Why We Care About Marine Meteorology

An Introduction to Marine Meteorology

An Introduction to Marine Meteorology

If only it were this simple!

How Does Ocean Differ from Land?

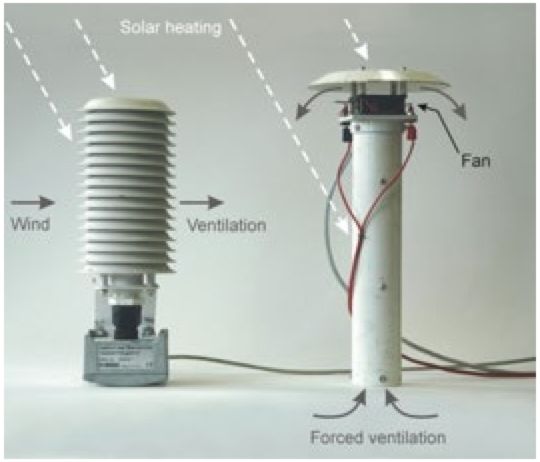
- **Homogeneity**
- **Moisture source**
- **Surface friction**
- **Diurnal cycles**
- **Harshness**

What to Measure

What to Measure

- Meteorology
  - Wind direction and speed
  - Air temperature
  - Humidity
  - Pressure
  - Rainfall
  - Radiation
    - SW, LW, PAR





What to Measure

- Oceanography
  - Sea temperature
  - Salinity
- Navigation
  - Latitude and longitude
  - Course over ground
  - Speed over ground
  - Speed relative to water
  - Heading

TSG

Hull

IR

Who Uses the Data?

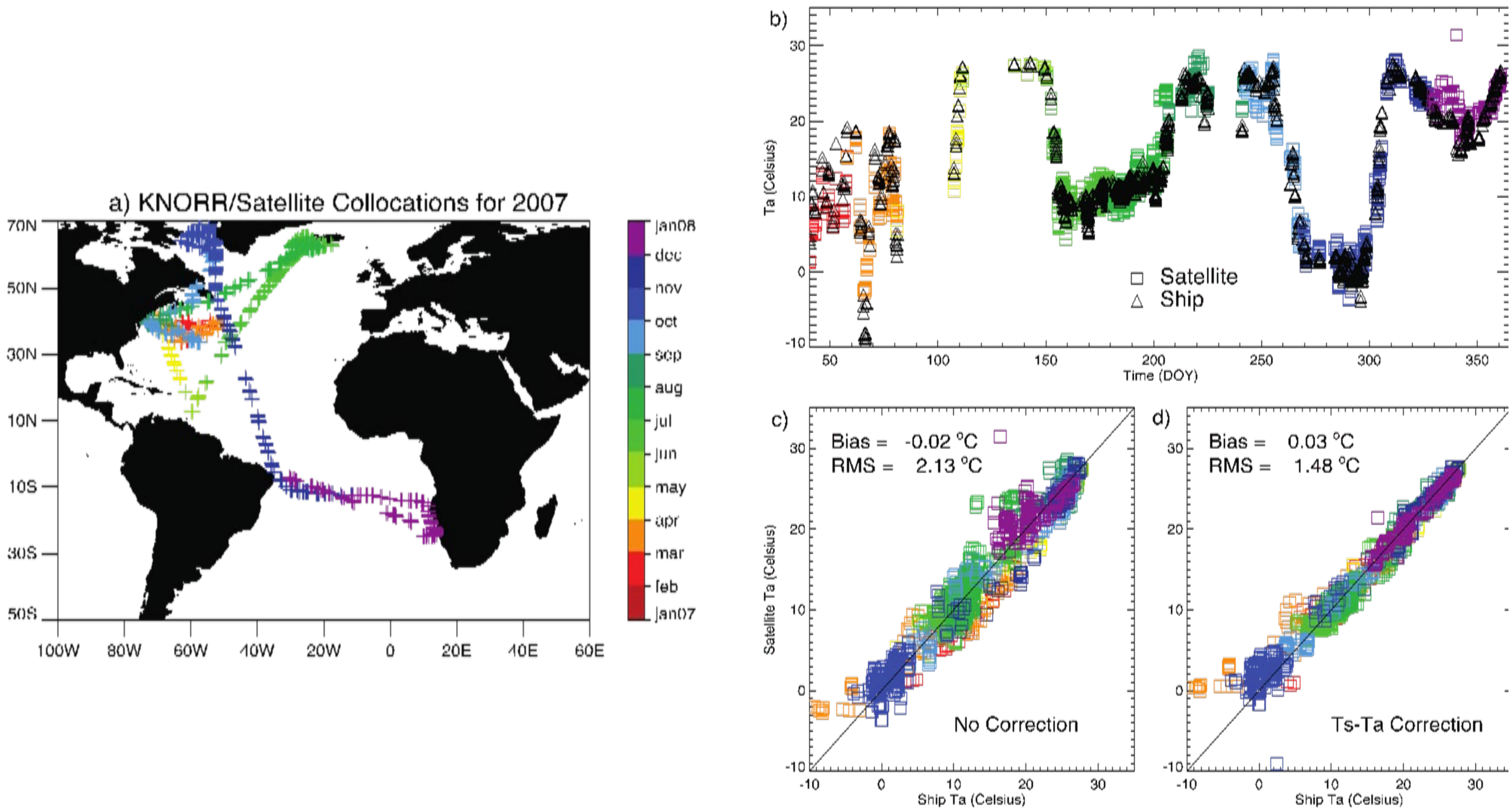
Who Uses the Data?

- Shipboard personnel
  - Vessel operations
  - Ocean deployments (buoys, CTDs, towed instruments, autonomous platforms)
  - Science during cruise

Who Uses the Data?

- Shipboard personnel
  - Vessel operations
  - Ocean deployments (buoys, CTDs, towed instruments, autonomous platforms)
  - Science during cruise
- Secondary users (not on cruise)
  - Ocean and atmosphere modelers, including National Met Services
  - Satellite and other remote measurement communities
  - Air-sea interaction researchers
  - Product developers (climate atlases, gridded fields)
  - Instrument developers

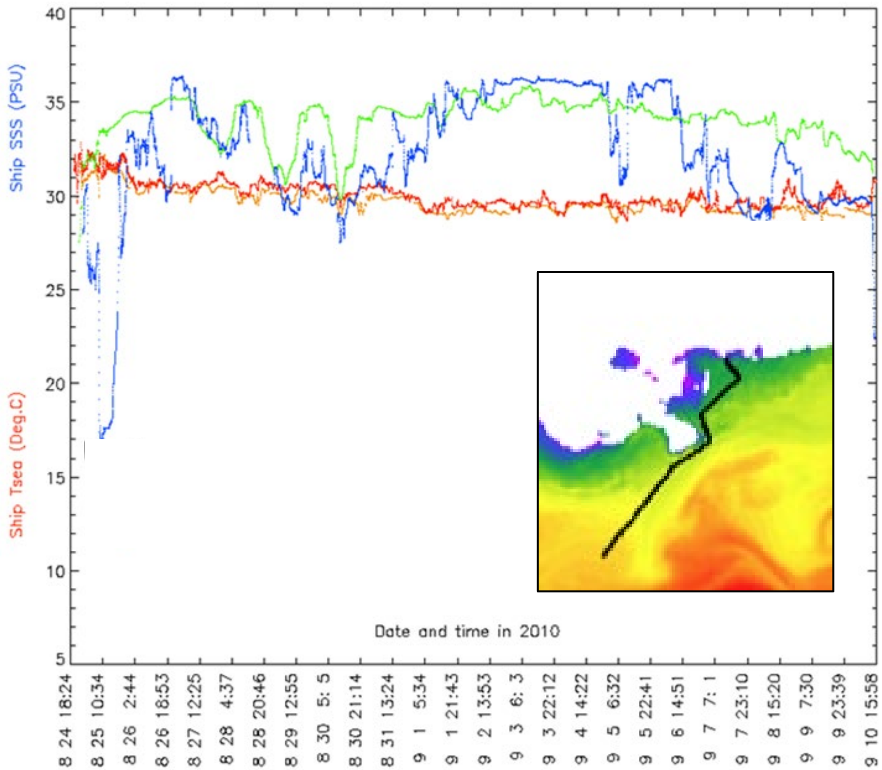
Satellite Calibration and Algorithm Development



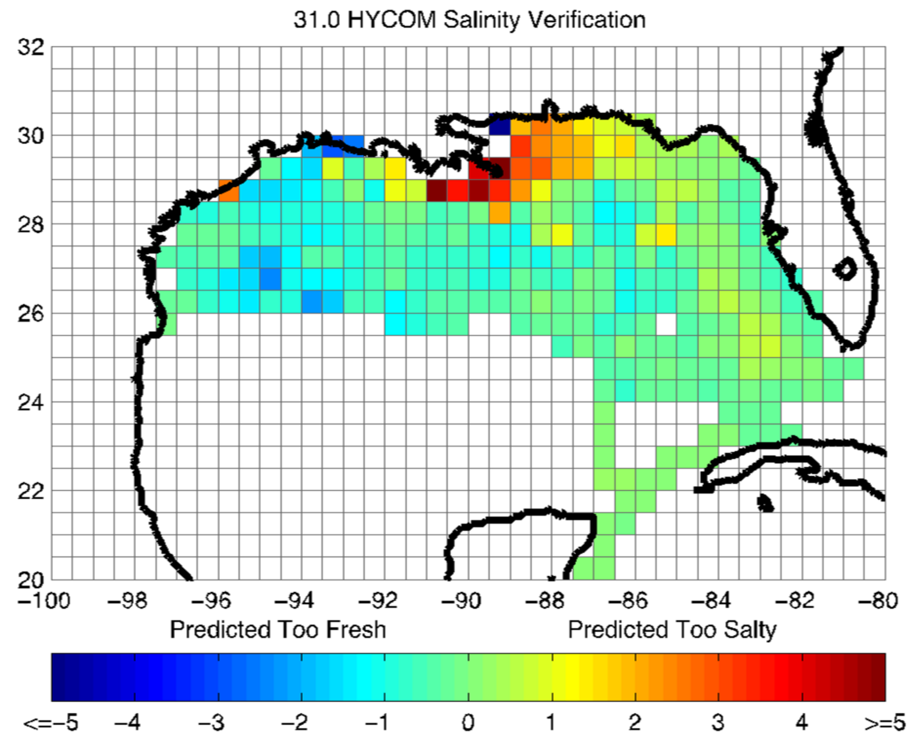
Adapted from Smith, Bourassa, and Jackson, *Sea Technology*, June 2012

Ocean Model Evaluation

Sea Temperature and Salinity Time Series



Model vs. Ship Salinity: Multi-ship Comparison



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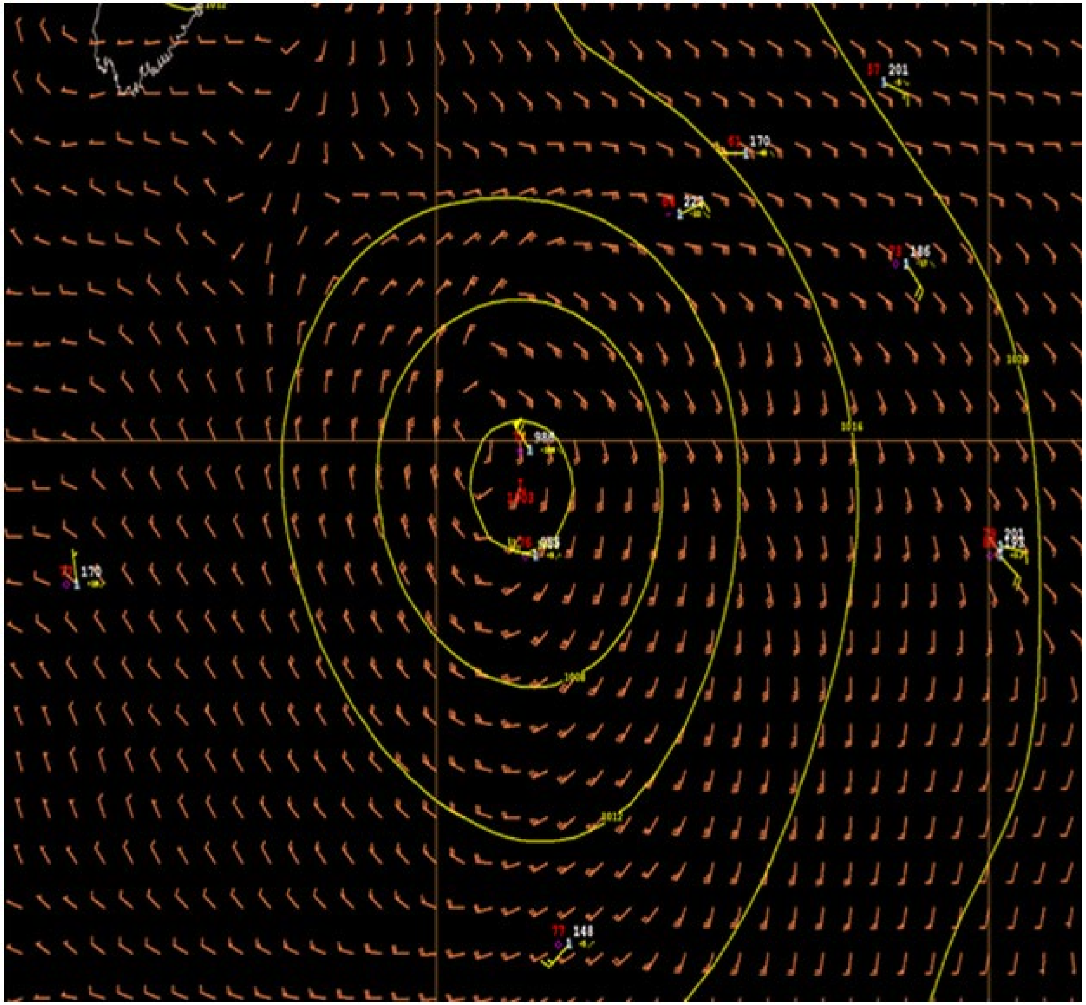
Shipboard Automated Meteorological and Oceanographic System

Real-Time Forecast Validation
Data QC

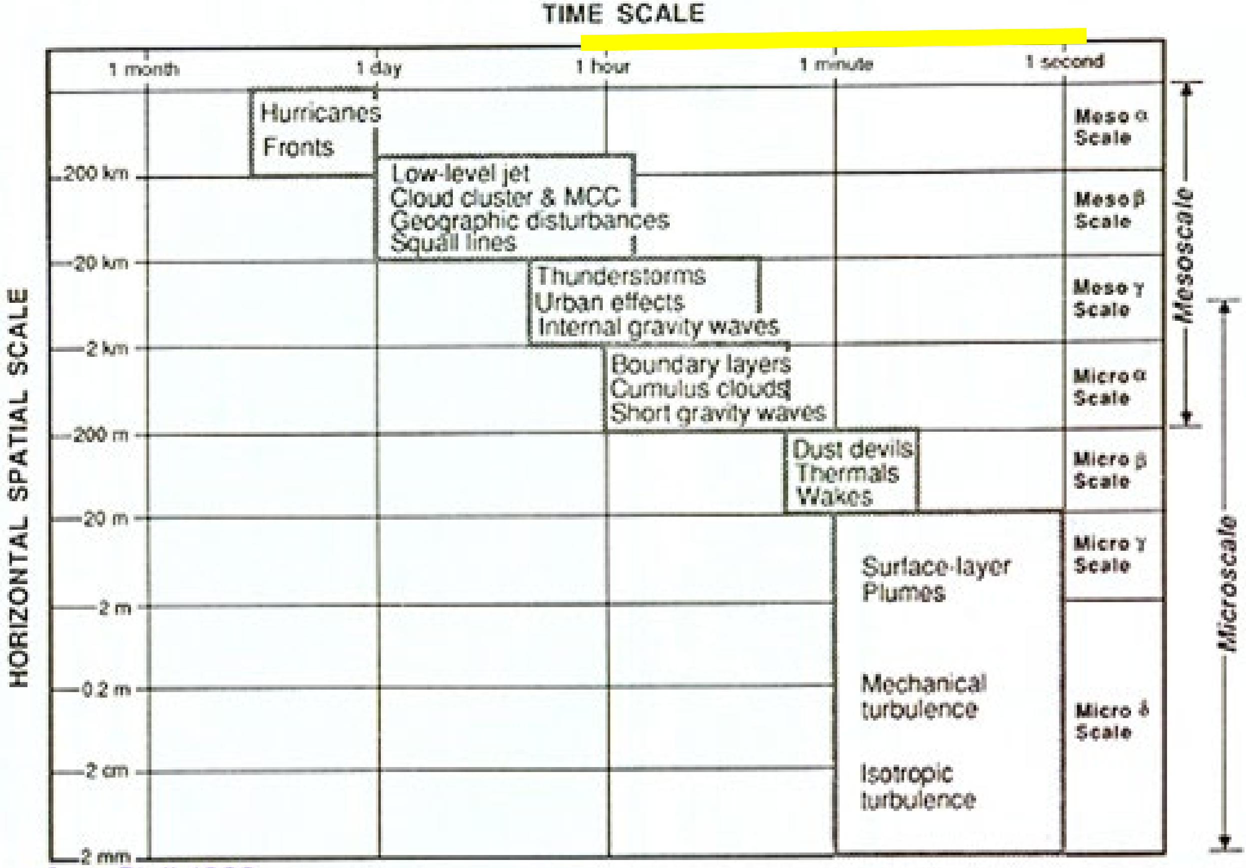


How to Measure

- Know what you want to measure . . . parameter(s).
- Know the temporal and spatial scales.
- Know the sensor characteristics.
  - Accuracy, precision, range, . . .
- Know the data acquisition system.
- Know the environment you will be working in.

End
Lesson 1

Time Scales



from Stull 1988

Fig. 1.15 Typical time and space orders-of-magnitude for micro and mesoscales. (After Orlanski, 1975.)

Sampling Rates

The **Nyquist-Shannon sampling theorem** in general states a signal can be reconstructed from its samples if the sampling frequency is greater than twice the highest frequency of the signal (also known as the **Nyquist frequency)**.

Oversampling is often preferred as it can

- aid in anti-aliasing,
- be used to increase resolution when using A/D convertors, and
- help reduce uncorrelated noise when averaging multiple samples.

Accuracy/Precision Targets

Table 1: Accuracy, precision and random error targets for SAMOS.

Parameter	Accuracy of Mean (bias)	Data Precision
Latitude and Longitude	0.001°	0.001°
Heading	2°	0.1°
Course over Ground	2°	0.1°
Speed over Ground	Larger of 2% or 0.2 m/s	0.1 m/s
Speed over Water	Larger of 2% or 0.2 m/s	0.1 m/s
Wind Direction	3°	1°
Wind Speed	Larger of 2% or 0.2 m/s	0.1 m/s
Atmospheric Pressure	0.1 hPa (mb)	0.01 hPa (mb)
Air Temperature	0.2°C	0.05°C
Dewpoint Temperature	0.2°C	0.1°C
Wet-Bulb Temperature	0.2°C	0.1°C
Relative Humidity	2%	0.5 %
Specific Humidity	0.3 g/kg	0.1 g/kg
Precipitation	~0.4 mm/day	0.25 mm
Radiation (SW in, LW in)	5 W/m²	1 W/m²
Ocean Surface:		
Sea Temperature	0.1°C	0.05°C
Salinity	0.1 psu	0.05 psu

Manufacturer Accuracy

+/- 5° (Wind Direction)

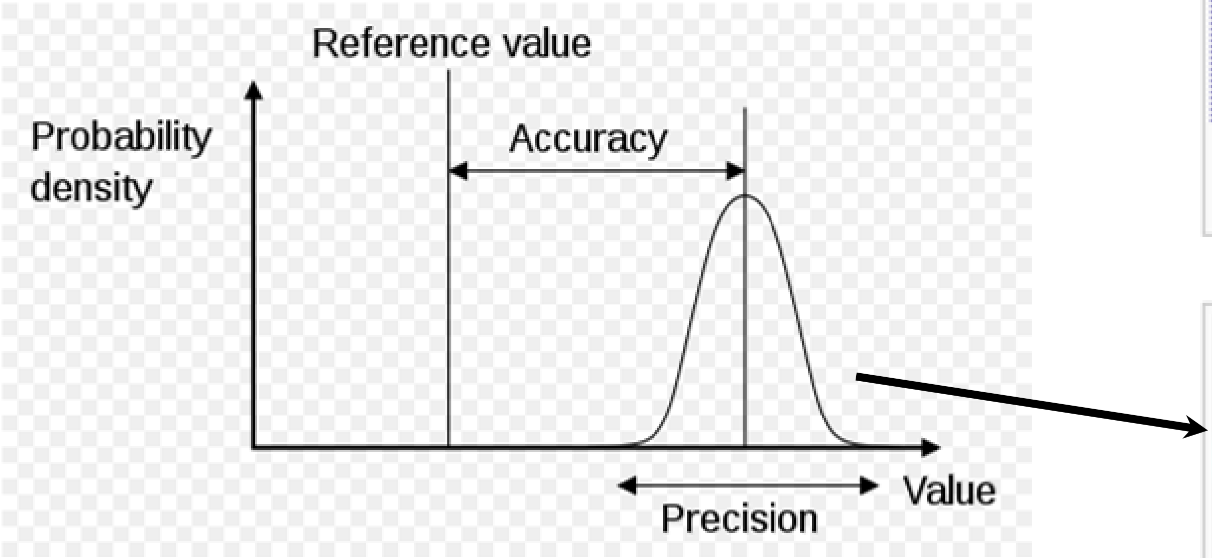
+/- .3 m/s (Wind Speed)

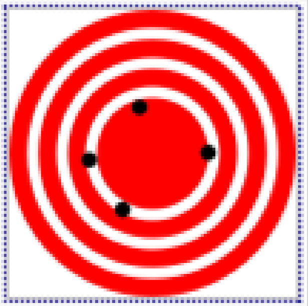
+/- .3 hPa (Analog) **+/- .1 hPa (Digital)** (Atmospheric Pressure)

+/- .17°C (Analog) **+/- .12°C (Digital)** (Air Temperature)

+/- 2% (0-90%) **+/- 3% (90-100%)** (Relative Humidity)

Accuracy/Precision

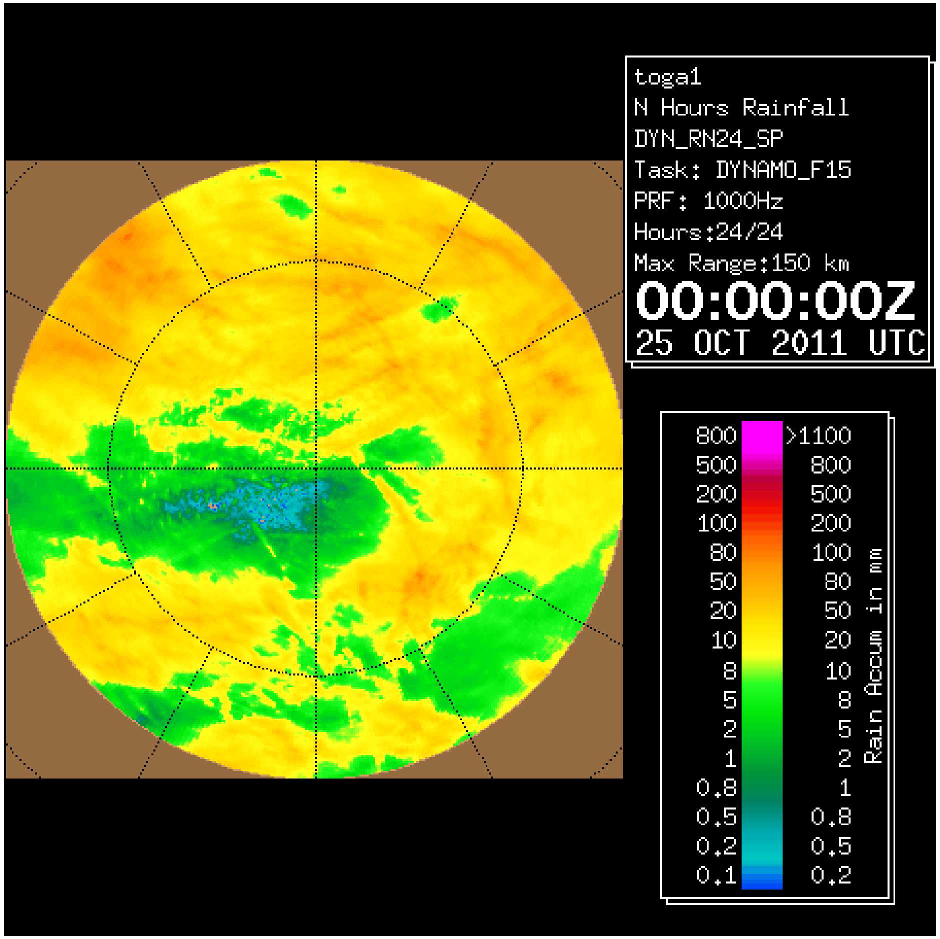




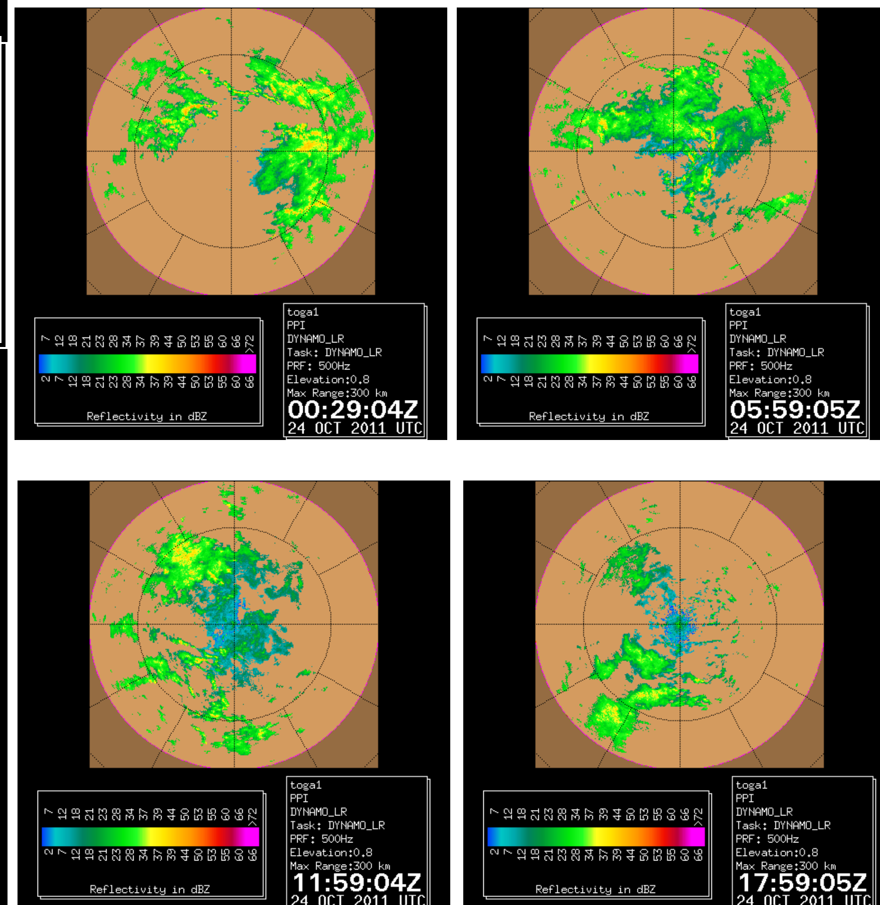
High **accuracy**, but low **precision**

High **precision**, but low **accuracy**

Precipitation/Clouds



24 hr Accumulated Rain



Radar Reflectivity

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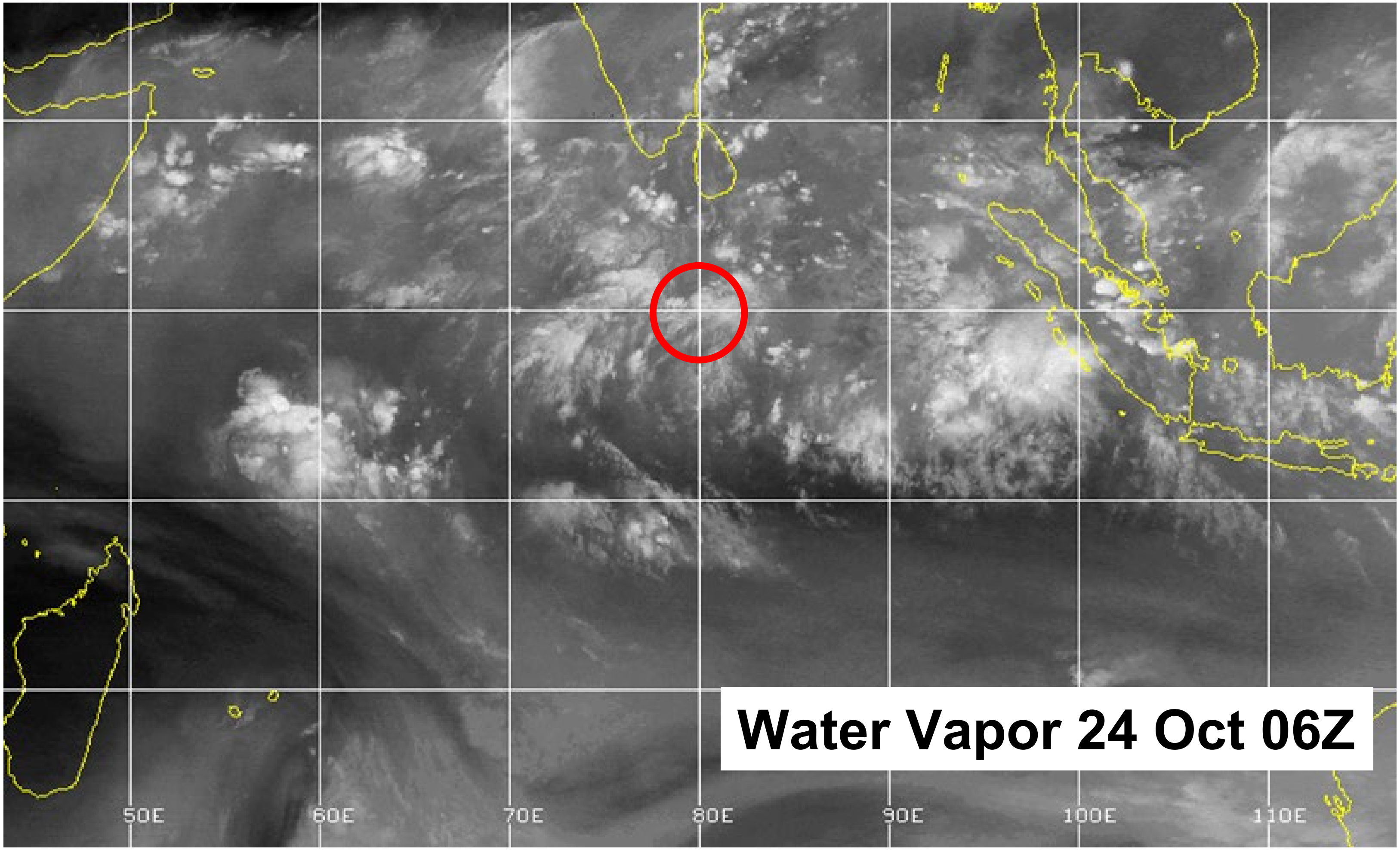
Satellite



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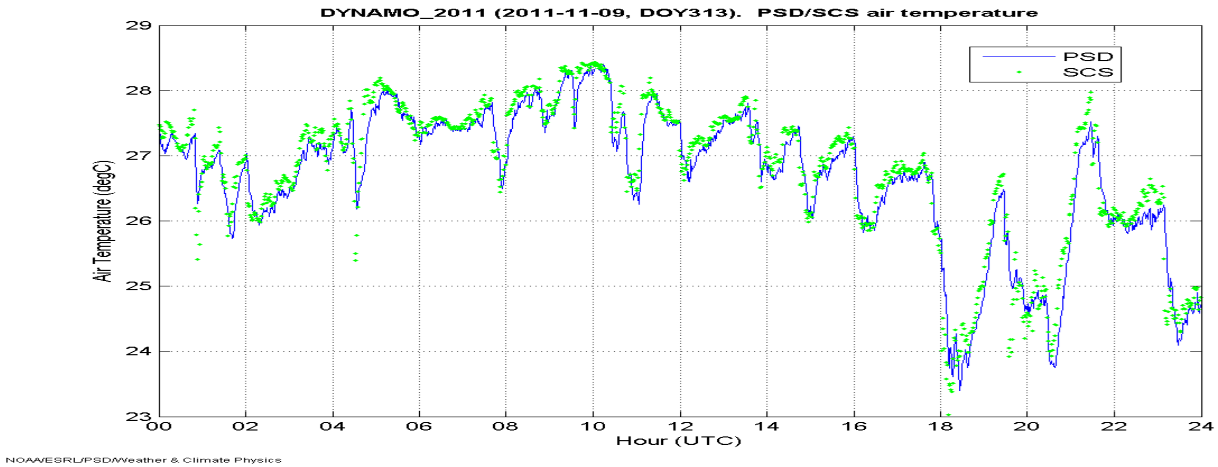
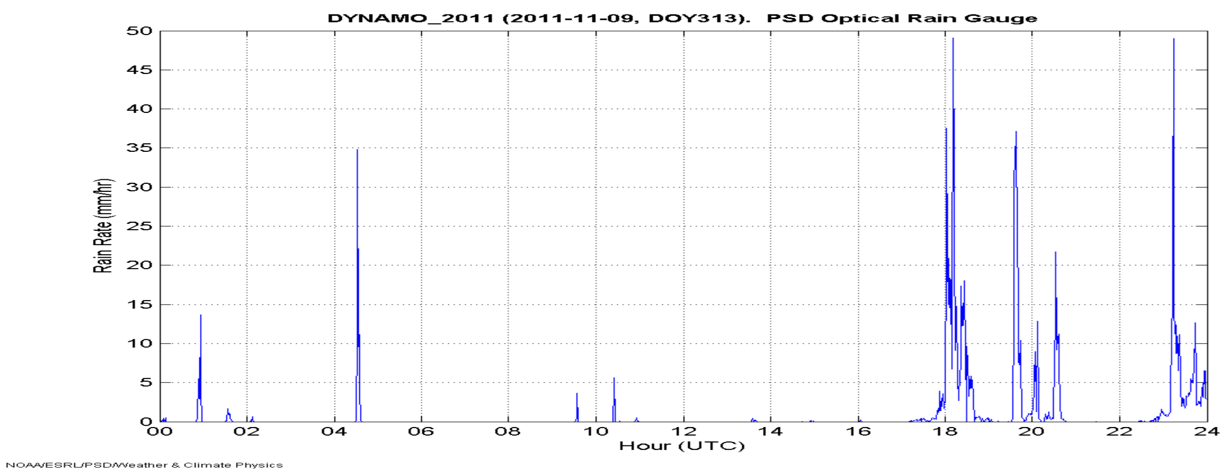
Temperature

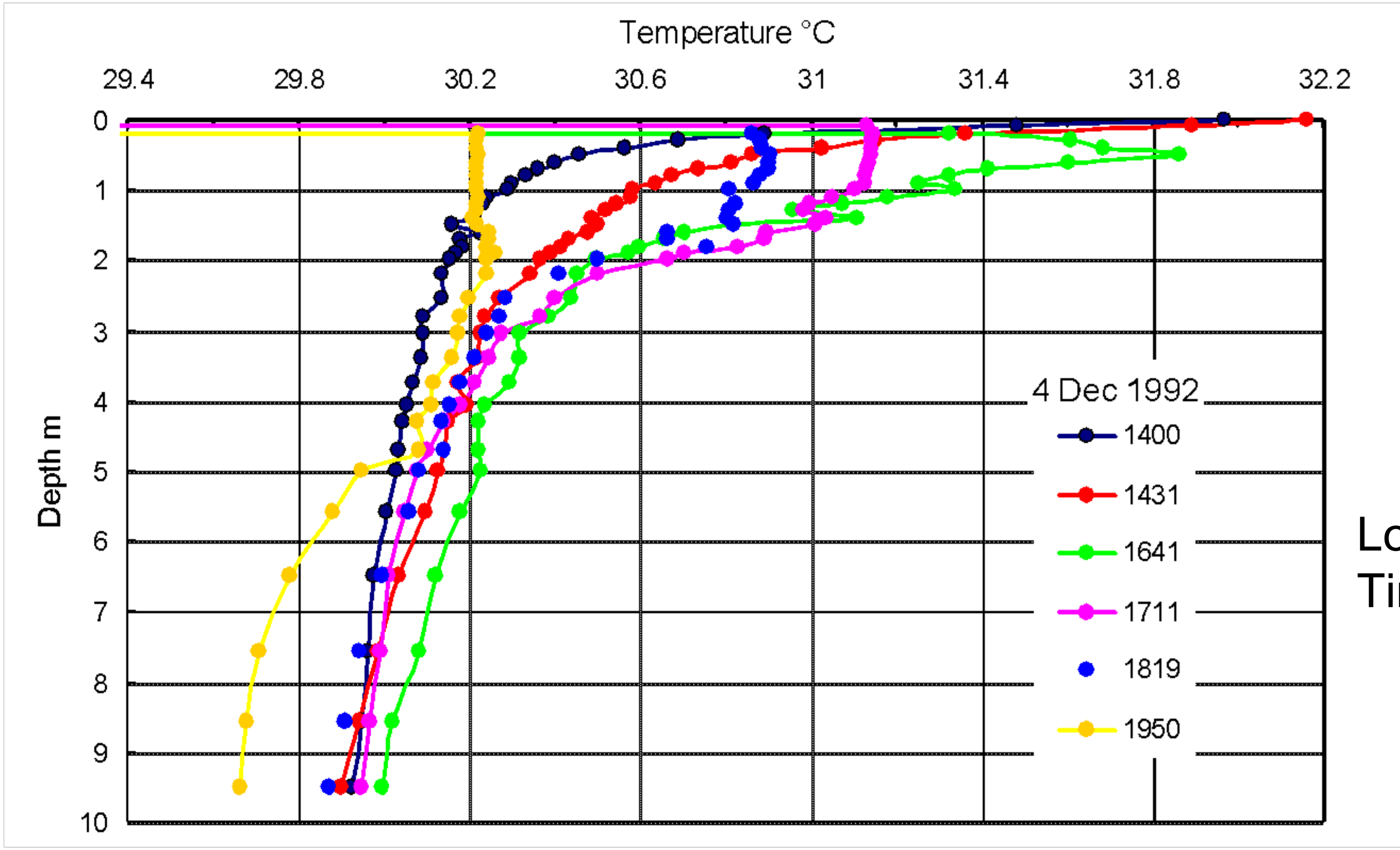


Air



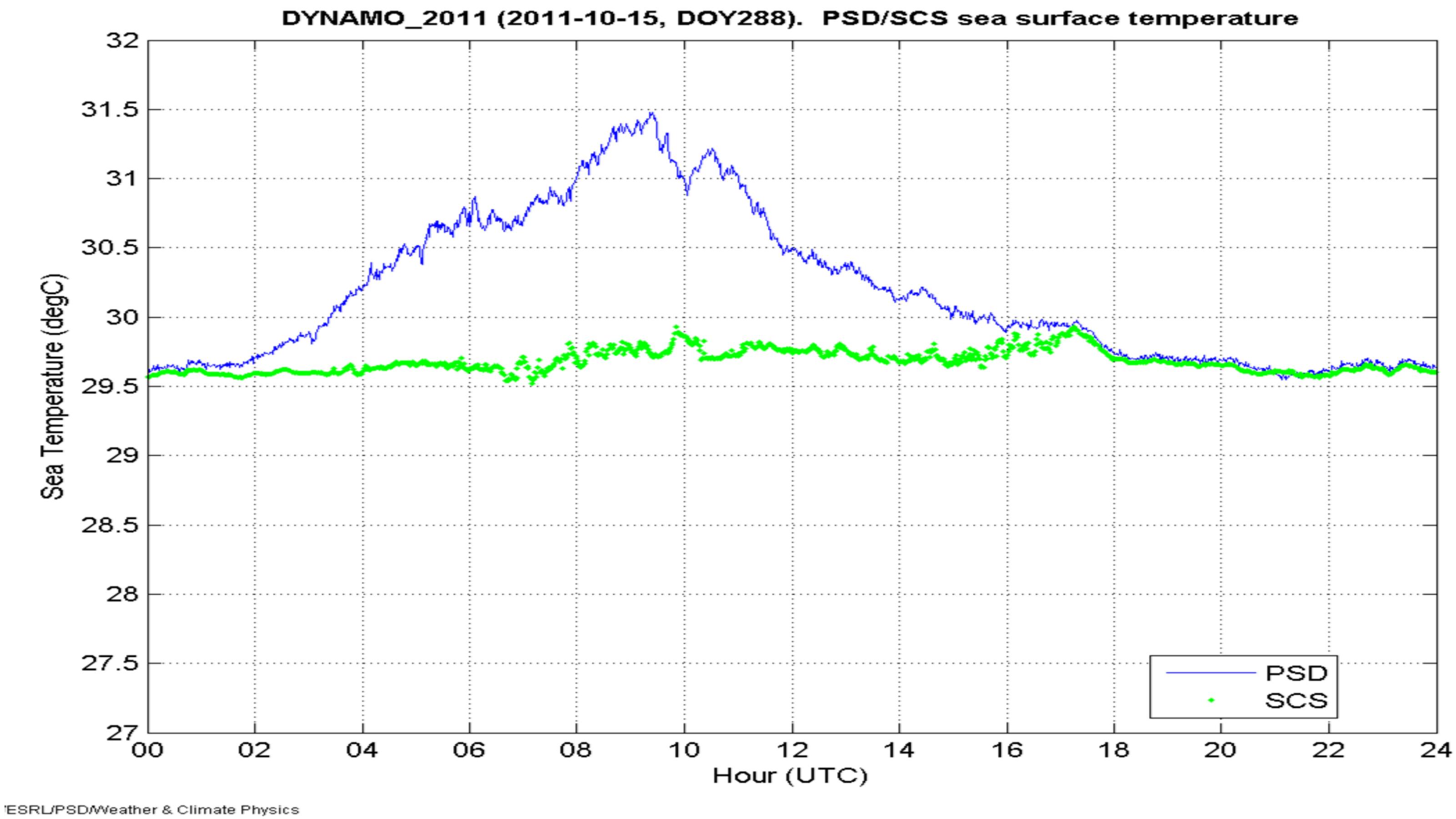
Rain Rate

Sea Temperature



Local Time

Sea Temperature



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SAMOS
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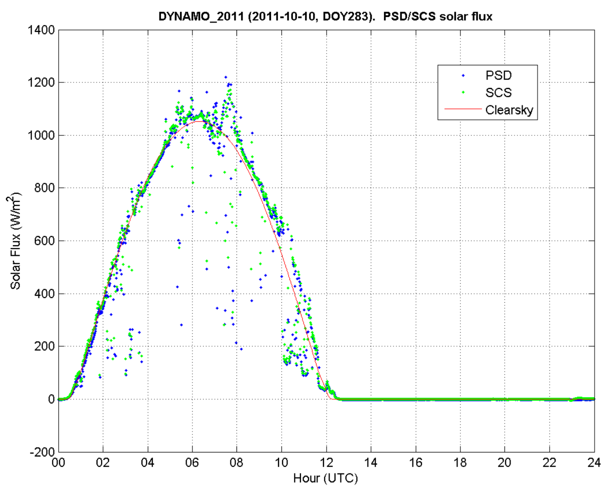
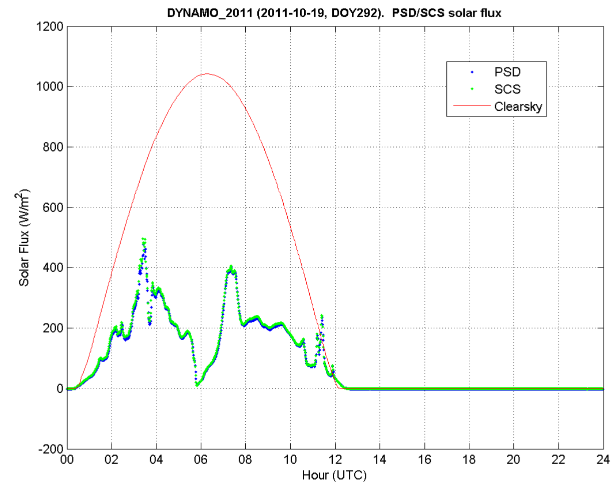
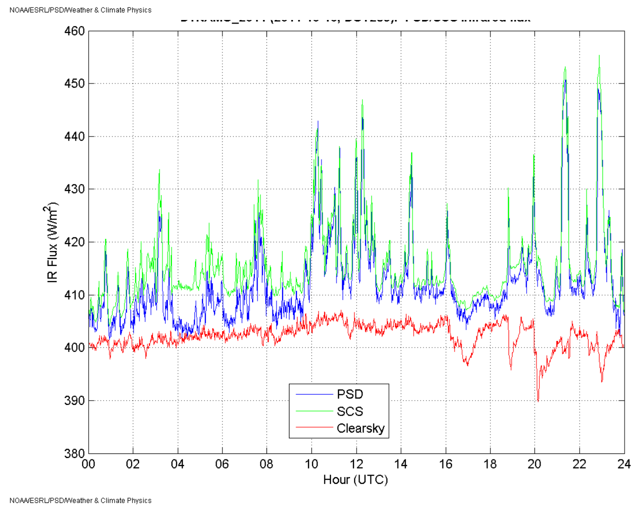
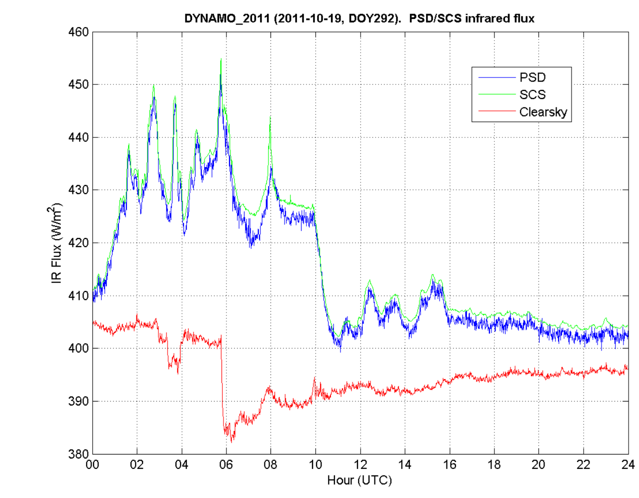
Radiation





SW





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Sensor Siting and Exposure

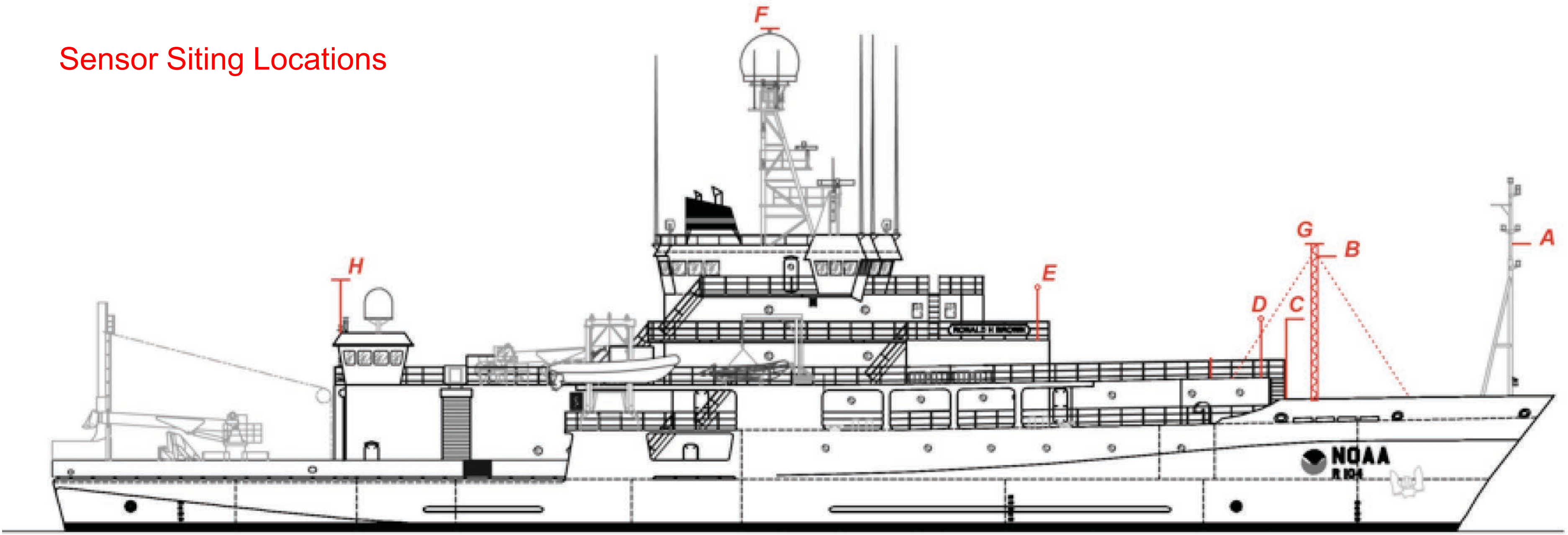
Presented by Marc Castells

Introduction

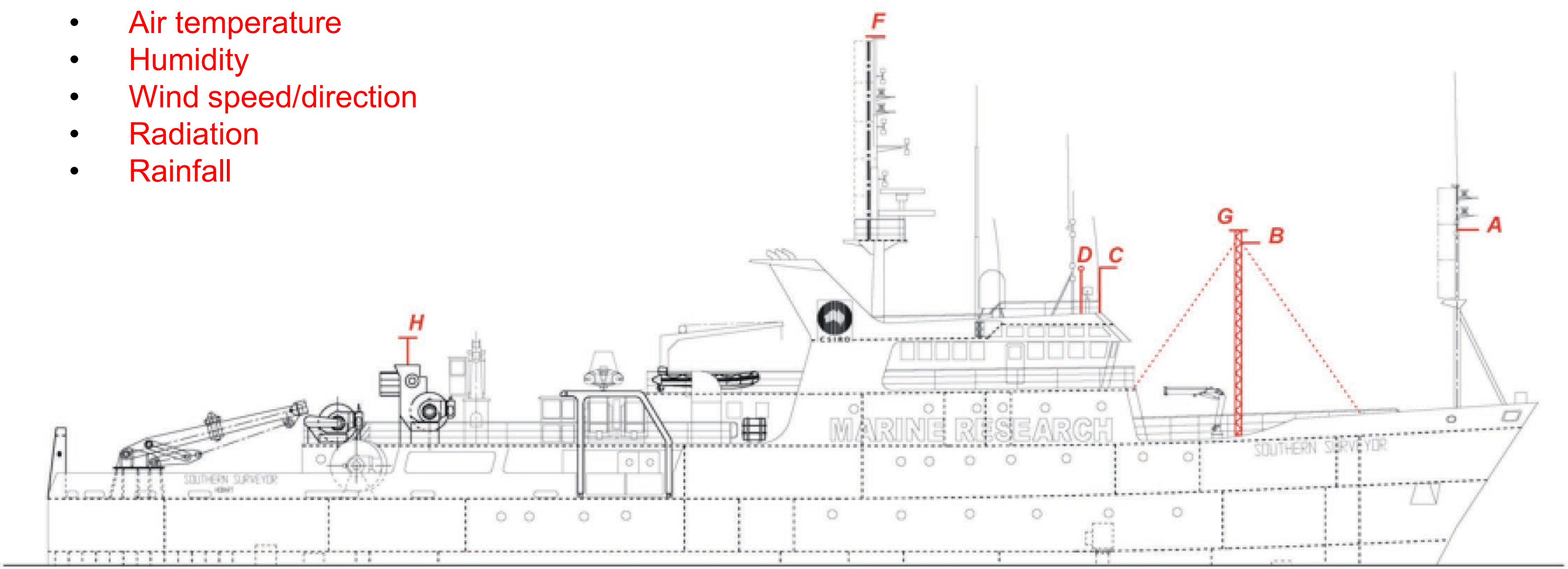
- **Location of the sensors is the most critical aspect for accurate measurement of meteorological variables.**

- The difficulties of making these measurements aboard a ship include:
  - alteration of airflow by the vessel structure prior to air reaching the sensor (known as flow distortion);
  - exposure of the sensor to sea spray, salt contamination, and vessel exhaust;
  - vessel motion influencing collected data; and
  - maintaining hard to reach instruments while underway.

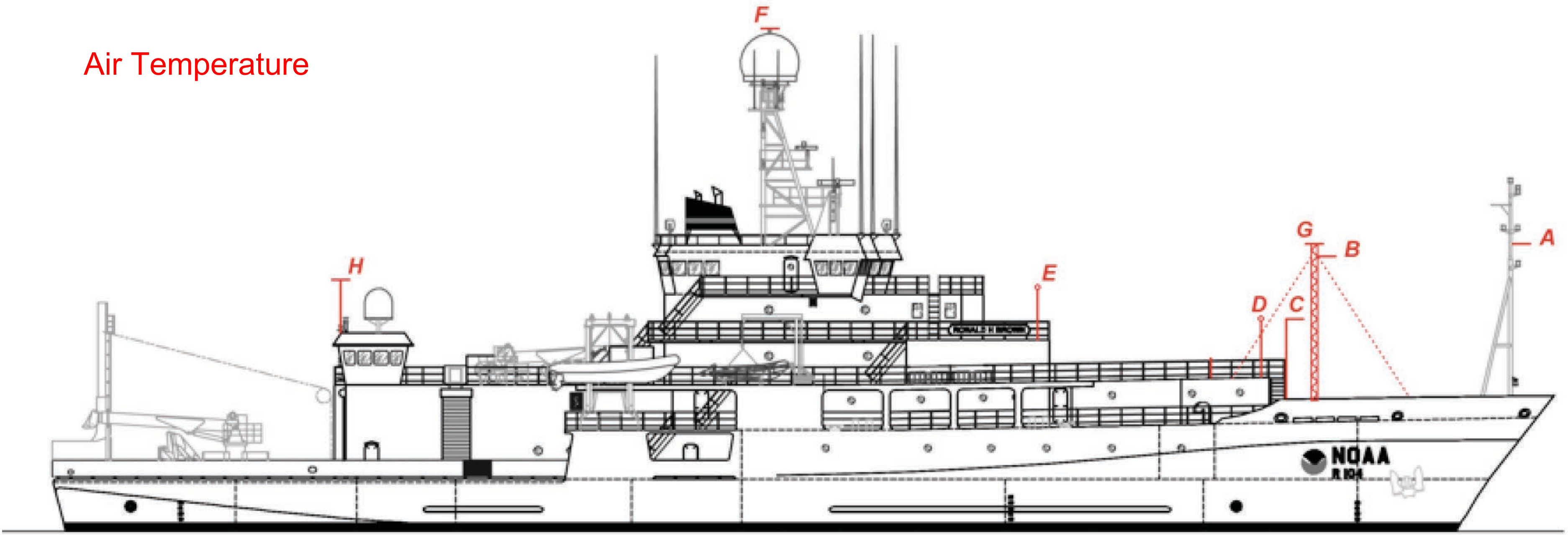
Sensor Siting Locations

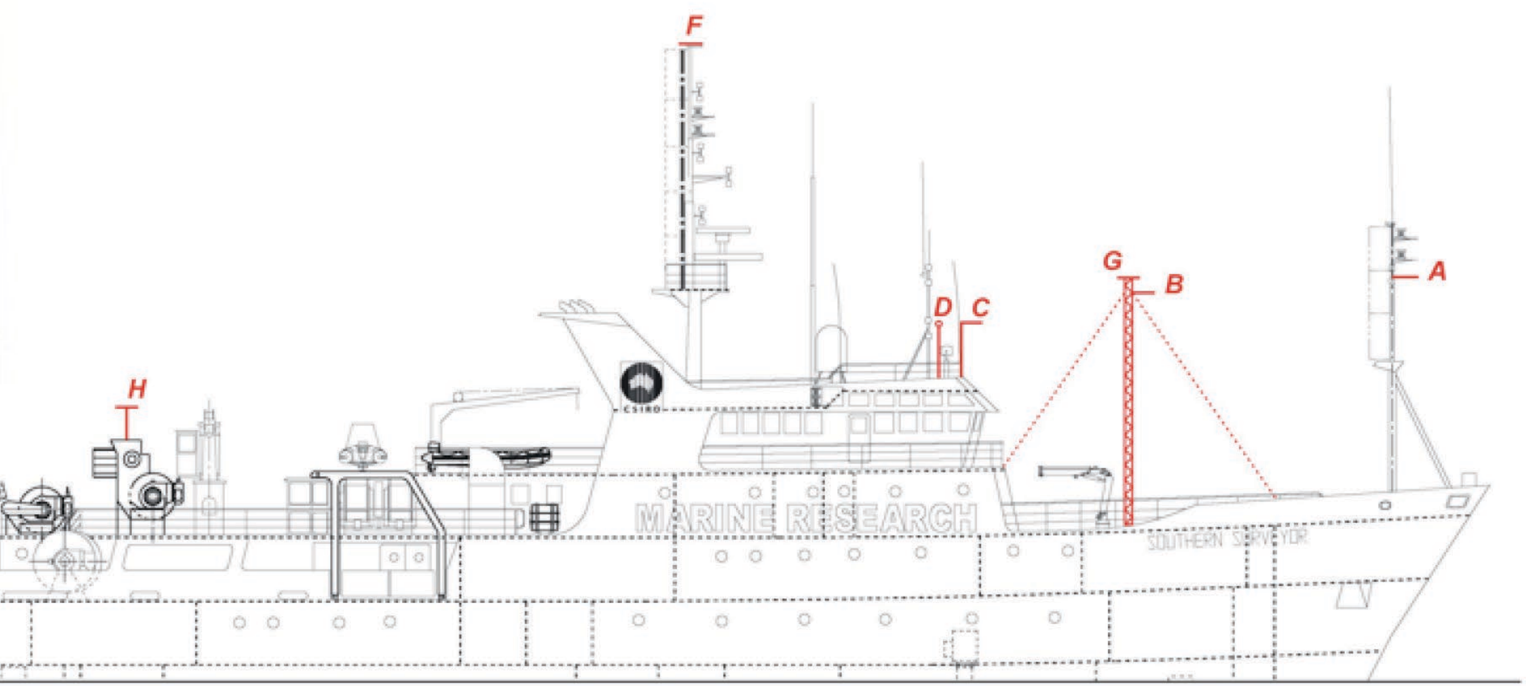


- Air temperature
- Humidity
- Wind speed/direction
- Radiation
- Rainfall



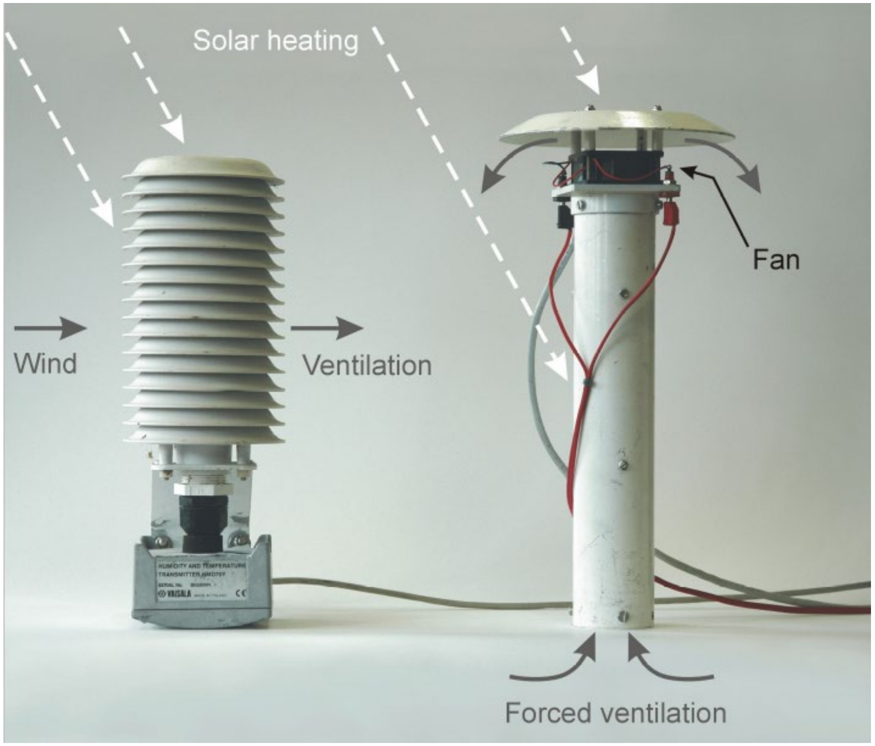
Air Temperature



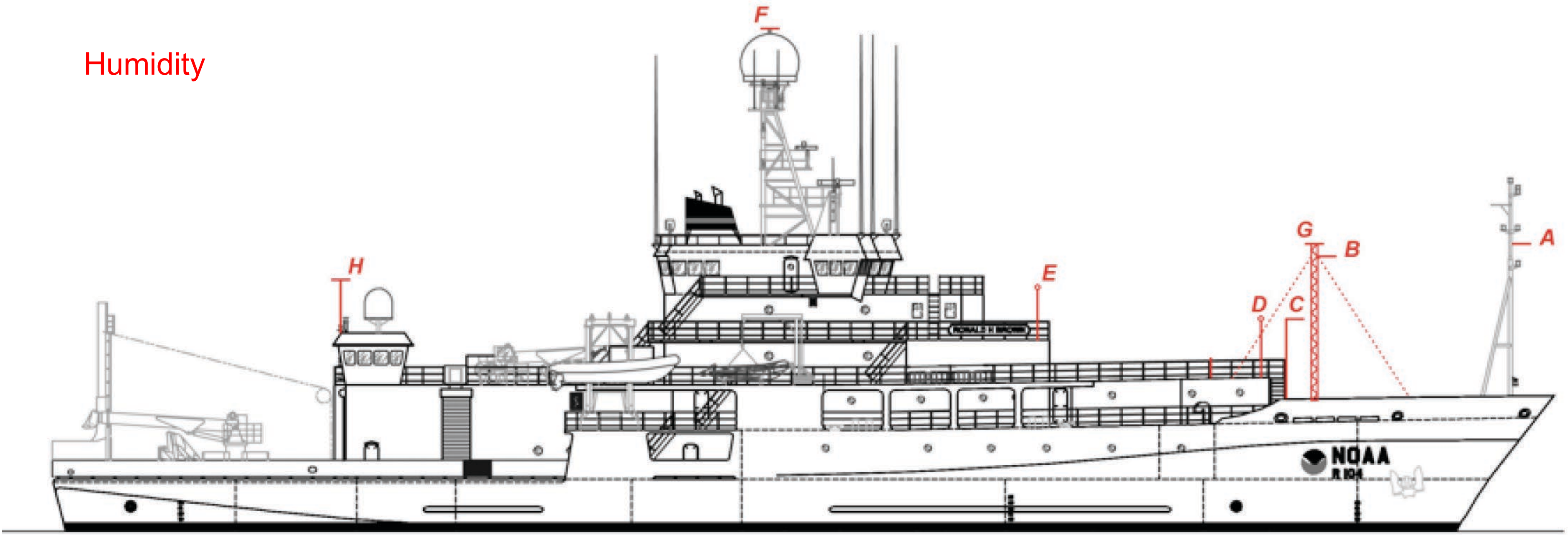


Air Temperature Sensor

- Mounted as far forward as possible to avoid heat contamination from the ship.
- Having duplicate sensors to port and starboard provides better data recovery.
- Sensor should be shielded and ventilated.
- Must avoid sea spray being drawn into the air inlet.



Humidity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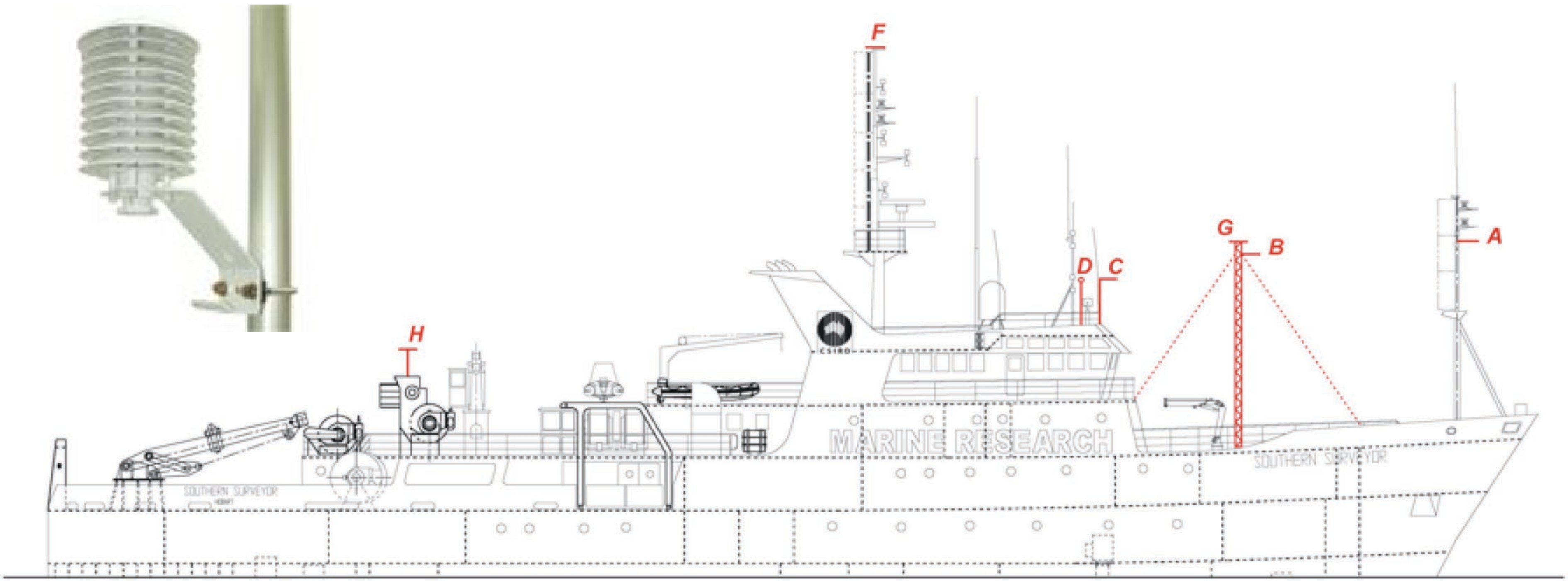
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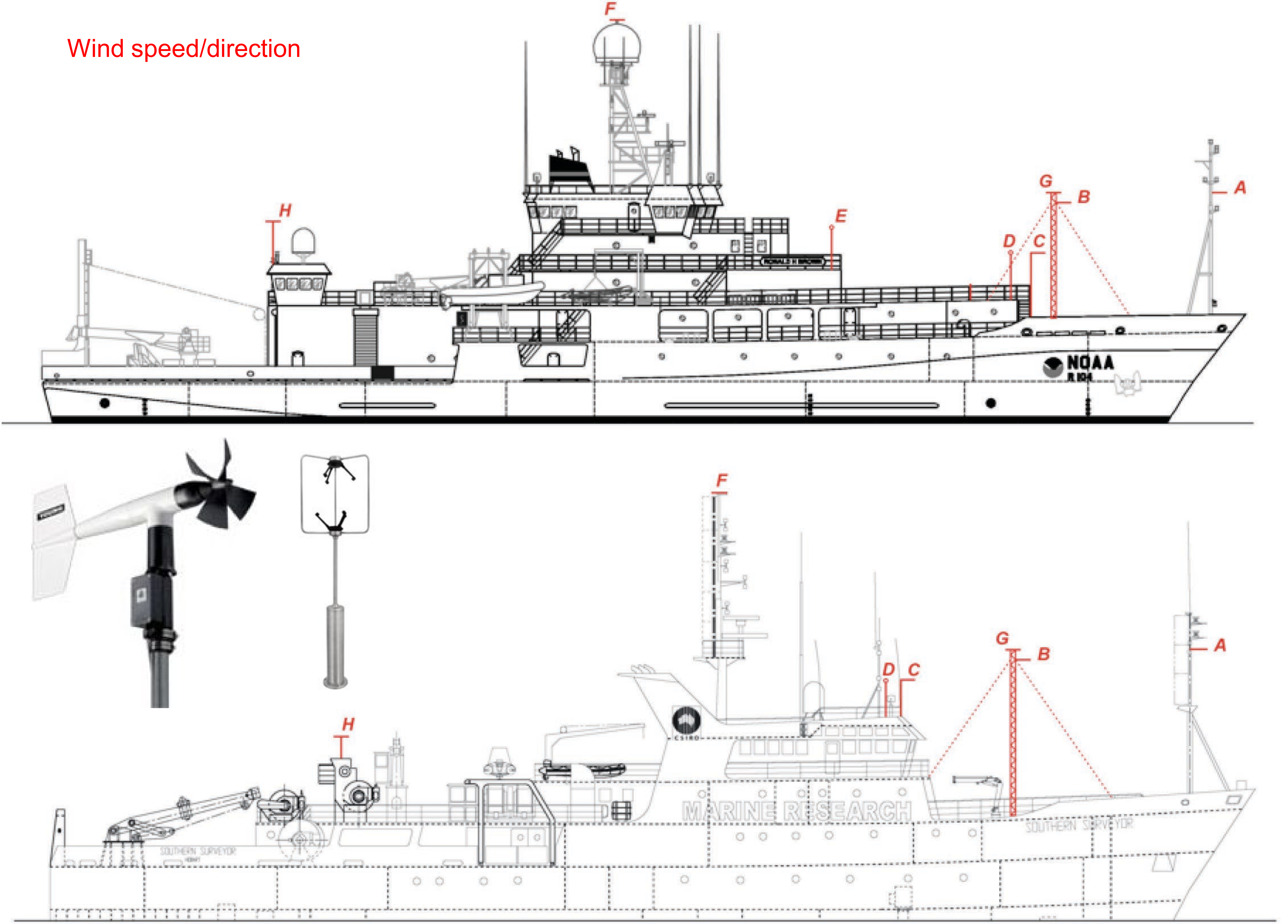
Humidity Sensor

- Not affected much by wind and temperature distortion of the ship.
- However, air temperature surrounding humidity sensor must be recorded, and the two measurements are usually made in the same package.
- Therefore, the more stringent exposure requirements of the temperature sensor ensure that the humidity sensor is also well exposed.

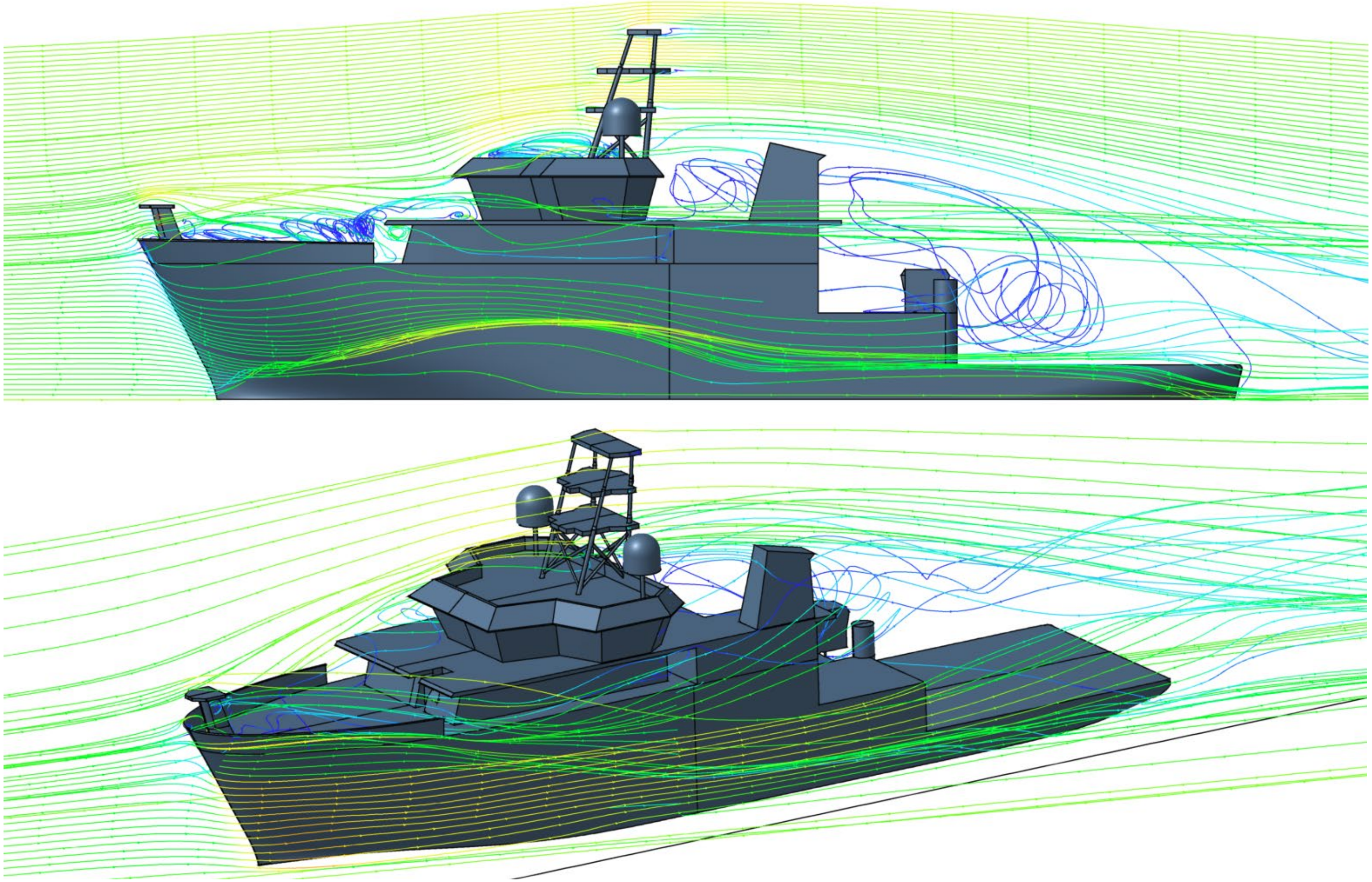
Wind speed/direction



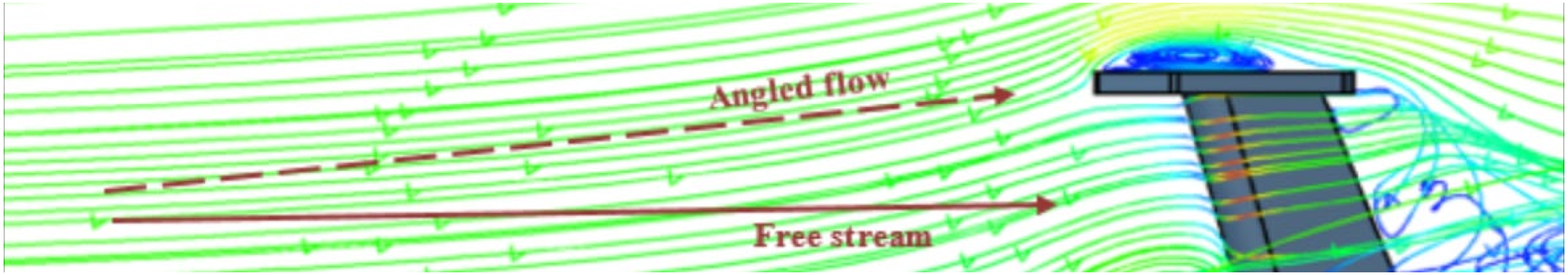
Wind Speed and Direction Sensor

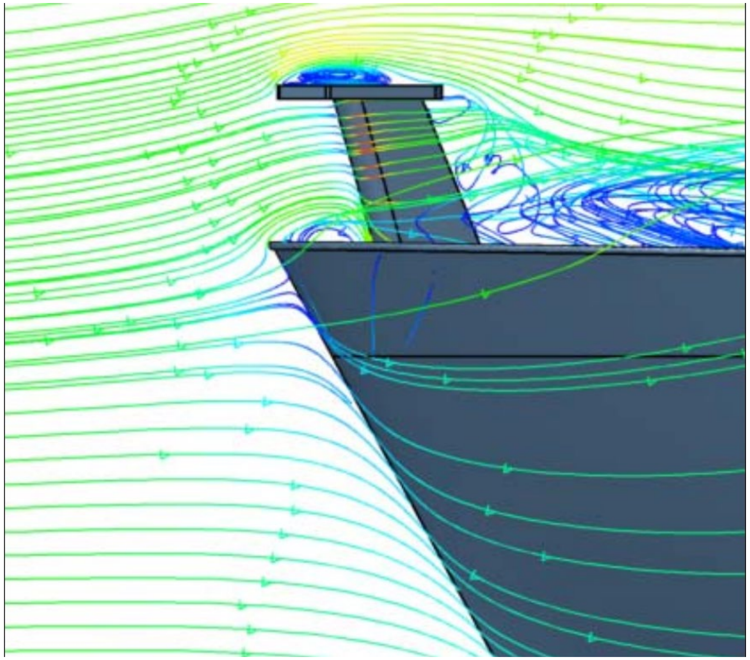
- Should have no obstruction upwind.
- A single speed/direction sensor can be mounted on a forward-facing arm from a foremast or high on the mainmast.
- With only one set of instruments, there will always be a sector astern over which the relative wind will be in error.
- If two wind sets are available, it is good practice to mount one on each side of the ship and give preference to whichever has the best exposure to the relative wind.

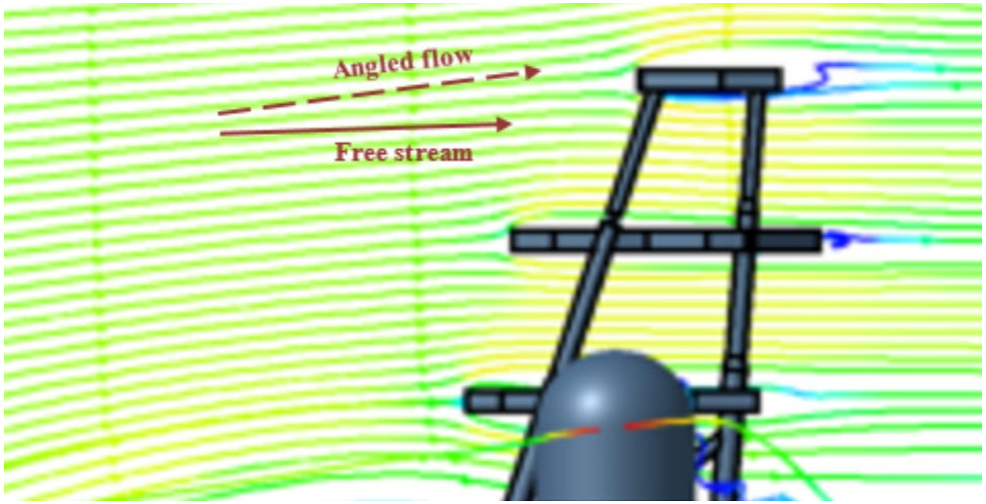
Flow Distortion



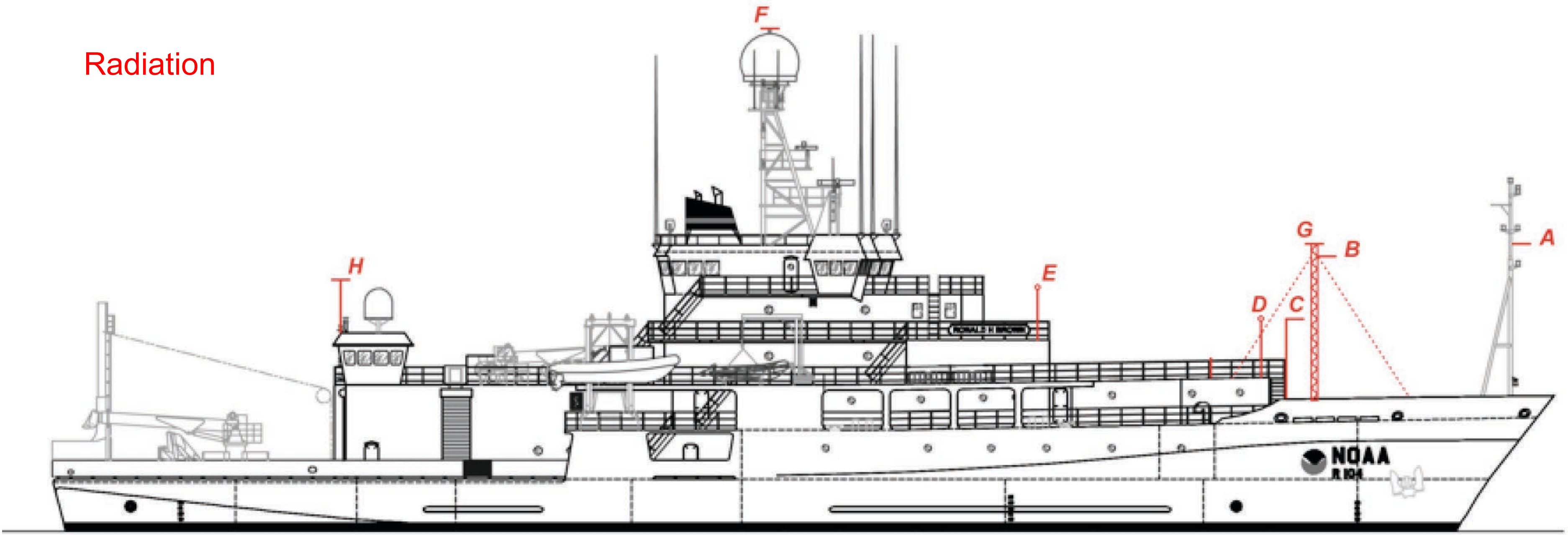
Forwemast and Mainmast







Radiation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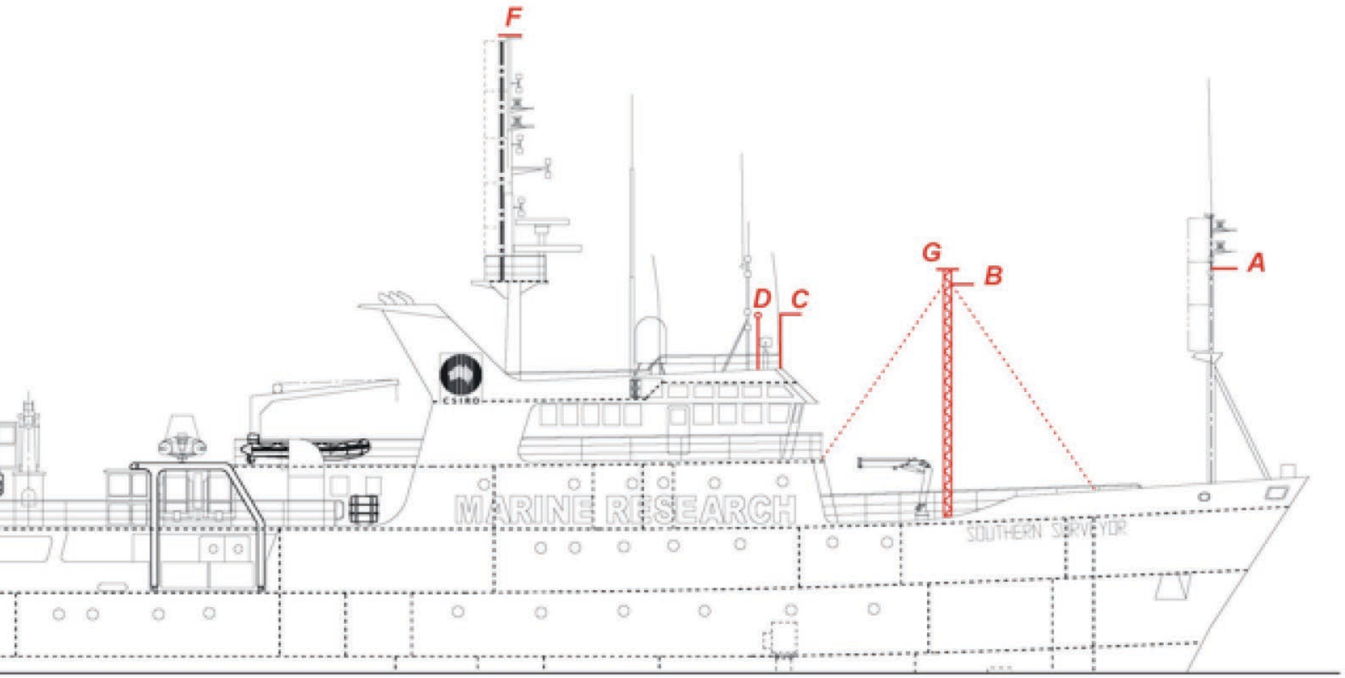
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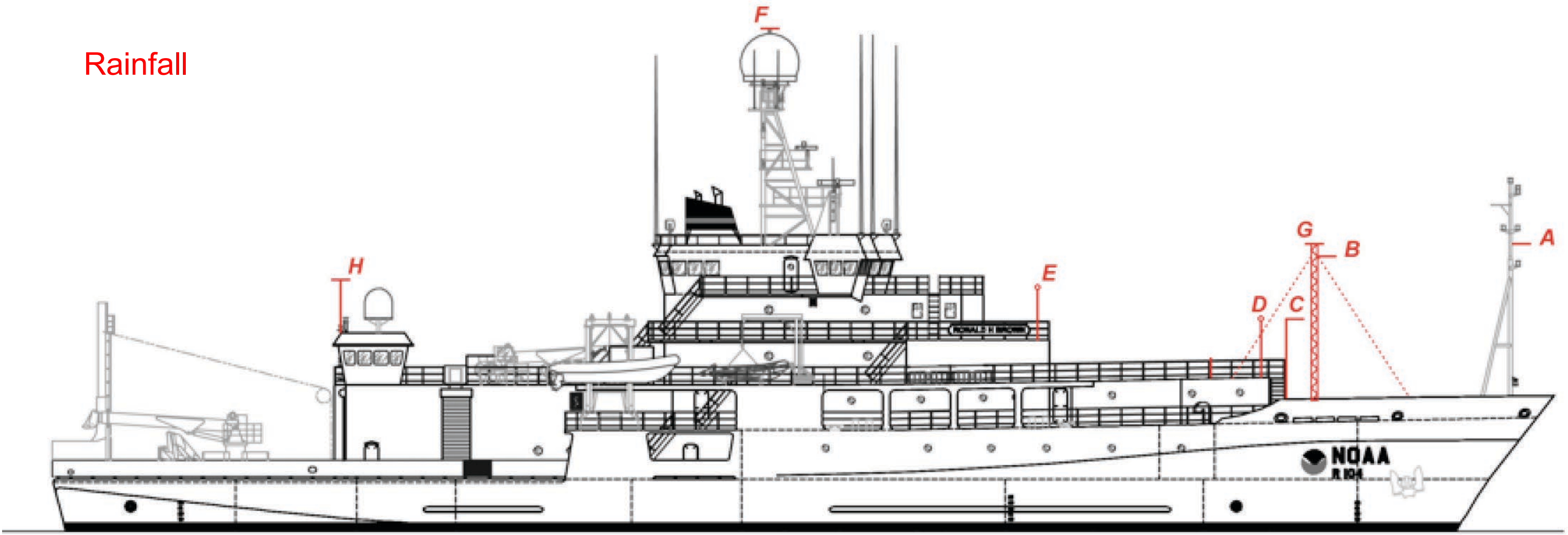
Radiation Sensor

- Upward-facing radiometers need an all-round, horizon-to-horizon view with minimal obstruction by parts of the ship, which will cast shadows on the pyranometer and be a source of thermal radiation for the pyrgeometer.

- Possible locations are the top of the mainmast or foremast, providing they are accessible at sea under moderate weather conditions so that the domes can by cleaned periodically and the desiccant replaced.

Rainfall



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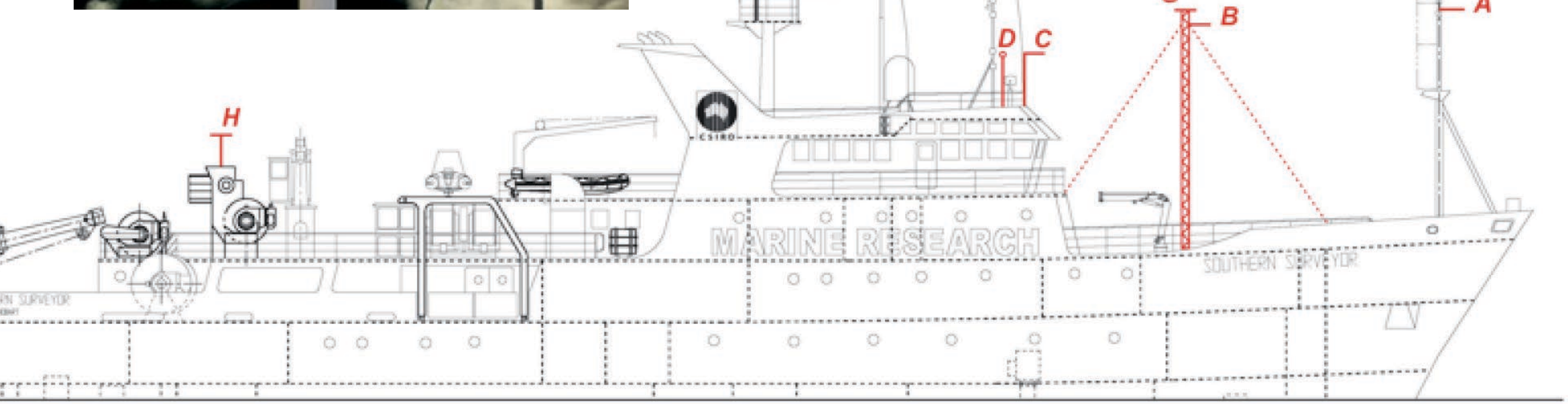

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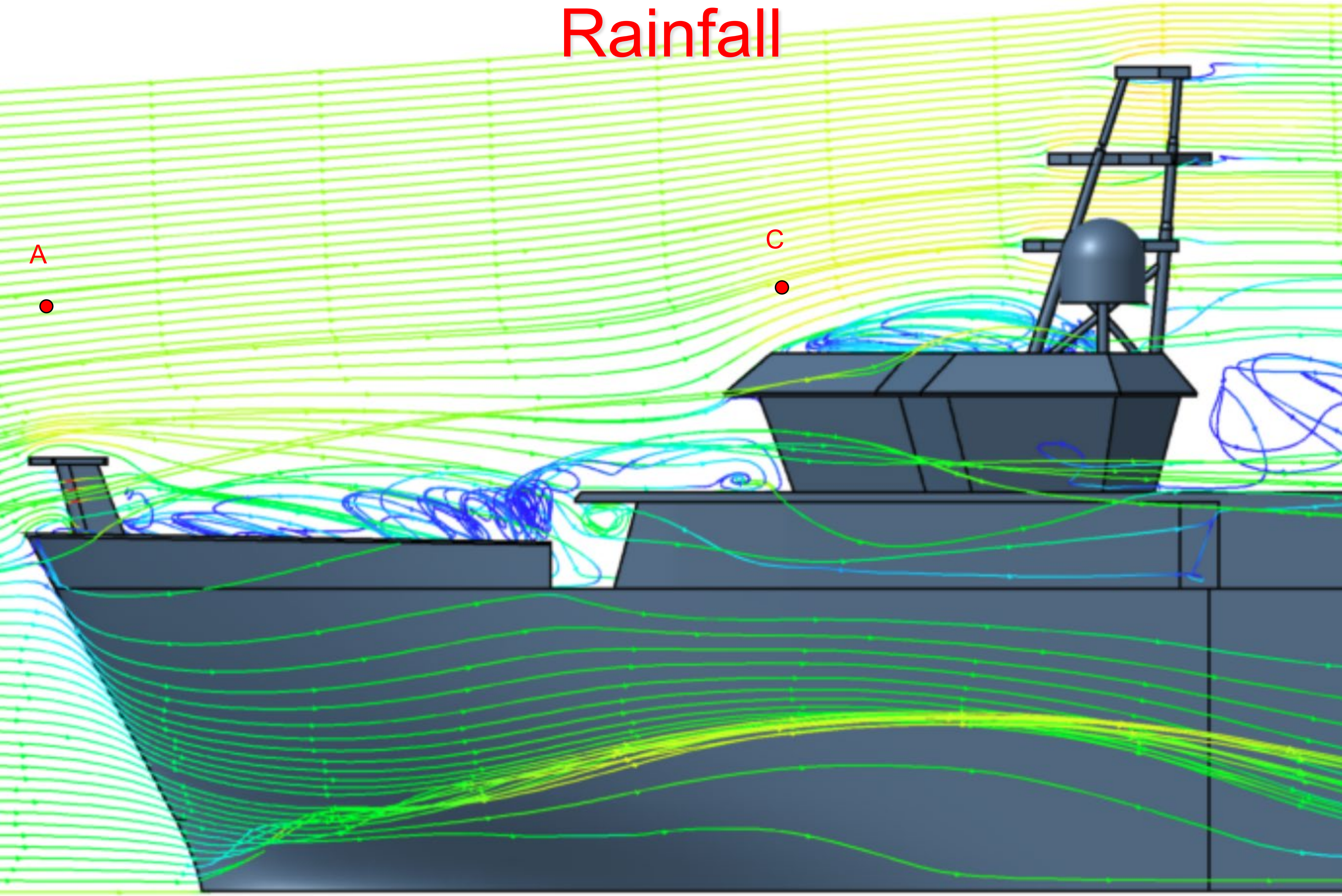
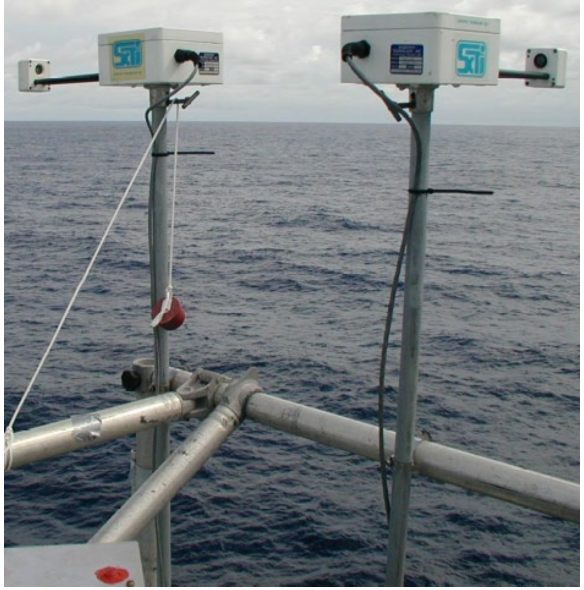
Rainfall



Rainfall Sensor

- Accurate measurements of rainfall on ships has a strong dependence on location of the instruments, with the foremast being the best location.



- Funnel gauges should not be mounted in a location of strong updrafts, such as on a rail just above the side of the ship or above the wheelhouse, where they will lose catch.

- Rain gauges located on the aft part of the ship may overestimate by catching water that has accumulated on the superstructure.

Takeaways

- Sensor location and exposure will be a compromise between the scientifically “best” location for the sensor and the operational realities on board a vessel.
- Ideally, sensors should be exposed to the air before it flows over the bulk of the vessel’s decks and super structure, i.e. forward on the ship, ahead of the engine and air-conditioner exhausts, preferably high on a forward mast, high enough to be above spray when the ship pitches in heavy seas.
- Deploying redundant sensors can allow the selection of data from the sensor that is best exposed to the vessel-relative wind flow.

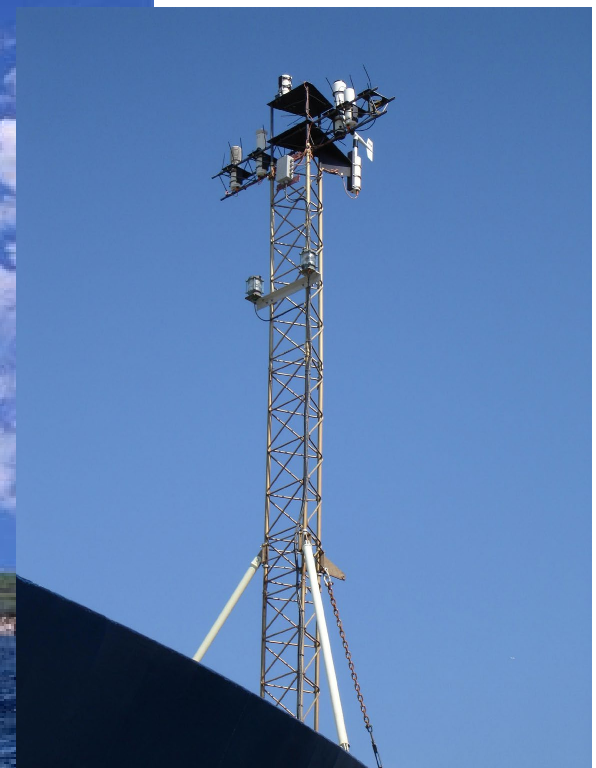
Instrument Location Examples

Thanks to operators for providing images!


FURUNO


08.11.2011 14:23
Gill Temp / RH shield
Gill Pressure Port


08.11.2011 14:23



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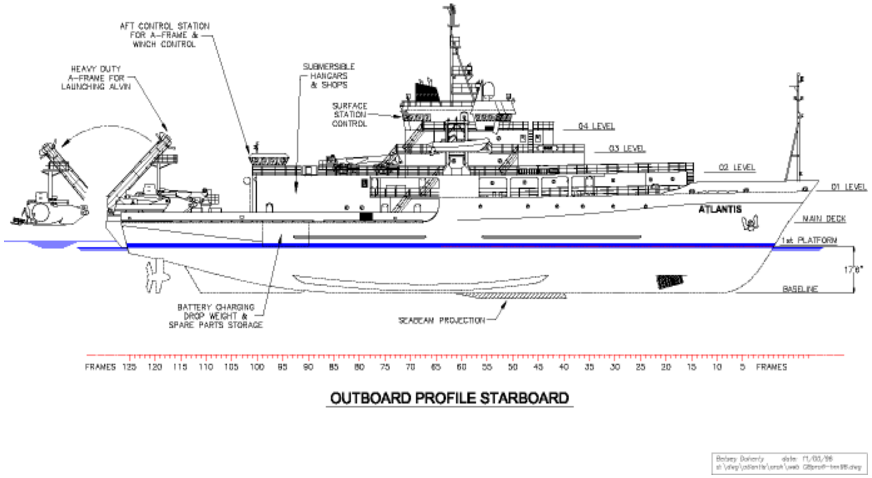
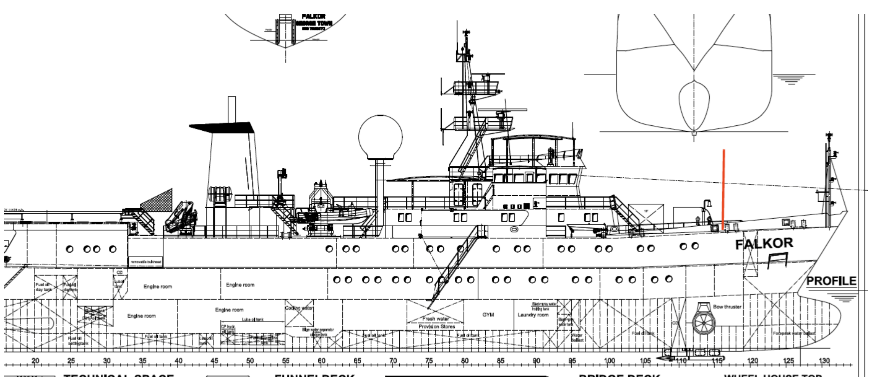
FURUNO
FURUNO


Sea Tel

Questions?

Invitation to Examine Your Vessel





- We invite each operator to examine the location of the Met and sea water measurement systems on their vessel.
- Please consider the exposure of each instrument discussed in this short course. Is it in the best possible location?
- Please contact either of the facilitators or send a message to samos@coaps.fsu.edu to get recommendations for your vessel.
- Digital imagery and schematics are essential to make these determinations for someone not on the vessel.

Wrap-Up

- Thank you for participating!
- Please take a moment to provide feedback on the course at
  http://www.surveymonkey.com/s/SH3RBQR
- Course content and presentations will be available at
  http://samos.coaps.fsu.edu/html/mt_shortcourses/http://samos.coaps.fsu.edu/html/mt_shortcourses/shortcourse_Inmartech2014.http://samos.coaps.fsu.edu/html/mt_shortcourses/shortcourse_Inmartech2014.php
- Questions can be sent to
  Shawn Smith: smith@coaps.fsu.edu
  Daniel Wolfe: Daniel.Wolfe@noaa.gov
  Jeremy Rolph: rolph@coaps.fsu.edu

Data Adjustments: Pressure and True Wind

Presented by Marc Castells

Introduction to True Wind

True Wind

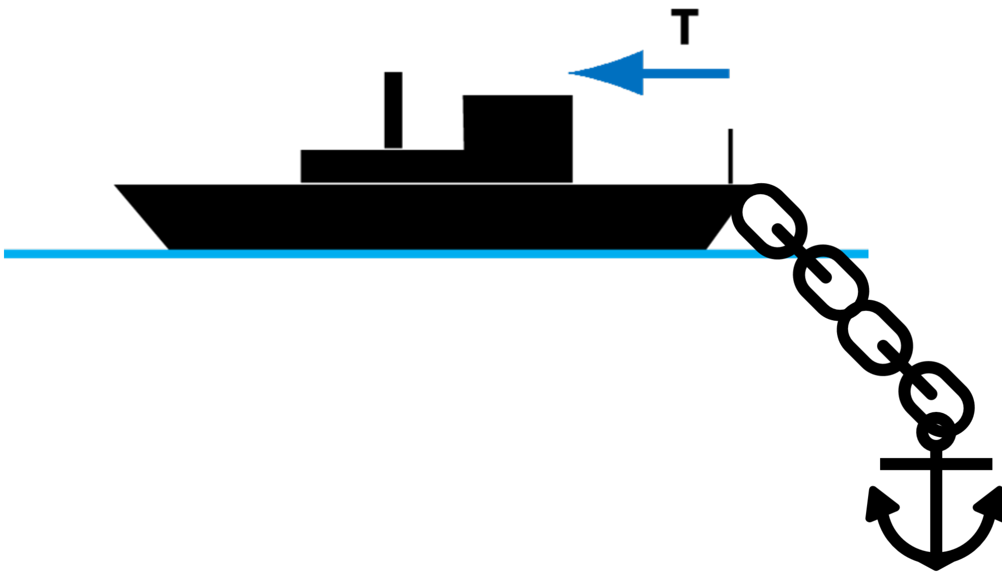
- The wind relative to the ground.
- What a wind instrument measures if it is affixed to the ground.
- What you would feel on deck if the ship is completely stationary (i.e., when true = apparent.)
- The apparent wind minus the wind induced by the ship's movement.

Apparent Wind

- The wind relative to the ship.
- What a wind instrument measures when it is affixed to a moving platform.
- The wind that you feel when standing on deck or putting your hand out of a car window.
- Vector sum of the true wind and the wind induced by the ship's movement.

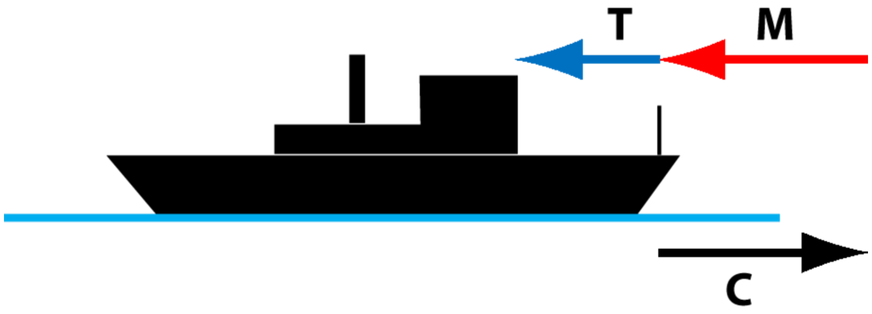
1D Example of True Wind Vector Math

- Vessel is stationary on a day with true wind blowing directly over the bow.



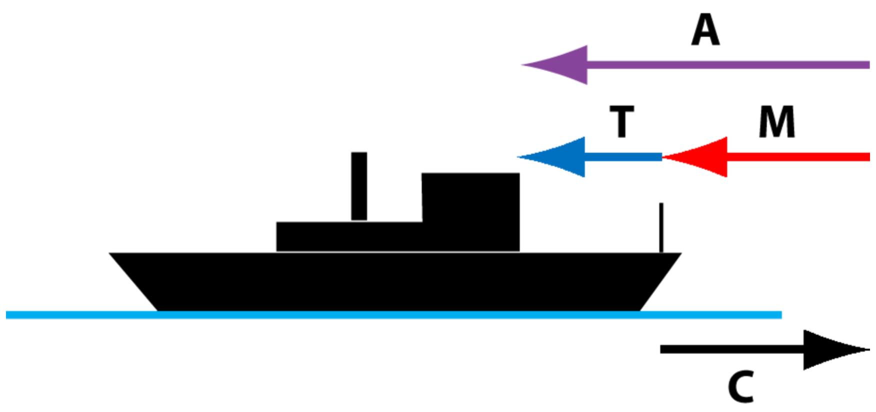
1D Example of True Wind Vector Math

- Vessel moves forward inducing additional wind relative to the vessel.

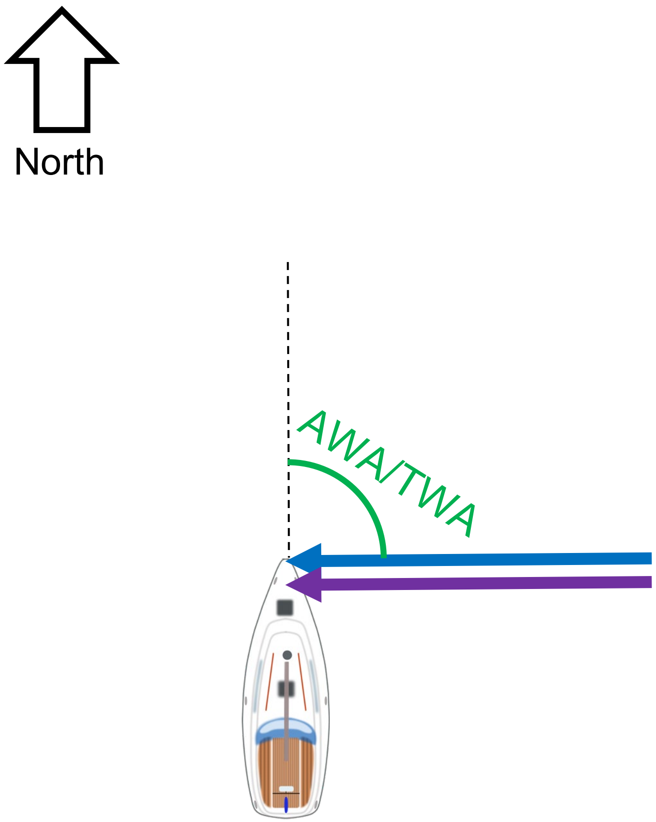


1D Example of True Wind Vector Math

- $A = T + M$
- $T = A - M$
- $M = -C$
- $T = A - (-C) = A + C$



2D Example of True Wind Vector Math

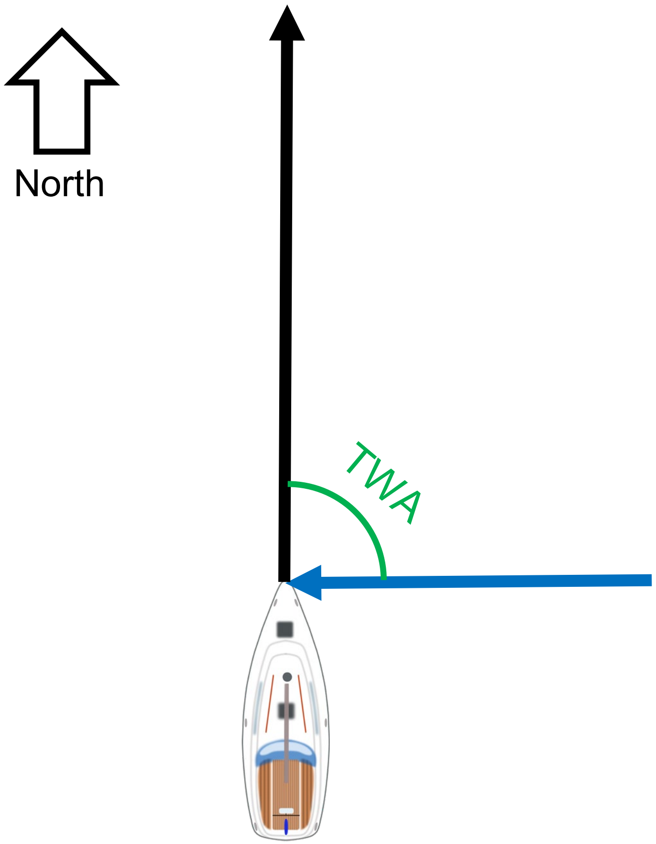


SOG: 0 kts
HDG: 000
COG: 000

AWA: 090
AWS: 10 kts

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

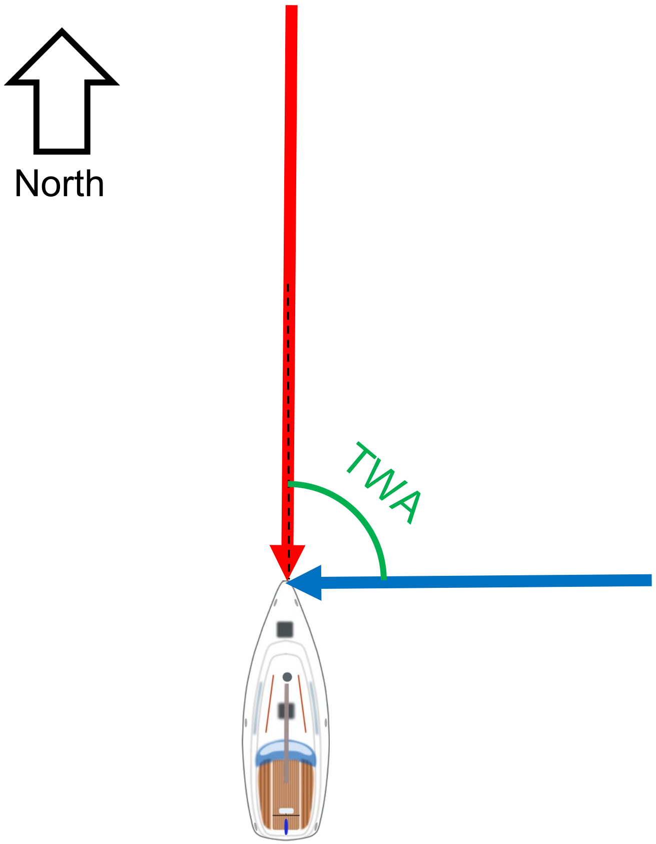


SOG: 15 kts
HDG: 000
COG: 000

AWA: ?
AWS: ?

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

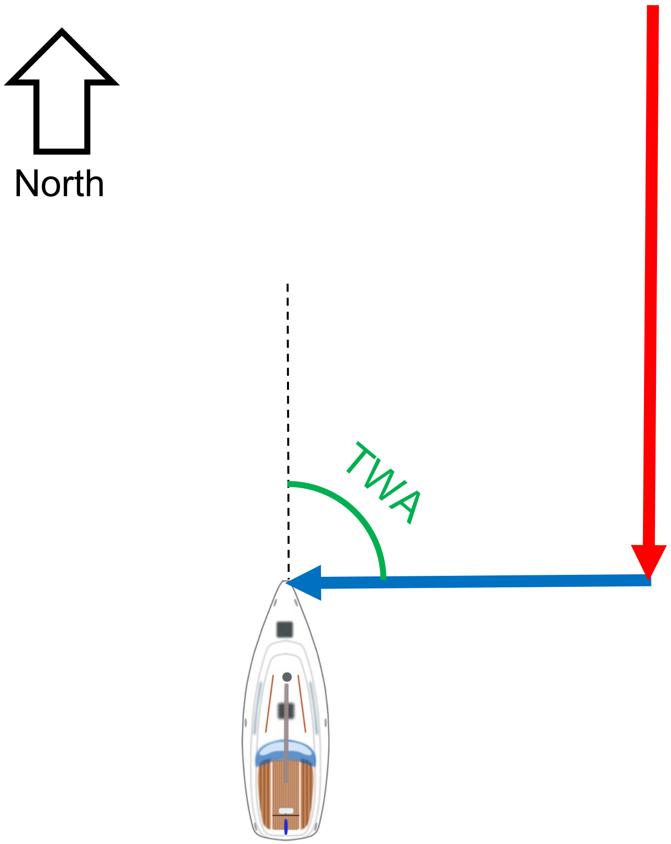


SOG: 15 kts
HDG: 000
COG: 000

AWA: ?
AWS: ?

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

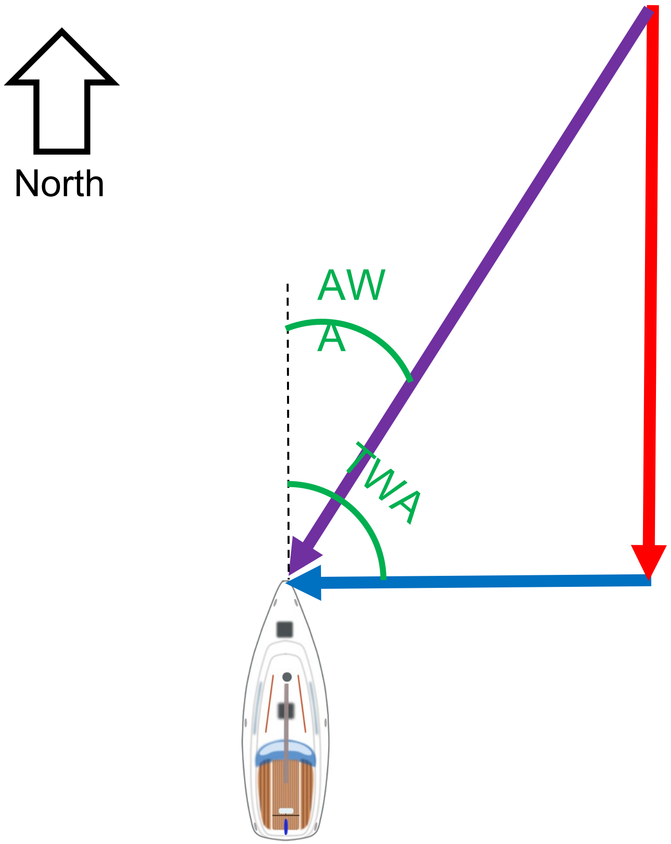


SOG: 15 kts
HDG: 000
COG: 000

AWA: ?
AWS: ?

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

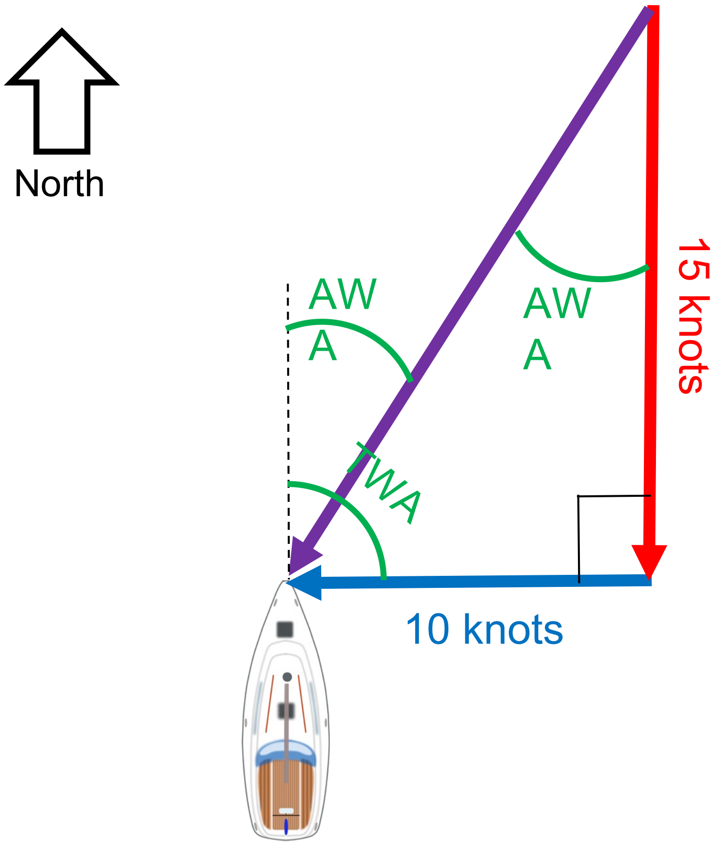


SOG: 15 kts
HDG: 000
COG: 000

AWA: ?
AWS: ?

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

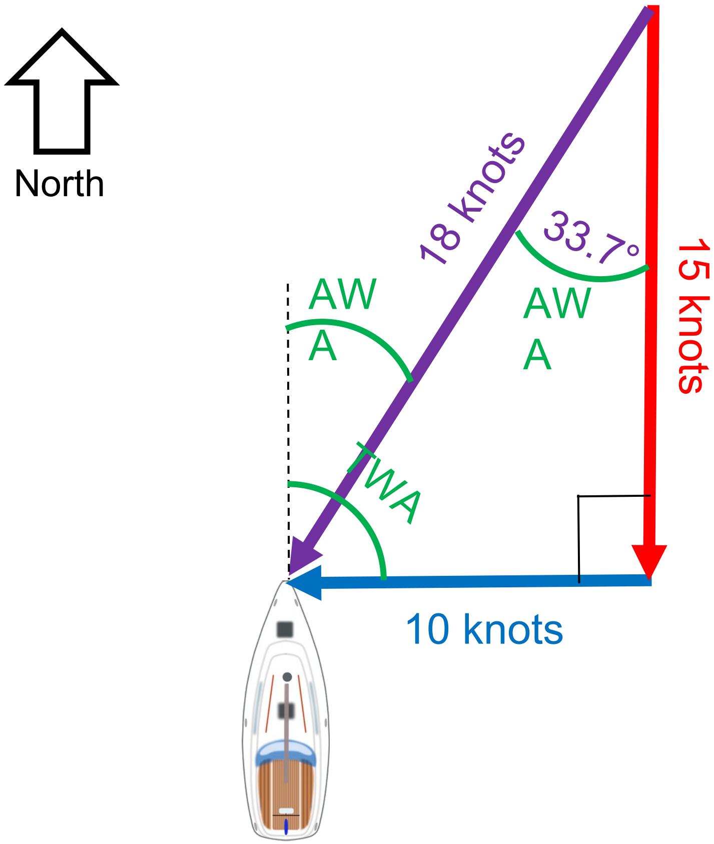


SOG: 15 kts
HDG: 000
COG: 000

AWA: ?
AWS: ?

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

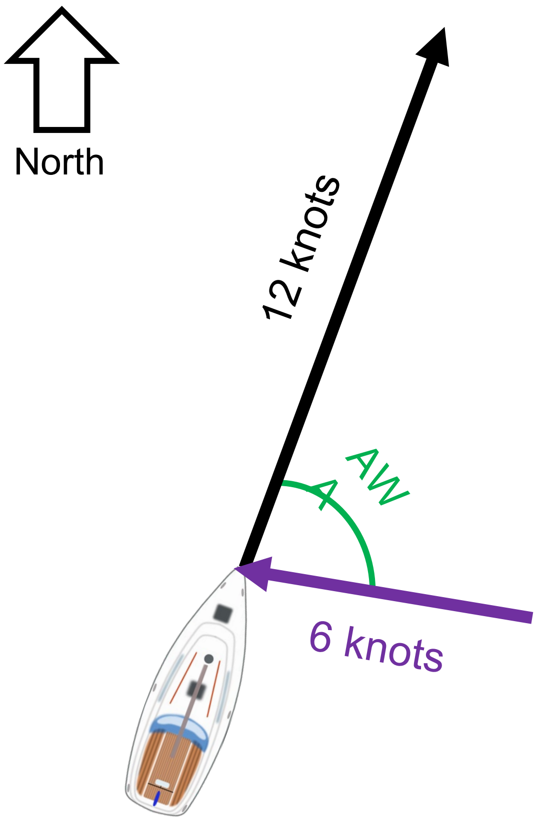


SOG: 15 kts
HDG: 000
COG: 000

AWA: $\tan^{-1}(15kts/10kts)$ = 034 S
AWS: $\sqrt{(10\ kts)^2 + (15\ kts)^2}$ = 18.03 kts

TWA: 090 S
TWS: 10 kts

2D Example of True Wind Vector Math

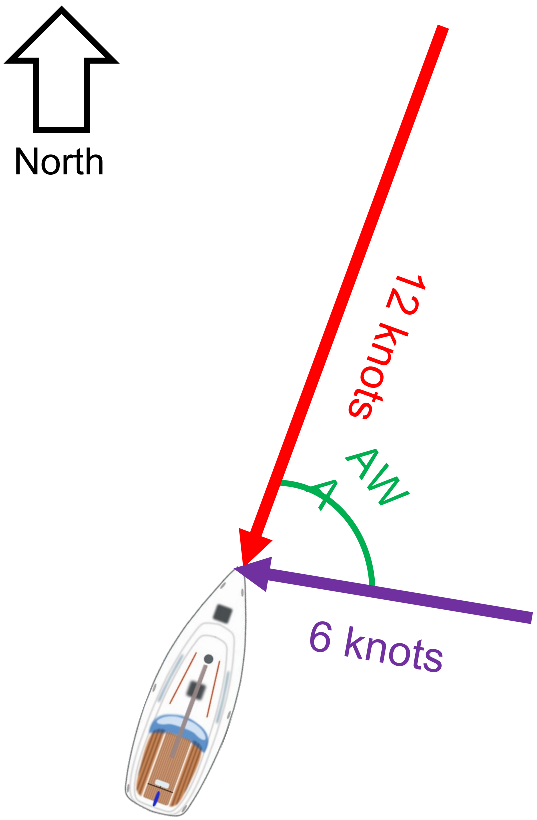


SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: ?
TWS: ?

2D Example of True Wind Vector Math

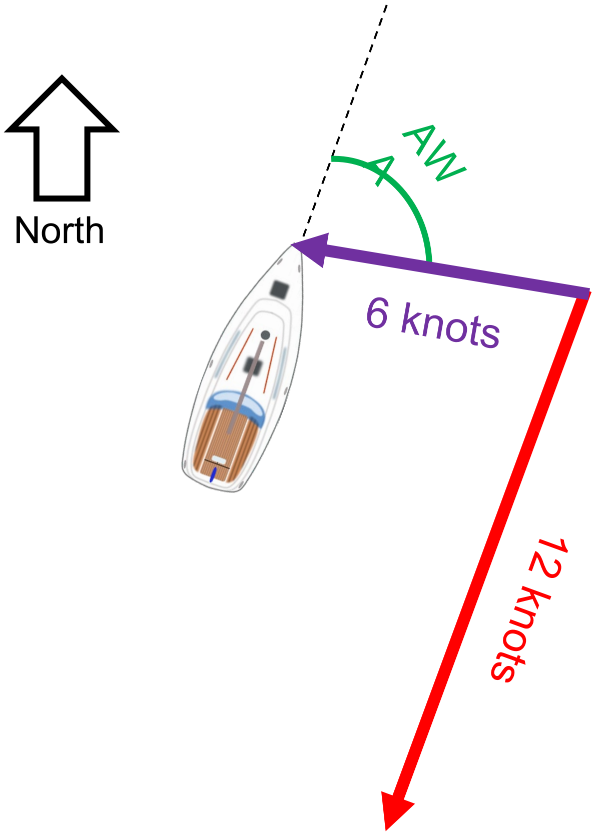


SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: ?
TWS: ?

2D Example of True Wind Vector Math

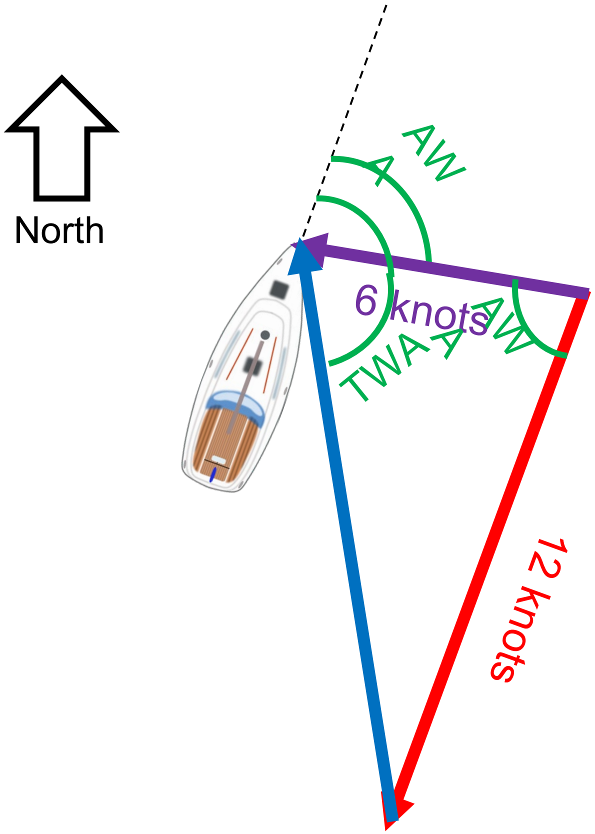


SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: ?
TWS: ?

2D Example of True Wind Vector Math

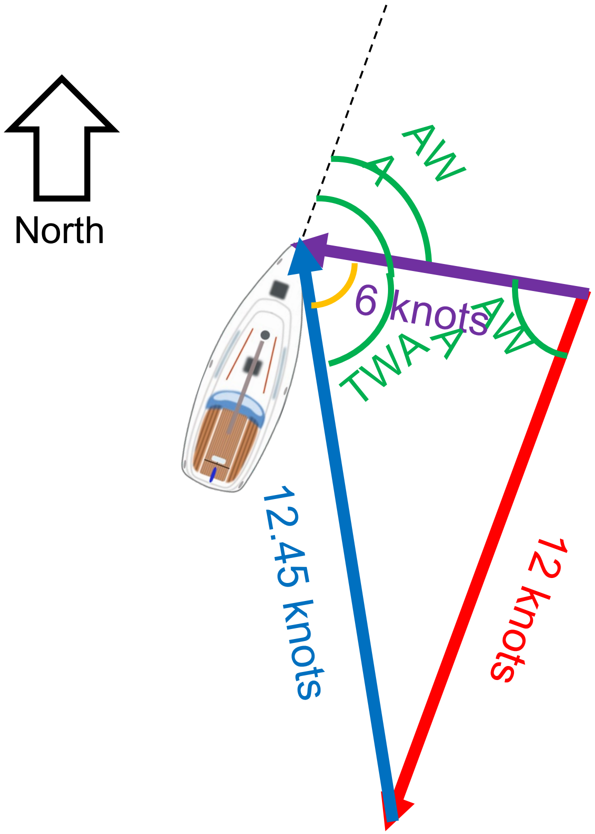


SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: ?
TWS: ?

2D Example of True Wind Vector Math



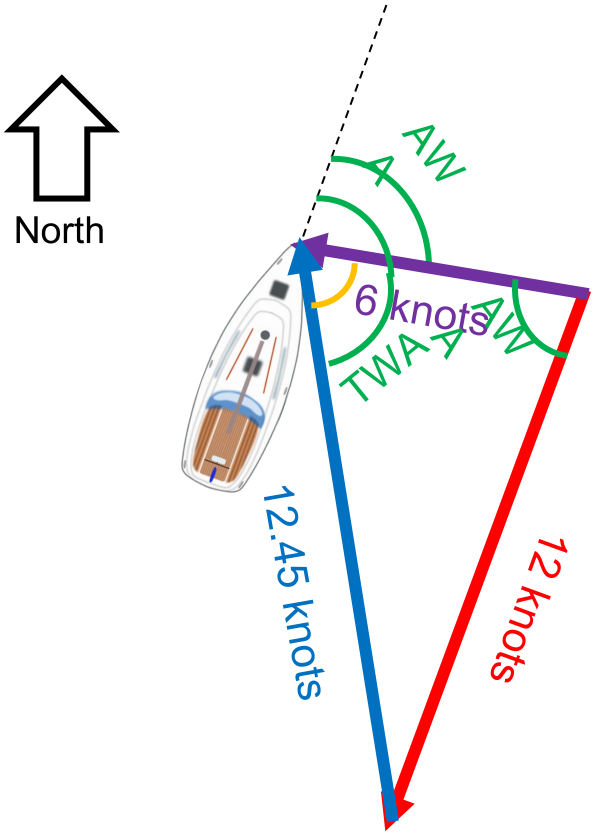
SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: ?
TWS: 12.45 kts

$$TWS = \sqrt{(6kts)^2 + (12kts)^2 - 2(6kts)(12kts)\cos(80)}$$

2D Example of True Wind Vector Math



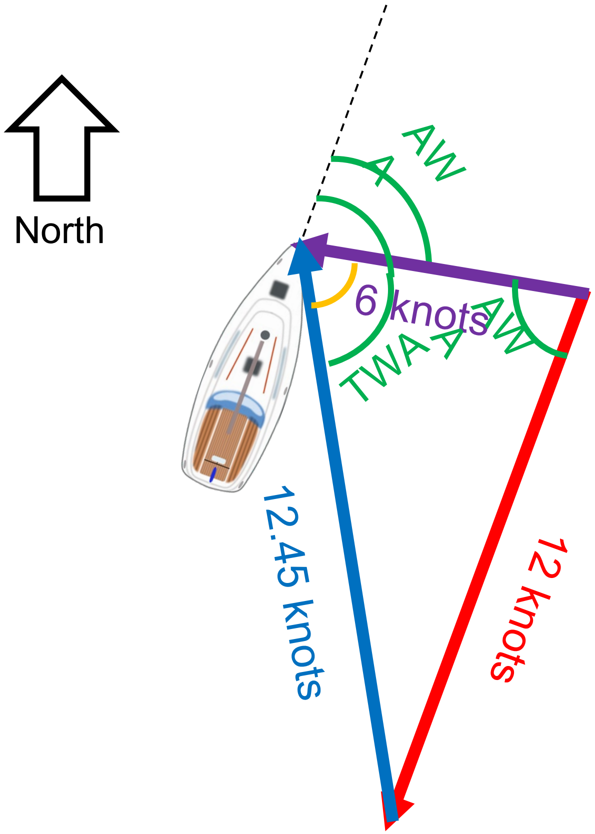
SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

TWA: 71.7° + 80° = 152 S
TWS: 12.45 kts

$$= \cos^{-1}\left(\frac{(12.45\text{kts})^2 + (6\text{kts})^2 - (12\text{kts})^2}{2 * (12.45\text{kts}) * (6\text{kts})}\right) = 71.7°$$

2D Example of True Wind Vector Math



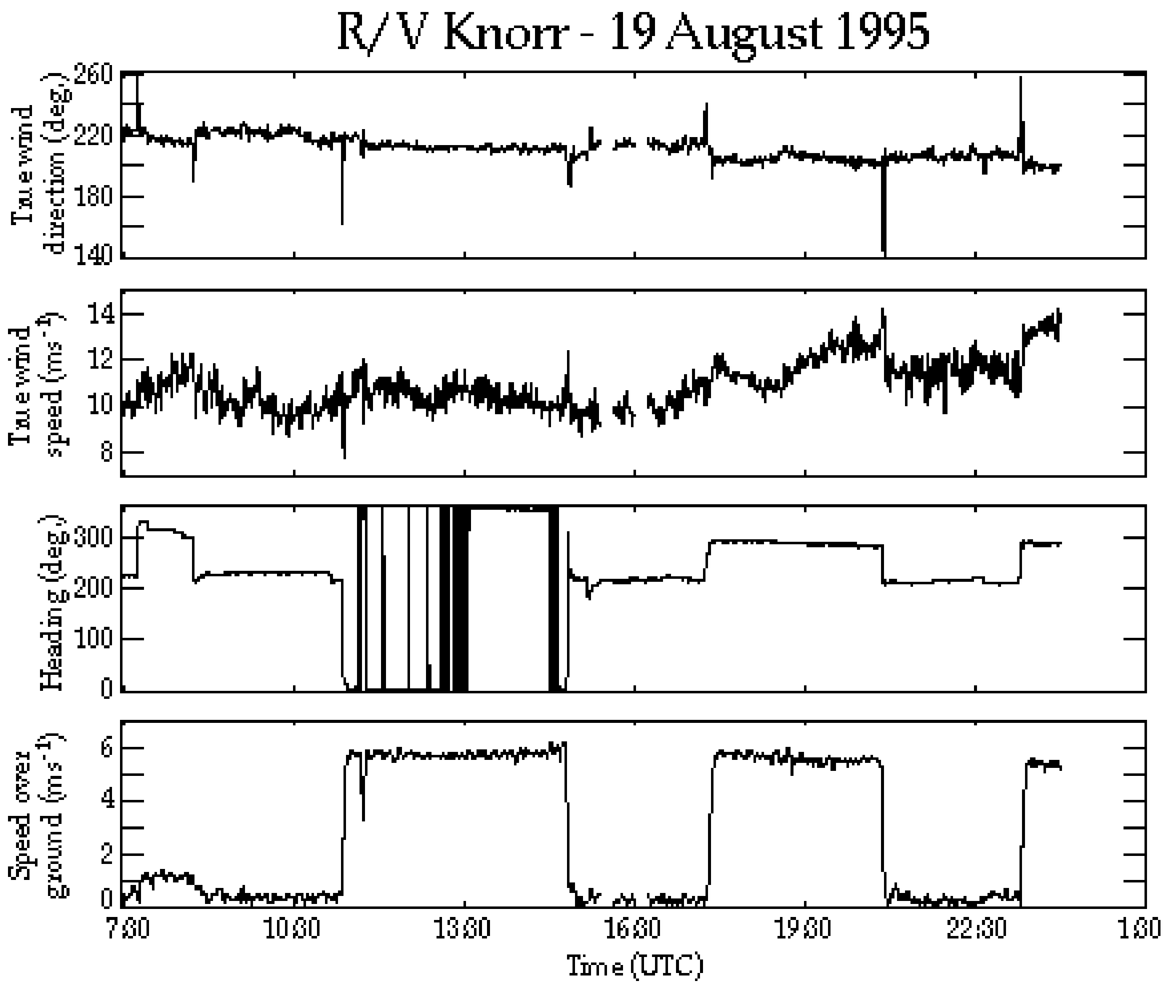
SOG: 12 kts
HDG: 020
COG: 020

AWA: 080 S
AWS: 6 kts

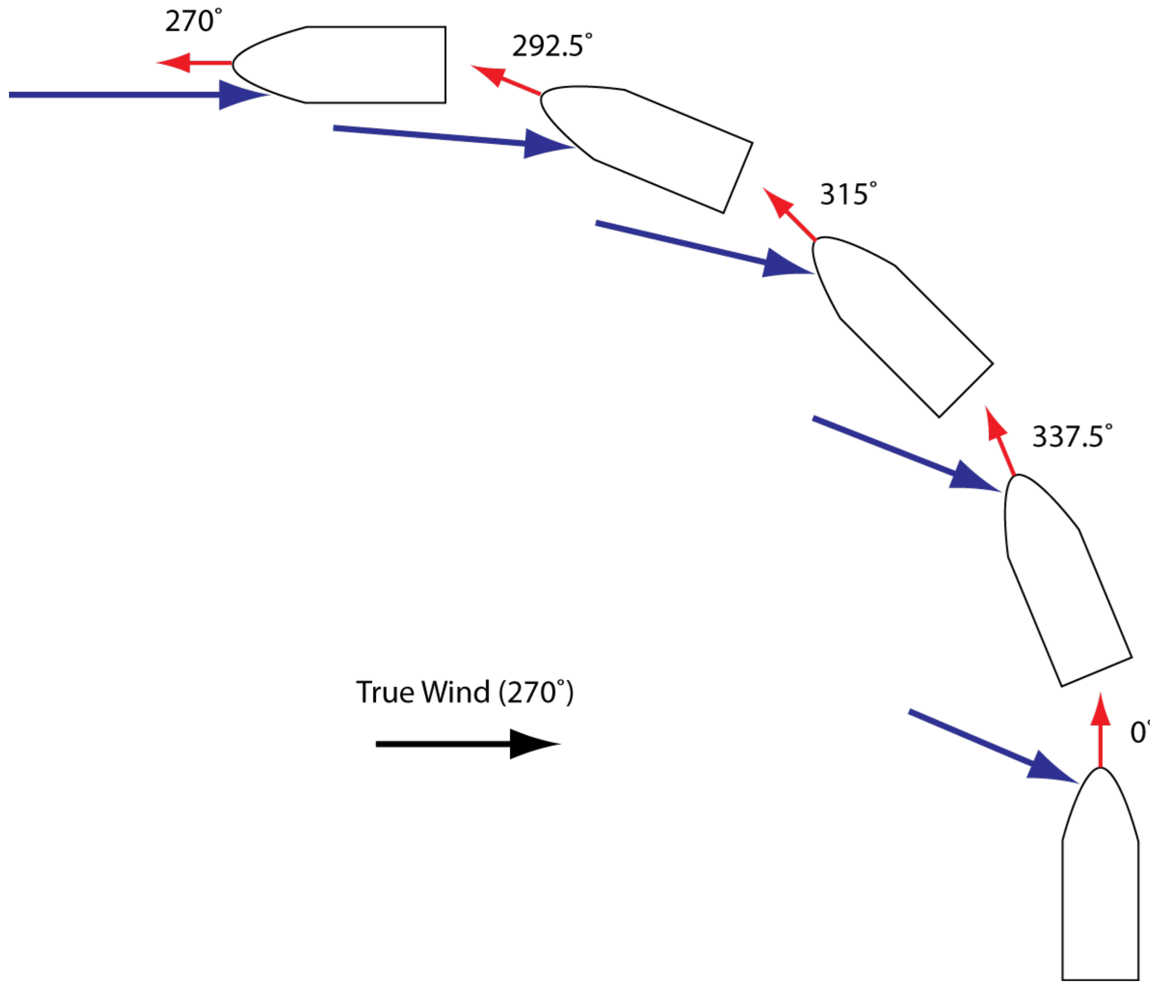
TWA: 71.7° + 80° = 152 S
TWS: 12.45 kts

COG + TWA = TWD
020 + 152 = 172

Averaging Errors



Turning Ship Alters Apparent Wind



Incorrect Averaging Method

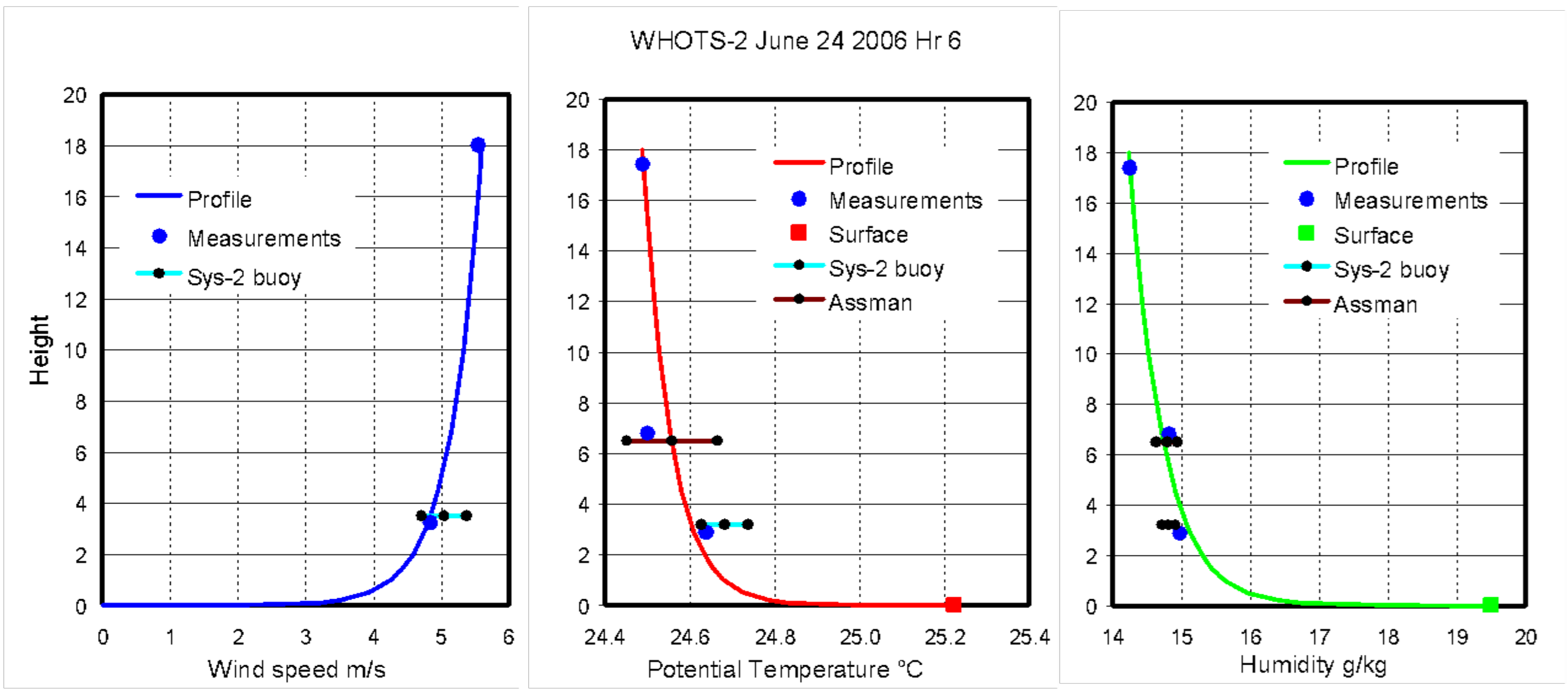
Course	Speed	Heading	P. Wind Direction	P. Wind Speed	True Wind Direction	True Wind Speed
0.0	5.0	0.0	300.0	10.0		
350.0	5.0	350.0	305.0	10.5		
340.0	5.0	340.0	310.0	11.0		
330.0	5.0	330.0	315.0	11.5		
320.0	5.0	320.0	320.0	12.0		
310.0	5.0	310.0	330.0	13.0		
300.0	5.0	300.0	340.0	13.5		
290.0	5.0	290.0	350.0	14.0		
280.0	5.0	280.0	355.0	14.5		
270.0	5.0	270.0	0.0	15.0		
315.0	5.0	315.0	331.2	11.7	**271.1**	**8.1**

Correct Averaging Method

Course	Speed	Heading	P. Wind Dir	P. Wind Speed	True Wind Dir	True Wind Speed
0.0	5.0	0.0	300.0	10.0	270.0	8.7
350.0	5.0	350.0	305.0	10.5	266.8	8.7
340.0	5.0	340.0	310.0	11.0	263.8	8.7
330.0	5.0	330.0	315.0	11.5	261.1	8.7
320.0	5.0	320.0	320.0	12.0	258.5	8.8
310.0	5.0	310.0	330.0	13.0	263.9	9.0
300.0	5.0	300.0	340.0	13.5	269.0	9.0
290.0	5.0	290.0	350.0	14.0	274.5	9.1
280.0	5.0	280.0	355.0	14.5	272.4	9.5
270.0	5.0	270.0	0.0	15.0	270.0	10.0
					267.1	**9.0**

Height Matters

Wind, Temperature, and Humidity



Pressure

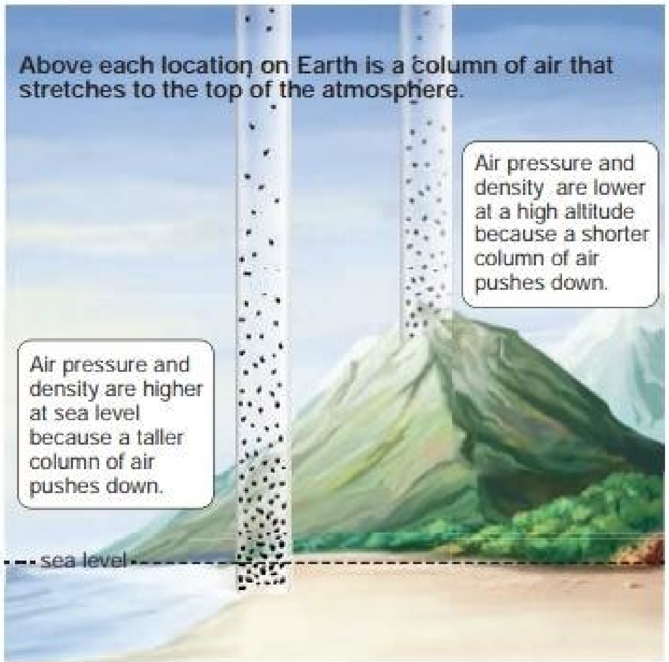
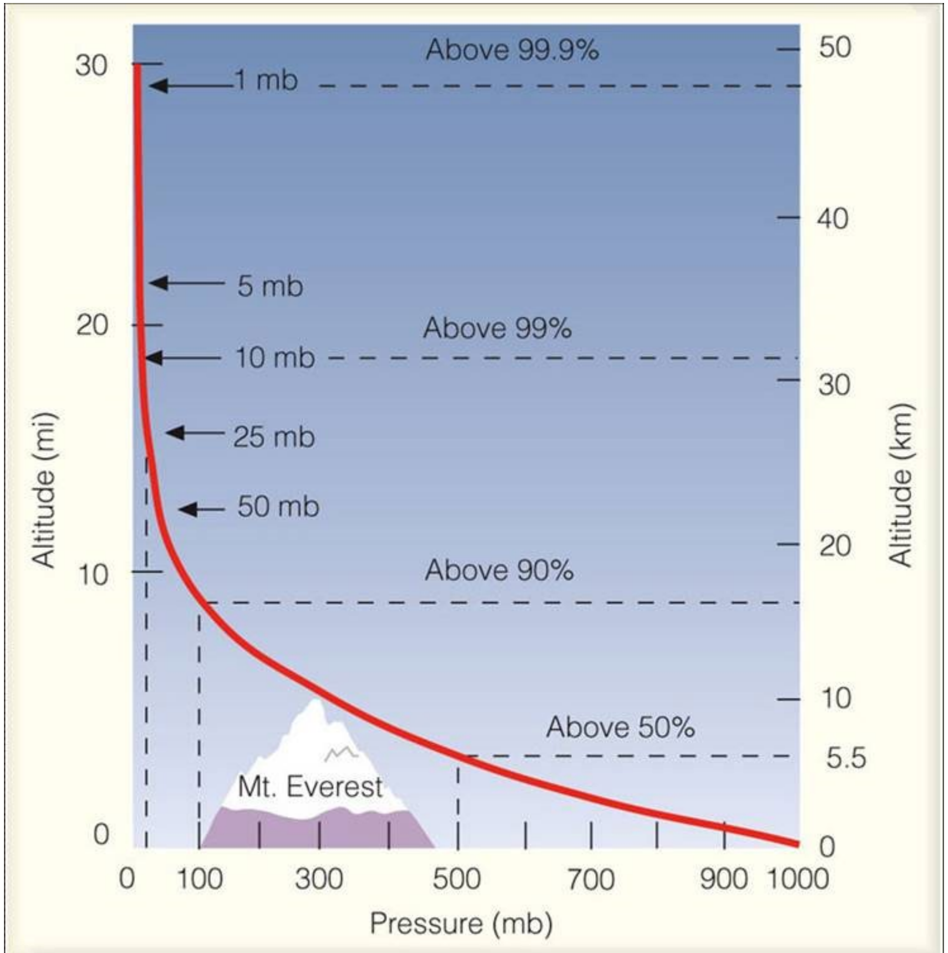
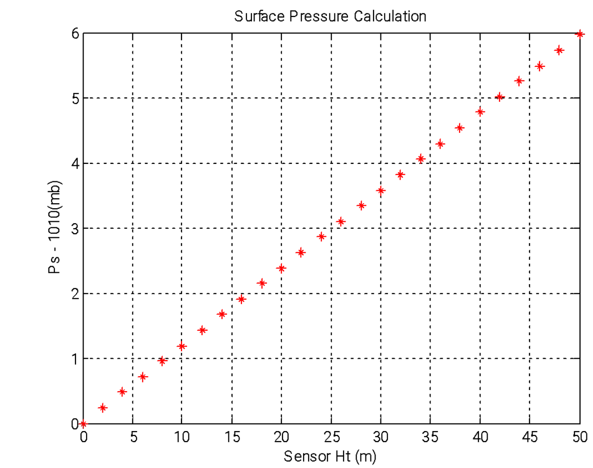
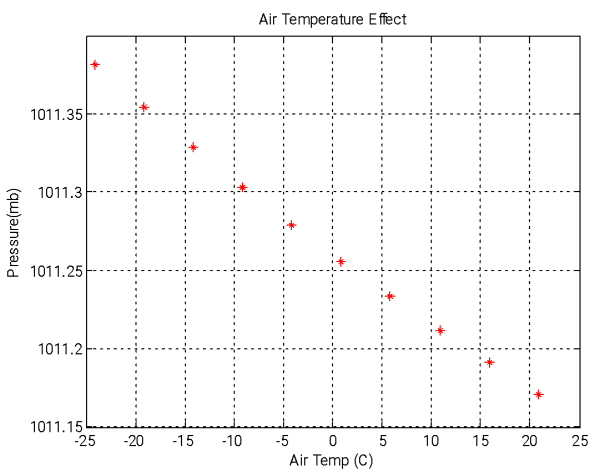


Figure 1.10 Atmospheric pressure acts like a column



Station Pressure to Sea Level calculation





$$P_s = P_z e^{(gz/RaT)}$$

P_z = Station pressure (mb)

Ra = Universal Constant (J/kgK)… 287.05;

T = Temperature (K)

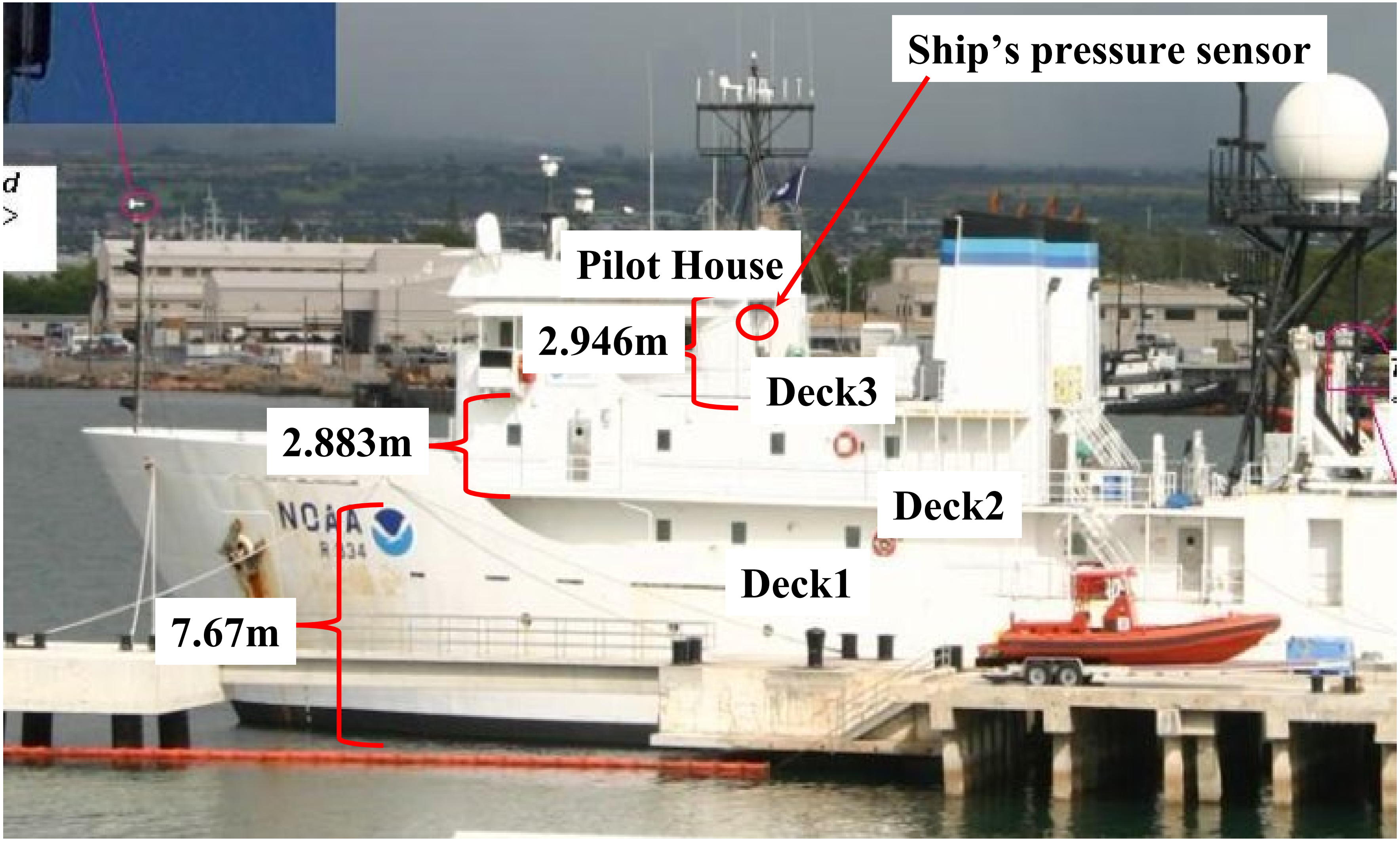
g = gravity (m/s)… 9.81;

z = height of pressure sensor (m)

P_s = sea level pressure (SLP mb)

Rough guesstimate 1mb = 10m

SLP >= Station Pressure



7/11/2013 Measurements

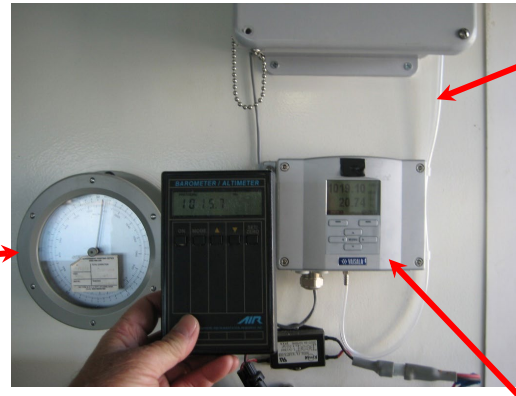
PSD dynamic pressure port and sensor
14.388m above water

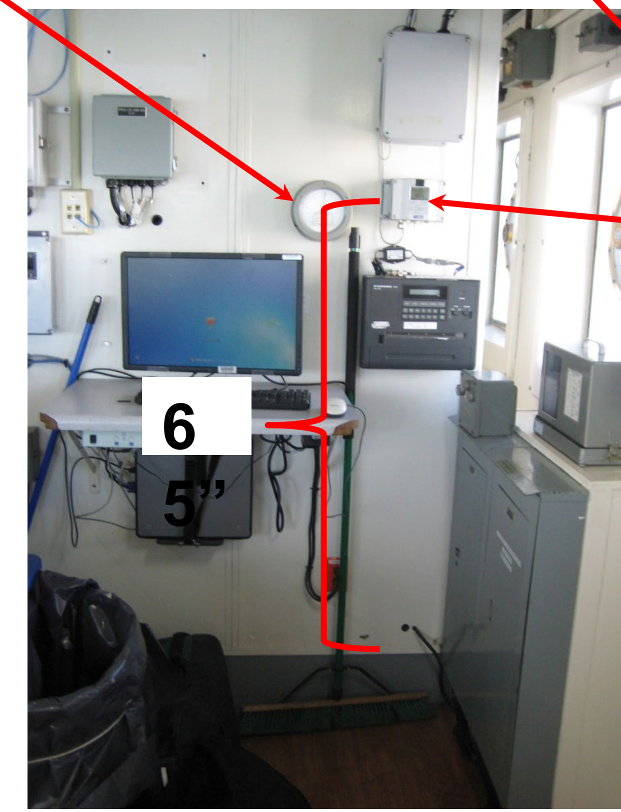
Ship dynamic pressure port
12.02m above water

Ship ~1.38 mb @ 25°C
PSD ~1.66 mb @ 25°C

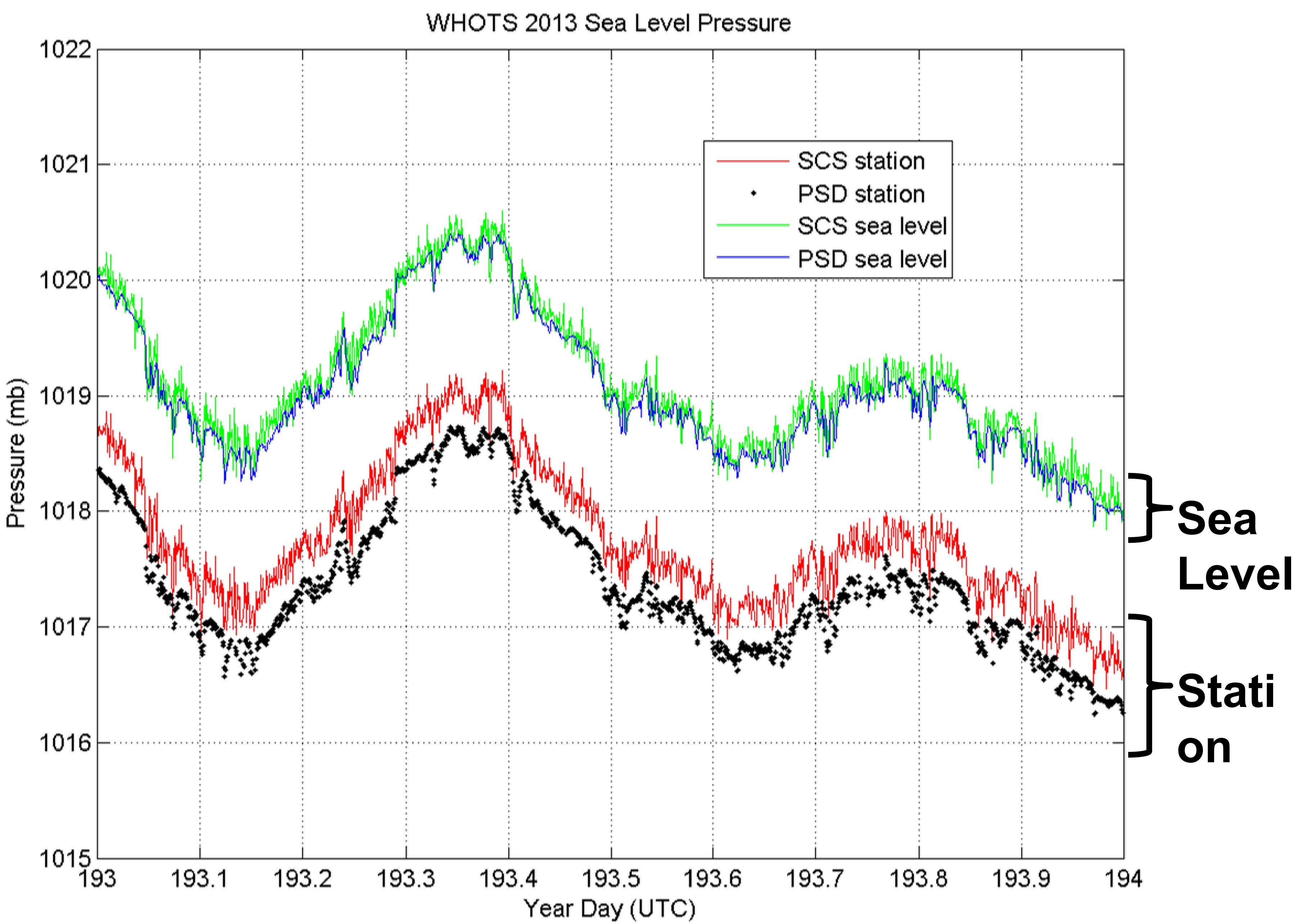
Tygon tubing to dynamic pressure port

NWS barometer

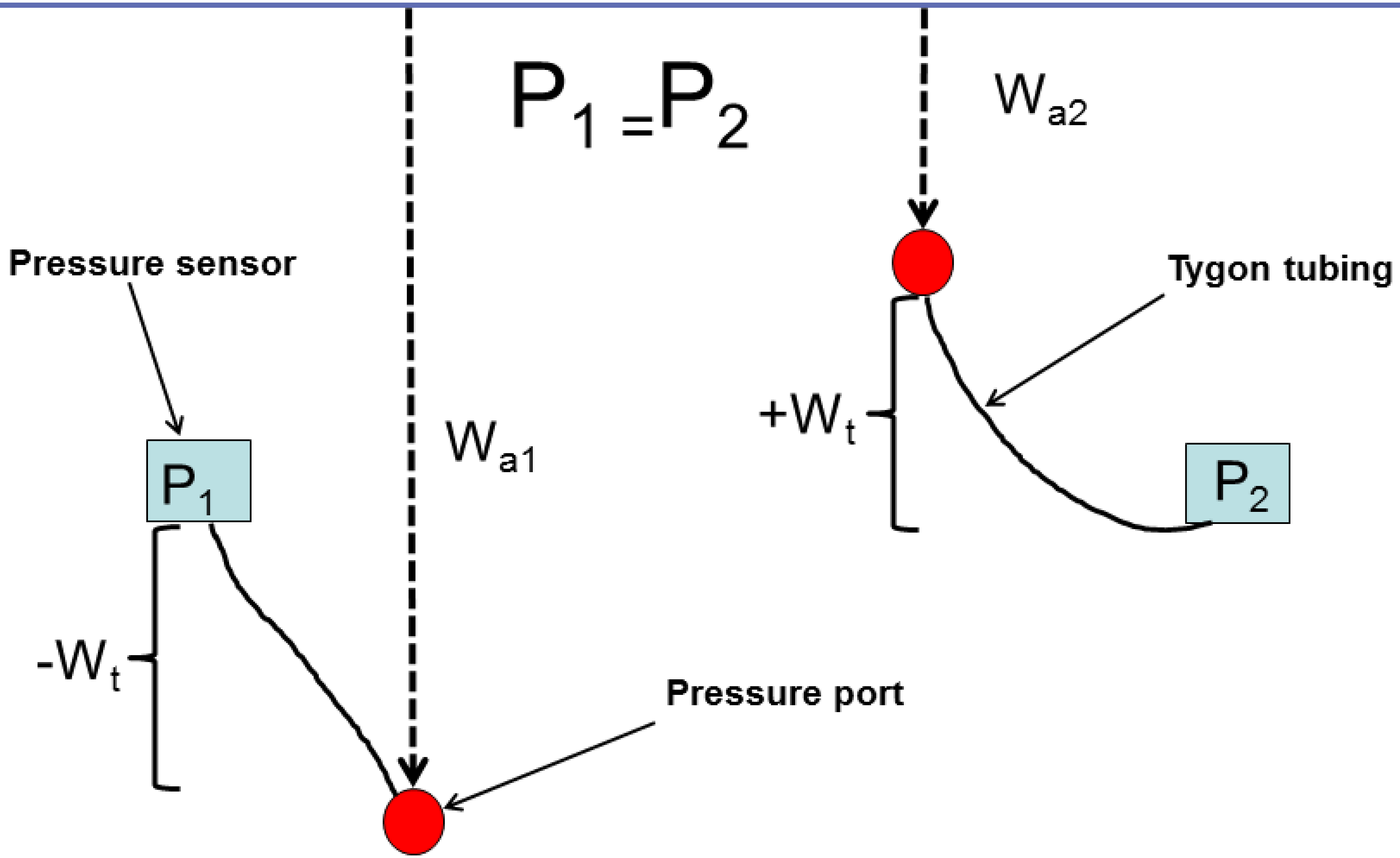




Ship pressure 12.02m above water


WHOTS 2013 Sea Level Pressure
SCS station
PSD station
SCS sea level
PSD sea level
Pressure (mb)
1022
1021
1020
1019
1018
1017
1016
1015
193
193.1
193.2
193.3
193.4
193.5
193.6
193.7
193.8
193.9
194
Year Day (UTC)
Sea Level
Stati on

Weight of the Atmosphere



Accuracy Targets

Table 1: Accuracy, precision and random error targets for SAMOS.

Parameter	Accuracy of Mean (bias)	Data Precision
Latitude and Longitude	0.001°	0.001°
Heading	2°	0.1°
Course over Ground	2°	0.1°
Speed over Ground	Larger of 2% or 0.2 m/s	0.1 m/s
Speed over Water	Larger of 2% or 0.2 m/s	0.1 m/s
Wind Direction	3°	1°
[illegible]	[illegible]	[illegible]
Atmospheric Pressure	0.1 hPa (mb)	0.01 hPa (mb)
[illegible]	0.2°C	[illegible]
Dewpoint Temperature	0.2°C	0.1°C
Wet-Bulb Temperature	0.2°C	0.1°C
Relative Humidity	2%	0.5 %
Specific Humidity	0.3 g/kg	0.1 g/kg
Precipitation	~0.4 mm/day	0.25 mm
Radiation (SW in, LW in)	5 W/m²	1 W/m²
Ocean Surface:		
Sea Temperature	0.1°C	0.05°C
Salinity	0.1 psu	0.05 psu

Applying Heights in the Field

Takeaways

- Apparent wind is a combination of the true wind and the wind induced by the ship's motion. This is the wind that you feel on deck and the wind that is measured by the ship's anemometers.
- The data from many of the instruments are unusable if the height of the instrument is unknown.
- For barometers, the height of the sensor must be used, not the height of the pressure port.
- Adjusting pressure to sea level allows for comparison with nearby moorings or land stations.

Questions?

Calculation Details

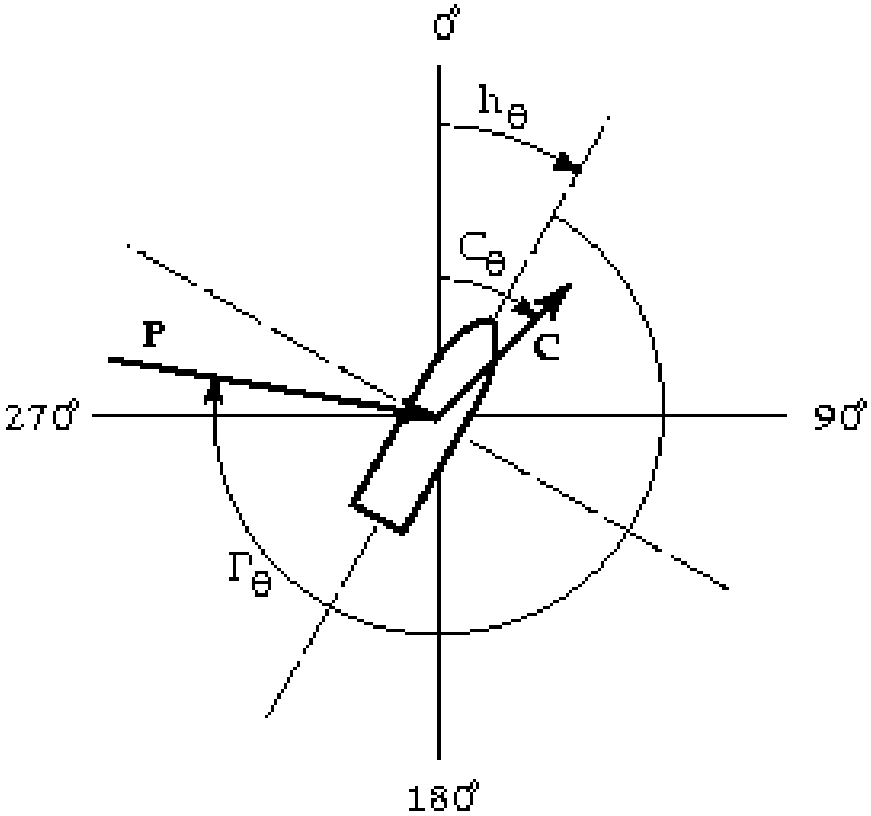
1. Calculate the apparent wind in math coordinates.

   $A'_\theta = 270^\circ - (h_\theta + R_\theta + P_\theta)$

   $|\mathbf{A}| = |\mathbf{P}|$

1. Adjust the course over ground to math coordinates.

   $C'_\theta = 90^\circ - C_\theta$



Calculation Details

3. Calculate the components of the true wind vector.

   $T_u = T'_u = |\mathbf{A}| \cos(A'_\theta) + |\mathbf{C}| \cos(C'_\theta)$

   $T_v = T'_v = |\mathbf{A}| \sin(A'_\theta) + |\mathbf{C}| \sin(C'_\theta)$

3. Calculate the true wind speed and direction from which the wind is blowing.

   $|\mathbf{T}| = (T_u^2 + T_v^2)^{0.5}$

   $T_\theta = 270^\circ - \arctan(T_v/T_u)$

- NOTE: Arctan function must have a range of -180˚ to +180˚.

Pressure Exercise

- Using the equation ⟶ $p_s = p_z e^{(gz/R_a T)}$
- Given
  - p_z = 1010 hPa
  - T = 290 K

  } Pressure and temperature at a given time

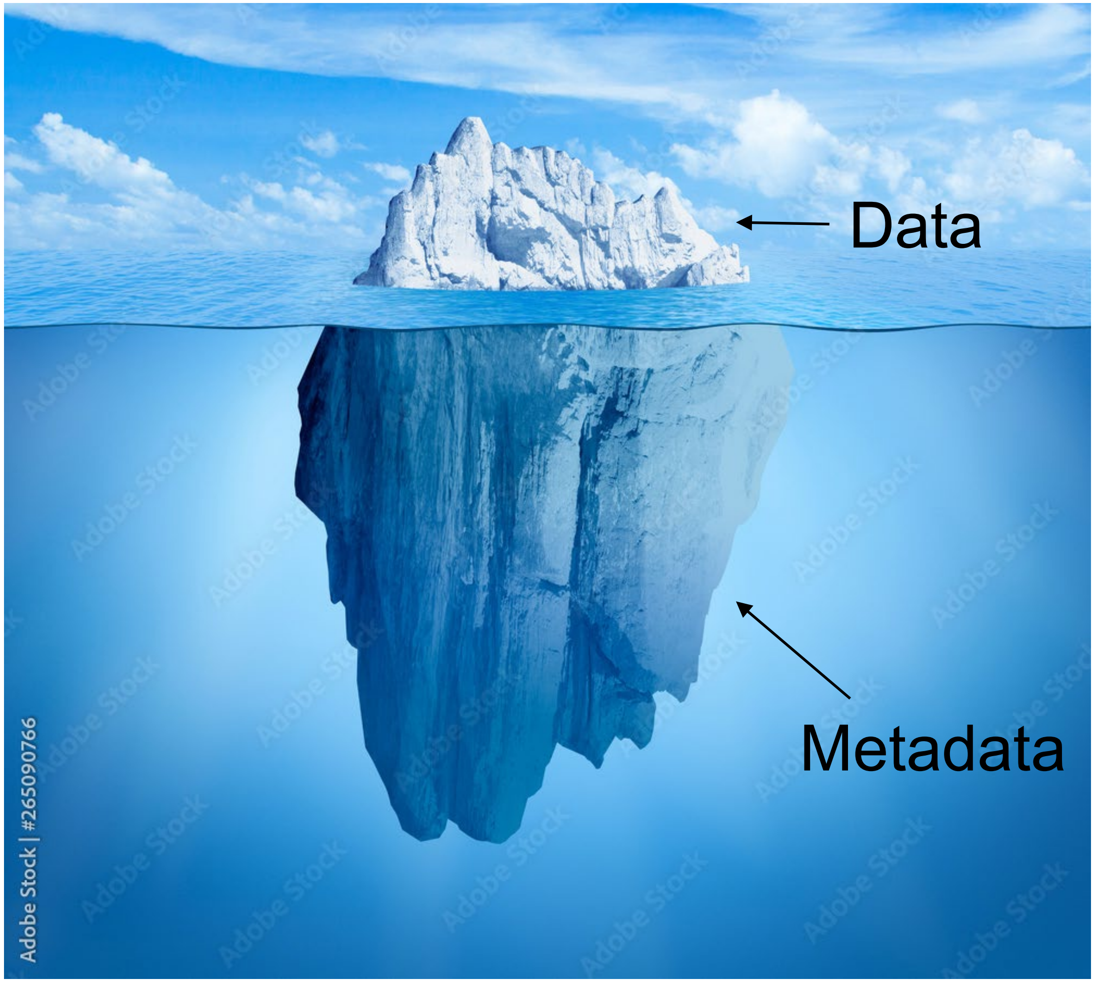
  - g = 9.81 m s^{-2}
  - R_a = 287.05 J kg^{-1} K^{-1}
  - e = 2.718281

  } Constants

- Calculate the surface pressure (p_s) for your vessel using your barometer height (z).
- Calculate the pressure difference ($p_s - p_z$) and add it to the list on the whiteboard.

Sensor Metadata and QC

Making Data Meaningful



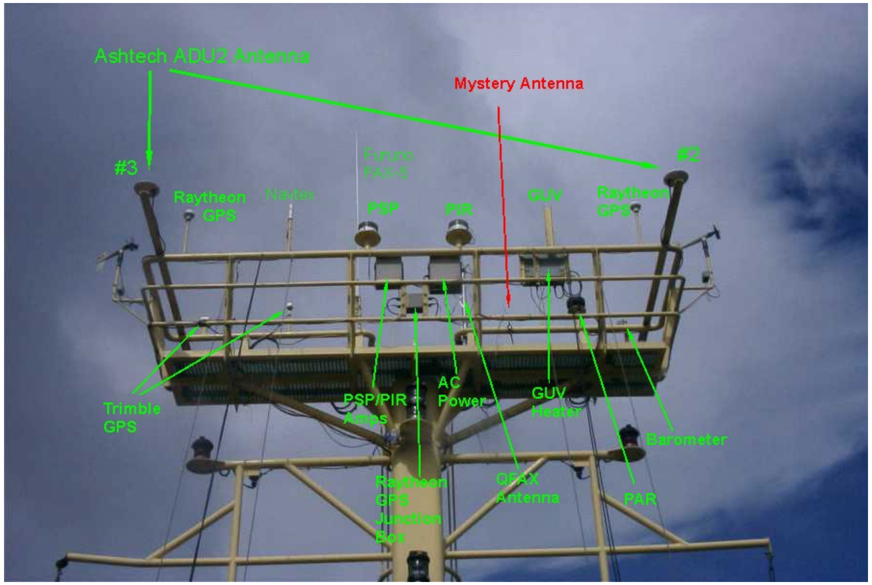
Metadata

- **The basics**
  - Ship name
  - Time convention (preferably GMT [UTC])
  - Parameters measured
  - Recorded units of observations (preferably SI)
  - Data sampling rates
  - Averaging or calculation methods (e.g., true wind vs. ocean-relative winds)
- **Sensor calibration & history**
  - Make/Manufacturer
  - Model
  - Serial number
  - The date and source of each calibration (indicates stability of sensor)
  - Dates of sensor deployment (and recovery)
  - Incidents during deployment period (maintenance, repairs, mishaps--e.g., swamped by wave over bow)

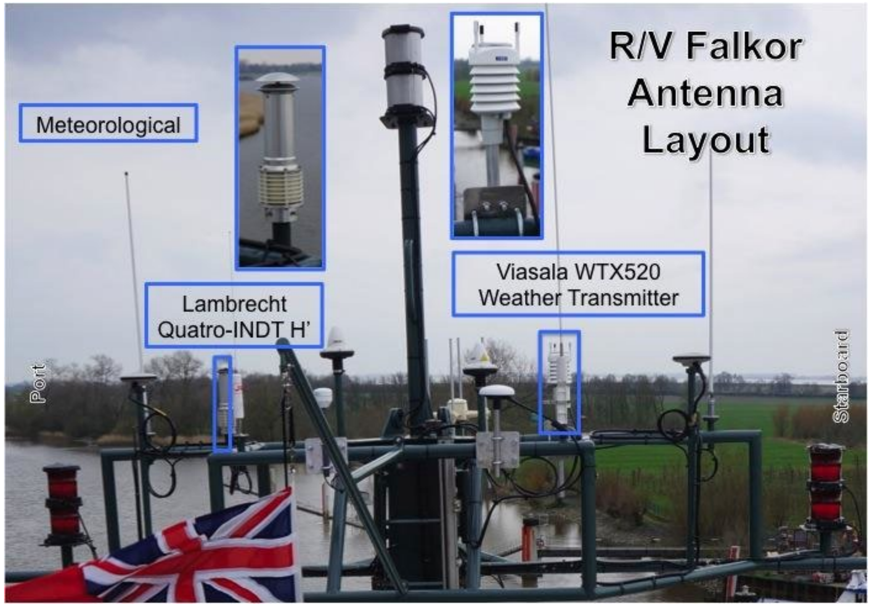
Instrument Location Metadata

- Height/depth from the waterline and/or height above some ship reference (e.g., 15.3 m above foredeck)
- Position w.r.t. ship's centerline (e.g., 2.5 m to port or stbd)
- Distance from bow
- Depth of sea water intake
  - Also, approximate pipe run length to sensor
- Coordinate system of vessel - https://www.rvdata.us/community/ship-operators/sensor
- Description and location of main support (e.g., foremast, forward rail above wheelhouse)
- Any significant object that may affect the exposure of the instrument (e.g., Inmarsat dome on rail 2 m to port; after installation large instrument box mounted 1 m forward)

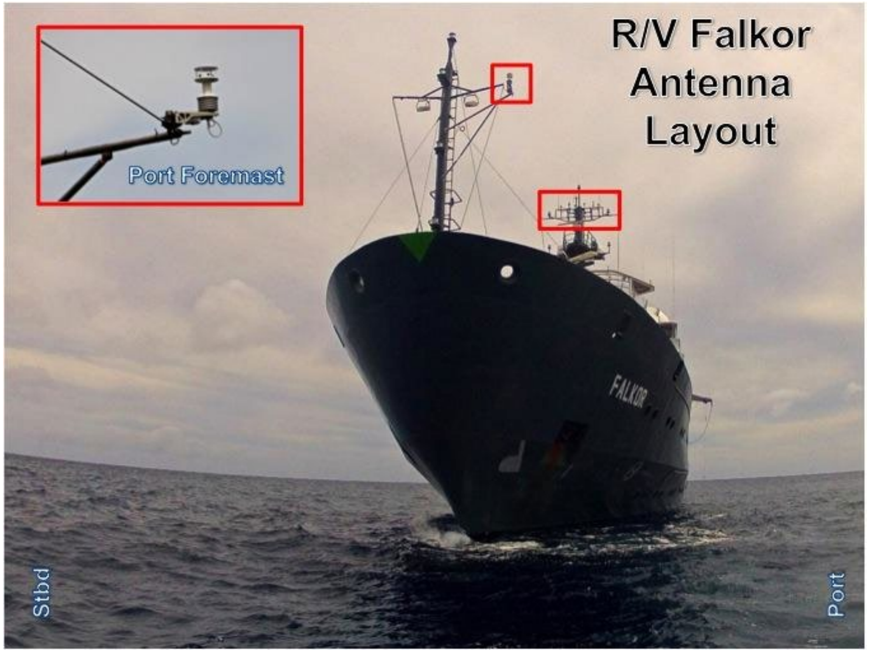
Digital Imagery Metadata



Digital Imagery Metadata

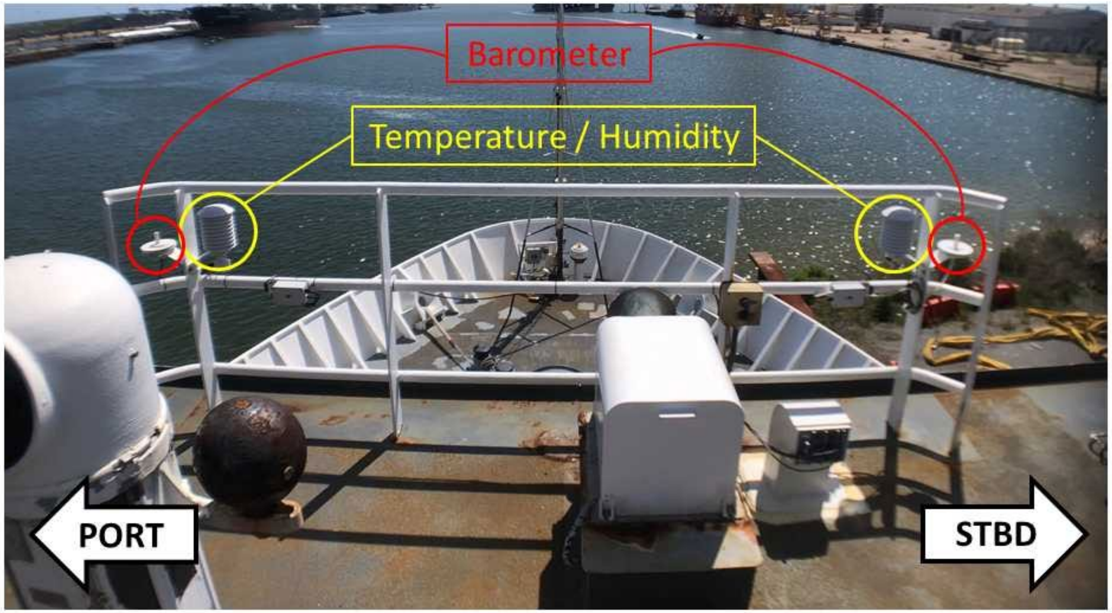


2013



2014

Metadata about Metadata!



Instrument	Other
Instrument	multiple devices 14 characters left
Vessel View	N/A
Image Type	Photo
Location	Other
Location	top of pilot house 12 characters left
Image Credits	Danielle Power 241 characters left
Picture Caption	Locations of RM Young T/RH and P probes. Note location susceptible to flow issues/deck 0 characters left

Managing Data Quality

http://samos.coaps.fsu.edu

SAMOS
Shipboard Automated Meteorological and Oceanographic System

NSF NOAA COAPS

Five Steps for Quality Assurance

- Good sensor exposure
- Sensor calibration
- Program for cleaning and maintenance
- Routine checks of sensor output
- Documentation (a.k.a. metadata)

Spot Checks of Data

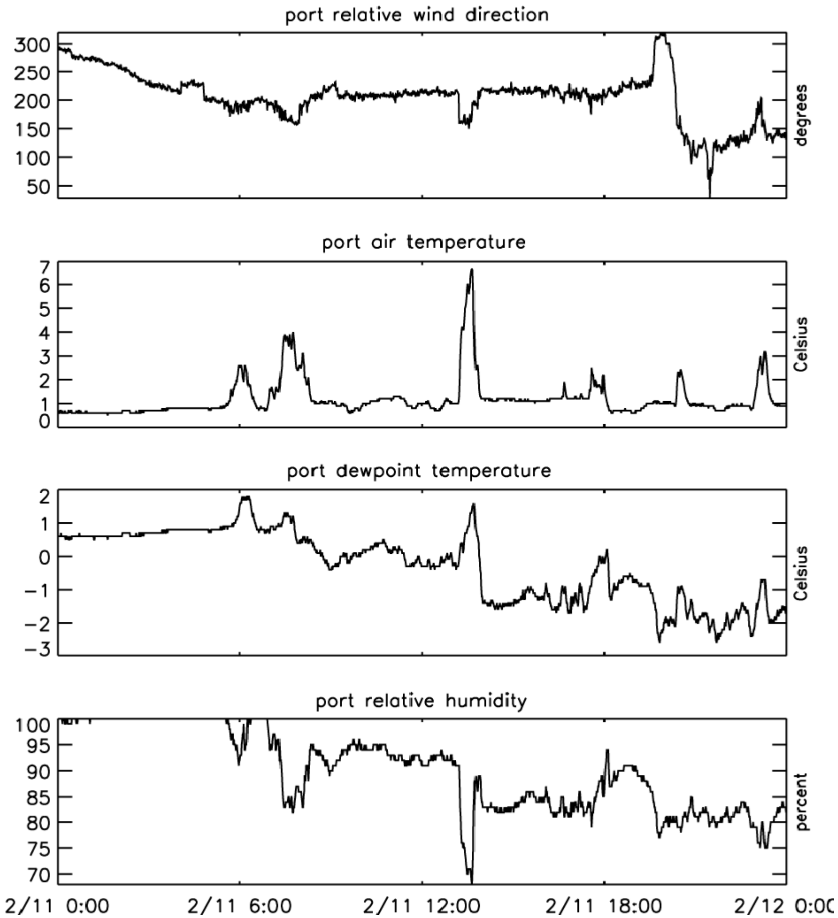
- Monitor data
  - Use graphical displays on the vessel (daily if possible).
  - Conduct periodic checks with handheld instruments.
  - Compare to nearby station
  - Make visual estimates to verify winds. http://en.wikipedia.org/wiki/Beaufort_scale.
  - Participate in a shoreside monitoring program.

Quality Control

- Responsibility of data users and data center
- Common quality control includes the following:
  - Verifying temporal sequence
  - Ensuring values are in a plausible range
  - Comparing values to a known marine climatology
  - Verifying physical relationships (e.g., dew point temperature not greater than air temperature)
  - Ensuring ship position is over water and distance between sequential locations is plausible (track checking)
  - Validating true wind (and other) calculated values
- SAMOS provides shoreside monitoring and quality control.

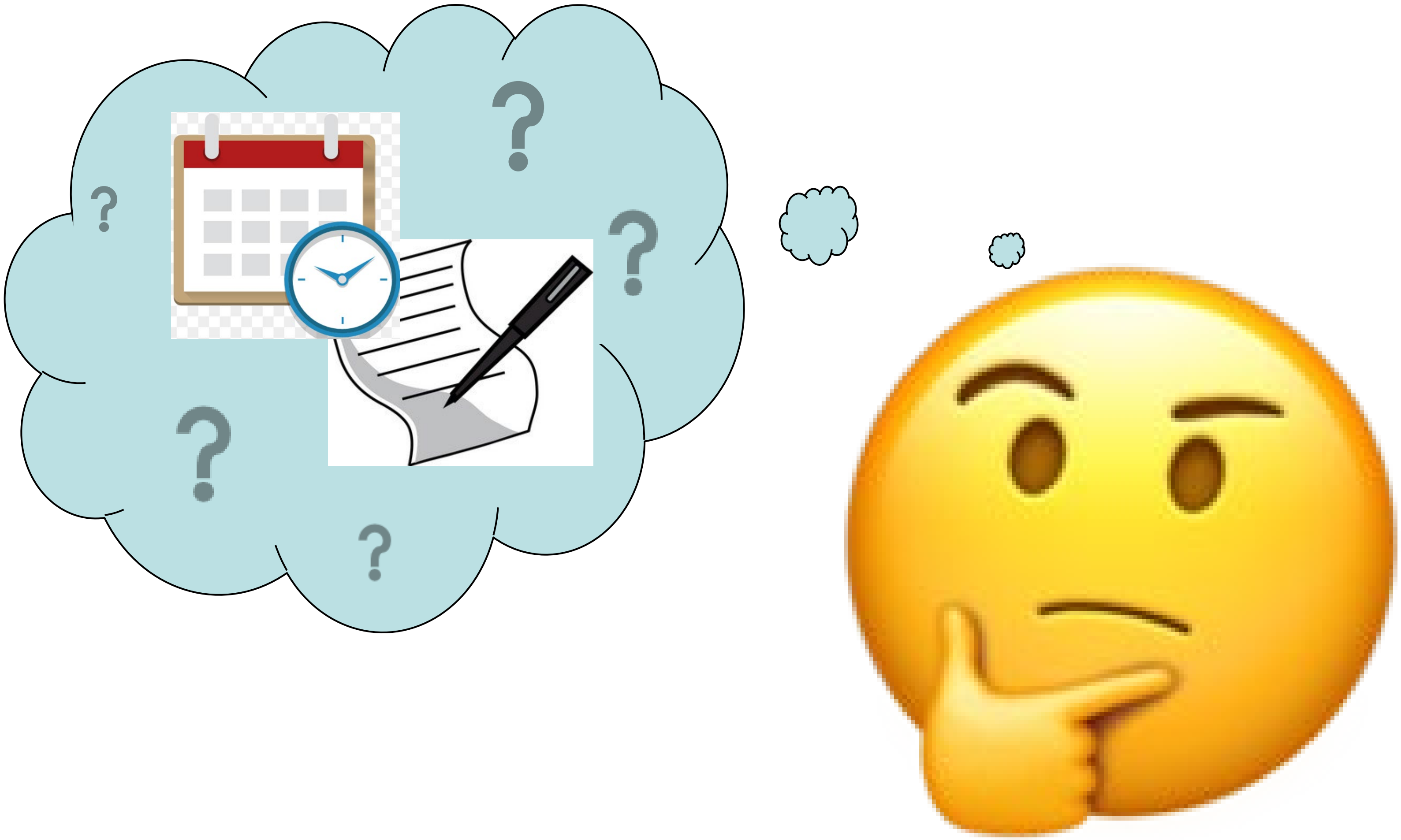
QC Example

- Not all problems can be identified with simple QC tests.
- Visual inspection and use of metadata can identify problems.



QC Example

Keeping Metadata Current



Keeping Metadata Current - Other Ideas?

ACQ SAMOS DESIGNATOR	METADATA FIELD	LAST KNOWN INFO
ATEMP	Average Length	
	Average Method	average
	Averaging Time Center	unknown
	Data Precision	
	Descriptive Name	air temperature
	Distance from Bow	
	Distance from Center Line	
	Height	
	Instrument Make & Model	
	Last Calibration	
	Observation Type	measured
	Sampling Rate	
	Serial Number	
	Units	celsius
BARO	Average Length	60
	Average Method	average
	Averaging Time Center	time at end of period
	Data Precision	
	Descriptive Name	atmospheric pressure
	Distance from Bow	21.3
	Distance from Center Line	0.3
	Height	11.7
	Instrument Make & Model	RM Young 61201
	Last Calibration	20140109
	Mean SLP Indicator	unknown
	Observation Type	measured
	Sampling Rate	1

METADATA FIELD KEY:

All distance and location measurememts are in met

Instrument Height is + for above the water line and

Instrument Distance from Center Line is + (or "S") fc

Sampling Rate is in Hertz

Average Method choices are "average" or "spot" (al

Average Length is in seconds (this field only applies

Averaging Time Center (this field only applies when "end" of the averaging period (*for SCS averages thi

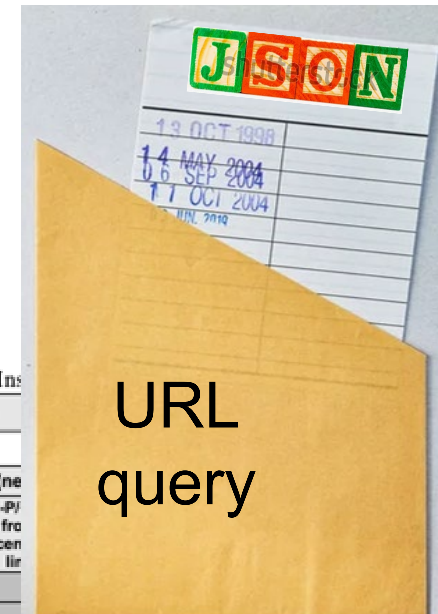
Last Calibration (or approx. installation date if instru

Observati

Mean SLP

Anemome from the l

Wind Dire direction



air temperature

Designator: AIRTEMP1 | Date Valid: 03/21/2022 to Today

Descriptive Name	Original Units	Instrument Make & Model	Serial Number
air temperature (flying bridge	celsius	RM Young 41382VC, with as	25597

Last Calibration	Observation Type	Distance from Bow	Distance from Center Line
20220214	measured	24	-3

Height	Average Method	Averaging Time Center	Average Length
12	average	time at start of period	60

Sampling Rate	Data Precision
1	0.3

[Add/Modify] variable with:

Designator: | Date Valid: Today to Today [Today]

10/22/21 SAMOS Ins

Primary Instrument Metadata				Vessel Name		
Logging System Name						
Parameter	Designator for SAMOS	Instrument: Make + Model	Instrument: Serial Number	Units	Distance (ne: From bow (+)	-P/ fro cen lin
Time						
Latitude						
Longitude						
Heading						
Course over ground						
Speed over ground						
Speed over water						
Vessel-relative wind speed						
Vessel-relative wind direction	*Wind direction convention? To or From*			*Anemometer zero-line reference (deg)*		
Earth-relative wind speed						
Earth-relative wind direction	*Wind direction convention? To or From*					
Atmospheric						

Wrap-Up

Common Installation Problems

- Anemometer orientation

- Pressure port (dynamic shield)

Suggested Calibration Intervals

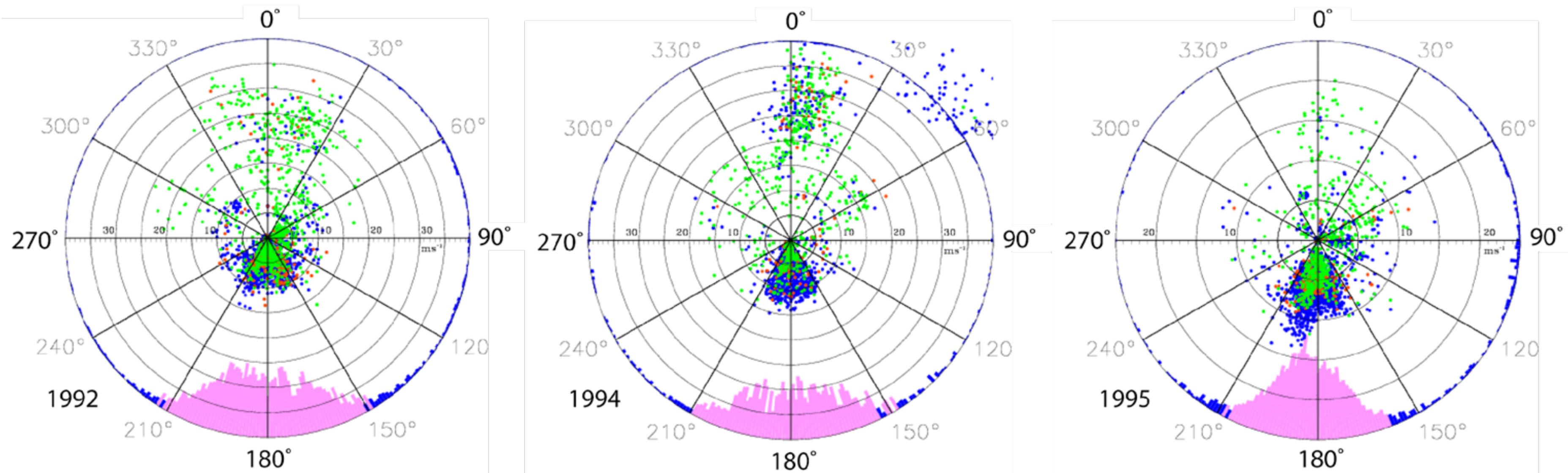
- Mechanical Anemometer – Yearly (more often, if possible)
- Sonic Anemometer – 3 to 5 years (generally replace)
- Thermometer/Hygrometer – 1-2 years (if routinely cleaned, also generally replaced)
- Radiometers – 3 to 4 years (if cleaned and inspected)
- Barometer – 3 to 5 years (pretty robust sensors)
- Siphon rain gauge – Yearly
- Optical rain gauge – unknown
- TSG – Yearly (more often depending on operating conditions)

Maintenance

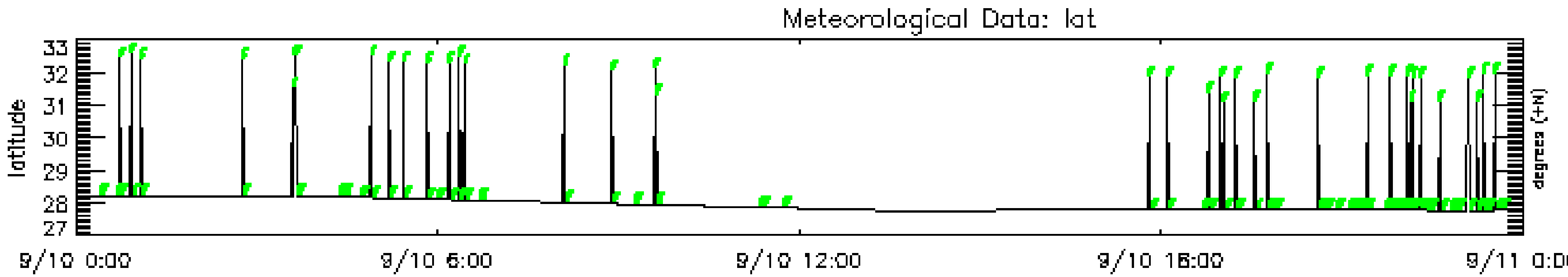
- Critical to data accuracy
  - Cleaning radiometer domes, removing salt buildup
  - Replacing filters, desiccant, etc.

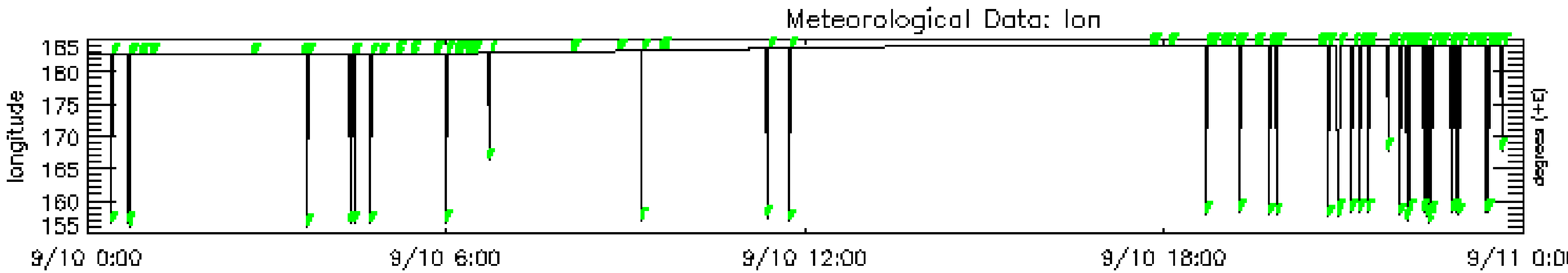
QC Example

Temperature Flags Plotted with the Platform-Relative Wind Direction



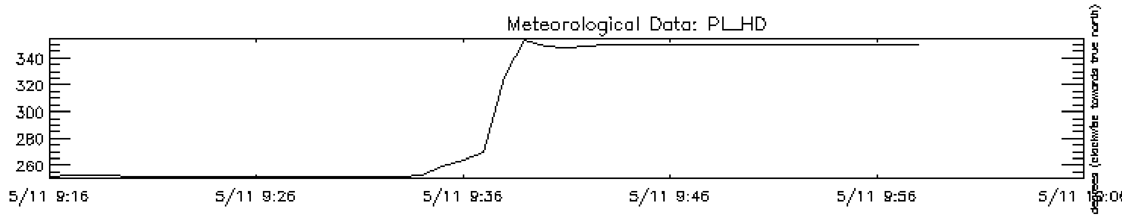
SAMOS examples: Lat/Lon Spikes



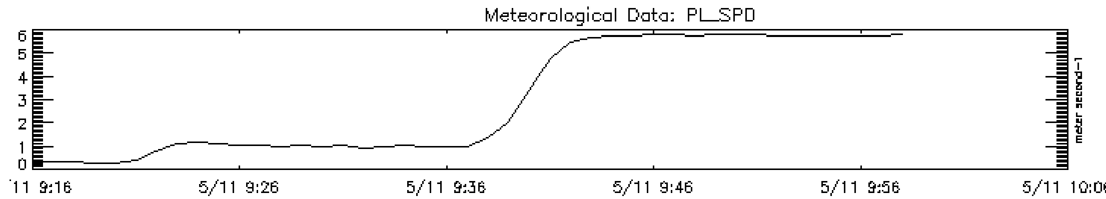


SAMOS examples: Acceleration Spikes

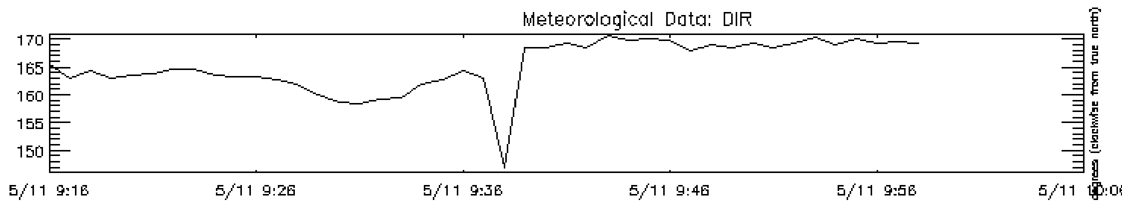
Heading



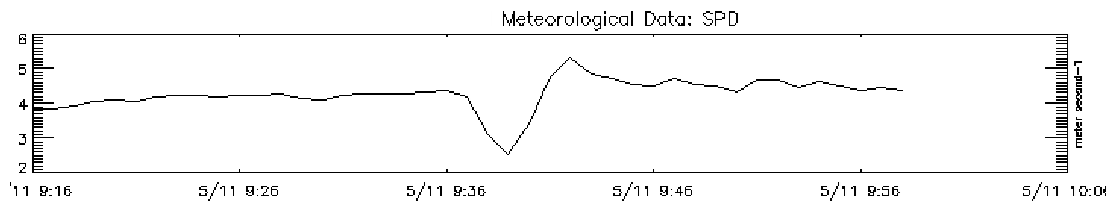
SOG



True Wind Direction

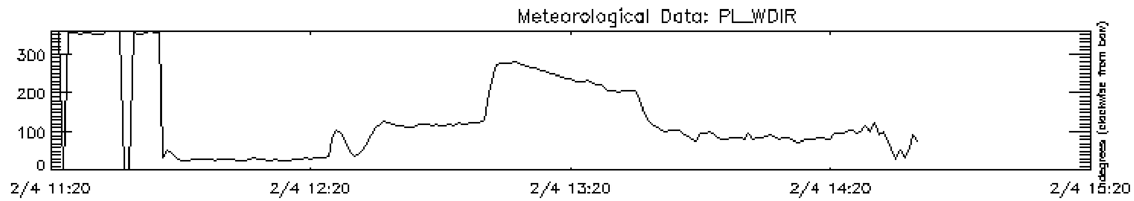


True Wind Speed

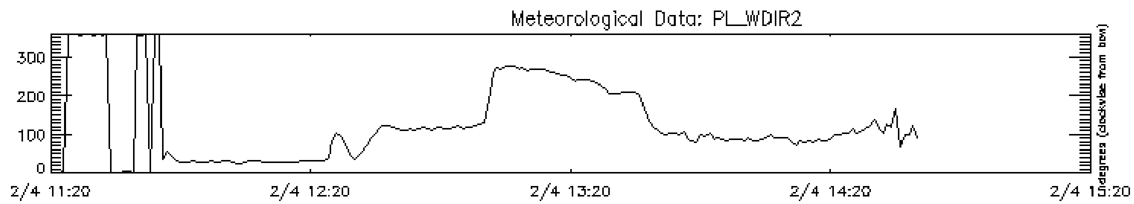


SAMOS examples: Air Flow Obstruction

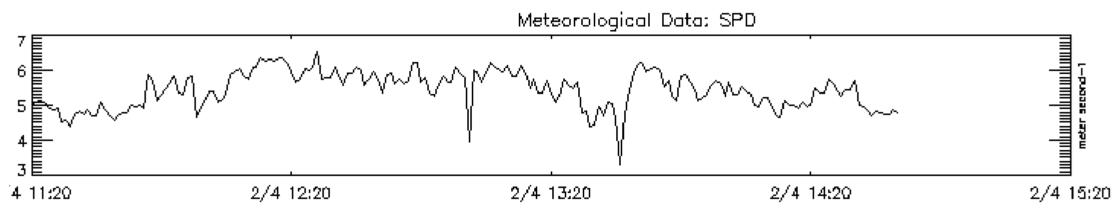
Port Relative Wind Direction



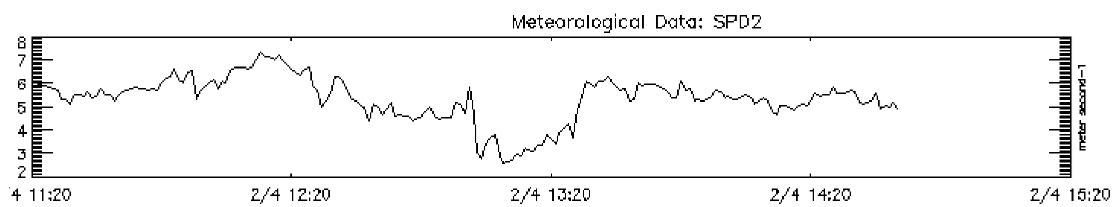
Stbd. Relative Wind Direction



Port True Wind Speed



Stbd. True Wind Speed



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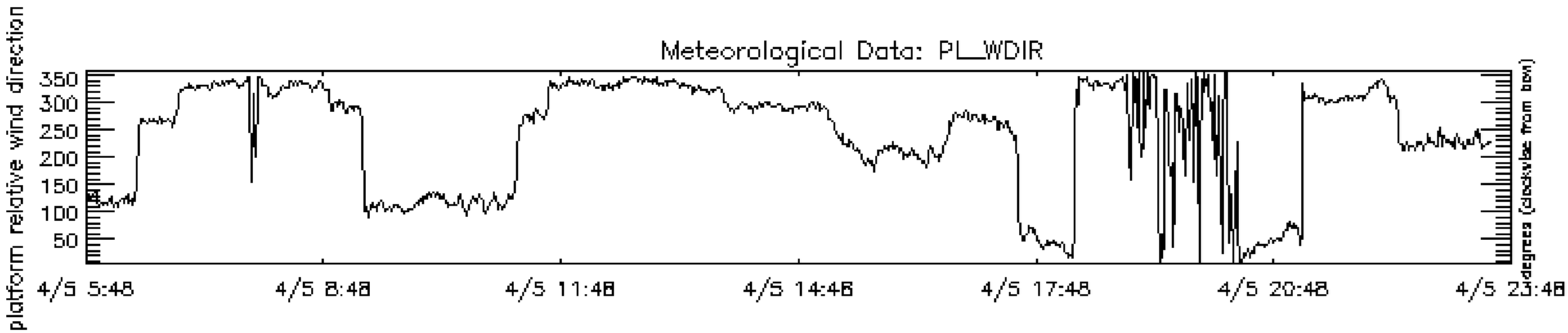
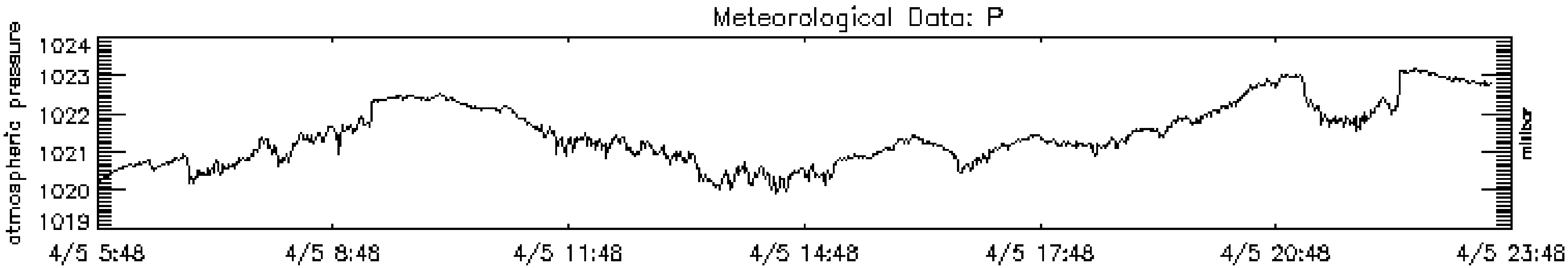
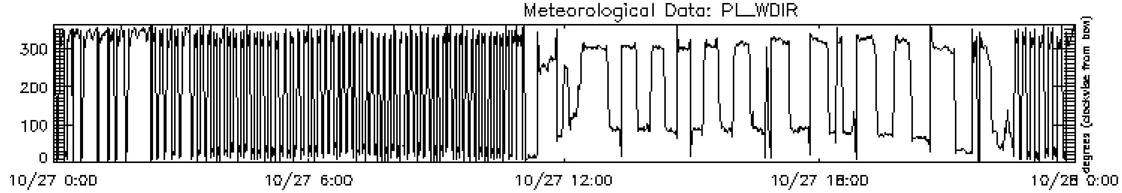
SAMOS examples: No Pressure Port



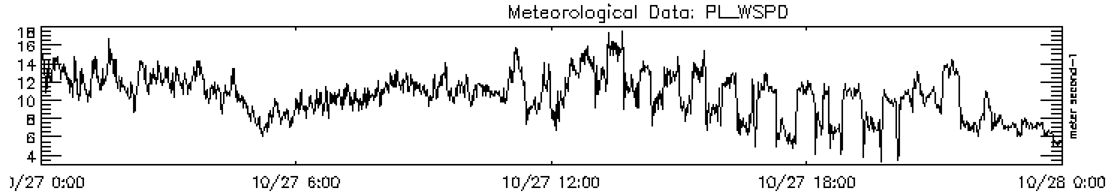


SAMOS examples: T/RH Steps

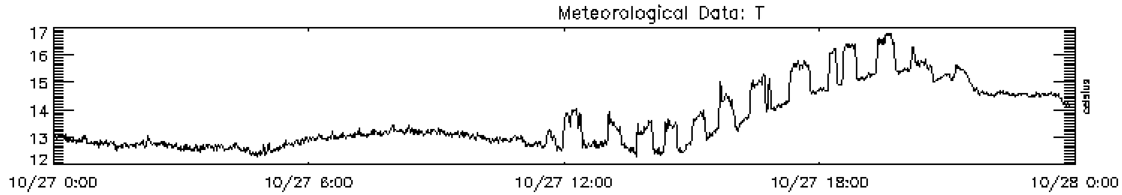
Ship-Relative Wind Direction



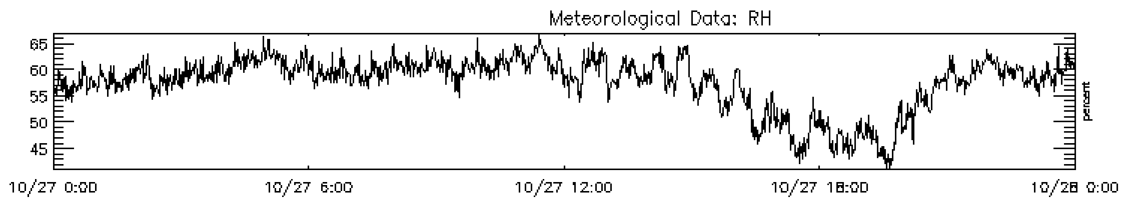
Ship-Relative Wind Speed



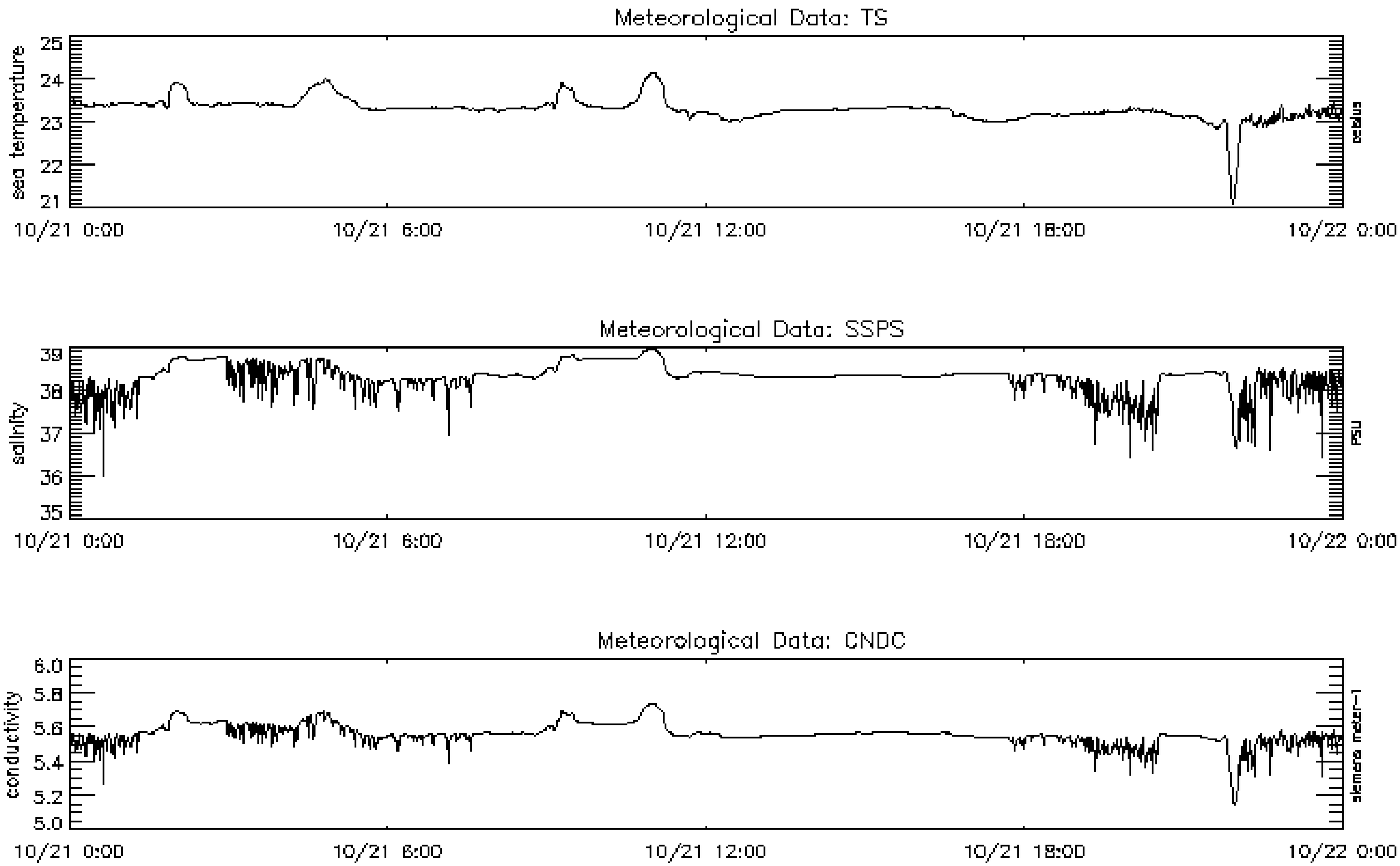
Air Temperature



Relative Humidity



SAMOS examples: T_{sea} Intake Problem



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Metadata XML Example


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        </Instrument>
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Wrap-Up

- Thank you for participating!

- Course content and presentations will be available at
  http://samos.coaps.fsu.edu/html/mtshortcourse.php

- Questions can be sent to
  Shawn Smith: smith@coaps.fsu.edu
  Kristen Briggs: kbriggs@coaps.fsu.edu
  Marc Castells: mcastells@coaps.fsu.edu

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