Underwater Radiated Noise from Vessels (SATURN)
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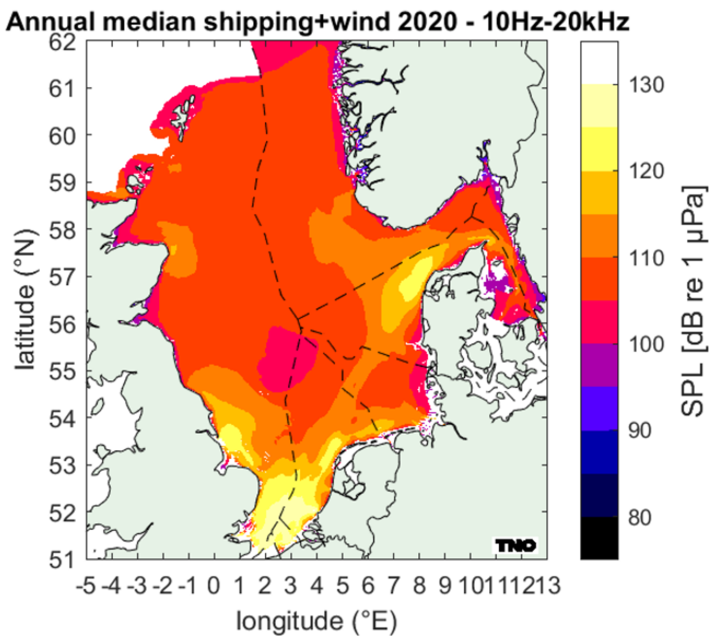
Webinar Questions

Can you explain what you mean by sound maps? As someone based in Sound Studies and not Acoustics or science, my idea of a sound map might be very different!
Sound maps are a way of showing how loud the underwater sound is over a 2-dimensional area to visualize the "footprint" of underwater radiated noise in a given environment. If we have a sound map, we can infer how the underwater radiated noise may impact marine life in different areas.

For example, this map shows the temporal median depth averaged sound pressure level over the year 2020 for the North Sea.



Has prop cavitation been found to contribute significantly to URN?
Prop cavitation is a dominant source of ship URN. It creates a different kind of underwater radiated noise than machinery noise. Machinery noise is typically more tonal (sound energy is more concentrated at certain frequencies) while cavitation is impulsive and broadband (sound energy is spread out over a wider range of frequencies). Propeller cavitation noise increases much more with ship speed than machinery noise and, therefore, it is usually the dominant source of URN at design speed of ships.

Can I find the type of ship from underwater radiated noise?
The characteristics of underwater radiated noise are related to the ship hull size, speed, type of propulsion system, propeller tip speed, and engine operational frequencies (among other things). The acoustic signatures can be used to classify ships based off of these characteristics. Signature details differ between individual ships. Generic differences between ship types are more difficult to identify.

Are there active noise cancellation techniques?
Active noise cancellation is generally more complex and expensive than passive noise control. It may solve problems that cannot be solved easily with passive means. There are examples of active control of engine and gearbox vibrations in naval vessels (e.g. https://research.utwente.nl/en/publications/active-vibration-control-for-underwater-signature-reduction-of-a-)

Do ships with water wings that lift them out of the water have a lot of cavitation noise?
To our knowledge, there is no data available for such ships. However, as these are fast sailing vessels, a relative large thrust is required for a small propulsion area implying that cavitation noise can certainly be expected. As the ship hull is not in direct contact with water in the foil-born mode, one can expect that the contribution of machinery noise to the underwater radiated noise for that situation is small.

And maybe also what is difference between sound loudness and sound pressure level?
Sound pressure level quantifies mean-square amplitude of the sound pressure in decibels. Loudness is the perception of the sound pressure, depending on the hearing sensitivity of the listener.

Is there any relevant influence of cavitation patterns by environmental factors such as water temperature, salinity, acidity or e.g. presence of sea ice?
Systematic studies on this topic are very difficult to perform and not much data is available. The effect of salinity has been investigated in model-scale facilities, see e.g. doi: 10.1115/1.2819102, in which it was shown that cavitation bubbles in salt water generate more noise than in fresh water, but the results may be affected by nuclei contents. This is currently topic of research in the new Multi-Phase Flow Tunnel of the University of Delft.

Are there any plans to test toroidal propellers to see if they can be scaled up to larger vessels?
Yes, see https://www.saturnh2020.eu/post/testing-a-new-propeller-design-in-france-video

I assume most experiments and standards target the main propulsion propellers. What about maneuvering thrusters since their purpose is highly context-dependent and even more varied than main propulsion for transient shipping?
The underwater radiated noise of thrusters is being investigated, both in model-scale facilities with respect to cavitation noise and at full-scale. The operational range of thrusters is indeed larger than for the main propulsion propellers which makes its prediction and evaluation more complicated. Measurement standards and class limits do not distinguish between propellers and thrusters and usually focus on specific sailing conditions. Dynamic positioning is not part of these standards and limits.

I have seen advertisements for propellers with "pores" that say they will decrease cavitation and noise. Can you help us explain if that would work, and why?
Pores in the propeller blade lead to a reduction of the pressure difference between the fore and aft surface of the blade which increases the value of the minimum pressure in that region and thereby decrease cavitation extents and cavitation noise. The pores are usually applied in the tip region of the propeller blade and can be seen as an alternative to geometrical modification of the blade to unload the tip.

The Prairie-like system sounds interesting. Intuitively, introducing more nuclei in the propeller inflow should increase cavitation and noise but the results look promising. Any thoughts on why this occurs? Are the blades supercaviting at this point?

An advantage of the Prairie system is that it can be switched off when there is no or little cavitation on the blade and activated when substantial cavitation is present and cavitation noise needs to be reduced. The air bubbles indeed lead to an increase in cavity size but also adds compressibility to the cavity (the pressure in the cavity will increase during to the collapse due to the increase of the partial pressure of air) thereby dampening the cavity collapse and reducing the low frequency radiated broadband noise. The blades do not necessarily have to supercavitate for this to occur. At very low frequencies (blade rate frequency and first few harmonics thereof) one typically sees an increase of the radiated noise, most likely related to the increase in cavity size. The effect on high frequency noise is small, so probably the effect of increasing cavity size and dampened collapse cancel each other.

Please what are the available regulations for underwater noise from ships?

There are no global regulations for URN from ships. IMO has issued non-mandatory guidelines for reducing URN. In some regions there are voluntary speed slow down initiatives to reduce URN (e.g. https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/maintaining-healthy-ecosystems-throughout-our-jurisdiction/echo-program/projects/haro-slowdown/)