NOAA Pacific Marine Environmental Laboratory
Ocean Climate Stations Project

DATA ACQUISITION AND PROCESSING REPORT FOR PA001

Site Name:	Ocean Station Papa
Deployment Number:	**PA001**
Year Established:	2007
Nominal Location:	50°N 145°W
Anchor Position:	50.12°N 144.84°W
Deployment Date:	June 7, 2007
Recovery Date:	June 10, 2008
Project P.I.:	Dr. Meghan F. Cronin
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Date of Report:	August 4, 2017
Revision History:	June 30, 2017

Special Notes:

This mooring was established through support from the US NSF and NOAA, and in collaboration with the Canadian Department of Fisheries and Oceans (DFO) Line P Program.

Table of Contents

List of Tables

List of Figures

Data Acquisition and Processing Report for OCS Mooring PA001

1.0 Mooring Summary

The NOAA Ocean Climate Stations surface mooring at Ocean Station Papa was initiated through a National Science Foundation Carbon and Water in the Earth System project "North Pacific Carbon Cycle" to Dr. S. Emerson (UW). NOAA in-kind support was provided through the Office of Ocean and Atmospheric Research. The mooring deployment and servicing occurred in collaboration with the Fisheries and Oceans Canada, Pacific Region, Line-P Program aboard the CCGS JOHN P. TULLY. OCS is thankful for the generous ship time provided by Fisheries and Oceans Canada, as part of a cruise headed by the Institute of Ocean Sciences (IOS). The captain, crew, and scientists aboard are also gratefully acknowledged for their contributions.

The PA001 mooring was deployed in June 2007 at Ocean Station Papa to monitor ocean-atmosphere interactions, carbon uptake, and ocean acidification. PA001 was the first NOAA OCS deployment at this site. It was originally intended to be a 9-month mooring (deployed June 2007 and recovered February 2008) since the pH sensor was known to perform poorly past that period. Due to weather, however, no mooring operations could be completed on the February 2008 cruise. A second turnaround cruise was successfully completed in June 2008. Since then, OCS has maintained a 1-year turnaround schedule on the Line-P June cruises.

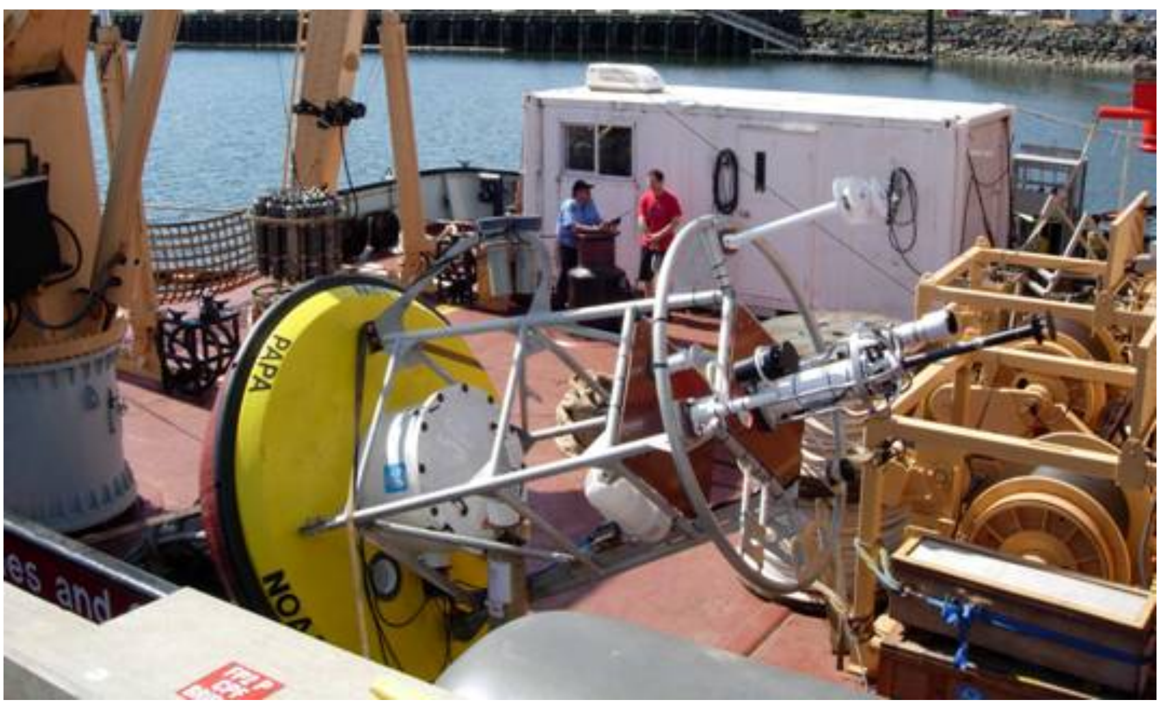

Figure 1: PA001 mooring prior to deployment.

A separate subsurface ADCP mooring was anchored 7.7km from the PA001 anchor. The map below shows the mooring locations, and additional details on the subsurface mooring can be found in Appendix C.

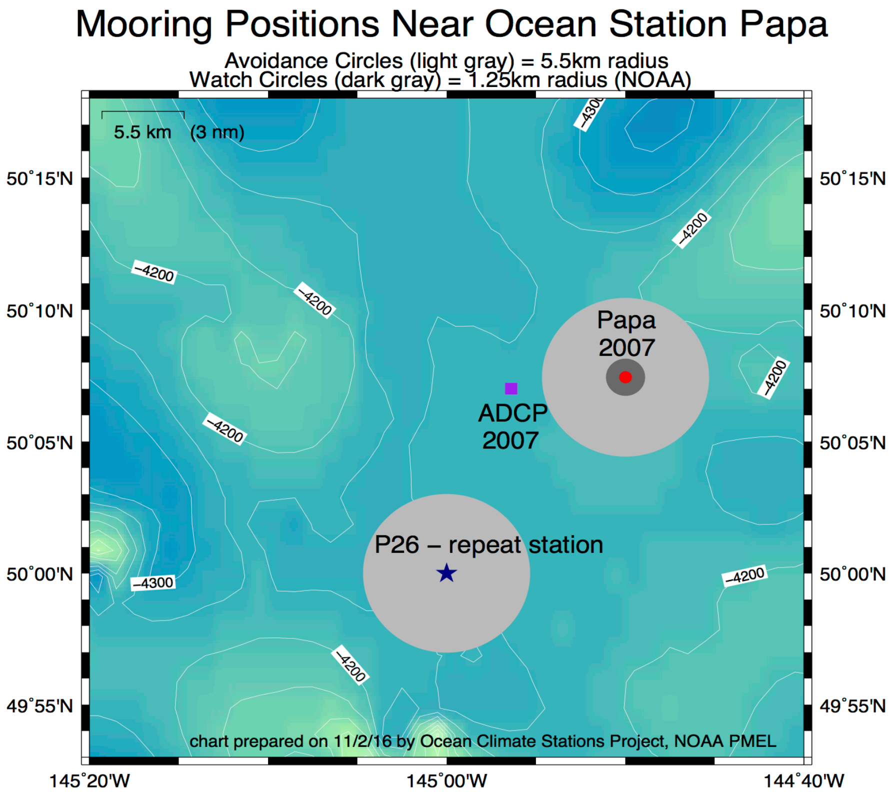

Figure 2: Mooring positions around station P26.

1.1 Mooring Description

The PA001 mooring was a taut-line mooring, with a nominal scope of 0.985. Non-rotating 7/16" (1.11cm) diameter wire rope, jacketed to 1/2" (1.27cm), was used in the upper 16.4m of the mooring line. A break in the wire, with 3/4" chain, was used to mount a CTD/GTD/O2 instrument package at 20m. This was followed by another 679m of wire rope used to mount additional subsurface instruments. The remainder of the mooring consisted of plaited 8-strand nylon line to the acoustic release in line above the anchor. The 6,850lb (3,107kg) anchor was fabricated from scrap railroad wheels.

The surface buoy was a solid-hull fiberglass-over-foam discus buoy, with a watertight center well. It had an aluminum tower and a stainless steel bridle. No load cell was deployed on PA001.

A CO_2 flux monitoring system was also deployed on the PA001 mooring, in collaboration with the PMEL Carbon Group. OCS is not responsible for the acquisition or processing of these data. No further discussion of that system is included in this report. For further information on the Papa biogeochemistry data, see http://www.pmel.noaa.gov/co2/.

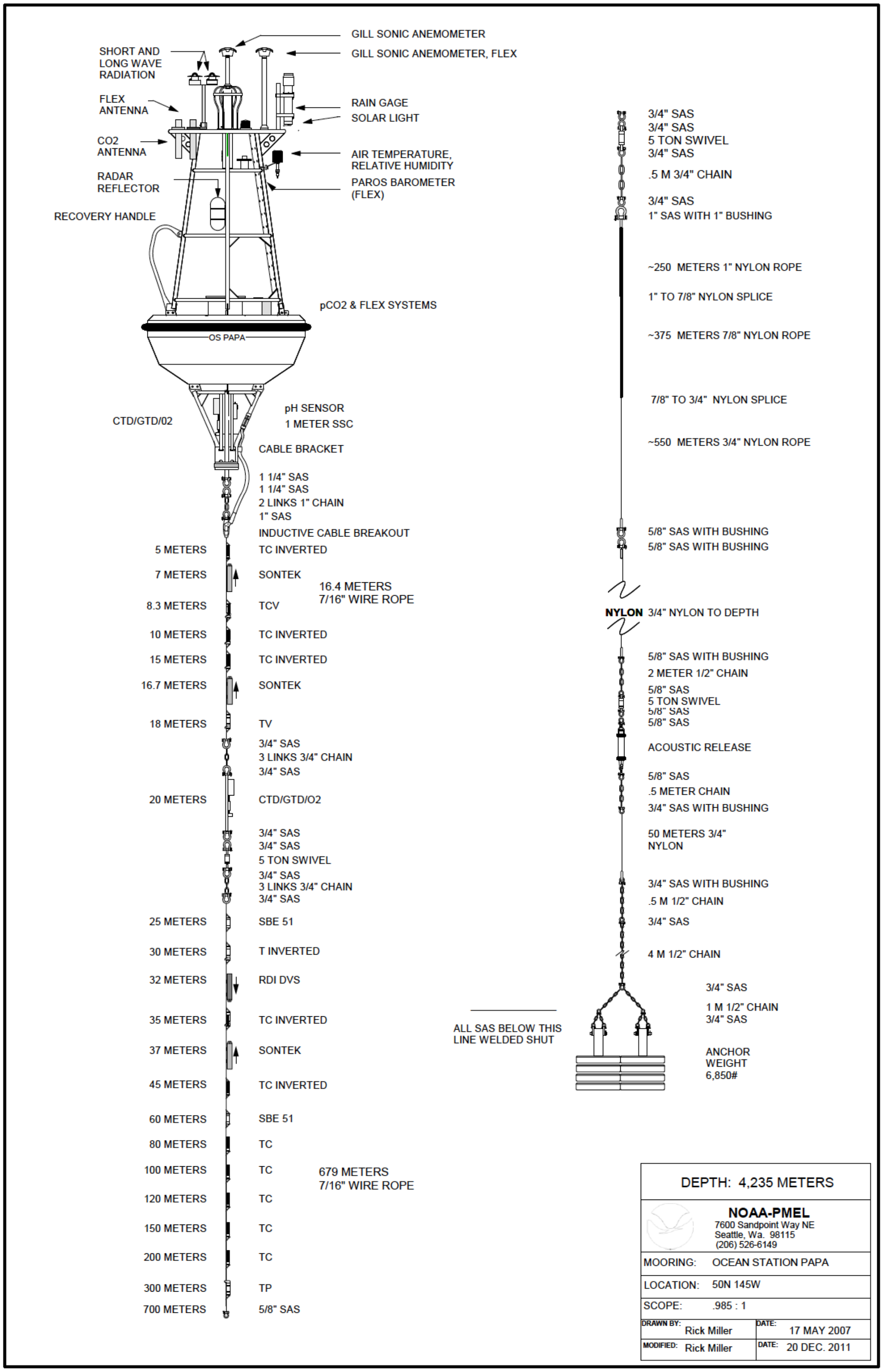

Figure 3: PA001 mooring diagram.

1.2 Instrumentation on PA001

The following instrumentation was deployed on PA001. Redundant data acquisition systems were used; ATLAS and Flex. ATLAS meteorological sensors were considered primary, except in cases where a sensor was only deployed on the Flex system (e.g. BP).

DEPLOYMENT: PA001					
Met Sensors				**Serial #**	**Notes**
Height	Acquisition		**ATLAS**	685	w/ C100 compass
2.6m	ATRH		Rotronics MP101	59287	
3.6m	Rain		RM Young/50203	882	
3.6m	SWR		Epply PSP	31649	
3.6m	LWR		Epply PIR	33346	
4.2m	Wind		Gill Windsonic	51415	
	Acquisition		**Flex**	0001	
3.7m	Wind		Gill Windsonic	52263	
2.6m	BP		Paroscientific/MET1-2	99453	
CO2	Electronics		PMEL	0017	
	Span gas			JA02402	419.61 ppm CO2
Subsurface					
Bridle					
1m	SSC		ATLAS SSTC Module	14128	
1m	pH		SAMI (UW)	56	
1m	CTD/GTD/O2		SBE16+ (UW)	5105	
Depth					
5m	TC		ATLAS TC Module	11162	Inverted
7m	Current mtr		Sontek Argonaut	521	
8.3m	TCV		ATLAS TCV Module	12986	
10m	TC		ATLAS TC Module	11167	Inverted
15m	TC		ATLAS TC Module	11168	Inverted, knocked out of mount
16.7m	Current mtr		Sontek Argonaut	554	Top clamp broken on dep.
18m	TV		ATLAS TV Module	12604	Last inductive sensor on wire
20m	CTD/GTD/O2		SBE16+	5106	(UW)
25m	TC		Seabird SBE-51TC	0004	
30m	T		ATLAS T Module	12632	Inverted
32m	Current mtr		RDI DVS	0014	Downward, ended early
35m	TC		ATLAS TC Module	11571	Inverted
37m	Current mtr		Sontek Argonaut	571	Upward
45m	TC		ATLAS TC Module	11608	Inverted
60m	TC		Seabird SBE-51TC	0005	
80m	TC		ATLAS TC Module	14086	
100m	TC		ATLAS TC Module	14087	
120m	TC		ATLAS TC Module	14306	
150m	TC		ATLAS TC Module	14333	
200m	TC		ATLAS TC Module	14334	
300m	TP		ATLAS TP Module	14166	

Table 1: Instruments deployed on PA001.

2.0 Data Acquisition

Two independent data acquisition systems were deployed on PA001. The ATLAS data acquisition system transmits daily average and intermittent spot meteorological measurements to shore through Service Argos satellites. The Flex system uses Iridium satellite communications to transmit hourly data. For PA001, ATLAS was connected to the subsurface instruments (above 18m) using an inductive line. High resolution surface data from the acquisition systems, as well as internally logged data from the subsurface instruments, were downloaded upon recovery of the mooring.

The ATLAS system does not acquire or store position information, but buoy positions are provided by the Service Argos satellites. When four or more satellites are in the buoy's field of view during data transmissions, the satellites assess the Doppler shift of the known transmission frequency to generate estimates of latitude and longitude. These opportunistic position estimates are then appended to the data transmissions.

More accurate Global Positioning System (GPS) data were also acquired and telemetered to shore, via two Iridium Positioning beacon Systems (IPS) on the buoy. GPS/IPS positions were recorded by the Flex system at approximately six-hour intervals.

2.1 Sampling Specifications

The tables below describe the high-resolution sampling schemes for the PA001 mooring. Observation times in data files are assigned to the center of the averaging interval.

PRIMARY SENSORS

Measurement	Sample Rate	Sample Period	Sample Times	Recorded Resolution	Acquisition System
Wind Speed/Direction	2 Hz	2 min	2359-0001, 0009-0011…	10 min	ATLAS
Air Temperature/ Relative Humidity	2 Hz	2 min	2359-0001, 0009-0011…	10 min	ATLAS
Barometric Pressure	1 Hz	2 min	2359-0001, 0009-0011…	10 min	Flex
Rain Rate	1 Hz	1 min	0000-0001, 0001-0002…	1 min	ATLAS
Shortwave Radiation	1 Hz	2 min	2359-0001, 0001-0003…	2 min	ATLAS
Longwave Radiation (Thermopile, Case & Dome Temperatures)	1 Hz	2 min	2359-0001, 0001-0003…	2 min	ATLAS
Seawater Temperature, Pressure & Conductivity	1 per 10 min	Instant.	0000, 0010,…	10 min	Internal
UW CTD (1m / 20 m)	1 per hour	Instant.	0000, 0100,…	1 hour	Internal
Ocean Currents (Point)	1 Hz	2 min	2359-0001, 0019-0021…	20 min	Internal

Table 2: Sampling parameters of primary sensors on PA001.

SECONDARY SENSORS

Measurement	Sample Rate	Sample Period	Sample Times	Recorded Resolution	Acquisition System
Wind Speed/Direction	1 Hz	2 min	2359-0001, 0009-0011…	10 min	Flex
GPS Position	1 per 6 hrs	Instant.	~0030, ~0630, …	~6 hrs	Flex

Table 3: Sampling parameters of secondary sensors on PA001.

2.2 Primary Data Returns

```
ATLAS Tube 685, software version 4.10:
        Wind    51415   96.7%
        AirT    59287   96.7%
          RH    59287   61.2%
         SWR    31649   96.7%
        Rain      882   95.4%
         LWR    33346   96.7%  65 flags
   (Flex) BP    99453   69.7% (from raw flash data)


Modules:
          1m   SSC     #14128  100%  t, 99.2% c
          1m  SBE16+   #5105   74.0% t, 74.0% c
          5m   TC      #11162  46.3% t, 46.3% c  battery died
          8m   TCV     #12986  100%  t, 99.9% c
         10m   TC      #11167  100%  t&c
         15m   TC      #11168  0%   lost
         18m   TV      #12604  0%   flooded beyond repair
         20m  SBE16+   #5106   91.9% t, 91.9% c
         30m    T      #12632  100%
         35m   TC      #11571  100%  t&c
         45m   TC      #11608  100%  t&c
         80m   TC      #14086  100%  t&c
        100m   TC      #14087  100%  t&c
        120m   TC      #14306  100%  t&c
        150m   TC      #14333  100%  t&c
        200m   TC      #14334  100%  t&c
        300m   TP      #14166  100%  t&p
```

2.3 Known Sensor Issues

On January 17, 2008 [017], the RH data became intermittent, reporting values that were increasingly out of bounds. Data measured >100% was not reported by the sensor (1E+34, equivalent to Q5). Water damage was found under the filter cap when the sensor was recovered.

The rain gauge failed on September 28, 2007 [271]. The instrument reported 0 accumulation and indicated a high % time raining. Rain data were flagged as bad after this date.

Although real-time data from the 7m Sontek (measuring at 5m depth) was flagged 1E+35 May 17, 2008 [138], the full delayed mode record was recovered, and standard quality flags of Q2 were assigned.

A DVS deployed at 32m failed on September 28, 2007 [271], less than 1/3rd of the way through the deployment. Battery failure is suspected, as they were dead upon recovery.

The 5m module stopped sending real-time data due to a dead battery, but the delayed-mode data were salvaged up until its failure. The 15m module was missing upon recovery, so no high-resolution data were available.

The TV module at 18m was found flooded upon recovery. Real-time data from the TV module ended on June 9, 2007 [160], shortly after the deployment. No high-resolution data were available. The TV cable to the 17m Sontek was found to have parted, and the Sontek was missing.

The ATLAS data acquisition system dropped into a “failsafe” mode as its logic battery was failing and stopped storing data to memory on May 29, 2008 [150], just days before recovery. The last transmitted diagnostic indicated the logic and transmit batteries, were down to 5.7 and 8.8 volts, respectively. No high-resolution primary meteorological data were recorded after May 29th, explaining the maximum surface data returns of 96.7%.

The Flex data acquisition system failed on March 8th, 2008 [068], due to a dead battery. The final telemetered diagnostic showed that the battery had dropped to 7.5 volts. The Flex system controlled the primary barometric pressure sensor and the secondary wind sensor, so data from both instruments ended at the time the battery failed.

Additional damage was found after recovery on June 10, 2008 [162]. The radiation sensor shields were slightly bent, and the rubber bumper was partially torn off the buoy hull. The SBE51 TC instruments at 25m and 60m were unresponsive. The instruments were sent to SBE, but there are no indications that any high-resolution data were recovered. Since these instruments were below the inductive portion of the wire, no real-time data were captured either.

3.0 Data Processing

Processing of data from OCS moorings is contracted to the PMEL Tropical Atmosphere Ocean (TAO) project group. Data processing follows the methods described below. The process included assignment of quality flags for each observation, which are described in Appendix A. Any issues or deviations from standard methods are noted in processing logs, and in this report.

Raw data recovered from the internal memory of the data acquisition system are first processed using computer programs. Pre-deployment calibrations are applied to raw ATLAS data (recorded as sensor counts), to generate a data time series in engineering units. Instrumentation recovered in working condition is returned to PMEL for post-recovery calibration before being reused on future deployments. These post-recovery calibration coefficients are compared to the pre-deployment coefficients. If the comparison indicates a drift greater than the expected instrument accuracy, the quality flag is lowered for the measurement. If post-recovery calibrations indicate that sensor drift was within expected limits, the quality flag is raised. Post-recovery calibrations are not generally applied to the data, except for seawater salinity, or as otherwise noted in this report. Failed post-recovery calibrations are noted, along with mode of failure, and quality flags are left unchanged to indicate that pre-deployment calibrations were applied and sensor drift was not estimated.

The automated programs also search for missing data, and perform gross error checks for data that fall outside physically realistic ranges. A computer log of potential data problems is automatically generated as a result of these procedures.

Time series plots, spectral plots, and histograms are generated for all data. Plots of differences between adjacent subsurface temperature measurements are also generated. Statistics, including the mean, median, standard deviation, variance, minimum and maximum are calculated for each time series.

Individual time series and statistical summaries are examined by trained analysts. Data that have passed gross error checks, but which are unusual relative to neighboring data in the time series, or which are statistical outliers, are examined on a case-by-case basis. Mooring deployment and recovery logs are searched for corroborating information such as battery failures, vandalism, damaged sensors, or incorrect clocks. Consistency with other variables is also checked. Data points that are ultimately judged to be erroneous are flagged, and in some cases, values are replaced with “out of range” markers. For a full description of quality flags, refer to Appendix A.

For some variables, additional post-processing after recovery is required to ensure maximum quality. These variable-specific procedures are described below.

3.1 Buoy Positions

Since Papa is a taut-line mooring with a short scope, the buoy has a small watch circle radius of 1.25km. When using Papa data in scientific analyses, the nominal position is usually adequate. For users wanting additional accuracy, the more accurate positions from GPS/IPS are also provided at their native resolution. Gross error checking was performed to eliminate values outside the watch circle, but no further processing was performed.

3.2 Meteorological Data

The ATLAS data acquisition system stopped storing data to memory on May 29, 2008 [150], just days before recovery. No high-resolution primary meteorological data were recorded after this time.

Data from secondary sensors are not included in the final data sets, except when provided in OceanSITES format.

3.2.1 Winds

The recovered high resolution wind speeds from the Gill sensor were in units of 0.1m/s per count rather than 0.2m/s per count from the real-time data. Coefficients were adjusted during processing to obtain the correct velocities.

3.2.2 Air Temperature

There are no special processing notes for air temperature at PA001. Refer to section 3.0 for general remarks.

3.2.3 Relative Humidity

The relative humidity data contained 18,782 1E+34 (out of the 0-100% range) values starting on January 17, 2008 [017]. The instrument alternated between high and low hex values (FF and 00). Thereafter, the sensor reported a few data points just below 100%, as if the mean curve had shifted up over 100%, maxing out the sensor. There are no historic or adjacent data for comparison, but the other meteorological data were comparably seasonal. The air temperature data matched the longwave radiation sensor's case and dome temperature data very well, and there were numerous rain events matching the high relative humidity. It is assumed that sensor damage first occurred January 17, 2008 [017], and the data were left with default quality flags prior to this time.

The relative humidity sensor failed its post recovery calibration. It was noted that the measured values ramped up sharply at higher humidity levels during the calibration run. Water damage was found under the filter cap.

3.2.4 Barometric Pressure

The BP sensor on PA001 failed on March 8th, 2008, as the Flex system's battery power became depleted. No data exists after this date, as the BP sensor does not internally record data.

3.2.5 Rain

Rain data are acquired as accumulation values, and then converted to rain rates during processing. Rainfall data are collected using an RM Young rain gauge, and recorded internally at a 1-min sample rate. The gauge consists of a 500mL catchment cylinder which, when full, empties automatically via a siphon tube. Data from a three minute period centered near siphon events are ignored. Occasional random spikes in the accumulation data, which typically occur during periods of rapid rain accumulation, or immediately preceding or following siphon events, are eliminated manually.

To reduce instrumental noise, internally recorded 1-minute rain accumulation values are smoothed with a 16-minute Hanning filter upon recovery. These smoothed data are then differenced at 10-minute intervals and converted to rain rates in mm/hr. The resultant rain rate values are centered at times coincident with other 10-minute data (0000, 0010, 0020...).

Residual noise in the filtered data may include occasional negative rain rates, but these rarely exceed a few mm/hr. No wind correction is applied, as this is expected to be done by the user. The wind effect can be large. According to the Serra, et al (2001) correction scheme, at wind speeds of 5 m/s the rain rates should be multiplied by a factor of 1.09, while at wind speeds of 10 m/s, the factor is 1.3.

The PA001 rain data contained 209 sporadic 1E+34 (out of range) values starting at 22:10 on May 27, 2008 [148]. In addition, the data showed thick small-scale noise and some large spikes, just before the ATLAS tube stopped storing data. While rain data usually contains some noise, additional noise could have been due to the dying battery and ATLAS tube failure.

Small diurnal spikes appeared in the data at noon and midnight, with a few large spikes scattered throughout the data. These were removed during quality flagging, along with the thick small-scale noise and large spikes mentioned above. The instrument passed a bench test after recovery.

3.2.6 Shortwave Radiation

There are no special processing notes for shortwave radiation at PA001. Refer to section 3.0 for general remarks.

3.2.7 Longwave Radiation

The downwelling longwave radiation is computed from thermopile voltage, dome temperature, and instrument case temperature measurements, using the method described by Fairall et al. (1998).

The longwave radiation data contained 65 1E+34 (out of range) values scattered randomly throughout the last two days of data, starting at 22:10 on May 27, 2008 [148]. This was likely related to the failing ATLAS tube.

3.3 Subsurface Data

When the ATLAS tube stopped communicating with them on May 29, 2008 [150], the module clocks began drifting. At recovery, they were all found to be slow by 8-19 minutes. An automated script was used to linearly interpolate the data to the correct timestamps, between the start of the drift and the end of the data files (from 00:00Z on May 29, 2008 to 16:30Z on June 13th, 2008). The temperature, pressure, salinity, conductivity, and density files were all adjusted, and were flagged with Q3 (adjusted) due to the interpolation.

<u>Subsurface clock drifts (in minutes, negative = slow):</u>

Depth:	Clock Drift:
1m	-8.32
5m	Not measured (low battery)
8m	-8.6
10m	-8.38
15m	Lost before recovery
18m	Flooded
20m	Not initially obtained (both UW instruments were later corrected by +7 hrs)
30m	-8.13
35m	-11.13
45m	-12.05
80m	-11.2
100m	-11.63
120m	-9.43
150m	-18.75
200m	-9.85
300m	-12.57

Since 2007, the measurement point for SST/C is known to have varied between 1.0 - 1.3m depth. Uncertainties in actual measurement depth are introduced by changes in buoy waterlines, variation between instrument mounting locations, and alteration of measurement points with different instrument versions. For these reasons, the nominal depth for the SST/C measurement is stated as 1m.

3.3.1 Temperature

There were numerous temperature inversions in the 80m - 150m temperatures, but no corresponding density inversions, so no temperature adjustments were made.

Temperature sensors typically have negligible drift over the course of a deployment. Accuracy, which includes sensor drift, is listed as ± 0.02°C for ATLAS modules. No post-calibration adjustments were applied during processing. See Section 3.3.2 for additional notes about temperature quality flags.

3.3.2 Pressure

Since this was a taut mooring, actual pressures are expected to be close to the pressures at nominal depths. There was only one pressure sensor on the mooring line, the SBE39-TP at 300m. There were no spikes seen in the 300m pressures attributable to vandalism. However, the baseline of the pressures sat right at the lower pressure bound of 305dB throughout the deployment. There were no notes in the recovery log to indicate that the module was found deeper than its nominal depth. It is possible the sensor was reading slightly low, but no adjacent pressure measurements were available to confirm. The percent of data out-of-bounds was 20.98%.

Temperature and salinity values for all depths below 1m, corresponding to the out-of-range pressures, were assigned Q4 quality flags for potentially being out of their nominal depths.

3.3.3 Salinity

Salinity values were calculated from measured conductivity and temperature data using the method of Fofonoff and Millard (1983). Conductivity values from all depths were adjusted for sensor calibration drift by linearly interpolating over time between values calculated from the pre-deployment calibration coefficients and those derived from the post-deployment calibration coefficients. Salinities were calculated from both the pre and post conductivity values to determine the drift in the salinity measurement.

Salinity Drifts in PSU (post - pre):

Depth:	**Drift:**
1m	0.0118
5m	0.0000
8m	-0.0008
10m	0.0229
15m	Lost
35m	0.0075
45m	0.0187
80m	0.0030
100m	0.0092
120m	-0.0145
150m	0.0009
200m	0.0208

*Negative values indicate scouring; positive values indicate fouling.

The values above indicate the change in calculated salinity data values when post-recovery calibrations were applied to the conductivity measurement, versus when pre-deployment calibrations were applied. Negative differences suggest that the instrument drifted towards higher values while deployed, and indicate expansion of the conductivity cell's effective cross-sectional area. This expansion is possibly due to scouring of the cell wall by abrasive material in the sea water. Positive values indicate a decrease in the cell's effective cross-sectional area, presumably due to fouling, and secondarily due to fouling or loss of material on the cell electrodes.

A thirteen point Hanning filter was applied to the high-resolution (ten minute interval) conductivity and temperature data. A filtered value was calculated at any point for which seven of the thirteen input points were available. The missing points were handled by dropping their weights from the calculation, rather than by adjusting the length of the filter. Salinity values were then recalculated from the filtered data.

Manual Salinity Adjustments

The drift-corrected salinities were checked for continuity across deployments. The instruments and 1m and 45m compared well with salinity measurements on PA002, so no adjustments were made. Sensors were not deployed at any other matching depths between the two years.

Additional linear corrections were also applied to the salinity data in time segments across the deployment. These corrections were based on comparisons with neighboring sensors on the mooring line. If an unrealistic prolonged, unstable density inversion was found, an attempt was made to identify the sensor at fault and adjust its data based on differences with data from adjacent depths during unstratified conditions (e.g. within the mixed layer during nighttime). These *in situ* calibration procedures are described by Freitag *et al.* (1999).

As noted in Section 3.3.1, there were numerous temperature inversions in the 80m - 150m temperatures for PA001, but no corresponding density inversions. Several small drift corrections were made to the 1m salinities. Start and end points of the adjustment segments shown below are in the format of Year, Year day, Hour, Minute, Second (YYYYDDDHHMMSS). The adjustment amounts listed were applied linearly to the measured values over that time period, as shown in Figure 4.

1m Salinity Adjustments

2007185031000 - 2007225090000 0.000 -> 0.085
2007225091000 - 2007250170000 0.085 -> 0.085
2007250171000 - 2007272133000 0.085 -> 0.122
2007272134000 - 2008071000000 0.122 -> 0.122
2008071001000 - 2008090090000 0.122 -> 0.130
2008090091000 - 2008151233000 0.130 -> 0.169
2008151234000 - 2008162163000 0.169 -> 0.200

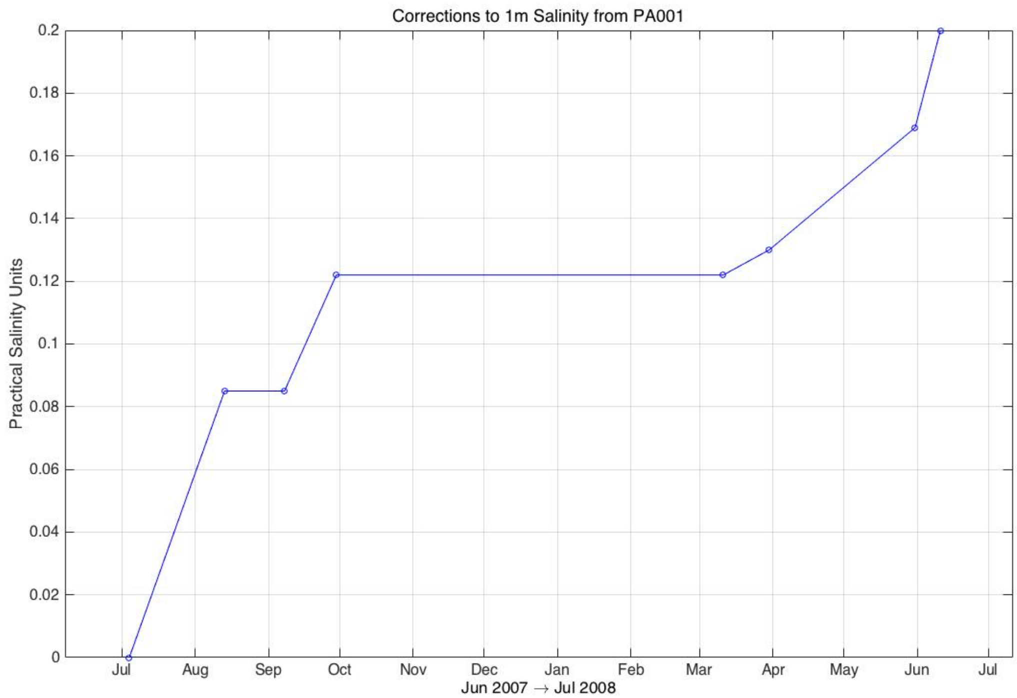

Figure 4: Linear corrections applied to 1m salinity data.

The high-resolution salinity measurements at 1m and 8m contained noise that was flagged (1E+33, equivalent to Q5). Flagging started at September 14, 2007 [257] and November 9, 2007 [313] for the 1m and 8m data, respectively. The sections of flagged data were short enough that they only impacted the hourly data. The final daily averages were not affected.

Additional salinity measurements were available from two CTD/GTD/O2 instruments provided by the University of Washington, deployed at 1m and 20m on PA001. The 20m instrument was considered primary, but since the 1m instrument was redundant with the 1m SSTC, it was classified as secondary.

Salinity drift (post cal data - pre cal data) for UW instruments:
1m 0.0120
20m 0.0569
*Negative values indicate scouring; positive values indicate fouling.

Small linear adjustments were made to each data set:
1m: 2007158230000 - 2008067110000 -0.011 -> -0.026
20m: 2007158230000 - 2008133130000 0.000 -> -0.06

Both sets of data from the UW instruments ended early. The 1m data ended in early March, and the 20m data ended in early May. When data from the UW instruments were plotted alongside data from adjacent instruments, a 7 hour time offset was discovered throughout the deployment, likely due to incorrectly set clocks. The time stamps from the UW instruments were adjusted forward by 7 hours in the final files to correct the offset. No Hanning filter was applied to the UW instrument data, as their highest resolution data was already hourly.

A CTD cast was performed near the PA001 mooring. Data from the mooring and CTD cast compared favorably, given the measurements were taken 10NM apart.

3.3.4 Currents

Point current meters were deployed at four depths on the PA001 mooring. The stated head depth differs from the actual current measurement depth, because the instruments require a blanking distance. Currents from the instruments deployed at 7, 16.7, 32, and 37m measured velocities at 5, 15, 34, and 35m, respectively. The 32m instrument was an RDI DVS current meter, which failed early, while the remaining instruments were Sontek current meters. Since the PA001 mooring line was taut, current meters were not corrected for negligible buoy motion.

The current meters on PA001 measured the speed of sound, and internally applied sound velocity corrections to current measurements. During post-processing, a correction for magnetic declination was applied. A (thirteen/seven) point Hanning filter was applied to the (DVS/Sontek) data at (10/20) minute resolution to get hourly data, and a boxcar filter was applied to the high resolution data to produce daily averaged values.

The Sontek current meter at 16.7m was lost, and its corresponding TV module was flooded, so no high-resolution data were recovered. Real-time data ended on June 9, 2007 [160], before any daily averages were computed.

The Sonteks at 7m and 37m had 100% data return. During processing, very large tidal velocities (up to 0.65m/s) were noted. This made comparisons with the nearby ADCP mooring difficult. The comparison did indicate a difference of up to 2° in the ADCP compass, but since both instrument models have compass accuracies of ±2°, this is within accuracy specifications.

The Sonteks had 8 to 11 minute clock errors by the end of the deployment, but this was not adjusted in the data. It is not known whether the drift occurred gradually, and interpolating for time drifts tends to diminish data quality. Also, quality flags were not set to Q4 for times when the 300m pressure was out of range.

4.0 References

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5.0 Acknowledgements

Dr. Steve Emerson (UW) was lead PI for the NSF project that funded this deployment. The OCS project office is grateful for his vision and efforts to make the NOAA surface mooring at Station Papa possible.

The OCS project office thanks the Line P program for providing ship time, Chief Scientist, Marie Robert, and the captain and crew of the CCGS JOHN P. TULLY for the deployment and recovery of this mooring. D. Zimmerman and P. A'Hearn (both of UW JISAO) participated in the deployment cruise. P. A'Hearn and LCDR R. Kamphaus (NOAA Corp) participated in the February 2007 recovery cruise (where no mooring work could be completed due to weather) and P. A'Hearn participated in the successful June 2008 recovery cruise.

S. Brown (UW JISAO) processed ATLAS meteorological data, subsurface temperature, pressure and conductivity/salinity data. P. Plimpton (NOAA PMEL) processed the NP001 ADCP data and current meter data, with additional work on the current meter data done by C. Fey in 2014.

6.0 Contact Information

For more information about this mooring and data set, please contact:

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APPENDIX A: Data Quality Flags

Instrumentation recovered in working condition is returned to PMEL for post-recovery calibration before being reused on future deployments. The resultant calibration coefficients are compared to the pre-deployment coefficients, and measurements are assigned quality indices based on drift, using the following criteria:

Q0 - No Sensor, or Datum Missing.

Q1 - Highest Quality. Pre/post-deployment calibrations agree to within sensor specifications. In most cases, only pre-deployment calibrations have been applied.

Q2 - Default Quality. Pre-deployment calibrations only or post-recovery calibrations only applied. Default value for sensors presently deployed and for sensors which were not recovered or not calibratable when recovered, or for which pre-deployment calibrations have been determined to be invalid.

Q3 - Adjusted Data. Pre/post calibrations differ, or original data do not agree with other data sources (e.g., other in situ data or climatology), or original data are noisy. Data have been adjusted in an attempt to reduce the error.

Q4 - Lower Quality. Pre/post calibrations differ, or data do not agree with other data sources (e.g., other in situ data or climatology), or data are noisy. Data could not be confidently adjusted to correct for error.

Q5 - Sensor, Instrument or Data System Failed.

For data provided in OceanSITES format, the standard TAO quality flags described above are mapped to the different OceanSITES quality flags shown below:

Q0 -	No QC Performed.	
Q1 -	Good Data.	(TAO Q1, Q2)
Q2 -	Probably Good Data.	(TAO Q3, Q4)
Q3 -	Bad Data that are Potentially Correctable.	
Q4 -	Bad Data.	(TAO Q5)
Q5 -	Value Changed.	
Q6 -	Not Used.	
Q7 -	Nominal Value.	
Q8 -	Interpolated Value.	
Q9 -	Missing Value.	(TAO Q0)

APPENDIX B: High Resolution Data Plots

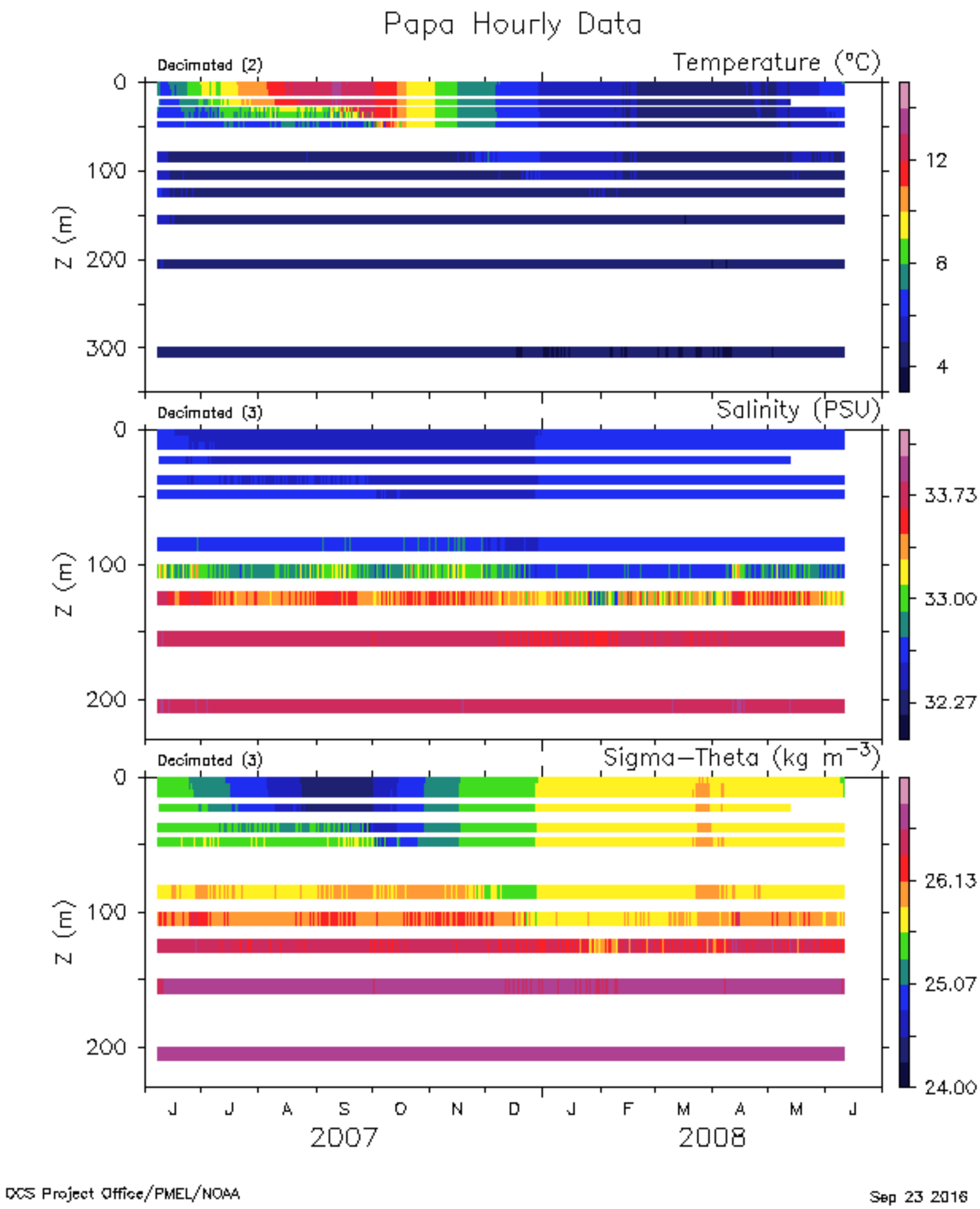

Figure B 1: PA001 subsurface temperature, salinity, and density at hourly resolution (decimated).

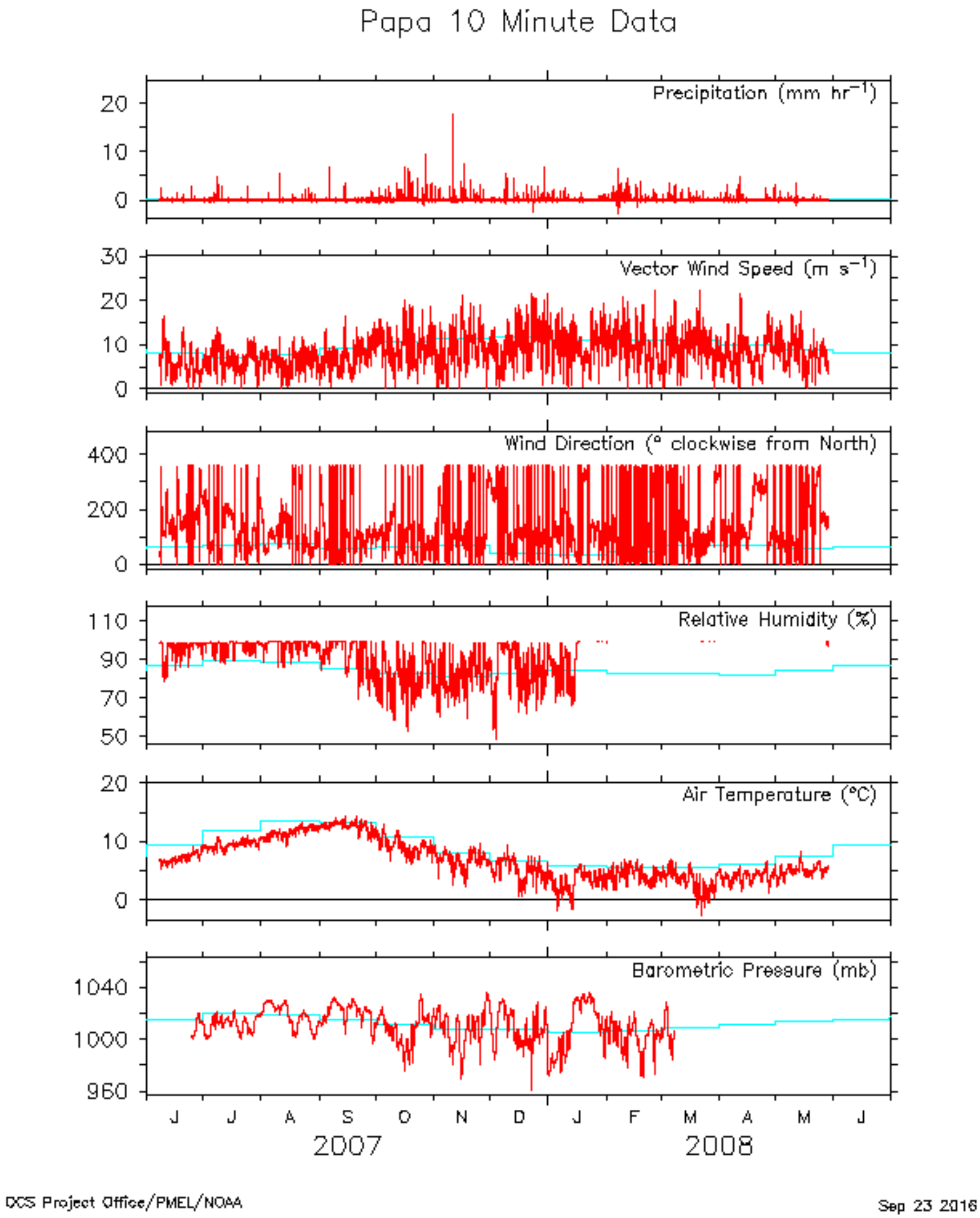

Figure B 2: PA001 high resolution (10-min) primary surface meteorological data.

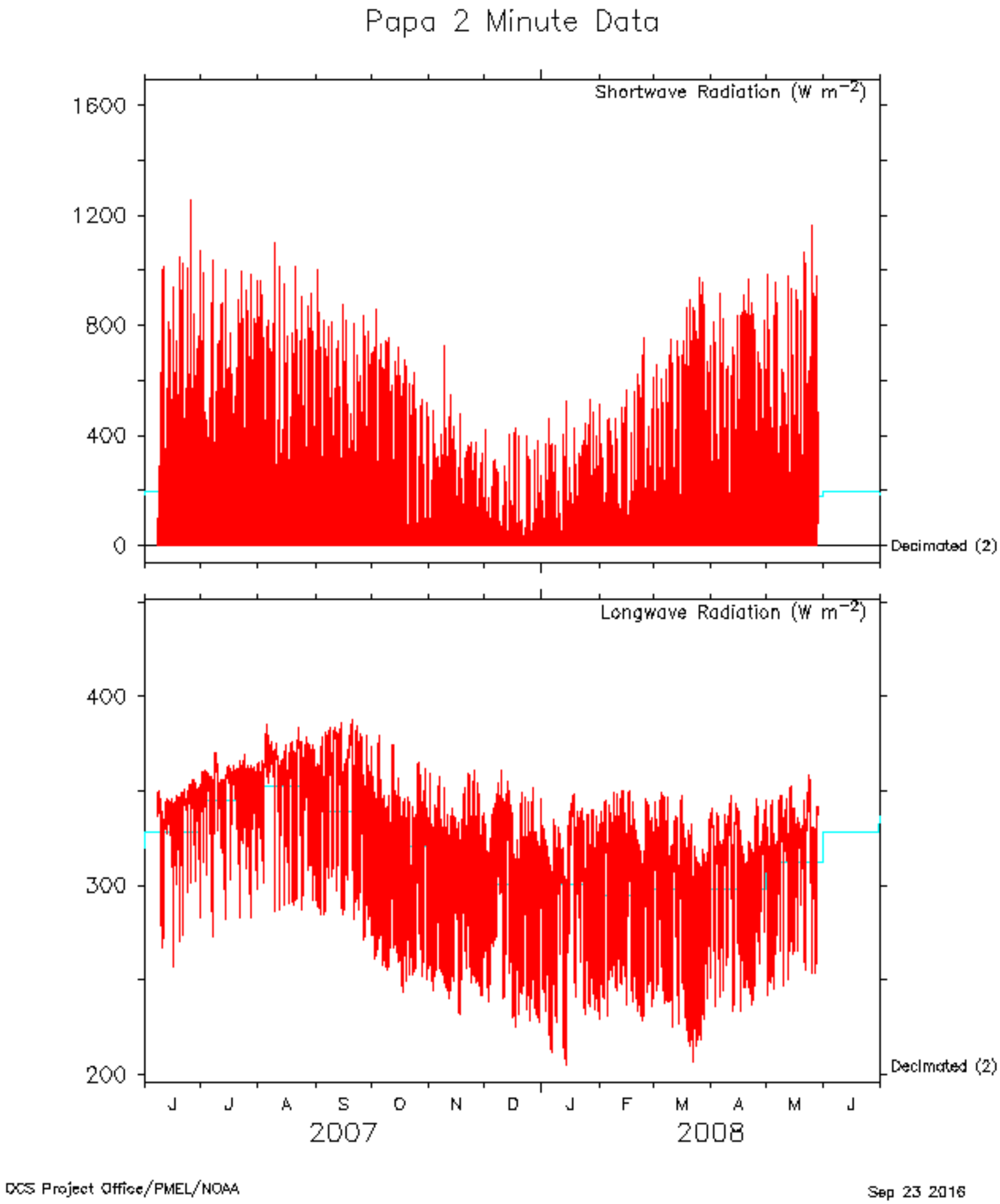

Figure B 3: PA001 high resolution (2-min) radiation data.

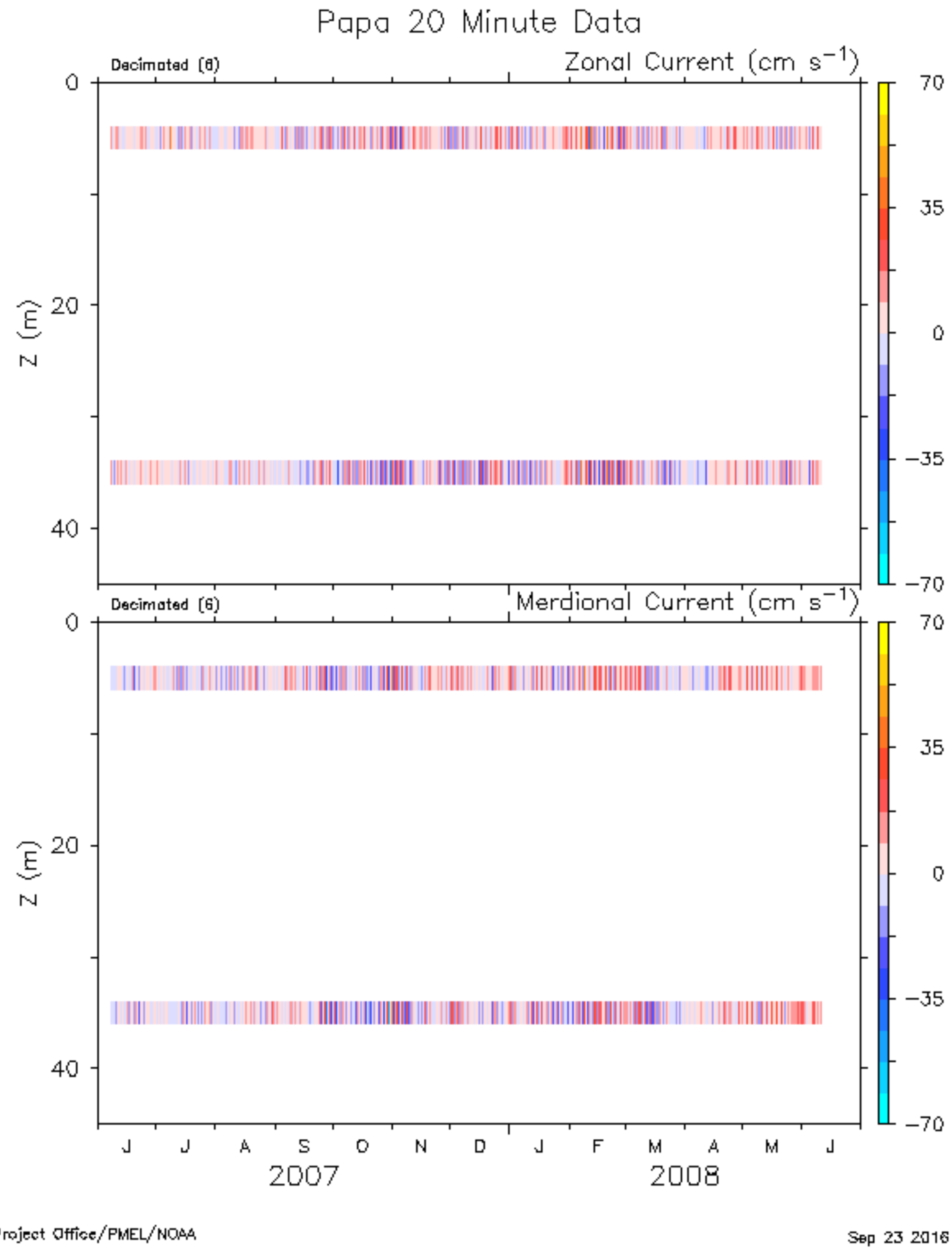

Figure B 4: Zonal and meridional current meter data (decimated) from PA001. The 16.7m Sontek was lost, and the 32m (measuring at 35m) DVS data was cut short due to dead batteries. The DVS data overlapped the 35m Sontek data seen in this figure, and the more complete Sontek record was considered primary.

APPENDIX C: Papa ADCP Subsurface Mooring

Mooring Description

A separate subsurface mooring (NP001) was deployed in proximity to PA001 that contained a 150KHz, upward-looking ADCP at a nominal depth of 160m and nominal position of 50.12N, 144.97W. Deployed 6/6/07 and recovered 6/9/08, an ADCP (SN 542) on loan from NOAA's PMEL ECO FOCI group recorded data over a depth range of 28-160m in 2m bins. The pre-deployment file, confirmed by RDI technicians, indicates that there were 300 pings per ensemble, with a ping interval of 3 second, to center data on the hour. Figure C1 shows the mooring diagram of this deployment, but the depths are approximately 19m too shallow due to incorrect mooring line lengths, which placed the actual head depth of 164m near the nominal depth.

The NP001 mooring also carried a Passive Acoustic Listening Device (PAL) at 175 + 19 = 194m. PALs can be used to monitor wind speed, rain, marine mammals, and other ambient noise signals. These data are available from the PIs, Dr. Jeff Nystuen (UW APL) and Dr. Jie Yang* (UW APL).

*Dr. Jie Yang has taken over the PAL program at UW APL.

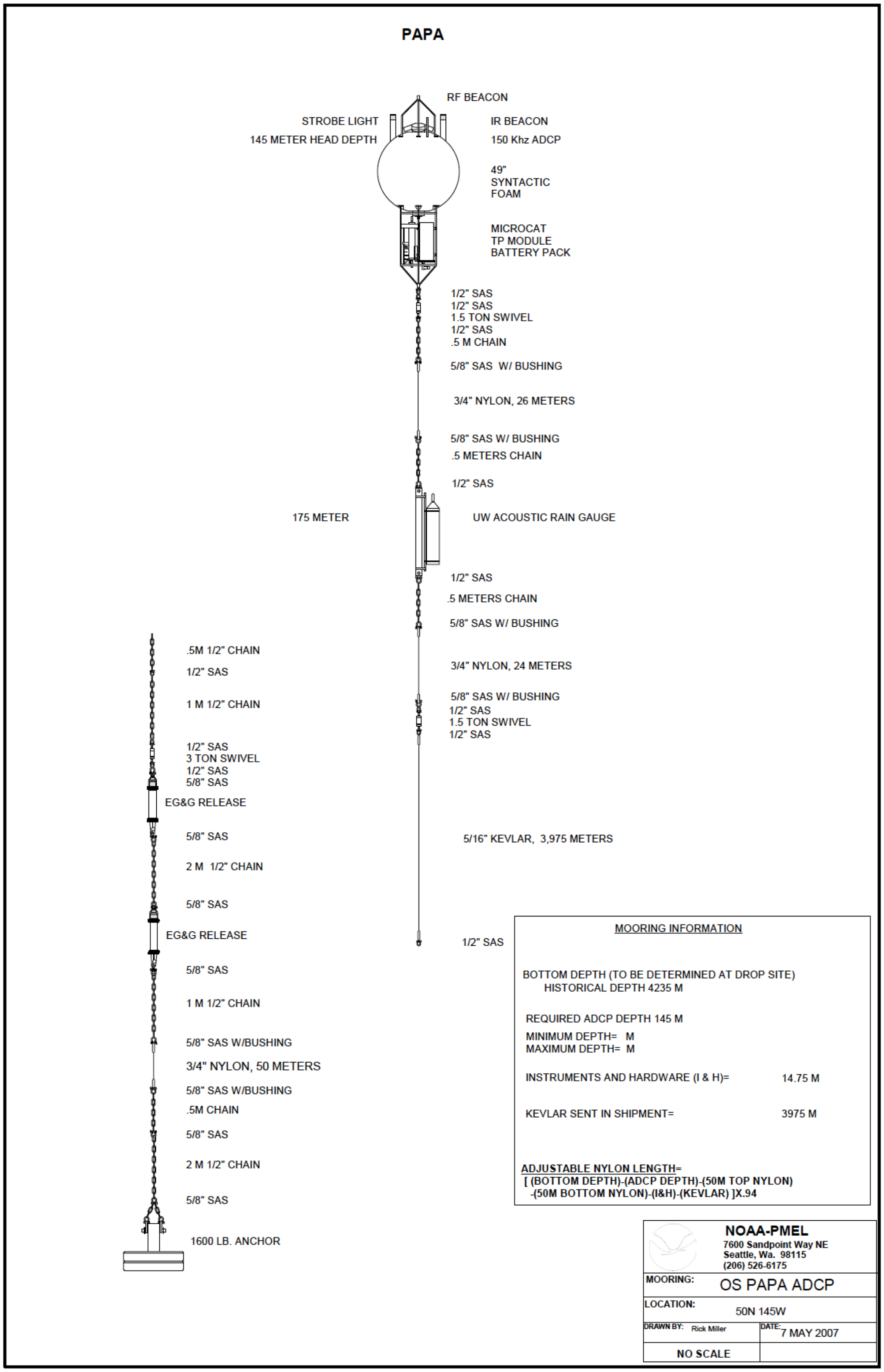

Figure C 1: Subsurface mooring diagram near Ocean Station Papa.

ADCP Data

The highest resolution data available from the PA001 subsurface mooring was hourly. Figure C2 shows U and V velocity data from the entire deployment. The diagonal feature crossing the center of the plot is the ADCP resolving the seasonal change in mixed layer depth, increasing from <30m in September to ~120m in February.

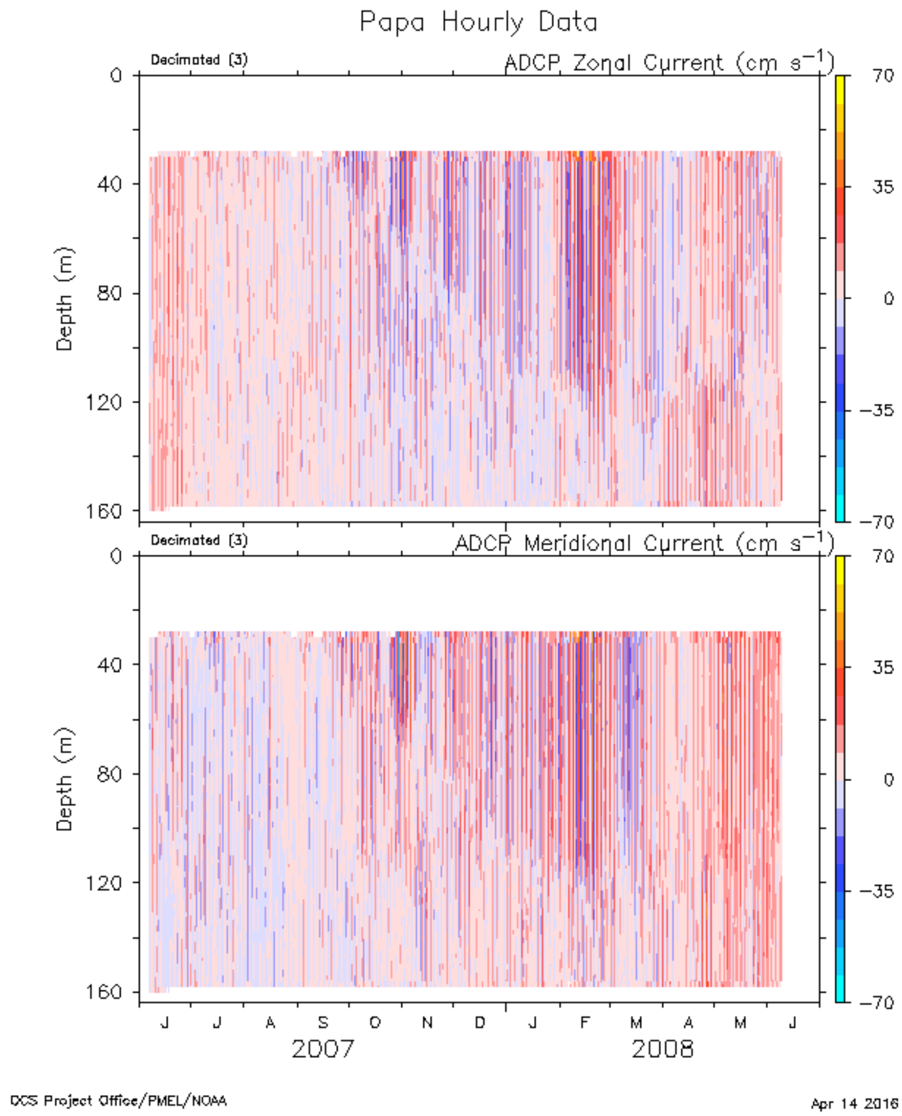

Figure C 2: Papa North Pacific (PAPANP) subsurface ADCP deployment near the OCS Papa mooring.