Data quality assurance and validation of the SNL SWiFT meteorological tower

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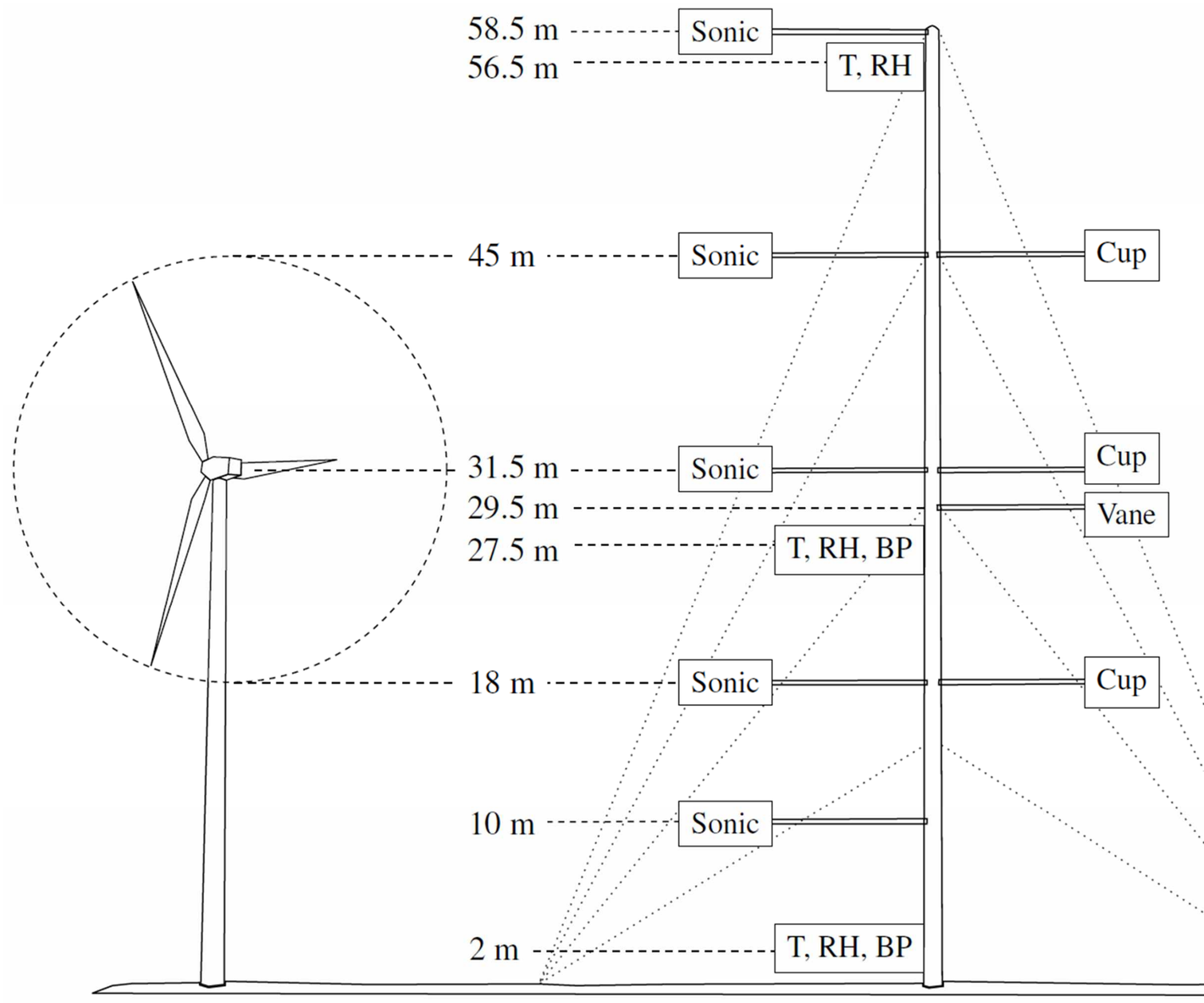
Motivation

Understanding atmospheric effects on wind turbine performance is a pacing challenge for wind energy research.

Sandia's Scaled Wind Farm Technology (SWiFT) facility is a state-of-the-art wind testing site, and serves as a research testbed for advanced rotor designs.

To further these efforts, SWiFT includes multiple meteorological towers to allow for detailed characterization of atmospheric effects crucial for next-generation turbine designs.



Objective

Support SWiFT meteorological tower construction and operation through development of automated scripts to ensure optimal sensor performance, data acquisition, and data quality.

Method

Deployable tool to aggregate, inspect, and summarize raw data from all met tower sensors. Data quality assurance and validation methods include:

Spike detection

Spikes are statistical outliers in the time series data and are detected using the median absolute deviation (MAD). This method relies on the sample median and median absolute deviation, which are robust measures of central tendency and variability.

Hold detection

Holds are intervals where consecutive readings return a constant value, indicating a non-responsive instrument, data transmission or data ingest problems. Holds are detected using a running window of frequency distributions, and flagged when *n* consecutive readings fall into the same frequency bin.

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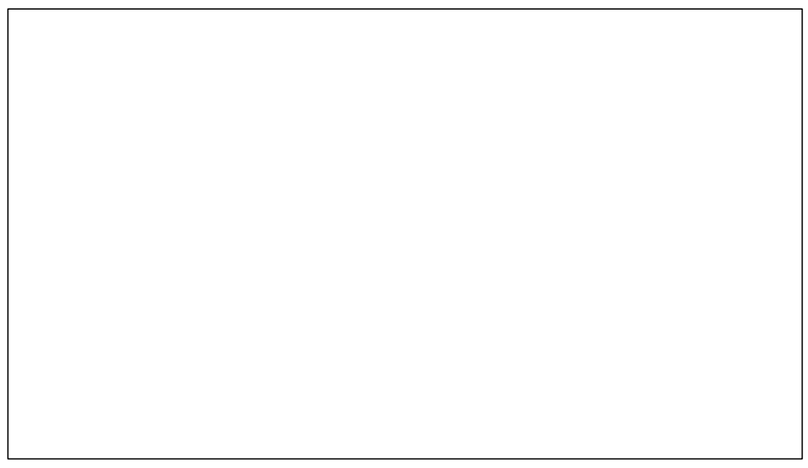


One-dimensional (streamwise) spectra of velocity and temperature with predicted -5/3 Kolmogorov fall-off

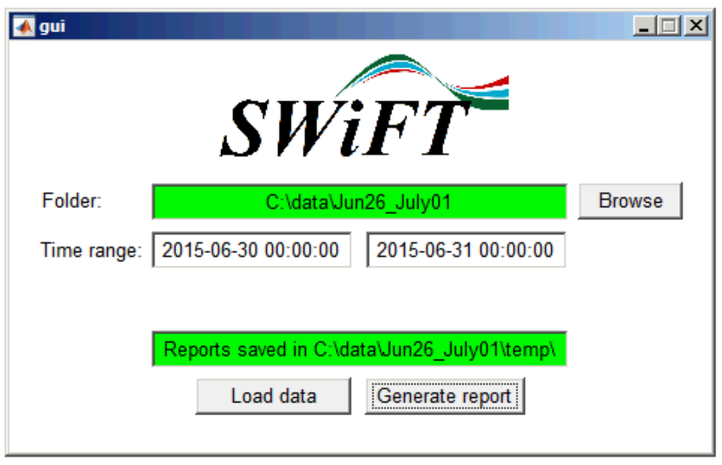
Spectral behavior

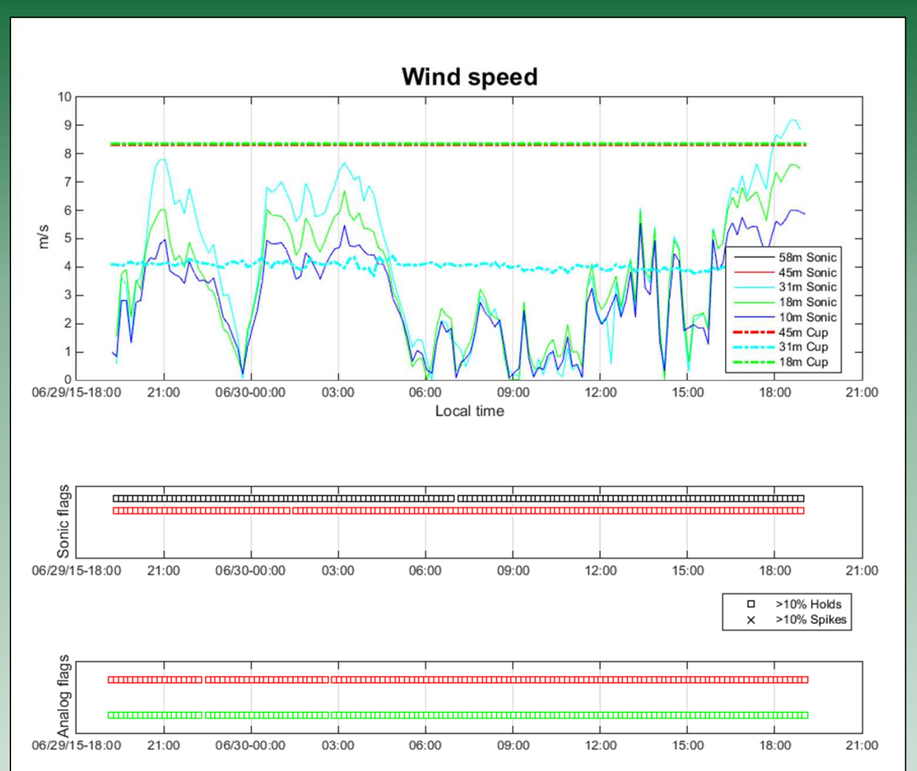
Atmospheric turbulence spans a wide range of scales. Energy is created at the largest scales (~1 km) and dissipated at the smallest scales (~1 mm). Turbulence theory predicts a constant flux of energy down-scale, such that the spectrum in the intermediate region has a constant, predictable fall-off.

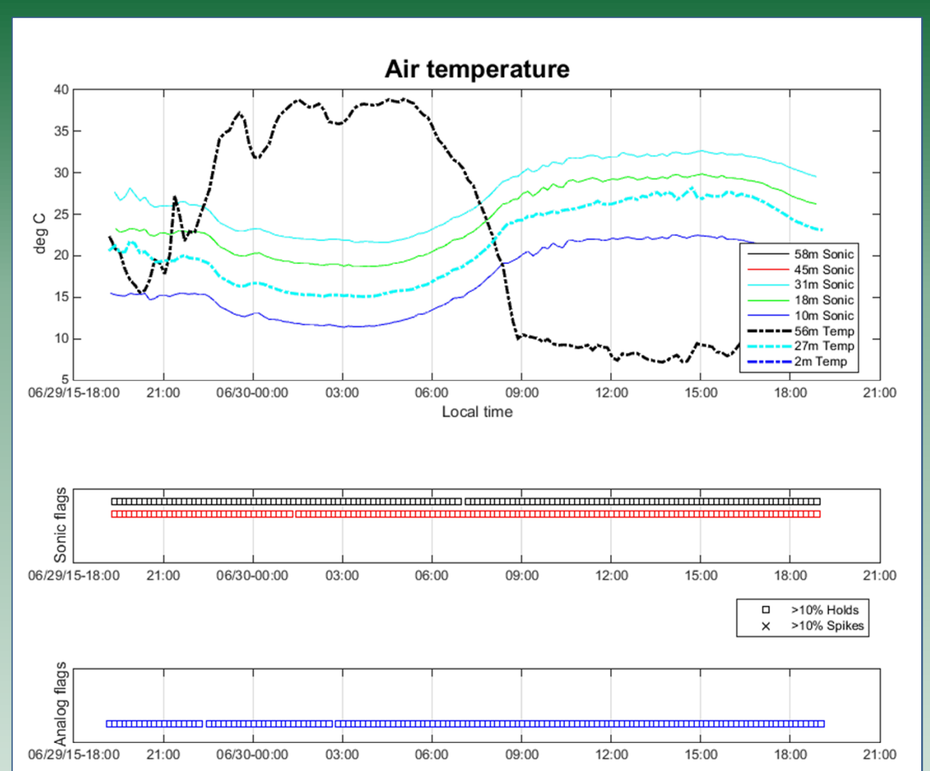
Results

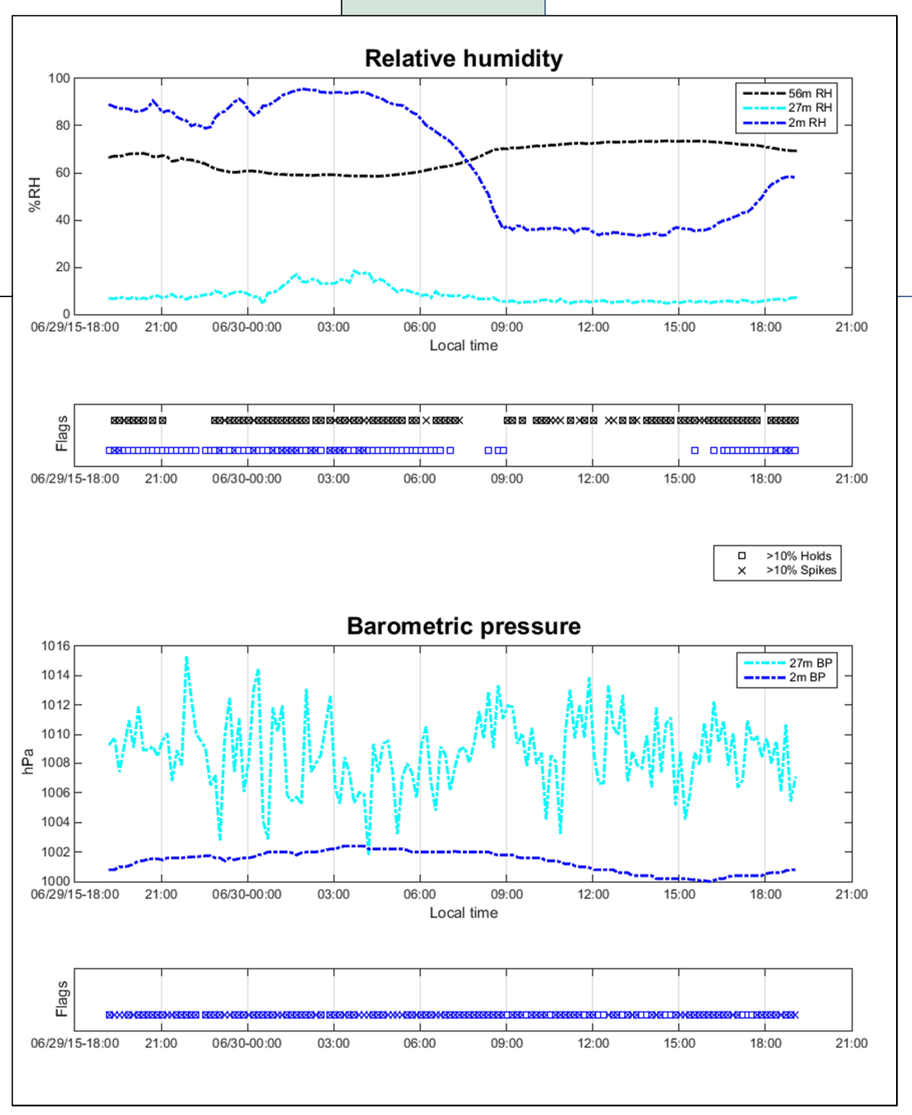
Daily status reports of instrument errors and sensor-to-sensor correlations to aid completion of met tower construction.

Searchable daily summaries of important meteorological variables most important to modelers and scientists.









Example daily status reports of bin-averaged met quantities. Bin are selected to properly capture atmospheric dynamics. Flags indicate data uncertainty.

Outlook

Future uses (searchable database for in-depth studies, simulation inflow conditions, supplementary data for future SWiFT field campaigns, eg SWIS)

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