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Air-Land Interactions

# Toward quantifying turbulent vertical airflow in tall forest canopies using fiber-optic distributed temperature sensing

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# Introduction:

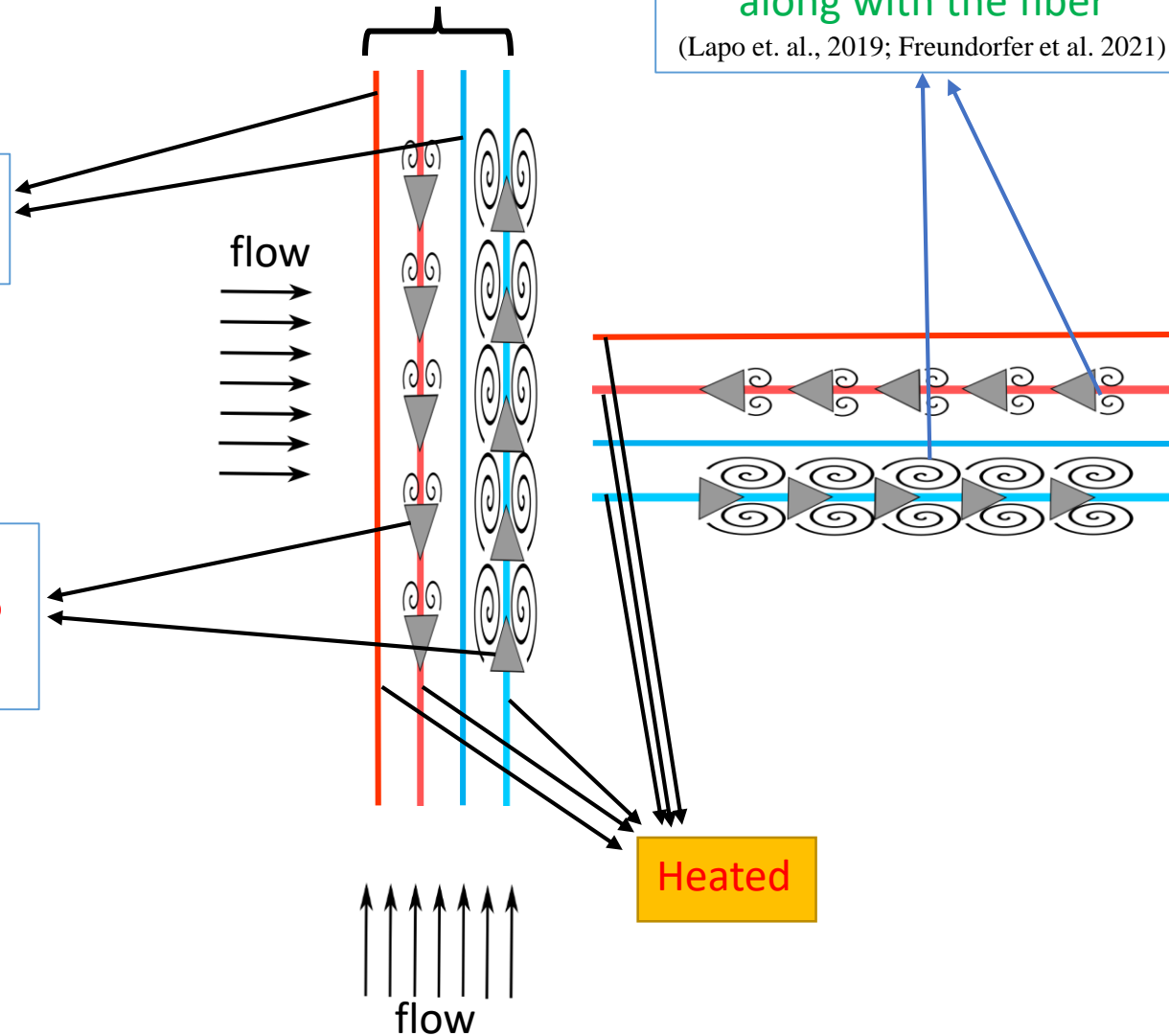


Wind speed perpendicular  
to the fiber (Sayde et al., 2015)



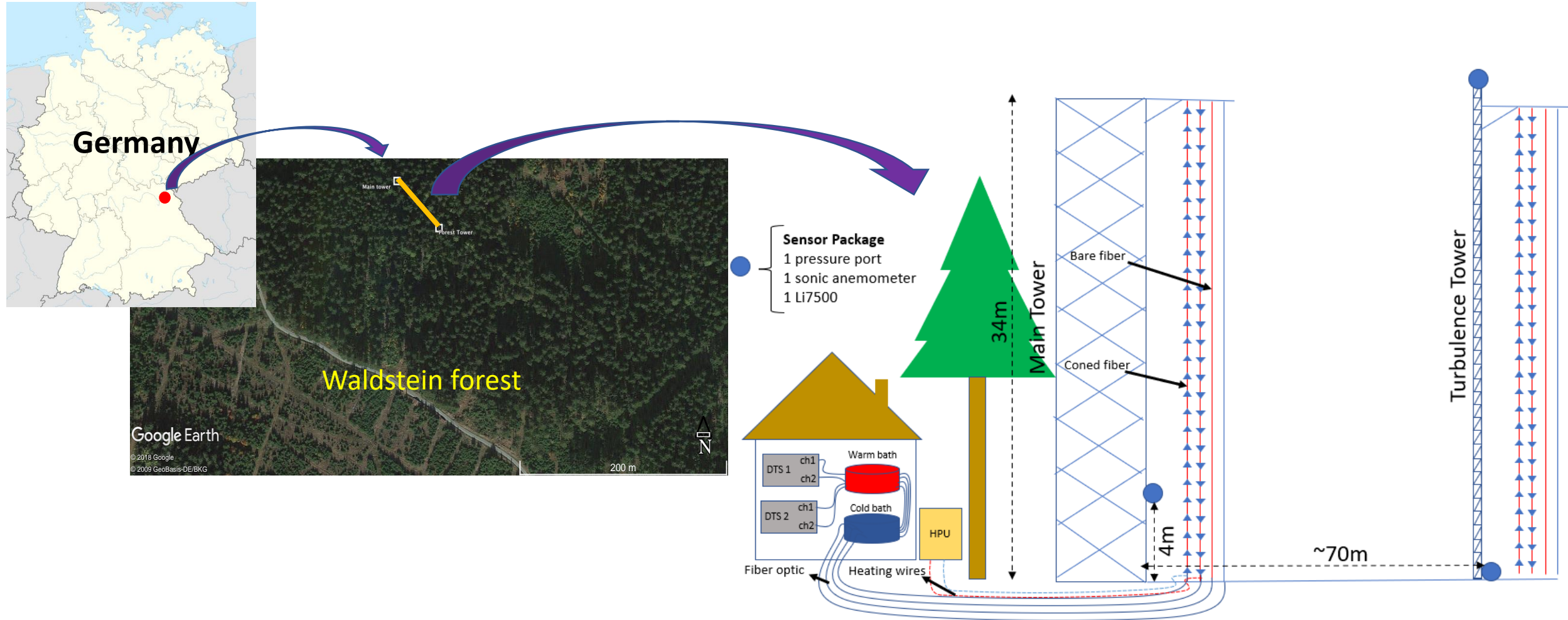
- I. Vertical wind speed?
- II. Vertical wind direction?
- III. Sensible heat flux?

Quartet fiber optic cable





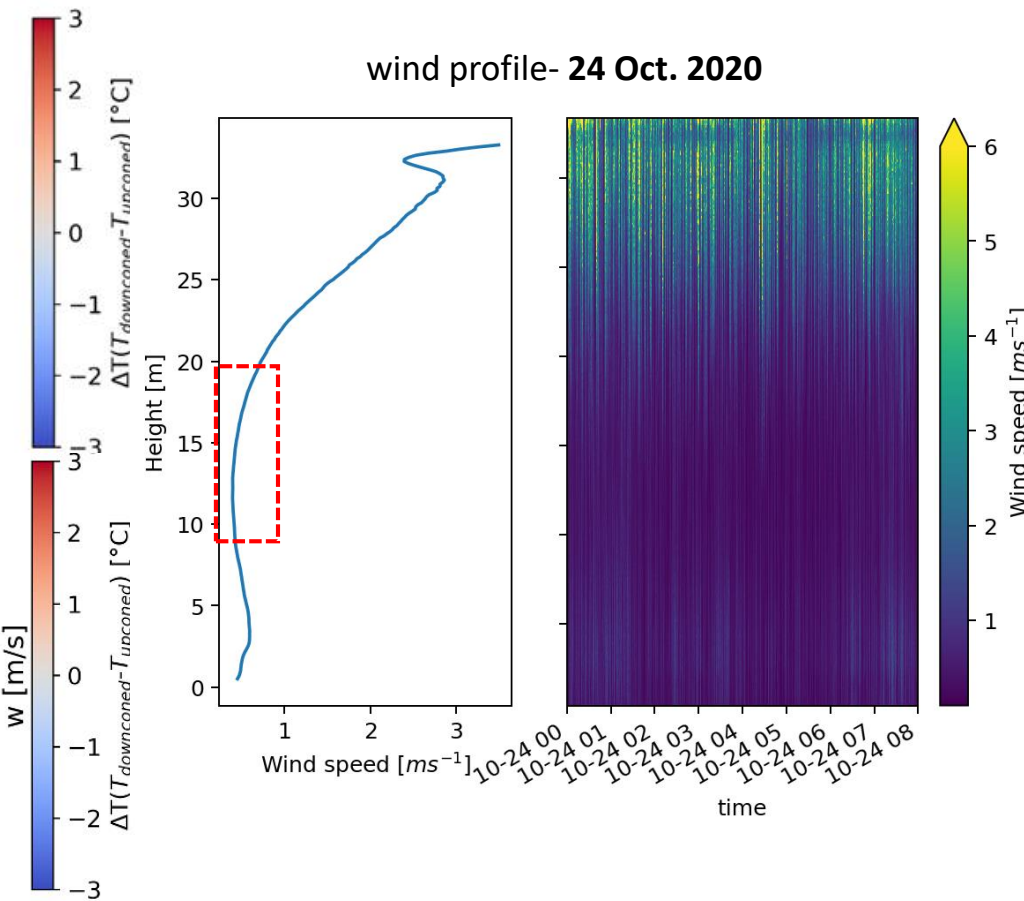
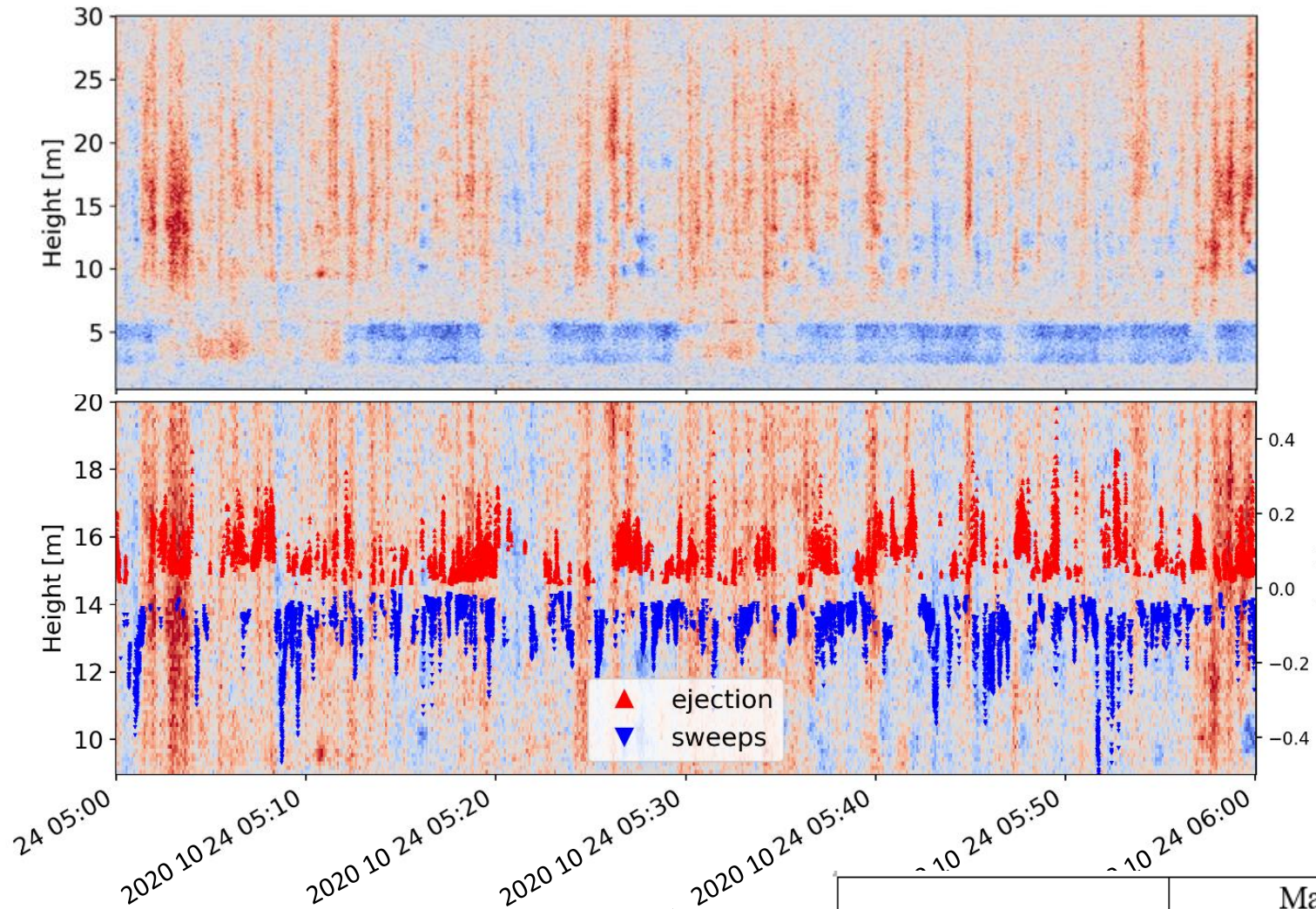
# Experimental setup:



- Data acquisition: 0.127m, 6s for DTS measurement, and 20Hz for point measurements

# Results:

Time difference of upconed and downconed fibers - main tower- **24 Oct. 2020**



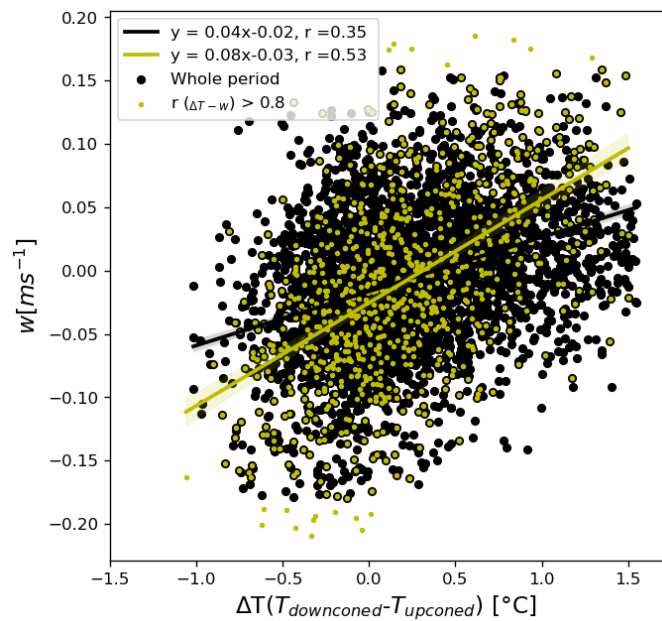
success rate of observing  
vertical wind direction

	Main tower		Turbulence tower	
	N	Success rate (%)	N	Success rate (%)
All of the data	4200	60	4200	63
Rolling-Corr. $\Delta T-w > 0.8$	834	71	753	67

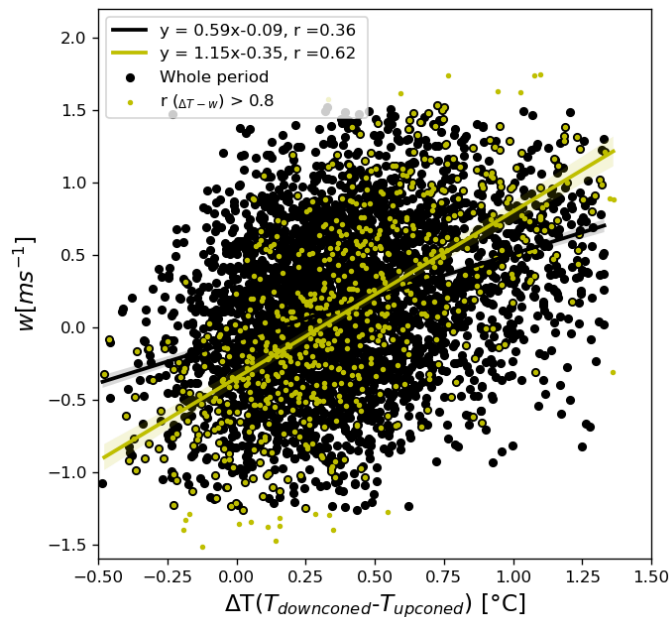


# Results:

## Main tower



## Turbulence tower



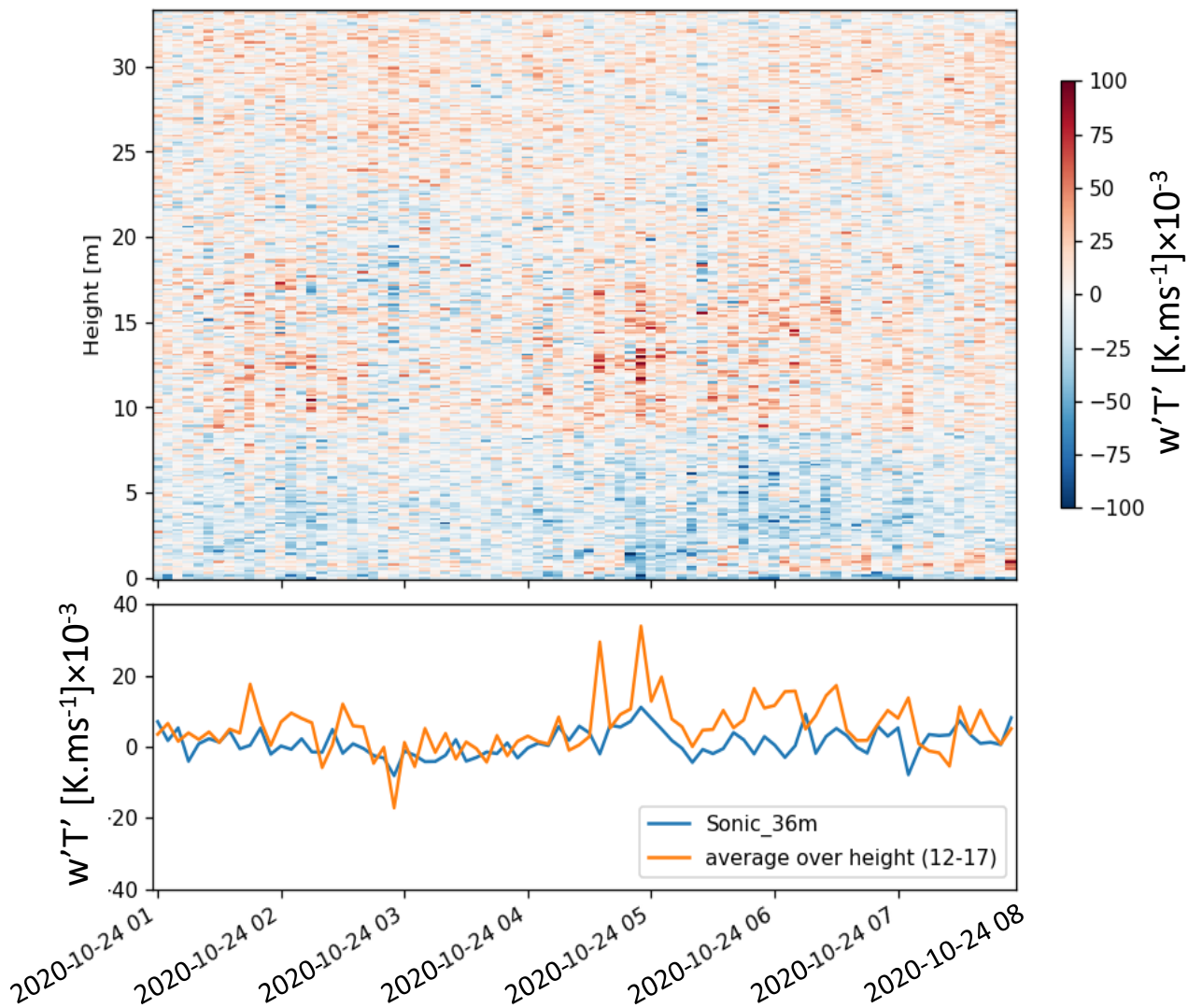
$\Delta T$  from coned fiber

$$\pm \overline{W'T'}$$

Bare fiber

Linear model between  $\Delta T$  and  $w$ , coned fiber

## Distributed sensible heat flux for turbulence tower, 5 min, 24 Oct. 2020



# Conclusion:

- I. The setup can detect the vertical wind direction/coherent structure events
  - II. There is a relationship between  $\Delta T$  from the quartet fiber configuration and w
  - III. Sensible heat flux solely calculated from fiber-optic distributed temperature sensing within the range of the direct EC flux
- 
- I. These findings motivate further development of the method



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## References:

Lapo, Karl, Anita Freundorfer, Lena Pfister, Johann Schneider, John Selker, and Christoph Thomas. 2020a. "Distributed Observations of Wind Direction Using Microstructures Attached to Actively Heated Fiber-Optic Cables." *Atmospheric Measurement Techniques* 13(3):1563–73. doi: 10.5194/amt-13-1563-2020.

Freundorfer, Anita, Karl Lapo, Johann Schneider, and Christoph K. Thomas. 2021. "Distributed Sensing of Wind Direction Using Fiber-Optic Cables." *Journal of Atmospheric and Oceanic Technology* 1871–83. doi: 10.1175/jtech-d-21-0019.1.

Sayde, Chadi, Christoph K. Thomas, James Wagner, and John Selker. 2015. "High-Resolution Wind Speed Measurements Using Actively Heated Fiber Optics." *Geophysical Research Letters* 42(22):10064–73. doi: 10.1002/2015GL066729.

**Thank You For Your Attention!**  
**Any Question?**