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Arctic Acoustic Environments

Federating observations and analyses with the International Quiet Ocean Experiment

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³ M.-N. Houssais; P. Mikhalevsky; J. Pajala; R. Racca; J. Tęgowski; O. Tervo; K. Thomisch; J. Tougaard ; E. Urban; A. Vedenev



Rapid changes over large volumes

Risk:

*Fresh Water (FW) decreasing
Sea ICE volumes decreasing
Upper ocean warming
Wind speeds increasing*

Unknowns:

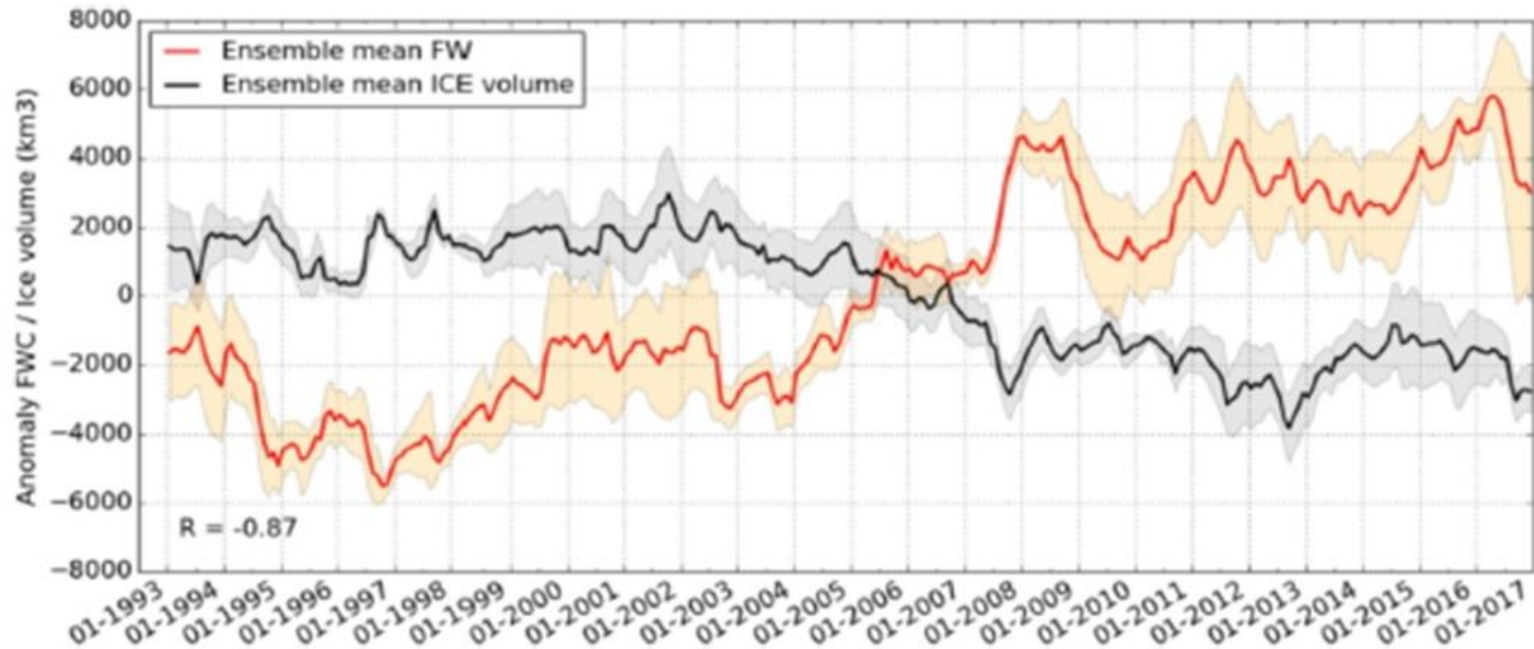
*Simulations lagging behind
measurements*

Regional and local variations

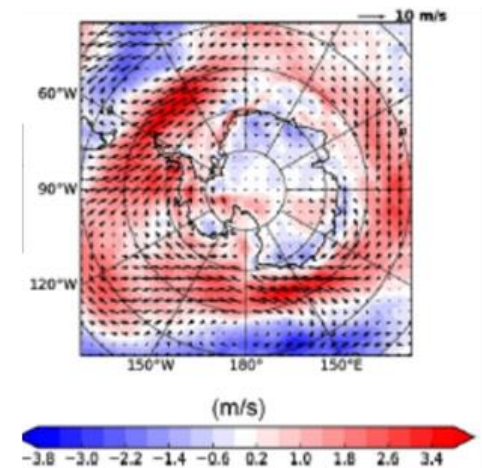
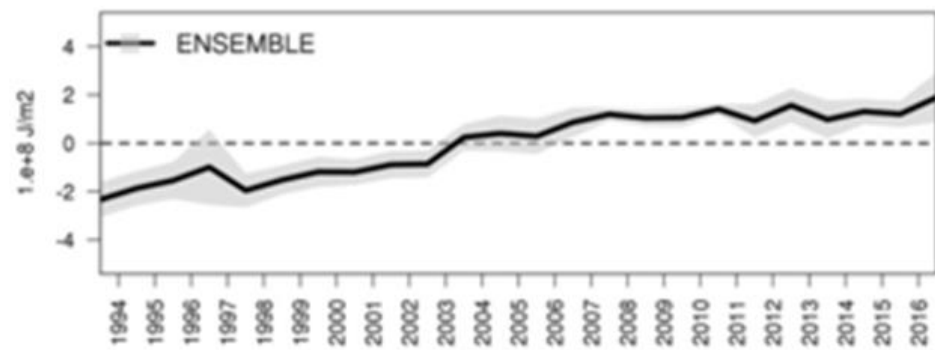
Acoustic tomography

Affects on soundscapes

Links to bioacoustics



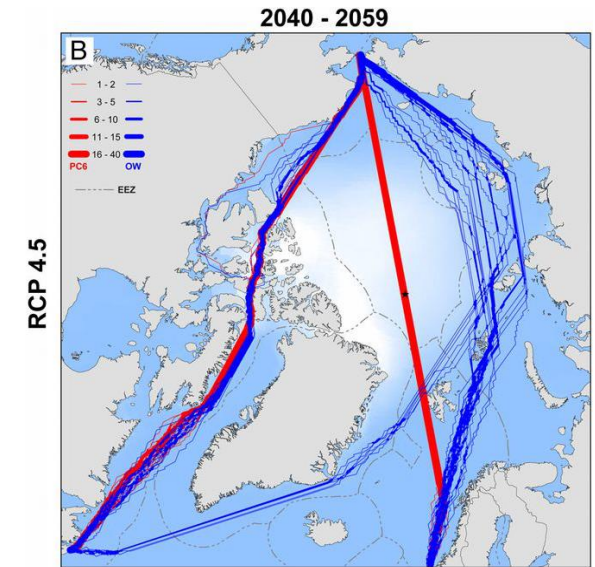
ARCTIC OCEAN HEAT CONTENT (0-700m)



Increasing human presence



Griger, European Parliamentary Briefing PE 620.231 – May 2018



Smith & Stephenson, PNAS, 2013

Development of Northern Sea Routes – More accessible Arctic waters – **Increasing traffic**

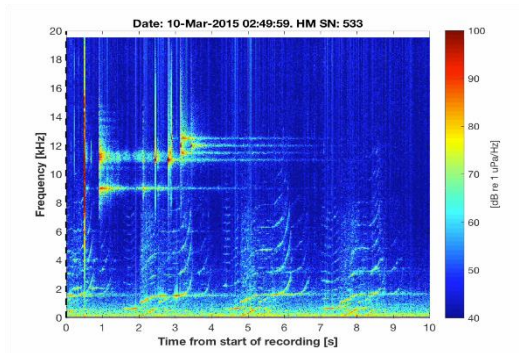
Not restricted to Arctic countries (e.g. China's White Paper on Arctic Policy, 01/2018)

Expansion of Arctic constructions (harbours and facilities), tourism and **human presence in general**

Acoustic monitoring: small-scale and large-scale variations + effects on ecosystems

Arctic Acoustic Environments

Fragile environments, at immediate and increasing risk from climate change and human activities



Hydroacoustics is the ideal tool to monitor changes and impacts:

- Warming oceans
- Changes in sea ice
- Melting glaciers
- Changes in freshwater ice
- Shore erosion/instability
- Biodiversity/fisheries

Long-range tomography

Ocean observatories, multi-purpose platforms, field surveys

Long-term and short-term deployments

Local measurements

Earthquake/landslide/tsunami warnings

Bioacoustics – surveys and observatories

International Quiet Ocean Experiment

The science of IQOE is described with 5 fundamental questions:

1. Have human activities affected global ocean soundscapes compared with natural changes over time?
2. What are the current levels and distribution of sound in ocean?
3. What are the trends in sound levels across global ocean?
4. What are the current effects of anthropogenic sound on important marine animal populations?
5. What are the potential future effects of sound on marine life?



Arctic Acoustic Environments – Working Group

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Alexander Vedenev		Russia	<i>Shirshov Institute of Oceanology</i>

Teleconference – November 2017; Chair Meeting – Bergen, February 2018; Partial Meeting – Victoria, BC, November 2018
Plenary Meeting – Paris, January 2019



Virtual Conference, 11-12 November 2020

Arctic Acoustic Environments

Research snapshot– 2 days, 94 registrations, 4 continents

<https://scor-int.org/wp-content/uploads/2020/08/Agenda.pdf>

Challenges of Arctic deployments and recoveries

Access to ships and to field locations (common pools, back-up plans)

<https://www.nersc.no/news/rescuing-important-ocean-climate-observations-caatex>

Long-term measurements: large datasets and permanent accessibility

“Big Data”: can we store everything? Can we share everything? Can we keep it forever?

Sharing and spreading the knowledge: platforms, funding but also standards and reporting

New tools and techniques

Vector sensors – Machine learning – Sharing, traceability, use by non-specialists

Soundscapes and marine life

Marine mammals – Protected species ... and the others?

Models (acoustic propagation in particular)

Validating, benchmarking, sensitivity to input parameters, full reporting of how they are used

Local and traditional knowledge

Embedding it into the research , co-ownership, dialogue and respect of local constraints

Federating observations

POGO and IQOE developed the description of the **Essential Ocean Variable for the Acoustic Environment**.

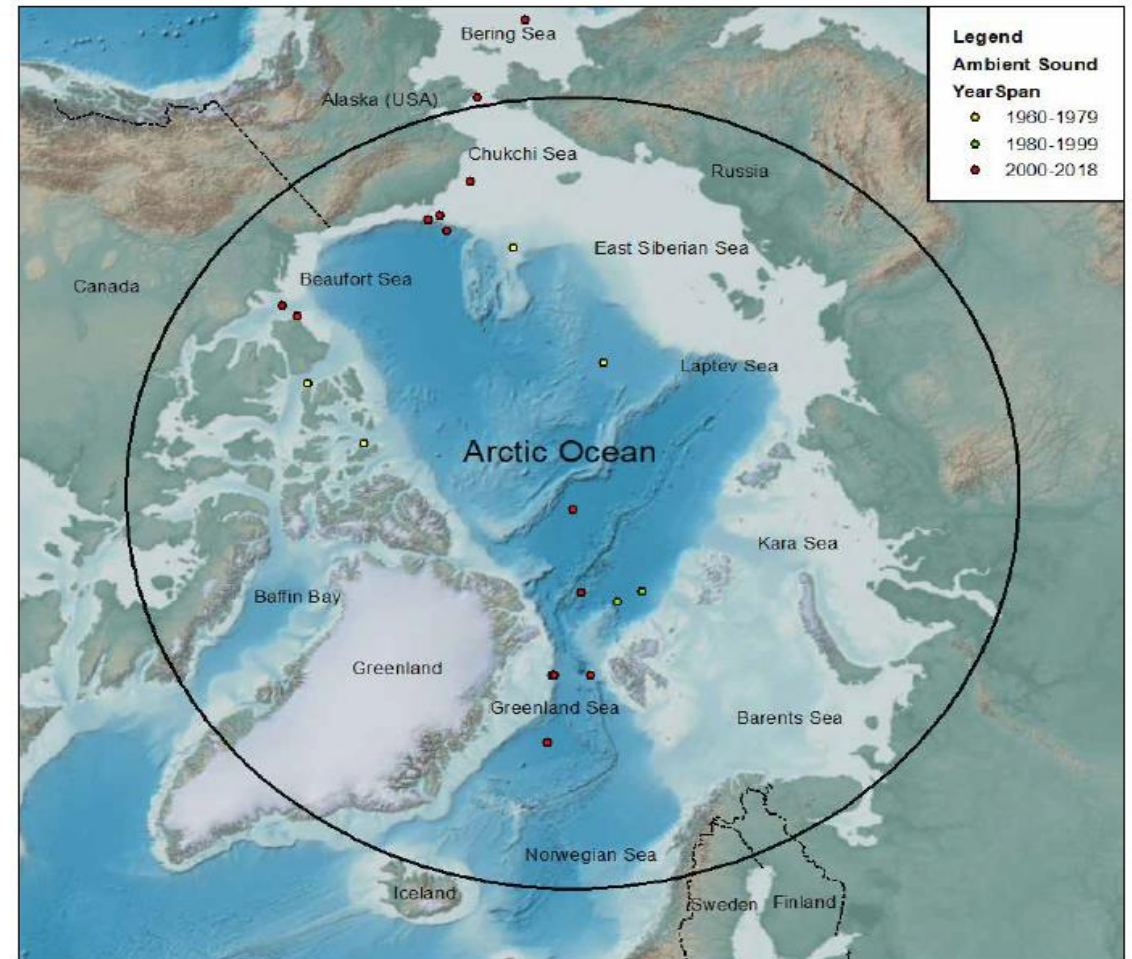
[Ocean Sound approved as an Essential Ocean Variable](#)
by GOOS Biology and Ecosystems and Physics and Climate Expert Panels

Links with PAME, CAFF, INTAROS, CAATEX projects

Recommendation from *OceanObs19*

- **Pilot a sustained multipurpose acoustic network** for passive acoustics, tomography, underwater positioning/communications, integrated with Arctic observing systems covering the central Arctic Ocean
Mikhalevsky, Sagen et al. 2015, Howe et al. 2019
- **By 2029**, the Arctic should prominently demonstrate that it has a **fully developed, implemented, and sustained ocean observing system** that meets at a minimum, Earth System prediction needs – but also meets other critical Arctic Societal Benefit Needs
Lee et al. 2019

Figure 1. Location of ambient sound level studies (dots) in the Arctic. Symbols are colour-coded by the timeframe of the study, with yellow for 1960-1979, green for 1980-1999, and red for 2000-2018. Basemap credit: National Oceanic and Atmospheric Administration, National Geophysical Data Center, and International Bathymetric Chart of the Arctic Ocean, and General Bathymetric Chart of the Ocean.



Conclusion

2018 [Endorsement](#) of our goals and activities by Arctic Observing Summit 2018



2019 [Ocean Sound](#) approved as [Essential Ocean Variable](#) for Global Ocean Observation Systems

2020 [Arctic Observing Summit 2020](#) and [International Arctic Science Committee Marine Working Group SAON Roadmap for Arctic Observing and Data Systems](#)

Now * planning for a multi-purpose acoustic network (OceanObs19 recommendation) – target date: 2029
* federating analyses of Arctic change and unanticipated global event (Covid)

JASA Special Issues

JMSE Special Issue

* sharing with other communities – Long-term legacy, traceability and links to local communities

Underwater sound meets the criteria for Essential Arctic Variables

using the SAON Roadmap for Arctic Observing and Data Systems