# NAB08 Lagrangian Float 48 Sampling Methodology

V1, For BCO-DMO, November 30, 2010

**Float Description**

The 2008 North Atlantic Bloom Experiment (NAB08) employed a "Lagrangian float", built at the University of Washington Applied Physics Laboratory. (D'Asaro 2003). This float is not an ARGO float. It is primarily designed to accurately follow the three-dimensional motion of water parcels within the mixed layer, through a combination of neutral buoyancy and high drag provided by a one meter diameter black drogue. Typical buoyancies of a few grams result in vertical velocities relative to the water of a few mm/s, small compared to the cm/s turbulent velocities in the mixed layer. The float's motion within the mixed layer thus closely imitates that of a planktonic organism. The float can also profile vertically. It sends data and receives commands using the Iridium satellite system. The float is designed to accommodate a wide variety of sensors, in particular the suite of sensors from NAB08 shown in Figure. 1.

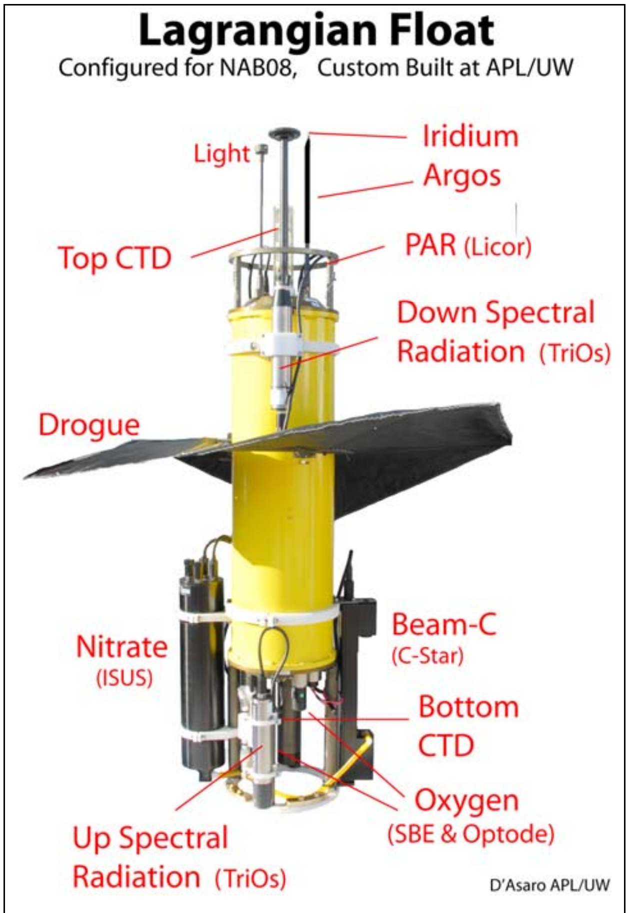



**Figure 1.** The Lagrangian float used in the 2008 North Atlantic Bloom Experiment.

**NAB08 Float Modes and Cycle (Parameter names: mode, cycle)**

The daily cycle of NAB08 float consisted of a sequence profiling and drifting (Figure 2). One profile was completed each day, except during the first 2 days of the mission (yeardays 95, 96), the float completed two cycles per day. Parameter name “cycle” counts each cycle.

Each cycle is defined by the following sequence of modes, available as parameter name “mode”: coincident with every sensor measurement:

- **Profile down (mode 0):** Profile down to about 250 m with the drogue closed.
- **Settle (mode 1):** Move to a selected isopycnal and remain there with the drogue closed. The isopycnal was manually selected each day and varies over the full depth range of the float. In the lower panel of Fig. 2 the two settles (green dots) target isopycnals near 60m and 140m. Often, the float moves a large vertical distance while travelling to the selected isopycnal so the Settle mode can also act as a profile.
- **Drift (modes 3, 5):** Move into the mixed layer and attempt to follow the three-dimensional motion of the water. Typically, the float moves repeatedly across the mixed layer, as seen in Fig. 2, carried by the turbulent eddies. If the winds are weak, the float may instead come to rest at a shallow depth near the surface. Drogue is open. In mode 3 (drift_iso), the float actively matches its density to the local mixed layer density; in mode 5 (drift_ml) it matches the potential density of the mixed layer. This distinction will not important to most users; selecting data with mode > 2 can reliably be used to study water-following samples.
- **Profile up (mode 2):** Profile up to surface with drogue closed. Vertical speed is faster than when profiling down (mode 0) so the data points are more widely spaced in depth.
- **Communication:** Turn off scientific sampling and reach the surface. Get GPS fixes. Transmit sub-sampled “Quicklook” sensor data via Iridium. During this time, there is a gap in CTD and sensor data. Float GPS data documents the position and time of these communications. This typically happens within 2 hours of solar noon, so that the preceding Profile up (mode 2) and following profile down (mode 0) make the most useful profiles of radiation.

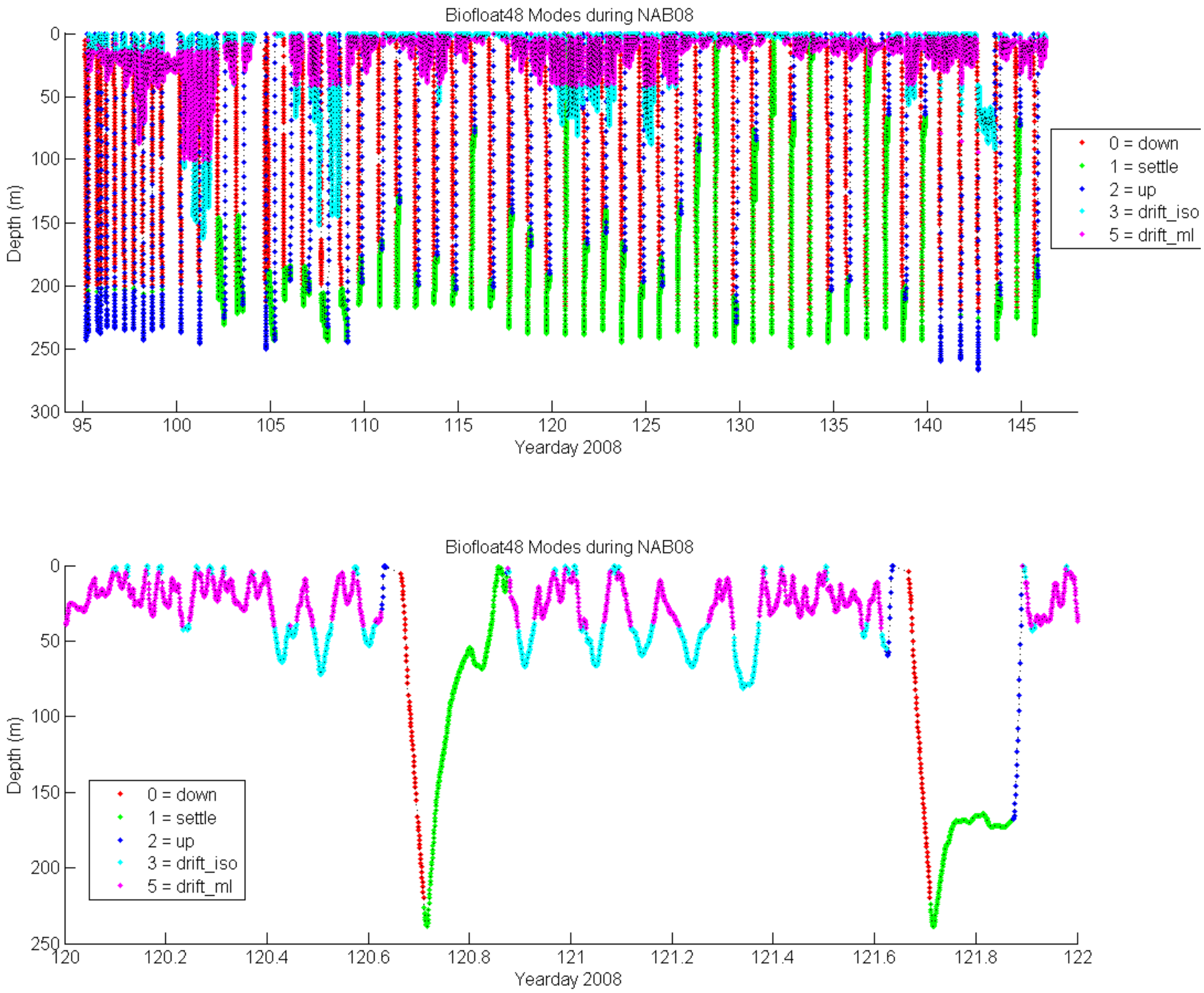



**Figure 2.** Mode history of NAB08 Lagrangian Float 48. (Upper) Entire mission (Lower) One cycle starting with down profile (red) at approximately yearday 120.65 ending with communication period at yearday 121.6.

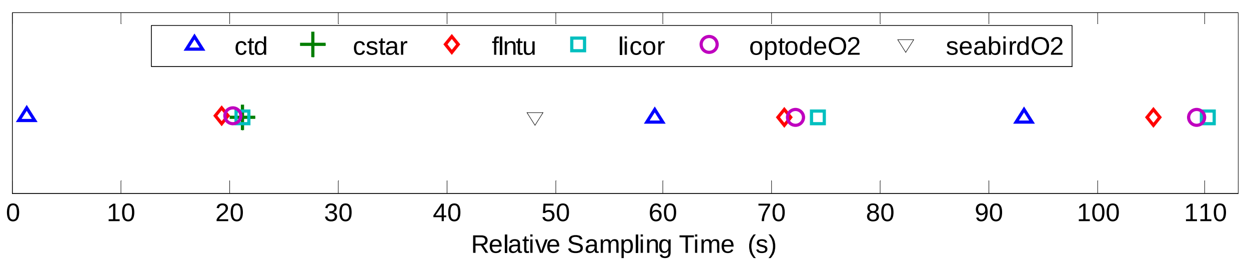
**Sensor Sampling Strategy**

The float sampled data a full resolution and transmitted sub-sampled “QuickLook” resolution data to University of Washington via Iridium each day. Sensor sampling intervals were different for profiling and drifting:

**Profile Mode (mode = 0 or 2):** All sensors are sampled every ~40-60 s, except ISUS, which is sampled every 4 loop iterations (160-240 s). For satellite ‘quicklook’ transmission, profile data is decimated by a factor of 8, (~320-480 s), except for TriOS radiometers, which are decimated by a factor of 32 (~1600 s). See Figure 3 below.

**Settle Mode (mode = 1), Drift Mode *(*mode** > **2**): Sensors sampling is initiated on an integer multiple ("sampling divisor") of a 50 s heartbeat. Initiation of the heartbeat may vary by a few seconds. For satellite transmission, drift data was decimated to “QuickLook” resolution. See Figure 4 and Table 1 below.

**All Modes:** Sensors ready to be sampled on a particular loop iteration (profiling) or heartbeat (drift mode) are sampled sequentially and rarely simultaneously. Therefore, the timebase (parameter names “time” and “yrday”) will be different for every sensor, even for sensors with the same sample interval. An example showing drift mode sampling of a subset of the float sensors over 110 seconds is shown below.




**Light Field:** LI-COR PAR and TriOS radiometric sensors (acc, arc) are sampled only during daytime (a function of date, time, latitude and longitude.) Occasional “dark” samples are taken for both sensors to monitor sensor bio-fouling and drift.

**Table 1** Biofloat Drift Mode Sampling Details

| Biofloat Drift / Settle Sampling | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Full Resolution Data | | | QuickLook Resolution Data | | | | |
| | **Sampling Divisor** | **Sample Interval** | **samples/day** | **divisor** | **subsample interval** | | **Subsamples /day** | |
| | | s | | | s | min | | |
| Upper/Lower CT | 1 | 50 | 1,728 | | | | | |
| Pressure | 1 | 50 | 1,728 | | | | | |
| FLNTU | 1 | 50 | 1,728 | 8 | 400 | 6.7 | 216 | |
| FLNTU Shutter | 10 | 500 | 173 | 8 | 400 | 6.7 | 216 | |
| TriOS acc, arc Radiometers | 4 | 200 | 290 | 32 | 1600 | 26.7 | 36 | at avg. 16.1 h sun/day |
| C-Star | 4 | 200 | 432 | 8 | 400 | 6.7 | 216 | |
| ISUS | 32 | 1600 | 54 | 32 | 1600 | 26.7 | 54 | |
| Aanderaa $O_2$ | 1 | 50 | 1,728 | 8 | 400 | 6.7 | 216 | |
| LI-COR | 1 | 50 | 1,162 | 8 | 400 | 6.7 | 145 | at avg. 16.1 h sun/day |
| Seabird $O_2$ | 8 | 400 | 216 | 8 | 400 | 6.7 | 216 | |
| Pump | 1 | 50 | 1,728 | | | | | |

**Figure 3 Profile Sampling (QL = QuickLook Samples)**

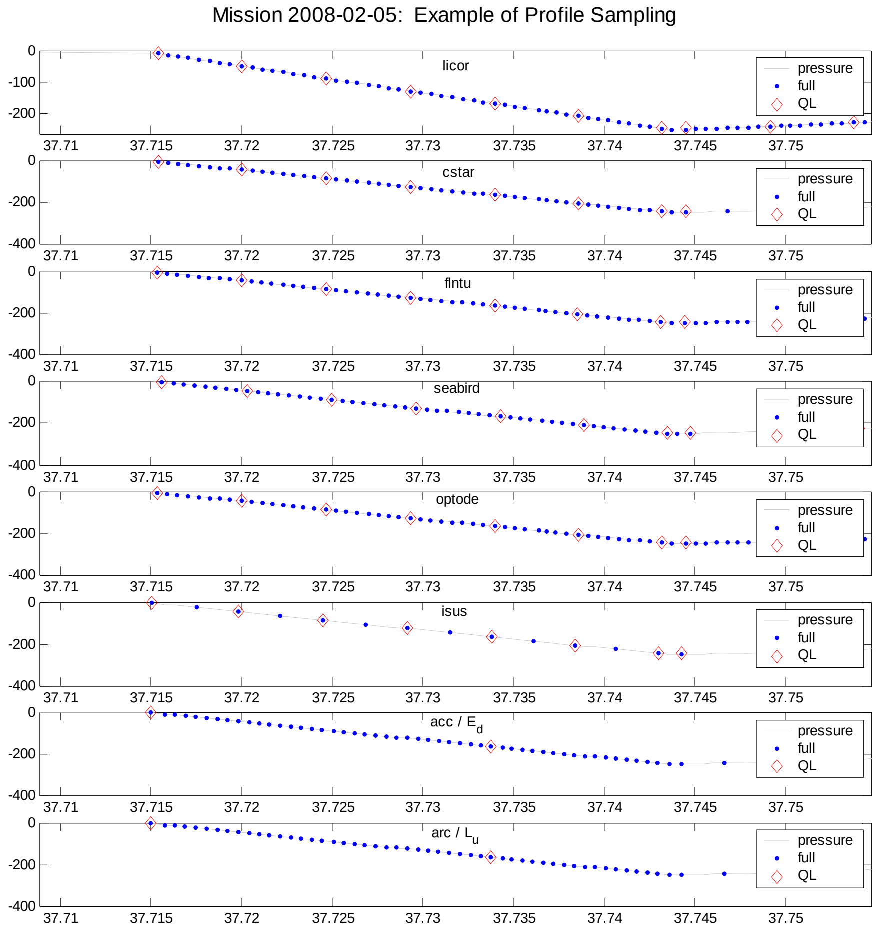
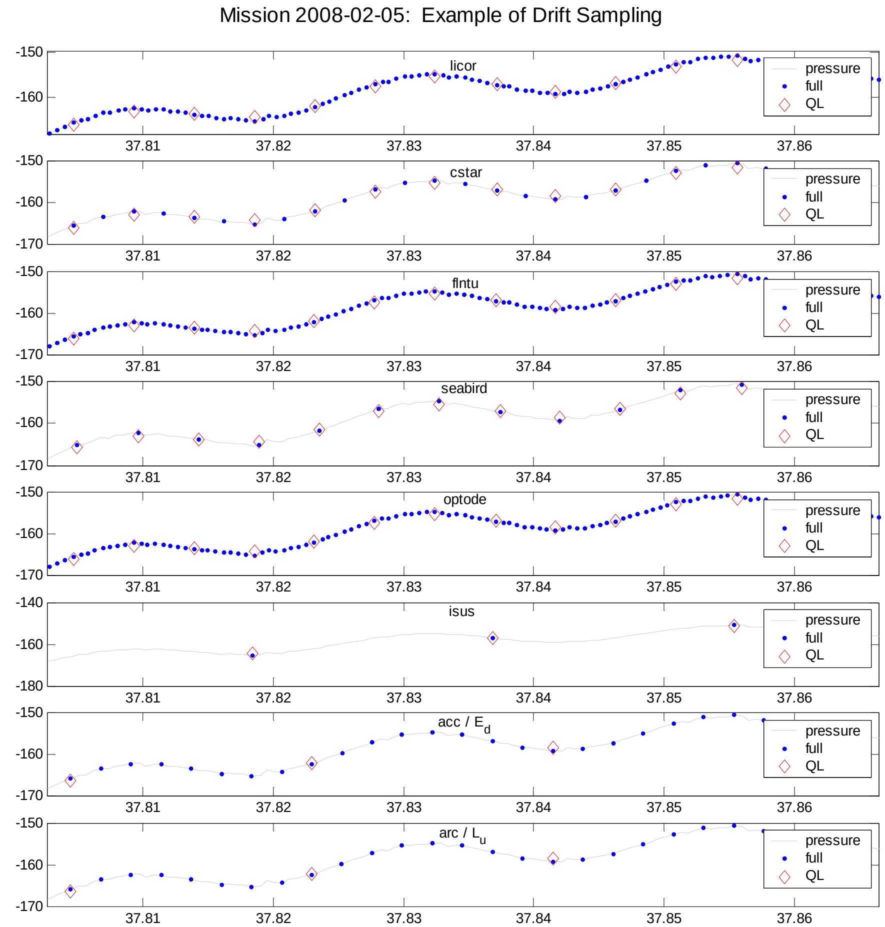



**Figure 4 Drift Mode Sampling**



## Other details including missing data:

- The float suffered a software failure on day 104. From approximately yearday 104.124 to 104.685, NAB08 Lagrangian Float 48 drifted at the surface; no data was collected during this time. Prior to yearday 104.124, only reduced temporal resolution ("Quicklook") sensor data is available for Float 48 sensors, except the CTD where full resolution data is available. After yearday 104.685, full resolution data is available for all sensors.
- During the first 2 days of the mission (yeardays 95, 96) Float 48 completed two cycles per day.
- Biofouling considerations: Pumped seawater output from the lower conductivity cell, containing a biocide, periodically flushed the up-facing C-Star transmitter pressure window before each measurement. Pumped seawater output from the lower conductivity cell, containing a biocide, was used for ISUS nitrate measurement. The FLNTU chlorophyll fluorometer & backscattering sensor included copper shutter with rubber wiper was used to protect against biofouling.
- From approximately yearday 120 to 142, the downwelling hyperspectral irradiance sensor (parameter name Ed), was biofouled. Parameter name qflag is set to 1 where radiometric data is acceptable, qflag = 0 where biofouling is suspected. For additional details, see *Radiometric_Calibration-NAB08v1.0.pdf*.
- The MLFII floats used in NAB08 will almost certainly spin about their vertical axis. The drogues have a pinwheel aspect to them when retracted during profiling. In another experiment where an MLFII float was equipped with an accelerometer, the float spun with a rotation period during profiling of about 80s. During drift mode when the drogue is deployed, the float will also spin, with the spin rate probably more irregular and depending strongly on the turbulence levels. A spin rate of 1 RPM would not be unusual.
- GPS coordinates are only truly accurate for the time that the float is at the surface, specifically, when the float is at a depth of < 1 m at the end of a daily "up" profile. (See Figure 2.) Latitude and longitude at other times are interpolated between these daily surface GPS fixes.

**References**

D'Asaro, E. A., 2003. Performance of Lagrangian Floats, Journal of Atmospheric and Oceanic Technology, Vol. 20, 896-911