



# Using metadata to understand VOS meteorological data

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Pictures from: <http://www.shipphotos.co.uk/>



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# Outline

- Introduction - what are metadata?
- What metadata are available?
- Why are metadata important?
- How we are using metadata
  - SST
  - Air Temperature
  - Wind Speed
- Conclusions



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# What are metadata?

- Metadata: "a set of data that describes and gives information about other data"
- We use metadata for information about:
  - Methods of measurement
  - Heights and locations of observations
  - Type of observing platform
  - Size and type of ship



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# What sources do we have?

- Metadata within datasets such as I-COADS
  - Methods of measurement, wind speed and SST
  - Platform types, data sources
- WMO "International List of Selected, Supplementary and Auxiliary Ships"
  - Measurement methods
  - Heights of observation
- Lloyds List
  - Ship type, length, draft etc.
- National and international instructions to observers



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# Why are metadata important?

- We have differences between observations which depend on which methods were used to make them
- Some observations need to be corrected for height (e.g. air temperatures and wind speeds)
- Observation heights and methods can change systematically over time and effects need to be removed from the climate record
- We can only account for these effects if we have metadata



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# Using metadata with I-COADS

- SST
  - Random errors
  - Buckets and engine intakes
- Air Temperature
  - Observation heights
  - Solar radiation errors
- Wind Speed
  - Observation heights

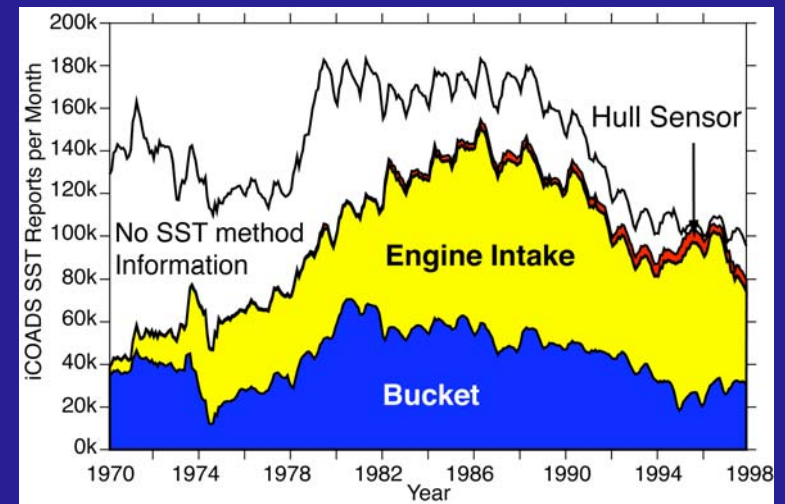
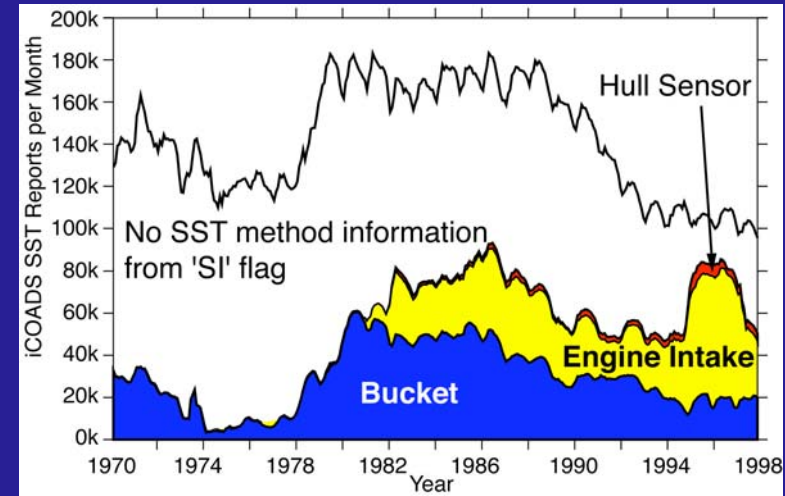


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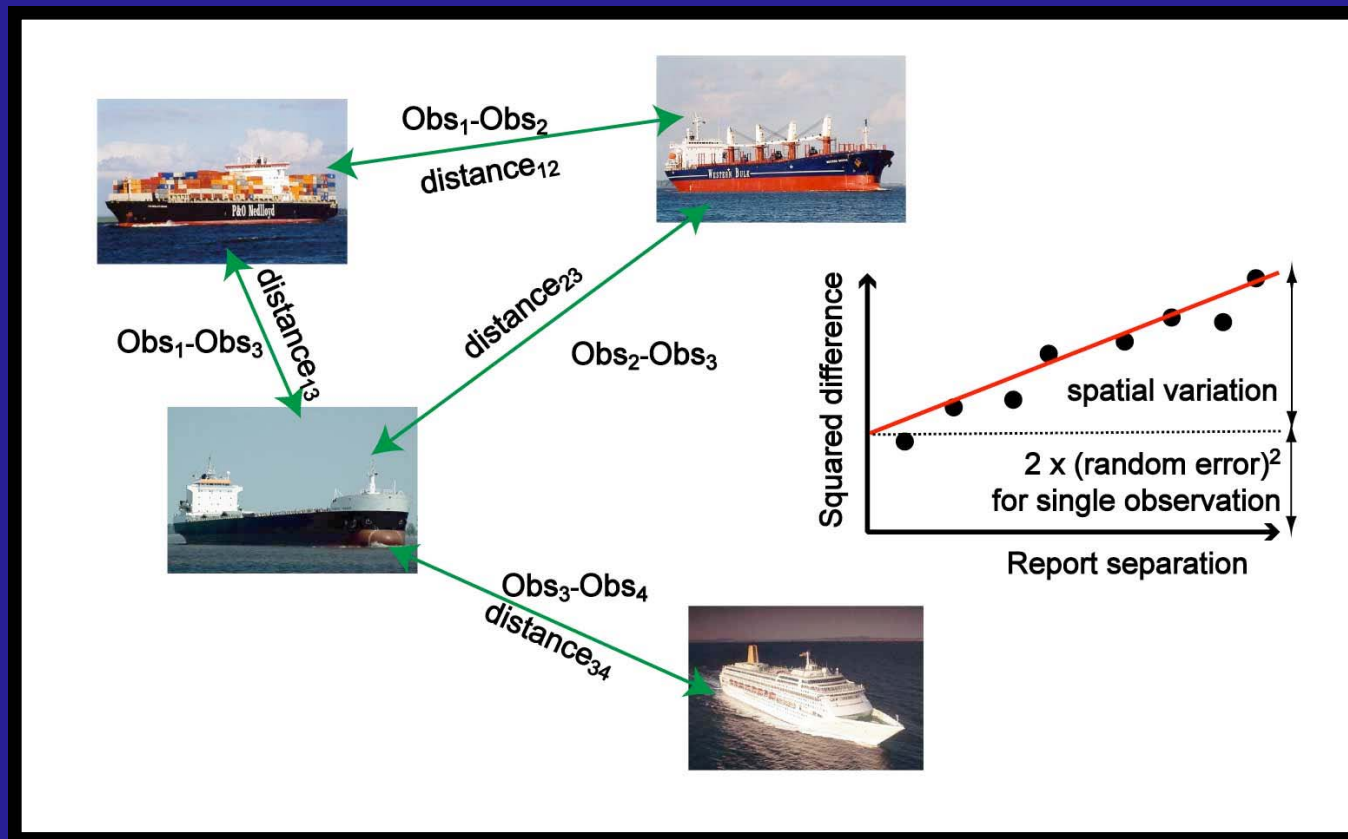
# SST metadata

- SST metadata on method of measurement is contained within I-COADS.
- However if we combine this with information from WMO Publication No. 47 we can make comparisons back to the early 1970s.
- Metadata are available from 1973 to 1999, presently I-COADS covers the period up to 1997.



# SST Random Errors

We can calculate random errors in I-COADS variables using the semivariogram method (see poster P-I-6).



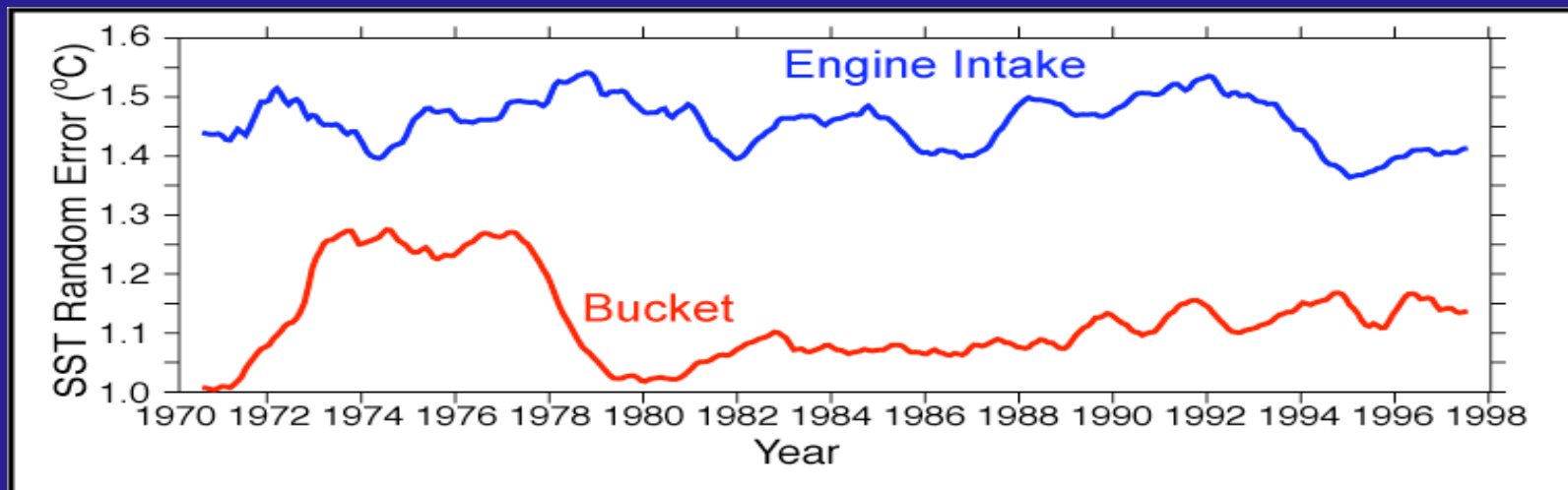
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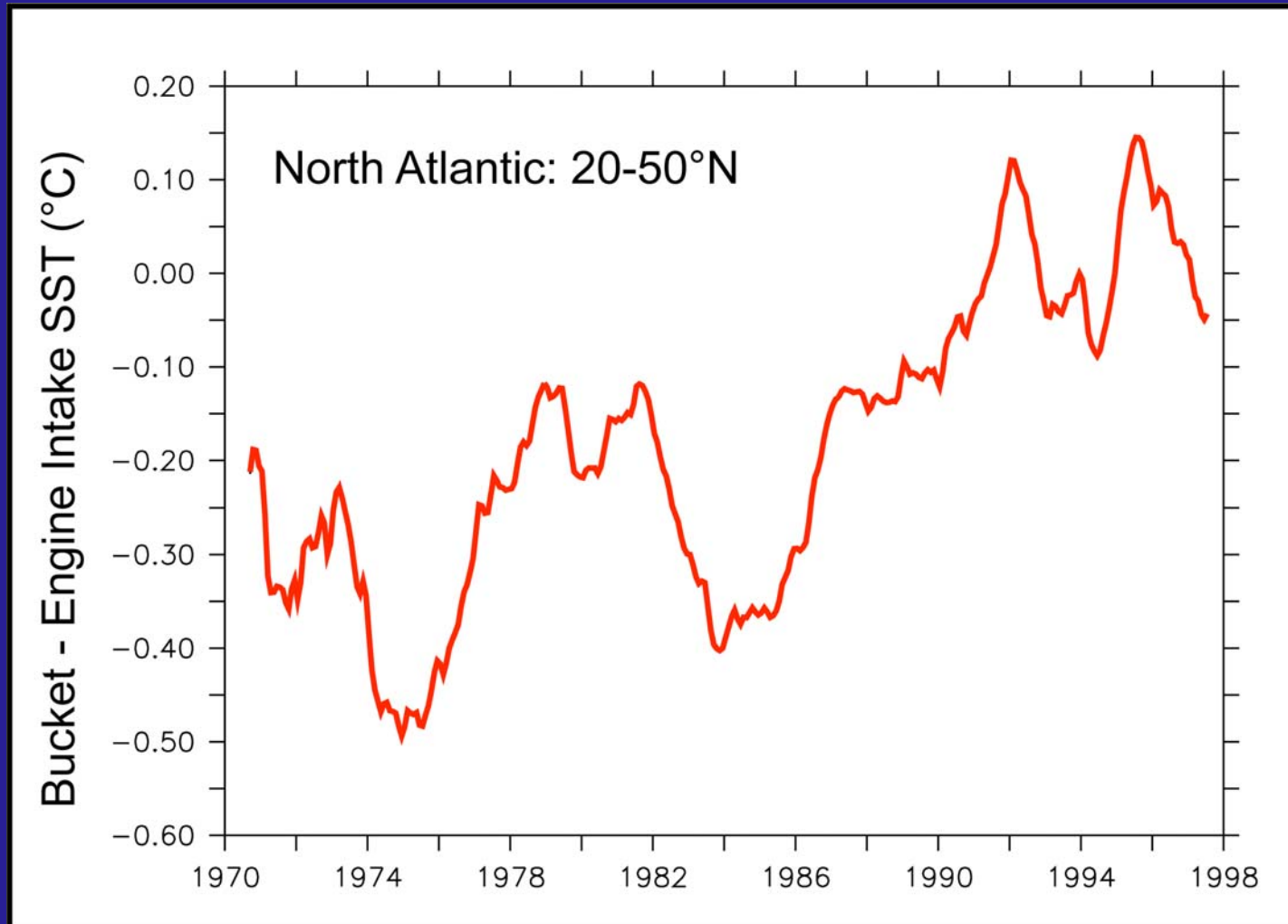


# SST Random Observation Errors

- SST random errors vary with location  
(see poster)
- .... and with time and method of measurement



Difference between bucket-only and engine intake-only SST climatologies. Differences are calculated monthly and smoothed with a 12-point filter.



# Model for SST Errors (see P-III-6)

- Assume:

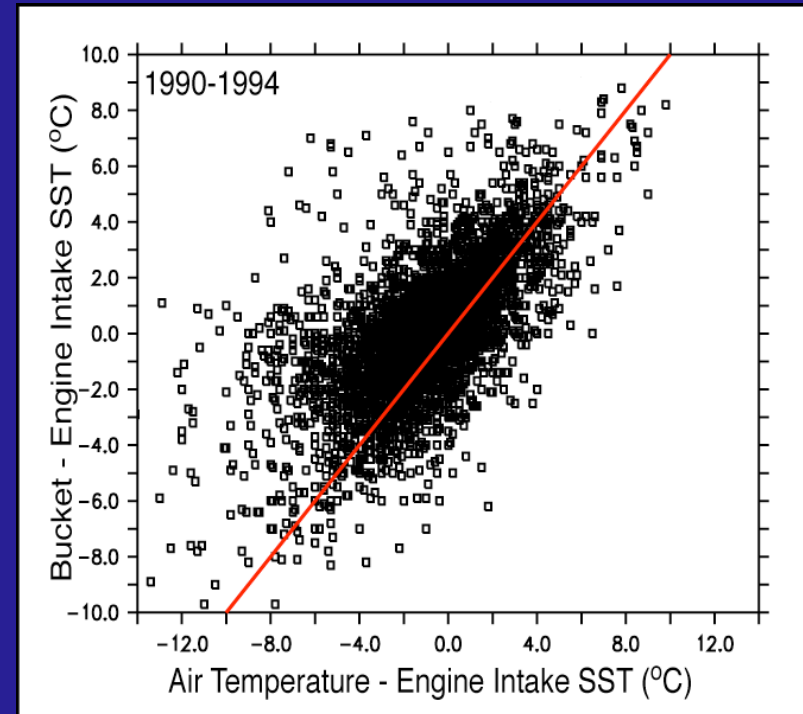
- the buckets lose heat
- the engine intakes are biased
- we can approximate the cooling using the air-sea temperature difference

- Use:

- Night-time data
- Moderate wind speeds
- 5-year periods of data

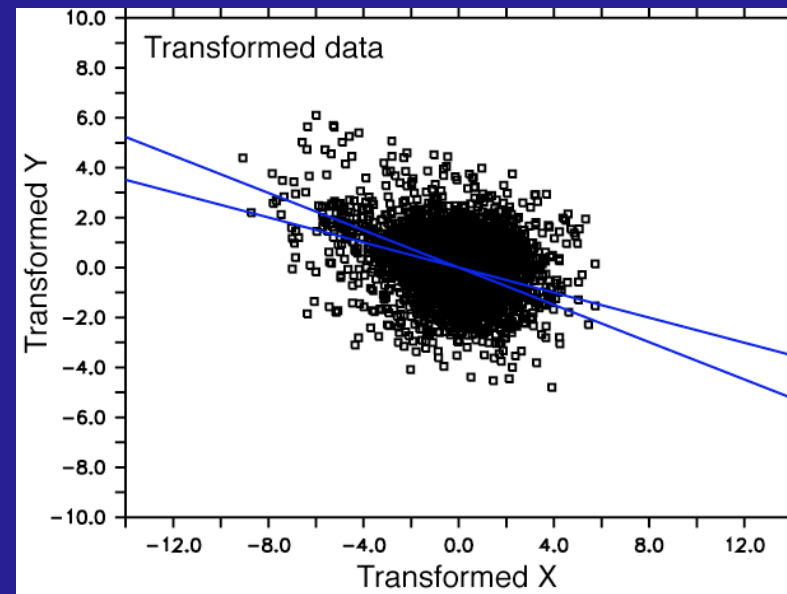
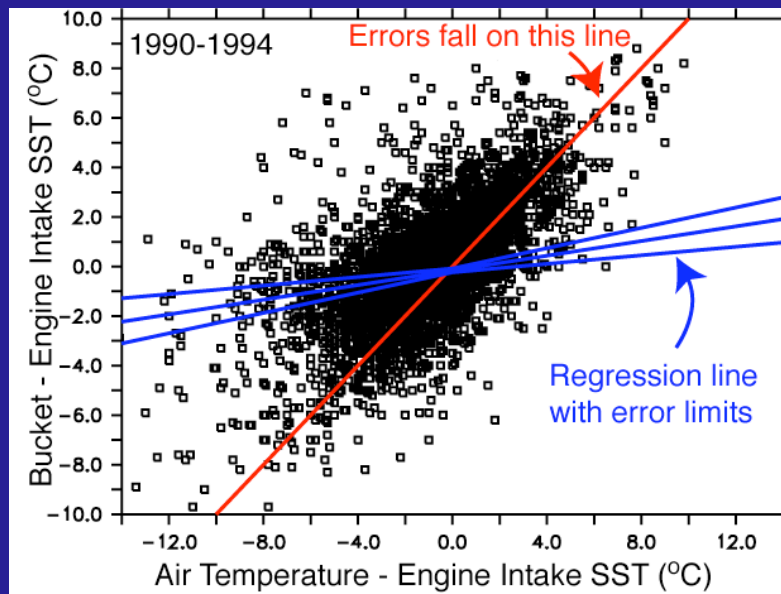
## Model:

$$SST_{bu} - SST_{eri} = \alpha ( T_{air} - SST_{eri} ) + \beta$$



# SST Bias Model (cont, P-III-6)

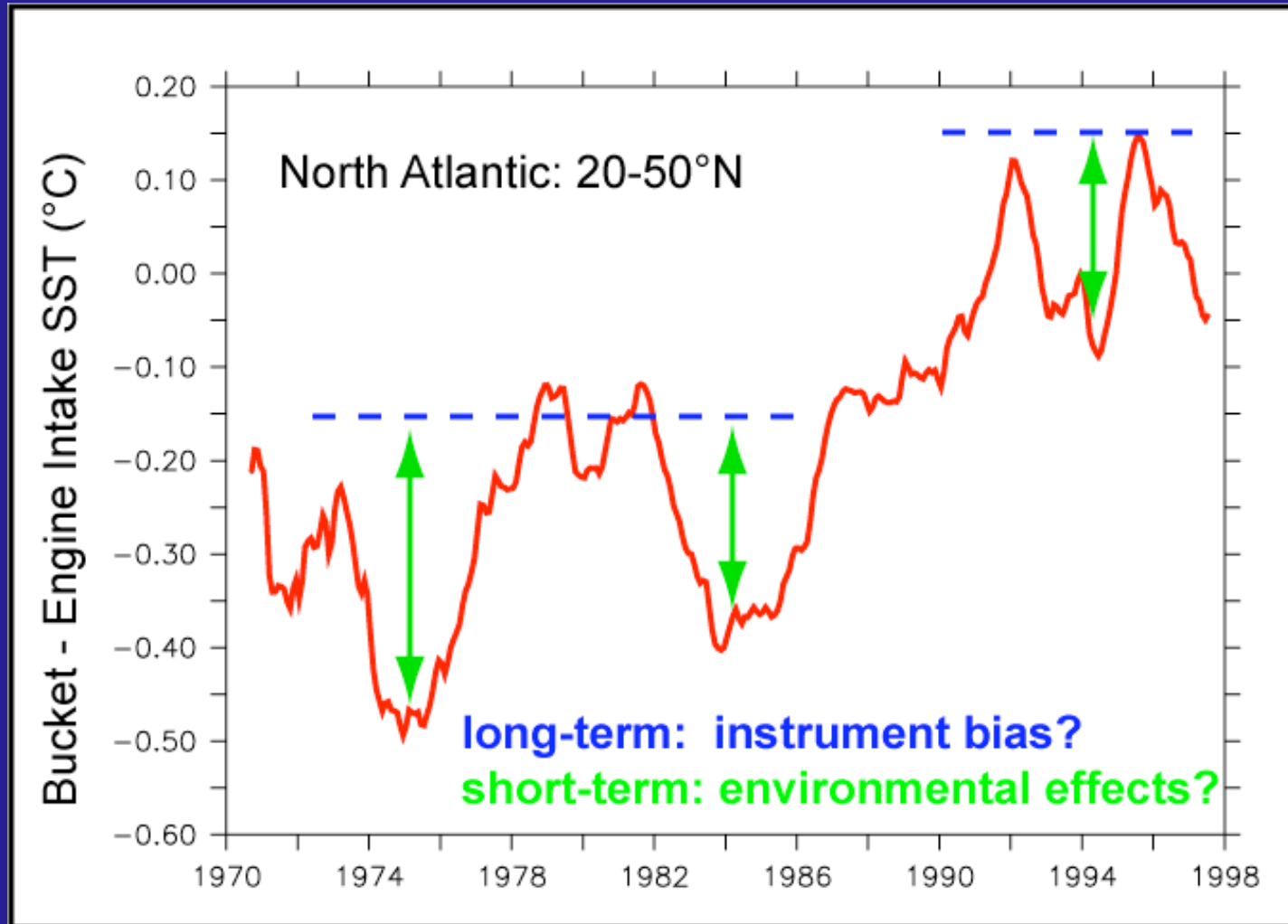
- We can transform the data into a co-ordinate system where the errors in each side of the equation are equal and uncorrelated
- We then perform an orthogonal linear regression
- ... and transform the data back into 'real-space'



# SST Bias: Results

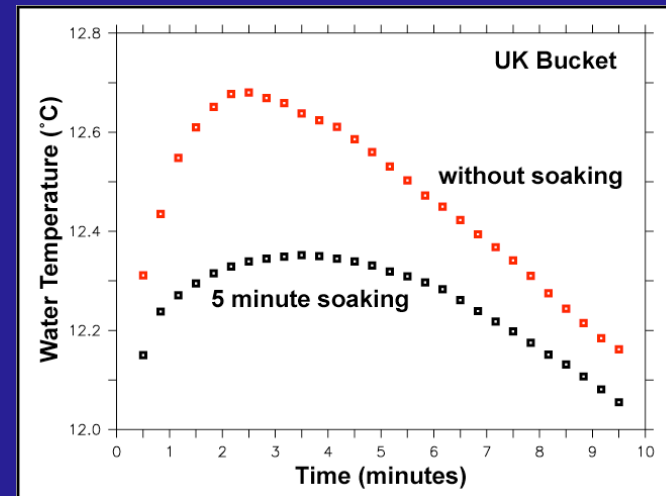
- Buckets lose heat, about 10-15% of the air-sea temperature difference
- Engine intake SST was biased warm in the past (but less than suggested in previous studies) but more recent observations are biased slightly cold
- The model is very simple and we have only analysed night-time data - more work is needed to confirm these results

# Bucket - Engine Intake SST



# Do insulated buckets lose heat?

- We have measured the heat loss from buckets on a pontoon
- Buckets supplied by different countries have different characteristics (German bucket shown)
- The plot shows the effects of heat loss on the water in the bucket, not soaking the bucket to equilibrium and, we think, the initial equilibration of the water and probe temperatures
- More work is needed to relate the heat loss to the heat fluxes



# SST summary

- There are significant and time-varying differences between bucket and engine intake SST.
- We need to understand and account for these differences in climate change studies.
- External sources of metadata are required, especially before 1982.
- We need more information about observing practice.



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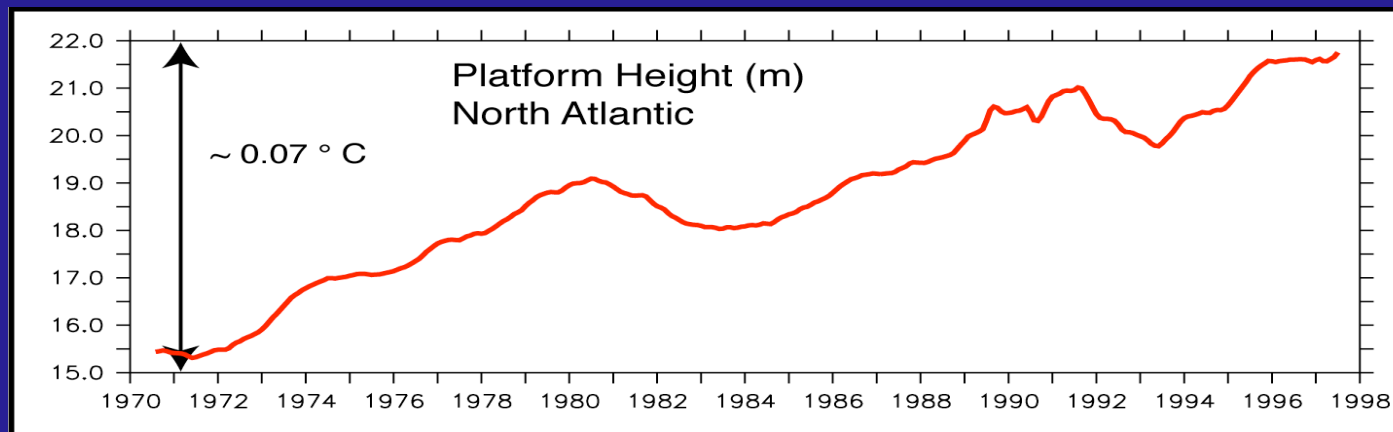
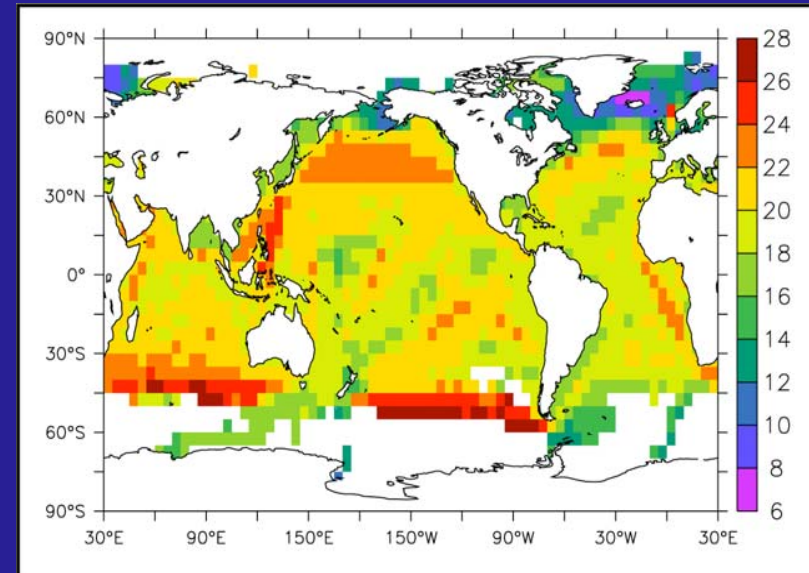
# Air Temperature

- Measurement Height
  - Metadata from WMO Pub. 47  
(also have instrument type information)
- Instrument Exposure
  - Metadata only from special projects  
(e.g. VSOP-NA, VOSCLim)
  - Metadata proxies?

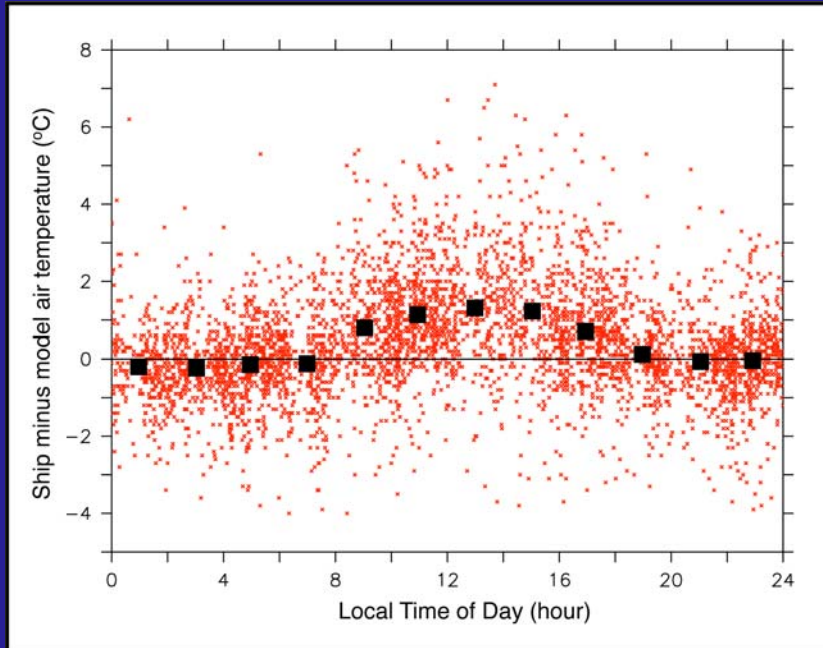


# Air Temperature Measurement Heights

- We can get an estimate of the air temperature measurement height by combining WMO Pub No. 47 with I-COADS.
- The map shows the  $2^\circ \times 2^\circ$  average measurement height for the period 1970 - 1997.
- The heights vary with space (right) and time (below).



# VOSClm: Air Temperature

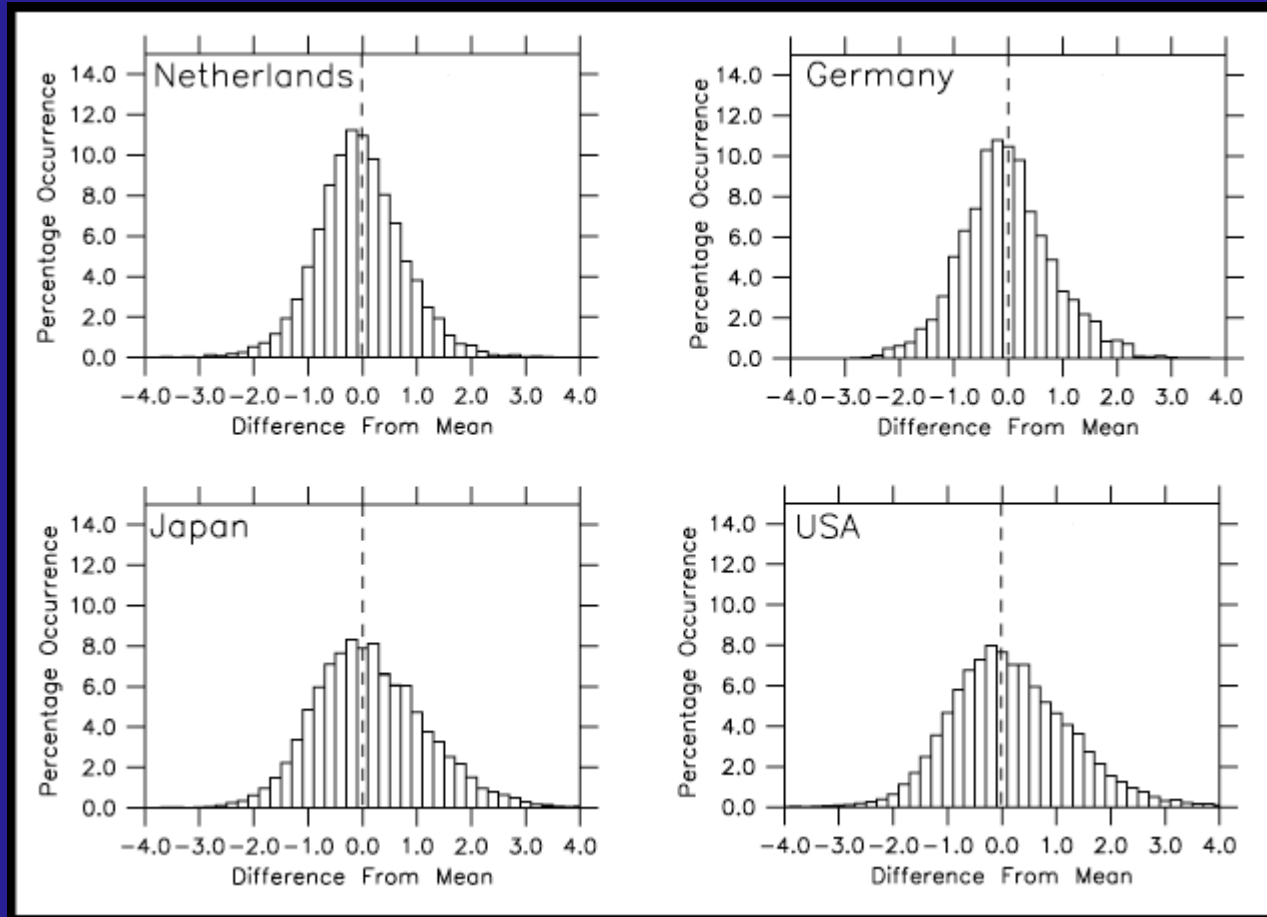


- Strong diurnal cycle in Tropical ship-model differences from the VOSClm dataset of selected VOS data merged with output of the Met Office Forecast model (more information from <http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclim.html>).
- The effects of solar heating depend on instrument exposure, VOSClm metadata contains photos of instrument location which will help our analysis.



# Metadata proxies: Recruiting Country

July 1980-1997 Normalised Air Temperature Deviations from Local Mean



Air temperature observations from the Netherlands and Germany have smaller standard deviations than those from US or Japanese ships. The US and Japanese distributions also have longer warm tails suggesting poorer exposure.

We may therefore be able to use recruiting country to give a rough idea of likely instrument exposure.

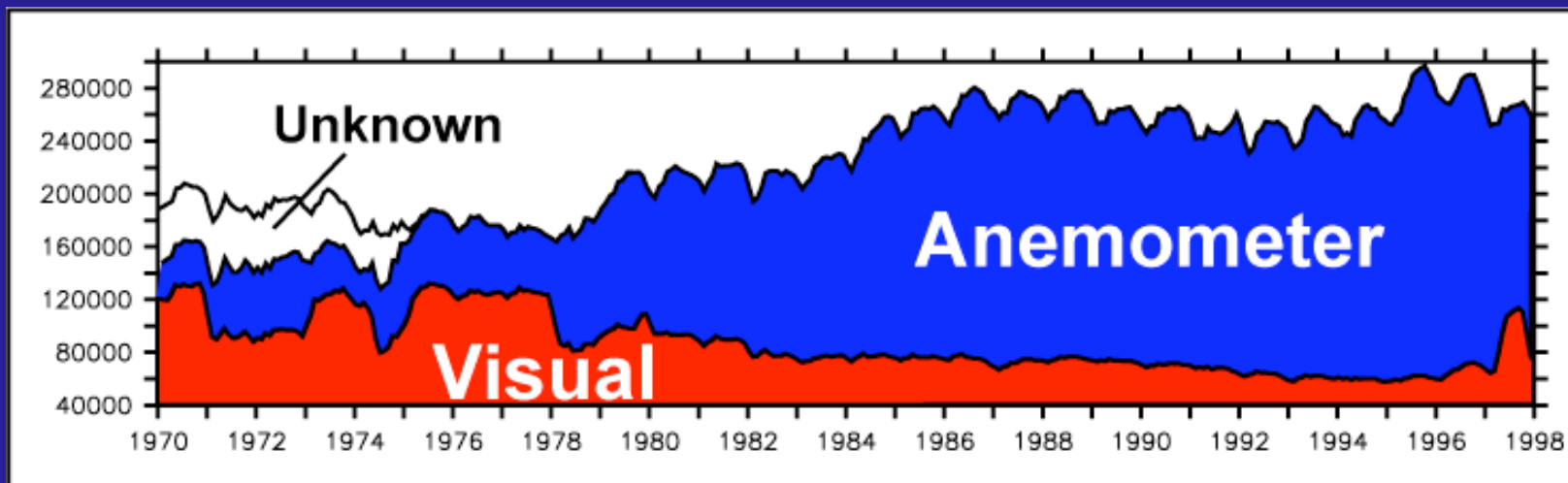


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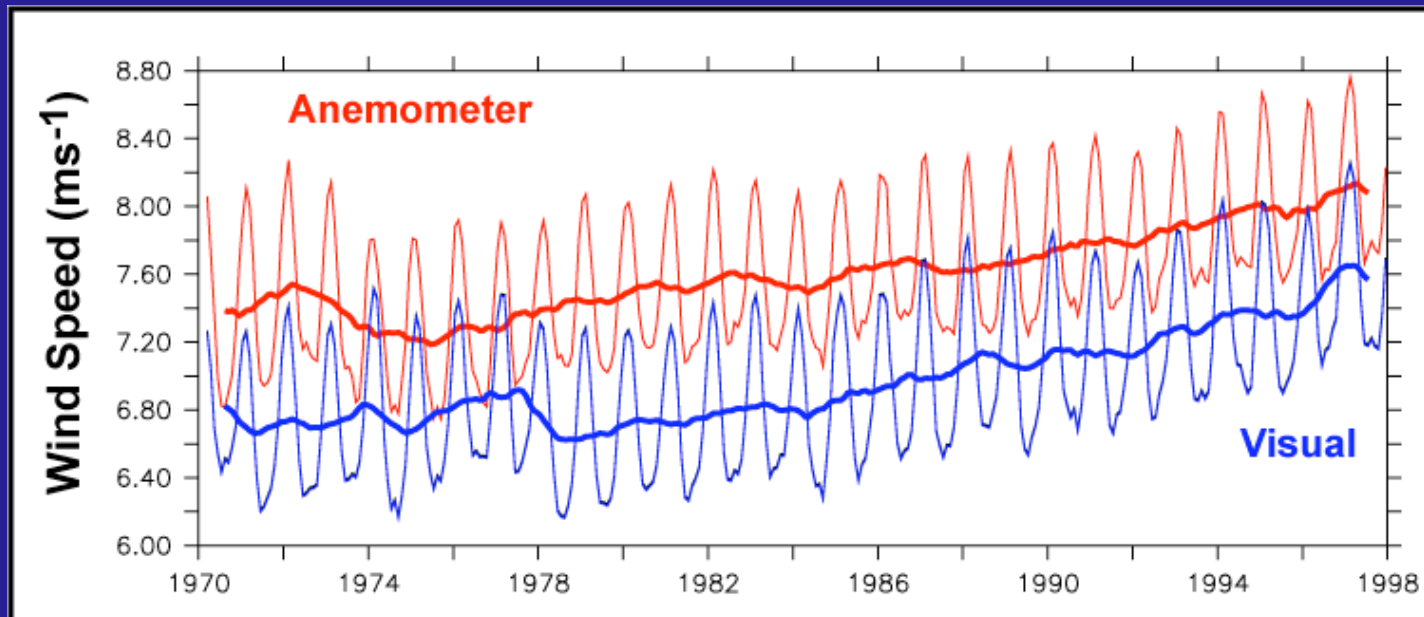
# Wind Speeds

- Need to know whether observations are visual or anemometer (from I-COADS "WI" flag)
- More and more wind speeds are being measured using anemometers rather than visually estimated from sea state
- This could lead to changing biases - and mean that air flow distortion effects become even more important



# Wind Speeds

- For anemometer winds we need to know the measurement height (from Pub. 47)
- Wind measurement heights show similar trends and spatial patterns to the air temperature heights
- Are the trends we see in wind speed real?



# Summary

- Metadata are needed to identify biases in VOS data
- WMO Publication 47 metadata:
  - must be promptly made available to climate scientists (and to the operational community)
  - archives (1954 to 1972) will soon be digitised by US
- Changes in practice and instrumentation must be documented and identifiable
- Current and historical observation practice documentation is part of the metadata and needs to be archived
- VOSCLim shows the importance of detailed metadata for selected ships





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