Assessment of the Marine Observing System (ASMOS)

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ASMOS: Motivation

- Monitoring of the observing system is essential
- Monitoring must meet a range of user requirements
- Regular assessments are required so information can be fed back operators

How do we Monitor Marine Meteorological Observations?

- Need user requirements
  - e.g. Global uncertainty in surface mean temperature
  - or Grid-box accuracies
  - Bias/random error
  - Desirable/usable accuracy

User requirements

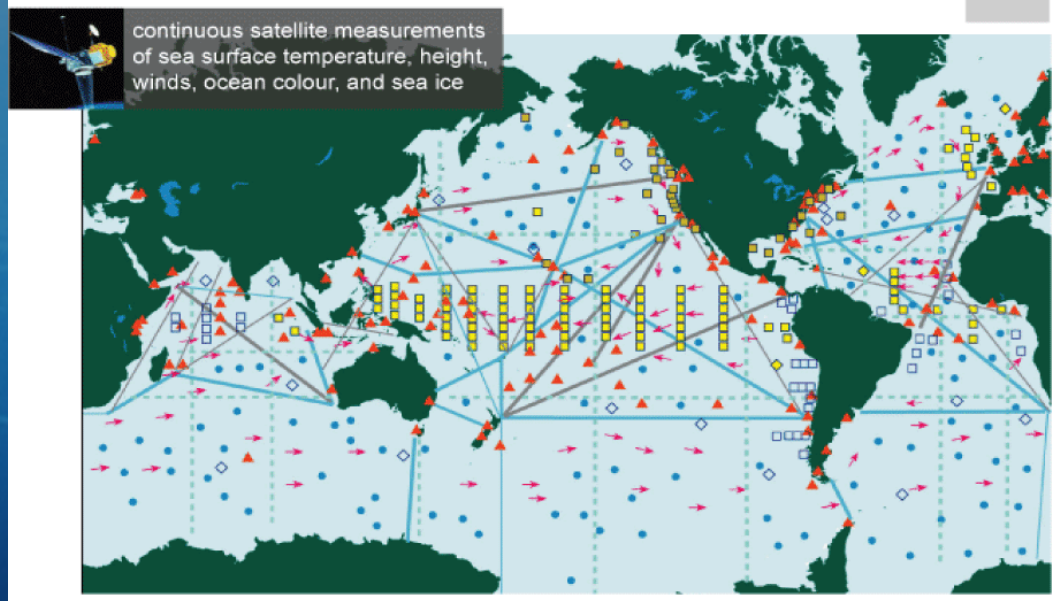
- Sources of information
  - GCOS Implementation Plan (2004)
  - OceanObs99
  - Ocean Observing System Development Panel (OOSDP) 1995
  - Database of user requirements from WMO (Space-based).

How can we monitor the observing system?

- By generating datasets with uncertainty estimates
- Using metrics
  - Observation counts
  - Platform counts

Initial Global Ocean Observing System for Climate

Status against the GCOS Implementation Plan and JCOMM targets



Surface measurements from volunteer ships (VOSclim)

200 ships in pilot project

Global drifting surace buoy array

5° resolution array: 1250 floats

Tide gauge network (GCOS subset of GLOSS core network)

170 real-time reporting tide gauges

XBT sub-surace temperature section network

51 lines occupied

Argo profiling float network

3° resolution array: 3000 floats

Repeat hydrography and carbon inventory

Full ocean survey in 10 years

Reference time series

58 sites

Global **reference mooring** network

29 moorings planned

Global tropical **moored buoy** network

119 moorings planned

GCOS

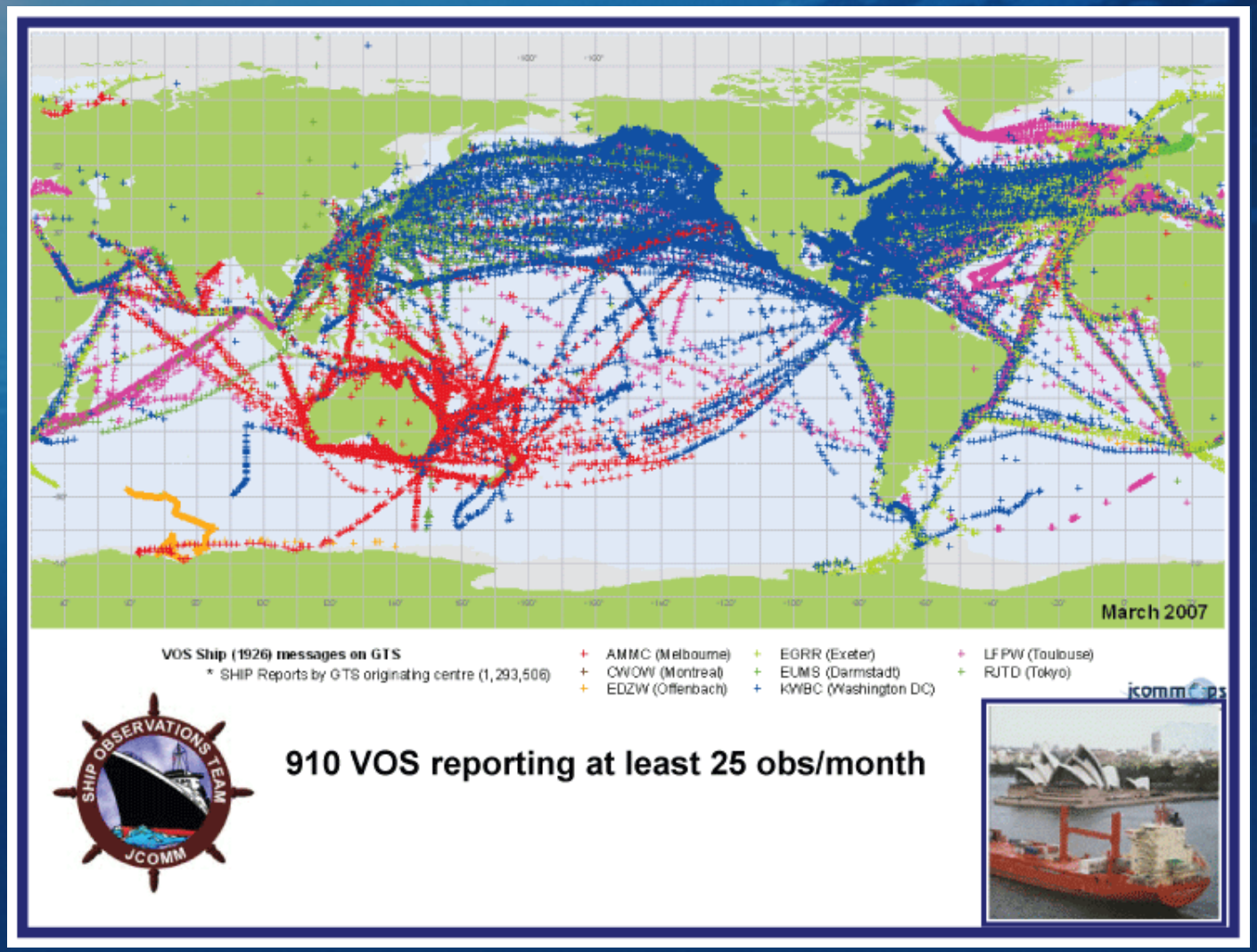
GOOS

jcomm

OCEANOGRAPHY & MARINE METEOROLOGY

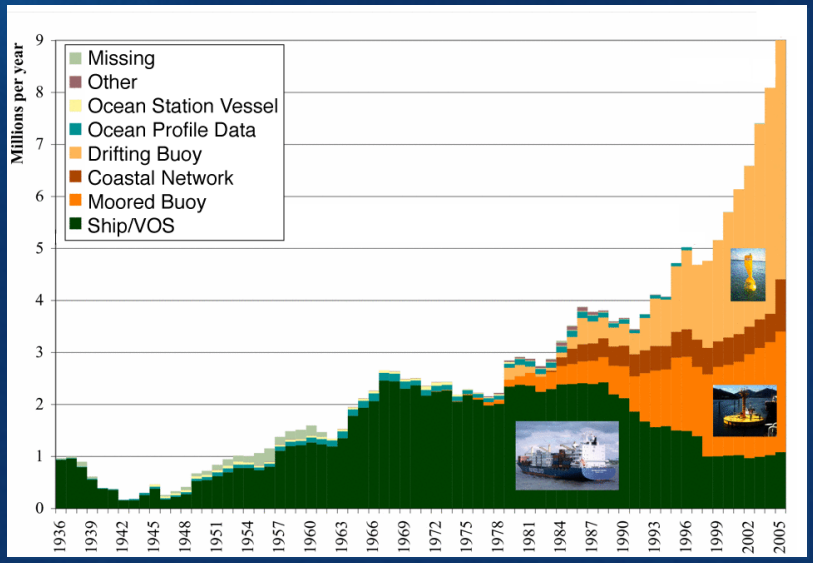
- A total of 5635 platforms are maintained globally.

Report to the 4th meeting of the JCOMM Ship Observations Team (April 2007)
by the Observations Programme Area Coordinator (Mike Johnson, NOAA)



How do we monitor the surface marine observing system?

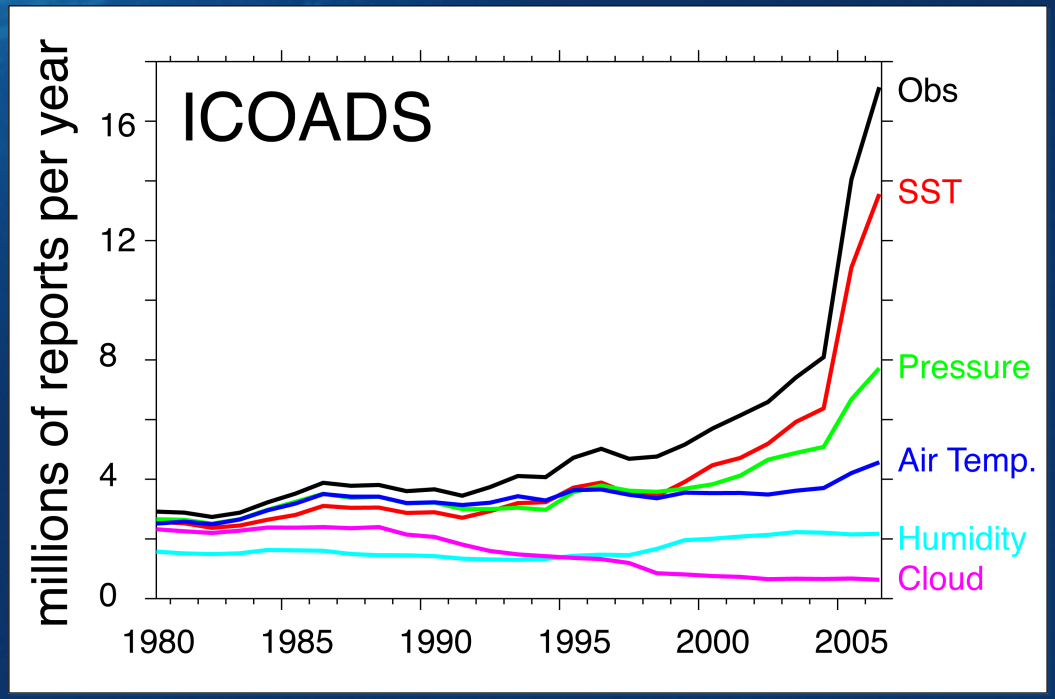
- Observation counts?



- Plot shows number of observations per year in ICOADS to 2005.

How do we monitor the surface marine observing system?

- Need separate counts for different variables.
- And for different platforms?



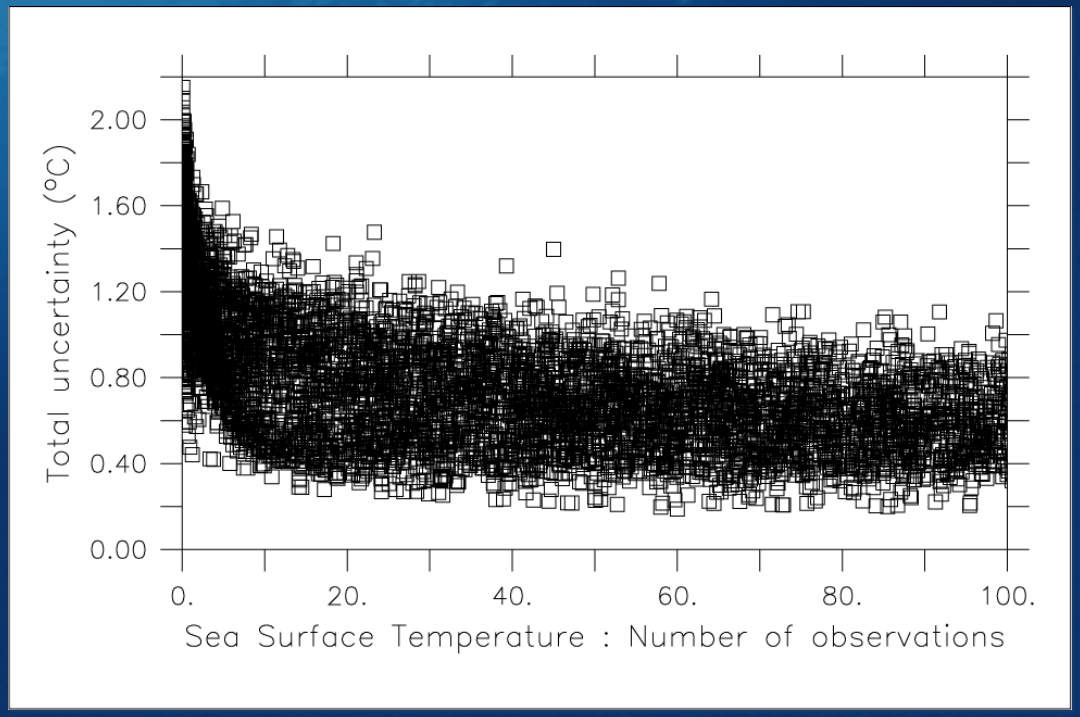
How do we monitor the observations?

- Need to account for:
  - Number of observations
  - Data quality
  - Distribution in space and time
  - Contribution from different platforms
  - Natural variability

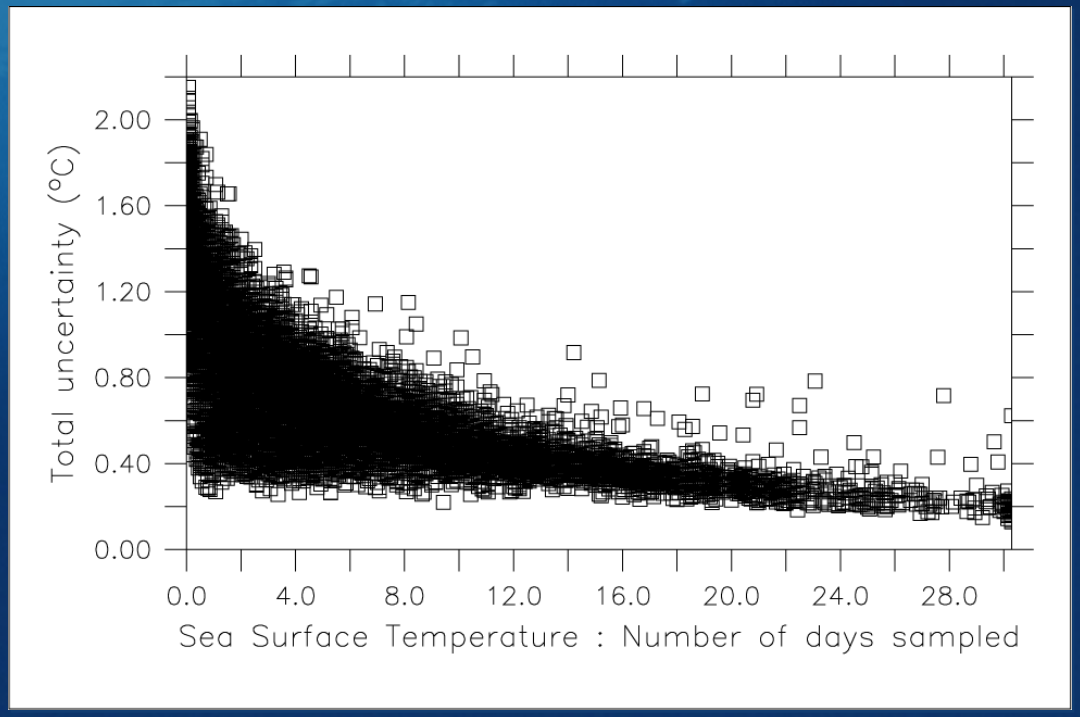
How do we monitor the observations?

- Can we relate uncertainty in a gridded dataset to simple metrics? e.g.
  - Number of observations
  - Number of days sampled
  - Number of different platforms

SST: Uncertainty against number of observations



SST: Uncertainty against number of days sampled



Incompletely sampled coherent datasets (David Parker, Journal of Climatology, 1984)

- For independent data factor is $\sqrt{n}$
- For correlated data need to consider:
  - autocorrelation of data
  - autocorrelation of sampling

n is the number of observations if fully sampled,
p is the probability of a sample being present (so n*p is the number of samples),
r_k is the autocorrelation of the data at lag k,
ρ_k is the autocorrelation at lag k of a timeseries which indicates the presence or absence of a sample ($\delta_1, \delta_2 \ldots \delta_n$; where for the jth term $\delta_j = 1$ if data is present and $\delta_j = 0$ if data is absent).

$$\frac{1}{n'} = \frac{1}{np}\left\{1 + \frac{2}{n}\left[\sum_{k=1}^{n-1}(n-k)\left(r_k\rho_k(1-p) + r_k p\right)\right]\right\}$$

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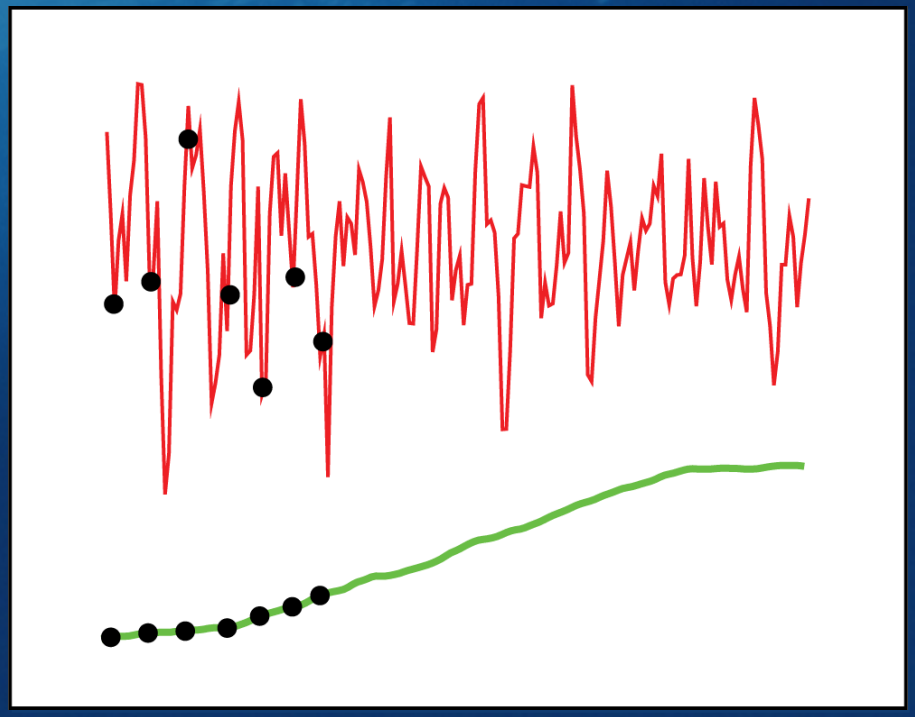
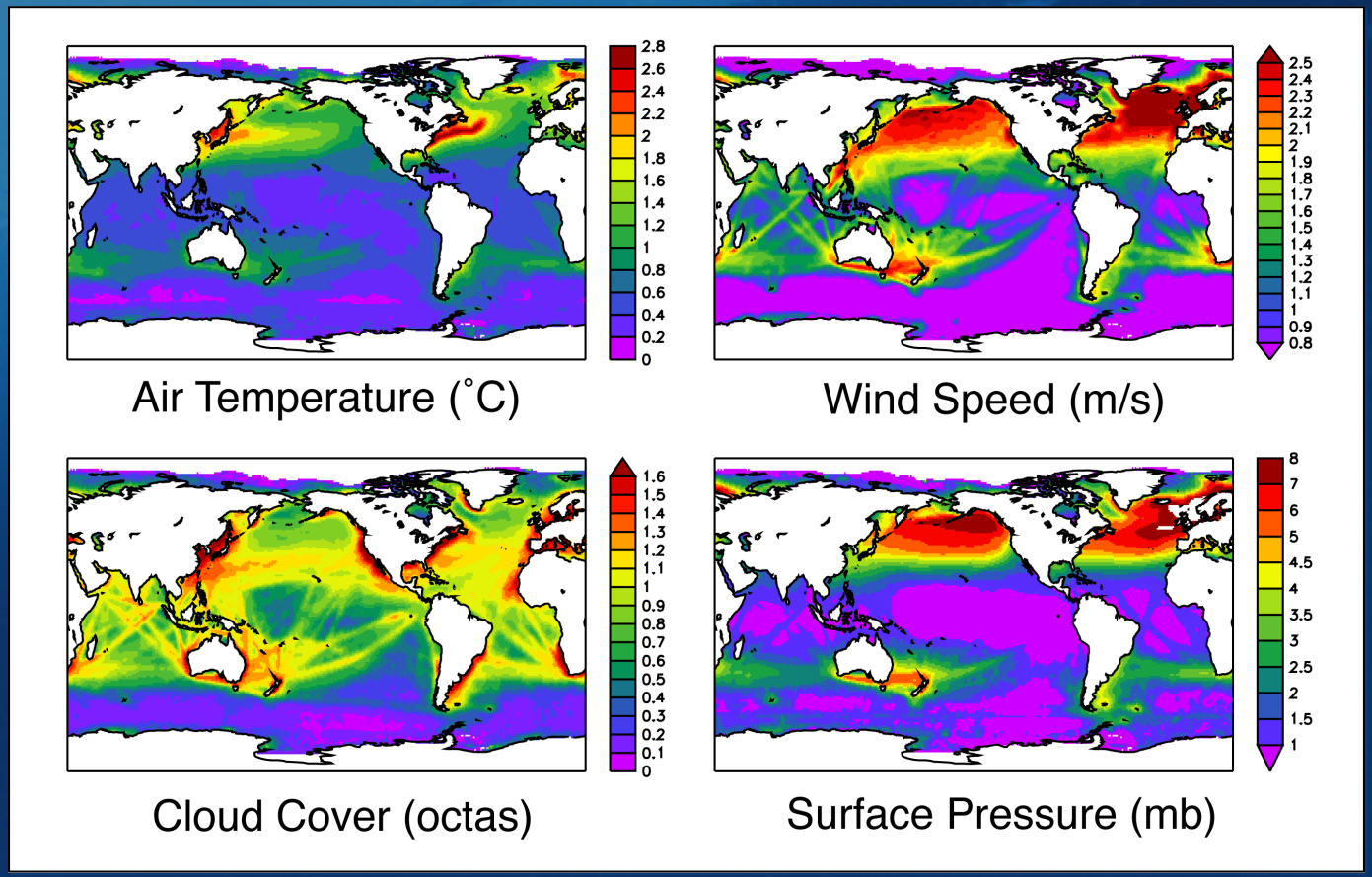
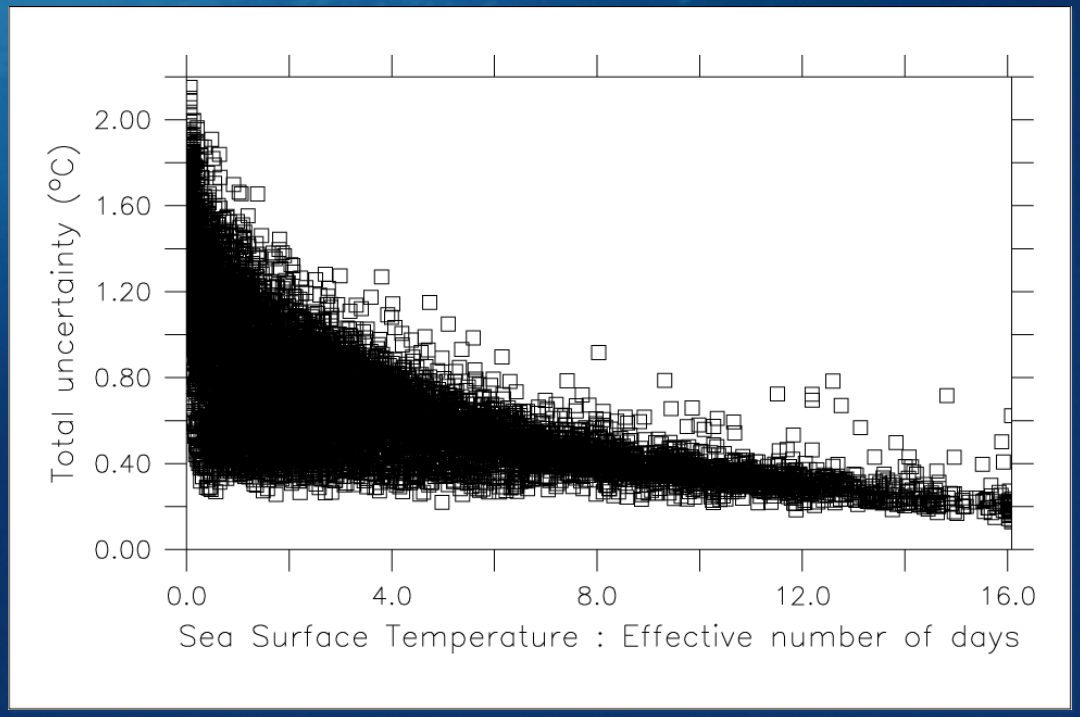
Example: incomplete sampling: effect on uncertainty



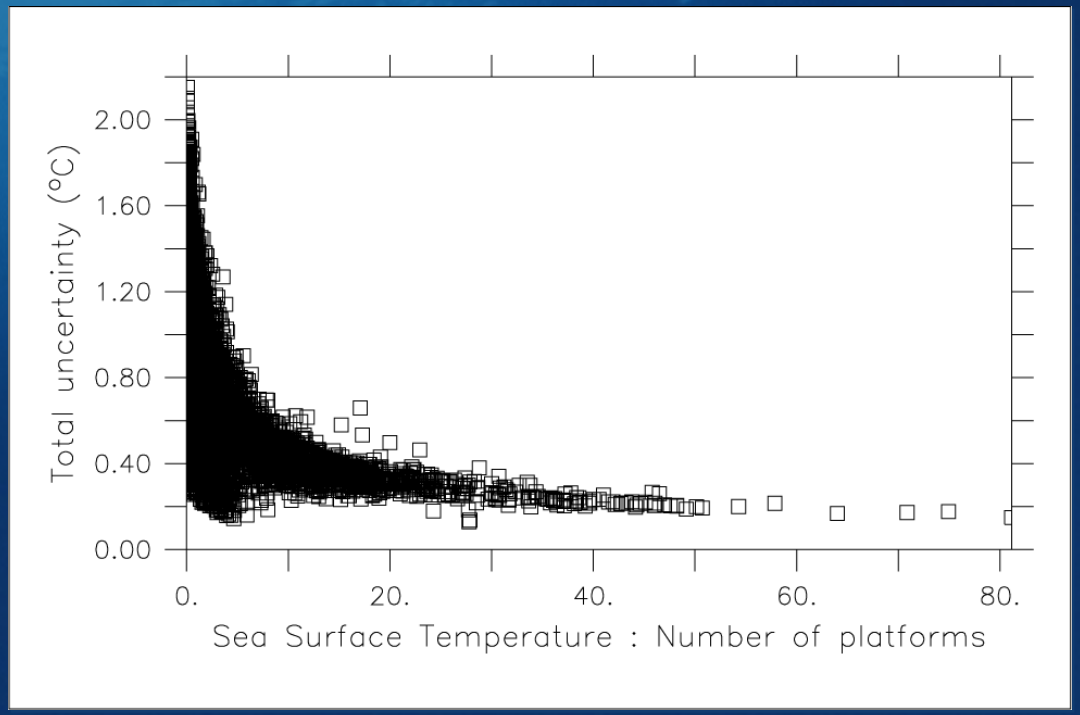
Within month variability



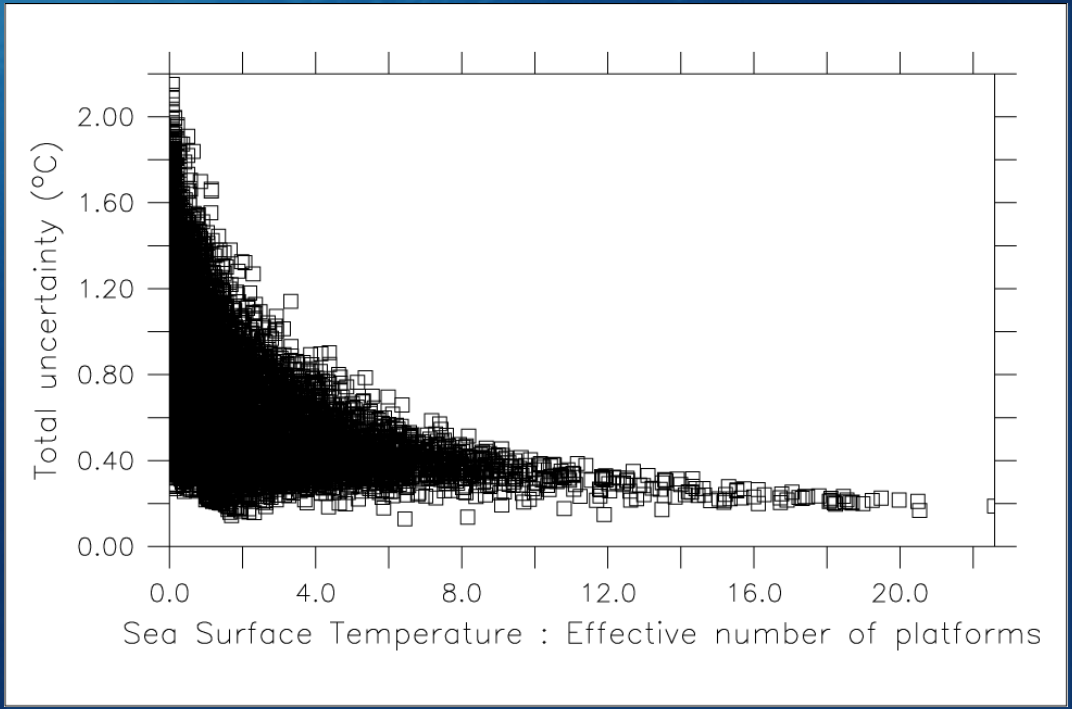
SST: Uncertainty against "effective" number of days sampled



SST: Uncertainty against number of platforms



SST: Uncertainty against "effective" number of platforms



Why do we need to know about individual platforms?

- Define:
  - Intra-platform uncertainty
    - uncertainty intrinsic to a measurement method
    - excludes a bias for an individual platform (e.g. calibration error)
  - Inter-platform uncertainty
    - bias between means from different platforms (e.g. including calibration error)

Why do we need to know about individual platforms?

- To calculate an accurate grid-box mean:
  - Need many observations from many different platforms
- OR
  - Many observations from a small number (single?) very accurate platform.

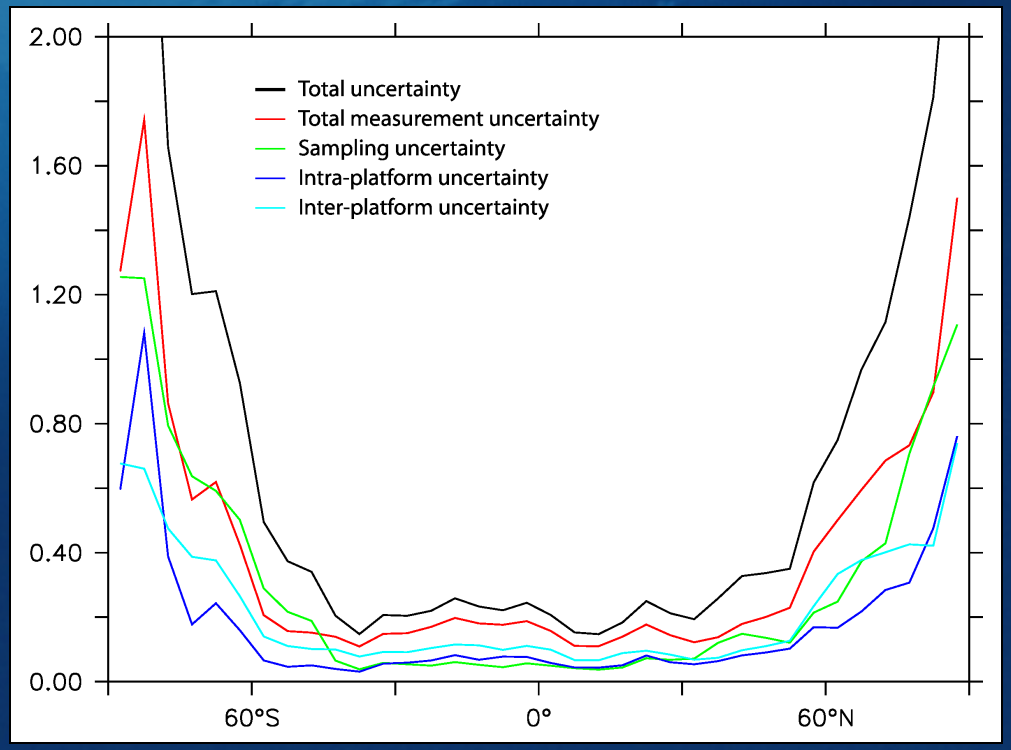
Why do we need to know about individual platforms?

Platform	SST Intra-platform Uncertainty (˚C)	SST Inter-platform Uncertainty (˚C)
Ships	0.7	0.8
Moored Buoy	0.3	0.2
Drifting Buoy	0.6	0.3

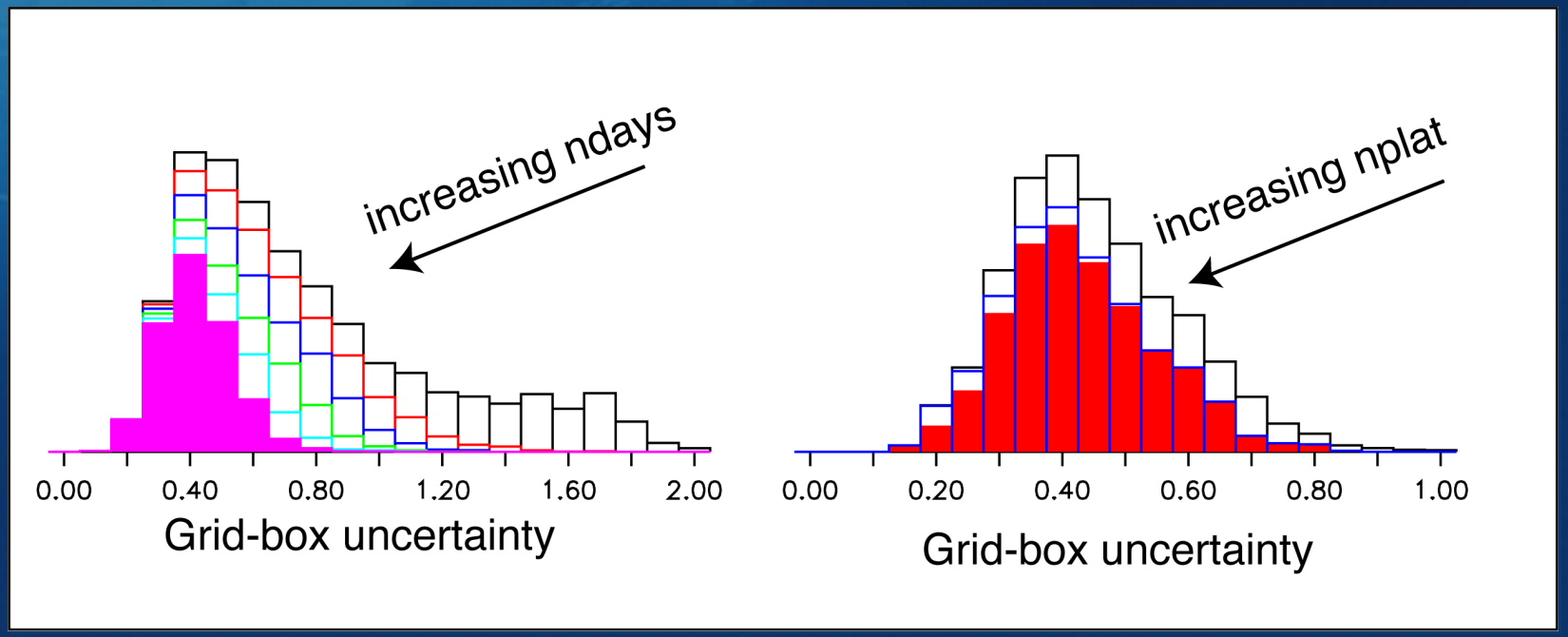
Total grid-box uncertainty depends on:

- Temporal sampling of natural variability
  - to adequately measure conditions
- Number of observations
  - reduces random intra-platform uncertainty
- Number of platforms
  - to average out inter-platform biases

How do the different components contribute to the total? (e.g. SST)



What should the metrics be?

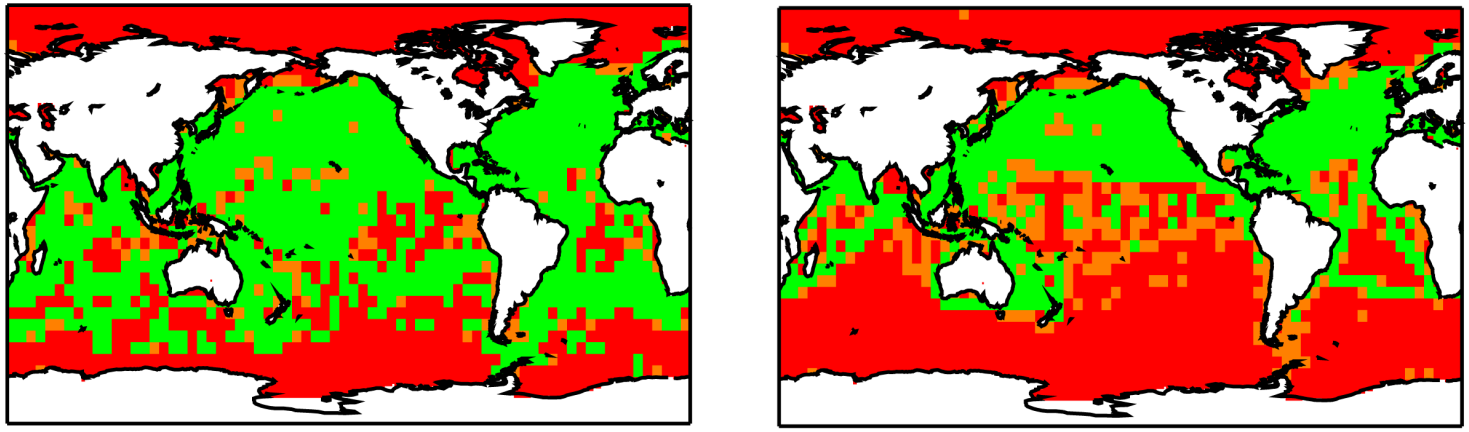


What should the metrics be? (very preliminary results)

Variable	Number of days sampled (per month)	Number of platforms	Number of moored buoys	Number of drifting buoys	Indicative gridbox uncertainty (1˚ - 10˚)
SST	≥ 4-6	≥ 4	or ≥ 1	or ≥ 2	0.4 - 0.2 ˚C
Air temperature	≥ 4-6	≥ 4	or ≥ 1		0.4 - 0.3 ˚C
Surface pressure	≥ 4-6	≥ 4	or ≥ 1	or ≥ 2	0.5 - 0.4 mb
Cloud cover	≥ 4-6	≥ 4			0.4 - 0.2 octas
Wind speed	≥ 4-6	≥ 4	or ≥ 1		0.7 - 0.5 ms^{-1}
Dewpoint	≥ 4-6	≥ 4			0.5 - 0.3 ˚C

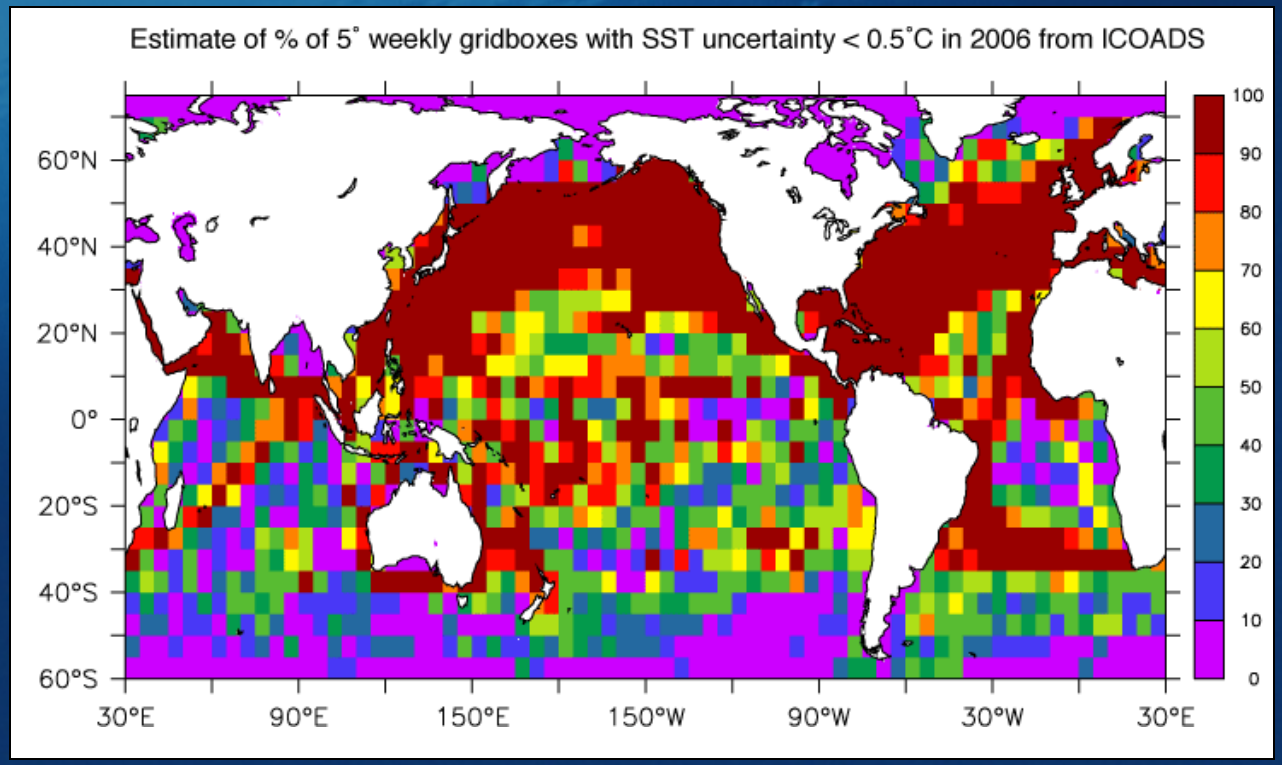
Sample observing system assessment

SST February 2007 Air Temperature



Green: uncertainty < 0.4˚C; Orange: meets sampling metrics

Another view: weekly uncertainty



Other things to consider

- Sampling of diurnal cycle
- Near-neighbours for "buddy-check" QC
- Other space and time scales
- High consistency over time

Conclusions

- Every user requirement requires a separate adequacy assessment
- Simple metrics can give a good indication of observing system health
- Observations from multiple platforms highly desirable
- Lack of observations means adequacy can be hard to assess
- User requirements require revisiting
- Monitoring should start as soon as possible