Care and Feeding of Sea-Bird Sensors on Arvor/Provor Floats

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Outline

- Sea-Bird Sensors available on Provor floats
  - SBE 41cp CTD
  - SBE 61 CTD
  - Rem-A: Fluorometer, Backscatter, FDOM and Downwelling Irradiance
  - SUNA Nitrogen Sensor
  - Float pH
- Calibration and Data
- Best practices for deployment for each sensor

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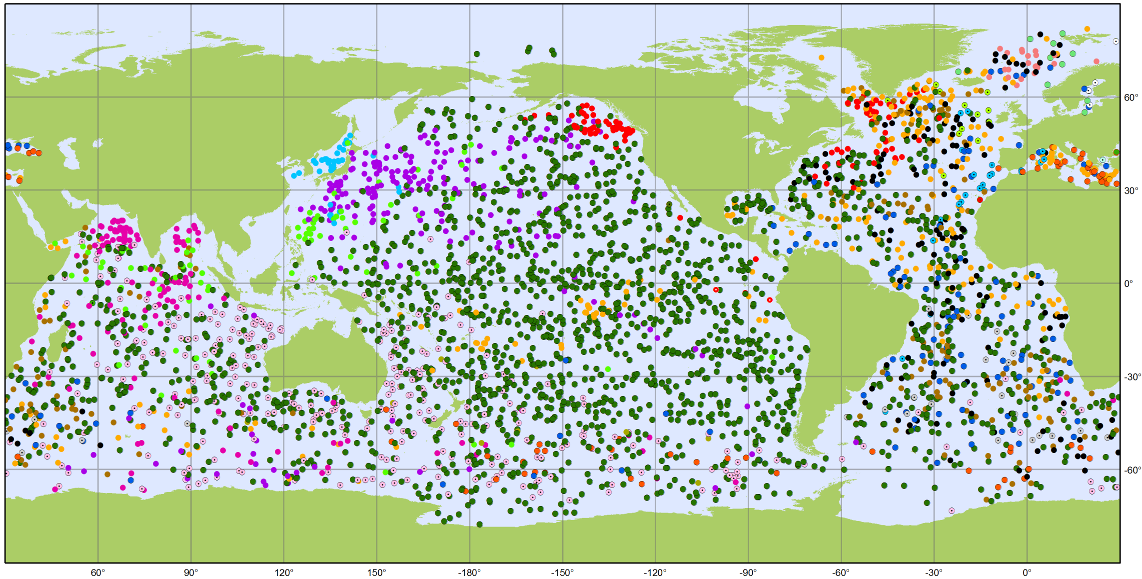
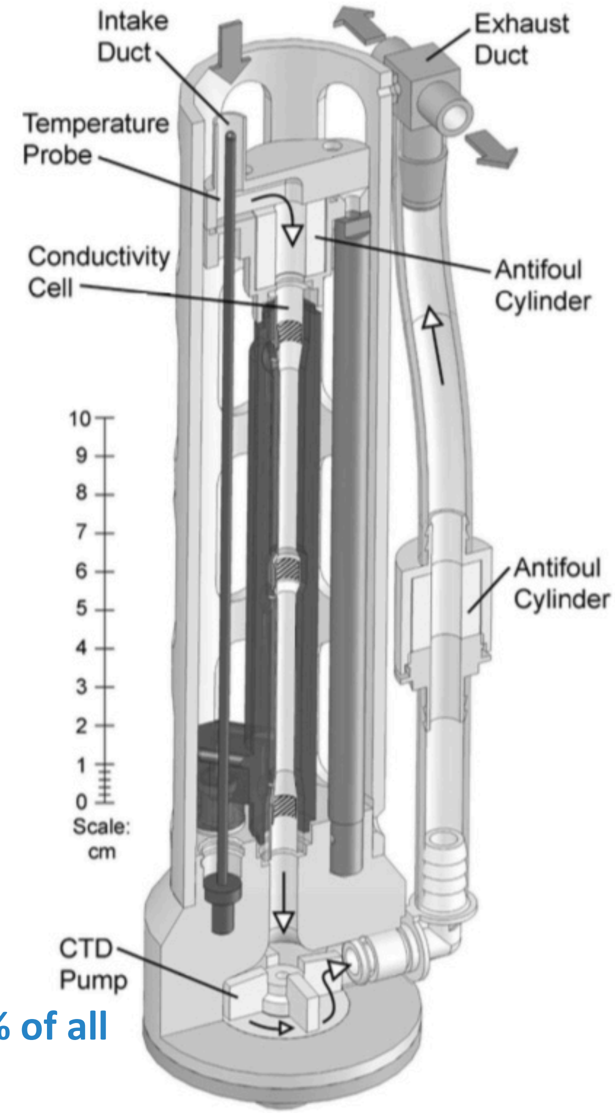
Core Argo: SBE 41cp CTD



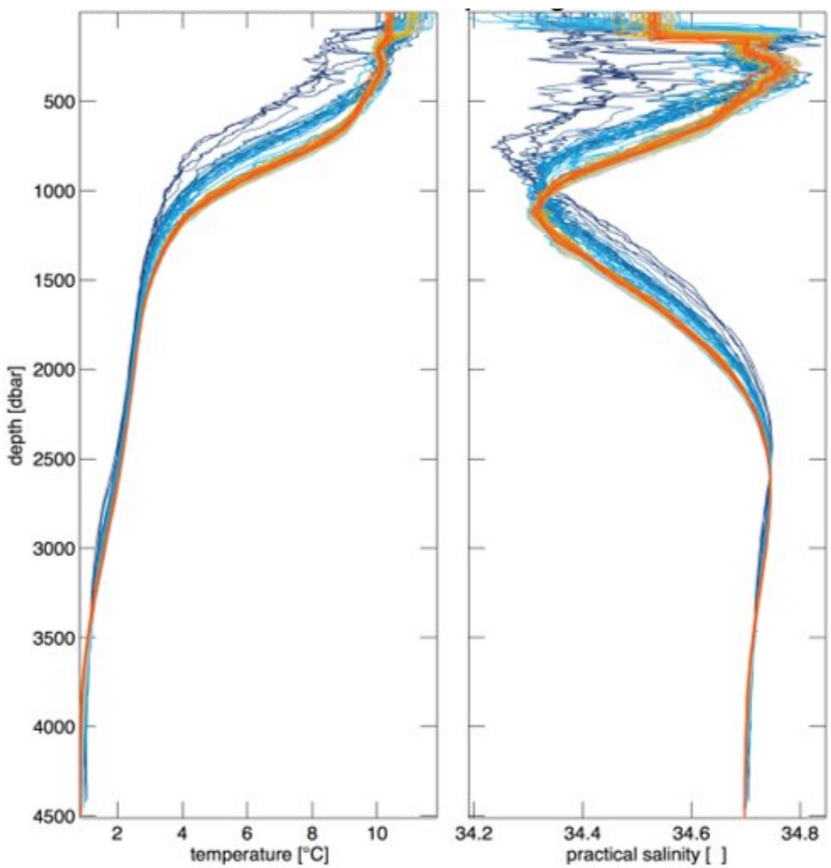
SBE 41cp Specifications	
Conductivity Accuracy	±0.0003 S/m (±0.0035 PSU)
Conductivity Typical Stability	0.0003 S/m per month (0.0011 PSU per year)
Pressure Initial Accuracy	±2 dbar / 2000 dbar
Pressure Typical Stability	0.8 dbar per year
Temperature Initial Accuracy	±0.002 °C
Temperature Typical Stability	0.0002 °C per year

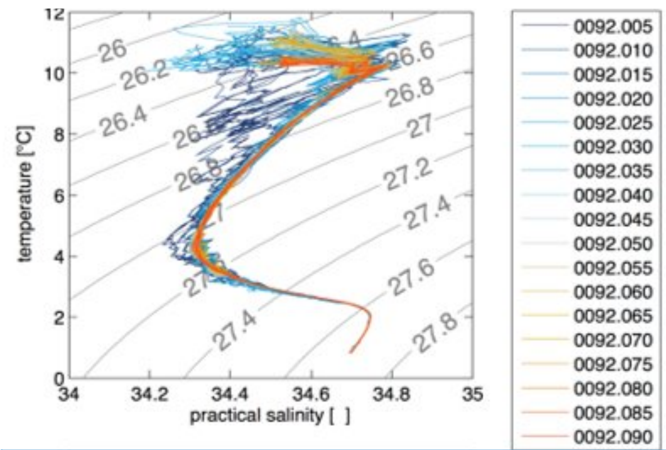
As of Jan 2020: deployed on 99.9% of all operational floats



[Johnson et al. 2007]

Deep Argo: SBE 41cp and SBE 61





SBE 61 Specifications

Conductivity Accuracy	±0.0002 S/m
Conductivity Typical Stability	0.002 S/m over 10 years
Pressure Initial Accuracy	±4.5 dbar / 7000 dbar
Pressure Typical Stability	0.8 dbar per year
Temperature Initial Accuracy	±0.001 °C
Temperature Typical Stability	0.0002 °C per year

Deep Argo: SBE 41 versus SBE 61

- SBE 41 "Deep"
  - Same CTD as SBE 41 except 7000 dbar Kistler pressure sensor
  - Same calibration as SBE 41
    - Four to five temperature and conductivity calibrations over 2-3 week period
    - Pressure sensitivity to temperature calibrated over oceanographic range
    - Pressure calibrated at room temperature

- SBE 61 Deep Argo CTD
  - Best circuit components in conductivity sensor
  - Pressure sensor calibrated at four temperatures across oceanographic range
  - Temperature and conductivity typically calibrated 15 – 20 times over 6 months to measure drift
  - Continued development effort via NOPP to improve pressure accuracy and conductivity drift

Pre-Deployment Checks: CTDs

- Verify the CTD serial number

- Verify the calibration coefficients match the most recent calibration sheet shipped with the float

- Take a sample in air

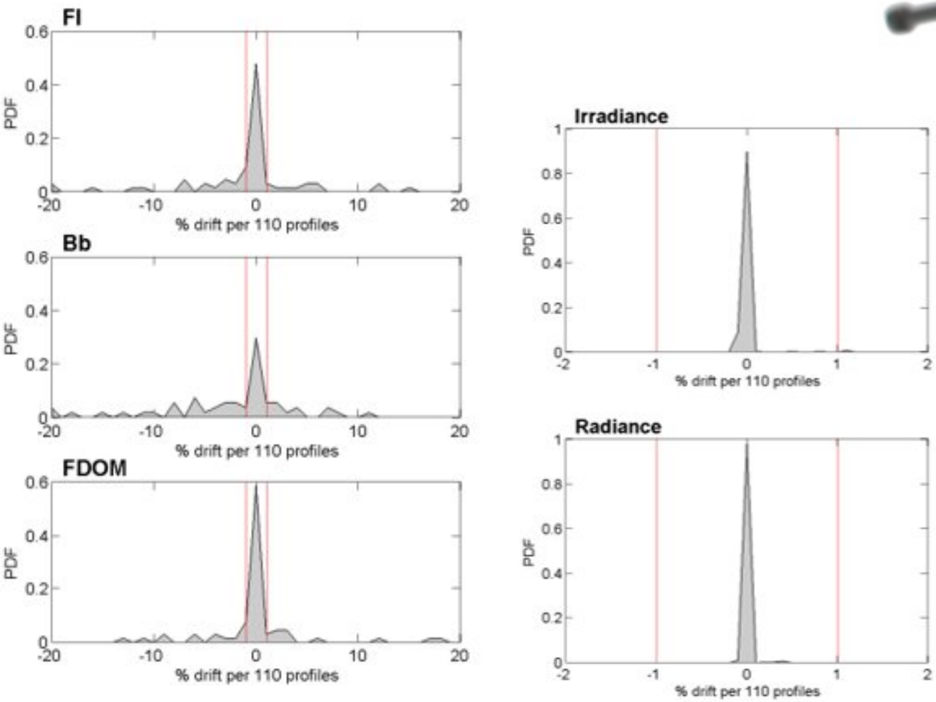
  Pressure should read 0.0 ± 0.5 dbar
  Temperature should be close to room temperature (15-20 °C)
  Salinity should be 0.0PSU

- Groups at the University of Washington and NOAA PMEL have developed methods for pre-deployment salinity checks. These have been valuable in identifying fouling that may occur, but can be a challenge to set up properly. We can provide guidance for this.

Fluorescence, Backscatter, FDOM and Downwelling Irradiance

- Rem-A is a bio-optical sensor system with 7 channels

- Field data shows low drift



Pre-Deployment Checks: Fluorescence, FDOM, Backscatter

- Upon receipt, remove the cover. Check the glass optical faces for scratches.
- Take care not to touch the optical faces with your fingers as it can leave residue that will degrade the instrument.
- If dirty, clean the glass with deionized water and a clean, lint-free cloth, gently wiping from the center outward.
- Some groups have used Leica Lint-Free Glass wipes. But ingredients have not been verified.

- Take in-air samples
  - For fluorescence, backscatter and FDOM when uncovered voltage values should be close to the dark counts on the sheet
  - To test functionality, cover the optical face with a clean sheet of paper. If functioning correctly, the signal should increase.

Pre-deployment Checks: Downwelling Irradiance

- Check glass faces for scratches.
- Take care not to touch the optical faces with your fingers as it can leave residue that will degrade the instrument.
- If dirty, clean the glass with deionized water and a clean lint-free cloth, gently wiping from the center outwards.
- To check for functionality, cover the sensor with a dark piece of paper and execute a measurement. Then saturate the sensor by shining an incandescent light at the sensor face and execute a measurement.
- An incandescent light must be used to test for functionality. Many LED lights don't emit light in the spectral band sensed by the OCR.

Deep SUNA Ocean Nitrate Sensor

- Based on the MBARI-ISUS sensor, redesigned for use on floats.
- Detects nitrate based on absorption spectrum in the UV range
- Calibrated for seawater
- Onboard temperature and salinity correction to remove bromide component.

Deep SUNA Specifications	
Limit of Detection	0.5 µM (SW with T/S correction processing)
Range of Detection	3000 µM
Accuracy (greater of)	±2 µM (±0.028 mg/L -N) or ±10% of reading
Precision (short term)	0.3 µM (SW with T/S correction processing)
Drift (per hour lamp time)	0.3 µM (SW with T/S correction processing)
Pathlength	0.0002 °C per year
Wavelength Range	190-370 nm

Pre-Deployment Checks: SUNA Nitrate

- SUNA is a nitrate sensor with an identical software interface to ISUS. Anywhere where ISUS is mentioned, please read as SUNA.

- These checks and the reference update (next slide) can be performed without removing the SUNA from the float.

- Check the optical surfaces for any smears or smudges. Clean as optics above.

- Get an in-air sample for SUNA

  In free air, a value of 0-2μM is typical

Pre-Deployment Setup: SUNA Reference Update

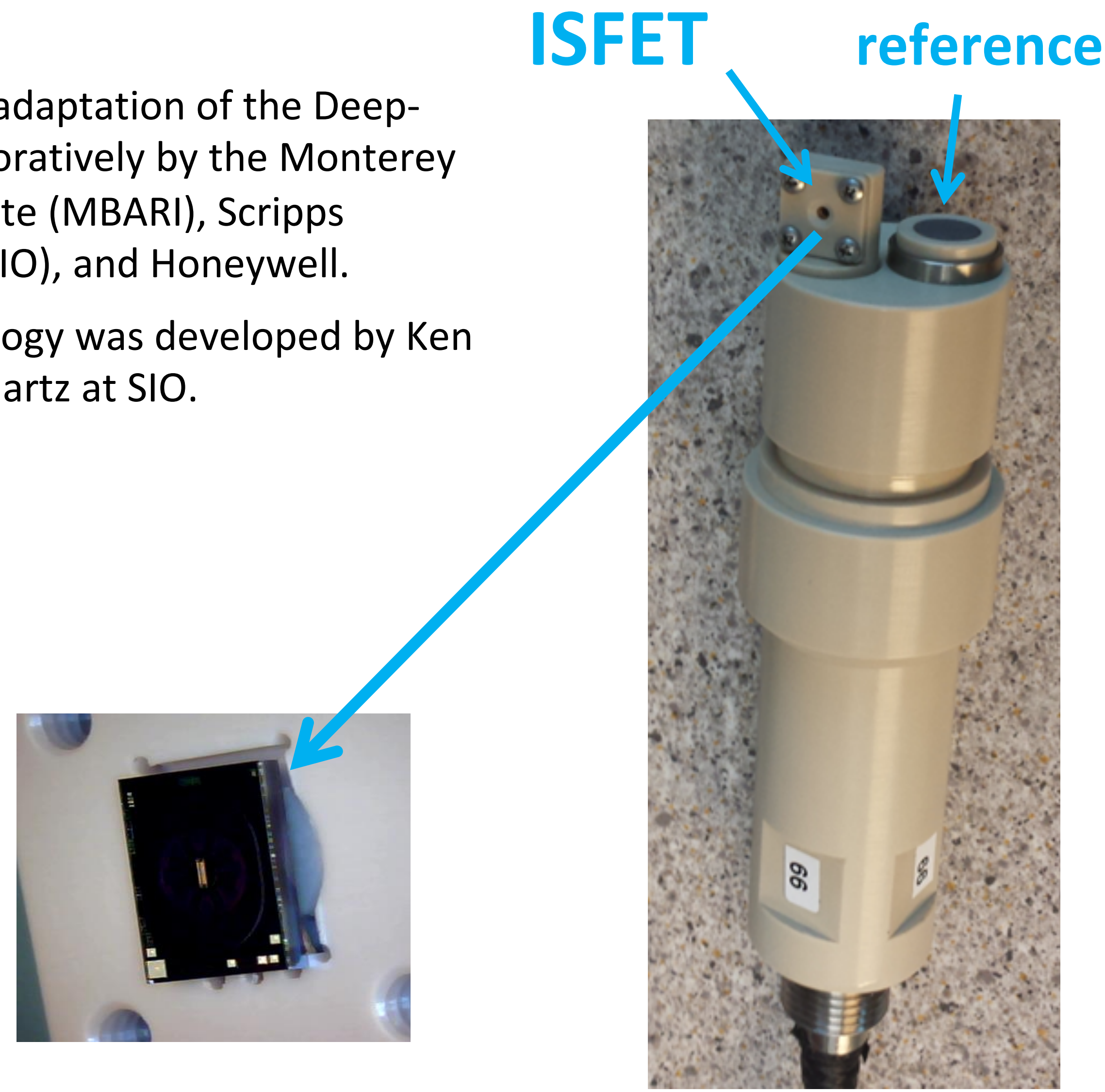
- A reference update must be made to the SUNA before deployment. This updates the reference spectra to account for any lamp drift since being calibrated at the Sea-Bird Factory.

- This can be done while the instrument is on the float, but it must be connected to an external PC running Sea-Bird UCI’s software.

- You will need: power supply, fresh DIW, lint free wipes, cotton swabs, Isopropyl alcohol

- Instructions for the reference update can be found in the manual on the Deep SUNA downloads page at www.seabird.com

Float pH



- The Float Deep SeaFET™ is an adaptation of the Deep-Sea DuraFET developed collaboratively by the Monterey Bay Aquarium Research Institute (MBARI), Scripps Institution of Oceanography (SIO), and Honeywell.
- The Deep Sea DuraFET technology was developed by Ken Johnson at MBARI and Todd Martz at SIO.
- 2000 m depth rating

Float pH Specifications	
Accuracy	± 0.05 pH
Typical Stability	0.0036 pH per year

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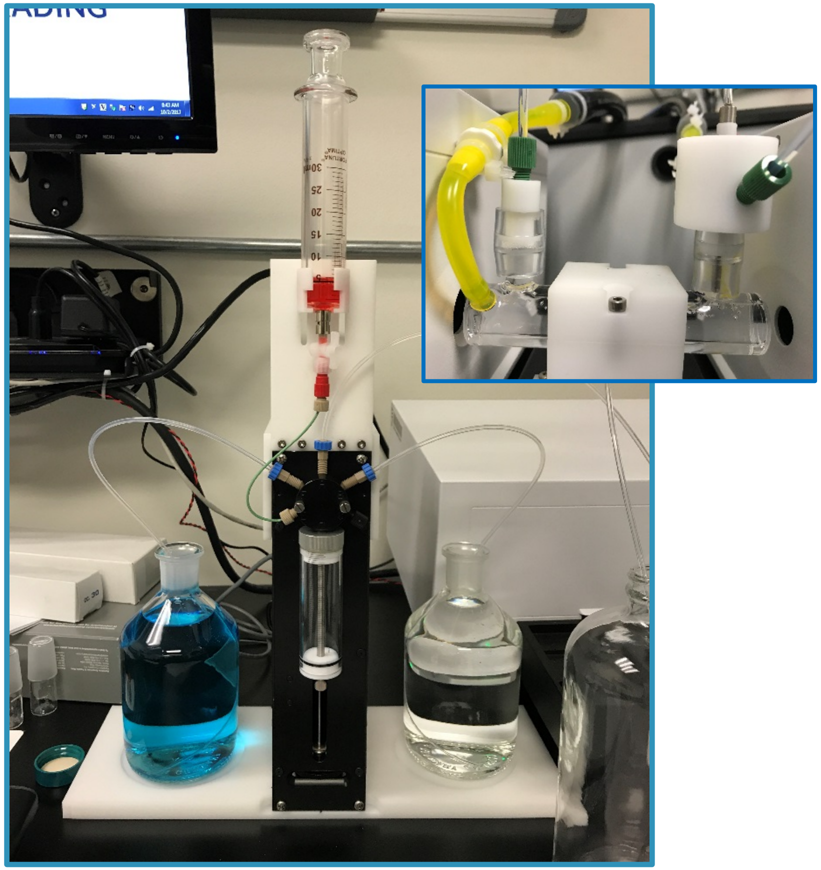
Float pH: Calibration Standard

- The primary standard for ocean pH is buffered seawater measured spectrophotometrically with purified m-cresol dye at 25C.
- Standard seawater is prepared at Andrew Dickson's laboratory
- Measurement method was developed by Andrew Dickson as well. Results of a lab comparison are shown below

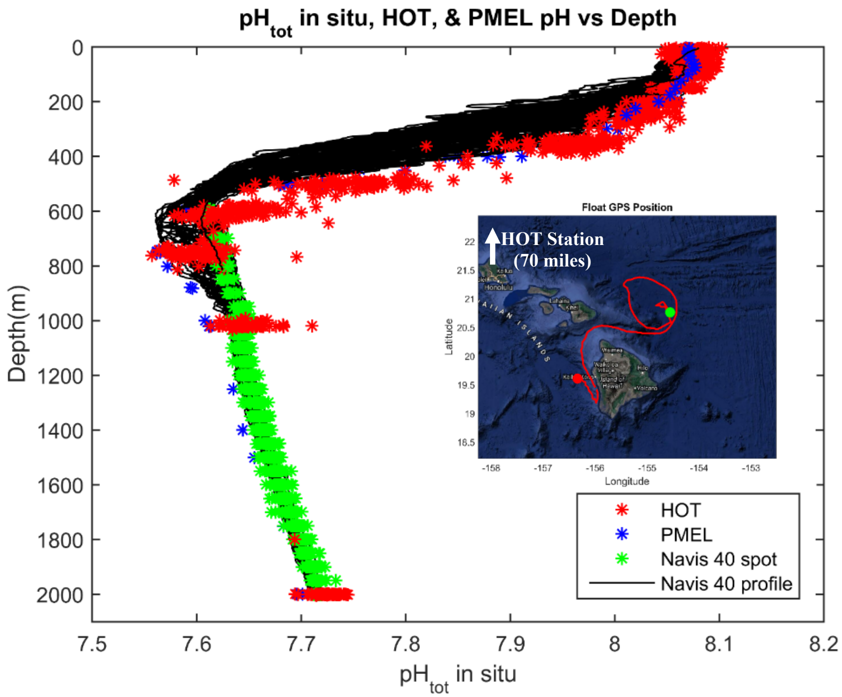
	Scripps Measured pH	Sea-bird Measured pH	Sea-Bird pH - Scripps pH
	Total Scale, 25C	Total Scale, 25C	Total Scale, 25C
Batch 162	7.910	7.9031	**-0.007**
Std Dev	**0.0005**	**0.0018**	
Batch 164	7.5407	7.5463	**0.0056**
Std Dev	**0.001**	**0.00085**	

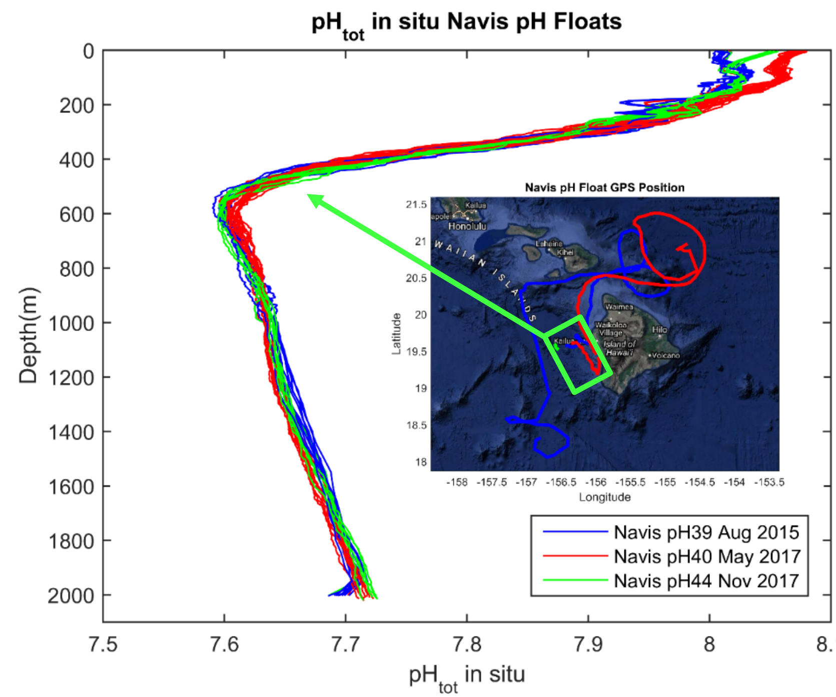
Precision <0.0015 pH **Accuracy <0.006 pH**

Automated Spectrophotometry System (adapted from Dickson Lab)



Float pH: Comparison to Hawaii Ocean Time Series

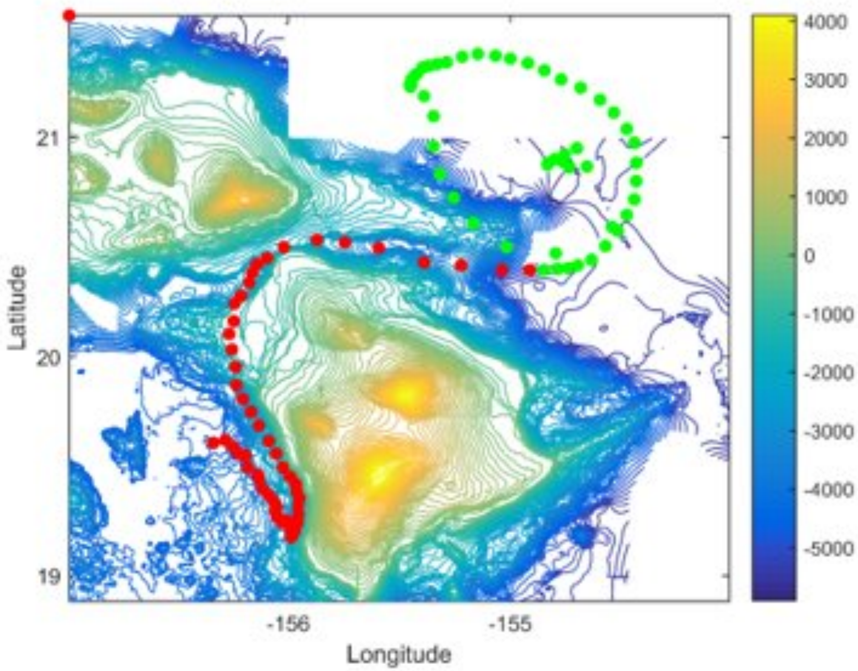


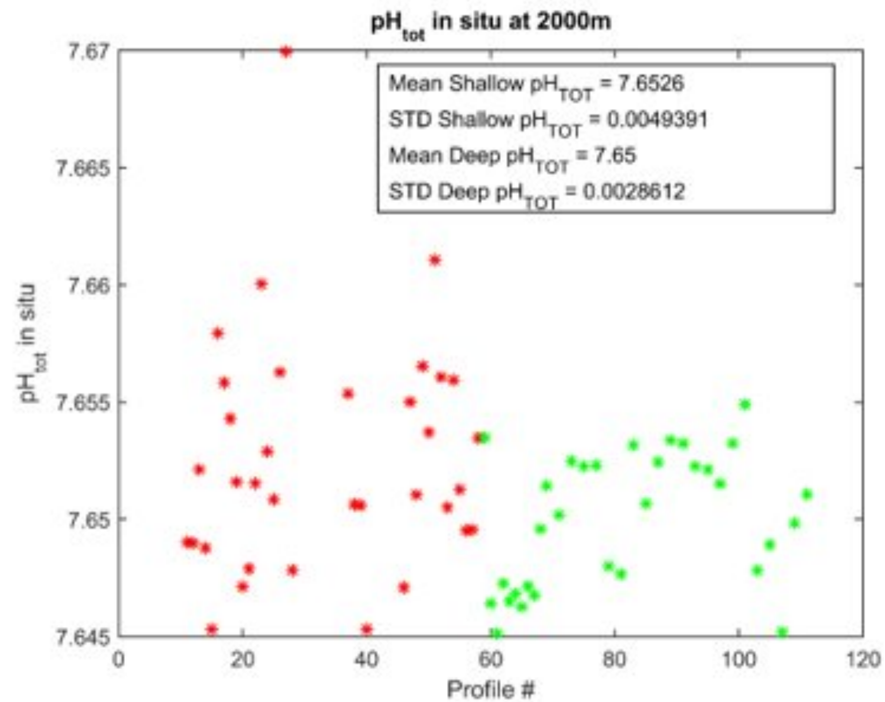


Comparison of Argo float pH measurements to historic HOT site pH measurements

Three Argo floats deployed in same area show reproducibility in pH measurement

Ongoing Navis Development





- The pH at 2000m can be used to assess sensor drift, pH is constant
- **The stability of the pH sensor is less then 0.005 pH over a 9 month deployment.**
- pH shifts as float moves offshore into deep ocean

Pre-Deployment Checks: Float pH

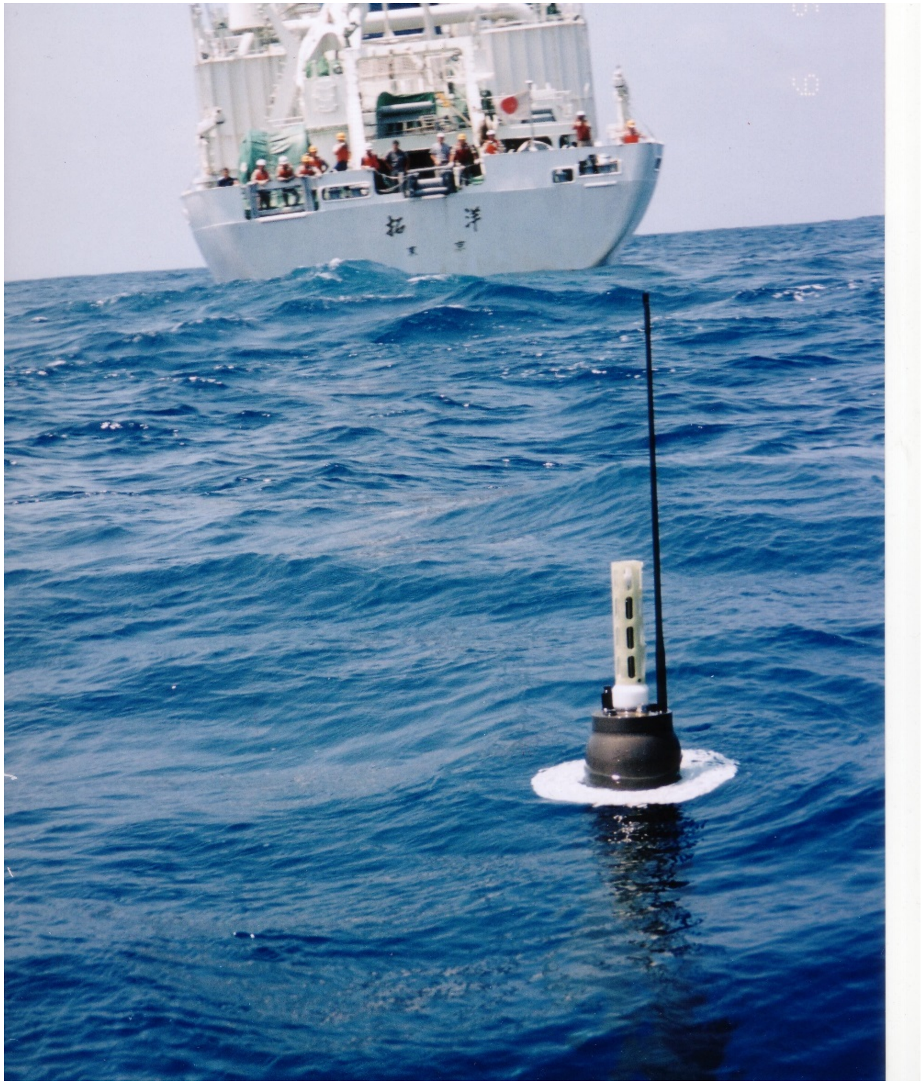
- This is a very delicate instrument that must only come in contact with ***filtered and UV sterilized natural seawater only*** – nothing else. If this is not obtainable by the user's lab, then the pH sensor must be taken out of the CTD loop before cleaning of the conductivity cell with deionized water.

- To get the best results from the pH sensor, it is suggested to fill the CTD tubing with filtered and natural seawater while in the laboratory. Preferably this seawater was taken from an area near to where the float will be deployed.

- Take a sample with the pH sensor in seawater

  -0.8 to -0.95 expected for V_{rs} and V_k , less than -1e-7 for I_b and I_k

Questions



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