Buffalo Bomb Cyclone
STEM Competition Club
Friends' Central School, Wynnewood, Pennsylvania

ABSTRACT

In this project, we used GOES satellite images to understand why and how the storm in Buffalo, NY happened on 12/23/2022 and how we can predict future storms by using the GOES satellite images for different bands.

First, this project helps the user to observe cloud movement in different GOES EAST Satellite Bands 8, 13, and 14 by using stored satellite gif animations and images. Second, we analyze information from multiple bands to understand how clouds are moving around a particular location and how the weather conditions are changing with time. Third, this project helps the user to understand the cloud movement in detail by calculating and using motion vectors. Fourth, this work helps the user to generate ideas and theories to predict storms early by using the extracted information from the satellite images and gif animations, which may warn the officials to communicate to people in danger areas so that they can prepare.

After processing different GOES satellite bands and finding motion vectors; we can group and analyze these vectors, observe troughs in jet stream and observe certain cloud motion patterns to predict future storms.
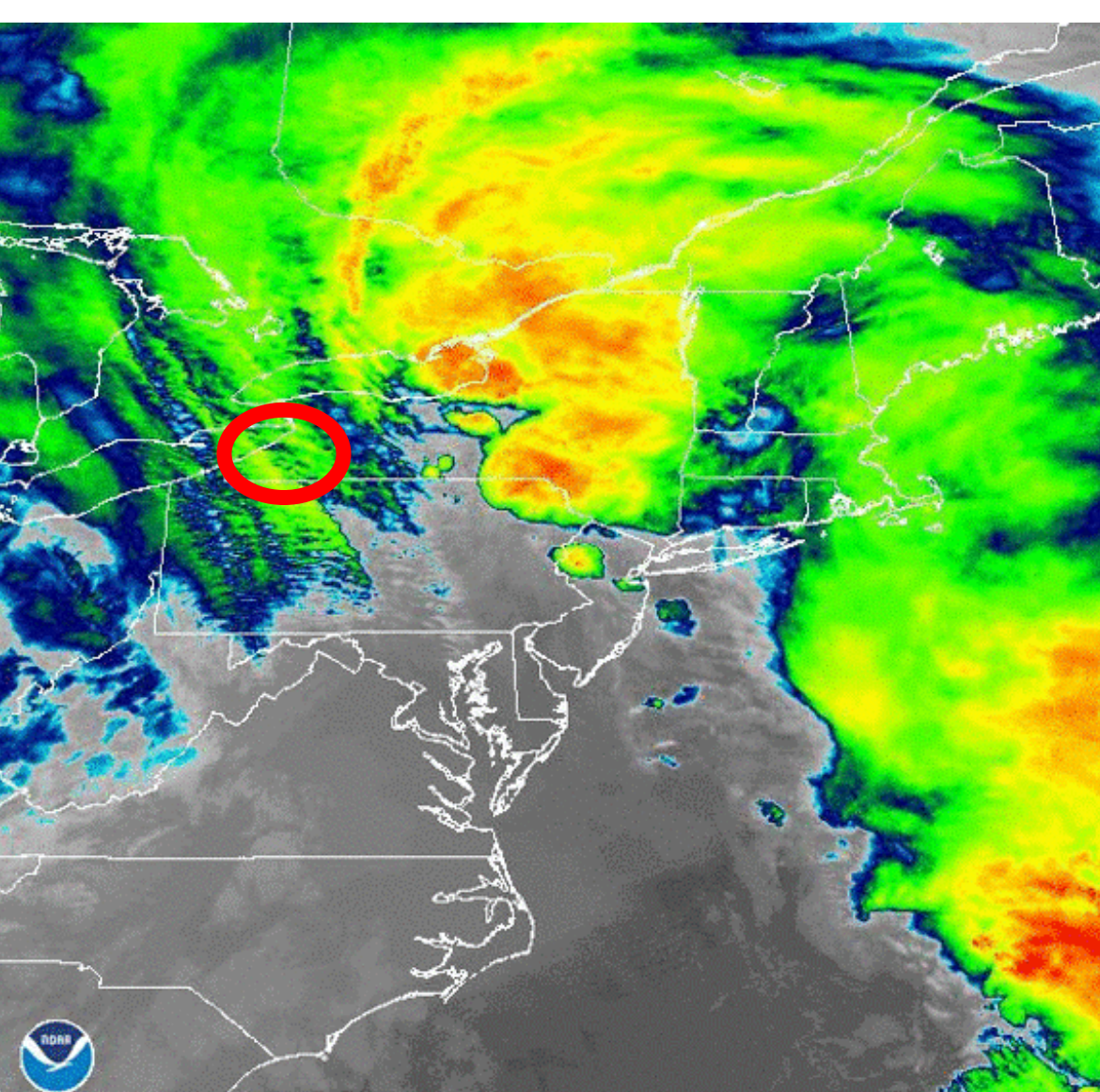
RESEARCH QUESTION

We will see future trends of even deadlier winter storms due to special causes for a bomb cyclone to be more common. How can we use information from multiple satellite bands to analyze past storms and use the findings to protect future storms?
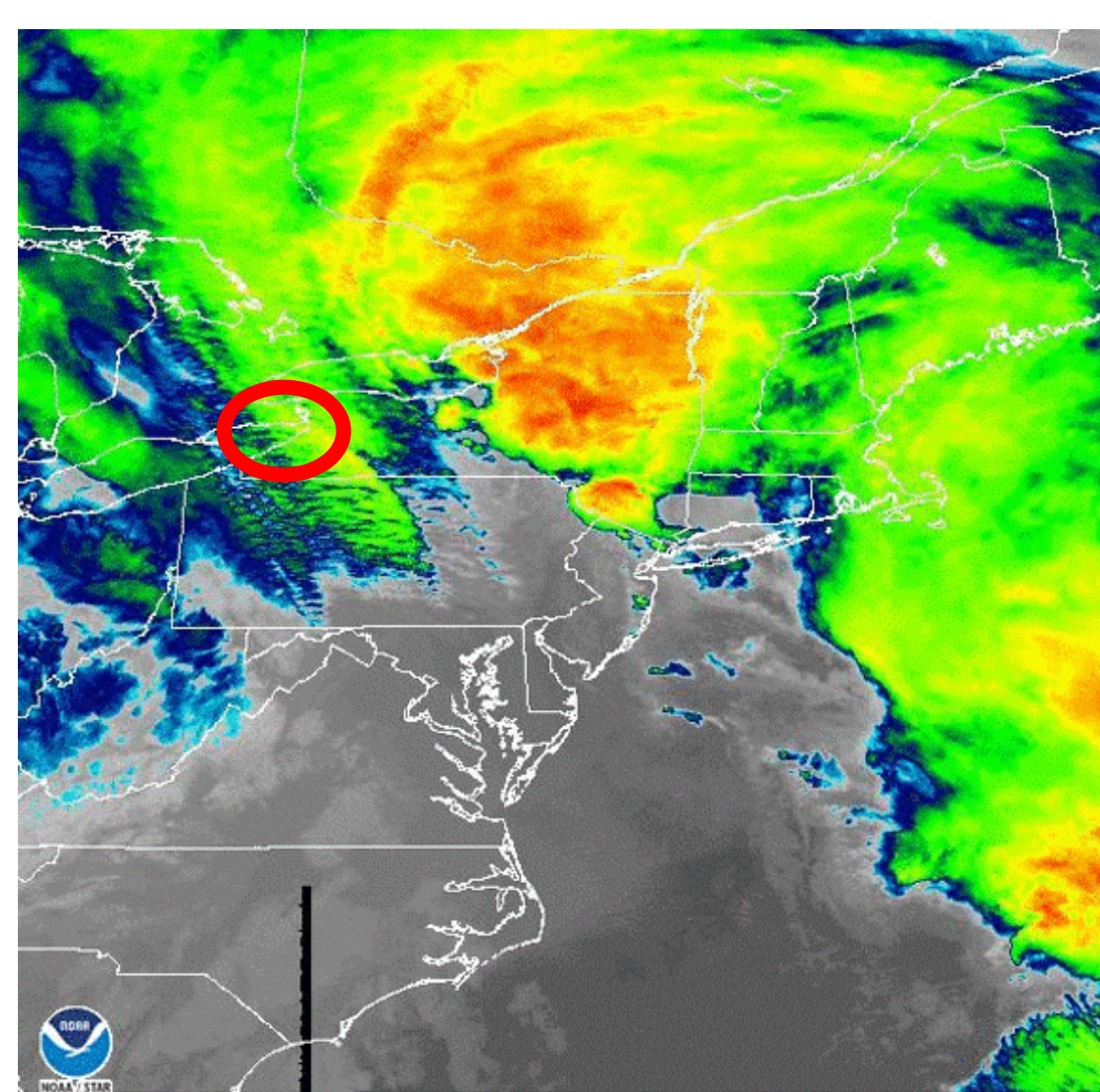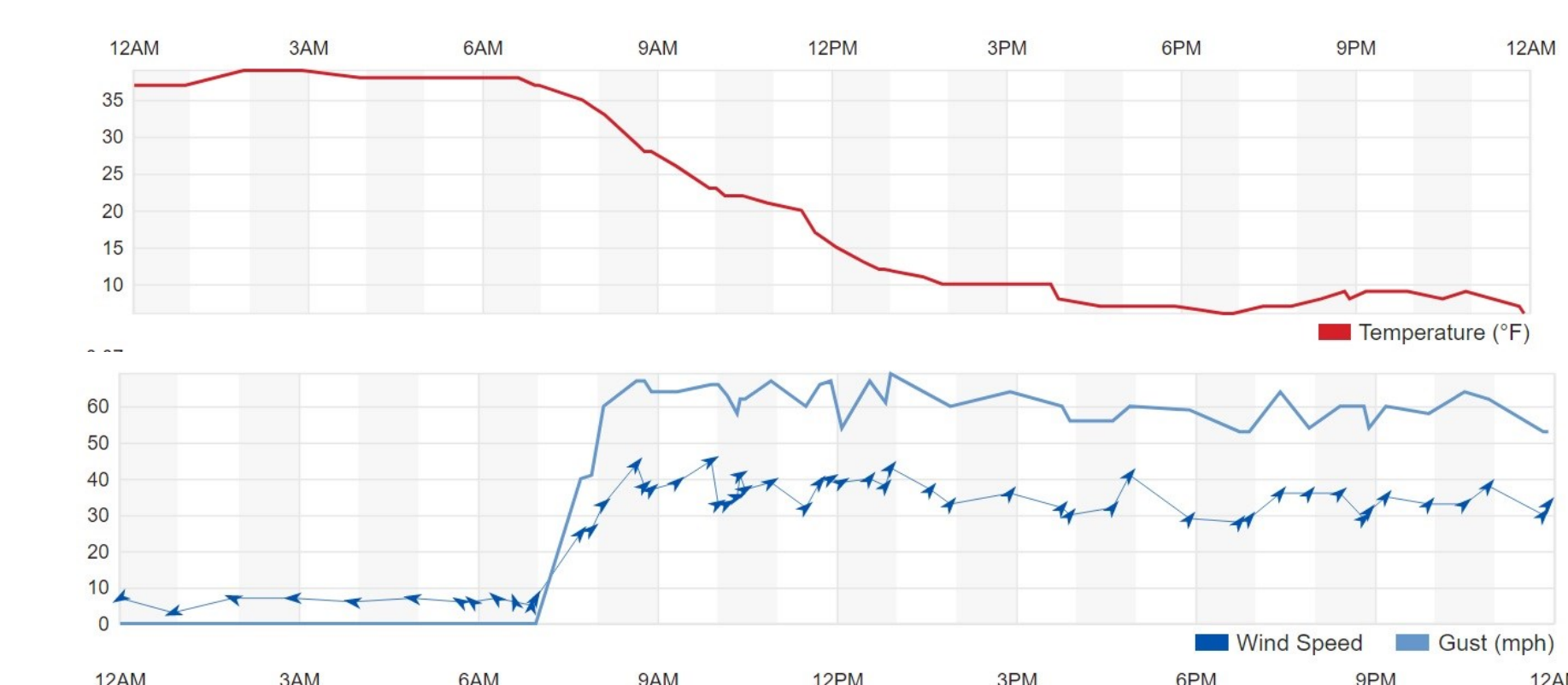
RESEARCH with Satellite Images & ABI Bands
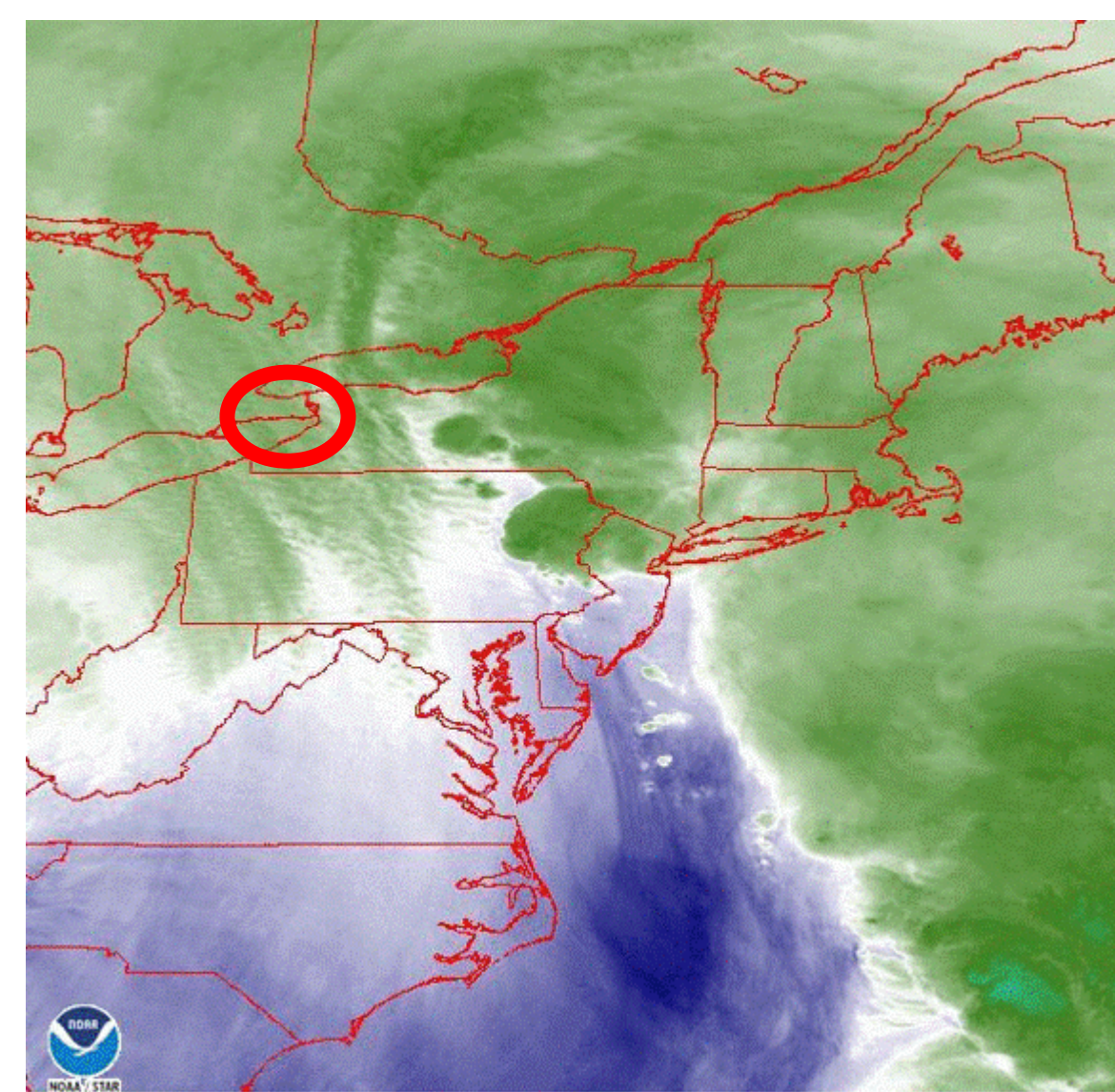
Band 08. 12/23/2022

Band 13. 12/23/2022

Band 14. 12/23/2022

Temp and Wind Change on 12/23/2022

What is different from other storms?
- The lack of ice on Lake Erie caused large amounts of moisture and as a result lake effect snow with blizzard conditions
- Very high central pressure (1060 millibars) in the high-pressure area (West)
- Hyper dense, very cold air mass above Midwest and Great Lakes area
- Jet stream, circling Great Lake area, within jet stream there is a pocket of very high winds, called jet streak (150 mph winds)

RESULT: BOMB CYCLONE

Why did we use Bands 8, 13, and 14?
- Band 8 helped us to track upper-tropospheric winds and enabled us to track the humidity change
- Band 13 helped us to observe how cloud-top temperature changed during the storm
- Band 14, similar to Band 13, more affected by water vapor, used for motion wind vector calculations. We used STEM Club developed software for motion vector calculations
- Three bands together helped us to find:
  a) Exact location of the trough
  b) Change of the wind direction over time
  c) Change of cloud and wind pattern
  d) Temperature change in the upper levels
  e) Approximation of jet streak location
  f) Circular motion of clouds over Buffalo
 g) Change has been observed for three days, December 22, 23, and 24

Methodology
- We collected gif images and gif animations from NOAA's GOES East for Sector East and Northern US for December 22, 23, 24
- We used our own software for motion vector calculations for GIF animations

RESULTS and CONCLUSIONS
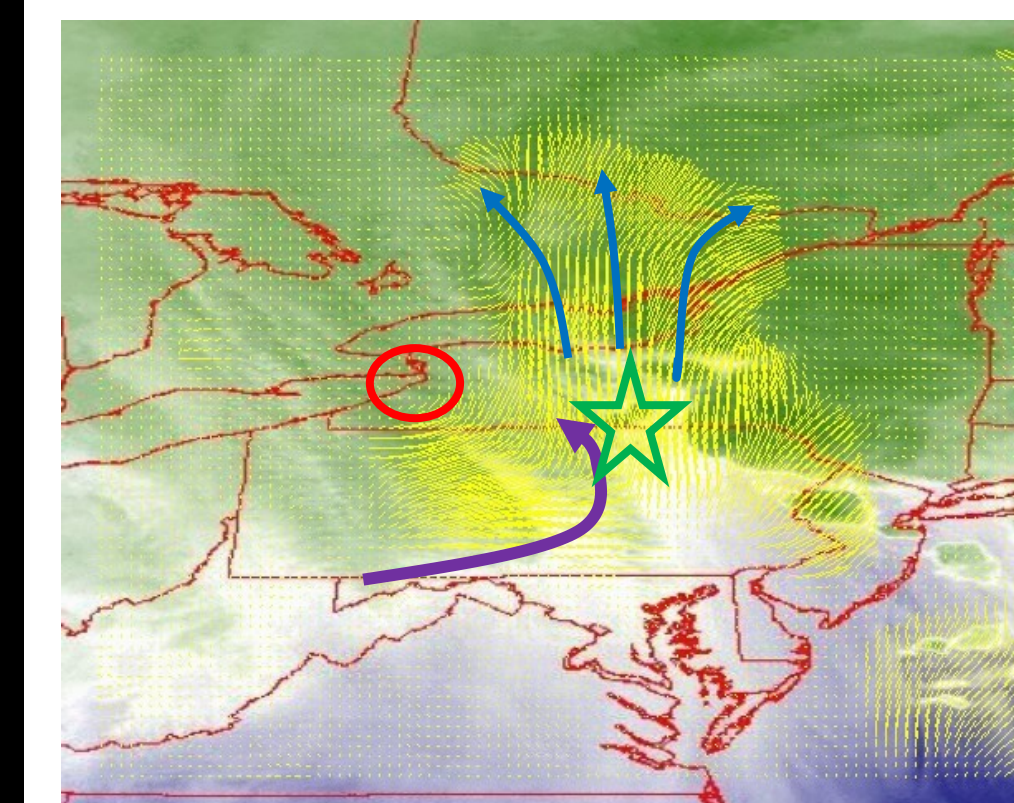
- December 23, Morning, Band 8, motion vectors
- Motion vectors indicate that the moisture is turning over Buffalo
- Jet streak is curling toward Buffalo
- Air exiting the eastern bend of the jet stream fanned out northward, as shown by blue arrows.
- Air suddenly rises from lower to upper levels around the green star: Low Pressure Area Developed
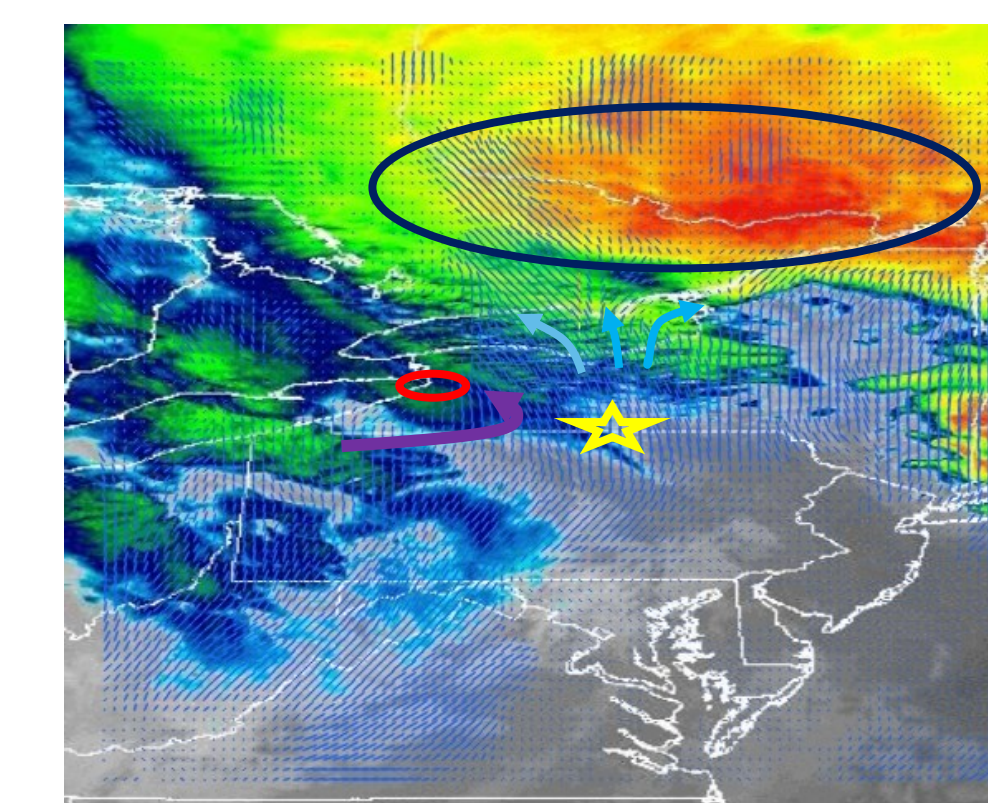
- December 23, Morning, Band 14, motion vectors
- Motion vectors indicate that the moisture is turning over Buffalo
- Jet streak is curling toward Buffalo
- Air exiting the eastern bend of the jet stream fanned out northward, as shown by blue arrows.
- Air suddenly rises from lower to upper levels around the yellow star: Low Pressure Area Developed
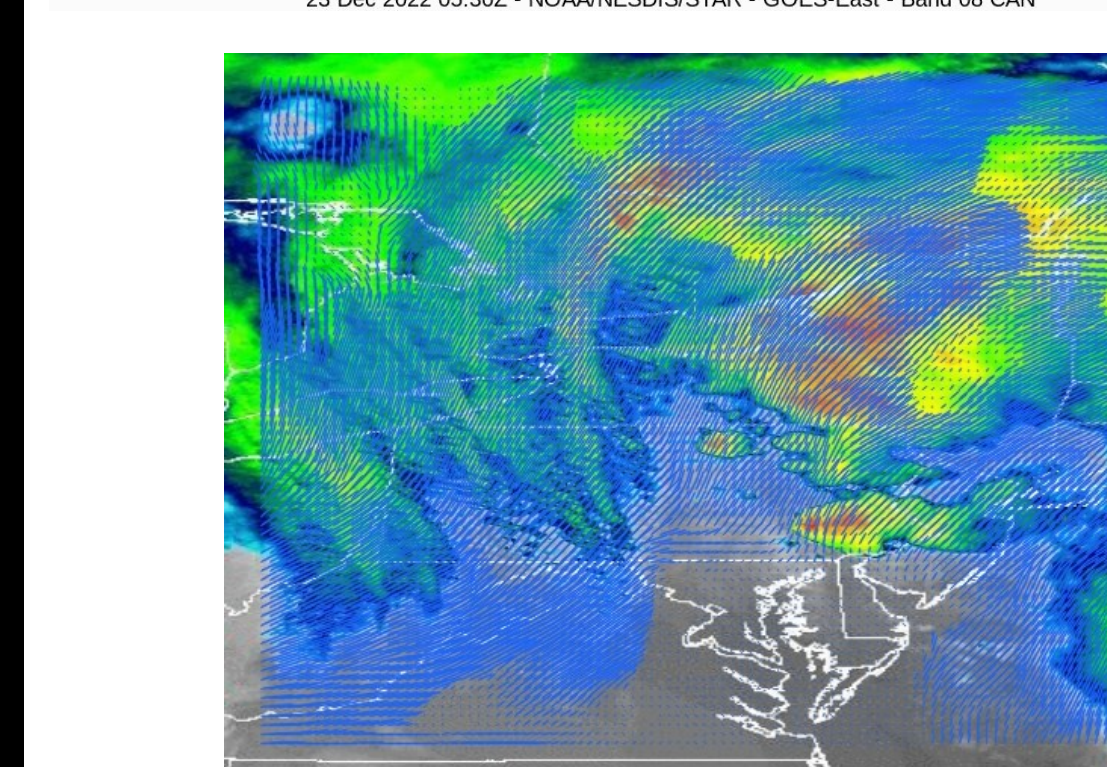- Very cold upper-level cloud tops form

How can this data be used for future storms and predictions?
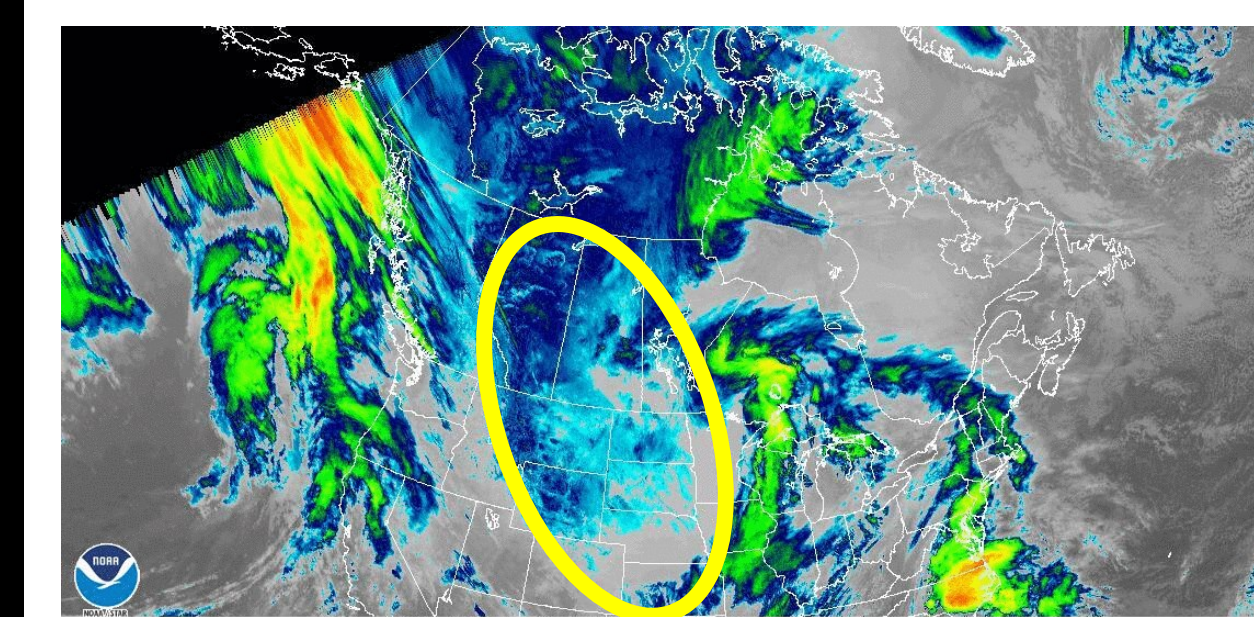
OBSERVE TROUGHS in JET STREAM to PREDICT FUTURE STORMS ON THE DOWNSIDE of the TROUGH
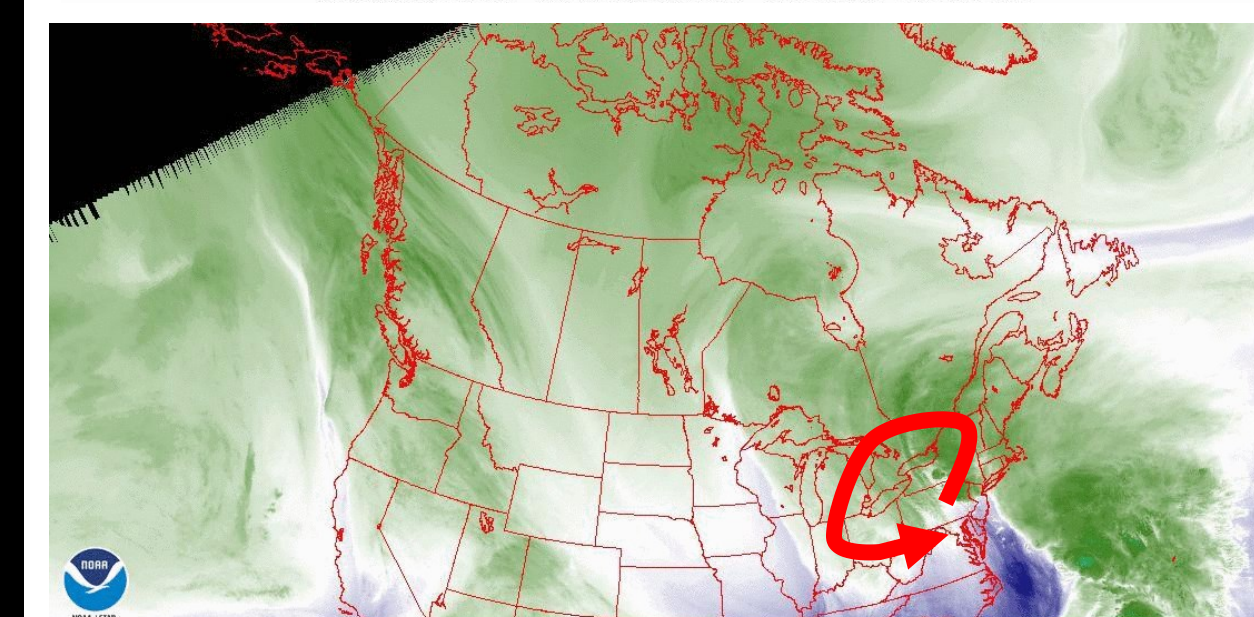
OBSERVE CIRCULAR MOTION PATTERN of MOISTURE to PREDICT STORMS

OBSERVE, GROUP, and ANALYZE MOTION VECTORS to FIND A PATTERN and to PREDICT STORMS

References

[1]https://www.washingtonpost.com/weather/2022/12/27/buffalo-storm-blizzard-warnings/
[2]https://www.washingtonpost.com/weather/2022/12/28/buffalo-blizzard-bomb-cyclone/
[3]https://www.wunderground.com/history/daily/us/ny/cheektowaga/KBUF/date/2022-12-23
[4]https://www.goes-r.gov/education/docs/Factsheet_ABI.pdf
[5] https://www.weather.gov/btv/December-23-25th-Multi-Hazard-Storm
[6]https://www.weather.gov/source/zhu/ZHU_Training_Page/winds/JetStream_Stuff/300_200_chart.htm