2018 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.

Table of Contents

1. Introduction

This report describes the quantity and quality of observations collected in 2018 by research vessels participating in the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative (Smith et al. 2018). 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. Original measurements from installed instrumentation 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 <u>not</u> provided by the SAMOS initiative.

Data management at the DAC focuses on 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. Data reduction from original measurements down to 1-minute averages is completed onboard each ship using their respective data acquisition software. Broadband satellite communication facilitates transferal of SAMOS data to the DAC 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 2018, out of 36 active recruits, a total of 31 research vessels routinely provided SAMOS observations to the DAC (Table 1). SAMOS data providers included the National Oceanographic and Atmospheric Administration (NOAA, 15 vessels), the Woods Hole Oceanographic Institution (WHOI, 2 vessels), the National Science Foundation Office of Polar Programs (OPP, 2 vessels), the United States Coast Guard (USCG, 1 vessel), the University of Hawaii (UH, 1 vessel), the University of Washington

(UW, 1 vessel), Scripps Institution of Oceanography (SIO, 3 vessels), the Schmidt Ocean Institute (SOI, 1 vessel), the Australian Integrated Marine Observing System (IMOS, 3 vessels), the Louisiana Universities Marine Consortium (LUMCON, 1 vessel), and the University of Alaska (UA, 1 vessel). One additional NOAA vessel – the *Ferdinand Hassler* – one additional USCG vessel – the *Polar Sea* – the Bermuda Institute of Ocean Sciences (BIOS) vessel – the *Atlantic Explorer* – 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, mid-life refit, changes to shipboard acquisition or delivery systems, satellite communication problems, etc.) were unable to contribute data in 2018.

IMOS is an initiative to observe the oceans around Australia (see 2010 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. In 2015 code was developed at the SAMOS DAC which allows for harvesting both *Tangaroa* and *Investigator* SAMOS data directly from the IMOS THREDDS catalogue. In late 2018, through communications initiated by IMOS, it was discovered that pre-existing software problems at IMOS which interrupted the data flow from the *Aurora Australis* had been resolved in early 2017. Consequently, the SAMOS DAC database and the IMOS THREDDS harvesting code were updated in 2018 to restore SAMOS data processing for the *Australis*. The 2017-2018 back catalogue for the *Australis* was processed by the DAC and now we are routinely receiving daily SAMOS data from the *Australis*. In addition to running a parallel system to SAMOS in Australia, IMOS is the only international data contributor to SAMOS.

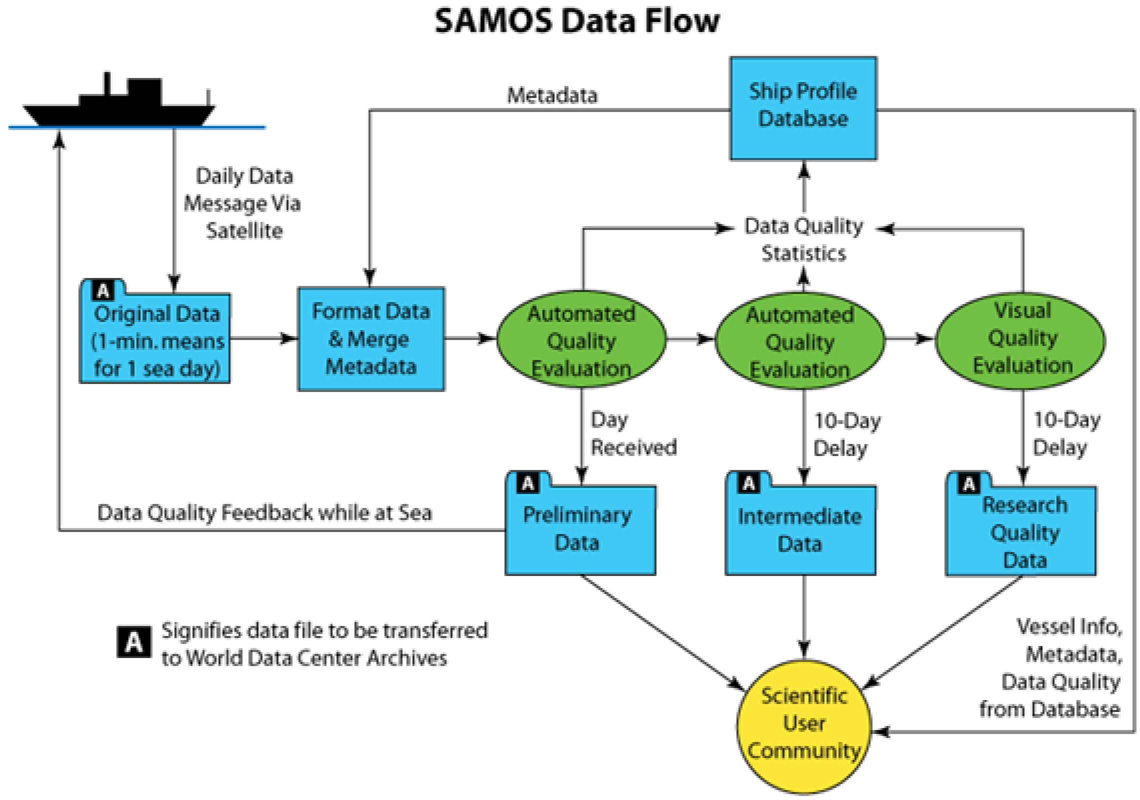

Figure 1: Diagram of operational data flow for the SAMOS initiative in 2018.

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 2018, 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), in particular sensor or equipment affected by moisture issues (*Sikuliaq*, *Gordon Gunter*, *Henry Bigelow*), sensors or equipment that remained problematic or missing for extended periods (namely, the photosynthetically active atmospheric radiation sensor on the *Falkor*, the long wave radiation sensor on the *Atlantis*, the relative humidity sensor and the rotated wind sensor on the *Reuben Lasker*, the secondary wind sensor on the *Oscar Dyson*, and the relative humidity sensor on the *Oscar Elton Sette*), erroneously characterized data units (*Okeanos Explorer*), missing data (*Investigator*), problematic designators (*Rainier*), and data transmission oversights or issues.

This report begins with an overview of the vessels contributing SAMOS observations to the DAC in 2018 (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 2019. Annexes include a listing of vessel notifications and 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 2018, a total of 36 research vessels were under active recruitment to the SAMOS initiative; 31 of those vessels routinely provided SAMOS observations to the DAC (Table 1). The *Atlantic Explorer* crew have undertaken building a new data acquisition system from the ground up and have not yet achieved SAMOS data transmission capacity, thus there are no data from her in 2018. The *Polar Sea* was out of service in 2018, so naturally there was no data from her, either. The *Ferdinand Hassler* did sail in 2018, but despite repeated attempts to reestablish transmission no SAMOS data were received from her. 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. Real-time data were not received in 2018 from the *Endeavor* because they have not been able to transition back to SAMOS 1.0 format (FSU is no longer developing SAMOS 2.0).

In total, 6,333 ship days were received by the DAC for the January 1 to December 31, 2018 period, resulting in 8,472,101 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 8,472,101 records received in 2018, a total of 179,211,114 distinct measurements were logged. Of those, 8,531,714 were assigned A-Y quality control flags – about 5 percent – by the SAMOS DAC (see section 3a for descriptions of the QC flags). This is about the same as in 2017. Measurements deemed "good data," through both automated and visual QC inspection, are assigned Z flags. In total, fifteen of the SAMOS vessels (the *Tangaroa, Investigator, Aurora Australis, Atlantis, Neil Armstrong, Laurence M. Gould, Nathaniel B. Palmer, Healy, Kilo Moana, Thomas G. Thompson, Sikuliaq, Pelican, Roger Revelle, Sally Ride*, 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	-	6,333	658	8,472,101	8,531,714	179,211,114
ROGER REVELLE	KAOU	292	24	386,413	598,378	9,273,912
ATLANTIS	KAQP	360	29	501,265	279,488	14,452,220
T.G. THOMPSON	KTDQ	138	20	180,355	86,137	3,021,483
HEALY	NEPP	119	30	148,606	281,343	4,458,180
INVESTIGATOR	VLMJ	235	31	312,814	326,162	9,255,733
AURORA AUSTRALIS	VNAA	141	28	194,829	97,334	5,343,558
NEIL ARMSTRONG	WARL	303	31	426,131	263,416	12,751,533
NATHANIEL B. PALMER	WBP3210	227	23	325,123	285,573	7,421,669
LAURENCE M. GOULD	WCX7445	363	23	514,129	743,269	10,603,452
KILO MOANA	WDA7827	224	22	295,000	11,392	6,267,597
PELICAN	WDD6114	52	16	59,560	12,344	848,339
SIKULIAQ	WDG7520	342	21	490,727	532,570	9,092,028
SALLY RIDE	WSAF	334	22	435,984	444,463	9,591,648
ROBERT GORDON SPROUL	WSQ2674	305	18	386,912	361,613	6,964,416
HENRY B. BIGELOW	WTDF	171	16	212,711	194,133	3,354,571
OKEANOS EXPLORER	WTDH	173	16	225,085	163,647	3,541,122
PISCES	WTDL	174	18	229,035	456,942	4,105,942
OREGON II	WTDO	171	16	219,110	150,346	3,471,508
THOMAS JEFFERSON	WTEA	176	16	231,903	155,000	3,710,448
FAIRWEATHER	WTEB	122	16	158,488	163,042	2,440,193
RON BROWN	WTEC	203	18	279,107	252,178	4,685,779
BELL M. SHIMADA	WTED	203	20	255,656	188,571	5,069,290
OSCAR ELTON SETTE	WTEE	157	16	201,181	156,586	3,140,677
RAINIER	WTEF	109	13	146,034	67,648	1,898,442
REUBEN LASKER	WTEG	173	20	228,054	487,615	4,032,029
GORDON GUNTER	WTEO	184	16	245,900	197,953	3,927,958
OSCAR DYSON	WTEP	169	31	219,963	567,083	6,469,291
NANCY FOSTER	WTER	133	17	166,378	69,827	2,438,370
HI'IALAKAI	WTEY	91	19	119,021	87,642	2,213,040
FALKOR	ZCYL5	203	35	272,160	315,348	8,515,218
TANGAROA	ZMFR	286	17	404,467	534,671	6,851,468

Table 1: CY2018 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 one-minute 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 CY2018 scheduling information was not obtainable for the *Healy* prior to this report distribution.) Scheduled days may sometimes include days spent at port, 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 (e.g. within an exclusive economic zone, marine protected area, etc., 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. The DAC provides JSON web services (http://samos.coaps.fsu.edu/html/webservices.php) to allow interested parties to track the date data was last received by the DAC for each vessel (Preliminary File) and the results of the automated quality control on these files (Preliminary Quality). This allows operators and the DAC to track the completeness of SAMOS data for each vessel and to identify when data are not received within the 10-day limit for visual quality control. When data are received after the 10-day limit, current funding for the SAMOS initiative does 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.

In Figure 2, we directly compare the data we've received (green and blue) to final 2018 ship schedules provided by each vessel's institution. (*Note again that a schedule was not obtained for the *Healy*.) 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 and yellow, with yellow applying only to the period 10/10-10/11, during which time there was a catastrophic hurricane-related mail service failure at the DAC. (It would be ideal to recover any of these yellow ship days, if possible.) Within the grey and yellow 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. Note in Table 2 any "yellow" days have not been counted against vessel transmissivity out of fairness to any failed transmission attempts. All data received for 2018, with the exceptions of *Tangaroa*, *Aurora Australis* 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		S	S	S	S	S	S	S	S	S	S	S	S	S	S																
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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			
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Figure 2: 2018 calendar showing (**green** and **blue**) ship days received by DAC and (grey and yellow) additional days reported afloat by vessels; "***S***" denotes vessel reportedly at sea, "*" 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
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WDC9417			S	S	S	S											S	S	S	S	S	S	S							S	
WDD6114			S						S	S	S	S	S	S									S	S	S	S	S	S			
WDG7520																															
WSAF																															
WSQ2674																															
WTDF											S																				
WTDH																															
WTDL											S	S	S	S	S																
WTDO					S															S											
WTEA																															
WTEB																									S		S				
WTEC	S										S						*	*	*												
WTED										S					S																
WTEE								S																							
WTEF																															
WTEG																															
WTEK																															
WTEO																															
WTEP																															
WTER	S	S	S	S	S	S	S																							S	S
WTEY																															
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																														
KAQP																															
KTDQ						S													S	S											
NEPP																															
VLMJ																															
VNAA																															
WARL																															
WBP3210																															
WCX7445																															
WDA7827	S	S	S																						S						
WDC9417												S	S	S	S	S	S					S	S	S	S	S	S	S	S	S	S
WDD6114	S	S	S	S	S	S								S	S	S	S	S	S	S	S	S									
WDG7520																															
WSAF																															
WSQ2674																															
WTDF							S																								S
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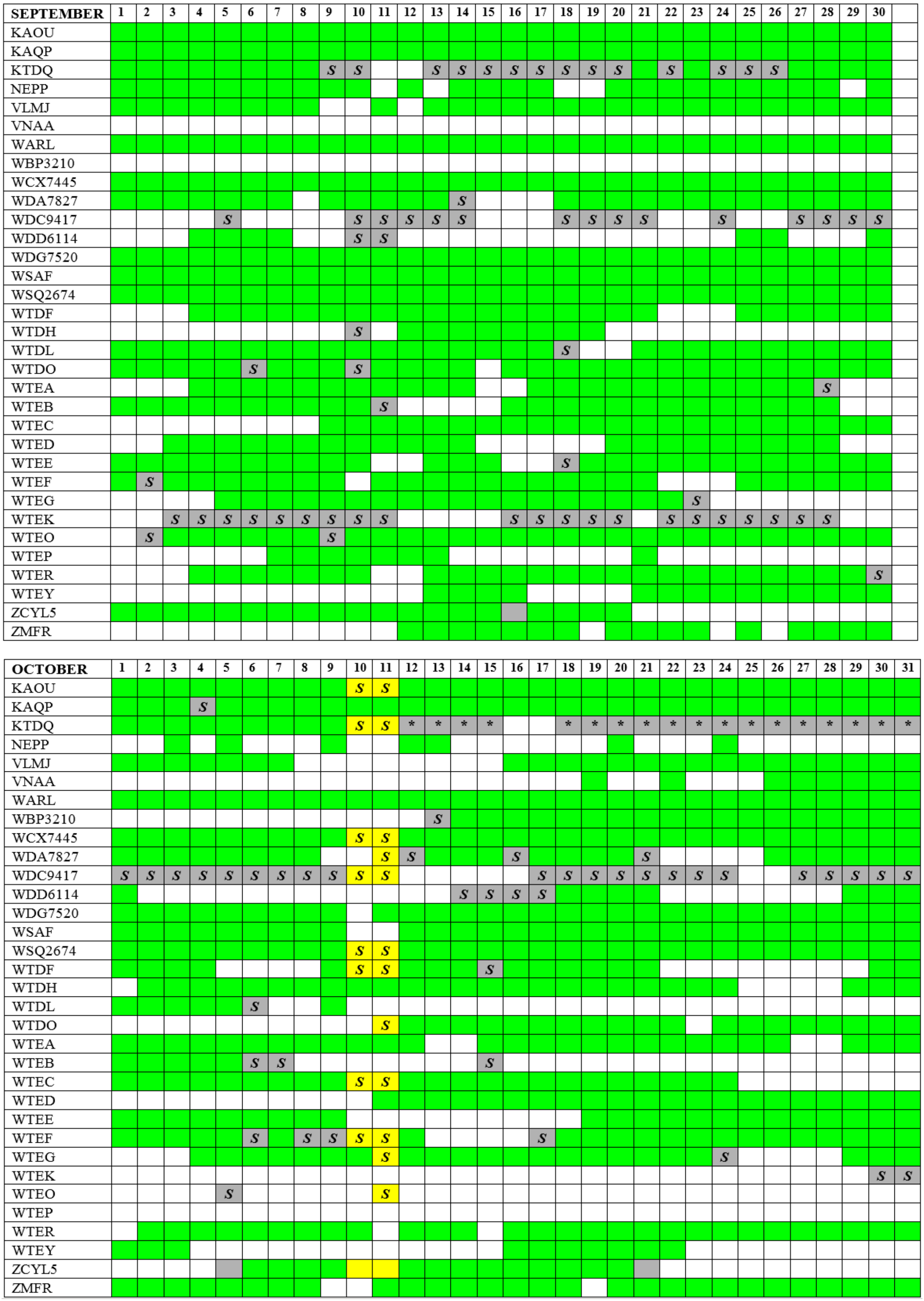
WTEO																															S
WTEP																															S
WTER	S	S	S	S	S	S	S	S					S	S									S		S						
WTEY																															
ZCYL5																															
ZMFR																															

(Figure 2: cont'd)



(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												S																			
KAQP																															
KTDQ																															
NEPP																															
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VNAA																															
WARL																															
WBP3210																															
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WDA7827						S	S												S												
WDC9417					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	
WDD6114														S	S	S															
WDG7520																															
WSAF																															
WSQ2674																															
WTDF																															
WTDH																															
WTDL							S																				S	S	S	S	
WTDO																					S										
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WTEO																															
WTEP																															
WTER														S			S														
WTEY																															
ZCYL5																															
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		S	S	S	S	S	S	S	S																*	*	*	*			
NEPP																															
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VNAA																															
WARL																															
WBP3210																															
WCX7445																															
WDA7827	S	S	S	S	S																										
WDC9417	S	S	S			S	S	S	S	S	S		S	S	S	S	S														
WDD6114						S									S	S	S	S	S	S	S	S									
WDG7520																															
WSAF																															
WSQ2674																															
WTDF																															
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WTEO				S																											
WTEP																															
WTER																															
WTEY																															
ZCYL5																															
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**
# scheduled at-sea days	191	112	57	169	170	70	145	174
# matching SAMOS days	179	101	0	163	159	64	113	163
→% received	94%	90%	0%	96%	94%	91%	78%	94%

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**
# scheduled at-sea days	174	170	136	188	130	161	206	176
# matching SAMOS days	168	164	121	168	103	151	192	170
→% received	97%	96%	89%	89%	79%	94%	93%	97%

TOTAL scheduled at-sea days:	2429
TOTAL matching SAMOS days:	2179
OVERALL RATIO:	**90%**

Table 2: 2018 data submission performance metrics listed by institution and ship. Note where official schedules specify "at sea" days only those days are counted. In all other cases "at sea" is assumed and scheduled days are counted as-is. Note also while SAMOS days follow GMT, ship schedules may not. This leaves room for some small margin of error. Lastly, note any transit through an exclusive economic zone, marine protected area, etc. may preclude data transmission. For 2018, missing "at sea" 10/10-10/11 dates have herein been granted complimentary "received" status because on those dates a hurricane-related mail server failure existed at the FSU MDC, preventing data receipt. Excepting the *Laurence M. Gould* and *Nathaniel B. Palmer*, for which only private ship schedules were available in 2018, all schedule resources are listed in the References. Note in the case of the USCGC *Healy* no published schedule is available, hence that vessel is not represented here.

IMOS			
Ship Name	Aurora Australis	Investigator	Tangaroa
Call Sign	VNAA	VLMJ	ZMFR
# scheduled at-sea days	141	244	282
# matching SAMOS days	141	244	282
→% received	100%	100%	100%
TOTAL scheduled at-sea days:	667		
TOTAL matching SAMOS days:	667		
OVERALL RATIO:	100%		

OPP		
Ship Name	Laurence M. Gould	Nathaniel B. Palmer
Call Sign	WCX7445	WBP3210
# scheduled at-sea days	230	199
# matching SAMOS days	230	198
→% received	100%	99%
TOTAL scheduled days:	429	
TOTAL matching SAMOS days:	428	
OVERALL RATIO:	100%	

SIO			
Ship Name	Robert G. Sproul	Roger Revelle	Sally Ride
Call Sign	WSQ2674	KAOU	WSAF
# scheduled at-sea days	67	234	216
# matching SAMOS days	66	220	214
→% received	99%	94%	99%
TOTAL scheduled at-sea days:	517		
TOTAL matching SAMOS days:	500		
OVERALL RATIO:	97%		

WHOI		
Ship Name	R/V Atlantis	R/V Neil Armstrong
Call Sign	KAQP	WARL
# scheduled at-sea days	281	224
# matching SAMOS days	280	224
→% received	100%	100%
TOTAL scheduled at-sea days:	505	
TOTAL matching SAMOS days:	504	
OVERALL RATIO:	100%	

	BIOS	LUMCON	SOI	UAF	UHI	UW
Ship Name	Atlantic Explorer	Pelican	Falkor	Sikuliaq	Kilo Moana	Thomas G. Thompson
Call Sign	WDC9417	WDD6114	ZCYL5	WDG7520	WDA7827	KTDQ
TOTAL scheduled at-sea days	184	159	196	220	250	285
TOTAL matching SAMOS days	0	45	160	220	219	138
OVERALL RATIO:	0%	28%	82%	100%	88%	48%

(Table 2: cont'd)

b. Spatial coverage

Geographically, SAMOS data coverage continues to be noteworthy in 2018, with both the typical exposures and numerous points of interest outside traditional mapping/shipping lanes. Cruise coverage for the January 1, 2018 to December 31, 2018 period is shown in Figure 3. It includes a broad sampling of the North Atlantic provided by the *Atlantis*, *Okeanos Explorer*, *Pisces*, and *Neil Armstrong*, with a brushing of Cape Verde by *Atlantis* and additional exposures around Greenland and Iceland by the *Armstrong*, as well as numerous lengthy swaths of the Pacific and heavy coverage in and around Hawaii provided by the *Kilo Moana*, *Falkor*, *Hi'ialakai*, *Oscar Elton Sette*, and *Roger Revelle* (among others). The Antarctic and the Southern Ocean were again frequented by both the IMOS vessels (*Aurora Australis*, *Tangaroa*, *Investigator*) and the OPP vessels (*Laurence M. Gould* and *Nathaniel B. Palmer*), with the *Palmer* additionally providing data up along the Argentine coastline. Australia and New Zealand saw coverage via the *Tangaroa*, *Investigator*, and *Thomas G. Thompson*. The *Thompson* further offered data from around Singapore and the South China Sea. Natively, the entire east coast U.S. was densely sampled by the *Henry Bigelow*, *Nancy Foster*, *Gordon Gunter*, and *Oregon II* (among others). Similar coverage of the west coast, from Vancouver Island all the way down through Baja California Sur, was provided by the *Bell M. Shimada*, *Rainier*, *Reuben Lasker*, *Roger Revelle*, *Neil Armstrong*, and *Sally Ride* (among others). A focus in and around the Channel Islands of California was contributed by the *Robert Gordon Sproul*. Substantial coverage of Alaska, including some arctic circle exposure, was furnished by the *Sikuliaq*, *Healy*, *Oscar Dyson*, and *Fairweather*. Comprehensive coverage of the northern Gulf of Mexico and the Florida coastline was again provided by the *Oregon II*, *Gordon Gunter*, and *Pisces* (among others), with a concentrated effort south of the Mississippi River Delta area of Louisiana supplied by the *Pelican* and some Bahamas passage given by the *Bigelow* and *Okeanos Explorer*. Some tropical exposure extended out through the northern coastlines of Cuba and Hispaniola (*Nancy Foster*), to Puerto Rico and the British and U.S. Virgin Islands and beyond (*Foster* again, and the *Okeanos Explorer*, *Pisces*, and *Atlantis*). The *Atlantis* further traversed most of the South American coastline. Finally, the *Ronald H. Brown* made a roughly equatorial eastward circumnavigation of the globe in 2018 that included a foray up into the Arabian Sea after rounding Cape Horn and culminated in a crossing of the Panama Canal.

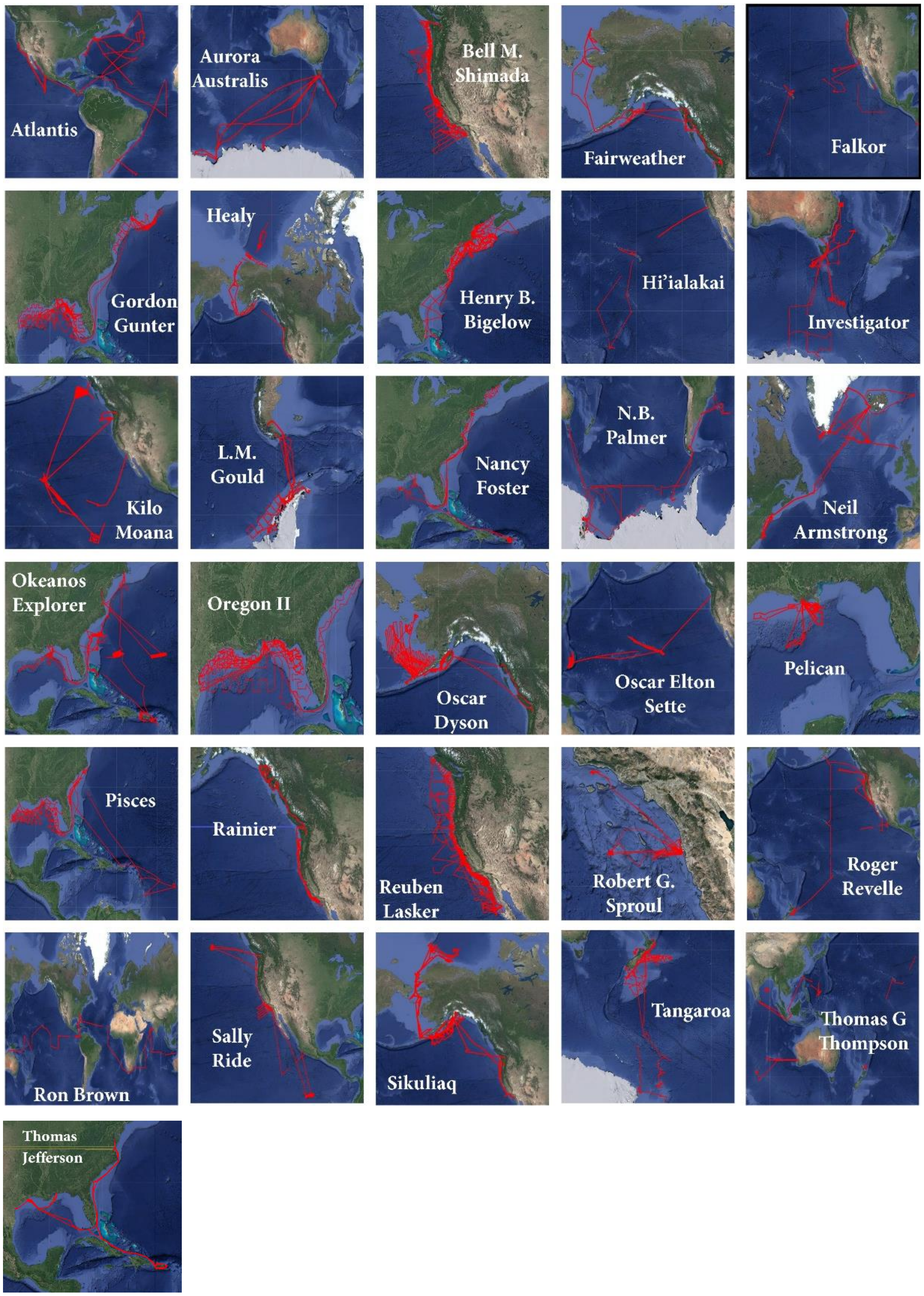


Figure 3: Cruise maps plotted for each vessel in 2018.

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 *Roger Revelle*, *Sally Ride* and *Thomas Jefferson* are all capable of providing dew point temperature, although only the *Thomas Jefferson* did so in 2018. The *Jefferson* is also the only vessel set up to provide wet bulb temperature and did so in 2018. 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 at the writing of this publication. (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, and those boxes in columns 6 through 26 in Table 4 with multiple entries indicate the number of redundant sensors available for reporting and processing in 2018/2019; 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 and detailed descriptions of the quality tests are provided in Smith et al. (2018). It should be noted that no secondary automated QC was active in 2018 (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. 2018 quality across-system

This section presents the overall quality from the system of ships providing observations to the SAMOS data center in 2018. 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.

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.

The *Revelle* was outputting a likely missing value (-99) for most of her parameters (including P and P2) in January and March, all of which would have been flagged as out of bounds. This probably explains the slight upticks in flagging seen in P and P2 for those months. It is not immediately clear what caused the uptick in April in P, nor in November in P3. A likely explanation would seem to be an increased number of ships experiencing the common problems listed above all at the same time.

We note at some time during the months of January, June, and August *Neil Armstrong* had special values assigned to several parameters, P2 being one of them, and the same occurred for *Atlantis* during the months of August through October, which again includes P2. These special values were probably the result of maintenance activities on each vessel.

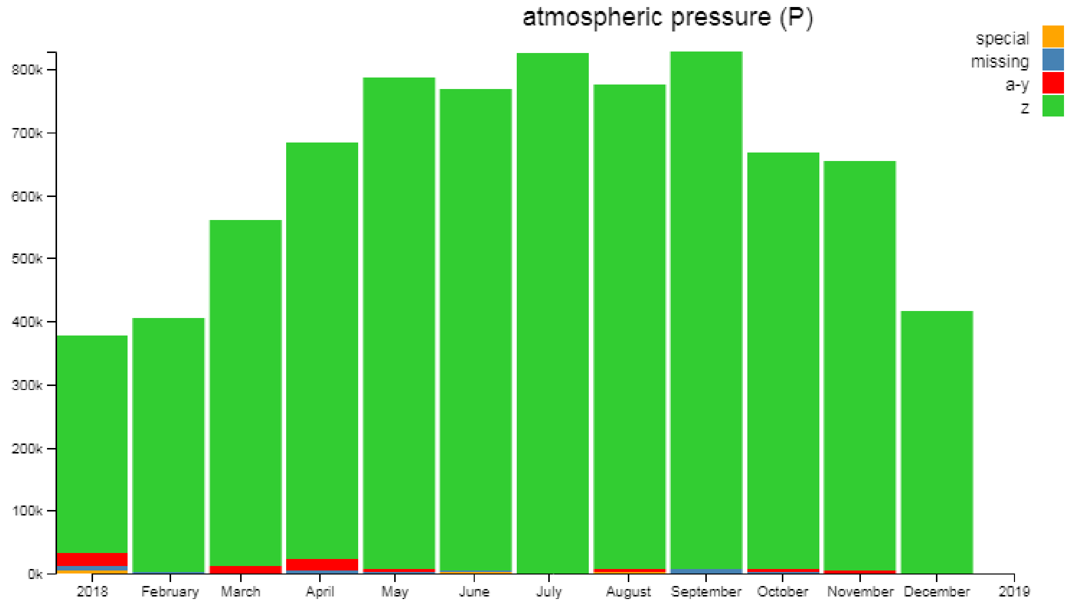
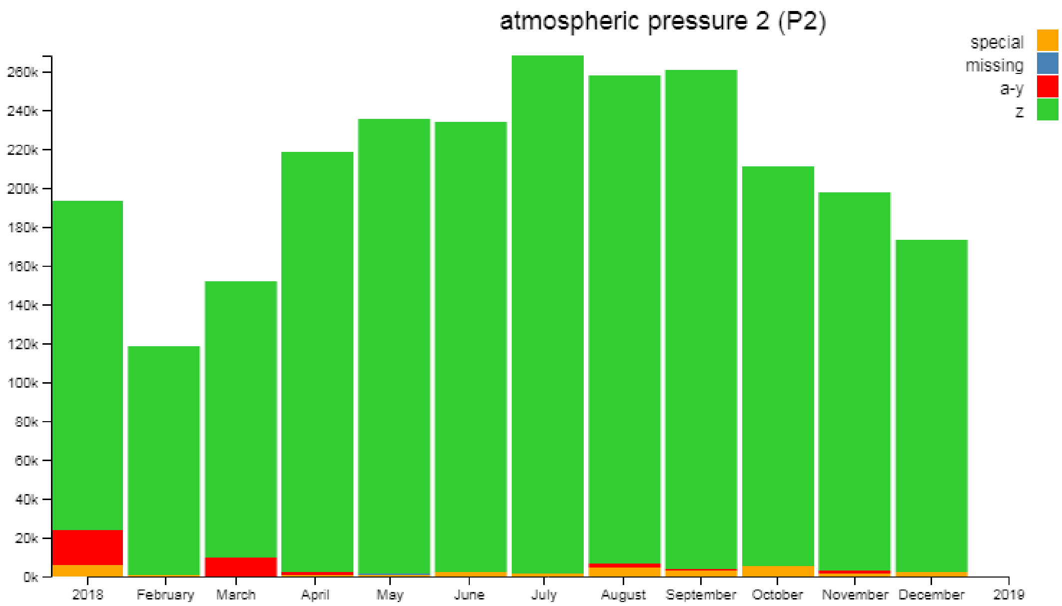
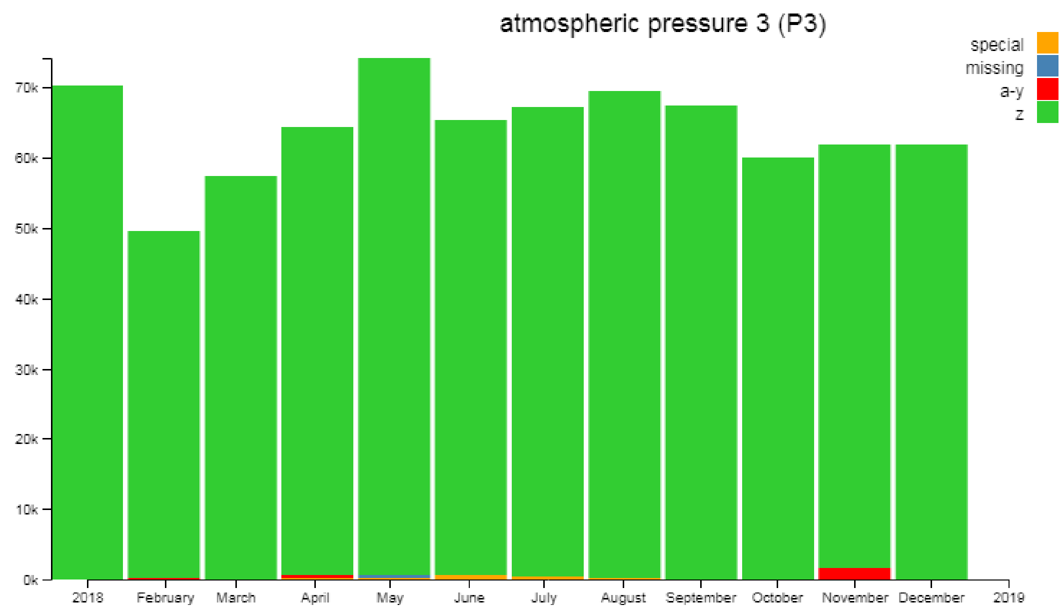


Figure 4: Total number of (this page) atmospheric pressure – P – (next page, top) atmospheric pressure 2 – P2 – and (next page, bottom) atmospheric pressure 3 – P3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that 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). With the air temperature sensors, again flow obstruction is 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. Thermal contamination 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). Figure 55 is a good example of contamination from thermal proximity. Contamination from stack exhaust was also a common problem. Figure 42 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.

The upticks in flagging in November seen in both T and T2 are likely attributed to *Sally Ride*, which vessel experienced a T (and possibly T2 as well) sensor failure that month. The April and May upticks seen in T2 are also likely attributable to the *Ride*, as the sensor appeared to go bad during the period (documented; see individual vessel description in section 3c for details). The January and March upticks in T are again probably due to the *Revelle's* reporting likely missing values (-99). The origins of any of the other upticks remain unclear; once again it's likely several vessels were simultaneously experiencing common sensor issues.

We note T2 was another variable that received some special values for *Armstrong* in January, June, and August and for *Atlantis* in August through October, probably during maintenance periods.

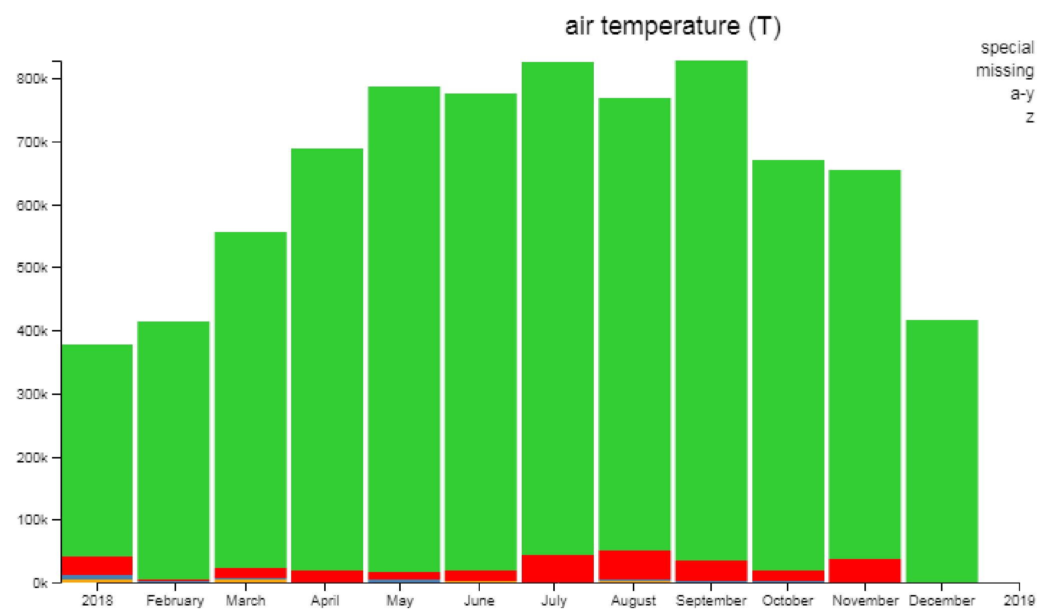
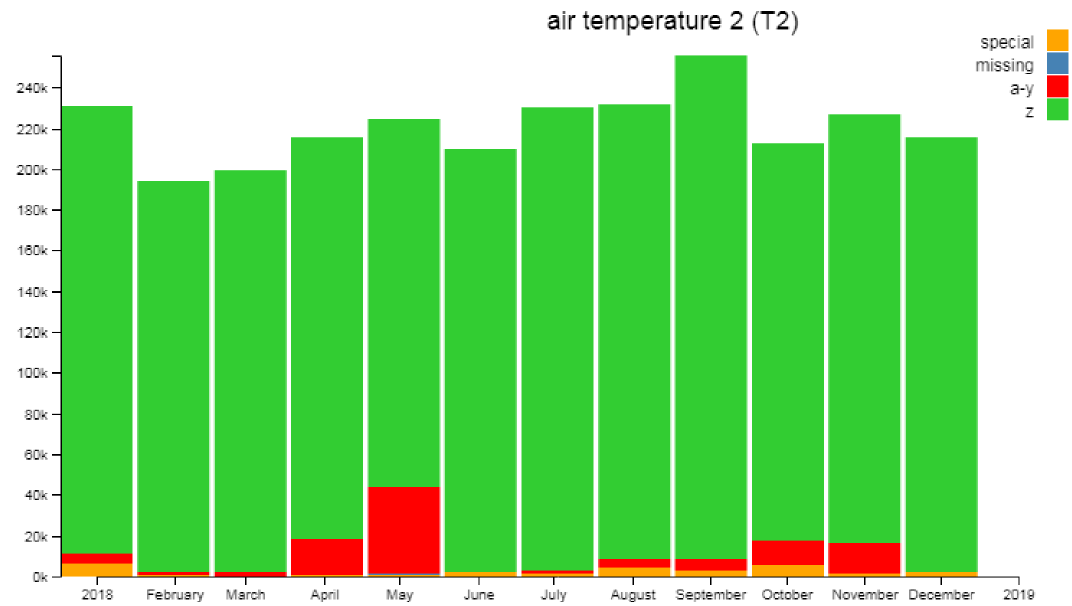
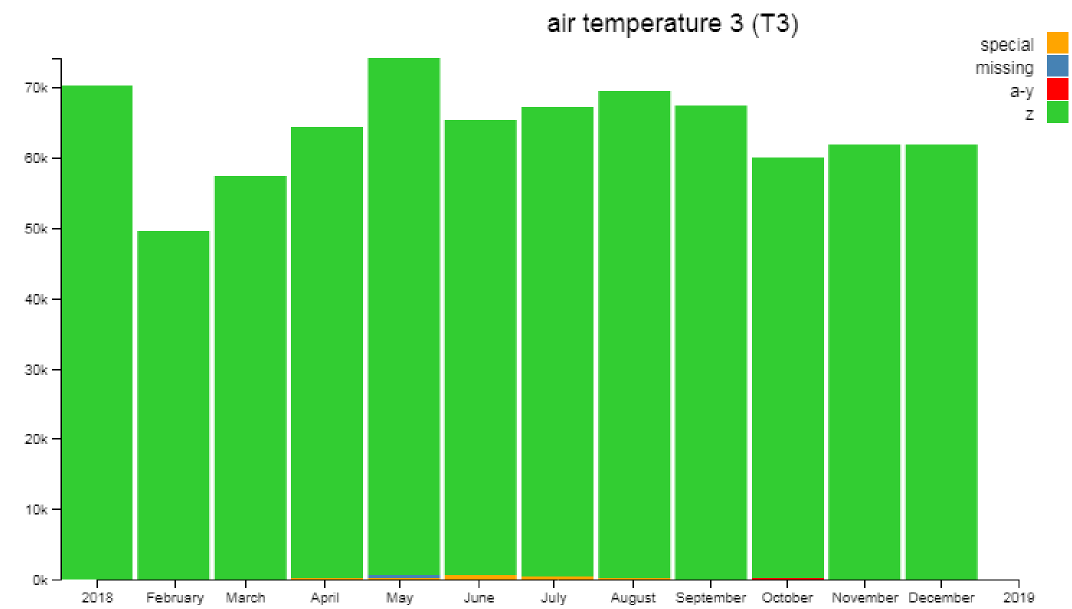


Figure 5: Total number of (this page) air temperature – T – (next page, top) air temperature 2 – T2 – and (next page, bottom) air temperature 3 – T3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of 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 2018; namely, the *Thomas Jefferson*, which is also the only vessel currently set up to report wet bulb. (We note TW from the *Jefferson* is a calculated value, rather than being directly measured.)

There were no notable issues with TW in 2018.

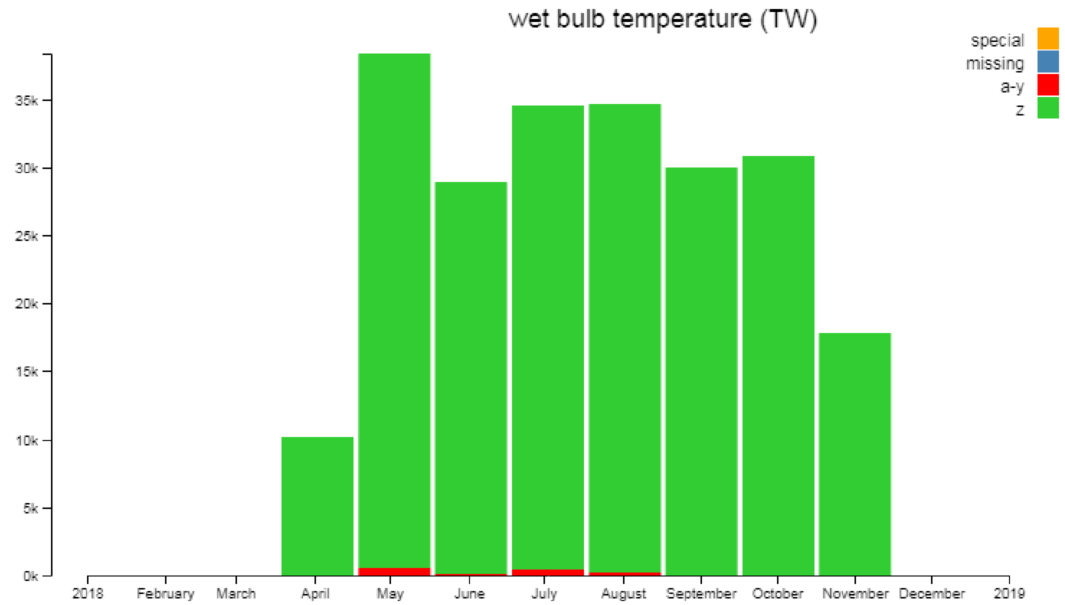


Figure 6: Total number of wet bulb temperature – TW – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

Dew point temperature (Figure 7) was also only reported by one vessel in 2018; again, the *Thomas Jefferson*, although three additional vessels are currently set up to report dew point if they wish. (Again, we note TD from the *Jefferson* is a calculated value, rather than being directly measured.) As with TW, there were no notable issues with TD in 2018.

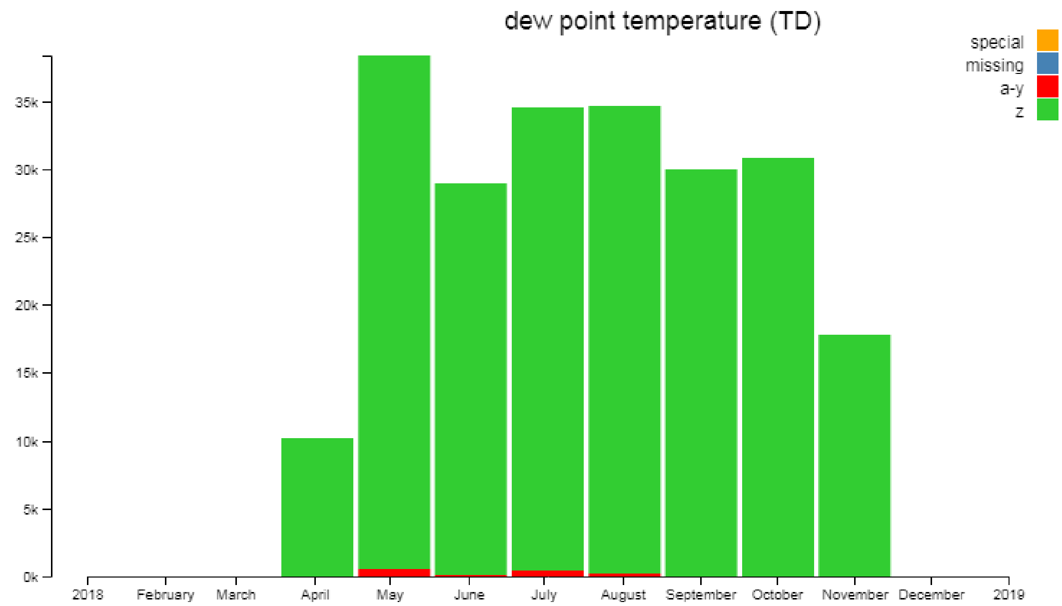
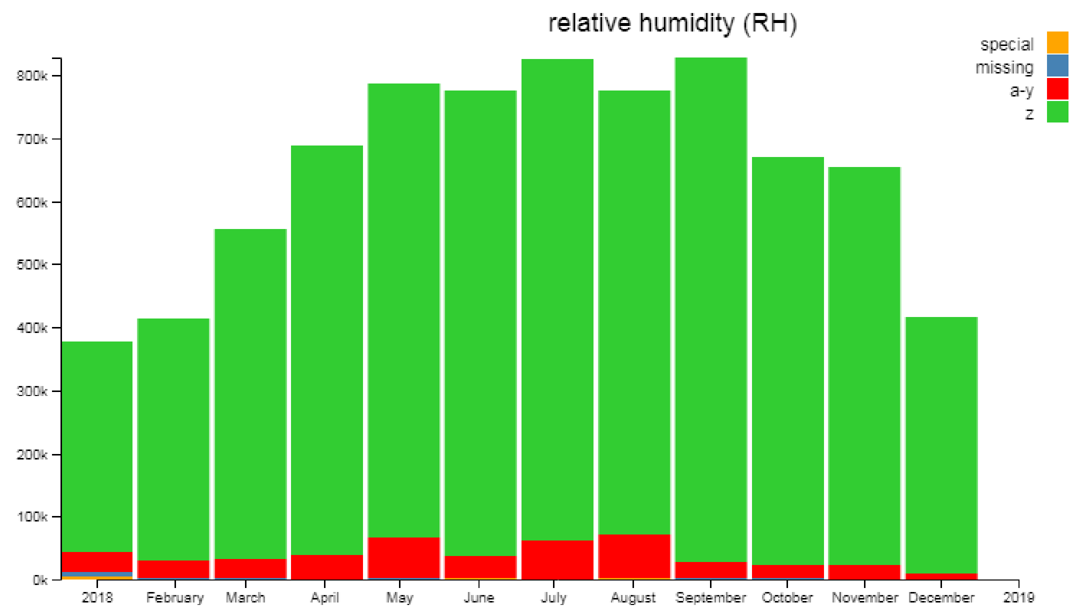


Figure 7: Total number of dew point temperature – TD – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are 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.

The uptick in flagging in May seen in RH was partly because of *Sally Ride* needing to clean the sensor's windscreen (documented; see individual vessel description in section 3c for details) and partly due to the *Gould* (details unknown). In July and August 3 separate vessels were experiencing issues with RH: the *Lasker's* sensor was not actually hooked up at the time and was recording/reporting an unknown signal (documented; see individual vessel description in section 3c for details), the *Sette's* sensor had apparently maxed out its service life (documented; see individual vessel description in section 3c for details), and the *Sikuliaq's* sensor suffered from unknown causes. We note here that RH was another of the parameters for which *Revelle* was reporting the likely missing value (-99) in January and March.

We note RH2 was another variable that received some special values for *Armstrong* in January, June, and August and for *Atlantis* in August through October, probably during maintenance periods.



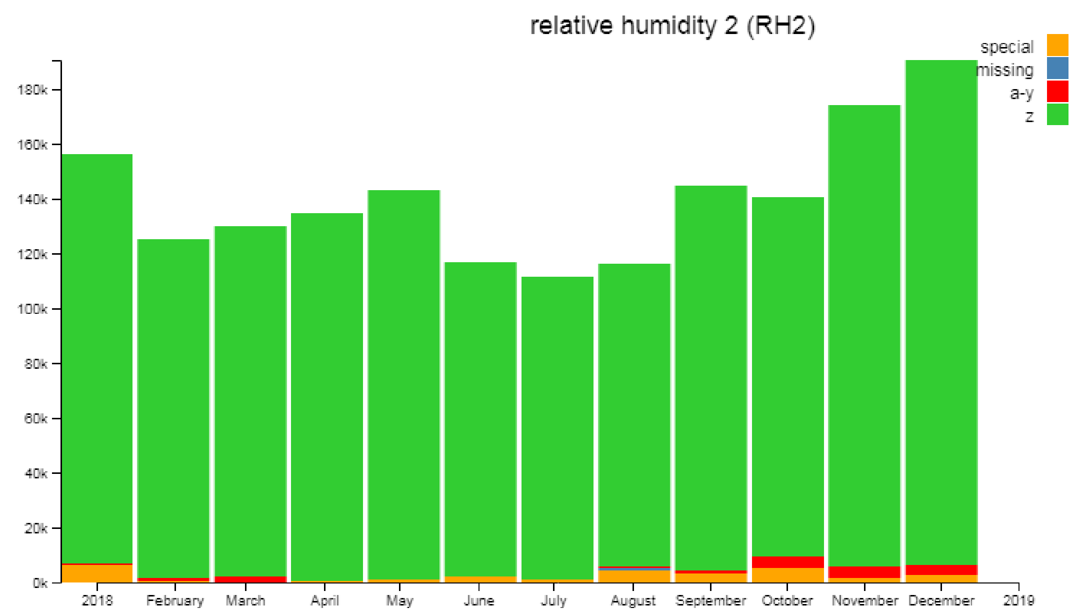
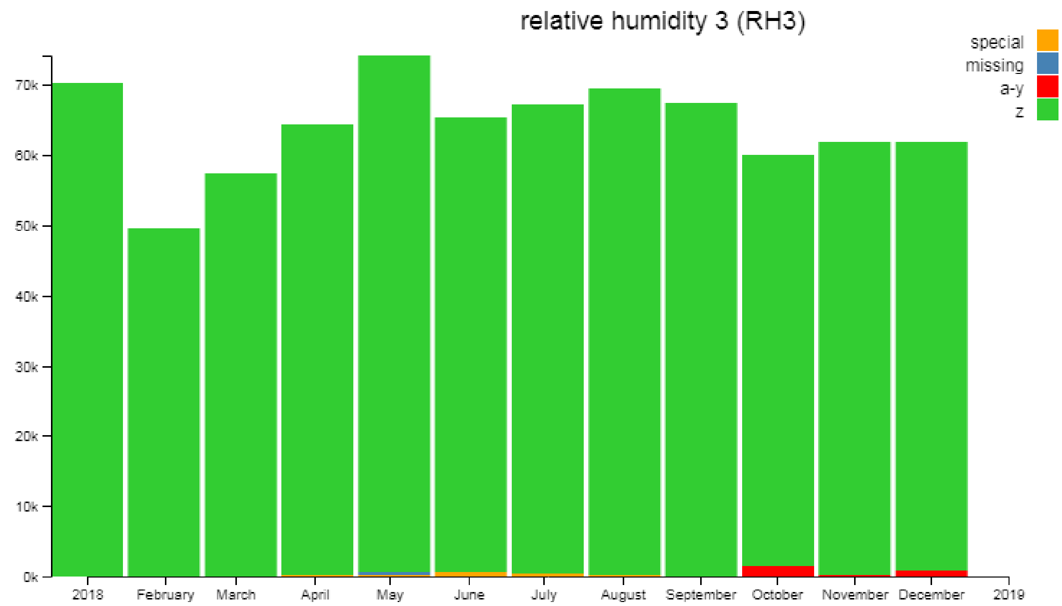


Figure 8: Total number of (this page, top) relative humidity – RH – (this page, bottom) relative humidity 2 – RH2 – and (next page) relative humidity 3 – RH3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed 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 2018. 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.

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 several 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.

The upticks in flagging in January through March seen in DIR appear to be due to the *Sproul* (reasons unknown), while those in April through May appear to be due to the *Pelican* (again, reasons unknown). Also, in May the *Lasker's* primary anemometer suffered from 180°-rotated installation, so they contributed to the increased flagging in

DIR (and SPD) then, as well. Regarding SPD, for the period March through May the *Okeanos Explorer* reported their platform relative wind speed with different units than they had provided in their metadata, which caused a lot of failed the true wind test (E) flagging of both DIR and SPD (documented; see individual vessel description in section 3c for details). As for SPD2, DIR3, and SPD3, all the obvious upticks in July and August likely came from the *Oscar Dyson*, which vessel developed a misalignment of their secondary wind sensor in July and August due to rough seas/weather and also suffered the destruction (by bald eagles!) of their tertiary wind sensor in July (documented; see individual vessel description in section 3c for details).

We note DIR2 and SPD2 were two more variables that received some special values for *Armstrong* in January, June, and August and for *Atlantis* in August through October, probably during maintenance periods.

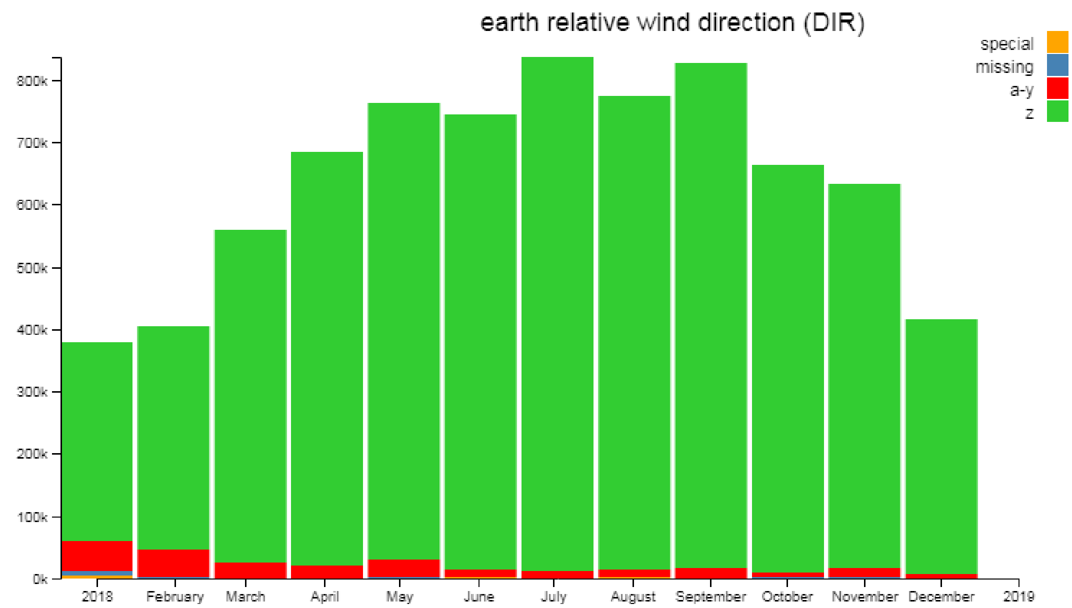
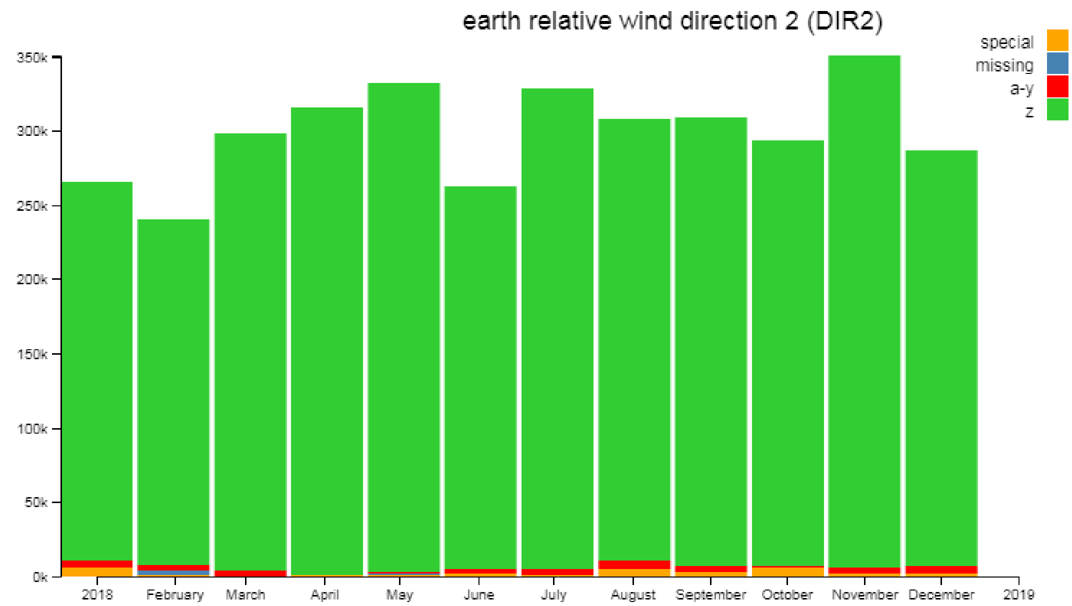
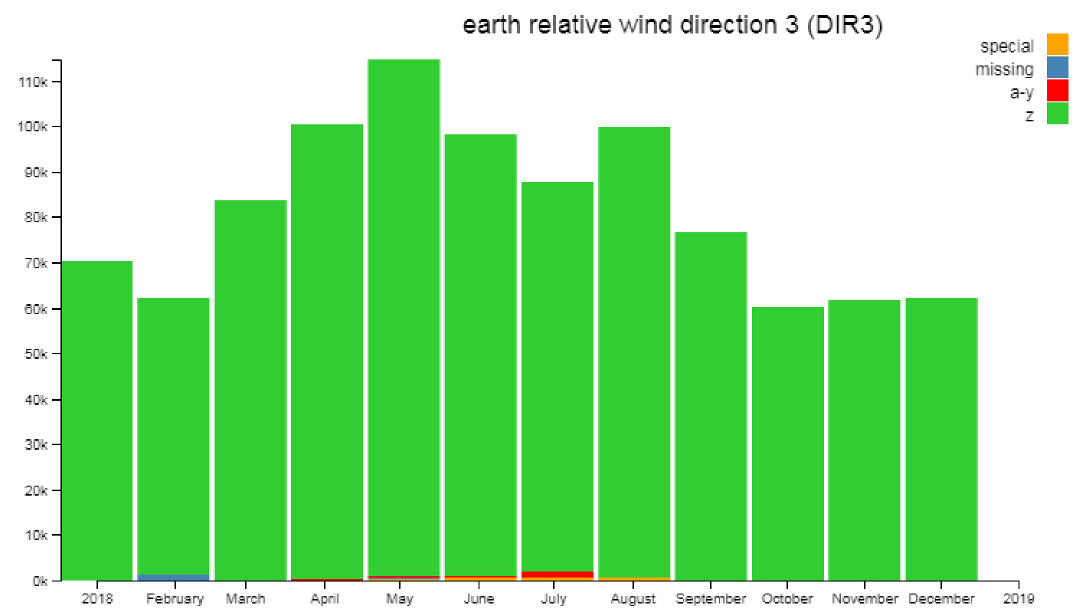
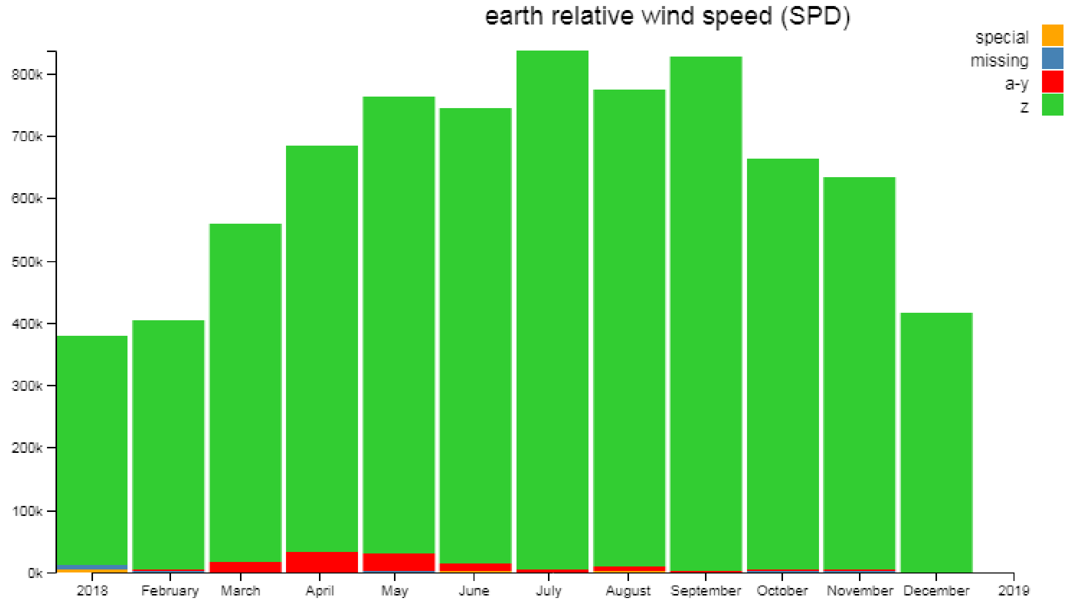


Figure 9: Total number of (this page) earth relative wind direction – DIR – (next page, top) earth relative wind direction 2 – DIR2 – and (next page, bottom) earth relative wind direction 3 – DIR3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) 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)



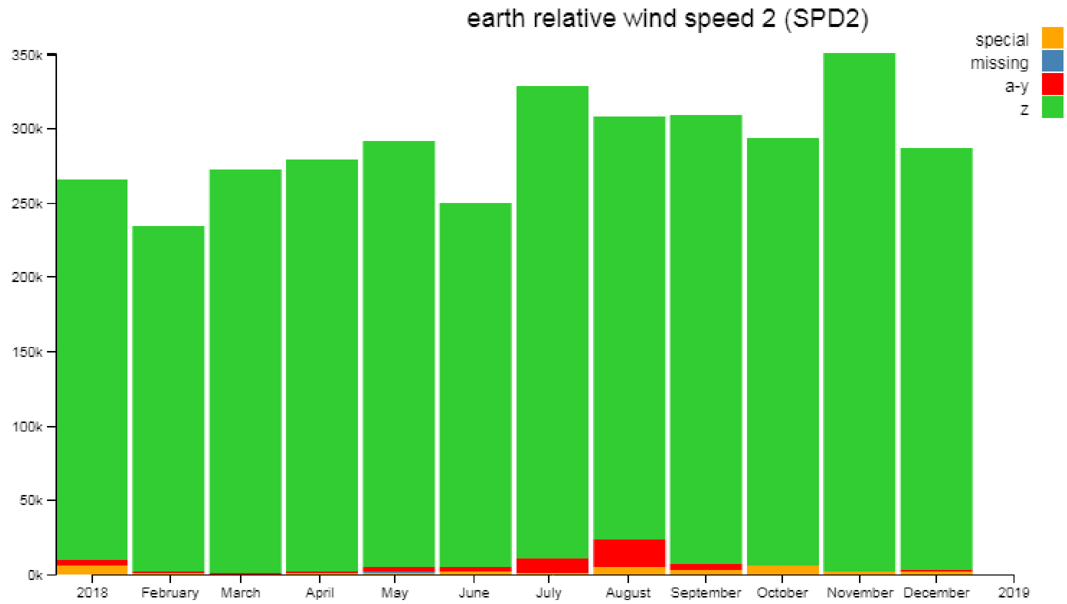
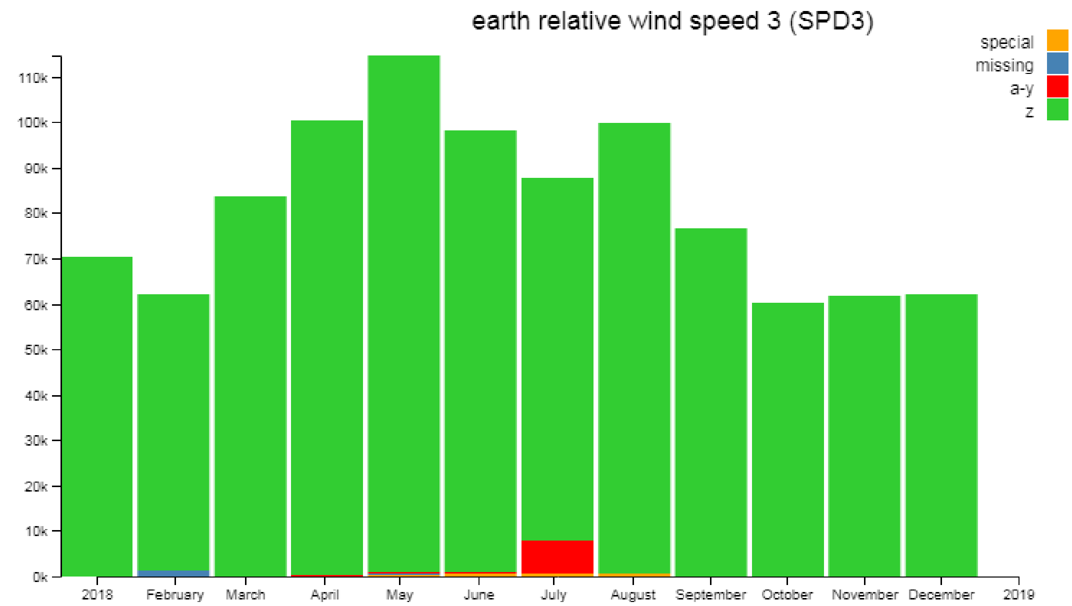


Figure 10: Total number of (this page, top) earth relative wind speed – SPD – (this page, bottom) earth relative wind speed 2 – SPD2 – and (next page) earth relative wind speed 3 – SPD3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values 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.

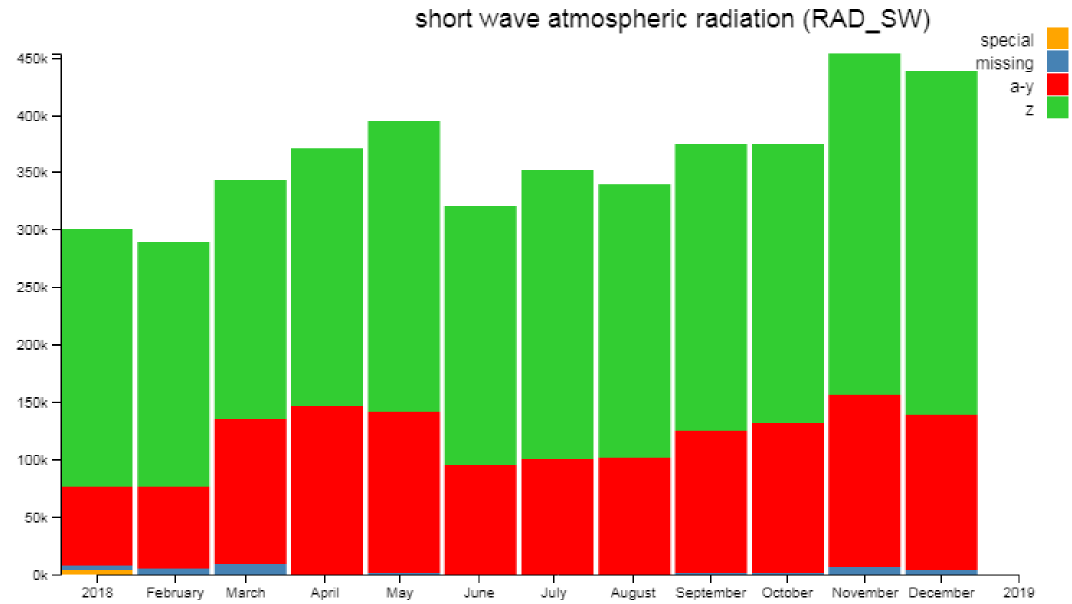


(Figure 10: cont'd)

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 January and March are likely attributable to the two vessels: the *Atlantis*, which vessel's sensor was frequently reporting bad values until it was ultimately disabled from processing in June (documented; see individual vessel description in section 3c for details), and also once again the *Revelle* and her likely missing values (-99). The uptick seen in RAD_PAR in January appears to have been largely due to the *Revelle* again, and the *Neil Armstrong*, for reasons unknown.

We note the special values seen in RAD_PAR and RAD_PAR2 seen in October through December were due to the *Falkor*, which vessel had some trouble getting the sensors outputting correct values (documented; see individual vessel description in section 3c. for details). The special values seen in RAD_LW and RAD_PAR in January were again the *Neil Armstrong*.



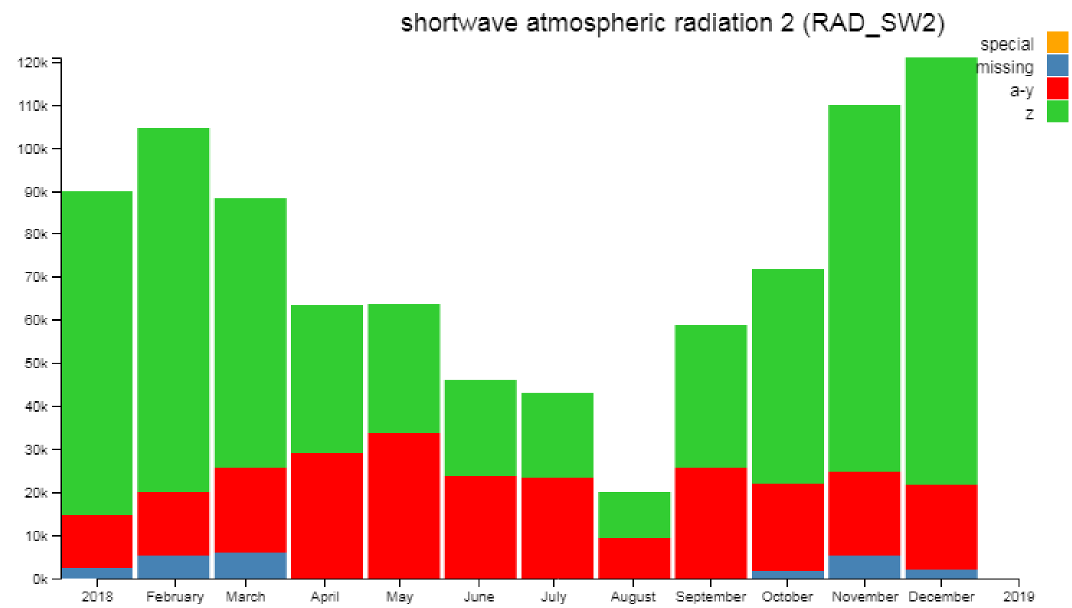


Figure 11: Total number of (top) shortwave atmospheric radiation – RAD_SW – and (bottom) shortwave atmospheric radiation 2 – RAD_SW2 –observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

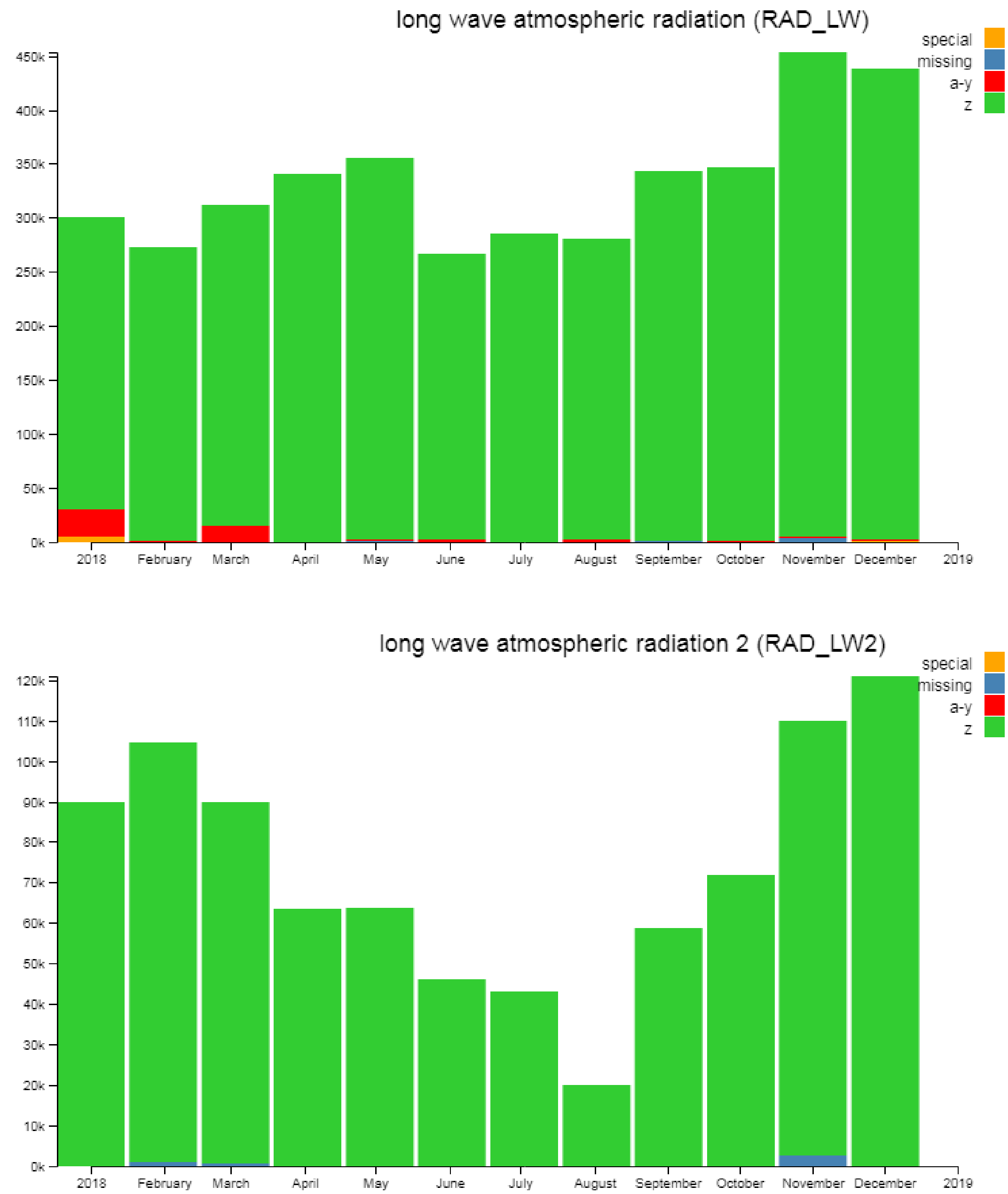
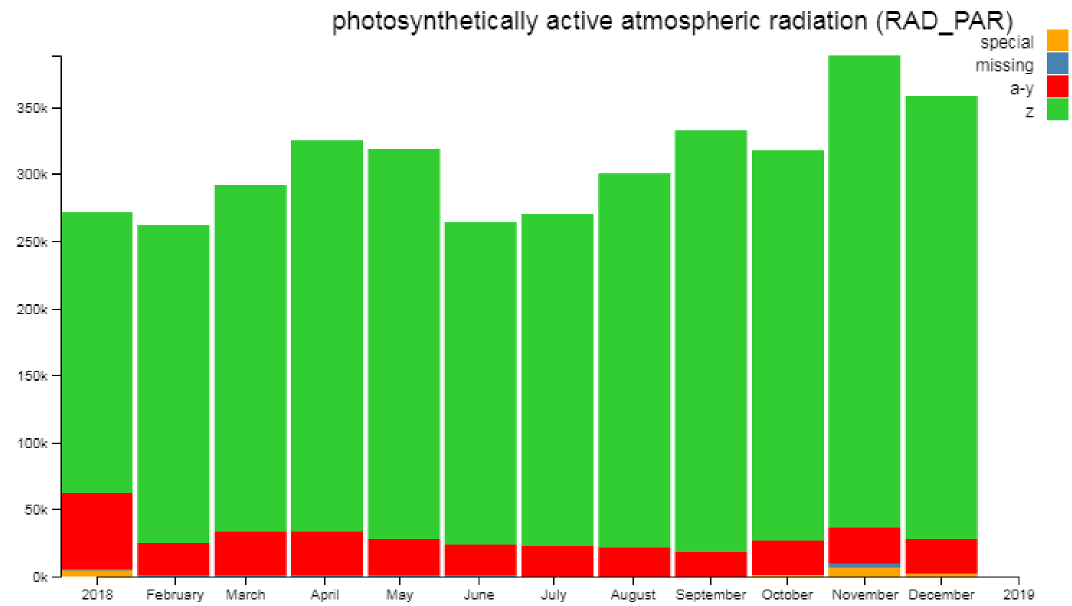


Figure 12: Total number of (top) long wave atmospheric radiation – RAD_LW – and (bottom) long wave atmospheric radiation 2 – RAD_LW2 –observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



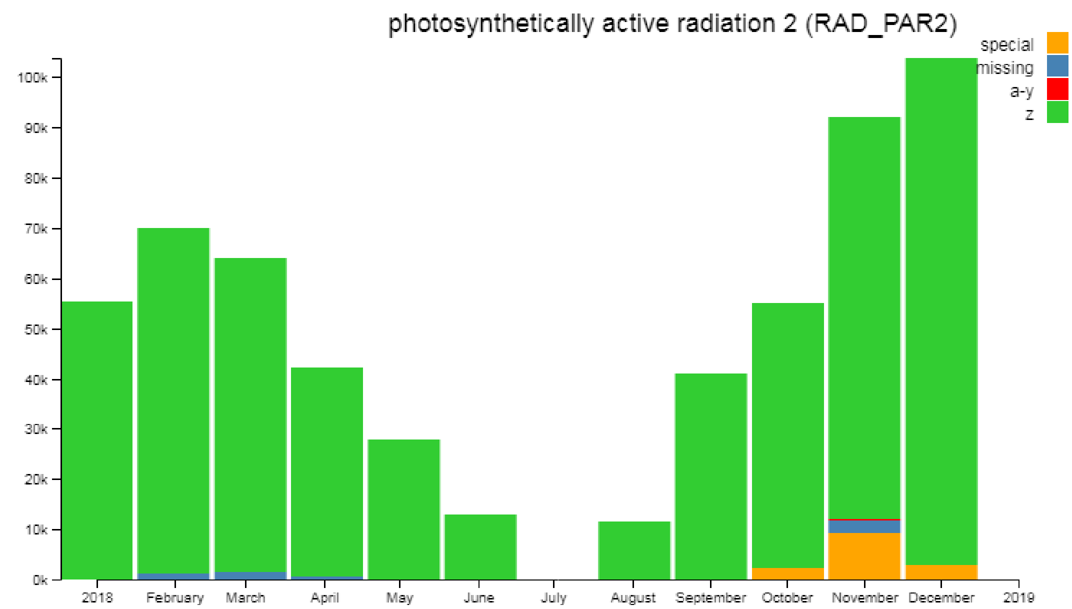
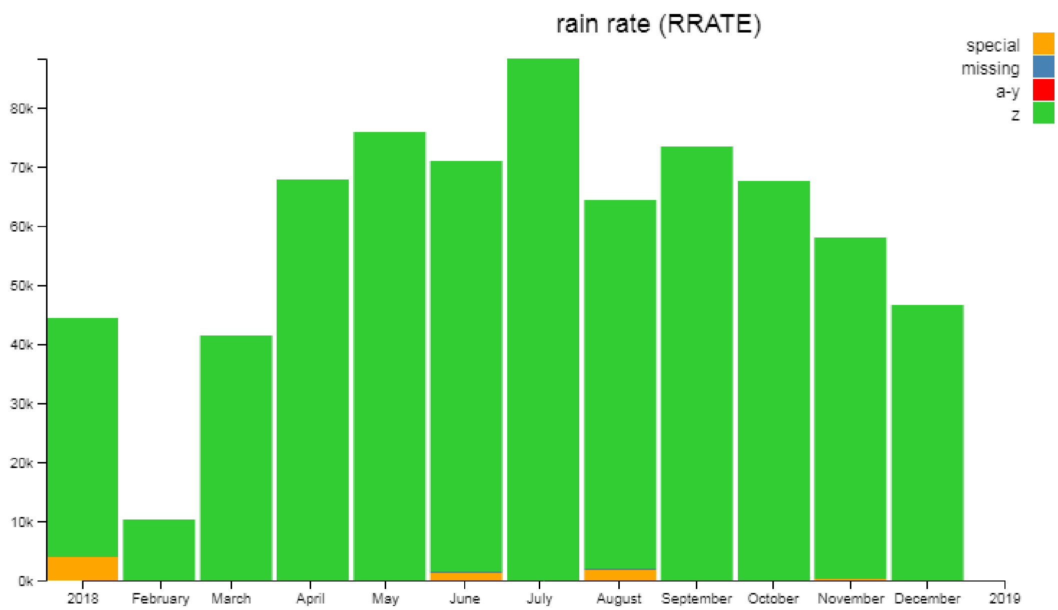


Figure 13: Total number of (top) photosynthetically active atmospheric radiation – RAD_PAR – and (bottom) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values 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.

There were no major problems of note with either the rain rate (Figure 14) or precipitation accumulation (Figure 15) parameters. It should 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.

We note RRATE and RRATE2 were two more variables that received some special values for *Armstrong* in January, June, and August and the same for RRATE2 for *Atlantis* in August through October, probably during maintenance periods. The special values seen in RRATE in July, November, and December were also from the *Atlantis*, again a likely maintenance artifact. All the above holds for PRECIP and PRECIP2 special values, as well.



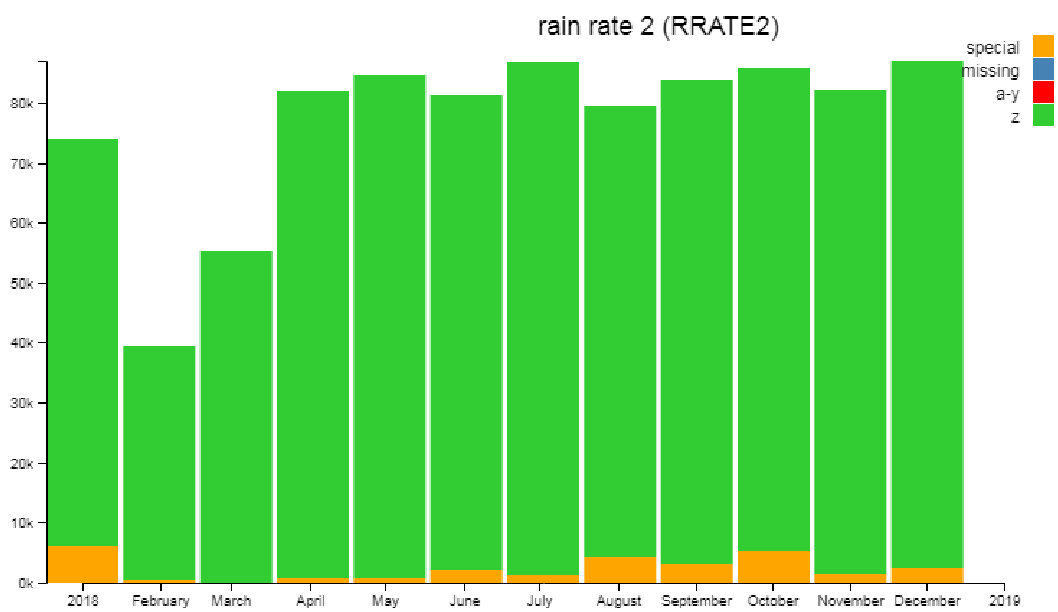
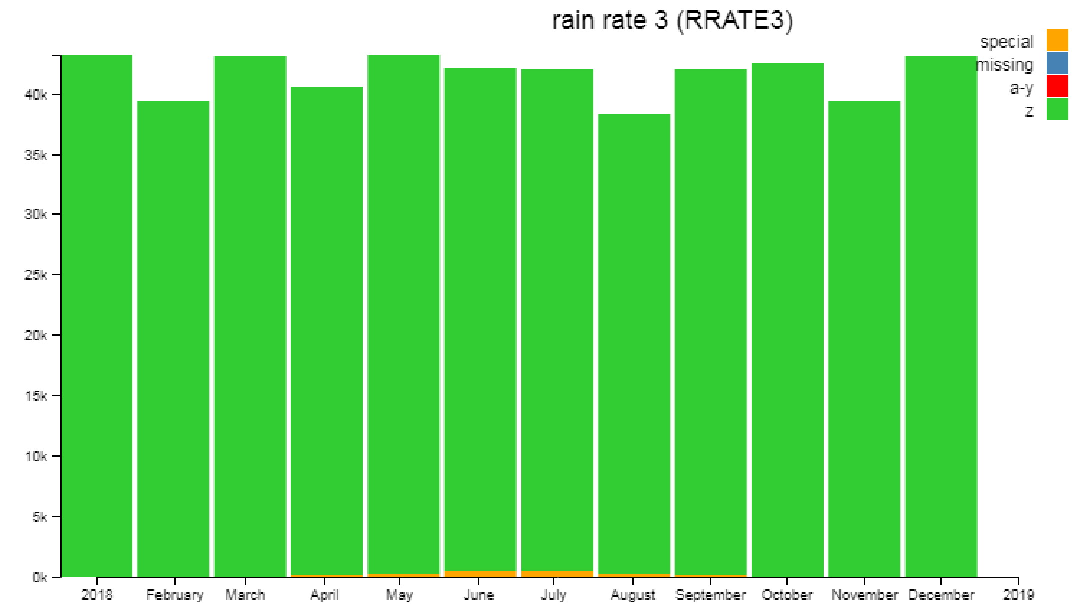


Figure 14: Total number of (this page, top) rain rate – RRATE – (this page, bottom) rain rate 2 – RRATE2 – and (next page) rain rate 3 – RRATE3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the 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)

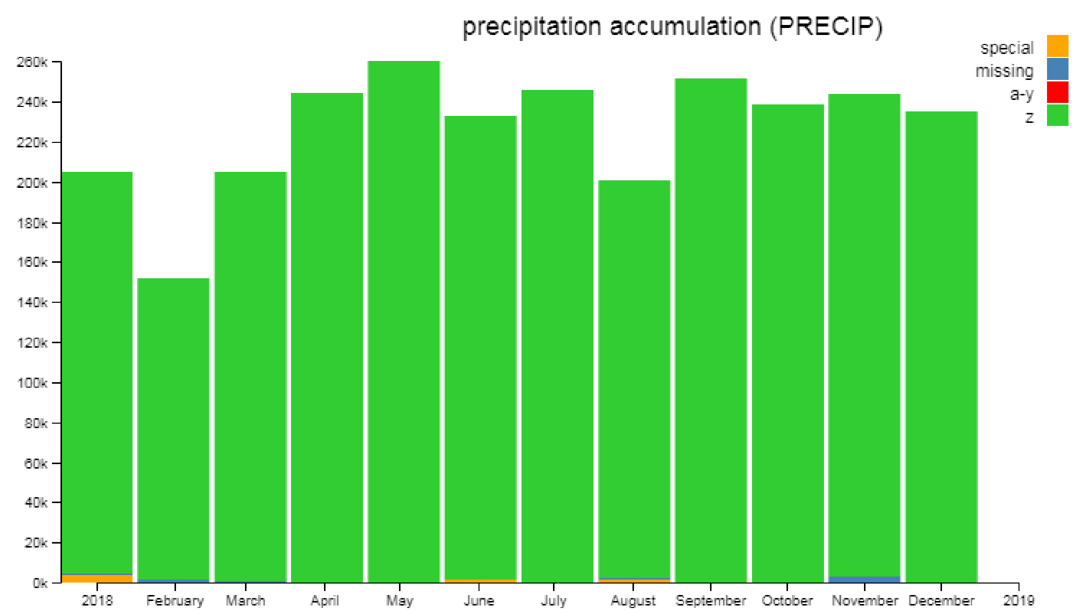
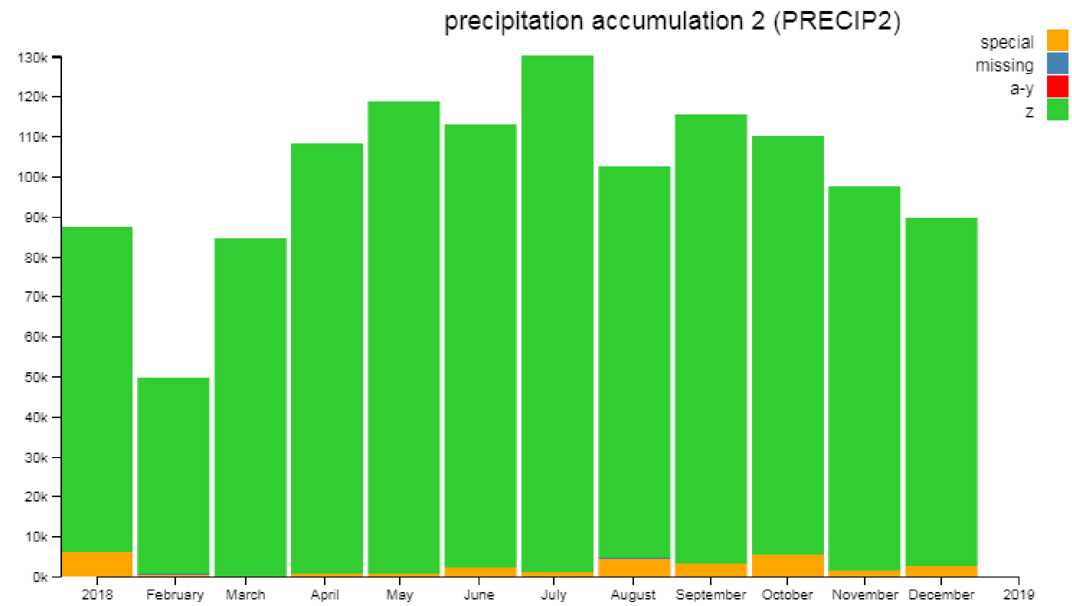
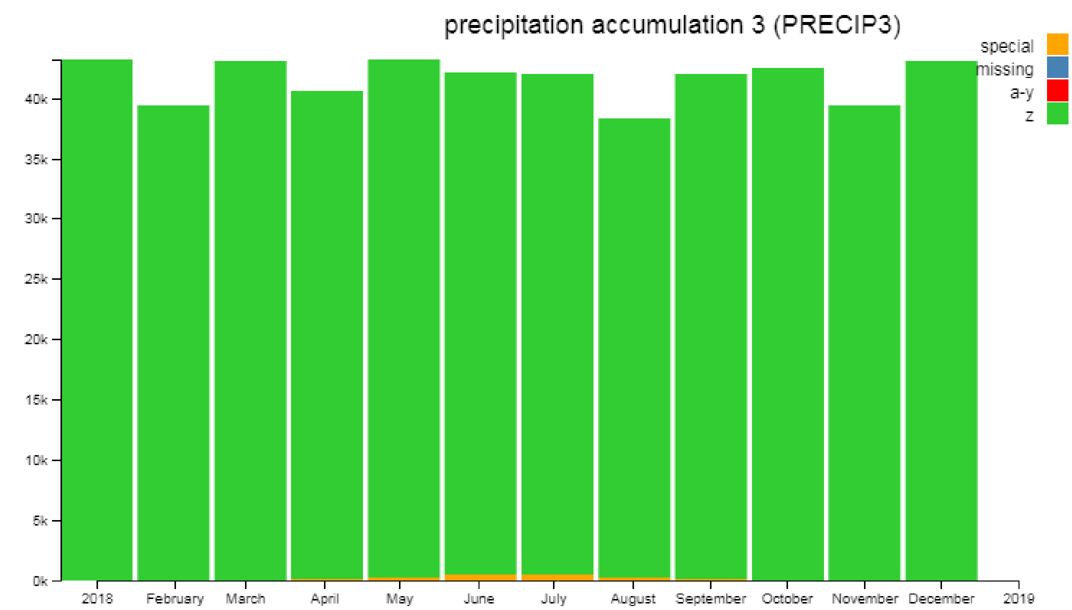


Figure 15: Total number of (this page) precipitation accumulation – PRECIP – (next page, top) precipitation accumulation 2 – PRECIP2 – and (next page, bottom) precipitation accumulation 3 – PRECIP3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) 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)

The main problem identified with the sea temperature parameter (Figure 16) 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, 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 2018.

The increase in flagging in January seen in TS seems to have been due to the *Sally Ride* (reasons unknown), while that in February is attributable to the *Bell M. Shimada*, which experienced a TS sensor interfacing issue that month (documented; see individual vessel descriptions in section 3c for details). The uptick seen in January in T2 seems to have come from the *Falkor*, likely because the sea water system was secured due to bad weather. In July the *Healy* reported likely missing values (-99 and 0) for their secondary TSG, so that probably goes a long way towards explaining the upticks seen that month in TS2. A good deal of the flagging of TS2 may also be explained via the *Sikuliaq*, as their infrared thermometer is commonly pointed at the dock when they are tied up, effectively measuring the dock temperature, which was subsequently frequently flagged as greater than four standard deviations from climatology (G). The reasoning behind any of the other increases in flagging are not immediately evident but probably once again we are dealing with numerous ships experiencing the usual flagging scenarios at the same time. We note TS and TS2 were two more parameters for which *Revelle* was reporting likely missing values (-99) in January and March.

Special values seen in TS in July were due to the *Atlantis*, for reasons unknown. Only *Oscar Dyson* reported TS5 in 2018, so the few special values seen there in February were hers. We note *Dyson* added TS numbers 3 through 6 in February so there were likely some initial kinks in the data.

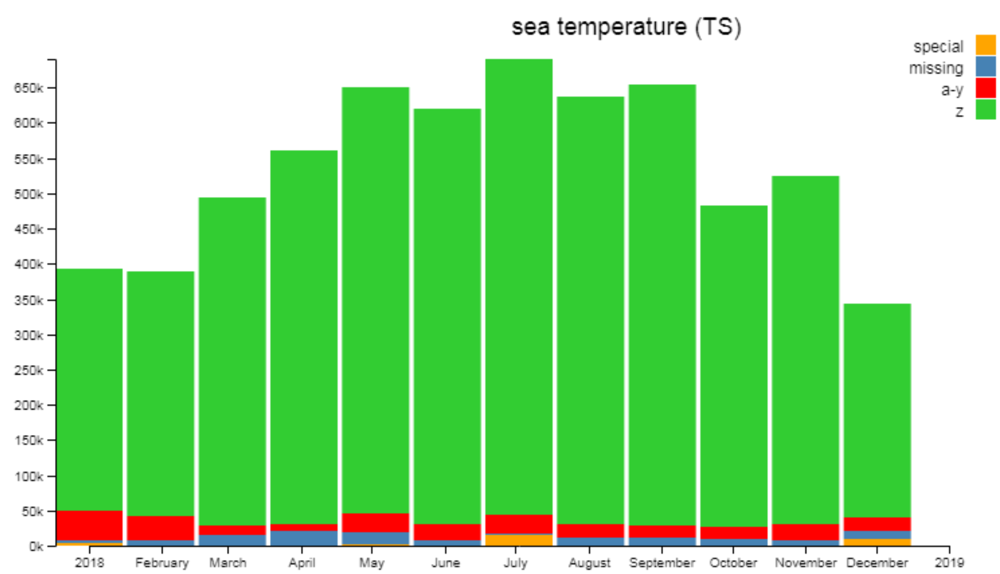
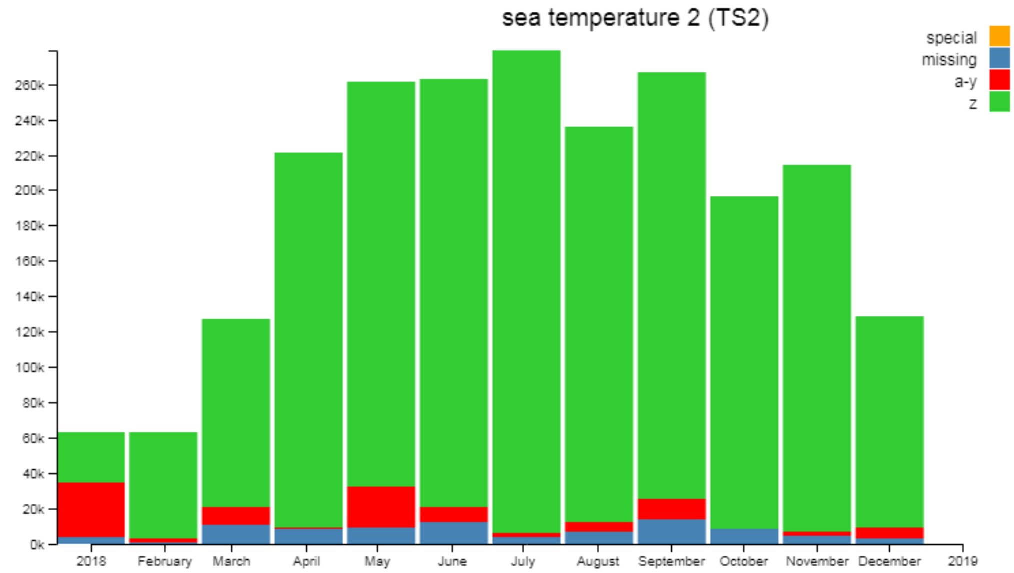
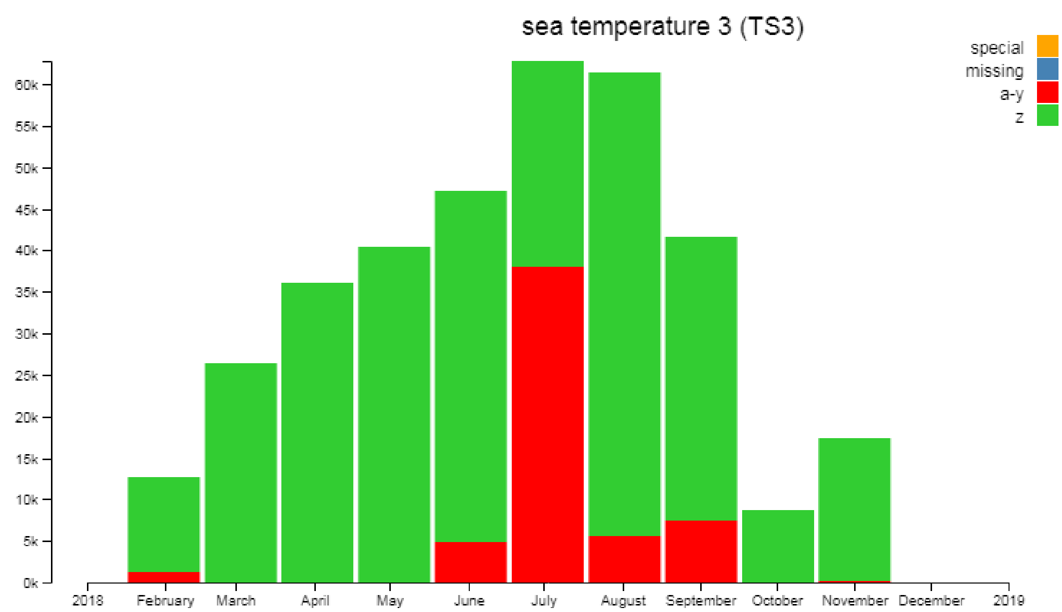
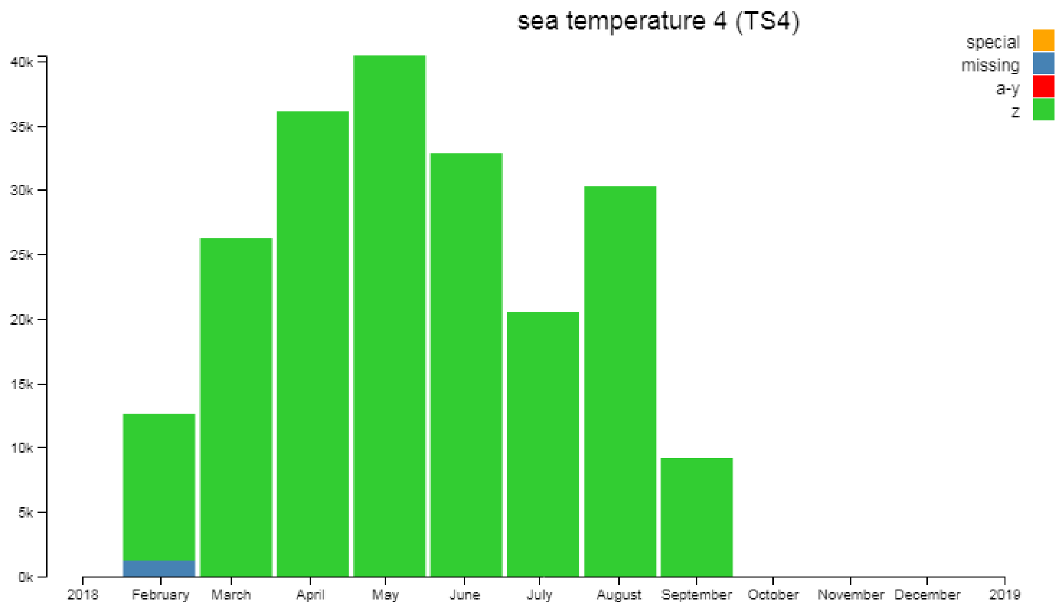


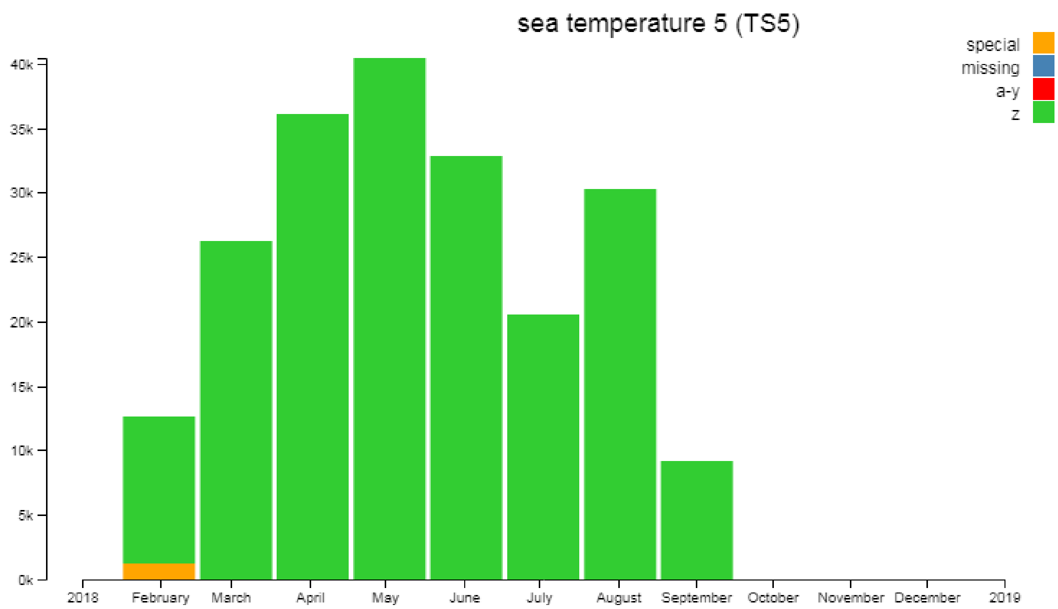
Figure 16: Total number of (this page) sea temperature – TS – (next page, top) sea temperature 2 – TS2 – (next page, bottom) sea temperature 3 – TS3 – (third page, top) sea temperature 4 – TS4 – (third page, bottom) sea temperature 5 – TS5 – and (fourth page) sea temperature 6 – TS6 – observations provided by all ships for each month in 2018. 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.



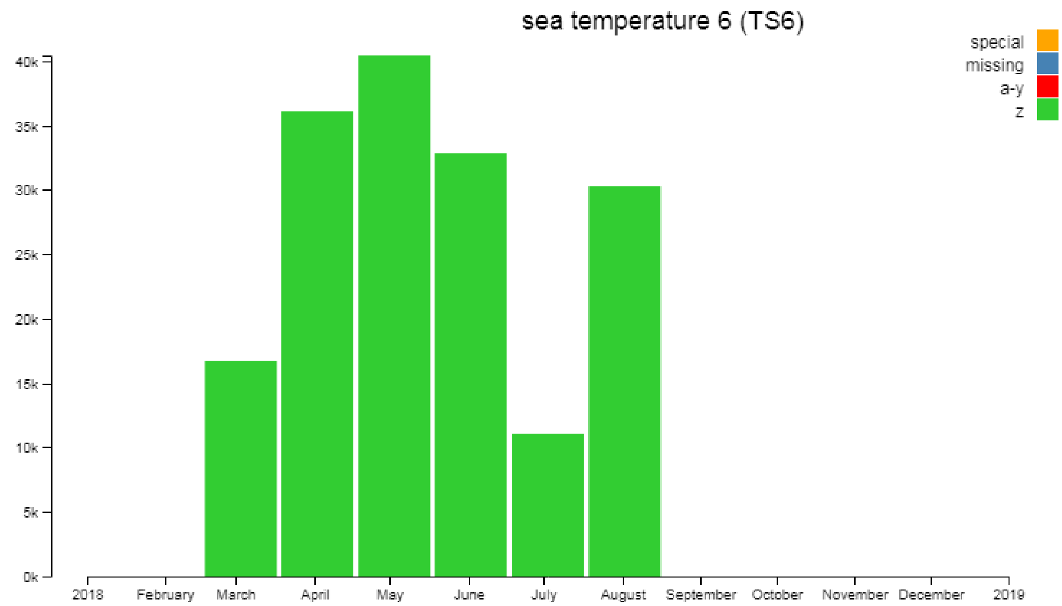


(Figure 16: cont'd.)





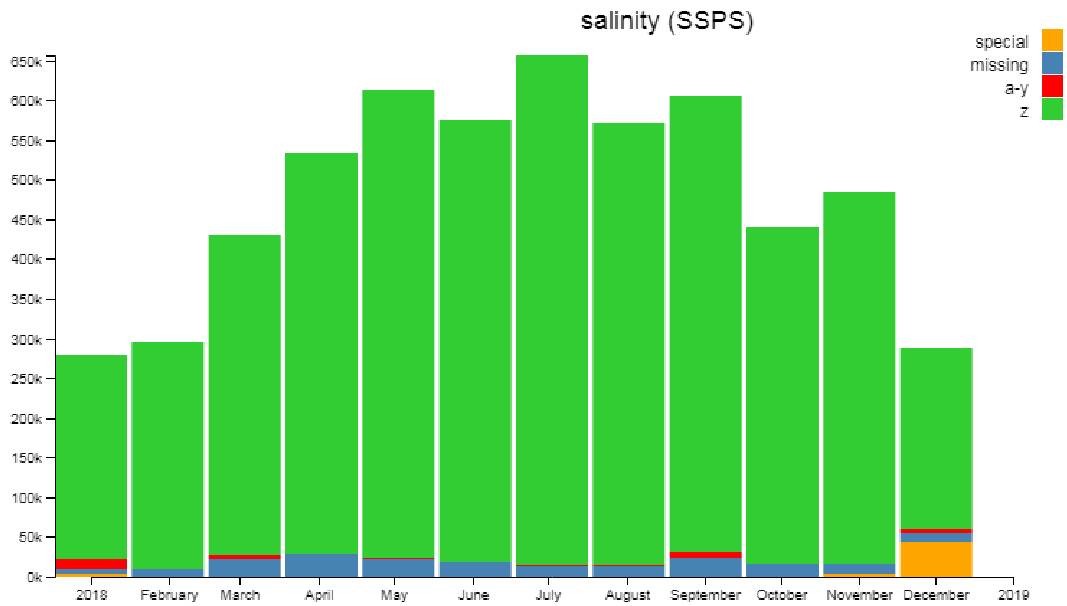
(Figure 16: cont'd.)



(Figure 16: cont'd.)

Salinity and conductivity (Figures 17 and 18, 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. Despite these issues, though, salinity and conductivity data in 2018 were still rather good. Again, in July the *Healy* reported likely missing values (-99 and 0) for their secondary TSG, so that probably goes a long way towards explaining the upticks seen that month in SSPS2 and CNDC2. SSPS2 and CNDC2 were also the last two parameters for which *Revelle* reported their likely missing values (-99) in January and March.

The special values seen in SSPS and CNDC in December were largely due to the *Atlantis* and *Neil Armstrong*. It isn't immediately clear which vessel(s) prompted the special values seen in CNDC in April and May.



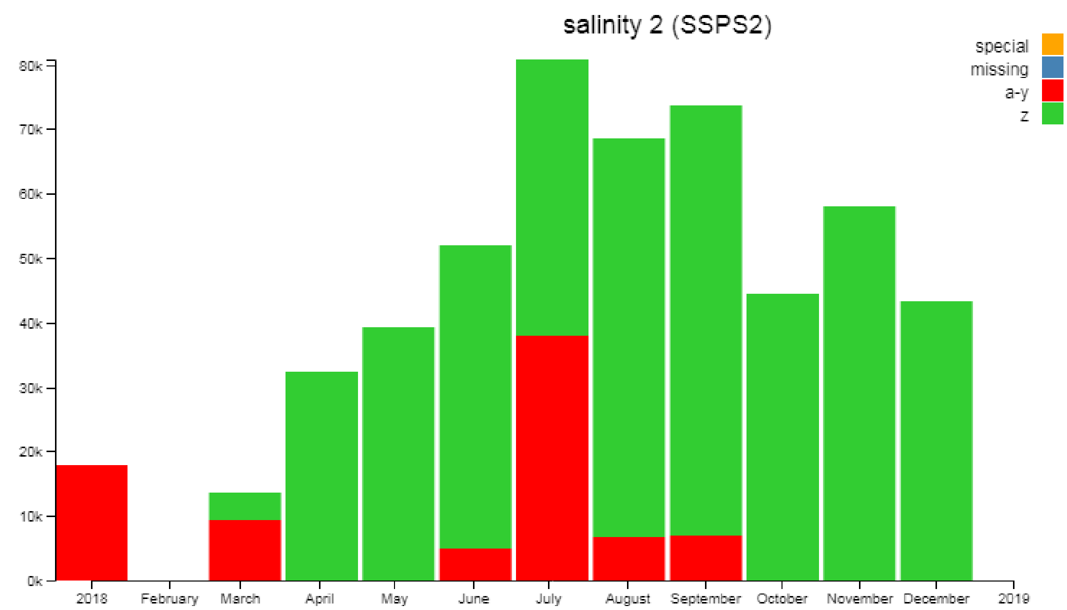
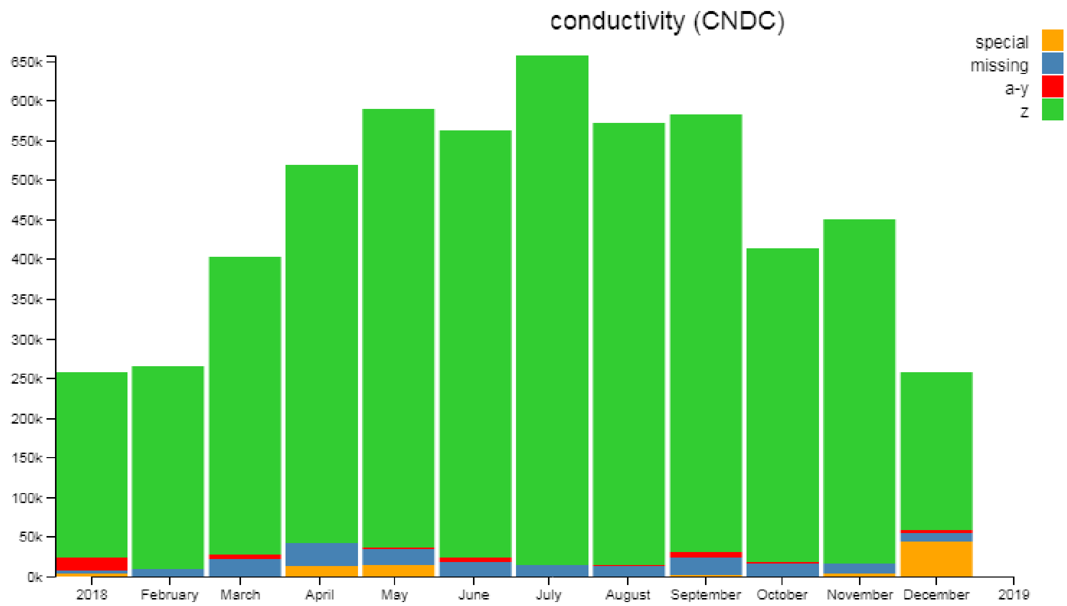


Figure 17: Total number of (top) salinity – SSPS – and (bottom) salinity 2 – SSPS2 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



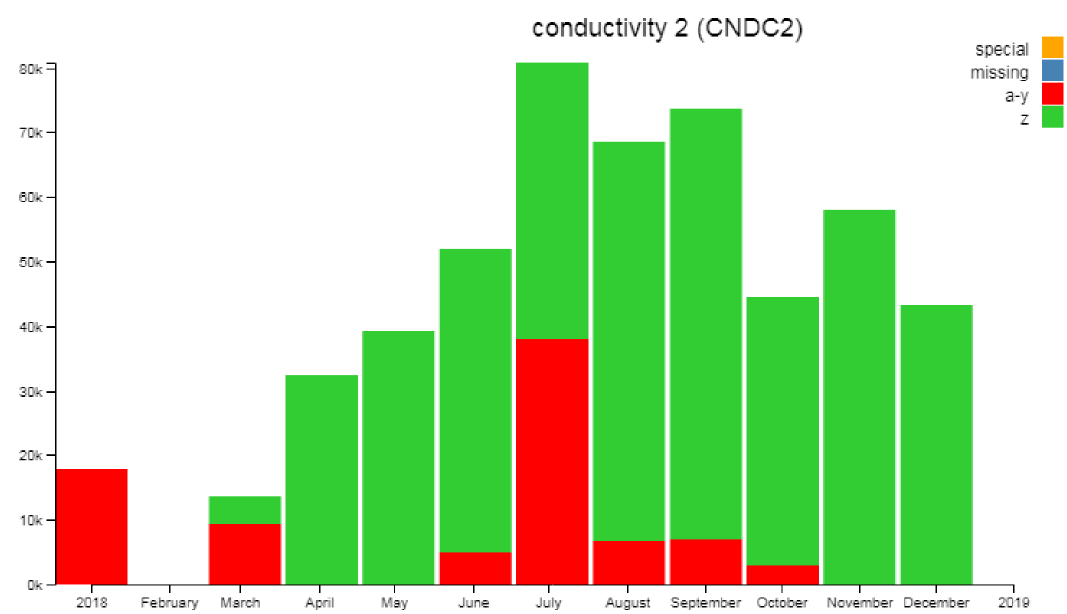
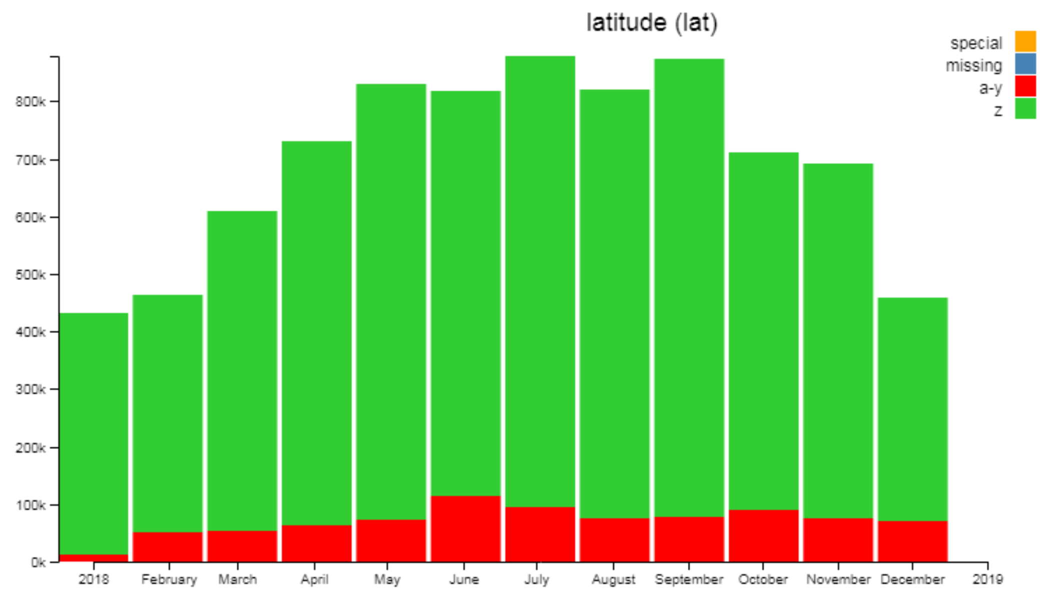


Figure 18: Total number of (top) conductivity – CNDC – and (bottom) conductivity 2 – CNDC2 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

Latitude and longitude (Figure 19) 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). It should be noted that *Atlantis*, *Sikuliaq*, *Palmer*, and *Gould* in particular are known to 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 2018. It should also be noted that a new one-minute land mask, used for the land check routine, was implemented on 1 June 2017, replacing the previous two-minute land mask. We note the switch to a one-minute land mask has resulted in a slight increase in L-flagging overall, presumably as coastlines and small oceanic landmasses have become better defined (i.e. what once was “water” may now be “land”).



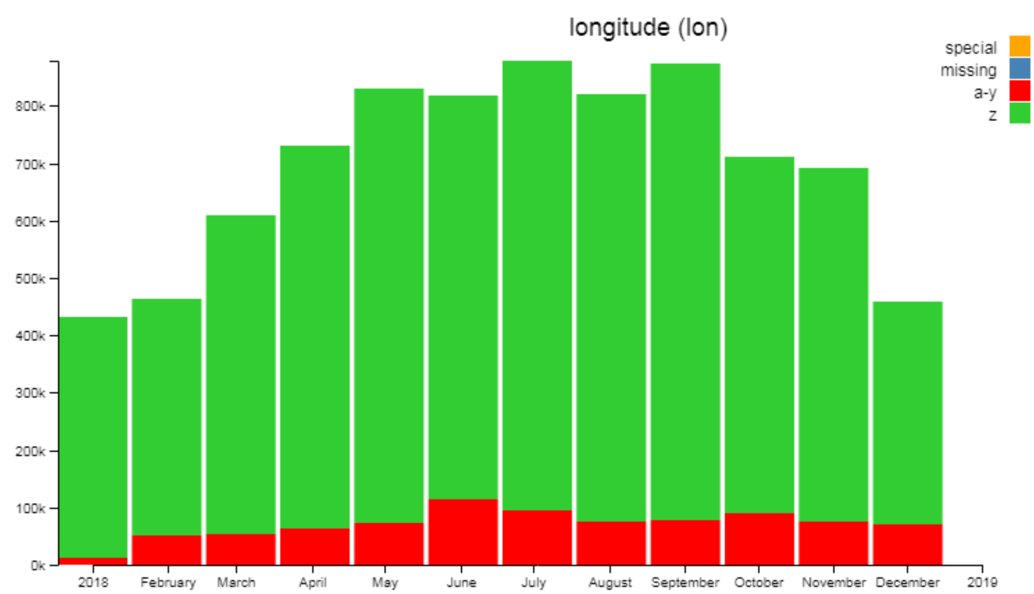
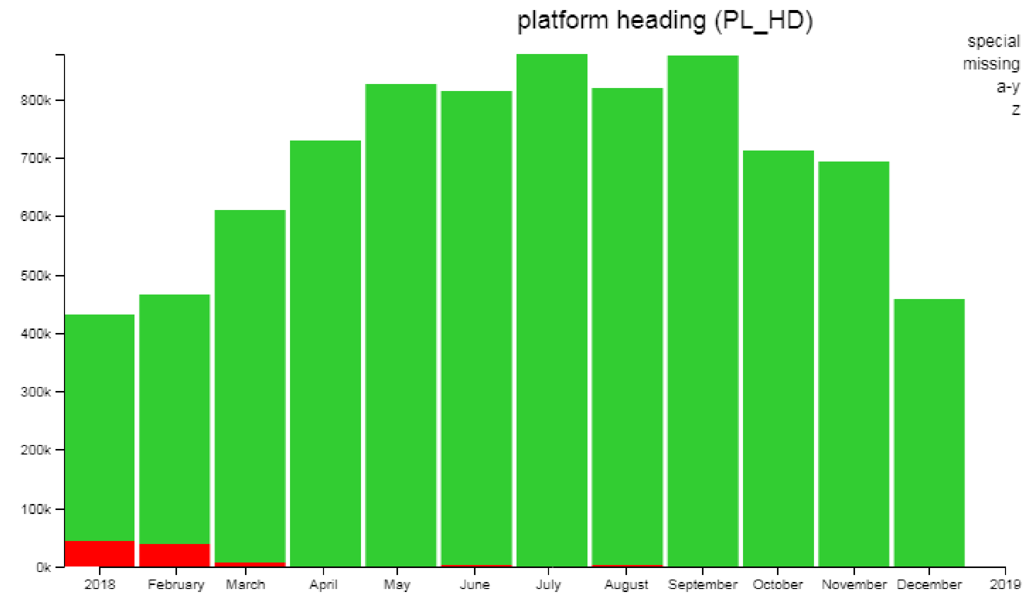


Figure 19: Total number of (top) latitude – LAT – and (bottom) longitude – LON – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

Except for the *Sproul* engendering an increase in flagging of PL_HD in January and February (for reasons unknown), the remainder of the navigational parameters exhibited no real problems of note. They are nevertheless included for completeness: platform heading (Figure 20), platform course (Figure 21), platform speed over ground (Figure 22), and platform speed over water (Figure 23).

All of the special values seen in PL_SOW appear to have come from the *Neil Armstrong*, for reasons unknown.



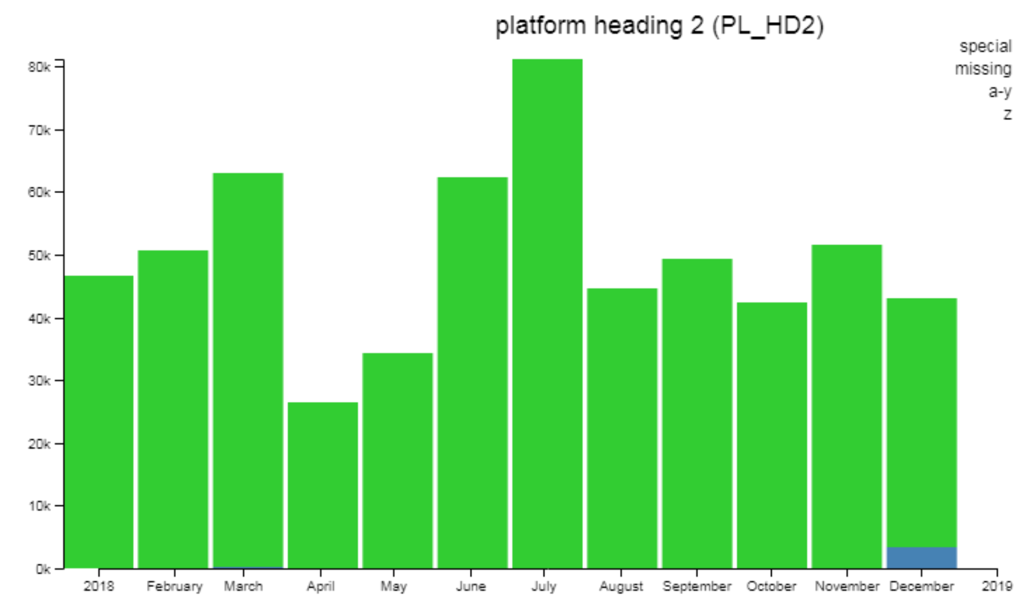
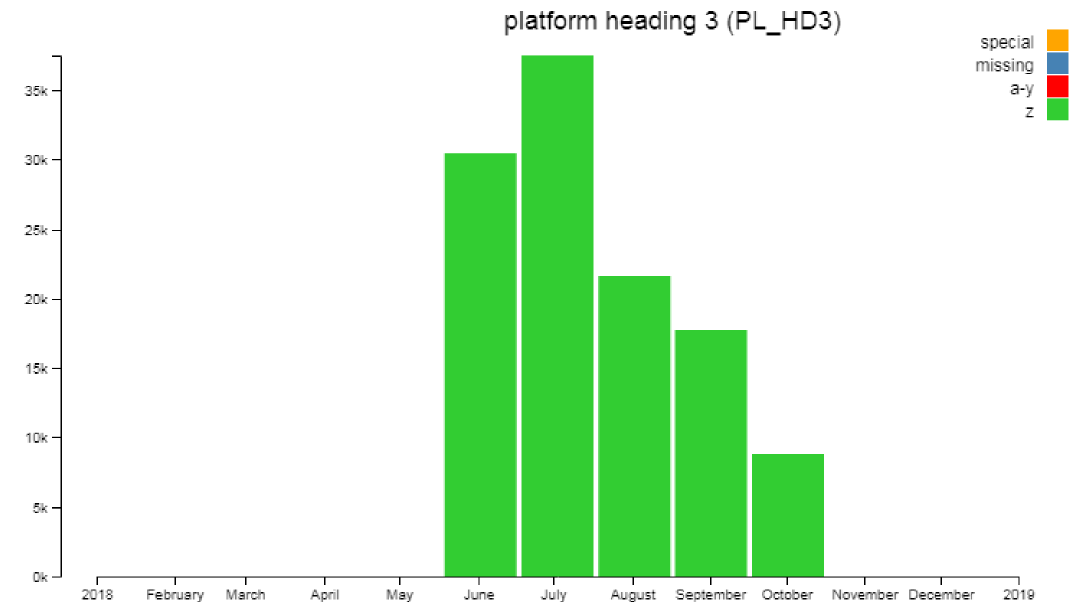


Figure 20: Total number of (this page, top) platform heading – PL_HD – (this page, bottom) platform heading 2 – PL_HD2 – and (next page) platform heading 3 – PL_HD3 – observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that 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 20: cont'd)

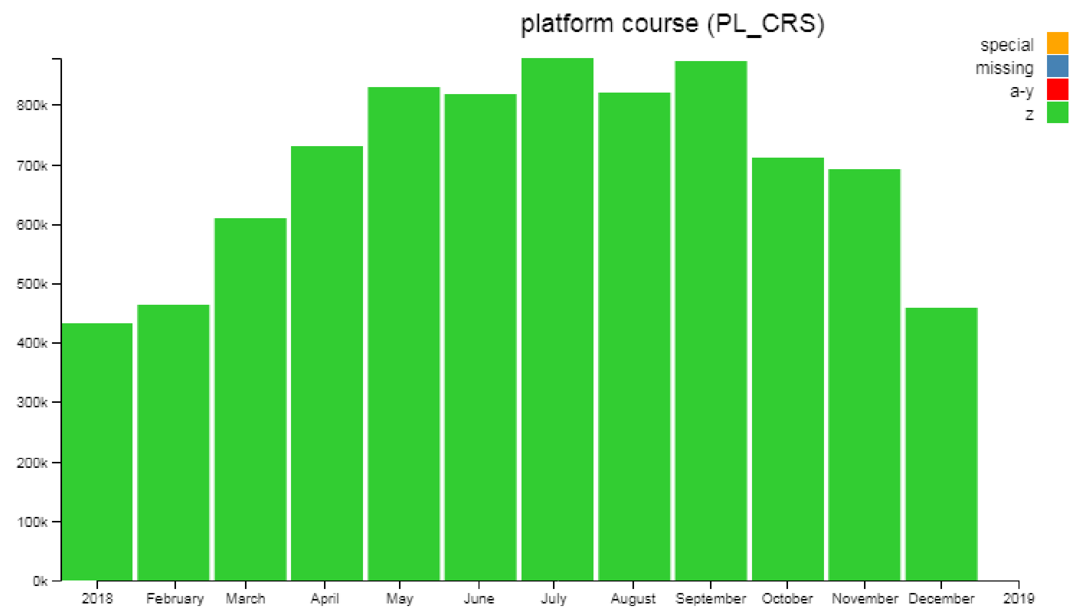


Figure 21: Total number of platform course – PL_CRS –observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

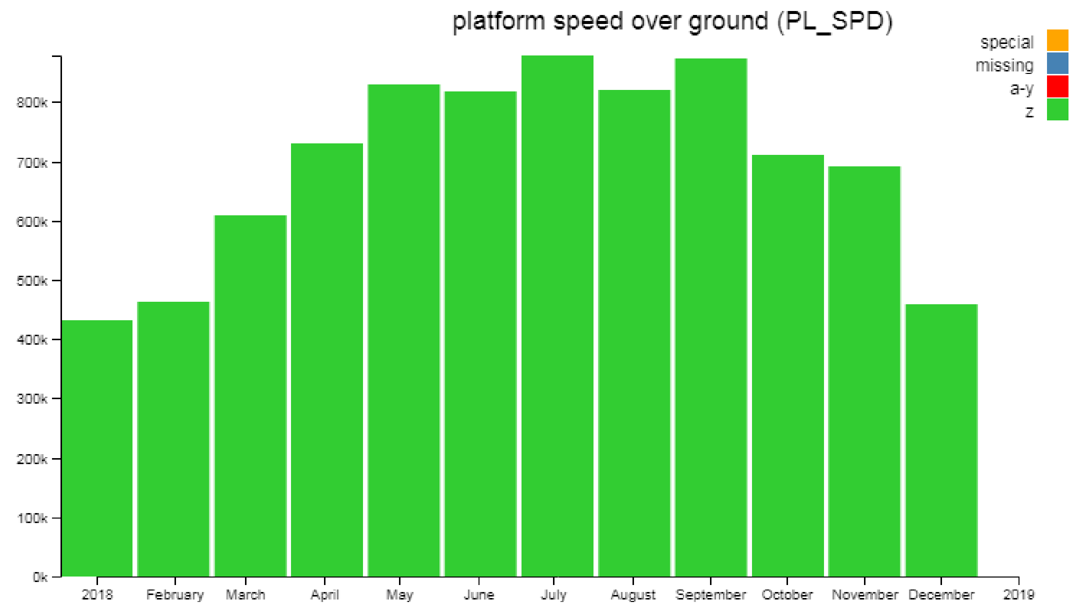


Figure 22: Total number of platform speed over ground – PL_SPD –observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

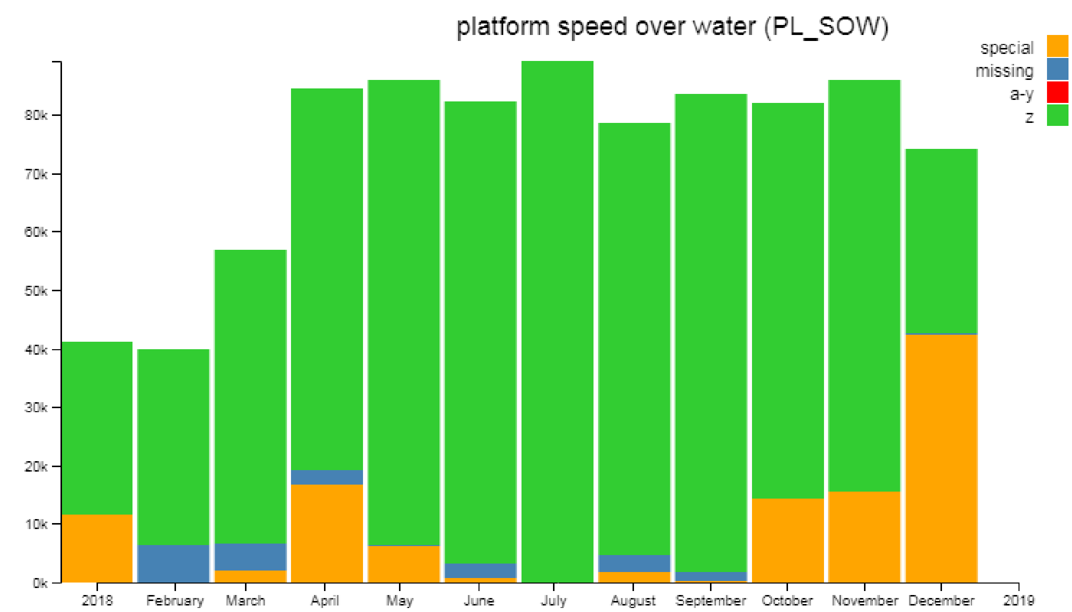
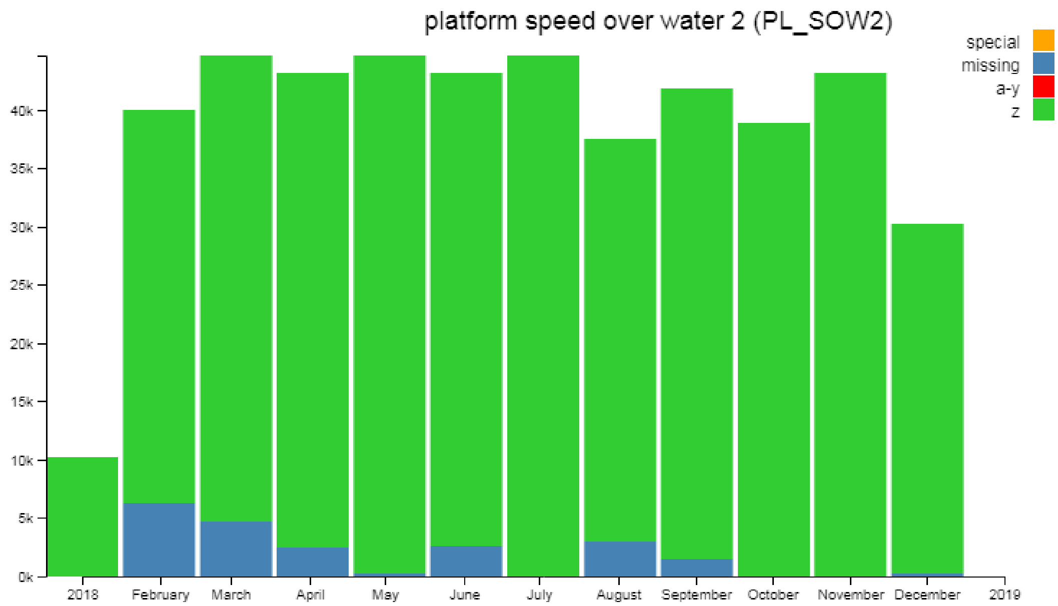


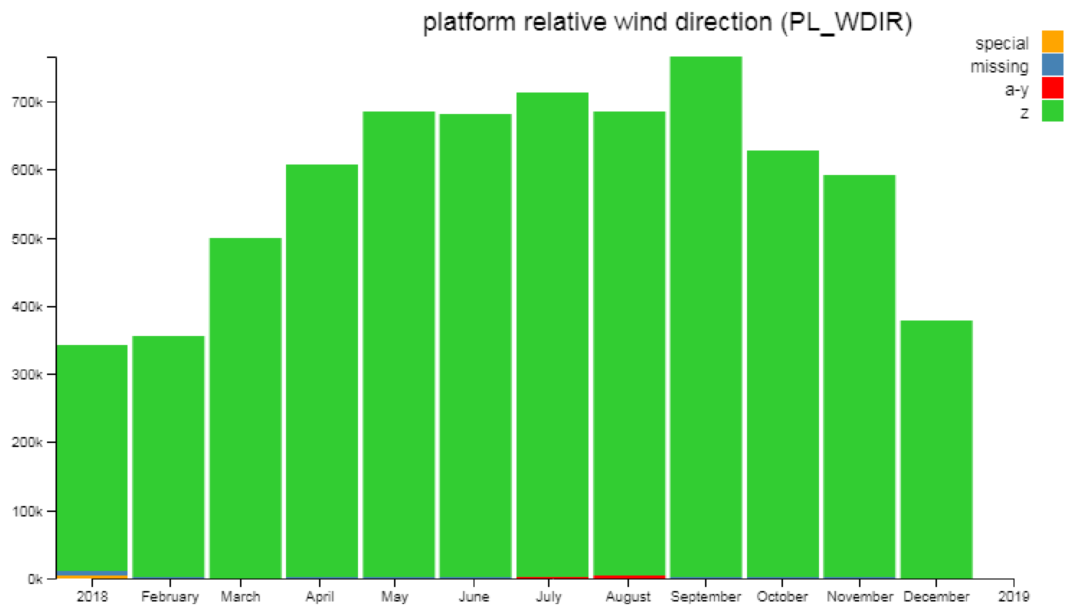
Figure 23: Total number of (this page) platform speed over water – PL_SOW – and (next page) platform speed over water 2 – PL_SOW2 observations provided by all ships for each month in 2018. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.



(Figure 23: cont'd)

The platform relative wind parameters, both direction (Figure 24) and speed (Figure 25), also exhibited no problems of note, save that a few rare sensor and/or connectivity failures occurred. These sparse cases were treated with J and M flags in those vessels that receive visual quality control but left alone (and more than likely unflagged by the auto flagger) for the remaining vessels.

We note PL_WDIR2 and PL_WSPD2 were the final two variables that received some special values for *Armstrong* in January, June, and August and for *Atlantis* in August through October, probably during maintenance periods.



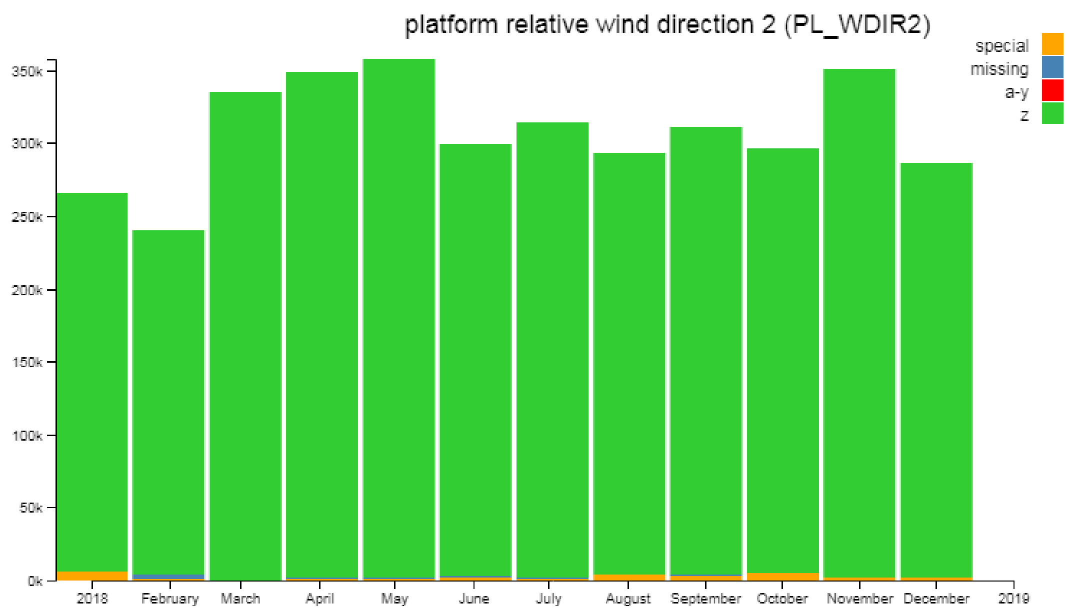
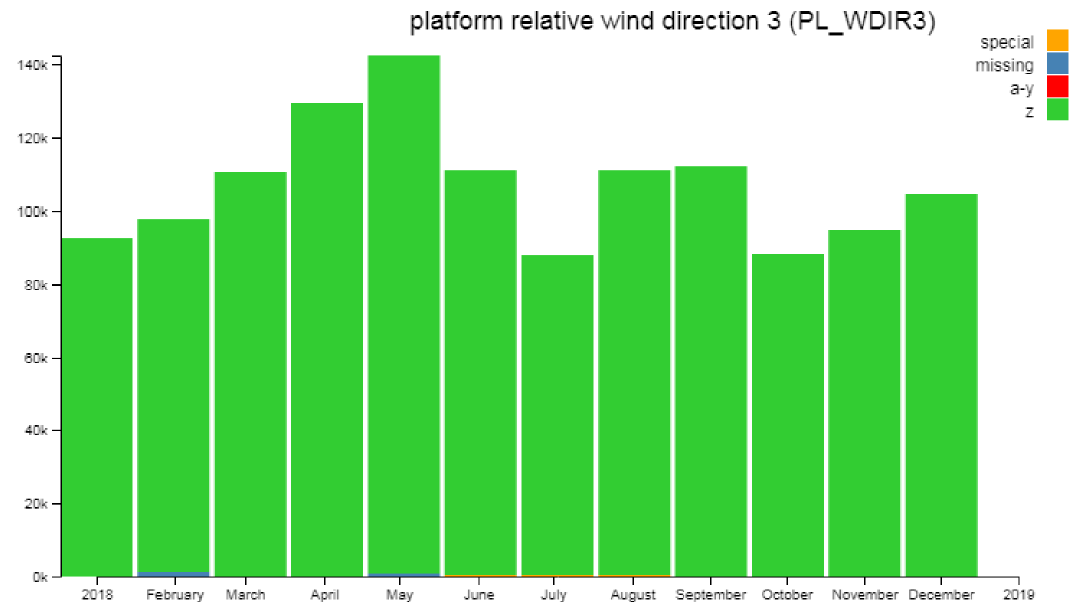


Figure 24: Total number of (this page, top) platform relative wind direction – PL_WDIR – (this page, bottom) platform relative wind direction 2 – PL_WDIR2 – and (next page) platform relative wind direction 3 – PL_WDIR3 – observations provided by all ships for each month in 2018. The colors represent 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)

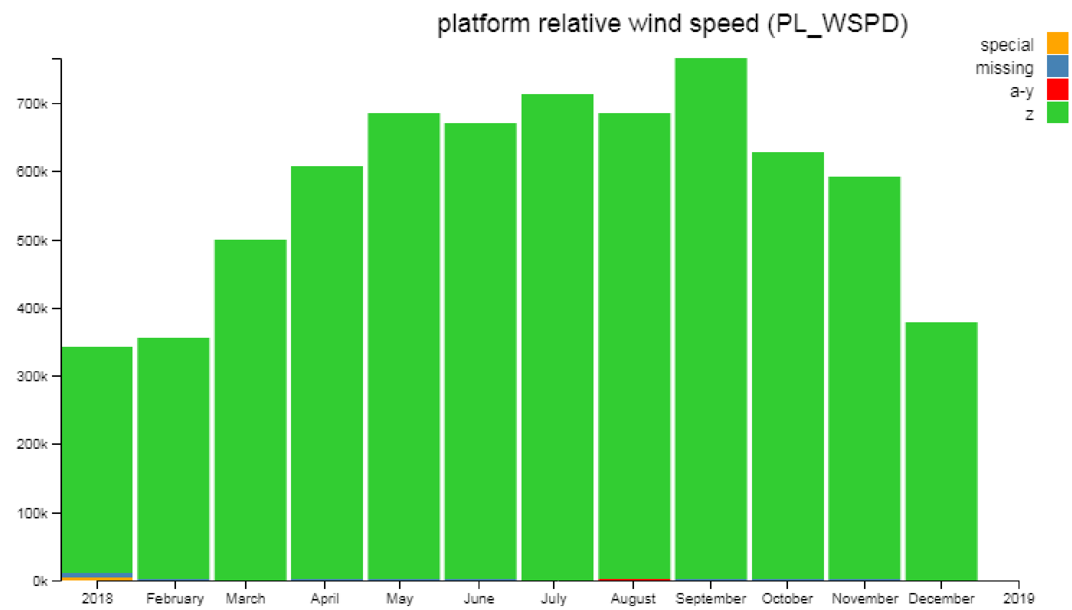
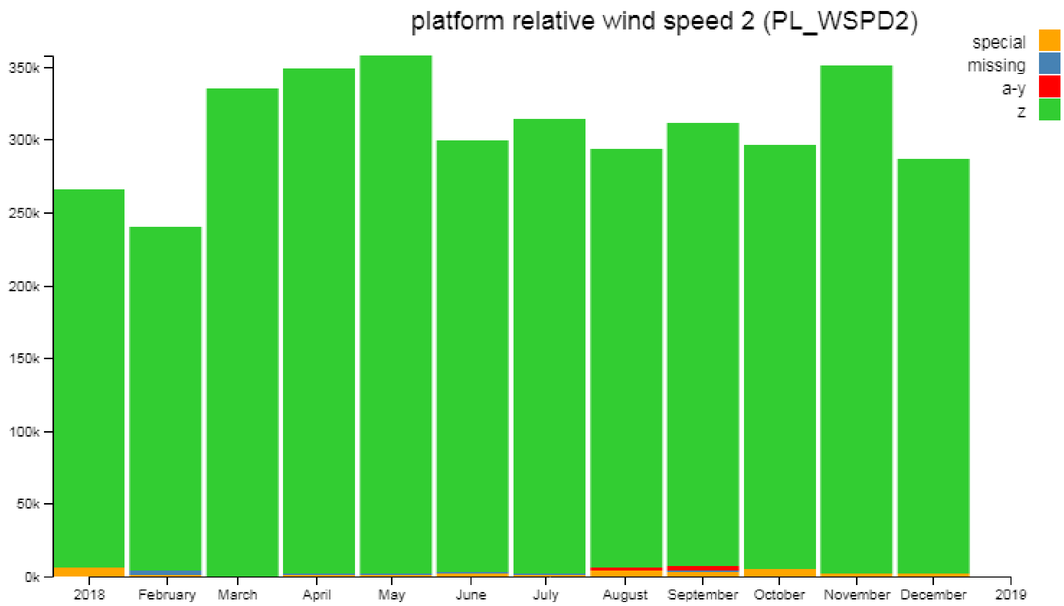
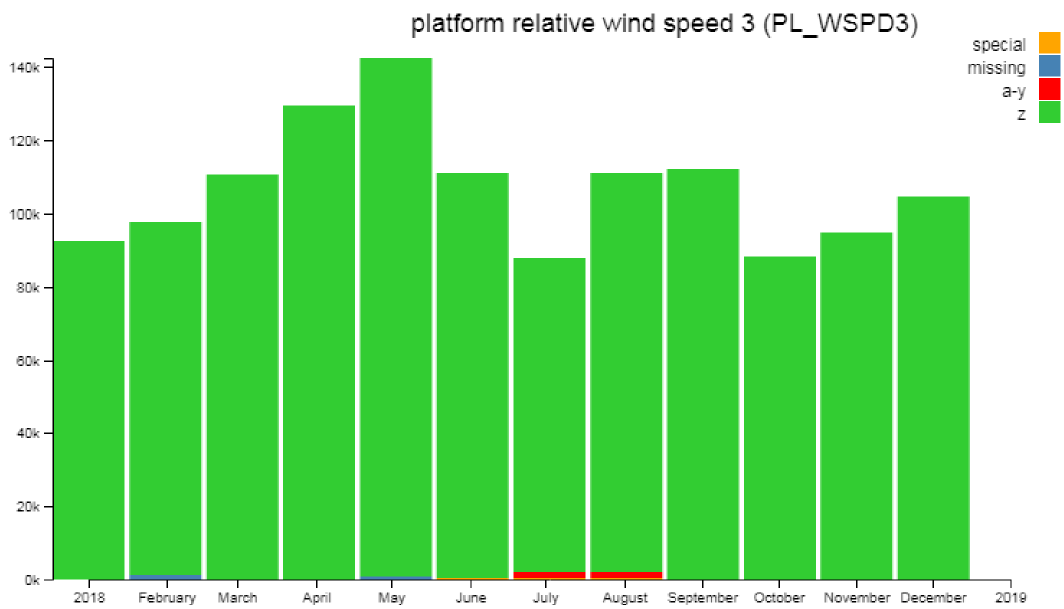


Figure 25: Total number of (this page) platform relative wind speed – PL_WSPD – (next page, top) platform relative wind speed 2 – PL_WSPD2 – and (next page, bottom) platform relative wind speed 3 – PL_WSPD3 – observations provided by all ships for each month in 2018. The colors represent the number of 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)

c. 2018 quality by ship

Aurora Australis

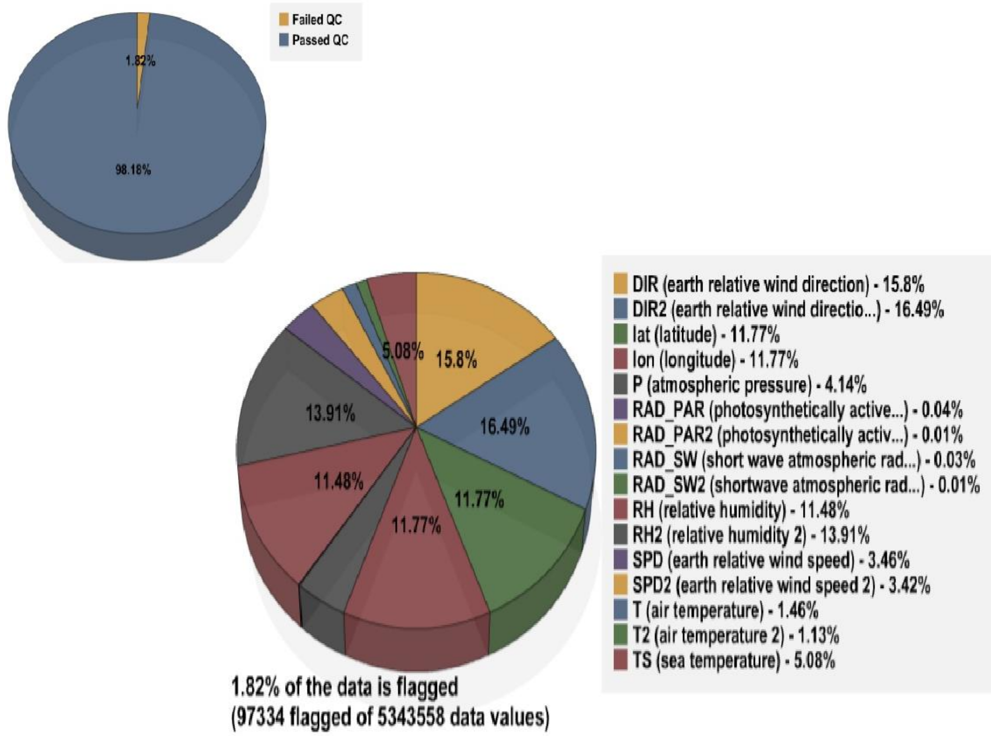


Figure 26: For the *Aurora Australis* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Aurora Australis* provided SAMOS data for 141 ship days, resulting in 5,343,558 distinct data values. After automated QC, 1.82% of the data were flagged using A-Y flags (Figure 26). This is under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data. NOTE: The *Aurora Australis* does not receive visual quality control by the SAMOS DAC, so all the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Aurora Australis*).

There were no specific issues noted for the *Aurora Australis* in 2018. Looking at the flag percentages in Figure 26 there are no parameters that particularly stand out, and with such a low overall total flagged percentage further investigation would provide no real benefit.

Investigator

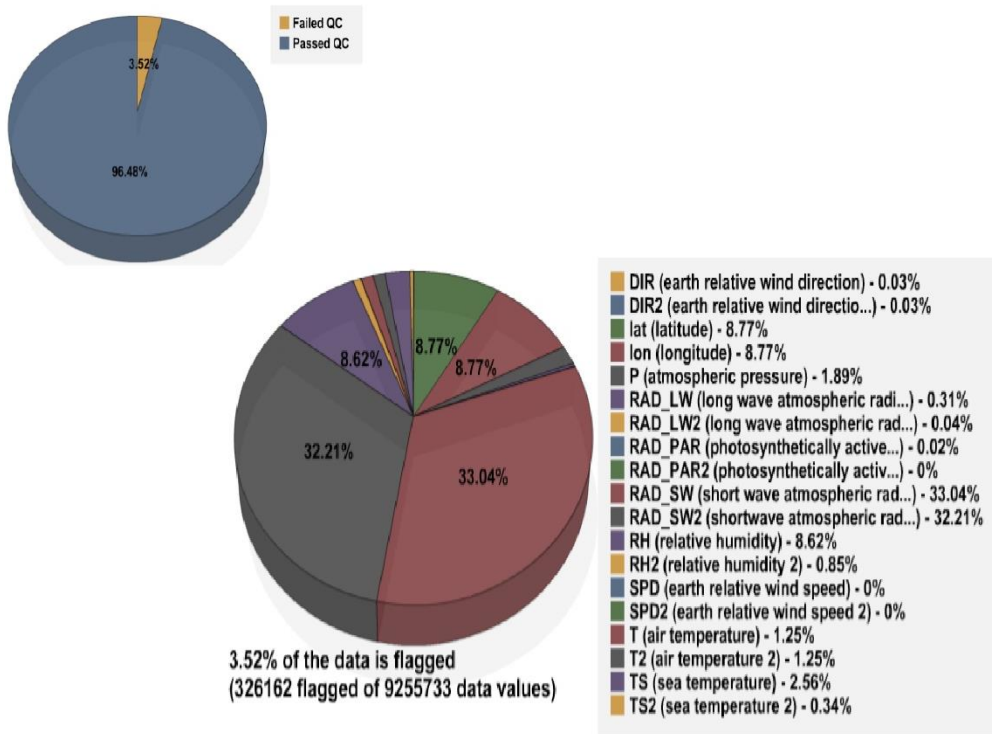


Figure 27: For the *Investigator* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Investigator* provided SAMOS data for 235 ship days, resulting in 9,255,733 distinct data values. After automated QC, 3.52% of the data were flagged using A-Y flags (Figure 27). This is about half a percentage point lower than in 2017 (4.09%) and is under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data. NOTE: The *Investigator* does not receive visual quality control by the SAMOS DAC, so all the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Investigator*).

Looking at the flag percentages in Figure 27, about 65% of the total flags were applied to the redundant shortwave atmospheric radiation parameters (RAD_SW and RAD_SW2). Upon inspection the flags, which are unanimously out of bounds (B) flags (Figure 28), appear to have been applied mainly to the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

As a side note, it was discovered in mid-September the SAMOS exchange format text files we pull from the BOM THREDDS service for the *Investigator* (see References for BOM THREDDS web link) do not and have not ever contained earth relative wind speed and direction from the vessel's ultrasonic wind sensor. As designated in the instrument metadata for *Investigator* provided to us by BOM, we would expect to (but do not) find earth relative wind direction and speed under the data variable identifiers DIRU and

SPDU, respectively, in the THREDDS text files. Through discussion with BOM personnel we understand that earth relative wind direction and speed from the vessel's ultrasonic sensor do exist and are featured in the IMOS-format SST and Flux netCDF files for *Investigator*, ostensibly under data variable identifiers DIR3 and SPD3. We stress, however, that the SAMOS exchange format text files we pull use different data variable identifiers. DIRU and SPDU are not present in the SAMOS exchange format text files, nor are there any unexplained variable identifiers present that might yet be the ultrasonic earth relative winds.

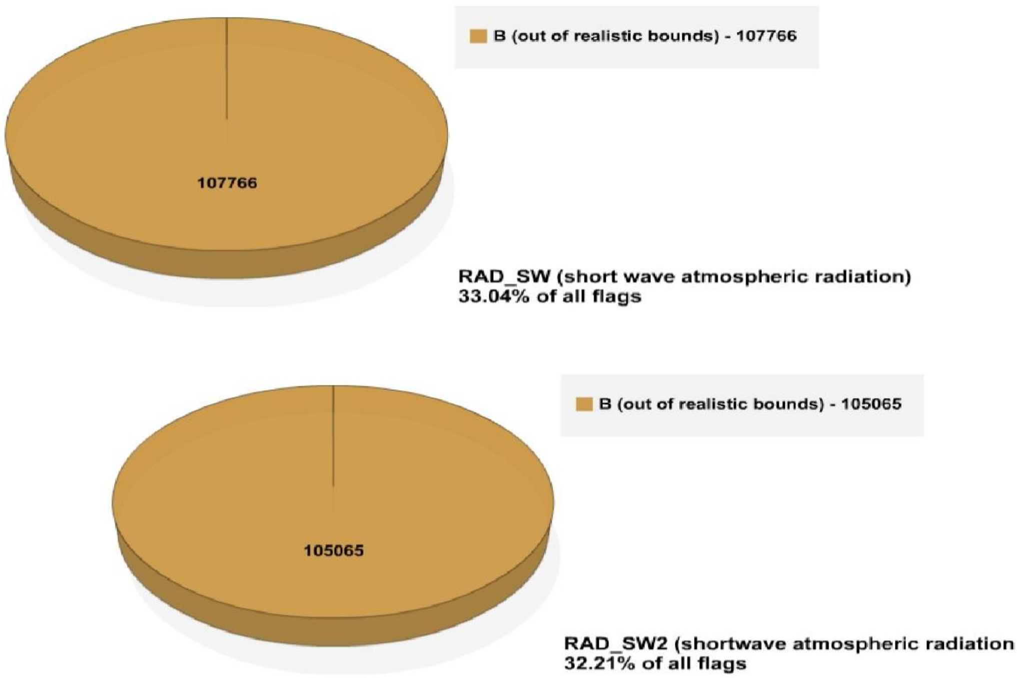
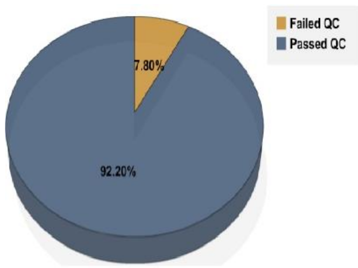


Figure 28: Distribution of SAMOS quality control flags for (top) shortwave atmospheric radiation – RAD_SW – and (bottom) shortwave atmospheric radiation 2 – RAD_SW2 – for the *Investigator* in 2018.

Tangaroa



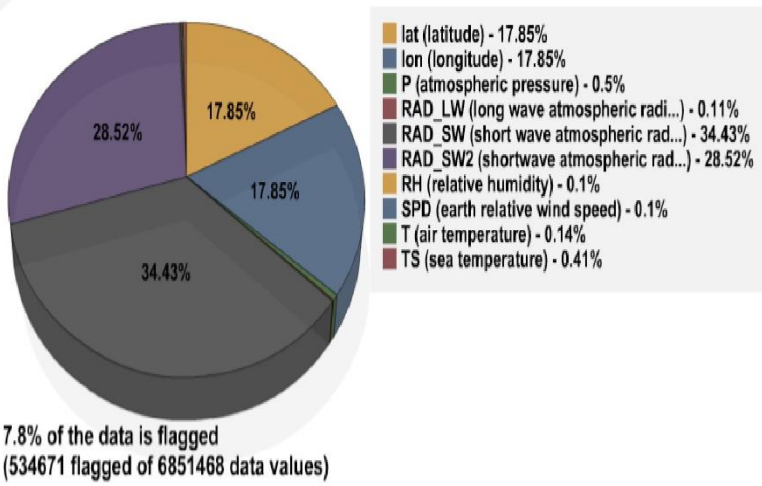


Figure 29: For the *Tangaroa* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Tangaroa* provided SAMOS data for 286 ship days, resulting in 6,851,468 distinct data values. After automated QC, 7.8% of the data were flagged using A-Y flags (Figure 29). This is about three percentage points lower than in 2017 (10.62%). NOTE: the *Tangaroa* does not receive visual quality control by the SAMOS DAC, so all flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Tangaroa*).

As in previous years, *Tangaroa's* two short wave atmospheric radiation parameters (RAD_SW and RAD_SW2) acquired a sizable portion of the total flags, roughly 65% taken together (Figure 29). These were exclusively out of bounds (B) flags (Figure 30). Once again, it appears most or all the B flags applied to RAD_SW and RAD_SW2 were the result of the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

Latitude (LAT) and longitude (LON) flags together further comprised roughly 35% of the total (Figure 29). A quick inspection reveals these were virtually all land check (L) flags (Figure 30) that were generally applied when the vessel was in port. This is not uncommon, as the land mask in use for the land check routine is often incapable of resolving the very fine detail of an inland port. This is true of both the older 2-minute land mask and the newer 1-minute one introduced in mid-2017.

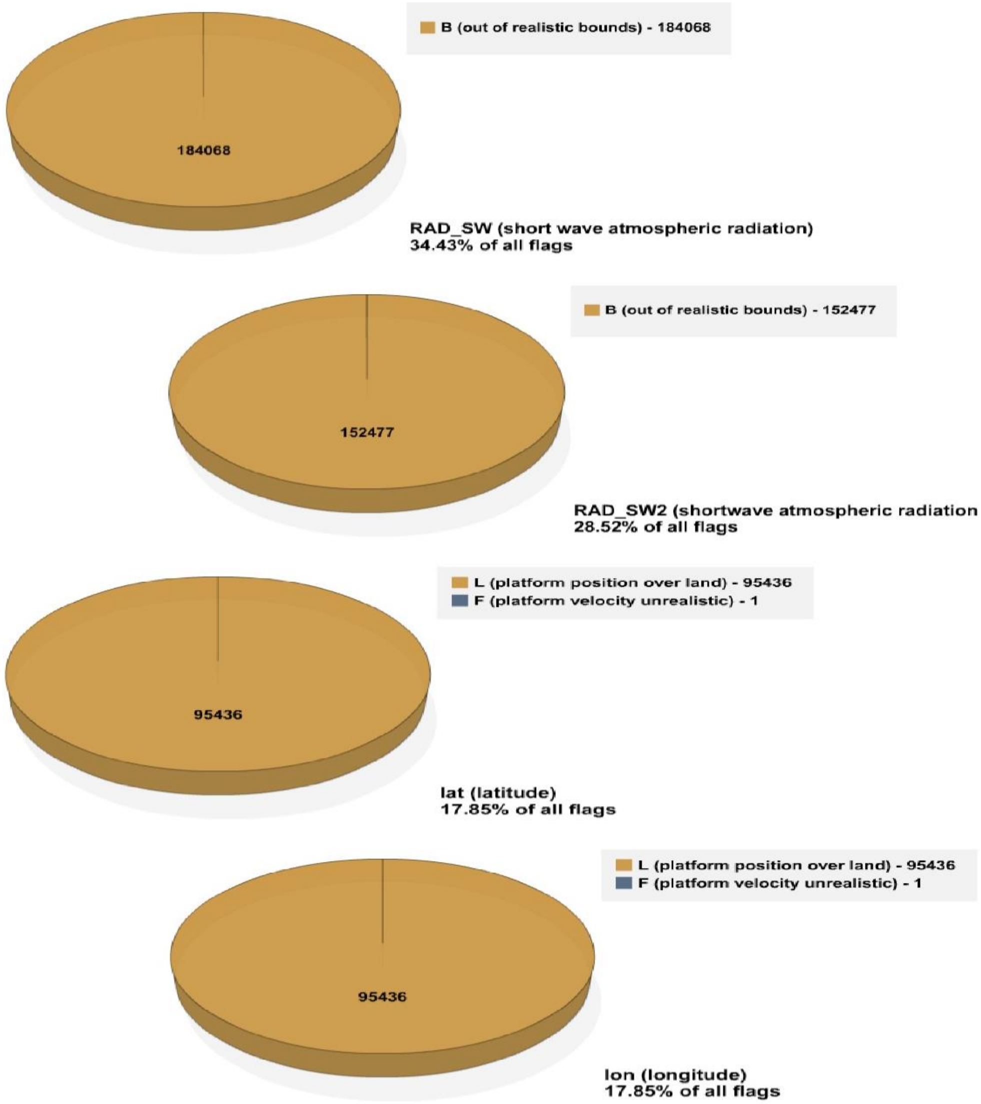
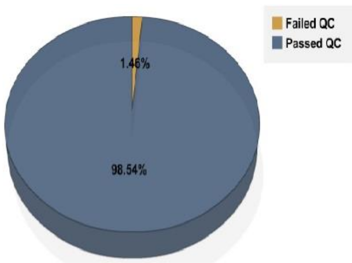


Figure 30: Distribution of SAMOS quality control flags for (first) shortwave atmospheric radiation – RAD_SW – (second) shortwave atmospheric radiation 2 – RAD_SW2 – (third) latitude – LAT – and (last) longitude – LON – for the *Tangaroa* in 2018.

Pelican



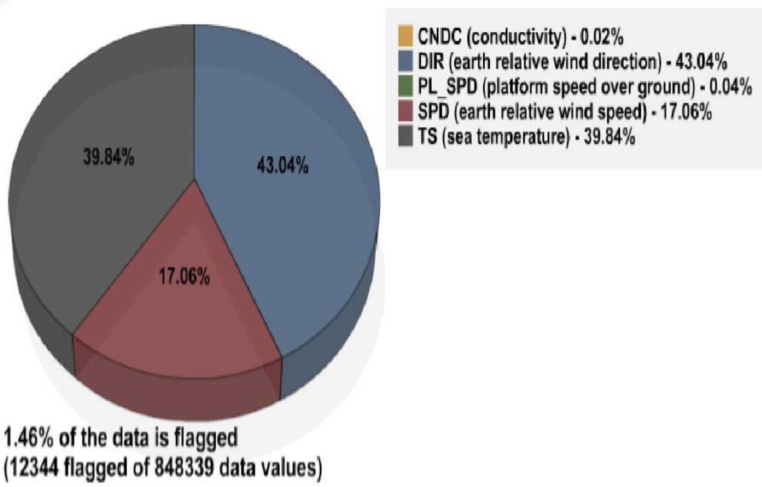


Figure 31: For the *Pelican* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Pelican* provided SAMOS data for 52 ship days, resulting in 848,339 distinct data values. After automated QC, 1.46% of the data were flagged using A-Y flags (Figure 31), which is under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *Pelican* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Pelican*).

After more than a year without a submission, SAMOS data transmission from the *Pelican* was finally reestablished on 6 April. We note, though, that *Pelican's* 2018 SAMOS data transmission rate nevertheless was 28% (see Table 2). It would be desirable to recover any data not received by us, if possible (see Figure 2).

In late August it was noted *Pelican's* data files contained only sea and navigational parameters. The vessel was contacted via email on 28 August regarding the omission. We were advised the primary weather station had gone down in mid-August and a new one had just been installed. After a bit of back and forth vessel technicians were able to get the new data into the SAMOS event, but meanwhile there were no meteorological data in the *Pelican's* files for the period 25 August through 7 September.

There were no other issues noted for the *Pelican* in 2018. Looking at the flag percentages in Figure 31, almost all the flags were split between the earth relative wind direction and speed (DIR and SPD, respectively) and sea temperature (TS) parameters. Virtually all the flags applied to the two wind parameters were failures of the true wind recomputation test (E) flags (Figure 32). Most flags applied to TS were greater than four standard deviations from climatology (G) flags, with a small additional quantity of out of bounds (B) flags (Figure 32). A quick inspection of the TS data suggests these flags were acquired mainly when the sea water intake pump was off, such as is often the case when a vessel is in port. Considering the very low overall flag percentage, none of the above flag situations is of any cause for concern.

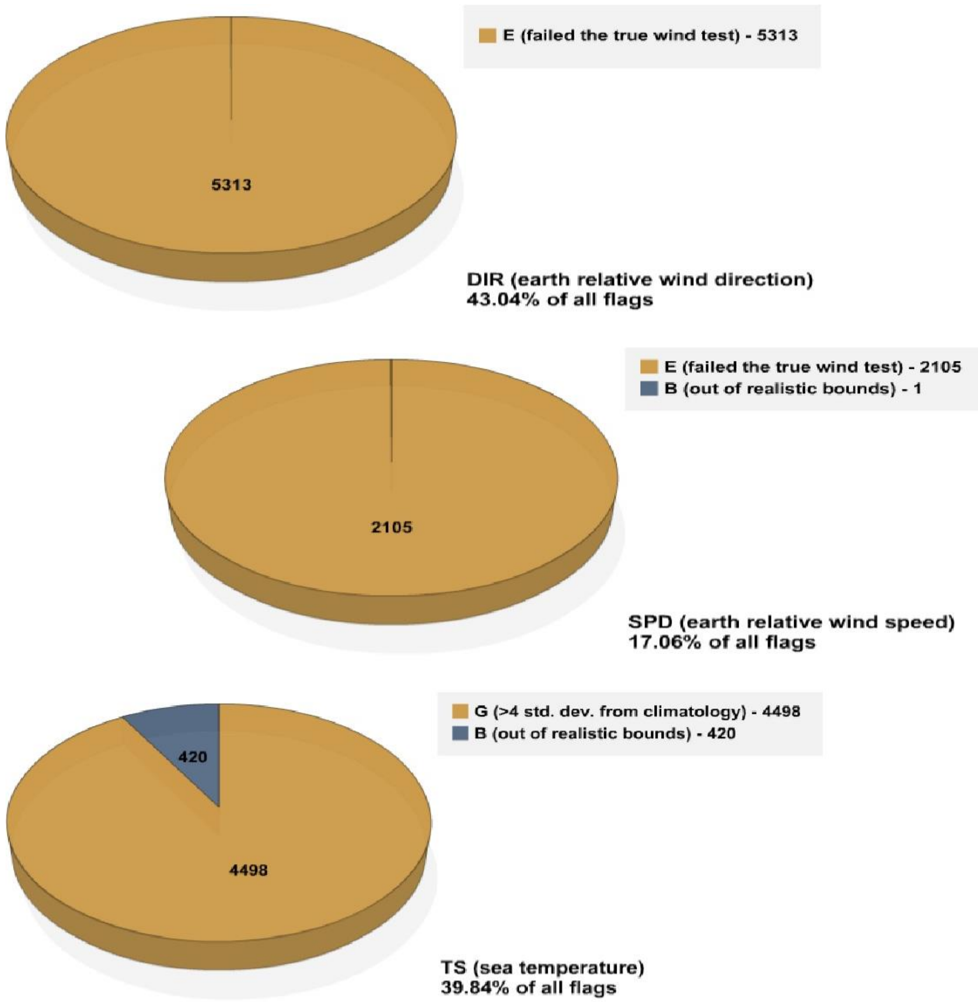
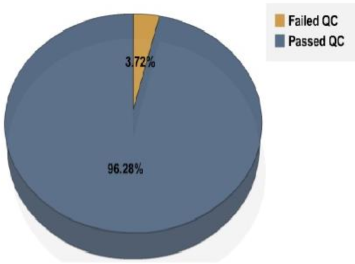


Figure32: Distribution of SAMOS quality control flags for (top) earth relative wind direction – DIR – (middle) earth relative wind speed – SPD – and (bottom) sea temperature – TS – for the *Pelican* in 2018.

Bell M. Shimada



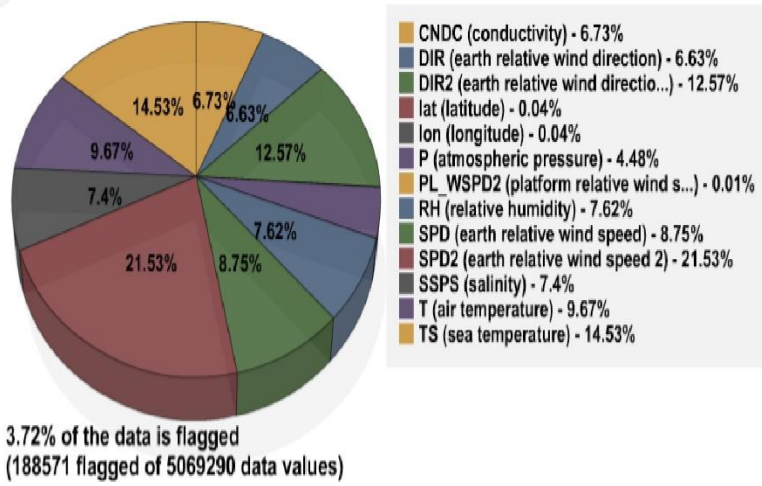


Figure 33: For the *Bell M. Shimada* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Bell M. Shimada* provided SAMOS data for 203 ship days, resulting in 5,069,290 distinct data values. After both automated and visual QC, 3.72% of the data were flagged using A-Y flags (Figure 33). This is virtually unchanged from 2017 (3.43% total flagged) and *Shimada* remains under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

Around 14% of the total flags were applied to the intake sea temperature (TS) parameter (Figure 33). Some large portion of this number was due to flagging the sea water data while the intake pump appeared to be off (common in port). However, from 1 February, when *Shimada* first reported sea water data to SAMOS in 2018, TS values were around negative 10 degrees Celsius. On 15 February the vessel was notified via email that their TS values were unrealistic. Vessel technicians determined there was an interfacing issue with the intake sea temp sensor feed, and this was addressed while the vessel was in port. When data transmission resumed on 27 February the issue was resolved. The episode resulted in the application of out of bounds (B) and malfunction (M) flags to TS (Figure 34).

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 (not shown). From the slightly outsized proportion of flags (Figure 33) that were applied to the earth relative wind speed and direction from

Shimada's secondary wind sensors (SPD2 and DIR2, respectively), it would seem those measurements (from an RM Young 85000 located amidships) are the most susceptible to distortion. We note, though, that while it can be a challenge to site sensors ideally on a ship, with such a low overall flag percentage as the *Shimada* typically receives these sensor location issues are not terribly consequential for her.

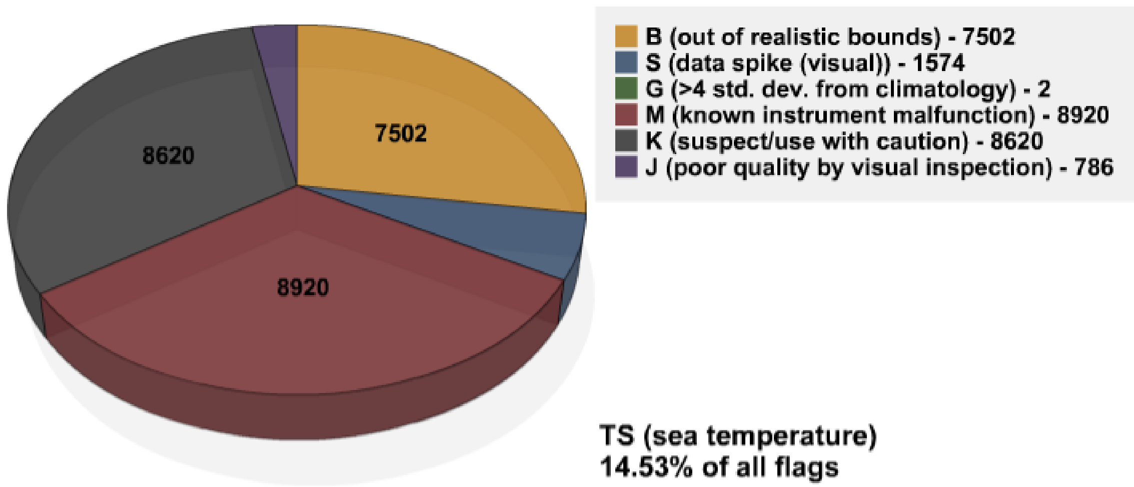


Figure 34: Distribution of SAMOS quality control flags for sea temperature – TS – for the *Bell M. Shimada* in 2018.

Fairweather

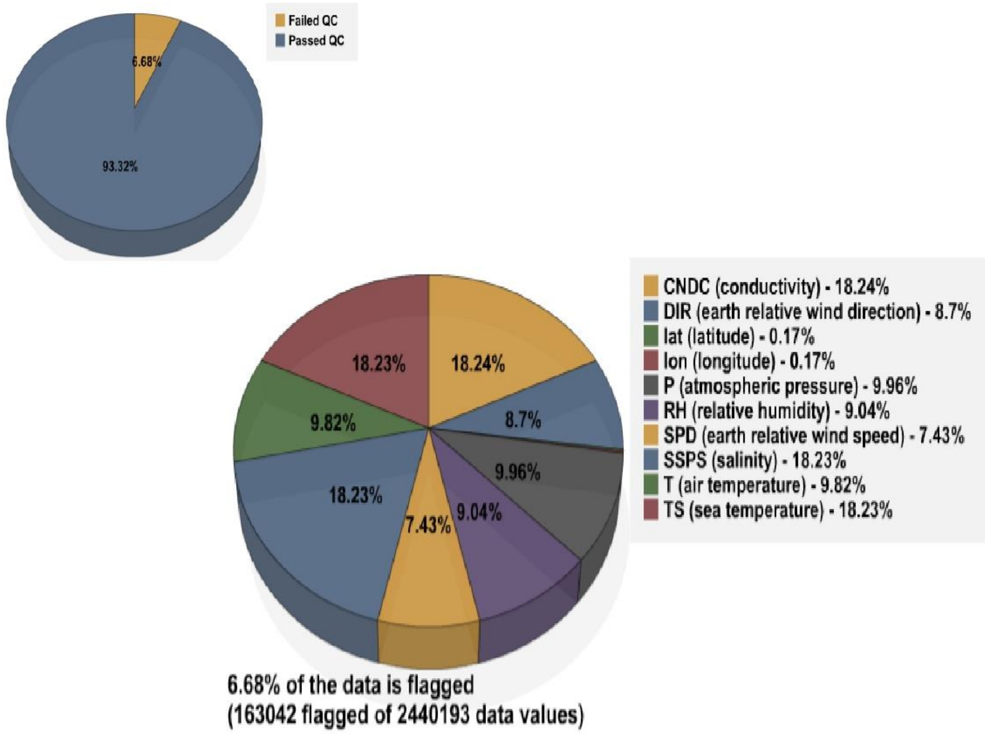


Figure 35: For the *Fairweather* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Fairweather* provided SAMOS data for 122 ship days, resulting in 2,440,193 distinct data values. After both automated and visual QC, 6.68% of the data were flagged using A-Y flags (Figure 35). This is a significantly lower total flagged percentage than in 2017 (13.09%).

For the *Fairweather*, the most heavily flagged data in 2018 were the three sea water parameters – namely, sea temperature (TS), salinity (SSPS), and conductivity (CNDC) – each receiving about 18% of the total flags (Figure 35). The flags applied to each were overwhelmingly caution/suspect (K) flags (Figure 37). Some portion of these flags were assigned because the intake pump appeared to be off (common in port). Occasionally flags were applied during episodes when the sea water data exhibited a gradual departure away from the general trend before abruptly "snapping back" (Figure 36), despite the vessel being situated away from coastlines and sharp open ocean TS gradients (as indicated by global gridded microwave sea temperature data) . It isn't clear what causes this odd behavior, but this analyst suspects a plumbing issue whereby a fresh supply of water at the intake is interrupted by some unintended mechanism (pump shutdown or a clog in the pipes, for example). A further minor issue exists with the *Fairweather's* sea water parameters, although it's not seen in the flag totals, whereby the instrument providing the data occasionally, for reasons unknown, begins sending an incorrectly formatted message to the data acquisition system. The result has usually been that CNDC outputs the current date (MM/DD/YYYY) rather than scientific values, which leads to “special values” being assigned by SAMOS processing; meanwhile SSPS and TS do not output anything. This scenario occurred twice in 2018, once in early May and again in mid-September. Each time vessel operators were notified by email and each time the issue was promptly addressed.

More generally, *Fairweather* data continues to suffer from problematic sensor location, although neither adequate metadata nor digital imagery nor a detailed flow analysis exists for this vessel, preventing diagnosis (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 reflected in the flagged percentages seen in Figure 35.

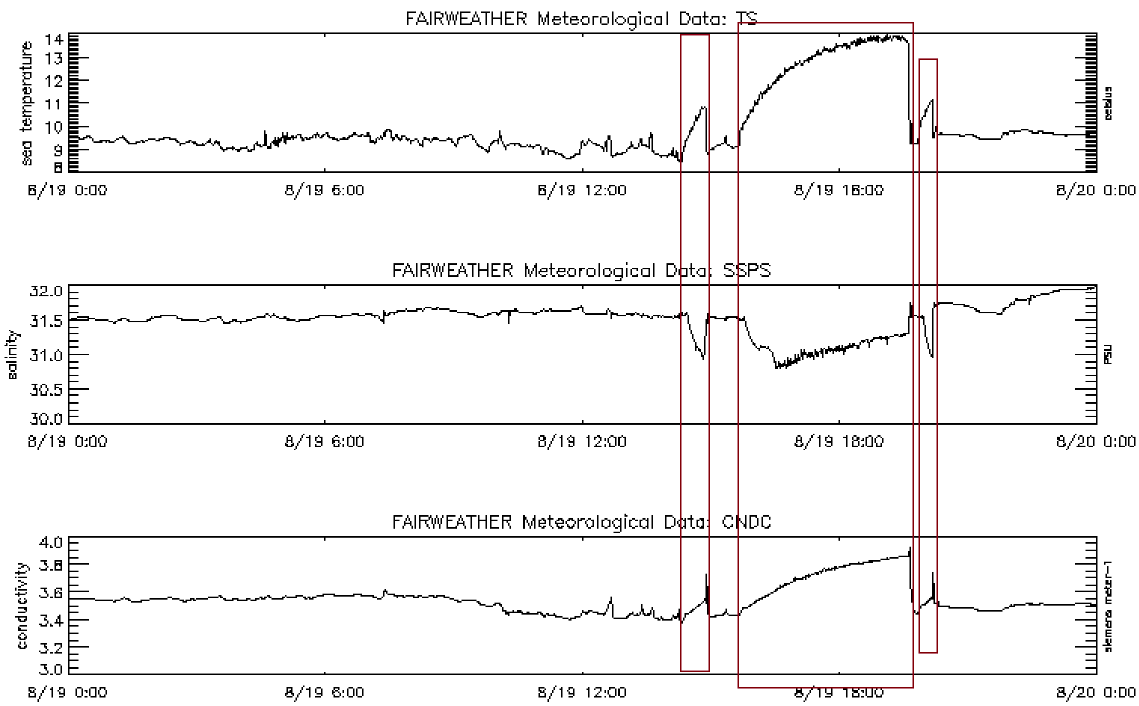


Figure 36: *Fairweather* SAMOS (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – for 19 August 2018. Note the anomalous rises in TS/CNDC and falls in SSPS terminated by an abrupt return to the overall trend enclosed within maroon boxes.

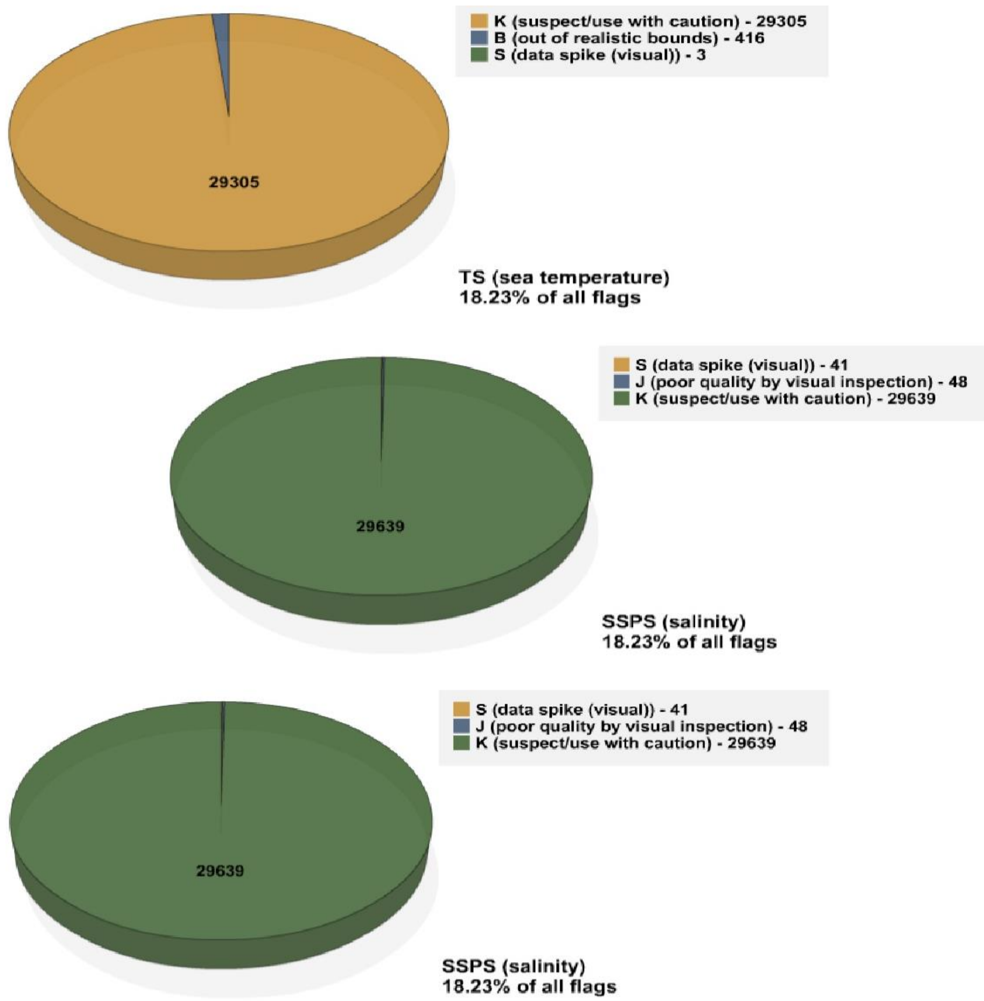


Figure 37: Distribution of SAMOS quality control flags for (top) sea temperature – T – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – for the *Fairweather* in 2018.

Gordon Gunter

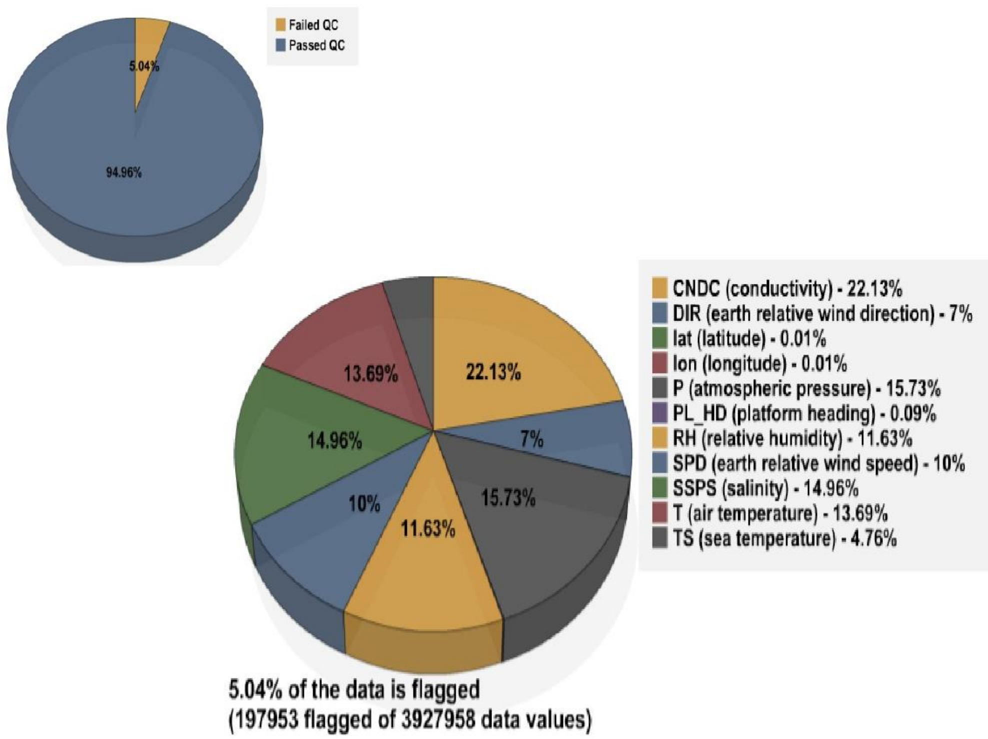


Figure 38: For the *Gordon Gunter* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Gordon Gunter* provided SAMOS data for 184 ship days, resulting in 3,927,958 distinct data values. After both automated and visual QC, 5.04% of the data were flagged using A-Y flags (Figure 38). This is only a small change from the total flagged percentage in 2017 (4.39%) but it does bump the *Gunter* just over the 5% total flagged cutoff regarded by SAMOS to represent "very good" data (barely).

The roughly even spread of flag percentages across the *Gunter's* scientific parameters (Figure 38) together with her hovering just at the 5% total flagged threshold suggest any issues with her data aren't terribly consequential. As a general note, air temperature (T), relative humidity (RH), earth relative wind direction and speed (DIR and SPD, respectively), and atmospheric pressure (P) on the *Gunter* all show signs of moderate flow distortion (common on most vessels), which oftentimes results in caution/suspect (K) flags for each of those parameters (not shown). We note it can be a challenge to site sensors ideally on a ship.

Conductivity (CNDC) held the highest percentage of flags, about 22% (Figure 38). Most of those flags were poor quality (J) flags (Figure 40), and most of those J flags were applied between 11 – 25 November. During that time, CNDC was reporting values an order of magnitude too small. This analyst suspected the units of the data had perhaps been changed without notice, but upon contacting the vessel via email learned the problem was a sensor configuration error within the data acquisition system whereby the leading digit in the CNDC value was getting truncated. Once aware, the vessel technician immediately addressed the error. Salinity (SSPS) and sea temperature (TS) were unaffected.

The next highest flag percentage belonged to atmospheric pressure (P), roughly 16% (Figure 38). Flags applied to P were overwhelmingly suspect/caution (K) flags (Figure 40). While the majority of those were likely the result of simple flow distortion, some amount stemmed from sporadic dubious behavior. From time to time, often at the start of a cruise, P seemed to read a few millibars higher than expected (as compared to buoy or station data and/or gridded analyses), resulting in some K flags. This apparent overshooting only ever seemed to last a short while, as later verification attempts always yielded a potential bias closer to ~1 millibar, which incidentally was typically not flagged since it's unknown whether the *Gunter's* P is reported at the height of the sensor or adjusted to sea surface values. A more complicated picture emerged in November when there was an odd +2 to +5 mb bump in the P data, which did not seem to correlate with any other parameter, and which was followed by some spurious discontinuities, steps, and noise (Figure 39). Some other sensors aboard the *Gunter* have been known in the past to be subject to waterlogging, so perhaps that is the situation with P as well. A slow evaporation within the pressure tubing could certainly explain why the apparent elevations in P always seem to taper off. It's also possible the P scenario depicted in Figure 39 features more than one data issue.

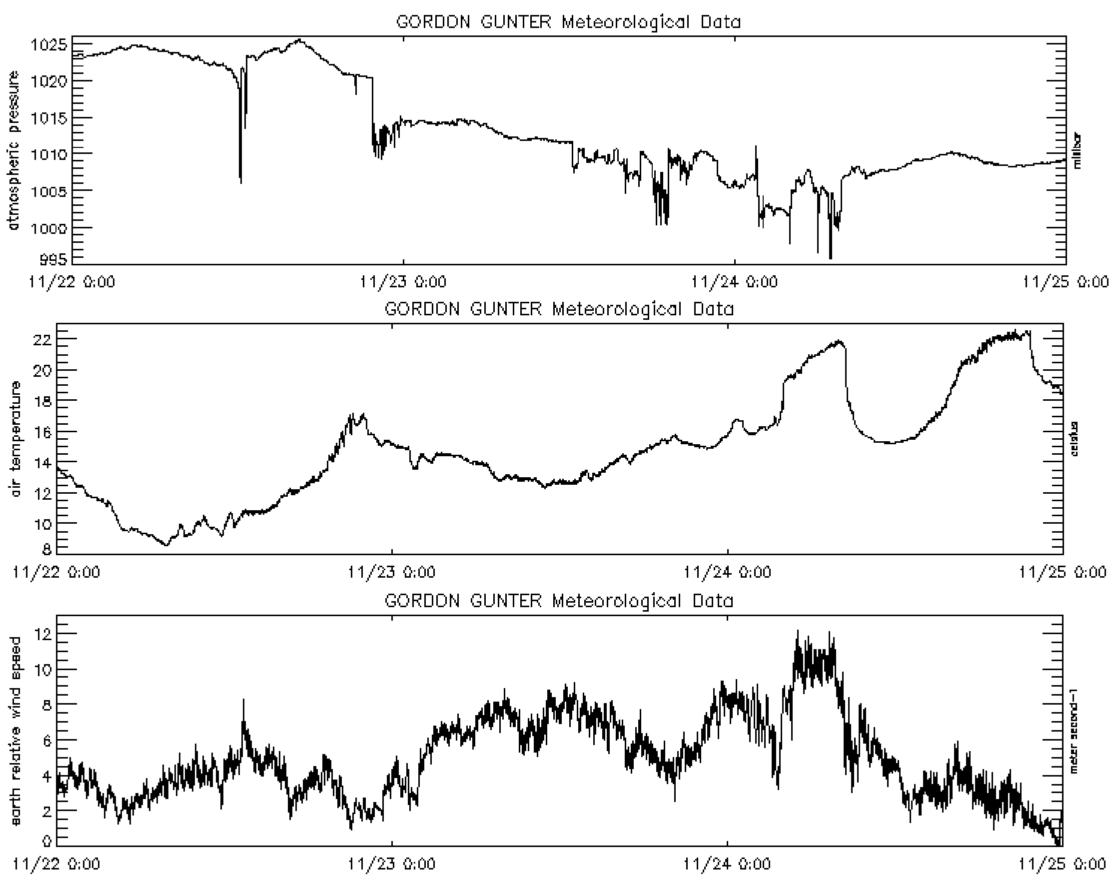


Figure 39: *Gordon Gunter* SAMOS (top) atmospheric pressure – P – (middle) air temperature -- T -- and (bottom) earth relative wind speed –SPD – data for 22 November 2018. Note dubious upward bump in P during the latter half of 11/22 and multiple noisy steps thereafter.

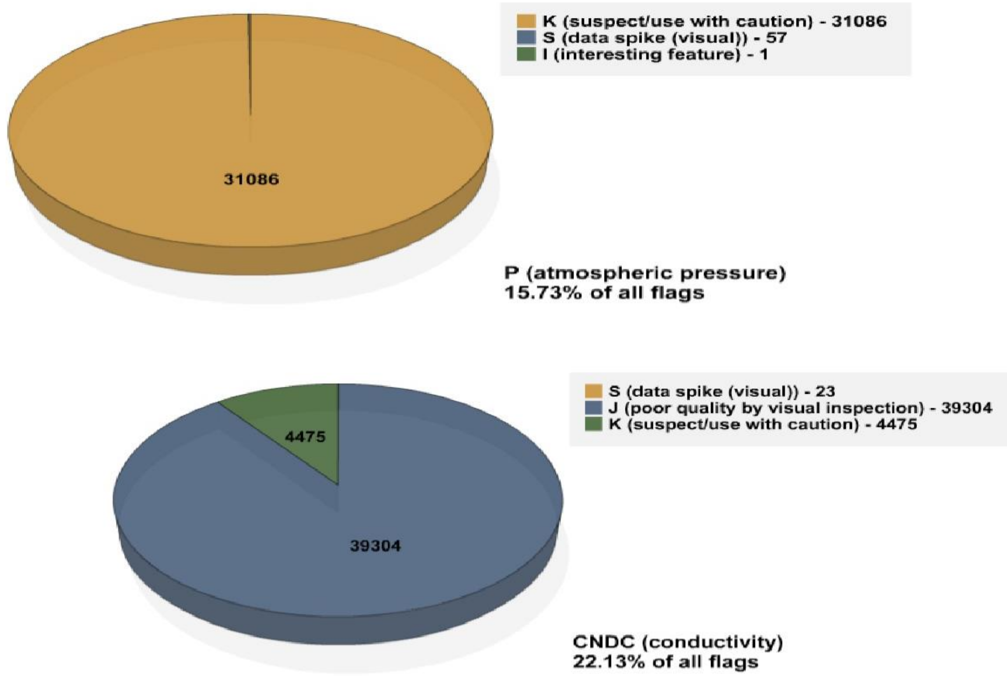


Figure 40: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – and (bottom) conductivity – CNDC – for the *Gordon Gunter* in 2018.

Henry B. Bigelow

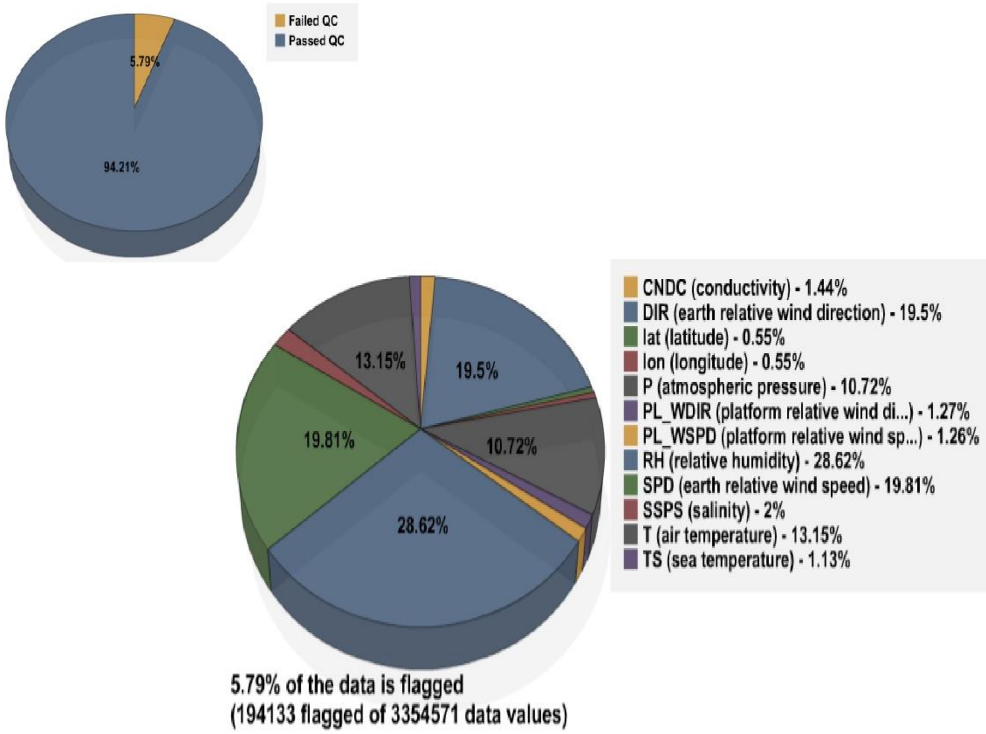


Figure 41: For the *Henry B. Bigelow* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Henry Bigelow* provided SAMOS data for 171 ship days, resulting in 3,354,571 distinct data values. After both automated and visual QC, 5.79% of the data were flagged using A-Y flags (Figure 41). This is a percentage point lower than in 2017 (6.75%).

The vast majority of all *Bigelow's* flags in 2018 were applied to the meteorological parameters – atmospheric pressure (P), earth relative wind direction and speed (DIR and SPD, respectively), air temperature (T), and relative humidity (RH) (Figure 41). All meteorological parameters reported by the *Henry Bigelow* suffer the myriad effects of less-than-ideal sensor placement (e.g. flow interruption, exhaust contamination). The result is steps and spikes in the data, which acquire spike (S) and caution/suspect (K) flags (Figure 44). This is not uncommon among sea-faring vessels, although the effects are perhaps a little more pronounced on the *Bigelow* than on the average SAMOS ship. Exhaust contamination is particularly evident in T (rising) and RH (dropping) when the platform-relative wind is from the stern (Figure 42). In February, the lead SAMOS data analyst made a site visit to the *Bigelow*, the results of which included recommendations for re-siting several of the sensors or perhaps acquiring additional sensors to site in recommended locations.

In addition to K flags, DIR and SPD values both accrued a sizable amount of failed the true wind recomputation test (E) flags (Figure 44). There is some suspicion the platform relative winds either do not originate with the same sensor as that of the earth relative winds or else may not be averaged identically to the earth relative winds. It was also recommended during the February site visit that a wind sensor specifically be sited on the forward bow for the best exposure.

RH additionally sometimes read a few percent over 100 in 2018, which resulted in out of bounds (B) flags (Figure 44). This may have been the commonplace result of sensor tuning and saturated atmospheric conditions (see 3b.), although the possibility exists there could have been a moisture issue such as has occurred in other equipment on the flying bridge.

Bigelow's pressure tubing is one of those prone to moisture infiltration, which typically causes the data to range anomalously higher during the day and lower at night. In early September it was noted the pressure readings were ranging too much over the course of the day again (Figure 43), leading to additional K flags (Figure 44). Vessel techs were alerted by email to the analyst's suspicions. They replied they did find moisture in the tubing and blew it out with a vacuum. Afterwards, reading returned to normal. It was advised during the February site visit they retube their barometer annually to minimize the problem.

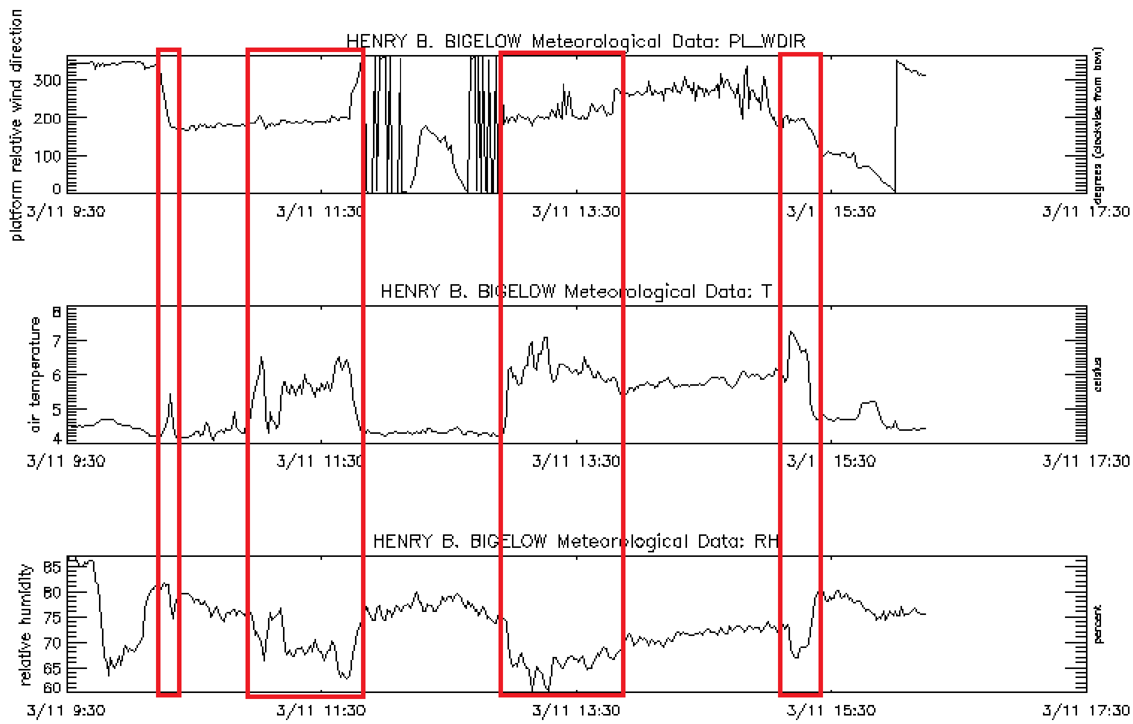


Figure 42: *Henry Bigelow* SAMOS (top) platform relative wind direction – PL_WDIR – (middle) air temperature – T – and (bottom) relative humidity – RH – for 11 March 2018. Note steps in T and RH (in red) when the relative wind is roughly 180°.

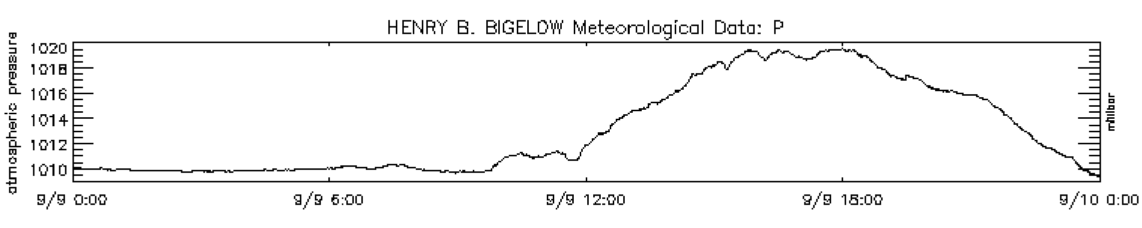


Figure 43: *Henry Bigelow* SAMOS atmospheric pressure –P – data for 9 September 2018. Note 10 mb range in P. Two nearby buoys reported a range in P of ~1012-1015 mb throughout the day .

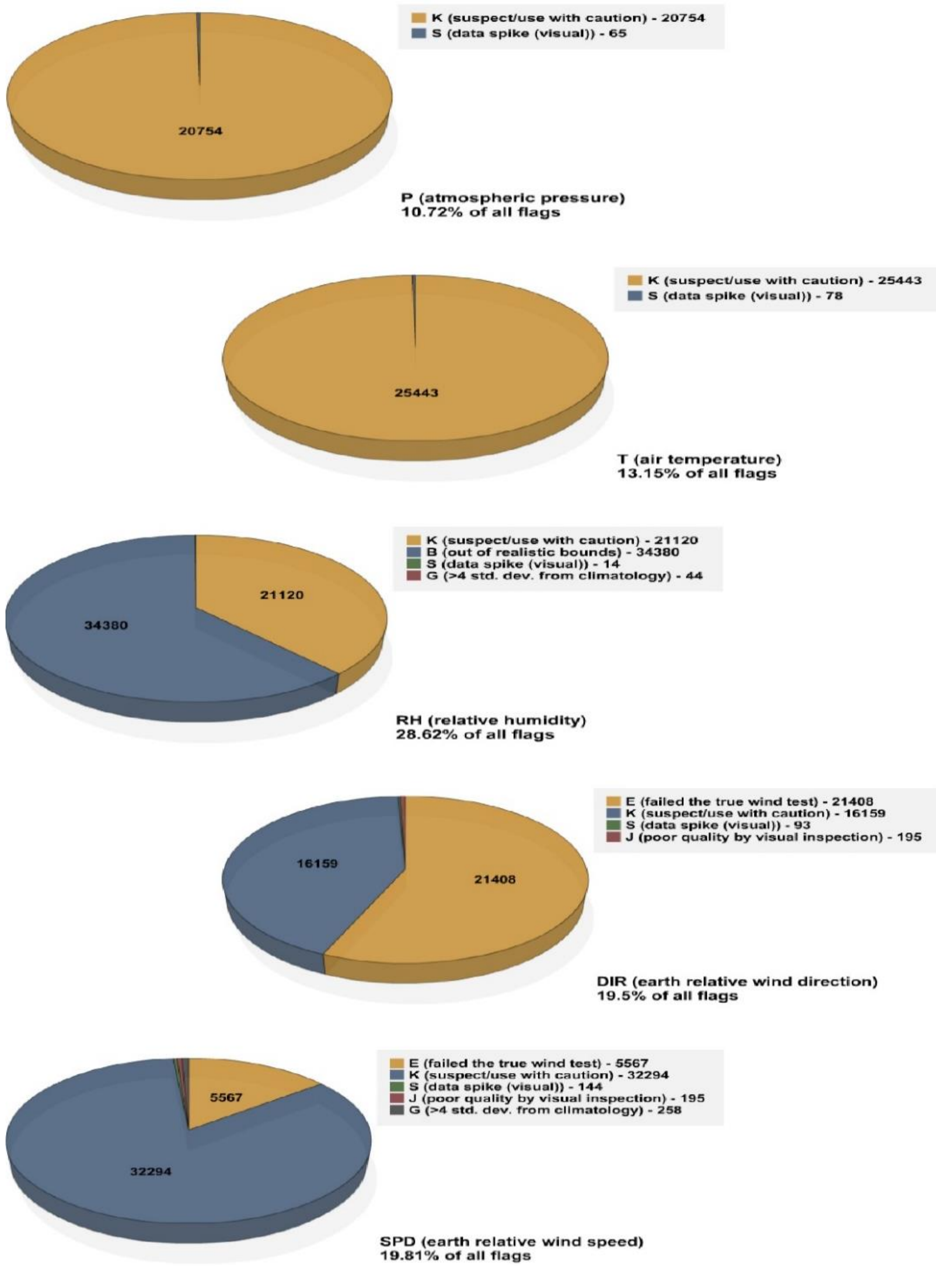


Figure 44: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Henry B. Bigelow* in 2018.

Hi'ialakai

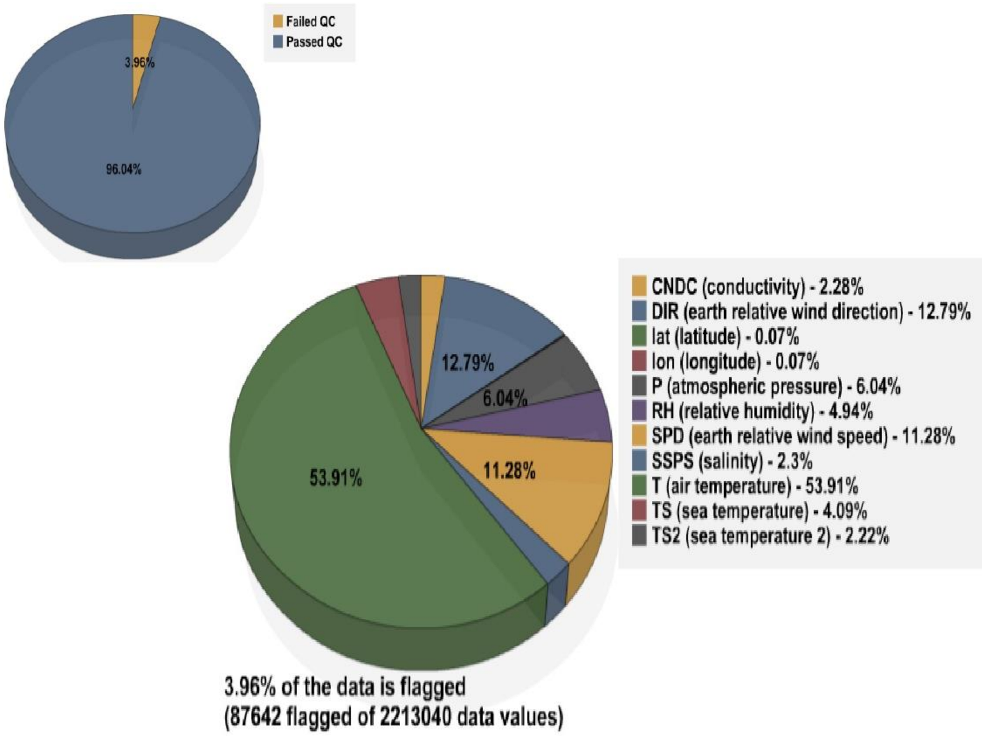


Figure 45: For the *Hi'ialakai* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Hi'ialakai* provided SAMOS data for 91 ship days, resulting in 2,213,040 distinct data values. After both automated and visual QC, 3.96% of the data were flagged using A-Y flags (Figure 45). This is about 1.5 percentage points lower than 2017 (5.63%) and brings *Hi'ialakai* under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

As a general note, air temperature (T), relative humidity (RH), earth relative wind direction and speed (DIR and SPD, respectively), and atmospheric pressure (P) on the *Hi'ialakai* all show signs of moderate flow distortion and, in the case of T and RH, contamination from daytime ship heating and/or stack exhaust (all common on most vessels), which oftentimes results in caution/suspect (K) flags for each of those parameters (not shown). These K flags explain the bulk of the percentages seen in Figure 45 for those variables. However, T, holding the largest percentage, also continues to suffer from what appears to be low-grade electrical interference on and off throughout the year (Figure 46), meaning a higher proportion of K flags for that variable (Figure 47). It's possible some other machinery or instrumentation nearby the T sensor is regularly bleeding voltage.

We note, though, that while it can be a challenge to site sensors ideally on a ship, with such a low overall flag percentage these sensor location issues were not terribly consequential for *Hi'ialakai* in 2018; however, the source of the noise in the T sensor data needs further investigation.

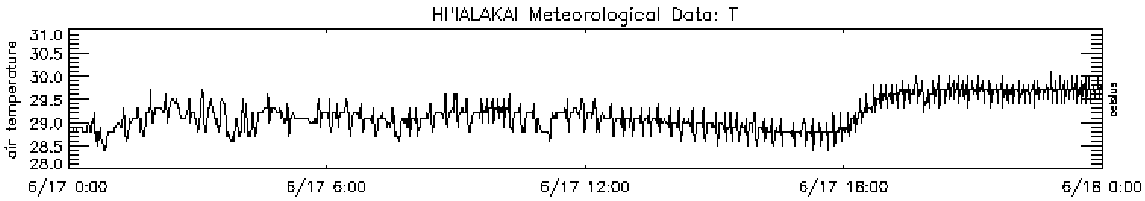


Figure 46: *Hi'ialakai* SAMOS air temperature – T – for 17 June 2018. Note periodic signal present in the data (presumed electrical interference).

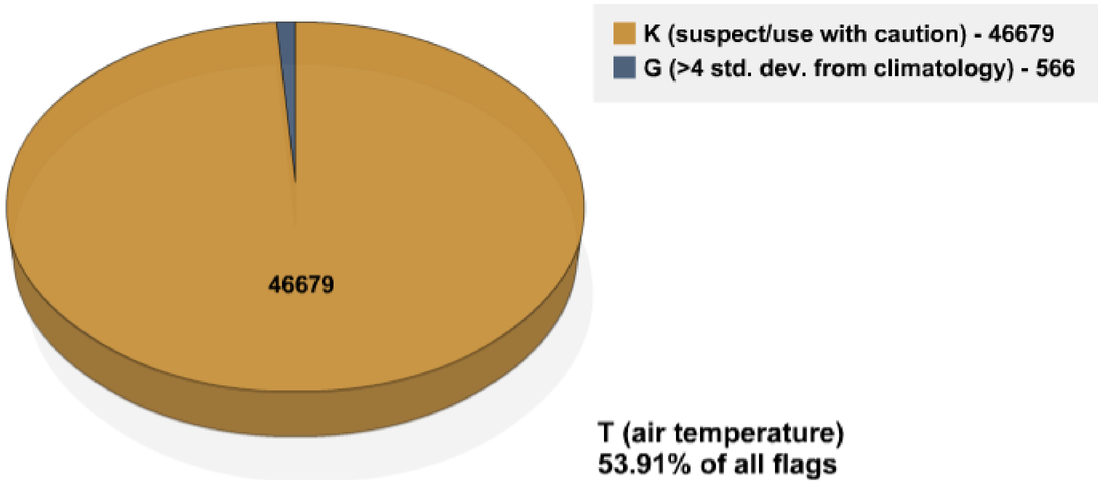


Figure 47: Distribution of SAMOS quality control flags for air temperature – T – for the *Hi'ialakai* in 2018.

Nancy Foster

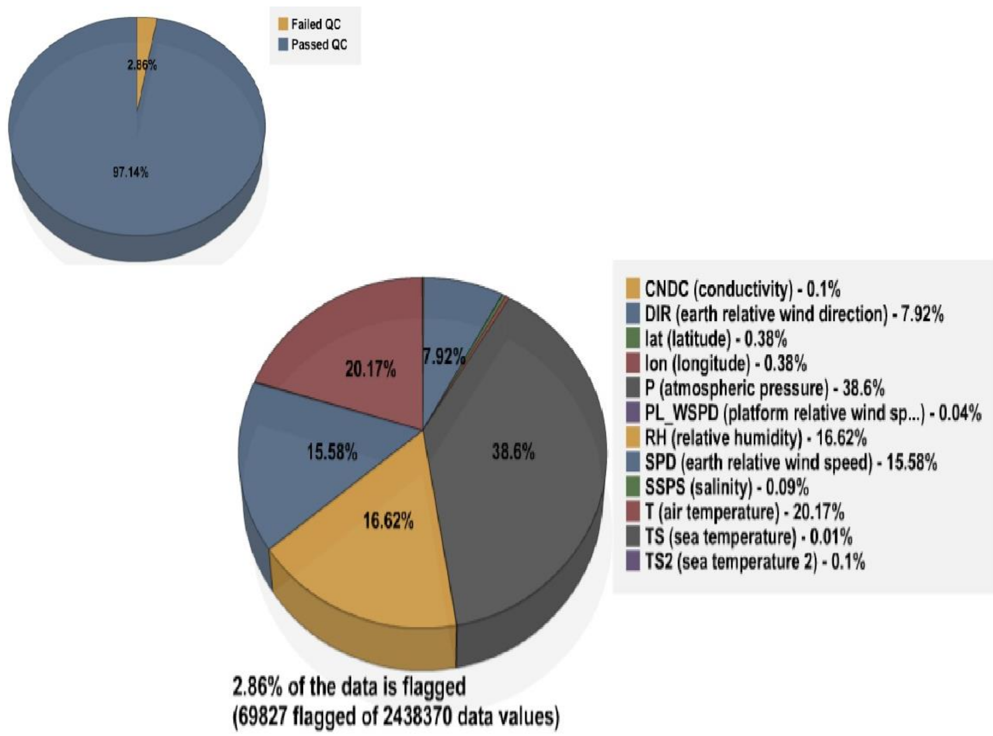


Figure 48: For the *Nancy Foster* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Nancy Foster* provided SAMOS data for 133 ship days, resulting in 2,438,370 distinct data values. After both automated and visual QC, 2.86% of the data were flagged using A-Y flags (Figure 48). This is about a percentage point lower than 2017 (3.97%) and maintains *Foster's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

Thermosalinograph data had been missing from the *Foster's* SAMOS data roster for a few years, so in mid-June the vessel was contacted via email to ascertain whether circumstances might now allow for the flow of TSG data to be reestablished. After a bit of discussion and a false start in mid-July, vessel technicians were able to get the sea data flowing reliably as of 5 September.

When a vessel makes a near approach to buoys or land-based stations the visual QC analyst usually attempts to make a direct data comparison. At times, the *Foster's* atmospheric pressure (P) can appear low by anywhere from 3 to 6 millibars. Email discussions with *Foster* technicians in early September regarding the possibility of compromised P did not result in any firm conclusions, perhaps because of the occasional nature of the issue. It is suspected (although not confirmed) P is measured at-height, so that could account for 1-2 mb of the discrepancy. Where the discrepancy tends towards the larger number P is often assigned caution/suspect (K) flags (Figure 50).

Air temperature (T), pressure (P), relative humidity (RH), and to a lesser extent platform- and earth-relative wind speeds (PL_WSPD and SPD, respectively) and (only occasionally) earth relative wind direction (DIR) are prone to exhibiting spikes (Figure 49, not all shown) at various times in the sailing season, to which mainly spike (S) flags are assigned (Figure 50, not all shown). It is not certain whether these spikes are tied to a particular platform relative wind direction, although this analyst suspects not. This has been the ongoing scenario for several years, and despite numerous attempts over the years to identify the spikes' origin, the cause remains unknown. 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.).

As a general note, in addition to the spike issue, P, T, RH, and, to a lesser extent, both SPD and DIR exhibit clear sensor exposure issues (common on most vessels), which generally results in the application of caution/suspect (K) flags (Figure 50). 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. In any case, with an overall flag percentage under 5%, any sensor location issues on the Foster should not be considered terribly consequential.

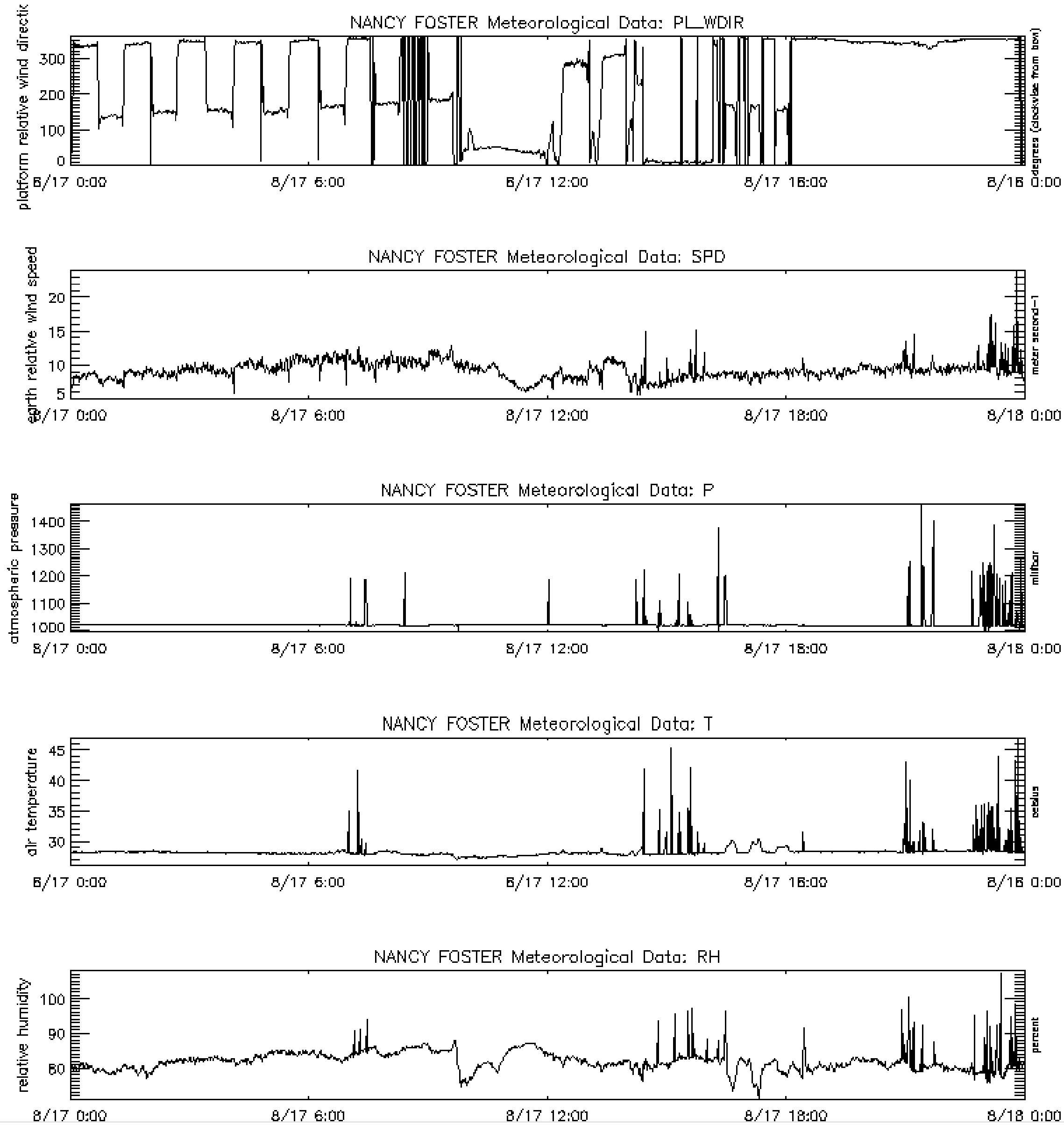


Figure 49: *Nancy Foster* SAMOS (first) platform relative wind direction – PL_WDIR – (second) earth relative wind speed – SPD – (third) atmospheric pressure – P – (fourth) air temperature – T – and (last) relative humidity – RH – for 17 August 2018. Note anomalous spikes in SPD, P, T, and RH.

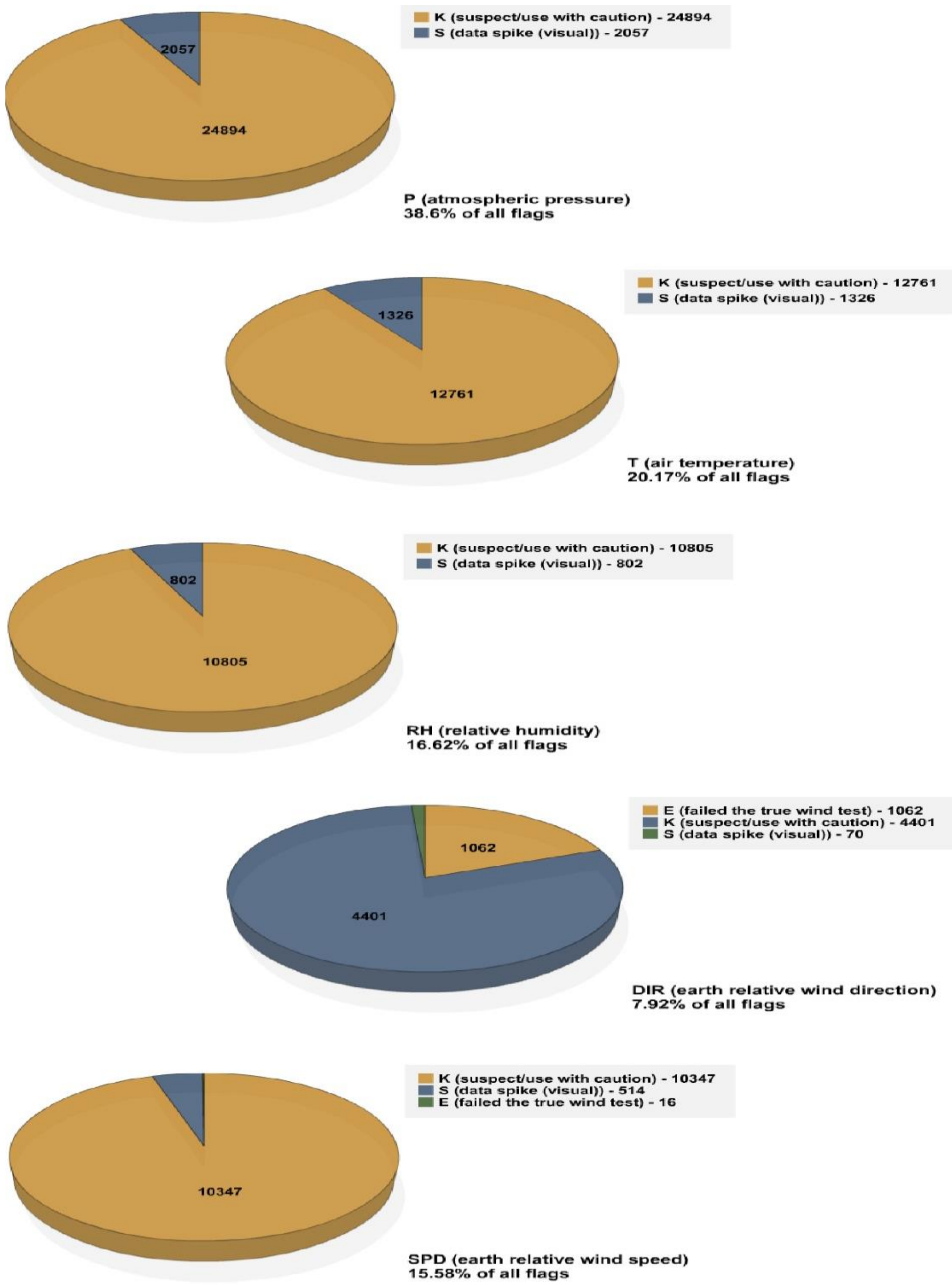


Figure 50: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Nancy Foster* in 2018.

Okeanos Explorer

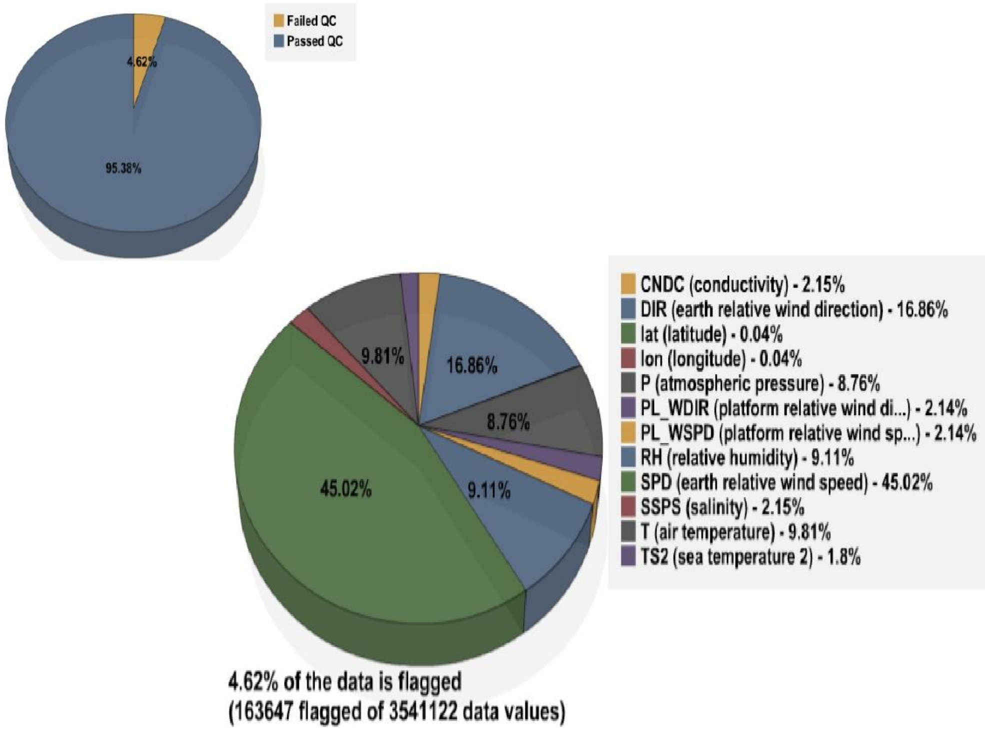


Figure 51: For the *Okeanos Explorer* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Okeanos Explorer* provided SAMOS data for 173 ship days, resulting in 3,541,122 distinct data values. After both automated and visual QC, 4.62% of the data were flagged using A-Y flags (Figure 51). This is a substantially lower than in 2017 (12.54%) and moves the *Explorer* under the 5% total flag cutoff regarded by SAMOS to represent “very good” data.

At the start of the sailing season it was noted the platform relative wind direction (PL_WDIR) and platform relative wind speed (PL_WSPD) parameters appeared to be swapped (Figure 52). The vessel was contacted via email and the issue was promptly corrected. *Explorer* technicians confirmed the swap and noted they’d just rebuilt their SCS server and were still working out the kinks. For the few days while the parameters were swapped each was assigned malfunction (M) flags (Figure 53).

In addition, the earth relative wind direction and speed (DIR and SPD, respectively) amassed failed the true wind recomputation test (E) flags as a result of the erroneous platform relative wind data (Figure 53). However, even after the platform relative wind issue was fixed both SPD and, to a lesser extent, DIR continued to accrue E flags. It was strongly suspected the units of the platform relative wind speed, listed as m s^{-1}, were incorrect. It was believed the PL_WSPD data were being reported in kt, as the SPD data were (and which were verifying ok). This was all communicated to the vessel on more than one occasion along with a request to confirm units on all wind parameters. However, no such confirmation was forthcoming. In early June the NOAA/OMAO data manager was enlisted to help get to the bottom of the matter. Consequently, on 12 June the PL_WSPD units were confirmed by the vessel to be knots, dating back to the start of the 2018 field season. As we do not currently have the ability to retroactively change a portion of data that has already undergone visual QC, we must here advise science users that all platform relative wind speeds from the *Okeanos Explorer* for 14 March through 6 June 2018 require a unit conversion of kts to m s^{-1}, even though they are stated to be in m s^{-1}.

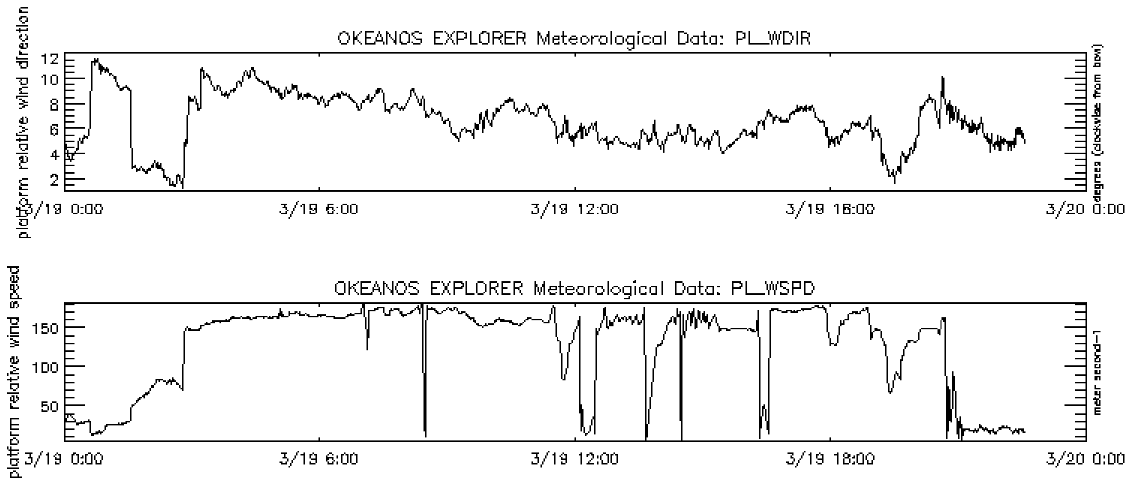


Figure 52: *Okeanos Explorer* SAMOS (top) platform relative wind direction – PL_WDIR – and (bottom) platform relative wind speed – PL_WSPD – for 19 March 2018. Note PL_WSPD features a range normally expected from PL_WDIR, and vice versa.

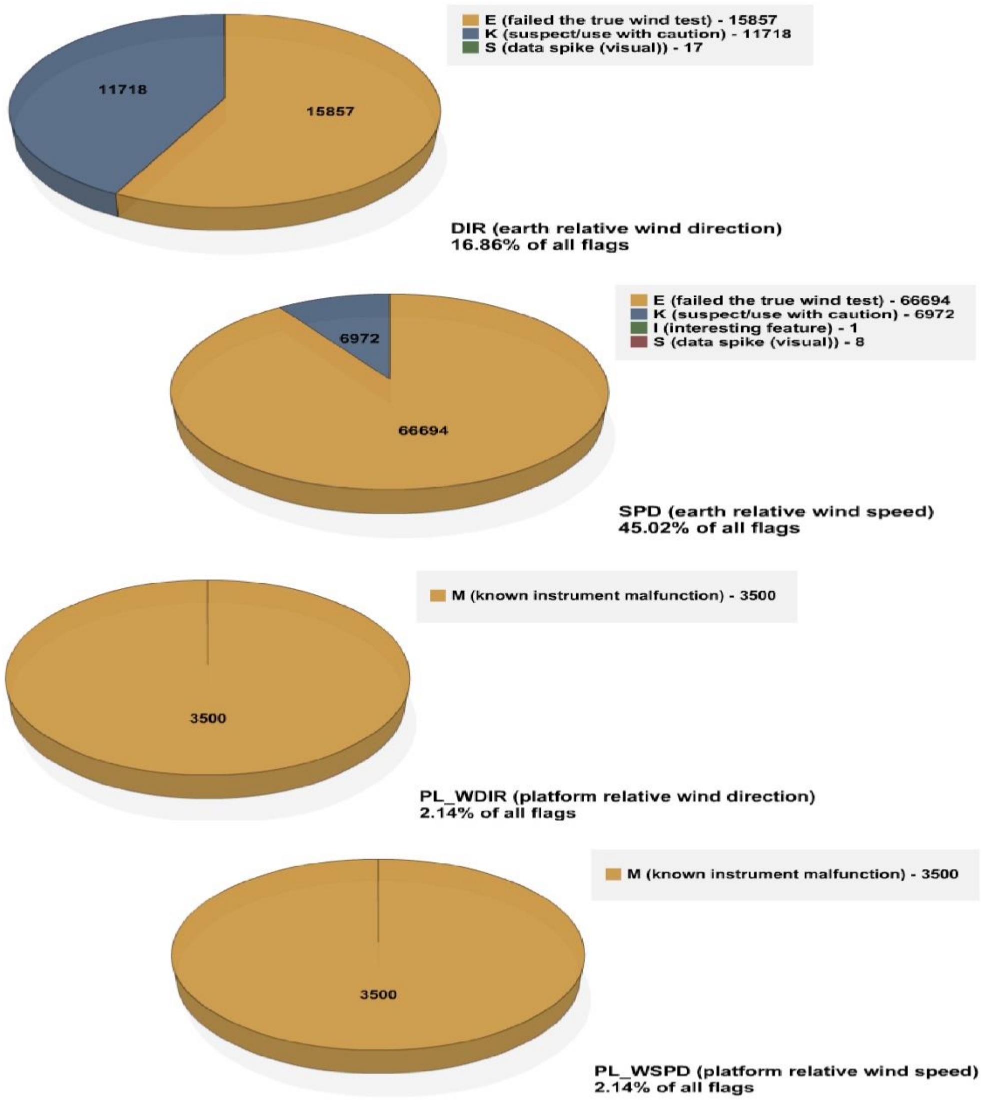


Figure 53: Distribution of SAMOS quality control flags for (first) earth relative wind direction – DIR – (second) earth relative wind speed – SPD – (third) platform relative wind directions – PL_WDIR – and (last) platform relative wind speed – PL_WSPD – for the *Okeanos Explorer* in 2018.

Oregon II

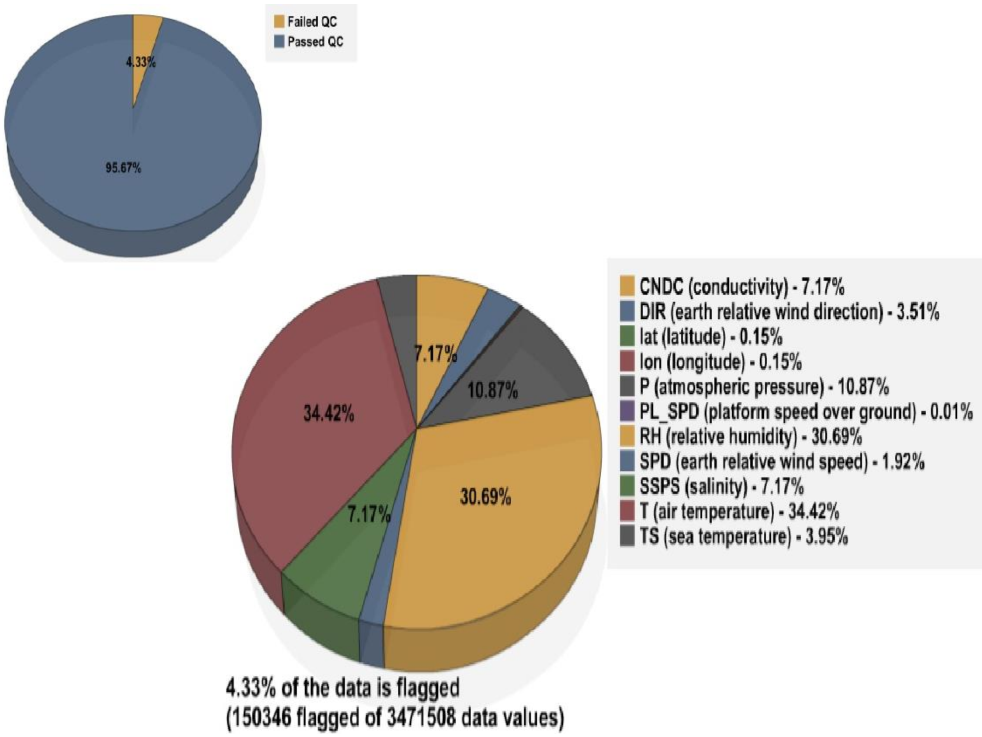


Figure 54: For the *Oregon II* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oregon II* provided SAMOS data for 171 ship days, resulting in 3,471,508 distinct data values. After both automated and visual QC, 4.33% of the data were flagged using A-Y flags (Figure 54). This is a few percentage points lower than in 2017 (7.37%) and moves the *Oregon II* under the 5% total flagged cutoff regarded by SAMOS to represent “very good” data.

There were no specific issues noted for the *Oregon II* in 2018. As a general note, air temperature (T), relative humidity (RH), earth relative wind direction and speed (DIR and SPD, respectively), and atmospheric pressure (P) on the *Oregon* all suffer the myriad effects of less-than-ideal sensor placement (e.g. flow distortion, stack exhaust contamination, ship heating), which oftentimes results in caution/suspect (K) flags for each of those parameters (Figure 56, not all shown). What looks to be the effect of localized ship heating seems particularly evident in T and RH on sunny days when the relative wind is from broadly port to astern (Figure 55). All these effects are common among sea-faring vessels, where instrument siting can be tricky, although the effects are perhaps a little more pronounced on the *Oregon* than on the average SAMOS ship. We note *Oregon II* metadata is likely outdated and digital imagery/schematics of the vessel are unavailable, so accurately diagnosing flow issues isn’t possible. In any case, the resulting flags make up most percentages seen in Figure 54 for each parameter. And with an overall flag percentage under 5%, any issues aren’t cause for too much concern.

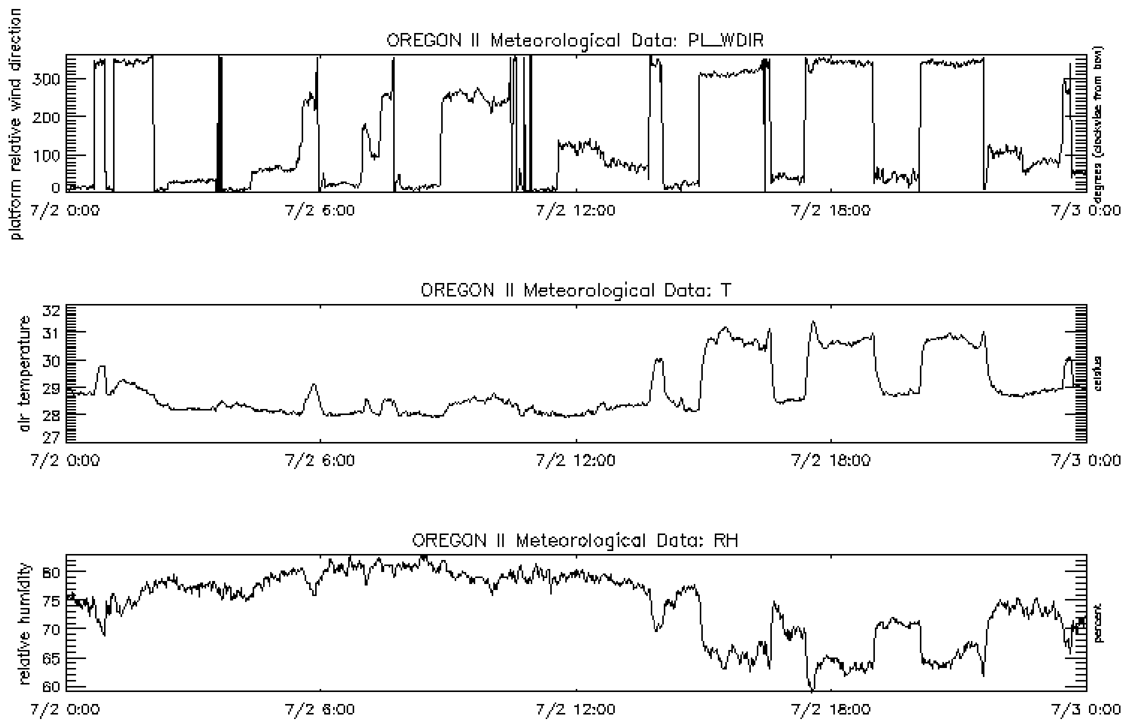


Figure 55: *Oregon II* SAMOS (top) platform relative wind direction – PL_WDIR – (middle) air temperature – T – and (bottom) relative humidity – RH – for 2 July 2018. Note steps in T and RH when PL_WDIR is generally anywhere on the port side. Also note steps are more pronounced during daylight (time series is UTC; cruise region was CDT).

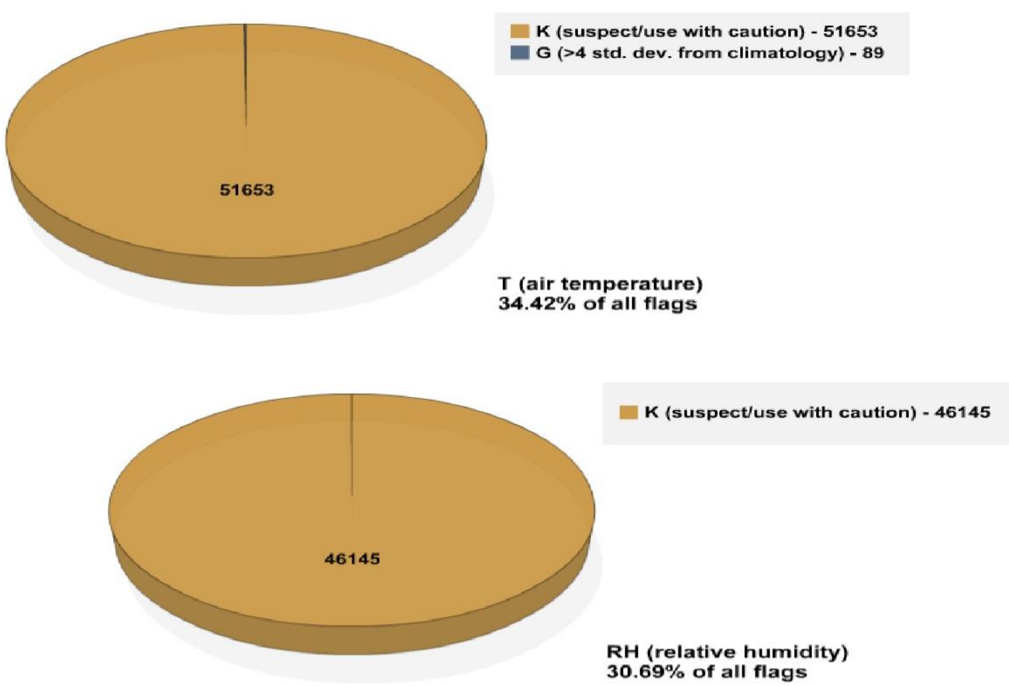


Figure 56: Distribution of SAMOS quality control flags for (top) air temperature – T – and (bottom) relative humidity – RH – for the *Oregon II* in 2018.

Oscar Dyson

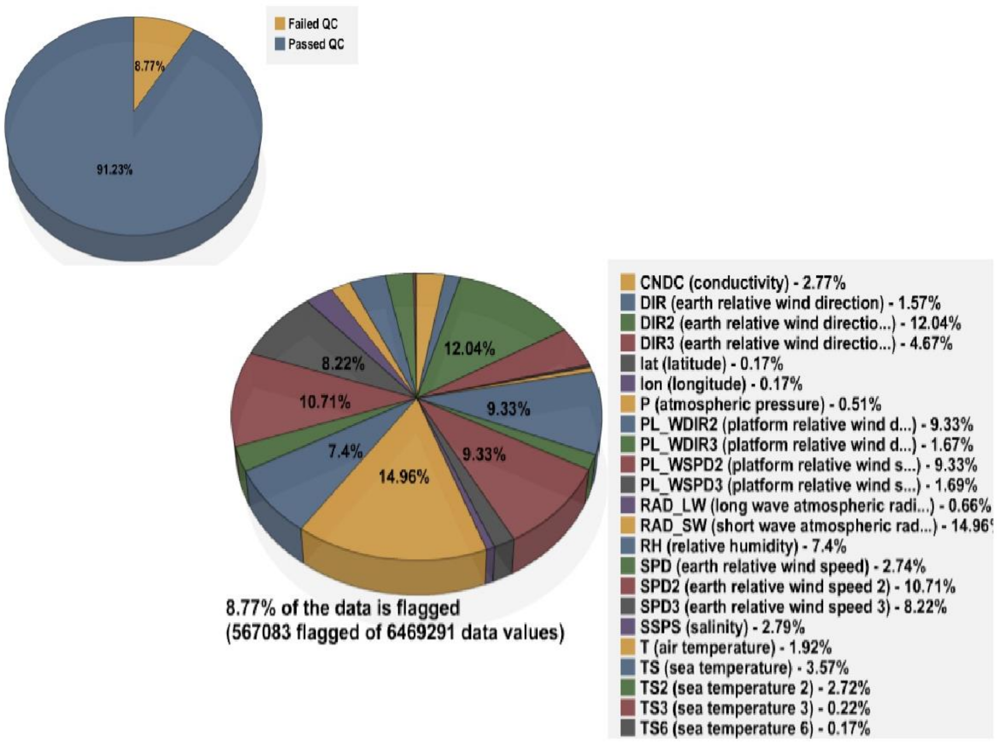


Figure 57: For the *Oscar Dyson* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oscar Dyson* provided SAMOS data for 169 ship days, resulting in 6,469,291 distinct data values. After both automated and visual QC, 8.77% of the data were flagged using A-Y flags (Figure 57). This is more than 7 percentage points higher than in 2017 (1.06%) and puts *Dyson* over the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

On or around 17 June, while augmenting on the *Dyson*, Chief Survey technician Phil White added an offset to the jack staff vane and propeller anemometer, which installation he found to be misaligned by 12.3 degrees. He also determined the port ultrasonic wind sensor was off by ~8 degrees and the starboard by ~5 degrees, but as those sensors do not go through a translator there was no way to apply an offset in the same way as the jack staff instrument. Throughout the year these misalignments sometimes fostered suspect/caution (K) flagging of the true wind measurements – both direction (DIR/DIR2/DIR3) and speed (SPD/SPD2/SPD3) – when there were overt discrepancies between the sensors (Figure 59, not all shown). But as a general note science users should be advised the misalignments affect the accuracy of the platform relative wind direction (PL_WDIR/PL_WDIR2/PL_WDIR3)and DIR/DIR2/DIR3 and SPD/SPD2/SPD3, however minimally.

Additionally, on or around 1 July the starboard ultrasonic anemometer was destroyed by bald eagles (Yes, that is an unexpected problem!). As a result, PL_WDIR3 and DIR3 became erratic while platform relative wind speed 3 (PL_WSPD3) and SPD3 were highly erroneous (Figure 58). These negative data effects, and the knowledge of their origin, necessitated application of malfunction (M) flags to all four parameters from 1 through 19 July (Figure 59, not all shown). On 24 July, a few days after the starboard anemometer was fixed, the port anemometer suffered a suspected sudden misalignment due to turbulent weather and a rough ride. Again, wind measurements from that sensor were noticeably off from the other two anemometers, resulting in the application of poor quality (J) flags to PL_WDIR2, DIR2, PL_WSPD2, and SPD2 (Figure 59, not all shown). Weather conditions continued to be poor and it was not feasible for technicians to go aloft and investigate by the end of the season, so the J flagging persisted through 21 September, the last day of data.

The relative humidity (RH) sensor onboard the *Dyson* became saturated on 6 June. Vessel techs attempted to dry the sensor out but nevertheless it continued to report a constant 100%. The spare RH sensor available at the time was deemed unfit, and it wasn't until 1 July they were able to install a replacement. As such, between 6 June and 1 July RH was assigned M flags (Figure 59).

We note the largest percentage of flags was assigned to the short wave radiation (RAD_SW) parameter (Figure 57). However, these were overwhelmingly out of bounds (B) flags (not shown) applied to the slightly negative values that commonly occur at night due to instrument tuning (see 3b. for details). This mode of flagging does not signify a problem.

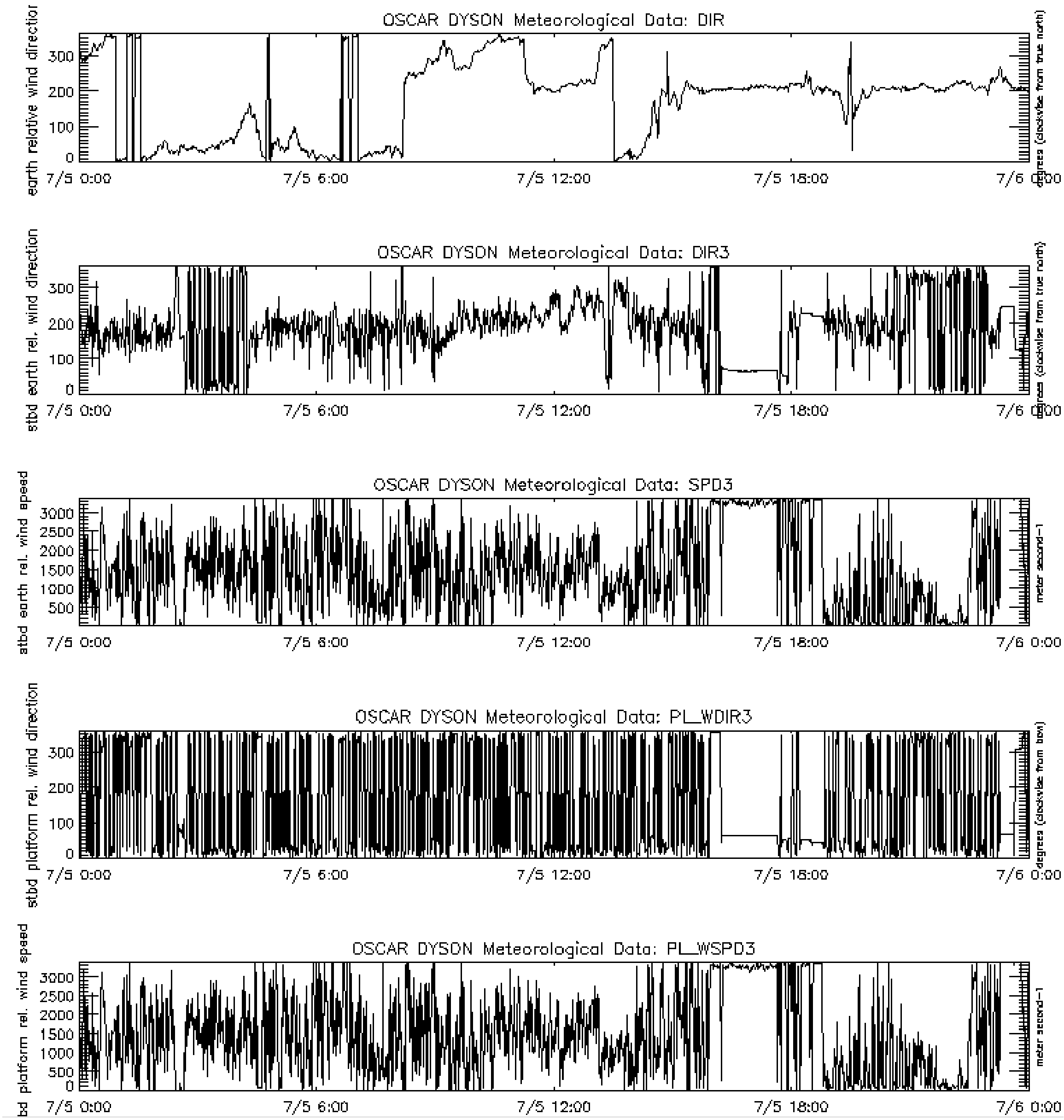


Figure 58: *Oscar Dyson* SAMOS (first) earth relative wind direction – DIR – (second) earth relative wind direction 3 – DIR3 – (third) earth relative wind speed 3 – SPD3 – (fourth) platform relative wind direction 3 – PL_WDIR3 – and (last) platform relative wind speed 3 – PL_WSPD3 – data for 5 July 2018. Note erratic behavior of PL_WDIR3 and DIR3 (plus stark disagreement with DIR) and unreasonable PL_WSPD3 and SPD3 values.

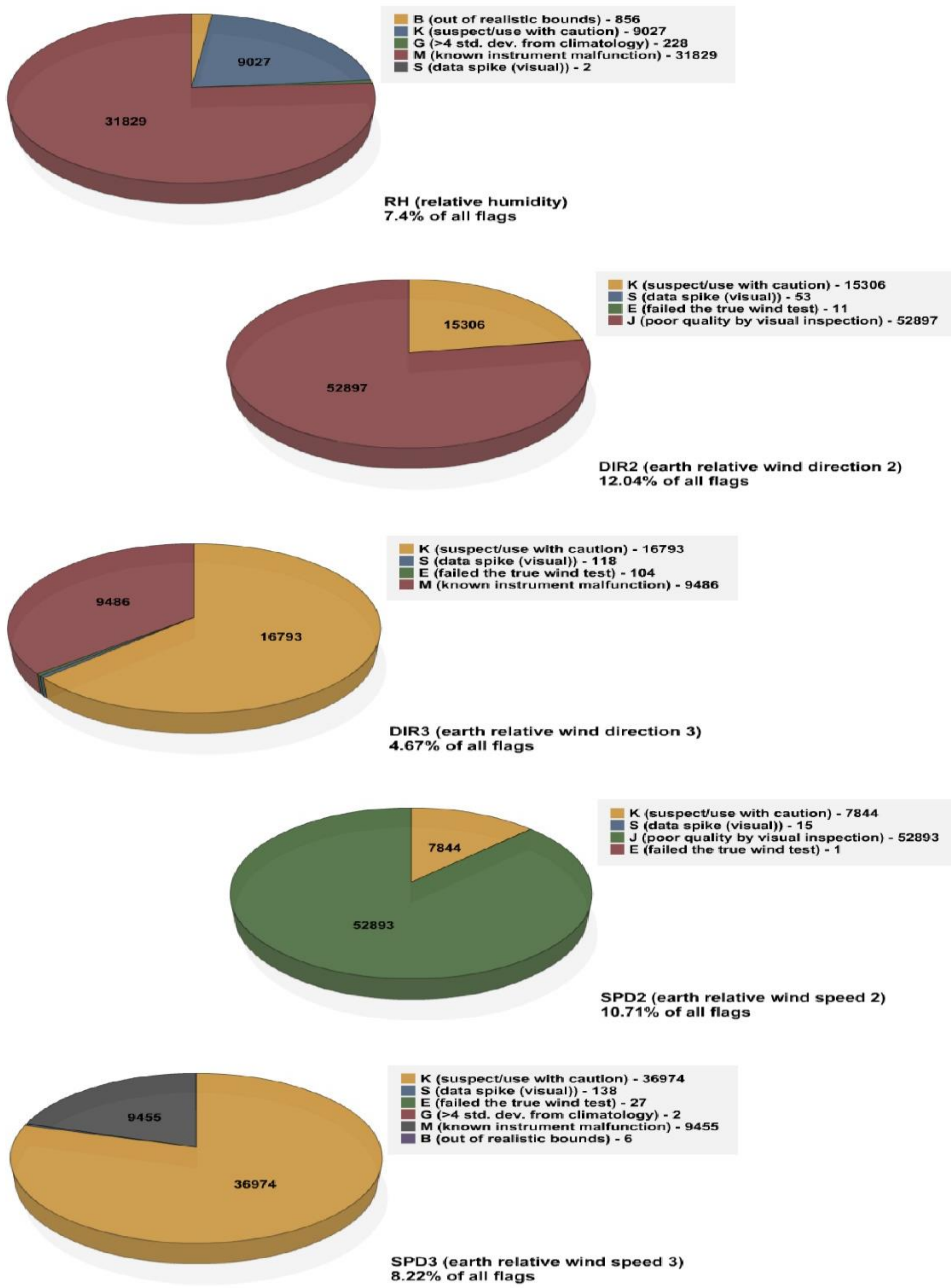


Figure 59: Distribution of SAMOS quality control flags for (first) relative humidity – RH – (second) earth relative wind direction 2 – DIR2 – (third) earth relative wind direction 3 – DIR3 – (fourth) earth relative wind speed 2 – SPD2 – and (last) earth relative wind speed 3 – SPD3 –for the *Oscar Dyson* in 2018.

Oscar Elton Sette

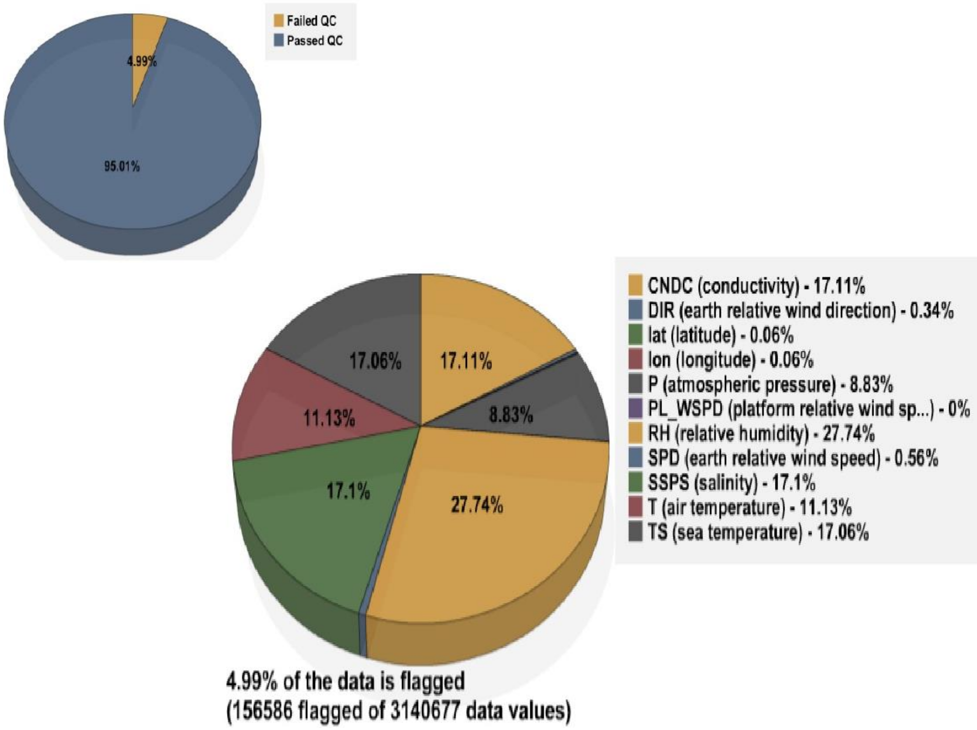


Figure 60: For the *Oscar Elton Sette* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Oscar Elton Sette* provided SAMOS data for 157 ship days, resulting in 3,140,677 distinct data values. After both automated and visual QC, 4.99% of the data were flagged using A-Y flags (Figure 60). This is a little higher than in 2017 (3.13%) but maintains the *Sette's* standing just under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

Each of the three sea parameters – sea temperature (TS), salinity (SSPS), and conductivity (CNDC) – received about 17% of the total flags (Figure 60). Taken together, these three parameters comprise more than half of all flags. However, the vast majority were caution/suspect (K) and poor quality (J) flags (Figure 62) assigned when the flow water system appeared to be off, a common enough occurrence among vessels that generally does not indicate a problem.

In early August it was noted the *Sette's* relative humidity (RH) sensor seemed to have been stuck at 100% for an extended period, despite less than saturated atmospheric conditions. The vessel was notified via email on 7 August and technicians advised they would immediately replace the sensor. Over the next few days RH and air temperature (T) trended through a few iterations of questionable/bad data (Figure 61) and the vessel was contacted again. Through some trial and error, it was ultimately determined all *Sette's* T/RH sensors were beyond their service life. Crew were able to borrow a spare T/RH sensor from NOAA vessel *Hi'ialakai* in late August while new sensors for the *Sette* were on order. Nevertheless, for the period 22 July through 31 August RH received a volume of out of bounds (B), J, and K flags and T received a lesser quantity of K and J flags (Figure 62).

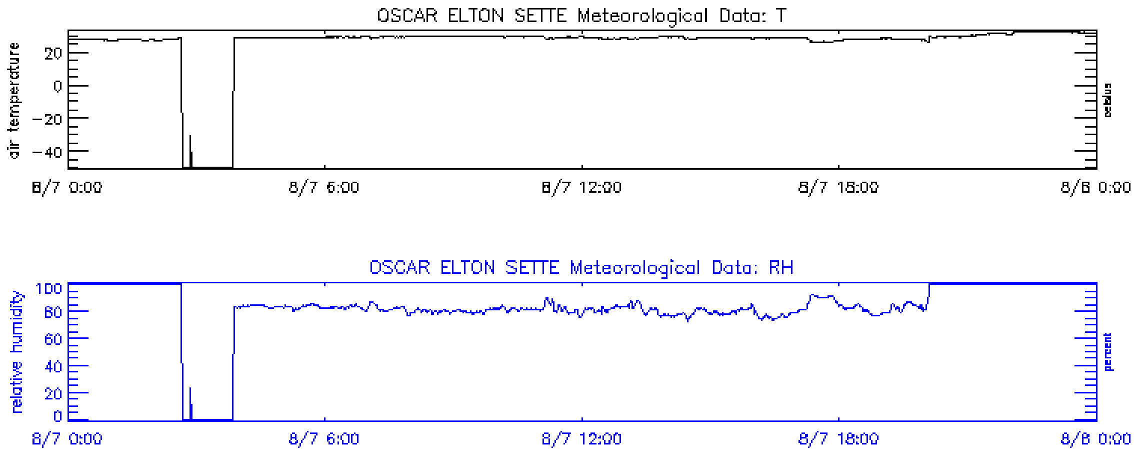


Figure 61: *Oscar Elton Sette* SAMOS (top) air temperature – T – and (bottom) relative humidity – RH – for 7 August 2018. Note constant RH 100% at the beginning and end of the day. Also note discontinuities in T and RH around 0300 UTC, presumably the first time the sensor was removed for troubleshooting.

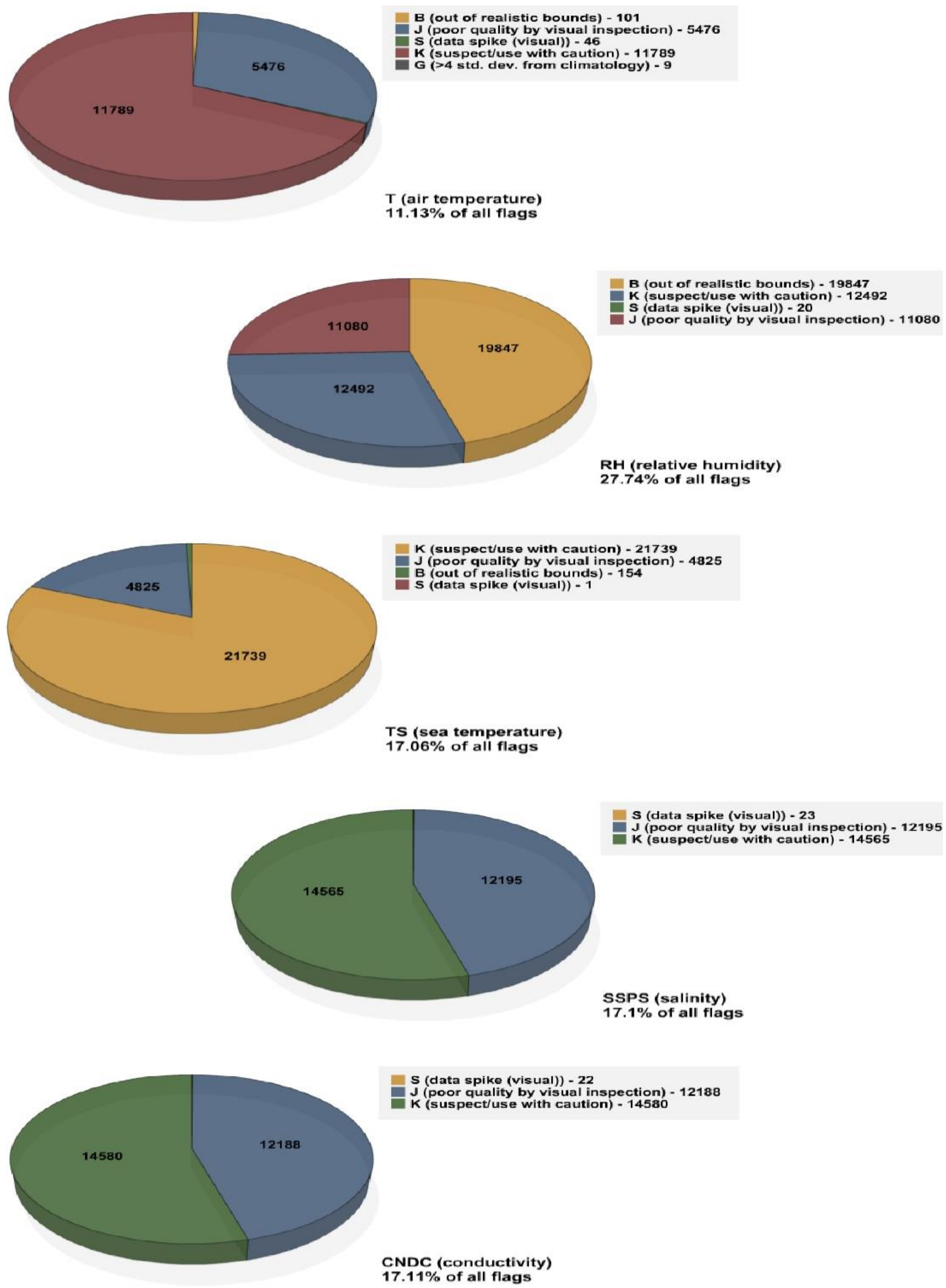


Figure 62: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) relative humidity – RH – (third) sea temperature – TS – (fourth) salinity – SSPS – and (last) conductivity – CNDC – for the *Oscar Elton Sette* in 2018.

Pisces

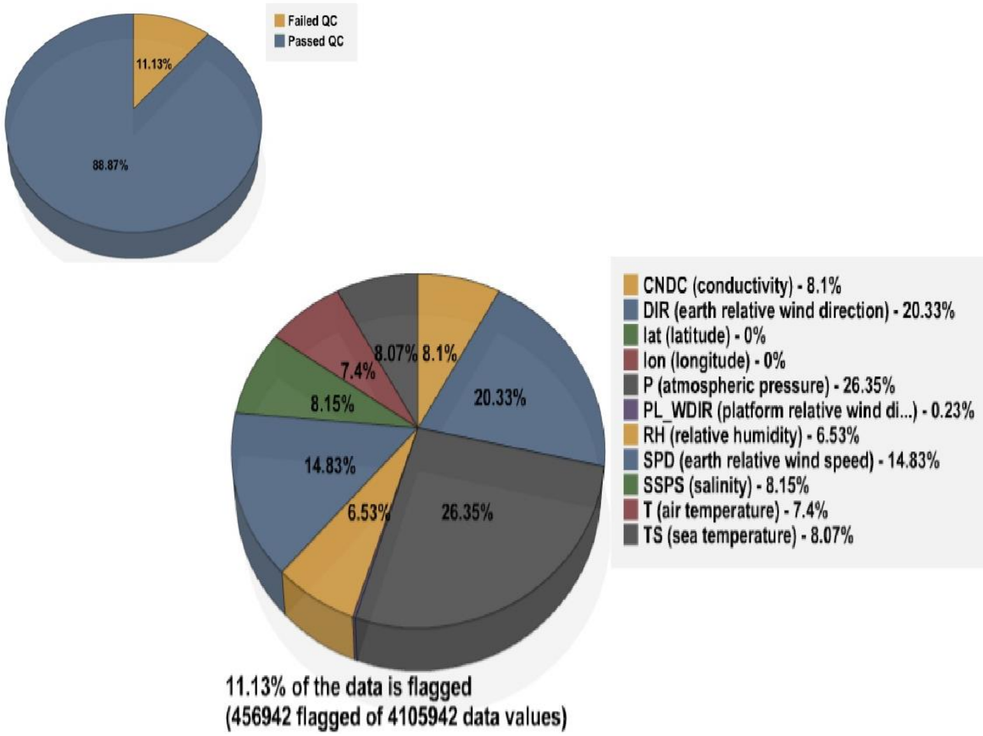


Figure 63: For the *Pisces* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Pisces* provided SAMOS data for 174 ship days, resulting in 4,105,942 distinct data values. After both automated and visual QC, 11.13% of the data were flagged using A-Y flags (Figure 63). This is a little bit higher than in 2017 (9.77%).

There were no singular data issues noted for the *Pisces* in 2018. Nevertheless, her ~11% total flagged percentage (Figure 63) belies the fact *Pisces* endures data issues arising from flow distortion and ship heating/stack exhaust contamination to a greater degree than the typical SAMOS vessel. As a result, air temperature (T), relative humidity (RH), atmospheric pressure (P), and especially DIR and SPD on the *Pisces* all often accrue caution/suspect (K) flags (Figure 66, not all shown). Sensor relocations could possibly help alleviate the ill effects on the various sensors.

P further suffers from a long-standing issue of indeterminate source wherein occasional negative steps are observed in the data (Figure 64). It’s never been clear what causes these steps, but this analyst notes they may be more common when the sun is up so one idea could be interference from an air conditioning system. In any case, such steps in the P data are assigned additional K flags (Figure 66).

Lastly, it has been noted in the past by *Pisces* technicians that there is very poor sea water piping on the vessel, and that ambitions to address the problem have strained to gain traction. These factors likely explain the bulk of the ~25% combined total flagged percentages assigned to sea temperature (TS), salinity (SSPS), and conductivity (CNDC) in 2018 (Figure 63). The usual manifestation of the plumbing issue is noise in the sea water data (Figure 65), and the usual SAMOS response is the application of K flags (Figure 66, not all shown).

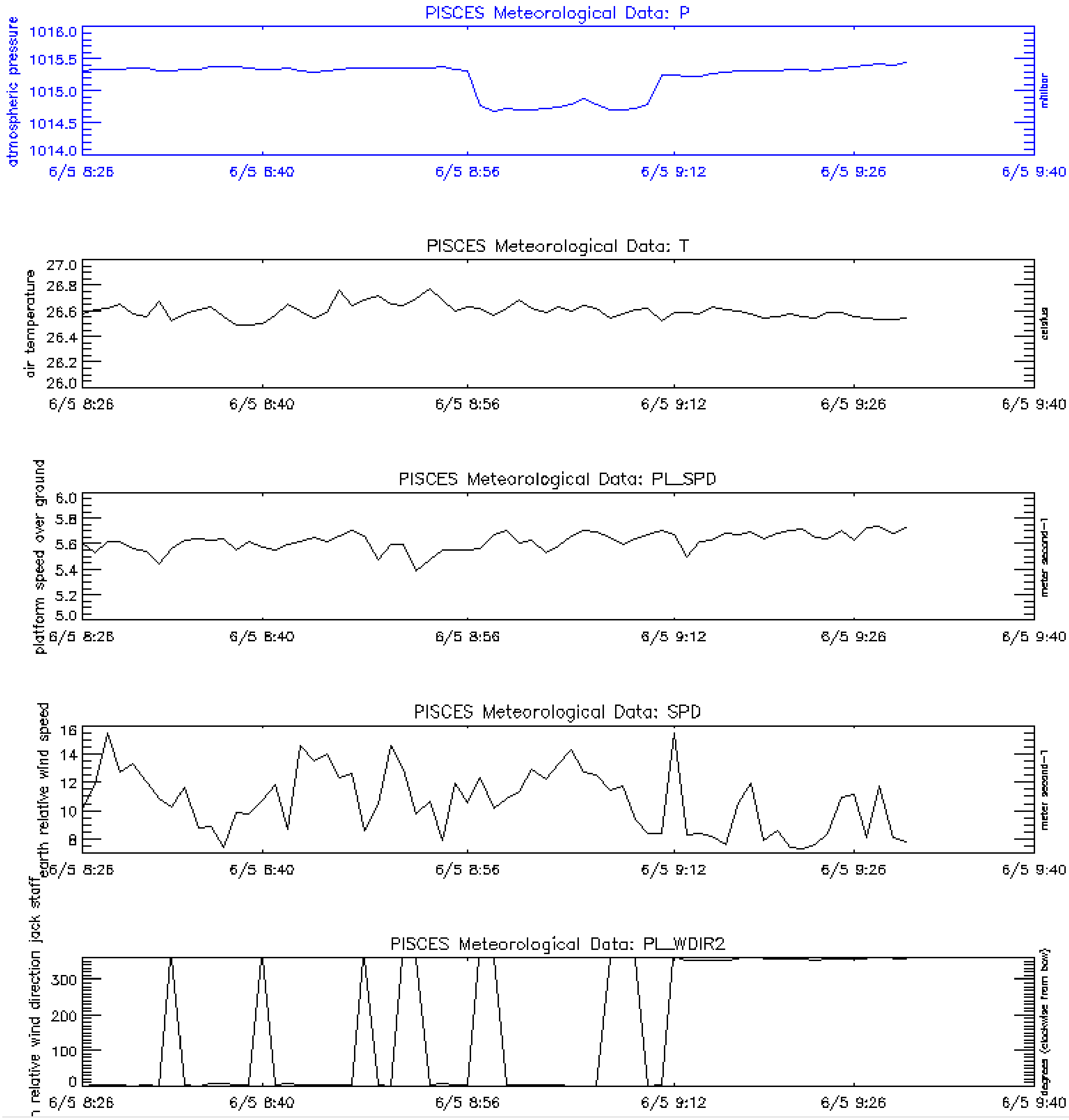


Figure 64: *Pisces* SAMOS (first) atmospheric pressure – P – (second) air temperature – T – (third) platform speed – PL_SPD – (fourth) earth relative wind speed – SPD – and (last) platform relative wind direction 2 – PL_WDIR2 – for 5 June 2018. Note negative step in P with no apparent correlation to any other parameter.

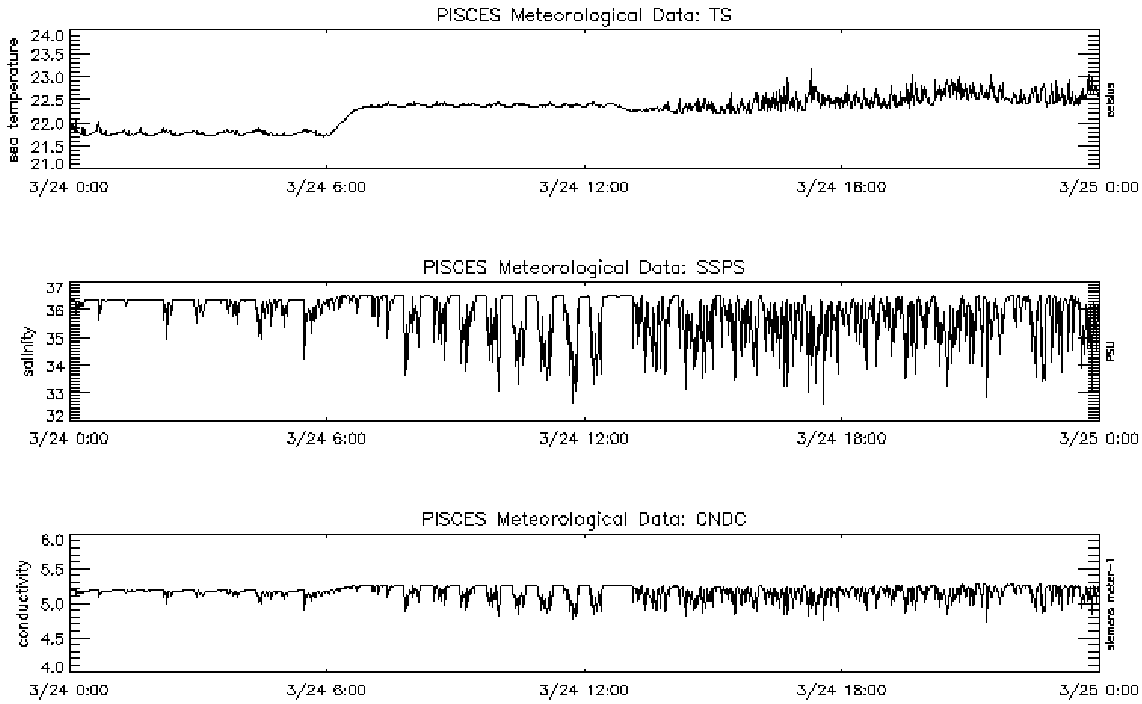


Figure 65: *Pisces* SAMOS (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC – for 24 March 2018. Note the regular infiltration of gritty noise in the data.

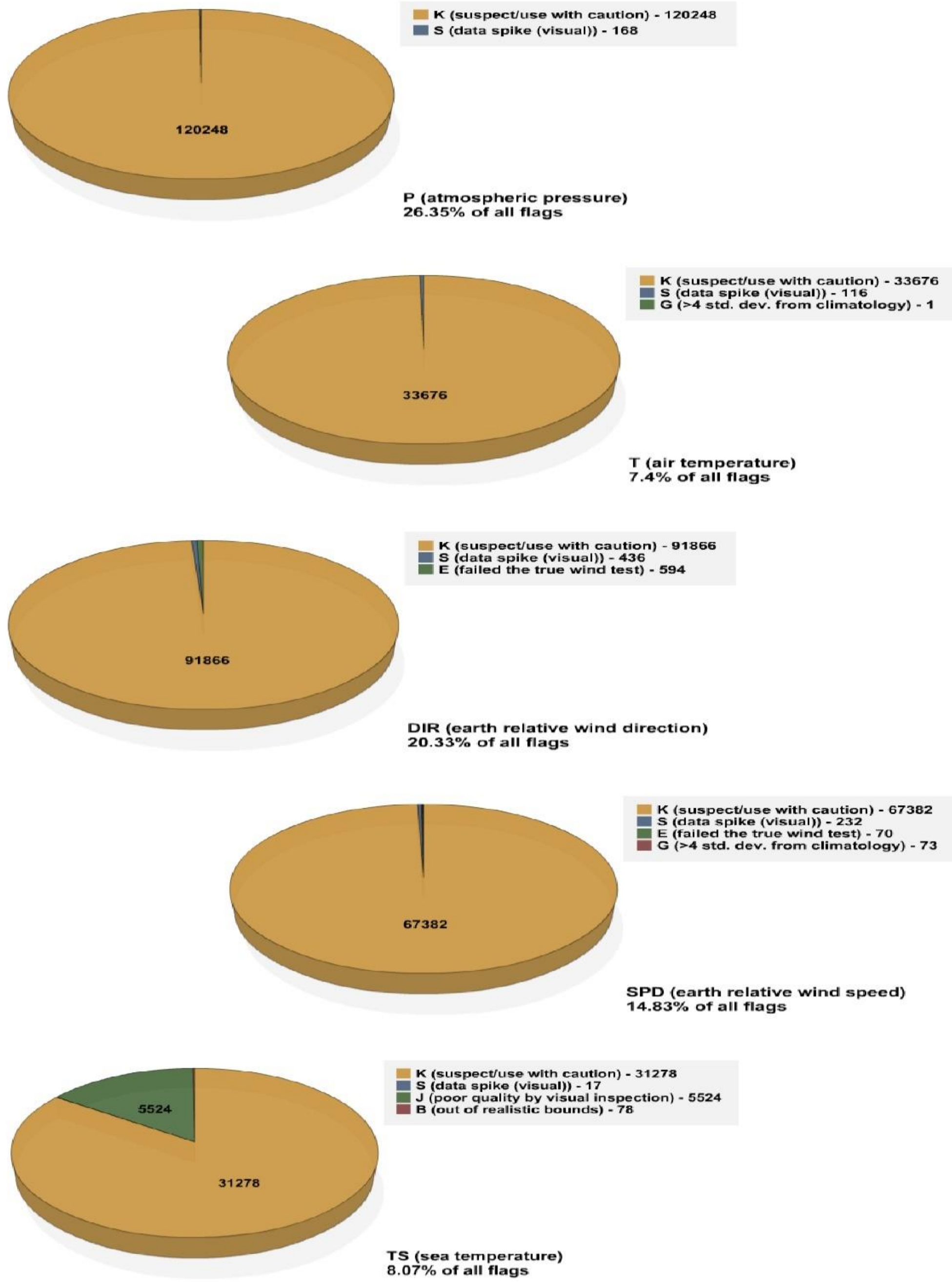


Figure 66: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) earth relative wind direction – DIR – (fourth) earth relative wind speed – SPD – and (last) sea temperature – TS – for the *Pisces* in 2018.

Rainier

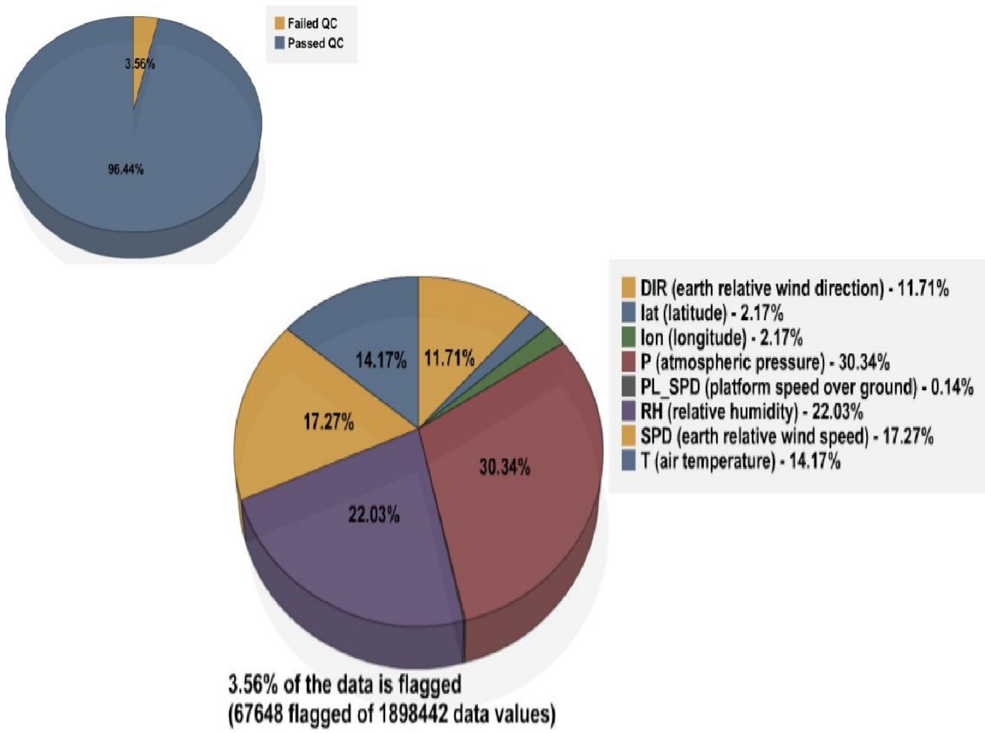


Figure 67: For the *Rainier* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Rainier* provided SAMOS data for 109 ship days, resulting in 1,898,442 distinct data values. After both automated and visual QC, 3.56% of the data were flagged using A-Y flags (Figure 67). This is about the same as 2017 (3.91%) and maintains the *Rainier's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

There were no specific data issues noted for *Rainier* in 2018. There was, however, an ultimately problematic "key:value" data pair introduced into *Rainier's* SAMOS files in mid-October. The designator "Cruise / Leg" was supplied in the files, which caused errors when the National Centers for Environmental Information (NCEI) attempted to archive the data set. The issue turned out to be the blank spaces in the designator. We took steps to address the issue DAC-side and have since updated SAMOS recruiting materials to include the requirement that all SAMOS designators must be alphanumeric, without any spaces, to enable archiving with NCEI.

As a general note, it is known that *Rainier* exhibits a somewhat pronounced flow distortion problem. This is compounded by the fact her meteorological parameters – namely, air temperature (T), relative humidity (RH), atmospheric pressure (P), and earth relative wind direction and speed (DIR and SPD, respectively) – all come from an all-in-one Airmar weather station, known to be of lesser scientific quality than other types of vessel-bound weather equipment installations. The flow distortion frequently requires the application of caution/suspect (K) flags for all five parameters (Figure 68).

Additionally, RH occasionally gets stuck at slightly over 100% after a bout of atmospheric saturation, leading to an accumulation of out of bounds (B) flags (Figure 68). We note that *Rainier's* sensor metadata is still insufficient for us to be able to pinpoint any flow problems. The digital imagery available to us is also inadequate for diagnosis. Notwithstanding the low overall flagged percentage acquired by *Rainier* in 2018, we further reiterate that the Airmar isn't capable of as robust data as is required to meet many scientific objectives. If the vessel prefers to operate with an all-in-one sensor, we can suggest several better alternatives.

Additionally, no sea water data were reported by the *Rainier* in 2018 (or 2017). It is not known definitively why not, although we recognize that the sea data provided in 2016 were the main cause of her significantly higher total flagged percentage that year. It had thence been suggested it might make sense to discontinue the sea data if it could not be improved.

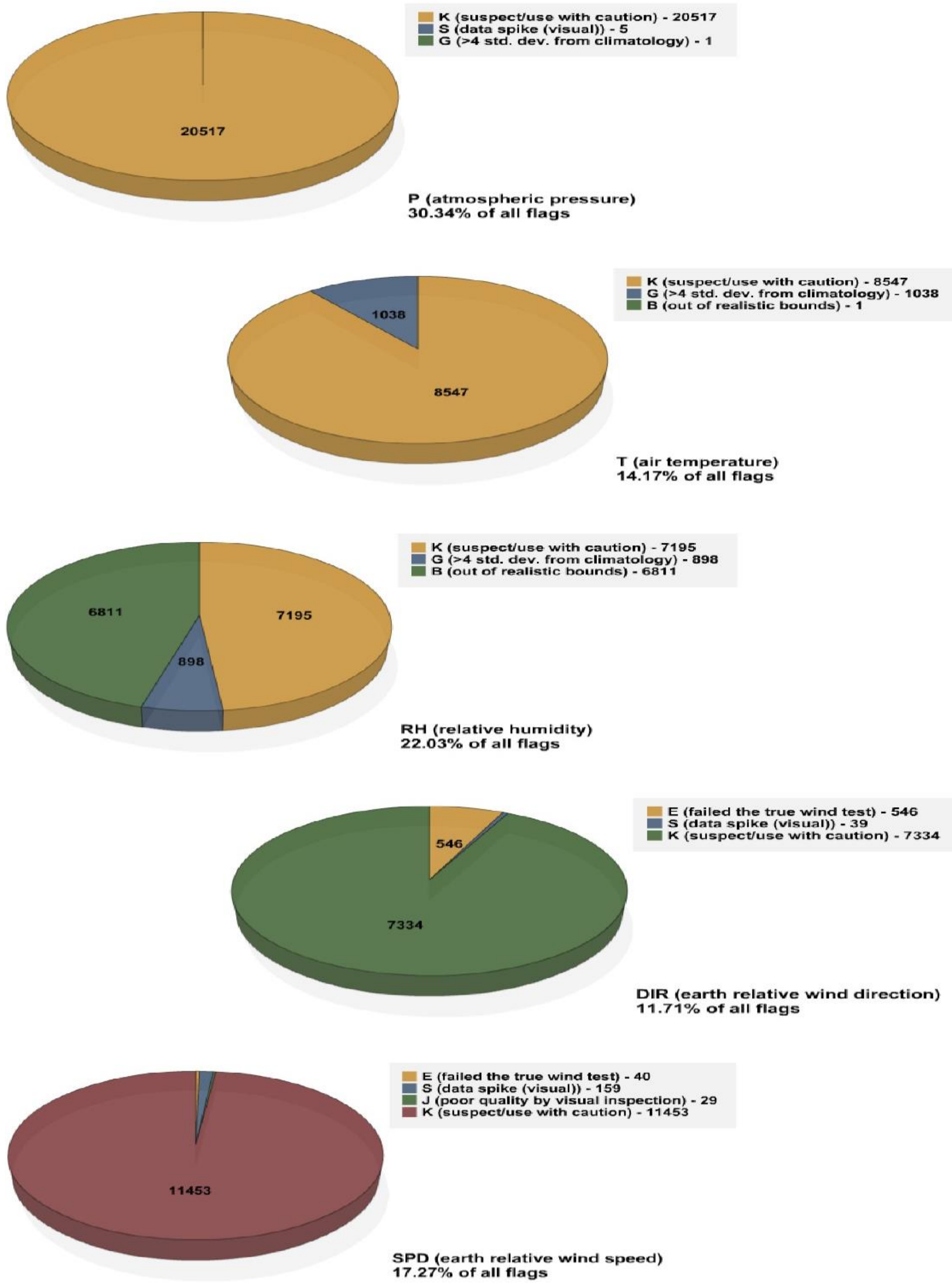


Figure 68: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) air temperature – T – (third) relative humidity – RH – (fourth) earth relative wind direction – DIR – and (last) earth relative wind speed – SPD – for the *Rainier* in 2018.

Reuben Lasker

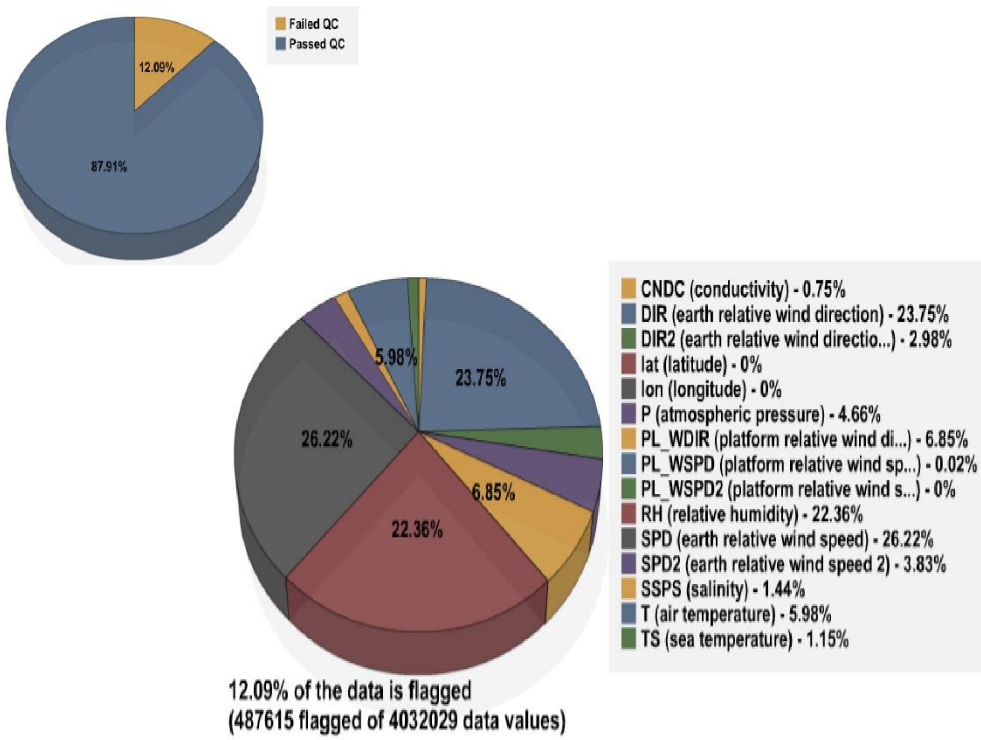


Figure 69: For the *Reuben Lasker* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Reuben Lasker* provided SAMOS data for 173 ship days, resulting in 1,898,442 distinct data values. After both automated and visual QC, 12.09% of the data were flagged using A-Y flags (Figure 69). This is significantly higher than 2017 (4.35%) and puts *Lasker* well outside the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

In early May, as the *Lasker* was getting into their science season, it was noted the earth relative wind direction (DIR) appeared possibly to be off by 180 degrees. Additionally, there were quite a lot of steps evident in both DIR and the earth relative wind speed (SPD), with SPD generally changing in lockstep with the platform speed (Figure 70). Vessel technicians were contacted via email on 23 May and ongoing discussions ensued. At this time both DIR and SPD were often assigned caution/suspect (K) flags (Figure 73). Then on 14 June technicians added the *Lasker's* ultrasonic anemometer data to their SAMOS files, and the 180-degree rotation of the primary wind sensor seemed undeniable (Figure 71). At this point flagging of DIR and SPD was switched to constant poor quality (J) flags, and the platform relative wind direction (PL_WDIR) received constant J flags, as well (Figure 73). Finally, on 19 July technicians were able to go aloft and try rotating the sensor, after which all the primary wind parameters looked much improved, and thus confirming the initial installation had indeed been the problem.

Also noted near the beginning of *Lasker's* science season, the air temperature (T) data appeared compromised, reading between about -2 and 2 degrees C, an unreasonable range given their area of operations. When the vessel was contacted via email, technicians responded they'd been having issues with the sensor for a while and had recently tried moving some wires around, which had unfortunately worsened the problem and caused the negative T readings. At this point the technician switched T to a different thermometer onboard and the T data improved, but for the several days prior T was assigned J and out of bounds (B) flags.

Soon afterwards, however, it was suspected there was an issue with the relative humidity (RH), with readings frequently topping 115%. When the vessel was contacted again, they informed us they'd removed the original T/RH sensor but hadn't stopped the RH feed to the SAMOS files. Strangely, the RH trace from after the removal still had the look of scientific data (Figure 72), but we note if a wire is running into an acquisition system it may be able to measure "something" (a voltage, random electrical inputs from the atmosphere, etc.) Had we not contacted the vessel we may never have understood the sensor was no longer deployed. As we did have that information, though, RH was assigned malfunction (M) flags (Figure 73) from 3 June through 19 July, at which point a new sensor was installed. After this installation RH still looked questionable, seeming not to vary much from ~50% day after day. Once more we sent an email to the vessel, on 31 July, and learned technicians were reportedly having multiple issues, with RH being one of them. RH was thus assigned J flags from about 22 July through 13 August (Figure 73).

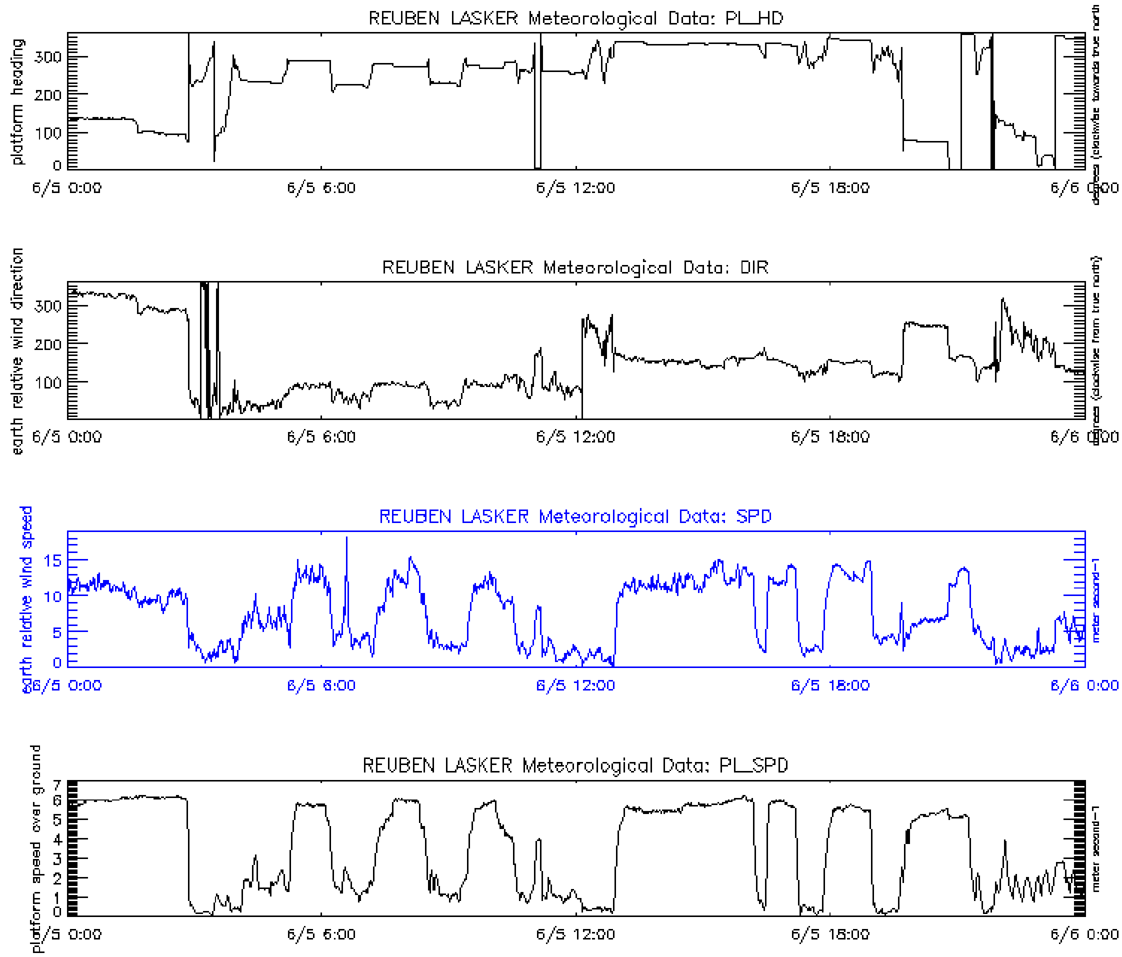


Figure 70: *Reuben Lasker* SAMOS (first) platform heading – PL_HD – (second) earth relative wind direction – DIR – (third) earth relative wind speed – SPD – and (last) platform speed – PL_SPD – data for 5 June 2018. Note steps in both DIR and SPD as well as frequent SPD mirroring of PL_SPD.

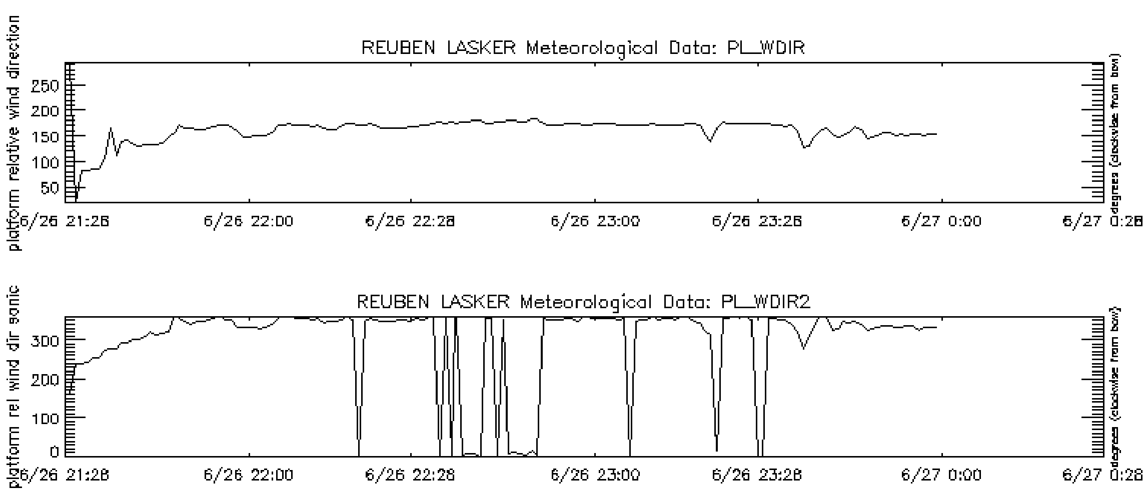


Figure 71: *Reuben Lasker* SAMOS (top) platform relative wind direction – PL_WDIR – and (bottom) platform relative wind direction 2 – PL_WDIR2 – data for 26 June 2018. Note the obvious 180 degree difference.

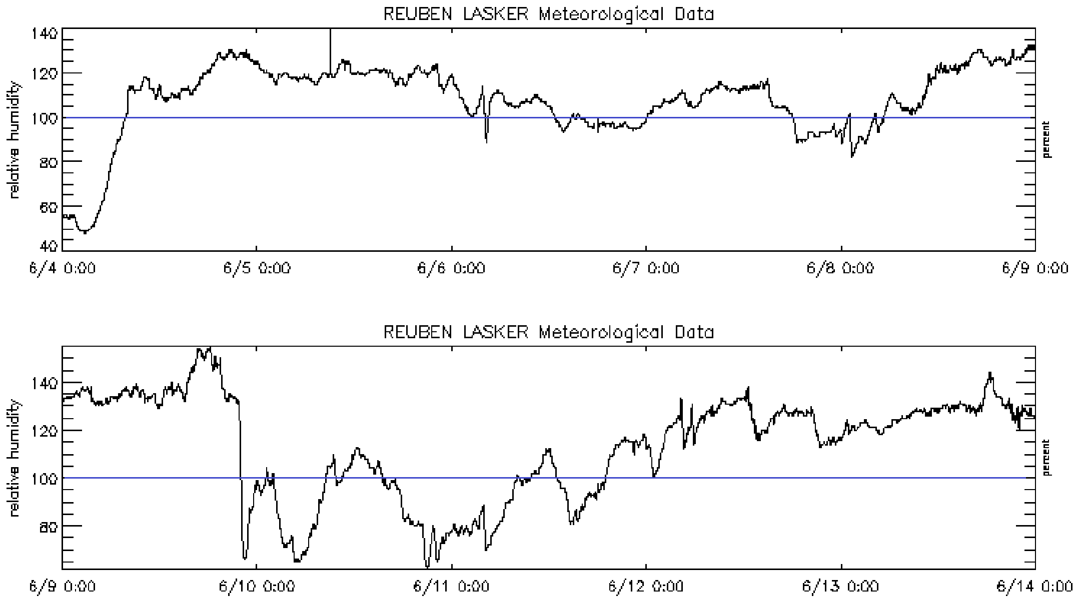


Figure 72: *Reuben Lasker* SAMOS relative humidity – RH – data for (top) 4 through 8 June and (bottom) 9 through 13 June. Note while much of the data was over 100% (blue line) the traces still resemble humidity data (or some other atmospheric quality) in shape alone.

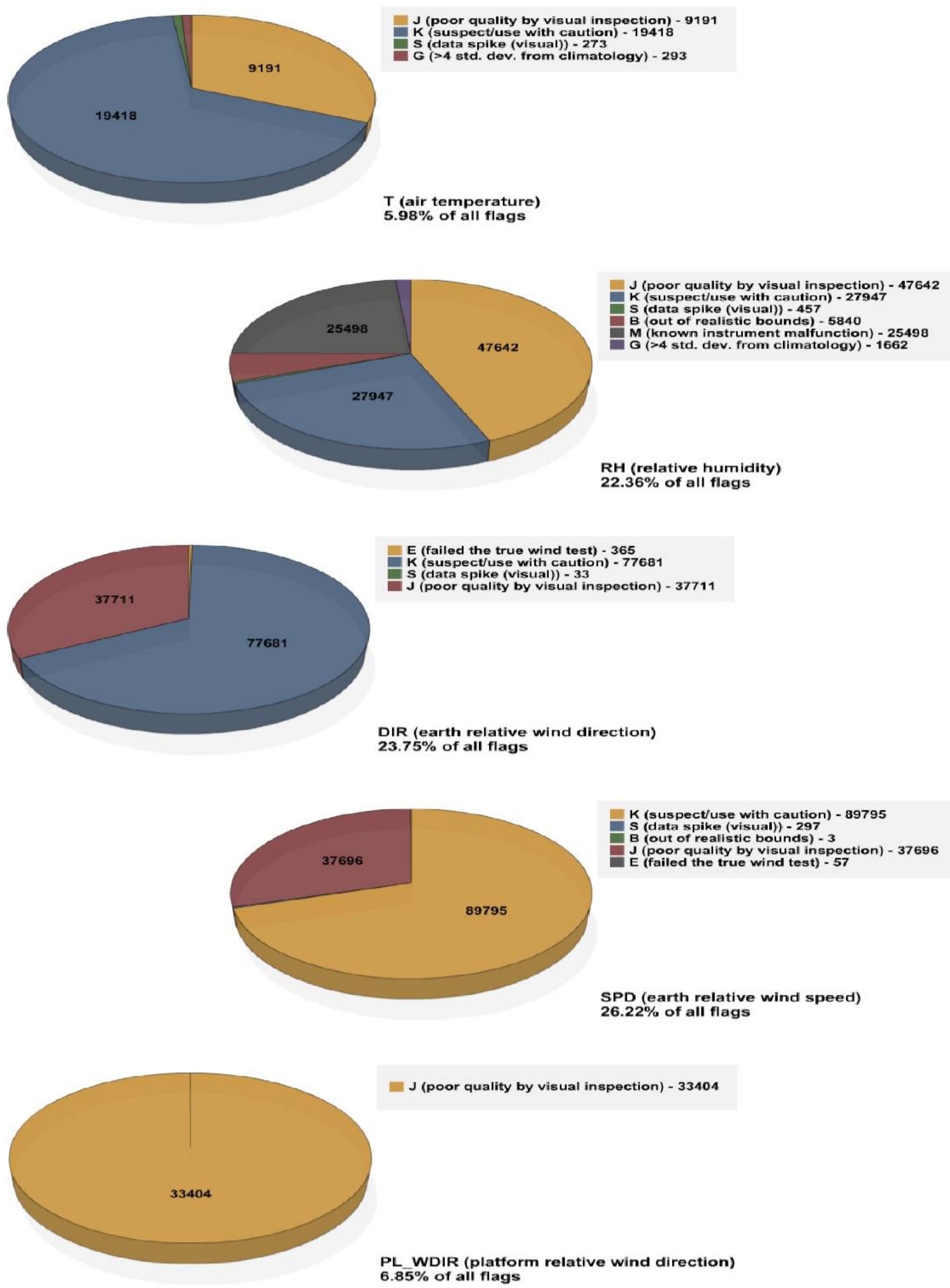
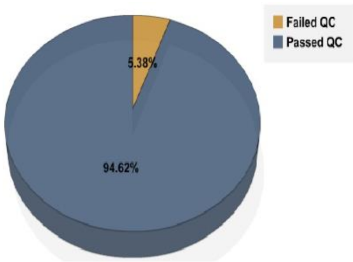


Figure 73: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) relative humidity – RH – (third) earth relative wind direction – DIR – (fourth) earth relative wind speed – SPD – and (last) platform relative wind direction – PL_WDIR – for the *Reuben Lasker* in 2018.

Ronald H. Brown



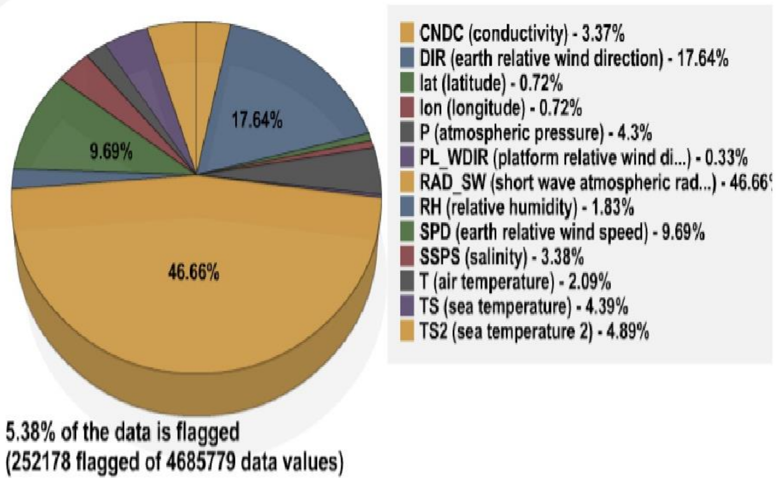


Figure 74: For the *Ronald H. Brown* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Ronald H. Brown* provided SAMOS data for 203 ship days, resulting in 4,685,779 distinct data values. After both automated and visual QC, 5.38% of the data were flagged using A-Y flags (Figure 74). This is one percentage point higher than in 2017 (4.38%) and puts the *Brown* just above the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

At first glance the short wave radiation (RAD_SW) parameter, holding almost half of all flags (Figure 74), would appear to be especially problematic for the *Brown*. However, these were almost exclusively out of bounds (B) flags (Figure 75), which have been applied mainly to the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.) This does not indicate a data issue. Incidentally, the small amount of failing the true wind test (E) flags erroneously assigned to RAD_SW (Figure 75) were likely the result of a very infrequent file merge issue. The particulars of the merge issue were discovered in 2018 and a temporary workaround has been put in place until such time as programming hours allow for a permanent fix. Meanwhile, these noted E flags probably escaped visual detection being buried among the nighttime B flags.

Vessel technicians were able to restore the platform relative wind speed (PL_WSPD) and direction (PL_WDIR) parameters to the *Brown's* SAMOS files on 12 March, after a nearly two-year omission. We note once the relative winds were in the files and the true wind recomputation quality control test was able to be performed, earth relative wind speed (SPD) and especially earth relative wind direction (DIR) frequently picked up E flags (Figure 75). As PL_WDIR was often noisy, it was suspected the averaging for the relative winds may not have been the same as that for the true winds, or even that perhaps the relative winds were not from the same sensor as DIR and SPD. In fact, in early 2019 we learned the platform relative wind speed (PL_WSPD), SPD, and DIR were all coming from one sensor while just PL_WDIR came from another one. This is not standard practice and should be avoided. The sensor mismatch issue has very recently been addressed and we expect a much smaller volume of E flags in 2019.

It was also discovered in early 2019 that, due to sensor installation and sea chest water draw issues, a pocket of air occasionally formed at the top of the sea chest and left the *Brown's* secondary sea temperature sensor (TS2) taking measurements from above the water level. TS2 data became smoothed and appeared less responsive to sea changes as a result. These affected data were occasionally flagged with caution/suspect (K) flags (Figure 75), although the details surrounding the issue were not known at the time. Again, note the erroneous E flags on TS2 (Figure 75), likely also from the aforementioned file merge issue. It is not immediately clear how these E flags escaped visual detection.

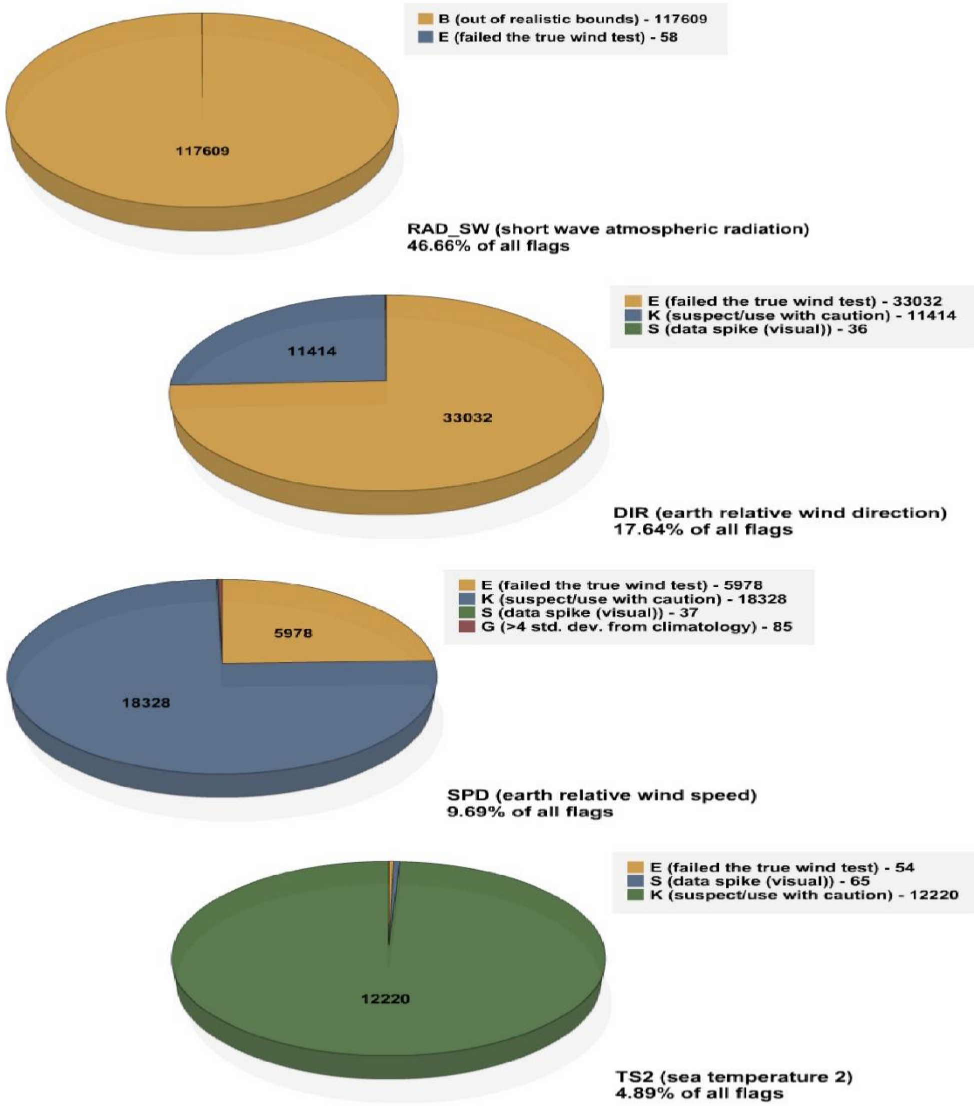
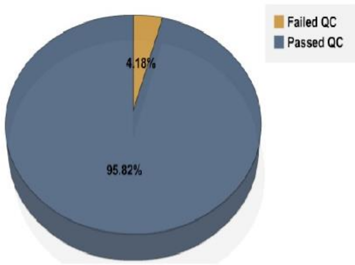


Figure 75: Distribution of SAMOS quality control flags for (first) short wave atmospheric radiation – RAD_SW – (second) earth relative wind direction – DIR – (third) earth relative wind speed – SPD – and (last) sea temperature 2 – TS2 – for the *Ronald Brown* in 2018.

Thomas Jefferson



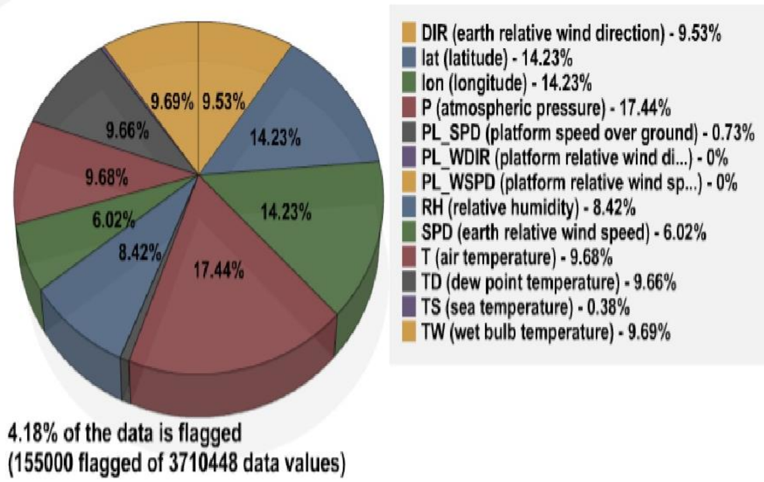


Figure 76: For the *Thomas Jefferson* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Thomas Jefferson* provided SAMOS data for 176 ship days, resulting in 3,710,448 distinct data values. After both automated and visual QC, 4.18% of the data were flagged using A-Y flags (Figure 76). This is several percentage points lower than in 2017 (9.76%) and brings the *Jefferson* under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

As a general note, air temperature (T), relative humidity (RH), TD, TW, earth relative wind direction and speed (DIR and SPD, respectively), and especially atmospheric pressure (P) on the *Jefferson* all suffer the myriad effects of less-than-ideal sensor placement (e.g. flow interruption, exhaust contamination) and susceptibility to changes in the ship's motion. The result is frequent steps and spikes in the data, which acquire spike (S) and caution/suspect (K) flags (Figure 78, only SPD shown). This is not uncommon among sea-faring vessels, although the effects are perhaps a little more pronounced on the *Jefferson* than on the average SAMOS ship. It's understood that the *Jefferson* is a hydrographic survey vessel 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 suggest more suitable locations for many of the sensors, thereby potentially alleviating some of the flagging. Nevertheless, with a total flagged percentage under 5%, none of these issues should be considered terribly consequential.

Perhaps the more noteworthy data issue for the *Jefferson* is the presence of frequent, numerous spikes in latitude (LAT), longitude (LON), and occasionally platform speed

(PL_SPD) and, by extension, earth relative wind speed (SPD) (Figure 77). This scenario has been ongoing for years and always results in the application of land error (L) and platform velocity unrealistic (F) flags to the affected LAT and LON data, out of bounds (B) and spike (S) flags to the affected PL_SPD data, and S flags to the affected SPD data (Figure 78). It is not known what causes the data spikes.

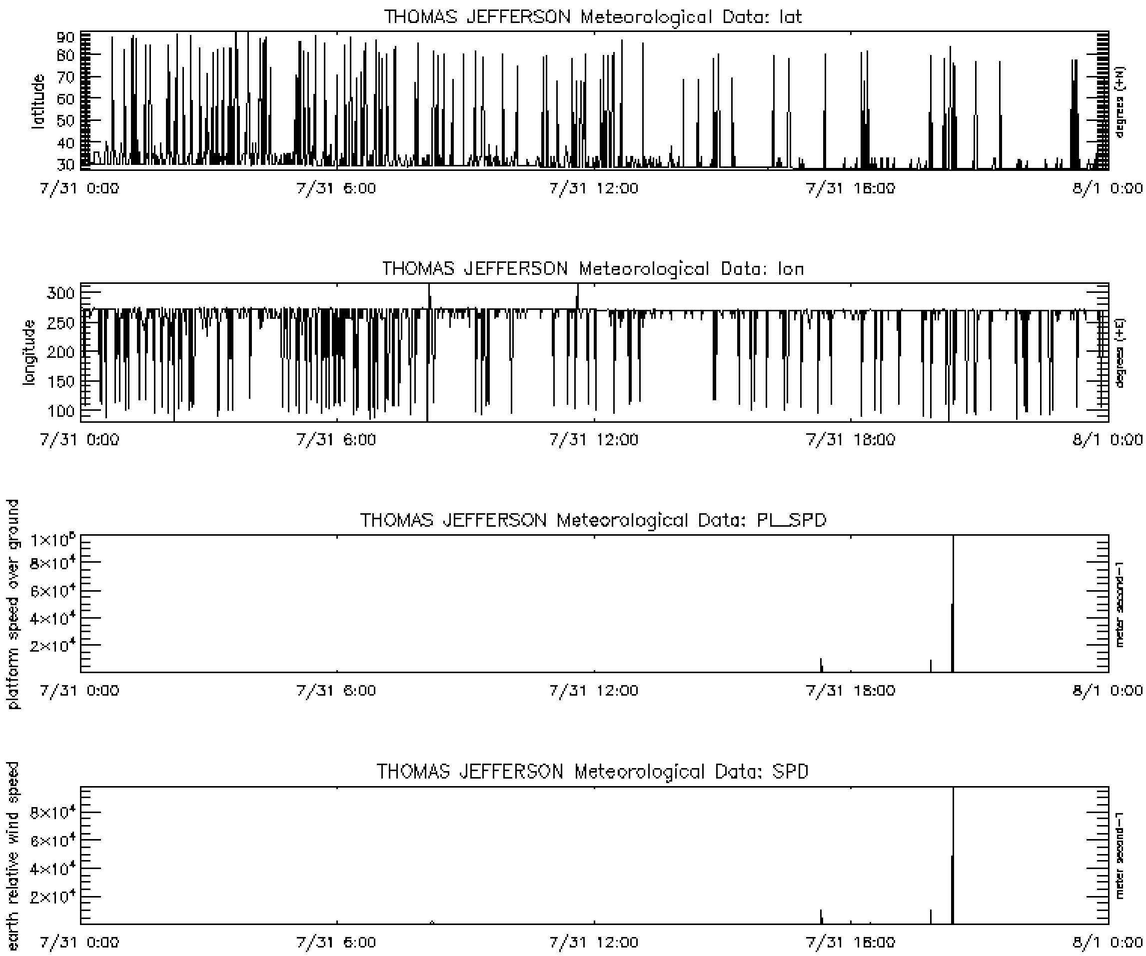


Figure 77: *Thomas Jefferson* SAMOS (first) latitude – LAT – (second) longitude – LON – (third) platform speed – PL_SPD – and (last) earth relative wind speed – SPD – for 31 July 2018. Note spikes in all parameters.

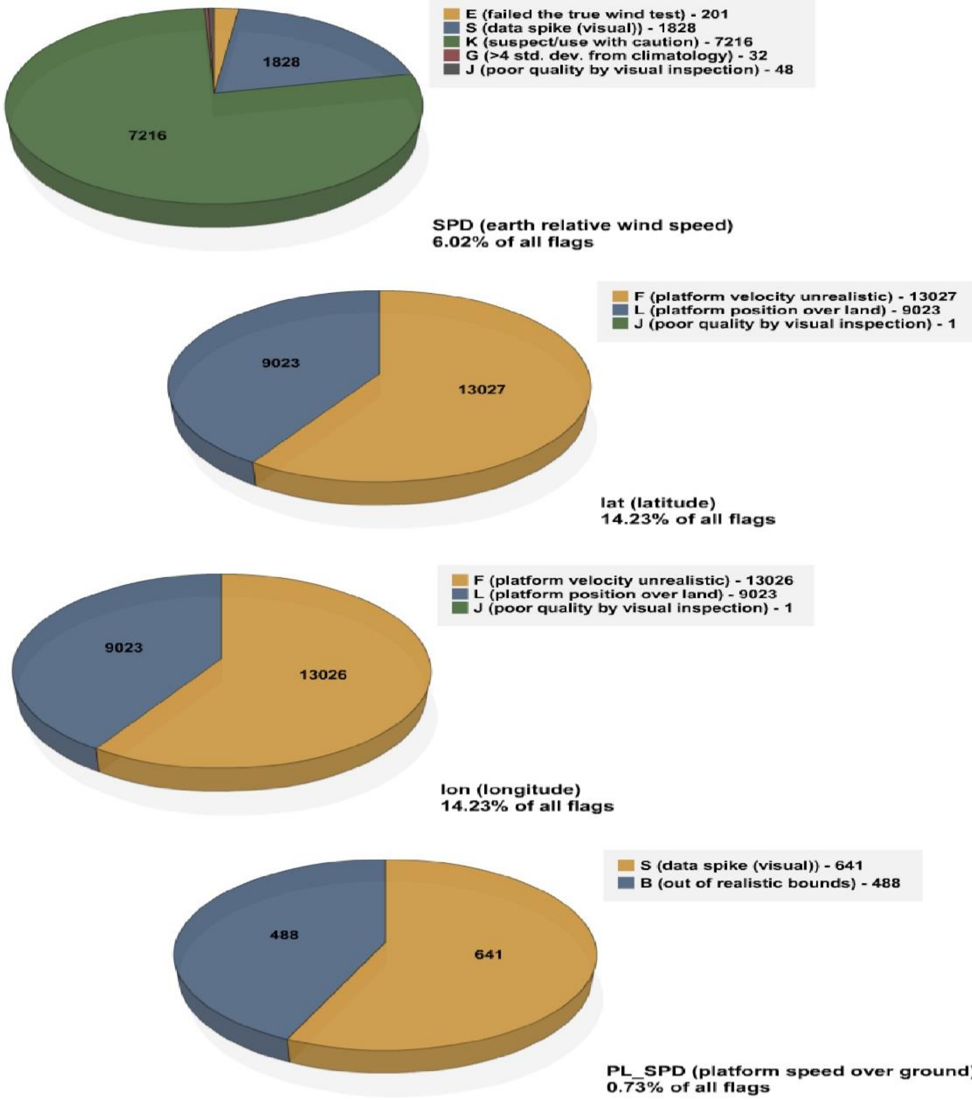


Figure 78: Distribution of SAMOS quality control flags for (first) earth relative wind speed –SPD – (second) latitude – LAT – (third) longitude – LON – and (last) platform speed – PL_SPD – for the *Thomas Jefferson* in 2018.

Laurence M. Gould

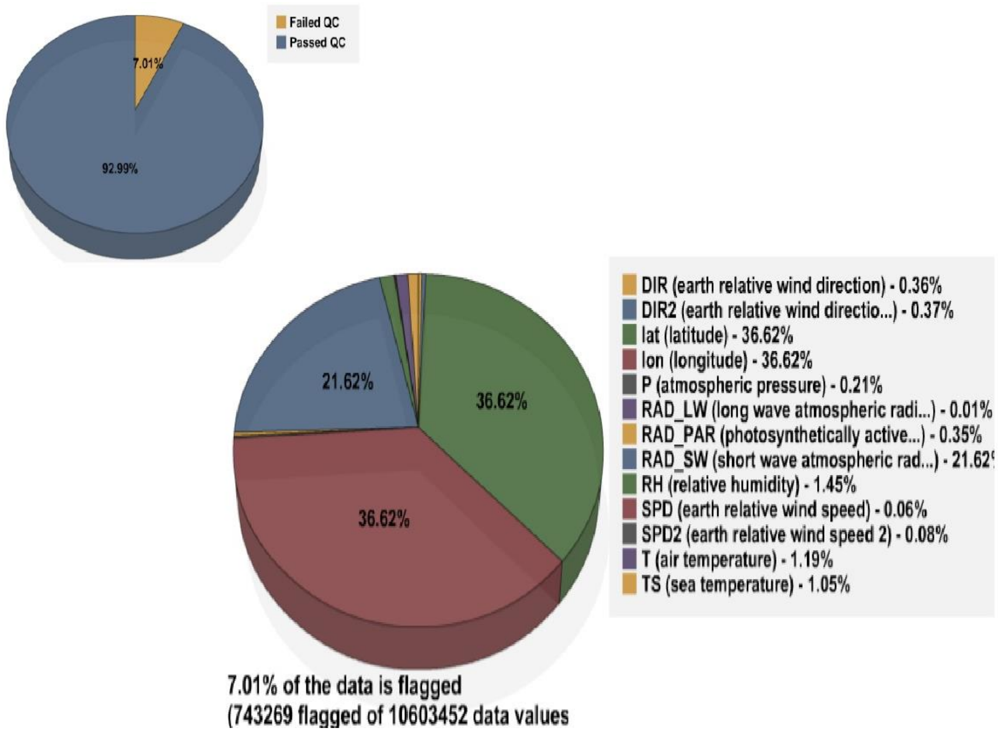


Figure 79: For the *Laurence M. Gould* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Laurence M. Gould* provided SAMOS data for 363 ship days, resulting in 10,603,452 distinct data values. After automated QC, 7.01% of the data were flagged using A-Y flags (Figure 79). This is a few percentage points higher than in 2017 (4.51%) and puts *Gould* over the 5% total flagged cutoff regarded by SAMOS to represent "very good" data. It should be noted the *Gould* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Laurence M. Gould*).

On 27 March, *Gould* personnel contacted the DAC via email to advise us their air temperature (T) and relative humidity (RH) data had been bad since about 0600 UTC 25 March. They were able to replace the T/RH sensor on 1 April, but we note the affected data during the “bad” period went largely unflagged by automated processing.

There were no other specific issues noted in 2018 for the *Gould*. Looking at the flag percentages in Figure 79, nearly all the flags applied were assigned to latitude (LAT), longitude (LON), and short wave atmospheric radiation (RAD_SW). These were land error (L) flags in the case of LAT and LON (Figure 80), which look to have been acquired mainly when the vessel was either in port or else moored just off the Antarctic coastline. This is not uncommon, as the land mask in use for the land check routine is often incapable of resolving the very fine detail of an inland port (or, indeed, the Antarctic coastline). This is true of both the older 2-minute land mask and the newer 1-minute one introduced in mid-2017. In the case of RAD_SW, all the flags applied were out of bounds (B) flags (Figure 80) and look to have been mainly the result of the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

As a general note, it is known that the *Gould* sensors are frequently affected by airflow being deflected around the super structure, as well as stack exhaust contamination, although, being a vessel that does not receive visual QC, none of this is evident in the flag percentages seen in Figure 79.

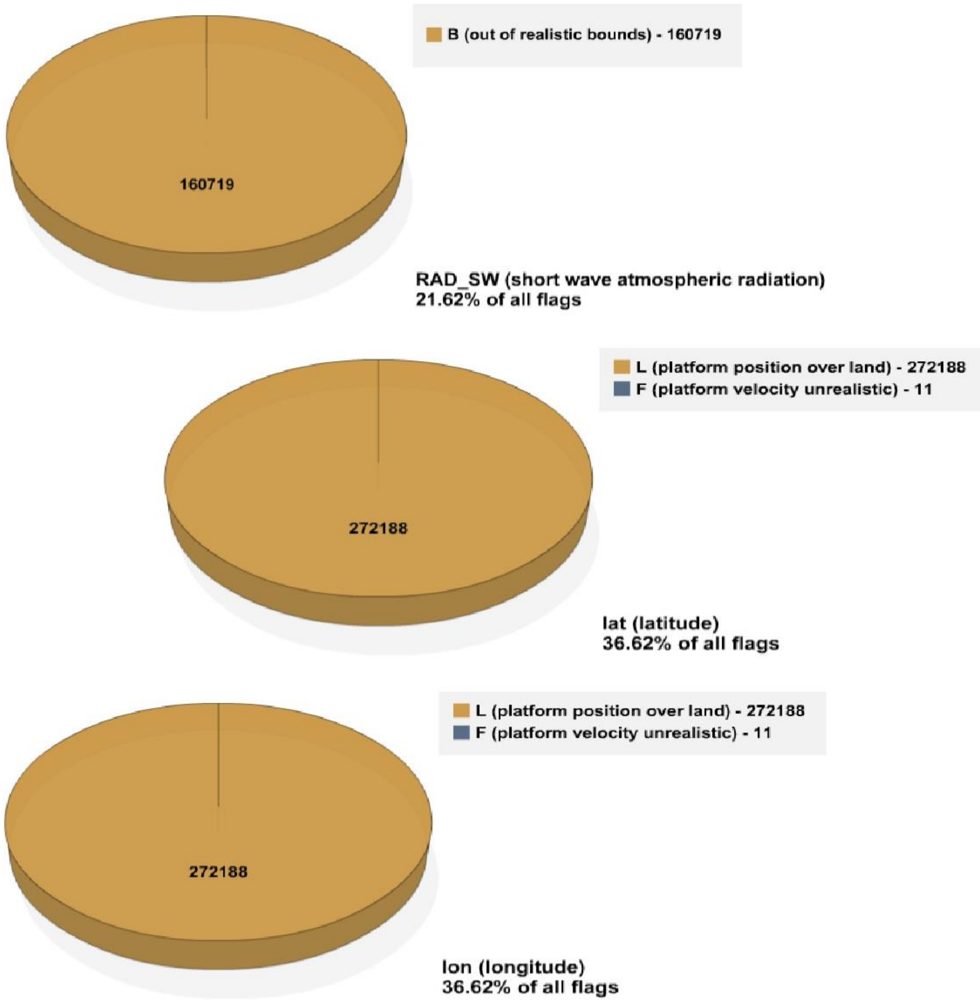


Figure 80: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – (middle) latitude – LAT – and (bottom) longitude – LON – for the *Laurence M. Gould* in 2018.

Nathaniel B. Palmer

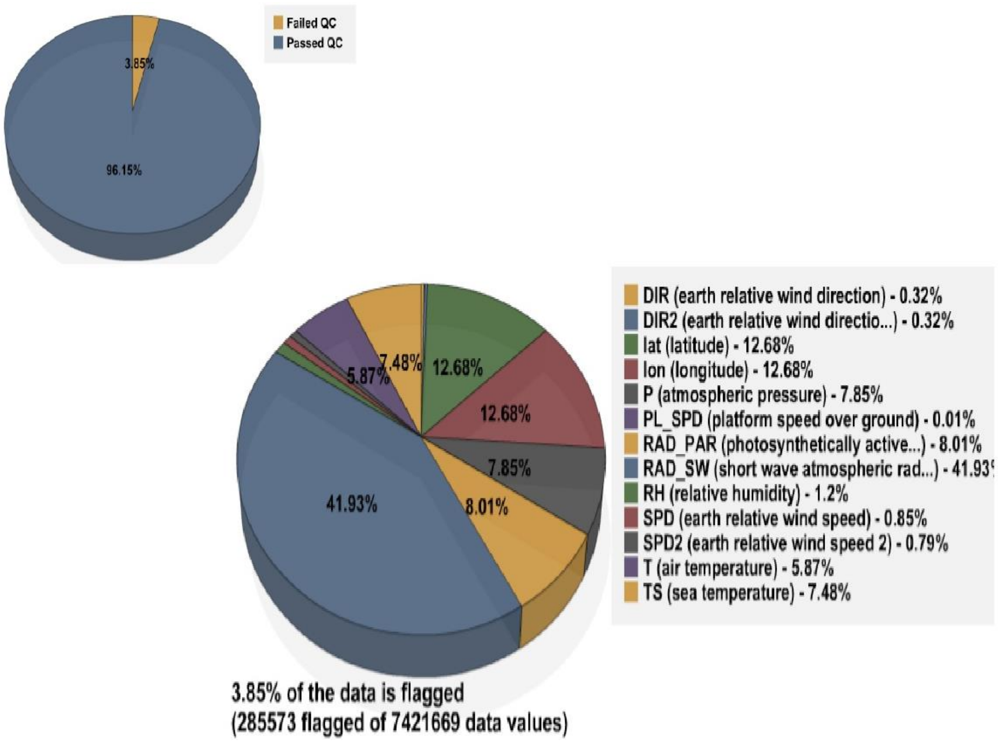


Figure 81: For the *Nathaniel B. Palmer* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Nathaniel Palmer* provided SAMOS data for 227 ship days, resulting in 7,421,669 distinct data values. After automated QC, 3.85% of the data were flagged using A-Y flags (Figure 81). This is about a percentage point lower than in 2017 (4.56%) and maintains the *Palmer's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *Palmer* receives only automated QC, and visual QC is when the bulk of flags are typically applied.

There were no specific issues noted for the *Nathaniel B. Palmer* in 2018. As a general note, it is known that the *Palmer* sensors are frequently affected by airflow being deflected around the super structure, as well as stack exhaust contamination, although, being a vessel that does not receive visual QC, none of this is particularly evident in the flag percentages seen in Figure 81. In fact, from those percentages, the one standout parameter would seem to be short wave atmospheric radiation, holding nearly 42% of all flags. However, upon inspection these were exclusively out of bounds (B) flags (Figure 82), which have been applied mainly to the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.) This does not indicate a data issue.

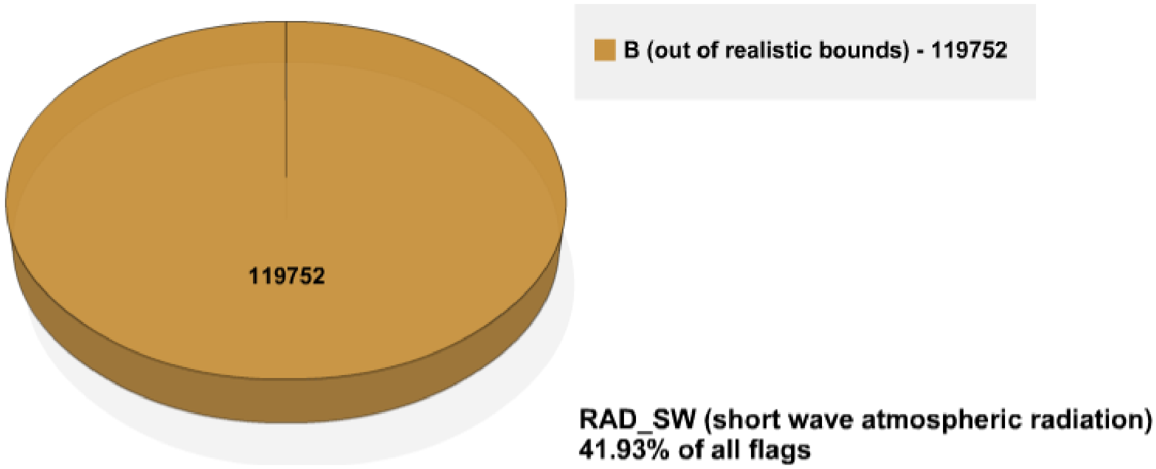
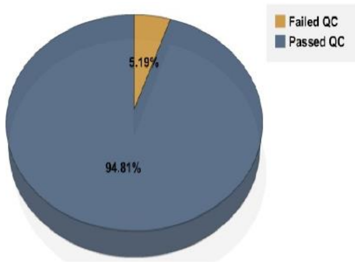


Figure 82: Distribution of SAMOS quality control flags for short wave atmospheric radiation – RAD_SW – for the *Nathaniel B. Palmer* in 2018.

Robert Gordon Sproul



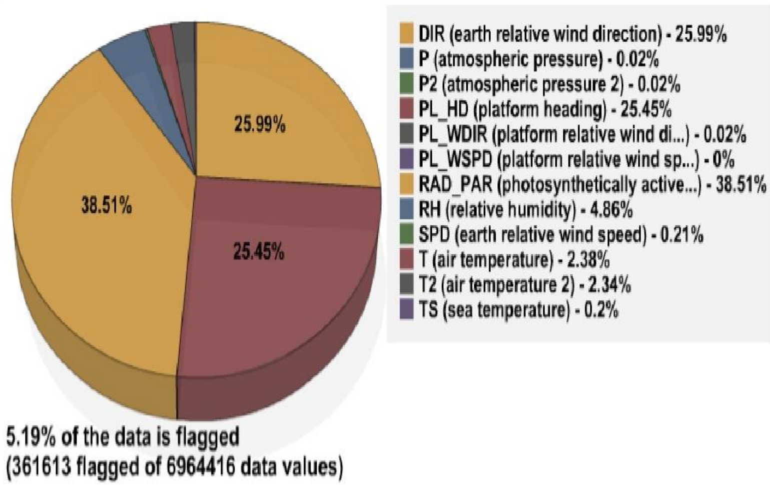


Figure 83: For the *Robert Gordon Sproul* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Robert Gordon Sproul* provided SAMOS data for 305 ship days, resulting in 6,964,416 distinct data values. After automated QC, 5.19% of the data were flagged using A-Y flags (Figure 83). This is about a percentage point higher than in 2017 (4.02%) and puts the *Sproul* over the 5% total flagged cutoff regarded by SAMOS to represent "very good" data. It should be noted the *Sproul* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Robert Gordon Sproul*).

There were no specific issues noted for the *Sproul* in 2018. Looking at the flag percentages in Figure 83, earth relative wind direction (DIR), photosynthetically active atmospheric radiation (RAD_PAR), and platform heading (PL_HD) together made up ~90% of the total flags for the year. For both RAD_PAR and PL_HD, the accumulated flags were strictly out of bounds B flags (Figure 84). A quick inspection of the RAD_PAR data suggests those were mainly the result of the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.) Regarding PL_HD, most of the flags appear to have been applied during the period 1 January to 6 March. A quick look at the PL_HD data suggests the sensor may not have been deployed for that period, as the values were a constant -99 (a likely missing value indicator). The flags applied to DIR were exclusively failed the true wind test (E) flags (Figure 84) and seemed to have accrued mainly during the same period as the PL_HD B flags. (The true wind recalculation relies on PL_HD so it makes sense the bad values would have caused E flags in the wind.)

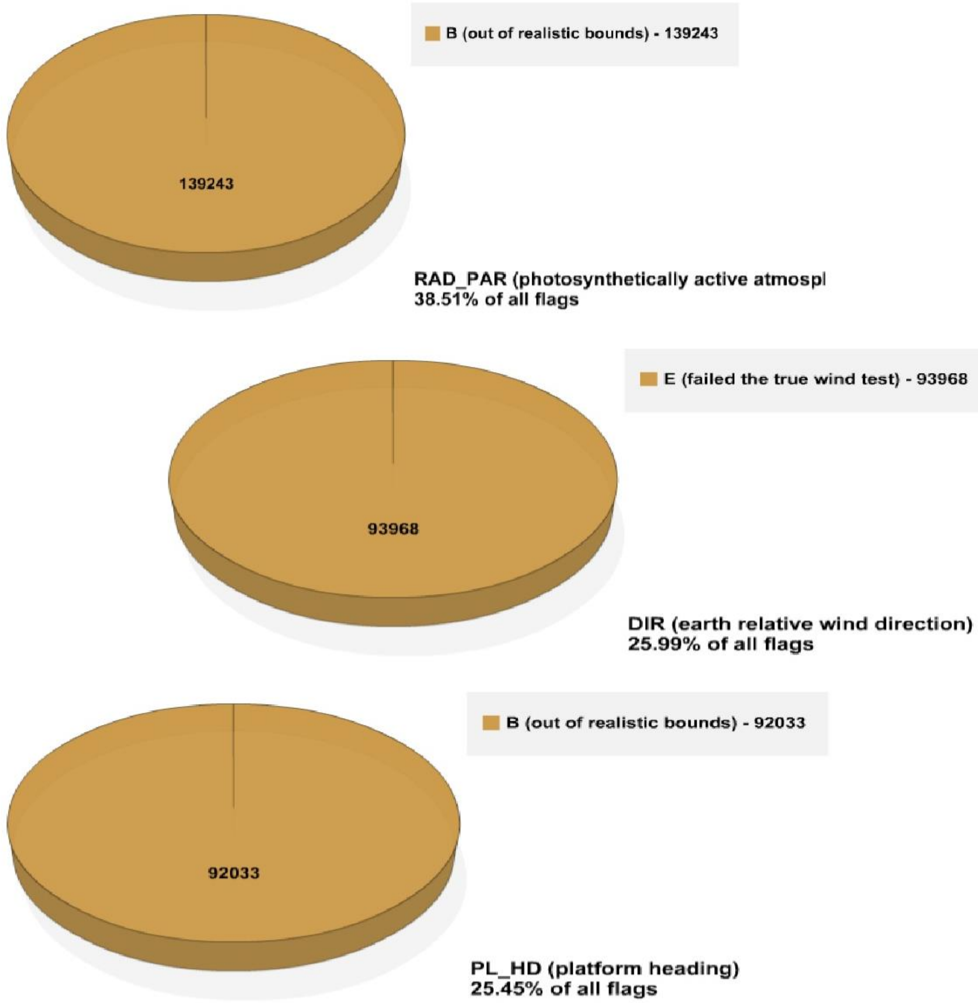


Figure 84: Distribution of SAMOS quality control flags for (top) photosynthetically active atmospheric radiation – RAD_PAR – (middle) earth relative wind direction – DIR – and (bottom) platform heading – PL_HD – for the *Robert Gordon Sproul* in 2018.

Roger Revelle

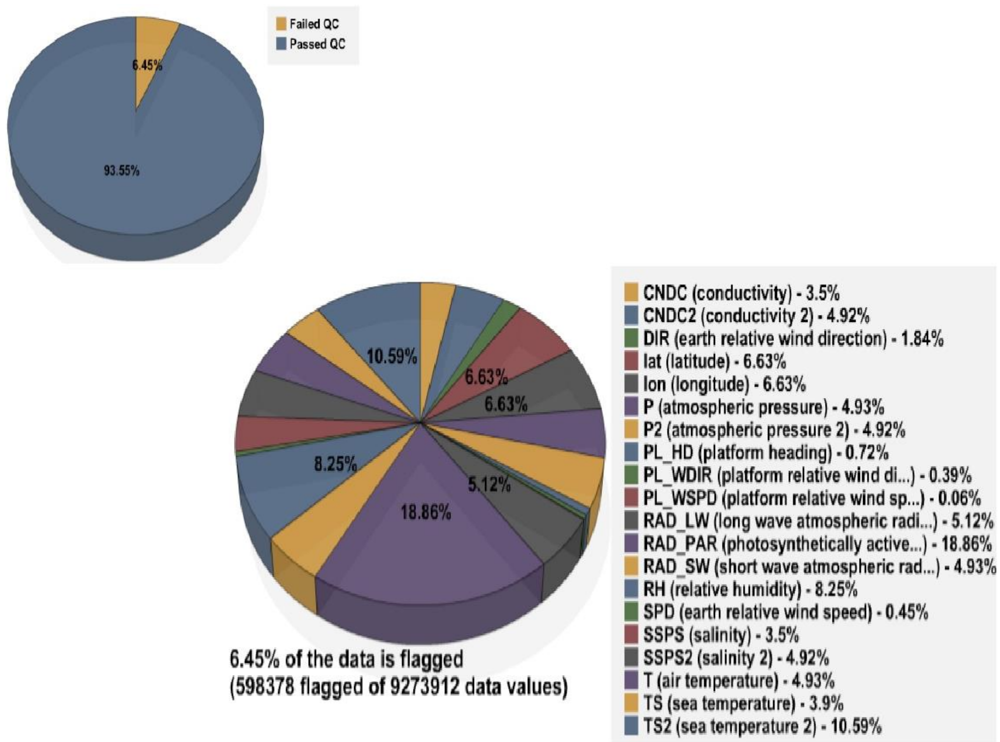


Figure 85: For the *Roger Revelle* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Roger Revelle* provided SAMOS data for 292 ship days, resulting in 9,273,912 distinct data values. After automated QC, 6.45% of the data were flagged using A-Y flags (Figure 85). This is about the same as in 2017 (7.19%). It should be noted the *Revelle* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Roger Revelle*).

There are no specific issues on record for the *Revelle* in 2018. Looking at the flag percentages in Figure 85, photosynthetically active atmospheric radiation (RAD_PAR), sea temperature 2 (TS2), and relative humidity (RH) hold some of the highest amounts. A quick inspection of these data reveals firstly that there was a period from about 1 January through 15 March during which the majority of *Revelle's* parameters reported a constant value of -99 (probably a missing value indicator). This resulted in an accumulation of out of bounds (B) flags across many parameters (not shown), including RAD_PAR, TS2, and RH, and probably goes a long way towards explaining most of the flag percentages seen in Figure 85. But further inspection specific to TS2 indicates the portion of greater than four standard deviations from climatology (G) flags acquired by the variable (Figure 86) were mainly applied while an intake pump was off, a standard practice for vessels in port or in excessively rough seas. Regarding RAD_PAR, further inspection of that variable indicated only (B) flags (Figure 86) such as result from the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.) The B flags applied to RH appear to have been assigned mainly when the sensor read slightly over 100%, either as a result of instrument tuning combined with atmospheric saturation (see 3b. for details) or perhaps because the sensor was getting swamped in heavy seas.

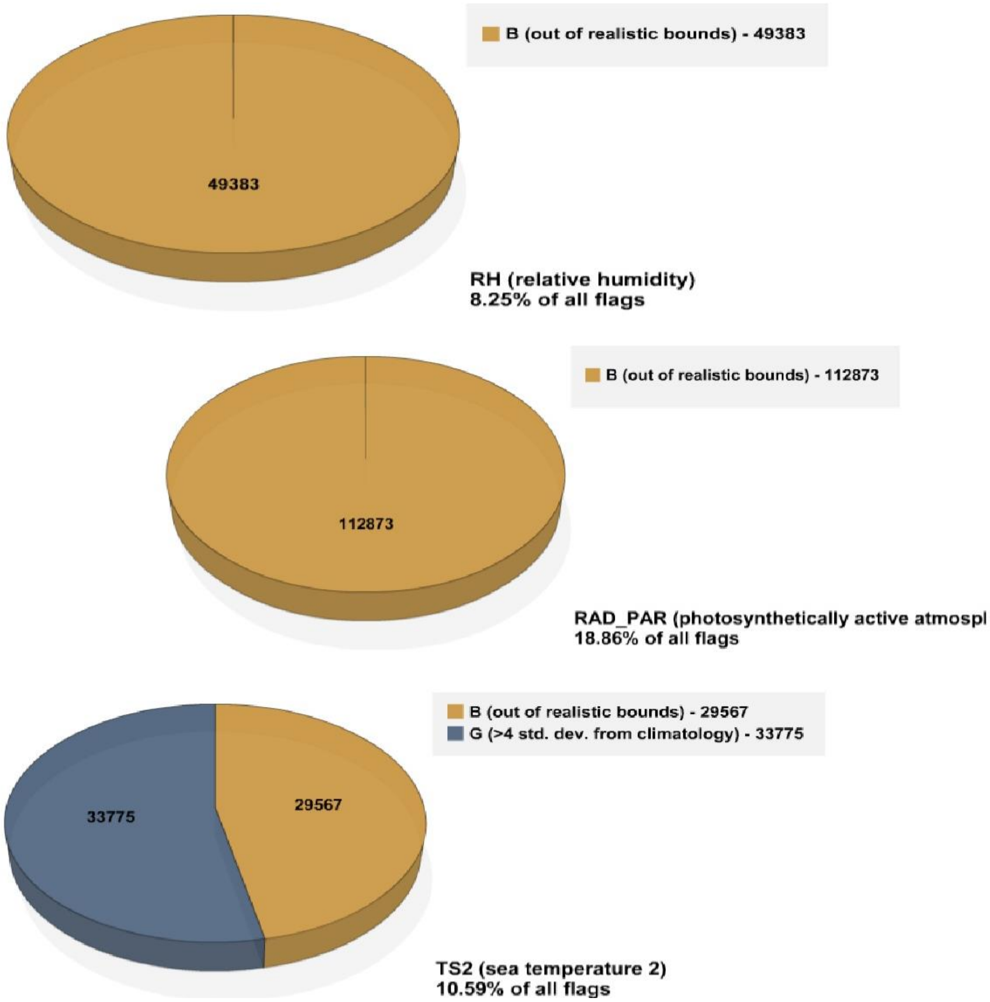


Figure 86: Distribution of SAMOS quality control flags for (top) relative humidity – RH – (middle) photosynthetically active atmospheric radiation – RAD_PAR – and (bottom) sea temperature 2 – TS2 – for the *Roger Revelle* in 2018.

Sally Ride

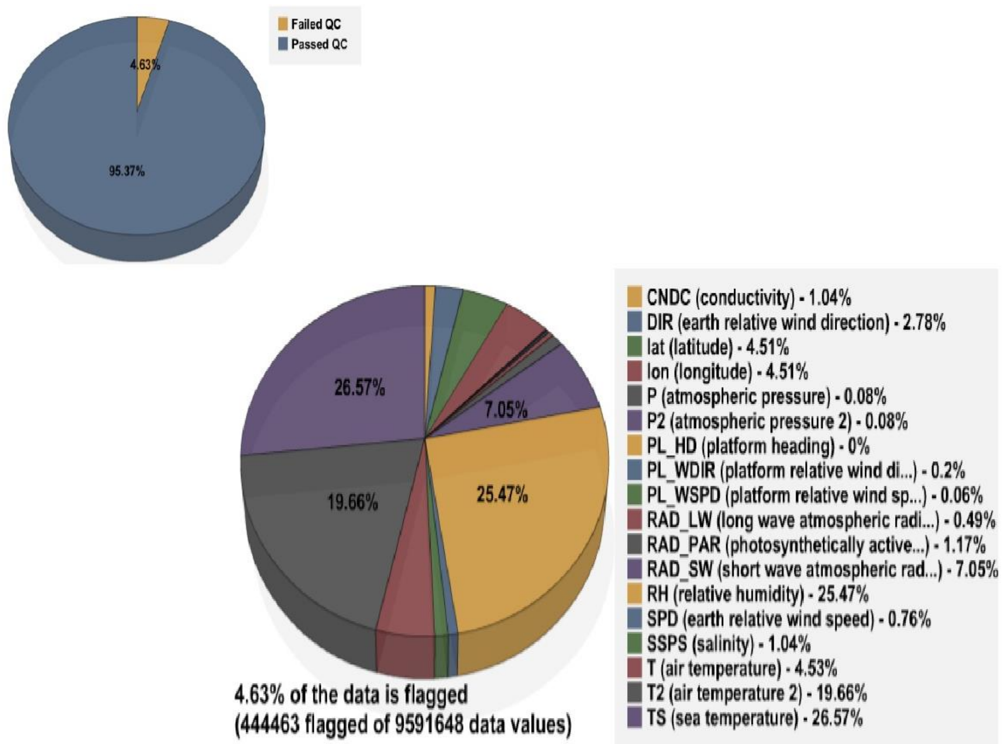


Figure 87: For the *Sally Ride* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Sally Ride* provided SAMOS data for 334 ship days, resulting in 9,591,648 distinct data values. After automated QC, 4.63% of the data were flagged using A-Y flags (Figure 87). This is a little bit higher than in 2017 (3.1%) but is still under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *Sally Ride* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Sally Ride*).

Looking at Figure 87, sea temperature (TS) amassed the largest portion flags, 26.57%. Upon inspection, these were overwhelmingly greater than four standard deviations from climatology (G) flags. It isn't clear from a quick look at the data whether these may have been mostly valid data, or whether perhaps the sea water intake was simply off much of the time, as commonly occurs when a vessel is in port or otherwise stationary (and which does not indicate a problem).

On 23 April a Scripps contact advised us the relative humidity (RH) sensor on board the *Sally Ride* needed a windscreen cleaning and the data were "off." A quick glance at RH shows an extended period in the Spring when RH frequently read a little over 100%, a likely result of this need. Any value over 100% was automatically assigned out of bounds (B) flags (Figure 88) by the auto flagger. The precise date the windscreen cleaning took place is not known but after 31 May the RH data seemed within reason and the excessive automatic flagging ceased.

The secondary air temperature (T2) sensor also appeared to have gone “bad” in the Spring, from about 19April through about 31 May. A quick glance at the data shows T2 read a constant 50 degrees C much of the time during that period, acquiring mainly B but also some greater than four standard deviations from climatology (G) flags (Figure 88).

Much later in the year, the primary air temperature sensor (T) also suffered some sort of failure, reading between -40 - 0 degrees C. Vessel technicians were contacted on 14 November via email regarding the situation and they responded they would investigate it. It is not known what the issue was, but it appears to have been corrected by 17 November. Meanwhile, for the period 24 October to 16 November T accumulated a good deal of B and G flags (Figure 88).

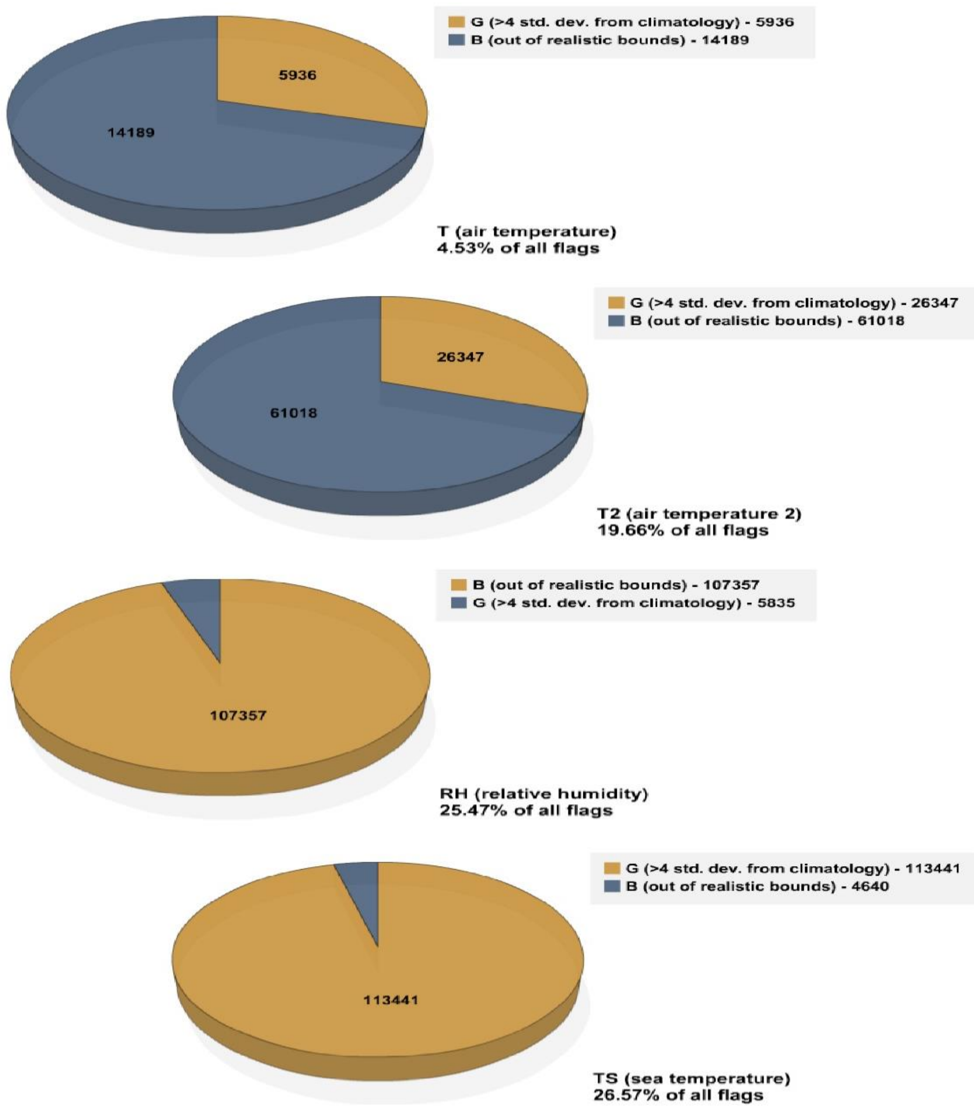


Figure 88: Distribution of SAMOS quality control flags for (first) air temperature – T – (second) air temperature 2 – T2 – (third) relative humidity – RH – and (fourth) sea temperature – TS – for the *Sally Ride* in 2018.

Falkor

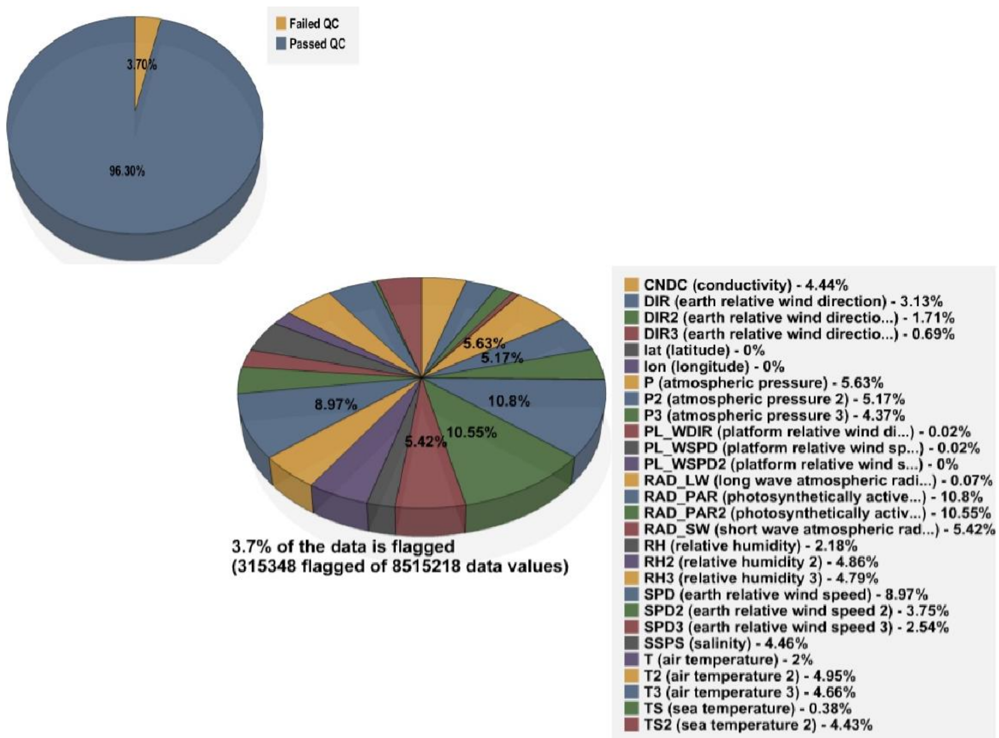


Figure 89: For the *Falkor* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Falkor* provided SAMOS data for 203 ship days, resulting in 8,515,218 distinct data values. After both automated and visual QC, 3.7% of the data were flagged using A-Y flags (Figure 89). This is about a percentage point lower than in 2017 (4.85%) and maintains the *Falkor's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data.

Continuing from 2017, both photosynthetically active atmospheric radiation parameters (RAD_PAR and RAD_PAR2) were initially missing from *Falkor's* SAMOS data files. (Information about how to calculate the derived values RAD_PAR and RAD_PAR2 in SCS had been lost in 2017.) On 13 March RAD_PAR and RAD_PAR2 began showing up in the data files again; however, the data were no good. (Each read a noisy but constant ~3 μE cm^{-2} sec^{-1}.) We were advised by vessel personnel just prior to receiving the data that they had no light sensors working at that time, and in fact one of the PAR sensors was away for repairs. As such, RAD_PAR and RAD_PAR2 were assigned malfunction (M) flags (Figure 90) from 13 March to 14 April. After that first month, in order to halt the accumulating M flags, it was decided to disable RAD_PAR and RAD_PAR2 in the SAMOS database until such time as the *Falkor* was ready to send good PAR data again.

On 17 September RAD_PAR and RAD_PAR2 data finally resumed. This time the data appeared to be within reason. However, in early November we were again advised by vessel technicians that they'd discovered their slope values used in the RAD_PAR and

RAD_PAR2 derivations had not been updated to reflect current calibration values. As such, we must here advise science users that the *Falkor's* RAD_PAR and RAD_PAR2 data between 17 September and 20 October should not be used. (These data had unfortunately already undergone visual QC, so they are not flagged.) While the technicians were working out the new RAD_PAR and RAD_PAR2 calculations, the data were poor quality (J) flagged (Figure 90) from November 5 through November 14.

There were also a few brief periods in 2018 – on the order of 1-2 days each, at most – during which *Falkor* personnel advised us, for various reasons (e.g. system secured due to bad weather), their thermosalinograph sea temperature (TS2), salinity (SSPS), and conductivity (CNDC) should not be used. Each of these short periods produced a small quantity of poor quality (J) and, in one case, M flags (Figure 90).

There were no other data issues recorded for the *Falkor* in 2018. As a general note, it is known that data from the foremast Gill metpak sensors – namely, air temperature (T), relative humidity (RH), atmospheric pressure (P), and earth relative wind speed and direction (SPD and DIR, respectively) – often suffer in rough seas and/or bad weather because the instrument is basically underwater, easily getting washed with seawater. This leads to frequent caution/suspect (K) flagging of all affected parameters (not shown) and explains most of the flag percentages seen in Figure 89 for those parameters. We note that when conditions are especially bad *Falkor* technicians occasionally suspend the foremast Gill metpak SAMOS data for a time. To a lesser extent data from the two main mast Gill metpak sensors (i.e. the "2" and "3" versions of the foremast parameters listed above) also suffer in bad weather, likewise accumulating K flags when necessary (not shown). Yet, with an overall flag percentage under 5% in 2018, there is not a lot of cause for concern here.

Finally, we note *Falkor* added both short wave (RAD_SW) and long wave (RAD_LW) atmospheric radiation sensors to their SAMOS lineup in late 2018.

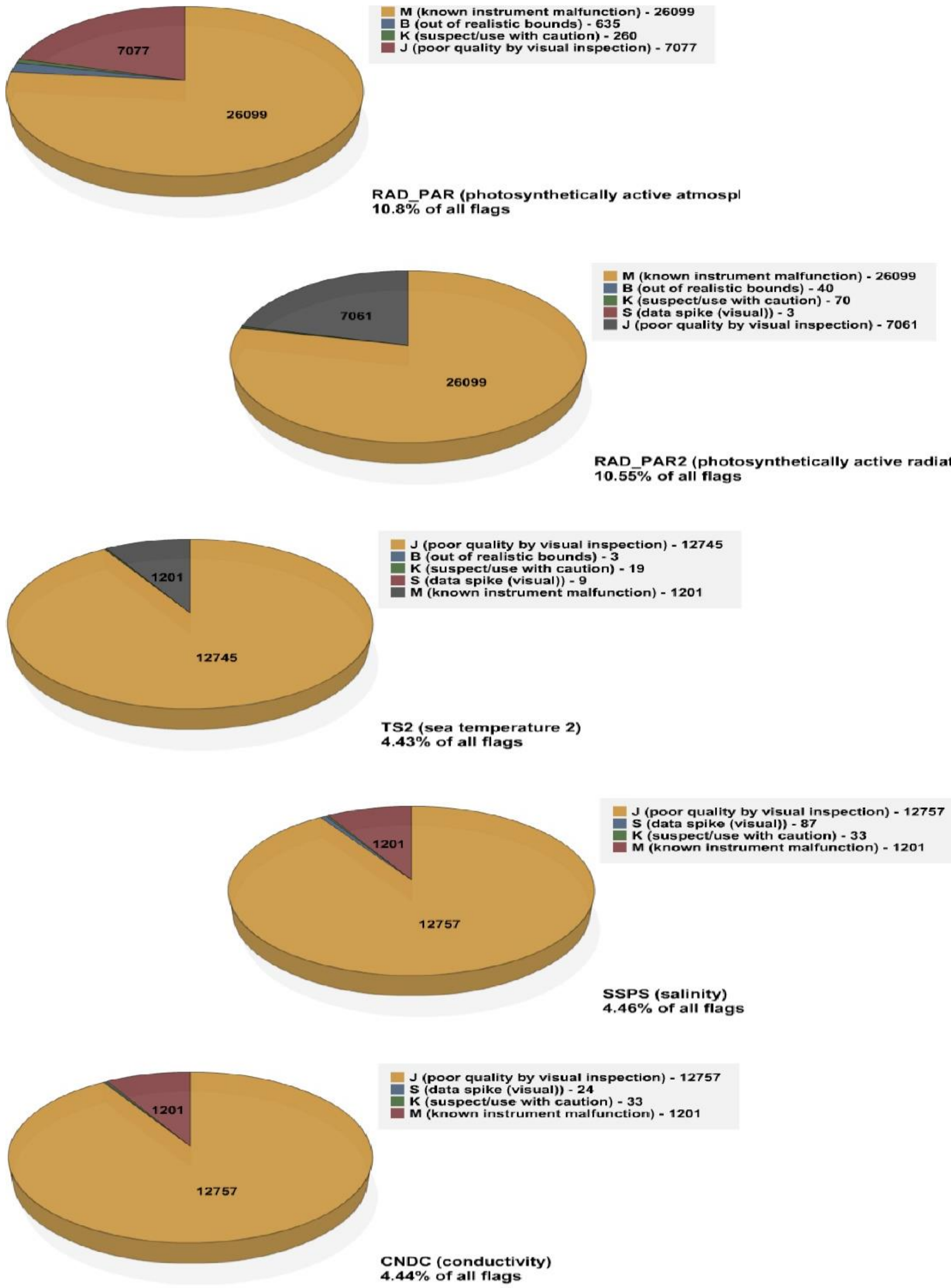


Figure 90: Distribution of SAMOS quality control flags for (first) photosynthetically active atmospheric radiation – RAD_PAR – (second) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – (third) sea temperature 2 – TS2 – (fourth) salinity – SSPS – and (last) conductivity – CNDC – for the *Falkor* in 2018.

Sikuliaq

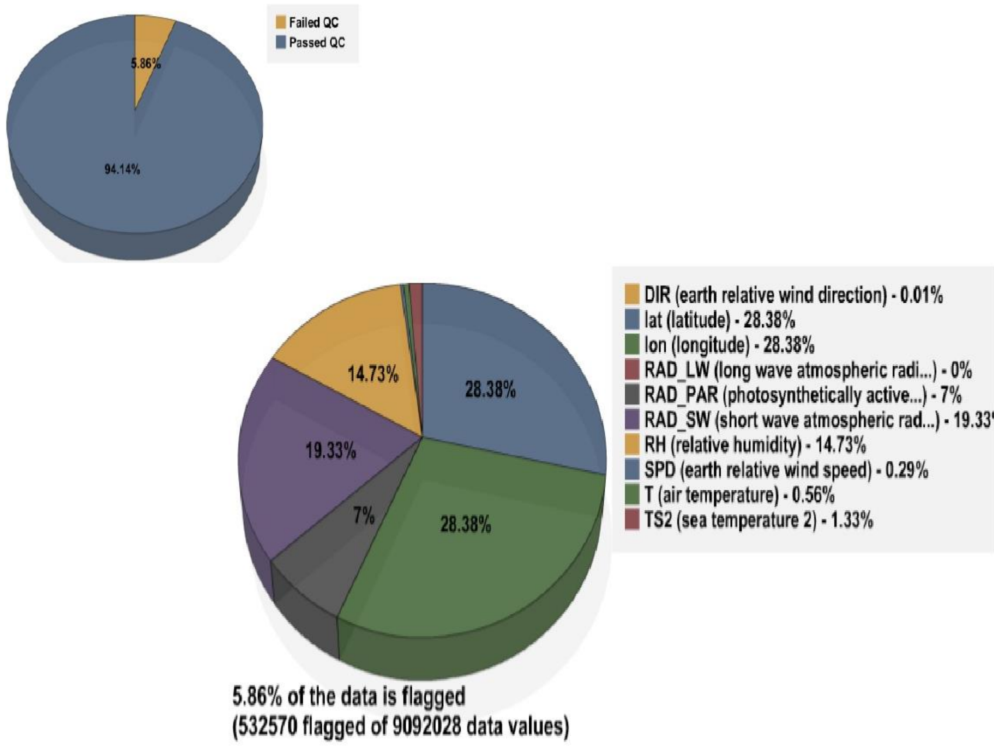


Figure 91: For the *Sikuliaq* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Sikuliaq* provided SAMOS data for 342 ship days, resulting in 9,092,028 distinct data values. After automated QC, 5.86% of the data were flagged using A-Y flags (Figure 91). This is about two percentage points higher than in 2017 (3.76%) and puts the *Sikuliaq* over the 5% total flagged cutoff regarded by SAMOS to represent "very good" data. It should be noted the *Sikuliaq* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Sikuliaq*).

Over half of the total flags were held by latitude (LAT) and longitude (LON) combined (Figure 91). These were exclusively land error (L) flags (Figure 92), assigned when the vessel was in port (generally either in Seattle or else her home port in Seward, AK). This is not an uncommon occurrence, as the land mask in use for the land check routine is often incapable of resolving the very fine detail of an inland port. This is true of both the older 2-minute land mask and the newer 1-minute one introduced in mid-2017.

On 17 September *Sikuliaq* personnel contacted the DAC to advise that their previous long wave atmospheric radiation (RAD_LW) installation had been producing bad RAD_LW values for all of 2018. However, we discovered at that time that both RAD_LW and short wave atmospheric radiation (RAD_SW) data had not been furnished in *Sikuliaq's* SAMOS files in several years. (They were previously reported for only 6 days in 2015.) Once the radiometers were replaced, on 16 September, the light data began flowing into the SAMOS data files again. We note about 20% of the total flags in 2018 was subsequently assigned to RAD_SW (Figure 91). However, upon inspection, these were exclusively out of bounds (B) flags (Figure 92) that appear to have been assigned to the slightly negative values that can occur with these sensors at night as a function of instrument tuning (see 3b. for details). Given that all the 2018 RAD_SW data occurred in winter and given that *Sikuliaq* spends her time near or above the arctic circle, this type of B flag has accumulated at a greater rate for her than for most other vessels.

A further ~15% of the total flags was held by relative humidity (RH). These were mainly out of bounds (B) flags (Figure 92). It is known RH on the *Sikuliaq* frequently reads a little over 100% (~110%). Through email discussions that transpired in early September it became clear the issue results from a combination of mechanical heating applied to the instrument (again, *Sikuliaq* frequently works in sub-zero climes) and commonly high humidity. In our last communication with *Sikuliaq* regarding RH, a colleague at USAP who has dealt with the same issues was able to offer his solutions/recommendations for RH sensors that work well in marine and Arctic environments.

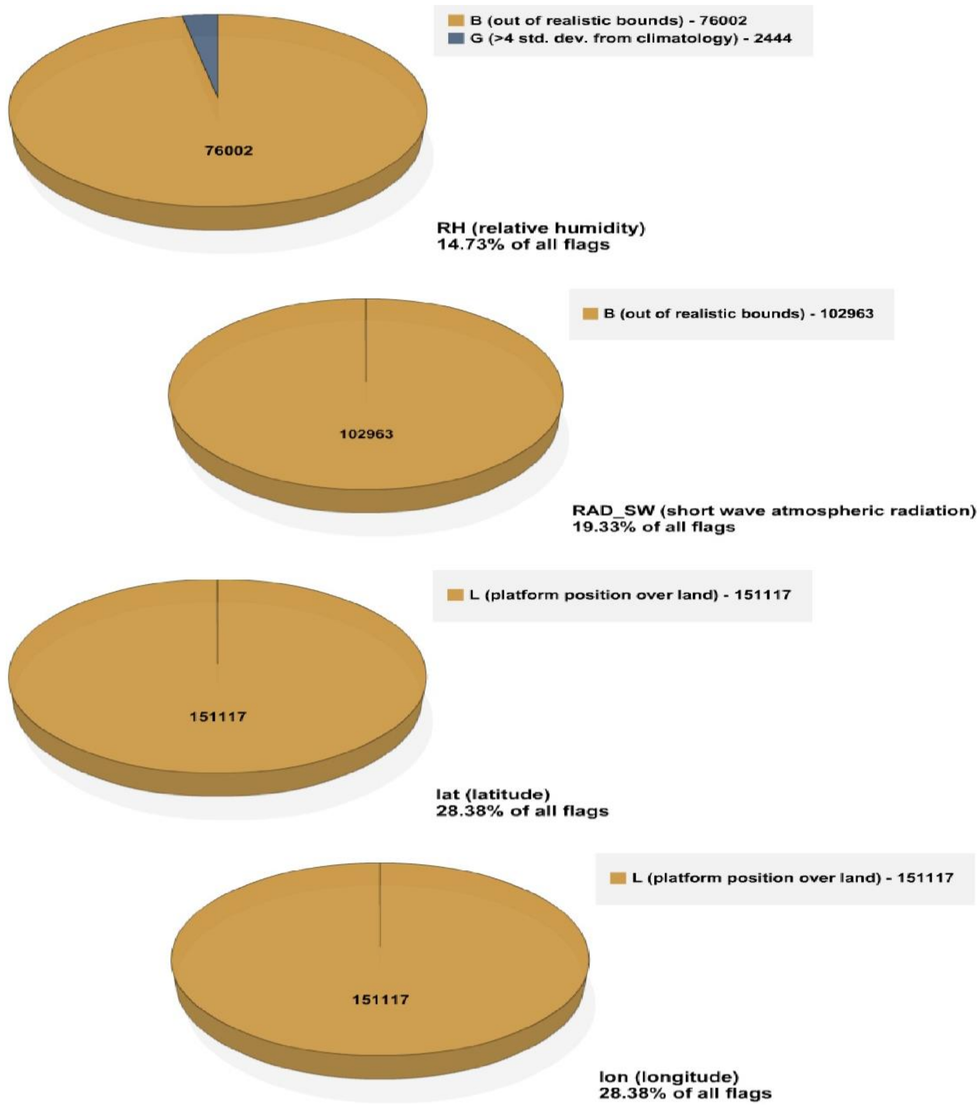
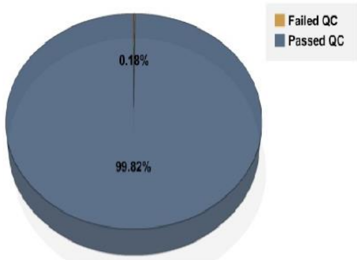


Figure 92: Distribution of SAMOS quality control flags for (first) relative humidity – RH – (second) short wave atmospheric radiation – RAD_SW – (third) latitude – LAT – and (last) longitude – LON – for the *Sikuliaq* in 2018.

Kilo Moana



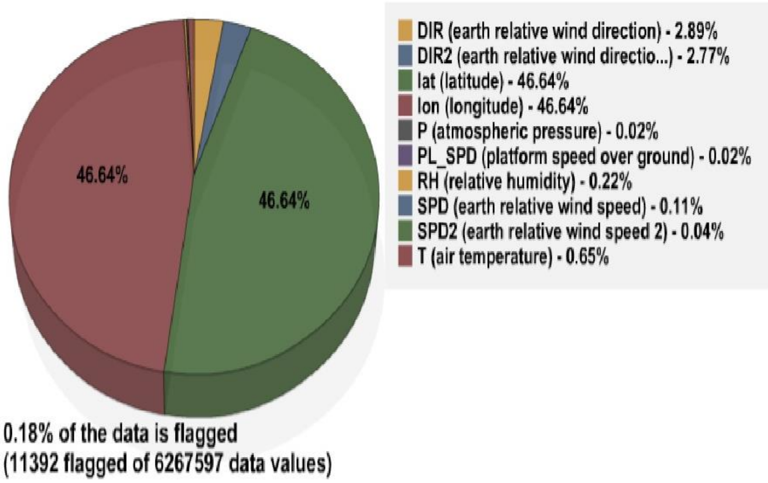


Figure 93: For the *Kilo Moana* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Kilo Moana* provided SAMOS data for 224 ship days, resulting in 6,267,597 distinct data values. After automated QC, 0.18% of the data were flagged using A-Y flags (Figure 93). This is essentially unchanged from 2017's total flagged percentage (0.3%) and is well under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *Kilo Moana* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Kilo Moana*).

With such an extraordinarily low flagged percentage it isn't practical to attempt any individual parameter quality analysis based on the flags applied. Additionally, there were no specific data issues noted for the *Kilo Moana* in 2018.

Thomas G. Thompson

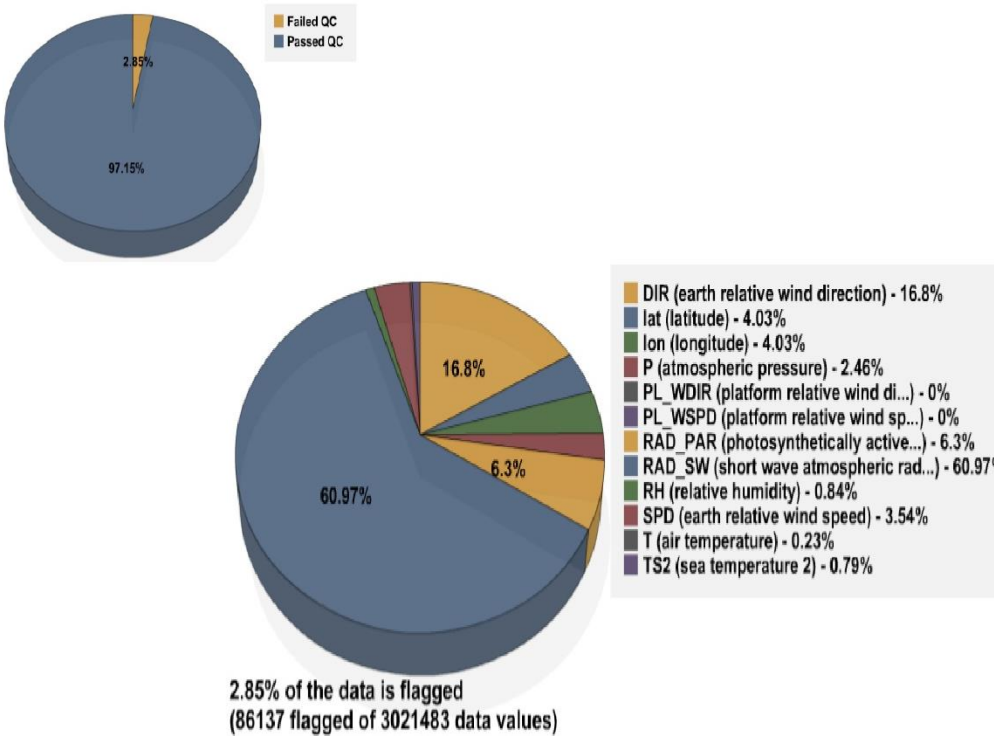


Figure 94: For the *Thomas G. Thompson* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Thomas G. Thompson* provided SAMOS data for 138 ship days, resulting in 3,021,483 distinct data values. After automated QC, 2.85% of the data were flagged using A-Y flags (Figure 94). This is about a percentage point lower than in 2017 (3.76%) and maintains the *Thompson's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *T. G. Thompson* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *T. G. Thompson*).

It is worth noting that the *Thompson's* 2018 SAMOS data transmission rate was 48% (see Table 2). It would be desirable to recover any data not received by us, if possible (see Figure 2). We note, though, that at least some of the missing days the vessel was in an EEZ and could not transmit data. We note, also, that *Thompson* advised us they had issues with their SCS SAMOS Event and/or mailers not running at several points during the year. So, in the end there may not be much actual SAMOS data missed.

After a successful mid-life refit, the *Thompson* began transmitting SAMOS data on 10 February. However, between sensors that were not yet reinstalled and any other modifications that took place, it wasn't until 23 July that technicians were able to get the wind (platform relative speed and direction – PL_WSPD and PL_WDIR, respectively – and earth relative speed and direction – SPD and DIR, respectively), light (short wave and photosynthetically active atmospheric radiations – RAD_SW and RAD_PAR, respectively), and sea temperature 2 (TS2) data into the SAMOS files.

Looking at the flag percentages in Figure 94, considering the low overall total the only parameter that stands out is RAD_SW, holding ~60% of the total flags. Upon inspection, these were exclusively out of bounds (B) flags (Figure 95), which appear to have been assigned mainly to the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

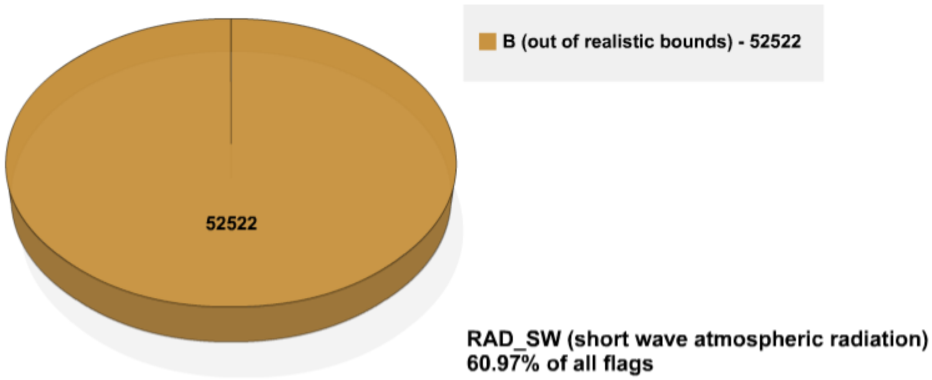
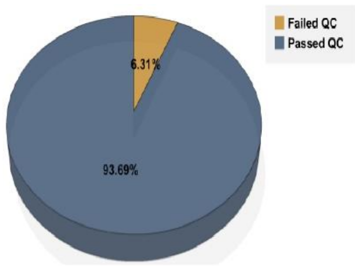


Figure 95: Distribution of SAMOS quality control flags for short wave atmospheric radiation – RAD_SW – for the *Thomas G. Thompson* in 2018.

Healy



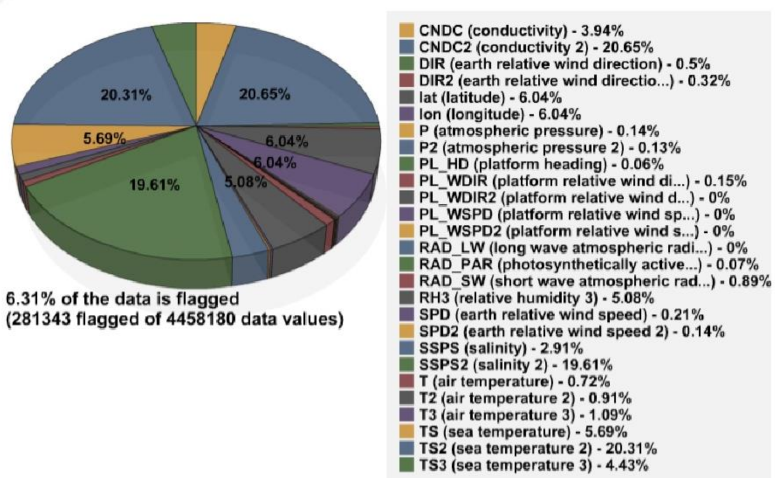


Figure 96: For the *Healy* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Healy* provided SAMOS data for 119 ship days, resulting in 4,458,180 distinct data values. After automated QC, 6.31% of the data were flagged using A-Y flags (Figure 96). It should be noted *Healy* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All the flags are the result of automated QC only (no research-level files exist at the SAMOS DAC for the *Healy*).

After more than a year without a submission, SAMOS data transmission from the *Healy* was finally reestablished on 21 June. New sensor metadata for nearly all sensors accompanied these initial transmissions and the information was entered into the SAMOS database. However, it came to light on 10 September that the units for the conductivity (CNDC) parameter had unfortunately been entered incorrectly. The oversight was immediately corrected, but science users should be advised SAMOS CNDC data for the *Healy* for the period 21 June through 10 September were incorrectly assumed to be $\mu S\ cm^{-1}$ and were adjusted to $S\ m^{-1}$ accordingly, when in fact the adjustment to $S\ m^{-1}$ should have been from $mS\ cm^{-1}$. As the values were still within bounds, this situation was likely not caught by the auto flagging process.

The sea parameters from the secondary sensor – namely, sea temperature 2 (TS2), salinity 2 (SSPS2), and conductivity 2 (CNDC) – together amassed ~60% of the total flags in 2018 (Figure 96). These were almost exclusively out of bounds (B) flags (Figure 97). A quick inspection reveals several significant bouts of likely missing values for all three parameters (-99 for both TS2 and SSPS2, and 0 for CNDC2). It is not known why the missing values presented.

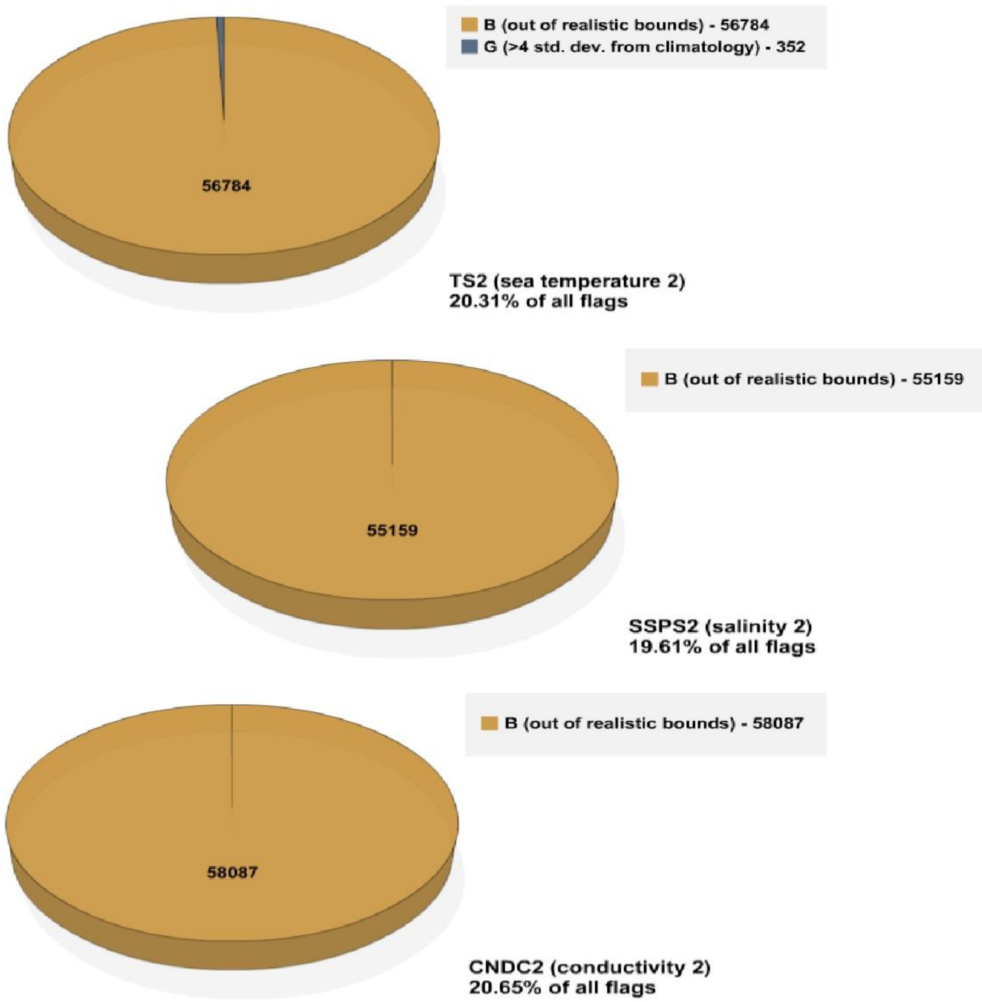


Figure 97: Distribution of SAMOS quality control flags for (top) sea temperature 2 – TS2 – (middle) salinity 2 – SSPS2 – and (bottom) conductivity 2 – CNDC2 – for the *Healy* in 2018.

R/V Atlantis

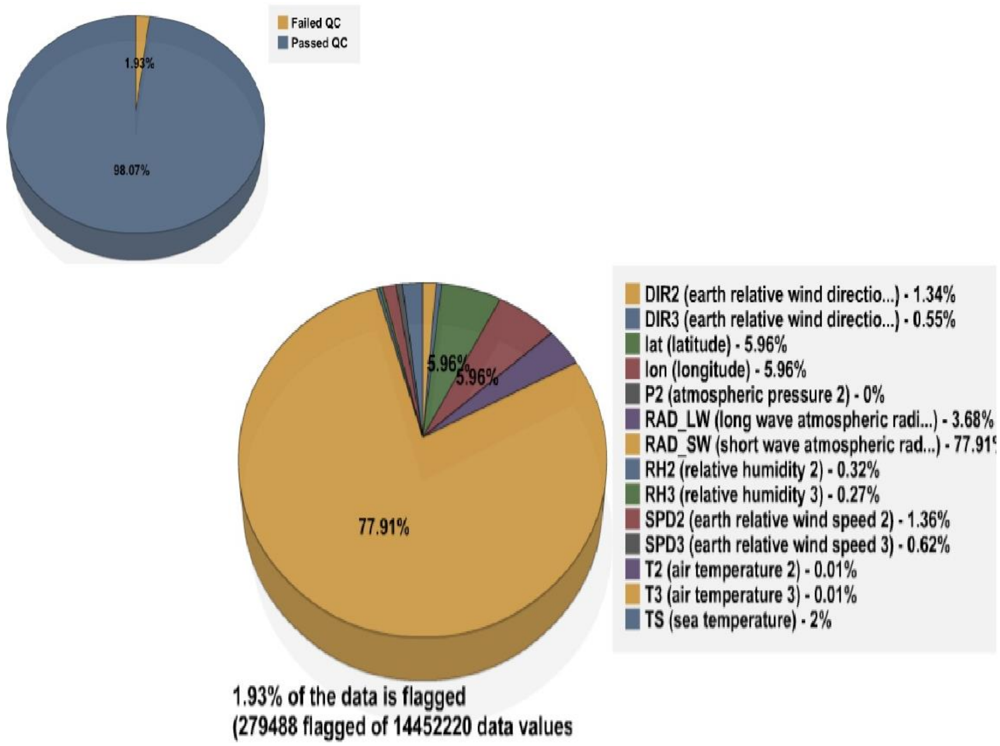


Figure 98: For the *R/V Atlantis* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *R/V Atlantis* provided SAMOS data for 360 ship days, resulting in 14,452,220 distinct data values. After automated QC, 1.93% of the data were flagged using A-Y flags (Figure 98). This is essentially unchanged from 2017's total flagged percentage (1.74%) and is well under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *R/V Atlantis* receives only automated QC, and visual QC is when the bulk of flags are typically applied.

Looking at the flag percentages in Figure 98, the only parameter that stands out is short wave atmospheric radiation (RAD_SW), holding ~78% of all flags in 2018. However, a quick inspection reveals exclusively out of bound (B) flags (Figure 100) which were mainly the result of the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

Long wave atmospheric radiation (RAD_LW), on the other hand, did experience a problem in 2018. On 23 February it was noted RAD_LW was highly suspicious, with many spikes/steps and negative values in the data (Figure 99), which resulted in copious out of bounds (B) flags. Vessel technicians were alerted via email and they responded they'd also noticed but were heading into some bad weather and would not be able to address it right away. They stated they were hoping to be able to do so in a few weeks. Meanwhile, the B flags continued. By 13 June RAD_LW had not improved, so the decision was made to disable the sensor in the SAMOS data base to avoid further accumulation of B flags. On 18 August we were advised the sensor had been replaced. RAD_LW was re-enabled in the SAMOS data base and we began collecting good data as of 14 August.

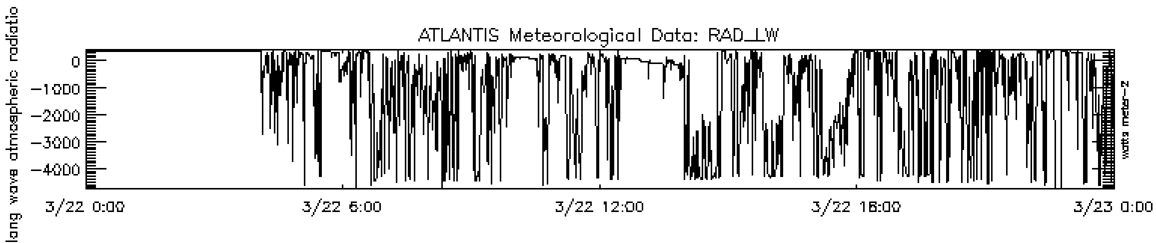


Figure 99: *R/V Atlantis* SAMOS long wave atmospheric radiation – RAD_LW – for 22 March 2018. Note significantly negative values.

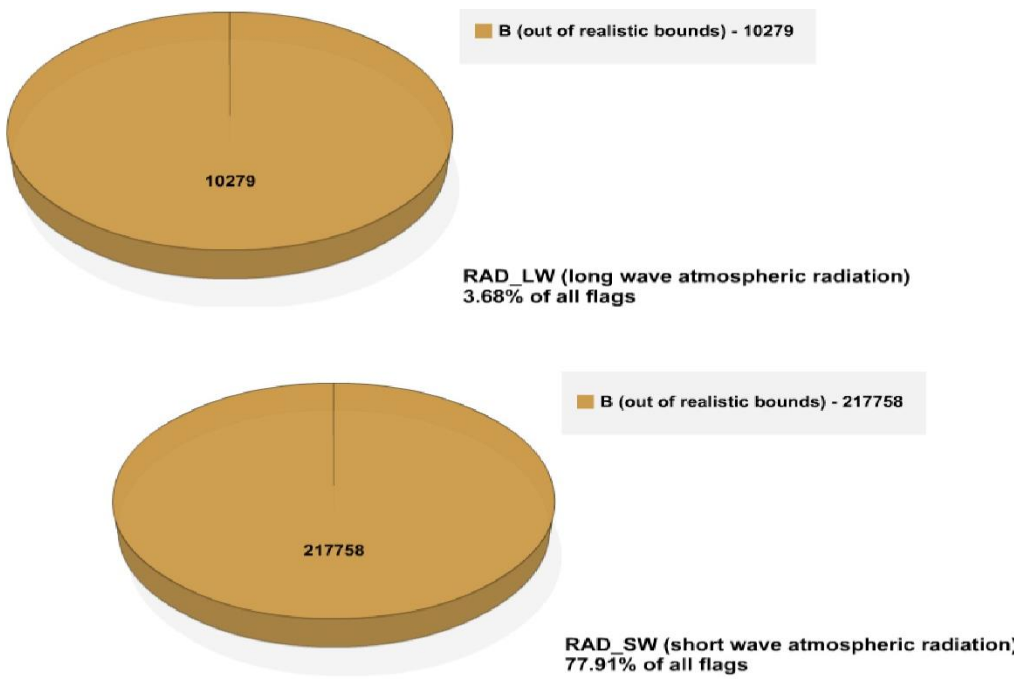


Figure 100: Distribution of SAMOS quality control flags for (top) long wave atmospheric radiation – RAD_LW – and (bottom) short wave atmospheric radiation – RAD_SW – for the *R/V Atlantis* in 2018.

R/V Neil Armstrong

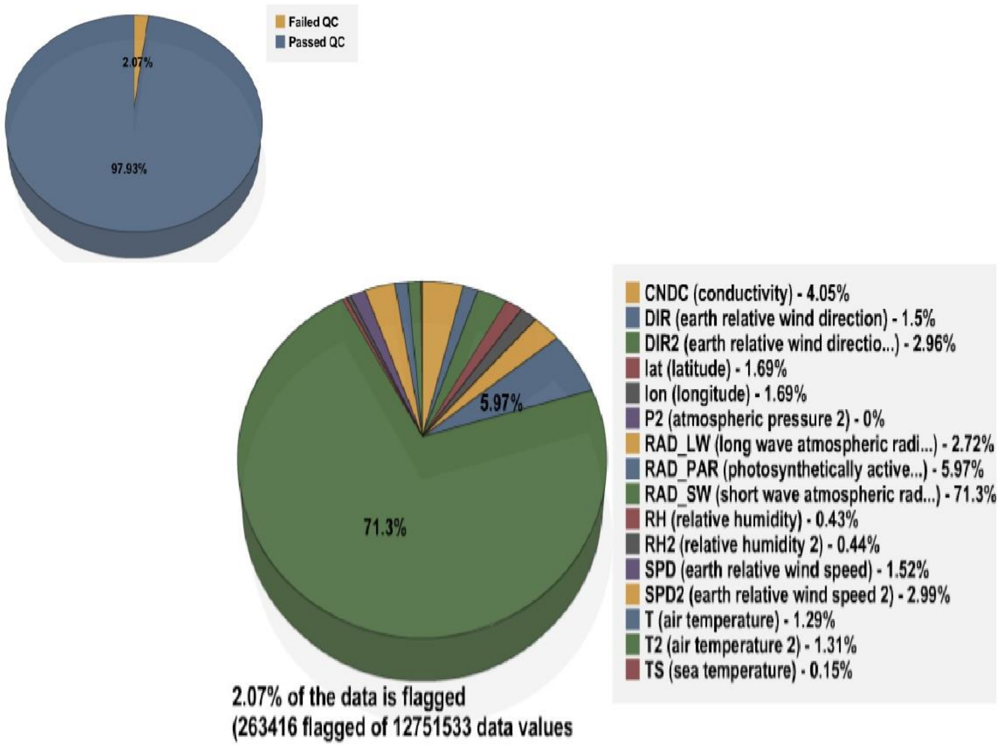


Figure 101: For the *R/V Neil Armstrong* from 1/1/18 through 12/31/18, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *R/V Neil Armstrong* provided SAMOS data for 303 ship days, resulting in 12,751,533 distinct data values. After automated QC, 2.07% of the data were flagged using A-Y flags (Figure 101). This is a little bit lower than in 2017 (3.58%) and maintains the *Armstrong's* standing under the 5% total flagged cutoff regarded by SAMOS to represent "very good" data, although it must be noted the *R/V Neil Armstrong* receives only automated QC, and visual QC is when the bulk of flags are typically applied. All 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 issue on record for the *R/V Neil Armstrong* in 2018 is not reflected in the flag percentages seen in Figure 101: On 5 September it was discovered the platform relative wind parameters from *Armstrong's* port weather transmitter (direction and speed – PL_WDIR and PL_WSPD, respectively) were not being provided in the Armstrong's SAMOS files since 24 January 2018. Upon alerting the vessel via email, *Armstrong's* technician learned the two variables were accidentally being cut off from the SAMOS data record. It seems PL_WDIR and PL_WSPD had at some point been added to the SAMOS output (which itself must not have been the original version) but the total number of outputs had not been updated to account for the addition. As such, the program that constructs the data record was omitting those two parameters. On or around 10 September this programming issue was corrected.

Regarding the flag percentages in Figure 101, the only parameter that stands out is short wave atmospheric radiation (RAD_SW). A quick inspection reveals exclusively out of bounds (B) flags (Figure 102) which were mainly the result of the slightly negative values that can occur with these sensors at night (a consequence of instrument tuning, see 3b.)

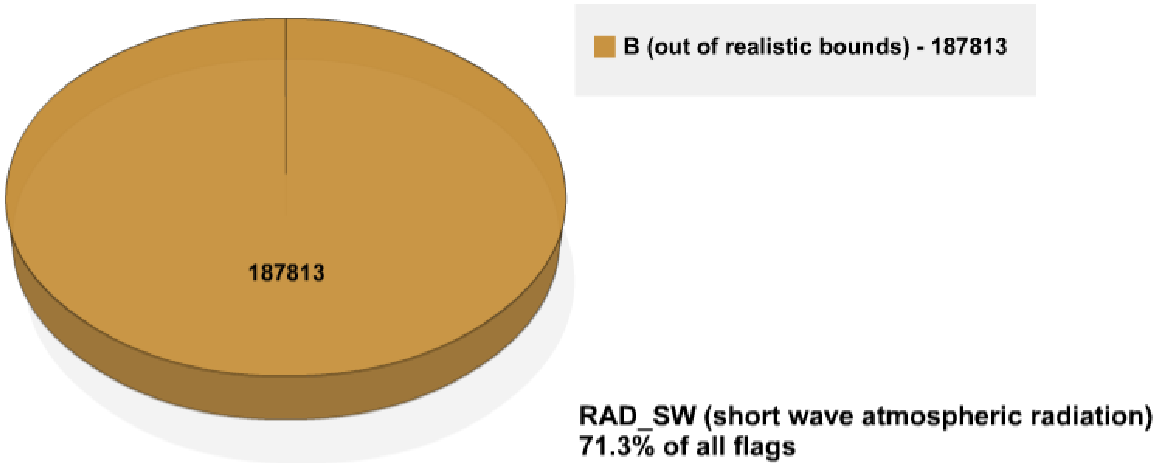


Figure 102: Distribution of SAMOS quality control flags for short wave atmospheric radiation – RAD_SW – for the *R/V Neil Armstrong* in 2018.

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 103 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 104. (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 104 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.)

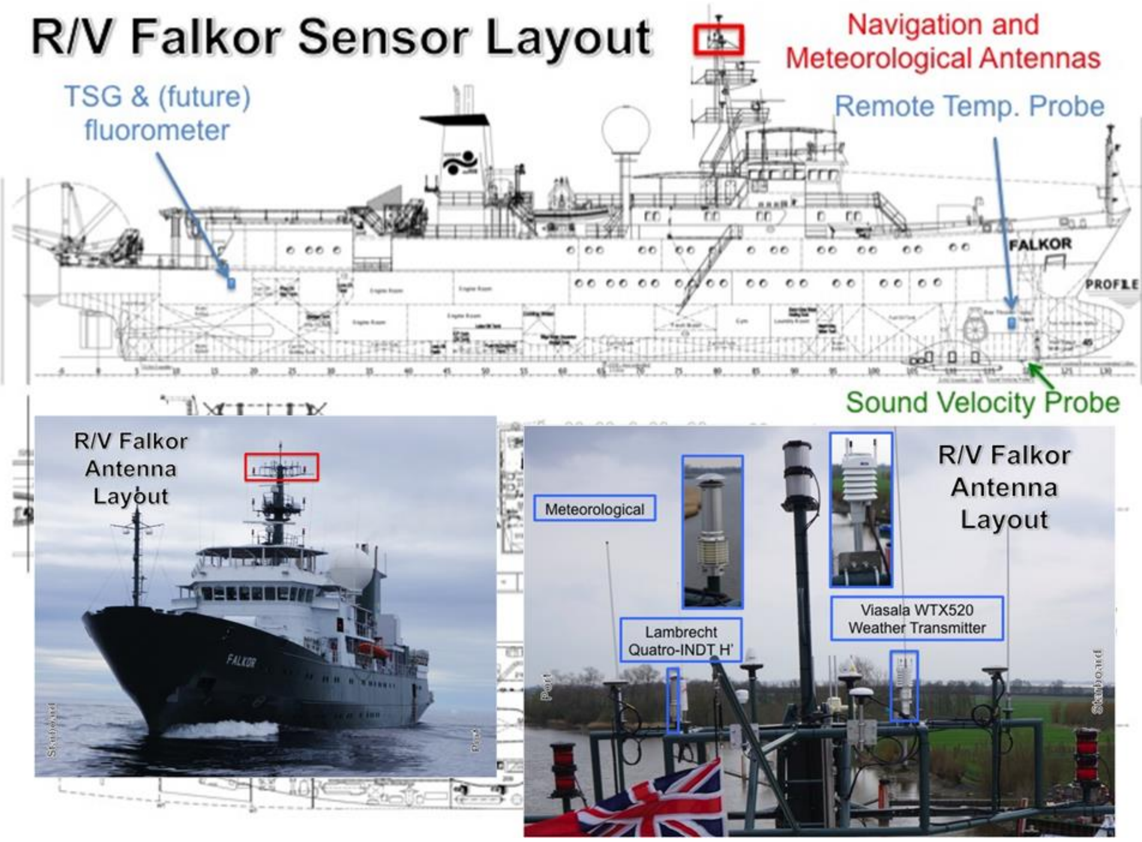


Figure 103: Examples of detailed vessel instrument imagery from the *R/V Falkor*.

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 104: 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	I		I	I,I	C	C
NEPP	C	C	C	Yes	I	I	I	I	I	I,C	I,C	I,C	I,I	I,I,I			I,I	I			I	I		I	I,I,I	I,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	I			C	I			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		I
WDC9417	C	C	C	Yes																							
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
WSAF	C	C	I	No	I	I	I	I	I	C	C	C	C	C,C	I		C,C	C	C		I	I		I	I,I	I,I	I,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,I	I	I
WTDH	C	I	C	Yes	I	I	I	I	I	I	I	C	C	I			I	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	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,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,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	C	I	I	Yes	I	I	I	I	I	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	C	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
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	C							I,I	I	I
ZCYL5	C	C	C	Yes	C	C	C	C	C,C,C	C,C,C	C,C,C	C,C,C	C,C,C	C,C,C			I,I,I	C,C,C			I	I		C,C	C,C	C	C
ZMFR	C	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. Only metadata valid as of the writing of this report is shown. "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 2019

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 DAC 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 has developed procedures 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 2018, the university-operated vessels contributing to the SAMOS DAC were those operated by WHOI, SIO, UA, UH, UW, LUMCON, 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 2019, we wish to restore SAMOS contributions from the Oceanus and Endeavor and are open to recruiting additional UNOLS vessels. The R2R team is also developing best practices for the acquisition of data from transmissometers to support real-time quality control.

Nearing completion is the creation of an hourly subset of all available SAMOS data for the period 2015-2018 (along with updates to the subsets from 2005-2014) 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.

The SAMOS DAC is also beginning a multi-year process to revise and open-source our data quality software and visual analysis tools. The goal is to make the code available to operators and the international research vessel community so that additional vessels can produce high-quality data that conforms to SAMOS procedures and practices.

6. References

Hill, K., T. Moltmann, R. Proctor, S. Allen, 2010: The Australian Integrated Marine Observing System: Delivering Data Streams to Address National and International Research Priorities. *Marine Tech Society J.*, **44**(6), 65-72. https://doi.org/10.4031/MTSJ.44.6.13

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., K. Briggs, M. A. Bourassa, J. Elya, and C. R. Paver, 2018: Shipboard automated meteorological and oceanographic system data archive: 2005–2017. *Geosci Data J.*, **5**, 73–86. https://doi.org/10.1002/gdj3.59

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:

IMOS data availability is found online at http://opendap.bom.gov.au:8080/thredds/catalog/imos_samos_archive/catalog.html (*Aurora Australis*, *Investigator*, and *Tangaroa)*

R2R vessels are found online at http://www.rvdata.us/catalog (*Falkor*)

UNOLS vessels are found online at http://strs.unols.org/public/search/diu_all_schedules.aspx?ship_id=0&year=2018 (all other vessels, except *Laurence M. Gould*, *Nathaniel B. Palmer*, and *Healy*)

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

Excepting the *Falkor* and *Okeanos Explorer*, the vessels listed here do not receive visual quality control. As such, this compilation relies almost entirely on notifications sent to the DAC by vessel operators or email exchanges initiated by the DAC; in many cases the exact cause of any issues and/or the exact date range under impact are unknown.

Atlantis:

- 21 July - 19 August: in port, flow-through system secured, IMET mast likely went up and down a few times. TSG data should not be used, and meteorological data should be considered suspect.
- 4-6 September: port Vaisala wind sensor dead, no "2" wind data should be used.

Falkor:

- 17 September - 20 October: RAD_PAR and RAD_PAR2 calculations inaccurate, data should not be used.

Healy:

- 21 June - 10 September: CNDC units incorrectly adjust from $\mu S\ cm^{-1}$ to $S\ m^{-1}$, the adjustment to $S\ m^{-1}$ should have been from $mS\ cm^{-1}$

Investigator: no notes.

Kilo Moana: no notes.

Laurence M. Gould:

- 24 March: AT/RH probe filter cleaned 14:40 UTC
- 25 March - 1 April: T/RH sensor dead, data should not be used

Nathaniel B. Palmer: no notes.

Neil Armstrong:

- 30 November - date unknown (duration stated to be "a few weeks"): meteorological tower in maintenance mode, all meteorological data should be considered suspect.

Okeanos Explorer:

- 14 March - 6 June 2018 PL_WSPD requires a unit conversion of kts to m/s

Pelican: no notes.

Robert Gordon Sproul: no notes.

Roger Revelle: no notes.

Sally Ride:

- 23 April - end date unknown, but before 11 June: RH windscreen dirty, data should not be used

Sikuliaq: no notes.

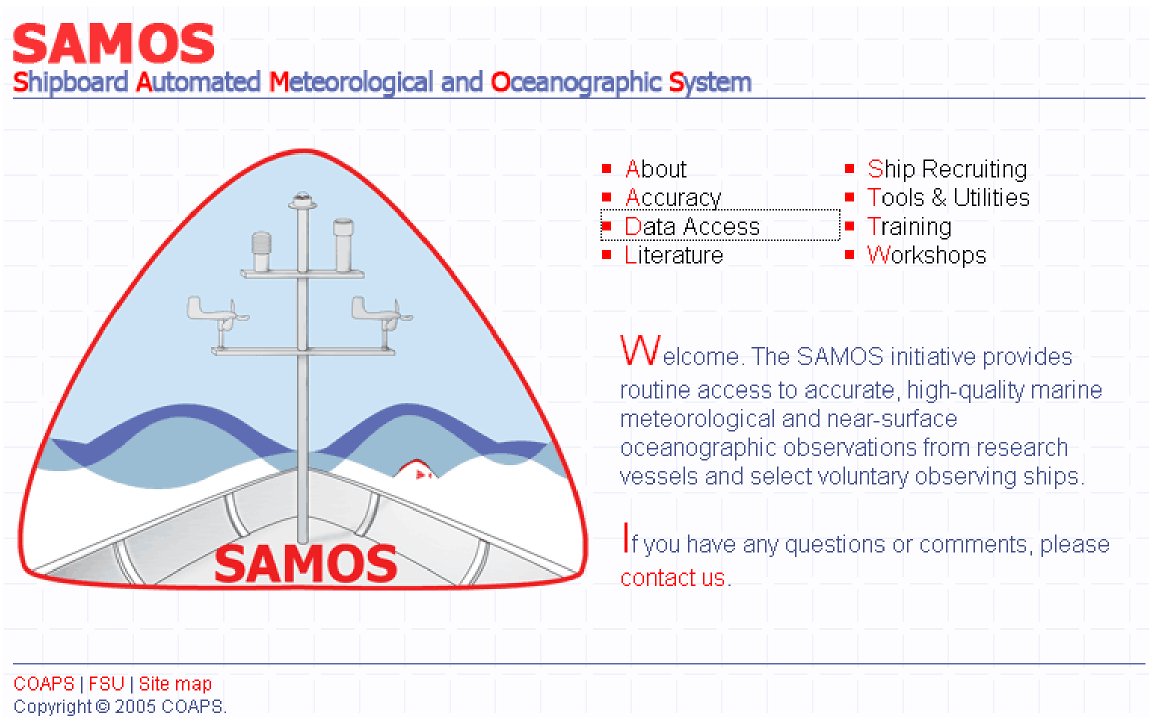
Tangaroa: no notes.

T.G. Thompson: no notes.

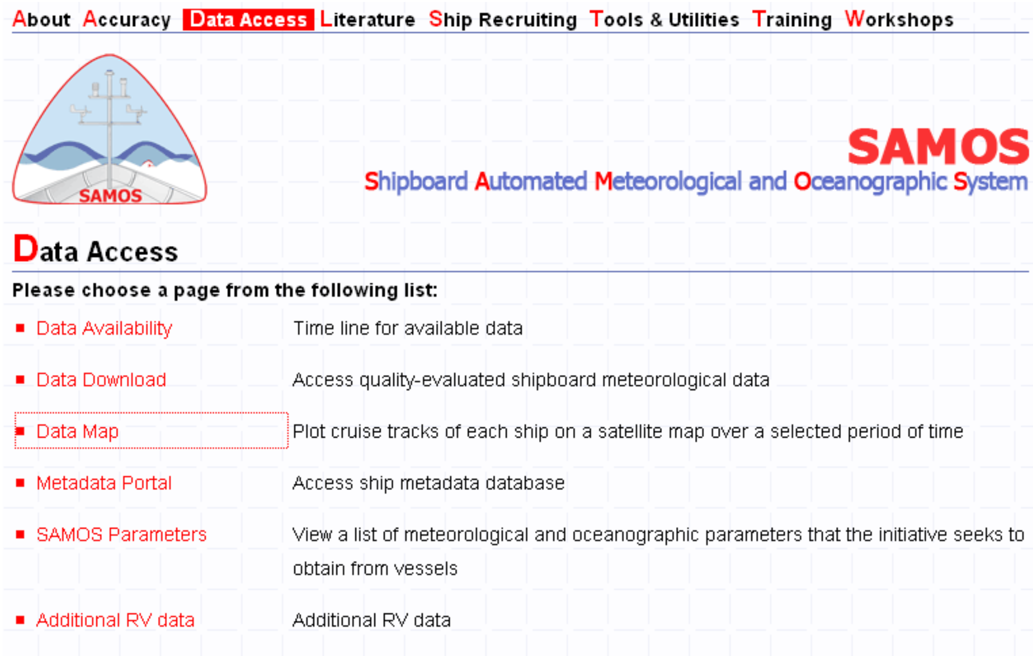
Annex B: SAMOS Online Metadata System Walk-through Tutorial

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:



About Accuracy **Data Access** Literature Ship Recruiting Tools & Utilities Training Workshops

SAMOS

Shipboard Automated Meteorological and Oceanographic System

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

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

Data Map

To use the data map, select one or more ships from the menu. Then, using either the calendar or the drop-down menus, select a date range. To access the calendar, click the icon next to the start or end selection menus. Since the data takes 10 days to process, please keep this in mind when selecting your end date range. A maximum of 16 ships can be displayed on the map at a single time. Please contact us if you have any questions.

Choose a Ship

or Multiple Ships

(ctrl-click or apple key-click)

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

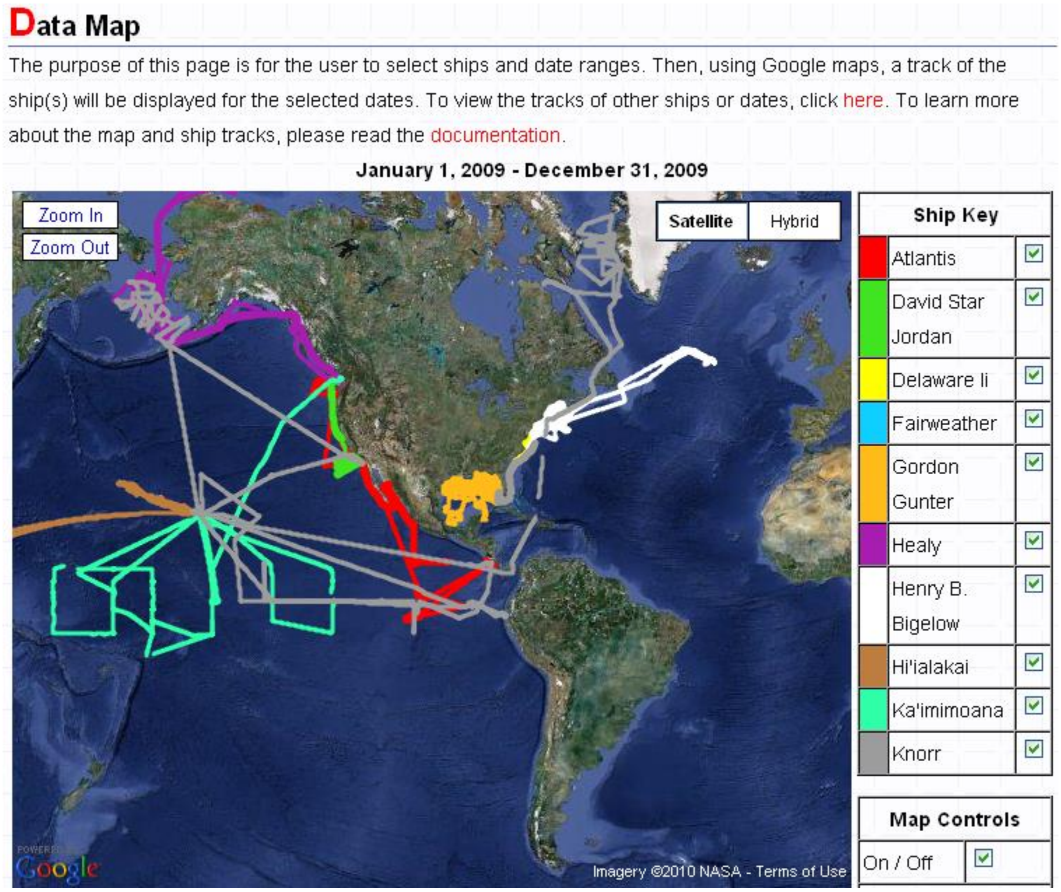
Select a Date

Start: January 1 , 2009

End: December 31 , 2009

Search

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



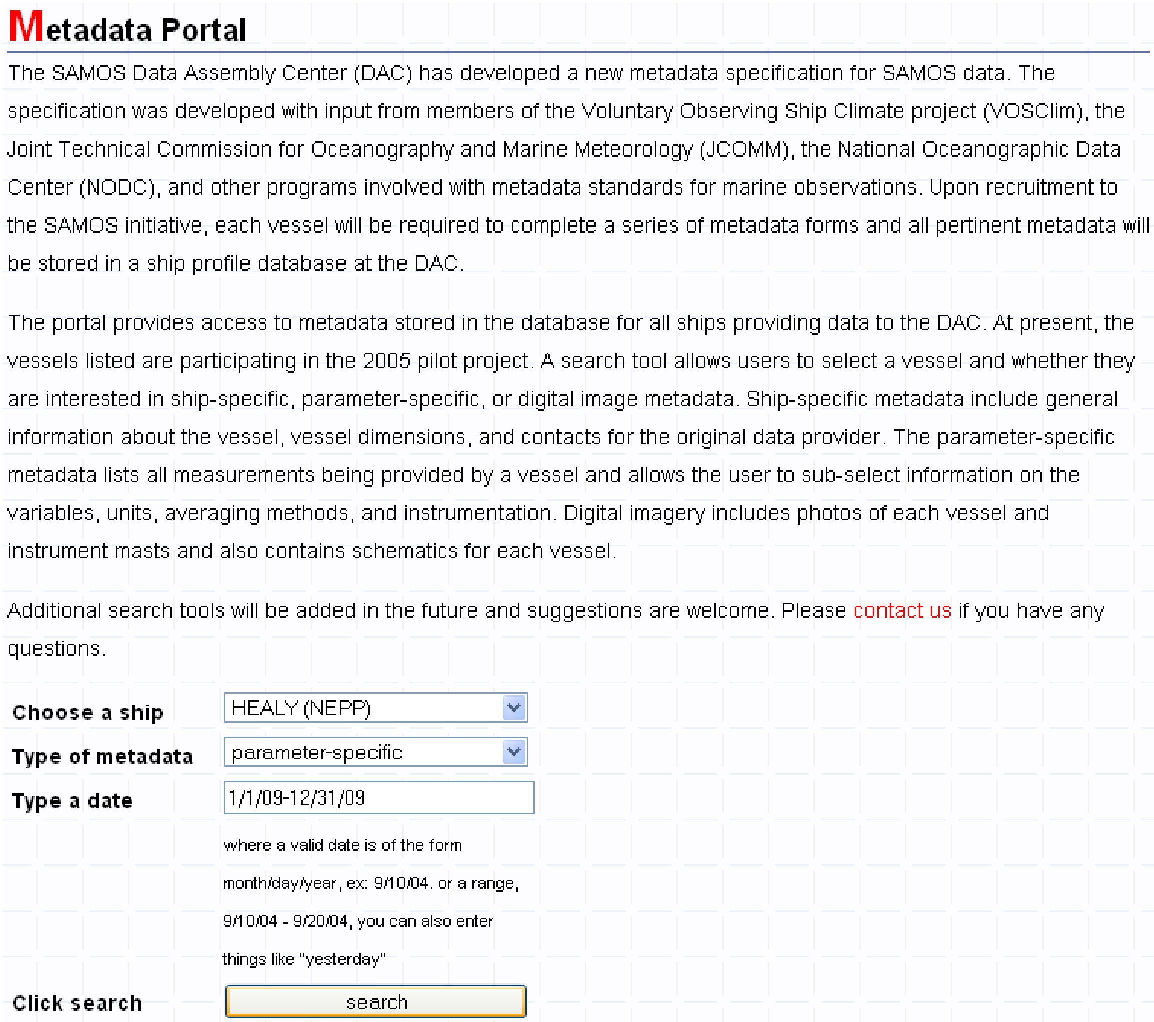
Now the user can see that both the *Healy* and the *Knorr* cruised in the north-polar region in 2009. The next step might be to see what parameters are available on each ship. Returning to the Data Access page, the user this time selects the Metadata Portal:

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

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:

Metadata Portal

HEALY

Expand each of the ship's variables for a detailed view

[Show All] [Hide All]

Order: [Alphabetically] [netCDF order]

Download PDF

- time
- latitude
- longitude
- platform heading
- platform heading 2
- platform course
- earth relative wind direction
- earth relative wind direction 2
- platform relative wind direction
- platform relative wind direction 2
- platform speed over ground
- platform speed over water
- platform speed over water 2
- earth relative wind speed
- earth relative wind speed 2

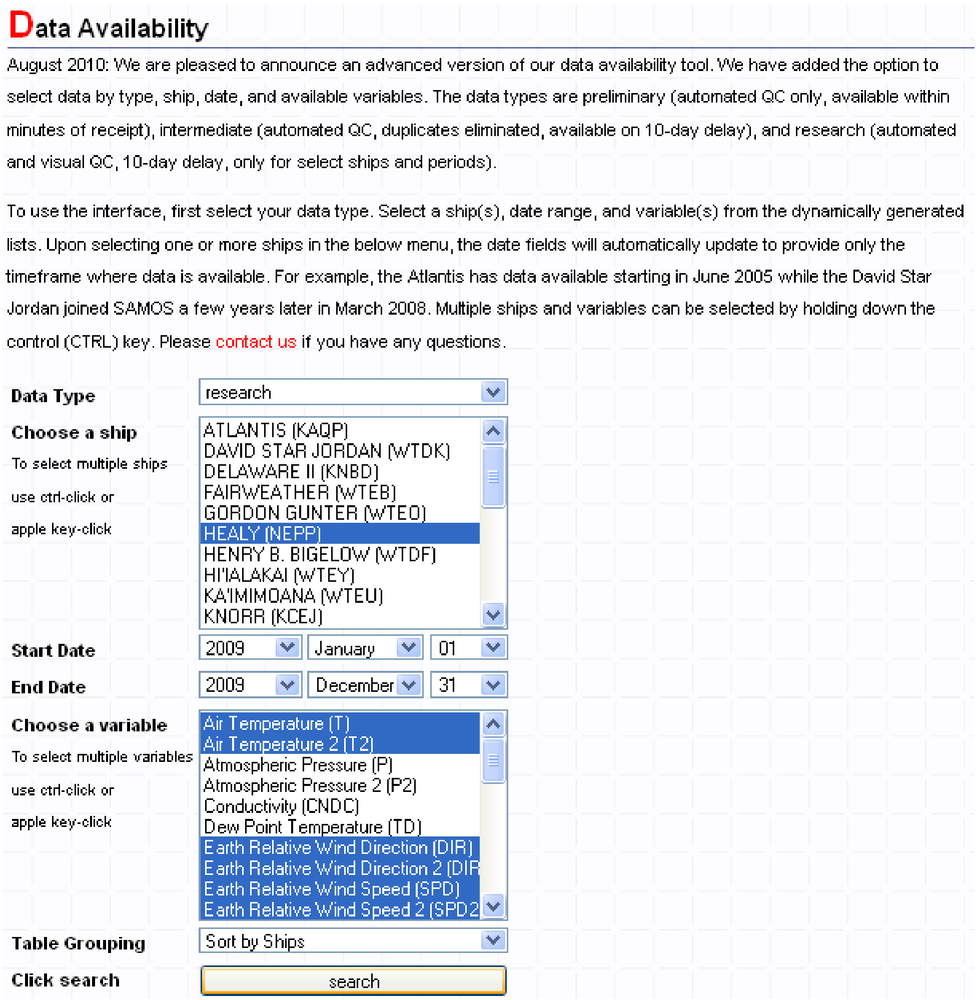
A thorough investigation of the list (note: image is truncated) tells the user the *Healy* did in fact provide both wind and temperature data in 2009. (Throughout the online SAMOS system, clicking on a "+" will yield further information; in this case the result would be metadata for the individual parameters.) 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:

Data Access

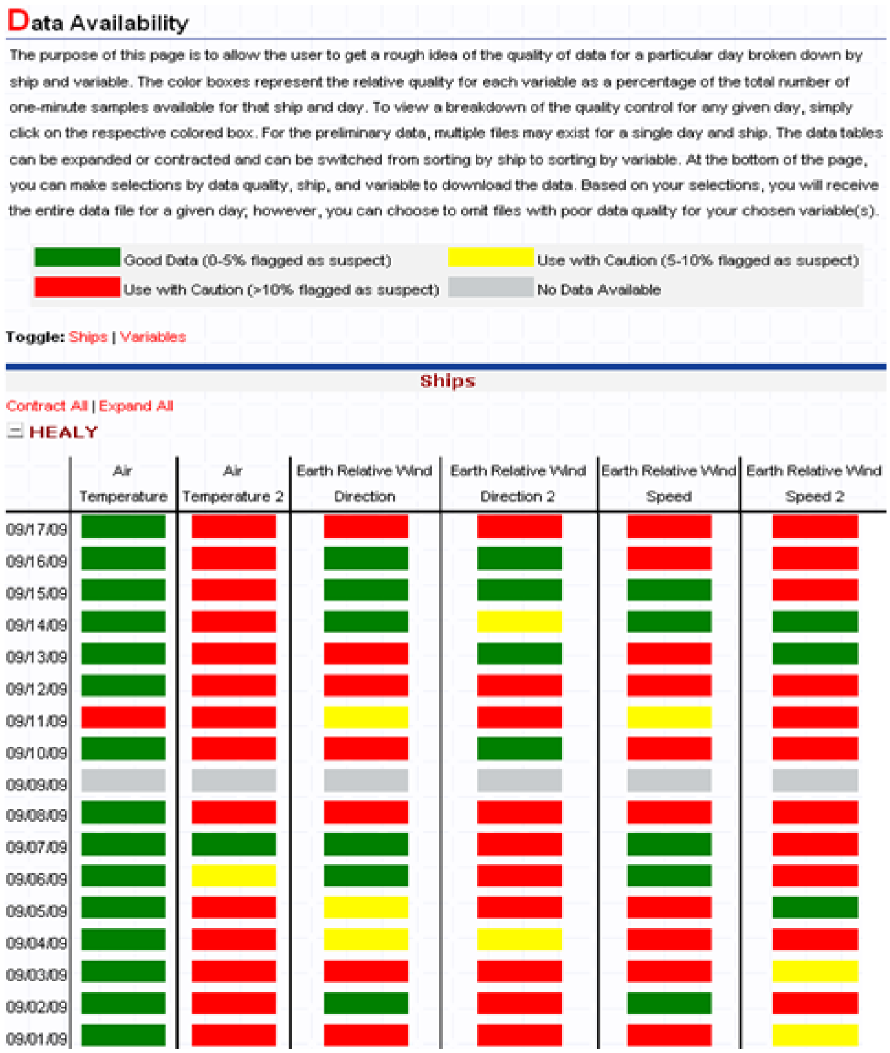
Please choose a page from the following list:

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

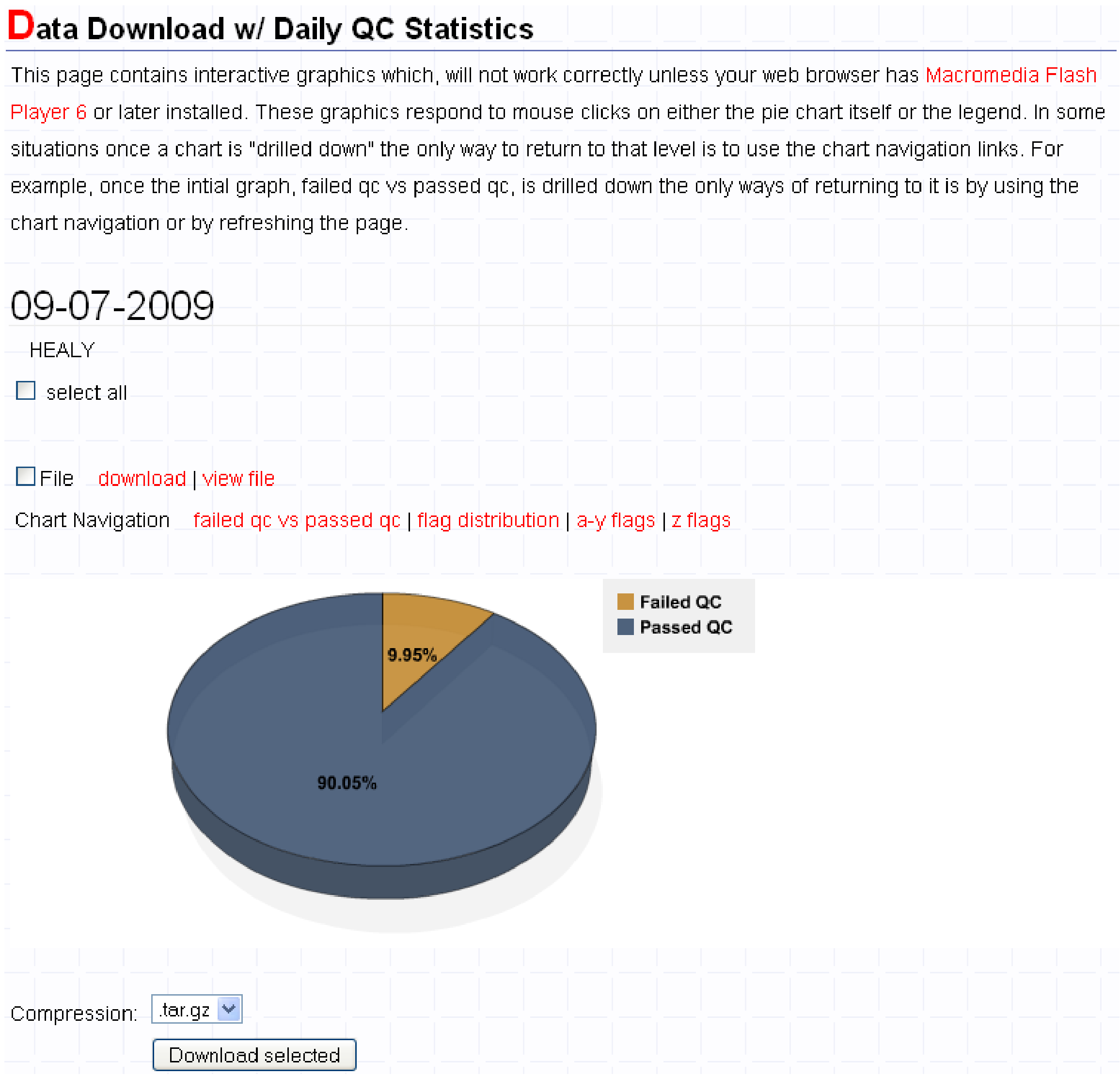
After selecting the *Healy* along with the desired parameter(s), date range, and data version (preliminary, intermediate, or research), noting that the default date range and available parameters will change once a vessel and data version are selected, and then clicking "search":



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 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:



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

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.

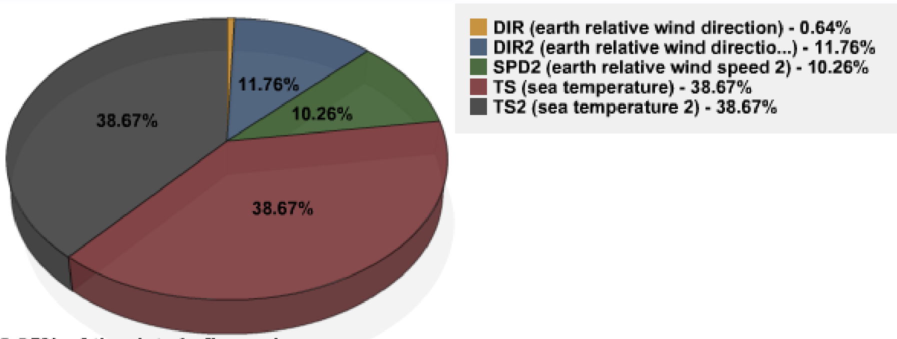
09-07-2009

HEALY

☐ select all

☐ File download | view file

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

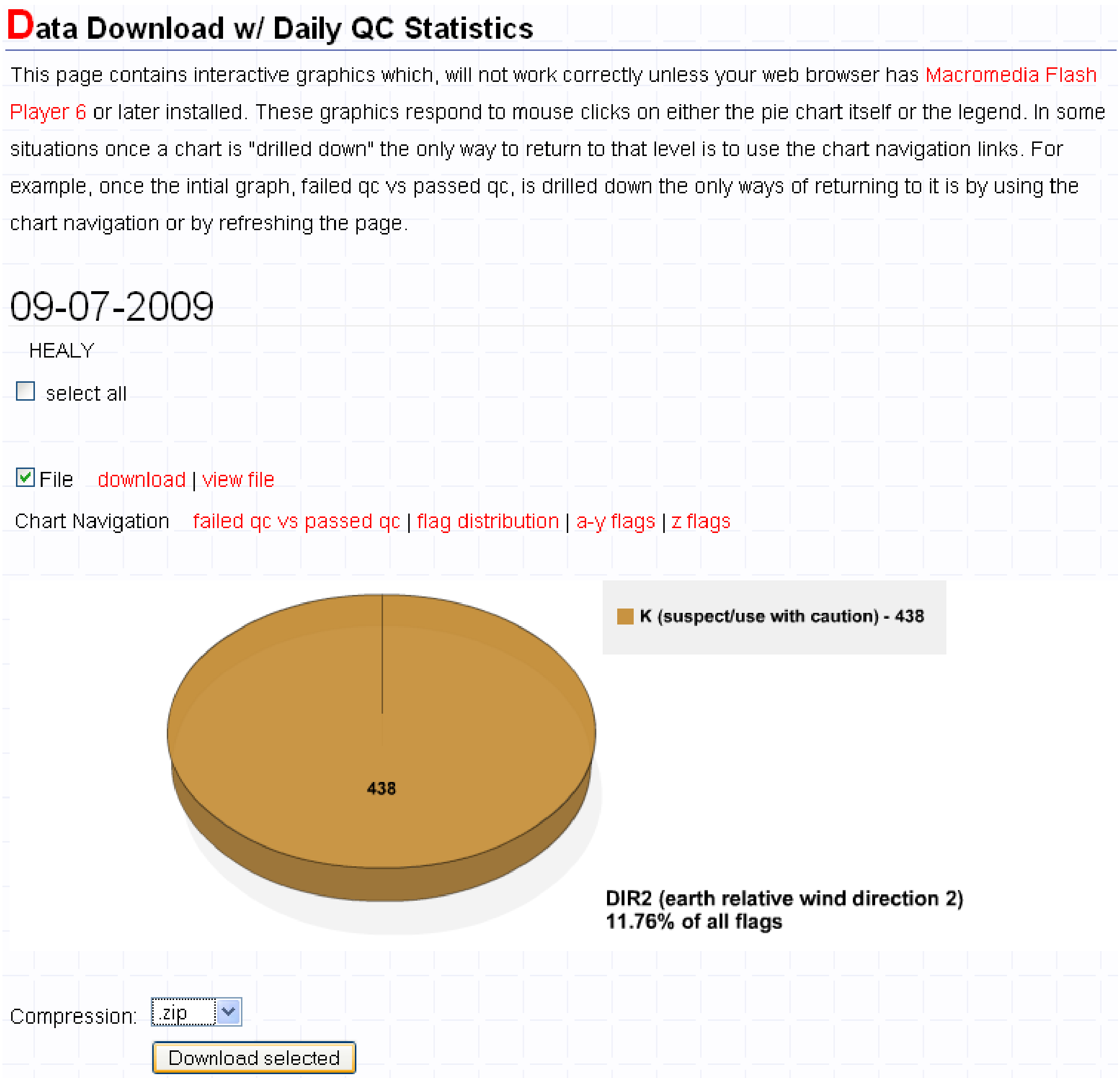


9.95% of the data is flagged
(3724 flagged of 37440 data values)

Compression: .tar.gz

Download selected

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:



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

K (suspect/use with caution) - 438

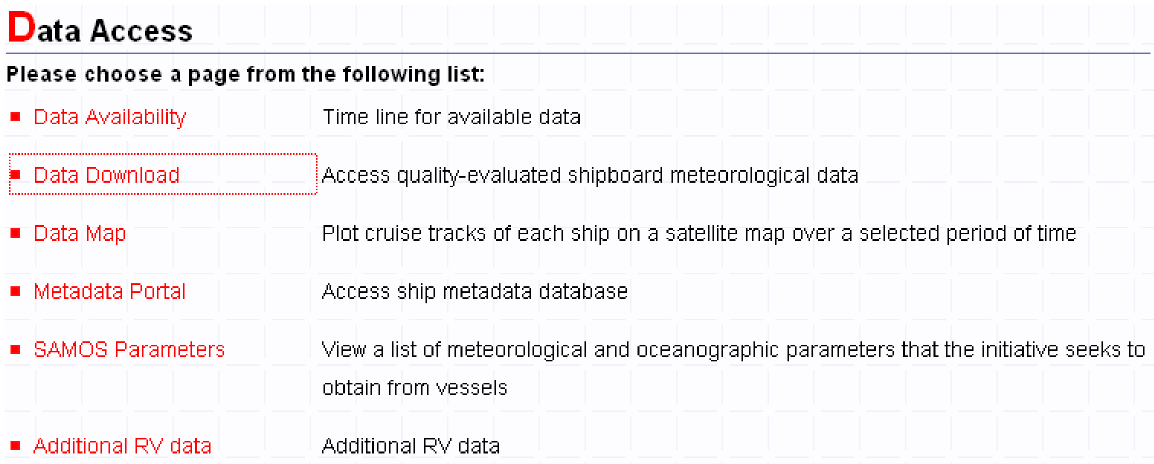
438

DIR2 (earth relative wind direction 2)
11.76% of all flags

Compression: .zip

Download selected

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:

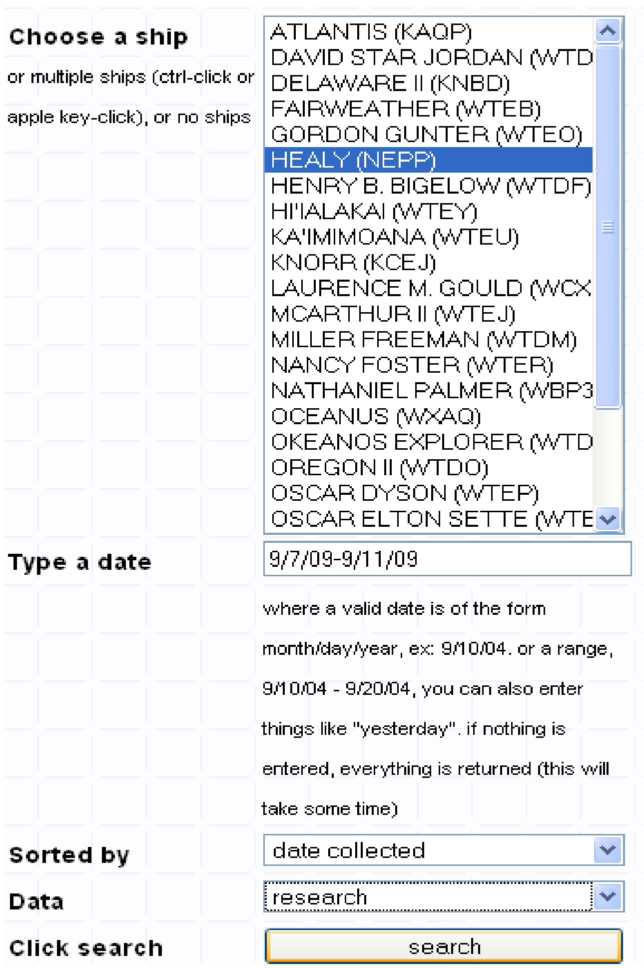


Data Access

Please choose a page from the following list:

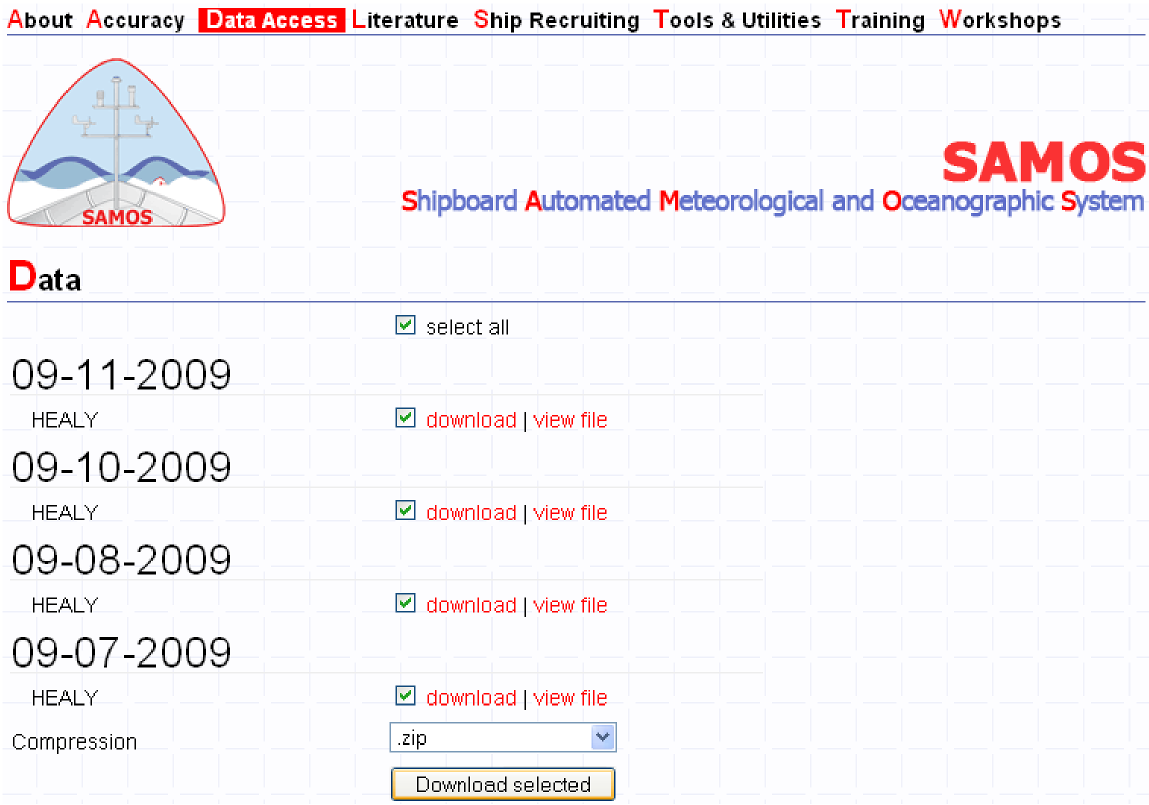
Data Availability	Time line for available data
Data Download	Access quality-evaluated shipboard meteorological data
Data Map	Plot cruise tracks of each ship on a satellite map over a selected period of time
Metadata Portal	Access ship metadata database
SAMOS Parameters	View a list of meteorological and 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:



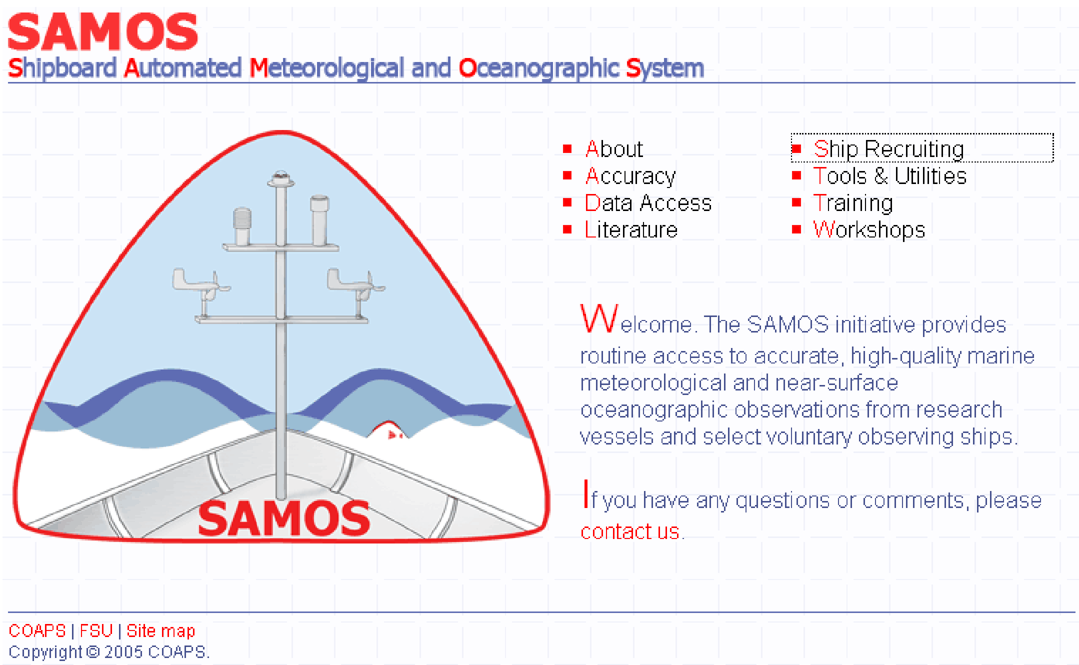
PART 2: the SAMOS operator

(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)

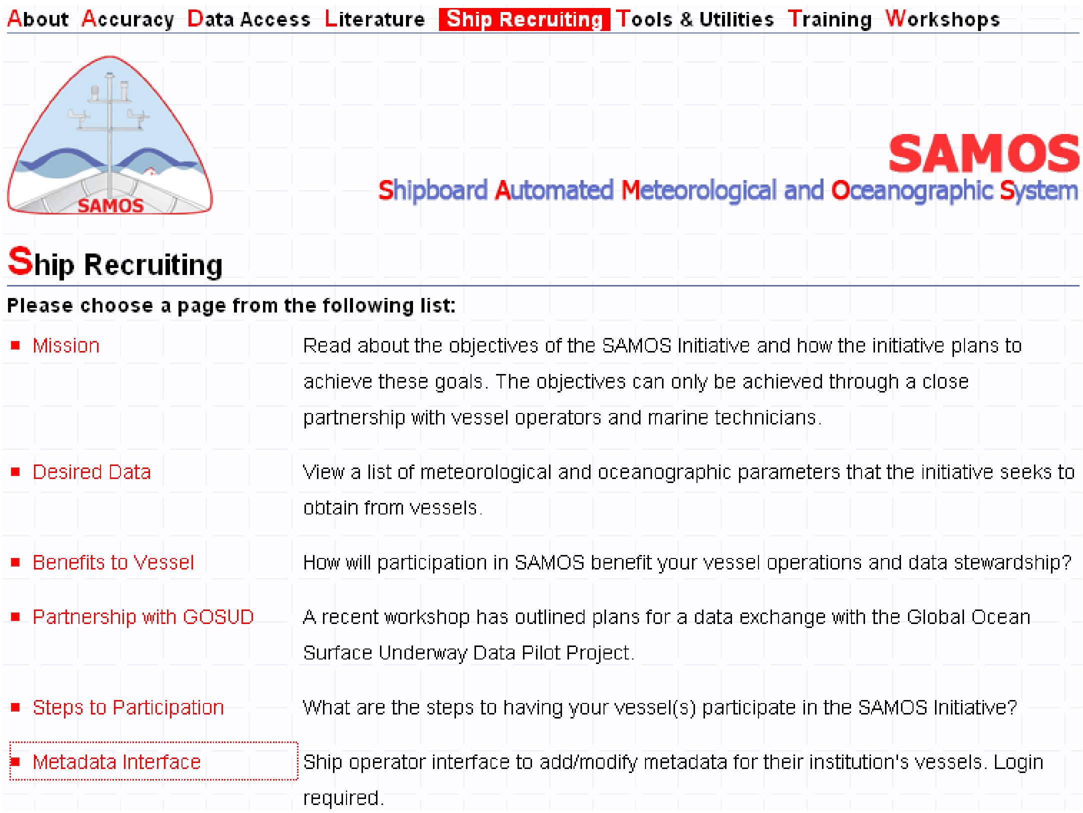
A SAMOS operator might choose to follow the steps outlined in part one as a simple way to keep tabs on the performance of his instruments. When problems are observed, vessel and instrument metadata are important tools for diagnosing a problem and finding a solution. For this reason, we strongly emphasize 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.

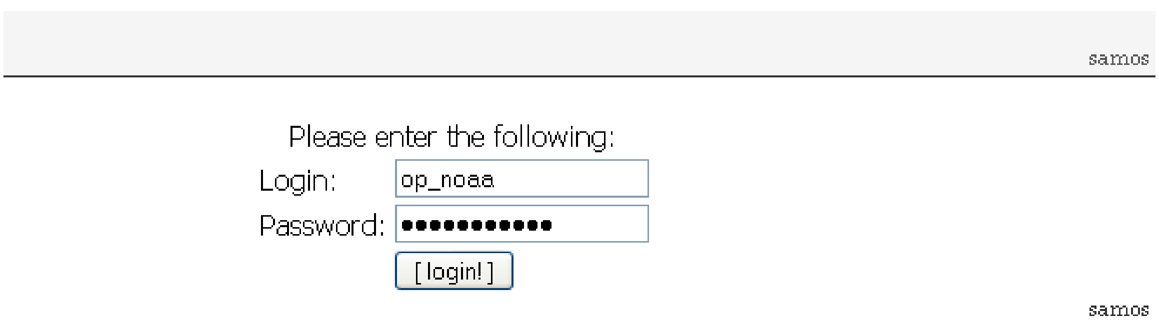
The database can be accessed by visiting the main page and choosing Ship Recruiting:



(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]

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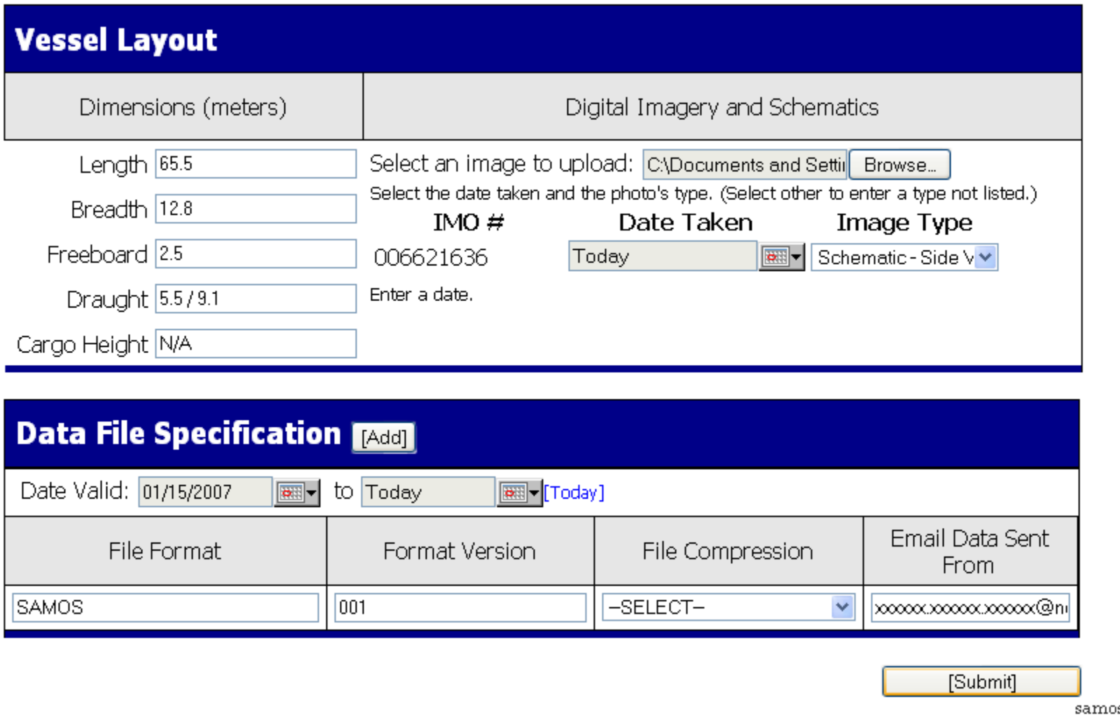
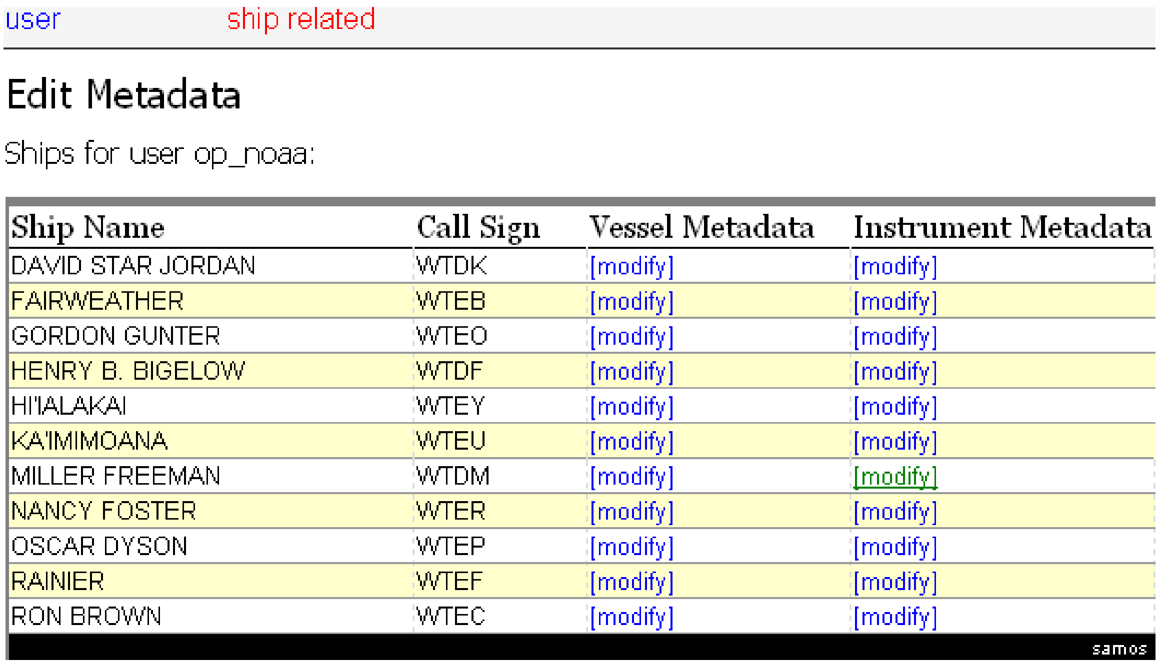
This metadata form provides Vessel Information (such as call sign and home port location), Contact Information for the home institution and shipboard technicians (as well as any other important persons), Vessel Layout, which details ship dimensions and allows for the uploading of digital imagery, and 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]

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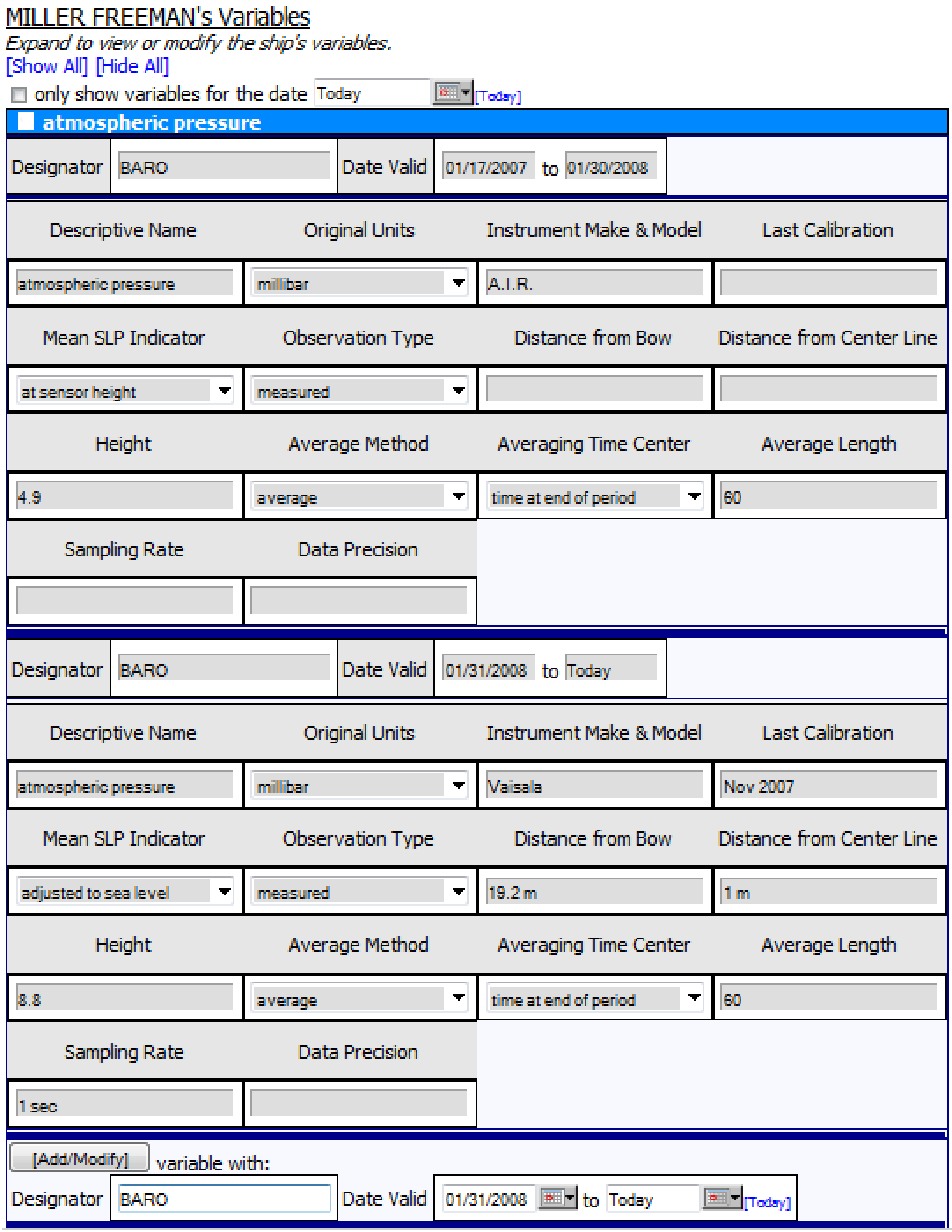
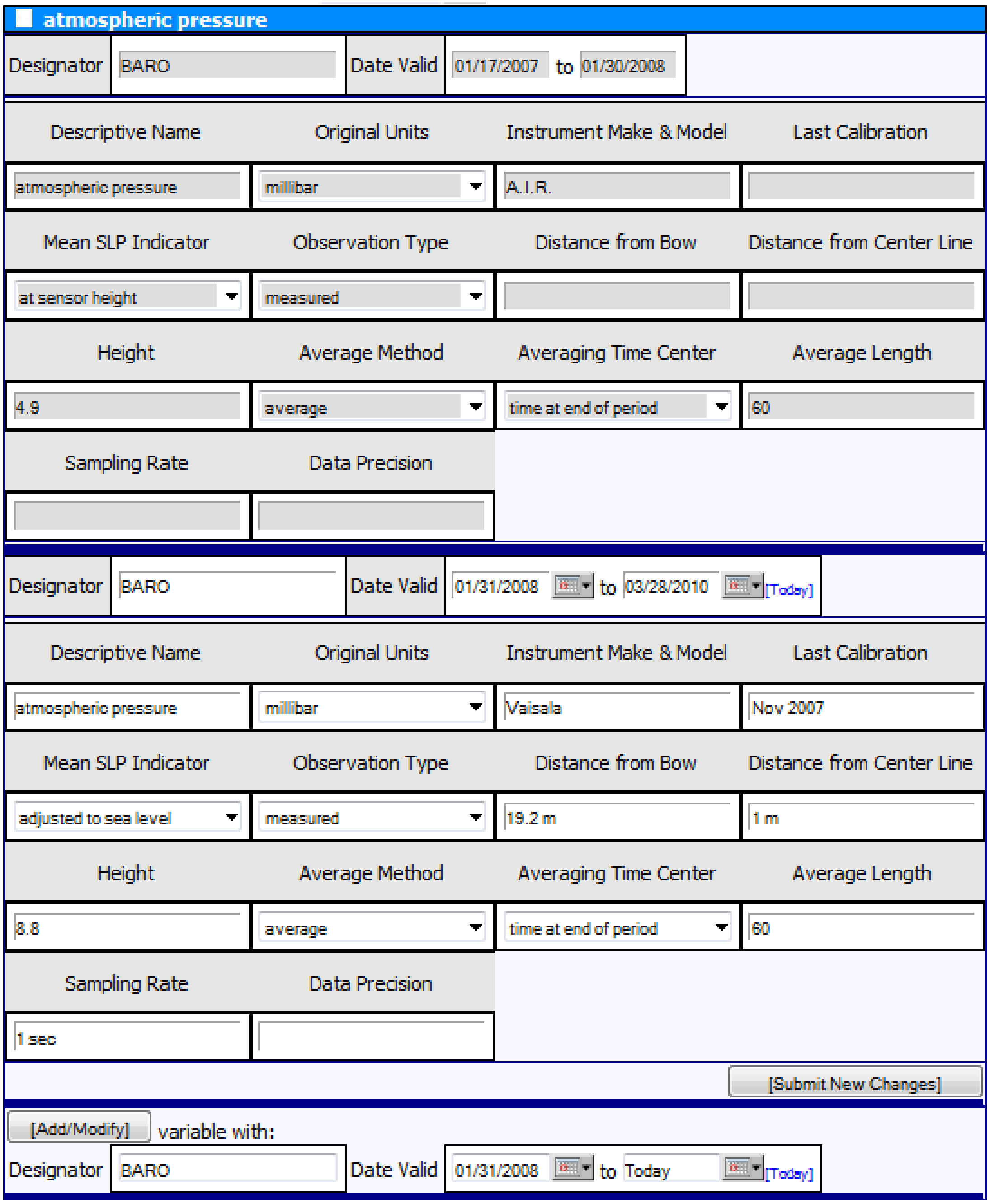
Adding and editing instrument (or parameter) metadata follow a slightly different procedure. The first step for the SAMOS operator is to identify which parameter he wishes to add or modify. Let us first consider the case of modifying a parameter already in use. Let us assume that a pressure sensor has 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:



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):


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 03/28/2010 [Today]

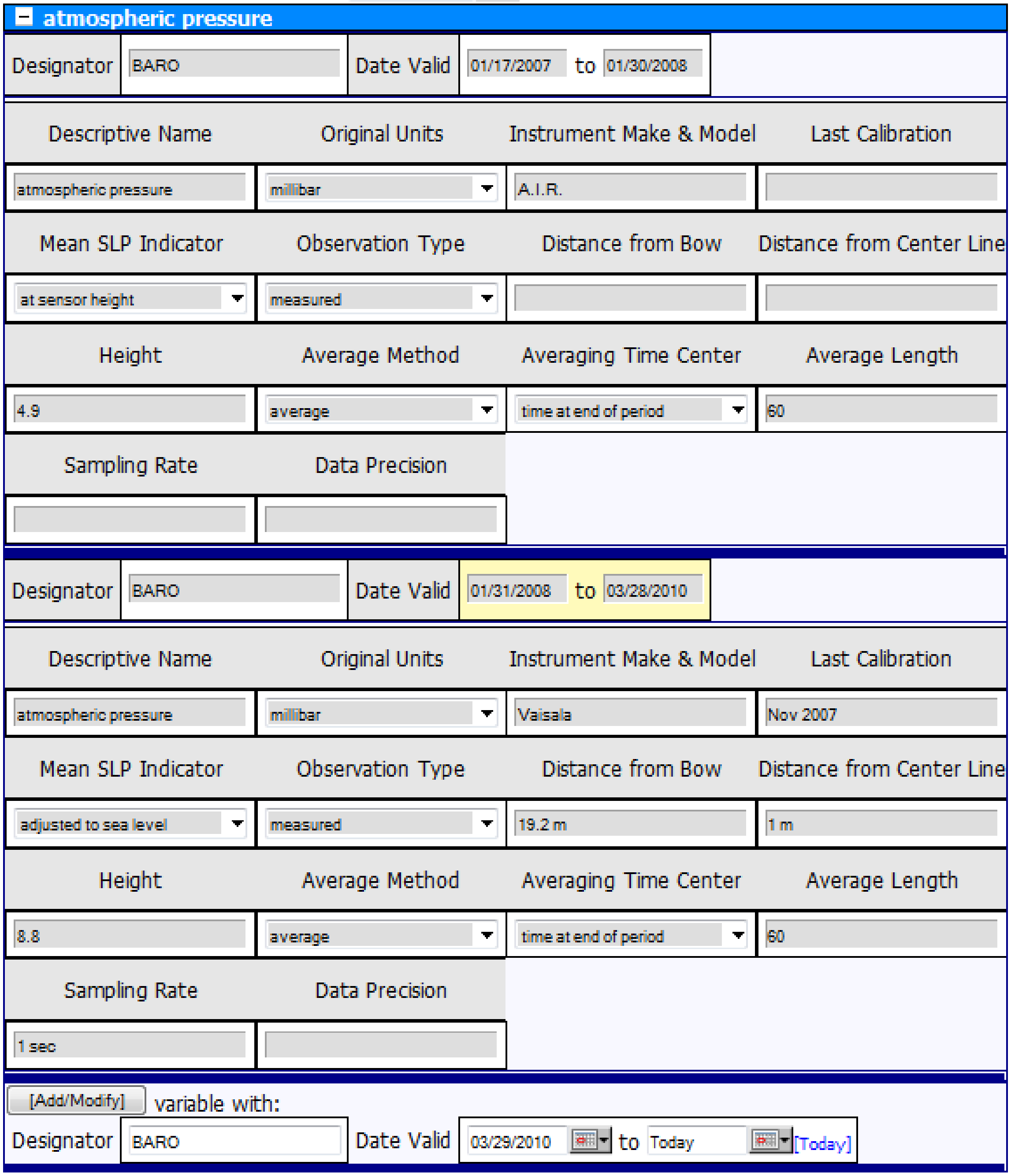
Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
atmospheric pressure	millibar	Vaisala	Nov 2007
Mean SLP Indicator	**Observation Type**	**Distance from Bow**	**Distance from Center Line**
adjusted to sea level	measured	19.2 m	1 m
Height	**Average Method**	**Averaging Time Center**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

[Submit New Changes]

[Add/Modify] variable with:

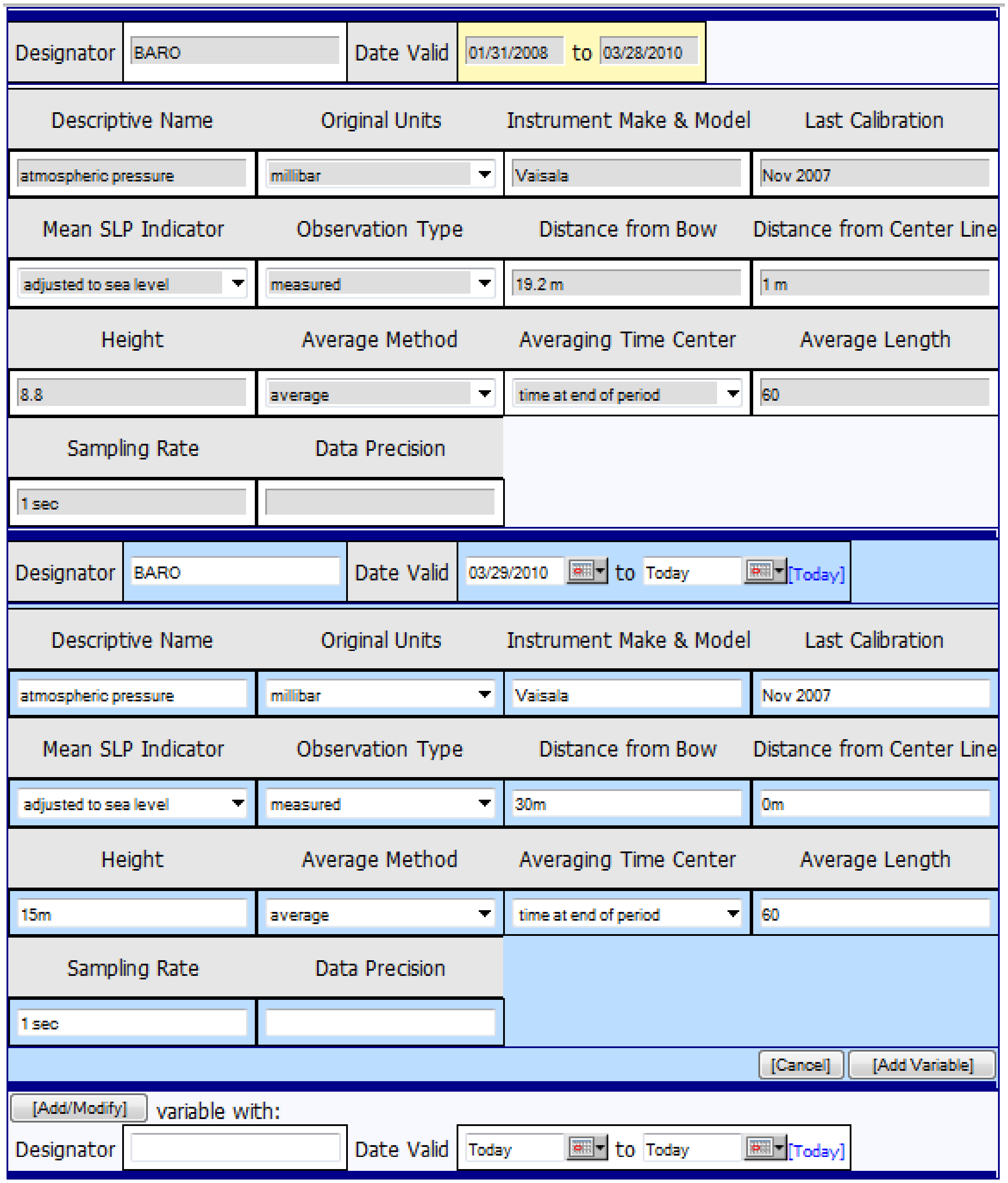
Designator	BARO	Date Valid	01/31/2008 to Today [Today]

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":



Designator	BARO	Date Valid	01/31/2008 to 03/28/2010
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			

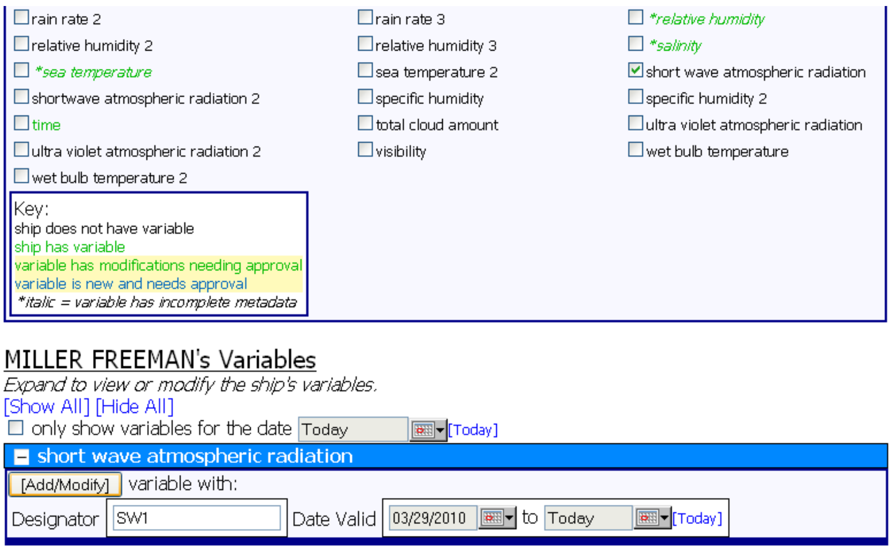
Designator	BARO	Date Valid	03/29/2010 to Today [Today]
Descriptive Name	Original Units	Instrument Make & Model	Last Calibration
atmospheric pressure	millibar	Vaisala	Nov 2007
Mean SLP Indicator	Observation Type	Distance from Bow	Distance from Center Line
adjusted to sea level	measured	30m	0m
Height	Average Method	Averaging Time Center	Average Length
15m	average	time at end of period	60
Sampling Rate	Data Precision		
1 sec			

[Cancel] [Add Variable]

[Add/Modify] variable with:

Designator | Date Valid Today to Today [Today]

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:



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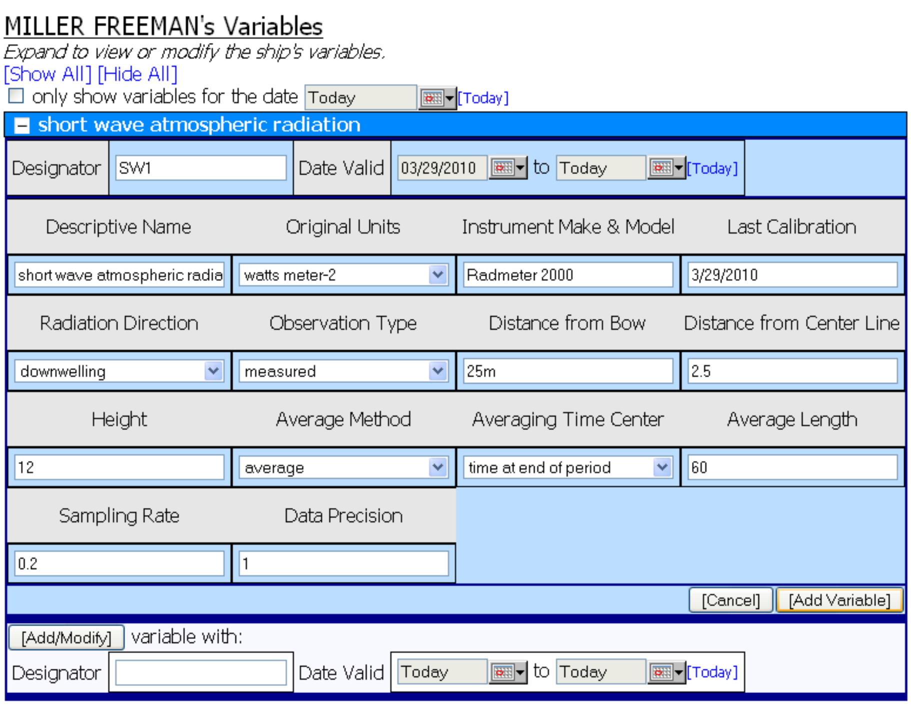
the user is immediately given the new set of fields, to be filled in as desired:



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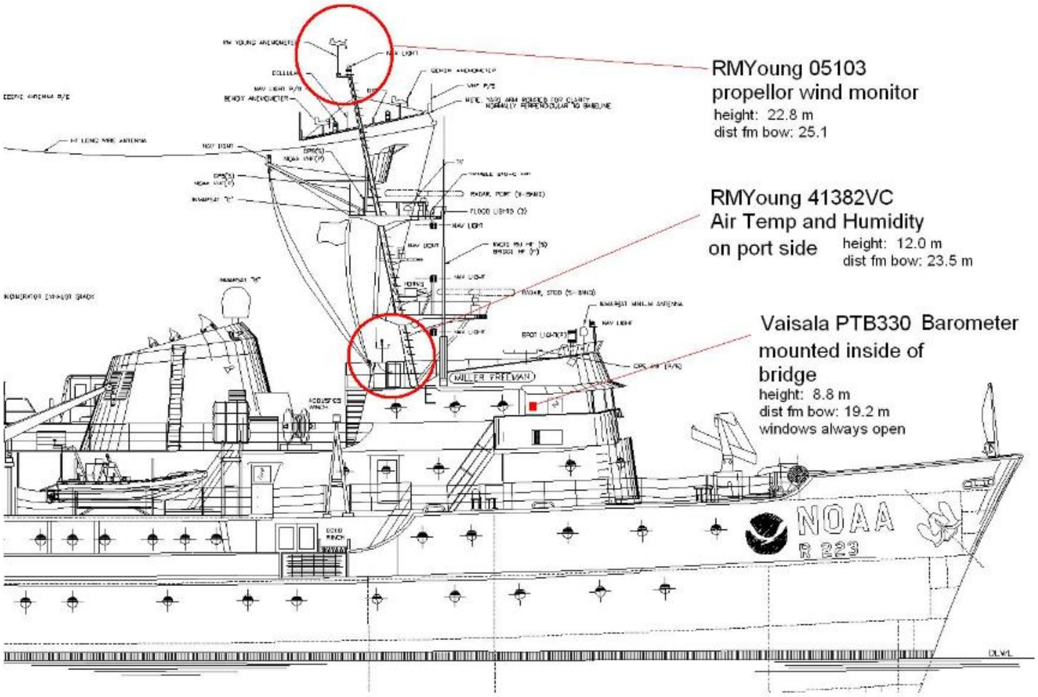
Clicking on the image itself would give us an enlarged view. In this case, the photo provides details about the locations of three MET sensors:



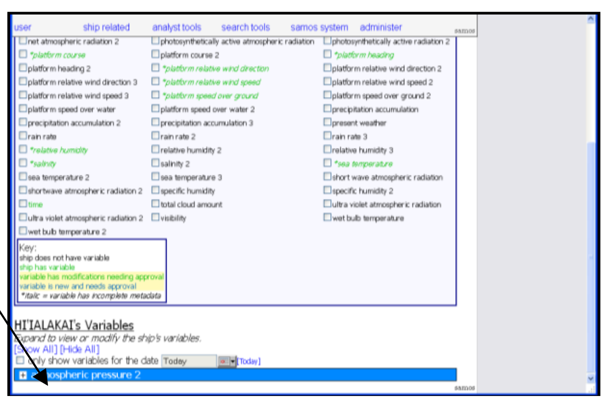
As a SAMOS user becomes familiar with following the metadata modification steps outlined in this section, chores such as adding duplicate sensors, logging sensor relocations, and keeping calibrations up-to-date become straightforward tasks. Naturally, complete and accurate metadata make for better scientific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

UPDATING SAMOS METADATA: STEP BY STEP EXAMPLE

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

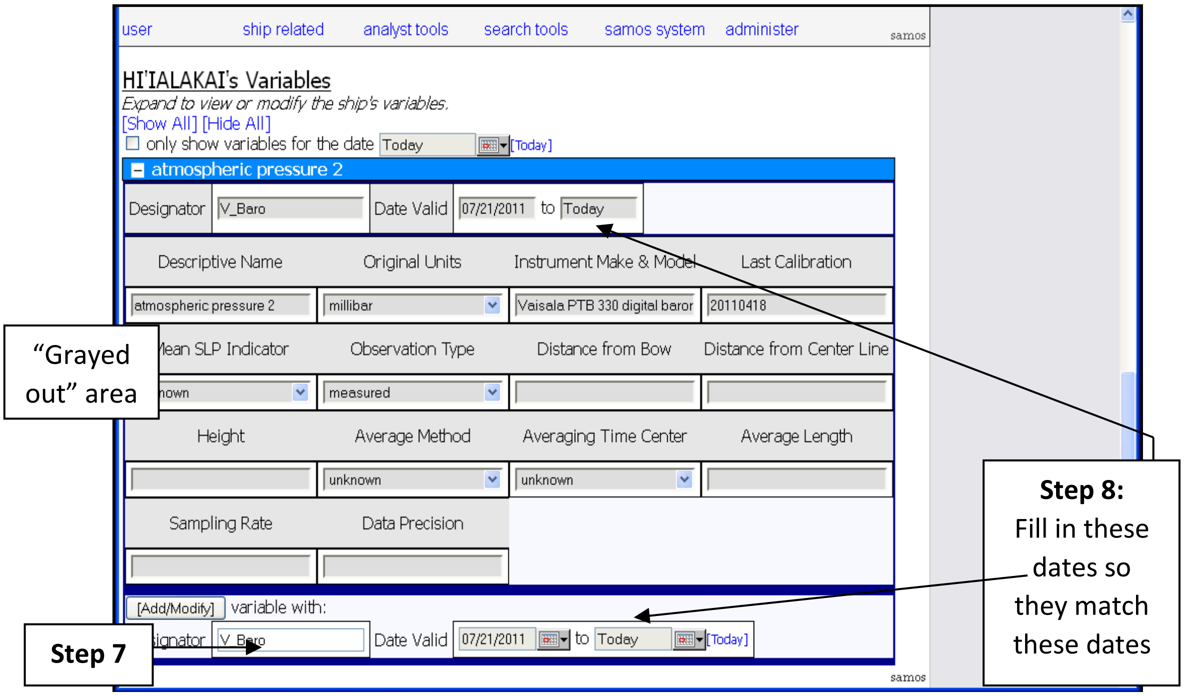
1. Go to: http://samos.coaps.fsu.edu/html/
   a. Click "Ship Recruiting"
   b. Click "Metadata Interface"
2. Enter login ID and password (case sensitive)
3. You can choose to modify Vessel or Instrument Metadata; you will likely choose Instrument. Vessel Metadata does not often change, other than the 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.



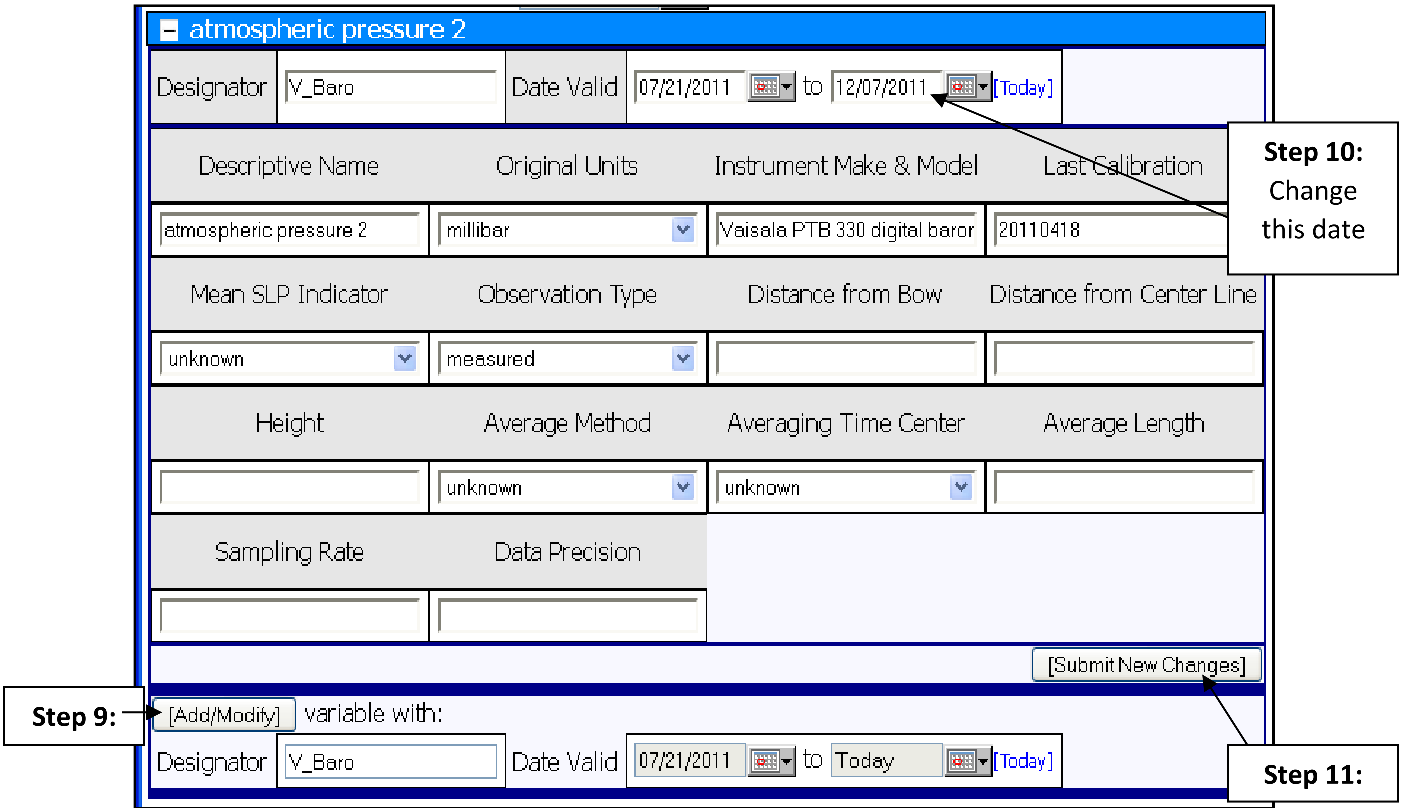
7. You first need to let the system know for which sensor you want to change information. In the box that appears at the very bottom (see image above), enter the name of the designator just at it appears in the box next to 'Designator' in the grayed out area.
   a. For the example above you would enter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

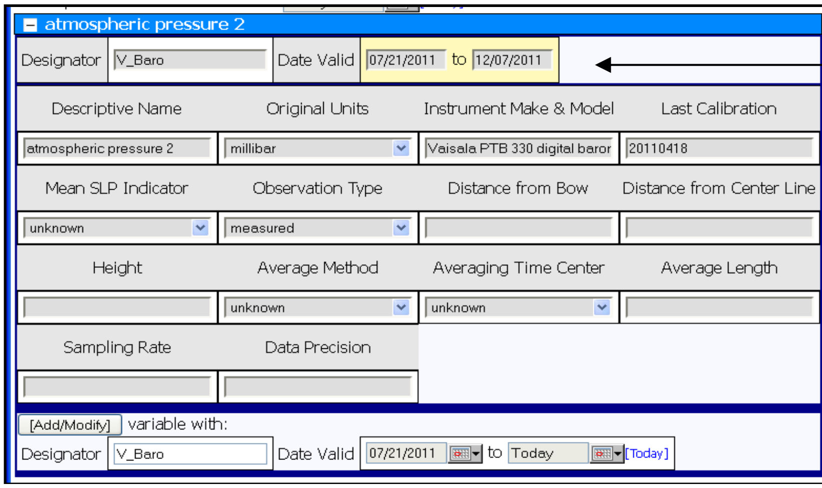
   a. This step simply closes out the current data; letting the system know the start and end dates for which the data on the screen about that sensor are valid. You will probably not change any data here; only the end date.

   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.

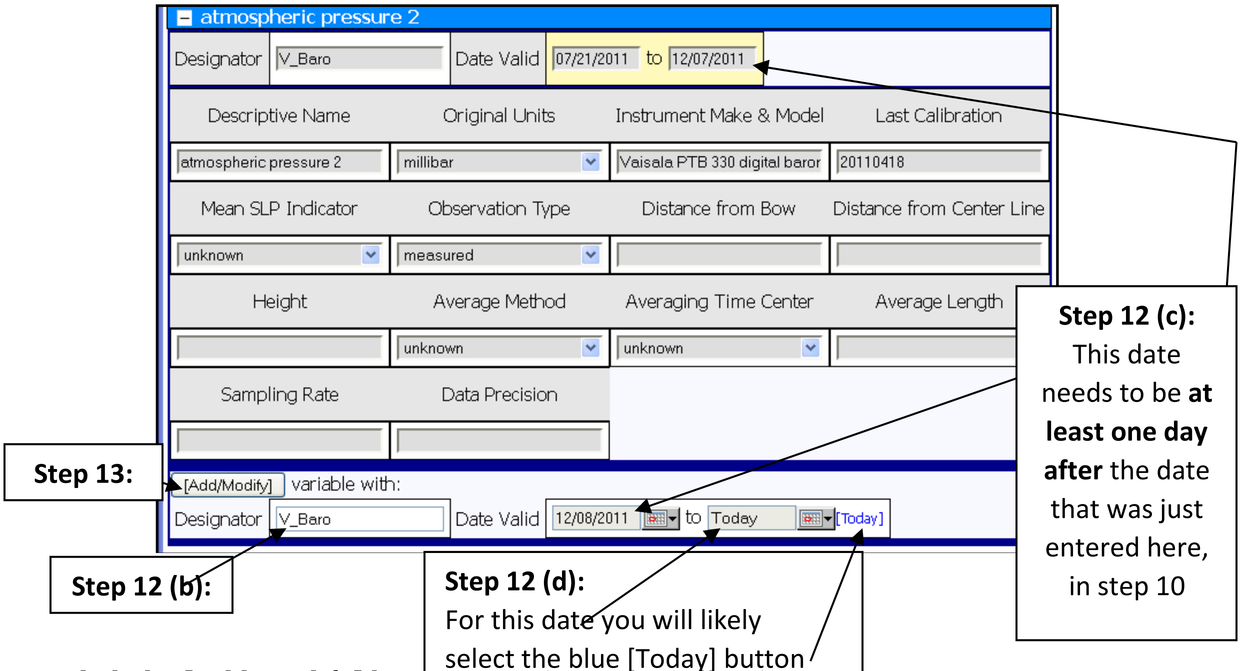
11. Click "Submit New Changes" on the bottom right of the data box (see image above)

   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).

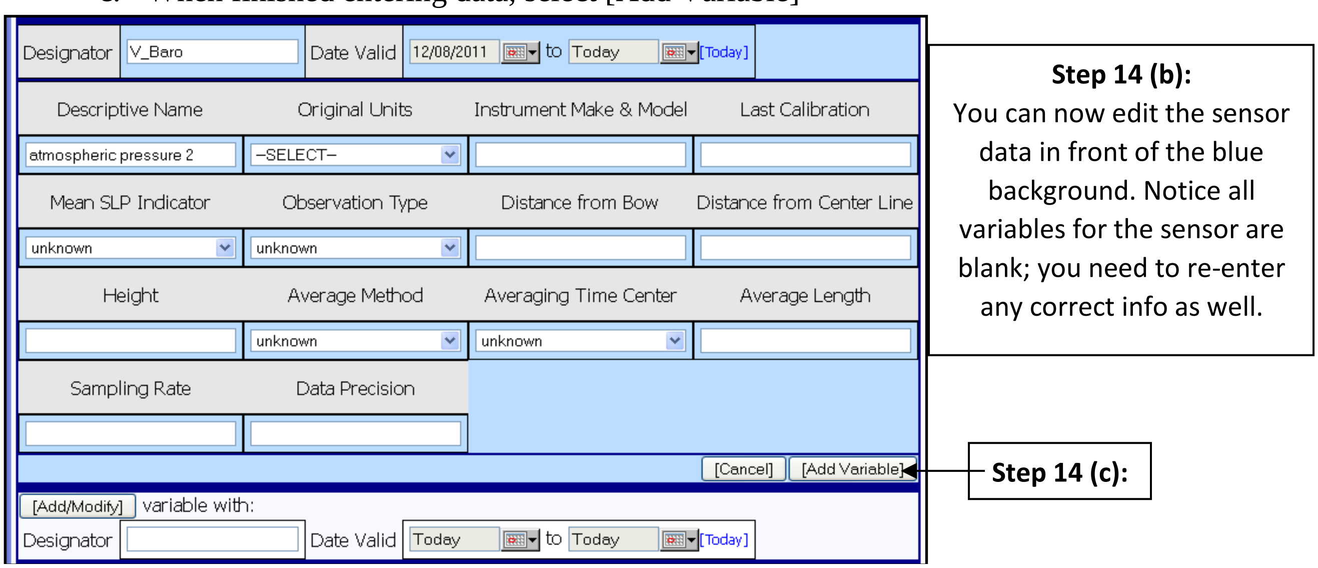
Step 11 (a):



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.

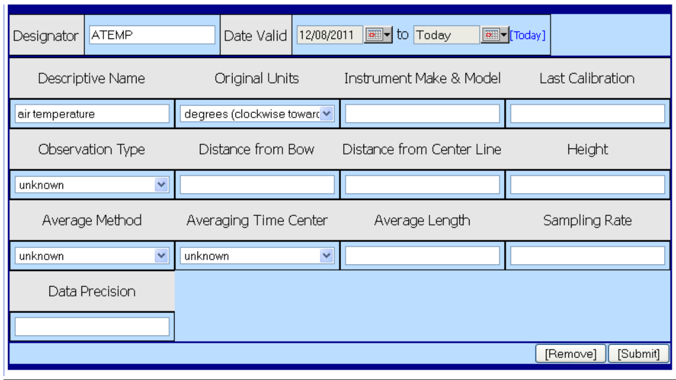


13. Click the [Add/Modify] button again (see image above)
14. You will now see a new, editable data box at the bottom of the screen that has blue around the sensor info instead of gray.
    a. Leave the Date Valid area the same
    b. You can now change the sensor data to reflect updates and add new 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