Demonstrating GOES-Derived Lake Effect Snow QPE Product and Improvements for the Great Lakes Region

Alyssa Shih[1] and Mark Kulie[2]
[1]University of Illinois at Urbana-Champaign
[2]NOAA/NESDIS/STAR

21st Annual Symposium on Operational Environmental Satellite Systems
American Meteorological Society Annual Meeting
14 January 2025

Contact Info: ashih4@illinois.edu, alyssa.shih@noaa.gov, alyssa.shih18@gmail.com, mark.kulie@noaa.gov



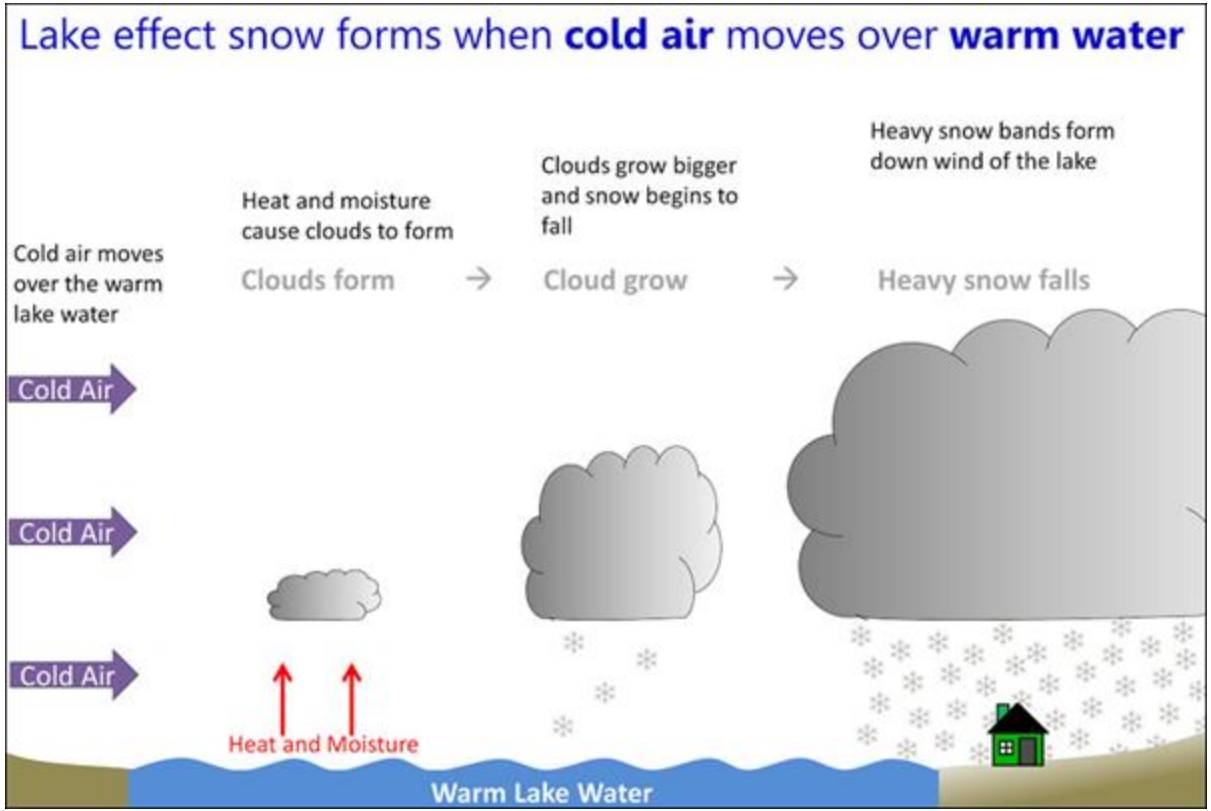
1 Background

2 Impacts

3 Improvements

4 Future Work

What is Lake Effect Snow (LES)?

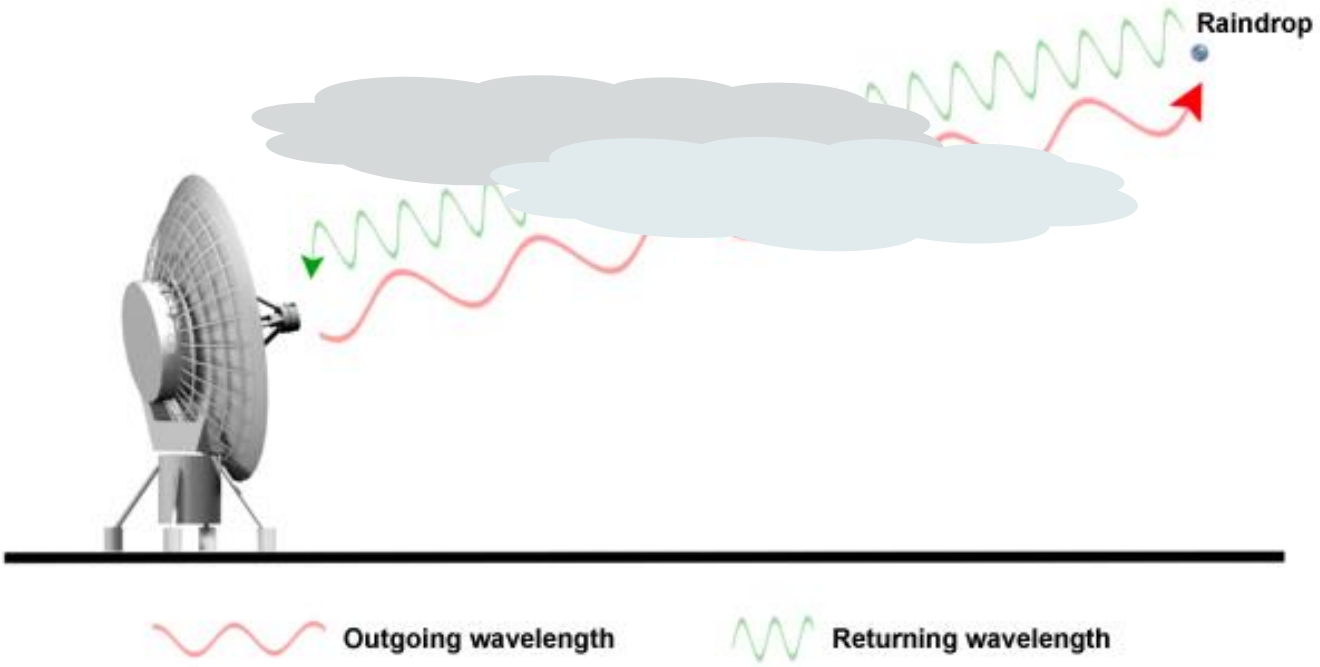


Who experiences LES?



Source: University of Michigan/GLISA

How does weather radar work?



Source: NCAR

Introducing: CLAVR-x

Clouds from AVHRR Extended Systems

Case Studies and Criteria

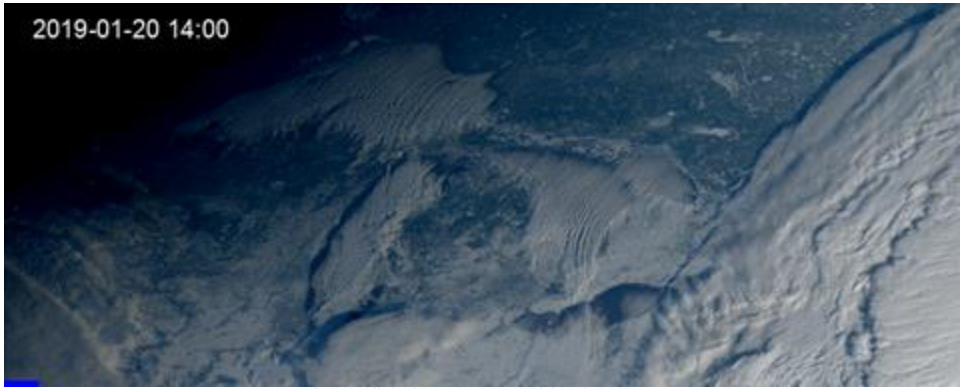
Area of focus: Upper Peninsula (UP) of Michigan

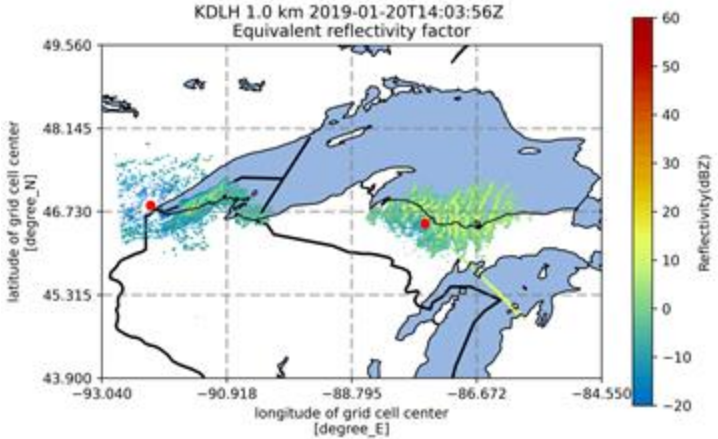
Criteria:

- Organized LES bands with measurable snowfall
- Little to no cirrus contamination
- Impacting the Western UP as well as the Eastern UP

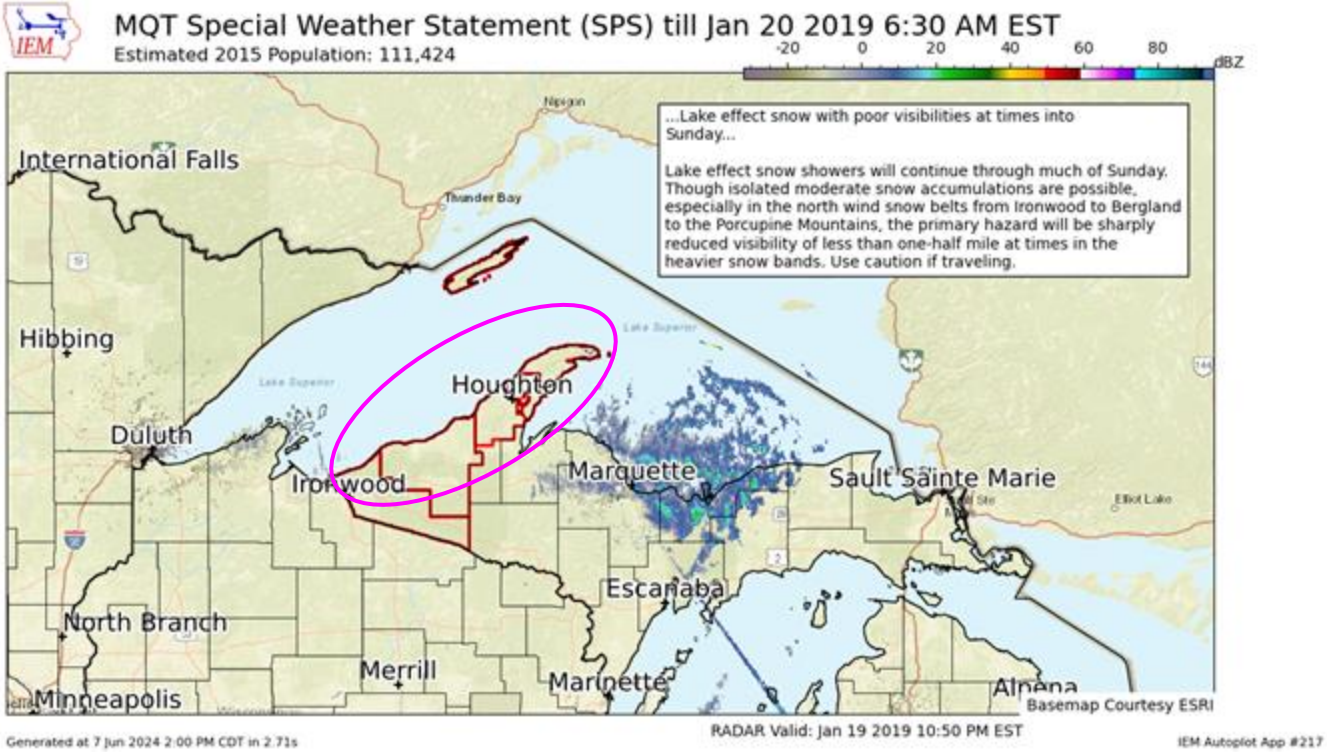


Case Study 1: 2019-01-20

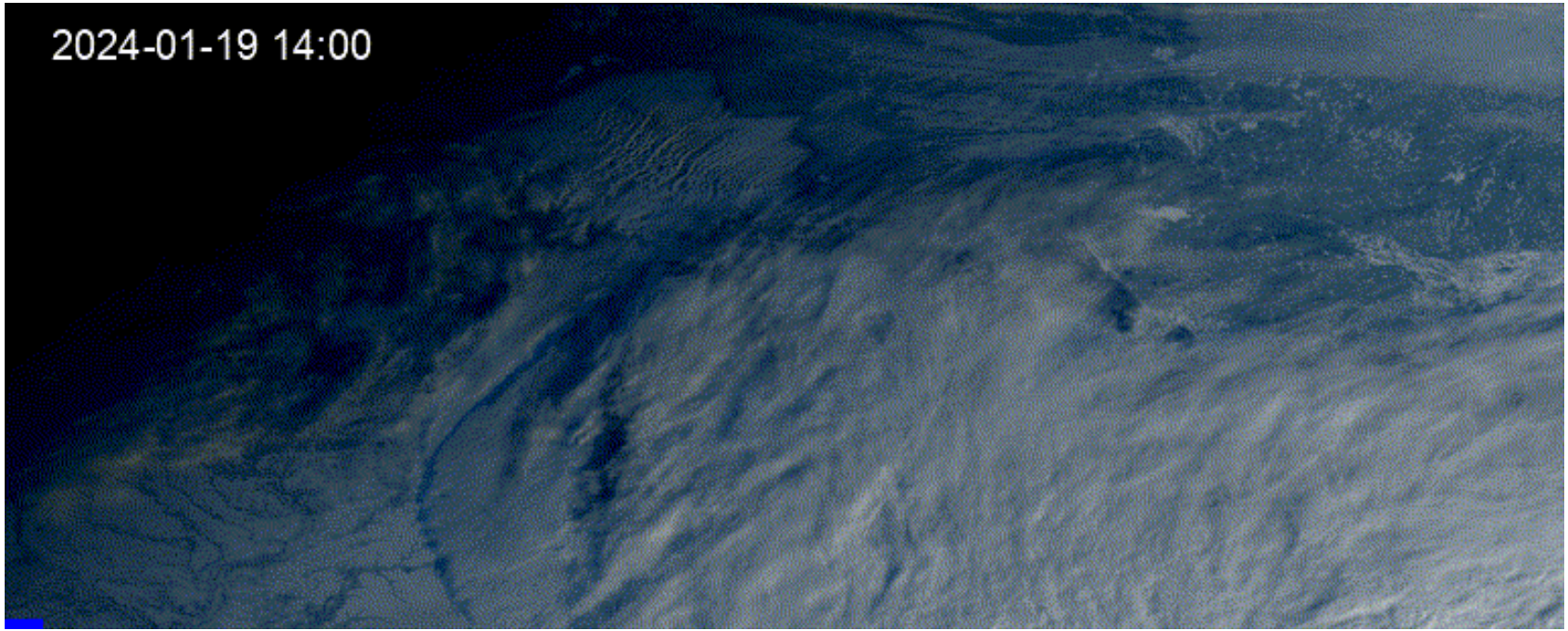




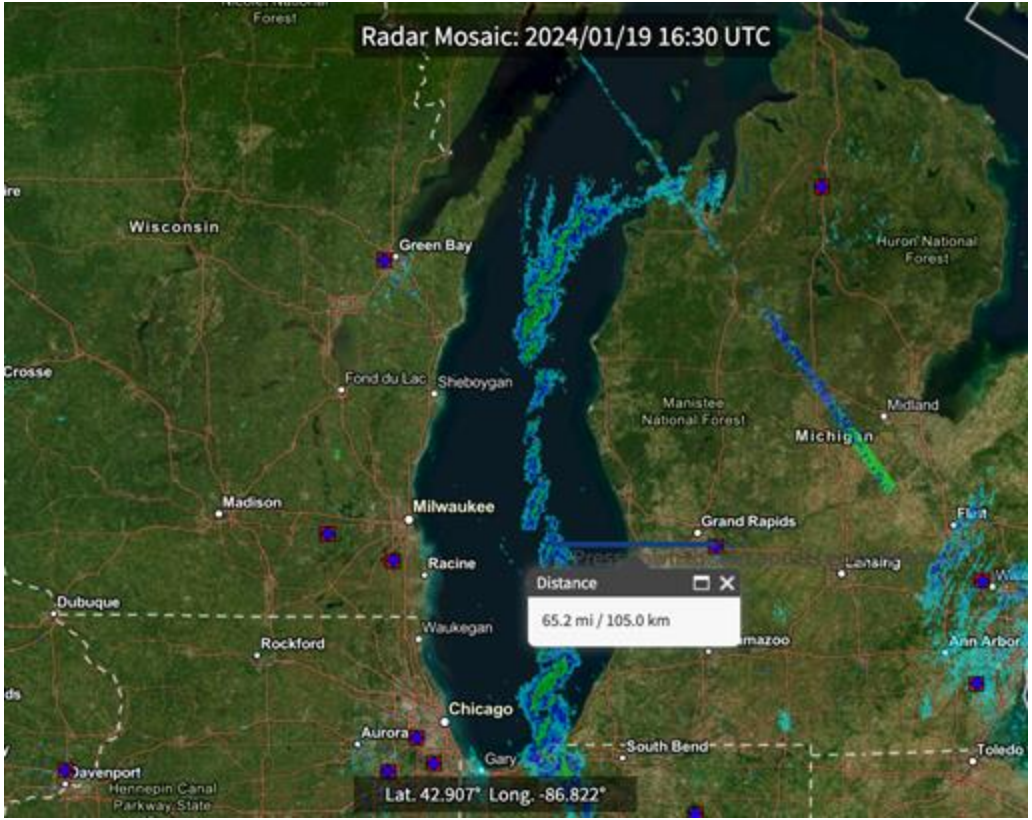
Case Study 1: 2019-01-20



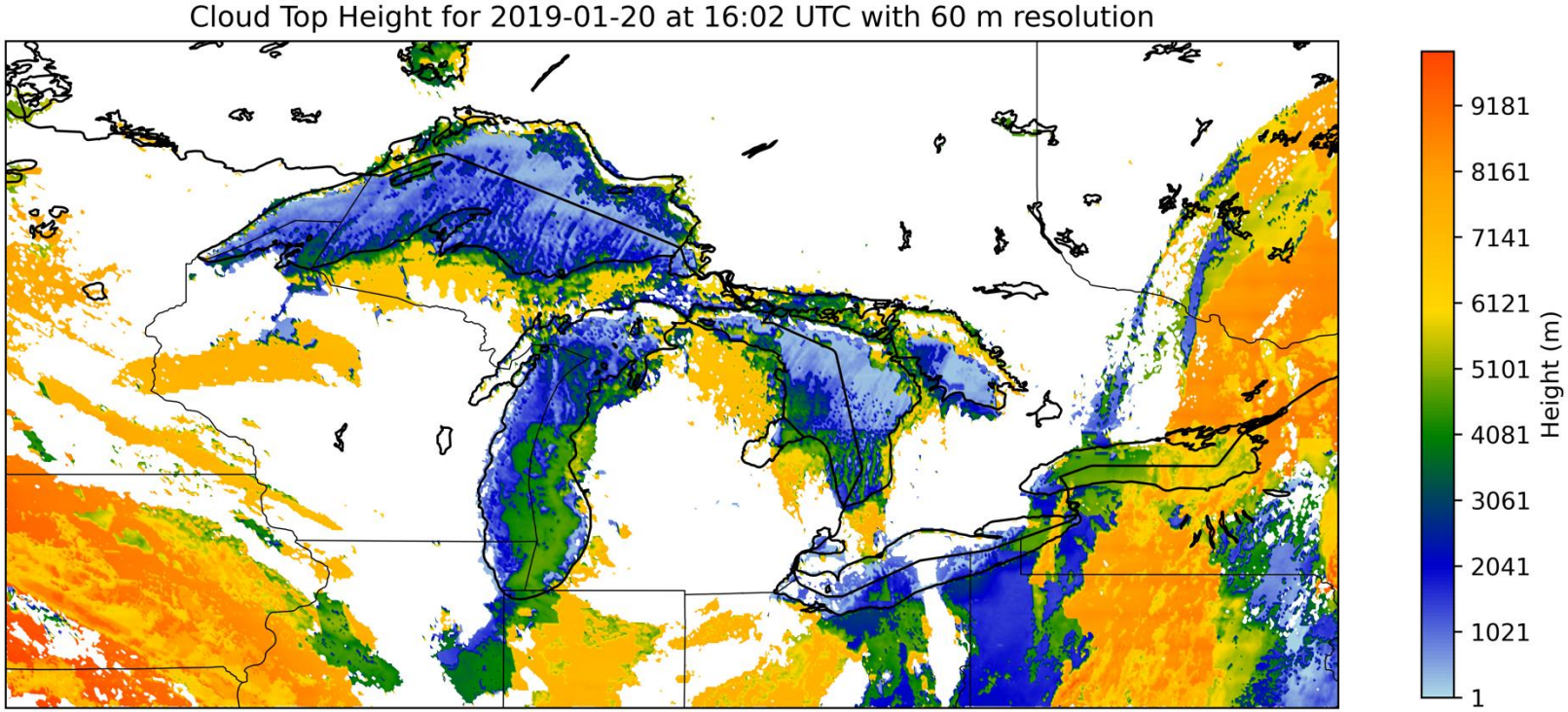
Case Study 4: 2024-01-19



Case Study 4: 2024-01-19

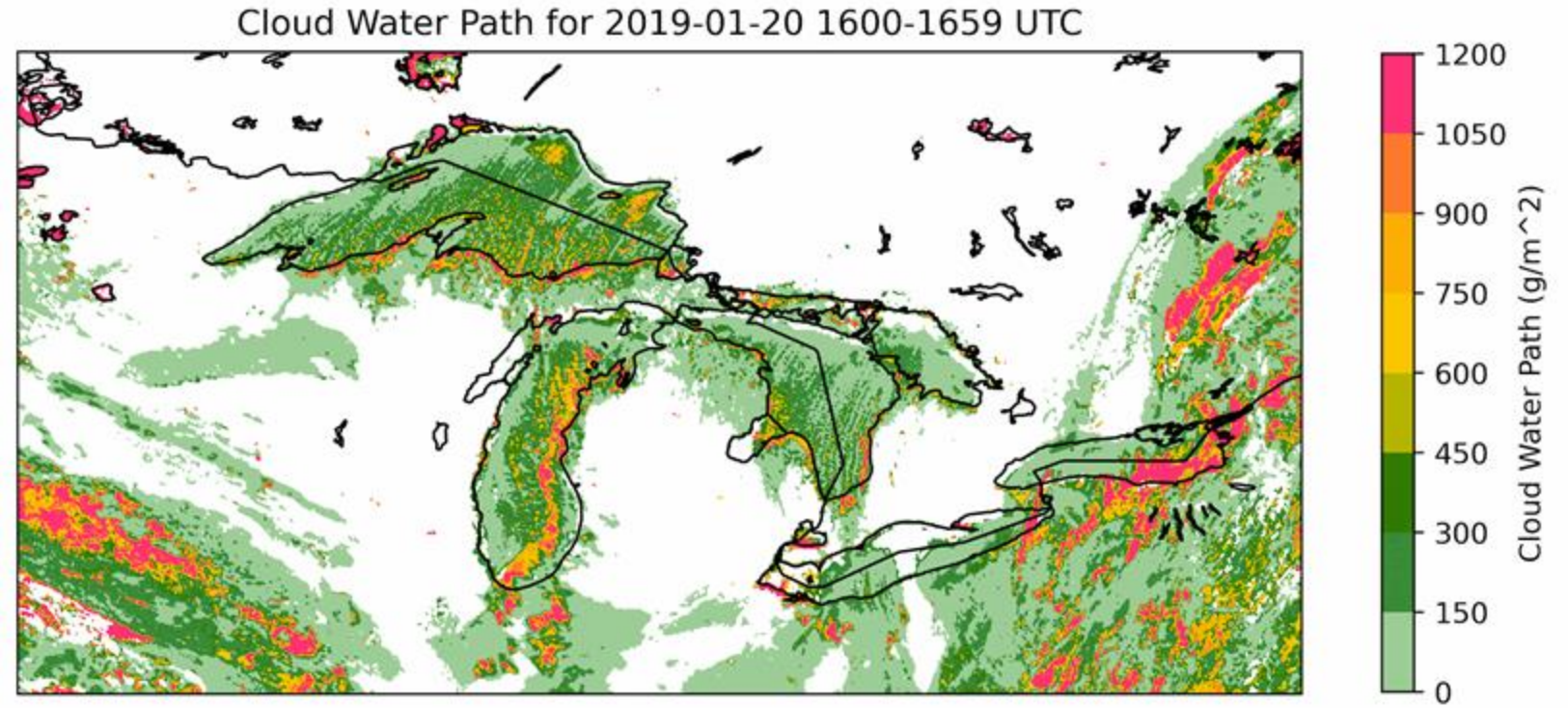


How CLAVR-x can help

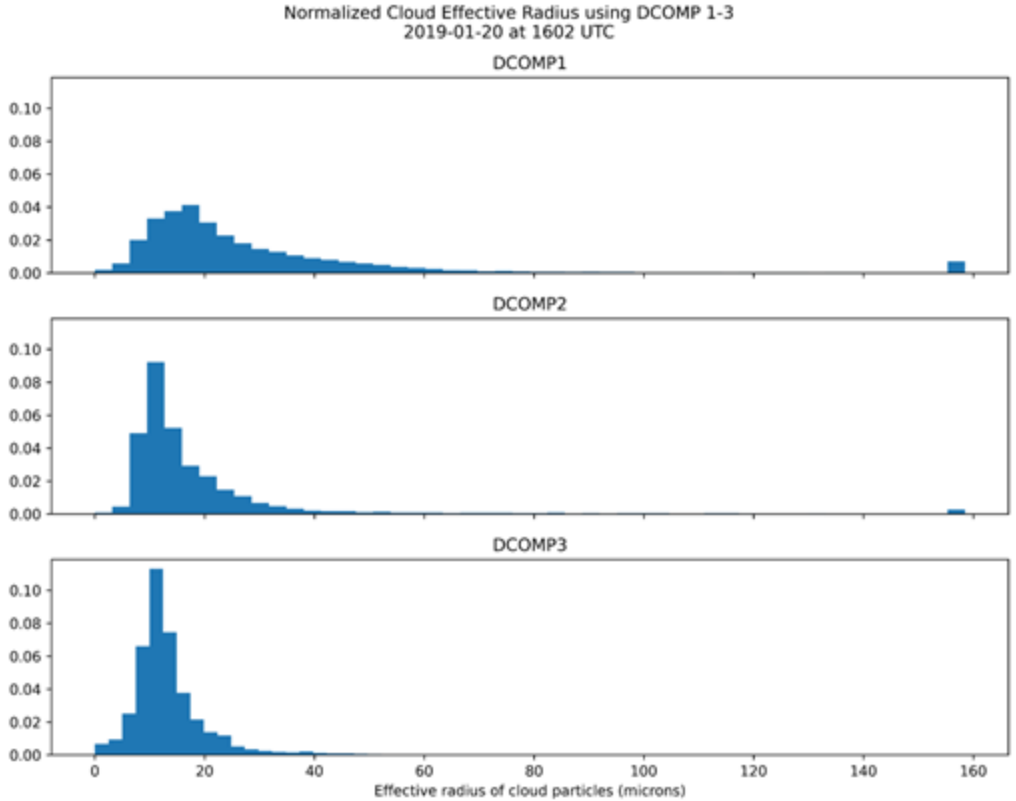


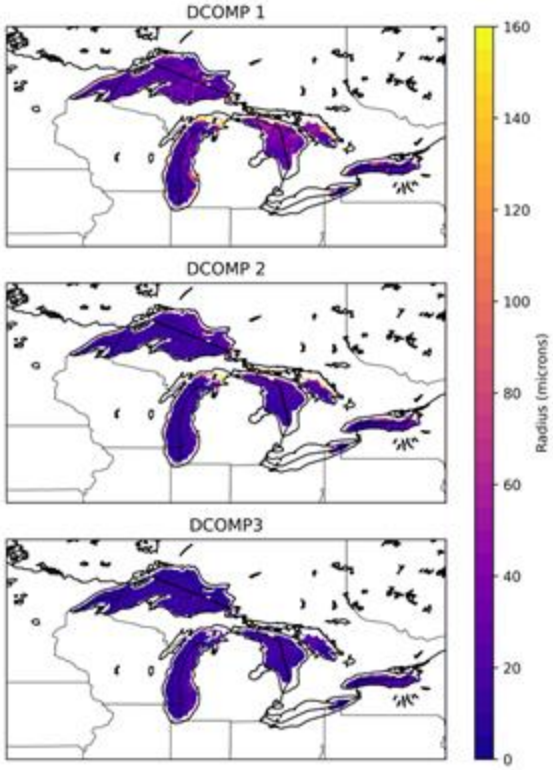
Cloud Water Path (CWP)

Daytime Cloud Optics and Microphysical Properties Algorithm (DCOMP)

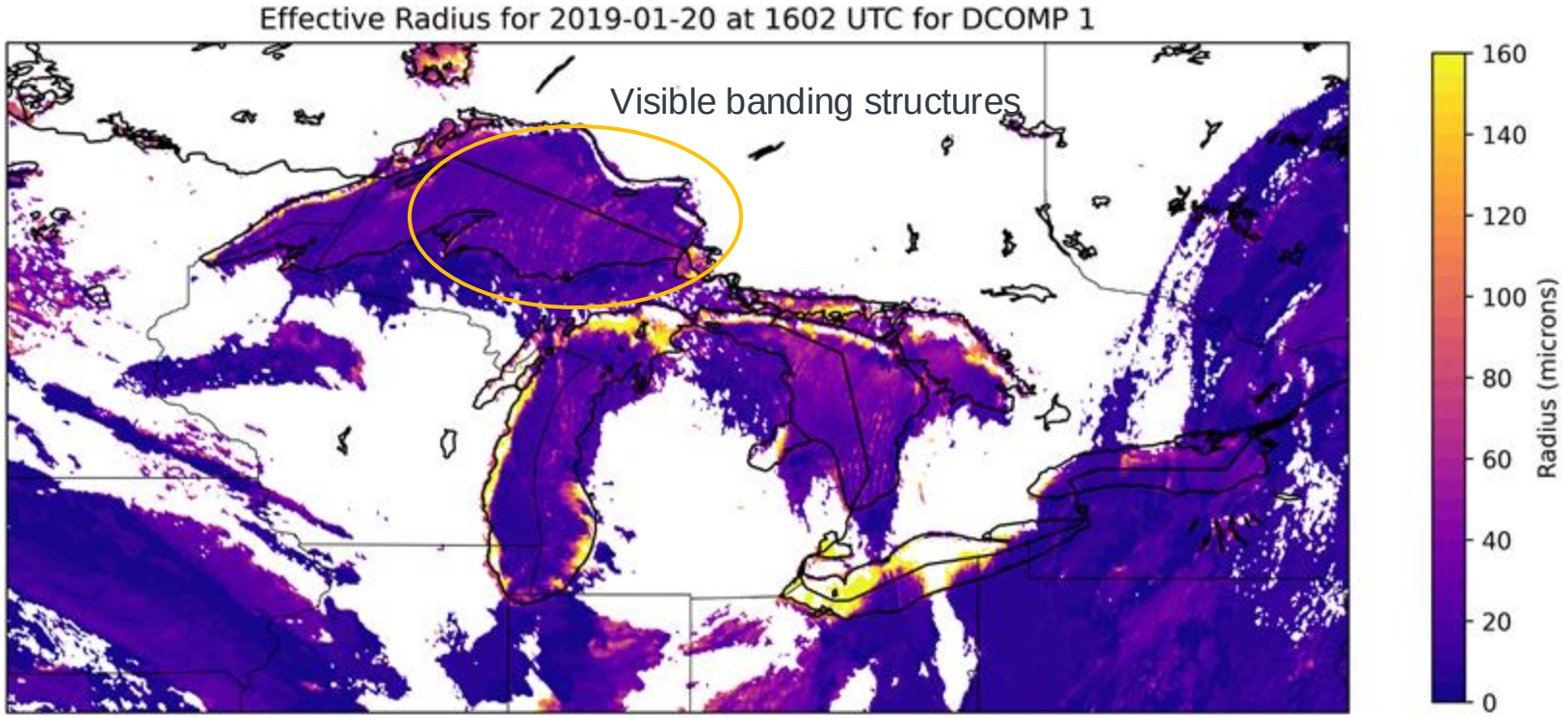


Cloud Effective Radius (Reff)

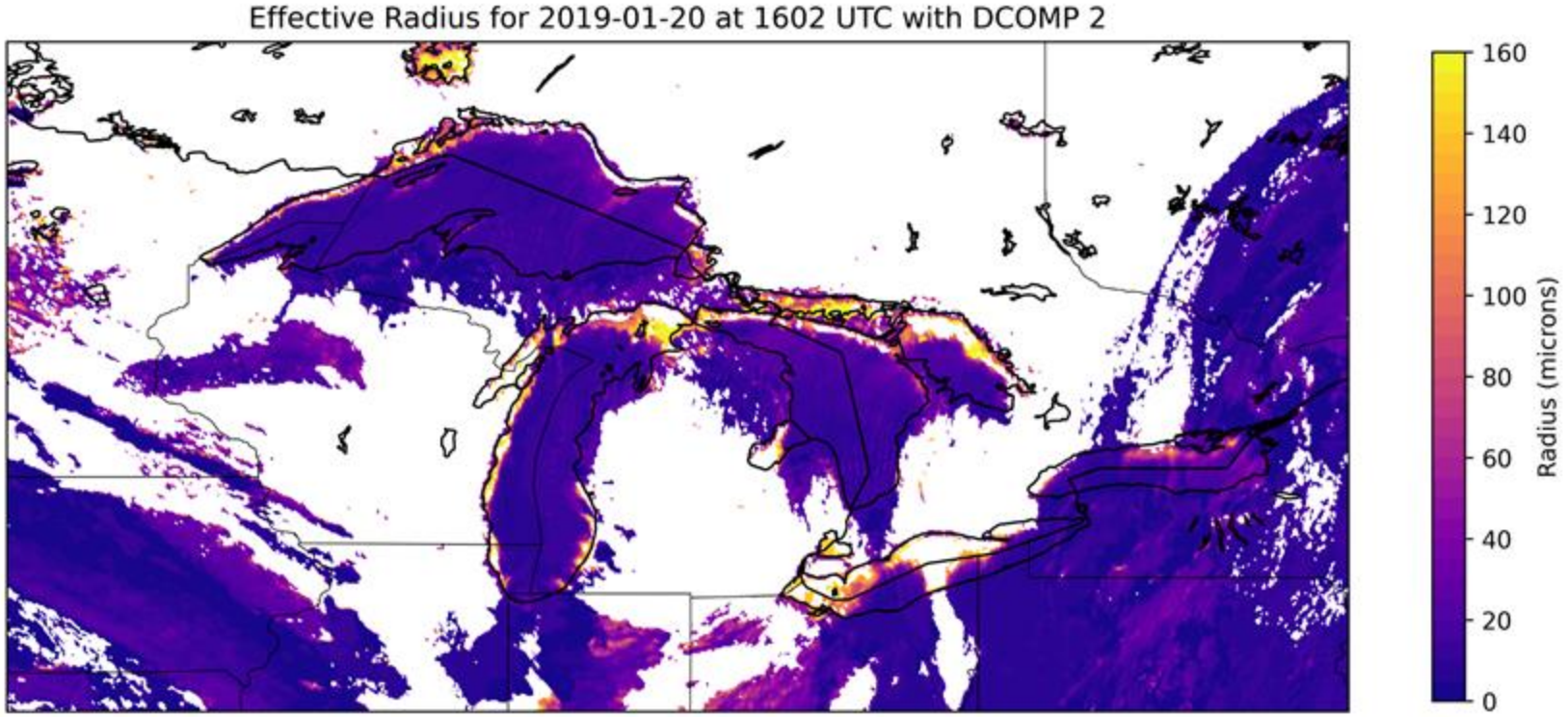




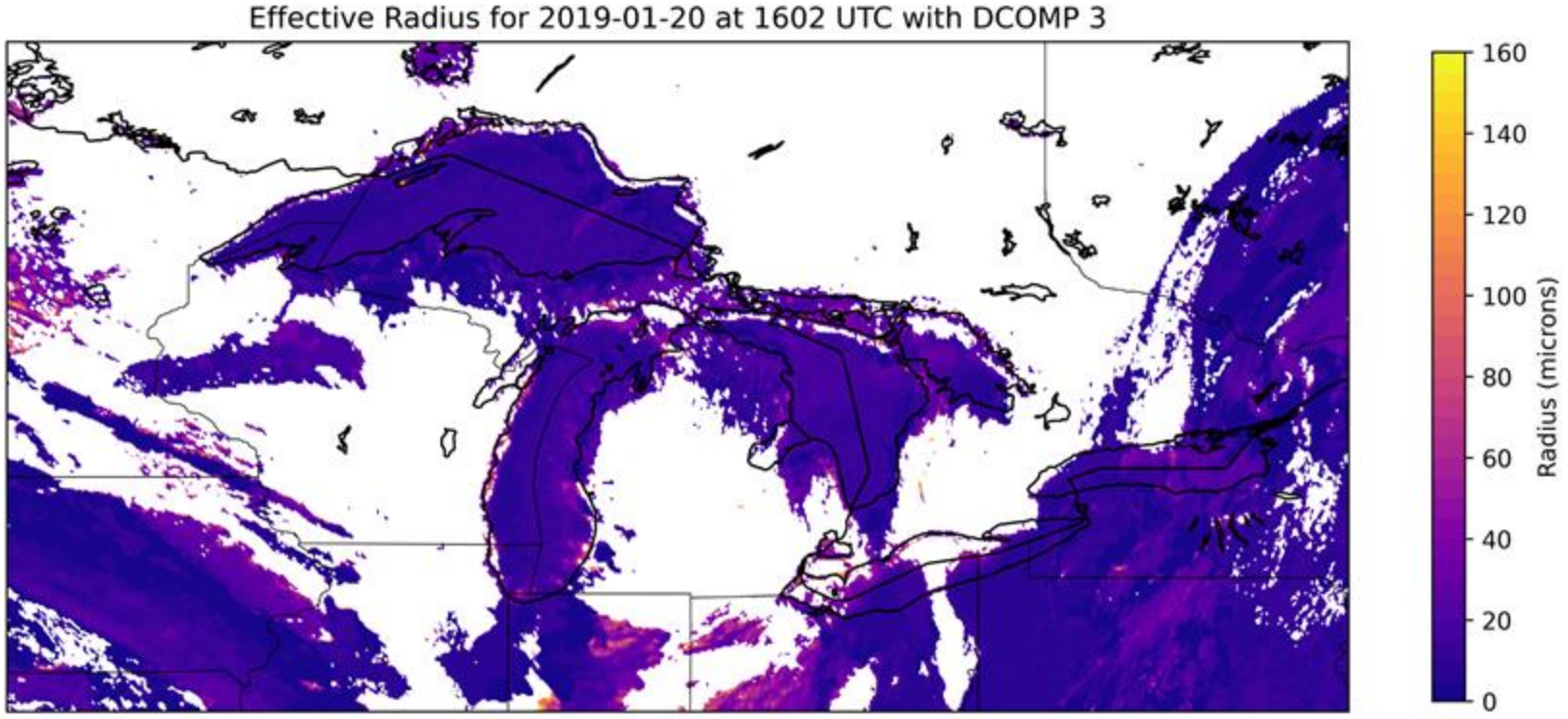
Reff DCOMP 1


Effective Radius for 2019-01-20 at 1602 UTC for DCOMP 1
Visible banding structures
160
140
120
100
80
60
40
20
0
Radius (microns)

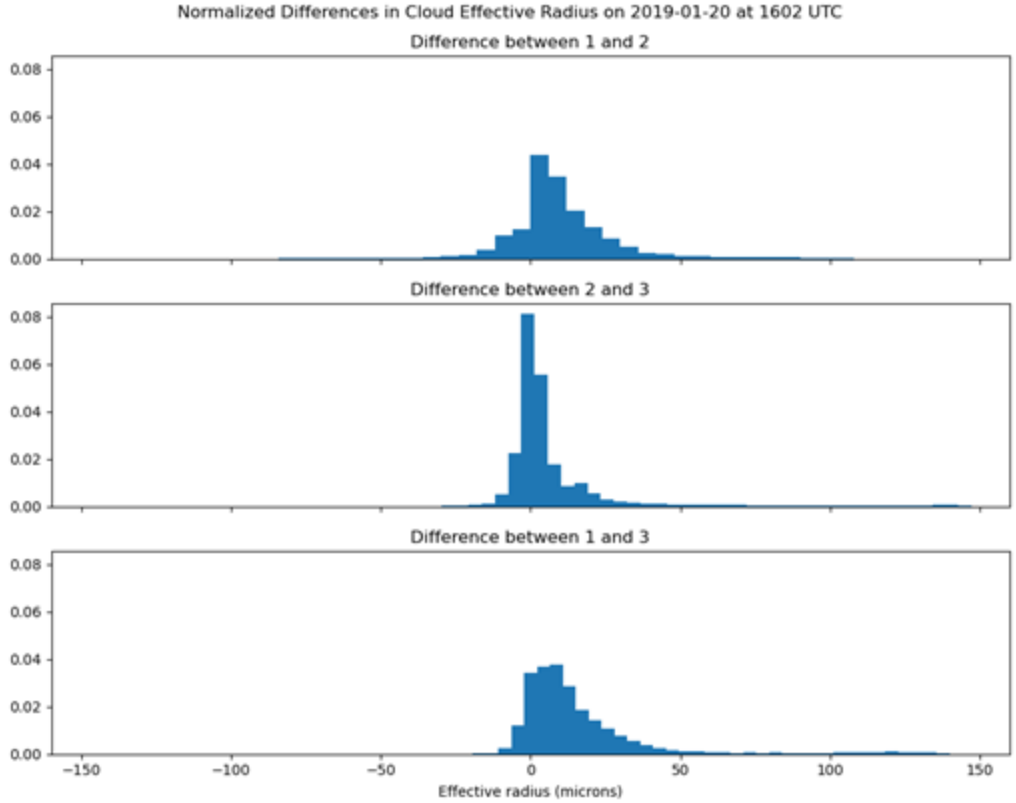
Reff DCOMP 2

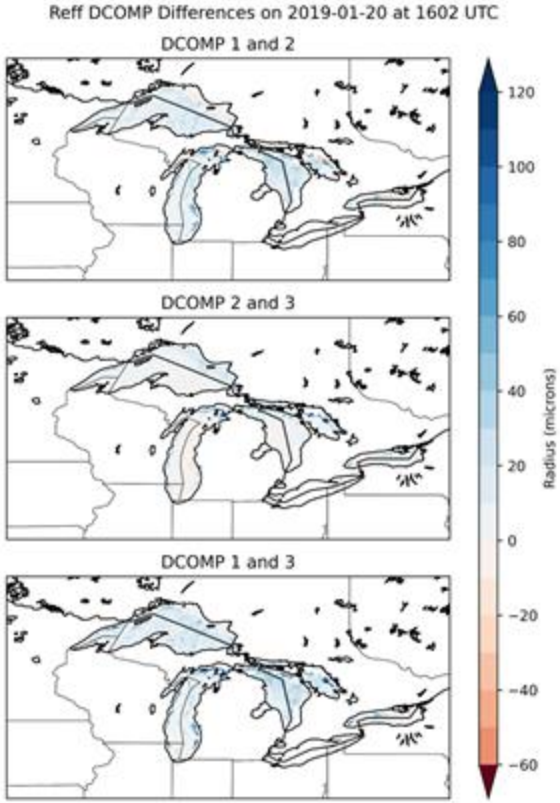

Effective Radius for 2019-01-20 at 1602 UTC with DCOMP 2
160
140
120
100
80
60
40
20
0
Radius (microns)

Reff DCOMP 3

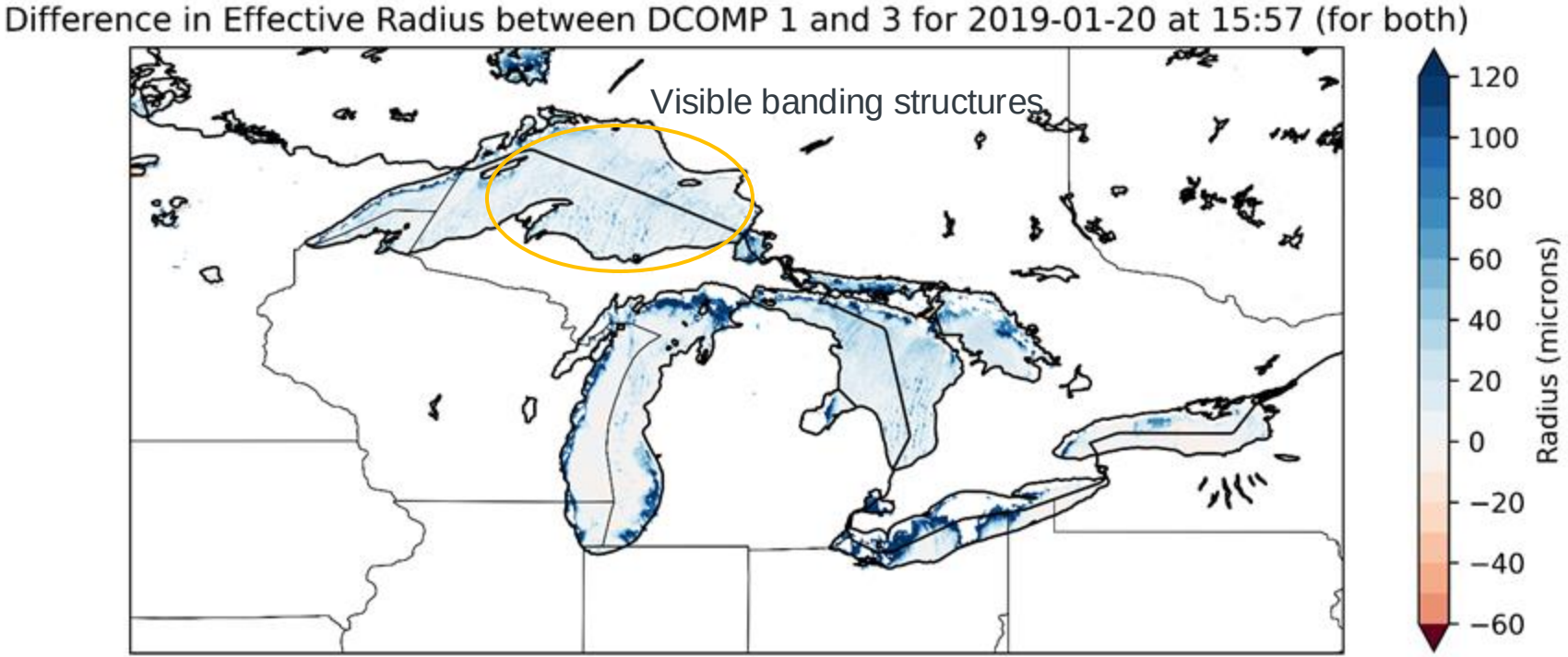

Effective Radius for 2019-01-20 at 1602 UTC with DCOMP 3
160
140
120
100
80
60
40
20
0
Radius (microns)

Reff DCOMP Differences



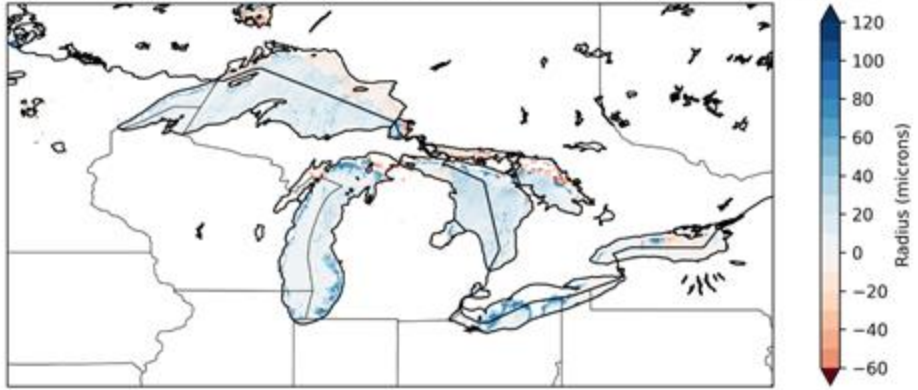


Reff DCOMP 1-3

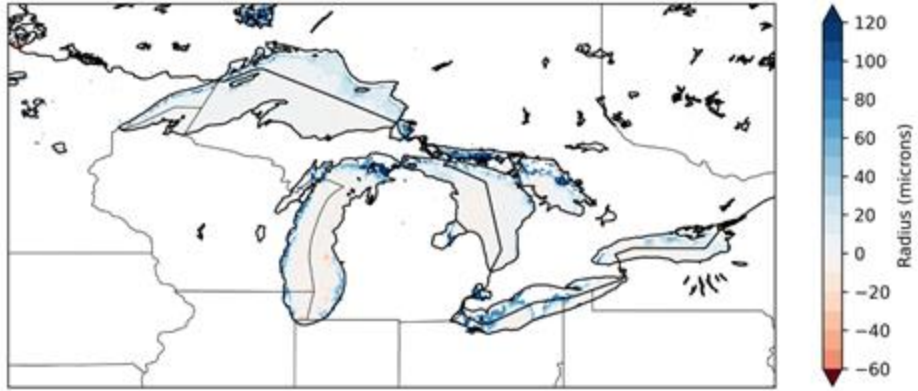


Reff Diff 1-2 and 2-3

Difference in Effective Radius between DCOMP 1 and 2 for 2019-01-20 at 15:57 (for both)



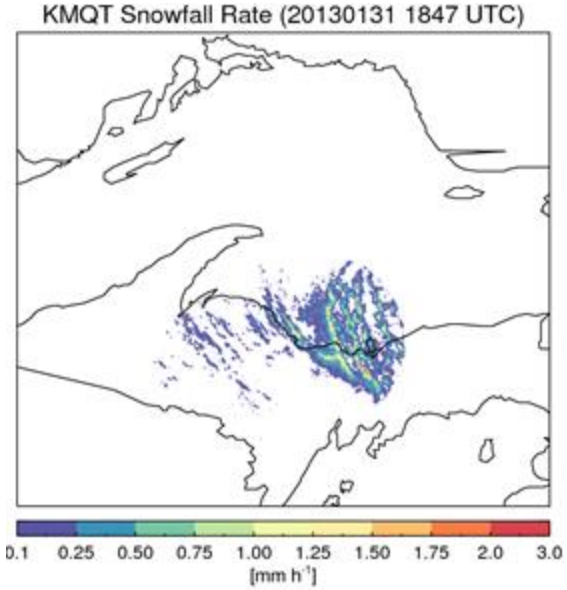
Difference in Effective Radius between DCOMP 2 and 3 for 2019-01-20 at 15:57 (for both)

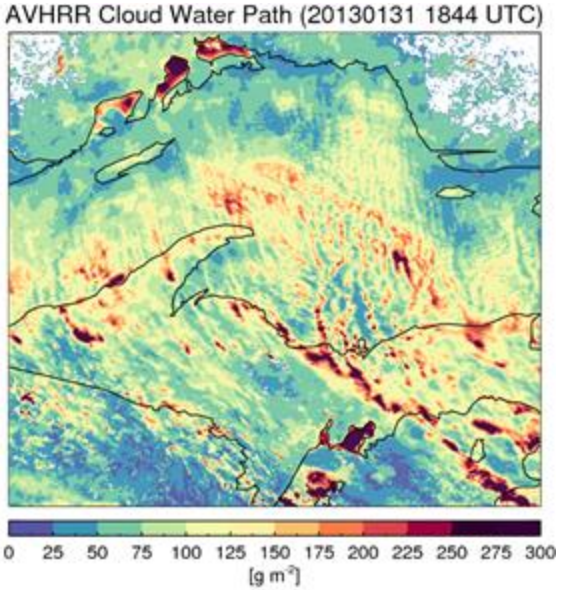


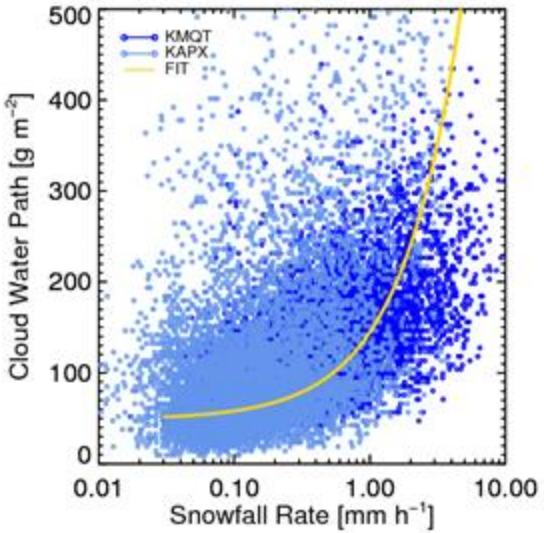
Using CLAVR-x for QPE

What we have and where we're going

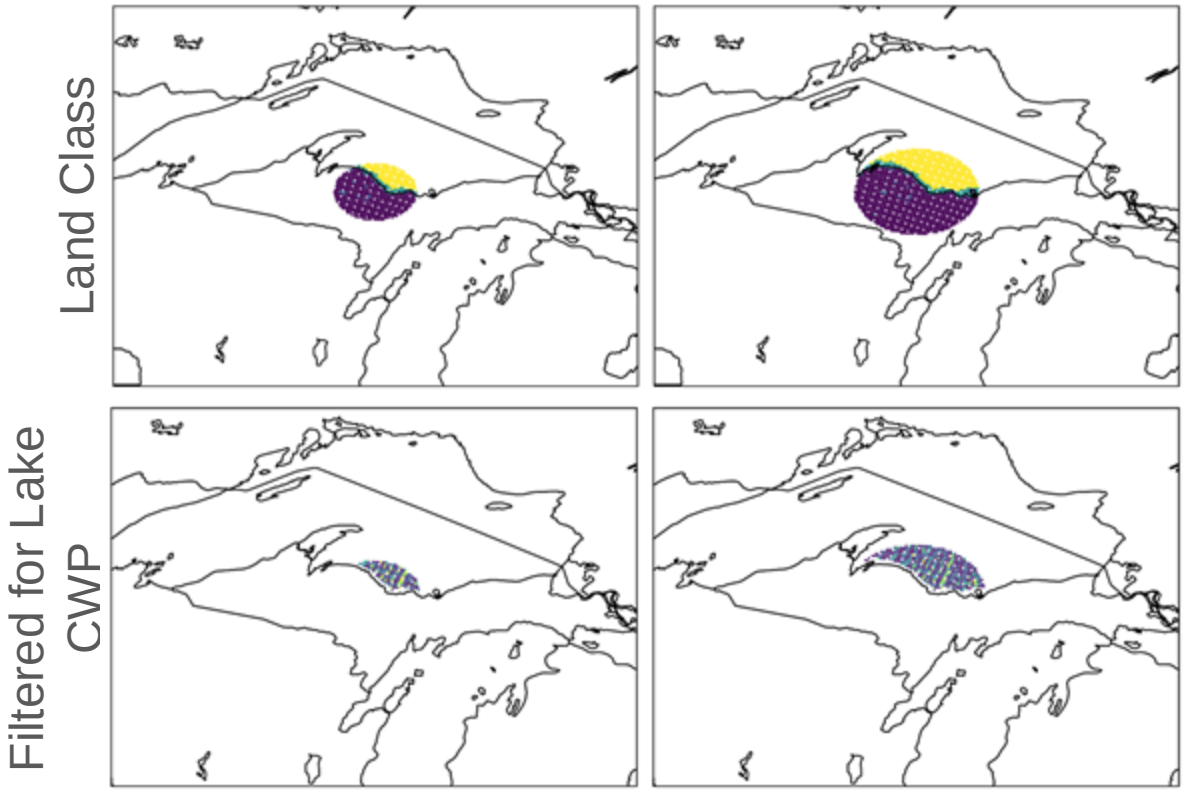
Starting Point: what we already have



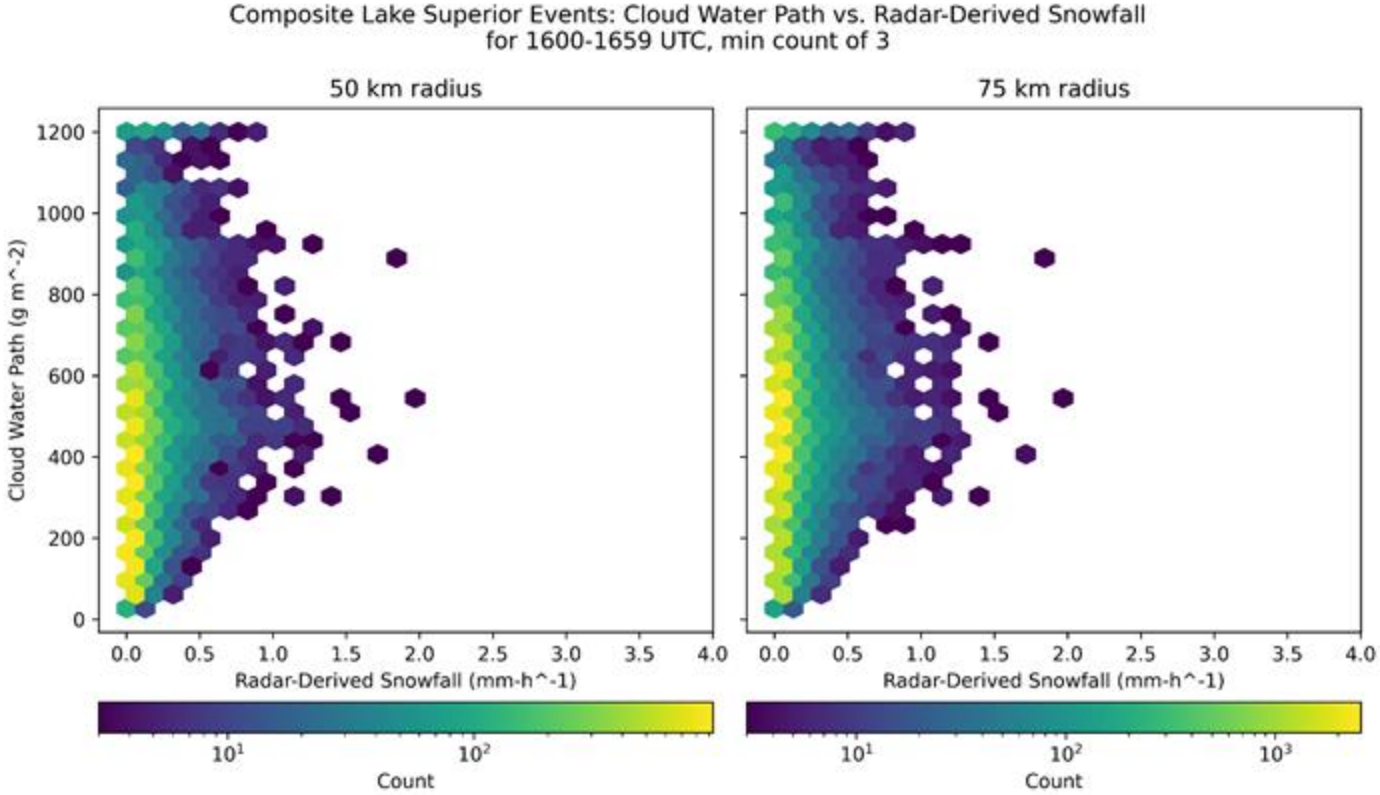




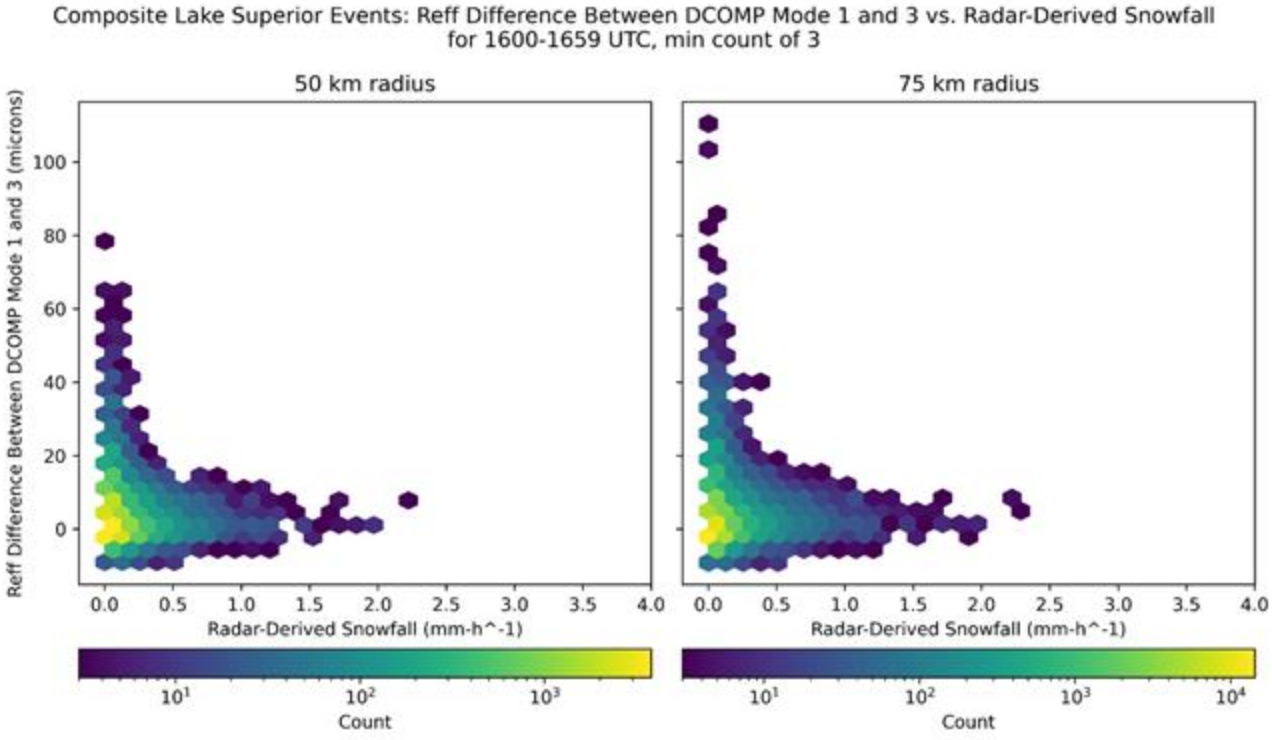
The Strategy: Co-locate NEXRAD-GOES



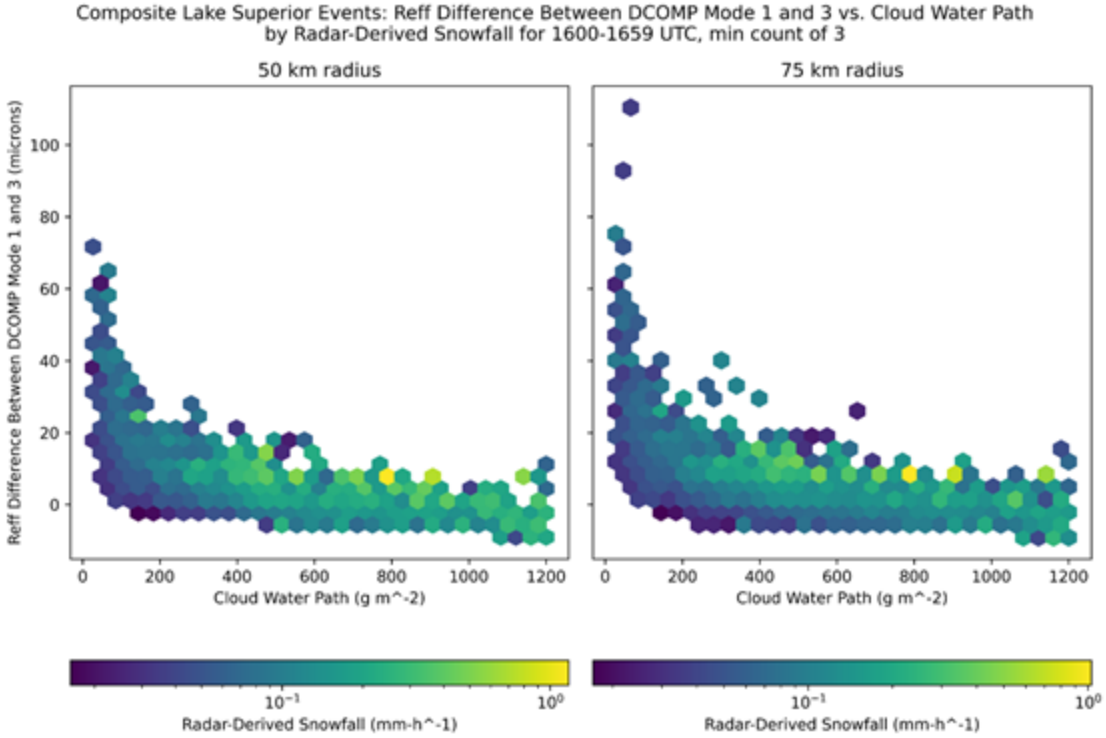
Attempt 1: CWP vs. Radar-Derived Snowfall



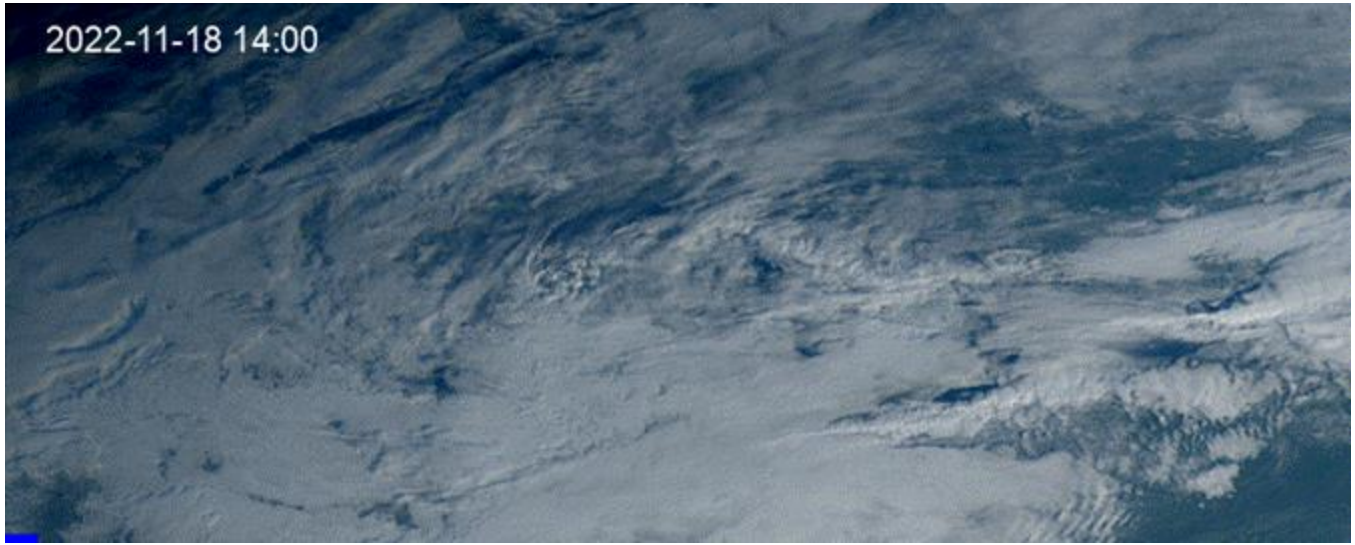
Attempt 2: Reff Difference vs. Radar-Derived Snowfall



Attempt 3: CWP vs. Reff Difference by Radar-Derived Snowfall



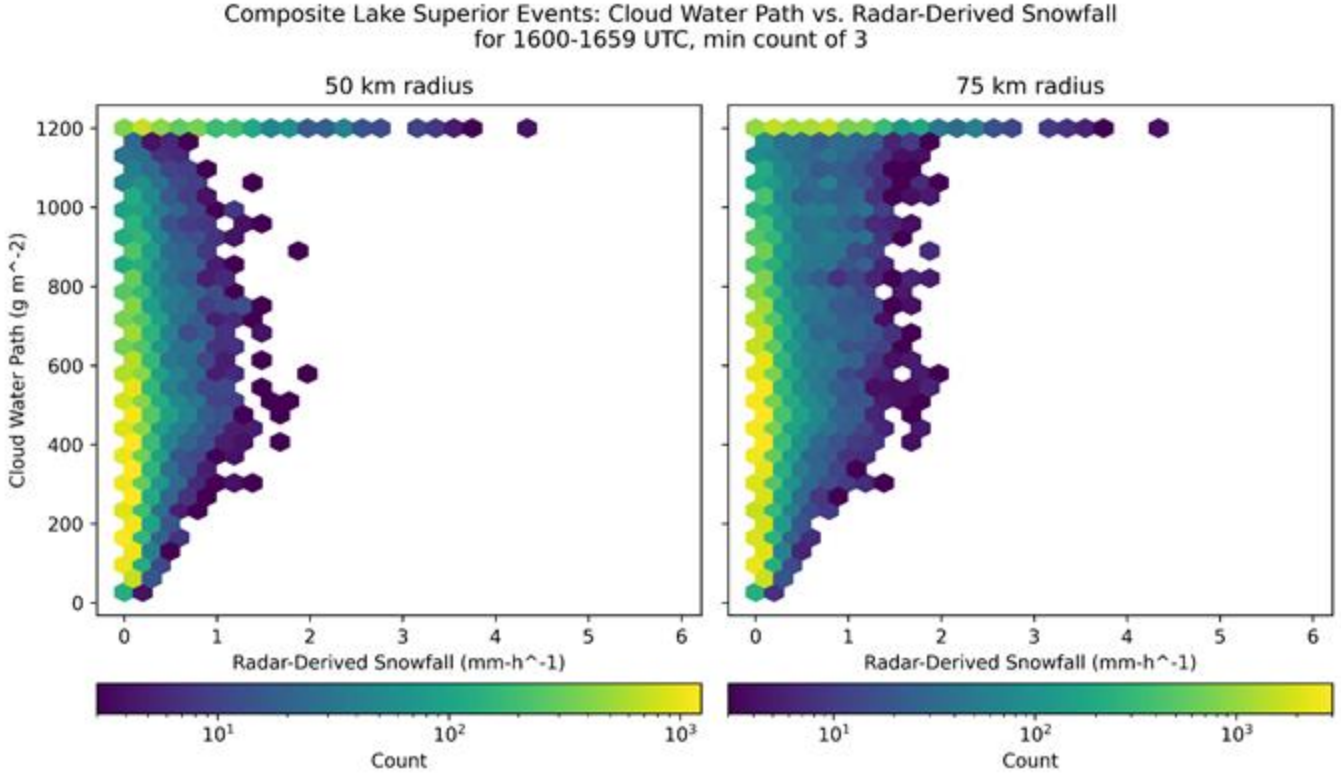
An Issue: Low Snowfall Rates



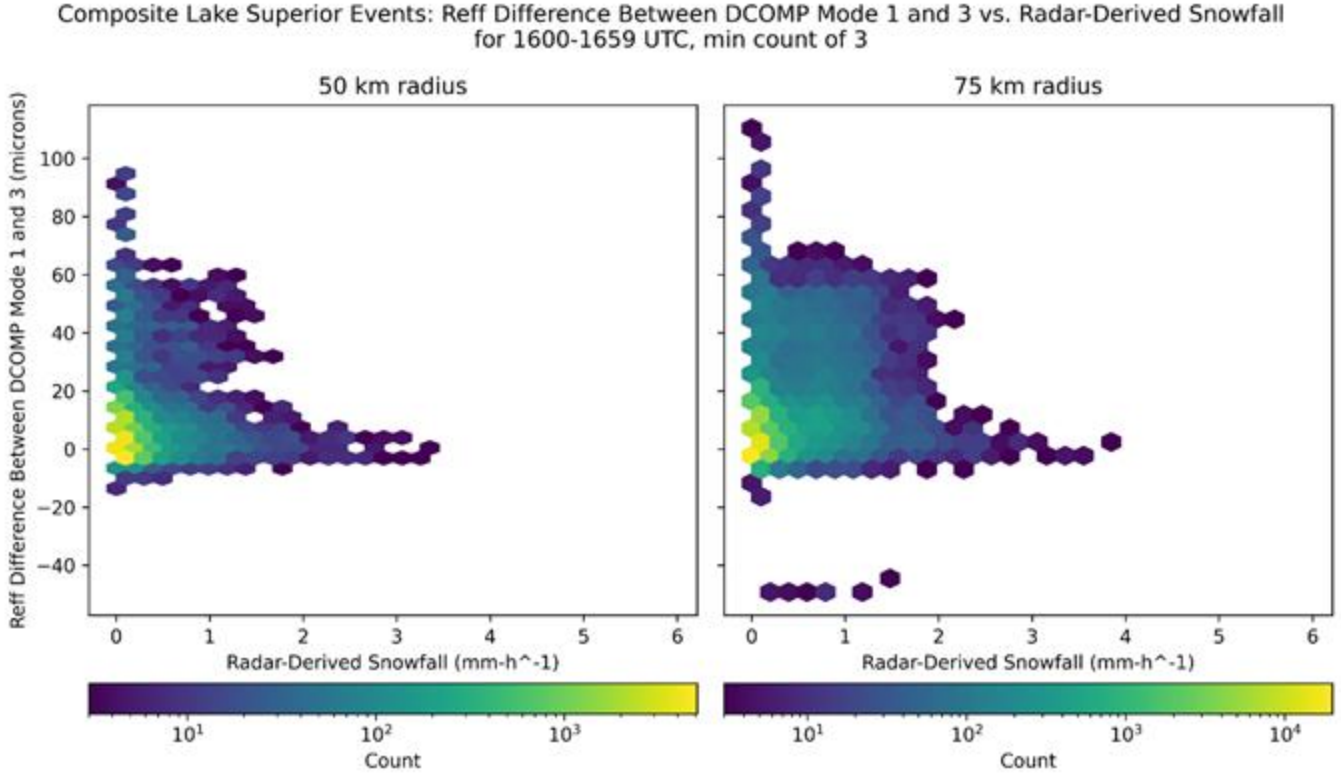
LAKE EFFECT STORM
November 17-20, 2022

Maximum Snowfall: Lk. Erie 81.2" (Hamburg); 76.0" (Blasdell 3 SSW)
Lk. Ontario 49" (W. Carthage 0.3 ENE; 38" (Croghan 6.2 N)
Duration: 60 hours +/-
Flake Scale: 5 flakes *****

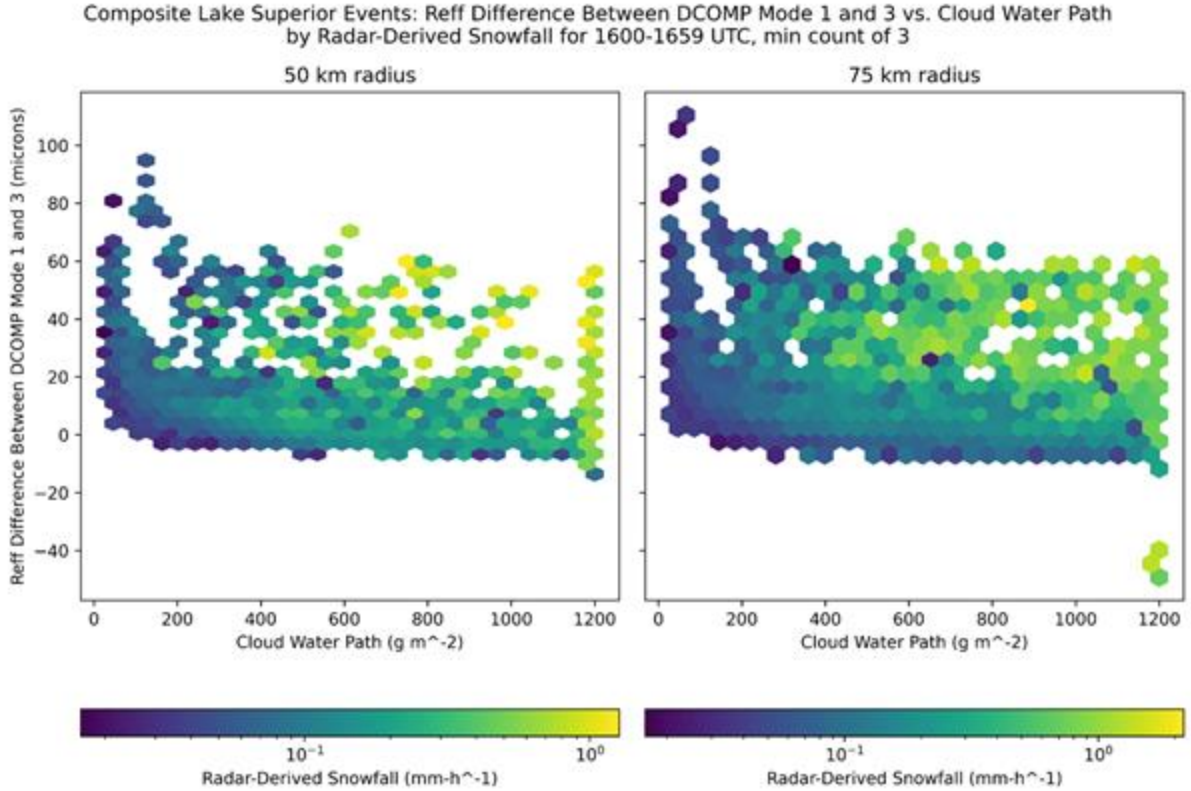
Attempt 1: with Lake Erie event



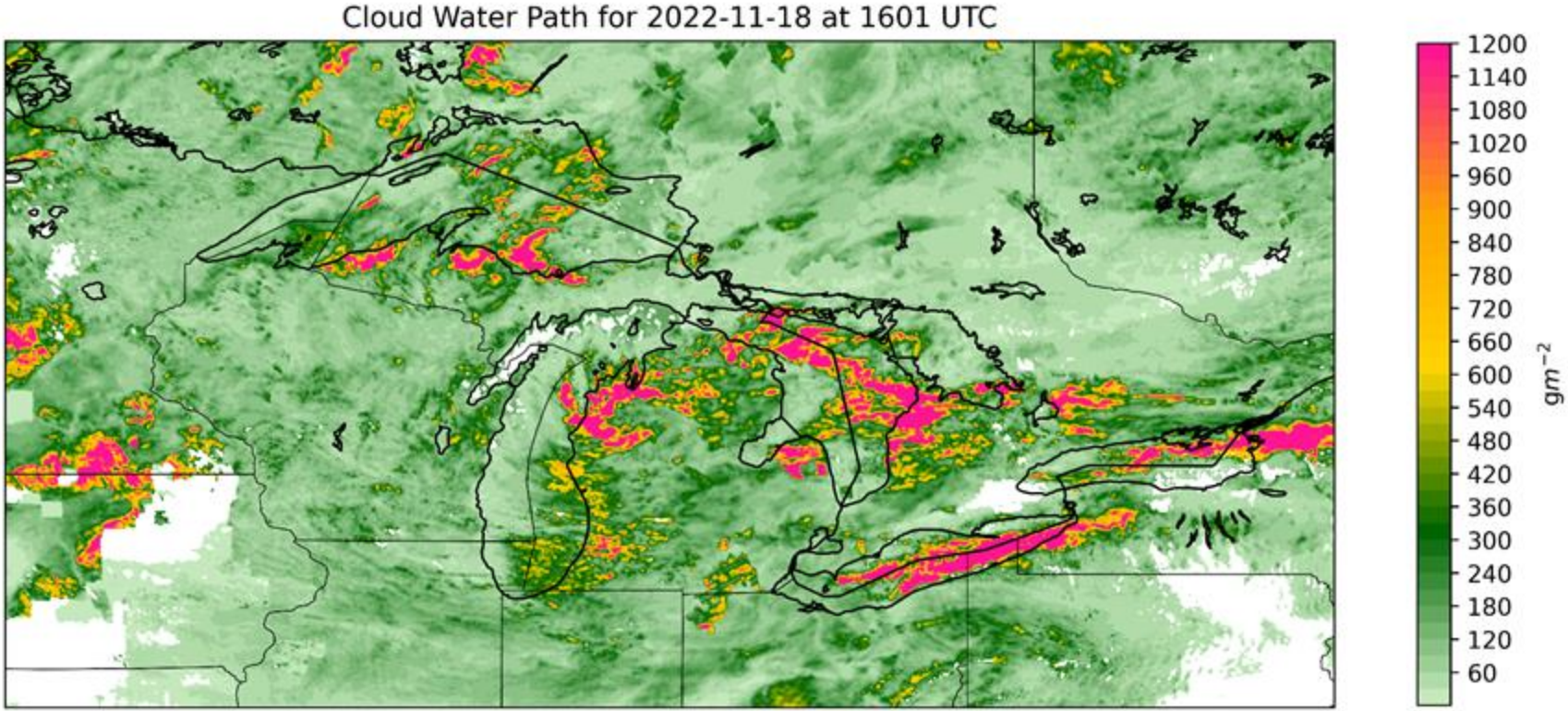
Attempt 2: with Lake Erie event



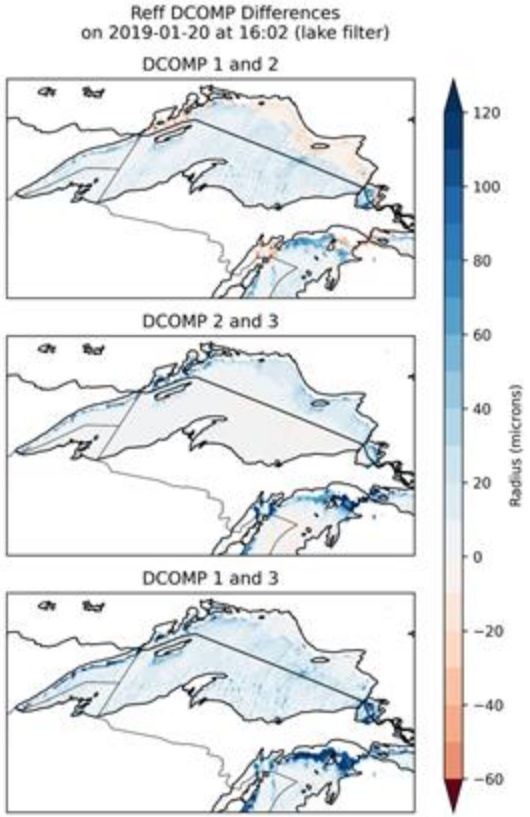
Attempt 3: with Lake Erie event

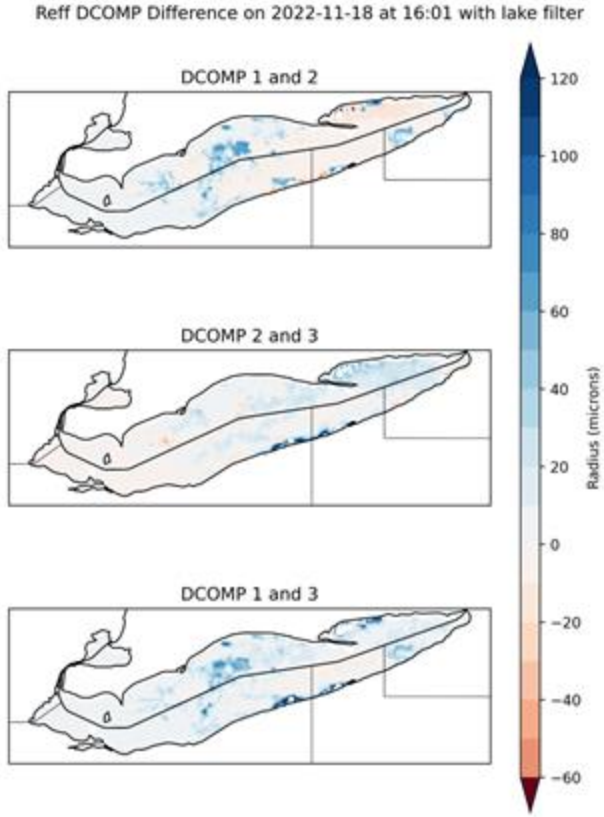


Issue 1: CWP saturation

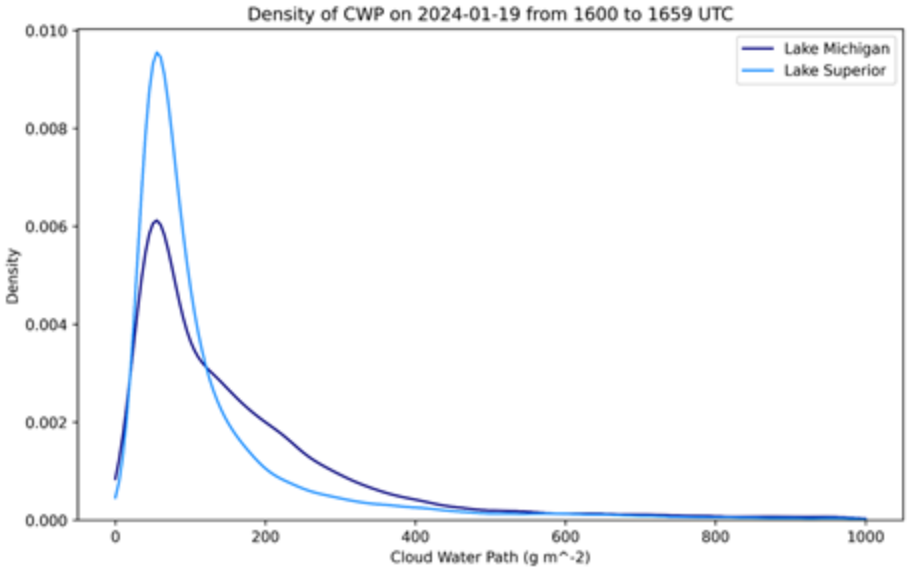


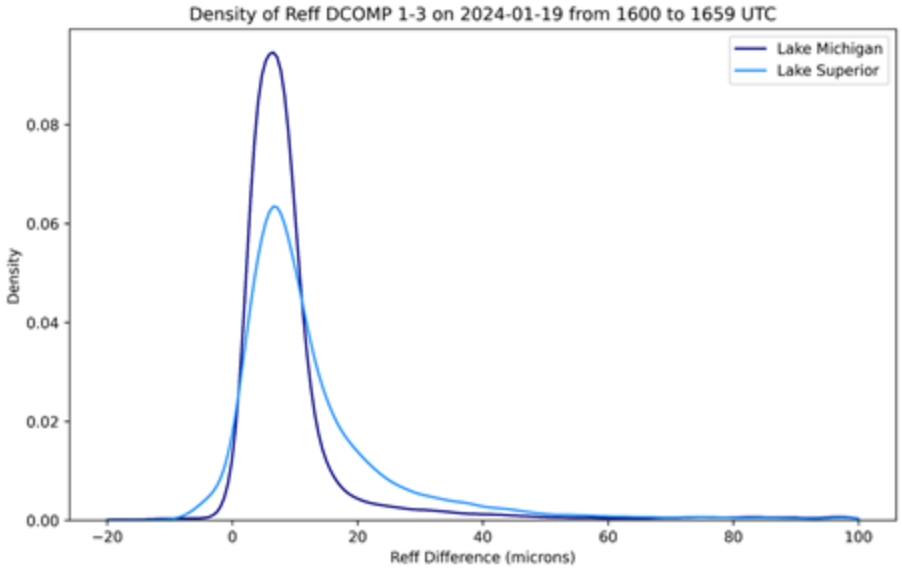
Issue 2: Differences in LES structure





Issue 2: Differences in LES structure





So, what have we learned?

This is more complicated than we thought!

But improving the QPE product has real uses.

Conclusions from Part 2

1 Finding data that fits all the criteria is hard.

2 Low snowfall rate events dominate the Upper Great Lakes.

3 Trying to use *just* Lake Superior has its pros and cons.

4 There are noticeable differences between LES structures.



Future Work

1 More data

2 Better understanding of Reff DCOMP differences

3 Create a LES typology to fine tune the analysis

4 Make use of AI/ML to analyze the plethora of variables and combinations



Acknowledgements

This research was done under the NOAA Lapenta program.

I would like to thank Dr. Mark Kulie for his guidance this summer. Many thanks to Leila Gabrys and the team at University of Wisconsin CIMSS that gave advice and input.

Thank you to the School of Earth, Society & Environment for their support through the Schlesinger Travel Grant that enabled my participation.

Contact Info: ashih4@illinois.edu, alyssa.shih@noaa.gov, alyssa.shih18@gmail.com, mark.kulie@noaa.gov