

Validating Model Freezing Level Heights for West Lafayette, Indiana using Purdue University Radiosonde Data



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Looking at how observed data correlates with simulated forecast data.

Background:

- 70,000 radiosondes are launched by the National Weather Service yearly, none from West Lafayette (see Fig. 1).
- 0°C height (freezing level) is important for aviation and meteorology.
- BUFKIT provides forecasted sounding-like data for weather stations in the U.S. that do not launch radiosondes (NOAA/NWS 2016; Mahoney & Niziol 1997).

Objective:

- Validate 0°C heights for BUFKIT over Purdue for two numerical weather prediction (NWP) models, HRRR and RAP, using 33 in situ soundings collected from 2017 to 2023.

Hypothesis:

- There will be a strong correlation ($r > 0.8$) between the BUFKIT and radiosonde-collected freezing level heights.

Correlation coefficients remained high for different models and meteorological scenarios.

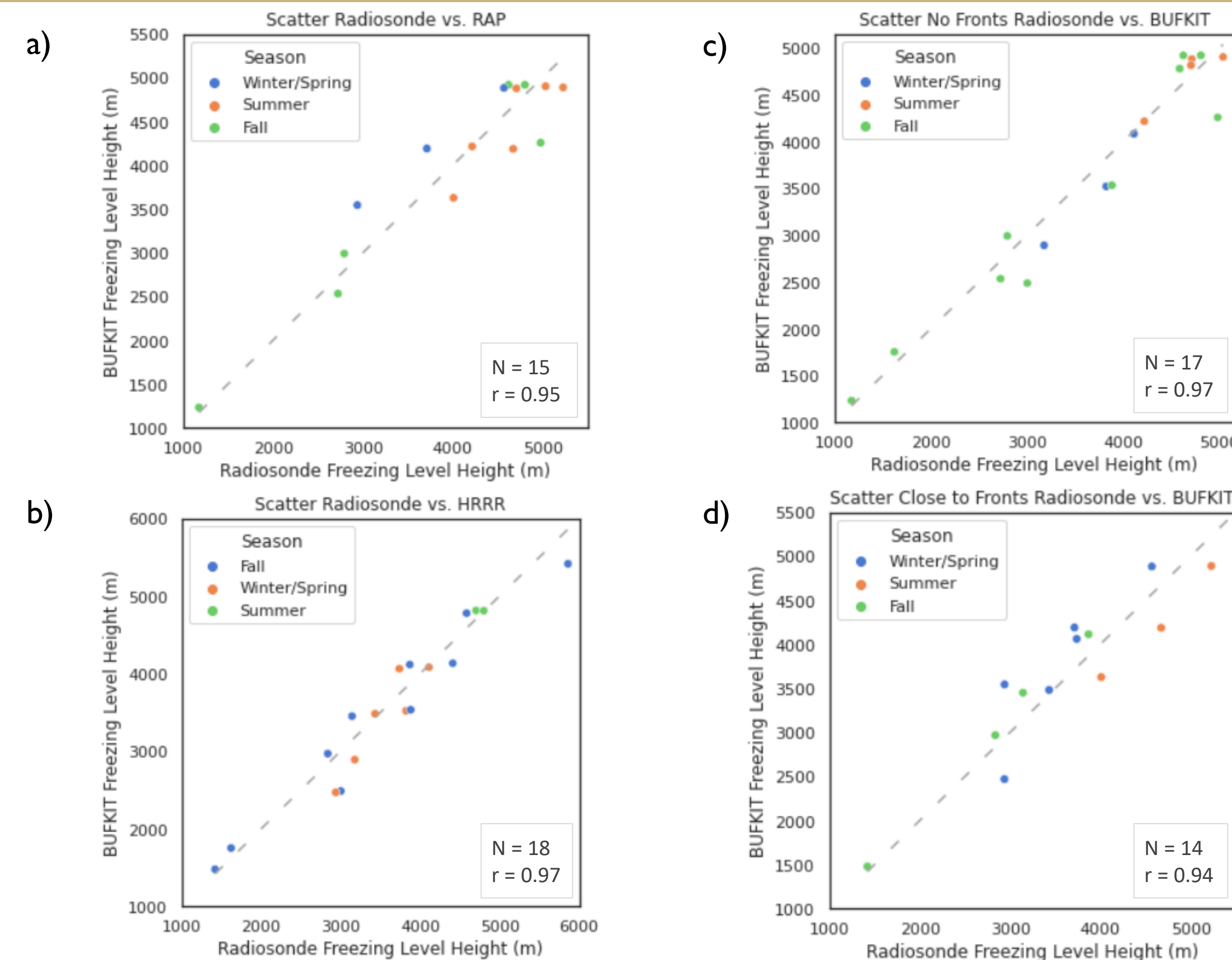


Fig.2. Scatter plots of NWP model used and proximity to fronts, where a) shows the RAP freezing level heights, b) shows HRRR data, c) is soundings with no fronts present, and d) is soundings where fronts were in the vicinity (150 km radius). Meteorological seasons are used (summer is Jun-Aug, fall is Sep-Nov, etc.).

Correlation between radiosonde and BUFKIT freezing levels was excellent ($r=0.96$).

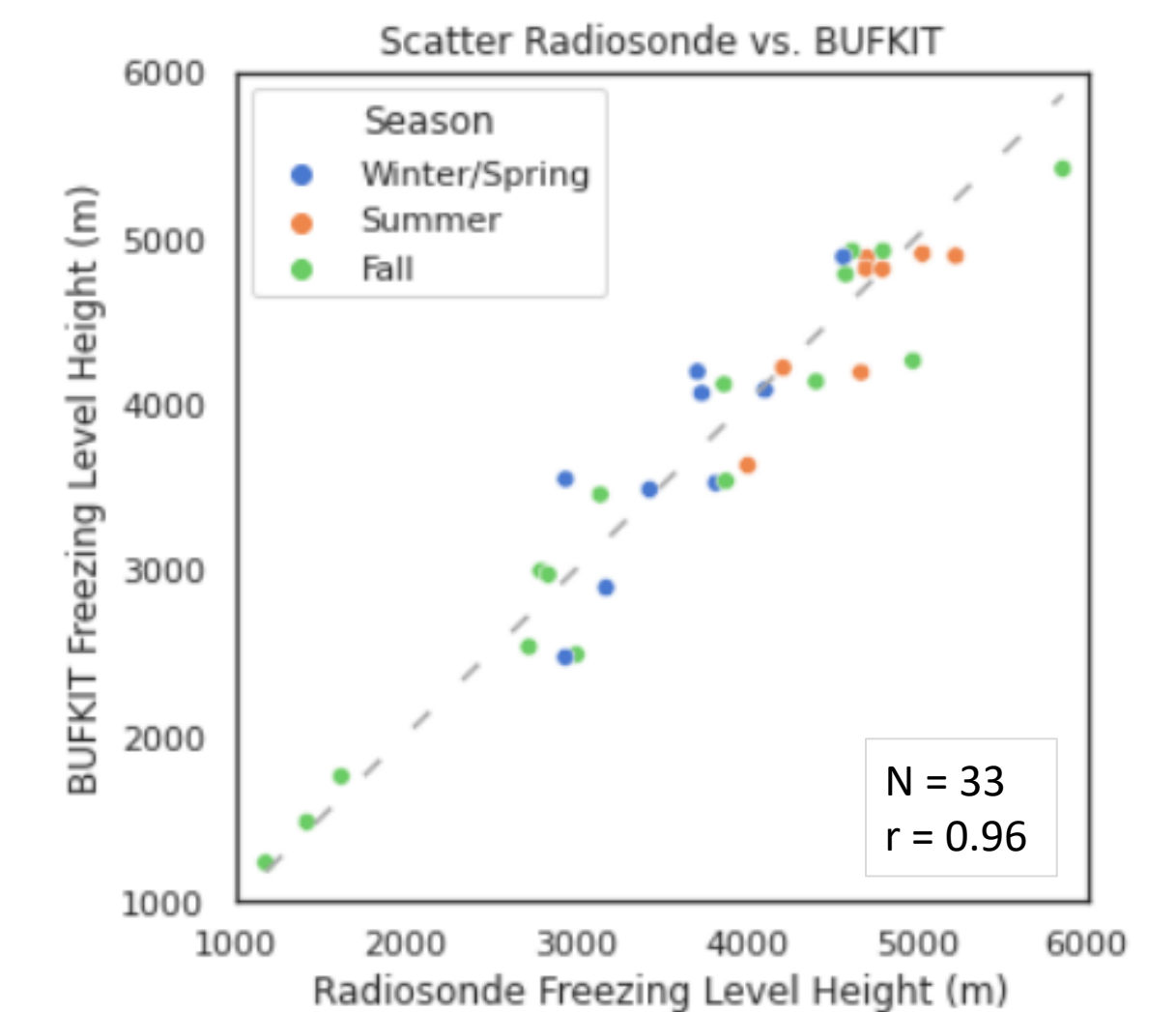


Fig. 3. Scatter plot displaying freezing level heights (in m) at each date for both BUFKIT and weather balloon data. The data is coded by season.

Purdue EAPS launches radiosondes for classes and other activities.



Fig. 1. The first author, holding a radiosonde (Windsond.com) that was launched 31 March 2023. The electronics in the cup to the right allow for data recording. Windonds have been used in meteorological research (Markowski et al., 2017).

Implications of the findings.

Overall, we found a strong correlation (>0.8) between the BUFKIT freezing level heights and the weather balloon freezing level heights. Researchers can feel confident using BUFKIT to ascertain freezing level heights for the Lafayette and West Lafayette area. This conclusion is supported by the relatively low bias and uncertainty values that were calculated, as well as the high correlation coefficients for the total and the split data values.

References.

- Markowski, P. M., Y. P. Richardson, S. J. Richardson, and A. Petersson, 2017: *Bull. Amer. Meteor. Soc.*, **99**, 711–724, <https://doi.org/10.1175/BAMS-D-17-0204.1>.
- NOAA's National Weather Service. (2016, January 15). *Bufkit Data*. National Weather Service. Retrieved March 30, 2023, from <https://www.weather.gov/cae/bufkit.html>.
- Mahoney, E. A., and T. A. Niziol, 1997: BUFKIT: A software application toolkit for predicting lake effect snow. Preprints, 13th International Conf. on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, Long Beach, California, American Meteorological Society, 388–391.

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Did BUFKIT's performance depend on season, model, or meteorological scenario?

The freezing level height data correlation coefficient ranged from 0.83 to 0.98. The overall data (Fig.3) had a correlation of 0.96. Statistically, this indicates that NWP models are strongly representative of freezing level heights over Purdue. The bias was about -35 m, meaning BUFKIT freezing level heights tended to be 35 m lower than those measured by radiosondes. The uncertainty of BUFKIT freezing level heights was ± 320 m, owing to the coarse vertical grid spacing of the models.

We can further analyze our data (Fig.2):

- Winter and spring months combined due to small number of radiosondes launched in those seasons
- Fall had highest correlation coefficient at 0.98, and summer had the lowest at 0.83 – still very strong correlation
- Slightly higher correlation for HRRR (0.97) than RAP (0.95)
- Freezing level heights near a front had a lower correlation coefficient (0.94) than those that were not near a front (0.97)