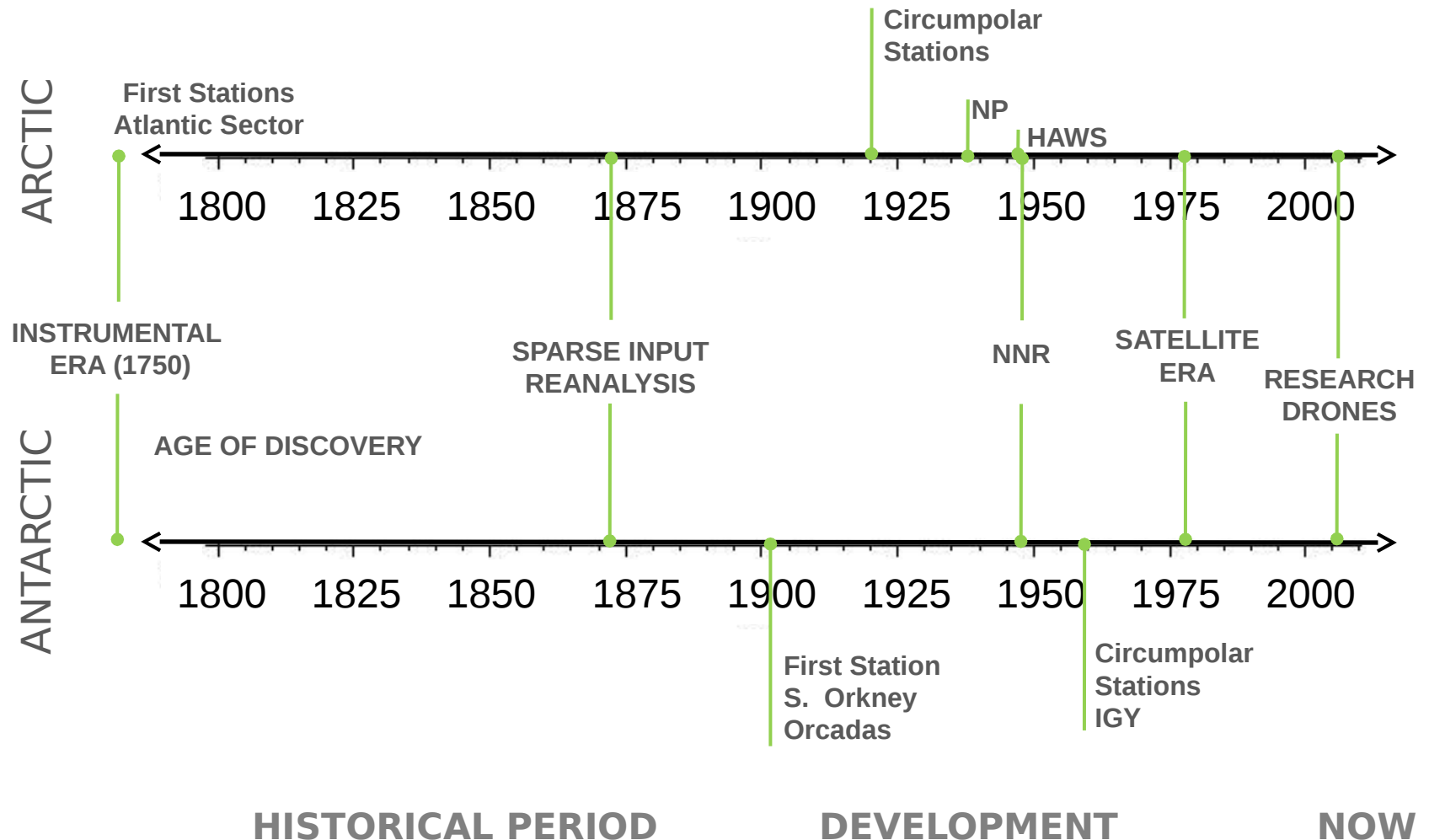


12 - 14 June 2013
Copenhagen

HIGH LATITUDE SURFACE TEMPERATURES

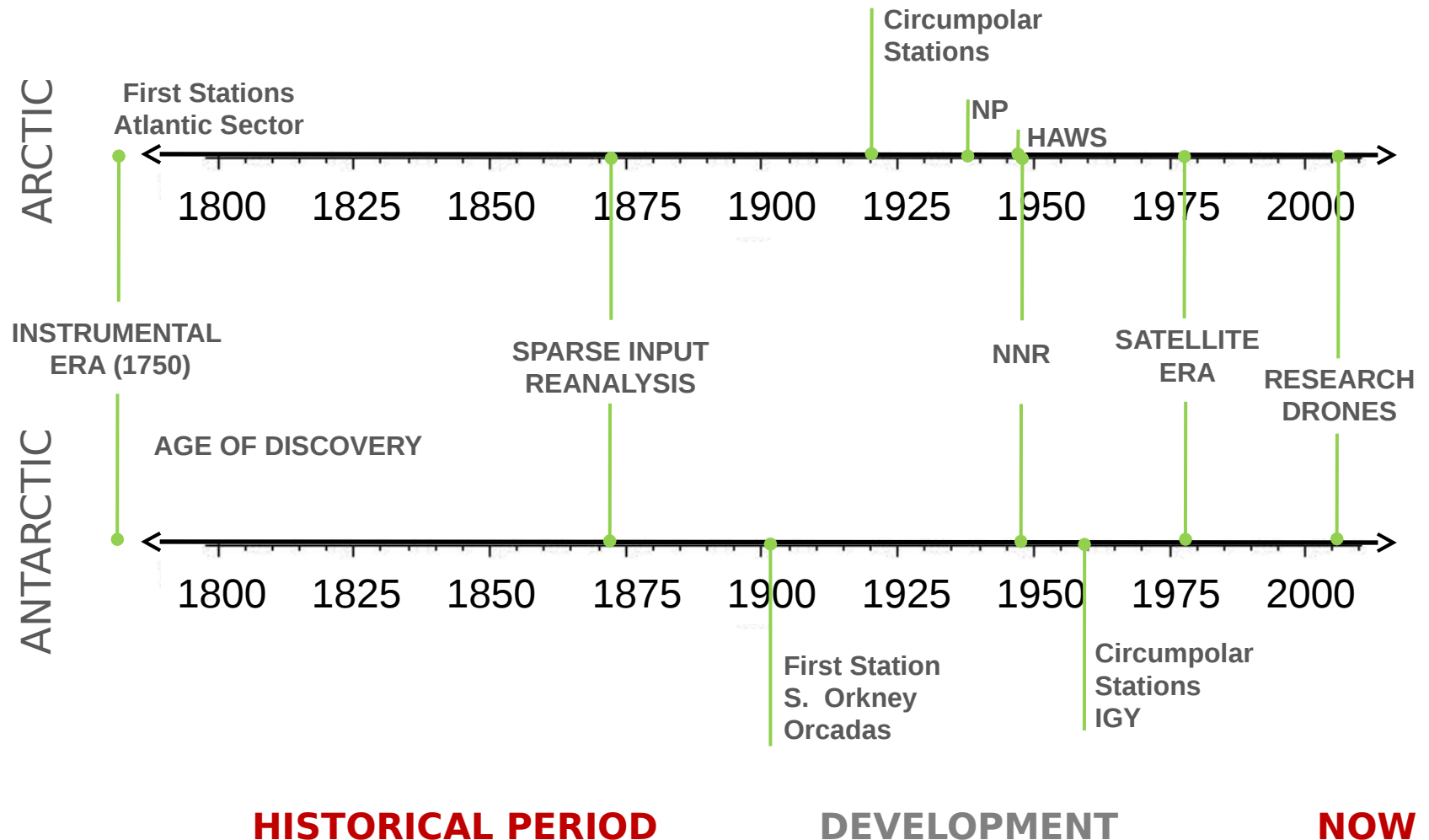
Synthesis
of data sets
and what
they tell us

Meteorology in the Polar Regions



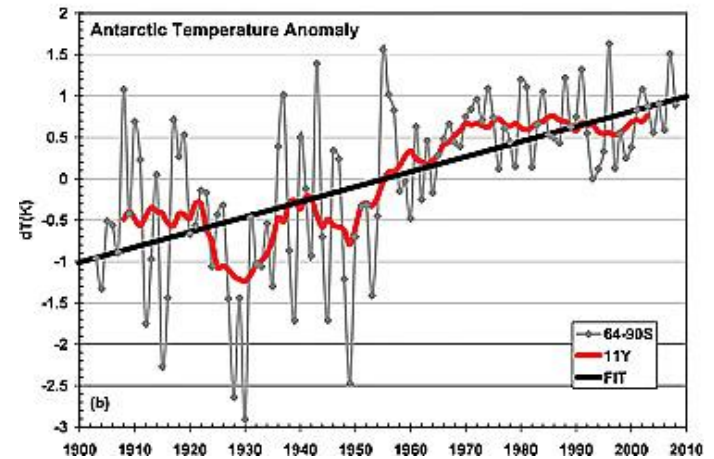
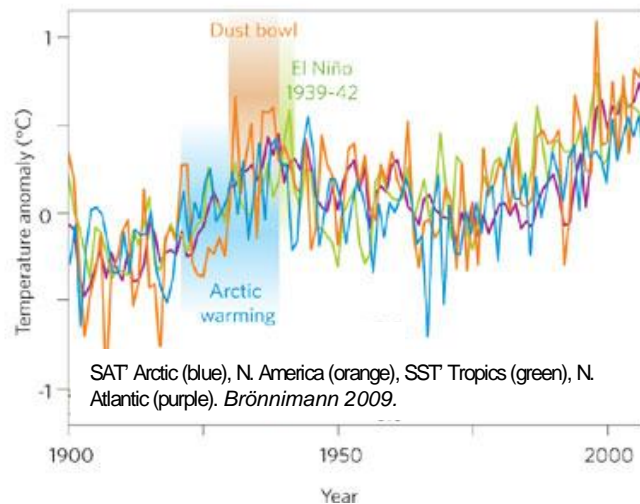
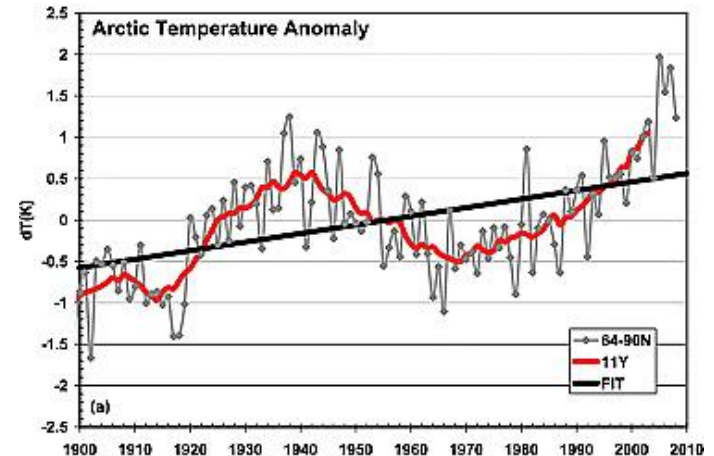
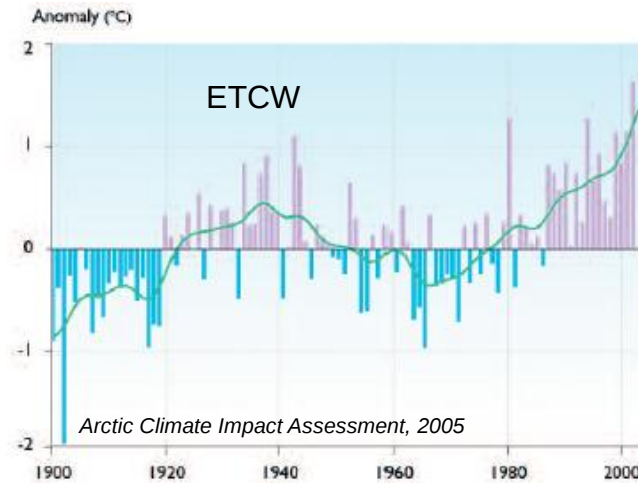
An **ever evolving** but **always sparse** constellation of assets

Meteorology in the Polar Regions



I'm going to focus on – and link – the historical period with the present

Historical period

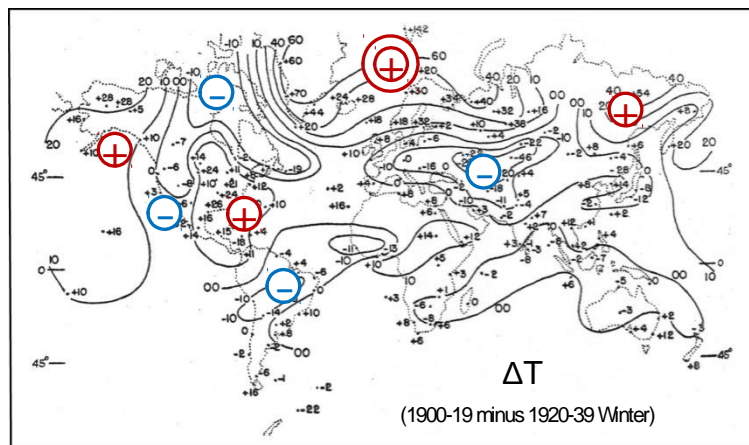


Chylek et al. 2010 (Derived from GISS)

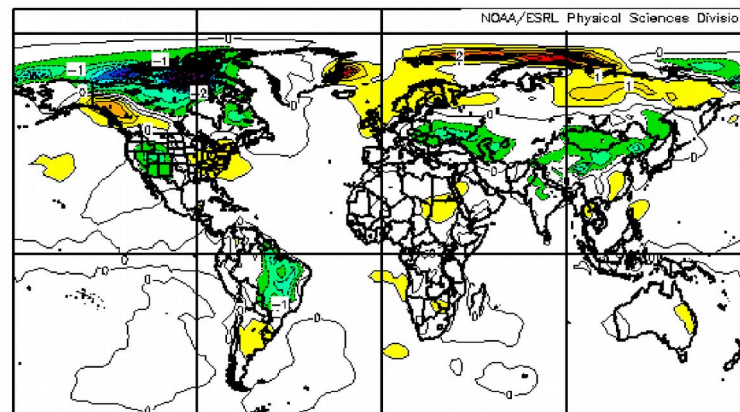
Are they representative of the **regions** as described?

Spatial pattern of ETCW

Willet 1950



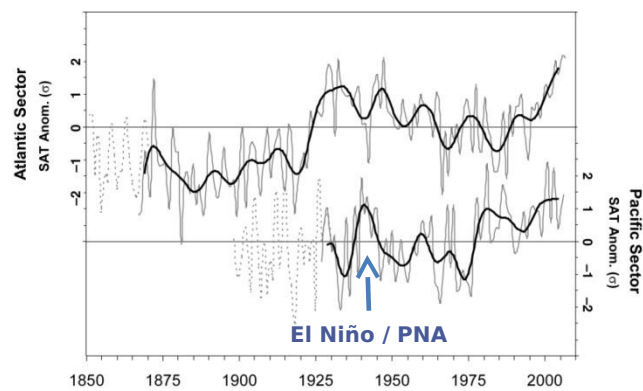
20CR V2



Dec to Mar: 1920 to 1939 minus 1900 to 1919



CRUTEM3v



- Largest SAT anomalies in the Atlantic – Arctic region
- Attribution: low-frequency climate oscillation (e.g. AMO) or red noise?
- Resolution confounded by lack of long marine-met & station records

Extended instrumental series



Atlantic-Arctic

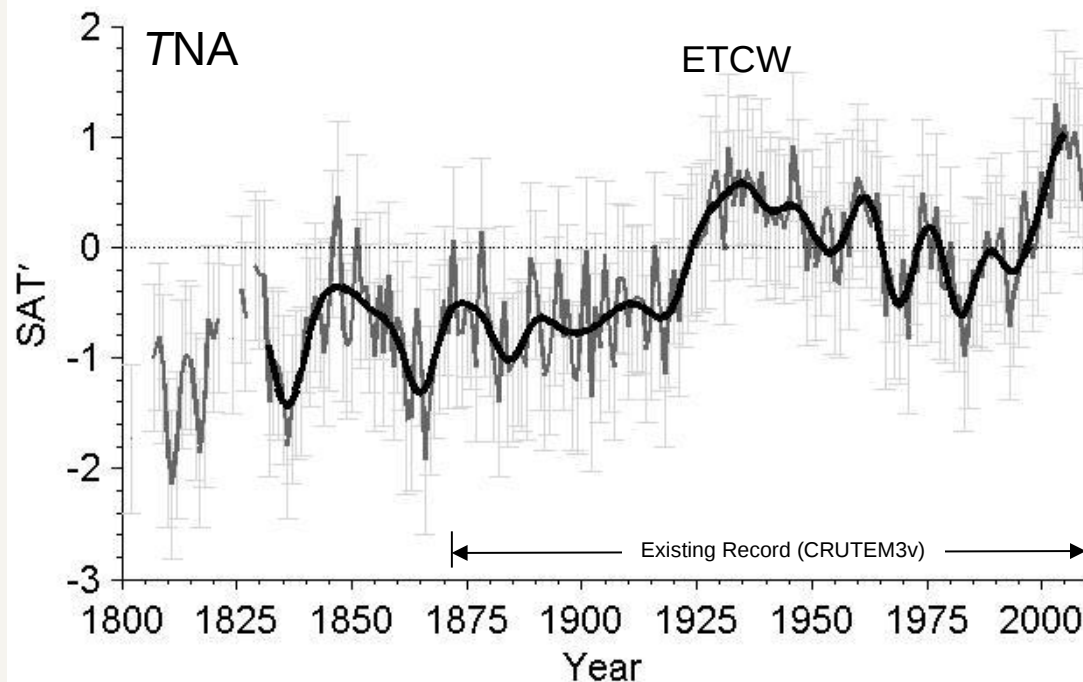
Station-based reconstruction

Calibrated on modern data

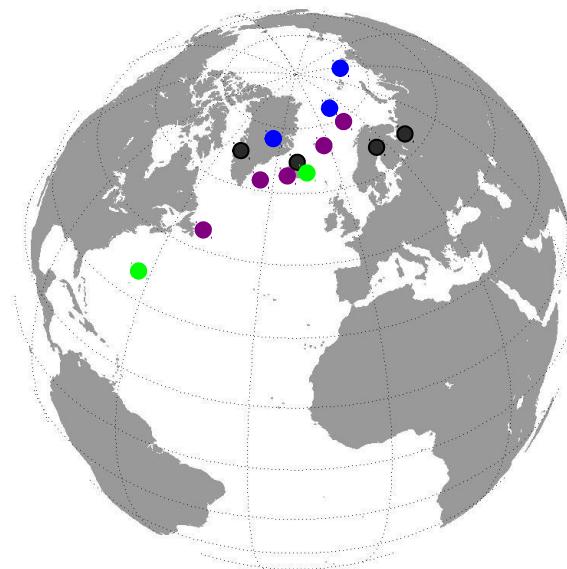
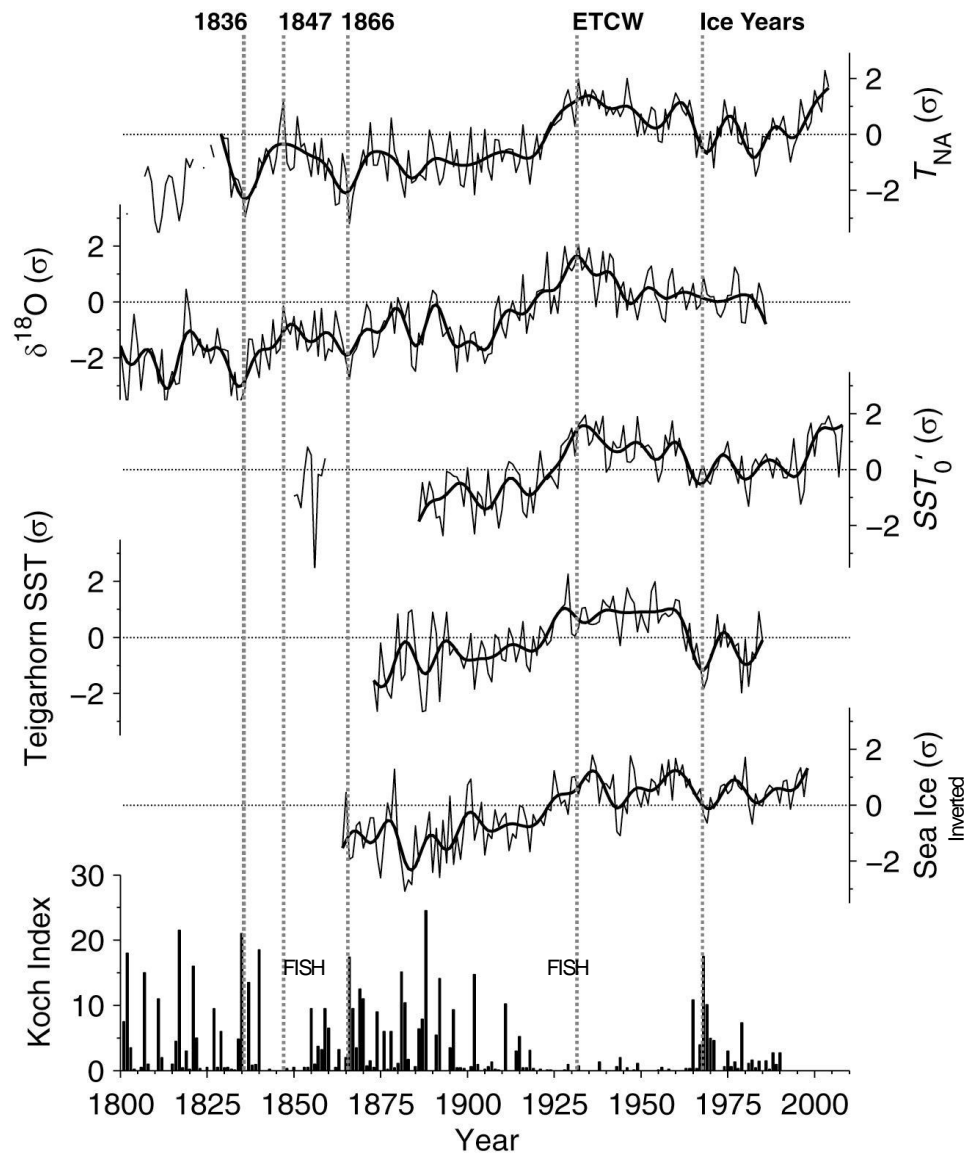
Correlation ≥ 0.95

Homogeneity questions

Independent confirmation



Credible?

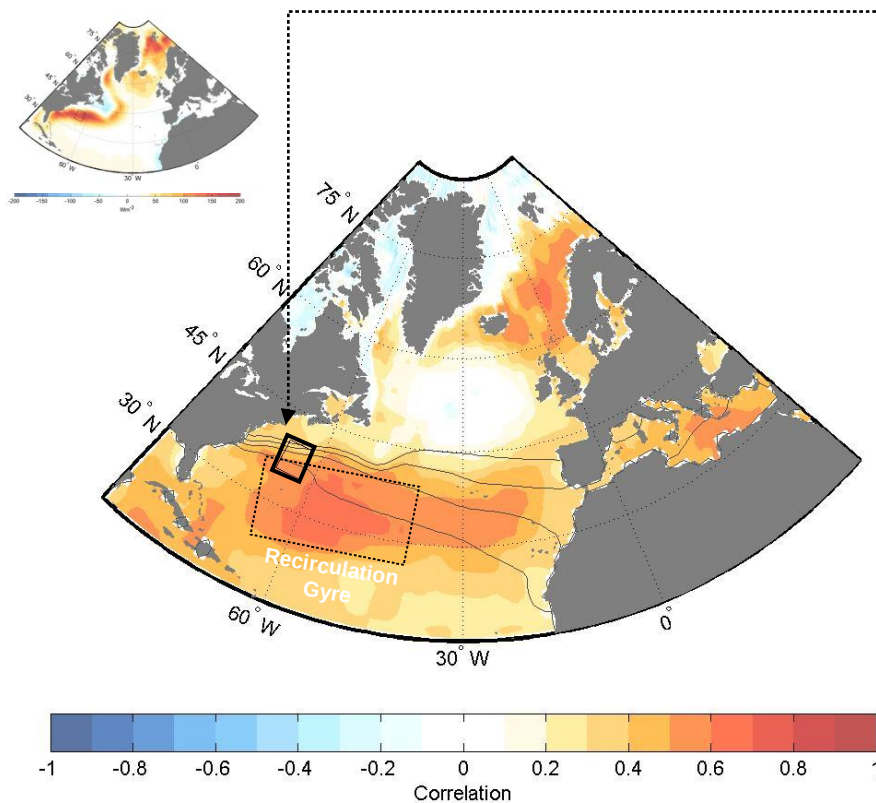


- Composite SAT locations
- Ice cores
- SST anomaly records
- Sea ice indexes

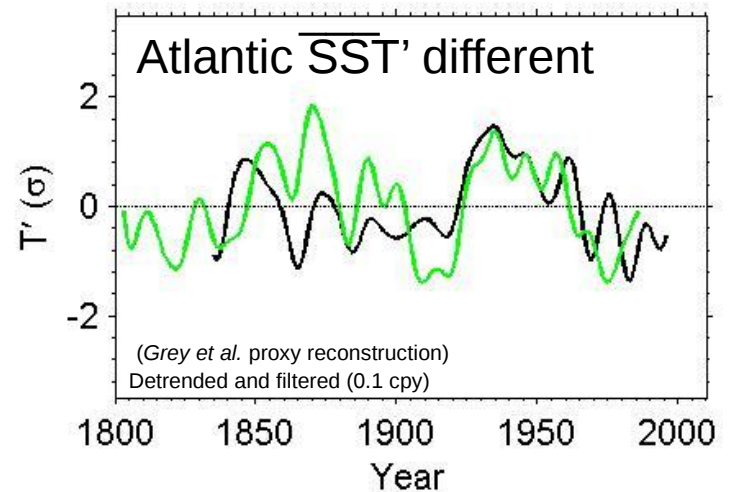
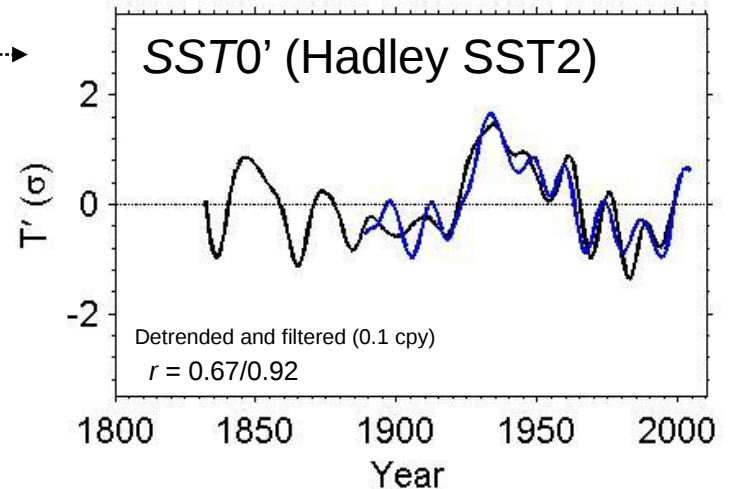
Correlation	$\delta^{18}\text{O}$	SST_0'	Teigarhorn SST'	Sea Ice
Annual	0.67	0.67	0.72	-0.64
Filtered ^a	0.82	0.92	0.85	-0.84

^aAs in Figure 1.

Mid-Atlantic connection



Hadley ISST
Contours: Mean SST' (16-22° C)



Fragments in time

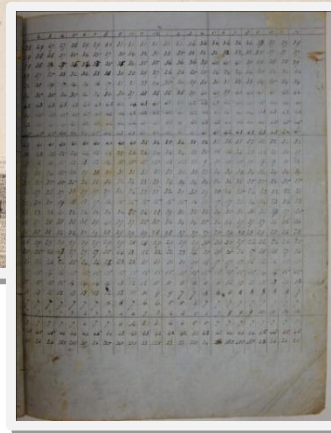
Most historical Arctic data are marine-met & temporary stations



HMS *Plover* intercomparison project

Problems:

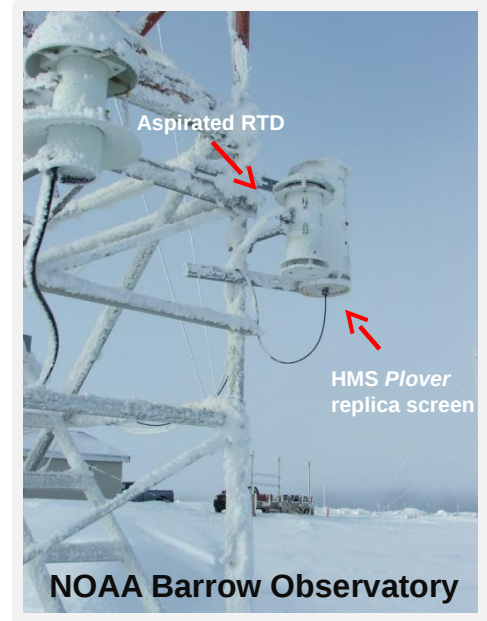
- Too cold for Hg LIG
- Calibration issues
- Strange exposures
- Various methods



Hourly SAT register

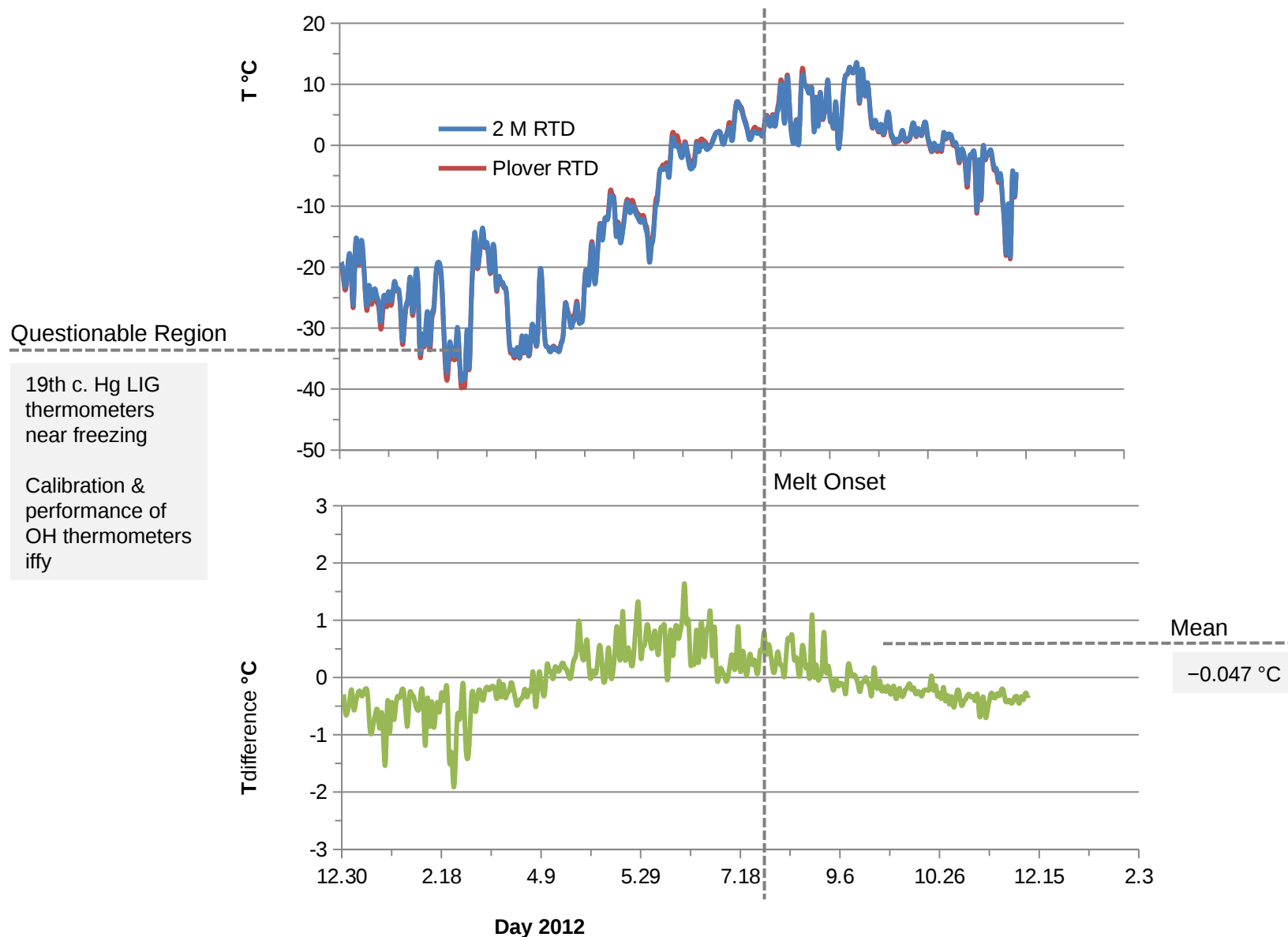
Metadata!

The spirit thermometer for use was placed in a tin cylinder $2\frac{1}{2}$ inches in diameter, with a longitudinal opening through which it could be easily read; this cylinder was kept in another of the same material which was painted white, seven inches in diameter, having a conical projecting roof, and a flat bottom, with numerous small openings in both, and a door opening like a common tin lantern: this again, with its door facing the north, was fixed to a stout stake, placed in the ice at a distance of 90 feet to the eastward of the ship. The arrangement so made was to protect the instrument from the wind and snow-drift, and from the influence of the sun, while admitting the easy access of air. To have placed it further from the ship would have been to put it in the way of natives, who might steal or break it; and as the ship's hull was banked round with snow, and the prevailing winds came in from the N.E., it was thought the effect of her presence on the thermometer at that distance would be little or none.

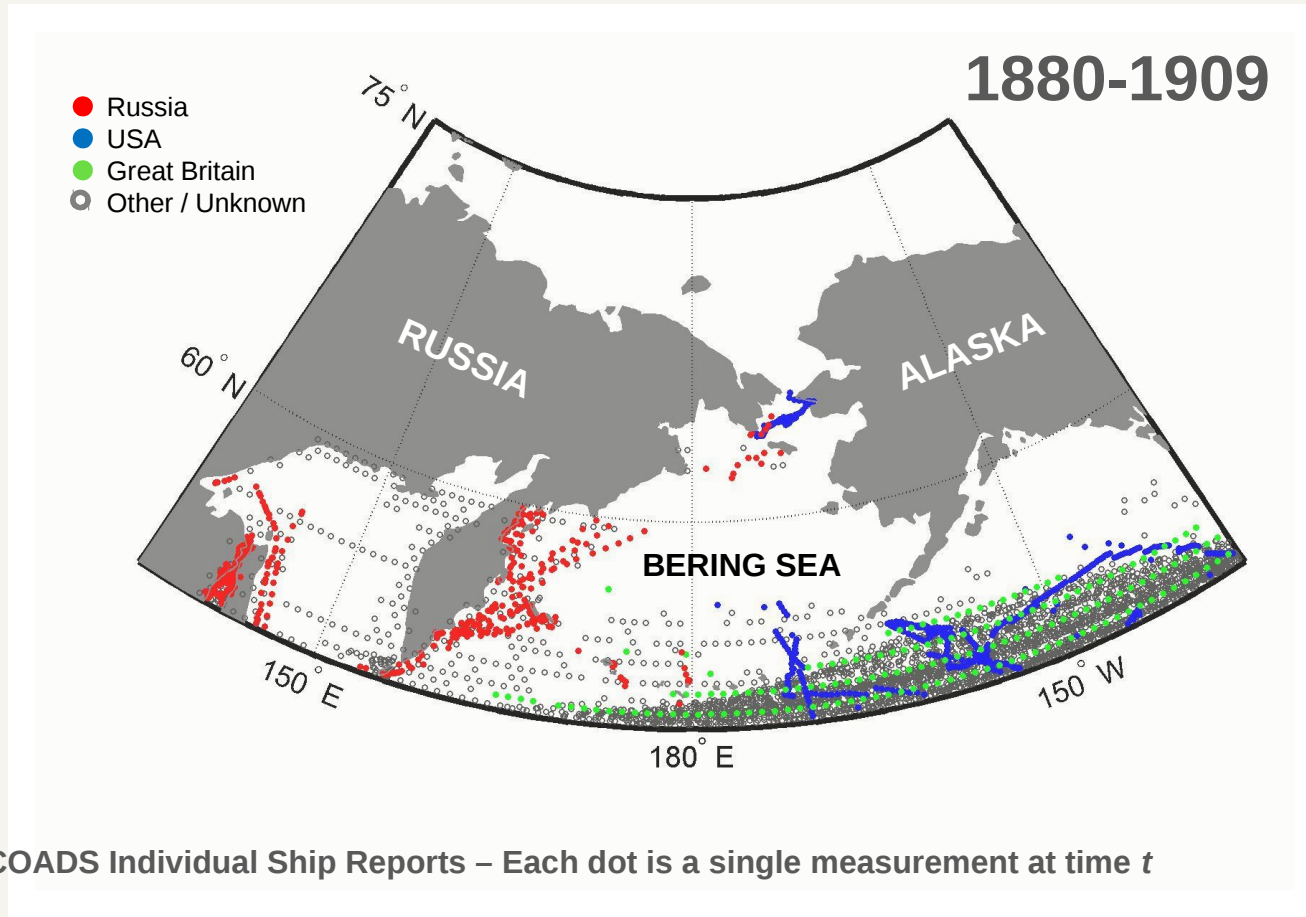


How **big** a problem?

Screen bias – not BIG



Much more data out there

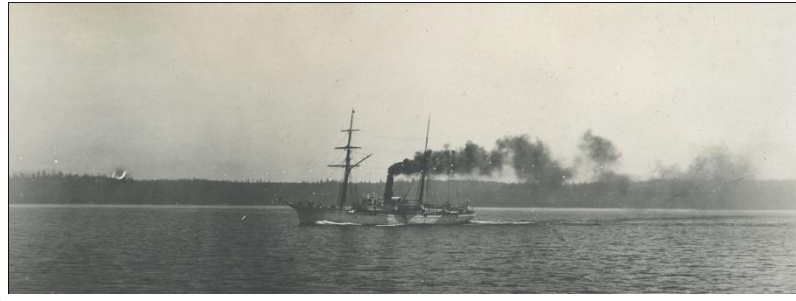


We know **many ships** were collecting hourly observations in this region...

Ships like these...



USRC *Bear*



USRC *Perry*



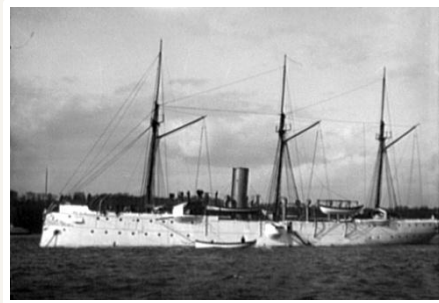
USCS *Patterson*



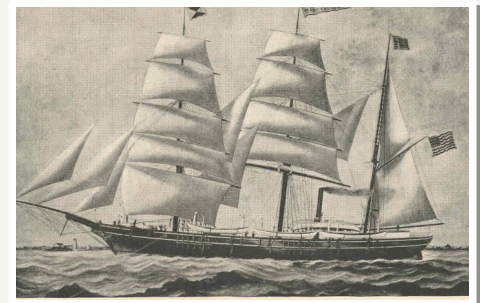
USRC *Corwin*



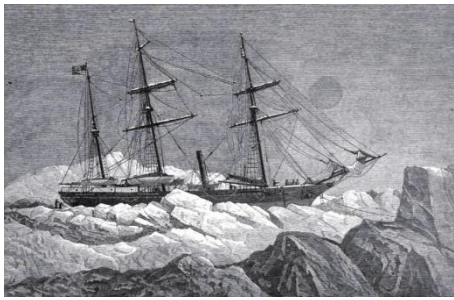
USS *Vicksburg*



USS *Yorktown*



USS *Rodgers*



USS *Jeannette*



USRC *Rush*

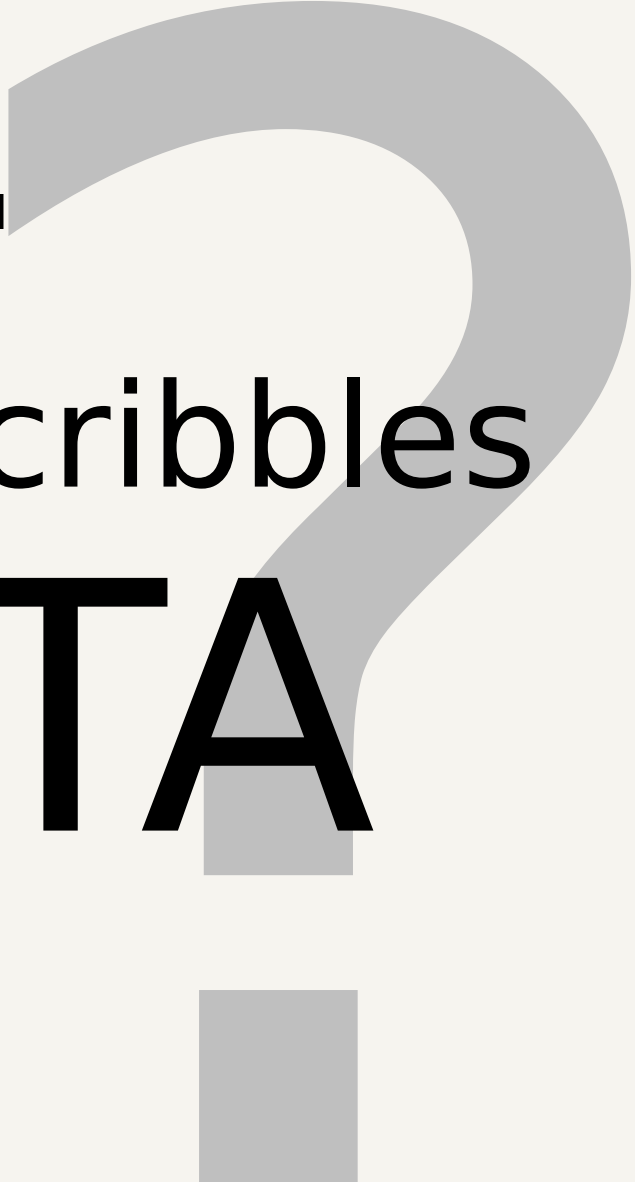


USS *Pinta*

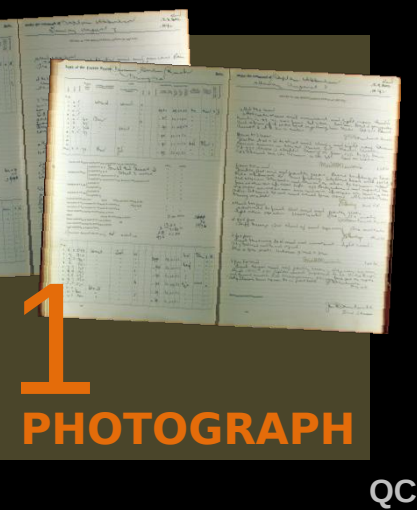


USRC *Thetis*

HOW do
you
get
all those scribbles
turned
into
DATA



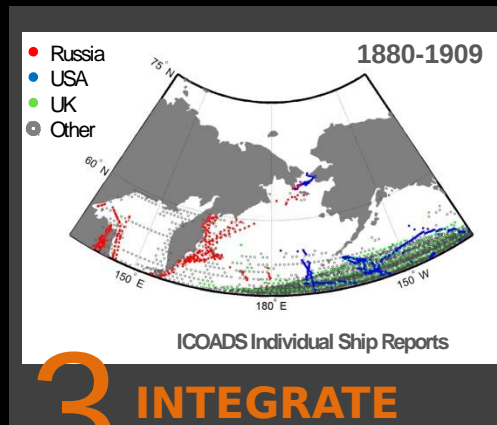
End-to-end data rescue



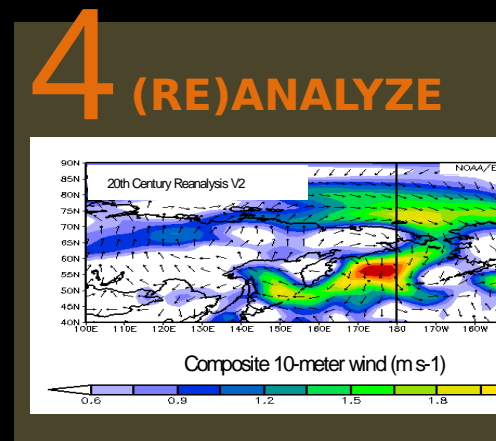
QC



QC



QC



Handwriting

10x Efficient

Faster

More accurate

Higher resolution



1881

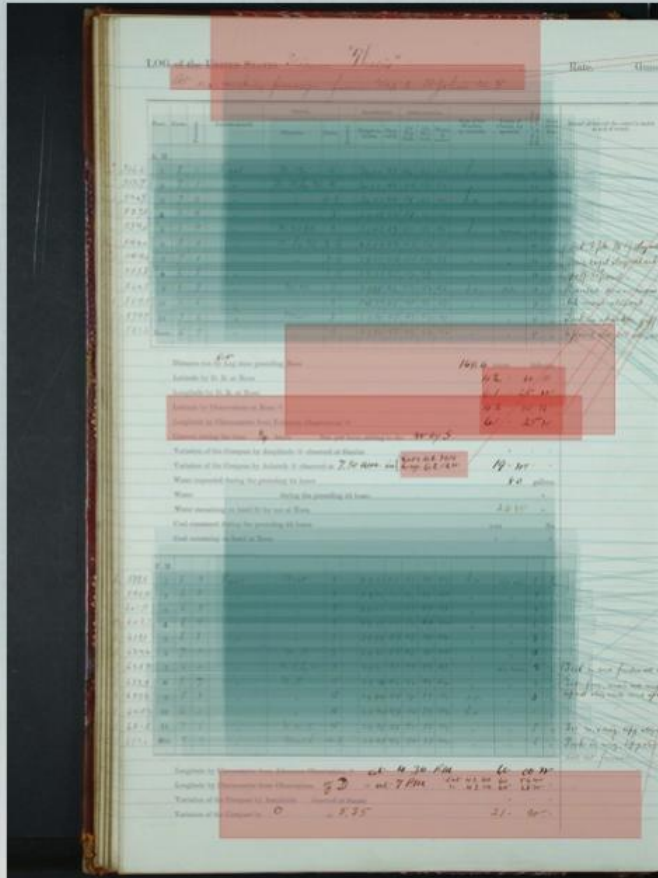


Today

Old Weather – Arctic

275,000 pages photographed –
23 million new-to-science observations
25,000 pages transcribed so far

Looks like this:



Position: latitude: 42 44 N
longitude: 61 25 W
port: XX

	Air	Bulb	Sea	Bar	Attc	Wind	Force	Code
01:	46	: 46	: 44	: 30.02	: 45	: nw	: 4	: b
02:	44	: 44	: 40	: 30.02	: 44	: nwxn	: 4	: b
03:	41	: 40	: 40	: 30.01	: 44	: nwxn	: 4-3	: bc
04:	41	: 40	: 40	: 29.98	: 44	: nwxn	: 3	: bc
05:	41	: 41	: 40	: 29.98	: 43	: nnw	: 3	: b
06:	42	: 42	: 43	: 29.99	: 43	: nxw	: 3-4	: b
07:	44	: 44	: 43	: 29.99	: 44	: nxw	: 3-4	: b
08:	42	: 42	: 41	: 29.99	: 45	: nxw	: 3-4	: b
09:	42	: 42	: 40	: 29.98	: 46	: nw	: 3	: bc
10:	41	: 41	: 40	: 29.97	: 46	: nw	: 3	: bc
11:	43	: 42	: 40	: 29.95	: 48	: w	: 3	: bc
12:	43	: 42	: 40	: 29.95	: 48	: w	: 3	: bc
13:	46	: 45	: 44	: 29.93	: 46	: w	: 3	: bc
14:	46	: 45	: 44	: 29.92	: 45	: w	: 3	: bc
15:	47	: 47	: 43	: 29.91	: 49	: w	: 3	: bc
16:	50	: 49	: 44	: 29.88	: 48	: w	: 3	: bc
17:	46	: 45	: 44	: 29.88	: 49	: w	: 3	: bc
18:	46	: 45	: 44	: 29.90	: 52	: ne	: 3	: bc
19:	43	: 43	: 43	: 29.91	: 51	: nexn	: 3	: bc
20:	40	: 40	: 42	: 29.92	: 46	: ne	: 4	: bc
21:	40	: 39	: 42	: 29.94	: 44	: ne	: 4	: oc
22:	40	: 39	: 42	: 29.94	: 43	: ne	: 4	: bc
23:	40	: 39	: 42	: 29.95	: 43	: nne	: 4	: bc
24:	39	: 38	: 42	: 29.95	: 42	: n	: 4-5	: bc

500dc361cd0db4000200006d

What can we expect?

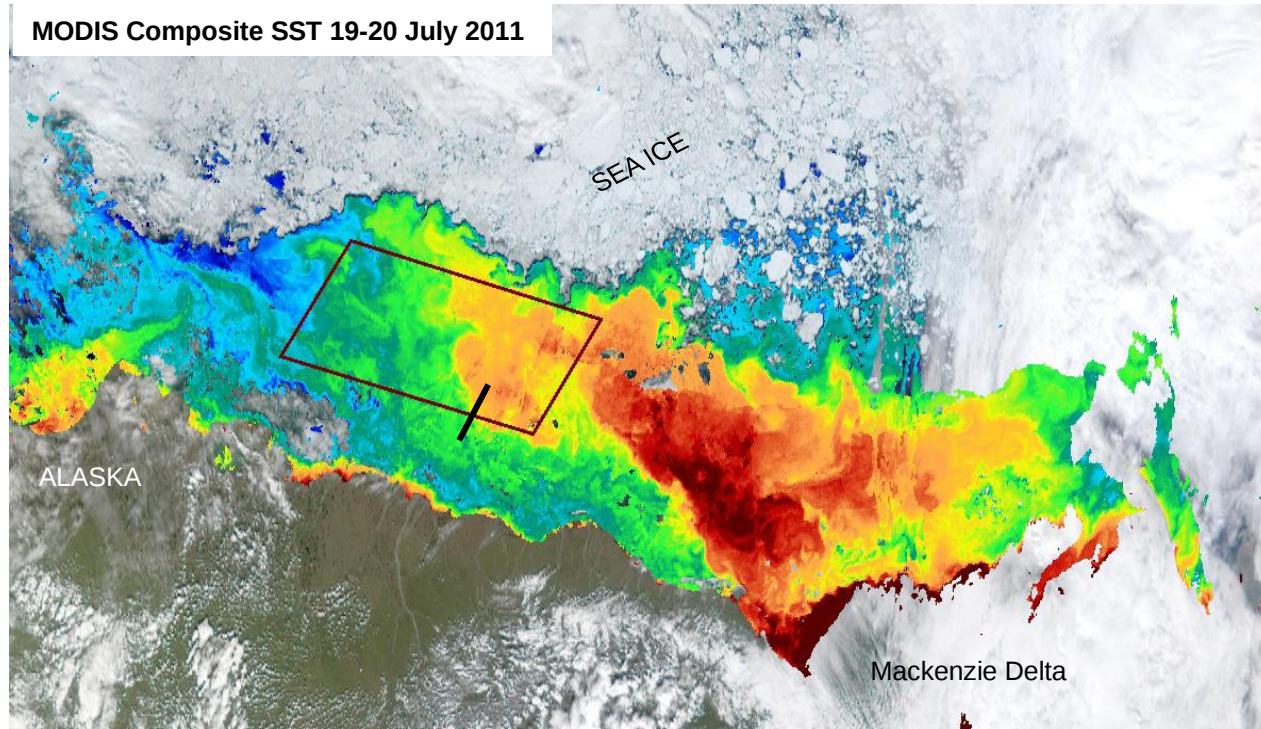
- New-to-science data in the Pacific – Arctic 1849 on
- Perspective on change in large-scale sea ice dynamics
- Fill in data gaps around WW1 and WW2
- Extended SST/wx records in times and regions where now limited

Transcribed observations are currently being used in at least 4 reanalyses:

- 20CR V3 (Gil Compo, Colorado)
- ERA-Clim (Dick Dee, ECMWF)
- SODA (Ben Geise, Texas A&M)
- HURDAT (Chris Landsea, NOAA)

They are also being used for verification of HadISST2...*and more*

Now: emerging phenomena?



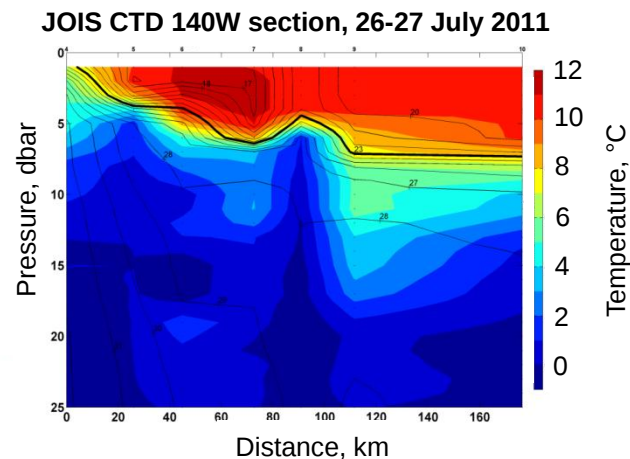
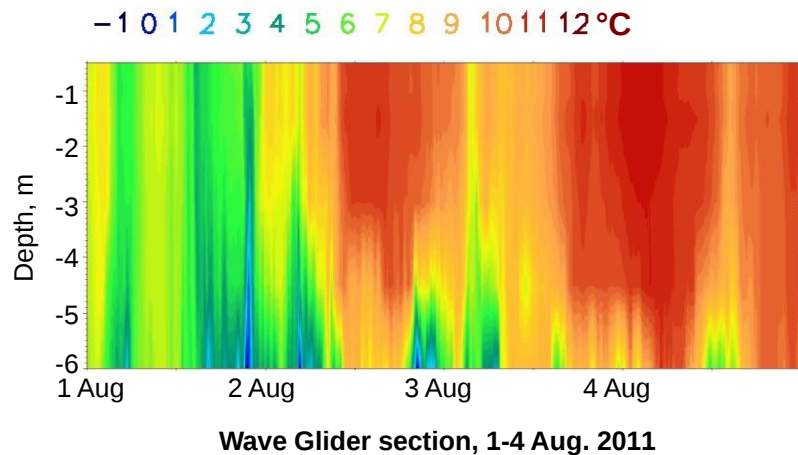
FACTORS

Anomalous
easterly winds

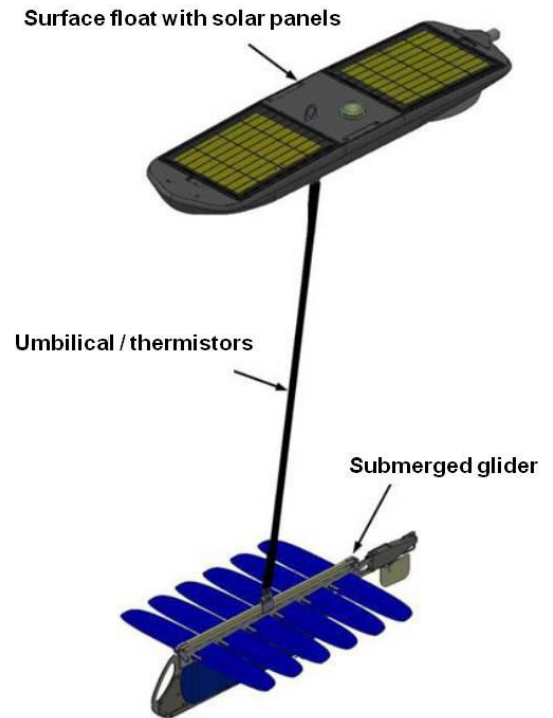
Sea ice
in motion

Runoff entrained
under sea ice
(129 of 246 km³)

Rapid
advection
stratification
heating
sea ice melt

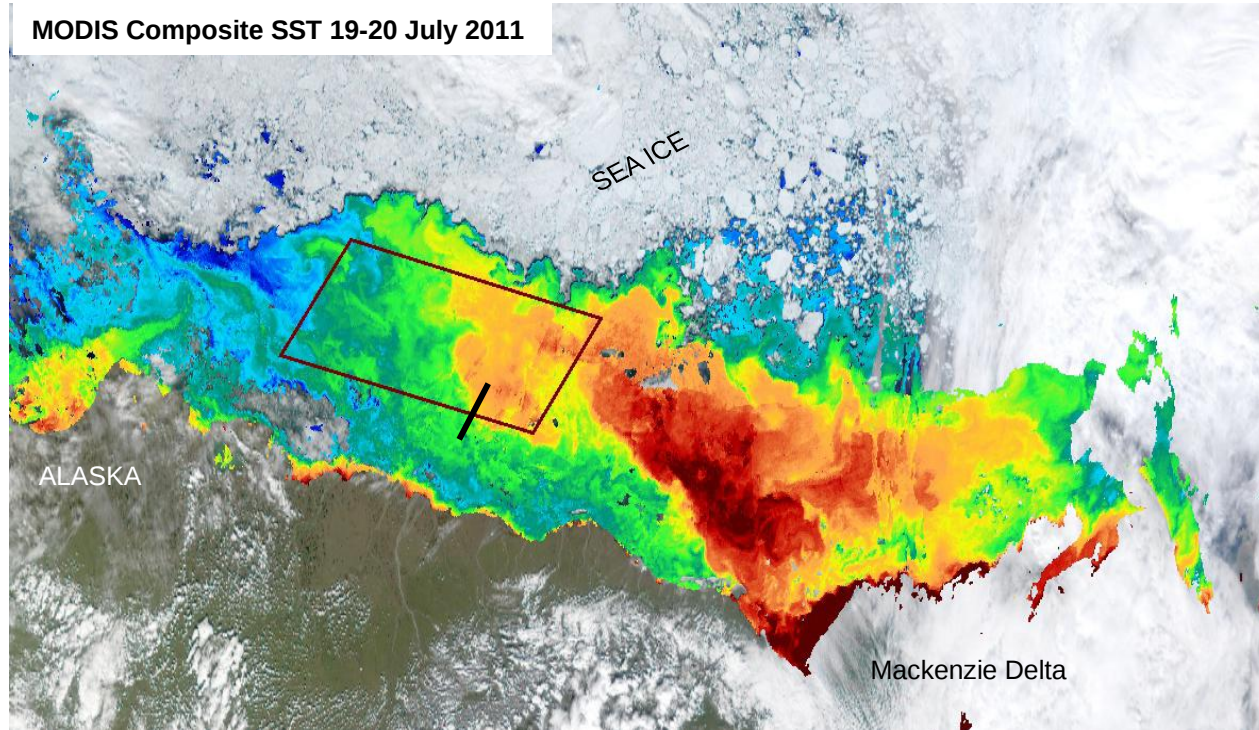


Arctic Wave Glider



Now: emerging phenomena?

MODIS Composite SST 19-20 July 2011



FACTORS

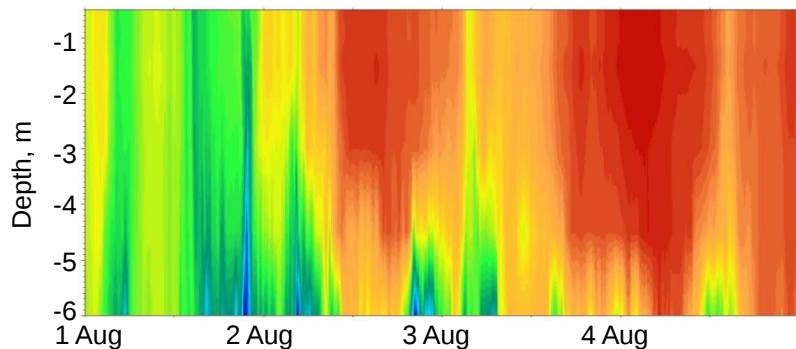
Anomalous
easterly winds

Sea ice
in motion

Runoff entrained
under sea ice
(129 of 246 km³)

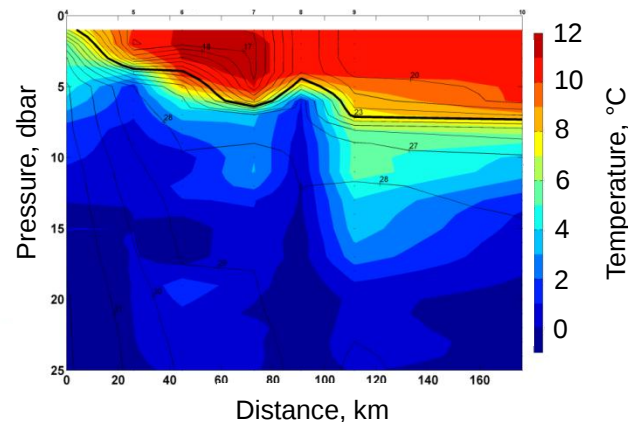
Rapid
advection
stratification
heating
sea ice melt

-1 0 1 2 3 4 5 6 7 8 9 10 11 12°C



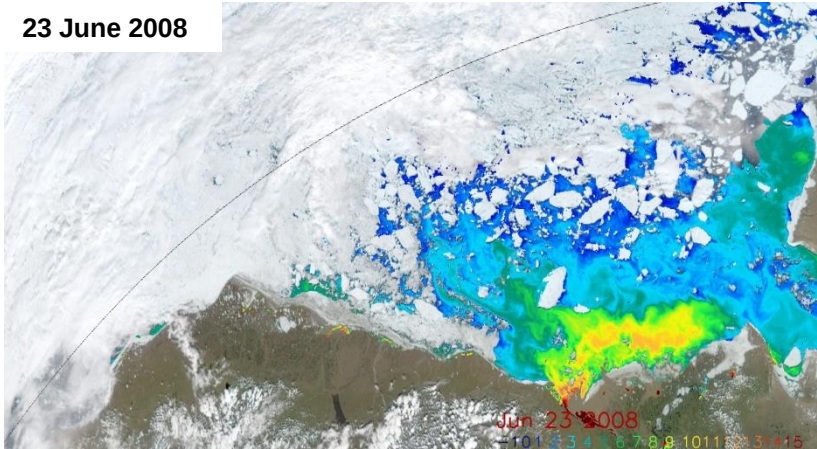
Wave Glider section, 1-4 Aug. 2011

JOIS CTD 140W section, 26-27 July 2011

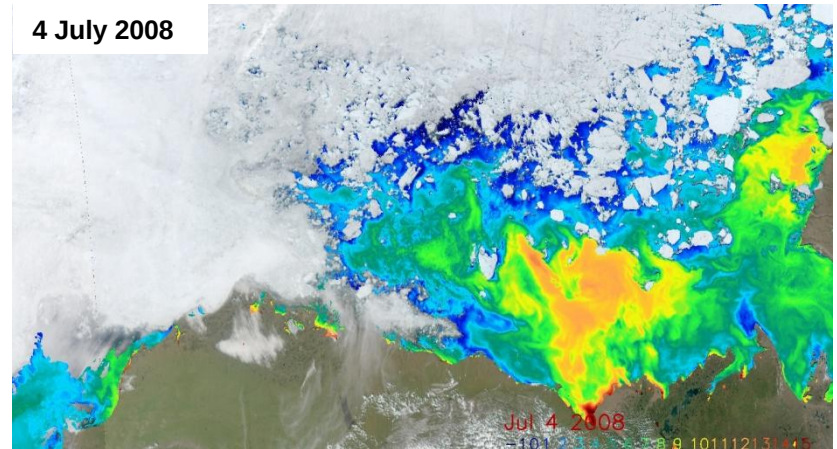


Three weeks in July

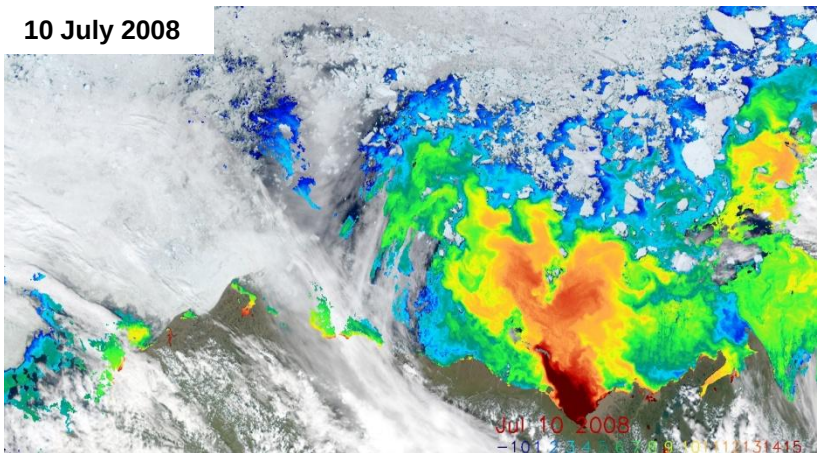
23 June 2008



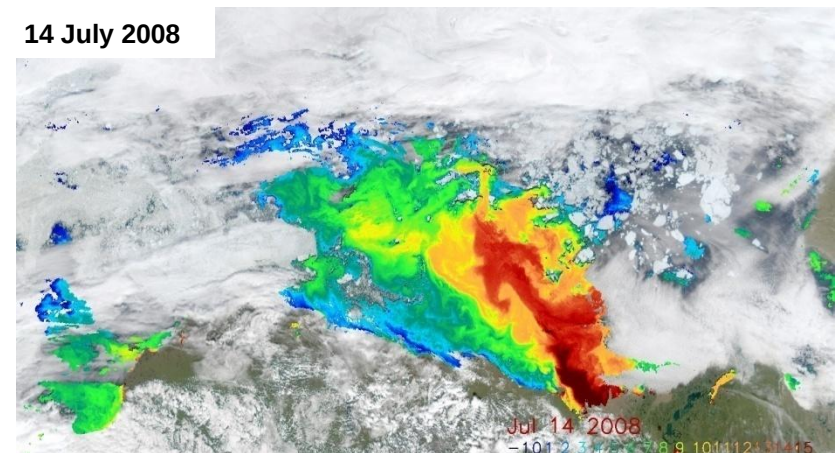
4 July 2008



10 July 2008



14 July 2008



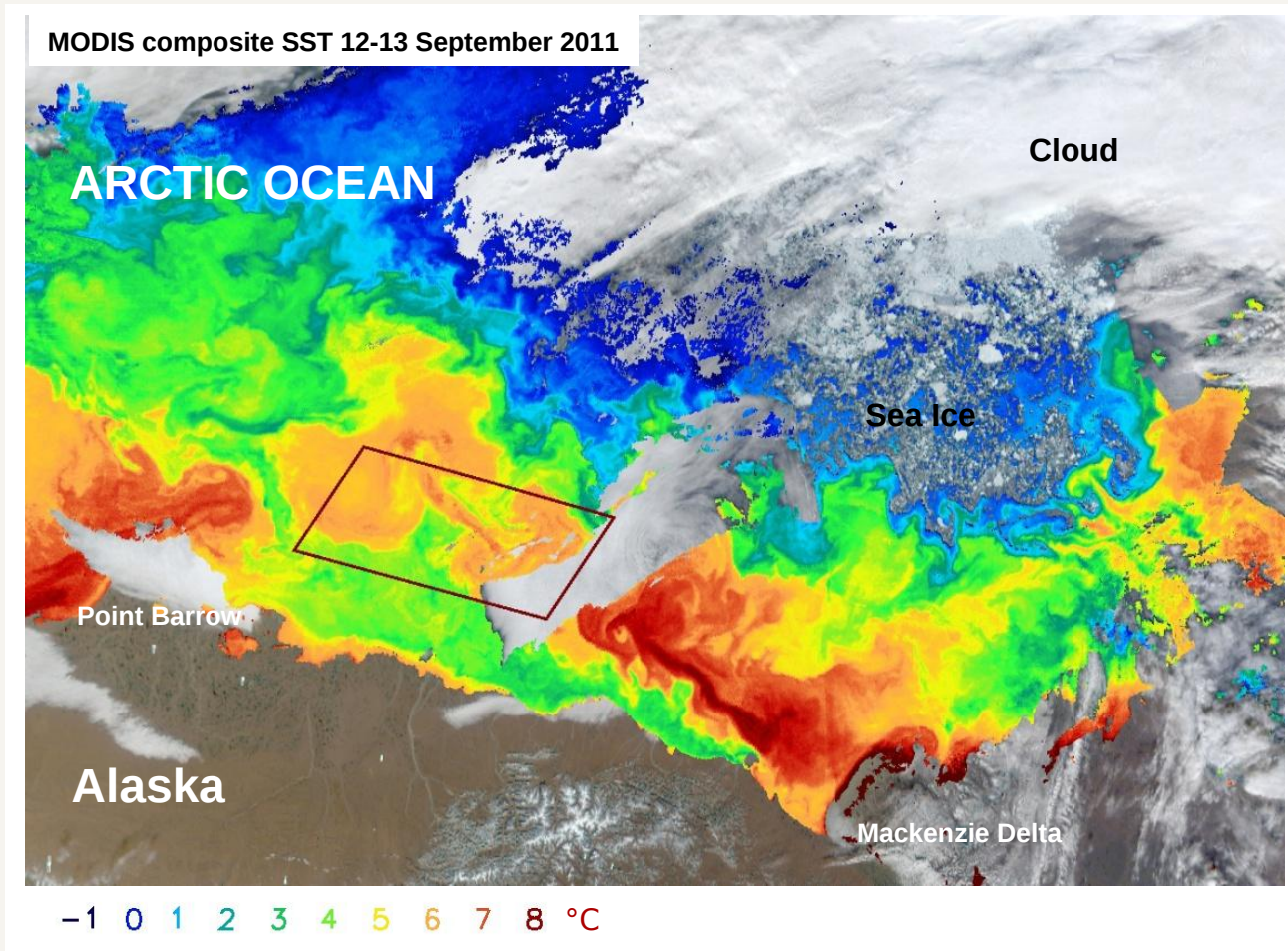
MODIS sequence shows rapid warming (~ 0.5 °C day⁻¹) under clear-sky conditions

Animations at:

http://www.pmel.noaa.gov/arctic/glider/movies/mackenzie_composite_2008.mp4

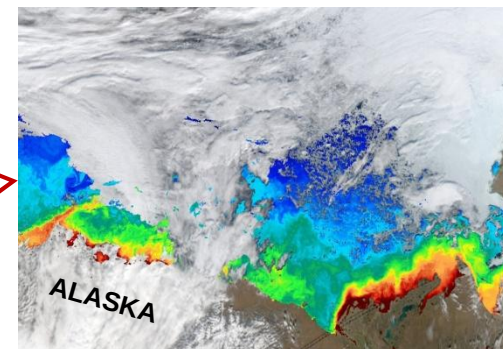
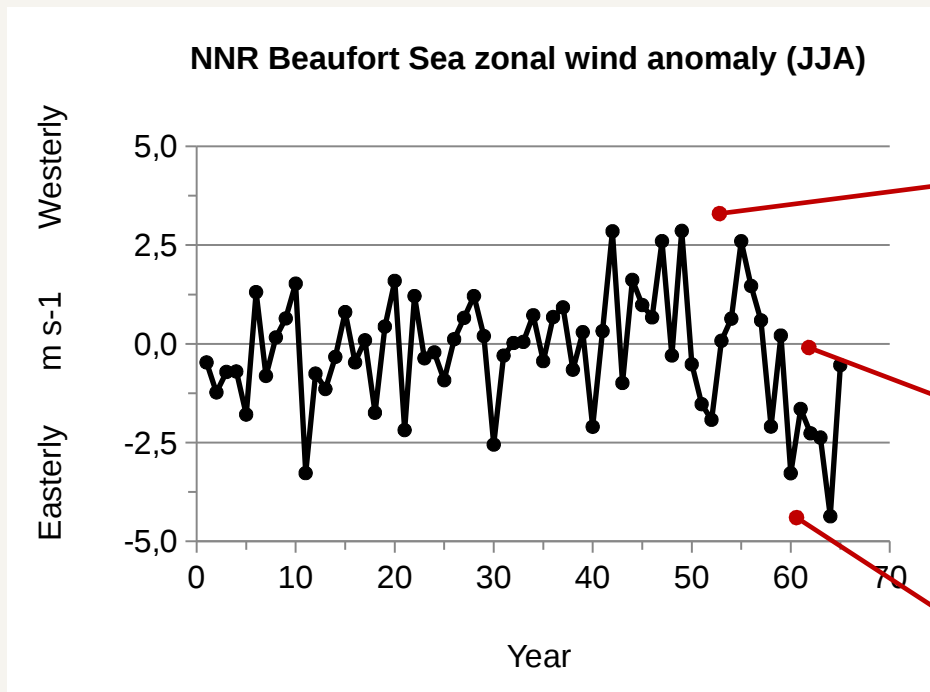
http://www.pmel.noaa.gov/arctic/glider/movies/mackenzie_composite_2008.wmv

Leads to...

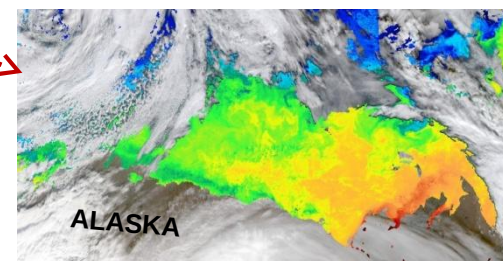


...unseasonable warmth into freeze-up
(and melt potential equivalent to annual Bering Strait inflow)

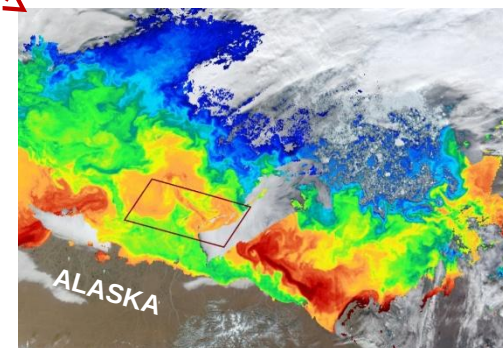
Variations



7 September 2002



17-21 September 2012

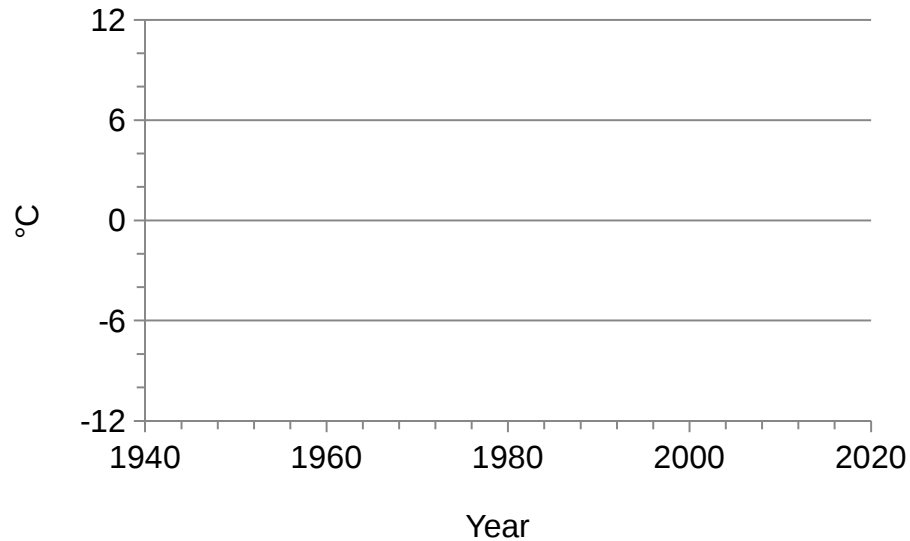


12-13 September 2011

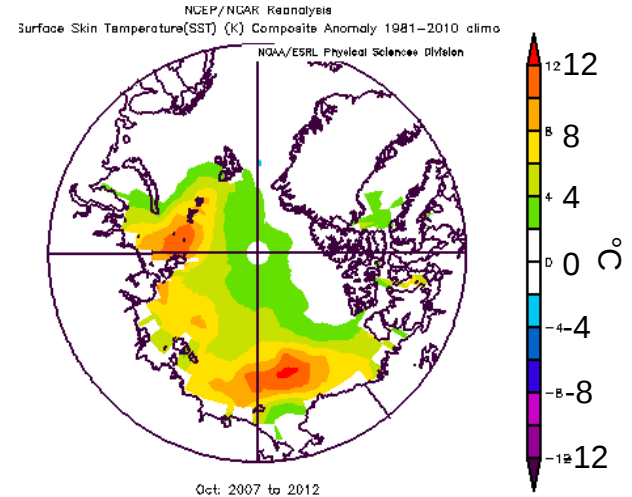
Plume sensitivity to winds...
probably increases as ice pack becomes more mobile in the early summer

Now – in context

Temperature anomaly at freeze-up (Oct)



Black = 1000 hPa over-ocean temperature (NCEP-DOE R-2)
Grey = Barrow WSO SAT from GHCN-D



Mean NNR surface skin temperature difference in October for the period 2007-2012 compared to climatology

Not so chilly.

How it fits together

- There are emerging and/or newly observable temperature phenomena in the Polar Regions – how does this inform interpretations based on the historical record?
- Most Arctic historical data is useful given suitable attention to limitations – but some is worthless.
- Essential to understand both the distribution and quality of the data underlying any representation of regional temperatures – without which misleading results are guaranteed.

How it fits together

- There are emerging and/or newly observable temperature phenomena in the Polar Regions – how does this inform interpretations based on the historical record?
- Most Arctic historical data is useful given suitable attention to limitations – but some is worthless.
- Essential to understand both the distribution and quality of the data underlying any representation of regional temperatures – without which misleading results are guaranteed.
- Next – NOAA Hurricane Hunter heads to the Arctic to get a better look at autumn storms and heat flux over the Beaufort/Chukchi Seas.

