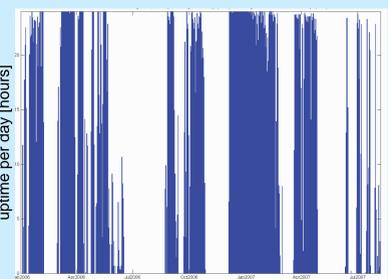
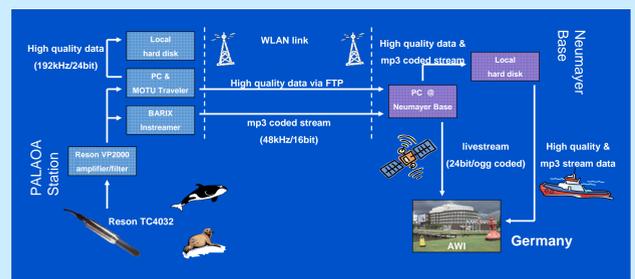
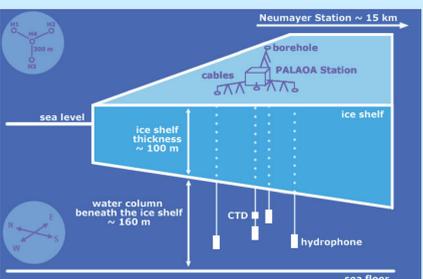
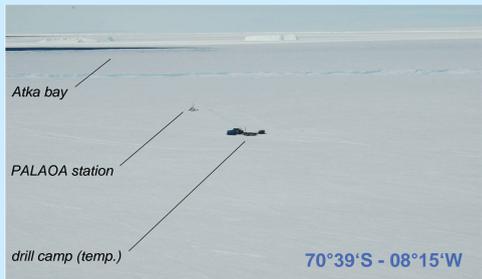


PALAOA¹: Broadband recordings of the Antarctic coastal soundscape

The station



Motivation: Acoustic recordings from a pristine region for comparison with regions exposed to anthropogenic noise.

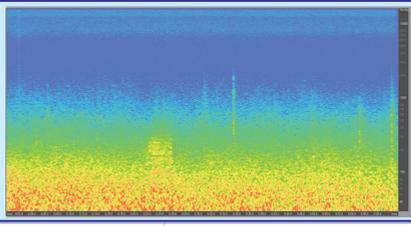
Location: Southern Ocean (Atlantic Sector), Weddell Sea, Atka Bay.

Realization: Hydrophone array deployed underneath the free-floating ice-shelf, energetically self-sufficient.

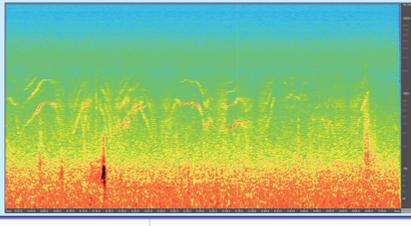
Access: Live acoustic „online“ stream (low bandwidth) via satellite and wide bandwidth „offline“ streams recovered annually. Open access via www.awi.de/acoustics

Uptime: Operational since 01 Jan 2006, total time of recordings (by 7 Aug. 07) 6123 hours on 333 days.

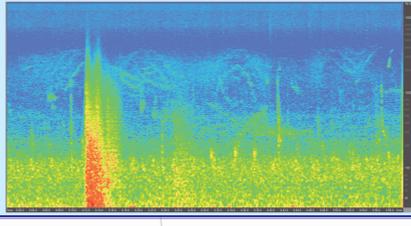
Acoustic signatures of natural, non-biological sounds



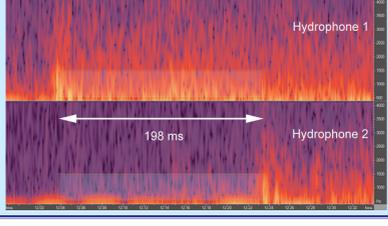
Quiet ocean: 20 Feb 2007, 23:50; Spectrum 1
Duration of periods: order of hours, interrupted frequently.
SPL_{peak}⁽²⁾: 111 dB SPL_{RMS}⁽³⁾: 98 dB
Quiet periods not uncommon, but dependent on stagnation of tidal flow, and absence of marine mammal vocalizations.



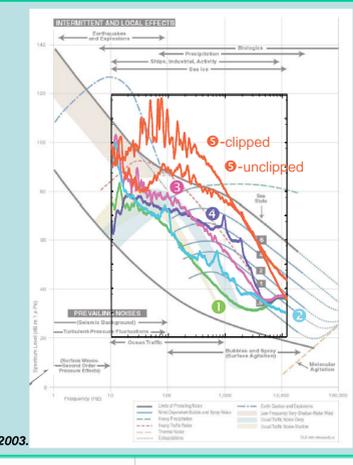
Whining: 04 Feb 2007, 00:05; Spectrum 2
Duration of event: order of minutes, quasi-continuous.
Basic frequency: 300Hz – 1kHz, sometimes at 3kHz.
SPL_{RMS}⁽³⁾: 94 dB
Events occasional;
Origin unknown, presumably sea-ice related.



Calving: 21 Jul. 2007, 17:40; Spectrum 3
Duration: 5.8 s Rise Time: 1-5 ms
SPL_{peak}⁽²⁾: 118 dB Est. SL_{peak}: > 150 - 158 dB
SPL_{RMS}⁽³⁾: 103 dB Est. SL_{RMS}: > 135 - 141 dB
SEL⁽⁴⁾: 111 dB Est. SEL @ Source: > 143 - 149 dB
Events common throughout year, peaking in late austral summer.



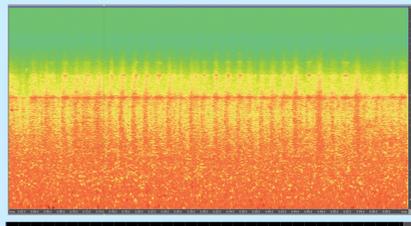
Difference of times of arrival between hydrophone 1 and 2 equals 198 ms.
→ sound arrived 275°T or 305°T. Intercept with ice shelf break gives estimated distance of 1500 to 6700 m.



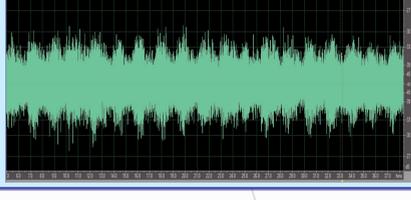
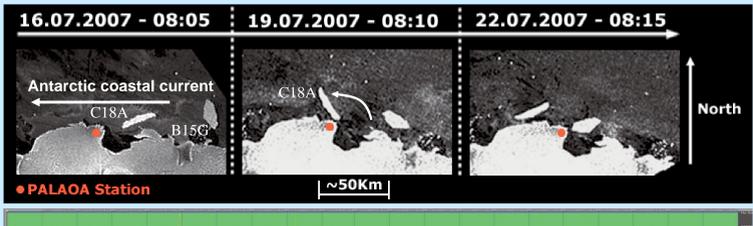
Summary

Quiet ocean (1) similar to „Usual Traffic Noise, shallow“. Peak near 15 Hz probably due to cable motion.
Whining (2) similar to quiet ocean, with spectral peaks at 400 and 800 Hz.
Calving (3) shows 10 to 20 dB elevated levels between 20Hz and 3 kHz relative to quiet ocean. Levels at and above upper bound of range of „Usual Traffic Noise, Deep“.
Singing iceberg (4) shows peaks near 1 and 2 kHz, close to sea-state 6 levels and higher frequency in excess of „Heavy Traffic Noise“.
Iceberg collision (5), preliminary estimates) show highest spectral levels over full freq. range, similar to seismic events but at higher frequencies, 100 Hz – 1kHz.

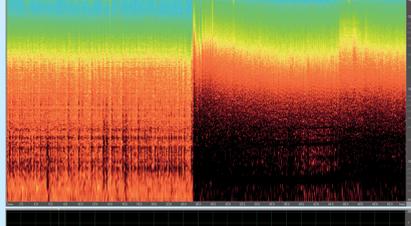
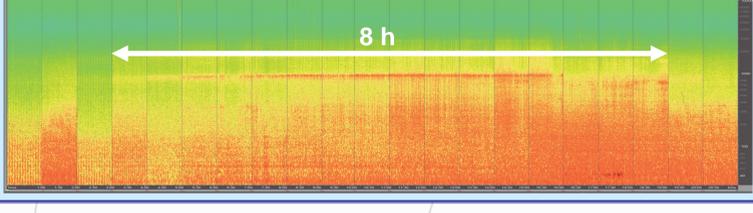
Background graphics by D'Spain and Watzok, 2004, adopted from „Ocean Noise and Marine Mammals, Nat'l Acad. Sci., 2003.



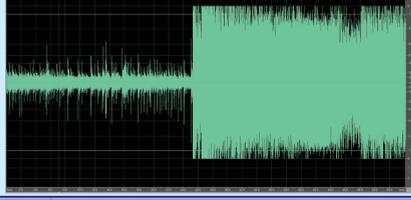
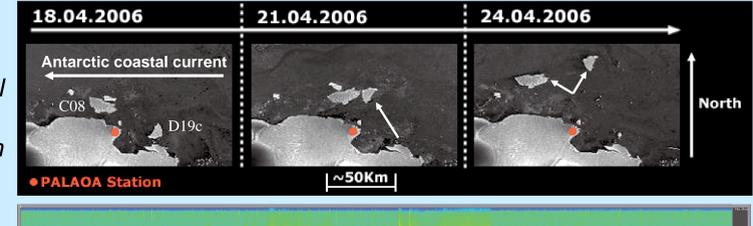
Singing iceberg: 17 Jul 2007, 04:01, Spectrum 4
Between 16 and 19 July, the western tip of the iceberg C18A most likely became grounded on the shoaling sea-floor of Atka Bay. Currents then presumably rotated the iceberg around the grounding point before the iceberg continued drifting westwards.
Commencing on 16 July, 9:30pm, an unusual tone between 900 and 950 Hz with a harmonic near 1850 Hz was recorded by PALAOA while the overall waveform became modulated with a frequency of about 0.56 Hz, generating a surf-like sound..



Duration: order of 8 hours
SPL_{peak}⁽²⁾: 115 dB; SPL_{RMS}⁽³⁾: 103 dB SEL⁽⁴⁾ = 148 dB
Events occasional; LF Modulation confirmed by Neumayer station seismic records and observed on other occasions as well. Origin of 1kHz tone unclear, possible options include a) flow of water through cavities in iceberg, internal sound generation by flexing iceberg, non-linear effects of recording system due to LF sound pressure levels or low batteries, decision pending.



Collision of two icebergs 19 Apr. 2006, 08:14; Spectrum 5
On 18 Apr., iceberg C08 appears grounded to the northwest of PALAOA. Iceberg D19 moves rapidly westwards (mean speed of about 0.1 m s⁻¹) with the Antarctic coastal current. On 19 April 2006 the yet most extreme acoustic event was recorded by PALAOA. Much of the waveform is clipped. Two days after this acoustic event, the two bergs were observed in close vicinity of each other (21. Apr.), before separating again (24 Apr.)



Duration of event: 10 min Duration of clipped amplitude: 5 min Rise Time: 1 ms
SPL_{peak}⁽²⁾: > 153 dB SPL_{RMS}⁽³⁾: > 153 dB SEL⁽⁴⁾: > 178 dB
Distance from PALAOA (estimated from satellite image): 20 km
Estimated SL_{peak}⁽²⁾: > 205 dB Estimated SEL⁽⁴⁾ @ source: 230 dB
Events rare, recorded only once during 333 days of operation. Origin rather certain due to sound characteristic, magnitude and correlation with satellite images.

