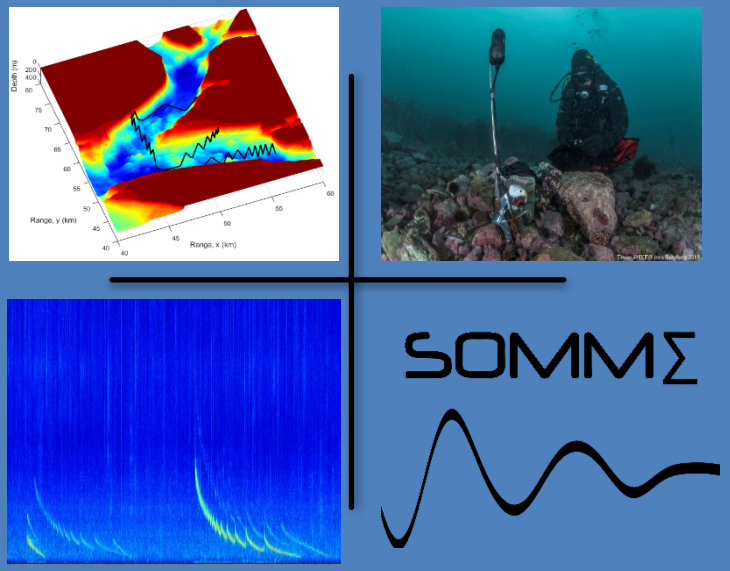
# Prediction of acoustic pollution in Arctic fjords: the importance of 3-D acoustic propagation modeling.



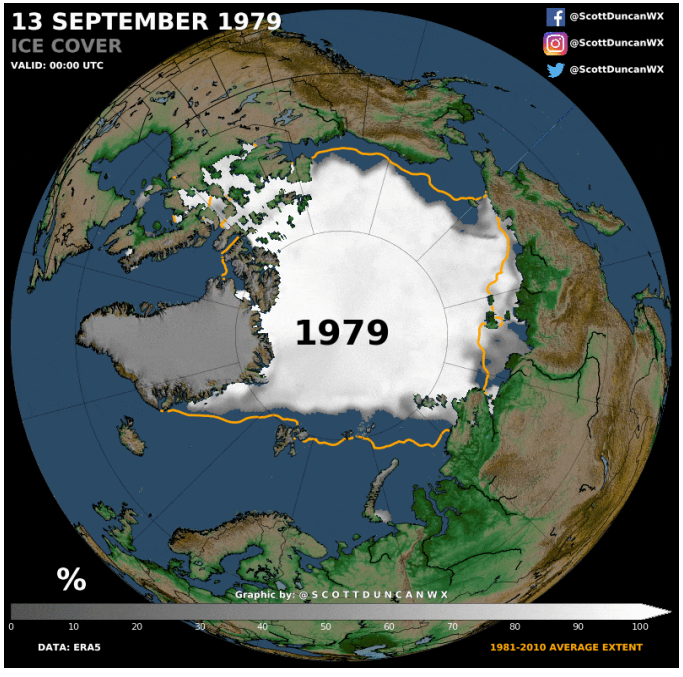

Gaëtan Richard [1,2], Delphine Mathias [1], Jérémy Collin [2], Laurent Chauvaud [2] and Julien Bonnel [3]

[1] Société d'Observation Multi-Modale de l'Environnement (SOMME), 38 rue Jim Sevellec, 29200 Brest
[2] Institut Universitaire Européen de la Mer, CNRS (UMS3113), Technopôle Brest Iroise, 29280 Plouzané
[3] Woods Hole Oceanographic Institution, Applied Ocean Physics and Engineering department, 266 Woods Hole Rd, Woods Hole, MA 02543-1050, USA

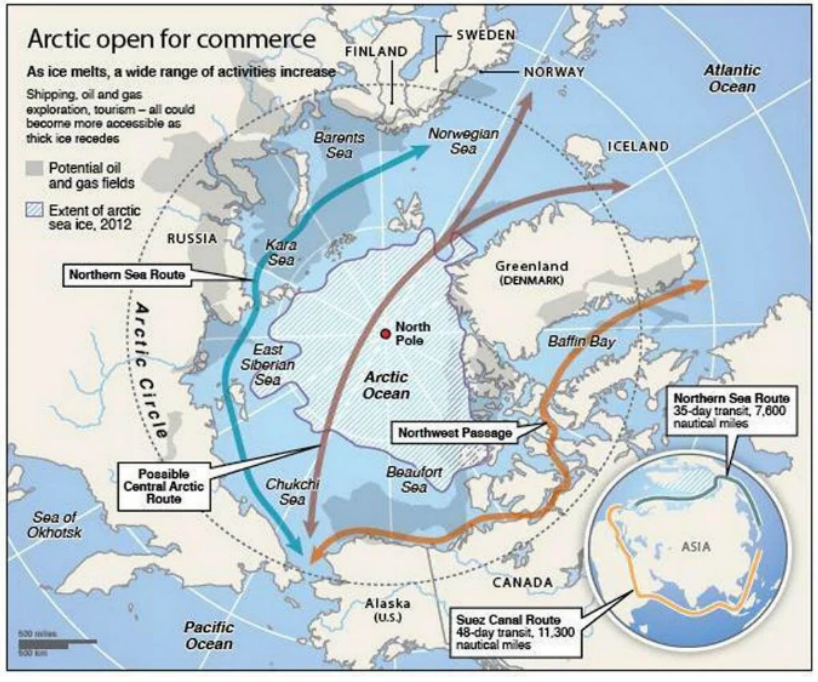
Séminaire national
sur le bruit sous-marin
Juin 2022

# The Arctic is warming rapidly

Sea-ice covering declines drastically,
with a potential ice-free summer predicted by 2040:




*Scott Duncan*



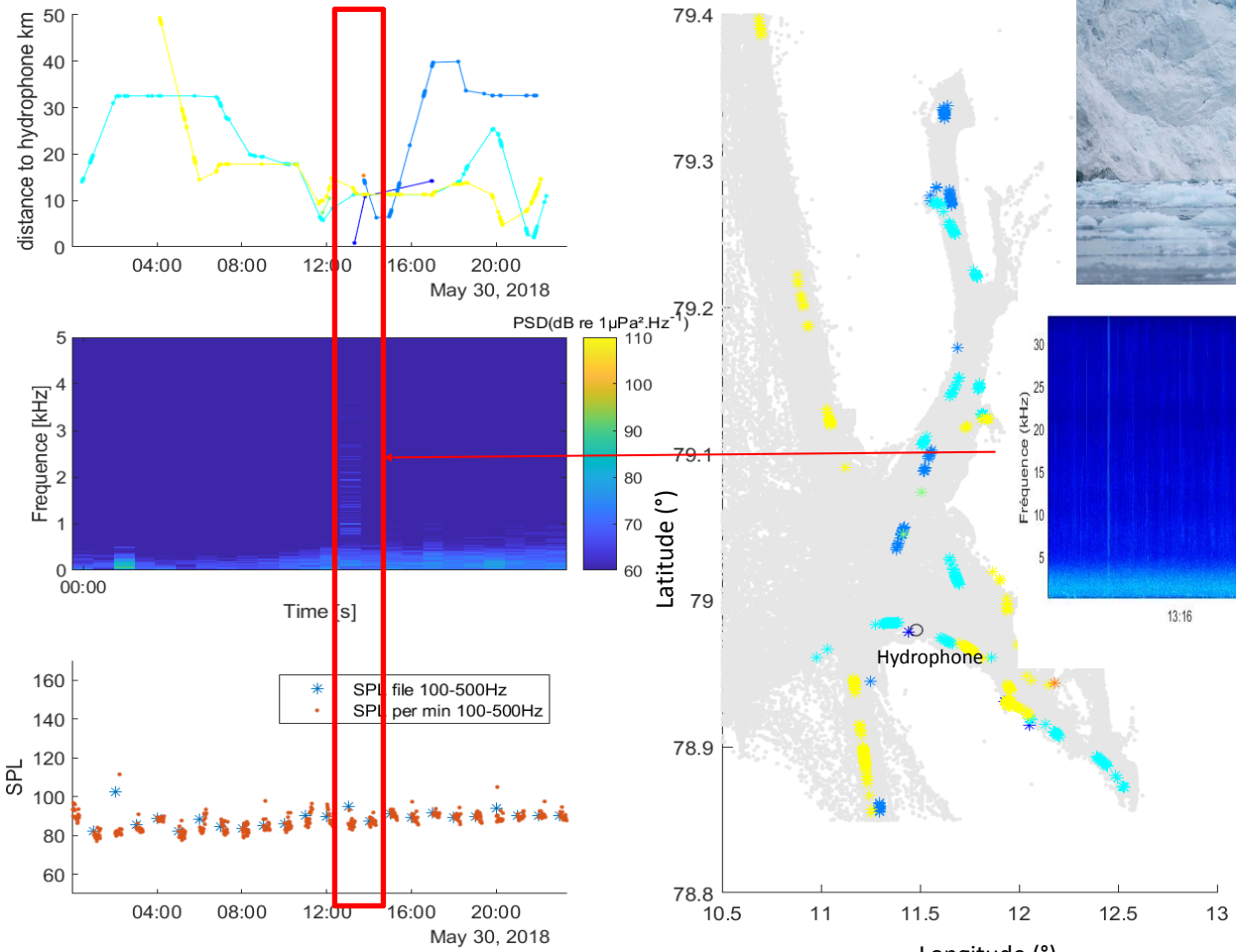

**Unprecedented access to the Arctic for anthropogenic activities :**

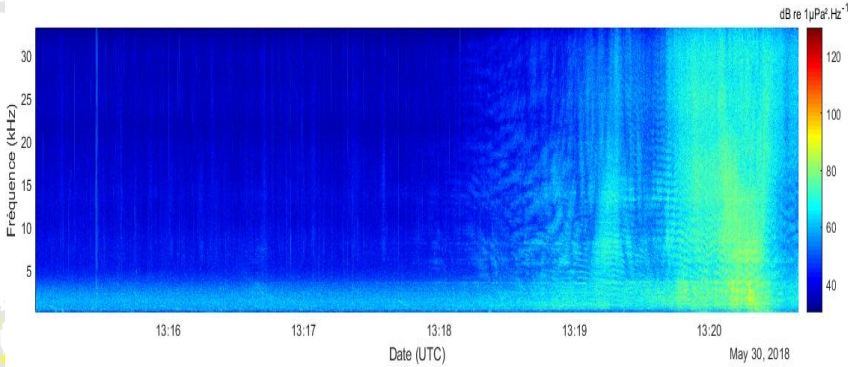
**Increasing anthropogenic noise in a nearly pristine acoustic environment**

Increasing noise pollution ?

## Underwater passive acoustic research in Ny Alesund :

- Describe soundscape (biophony, geophony, anthropophony)
- Monitor changes over time;
- Assess impact of anthropogenic noise on marine fauna.

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Increasing noise pollution ?

## Underwater passive acoustic research in Ny Alesund :

- Describe soundscape (biophony, geophony, anthropophony);
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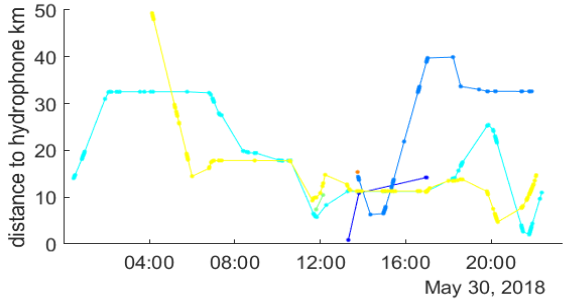
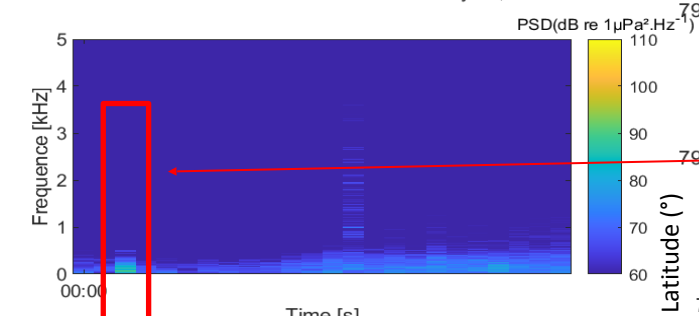
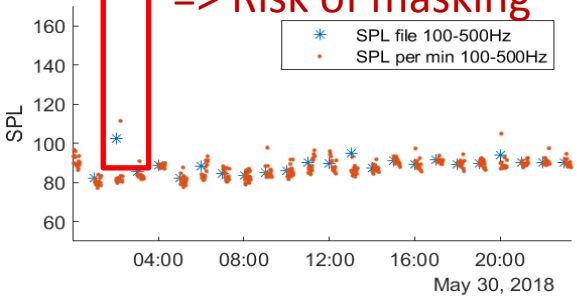
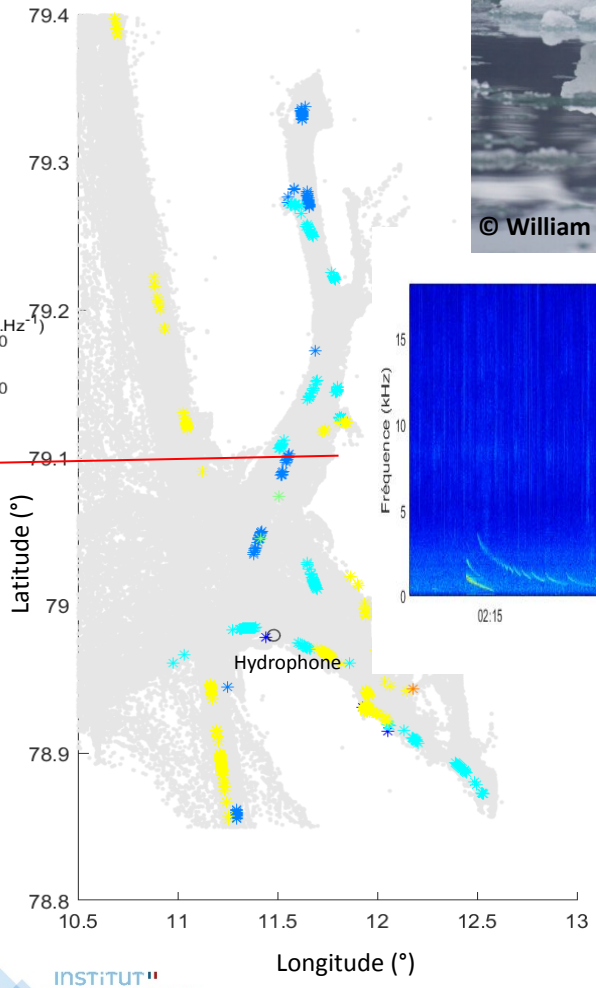
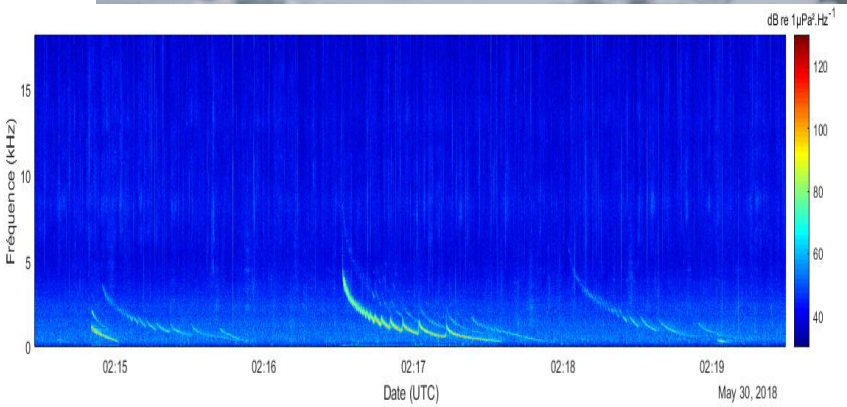



=> Risk of masking

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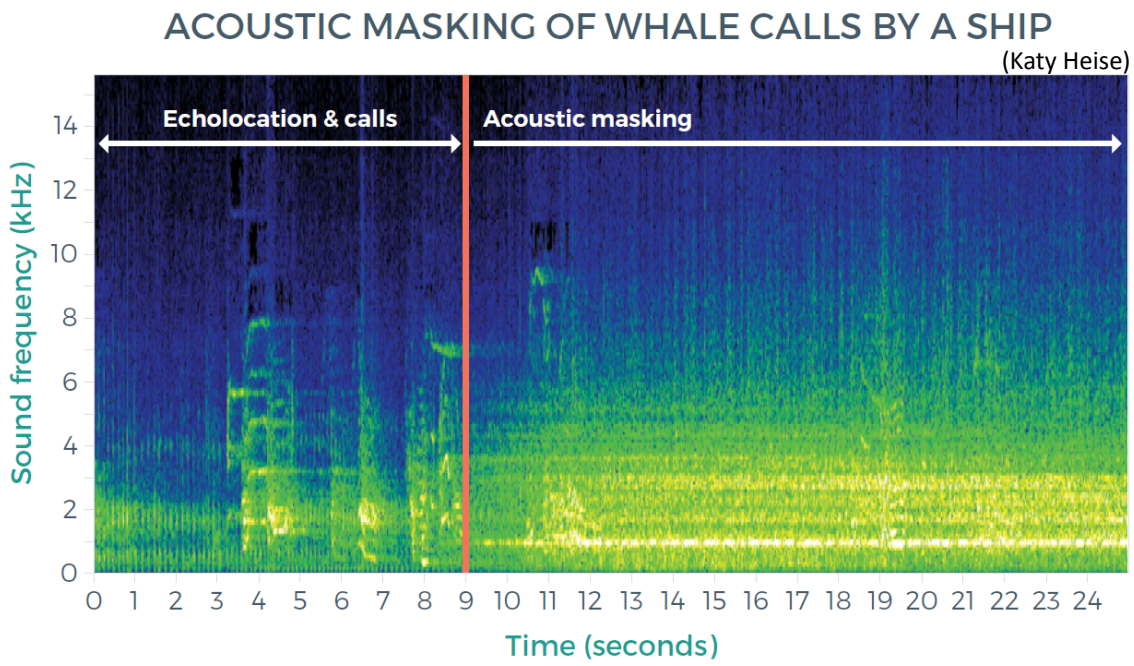
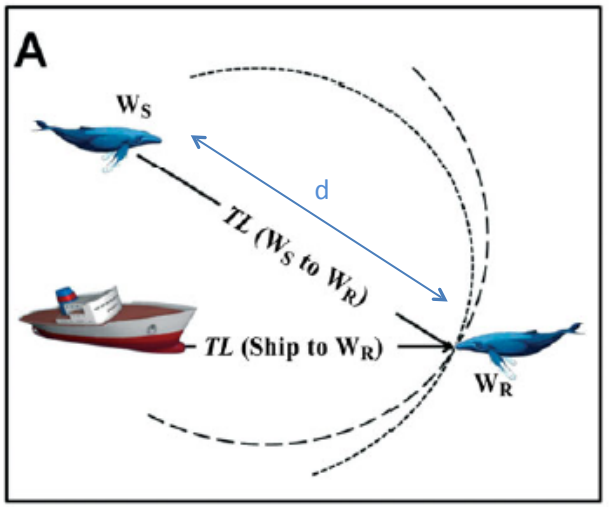
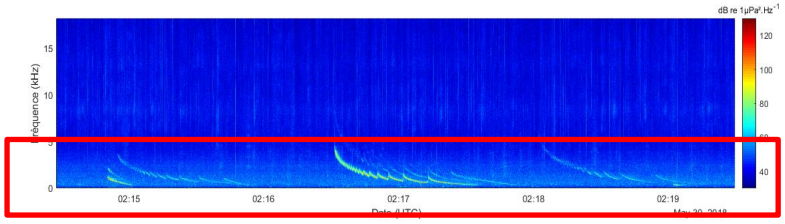
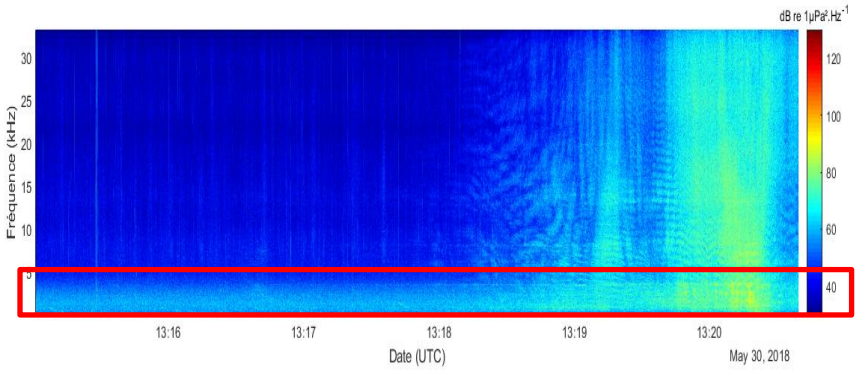


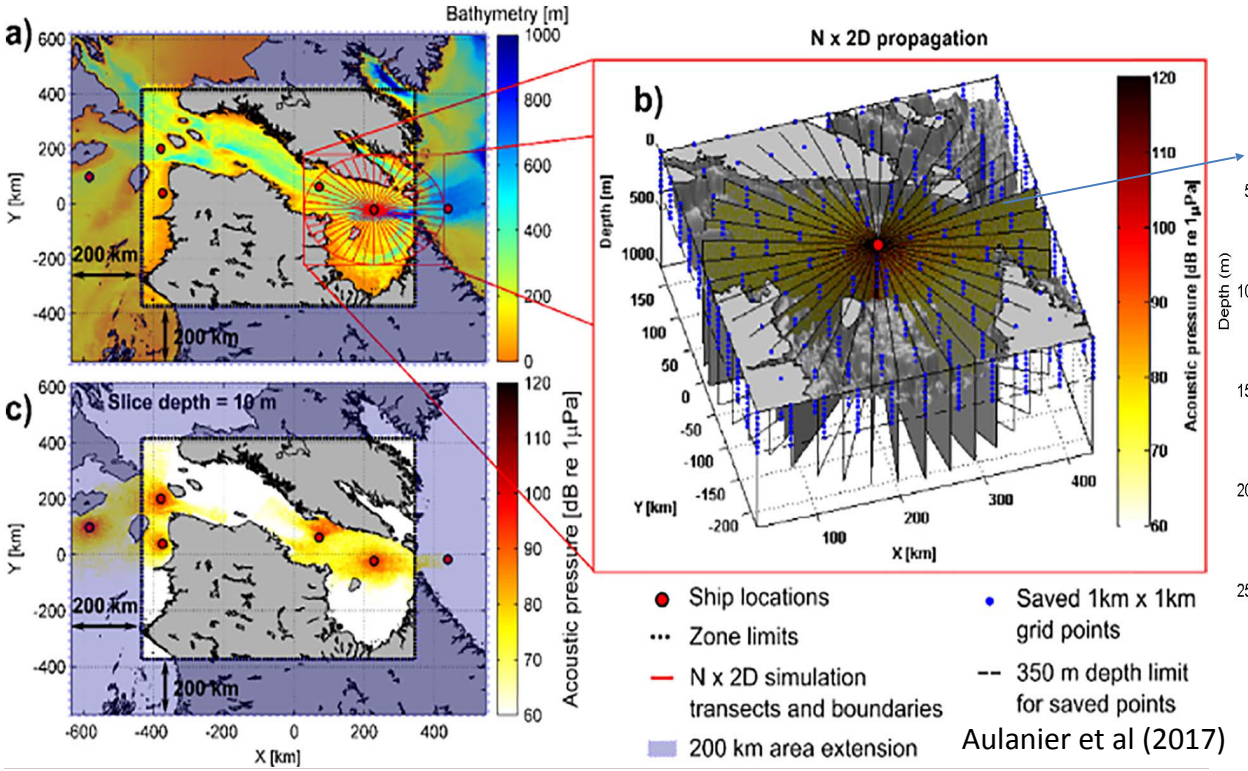

TL ~ 20log(d) , with d distance (source-receiver)



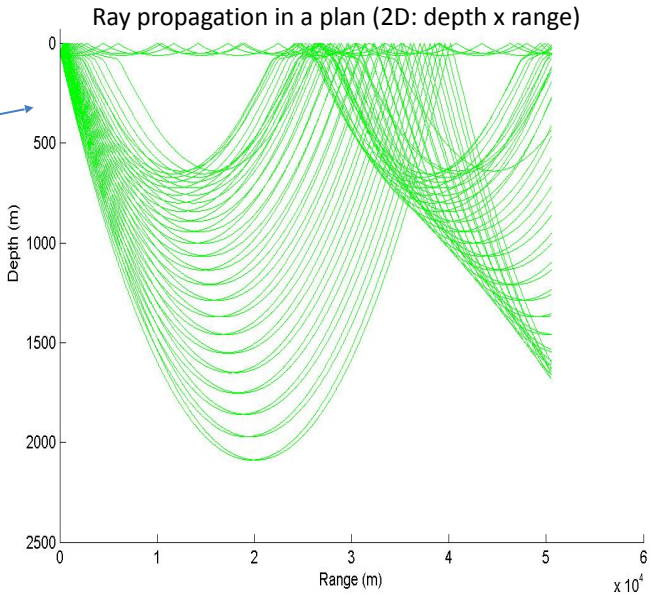



Acoustic propagation modeling to predict noise pollution

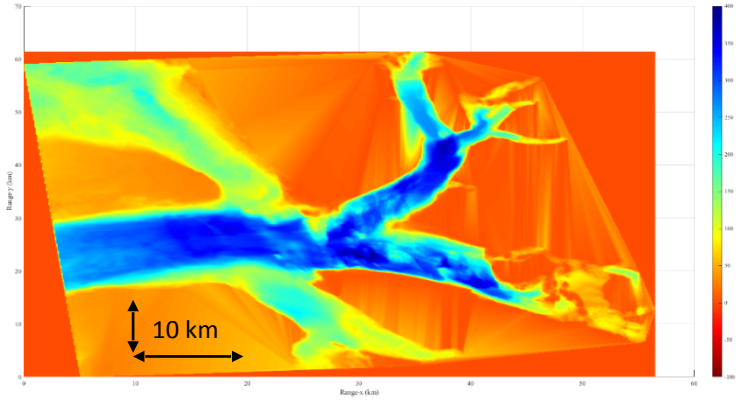
⇒ spatial acoustic propagation is often simplified in several (N) plans (2D)




Aulanier et al (2017)




**Is a traditional N x 2D propagation model sufficient in Arctic fjords?**

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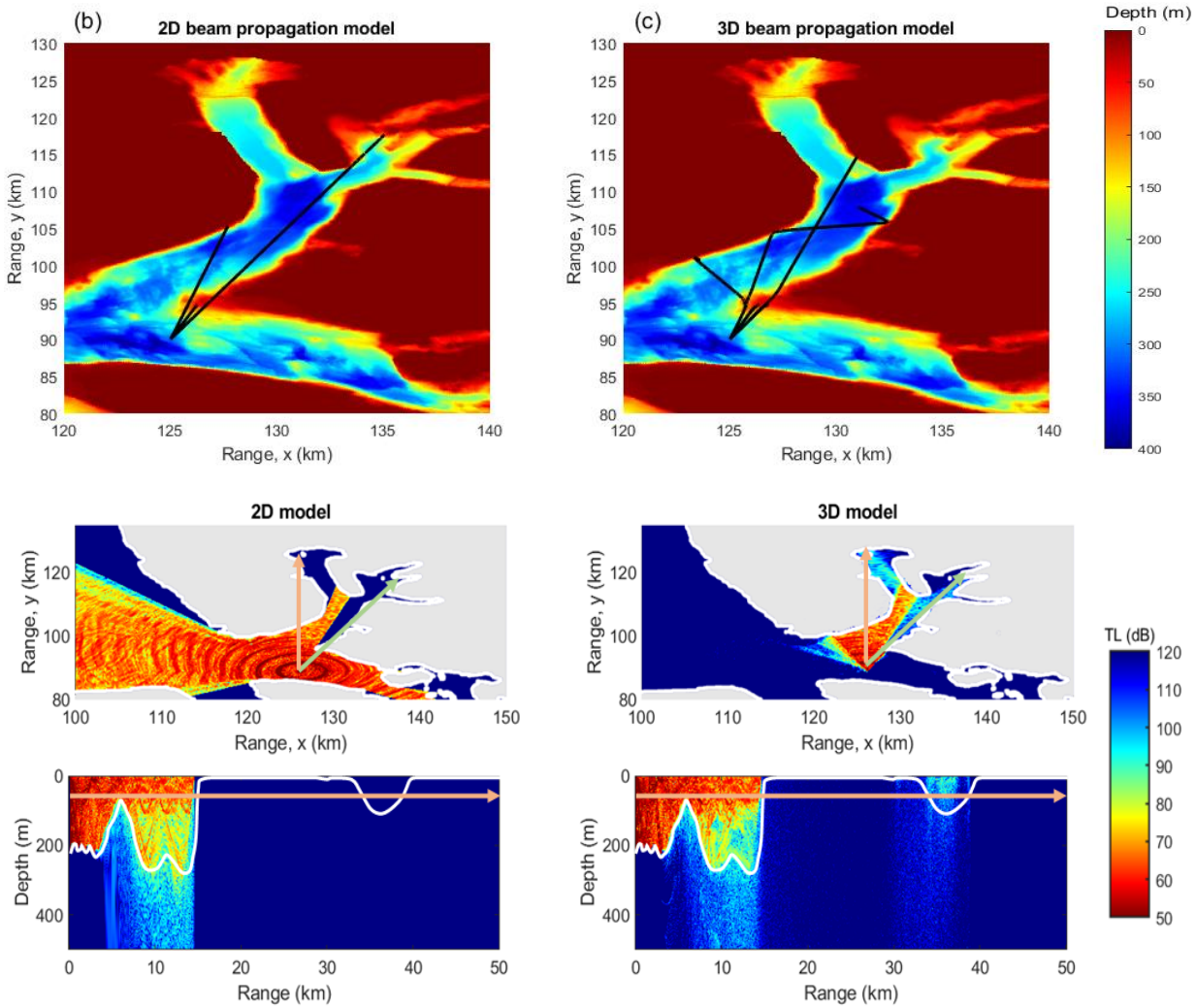
Propagation model considering the Fjord bathymetry and geography in 3D (Bellhop 3D)

➢ **Comparison propagation model nx2D vs 3D**



# Footprint estimation via 3D propagation model

Propagation model considering the Fjord bathymethry and geography in 3D (Bellhop 3D)

➢ **Comparison propagation model 3D vs nx2D**

Signal Excess estimation:

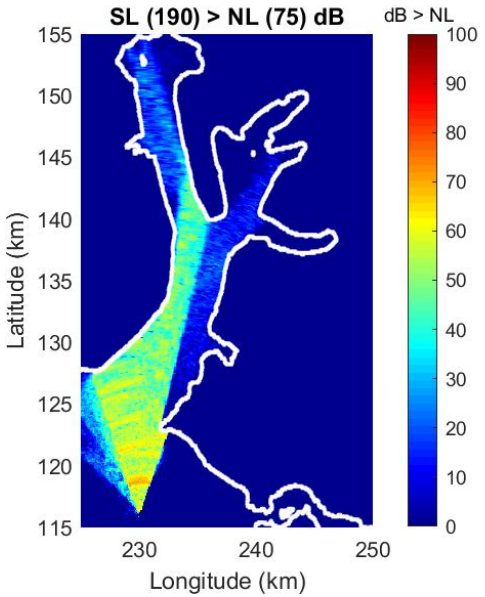
SE =SL-TL-NL

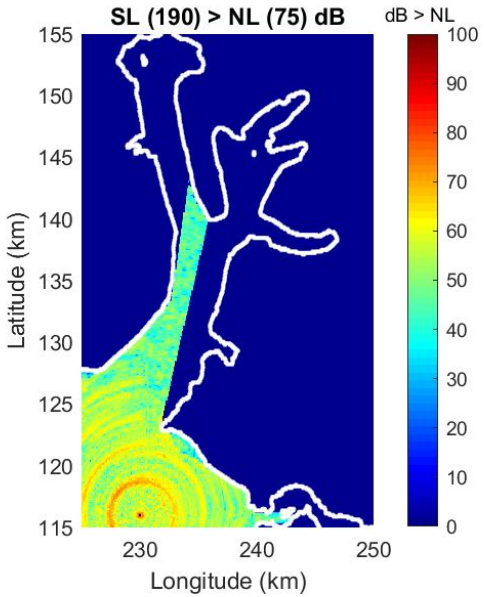
A ‘pessimist’ scenario:

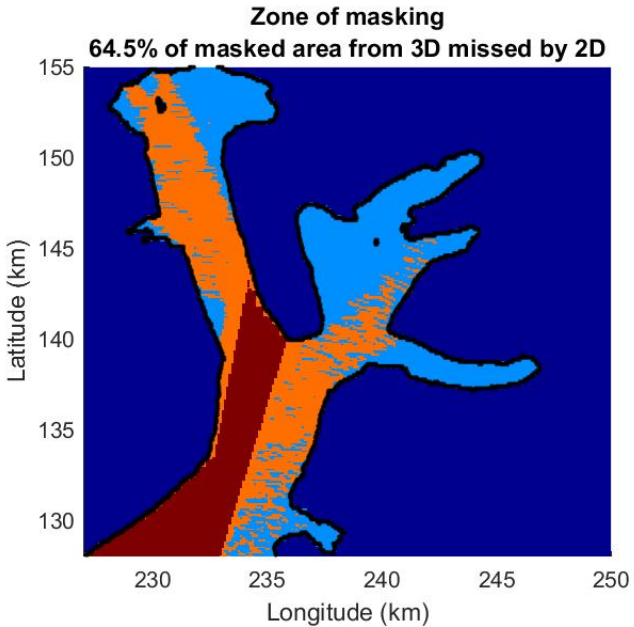
SL ~ value of nosiest vessel from literature

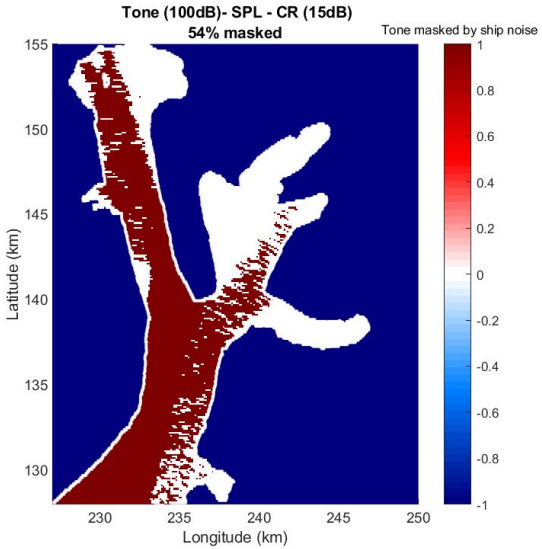
SL=190 dB

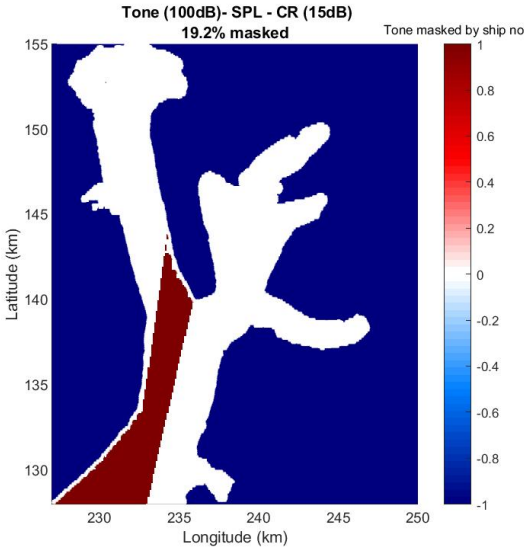
ex: Cargo (~100m)



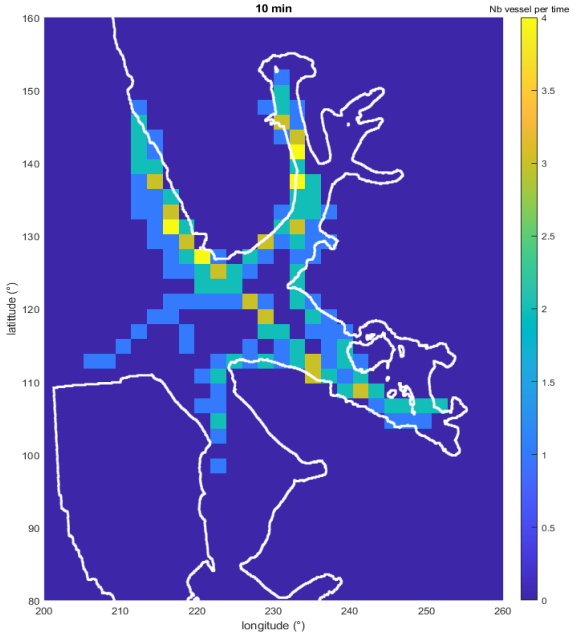



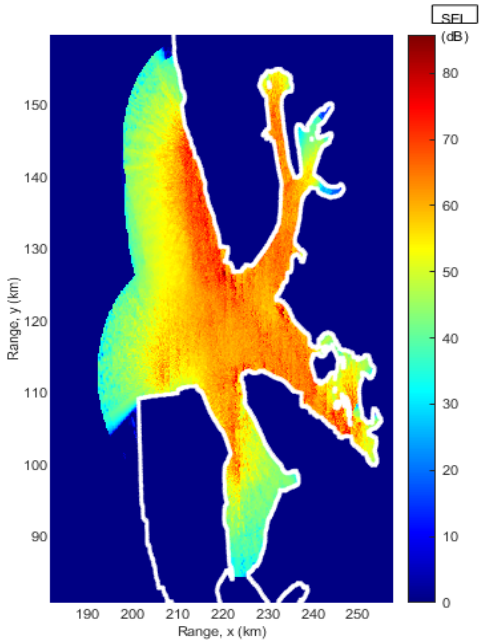
# Toward a better qualification and quantification of anthropophony impacts for marine spatial planning through a 3D propagation model

- At a spatial scale: mapping acoustic footprint where 2D propagation models can't propagate sounds

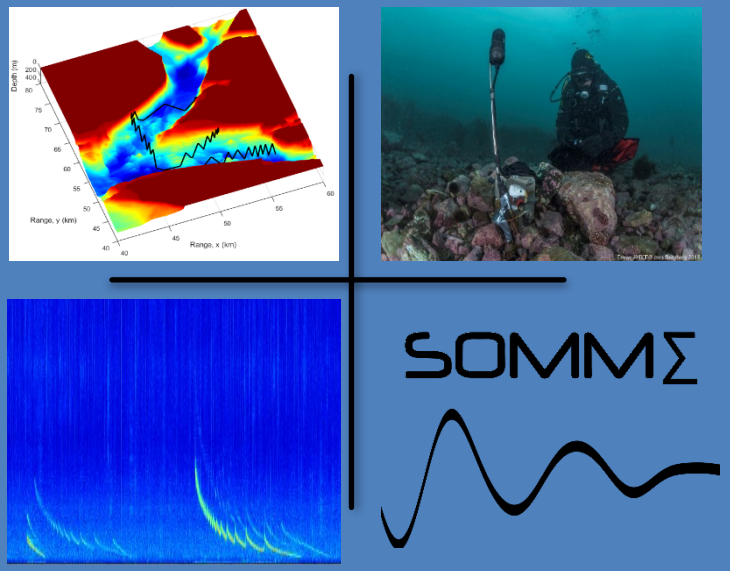
- Improvement of sound exposure level estimation : highlighting higher acoustic exposure to shipping noise to marine species than 2D propagation models

- Perspectives : predict acoustic footprint in the fjords.



# Thank you for your attention
# Any question ?



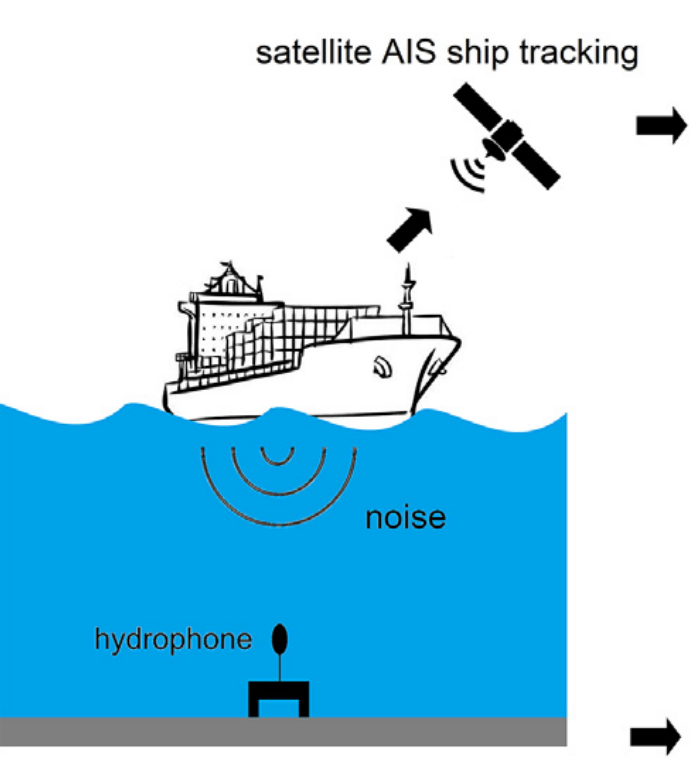

richard.somme@orange.fr

https://seaobs-somme.fr/

Workshop SERENADE

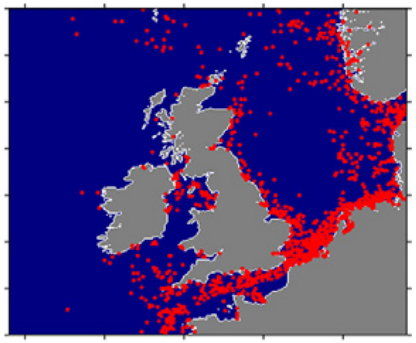
Juin 2022

# Acoustic propagation modeling to predict noise pollution

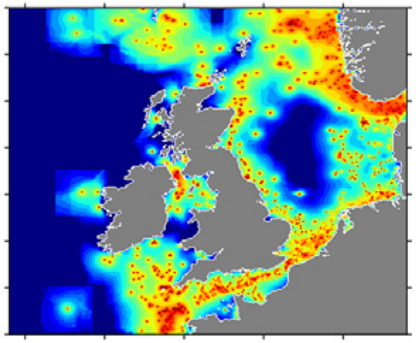



validation of modelled noise maps using hydrophone measurements

ship-tracking data



modelled ship noise map



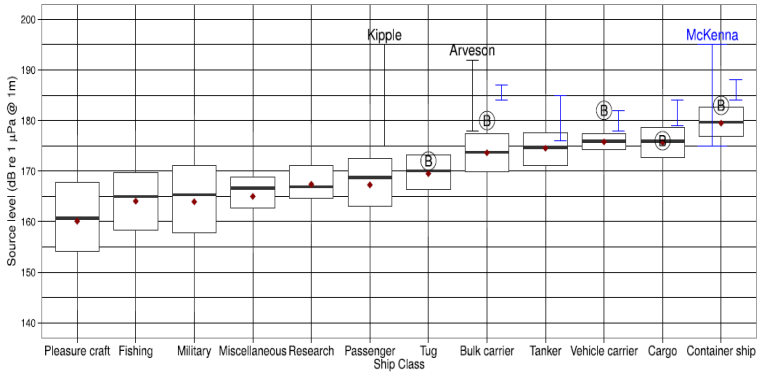
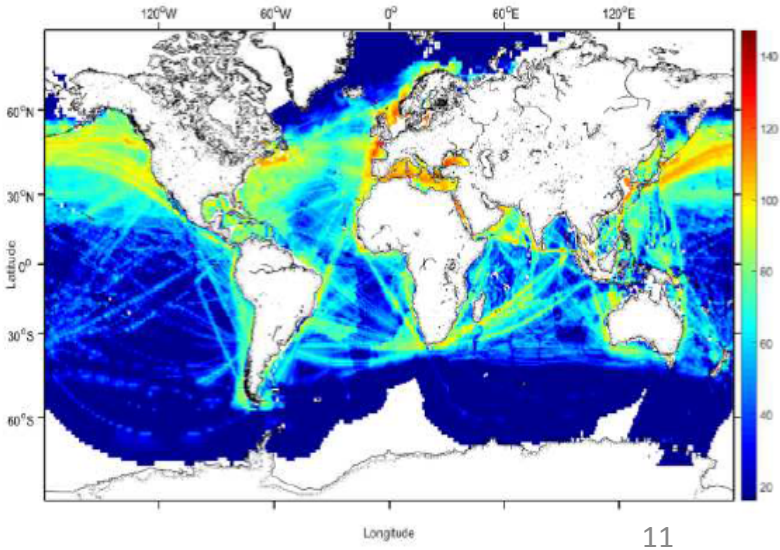



Figure 2 **Comparison of source levels from different studies for various classes of ships.** Broadband source level (*SL*) statistics for each ship class juxtaposed with results from recent studies of comparable classes. Bold horizontal lines are medians; gray box hinges are 25% and 75% quantiles; gray whiskers extend to the value that is most distant from the hinge but within 1.5 times the inter-quartile range (distance between the 25% and 75% quantiles); red dots are mean values from Table 2. Each encircled letter B represents a mean from *Bassett et al. (2012)*; blue vertical bars represent means from *McKenna et al. (2012)* with the container ship estimate of *McKenna, Wiggins & Hildebrand (2013)* labeled McKenna; black vertical bars represent estimates from *Kipple (2002)* and *Arveson & Vendittis (2000)*.






Le Courtois et al (2016),Veirs et al. (2016), Farcas et al (2020)