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Wind Noise Reduction System Impacts on Sensor Cavity Temperature

PRESENTED BY

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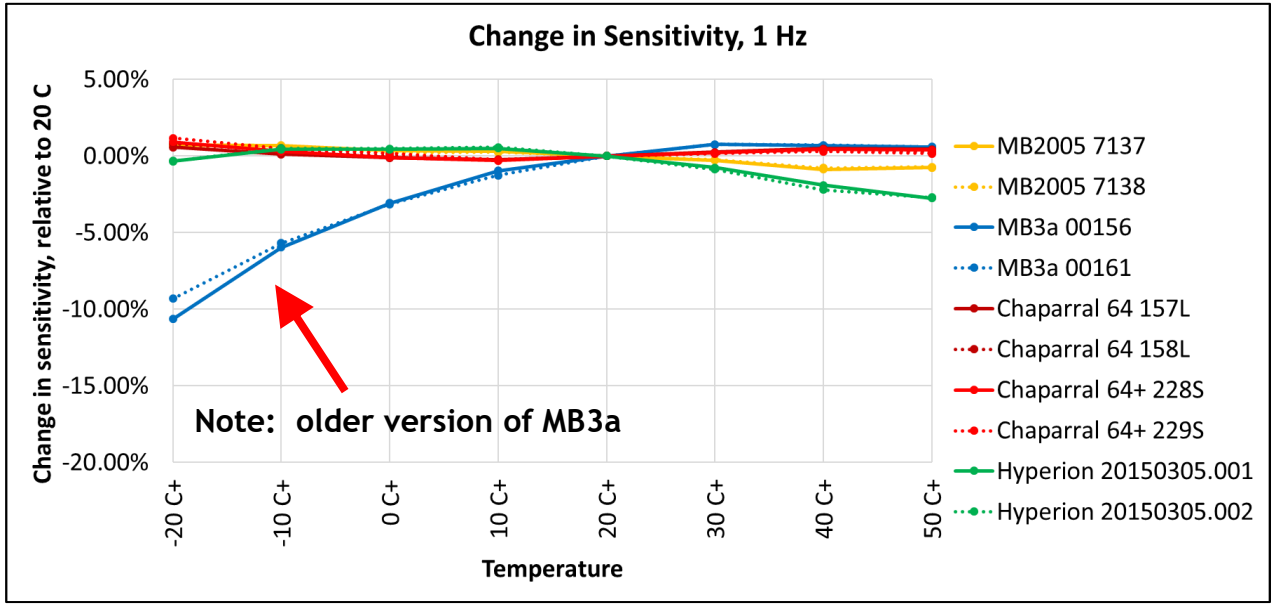
Motivation

- Past infrasound sensor evaluations have shown measurable changes in response due to temperature changes.
- Infrasound sensors are typically installed in underground vaults or well-insulated enclosures, which help to stabilize temperature around the sensor.
- However, the temperature at the sensor transducer is what matters.
- Infrasound sensors are inherently connected to the outdoors via a WNRS

Questions, motivated by discussions with IMS staff:

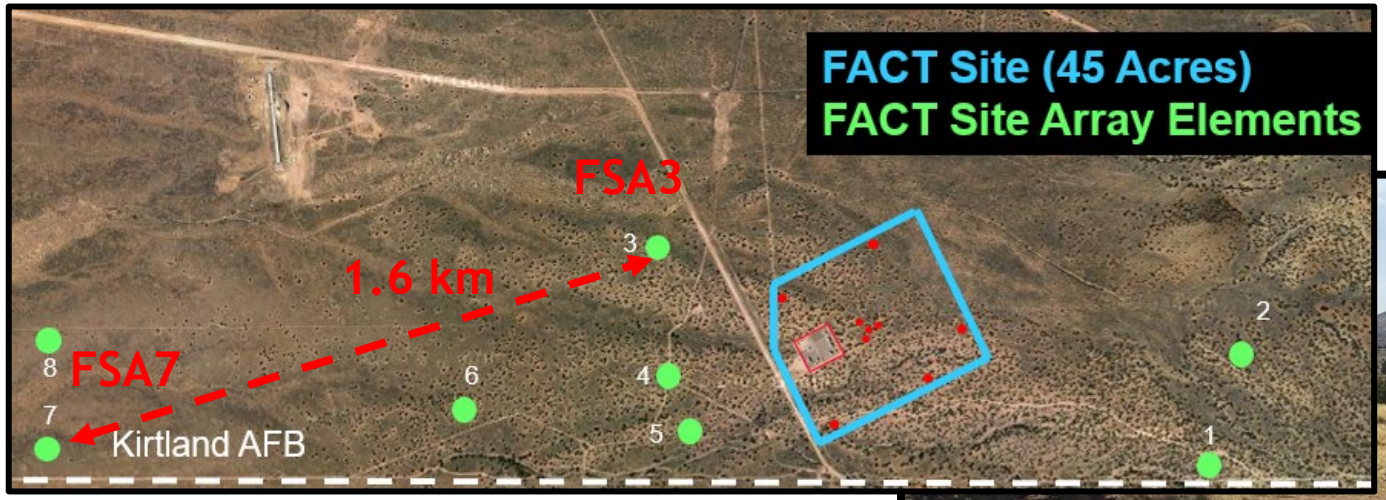
- What is the temperature of the transducer while operating in a field environment?
- How much does the WNRS affect transducer temperature?



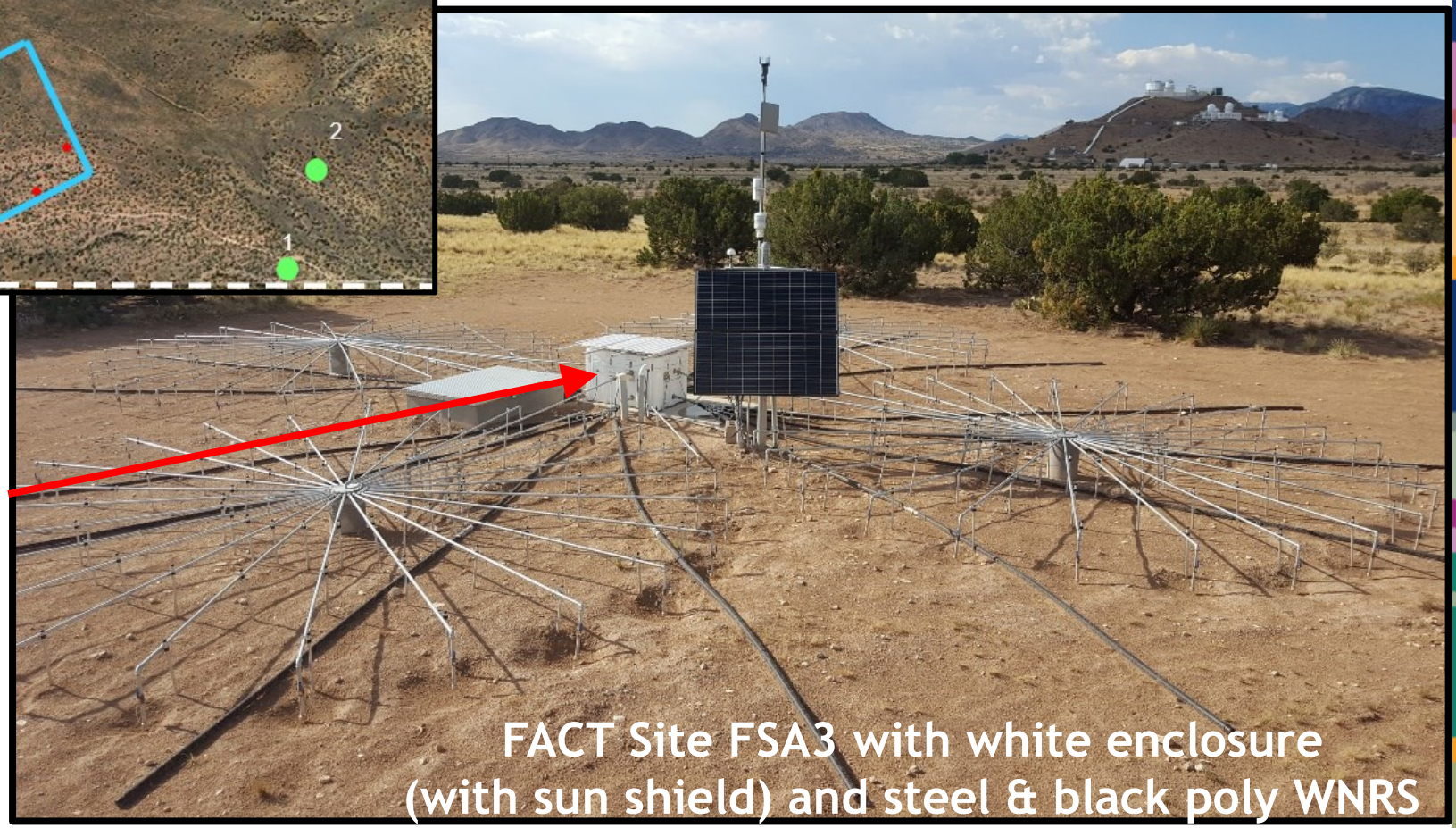
Change in Sensitivity at 1 Hz, due to temperature (Merchant, ITW 2019)

Experiment Location

- Experiment duplicated at 2 independent infrasound stations at SNL FACT Site: FSA3 and FSA7



- Two infrasound sensors at each station, one each with a steel rosette or black polyethylene pipe WNRS



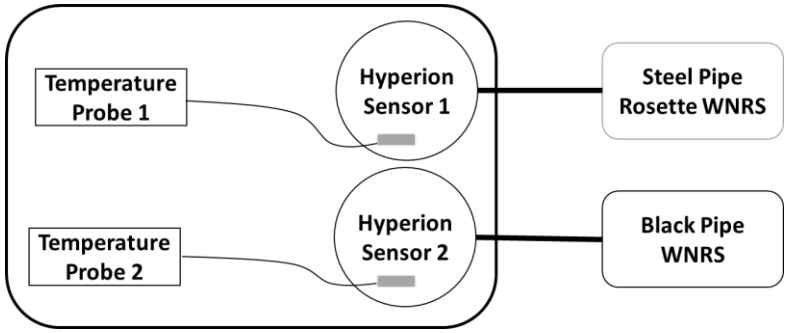
- Sensors are in an above ground white enclosure with 5 cm insulation and sunshield on top, similar to other US IMS Infrasound Stations

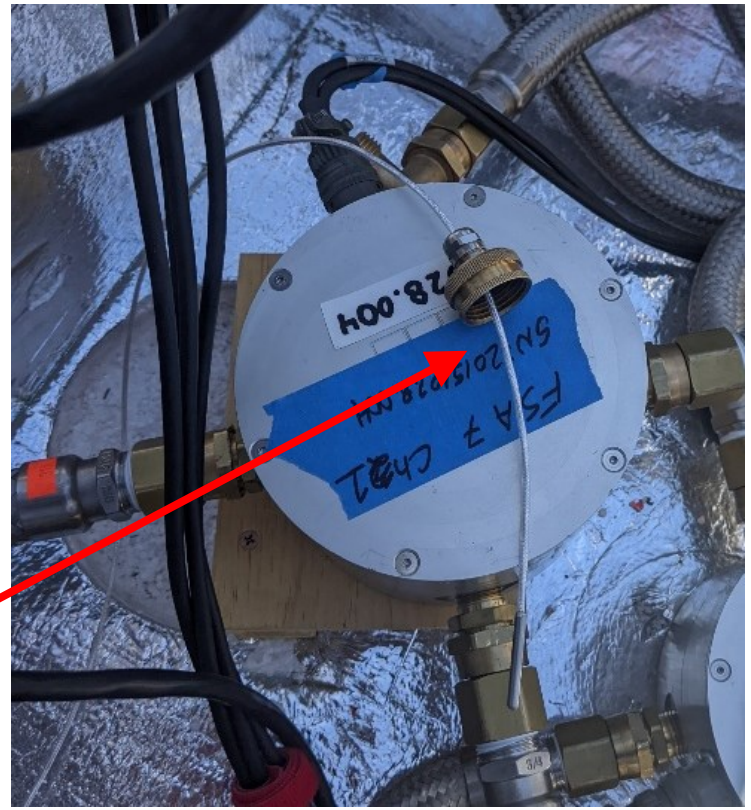
Experiment Setup

Monitor exterior air temperature with an on-site weather station.

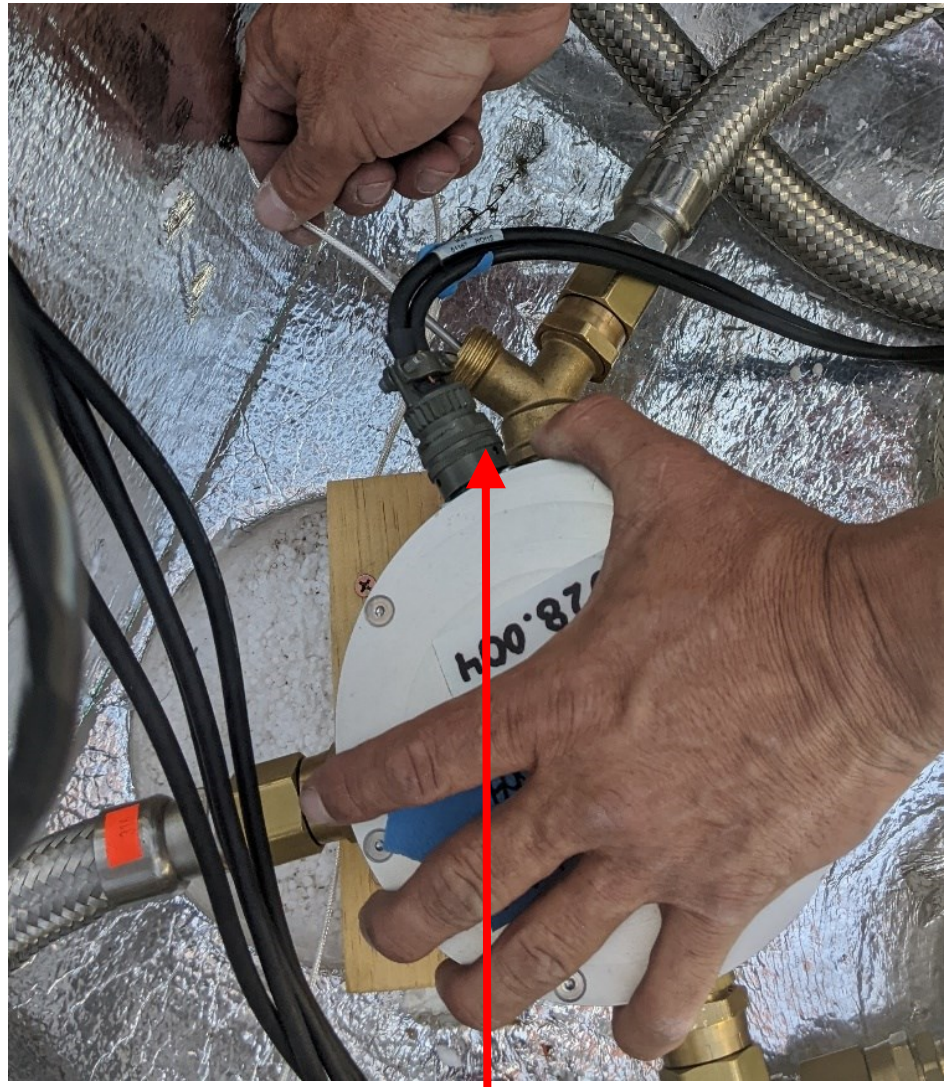
Install PT100 temperature probes:

- In the free air inside the insulated enclosure
- Centered inside each infrasound sensors' transducer cavity





Temperature probe passes through a gland fitting and gasketed cap to ensure an airtight seal



Probe tip is installed into the center of the sensor cavity via an Y fitting

Experiment Setup – potential complications

Slight difference in sensors installed at FSA3 and FSA7

FSA3:

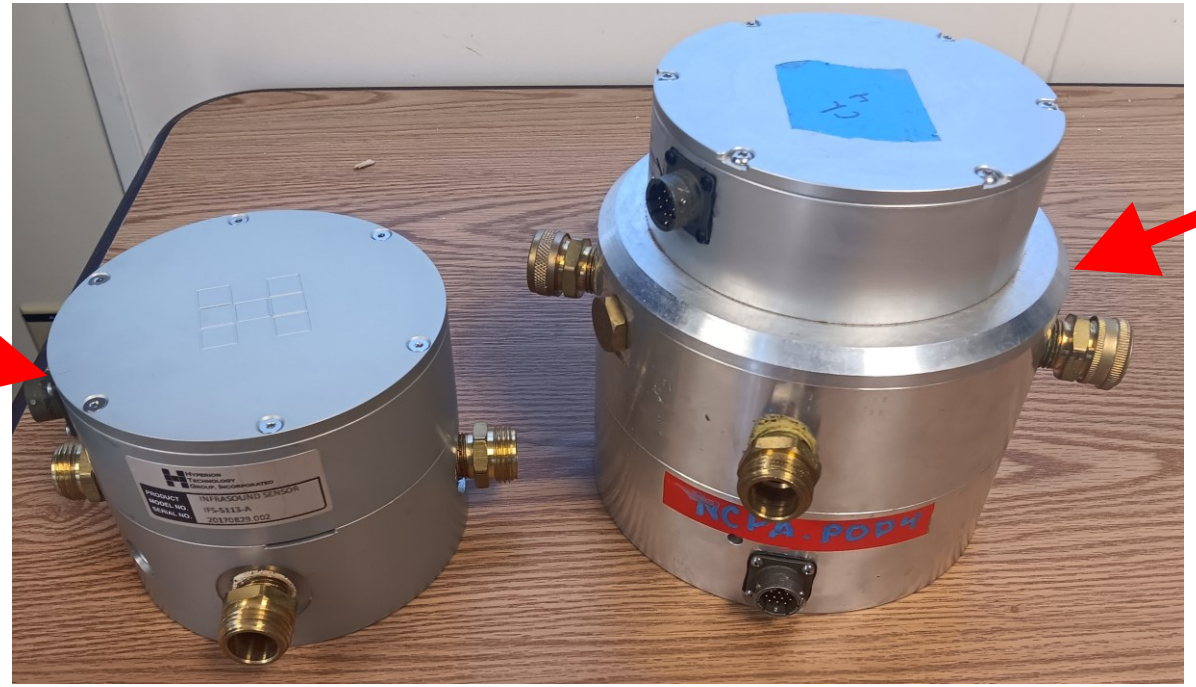
- Steel Rosette WNRS has a standard Hyperion infrasound sensor
- Black Pipe WNRS has a Hyperion with a prototype shroud, increased thermal mass

FSA7:

- Hyperion sensors on both WNRS are identical

Hyperion Sensor with prototype shroud

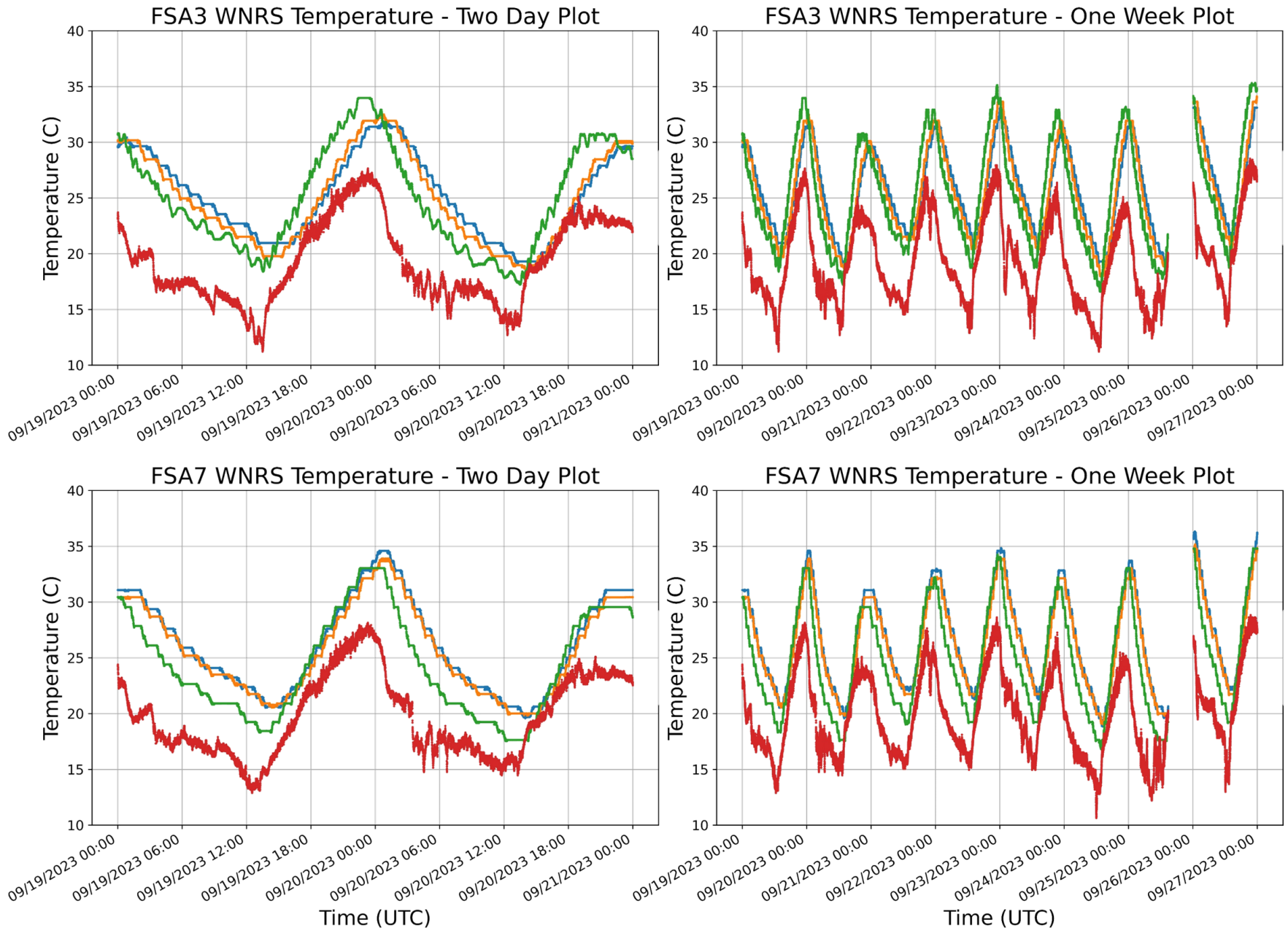
Standard Hyperion Sensor



Results - Summer

Summer

- Examined a summer 7-day period where outside air temperatures ranged from +10 C to +28 C
- Sensor cavity temperature tracks enclosure temperature with a time delay.
- Enclosure temperatures are generally warmer than outside air temperature (solar heating), tracks with a time delay and less high frequency variability.



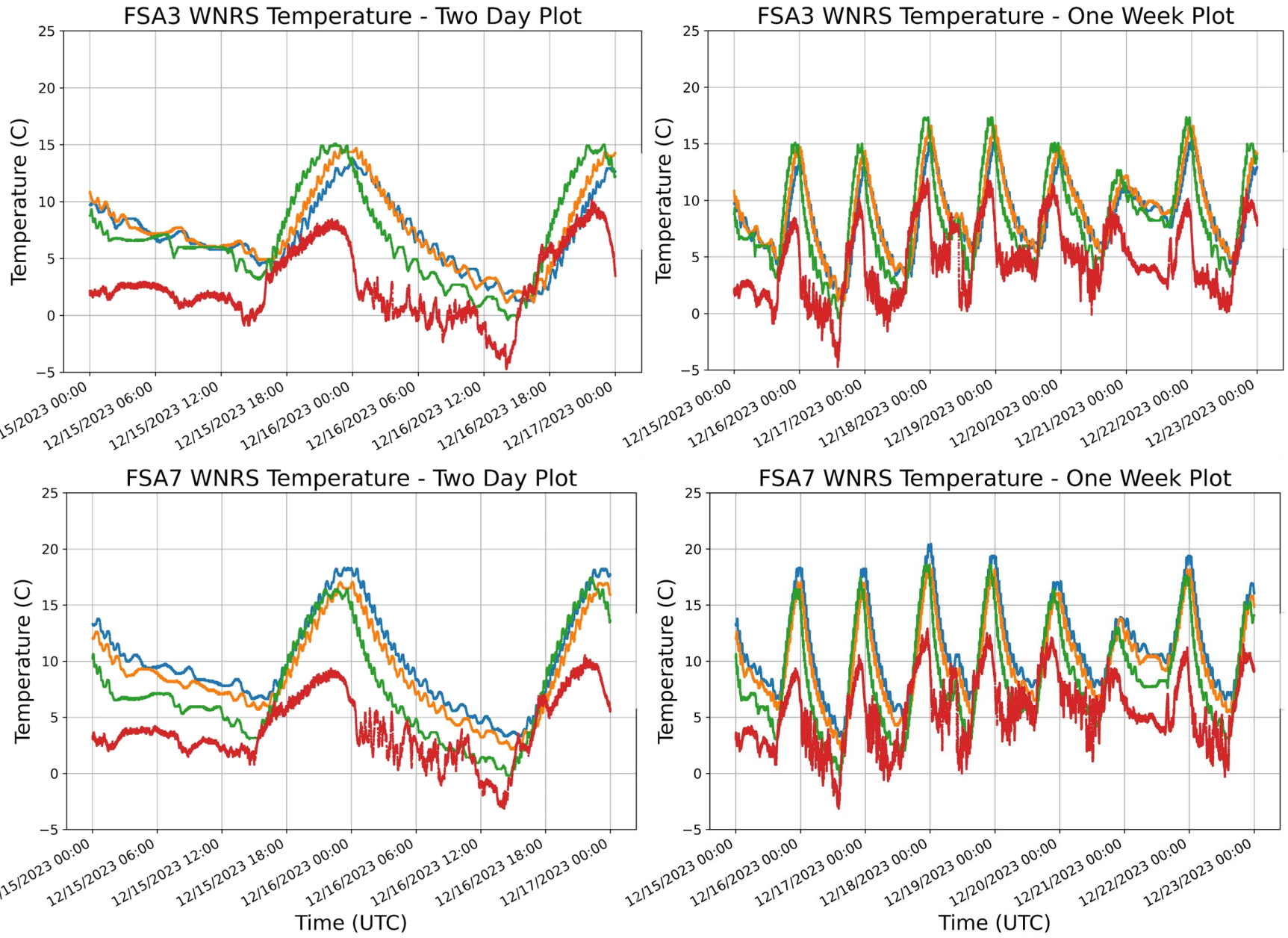
Outdoor Air Temperature
Enclosure Temperature
Sensor Temperature (Black Pipe WNRS)
Sensor Temperature (Rosette WNRS)

Results - Winter

- Examined a winter 7-day period where outside air temperatures ranged from -5 C to +12 C
- Sensor cavity temperature tracks enclosure temperature with a time delay.
- Enclosure temperatures are generally warmer than outside air temperature (solar heating), tracks with a time delay and less high frequency variability.

Outdoor Air Temperature
Enclosure Temperature
Sensor Temperature (Black Pipe WNRS)
Sensor Temperature (Rosette WNRS)

Winter

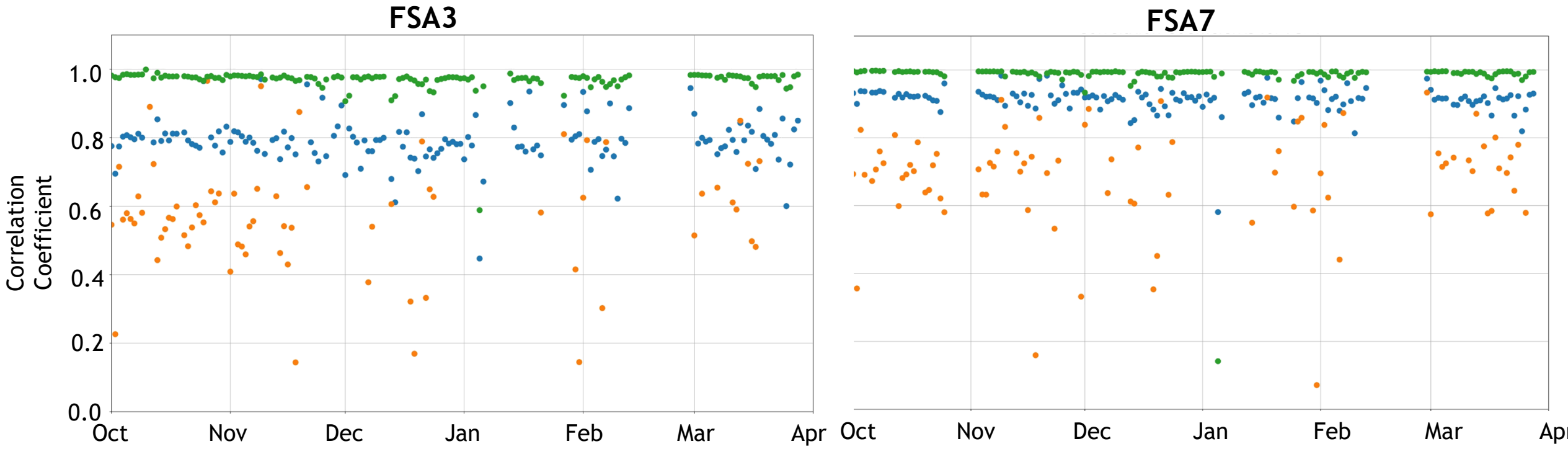


Correlation between temperature measurements

Temperature correlation coefficients calculated for each 24hr period from October 2023 to April 2024

- Temperature between sensors is highly correlated, generally 0.98+, regardless of WNRS style
- Enclosure temperature is slightly less correlated, 0.8 to 0.9
- Outside temperature is weakly correlated and variable

Correlation between
Rosette Sensor Cavity Air Temperature and:
- Black Pipe Sensor Cavity Air Temperature
- Enclosure Air Temperature
- Outdoor Air Temperature



Summary and Next Steps

- Style of WNRS does not appear to introduce significant variability in the sensor cavity temperature.
- Sensor cavity temperature is strongly correlated with the enclosure air temperature and less correlated with outdoor air temperature.
- Sensor cavity temperature tracks enclosure temperature with a slight time delay, likely due to the thermal mass of the sensor delaying its temperature coming to equilibrium with the air temperature around it.
- Sensor cavity temperature may slightly exceed enclosure air temperature at its peak, likely due to heating from the sensor electronics.
- Sensor cavity temperature does not drop below the enclosure air temperature at night, even when the outdoor air temperature is colder.

- Another year for study is planned in which insulating covers are placed around the infrasound sensors to determine how this will moderate variability in the sensor transducer temperature and impact the relative correlation with enclosure and outdoor air temperatures.