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Impact of COVID 19 lockdown on Underwater ambient noise

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Abstract

The COVID-19 pandemic has a significant impact on underwater noise. The impact of lockdown during the pandemic resulted in changes in the acoustic environment. The primary goal of this study is to differentiate the sound pressure level before and during the COVID-19 lockdown. A Passive Ambient Noise Measurement System was deployed in the Central Arctic Ocean as part of an acoustic experiment during 2019–20. The system consisted of hydrophones with associated data acquisition modules for acquisition and storage of ocean ambient noise. The time series acoustic data recorded by the system was used to study the variation in Sound Pressure Level (SPL) before and during the lockdown. The data from the hydrophone, positioned at 60 m depth from the surface is used for spectral analysis. Considering the depth, surface noise due to ice dynamics and anthropogenic noise due to shipping is prevalent at the location.

Spectral analysis carried out and the results are quantified and presented here. From the analysis of Sound Pressure Level (SPL) we saw that noise is more intense in the low-frequency band and decreases toward the high-frequency band. The one-third octave bands are considered between 63 Hz and 2 kHz, with frequencies 63 Hz, 80 Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz, 800 Hz, 1 kHz, 1.25 kHz, 1.6 kHz, and 2 kHz respectively. The variation in average sound pressure level is in the range of 3 to 11 dB with maximum at 630 Hz, which is 11.7 dB. In the low-frequency band, shipping plays a very vital role in increasing the sound pressure level before lockdown. Since the Central Arctic Ocean is covered by ice sheets, surface noise is mainly contributed by ice interactions.

Biological noise is also a component of underwater ambient noise mainly for species' communication. Marine species use both active and passive sounds to communicate and sense their environment. According to Dunlop et al., 2010, it was found that when the underwater ambient noise level changes, whale communication behaviour occasionally varies. Three minke whale thumps were observed for 3 sec, 3 sec, and 4 sec durations during lockdown on April 5, 2020. The minke whale thumps sounds was observed in a frequency band between 1 kHz to 2 kHz and peak frequency was observed at 1410 Hz. From this study, it has been observed that before the COVID-19 lockdown, the sound pressure level was high, which further decreased during the lockdown period.

keywords: lockdown, one-third octave, Sound Pressure Level, Minke whale, thumps sounds.

1. Introduction

There has been an increase in anthropogenic noise in the oceans over the past 50 years. Various human maritime activities contribute to acoustic pollution, such as seismic exploration in oil and gas, using sonar for military and commercial purposes, and recreational boating.

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Due to COVID-19, there has been a slowdown in global trade, which has decreased the amount of commercial marine traffic. Growth in economic activity is well correlated with ambient noise levels in oceans around the world (Frisk, 2012). The major source of ocean noise in the low-frequency range is marine shipping. Ship movements, tourism, fishing, energy exploration, and offshore drilling all showed dramatic declines during the COVID-19 lockdown. The global pandemic has given scientists the opportunity to examine how a sudden decrease in anthropogenic activities affects underwater sound levels.

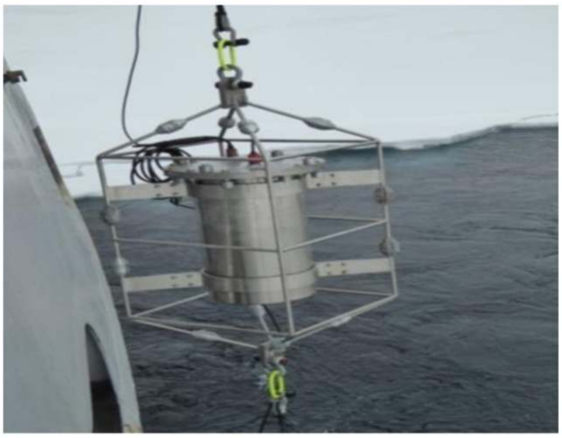
As far as marine mammals are concerned, increased noise pollution has a huge impact on them. Sound is commonly used by oceanic creatures such as whales to communicate, hunt for food, and navigate (Tyack, 2000). The primary goal of this work is to find out the variation in sound pressure level before and during the COVID-19 lockdown.

2. Data and methodology

A Passive Ambient Noise Measurement System (ANMS) was deployed in the Central Arctic Ocean as part of an acoustic experiment during 2019–20. The system consisted of hydrophones with associated data acquisition modules for acquisition and storage of ocean ambient noise. The Reson TC 4014 hydrophone was installed at a depth of 60 m below the ocean's surface. For this experiment, two days of data have been used. The duration of the time series raw data is 1 hour. The data is sampled at 4 kHz sampling frequency mainly to investigate low frequency noise sources in the region. The frequency bandwidth of the hydrophone is 30 Hz to 100 kHz. This hydrophone's preamplifier has a gain of 26 dB and a sensitivity of -180.7 dB re 1V/uPa. Tests and calibrations were performed at the Underwater Acoustic Test Facility of NIOT, which is accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) in India.

A preliminary observation of underwater ambient noise for the Central Arctic Ocean (CAO) has been carried out in order to evaluate the variation of sound pressure level before and during COVID 19. Acoustic spectral analysis was performed on the ANMS time series acoustic data. The hydrophone's receiving sensitivity must be used in order to convert the voltage output into pressure.

Sound pressure levels were estimated using Welch's Power Spectral Density (PSD) method (SPL). Based on Welch's approach, a signal's power can be calculated at various frequencies. Instead of performing the Fourier transform on the entire signal, Welch divides the signal into smaller portions and then performs the Fourier transform on each sector separately. A final Fourier transform is calculated by averaging all the individual Fourier transforms. PSD estimations were calculated by using a 4096-point FFT with 50% overlap and a hamming window.



Deployment of ANMS

Fig.1. Ambient Noise Measurement System (ANMS) location

3. Results and Discussions

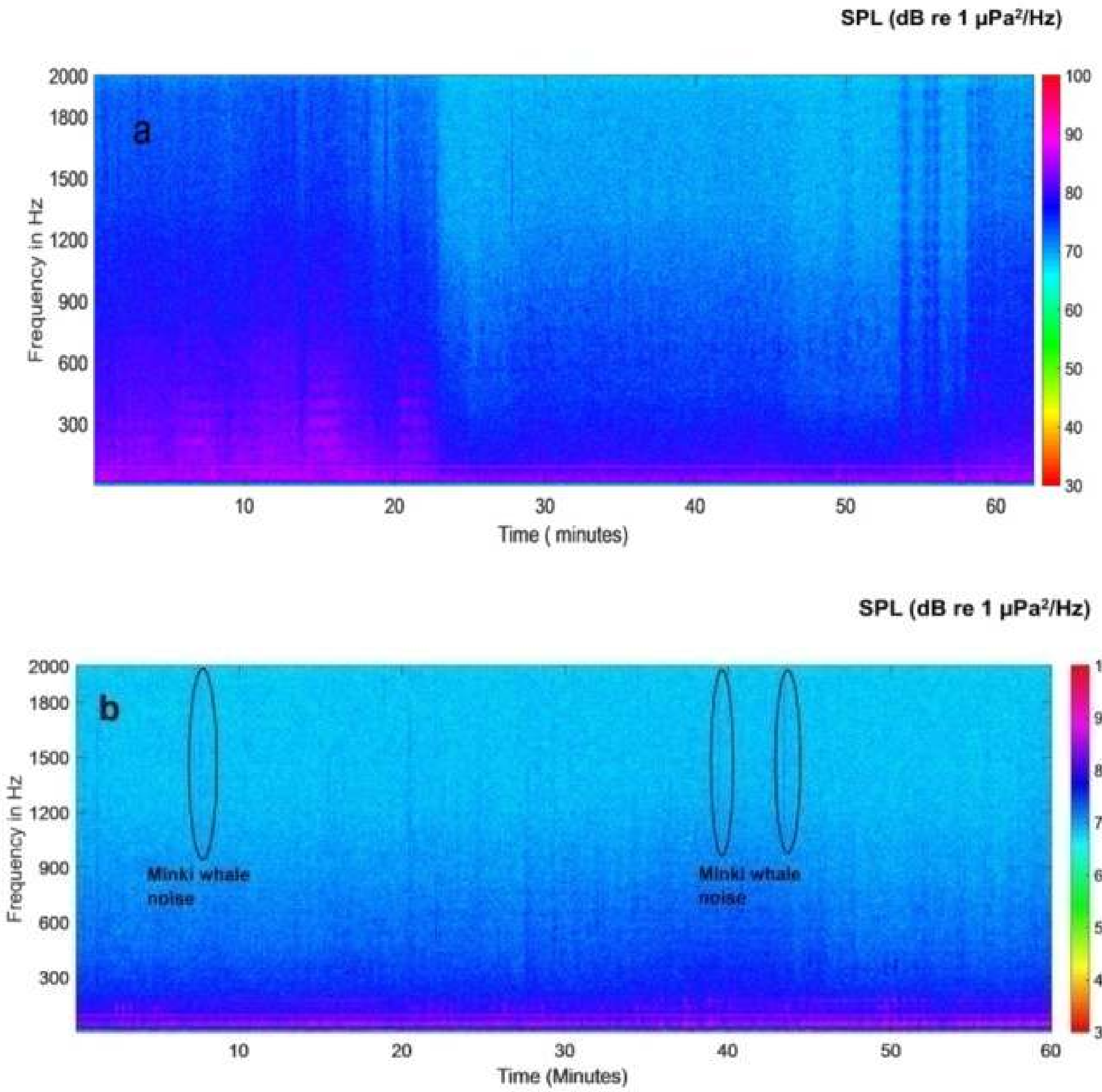


Fig.2.(a) Spectrogram of 5th March 2020 and Fig.2.(b) Spectrogram of 5th April 2020

From the analysis of time series underwater ambient noise data of 5th March 2020 and 5th April 2020 it has been observed that the sound pressure level on 5th March 2020 is more as compared to 5th April 2020. The decrease in underwater sound pressure level during the COVID-19 lockdown is primarily due to the decrease in shipping activity (Thomson, 2020). Shipping is a major contributor to underwater noise pollution. Most of the countries in the Arctic region implemented their lockdown in the middle of March 2020; for Norway, the first COVID-19 lockdown started on March 12, 2020, On March 30, 2020, Russia imposed the first COVID-19 lockdown, and on March 25, 2020, Canada imposed its first COVID-19 lockdown. Figure 2. (a, b) represents the sound pressure level before (5th March 2020) and during (5th April 2020) the lockdown. The results of spectral analysis are quantified and presented here. Sound Pressure Level (SPL) analysis shows that low-frequency noise is more intense than high-frequency noise because of distance shipping.

One-third octave bands range from 63 Hz to 2 kHz, with frequencies such as 63 Hz, 80 Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz, 800 Hz, 1 kHz, 1.25 kHz, 1.6 kHz, and 2 kHz have been utilised for the investigation of SPL at various frequencies. The average sound pressure level varies between 3 and 11 dB, reaching a high of 11.74 dB at 630 Hz. There was a maximum difference in sound pressure level of over 10 dB between 315 Hz and 1250 Hz. The whole information about the 1/3 octave band frequency and corresponding sound pressure level is shown in Table 1.

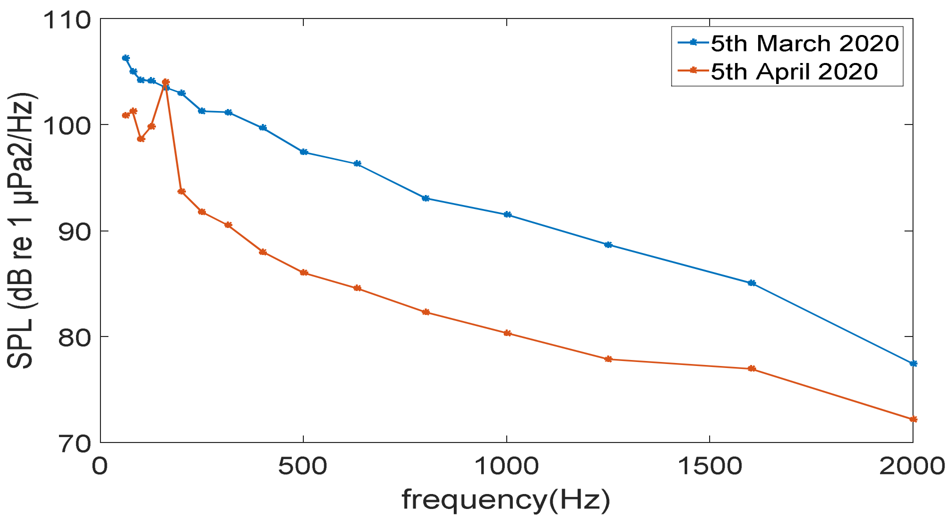


Fig.3. Noise level of 5th March 2020 and 5th April 2020

Table-1(1/3 octave band frequency and the corresponding sound pressure level on 5th March 2020 and 5th April 2020)

Frequency (Hz)	5th March 2020	5th April 2020	SPL Difference(dB re 1 µPa^2/Hz)
62.5	106.27	100.83	5.44
80.07	105.0	101.24	3.76
99.60	104.18	98.66	5.52
125	104.15	99.79	4.36
160.15	103.51	104.0	-0.49

199.21	102.97	93.69	9.28
250	101.27	91.76	9.51
314.45	101.17	90.50	10.67
400.39	99.66	87.98	11.68
500	97.39	86.01	11.38
630.85	96.29	84.55	11.74
800.78	93.05	82.30	10.75
1000	91.50	80.32	11.18
1250	88.67	77.85	10.82
1601.56	85.05	76.95	8.1
2000	77.42	72.18	5.24

During the lockdown period 5th April 2020, 3 minke whale sounds were observed with a duration of 2 seconds, 2 seconds, and 3 seconds, respectively. The minke whale can be found in various locations around the world, including the North Pacific ,North Atlantic waters (Vıkingsson, 2014). It is a migratory species, often seen in the northern waters of the Svalbard region of the Arctic Ocean. The minke whale noise was observed in a frequency range above 1 kHz, with pick frequency between 1400 to 1600 Hz having the maximum sound pressure level of 90 dB.

Fig.4.(a, b) represent the Frequency Spectrum and Spectrogram of minke whale noise .

The reduction in noise levels due to the COVID-19 lockdown could have created a more attractive environment for minke whales, making them more likely to be spotted in certain locations. However, it's not guaranteed that the minke whale was observed in that location due to the lockdown. The presence of the minke whale could be due to a variety of other factors, such as food availability or seasonality.

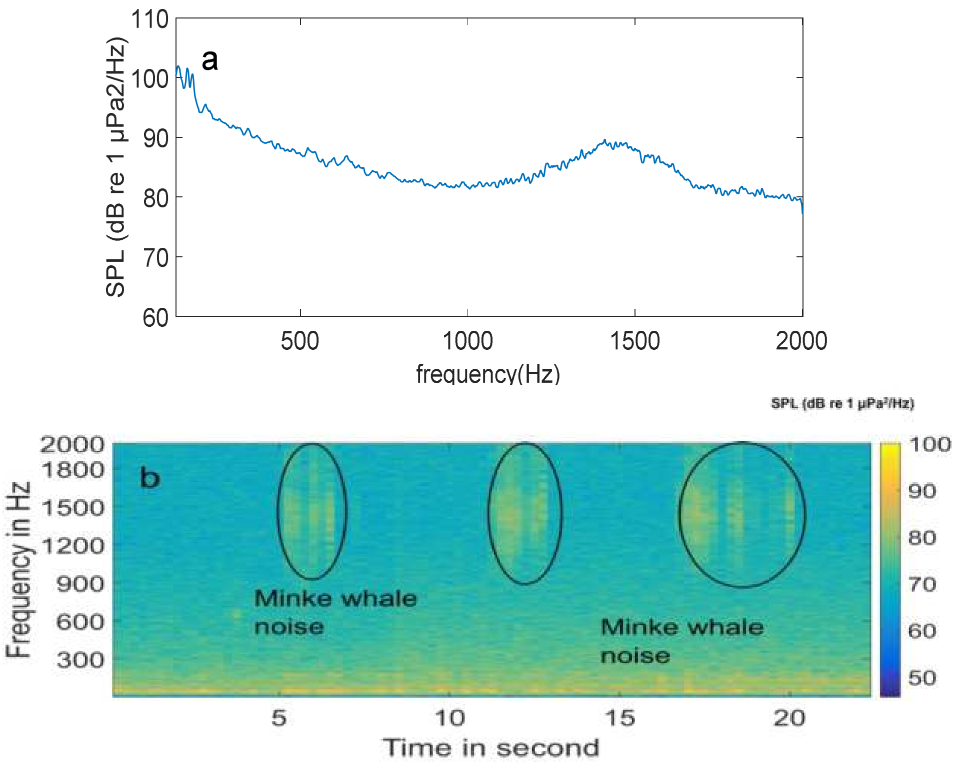


Fig.4.(a) Frequency Spectrum minke whale and Fig.4.(b) Spectrogram of minke whale.

4. Conclusions

The noise levels in the frequency band <2000 Hz have been analyzed before and during lockdown. It is understood from the ambient noise data sets that the noise in the central Arctic Ocean is strongly influenced by shipping noise before lockdown. In most of the frequencies, there is a maximum difference of noise level is 11 dB and a minimum difference of noise level is 3 dB. As a result of the COVID-19 lockdown, noise levels may have become lower, creating a more favourable environment for minke whales. The lockdown, however, does not guarantee that the minke whale was actually observed at that location. A variety of factors could contribute to the minke whale's presence, such as the availability of food or seasonality. This result gives a primary understanding of the variation in underwater noise levels before and during the lockdown. A better understanding can be gained by measuring long-term underwater ambient noise before and during the lockdown.

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