Infrasound Measurements in the Arctic on a Long-Duration Balloon

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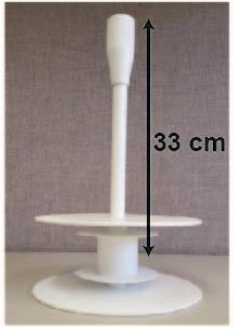
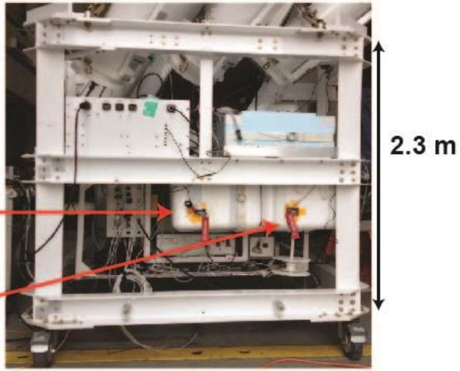
PMC-Turbo Stratospheric Flight

- Primary mission (PMC-Turbo) on-board a NASA Long-Duration Balloon (LDB) to observe Polar Mesospheric Clouds
- Payload for Infrasound Measurement in the Arctic (PIMA) and Trans-Atlantic Infrasound Payload (TAIP) flew as piggybacks
- PIMA contained two packages containing Paroscientific Digiquartz barometers and InertialSense IMUs, one with and one without a noise reduction port.
- TAIP contained a GEM infrasound logger
- Flight flew from Sweden-Canada, PIMA data available for 76 hours, TAIP data available throughout.

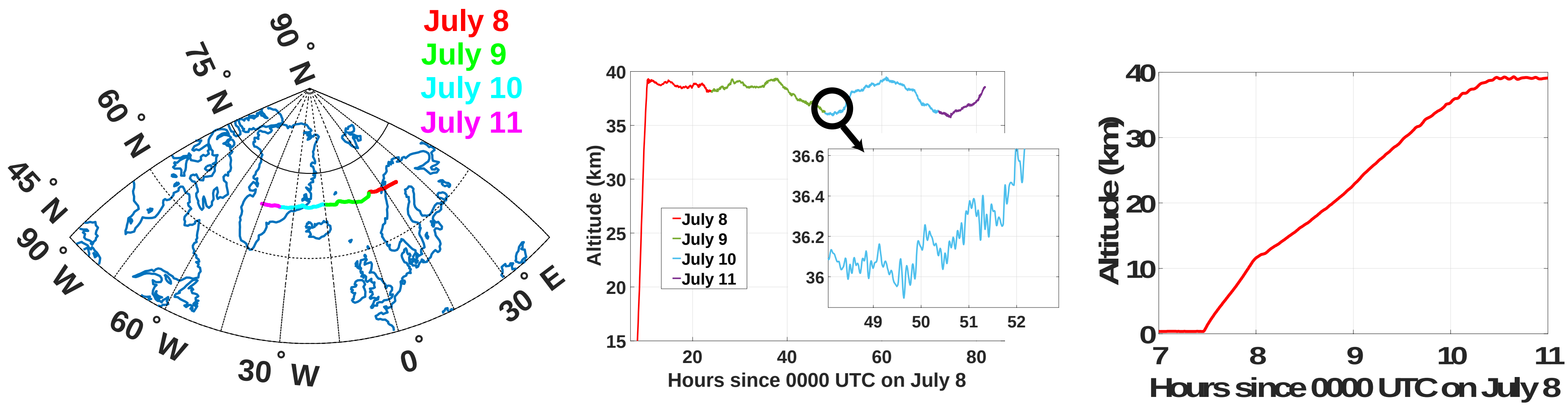




Campaign Objectives

- Record infrasound noise background on different infrasound sensors
- Measure the efficacy of the Bedard quad-disc wind noise reduction port in the stratosphere
- Record infrasound from geophysical signals of opportunity such as ocean microbarom, aurora, and bolides

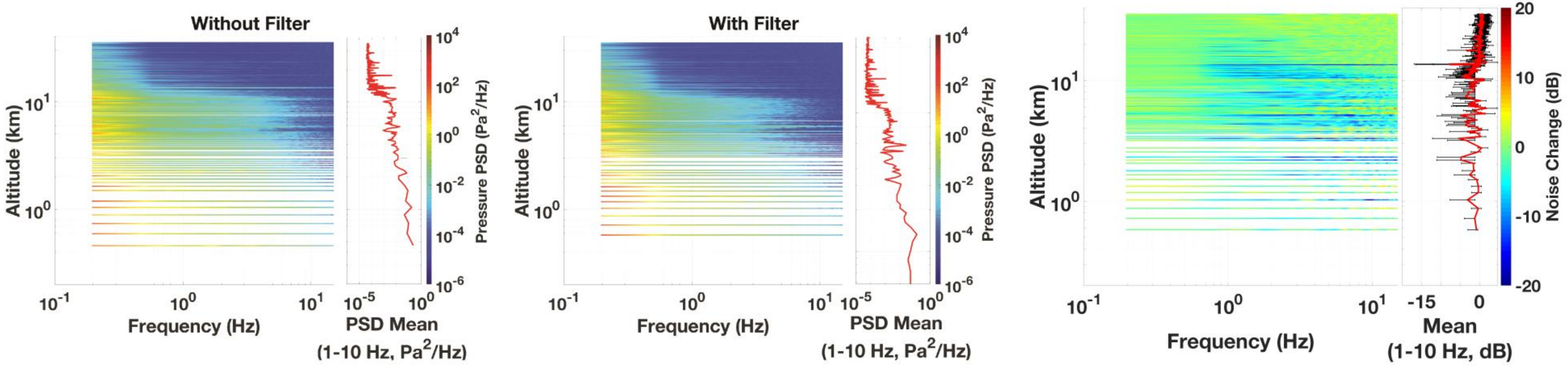
PIMA Trajectory



(a) (b) (c)

- Flight took off from Esrange, Sweden at 0727 UTC on July 8, 2018
- PIMA payload recorded trajectory for 76 hours, data logging ended over Greenland
- Flight float altitude varied between 36-39 km MSL

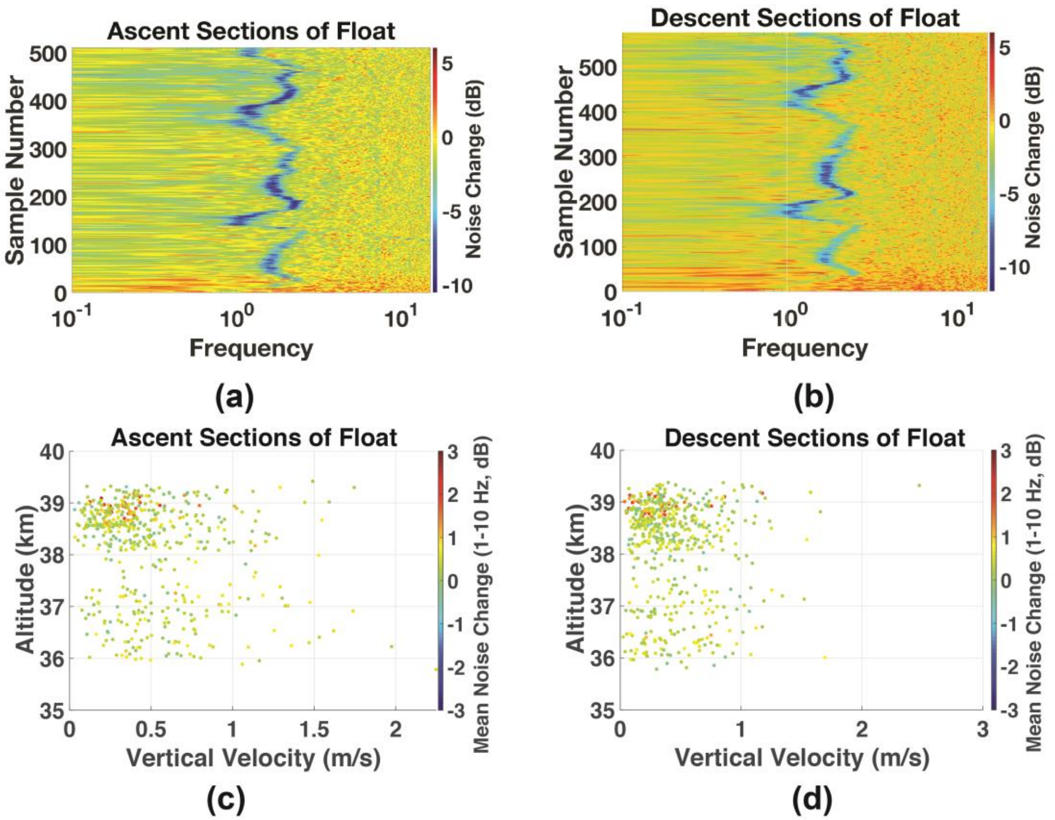
Ascent Noise Comparison



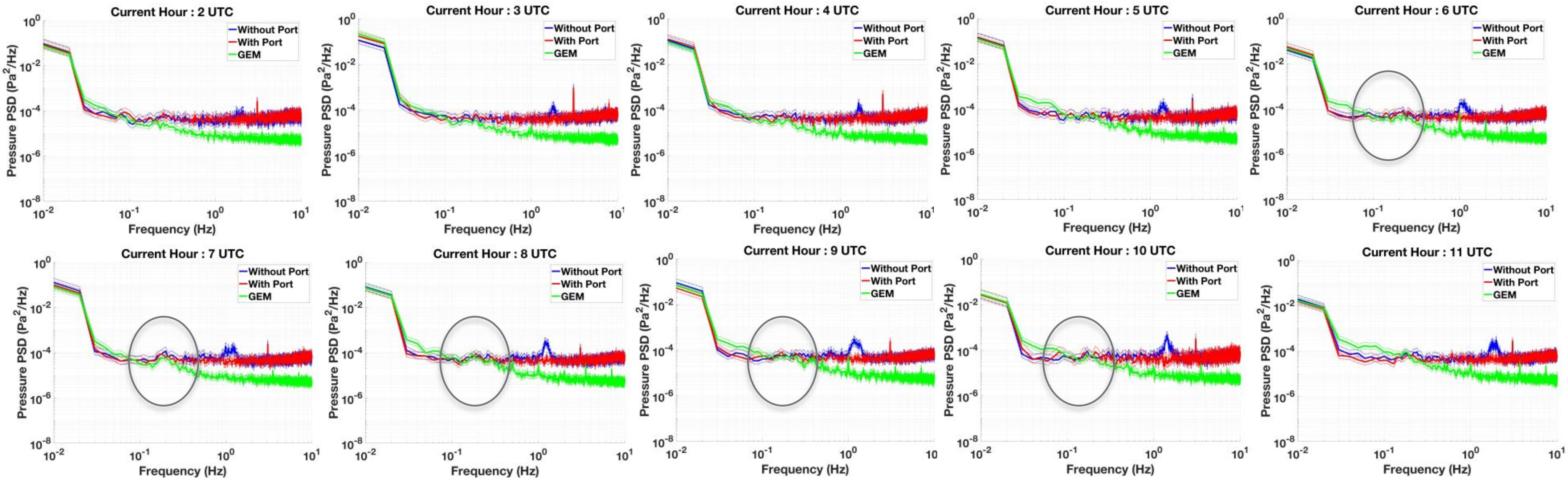
- Averaged background periodograms for 20s of ascent
- Noise drops sharply across the tropopause
- Wind noise filter is effective in the troposphere but not in the stratosphere

Float Phase Noise Comparison

- Bedard noise port is ineffective outside a narrow band between 0-1 Hz
- At various altitudes and vertical velocities, the noise port is not effective
- The source of this signal in the un-shrouded inlet is unknown

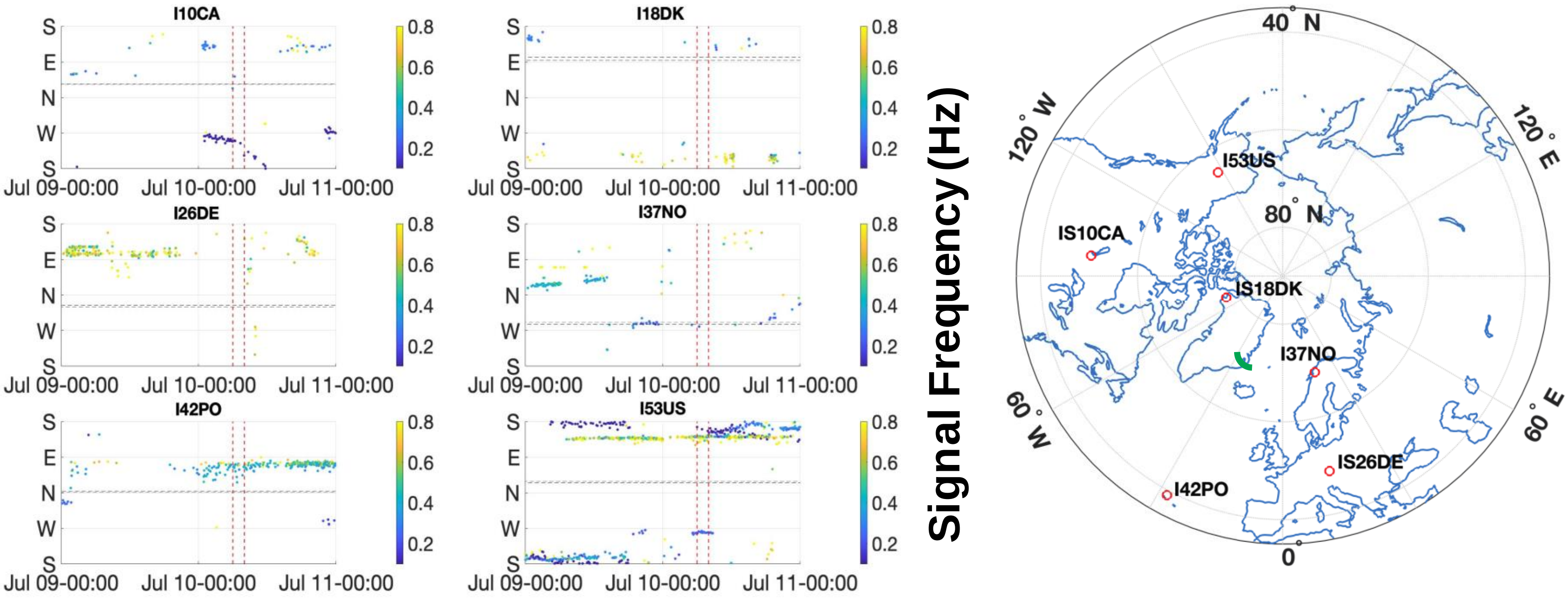


Coastally-Reflected Microbarom Detection



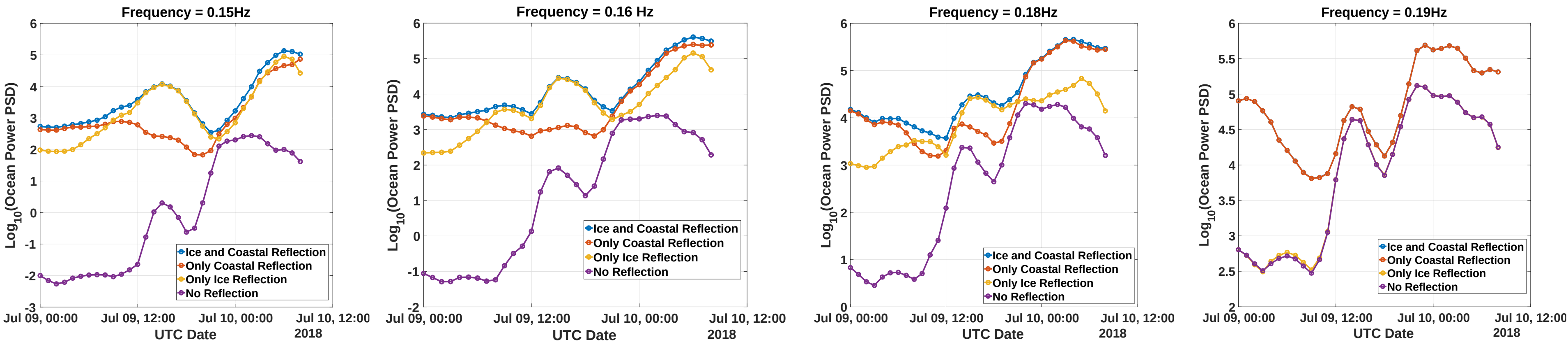
- Hourly spectra show microbarom peak, most pronounced between 0600-0900 UTC on July 10, 2010
- No other microbarom peak detected for the rest of the flight

Coastally-Reflected Microbarom Detection



- None of the IMS ground stations in different directions detected this signal

Coastally-Reflected Microbarom Detection



- Wave action model (WAM) used to simulate atmospheric pressure perturbation by ocean within 50 km distance under the balloon

- Only the models that include coastal and ice reflection off the coast account for the power increase in 0.15-0.19 Hz during 0600-1000 UTC on July 10

Is the Detection Important?

- Balloons offer a unique vantage point for observing geophysical infrasound signals, as demonstrated by the detection of a weak infrasound signal by a balloon-based barometer but not by nearby ground stations

- Balloon measurements demonstrate that ice and coastal reflections can contribute to the production and propagation of microbarom and microseisms from the Earth's oceans.

- Balloon observations and simulation models may be combined effectively to study geophysical phenomenology.

Future Work

- Dataset still being examined for auroral infrasound
- Noise characterization and microbarom detection are being prepared as manuscripts
- Piggyback payloads contributed to LDB flight in Ft. Sumner in 2019, two wind noise ports at different angles of attack. Data analysis is pending.

Acknowledgments

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