NOAA Pacific Marine Environmental Laboratory

Ocean Climate Stations Project

DATA ACQUISITION AND PROCESSING REPORT FOR KE002

Site Name:	Kuroshio Extension Observatory (KEO)
Deployment Number:	**KE002**
Year Established:	2004
Nominal Location:	32.3°N 144.6°E
Anchor Position:	32.35°N 144.64°E
Deployment Date:	May 28, 2005 (Top 700m)
Recovery Date:	November 10, 2005
Project P.I.:	Dr. Meghan F. Cronin
Report Authors:	J.A. Keene, M.F. Cronin, K. Ronnholm, H.P. Freitag, N.D. Anderson
Data Processors:	S. Brown, S. Moon, C. Fey
Date of Report:	August 22, 2016
Revision History:	

Special Notes:

This buoy went adrift on November 6, 2005. Data files are truncated at that time, so no data are served from the time during which the buoy was drifting.

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Data Acquisition and Processing Report for OCS Mooring KE002

1.0 Mooring Summary

The NOAA Ocean Climate Stations reference mooring at the Kuroshio Extension Observatory (KEO) site was established with the deployment of the KE001 mooring in June 2004. KE002 was part of the second year of the two-year Kuroshio Extension System Study (KESS). KE002 was located next to the Woods Hole Oceanographic Institution (WHOI) KESS-7 subsurface mooring (Figure 1). More information about the K7 mooring can be found in Appendix C.

The KE002 mooring was deployed by the R/V REVELLE in May 2005 on the second KESS cruise. Only the buoy and top 700m of the existing KE001 mooring were replaced, leaving the anchor location unchanged. The longwave radiation sensor failed shortly after deployment, and was replaced by the R/V REVELLE in June 2005. The buoy went adrift November 6th, 2005, and the buoy and upper ~1000 meters of mooring line was recovered by the R/V KAIYO on November 9th.

Analysis of the recovered mooring line (Lawrence-Slavas et al. 2006) revealed that the line had parted in the middle of a continuous section of ¾" nylon, around 300 m below the lower terminus of the jacketed wire rope and approximately 1000 m below the surface. While analysis of the load cell data exposed patterns of shock loading, the recorded maximum force never exceeded 3,000lbs. The nylon was rated for 15,000 lbs., and post-recovery strength tests indicated a breaking strength of 10,300 lbs. Additionally, a KEO mooring model showed that line tension at depth was further minimized and isolated from shock, so a purely tension-based break was unlikely. The unbraiding of the nylon line near the break was consistent with defective nylon, but contributing factors could have included fishing line, deployment/recovery line stress, or fish bite damage, which was observed in the inductive cable at 550 m. Future recommendations included switching to a high latitude buoy, removing 275 m of fairings, inspecting mooring line, and eliminating causes of line abrasion.

The mooring operation assistance from the KESS scientists and technicians, and the captains and crews of the R/V REVELLE and R/V KAIYO are gratefully acknowledged. The KEO project office is deeply grateful to chief scientist Dr. H. Ichikawa (JAMSTEC) for the mooring rescue, as well as chief scientists Drs. S. Jayne and N. Hogg (WHOI), and other KESS PIs for inviting the KEO group to participate on the KESS cruises. For further information on KESS, see http://uskess.whoi.edu and Donohue et al. (2008).

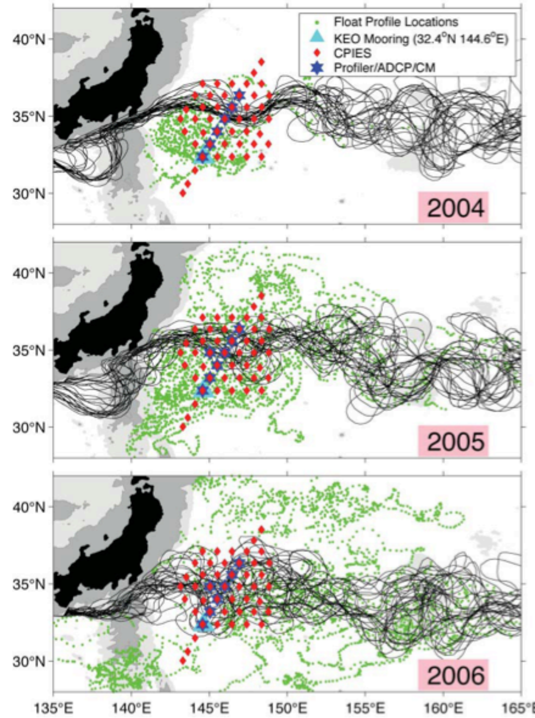

Figure 1: Maps of the KESS array during 2004-2006, from Donohue et al. 2008. Black lines are the biweekly Kuroshio Extension path based on the 170 cm contour of sea surface height.

1.1 Mooring Description

The KE002 mooring was a slack-line mooring, with a nominal scope of 1.4. The scope is defined as the ratio of the mooring length, 7,910m, to the water depth, 5,650m. Non-rotating 7/16” (1.11cm) diameter wire rope, jacketed to 1/2" (1.27cm), was used in the upper 700m of the mooring line. Plastic fairings were installed on the wire rope to a depth of 525m. The remainder of the mooring line consisted of plaited 8-strand nylon line, spliced to buoyant polyolefin, as shown in Figure 3. There were four glass balls in line above the acoustic release. The 6,820lb (3,094kg) anchor was fabricated from scrap railroad wheels.

The upper portion of the mooring was kept fairly vertical by using a reverse catenary design, but less so than taut-line moorings. Pressure measurements were recorded at seven nominal depths of 100 m, 175 m, 250 m, 300 m, 375 m, 425 m, and 500 m. Time series of pressure at other sensor levels were interpolated from observed values, and both observed and interpolated pressure time series are included with the data.

The surface buoy was a 2.3m fiberglass-over-foam toroid buoy, with a solid core. It had an aluminum tower and a stainless steel bridle. A CO_2 flux monitoring system was also deployed on the KE002 mooring, in collaboration with the PMEL Carbon Group. OCS is not responsible for the acquisition or processing of these data, aside from position data.

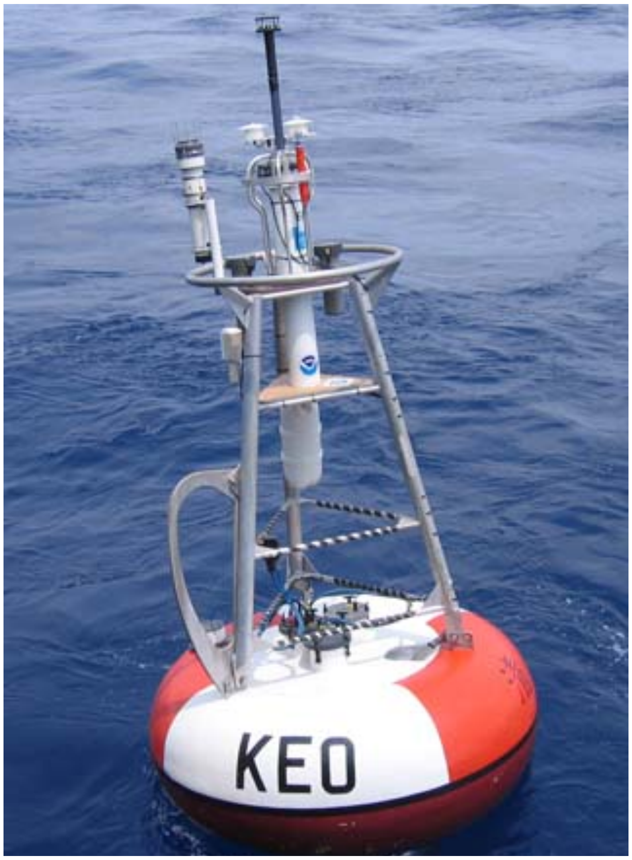

Figure 2: KE002 mooring as deployed.

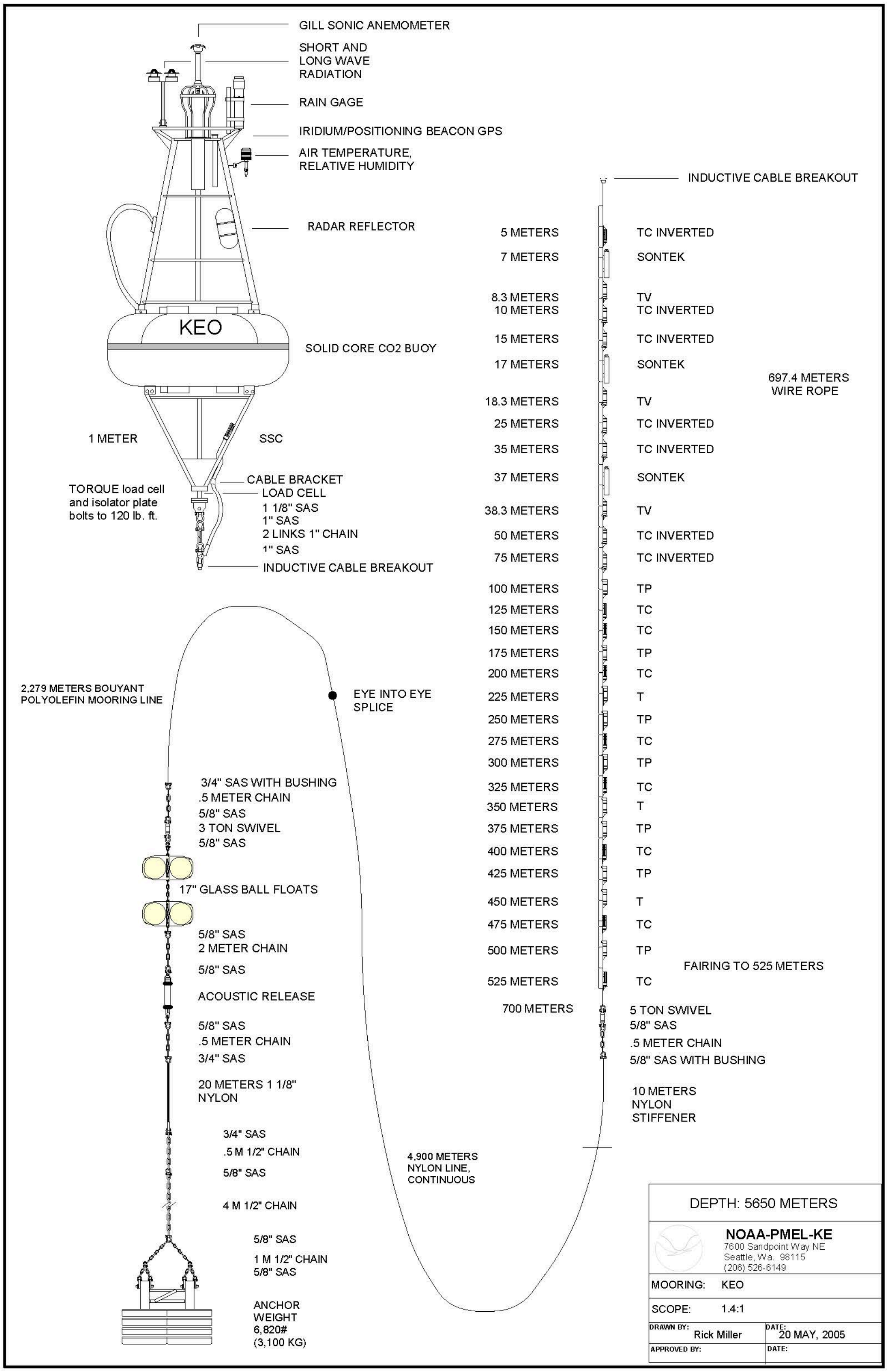

Figure 3: KE002 mooring diagram.

1.2 Instrumentation on KE002

The following instrumentation was deployed on KE002. The ATLAS data acquisition system was used, and a CO_2 system was deployed for the first time on KE002.

Deployment:		**KE002**			
Met Sensors		**Model**	**Serial #**		**Notes**
Height	Acquisition	ATLAS	621		
3m	ATRH	Rotronics MP-101	59324		
3.5m	Rain	RM Young	895		
3.5m	SWR	Eppley PSP	33359		
3.5m	LWR	Eppley PIR	32770		Replaced with S/N 32896
4m	Wind	Gill	51414		
CO2	Electronics	PMEL	9		
	Span Gas	Luxfer			
Subsurface Instrumentation					
Bridle		**Model**	**Serial #**		**Notes**
1m	SSC	ATLAS Module	11928		White
2m	Load Cell		A0502075		
Depth on Line		**Model**	**Serial #**	**IM ID**	**Notes**
5m	TC	ATLAS Module	11167	16	Inverted, White
7m	ADCP	Sontek	D378		
8.3m	TV	ATLAS Module	13497	13	Inverted
10m	TC	ATLAS Module	11932	1	Inverted, White
15m	TC	ATLAS Module	12073	2	Inverted
17m	ADCP	Sontek	D416		
18.3m	TV	ATLAS Module	13498	14	Inverted, White
25m	TC	ATLAS Module	12128	3	Inverted
35m	TC	ATLAS Module	13296	17	Inverted, White
37m	ADCP	Sontek	D173		
38.3m	TV	ATLAS Module	13499	15	
50m	TC	ATLAS Module	12284	4	Inverted
75m	TC	ATLAS Module	12304	5	Inverted, White
100m	TP	ATLAS Module	12952	8	Black
125m	TC	ATLAS Module	12319	18	White
150m	TC	ATLAS Module	12411	7	White, TCV Config as TC
175m	TP	ATLAS Module	13385	19	Black
200m	TC	ATLAS Module	12382	11	White, TCV Config as TC
225m	T	ATLAS Module	12444	20	
250m	TP	ATLAS Module	13386	21	Black
275m	TC	ATLAS Module	12986	22	White, TCV Config as TC
300m	TP	ATLAS Module	13111	9	Black
325m	TC	ATLAS Module	13120	23	White
350m	T	ATLAS Module	12944	24	Black
375m	TP	ATLAS Module	13183	25	White
400m	TC	ATLAS Module	13352	6	Black
425m	TP	ATLAS Module	13184	26	Black
450m	T	ATLAS Module	12020	12	Black
475m	TC	ATLAS Module	11758	27	Black
500m	TP	ATLAS Module	13112	10	Black
525m	TC	ATLAS Module	12137	28	Black

Table 1: Instruments deployed on KE002.

2.0 Data Acquisition

The ATLAS data acquisition system transmits daily average and intermittent spot meteorological measurements to shore through Service Argos satellites. High-resolution data are logged internally, and downloaded upon recovery of the mooring. Subsurface instruments log internally throughout the deployment.

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 acquired at irregular time intervals.

2.1 Sampling Specifications

Table 2 describes the high-resolution sampling scheme for the KE002 mooring. Observation times in data files are assigned to the center of the averaging interval.

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	2 Hz	2 min	2359-0001, 0009-0011…	10 min	ATLAS
Relative Humidity	2 Hz	2 min	2359-0001, 0009-0011…	10 min	ATLAS
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
Ocean Currents (Point)	1 Hz	2 min	2359-0001, 0009-0011…	10 min	Internal

Table 2: Sampling parameters of primary sensors on KE002.

2.2 Data Returns

KE002a 2005-05-28 06:47:00 [148] to 2005-06-21 00:00:00 [172]
ATLAS Tube 621, software version 4.10:

Wind	051414	100%
AirT	59324	100%
RH	59324	100%
SWR	33359	96.6%
Rain	895	99.4%
LWR	32770	31.53%

KE002b 2005-06-21 00:00:00 [172] to 2005-11-09 22:40:00 [313]
ATLAS Tube 621, software version 4.10:

Wind	051414	100.0%
AirT	59324	100.0%
RH	59324	100.0%
SWR	33359	99.3%
Rain	895	99.8%
LWR	32896	100.0%

Modules:

1m	SSC	#11928	100%	t&c
5m	TC	#11167	100%	t&c
8m	TV	#13497	100%	*See section 3.3.4*
10m	TC	#11932	100%	t&c
15m	TC	#12073	100%	t&c
18m	TV	#13498	100%	
25m	TC	#12128	100%	t&c
35m	TC	#13296	100%	t&c
38m	TV	#13499	100%	
50m	TC	#12284	100%	t&c
75m	TC	#12304	100%	t&c
100m	TP	#12952	100%	t&p
125m	TC	#12319	100%	t&c
150m	TC	#12411	100%	t&c
175m	TP	#13385	100%	t&p
200m	TC	#12382	100%	t&c
225m	T	#12444	100%	
250m	TP	#13386	100%	t&p
275m	TC	#12986	100%	t&c
300m	TP	#13111	100%	t&p
325m	TC	#13120	100%	t&c
350m	T	#12944	100%	
375m	TP	#13183	100%	t&p
400m	TC	#13352	100%	t&c
425m	TP	#13184	100%	t&p
450m	T	#12020	100%	
475m	TC	#11758	100%	t&c
500m	TP	#13112	100%	t&p
525m	TC	#12137	100%	t&c

2.3 Known Sensor Issues

The longwave radiation sensor (S/N 32770) failed in June 2005. After dome and case thermistors failed June 4 and June 6, respectively, all thermopile data reported 0000 by June 15. A replacement longwave radiation instrument (S/N 32896) was installed on June 20, 2005 [171] by the R/V REVELLE. Bench testing of the failed unit showed high current drain at 2mA, and all data output was 0. Moisture was found inside the instrument case, likely due to micro-cracks in the case. The replacement sensor performed well for the duration of the deployment.

The Sontek current meter deployed at 7m failed on June 16, 2005 [167]. Additional details are provided in Section 3.3.4.

A density inversion was observed in the raw data from the 10m and 15m subsurface modules. In the unstratified mixed layer, data indicating a persistent inversion points toward an issue of instrument calibration. Pressure sensor data ruled out mooring line excursions that could have changed the position of the 10m sensor. It was concluded that instrument miscalibration/offset in the 10m sensor caused the inversion.

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 KEO is a slack-line mooring with a large scope, the buoy has a watch circle radius of over 5km. When using KEO data in scientific analyses, it may be appropriate to consider the actual position of the buoy rather than its nominal position.

As described in Section 2.0, position data for KE002 were acquired by two methods; Service Argos location estimates, and the more accurate GPS fixes. The Service Argos and GPS position data were combined and distributed at their native resolution, which ranged from minutes to hours between position fixes. The native GPS data were also converted into 10-minute, hourly, and daily values to match the resolutions of other measurements from the mooring. The 10-minute and hourly resolutions were calculated through linear interpolation of the native GPS data. Daily GPS positions were the median value of the interpolated 10-minute data for each day.

Current meter corrections based on position data are described in section 3.3.4.

3.2 Meteorological Data

The KE002 deployment has two designations, KE002a and KE002b. The switch occurs at the time of the replacement of the longwave radiation sensor. The data files are truncated at the time when the buoy drifted outside its normal watch circle.

3.2.1 Winds

The recovered high resolution wind speeds from the Gill sensor were in units of 0.1 m/s per count rather than 0.2 m/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 KE002. Refer to section 3.0 for general remarks.

3.2.3 Relative Humidity

There are no special processing notes for relative humidity at KE002. Refer to section 3.0 for general remarks.

3.2.4 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 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. As winds are high at KEO, the user is strongly encouraged to apply an appropriate wind correction.

3.2.5 Shortwave Radiation

Dates given below are in the format of Year, Year day, Hour, Minute, Second (YYYYDDDHHMMSS). The SWR data inexplicably contained numerous gaps (1E+35) between 2005169222603 and the end of the deployment, with a large gap between 2005226004003 and 2005226235803. There were no pressure spikes seen in the subsurface data during this time, so if vandalism caused this gap, it was confined to the surface sensors. No recovery or repair logs stating the condition of any of the sensors were available for review, since no PMEL personnel were aboard the R/V KAIYO during the recovery.

3.2.6 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 sensor (S/N 32770) failed in June 2005. The LWR data were all flagged (1E+33, Q5) from 2005155222403 – 2005172000000, because the down-welling and its three components (thermopile, dome & case temps) were all anomalous as the sensor was failing. Once the sensor was replaced on June 20, 2005 [171] by the R/V REVELLE (S/N 32896), data quality returned to normal.

3.3 Subsurface Data

As with the meteorological data, the subsurface data from the KE002 deployment have two designations, KE002a and KE002b. The switch occurs at the time of the replacement of the longwave radiation sensor, though no changes were made to subsurface sensors. The data files are truncated at the time when the buoy drifted outside its normal watch circle.

3.3.1 Temperature

A calibration was accidentally started on four of the modules (TC12137, TC12986, TC13120 and TC11758) before data were recovered. It was stopped immediately, but some garbled data headers were the result. The binary files were converted to hex so that the correct record count and buffer size values of 240 and 591 could be manually entered. The resulting hex files were hand edited to remove two initial buffers that were followed by valid data. The end buffers were also deleted, since they were found to be from a prior deployment. After file format conversions and data processing, all parameters were corrected and valid data was extracted.

The density inversion observed in the raw data between 10m and 15m instruments, described in Section 2.3, indicated a miscalibration/offset in the 10m sensor. Since this report was written 11 years post-deployment, some processing details have been lost. Available notes indicated that the temperature data from the sensor at 10m (TC11932) were offset by -0.03°C for the whole mooring period, resulting in an offset in salinity data as well. The temperature data were adjusted during subsurface processing, making the 10m temperature, salinity, and density data more closely match measurements from adjacent instruments on the mooring line.

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. Processing notes did not include temperature drifts for KE002 because post-calibrations were not applied.

3.3.2 Pressure

Since this was a slack-line mooring, none of the sensors can be assumed to have been recording measurements at their nominal depths. Users are reminded that the depths of subsurface sensors must be computed from the observed and calculated pressures contained in the data file.

Pressure measurements were recorded at seven depths: 100 m, 175 m, 250 m, 300 m, 375 m, 425 m, and 500 m. Time series of pressure at other sensor levels were interpolated from observed values, and both observed and interpolated pressure time series are included with the data.

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 were calculated separately for the "a" and "b" segments of KE002, even though the subsurface sensors did not change throughout the deployment.

KE002a ATLAS Module
Salinity Drifts in PSU (post – pre):

Depth:	Drift:
1m	0.0060
5m	-0.0071
10m	-0.0120
15m	0.0036
25m	-0.0005
35m	-0.0204
50m	-0.0223
75m	-0.0201
125m	-0.0090
150m	-0.0049
200m	-0.0029
275m	0.2347
325m	0.0000
400m	-0.0449
475m	-0.0113
525m	0.0033

KE002b ATLAS Module
Salinity Drifts in PSU (post – pre):

Depth:	Drift:
1m	0.0017
5m	-0.0072
10m	-0.0115
15m	0.0036
25m	-0.0007
35m	-0.0199
50m	-0.0222
75m	-0.0201
125m	-0.0089
150m	-0.0049
200m	-0.0029
275m	0.2342
325m	0.0000
400m	-0.0450
475m	-0.0115
525m	0.0031

*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.

Linear corrections are often applied to salinity data in time segments across the deployment, but checks against neighboring sensors did not indicate the need for additional corrections. For KE002, there were no CTD casts performed at the site to be used for additional sensor validation.

There was a density inversion noted between the 10m and 15m sensors, related to the 10m temperature offset of -0.03°C (Section 3.3.1). The adjusted 10m temperature data corrected the density inversion and aligned salinity values with the surrounding instruments.

At 35m and 275m, the salinity data were over-corrected by the post-calibration, so the post-calibration was not applied. However, an adjustment of 0.09 was applied to the 275m salinity data from 02:20 UTC on June 20, 2005 [2005171022000] through the end of the deployment to account for a sudden drop observed in the salinity. No post-calibration was found in the database for the 325m instrument S/N 13120, explaining the 0.0000 difference between post and pre calibrations. The instrument was retired after KE002, with a reference to the conductivity cell being removed and placed into another instrument.

3.3.4 Currents

The deployed Sontek current meters measure the speed of sound, and internally apply sound velocity corrections to current measurements. During post processing, a correction for magnetic declination is applied. A thirteen point Hanning filter is applied to the 10 minute resolution data to get hourly data, and a boxcar filter produces daily averaged values.

Three Sontek current meters were deployed on KE002 wire at 7, 17, and 37m. The stated head depth is deeper than the actual current measurement, because the instrument requires a blanking distance. Currents were actually measured at 5, 15, and 35m, respectively. ATLAS TV modules were coupled to each Sontek, positioned 1.3m below each instrument, allowing Sontek data to be communicated in real-time through the inductive line.

Since the KEO buoy could move about its watch circle, the current meters did not measure true currents. Using time-stamped data from the two GPS systems, buoy velocity averages were generated. True currents were determined by adding calculated buoy motion to the measured current meter data.

Buoy motion was determined by first interpolating the acquired GPS positions onto a 10 minute grid (:05, :15, :25, etc.). Ten minute mooring velocities corresponding to current meter measurement intervals (:00, :10, :20, etc.) were then calculated using the haversine formula, to equate change in position over time to a mooring velocity. The calculated U and V velocities are shown in Figure 4. The few brief velocity spikes in Figure 4 were likely real, as all buoy velocities were reasonable, at less than 15 cm/s.

No flags were provided by the GPS systems, so data processors flagged the few acquired positions which placed the buoy outside the normal watch circle, but otherwise trusted the reasonable positions and calculated velocities. The CO_2 GPS failed in late September, causing less frequent GPS fixes and a smoothed velocity estimate (Figure 4, right side).

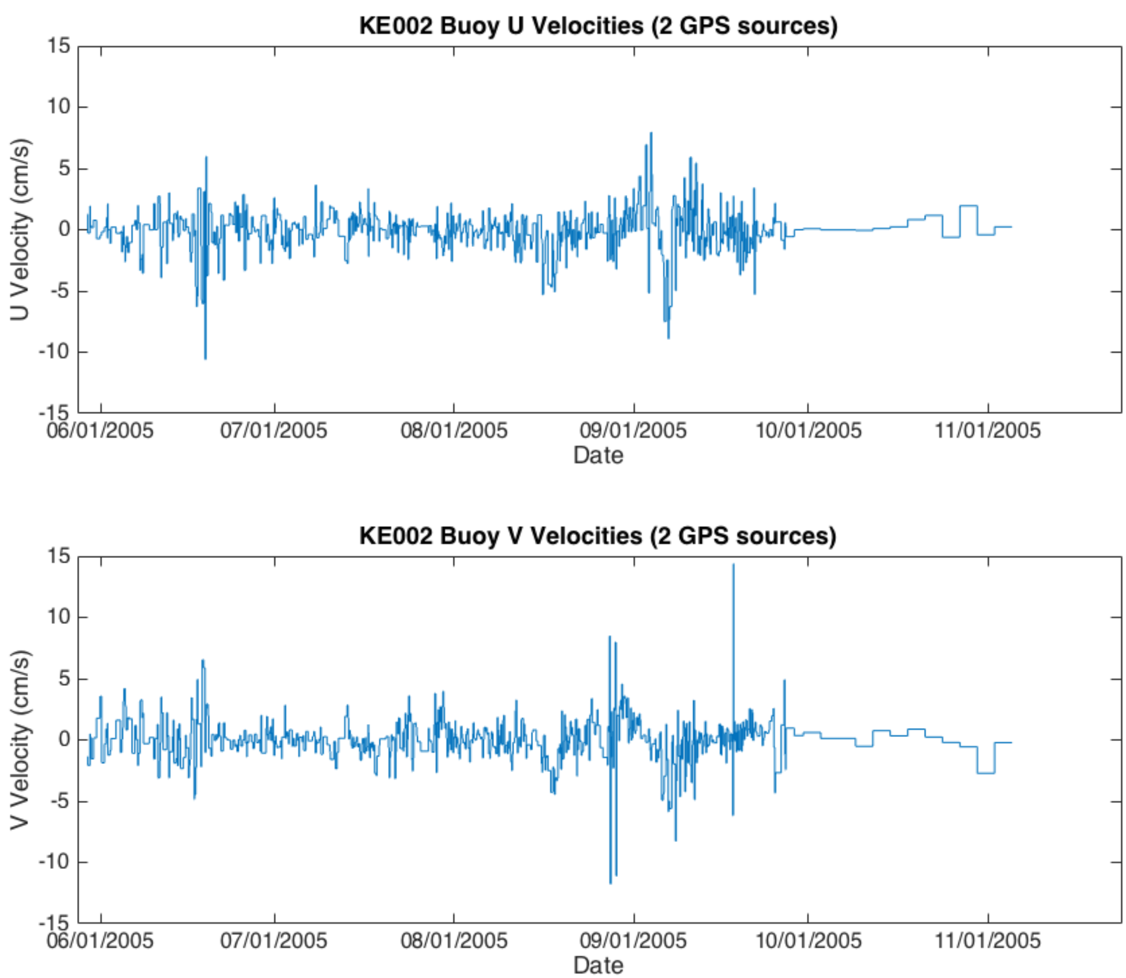

Figure 4: KE002 buoy velocities used to correct currents.

The Sontek current meter at 7m stopped working on June 16, 2005 [167], while the coupled TV module remained functional throughout the deployment. The recovered 7m Sontek files were fragmented, and were pieced together for the short duration over which the instrument was working. The instrument was sent to Sontek for repair, and was returned with a new CPU board for future deployments.

3.3.5 Load Cell

A load cell on the bridle provided tension readings from the mooring. These measurements were intended only for internal engineering diagnostics, and were not made publicly available. For further information on the load cell data, see Lawrence-Slavas et al. 2006.

4.0 References

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5.0 Acknowledgements

S. Brown and S. Moon (both of UW JISAO) processed the ATLAS meteorological, subsurface temperature, pressure and conductivity/salinity data. C. Fey processed the current meter data, and performed additional file formatting. Dr. L. Rainville (formerly of WHOI, now at UW APL) processed the K7 ADCP data.

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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 v1.2 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

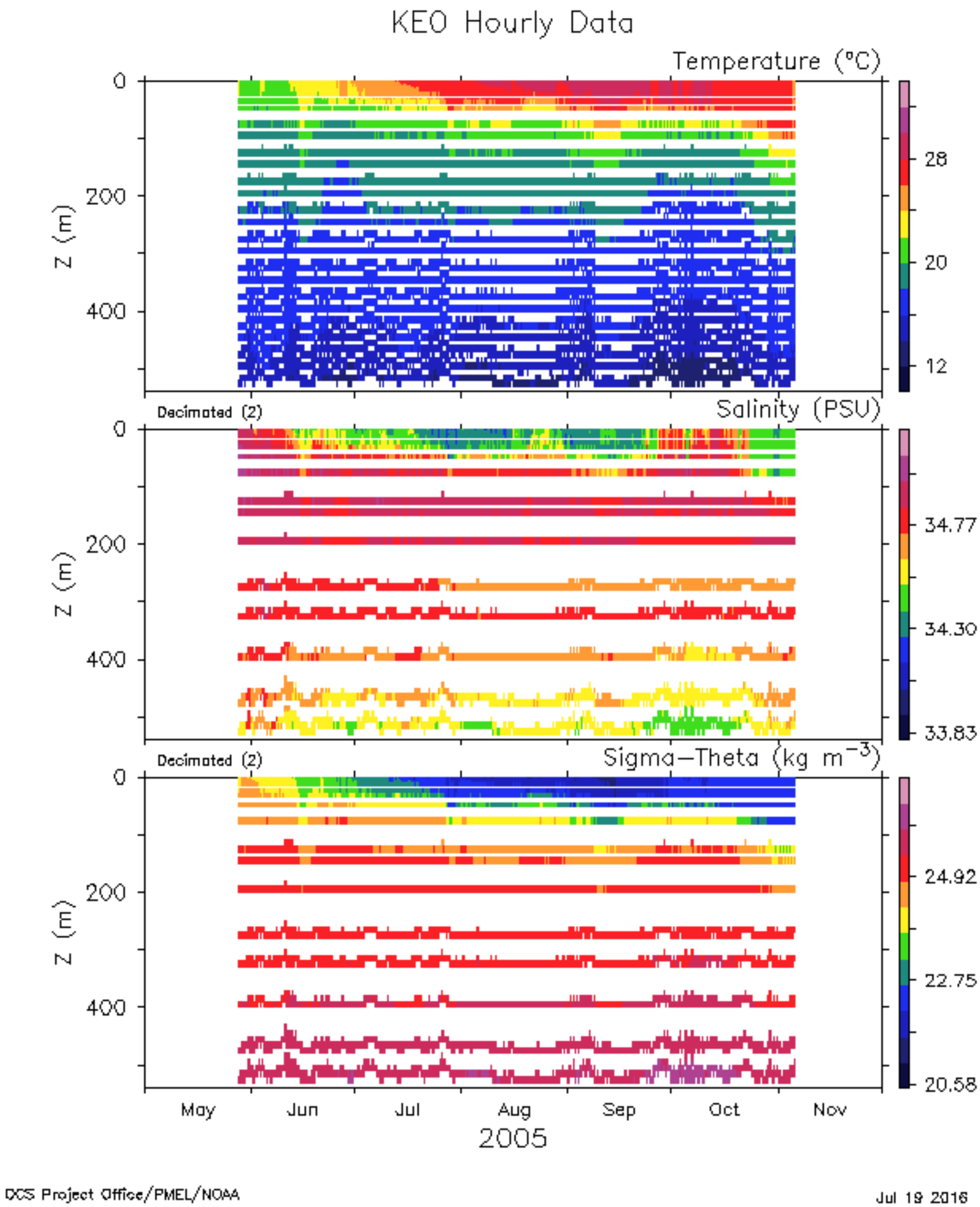

Figure B 1: KE002 subsurface temperature, salinity, and density at hourly resolution (decimated).

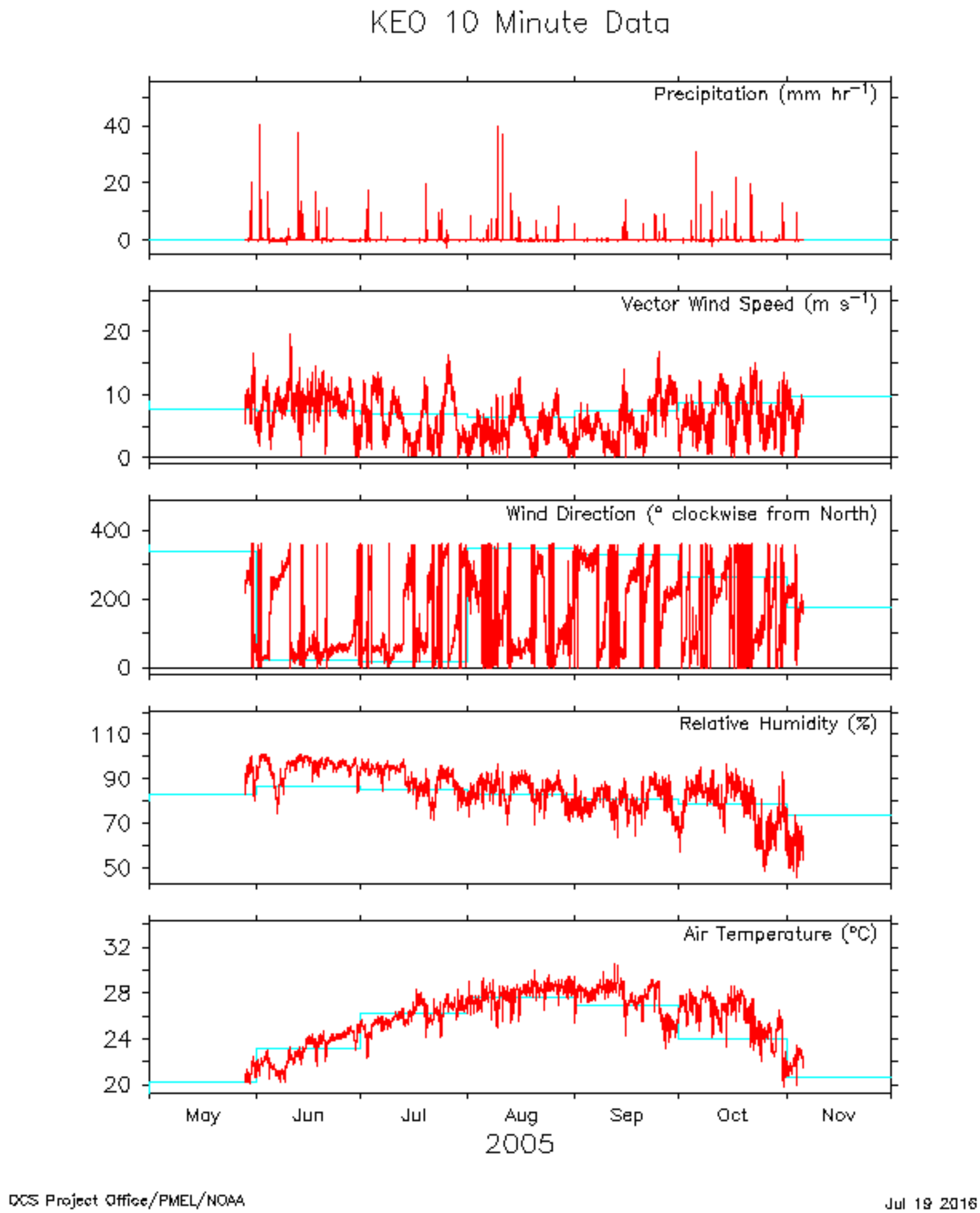

Figure B 2: KE002 high resolution (10-min) surface meteorological data.

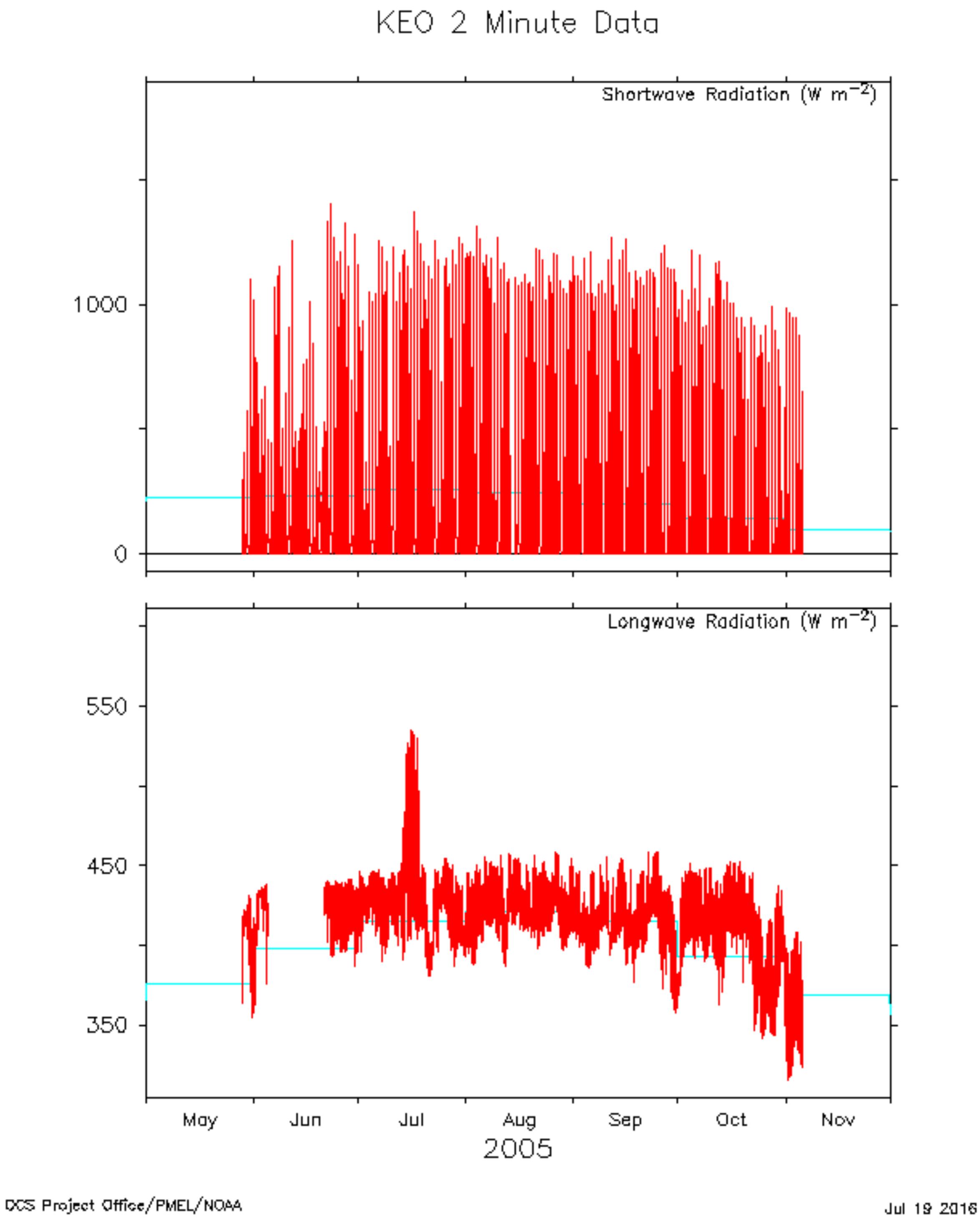

Figure B 3: KE002 high resolution (2-min) radiation data, showing the failed LWR sensor and swap.

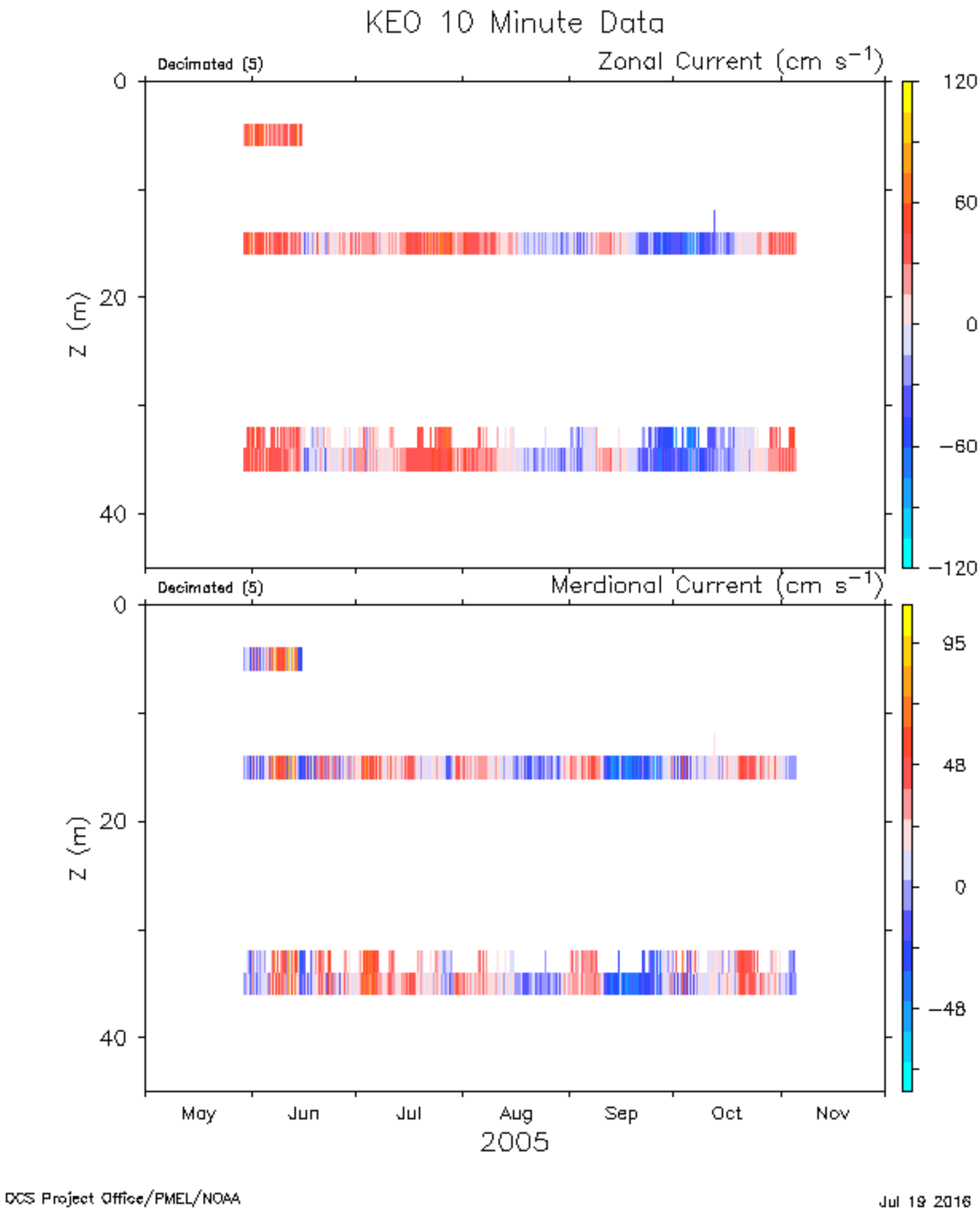

Figure B 4: Zonal and meridional current meter data corrected for buoy motion (decimated). The plot accounts for pressure, creating two adjacent bins for the 35m sensor, as it deviated from nominal depth throughout the deployment.

APPENDIX C: KESS-7 Subsurface Mooring

Mooring Description

As part of the Woods Hole Oceanographic Institution's (WHOI's) Kuroshio Extension System Study (KESS), an array of moorings were deployed in the Kuroshio Extension region (Section 1.0). The KESS-7 (K7) subsurface ADCP mooring was deployed near the OCS KEO buoy, at nominal location 32.4°N 144.6°E. The K7 mooring held an upward-looking, narrow-band Acoustic Doppler Current Profiler (ADCP, S/N 542) borrowed from the NOAA/PMEL/FOCI group. A mooring diagram is shown in figure C1.

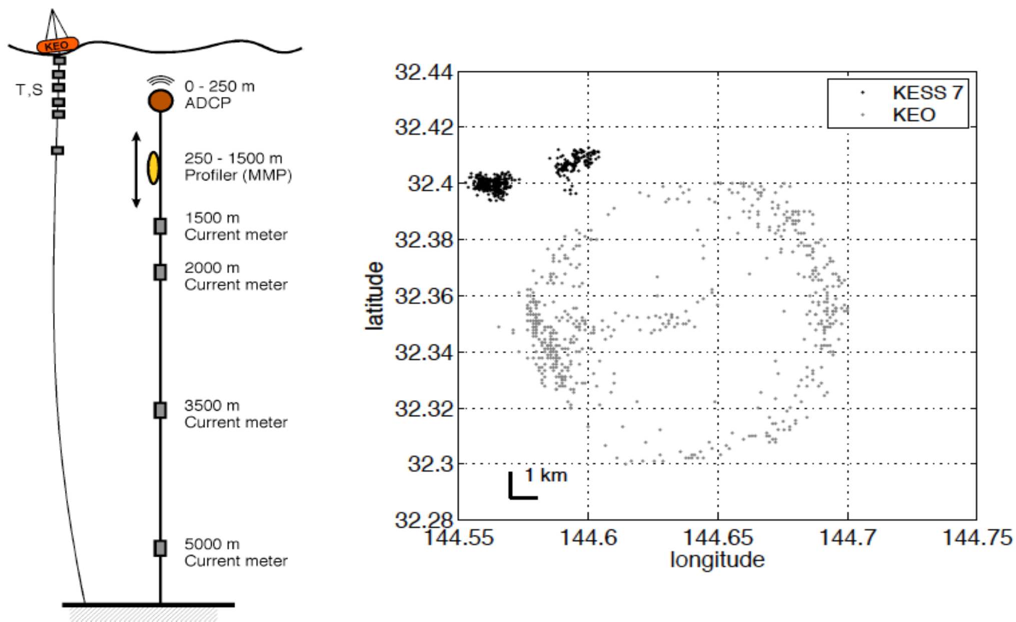

Figure C 1: KESS K7 mooring schematic (left) and proximity to KEO mooring (right).

Data Processing

The K7 ADCP data were initially processed at WHOI. Data were shifted onto a surface-relative depth grid, with 10m bins from the surface to the instantaneous head depth. Deviations from the ADCP's nominal 250m head depth due to mooring motions were accounted for in this processing (Rainville et al. 2009).

Additional processing was done at PMEL to remove side-lobe contamination near the surface. The following equation, provided by the instrument manufacturer, was used to calculate the depths to which side-lobe contamination from the surface occurs:

$$C = R(1-\cos(\theta))$$

R is the depth of the transducer head, θ is the beam angle from vertical (30°), and C is the contamination depth. Any bins shallower than the contamination depth were removed from the final file.

Data Plots

The processed ADCP data from the second K7 deployment are plotted in Figure C2.

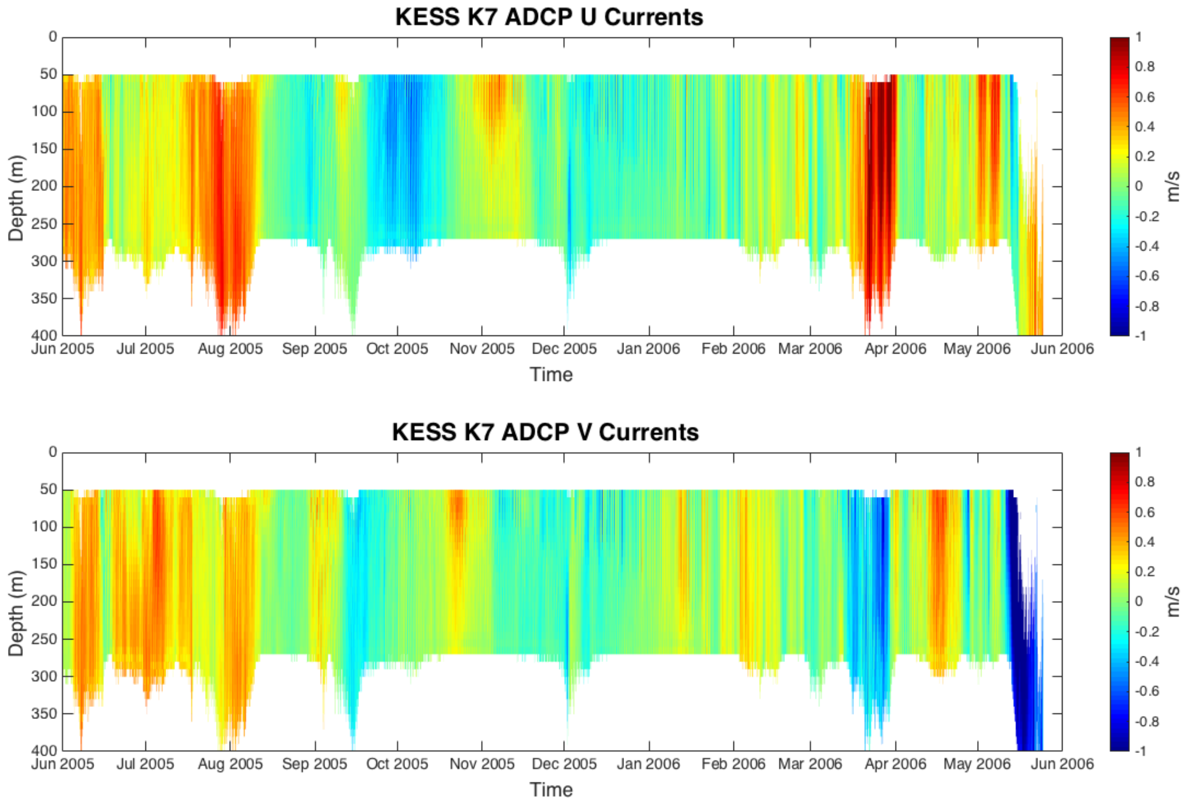

Figure C 2: ADCP U (top) and V (bottom) velocity data from the KESS K7 subsurface mooring.

KESS Resources

Additional data from the KESS project, along with more information, is available through the project website:
http://uskess.whoi.edu

The KESS Data Report can be found here:
http://uskess.whoi.edu/data/KESS Data Report – WHOI subsurface moorings.pdf