Ocean Mixing and Monsoon (OMM): Training on Lagrangian Float Assembly, Deployment, and data Analysis

1. Lagrangian Floats

An instrument that follows the water parcel exactly is called a Lagrangian float. These floats do not move on their own but instead float in the water. These are meter-sized devices designed to have the same velocity as the average velocity of the water surrounding them. On the meter scale, water acceleration is primarily due to pressure gradients, not viscosity, so a float with the same density as seawater will be accelerated by the same pressure gradients as the seawater and thus follow a similar trajectory. The main design challenge for Lagrangian floats is accurately matching the surrounding water's density. Floats with the wrong density will have a net buoyancy and thus fall or rise through the water.

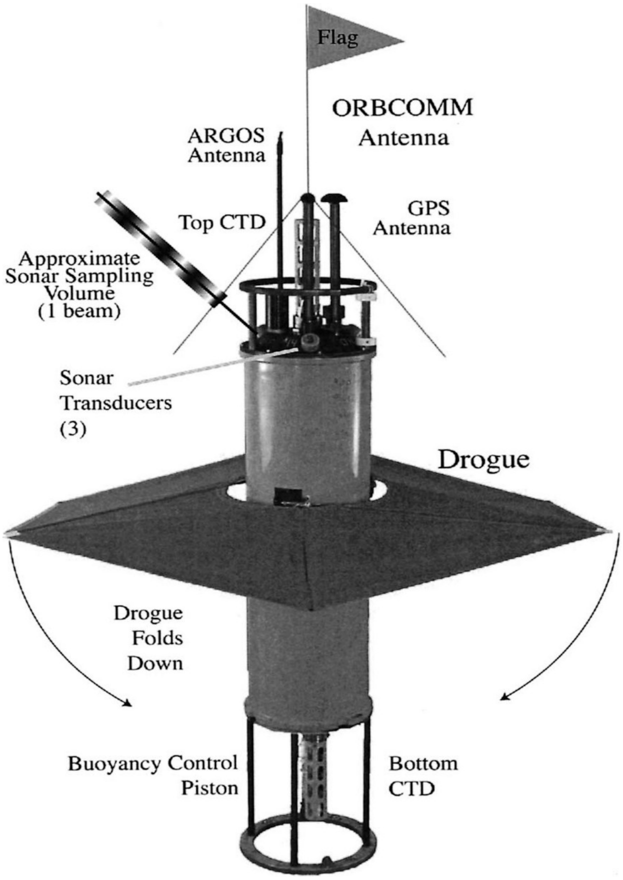

Figure 1: Typical Schematic of a second generation Mixed Layer Float (MLF-II).

A typical float design is shown in figure 1 (adapted from D'Saro 2003). Sensors (Temperature, Salinity, and radiation sensors) and communication devices (Argos and Iridium antennas) are fitted on top of the float. Additional T/S sensors are fitted at the bottom of the float. The large horizontal drougue at the middle of the float helps reduce the float's relative velocity and water. Float depth is measured using a pressure sensor. A piston that pushes out of the bottom endcap controls the float's buoyancy.

2. Custom-made INCOIS Lagrangian Float

INCOIS purchased a custom-made Lagrangian float from Applied Physics Laboratory (APL, Seattle, USA) in 2015. This float was fitted with Temperature / Conductivity sensors on top and bottom of the float, velocity measuring ADCP, PAR sensors etc. One typical feature of the float was an additional buoyancy machine which was needed for operating in low-density surface waters of the Bay of Bengal.

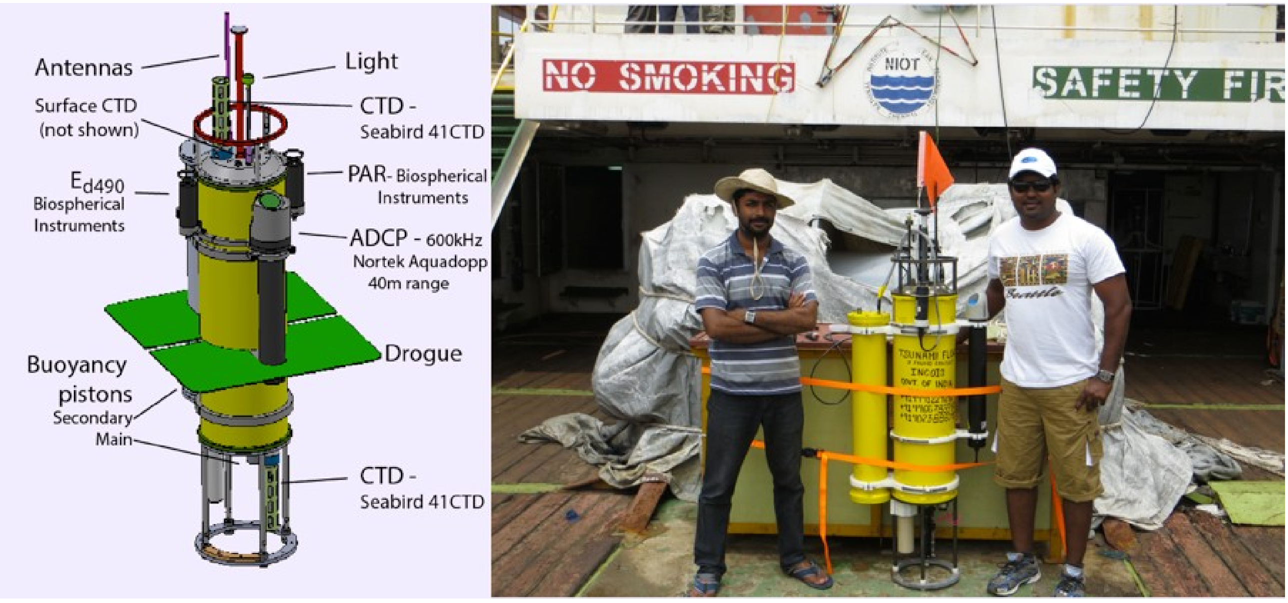

Figure 2: Lagrangian float as deployed on SN100. The picture shows float before deployment.

INCOIS Lagrangian Float is a standard MLF-II type float outfitted with the following sensors.

1. An auxiliary buoyancy unit. The normal MLF-II has 650cc of buoyancy control, enough to compensate for up to 13 psu salinity change. However, at least 300 cc is needed to surface the float, so the normal buoyancy engine can barely surface the float under the wide salinity variations in the Bay of Bengal. The auxiliary unit doubles the buoyancy control to 1300cc, which is more than enough to allow

operation under all likely open ocean conditions

2. Two standard Seabird SBE42 Conductivity/temperature sensors on top and bottom of the float. Two sensors provide redundancy and allow profiling closer to the surface Seabird Surface CTD. This makes high-resolution CTD measurements to within a few centimeters of the surface.
3. Two Pressure sensors- top and middle of the float. This measure the float depth. One Aquadopp 600 kHz ADCP – this measures velocity profiles relative to the float. It looked upward for up to 40m.
4. Two light sensors - both measuring downwelling radiation. Both are Biospherical instruments model 2150.
    - PAR – Photosynthetically Active Radiation
    - 490nm – Light close to 490nm wavelength

3. Onboard training in ORV Sagar Nidhi.

Prof. Eric D'Asaro from Applied Physics Laboratory (APL, Seattle, USA) provided extensive training to Dr. Praveen Kumar and Mr. Suresh Kumar of INCOIS on float assembly and preparation from 23 August – 15 September 2015 onboard Sagar Nidhi. He also provided general lectures on different lagrangian-type floats. This included instructions on float assembly, testing, deployment, operation during the mission, recovery and post-deployment data aggregation, quality control, and the first stages of scientific analysis.

The float was deployed on 04 September 2015 at 05:46 UTC within a cluster of surface drifters deployed from the R.V. Revelle. The float operated flawlessly, with only a minor interruption in the mission, required by a mission restart after two days. The typical mission cycle lasted about 3 hours, starting with a dive to about 30m, settling on an isopycnal near 18m for about 2 hours, a profile to the surface where the float obtained a GPS fix, communicated with the operators, and sent data. The float was recovered on 11 September 2015, 00Z, and the data was extracted. All sensors worked well for the seven days of the mission.

4. Training on Data Analysis at Applied Physics Laboratory, USA

Dr. Praveen Kumar from INCOIS visited Applied Physics Laboratory from 08 November to 07 December 2015 to work with Prof. Eric D'Asaro on float data analysis. This training involved data extraction from the float, initial quality checking, producing quality-checked data products, and then a detailed data analysis. Basic codes for the data extraction and quality control were exchanged and familiarized.

Following are some of the interesting observations obtained from the Lagrangian float.

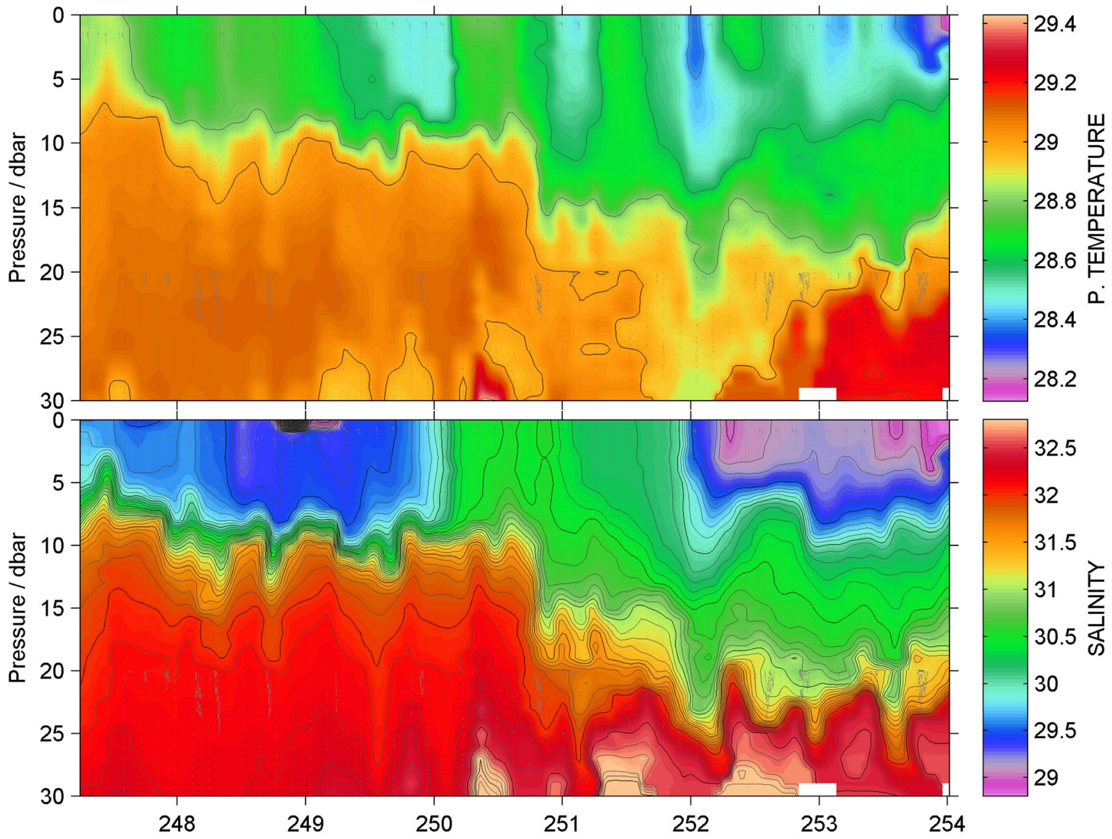

Figure 3: Temperature (top panel) and Salinity (bottom panal) as inferred from the MLF75 float.

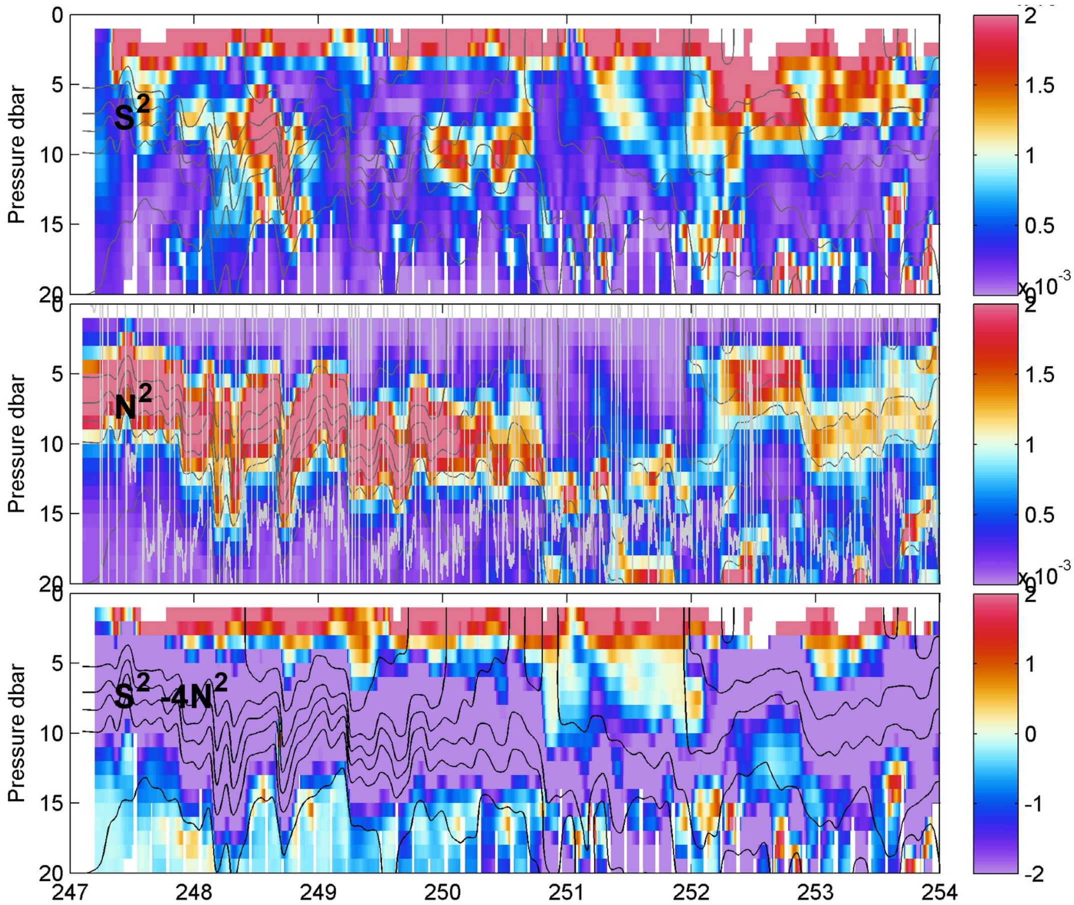

Figure 4: Velocity shear (top panel), buoyancy frequency (middle panel) and Reduced shear (bottom panel) based on the gradient Richardson and the salinity (contours). The shear instability criterion is simply rewritten as S 2 –4N 2 >0 to represent mixing events (values greater than 0) in yellow and red. Blue colors represent stable conditions. The analysis is based on MLF75 float data from the Bay of Bengal.