

1. Introduction

Herein, we outline the SAMOS data exchange format that has been in use by most recruited vessel for SAMOS data transfers since 2005. Use of the format is recommended for newly recruited vessels; however, the SAMOS Data Assembly Center (DAC) at the Florida State University (FSU) is willing to work with providers to develop alternative exchange formats (as resources allow). This document includes a range of details related to designators, parameters to include, averaging, reporting intervals, time zones, and data files to be transmitted. A separate document (SAMOS_metadata_op02.doc) and forms (SAMOS_instrument_form_op01.doc and SAMOS_vessel_form_op01.doc) will be provided to collect essential metadata.

Revision history:

Although this document has undergone several revisions, the SAMOS version 1 data exchange format has not been modified since its inception in 2005.

01: (Sept. 2006) Original documentation

02: (March 2007) Minor modifications in the desired parameters (Appendix B)

03: (May 2018) Included text noting that designators should not contain blanks. Minor editorial updates.

Questions about the exchange format can be directed to samos@coaps.fsu.edu.

2. SAMOS data exchange format

The exchange format uses two separators, a comma "," between key-value pairs and a colon ":" between the designator and the data value. Each key-value pair consists of an alphanumeric designator and the data value associated with the designator. An example of the format:

```
$SAMOS:001,CS:KAOU,YMD:20030907,HMS:000011,AT:17.40,BP:1010.27,....,  
WSP:5.6,WDP:354.4,TWP:5.4,TIP:278.3,WSS:6.7,WDS:350.5,TWS:6.6,TIS:274.4,....,  
LA:44.66956,LO:-130.35859,COG:149.5,SOG:0.9,GY:284.7,CS8:23
```

Note 1: The format is designed to have all values for a single observation time (YMD, HMS) in a single line. The line breaks in the example are just to improve readability in this document.

Note 2: The \$SAMOS:001 represents the first version of the SAMOS data exchange format. Please place this string at the beginning of each line. *The SAMOS data processing software at FSU searches for this key-value pair and will skip any line in the file that does not start with \$SAMOS.* In the future, additional format designators and versions are possible.

Note 3: Please follow the \$SAMOS:001 tagged pair with the call sign pair (CS:call_sign). *The CS:call_sign pair is essential for the data processing software to correctly associate your observations with the correct vessel.* Beyond these first two tagged pairs, the order of the data does not matter as the designators uniquely identify each tagged pair and their data values.

Note 4: Each institute can decide whether or not to include an 8-bit (or other) checksum for each line in the file (at the end of each line). If you do plan to provide a checksum, please provide the DAC with details on how the number is calculated so the value can be decoded.

3. Designators

For SAMOS, a unique designator is requested for each data value. Designators can vary from ship to ship. The designator definitions in the example above are:

Designator	Parameter	Units	Measured vs Calculated
\$SAMOS	SAMOS format version number	Unitless	N/A
CS	Vessel call sign	N/A	N/A
YMD	Year, month, day	UTC	N/A
HMS	Hour, minute, second	UTC	N/A
AT	Air Temperature	°C	M
BP	Barometric Pressure	hPa	M
WSP	Port ship-relative wind speed	m/s	M
WDP	Port ship-relative wind direction	°clockwise from bow	M
TWP	Port earth-relative (true) wind speed	m/s	C
TIP	Port earth-relative (true) wind direction	°clockwise from north	C
WSS	Starboard ship-relative wind speed	m/s	M
WDS	Starboard ship-relative wind direction	°clockwise from bow	M
TWS	Starboard earth-relative (true) wind speed	m/s	C
TIS	Starboard earth-relative (true) wind direct.	°clockwise from north	C
LA	Latitude	°+N	M
LO	Longitude	°+E, -W	M
COG	Course over ground	°clockwise from north	M
SOG	Speed over ground	Knots	M
GY	Heading	°clockwise from north	M
CS8	8-bit checksum	Unitless	C

Please use the following standards for designators:

1. Designators should be unique alphanumeric identifiers for each parameter and should not contain any blanks (white spaces). The two-character designators used by SIO are a good reference (Appendix A: Met-Sensors.txt) but should be modified slightly to uniquely identify multiple sensors deployed to measure a single parameter (e.g., 2 wind sensors).
2. Multiple sensors should be identified by adding an approximate measure of the sensor's location on the vessel to the designator. One example would be to add a P – port, S – starboard, or B – bow notation.
3. The exact choice of designators (and how they uniquely reference multiple sensors) can be decided by individual home institutions. Our ship profile database is designed to account for different designators from different vessels.
4. **A list of designators, which includes the long definition and units for each parameter, is required for each vessel participating in the SAMOS program.** This

information can be provided on the instrument metadata form (SAMOS_instrument_form_op01.doc) and will be stored in a ship profile database at the DAC. Without appropriate designators your data cannot be decoded by the DAC. This also means any changes to designators must be explicitly communicated to the DAC to ensure proper data processing.

4. Parameters to include

1. Primary and secondary parameters of interest to the SAMOS initiative are outlined in Appendix B: SAMOSdata_specs.doc.
2. One or more (depending on sensor redundancy) values for each available primary and secondary parameter should be included in each data record. A unique designator is required for each value (including redundant sensors).
3. If possible, data values provided should include pre-deployment instrument calibrations (should be corrected values). We are interested in the “best” value each ship can provide.
4. SAMOS, at present, is only interested in parameters observed by instruments that are permanently installed on a vessel (not those instruments that are brought on board by individual investigators).
5. When a sensor exists for a parameter, but the observation is not available (missing), please exclude the designator:value pair for that observation time

5. Requirements for all data

1. Observation times must be reported in the Universal Time Coordinate (UTC)
2. Time format: YYYYMMDDhhmmss (We recommend a 4-digit year and a year, month, day order for the date). Date and time portions can be separated as long as unique designators are used, e.g., YMD and HMS.)
3. Position format: We request that latitude and longitude values are provided in decimal degrees (as opposed to degrees, minutes, seconds) and that they are provided with as much precision as possible from the source navigation system (typically 4 decimal places or more with modern GPS technology).
4. Original units must be supplied (SI units preferred). Please include the original units for each value on the instrument metadata form (SAMOS_vessel_form_op01.doc). Please include latitude and longitude (e.g., +E, -W) and wind direction (to which, from which wind is blowing) conventions.

6. Reporting interval

We are requesting that the interval between reports (lines of data in the exchange file) is one minute (see averaging below).

7. Averaging procedure

1. SAMOS observations should be *one-minute averages* derived from higher frequency instrument measurements.
2. At present, the DAC recommends, based on empirical analysis (see below), that a minimum of 12 samples per minute be used to construct the one-minute averages.
 - a. To simplify future documentation, this minimum should be used for all parameters (regardless of whether the parameter is subject to more (winds) or less (pressure) natural variability over the one-minute averaging period.

- b. More than 12 samples per minute can be used, but this would not be required.
3. Ship-relative winds should be adjusted for ship motion for each instrument sample and then averaged to create one-minute average true winds
4. We also need to know whether the time stamp on each data record in the \$SAMOS format correspond to the beginning, center, or end of the averaging period. Centered averages are preferred, but not essential. There may be technical reasons that support placing the time stamp at either the beginning or end of the averaging period.

Notes on Averaging Procedure (Dr. Mark Bourassa, COAPS/FSU)

Wind speed and direction are often the variables most adversely impacted by the choice of averaging time and procedure. This problem occurs because the winds usually have more natural variability than other variables, and because maneuvering of the vessel is a non-linear term in the calculation of earth or current relative winds. True winds based on one-minute averages, compared to satellite winds, clearly showed that maneuvering caused a substantial error: about 0.2 ms^{-1} in speed (Smith et. al, 1999, <http://www.coaps.fsu.edu/woce/truwind/paper/index.html>). This error is greater than the uncertainty in either the satellite or the research vessels that were used in the study (Bourassa et al. 2003, http://www.coaps.fsu.edu/papers/seawinds_validation/). We have not evaluated fine temporal resolution data to assess how the averaging should be done. Our colleagues on the *R/V Polarstern* tried calculating true winds every five seconds (i.e., 12 samples per minute), and averaging these true winds each minute. This procedure dropped errors associated with maneuvering and changing winds to the point where we could not detect them in comparison to satellite vector winds. Such a procedure should work very well for winds and radiation, which can change rapidly. A smaller number of samples per minute is likely to be effective for less rapidly changing variables; however, at this time we cannot provide more quantitative guidance.

8. File delivery

1. The SAMOS data center wishes to receive all one-minute average data for a single observing day in one daily file (ideally the file would contain 1440 lines of data).
2. Daily data files should be transmitted to the data center as soon as possible after 0000 UTC. (e.g., day 1 data should be transmitted soon after 0000 UTC on day 2)
3. Present policy is to send data files as attachments to an email.
 - a. Files should be compressed using non-proprietary compression routine to reduce file transfer size (Please provide the compression method used; zip, gzip, etc.)
 - b. Send files to **samos_data@coaps.fsu.edu**
 - c. Please **do not** embed the data within the email body (this portion of the email is ignored), attached files only please.
4. We will identify the data for each vessel using the call sign within the emailed files. We recommend including the call sign in the attached file name and email subject line, if possible. Also, please include the date of the data within the file as part of the file name.
 - a. All files received will be verified and tracked
5. Note: our processing codes will take into account the possibility of:
 - a. Receiving multiple files for a single observing day
 - b. Receiving duplicate files for a single observing day
 - c. Receiving multiple observing days in one file

Appendix A

Possible designators to use when developing SAMOS data exchange for your vessel(s). The list is a subset of the designators used by the Scripps Institution of Oceanography. *These are suggestions only, not requirements.* Each operator can use designators that work best for their own operations and data acquisition software. Note that when multiple sensors exist for a single variable (e.g., air temperature), the designators used should be unique (e.g., ATP for port sensor, ATS for starboard sensor, etc). Designators are alphanumeric and should contain no spaces. Desired units are in ().

Designator	Parameter (units)
AT	Air Temperature (°C)
AX	Auxiliary Air Temperature (°C)
BC	Barometric Pressure Temp (°C)
BP	Barometric Pressure (mb)
CR	Ship's Course from GPS; COG (Deg)
DP	Dew Point (°C)
FL	Fluorometer (ug/l)
GY	Ship's Heading from Gyrocompass (Deg)
LA	Latitude; Decimal format (Deg)
LB	LWR Body Temperature (°K)
LD	LWR Dome Temperature (°K)
LO	Longitude; Decimal format (Deg)
LT	LWR Thermopile (Volts)
LW	Long Wave Radiation [LWR] from Pyrgeometer (W/m ²)
OG	Oxygen (mg/l)
OS	Oxygen Saturation value (ml/l)
OT	Oxygen Temperature (°C)
OX	Oxygen (ml/l)
PH	Alkalinity (pH)
PR	Precipitation (mm)
PT	Precipitation rate (mm/hr)
RH	Relative Humidity (%)
RT	Air Temp (RH module) (°C)
SA	Salinity (PSU)
SH	Ashtech Heading (Deg)
SL	Ship's Speed; Speed Log, Speed over water (m/s)
SM	Ashtech Pitch (Deg)
SP	Ship's Speed; GPS Speed over ground (m/s)
SR	Ashtech Roll (Deg)
ST	Sea Surface Temperature (°C)
SV	Sound Velocity [Chen/Millero] (m/s)
SW	Short Wave Radiation [SWR] from Pyranometer (W/m ²)
TB	Turbidity (NTU)
TC	SBE21 Conductivity (mS/m)
TI	True Wind Direction; Direction wind is coming from (Deg)

TK	True Wind Speed (m/s)
TR	Transmissometer (%)
TT	SBE21 Temperature (°C)
TW	True Wind Speed (m/s)
VH	VRU Heave (m)
VP	VRU Pitch (Deg)
VR	VRU Roll (Deg)
VX	Ship's Trim (Deg)
VY	Ship's List (Deg)
WD	Relative Wind Direction; Direction wind is coming from (Deg)
WS	Relative Wind Speed (m/s)
WT	Auxiliary water Temp (°C)
ZD	GPS Date Time GMT (Secs Since 00:00:00 01/01/1970)
Other appropriate time designators	
HMS	Hour, minute, second (hhmmss) time of reported spot or average observation in GMT
YMD	Year, month, day (YYYYMMDD) of reported spot or average observation in GMT
DT	Date and time (YYYYMMDDhhmmss) of reported spot or average observation in GMT

Appendix B

Parameters for routine data acquisition from Shipboard Automated Meteorological and Oceanographic Systems (SAMOS) on research vessels.

Primary data

1. Observation time
2. Latitude
3. Longitude
4. Ship course over ground
5. Ship speed over ground
6. Ship heading
7. Ship speed over water (fore-aft and along beam components)
8. Ship-relative wind direction (*as measured by anemometer*)
9. Ship-relative wind speed (*as measured by anemometer*)
10. Earth-relative (true) wind direction
11. Earth-relative (true) wind speed
12. Atmospheric pressure
13. Air temperature
14. Moisture (dewpoint temperature, wet-bulb temperature, relative humidity, and/or specific humidity)
15. Precipitation
16. Shortwave radiation
17. Longwave radiation
18. Sea temperature
19. Salinity
20. Conductivity

Secondary data (desired if available)

1. Vessel pitch, roll, and heave
2. Photosynthetically Active Radiation (PAR)
3. Ultraviolet radiation
4. Total Radiation
5. Visibility (from automated sensor)
6. Ceiling (from automated sensor)
7. Fluorescence
8. Other ocean surface measurements (pCO₂, oxygen, nutrients, etc.)
9. Radiometric Sea Surface Temperature
10. Swell and wind wave heights and directions (if measured by automated system)
11. Weather, cloud cover, and cloud height (not anticipated as automation is unlikely)