# Arctic and Antarctic soundscapes : contributors and acoustic levels

Delphine Mathias (1) and,
Sylvain Chauvaud (2), Frédéric Olivier (3) , Aurélie Jolivet (1, 2),
Christine David-Beausire (4), Marie-Noëlle Houssais (5), Erwan Amice (6), Laurent Chauvaud (6)

## Motivation

Environmental changes induced by global warming and the increase of anthropogenic activities may affect polar underwater soundscapes by changing acoustic propagation conditions and habitat usage. Ocean noise is a growing conservation concern, but management of underwater noise pollution is constrained by a lack of baseline data.

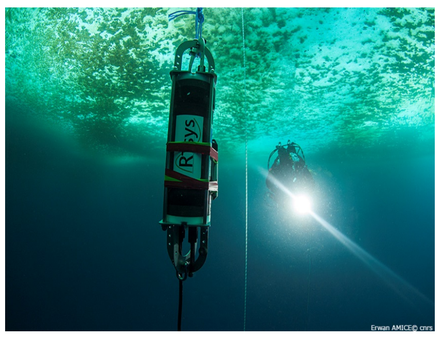
## Soundscape Analysis : Passive Acoustic Monitoring of Marine Environment

**Biophony**
Benthic organisms
Fish
Marine mammals

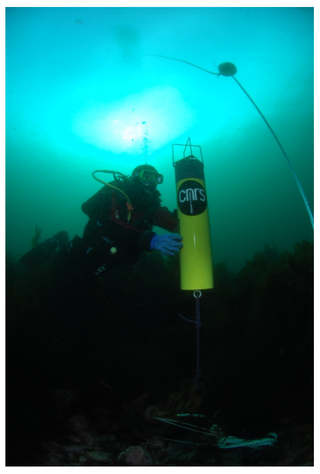
**Geophony**
Wind, Rain
Waves
Ice

**Anthropophony**
Shipping, Seismic surveys
Fishing, Marine energies
Recreational boats

**UNDERWATER SOUNDSCAPE**
**Environmental description and ecosystem monitoring**



**Hydrophones**
**Raw acoustic data**



**DATA PROCESSING : Ocean Science + Signal Processing + Algorithms**
- Characterization of sound sources and propagation channel
- Sound sources properties (frequency bandwidth, level, …)
- Temporal and spatial variability of various components

**Identifying and describing the features of the various sources of ocean noise allows to understand and monitor the state of marine environments (National Research Council 2003, 2005).**

## Scientific Objectives

1. Describe seasonal patterns of natural physical sound sources, biological sounds and anthropogenic noise, thus providing baseline data from which changing trends can be monitored.
2. Quantify contribution of various sound sources to the overall soundscape budget.
3. Describe spatial variability between sites.

## Multi-year & Multi-site Acoustic Dataset

| Site | Dates | Recording characteristics |
|---|---|---|
| **Arctic : Spitzberg NyAlesund - Kongsfjorden** | May 7th-8th, 2013 | Wildlife Acoustics SM2M , 28 hours of continuous data |
| | September 30th – Oct 2nd, 2013 | Wildlife Acoustics SM2M, , 48 hours of continuous data, close to Chlamys Islandica (scallop) |
| | Octobre 2nd – December 27th, 2013 | Wildlife Acoustics SM2M, , 3 months of recording (20 min/hr), close to Chlamys Islandica (scallop) |
| | May 27th – October 24th, 2018 | EA-SDA14 RTsys, 20 min/hr, many sea urchins<br>Tank recordings of sea urchins , crabs and scallops sounds<br>Sea ice recording |
| | **ON-GOING FIELD SEASON** April 29th – September, 2019 | EA-SDA14 RTsys, 20 min/hr, many sea urchins<br>Sea ice and walrus vocalization recordings |
| **Arctic : Greenland Young sound – Daneborg** | August 2015 August 2016 | EA-SDA14 RTsys, 24 hours continuous recordings and specific recordings of ice noise and walrus feeding sounds |
| | May 2018 | EA-SDA14 RTsys, 4 days of continuous recordings, recorder deployed under the ice |
| **Antarctica : Dumont d'Urville** | Dec 2015 – Janvier 2016 | EA-SDA14 RTsys and Wildlife SM3M, 3 weeks recording |

## Passive Acoustic Data Processing

- Overall sound levels : Long-term term spectral averages are computed in several frequency bands (15-100 Hz, 100 Hz-1kHz, 1kHz-3kHz, 3kHz-10kHz, 10kHz-30kHz)
- Seasonal patterns in the acoustic data are investigated by analyzing daily median band levels in several frequency bands.

## Results: Towards a better soundscape description and comparison between sites, and a long-term monitoring of polar marine habitats

- **Antarctica sound budget( Winter 2015 – 2016) :**

Antarctica soundscape is dominated by biological sound sources: benthic sounds and marine mammals vocalizations (including weddel seals, orcas and whales).

- **Greenland sound budget(August 2015 & 2016) :**

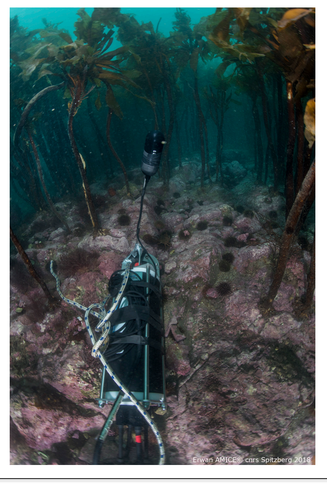
Extreme differences in noise levels between August 2015 and August 2016 with a very quiet environment in 2015 and many ice sounds in 2016.

- **Spitzbergen sound budget (2013-2018) :**

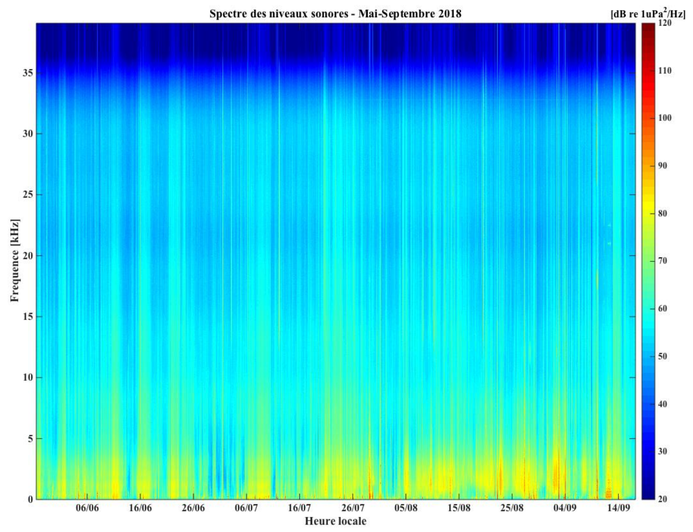
– Noise levels measured in Kongsfjorden in 2018 are up to 10 dB re1uPa. higher than those measured in 2013, due to an increase in boat traffic in the fjord.

- **On-going fieldwork : Spitzberg, April 2019 – September 2019**

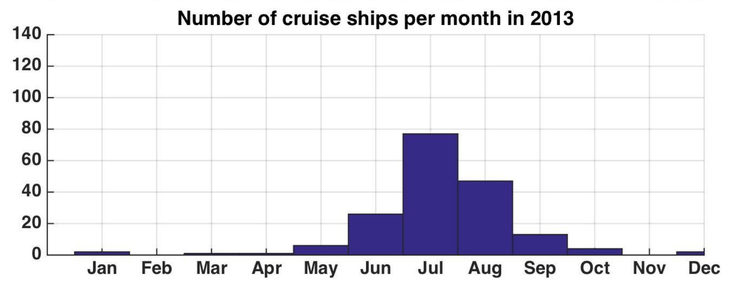
– Same deployment site as 2013.
– Differences in habitat (2018-2019 vs 2013) observed during the dives: dominated by sea urchins, algae have disappeared.
– Kelp forest : acoustic refuge ? up to 5 dB re1uPa difference below/above the kelp forest.

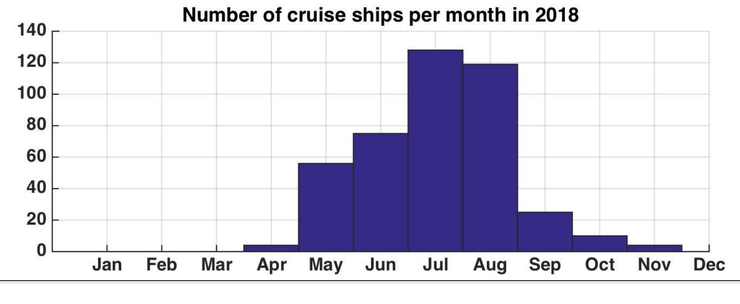


Power spectrum density in Kongsfjorden
June - September 2018




2013 ➔ 2018 : 2.5 fold increase in touristic boat traffic




[1]SOMME, Plouzané, France ,
[2] TBM Environnement, Auray, France, [3] Muséum National d'Histoire Naturelle, UMR BOREA 7208, CNRS/MNHN/ UPMC/IRD, Concarneau, France, [4] Institut Polaire Français Paul-Emile Victor, Plouzané, France, [5] Laboratoire d'Océanographie et du Climat, Paris Cedex 05, France, [6]Laboratoire des Sciences de l'Environnement Marin, UMR 6539, Plouzane, France

WORK CONDUCTED UNDER ANR GAAP (2016-2019) PROJECT AND H2020 INTAROS PROJECT (2016-2021)