ATMOSPHERIC PROTOCOLS AND THEIR REACTIONS TO A CHANGE IN SEASONS

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by

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16 Years of Age

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Abstract

This project focused on atmospheric protocols such as air and surface temperatures, clouds, and humidity. Our project focused on the change and variability of these different atmospheric details over a given amount of time throughout a change of seasons. We focused primarily in the fall into the wintertime, hypothesizing that all protocols would decrease in value over the time. We then tested our experiment over the course of a few months. At the end of our experimentation, we have deduced that our hypothesis was both supported and disproved, depending on the protocol being tested. We deduced a huge drop in air and surface temperatures over this period of time, yet a slight increase in pressure and humidity, spiking at the beginning of December. Our cloud data showed no pattern over the days, yet it did change randomly. This allowed us to deduce there was no significant impact on the changing of the seasons on cloud movement. Due to a few human errors, our experiment might not be the most accurate, such as a lack of data points on our first day of testing that caused our surface temperature to be much higher than what it should've been.

Introduction

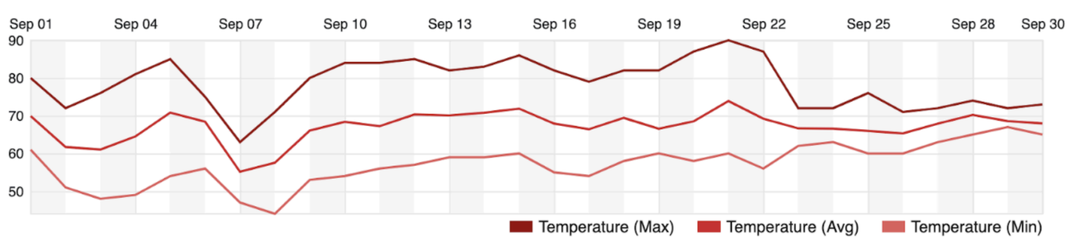
Question: How would temperature, humidity, and clouds change over time due to a decrease of temperature from fall into winter?

Hypothesis: If the seasons move from fall to winter, then the atmospheric qualities and quantities will decrease, because of the cold air that moves in over the local area of Toledo during the fall and winter months.

Background Research

The research and experiment on the atmosphere was prompted by a number of reasons, including interest in the atmosphere and the impact on the local area that it had. Out of the numerous options that were available, air and surface temperatures, humidity, and clouds seemed the most interesting to test. These then resulted in tons of research, leading to discoveries when referring back to the question at hand.

Firstly, air temperature was very helpful to the question as it helped refer to the main goal of seeing net change over the few months testing was to occur. As such, air temperature was one of the biggest priorities for the question at hand, and the research completed on other data and websites heavily talked about temperature and climate in the local area. According to Weather Underground, the local area's weather during testing in the latter 4 months and former month of the year shows an overall decline in temperature, which is normal. In September of 2024, Weather Underground reported an average of 67ºF, or 19ºC. This quickly dropped to an average of 33ºF, or 1ºC by December of 2024.



Weather Underground. (2025, January 28). Screenshot of September 2024 weather of Toledo, OH Weather [Image]. Weather Underground. https://www.wunderground.com/history/daily/us/oh/toledo/KOHTOLED220

Secondly, surface temperature is very closely related to air temperature, as both have a downward trend. This makes sense, as air temperature generally helps change the surface temperature in the same way the air changes in temperature. As the seasons turn from fall to winter, the research generally points in a colder direction for surface temperature. One source stated “Average daily temperatures have been sitting around 22 degrees, a noticeable drop from our long-term average of 28 degrees. The coldest night was this Wednesday, bottoming out at -3 degrees.” (WTOL 11, 2025). This is in reference to local weather, and due to its recent publishing, it shows how January was extremely cold. Logically, it can be deduced that the temperature of the numerous surfaces around the area would also diminish in temperature, in contrast to the much warmer September.

Humidity is also somewhat related to the temperature, however when the temperature decreases, the relative humidity increases. This inverse relationship is due to the fact that the amount of water vapor the air can hold increases with the temperature, and is true if the amount of water in the air stays constant. This research shows that in early fall, the relative humidity will be lower compared to the winter, as the temperature drops.

The formation of clouds is also similar to humidity in the fact that they rely on a large density of water vapor in the atmosphere to form. Temperature causing the air to move closer together allows for vapor density to increase, allowing more clouds to form. On average, there should be more clouds in the winter due to the decreased temperatures, but there should still be some sunny days. Clouds also block sunlight, decreasing the temperature even more.

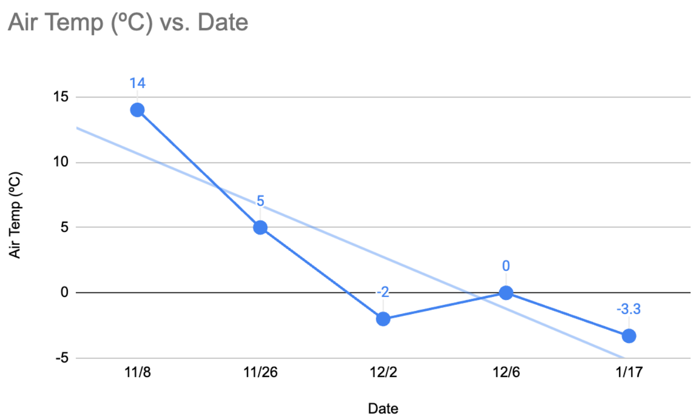
In conclusion, the research shows that the atmosphere changes noticeably due to the decrease in temperature from fall to winter. Relative humidity should increase due to the inverse relationship between it and temperature, and there should be more clouds on average.

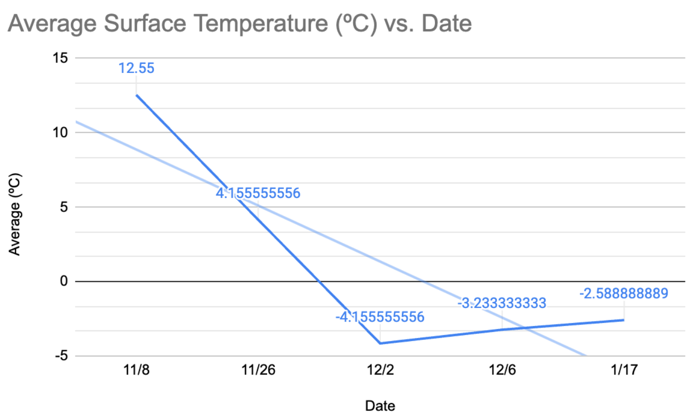
Methods and Materials

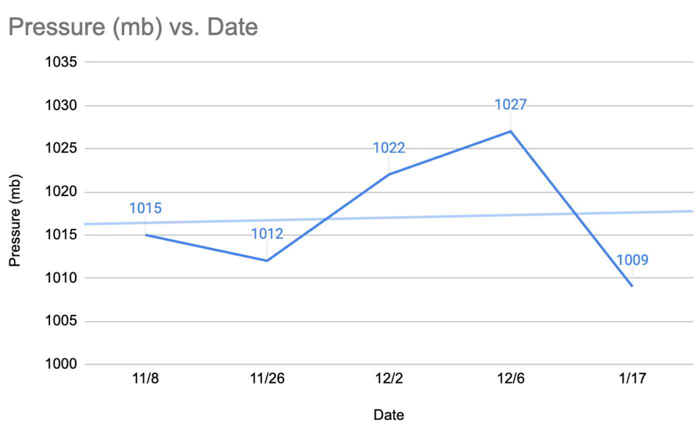
We decided to test our protocols of air temperature, surface temperature, clouds, and humidity through a few different ways. We used an in-class digital hydrometer and thermostat to help us get accurate measurements of humidity, pressure in mb, and air temperature of the outside in celsius. More specifically, the air temperature was of the air around the parking lot. However, this only helped with just a few of our protocols. We then decided to go outside of the classroom to our local school parking lot where we used an Etekcity infrared thermometer to measure the surface temperature of different parts of the blacktop, which was right near the air temperature recording. This way we were trying to record the most accurate data possible. We also used Globe data sheets from each protocol to help fill out our 9 data points for surface temperature (which was measured in celsius as well) and to record the different clouds located in our sky above us. To help us with clouds, we took a globe clouds chart to help show us which clouds were located where and what each one looked like. We also recorded precipitation, whether it was currently raining/snowing, or if there was some on the ground. We did a total of 5 total trials throughout the fall and winter, with the first one being on the 8^{th} of November and ending on the 17^{th} of January. Our other data was done on the days of the 26^{th} of

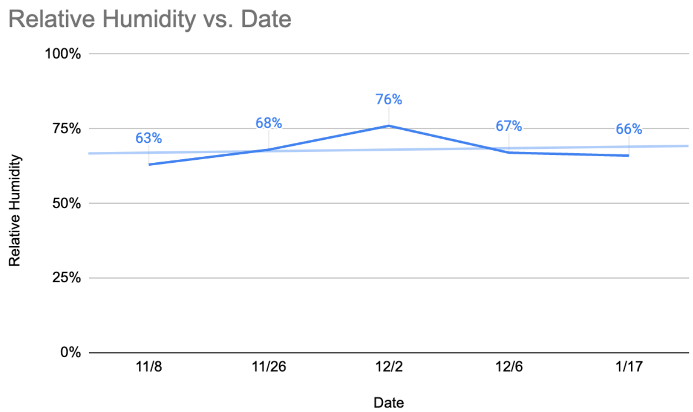
November, the 2nd of December, and the 6th of December.

Presentation of Data and Results









	11/8	11/26	12/2	12/6	1/17
Clouds Obscurity	**None**	**Overcast (90-100%)**	**Overcast (90-100%)**	**None**	**Few <10%**
Sky	**Blue, Clear**	**Blue, Clear**	**Cannot observe**	**Blue, Clear**	**Light Blue, Clear**
High Level	**None**	**None**	**None**	**None**	**Cirrocumulus, Translucent, Few (<10%)**
Mid Level	**None**	**Altostratus, Scattered (25-50%), Opaqu**	**Altostratus, Opaque Overcast (>90%)**	**None**	**None**
Low Level	**None**	**Stratus, Overcast (>90%), Opaque**	**Startocumulus, Opaque, Overcast (>90%)**	**None**	**None**
Snow/Ice	No	No	Yes	Yes	Yes
Standing Water	No	No	No	No	Yes
Muddy	No	No	No	No	Yes
Dry Ground	Yes	Yes	Yes	Yes	No
Leaves	Yes	Yes	Yes	Yes	No
Raining/Snowing	No	No	Yes	No	No

Our data helped show the temperature as it varies throughout the seasons of fall and oxygen. Our temperature data points totaled 9 (except for our first trial as we ran out of time, leaving us with only 2 points). As such, our temperature graph for the first date is much higher than the rest, due to the lack of a bigger sample size. To help us graph our points, we found the average of the multiple points we gathered each time we had time to record data. As our graph shows, we had a Leading up to the winter, the pressure slowly increased, before a peak midway through December. Afterwards, the pressure decreased until it was below where it was in the fall. As such, the pressure and temperature had an inverse and similar relationship, depending on the time of the months. Another data we measured was the humidity. Humidity also peaked in the beginning of December, just like our pressure. As such, we could see that humidity and pressure have a direct relationship with each other, as they track the same paths throughout the days we recorded our data. Overall, however, both humidity and pressure slightly increased over time, but with no significant difference than at the starting point. Our clouds had not varied that much, as it differed from time to time, with no clear pattern as the months went on during our recording of the data.

Analysis and Results

Our findings suggest that we had a very informative experiment. Our collected data helped prove our hypothesis both right and wrong. Regarding air temperature, our hypothesis was proven to be correct, as the air temperature had dropped by a total of approximately 15ºC from September to January when we collected data. Our surface temperature had a similar trend as well. However, our humidity and pressure increased in the beginning of December by 12 mB in terms of pressure and 13% in terms of humidity and then it decreased at the end of the said month. Our clouds did vary, but with no recognizable pattern, hence rejecting our hypothesis. Hence, our hypothesis was somewhat supported and rejected depending on the subject of what we were testing. Due to only 2 data points from our first day of testing, our surface temperature average for that day would be higher than usual due to the limited sample size. Next time, we would make sure to have more time to take more data for that day to have a more accurate average for surface temperature.

Conclusion

In conclusion, we have deduced that our hypothesis differed from protocol to protocol, as shown by our data. Due to this trend, we have come to the result that not all atmospheric measurements are impacted by the changing of the months and seasons. Previous to doing our experiment, we both undoubtedly agreed that temperature would be significantly impacted by the changing of the season from fall into winter. This became proven correct, as our temperature values decreased over the months we spent collecting our data. However, regarding humidity and pressure in our local area, we weren't as sure, and questionably thought that relative humidity and barometric pressure would both also decrease in value, as we predicted it would have a correlation with surface and air temperatures as they went down. This became known to us as a false statement, as our graphs actually showed a trendline that contradictingly slightly went up, instead. When regarding clouds, our data showed no clear-cut pattern that would show any causation of a change of time on cloud coverings. As such, our hypothesis, stating how clouds would also be impacted by the change of season, was technically right, as it did change. This change was random, rather than a more centralized model as we thought of when writing our hypothesis.

Discussion

If this were to be done in the future, we would make sure to have more data points tested on our first day to record more efficient averages for surface temperature. This way we would be able to more accurately graph our data points for surface temperature. Another thing we would alter to make our research experiment better is for us to get more time to record data then just the select few that we already collected. We believe our sample size is not enough for the best results. As such, we would definitely go outside and record more data in all of our different protocols that we decided to test to see if maybe a new pattern pops up or if our existing pattern would continue its trend further into the future.

Acknowledgments

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