Characterising surface temperatures in data-sparse and extreme regions (with focus on high-latitude domains)

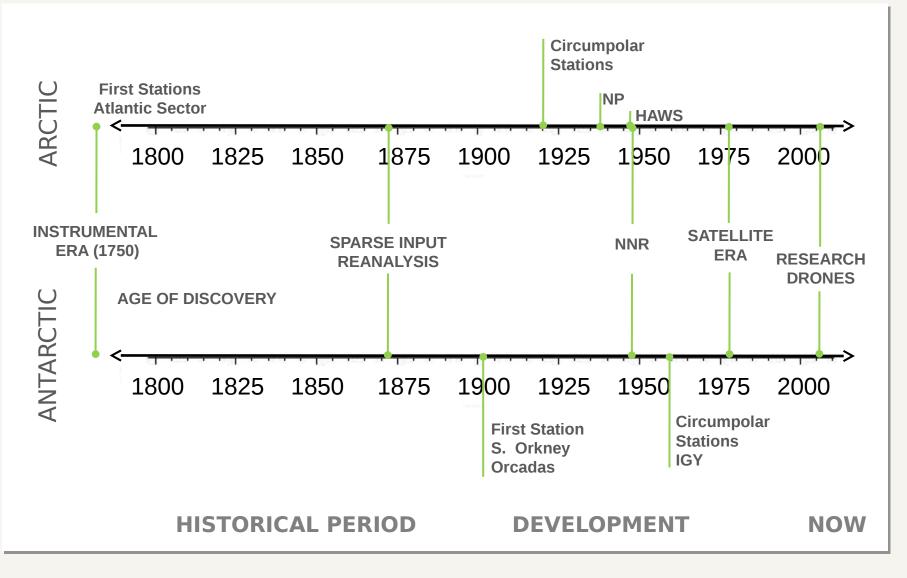
12 - 14 June 2013 Copenhagen

# HIGH LATITUDE SURFACE TEMPERATURES

Synthesis of data sets and what they tell us

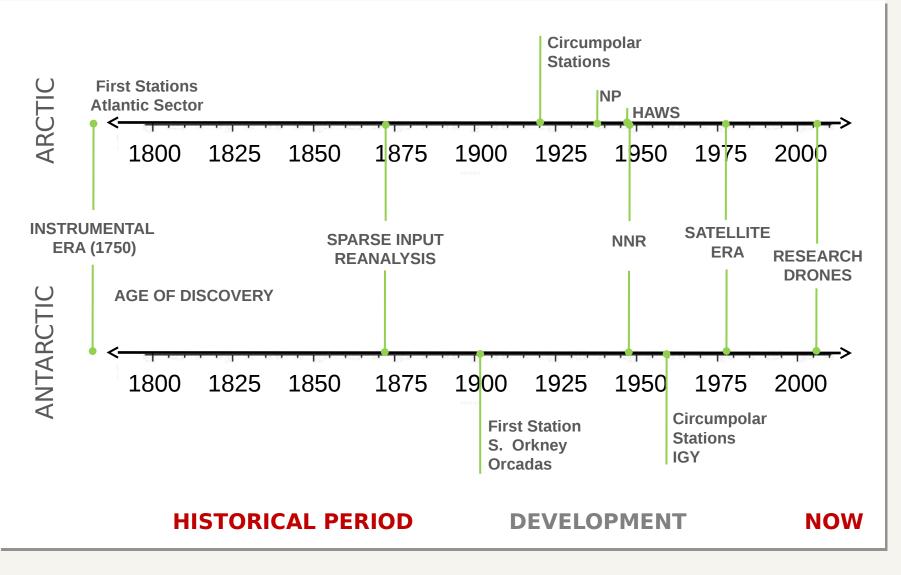


# Meteorology in the Polar Regions



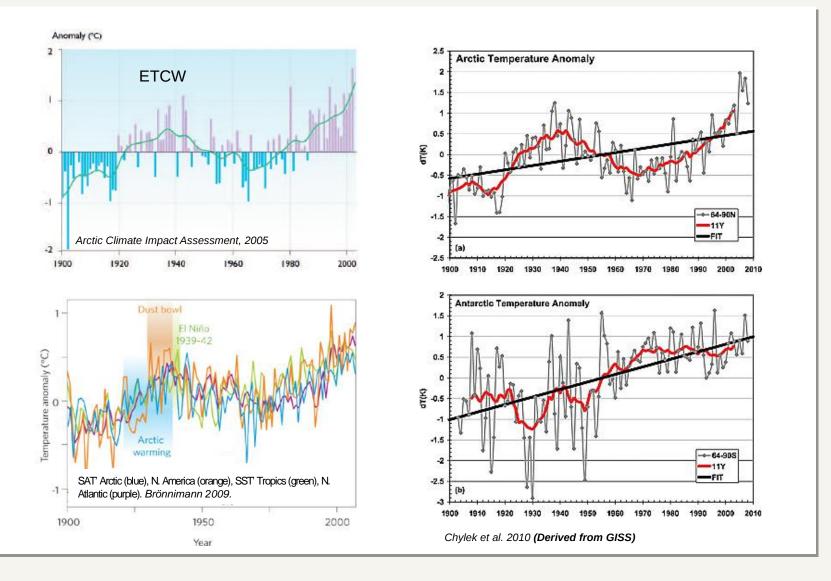
An ever evolving but always sparse constellation of assets

# Meteorology in the Polar Regions



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

### Historical period

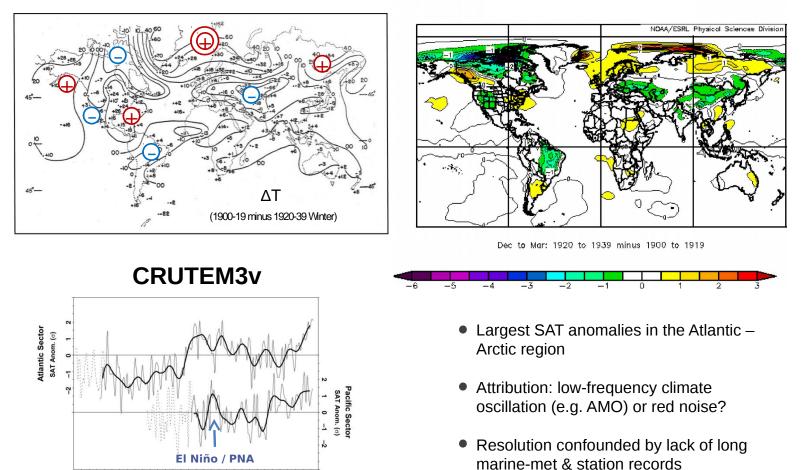


Are they representative of the **regions** as described?

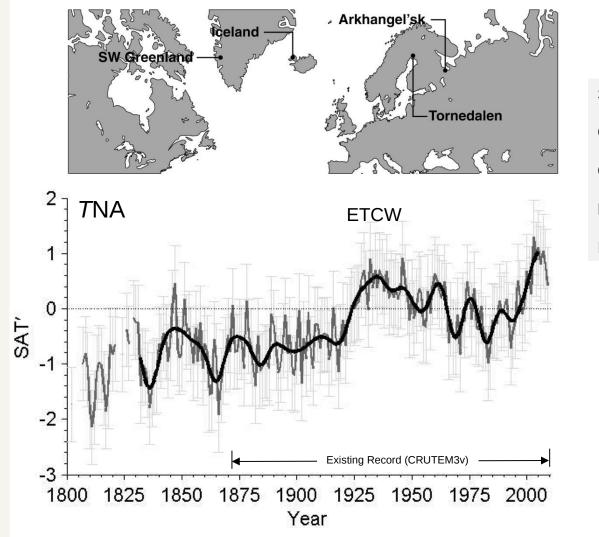
#### Spatial pattern of ETCW

#### Willet 1950

#### 20CR V2



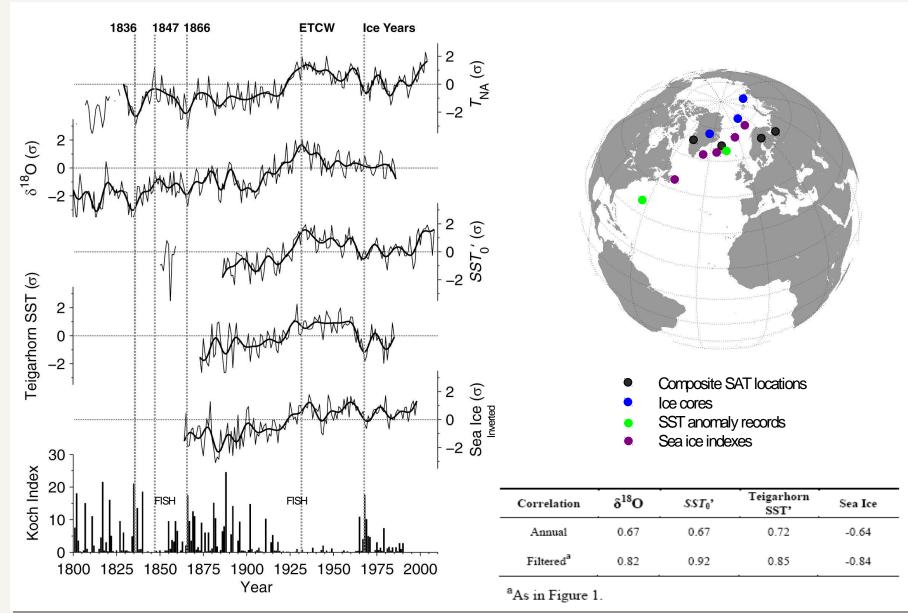
### Extended instrumental series



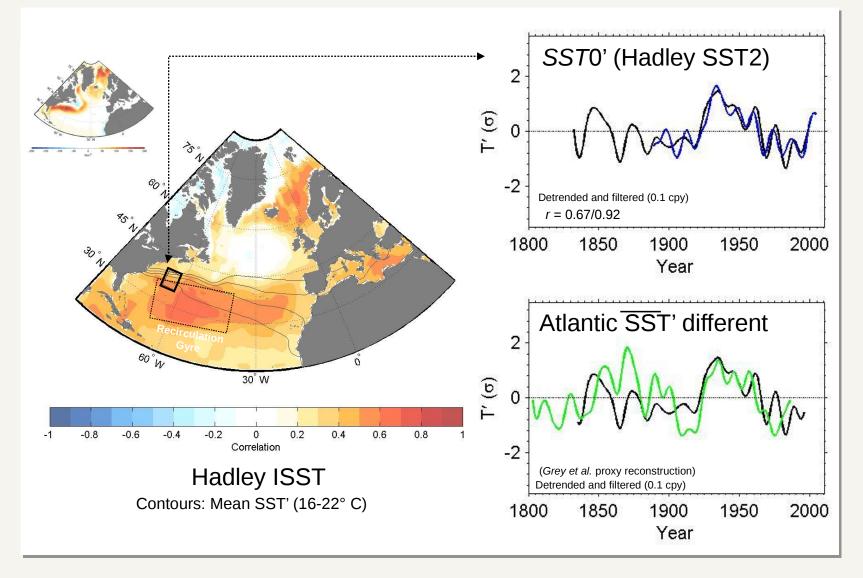
#### Atlantic-Arctic

Station-based reconstruction Calibrated on modern data Correlation ≥ 0.95 Homogeneity questions Independent confirmation

#### Credible?

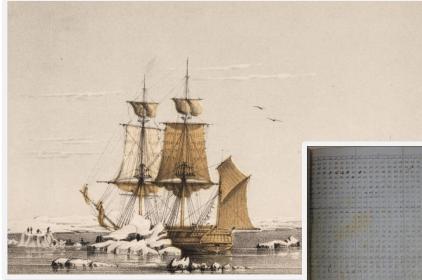


#### Mid-Atlantic connection



### 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

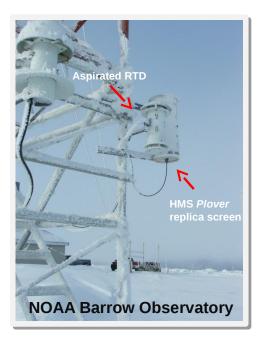
Various methods



Hourly SAT register

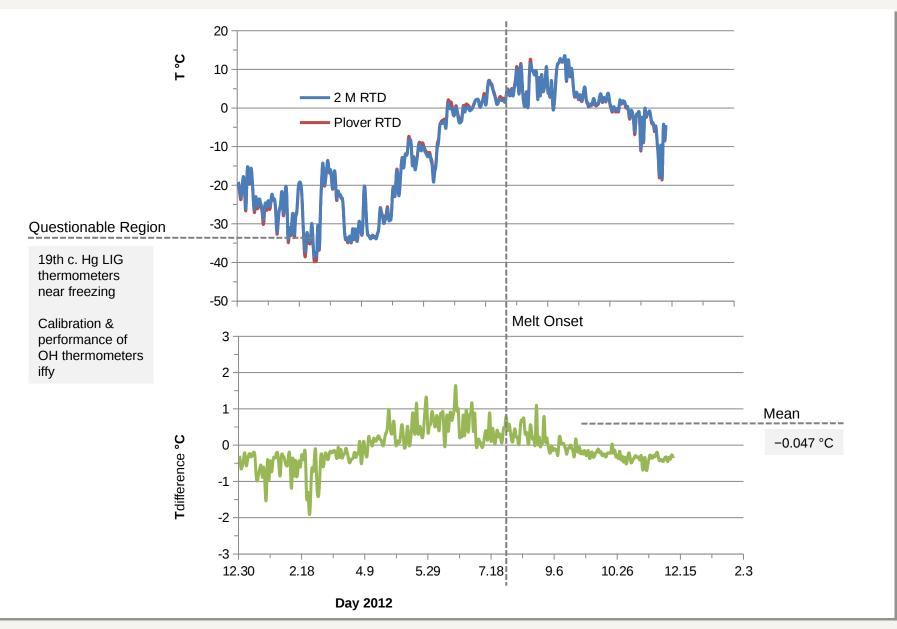
#### **Metadata!**

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.

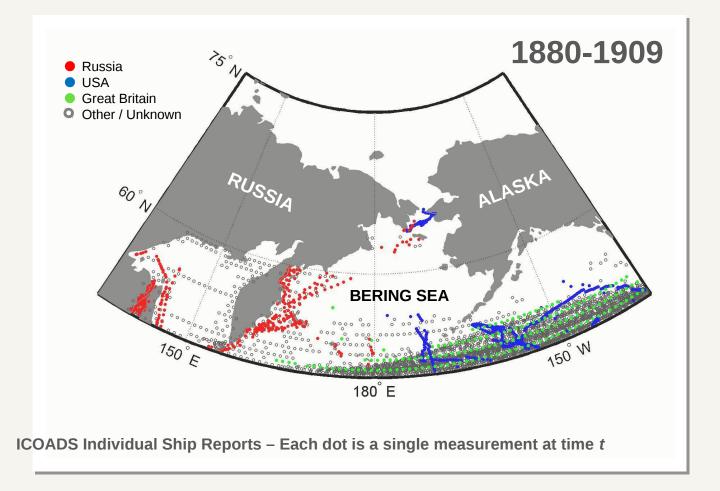


#### How **big** a problem?

#### Screen bias – not BIG



### Much more data out there



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

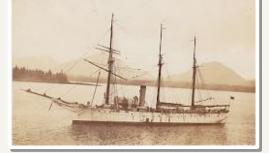
### Ships like these...



USRC Bear







**USCS** Patterson



USRC Corwin



USS Vicksburg



USS Yorktown



USS Rodgers



**USS** Jeannette



USRC Rush



USS Pinta



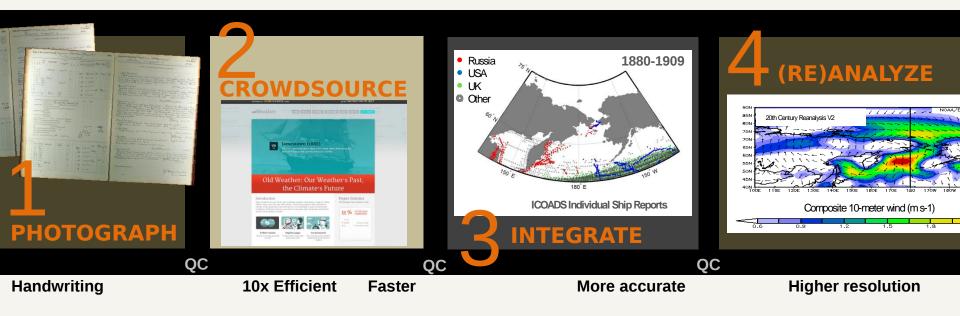
USRC Thetis

#### ... collected tons of data

LOG of the UNITED STATES Bleamer Bear	, Rate, Guns,	under the command of Leukinaut W. H. Eurony Jr. U.S. Na
Annual at Cape Sabie & Diecorny of mely Party		Sunday June 22 , 1884.
WINDS. BABOMETER, TEMPERATURE,		,100%.
Here, Kants, Stratter, Consens shared, Direction, Fars, Stratter, Consens shared, Direction, Fars, Stratter, Consens shared, Direction, Fars, Stratter, Consens shared, Direction, Consense shared, Direction, Di	Prema of $\begin{bmatrix} \frac{1}{2} & \frac{1}{2} \\ 0 & \frac{1}{2} \\ \frac{1}{2} \end{bmatrix}$ State looks, by $\frac{1}{2} \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} \end{bmatrix}$ Breard of the suil file yeard is under at end of watch.	RECORD OF THE MISCELLANEOUS EVENTS OF THE DAY.
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Latitude by Observations at Noon@ 1P.W Littlebre Dollard N 78	-24	stug last how beatles decracing help for a no to Why M. Currulli falling at 8 stranger
Longitude by Chronometer from Foreness Quartations of 19 Ac. 77. 73		ones to Ely Nr. at 10.30 eighted appe ausander. At 11.05 philes lead & the it one and
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Variation of the Compass by Azimuth ⊙ observed at	· · · ·	in for dittitude aland, at 12.20 sight Thete's at ductor to 1. N. 2. of the selands. at 1.10 cause to
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Variation of the Compass by Amplitude observed at sunset		Examined and found to be correct.
		h A i
Variation of the Compass by at	· · · ·	24/21/2

# HOW get all those scribbles turned ΙΑ into

### End-to-end data rescue







1881

Today

#### **Old Weather – Arctic**

275,000 pages photographed –23 million new-to-science observations

25,000 pages transcribed so far

### Looks like this:

Normality       Normality       Position:       Latitude:       42 44 N. Longitude:       61 25 W. port:       Normality         Air       Bulb       Sea       Bar       Attch       Wind       F         01:       46       :46       :44       :00::2:44       :44       :00::2:44       :10::2:9:98       :44       :nvw:n::4         02:       44       :40       :30:01::44       :nvw:n::4       :4       :04::41       :40       :30:01::44       :nvw:n::4         03:       41       :40       :40       :30:02::44       :nvw:n::4       :4         04:       :41       :40       :30:01::44       :nvw:n::4       :4         05:       :41       :41       :40       :29:99::43       :nxw::3         05:       :41       :41       :29:99::43       :nxw::3       :3         09:       :42       :42       :41       :29:99::45       :nxw::3         10:       :41       :40       :29:99::46       :nw::3         11:       :43       :42       :40       :29:97::46       :nw::3         12:       :43       :42       :40       :29:95::48       :w::3         12:       :45	
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#### User interface built by Arfon & Co at **ZOONIVERSE**

### 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

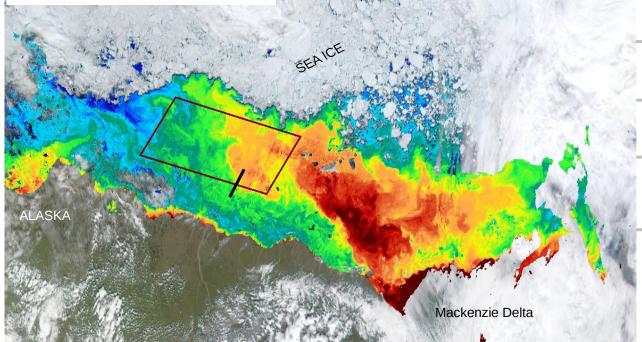
Transcribed observations are currently being used in at least 4 reanalyses:

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

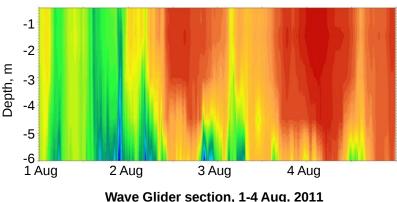
They are also being used for verification of HadISST2...and more

# Now: emerging phenomena?

#### MODIS Composite SST 19-20 July 2011



-10123456789101112°C





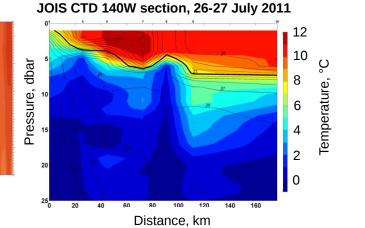
Anomalous easterly winds

Sea ice in motion

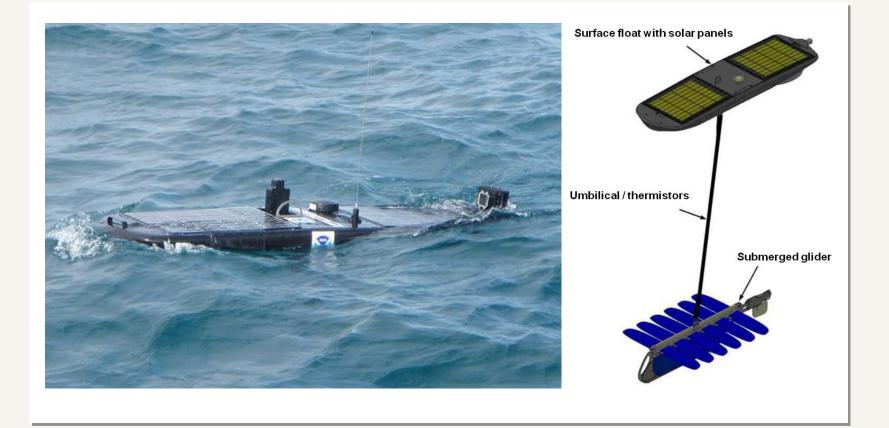
Runoff entrained under sea ice (129 of 246 km3)

#### Rapid

advection stratification heating sea ice melt

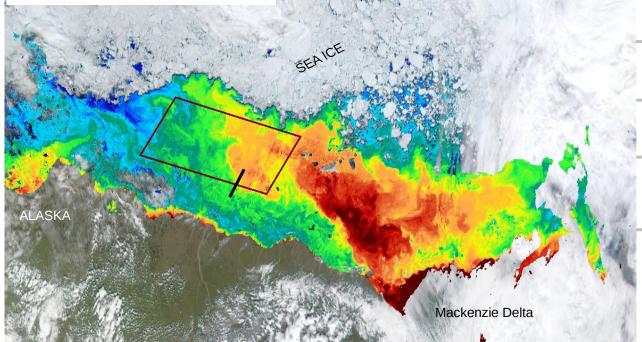


### Arctic Wave Glider

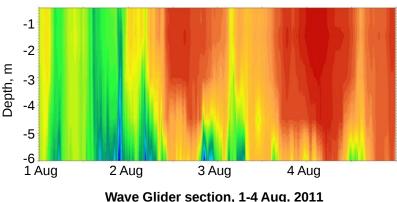


# Now: emerging phenomena?

#### MODIS Composite SST 19-20 July 2011



-10123456789101112°C





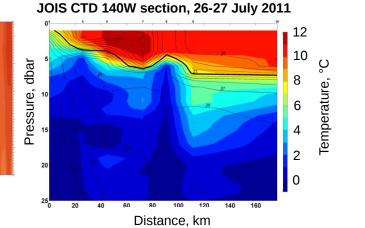
Anomalous easterly winds

Sea ice in motion

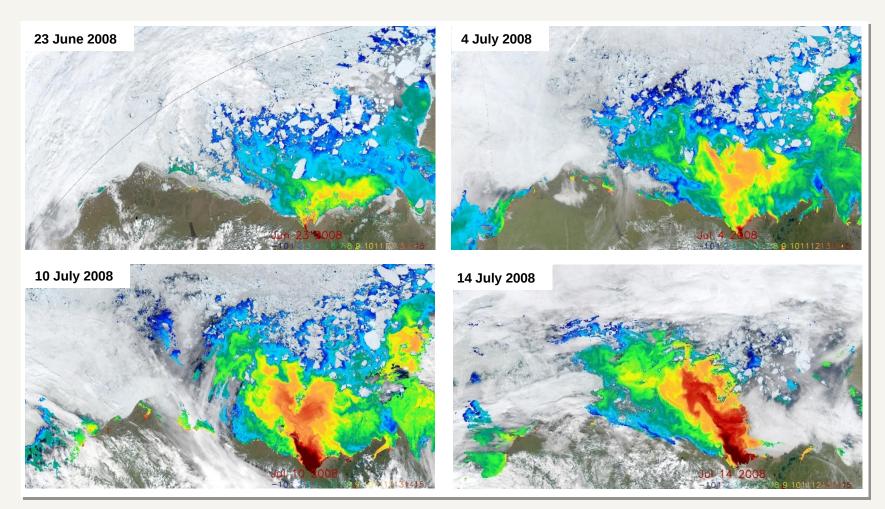
Runoff entrained under sea ice (129 of 246 km3)

#### Rapid

advection stratification heating sea ice melt



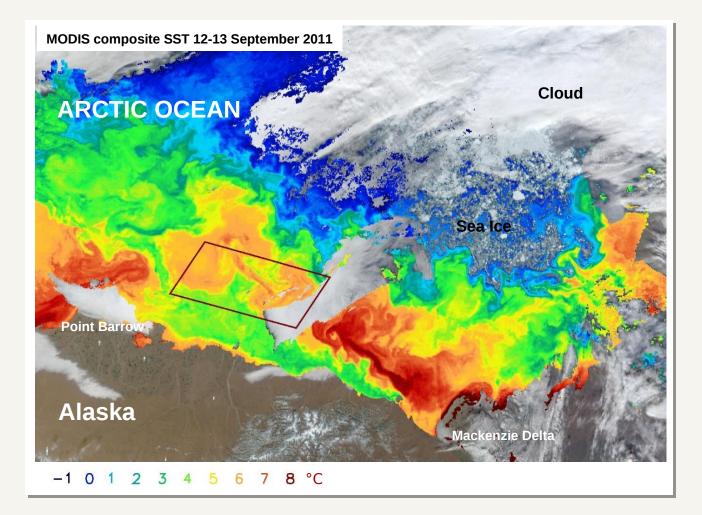
#### Three weeks in July



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

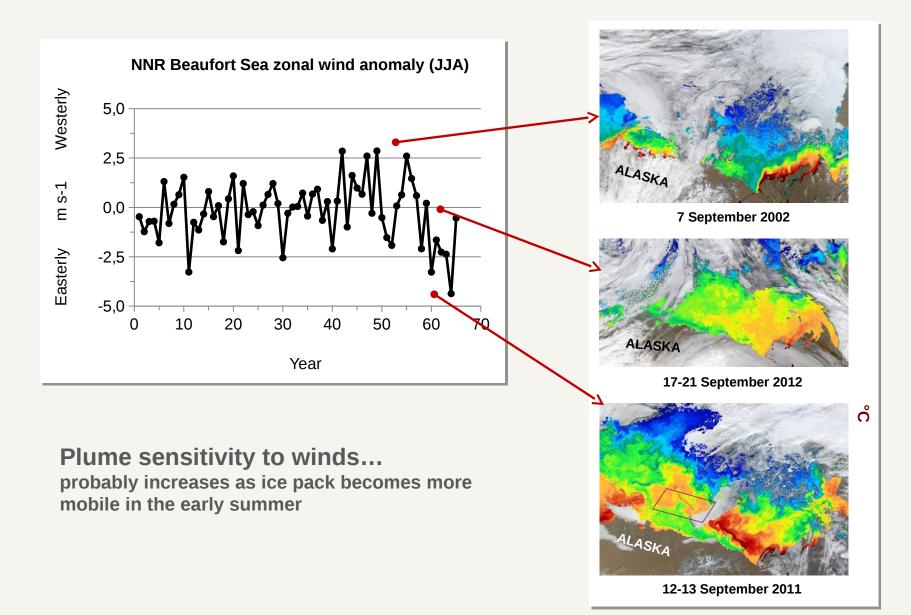
#### Leads to...



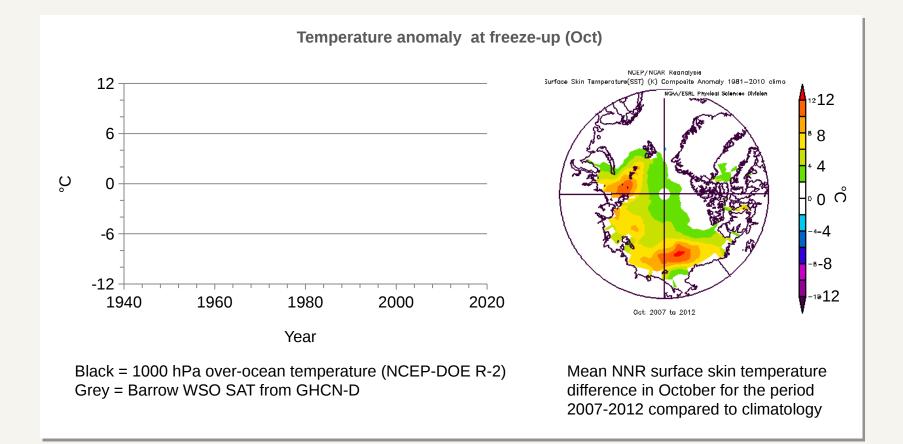
...unseasonable warmth into freeze-up

(and melt potential equivalent to annual Bering Strait inflow)

#### Variations



#### Now – in context



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.

