College of Arts and Sciences, Atmospheric Sciences Program

Evaluating Numerical Weather Prediction Forecasting Accuracy in Columbus, Ohio

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Poster: S204

INTRODUCTION

Numerical Weather Prediction Models are the backbone of weather forecasting. They work through synthesizing a variety of atmospheric variables to create one output predicting the future state of the atmosphere. Meteorologists use NWP Models daily to create forecasts.

OBJECTIVE

- Evaluate 3 NWP Models:
  - GFS (Global Forecasting System)
  - NAM (North American Mesoscale)
  - HRRR (High Resolution Rapid Refresh)
- Gather in situ data from a meteorological tripod
- Compare models with measured data
- Times of data collection:
  - 00Z, 06Z, 12Z, 18Z

METHODS

Data Collection

Meteorological Tripod Setup Instruments:

- Temperature and humidity sensor
- Anemometer
- Tipping bucket rain gauge

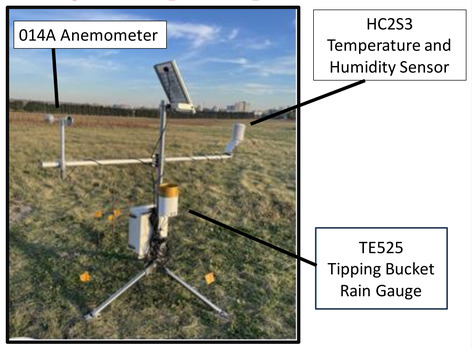
Initial period of data collection:

- 10/6/23 - 10/26/23

Secondary period of data collection:

- 11/4/23 - 11/21/23

Figure 1: Tripod Setup

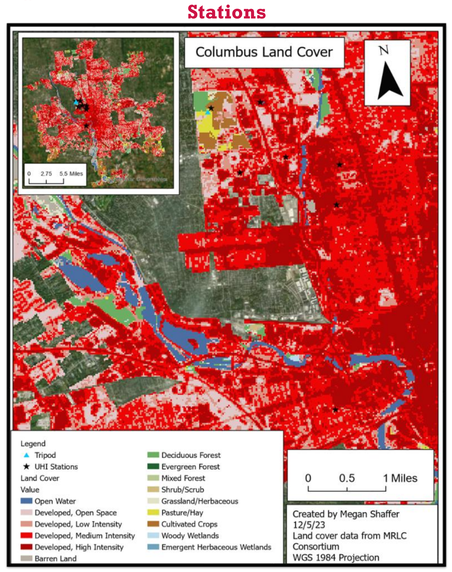


This image shows the team's tripod setup for the second round of data collection. It is equipped with a data logger and enclosure, HC2S3 temperature and humidity sensor, 014A anemometer, TE525 rain gauge, and solar panel to provide power.

Data Analyses

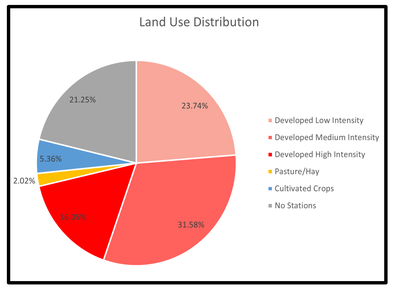
To get a comprehensive view of Columbus, we analyzed land cover of the city and used several Ohio State weather stations to average data in proportion to land use:

Figure 2: Columbus Land Cover and Weather Stations



This figure depicts a map of the Columbus city boundary with a data overlay from the National Land Cover database provided by the USGS. The stars and triangles represent weather stations used to create a city average.

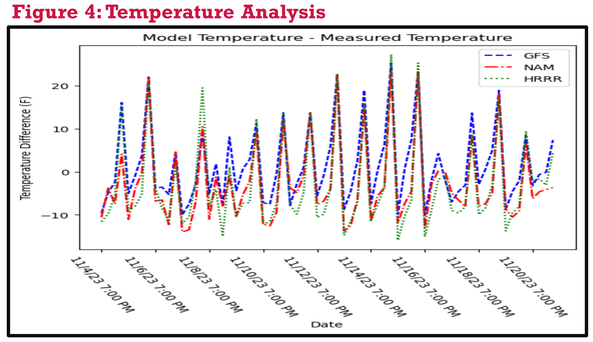
Figure 3: Columbus Land Use Distribution and Weather Station Locations



This figure shows a graph of total Columbus land area coverage on the left. 21% of the land types did not have weather stations. The chart on the right shows how many weather stations were located within specific land use types.

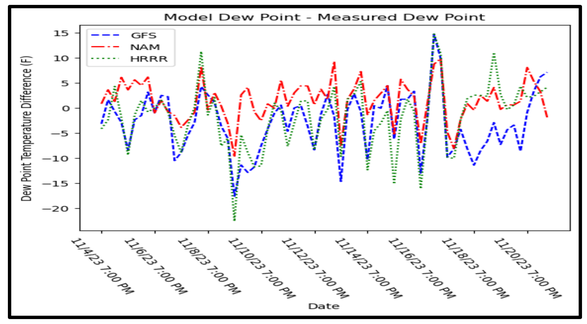
RESULTS

Figure 4: Temperature Analysis



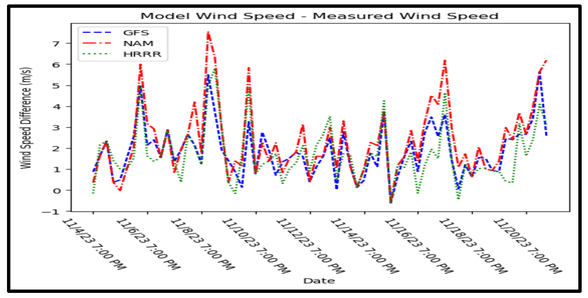
- Overestimations up to 30° F, underestimations of 20° F (11/15)

Figure 5: Dewpoint Analysis



- NAM consistently overestimated dewpoint temperatures and the GFS consistently underestimated.

Figure 6: Wind Speed Analysis



- The NAM and HRRR are more consistent with one another. The GFS predicts higher values.

Table 1: Absolute Error

	GFS	NAM	HRRR
Temperature (°F)	*6.87±0.18*	*8.40±0.18*	*9.67±0.18*
Dewpoint (°F)	*5.19±0.18*	*3.41±0.18*	*4.93±0.18*
Wind Speed (m/s)	*1.88±0.11*	*2.38±0.11*	*1.75±0.11*

Table 2: Final Results

	Most Accurate	→	Least Accurate
Temperature (F)	*GFS*	*NAM*	*HRRR*
Dewpoint (F)	*NAM*	*HRRR*	*GFS*
Wind Speed (m/s)	*HRRR*	*GFS*	*NAM*

CONCLUSIONS

Most Accurate:

- Temperature – GFS
- Dewpoint - NAM
- Wind Speed - HRRR

Impact of Our Research:

- Improves accuracy of forecasts and confidence in meteorologists to use particular NWP Models
- More accurate forecasts leads to the public's confidence in meteorologists' forecasts

Further Research:

- Deploying more stations in more diverse land cover zones, more consistent methodology of tripod deployment all throughout Columbus.
- Longer time period of data collection: our two week period fell in drought-like conditions resulting in lack of precipitation data.

BIBLIOGRAPHY

Columbus Department of Public Service, 2020. City of Columbus Corporate Boundary. The City of Columbus, accessed 12/3/23, https://opendata.columbus.gov/datasets/columbus::corporate-boundary/explore?location=39.982540%2C-82.990850%2C11.00&showTable=true

MRLC, 2021: National Land Cover Database. Multi-Resolution Land Characteristics Consortium, accessed 12/3/23, https://www.mrlc.gov/viewer/

State Climate Office of Ohio, 2023: OSU Campus Weather Stations. State Climate Office of Ohio, accessed 12/3/23, https://scoo.byrd.osu.edu/mesonet/dashboard

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