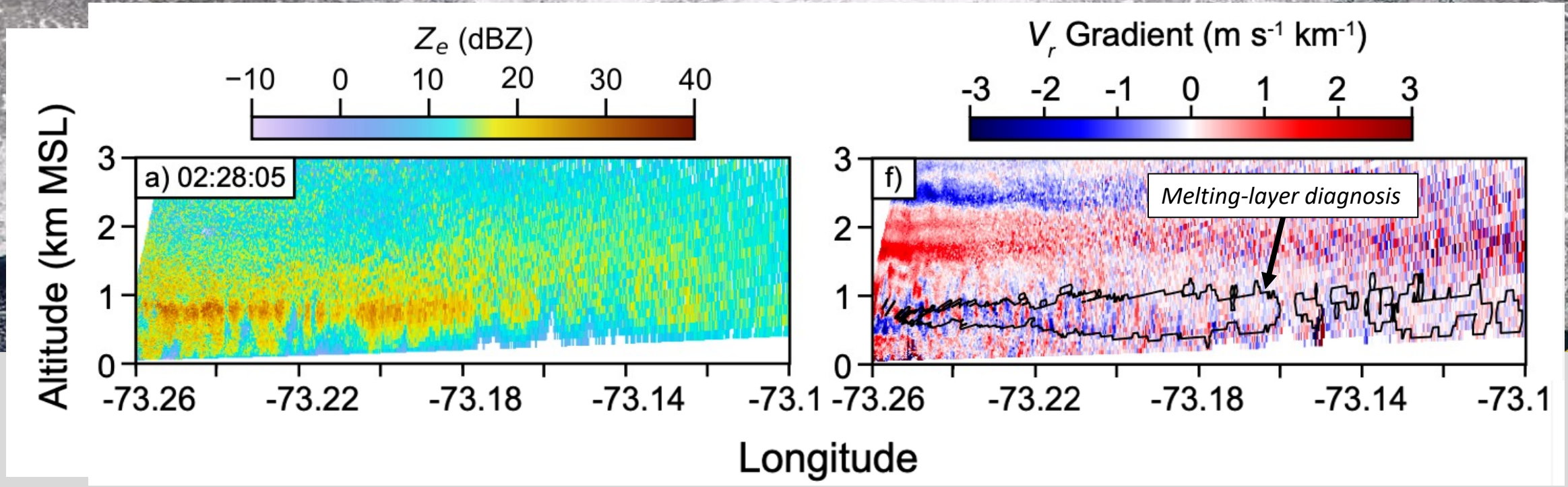
The role of turbulence in melting layers

Troy Zaremba

UNIVERSITY AT ALBANY
State University of New York



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Summary

- WINTRE-MIX is studying the variability and predictability of precipitation type and amount under near-freezing surface conditions
  - Multi-faceted observations in northern NY and southern QC
  - Examining roles of synoptic & mesoscale dynamics, turbulent motions, microphysics
- Initial analysis shows
  - Importance of very shallow and persistent cold air in valleys
  - Potential role for ice crystals in ice pellet formation
  - Mesoscale NWP struggles in simulating low-level cold air and p-type in valley
- Data published to EOL archive, publicly available

Justin Minder
jminder@albany.edu

Minder, J. R., and Coauthors, 2023: P-type Processes and Predictability: The Winter Precipitation Type Research Multiscale Experiment (WINTRE-MIX). *Bull. Amer. Meteor. Soc.*, https://doi.org/10.1175/BAMS-D-22-0095.1.

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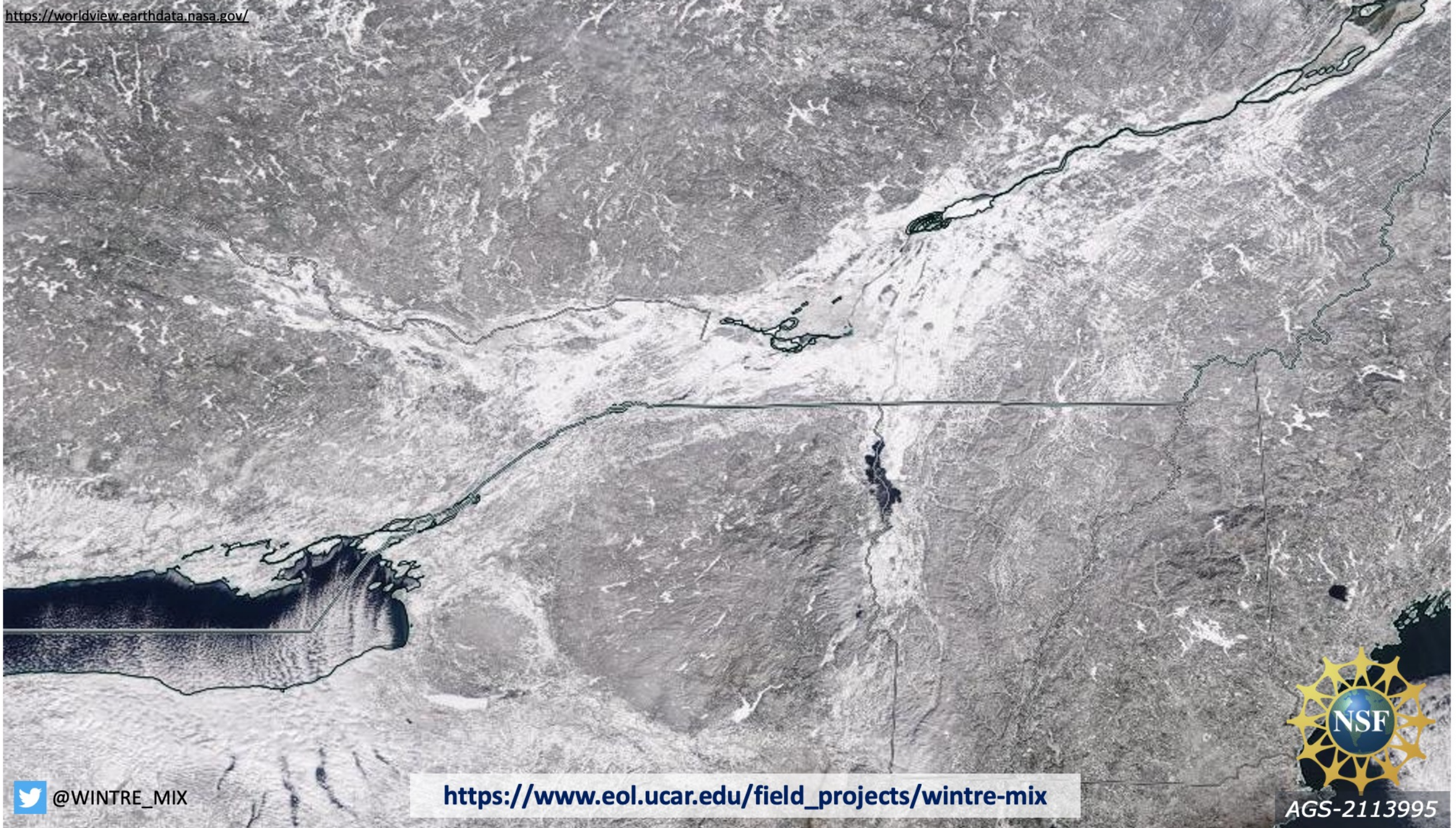
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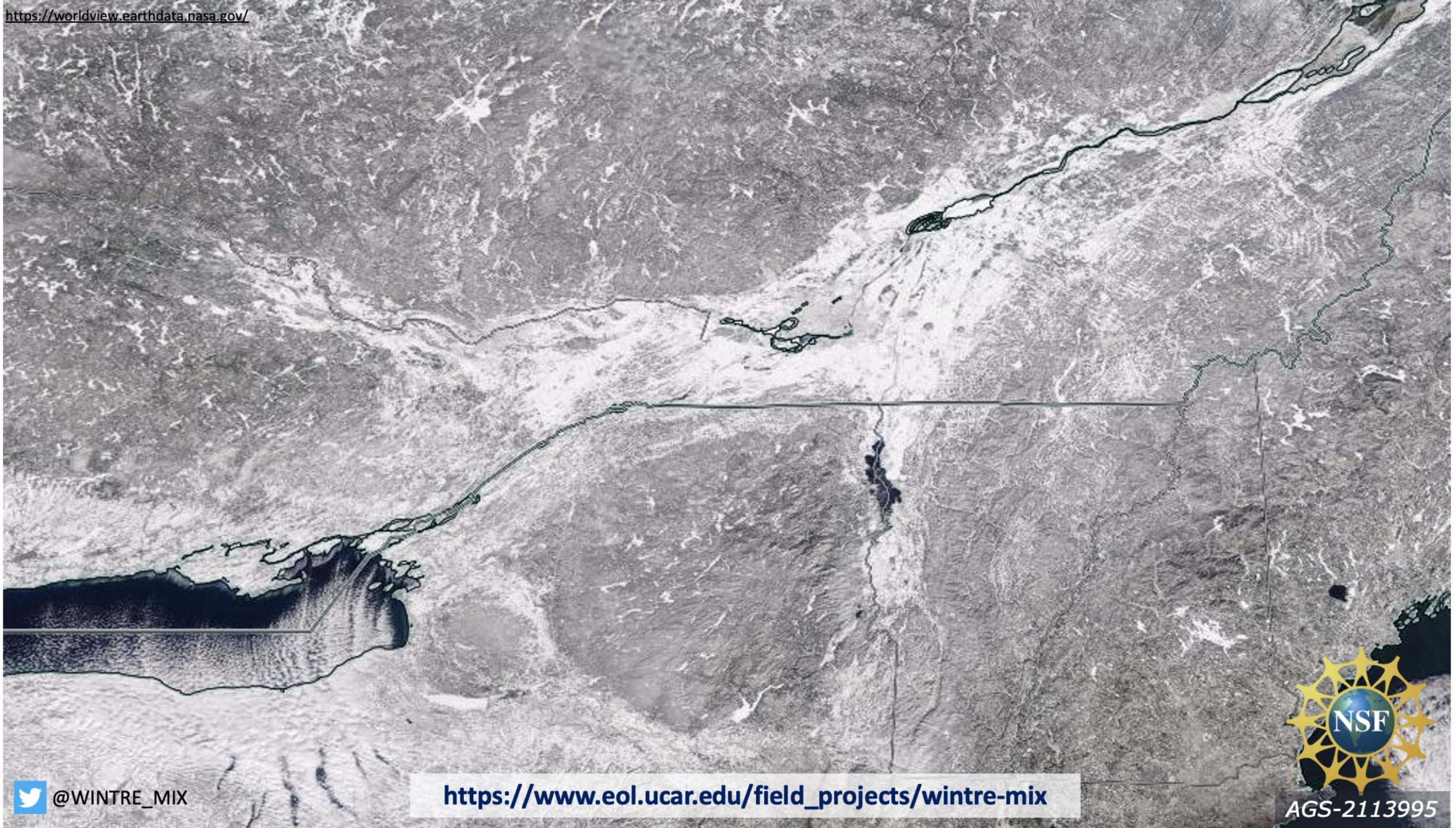
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Extra slides

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