Indian Arctic Mooring

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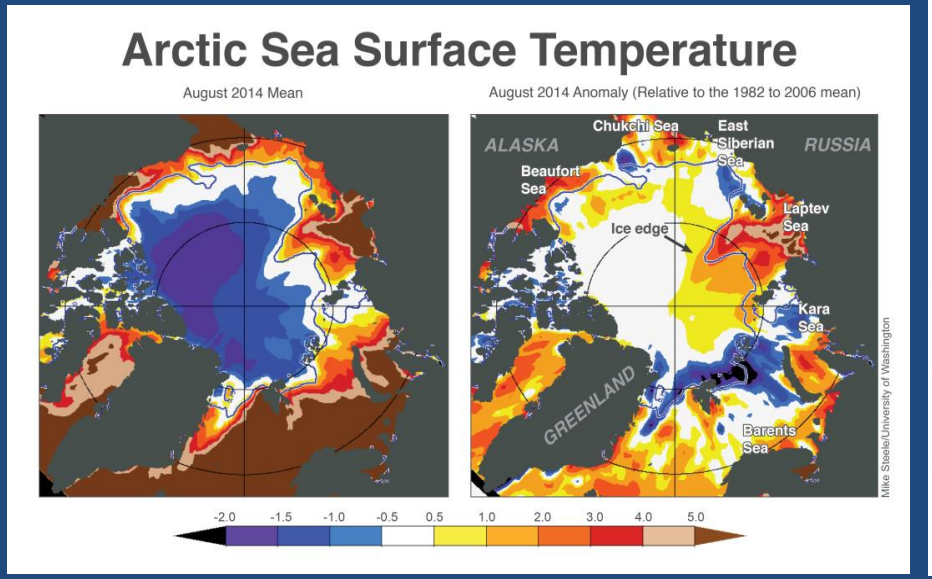
Coverage

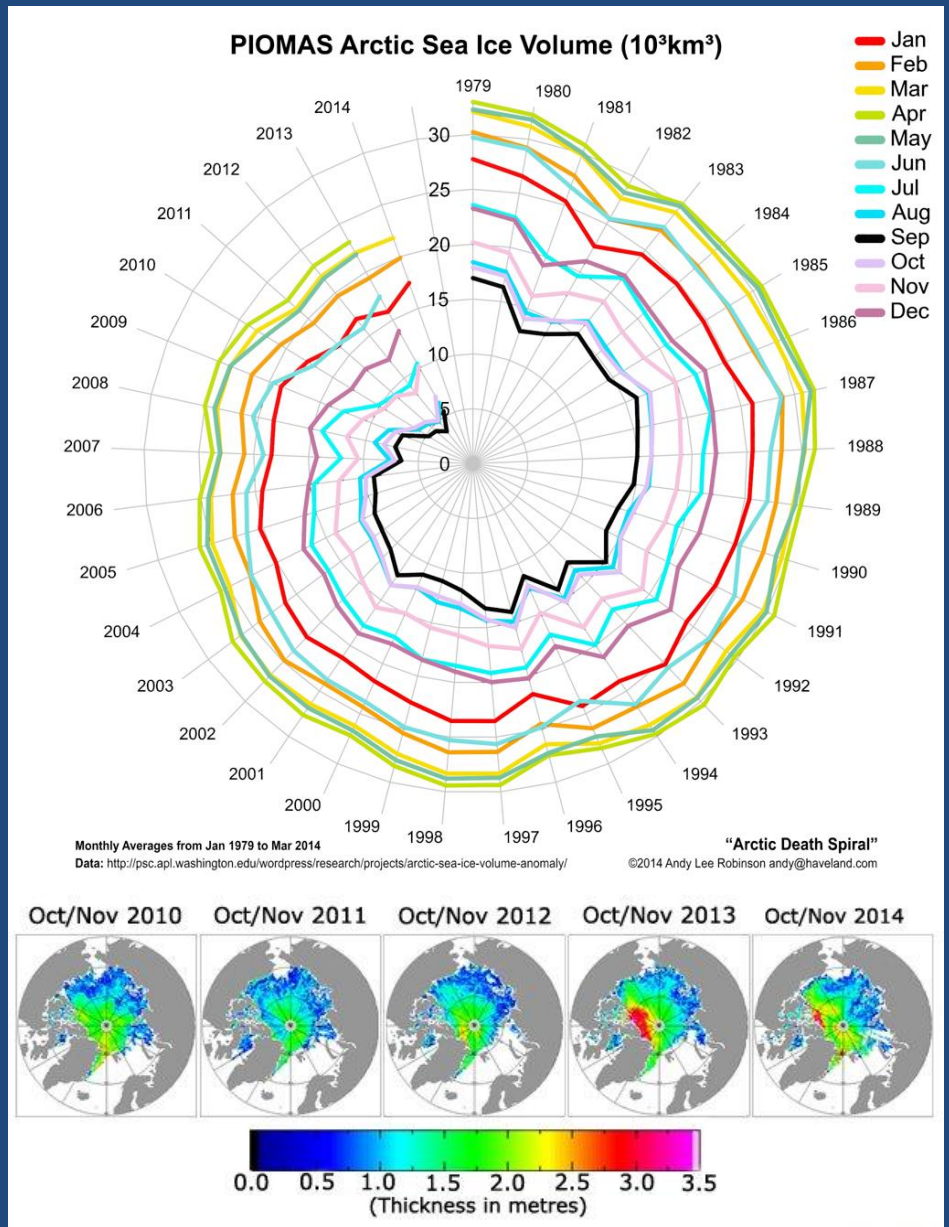
- Need for Arctic mooring
- Mooring details
- Deployment and retrieval of mooring
- Parameters measured and retrieved from moorings
- Ambient noise measurement in Arctic
- Mooring system, its qualification, deployment and retrieval
- Data analysis
- Conclusion

Introduction

- The studies in the Arctic region have received a lot of attention in the last two decades, since the sea level rise also depends on the melting of ice bergs.
- The Arctic is an exclusive environment, which is the least understood ecosystem on the earth.
- This area is undergoing radical changes and global warming is expected to cause a drastic reduction in sea-ice in the Arctic Ocean in 30 to 40 years .
- Acoustic observation can offer a valuable evidence on variations in the Arctic sea, together with the seasonal circulation. Also behaviour of marine mammals in these waters can be understood.
- Hence, study of the underwater noise in Arctic fjords, predominantly those that are surrounded by glaciers and ice berg, has gained importance.
- In order to determine the dynamics of the ice flow, a continuous long term observation is required .
- Passive acoustic monitoring gives the opportunity to survey the unreachable zones of Arctic without depending much on the meteorological parameters

ARCTIC – Raising Concerns

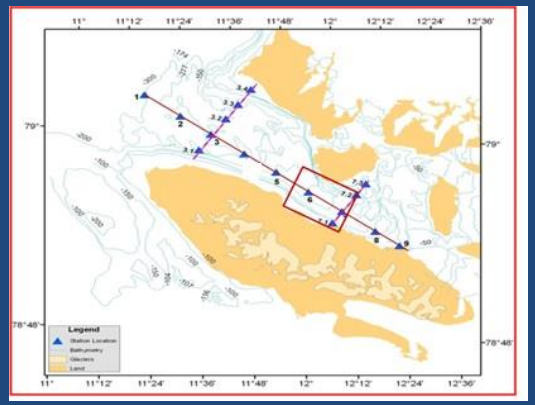




IndARC

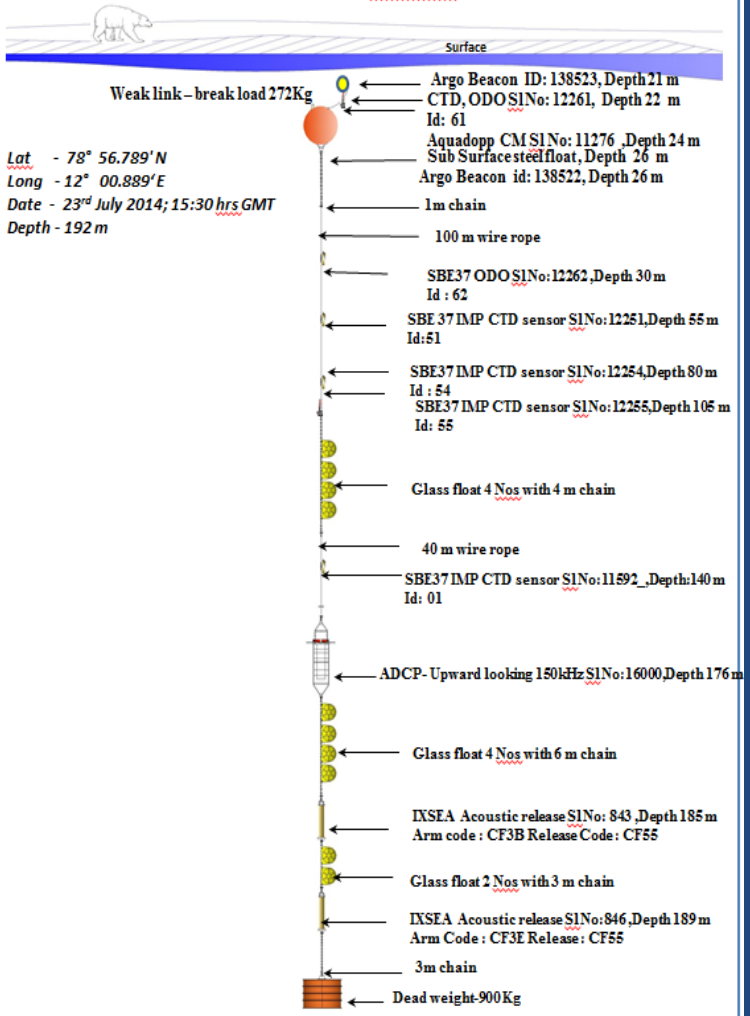
Indian Arctic Observatory at Kongsfjorden

- Arctic Ocean plays an important role in governing the earth's climate history. Highly uncertain sensitivity of the carbon cycle of the Arctic to the projected climate change is a major issue and studies suggest that Arctic has been a sink for atmospheric CO_2. This need, to monitor Ocean Parameters let to the deployment initiative of IndARC.
- A major milestone in India's scientific endeavours in the Arctic region was achieved on **23rd July, 2014.** A team of scientists from the ESSO-NIOT and the ESSO-NCAOR successfully deployed IndARC, the country's first multi-sensor moored observatory in the Kongsfjorden fjord of the Arctic, roughly half way between Norway and the North Pole.
- The observatory is presently anchored (78°57´ N 12°01´E), about 1100 km away from the North Pole at a depth of 192 m and has an array of ten state-of-the-art oceanographic sensors strategically positioned at discrete depths in the water column.
- These sensors are programmed to collect real-time data on seawater temperature, salinity, current and other vital parameters



Successful Deployment of IndARC Mooring at ARCTIC

MOORING LAYOUT FOR IndARC -JULY 2014



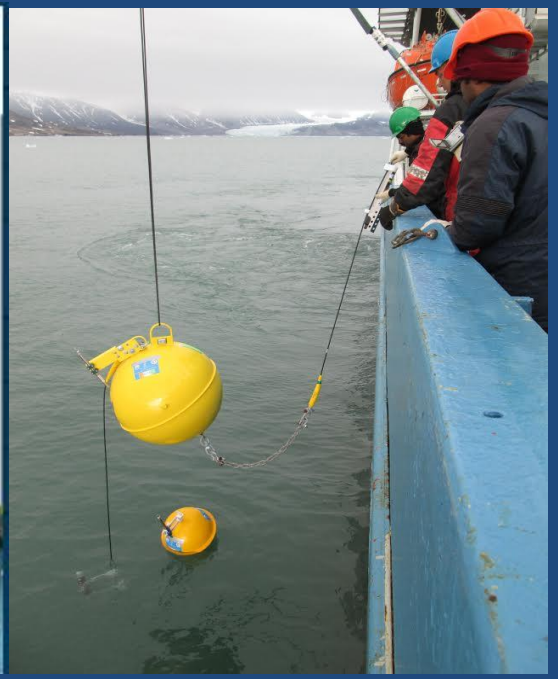
Lat - 78° 56.789' N
Long - 12° 00.889' E
Date - 23rd July 2014; 15:30 hrs GMT
Depth - 192 m

Ministry of Earth Sciences
Goverment of India

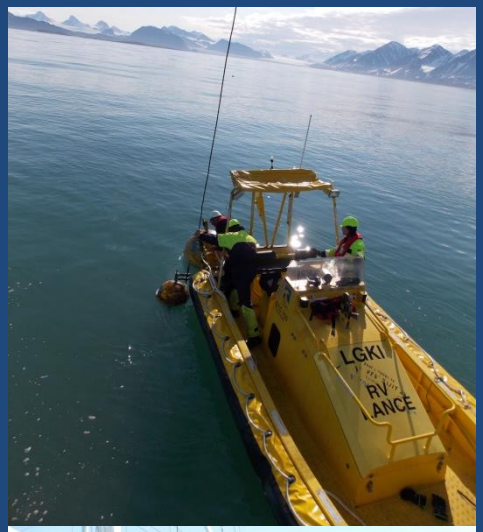
Indian Arctic Observatory

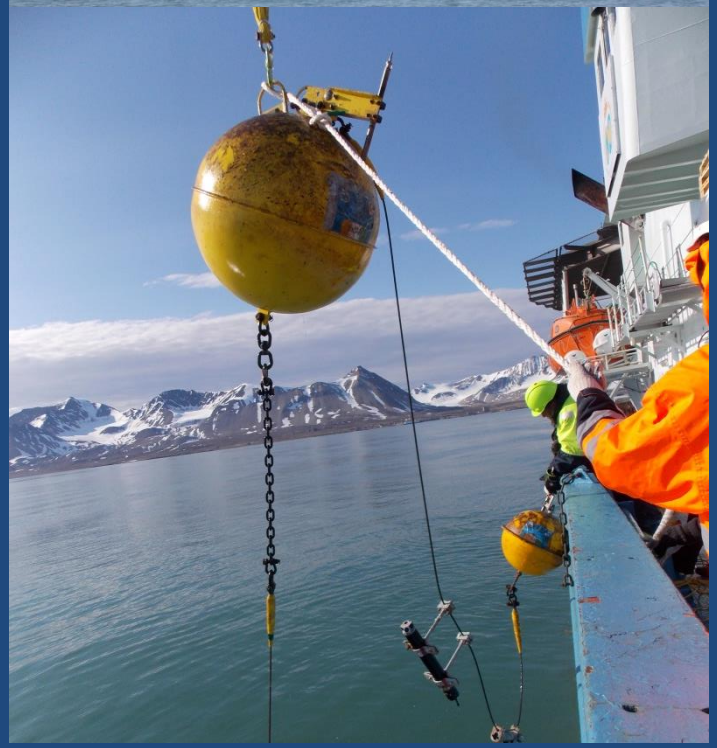
IndARC

+91-832-2525600 +47-79027209

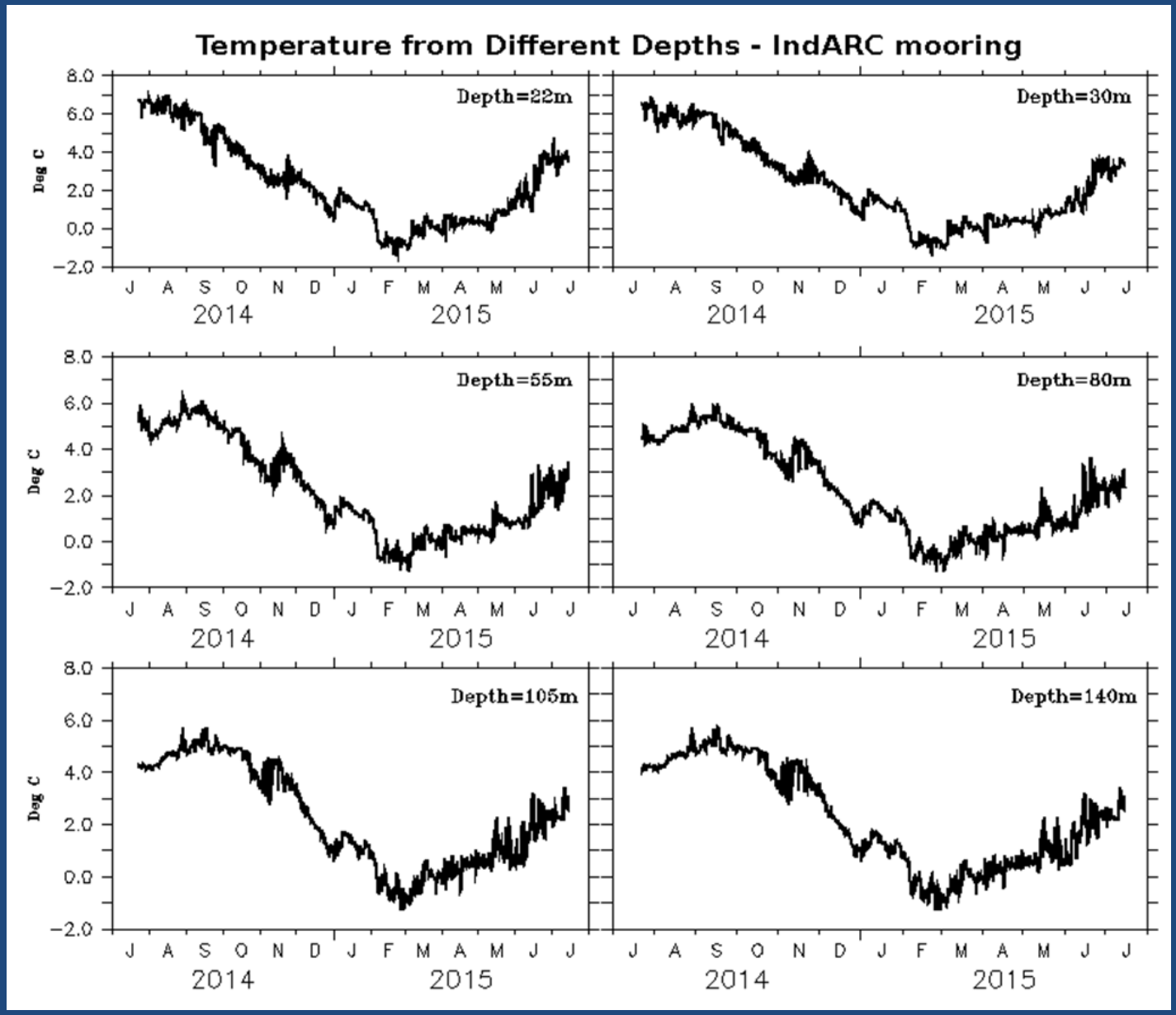


Successful Retrieval of IndARC Mooring at ARCTIC after an year

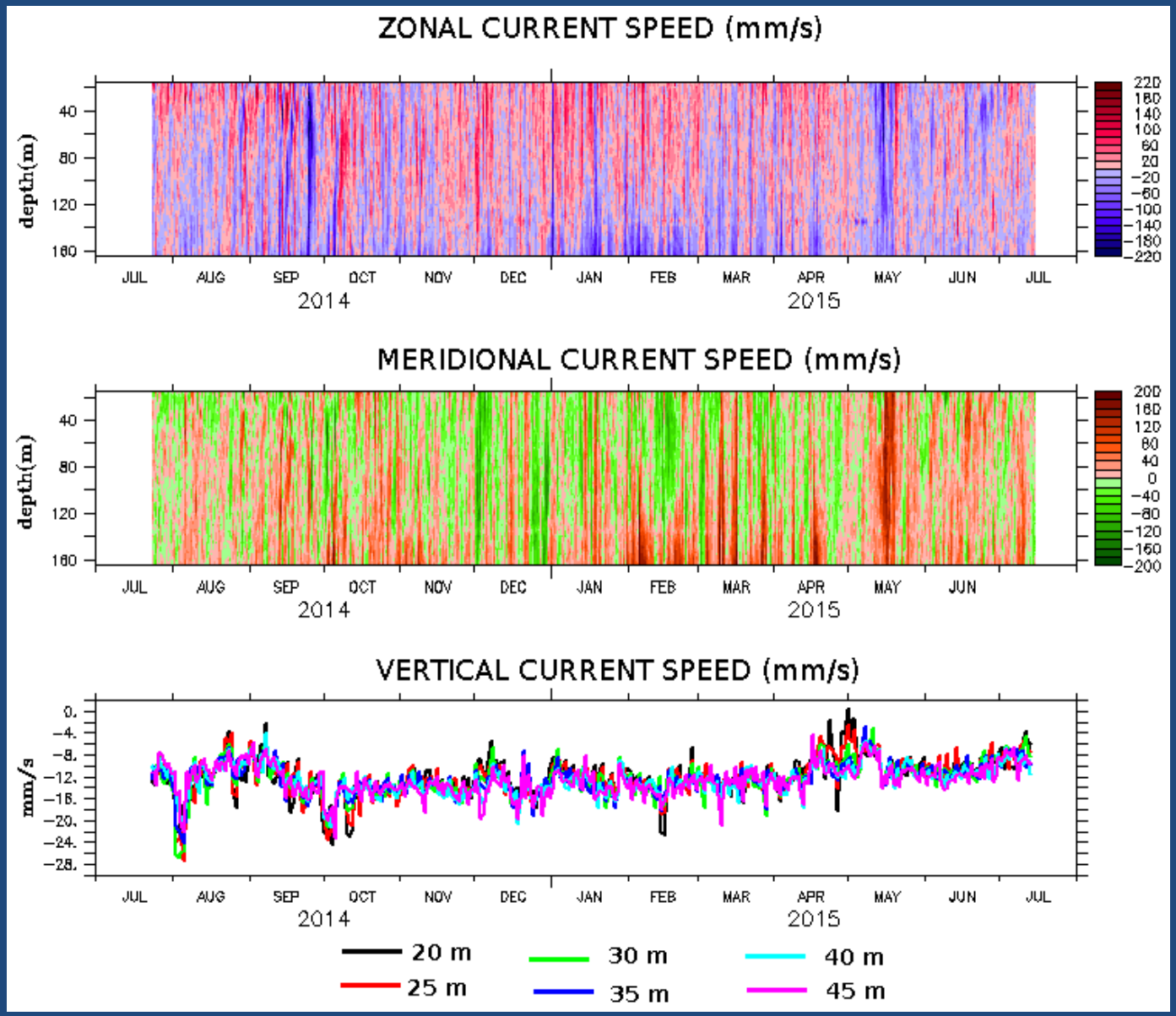




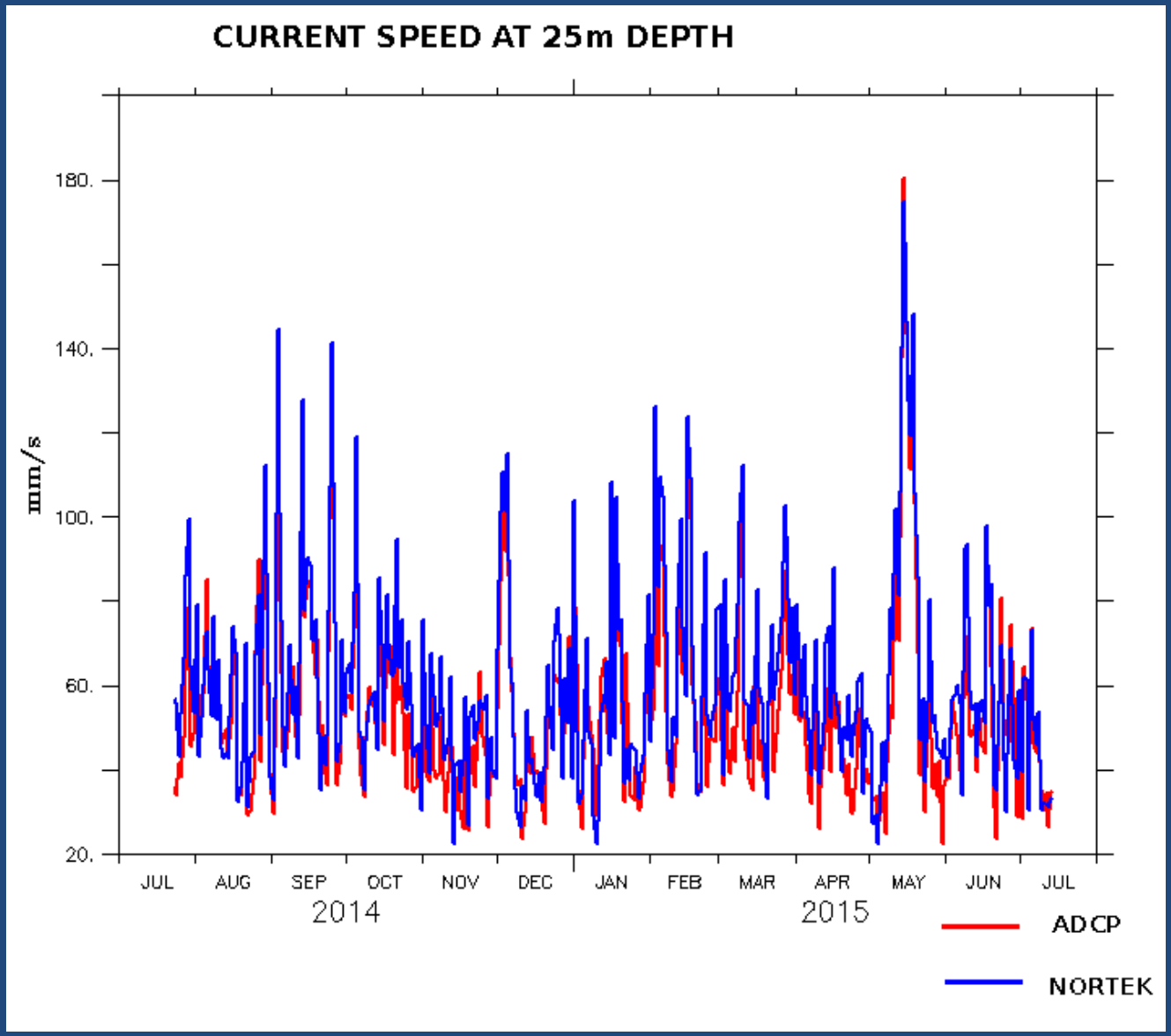
Data retrieved from IndARC Mooring



Data retrieved from IndARC Mooring



Data retrieved from IndARC Mooring



Data analysis results

- Temperature and salinity were obtained from discrete depth levels of 22, 30, 55, 80, 105 and 140 m depths from July 2014 to July 2015.
- The temperature at all depths were showing an annual cycle with maximum temperature of 7°C recorded during August and minimum temperature of -1.5°C during February.
- The salinity also varied in the range, 33.6 to 35.1 p.s.u. at all the depths with drastic changes observed during August - September where the salinity dropped by almost 2.7 p.s.u.
- Another lowest salinity was observed during November at deeper depths of 55, 80, 105 and 130 m.
- The dissolved oxygen was also measured at 22 m depth and it recorded minimum value of 6.6 ml/l during September and peaked during the month of May with a value of 9.5 ml/l.
- During May the oxygen content in the water has increased drastically from 7.7 ml/l to 9.5 ml/l.

Data analysis results

- The primary findings reveal that the fjord waters are well mixed during December to April. Then there is a strong current during May which suddenly increases the oxygen content of the region and thereafter the waters gets stratified.
- The zonal, meridional and vertical current obtained from the ADCP showed strong westerly currents during September and May. The strong westerly currents during May also coincided with strong northerly and positive entrainment as represented by middle and bottom panel. This strong current has driven the drastic increase of oxygen at 22m depth during May.
- Current speed obtained from ADCP at 25m depth was compared with current speed obtained from another current meter named Nortek. Both the instruments showed a peak in current speed during May with 180mm/s.

IndArc-Indian Arctic Underwater Multi-sensor Mooring

- Data sets are collected from ARCTIC for three years. Promising results are observed.
- IndARC IV was deployed successfully on 22nd July 2017.

	Deployed	Retrieved	Days
IndARC I	23rd July 2014	15th July 2015	357
IndARC II	19th July 2015	26th July 2016	373
IndARC III	27th July 2016	19th July 2017	357
IndARC IV	22nd July 2017	Continuing	

IndARC mooring deployment

More than 1200 Days of Continuous data captured.
> 45 Lakh Data points

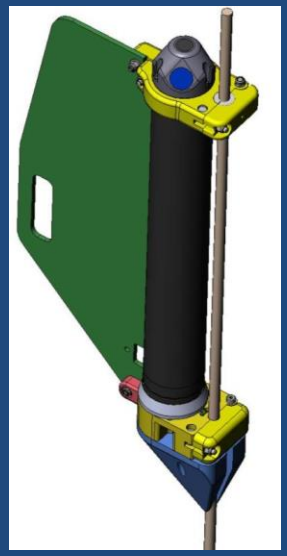
IndARC Payloads

C T D, DO, PAR, FLNTUS, SUNA, Currents

		Measurement Range	Initial Accuracy	Typical Stability	Resolution
Conductivity, Temperature and Depth sensor with ODO	Conductivity S/m	(0 to 70 mS/cm)	(0.003 mS/cm)	(0.003 mS/cm) p er month	(0.0001 mS/cm)
	Temperature (°C)	-5 to 35	± 0.002	0.0002 per month	0.0001
	Pressure(m of water)	1000 m	± 0.1% of full scale range	0.05% of full scale range per year	0.002% of full scale range
	Optical Dissolved Oxygen	120% of surface saturation	>±3 µmol/kg	< 1 µmol/kg	0.2 µmol/kg

TRDI 300kHz ADCP

Nortek Aquadopp SPCM



Passive Ambient Ocean Noise Measurement System

PAR/FLNTUS

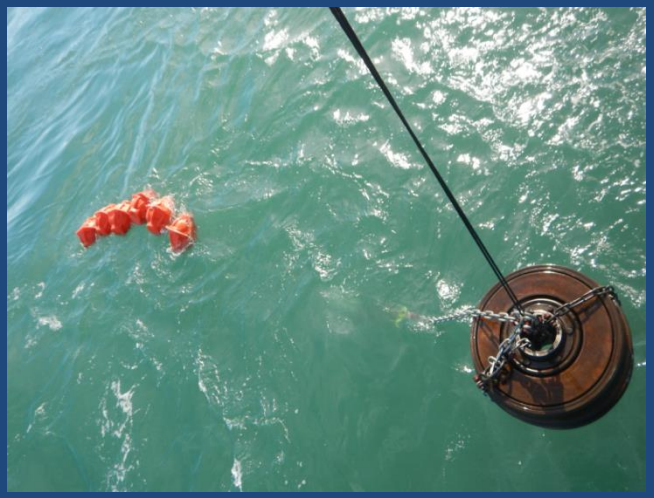
SUNA

Camera System for Short Term Video Recording

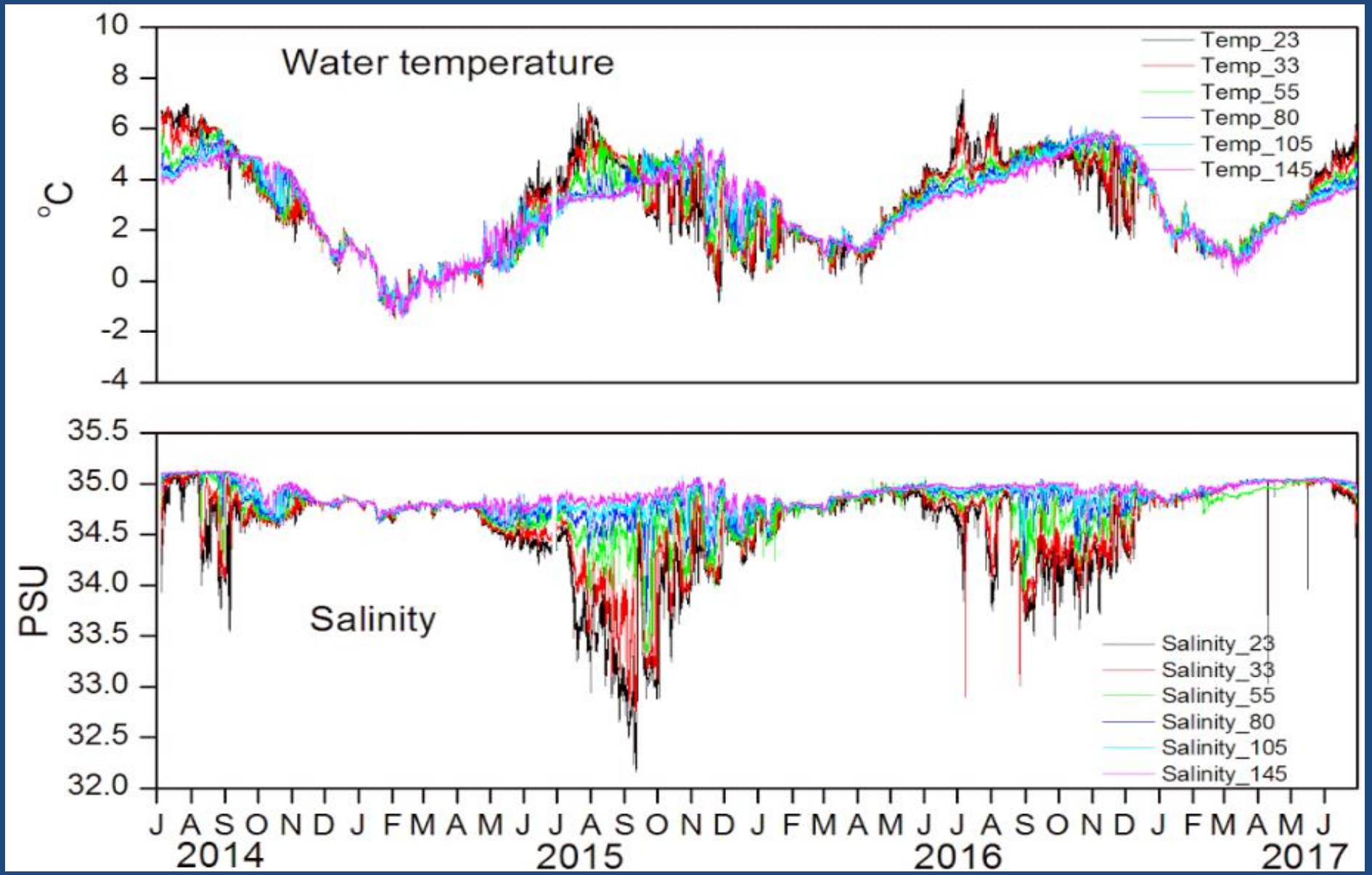
Collector area :86 mm²
Detectors :17 mm² silicon photodiode
Field of view :Cosine response (within 3% @ 0–60 °C)
Range :0–6500 µmol photons/m²/s

Retrieval of IndARC III Mooring

Deployment of IndARC IV Mooring



IndARC Data: Thermo Salino profile for 3 years at Arctic Ocean



Ambient noise measurements in the Arctic region to characterize Noise field and study ice flow dynamics

Arctic Region

- Kongsfjorden, a glacial fjord on the west coast of spitsbergen, an island which is a part of Svalbard archipelago in the arctic ocean.
- The fjord is divided into two, the outer fjord which is influenced by North Atlantic water mass and inner fjord by large glacial input.
- This different physical factors influence the biodiversity and animal population of the fjord (Svendsen et al., 2002).
- Ambient noise in the fjord varies temporally depending on geophony (ice melting, ice calving), biphony (Marine mammal noise) and anthrophony (Ship and vessel noise) sources.

Ambient noise system for Arctic

- The environmental conditions in the polar regions vary drastically from the tropics and care has to be taken in the system design, data acquisition, mooring configuration etc.

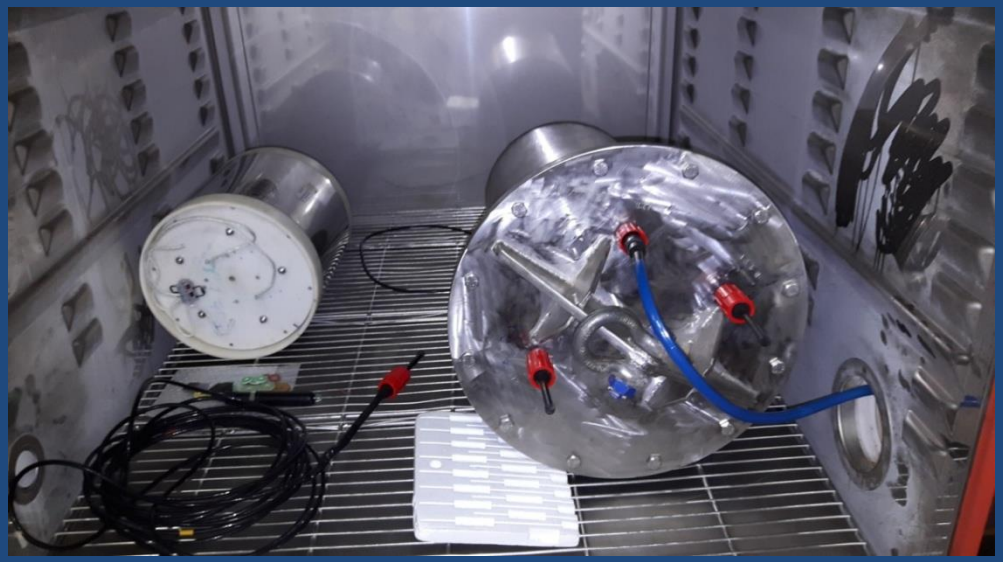
- The components and subcomponents used have to withstand the low temperature and low salinity conditions prevalent.

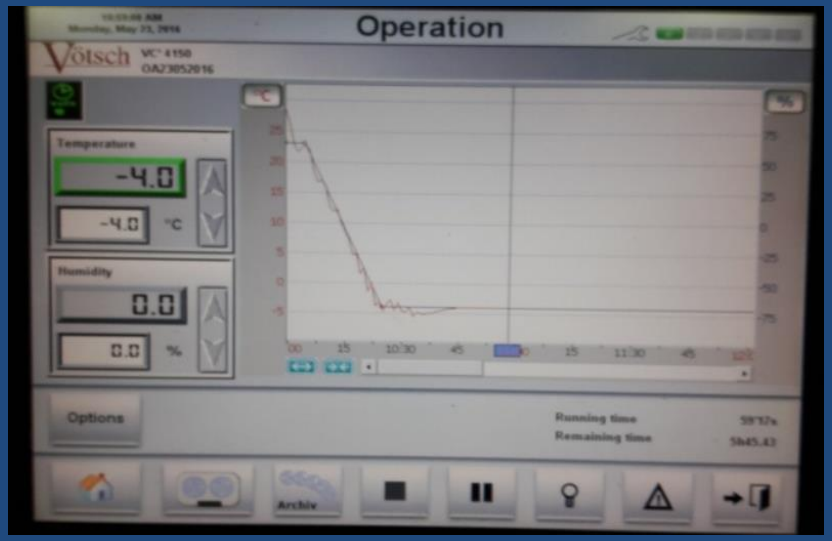
- Testing for performance at low temperature is essential and care has to be taken in the design of data acquisition enclosures and selection of hydrophones, connectors etc.

Qualifying in Environmental Chamber

Performance Testing of the system for Qualification for deployment in the Arctic region-Kongsfjorden :

- The Data Acquisition Enclosure of the system was subjected to pressure testing in hyperbaric chamber of NIOT.
- The hydrophones, enclosure and the battery casing were tested in the Environmental chamber for checking performance of the components at subzero temperature. System tested till -4 °C.
- Periodic measurements of noise were also acquired at the Kongsfjorden region.





ANMS testing in Environmental Chamber

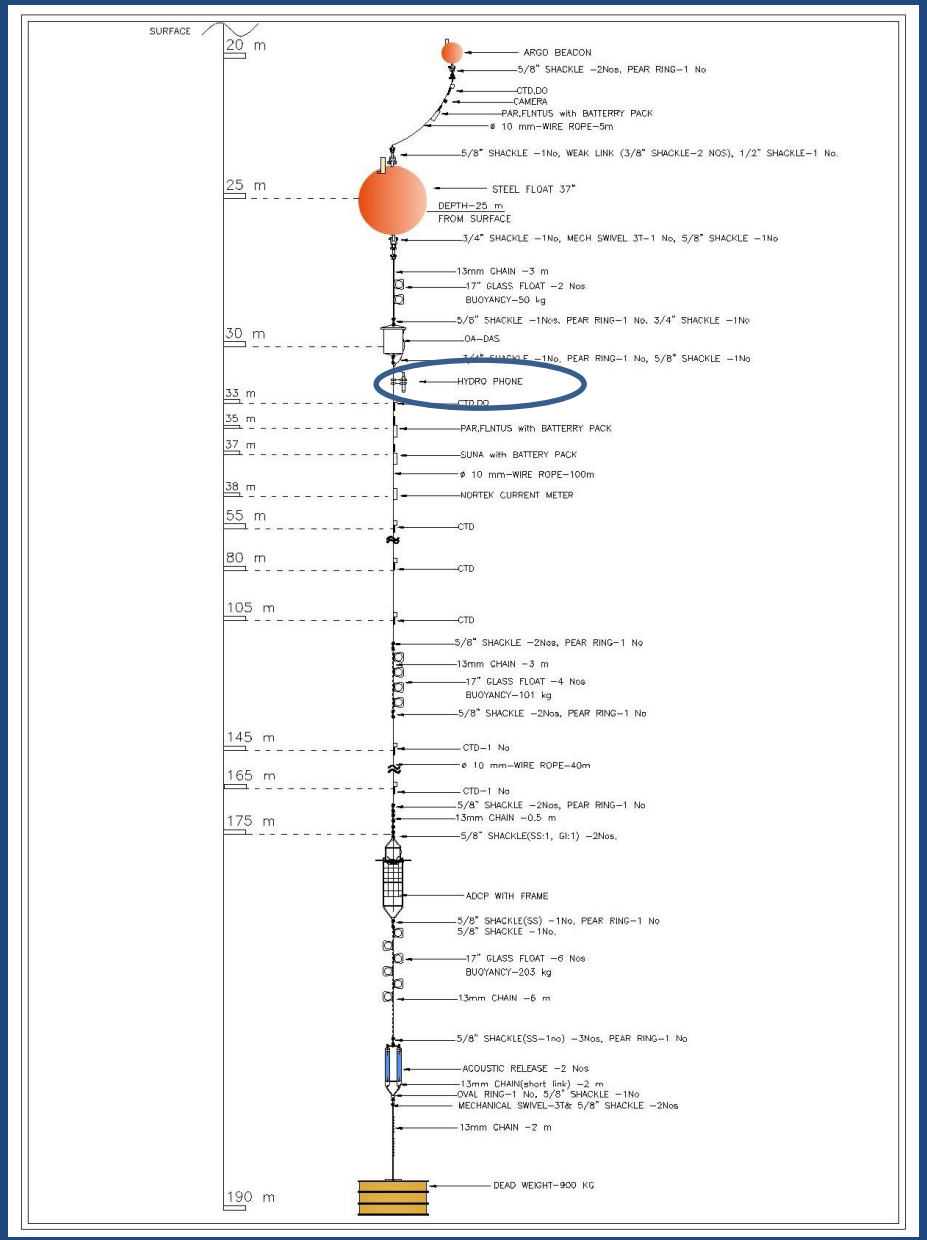
Testing of Acoustic Test Facility

- Calibration of Hydrophone
  - Receiving sensitivity
- Testing of data acquisition system at Acoustic Test Facility

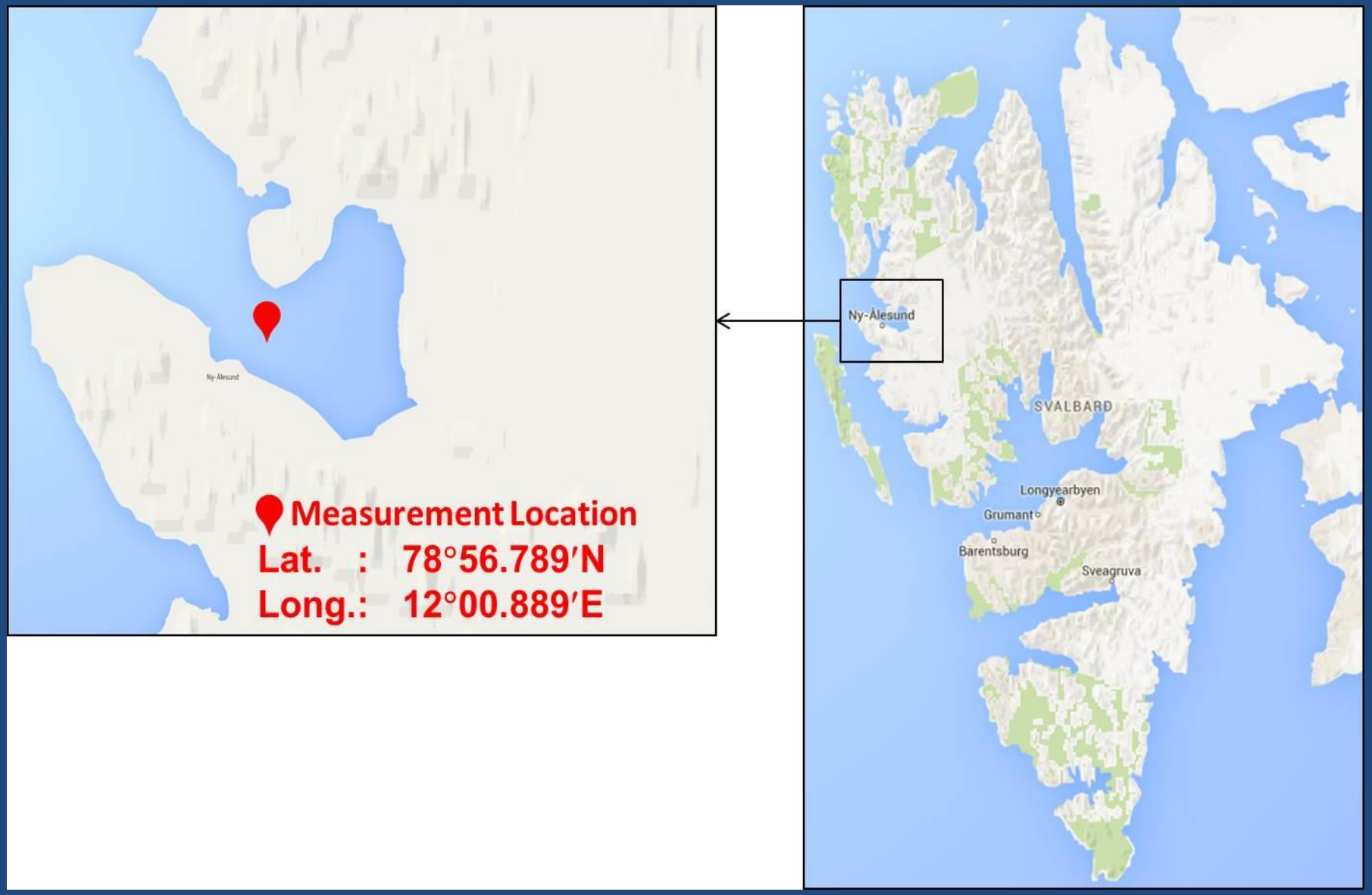
Data Collection parameters

- Sampling rate : 50 kHz
- Sampling duration : 60 seconds
- Number of hydrophone : 01 (Cetacean make)
- Frequency range : 8 Hz to 100 kHz
- Transducer depth : 30 m
- Ocean depth : 190 m

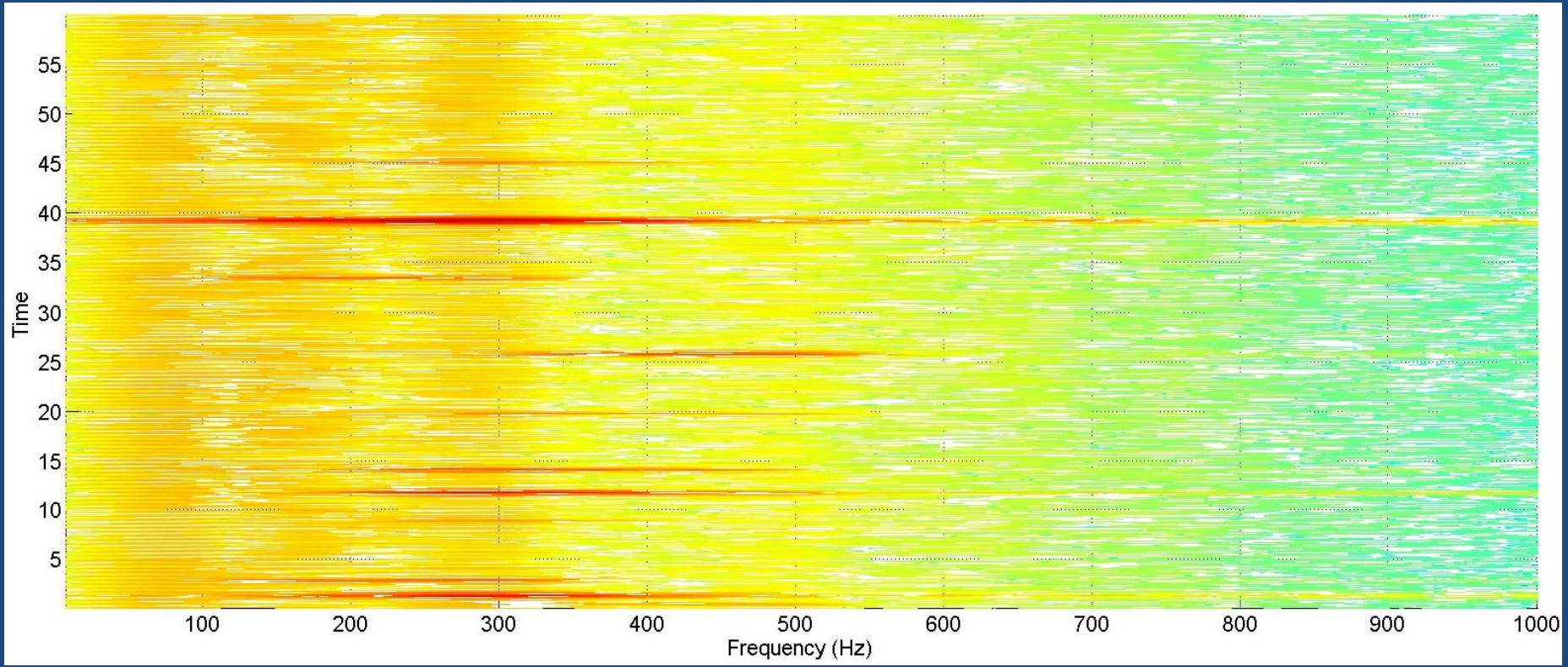
The ambient noise system was incorporated with IndArc system (Indian Arctic System) Mooring configuration



Deployment Location



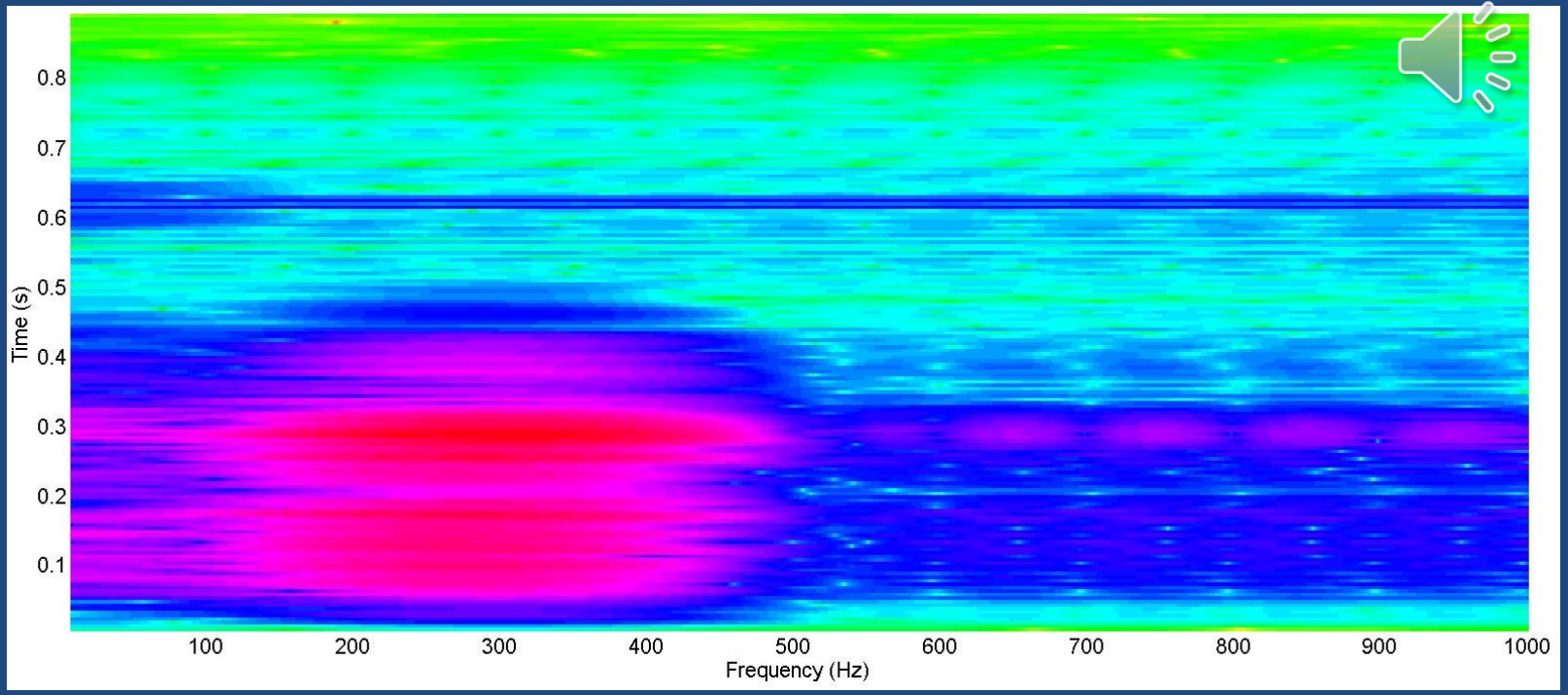
Spectrogram of the filtered time series data



- Removal of gen-set noise, shipping noise, propeller noise, man-made noise, self noise.
- Ashokan M, Latha G, Thirunavukkarasu A, Raguraman G and Venkatesan R, **"Ice berg cracking events as identified from underwater ambient noise measurements in the shallow waters of Ny-Alesund, Arctic", Polar Science, Elsevier publications, Vol. 10(2), June 2016, PP. 140-146.**

Spectrum of Iceberg calving and Iceberg bobbing noise

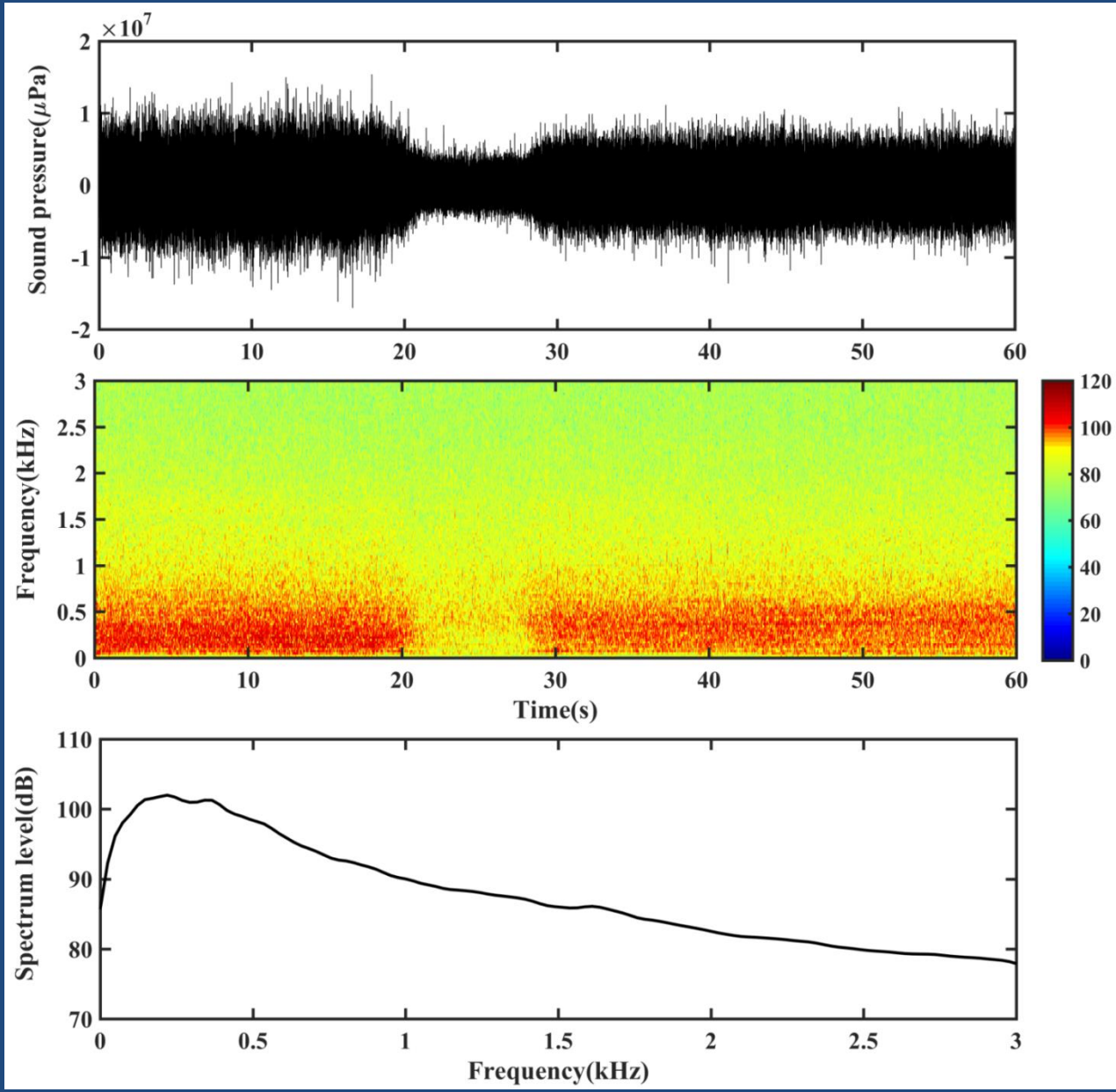
- Due to ice cover, Arctic region is an exceptional noise environment.
- Ice crack consists of short bursts noise with the time span of milli-seconds.
- In the Arctic summer season, there is an increase in the underwater ambient noise with most of the energy being generated at frequencies less than 500 Hz.
- The noise sources are at or nearby the surface of the ice berg and are mainly due to the ice berg calving and bobbing, which are caused by the thermal expansion in the ice.
- Monitoring the arctic underwater noise field would enable understanding of the ice flow dynamics.



Times series data collected

Period of the data collected		No. of data sets	Sampling frequency	Period of interval	Sampling duration
From	To				
19th July 2015	24th April 2016	2235	50 kHz	3 h	60s

Ice Calving Sound



Anthrophony

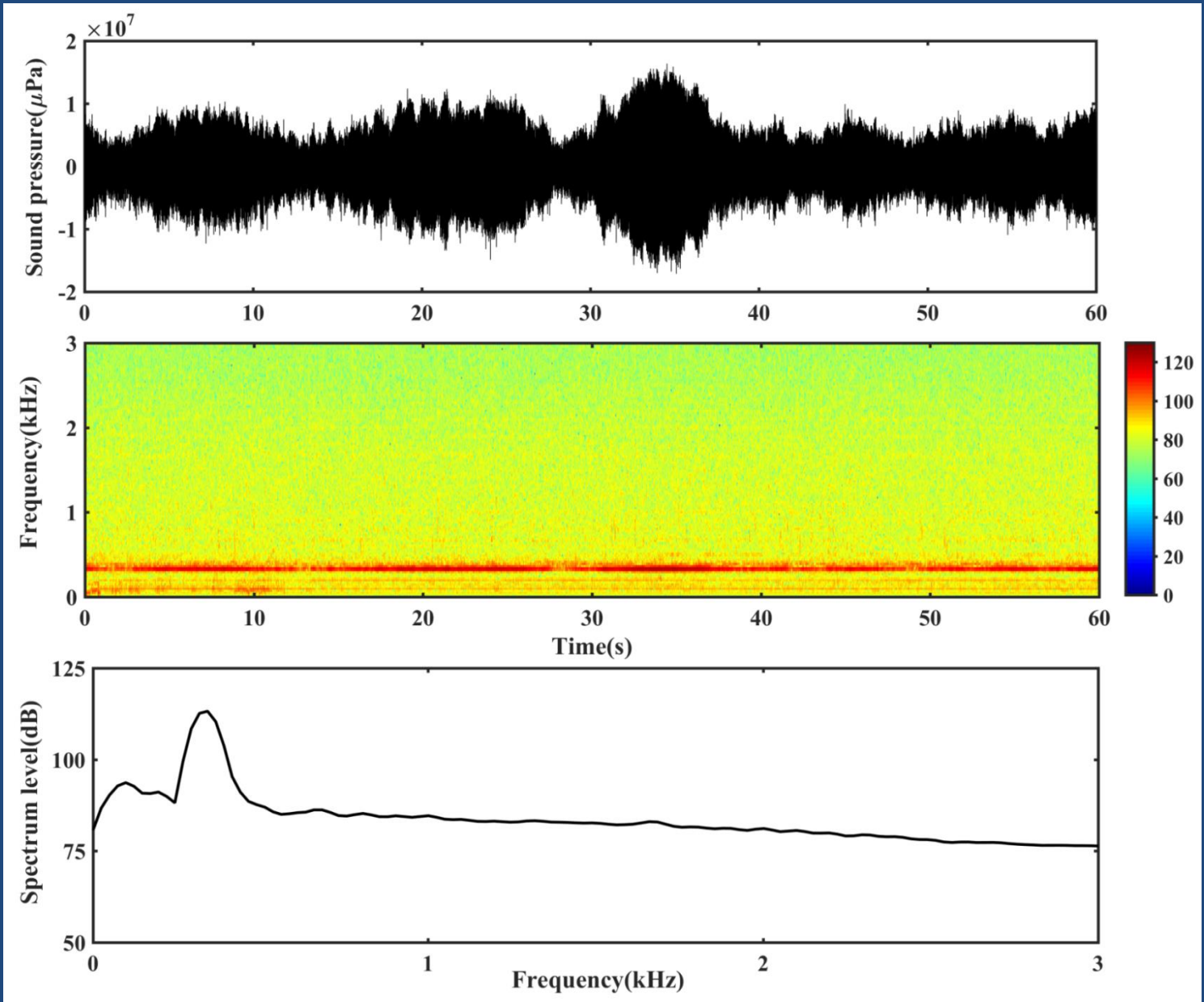
- The anthrophony sound is the growing concern in marine environments and adversely affecting the marine life. The source of anthrophony noise includes shipping, commercial vessels etc.

- Propeller cavitation is typically the strongest source of ship noise from large vessel and exhibits a broad band spectrum, amplitude modulated at the propeller blade rate.

- Most of the acoustic energy radiated from commercial vessels is <1kHz .

- Many of the container ships, vehicle carriers, cargo ships, and tankers have peaks near 0.4, 0.7 and 1kHz . These also generate narrower peaks between 1kHz and 10kHz, most predominantly at 2kHz and near 3kHz.

Ship Noise


×10^7
Sound pressure(μPa)
2
1
0
-1
-2
0
10
20
30
40
50
60
Frequency(kHz)
3
2
1
0
Time(s)
120
100
80
60
40
20
0
Spectrum level(dB)
125
100
75
50
Frequency(kHz)

Biophony

Walrus (Odobenus rosmarus):

- Walruses are highly sociable ice breeding pinniped species in arctic areas, and capable of diving to depths of > 250m and forage in waters of 80m in shallow waters of continental shelf (Sjare and Stirling, 1996; Born et al., 2003).

- Mating takes place in the water, and occurs in the areas of open water bounded by stable land-fast ice, usually from January through April, with February being the peak month (Sjare and Striling, 1996).

- They produce sounds in different patterns during breeding period such as knocking and tapping sequence, sometimes double knock completely in underwater as well as while they float at the water surface (Tyack and Miller, 2002).

- The knocking or tapping sequences are of pulsed sounds, a slower repetition rate (1-3/s) of intense 'knock' and the less intense of quick repetition 'tap' (10/s) (Stirling et al., 1983).

- The knock and taps have frequency range of approximately 0.2 to 4 kHz with most of the sound energy below 2 kHz. The double knock is a distinctive call produced by male before surfacing to breath (Stirling et al., 1983; Sjare, 1993).

Conclusion

- Data acquisition from Arctic has to be a continuous process
- Long term climate variations can be studied
- Many hypothesis and conclusions from other observations can be validated.
- Requires continuous support from Ministry and also from Norwegian counterparts
- Systems which can work for longer periods need to be innovated
- Data transfer on line through acoustic means periodically to be worked out


THANK YOU