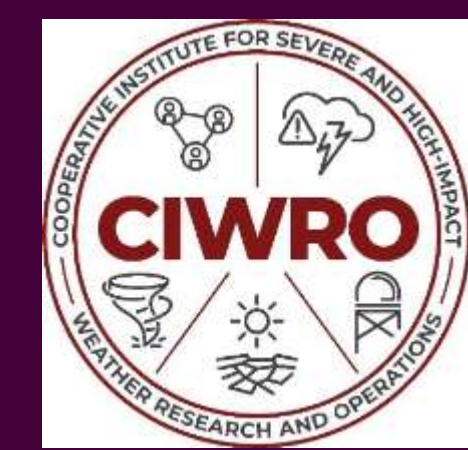




A Sneak Peek into Techniques for Improving Boundary Layer Measurements



Author: Arianna M. Jordan

Affiliation: University of Oklahoma



Abstract

The planetary boundary layer (PBL) is the lowest few kilometers of the atmosphere, where properties like wind velocity, turbulence, and aerosol backscatter vary on timescales shorter than those in the free atmosphere. These PBL properties can be observed with the Collaborative Lower Atmospheric Mobile Profiling System (CLAMPS), a versatile platform that houses a Doppler Lidar, microwave radiometer, and other valuable tools. In summer 2021, the collaborative BLISS research group at OU-NSSL-CIWRO deployed several such platforms to the OU Kessler Atmospheric and Ecological Field Station near Washington, Oklahoma. BLISSFUL CLAMPS data for the day of June 17th, 2021 are explored in this study. Additionally, new PBL height detection algorithms are examined using this dataset. The fuzzy logic method provided a diurnal height estimation depicting the evolution overtime, but failed when a huge surface inversion at 12Z was present. The sounding method was able to record the true height of the boundary layer at this time, but its spatial and temporal capabilities are limited. Both these methods and more will be further explored in future campaigns.

Methods and Data



1) Fuzzy Logic (Bonin et. al 2018):

- CLAMPS 2 at Kessler Farm in Purcell, OK: [2021-06-17](#) (full diurnal cycle)
- Membership functions from 0 to 1 → Weighted-mean 1st and 2nd step aggregation → Defuzzify → PBL height estimates

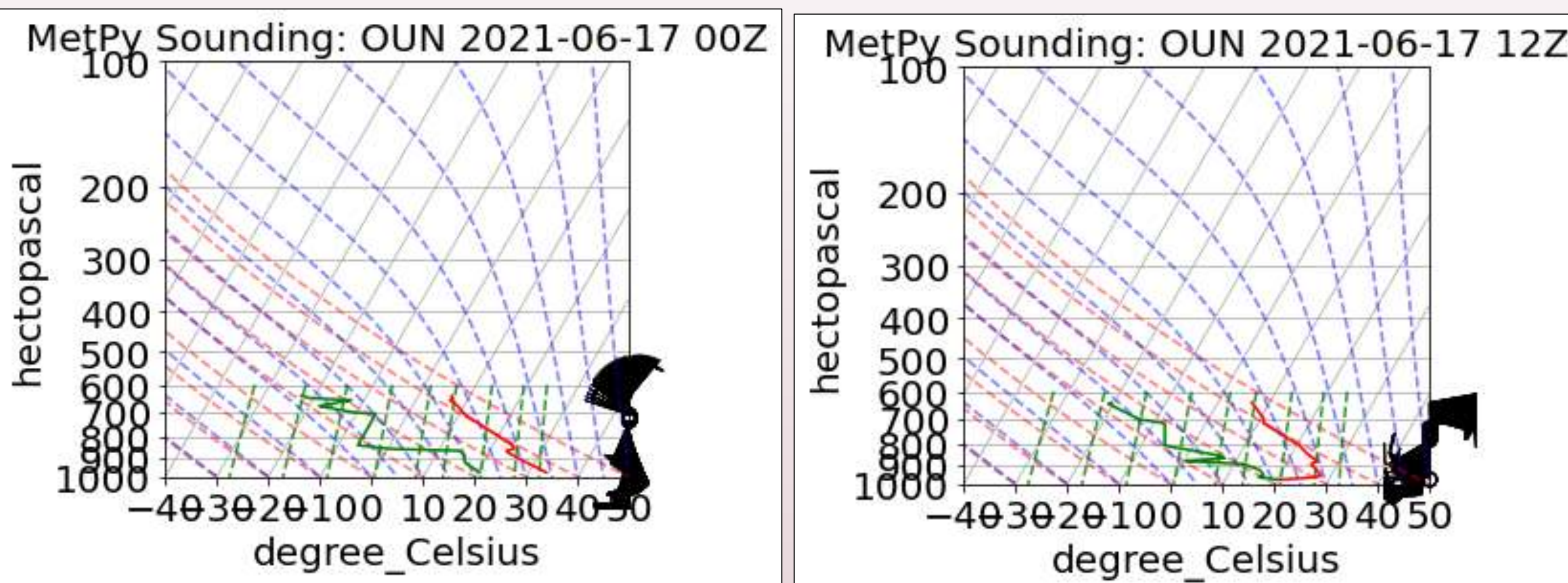
2) Sounding Method

- KOUN radiosondes launched: [2021-06-17](#) (00Z and 12Z)
- 7 methods utilized from Seidel et al. (2010) and Coniglio et al. (2013) listed in left plots below; median of 7 methods = PBL height estimates (black dashed line)

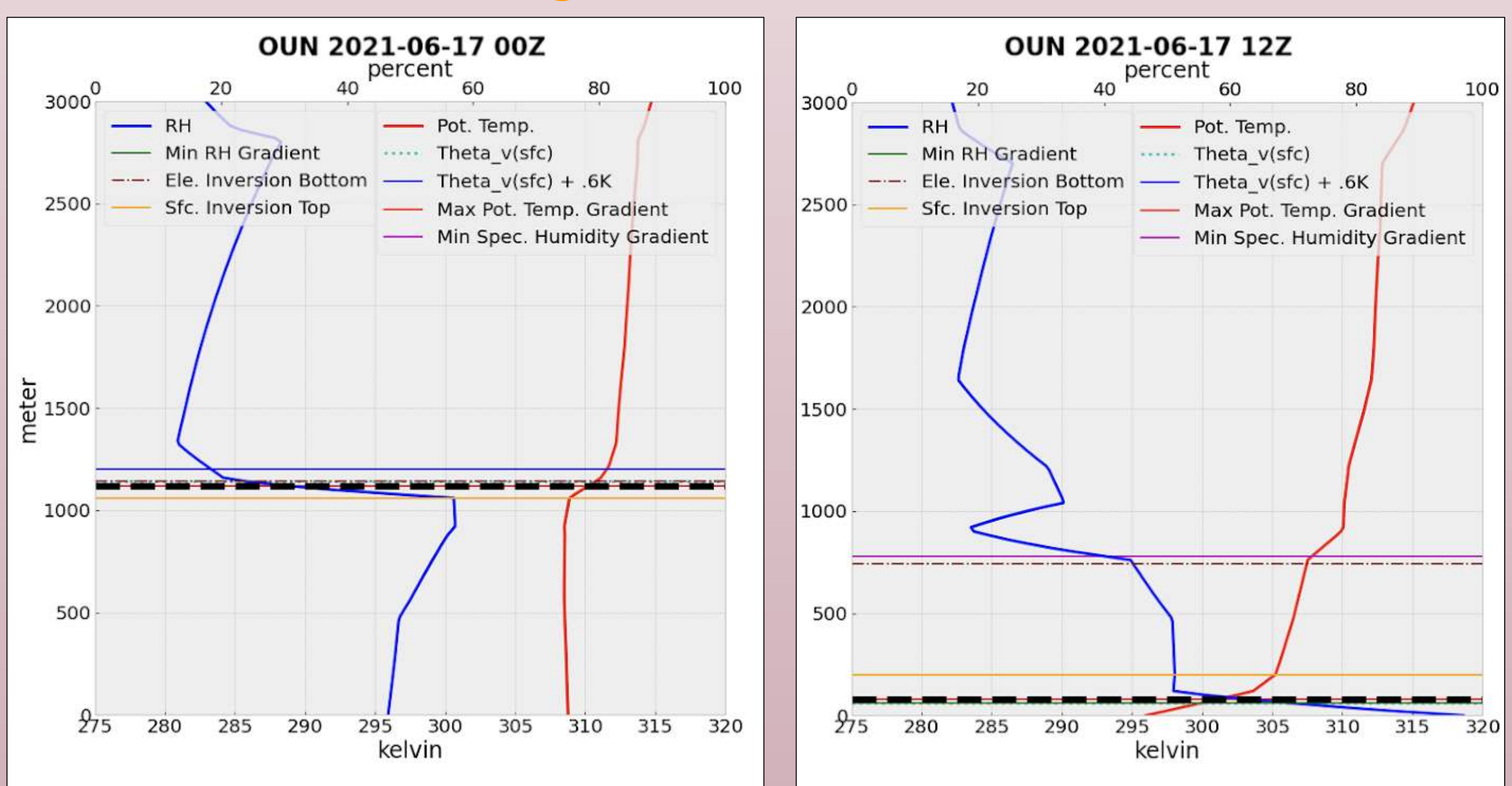
Results

Sounding Method

Environment based on Skew-T Log Diagrams



PBL Height Estimates at 00Z and 12Z

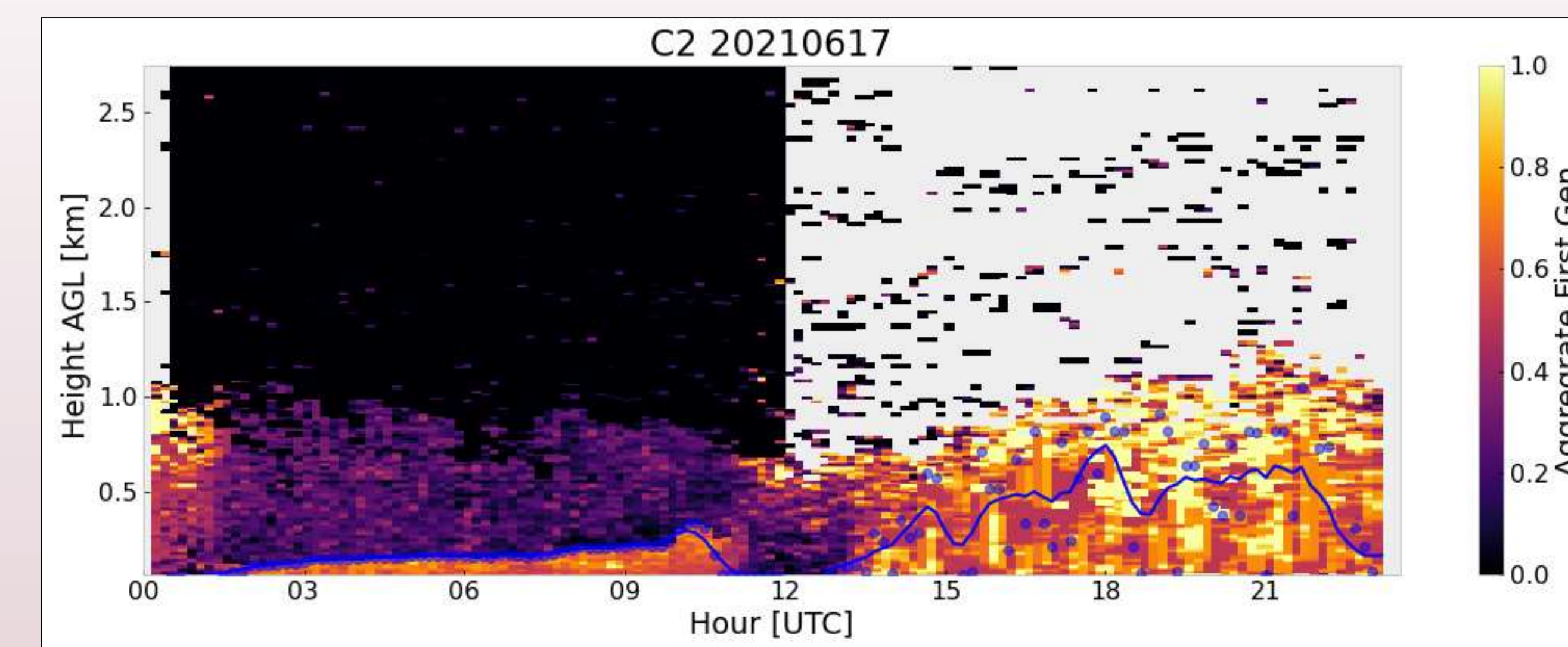


Discussion

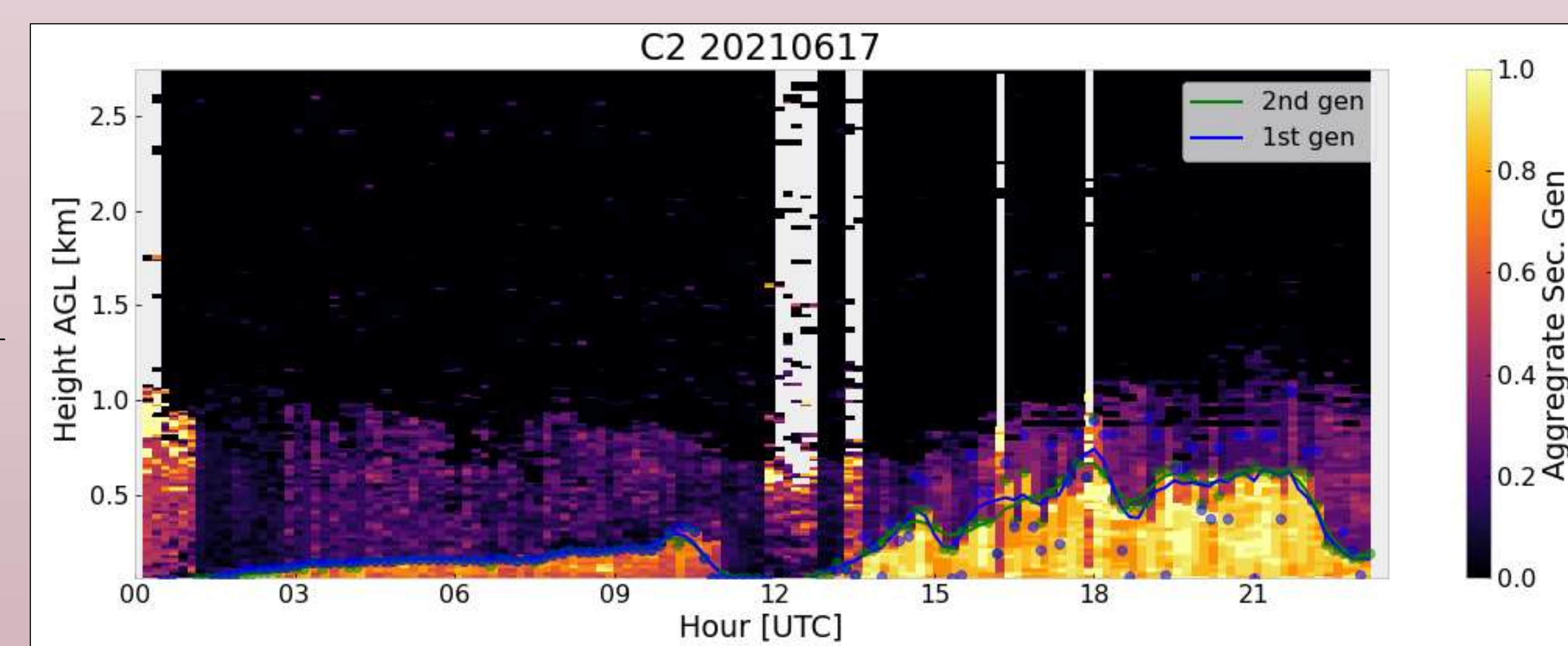
- **Sounding method:** little moisture at 00Z, huge surface inversion in 12Z Skew-T. Maximum potential temperature gradient performed best of 7 methods, using ensemble is ideal compared to using a single method
- **Fuzzy logic:** 2nd aggregation far less noisy and has less uncertainty (blue dots) than 1st aggregation, making it favorable for convective PBL. High aggregation values from earlier in the day shown at 00Z. Large inversion can be seen in the temperature gradient profile.
- **Comparison:** Sounding and fuzzy logic accurately computed the same height at 00Z. And 12Z, fuzzy logic fails suggesting soundings are more reliable for complex transitions from evening to morning.

Fuzzy Logic Method Results

PBL Height Estimate: 1st Generation Aggregation

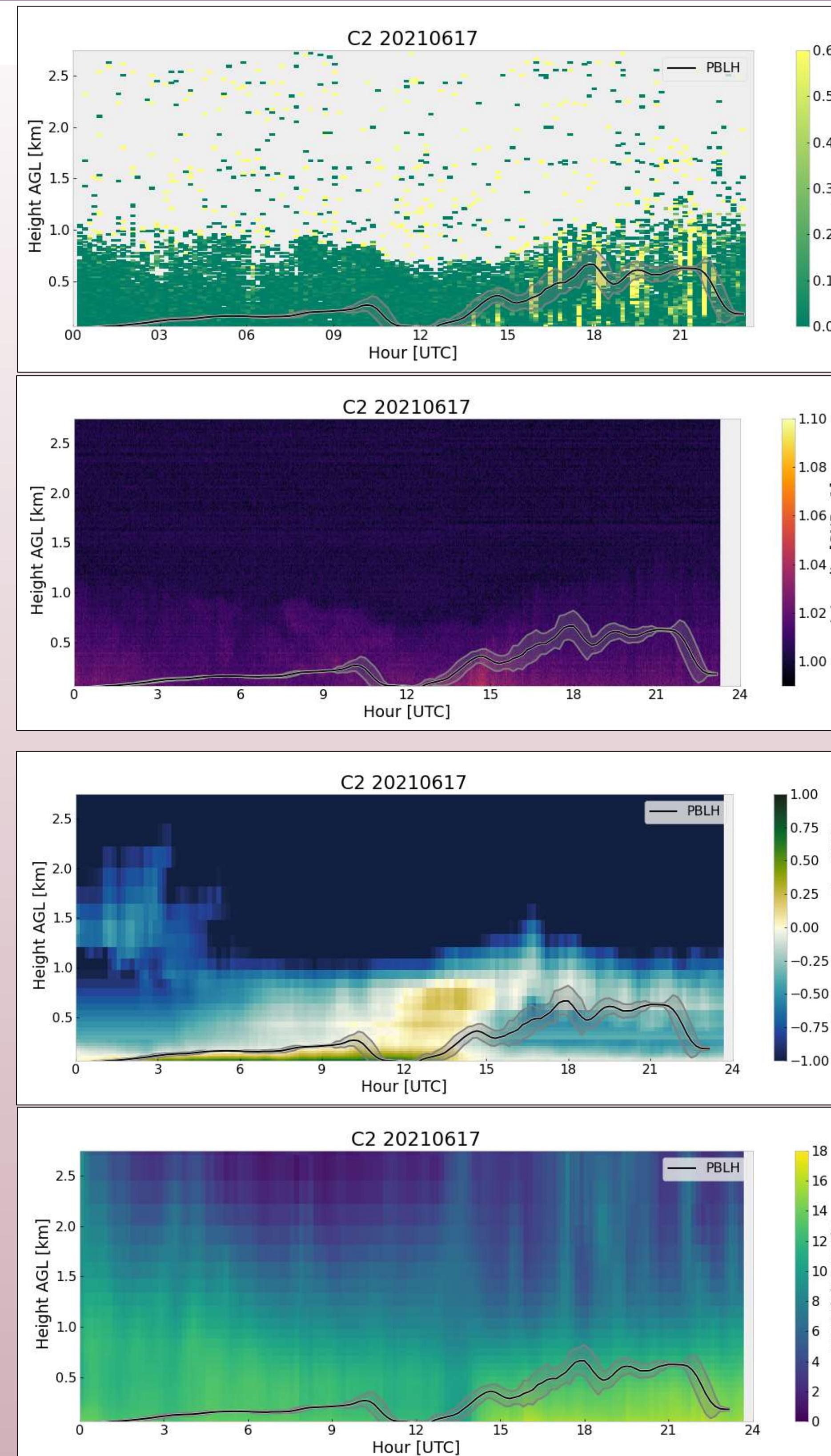


PBL Height Estimate: 2nd Generation Aggregation



Mixing in action

Results of mixing



Conclusion

- **Sounding method:** results were accurate, but lacked diurnal and nocturnal evolution ideal from PBL studies.
- **Fuzzy logic:** seems to have performed well in all the time periods except at 12Z, however this can be best confirmed by comparing more sounding data with different times in the day. Other BLISSFUL days have this data availability and will be further analyzed.
- **Comparison:** is most ideal for short-term fieldwork and cheaper than CLAMPS instrumentation. Fuzzy logic is best for extended work and studying convective conditions.

Future Work and Acknowledgments

- Implement more height detection methods: a machine learning approach that trains data with a random forest algorithm and radar
- Analyze more days from BLISSFUL time period (May 27th – July 7th 2021) and additional campaigns in different locations

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