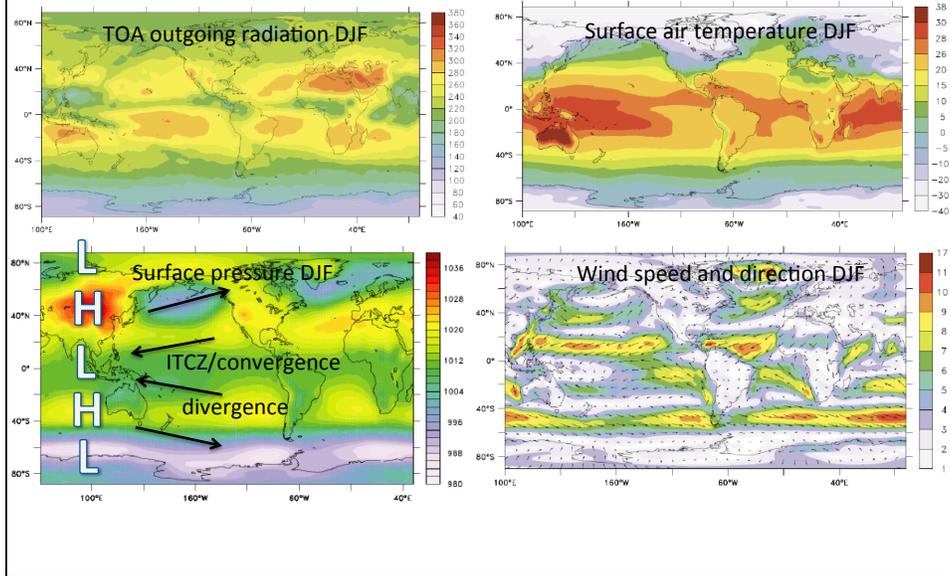
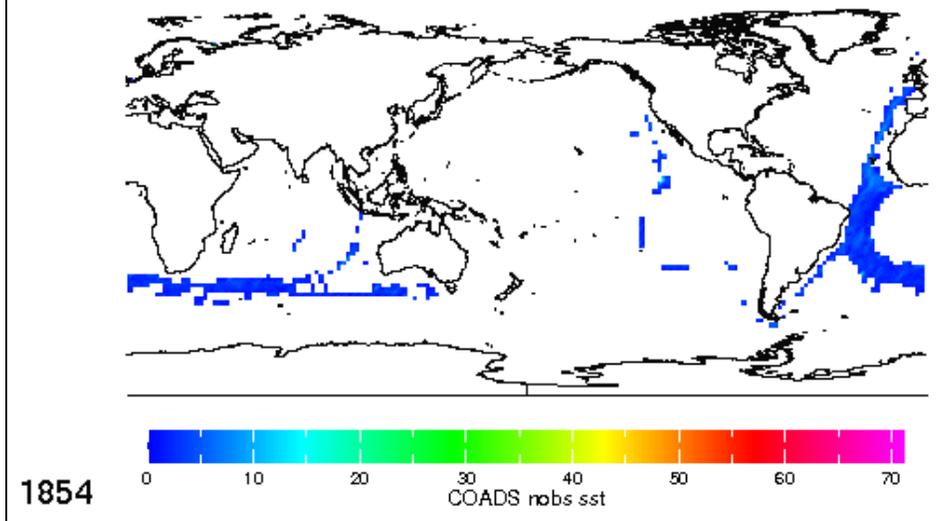


How we observe & simulate climate?



The history of climate data

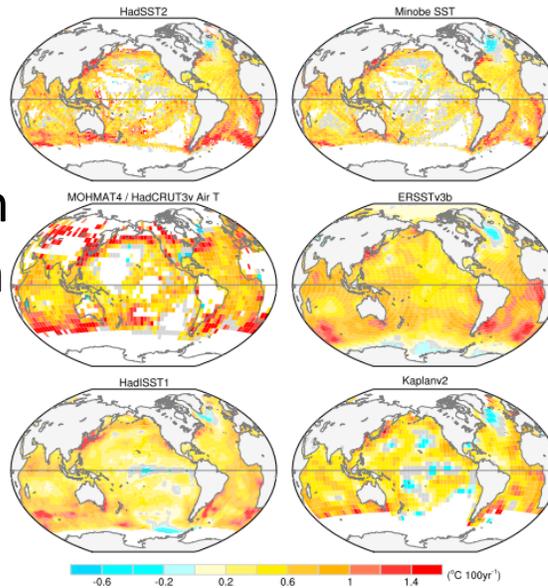
COADS number of observations



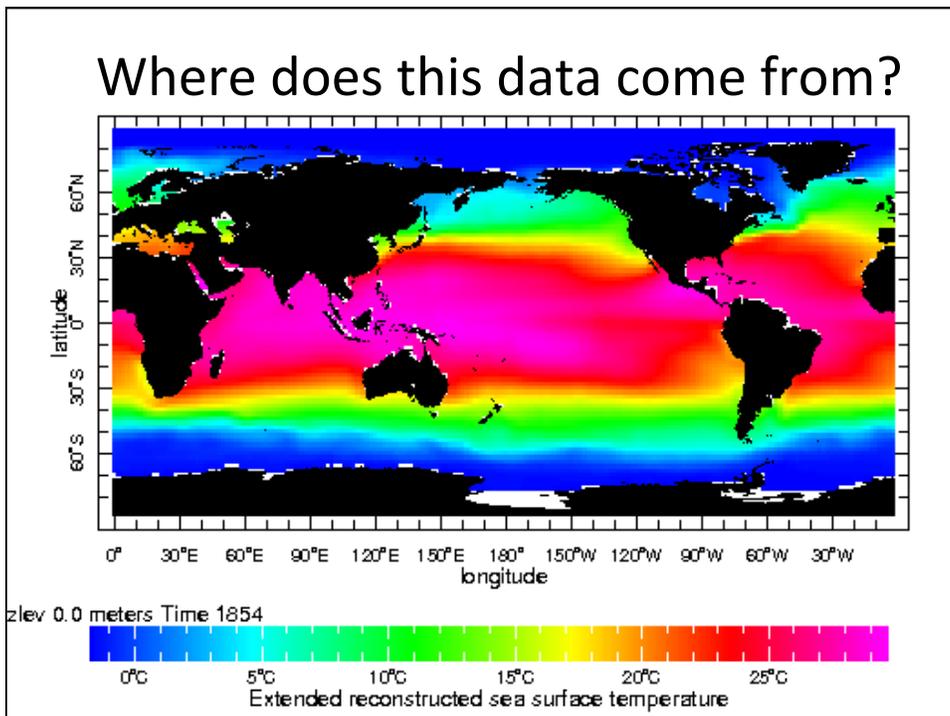
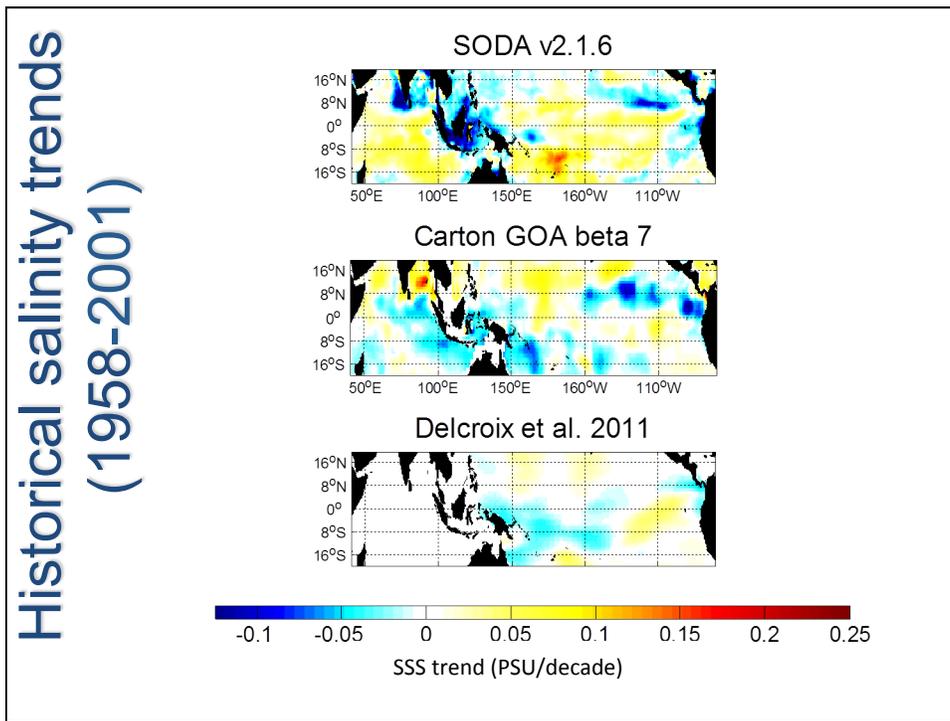
The history of climate data

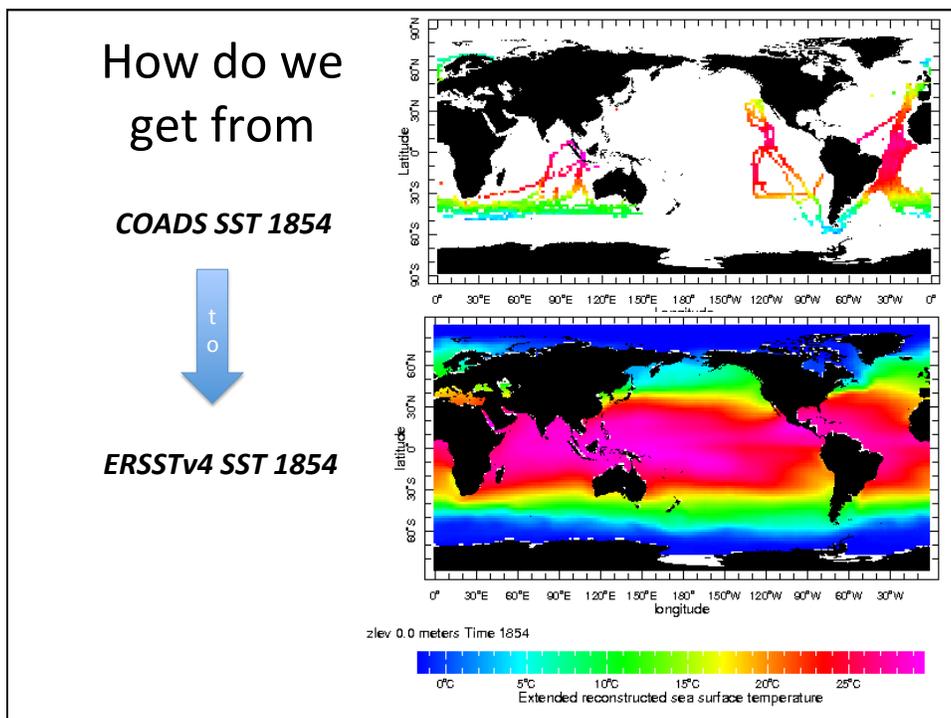
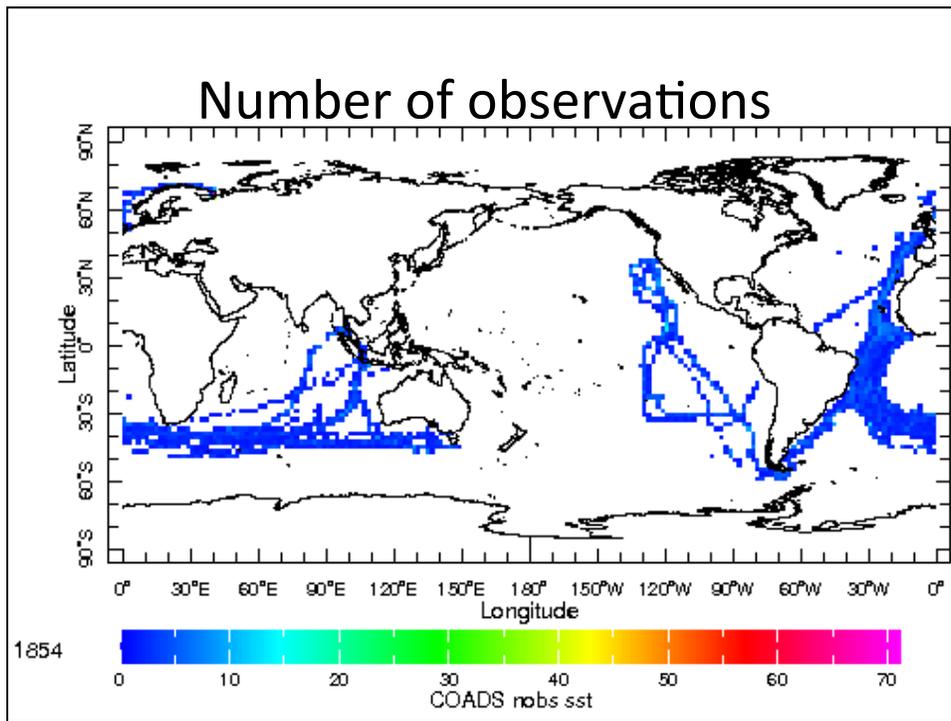
- Where does our data come from?
- What is the difference between historical observational products and reanalyses?

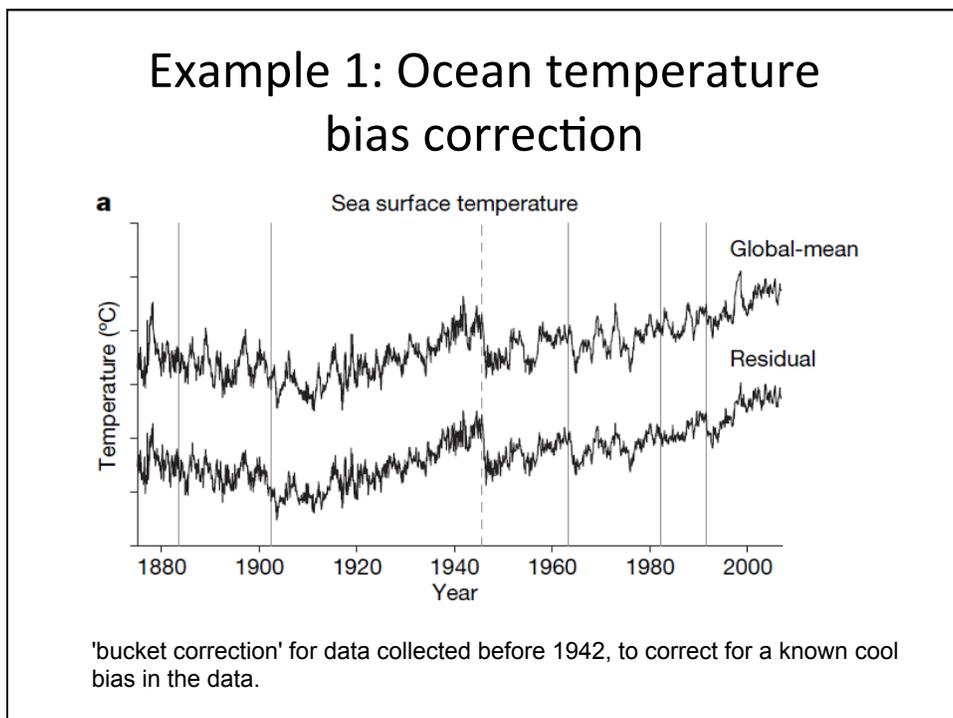
Why the
discrepancy in
surface ocean
trends??



Deser et al. 2010







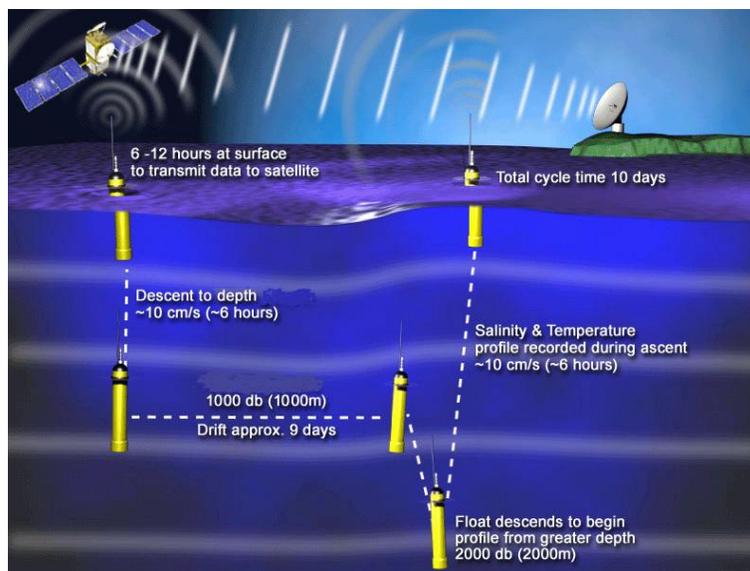
Ocean temperature measurement bias



- Canvas buckets: evaporation while hauling in the bucket, cooling the water → cool bias
- Wooden or rubber buckets: reduced evaporation effect.
- Engine room sensors: sample from deeper water, but the water is heated by the pipework → warm bias
- Hull sensors suffer similar problems to engine room sensors, although the effect is probably smaller
- Buoys tend to be more consistent.

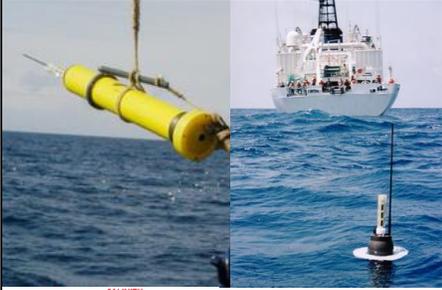
Kennedy et al. 2012

Profiling floats (e.g. ARGO)

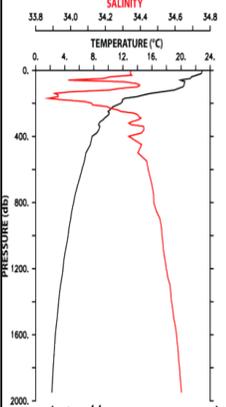


Each programmed to make ~150 cycles

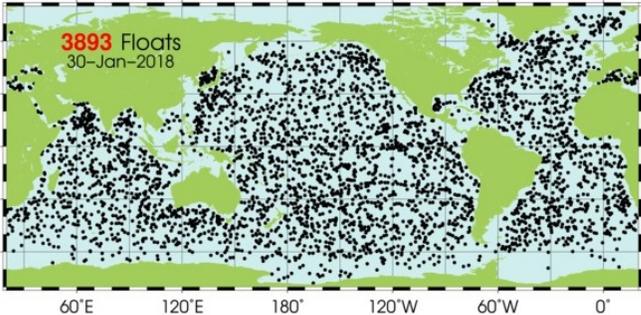
ARGO activity



- 19 countries
- Can stay at one level, or move up and down (programmable)
- Data include T, S, and location
- Gives surface and deep circulation, as well as T and S
- “real time”
- >3000 publications to date

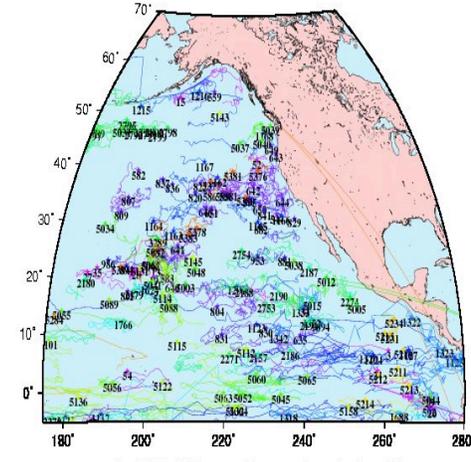


<http://www.argo.ucsd.edu/Frpictures.html>



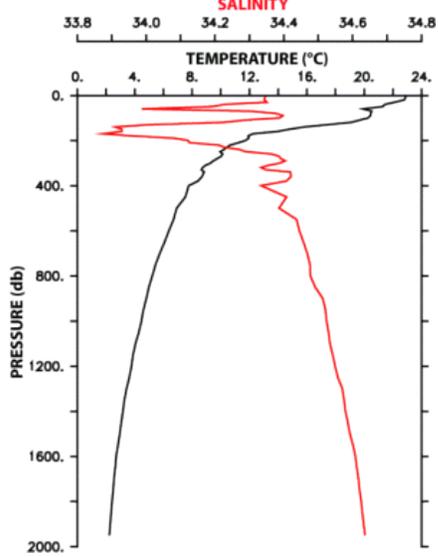
<http://www.argo.ucsd.edu/>

Profiling floats and drifters - data



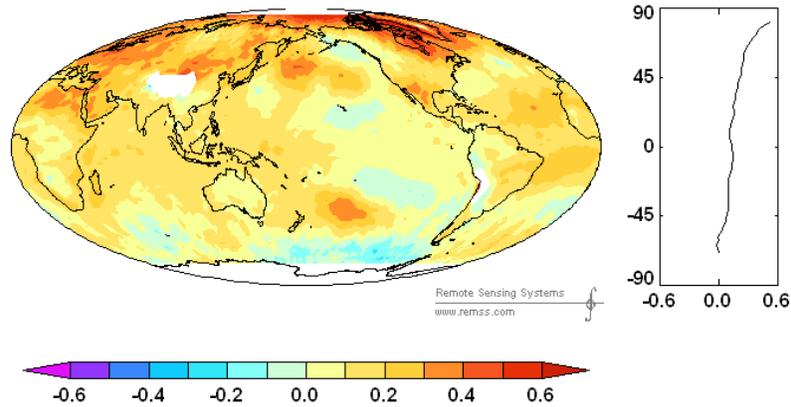
As of 31 Mar 2010 * : Most recent known location of float.

<http://flux.ocean.washington.edu/>



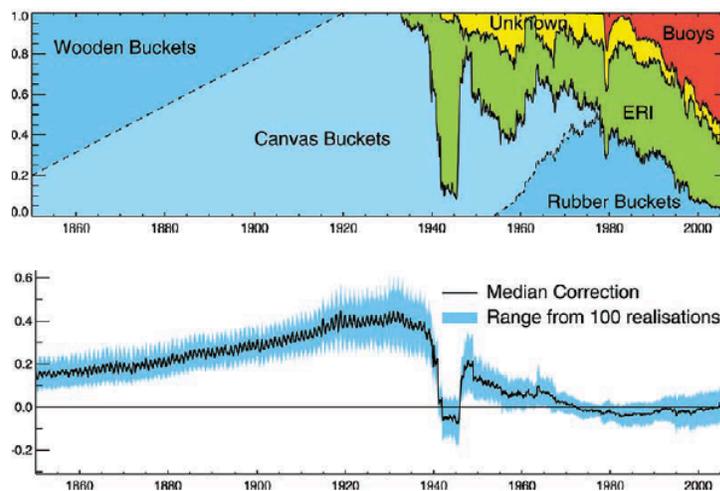
<http://www.argo.ucsd.edu/Frpictures.html>

Satellite observations

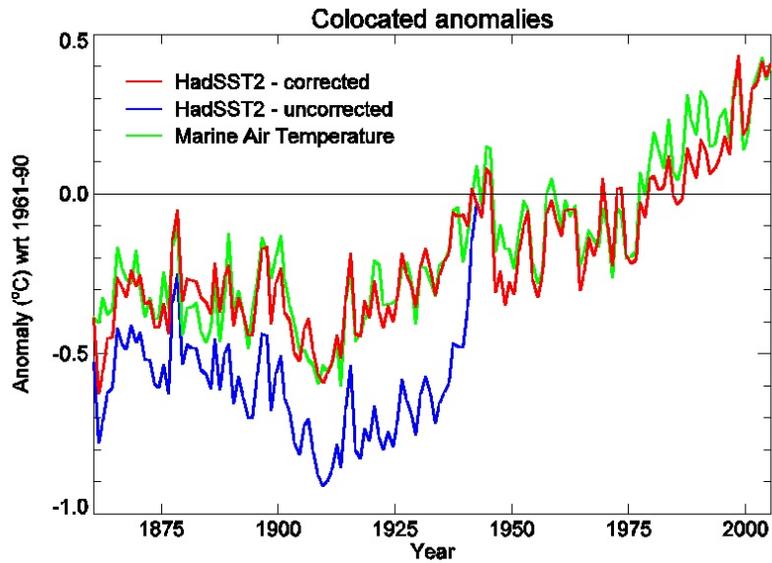


Trend in lower tropospheric temperature, 1979-2011 as measured by the Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit (AMSU)

Example 1: Ocean temperature bias correction

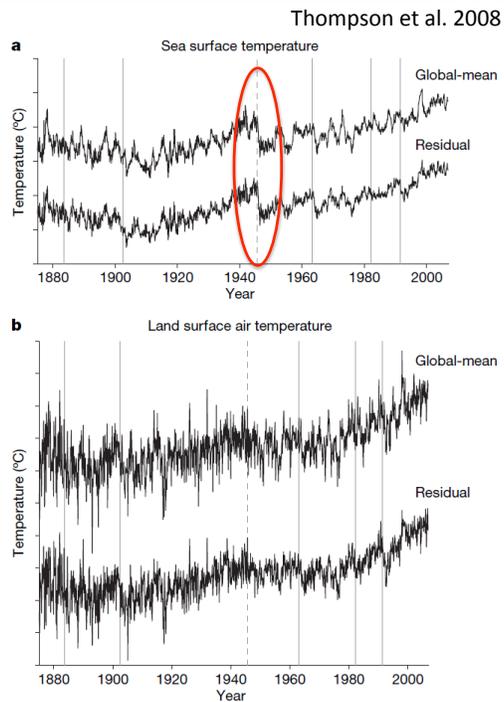


Corrected vs uncorrected SSTs

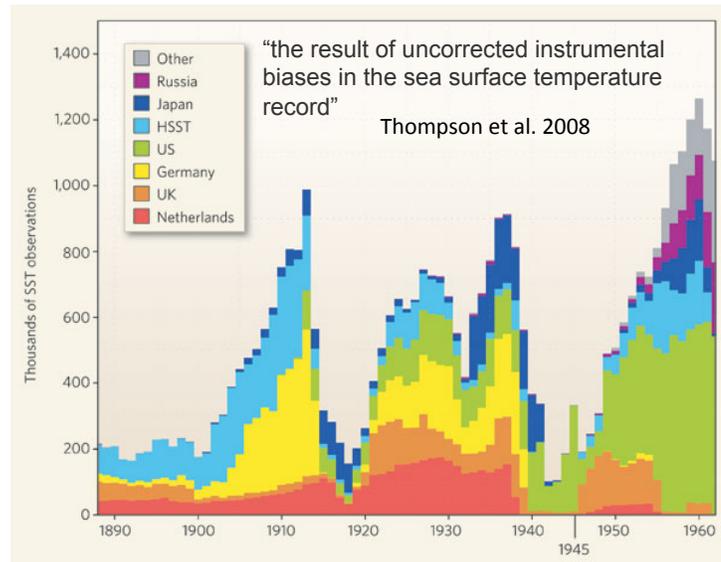


HadISSTv2 bias corrected data

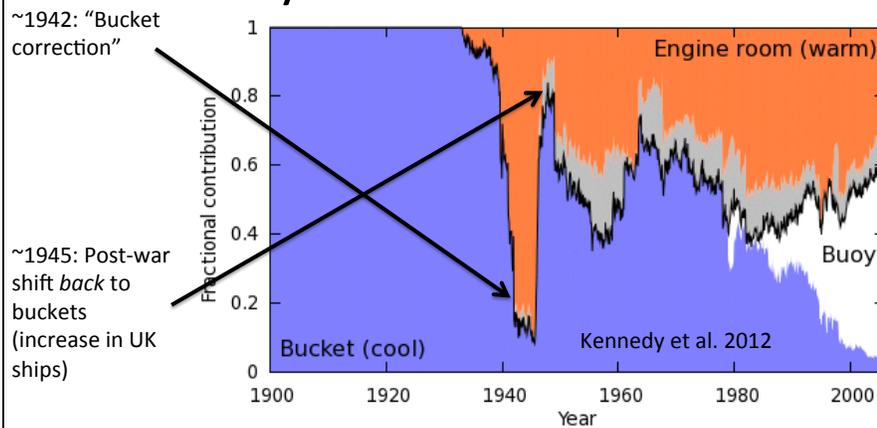
- What caused the ~ 0.3 °C drop in SST around 1945 (dashed line = Aug 1945)??
- (equivalent to $\sim 40\%$ of the century-long upward trend in global mean temperature!)
- only apparent in ocean data, but not in land measurements.



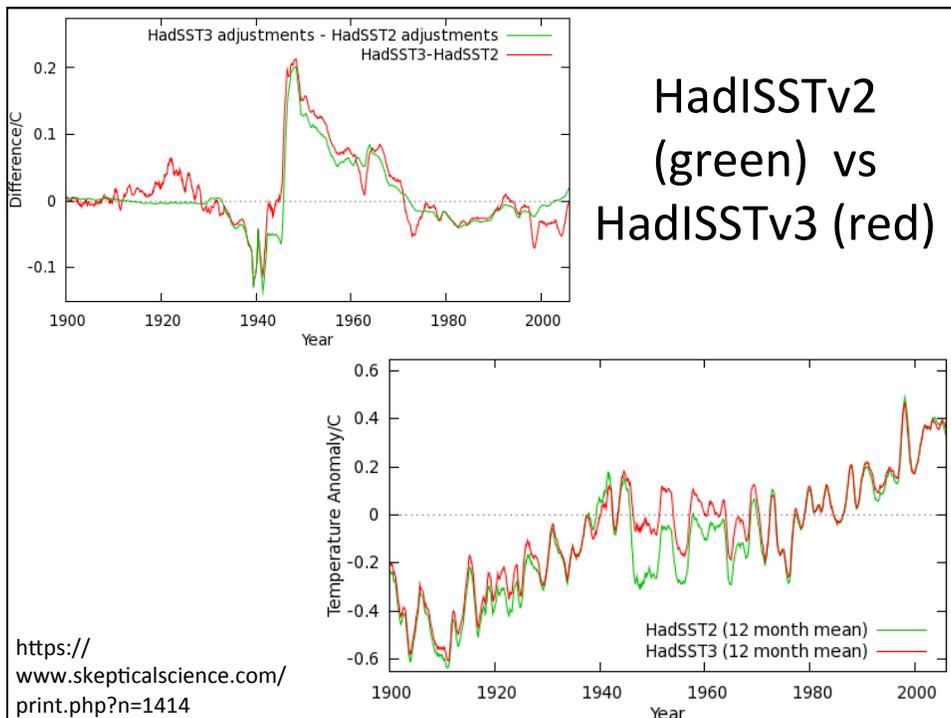
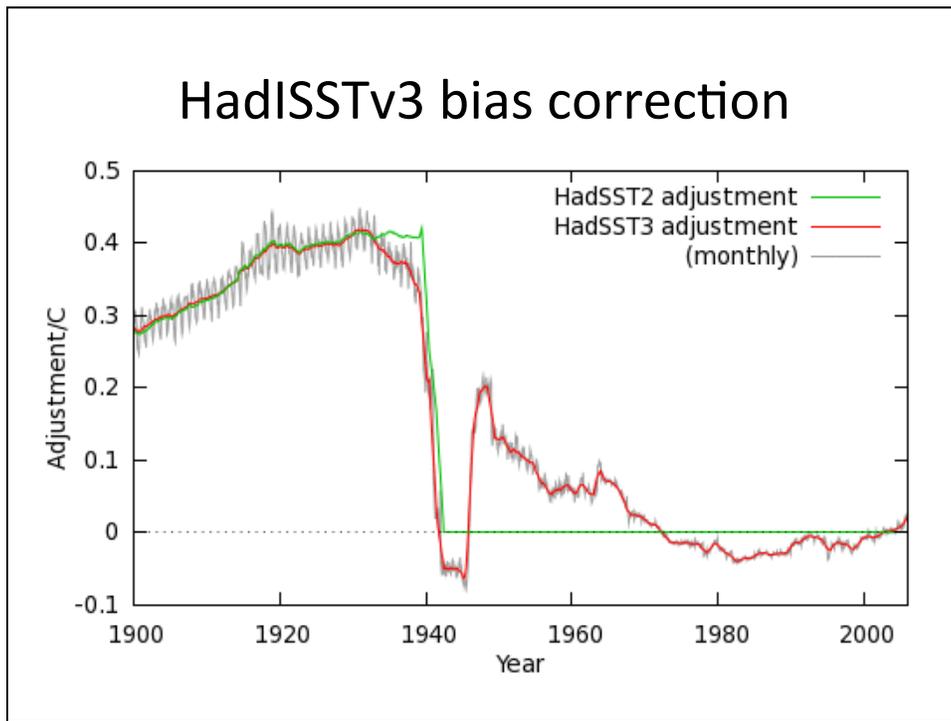
Post-World War II cooling a mirage



History of SST measurements

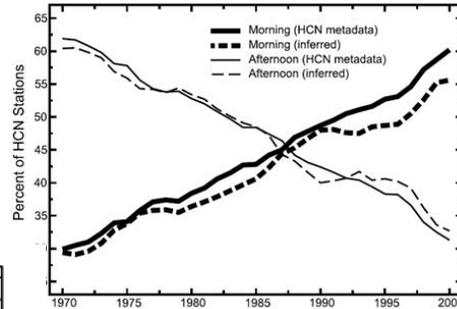
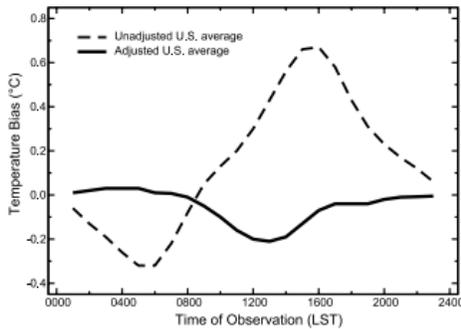


- The grey region represents measurements of unknown type.
- Black line: approximate indication of the correction required.
- When all the data come from cool-biased buckets, a positive adjustment is required
- When they come from warm-biased engine room intakes, a negative adjustment is required.



Example 2: Air temperature bias correction

1. Time of day

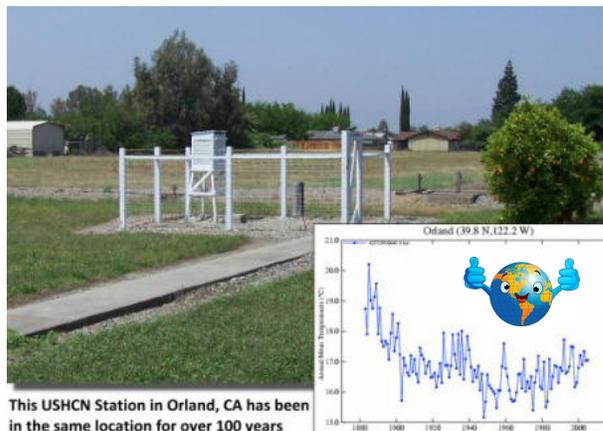


Historical climatology network (HCN)

Vose et al. 2003

Air temperature bias correction

1. Time of day
2. Location:
 - a. poor siting and changes to siting



This USHCN Station in Orland, CA has been in the same location for over 100 years

Air temperature bias correction

1. Time of day
2. Location:
 - a. poor siting and changes to siting



Air temperature bias correction

1. Time of day
2. Location:
 - a. poor siting and changes to siting
 - b. Urban vs rural

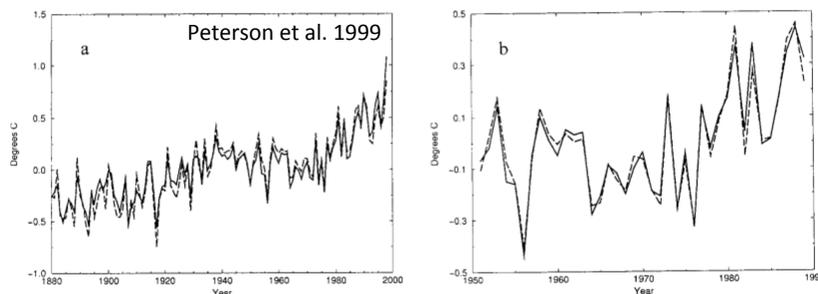


Figure 3. (a) Annual area-averaged mean global temperature anomalies (from 1880-1997 mean) from land stations. The value for 1998 based on January through September data only. (b) Annual averaged mean global temperature anomalies (from 1951-1989 mean) from land stations for the period 1951 to 1989 when there was the greatest rural coverage. Solid line from the full GHCN data set. Dashed line from rural stations only.

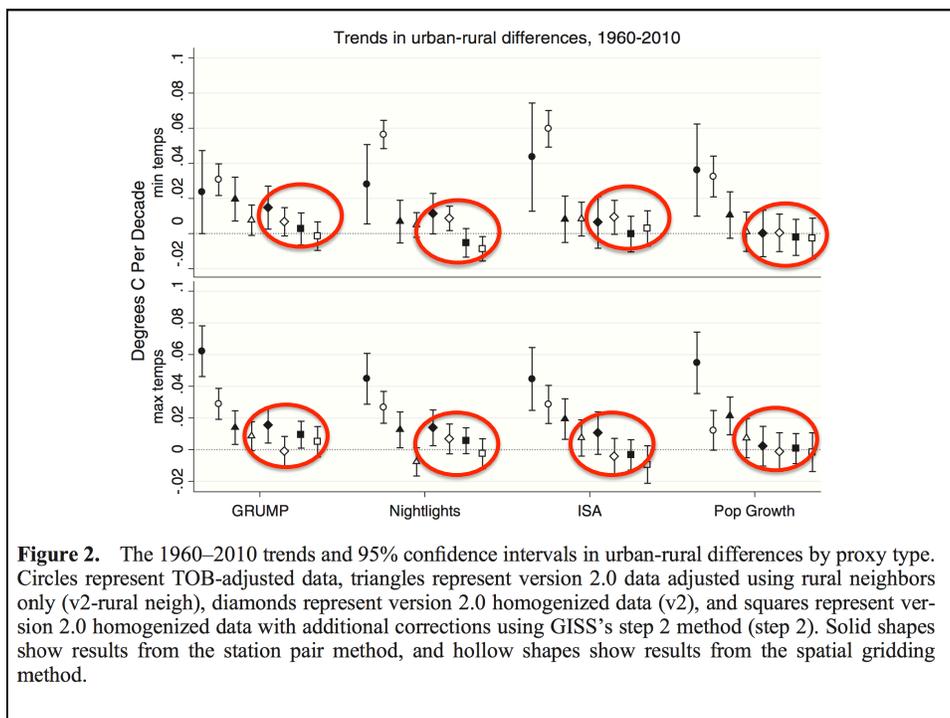
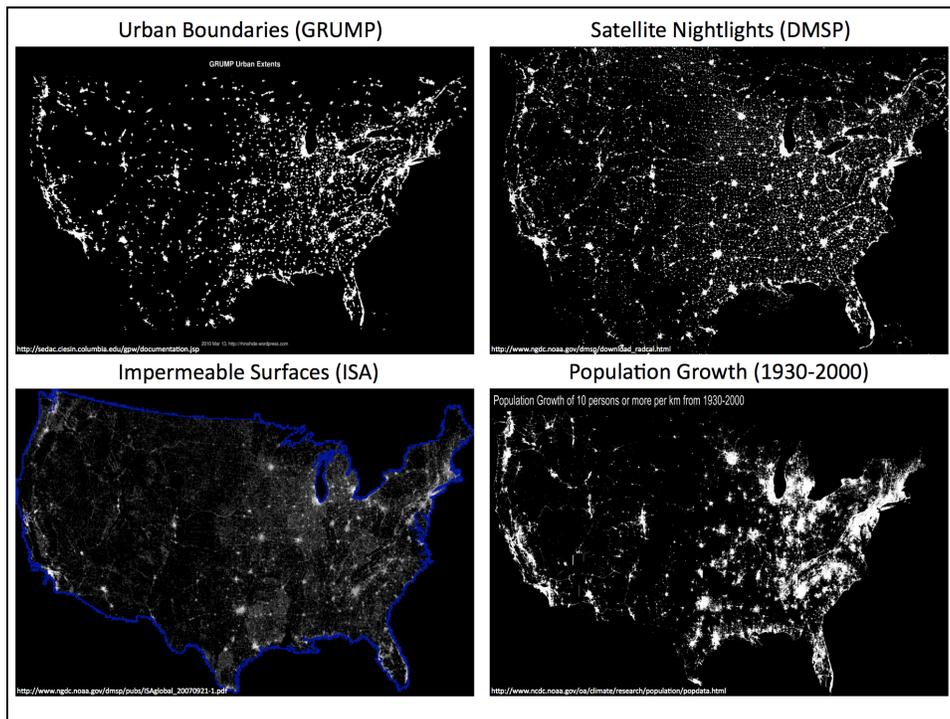
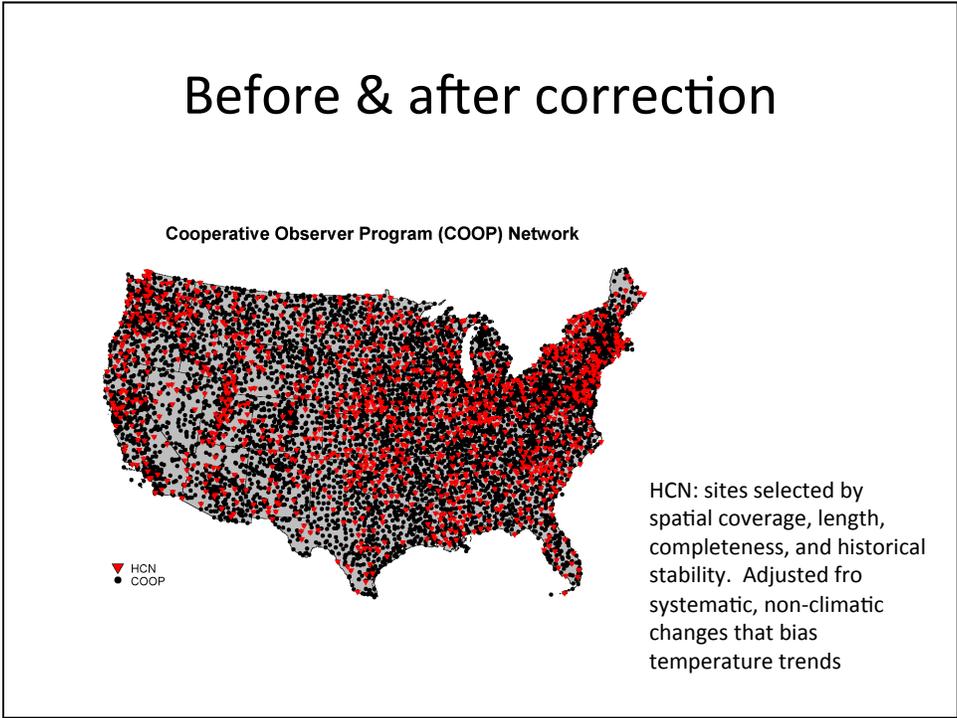
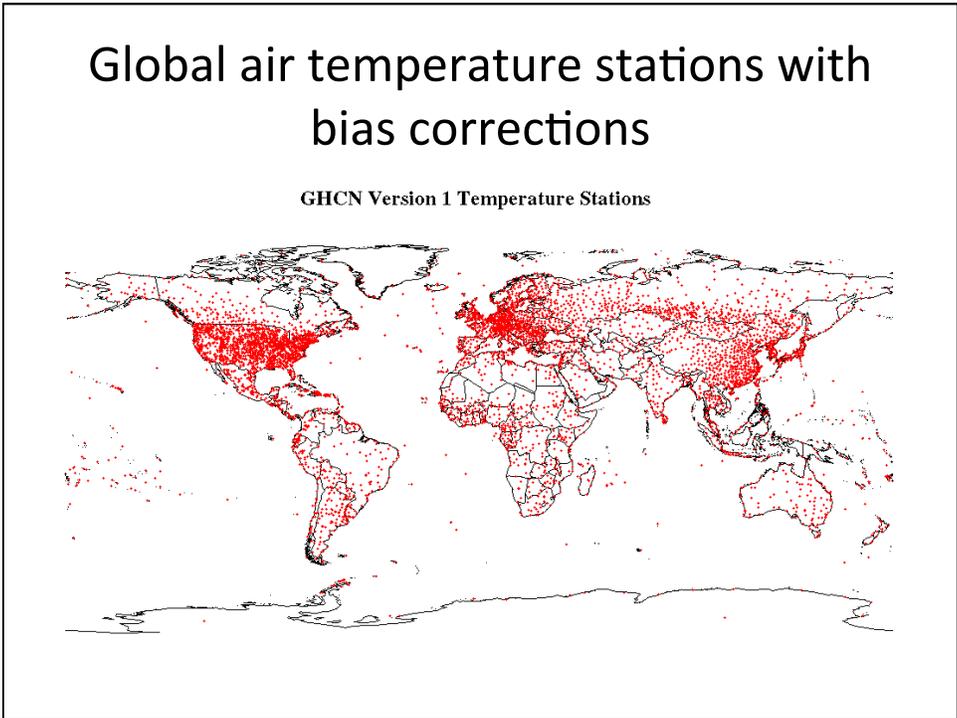


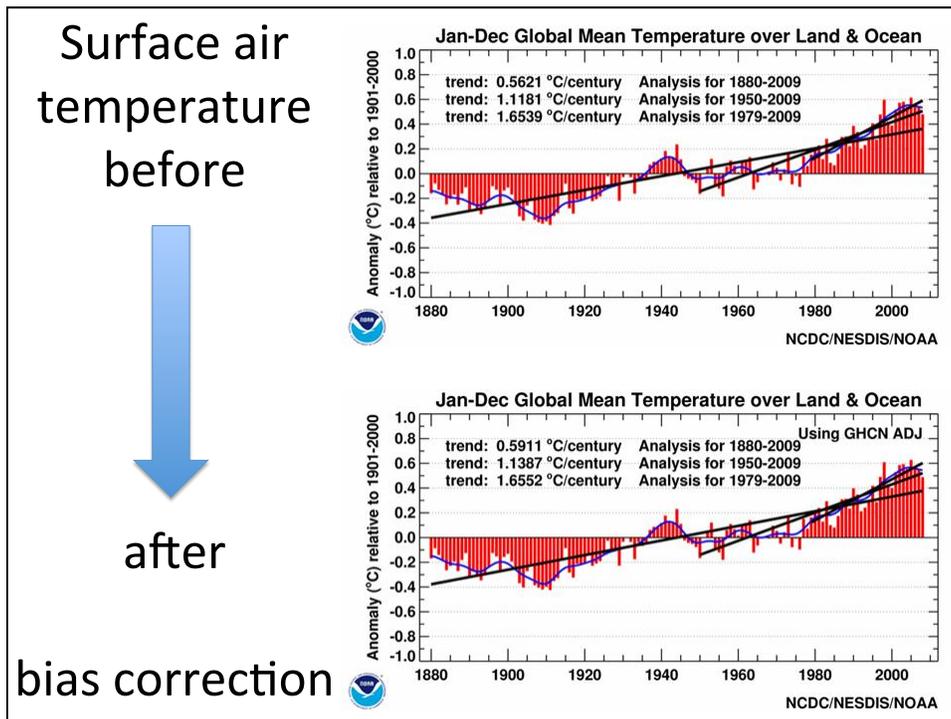
Figure 2. The 1960–2010 trends and 95% confidence intervals in urban-rural differences by proxy type. Circles represent TOB-adjusted data, triangles represent version 2.0 data adjusted using rural neighbors only (v2-rural neigh), diamonds represent version 2.0 homogenized data (v2), and squares represent version 2.0 homogenized data with additional corrections using GISS’s step 2 method (step 2). Solid shapes show results from the station pair method, and hollow shapes show results from the spatial gridding method.

Before & after correction



Global air temperature stations with bias corrections





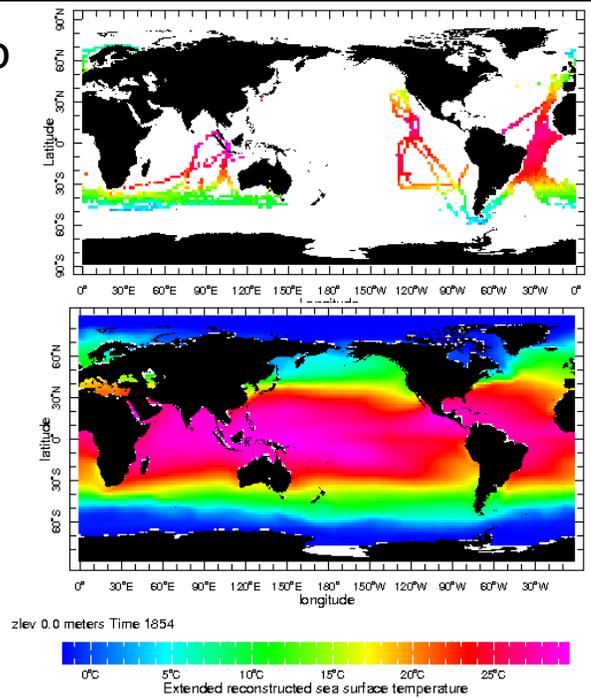
How are all of these disparate measurements incorporated into one temperature record??

BUT...how do we get from
we get from

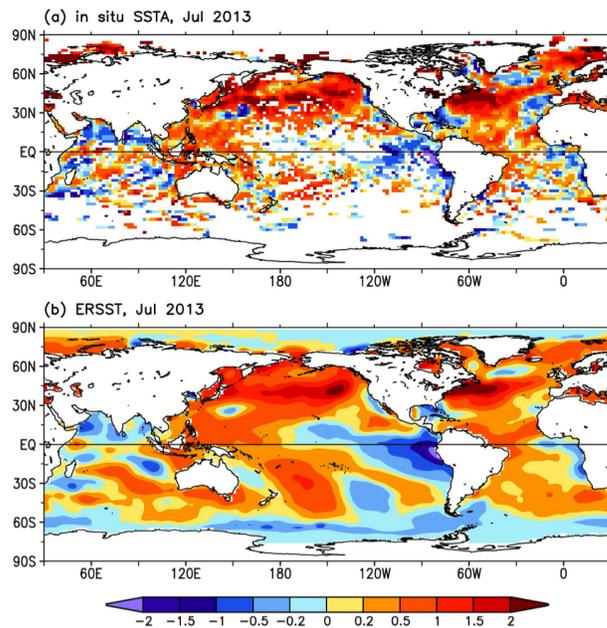
COADS SST 1854



ERSSTv4 SST 1854

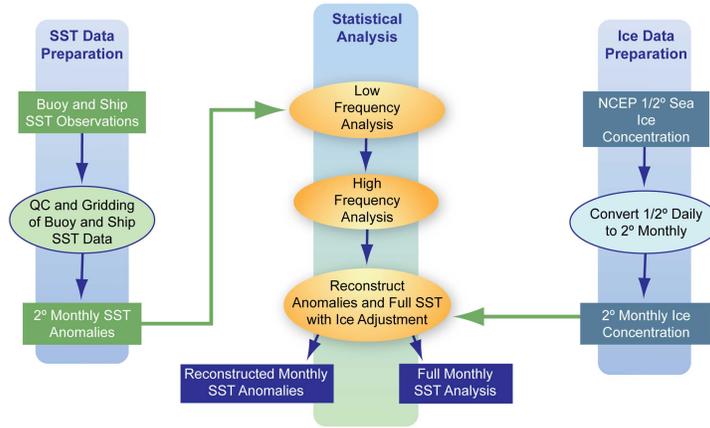


Option #1:
Interpolation/
Infilling
missing data



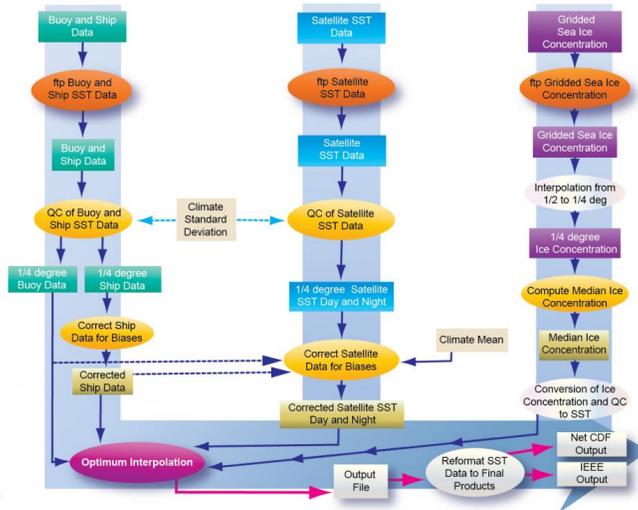
Example from ERSSTv3b

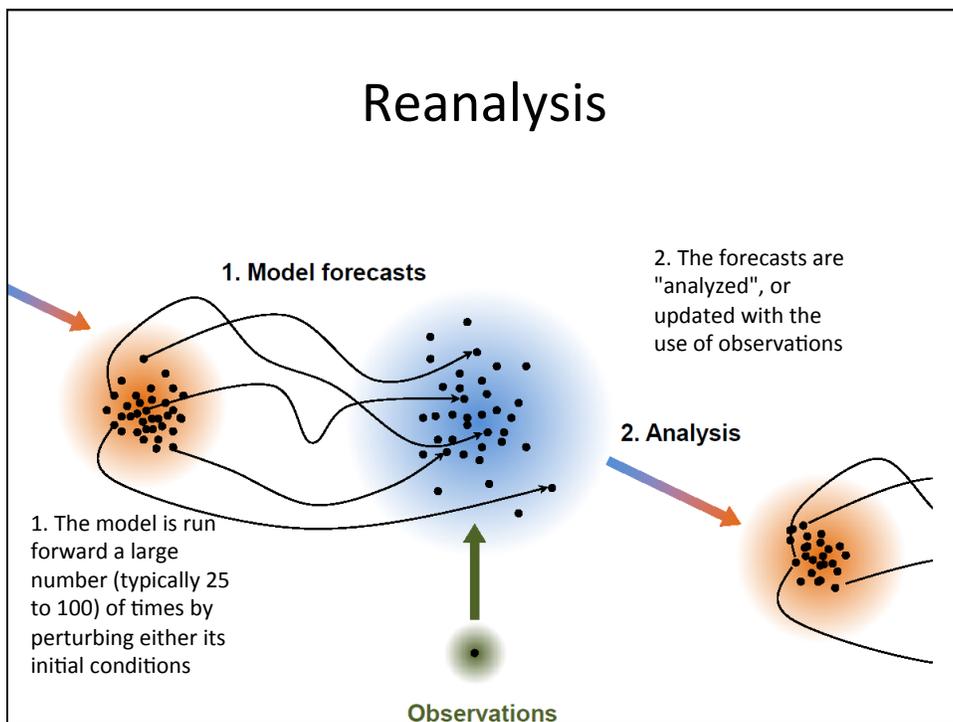
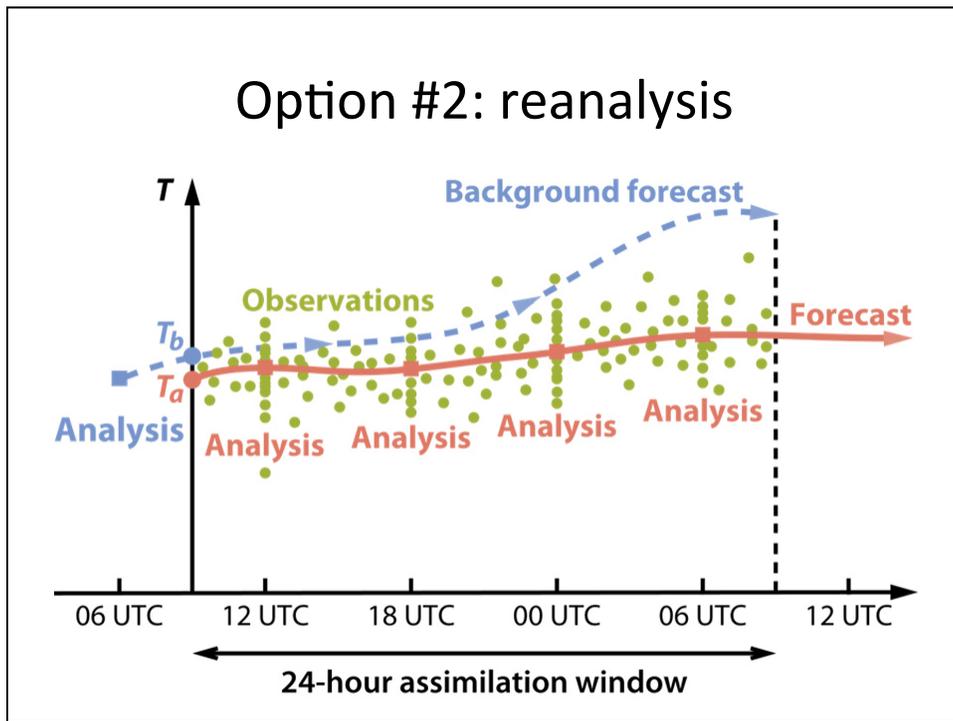
Extended Reconstruction Sea Surface Temperature
(ERSST v3b)
(Operational Mode: 1985 – Present)



Example from OISST

Daily Optimum Interpolation Sea Surface Temperature





Advantages & disadvantages of each type of data??

- Uninterpolated vs interpolated?
- Historical products vs reanalysis?