Diurnal Vertical Migration Observed in the ADCP Measurements in Arabian Sea

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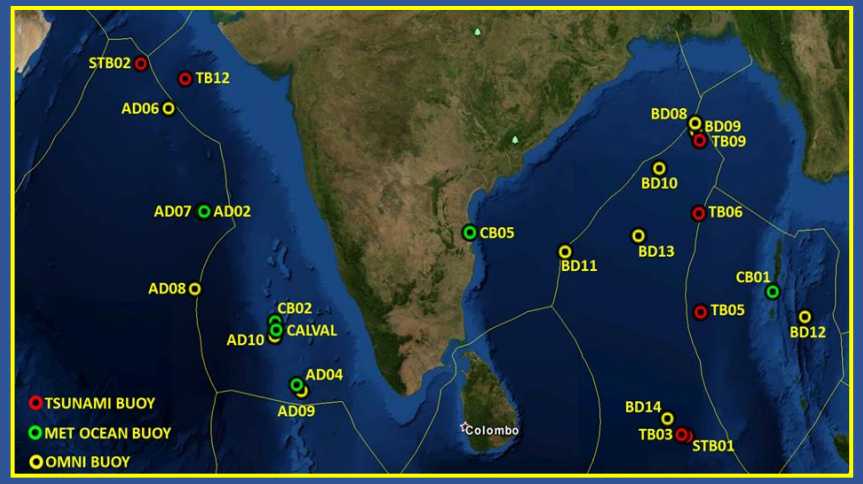
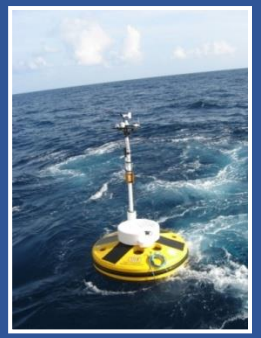
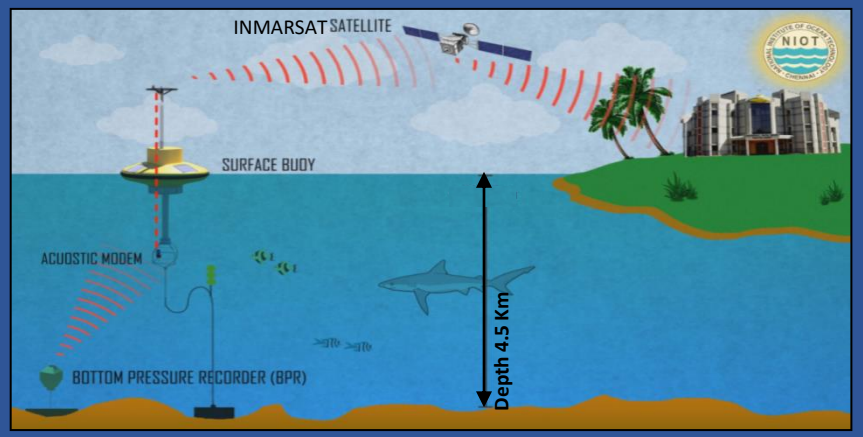
Ministry of Earth Sciences, Govt. of India

Ocean observation Systems







Establishment of
Ocean Observation Systems
in 1997 by

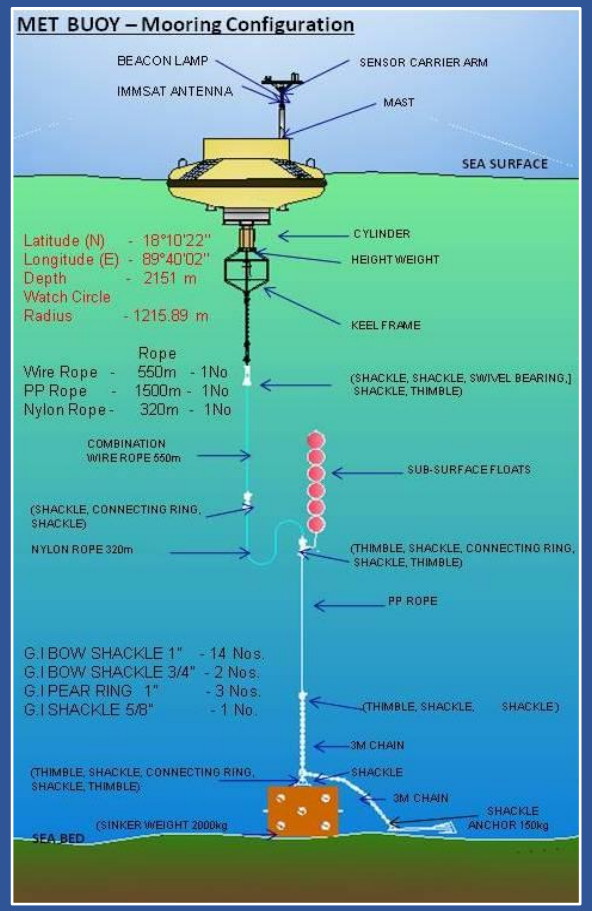
National Institute of Ocean Technology
ESSO - Ministry of Earth Sciences
Government of India

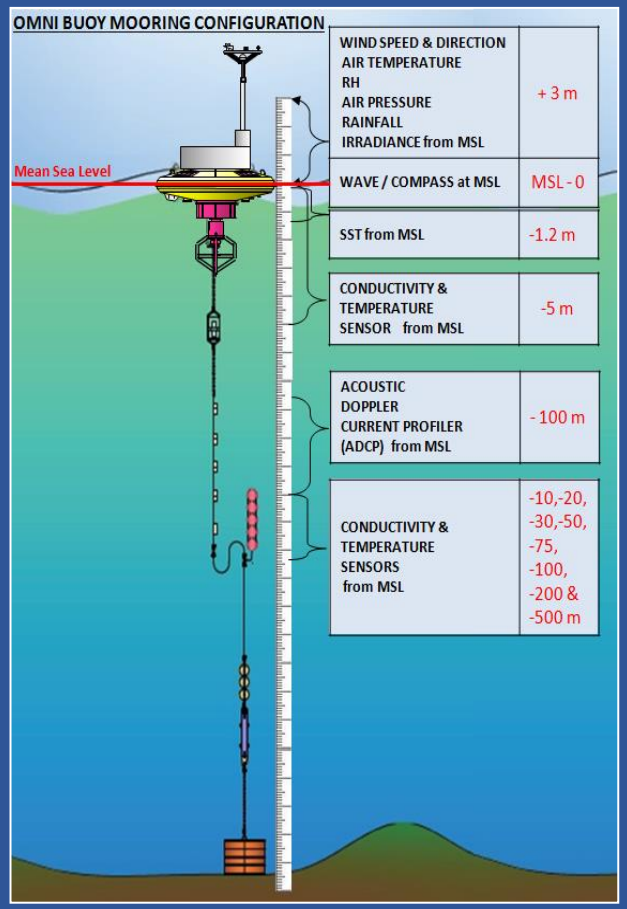
- **Data buoys provides Systematic time-series surface meteorological and oceanographic observations.**
- **Special underwater, marine and meteorological observational capability required to improve Oceanographic services and predictive capability of short and long-term climate changes.**
- **Provides critical information on hazards like Cyclones, Tsunami & Sea Level rise**

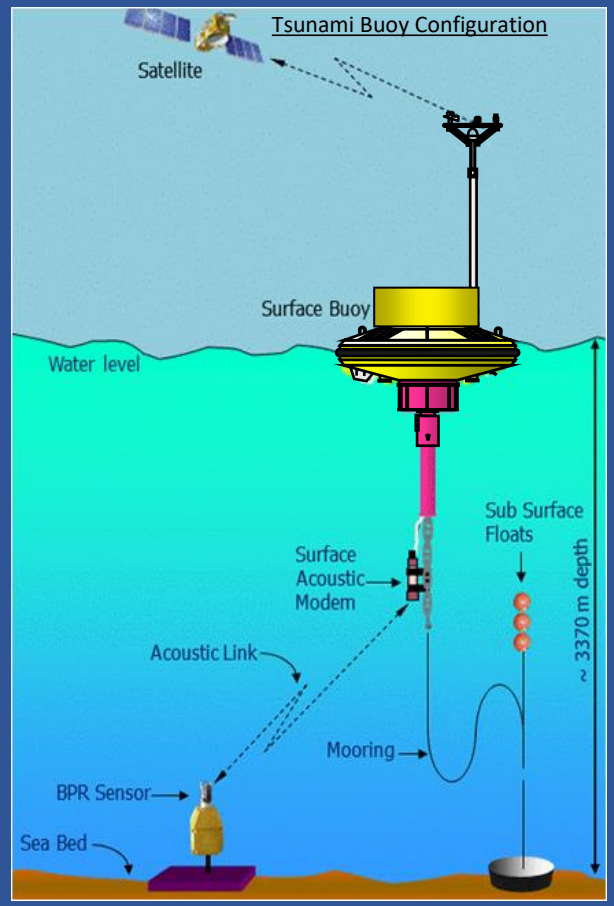
INSTITUTE OF OCEAN TECHNOLOGY · NATIONAL · NIOT · CHENNAI ·

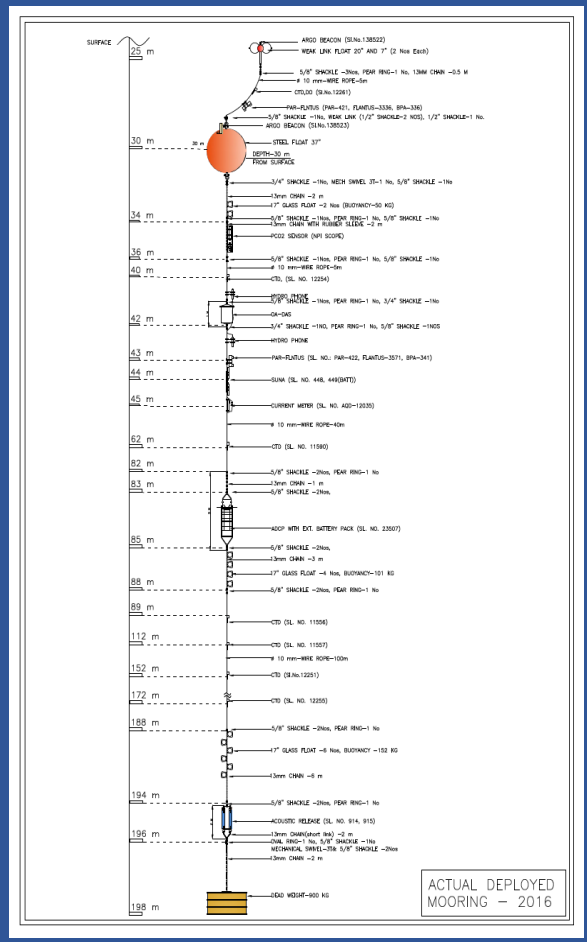
INCOIS

Types of Moorings handled by OOS









Mooring design Depth : 20m to 4000m

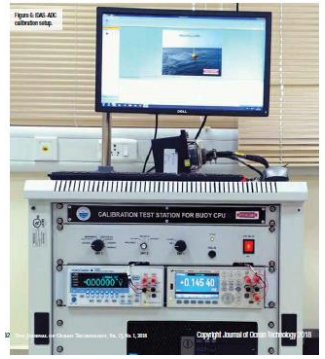
IndARC Mooring

Calibration Test Facility

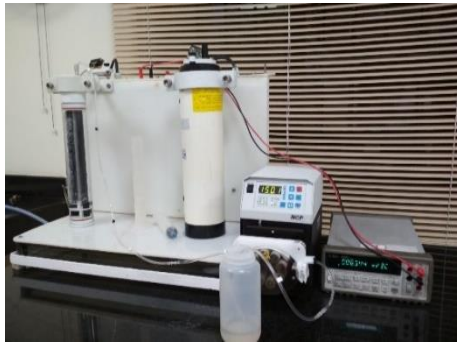
- Established Parameters - Atmospheric pressure,
  - Atmospheric temperature,
  - Atmospheric humidity,
  - Precipitation,
  - ADC (CPU) –analog channels
  - Compass (ADCP)

- ✓ Calibration before the deployment and after retrieval for quality data
- ✓ WMO recommended (RIC) reference standard are used
- ✓ Reference standard are having traceability with NPL, New Delhi.
- ✓ International interaction with M/s PMEL, USA and CSIRO Australia

Sensors name	Calibrated OEM/In house	Equipment needed for calibration	Proposed plan	Approximate cost to establish the calibration facility(in lakhs)
Air Pressure sensor	In house	Gas piston gauge (DWT)	Completed	--
Air temperature and humidity sensor	In house	Chilled mirror and PRT with AT and AH generator	Completed	--
Precipitation sensor	In house	Flow bench	Completed	--
DP CPU	In house	Digital source and multimeter	Completed	--
ADCP Compass and Digital compass in the buoy	In house	Turn table	Completed	
PSP (precision spectral pyranometers)	OEM	Standard Precision Pyranometer (SPP) with radiation source Ref: ISO 9847 - calibration of field pyranometers by comparison to a reference pyranometer	Will try to Utilize IMD facility	
CT(SMP/IM/IMP)	OEM	High stable temperature bath and reference sensor	FLUKE/CSIRO/SEABIRD/RBR	200
PIR (precision infrared radiometer)	OEM	Transfer standard with reference PIR sensor and blackbody source	Will try to Utilize IMD facility	



ADC calibration



Flow bench

Precipitation sensor calibration

Digital Gas Piston Gauge-
Barometric pressure sensor calibration

Chilled mirror and PRT
Air temperature and Humidity sensor calibration

ADCP- Compass calibration

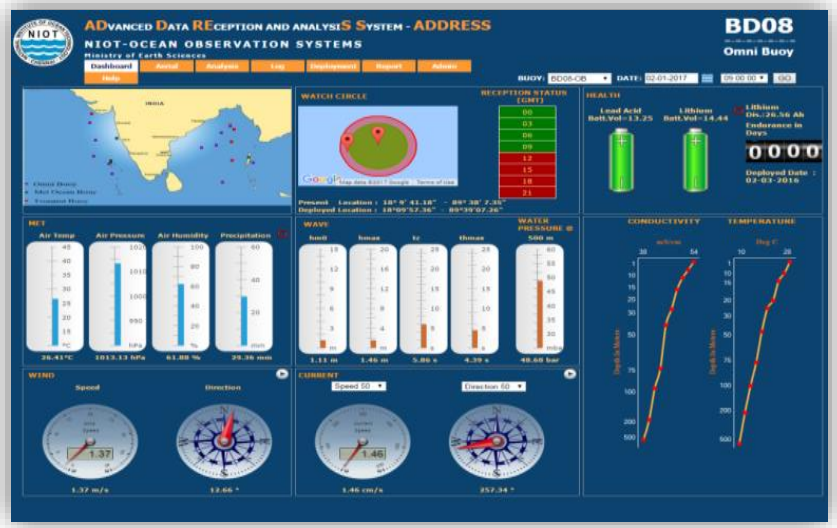
Data Reception Facility

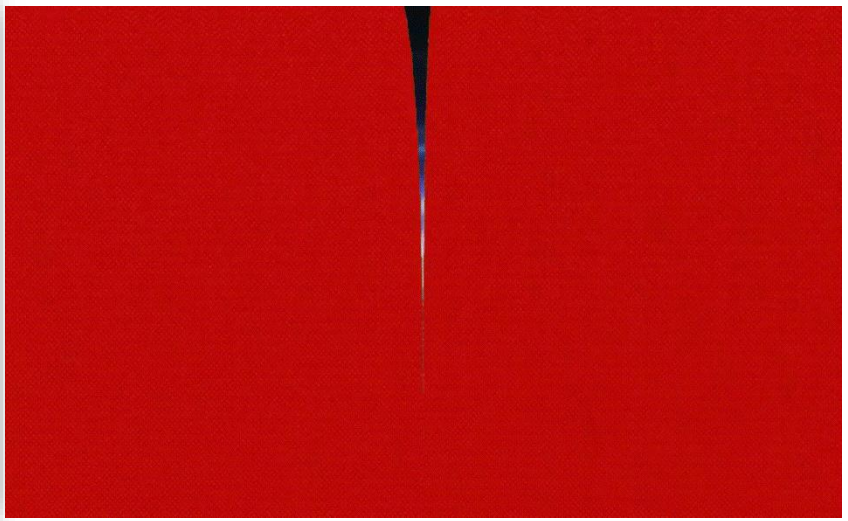
CORNEA - Centre for Ocean Realtime iNformation viEw and Archives

iMoon

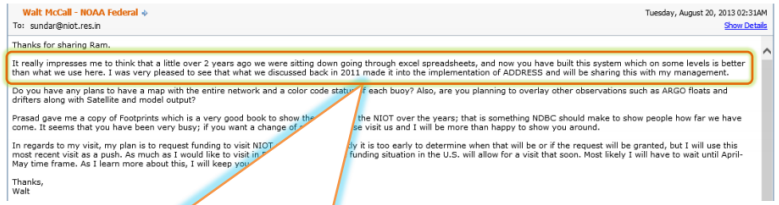
- Holds 3.7 crores of data records since 1997
- Real time data analysis
- Automated QC control
- Global Tier II Data Centre standards
- 24x7 operation
- Multi-level redundancy in terms of cooling, power, IT hardware and Application.
- High-end 4x3 Matrix Video Wall & Conferencing system to enable multi-window projection and wireless presentations to have better insight to data.
- Automatic alert on buoy movement due to drift
- Inventory management

ADDRESS – Data Reception and Analysis tool





Appreciation from NDBC


Walt McCall - NOAA Federal
To: sundar@niot.res.in
Tuesday, August 20, 2013 02:31AM
Show Details

Thanks for sharing Ram.

It really impresses me to think that a little over 2 years ago we were sitting down going through excel spreadsheets, and now you have built this system which on some levels is better than what we use here. I was very pleased to see that what we discussed back in 2011 made it into the implementation of ADDRESS and will be sharing this with my management.

Do you have any plans to have a map with the entire network and a color code stat… each buoy? Also, are you planning to overlay other observations such as ARGO floats and drifters along with Satellite and model output?

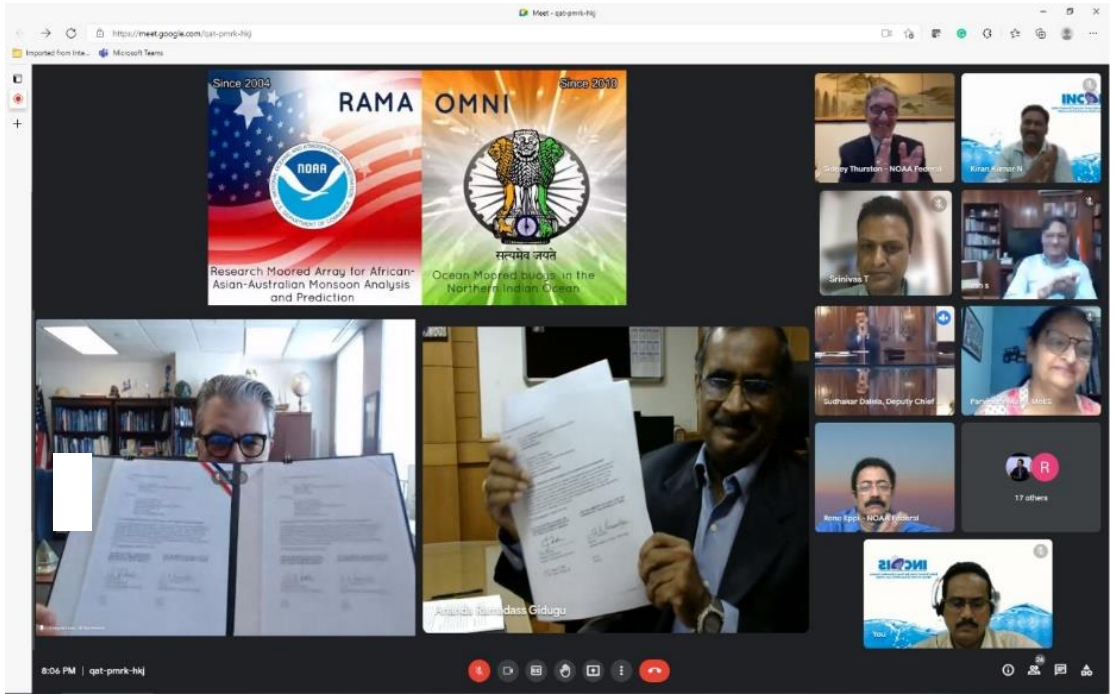
Prasad gave me a copy of Footprints which is a very good book to show th… the NIOT over the years; that is something NDBC should make to show people how far we have come. It seems that you have been very busy; if you want a change of… se visit us and I will be more than happy to show you around.

In regards to my visit, my plan is to request funding to visit NIOT… y it is too early to determine when that will be or if the request will be granted, but I will use this most recent visit as a push. As much as I would like to visit in… funding situation in the U.S. will allow for a visit that soon. Most likely I will have to wait until April-May time frame. As I learn more about this, I will keep you…

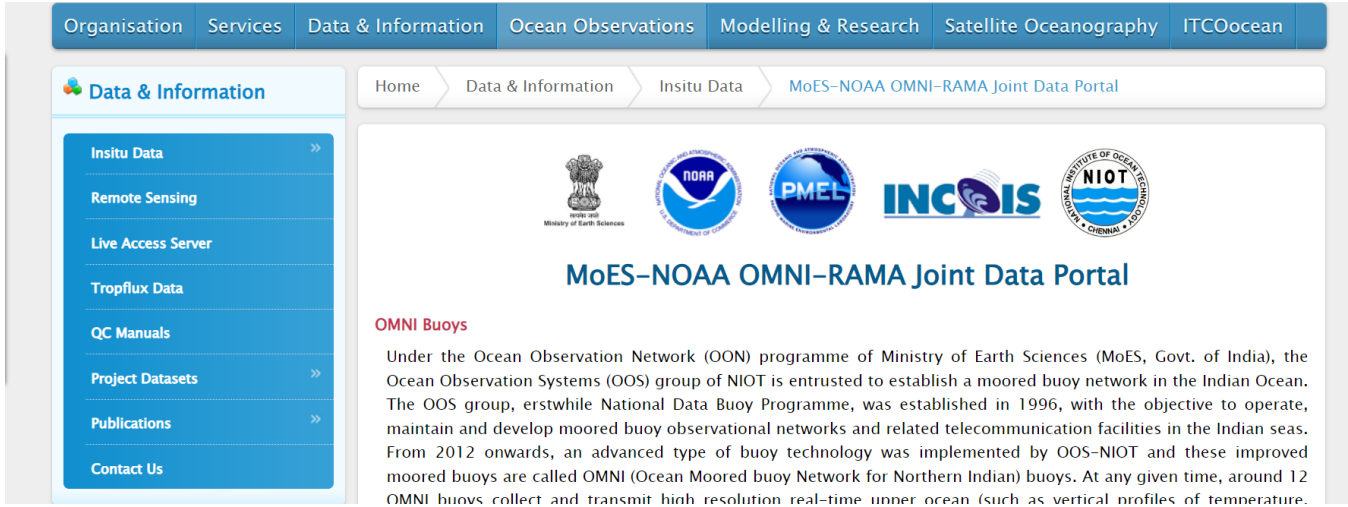
Thanks,
Walt

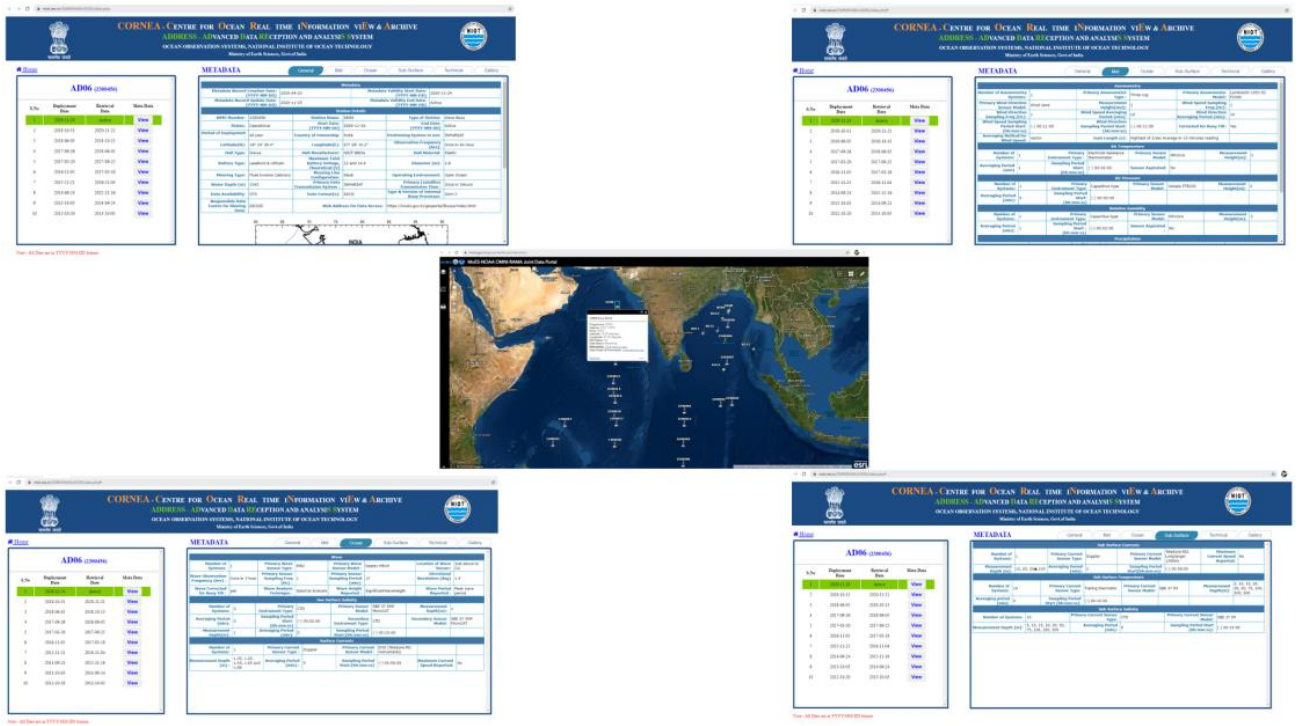
It really impresses me to think that a little over 2 years ago we were sitting down going through excel spreadsheets, and now you have built this **system** which is on some levels **is better than what we use here**. I was very pleased to see that what we discussed back in 2011 made it into implementation of ADDRESS and will be sharing this with my management.

OMNI – RAMA Joint Data Portal



MoU Signing Ceremony

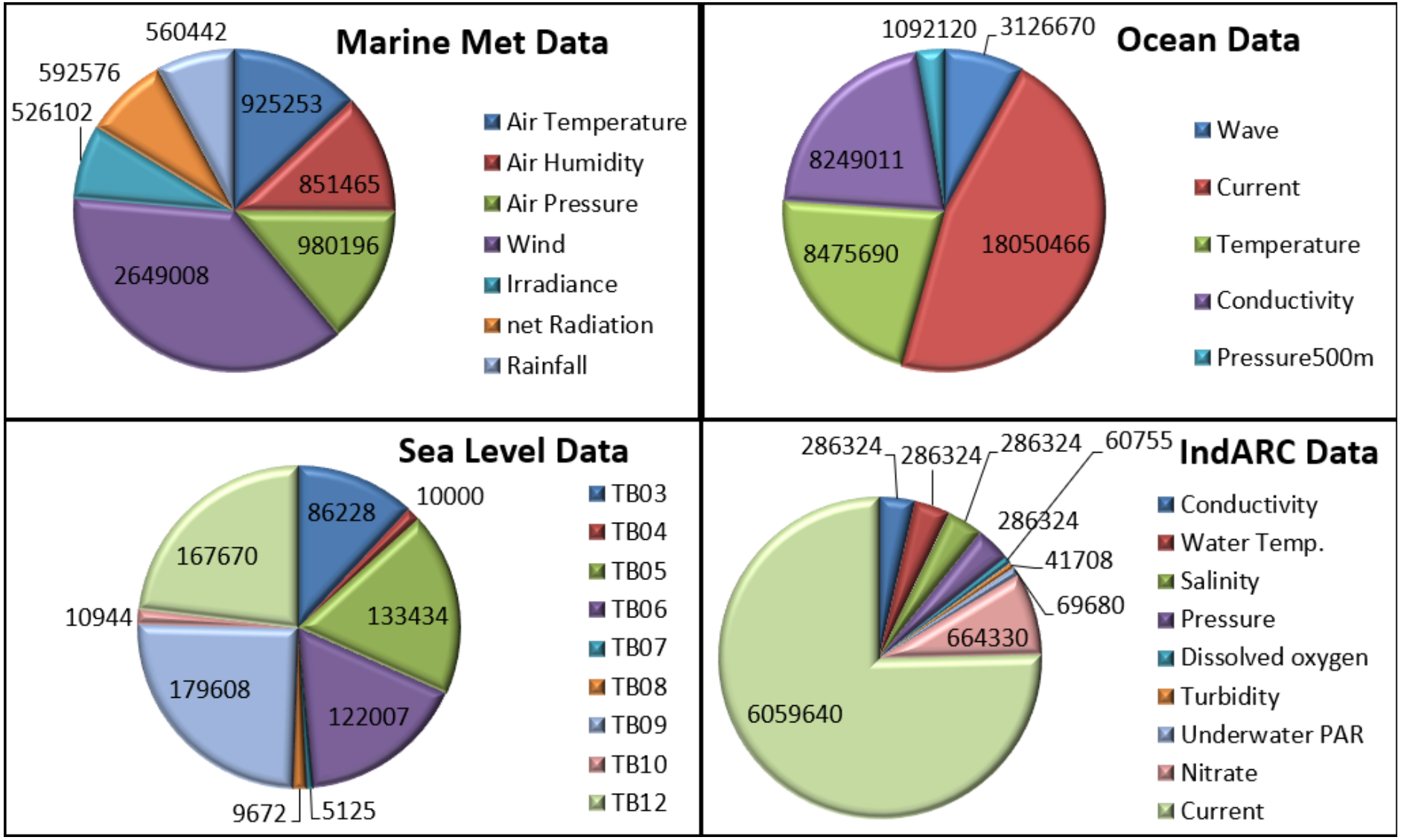




Dr. Ashutosh Sharma, Secretary MoES launched the portal in the presence of Mr. Craig McLean, Assistant Administrator for Research and Acting Chief Scientist of NOAA on 09th August 2021.

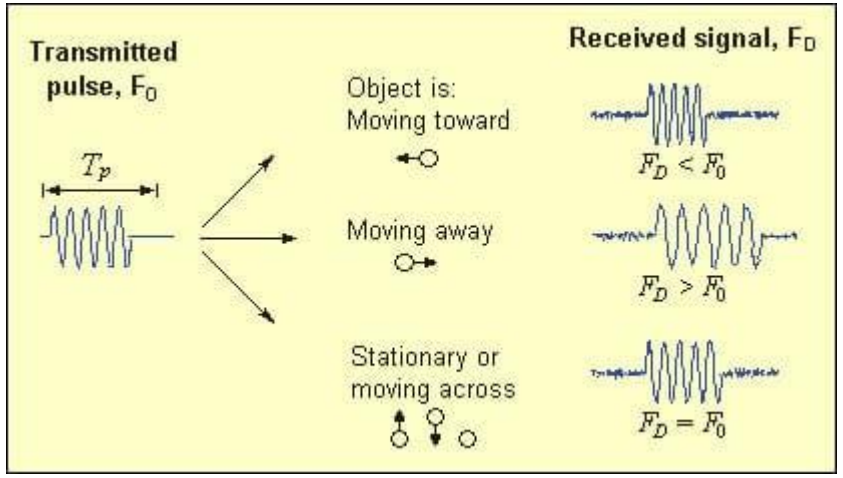
All moored buoy data outside the EEZ are shared to the public are being shared in this joint portal.

Moored buoy Data availability from 1997 to 2022

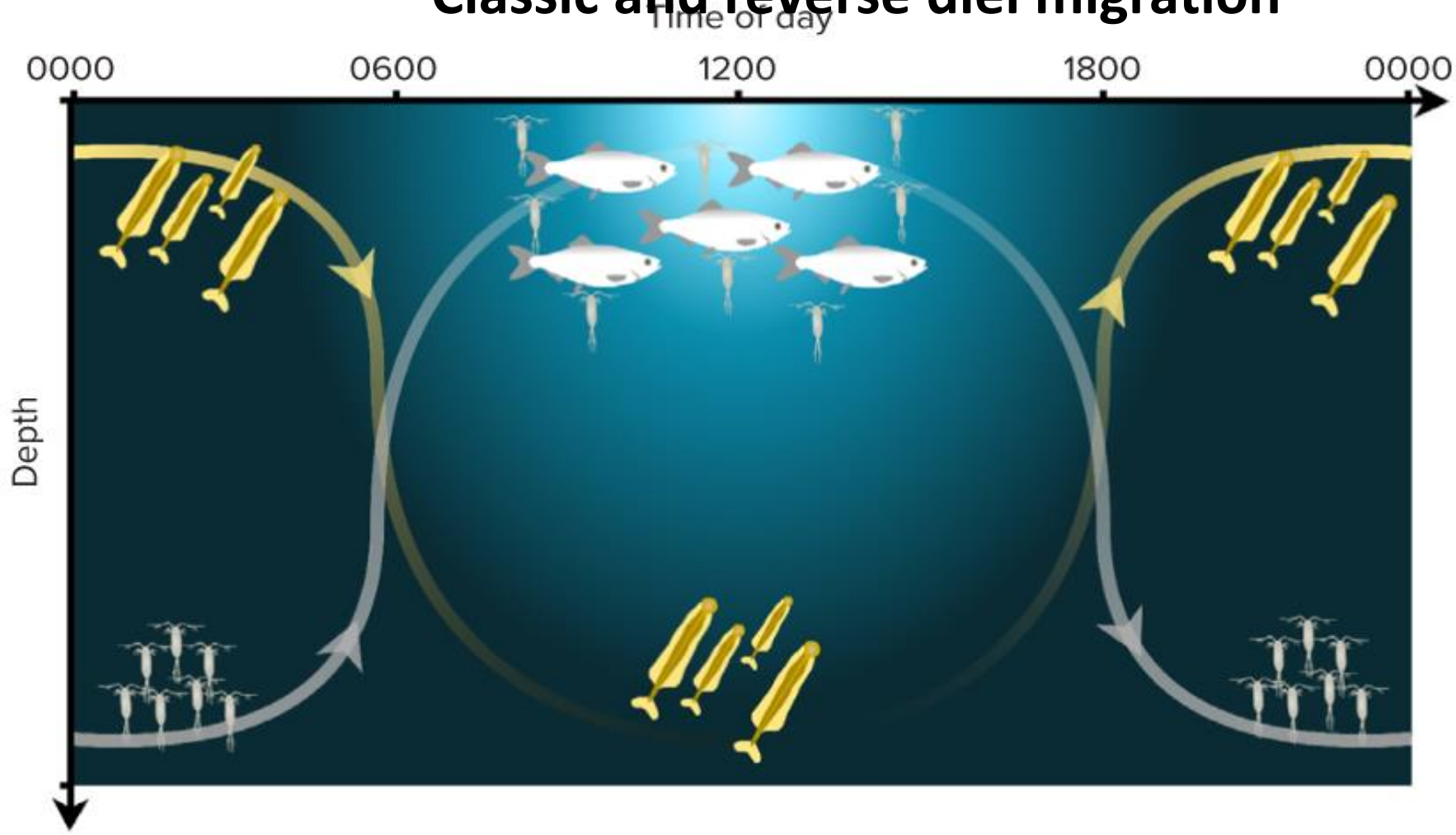


ADCP Configuration

- Acoustic Doppler Current Profiler
- Measures wave and current velocities and direction through the specified water column using an acoustic signal
- Eularian system (measures at one point over time)
- ADCP model : TELEDYNE Workhorse Quartermaster (75 KHz & 150 KHz)
- Deployed at 15 m depth
- Resolution: 0.5 m
- Recording interval data: 1 ping/3 sec x 60 samples
- Total bins: 40 and
- Each bin size: 5m



Classic and reverse diel migration

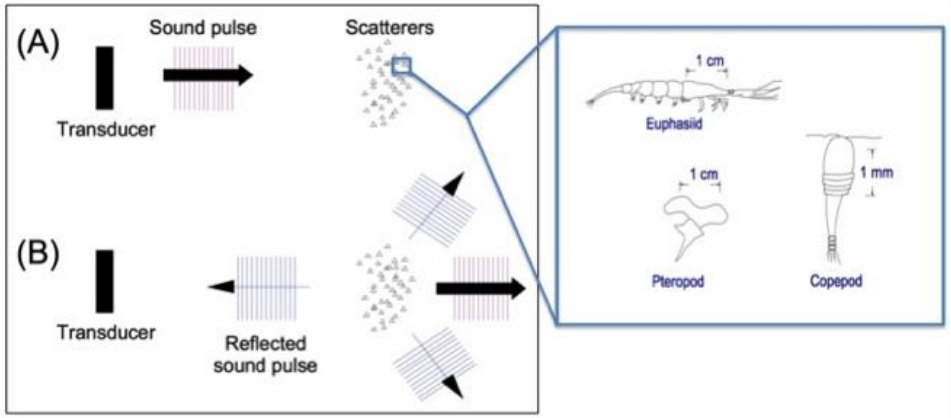


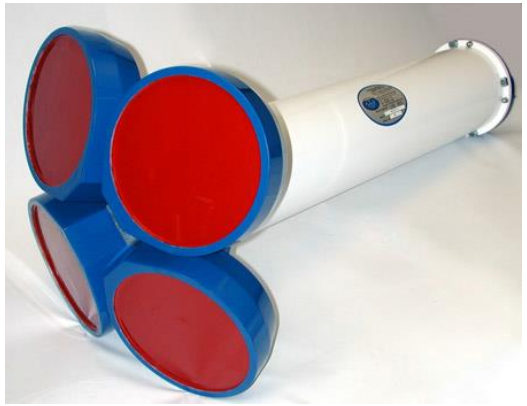
In the classic diel vertical migration pattern (yellow arrows), zooplankton such as marine worms (yellow) travel to the surface to feed at night when predators such as fish are absent. A reverse nightly migration (gray arrows) takes smaller zooplankton such as copepods to the deep, where they can avoid becoming the worms' prey.

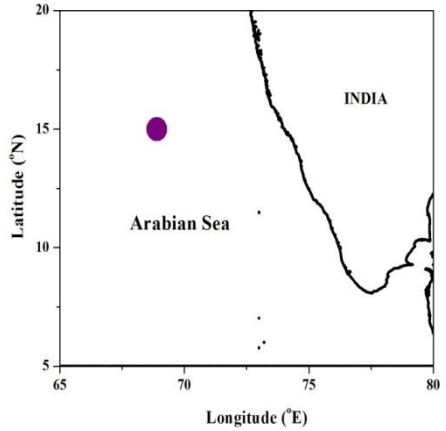
SOURCE: ADAPTED FROM K. BANDARA *ET AL* / *BIOLOGICAL REVIEWS* 2021

Diurnal Vertical Migration (DVM) in AS

- DVM is a pattern of movement used by some organisms to shallower/deeper depths during day/night.
- The vertical migration depends on the presence of light, predators, feeding strategy, phytoplankton abundance etc.
- The ADCP measurements in central Arabian Sea captured DVM
- Period : October 2013 to April 2014 , depth range is >150m



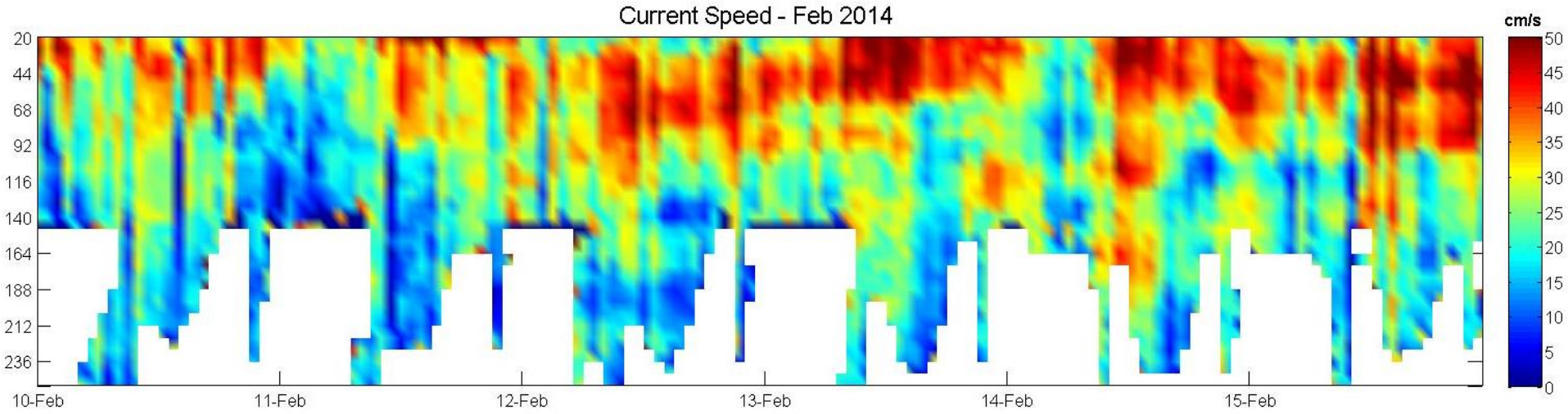




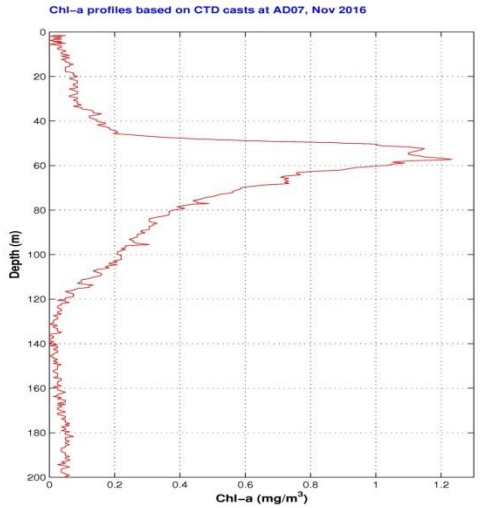
- The concentration of scatterers affects range because more scatterers reflect more sound.
- The dominant oceanic sound scatterer at ADCP frequencies is zooplankton with sizes on the order of one mm.
- Other scatterers can include suspended sediment, detritus, and density gradients.

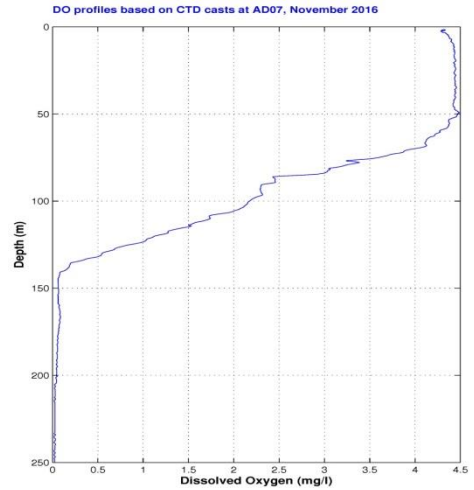
Diurnal Vertical Migration (DVM) in AS

- The scatters migrate to shallower depth during Night time
- They remain at deeper depths during day time
- It is observed that the scatterers travel the 100m distance in ~2hours



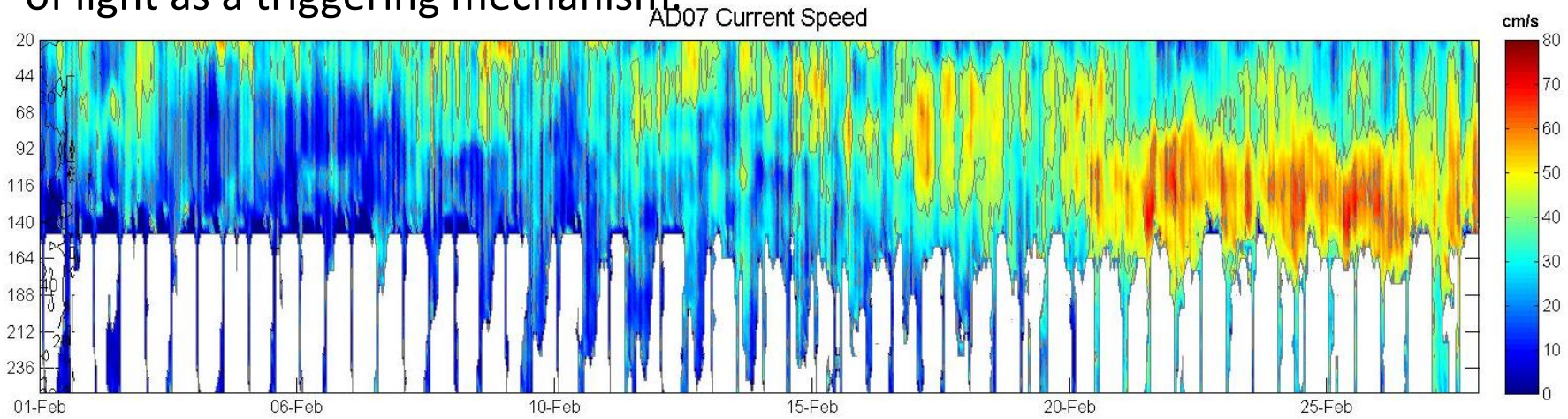
- The analysis of Dissolved oxygen and Chlorophyl-a indicates the presence of phytoplankton and hence the scatterers in the upper 150m.

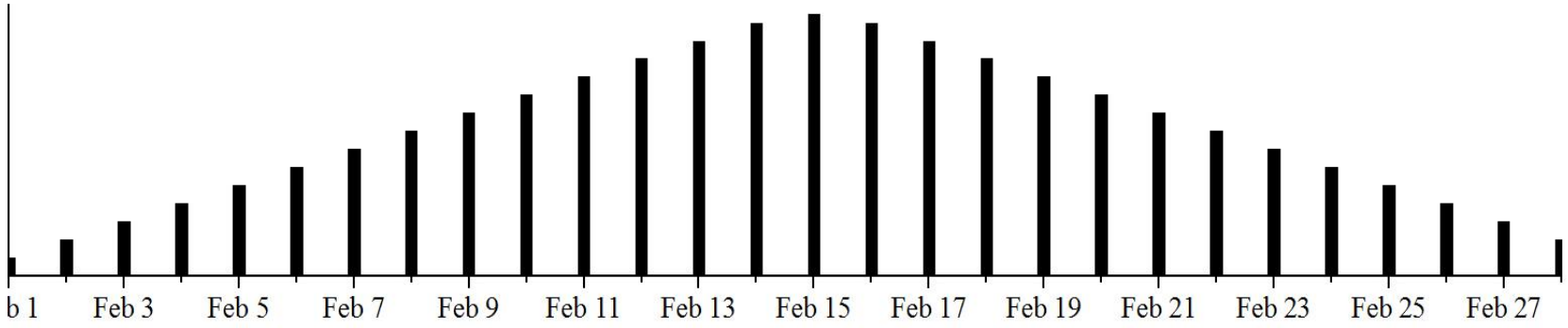




Diurnal Vertical Migration (DVM) in AS

- The distribution of depth which varies with lunar phase indicates the significance of light as a triggering mechanism.

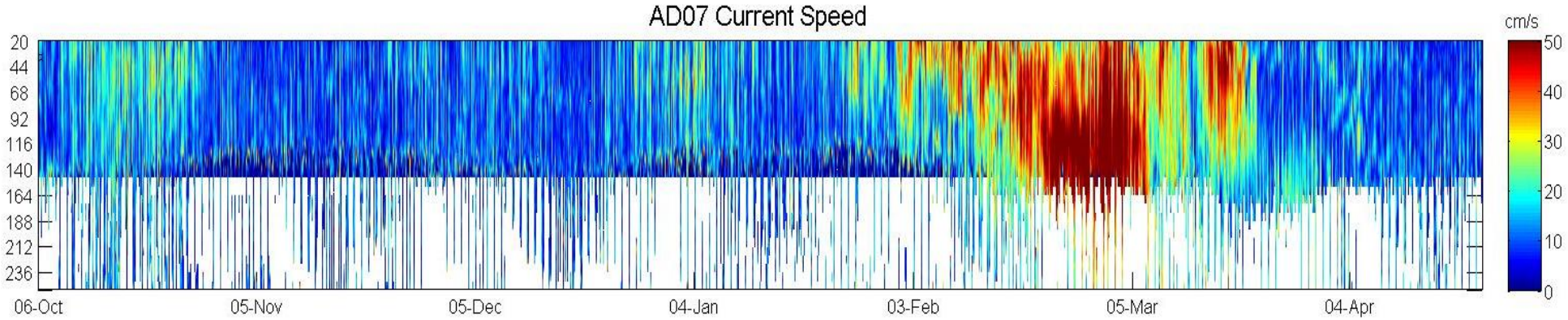


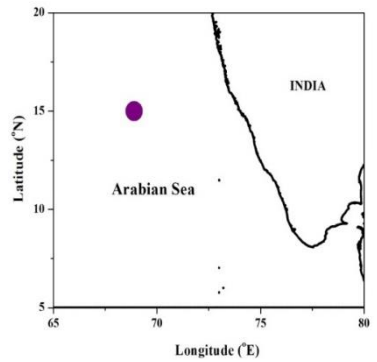


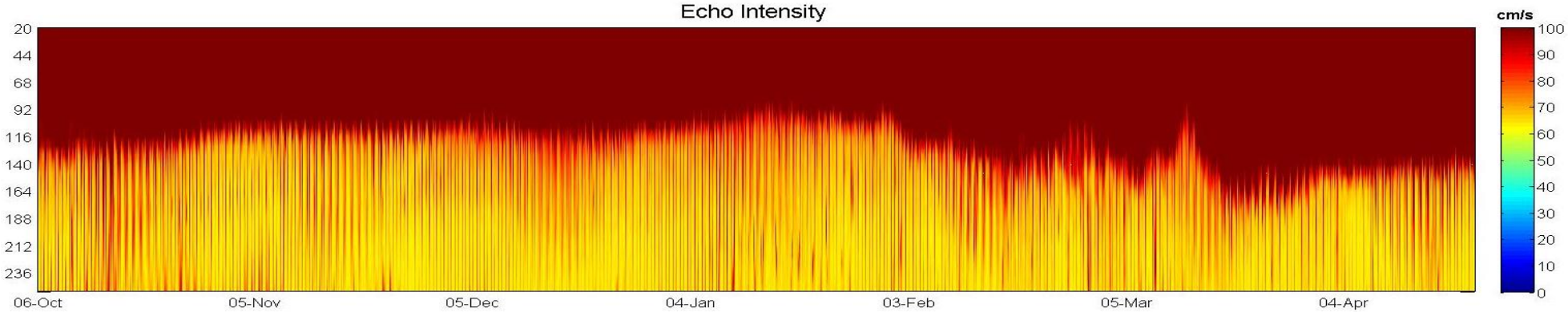
Lunar Phase

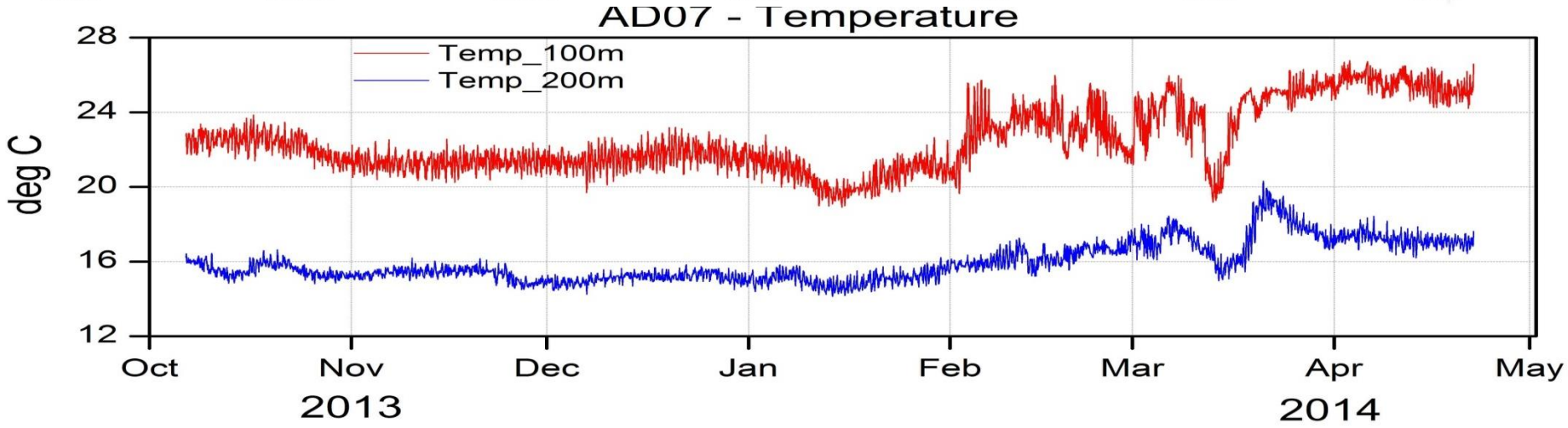
- The seasonal variability observed in DVM indicates the significance of light as a triggering mechanism.

Diurnal Vertical Migration (DVM) in AS

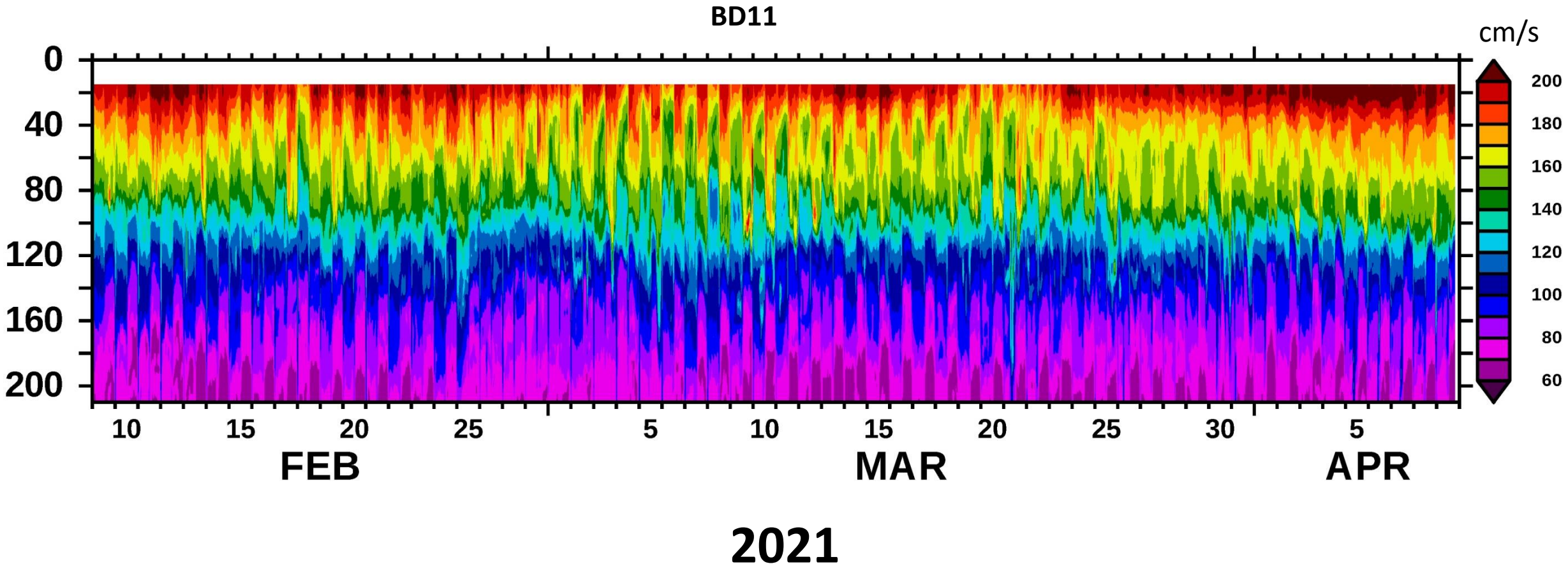




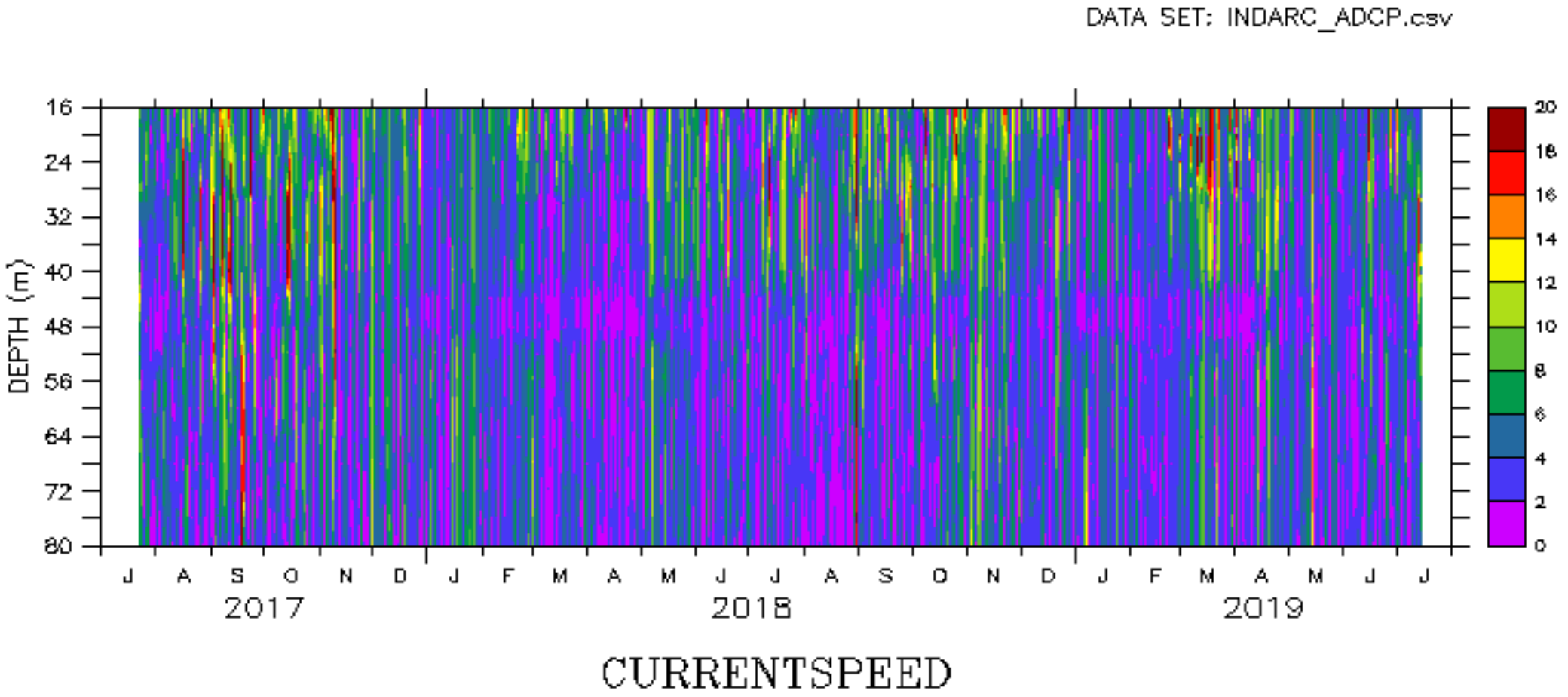




Diurnal Vertical Migration (DVM) in BoB



IndARC ADCP


DATA SET: INDARC_ADCP.csv
DEPTH (m)
16
24
32
40
48
56
64
72
80
J A S O N D J F M A M J J A S O N D J F M A M J J
2017
2018
2019
20
18
16
14
12
10
8
6
4
2
0
CURRENTSPEED

Conclusion

- ADCP measures the currents with the help of scatterers (zooplankton) with sizes on the order of one millimeter.
- Density of the zooplankton in the entire water column in not uniform and have higher concentration near the surface.
- The DVM is exhibited by the zooplankton to escape from predators.
- We also reveal marked DVM, with timing closely associated with the day-night light cycle—descent from the photic zone 1–2 h before sunrise, and reappearance in the near-surface about 1–2 h after sunset.
- The zooplanktons descends to deeper waters and resurfaces during the night.
- Echo intensity measured by the ADCP from the scatterers show large diurnal variation due to DVM.
- The migration consists of two distinct layers—a shallower layer reaching the interface level (~140 m) and a deep layer which descends to 240 m.

Thank you