# 2011 SAMOS Data Quality Report

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## 1. Introduction

This report describes the quantity and quality of observations collected in 2011 by research vessels participating in the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative. The SAMOS initiative focuses on improving the quality of, and access to, surface marine meteorological and oceanographic data collected *in-situ* by automated instrumentation on research vessels (RVs). A SAMOS is typically a computerized data logging system that continuously records navigational (ship position, course, speed, and heading), meteorological (winds, air temperature, pressure, moisture, rainfall, and radiation), and near-surface oceanographic (sea temperature, conductivity, and salinity) parameters while the RV is underway. Measurements are recorded at high-temporal sampling rates (typically 1 minute or less). A SAMOS comprises scientific instrumentation deployed by the RV operator and typically differ from instruments provided by national meteorological services for routine marine weather reports. The instruments are not provided by the SAMOS initiative.

Data management at the SAMOS data assembly center (DAC) provides a ship-to-shore-to-user data pathway (Figure 1). Daily packages of one-minute interval SAMOS data are sent to the DAC at the Florida State University via e-mail attachment. Broadband satellite communication facilitates this transfer as near as possible to 0000 UTC daily. A preliminary version of the SAMOS data is made available via web services within five minutes of receipt. The 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. 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://www.coaps.fsu.edu/RVSMDC/html/data.shtml) and long-term archiving occurs at the US National Oceanographic Data Center (NODC).

In 2011, out of 30 active recruits, a total of 25 research vessels routinely provided SAMOS observations to the DAC (Table 1). SAMOS data providers included the National Oceanographic and Atmospheric Administration (NOAA, 12 vessels), the Woods Hole Oceanographic Institution (WHOI, 3 vessels), the United States Coast Guard (USCG, 1 vessels), Raytheon Polar Services (RPS, 2 vessels from the National Science Foundation's Antarctic Program), University of Hawaii (UH, 1 vessel), Scripps Institution of Oceanography (SIO, 2 vessels), Bermuda Institute of Ocean Sciences (BIOS, 1 vessel), the New Zealand National Institute of Water and Atmospheric Research (NIWA, 1 vessel), and the Australian Integrated Marine Observing System (IMOS, 2 vessels).  Four additional NOAA vessels – the *Delaware II*, the *Fairweather*, the *Miller Freeman*, and the *Rainier* – and one additional USCG vessel – the *Polar Sea* – were active in the SAMOS system but for reasons beyond the control of the SAMOS DAC (e.g., extended repairs, caretaker status, etc.) were unable to contribute data in 2011.

IMOS is an initiative to observe the oceans around Australia (see 2008 reference). One component of the system, the "IMOS underway ship flux project" (hereafter referred to as IMOS), is modelled on SAMOS and obtains routine meteorological and surface-ocean observations from one New Zealand (*Tangaroa*) and two Australian (*Aurora Australis* and *Southern Surveyor*) RVs. In addition to running a parallel system to SAMOS in Australia, IMOS is the only international data contributor to SAMOS.
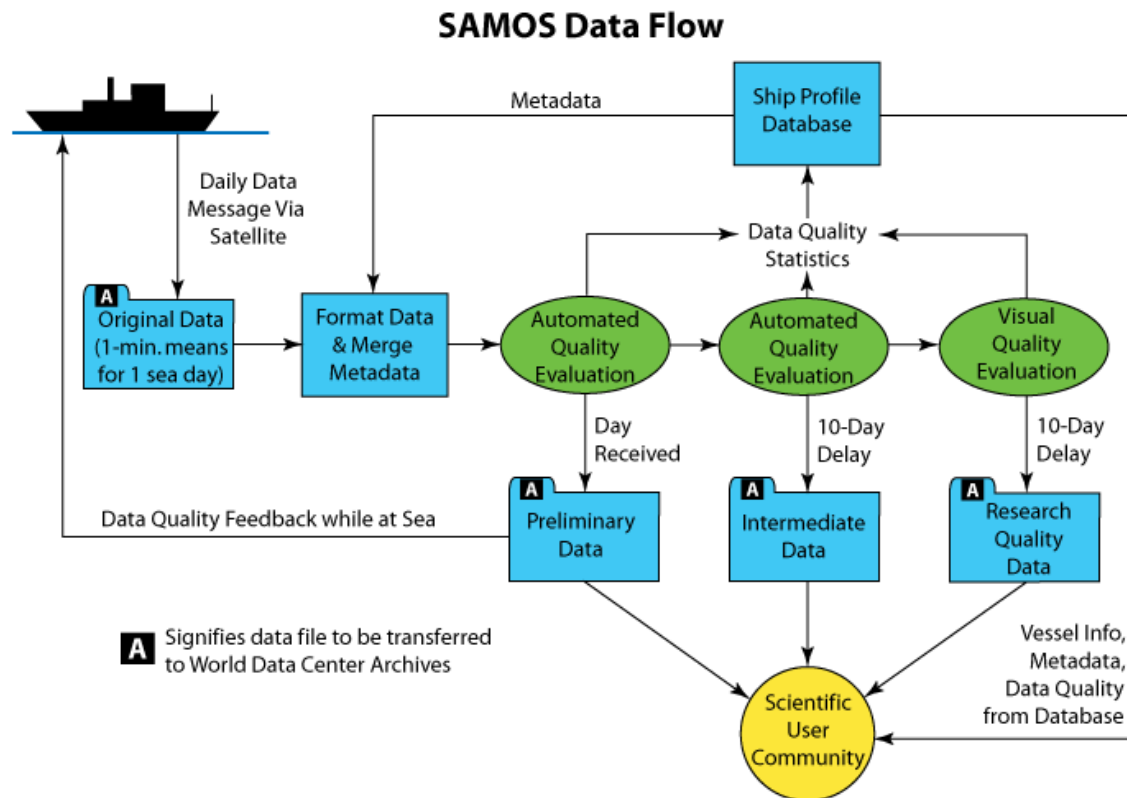
## SAMOS Data Flow



Figure 1: Diagram of operational data flow for the SAMOS initiative in 2011.

The quality results presented herein are from the research quality products, with the exception of data from the *Southern Surveyor, Aurora Australis, Tangaroa, Kilo Moana, Atlantic Explorer, Roger Revelle, Melville,* and the USCGC *Polar Sea*. In the case of the *Southern Surveyor*, *Aurora Australis,* and *Tangaroa*, the IMOS project conducts their visual QC (only automated QC for these vessels occur at the SAMOS DAC). For the *Polar Sea, Kilo Moana, Roger Revelle, Melville,* and *Atlantic Explorer*, current funding does not extend to cover visual QC of their data.  During 2011, 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 that remained problematic for most or all of 2011 (namely, the relative humidity sensor onboard the *Nancy Foster* and the photosynthetically active radiation sensor onboard the *Gould*), unmonitored transmission of erroneous data during the *Atlantis* dry dock period, a sudden, unannounced SAMOS data format change from the *Palmer* that necessitated

some quick legwork and backlogging of data, and mis-assigned units or designators in the metadata, such as occurred with the *Atlantis* and the *Healy*. On a positive note, the long-standing issue with the atmospheric pressure sensor onboard the *Hi'ialakai* was finally fixed on 30 August. There was also a productive teleconference between Shawn Smith (lead investigator on the SAMOS project), two SAMOS data analysts, and core NOAA personnel in July 2011 that led to plans to address other major vessel issues and the recruitment of new NOAA vessels coming on line in 2012.

This report begins with an overview of the vessels contributing SAMOS observations to the DAC in 2011 (section 2). The overview treats the individual vessels as part of a surface 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. A 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 2012. Annexes include web interface instructions for accessing SAMOS observations (Annex A, part 1) and metadata submission by vessel operators (Annex A, part2).

## 2. System review

In 2011, a total of 30 research vessels were under active recruitment to the SAMOS initiative; 25 of those vessels routinely provided SAMOS observations to the DAC (Table 1). The NOAA ship *Rainier* was not routinely sailing in 2011 as it was in the final phase of an extensive major repair period (C. Daniels, personal communication, 2012). The lack of any data in 2011 from the *Rainier* indicates to the SAMOS DAC that she never deployed in 2011. The *Polar Sea* has been placed in caretaker status by the USCG and did not deploy in 2011. Her status for 2012 is uncertain. The reasons for our not receiving data in 2011 from the *Delaware II*, *Fairweather*, and *Miller Freeman* are unknown, but there was some mention of an extended dry dock period for the *Miller Freeman* during our July meeting with OMAO.

In total, 4,568 ship days were received by the DAC for the January 1 to December 31 2011 period, resulting in 6,173,588 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 6,173,588 records received in 2011, a total of 134,192,147 distinct measurements were logged. Of those, 8,609,462 were assigned A-Y quality control flags – around 6.4 percent, a marginal improvement over 2010's approximate 6.6 percent – by the SAMOS DAC (see section 3a for descriptions of the QC flags). Measurements deemed "good data," through both automated and visual QC inspection, are assigned Z flags. The authors wish to note that 2011 was the third full year during which data analysts regularly performed visual QC. With three years of experience, it is likely the data analyst's quality control methods have essentially stabilized. This may partially explain the apparent consistency of overall data quality from 2010 to 2011. Additionally, recall that seven of the SAMOS vessels (the *Southern Surveyor, Aurora Australis, Tangaroa, Roger Revelle, Melville, Kilo Moana,* and the *Atlantic Explorer*) only underwent automated QC. (This is an increase over 2010's five SAMOS vessels that only underwent automated QC.) None of these vessels' data was assigned any additional flags, nor were any automatically assigned flags removed via visual QC, which may also contribute to the balance.

| SHIP NAME | CALL SIGN | Days at Sea | Tot. Days Reported Afloat | # of Days | # of Vars | # of Records | # of A-Y Flags | # of All Flags |
|---|---|---|---|---|---|---|---|---|
| TOTAL | - | - | - | 4,568 | 527 | 6,173,588 | 8,609,462 | 134,192,147 |
| ROGER REVELLE | KAOU | 269 | 325 | 200 | 25 | 285,529 | 268,685 | 6,956,828 |
| ATLANTIS | KAQP | 187 | 222 | 264 | 34 | 370,510 | 1,029,471 | 12,008,228 |
| KNORR | KCEJ | 264 | 354 | 334 | 29 | 468,100 | 652,080 | 13,574,900 |
| DELAWARE II | KNBD | - | - | 0 | 14 | - | - | - |
| HEALY | NEPP | | | 211 | 27 | 300,628 | 673,016 | 7,708,734 |
| POLAR SEA | NRUO | | | 0 | 22 | - | - | - |
| SOUTHERN SURVEYOR | VLHJ | 162 | 364 | 153 | 29 | 195,571 | 196,091 | 5,661,658 |
| AURORA AUSTRALIS | VNAA | 170 | 220 | 195 | 30 | 258,898 | 183,067 | 7,360,788 |
| NATHANIEL B. PALMER | WBP3210 | - | 243 | 188 | 23 | 265,285 | 307,042 | 4,690,643 |
| LAURENCE M. GOULD | WCX7445 | - | 238 | 328 | 23 | 472,320 | 1,502,634 | 10,863,360 |
| KILOMOANA | WDA7827 | 251 | 279 | 312 | 22 | 408,917 | 83,108 | 8,798,857 |
| ATLANTIC EXPLORER | WDC9417 | 170 | 242 | 163 | 21 | 187,825 | 106,535 | 3,938,088 |
| MELVILLE | WECB | 269 | 306 | 30 | 19 | 38,407 | 19,209 | 729,733 |
| HENRY B. BIGELOW | WTDF | - | - | 148 | 18 | 185,590 | 224,658 | 3,178,908 |
| OKEANOS EXPLORER | WTDH | - | - | 109 | 16 | 145,472 | 200,421 | 2,327,387 |
| PISCES | WTDL | - | - | 157 | 15 | 211,148 | 352,796 | 3,100,712 |
| MILLER FREEMAN | WTDM | - | - | 0 | 16 | - | - | - |
| OREGON II | WTDO | - | - | 156 | 14 | 197,790 | 79,438 | 2,769,060 |
| FAIRWEATHER | WTEB | - | - | 0 | 14 | - | - | - |
| RONALD H. BROWN | WTEC | - | - | 97 | 16 | 129,866 | 43,253 | 2,077,853 |
| OSCAR ELTON SETTE | WTEE | - | - | 147 | 16 | 194,892 | 101,656 | 3,069,587 |
| RAINIER | WTEF | - | - | 0 | 14 | - | - | - |
| MCARTHUR II | WTEJ | - | - | 84 | 16 | 111,046 | 107,646 | 1,726,631 |
| GORDON GUNTER | WTEO | - | - | 201 | 16 | 278,096 | 205,889 | 4,421,965 |
| OSCAR DYSON | WTEP | - | - | 141 | 16 | 185,645 | 135,917 | 2,930,531 |
| NANCY FOSTER | WTER | - | - | 132 | 17 | 165,820 | 248,392 | 2,762,595 |
| KA'IMIMOANA | WTEU | - | - | 190 | 19 | 259,204 | 128,697 | 4,187,574 |
| HI'IALAKAI | WTEY | - | - | 122 | 17 | 150,311 | 259,678 | 2,377,169 |
| OCEANUS | WXAQ | 201 | 296 | 307 | 32 | 422,128 | 1,193,573 | 12,136,648 |
| TANGAROA | ZMFR | | | 199 | 17 | 284,590 | 306,510 | 4,833,710 |

Table 1: CY2011 summary table showing (column three) number of vessel days reported specifically at sea by institution, (column four) total number of vessel days reported afloat in general by institution, (column five) number of vessel days received by the DAC, (column six) number of variables reported per vessel, (column seven) number of records received by DAC per vessel, (column eight) total incidences of A-Y flags per vessel, (column nine) total incidences of A-Z flags per vessel. A "–" denotes information not available.

### a. Temporal coverage

As shown in Table 1, the number of files received by the DAC from each vessel is rarely equal to the number of days reportedly at sea or even merely afloat. (*Note that complete CY2011 schedule information was not obtainable for the USCGC *Healy* and *Polar Sea*, nor the *Tangaroa*, nor any of the enrolled NOAA vessels prior to this report distribution.) Days "afloat" 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. However, when a vessel is reportedly "at sea" and we have not received underway data, we endeavor to reclaim any available data, usually via email communication with vessel technicians and/or lead contact personnel. (Annex B offers examples of operator/analyst interaction and demonstrates the extreme usefulness of ongoing communication.) For this reason we perform visual QC on a 10 day delay. SAMOS data analysts strive to follow each vessel's time at sea by focusing on continuity between daily files and utilizing online resources (when available), but as ship scheduling is subject to change and in some cases is unavailable in real time, we may be unaware a vessel is at sea until well after the 10 day delay period. An automated reporting service is currently in development that would, among other things, provide interested parties with a summary of ship days received by the DAC for each vessel. This product would likely be in comma-separated values format and would be emailed out automatically at the end of every month, the intent being that files that were "missed" can be identified

and manually sent to the DAC.  It should be noted, however, that current funding for the SAMOS initiative would not permit the visual quality control of a large number of "late" files, so it is important that vessel operators and SAMOS data analysts do their best to ensure files are received within the 10 day delayed-mode window.

In Figure 2, we compare the data we've received (green and blue) to final 2011 ship schedules provided by each vessel's institution.  (*Note again that the schedules were not obtained for the *Tangaroa,* the USCGC *Healy* and *Polar Sea*, or any of the NOAA vessels.)   A "blue" day denotes that the data file was received well past the 10 day delayed-mode window and thus missed timely processing and visual quality control, although processing (and visual QC where applicable) were 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 institutions schedule for which no data was received by the DAC are shown in grey. Within the grey boxes, an italicized "*S*" indicates a day reportedly "at sea."  It should be noted that the *Tangaroa* (ZMFR) was not recruited and made active in the SAMOS system until late April 2011, and likewise the *Roger Revelle* (KAOU) and the *Melville* (WECB) in early June 2011, such that any preceding "at sea" days would not be anticipated to be in the SAMOS data system.  Through agreement with IMOS, we receive data for the *Tangaroa, Southern Surveyor,* and the *Aurora Australis* and for these vessels perform automated QC only.  IMOS data is visually evaluated in Australia and archived within the IMOS DAC-eMarine Information Infrastructure (eMII).
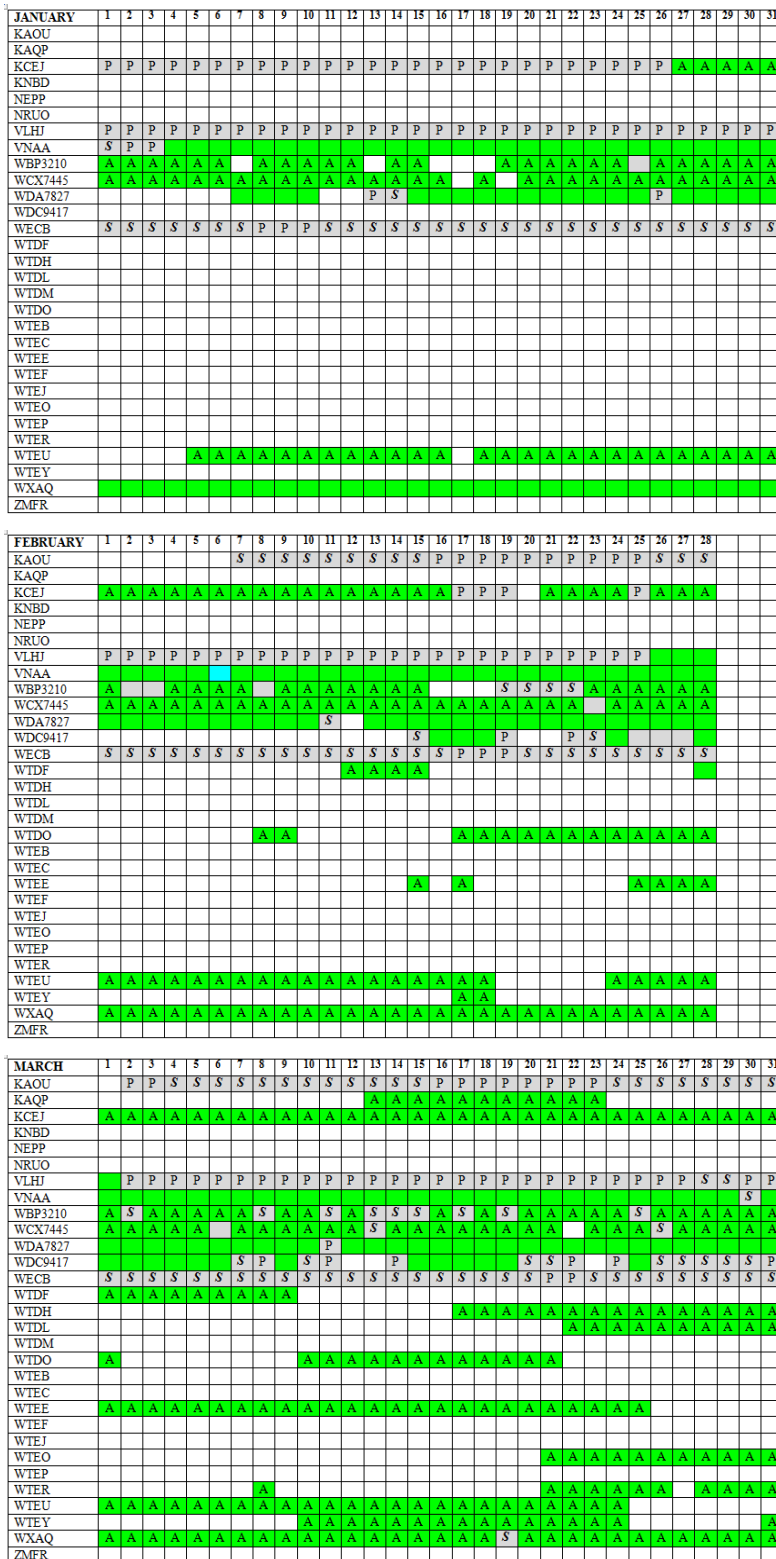
Figure 2: 2011 calendar showing (green and blue) ship days received by DAC and (grey) additional days reported afloat by vessels; "A" denotes data has been archived at NODC, "S" denotes vessel reportedly at sea, "P" denotes vessel reportedly at port. Vessels are listed by call sign (see Table 1).

**APRIL**

| APRIL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | P | P | P | P | P | P | P | P | P | P | P | P | P | S | S |
| KAQP | | | | | | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | S | S | S | S | | | | | | | | | | | | S | | | | | | P | P | P | P | | | P | P | P |
| VNAA | | | | | S | | | | | | | | | | | P | S | | | | | | | | | | | | | |
| WBP3210 | S | A | A | S | A | A | A | A | A | A | A | A | A | A | A | A | A | S | S | S | A | S | S | | | | | | | |
| WCX7445 | A | A | A | S | S | S | S | A | A | A | A | A | S | A | A | A | A | A | A | A | A | S | S | A | A | A | A | A | | |
| WDA7827 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WDC9417 | | | | | P | | | P | | P | P | P | | | P | P | | | | | | | P | | | | | P | | |
| WECB | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | P | P | P | P | P | S | S | |
| WTDF | | | | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | |
| WTDH | | | | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | |
| WTDL | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | | | | | | A | A | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | | | | | | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEE | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEO | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | |
| WTEP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTER | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | |
| WTEU | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | |
| WTEY | A | | | | | | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | A | | | | | | A | | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**MAY**

| MAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | P | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | P | P | P | | | | | | | | | | S | | | | | | | | | | | | | | | | | | |
| VNAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WBP3210 | | | | | | | | | A | A | A | A | A | | A | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WCX7445 | A | A | A | A | A | S | A | A | A | | A | A | A | A | A | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WDA7827 | | | | | | | | | | | | | | | | P | P | P | P | | | | | | | | | | | | |
| WDC9417 | P | | | S | P | | | | | P | | | | P | | | | | P | | | P | P | P | | | | | | | |
| WECB | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | P | P | S |
| WTDF | | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | |
| WTDH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDL | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | A | A | A | A | | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | |
| WTEO | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | |
| WTEP | | | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | A | | | |
| WTER | A | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | | A | | | | | |
| WTEU | | | | | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | |
| WTEY | A | A | A | A | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | S | S | S | P | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**JUNE**

| JUNE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | S | S | S | S | P | P | P | P | S | S | S | | | | | | | | | | | | | S | | | | | | |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | | | | | S | | | | | | | | S | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| VNAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WBP3210 | A | A | A | | | A | A | A | | | | | | | | | | | | | | S | S | | | | | | | |
| WCX7445 | A | A | | A | A | A | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | | A | A | | A | | | | |
| WDA7827 | | | | | | | P | P | | | | | | | | | | | | | | | | | | | | | | |
| WDC9417 | | | | | | | | S | P | P | | | | | | | | | S | P | | | | P | | | S | P | P | |
| WECB | S | S | S | S | S | S | S | S | S | S | S | P | P | | | | | | | | | | | S | | | | | | |
| WTDF | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | A | A |
| WTDH | | | | | | | | | A | A | A | A | A | A | | A | A | A | A | A | | | | | | | | | | |
| WTDL | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | A | A | A | A | A | A | A | | |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | | | | | | A | A | A | A | | | | | | | | | | | | | A | A | A | A | A | A | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | |
| WTEO | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | | |
| WTEP | A | A | A | A | A | A | A | A | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTER | | | | | | | | | | | | | | | | A | | | | | | | | | | | | | | |
| WTEU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

(Figure 2: cont'd)

**JULY**

| JULY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | | S | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | S |
| VNAA | | | | | | | | | | | | | | | | | | | S | S | S | S | P | S | S | S | S | S | S | S | S |
| WBP3210 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WCX7445 | A | A | A | A | | | A | A | A | A | A | A | A | | | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A |
| WDA7827 | | | | | | | | | | | | | | | | | | P | S | S | S | P | S | S | S | S | S | S | S | S | S |
| WDC9417 | | P | | P | | | | | | | S | P | | | | P | P | P | S | P | P | | | | | | | | | | |
| WECB | | | | | | | | | | | | | | | | | | | P | | | | | | | | P | S | S | S | S |
| WTDF | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTDH | A | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | A | A | A |
| WTDL | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | A | A | A | A |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | A | A | | | A | A | A | A | A | A | A | A | A | A | | | | | | | | | A | A | A | A | A | A | A | A | A |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEE | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | A |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEO | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | |
| WTER | | | | | | | | | | | | | | | | | | | A | A | | | | A | A | A | A | A | A | A | A |
| WTEU | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEY | | | | | | | A | A | A | A | A | A | A | A | | | | | | | | | | A | A | A | A | A | A | A | A |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | S | S | S | S |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**AUGUST**

| 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 | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | | | | | | | S | S | S | S | P | | | | | | | | | | S | P | P | | | | | | | | |
| VNAA | S | S | S | S | S | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WBP3210 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WCX7445 | A | A | A | A | A | A | A | | A | A | S | A | A | S | A | A | A | A | S | A | A | A | A | A | A | A | A | A | A | A | A |
| WDA7827 | S | S | S | S | S | S | S | S | S | S | | | | | | | | | S | | | | | P | | | | | | | |
| WDC9417 | | | | P | | | | | | | | | | | | P | | | | | | | P | | | | | | | | |
| WECB | S | S | S | S | P | | | | | S | S | | | | | S | | | | S | S | S | S | S | S | S | S | S | S | S | P |
| WTDF | | | | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | |
| WTDH | | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | A | A | A | A | A | A | A | A | A | A | A |
| WTDL | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | A | A | A |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | A | A |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | A | A | A | |
| WTEE | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | A | A | A | A | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEO | A | A | | | | | | | | | | | | | | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEP | | | | | A | A | A | A | A | A | A | A | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A |
| WTER | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEU | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | A | A | A | A | A | A | | | | A | A |
| WTEY | A | A | A | | | A | A | A | A | A | A | | | A | A | A | A | A | | | | | | | | | | | | A | A |
| WXAQ | S | S | | | P | P | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**SEPTEMBER**

| SEPTEMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | S | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | S | P | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | | A | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | S | | | | | | | | | | | P | P | P | P | P | P | S | | | | S | | | | | | | | |
| VNAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WBP3210 | | | S | S | S | S | S | S | A | A | | | | | | | | | A | | A | A | A | A | A | | A | A | A | |
| WCX7445 | A | A | A | A | A | A | A | A | A | A | A | S | A | A | A | S | A | A | A | A | A | A | A | | A | A | A | A | A | |
| WDA7827 | | | | | | | | | | | | | | | | | | | S | | | | | | | | | | | |
| WDC9417 | | | P | | | | | P | P | P | | | | | | | | | P | P | | | P | P | P | | | | | |
| WECB | P | P | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S |
| WTDF | | | | | A | A | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | A | A | A |
| WTDH | A | A | A | A | A | A | A | A | A | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | |
| WTDL | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | A | | | | | | A | A | A | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | | | | | | | | | | | | | | | | | | | | | | A | A | A | A |
| WTEE | A | A | A | A | A | A | A | A | A | A | | | | | | A | A | A | A | A | A | A | A | A | | A | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | A | | | | A | A | A | A | A | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEO | A | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | A | A | A |
| WTEP | A | A | | A | A | A | A | A | A | A | A | A | A | A | A | | | | A | A | A | A | A | A | A | A | A | | | |
| WTER | A | | | | | | | | A | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | | |
| WTEU | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | |
| WTEY | A | A | A | | | | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | A | A | A | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | A | A | A | A | A | A | A | P | | A | A | |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

(Figure 2: cont'd)

13

**OCTOBER**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | S | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | | | | | | | | | | | | | | | | | | P | P | | | | | | | | | | | | |
| VNAA | | | | | | | | | | | | | | | | | | | | S | | | | | | | | | | | |
| WBP3210 | A | A | A | A | | A | A | A | A | A | A | A | | A | A | A | A | A | A | | A | A | | | A | A | | | A | A | A | A |
| WCX7445 | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | A | A | A | A | A |
| WDA7827 | | | | | | | | | | | | | | | | | | | | | | | | | | | P | | | | |
| WDC9417 | | | | | | | | | | | | | | | | | | | | P | P | P | | | | P | | | | | |
| WECB | S | S | S | S | S | S | S | S | P | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S |
| WTDF | A | A | A | A | | | | | | A | A | A | A | A | A | A | A | A | | | | | | | A | A | A | A | A | A | A |
| WTDH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDL | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | | | | | | A | A | A | A | A | | | A | A | A | A | A | A | A | A | | | A | A | A | A | A | A | A | A | A |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | |
| WTEE | | | | | | | | | | | | | | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEO | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEP | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | A | A | A | A | A | A | A | A | A | A | A | A | | |
| WTER | | A | A | A | A | A | A | | | | | | A | | | | | | | | | | | | | | | | | | |
| WTEU | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WTEY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**NOVEMBER**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KAQP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | | | | | | | | | P | | | | | | | | | | | P | | | | | | | P | P | P | P |
| VNAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P | |
| WBP3210 | A | A | A | | | | | | | | | | | | | | | | A | | A | A | A | | A | A | A | A | A | A |
| WCX7445 | A | A | S | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | A | A | A | A | S | A | |
| WDA7827 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WDC9417 | | S | | | S | P | | | S | | | S | P | | | | | | | | P | | | | | | | P | | |
| WECB | P | P | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | S | P | P | P | P | P | P |
| WTDF | A | A | A | A | | | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | | |
| WTDH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDL | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | | | | A | A | A | A | A | A | A | A | A | A | | | | | | A | A | A | A | A | A | A | A | A | A |
| WTEE | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEO | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | |
| WTEP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEU | A | | | | | | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | |
| WTEY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WXAQ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | | | | | | | A |
| 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 | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KCEJ | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KNBD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NEPP | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| NRUO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLHJ | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| VNAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WBP3210 | A | A | A | A | A | A | A | A | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WCX7445 | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| WDA7827 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WDC9417 | S | | S | | | S | | | | S | P | | | | | | | | | | | | | | | | P | | | | |
| WECB | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| WTDF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDH | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTDO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEC | | | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEU | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WTEY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| WXAQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZMFR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

(Figure 2: cont'd)

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### b. Spatial coverage

Geographically, SAMOS data for 2011 is fairly comprehensive.  Cruise coverage for the January 1, 2011 to December 31, 2011 period (Figure 3) includes occurrences poleward of both the Arctic (*Healy*) and Antarctic (*Aurora Australis, Palmer,* and *Gould*) circles, additional exposure in Alaskan waters (*Oscar Dyson*), occurrences at Cape Horn, Africa and the eastern coastline of South America (*Ron Brown*), as well as the Latin American coastline (*Melville*), samples in both the Mediterranean Sea (*Atlantis*) and the Indian Ocean (*Roger Revelle*), and a sizable area in the South Pacific (*Southern Surveyor*, *Tangaroa*).  The *Knorr* also provided data from the Labrador Sea region and waters north.  Natively, the western coastal United States is covered by the *Atlantis*, and the eastern coastal United States is heavily covered by the *Henry Bigelow*, *Oceanus*, and *Gordon Gunter*, among others.  *Nancy Foster* and *Okeanos Explorer* round the southeast coastline from Louisiana to the Carolinas, while the northern Gulf of Mexico is virtually covered by the *Oregon II* and *Pisces*. Hawai'ian waters are well-sampled by the *Oscar Elton Sette* and the *Kilo Moana,* as well as the *Ka'imimoana* and *Hi'ialakai*, both of which routinely cruise to the Hawai'ian waters from their home port in Seattle.
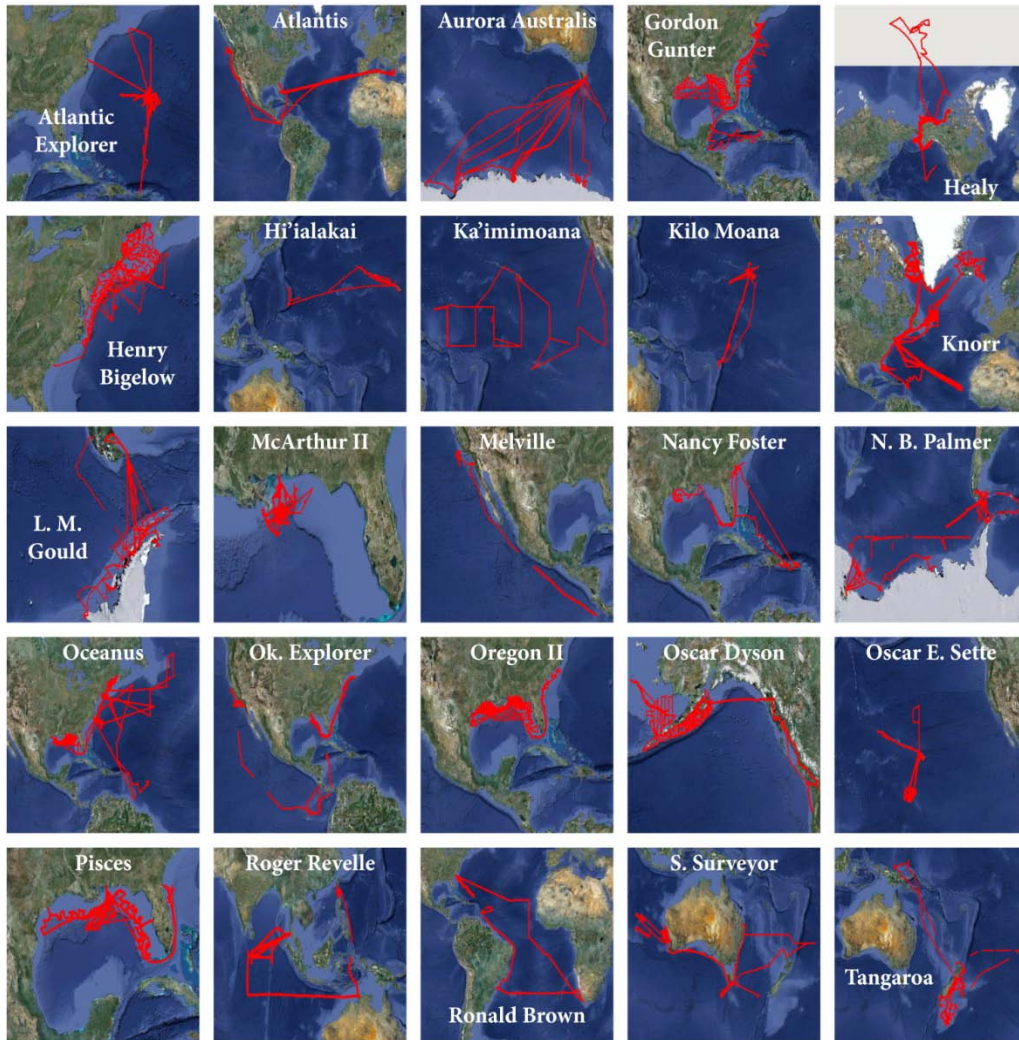


Figure 3: Cruise maps plotted for each vessel in 2011.

### c. Available parameter coverage

The core meteorological parameters – earth relative wind speed and direction, atmospheric pressure, and air temperature and relative humidity – and the oceanographic parameter sea temperature are reported by all ships. Many SAMOS vessels also report precipitation accumulation, rain rate, longwave, shortwave, net, and photosynthetically active radiations, along with sea water conductivity and salinity.  Additionally, in 2012 processing of dew point temperature was enabled by the DAC and dew point data were provided by two vessels (*Healy* and *Roger Revelle*).  A quick glance at Table 3 (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 reported and processed in 2011.  (Further detail on Table 3 is discussed in Section 4.)  Some vessels furnish redundant sensors, which can be extremely helpful for visually assessing data quality.  Again referring to Table 3, those boxes in columns 6 through 26 with multiple entries indicate the number of redundant sensors reported and processed in 2011; 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 2. It should be noted that no secondary automated QC was active in 2011 (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 don't necessarily imply a problem. The port flag is applied to indicate the vessel is in port and may be combined with flags on other parameters to note questionable data that are likely attributable to dockside structural interference or, as in the case of sea temperature, the fact that some apparatus are habitually turned off while a vessel is in port. 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 2: Definitions of SAMOS quality control flags

### b. 2011 quality across-system

This section presents the overall quality from the system of ships providing observations to the SAMOS data center in 2011. 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 good, overall (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. Two vessels, *Okeanos Explorer* and *Hi'ialakai* received a large quantity of K, J, and out of bounds (B) flags due to frequent readings that were out of range for the region of operation (see individual vessel descriptions in section 3c for details).
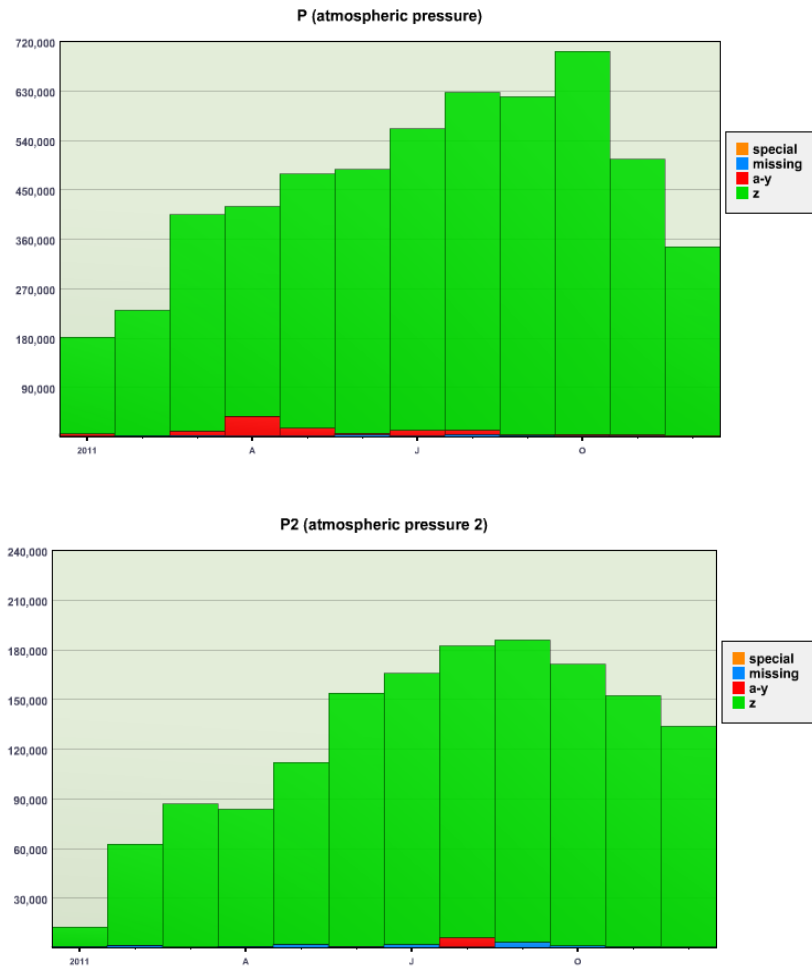


Figure 4: Total number of (top) atmospheric pressure – P – (bottom) atmospheric pressure 2 – P2 – and (next page) atmospheric pressure 3 – P3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

P3 (atmospheric pressure 3)
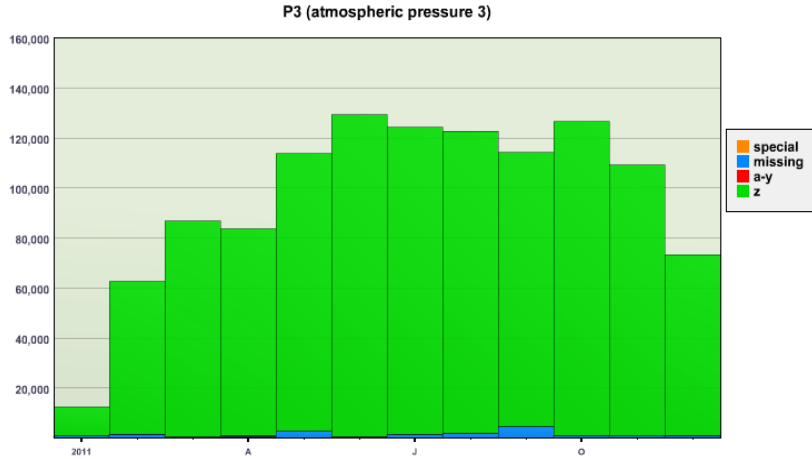
(Figure 4: cont'd)

Air temperature was also of decent quality (Figure 5). A slight increase of flagging of T in June is likely due to a 3-day T sensor failure onboard the *Gould*, and, similarly, a slight increase of flagging of T in December is likely due to a T sensor failure onboard the *Fairweather* that persisted for about a month. But for the most part, flagging occurred across multiple vessels in any given month for typical reasons. With the air temperature sensors, again flow obstruction was a primary problem. In this case, when the platform relative wind direction is such that regular flow to the sensor is blocked, unnatural heating of the sensor location can occur. Deck heating can also occur simply when winds are light and the sensor is mounted on or near a large structure that easily retains heat (usually metal). Contamination from stack exhaust was also a common problem. 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.
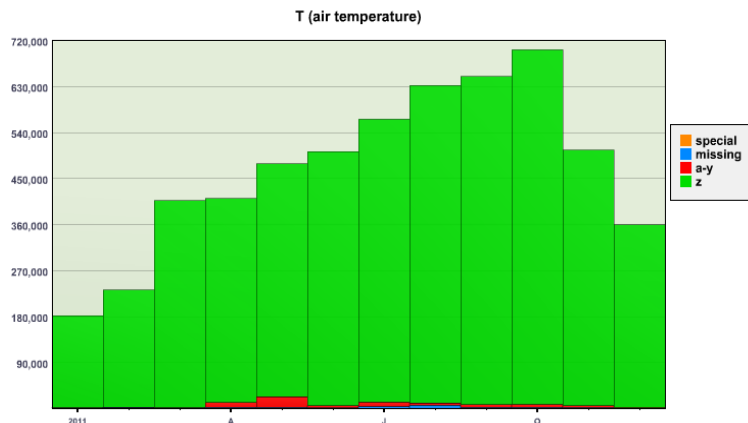


T (air temperature)

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 2011. 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.

T2 (air temperature 2)



T3 (air temperature 3)
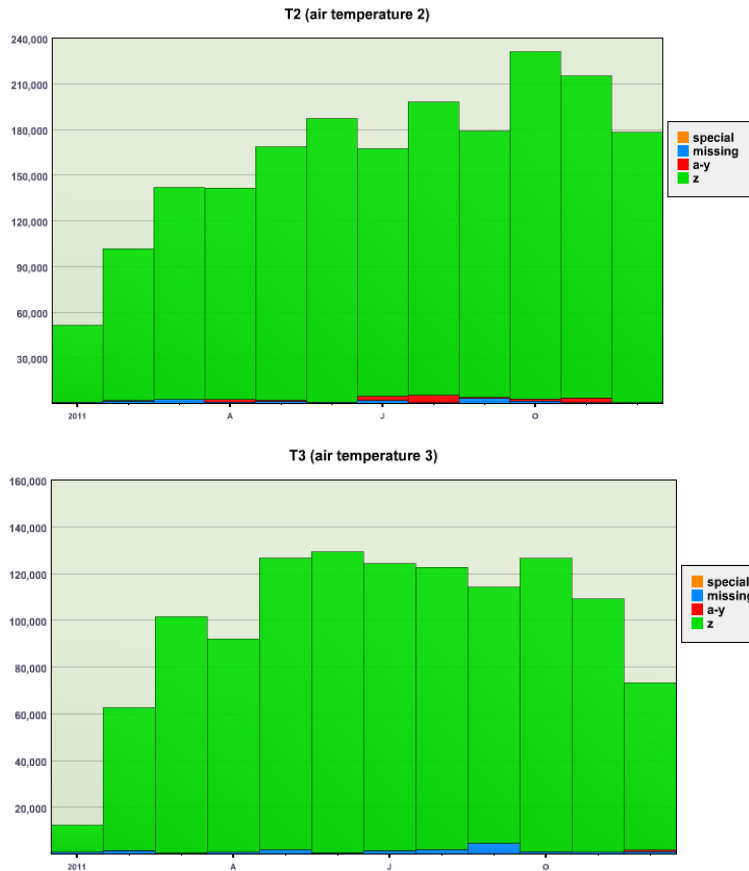
(Figure 5: cont'd).

Dew point temperature was a new variable in 2011, in terms of processing, available from the *Healy* and the *Roger Revelle*. It's important to note that in the case of the *Healy*, dew point temperature (TD) was exchanged for dew point temperature 2 (TD2) in the metadata, as the parameter was initially set up so as to compare to the wrong air temperature variable. This switch took place on 12 July 2011, which likely explains the decrease in TD observations and concurrent increase in TD2 observations after June. Because TD values from the *Healy* were initially being compared against the wrong air temperature values they also incurred a fair amount of failed T>Tw>Td (D) flags, which most likely explains the larger number of flags applied to TD prior to the switch. Otherwise, dew point temperature was of decent quality (Figure 6). In fact, it's interesting to note that after the *Healy's* switch from TD to TD2 in July, the variable TD incurred minimal flagging (especially for the months August through December). As these data were exclusively from the *Roger Revelle*, we have compelling evidence that the *Revelle* gathers very good dew point temperature data; however, because of funding constraints the *Revelle* does not undergo visual quality control, so we cannot conclude this with any certainty.
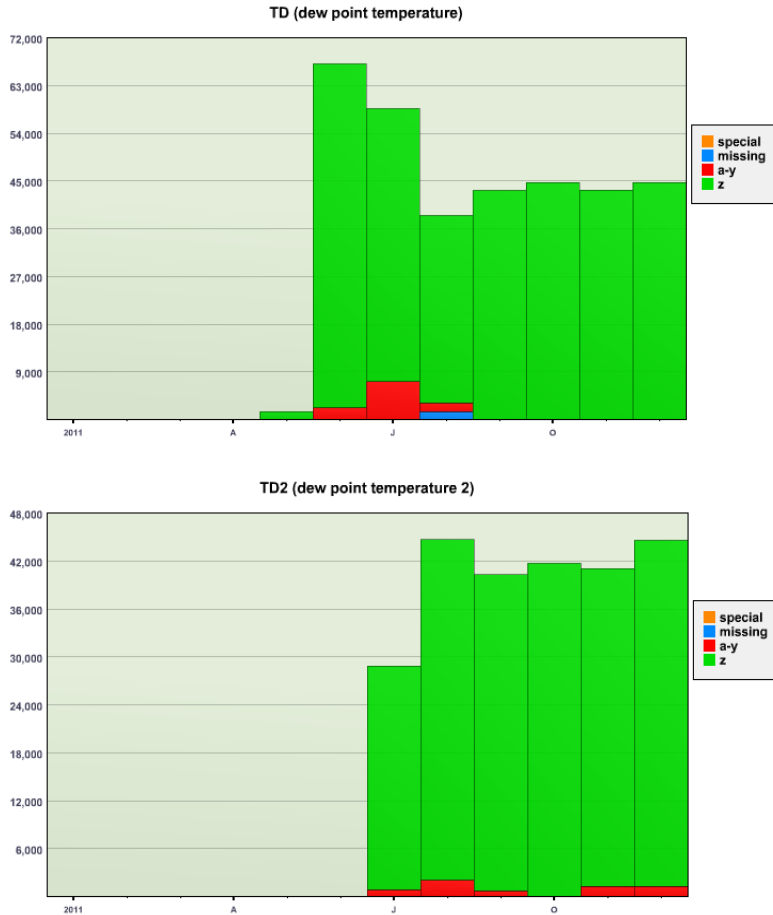
Figure 6: Total number of (top) dew point temperature – TD – and (bottom) dew point temperature 2 – TD2 –observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing 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 7.
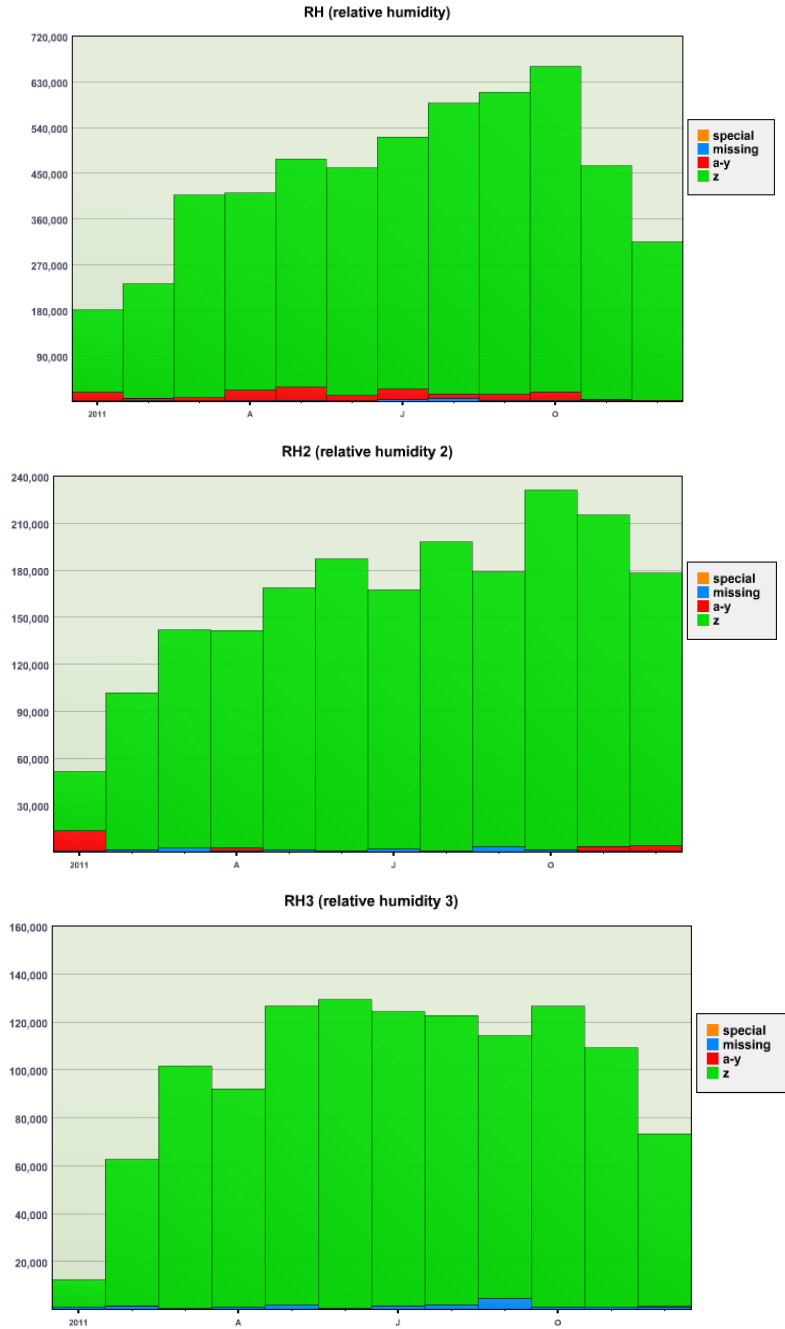
Figure 7: Total number of (top) relative humidity – RH – (middle) relative humidity 2 – RH2 – and (bottom) relative humidity 3 – RH3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

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

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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 readily incorporated into wind measurements. These flow-obstructed and platform speed-affected wind data were the most common problems across SAMOS vessels in 2011.

The overall quality of the 2011 SAMOS wind data was nonetheless good, as shown in Figures 8 (earth relative wind direction) and 9 (earth relative wind speed). In SAMOS visual quality control, compromised wind data is addressed with caution/suspect (K), visual spike (S), and sometimes poor quality (J) flags. Where comprehensive metadata and digital imagery exist, flow obstructed platform relative wind bands can often be diagnosed based on the structural configuration of the vessel and recommendations can be made to the vessel operator to improve sensor locations. Another diagnostic tool available to SAMOS data analysts is a polar plotting routine, which can look at a single variable and identify the ratio of flagged observations to total observations in one degree (platform relative wind direction) bins. In this way, platform relative wind bands that interfere with sensor readings may be identified. Currently the polar plot program is configured to accept air temperature, humidity, and true wind speed and direction data with corresponding platform relative wind data. The polar plotting program is not currently in regular use by SAMOS data analysts because it is a time consuming process and the routines need more tuning, but its attributes could be improved and its benefits further explored in the future.

The other major problem with earth relative wind data is errors caused by changes in platform speed. Figure 80 in the next section shows the spikes and steps that can occur in SPD and the spikes that can occur in DIR when the platform speed changes. Occasionally, a wind direction sensor is also suspected of being "off" by a number of degrees. Historically, SAMOS data analysts had access to global gridded wind data from the space-based QuikSCAT scatterometer with which to compare true wind speed and direction measurements. However, the QuikSCAT product terminated in late 2009 when the satellite failed in orbit. In general, if a technician suspects a wind direction bias it is critical they communicate that suspicion to SAMOS personnel, as otherwise the data analysts often will have no reliable means of discovering the problem themselves. Suspected wind direction biases are typically flagged with K flags, or J flags if the case is extreme and/or verifiable.

Figure 8: Total number of (top) earth relative wind direction – DIR – (middle) earth relative wind direction 2 – DIR2 – and (bottom) earth relative wind direction 3 – DIR3 – observations provided by all ships for each month in 2010. 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.
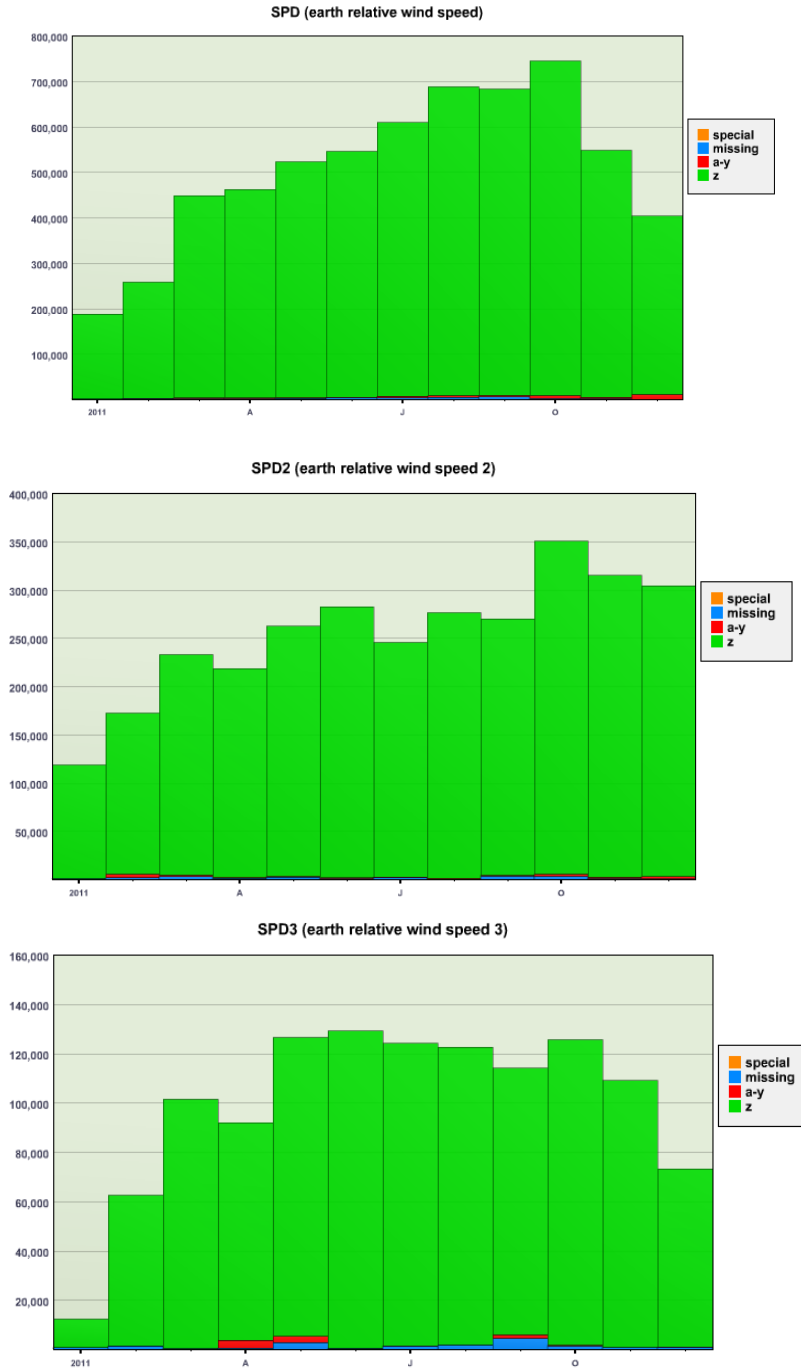
Figure 9: Total number of (top) earth relative wind speed – SPD – (middle) earth relative wind speed 2 – SPD2 – and (bottom) earth relative wind speed 3 – SPD3 – observations provided by all ships for each month in 2010. The colors represent the number of good (green) values versus the values that failed 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.

Most of the flags applied to the radiation parameters were assigned by the autoflagger, primarily to short wave radiation (Figure 10). 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, has perhaps the smallest percentage of data flagged for parameters submitted to SAMOS (Figure 11). Overall quality for photosynthetically active atmospheric radiation and net atmospheric radiation also appears quite good (Figures 12, and 13, respectively), aside from a sizable number of B flags applied specifically to the *Laurence M. Gould's* RAD_PAR throughout most of 2012 as a result of a suspected sensor calibration drift (see next section for details). The LW, PAR, and NET radiation sensors are also provided by a very limited subset of SAMOS vessels (Table 3).
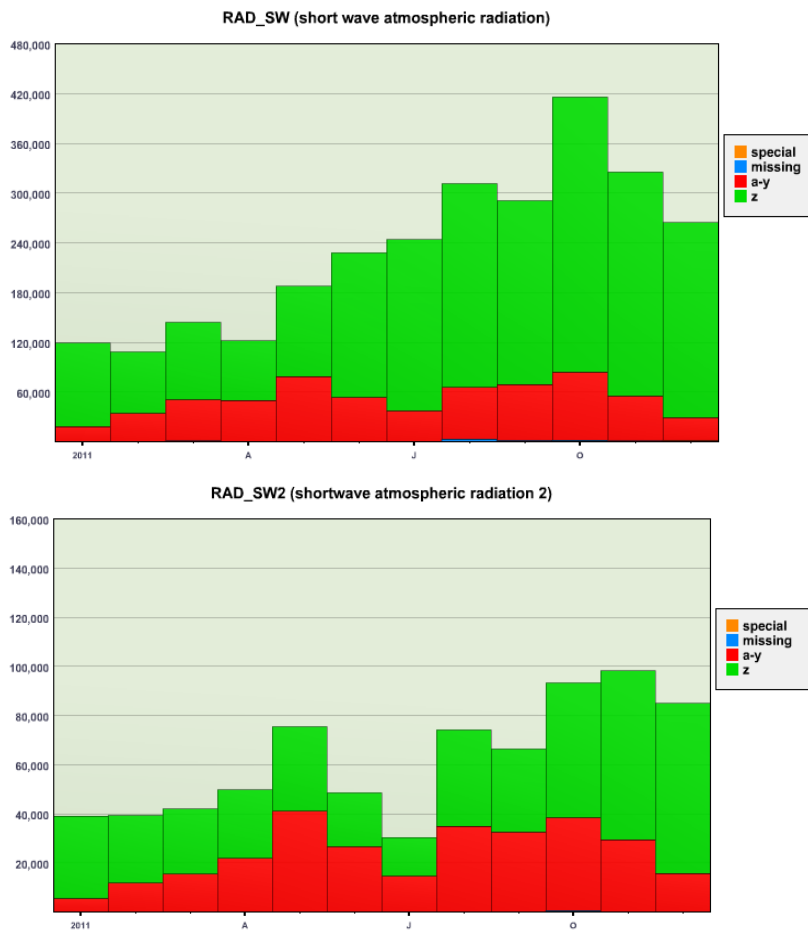


Figure 10: Total number of (top) shortwave atmospheric radiation – RAD_SW – and (bottom) shortwave atmospheric radiation 2 – RAD_SW2 –observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
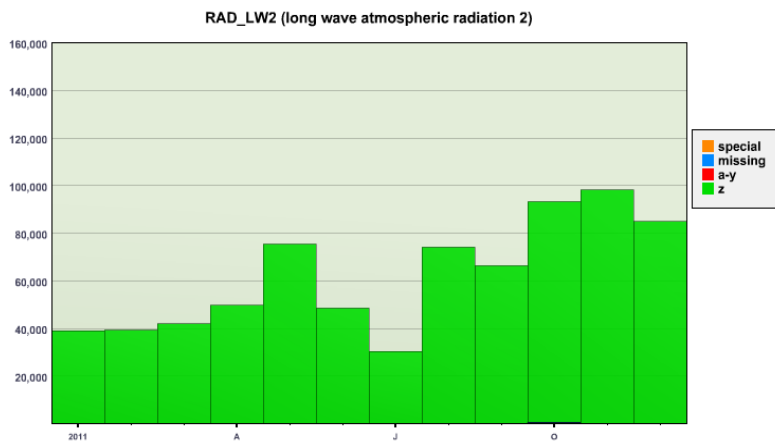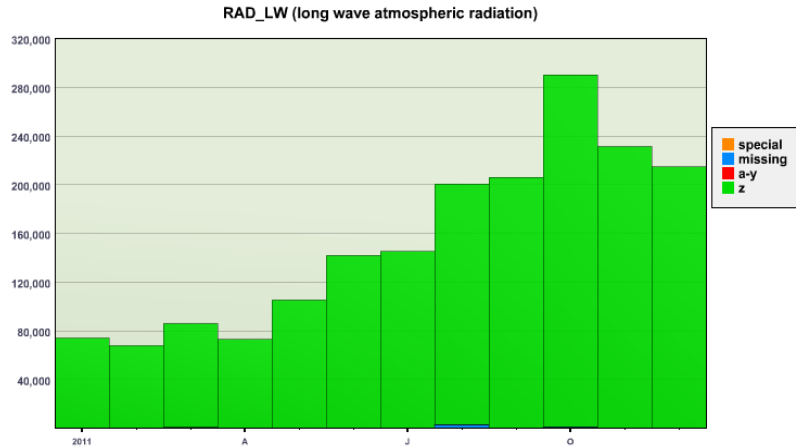
Figure 11: Total number of (top) long wave atmospheric radiation – RAD_LW – and (bottom) long wave atmospheric radiation 2 – RAD_LW2 –observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
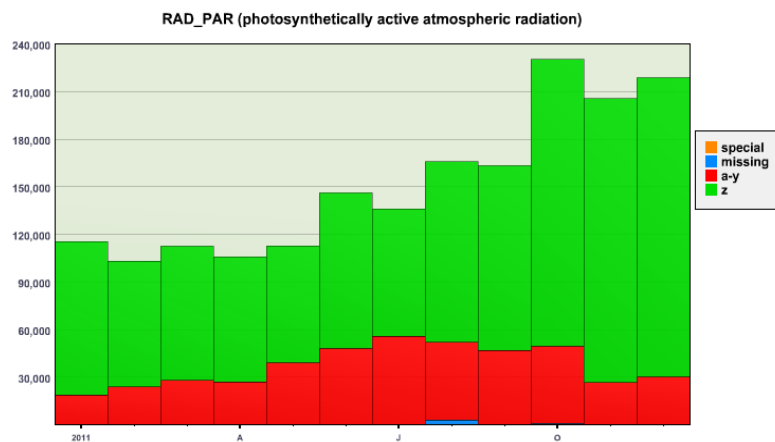


Figure 12: Total number of (this page) photosynthetically active atmospheric radiation – RAD_PAR – and (next page) photosynthetically active atmospheric radiation 2 – RAD_PAR2 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
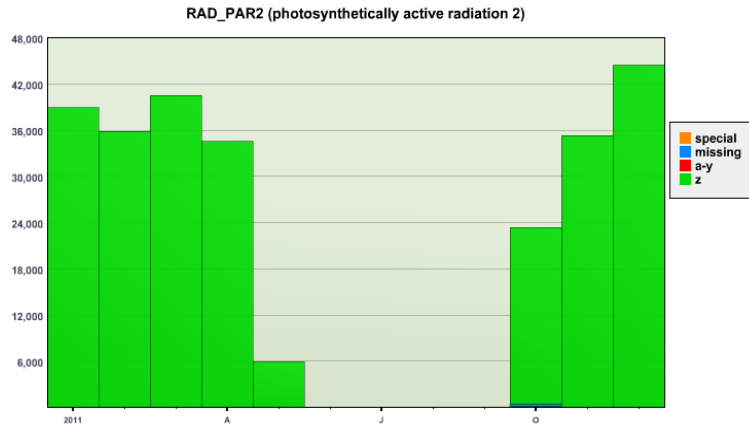
(Figure 12: cont'd)
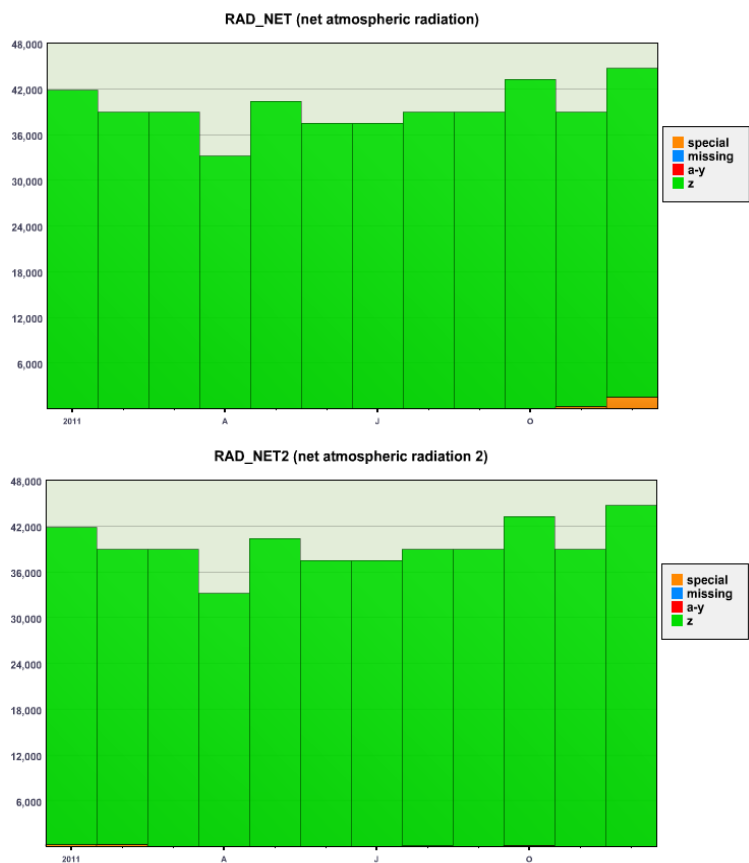




Figure 13: Total number of (top) net atmospheric radiation – RAD_NET – and (bottom) net atmospheric radiation 2 – RAD_NET2 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). 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 in general, although there was an error

in the metadata for the *R/V Atlantis's* rain rate parameters that caused them to incur some B flags (see next section for details). It should also be noted that some accumulation sensors will occasionally exhibit slow leaks and/or evaporation. These data are not typically flagged; nevertheless, frequent emptying of precipitation accumulation sensors is always advisable.
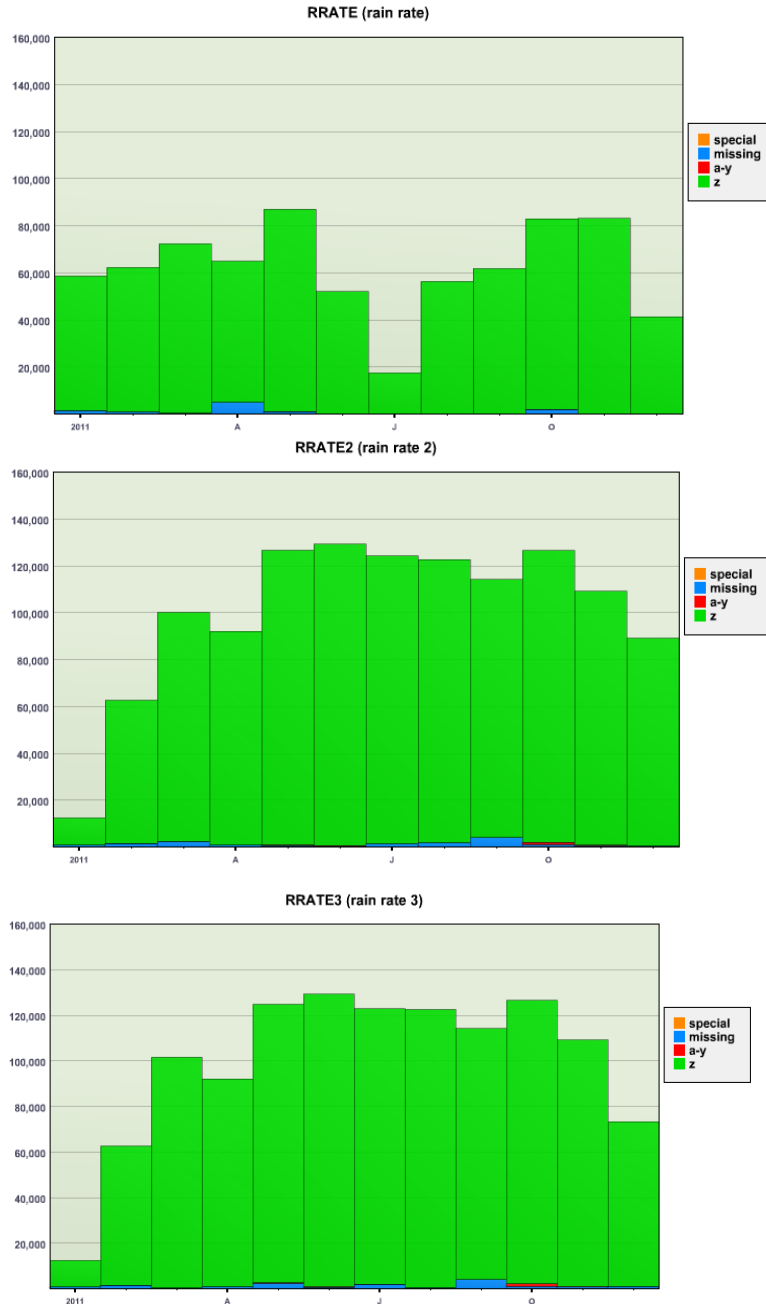


Figure 14: Total number of (top) rain rate – RRATE – (middle) rain rate 2 – RRATE2 – and (bottom) rain rate 3 – RRATE3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
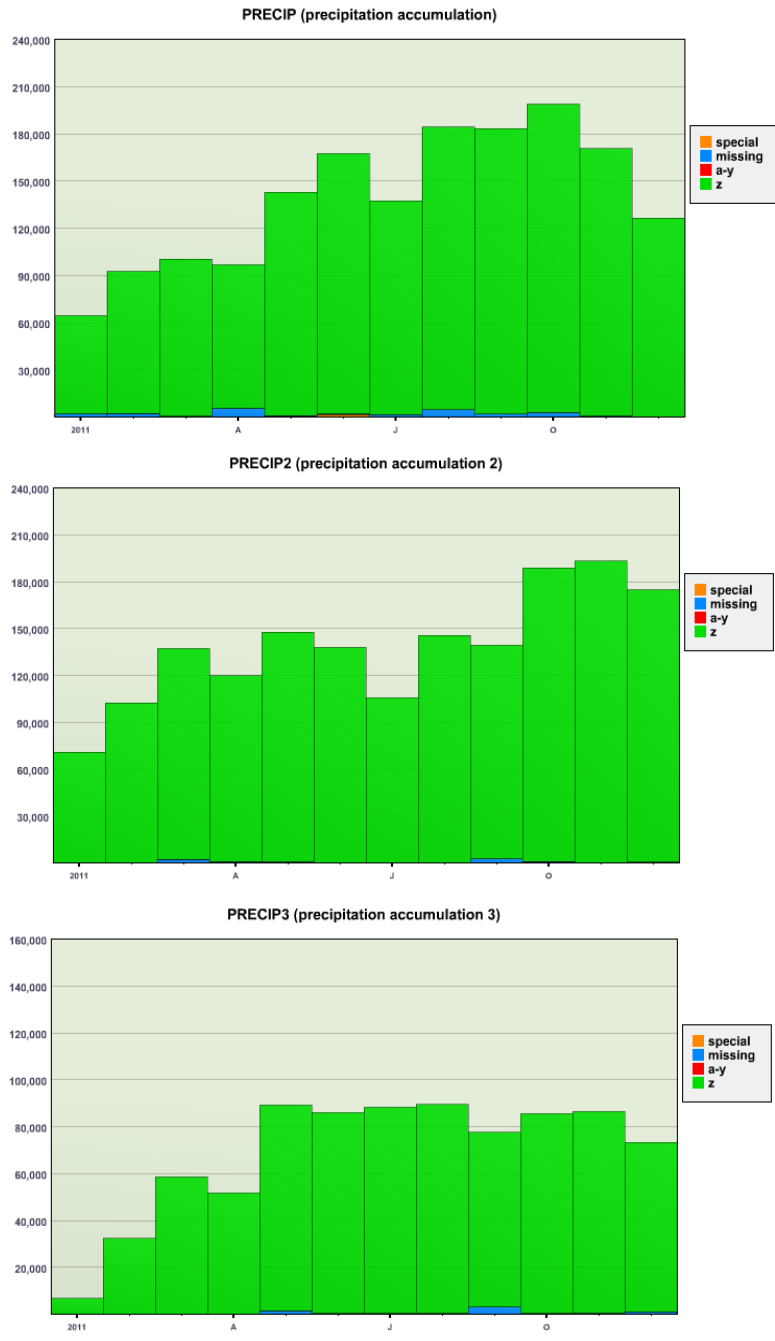
Figure 15: Total number of (top) precipitation accumulation – PRECIP – (middle) precipitation accumulation 2 – PRECIP2 – and (bottom) precipitation accumulation 3 – PRECIP3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

The main problem identified with the sea temperature parameter (Figure 16) occurred when the sensor was denied a continuous supply of seawater. In these situations, either the resultant sea temperature values were deemed inappropriate for the region of operation (using gridded SST fields as a guide), in which case they were flagged with suspect/caution (K) flags or occasionally poor quality (J) flags if the readings were

extraordinarily high or low, or else the sensor reported a constant value for an extended period of time, in which case they were unanimously J-flagged. The authors note that this often occurred while a vessel was in port, which is rather anticipated as the normal ship operation practice by SAMOS data analysts. It also occurs frequently when a vessel is in icy waters, as happens with the *Gould* and *Palmer* in austral winter, which may explain the increased flags in TS2 in the months of June and July.
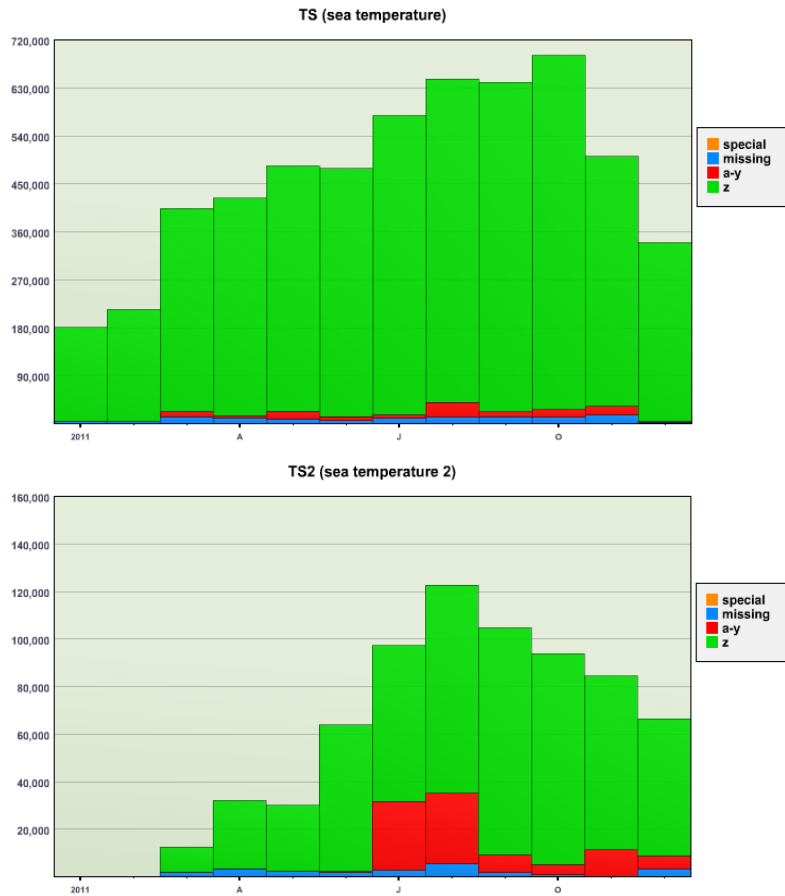


Figure 16: Total number of (top) sea temperature – TS – and (bottom) sea temperature 2 – TS2 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

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 the flow water system that feeds the probes was usually shut off, resulting in either inappropriate or static values. *Hi'ialakai* also experienced conductivity output units issues in 2011 (details in 3c). In spite of these issues, though, salinity and conductivity data was still rather good. The authors do note that all the salinity values are relative and no effort was made to benchmark the values to water calibration samples. Calibration of salinity data is beyond the scope of SAMOS.
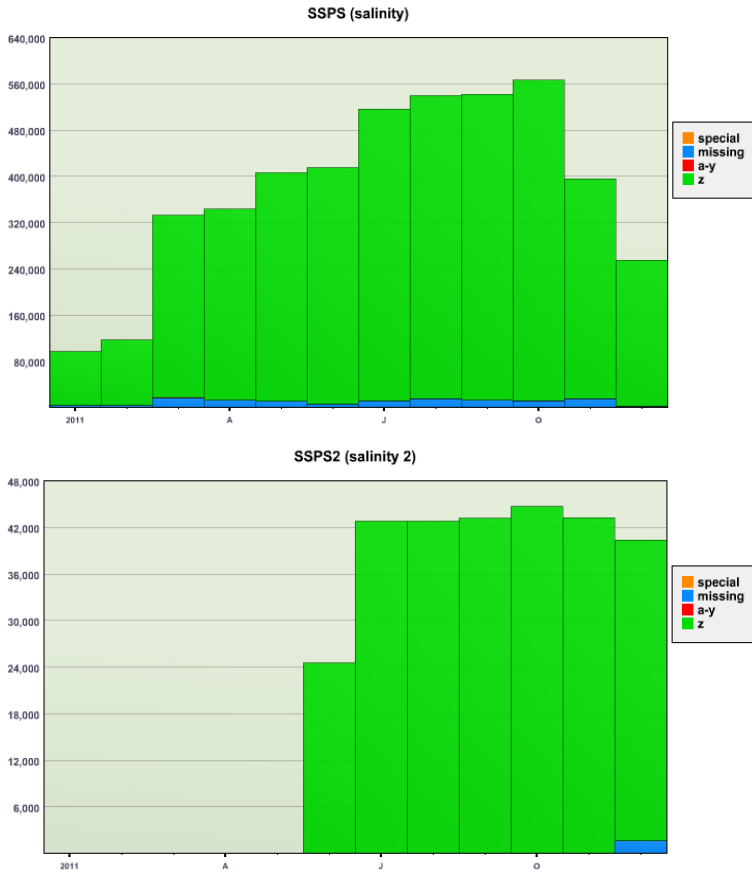
Figure 17: Total number of (top) salinity – SSPS – and (bottom) salinity 2 – SSPS2 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
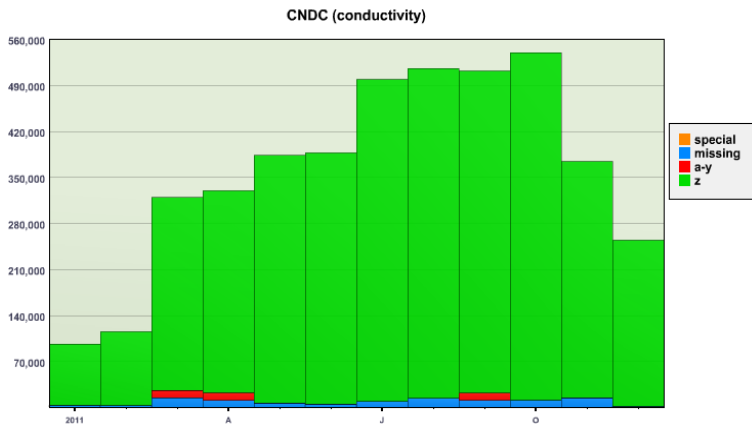


Figure 18: Total number of (this page) conductivity – CNDC – and (next page) conductivity 2 – CNDC2 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.

CNDC2 (conductivity 2)
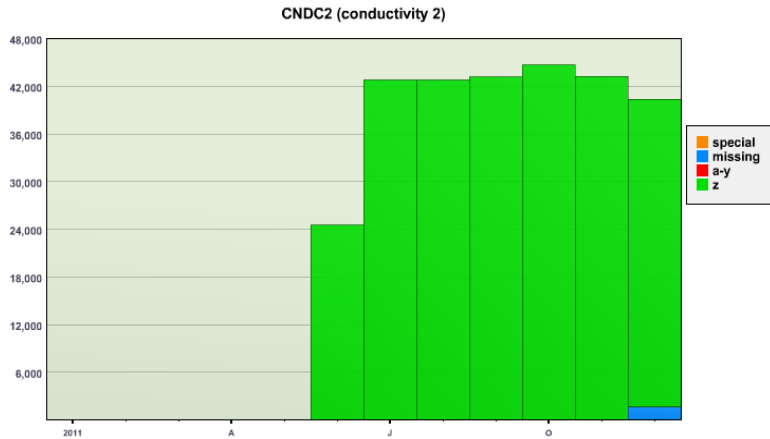
(Figure 18: cont'd)

Latitude and longitude (Figure 19) primarily only receive flags via the autoflagger, 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. The geographic land/water mask in use for determining land positions in 2011 was a two-minute grid. Additionally, both the *Knorr* (in November) and the *Oceanus* (in December) transmitted SAMOS data while in dry dock periods; hence, they received port (N) flags, which drove up the November/December a-y flag totals.
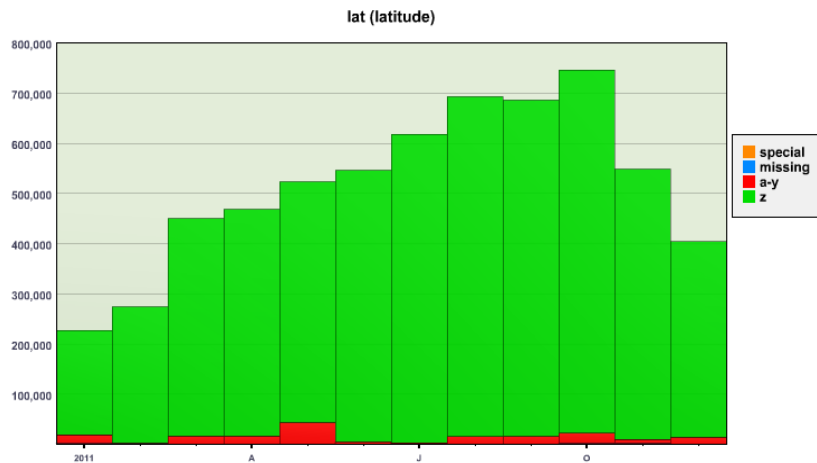


lat (latitude)

Figure 19: Total number of (this page) latitude – LAT – and (next page) longitude – LON – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
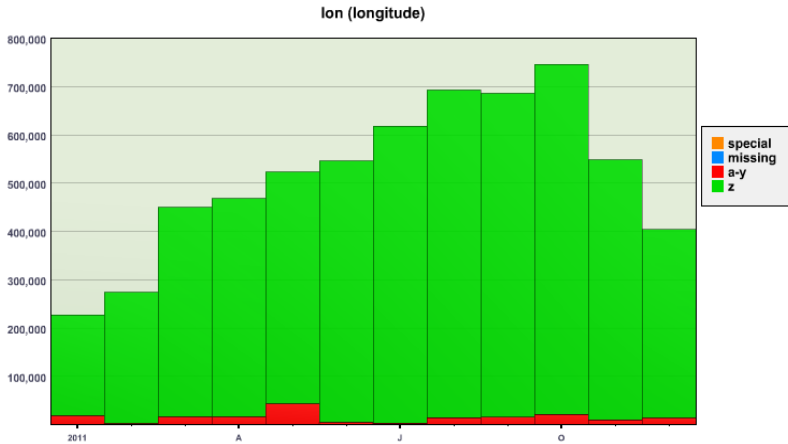
(Figure 19: cont'd)

The remainder of the navigational parameters exhibited no 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). Note, however, a short stint of questionable PL_SOW data in May, which occurred on the *Kilo Moana*.
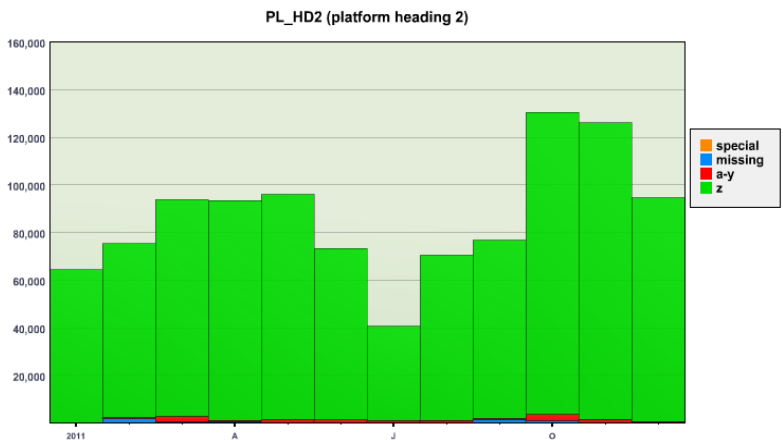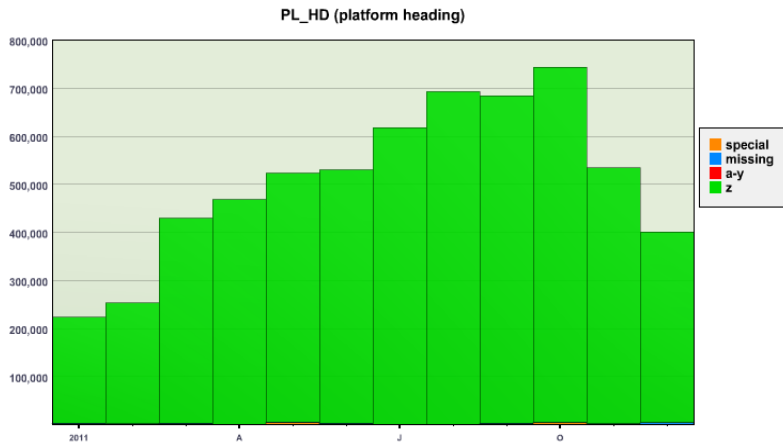




Figure 20: Same as Figure 19, except for (top) platform heading – PL_HD – and (bottom) platform heading 2 – PL_HD2.
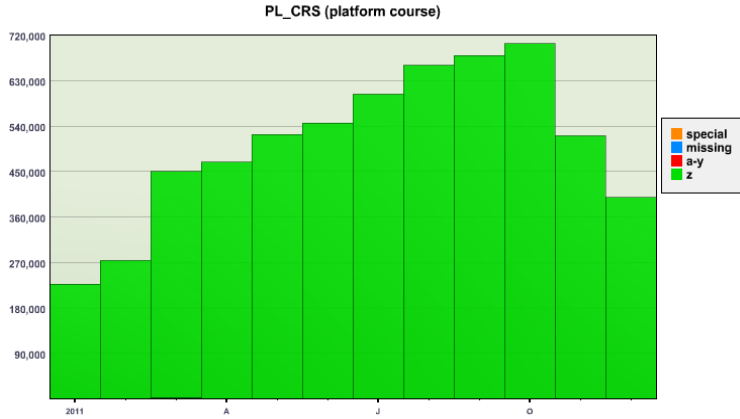
Figure 21: Total number of platform course – PL_CRS –observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
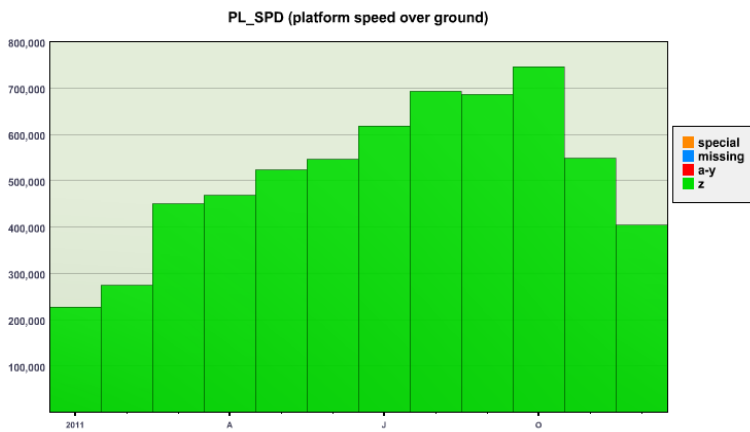


Figure 22: Total number of platform speed over ground – PL_SPD –observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus the values that failed one of the SAMOS QC tests (red). Values noted as missing or special values by the SAMOS processing are also marked in blue and orange, respectively.
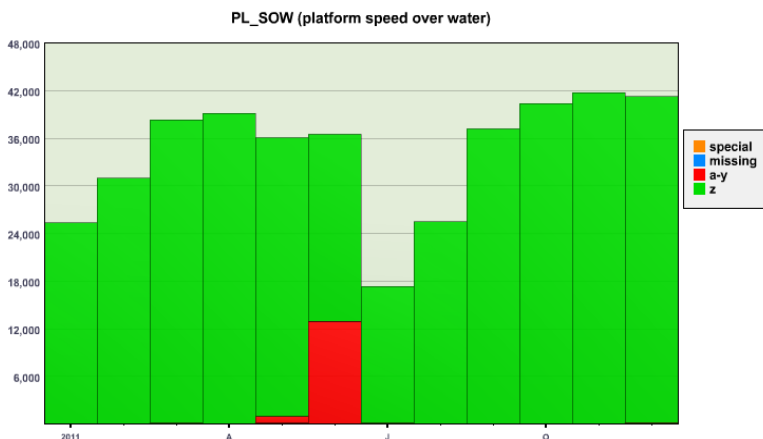


Figure 23: Same as Figures 22 and 23, except for platform speed over water – PL_SOW.

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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.
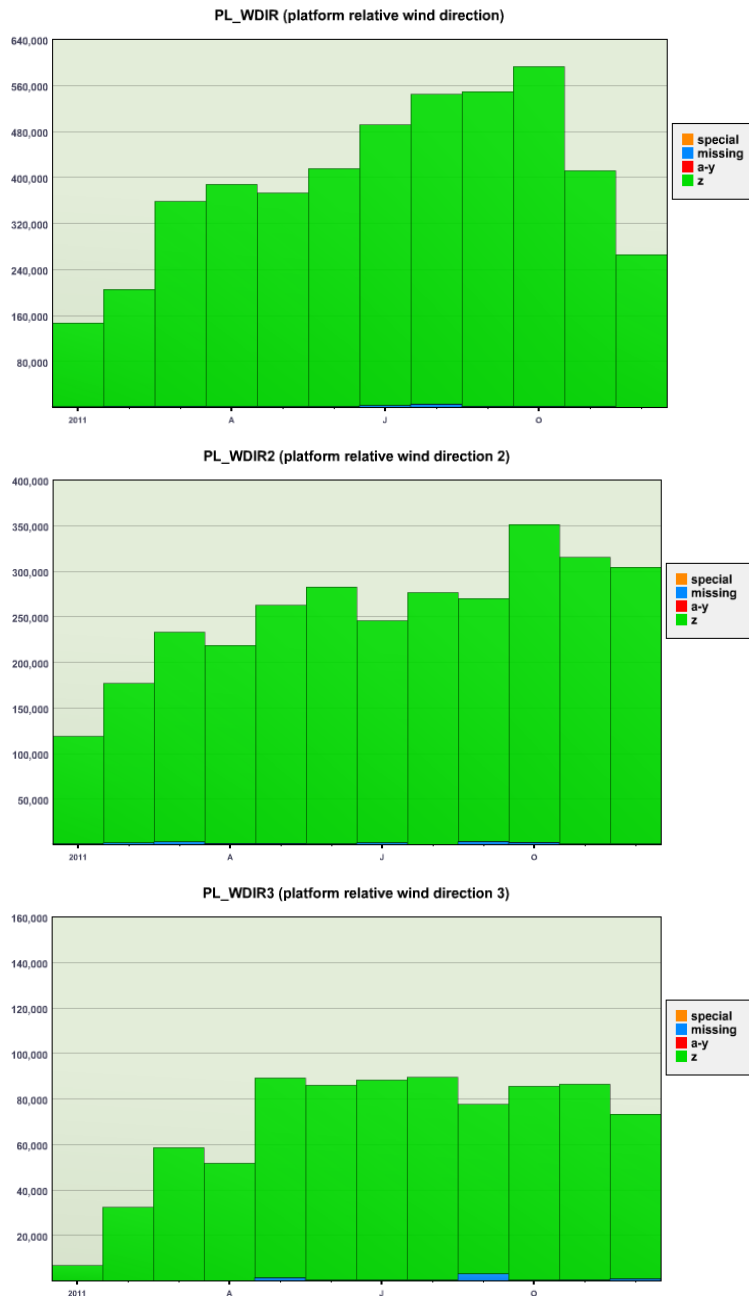


Figure 24: Total number of (top) platform relative wind direction – PL_WDIR –(middle) platform relative wind direction 2 – PL_WDIR2 – and (bottom) platform relative wind direction 3 – PL_WDIR3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) 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.
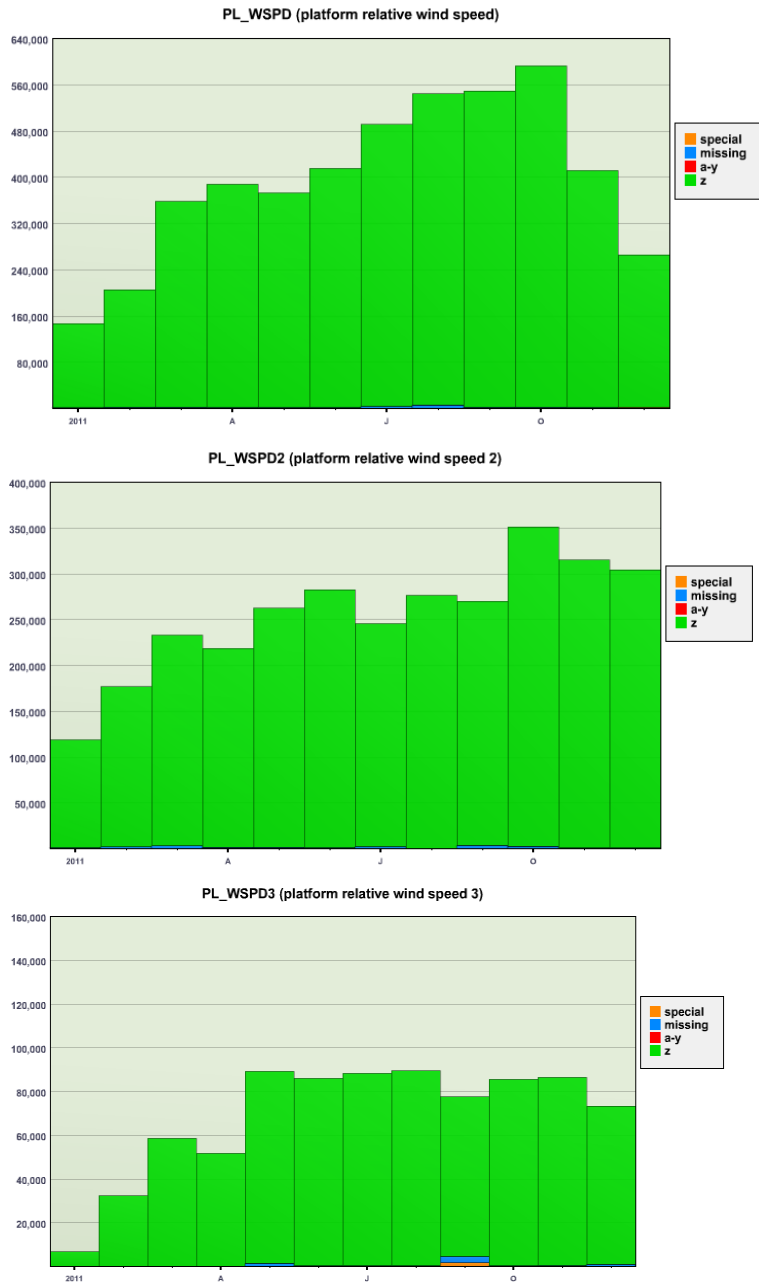
Figure 25: Total number of (top) platform relative wind speed – PL_WSPD – (middle) platform relative wind speed 2 – PL_WSPD2 – and (bottom) platform relative wind speed 3 – PL_WSPD3 – observations provided by all ships for each month in 2011. The colors represent the number of good (green) values versus 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.

### c. 2011 quality by ship
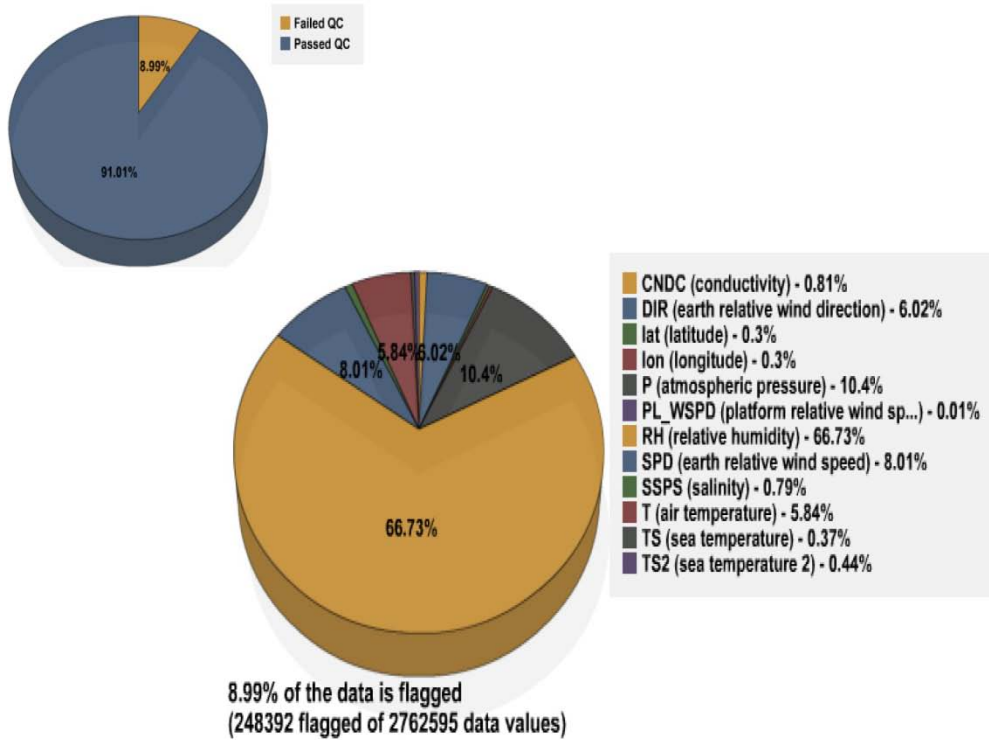
*Atlantic Explorer*
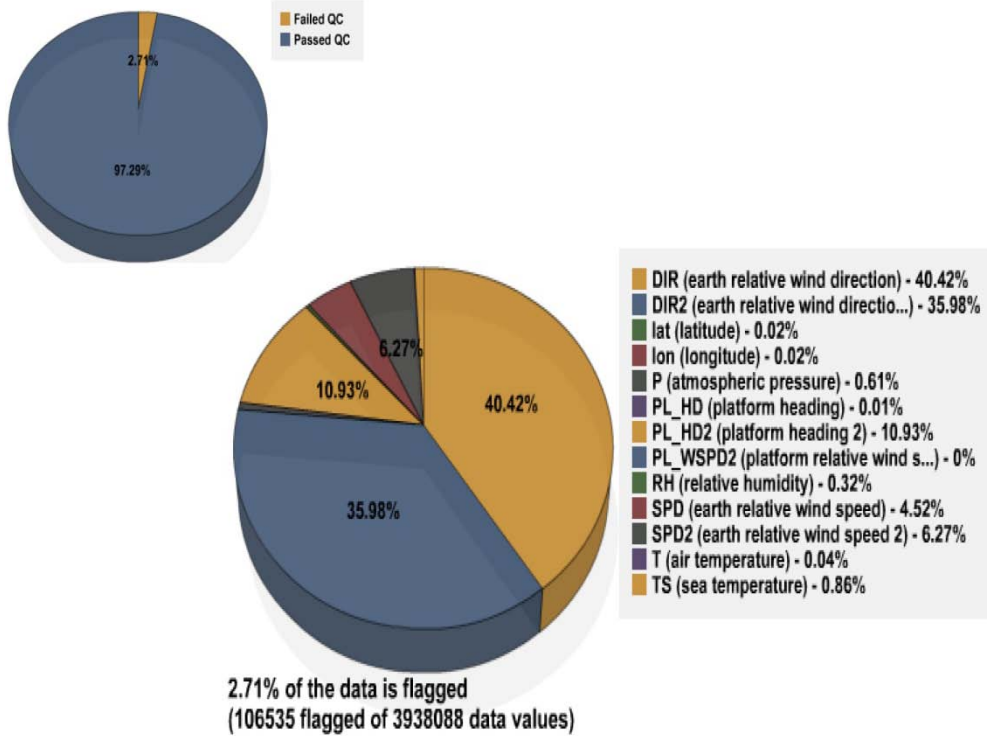


Figure 26: For the *Atlantic Explorer* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Atlantic Explorer* provided SAMOS data for 163 ship days, resulting in 3,938,088 distinct data values. After automated QC, 2.71% of the data was flagged using A-Y flags (Figure 26). This is virtually unchanged from 2010 (2.96% flagged) and remains a notably low percentage of flagged values, but it is important to note that the *Atlantic Explorer*, like the *Kilo Moana*, does not receive visual QC (due to a lack of funding), which is when the bulk of flags are usually applied. Perhaps more telling of the *Atlantic Explorer's* actual data quality is the fact that the majority of the flags (nearly 77%, combined) were again applied to the two earth relative wind direction parameters (DIR and DIR2). The flags applied were exclusively failing the true wind test (E) flags (Figure 27), again as they were in 2010. This is possibly due to a combination of less than ideal sensor location (i.e. flow distortion) and possible true wind averaging problems; however, these unfortunately are not issues we are currently funded to sort out. An additional problem exists with platform heading 2 (PL_HD2) whereby missing values get into the averaging, resulting in a good deal of out of bounds (B) flags being applied during automated quality control. During conversation, *Explorer* personnel have expressed their belief that this problem cannot be resolved.

- E (failed the true wind test) - 43064

43064

**DIR (earth relative wind direction)
40.42% of all flags**

- E (failed the true wind test) - 38335

38335

**DIR2 (earth relative wind direction 2)
35.98% of all flags**
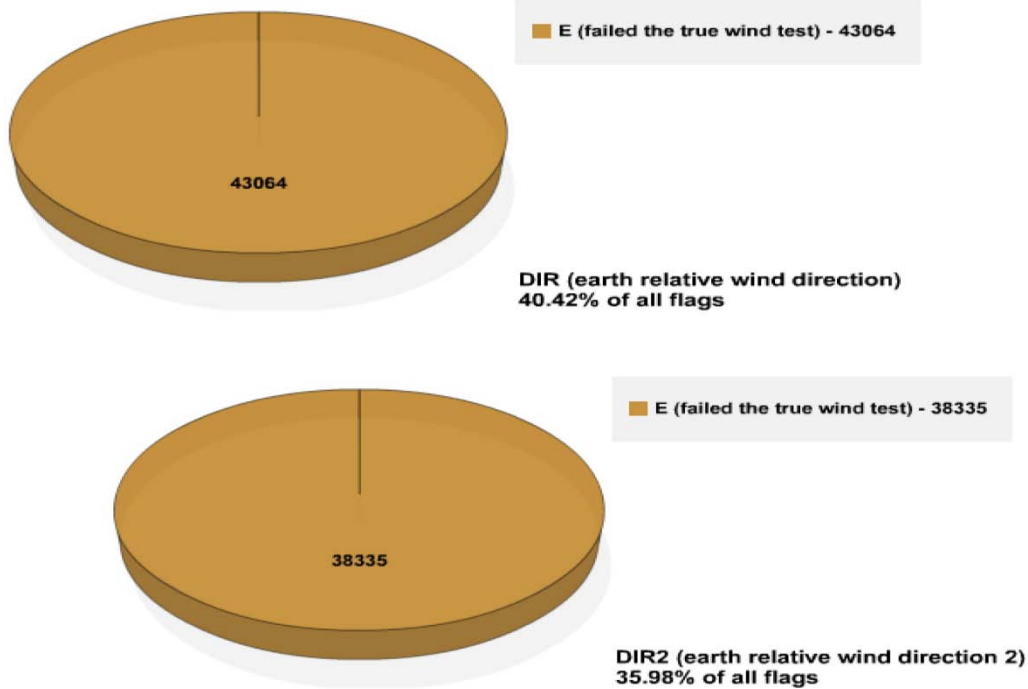
Figure 27: Distribution of SAMOS quality control flags for (top) earth relative wind direction – DIR – and (bottom) earth relative wind direction 2 – DIR2 –for the *Atlantic Explorer* in 2011.

## *Aurora Australis*



- Failed QC
- Passed QC

2.49%

97.51%

DIR (earth relative wind direction) - 1.09%
DIR2 (earth relative wind directio...) - 1.05%
lat (latitude) - 1.97%
lon (longitude) - 1.97%
P (atmospheric pressure) - 5.63%
PL_SPD (platform speed over ground) - 0.01%
RAD_PAR (photosynthetically active...) - 0.01%
RAD_PAR2 (photosynthetically activ...) - 0%
RAD_SW (short wave atmospheric rad...) - 22.43%
RAD_SW2 (shortwave atmospheric rad...) - 36.09%
RH (relative humidity) - 8.67%
RH2 (relative humidity 2) - 9.68%
SPD (earth relative wind speed) - 1.09%
SPD2 (earth relative wind speed 2) - 0.81%
T (air temperature) - 2.61%
T2 (air temperature 2) - 2.59%
TS (sea temperature) - 4.3%

5.63%
9.68%
8.67%
22.43%
36.09%

2.49% of the data is flagged
(183067 flagged of 7360788 data values)

Figure 28: For the *Aurora Australis* from 1/1/11 through 12/31/11, (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 195 ship days, resulting in 7,360,788 distinct data values. After automated QC, 2.49% of the data was flagged using A-Y flags (Figure 28). This is a change of -1.83% from 2010 (4.32% flagged). NOTE: the *Aurora Australis* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Aurora Australis*).

Roughly 60% of the flags applied belong to the two short wave radiation parameters (RAD_SW and RAD_SW2), and those are overwhelmingly of the out of bounds (B) variety (Figure 29). Upon inspection, it is apparent the short wave radiation B flags were applied to short wave radiation values slightly below zero. This is a common situation wherein the sensors are tuned for greater accuracy at much higher readings (see section 3b). NOTE: The IMOS group at the Australian Bureau of Meteorology does conduct visual quality control and makes research quality data files for the *Aurora Australis*.
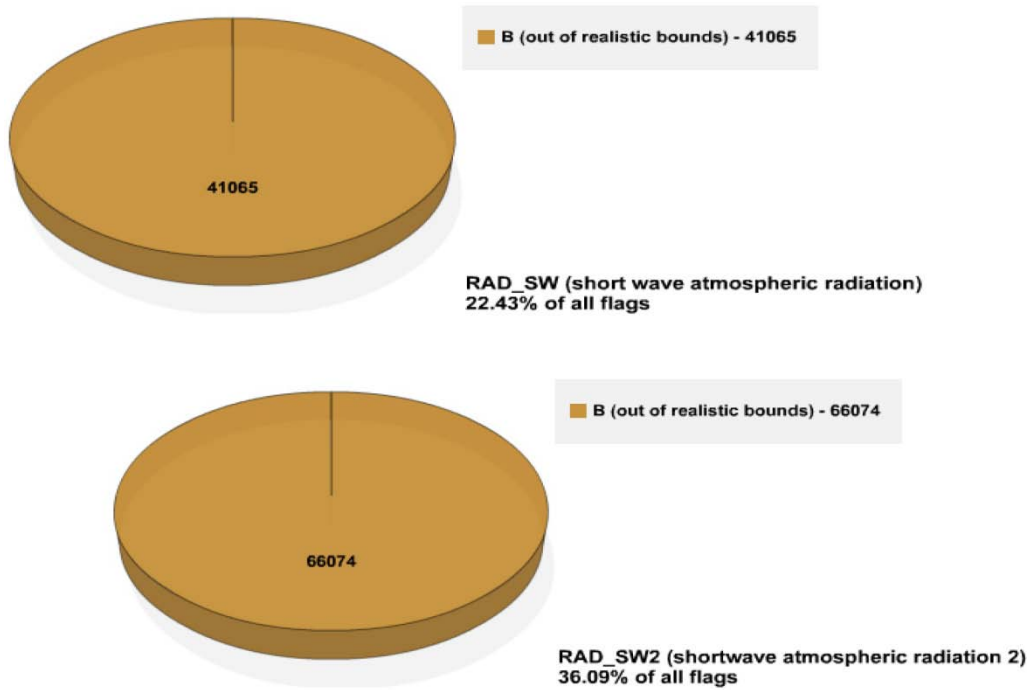


Figure 29: Distribution of SAMOS quality control flags for (top) shortwave atmospheric radiation – RAD_SW – and (bottom) shortwave atmospheric radiation 2 – RAD_SW2 –for the *Aurora Australis* in 2011.
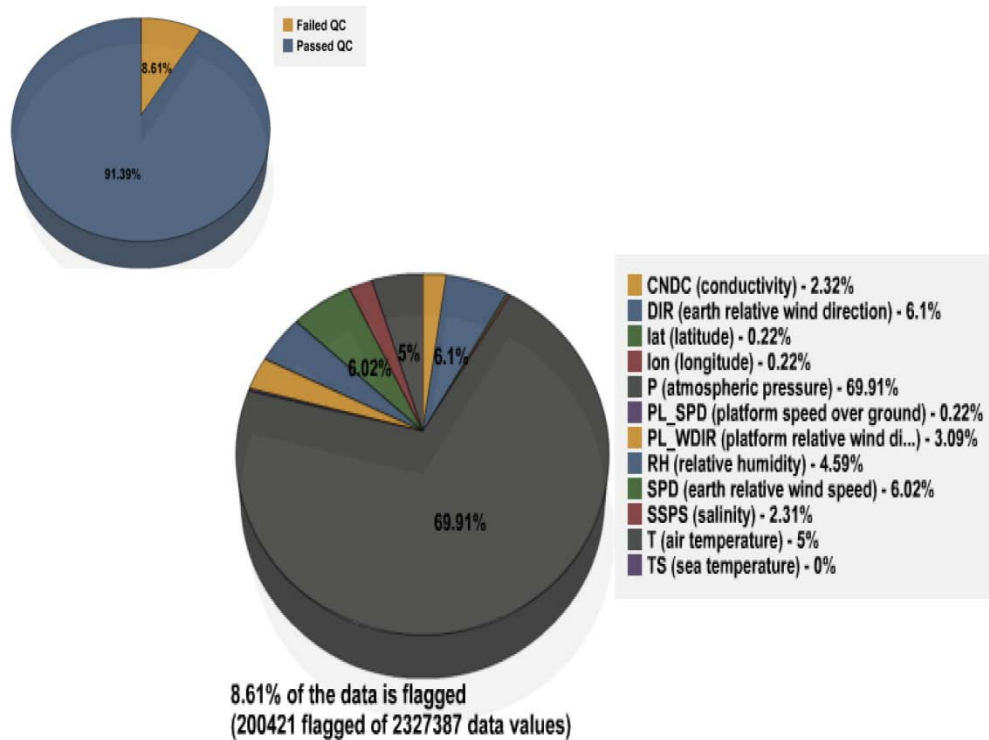
*Southern Surveyor*
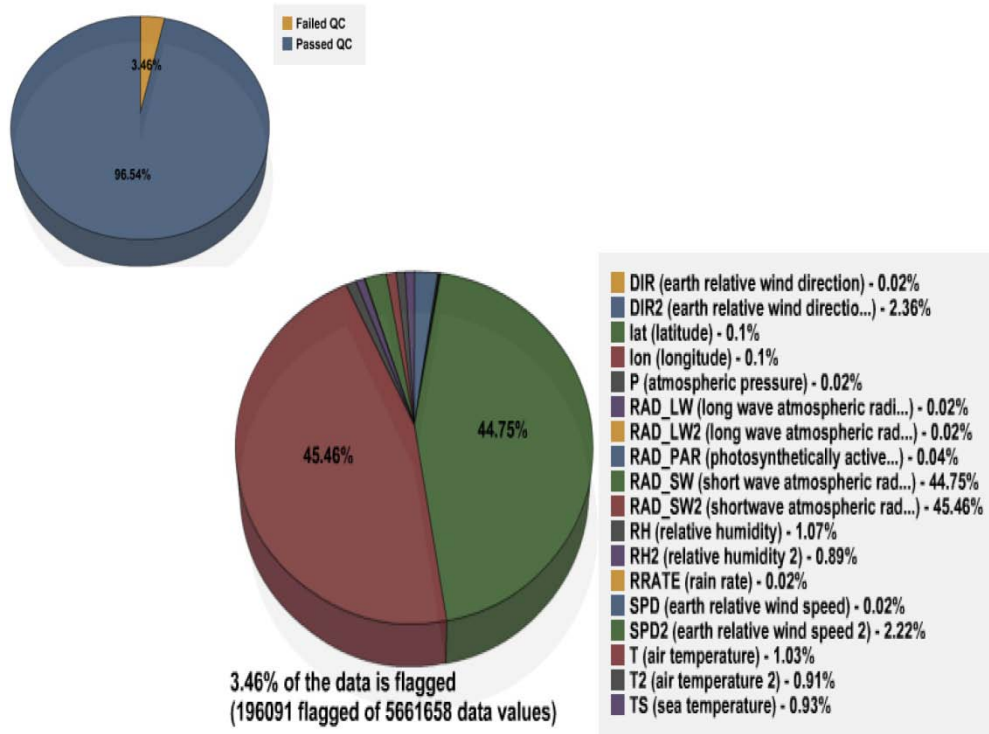


Figure 30: For the *Southern Surveyor* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Southern Surveyor* provided SAMOS data for 153 ship days, resulting in 5,661,658 distinct data values. After automated QC, 3.46% of the data was flagged using A-Y flags (Figure 30). This is a change of -1.09% from 2010 (4.55% flagged). NOTE: the *Southern Surveyor* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Southern Surveyor*).

Nearly 90% of the flags applied belong to the two short wave radiation parameters, and those are overwhelmingly of the out of bounds (B) variety (Figure 31). Interestingly, this is the exact statement that was made for the *Surveyor* in both the 2009 and the 2010 SAMOS Data Quality Reports, with very similar distributions of flag percentages between the two parameters. Upon inspection, though, it is apparent the B flags were once again applied to short wave radiation values slightly below zero. This is a common situation wherein the sensors are tuned for greater accuracy at much higher readings (see section 3b), and as such it is not surprising after all that the flag situation remains static from 2009 to 2010 to 2011. NOTE: The IMOS group at the Australian Bureau of Meteorology does conduct visual quality control and makes research quality data files for the *Southern Surveyor*.

B (out of realistic bounds) - 87741

87741

RAD_SW (short wave atmospheric radiation)
44.75% of all flags



B (out of realistic bounds) - 89134

89134

RAD_SW2 (shortwave atmospheric radiation 2)
45.46% of all flags
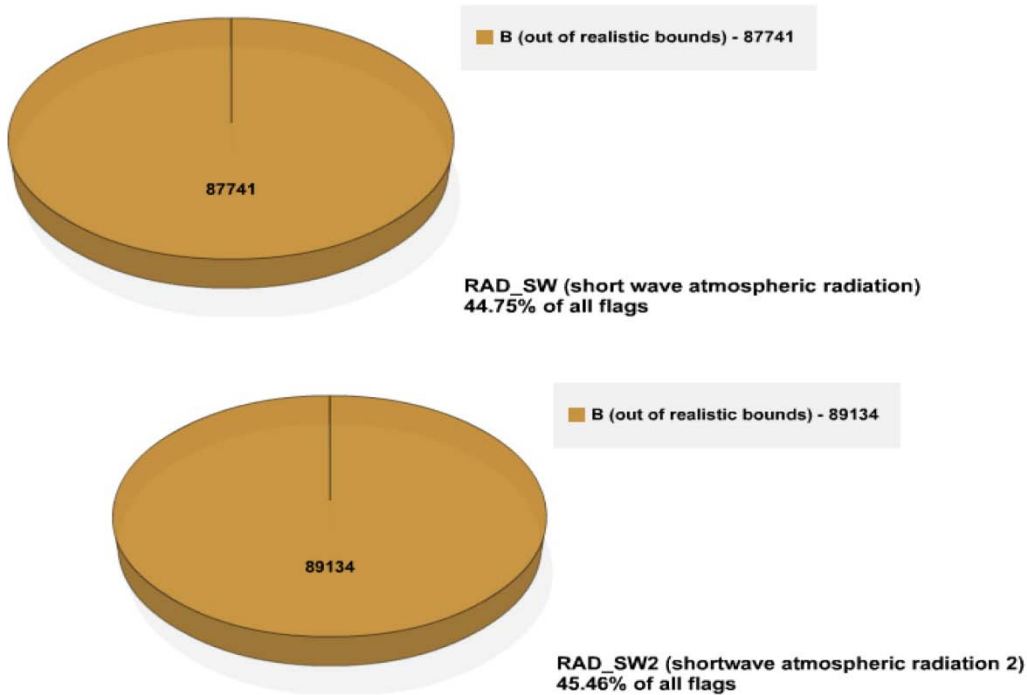
Figure 31: Distribution of SAMOS quality control flags for (top) shortwave atmospheric radiation –
RAD_SW – and (bottom) short wave atmospheric radiation 2 – RAD_SW2 for the *R/V Southern
Surveyor* in 2011.

*Tangaroa*



Failed QC
Passed QC

6.34%

93.66%

DIR (earth relative wind direction) - 0.02%
lat (latitude) - 7.31%
lon (longitude) - 7.31%
RAD_SW (short wave atmospheric rad...) - 41.93%
RAD_SW2 (shortwave atmospheric rad...) - 42.16%
RH (relative humidity) - 0.26%
SPD (earth relative wind speed) - 0.44%
T (air temperature) - 0.28%
TS (sea temperature) - 0.29%

7.31%
7.31%
42.16%
41.93%

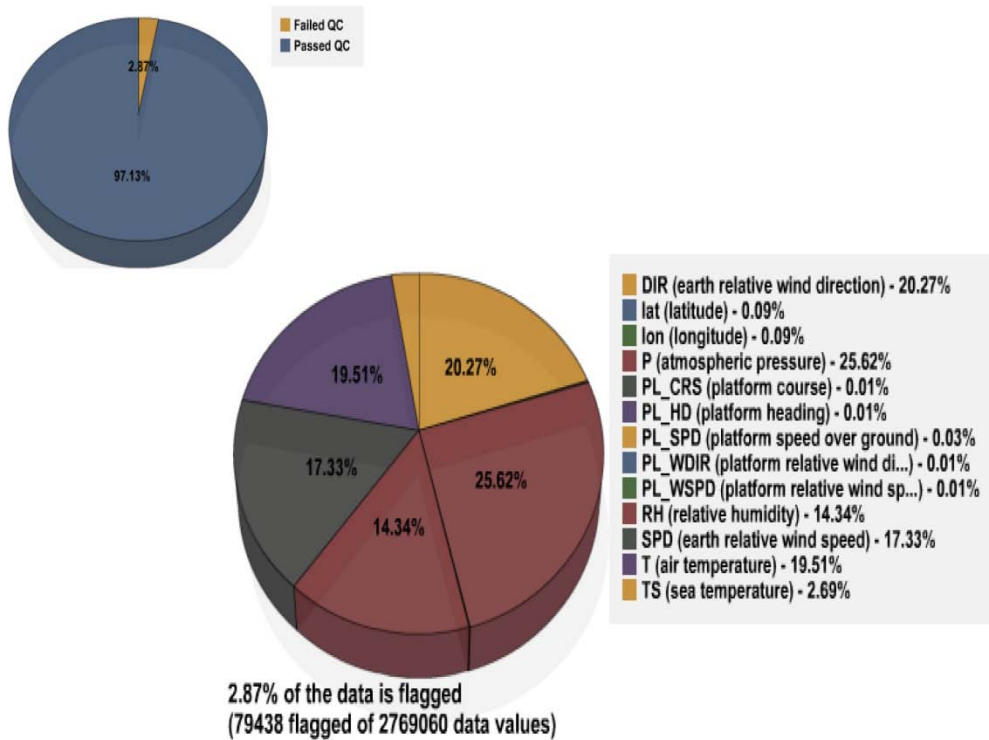6.34% of the data is flagged
(306510 flagged of 4833710 data values)

Figure 32: For the *Tangaroa* from 1/1/11 through 12/31/11, (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 199 ship days, resulting in 4,833,710 distinct data values. After automated QC, 6.34% of the data was flagged using A-Y flags (Figure 32). 2011 is the first year in which SAMOS received data from the *Tangaroa*. NOTE: the *Tangaroa* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Tangaroa*). The IMOS group at the Australian Bureau of Meteorology does conduct visual quality control and makes research quality data files for the *Tangaroa*.

The two short wave radiation parameters (RAD_SW and RAD_SW2) garnered nearly 85% of the total flags. The flags applied to the parameters were out of bounds (B) flags, exclusively (Figure 33). However, it appears the issue is merely the common occurrence of radiation readings slightly below zero in nighttime conditions, owing to sensor tuning (see Section 3b for details).
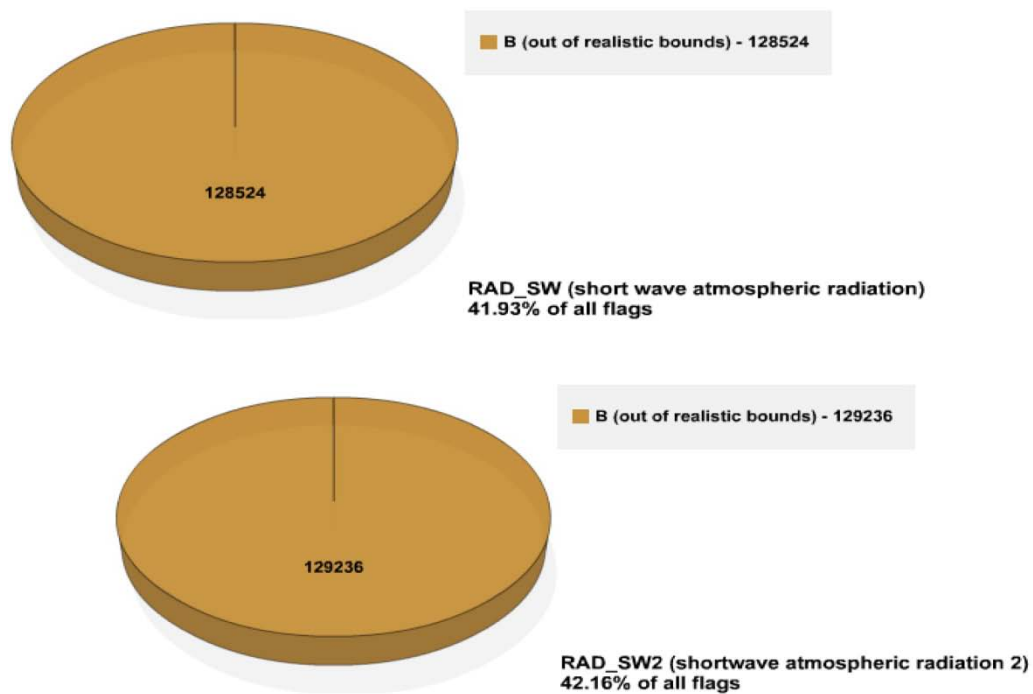


Figure 33: Distribution of SAMOS quality control flags for (top) short wave atmospheric radiation – RAD_SW – and (bottom) short wave atmospheric radiation 2 – RAD_SW2 – for the *Tangaroa* in 2011.

***Gordon Gunter***





4.66% of the data is flagged
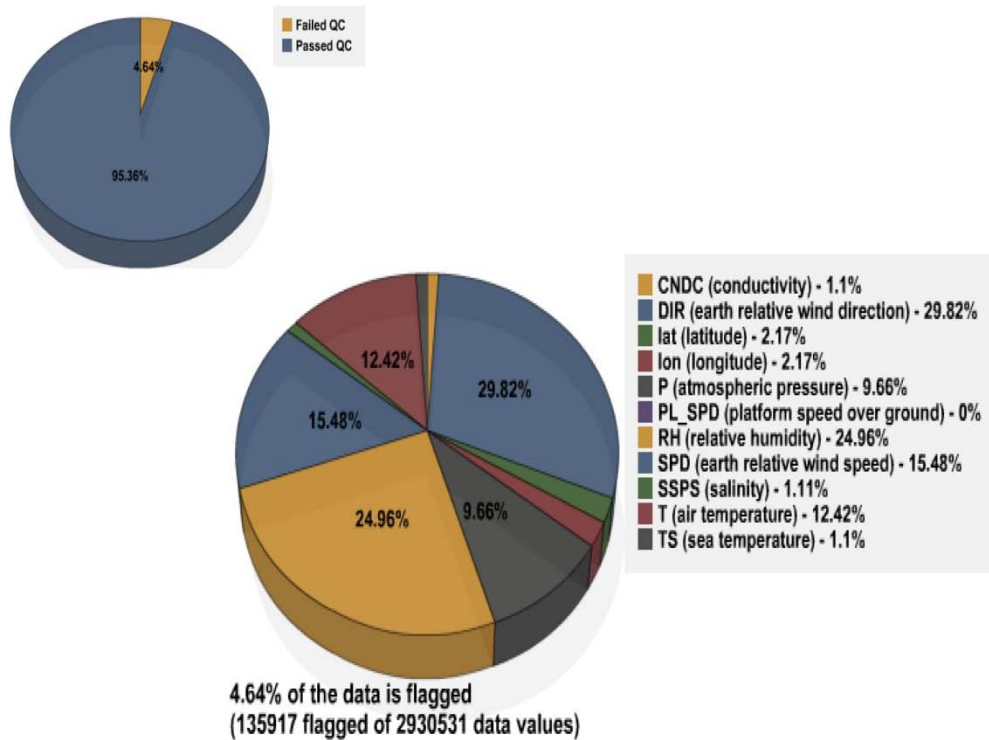(205889 flagged of 4421965 data values)
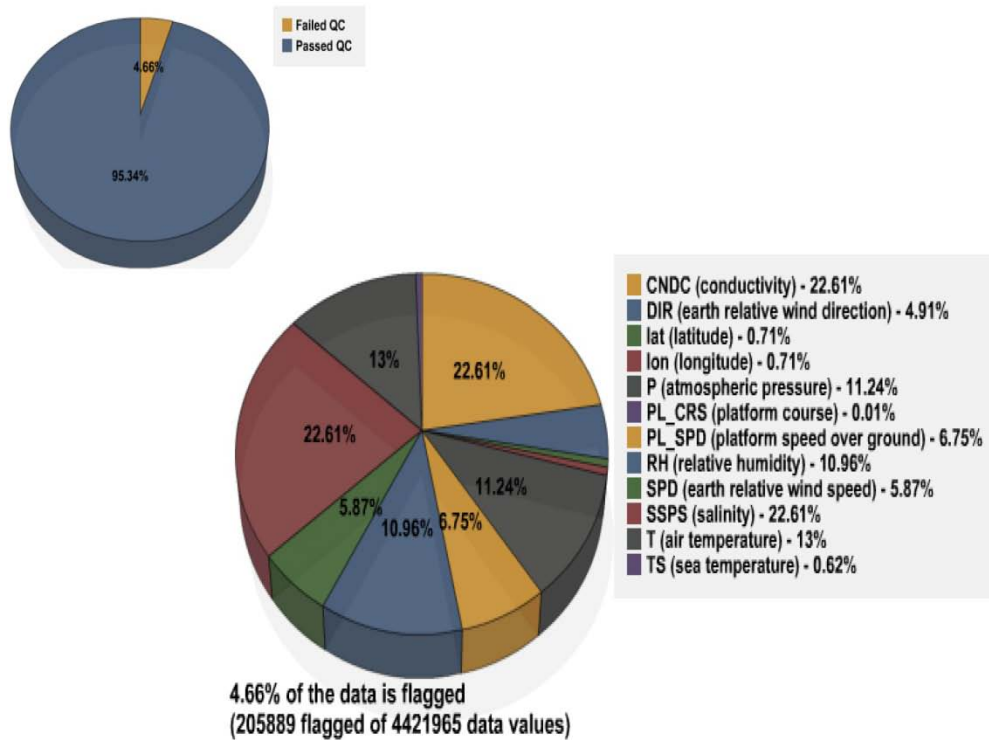
Figure 34: For the *Gordon Gunter* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

    The *Gordon Gunter* provided SAMOS data for 201 ship days, resulting in 4,421,965 distinct data values. After both automated and visual QC, 4.66% of the data was flagged using A-Y flags (Figure 34). This is essentially unchanged from 2010 (4.75% flagged), keeping the *Gunter* within the coveted < 5% flagged bracket for 2011.

    The biggest issue with the *Gunter* data concerned sea surface salinity (SSPS) and conductivity (CNDC), though the problem was not the same as in 2010, when the parameters exhibited unexplained erratic behavior. Rather, in 2011, it was simply a case of sensors and/or flow water systems being turned off, resulting in near-zero static values for both parameters. This resulted in a fair amount of poor quality (J) flagging (Figure 35).
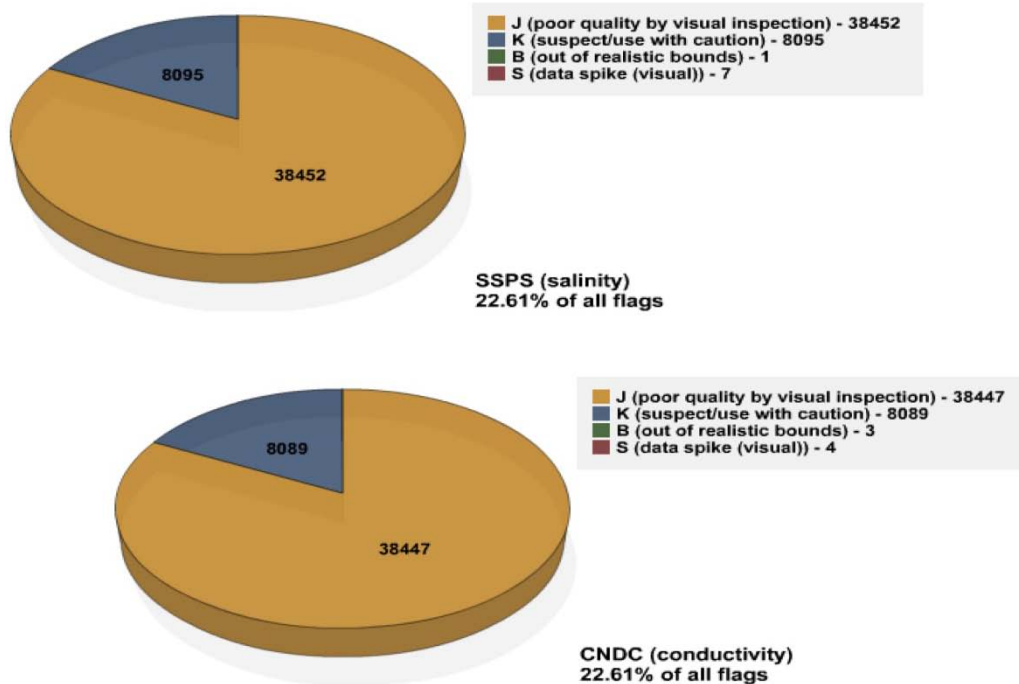
Figure 35: Distribution of SAMOS quality control flags for (top) salinity – SSPS – and (bottom) conductivity – CNDC – for the *R/V Gordon Gunter* in 2011.

## *Henry B. Bigelow*
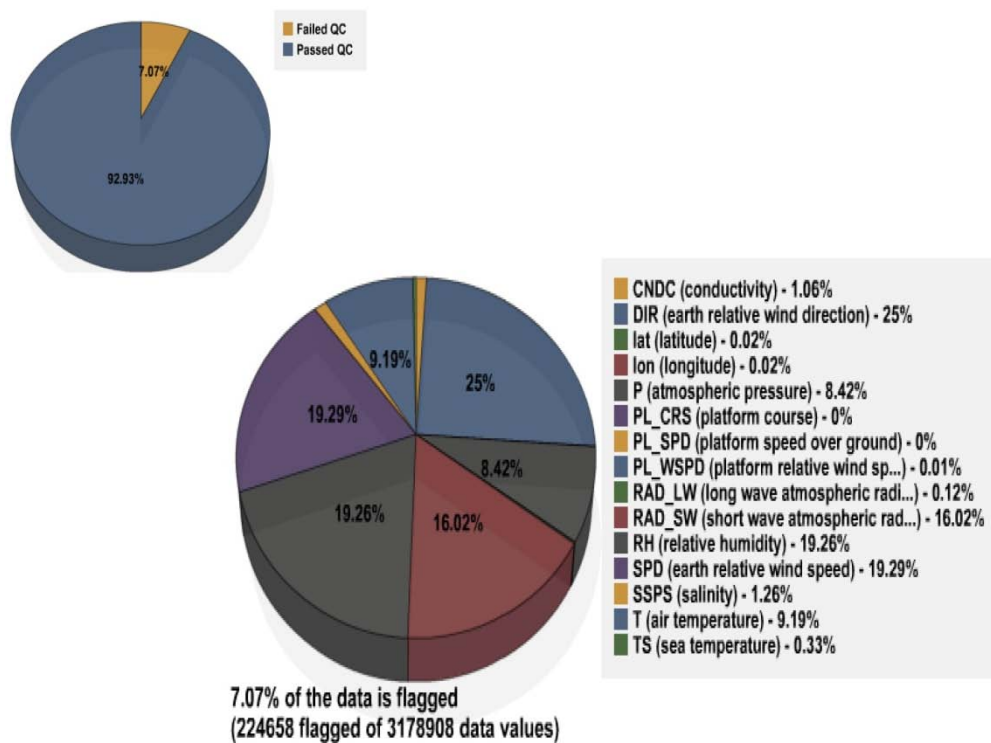


Figure 36: For the *Henry B. Bigelow* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Henry Bigelow* provided SAMOS data for 148 ship days, resulting in 3,178,908 distinct data values. After both automated and visual QC, 7.07% of the data was flagged using A-Y flags (Figure 36). This is a mere change of +0.8% from 2010 (6.27% flagged). Again, digital imagery of the sensor's location and more complete metadata for the sensor would help in diagnosing the issue.

Earth relative wind direction (DIR) and speed (SPD) and relative humidity (RH) showed signs of a fair amount of airflow obstruction. In all three cases this resulted in a number of caution/suspect (K) flags (Figure 37). The winds also experienced some failed true wind test (E) flagging. Additionally, RH encountered the common occurrence of near-saturation values actually being reported as >100%, due to sensor tuning (see 3b for details), which resulted in some out of bounds (B) flags. A similar situation led to a percentage of flags, mainly B flags, being applied to the short wave radiation (RAD_SW) parameter. The flags, similarly to many other SAMOS vessels, are applied mainly to the slightly negative short wave values that result from tuning the sensor for optimal performance at much higher values (see Section 3b).
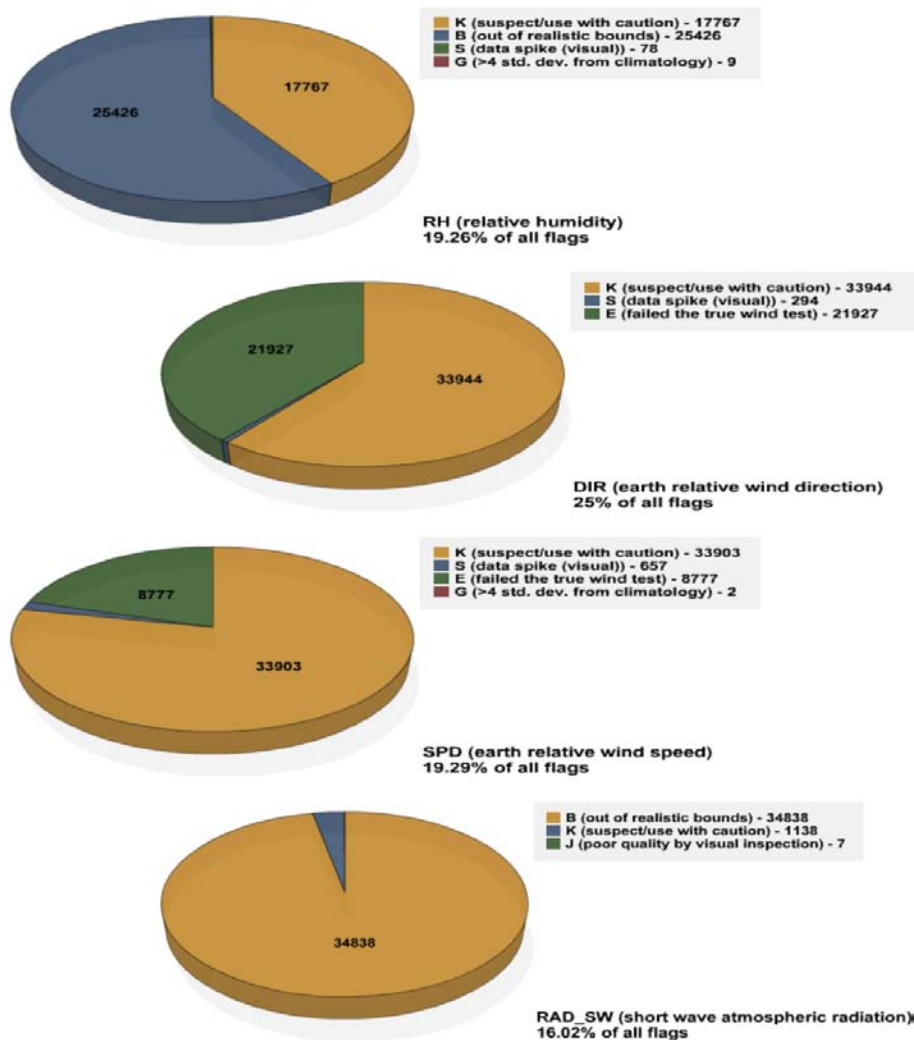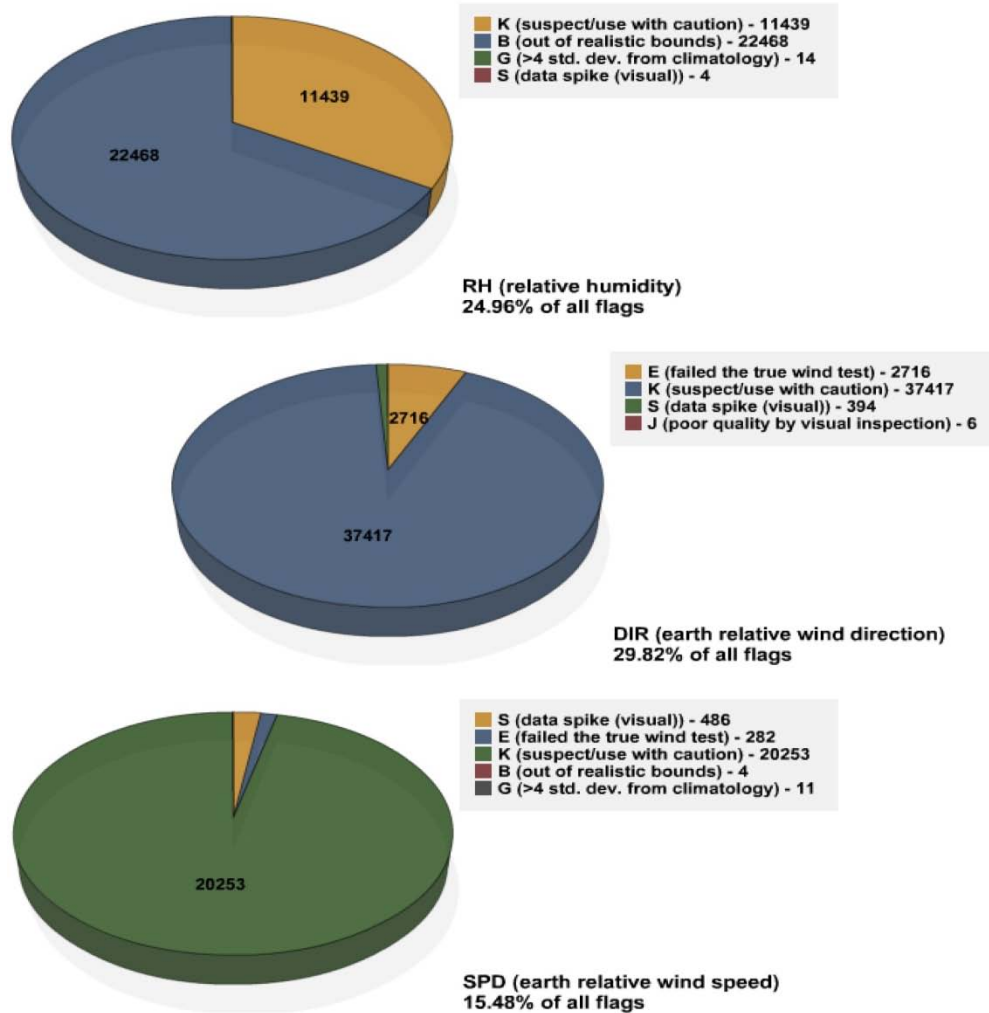


Figure 37: Distribution of SAMOS quality control flags for (first) relative humidity – RH – (second) earth relative wind direction – DIR – (third) earth relative wind speed – SPD – and (last) short wave atmospheric radiation – RAD_SW – for the *Henry B. Bigelow* in 2011.
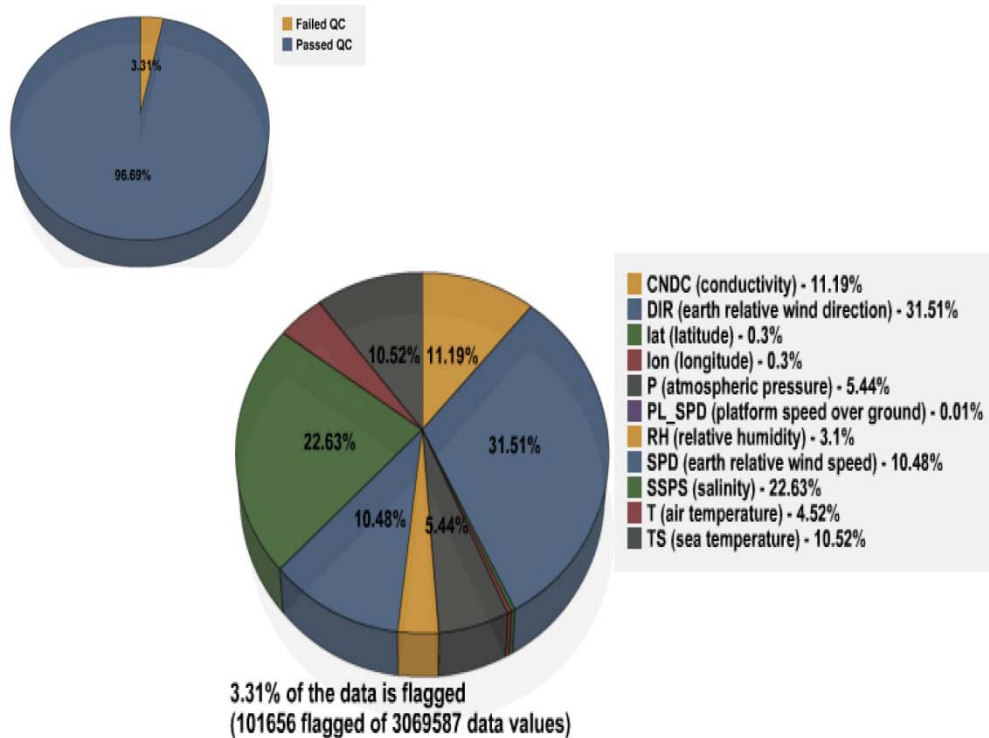
47
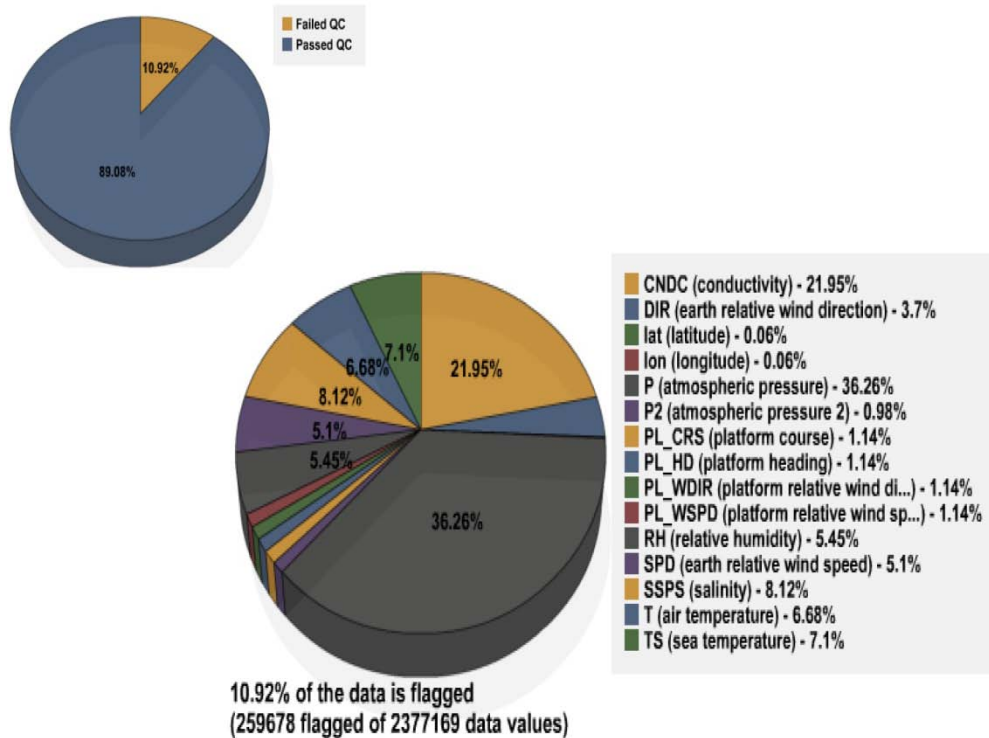
*Hi'ialakai*



Figure 38: For the *Hi'ialakai* from 1/1/11 through 12/31/11, (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 122 ship days, resulting in 2,377,169 distinct data values. After both automated and visual QC, 10.92% of the data was flagged using A-Y flags (Figure 38). This is virtually unchanged from 2010's 10.58% flagged.

The *Hi'ialakai* addressed their ongoing problem of atmospheric pressure (P) reading too low (throughout 2010 and 2009) when they relocated the sensor in February 2011. However, after reading in a reasonable range for just a few days, the pressure again began to track below what was expected (as compared to land stations/buoys). As a result, there was quite a bit of caution/suspect (K) and poor quality (J) flagging of the P parameter (Figure 39) during the first half of 2011. Then, on 08 August 2011 the *Hi'ialakai* enabled a second, brand-new pressure sensor that read spot-on. As a result, SAMOS personnel decided to deactivate the first (problematic) pressure sensor P in the SAMOS system and only include the good sensor's data (P2) in the QC'd SAMOS data files starting on 30 August 2011. It is expected that the *Hi'ialakai's* overall flag percentage will greatly improve in 2012 as a result of these actions. The other problem of note onboard the *Hi'ialakai* in 2011 concerned the conductivity (CNDC) parameter, which received ~22% of the total flags (Figure 39). From 17 February through 14 April 2011 conductivity values were not at all representative of real sea conditions. The values were always in the vicinity of 24 Siemens meter[-1], but it's unusual to see conductivities of even 7 Siemens meter[-1] or more anywhere in the ocean. There was a great deal of email communication

between SAMOS data analysts and the ship technician(s), as well as a good amount of troubleshooting on the part of the techs, until it was finally discovered that the value being reported wasn't actually conductivity; rather, it was a component of the conductivity measurement.  Once the problem was discovered it was immediately fixed. Perhaps precipitated by that chain of events, one of the HA's main technicians thereafter made a commitment to improving the SAMOS/shipboard interaction and has since then worked at improving *Hi'ialakai*'s instrument and vessel metadata.  She has also formulated her own version of the update metadata tutorial, many parts of which have been incorporated into the SAMOS update metadata tutorial (Annex A, Part 2).  The *Hi'ialakai* exemplifies the value of shore-side data monitoring and what can be achieved through a productive and mutually beneficial communicative relationship between ship techs and SAMOS personnel.
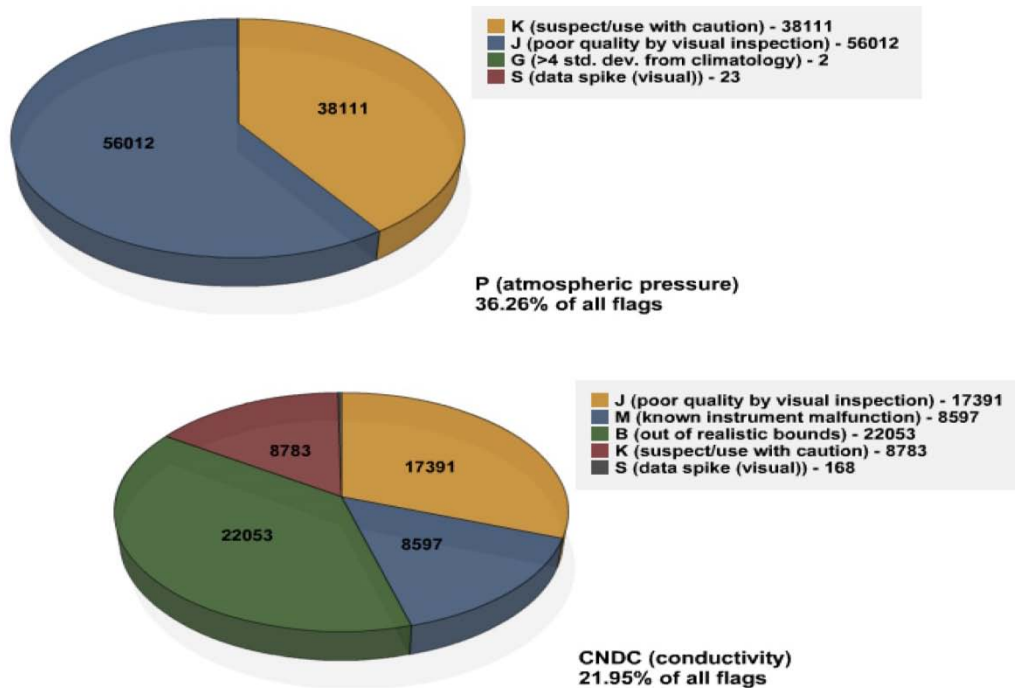


Figure 39: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – and (bottom) conductivity – CNDC –for the *R/V Hi'ialakai* in 2011.

*Ka'imimoana*



CNDC (conductivity) - 5.58%
DIR (earth relative wind direction) - 9.98%
lat (latitude) - 12.51%
lon (longitude) - 12.51%
P (atmospheric pressure) - 15.88%
RAD_LW (long wave atmospheric radi...) - 0.06%
RAD_SW (short wave atmospheric rad...) - 4.17%
RH (relative humidity) - 8.21%
SPD (earth relative wind speed) - 15.33%
SSPS (salinity) - 5.66%
T (air temperature) - 9.96%
TS (sea temperature) - 0.17%

3.07% of the data is flagged
(128697 flagged of 4187574 data values)

Figure 40: For the *Ka'imimoana* from 1/1/11 through 12/31/11, (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 *Ka'imimoana* provided SAMOS data for 190 ship days, resulting in 4,187,574 distinct data values. After both automated and visual QC, 3.07% of the data was flagged using A-Y flags (Figure 40). This is a slight improvement of -1.68% over the 2010 percentage (4.75% flagged), and *Ka'imimoana* remains in the highly desirable $< 5\%$ flagged bracket, denoting "very good" data overall.

It should again be stressed, as it was in 2009, that *Ka'imimoana* both provided one of the best data sets (with the atmospheric pressure exception) and represents one of the best instances of open communication between ship technicians and data analysts. From 05 January to 18 January 2011 the *Ka'imimoana's* latitude (LAT) and longitude (LON) data were land (L) flagged by the autoflagger (Figure 42) while she likely sat at port in Pearl Harbor (see Figure 41). Increasing the significant digits for the two parameters would probably prevent any such future occurrence, although this really isn't a worrisome issue to begin with. Other than the lat/lon issue, the rest of the flagging was pretty evenly spread amongst the meteorology and ocean parameters, suggesting no major problems, with just a slightly elevated amount of flagging present in atmospheric pressure (P) and earth relative wind speed (SPD). In the case of P, readings on the order of 1000x too high were discovered in mid-July, which led to some out of bounds (B) flagging of the parameter (Figure 42). Through ongoing communication with the *Ka'imi's* lead technician, it was realized that during the course of installing a new pressure sensor the SAMOS mailer was erroneously altered, resulting in the enormous pressure values. It was subsequently fixed and *Ka'imi* now provides appropriate pressure data. The issue

with SPD appears to be nothing more than a bit of flow distortion, resulting in caution/suspect (K) flags (Figure 42).



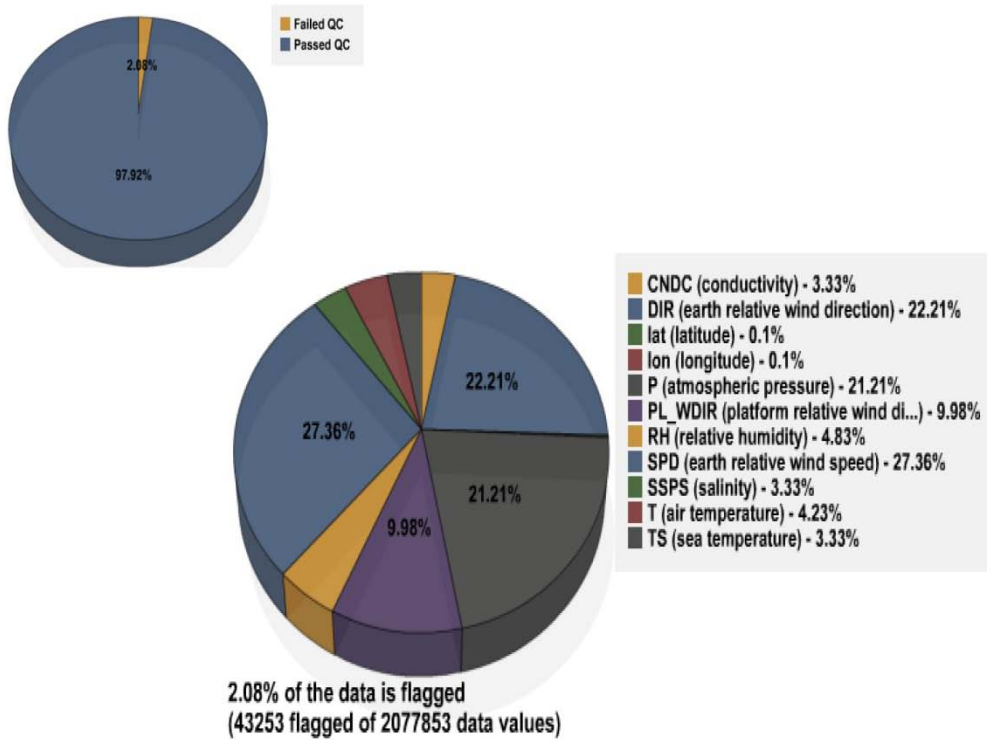Figure 41: 05 January 2011 ship location for the *Ka'imimoana* shown.
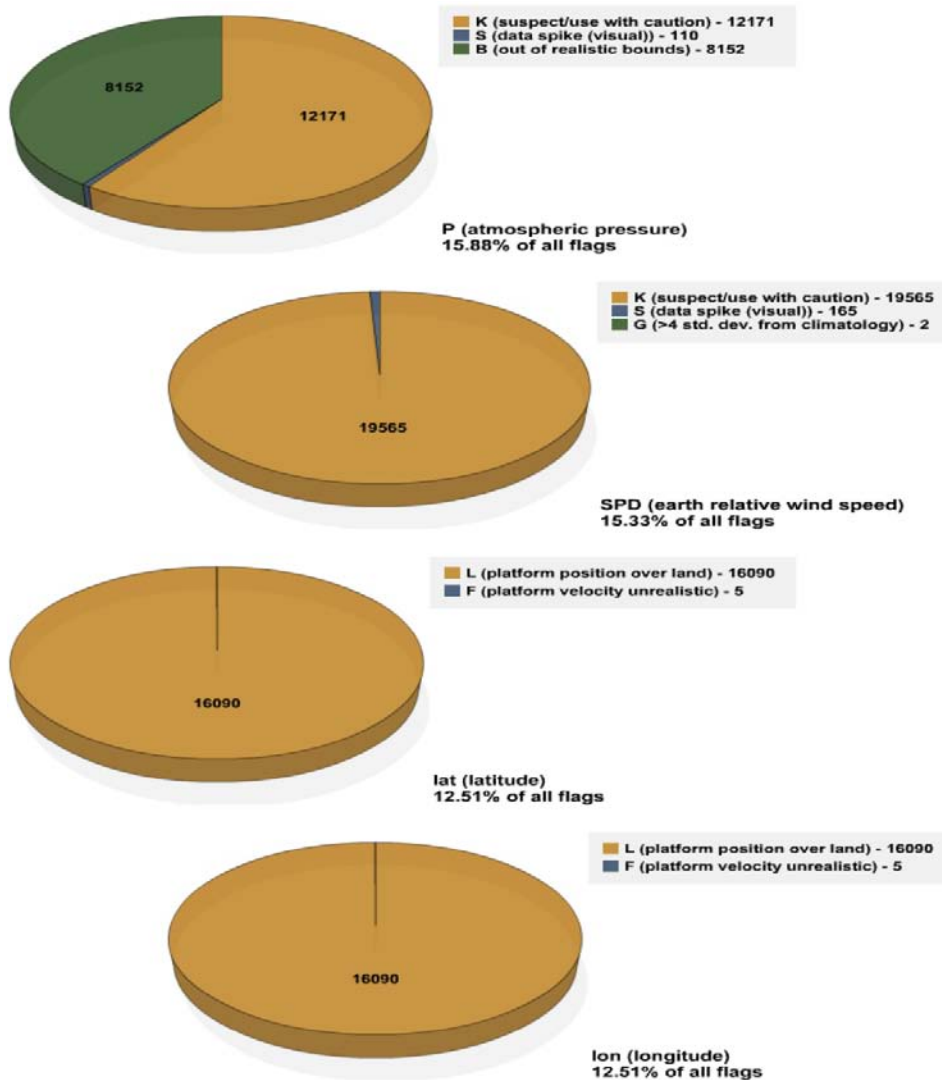


Figure 42: Distribution of SAMOS quality control flags for (first) atmospheric pressure – P – (second) earth relative wind speed – SPD – (third) latitude – lat – and (last) longitude – lon – on the *R/V Ka'imimoana* in 2011.

*McArthurII*
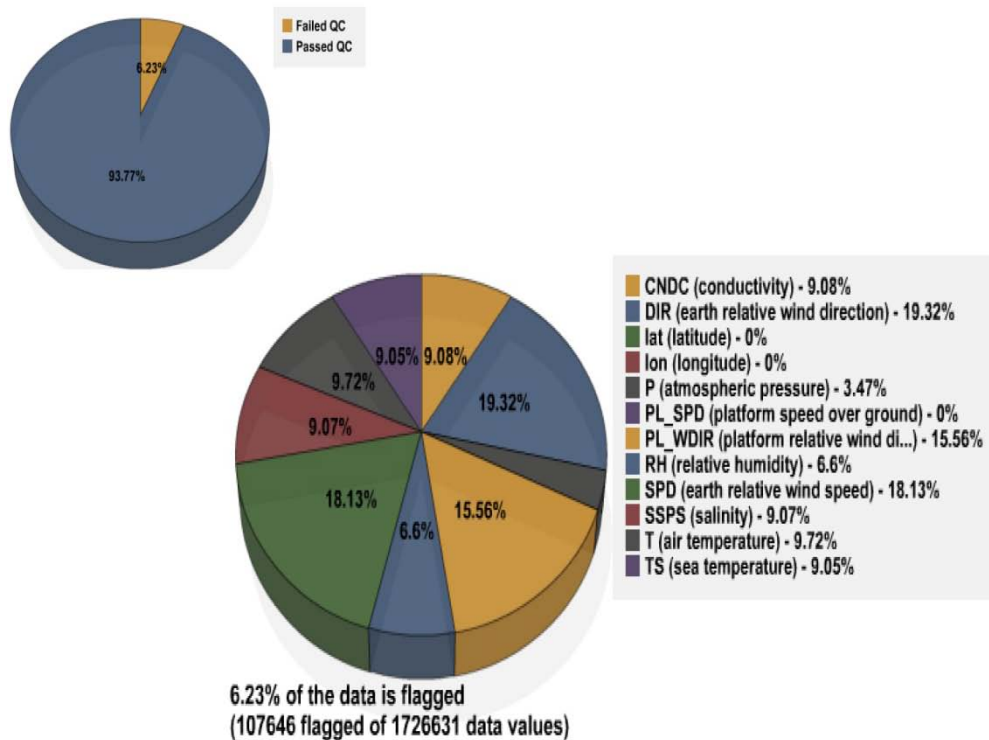


Figure 43: For the *McArthur II* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *McArthur II* provided SAMOS data for 84 ship days, resulting in 1,726,631 distinct data values. After both automated and visual QC, 6.23% of the data was flagged using A-Y flags (Figure 43). This change of +2.28% over 2010's 3.95% takes the *McArthur II* out of the $< 5\%$ flagged bracket denoting "very good" data. The main issue with the *McArthur II* in 2011 was the wind data: earth relative wind speed (SPD) and direction (DIR) together incurred almost 40% of the total flags, and the platform relative wind direction (PL_WDIR) garnered a further ~15.5% (Figure 45). In addition to the usual suspect (i.e. flow obstruction), a problem with PL_WDIR was discovered on 19 July 2011 (see Figure 44) whereby the value of PL_WDIR never went outside of the range of 0 to about 25 degrees. In fact, the data analyst felt that PL_WDIR pretty closely mimicked platform relative wind speed (PL_WSPD). The analyst communicated the issue and her suspicions to the *McArthur II* and quickly received word back that the tech had been having problems with a wind bird translator but was unaware there was a problem with the SAMOS data, as he had thought the SAMOS wind data came from a different sensor. The problem persisted until 31 July, at which time transmission of PL_WDIR and PL_WSPD stopped. Both parameters returned, in correct form, on 30 August.
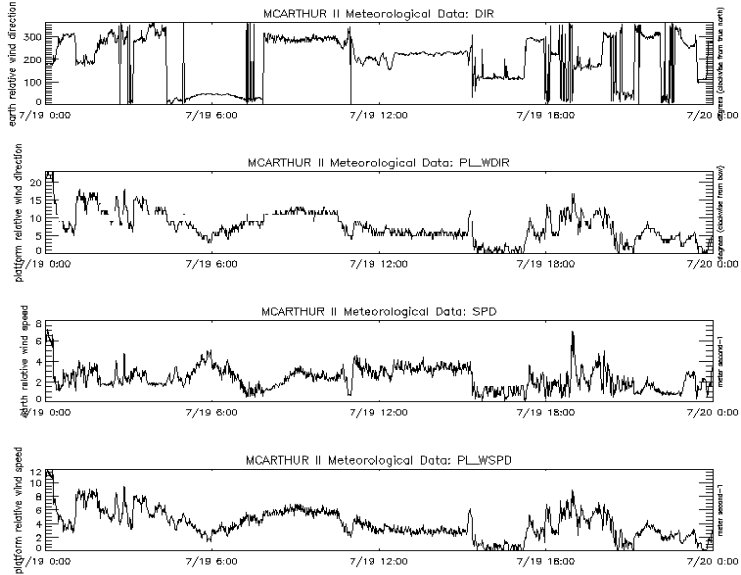
Figure 44: *McArthur II* SAMOS data for 19 July 2011: (first) earth relative wind direction – DIR – (second) platform relative wind direction – PL_WDIR – (third) earth relative wind speed – SPD – and (last) platform relative wind speed – PL_WSPD.  Note the striking similarity between PL_WDIR and PL_WSPD.  This behavior resulted in both K and J flagging of PL_WDIR as well as subsequent K and J flagging of the earth relative wind parameters, as they are derived in part from PL_WDIR.
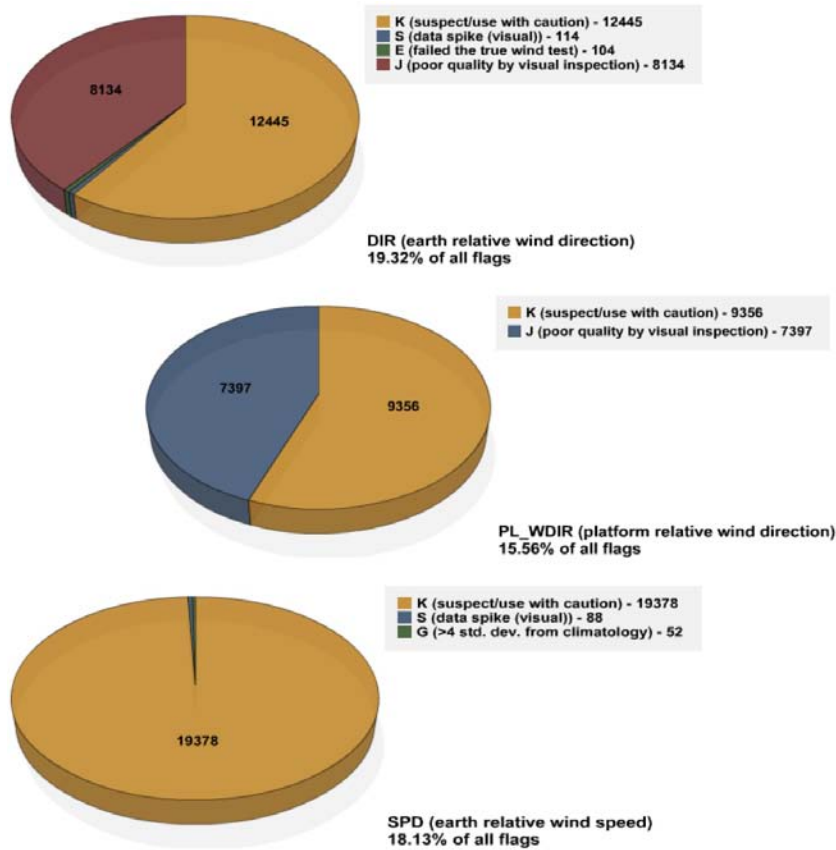


Figure 45: Distribution of SAMOS quality control flags for (top) earth relative wind direction – DIR – (middle) platform relative wind direction – PL_WDIR – and (bottom) earth relative wind speed – SPD – for the *R/V McArthur II* in 2011.
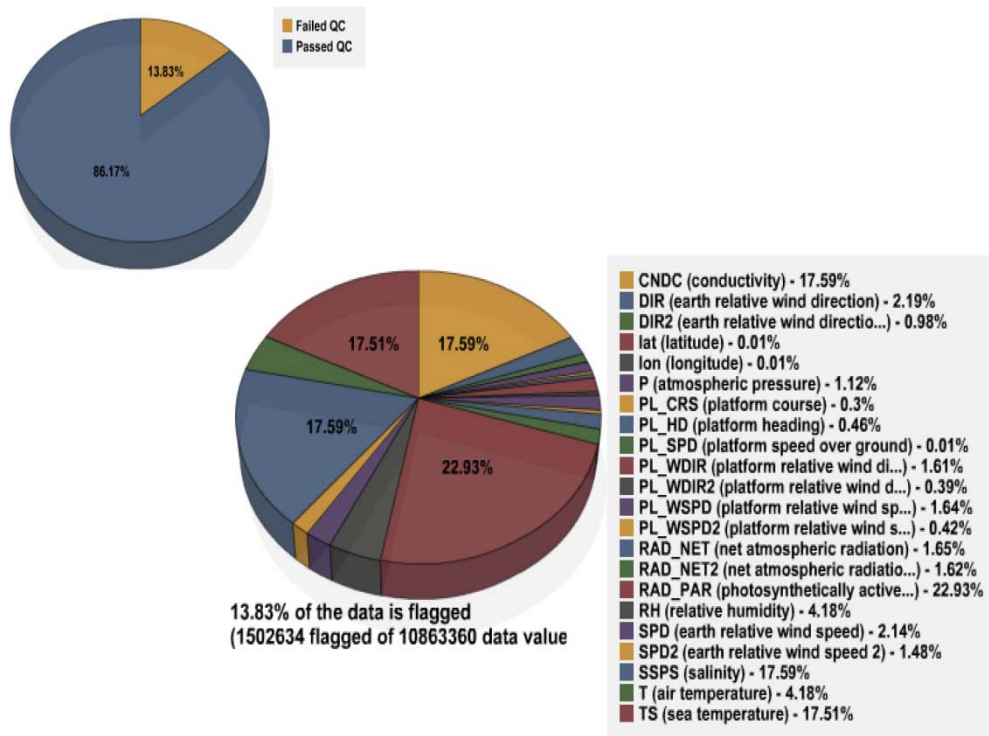
*Nancy Foster*



Figure 46: For the *Nancy Foster* from 1/1/11 through 12/31/11, (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 132 ship days, resulting in 2,762,595 distinct data values. After both automated and visual QC, 8.99% of the data was flagged using A-Y flags (Figure 46). While this is an improvement over 2010's 12.07%, it MUST be stressed that the *Foster's* long-standing relative humidity problem still persists, after several years. As stated, the overwhelming problem with *Nancy Foster's* data in 2011 continued to be the known malfunction of the relative humidity parameter. The problem was three-fold (refer to Figure 47, an extremely clear example taken from 2009 data): First, the readings displayed an improbably minimal amount of variability. Operating along the eastern seaboard and the Gulf of Mexico out of Norfolk, VA the *Foster* would likely have experienced cold fronts, fog, convective storms etc. at some point, but these natural variations never occurred in the RH data. Second, the data did not appear to adhere to the equation of state $p = \rho RT$ (where $p$ is pressure, $\rho$ is air density, $T$ is air temperature, and $R$ is a constant value); meteorologically speaking, this equation means that for the most part when the air temperature increases relative humidity should decrease, except in special situations such as a convective storm. Contrary to this rule of general behavior, however, the shape of the *Foster's* relative humidity traces always mimicked exactly the shape of the air temperature trace. Third, the number of decimal places being returned in the data was inconsistent. The readings normally came out in whole percents but would sporadically go into finer (~.01%) resolution. With roughly 60 samples per minute, it seemed highly unlikely the average value would almost always come out to a whole number. Both SAMOS personnel and *Foster* personnel were aware

of the issues and had a lot of discussion in 2009, as well as heavy reiteration during a SAMOS/NOAA teleconference in November 2010 and a second teleconference in July 2011.. As a consequence of these problems, RH was flagged with malfunction (M) flags yet again for the duration of 2011 (Figure 48). *The authors wish to make note that as of distribution of this report, the problem with relative humidity onboard the Nancy Foster has been fixed.*
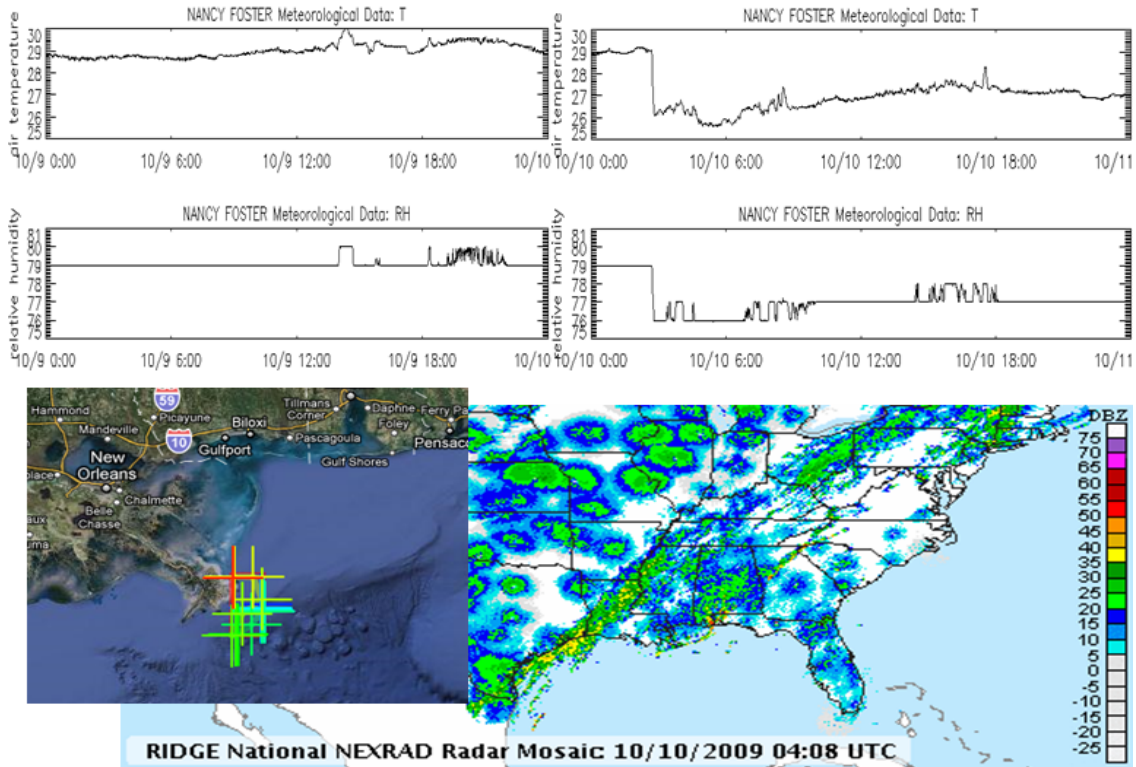


Figure 47: (top) *Nancy Foster* SAMOS air temperature (°C) – T – and relative humidity (%) – RH – data for 9 October through 10 October 2009; (bottom) archived NEXRAD radar image for 10 October 2009 at approximately 04:00 UTC (photo courtesy http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwNexrad~SelectedImage ~20091010~0400) with (inset) 9 October 2009 ship track for the *Foster* shown. Nearby Boothville, LA reported a maximum humidity of 94% and rain around 10pm local (03:00 UTC), and the radar image suggests rain at the vessel location around 04:00 UTC. RH data for the *Foster*, however, gives no evidence of saturation and rain, even around the frontal passage evident in the SAMOS RH trace around 03:00 UTC. The RH traces exhibit all 3 problems mentioned in the text: minimal variability, constant mirroring of T behavior, and apparent inconsistency of decimal accuracy.
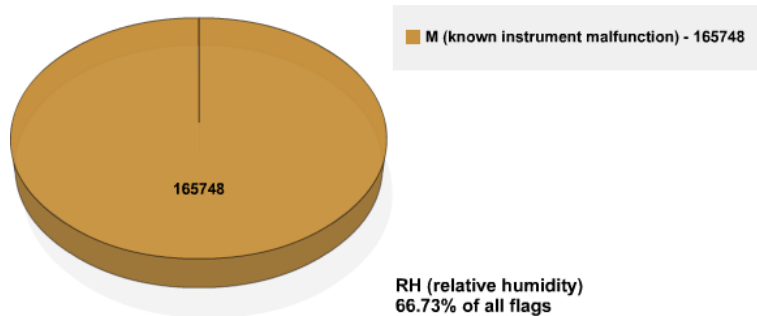


Figure 48: Distribution of SAMOS quality control flags for relative humidity – RH –for the *R/V Nancy Foster* in 2011.
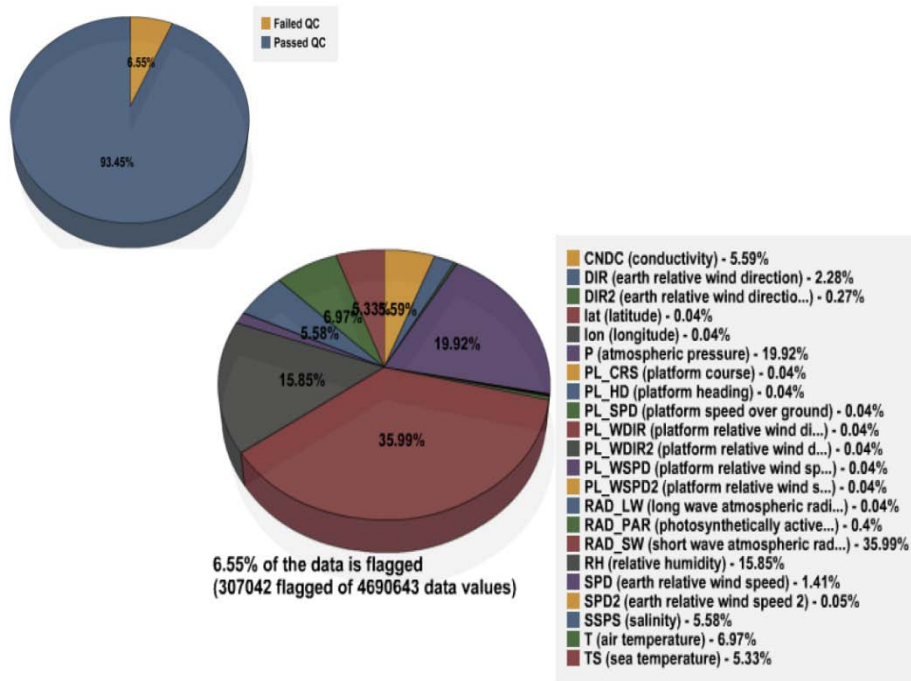
55

***Okeanos Explorer***



Figure 49: For the *Okeanos Explorer* from 1/1/11 through 12/31/11, (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 109 ship days, resulting in 2,327,387 distinct data values. After both automated and visual QC, 8.61% of the data was flagged using A-Y flags (Figure 49). With a deviation of only +0.24% from 2010 (8.37% flagged), data quality for the *Explorer* is essentially unchanged from 2010.

Overwhelmingly, the *Explorer's* largest data quality problem occurred with the atmospheric pressure (Figure 50), holding ~70% of the total flags. Although the previous pressure issue was resolved back in 2010(namely, pressure readings being consistently and unquestionably too high for their geographic location),values were still offset by a few millibars. Through discussions with *Explorer* personnel, it is clear the issue involved a +3.9mb "correction" applied to the pressure data at the behest of the National Weather Service, to whom the *Explorer* provides three-hourly data. (The +3.9, however, did not seem to be quite the "correct" value to apply, as readings were a little too low as compared to nearby land stations and buoys.) As a result, P incurred a large amount of caution/suspect (K) flagging throughout 2011. It's also noteworthy that *Okeanos Explorer* personnel provided new metadata for most sensors in March 2011.
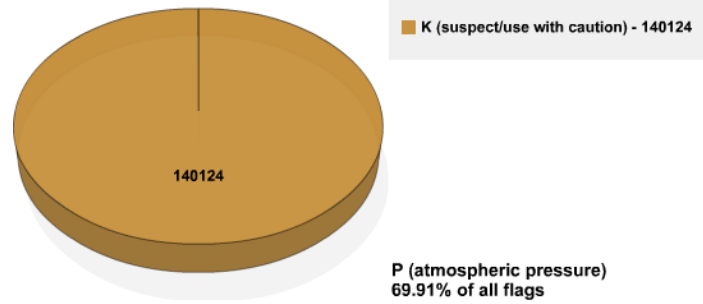
Figure 50: Distribution of SAMOS quality control flags for atmospheric pressure – P for the *R/V Okeanos Explorer* in 2011.

### *Oregon II*



2.87% of the data is flagged
(79438 flagged of 2769060 data values)

Figure 51: For the *Oregon II* from 1/1/11 through 12/31/11, (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 156 ship days, resulting in 2,769,060 distinct data values. After both automated and visual QC, 2.87% of the data was flagged using A-Y flags (Figure 51). This is a deviation of -2.93% from 2010 (5.8% flagged). This appreciable improvement puts *Oregon II* below the < 5% flagged threshold regarded by SAMOS to represent "very good" data. *Oregon II* also took second place for lowest flag percentage of all SAMOS vessels receiving visual QC in 2011.

With such a low total flag percentage one intriguing possibility continues to exist regarding the fairly even distribution of these flags: the authors can surmise that no severe flow obstruction and/or stack exhaust contamination issues exist with the *Oregon*

*II*. (Indeed, it appears no major issues of any kind exist on the *Oregon*!)  Again, if this conjecture is accurate, it might imply the *Oregon II* is a model vessel for ideal sensor placement.  However, no digital imagery exists in the SAMOS database for the *Oregon II* and location metadata for all meteorological parameters is unavailable.

### *Oscar Dyson*



Figure 52: For the *Oscar Dyson* from 1/1/11 through 12/31/11, (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 141 ship days, resulting in 2,930,531 distinct data values.  After both automated and visual QC, 4.64% of the data was flagged using A-Y flags (Figure 52).  This is an improvement of -2.16% over  2010's 6.8%, an improvement which it is well worth mentioning brings the *Dyson* within the <5% flagged bracket for "very good" data.

The logic behind the flagging of the MET parameters  remains essentially unchanged from the 2010 analysis, although obviously with improvement to the flag percentages. With some vessels, the *Dyson* among them, SAMOS data analysts can attempt to compile a list of platform-relative wind direction bands that routinely produce compromised readings from the various MET sensors.  The *Dyson* retains one of the longest lists of suspicious wind bands.  This suggests the *Oscar Dyson* experiences a multitude of platform-relative wind directions where the airflow to the sensors is obstructed.  It is worth mentioning that the *Dyson* spends a lot of time in fjord regions and rounding the many mountainous island of Alaska, with the result that the vessel often travels through erratic winds.  But while this complicates the data analysts attempts to identify obstructed platform relative wind directions, several bands of platform relative wind directions have

nevertheless been identified with a fair amount of confidence. The vessel's cruise activity commonly requires repeated turns, passing the various MET sensors back and forth through these wind bands. The result is frequent caution/suspect (K) flags on atmospheric pressure (not shown), air temperature (not shown), relative humidity, and both earth relative wind parameters (Figure 53). Relative humidity also incurred some out of bounds (B) flagging in near-saturation conditions that actually read as slightly over 100% (see section 3b for detail).



Figure 53: Distribution of SAMOS quality control flags for (top) relative humidity – RH – (middle) earth relative wind direction – DIR – and (bottom) earth relative wind speed – SPD – for the *R/V Oscar Dyson* in 2011.

*Oscar Elton Sette*



CNDC (conductivity) - 11.19%
DIR (earth relative wind direction) - 31.51%
lat (latitude) - 0.3%
lon (longitude) - 0.3%
P (atmospheric pressure) - 5.44%
PL_SPD (platform speed over ground) - 0.01%
RH (relative humidity) - 3.1%
SPD (earth relative wind speed) - 10.48%
SSPS (salinity) - 22.63%
T (air temperature) - 4.52%
TS (sea temperature) - 10.52%

3.31% of the data is flagged
(101656 flagged of 3069587 data values)

Figure 54: For the *Oscar Elton Sette* from 1/1/10 through 12/31/10, (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 147 ship days, resulting in 3,069,587 distinct data values. After both automated and visual QC, 3.31% of the data was flagged using A-Y flags (Figure 54). This is a great deviation of -3.75% from 2010 (7.06% flagged), bringing the *Sette* well inside of the <5% flagged bracket, denoting "very good" data.

Nearly half of the flagged data is comprised of earth relative wind direction and earth relative wind speed (~31% and ~18%, respectively). This is very similar to the *Sette's* performance in 2009 (although with a somewhat lowered percentage for SPD – ~18% vs. ~31% in 2009); however, the issue is not the same. In 2009, the *Sette* experienced an extended duration where the algorithm used to calculate the true winds was incorrectly removing the vessel's motion. As in 2010, the *Sette's* winds still seems to endure caution/suspect (K) and failed true wind recomputation test (E) flags, particularly the earth relative wind direction (DIR) parameter (Figure 56, top). Once again it's believed the culprit is airflow-obstructed platform relative wind directions. This problem is easily picked out visually in the data by the appearance of "steps". However, it should be stressed that the *Sette* appears to have a particularly comprehensive set of "bad" relative wind directions, which are extremely difficult to nail down and diagnose since there is no sensor location metadata or digital imagery available. The other issue of note on the *Sette* in 2011 involved the sea parameters: sea temperature (TS), salinity (SSPS, shown in Figure 56, bottom), and conductivity (CNDC). As demonstrated in Figure 55, the three

parameters often arbitrarily exhibited unusual behavior not typical of sea water, regardless of whether the vessel was cruising or not. The cause is not known, but the analysts suspect a faulty sensor.
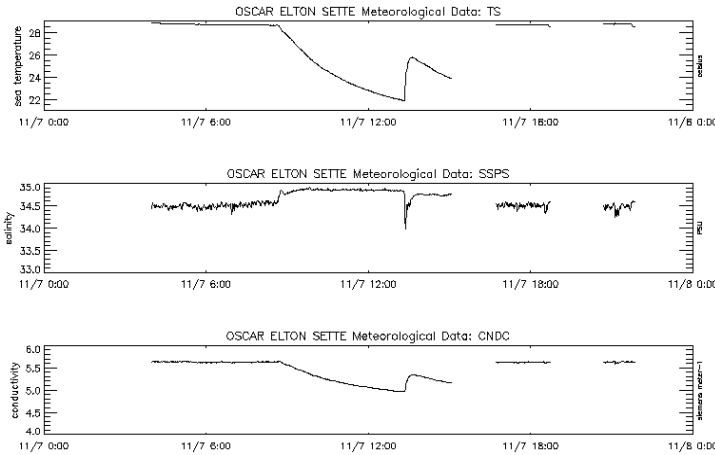


Figure 55: *Oscar Elton Sette* SAMOS data for 07 November 2011: (top) sea temperature – TS – (middle) salinity – SSPS – and (bottom) conductivity – CNDC. Note unusual behavior between approximately 8:00 and 15:00.
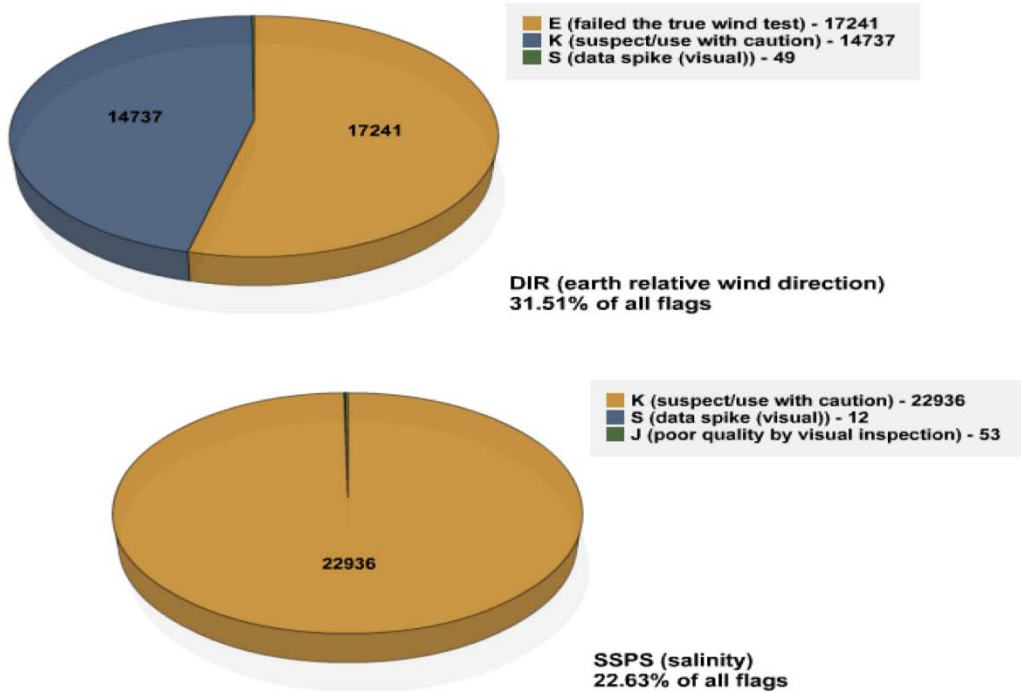


Figure 56: Distribution of SAMOS quality control flags for (top) earth relative wind direction – DIR – and (bottom) salinity – SSPS –for the *R/V Oscar Elton Sette* in 2011.

*Pisces*





DIR (earth relative wind direction) - 24.19%
lat (latitude) - 0.02%
lon (longitude) - 0.02%
P (atmospheric pressure) - 27.27%
PL_WDIR (platform relative wind di...) - 0.02%
PL_WSPD (platform relative wind sp...) - 1.82%
RH (relative humidity) - 7.81%
SPD (earth relative wind speed) - 21.68%
SSPS (salinity) - 4.02%
T (air temperature) - 9.15%
TS (sea temperature) - 3.99%

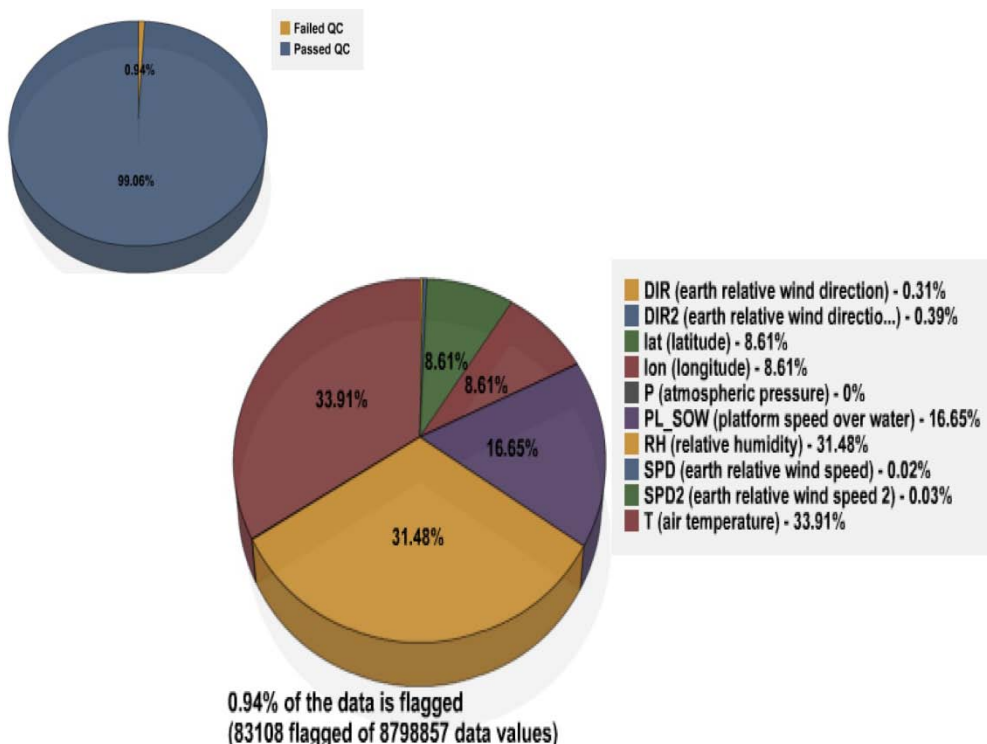11.38% of the data is flagged
(352796 flagged of 3100712 data values)

Figure 57: For the *Pisces* from 1/1/11 through 12/31/11, (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 157 ship days, resulting in 3,100,712 distinct data values. After both automated and visual QC, 11.38% of the data was flagged using A-Y flags (Figure 57). This number is essentially unchanged from 2010's 11.44%, and the flag distribution and reasoning remains the same as well. Pisces wind data was among the least reliable of vessels reporting to SAMOS. Indeed, earth relative wind speed and direction received the highest percentage of flags for the *Pisces*, totaling a combined ~46% of all flags. Most of the flags applied to earth relative wind data were caution/suspect (K) flags (Figure 58, middle and bottom). Upon inspection, the most notable cause appeared to be airflow obstruction occurring for multiple platform relative wind directions. However, without adequate metadata or digital imagery of the vessel, it is difficult to adequately diagnose any of these problems. It should be noted, though, that these wind issues were specifically communicated to NOAA personnel in November 2010 during a SAMOS/NOAA teleconference. It was expected the issues would be addressed sometime in 2011, but no action has been communicated to the SAMOS DAC to date.

Atmospheric pressure (P) also received a substantial portion of the total flags, mostly of the K variety (Figure 58, top). Upon inspection, it appears that the atmospheric pressure sensor also suffers from airflow obstruction, although again more detailed metadata are needed to accurately diagnose the condition.

The authors also would like to stress that conductivity is still not reported from the *Pisces*, although it is presumably available from the same thermosalinograph that provides the salinity data. Adding the conductivity parameter to the *Pisces* data set would be highly desirable in 2012.
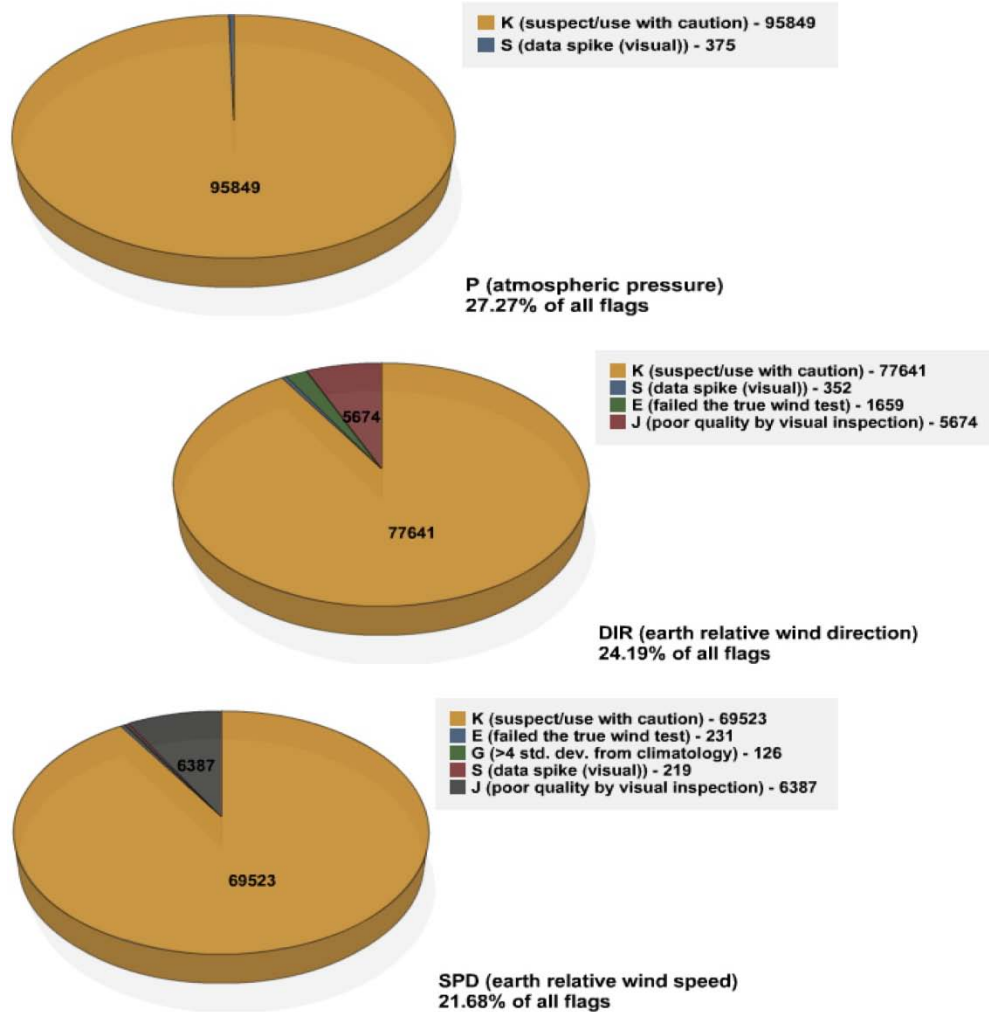


Figure 58: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) earth relative wind direction – DIR – and (bottom) earth relative wind speed – SPD – for the *Pisces* in 2011.

*Ronald H. Brown*



CNDC (conductivity) - 3.33%
DIR (earth relative wind direction) - 22.21%
lat (latitude) - 0.1%
lon (longitude) - 0.1%
P (atmospheric pressure) - 21.21%
PL_WDIR (platform relative wind di...) - 9.98%
RH (relative humidity) - 4.83%
SPD (earth relative wind speed) - 27.36%
SSPS (salinity) - 3.33%
T (air temperature) - 4.23%
TS (sea temperature) - 3.33%

2.08% of the data is flagged
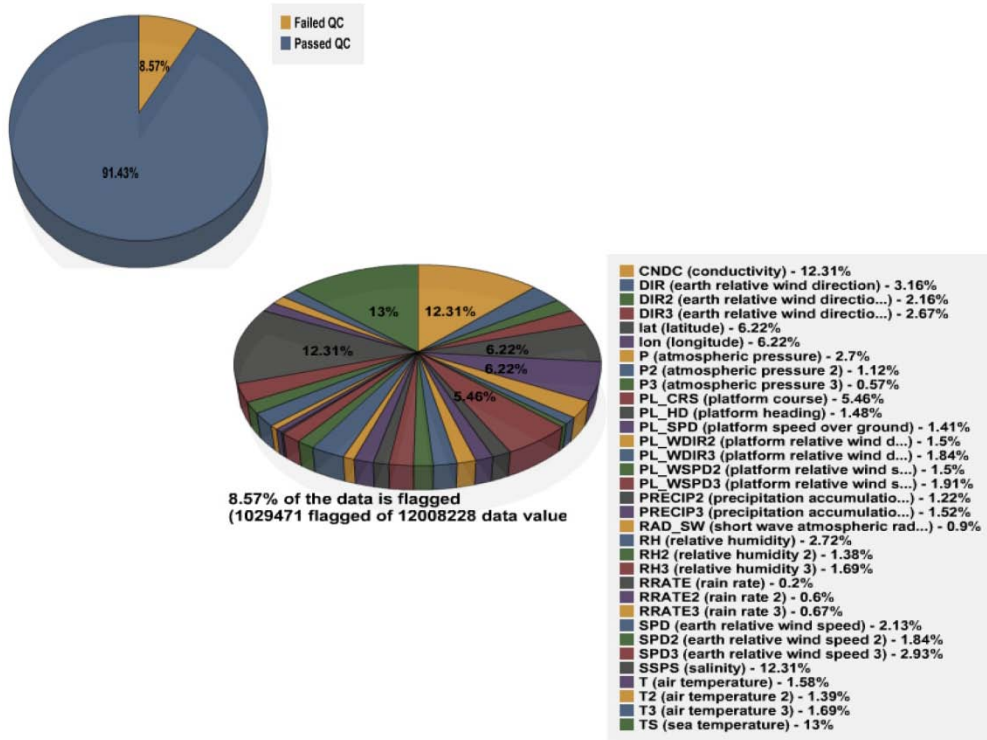(43253 flagged of 2077853 data values)

Figure 59: For the *Ronald H. Brown* from 1/1/11 through 12/31/11, (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 SAMOS data center has a long history of evaluating the data quality for the *Ron Brown*. A number of previous discussions with the vessel technicians had resulted in great improvements to the vessel's data quality. Unfortunately, due to a communication oversight, in 2011 the *Ron Brown* provided SAMOS data for only 97 ship days, resulting in just 2,077,853 distinct data values. (Referring to Figure 2 in section 2, though, a clear restart of data transmission followed a teleconference with OMAO in July.) After both automated and visual QC, 2.08% of the data was flagged using A-Y flags (Figure 59). This deviation of -1.54% from 2010 (3.62% flagged) put the *Ron Brown* in first place for lowest flag percentage of all SAMOS vessels receiving visual QC in 2011. However, this analyst wonders if the smaller sample size has any bearing on that result; it would have been interesting to see whether the providing of all available *Ron Brown* data in 2011 had any effect on the flag percentage. In any case, though, it still seems safe to say that the *Ron Brown* provides one of the most reliable data sets in all of SAMOS.

Quite similar to 2009 and 2010, the three variables most frequently failing SAMOS QC in 2011 (Figure 60) were the earth relative wind direction (DIR), earth relative wind speed (SPD), and atmospheric pressure (P). The authors suspect again for 2011 that some small amount of flow obstruction is the most likely cause of the problems. Since recruitment into SAMOS, the metadata for most all sensors is incomplete for the *Ron Brown* and no recent digital imagery exists in the database to ascertain the current location of the sensors. Therefore, the authors cannot confirm our suspicions as to the source of the QC flags during 2011.

K (suspect/use with caution) - 9130
S (data spike (visual)) - 28
G (>4 std. dev. from climatology) - 15

9130

P (atmospheric pressure)
21.21% of all flags

K (suspect/use with caution) - 9513
S (data spike (visual)) - 95

9513

DIR (earth relative wind direction)
22.21% of all flags

K (suspect/use with caution) - 11662
S (data spike (visual)) - 66
G (>4 std. dev. from climatology) - 104

11662

SPD (earth relative wind speed)
27.36% of all flags

Figure 60: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P – (middle) earth relative wind direction – DIR – and (bottom) earth relative wind speed – SPD for the *R/V Ronald H. Brown* in 2011.

*Laurence M. Gould*



Figure 61: For the *Laurence M. Gould* from 1/1/11 through 12/31/11, (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 328 ship days, resulting in 10,863,360 distinct data values. After both automated and visual QC, 13.83% of the data was flagged using A-Y flags (Figure 61). This is a change of +3.42% from 2010 (10.41% flagged).

As always, it is important to note that the location and exposure of the instruments on the *Gould* contribute to problems with the atmospheric observations. The T/RH sensor is located low on the mid-ship instrument mast, which is located aft of the vessel stack and main superstructure. In addition to being poorly exposed to the free atmosphere when the winds are from the forward portion of the vessel, some ship relative wind angles will contaminate the T/RH sensor with the ship's exhaust (typically resulting in increased T and RH values).Winds are also easily contaminated by flow distortion, again owing to the massive superstructure and block construction resident on the *Gould*.

The largest portion of flags, however, belongs to the sea parameters of sea temperature (TS), conductivity (CNDC), and salinity (SSPS), and to the photosynthetically active radiation parameter (RAD_PAR). In the case of the sea parameters, poor quality (J) flags were applied almost exclusively when the sea water pumps were turned off due to vessel either being in ice or in port (Figure 64). Regarding RAD_PAR, applied flags are primarily out of bounds (B) flags (Figure 64). These flags were applied to values well below zero. In fact, RAD_PAR data for the *Gould* experienced an offset of about -500 microeinsteins meter$^{-2}$ second$^{-1}$ for the majority of 2011 (see Figure 62). According to

*Gould* personnel, the sensor likely experienced a drift in calibration, which was not fixed until 02 November 2011.

Also of note but not shown in Figure 64 is the problem of *Gould's* anemometers occasionally freezing (see Figure 63). Given that the *Gould* routinely cruises in the frigid Antarctic, this is certainly to be expected. It does result, however, in caution/suspect (K) and poor quality (J) flagging of the affected wind data, both true and platform-relative.
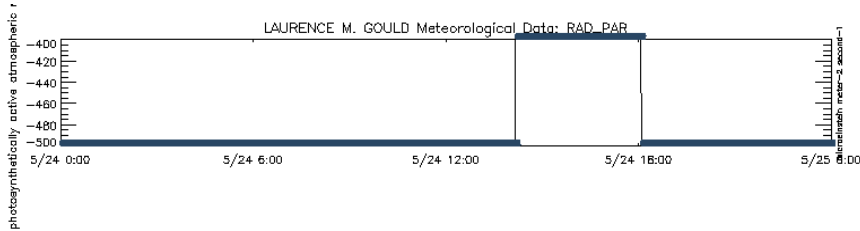


Figure 62: *Laurence M. Gould*: SAMOS data for 24 May 2011: photosynthetically active radiation – RAD_PAR. Note the erroneous -500 microeinsteins meter$^{-2}$ second$^{-1}$ offset.
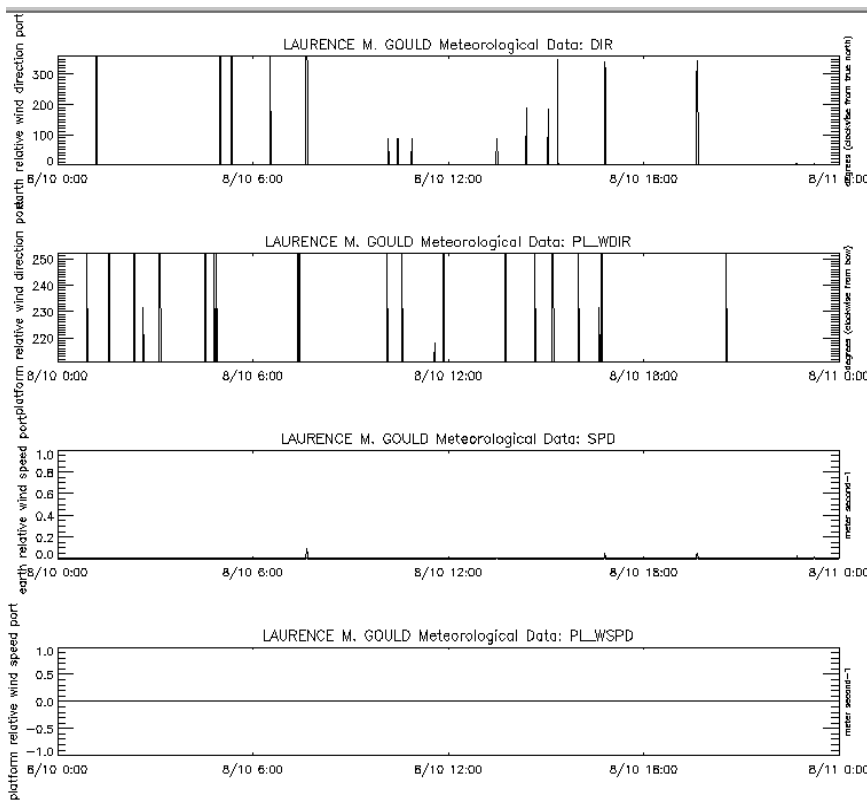


Figure 63: Example of frozen anemometer data for *Laurence M. Gould*: SAMOS data for 10 August 2011: (first) earth relative wind direction – DIR – (second) platform relative wind direction – PL_WDIR – (third) earth relative wind speed – SPD – and (last) platform relative wind speed – PL_WSPD.
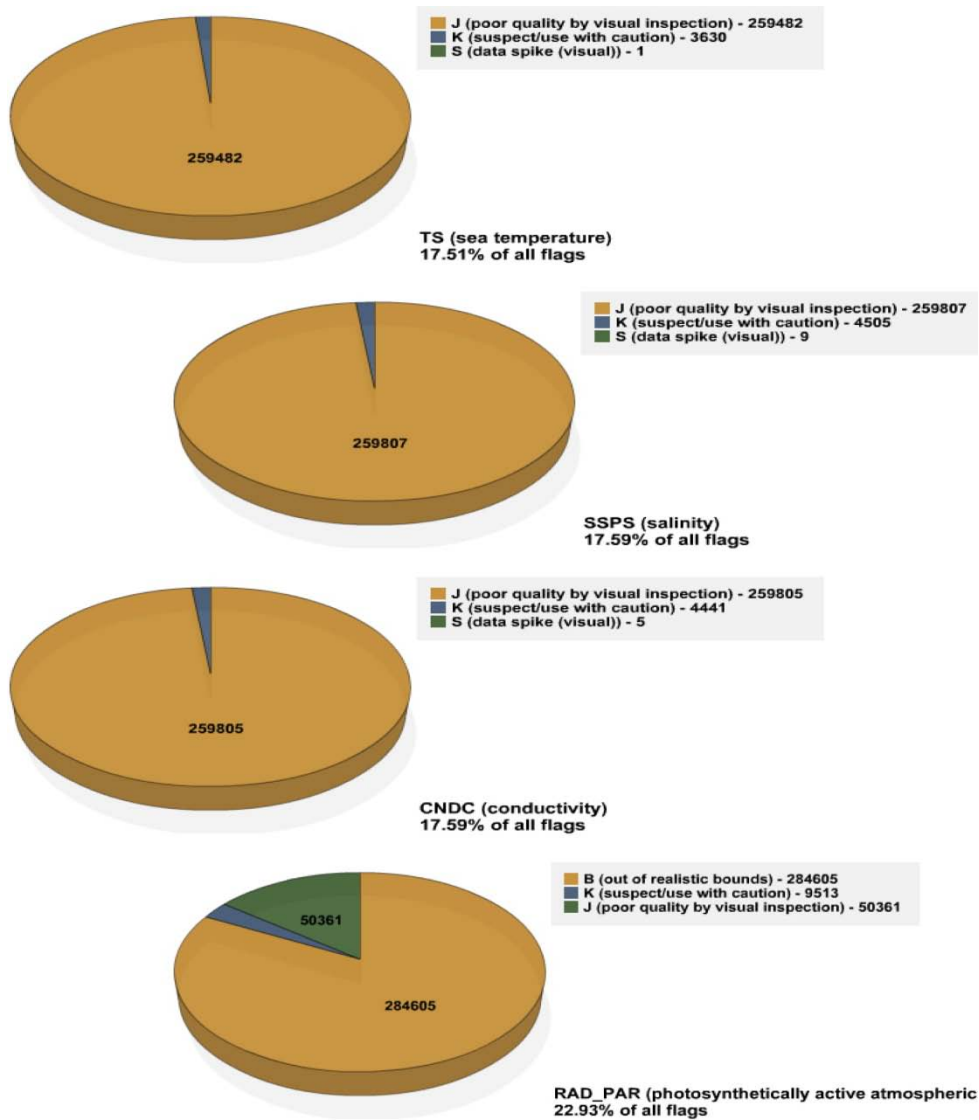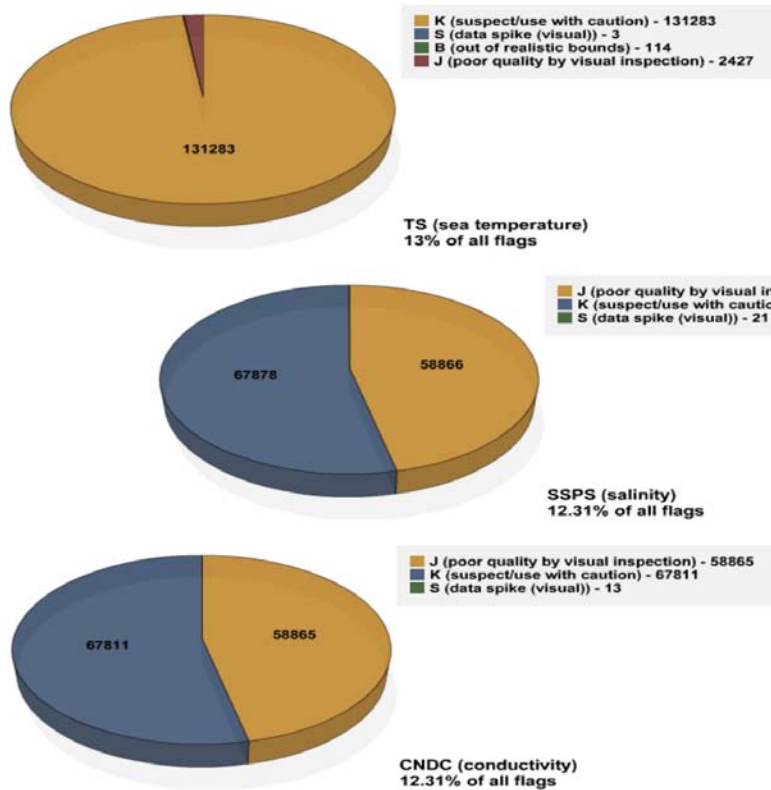
Figure 64: Distribution of SAMOS quality control flags for (first) sea temperature – TS – (second) salinity – SSPS – (third) conductivity – CNDC – and (last) photosynthetically active radiation – RAD_PAR –for the *R/V Lawrence M. Gould* in 2011.

*Nathaniel B. Palmer*



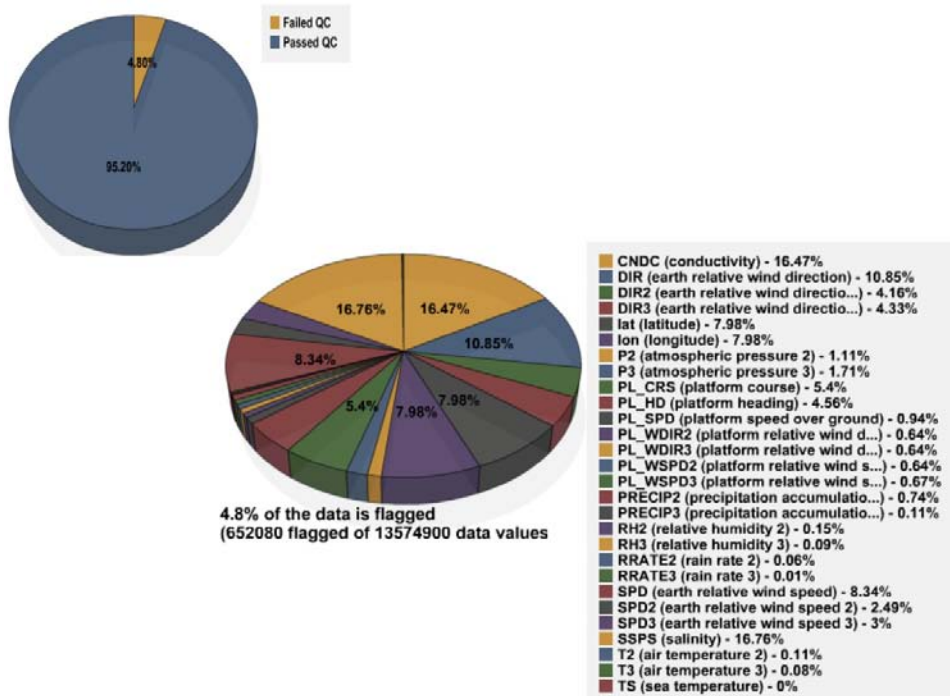Figure 65: For the *Nathaniel B. Palmer* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Nathaniel Palmer* provided SAMOS data for 188 ship days, resulting in 4,690,643 distinct data values.   After both automated and visual QC, 6.55% of the data was flagged using A-Y flags (Figure 65). This is a change of +1.13% from 2010 (2.87% flagged).

Flag distribution and reasoning is essentially unchanged from 2010.  By far, the largest portion of flags applied (~36%) were once again to short wave radiation (RAD_SW). This was also the case in both 2009 and 2010, and the issue was the same for all three years – namely, out of bounds (B) flagging of short wave radiation values slightly below zero.  This is a common consequence of tuning radiation sensors for better accuracy at much higher values (see Section 3b).  Another notable portion (~16%) was given to relative humidity (RH), which was also very similar to the 2009 and 2010 analysis.  Both parameters received primarily out of bounds (B) flags (Figure 66).  Upon inspection, the issue in both cases was primarily the incidental (and common) result of the sensors being tuned for greater accuracy within the more significant ranges (see Section 3b).  However, RH also received caution/suspect (K) flags, as did air temperature (T) and more notably atmospheric pressure (P) (Figure 66).  Airflow obstruction is suspected in most cases, as the *Palmer* is an ice-capable research vessel that houses a large superstructure with the primary instrument mast located amidships.  Indeed, photographic metadata for the *Palmer* clearly shows that the T/RH sensors are mounted down on a rail near the middle of the vessel where flow distortion and stack exhaust will be an issue.

On 07 December 2011, *Palmer* data began arriving at the SAMOS DAC in the SAMOS 1.0 key:value format without warning.  (Prior to 07 December *Palmer* data was

always received in JGOFS format.)  Appropriate *Palmer* personnel were immediately
contacted by SAMOS personnel via email to inquire about the change but no response
was received.  Nevertheless, ingesting the SAMOS-formatted data into the SAMOS
system required metadata within our SQL database for the *Palmer* to be adjusted and
augmented by SAMOS personnel.  While it was a beneficial change that resulted in
additional parameters, the delays caused by lack of timely communication with the
*Palmer* and metadata updating processes caused an approximate 15-day backlog of
*Palmer* data.  Fortunately, the primary data analyst was still able to process the data and
perform visual quality control, as there was a typical lull in most other SAMOS vessels'
data at that time of year.  Another interesting note is that the *Palmer's* designators for
short wave atmospheric radiation (RAD_SW) and long wave atmospheric radiation
(RAD_LW) appear to be switched; it seems LW is the designator for short wave and SW
the designator for long wave in the *Palmer's* SAMOS-formatted data files.  SAMOS
personnel contacted *Palmer* personnel about this question as well, but in the absence of a
response SAMOS data analysts simply decided to let logic dictate a swap in the metadata.
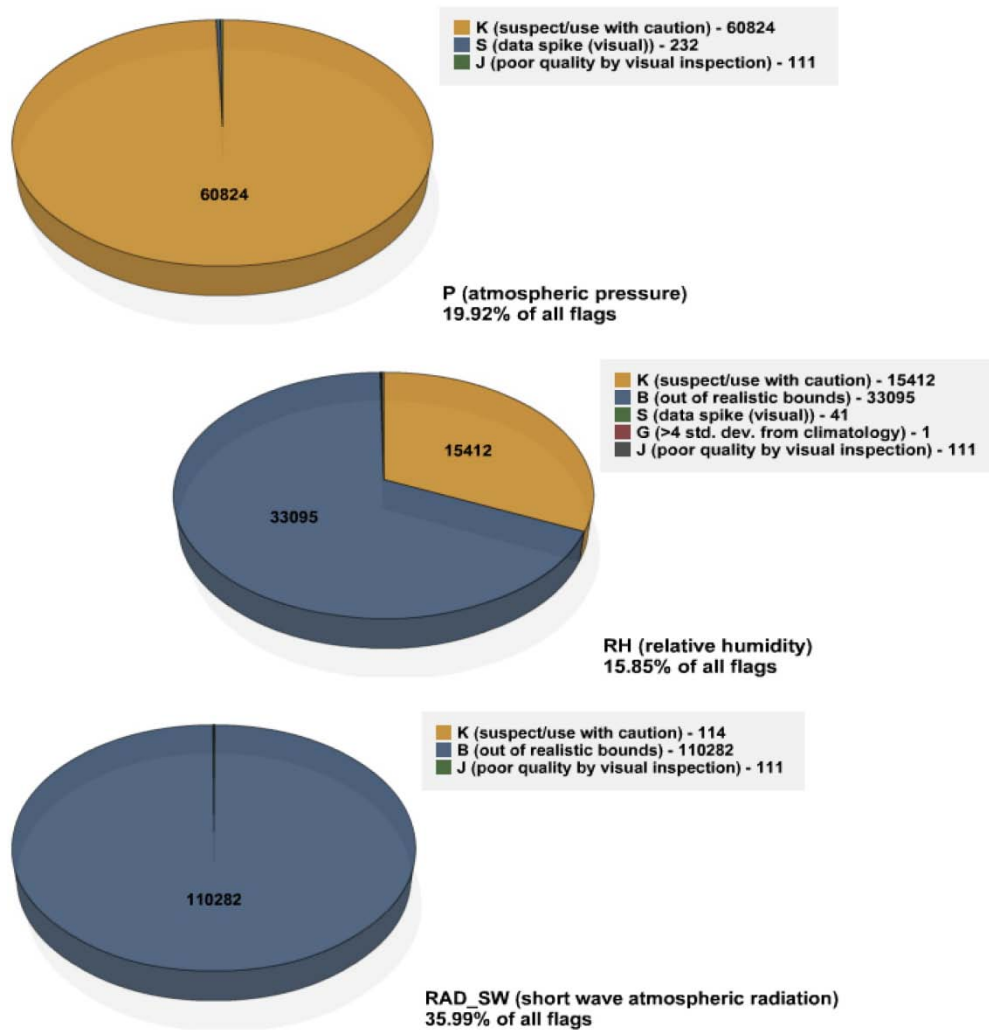


Figure 66: Distribution of SAMOS quality control flags for (top) atmospheric pressure – P –(middle)
relative humidity – RH – and (bottom) short wave atmospheric radiation – RAD_SW for the *R/V
Nathaniel B. Palmer* in 2011.

*Melville*





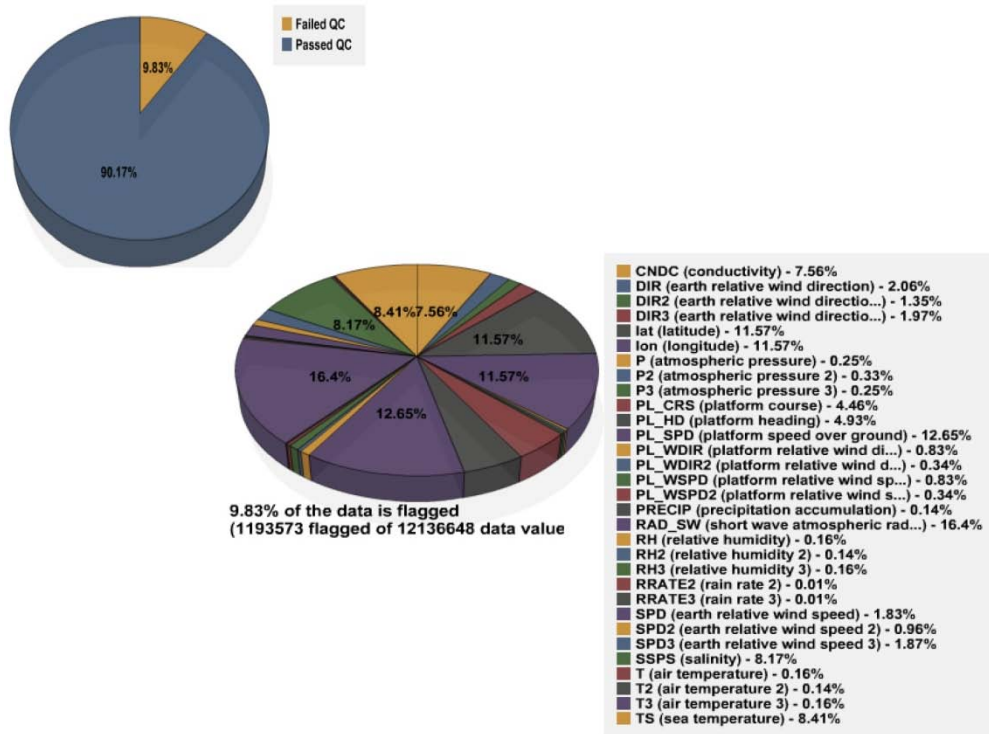2.63% of the data is flagged
(19209 flagged of 729733 data values)
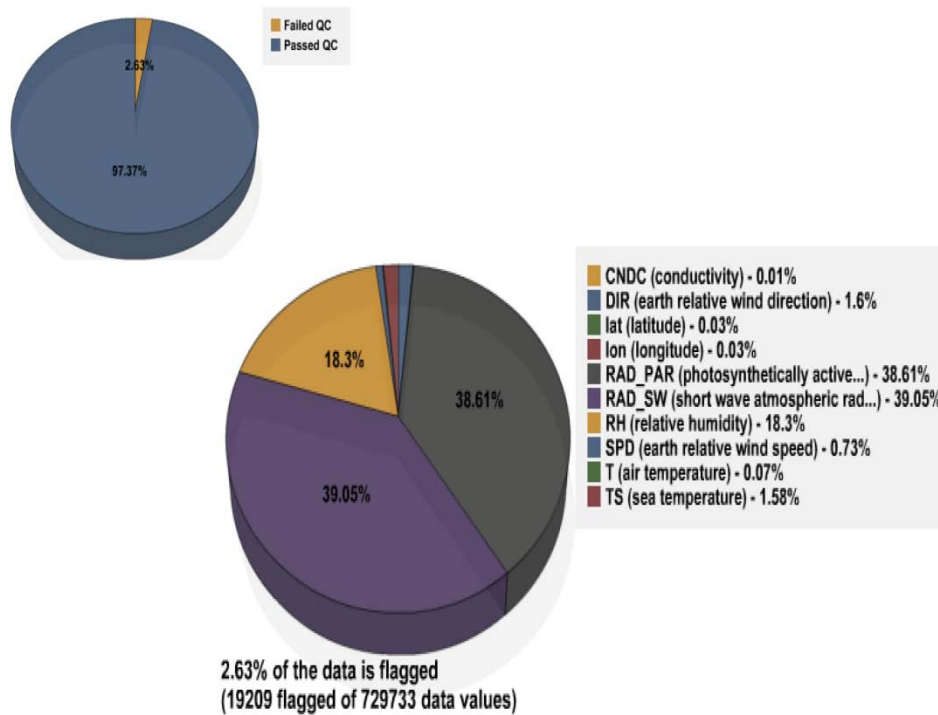
Figure 67: For the *Melville* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Melville* provided SAMOS data for 30 ship days, resulting in 729,733 distinct data values. After automated QC, 2.63% of the data was flagged using A-Y flags (Figure 67). 2011 is the first year in which SAMOS received data from the *Melville*. NOTE: the *Melville* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Melville*).

The highest percentages of flags (each ~39%) were applied to shortwave atmospheric radiation (RAD_SW) and photosynthetically active radiation (RAD_PAR). All of those flags were out of bounds (B) flags (Figure 69). It is likely these were due mostly to the common occurrence of radiation readings slightly below zero in nighttime conditions, owing to sensor tuning (see Section 3b for details). Relative humidity (RH) received the third largest portion of flags (~18%), most of which were also B flags, with a small portion of greater than 4 standard deviations (G) flags as well (Figure 69). Upon inspection, the RH sensor seems to have periods of poor behavior, resulting in "B" flags. This analyst discovered at least three multi-day stretches where the values step down to zero after saturation and remain there for a while (Figure 68). The fact that these steps appear to occur once saturation is reached is suggestive of a cause; unfortunately, we are not funded to decipher problems that are only identified in visual inspection. Perhaps as a consequence of that fact, the RH problem onboard the *Melville* persists in 2012 as well. Interestingly, the sensor that was the most problematic for *Melville*, the atmospheric pressure parameter, is missing from the flag totals. This is because when *Melville* was

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introduced into the SAMOS system it was determined that pressure (and, incidentally, dew point temperature) should be excluded from processing due to suspect quality. These concerns were discussed with *Melville* personnel, and to date no resolution has been found.
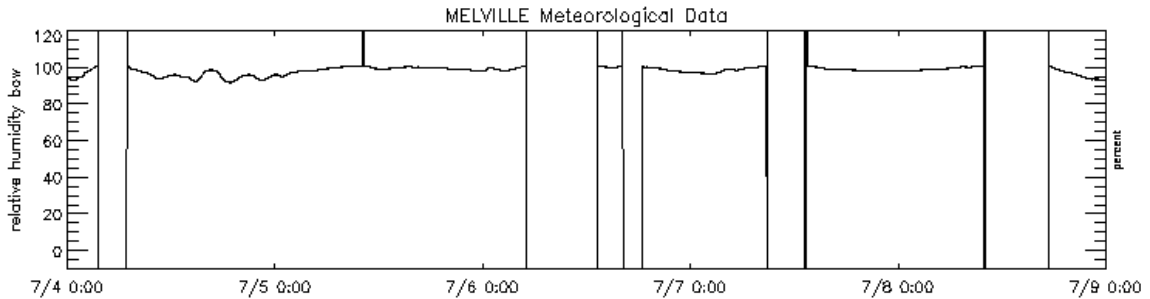


Figure 68: SAMOS relative humidity data from the *Melville* for 4 – 9 July, 2012. Note the several sudden drops to zero.
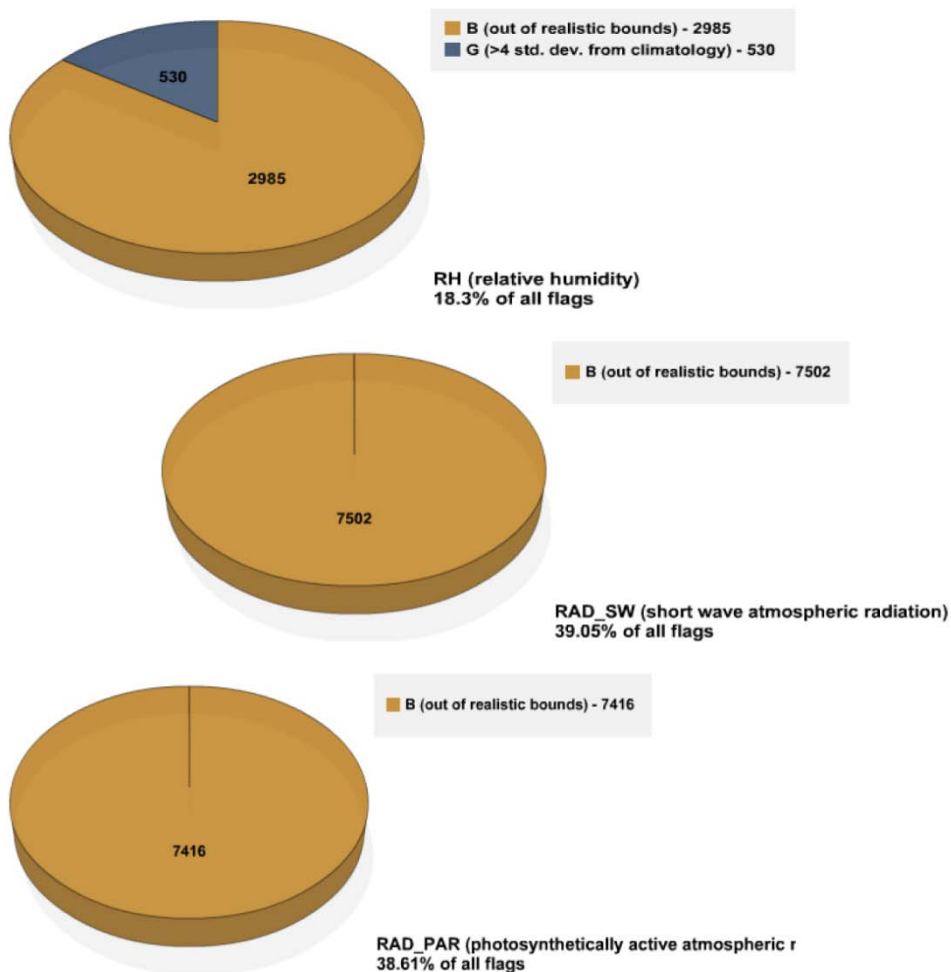


Figure 69: Distribution of SAMOS quality control flags for (top) relative humidity – RH – (middle) short wave atmospheric radiation – RAD_SW – and (bottom) photosynthetically active atmospheric radiation – RAD_PAR – for the *Melville* in 2011.

*Roger Revelle*
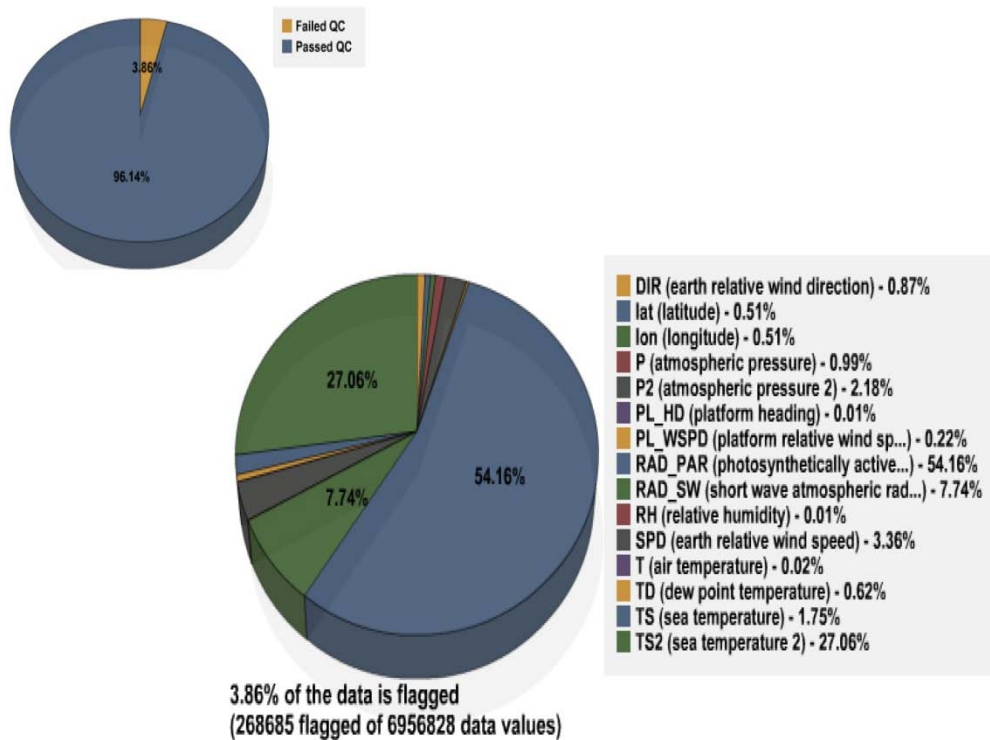


Figure 70: For the *Roger Revelle* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Roger Revelle* provided SAMOS data for 200 ship days, resulting in 6,956,828 distinct data values. After automated QC, 3.86% of the data was flagged using A-Y flags (Figure 70). 2011 is the first year in which SAMOS received data from the *Roger Revelle*. NOTE: the *Roger Revelle* does not receive visual quality control by the SAMOS DAC, so all of the flags are the result of automated QC (no research-level files exist at the SAMOS DAC for the *Roger Revelle*).

The highest percentage of flags was applied to photosynthetically active radiation (RAD_PAR). All of those flags were out of bounds (B) flags (Figure 71, bottom). These were due mostly to the common occurrence of radiation readings slightly below zero in nighttime conditions, owing to sensor tuning (see Section 3b for details), as well as slightly out of bounds at the upper limit, another common occurrence.

Sea temperature 2 (TS2) received the second largest portion of flags, all of which were greater than 4 standard deviations (G) flags (Figure 71, top). TS2 on the *Roger Revelle* is described as a "hydro lab TSG;" it appears that the cause of the flags results when the water supply to the hydro lab TSG is interrupted, such that the water temperature being measured is actually standing water inside the lab system. If the *Roger Revelle* received visual quality control, these flags would likely be swapped with suspect/caution (K) flags.

G (>4 std. dev. from climatology) - 72708

72708

TS2 (sea temperature 2)
27.06% of all flags

B (out of realistic bounds) - 145507

145507

RAD_PAR (photosynthetically active atmospheric
54.16% of all flags
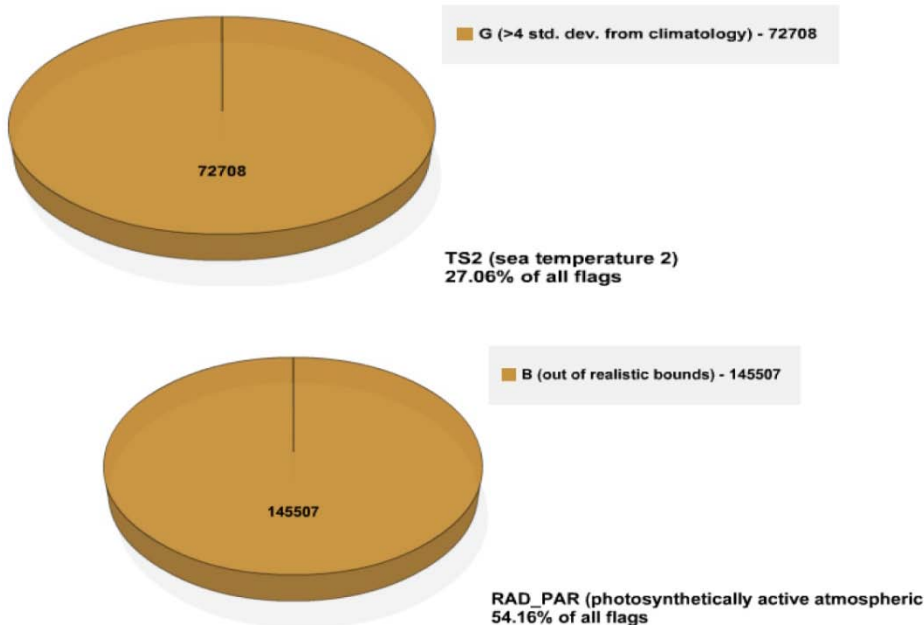
Figure 71: Distribution of SAMOS quality control flags for (top) sea temperature 2 – TS2 – and (bottom) photosynthetically active atmospheric radiation – RAD_PAR – for the *Roger Revelle* in 2011.

### Kilo Moana



Failed QC
Passed QC

0.94%

99.06%

DIR (earth relative wind direction) - 0.31%
DIR2 (earth relative wind directio...) - 0.39%
lat (latitude) - 8.61%
lon (longitude) - 8.61%
P (atmospheric pressure) - 0%
PL_SOW (platform speed over water) - 16.65%
RH (relative humidity) - 31.48%
SPD (earth relative wind speed) - 0.02%
SPD2 (earth relative wind speed 2) - 0.03%
T (air temperature) - 33.91%

8.61%
8.61%
33.91%
16.65%
31.48%

0.94% of the data is flagged
(83108 flagged of 8798857 data values)

Figure 72: For the *Kilo Moana* from 1/1/11 through 12/31/11, (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.

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The *Kilo Moana* provided SAMOS data for 312 ship days, resulting in 8,798,857 distinct data values. After automated QC, 0.94% of the data was flagged using A-Y flags (Figure 72), far and away the lowest flag percentage among all SAMOS vessels. However, due to funding constraints, the *Kilo Moana* does not receive visual QC, which is when the bulk of quality control flags are usually applied. As such, the authors cannot determine the cause of limited number (83,108) of flagged data values. Still, it may as well be noted that there was a scant +0.91% change in overall flag percentage from 2010 (0.03% flagged) to 2011. Hopefully resources can be secured in the future for visual QC.

*Healy*
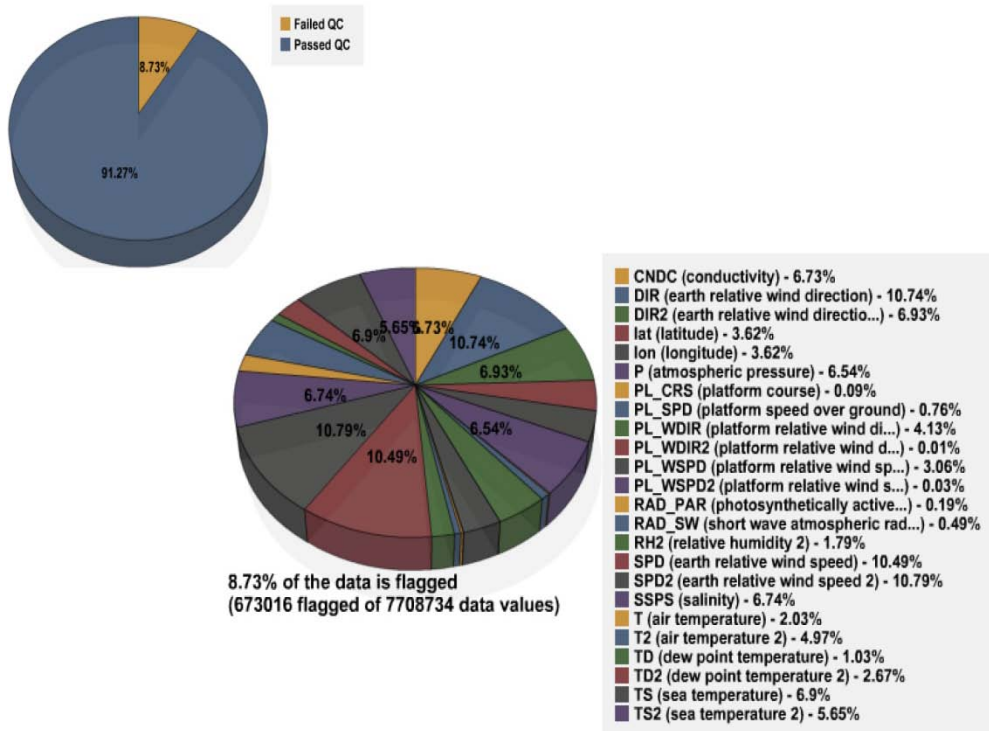


Figure 73: For the *Healy* from 1/1/11 through 12/31/11, (left) the percentage of all observations that passed vs. failed SAMOS quality control tests and (right) the percentage of the overall failed observations broken down by parameter.

The *Healy* provided SAMOS data for 211 ship days, resulting in 7,708,734 distinct data values. After both automated and visual QC, 8.73% of the data was flagged using A-Y flags (Figure 73). This is a slight improvement (-2.79%) over 2010's 11.52% flagged.

The authors stress, as they did in the 2009 and 2010 reports, that the block-house shape of the superstructure on the *Healy* makes flow obstruction nearly unavoidable and provides few good locations for meteorological sensors. As such, the majority of the flagging in most of the MET parameters was likely due to airflow obstruction. Once again, the many redundant sensors on board the *Healy* are clear evidence of that fact, as redundant sensors commonly differed from each other appreciably. However, as stated in 2009 and 2010, no definitive statement can be made regarding airflow obstruction without detailed airflow modeling of the *Healy*. The wind sensors seem to be the most

affected sensors, as seen in Figures 73 and 74.  Also noteworthy on the *Healy* in 2011: a dew point temperature parameter was added to the host of MET parameters on 25 May. It was erroneously matched to the wrong air temperature sensor (from which dew point is derived) initially, resulting in a small amount of failed T>Tw>Td (D) flags (not shown). The error was corrected by SAMOS personnel on 12 July and discussion is ongoing about whether the incorrectly matched data needs to be addressed in some way (e.g. reprocessing).



J (poor quality by visual inspection) - 37317
K (suspect/use with caution) - 32522
E (failed the true wind test) - 2048
S (data spike (visual)) - 379

DIR (earth relative wind direction)
10.74% of all flags

K (suspect/use with caution) - 51070
S (data spike (visual)) - 475
G (>4 std. dev. from climatology) - 167
E (failed the true wind test) - 29
B (out of realistic bounds) - 1
J (poor quality by visual inspection) - 18850

SPD (earth relative wind speed)
10.49% of all flags

K (suspect/use with caution) - 71932
S (data spike (visual)) - 286
G (>4 std. dev. from climatology) - 210
E (failed the true wind test) - 144
B (out of realistic bounds) - 41
J (poor quality by visual inspection) - 7

SPD2 (earth relative wind speed 2)
10.79% of all flags

Figure 74: Distribution of SAMOS quality control flags for (top) relative earth relative wind direction – DIR – (middle) earth relative wind speed – SPD – and (bottom) earth relative wind speed 2 – SPD2 – for the *R/V Healy* in 2011.

**R/V Atlantis**

Legend (left pie):
- Failed QC
- Passed QC

8.57%
91.43%

Right pie legend:
- CNDC (conductivity) - 12.31%
- DIR (earth relative wind direction) - 3.16%
- DIR2 (earth relative wind directio...) - 2.16%
- DIR3 (earth relative wind directio...) - 2.67%
- lat (latitude) - 6.22%
- lon (longitude) - 6.22%
- P (atmospheric pressure) - 2.7%
- P2 (atmospheric pressure 2) - 1.12%
- P3 (atmospheric pressure 3) - 0.57%
- PL_CRS (platform course) - 5.46%
- PL_HD (platform heading) - 1.48%
- PL_SPD (platform speed over ground) - 1.41%
- PL_WDIR2 (platform relative wind d...) - 1.5%
- PL_WDIR3 (platform relative wind d...) - 1.84%
- PL_WSPD2 (platform relative wind s...) - 1.5%
- PL_WSPD3 (platform relative wind s...) - 1.91%
- PRECIP2 (precipitation accumulatio...) - 1.22%
- PRECIP3 (precipitation accumulatio...) - 1.52%
- RAD_SW (short wave atmospheric rad...) - 0.9%
- RH (relative humidity) - 2.72%
- RH2 (relative humidity 2) - 1.38%
- RH3 (relative humidity 3) - 1.69%
- RRATE (rain rate) - 0.2%
- RRATE2 (rain rate 2) - 0.6%
- RRATE3 (rain rate 3) - 0.67%
- SPD (earth relative wind speed) - 2.13%
- SPD2 (earth relative wind speed 2) - 1.84%
- SPD3 (earth relative wind speed 3) - 2.93%
- SSPS (salinity) - 12.31%
- T (air temperature) - 1.58%
- T2 (air temperature 2) - 1.39%
- T3 (air temperature 3) - 1.69%
- TS (sea temperature) - 13%

8.57% of the data is flagged
(1029471 flagged of 12008228 data value

Figure 75: For the *R/V Atlantis* from 1/1/11 through 12/31/11, (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 264 ship days, resulting in 12,008,228 distinct data values. After both automated and visual QC, 8.57% of the data was flagged using A-Y flags (Figure 75). This is a change of +5.05% from 2010 (3.52% flagged) – a change that put *Atlantis* over the <5% flagged limit set for determining "good" data. However, this higher percentage is likely due in large part to the *Atlantis* continuing to send SAMOS data throughout their dry dock period, which continued from the beginning of 2011 until the first week in March. (Excluding the months of January, February, and March from the flag percentage calculation results in only 5.82% being flagged using A-Y flags, much closer to the <5% flagged "good" data limit.) In the case of dry dock data, all data is always flagged with at minimum caution/suspect (K) and more likely poor quality (J) flags. Additionally, latitude (LAT) and longitude (LON) are always flagged with land error (L) flags. Port (N) flags could have been used but it is the analyst's practice to use port flags in a situation where, for example, a mast is lowered while in port; because the vessel was actually on dry land, L flags were used to make a distinction between the two cases.

Flags were spread pretty evenly amongst most of the variables, with the exception of the three sea parameters of sea temperature (TS), conductivity (CNDC), and salinity (SSPS). Each of these three received about 13% of the total flags, with the majority of flags being caution/suspect (K) and poor quality (J) flags (Figure 78). In most cases, the application of these flags was precipitated by the onboard technician notifying the DAC

via email that their sea surface system was temporarily turned off, for such things as canal transits and port stops.  This is an excellent practice, as it takes the guesswork out of visual data quality evaluation.

   Two other issues arose frequently onboard the *Atlantis* in 2011 that are difficult to see in the flag percentages: First, air temperature (T) and relative humidity (RH) frequently had anomalous spikes in the data (Figure 76), which always receive either automated out of bounds (B) or manual spike (S) flags.  The cause of these spikes is not known, but problems of this type are often explained by electrical interference of some sort.  The second issue was with both rain rate parameters (RRATE and RRATE2).  Both parameters often experienced out of bounds (B) flags when there was a rain event (Figure 77).  In 2012, it was discovered that the metadata for both of these parameters erroneously stated the original units for the data were mm/min.  Because that is the standard units used by SAMOS for that parameter, no conversion was being applied to the data, the result being that all rain rate data for the *Atlantis* in 2011 was actually inflated by a factor of 100.  (In very light or very short duration rain, this error was not noticed by either the automated flagger or the SAMOS data analyst).  As of 2012, the metadata has been corrected and discussion is underway about how to address the data prior to the fix.
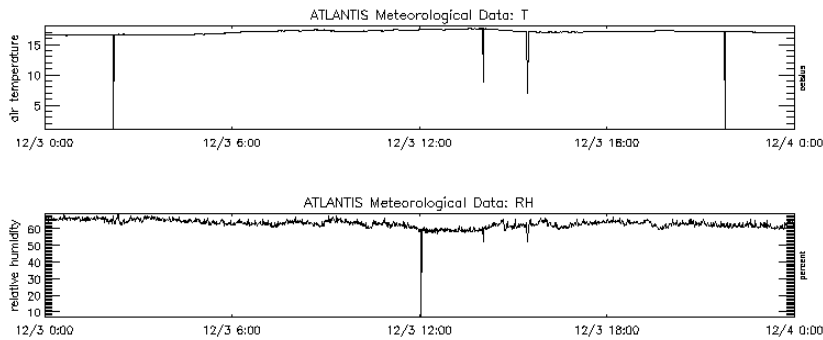


Figure 76: *R/V Atlantis* SAMOS data for 03 December 2011: (top) air temperature – T – (bottom) relative humidity – RH.
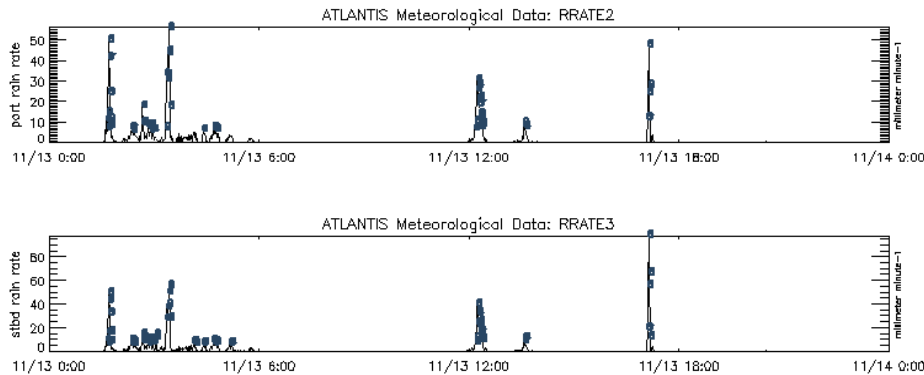


Figure 77: *R/V Atlantis* SAMOS data for 13 November 2011: (top) rain rate 2 – RRATE2 – (bottom) rain rate 3 – RRATE3.  Note "B" flags applied by autoflagger as a result of values 100x too high.

Figure 78: Distribution of SAMOS quality control flags for (top) sea temperature – TS –(middle) salinity – SSPS – and (bottom) conductivity – CNDC –for the *R/V Atlantis* in 2011.

## *R/V Knorr*



Figure 79: For the *R/V Knorr* from 1/1/11 through 12/31/11, (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 Knorr* provided SAMOS data for 334 ship days, resulting in 13,574,900 distinct data values.  After both automated and visual QC, 4.8% of the data was flagged using A-Y flags (Figure 79). This is a change of +1.01% from 2010 (3.79% flagged). Even with this slight decline in overall data quality, however, the *Knorr* still passes the <5% flagged test to be considered "good" data.

The sea parameters conductivity (CNDC) and salinity (SSPS) received the highest percentage of flags, with each receiving around 16.5%.  The flags for these two parameters were split between caution/suspect (K) and poor quality (J) flags (Figure 81). These flag applications usually occurred whenever it appeared the flow water system that supplied sea water to the sensors was shut off, usually while the vessel was in port.  The other issue of note with the *Knorr* is that the wind parameters are particularly vulnerable to acceleration spikes/steps (see Figure 80), with the R.M. Young C202 performing a little worse than the two Vaisala WXTs.  Hence, earth relative wind direction (DIR) and speed (SPD), the two parameters derived from the R.M. Young, received a slightly larger percentage of flags than the other wind parameters (~10% and ~8.5%, respectively; see Figure 81).
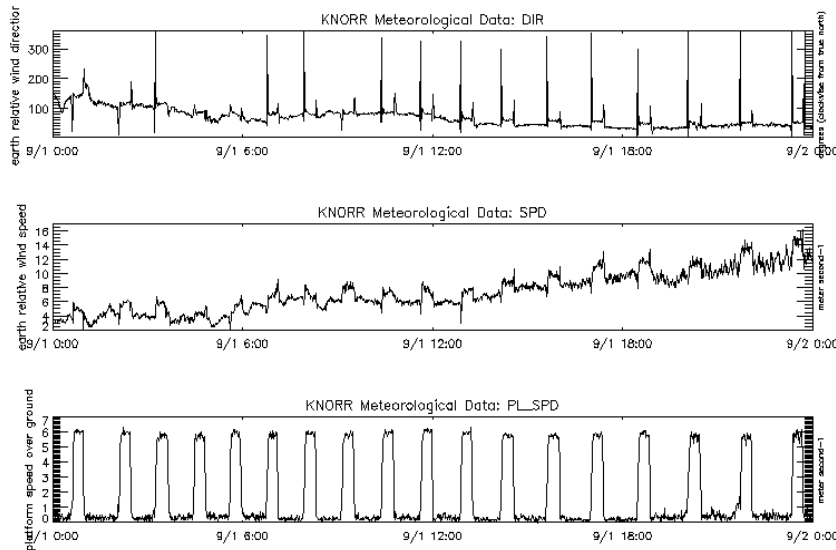


Figure 80: *R/V Knorr* SAMOS data for 01 September 2011: (top) earth relative wind direction – DIR – (middle) earth relative wind speed – SPD – and (bottom) platform speed over ground – PL_SPD.  Note spikes and steps in wind data in relation to platform speed changes.

J (poor quality by visual inspection) - 29545
K (suspect/use with caution) - 38415
S (data spike (visual)) - 2766
I (interesting feature) - 1
L (platform position over land) - 1

**DIR (earth relative wind direction)**
**10.85% of all flags**

J (poor quality by visual inspection) - 29539
K (suspect/use with caution) - 23810
I (interesting feature) - 1
S (data spike (visual)) - 902
B (out of realistic bounds) - 102
G (>4 std. dev. from climatology) - 27
L (platform position over land) - 1

**SPD (earth relative wind speed)**
**8.34% of all flags**

K (suspect/use with caution) - 59719
J (poor quality by visual inspection) - 49087
S (data spike (visual)) - 490
B (out of realistic bounds) - 1

**SSPS (salinity)**
**16.76% of all flags**

K (suspect/use with caution) - 58024
J (poor quality by visual inspection) - 49074
S (data spike (visual)) - 270
B (out of realistic bounds) - 9

**CNDC (conductivity)**
**16.47% of all flags**

Figure 81: Distribution of SAMOS quality control flags for (first) earth relative wind direction  – DIR – (second) earth relative wind speed – SPD – (third) salinity – SSPS – and (last) conductivity  – CNDC –for the *R/V Knorr* in 2011.

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**R/V Oceanus**



Figure 82: For the *R/V Oceanus* from 1/1/11 through 12/31/11, (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 *Oceanus* provided SAMOS data for 307 ship days, resulting in 12,136,648 distinct data values. After both automated and visual QC, 9.83% of the data was flagged using A-Y flags (Figure 82). This is a slight deviation of -0.45% from 2010 (10.28% flagged). However the high flag percentage is somewhat misleading, as it was in 2009 and 2010, and for the same reason: The *Oceanus* often transmits port data. In the first place, this practice results in occasional port (N) flagging of the lat/lon parameters (Figure 84) whenever other parameters are flagged while in port as well. Additionally, in 2011 the platform speed (PL_SPD) almost always read at a nearly constant, slightly positive value whenever the vessel was in port (Figure 83). This resulted in a sizable amount of poor quality (J) flagging of the PL_SPD parameter (Figure 84). The highest percentage of flags (~16%) belonged to the short wave atmospheric radiation (RAD_SW) parameter. However, as these were most out of bounds (B) flags, the issue was likely readings slightly below zero at night, a common occurrence owing to sensor tuning (see section 3b). The remainder of the flags were spread fairly evenly among the other MET and sea water parameters, and were likely influenced by port stays as well.

The authors wish to note that at the end of 2011, the *Oceanus* was transferred from WHOI to the Oregon State University. We anticipate a break in the time series of *Oceanus* data being received at the SAMOS DAC. Discussions are underway with OSU to restart the SAMOS transmissions, but changes in personnel and the shipboard data acquisition system will slow the process. The authors wish to acknowledge the hard work

and dedication of the WHOI personnel who contributed *Oceanus* data reliably to the DAC since 2008.
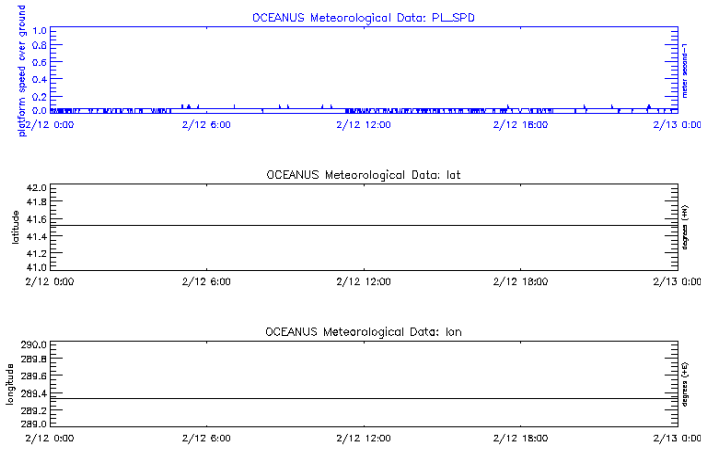


Figure 83: *Oceanus* SAMOS data for 12 February 2011: (top) platform speed over ground – PL_SPD – (middle) latitude – lat – and (bottom) longitude – lon.  Note the vessel was actually stationary at this time, throwing the near-constant speed (albeit very small) into question.
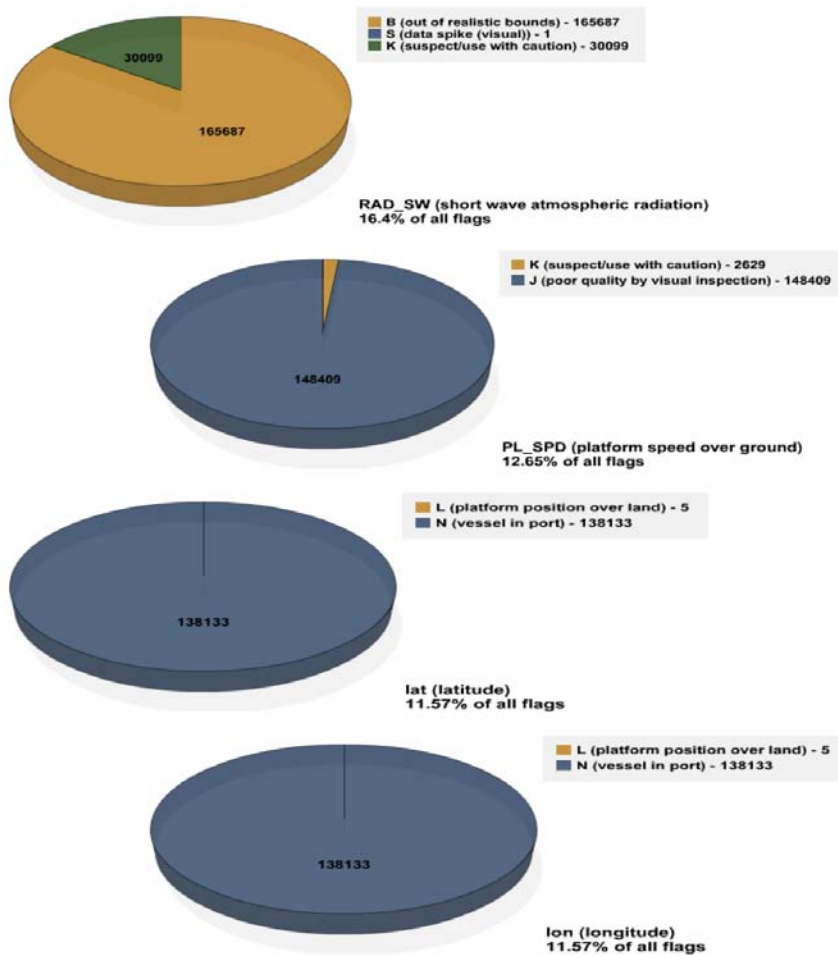


Figure 84: Distribution of SAMOS quality control flags for (first) short wave atmospheric radiation – RAD_SW – (second) platform speed over ground – PL_SPD – (third) latitude – lat – and (last) longitude – lon –for the *R/V Oceanus* in 2011.

## 4. Metadata summary

Adequate metadata is the backbone of good visual QC. As such, vessel operators are strongly advised to keep vessel and parameter metadata complete and up to date. Annex A, Part Two walks SAMOS operators through editing metadata online (**\*new and improved!**), 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. Note that for the IMOS ships *Aurora Australis* and *Southern Surveyor*, while Vessel contact information is considered "incomplete" in Table 3, there is intentionally no onboard contact information, at the discretion of the Australian Bureau of Meteorology. Vessel metadata should also include vessel imagery (highly desirable, see Figure 85 for examples) and a web address for a vessel's home page.

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 86. (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 86 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. The authors wish to point out that the field "Data Reporting Interval" erroneously appears in several of the parameters. This field is actually only applicable to the time parameter and the Vessel information metadata. The erroneous field needs to be removed and was not considered for completeness of any parameter in Table 3. To access and download (in PDF format) any participating vessel's metadata forms, visit the SAMOS Metadata Portal at http://samos.coaps.fsu.edu/html/meta.php. Detailed instructions for this feature are also covered in Annex A, Part 1: the end user.
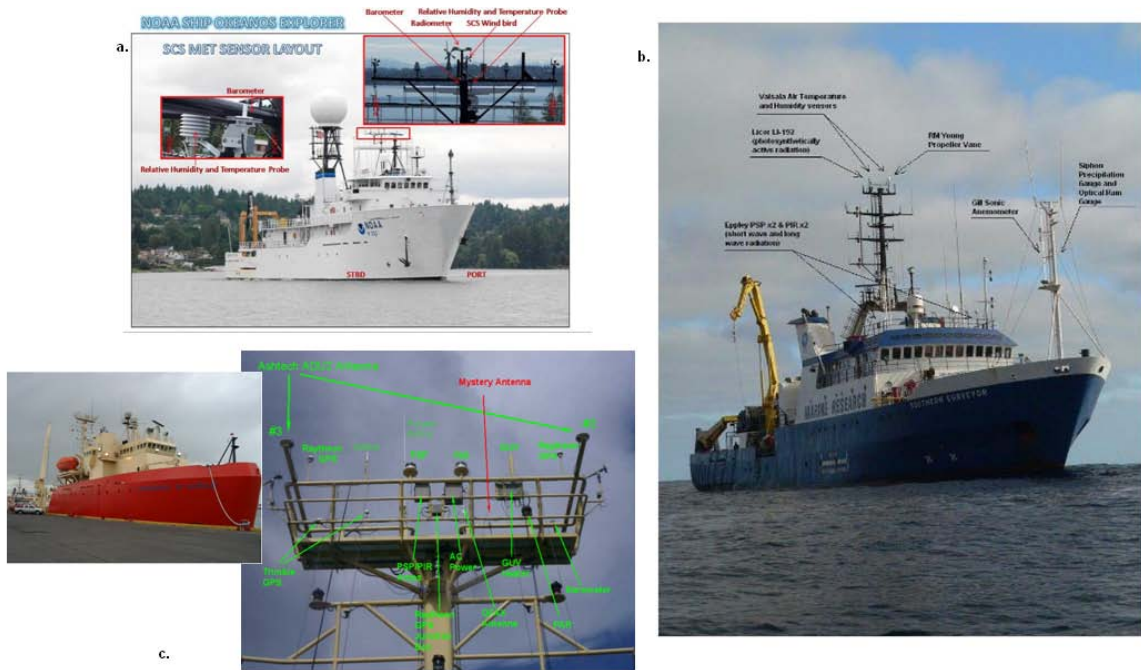
Figure 85: Examples of detailed vessel instrument imagery from (a) *Okeanos Explorer*, (b) *Southern Surveyor*, and (c) *Laurence M. Gould*



Figure 86: 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 3 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 | P | RH | PRECIP | R RATE | LW | SW | NET RAD | PAR | TS | CON | SAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAOU | C | C | I | 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,I,I | C,I,I | C,I,I | C,I,I | C,I,I | | C,I,I | C,I,I | C,I,I | I,I,I | | C | | | C | I | C |
| KCEJ | C | C | C | Yes | I | I | I | I | I | C,I,I | C,I,I | C,I,I | C,I,I | C,I,I | | C,I,I | C,I,I | I,I | C,I,I | | C | | | I | I | I |
| KNBD | C | C | C | No | I | I | I | I | I | I | I | C | C | I | | I | I | | | | | | | I | | |
| NEPP | C | C | I | Yes | I | I | I,I | I | I,I,I | C,C | C,C | C,C | C,C | C,C | C | C,I | C,C | C | | C | C | | | C,C | C | C |
| NRUO | I | I | I | No | I | I | I | I,I | I,I | I,I | I,I | I,I | I,I | I | | I | I | | | | | | | I,I | | I |
| VLHJ | C | I | I | Yes | I | I | I,I | I | I | C,C | C,C | I,I | I,I | C,C | | I | C,C | C,C | C | C,C | C,C | | C | I | | |
| VNAA | 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 | I | I,I | I,I | | I,I | I | | |
| WBP3210 | C | I | I | Yes | 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 | I,I | I,I | I,I | I,I | I | | I | I | | | | 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 | I | I | I | No | I | I | I,I | I | I | C,C | C,C | C,C | C,C | C | | C | C | | | | | | | I,I | I | I |
| WECB | C | C | I | No | I | I | I | I | I | I | I | I | I | I | C | C,I | I | I | | I | I | | I | I | I | I |
| WTDF | C | C | I | No | I | I | I | I | I | I,I,I | I | I | I | I | | I | I | | | I | I | | | I | I | I |
| WTDH | C | C | I | Yes | I | I | I | I | I | I | I | I | I | I | | C | I | | | | | | | I,I | I | I |
| WTDL | I | I | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | | I |
| WTDM | C | C | C | Yes | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WTDO | I | I | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | | |
| WTEB | I | I | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | | |
| WTEC | C | C | I | No | 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 | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | | |
| WTEJ | I | I | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WTEO | I | I | I | Yes | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WTEP | C | C | I | Yes | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WTER | C | C | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I,I | I | I |
| WTEU | C | C | I | No | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WTEY | C | C | I | Yes | I | I | I | I | I | I | I | I | I | I | | I | I | | | | | | | I | I | I |
| WXAQ | C | C | C | Yes | I | I | I | I | I | I,I | I,I | I,I,I | I,I,I | I,I,I | | I,I,I | I,I,I | I,I,I | I,I,I | | I | | | I | I | C |
| ZMFR | I | I | I | No | I | I | I | I | I | | | I | C | I | | I | I | I | | I,I | I,I | | | I | | |

Table 3: Vessel and parameter metadata overview. "C" indicates complete metadata; "I" indicates incomplete metadata. Under "Digital Imagery," "Yes" indicates the existence of vessel/instrument imagery in the SAMOS database, "No" indicates non-existence. Empty boxes indicate non-existence of a parameter; multiple entries in any box indicate multiple sensors for that parameter and vessel.

## 5. Plans for 2011

The SAMOS DAC has an ongoing partnership with the Rolling deck To Repository (R2R; http://www.rvdata.us/overview) project. Funded by the National Science Foundation, R2R is developing a protocol for transferring all underway data (navigation, meteorology, oceanographic, seismic, bathymetry, etc) collected on U. S. University National Oceanographic Laboratory System (UNOLS) research vessels to a central onshore repository. During 2011, the university-operated vessels contributing to the SAMOS DAC were those operated by WHOI, SIO, UH, and BIOS. The focus of the R2R is capturing all these data at the end of each planned cruise; however, the SAMOS DAC is developing a real-time component to transfer a subset of meteorological and surface-oceanographic data from ship to shore. The data will be transferred at the full observational resolution for the specified sensor (in some cases up to 1Hz samples) on an hourly to daily schedule, depending on the operator. The transfer protocol will take full advantage of the evolving broadband satellite communication technology. In early 2012, a prototype was completed and tested using an extensible mark-up language (XML) format that was developed in consultation with Oregon State University and the University of Rhode Island. We anticipate recruiting the *Endeavor* and restarting transmissions from the *Oceanus* in 2012 using this new, SAMOS 2.0 data protocol.

In addition to new data transfer and processing protocols related to the R2R, we plan to step up development of new automated quality control procedures in 2012. The experience from past visual QC will allow us to develop new procedures that will streamline the QC process and reduce visual analyst time spent on individual data streams. This change is necessary in the face of reducing budgets and an increased number of vessels contributing to SAMOS.

Finally, in an effort to improve communication with our data providers, vessel operators, and shipboard technicians, a subscription service for routine data reports will be made available in 2012. A prototype has been developed and is undergoing final testing prior to release. We plan to create daily, weekly, and/or monthly reports regarding data flow (what have we received) and data quality. Several of those reports will be based on the information provided in this annual report. We are open to suggestions and ask operators and technicians to feel free to contact us at samos@coaps.fsu.edu.

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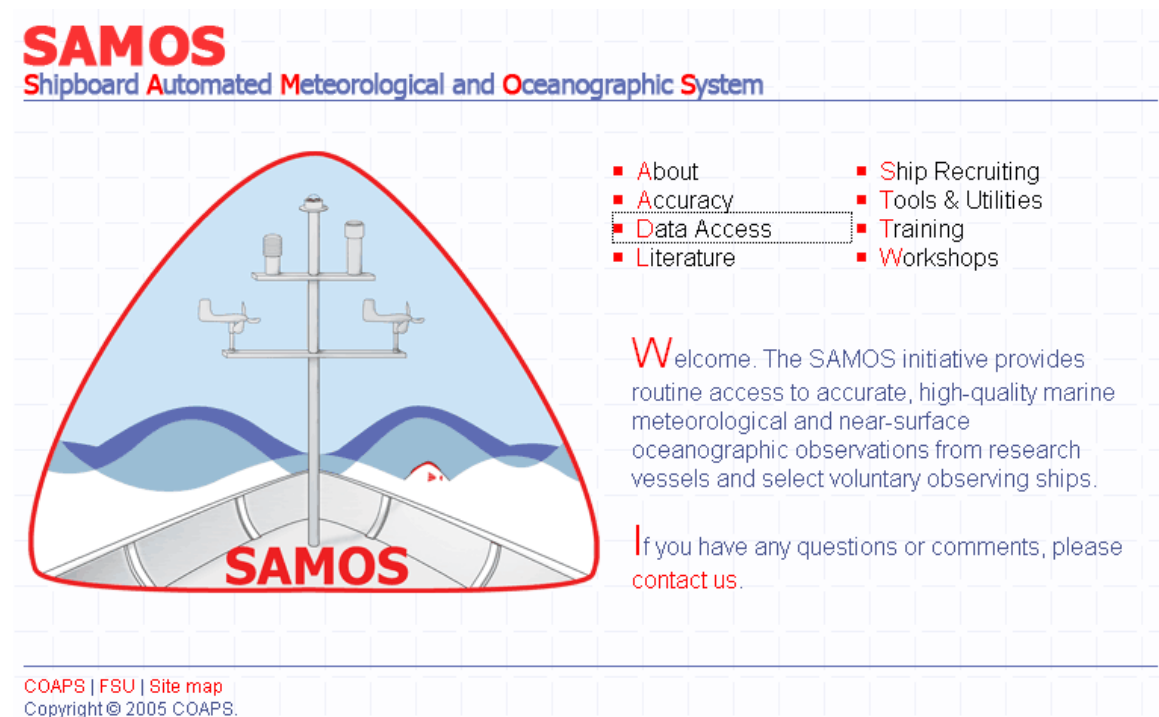
The Australian Integrated Marine Observing System, 2008: *J. Ocean Technology* **3**(3), 80-81.

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

Annex A:  SAMOS Online Metadata System Walk-through Tutorial


PART 1: the end user

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



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

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

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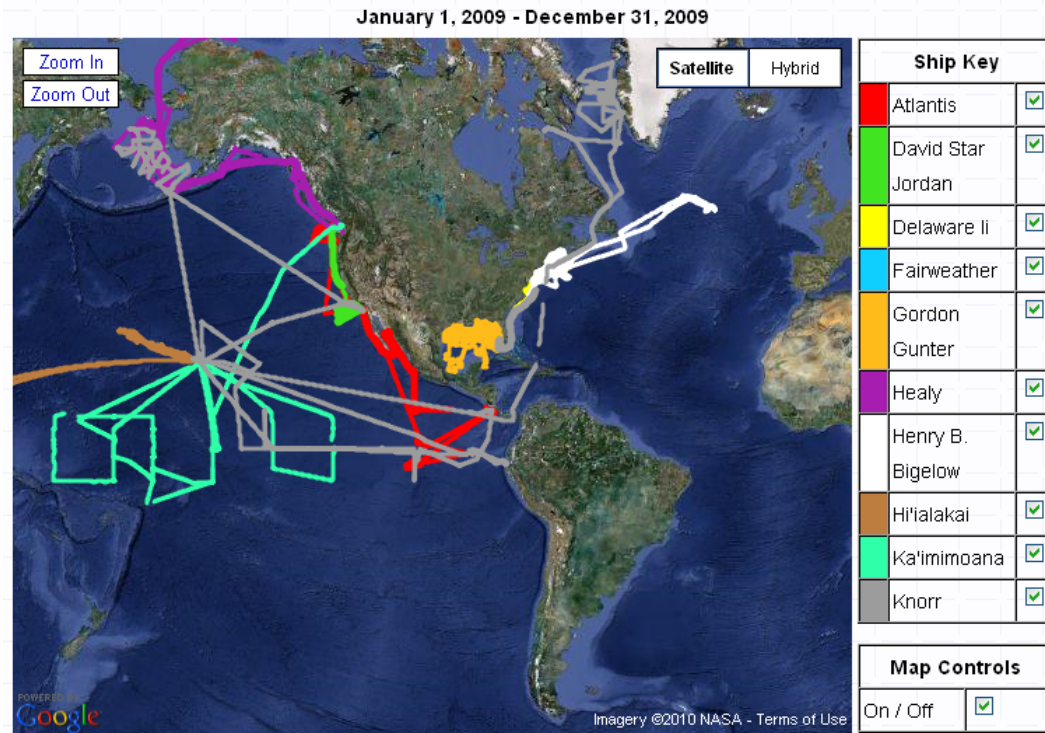


Now the user can see that both the *Healy* and the *Knorr* cruised in the north-polar region in 2009. The next step might be to see what parameters are available on each ship. Returning to the Data Access page, the user this time selects the Metadata Portal:

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



**Metadata Portal**

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

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

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

Choose a ship   HEALY (NEPP)

Type of metadata   parameter-specific

Type a date   1/1/09-12/31/09

where a valid date is of the form
month/day/year, ex: 9/10/04. or a range,
9/10/04 - 9/20/04, you can also enter
things like "yesterday"

Click search   search

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

## 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):

## Data Availability

The purpose of this page is to allow the user to get a rough idea of the quality of data for a particular day broken down by ship and variable. The color boxes represent the relative quality for each variable as a percentage of the total number of one-minute samples available for that ship and day. To view a breakdown of the quality control for any given day, simply click on the respective colored box. For the preliminary data, multiple files may exist for a single day and ship. The data tables can be expanded or contracted and can be switched from sorting by ship to sorting by variable. At the bottom of the page, you can make selections by data quality, ship, and variable to download the data. Based on your selections, you will receive the entire data file for a given day; however, you can choose to omit files with poor data quality for your chosen variable(s).

- Good Data (0-5% flagged as suspect)
- Use with Caution (5-10% flagged as suspect)
- Use with Caution (>10% flagged as suspect)
- No Data Available

Toggle: Ships | Variables

### Ships

Contract All | Expand All

⊟ HEALY

| | Air Temperature | Air Temperature 2 | Earth Relative Wind Direction | Earth Relative Wind Direction 2 | Earth Relative Wind Speed | Earth Relative Wind Speed 2 |
|---|---|---|---|---|---|---|
| 09/17/09 | green | red | red | red | red | red |
| 09/16/09 | green | red | green | green | red | red |
| 09/15/09 | green | red | green | green | green | red |
| 09/14/09 | green | red | green | yellow | green | green |
| 09/13/09 | green | red | red | green | green | green |
| 09/12/09 | green | red | red | red | red | red |
| 09/11/09 | red | red | yellow | red | yellow | red |
| 09/10/09 | green | red | red | green | red | red |
| 09/09/09 | grey | grey | grey | grey | grey | grey |
| 09/08/09 | green | red | red | red | red | red |
| 09/07/09 | green | green | green | red | green | red |
| 09/06/09 | green | yellow | green | red | green | red |
| 09/05/09 | green | red | yellow | red | red | green |
| 09/04/09 | green | red | yellow | yellow | red | red |
| 09/03/09 | green | red | red | red | red | yellow |
| 09/02/09 | green | red | red | red | green | red |
| 09/01/09 | green | red | red | red | red | yellow |

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

# Data Download w/ Daily QC Statistics

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

## 09-07-2009

HEALY

☐ select all

☐ File    download | view file

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



Compression:  .tar.gz ▾

Download selected

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

**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



■ DIR (earth relative wind direction) - 0.64%
■ DIR2 (earth relative wind directio...) - 11.76%
■ SPD2 (earth relative wind speed 2) - 10.26%
■ TS (sea temperature) - 38.67%
■ TS2 (sea temperature 2) - 38.67%

11.76%
10.26%
38.67%
38.67%

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:

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:

## About Accuracy Data Access Literature **Ship Recruiting** Tools & Utilities Training Workshops
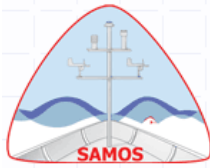
**SAMOS**
Shipboard Automated Meteorological and Oceanographic System

## Ship Recruiting

**Please choose a page from the following list:**

- Mission — Read about the objectives of the SAMOS Initiative and how the initiative plans to achieve these goals. The objectives can only be achieved through a close partnership with vessel operators and marine technicians.

- Desired Data — View a list of meteorological and oceanographic parameters that the initiative seeks to obtain from vessels.

- Benefits to Vessel — How will participation in SAMOS benefit your vessel operations and data stewardship?

- Partnership with GOSUD — A recent workshop has outlined plans for a data exchange with the Global Ocean Surface Underway Data Pilot Project.

- Steps to Participation — What are the steps to having your vessel(s) participate in the SAMOS Initiative?

- Metadata Interface — Ship operator interface to add/modify metadata for their institution's vessels. Login required.

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):

samos

Please enter the following:

Login: op_noaa

Password: •••••••••••

[ login! ]

samos

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

a. Select Vessel Metadata



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:

| ☐ *air temperature* | ☐ air temperature 2 | ☐ air temperature 3 |
| ☑ *atmospheric pressure* | ☐ atmospheric pressure 2 | ☐ atmospheric pressure 3 |
| ☐ ceiling height | ☐ cloud base height | ☐ *conductivity* |
| ☐ conductivity 2 | ☐ dew point temperature | ☐ dew point temperature 2 |
| ☐ *earth relative wind direction* | ☐ earth relative wind direction 2 | ☐ earth relative wind direction 3 |
| ☐ *earth relative wind speed* | ☐ earth relative wind speed 2 | ☐ earth relative wind speed 3 |
| ☐ high cloud type | ☐ *latitude* | ☐ long wave atmospheric radiation |
| ☐ long wave atmospheric radiation 2 | ☐ *longitude* | ☐ low cloud type |
| ☐ low/middle cloud amount | ☐ middle cloud type | ☐ net atmospheric radiation |
| ☐ net atmospheric radiation 2 | ☐ photosynthetically active atmospheric radiation | ☐ photosynthetically active radiation 2 |
| ☐ *platform course* | ☐ platform course 2 | ☐ *platform heading* |
| ☐ platform heading 2 | ☐ *platform relative wind direction* | ☐ platform relative wind direction 2 |
| ☐ platform relative wind direction 3 | ☐ *platform relative wind speed* | ☐ platform relative wind speed 2 |
| ☐ platform relative wind speed 3 | ☐ *platform speed over ground* | ☐ platform speed over ground 2 |
| ☐ platform speed over water | ☐ platform speed over water 2 | ☐ precipitation accumulation |
| ☐ precipitation accumulation 2 | ☐ precipitation accumulation 3 | ☐ present weather |
| ☐ rain rate | ☐ rain rate 2 | ☐ rain rate 3 |
| ☐ *relative humidity* | ☐ relative humidity 2 | ☐ relative humidity 3 |
| ☐ *salinity* | ☐ salinity 2 | ☐ *sea temperature* |
| ☐ sea temperature 2 | ☐ sea temperature 3 | ☐ short wave atmospheric radiation |
| ☐ shortwave atmospheric radiation 2 | ☐ specific humidity | ☐ specific humidity 2 |
| ☐ time | ☐ total cloud amount | ☐ ultra violet atmospheric radiation |
| ☐ ultra violet atmospheric radiation 2 | ☐ visibility | ☐ wet bulb temperature |
| ☐ wet bulb temperature 2 | | |

Key:
ship does not have variable
ship has variable
variable has modifications needing approval
variable is new and needs approval
*italic = variable has incomplete metadata*

MILLER FREEMAN's Variables
*Expand to view or modify the ship's variables.*
[Show All] [Hide All]
☐ only show variables for the date  Today  [Today]
⊞ **atmospheric pressure**

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

## MILLER FREEMAN's Variables

*Expand to view or modify the ship's variables.*

[Show All] [Hide All]

☐ only show variables for the date Today [📅▾] [Today]

### ■ atmospheric pressure

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

| Descriptive Name | Original Units | Instrument Make & Model | Last Calibration |
|---|---|---|---|
| atmospheric pressure | millibar ▾ | A.I.R. | |

| Mean SLP Indicator | Observation Type | Distance from Bow | Distance from Center Line |
|---|---|---|---|
| at sensor height ▾ | measured ▾ | | |

| Height | Average Method | Averaging Time Center | Average Length |
|---|---|---|---|
| 4.9 | average ▾ | time at end of period ▾ | 60 |

| Sampling Rate | Data Precision | |
|---|---|---|
| | | |

| Designator | BARO | | Date Valid | 01/31/2008 to Today |
|---|---|---|---|---|

| Descriptive Name | Original Units | Instrument Make & Model | Last Calibration |
|---|---|---|---|
| atmospheric pressure | millibar ▾ | Vaisala | Nov 2007 |

| Mean SLP Indicator | Observation Type | Distance from Bow | Distance from Center Line |
|---|---|---|---|
| adjusted to sea level ▾ | measured ▾ | 19.2 m | 1 m |

| Height | Average Method | Averaging Time Center | Average Length |
|---|---|---|---|
| 8.8 | average ▾ | time at end of period ▾ | 60 |

| Sampling Rate | Data Precision | |
|---|---|---|
| 1 sec | | |

[Add/Modify] variable with:

| Designator | BARO | | Date Valid | 01/31/2008 [📅▾] to Today [📅▾] [Today] |
|---|---|---|---|---|

If the identification procedure is successful, there will be a "Submit New Changes" button visible in the desired version metadata area.  User op_noaa must first close out the current metadata version (so the previous data is still associated with the correct information) and then initiate a new version.  To close out the current version, the user would change the Date Valid field in the metadata area to reflect the last date the

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metadata displayed for an instrument was associated with at the old location and then click "Submit New Changes."  (Note the first version, i.e. with Dates Valid 01/17/2007 to 01/30/2008, is left untouched):



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

## 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 | |

| Descriptive Name | Original Units | Instrument Make & Model | Last Calibration |
| --- | --- | --- | --- |
| atmospheric pressure | millibar | Vaisala | Nov 2007 |

| Mean SLP Indicator | Observation Type | Distance from Bow | Distance from Center Line |
| --- | --- | --- | --- |
| adjusted to sea level | measured | 19.2 m | 1 m |

| Height | Average Method | Averaging Time Center | Average Length |
| --- | --- | --- | --- |
| 8.8 | average | time at end of period | 60 |

| Sampling Rate | Data Precision |
| --- | --- |
| 1 sec | |

[Add/Modify] variable with:

| Designator | BARO | | Date Valid | 03/29/2010 | to | Today | [Today] |

*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] |
|---|---|---|---|---|---|---|

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



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



Once an addition or modification to metadata has been submitted, a SAMOS associate at COAPS is automatically notified that approval is needed. Once approved, the new

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information will be visible to the public, via the Metadata Portal, accessed from the Data Access page as outlined in part one:



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<br>Breadth:  12.8<br>Freeboard:  2.5<br>Draught:  5.5 / 9.1<br>Cargo Height:  N/A | <br>Schematic - Side View |

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:



RMYoung 05103
propellor wind monitor
height: 22.8 m
dist fm bow: 25.1

RMYoung 41382VC
Air Temp and Humidity
on port side    height: 12.0 m
dist fm bow: 23.5 m

Vaisala PTB330 Barometer
mounted inside of
bridge
height: 8.8 m
dist fm bow: 19.2 m
windows always open
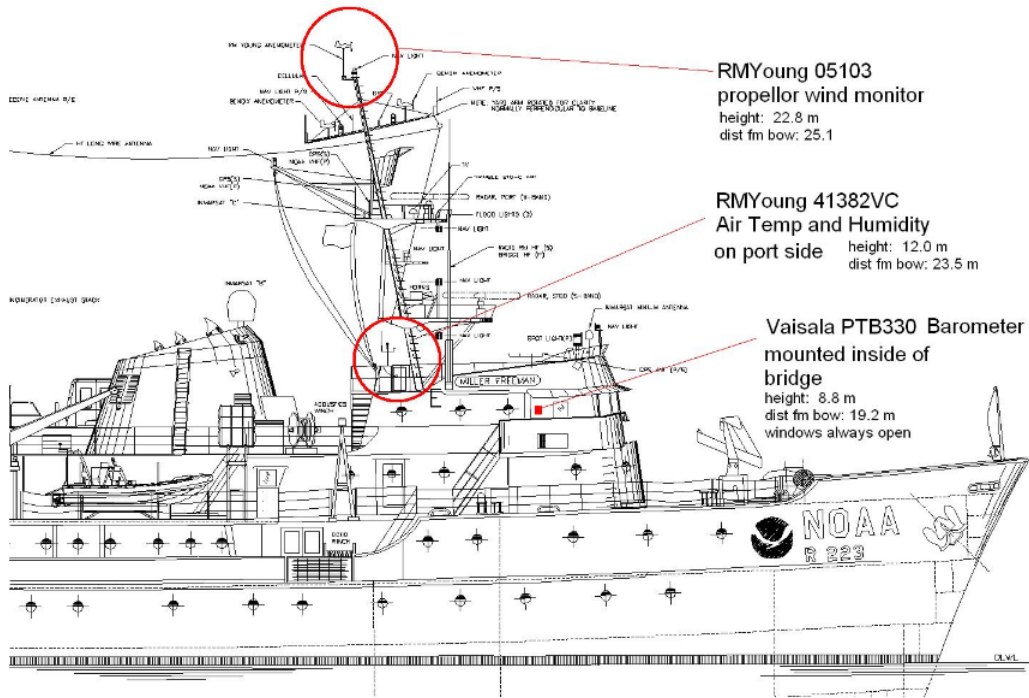
As a SAMOS user becomes familiar with following the metadata modification steps outlined in this section, chores such as adding duplicate sensors, logging sensor relocations, and keeping calibrations up-to-date become straightforward tasks. Naturally, complete and accurate metadata make for better scientific 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
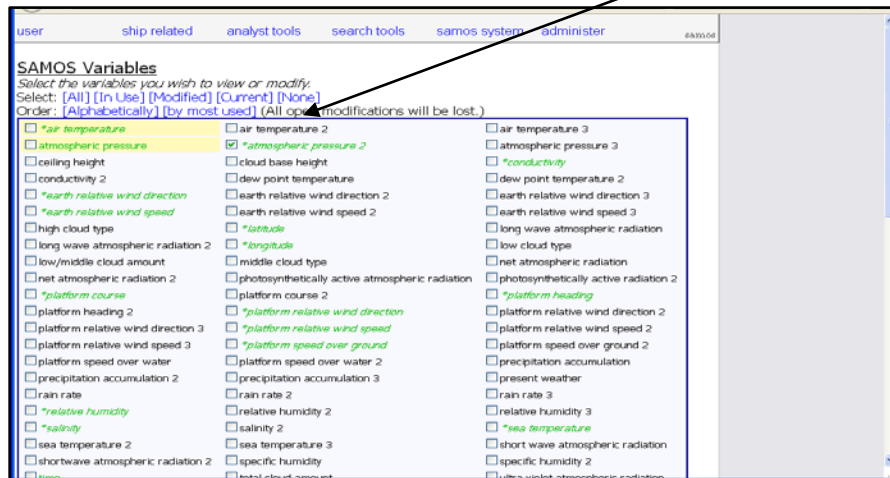


5. You will now see that sensor below, highlighted in Blue; click the plus sign to the left to expand the info about that sensor
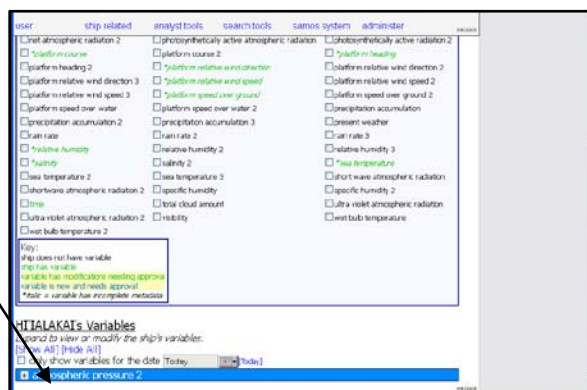


6. You will now see the current data for that sensor, grayed out at the top (see image below). You are unable to make changes at this point in the grayed out sensor info area.

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.

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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).

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**Step 11**

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.

**Step 13:**

**Step 12**

**Step 12 (c):** This date needs to be **at least one day after** the date that was just entered here, in step 10

**Step 12 (d):** For this date you will likely select the blue [Today] button

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]



**Step 14 (b):** You can now edit the sensor data in front of the blue background. Notice all variables for the sensor are blank; you need to re-enter any correct info as well.

**Step 14**

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

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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