The Questions
- What are the spectral, temporal and spatial characteristics of the Southern Oceans soundscape?
- What is the distribution and migration of acoustically active marine mammals in the Southern Ocean?
- Are there latitudinal offsets in marine mammals between the recorders?
- Monitoring of acoustically active marine mammals in the Southern Ocean.
- Wind and wave induced noise.
- Displays acoustic energy distribution in the Southern Oceans.
- Analyses of acoustic data during seasonal variation in the Southern Oceans.

The Technology
- Deployment of 2 autonomous underwater recorders: Aural 66°.
- Devices: Aural 66° by Multi-Electronique Inc.
- Deployment Depth: ca. 200 m at 3000 m water depth.
- Frequency Range: 10-16000 Hz.
- Sampling Scheme: 5 min files every 4 h.
- The soundscape describes the acoustic component of an environment.
- Analysis of acoustic data was focused on ambient noise, which is defined as the acoustic energy not assignable to a specific source.

Sound pressure level variation
- Annual SPL variation:
  - Range from 102 to 115 dB re 1 μPa (broadband SPL 5th and 95th percentiles).
  - Annual variation due to seasonal change of sea state (wind speed) and ice cover.

Multi-year ambient noise spectrograms
- Displays acoustic spectrum (PSD) over time.
- Distinct bands or "choruses" originating from marine mammals vocalizations.
- Temporal offsets in the fin whale band between the recorders suggest latitudinal migration.
- PSD in dB re 1 μPa/Hz.

Abiotic sound sources: Wind, waves and ice
- Wind and wave induced noise above 150 Hz in Summer.
- Ice cover in winter dampens wind noise.

Bimodal distribution of broadband SPL:
- In winter SPL mode was 106 dB re 1 μPa.
- Storms in open ocean in summer resulted in an SPL mode of 111 dB re 1 μPa.

Conclusion
- Southern Ocean soundscape strongly seasonal.
- Sea ice has major influence on ambient noise levels and spectral characteristics of soundscape in polar oceans.
- Monitoring of acoustically active marine mammals possible using noise bands.
- Latitudinal offsets in marine mammal bands might be related to the response of these species to the seasonal variation in extent and density of sea ice.
- Right plot displays the mean ambient noise spectra for different wind and ice conditions in black and white, and the marine mammals bands in color, as obtained by the Aural 66°.

Outlook
- Additional recorders deployed in the basin wide HAP02 array will expand the spatial-temporal resolution of the acoustic dataset.
- Detailed multiyear studies of marine mammal acoustic presence and behavior throughout the Weddell Sea.
- Deployed SonoVault autonomous underwater recorders.

References
Whale drawings by Jim Thomason, Olaf Struthman, Elke Strothman, Karolin Wegener; the AWI Ocean acoustics group and the entire Polarstern crew.

For further information and sound examples see: www.awi.de/palaoa