Michael Steele
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GHRSST, D.C.
June 9, 2016

SST in the Marginal Ice Zone of the Arctic Ocean

Michael Steele

& Suzanne Dickinson, Wendy Ermold, Sarah Dewey

Polar Science Center, Applied Physics Lab, University of WA
Seattle, WA USA

w/ input from ***Peter Minnett***
&
not-ready-for-sharing analysis by ***Chelle Gentemann***

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…preliminary work!

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Sea Ice Decline

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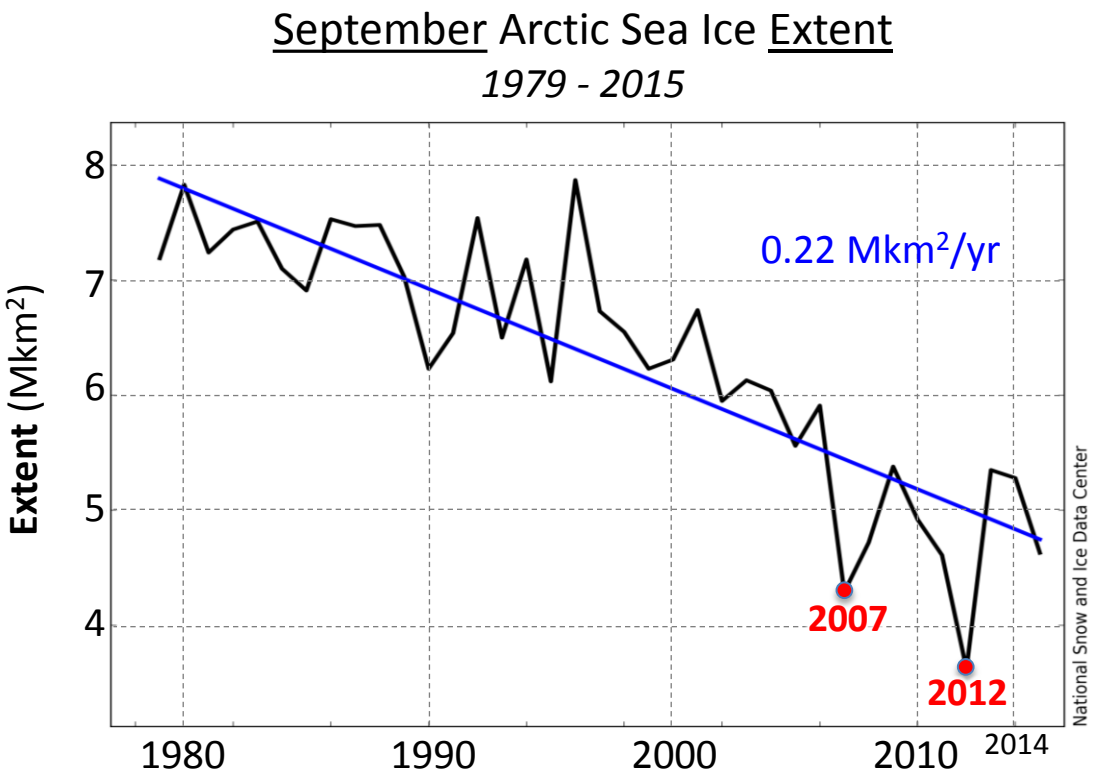

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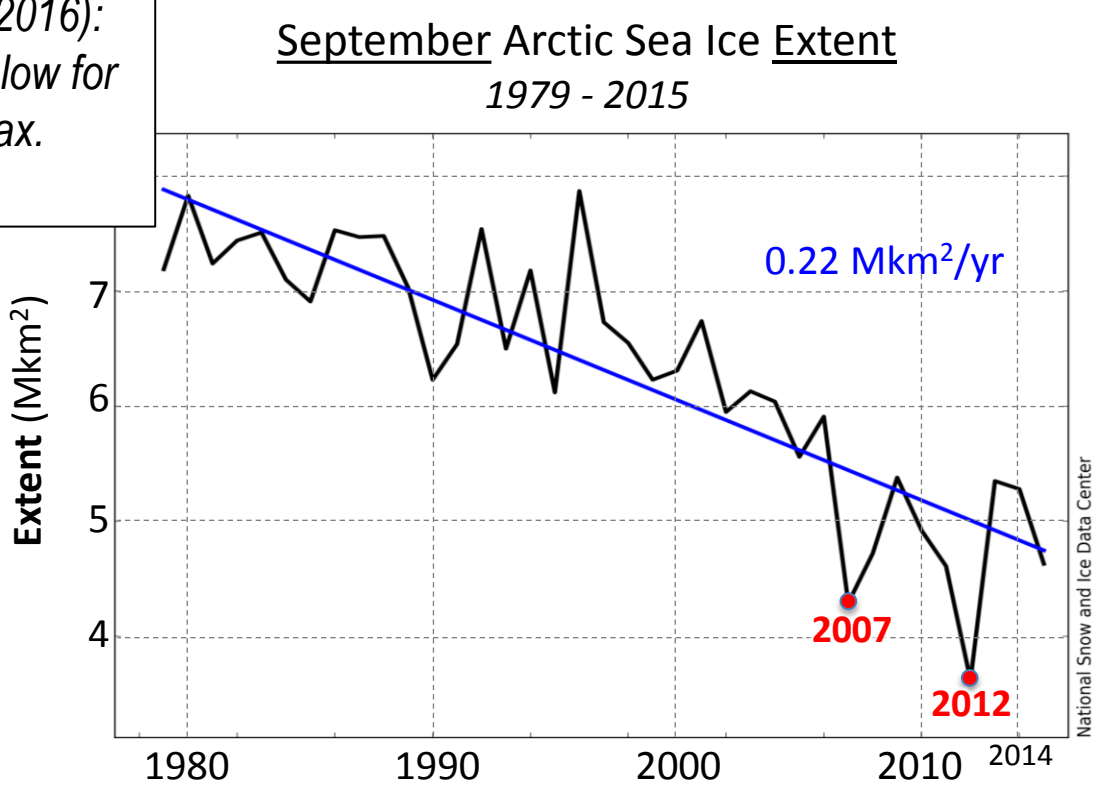
Sea Ice Decline

NSIDC *(March, 2016): "Another record low for Arctic sea ice max.* ***winter*** *extent"*



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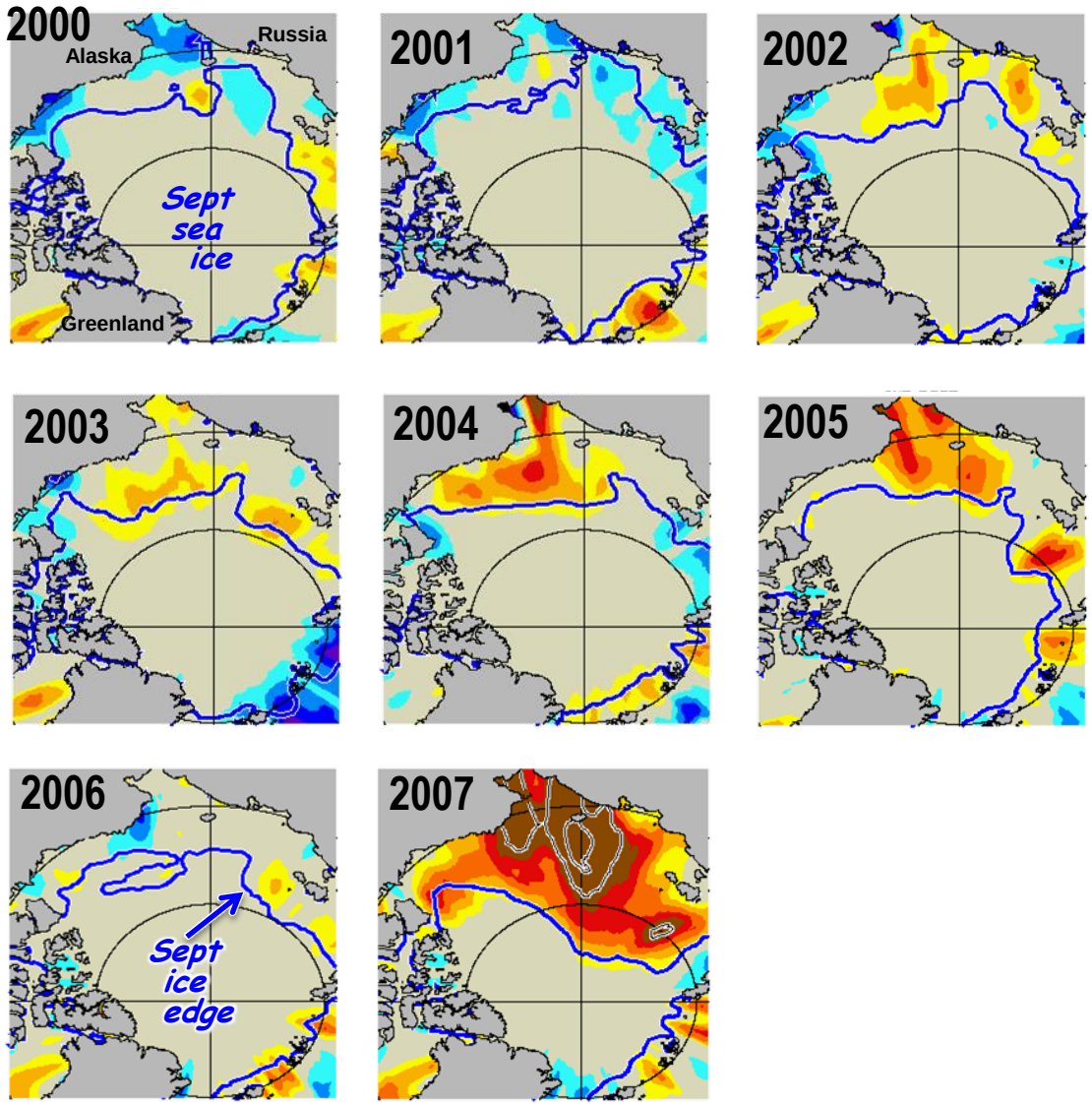
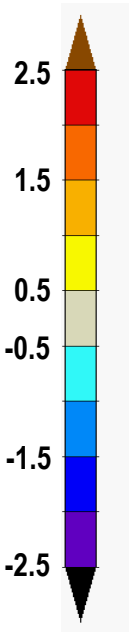
Ice Retreat ➔ Ocean Warming



15% ice concentration
(NSIDC's NASA Team SSMIS 25 km)

Steele et al., GRL 2008



Anomaly of Summer ≡ JAS
Sea Surface Temperature (°C)
(relative to 1982-2007 mean)
daily OI.v2 (AVHRR only)

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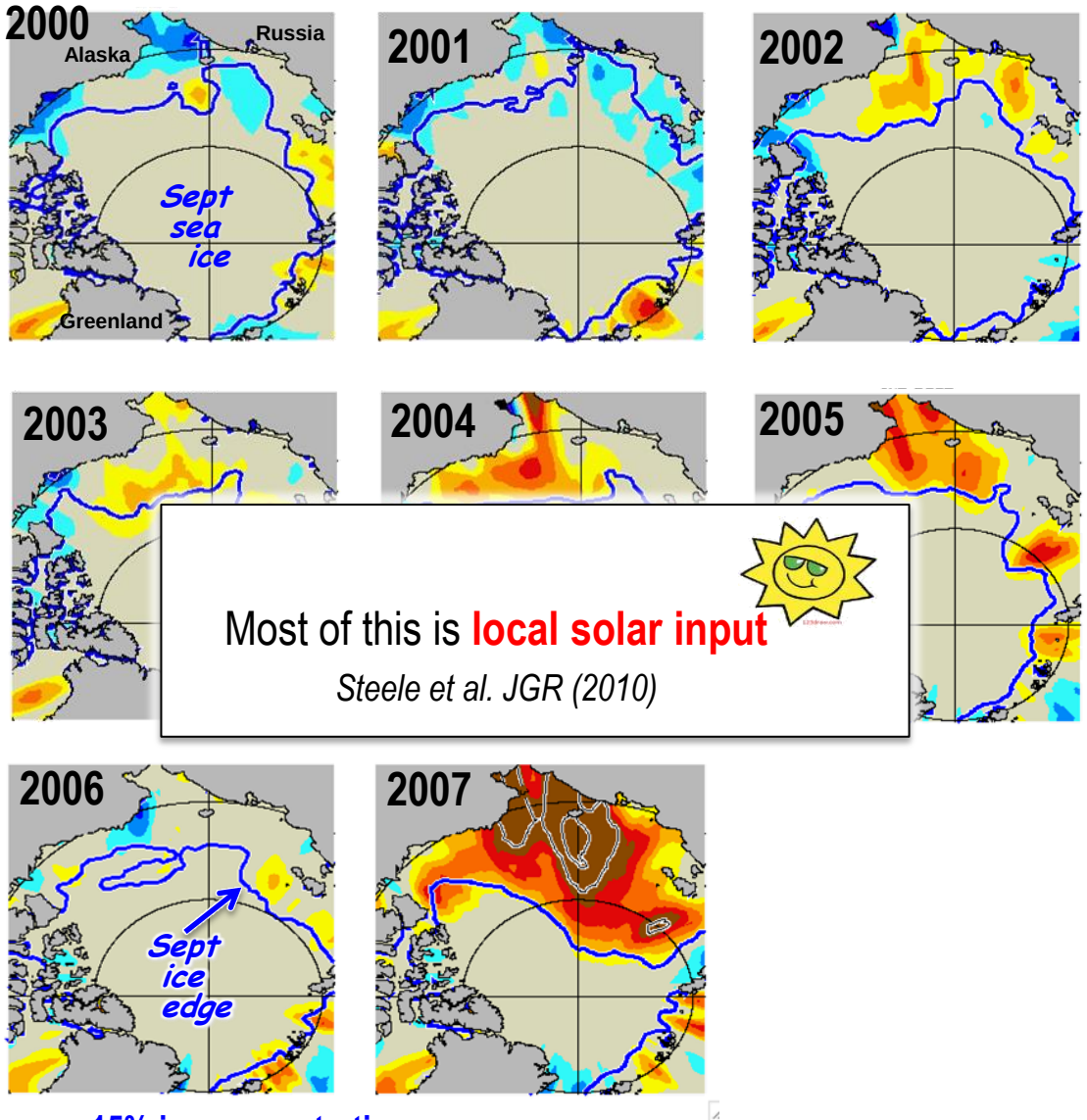
Ice Retreat ➔ Ocean Warming



Most of this is **local solar input**

Steele et al. JGR (2010)

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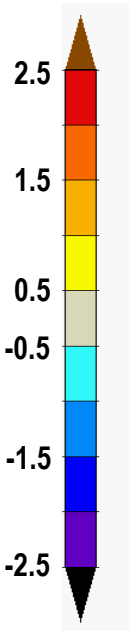

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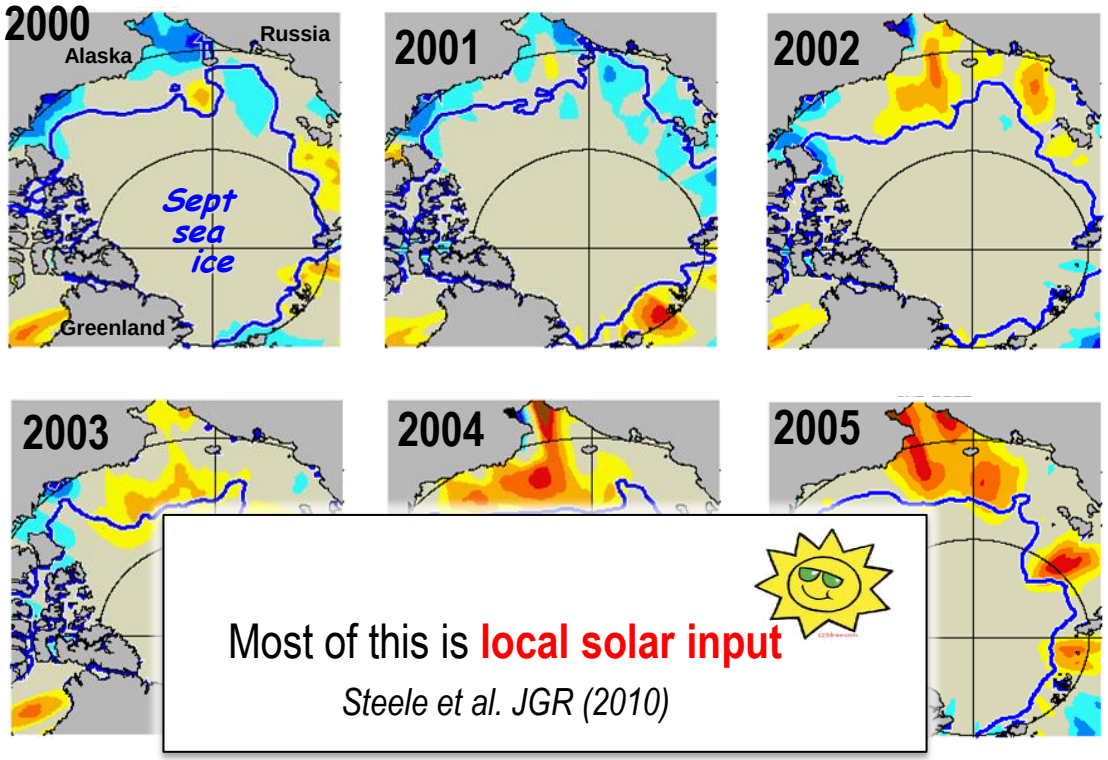

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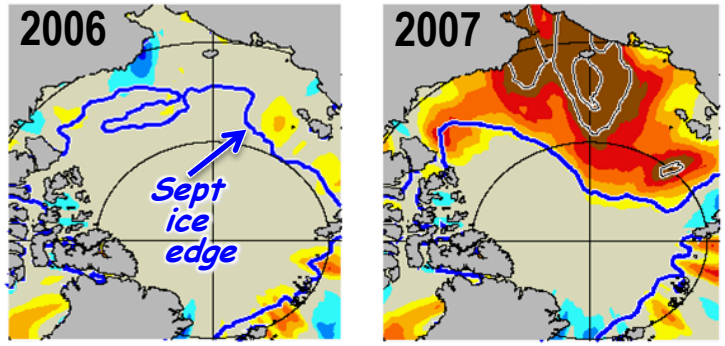

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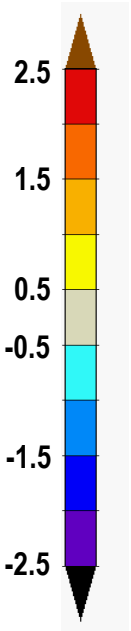

Anomaly of Summer ≡ JAS
Sea Surface Temperature (°C)
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So what?

- ecosystems
- air-sea fluxes
- sub-surface T_{max} layers
- ice edge "loitering" *(Steele et al., 2015)*
- ice-albedo fdbk

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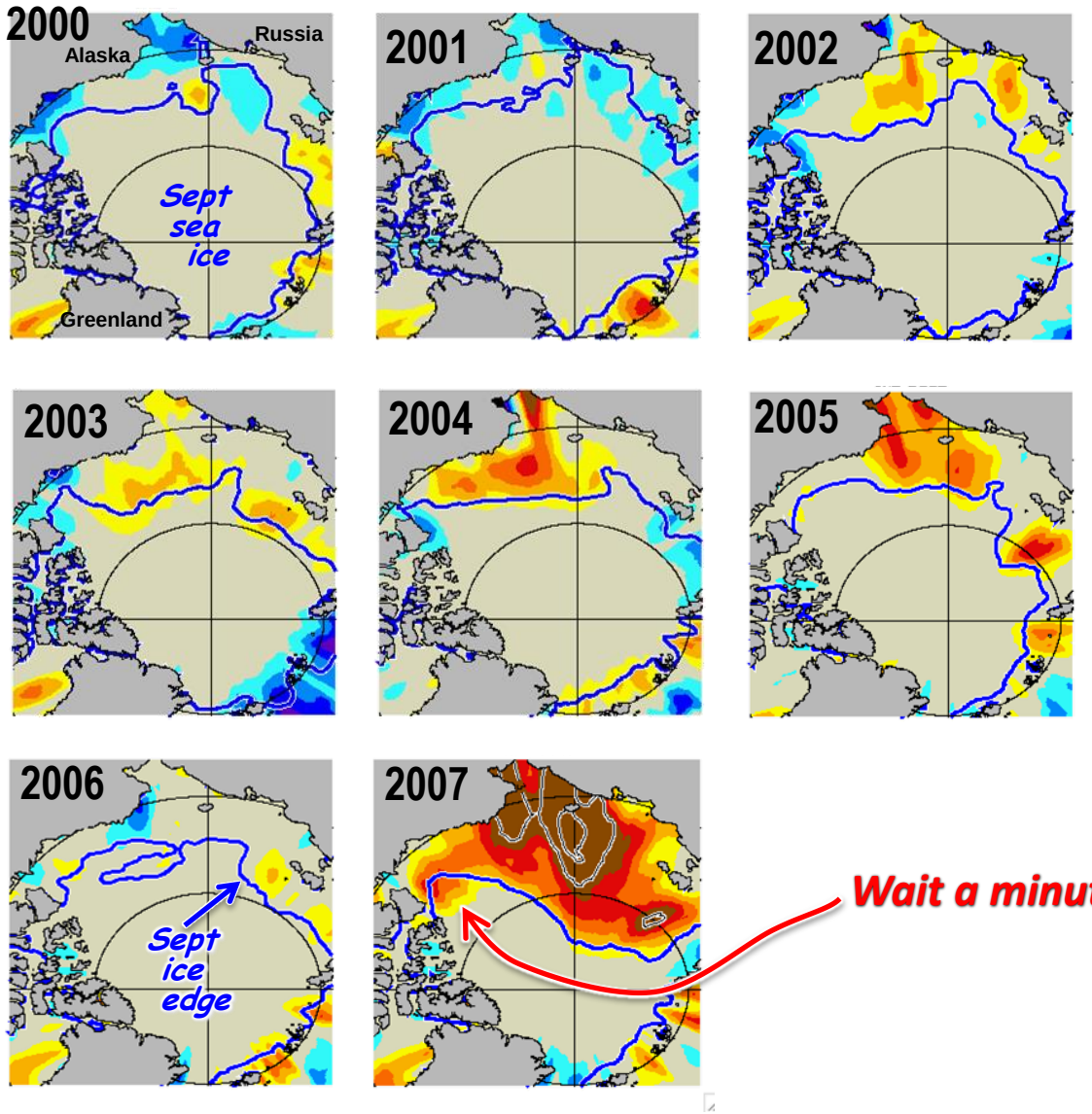
Ice Retreat ➔ Ocean Warming



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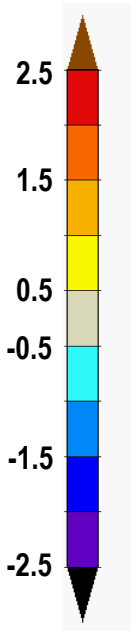

Anomaly of Summer ≡ JAS
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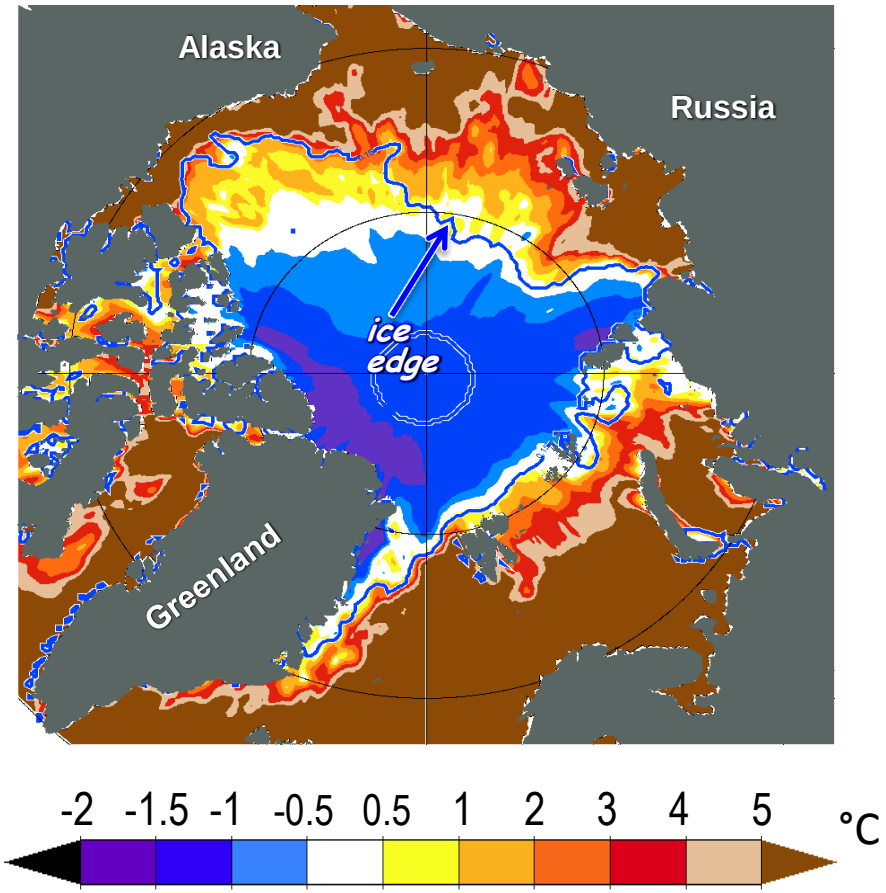
Warm SST under the ice?!

...not the anomaly

SST: August 15, 2007 *OI.v2 (AVHRR only)*



This is built into *(all?)* L4 SSTs

...but how realistic is it?

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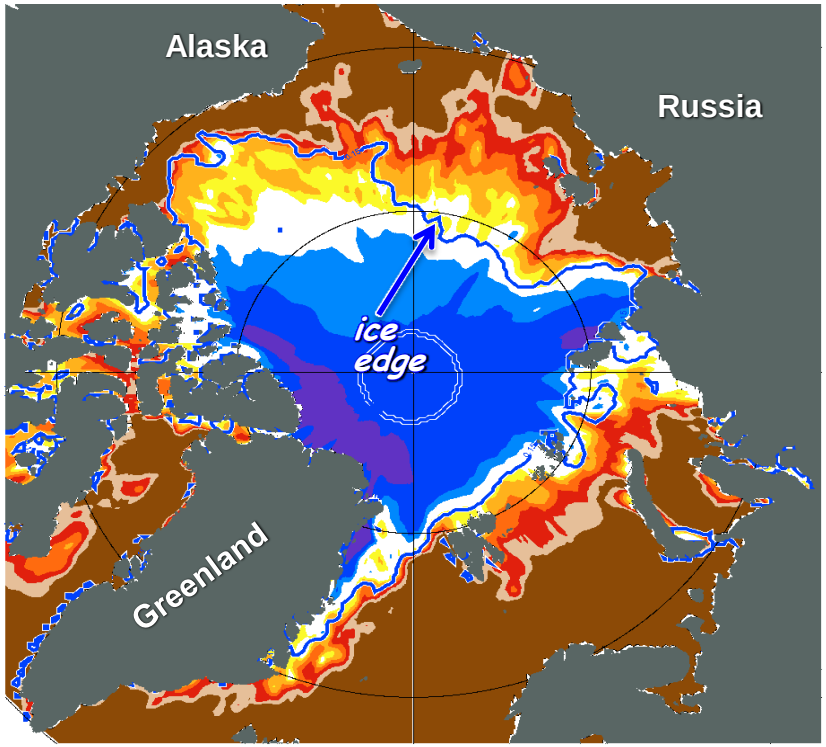

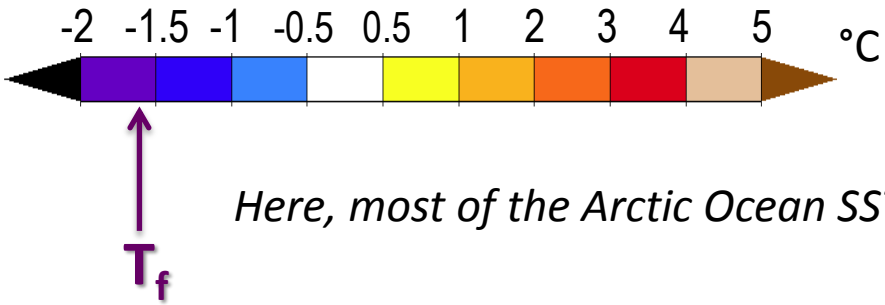

This is built into *(all?)* L4 SSTs

...but how realistic is it?

Here, most of the Arctic Ocean SST > T_f

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Ice pack SST *(summer)*

0 < ice concentration < 100%

- How **warm**?
- How **deep**?
- **Wind**, **solar** forcing?

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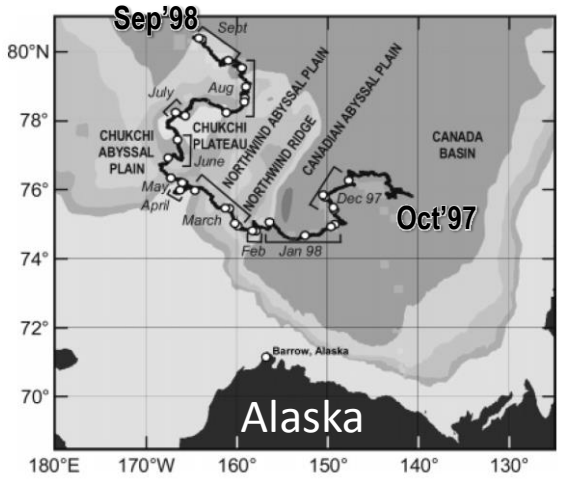
Ice pack SST



"SHEBA" project

Oct 1997 - Sep 1998 drift

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Ice pack SST

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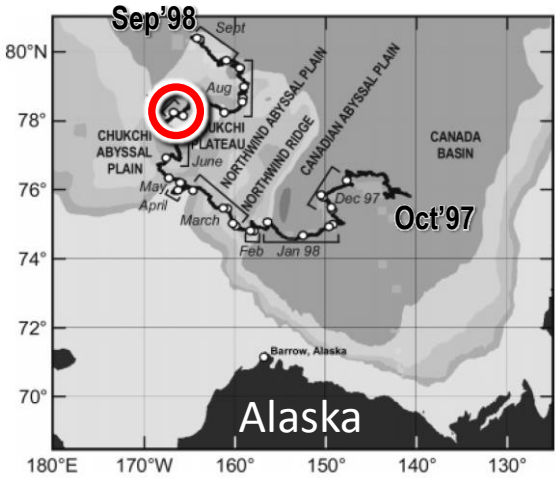
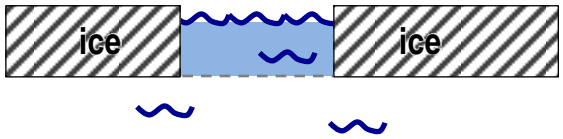


"SHEBA" project

Oct 1997 - Sep 1998 drift

CTD obs in a <u>lead</u>

Summer, 1998



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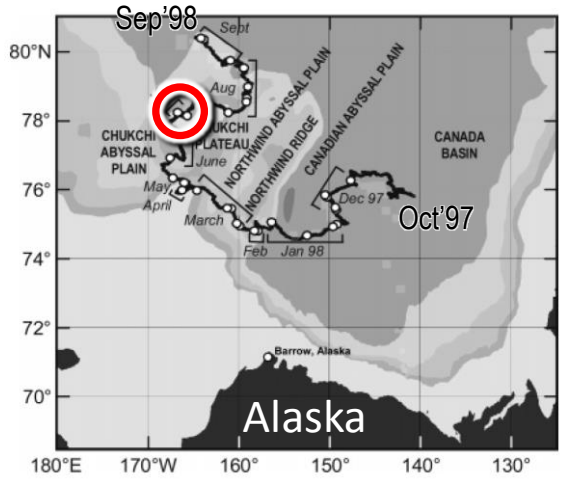
Ice pack SST



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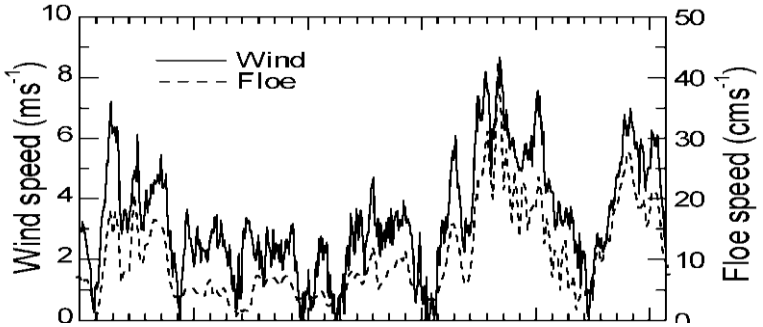

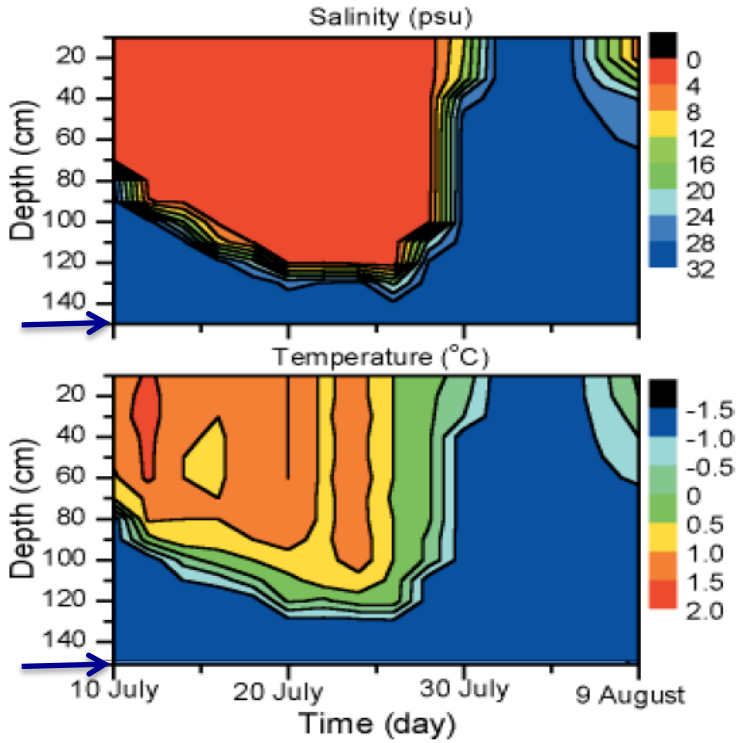

1.5 meters!

1.5 meters!

Richter-Menge et al., Annals Glaciol., 2001

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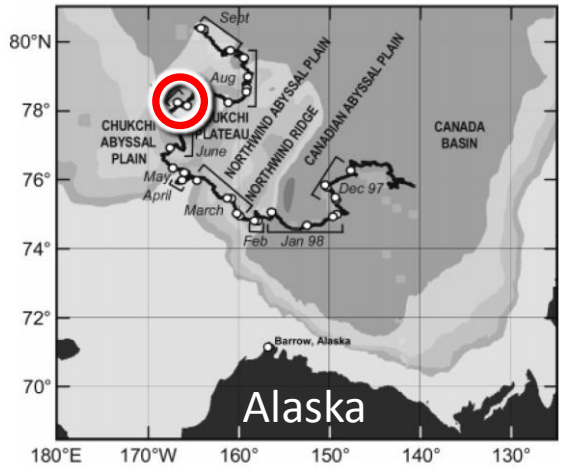
Ice pack SST



"SHEBA" project

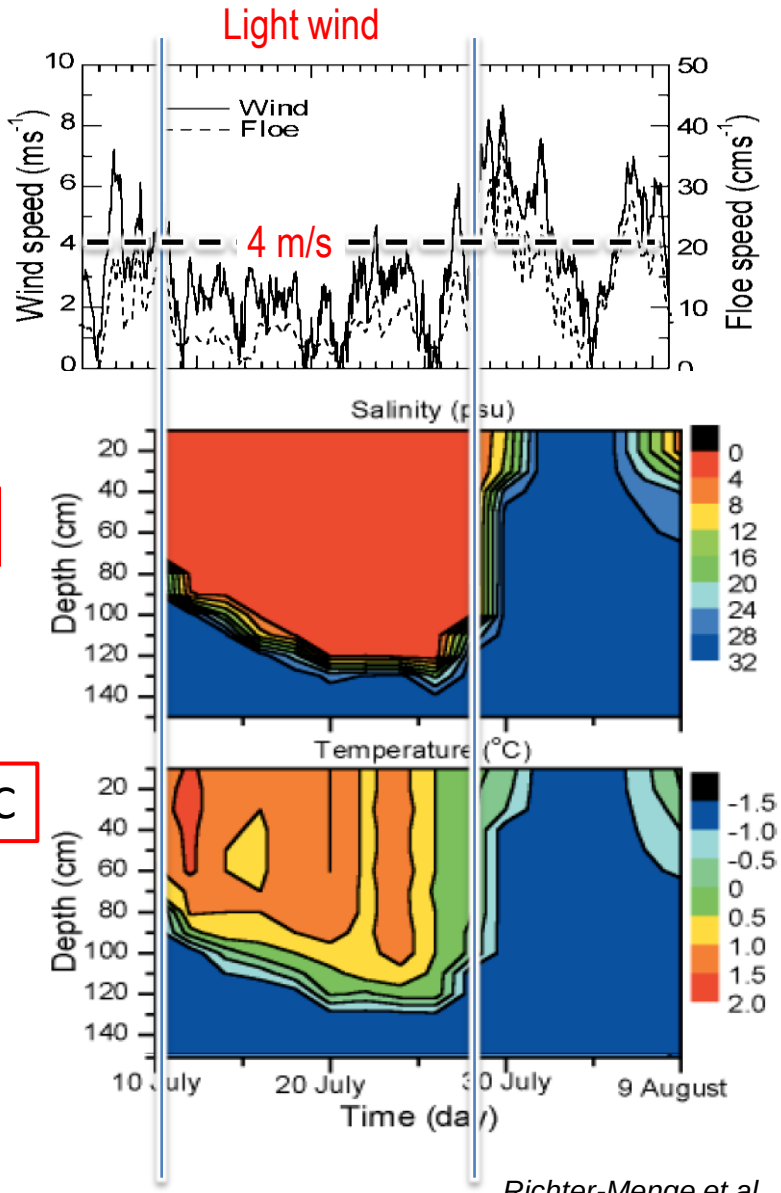
Oct 1997 – Sep 1998 drift

CTD obs in a <u>lead</u>

2-4 psu!

up to 1.5°C

...or about 3°C above T_f



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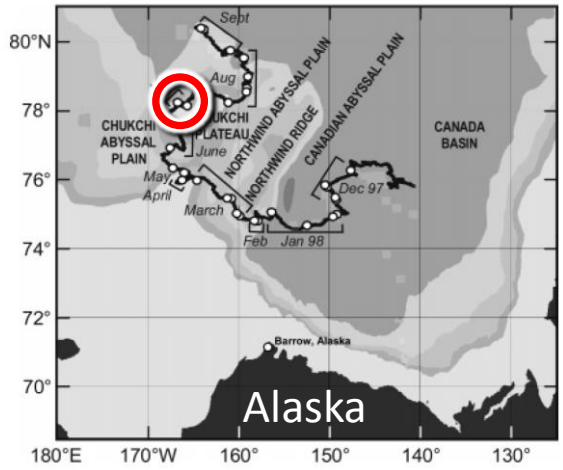
Ice pack SST



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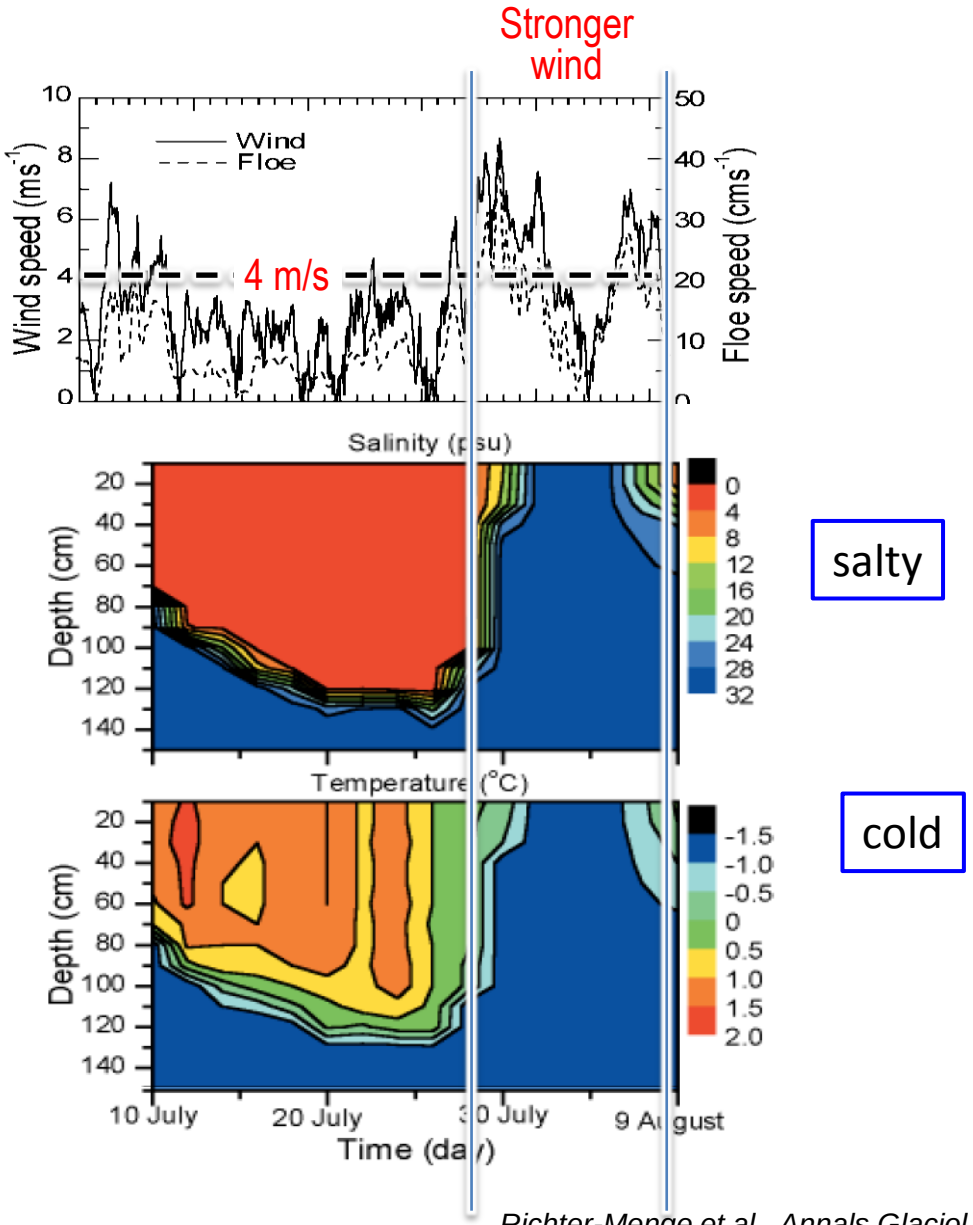

salty

cold

Richter-Menge et al., Annals Glaciol., 2001

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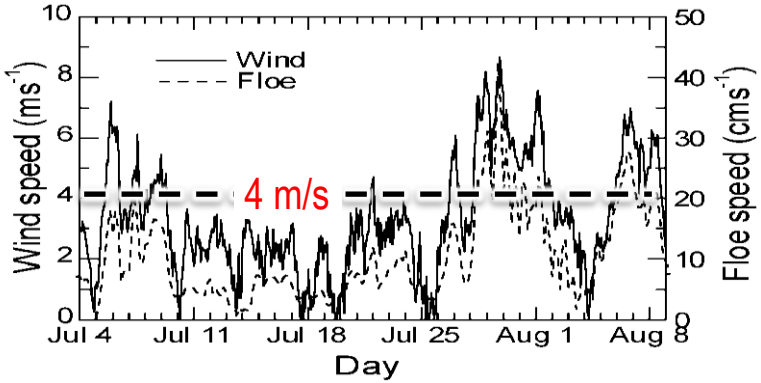
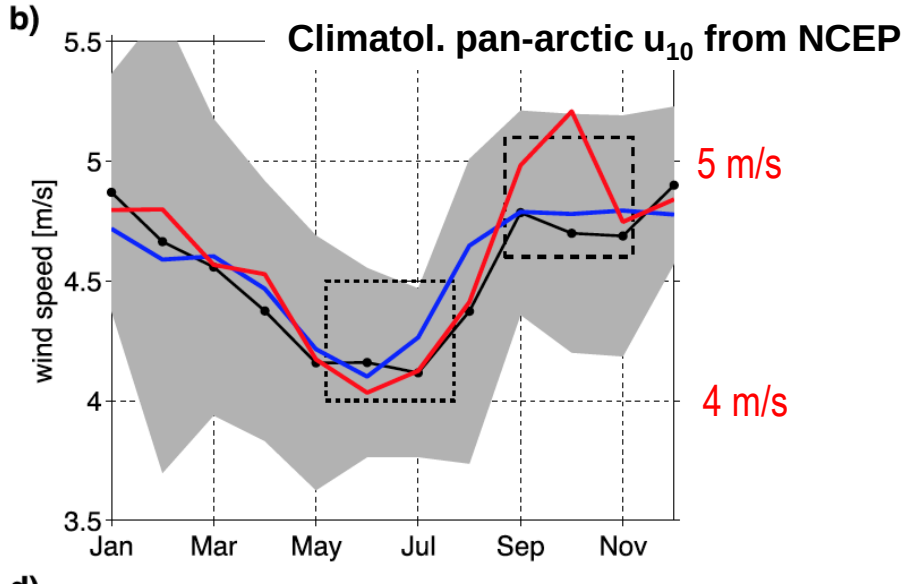
Ice pack SST

"Light vs. strong winds"

How often?

...hmmm...





Martin et al., JGR 2014

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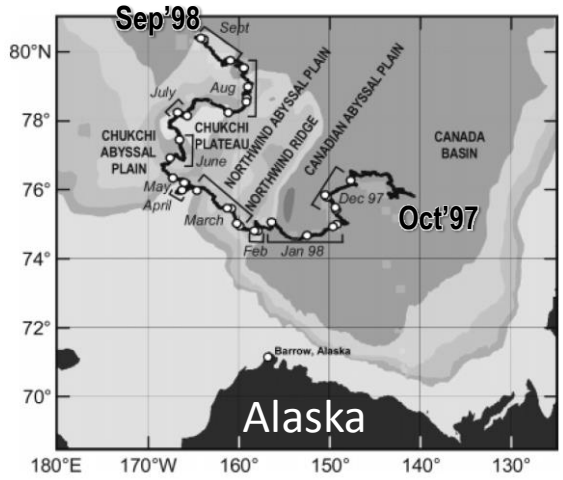
Ice pack SST



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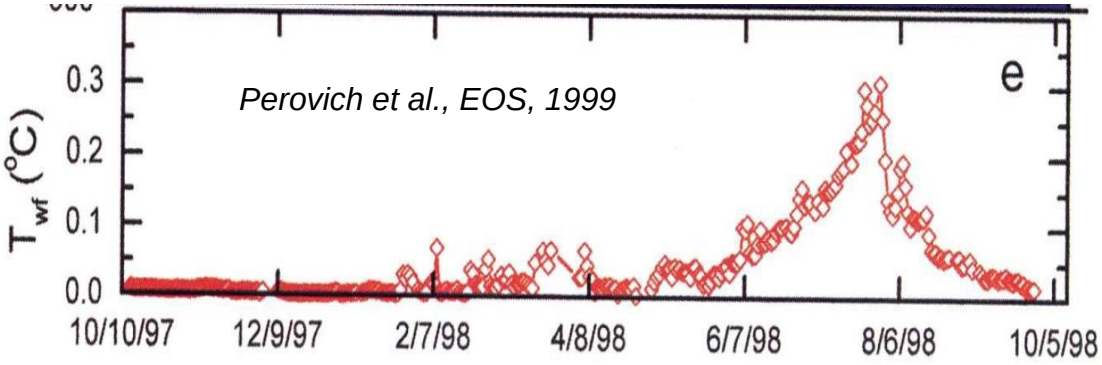
Oct 1997 – Sep 1998 drift

CTD obs in the mixed layer

$T_{mixed\ layer} - T_f$



summer

...only up to 0.3°C above T_f

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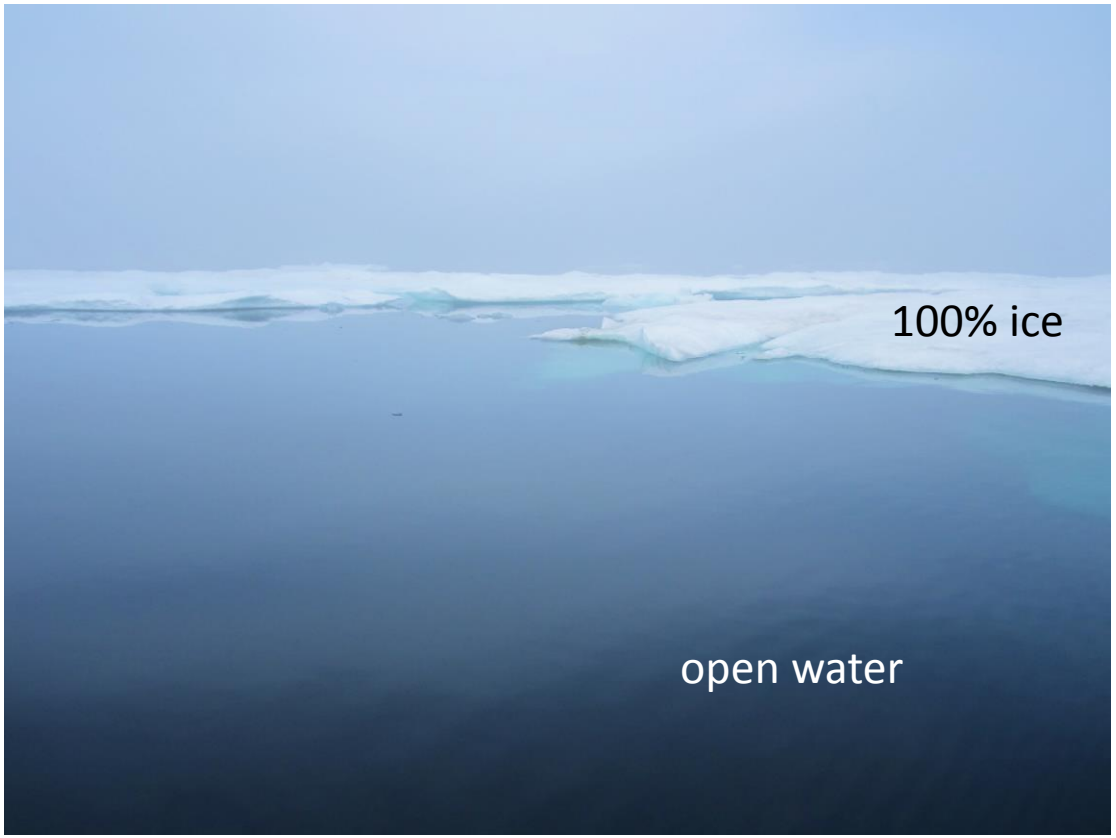
The Ice Edge

Sometimes it's sharp



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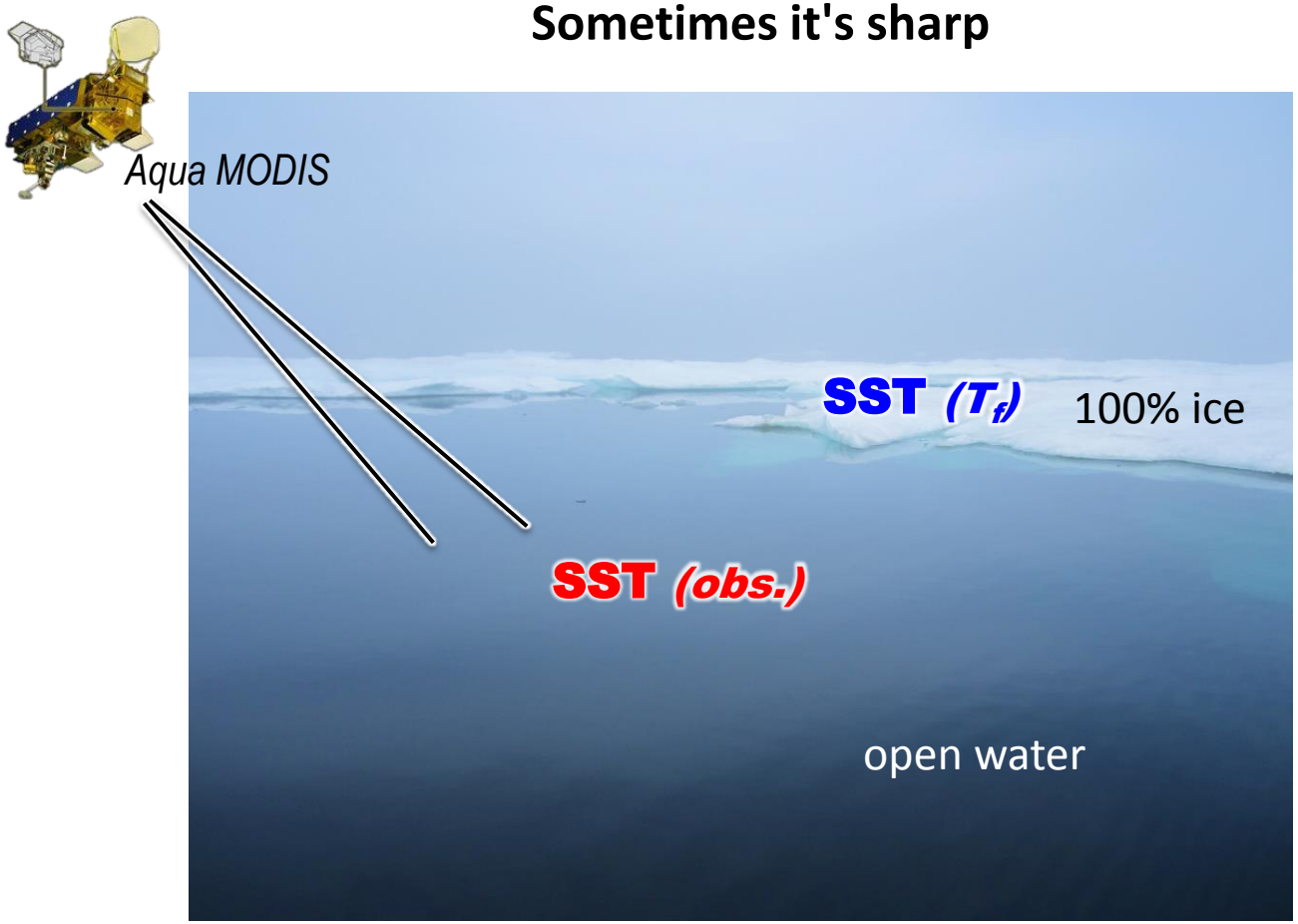

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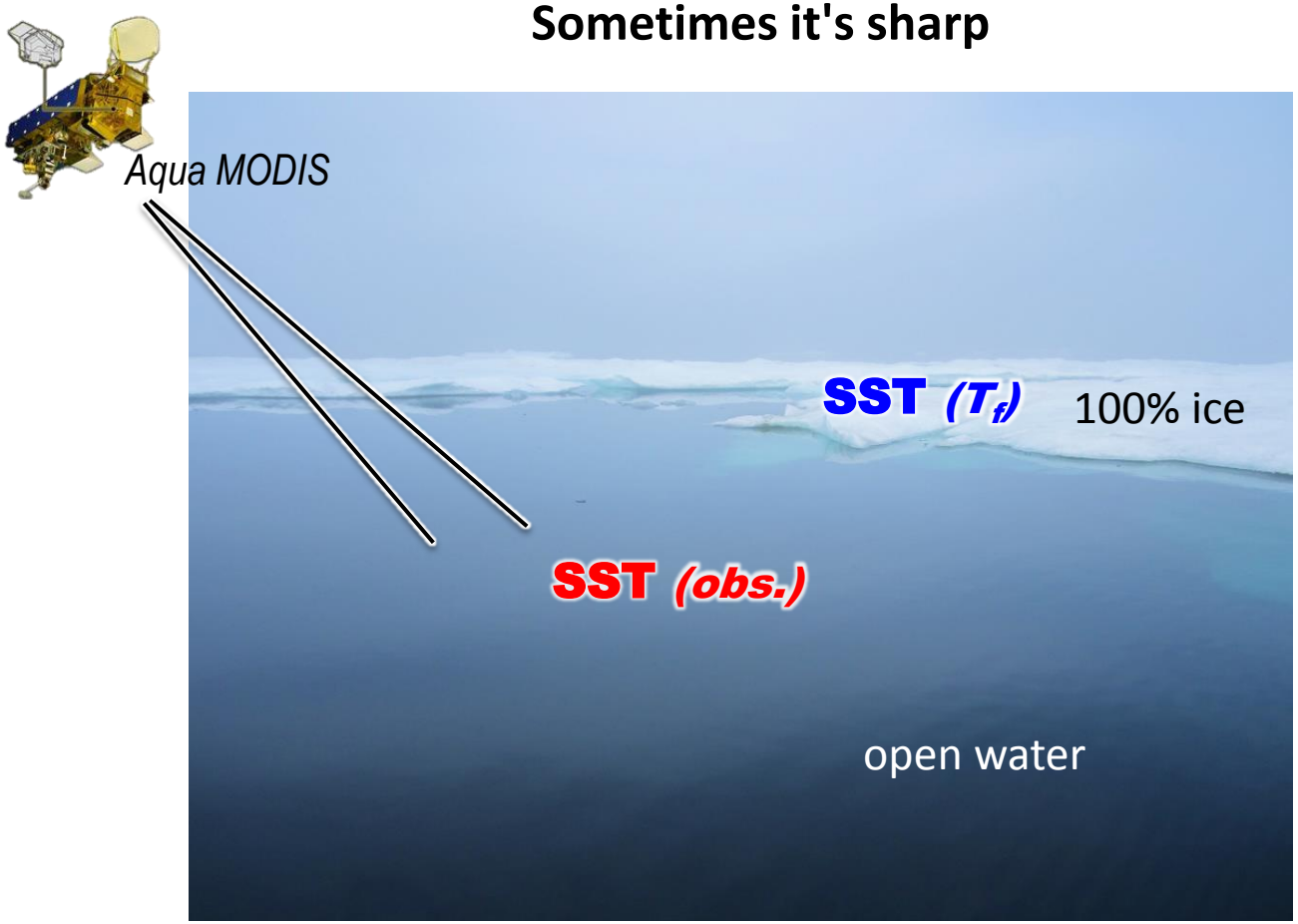

...but often it's not!

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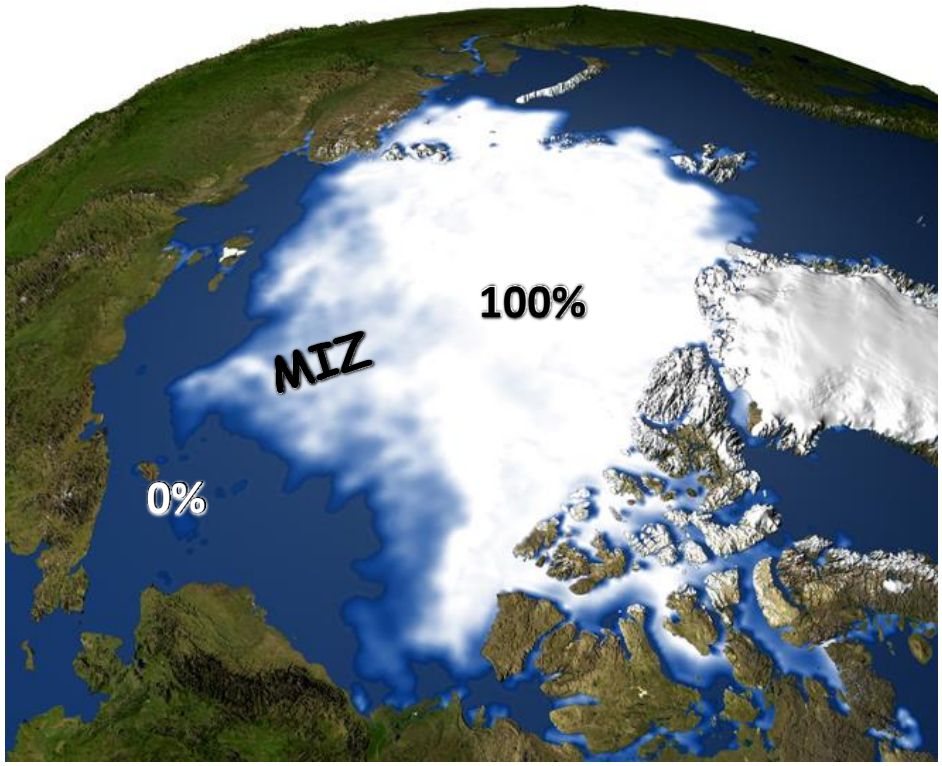
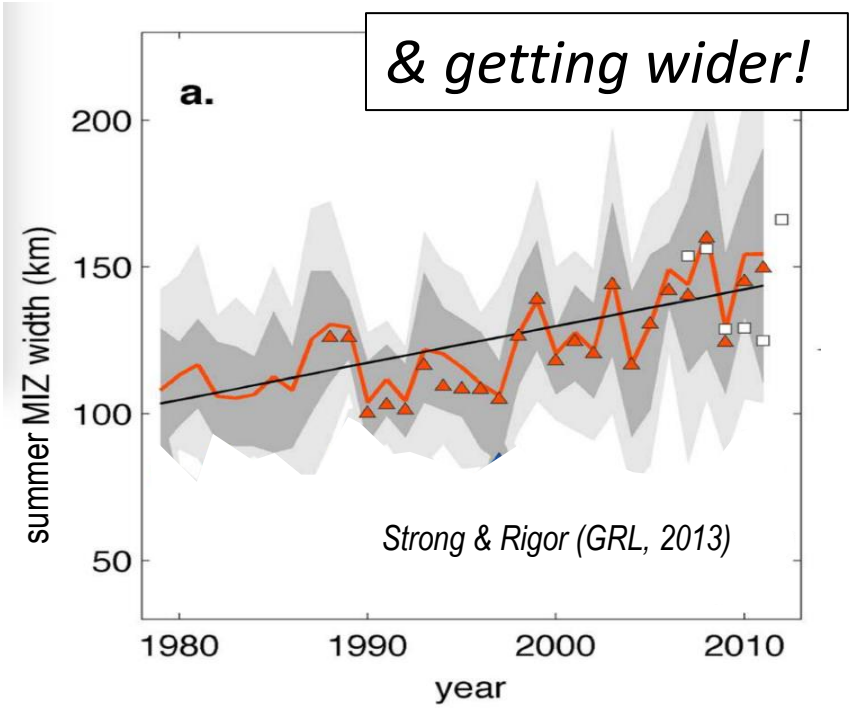
The **M**arginal **I**ce **Z**one (**MIZ**)



~ 100 km

& getting wider!



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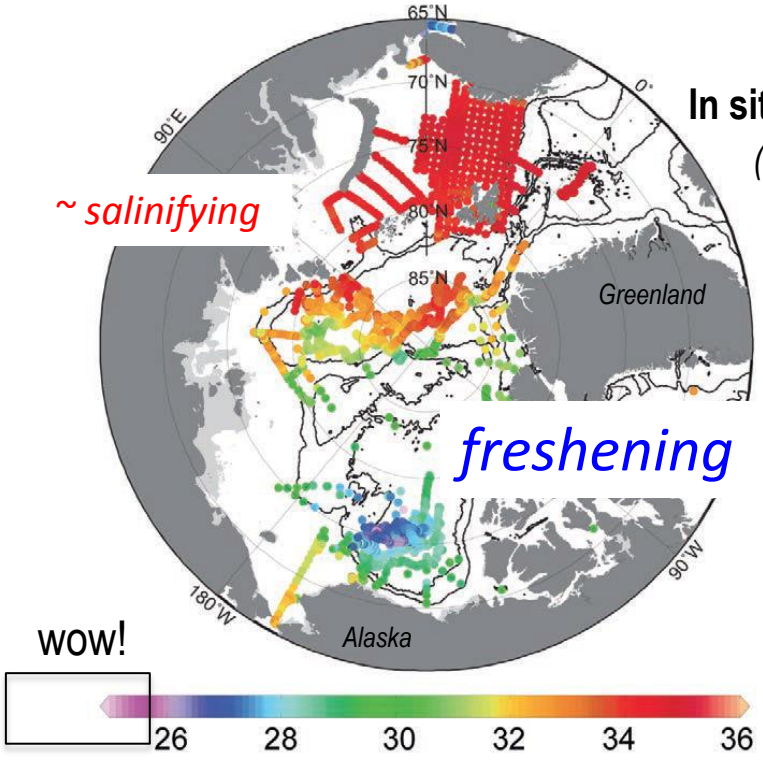
$T_f = T_f(S)$



In situ salinity @ 20 m depth

(2013: ship CTD, buoys)

*...mostly **summer***

Timmermans et al. (BAMS, 2014)

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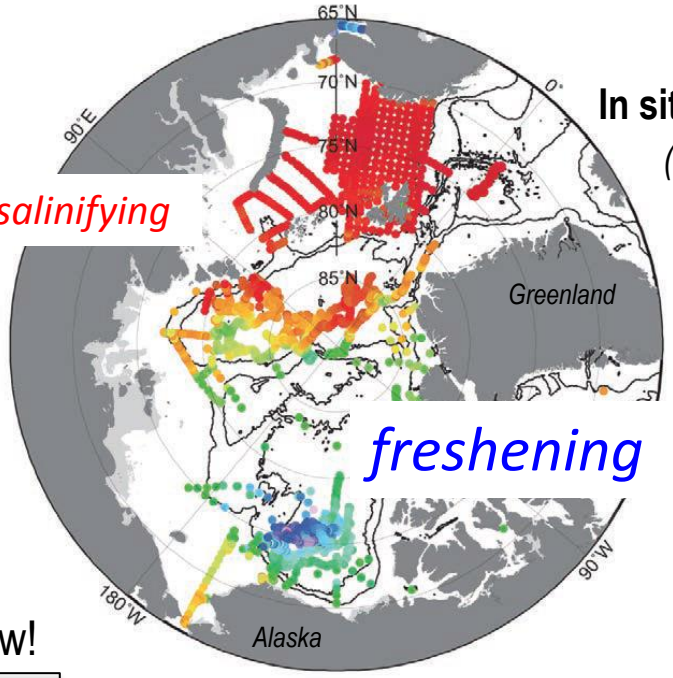

Timmermans et al. (BAMS, 2014)

In situ salinity @ 20 m depth

(2013: ship CTD, buoys)

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annual mean
⟨Arctic Ocean⟩
under-ice
SST = -1.6°C

Stroh et al. (JGR, 2015)

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MIZ SST Summary

- summer MIZ SST is **> T_f**

  ...but (*some*?) L4 data sets are **too warm**

  → *more L4's, more in situ obs*

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- Wind/SST **matchups**

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- Seasonal, geographic **vars**
  *e.g., Arctic/**Antarctic***
  ***winter**/summer*

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  *Arctic/****Antarctic***

- "**coupled** variables"
  e.g., MIZ ***SSS****, surface* ***stress***

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Thank you