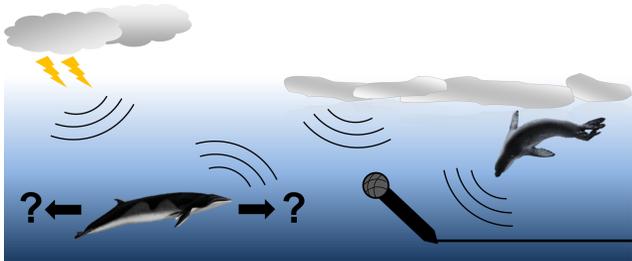


# Soundscapes of the Southern Ocean: Passive Acoustic Monitoring in the Weddell Sea

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## 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?

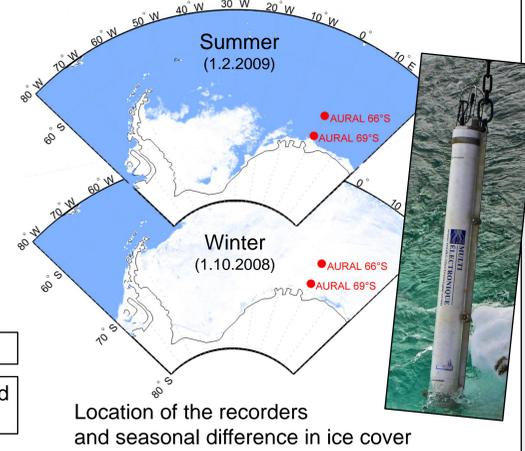
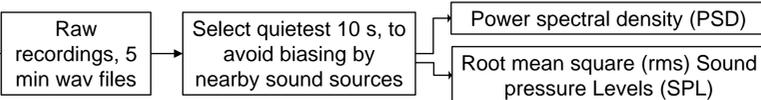


## The Technology

Deployment of 2 autonomous underwater recorders:

Devices: Aural M2 by Multi-Electronique-Inc.  
 Deployment period: March 2008 – December 2010  
 Deployment Depth: ca. 200 m at 3000 m water depth  
 Frequency Range: 10-16000 Hz  
 Sampling Scheme: 5 min files every 4 h

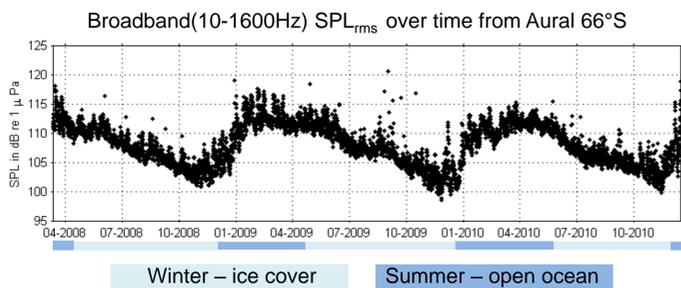
The **soundscape** describes the acoustic component of an environment. Analysis of acoustic data was focused on **ambient noise**, which is defined as the acoustic energy not assignable to a specific source.



## Sound pressure level variation

### Annual SPL variation:

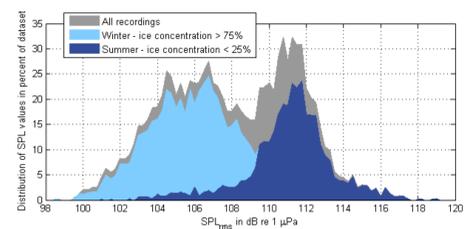
- Ranging from 102 to 115 dB<sub>rms</sub> re 1 μPa (broadband SPL 5th and 95th percentile)
- Annual variation due to seasonal change of sea state (wind speed) and ice cover



### Bimodal distribution of broadband SPL:

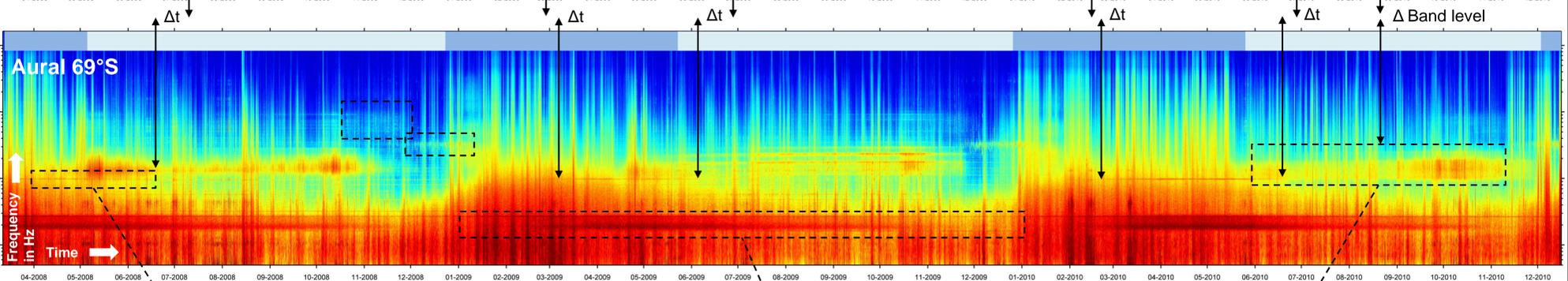
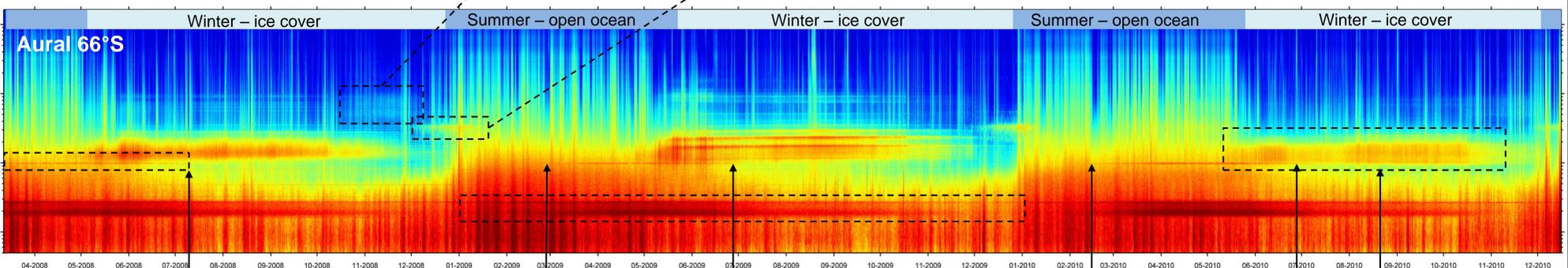
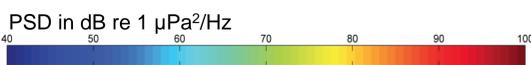
- In winter SPL mode was 106 dB<sub>rms</sub> re 1 μPa
- Storms in open ocean in summer resulted in an SPL mode of 111 dB<sub>rms</sub> re 1 μPa.

### Histogram of SPL<sub>rms</sub> with different ice concentrations above recorder Aural 66°S



## Multi year ambient noise spectrograms

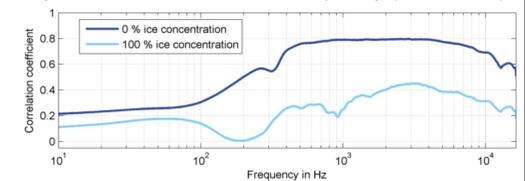
- Displays acoustic spectrum (PSD) over time
- Distinct bands or "choruses" originating from marine mammals vocalizations
- Temporal offsets in the fin whale band between the recorders suggest latitudinal migration



### Abiotic sound sources: Wind, waves and ice

- Wind and wave induced noise above 150 Hz in Summer
- Ice cover in winter dampens wind noise

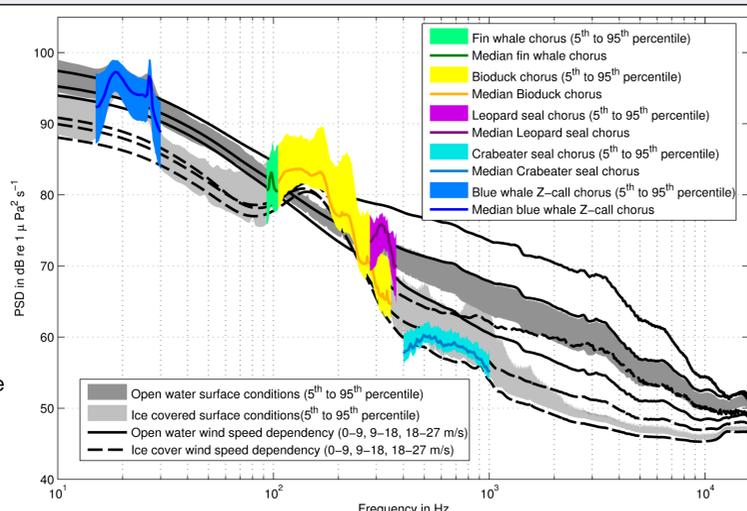
### Correlation coefficient of band level and wind speed above recorder over frequency (Aural 66°S)



## 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

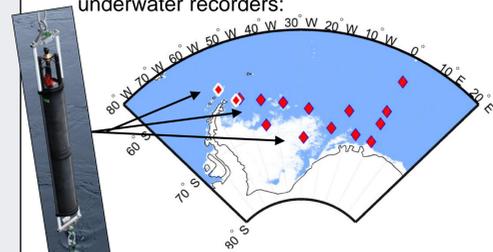
Right plot displays the mean ambient noise spectra for different wind and ice conditions in black and white, and the marine mammals bands in color, as obtained by the Aural 66°S



## Outlook

- Additional recorders deployed in the basin wide HAFOS array will expand the spatio-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:



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## References

Whale drawings by Jim Thomas and Lycaon.cl from the Wikimedia commons web archive

## Acknowledgements

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For further information and sound examples see [www.awi.de/palaoa](http://www.awi.de/palaoa)

