SnT 2025
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Hydroacoustic signals detected in the Indian Ocean during the global outbreak of the COVID-19 pandemic

A. Raveloson [1], and J. A. Andriamampandry [2]

[1] Institute and Observatory of Geophysics of Antananarivo (IOGA)
[2] Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)

INTRODUCTION AND MAIN RESULTS

Lockdown measures during the COVID-19 pandemic led to a significant reduction of major human activities around the world. That impacted maritime activities and obviously suppressed anthropogenic signals and improved detectability of natural hydroacoustic sources. In this study, data recorded between 2018 and 2022 at the hydroacoustic stations HO1W, HO8S and HO4N were analyzed by the National Data Centre (NDC) in Madagascar using the PMCC method. Continuous signal from different natural sources were observed at azimuths ranging from 140 to 250 for HO1W, 27 to 35 for HO8S, and 150 to 200 for HO4N. Detections between December and March at stations HO1W and HO4N were increased. In addition, several events such as earthquakes along the Indian Ocean Ridge, the Tsunami generated after the Krakatoa volcano eruption on 22 December 2018, ice breaking, and more were detected.

SnT 2025
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

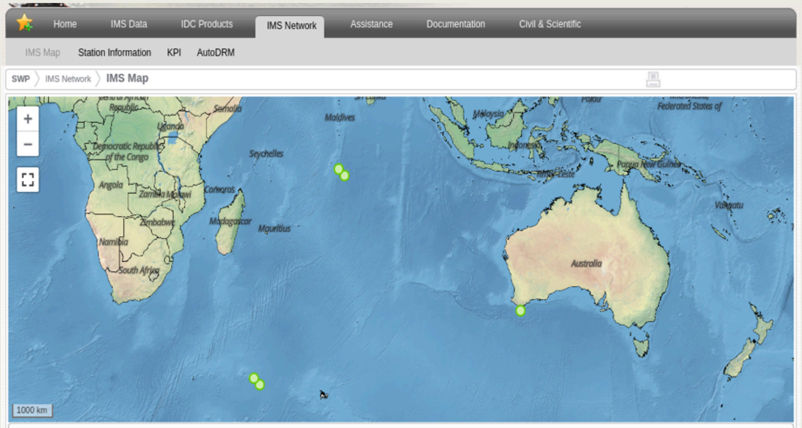
Hydroacoustic signals detected in the Indian Ocean during the global outbreak of the COVID-19 pandemic

A. Raveloson, and J. A. Andriamampandry

P5.2-130

INTRODUCTION

A lockdown measure that has been implemented during COVID-19 led to a significant reduction of major human activities around the world. Consequently, numerous anthropogenic sources, such as ship traffic, industrial activities (e.g., drilling), marine explorations, that emit hydroacoustic sound were suppressed.

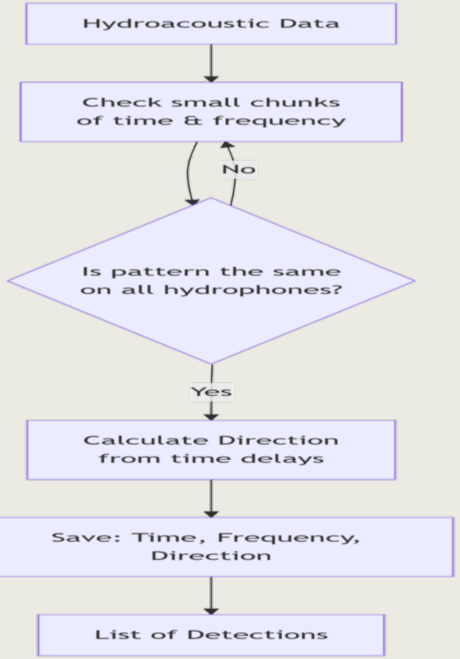


Map showing the location of Hydroacoustic stations in the Indian Ocean

The main objective of this work is to better detect and identify natural sources of hydroacoustic waves by following recommended data processing steps described in the NIAB. These analysis provide a better understanding of natural sources of hydroacoustic waves that might be useful not only for the improvement of monitoring algorithms to discriminate between explosion signals and what is considered as natural noise but for sensor calibration as well.

METHODS

Analyses were performed following CTBTO NIAB procedures, including PMCC processing and seasonal assessment.



DATA

Hydroacoustic data retrieved from the CTBTO SWP covering the period between 2018 and 2022 were used in this study. A shell script was used to automatically download daily recordings. Due to portal restrictions, only a limited amount of data could be retrieved per day; increasing this limit could improve coverage for future analysis.

RESULTS

Table below shows the continuous signals detected from different ranges of azimuth at each station.

Hydroacoustic Stations — Continuous Detections

Station	Azimuth	Direction	Likely source
HO1W (Cape Leeuwin, AU)	140–250	Central/ Southern Indian Ocean, E Antarctica	Storm belt swell, Antarctic ice, whales, shipping, ridge seismicity
HO8S (Crozet)	27–35	NNE (toward Madagascar)	Shipping lanes, Central Indian Ridge activity, whale migration calls
HO4N (Diego Garcia)	150–200	S–SSW (ridge & Antarctica)	Ridge seismicity, Antarctic ice, shipping

UNIVERSITÉ D'ANTANANARIVO
IOGA
INSTITUT ET OBSERVATOIRE DE GÉOPHYSIQUE D'ANTANANARIVO

SnT 2025 — 8 SEPTEMBER ONLINE DAY — 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE — CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

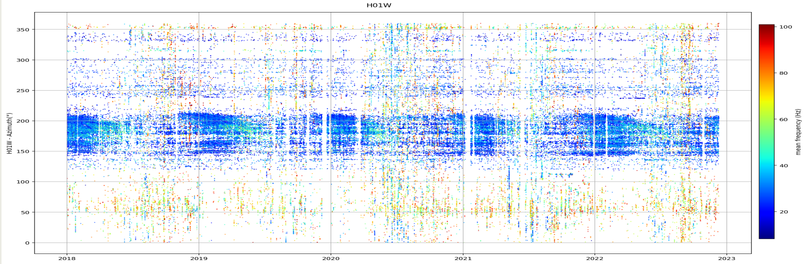
Hydroacoustic signals detected in the Indian Ocean during the global outbreak of the COVID-19 pandemic

A. Raveloson, and J. A. Andriamampandry

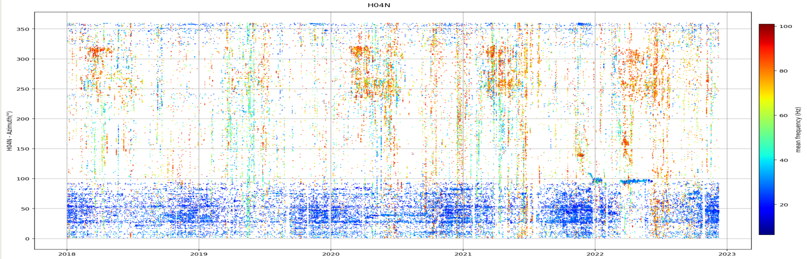
P5.2-130

RESULTS

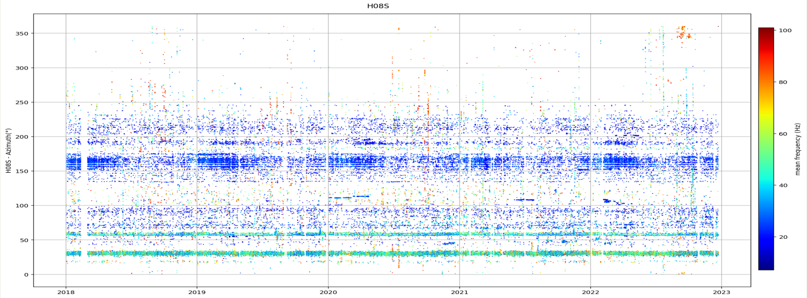
Figures below show detection per station from 2018 until 2022. Each figures shows the frequency content of the detected signal (color-coded) as a function of azimuth.



Hydroacoustic signals detected from 2018 to 2022 at station H01W



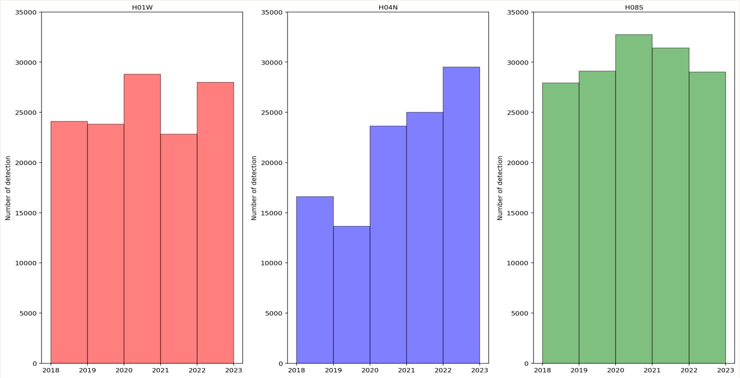
Hydroacoustic signals detected from 2018 to 2022 at station H04N



Hydroacoustic signals detected from 2018 to 2022 at station H08S

DISCUSSION

- Continuous hydroacoustic detections vary by station due to azimuthal coverage and source types.
- HO1W and HO4N show clear seasonal enhancements during December–March, reflecting:
  - Austral summer storms
  - Antarctic ice activity
  - Whale choruses
- HO8S shows more persistent year-round signals from shipping and tectonic sources.
- Patterns highlight how natural and anthropogenic sources contribute differently by location and season.
- Long-term monitoring is very important for the basic understanding of ocean noise and detecting unusual events.



Detectability per station in a period between 2018 and 2022

CONCLUSIONS

Detectability of hydroacoustic signals during the covid-19 pandemic was higher than in the normal days. Due to a reduced anthropogenic sources, numerous natural sources were detected in the Indian Ocean basin between 2018 and 2022:

- Hydroacoustic signals were permanently detected at azimuths 140–250° (HO1W), 27–35° (HO8S), and 150–200° (HO4N). These are dominantly signals from seismic ridge activities.
- These observations were consistent with austral summer storm-driven ocean noise, Antarctic ice activity, and seasonal whale choruses.
- HO8S showed less sensitivity on seasonal signals. This reflects its narrow azimuthal observations toward persistent shipping and tectonic sources.
- Events such as Indian Ocean Ridge earthquakes, the 22 December 2018 Krakatoa tsunami, and ice-related signals were detected, highlighting the variety of natural hydroacoustic phenomena captured across the Indian Ocean.
- Variability across stations highlights spatial and seasonal differences of hydroacoustic noise in the Indian Ocean.

UNIVERSITÉ D'ANTANANARIVO
IOGA — Institut et Observatoire de Géophysique d'Antananarivo