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Creating a Consistent Time Series of Global Sea-Surface Temperature using *in situ* and Satellite Data Sources

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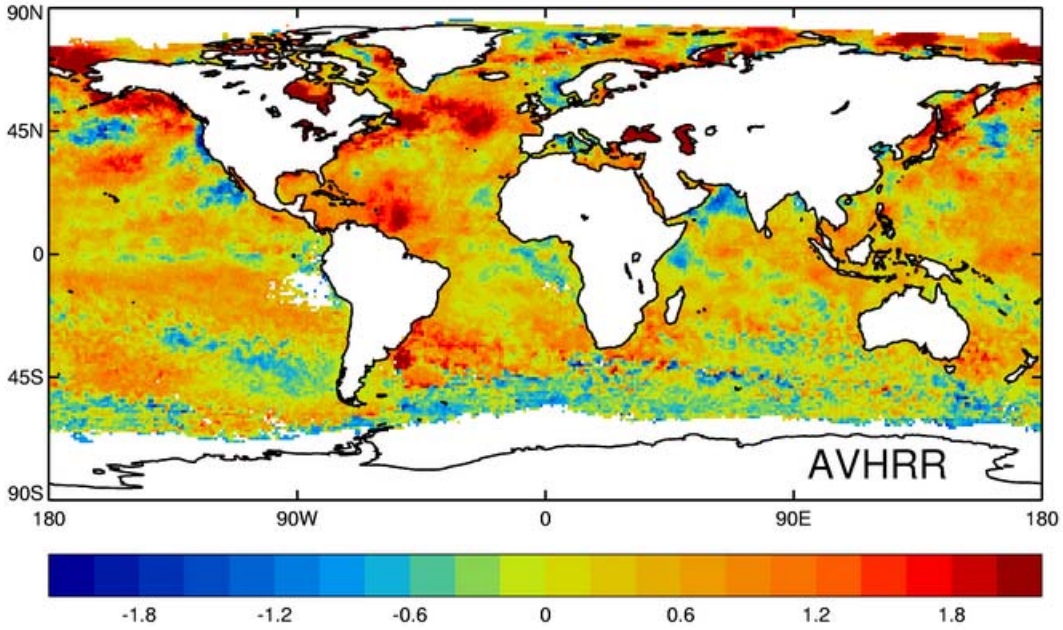
- We want to draw on the strengths of both satellite and *in situ* sources
- Aim to create an SST record that is
  - Long: 1850-present (in situ)
  - High temporal and spatial resolution (satellite)
  - High accuracy (ATSR)
  - High coverage (AVHRR)
  - Homogeneous, free from data biases and other artefacts
  - Uncertainties quantified (and preferably small)
- Also want the system to be flexible so that we can include other data sources at a future date

Data sources

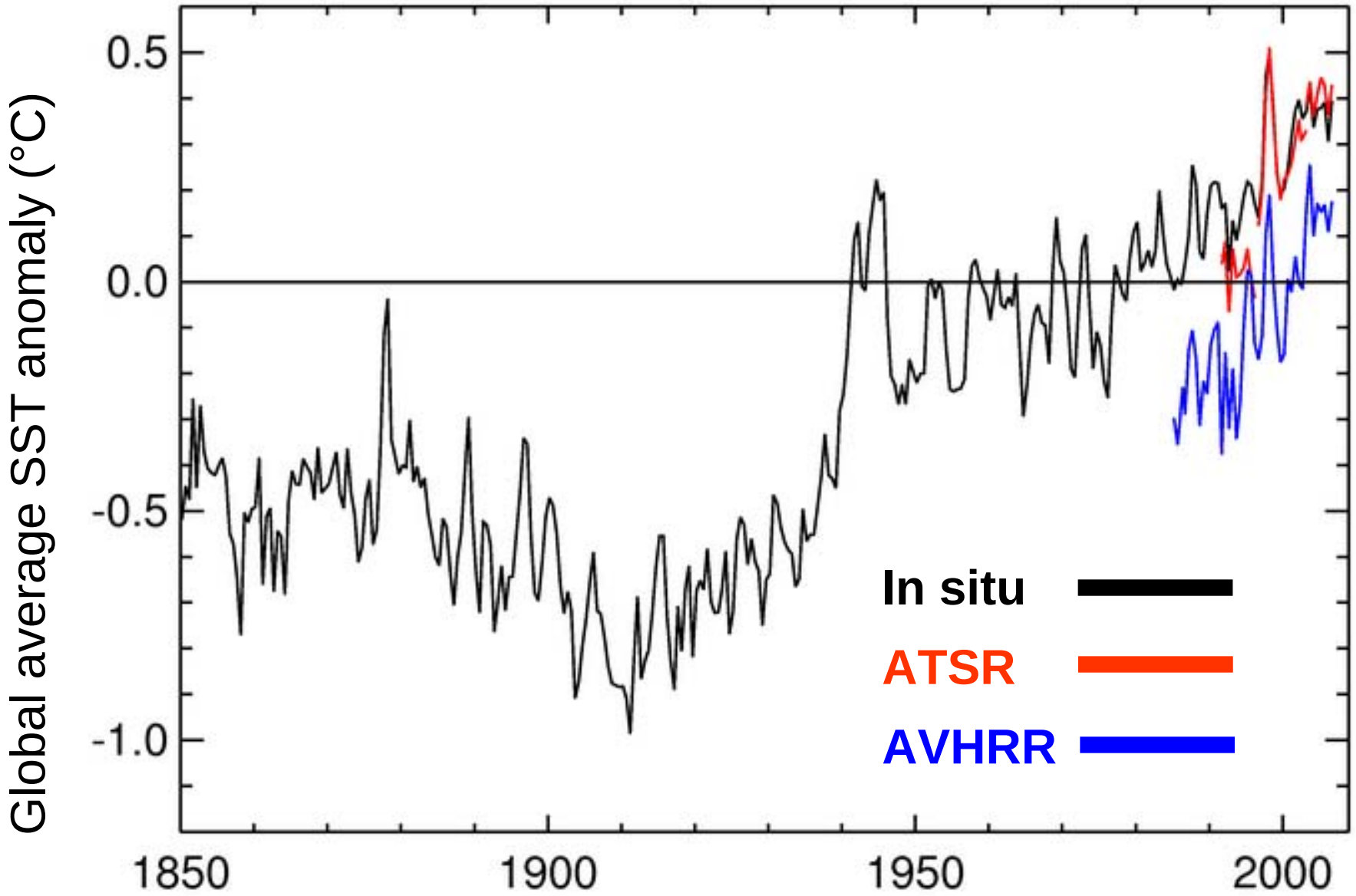
- In situ data HadSST3
  - Ships
  - Drifting Buoys
  - Moorings
- (A)ATSR – (Advanced) Along Track Scanning Radiometer
- AVHRR – (Advanced Very High Resolution Radiometer)



Grid data in a consistent fashion

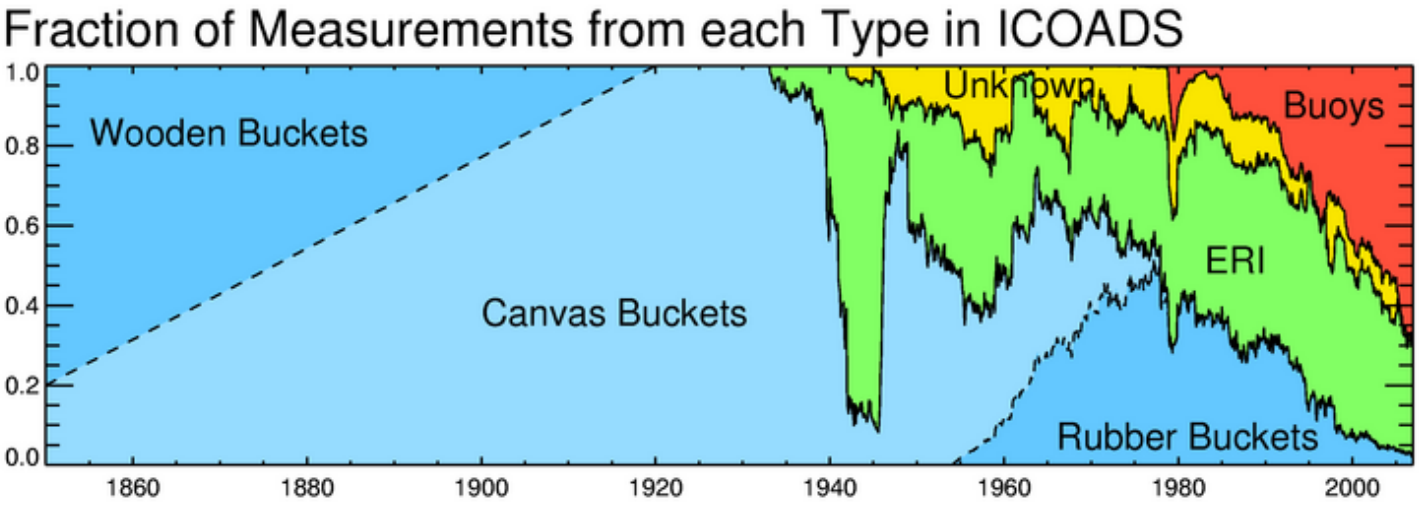
- 0.25° latitude x 0.25° longitude daily climatology
- Based on Daily OI adjusted to 1961-1990
- SSTs turned to anomalies
- Use robust averaging to reduced sensitivity to outliers.

Raw gridded data

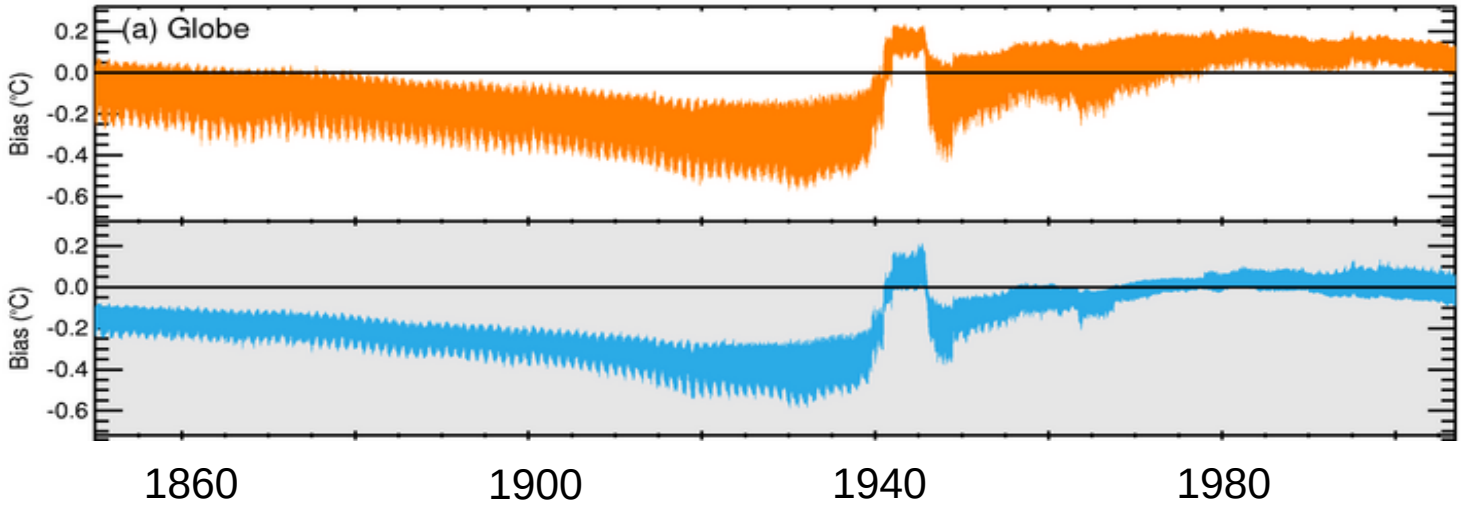


Data sources 1: in situ HadSST3

How obs were made

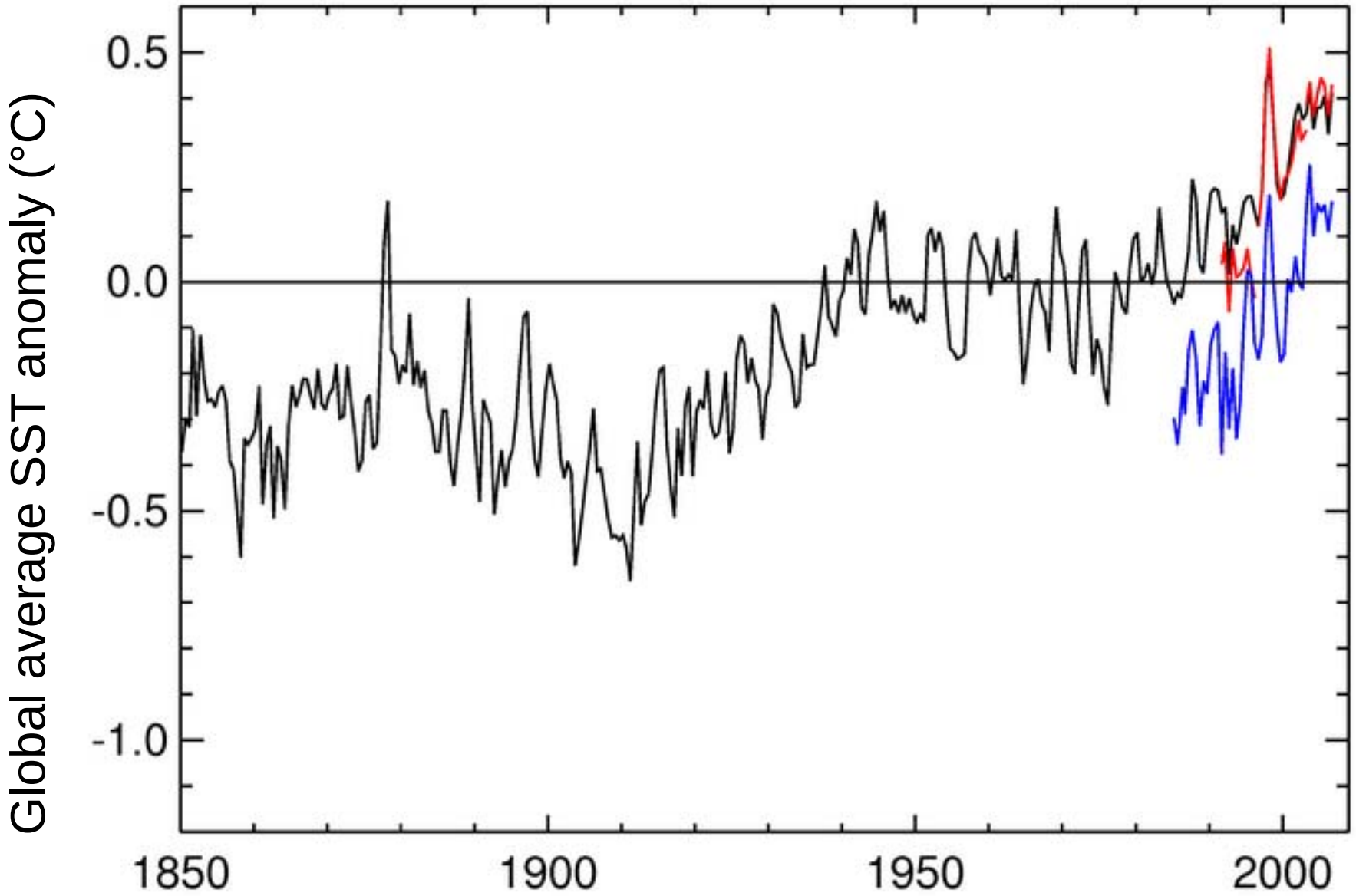


Estimated Biases



Kennedy et al. 2011

In situ bias adjusted



Data sources 1: (A)ATSR

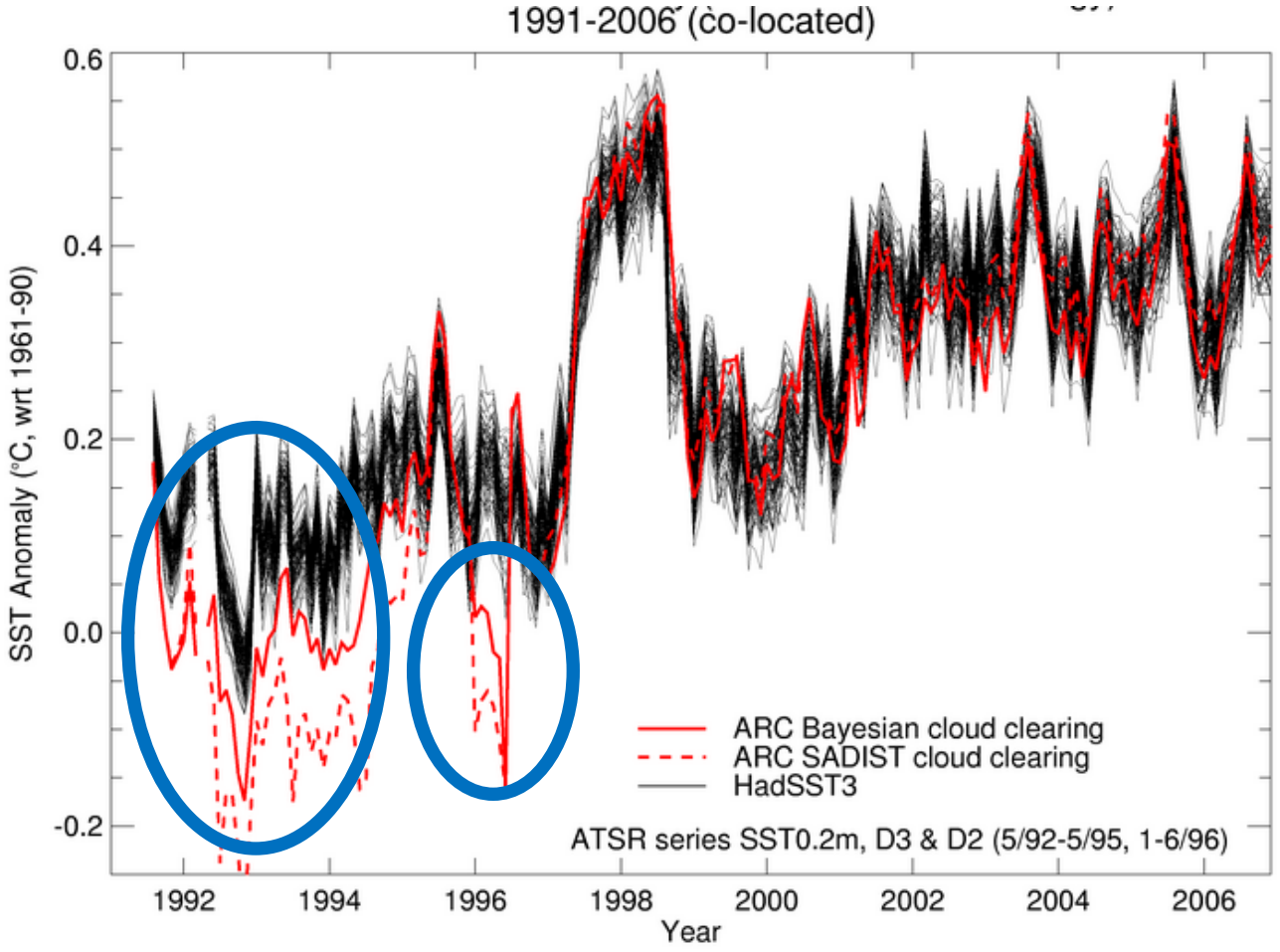
- Three ATSR instruments have flown
  - ATSR1 (1991-1996)
  - ATSR2 (1995-2008)
  - AATSR (2002-present)

- Potential target performance very high
  - Dual view
  - On-board black body calibration
  - Low estimated SST error 0.1K (Buoys 0.3K, AVHRR 0.7K)

- Currently using 10 arc minute METEO product

- We will incorporate a reanalysis of the data from ARC - ATSR Reanalysis of Climate

In situ vs ARC data early look



- Agreement between bias corrected *in situ* and ARC data is good (except in ATSR1 period)

Data sources 2: AVHRR

Using Pathfinder V5 data we apply:

- Aerosol corrections
- Drift in equator crossing time

ATSR

- Residual bias

in situ

AVHRR aerosol correction

- Using data from Total Ozone Mapping Spectrometer (TOMS)
- TOMS provides monthly aerosol optical depth (AOD) product at 380nm and 500nm
- Use this to estimate adjustment for AVHRR data by multiple regression
- Adjustments only applied if AOD exceeds threshold value.
- Adjustments fixed above a certain AOD

Effect of Aerosol corrections

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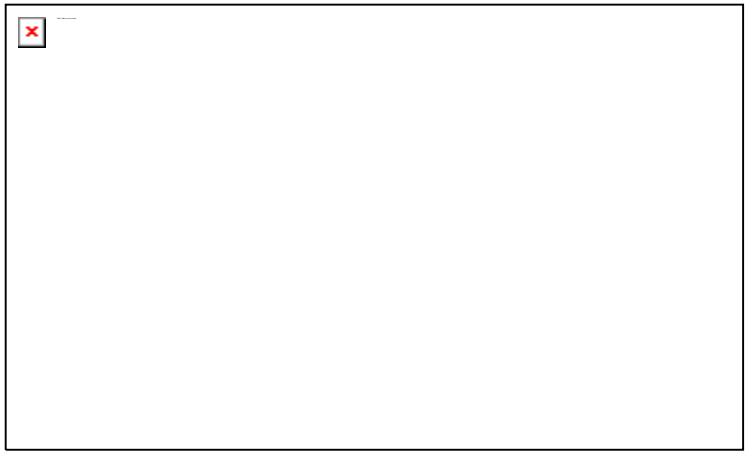
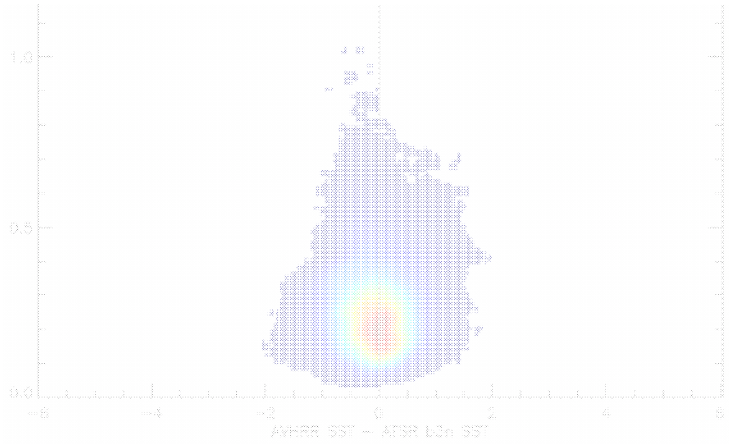
Unadjusted

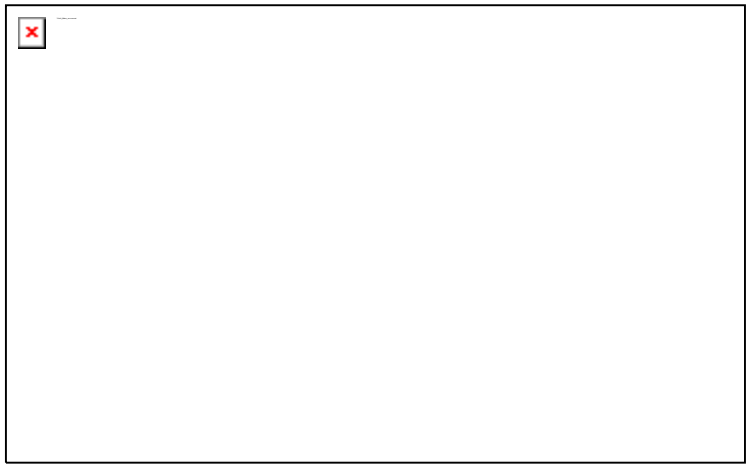
Adjusted

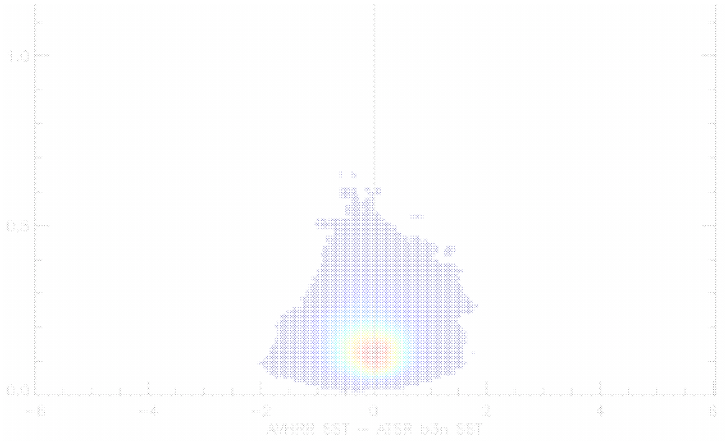
AOD 380nm





AOD 500nm





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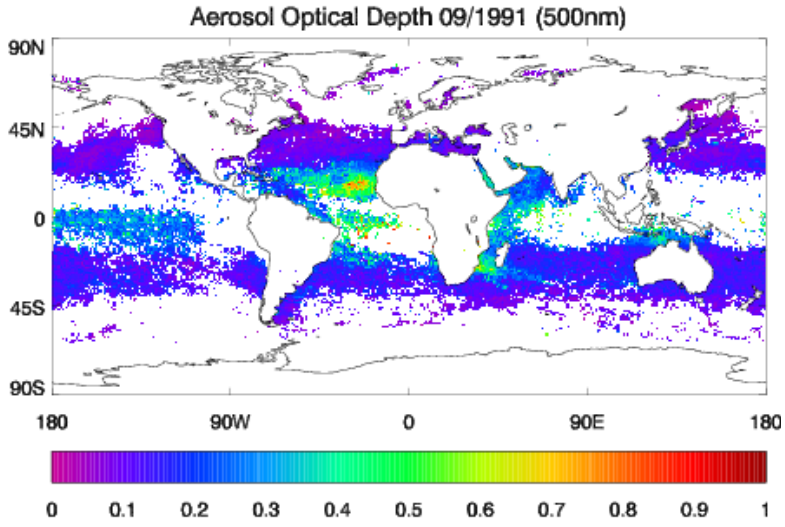
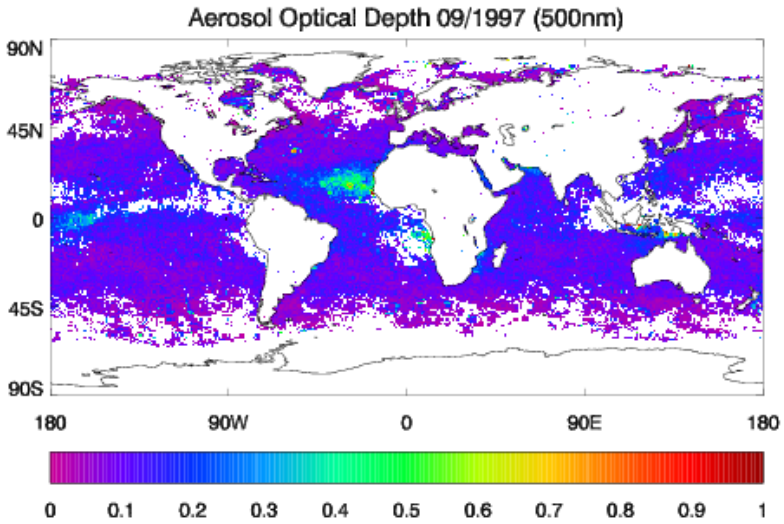
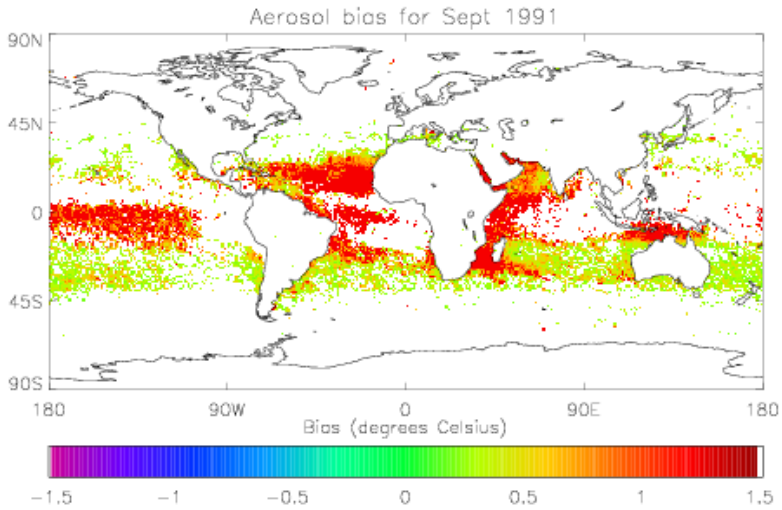
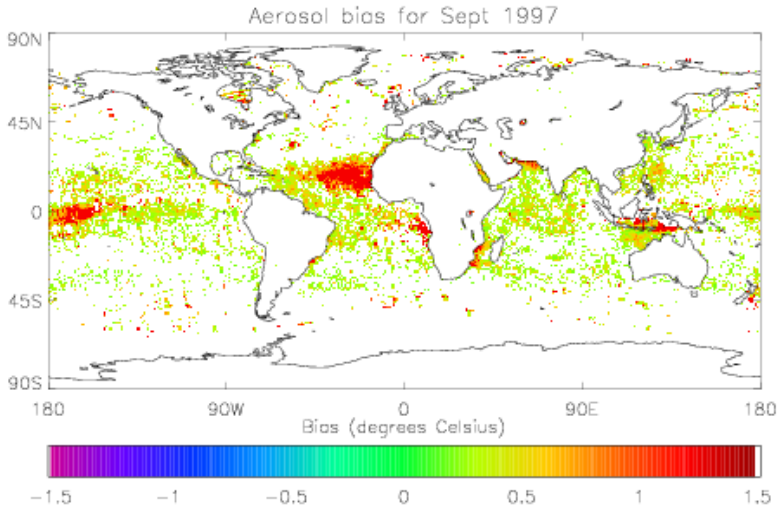
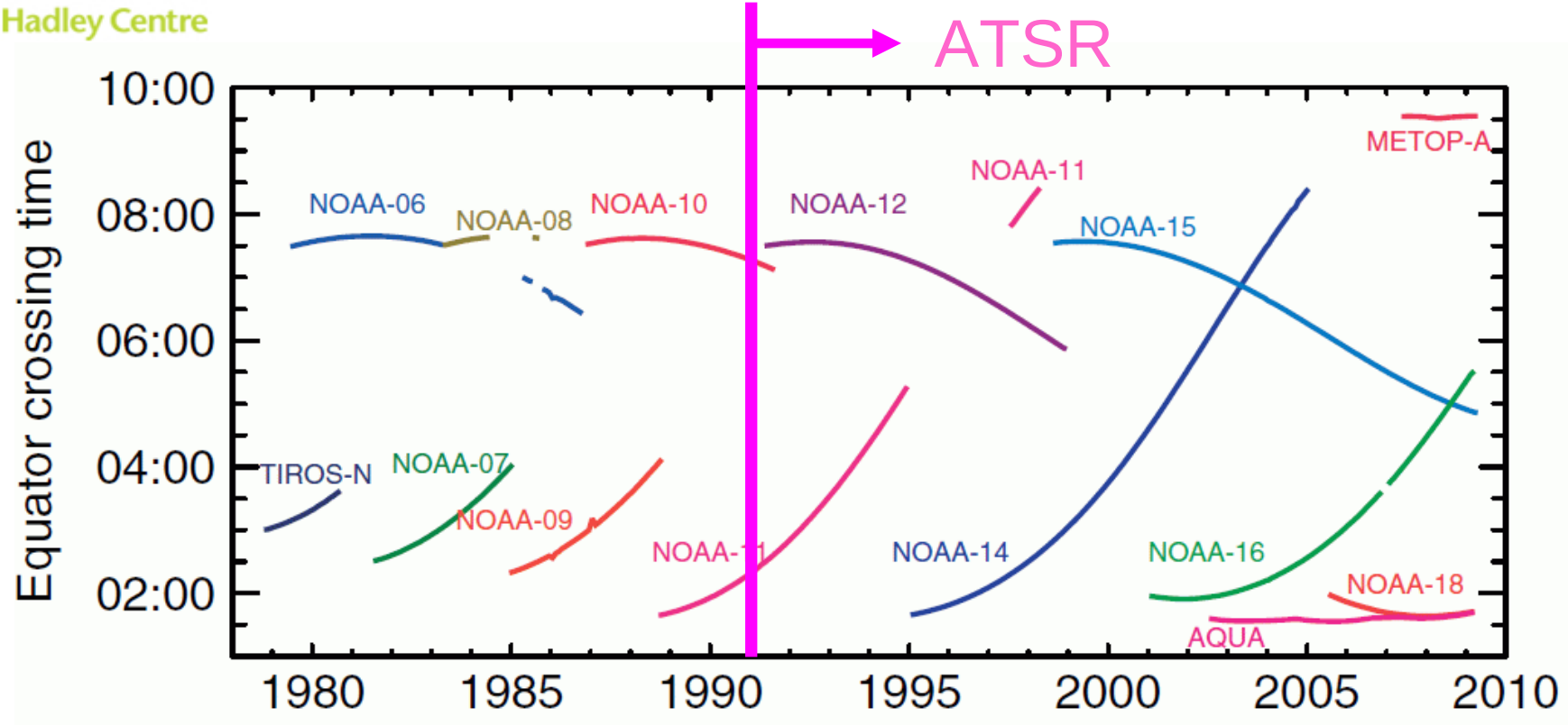






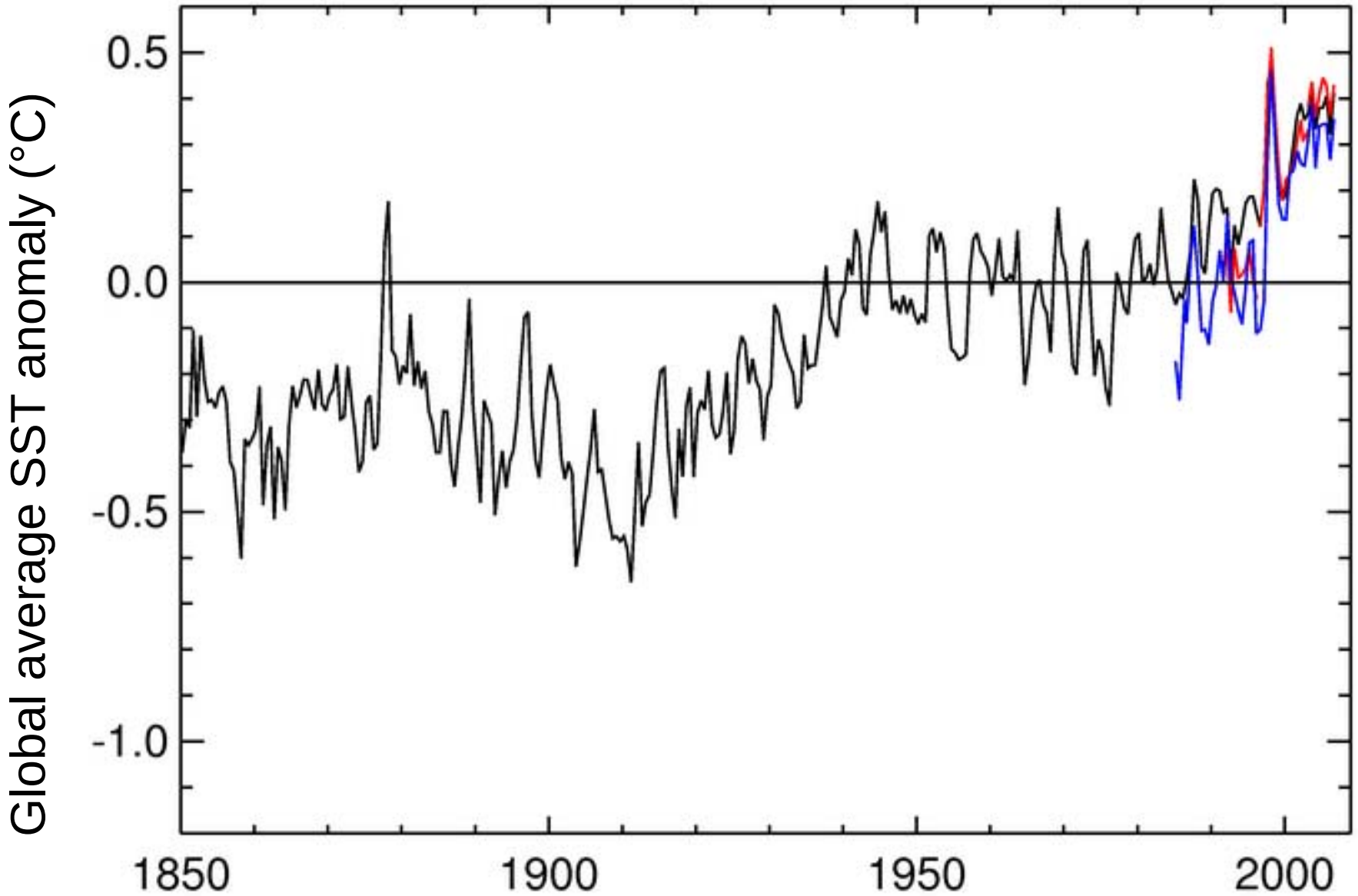


AVHRR LECT



- AVHRR drifts through diurnal cycle
- Use same-day overpasses of ATSR to correct over successively larger areas
- Create look-up table for pre-ATSR period

AVHRR bias adjusted



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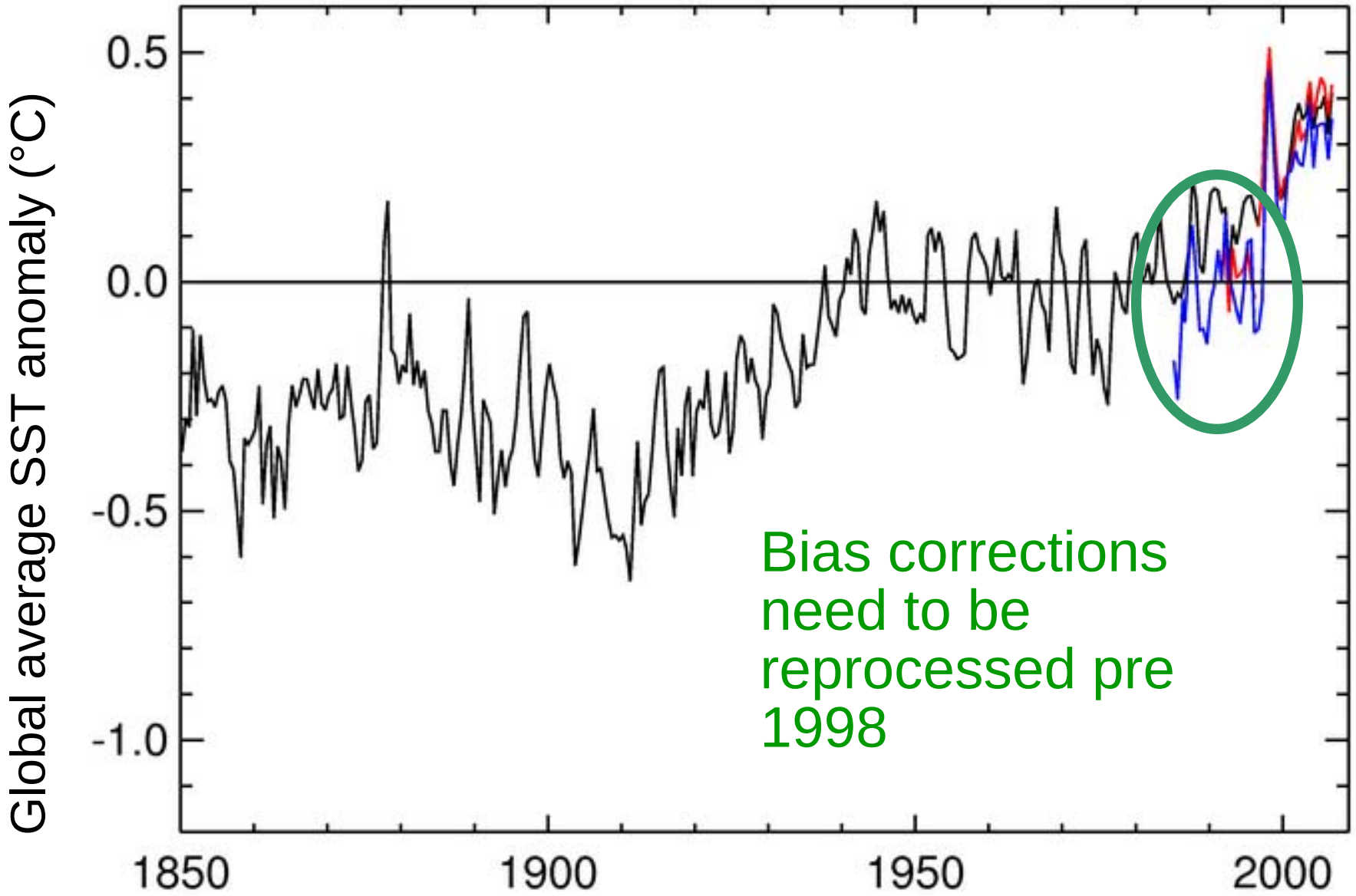

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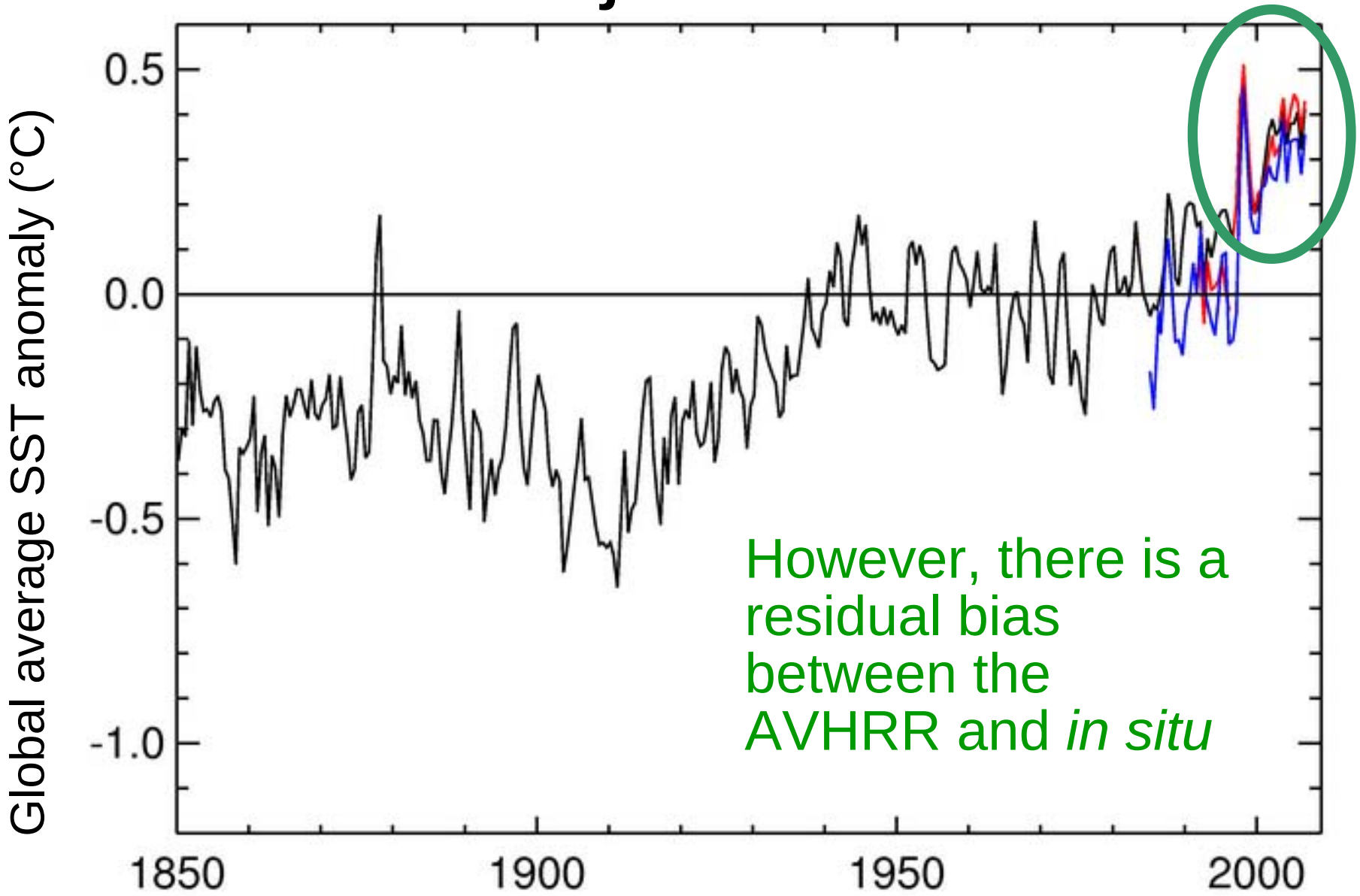
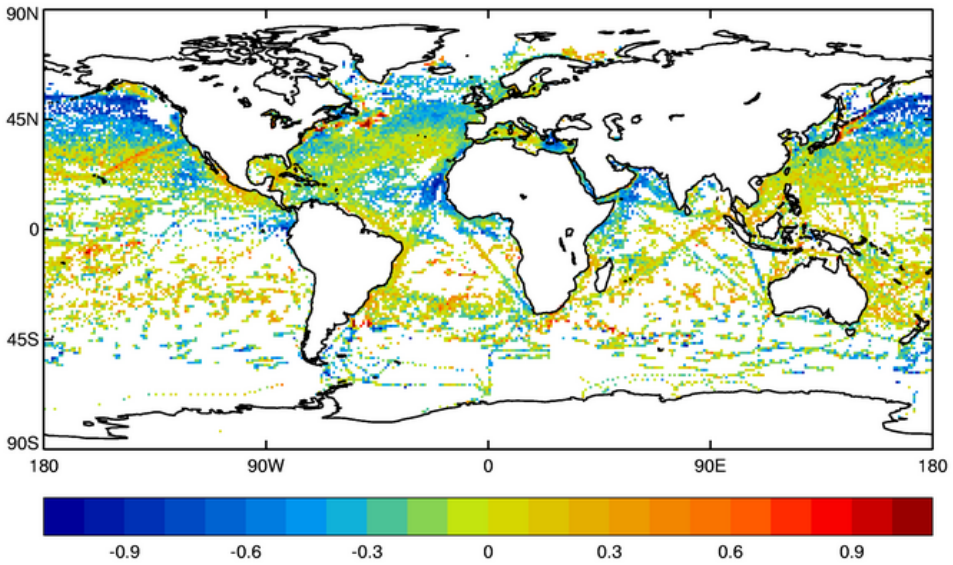
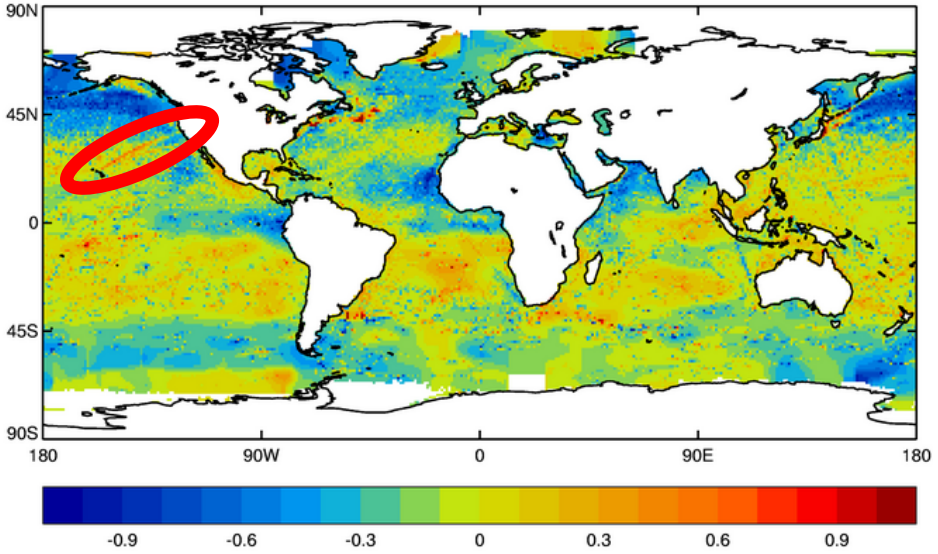


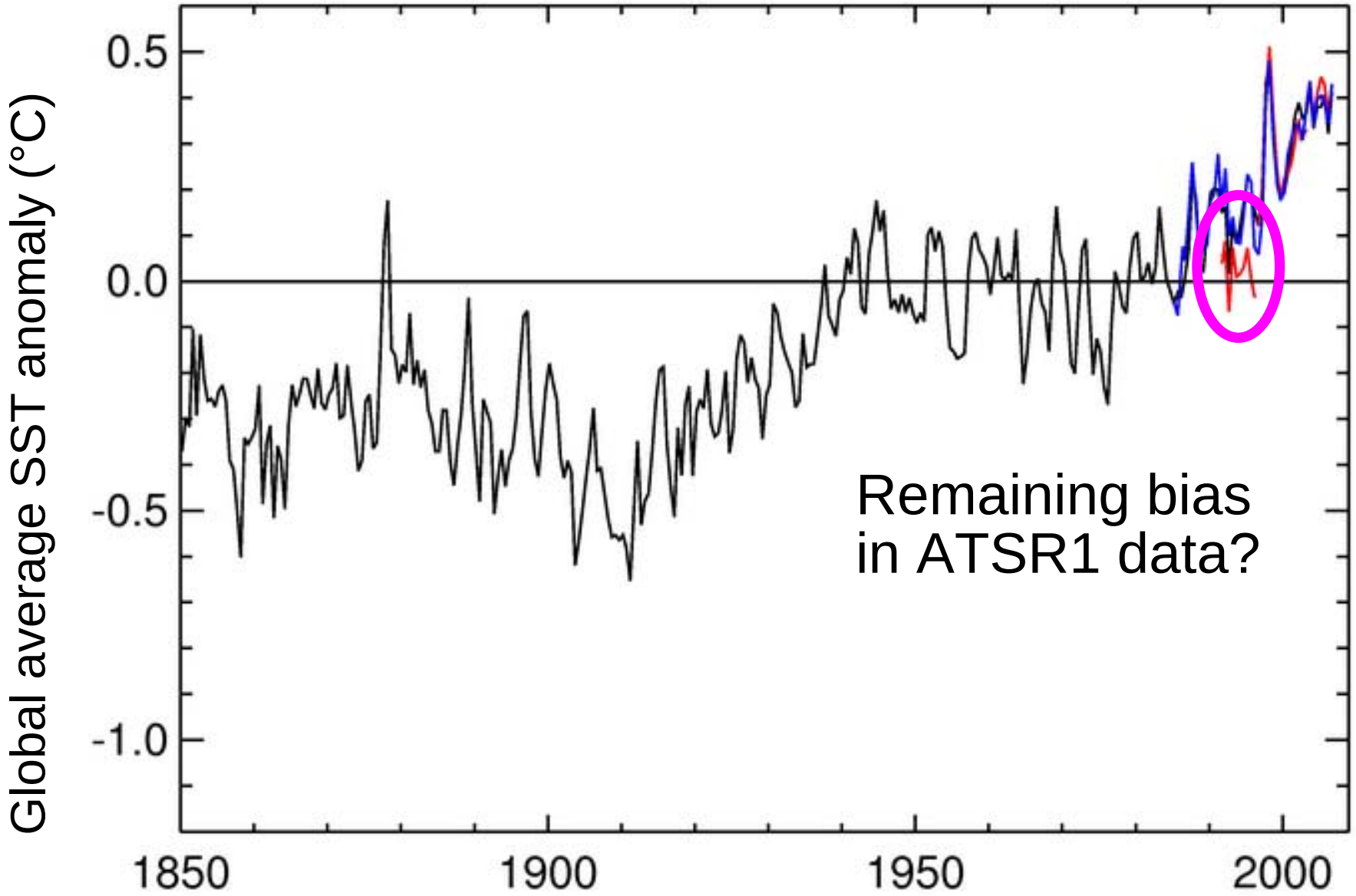
AVHRR residual bias

- Take difference between bias adjusted AVHRR and *in situ* data
- Reconstruct difference fields using EOFs
- Fill gaps in fields using inverse distance weighting
- Apply resulting correction to AVHRR data.

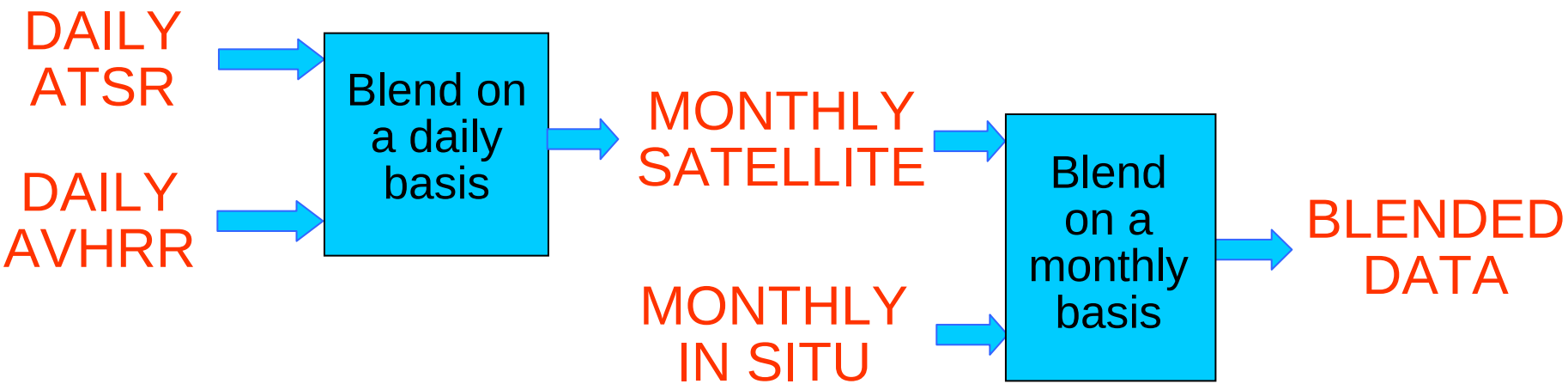




AVHRR bias adjusted II



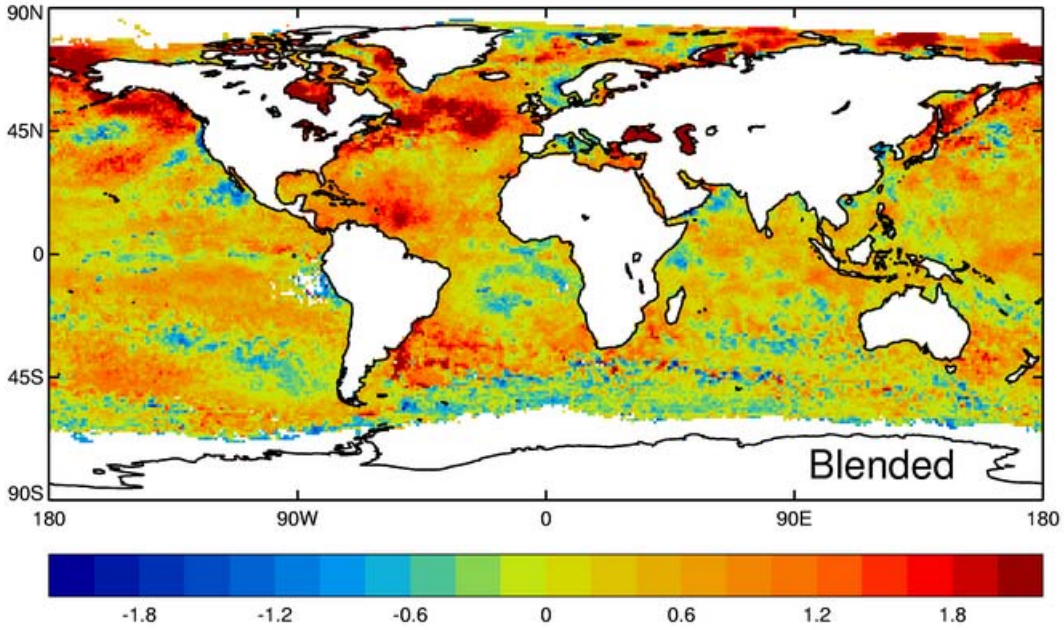
Bringing sources together



Blend using uncertainties as weights

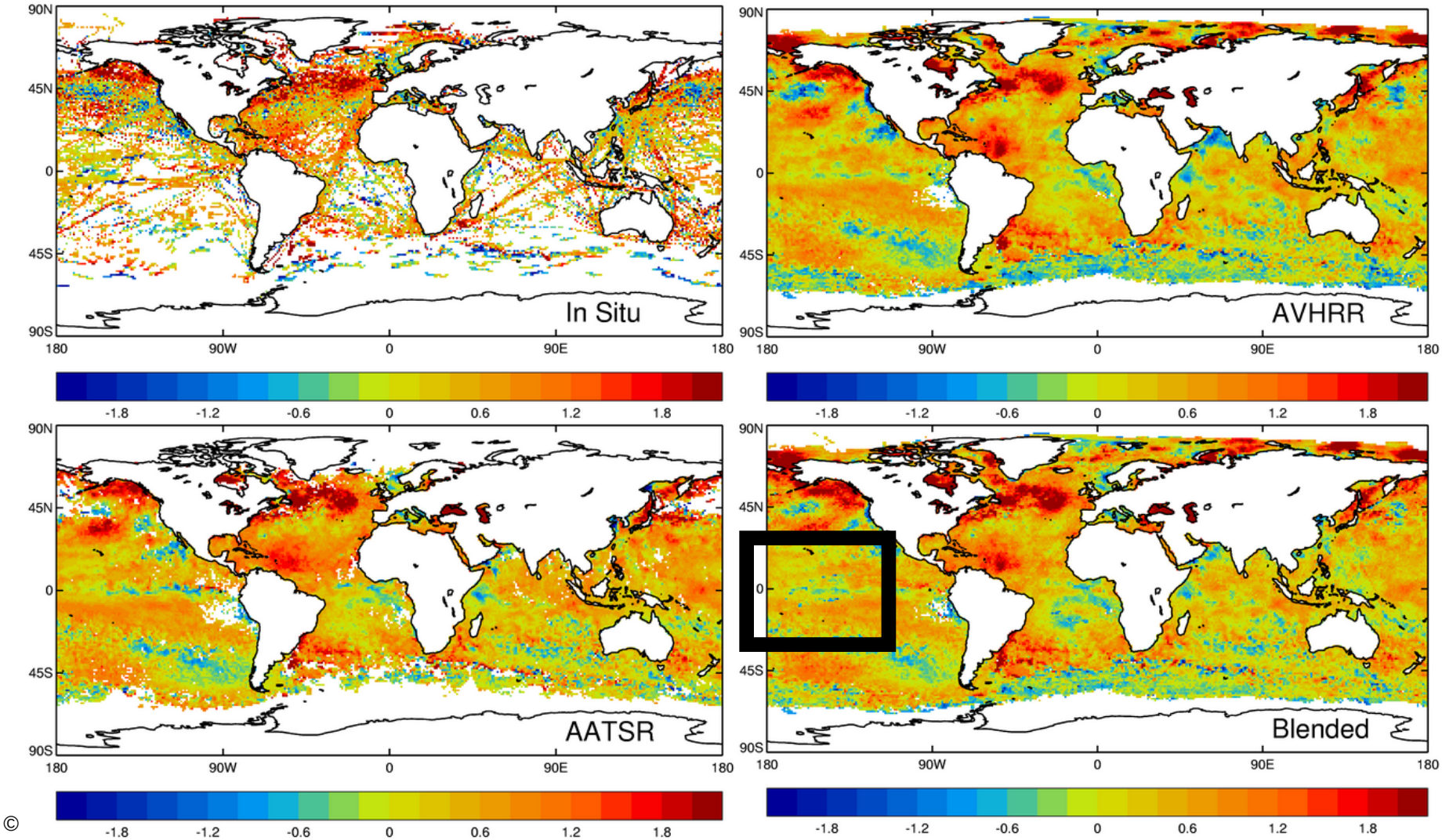
Data sources

- In situ data HadSST3
  - Ships
  - Drifting Buoys
  - Moorings
- (A)ATSR
- AVHRR

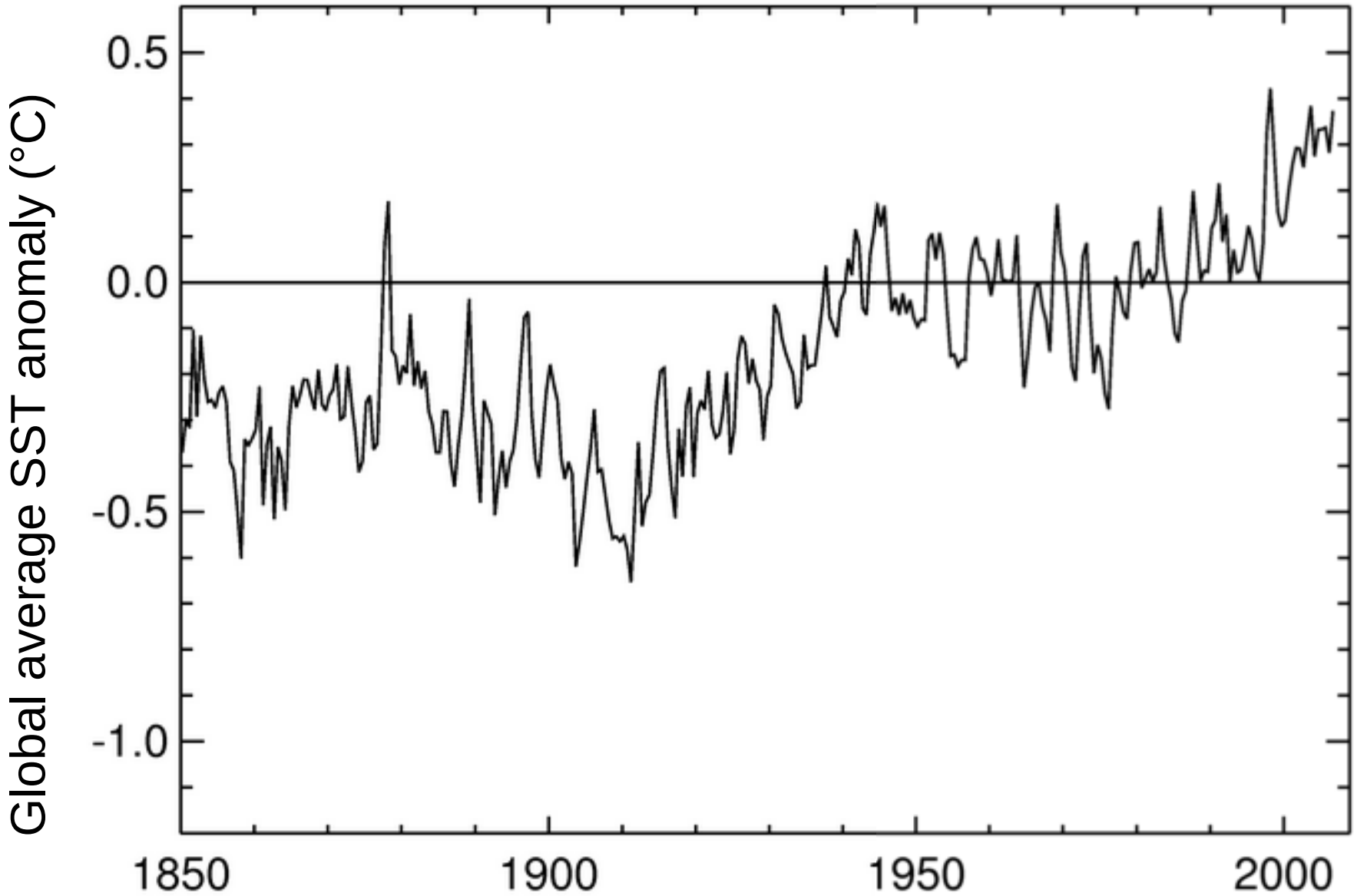


- Flexible system will allow new satellite data sources to be added

Side by side comparison



Fully blended time series



Uncertainties – generate multiple realisations

- Use a Monte Carlo approach
- Generate multiple realisations of the data by sampling from uncertainty distributions
- Preserves the covariance structure in the uncertainties
- Easy to pass on to later stages of the analysis – for example reconstruction of early data.

Loose ends

- Residual biases in ATSR1
- Currently reprocessing data streams
  - ARC
  - AVHRR bias adjustments
- We need fully characterised uncertainties wherever possible e.g. those from ESA Climate Change Initiative
- Regular updates not yet available

Summary

- Draw on strengths of each data source
- It is a lengthy process, but it is doable
- Having a generic framework will help to bring in other data sets such as Microwave retrievals.
- Data used as input for HadISST2 where satellite data can help with reconstructions of sparse early data

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Questions and answers