2016 SAMOS Data Quality Report

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The authors wish to thank the technicians working onboard participating research vessels. You are the backbone to the data system, which makes the SAMOS Initiative possible and successful. We also thank the operators, captains, and crews of these vessels.

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1. Introduction

This report describes the quantity and quality of observations collected in 2016 by research vessels participating in the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative. The SAMOS initiative focuses on improving the quality of, and access to, surface marine meteorological and oceanographic data collected *in-situ* by automated instrumentation on research vessels (RVs). A SAMOS is typically a computerized data logging system that continuously records navigational (ship position, course, speed, and heading), meteorological (winds, air temperature, pressure, moisture, rainfall, and radiation), and near-surface oceanographic (sea temperature, conductivity, and salinity) parameters while the RV is underway. Measurements are recorded at high-temporal sampling rates (typically 1 minute or less). A SAMOS comprises scientific instrumentation deployed by the RV operator and typically differs from instruments provided by national meteorological services for routine marine weather reports. The instruments are not provided by the SAMOS initiative.

In 2016 the SAMOS data assembly center (DAC) underwent a major server migration and software upgrades that have the effect of ensuring SAMOS data processing will be stable for the next 3-5 years (assuming continued funding for DAC personnel is maintained). The actual process of data management regardless remains unchanged:

Data management at the DAC provides a ship-to-shore-to-user data pathway (Figure 1). SAMOS version 1.0 relies on daily packages of one-minute interval SAMOS data being sent to the DAC at the Florida State University via e-mail attachment. Broadband satellite communication facilitates this transfer as near as possible to 0000 UTC daily. For SAMOS 1.0, a preliminary version of the SAMOS data is made available via web services within five minutes of receipt. All preliminary data undergo common formatting, metadata enhancement, and automated quality control (QC). A data quality analyst examines each preliminary file to identify any major problems (e.g., sensor failures). When necessary, the analyst will notify the responsible shipboard technician via email while the vessel is at sea. On a 10-day delay, all preliminary data received for each ship and calendar day are merged to create daily intermediate files. The merge considers and removes temporal duplicates. For all NOAA vessels and the *Falkor* visual QC is conducted on the intermediate files by a qualified marine meteorologist, resulting in research-quality SAMOS products that are nominally distributed with a 10-day delay from the original data collection date. All data and metadata are version controlled and tracked using a structured query language (SQL) database. All data are distributed free of charge and proprietary holds through the web (http://samos.coaps.fsu.edu/html/) under "Data Access" and long-term archiving occurs at the US National Centers for Environmental Information (NCEI). SAMOS data at NCEI are accessible in monthly packages sorted by ship and have been assigned a collection-level reference and digital object identifier (Smith et al. 2009) to facilitate referencing the SAMOS data in publications.

In 2016, out of 35 active recruits, a total of 31 research vessels routinely provided SAMOS observations to the DAC (Table 1). One additional vessel – the *Melville* – was separated from the SAMOS initiative as of 1 January 2015 but continued to submit data through 8 March 2016 from the dock in San Diego prior to the vessel's transfer to new owners. Her data quality is not analysed herein. SAMOS data providers included the National Oceanographic and Atmospheric Administration (NOAA, 16 vessels), the Woods Hole Oceanographic Institution (WHOI, 2 vessels), National Science Foundation Office of Polar Programs (OPP, 2 vessels), United States Coast Guard (USCG, 1 vessel), University of Hawaii (UH, 1 vessel), University of Washington (UW, 1 vessel), Scripps Institution of Oceanography (SIO, 2 vessels), Bermuda Institute of Ocean Sciences (BIOS, 1 vessel), Schmidt Ocean Institute (SOI, 1 vessel), the Australian Integrated Marine Observing System (IMOS, 2 vessels), the University of Alaska (UA, 1 vessel), and the Louisiana Universities Marine Consortium (LUMCON, 1 vessel). One additional IMOS vessel – the *Aurora Australis* – one additional USCG vessel – the *Polar Sea* – the University of Rhode Island (URI) vessel – the *Endeavor* – and one additional vessel formerly with WHOI and transferred to Oregon State University in March 2012 – *Oceanus* – were active in the SAMOS system but for reasons beyond the control of the SAMOS DAC (e.g., caretaker status, changes to shipboard acquisition or delivery systems, satellite communication problems, etc.) were unable to contribute data in 2016.

IMOS is an initiative to observe the oceans around Australia (see 2008 reference). One component of the system, the "IMOS underway ship flux project" (hereafter referred to as IMOS), is modelled on SAMOS and obtains routine meteorological and surface-ocean observations from one vessel (*Tangaroa)* operated by New Zealand and two vessels (*Investigator* and *Aurora Australis*) operated by Australia. Software problems at IMOS have resulted in the interruption of the data flow from the *Aurora Australis*. In 2015 code was developed at the SAMOS DAC to harvest *Tangaroa* SAMOS data directly from the IMOS THREDDS catalogue; this capability was extended to additionally directly harvest SAMOS data for the new IMOS vessel *Investigator* in late 2016. In addition to running a parallel system to SAMOS in Australia, IMOS is the only international data contributor to SAMOS.

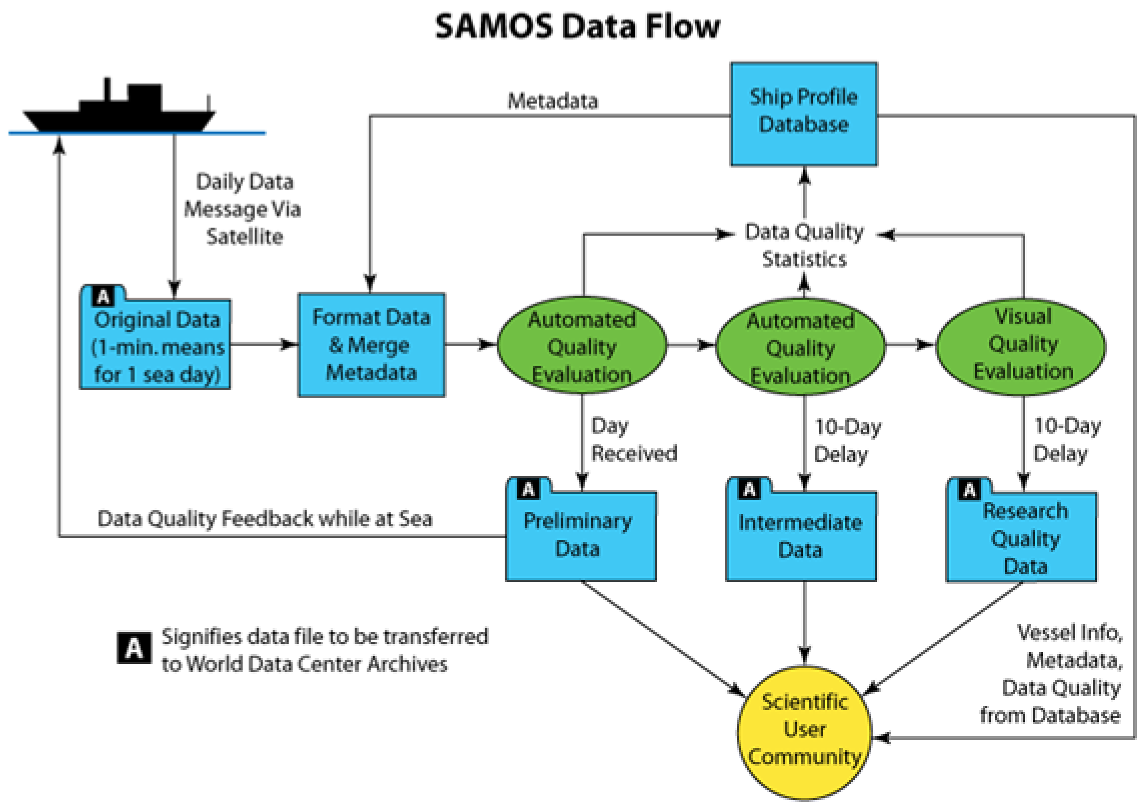

Figure 1: Diagram of operational data flow for the SAMOS initiative in 2016.

Beginning in 2013, funding did not allow for visual quality control procedures for any non-NOAA vessels except the *Falkor*, which is separately supported via a contract with SOI. As such, visual QC for all remaining vessels was discontinued, until such time as funding is extended to cover them. It should be noted that in the case of the *Aurora Australis* and *Tangaroa*, the IMOS project conducted their own visual QC until a personnel change there in June 2013. Only automated QC for the *Investigator*, *Aurora Australis*, and *Tangaroa* occurs at the SAMOS DAC. The quality results presented herein are from the research quality products for all NOAA vessels and the *Falkor*, and automated-only quality control-level (intermediate) products for all remaining vessels. During 2016, the overall quality of data received varied widely between different vessels and the individual sensors on the vessels. Major problems included poor sensor placement that enhanced flow distortion (nearly all vessels experience some degree of flow distortion), sensors suspected of inferior quality (*Rainier*), sensor failures (many vessels), sensors or equipment that remained problematic for extended periods (namely, one of the atmospheric pressure sensors on board the *Falkor*, the wind sensors on board both the *Oregon II* and the *Ron Brown*, and one of the temperature and relative humidity sensors on board the *Falkor*), incorrectly declared data units (*Bigelow* and *Gould*), improperly linked designators (*Falkor* and *Shimada*), and data transmission oversights or issues, including a unique calendar bug inherent in the NOAA SCS system, that created a significant volume of backlogged data (primarily *Atlantic Explorer*, *Robert Gordon Sproul*, *Oscar Elton Sette*, *Ferdinand Hassler*, and *Falkor*).

This report begins with an overview of the vessels contributing SAMOS observations to the DAC in 2016 (section 2). The overview treats the individual vessels as part of a global ocean observing system, considering the parameters measured by each vessel and the completeness of data and metadata received by the DAC. Section 3 discusses the quality of the SAMOS observations. Statistics are provided for each vessel and major problems are discussed. An overview status of vessel and instrumental metadata for each vessel is provided in section 4. Recommendations for improving metadata records are discussed. The report is concluded with the plans for the SAMOS project in 2017. Annexes include a listing of vessel data identified as suspect but not flagged by quality control procedures (Annex A) and web interface instructions for accessing SAMOS observations (Annex B, part 1) and metadata submission by vessel operators (Annex B, part2).

2. System review

In 2016, a total of 35 research vessels were under active recruitment to the SAMOS initiative; 31 of those vessels routinely provided SAMOS observations to the DAC (Table 1). The *Polar Sea* was out of service in 2016, so naturally there was no data from her. The *Aurora Australis* sailed in 2016 but the data processing/delivery systems in place for the IMOS vessels had some failures that have not yet been resolved (partially the result of IMOS funding challenges). In March 2012 stewardship of the *Oceanus* was transferred from WHOI to OSU and she underwent a major refit. *Oceanus* planned to return to SAMOS using the 2.0 data protocol, but this transition will not occur, hence the lack of any data since 2012. In later 2016, however, a dialog was begun regarding restoration of the *Oceanus* using SAMOS 1.0. At the time of the discussions *Oceanus* was undergoing a data acquisition system (DAS) transition to the NOAA-provided DAS, which is readily compliant with the SAMOS program. Real-time data were not received in 2016 from the *Endeavor* because problems with satellite communications limit the *Endeavor's* ability to transmit SAMOS 2.0 formatted data files. New options continue to be explored to transition the *Endeavor* to SAMOS 1.0 in 2017.

In total, 5,247 ship days were received by the DAC for the January 1 to December 31 2016 period, resulting in 7,015,935 records. Each record represents a single (one minute) collection of measurements. Records often will not contain the same quantity of information from vessel to vessel, as each vessel hosts its own suite of instrumentation. Even within the same vessel system, the quantity of information can vary from record to record because of occasional missing or otherwise unusable data. From the 7,015,935 records received in 2016, a total of 136,895,329 distinct measurements were logged. Of those, 5,828,721 were assigned A-Y quality control flags – about 4 percent – by the SAMOS DAC (see section 3a for descriptions of the QC flags). This is around a percentage point lower than that in 2015 (about 5%). Measurements deemed "good data," through both automated and visual QC inspection, are assigned Z flags. In total, fourteen of the SAMOS vessels (the *Tangaroa, Investigator, Healy, Atlantis, Neil Armstrong, Laurence M. Gould, Nathaniel B. Palmer, T.G. Thompson, Kilo Moana, Atlantic Explorer, Pelican, Sikuliaq, Roger Revelle,* and the *Robert Gordon Sproul*) only underwent automated QC. None of these vessels' data were assigned any additional flags, nor were any automatically assigned flags removed via visual QC.

SHIP NAME	CALL SIGN	# of Days	# of Vars	# of Records	# of A-Y Flags	# of All Flags
TOTAL	-	5,247	611	7,015,935	5,828,721	136,895,329
ROGER REVELLE	KAOU	256	24	351,937	337,162	8,343,187
ATLANTIS	KAQP	228	29	311,780	139,453	9,041,620
THOMAS G. THOMPSON	KTDQ	102	21	127,886	94,936	2,649,110
HEALY	NEPP	22	30	21,974	34,810	529,322
INVESTIGATOR	VLMJ	187	31	230,534	273,204	6,720,919
NEIL ARMSTRONG	WARL	170	29	232,771	253,761	6,750,359
NATHANIEL B. PALMER	WBP3210	361	23	515,007	318,895	11,664,558
LAURENCE M. GOULD	WCX7445	364	23	522,777	139,864	11,047,429
KILO MOANA	WDA7827	102	21	140,457	1,105	2,949,597
ATLANTIC EXPLORER	WDC9417	111	26	119,358	23,711	2,638,560
PELICAN	WDD6114	31	16	34,779	4,888	552,096
SIKULIAQ	WDG7520	324	19	464,992	186,858	8,464,740
ROBERT GORDON SPROUL	WSQ2674	355	18	480,678	89,468	8,652,204
HENRY B. BIGELOW	WTDF	116	18	151,600	194,454	2,521,076
OKEANOS EXPLORER	WTDH	152	16	199,837	493,122	3,156,208
PISCES	WTDL	147	16	190,415	367,204	3,035,438
OREGON II	WTDO	181	16	231,581	423,970	3,690,216
THOMAS JEFFERSON	WTEA	35	16	41,349	32,865	646,303
FAIRWEATHER	WTEB	142	13	183,733	120,591	2,191,890
RONALD H. BROWN	WTEC	193	17	257,742	279,556	3,872,664
BELL M. SHIMADA	WTED	210	20	277,514	197,949	5,527,879
OSCAR ELTON SETTE	WTEE	191	16	248,968	66,032	3,961,618
RAINIER	WTEF	73	16	98,866	293,290	1,545,679
REUBEN LASKER	WTEG	168	16	223,716	258,752	3,574,667
FERDINAND HASSLER	WTEK	83	13	106,912	122,723	1,389,856
GORDON GUNTER	WTEO	157	16	199,419	109,547	3,184,314
OSCAR DYSON	WTEP	203	16	271,834	65,546	4,335,112
NANCY FOSTER	WTER	182	14	232,320	110,393	3,240,962
HI'IALAKAI	WTEY	42	19	56,996	45,532	927,700
FALKOR	ZCYL5	175	26	223,433	470,914	5,596,132
TANGAROA	ZMFR	184	17	264,770	278,166	4,493,914

Table 1: CY2016 summary table showing (column three) number of vessel days received by the DAC, (column four) number of variables reported per vessel, (column five) number of records received by DAC per vessel, (column six) total incidences of A-Y flags per vessel, (column seven) total incidences of A-Z flags per vessel.

a. Temporal coverage

As demonstrated in Figure 2, the files received by the DAC from each vessel are not often equally matched to the scheduled days reported by each institution. (*Note that CY2016 scheduling information was not obtainable for the *Tangaroa* prior to this report distribution.) Scheduled days sometimes include days spent at port (denoted with a "P" in Figure 2, when possible), which are assumedly of less interest to the scientific community than those spent at sea. We are therefore not intensely concerned when we do not receive data during port stays, although if a vessel chooses to transmit port data we are pleased to apply automated and visual QC and archive it. Occasionally vessel technicians may be under orders not to transmit data due to vessel location in a maritime exclusive economic zone (EEZ, denoted with a "*" in Figure 2, when known). However, when a vessel is reportedly "at sea" (denoted with an "*S*" in Figure 2, when possible) and we have not received expected underway data, we endeavor to reclaim any available data, usually via email communication with vessel technicians and/or lead contact personnel. For this reason, we perform visual QC on a 10-day delay. SAMOS data analysts strive to follow each vessel's time at sea by focusing on continuity between daily files and utilizing online resources (when available), but as ship scheduling is subject to change and in some cases is unavailable in real time, we may be unaware a vessel is at sea until well after the 10-day delay period. An automated reporting service went live in early

2013 that, among other things, provides interested parties with a summary of ship days received by the DAC for each vessel. This product is available in both PDF and comma-separated values formats and can be emailed out automatically at the end of every month, the intent being that files that were “missed” can be identified and manually sent to the DAC. (Reports are accessed at https://samos.coaps.fsu.edu/html/subscription/index.php with a login ID and password; see Section 4 for additional details.) It should be noted, however, that current funding for the SAMOS initiative would not permit the visual quality control of a large number of “late” files, so it is important that vessel operators and SAMOS data analysts do their best to ensure files are received within the 10 day delayed-mode window. There is also a tool available to the DAC that can alert analysts, via email reporting and a JSON web service (https://samos.coaps.fsu.edu/html/webservices.php), when a vessel has not submitted data for a chosen amount of days, providing one additional step towards ensuring no “missed/late” data.

In Figure 2, we directly compare the data we've received (green and blue) to final 2016 ship schedules provided by each vessel's institution. (*Note again that the schedule was not obtained for the *Tangaroa.*) A “blue” day denotes that the data file was received past the 10-day delayed-mode window (or otherwise entered the SAMOS processing system well past the window) and thus missed timely processing and visual quality control, although processing (and visual QC where applicable) was eventually applied. (It must be noted, though, that “late” data always incurs the risk of not being visually quality controlled, based on any time or funding constraints.) Days identified on the vessel institution’s schedule for which no data was received by the DAC are shown in grey. Within the grey boxes, an italicized "*S*" indicates a day reportedly "at sea." As an added metric, Table 2 attempts to measure each vessel’s actual submission performance by matching scheduled at-sea (or assumed at-sea) days to the availability of SAMOS data files for those days. All data received for 2016, with the exceptions of *Tangaroa* and *Investigator,* has been archived at the NCEI. Through agreement with IMOS, we receive data for the *Tangaroa*, the *Investigator*, and the *Aurora Australis* and for these vessels perform automated QC only. IMOS data is archived within the IMOS DAC-eMarine Information Infrastructure (eMII).

JANUARY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU																															
KAQP																															
KTDQ	P	P	P	P	*S*	*S*	P	P	P		*S*						P	*S*	*S*	*S*	*S*	*S*	*S*	*S*							P
NEPP																															
VLMJ																															
VNAA	*S*	*S*	*S*	*S*	*S*	*S*	*S*	P	P	P	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	P	P	P	P	P	P	P	P	P	P
WARL																															
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417		*S*	*S*	P																											
WDD6114														P	P	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	*S*	P	P				
WDG7520																															
WECB																															
WSQ2674																															
WTDF																															
WTDH																				*S*											
WTDL																															
WTDO																															
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WTEE																															
WTEF																															
WTEG																														*S*	
WTEK																															
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WTEP																				*S*	*S*	*S*								*S*	
WTER					*S*																										
WTEY																															
ZCYL5																*S*		*S*	*S*									*S*	*S*	*S*	*S*
ZMFR																															

FEBRUARY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29		
KAOU															*S*																
KAQP															*S*	*S*	*S*	*S*	*S*			*S*	*S*	*S*	*S*	*S*	*S*	*S*			
KTDQ	P	P	P	P	P				P	P	P	P									P					*S*	P	P	P		
NEPP																															
VLMJ																															
VNAA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	*S*	*S*	*S*	*S*	*S*	*S*	P	P	P	P	P	P	P	P	P		
WARL																															
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417																												P	*S*		
WDD6114												P	*S*	*S*	*S*	*S*	*S*	P													
WDG7520																															
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WTER																															
WTEY																															
ZCYL5	*S*					*S*	*S*	*S*	*S*	*S*	*S*																				
ZMFR																															

Figure 2: 2016 calendar showing (**green** and **blue**) ship days received by DAC and (**grey**) additional days reported afloat by vessels; "*S*" denotes vessel reportedly at sea, "P" denotes vessel reportedly at port, "*" denotes vessel known to be in a maritime EEZ with no expectation of data. Vessels are listed by call sign (see Table 1).

MARCH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU																															
KAQP																															
KTDQ																															*
NEPP																															
VLMJ																							S								
VNAA	P	S	S	S	S	S	S	S	S	S	S	S																			
WARL																															
WBP3210																															
WCX7445																															
WDA7827																		P	P	S	S										
WDC9417			S	S	P	P	S	S	S	S	S	P						P	P	P	S		S			P	P	P			
WDD6114						S	P								P	S	S	S	S	S	S	S	S	S	S	S	S	P	S	S	S
WDG7520																															
WECB																															
WSQ2674																															
WTDF																															
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WTEY																															
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ZMFR																															

APRIL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
KAOU																															
KAQP				P													P	S													
KTDQ	*	*	*	*	*											S										S	S	S	S	S	
NEPP																															
VLMJ														S		S	P	P	P	P	P	P	P	P							
VNAA																															
WARL			S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	P	
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417		P	S										P						S	P	P	P						S	P	S	
WDD6114	S	S	S	S	S	S	S	S	S	S	S	S	P	S	S	S	S	S	S	S	S	S	S	S	P	S					
WDG7520																															
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WSQ2674																															
WTDF				S	S	S																S									
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WTEY				S													S													S	
ZCYL5							S																								
ZMFR																															

(Figure 2: cont'd)

MAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU												S	S	S	S	S	P	P	P	S	S	S	S	S	S	S	S	S	S	P	P
KAQP										P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
KTDQ				S																S	P					P	P	P	P	P	P
NEPP										S	S		S																		
VLMJ								S																							
VNAA																															
WARL	P	S	S	S	S	S	S	S	S	P	P	S	S	S	S	P	S	S	S	S	S	S	S	S			S				
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417	S	P										P	S														S	P			
WDD6114			S	P	P		S	P	P					S	S					S	S	P	P	P	S	S	S	P			
WDG7520																															
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WTEP			S														S	S									S	S	S		
WTER		S																													
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ZCYL5				S	S																										
ZMFR																															

JUNE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
KAOU	P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	P	S	S	S	S	P	
KAQP	S	S	S	S	S	P	P												S	S	S	S	S	S	S	P	S	S	S	S	
KTDQ	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P																
NEPP																									S	S		S	S		
VLMJ																															
VNAA																															
WARL																											P				
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417					P	S				P	P									P	P							P	S		
WDD6114												P	P	S		S	S						S	S	S	P	P	P	S	S	
WDG7520																															
WECB																															
WSQ2674																															
WTDF						S	S	S																							
WTDH																															
WTDL																						S	S	S						S	
WTDO																				S											
WTEA																															
WTEB					S															S								S			
WTEC																						S									
WTED												S																			
WTEE																															
WTEF																				S											
WTEG												S																			
WTEK																								S	S	S	S	S	S	S	
WTEO			S																	S							S	S	S		
WTEP												S																			
WTER																											S				
WTEY	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S																
ZCYL5				S																S	S										
ZMFR																															

(Figure 2: cont'd)

JULY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU	P	P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
KAQP	S	S	S	S	S	S	S	S	S	S	S	S	S																		
KTDQ																															
NEPP		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
VLMJ																															
VNAA																															
WARL																															
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417					P		P	S				S	P							P		S	S	S	S	S	P	S		P	
WDD6114	S	S	S	S		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
WDG7520																															
WECB																															
WSQ2674							P									S	P														
WTDF																		S													
WTDH									S	S																	S	S	S	S	S
WTDL	S	S													S																
WTDO											S	S								S											
WTEA																															
WTEB					S																										
WTEC													S	S																	
WTED													S																		
WTEE																															
WTEF					S	S	S	S	S	S	S	S																			
WTEG																									S	S	S	S	S	S	S
WTEK	S							S	S	S	S	S	S	S	S										S	S	S	S	S	S	S
WTEO															S																
WTEP			S			S																			S						
WTER																															
WTEY												S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S		
ZCYL5																															
ZMFR																															

AUGUST	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU	S	S	S	S		P	P	P																							
KAQP								P																	P						
KTDQ																															
NEPP	S	S	S	S	S	S	S	S	S	S							S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
VLMJ																															
VNAA																															
WARL																															
WBP3210																												S			
WCX7445																															
WDA7827																															
WDC9417	P	P										S	P		P			S			S	P							P		S
WDD6114	S	S	P	P																	P	S	S	P	P	S	S	S	S	S	S
WDG7520																															
WECB																															
WSQ2674																															
WTDF										S	S																				
WTDH	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S												
WTDL																			S												
WTDO																												S			
WTEA																															
WTEB																														S	
WTEC																															
WTED																															
WTEE			S																						S						
WTEF																															
WTEG	S	S	S					S	S	S	S				S	S	S	S	S												
WTEK	S	S	S	S	S			S	S	S	S	S	S	S	S	S	S	S	S				S	S	S	S	S	S	S	S	S
WTEO					S																					S					
WTEP																	S														
WTER																															
WTEY																													S	S	S
ZCYL5																															
ZMFR																															

(Figure 2: cont'd)

SEPTEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
KAOU																															
KAQP																															
KTDQ																															
NEPP	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
VLMJ																															
VNAA																															
WARL																															
WBP3210																															
WCX7445																											S				
WDA7827																															
WDC9417	P					P												P		S			S	P	P			P			
WDD6114	S	S	S	S	S	S	S	S	S	P	P													P	S	S	S	P			
WDG7520																															
WECB																															
WSQ2674																	S	P	P	P	P	P	P	P	P	P					
WTDF	S					S	S						S	S	S	S	S	S	S	S	S	S	S				S	S	S	S	
WTDH																														S	
WTDL				S	S	S	S																						S	S	
WTDO															S																
WTEA																										S	S	S	S	S	
WTEB														S		S															
WTEC																															
WTED																														S	
WTEE						S																									
WTEF						S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S			S	S	S	S	S	
WTEG					S																										
WTEK	S	S				S	S	S											S	S	S	S	S	S	S	S	S	S	S	S	
WTEO																															
WTEP						S		S	S	S	S	S																			
WTER									S								S	S													
WTEY	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	
ZCYL5																															
ZMFR																															

OCTOBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU																															
KAQP																															
KTDQ																															
NEPP	S	S	S	S	S				S	S	S	S	S	S	S																
VLMJ																															
VNAA																			P	P	S	S	P	S	S	P	S	S	S	S	S
WARL							P																								
WBP3210																															
WCX7445																															
WDA7827																															
WDC9417								S	S	S	S					P	P	S	S	S	S	S	P	P	S	S	S	S	S	S	P
WDD6114	P	S	S	S	S	S	S	S	P			P	S	S	S	S	S	S	S	S	S	S	P	P	S	S	P				
WDG7520																															
WECB																															
WSQ2674																															
WTDF	S	S	S	S	S	S	S				S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S			
WTDH																															
WTDL													S																		
WTDO							S														S										
WTEA	S	S	S																		S	S						S			
WTEB												S																			
WTEC																						S									
WTED													S	S	S	S															
WTEE						S																									
WTEF	S	S	S	S	S	S	S			S	S	S	S	S	S	S	S	S	S	S	S			S	S	S	S	S	S	S	S
WTEG													S							S	S	S	S	S	S	S				S	S
WTEK			S	S	S	S	S	S	S	S	S	S	S	S			S	S										S			S
WTEO	S	S										S	S	S	S	S	S	S	S	S	S	S	S	S						S	
WTEP							S																								
WTER					S	S	S	S	S	S	S	S																			
WTEY																															
ZCYL5																															
ZMFR																															

(Figure 2: cont'd)

NOVEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
KAOU																														
KAQP																														
KTDQ																														
NEPP																														
VLMJ																														
VNAA	S	S	S	S	S	S	S	S	S	S	S	P	P	P	P	P	P	P	S	S	S	S	S	S	S	S	S	S	S	S
WARL																														
WBP3210																														
WCX7445																														
WDA7827																							P	S						
WDC9417	P		S	P	P	P	P	P	P	P	P	P	P	P	P	P						S	P	P	P	P	P	P	P	P
WDD6114																														
WDG7520																									S		S	S	S	P
WECB																														
WSQ2674																														
WTDF										S	S	S	S																	
WTDH																														
WTDL								S	S	S	S							S	S	S	S	S	S					S	S	S
WTDO						S														S	S									
WTEA	S										S	S	S	S	S	S	S	S	S										S	S
WTEB																													S	
WTEC							S					S				S	S				S	S	S							
WTED																														
WTEE				S																										
WTEF	S	S	S	S	S	S	S	S	S	S					S				S											
WTEG	S	S																			S	S	S							
WTEK	S	S	S	S	S	S	S	S	S	S				S	S	S	S	S												
WTEO														S	S	S	S					S						S	S	S
WTEP																														
WTER										S																			S	S
WTEY	S	S	S	S	S	S	S	S	S	S	S	S																		
ZCYL5									S																				S	S
ZMFR																														

DECEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
KAOU																															
KAQP																															
KTDQ																															
NEPP																															
VLMJ																															
VNAA	S	S	S	P	P	P	P	S	S	S	S	S	S	S	S	S	S	S	S	P	P	P	P	P	P	P	S	S	P	P	P
WARL																															
WBP3210																															
WCX7445																															
WDA7827				S																											
WDC9417	P	P	P		P	S	S	P	P	P	P	S	S	S	S	S	P	S	S	P											
WDD6114									P	S	S	S	S	S	S	S	P														
WDG7520	P	S		S																											
WECB																															
WSQ2674																															
WTDF																															
WTDH	S	S						S							S	S															
WTDL	S																														
WTDO		S	S	S																											
WTEA	S																				S	S	S								
WTEB			S	S	S																										
WTEC									S													S	S	S				S	S	S	
WTED												S	S																		
WTEE																															
WTEF																															
WTEG																															
WTEK																															
WTEO	S	S	S	S																											
WTEP												S																			
WTER									S				S																		
WTEY																															
ZCYL5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S											
ZMFR																															

(Figure 2: cont'd)

NOAA

Ship Name	Bell M. Shimada	Fairweather	Ferdinand Hassler	Gordon Gunter	Henry Bigelow	Hi'ialakai	Nancy Foster	Okeanos Explorer
Call Sign/ Ship Code	WTED/SH	WTEB/FA	WTEK/FH	WTEO/GU	WTDF/HB	WTEY/HI	WTER/NF	WTDH/EX
# SDAL scheduled days	223	149	151	205	170	146	176	185
# matching SAMOS days	209	121	50	147	113	42	156	146
→% received	94%	81%	33%	72%	66%	29%	89%	79%

NOAA (cont'd)

Ship Name	Oregon II	Oscar Dyson	Oscar E. Sette	Pisces	Rainier	Reuben Lasker	Ronald Brown	Thomas Jefferson
Call Sign/ Ship Code	WTDO/OT	WTEP/OD	WTEE/OS	WTDL/PI	WTEF/RA	WTEG/RL	WTEC/RB	WTEA/TJ
# SDAL scheduled days	191	218	197	164	116	207	196	59
# matching SAMOS days	175	190	185	133	42	163	176	32
→% received	92%	87%	94%	81%	36%	79%	90%	54%

TOTAL SDAL scheduled days:	2753
TOTAL matching SAMOS days:	2080
OVERALL RATIO:	76%

OPP

Ship Name	Laurence M. Gould	Nathaniel B. Palmer
Call Sign	WCX7445	WBP3210
# scheduled days	113	223
# matching SAMOS days	113	222
→% received	100%	100%

TOTAL scheduled days:	336
TOTAL matching SAMOS days:	335
OVERALL RATIO:	100%

SIO

Ship Name	Robert G. Sproul	Roger Revelle
Call Sign	WSQ2674	KAOU
# scheduled at-sea days	52	271
# matching SAMOS days	50	195
→% received	96%	72%

TOTAL scheduled at-sea days:	323
TOTAL matching SAMOS days:	245
OVERALL RATIO:	76%

Table 2: 2016 data submission performance metrics, listed by institution and ship. Note that where official schedules specified "at sea" days, only those days were counted. In all other cases "at sea" was assumed and scheduled days were counted as-is. Note also that while SAMOS days follow GMT, ship schedules may not. This leaves room for some small margin of error. Lastly, note that any transit through maritime EEZs may preclude data transmission. Public ship schedule resources are listed in the References, where possible.

WHOI		
Ship Name	R/V Atlantis	R/V Neil Armstrong
Call Sign	KAQP	WARL
TOTAL scheduled at-sea days	243	156
TOTAL matching SAMOS days	180	108
→% received	74%	69%
TOTAL scheduled at-sea days:	399	
TOTAL matching SAMOS days:	288	
OVERALL RATIO:	72%	

	BIOS	IMOS	LUMCON	SOI	UAF	UHI	USCGC	UW
Ship Name	Atlantic Explorer	Investigator	Pelican	Falkor	Sikuliaq	Kilo Moana	Healy	Thomas G. Thompson
Call Sign	WDC9417	VLMJ	WDD6114	ZCYL5	WDG7520	WDA7827	NEPP	KTDQ
TOTAL scheduled at-sea days	155	92	176	159	238	105	119	118
TOTAL matching SAMOS days	92	89	26	114	232	101	15	93
OVERALL RATIO:	59%	97%	15%	72%	97%	96%	13%	79%

(Table 2: cont'd)

b. Spatial coverage

Geographically, SAMOS data coverage continues to be fairly comprehensive in 2016. Cruise coverage for the January 1, 2016 to December 31, 2016 period (Figure 3) again includes Antarctic/Southern Ocean exposure and the Strait of Magellan (*Palmer* and *Gould*), exposure in Alaskan waters (*Fairweather*, *Dyson*, and *Sikuliaq*), the far Northern Atlantic (*Neil Armstrong)*, and samples along the northern Caribbean island coastlines, from Cuba to Puerto Rico (*Nancy Foster*). The *Roger Revelle* again sampled the Indian Ocean, the *Falkor* cruised both the Philippine and South China Seas, and the *Investigator* and *Tangaroa* blanketed the waters on the eastern sides of Australia and New Zealand, respectively. The *Atlantic Explorer* provided a broad sample of the Atlantic (including Bermuda), while the *Ron Brown*, *Oscar Elton Sette*, *Okeanos Explorer,* and *Healy* together do the same for the Pacific. Natively, the western coastal United States is heavily covered by, among others, the *Bell M. Shimada*, *Rainier*, *Reuben Lasker*, and *Atlantis*, with additional coverage of the western Mesoamerican coastline by the *T.G. Thompson* and *Atlantis*; the *Atlantis* even provided a transit through the Panama Canal. The eastern coastal waters of the United States are thoroughly canvassed from the southern tip of Florida all the way up to Nova Scotia by the *Gordon Gunter*, *Henry Bigelow*, *Ferdinand Hassler*, *Pisces*, and *Thomas Jefferson*, among others. The northern Gulf of Mexico is virtually covered by the *Oregon II*, *Pelican*, and *Gordon Gunter*, with some additional coverage in the southwestern Gulf by the *Pelican*. Hawai'ian waters are well sampled by the *Oscar Elton Sette*, *Kilo Moana*, and *Hi'ialakai*.

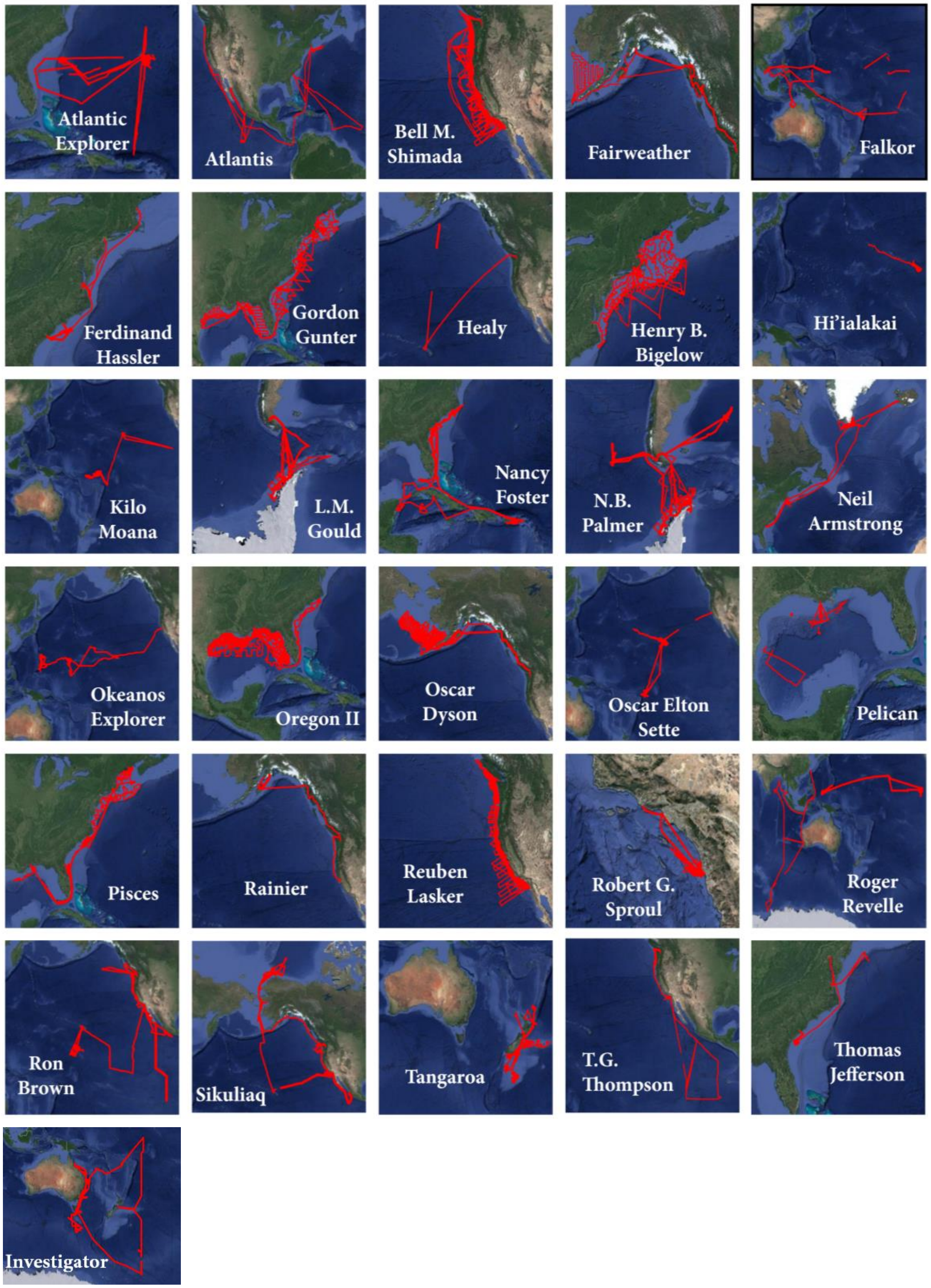


Figure 3: Cruise maps plotted for each vessel in 2016.

c. Available parameter coverage

The core meteorological parameters – earth relative wind speed and direction, atmospheric pressure, and air temperature and relative humidity – are reported by all ships. Most ships also report the oceanographic parameter sea temperature. Many SAMOS vessels additionally report precipitation accumulation, rain rate, longwave, shortwave, net, and photosynthetically active radiations, along with seawater conductivity and salinity. Additionally, the *Healy*, *Roger Revelle*, and *Thomas Jefferson* are all capable of providing dew point temperature, although only the *Healy* and the *Thomas Jefferson* did so in 2016. The *Jefferson* is also the only vessel set up to provide wet bulb temperature, and did so in 2016. A quick glance at Table 4 (located in Section 4) shows which parameters are reported by each vessel: those boxes in columns 6 through 26 with an entry indicate a parameter was enabled for reporting and processing in 2016. (Further detail on Table 4 is discussed in Section 4.) Some vessels furnish redundant sensors, which can be extremely helpful for visually assessing data quality. Again referring to Table 4, those boxes in columns 6 through 26 with multiple entries indicate the number of redundant sensors available for reporting and processing in 2016; boxes with a single entry indicate the existence of a single sensor.

3. Data quality

a. SAMOS quality control

Definitions of A-Z SAMOS quality control flags are listed in Table 3. It should be noted that no secondary automated QC was active in 2016 (SASSI), so quality control flags U-Y were not in use. If a coded variable does not contain an integer pointer to the flag attribute it is assigned a "special value" (set equal to -8888). A special value may also be set for any overflow value that does not fit the memory space allocated by the internal SAMOS format (e.g., character data value received when numeric value was expected). A "missing value" (set equal to -9999) is assigned for any missing data across all variables except time, latitude, and longitude, which must always be present. In general, visual QC will only involve the application of quality control flags H, I, J, K, M, N and S. Quality control flags J, K, and S are the most commonly applied by visual inspection, with K being the catchall for the various issues common to most vessels, such as (among others) steps in data due to platform speed changes or obstructed platform relative wind directions, data from sensors affected by stack exhaust contamination, or data that appears out of range for the vessel's region of operation. M flags are primarily assigned when there has been communication with vessel personnel in which they have dictated or confirmed there was an actual sensor malfunction. Port (N) flags are reserved for the latitude and longitude parameters and are rarely used, in an effort to minimize over-flagging. The primary application of the port flag occurs when a vessel is known to be in dry dock. The port flag may also be applied, often in conjunction with flags on other parameters, to indicate that the vessel is confirmed (visually or via operator) in port and any questionable data are likely attributable to dockside structural interference, although this practice is traditionally only used in extreme cases. (We note that, owing to a timeworn visual flagging platform, the H flag is not routinely used, in order to achieve expeditious flagging.) SAMOS data analysts may also apply Z flags to data, in effect removing flags that were applied by automated QC. For example, B flagging is dependent on latitude and occasionally a realistic value is assigned a B flag simply because it occurred very close to a latitude boundary. This happens with sea temperature from time to time in the extreme northern Gulf of Mexico – TS values of 32˚C or 33ºC are not unusual there in the summer, but portions of the coastline are north of 30 degrees latitude and thus fall into a region where such high temperature are coded as "out of bounds." In this case the B flags would be removed by the data analyst and replaced with good data (Z) flags.

Flag	Description
A	Original data had unknown units. The units shown were determined using a climatology or some other method.
B	Original data were out of a physically realistic range bounds outlined.
C	Time data are not sequential or date/time not valid.
D	Data failed the T>=Tw>=Td test. In the free atmosphere, the value of the temperature is always greater than or equal to the wet-bulb temperature, which in turn is always greater than or equal to the dew point temperature.
E	Data failed the resultant wind re-computation check. When the data set includes the platform's heading, course, and speed along with platform relative wind speed and direction, a program re-computes the earth relative wind speed and direction. A failed test occurs when the wind direction difference is >20 or the wind speed difference is >2.5 m/s.
F	Platform velocity unrealistic. Determined by analyzing latitude and longitude positions as well as reported platform speed data.
G	Data are greater than 4 standard deviations from the ICOADS climatological means (da Silva et al. 1994). The test is only applied to pressure, temperature, sea temperature, relative humidity, and wind speed data.
H	Discontinuity found in the data.
I	Interesting feature found in the data. More specific information on the feature is contained in the data reports. Examples include: hurricanes passing stations, sharp seawater temperature gradients, strong convective events, etc.
J	Data are of poor quality by visual inspection, DO NOT USE.
K	Data suspect/use with caution – this flag applies when the data look to have obvious errors, but no specific reason for the error can be determined.
L	Oceanographic platform passes over land or fixed platform moves dramatically.
M	Known instrument malfunction.
N	Signifies that the data were collected while the vessel was in port. Typically these data, though realistic, are significantly different from open ocean conditions.
O	Original units differ from those listed in the *original_units* variable attribute. See quality control report for details.
P	Position of platform or its movement is uncertain. Data should be used with caution.
Q	Questionable – data arrived at DAC already flagged as questionable/uncertain.
R	Replaced with an interpolated value. Done prior to arrival at the DAC. Flag is used to note condition. Method of interpolation is often poorly documented.
S	Spike in the data. Usually one or two sequential data values (sometimes up to 4 values) that are drastically out of the current data trend. Spikes for many reasons including power surges, typos, data logging problems, lightning strikes, etc.
T	Time duplicate.
U	Data failed statistical threshold test in comparison to temporal neighbors. This flag is output by automated Spike and Stair-step Indicator (SASSI) procedure developed by the DAC.
V	Data spike as determined by SASSI.
X	Step/discontinuity in data as determined by SASSI.
Y	Suspect values between X-flagged data (from SASSI).
Z	Data passed evaluation.

Table 3: Definitions of SAMOS quality control flags

b. 2016 quality across-system

This section presents the overall quality from the system of ships providing observations to the SAMOS data center in 2016. The results are presented for each variable type for which we receive data and are broken down by month. The number of individual 1 minute observations varies by parameter and month due to changes in the number of vessels at sea and transmitting data.

We note that while the *Melville's* data quality was not monitored in 2016 and is not discussed in this report (she was officially "separated" from SAMOS in 2015), she nevertheless transmitted data to us through early March and thus underwent automatic SAMOS processing/automated QC. Any automated QC flags her data may have incurred are not exempted from the overall quality figures in this section.

The quality of SAMOS atmospheric pressure data is generally good (Figure 4). The most common problems with the pressure sensors are flow obstruction and barometer response to changes in platform speed. Unwanted pressure response to vessel motion can be avoided by ensuring good exposure of the pressure port to the atmosphere (not in a lab, bridge, or under an overhanging deck) and by using a Gill-type pressure port. Note that *Falkor's* P data was almost entirely J-flagged (poor quality) for most of 2016 (January through September). The uptick in flagging seen in April and May is likely attributed to the *Hassler*. The increase in flagging of P2 seen in August references the *Revelle*, and those in January and September are likely from the *Falkor*. (All issues are documented in the individual vessel description in section 3c for details). The special values seen in P3 must be attributed to *Atlantis* as only she and *Healy* report that parameter and the *Healy's* data transmission was limited pretty much to the month of June in 2016. The details surrounding the special values, however, are unknown.

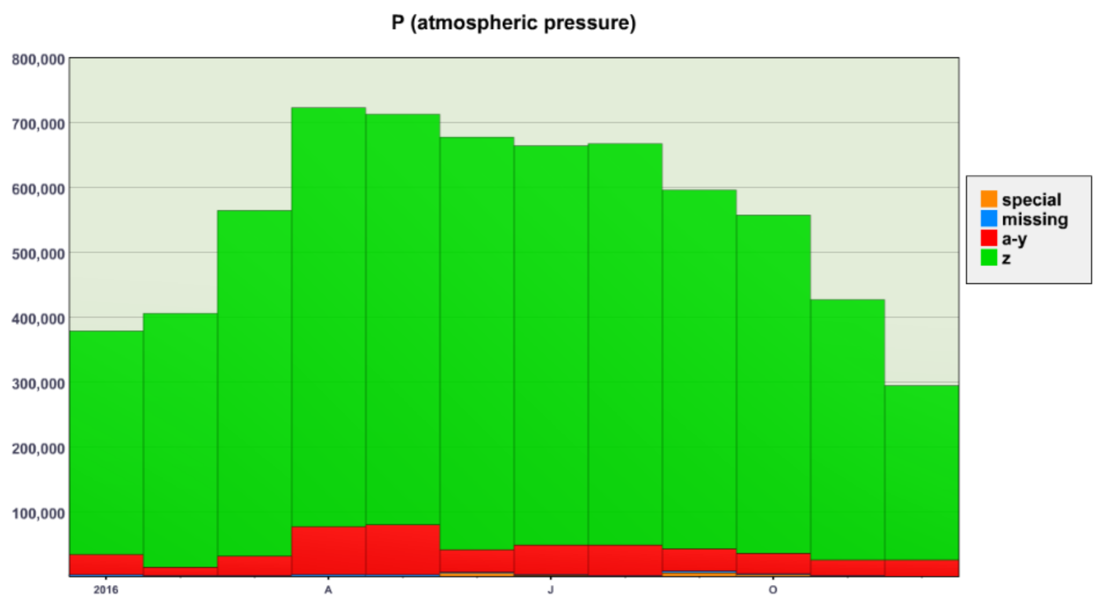
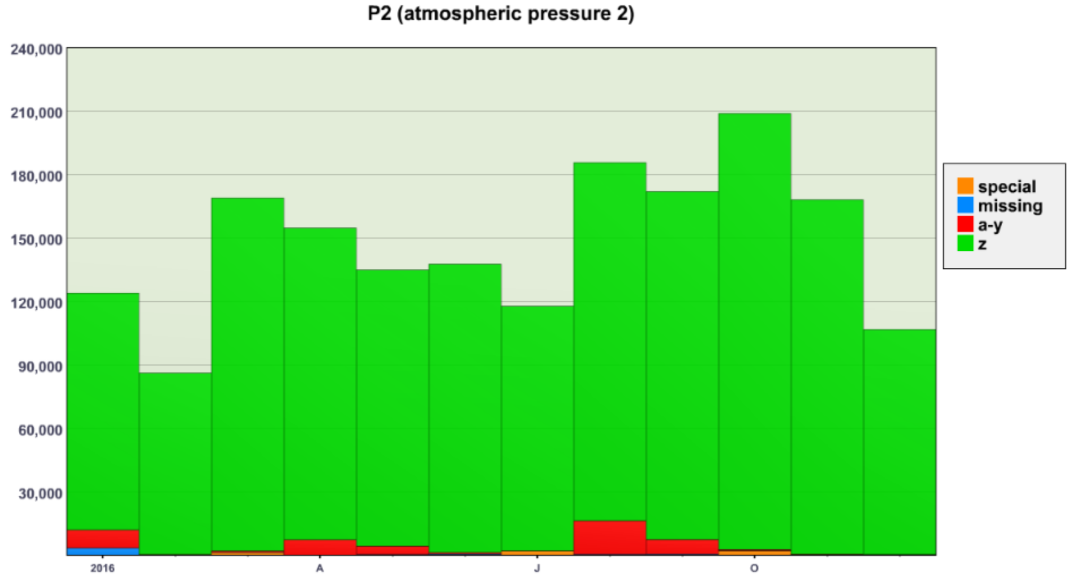
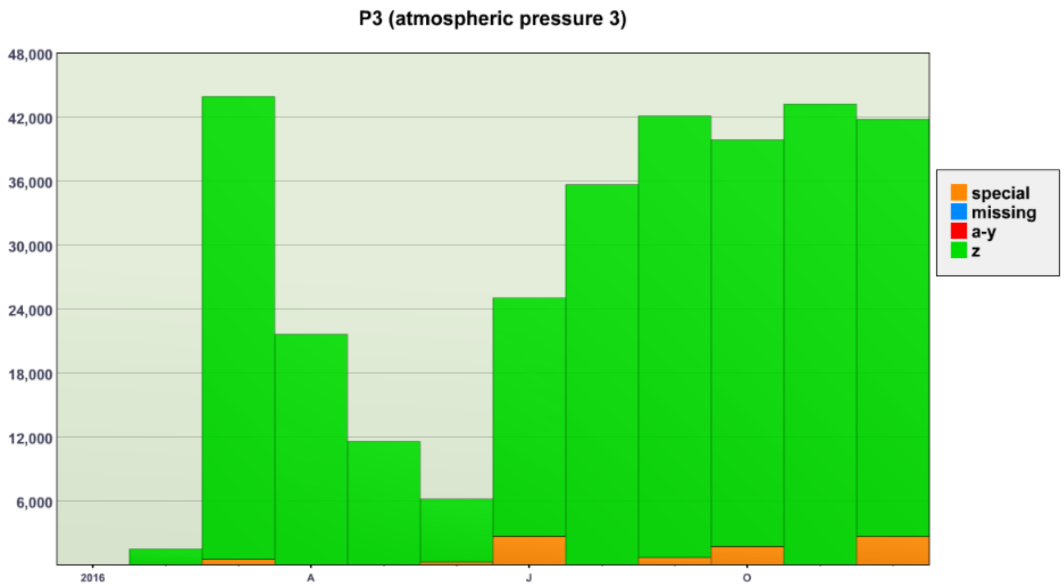


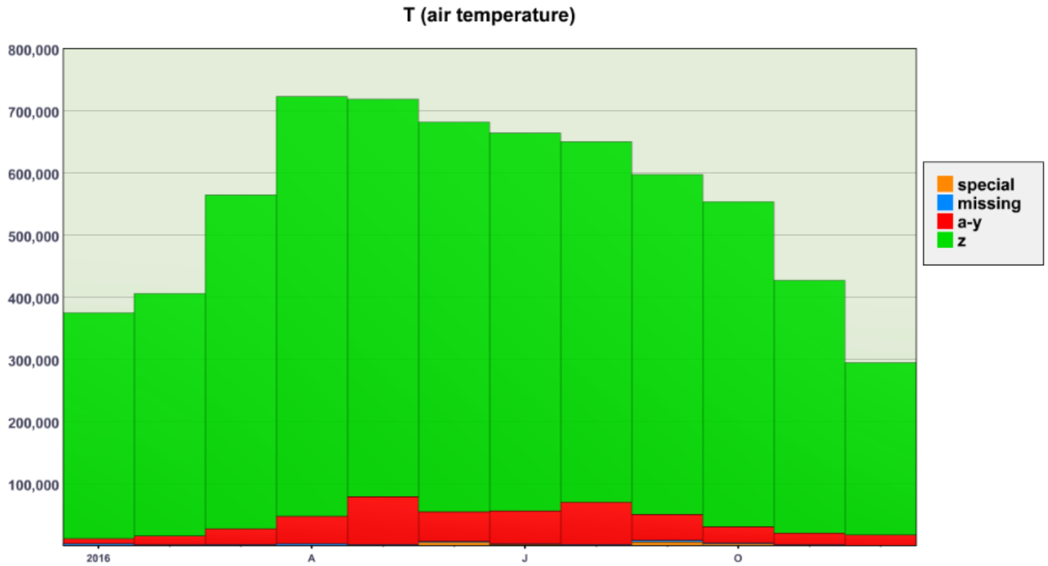
Figure 4: Total number of (this page) atmospheric pressure – P – (next page, top) atmospheric pressure 2 – P2 – and (next page, bottom) atmospheric pressure 3 – P3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.





(Figure 4: cont'd)

Air temperature was also of decent quality (Figure 5). The increase in flagging of T in May is probably due to the *Rainier*, and the increase evident in August was surely the *Fairweather* (documented; see individual vessel description in section 3c for details). The increases in flagging of T2 seen in September and October are owing to both the *Sproul* and *Falkor* (documented; see individual vessel description in section 3c for details). And as with P3, the special value flags during seen in T3 again must by default be from the *Atlantis* (details unknown). But for the most part, flagging occurred across multiple vessels in any given month for typical reasons. With the air temperature sensors, again flow obstruction was a primary problem. In this case, when the platform relative wind direction is such that regular flow to the sensor is blocked, unnatural heating of the sensor location can occur. Deck heating can also occur simply when winds are light and the sensor is mounted on or near a large structure that easily retains heat (usually metal). Contamination from stack exhaust was also a common problem. Figure 86 does a good job of demonstrating stack exhaust contamination. Each of these incidences will result in the application of either caution/suspect (K) or poor quality (J) flags. In the case of stack exhaust, the authors wish to stress that adequate digital imagery, when used in combination with platform relative wind data, can facilitate the identification of exhaust contamination and subsequent recommendations to operators to change the exposure of their thermometer.



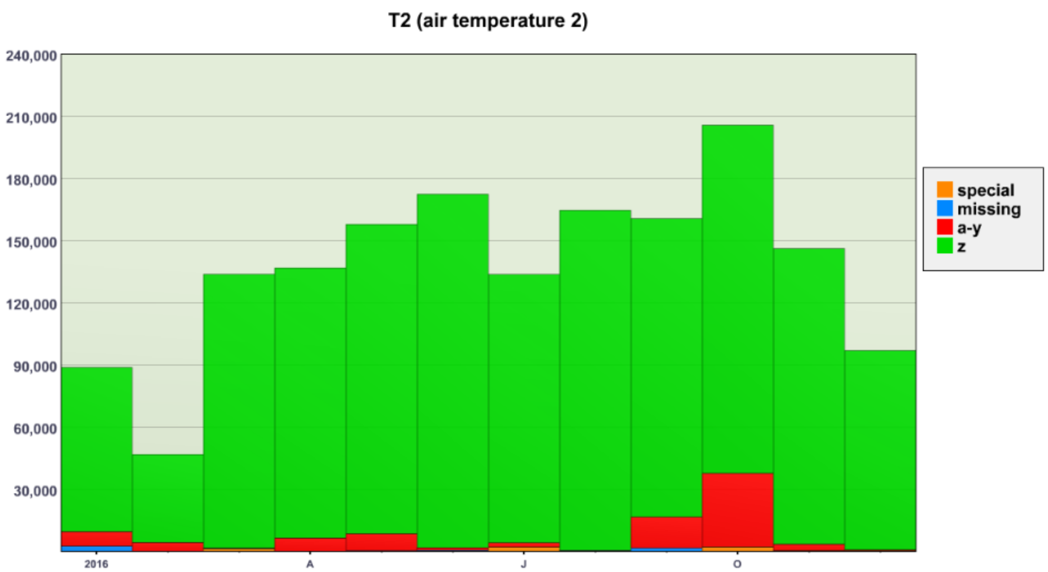
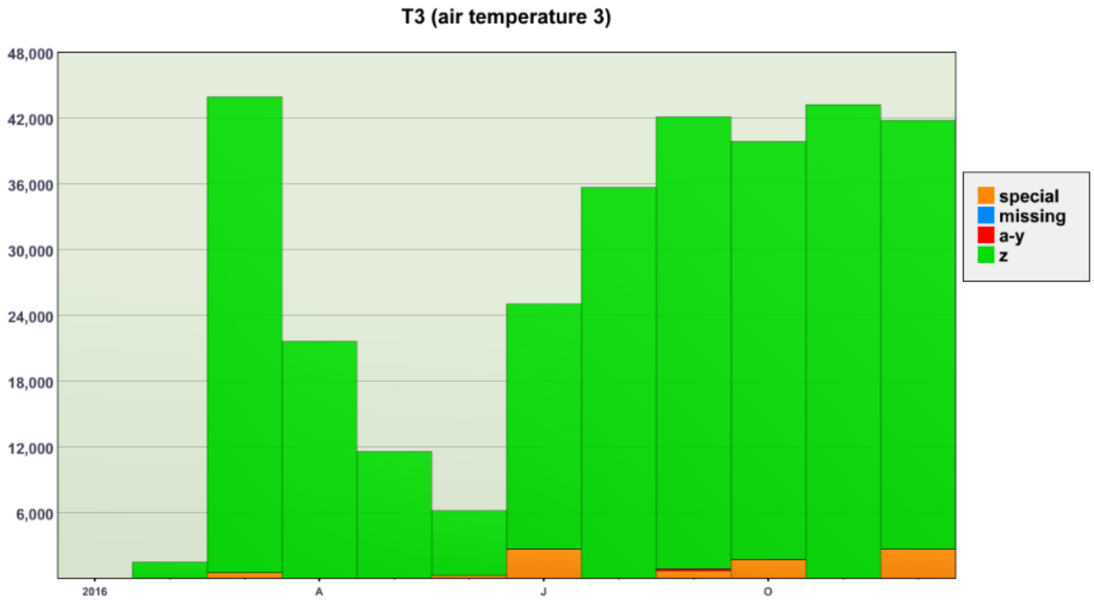


Figure 5: Total number of (this page, top) air temperature – T – (this page, bottom) air temperature 2 – T2 – and (next page) air temperature 3 – T3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 5: cont'd)

Wet bulb temperature (Figure 6) was reported by only one vessel in 2016; namely, the *Thomas Jefferson*, which is also the only vessel currently set up to report wet bulb. The flags applied in this case were mainly due to steps in the data as a result of platform relative wind direction sensitivity, as described in the individual vessel description in section 3c. No significant issues appear to exist with the parameter.

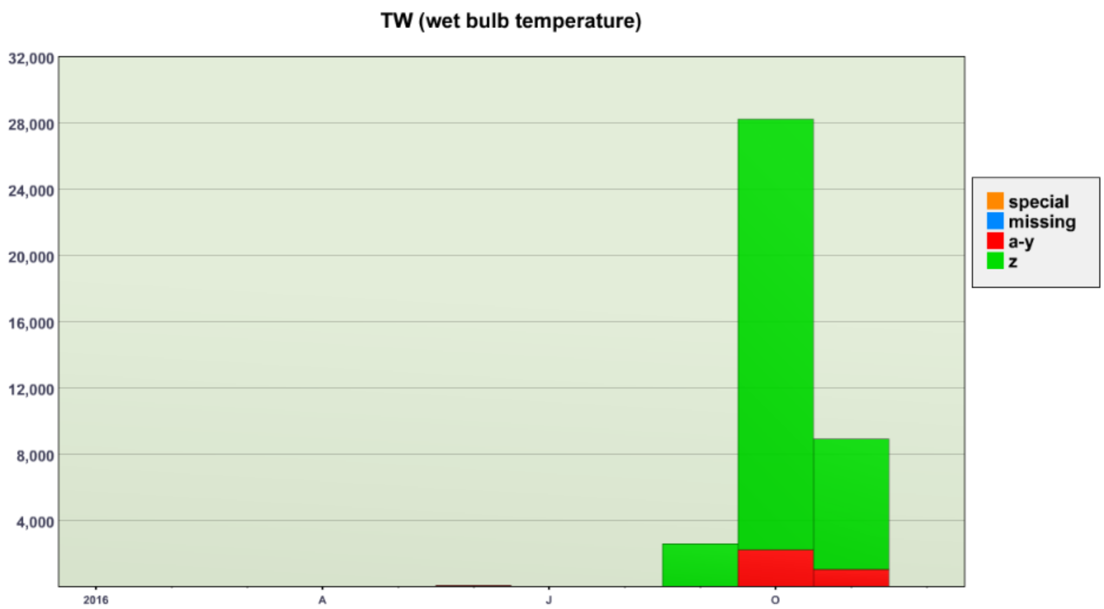


Figure 6: Total number of wet bulb temperature – TW – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

Dew point temperature (Figure 7) was only reported by two vessels in 2016; namely, the *Thomas Jefferson* and the *Healy*, although one other vessel is currently set up to report dew point if they wish. So the flags seen here, again, were mainly due to steps in the data as a result of platform relative wind direction sensitivity, as described in the individual vessel description in section 3c. We do note that the *Healy* definitely contributed to the flagging of TD seen in June (documented; see individual vessel description in section 3c for details).

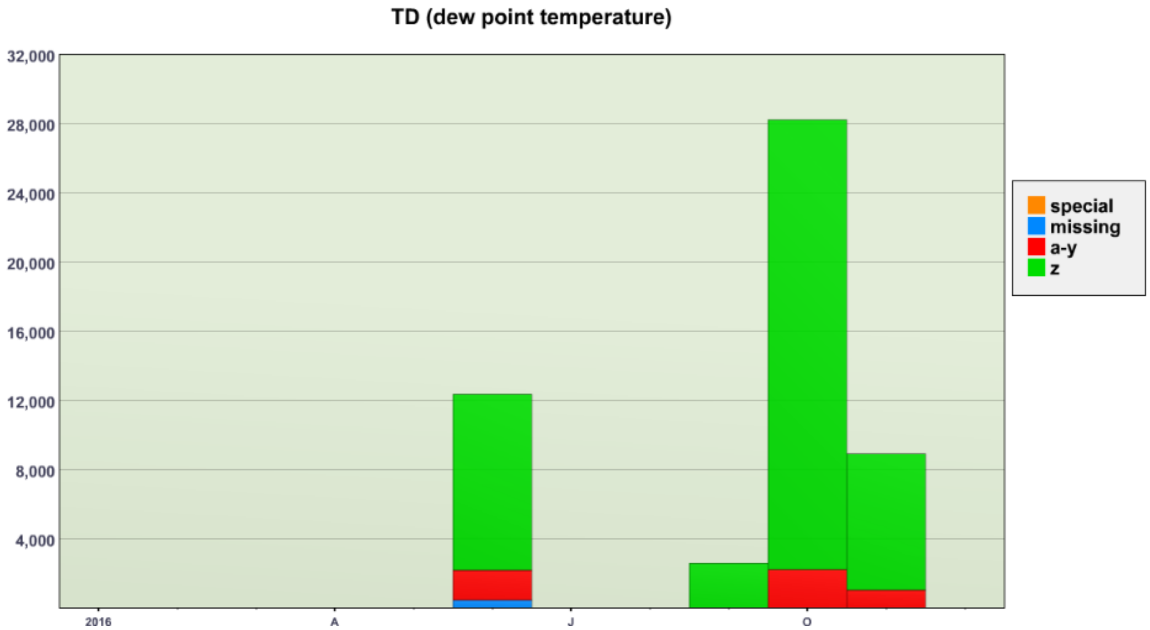
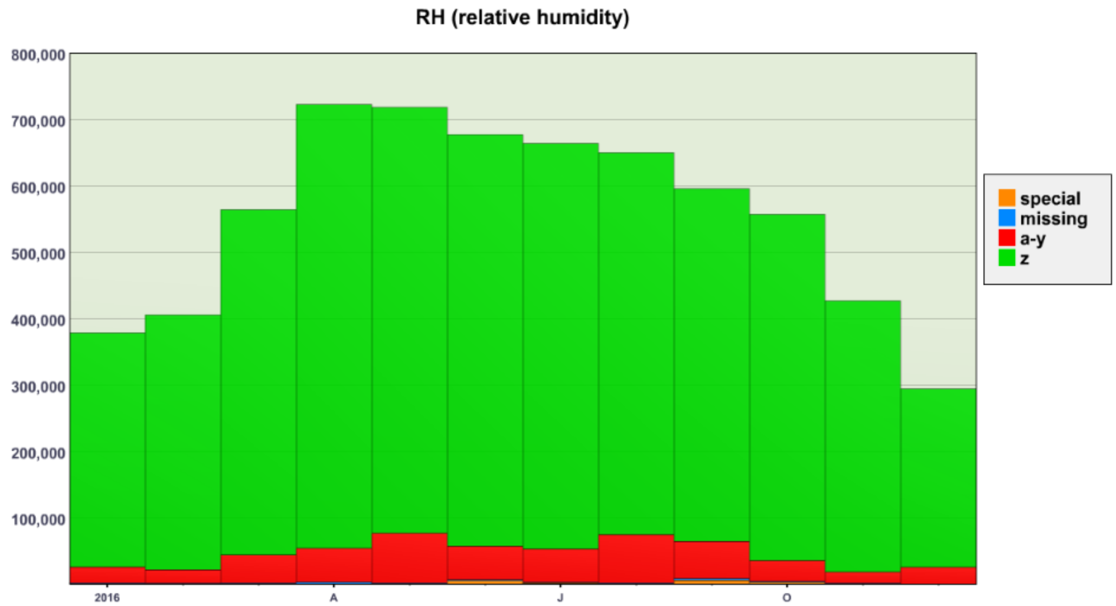


Figure 7: Total number of dew point temperature – TD – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

With relative humidity, the most common issue is readings slightly greater than 100%. If these measurements were sound they would imply supersaturated conditions, but in fact that scenario is quite rare near the surface of the ocean. When it comes to relative humidity, the mechanics of most types of sensors is such that it is easier to obtain high accuracy over a narrow range than over a broader range, say from 10% to 100% (Wiederhold, 2010). It is often desirable to tune these sensors for the greatest accuracy within ranges much less than 100%. The offshoot of such tuning, of course, is that when conditions are at or near saturation (e.g. rainy or foggy conditions) the sensor performs with less accuracy and readings over 100% commonly occur. While these readings are not really in grave error, they are nonetheless physically implausible and should not be used. Thus, they are B flagged by the automated QC flagger. These B flags likely account for a large portion of the A-Y flagged portions depicted in Figure 8. Additionally, several vessels (e.g. *Fairweather*, *Gunter*, *Okeanos Explorer*, *Rainier*, *Sproul*, and *Falkor*, among others) encountered some challenges with their RH data at various points throughout the year; the confluence of these events likely explain any increases in flagging seen in RH (documented; see individual vessel description in section 3c for details). The increased flags seen in RH2 in January and September are again likely owing to the *Falkor* (also documented; see individual vessel description in section 3c for details), while the upticks in April and May appear likely to be from the *Investigator* (details unknown). We note that RH3 was evidently another of *Atlantis's* variables that received a quantity of special value flags during the year (details unknown).



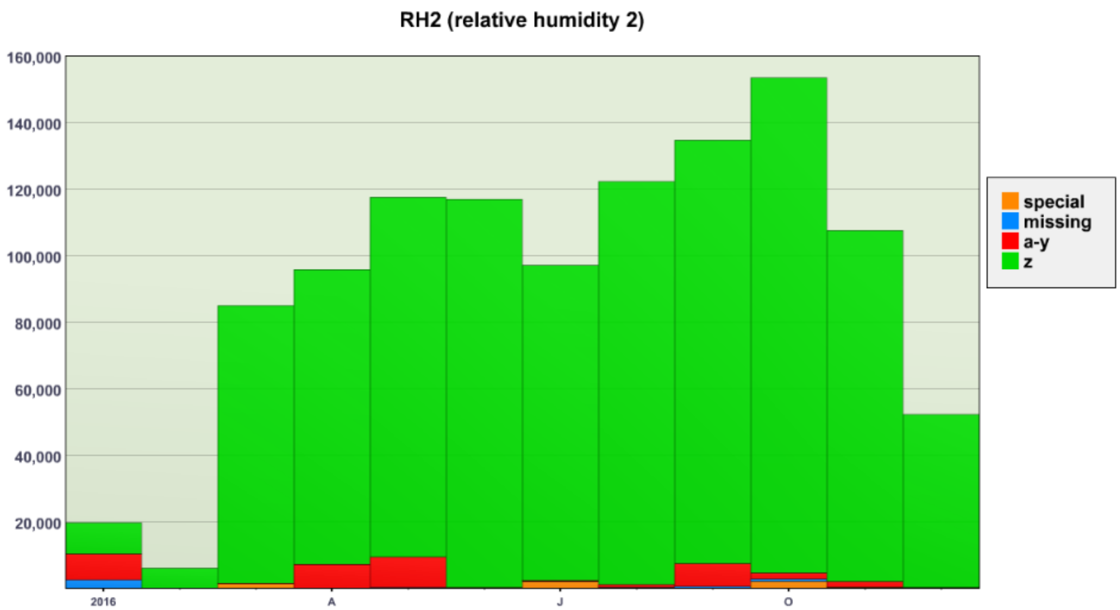
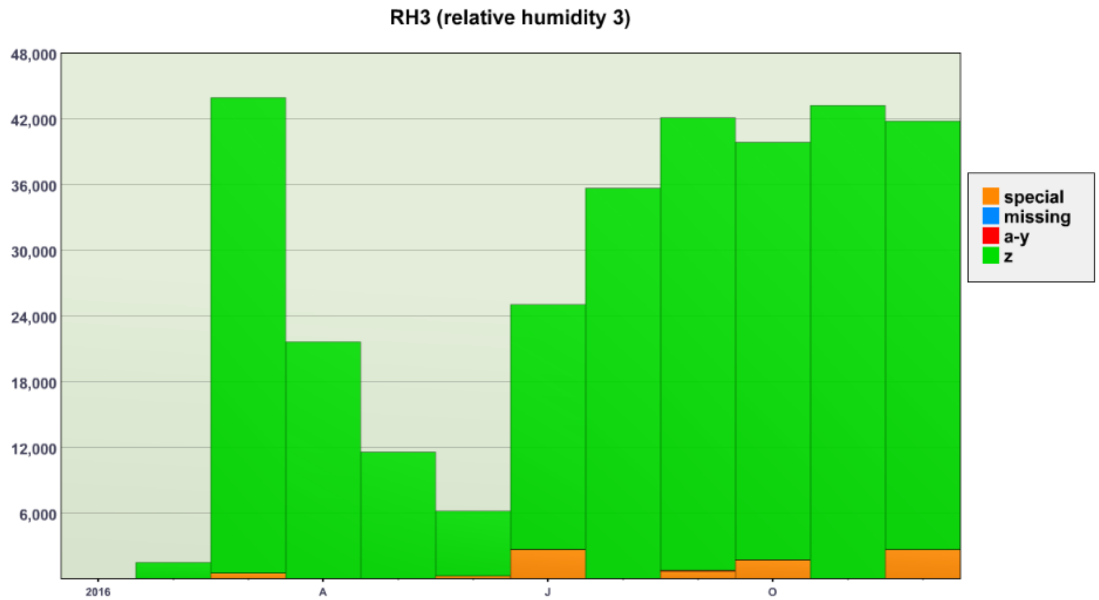


Figure 8: Total number of (this page, top) relative humidity – RH – (this page, bottom) relative humidity 2 – RH2 – and (next page) relative humidity 3 – RH3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

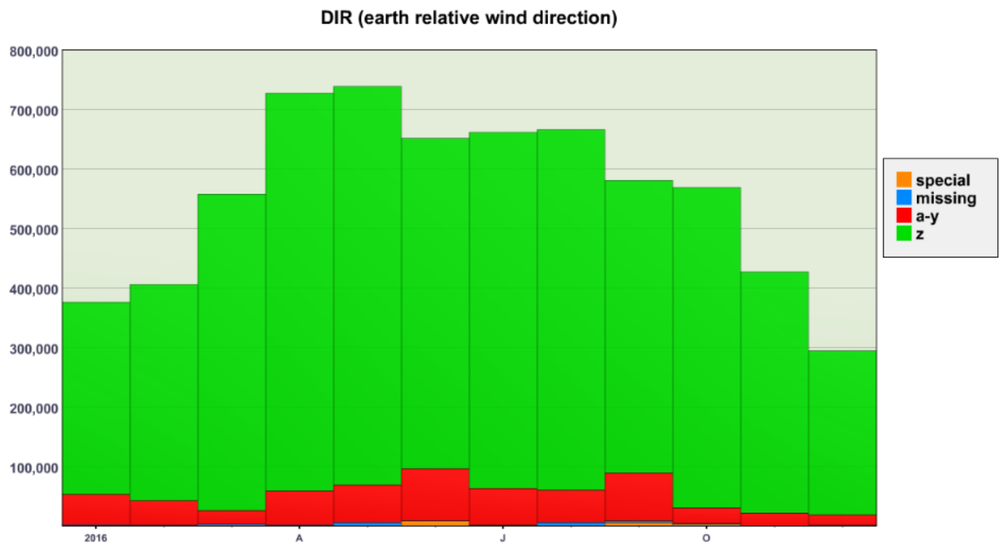


(Figure 8: cont'd)

Wind sensors, both direction and speed, are arguably the instruments most affected by flow obstruction and changes in platform speed. Because research vessels traditionally carry bulky scientific equipment and typically have multi-level superstructures, it is a challenge to find locations on a research vessel where the sensors will capture the free-atmospheric circulation. Unlike other met sensors such as air temperature and relative humidity that are designed to function more or less independent of the micro scale nuances in airflow surrounding them, nuances in flow are the very thing that wind sensors are intended to measure. This is why obstructed flow is so readily incorporated into wind measurements. These flow-obstructed and platform speed-affected wind data were a common problem across SAMOS vessels in 2016.

There were several vessels that encountered some serious wind issues in 2016, often persisting for months at a time (most notably, *Okeanos Explorer*, *Oregon II*, and *Ron Brown*, all documented in the individual vessel description in section 3c). This is probably why the flagging is greatest in both DIR and SPD. Otherwise, the overall quality of the 2016 SAMOS wind data was generally good. (We note the special values once again in DIR3 and SPD3 are likely all due to *Atlantis*, and the flags, as well.) In SAMOS visual quality control, compromised wind data is addressed with caution/suspect (K), visual spike (S), and sometimes poor quality (J) flags. Where comprehensive metadata and digital imagery exist, flow obstructed platform relative wind bands can often be diagnosed based on the structural configuration of the vessel and recommendations can be made to the vessel operator to improve sensor locations. Another diagnostic tool available to SAMOS data analysts is a polar plotting routine, which can look at a single variable and identify the ratio of flagged observations to total observations in one degree (platform relative wind direction) bins. In this way, platform relative wind bands that interfere with sensor readings may be identified. Currently the polar plot program is configured to accept air temperature, humidity, and true wind speed and direction data with corresponding platform relative wind data. The polar plotting program is not currently in regular use by SAMOS data analysts because it is a time consuming process and the routines need more tuning, but its attributes could be improved and its benefits further explored in the future.

The other major problem with earth relative wind data is errors caused by changes in platform speed. Occasionally, a wind direction sensor is also suspected of being "off" by a number of degrees. Satellite wind products and in-situ data (buoys, pier-based stations, etc.) can sometimes clue data analysts in to such a bias, particularly if the bias is very large. But in general, if a technician suspects a wind direction bias it is critical they communicate that suspicion to SAMOS personnel, as otherwise the data analysts often will have no reliable means of discovering the problem themselves. Suspected wind direction biases are typically flagged with K flags, or J flags if the case is extreme and/or verifiable.



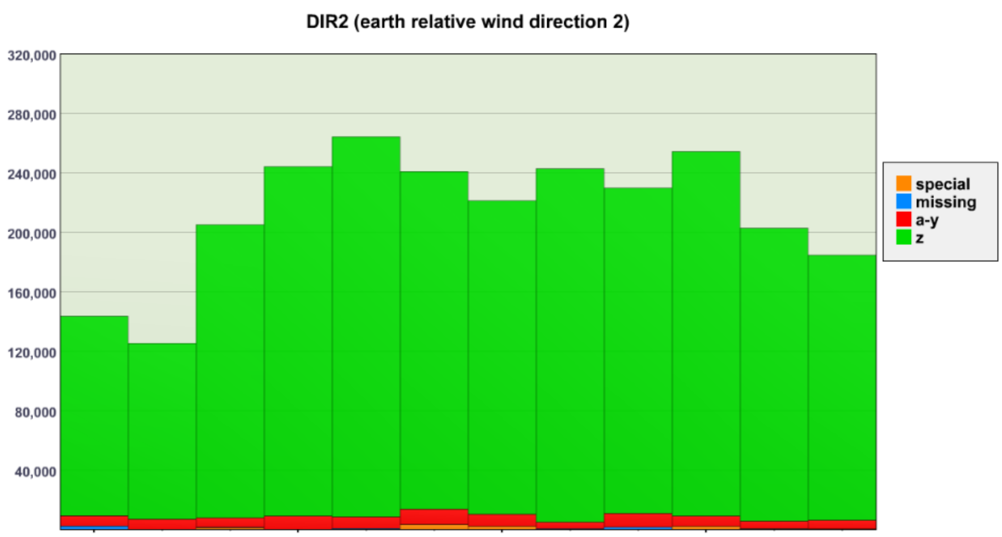
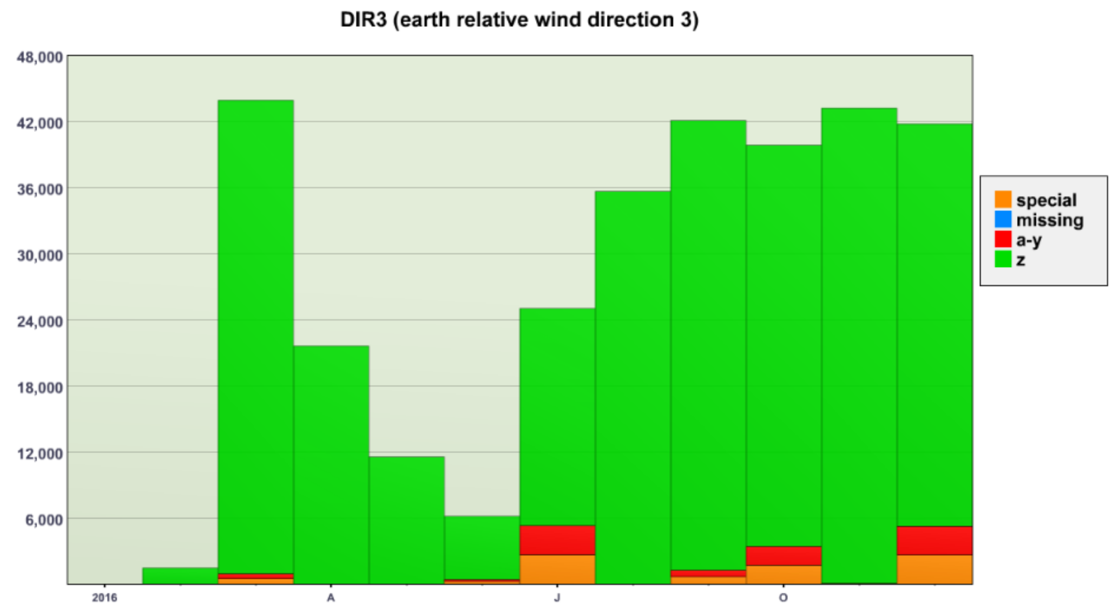


Figure 9: Total number of (this page, top) earth relative wind direction – DIR – (this page, bottom) earth relative wind direction 2 – DIR2 – and (next page) earth relative wind direction 3 – DIR3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 9: cont'd)

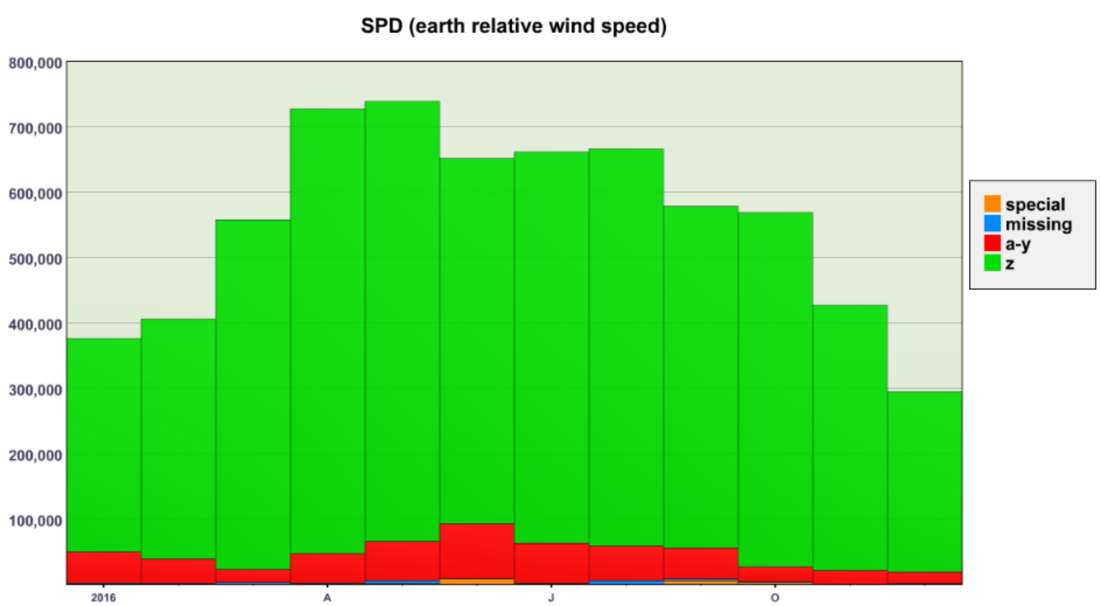
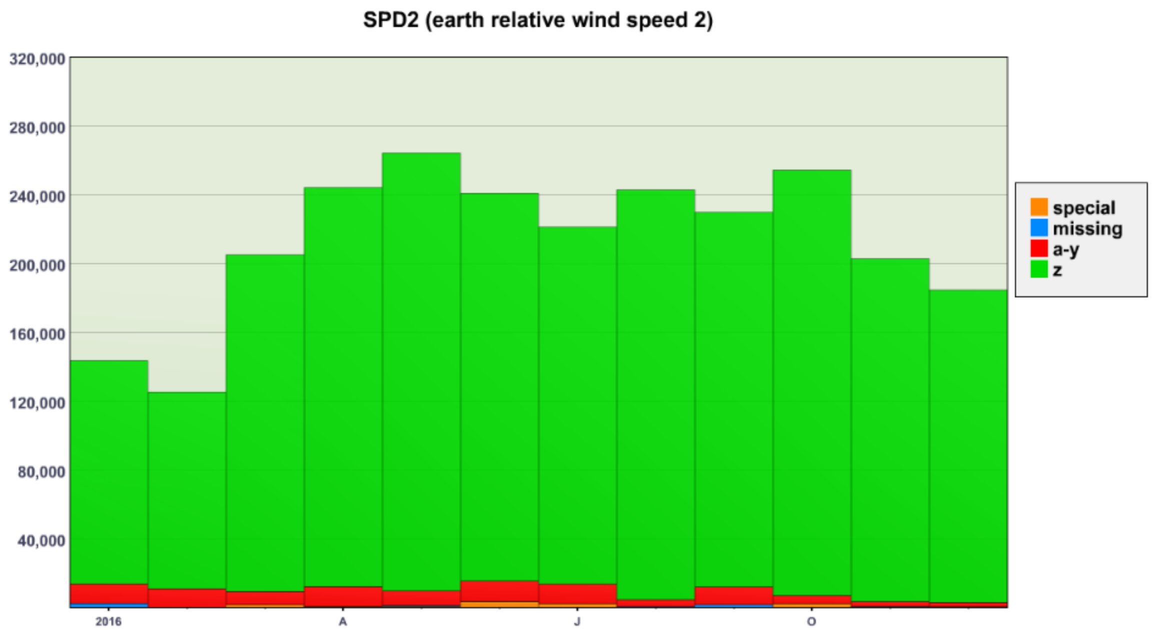
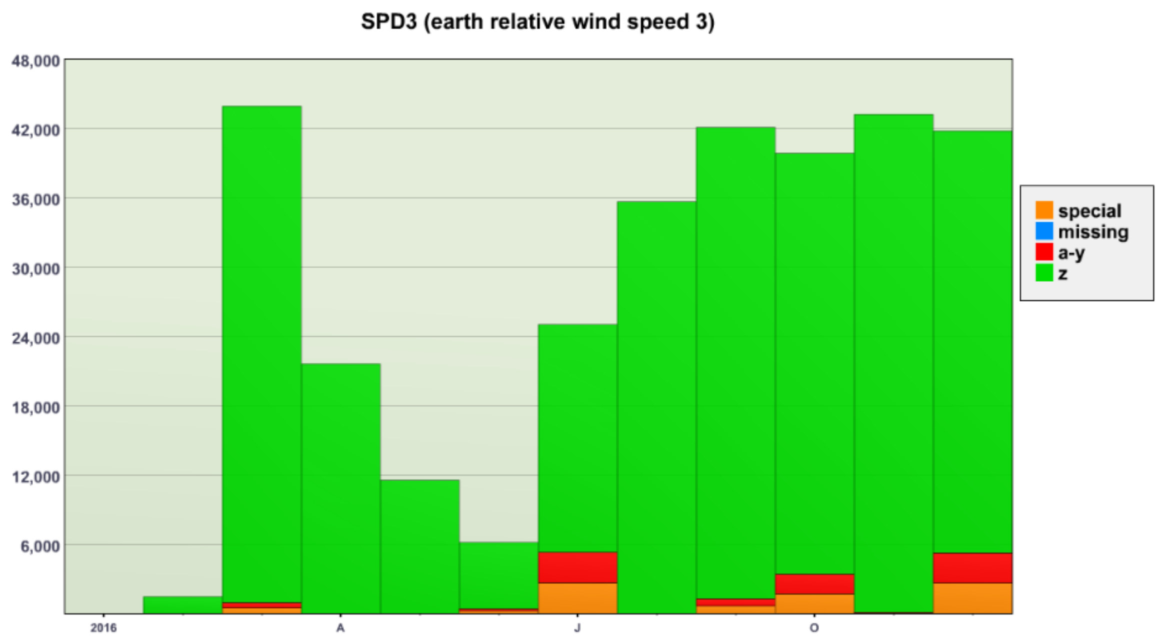


Figure 10: Total number of (this page) earth relative wind speed – SPD – (next page, top) earth relative wind speed 2 – SPD2 – and (next page, bottom) earth relative wind speed 3 – SPD3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.





(Figure 10: cont'd)

Most of the flags applied to the radiation parameters were assigned by the auto flagger, primarily to short wave radiation (Figure 11). Short wave radiation tends to have the largest percentage of data flagged for parameters submitted to SAMOS. Out of bounds (B) flags dominate in this case. Like the relative humidity sensors, this is again a situation where a high degree of accuracy is impossible over a large range of values. As such, shortwave sensors are typically tuned to permit greater accuracy at large radiation values. Consequently, shortwave radiation values near zero (i.e., measured at night) often read slightly below zero. Once again, while these values are not a significant error, they are nonetheless invalid and unsuitable for use as is and should be set to zero by any user of these data. Long wave atmospheric radiation, on the other hand, usually has the smallest percentage of data flagged among the radiation parameters submitted to SAMOS (Figure 12). The increases in flagging of RAD_LW in March, April, and May are likely due to a sensor failure on the *Roger Revelle*. The increases in flagging of RAD_LW in August, September, and November are due to the *Bigelow*, whose original units are misidentified in the metadata. The increases in flagging in RAD_PAR for June through October are likely a combination of the *Armstrong* and the *Revelle*. The increases in flagging of RAD_PAR2 in January and February are owed to the *Falkor*. (Note all of these issues are documented; see individual vessel description in section 3c for details.) The special values on RAD_PAR and RAD_PAR2 in October and November are due to the *Falkor*, although it isn't known precisely why they occurred. Otherwise, overall quality for the short wave and long wave parameters looks good, as does the overall quality for photosynthetically active atmospheric radiation and especially net atmospheric radiation (Figures 13, and 14, respectively), although ironically we note that the only RAD_NET/RAD_NET2 data that were reported to us in 2016 weren't actually net radiation parameters at all (see *Gould's* individual vessel description in section 3c for details).

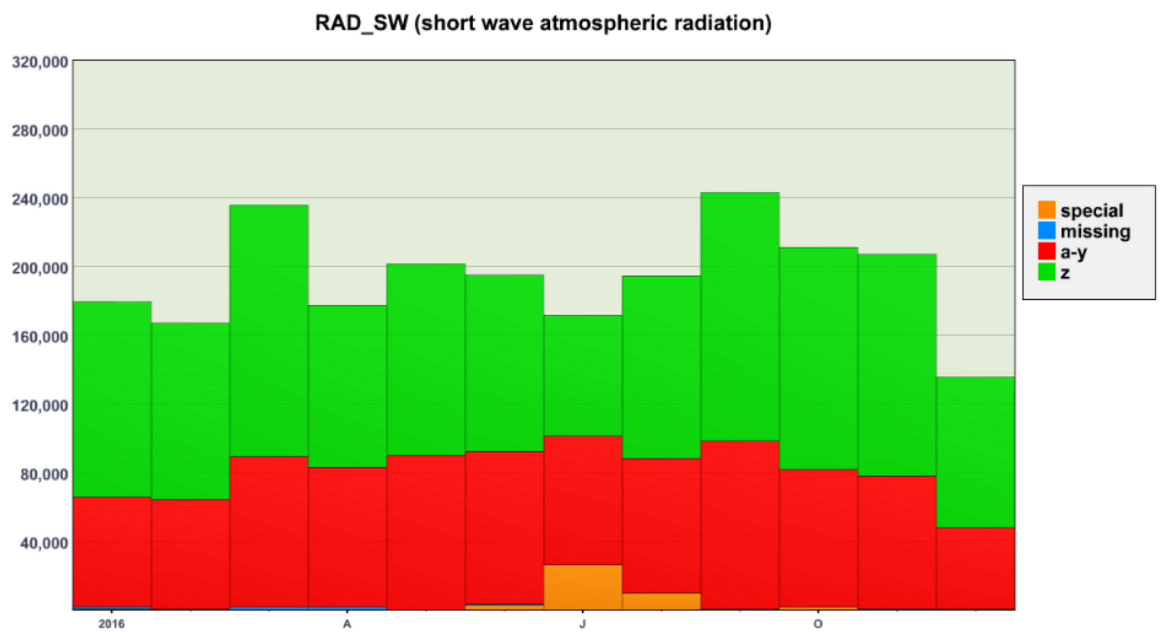
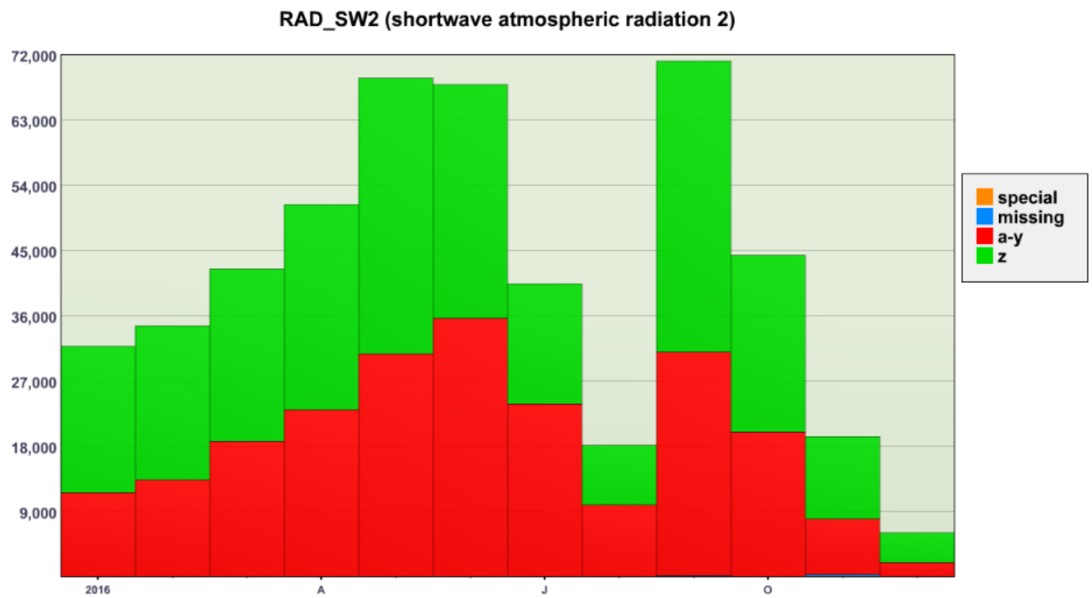


Figure 11: Total number of (this page) shortwave atmospheric radiation – RAD_SW – and (next page) shortwave atmospheric radiation 2 – RAD_SW2 –observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 11: cont'd)

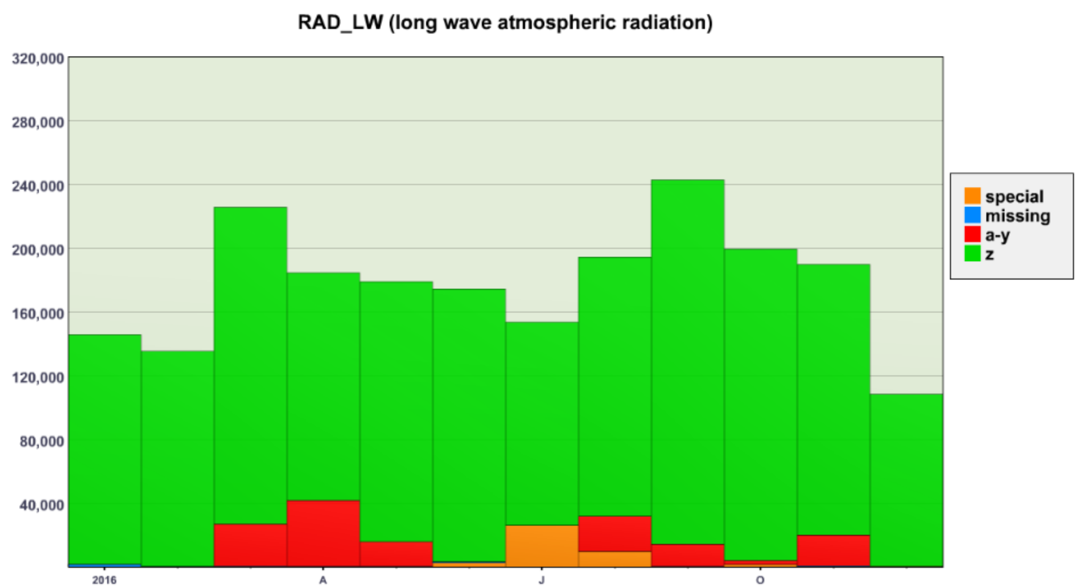
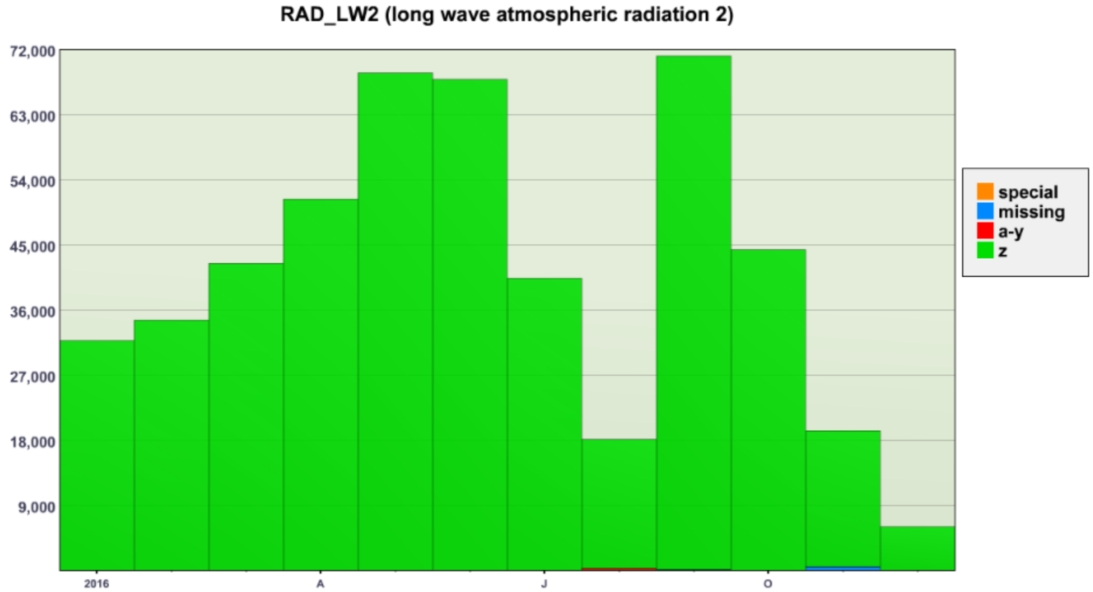


Figure 12: Total number of (this page) long wave atmospheric radiation – RAD_LW – and (next page) long wave atmospheric radiation 2 – RAD_LW2 –observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 12: cont'd)

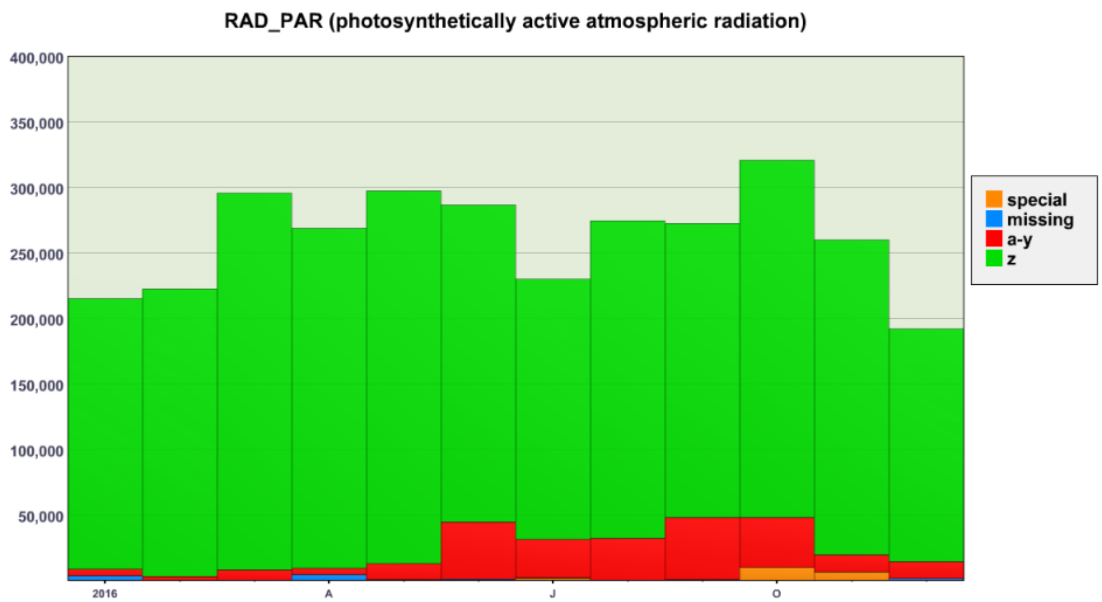
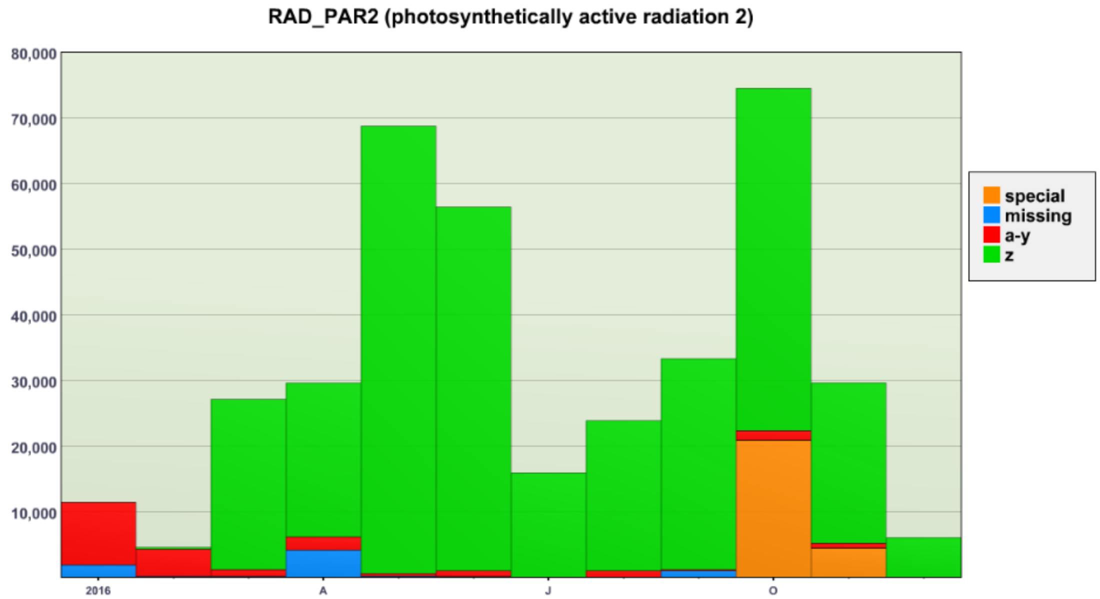


Figure 13: Total number of (this page) photosynthetically active atmospheric radiation – RAD_PAR – and (next page) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 13: cont'd)

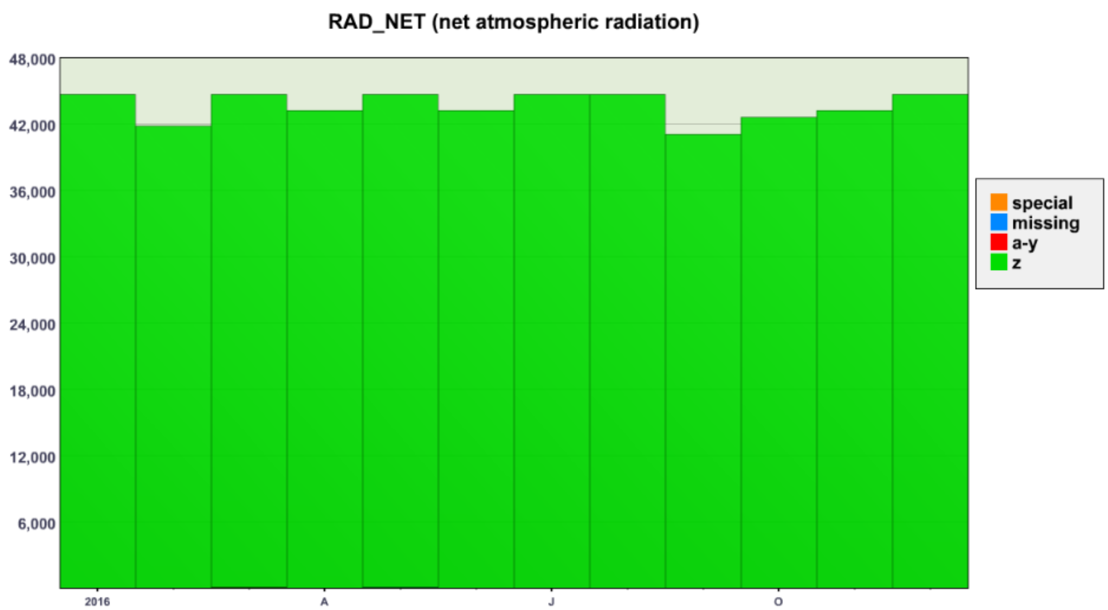
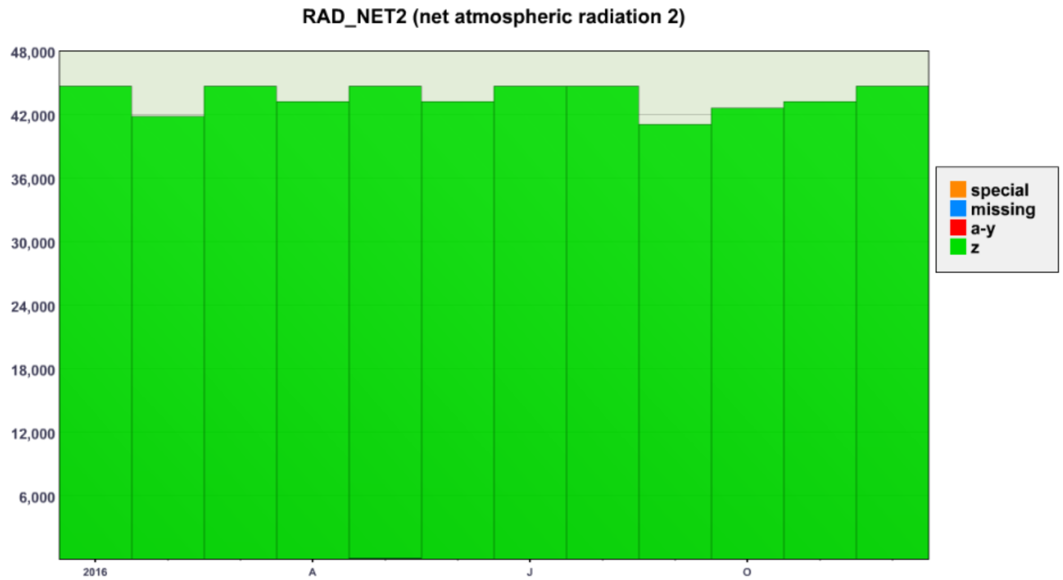


Figure 14: Total number of (this page) net atmospheric radiation – RAD_NET – and (next page) net atmospheric radiation 2 – RAD_NET2 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 14: cont'd)

There were no major problems of note with either the rain rate (Figure 15) or precipitation accumulation (Figure 16) parameters, although we note that RRATE3 and PRECIP3 were two more of *Atlantis's* variables that received a quantity of special value flags in 2016 (details unknown). It isn't known which vessel(s) contributed the noticeable volume of special values noted in RRATE. It should also be noted that some accumulation sensors occasionally exhibit slow leaks and/or evaporation. These data are not typically flagged; nevertheless, frequent emptying of precipitation accumulation sensors is always advisable.

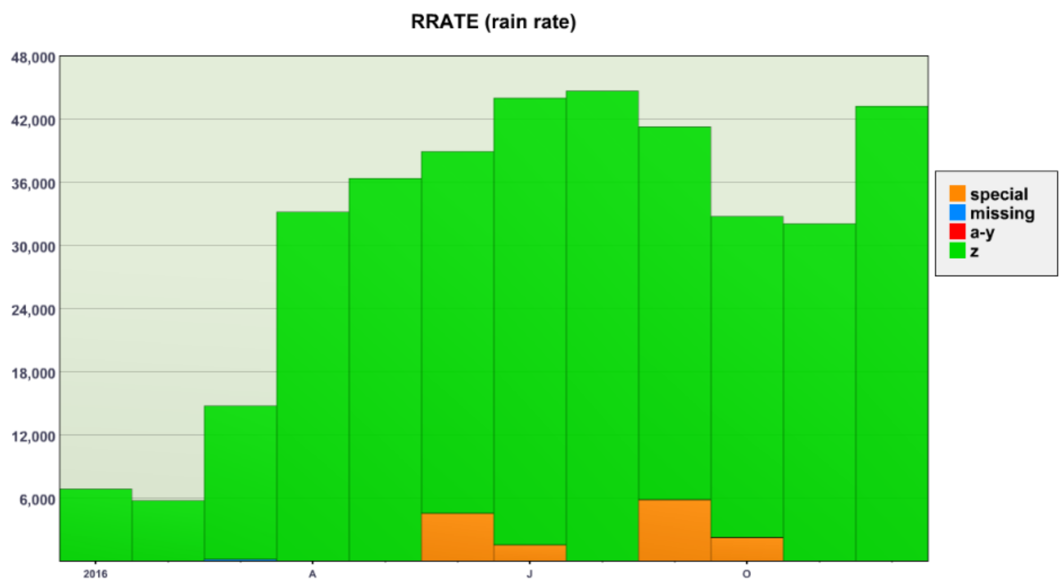
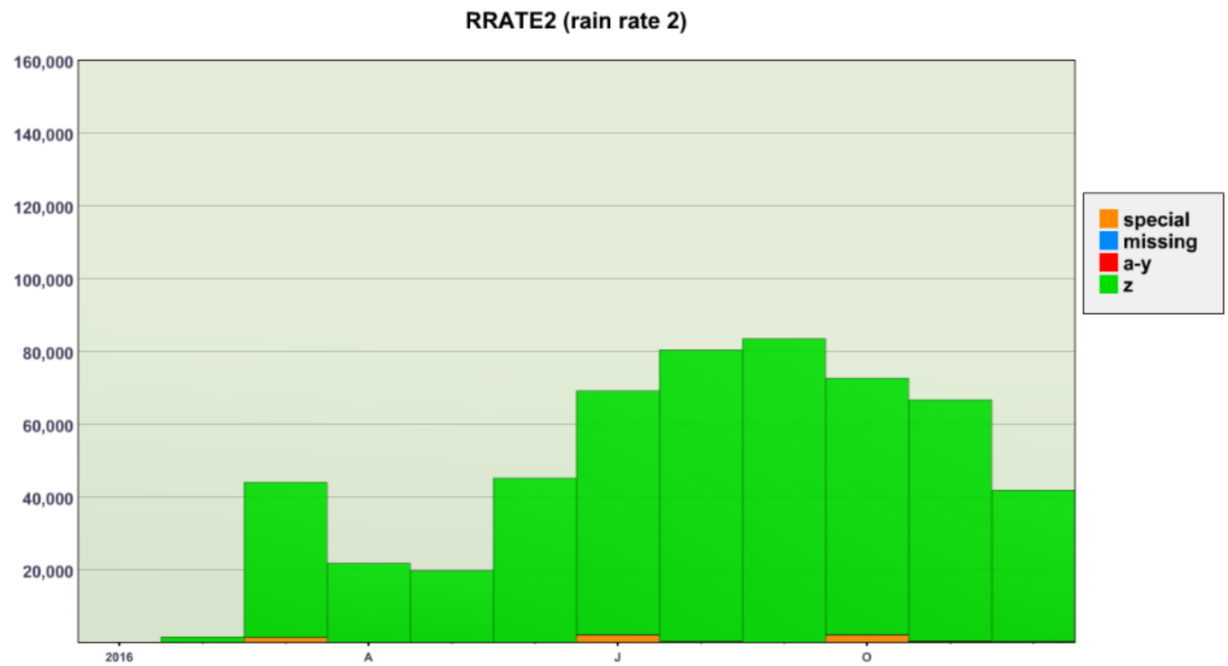
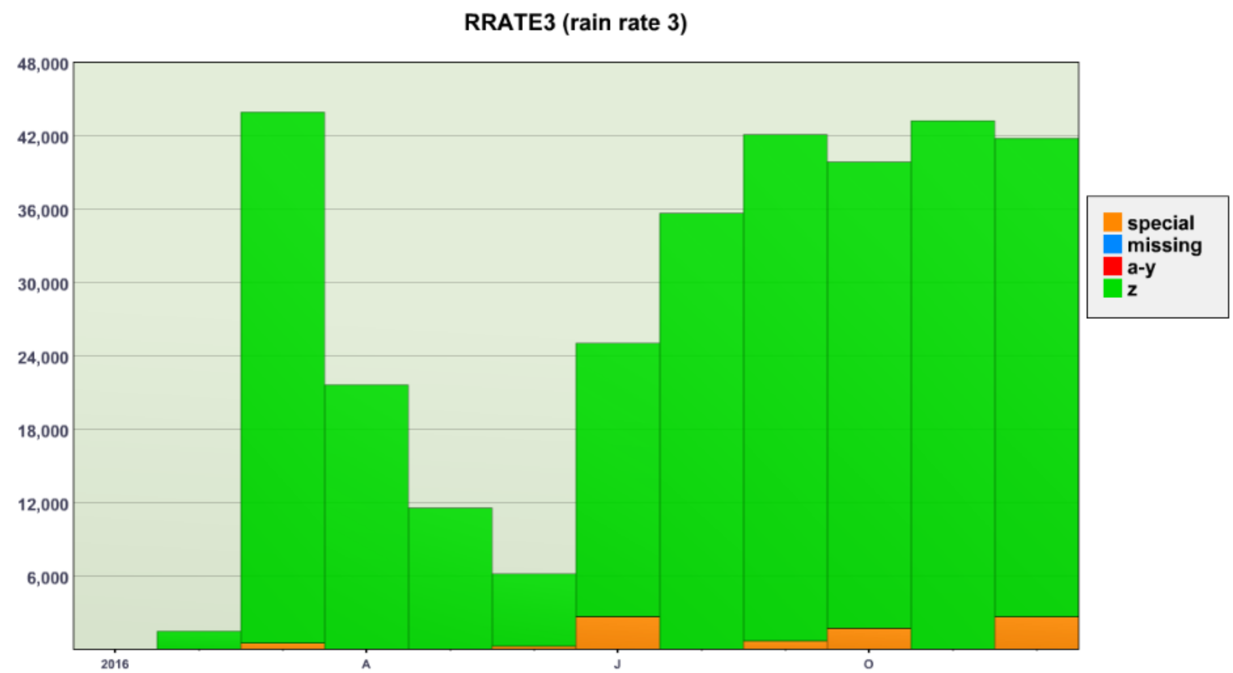
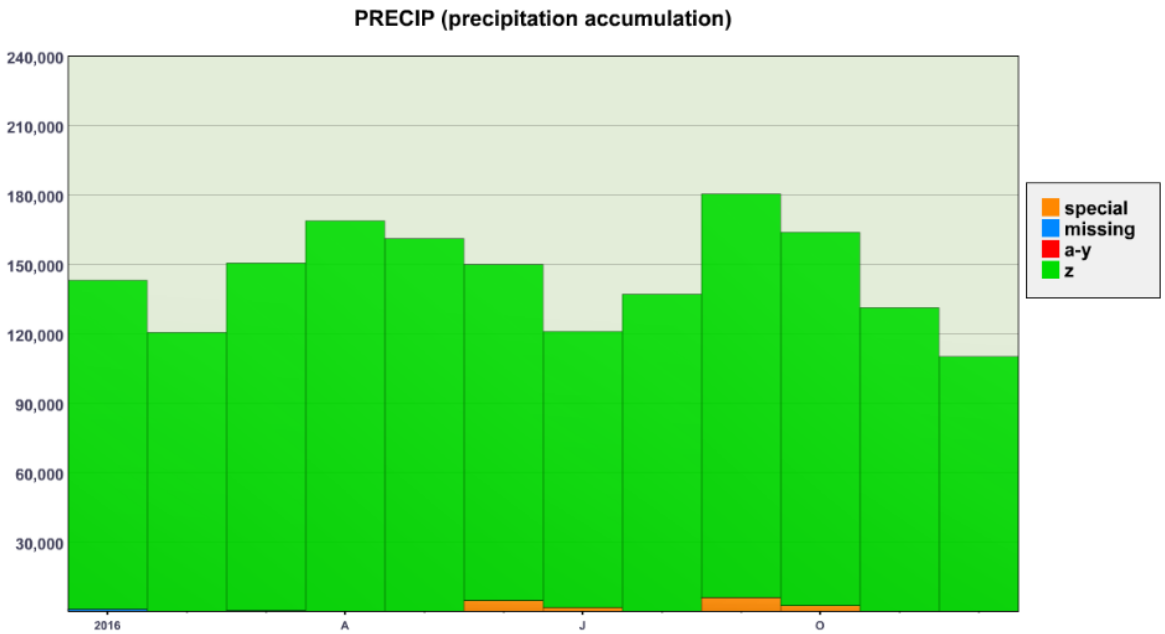


Figure 15: Total number of (this page) rain rate – RRATE – (next page, top) rain rate 2 – RRATE2 – and (next page, bottom) rain rate 3 – RRATE3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.





(Figure 15: cont'd)



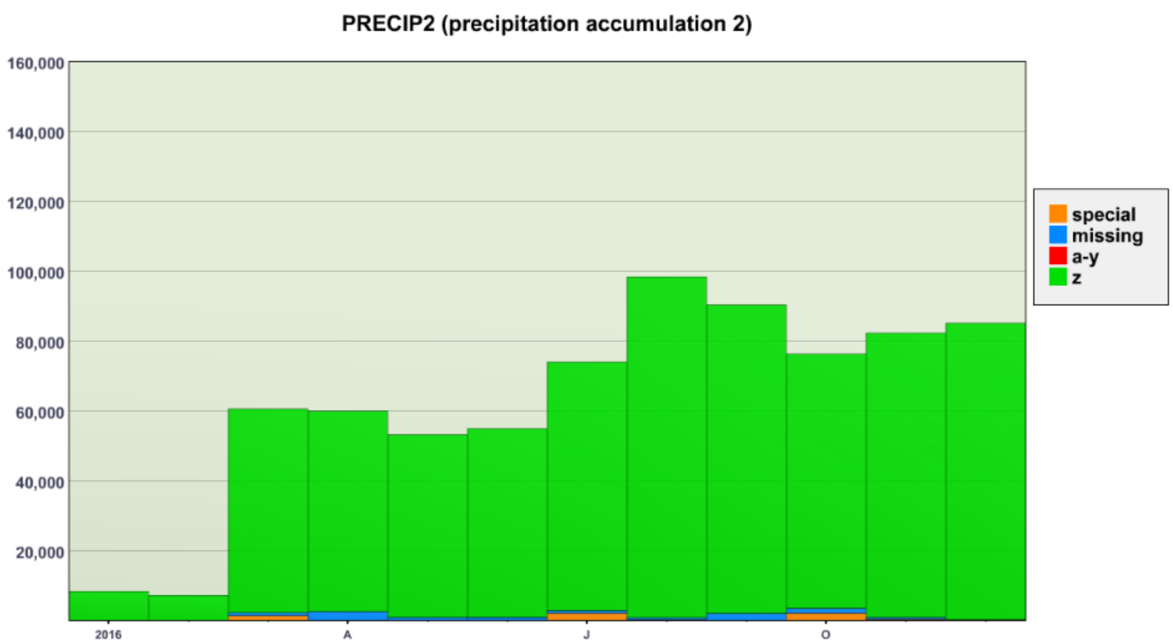
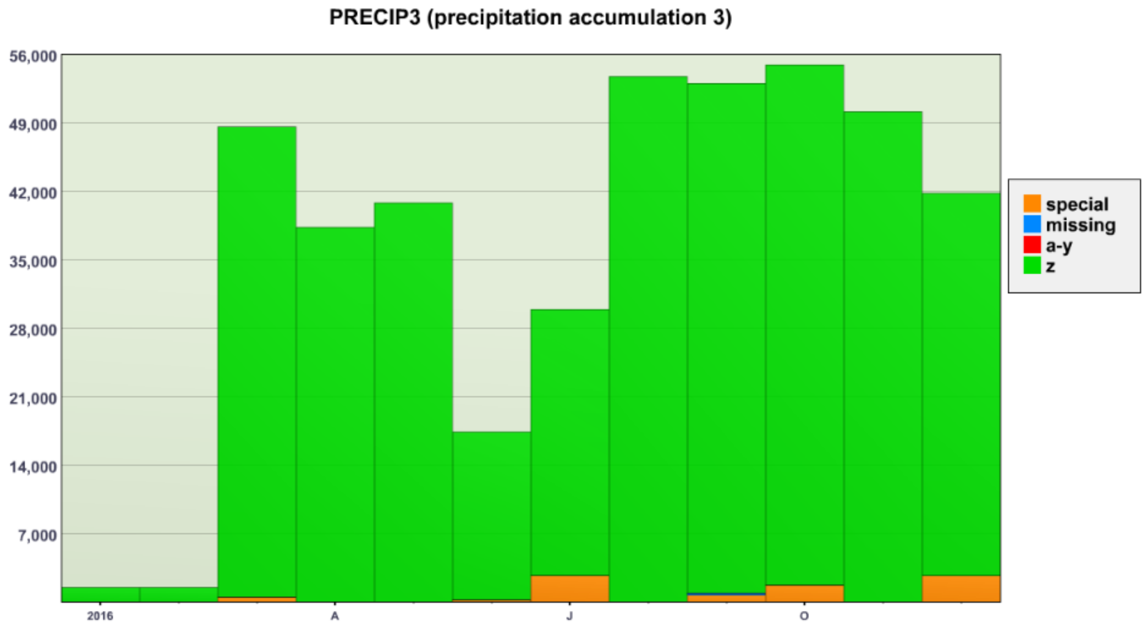
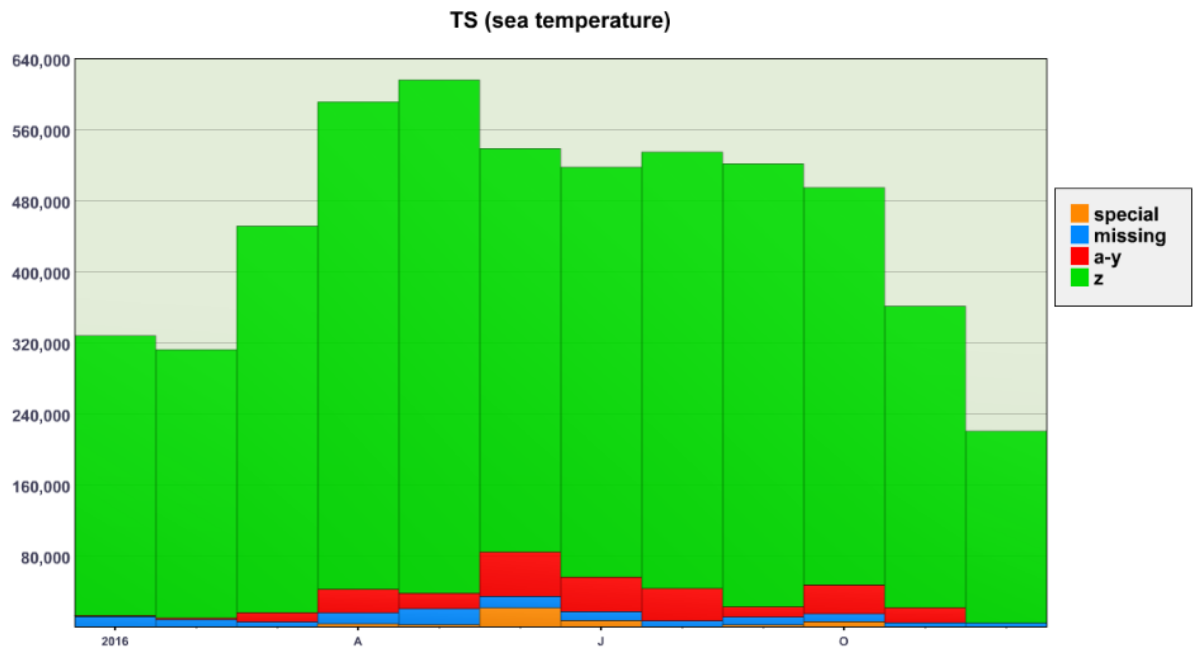


Figure 16: Total number of (this page, top) precipitation accumulation – PRECIP – (this page, bottom) precipitation accumulation 2 – PRECIP2 – and (next page) precipitation accumulation 3 – PRECIP3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 16: cont'd)

The main problem identified with the sea temperature parameter (Figure 17) occurs when the sensor is denied a continuous supply of seawater. In these situations, either the resultant sea temperature values are deemed inappropriate for the region of operation (using gridded SST fields as a guide), in which case they are flagged with suspect/caution (K) flags or occasionally poor quality (J) flags if the readings are extraordinarily high or low, or else the sensor reports a constant value for an extended period of time, in which case they are unanimously J-flagged. The events are also frequently extreme enough for the auto flagger to catch them and assign greater than four standard deviations from climatology (G) or out of bounds (B) flags. The authors note that this stagnant seawater scenario often occurs while a vessel is in port, which is rather anticipated as the normal ship operation practice by SAMOS data analysts. Other than this expected performance, the TS data were generally good in 2016. The increases in flagging in TS seen June – August are probably from the *Rainier*, whose sensor is suspected to be of low quality (documented; see individual vessel description in section 3c for details), although it isn't immediately apparent what is responsible for the uptick in October. A good deal of the flagging of TS2 is likely explained via the *Sikuliaq*, as their infrared thermometer commonly pointed at the dock when they were tied up, effectively measuring the dock temperature, which was subsequently frequently flagged as greater than four standard deviations from climatology (G). The greater volume of flags on TS2 in October and November appear to be coming from the *Roger Revelle*.



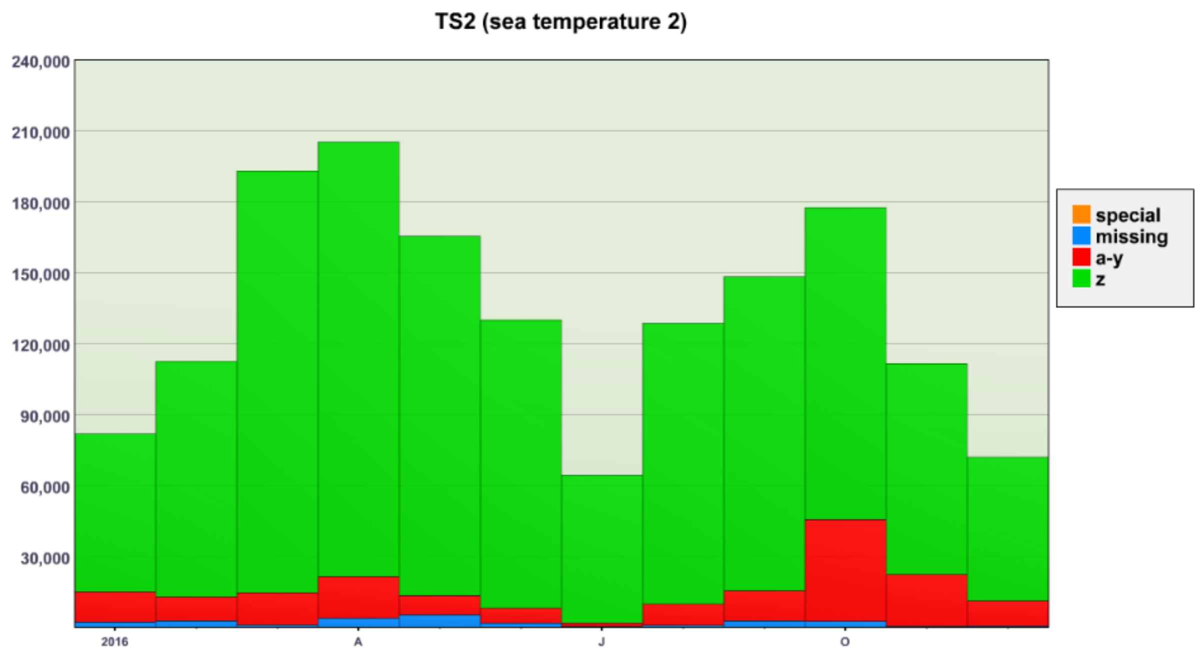
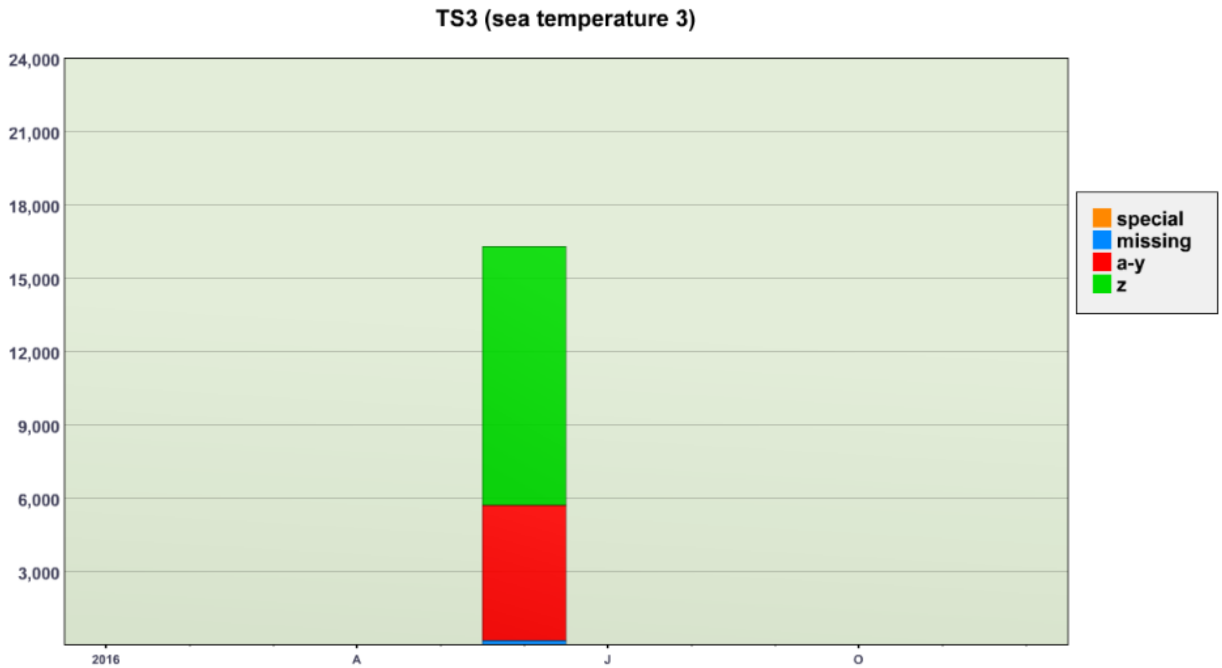


Figure 17: Total number of (this page, top) sea temperature – TS – (this page, bottom) sea temperature 2 – TS2 – and (next page) sea temperature 3 – TS3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 17: cont'd)

Salinity and conductivity (Figures 18 and 19, respectively) experienced the same major issue as sea temperature; namely, when a vessel was in port or ice or rough seas the flow water system that feeds the probes was usually shut off, resulting in either inappropriate or static values. Another fairly common issue with salinity and conductivity, though, is that on some vessels the intake port is a little shallower than is desirable, such that in heavy seas the intake cyclically rises above the waterline and air gets into the sample. When this occurs, the data can be fraught with spikes. Data such as this is typically flagged with either spike (S), suspicious quality (K), or occasionally even poor quality (J) flags. In spite of these issues, though, salinity and conductivity data in 2016 was still rather good. The increases in flagging noted in both SSPS and CNDC in the period June through August are again owing largely to the *Rainier*, just as with TS. The increases seen in both of those in September and October were probably mainly the *Lasker*. (Issues documented; see individual vessel description in section 3c for details) The increase in flagging in CNDC2 in January must have been, by default, from the *Revelle*; likely, it was an issue of the flow water pump being turned off as opposed to a problem with the sensor. The authors do note that all the salinity values are relative and no effort was made to benchmark the values to water calibration samples. Calibration of salinity data is presently beyond the scope of SAMOS.

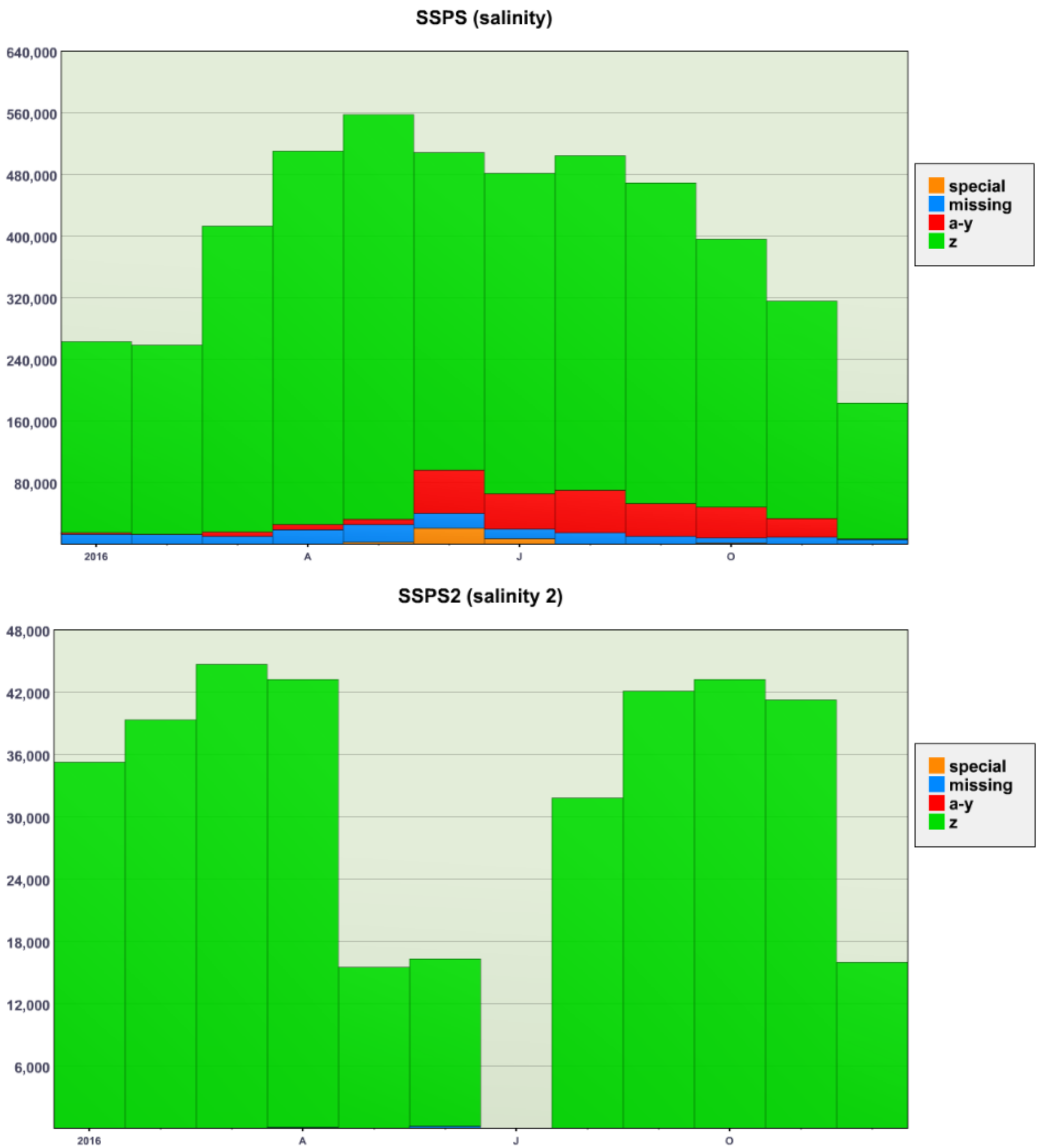
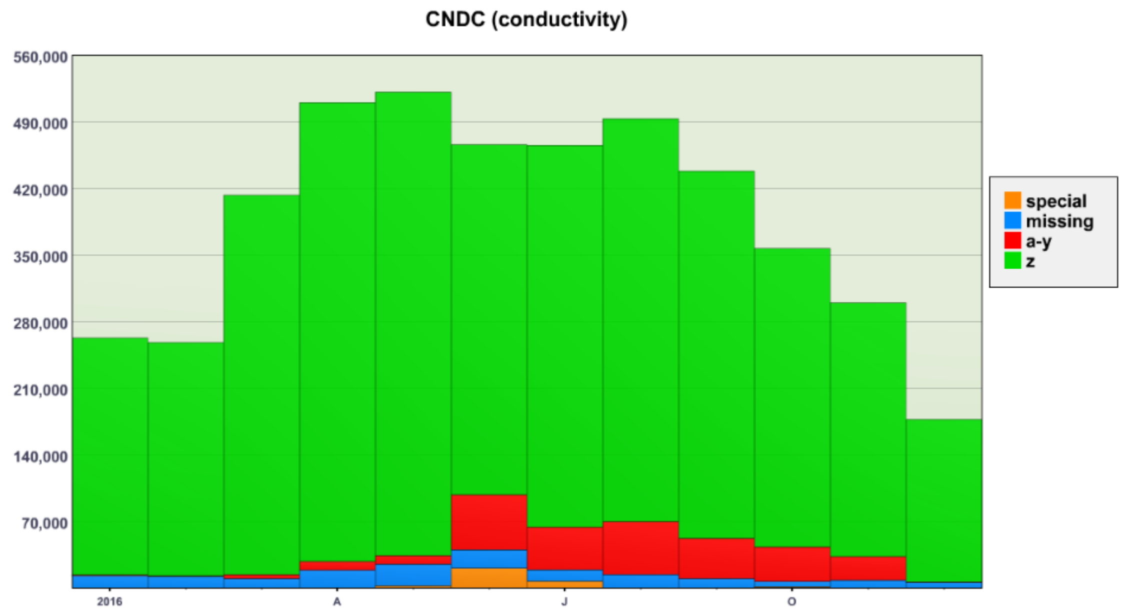


Figure 18: Total number of (top) salinity – SSPS – and (bottom) salinity 2 – SSPS2 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



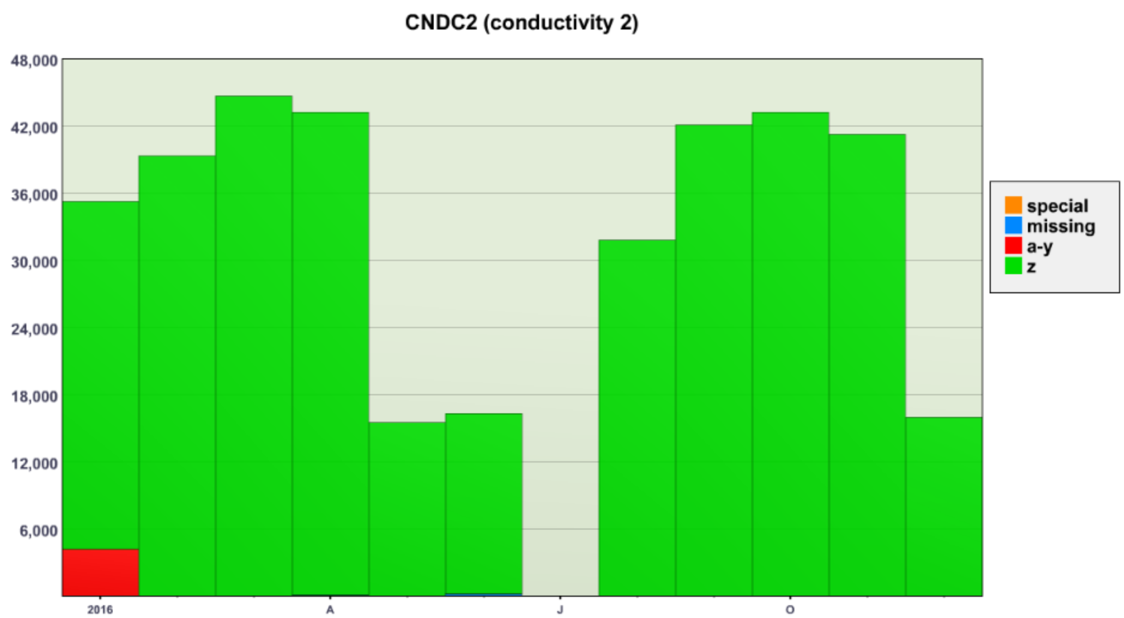
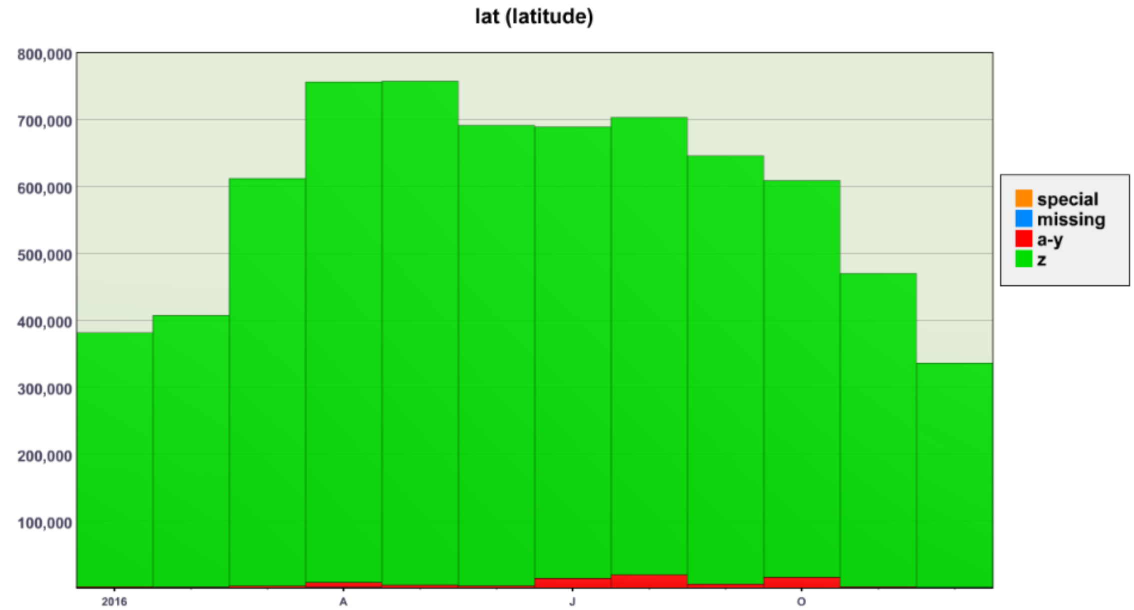


Figure 19: Total number of (top) conductivity – CNDC – and (bottom) conductivity 2 – CNDC2 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

Latitude and longitude (Figure 20) primarily only receive flags via the auto flagger, although occasionally the data analyst will apply port (N) flags as prescribed in the preceding section 3a, and in the rare cases of system-wide failure they can each be assigned malfunction (M) flags by the data analyst. Other than these few cases, LAT and LON each primarily receive land error flags, which are often removed by the data analyst when it is determined that the vessel was simply very close to land, but still over water (although for non-visual QC ships this step is not taken). The geographic land/water mask in use for determining land positions in 2016 was a two-minute grid. It should be noted that *Atlantis* and *Pelican* in particular transmit a good deal of port data and since they do not receive visual QC, some amount of erroneous L (position over land) auto flagging would be expected for 2016. It should also be noted that a new one-minute land-sea mask is currently undergoing testing at the SAMOS DAC.



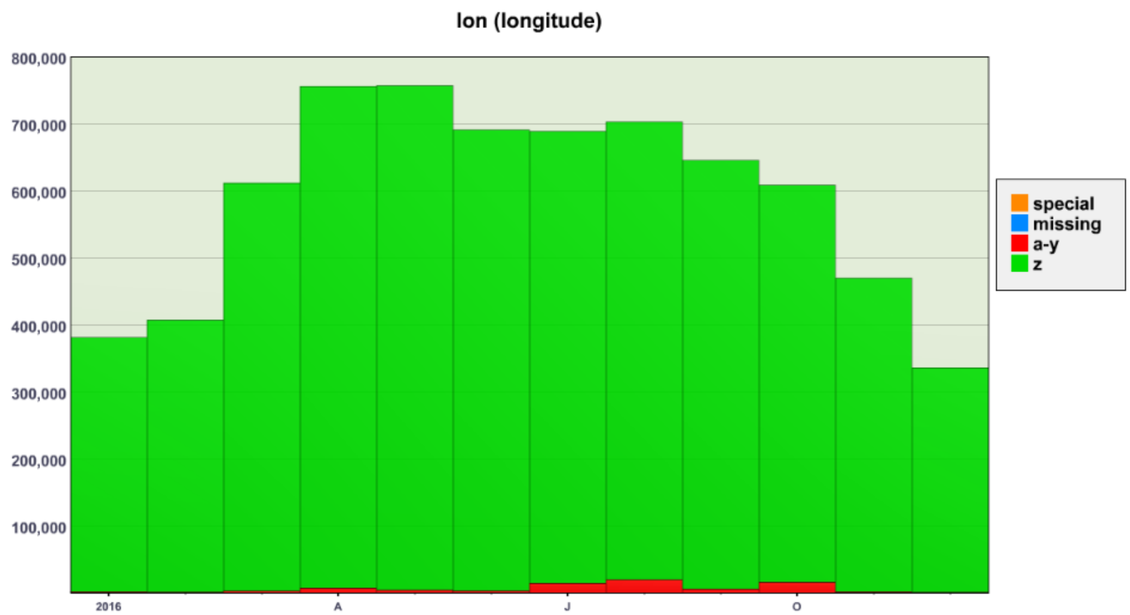
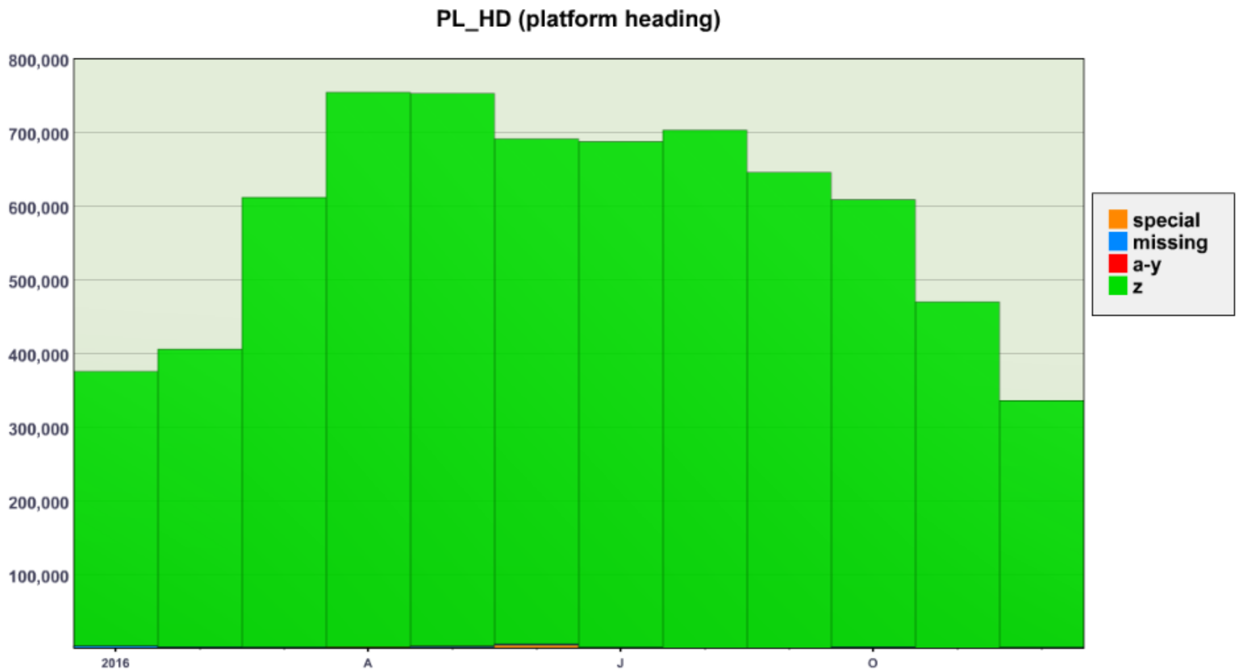


Figure 20: Total number of (top) latitude – LAT – and (bottom) longitude – LON – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

The remainder of the navigational parameters exhibited no problems of note. They are nevertheless included for completeness: platform heading (Figure 21), platform course

(Figure 22), platform speed over ground (Figure 23), and platform speed over water (Figure 24).



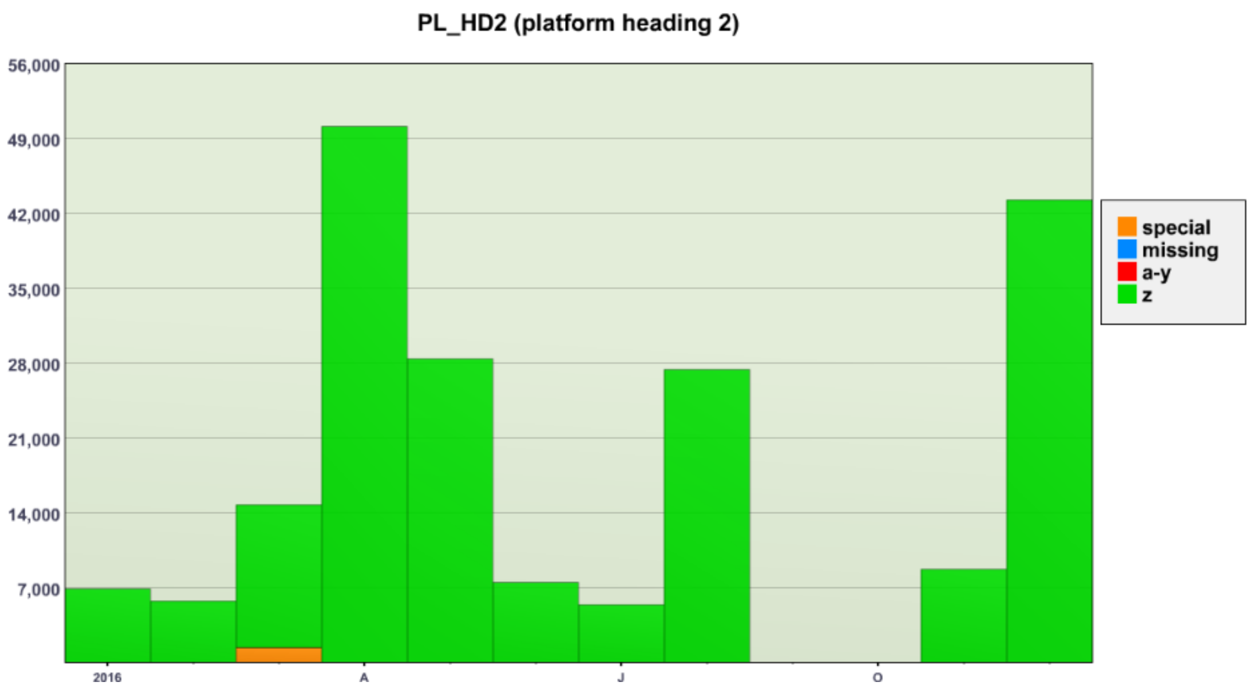
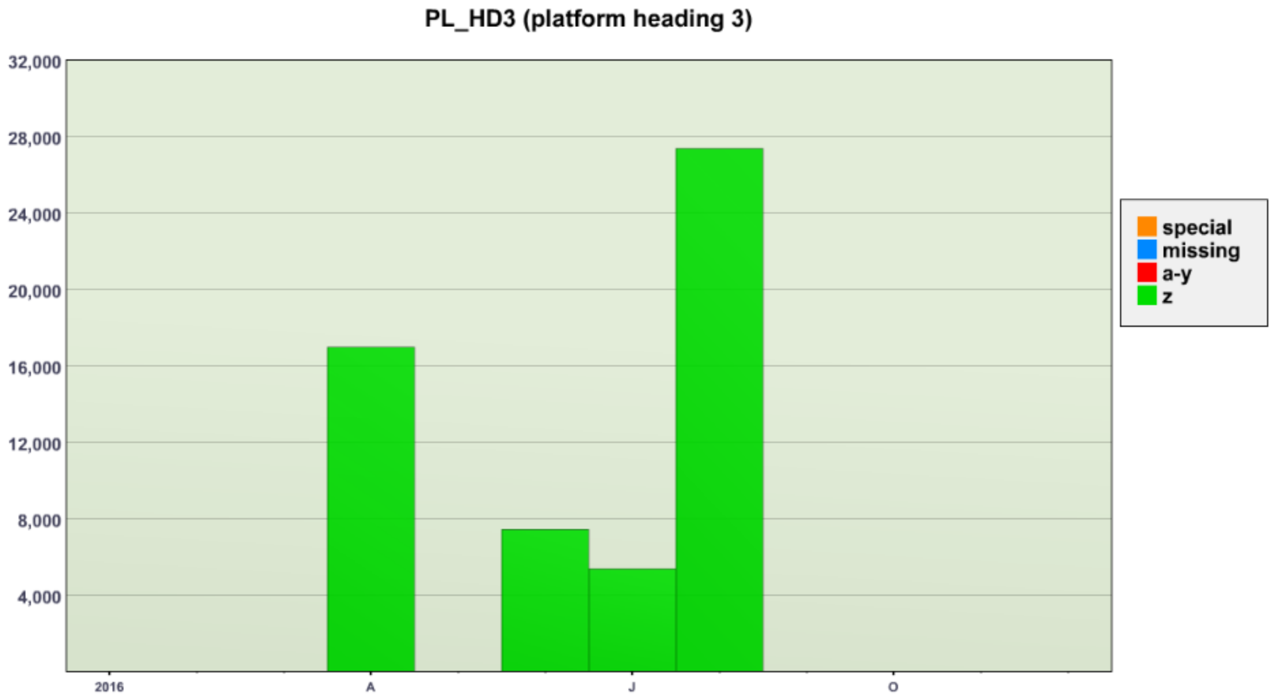


Figure 21: Total number of (this page, top) platform heading – PL_HD – (this page, bottom) platform heading 2 – PL_HD2 – and (next page) platform heading 3 – PL_HD3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 21: cont'd)

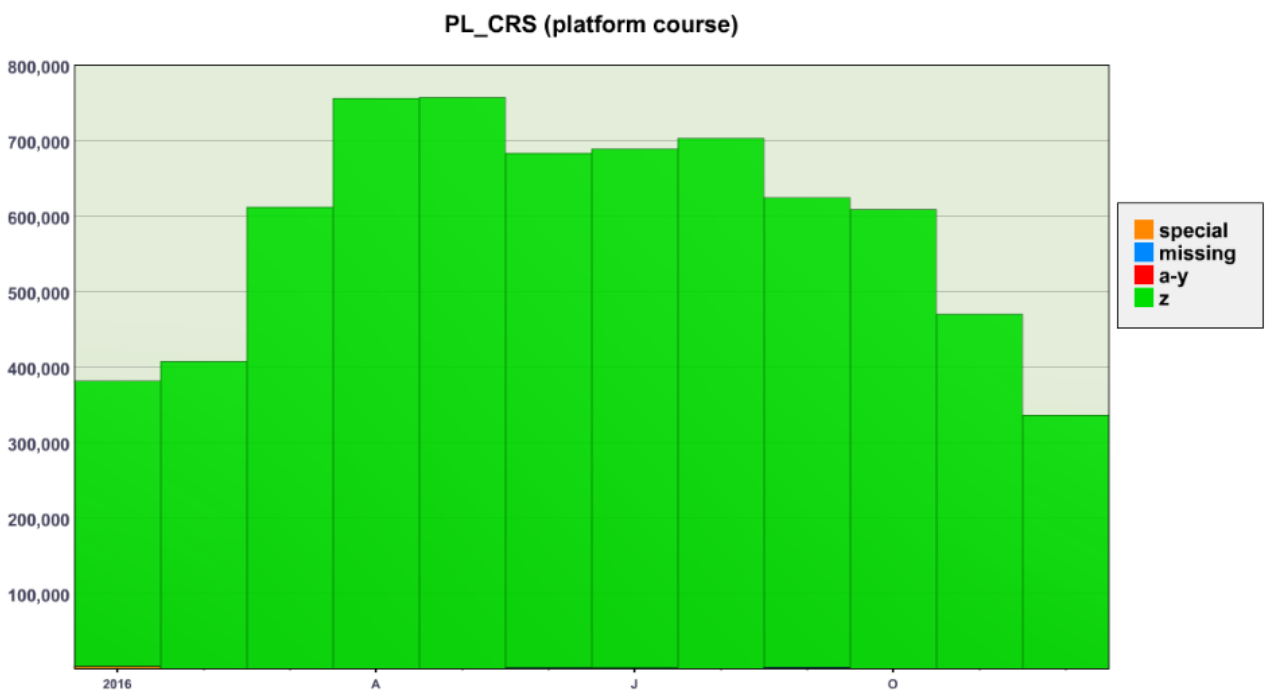


Figure 22: Total number of platform course – PL_CRS –observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

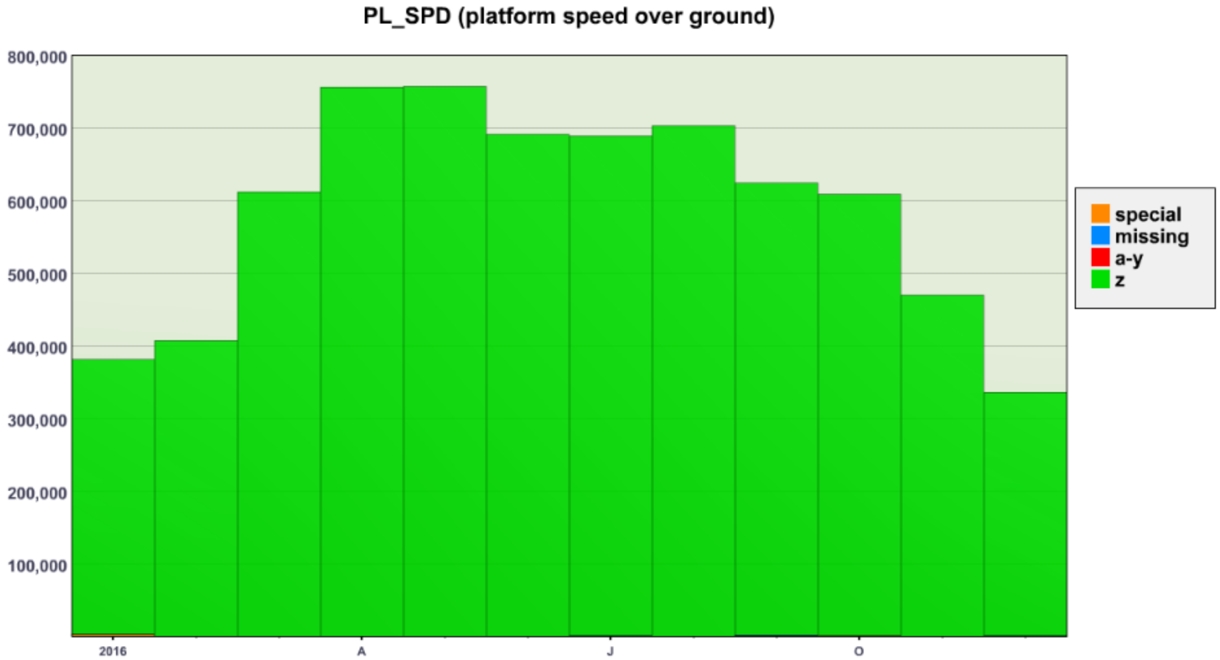


Figure 23: Total number of platform speed over ground – PL_SPD –observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

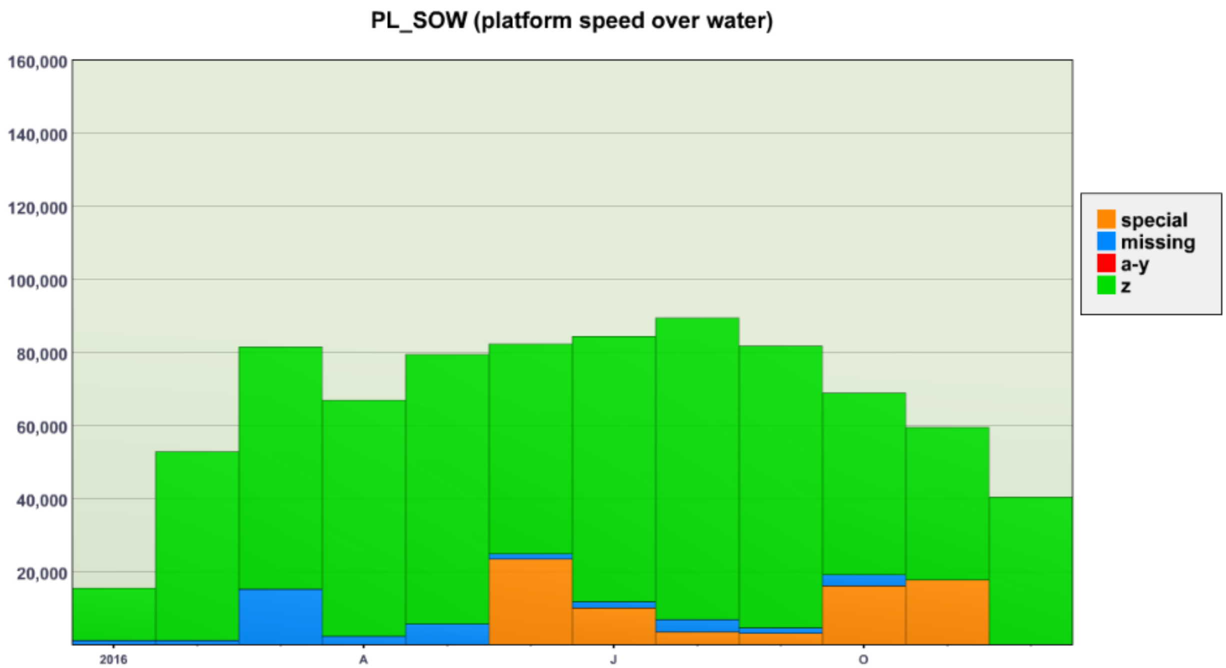
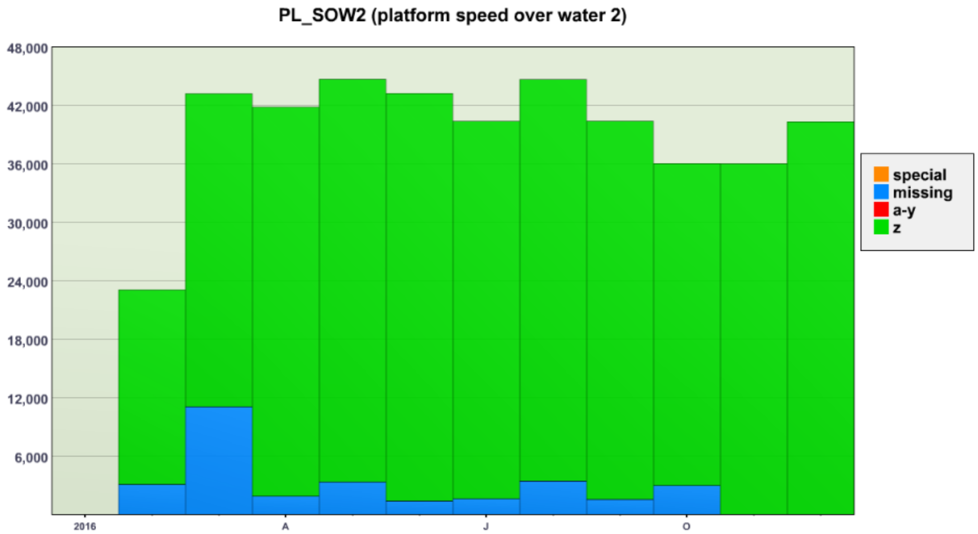


Figure 24: Total number of (this page) platform speed over water – PL_SOW – and (next page) platform speed over water 2 – PL_SOW2 observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 24: cont'd)

Regarding the platform relative wind parameters, both direction (Figure 25) and speed (Figure 26), any issues were mainly confined to the three vessels that experienced extensive wind problems in 2016; namely, the *Oregon II*, the *Okeanos Explorer* and the *Ron Brown* (documented; see individual vessel description in section 3c for details). These three vessels will account for the majority of the increases in flagging seen in both PL_WDIR and PL_WSPD. The slight increases in flagging seen in September in both PL_WDIR2 and PL_WSPD2 were probably from the *Falkor*, as she saw almost all of her parameters completely flagged during the period 24-30 September (documented; see individual vessel description in section 3c for details). We point out, too, that PL_WDIR3 and PL_WSPD3 were the final two of *Atlantis's* variables that received a quantity of special value flags during the year (details unknown).

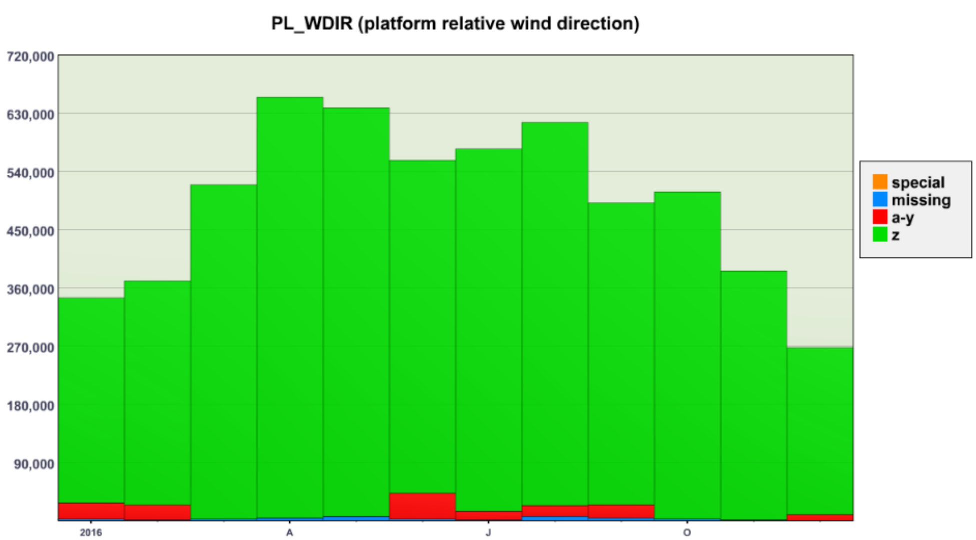
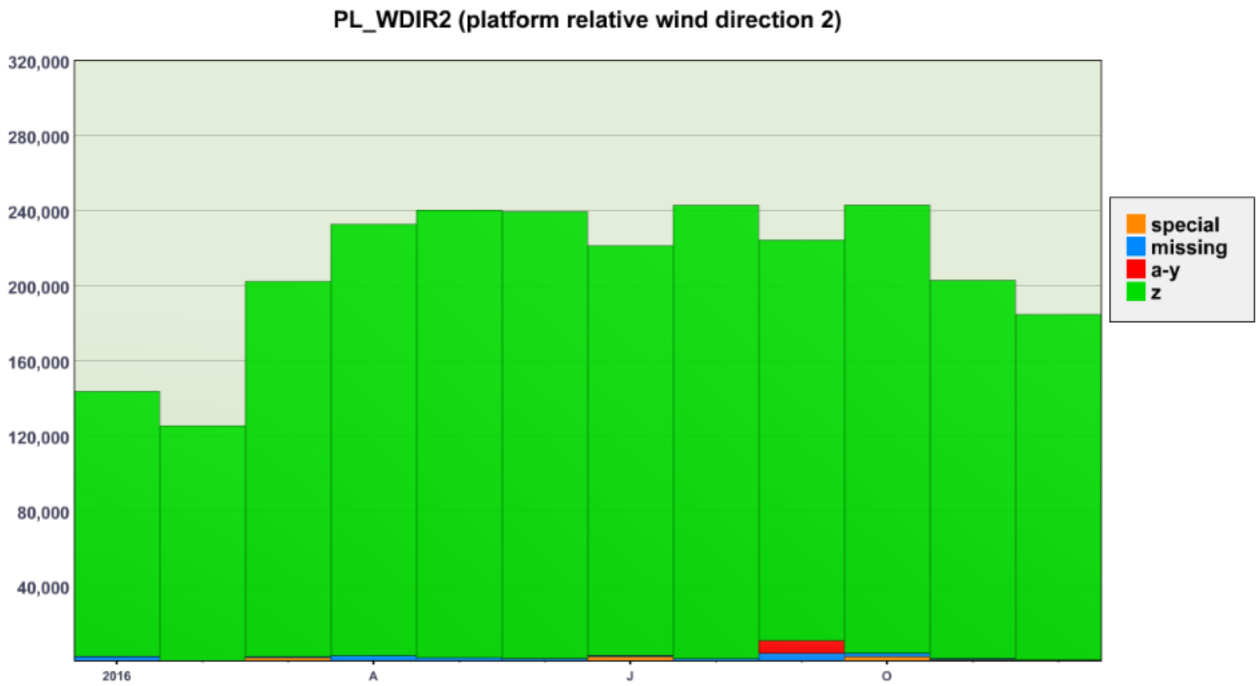
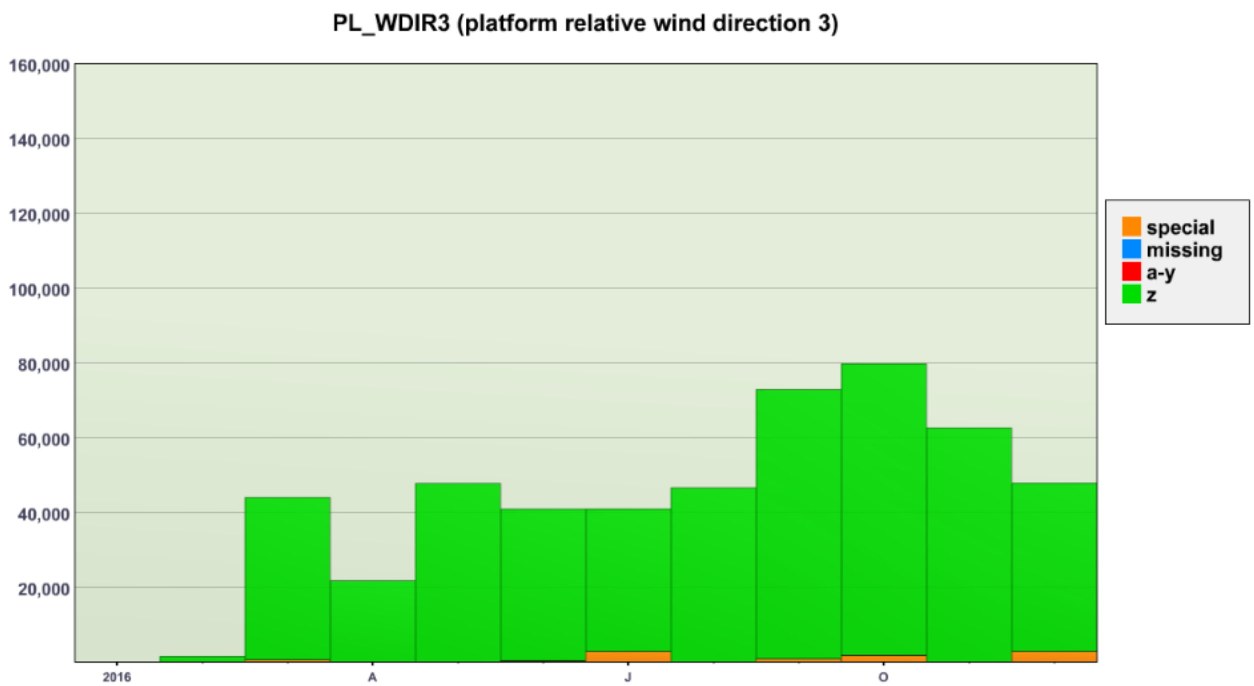
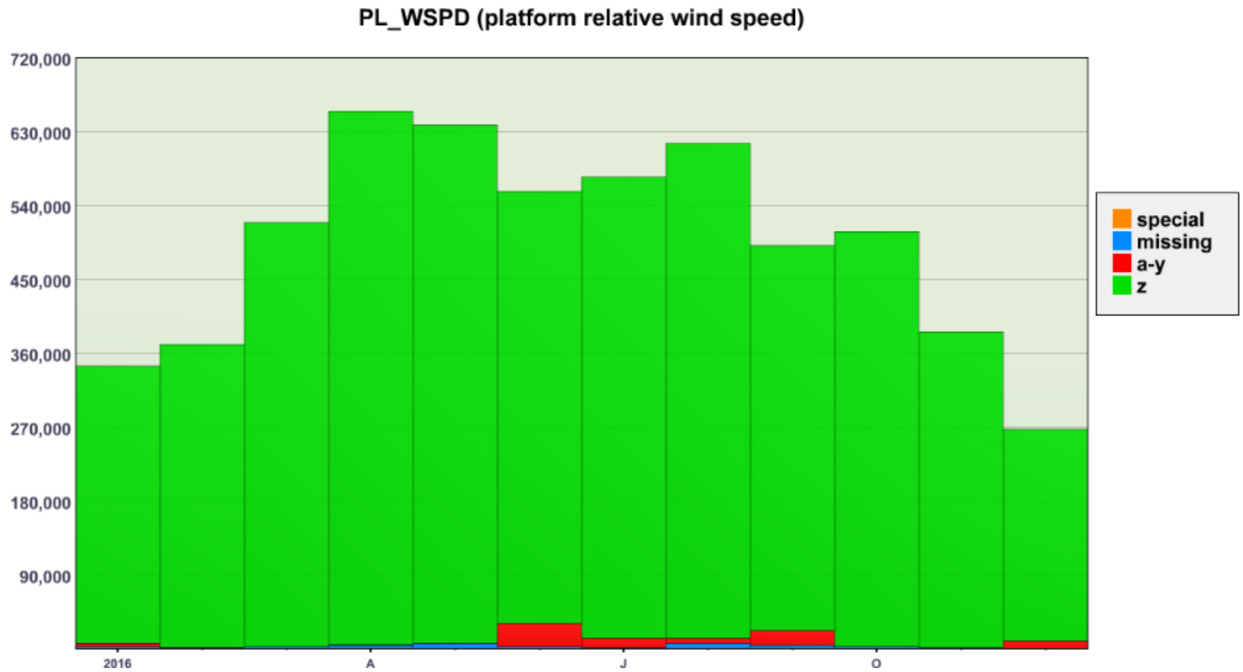


Figure 25: Total number of (this page) platform relative wind direction – PL_WDIR – (next page, top) platform relative wind direction 2 – PL_WDIR2 – and (next page, bottom) platform relative wind direction 3 – PL_WDIR3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.





(Figure 25: cont'd)



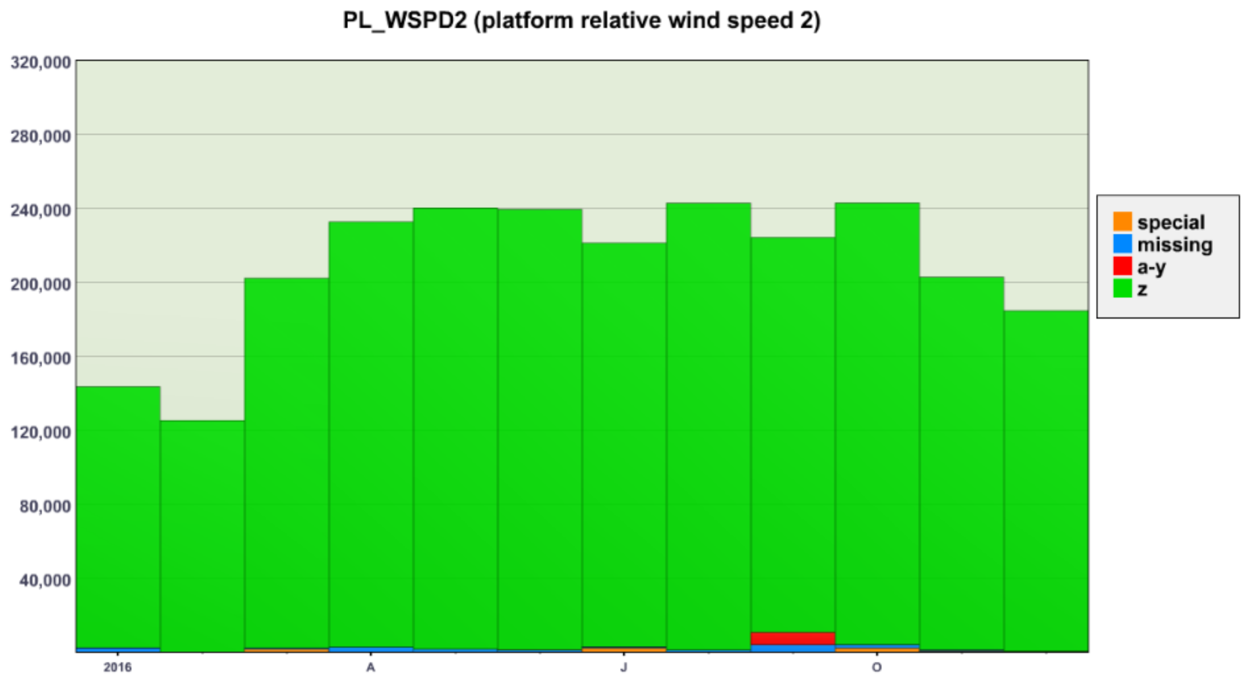
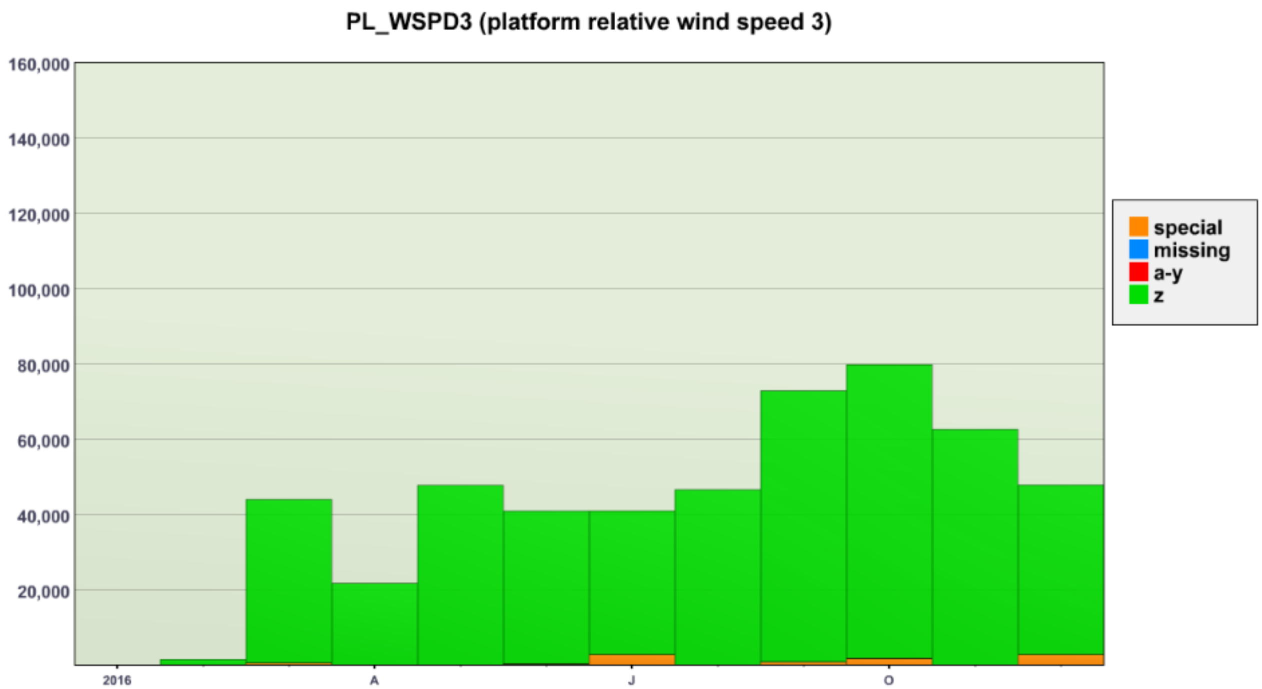


Figure 26: Total number of (this page, top) platform relative wind speed – PL_WSPD – (this page, bottom) platform relative wind speed 2 – PL_WSPD2 – and (next page) platform relative wind speed 3 – PL_WSPD3 – observations provided by all ships for each month in 2016. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 26: cont'd)

c. 2016 quality by ship

Atlantic Explorer

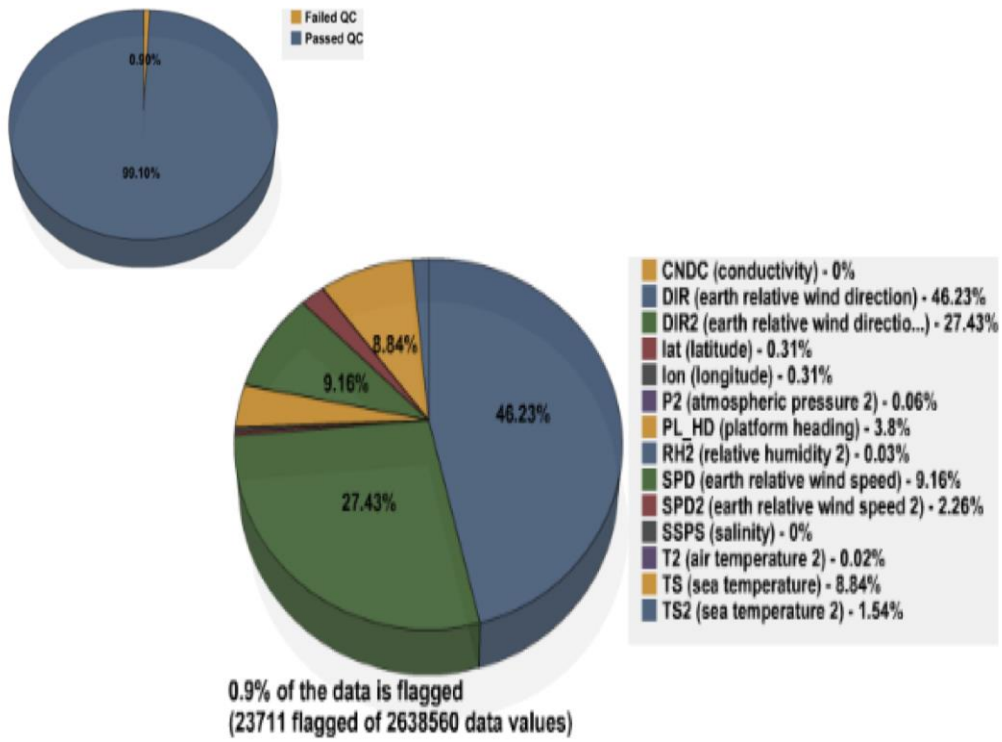


Figure 27: For the *Atlantic Explorer* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Atlantic Explorer* provided SAMOS data for 111 ship days, resulting in 2,638,560 distinct data values. After automated QC, 0.9% of the data were flagged using A-Y flags (Figure 27). This is a notably low percentage of flagged values, as well as being a modest improvement over 2015's 2.72% total flagged, but it is important to note that the *Atlantic Explorer* does not receive visual QC (due to a lack of funding), which is when the bulk of flags are usually applied. It is worth mentioning, too, that the *Explorer's* SAMOS data transmission rate was around 60% in 2016 (see Table 2) – not terrible, but there's certainly room for improvement. It would also be desirable to recover any data not received by us.

There is not much worth detailing quality-wise with respect to the *Explorer's* extremely low total flagged percentage, but it can at least be noted again that, as in previous years, the variables amassing the majority of the flags are the true wind direction parameters (DIR and DIR2). These are unanimously "failing the true wind test" (E) flags (Figure 29) and we continue to assert the possibility this is due to a combination of less than ideal sensor location (i.e. flow distortion) and possible true wind averaging problems. Once again, though, these unfortunately are not issues we are currently funded to sort out.

In early May an issue arose, which is not reflected in the flag totals, wherein missing values and/or spikes in the platform heading (PL_HD, not shown) were suspected of influencing the true wind direction and speed calculations for *Explorer's* port anemometer (DIR2 and SPD2, respectively), the end result being anomalous steps in the true wind data that traced the platform speed (PL_SPD), as seen via the red boxes in Figure 28. A possible 'backwards' installation was additionally suspected for the port anemometer, as there was an obvious offset in the true wind direction between the port (DIR2) and starboard (DIR) anemometers (Figure 28). The vessel was notified of these issues via email on 12 May. No reply was received; however, the issues appeared resolved as of 20 May. (We retain no record of any resolving actions.)

A second issue, also not reflected in the flagged totals, arose in mid-August wherein the platform relative wind direction and speed (PL_WDIR and PL_WSPD, respectively, not shown) began reading a constant 180 degrees and 0 m/s, respectively. Technicians were notified via email on 18 August. No reply was received and the issue persisted until 14 October. (We again retain no record of any resolving actions.)

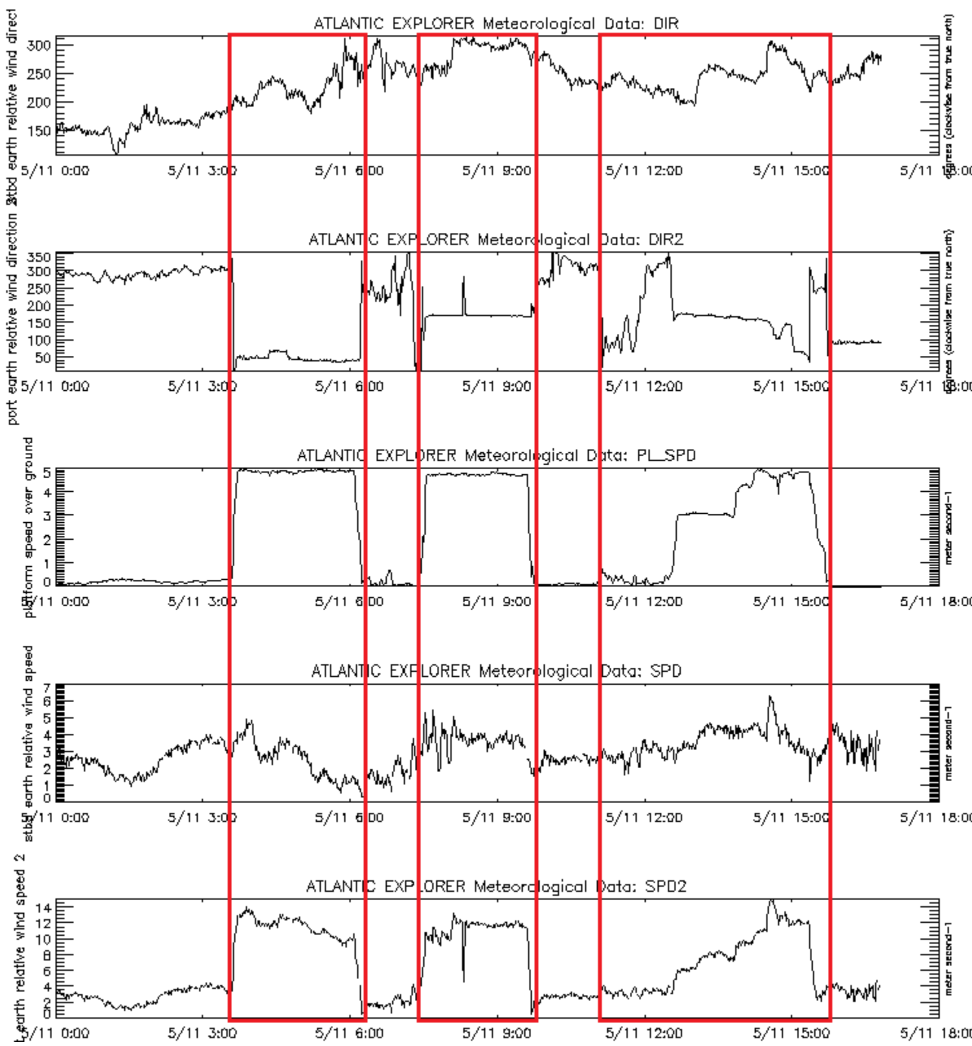


Figure 28: *Atlantic Explorer* SAMOS (first) earth relative wind direction – DIR – (second) earth relative wind direction 2 – DIR2 – (third) platform speed – PL_SPD – (fourth) earth relative wind speed – SPD – and (last) earth relative wind speed 2 – SPD2 – for 11 May 2016. Note DIR2/SPD2 steps inside red boxes.

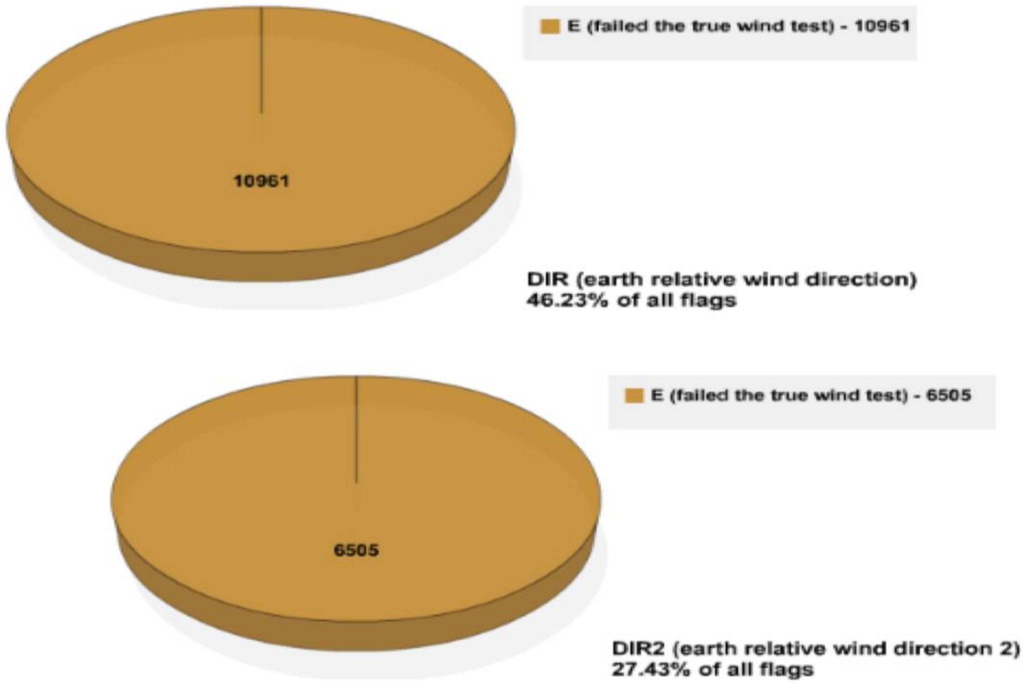


Figure 29: Distribution of SAMOS quality control flags for (top) earth relative wind direction – DIR – and (bottom) earth relative wind direction 2 – DIR2 – for the *Atlantic Explorer* in 2016.

Investigator

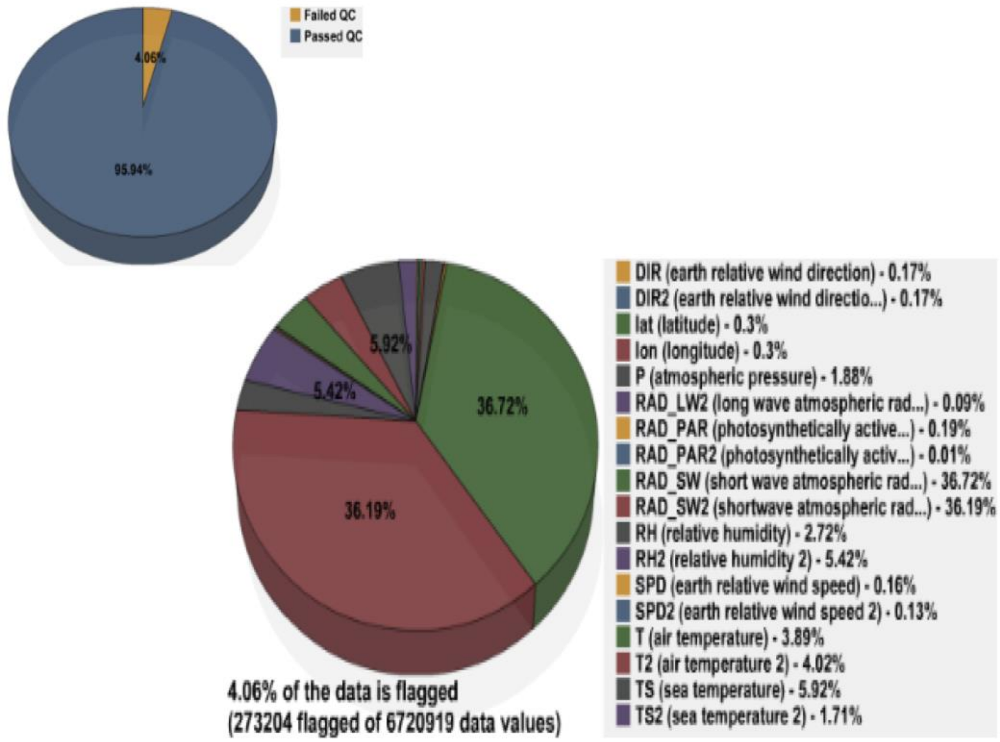


Figure 30: For the *Investigator* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Investigator* was made operational in the SAMOS database in late March 2016, and direct harvesting from the IMOS THREDDS service was initiated, tested, and made operational thereafter, utilizing the same code developed at the SAMOS DAC that enables direct harvesting of SAMOS daily files for the *Tangaroa* from IMOS. 24 March marks the first daily *Investigator* SAMOS file. The *Investigator* ultimately provided SAMOS data for 187 ship days, resulting in 6,720,919 distinct data values. After automated QC, 4.06% of the data were flagged using A-Y flags (Figure 30). NOTE: the *Investigator* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Investigator*).

The two *Investigator* parameters of note, holding about 36% of the total flagged percentage each (Figure 30), are from the redundant short wave atmospheric radiation sensors (RAD_SW and RAD_SW2). Upon inspection the flags, which are unanimously "out of bounds" (B) flags (Figure 31), appear to have been applied mainly to the slightly negative values that can occur with these sensors at night (a result of instrument tuning, see 3b.)

With no other noted issues, we welcome *Investigator* to the SAMOS family of vessels and congratulate her on an agreeable first year.

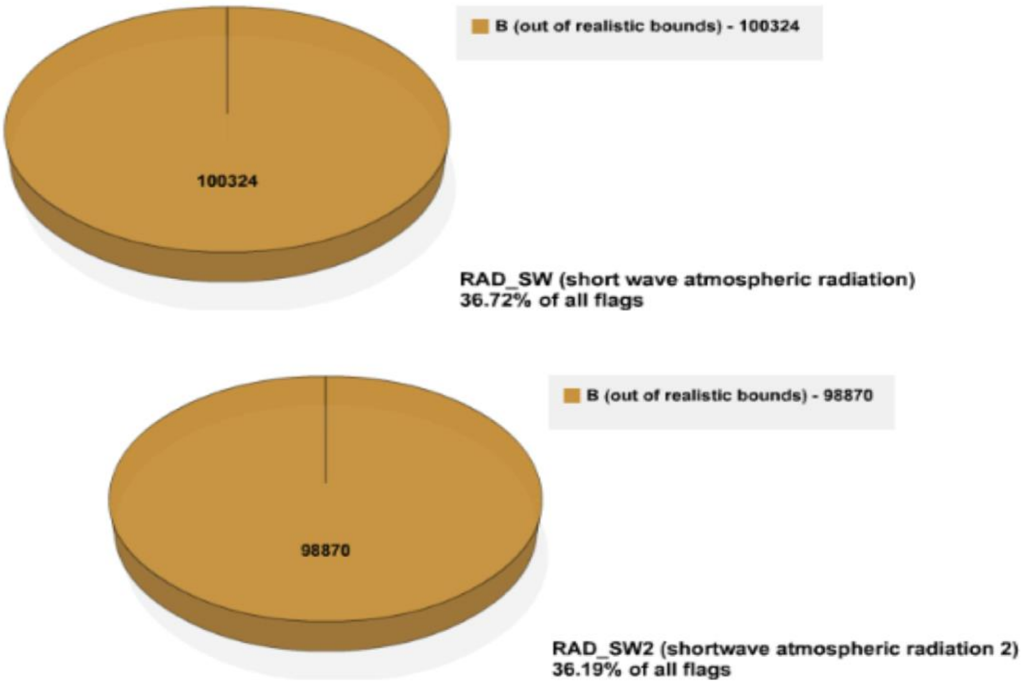


Figure 31: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – and (bottom) short wave atmospheric radiation 2 – RAD_SW2 – for the *Investigator* in 2016.

Tangaroa

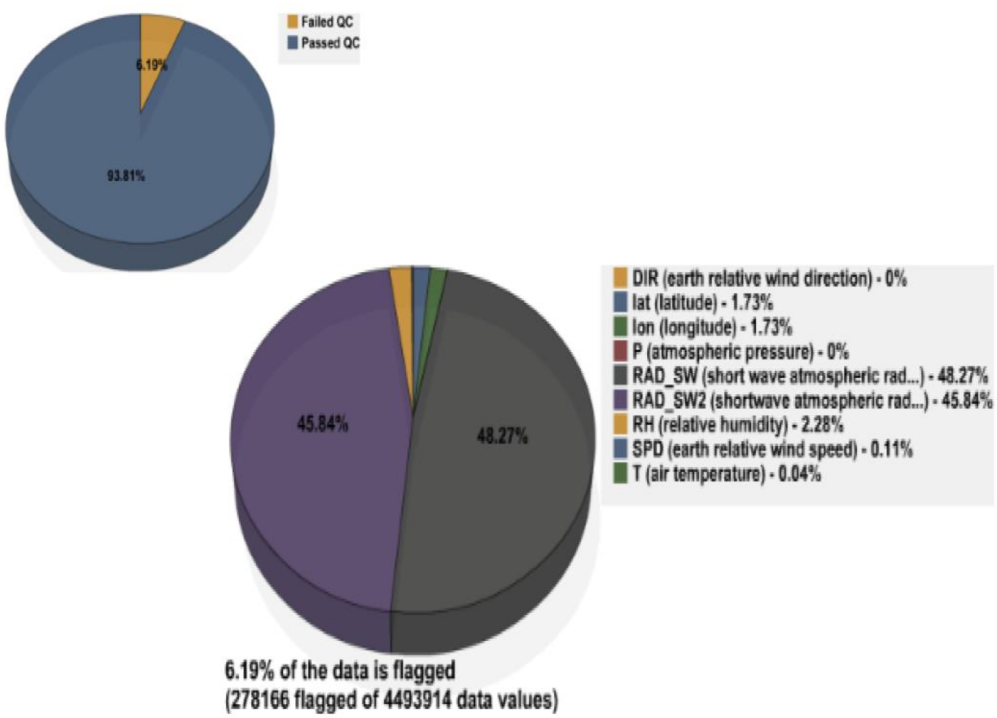


Figure 32: For the *Tangaroa* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Tangaroa* provided SAMOS data for 184 ship days, resulting in 4,493,914 distinct data values. After automated QC, 6.19% of the data were flagged using A-Y flags (Figure 32). NOTE: the *Tangaroa* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Tangaroa*).

Tangaroa's two short wave atmospheric radiation parameters (RAD_SW and RAD_SW2) again made up over 90% of the total flags (Figure 32). Just as with the *Investigator*, all of these flags were out of bounds (B) flags (Figure 33). Upon inspection, and also echoing *Investigator*, it appears most or all of the B flags applied to RAD_SW and RAD_SW2 were linked to short wave radiation values slightly less than zero, such as occurs at night. Although technically impossible, short wave radiation sensors commonly read slightly below zero at night, owing to sensor tuning (see 3b for discussion).

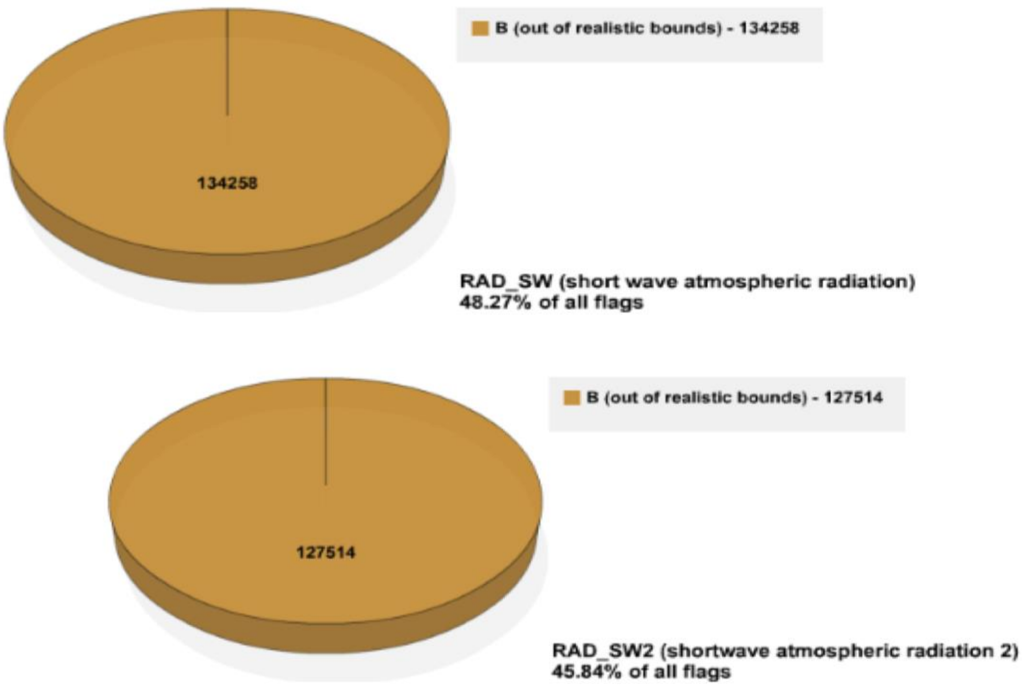


Figure 33: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – and (bottom) short wave atmospheric radiation 2 – RAD_SW2 – for the *Tangaroa* in 2016.

Pelican

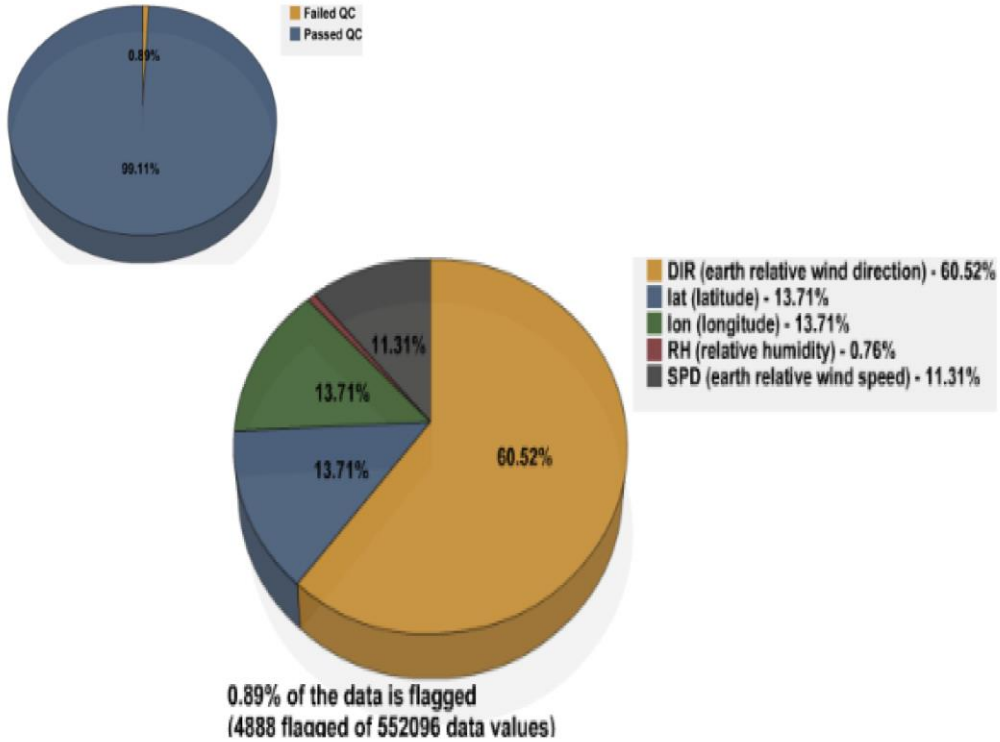


Figure 34: For the *Pelican* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Pelican* provided SAMOS data for 31 ship days, resulting in 552,096 distinct data values. After automated QC, 0.89% of the data were flagged using A-Y flags (Figure 34). This is substantially lower than 2015's 6.35% total flagged, but it is important to note that the *Pelican* does not receive visual quality control by the SAMOS DAC. The extremely low flag percentage may therefore be misleading, even while the decrease does have some positive implication. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Pelican*). It should be noted, too, that *Pelican's* SAMOS data transmission rate in 2016 was only around 15% (see Table 2). It would be desirable to recover any data not received by us.

While the *Pelican's* total flagged percentage is remarkably low, it is nevertheless notable that the earth relative wind direction (DIR) received the largest portion of those flags by far, over 60% (Figure 34). These were exclusively failing the true wind recalculation test (E) flags and the E flagging occasionally spilled over into the earth relative wind speed (SPD) parameter as well (Figure 36). Upon inspection, it seems that DIR can at times become noisy. It is likely an issue exists with the true wind calculation – perhaps an averaging problem – as the noise in DIR isn't always present in conjunction with obvious noise in other related parameters (Figure 35). Unfortunately, this is not an issue we are currently funded to sort out. At best, we can repeat advisement of a thorough investigation of the *Pelican's* true wind calculation.

An additional ~25% of all flags were applied to the latitude and longitude (lat, lon) parameters (Figure 34). These were exclusively "platform over land" (L) flags (Figure 36). Upon inspection these L flags were applied mainly while the *Pelican* sat afloat at her home port nestled in the Louisiana bayou at LUMCON, echoing the L flagging we saw in 2015 with this vessel. This L flagging of position data in narrow channels is a common occurrence, owing to the two minute land-water mask used in SAMOS data processing. We note that in these cases the L flags would normally be removed by during visual quality inspection; however, the *Pelican* is not currently funded for visual QC.

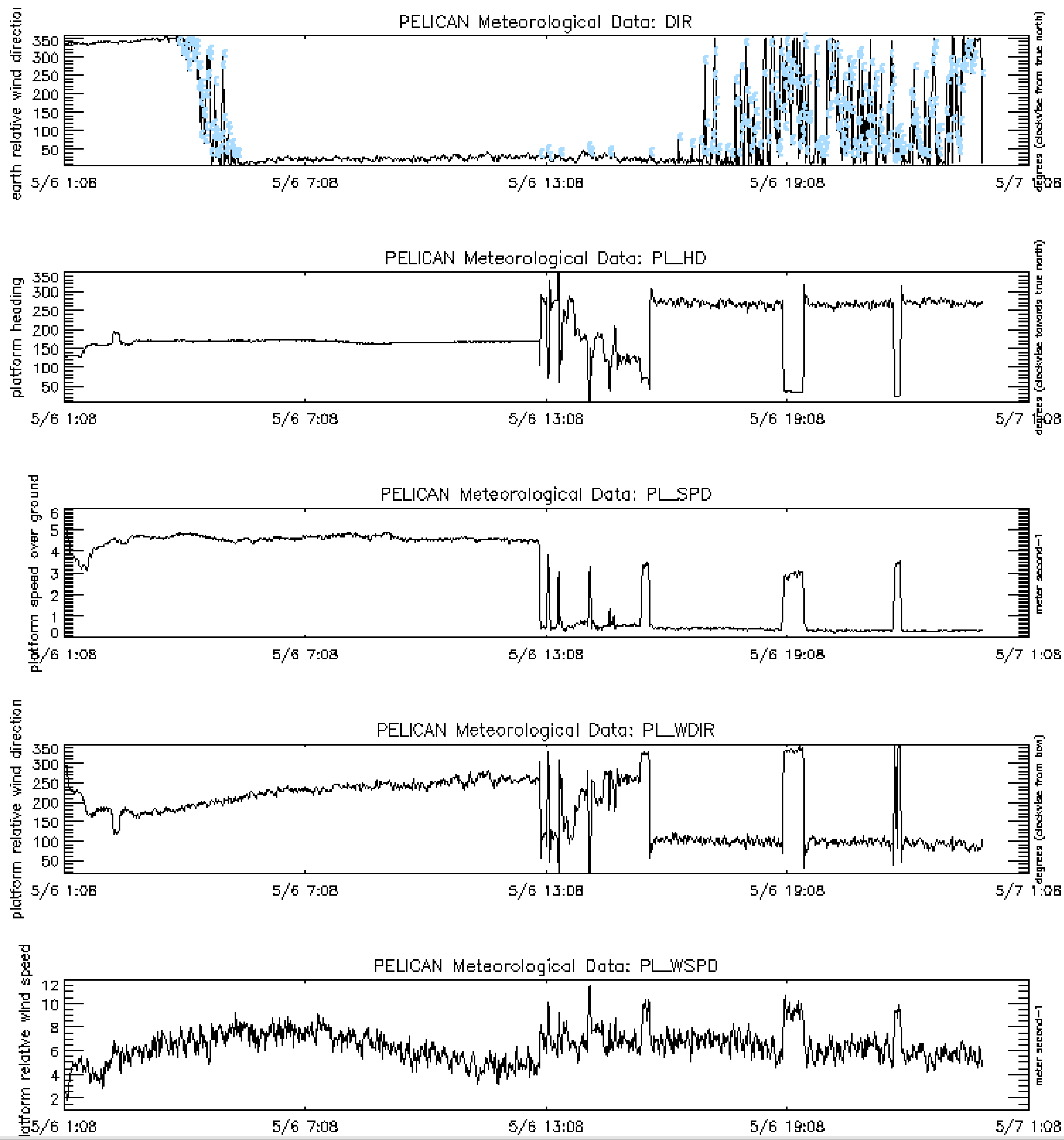


Figure 35: *Pelican* SAMOS (first) earth relative wind direction – DIR – (second) platform heading – PL_HD – (third) platform speed – PL_SPD – (fourth) platform relative wind direction – PL_WDIR – and (last) platform relative wind speed – PL_WSPD – data for 6 May 2016. Note light blue "failing the true wind test" (E) flags on DIR with no clear origin of noise seen elsewhere.

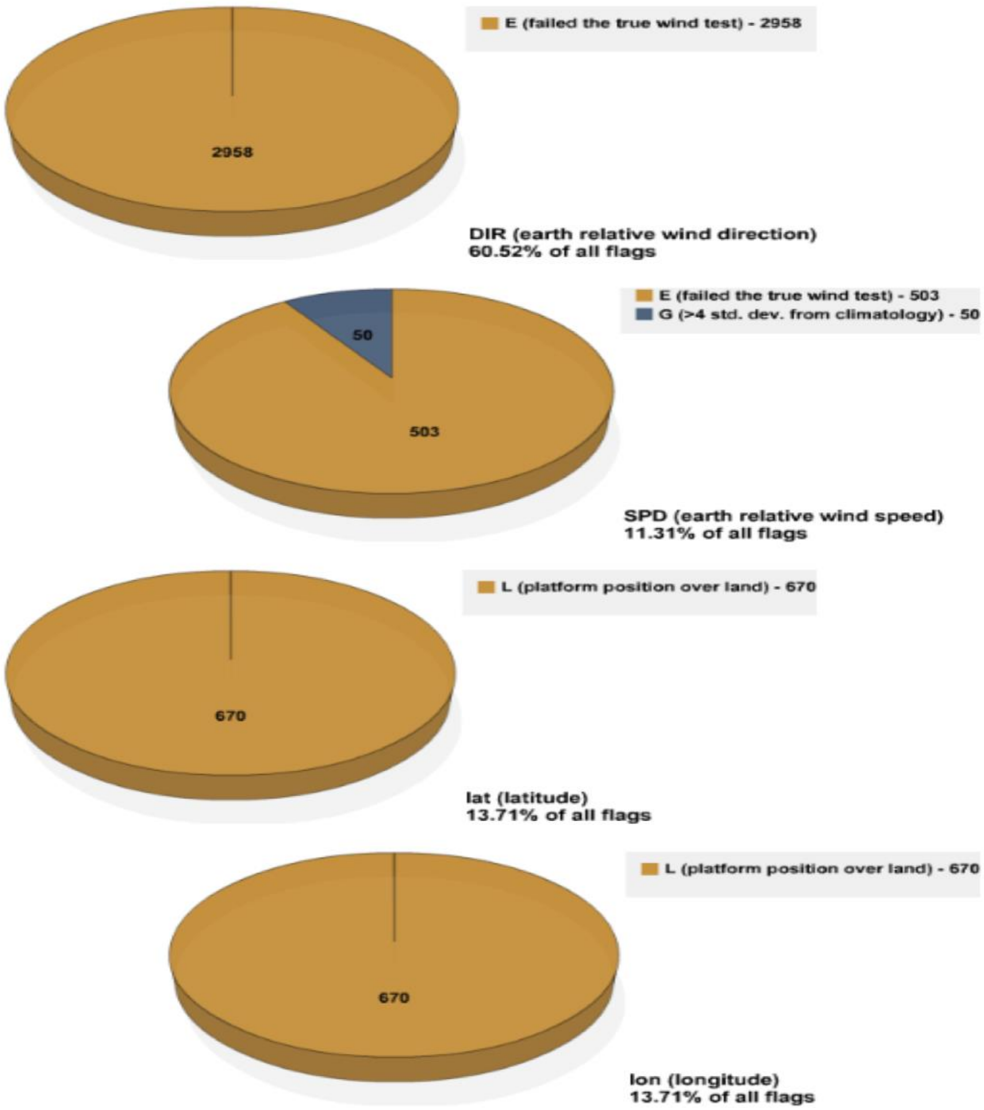


Figure 36: Distribution of SAMOS quality control flags for (first) earth relative wind direction – DIR – (second) earth relative wind speed – SPD – (third) latitude –lat – and (last) longitude – lon – for the *Pelican* in 2016.

Bell M. Shimada

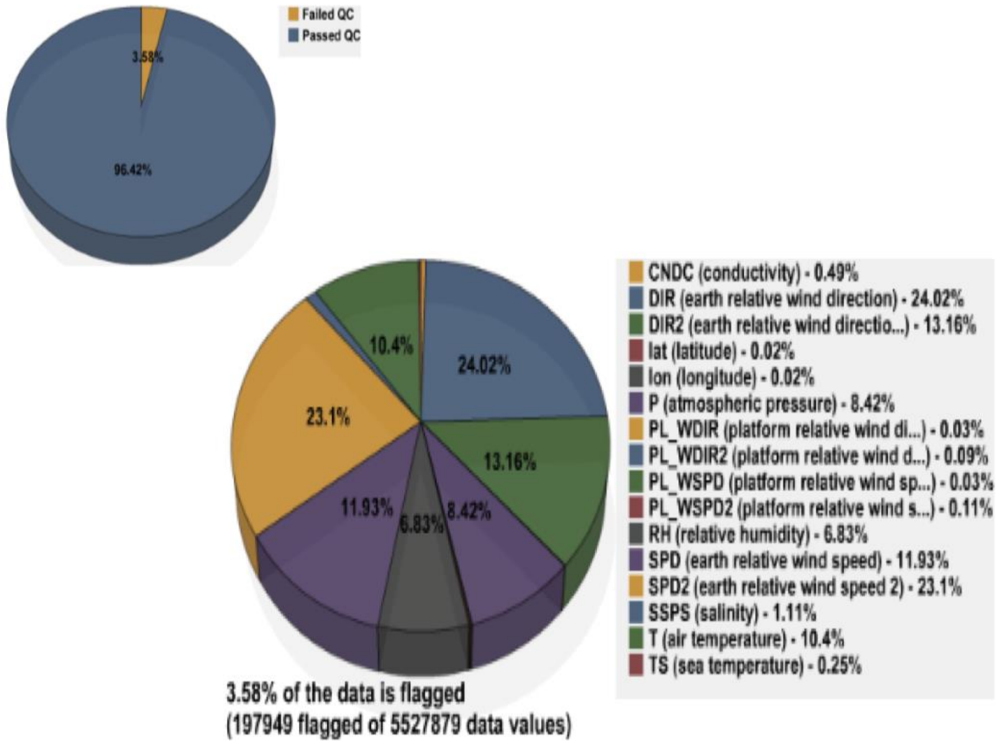


Figure 37: For the *Bell M. Shimada* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Bell M. Shimada* provided SAMOS data for 210 ship days, resulting in 5,527,879 distinct data values. After both automated and visual QC, 3.58% of the data were flagged using A-Y flags (Figure 37). This is essentially unchanged from 2015 (3.66% total flagged) and *Shimada* remains under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

It can be a challenge to site sensors ideally on a ship. As with most vessels, *Shimada's* various meteorological sensors do occasionally exhibit data distortion that is dependent on the vessel relative wind direction and, in the case of air temperature, likely ship heating. Where the data appears affected, it is generally flagged with caution/suspect (K) flags. As in years before, this type of flagging constitutes the majority of the percentages seen in *Shimada's* atmospheric variables (see Figure 37) – namely, the earth relative wind direction and speed (DIR, DIR2, SPD, SPD2) and the pressure, air temperature, and relative humidity (P, T, RH). We note again, though, that with such a low overall flag percentage these sensor location issues are not terribly consequential. (We refer interested parties to pp. 58-59 in the 2015 Annual Report for a detailed discussion of these sensor locations http://samos.coaps.fsu.edu/html/docs/2015SAMOSAnnualReport_final.pdf).

In addition to these sensor location issues, however, the SAMOS data analyst in charge of the quick visual inspection that occurs when daily files are received noted in early September that the bow anemometer true wind direction (DIR) had suddenly gone haywire on the first of the month and thereafter appeared to probably be a trace of 2x the earth relative wind speed (SPD). The vessel was notified on 7 September and word quickly came back that the science party on board had requested lowering the jackstaff, where the affected anemometer was located, and the wind data associated with DIR and SPD were being pulled from the starboard sonic wind sensor instead (i.e. PL_WDIR2/PL_WSPD2) for the duration of the cruise. Technicians were re-notified six days later via email that DIR was nonetheless still apparently true wind speed 2 (SPD2) doubled (see Figure 38), but this communication appears not to have been clear and DIR maintained erroneous reporting through the end of the cruise on 29 September. As a result of these circumstances, DIR was flagged first with "poor quality" (J) and later "malfunction" (M) flags for all of September (Figure 39).

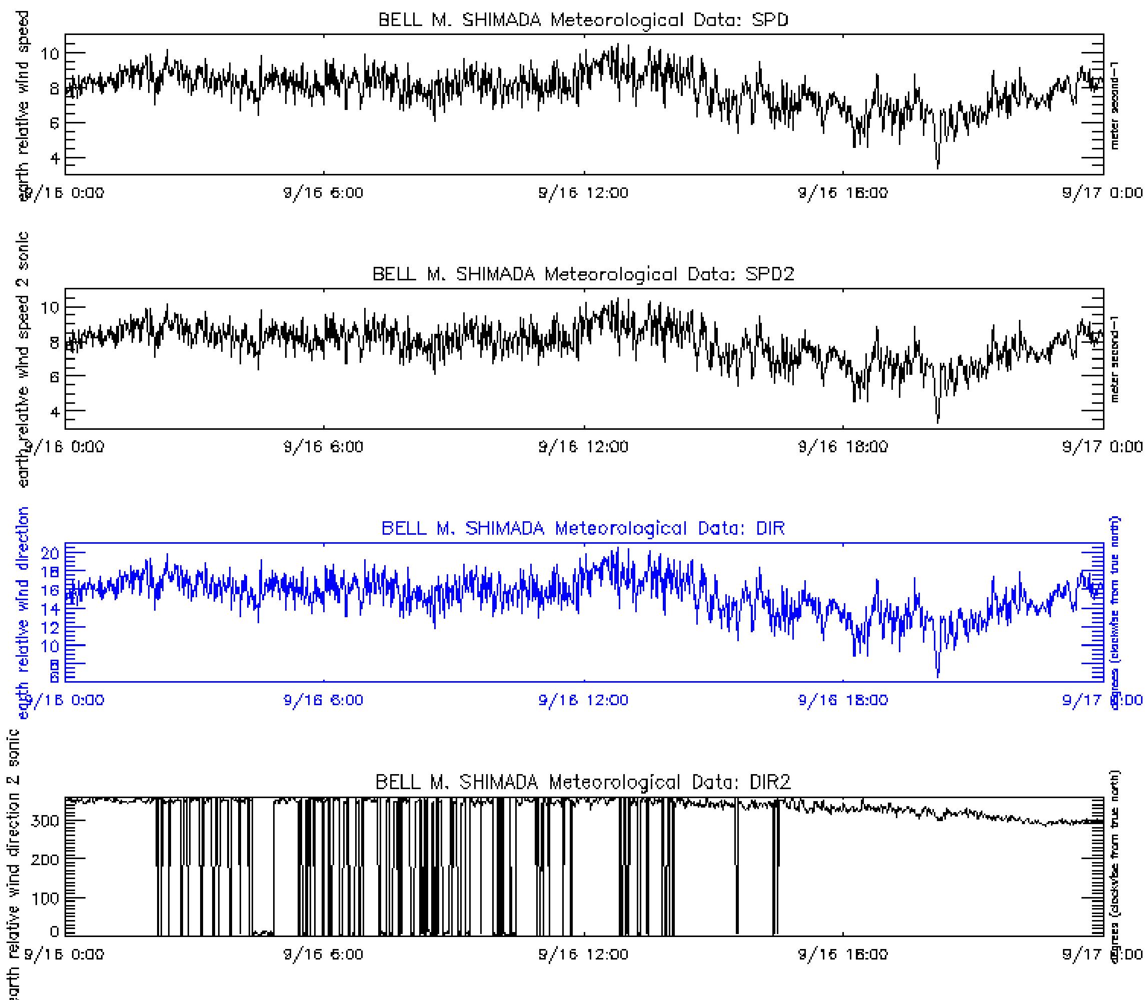


Figure 38: *Shimada* SAMOS (first) earth relative wind speed – SPD – (second) earth relative wind speed 2 – SPD2 – (third, in blue) earth relative wind direction – DIR – and (last) earth relative wind direction 2 –DIR2 – data for 16 September 2016. Note DIR = SPD2 x 2 (and SPD = SPD2).

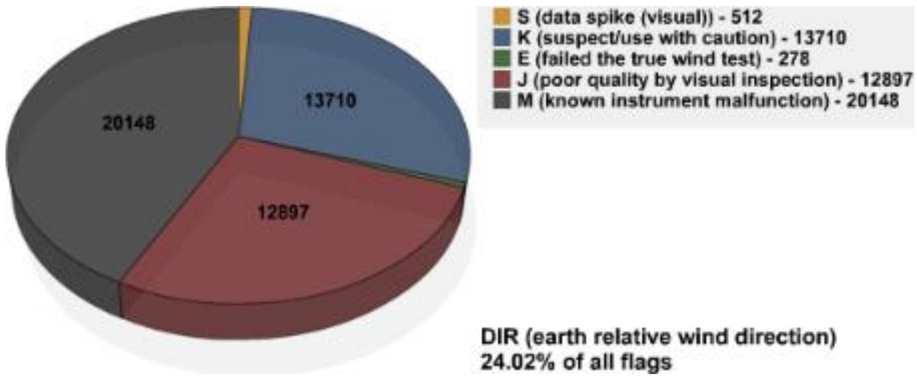


Figure 39: Distribution of SAMOS quality control flags for earth relative wind direction – DIR – for the *Bell M. Shimada* in 2016.

Fairweather

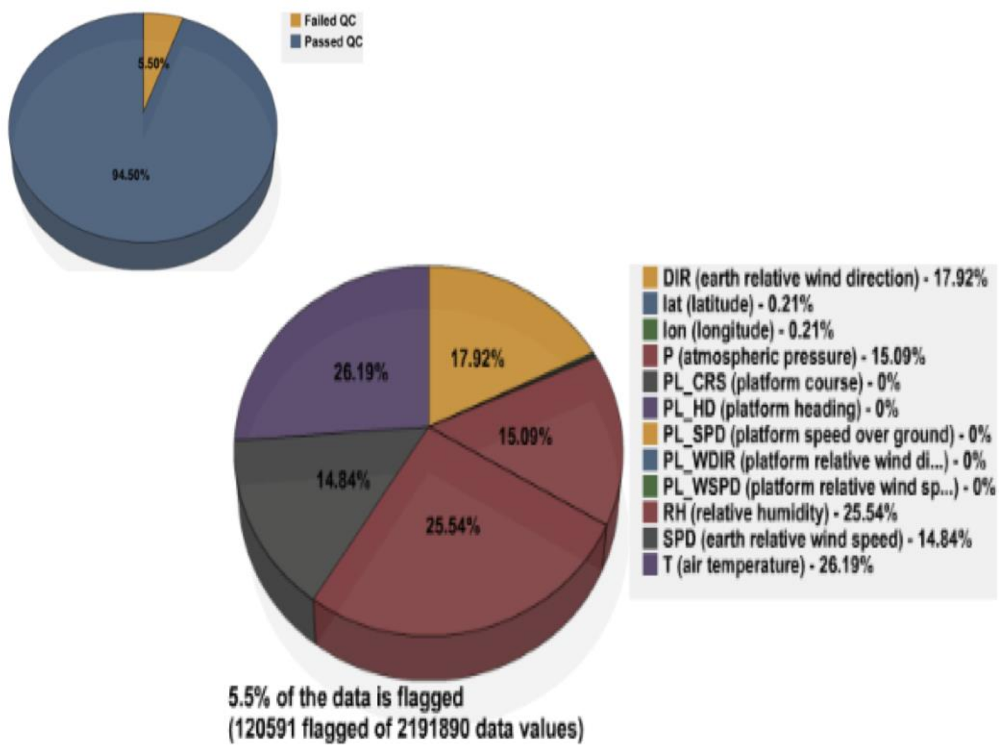


Figure 40: For the *Fairweather* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Fairweather* provided SAMOS data for 142 ship days, resulting in 2,191,890 distinct data values. After both automated and visual QC, 5.5% of the data were flagged using A-Y flags (Figure 40), an improvement over 2015 performance (7.15% total flagged) that brings *Fairweather* very close to the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

The biggest issue with the *Fairweather* data likely continues to be problematic sensor location, although neither adequate metadata nor digital imagery nor a detailed flow analysis exists for this vessel preventing confirmation (see Table 4). All five of the meteorological parameters offered by *Fairweather* – earth relative wind direction (DIR), earth relative wind speed (SPD), air temperature (T), relative humidity (RH), and atmospheric pressure (P) – show a considerable amount of flow obstruction and/or interference from stack exhaust or ship heating, which is plainly reflected in the flagged percentages seen in Figure 40. Effects are generally seen as "steps" in the affected data in concert with platform speed and/or platform relative wind direction/speed changes (examples Figure 41). These steps are generally assigned "caution/suspect" (K) flags (Figure 43). There are also some additional "failed the true wind test" (E) flags on the wind parameters, mainly DIR, as well as some "spike" (S) flags on P (Figure 43).

Additionally, T and RH appeared to suffer some sort of failure on 3 August whereby data values read clearly outside of realistic expectations (example Figure 42). This behavior persisted through mid-month and garnered a good deal of "out of bounds" (B) and "poor quality" (J) flags on both parameters (Figure 43) until transmission of T and RH ceased altogether on 18 August. When T and RH transmission resumed in September the data were once again chiefly in line with expected values. (We retain no record of the problem or of the subsequent solution.)

Outside of the issues that are clearly affirmed in the flag percentages, *Fairweather* also experienced a period from 30 May through 2 July during which no wind data were reported. Technicians were notified via email once or twice concerning the omission, however no response was ever received. Wind data transmission resumed on 6 July. We further note that *Fairweather* did not contribute any sea parameter data in 2016 (i.e. sea temp, salinity, conductivity).

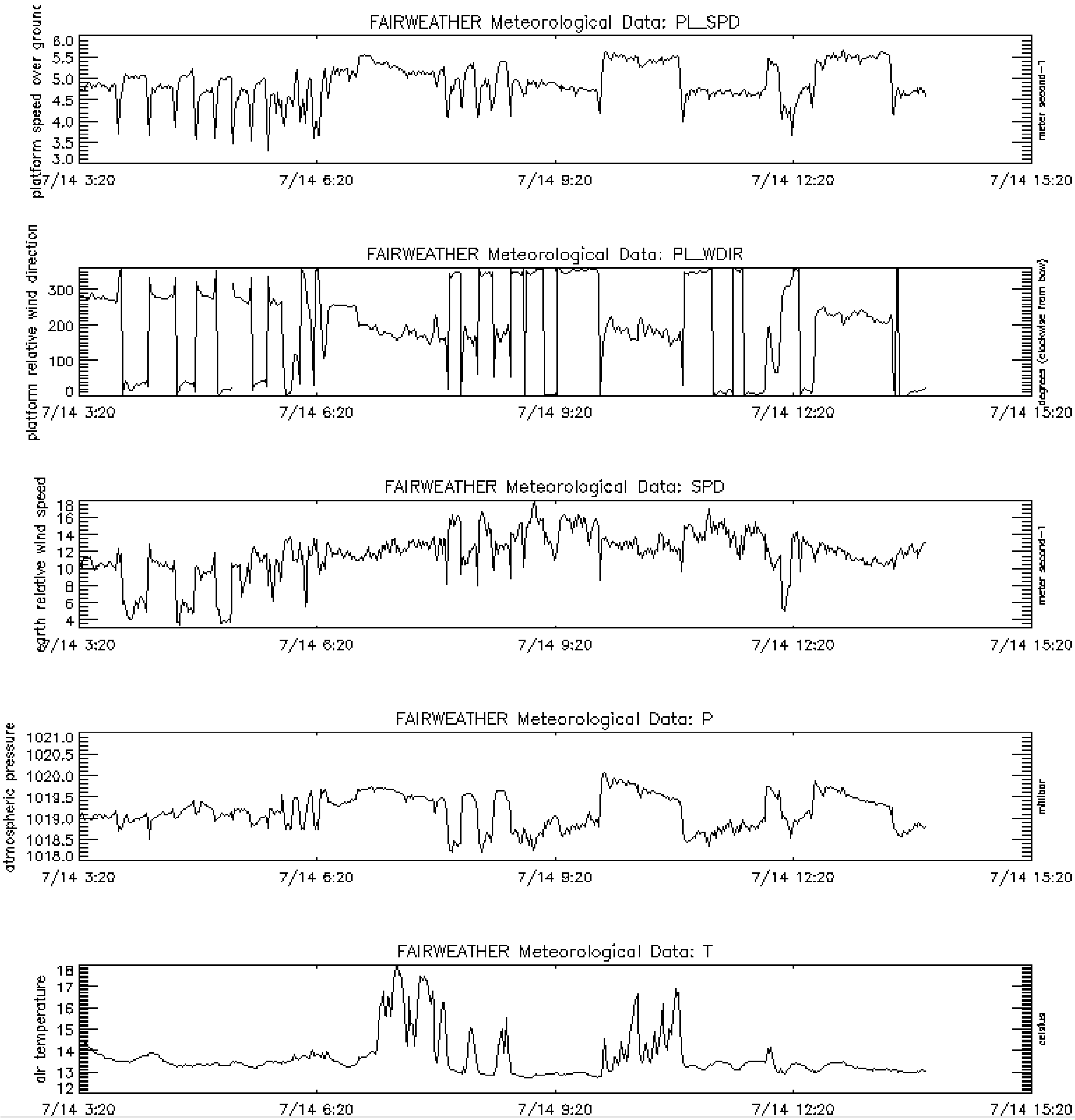


Figure 41: *Fairweather* SAMOS (first) platform speed – PL_SPD – (second) platform relative wind direction – PL_WDIR – (third) earth relative wind speed – SPD – (fourth) atmospheric pressure – P – and (last) air temperature – T – data for 14 July 2016. Note the many steps in SPD, P, and T in conjunction with changing PL_SPD/PL_WDIR. There likely exist multiple platform relative wind directions that interfere with the various met sensors.

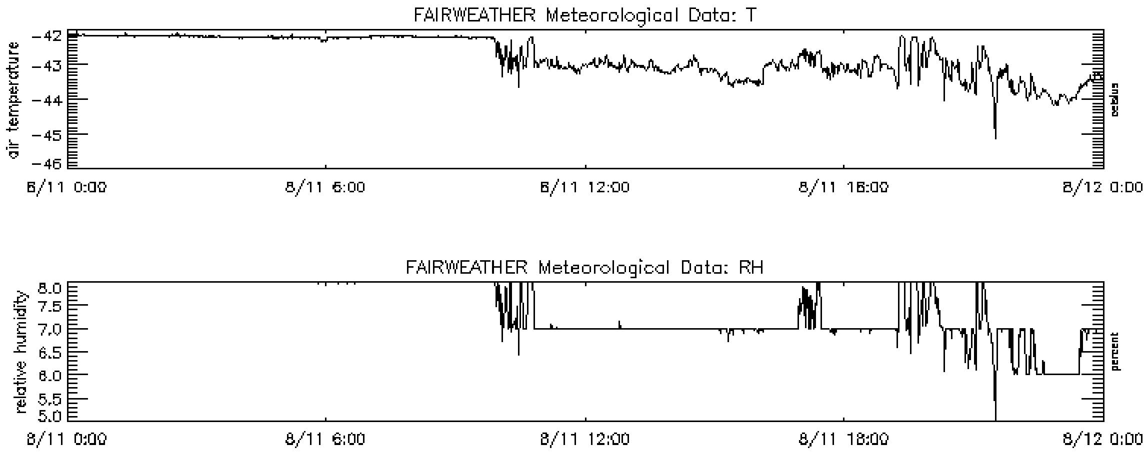


Figure 42: *Fairweather* SAMOS (top) air temperature – T – and (bottom) relative humidity – RH – data for 11 August 2016. Note unrealistic data values/trends.

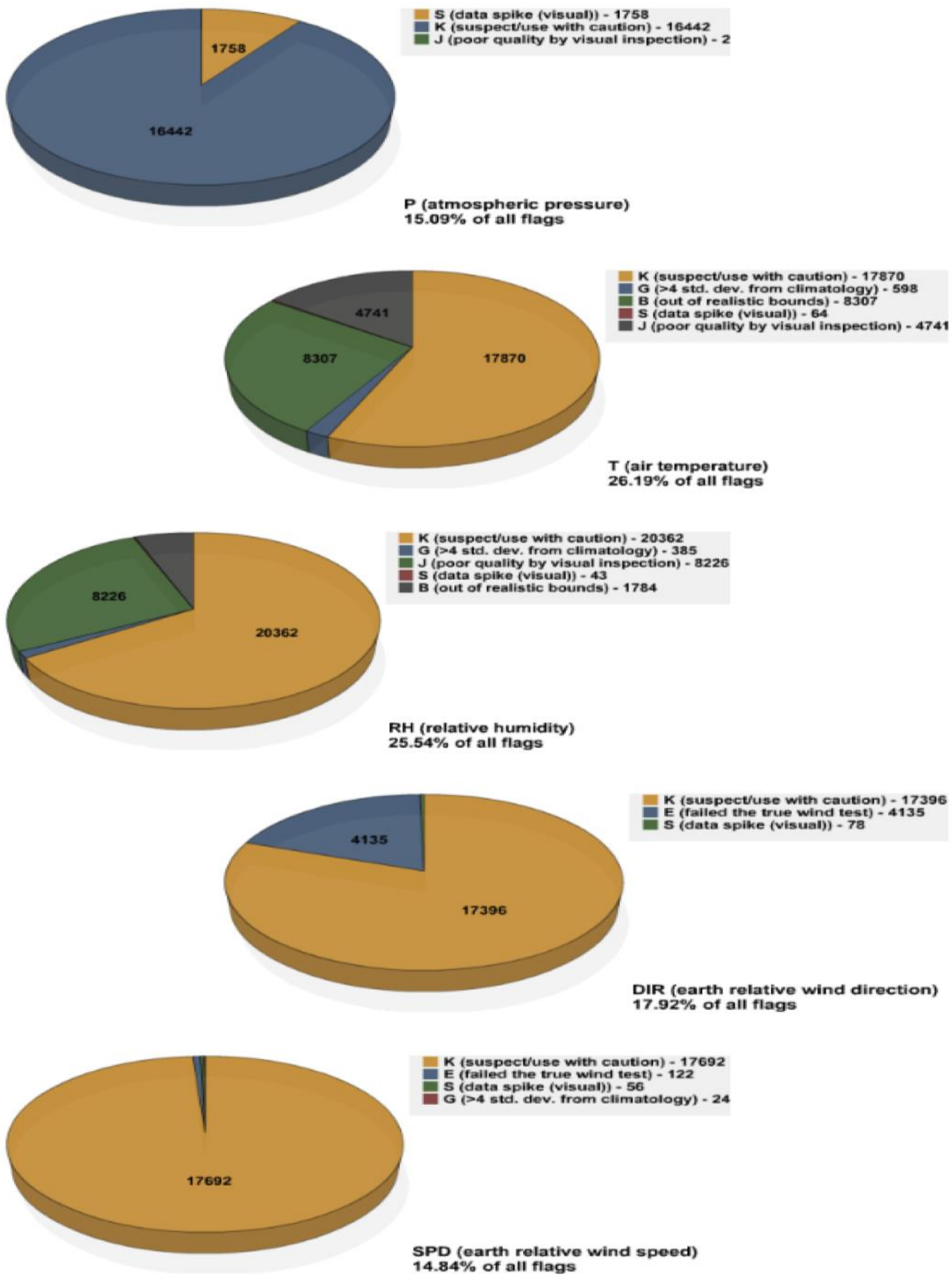


Figure 43: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Fairweather* in 2016.

Ferdinand Hassler

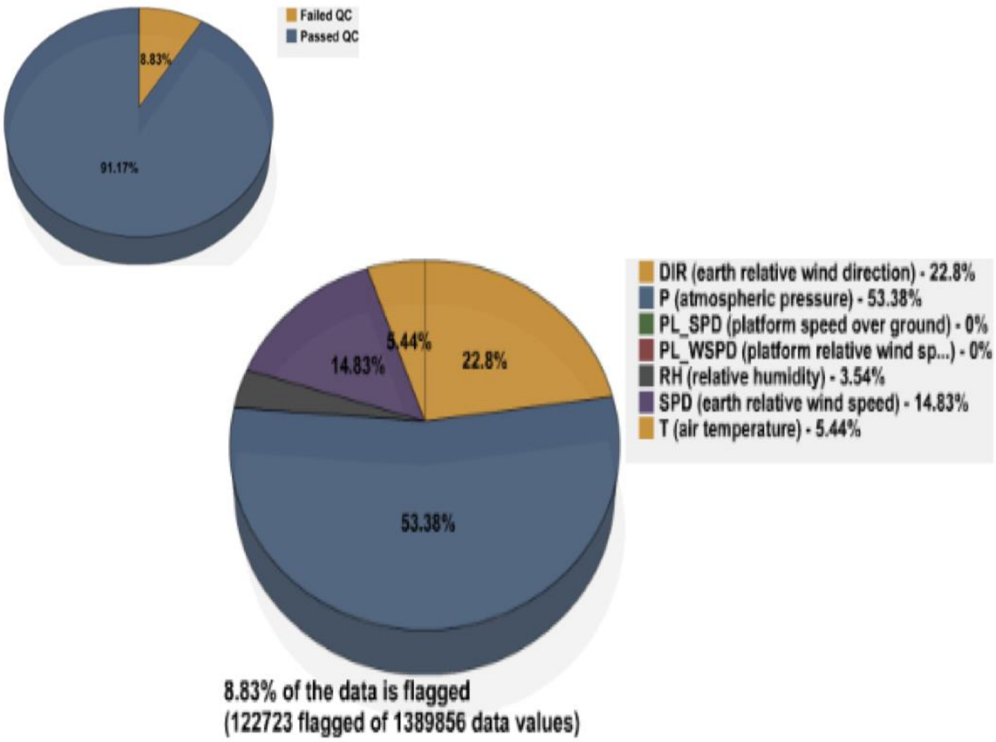


Figure 44: For the *Ferdinand Hassler* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Hassler* provided SAMOS data for 83 ship days, resulting in 1,389,856 distinct data values. After both automated and visual QC, 8.83% of the data were flagged using A-Y flags (Figure 44). This is an increase of about 2.5 percentage points over *Hassler's* 2015 performance (6.15% total flagged). It should be noted, too, that *Hassler's* SAMOS data transmission rate was only around 35% in 2016 (see Table 2). It would be desirable to recover any data not received by us, even if it might not be possible to apply visual QC.

Clearly the biggest issue with the *Hassler* in 2016 concerned the atmospheric pressure (P) parameter, which holds more than half of all flags applied (Figure 44). These flags were primarily of the "caution/suspect" (K) variety (Figure 46). While a portion of these flags were a result of "steps" that routinely appear in *Hassler's* P data (as a result of likely flow distortion and sensitivity to platform speed changes), a good deal more were applied to pressure readings that appeared a bit low – on average ~3mb too low – as compared to various verification data (e.g. buoys, gridded analyses). It is possible the reporting barometer was or is in need of servicing/calibration. We note that much of the presumably low-reading data resided in several backlogged batches of data (see Figure 2), such that vessel notification would have been ineffectual. There has not yet been enough data in 2017 to determine if low P readings persist, but it is something we intend to keep an eye on. (We here note that unfortunately there was a further large chunk of backlogged 2015 data, which will not receive visual QC as it came in over a year late.)

Most of the remaining flags (~37% combined, Figure 44) went to the earth relative wind direction (DIR) and earth relative wind speed (SPD) parameters, primarily caution/suspect (K) flags (Figure 46). These flags were mainly applied to the steps commonly seen in *Hassler's* earth relative wind parameters, more so in DIR than in SPD, and similar to P (example Figure 45). As in 2015, problems with the true wind calculation seem unlikely to be the culprit (though still not ruled out) as the platform speed often remains relatively constant while the winds are stepping. Rather, we again assert this is probably primarily an issue of flow distortion, whereby flow to the sensors is regularly blocked or accelerated when the platform relative wind is from a specific direction or directions. Unfortunately, adequate metadata and digital imagery are needed to confirm this suspicion, and the *Hassler* still lacks both (see Table 4). (We note that, to a lesser extent, air temperature (T) and relative humidity (RH) – not shown but also lacking adequate metadata – appear subject to flow distortion or possibly ship heating, as well.)

Lastly, we reiterate that we do not receive thermosalinograph data from the *Hassler,* although we became aware of the existence of TSG data from the *Hassler* in late 2014 when it appeared in some augmented, backlogged files. (We were unable to process the backlogged 2014 TSG data because the original data files had already undergone visual QC, and also because we have no metadata for the TSG.) No TSG data were present in *Hassler's* 2016 (or 2015) SAMOS files, but if the TSG data are in fact available we would like to add them to her SAMOS submissions if at all possible. Again, we also would still need metadata for the TSG, as the data could not be processed without it.

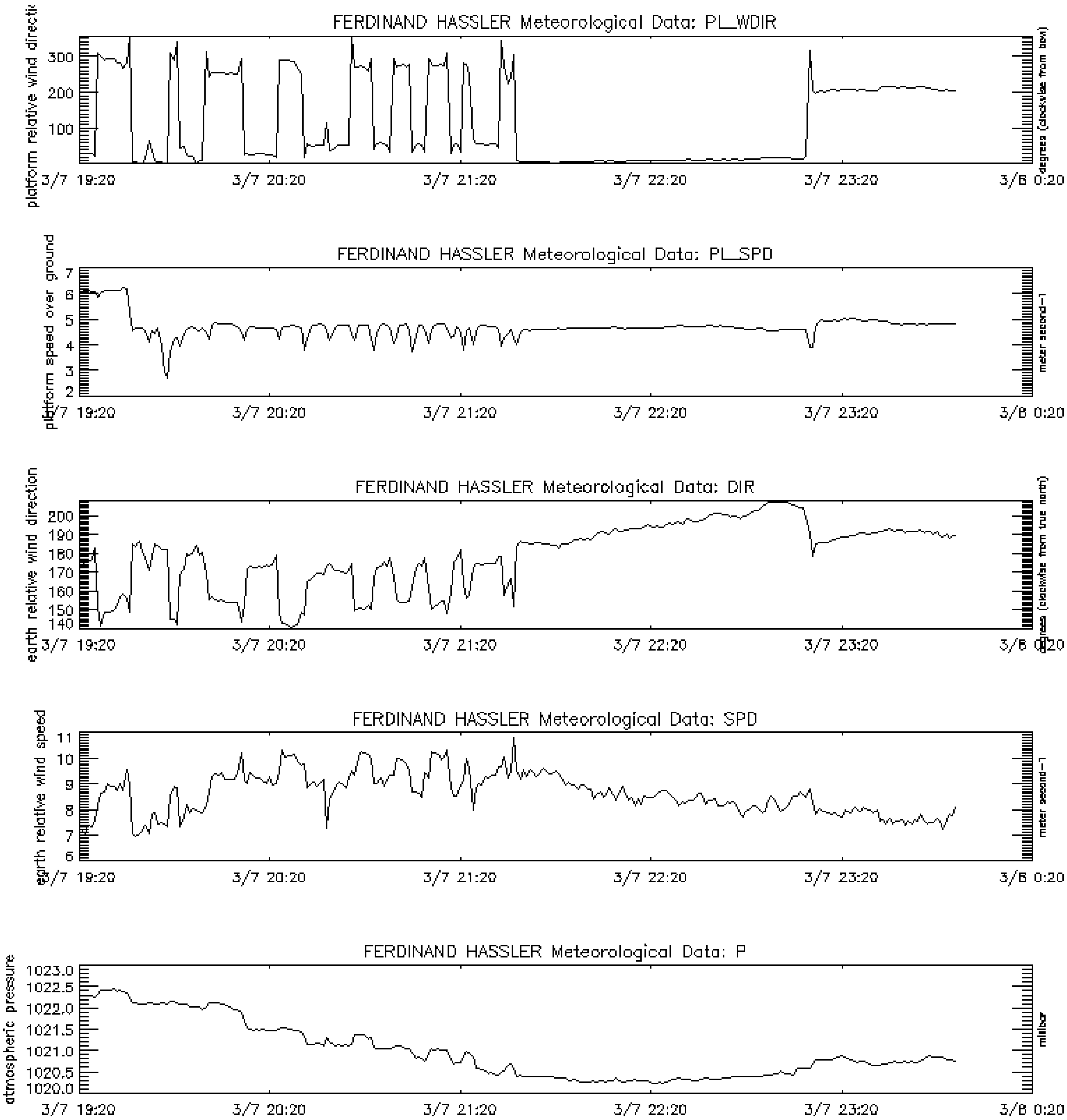


Figure 45: *Hassler* SAMOS (first) platform relative wind direction – PL_WDIR – (second) platform speed – PL_SPD – (third) earth relative wind direction – DIR – (fourth) earth relative wind speed – SPD – and (last) atmospheric pressure – P – data for 7 March 2016. Note the many steps in DIR, SPD, and P in conjunction with changing PL_WDIR/PL_SPD. There may exist multiple platform relative wind directions that interfere with the sensors.

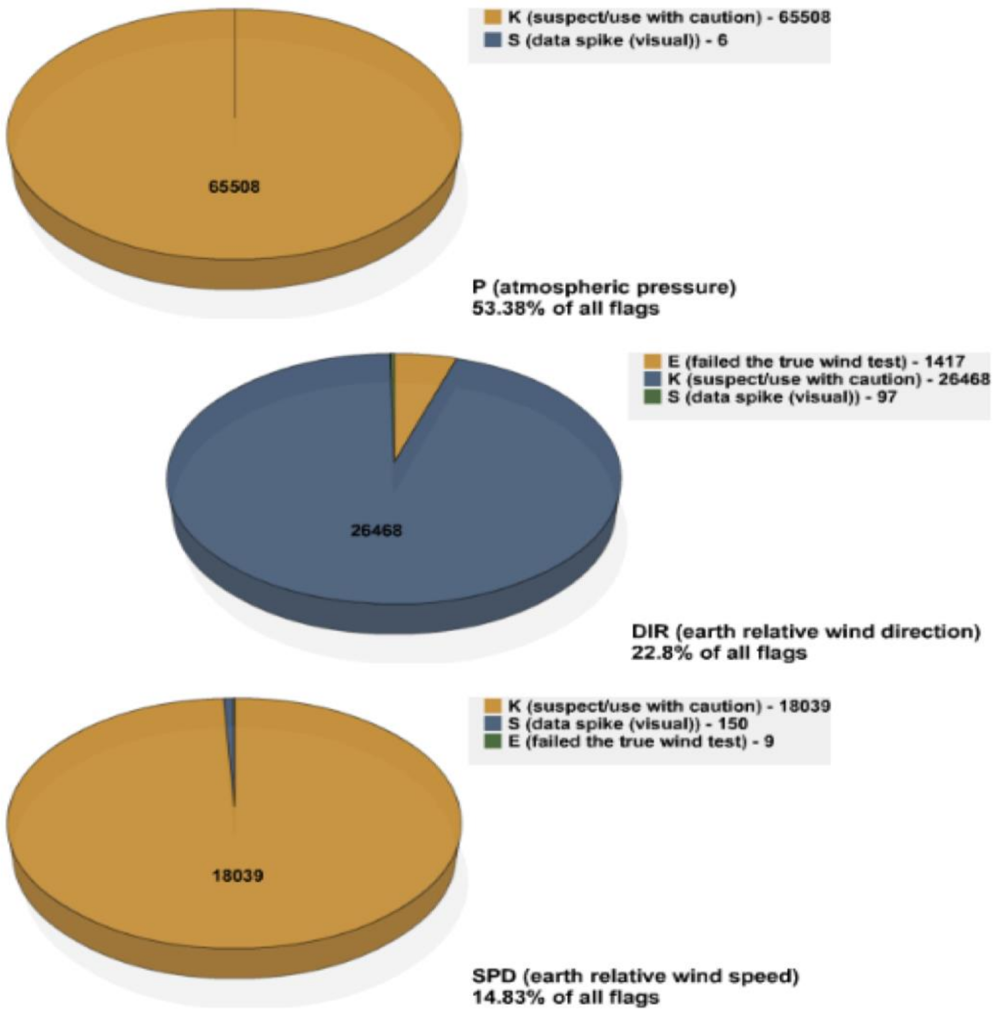


Figure 46: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) earth relative wind direction – DIR – and (bottom) earth relative wind speed – SPD – for the *Ferdinand Hassler* in 2016.

Gordon Gunter

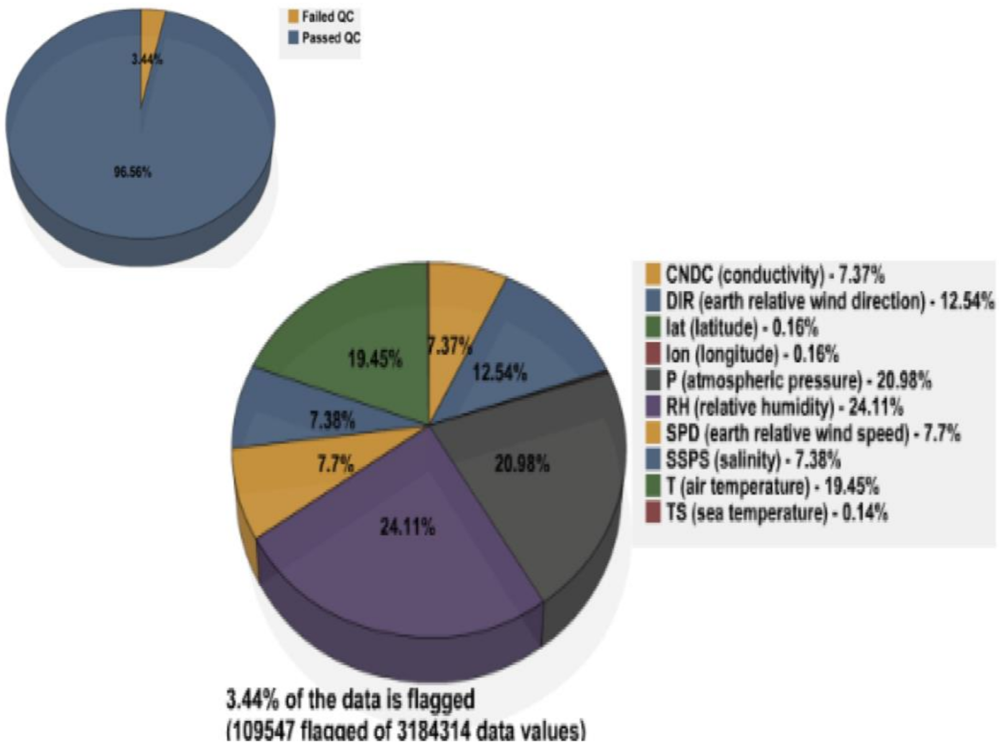


Figure 47: For the *Gordon Gunter* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Gordon Gunter* provided SAMOS data for 157 ship days, resulting in 3,184,314 distinct data values. After both automated and visual QC, 3.44% of the data were flagged using A-Y flags (Figure 47). This is about a four percentage point improvement over 2015 (7.26% total flagged) and brings *Gunter* cleanly under the < 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

Earth relative wind direction and speed (DIR and SPD, respectively, not shown), air temperature (T), relative humidity (RH), and atmospheric pressure (P) on the *Gunter* all show signs of moderate flow distortion (common on most vessels), which often resulted in some "caution/suspect" (K) flagging (Figure 50). T and RH particularly exhibit a lot of "stepping" behavior the closer the relative winds get, on the starboard side, to being from astern (Figure 48, top three panels), and P in particular often exhibits steps when the relative winds are from approximately 300° or so (Figure 48, bottom two panels). Notably, the steps in P occur despite the presence of a Gill pressure port on the sensor, suggesting the sensor would still benefit from relocation away from its current position on the outside port wall of the wheelhouse.

In addition to the usual roundup of moderately flow-hampered sensors, the *Gunter* in 2016 also experienced a gradual breakdown of her hygrometer that resulted in some "poor quality" (B) flags (Figure 50) and ultimately prompted a sensor replacement around mid-May. Sometime in mid-April, RH began exhibiting intermittent, unexplained drops to near 0% (example Figure 49). Then on 11 May RH flat lined at 0% and did not recover. When the vessel was notified on 12 May, response came back immediately that a new T/RH sensor was on order and would be installed at the earliest opportunity. We requested that the technicians confirm installation with us once it occurred, as well as provide the new make/model and sensor location info, however we did not receive any such communication. Nevertheless, RH readings returned to normal after 16 May.

Salinity (SSPS) and conductivity (CNDC) also received a quantity of J flags and, in the case of CNDC, a few "out of bounds" (B) flags as well (Figure 50); however, these were merely applied when the parameters read at or just under 0 because the vessel was in port (or otherwise stationary) and the apparatus was not turned on.

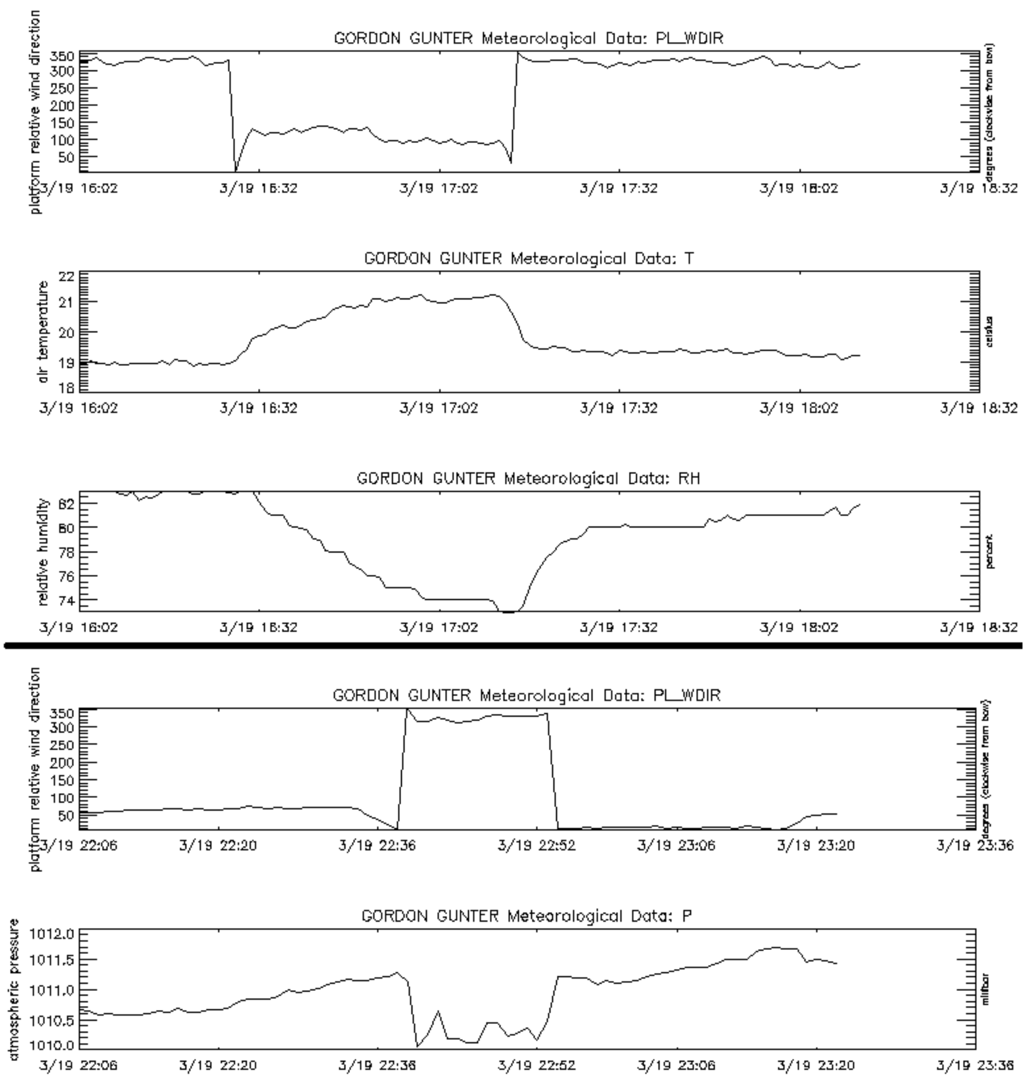


Figure 48: Two portions (~18Z, top three panels, and ~22Z, bottom two panels) of *Gordon Gunter* SAMOS (first) platform relative wind direction – PL_WDIR – (second) air temperature – T – (third) relative humidity – RH – (fourth) platform relative wind direction – PL_WDIR – and (last) atmospheric pressure – P – data for 10 March 2016. Note steps in the atmospheric data concurrent with specific PL_WDIR ranges.

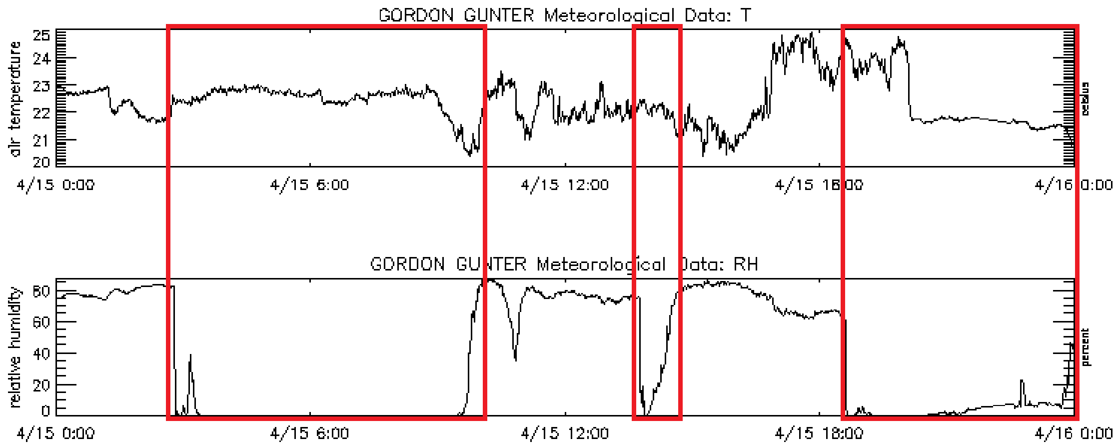


Figure 49: *Gordon Gunter* SAMOS (top) air temperature – T – and (bottom) relative humidity –RH – data for 15 April 2016. Note dubious drops in RH inside red boxes.

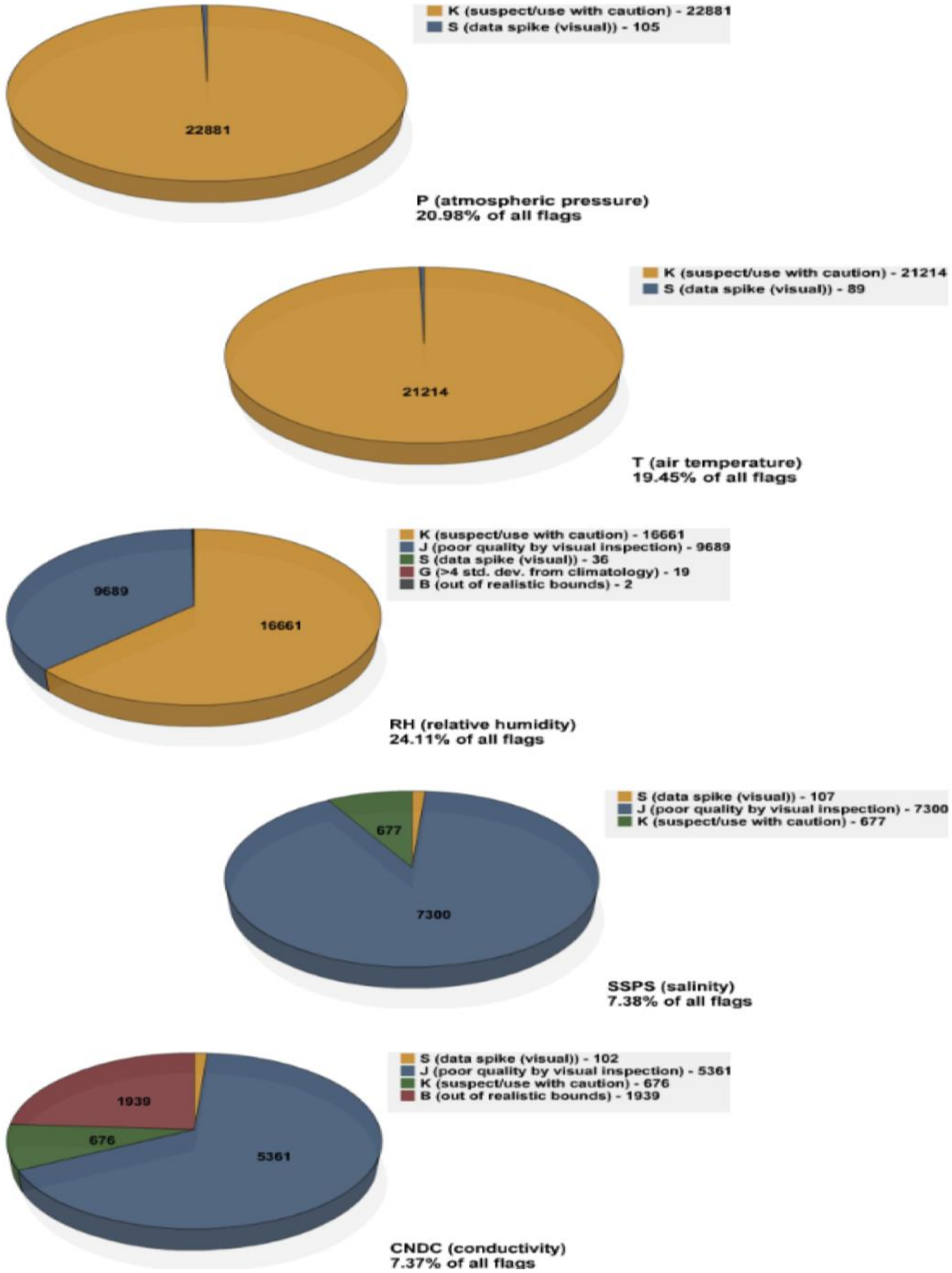


Figure 50: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) salinity – SSPS – and (last) conductivity – CNDC – for the *Gordon Gunter* in 2016.

Henry B. Bigelow

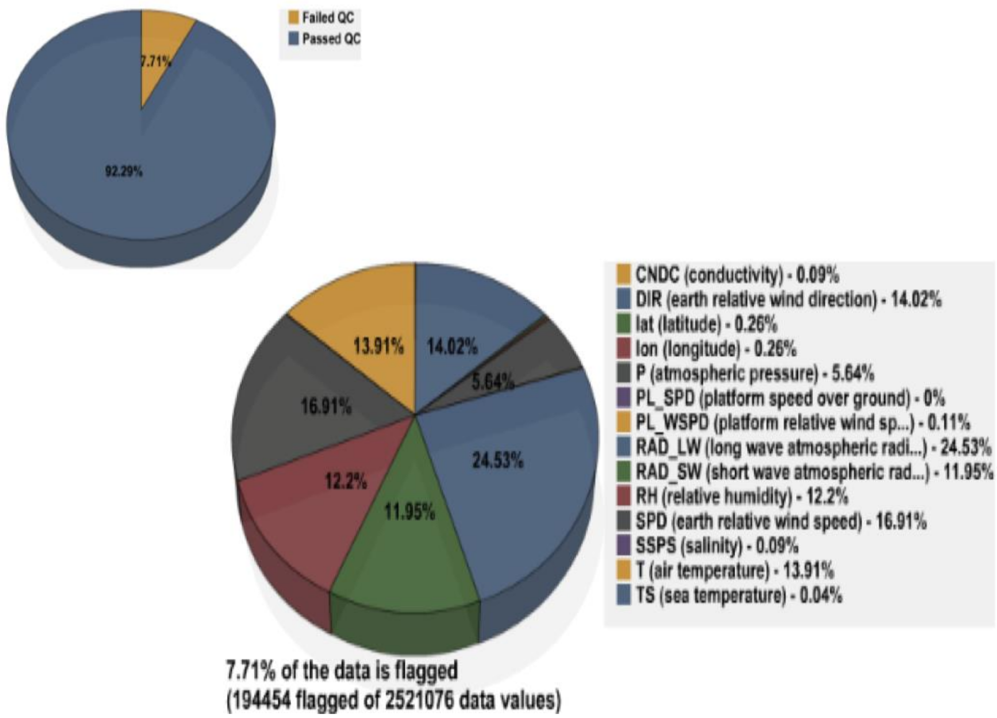


Figure 51: For the *Henry B. Bigelow* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Henry Bigelow* provided SAMOS data for 116 ship days, resulting in 2,521,076 distinct data values. After both automated and visual QC, 7.71% of the data were flagged using A-Y flags (Figure 51). This is about the same as in 2015 (7% total flagged).

All of the meteorological parameters reported by the *Henry Bigelow* – namely, earth relative wind direction and speed (DIR and SPD, respectively), atmospheric pressure (P), air temperature (T), and relative humidity (RH) (see Figure 51) – suffer, to some degree, the myriad effects of less-than-ideal sensor placement (e.g. flow interruption, exhaust contamination) and thus are appointed some portion of "caution/suspect" (K) flagging (not shown). This is common on most vessels, although it is perhaps a bit more pronounced on the *Bigelow* than on some others (hence the somewhat higher total flag percentage). We note, however, that there were two major breakthroughs communicated to us by *Bigelow* personnel that spelled an end in 2016 to additional specific issues with DIR/SPD and P that had been ongoing for a few years prior. The first concerns P: It was apparently discovered sometime in 2015 that there had been water in a loop of the pressure tubing. Once the tube was cleared of water and dried, P no longer exhibited the sometimes odd behavior and spurious ranginess (too low at night, too high mid-day) seen prior. A sensor calibration in early 2016 appears to have helped there, as well. The second breakthrough was the announcement that since 2013 the *Bigelow's* summer mammal cruise scientists had been requesting the forward mast lowered during daytime operations. This turns out to have been precisely the cause of the sudden exhibition of questionable behavior seen in *Bigelow's* DIR and SPD (which were then located on the forward mast), wherein both parameters would roughly follow the shape of the platform speed parameter and/or the platform heading during summer daytimes. A solution was effected in 2016 whereby DIR and SPD were switched to *Bigelow's* starboard wind bird for much or all of the duration of the summer cruises only. Although, we do note the starboard wind bird also apparently suffers from exposure issues (arguably a much lesser offense, of course).

The bigger issue with *Bigelow's* data in 2016 concerned the newly added (on 5 August) long wave radiation parameter (RAD_LW), which held the highest flag percentage (Figure 51). For the entirety of RAD_LW reporting in 2016, the data seem probably to have been in different units than those for which they are declared. The given metadata lists the units as W/m^2 but values were typically around 1300-1800, which is not realistic for units of W/m^2. *Bigelow* personnel were prompted during ongoing discussions for confirmation of RAD_LW units, but unfortunately there was no response this time and consequently virtually all of the RAD_LW data was prescribed "out of bounds" (B) and "poor quality" (J) flags (Figure 53). It isn't yet known whether this issue will persist in 2017, but if it does we will be sure to attempt verification again.

One final issue, which is not really seen in the flag percentages but is nonetheless worth a mention, concerns the conductivity (CNDC) and salinity (SSPS) parameters. Each of these will from time to time exhibit a sudden and short-lived drop to 0 (example Figure 52) that prompts some J flagging (Figure 53). Given the short durations, it seems more likely this is a performance issue (e.g. intermittent clogs, air in the intake) rather than a result of the thermosalinograph or intake pump being switched off, although that is still a possibility.

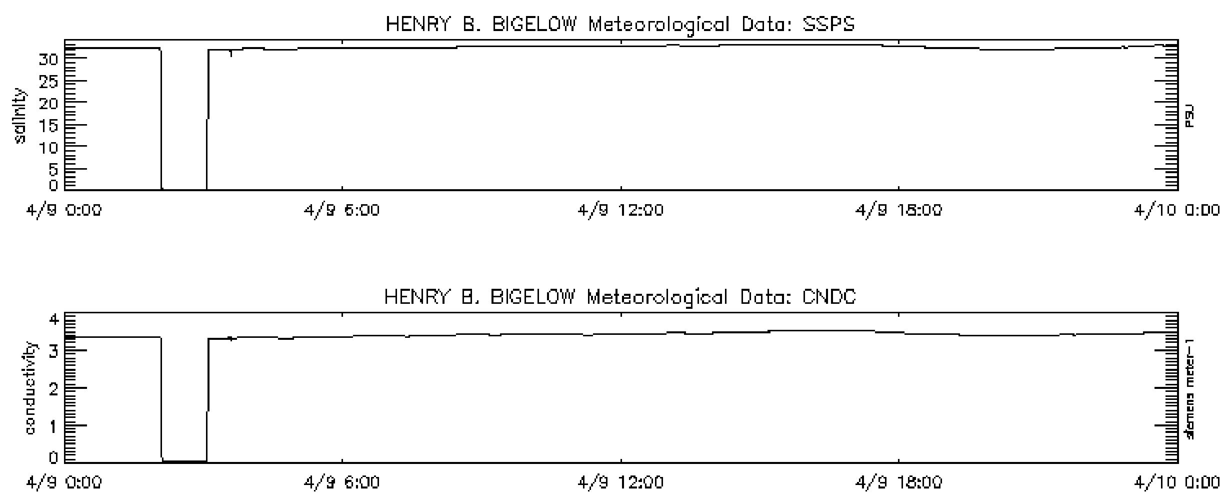


Figure 52: *Henry Bigelow* SAMOS (top) salinity – SSPS – and (bottom) conductivity – CNDC – data for 9Apriil 2016.

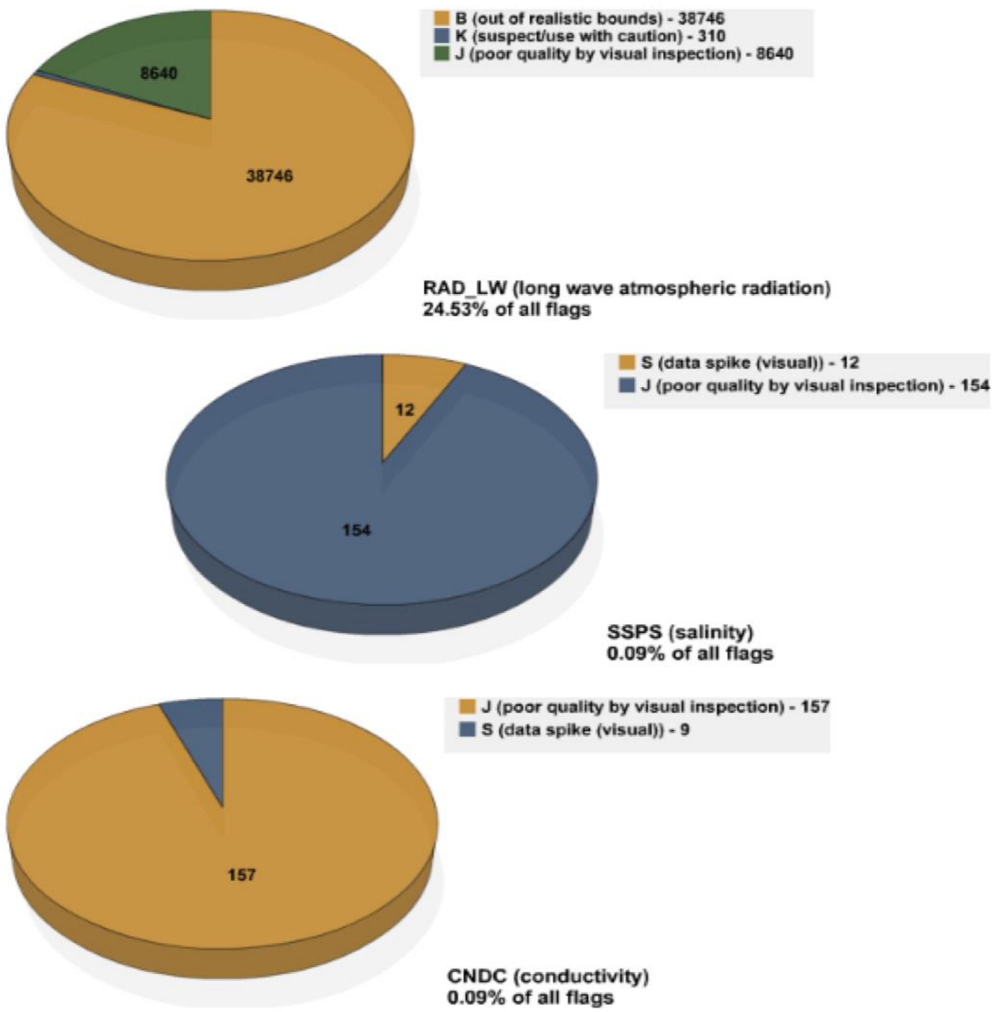


Figure 53: Distribution of SAMOS quality control flags for (top) long wave atmospheric radiation – RAD_LW – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – for the *Henry B. Bigelow* in 2016.

Hi'ialakai

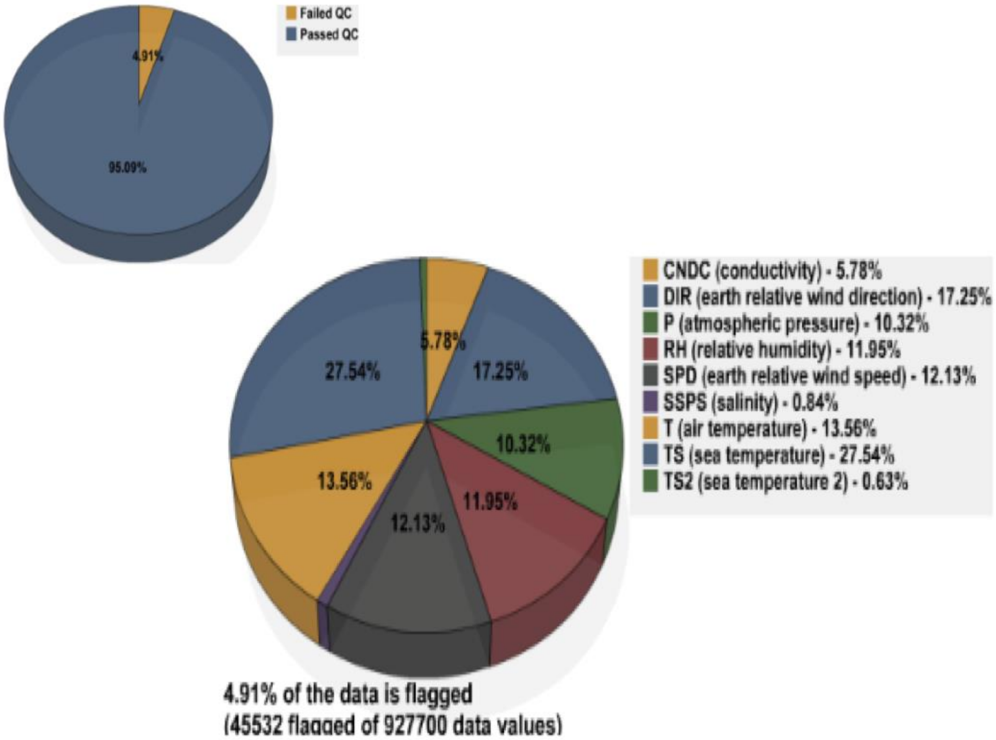


Figure 54: For the *Hi'ialakai* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Hi'ialakai* provided SAMOS data for 42 ship days, resulting in 927,700 distinct data values. After both automated and visual QC, 4.91% of the data were flagged using A-Y flags (Figure 54). This is a sizable improvement over 2015 (11.35% total flagged) that both returns the *Hi'ialakai* to her 2014 performance (4.54% total flagged) and brings her back under the < 5% total flagged bracket regarded by SAMOS to represent "very good" data. It should probably be noted, though, that her transmission performance in 2016 was only around 30% (see Table 2) so there was a lot of missed data. It would be desirable to recover any data not received by us, even if it might not be possible to apply visual QC.

The largest percentage of flags – around 27% (Figure 54) – was applied to the Sea-Bird Electronics 38 (SBE 38) sea temperature (TS). These were uniformly "caution/suspect" (K) flags (Figure 55), which were applied mainly throughout the month of April when the data seemed to have taken on the appearance of sea temperature sampled while the intake pump was turned off. In fact, the likely culprit, as was later reported by Phil White (who was onboard temporarily training a new survey technician), was a problem with the way the external SBE 38 was wired early on in the season (i.e. April). Or, the TS issue may possibly have stemmed from problems encountered after re-plumbing the *Hi'ialakai's* SBE 21 thermosalinograph, as reported to us via email in early May. The newly plumbed SBE 21 apparently had some issues working with the remote temperature probe, which incidentally forced a temporary removal of sea temperature 2

(TS2), conductivity (CNDC), and salinity (SSPS) from *Hi'ialakai's* SAMOS event template for most of the April data.

As a separate issue, none of *Hi'ialakai's* sea parameters (i.e. TS, TS2, SSPS, and CNDC) reported any values in the month of August, and it is not known precisely why. It appears she did cruise in August, although not extensively. However, we note that after 24 August only emails with empty data attachments were received from the *Hi'ialakai*. The emails also began originating from multiple new addresses at that time, so it seems likely there was some overarching SCS issue onboard. Email requests for resumption of data transmission unfortunately went unanswered.

Aside from all of the above issues, *Hi'ialakai* is alike many of her peers in that she also retains a short list of (known) minor sensor placement issues that routinely resulted in some K flagging (not shown) of air temperature (T), relative humidity (RH), atmospheric pressure (P), and earth relative wind direction and speed (DIR and SPD, respectively). SPD is additionally occasionally known to read 3-4 kts lower than other sensors in 15-20 kt winds (as reported by personnel onboard), although that scenario is not always caught and flagged during visual QC.

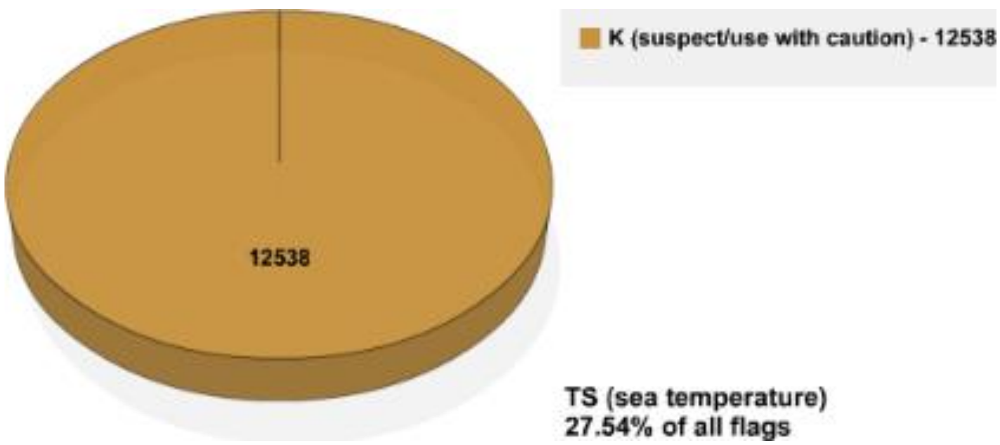


Figure 55: Distribution of SAMOS quality control flags for sea temperature – TS – for the *Hi'ialakai* in 2016.

Nancy Foster

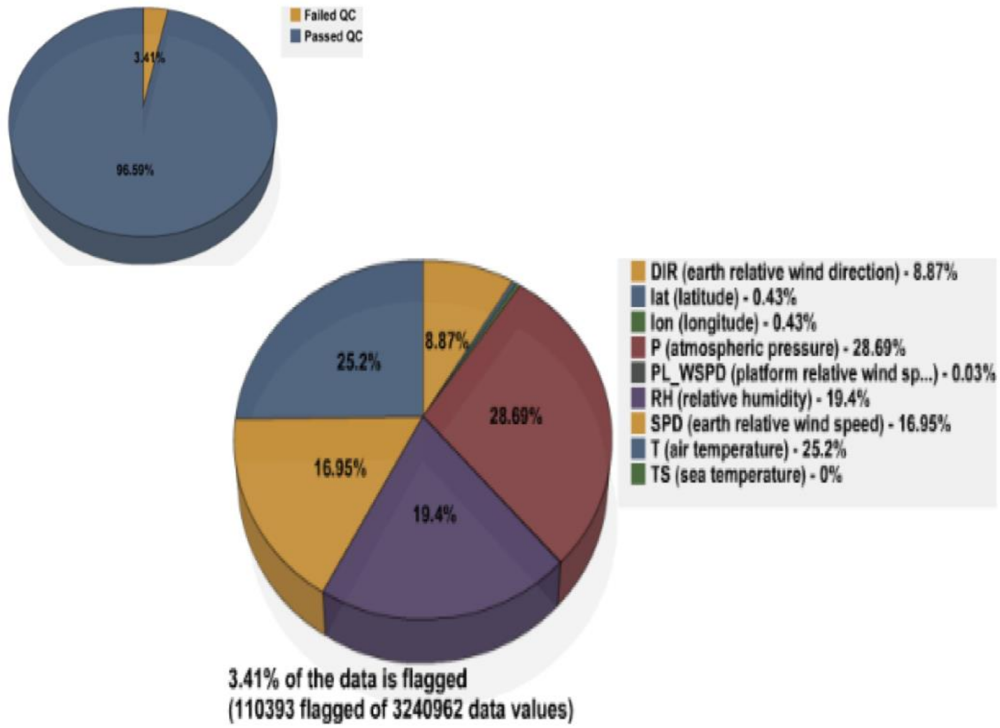


Figure 56: For the *Nancy Foster* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Nancy Foster* provided SAMOS data for 182 ship days, resulting in 3,240,962 distinct data values. After both automated and visual QC, 3.41% of the data were flagged using A-Y flags (Figure 56). This is essentially unchanged from 2015 (3.55% total flagged), and maintains the *Foster's* position well under the < 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

The flag analysis for the *Foster* also remains essentially unchanged from 2015:

The three atmospheric parameters air temperature (T), pressure (P), and relative humidity (RH) together comprised ~73% of the total flags, with a further ~18% going to the earth relative wind speed (SPD) (Figure 56). All four of these parameters (and occasionally also earth relative wind direction, DIR) exhibited a fair amount of spikes (see example Figure 57) at various times in the sailing season, to which mainly spike (S) and some small amount of caution/suspect (K) and/or poor quality (J) flags were assigned (Figure 58). *Foster* personnel were once again contacted via email (at the advent of her 2016 sailing season) concerning this spike behavior and, while there was some response and conjecture on both ends, there was ultimately no conclusive dialog confirming the source of these spikes. It remains unclear what is causing the spikes or whether they are indeed even recognized by the onboard technicians. We note that possibilities raised in 2016 on our end include the potential absence of a pressure port to dampen effects from the winds, and/or installation location perhaps playing a role in the contamination of the data (e.g. stack exhaust, etc.). We do again stress here, though, that with 3.41% total flagged data the *Foster's* SAMOS data is still considered very good, even in spite of these multitudinous spikes.

In addition to the spike issue, P, T, RH, and, to a lesser extent, both SPD and DIR also exhibit clear sensor exposure issues (common on most vessels), which resulted in some further K flagging of these parameters (Figure 58). Flow to the meteorological sensors generally seems contaminated when vessel relative winds are from the stern, but *Foster* metadata is still lacking instrument location specifics and detailed digital imagery of the vessel, both of which could aid in diagnosing the problem.

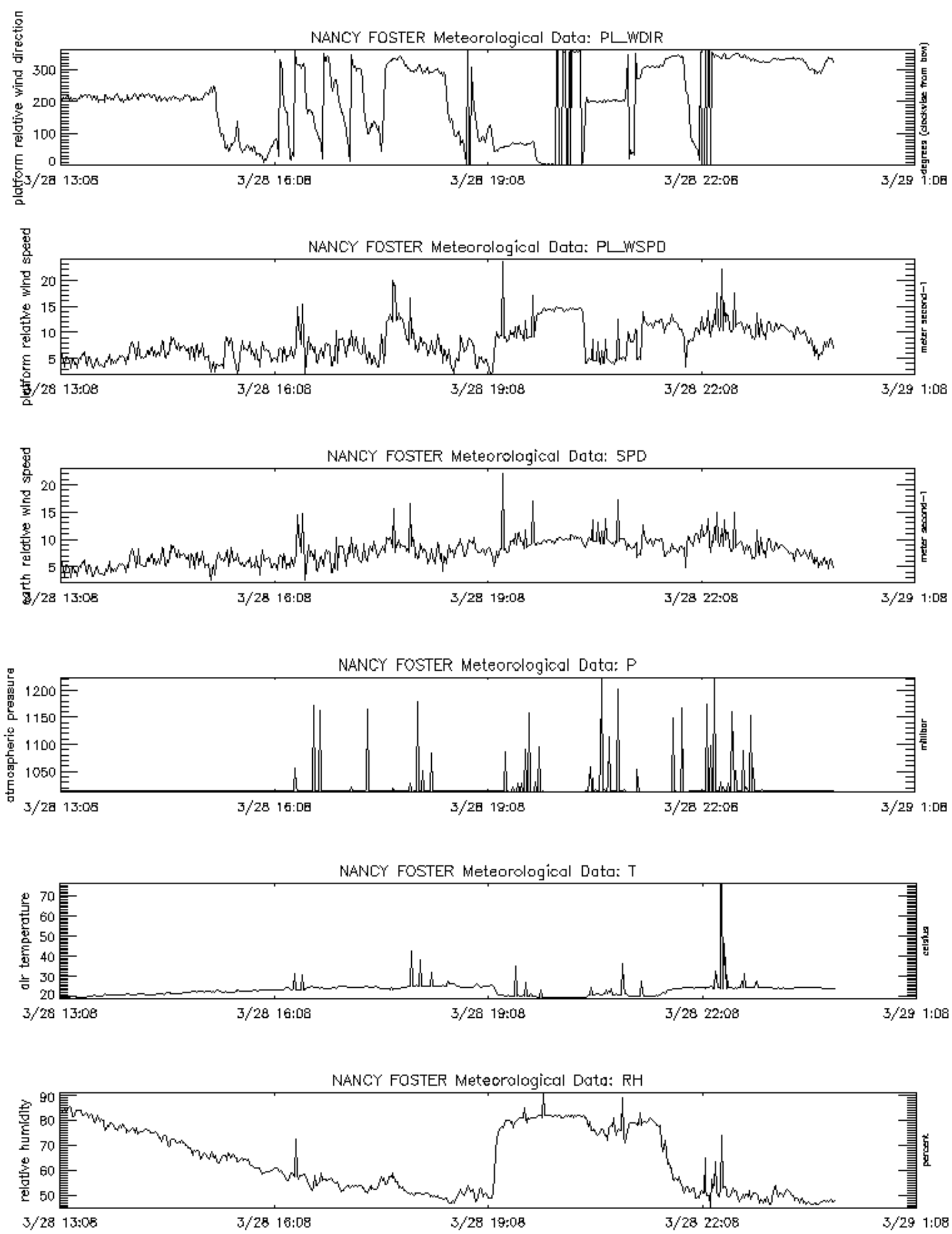


Figure 57: *Nancy Foster* SAMOS (first) platform relative wind direction – PL_WDIR – (second) platform relative wind speed – PL_WSPD – (third) earth relative wind speed – SPD – (fourth) atmospheric pressure – P – (fifth) air temperature – T – and (last) relative humidity – T – data for 24 October 2016. Note anomalous spikes in PL_WSPD, SPD, P, T, and RH.

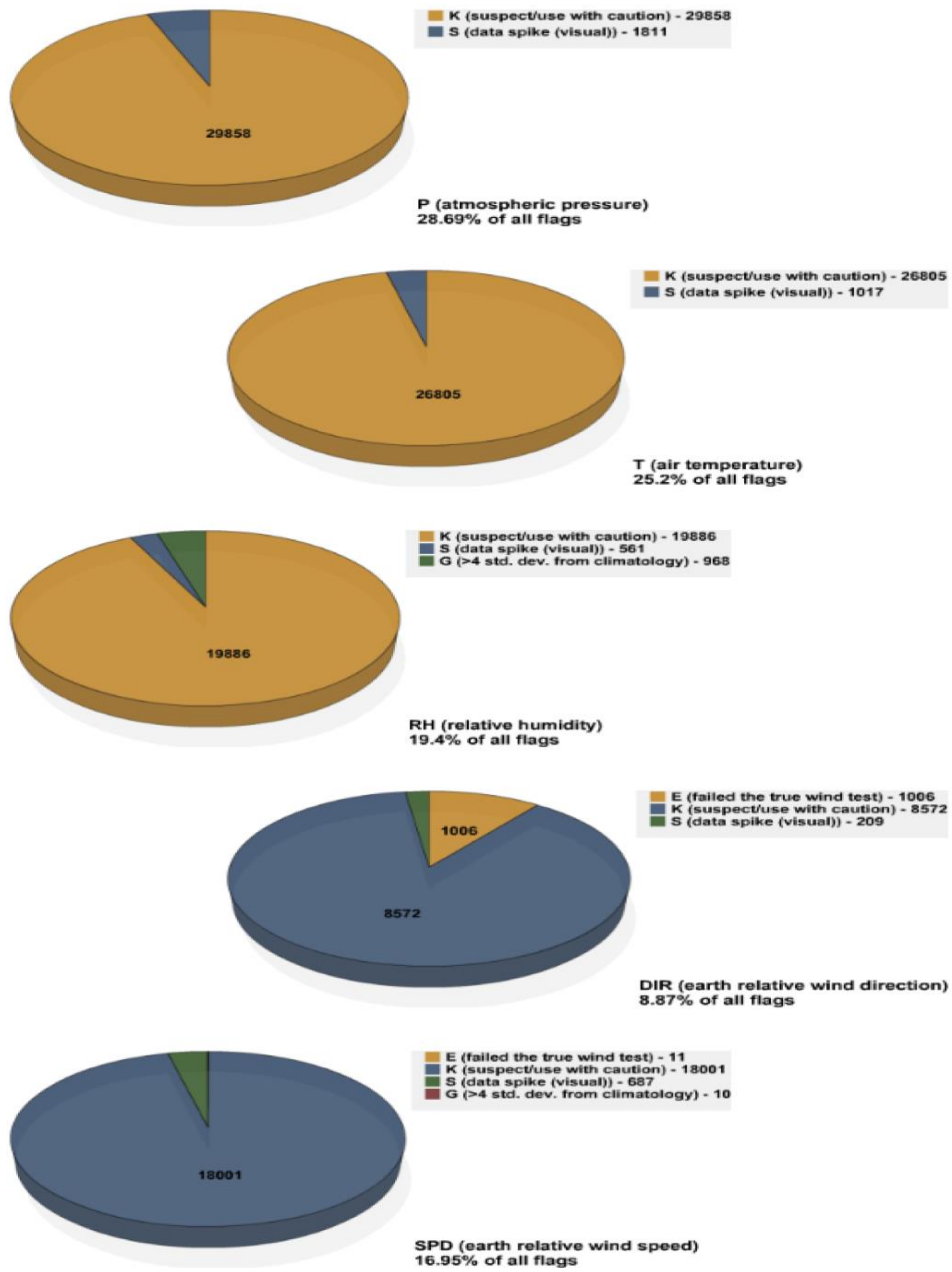


Figure 58: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Nancy Foster* in 2016.

Okeanos Explorer

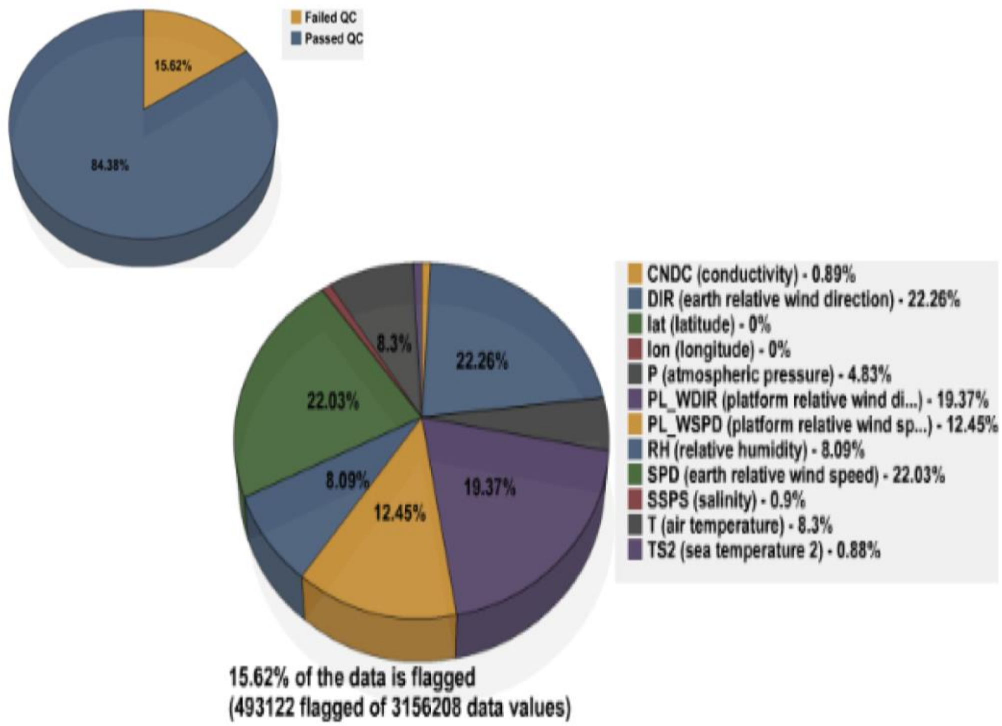


Figure59: For the *Okeanos Explorer* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Okeanos Explorer* provided SAMOS data for 152 ship days, resulting in 3,156,208 distinct data values. After both automated and visual QC, 15.62% of the data were flagged using A-Y flags (Figure 59). This is a sizable departure from the *Explorer's* 2015 performance (3.5% total flagged) and unfortunately moves the *Explorer* well outside the < 5% flagged bracket regarded by SAMOS to represent "very good" data.

A number of issues contributed to the higher than usual total flag percentage *Okeanos Explorer* experienced in 2016:

At the advent of the *Explorer's* 2016 season it was discovered that the platform relative wind direction (PL_WDIR) and, consequently, the earth relative wind direction (DIR) appeared to be rotated 180°. The visual quality control data analyst began by applying "poor quality" (J) flags to both PL_WDIR and DIR, as well as earth relative wind speed (SPD), and attempted to contact the vessel via email, on 25 January. Initially no response was received from the vessel so a second notification was sent on 10 February. This time a response came back, noting that the sensor was indeed known installed 180° out after return from calibration and maintenance. At this point the visual quality control analyst went back and changed all J flags to "malfunction" (M) flags, and continued to apply M flags until the orientation of the sensor was fixed, after 7 February (Figure 61).

Then in early March it was noted that the air temperature (T) and relative humidity (RH) had apparently gone bad, with T reading a nearly constant -39 C and RH nearly constant at 0%. The vessel was notified via email on 7 March and a response quickly came back stating that a technician had investigated and concurred there was a problem. He stated that he planned to get up to where the sensor was located ASAP, and then notified us on 11 March that the sensor was replaced. A subsequent request for details surrounding the issue went unanswered, so it is not known what caused the malfunction. But at any rate, the T and RH data between 1-11 March received M flags (Figure 61). This event particularly underscores the need for shore-side oversight of the data, as provided by SAMOS.

A little later in the year, between 16-19 May, the atmospheric pressure (P) began receiving some "caution/suspect" (K) flags when it started intermittently drifting a little too high and then abruptly dropping back down to normal (example Figure 60). This pattern continued when data transmission resumed at the end of the month, so the vessel was emailed on 31 May. A response came back that the barometer was frozen (cause unknown), and then a second response came back the next day stating that the Zeno Met data multiplexer had been reprogrammed (it had stopped working the day before) and the barometer was concurrently replaced. With this knowledge, "poor quality" (J) flags were applied to P during 29-31 May (Figure 61).

Unfortunately, this was the point at which the *Explorer's* most oppressing issue began. As related to us via extensive email communications, it seems that when the Zeno Met software was reloaded it reset everything, and the wind bird required a current calibration, which the technician was unsure how to do. He thought he had it close but was nevertheless in the process of requesting help from the vendor. In any case, PL_WDIR and DIR data were at that point clearly wrong (PL_WDIR lacked much variability, despite vessel maneuvering, hence DIR mimicked the platform heading). All of PL_WDIR, DIR, and SPD began receiving J flags (Figure 61, PL_WDIR not shown) and the platform wind speed (PL_WSPD) additionally began receiving K flags (not shown). Then on 7 June there was an abrupt change in PL_WDIR/PL_WSPD, after which they looked okay but DIR and SPD continued looking suspicious (DIR still mimicking platform speed and SPD much higher than ASCAT data), so PL_WDIR/PL_WSPD flagging was discontinued, while DIR J-flagging continued and SPD flagging changed to K. The vessel was contacted again on 28 June but unfortunately the response came back that technicians were still troubleshooting. We established contact again on 13 September and this time were told that the wind indicator had gone out of specs, causing bad true winds. The technician suspected the problem was with the wind bird itself rather than an error introduced into SCS as result of troubleshooting, and planned to send the unit out for repair and also replace it with an ultrasonic (using the original as a spare instead, once it was returned). As such, true wind flags were switched to M as of 3 September (Figure 61). Data submission stopped for a while after 11 September, and then when it resumed again on 3 December all of P, T, RH, and the true winds were all overtly bad data. Yet another email notification was sent out to the vessel on 9 December, and the immediate response indicated it was all under investigation, with the wind problem definitely being due to a missing translator box and the P/T/RH problem not yet definitively identified. The problem(s) were not solved by the end of the year, so for 3 December through the last day of data, 14 December, the true winds were blanketed with M flags and P, T, and RH with J flags (Figure 61).

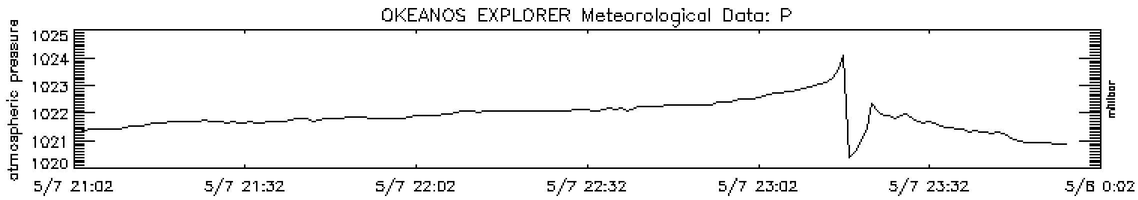


Figure 60: *Okeanos Explorer* atmospheric pressure – P – data for 7 May 2016.

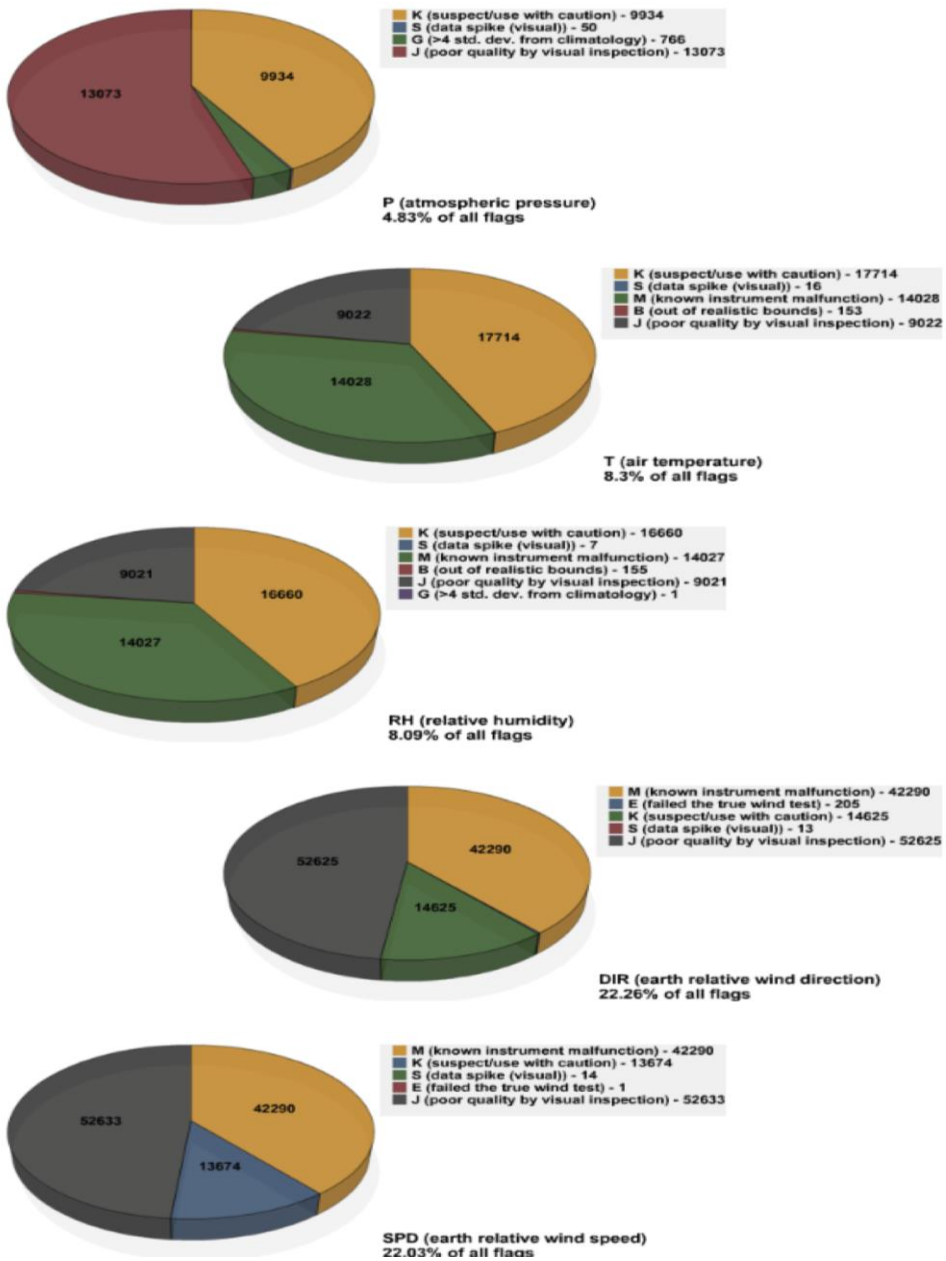


Figure 61: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Okeanos Explorer* in 2016.

Oregon II

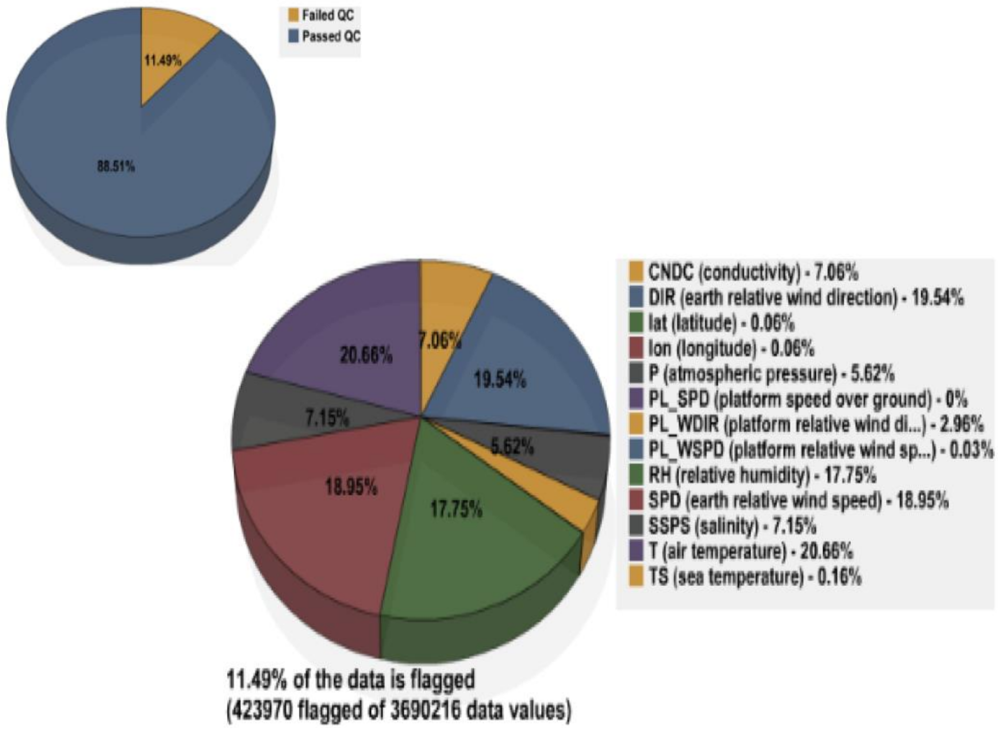


Figure 62: For the *Oregon II* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oregon II* provided SAMOS data for 181 ship days, resulting in 3,690,216 distinct data values. After both automated and visual QC, 11.49% of the data were flagged using A-Y flags (Figure 62). This is a modest improvement over 2015 (16.77% total flagged).

One of the issues with *Oregon's* data was a well-known one continued from 2015, concerning the platform relative wind direction (PL_WDIR), which in turn impacted the earth relative wind direction (DIR) and speed (SPD). Each of the earth relative wind parameters garnered a substantial portion of the total flags (about 19% for each of DIR and SPD), and there was a further ~3% for PL_WDIR (Figure 62). The problem continued to be that PL_WDIR routinely kept flatlining around ~225° for some obscure reason, causing DIR to step abruptly out of line and SPD to read very similar in shape to the platform speed. Compounding the issue, the PL_WDIR readings of ~225° often appeared inconsistent with the reality of satellite wind fields and occasional buoy data to begin with. Further, PL_WDIR values greater than ~225° were rarely seen. This all again resulted in a large volume of "poor quality" (J) and "caution/suspect" (K) flags being applied to, mainly, the true wind parameters (Figure 65, PL_WDIR not shown).

In a bit of a changeup, with the cruise beginning 22 June PL_WDIR data all became very suspect relative to the platform heading (see example, Figure 63) in that the changes didn't line up (and weren't reasonable on their own, as measured against any available verification data) so all of DIR, SPD, and PL_WDIR began receiving K flags. Then as of approximately 29 June PL_WDIR was obviously bad, ranging through only about 2° total, despite any heading changes. At this point all of the previous K flagging was switched to J flagging. Miraculously, in mid July, all of the wind data appeared mysteriously fixed. It is not known what the solution ultimately was, although it would be good to record it here and on the NOAA SCS Issue Tracking System Google Group, if possible.

Air temperature (T), and relative humidity (RH) also took on a combined ~38% of the total flags (Figure 62). These were overwhelmingly suspect/caution (K) flags (Figure 65) and continued to appear to be largely due to flow distortion or obstruction, just as in past years. Specifically, the T, RH, and additionally the P sensors seem to be in a wind shadow whenever apparent winds are from the port side and/or astern, particularly during daytime. T and RH were also occasionally affected by the apparent ~225° PL_WDIR occurrences (whether valid or not), though this may have only been coincidence. From the variable metadata we can at least tell that both the atmospheric pressure and relative humidity sensors are located about 20m back from the bow at heights less than 10m from the waterline. Digital imagery and ship measurements (length, breadth, freeboard, and draft) still do not exist in the SAMOS database for the *Oregon II* so nothing can be confirmed, but considering the relatively low heights of these two sensors and probable location amidships, it is suspected that they are installed somewhere on a level with the wheelhouse on the starboard side and thus in a severe wind shadow when the winds come in from the port. The air temperature sensor, reported to be at a height of about 16 meters, is a little less easy to conjecture about, but it would seem at least that it is located close to some ship structure prone to heating up from insolation when cut off from the platform relative winds (again, from the port). The suspected radiative heating appears strongest in the summer months, further supporting the conjecture. We stress again, too, that the *Oregon II* is understood to have an atypical structure – she is an old and low vessel – and it is suspected that her data problems may also be related to stack exhaust.

We shall mention conductivity (CNDC) and salinity (SSPS) here, as well, as they each received about 7% of the total flags (Figure 62). Similar to the *Bigelow*, the *Oregon II's* CNDC and SSPS data occasionally abruptly flat line around 0 (example Figure 64) from what is suspected to be intermittent debris clogs or air in the intake. These abrupt "steps" are generally assigned J flags (Figure 65, only salinity shown).

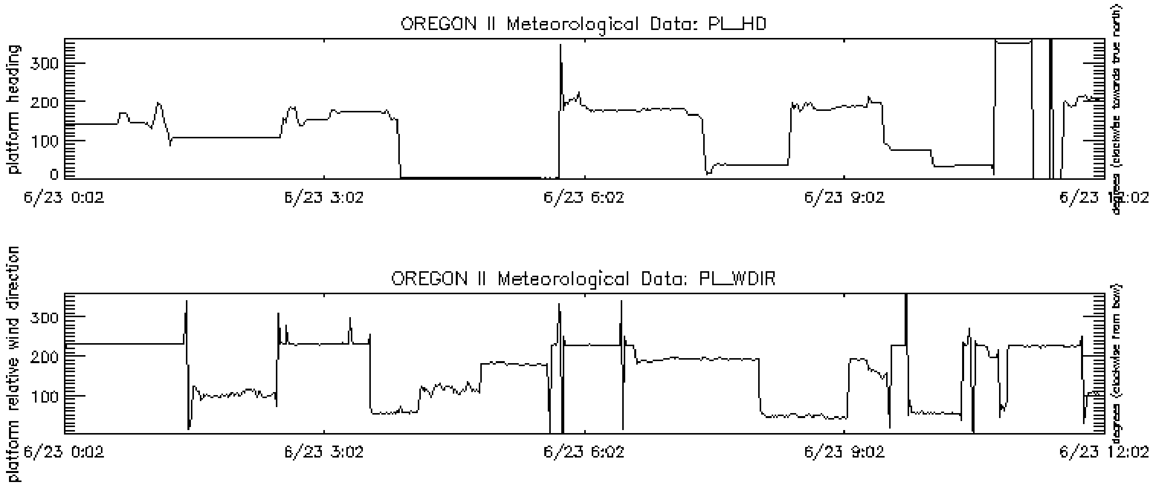


Figure 63: *Oregon II* SAMOS (top) platform heading – PL_HD – and (bottom) platform relative wind direction – PL_WDIR – data for 23 June 2016. Note abrupt changes in PL_WDIR do not all distinctly line up with changes in PL_HD.

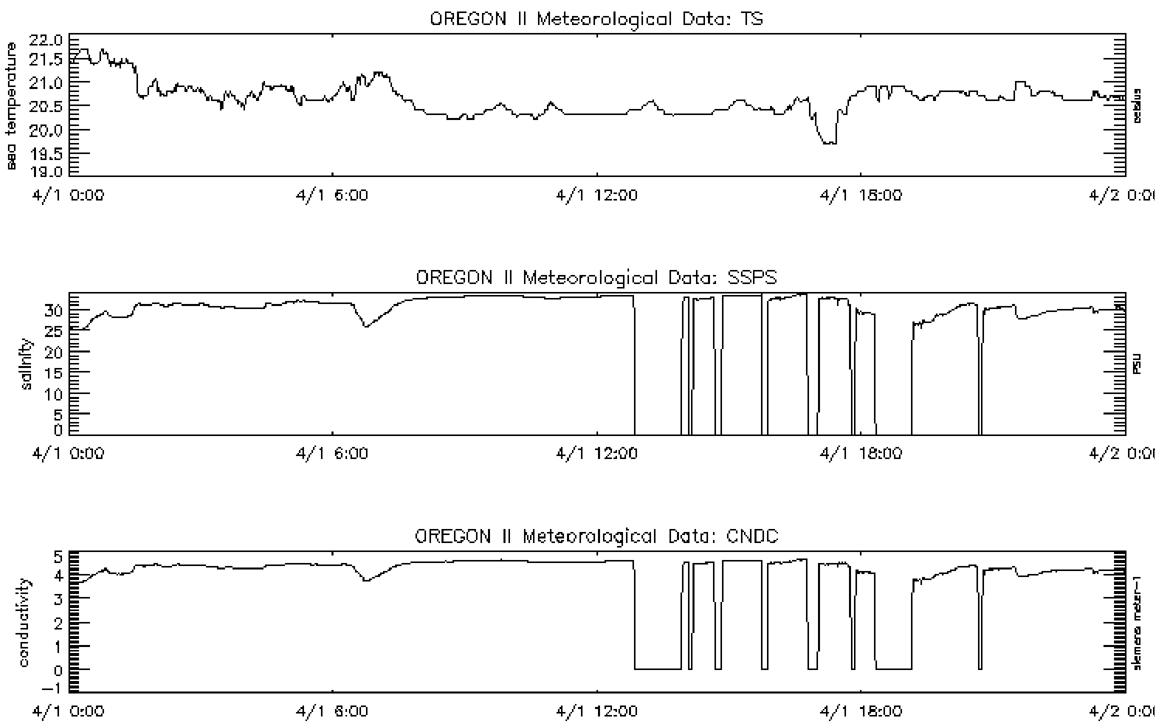


Figure 64: *Oregon II* SAMOS (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – data for 1April 2016.

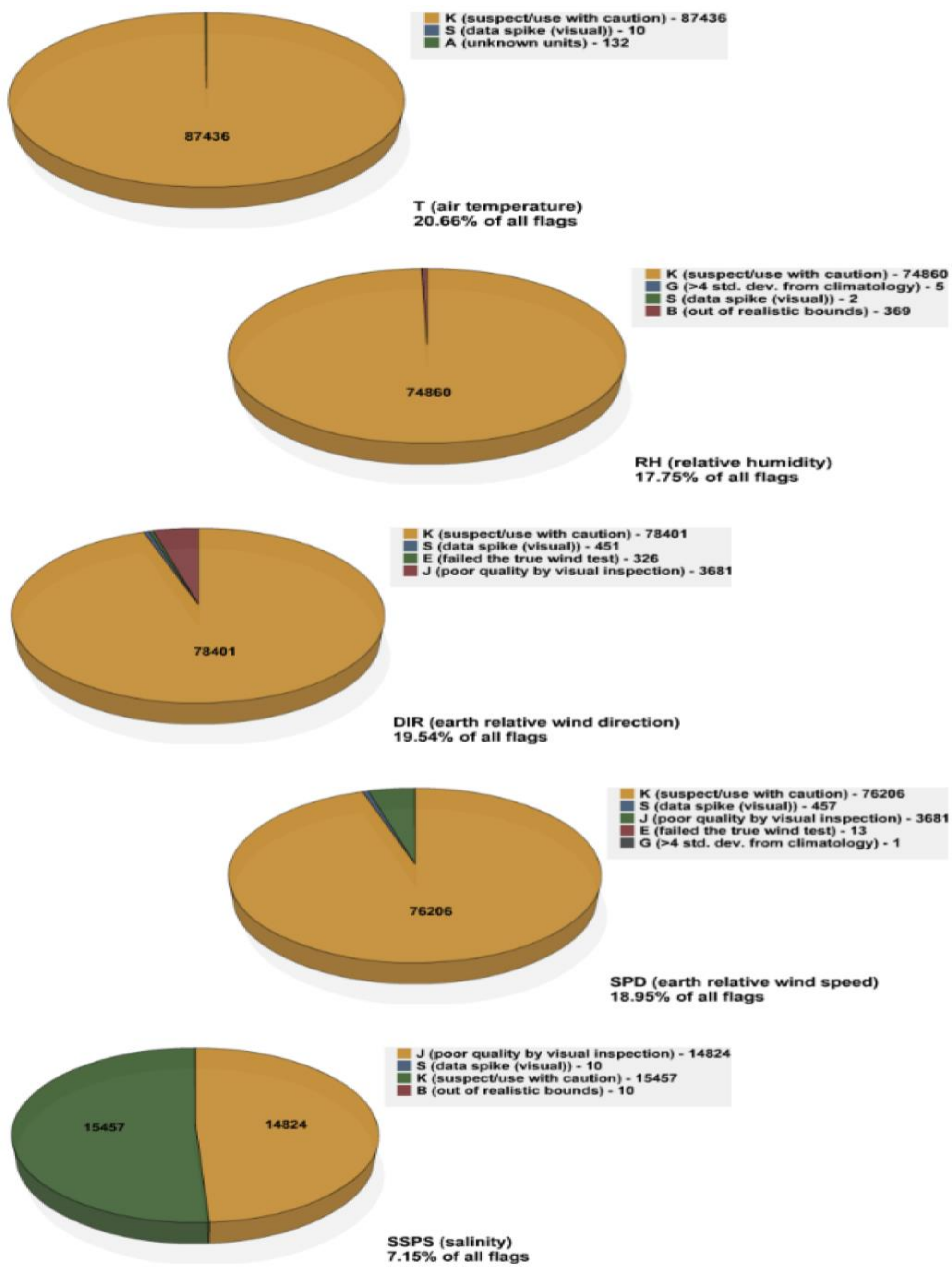


Figure 65: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) relative humidity – RH – (third) earth relative wind direction – DIR – (fourth) earth relative wind speed – SPD – and (last) salinity – SSPS –for the *Oregon II* in 2016.

Oscar Dyson

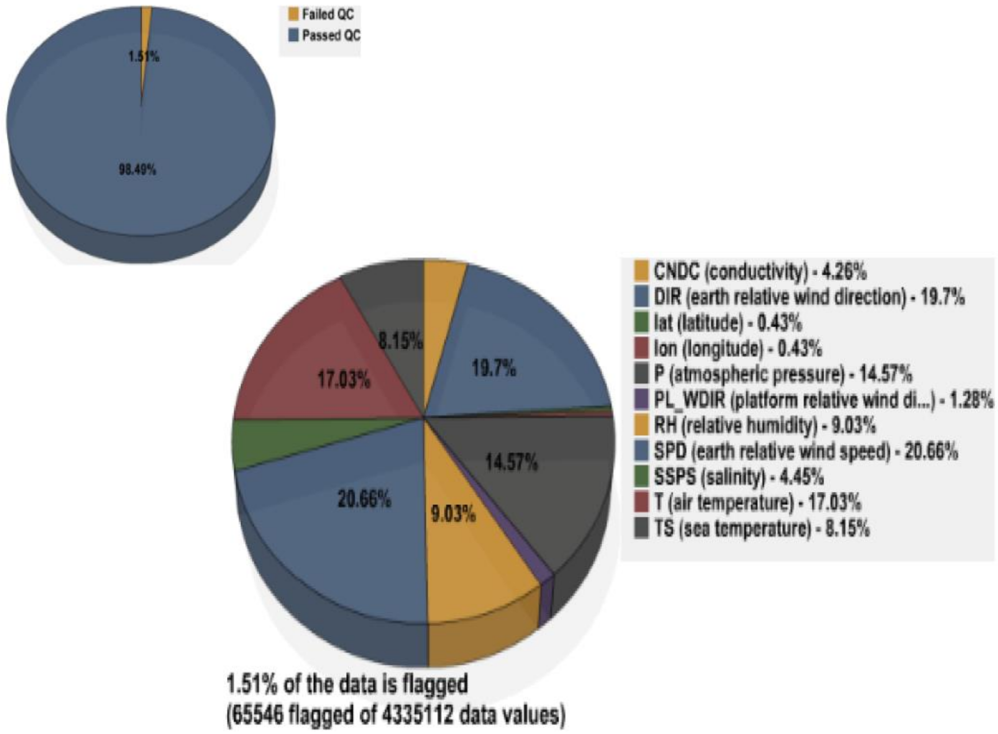


Figure 66: For the *Oscar Dyson* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oscar Dyson* provided SAMOS data for 203 ship days, resulting in 4,335,112 distinct data values. After both automated and visual QC, 1.51% of the data were flagged using A-Y flags (Figure 66). This is about the same as in 2015 (1.68% total flagged) and *Dyson* again remains robustly within the < 5% flagged bracket regarded by SAMOS to represent "very good" data.

The *Dyson* does suffer mildly from a bit of flow distortion and ship heating affecting her various atmospheric sensors, as do virtually all vessels, but really with so low a total flag percentage it seems the best message again to deliver here is "job well done." But for the sake of pursuing perfection, we shall once again repeat our usual recommendations from last year:

Digital imagery currently on file for the *Dyson* appears to show a potentially problematic location for the temperature (T) and relative humidity (RH) sensors in particular, low down on an instrument mast amidships and not far from the exhaust stack. As her metadata have never been updated, it's assumed that is still the location of her T/RH sensors, but again her total flagged percentage points toward minimal issue. It's possible that radiative heating is in this case less of a concern than we'd normally expect given the location of the sensors, simply by virtue of the *Dyson's* usual region of operations (generally sub-polar). Additionally, earth relative winds (direction – DIR – and speed – SPD) experience a bit of flow distortion particularly when the winds are from the stern. Digital imagery points to an explanation here, too, as the anemometer is shown to be on the jackstaff, with the main structure of the ship behind it (a common and fairly ideal placement, all things considered). Finally, digital imagery and variable metadata unfortunately do not specify where on the ship the atmospheric pressure (P) sensor is located. Looking at *Dyson's* P data, it isn't always clear whether the instrument is sensitive to a particular apparent wind direction, changes in ship speed, or both; all that is really certain is that the P data are relatively sensitive. It is likely either due to poor exposure or the need for a pressure port to attenuate any wind effects – perhaps both.

Oscar Elton Sette

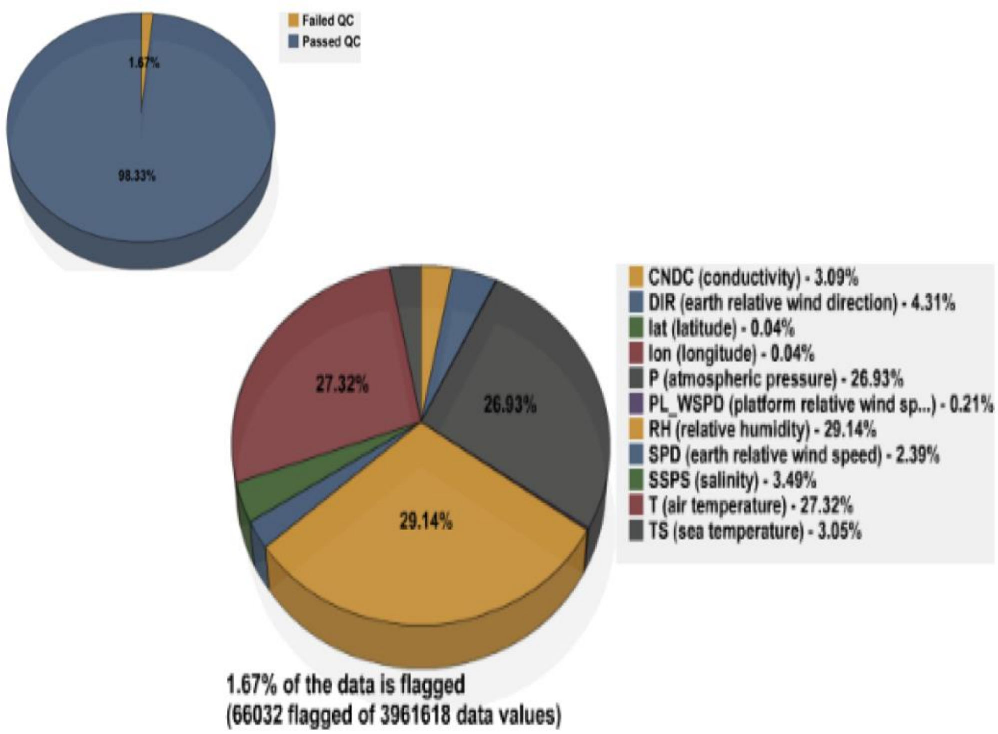


Figure 67: For the *Oscar Elton Sette* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oscar Elton Sette* provided SAMOS data for 191 ship days, resulting in 3,961,618 distinct data values. After both automated and visual QC, 1.67% of the data were flagged using A-Y flags (Figure 67). This is quite similar to 2015 (2.09% total flagged) and is once again impressively well inside of the < 5% total flagged bracket regarded by SAMOS to represent "very good" data.

With such an admirable flag percentage, and similar to the breakdown for the *Dyson* above, the main message that we have for the *Sette* must be "well done!" There are nevertheless a few items to note here.

Between 2-6 February, the atmospheric pressure (P) exhibited some abnormal pressure variations (example Figure 68). The vessel was notified via email and, although there was no response, the data appeared fine by 6 February. Regarding P, there are also sporadically some small negative steps in P, usually with no apparent cause although it does occasionally seem like changes in platform speed might be the culprit. All of these noted minor issues are generally "caution/suspect" (K) flagged during visual quality control (Figure 69).

Additionally, the air temperature (T) and relative humidity (RH) (as well as P) occasionally exhibit minor effects of flow distortion, as do virtually all vessels, but we again point out how low the overall flag percentage is to begin with. The fairly even spread of flag percentages across T, RH, and P further points to there not being any outstanding problems among the three (Figure 67). We note, however, that T and RH additionally occasionally exhibit a fair amount of spikes, which means some "spike" (S) flags in addition to the K flagging incurred as a result of flow distortion (Figure 69). The strongest recommendation we can make here, though, is for more complete instrument location metadata for each of the three sensors, plus digital imagery showing their locations and surroundings, as that would enable quality analysts at the DAC to diagnose whether and from what direction any flow contamination issues might be expected.

Lastly, we'll here repeat a caution from last year: Now and again the *Sette's* navigational data (latitude – LAT – and longitude – LON) exhibit anomalous spikes. It isn't clear what causes the spikes, and of course they incur unrealistic movement (F) or land error (L) flags (not shown). But even though they presented again throughout 2016 they contributed only a diminutive percentage to the already small total number of flags (Figure 67). They are thus of relatively minor concern to the SAMOS team, aside from noting that any faulty navigation data may affect true wind calculation.

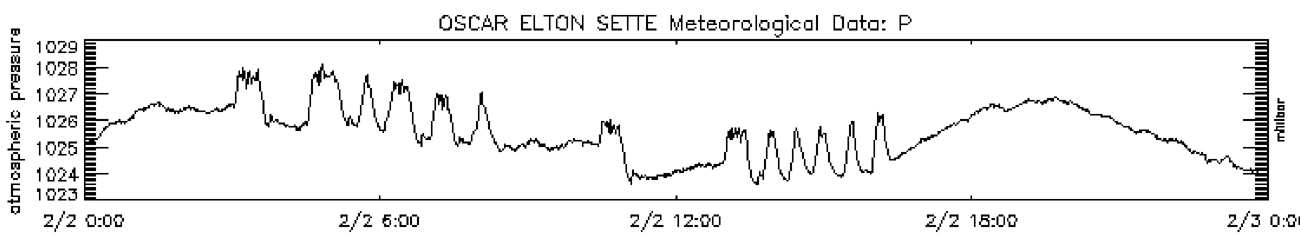


Figure 68: *Oscar Elton Sette* SAMOS atmospheric pressure – P – data for 2February 2016.

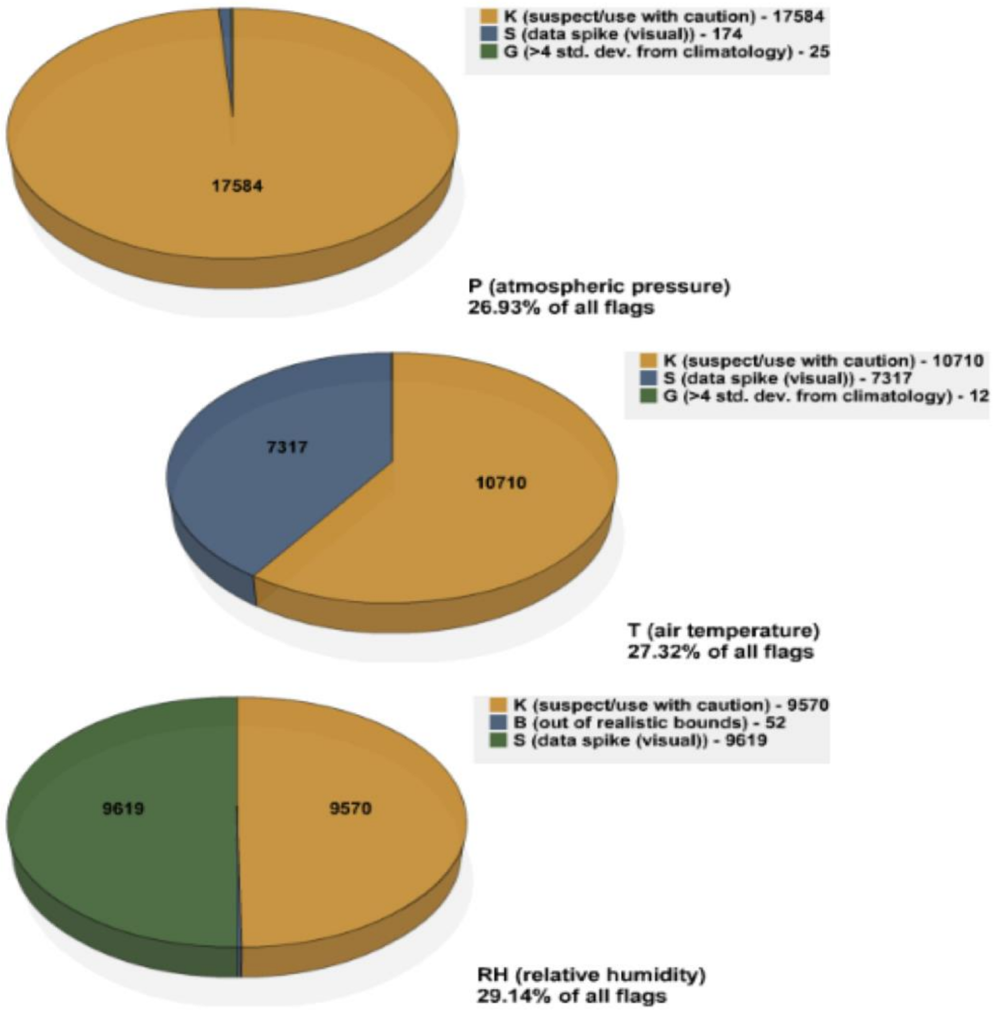


Figure 69: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) air temperature – T – and (bottom) relative humidity – RH – for the *Oscar Elton Sette* in 2016.

Pisces

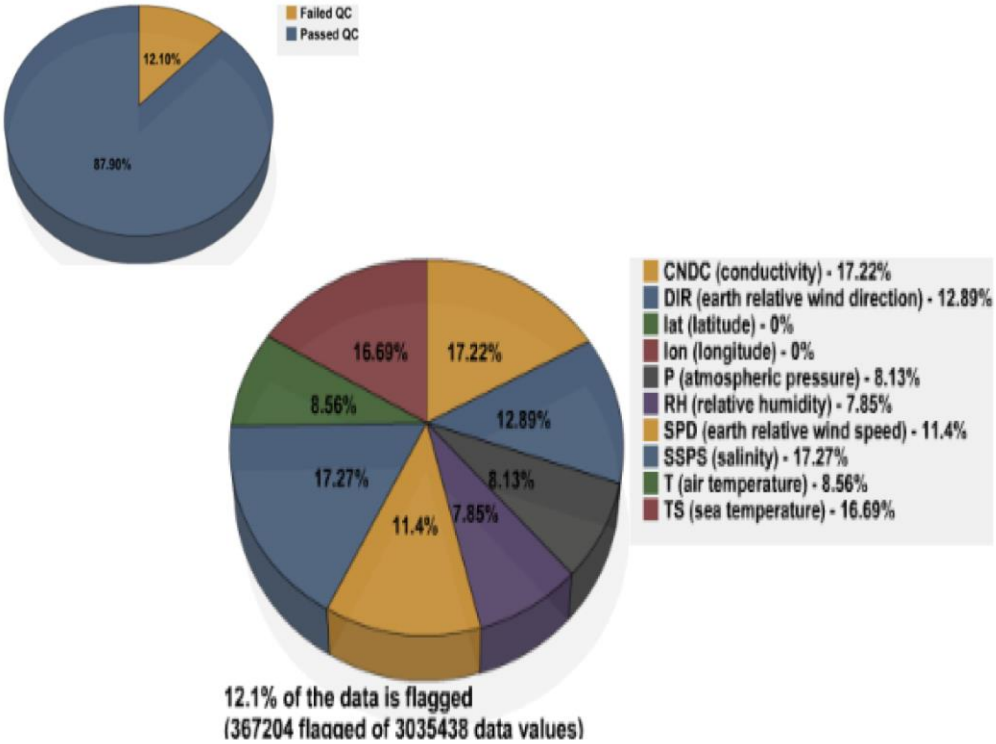


Figure 70: For the *Pisces* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Pisces* provided SAMOS data for 147 ship days, resulting in 3,035,438 distinct data values. After both automated and visual QC, 12.1% of the data were flagged using A-Y flags (Figure 70). This is quite a bit improved over *Pisces's* 2015 performance (19.88% total flagged) but unfortunately still leaves her well outside the < 5% total flagged bracket regarded by SAMOS to represent "very good" data.

The largest percentages of the total flags went to the sea parameters: sea temperature (TS), salinity (SSPS), and conductivity (CNDC) (Figure 70). Here, the majority of the time the issue is merely that the intake pump is off - a common enough occurrence when the vessel is in port or otherwise moored. This generally results in "poor quality" (J) flagging of CNDC and SSPS, which read around 0, and usually "caution/suspect" (K) flagging of TS. Again, the flags incurred as a result of a habitual turning off of the intake pump do not indicate a problem with the sensors. Sometimes, however, CNDC and SSPS will exhibit sudden, noisy steps (example Figure 71). It is not known what causes this behavior – perhaps there is debris somewhere in the plumbing contaminating the measurements – but we note this behavior has been going on for quite a while (since 2015, at least). In any case, when it occurs, the affected data are summarily "caution/suspect" (K) flagged (Figure 72).

The rest of the issues with *Pisces* 2015 data also remain essentially unchanged from previous years. We will recount those issues here:

Pisces wind data is among the least reliable of vessels reporting to SAMOS. Earth relative wind speed (SPD) and direction (DIR) together received about a quarter of the total flags (Figure 70). Most of the flags applied to earth relative wind data were caution/suspect (K) flags (not shown). This continually appears to be an airflow distortion/obstruction issue, originating at multiple platform relative wind directions. Several digital images of *Pisces* sensors do exist at SAMOS; however, it is not entirely clear in the images from which wind sensor SAMOS receives its data (the *Pisces* has several wind sensors). Without knowing this for a certainty, definitively diagnosing the issue with the wind data will be impossible.

Air temperature (T), relative humidity (RH), and atmospheric pressure (P) exhibit similar flow distortion behavior to DIR and SPD (flag breakdown not shown) and together picked up roughly another quarter of the total flags (Figure 70). It appears in the digital imagery as though the T, RH, and P sensors, at least, are in a potentially problematic location very close to the exhaust stack structure. This could certainly be a culprit of flow distortion where those three sensors are concerned; stack exhaust could also potentially interfere with those sensors' readings.

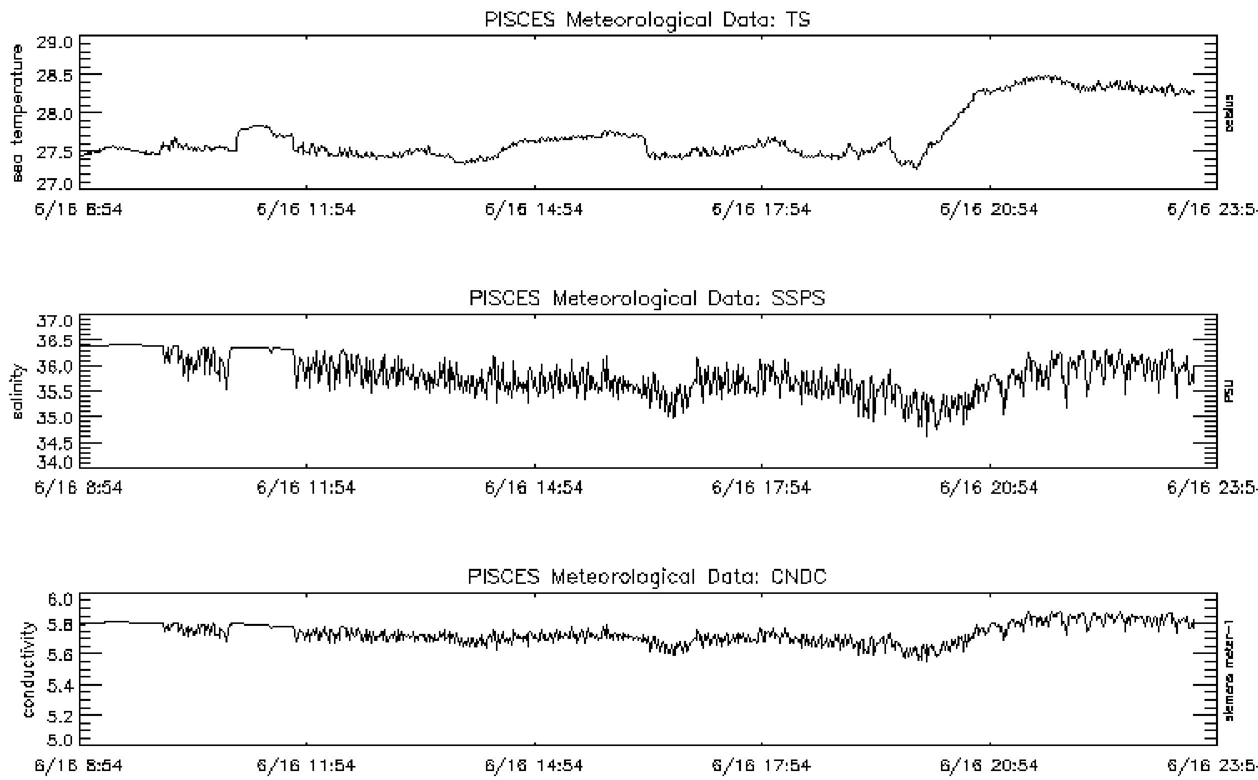


Figure 71: *Pisces* SAMOS (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – data for 16 June 2016.

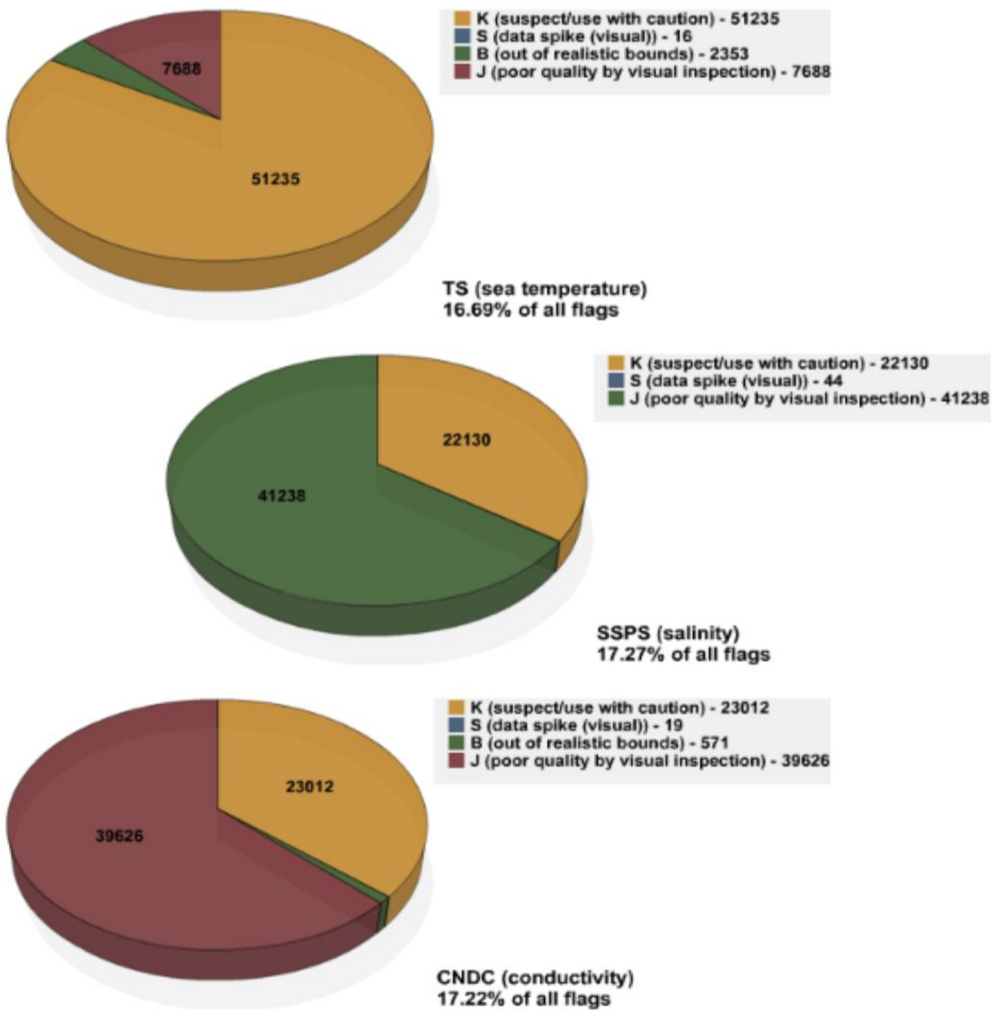


Figure 72: Distribution of SAMOS quality control flags for (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – for the *Pisces* in 2016.

Rainier

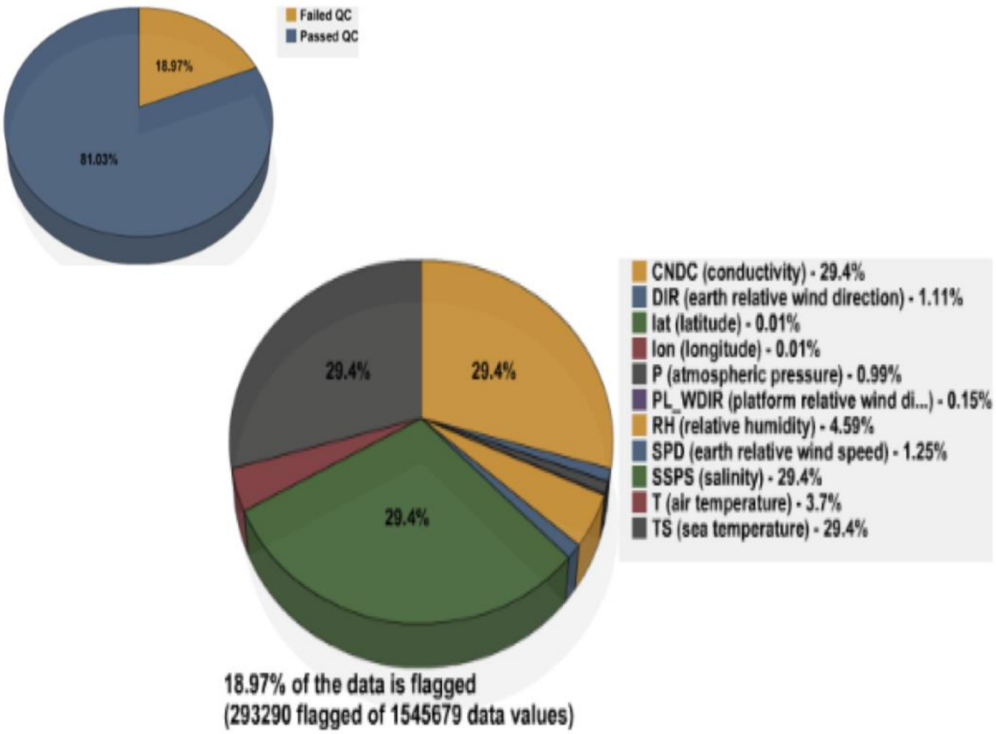


Figure 73: For the *Rainier* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Rainier* provided SAMOS data for 73 ship days, resulting in 1,545,679 distinct data values. After both automated and visual QC, 18.97% of the data were flagged using A-Y flags (Figure 73). This is over twelve percentage points higher than in 2015 (6.46% total flagged). It should be noted, too, that *Rainier's* SAMOS data transmission rate was only around 35% in 2016 (see Table 2). It would be desirable to recover any data not received by us, even if it might not be possible to apply visual QC.

Clearly the biggest issue with *Rainier's* data regards her sea parameters conductivity (CNDC), salinity (SSPS), and sea temperature (TS), together holding about 88% of the total flags (Figure 73). The issue here is that all three parameters are often low for the region, as verified by various platforms (e.g. global microwave data, nearby buoys, etc.), resulting in a very large amount of "caution/suspect" (K) flags being applied to each parameter (Figure 74). It may be that the sensors are often in a deliberate state of being denied a fresh sea water supply (whether in port or otherwise), or it may simply be that the sensors are not of the highest quality. We note that *Rainier* is known to be a hydrographic survey vessel, of which the focus is not necessarily on robust meteorological/sea surface data. We note that the sea parameters were newly added back into *Rainier's* SAMOS data roster this past year (previous data ended in 2014), as desired by the SAMOS team. However, seeing as how they significantly adversely affected her data quality results, it may make sense to discontinue TS/SSPS/CNDC again in the future if the data cannot be improved.

Also noteworthy in terms of data issues, at the advent of *Rainier's* sailing season it was recognized that the air temperature (T) and relative humidity (RH) data were bad, with T reporting a nearly static -49 C and RH reporting a nearly static 35%. The vessel was notified via email on 9 May, and the immediate response was "sorry, we're having an issue with it right now, please disregard and flag those values until we can resolve it." Rainier personnel updated us via email on 17 May that they had gotten the T/RH probe corrected. As a consequence of this interlude, both T and RH were first "poor quality" (J) and then "malfunction" (M) flagged for the duration of 8-14 May (Figure 74)

Rainier also exhibits a rather pronounced flow distortion problem. Unfortunately, *Rainier's* sensor metadata is still insufficient for us to be able to pinpoint the problem; we do not have any clue about where the sensors are located, and there is no adequate digital imagery available to show what structures might be interfering with the flow over the ship. But we do know that all of the meteorological parameters – namely, T, RH, atmospheric pressure (P), earth relative wind direction (DIR), and earth relative wind speed (SPD) – come from an Airmar weather station. These all-in-one weather stations typically do not produce the best underway data to begin with. "Steps" are readily seen in all of the met parameters, prompting a sizable volume of mainly caution/suspect (K) flags on all of the parameters (not all shown). In addition, RH occasionally virtually stagnates at 100% for long periods (several days or more), even while various verification data (e.g. buoys, other nearby vessels) do not support the readings. This again is probably related to the lower quality of the Airmar – the RH sensor is probably getting wet/saturated with condensation. While relocating the Airmar might alleviate some of the flow distortion problems mentioned above, we acknowledge there would likely still be some data issues; namely, P would probably still suffer from the lack of a Gill-type pressure port, RH might still condense easily, and all of the data would probably still not be superlative, simply because the Airmar isn't capable of producing as robust data as required to meet many scientific objectives. If the vessel prefers to operate with an all-in-one sensor, we can suggest several better alternatives.

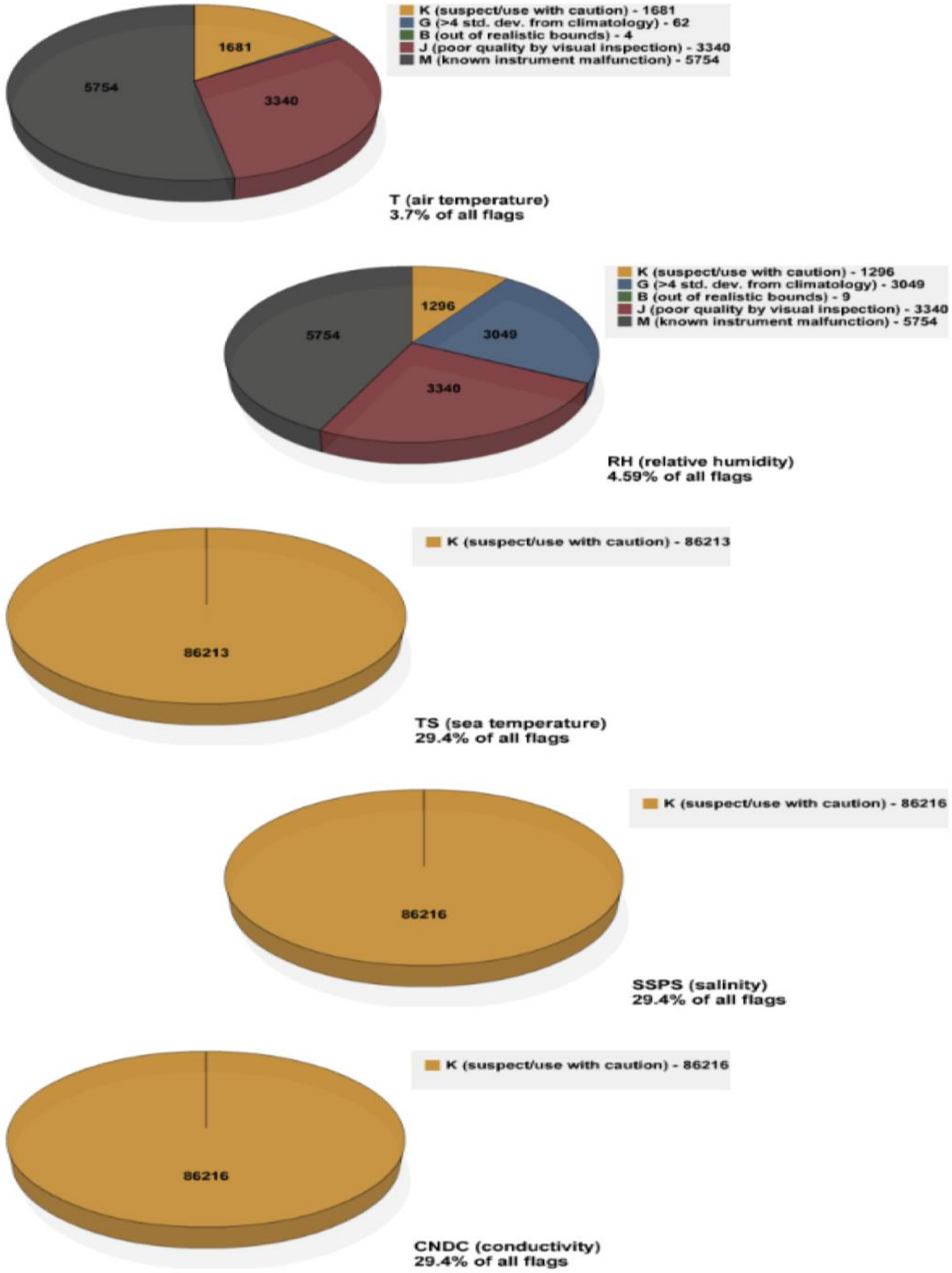


Figure 74: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) relative humidity – RH – (third) sea temperature – TS – (fourth) salinity – SSPS – and (last) conductivity – CNDC – for the *Rainier* in 2016.

Reuben Lasker

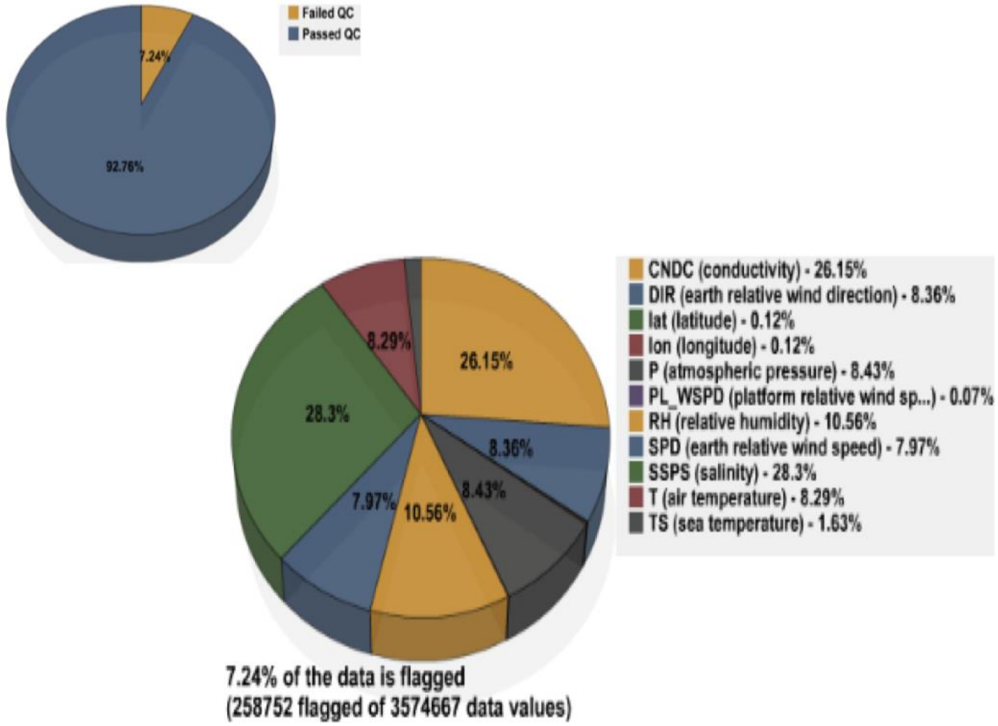


Figure 75: For the *Reuben Lasker* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Reuben Lasker* provided SAMOS data for 168 ship days, resulting in 3,574,667 distinct data values. After both automated and visual QC, 7.24% of the data were flagged using A-Y flags (Figure 75). This is pretty close to *Lasker's* 2015 performance (8.85% total flagged).

Conductivity (CNDC) and salinity (SSPS) took the biggest portion of the total flags, almost 55% combined (Figure 75). Most of the flags are of the "caution/suspect" (K) variety (Figure 78) and while a portion of these were applied simply to data recorded when intake pump was turned off, there does seem to be a sensitivity somewhere that can sometimes cause SSPS and CNDC to slide into a suspiciously low range and then suddenly bounce back (example Figure 76). This sensitivity is not noted in the sea temperature (TS), so it might be that TS is an unaffected external sea temp while the plumbing that supplies the internal CNDC and SSPS is vulnerable to taking on debris. We note that towards the end of the season the SSPS and CNDC values mostly remained low and fairly invariant. All of this unusual activity contributed to the K flags applied to each in 2016.

Additionally, *Lasker* is another vessel that seems to suffer from varying degrees of flow contamination acting on the meteorological sensors, that is, atmospheric pressure (P), air temperature (T), relative humidity (RH), earth relative wind direction (DIR), and earth relative wind speed (SPD). Steps are particularly evident in T and RH when the vessel relative winds are from astern and perhaps slightly to port (example Figure 77). This case appears similar to classical cases of stack exhaust contamination, and these steps generally receive "caution/suspect" (K) flags (Figure 78). DIR and SPD also exhibit steps, which are also K-flagged (not shown), though the affected vessel-relative winds are perhaps a bit more difficult to pin down. We note that we have no location measurements nor digital imagery of the vessel or any of the sensors in our metadata, so it is not currently possible to accurately diagnose any flow contamination issues.

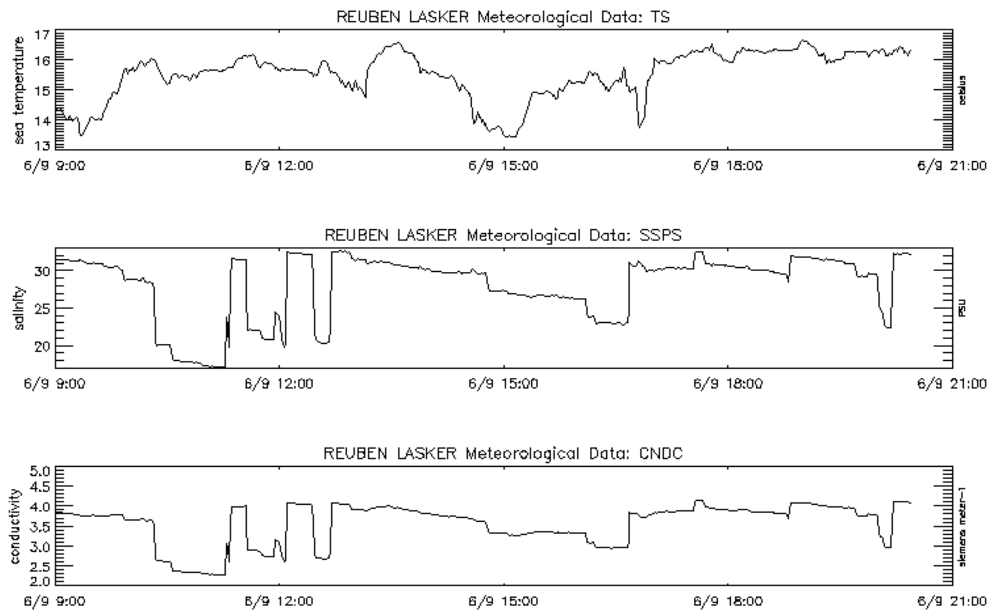


Figure 76: *Reuben Lasker* SAMOS (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – data for 9 May 2016. Note depression activity in SSPS/CNDC not present in TS.

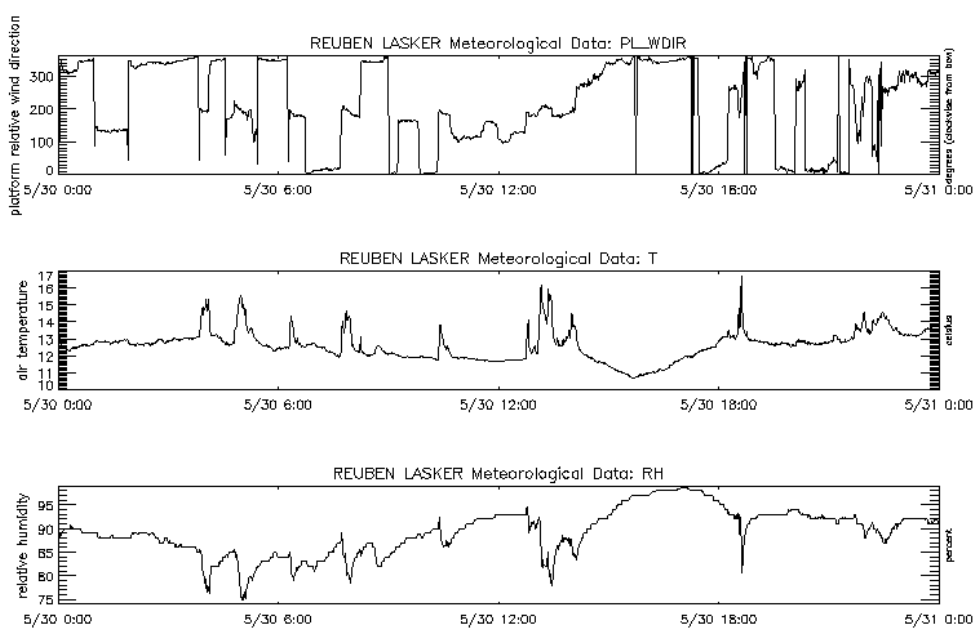
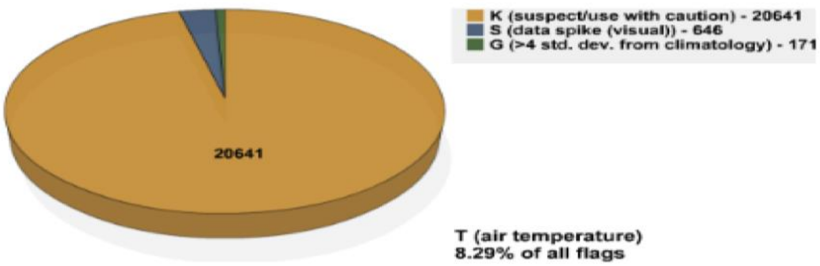
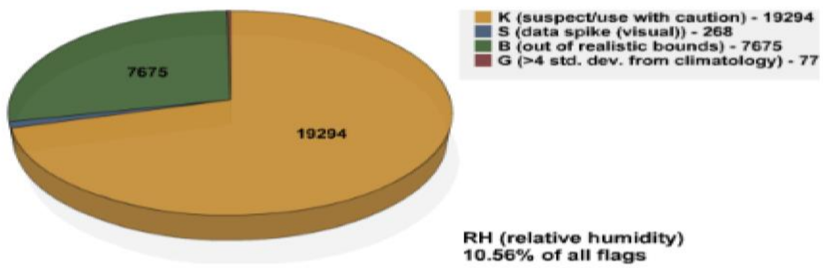
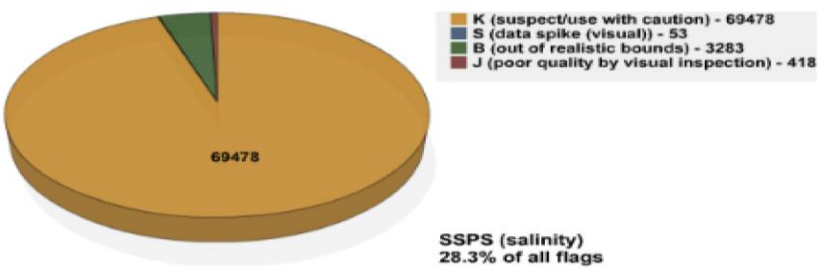


Figure 77: *Reuben Lasker* SAMOS (top) platform relative wind direction – PL_WDIR – (middle) air temperature – T – and (bottom) relative humidity – RH – data for 30 May 2016. Note steps in T/RH when PL_WDIR is from astern.







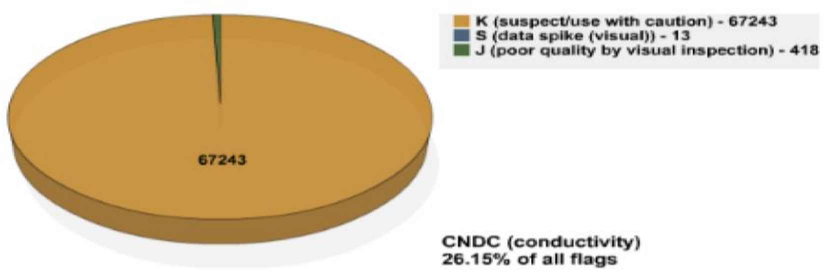


Figure 78: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) relative humidity – RH – (third) salinity – SSPS – and (last) conductivity – CNDC – for the *Reuben Lasker* in 2016.

Ronald H. Brown

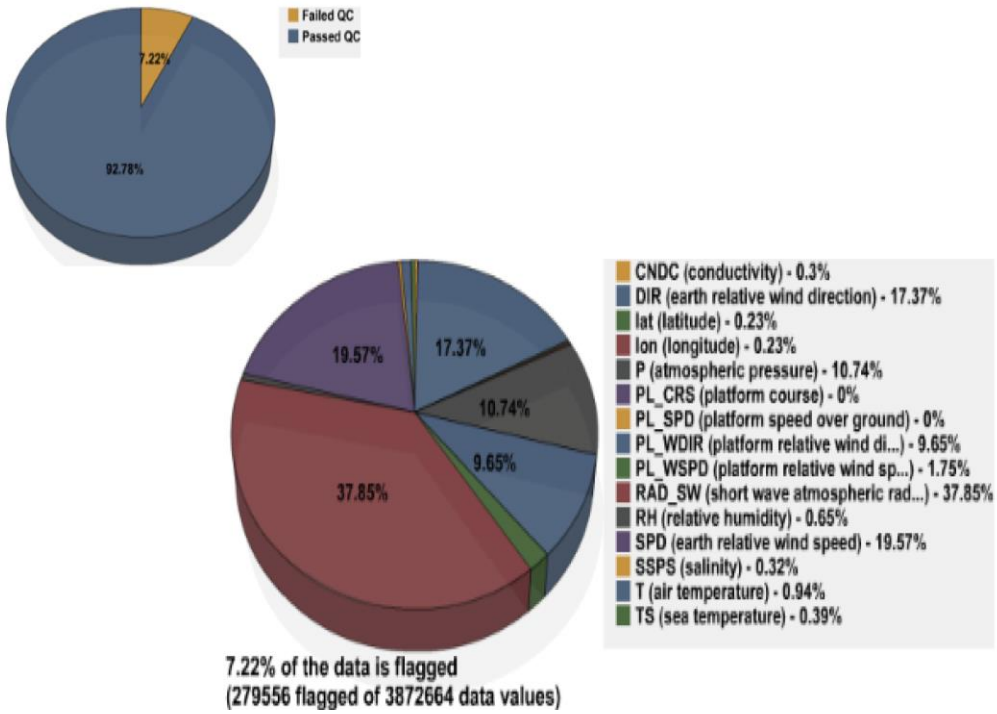


Figure 79: For the *Ronald H. Brown* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Ronald H. Brown* provided SAMOS data for 193 ship days, resulting in 3,872,664 distinct data values. After both automated and visual QC, 7.22% of the data were flagged using A-Y flags (Figure 79). This is a slight increase over 2015 (6.62% total flagged).

Similar to last year, at first glance the biggest issue with the *Ron Brown* data would appear to be the short wave atmospheric radiation (RAD_SW) parameter, holding more than a third of the total flags for 2016 (Figure 79). However, the flags applied to RAD_SW were overwhelmingly "out of bounds" (B) flags (not shown), applied to readings just slightly below zero as commonly occurs with these sensors at night (see 3b for details).

Earth relative wind direction (DIR) and speed (SPD) and platform relative wind direction (PL_WDIR) and speed (PL_WSPD), on the other hand, held smaller yet more qualitatively significant flag percentages (Figure 79). Wind sensor issues identified last year continued to evolve into the early months of 2016, and as a result DIR took on about 17% of the total flags, SPD over 19%, PL_WDIR over 9%, and PL_WSPD about 2% (Figure 79). The majority of these were "caution/suspect" (K) and "poor quality" (J) flags (Figure 81).

Initially the problem was a direct carryover from 2015, in that PL_WDIR was flatlined at 0°. Consequently, DIR essentially mimicked the shape of the platform heading, earning J flags for both DIR and PL_WDIR as well as first K and then later J flags for SPD.

Then on 7 January the *Brown* ceased reporting any SAMOS wind data. The vessel was contacted via email on 12 January. There was no response but wind data reporting was resumed as of the 12 January daily SAMOS file. At this point the character of the wind issue morphed, such that an apparent 90° rotation was noted in PL_WDIR/DIR and additionally PL_WDIR occasionally seemed to be pure noise while PL_WSPD would appear particularly dampened (Figure 80). As such, DIR and SPD continued receiving K and J flags, as warranted, with PL_WDIR and PL_WSPD also receiving some K flags.

On 2 February it was communicated to us that a scientist from NOAA's Earth Systems Research Laboratory would be visiting the *Brown* in mid-February and planned to address any outstanding issues. A roundup of ongoing data issues aboard the *Brown* – with the wind issues headlining – was subsequently passed along to the visiting scientist. Then on 17 February, once the visiting scientist was onboard, the *Brown's* SAMOS winds were switched from their forward mast IMET prop vane sensor to their starboard sonic wind sensor. All of her wind data showed drastic improvement after the switch, although with the sensor being sited somewhere on or above the bridge (note no metadata was ever received, despite numerous requests) the winds were still subject to quite a bit of directional sensitivity due to super structure deflection, meaning some continued K flagging for both DIR and SPD. In the meantime, the visiting scientist reportedly solved the issue with the IMET winds by "adding 90 degrees," although whether this was done in SCS during data logging or by physically rotating the sensor was not clarified (again, despite request).

The last chapter in 2016 began when the vessel resumed data transmission on 30 March. Upon our discovering the platform relative winds were now absent from the SAMOS daily files, we contacted vessel technicians via email once again, on 4 April. After a second email attempt on 12 April word came back to us that *Brown* personnel were having programming issues in conjunction with the SAMOS mailer such that they could not figure out how to get the platform relative winds into the SAMOS daily files. Compounding the issue, we noted (in one of the .elg files passed along by one of the *Brown* technicians during troubleshooting) that the *Brown's* SAMOS winds might possibly have been switched back to the IMET sensor without notice. Unfortunately, despite repeated attempts to confirm the source of the *Brown's* winds, as well as repeated discussions aimed at getting the platform relative winds back into the daily files, these two final issues remained unresolved throughout the remainder of 2016. To date it is still not totally clear from which sensor we are receiving the wind data, and we still do not receive any relative winds. We repeat here again that getting the relative winds back into the daily files is a high priority, as they are needed for true wind recalculation/verification.

Atmospheric pressure (P) also received a significant portion of the total flags (~10%, Figure 79). The issue here is that P is somewhat prone to sensitivity to ship motion and acceleration/deceleration. This scenario can result in "steps" in the P data, or occasionally even more substantial chunks of P presenting a few mb lower than available verification platforms (e.g. buoys and gridded analyses) if the vessel is strictly underway in a strong headwind. In these situations, P is typically K-flagged (Figure 81).

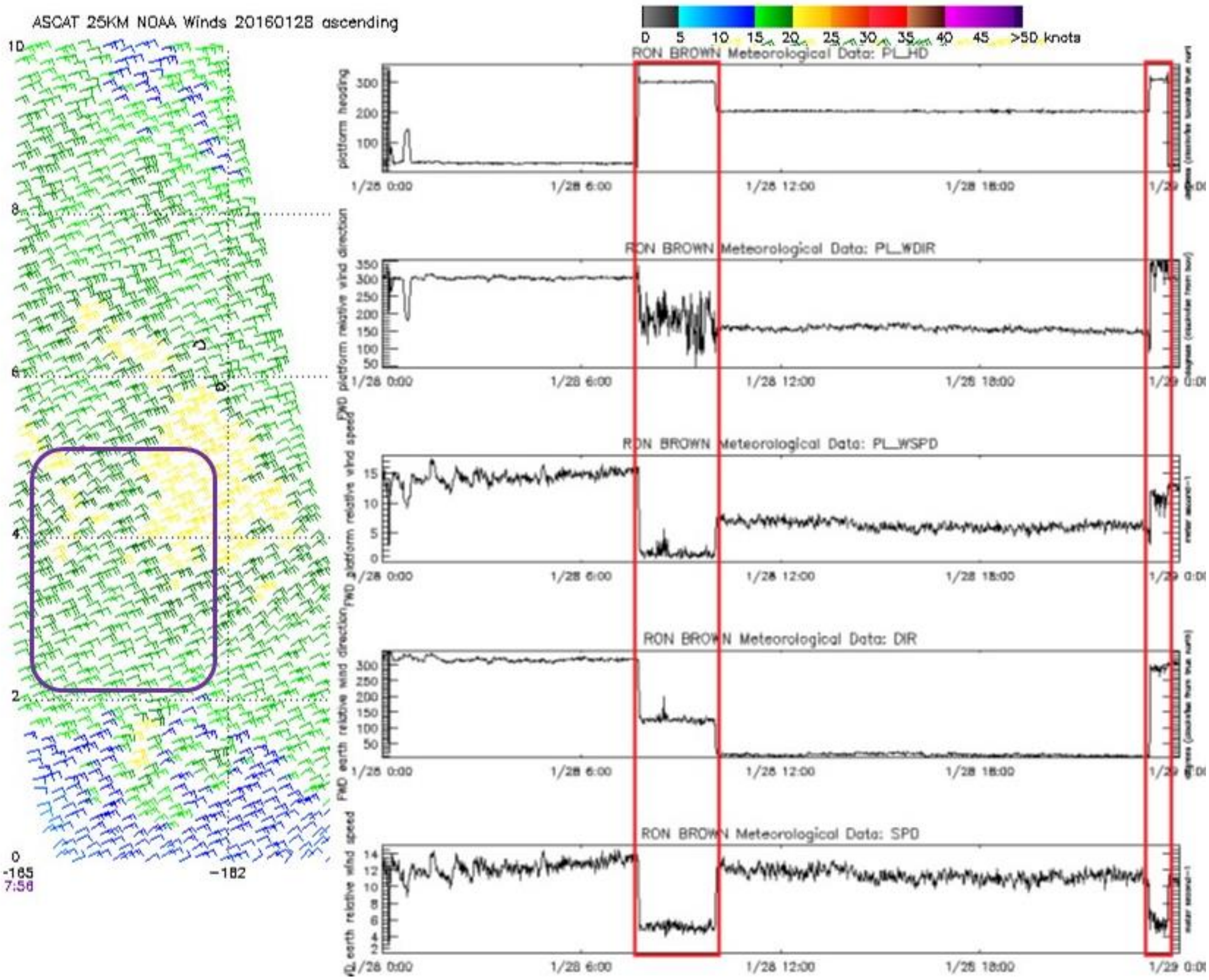


Figure 80: (LEFT) ASCAT wind swath (https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php) for 7:56 GMT 28 January 2016, note *Ron Brown* cruise location delimited by purple box, and (RIGHT) Ron *Brown* SAMOS (first) platform heading – PL_HD – (second) platform relative wind direction – PL_WDIR – (third) platform relative wind speed – PL_WSPD – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – data for 28 January 2016. Note noisy PL_WDIR and deadened PL_WSPD (as well as obvious effects on DIR and SPD) inside red boxes. Note also an apparent ~90 degree DIR shift as evidenced by 7:56 GMT ASCAT swath.

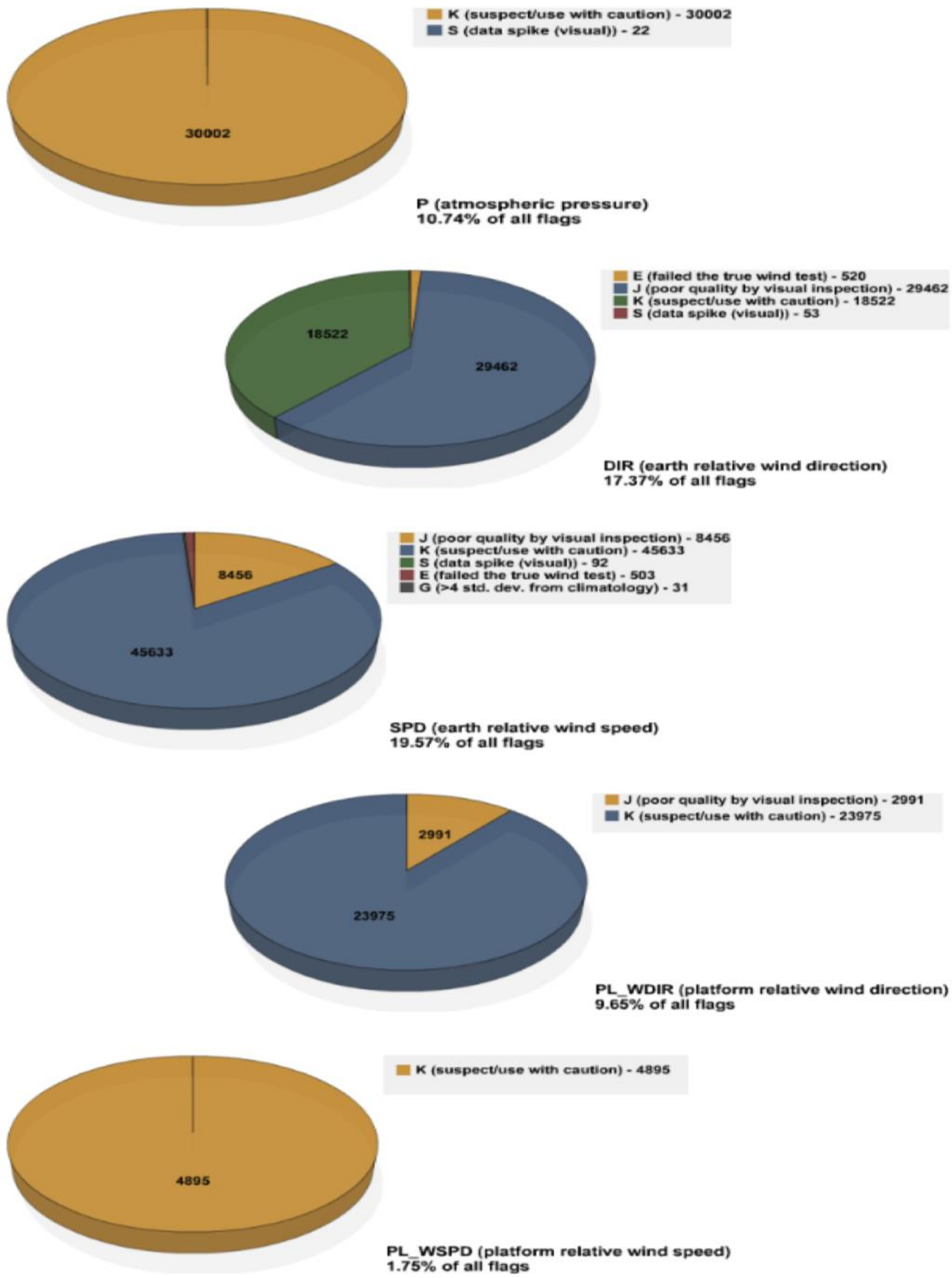


Figure 81: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) earth relative wind direction – DIR – (third) earth relative wind speed – SPD – (fourth) platform relative wind direction – PL_WDIR – and (last) platform relative wind speed – PL_WSPD – for the *Ronald H. Brown* in 2016.

Thomas Jefferson

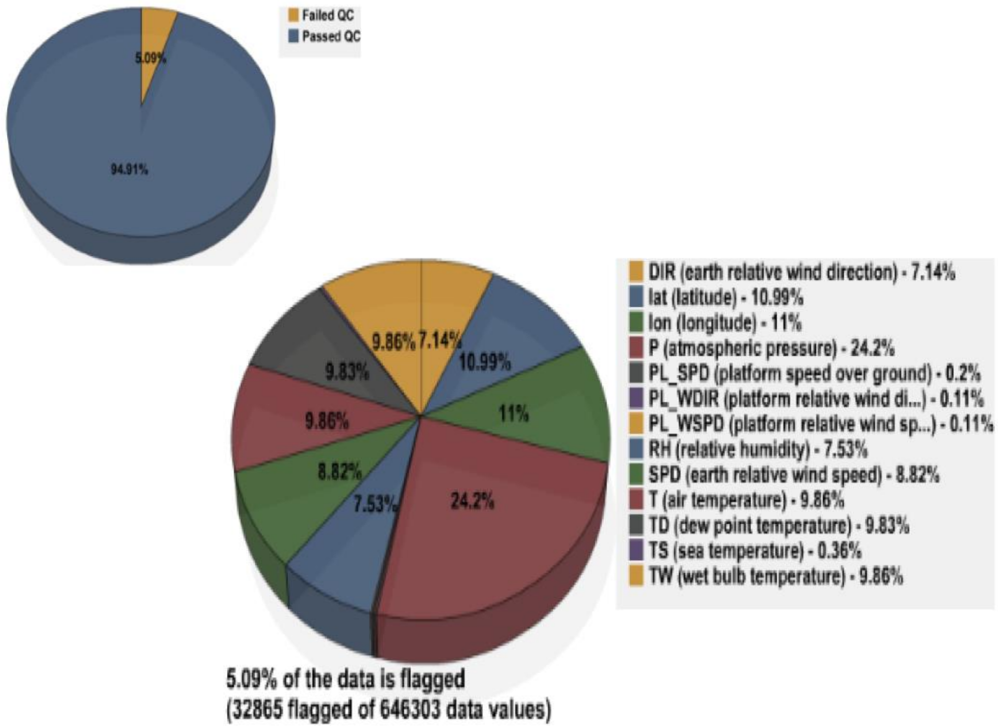


Figure 82: For the *Thomas Jefferson* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Thomas Jefferson* provided SAMOS data for 35 ship days, resulting in 646,303 distinct data values. After both automated and visual QC, 5.09% of the data were flagged using A-Y flags (Figure 82). This is essentially unchanged from the *Jefferson's* 2015 performance (5.19% total flagged) and once again keeps her just shy of the < 5% flagged cutoff regarded by SAMOS to represent "very good" data. It should probably be noted, too, that *Jefferson's* SAMOS data transmission rate was only around 55% in 2016 (see Table 2). It would be desirable to recover any data not received by us, even if it might not be possible to apply visual QC.

Echoing previous years, the main issue evident in the *Jefferson's* data appears once again to be the sensitivity of nearly all of the meteorological parameters to platform relative wind direction, and as always none more so than atmospheric pressure (P), with almost a quarter of the total flags being assigned to that variable in 2016 (Figure 82). Throughout the sailing season there were a lot of steps in P, air temperature (T), and subsequently both wet bulb and dew point temperatures (TW and TD, respectively), relative humidity (RH), and the earth relative winds, both direction (DIR) and speed (SPD) (examples Figure 83), resulting in the need for a good amount of suspect/caution (K) flagging of each affected parameter (Figure 84, TW and TD not shown). It was again anticipated that these types of suspicious behavior would be the case with the *Jefferson*, as it's understood to be a hydrographic survey vessel that is not equipped with research-quality meteorological sensors. However, if digital imagery of the vessel and of the various sensor locations were provided we might be able to at least suggest more suitable locations for many of the sensors, thereby potentially cutting off some of the flagging due to air flow obstruction/distortion. At any rate, though, as data quality continues to hover so close to < 5% total flagged, there isn't an enormous amount of concern here.

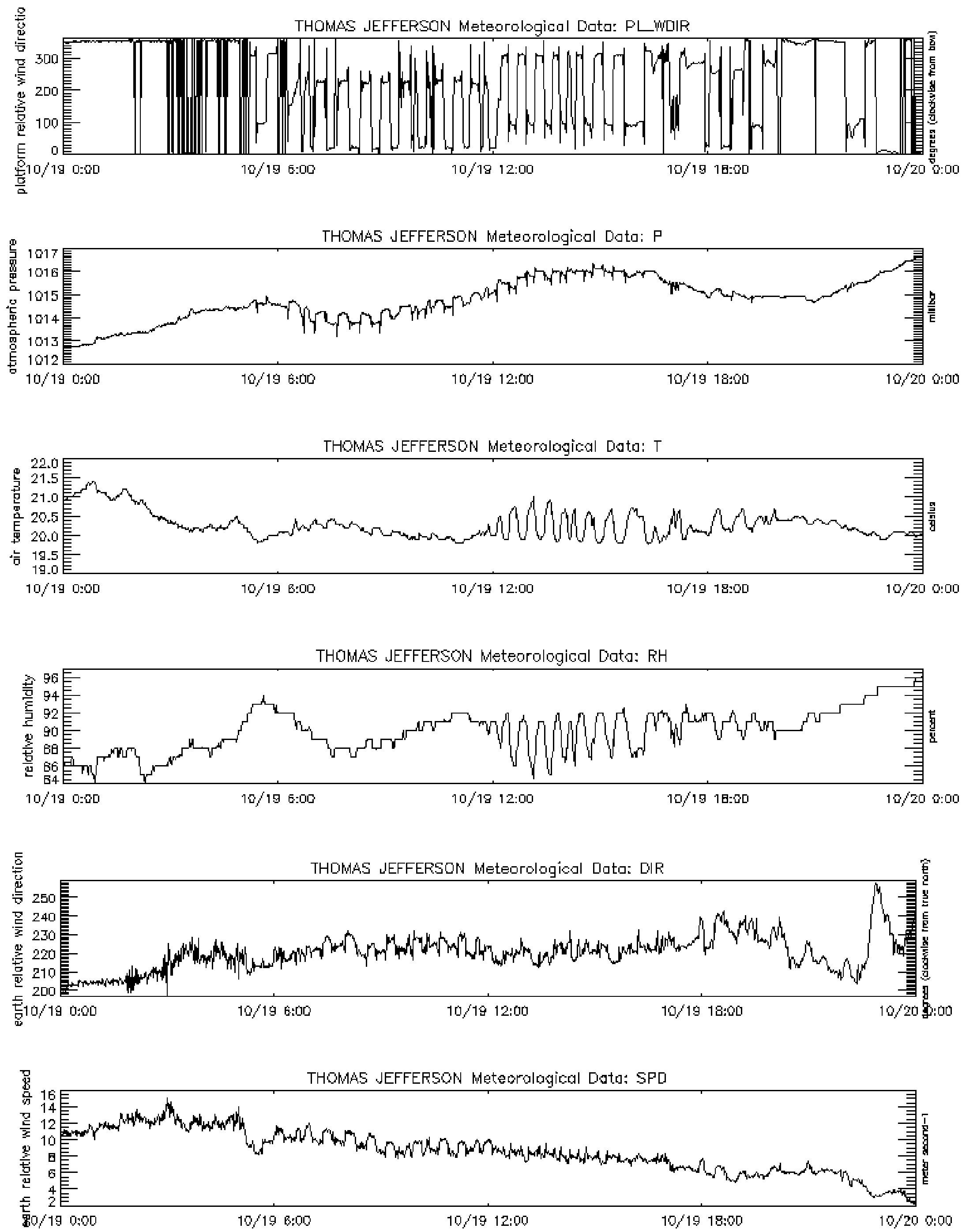


Figure 83: *Thomas Jefferson* SAMOS (first) platform relative wind direction –PL_WDIR – (second) atmospheric pressure – P – (third) air temperature – T – (fourth) relative humidity – RH – (fifth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – data for 19 October 2016. Note frequent steps in the met parameters when PL_WDIR changes.

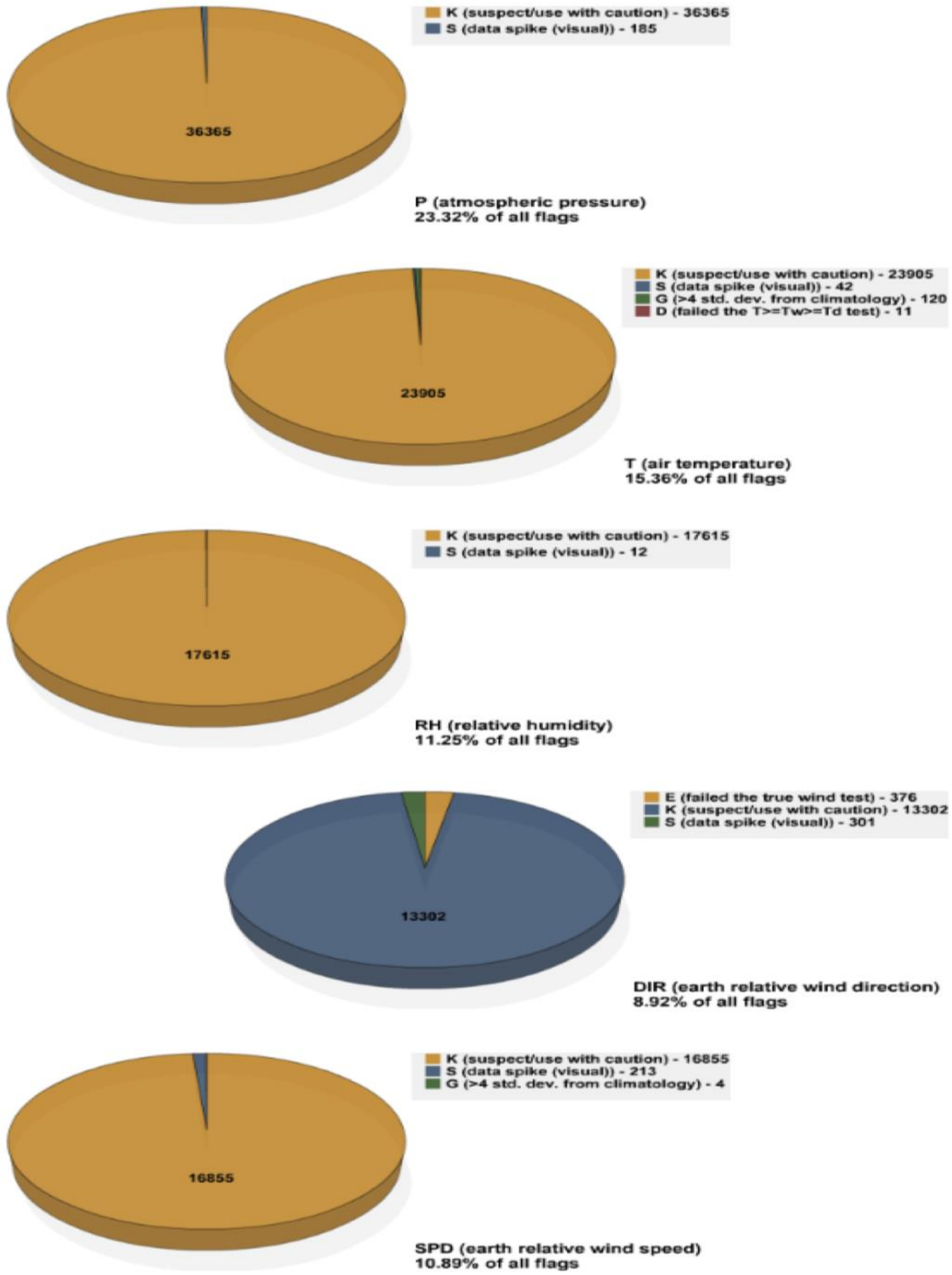


Figure 84: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH -- (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Thomas Jefferson* in 2016.

Laurence M. Gould

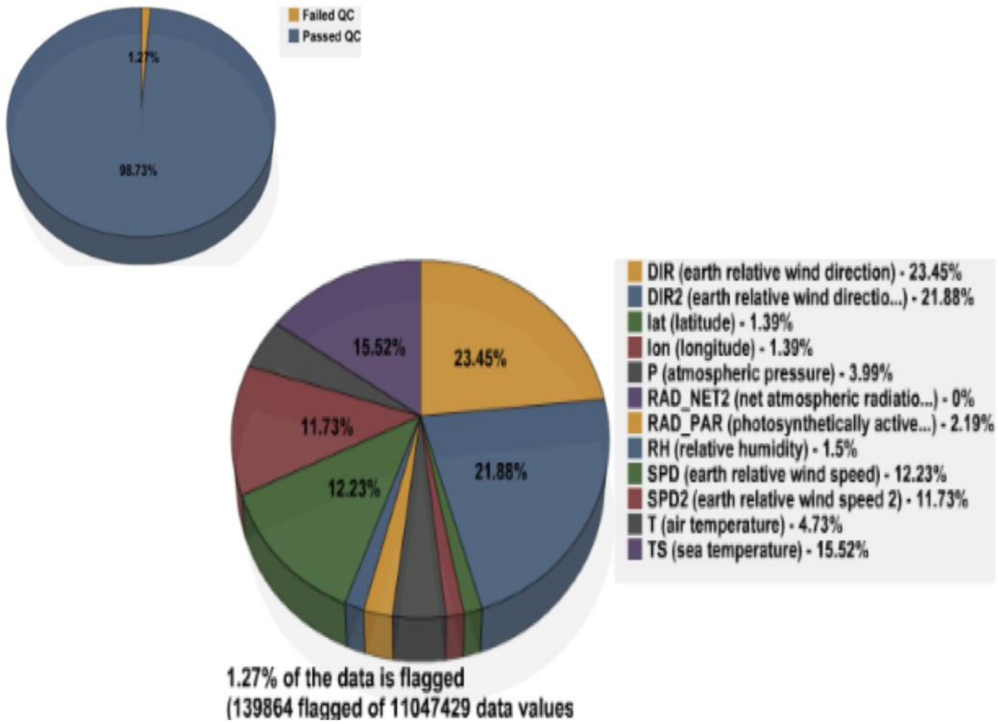


Figure 85: For the *Laurence M. Gould* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Laurence M. Gould* provided SAMOS data for 364 ship days, resulting in 11,047,429 distinct data values. After automated QC, 1.27% of the data were flagged using A-Y flags (Figure 85). This is about the same as in 2015 (1.07% total flagged). It bears remembering, though, that as the *Gould* does not receive visual QC this low percentage is likely misleading, since visual QC is when the bulk of flags are usually applied and the *Gould* historically maintains multiple data issues, owing in large part to the massive superstructure resident on the vessel.

Realistically, with such a low total flag percentage there isn't much use in attempting to diagnose potential data issues based on the distribution of flags. It is known, though, that the *Gould* sensors are frequently affected by airflow being deflected around the super structure, as well as stack exhaust contamination (example Figure 86).

Perhaps somewhat more evident in the flag percentages, though, is the fact that it was discovered in late 2016 (and through an oversight on our end not remedied until 2017) that the *Gould's* platform speed is now and has been for an indeterminate amount of time reported to us in kts, as opposed to the km/hr we have always had on record. What this means is that we have been applying an inaccurate conversion factor to the platform speed data when we convert to our standard m/s. This erroneous conversion may go a long way towards explaining the volume of "failed the true wind recomputation test" (E) flags (Figure 87) assigned to the earth relative wind directions (DIR and DIR2) and speeds (SPD and SPD2), as platform speed is used in that very recomputation. The units have been corrected in our database as of 18 January 2017, however, and we may see less E flags from now on.

At the same time the platform speed units came to light, we also learned that both the declared type and original units of two of the *Gould's* radiation parameters were also incorrect in our database, again for an indeterminate period of time. It should be noted that the net short wave (RAD_NET) and net long wave (RAD_NET2) radiation parameters are actually down welling short wave and down welling long wave, respectively, radiation measurements. Additionally, the measurements have been converted from microwatts/cm^2 to W/m^2 when in fact the data were already in W/m^2 when we received them. Again, these errors have been corrected in our database as of 18 January 2017.

There were three other items of note for *Gould* in 2016, all of them exposed during the quick visual inspection that occurs when daily files are first received at the SAMOS DAC. First, on 4 April the data analyst in charge of the daily quick look noted an abrupt 4 mb shift in the atmospheric pressure (P) data. The vessel was immediately prompted for input via email, and the response came back from *Gould* right away stating they had switched barometers because they'd found the replaced unit to be prone to icing and water in the line as of late. Then on 20 July the SAMOS data analyst noticed minimum RAD_NET values were falling as low as -35 W/m^2 at night, well below the usual -5 W/m^2 typically seen with the sensor. Upon email notification, a vessel technician stated it would be investigated. (No conclusion is on record, but the data do appear normalized shortly thereafter.) Finally, on 26 July the SAMOS data analyst again noted an issue with P. This time data were continuously 982.46 mb for several days. The vessel was contacted as usual and a technician responded that it would be fixed imminently (it was). These types of notification/resolution events underscore the importance of two-way communication between the SAMOS data analysts and the SAMOS vessel operators, especially in the case of ships that do not receive visual quality control (like the *Gould*). In many of these non-visQC cases there is nothing we can do to highlight suspicious or poor quality data, aside from making a formal note in these annual reports. But at least we can try to minimize the damage by pinpointing any issues early on and getting them resolved as quickly as possible with the help of the ships’ technicians.

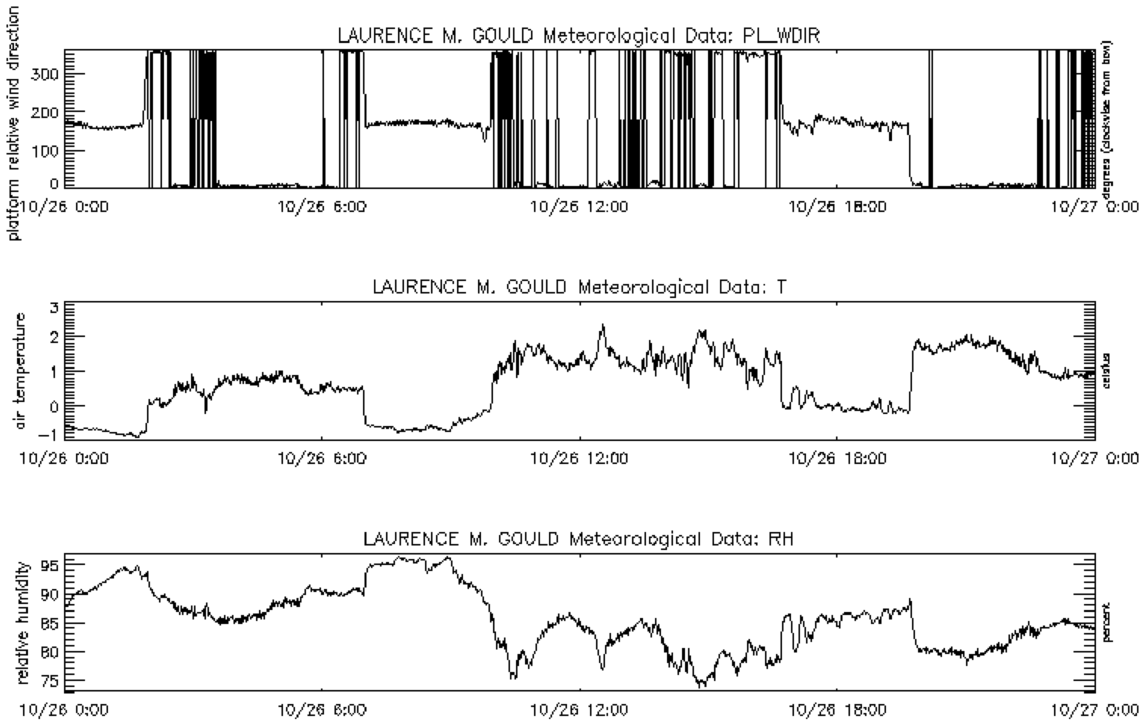


Figure 86: *Laurence M. Gould* SAMOS (top) platform relative wind direction – PL_WDIR – (middle) air temperature – T – and (bottom) relative humidity – RH – data for 26 October 2016. Note steps in T and RH with relative headwinds, a result of stack exhaust contamination.

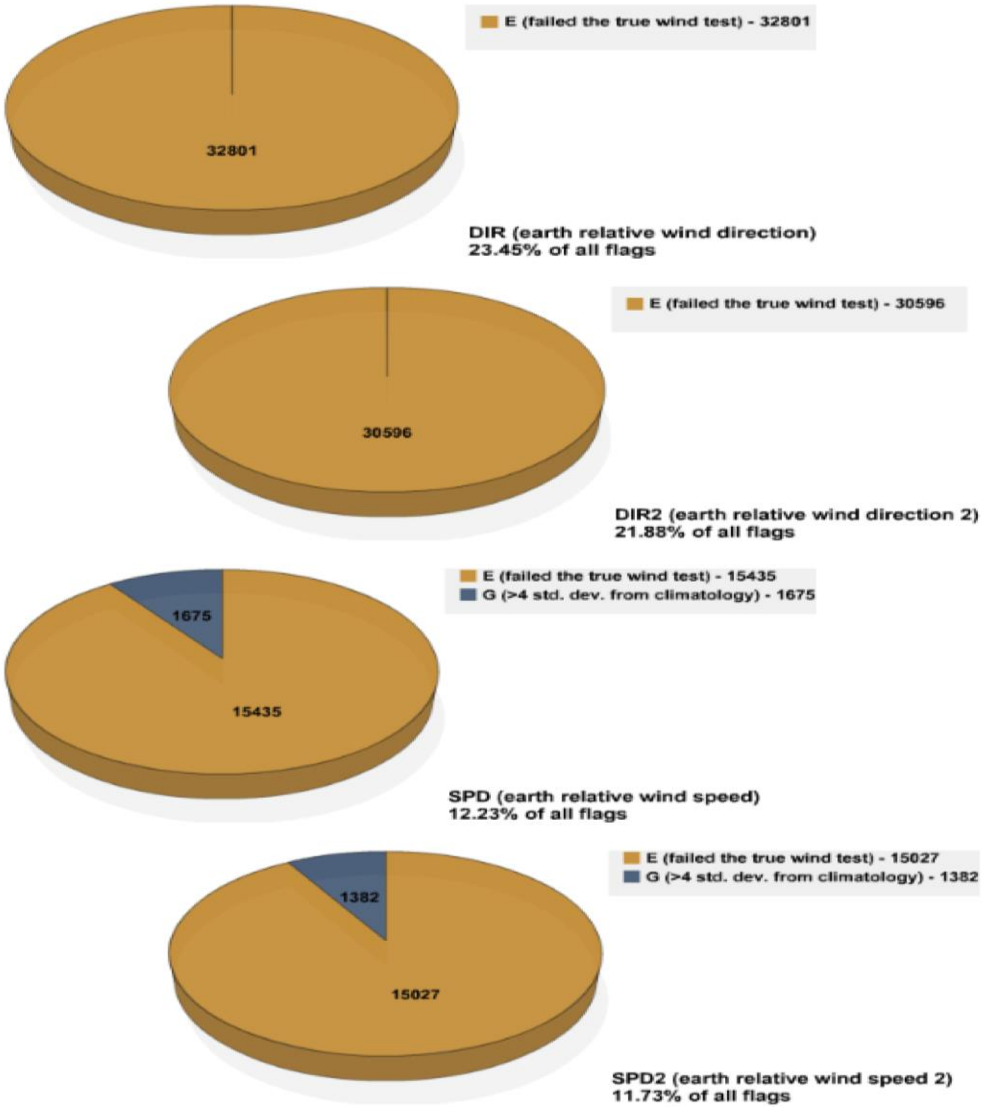


Figure 87: Distribution of SAMOS quality control flags for (first) earth relative wind direction – DIR – (second) earth relative wind direction 2 – DIR2 – (third) earth relative wind speed – SPD – and (last) earth relative wind speed 2 – SPD2 – for the *Laurence M. Gould* in 2016.

Nathaniel B. Palmer

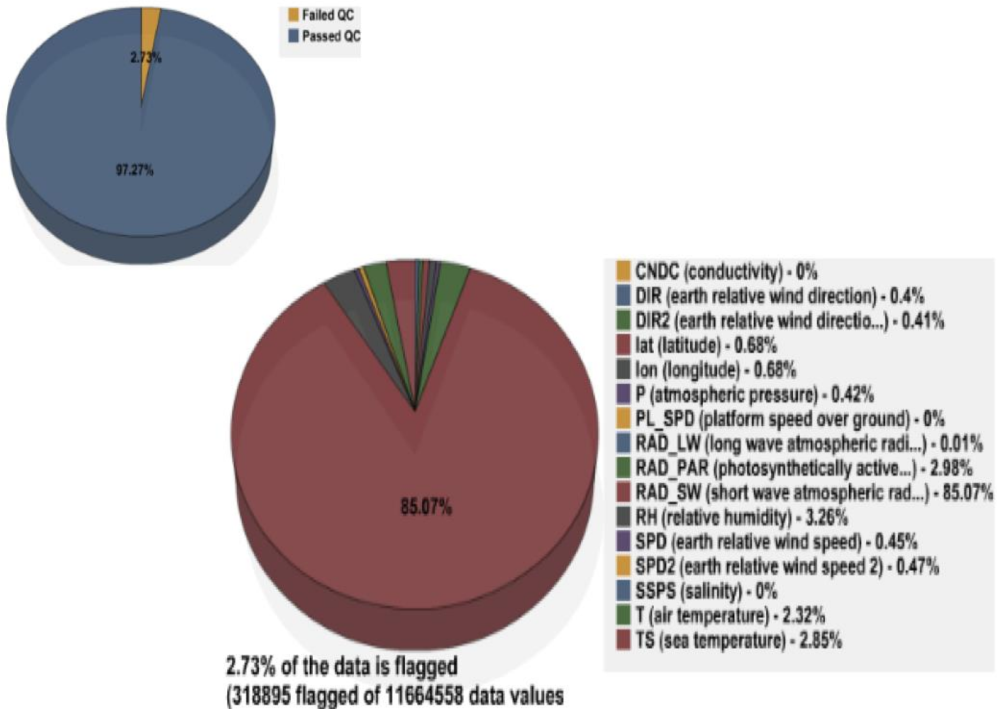


Figure 88: For the *Nathaniel B. Palmer* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Nathaniel Palmer* provided SAMOS data for 361 ship days, resulting in 11,664,558 distinct data values. After automated QC, 2.73% of the data were flagged using A-Y flags (Figure 88). This is about a six percentage point improvement over 2015 (8.47% total flagged). Like the *Gould*, the *Palmer* does not receive visual QC so again the percentage itself is likely to be misleading, although the decrease does have positive implications. Still, visual quality control is generally when the bulk of quality control flags are applied, and the *Palmer* and *Gould* alike have a history of multiple data issues, owing in large part to the massive superstructures resident on each vessel.

There were two issues of note with *Palmer* SAMOS data in 2016, both of them caught during the quick visual inspection that occurs when daily files are received. One of these issues is suggested in the flag percentages (Figure 88), involving the short wave atmospheric radiation (RAD_SW). On 12 July one of the data analyst noted RAD_SW was reporting erroneously low, with peak values of less than 10 W/m^2 and minimum values dipping below -30 W/m^2, clearly out of physical limits. The vessel was contacted via email and the ET Supervisor immediately responded, stating that there would be someone available to take a look at the situation in a couple of weeks. A second notice was sent on 21 July, but a quick look at some year-end data suggests this issue may be ongoing, at least the < -30 W/m^2 minimum value issue. This scenario likely contributed heavily to the "out of bounds" (B) flags applied to RAD_SW (Figure 89).

The second item of note occurred earlier in the year and involved the air temperature (T) and relative humidity (RH) parameters. On 23 January one of the data analysts noted an abrupt shift in T and immediately contacted the vessel via email. Word came back promptly that technicians had replaced the T/RH sensor on the 22nd, but as it immediately started showing problems with RH they replaced it again on the 23rd. This entire scenario was likely missed by automated flagging procedures, so it is especially helpful that we are able to communicate with the vessel operators and make note of the occurrences here.

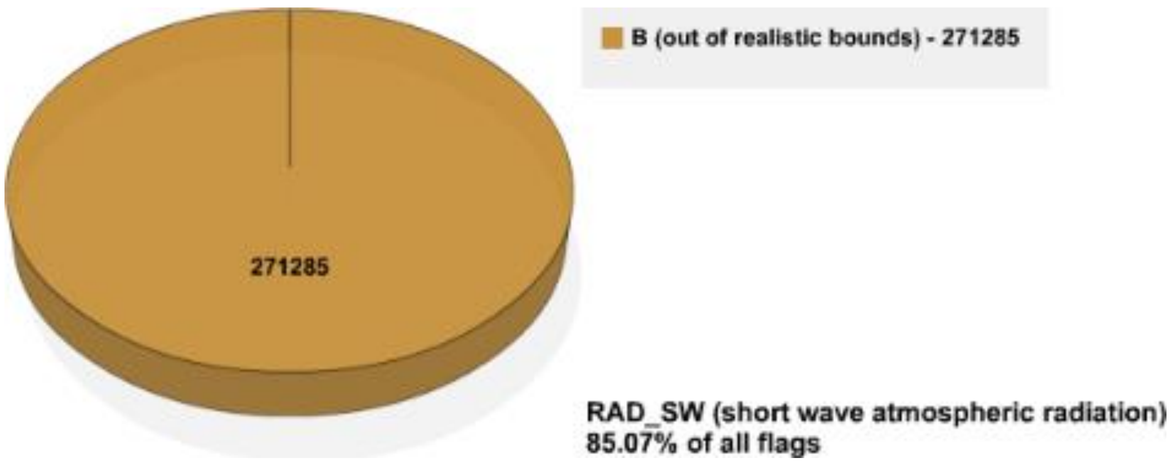


Figure 89: Distribution of SAMOS quality control flags for short wave atmospheric radiation – RAD_SW – for the *Nathaniel B. Palmer* in 2016.

Robert Gordon Sproul

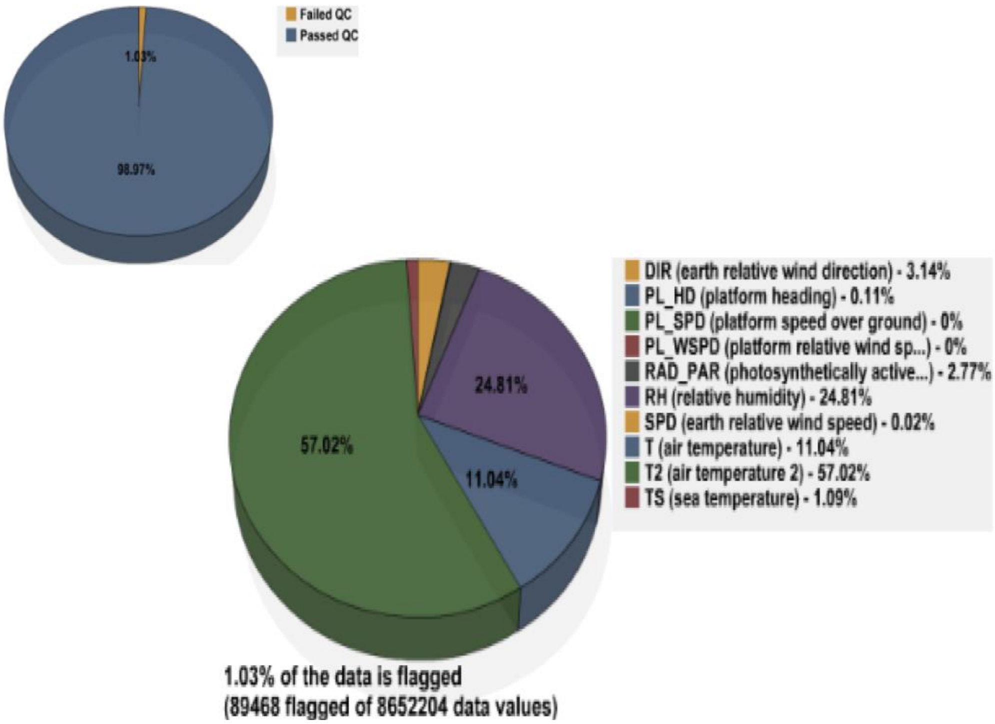


Figure 90: For the *Robert Gordon Sproul* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Robert Gordon Sproul* provided SAMOS data for 355 ship days, resulting in 8,652,204 distinct data values. After automated QC, 1.03% of the data were flagged using A-Y flags (Figure 90). This is essentially unchanged from 2015 (1.28% total flagged) and is again a notably low percentage; however, the *Robert Gordon Sproul* does not receive visual quality control by the SAMOS DAC, which is when the bulk of quality flags are usually applied, so the low percentage may be misleading. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Robert Gordon Sproul*).

There are two data issues of note on record for the *Sproul* in 2016, and both are suggested in the flag percentages. The first involves one of *Sproul's* air temperature sensors (T2), which held over half the total flags (Figure 90). It seems since fall of 2016 the sensor often read too high for the region of operation (and notably higher than the other temperature sensor, T) and sometimes exhibited large unexplained steps (example Figure 91). One of the SAMOS data analysts contacted the vessel multiple times via email regarding this issue (16 September, and 10 and 24 October). While there is no response on record, a quick scan of some year-end data suggests the issue has been rectified. Nevertheless, while it was ongoing T2 amassed a volume of mainly ">4 standard deviations from climatology" (G) flags (Figure 93). Had the *Sproul* been a vessel that receives visual QC these G flags would almost certainly have been changed to "caution/suspect" (K) or perhaps even "poor quality" (J) flags, as a G flag can suggest both a valid and a scientifically significant value.

The second issue on record involved relative humidity (RH). On 9 November the SAMOS data analyst emailed *Sproul* to alert them their RH sensor appeared to have gone "out to lunch" on the 5th. This apparently involved some very low values (near 0%) as well as some values over 100%. Again there is no response on record, but there is a clear shift in the data on the 9th pointing towards resolution (Figure 92). Prior to the resolution RH picked up some G as well as "out of bounds" (B) flags (Figure 93). (Again, the G flags would have been changed to K or J during visual quality control.)

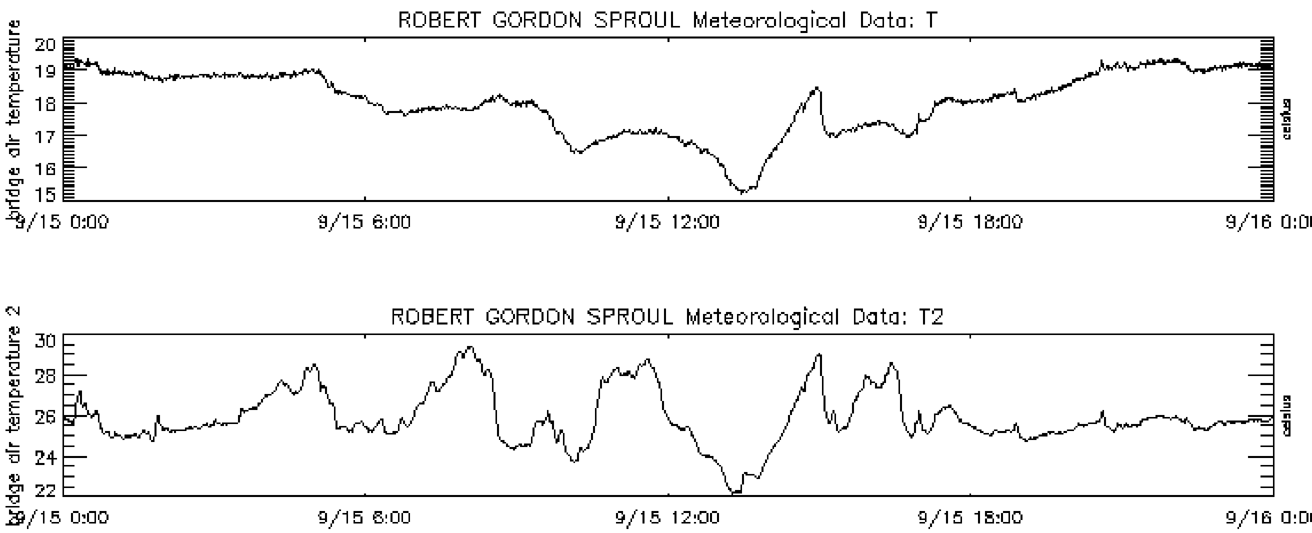


Figure 91: *Robert Gordon Sproul* SAMOS (top) air temperature – T – and (bottom) air temperature 2 – T2 – data for 15 September 2016. Note steps in T2 as well as roughly +7 C discrepancy between T2 and T.

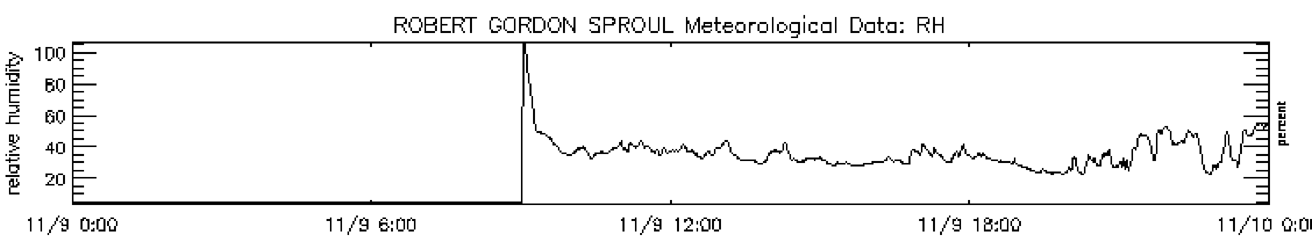


Figure 92: *Robert Gordon Sproul* SAMOS relative humidity – RH – data for 9 November 2016.

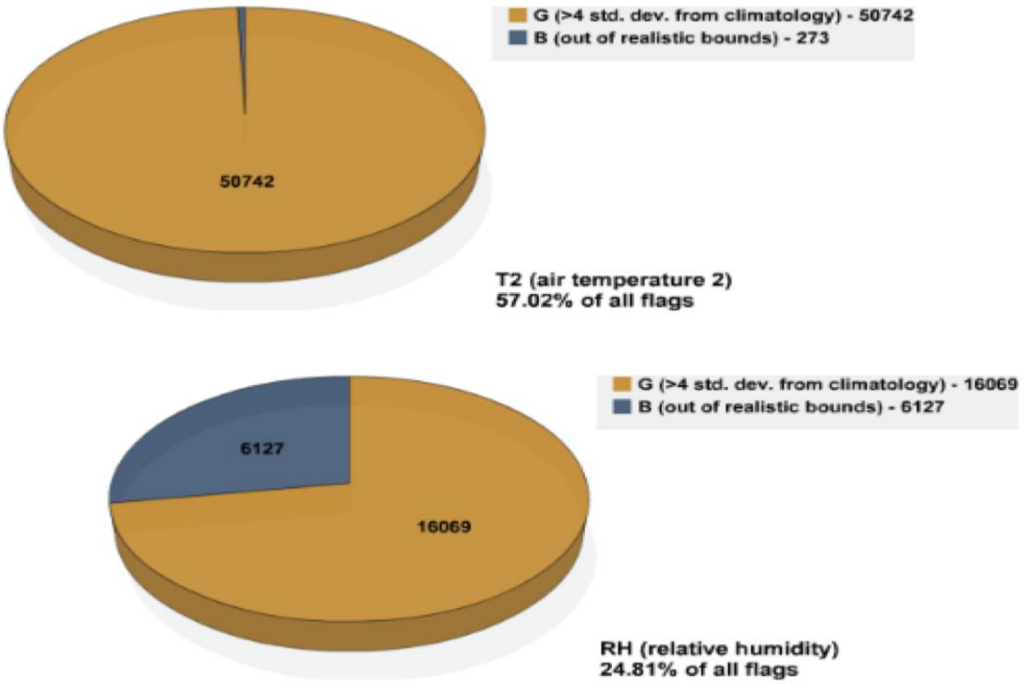


Figure 93: Distribution of SAMOS quality control flags for (top) air temperature 2 – T2 – and (bottom) relative humidity – RH – for the *Robert Gordon Sproul* in 2016.

Roger Revelle

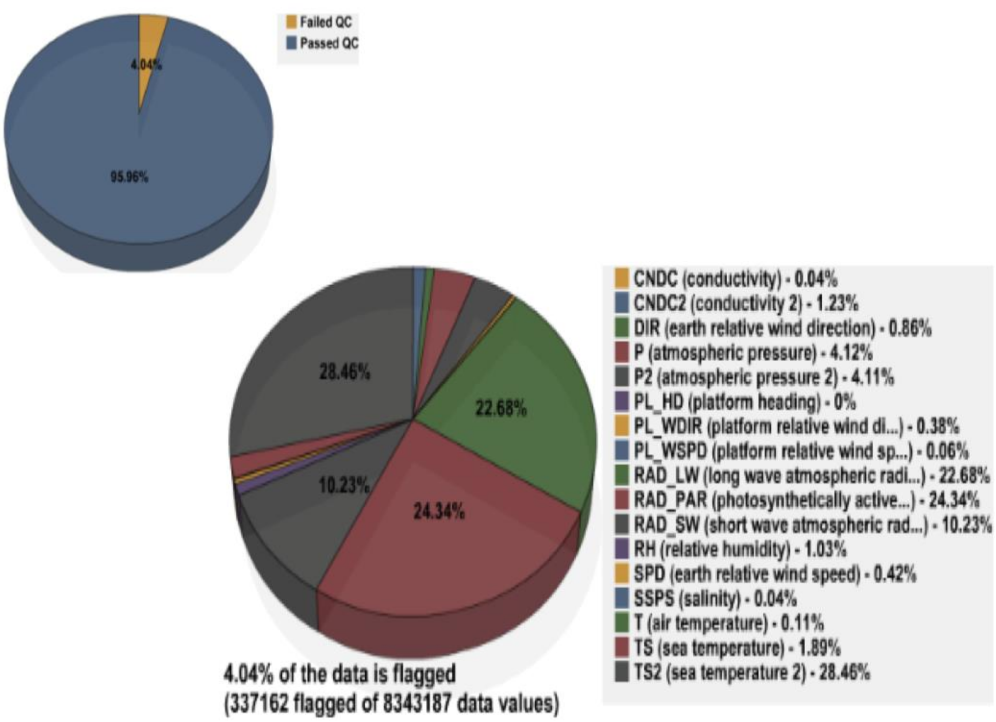


Figure 94: For the *Roger Revelle* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Roger Revelle* provided SAMOS data for 256 ship days, resulting in 8,343,187 distinct data values. After automated QC, 4.04% of the data were flagged using A-Y flags (Figure 94). This is about two percentage points higher than in 2015 (2.3% total flagged) and still a moderately low percentage; however, just as with the *Robert Gordon Sproul*, the *Revelle* does not receive visual quality control by the SAMOS DAC, which is when the bulk of quality flags are usually applied, so the low percentage may be misleading. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Roger Revelle*).

Some of the highest percentages of flags were applied to the sea temperature 2 (TS2), short wave atmospheric radiation (RAD_SW), photosynthetically active radiation (RAD_PAR), and long wave atmospheric radiation (RAD_LW) parameters (Figure 94). However, upon inspection the first three of these (namely, TS2, RAD_SW, and RAD_PAR) appear to be the typical result of routine operations and not indicative of a problem. In the case of RAD_SW and RAD_PAR, the flags applied are exclusively "out of bounds" (B) flags (not shown) mainly assigned to values slightly below zero at night, as commonly occurs with these sensors owing to sensor tuning (see details 3b). Likewise the flags applied to TS2 are almost exclusively greater than four standard deviations (G) flags (not shown), the majority of which appear to have been applied to the data while an intake pump was off. This securing of the seawater system is a pretty standard practice for vessels in port or occasionally in an excessive chop.

On the other hand, RAD_LW did actually did experience a problem in 2016. On 28 March the SAMOS data analyst responsible for quick visual inspection of incoming daily files emailed the *Revelle* to alert them that RAD_LW had only been observing negative values from about -90-0 W/m^2 since 19 March. There was some response from the vessel, but the issue does not appear to have been fixed immediately. The B flagging that ensued once the data went negative (Figure 95) appears to have continued until data transmission halted on 12 May. Once data transmission resumed in August, however, the issue does appear to have been addressed.

A second issue on record for the *Revelle* involved both atmospheric pressure parameters (P and P2), each of which received around 4% of the total flags (Figure 94). On 17 August the quick-look SAMOS data analyst noticed both P and P2 were recording pressures in the 900-902 mb range, which was clearly way too low for their region of operation east of Hawaii. An email notification was sent to the vessel, and while there is no response on record both parameters appear to have been restored to normal two days later. However, during the period 9-19 August both P and P2 were heavily B flagged (Figure 95).

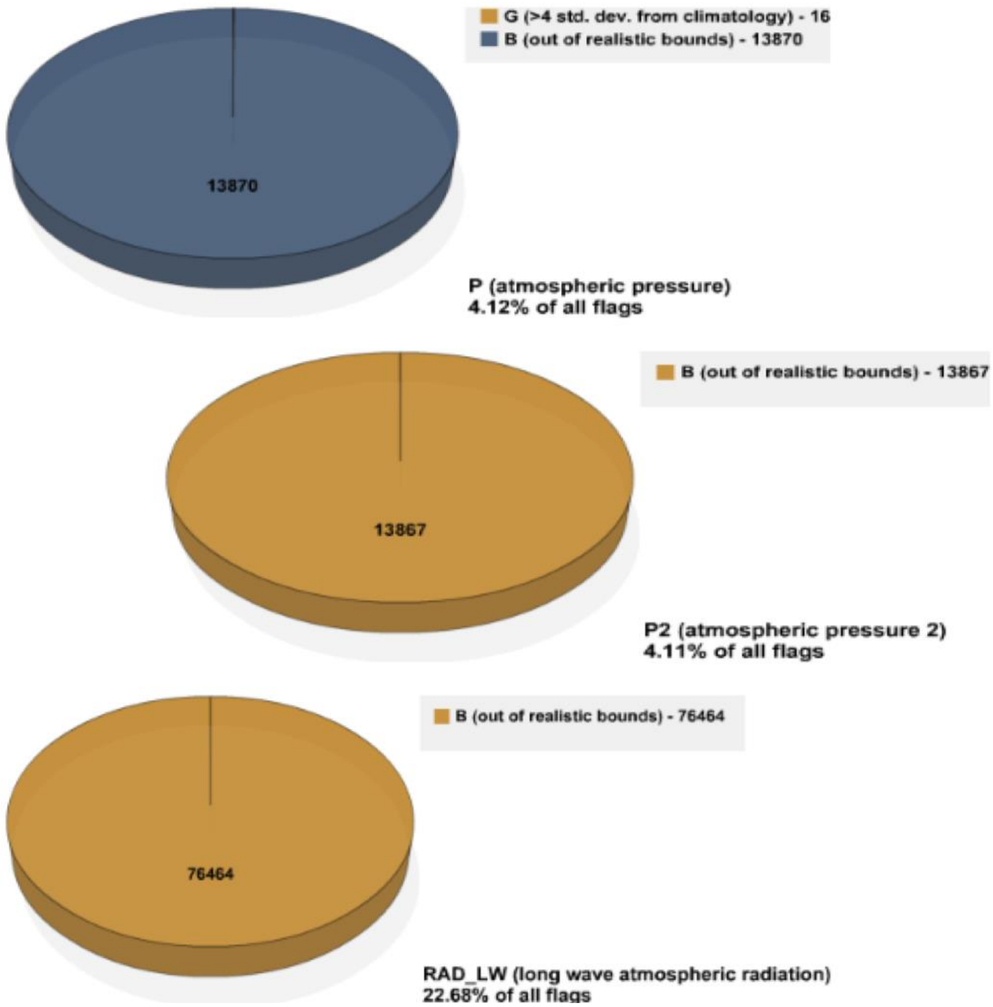


Figure 95: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) atmospheric pressure 2 – P2 – and (bottom) long wave atmospheric radiation – RAD_LW – for the *Roger Revelle* in 2016.

Falkor

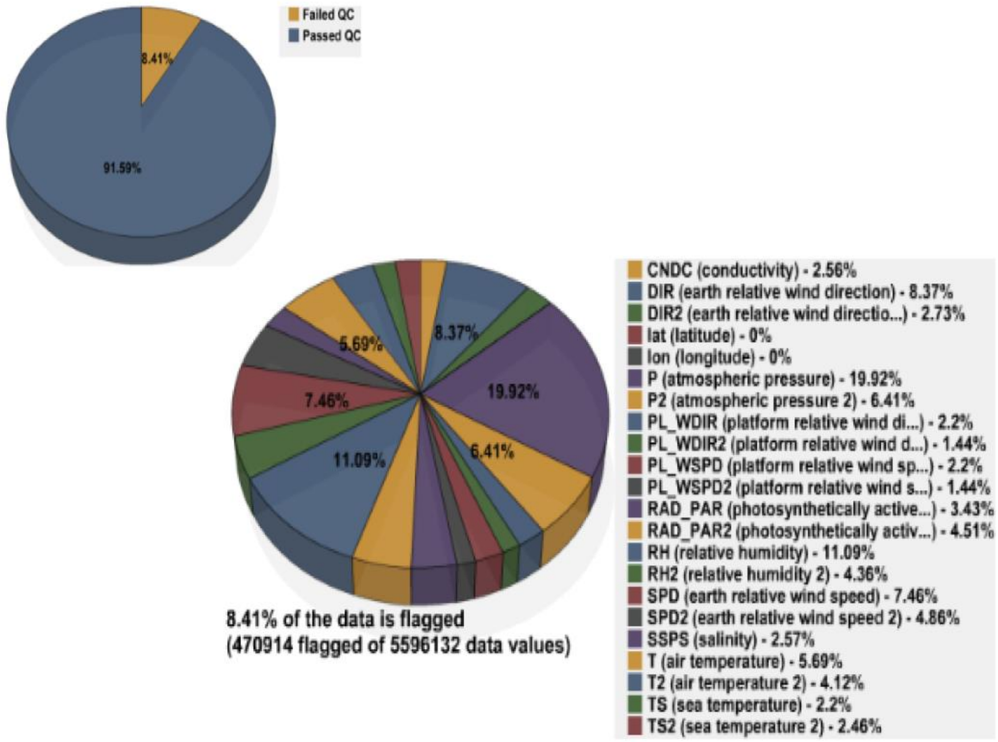


Figure 96: For the *Falkor* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Falkor* provided SAMOS data for 175 ship days, resulting in 5,596,132 distinct data values. After both automated and visual QC, 8.41% of the data were flagged using A-Y flags (Figure 96). This is a bit better than in 2015 (10.76% total flagged) but still outside the < 5% total flagged bracket regarded by SAMOS to represent "very good" data.

Perhaps the biggest issue with *Falkor's* data in 2016 referenced the SAMOS daily file transmission. There were multiple difficulties encountered (e.g. mailer issues, email connectivity, file formats, etc.) at various times that ultimately resulted in several volumes of backlogged data in the second half of the year. And while we stress that timely data transmission needs to be a priority so that data issues can be identified and quickly addressed when they occur, we do recognize the substantial efforts undertaken by the vessel technicians to solve these transmission problems, and we thank them for their perseverance. At any rate, since the *Falkor* SAMOS contract is always written for a set number of sea days, visual QC was and will always be performed on her data files, regardless of how late they come in.

The atmospheric pressure (P) parameter, which held the highest percentage of flags (Figure 96), continued to present challenges in 2016, as it did in 2015. Part of the problem was always that P was part of the ship's Vaisala weather package, considered a “navigation grade” instrument (as opposed to science) which had never been calibrated. Data were ostensibly of lower quality than those from *Falkor's* primary sensor (a Gill metpak). The larger issue, though, was that most of the time in 2016 (as in late 2015) P read unrealistically low (often as low as ~840 mb) and as a result much of the data were assigned "poor quality" (J) flags (Figure 100). It has never been definitively determined what was causing these very low readings, but the good news is that in October 2016 the Vaisala was finally replaced by a second Gill metpak. After that change was made the quality of P improved drastically on the *Falkor*.

Air temperature (T) and relative humidity (RH) likewise continued to suffer from issues initiated in late 2015 up until the time that the Vaisala was replaced. This mainly involved a voluminous multitude of "spikes" in the T and RH data (as well as in P), which again has never been definitely accounted for. RH in particular, though, also intermittently exhibited some of sort periodic interference (Figure 97), which resulted in a good deal of "caution/suspect" (K) flagging (Figure 100). Once again these particular issues with T and RH were relieved upon replacing the Vaisala instrument with the new Gill metpak.

Moving on to the (primary) Gill metpak data – namely, air temperature 2 (T2), relative humidity 2 (RH2), atmospheric pressure 2 (P2), earth relative wind direction 2 (DIR2), and earth relative wind speed 2 (SPD2) – the main issue there seems to be that, given its location on the foremast, in rough sea and/or bad weather the instrument is often basically underwater, easily getting washed with seawater. This causes a lot of noisy variability particularly in P2, T2, and RH2 (example Figure 98), and to some degree in the winds as well. All of the noisy data is caution/suspect (K) flagged during visual QC (not shown). We note that when conditions are especially bad, *Falkor* technicians occasionally suspends the foremast Gill metpak SAMOS data for a time.

A further data issue involved the starboard photosynthetically active atmospheric radiation parameter (RAD_PAR2). In late January the SAMOS data analyst in charge of visual quality control noted that RAD_PAR2 seemed to be going bad, reporting maximum values of about 100 microEinstein/sec^{2}m and displaying very uncharacteristic behavior (example Figure 99). The vessel was contacted via email on 25 January. A reply came back immediately stating that vessel technicians were aware of the issue and had tried a sensor restart, which didn't help, and they further hoped to be able to physically get up on the mast to check soon. Within a few days RAD_PAR2 appeared fixed, but by 3 February the data looked bad again. After 5 February, owing to an extensive failure of one of her generators, there was no *Falkor* data again until 5March, at which time RAD_PAR2 was back in line with the port sensor (RAD_PAR). Until this time RAD_PAR2 amassed both J and "malfunction" (M) flags (Figure 100).

In a final note, at the end of September most of the *Falkor's* parameter designators were swapped and/or mixed up in the daily files, such that the period 24-30 September is marked by erroneous meteorological, radiative, and sea water data, all of which were J flagged for the entire period (not shown).

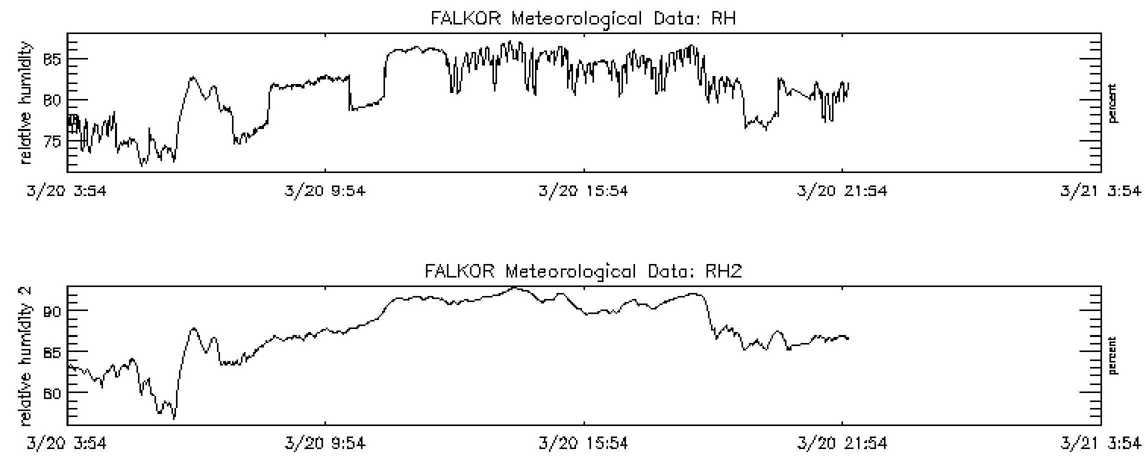


Figure 97: *Falkor* SAMOS (top) relative humidity – RH – and (bottom) relative humidity 2 – RH2 – data for 20 March 2016. Note unexplained periodic interference in RH not seen in RH2.

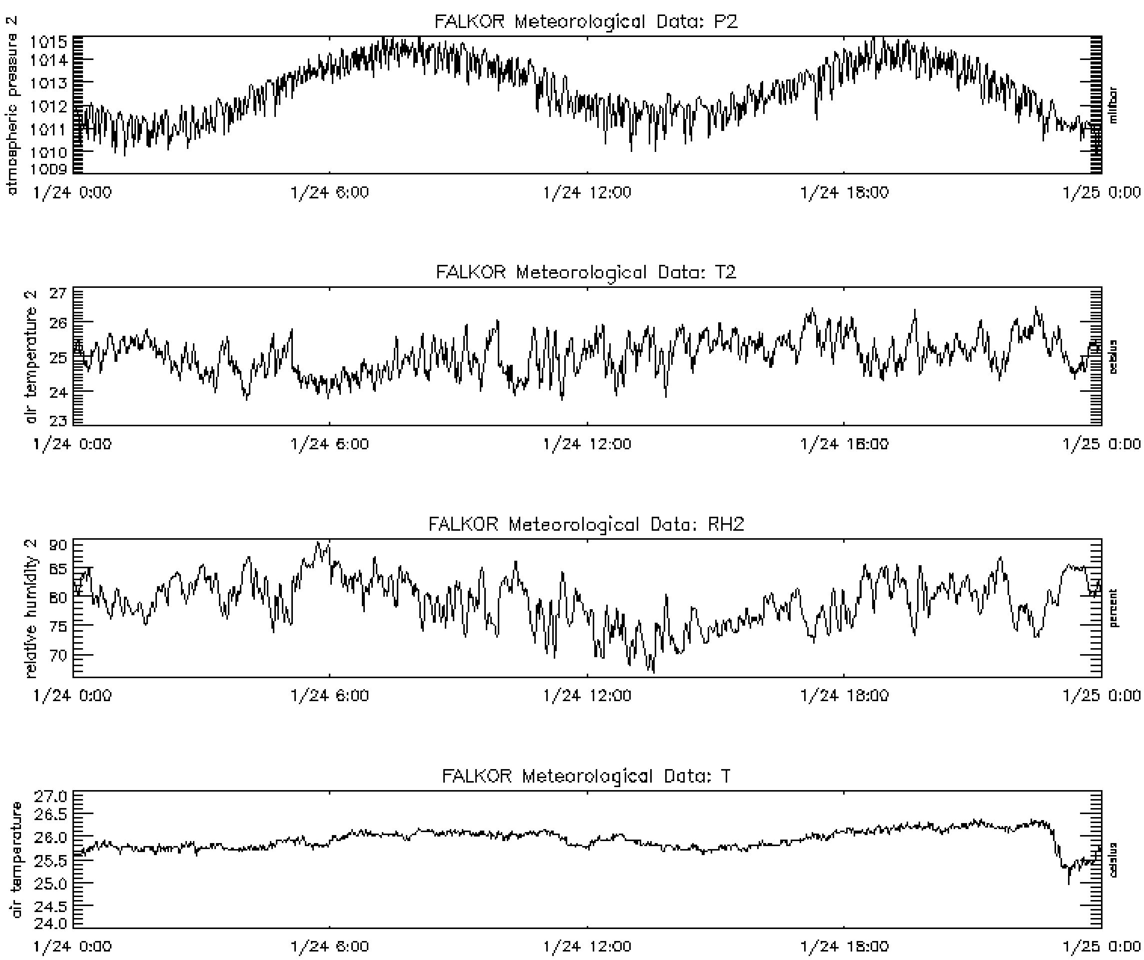


Figure 98: *Falkor* SAMOS (first) atmospheric pressure 2 – P2 – (second) air temperature 2 – T2 – (third) relative humidity 2 – RH2 – and (last) air temperature – T – data for 24 January 2016. Note noisy variability in P2/T2/RH2 as a result of sensor being continually splashed with sea water.

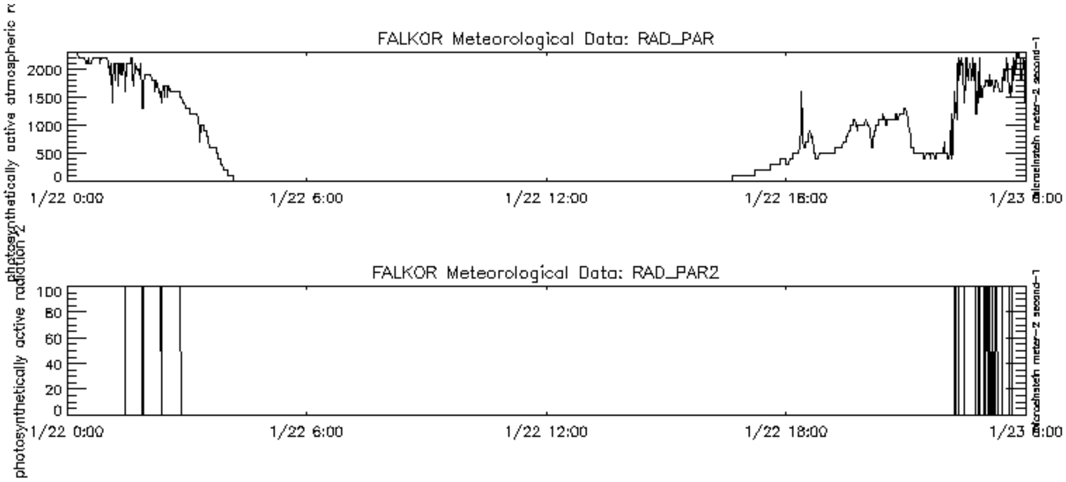


Figure 99: *Falkor* SAMOS (top) photosynthetically active atmospheric radiation – RAD_PAR – and (bottom) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – data for 22 January 2016.

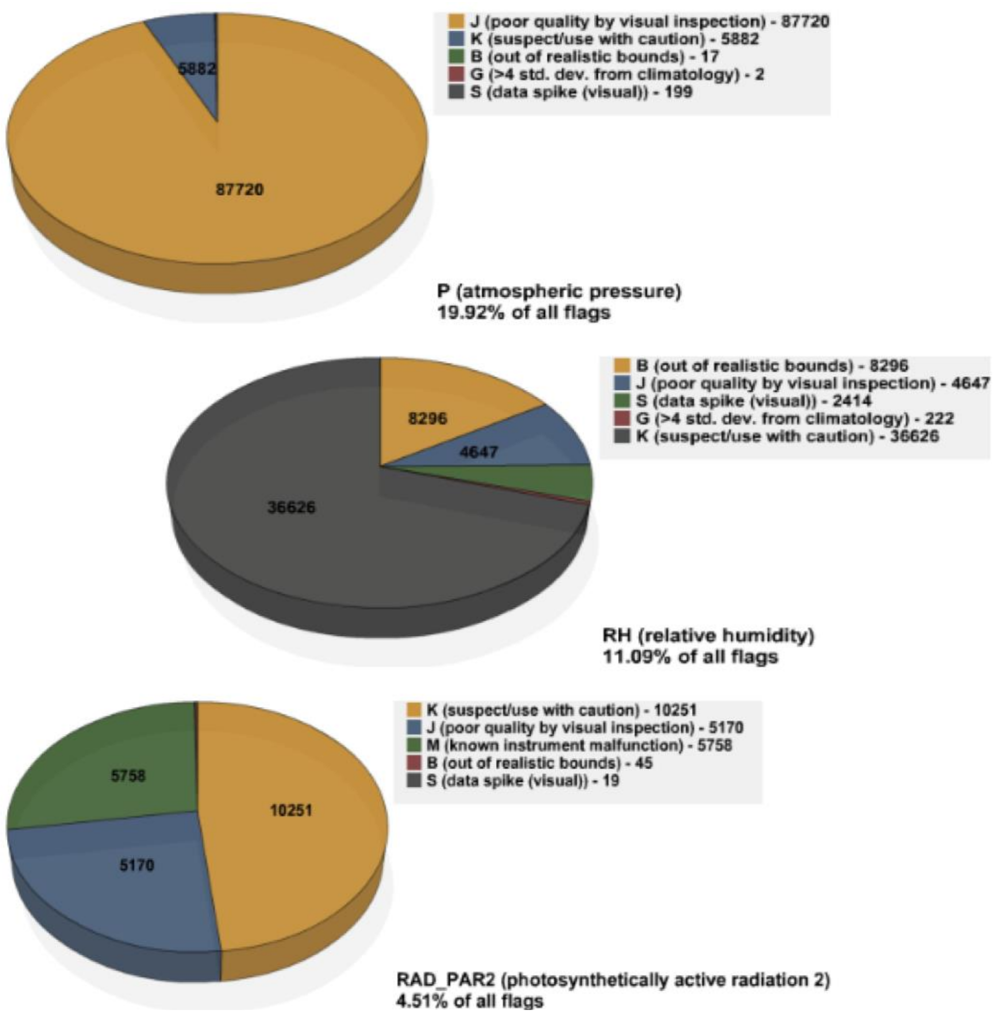


Figure 100: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) relative humidity – RH – and (bottom) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – for the *Falkor* in 2016.

Sikuliaq

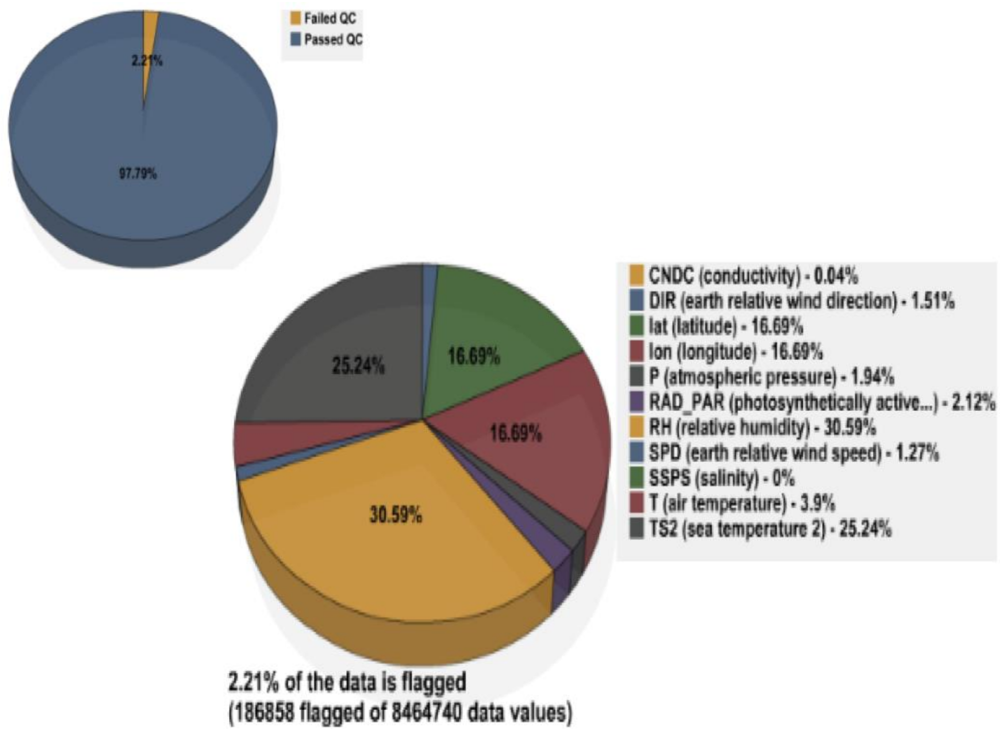


Figure 101: For the *Sikuliaq* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Sikuliaq* provided SAMOS data for 324 ship days, resulting in 8,464,740 distinct data values. After automated QC, 2.21% of the data were flagged using A-Y flags (Figure 101). This is about two percentage points lower than in 2015 (4.56% total flagged) and is a notably low percentage; however, *Sikuliaq* does not receive visual quality control by the SAMOS DAC, which is when the bulk of quality flags are usually applied, so the low percentage may be misleading. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Sikuliaq*).

Over 30% of all flags were assigned to the relative humidity (RH) parameter (Figure 101). A quick inspection reveals that, firstly, *Sikuliaq* occasionally encountered some verifiably lower than usual RH which resulted in "greater than four standard deviations from climatology" (G) flags (Figure 102), and, secondly, RH frequently reads a little over 100% (~110%). When these same high readings occurred last year, a *Sikuliaq* technician had noted that in heavy seas seawater may perhaps be getting in the sensor. Whatever the cause, any of the RH data that was over 100% was automatically "out of bounds" (B) flagged (Figure 102).

Another quarter of all flags were applied to the sea temperature 2 (TS2) parameter (Figure 101), which is the *Sikuliaq's* infrared (IR) skin temperature (skint) sensor. We note this is the first IR skint we've seen at SAMOS. While there doesn't seem to be an issue with the sensor itself, the problem seems to be that when the vessel is in port with the dock on her starboard side the IR thermometer is often pointing directly at concrete, rather than the water. When this happens TS2 is essentially recording the temperature of the dock rather than sea temperature. In addition, when the vessel is operating in the sea ice pack, this type of sensor will measure the temperature of the ice surface (not the ocean) which will generally be colder than the water. These occurrences resulted in a fair amount of TS2 data that were out of bounds or at least unusual for an actual sea temperature, meaning the parameter was automatically assigned a fair portion of B flags and G flags (Figure 102). We know of no automation that can account for the temperature variations in the ice pack, but we recommend users note the vessel's location and ignore TS2 data when the vessel is in port.

The final noteworthy flag percentages belong to latitude (lat) and longitude (lon), about 17% each (Figure 101). Upon inspection these are exclusively "land error" (L) flags (Figure 102) that look to have been applied mainly while the vessel was in port. This is a common occurrence, owing to the two-minute land-water mask used in SAMOS data processing. We note that in these cases the L flags would normally be removed by during visual quality inspection; however, the *Sikuliaq* is not currently funded for visual QC.

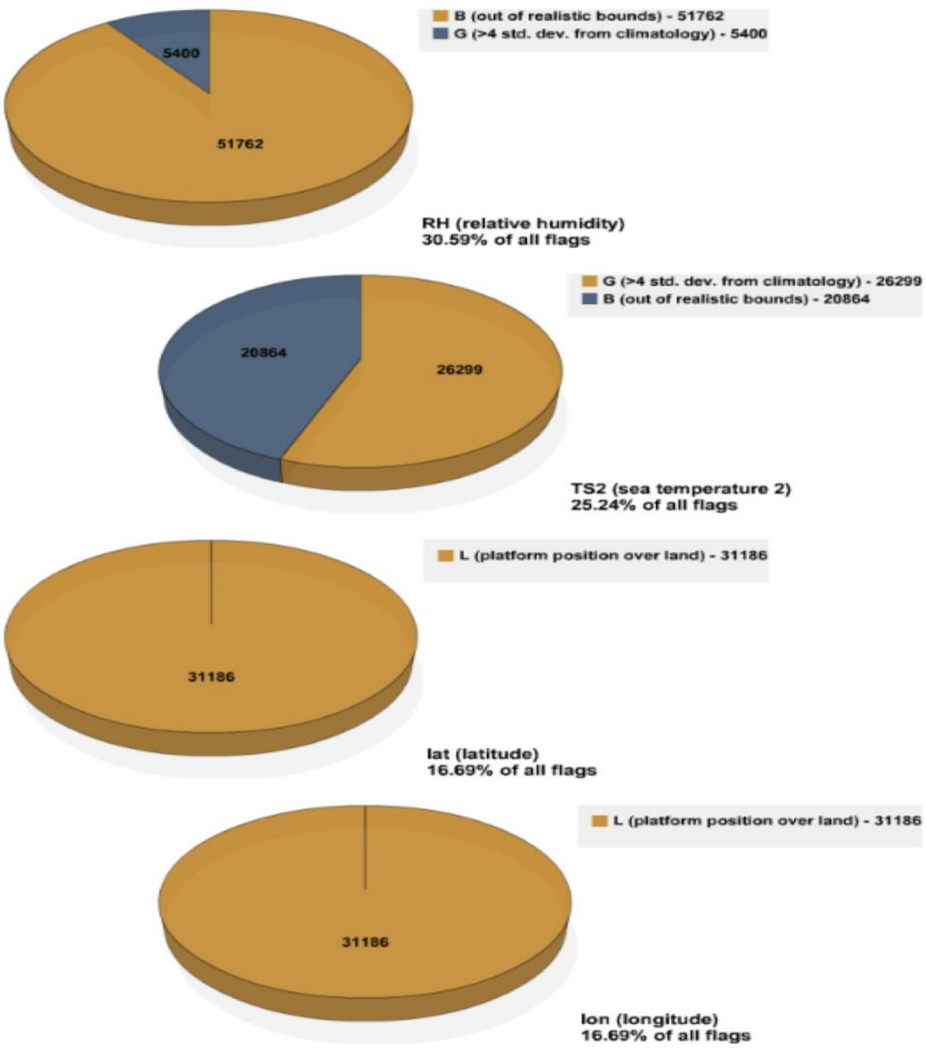


Figure 102: Distribution of SAMOS quality control flags for (first) relative humidity – RH – (second) sea temperature 2 – TS2 – (third) latitude – lat – and (last) longitude – lon – for the *Sikuliaq* in 2016.

Kilo Moana

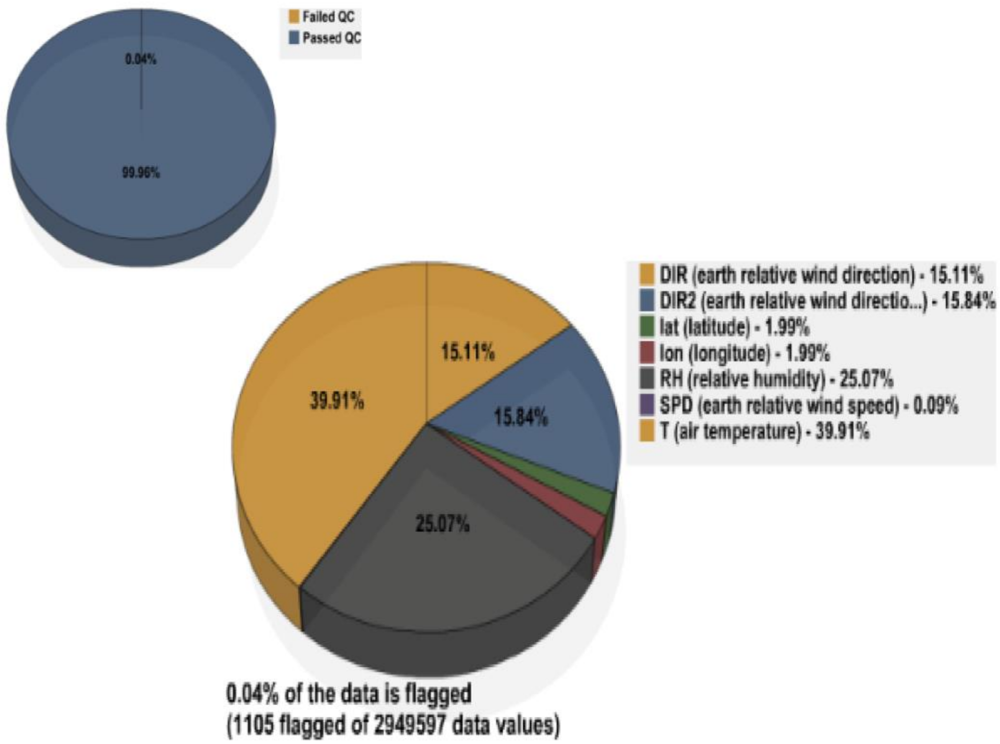


Figure 103: For the *Kilo Moana* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Kilo Moana* provided SAMOS data for 102 ship days, resulting in 2,949,597 distinct data values. After automated QC, 0.04% of the data were flagged using A-Y flags (Figure 103). This is both an extremely low flag percentage and essentially unchanged from previous years. However, due to funding constraints, the *Kilo Moana* does not receive visual QC, which is when the bulk of quality control flags are usually applied. Hopefully resources can be secured in the future for visual QC, as it's entirely within the realm of possibility that *Kilo Moana* would actually represent one of the best research quality data sets at SAMOS, if it were to reach that level.

With such an extraordinarily low flagged percentage it doesn't make much sense to attempt any individual parameter quality analysis based on the flags applied. Additionally, there are no issues of note on record for the *Kilo Moana*. All we can do this year is thank her for her service!

Healy

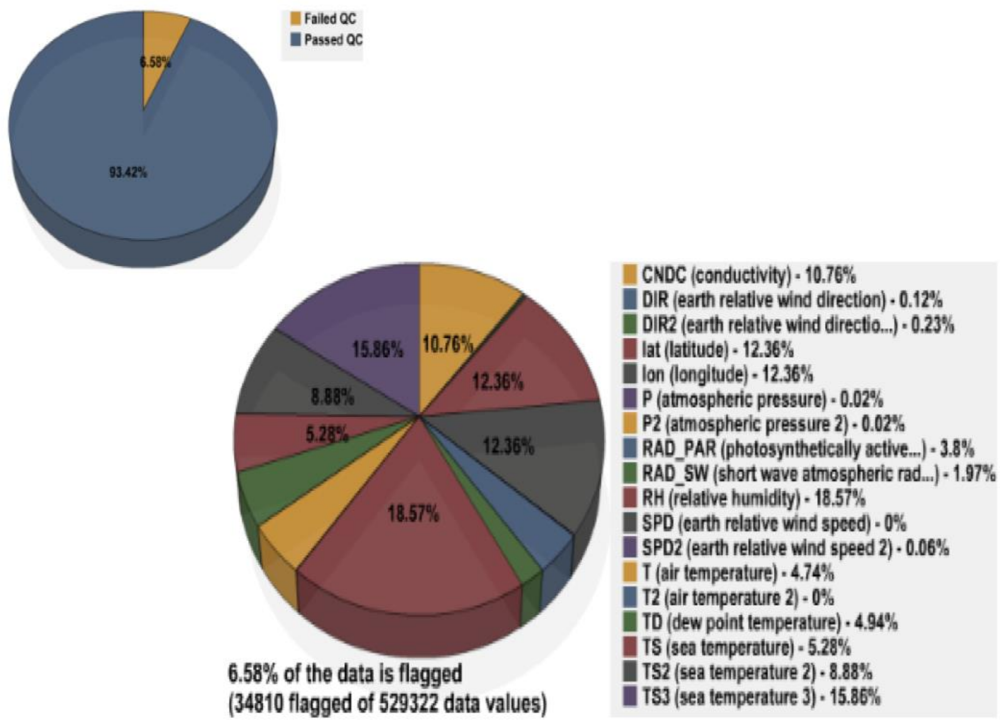


Figure 104: For the *Healy* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Healy* provided SAMOS data for 22 ship days, resulting in 529,322 distinct data values. After automated QC, 6.58% of the data were flagged using A-Y flags (Figure 104). NOTE: the *Healy* did not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Healy* in 2016). It is worth mentioning the *Healy's* 2016 SAMOS transmission performance was much improved over 2015, when only one file was received by us; however, with an overall transmission rate of around 15% (see Table 2) there is still room to grow, and it would additionally be beneficial to recover any data files we missed in 2016, if possible.

There appears to have been an issue with the *Healy's* relative humidity (RH) parameter in June, whereby the sensor was reading abnormally low while the vessel was located around Hawai'i. A quick glance at the data reveals values in the low 10s percent, and sometimes even just under 0%. It's not known what the issue was, but the result was a good deal of "greater than four standard deviations from climatology" (G) and "out of bounds" (B) flags (Figure 105) during the period 14-24 June. We note that had the *Healy* been a vessel that receives visual quality control, it is likely all of the data in this period would have instead been "poor quality" (J) or perhaps even "malfunction" (M) flags, had the issue been identified as such.

Air temperature (T) and dew point temperature (TD) were perhaps also affected by whatever issue was plaguing RH in June, as they each received a portion of "failing the T

≥ Tw ≥ Td test" (D) flags in June (Figure 105). Upon inspection neither of the parameters was reporting values out of range, they were simply very close to equal.

The remainder of the noteworthy flag percentages seen in Figure 104 – namely latitude (lat), longitude (lon), conductivity (CNDC), and the three sea temperatures (TS, TS2, and TS3) by and large do not appear to highlight any problems with the respective data. Rather, in the case of lat and lon, the flags applied were exclusively "land error" (L) flags (not shown) that appear to have been applied while the vessel was in port in Seattle (a common occurrence, owing to the two-minute land-water mask used in SAMOS data processing). As for the sea parameters, the flags are mainly G and B (not shown) flags that were applied as a consequence of either the TSG or the intake being shut off while in port, although there may have been a brief period in June when TS3 was reading unnaturally high, even for these situations (~38 C).

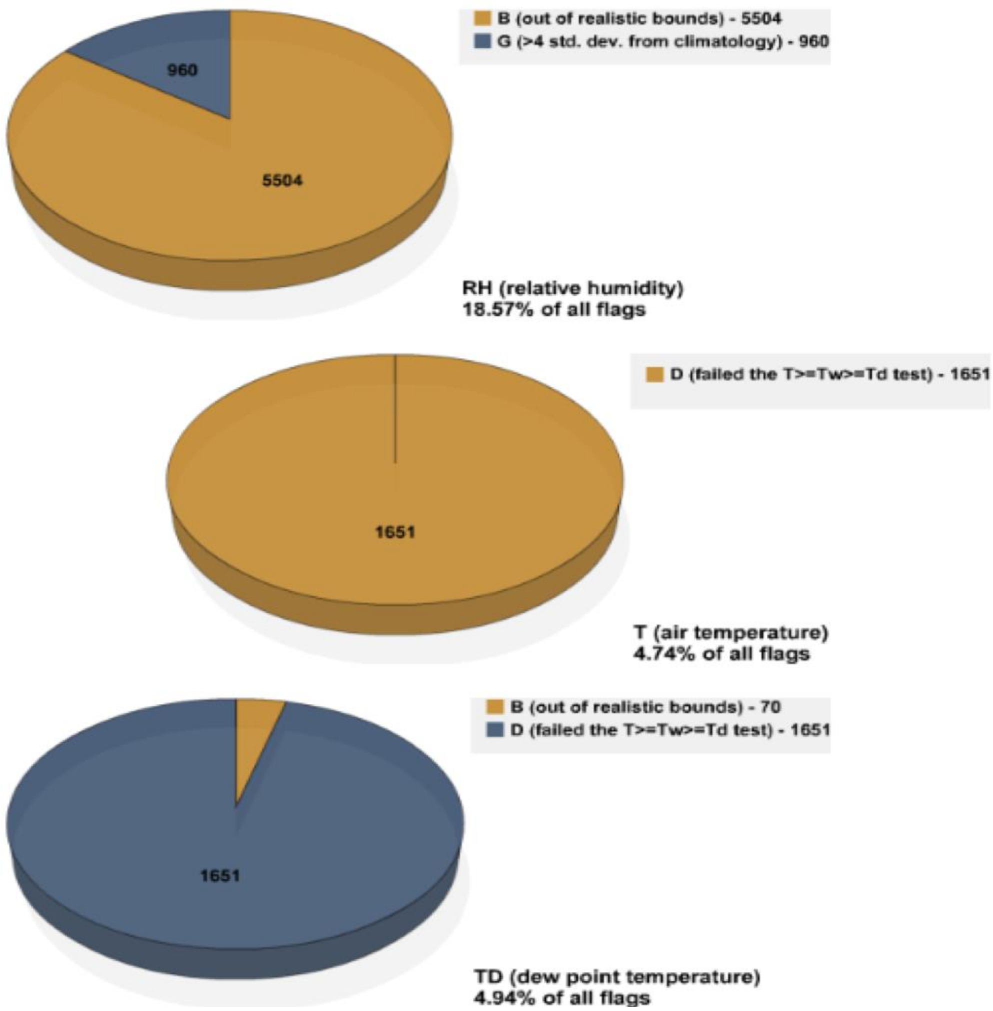


Figure 105: Distribution of SAMOS quality control flags for (top) relative humidity – RH – (middle) air temperature – T – and (bottom) dew point temperature – TD – for the *Healy* in 2016.

Thomas G Thompson

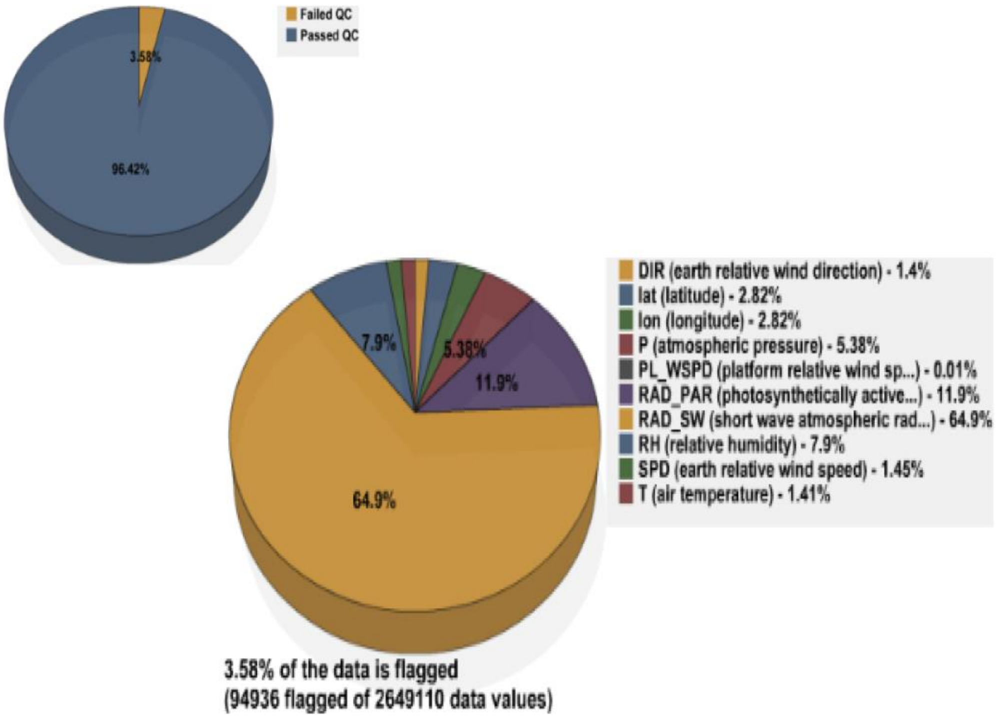


Figure 106: For the *Thomas G Thompson* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *T.G. Thompson* provided SAMOS data for 102 ship days, resulting in 2,649,110 distinct data values. After automated QC, 3.58% of the data were flagged using A-Y flags (Figure 106). This is about the same as 2015 (3.03% total flagged). NOTE: the *T.G. Thompson* does not receive visual quality control by the SAMOS DAC where the majority of flags are applied, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Thomas G Thompson*). The authors note that the *T.G. Thompson* entered ship yard for her mid-life refit in mid-2016 and is not expected to return to service until mid-2017.

The overwhelming majority (over 75% combined, Figure 106) of the flags applied to the *Thompson* data were again applied to the short wave atmospheric radiation (RAD_SW) and photosynthetically active radiation (RAD_PAR) parameters, as they have been in previous years. Upon inspection, it appears in both of these cases the flags applied were entirely "out of bounds" (B) flags (Figure 108) assigned to the slightly negative values such as commonly occur at night, owing to sensor tuning (see 3b for details).

Aside from these radiation flags, there was one noteworthy issue on record for the *Thompson* in 2016, involving the atmospheric pressure (P)/air temperature (T)/relative humidity (RH) sensor. On 14 January the SAMOS data analyst in charge of the quick visual inspection that occurs when daily files are received noted P, T, and RH data appeared highly erroneous, with "spikes," "steps," and unrealistic values (example Figure

107). The vessel was immediately notified via email, and a reply came back immediately stating that the vessel had recently encountered some nasty weather and the technicians suspected some of the sensors had taken some damage as a result. For the remainder of that cruise, P, T, and RH each took on some B as well as "greater than four standard deviations from climatology" (G) flags (Figure 108). Once data transmission resumed later in the month, however, the issue appears to have been addressed.

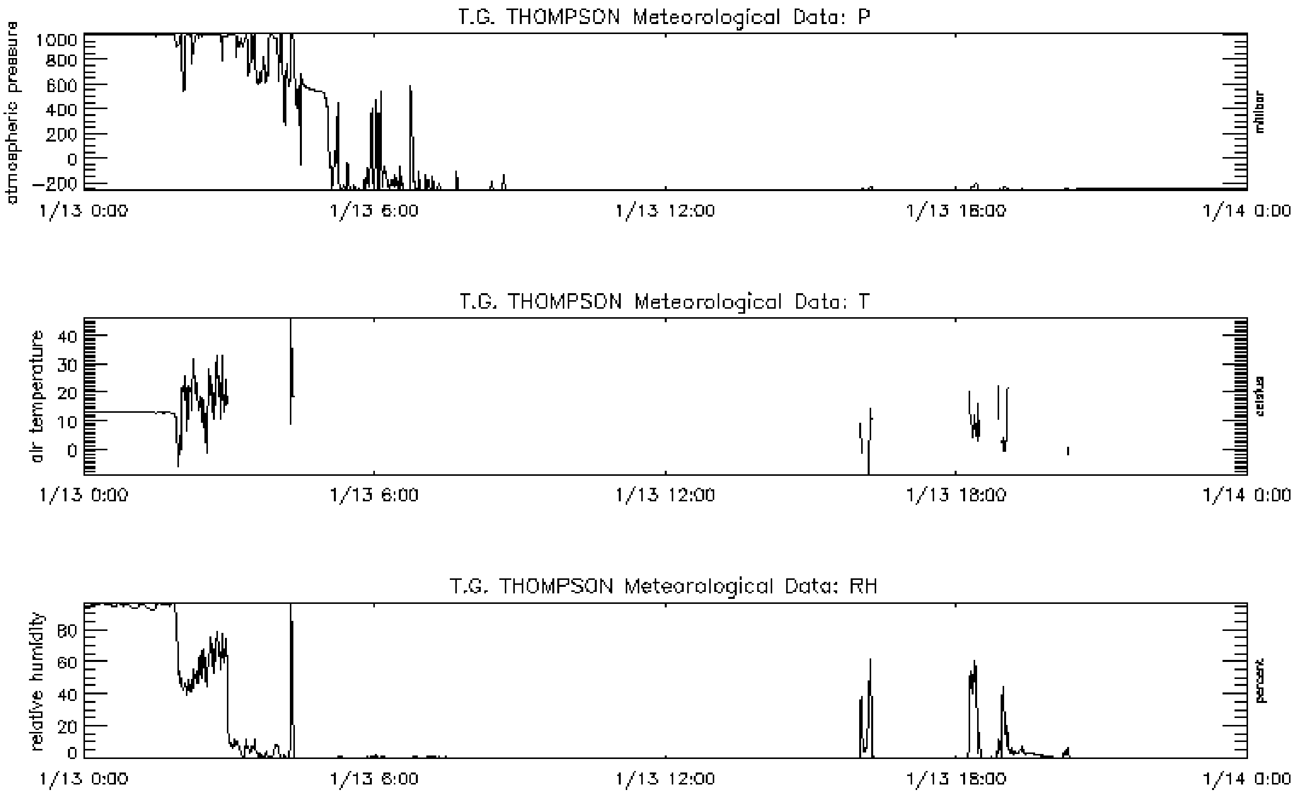


Figure 107: *Thomas G. Thompson* SAMOS (top) atmospheric pressure – P – (middle) air temperature – T – and (bottom) relative humidity – RH – data for 13 January 2016.

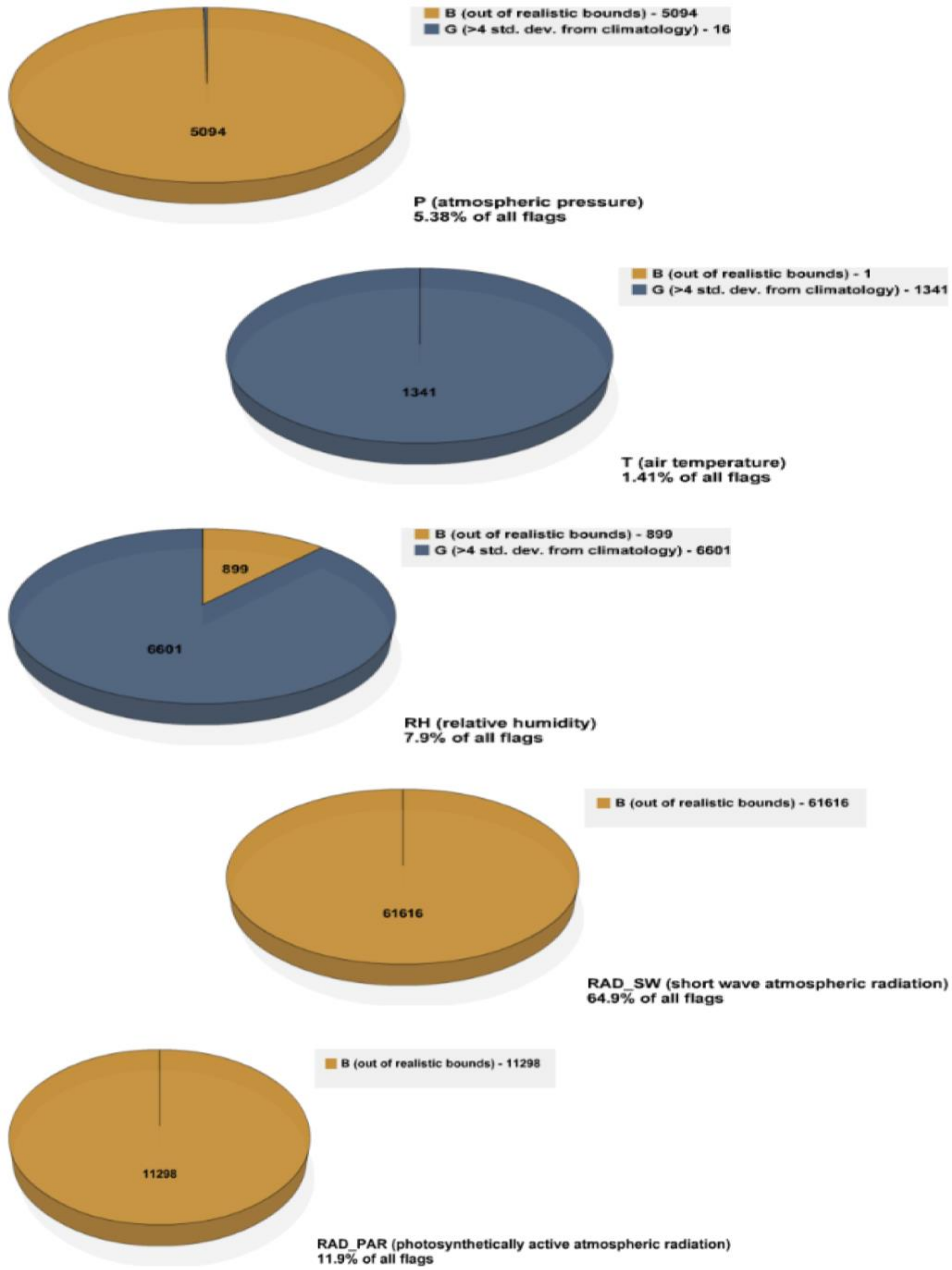


Figure 108: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) short wave atmospheric radiation – RAD_SW – and (last) photosynthetically active radiation – RAD_PAR – for the *Thomas G. Thompson* in 2016.

R/V Atlantis

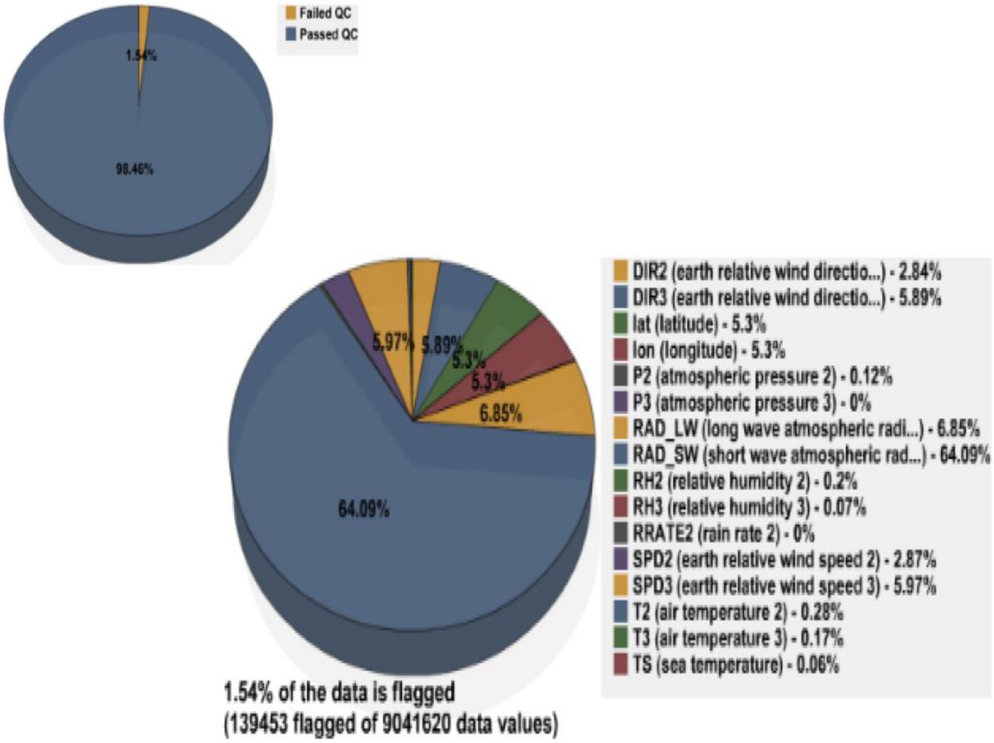


Figure 109: For the *R/V Atlantis* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *R/V Atlantis* provided SAMOS data for 228 ship days, resulting in 9,041,620 distinct data values. After automated QC, 1.54% of the data were flagged using A-Y flags (Figure 109). This is about one percentage point higher than in 2015 (0.66% total flagged). *Atlantis* still exhibits a remarkably low total flagged percentage; however, we note as always that the *R/V Atlantis* no longer receives visual quality control by the SAMOS DAC, which is when the bulk of quality flags are usually applied, so the low flagged percentage may be misleading. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *R/V Atlantis* in 2016).

With such a low total flagged percentage it makes little sense to attempt a full data quality analysis based on the applied flags. Indeed, the parameter that seems to stand out most in the flagged percentages – that of the short wave atmospheric radiation (RAD_SW, Figure 109) – in actuality does not seem to exhibit any issues. A quick inspection of the unanimously "out of bounds" (B) flags applied to RAD_SW (Figure 110) show them to be mainly applied to slightly negative values such as occur at night with these sensors (see 3b for details).

However, there was one issue on record for the Atlantis in 2016, involving long wave atmospheric radiation (RAD_LW). On 27 September the SAMOS data analyst in charge of the quick visual inspection that occurs when daily files are received noticed that RAD_LW values were ranging between -2500 and 250 Wm^{-2}, obviously unrealistic behavior. The vessel was contacted via email and technicians immediately responded, stating that they had also noticed and had concluded the sensor had "gone haywire." They were awaiting a response from tech support to see if the problem would be fixable. It is not known what the ultimate solution turned out to be, but we note that by 4 October RAD_LW resumed normal operation. Regardless, while the issue persisted RAD_LW continued to take on B flags (Figure 110).

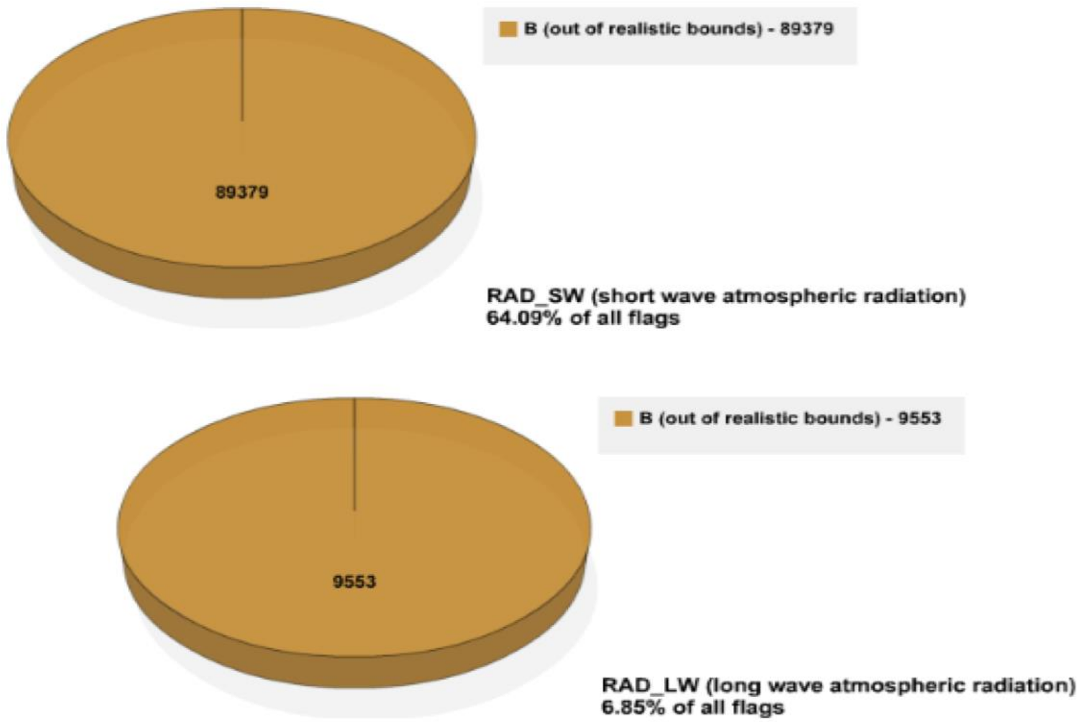


Figure 110: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – and (bottom) long wave atmospheric radiation – RAD_LW – for the *R/V Atlantis* in 2016.

R/V Neil Armstrong

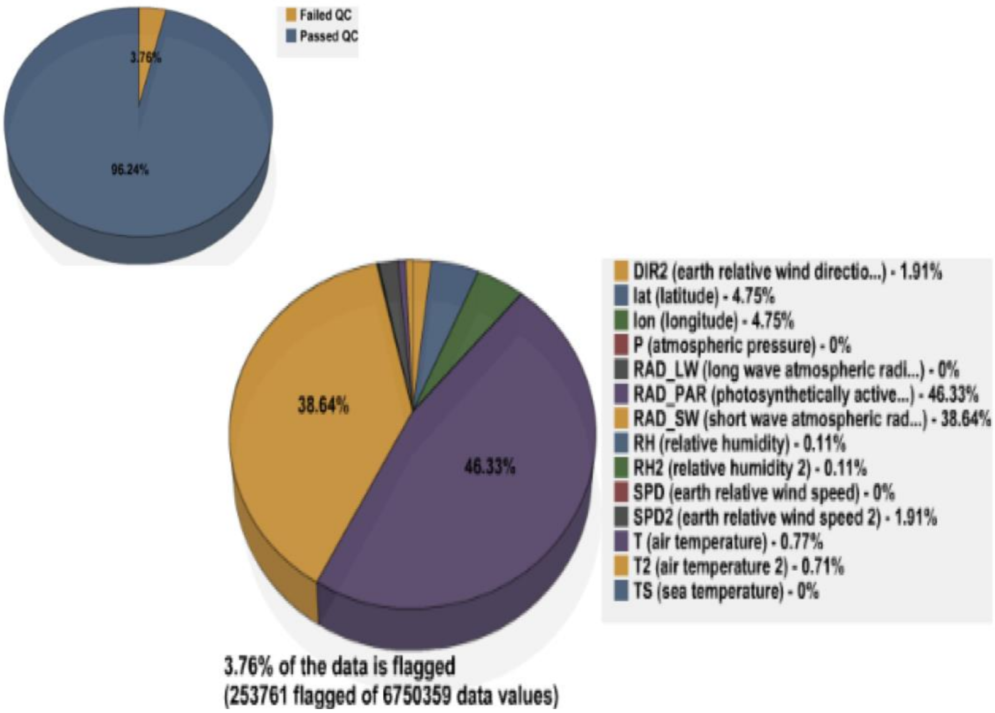


Figure 111: For the *R/V Neil Armstrong* from 1/1/16 through 12/31/16, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *R/V Neil Armstrong* was made operational in the SAMOS database in early April 2016; 25 May marks the first daily SAMOS file. The *R/V Neil Armstrong* provided SAMOS data for 170 ship days, resulting in 6,750,359 distinct data values. After automated QC, 3.76% of the data were flagged using A-Y flags (Figure 111). This is a respectable total flagged percentage; however, we must note that the *R/V Neil Armstrong* does not receive visual quality control by the SAMOS DAC, which is when the bulk of quality flags are usually applied, so the low flagged percentage may be misleading. All of the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *R/V Neil Armstrong*).

The only two parameters which would seem to be problematic for the *Neil Armstrong* are short wave atmospheric radiation (RAD_SW) and photosynthetically active radiation (RAD_PAR), together holding about 85% of the total flags (Figure 111). However, these flags are unanimously "out of bounds" (B) flags (Figure 112), and a quick inspection of the data reveals the flags are mainly applied to slightly negative values such as occur with these types of sensors at night (see 3b for details).

We would like to take this opportunity to thank everyone for their efforts in getting the *Armstrong* recruited and transmitting to the SAMOS initiative this past year. We have always valued our relationship with the Woods Hole folks, and we're delighted to have expanded their SAMOS roster again with this shiny new vessel! Cheers!

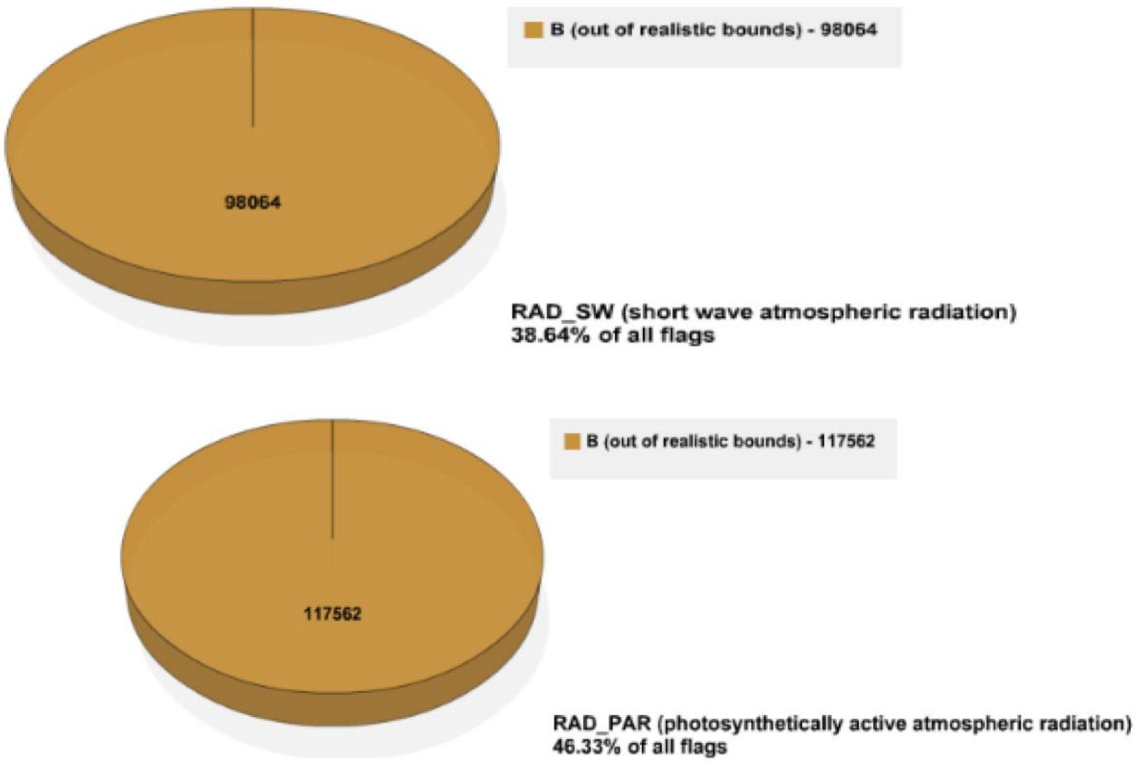


Figure 112: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – and (bottom) photosynthetically active atmospheric radiation – RAD_PAR – for the *R/V Neil Armstrong* in 2016.

4. Metadata summary

Adequate metadata is the backbone of good visual QC. It also improves the utility of any data set. As such, vessel operators are strongly advised to keep vessel and parameter metadata complete and up to date. Annex B, Part Two walks SAMOS operators through editing metadata online, step by step, while Part One offers instructions for monitoring metadata and data performance. For vessel metadata, the following are the minimum required items in consideration for completeness: Vessel information requires vessel name, call sign, IMO number, vessel type, operating country, home port, date of recruitment to the SAMOS initiative, and data reporting interval. Vessel layout requires length, breadth, freeboard, and draught measurements. Vessel contact information requires the name and address of the home institution, a named contact person and either a corresponding email address or phone number, and at least one onboard technician email address. A technician name, while helpful, is not vital. Vessel metadata should also include vessel imagery (highly desirable, see Figure 113 for examples) and a web address for a vessel's home page, if available.

Parameter metadata requirements for completeness vary among the different parameters, but in all cases "completeness" is founded on filling in all available fields in the SAMOS metadata form for that parameter, as demonstrated in Figure 114. (Any questions regarding the various fields should be directed to samos@coaps.fsu.edu. Helpful information may also be found at http://samos.coaps.fsu.edu/html/docs/samos_metadata_tutorial_p2.pdf, which is the metadata instruction document located on the SAMOS web site.) In this example (Figure 114 b.), as is frequently the case, the only missing field is the date of the last instrument calibration. Calibration dates may be overlooked as important metadata, but there are several situations where knowing the last calibration date is helpful. For example, if a bias or trending is suspected in the data, knowing that a sensor was last calibrated several years prior may strongly support that suspicion. Alternatively, if multiple sensors give different readings, the sensor with a more recent last calibration date may be favored over one whose last calibration occurred years ago. (Note that for those sensors not routinely calibrated, such as GPS instruments, an installation date is alternately desired.)

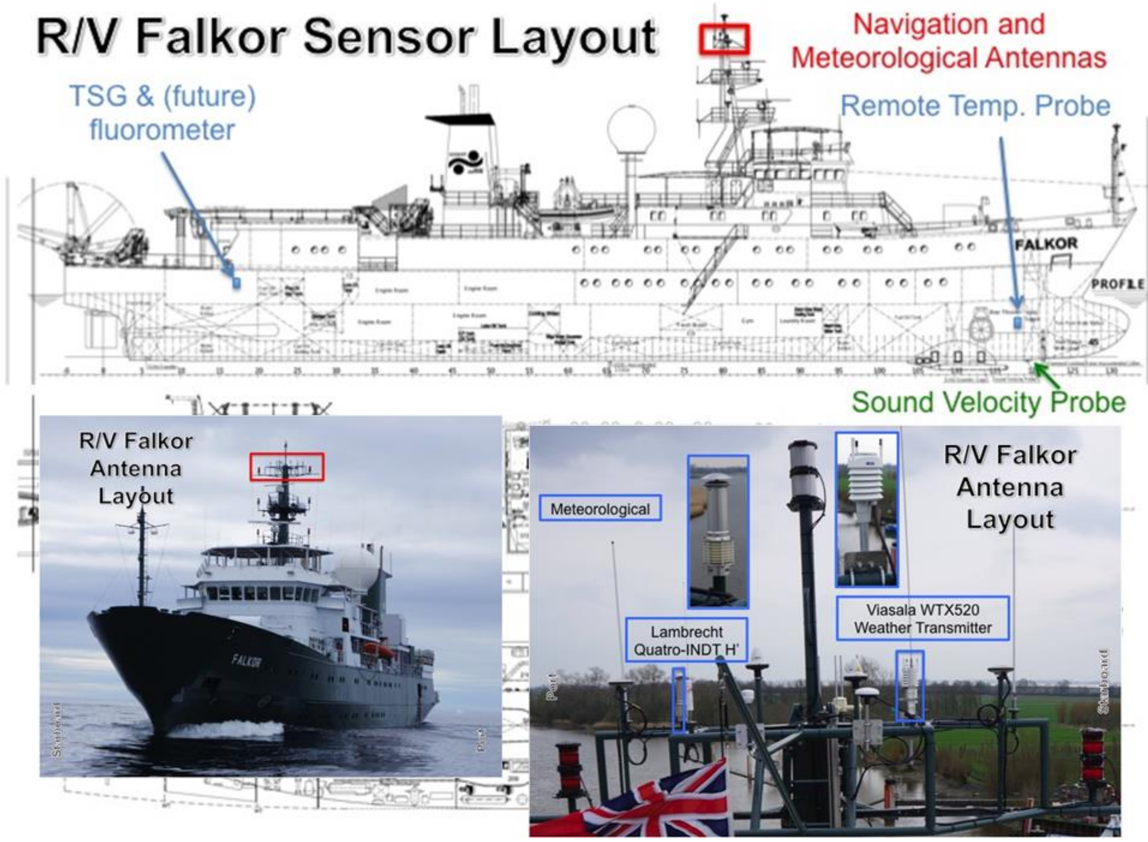


Figure 113: Examples of detailed vessel instrument imagery from the *R/V Falkor*.

a.

sea temperature			
Designator		Date Valid	
SST		06/01/2005 to Today	
Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
sea temperature	celsius	Falmouth Science Inc. OTM-S-212 (OTM1378)	August 2004
TS Sensor Category	Observation Type	Distance from Bow	Distance from Center Line
12	measured	0	0
Height	Average Method	Averaging Time Center	Average Length
-5.4	average	time at end of period	1
Sampling Rate	Data Precision		
4	0.01		

b.

sea temperature			
Designator		Date Valid	
SST		05/09/2005 to Today	
Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
sea temperature	celsius	Sea-bird SBE48 Hull Sensor	
TS Sensor Category	Observation Type	Distance from Bow	Distance from Center Line
hull contact sensor	measured	0	0
Height	Average Method	Averaging Time Center	Average Length
-5	average	time at end of period	1
Sampling Rate	Data Precision		
4	0.01		

Figure 114: Example showing parameter metadata completeness (a.) vs. incompleteness (b.). Note missing information in the "Last Calibration" field in (b.)

Following the above guidelines for completeness, Table 4 summarizes the current state of all SAMOS vessel and parameter metadata:

	Vessel Info	Contact Info	Vessel Layout	Digital Imagery	LAT	LON	HD	CRS	PL SPD	PL WSPD	PL WDIR	SPD	DIR	T	Td	Tw	P	RH	PRECIP	R RATE	LW	SW	NET RAD	PAR	TS	CON	SAL
KAOU	C	C	C	No	I	I	I	I	I	I	I	I	I	I	I		I,I	I	I		I	I		I	I,I,I	I,I	I,I
KAQP	C	C	C	Yes	I	I	I	I	I	C,C	I,I	C,C	C,C	C,C			C,C	C,C	C,C	I,C,C	I	I			C	I	I
KTDQ	C	C	C	No	I	I	I	I	I,C	C	C	C	C	C			C	C			C	I		I	I,I	C	C
NEPP	C	C	C	Yes	I	I	I	I	I	C,C	C,C	C,C	C,C	C,C	C		C,I	C			I	I		I	I,I,I	C,I	I,I
NRUO	C	I	I	No	I	I	I	I,I	I,I	I,I	I,I	I,I	I,I	I			I	I							I,I		I
VLMJ	C	C	I	No	I	I	I	I	I	I,I,I	I,I,I	C,C,C	C,C,C	I,I			I	I,I	I		I,I	I,I		I,I	I,I		I
VNAA	C	C	C	No	I	I	I,I	I	I	I,I	I,I	I,I	I,I	I,I			I	I,I	I,I	I	I,I	I,I		I,I	I		
WARL	C	C	I	No	I	I	I	I	I,C	I,I	I,I	I,I	I,I	I,I			I,I	I,I	C,C	C,C	I	I		I	I	I	I
WBP3210	C	C	C	Yes	I	I	I	I	I	I,I	I,I	I,I	I,I	I			I	I			I	I		I	I	I	I
WCX7445	C	C	C	Yes	I	I	I	I	I	C,C	I,I	C,C	C,C	C			C	C			I	I		I	I	I	I
WDA7827	C	C	C	No	I	I	I,I	I	I	I,I	I,I	I,I	I,I	I			I	I	I,I	I	I				I		I
WDC9417	C	C	C	Yes	I	I	I,I	I	I	I,I	I,I	I,I	I,I	I,I			I,I	I,I	I,I						I,I	I	I
WDD6114	C	C	I	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WDG7520	C	C	C	No	I	I	I	I	I,I,I	C	I	I	I	C			C	C			I	I		I	C	C	I
WSQ2674	C	C	I	No	I	I	I	I	I	I	I	I	I	I,I			I,I	I	I					I	I		
WTDF	C	C	C	No	I	I	I	I	I,I,I	I	I	I	I	I			I	I			I	I			I	I	I
WTDH	C	I	C	Yes	I	I	I	I	I	I	I	I	I	I			C	I							I,I	I	I
WTDL	C	I	C	Yes	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTDO	C	I	C	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEA	C	C	C	No	I	I	I	I	I	I	I	I	I	I	I	I	I	I							I		
WTEB	I	I	C	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEC	C	I	C	No	I	I	I	I	I	C	I	C	C	C			C	C				I			I	C	I
WTED	C	C	C	Yes	I	I	I	I	I	I,I	I,I	I,I	I,I	I			I	I			I	I			I	I	I
WTEE	C	C	C	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEF	I	I	C	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEG	I	I	I	No	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEK	I	I	C	No	I	I	I	I	I	I	I	I	I	I			I	I									
WTEO	C	I	C	Yes	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTEP	C	I	C	Yes	I	I	I	I	I	I	I	I	I	I			I	I							I	I	I
WTER	C	I	I	Yes	I	I	I	I	I	I	I	I	I	I			I	I							I,I	I	I
WTEY	C	I	C	Yes	I	I	I,I,I	I	I	I	I	I	I	I			I	I							I,I	I	I
ZCYL5	C	C	C	Yes	C	C	C	C	C,C,C	I,C	I,C	C,C	C,C	C,I			C,I	C,I						C,C	C,C	C	C
ZMFR	I	I	C	No	I	I	I	I	I			C	C	C			C	C	I		I,I	I,I			I		

Table 4: Vessel and parameter metadata overview. "C" indicates complete metadata; "I" indicates incomplete metadata. Under "Digital Imagery," "Yes" indicates the existence of vessel/instrument imagery in the SAMOS database, "No" indicates non-existence. Empty boxes indicate non-existence of a parameter; multiple entries in any box indicate multiple sensors for that parameter and vessel.

5. Plans for 2017

As the SAMOS initiative continues its second decade following the workshop where the concept was born (http://coaps.fsu.edu/RVSMDC/marine_workshop/Workshop.html), the SAMOS chairman would like to personally thank all of the technicians, operators, captains, and crew of the SAMOS research vessels for their dedication to the project. The data center team would also like to thank personnel within our funding agencies, NOAA OMAO, NOAA NCEI, NOAA ESRL, Australian IMOS project, and the Schmidt Ocean Institute for their continued support of the SAMOS initiative.

The SAMOS DAC also recognizes an ongoing partnership with the Rolling deck To Repository (R2R; http://www.rvdata.us/overview) project. Funded by the National Science Foundation, R2R is developing a protocol for transferring all underway data (navigation, meteorology, oceanographic, seismic, bathymetry, etc.) collected on U. S. University-National Oceanographic Laboratory System (UNOLS) research vessels to a central onshore repository. During 2015, the university-operated vessels contributing to the SAMOS DAC were those operated by LUMCON, WHOI, SIO, UA, UH, UW, and BIOS. The focus of the R2R is collecting and archiving the full-sampling-level (e.g., sampling rates up to 1 Hz) underway data at the end of each planned cruise, which are the source data for the 1-min averages submitted to SAMOS in daily emails. In 2017 we plan to recruit additional university-operated vessels into SAMOS including the newly launched *Sally Ride* from SIO.

In 2017, the DAC will be implementing three new automated quality control processes. The first will implement a 1-minute land mask for the land check (L-flag) routine. The second will test the difference in values from redundant sensors, beginning with sea temperature on vessels with multiple sea temperature sensors. Finally, we will be implementing a procedure to support auto-flagging of data for a given ship, parameter, and date range where the DAC has been notified of an existing malfunction or problem with a sensor (typically by the operator, but sometimes detected by the DAC analyst and confirmed with the operator). These tests will provide a new level of automated flagging and should reduce the workload of the visual quality analyst. Beyond May 2017, new development of the SAMOS QC system will be suspended until additional resources can be secured. Although improved automation is helpful, the chairman does wish to note that failure to conduct full visual quality control does degrade the quality of the data being provided to our users. Automated QC will never be able to replace a set of experienced "eyes on the data".

Also planned for 2017 is the creation of an hourly subset of all available SAMOS data for the period 2015-2016 for inclusion in the International Comprehensive Ocean-Atmosphere DataSet (ICOADS; Freeman et al. 2016). ICOADS offers surface marine data dating back to the 17th Century, with simple gridded monthly summary products for 2° latitude x 2° longitude boxes back to 1800 (and 1°x1° boxes since 1960)—these data and products are freely distributed worldwide. Inclusion of your data in ICOADS will expand the reach of the SAMOS observations to the wider marine climate and research communities. The procedure (Smith and Elya 2015) was developed to submit SAMOS data for 2005-2014 to ICOADS in 2016.

6. References

The Australian Integrated Marine Observing System, 2008: *J. Ocean Technology* **3**(3), 80-81.

Pieter R. Wiederhold, cited 2010: True Accuracy of Humidity Measurement. [Available online at http://archives.sensorsmag.com/articles/0997/humidity/index.htm.]

Smith, S. R., and J. Elya: 2015. Procedure for placing hourly super-observations from the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative into ICOADS**.** COAPS, Tallahassee, FL, USA, 34 pp. Available from Center for Ocean-Atmospheric Prediction Studies, Florida State University, Tallahassee, Florida, 32306-2840, USA and online at http://icoads.noaa.gov/e-doc/other/transpec/samos/SAMOS_RVtoIMMAprocedure_v2p1.pdf.

Smith, S. R., J. J. Rolph, K. Briggs, M. A. Bourassa, 2009: Quality-Controlled Underway Oceanographic and Meteorological Data from the Center for Ocean-Atmospheric Predictions Center (COAPS) - Shipboard Automated Meteorological and Oceanographic System (SAMOS). National Oceanographic Data Center, NOAA. Dataset. doi:10.7289/V5QJ7F8R

Freeman, E., S. D. Woodruff, S. J. Worley, S. J. Lubker, E. C. Kent, W. E. Angel, D. I. Berry, P. Brohan, R. Eastman, L. Gates, W. Gloeden, Z. Ji, J. Lawrimore, N. A. Rayner, G. Rosenhagen, and S. R. Smith, 2016: ICOADS Release 3.0: a major update to the historical marine climate record. Int. J. Climatol. doi:10.1002/joc.4775

Ship schedule references, publicly available only:

UNOLS vessels are found online at http://strs.unols.org/public/search/diu_all_schedules.aspx?ship_id=0&year=2010 (*Atlantic Explorer*, *Atlantis*, *Kilo Moana*, *Knorr*, *Laurence M. Gould*, *Nathaniel B. Palmer*, *Neil Armstrong*, *Pelican*, *Robert Gordon Sproul*, *Roger Revelle*, *Sikuliaq*, and *Thomas G. Thompson*)

R2R vessels are found online at http://www.rvdata.us/catalog (All of the above, and *Falkor*, *Healy*)

Aurora Australis and *Tangaroa* are found online at https://its-app3.aad.gov.au/public/schedules/index.cfm

Investigator is found online at http://mnf.csiro.au/Voyages/Investigator-schedules.aspx

Annex A: Data Subsets with Verified Issues, Unflagged (listed by vessel)

All of the following data subsets should be considered either suspect or unreliable, as noted. The vessels listed here do not receive visual quality control. As such, this compilation relies only on notifications sent to the DAC by vessel operators or email exchanges initiated by the DAC; in many cases the exact cause and/or the exact date range under impact are unknown.

Atlantic Explorer:

- early May – 20 May: DIR2/SPD2/PL_WDIR2 suspect (unconfirmed 180°-rotated installation)
- mid-August – 14 October: PL_WDIR/PL_WSPD/DIR/SPD unreliable (PL_WDIR/PL_WSPD constant valued)

Atlantis:

- ~mid-day 3 October - 2300 UTC 8 October: met tower down for maintenance, meteorological data unreliable

Investigator: no notes.

Kilo Moana: no notes.

Laurence M. Gould:

- all of 2016: RAD_NET/RAD_NET2 are actually down welling short wave and down welling long wave, respectively; additionally, data have erroneously gone through a microwatts/cm^2 to W/m^2 conversion, when in fact they were already in W/m^2 (metadata incorrectly identified original units as microwatts/cm^2 rather than W/m^2)
- all of 2016: PL_SPD has erroneously gone through a km/hr to m/s conversion; the conversion to m/s should have been from kts (metadata incorrectly identified original units as km/hr rather than kt)
- initial date unknown – 4 April: P suspect (icing and water discovered in the line)
- 20-26 July: P unreliable (stuck at 982.46 mb)

Nathaniel B. Palmer:

- initial date unknown – 22 January: T suspect (generally a few degrees C low)

Neil Armstrong:

- 25 October - (a few weeks later): met tower down for maintenance, meteorological data unreliable

Pelican: no notes.

Robert Gordon Sproul: no notes.

Roger Revelle: no notes.

Sikuliaq: no notes.

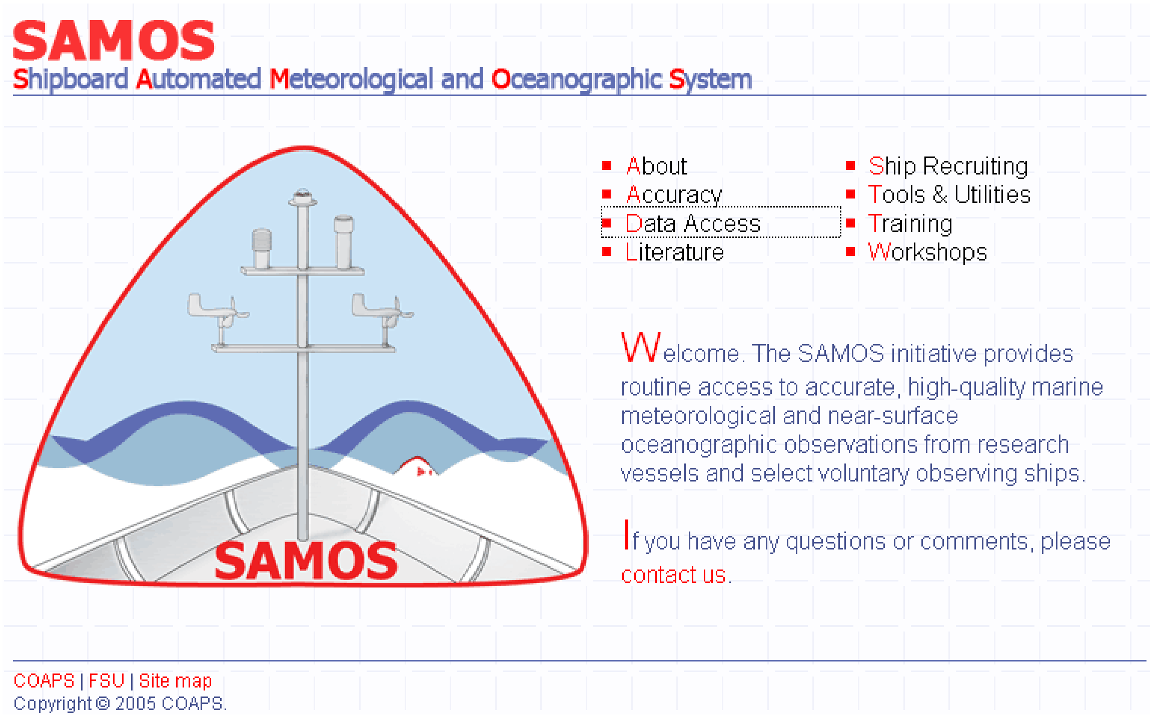
Tangaroa: no notes.

Thomas G. Thompson: no notes.

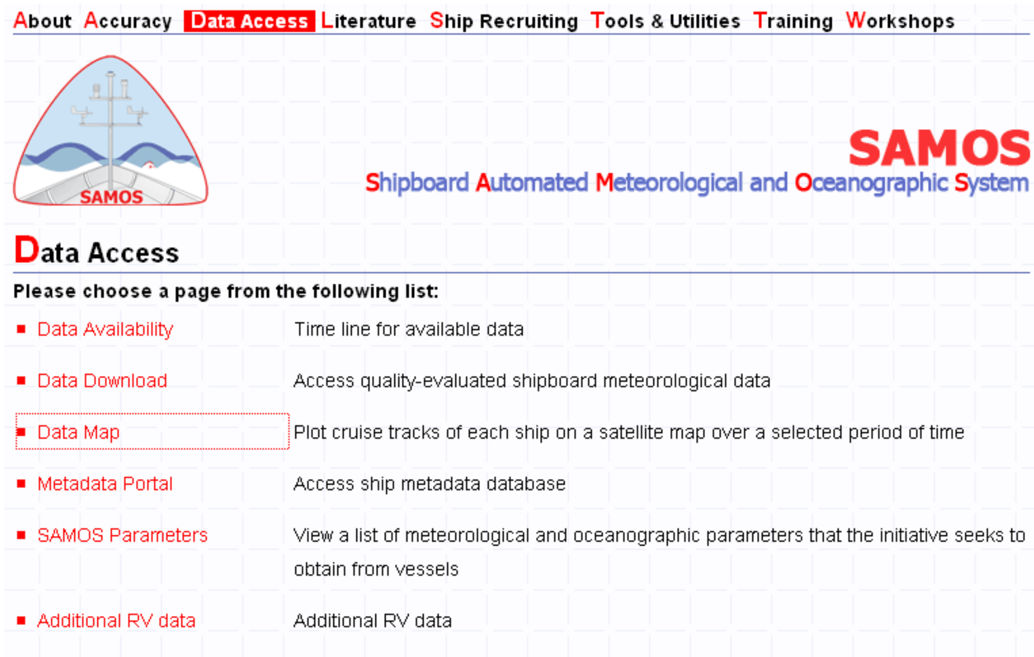
Annex B: SAMOS Online Metadata System Walk-through Tutorial

PART 1: the end user

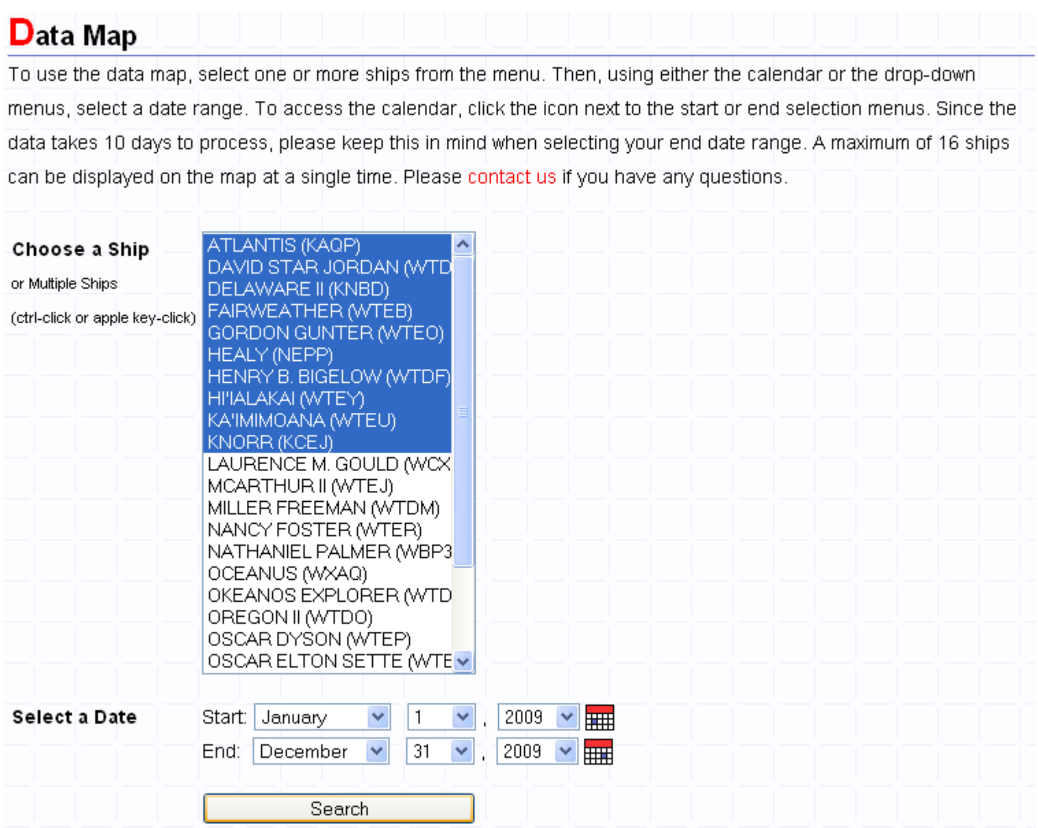
The SAMOS public website can be entered via the main page at
http://samos.coaps.fsu.edu/html/



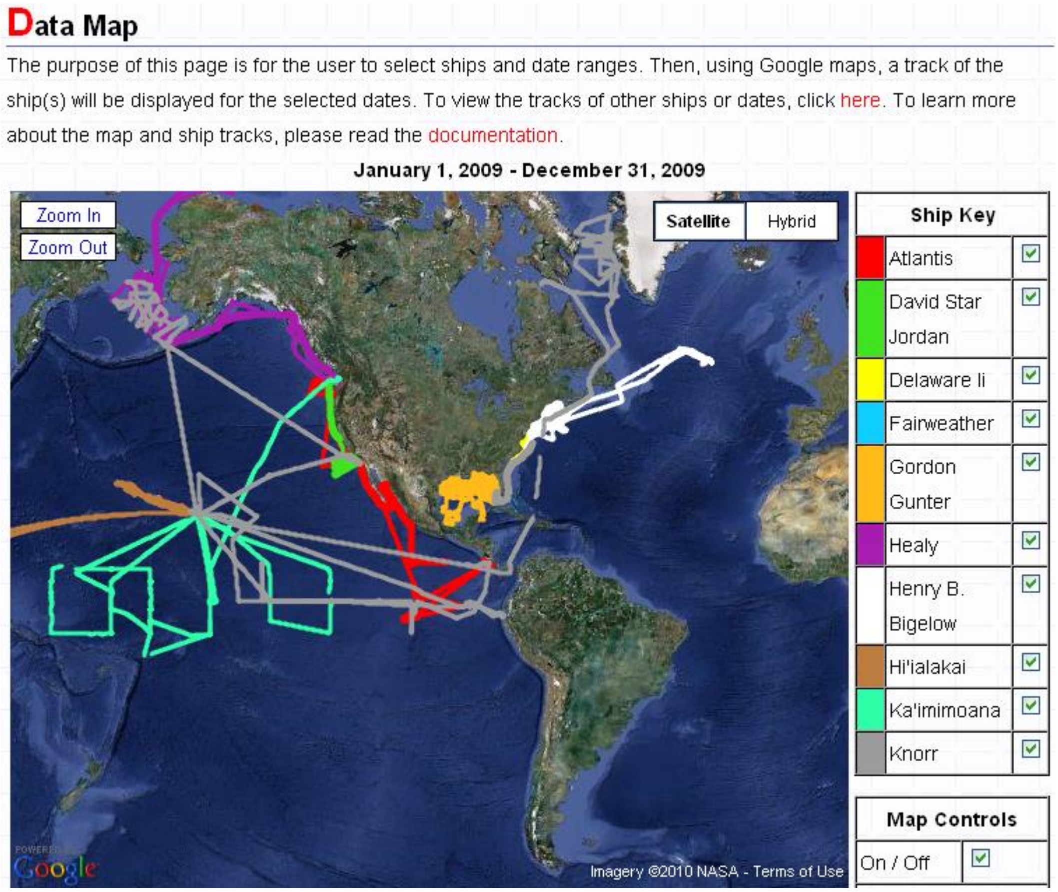
By choosing the Data Access link (boxed area), the user can access preliminary, intermediate, and research-quality data along with graphical representations of data availability and quality. As an example, consider the user who wants to find 2009 in situ wind and temperature data for the north-polar region. The first step would be to identify which ships frequented this area in 2009. To do so, choose Data Map on the Data Access page:



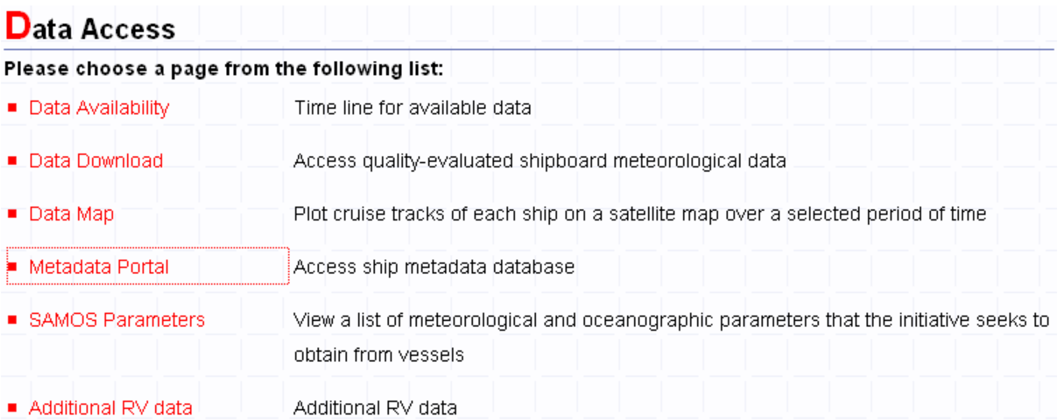
The user highlights a set of ships from the available list (10 ships may be chosen at a time):



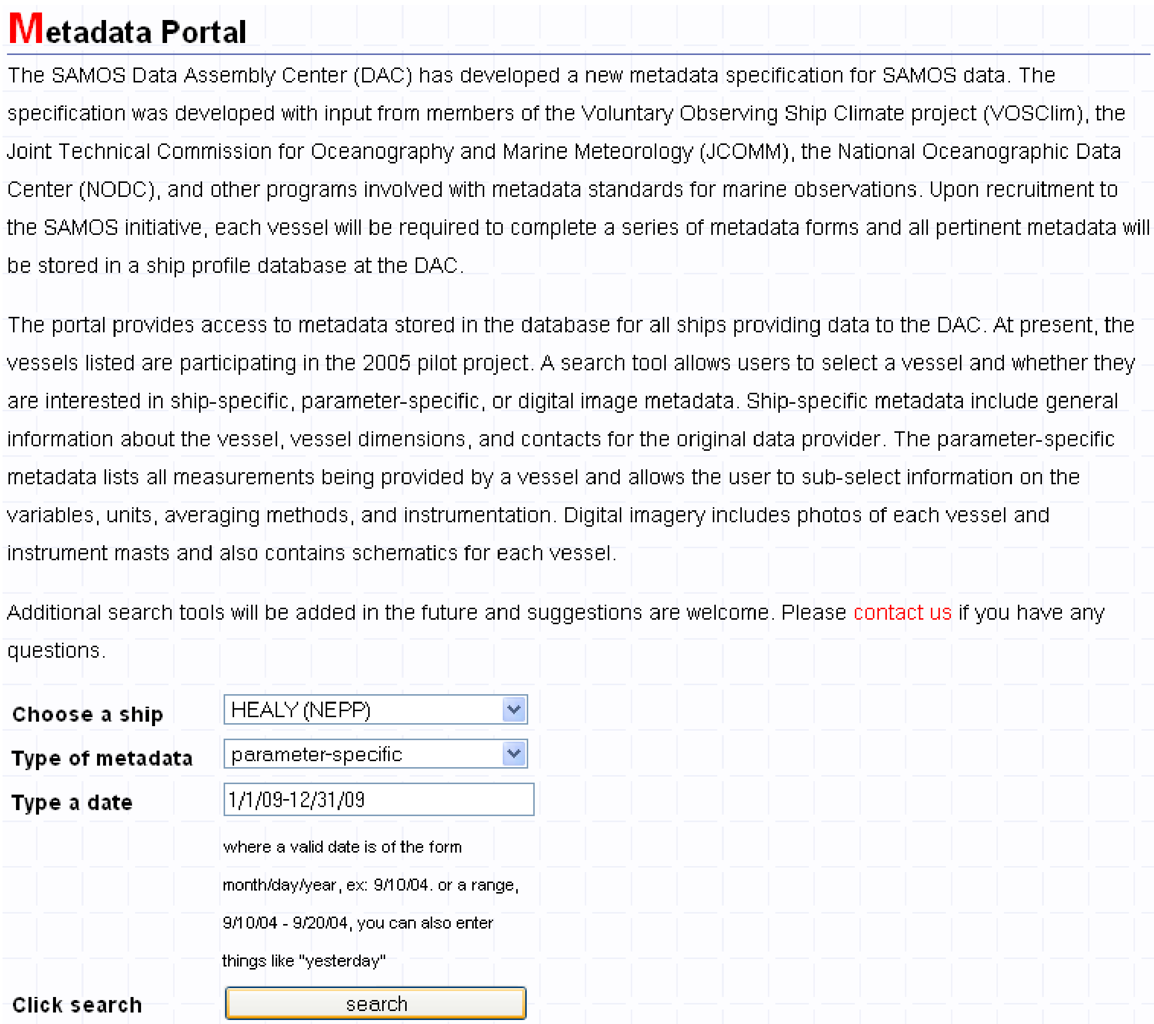
By entering a date range of January 1, 2009 to December 31, 2009 and clicking "search," a map is displayed showing all of the selected ship's tracks for the year 2009:



Now the user can see that both the *Healy* and the *Knorr* cruised in the north-polar region in 2009. The next step might be to see what parameters are available on each ship. Returning to the Data Access page, the user this time selects the Metadata Portal:



and first inputs the proper information for the *Healy*:


Metadata Portal

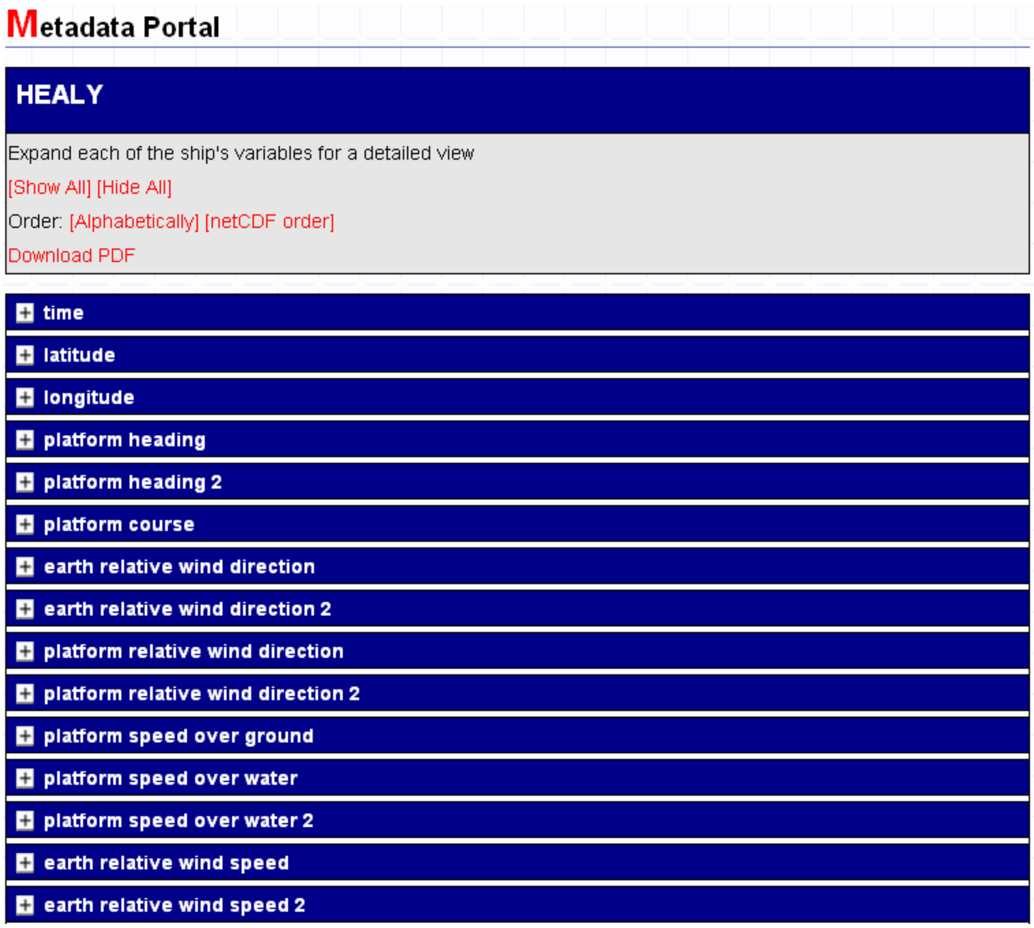
The SAMOS Data Assembly Center (DAC) has developed a new metadata specification for SAMOS data. The specification was developed with input from members of the Voluntary Observing Ship Climate project (VOSClim), the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), the National Oceanographic Data Center (NODC), and other programs involved with metadata standards for marine observations. Upon recruitment to the SAMOS initiative, each vessel will be required to complete a series of metadata forms and all pertinent metadata will be stored in a ship profile database at the DAC.

The portal provides access to metadata stored in the database for all ships providing data to the DAC. At present, the vessels listed are participating in the 2005 pilot project. A search tool allows users to select a vessel and whether they are interested in ship-specific, parameter-specific, or digital image metadata. Ship-specific metadata include general information about the vessel, vessel dimensions, and contacts for the original data provider. The parameter-specific metadata lists all measurements being provided by a vessel and allows the user to sub-select information on the variables, units, averaging methods, and instrumentation. Digital imagery includes photos of each vessel and instrument masts and also contains schematics for each vessel.

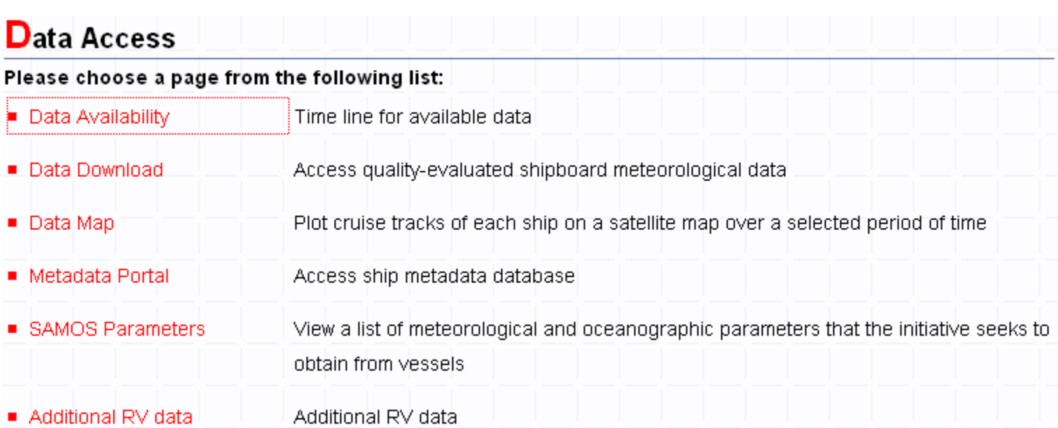
Additional search tools will be added in the future and suggestions are welcome. Please contact us if you have any questions.

Choose a ship	HEALY (NEPP)
Type of metadata	parameter-specific
Type a date	1/1/09-12/31/09
	where a valid date is of the form month/day/year, ex: 9/10/04. or a range, 9/10/04 - 9/20/04, you can also enter things like "yesterday"
Click search	search

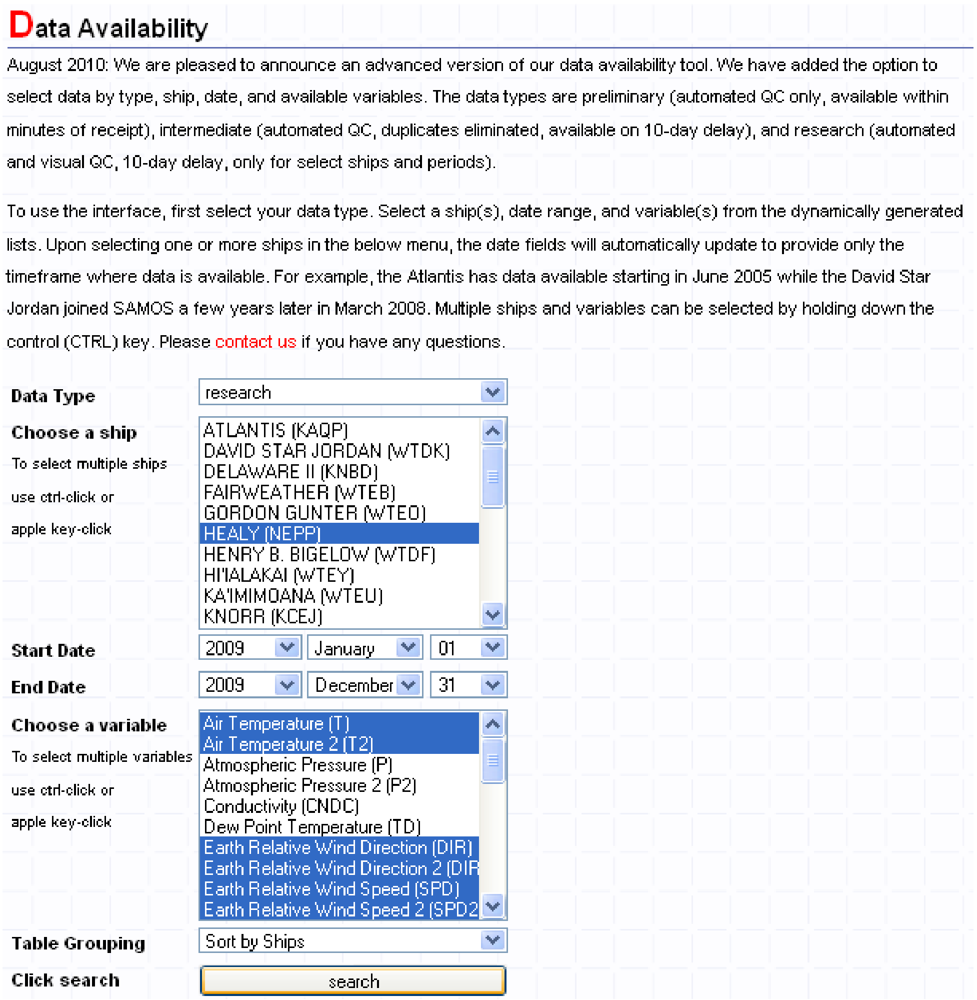
The result, once "search" is clicked, is an exhaustive list of all parameters available from the *Healy* in 2009:



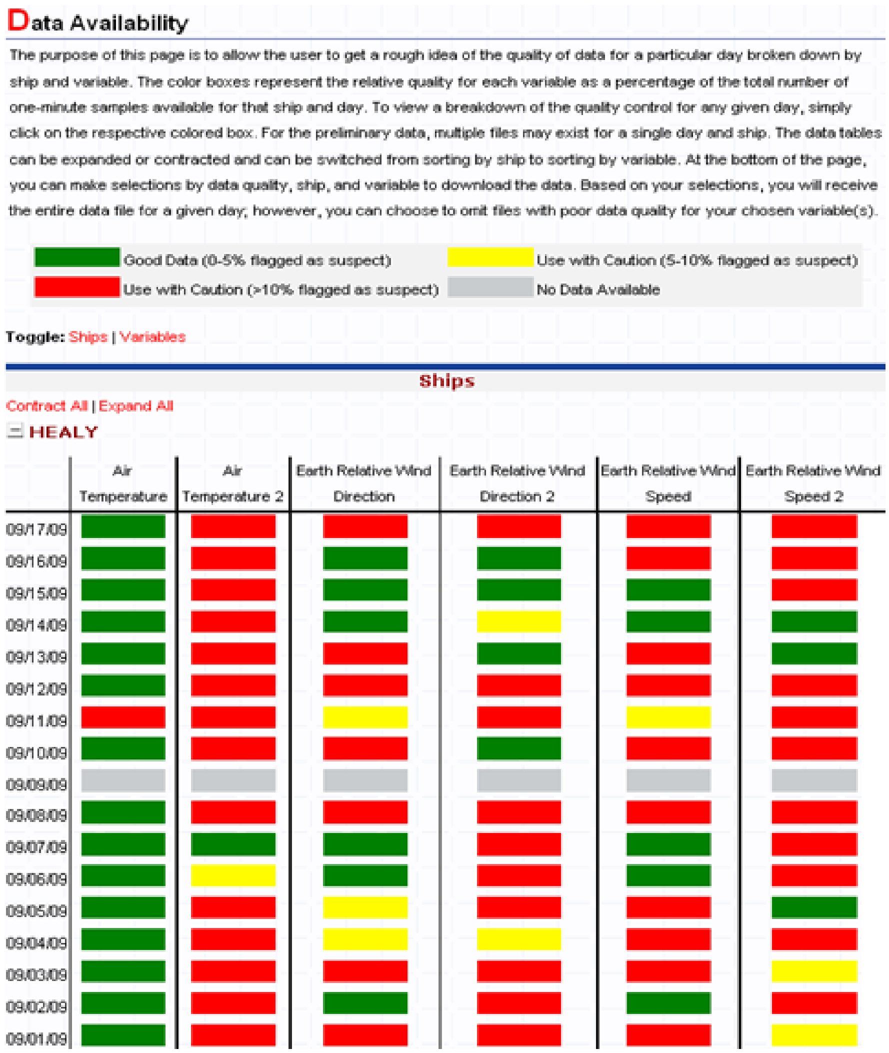
A thorough investigation of the list (note: image is truncated) tells the user the *Healy* did in fact provide both wind and temperature data in 2009. (Throughout the online SAMOS system, clicking on a "+" will yield further information; in this case the result would be metadata for the individual parameters.) Now the user will want to know the quality of the wind and temperature data. To find that, he returns once again to the Data Access page and this time chooses Data Availability:



After selecting the *Healy* along with the desired parameter(s), date range, and data version (preliminary, intermediate, or research), noting that the default date range and available parameters will change once a vessel and data version are selected, and then clicking "search":



the user arrives at a timeline showing on which days in 2009 the Healy provided data for the chosen parameter(s), as well as the quality of that data for each calendar day (note: image has been customized):



Color-coding alerts the user to the perceived quality of the data. As explained in the key at the top of the page, green indicates "Good Data" (with 0-5% flagged as suspect), yellow indicates "Use with Caution" (with 5-10% flagged as suspect), and red indicates a more emphatic "Use with Caution" (with >10% flagged as suspect). A grey box indicates that no data exists for that day and variable. In this case, the user can automatically see that on 09/07/09 all of the *Healy's* temperature data and the winds from the first wind sensor are considered "Good Data." More detailed flag information, as well as information pertaining to all other available parameters, can be found by simply clicking on any colored box. As an example, by clicking over the red bar for DIR2 on the date 09/07/09 a user can find out more specific information about data quality to determine whether the wind data might also be useful. When the red bar is clicked, the user is first directed to a pie chart showing overall quality:

Data Download w/ Daily QC Statistics

This page contains interactive graphics which, will not work correctly unless your web browser has Macromedia Flash Player 6 or later installed. These graphics respond to mouse clicks on either the pie chart itself or the legend. In some situations once a chart is "drilled down" the only way to return to that level is to use the chart navigation links. For example, once the intial graph, failed qc vs passed qc, is drilled down the only ways of returning to it is by using the chart navigation or by refreshing the page.

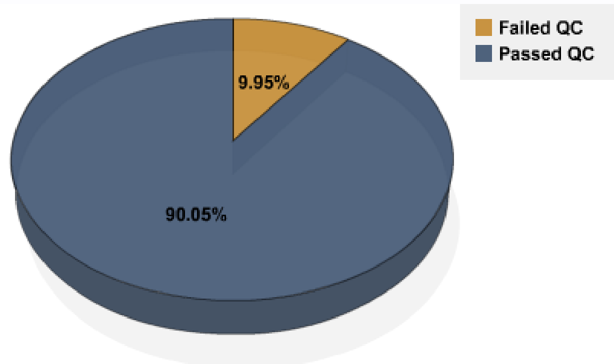
09-07-2009

HEALY

☐ select all

☐ File download | view file

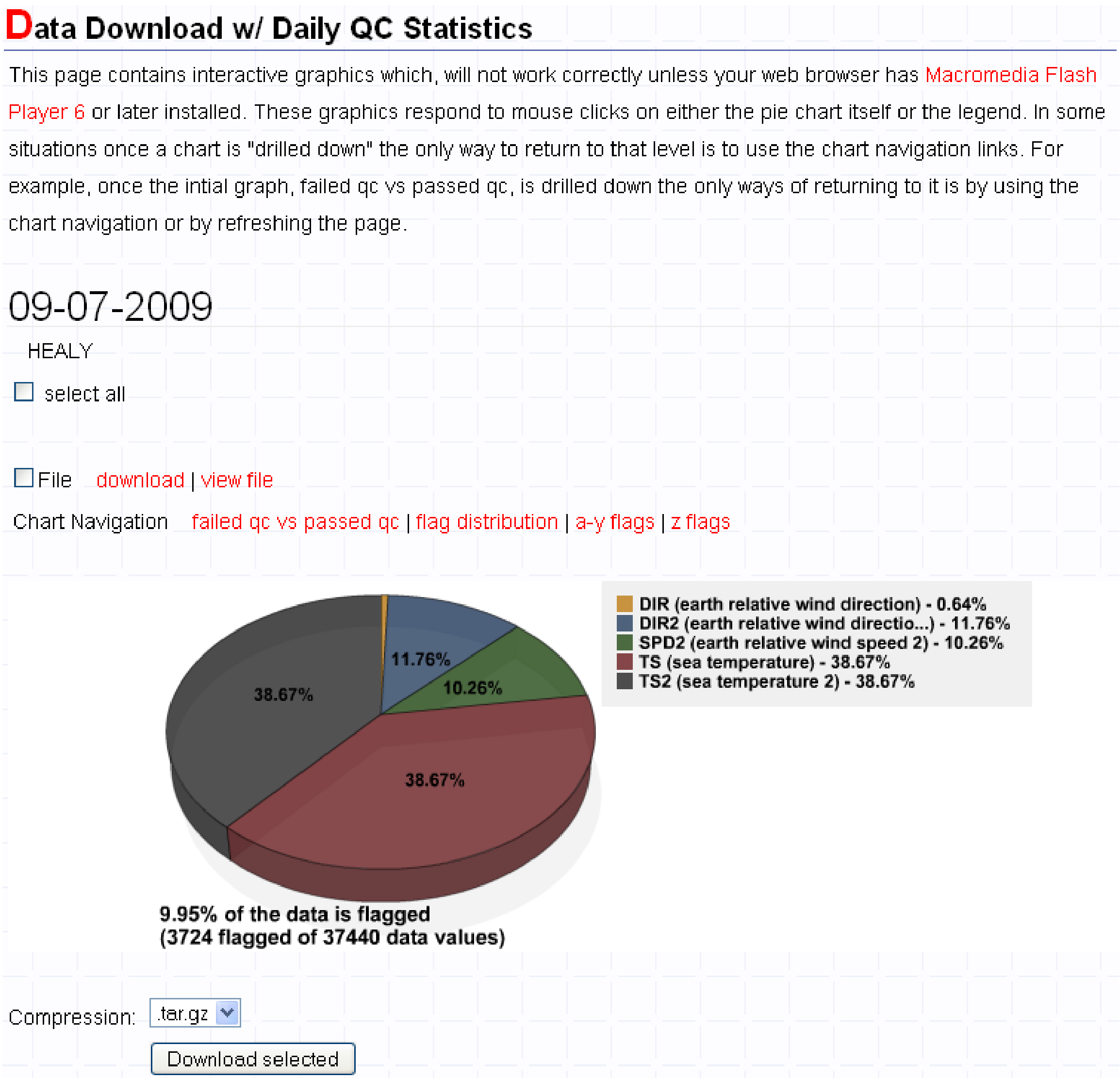
Chart Navigation failed qc vs passed qc | flag distribution | a-y flags | z flags



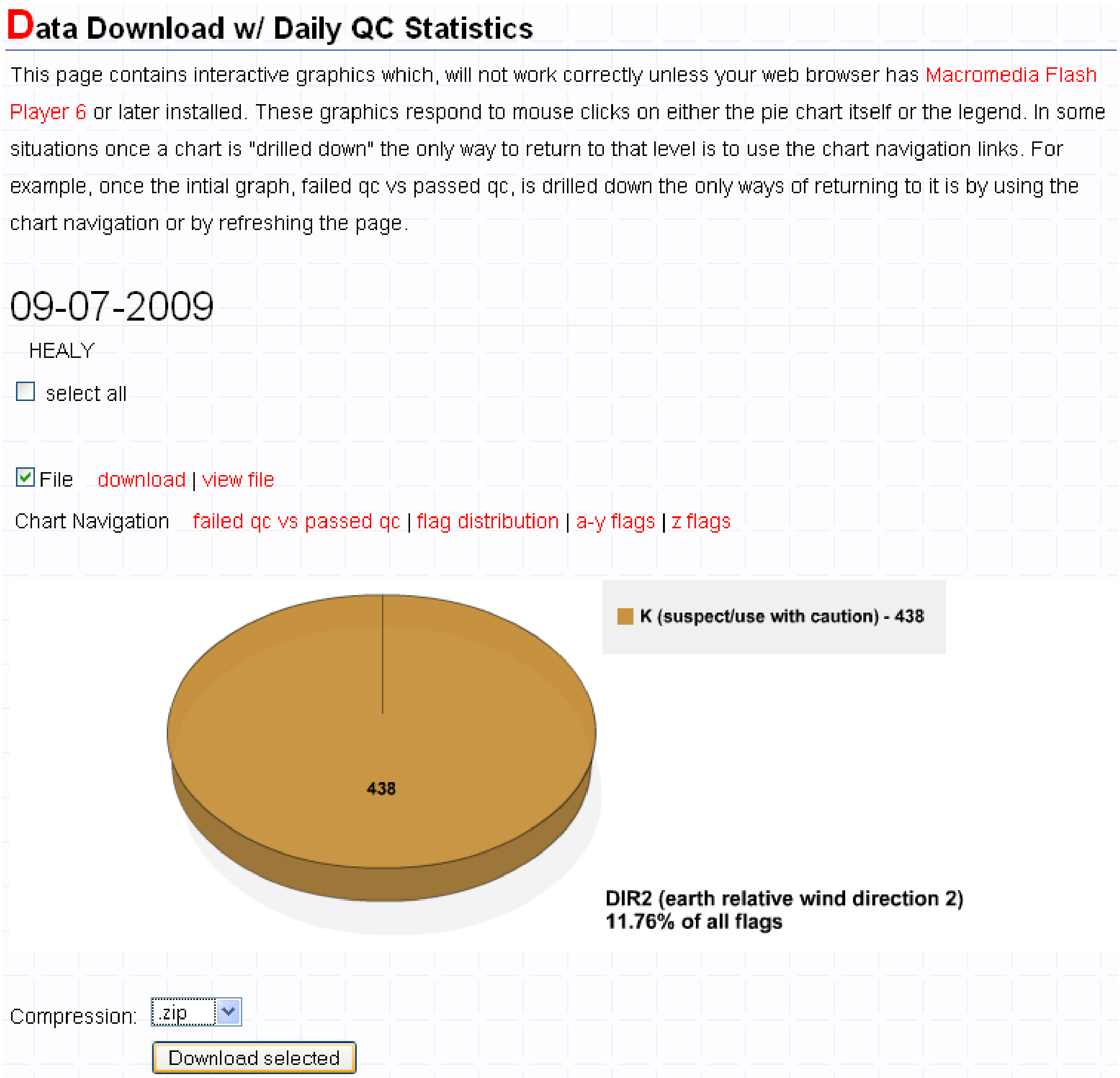
Compression: .tar.gz

Download selected

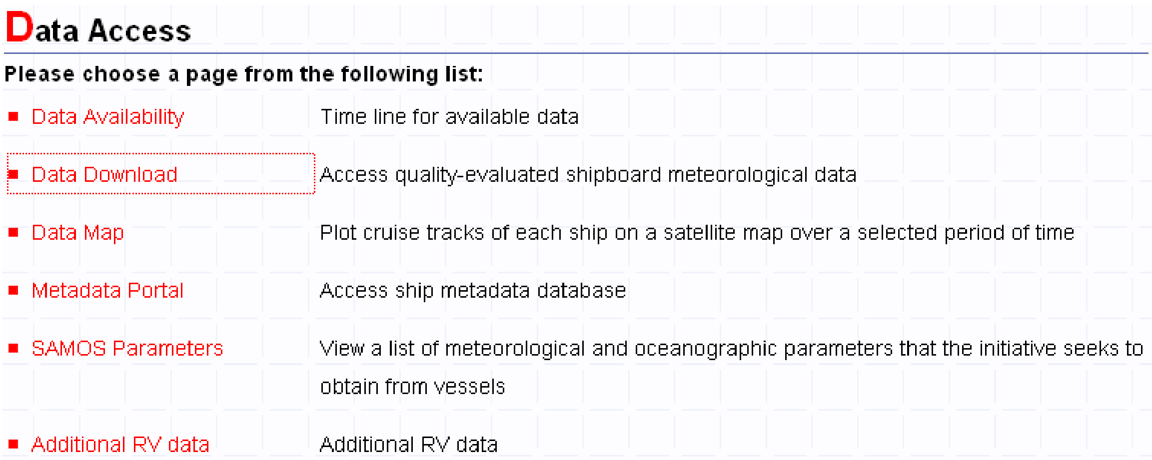
Clicking over the yellow pie slice showing the percentage of data that failed quality control yields a more in-depth look:



The user can now check to see precisely what types of flags were applied to the second wind sensor data, as only a portion of the data were flagged and they may still be usable. By clicking on either the blue pie slice for "DIR2" or the "DIR2" line in the grey box, he determines that "caution" flags were applied to a portion of the data:



In this example, the user might repeat these steps to evaluate the quality of "SPD2" for 09/07/09. In the end, perhaps he decides the second wind sensor data will also be useful to him and now he would like to download the data. There are a couple of ways to accomplish this: By toggling a check mark in the "File" box (as shown above) and choosing the preferred file compression format (".zip" in this case) on this or any of the pie chart pages, the 09/07/09 file containing all available parameters for that date is downloaded once "Download selected" is clicked. (Note that the entire file must be downloaded; individual parameters are not available for singular download at this time.) Alternatively, the user can return to the Data Access page and choose Data Download, where he will have an opportunity to download multiple files at one time:

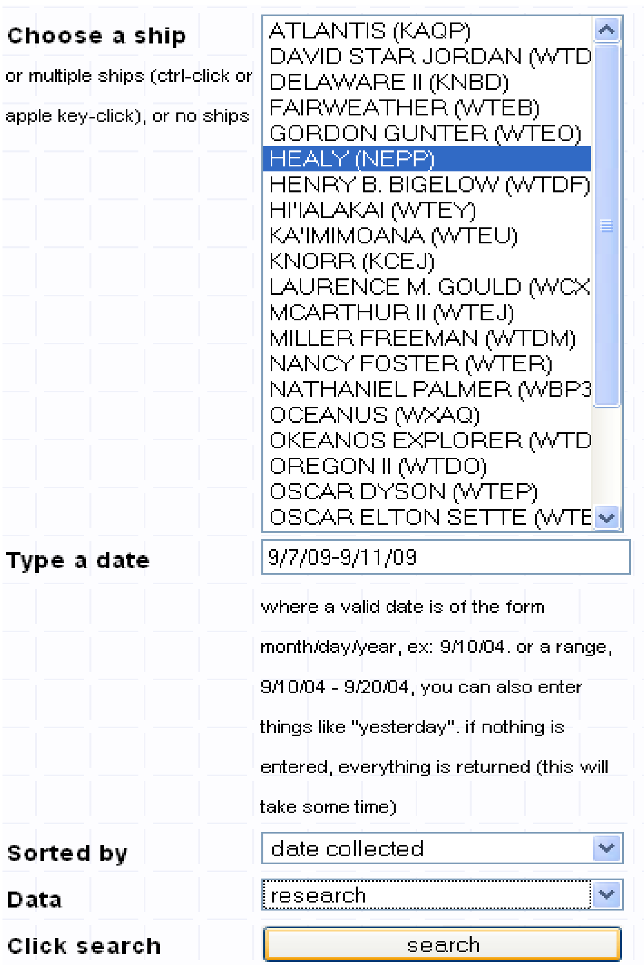


Data Access

Please choose a page from the following list:

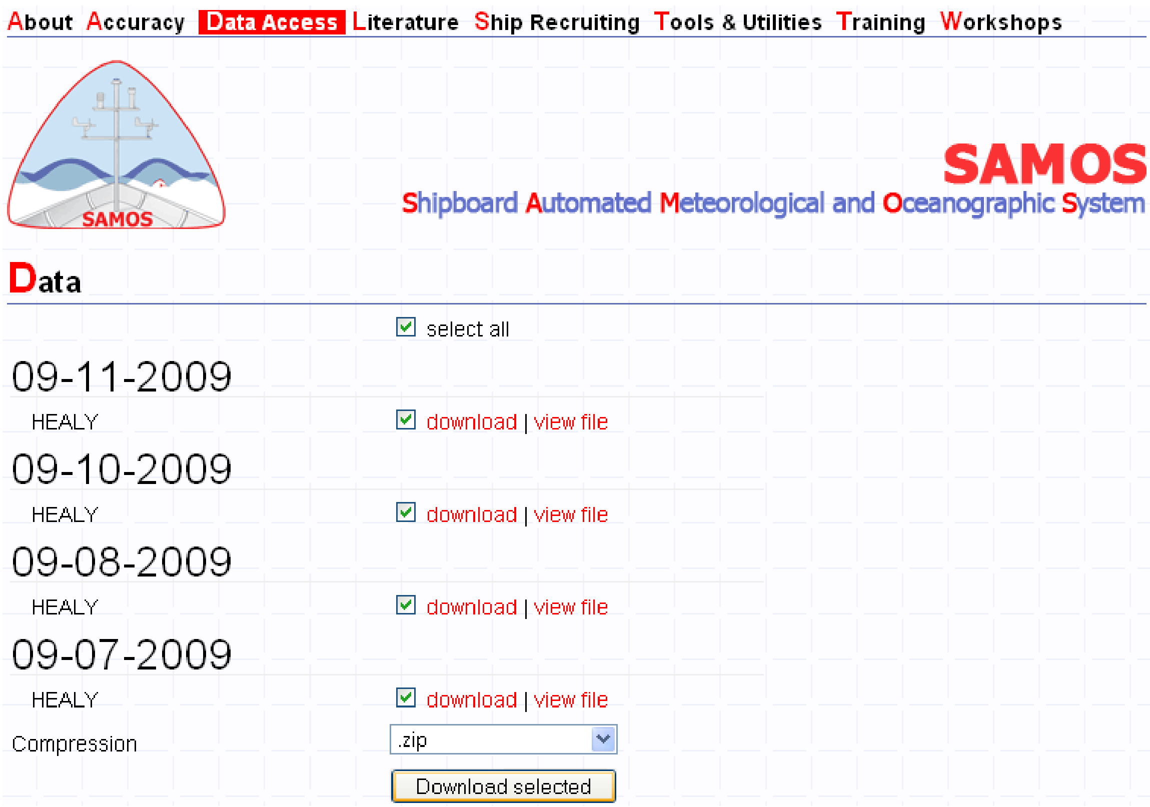
Data Availability	Time line for available data
Data Download	Access quality-evaluated shipboard meteorological data
Data Map	Plot cruise tracks of each ship on a satellite map over a selected period of time
Metadata Portal	Access ship metadata database
SAMOS Parameters	View a list of meteorological and oceanographic parameters that the initiative seeks to obtain from vessels
Additional RV data	Additional RV data

Let us assume that, after careful consideration of the quality of wind and temperature data from the *Healy* for the period from 09/07/09 to 09/11/09, the user decides he would like to download all available data from that period. By filling in the proper information on the Data Download page:



Choose a ship or multiple ships (ctrl-click or apple key-click), or no ships	ATLANTIS (KAQP) DAVID STAR JORDAN (WTD DELAWARE II (KNBD) FAIRWEATHER (WTEB) GORDON GUNTER (WTEO) HEALY (NEPP) HENRY B. BIGELOW (WTDF) HI'IALAKAI (WTEY) KA'IMIMOANA (WTEU) KNORR (KCEJ) LAURENCE M. GOULD (WCX MCARTHUR II (WTEJ) MILLER FREEMAN (WTDM) NANCY FOSTER (WTER) NATHANIEL PALMER (WBP3 OCEANUS (WXAQ) OKEANOS EXPLORER (WTD OREGON II (WTDO) OSCAR DYSON (WTEP) OSCAR ELTON SETTE (WTE
Type a date	9/7/09-9/11/09 where a valid date is of the form month/day/year, ex: 9/10/04. or a range, 9/10/04 - 9/20/04, you can also enter things like "yesterday". if nothing is entered, everything is returned (this will take some time)
Sorted by	date collected
Data	research
Click search	search

the user can choose "select all," along with a file compression format, and click "Download selected" to begin the download:



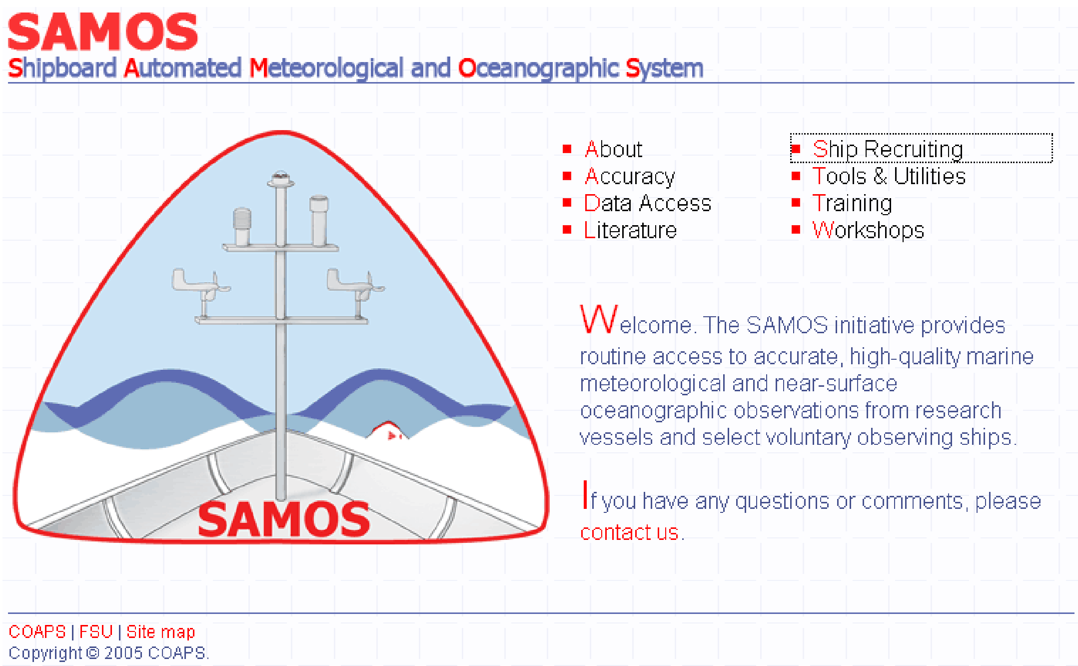
PART 2: the SAMOS operator

(NOTE: a step-by-step example created by a shipboard technician, suitable for saving and generalizing to any SAMOS instrument metadata change, follows this summary)

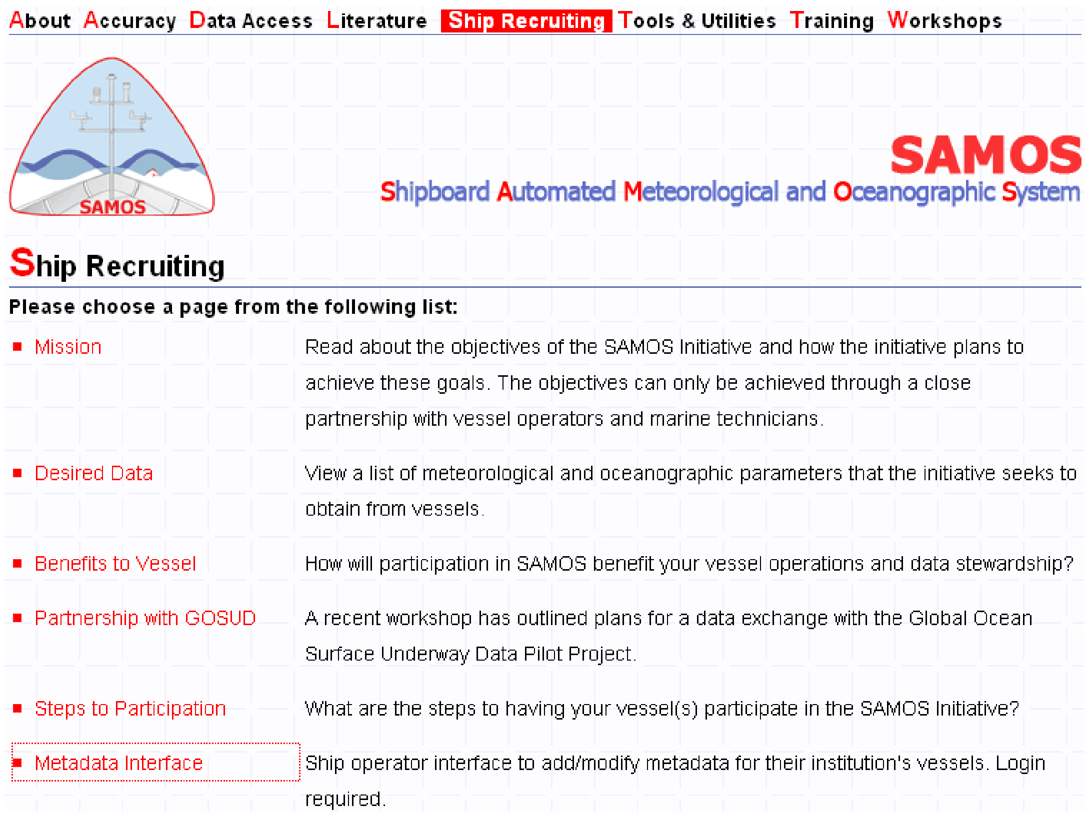
A SAMOS operator might choose to follow the steps outlined in part one as a simple way to keep tabs on the performance of his instruments. When problems are observed, vessel and instrument metadata are important tools for diagnosing a problem and finding a solution. For this reason we strongly emphasize the need for complete, accurate, up-to-date information about the instruments in use. Digital imagery of the ship itself and of the locations of instruments on the ship is also highly desirable, as it is often beneficial in diagnosing flow obstruction issues. As a SAMOS operator, it is important to note that metadata (vessel and/or instrument) should be updated whenever new instruments are added or changes are made to existing instruments (for example moving an instrument or performing a calibration). Inputting and modifying both vessel and instrument metadata are easy tasks that the SAMOS operator can perform via the internet at any time, provided the ship exists in the database and has been assigned "original time units" by a

SAMOS associate at COAPS. In order to use the online system, the SAMOS operator will need to be assigned a unique login and password for his ship, which is obtained by contacting samos@coaps.fsu.edu. With a login and password in hand, the following steps outline the methods for inputting and updating metadata.

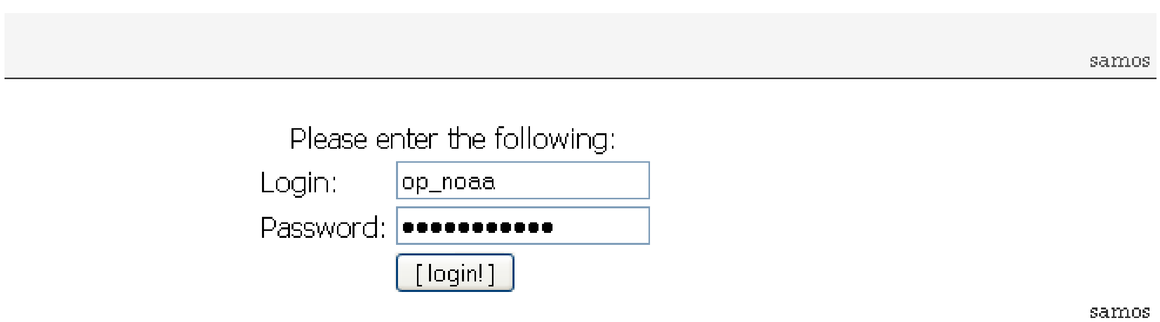
The database can be accessed by visiting the main page and choosing Ship Recruiting:



(or by navigating directly to the Ship Recruiting page, located at http://samos.coaps.fsu.edu/html/nav.php?s=4), and then choosing Metadata Interface:



The user will then be directed to log in, using their group's username and password (please contact samos@coaps.fsu.edu to obtain a username or for misplaced passwords):



Once logged in, the SAMOS operator chooses to modify either Vessel or Instrument Metadata..

a. Select Vessel Metadata

user ship related

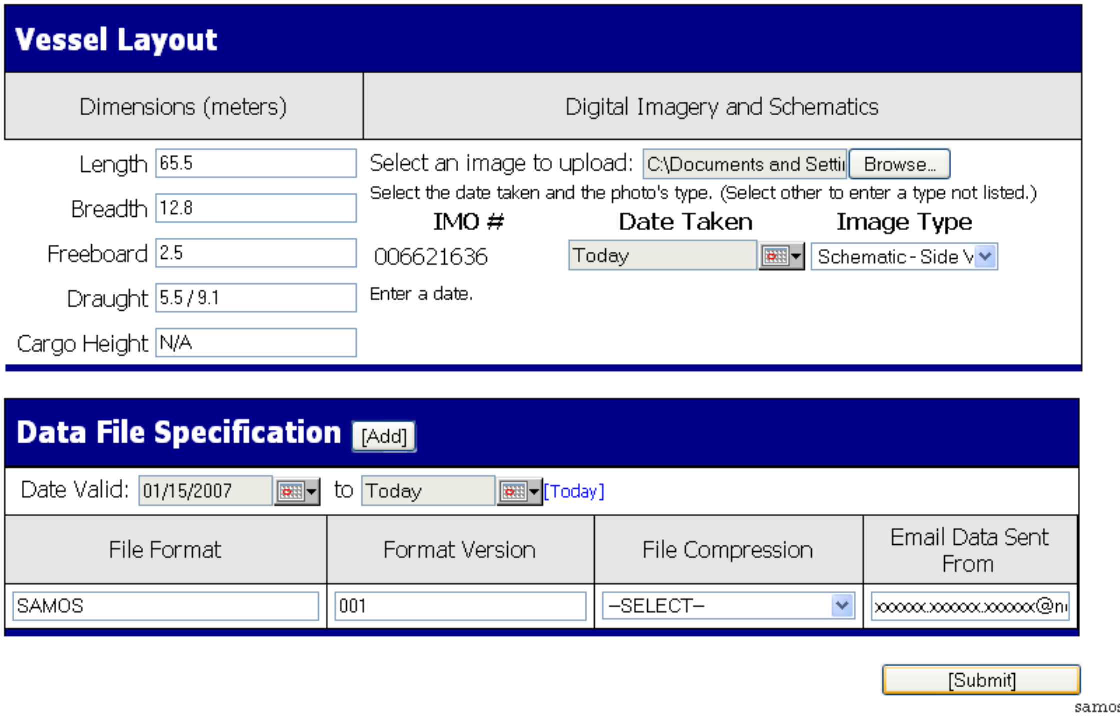
Edit Metadata

Ships for user op_noaa:

Ship Name	Call Sign	Vessel Metadata	Instrument Metadata
DAVID STAR JORDAN	WTDK	[modify]	[modify]
FAIRWEATHER	WTEB	[modify]	[modify]
GORDON GUNTER	WTEO	[modify]	[modify]
HENRY B. BIGELOW	WTDF	[modify]	[modify]
HI'IALAKAI	WTEY	[modify]	[modify]
KA'IMIMOANA	WTEU	[modify]	[modify]
MILLER FREEMAN	WTDM	[modify]	[modify]
NANCY FOSTER	WTER	[modify]	[modify]
OSCAR DYSON	WTEP	[modify]	[modify]
RAINIER	WTEF	[modify]	[modify]
RON BROWN	WTEC	[modify]	[modify]

samos

This metadata form provides Vessel Information (such as call sign and home port location), Contact Information for the home institution and shipboard technicians (as well as any other important persons), Vessel Layout, which details ship dimensions and allows for the uploading of digital imagery, and Data File Specification, which refers to the file format and file compression associated with SAMOS data transmission. On this page, all an operator would need to do is fill in the appropriate information and click "submit." For example, let us assume operator op_noaa desires to add a digital image to his vessel's metadata. Assuming the desired image is located on his native computer, he would merely need to click "Browse" to find the image he wants, fill in a Date Taken (if known) and choose an Image Type from the dropdown list, and then click "Submit" at the bottom of the page:



When editing Vessel Metadata, it is important to remember that submitting any new information will overwrite any existing information. The user should therefore take special care not to accidentally overwrite a valid field, for example the vessel Draught field. However, adding an image, as previously demonstrated, will not overwrite any existing images. This is true even if a duplicate Image Type is selected. The only way to remove an image is to contact SAMOS database personnel at COAPS. In any case, other than the addition of photos, Vessel Metadata does not often change. Additionally, except in the incidental case of Data File Specification (shown in image), changes are not date-tracked. Regarding the Date Valid field in the Data File Specification section, this date window maps to the File Format, Version, and Compression properties; it is not intended to capture the date Vessel Metadata changes were made by the SAMOS operator.

b. Select Instrument Metadata

(NOTE: a step-by-step example created by a shipboard technician, suitable for saving and generalizing to any SAMOS instrument metadata change, follows this summary)

user ship related

Edit Metadata

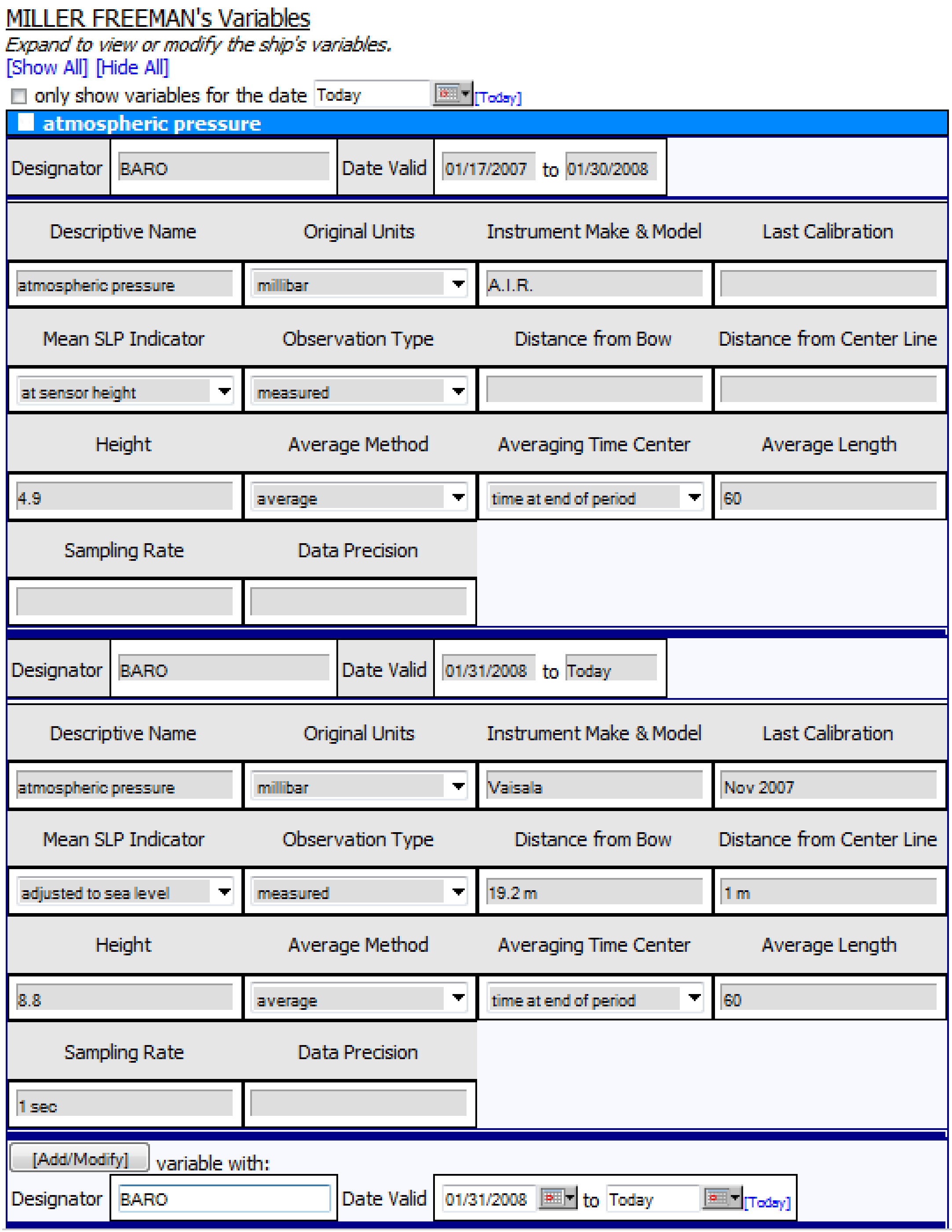
Ships for user op_noaa:

Ship Name	Call Sign	Vessel Metadata	Instrument Metadata
DAVID STAR JORDAN	WTDK	[modify]	[modify]
FAIRWEATHER	WTEB	[modify]	[modify]
GORDON GUNTER	WTEO	[modify]	[modify]
HENRY B. BIGELOW	WTDF	[modify]	[modify]
HI'IALAKAI	WTEY	[modify]	[modify]
KA'IMIMOANA	WTEU	[modify]	[modify]
MILLER FREEMAN	WTDM	[modify]	[modify]
NANCY FOSTER	WTER	[modify]	[modify]
OSCAR DYSON	WTEP	[modify]	[modify]
RAINIER	WTEF	[modify]	[modify]
RON BROWN	WTEC	[modify]	[modify]

samos

Adding and editing instrument (or parameter) metadata follow a slightly different procedure. The first step for the SAMOS operator is to identify which parameter he wishes to add or modify. Let us first consider the case of modifying a parameter already in use. Let us assume that a pressure sensor has been moved and user op_noaa wants to update the metadata for that parameter to reflect the new location. He would toggle a check in the box for *atmospheric pressure*, resulting in an expansion bar at the bottom of the screen:

Clicking over the "+" for atmospheric pressure opens the list of metadata fields associated with that parameter. The first step is to identify to the system which version (i.e. range of dates for which the listed metadata values are valid for the instrument) of the parameter metadata is being modified. (In most cases that will be the current version; however, it should be noted that occasionally there are multiple versions listed, as in this case, and a previous version needs to be edited retrospectively. For clarity, though, we will only be modifying the most recent in this example.) This identification is accomplished by filling in the sequestered set of Designator and Date Valid fields (located at the bottom below the metadata name, e.g., atmospheric pressure in the example below.) to exactly match those of the desired version metadata and then clicking "Add/Modify." Note that because we are modifying the most recent version, we choose our dates to match 01/31/2008 to today, instead of 01/17/2007 to 01/30/2008:



MILLER FREEMAN's Variables

Expand to view or modify the ship's variables.

[Show All] [Hide All]

only show variables for the date Today [Today]

atmospheric pressure

Designator	BARO	Date Valid	01/17/2007 to 01/30/2008

Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
atmospheric pressure	millibar	A.I.R.	
Mean SLP Indicator	**Observation Type**	**Distance from Bow**	**Distance from Center Line**
at sensor height	measured		
Height	**Average Method**	**Averaging Time Center**	**Average Length**
4.9	average	time at end of period	60
Sampling Rate	**Data Precision**		

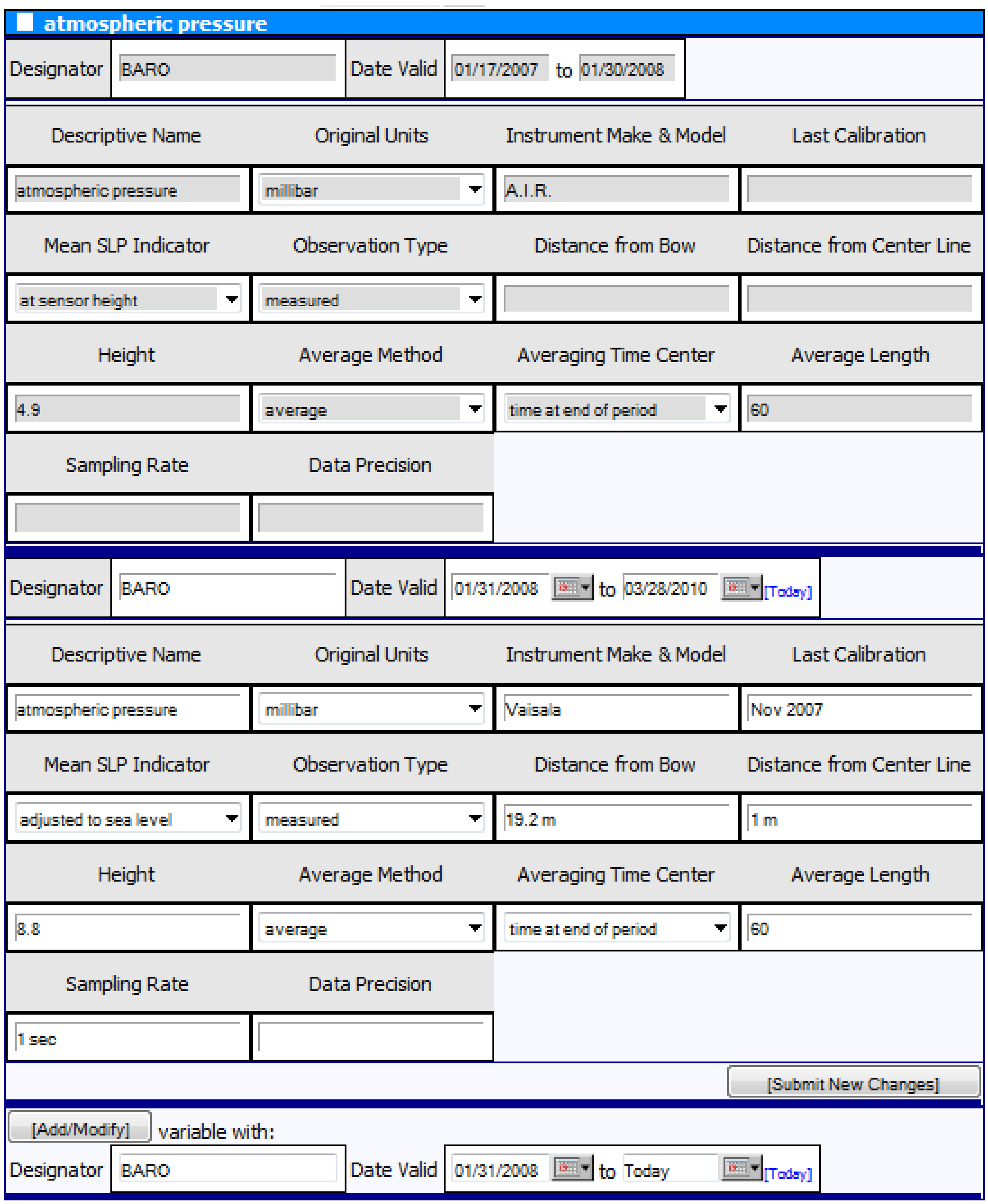
Designator	BARO	Date Valid	01/31/2008 to Today

Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
atmospheric pressure	millibar	Vaisala	Nov 2007
Mean SLP Indicator	**Observation Type**	**Distance from Bow**	**Distance from Center Line**
adjusted to sea level	measured	19.2 m	1 m
Height	**Average Method**	**Averaging Time Center**	**Average Length**
8.8	average	time at end of period	60
Sampling Rate	**Data Precision**		
1 sec			

[Add/Modify] variable with:

Designator	BARO	Date Valid	01/31/2008 to Today [Today]

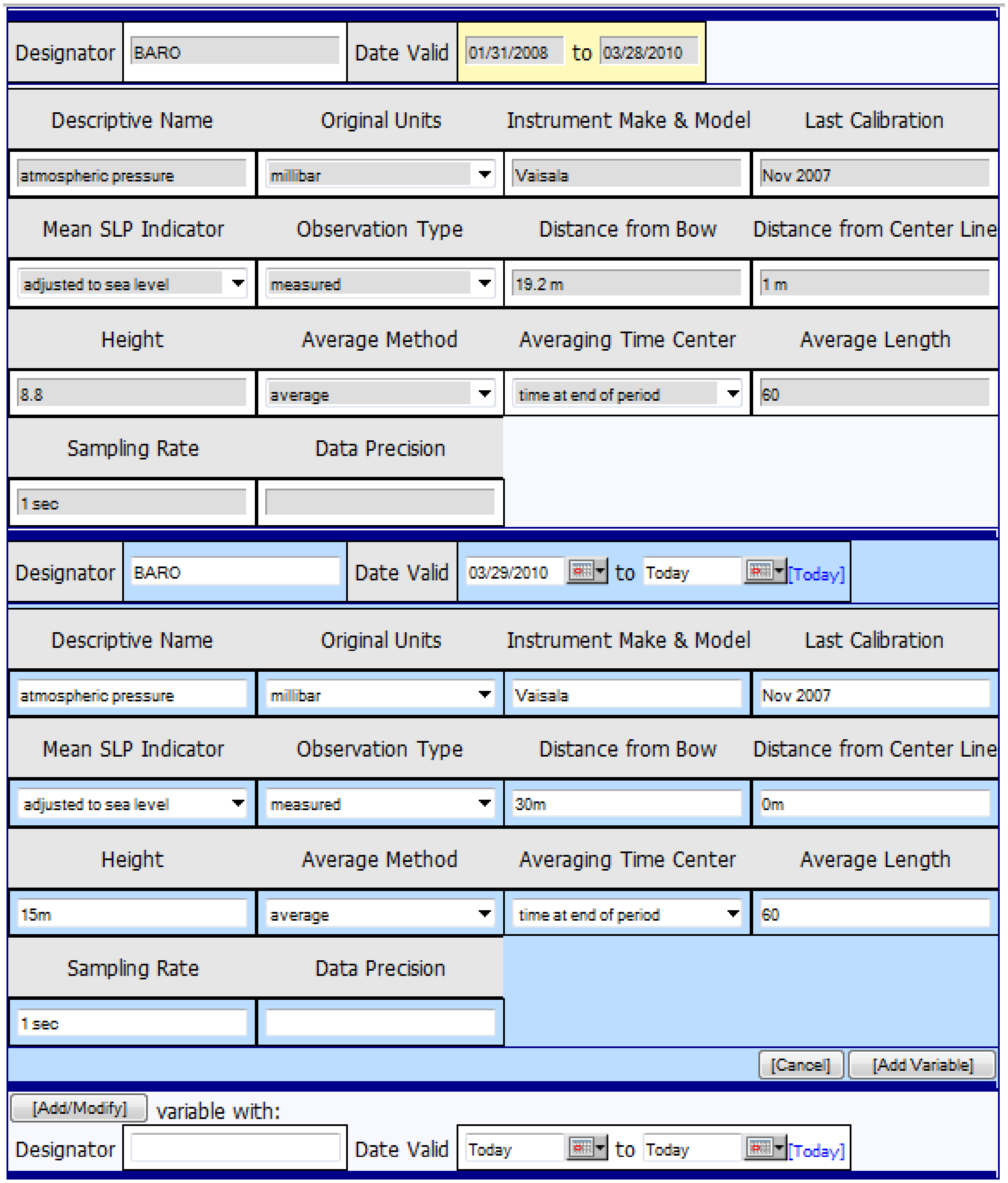
If the identification procedure is successful, there will be a "Submit New Changes" button visible in the desired version metadata area. User op_noaa must first close out the current metadata version (so the previous data is still associated with the correct information) and then initiate a new version. To close out the current version, the user would change the Date Valid field in the metadata area to reflect the last date the metadata displayed for an instrument was associated with at the old location and then click "Submit New Changes." (Note the first version, i.e. with Dates Valid 01/17/2007 to 01/30/2008, is left untouched):



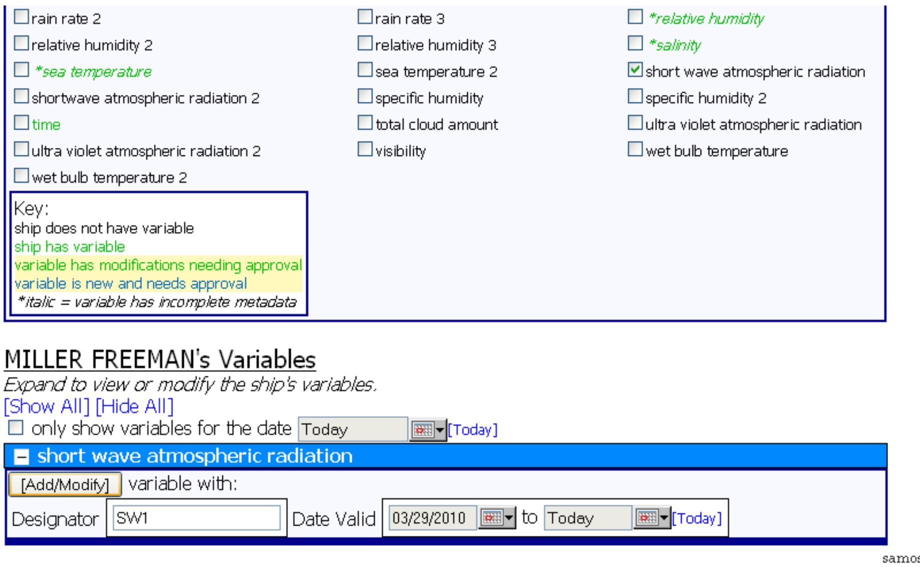
The user then initiates a new version by filling in the sequestered set of Designator and Date Valid fields to reflect the new period for the new or altered metadata, beginning at the date the instrument was relocated, and once again clicking "Add/Modify":

*It is crucial to note that Valid Dates cannot overlap for a single Designator, so if an instrument is moved in the middle of the day (and the Designator is not to be changed), the SAMOS user must decide which day is to be considered the "last" day at the old location, i.e. the day of the change or the day before the change. If the day of the change is considered the last day, then the new version must be made effective as of the day after the change. Likewise, if the day before the change is considered the last day, then the new version becomes effective as of the day of change. Let us assume the technician moved the instrument on 03/28/2010 and user op_noaa chose to consider that the last valid date for the old information, as demonstrated in the preceding figure.

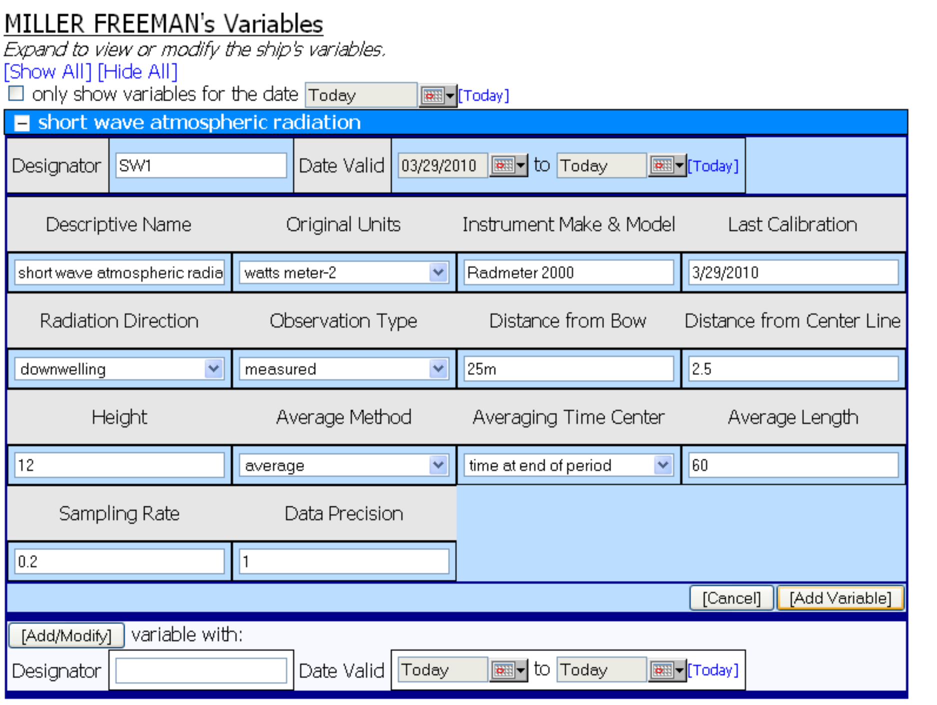
Once "Add/Modify" is clicked, a new set of fields opens up for the BARO parameter. All op_noaa need do at this point is recreate the parameter metadata entry, of course taking care to fill in the new location information, and click "Add Variable":



Adding an entirely new parameter follows only the latter part of these instructions: by simply choosing a parameter (for example short wave atmospheric radiation), clicking the "+" on the expansion bar, and entering either a new or not currently in use Designator and any Date Valid window:



the user is immediately given the new set of fields, to be filled in as desired:



Once an addition or modification to metadata has been submitted, a SAMOS associate at COAPS is automatically notified that approval is needed. Once approved, the new information will be visible to the public, via the Metadata Portal, accessed from the Data Access page as outlined in part one:

Data Access

Please choose a page from the following list:

▪ Data Availability	Time line for available data
▪ Data Download	Access quality-evaluated shipboard meteorological data
▪ Data Map	Plot cruise tracks of each ship on a satellite map over a selected period of time
▪ Metadata Portal	Access ship metadata database
▪ SAMOS Parameters	View a list of meteorological and oceanographic parameters that the initiative seeks to obtain from vessels
▪ Additional RV data	Additional RV data

For example, let's say we'd like to see the photo added by op_noaa for the *Miller Freeman*. We would simply choose the correct vessel from the dropdown list, choose "ship-specific" for the Type of metadata, and type in a date. (We choose "today" because we want the most up-to-date information.) Once we click "search,"

Metadata Portal

The SAMOS Data Assembly Center (DAC) has developed a new metadata specification for SAMOS data. The specification was developed with input from members of the Voluntary Observing Ship Climate project (VOSClim), the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), the National Oceanographic Data Center (NODC), and other programs involved with metadata standards for marine observations. Upon recruitment to the SAMOS initiative, each vessel will be required to complete a series of metadata forms and all pertinent metadata will be stored in a ship profile database at the DAC.

The portal provides access to metadata stored in the database for all ships providing data to the DAC. At present, the vessels listed are participating in the 2005 pilot project. A search tool allows users to select a vessel and whether they are interested in ship-specific, parameter-specific, or digital image metadata. Ship-specific metadata include general information about the vessel, vessel dimensions, and contacts for the original data provider. The parameter-specific metadata lists all measurements being provided by a vessel and allows the user to sub-select information on the variables, units, averaging methods, and instrumentation. Digital imagery includes photos of each vessel and instrument masts and also contains schematics for each vessel.

Additional search tools will be added in the future and suggestions are welcome. Please contact us if you have any questions.

Choose a ship	MILLER FREEMAN (WTDM)
Type of metadata	ship-specific
Type a date	today
	where a valid date is of the form month/day/year, ex: 9/10/04. or a range, 9/10/04 - 9/20/04, you can also enter things like "yesterday"
Click search	search

we are directed to a listing of all valid ship-specific information. At the bottom of the page we find the Vessel Layout items, including the newly added photo at the bottom of the Digital Imagery and Schematics scroll list:

Vessel Layout

Dimensions (meters)	Digital Imagery and Schematics
Length: 65.5 Breadth: 12.8 Freeboard: 2.5 Draught: 5.5 / 9.1 Cargo Height: N/A	 Schematic - Side View 

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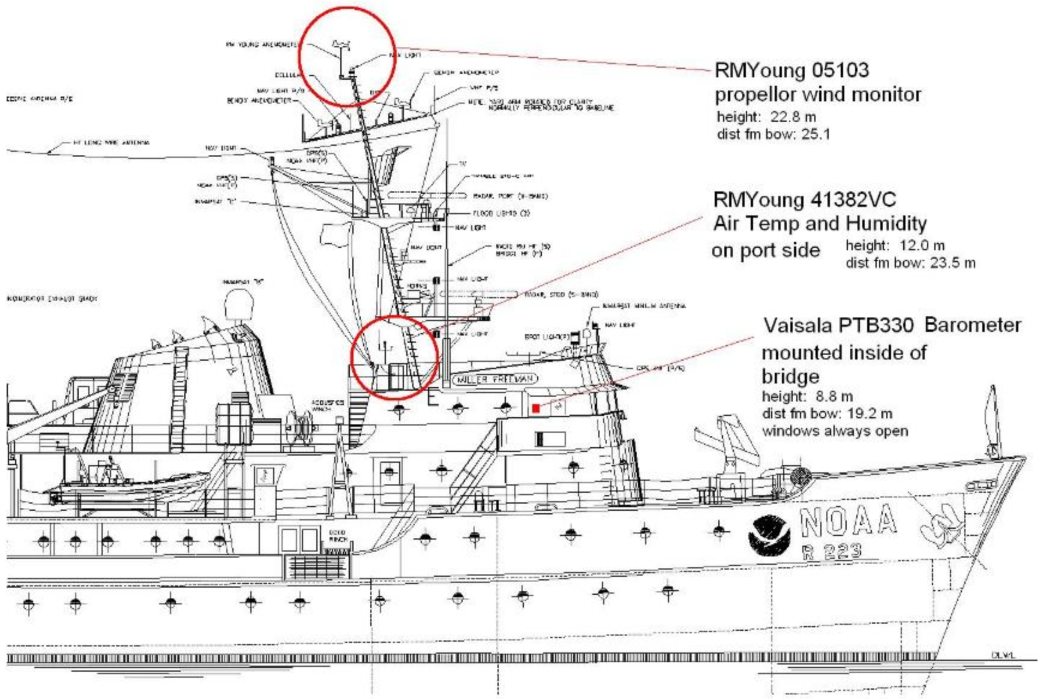
Clicking on the image itself would give us an enlarged view. In this case, the photo provides details about the locations of three MET sensors:



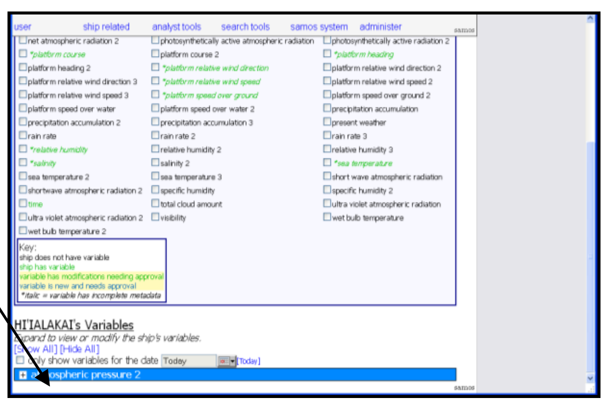
As a SAMOS user becomes familiar with following the metadata modification steps outlined in this section, chores such as adding duplicate sensors, logging sensor relocations, and keeping calibrations up-to-date become straightforward tasks. Naturally, complete and accurate metadata make for better scientific data. (and thus, happier end users!)

UPDATING SAMOS METADATA: STEP BY STEP EXAMPLE

(credit: Lauren Fuqua, chief technician for *Hi'ialakai*)

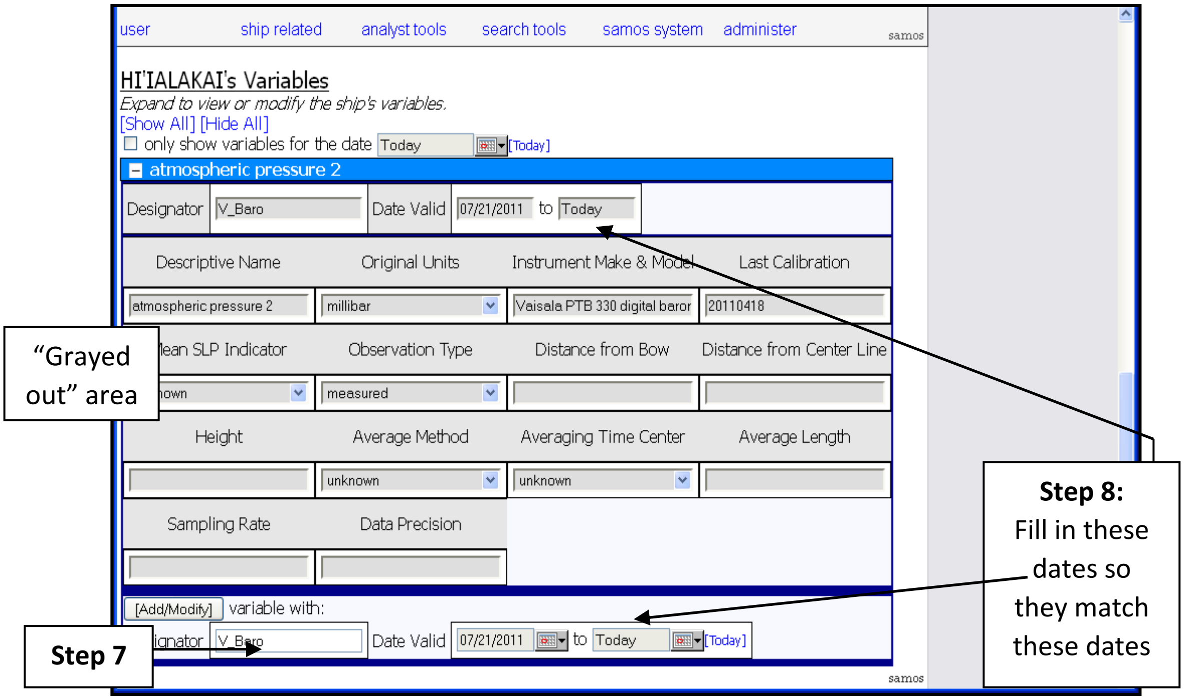
1. Go to: http://samos.coaps.fsu.edu/html/
    a. Click "Ship Recruiting"
    b. Click "Metadata Interface"
2. Enter login ID and password (case sensitive)
3. You can choose to modify Vessel or Instrument Metadata; you will likely choose Instrument. Vessel Metadata does not often change, other than the addition of photos.
4. Once "Instrument Metadata" is clicked, a box of sensors will appear. You will usually only be dealing with the Green ones (will look different if entering a new sensor).
    a. Select the sensor you want to Modify by clicking the box to the left of it

5. You will now see that sensor below, highlighted in Blue; click the plus sign to the left to expand the info about that sensor



6. You will now see the current data for that sensor, grayed out at the top (see image below). You are unable to make changes at this point in the grayed out sensor info area.

a. If this is a brand new sensor you will only see Designator and Date Valid.
b. If changes have already been made to this sensor you will see several sets of data boxes; scroll to the bottom one.



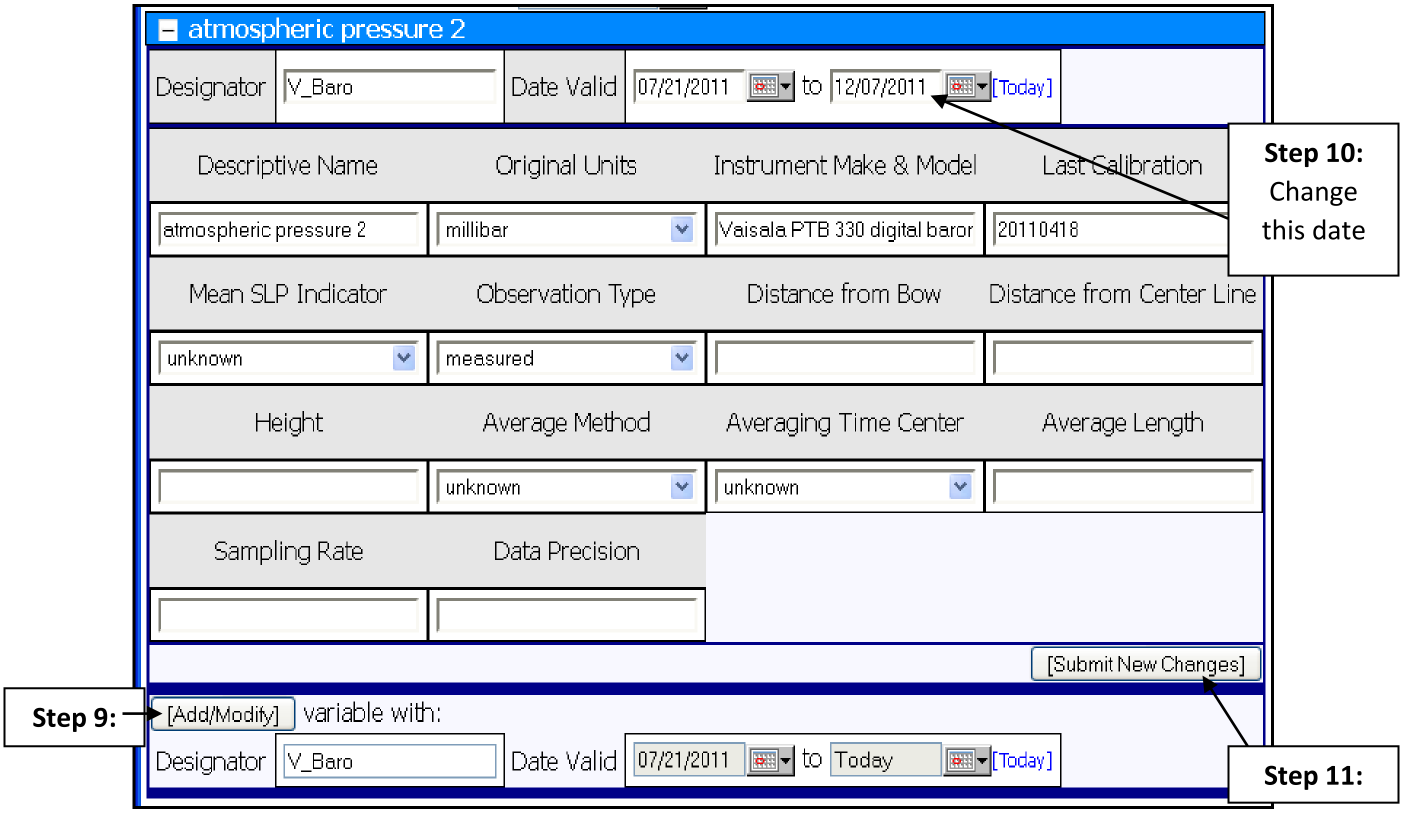
7. You first need to let the system know for which sensor you want to change information. In the box that appears at the very bottom (see image above), enter the name of the designator just at it appears in the box next to 'Designator' in the grayed out area.
   a. For the example above you would enter 'V_Baro' for atmospheric pressure 2

   * Note that before an updated version of sensor information can be entered, you must first "close out" the existing version. This is accomplished via steps 8 through 11. (The updated information will be entered in steps 12 through 15.)
8. In the bottom "Date Valid" boxes, make the dates match what you see above for the "Date Valid" dates in the grayed out area
   a. For the example above you would enter 02/01/2011 in the left box and you would click the blue [Today] button to make the right box read Today
   b. The right box will probably say 'TODAY' by default, and that is likely what you want.
      i. **NOTE:** The word 'Today' in any "Date Valid" entry is a floating date that implies the sensor is currently valid, no matter what day it is. The actual calendar dates mean the sensor starts & stops on the actual dates shown.

c. Months are changed using the arrows

d. Year is changed by clicking on the year (it will now be highlighted) and then typing in the year you want.

9. Click the [Add/Modify] button (see image below); this should change the text boxes in the data area from gray to white (as in the image below), so that you can now put your cursor in there. If you are unable to make changes in the data area, then the date valid dates and/or designator you entered are incorrect.



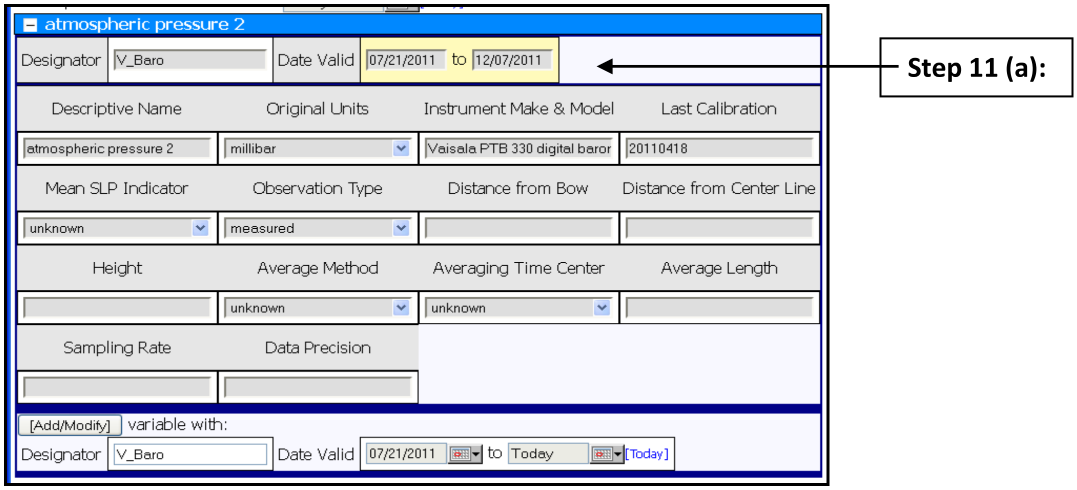
10. You now want to change the "Date Valid" info in this data box. The "Date Valid" start date (on the left) in this now edit-able area will likely stay the same unless you want to correct a previously entered erroneous start date. More than likely you will only be changing the end date, on the right.

a. This step simply closes out the current data; letting the system know the start and end dates for which the data on the screen about that sensor are valid. You will probably not change any data here; only the end date.

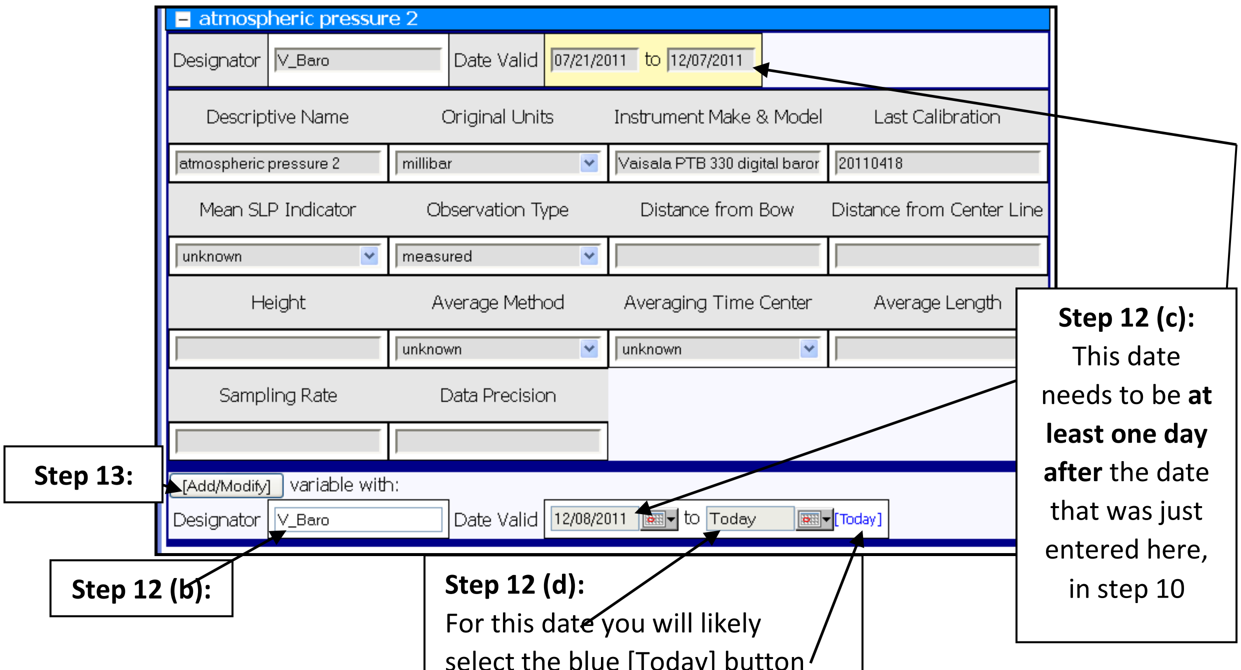
b. You will most likely be entering a calendar date in the right hand "Date Valid" box to close out the existing data for the sensor.

11. Click "Submit New Changes" on the bottom right of the data box (see image above)

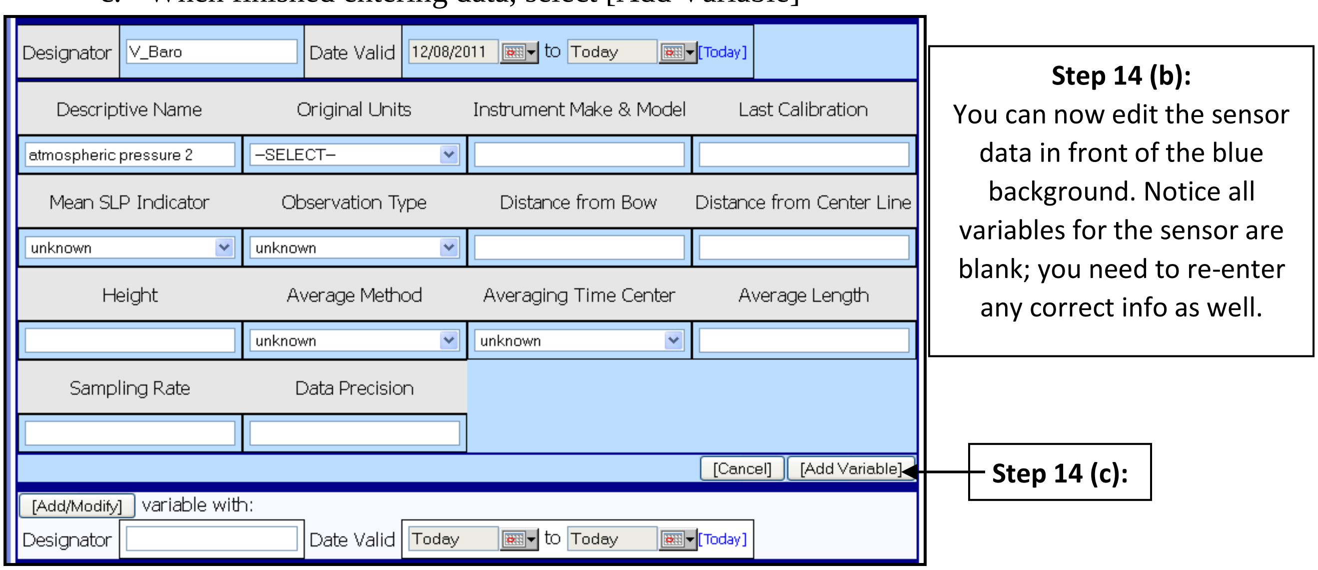
a. The text boxes in the data entry area should be grayed out again. The background of the dates that you just edited will be yellow (see image below).



12. Now you need to choose new "Date Valid" info in the bottom window (see image below). *Note again that steps 12 through 15 should NOT be performed until the previous set of instrument metadata has been "closed out" for that instrument, via steps 8 through 11.
    a. This step lets the system know the new valid dates for the new information about this sensor (you will enter the new information in Step 14).
    b. Make sure the same designator name is in the 'Designator' box
    c. The left box in the Date Valid area will indicate the start date for which the new sensor info is valid. **That start date needs to be at least one day after the end date that was just entered above in Step 10; the valid dates cannot overlap.**
    d. The right "Date Valid" date will most likely be Today (again, do this by clicking the blue [Today] button to the right of the box; not by putting in today's date on the calendar).
    e. Note: If you are seeing X's over the calendar date you want to select on the left hand "Date Valid" box, change the right hand box to Today first, and you will now be able to change the left box to the date you want.

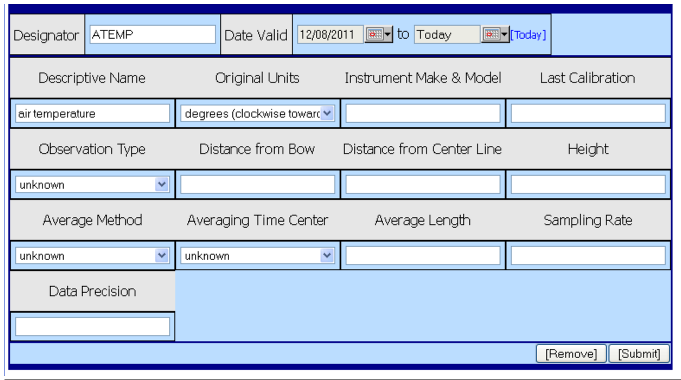


13. Click the [Add/Modify] button again (see image above)
14. You will now see a new, editable data box at the bottom of the screen that has blue around the sensor info instead of gray.
    a. Leave the Date Valid area the same
    b. You can now change the sensor data to reflect updates and add new information. Note that you need to re-enter any existing, correct info about the sensor.
    c. When finished entering data, select [Add Variable]



15. You do not need to click [Submit] on the new window that appears (see image below) unless you make any additional changes or corrections immediately after finishing step 11, for example if you realize you've entered incorrect info or you've accidentally left something out. Otherwise, your new data are now

waiting for approval from the SAMOS staff. To prevent anything being changed mistakenly from this point on, you should now close out that sensor window by going to the top window that has all of the sensors listed and un-checking the sensor you just edited. You can now either exit the website or select a new sensor



Step 15:

If all info entered is correct, **DO NOT** select the [Submit] button. Simply close out of SAMOS