
# Improved Meteorological Measurements from Merchant Ships

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# Summary

- What Merchant Ship observations do we have?
- Why improve the Merchant Ship Meteorological Observations?
- How do we do it?

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# What Merchant Ship Observations do we have?

- WMO Voluntary Observing Ships (VOS) Programme
- Observations are used in real-time for weather forecasting
- .... and in delayed-mode for climate studies

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# How are the observations made?

- **Instruments are basic and robust - the choice of measurement method is usually made by the recruiting country**
  - Wind Speed: anemometer or visual observation of sea state
  - SST: Bucket, engine intake or hull sensor
  - Air temperature and humidity: wet and dry bulbs exposed in a screen or psychrometer
  - Pressure: Aneroid barometer (historically a mercury barometer)

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# Why Improve the Merchant Ship Observations?

- To be useful in Numerical Weather Prediction, observations must be more accurate than the forecasts
- Better accuracy needed for climate studies
- Verification of numerical model output and remote sensed data

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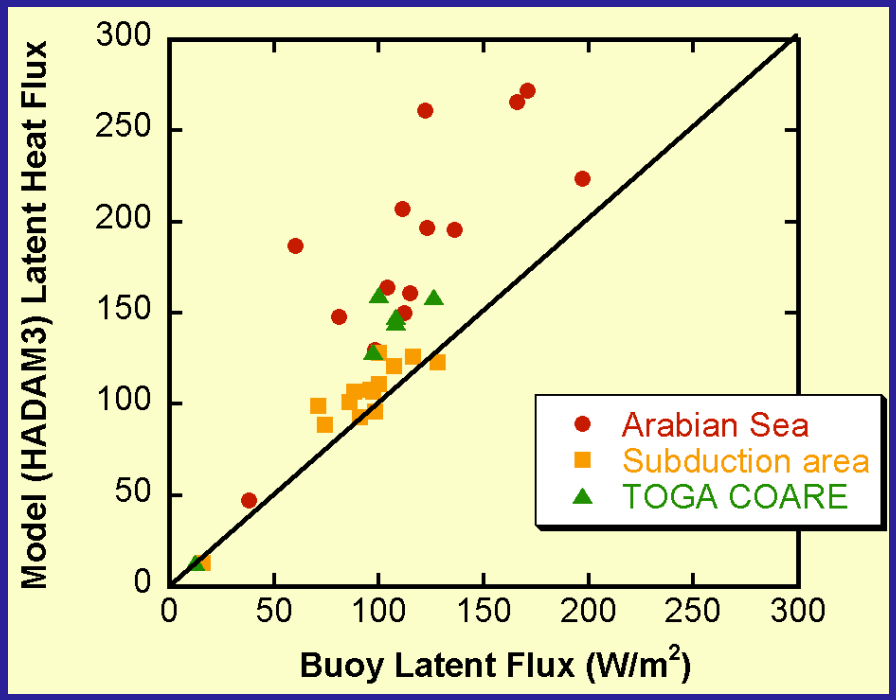
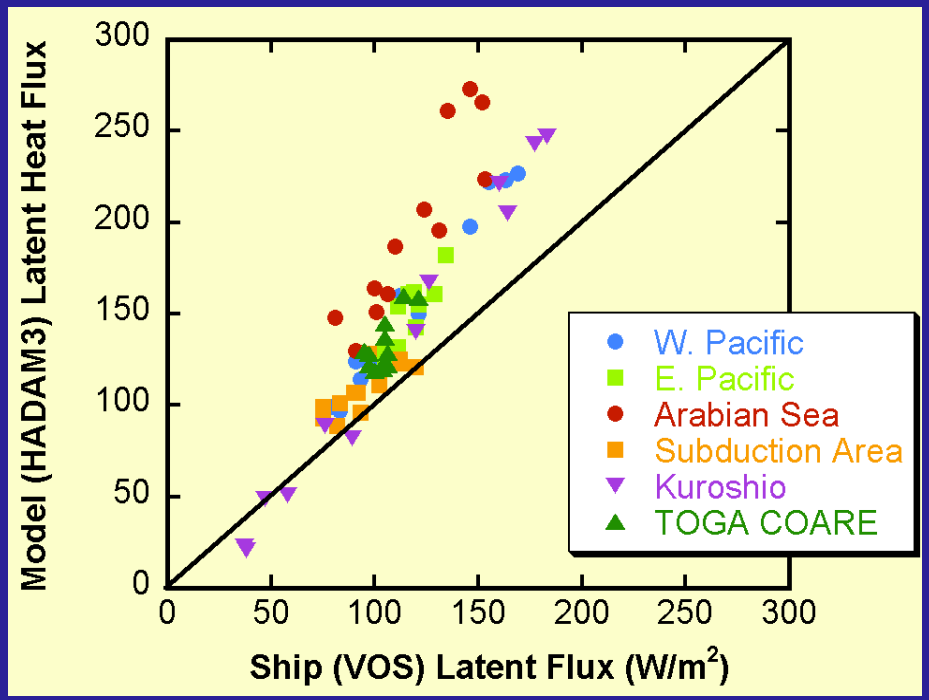
# Verification of NWP fluxes




- Buoy data shows that a typical model over-estimates the Latent Heat Flux

- Ship data extends the comparison to other areas and times (from Taylor et al. 2001)

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# How can we improve VOS Meteorological Observations?

- better understanding of the error characteristics
- better metadata and quality control (as in the VOS Climate Project, VOSClim)
- through automation and improved instrumentation (e.g. the Canadian AVOS or US ASIMET systems)

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# Better understanding of the error characteristics

- **Characterising historic measurement methods**
  (e.g. I-2 Koninckx, III-Inv-1 Parker et al., III-1 Rayner et al.)
- **Determining Sampling errors**
  (e.g. I-6 Gulev et al., I-9 Morrisey, III-2 Brohan et al.)
- **Quantifying present day random and bias errors**
  (e.g. P-I-6/P-II-6 Kent et al., P-I-12 Weller et al., II-Inv-2 Cardone, II-2 Moat, P-II-1/2 Thomas & Swail)

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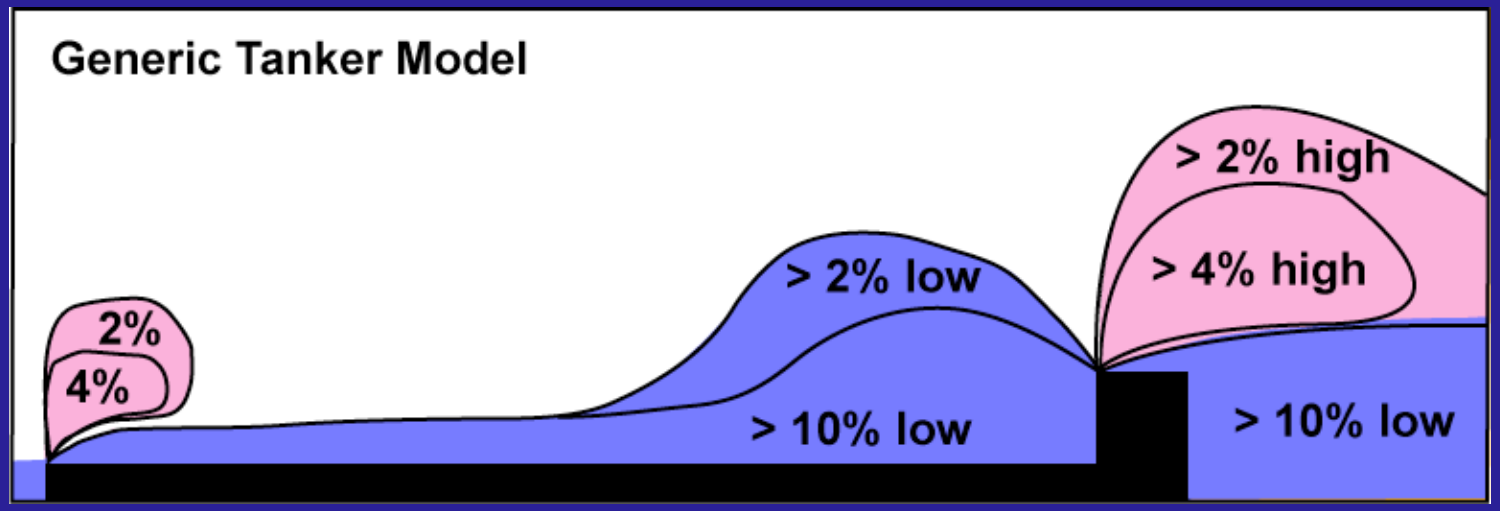
# Example: Airflow Errors

- The airflow over generic VOS types is being modelled using Computational Fluid Dynamics (CFD).

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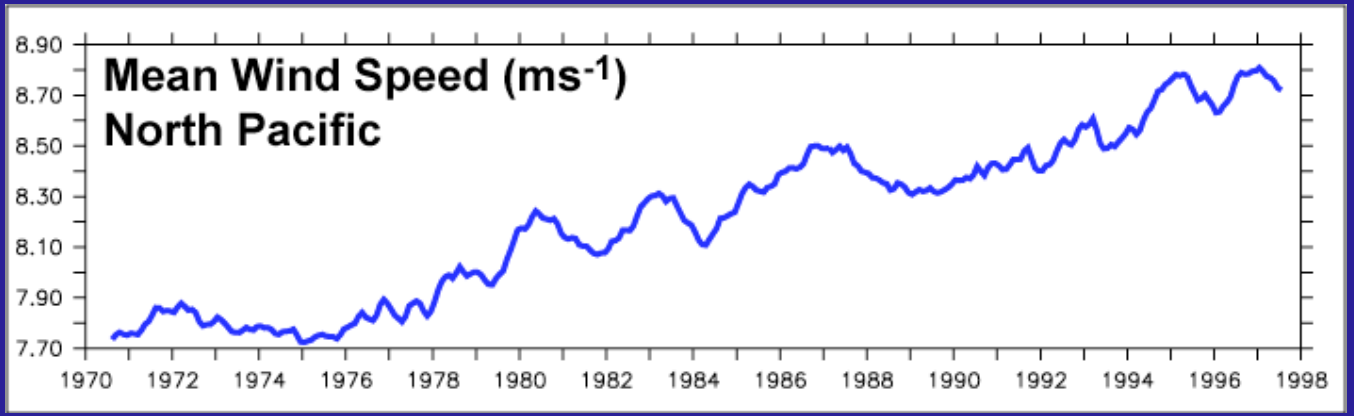
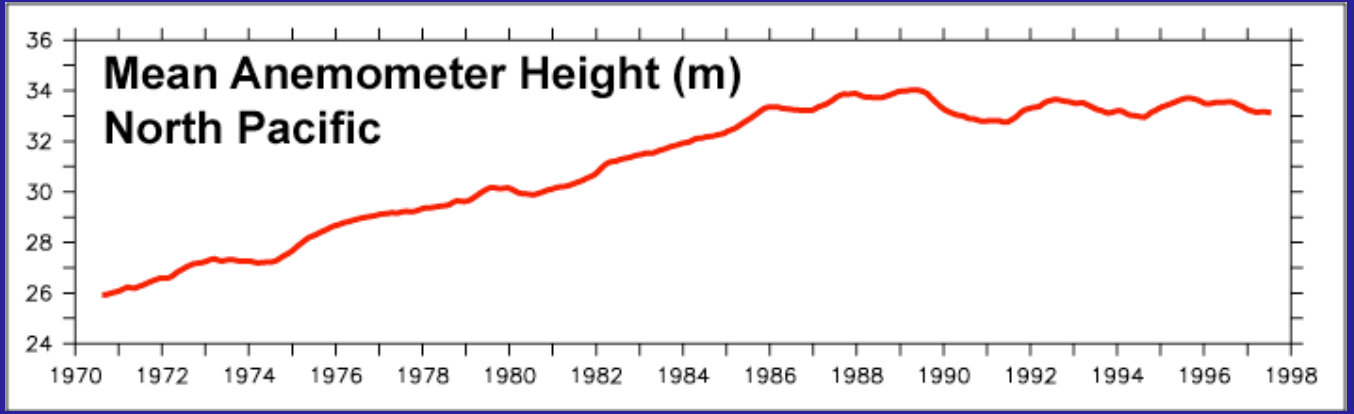
# Example: Height Correction




- The increase in wind speed cannot be explained by increases in anemometer height, but the height increase does contribute about 0.2 $ms^{-1}$ to the apparent increase

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# Better understanding of the error characteristics

- **Combining observations .....**
  - Using the relationship between pressure and wind (e.g. II-Inv-1 Lindau, II-1 Kaplan)
  - Using satellite + in situ SST data (e.g. III-Inv-2 Reynolds et al., III-Inv-3 Donlon, III-6 Casey, III-10 Gentemann et al., III-11 Vazquez & Armstrong)
  - Combining sea ice and SST analysis (e.g. III-12 Kaplan)

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# The JCOMM VOS Climate Project: VOSClim

- VOSClim initially aims to improve the metadata available from a subset of VOS
- The VOSClim ships are closely monitored and their reports archived with co-located NWP model output


P&O Nedlloyd Southampton - a VOSClim ship

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# VOSClim

- Recruits ships with a good reporting record, nearly 100 so far
- Collect extensive metadata in new WMO format
- Photographs taken of ship and instrument sites
- Extra parameters reported to help assess biases
- Observations intensively monitored by comparison with NWP output

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# VOSClim: Progress

- **Progress has been slower than hoped - partly due to diminishing resources for VOS in Operating Countries**
- **Metadata delivery by WMO is not yet in place (vital both for VOSClim and VOS)**
- **But .....**
  - Data have been collected for over 2 years
  - 7 countries participating
  - Ship and model comparisons show some interesting results

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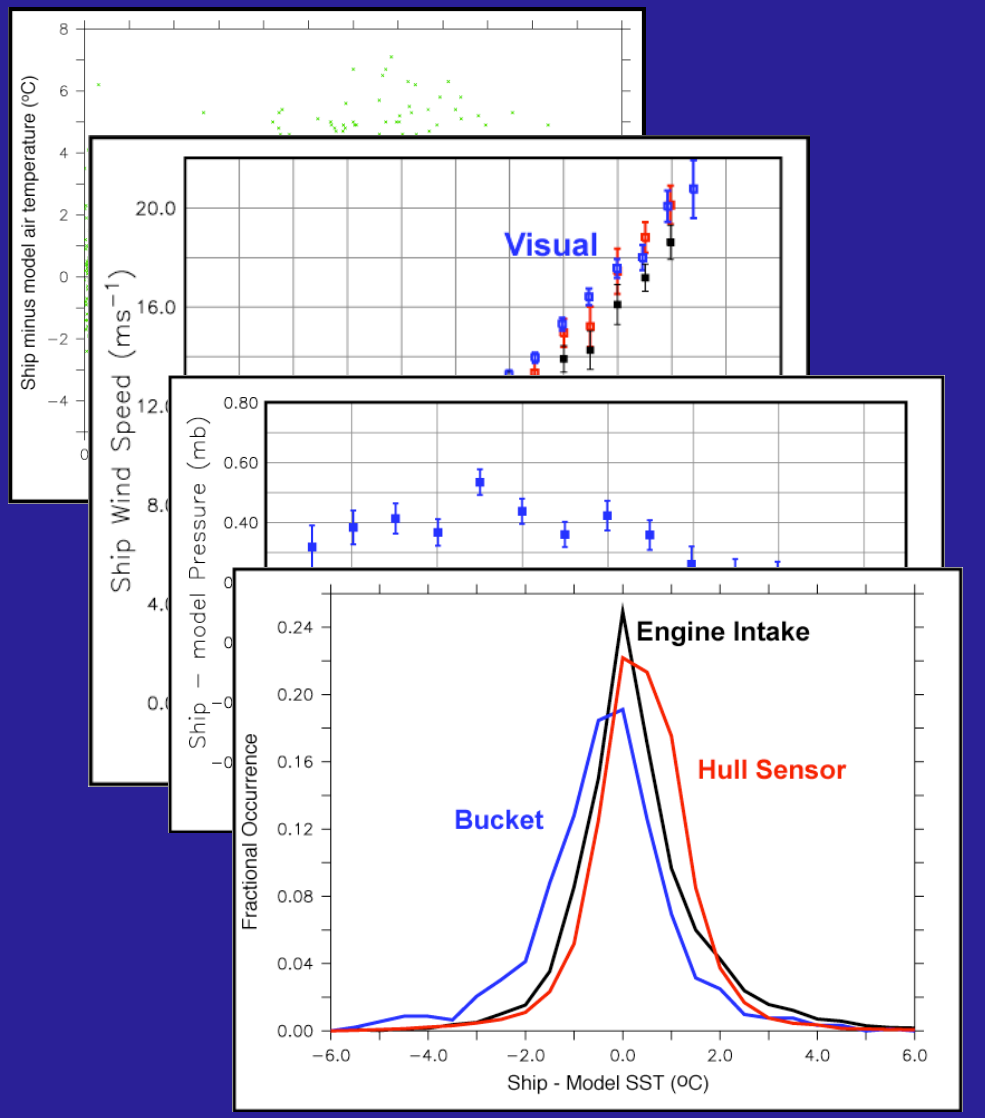
# VOSClim: Results

- **VOSClim ships show biases in...**
  - air temperature due to solar radiation
  - wind speed due to observation method
  - pressure - in the model ???
  - SST due to instruments used

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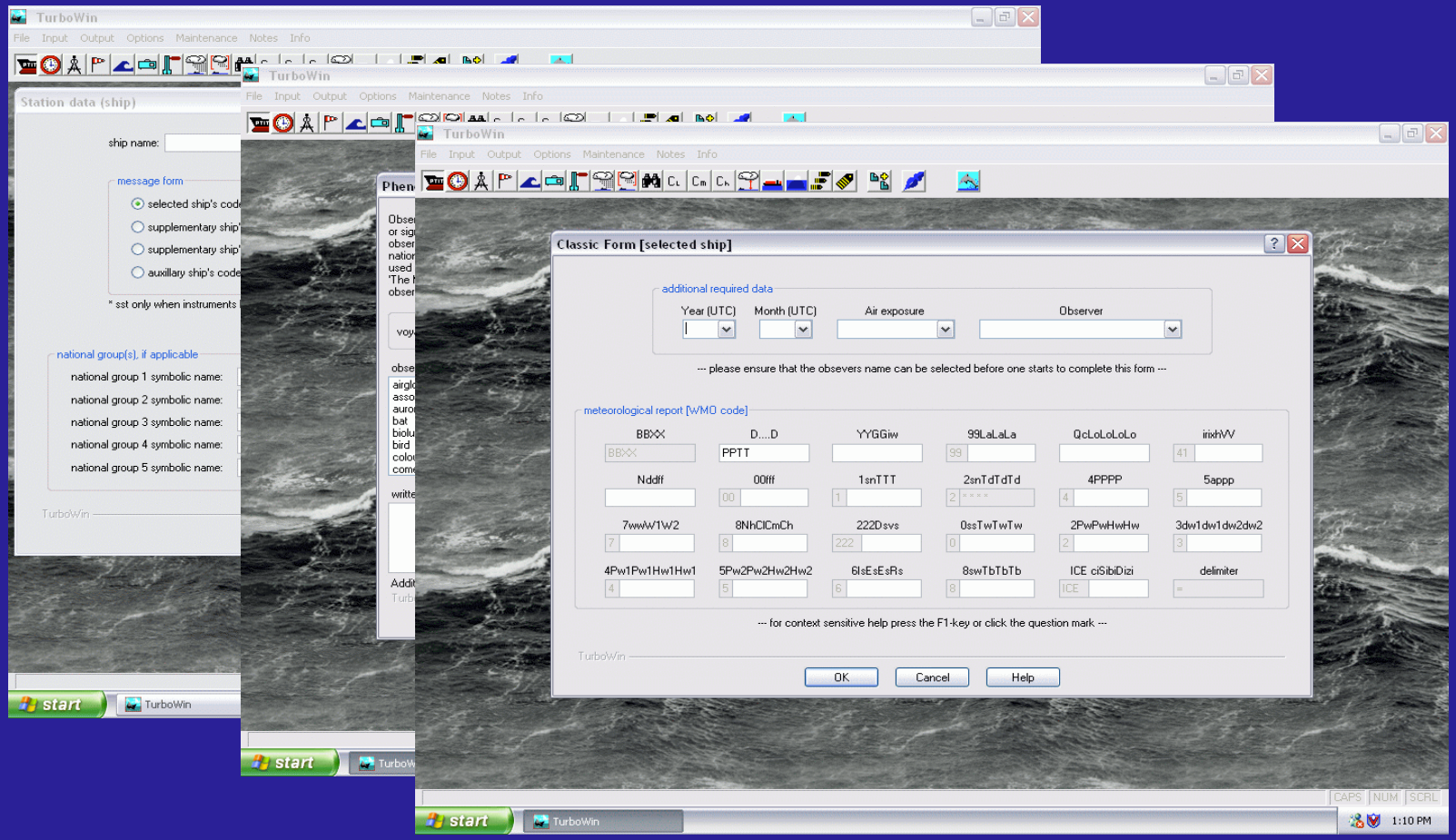
# Automation of Coding

- TurboWin guides the observer through a series of computer screens to assemble a coded message

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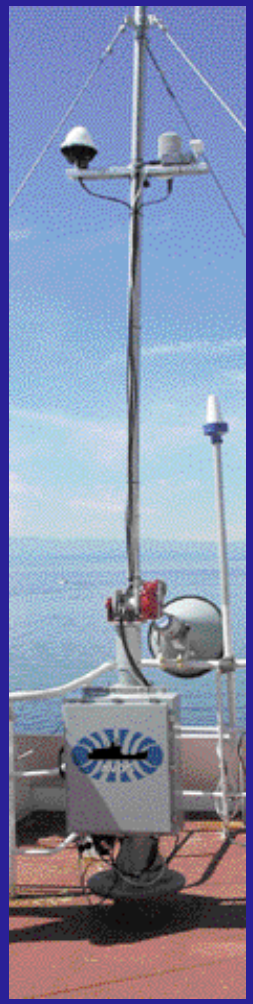
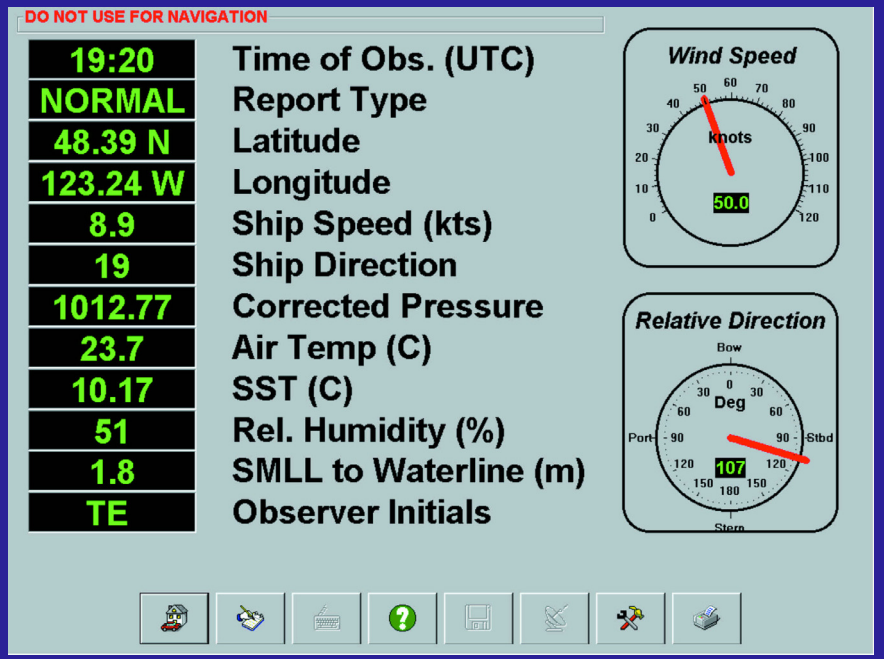
# Automatic Weather Stations - e.g. AVOS

**Now being installed throughout the Canadian VOS fleet AVOS provides automated coding, observations and a touch screen display on the ship's bridge**



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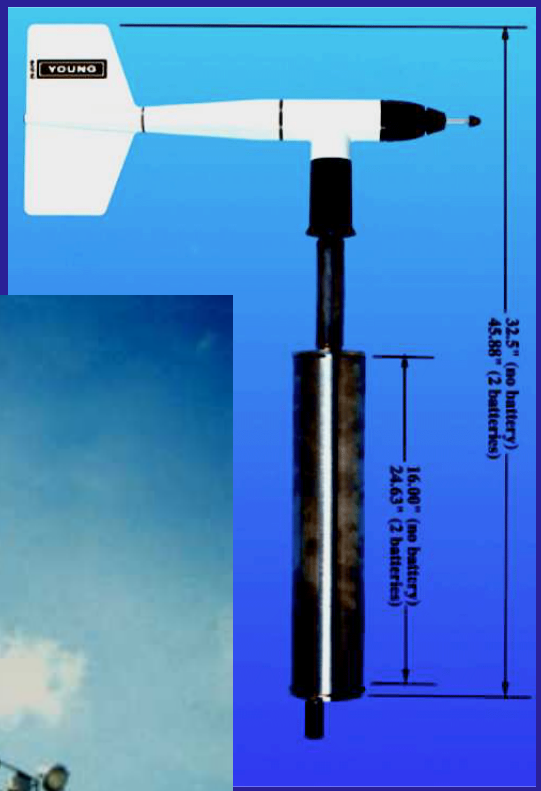
# Research quality instruments - e.g. ASIMET

Developed by WHOI, ASIMET sensors are attached to signal conditioning modules which are pre-programmed with the sensor calibration





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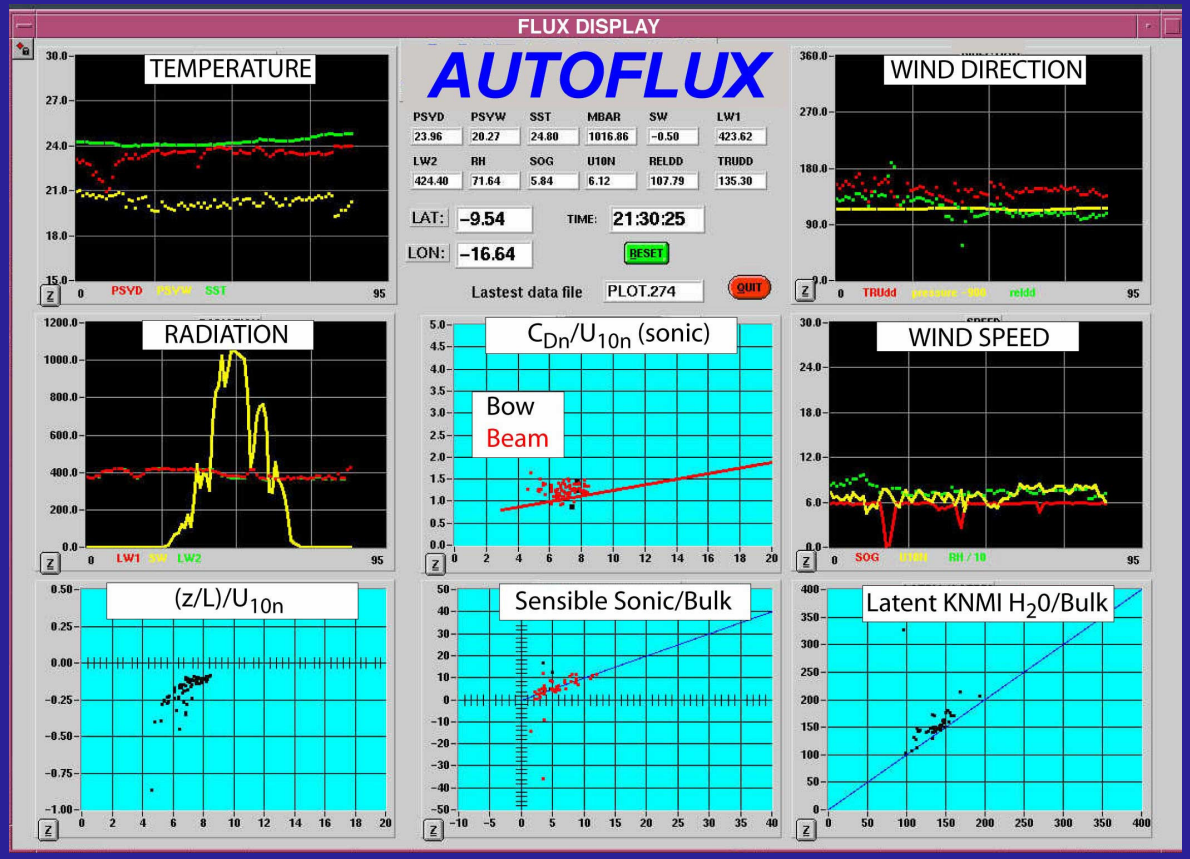
# "Direct" Flux Measurement - AutoFlux




**AutoFlux is a prototype system designed to use fast response sensors to estimate the air-sea fluxes as well as the mean meteorological variables.**

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# Summary - Methods of improving Merchant Ship Meteorological Observations

- Improved metadata and quality control - VOSClim
- Automated coding systems - TurboWin
- Automated observations - AVOS
- Better instrumentation - ASIMET, AutoFlux

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# Major Issue: Continuity of the Climate Record

- **The observing system is continually changing:**
  - Changes in ships: size, routes, manning
  - Different priorities: availability of satellite data, need for economies
  - Different observing techniques
- **New systems must overlap the older systems if the climate record is to be maintained**
- **Documentation of changes is vital**

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