Summertime temperature minimum as an indicator of properties of previous winter mixed layer

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Looking for the "remnant winter water" from summer observations

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Formation and evolution of the surface mixed layer and halocline of the Arctic Ocean

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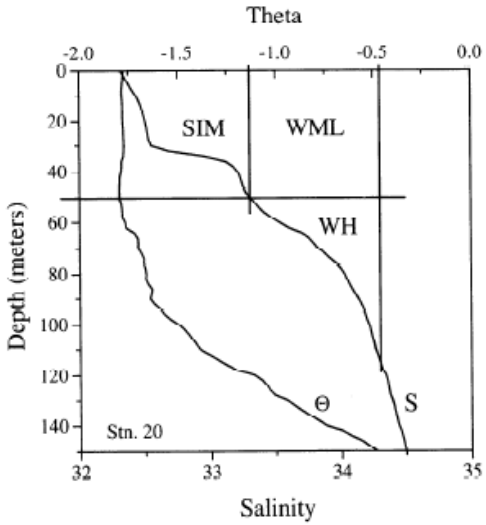
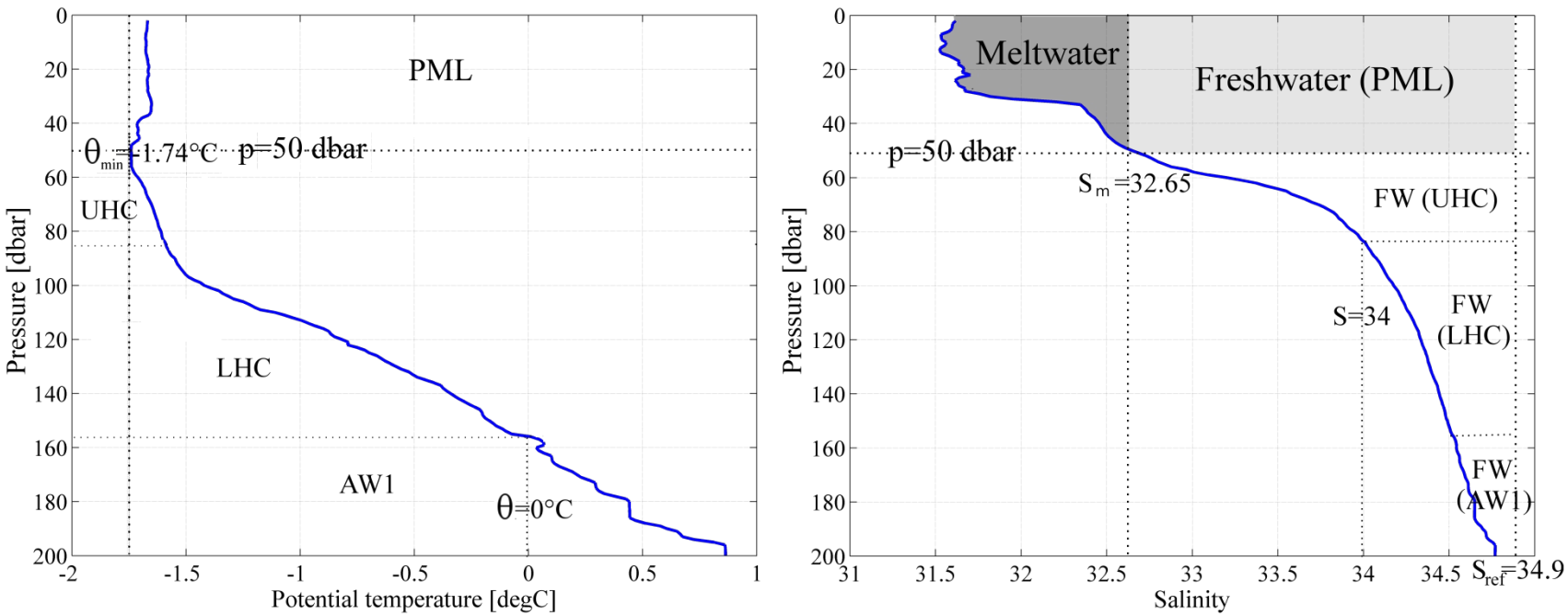


Figure 4. The definition of the three freshwater "pools": seasonal ice melt (SIM), winter surface mixed layer (WSML), and winter halocline (WH).

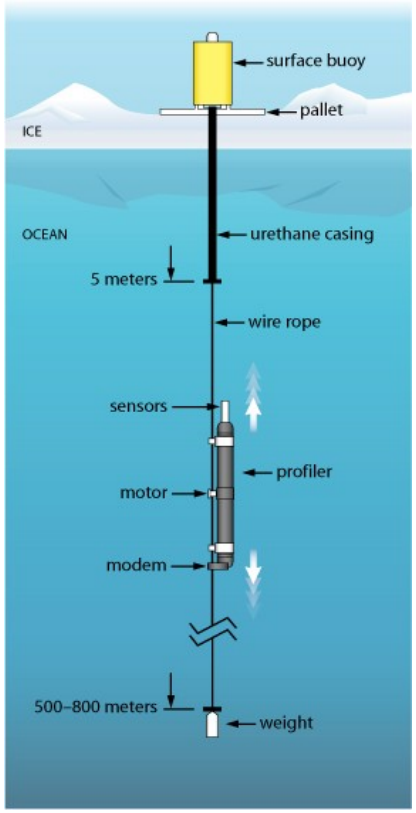
Motivation: Are the properties of the winter mixed layer maintained below the summer halocline?

Separating meltwater from freshwater content in the Polar Mixed Layer by salinity at the depth of temperature minimum

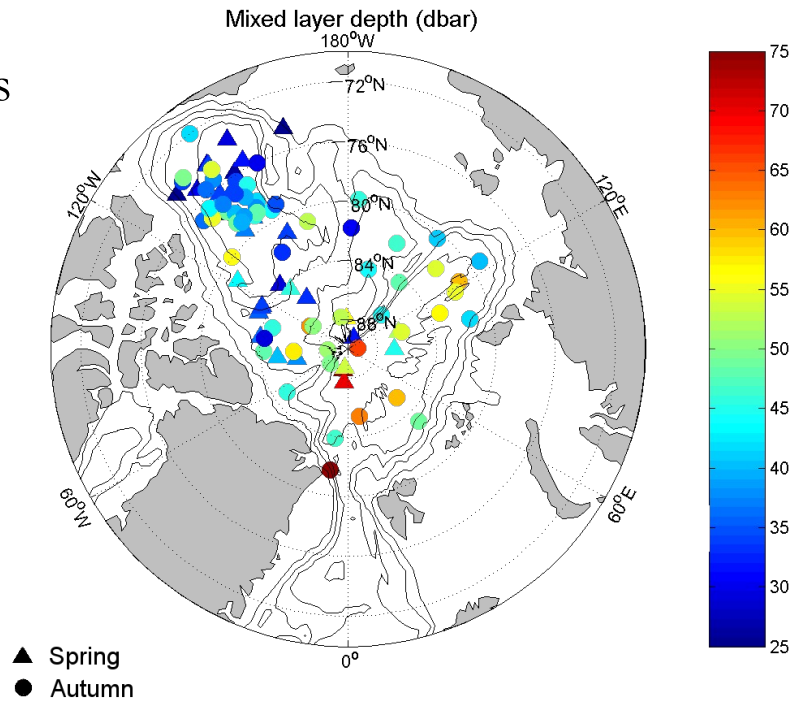


This method gives ~2 m of seasonal ice melt in the Southern Canada Basin, but only 0.5 m in the Nansen Basin. (Korhonen et al., OSD 2012)

Data



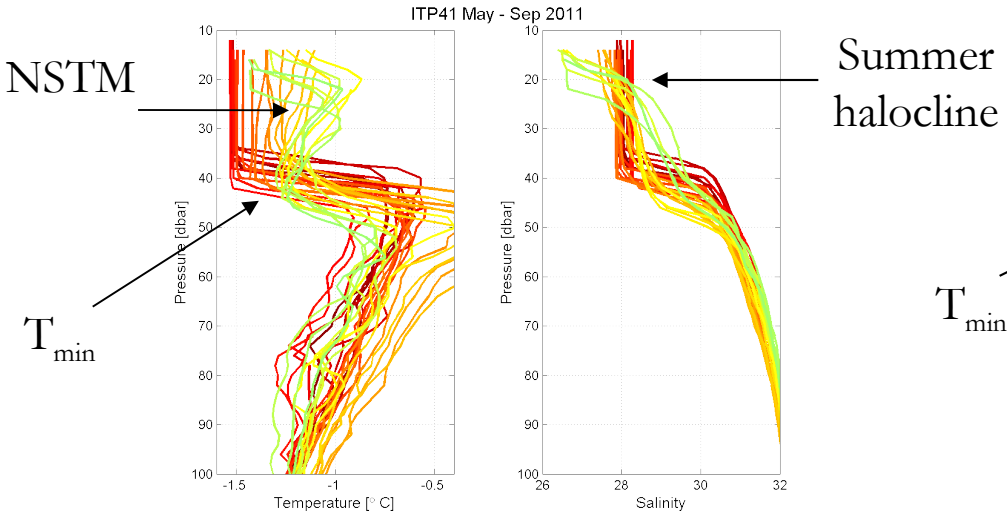
- Temperature and salinity profiles from Ice-Tethered Profilers (ITPs) (http://www.whoi.edu/itp)
- Observations from September 2004 to September 2012
- 31 data sets available from 36 ITPs operating in May
- 49 data sets from 38 ITPs operating in September-October
- Drift of sea ice makes comparison difficult; here we concentrate on the Canada Basin

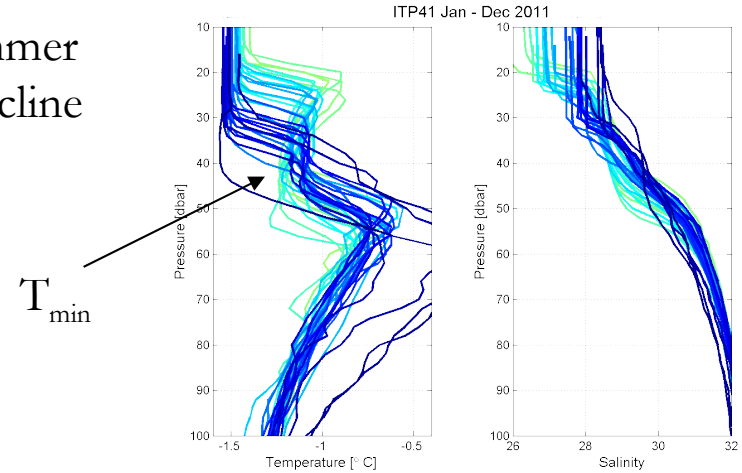


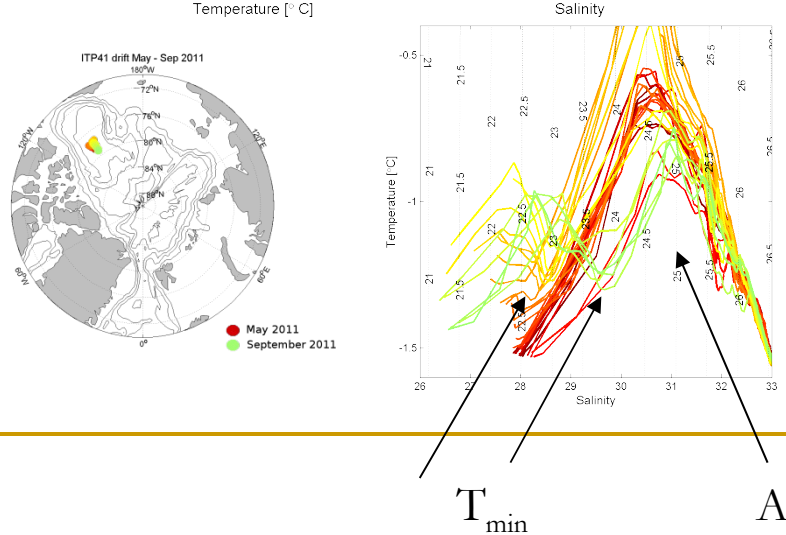
Introduction: Seasonal evolution of the surface mixed layer and its stratification

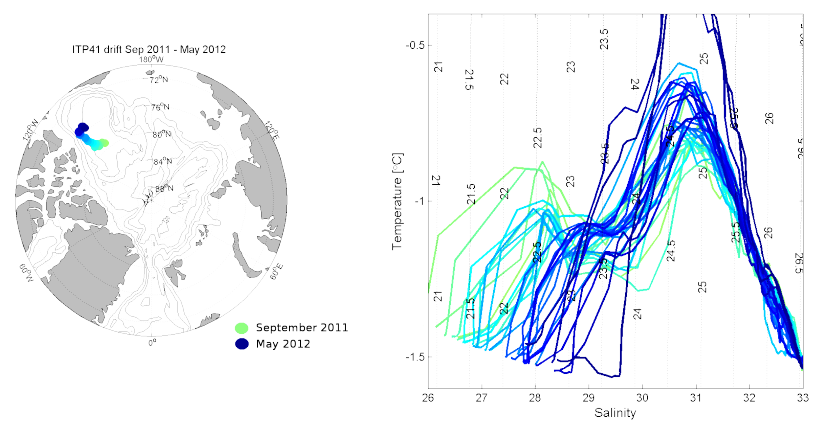
Summer warming: ITP41 May – Sep 2011

Winter cooling: ITP41 Sep 2011 – May 2012



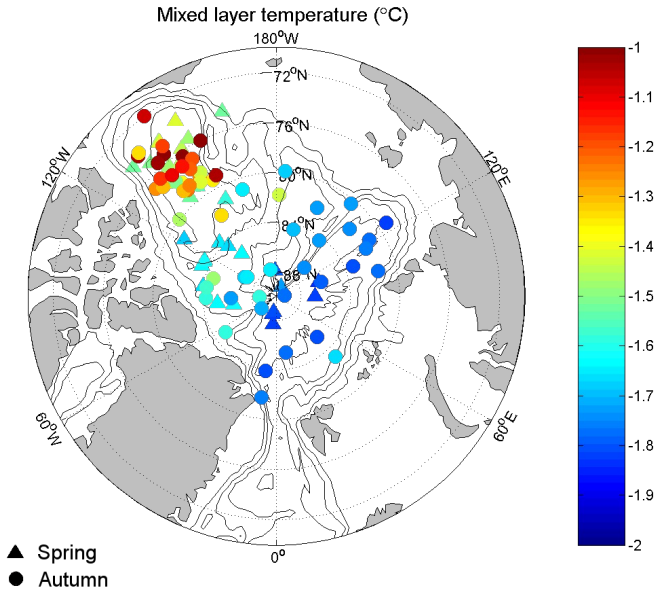


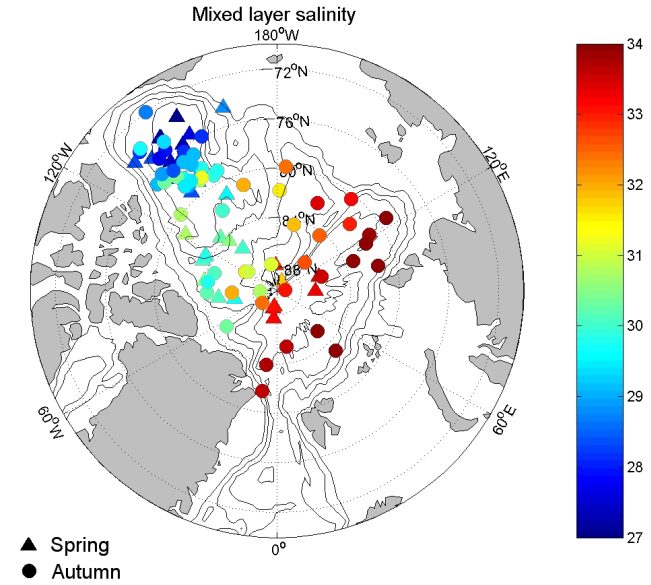




Definitions

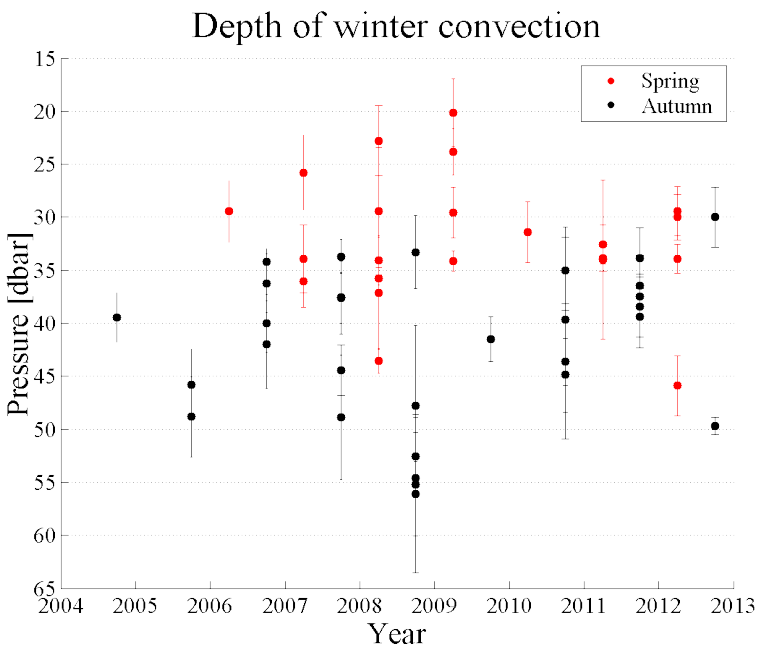
- Depth of maximum winter convection defined with temperature threshold first exceeding 0.02ºC
- Properties at this depth are averaged over the first week of May
- In autumn depth of temperature minimum is searched between p>20 dbar and S<31 in the Canada Basin (between 20 and 150 dbar in the Nansen Basin)
- Properties at the depth of temperature minimumare averaged over the first week in September

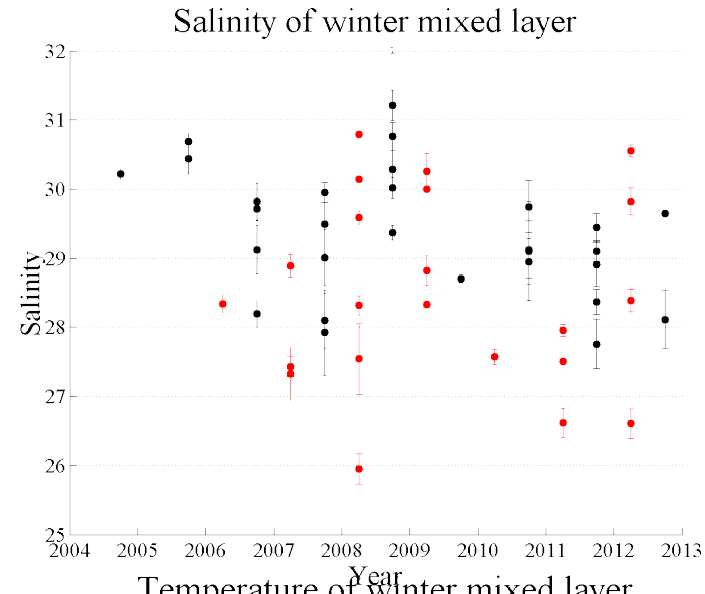


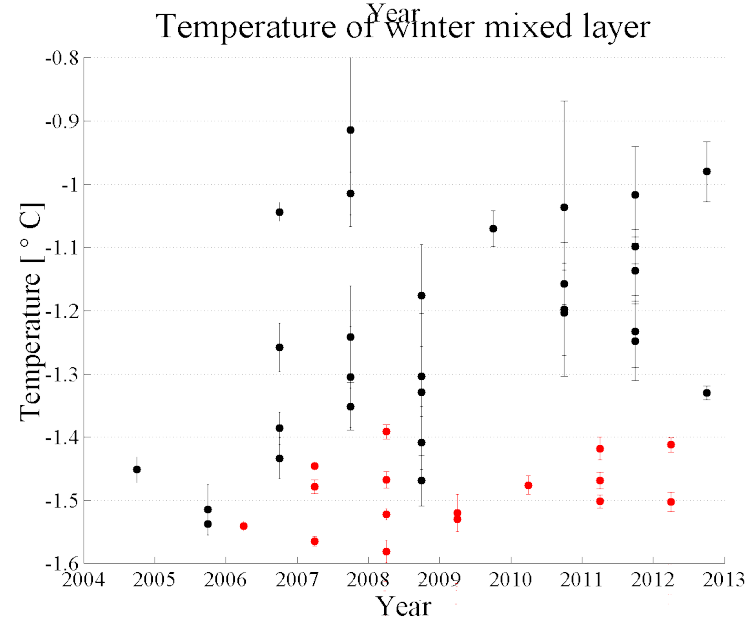


Results from the Canada Basin

- Depth of winter convection varies from 20 to 45 dbar
- Depth of temperature minimum varies from 30 to 55 dbar
- Warming by <0.5 degrees

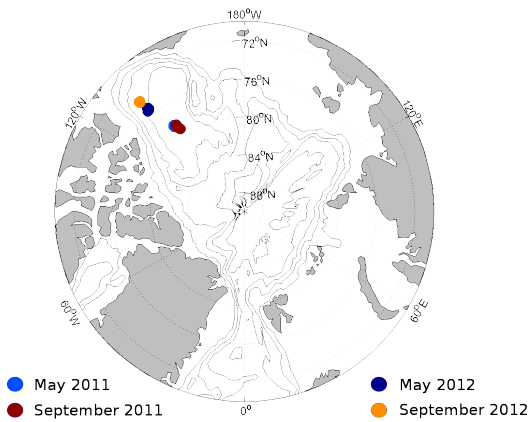




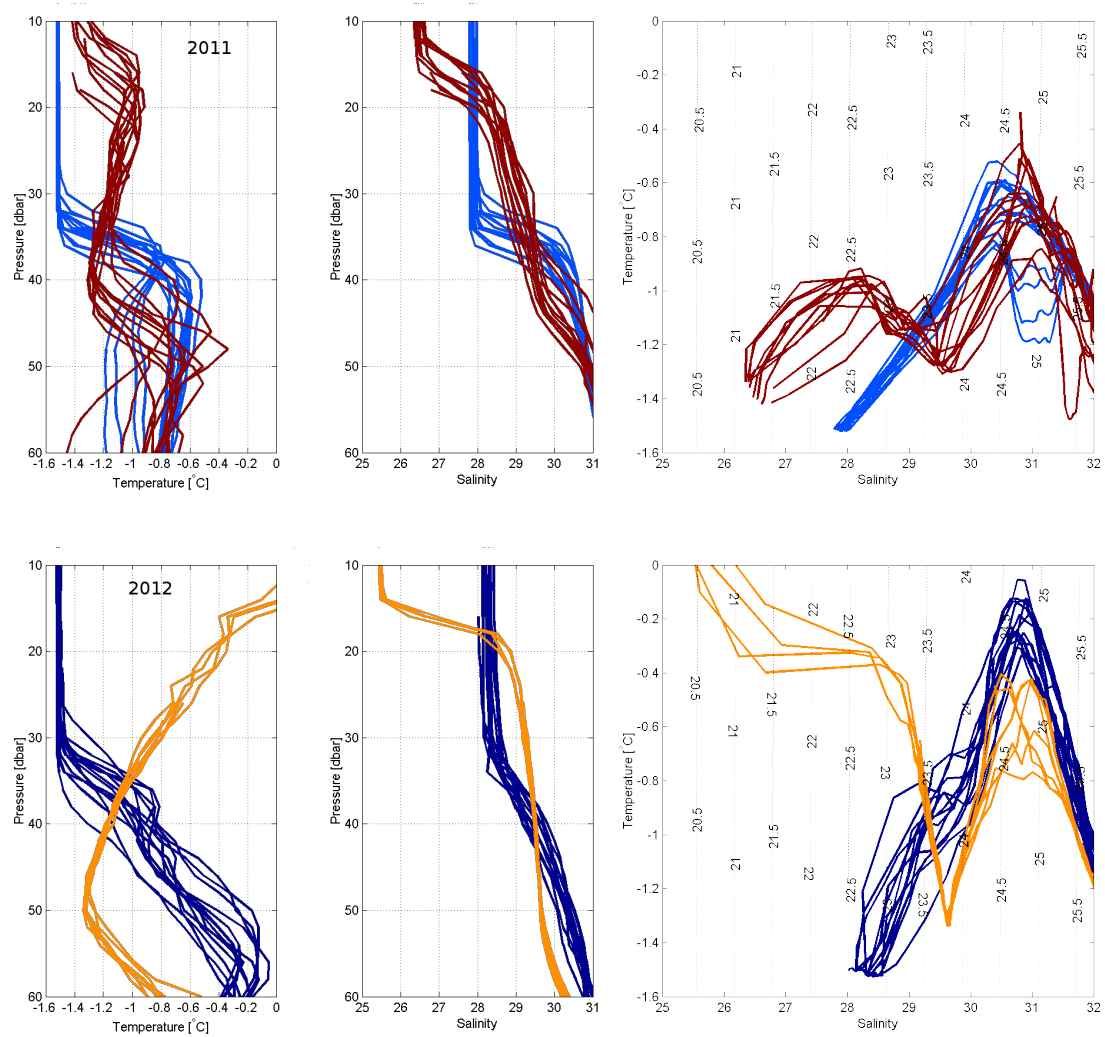


Case studies: ITP41 in the Canada Basin 2011-2012

- Distance drifted between May and September 2011: 85 km
- Deepening by 5 to 10 dbar
- Warming by 0.2ºC



- Distance drifted between May and September 2012: 120 km
- Deepening by 20 dbar
- Warming by 0.2ºC



Conclusions and outlook

- Ekman convergence is likely to cause deepening of temperature minimum by 5 to 20 dbar in the Canada Basin
- Warming by ~0.2ºC
- Salinification by ~1 ppt

- Uncertainity in meltwater estimates?
- Entrainment of heat from below may instead lift the temperature minimum in the Eurasian Basin?
- Diffusion coefficient for salinity