



An Analysis of Various Atmospheric Conditions during LaNina Winter in Southeastern Michigan

Elissa Hadla, Renee Harp, Lana Ibrahim, and Mariam Nasser
Crestwood Highschool, Dearborn Heights, MI



Abstract

In this research, researchers examined the relationship between surface temperature, snow depth, cloud coverage, sky visibility, and other atmospheric parameters in Dearborn Heights, Michigan. Researchers collected daily surface temperature and snow depth measurements at a school campus using an infrared thermometer and meter stick. In addition, sky visibility was recorded at an intersection, taking a picture of the Detroit skyline. Furthermore, parameters such as air temperature, barometric air pressure, and humidity were obtained using the WeatherBug app associated with our school's Weather Networks weather station. In addition, PM was recorded using our school's PurpleAir device. Over 20 days, trends indicated a steady decrease followed by an upward trend in surface and air temperatures in the winter. A strong relationship was also found between surface temperature and ambient air temperature. PM values are typically higher during low pressure conditions and lower during high pressure conditions, which may also influence the observed trends shown. Humidity and cloud coverage demonstrated a complex relationship, with high cloud coverage generally corresponding to increased humidity, but varying patterns when cloud coverage was low. Barometric pressure and sky visibility had an inverse relationship. As visibility increased, pressure decreased. Potential errors in data collection included environmental variability, and occasional gaps in daily measurements. This data leads to understanding seasonal climate variations on a local scale and highlights the need for further research to refine methods and expand study periods. The researchers suggest adding more parameters such as dew point to fully capture the capacity of the changing environment.

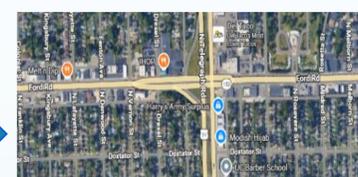
Methodology



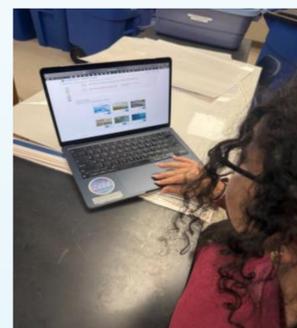
Satellite image of data collection at site #1, Crestwood High School.



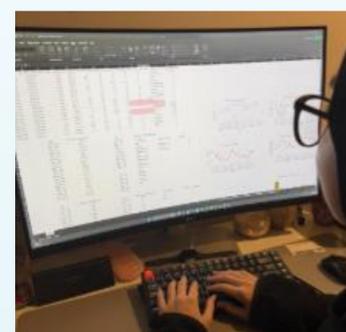
Researchers used the Infrared Thermometer and Meter stick to measure surface temperature and snow depth measurements.



Satellite image of data collection at site #2, Ford Rd. and Telegraph Rd. Intersection.



Lastly, the researchers input their findings into the GLOBE database.



Data collected gets exported into a spreadsheet to visualize the data with graphs.



Researchers took photos of the visibility of the Detroit's skyline to measure the level of haziness.

Conclusion

These patterns align with broader Great Lakes winter climate trends, including La Niña events. Incorporating five years of prior data highlighted long-term trends and supported continued student research to monitor winter atmospheric conditions, air quality, and visibility over time. To improve accuracy, future data collection could include multiple daily measurements rather than just once a day, nighttime observations, and additional locations where we observe the Detroit skyline. Long-term, yearly measurements following consistent protocols could allow students to monitor trends, study climate change impacts, and analyze how different winter conditions affect particulate matter and visibility. Overall, the research highlights clear patterns among winter atmospheric variables and emphasizes the importance of continued study to understand local environmental conditions.

Acknowledgements

The researchers collaborated with their former AP Environmental Science teacher and Science Club Advisor, Mrs. Diana Johns, who has continued to provide guidance throughout the research process. Mrs. Johns offered support on climate patterns and data collection methods. Mrs. Abbas currently serves as the AP Environmental Science teacher and GLOBE Advisor, and who provides ongoing guidance in data analysis and research writing. With mentorship from both advisors, the researchers developed a deeper understanding of the long-term significance and potential impact of their study. Thanks also to Mission Earth and the AREN Project for providing some of the instruments and grants to purchase materials necessary to collect data using GLOBE protocols.

Citations

Chalif, J. I., Osterberg, E. C., & Partridge, T. F. (2025). A Wavier Polar Jet Stream Contributed to the Mid-20th Century Winter Warming Hole in the United States. *AGU Advances*. <https://doi.org/10.1029/2024AV001399>

Hutson, A., Fujisaki-Manome, A., & Glassman, R. (2024). Historical Trends in Cold-Season Mid-Latitude Cyclones in the Great Lakes Region. *Geophysical Research Letters*, 51, e2024GL109890. <https://doi.org/10.1029/2024GL109890>

Kiefer, M. T., Andresen, J. A., McCullough, D. G., Wierich, J. B., Keyzer, J., & Marquie, S. A. (2023). Microclimatic Variability of Cold-Season Minimum Temperatures in Michigan, United States: A Study with Implications for Insect Mortality. *Journal of Applied Meteorology and Climatology*, 62(9), 1187-1203. <https://doi.org/10.1175/jamc-d-23-0067.1>

National Oceanic and Atmospheric Administration (NOAA). (2024, November 8). La Niña Impacts and Outlook: Great Lakes Region. <https://www.drought.gov/sites/default/files/2024-11/ENSO%20Great%20Lakes%20November%202024.pdf>

Screen, J. A., Bracegirdle, T. J., & Simmonds, I. (2018). Polar Climate Change as Manifest in Atmospheric Circulation. *Current Climate Change Reports*, 4(4), 383-395. <https://doi.org/10.1007/s40641-018-0111-4>

Zhang, L. (2023, July). Conceptual Models of PM_{2.5} in Great Lakes Region. Lake Michigan Air Directors Consortium (LADCO). https://www.ladco.org/wp-content/uploads/Training/Interns/LADCO_2023_Internship_Final-Report.pdf

Discussion

Winter surface temperature, air temperature, barometric pressure, relative humidity, and visibility were interrelated. Cooler surface temperatures resulted from reduced solar altitude and snow reflectivity, while barometric pressure and air temperature showed an inverse relationship. Increased humidity and cloud coverage contributed to haze and reduced visibility, and particulate matter (PM_{2.5} and PM_{1.0}) concentrations were strongly correlated, decreasing with higher wind speeds.

The findings of this study can be applied beyond general interest, showing that these variables collectively influence air quality and visibility, with higher humidity and cloud coverage contributing to haze, while wind helps disperse particulate matter. Calm conditions can increase pollutant buildup, affecting public health and outdoor safety.

Results

