

# CONSIDERATIONS ON THE COLLECTION OF DATA FROM BIO-ARGO FLOATS ACROSS SAMPLING SCALES.

## ABSTRACT

The flexibility of the current generation of float sensor packages provides an opportunity to craft mission specific sampling schemes that balance the collection of data for specific sampling goals with the practicalities of float operation.

Autonomous floats operate within constraints of battery life and data transfer rates. For simplicity of data transfer and handling, most float data sets are transmitted after binning on pressure. Within a given pressure bin different instruments will be sampling within a particular defined sequence. A sampling sequence should be balanced towards minimizing energy consumption while maximizing data accuracy of each instrument. As the number of sensors increases and the breadth of mission parameters expands it becomes more difficult to optimize data sequencing and reporting.

We consider methods to reduce the size of the problem by setting rules for sequence development and test those rules relative to field data. We examine a set of data from a float that was equipped with internal memory that captured the full set of sample data taken during the profiling mission. Comparing the 'raw' data and the transmitted data we examine the variance around the transmitted data and discuss the impact of data sequencing on the data.

## Data Output Structure

Time (sec)	Thermistor Output	Pres	Pres Therm	Con	OPPhase	OPRate	Chi cnts	bb700 cnts	bb532 cnts	pH V	pH T
1193	12952684	2643200	1581	3677.597	34.867	1.029505					
1194	12952685	2643200	1581	3677.597							
1195	12952686	2643200	1581	3677.597			73	433	154		
1196	12952687	2643200	1581	3677.597							
1197	12952688	2643200	1581	3677.597							
1198	12952689	2643200	1581	3677.597	34.864	1.029501					
1199	12952690	2643200	1581	3677.597							
1200	12952691	2643200	1581	3677.597							
1201	12952692	2643200	1581	3677.597							
1202	12952693	2643200	1581	3677.597							
1203	12952694	2643200	1581	3677.597	34.858	1.029495					
1204	12952695	2643200	1581	3677.597			73	444	159		
1205	12952696	2643200	1581	3677.597							
1206	12952697	2643200	1581	3677.597							
1207	12952698	2643200	1581	3677.597							
1208	12952699	2643200	1581	3677.597	34.861	1.029503					
1209	12952700	2643200	1581	3677.597							
1210	12952701	2643200	1581	3677.597							
1211	12952702	2643200	1581	3677.597							
1212	12952703	2643200	1581	3677.597							
1213	12952704	2643200	1581	3677.597	34.856	1.029503					
1214	12952705	2643200	1581	3677.597			72	439	157		
1215	12952706	2643200	1581	3677.597							
1216	12952707	2643200	1581	3677.597							
1217	12952708	2643200	1581	3677.597	34.858	1.029506					
1218	12952709	2643200	1581	3677.597							
1219	12952710	2643200	1581	3677.597							
1220	12952711	2643200	1581	3677.597							
1221	12952712	2643200	1581	3677.597							
1222	12952713	2643200	1581	3677.597	34.855	1.029507					
1223	12952714	2643200	1581	3677.597			76	454	202		
1224	12952715	2643200	1581	3677.597							
1225	12952716	2643200	1581	3677.597							

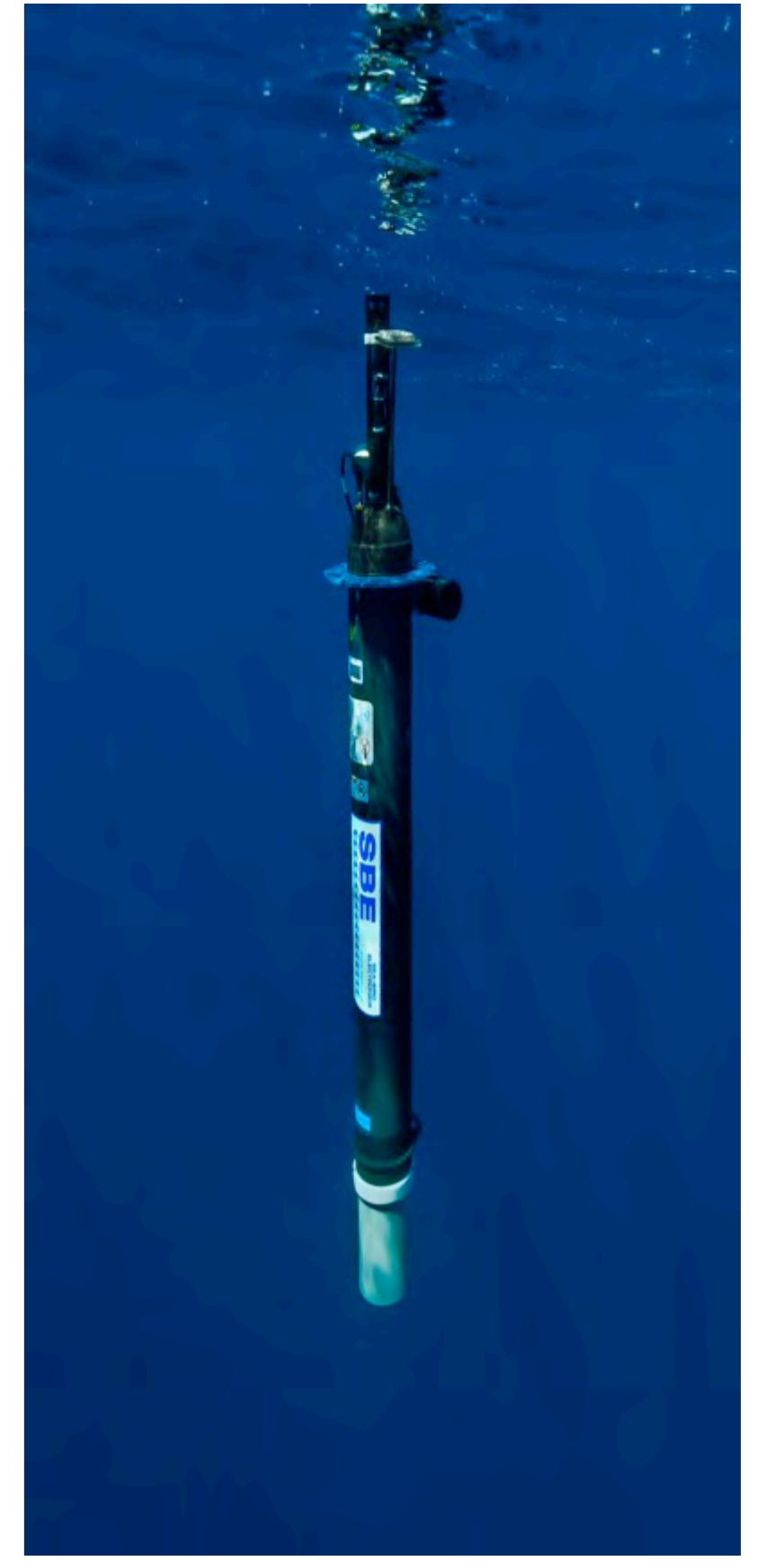
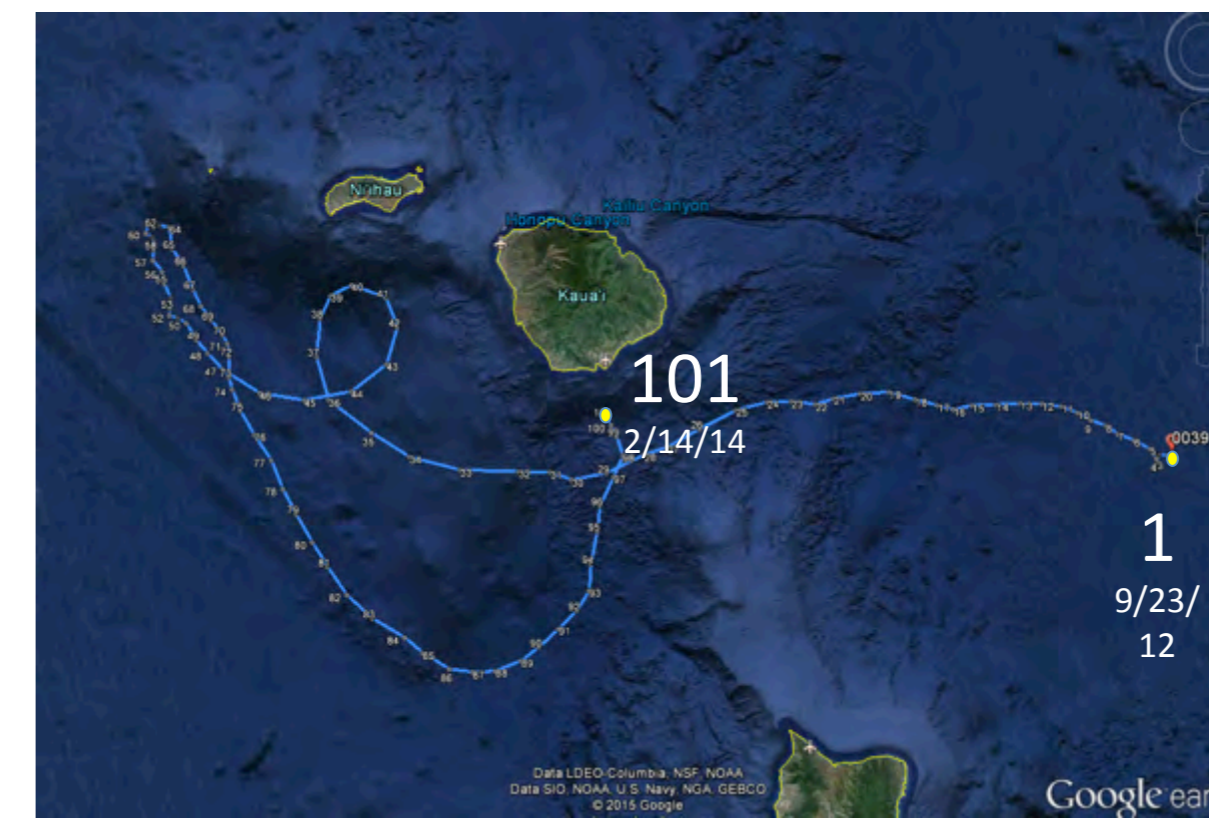
Data from each instrument is recorded as the float rises according to the programmed instrument sequence. The rise rate of the float determines the data density within the profile as the instruments are driven by the time sequence. For example, as the float rises past 700 dbar (top panel), four complete sequences of data are completed over 4.1 dbar in 32 seconds. Later in the profile as the float passes 100 dbar (bottom panel), the float covers 1.5 dbar in 32 seconds and records four complete sequences.

Time (sec)	Thermistor Output	Pres	Pres Therm	Con	OPPhase	OPRate	Chi cnts	bb700 cnts	bb532 cnts	pH V	pH T
9853	3269883	423020	1807	6794.761	34.834	0.974302					
9854	3269884	423020	1807	6794.761			212	536	223		
9855	3269885	423020	1807	6794.761							
9856	3269886	423020	1807	6794.761							
9857	3269887	423020	1807	6794.761							
9858	3269888	423020	1807	6794.761	34.821	0.974295					
9859	3269889	423020	1807	6794.761							
9860	3269890	423020	1807	6794.761							
9861	3269891	423020	1807	6794.761							
9862	3269892	423020	1807	6794.761							
9863	3269893	423020	1807	6794.761	34.826	0.974292					
9864	3269894	423020	1807	6794.761			187	549	227		
9865	3269895	423020	1807	6794.761							
9866	3269896	423020	1807	6794.761							
9867	3269897	423020	1807	6794.761	34.827	0.974289					
9868	3269898	423020	1807	6794.761							
9869	3269899	423020	1807	6794.761							
9870	3269900	423020	1807	6794.761							
9871	3269901	423020	1807	6794.761							
9872	3269902	423020	1807	6794.761							
9873	3269903	423020	1807	6794.761	34.828	0.974286					
9874	3269904	423020	1807	6794.761			187	521	225		
9875	3269905	423020	1807	6794.761							
9876	3269906	423020	1807	6794.761							
9877	3269907	423020	1807	6794.761							
9878	3269908	423020	1807	6794.761	34.838	0.974284					
9879	3269909	423020	1807	6794.761							
9880	3269910	423020	1807	6794.761							
9881	3269911	423020	1807	6794.761							
9882	3269912	423020	1807	6794.761							
9883	3269913	423020	1807	6794.761							
9884	3269914	423020	1807	6794.761	34.8	0.974283					
9885	3269915	423020	1807	6794.761			193	524	230		
9886	3269916	423020	1807	6794.761							

## Navis BGCi Float

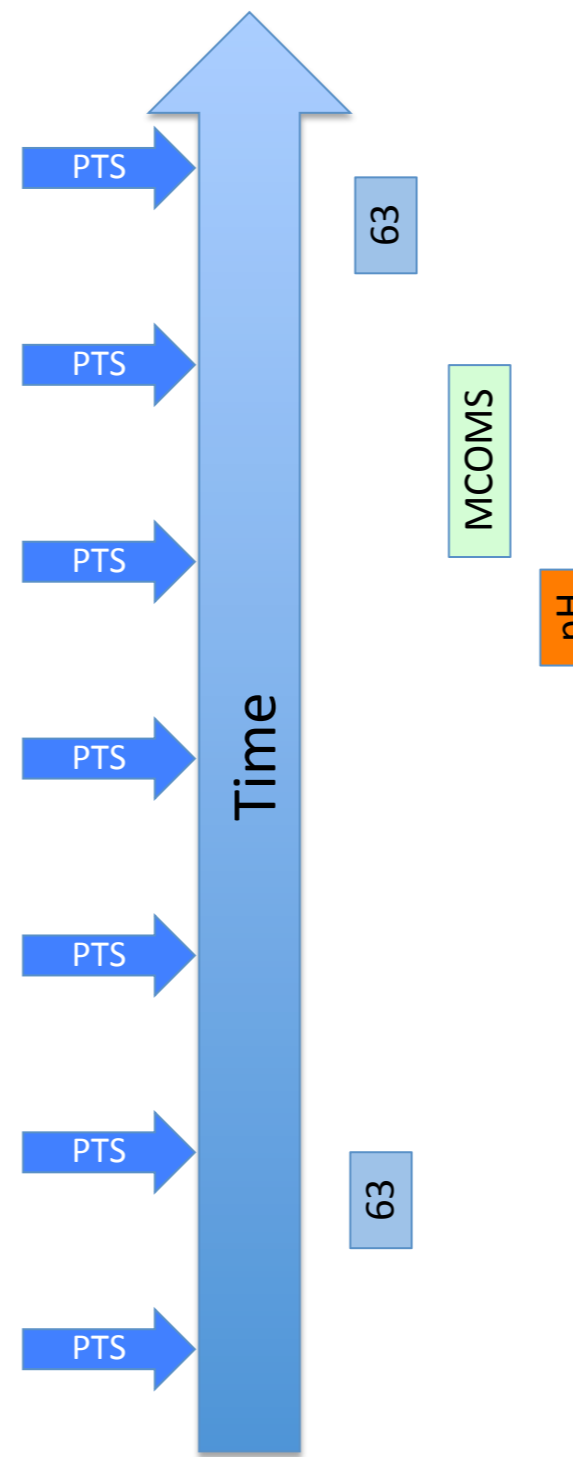
Sea-Bird Scientific has developed the Navis BGCi float as a flexible, multi-role scientific platform for autonomous biogeochemical research. The float incorporates Iridium two-way satellite communications for fast data transfer and mission adaptation. Lithium batteries are included for long deployment missions. The SBE 41N CTD measures conductivity, temperature, and pressure (depth). The SBE 63 Optical Dissolved Oxygen sensor is integrated within the CTD flow path, providing optimal correlation with CTD measurements. The MCOMS has three optical sensors, providing chlorophyll a, backscattering, and CDOM, or chlorophyll a and 2 backscattering channels. MCOMS is integrated directly into the float end cap and co-located with DO and physical measurements. The Navis float can be expanded with additional sensors, in this case with an experimental pH sensor.

NAVIS BGCi float 0038 was an experimental float deployed off Hawaii. The float was recovered after 100 profiles and five months at sea.



NAVIS BGC float 0028 (above) after deployment in the Mediterranean Sea. The float used in this study was equipped with and MCOMS and pH sensor. Photo by Christoph Gerick.

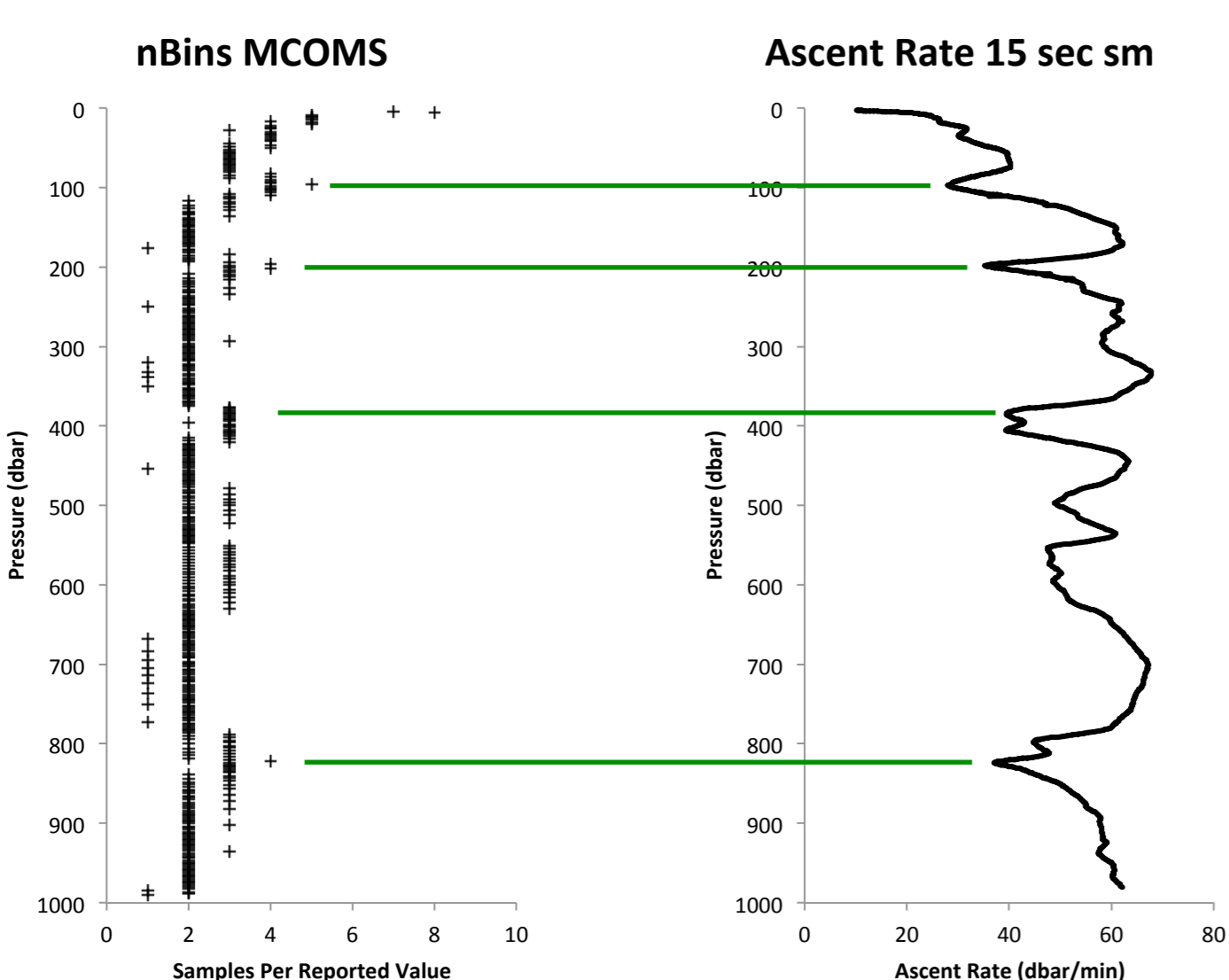
## Instrument Sequencing



Pressure, temperature and conductivity (PTS in the diagram) are measured at 1Hz while serial instruments can have independent update rates up to 1Hz and be mixed and matched, as the deployment requires. Each instrument can have its own inquiry mode: queried for a sample or free running with continuous output. In this example, the SBE 63 and pH sensors are continuously powered, queried for a value, and put to sleep between each measurement. In contrast, the MCOMS port is powered, the output is recorded, and power is removed at the desired update rate. The MCOMS operates at 1.4 kHz and internally averages packets of LED on/off cycles to remove ambient light. The MCOMS output rate is set at 1 Hz.

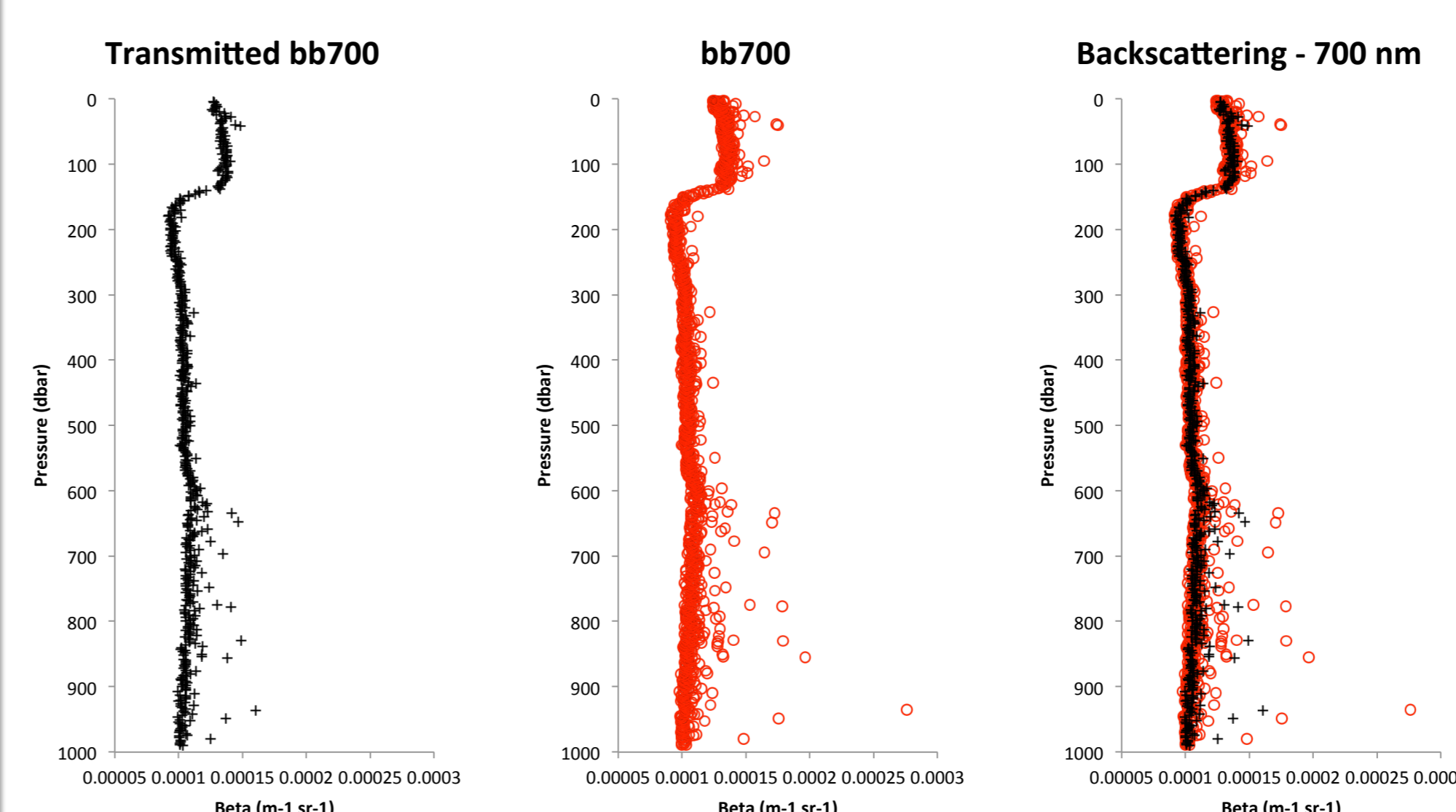
The sampling technique for each instrument can be tuned to optimize the data density for the power expended.

## Profiling Rate and Data Output



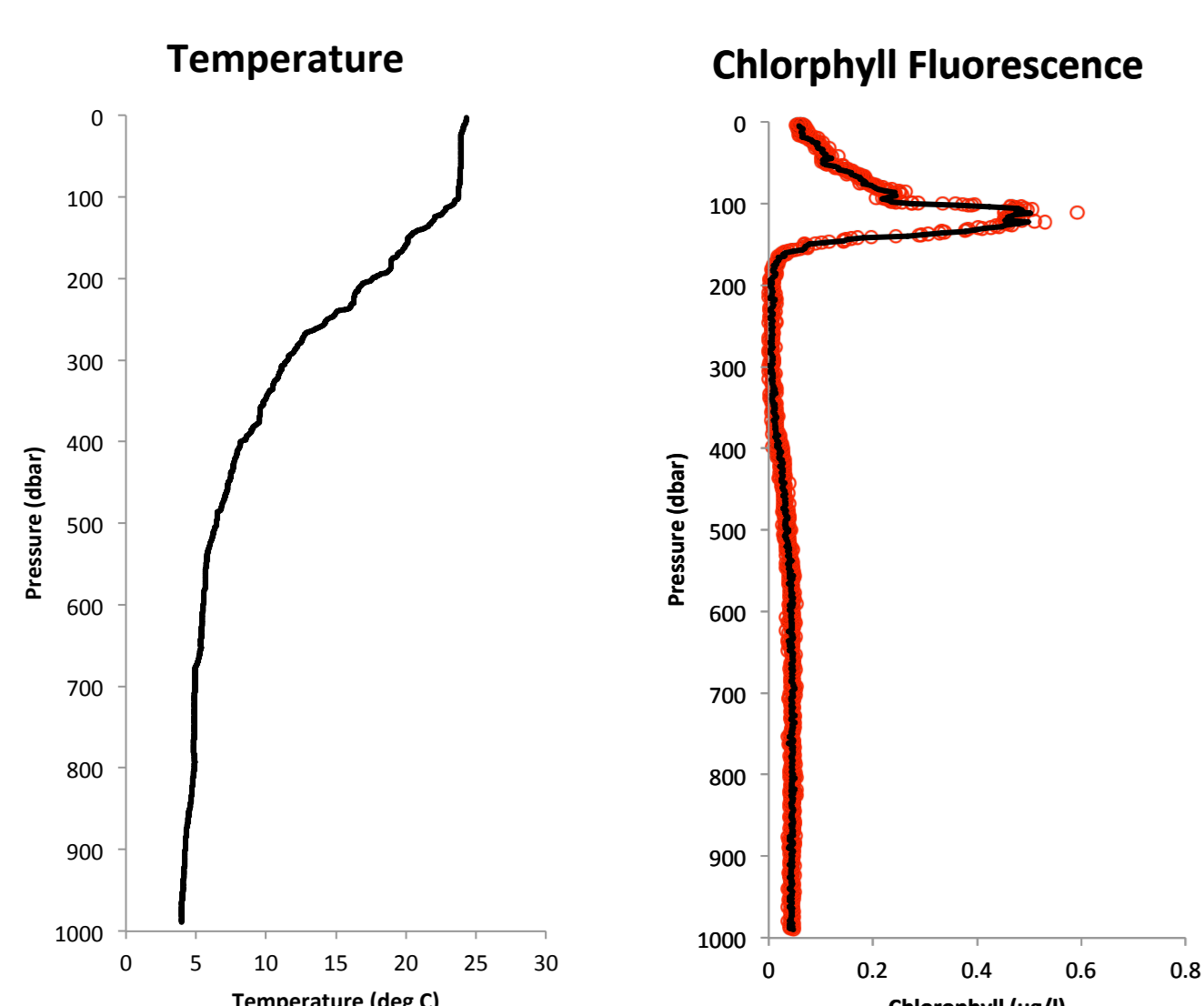
The Navis float's ascent rate modulates the number of subsamples within each individual transmitted bin. The horizontal lines connect the negative peaks in the ascent rate with the local increases in the number of subsamples per pressure bin. Since the ascent rate is a function of the density gradient, the float will collect more samples where the gradient is increasing.

## Transmitted v Recorded Data – Backscattering



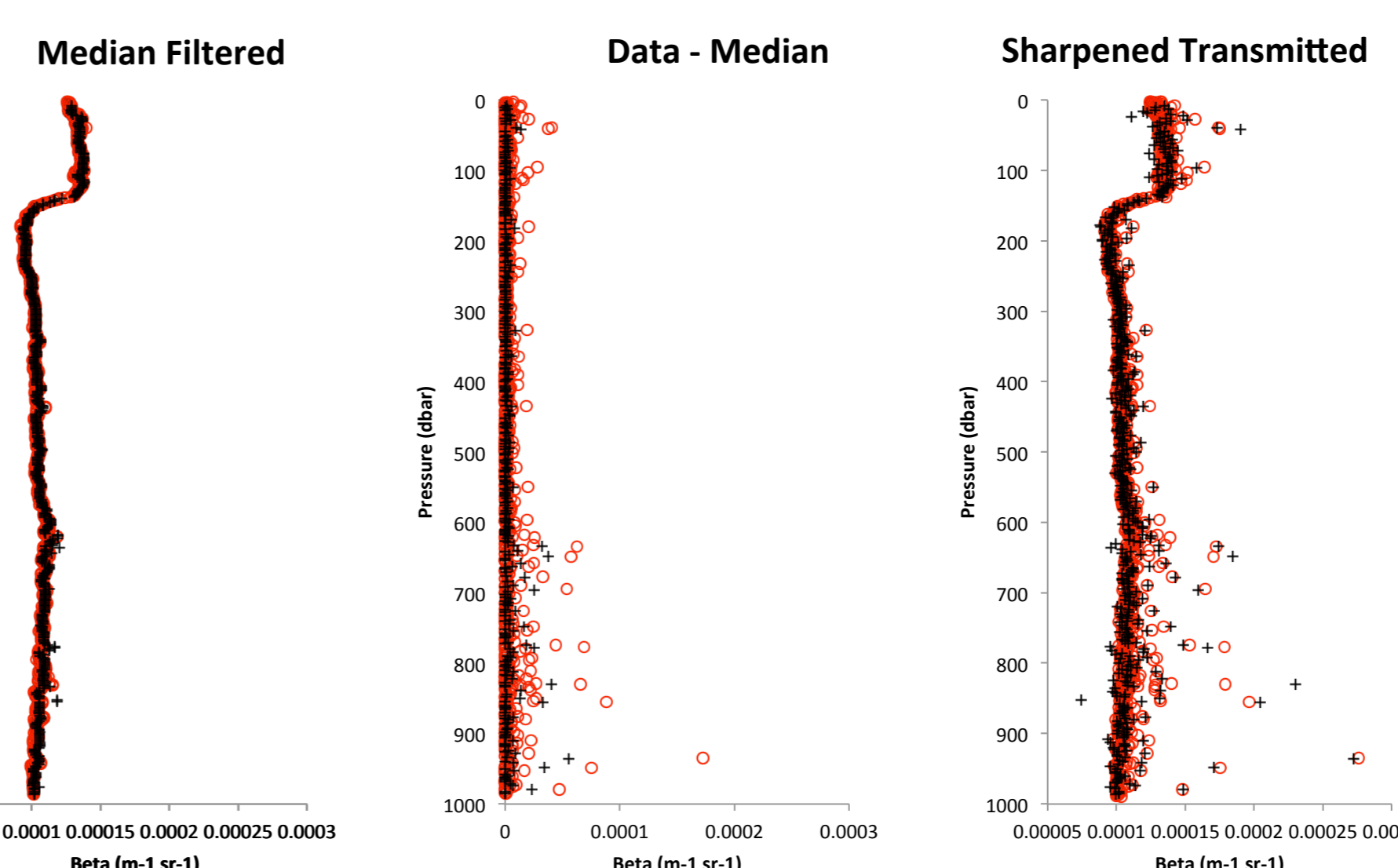
The transmitted backscattering data (far left), the recovered data (middle), and both data sets overlain (right). The recovered data demonstrates that the transmitted data smooths the variance in the recovered data. Assuming the 'spikes' represent relatively rare large particles, the transmitted data undercounts the large particles.

## Transmitted v Recorded Data – Temperature and Fluorescence



Temperature data (left panel) from both the transmitted and recorded data sets overlain in the left panel demonstrates no effective difference between the two data sets.

Chlorophyll data (right panel) from both data sets demonstrates no effective difference except for at the chlorophyll maxima. Transmitted data is the red circles.



Applying a running median filter to both data sets (far left) generates coherence between both profiles. The residual data, assumed to be the large particles, again shows the undercounting in the transmitted data (middle). Using a sharpening algorithm (right), much of the recovered data can be generated from the transmitted data.