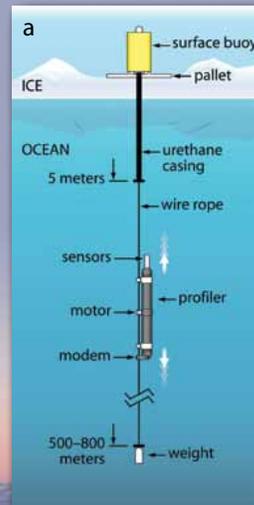


THE ICE-TETHERED PROFILER: ARGO OF THE ARCTIC

BY JOHN M. TOOLE, RICHARD A. KRISHFIELD,
MARY-LOUISE TIMMERMANS, AND ANDREY PROSHUTINSKY

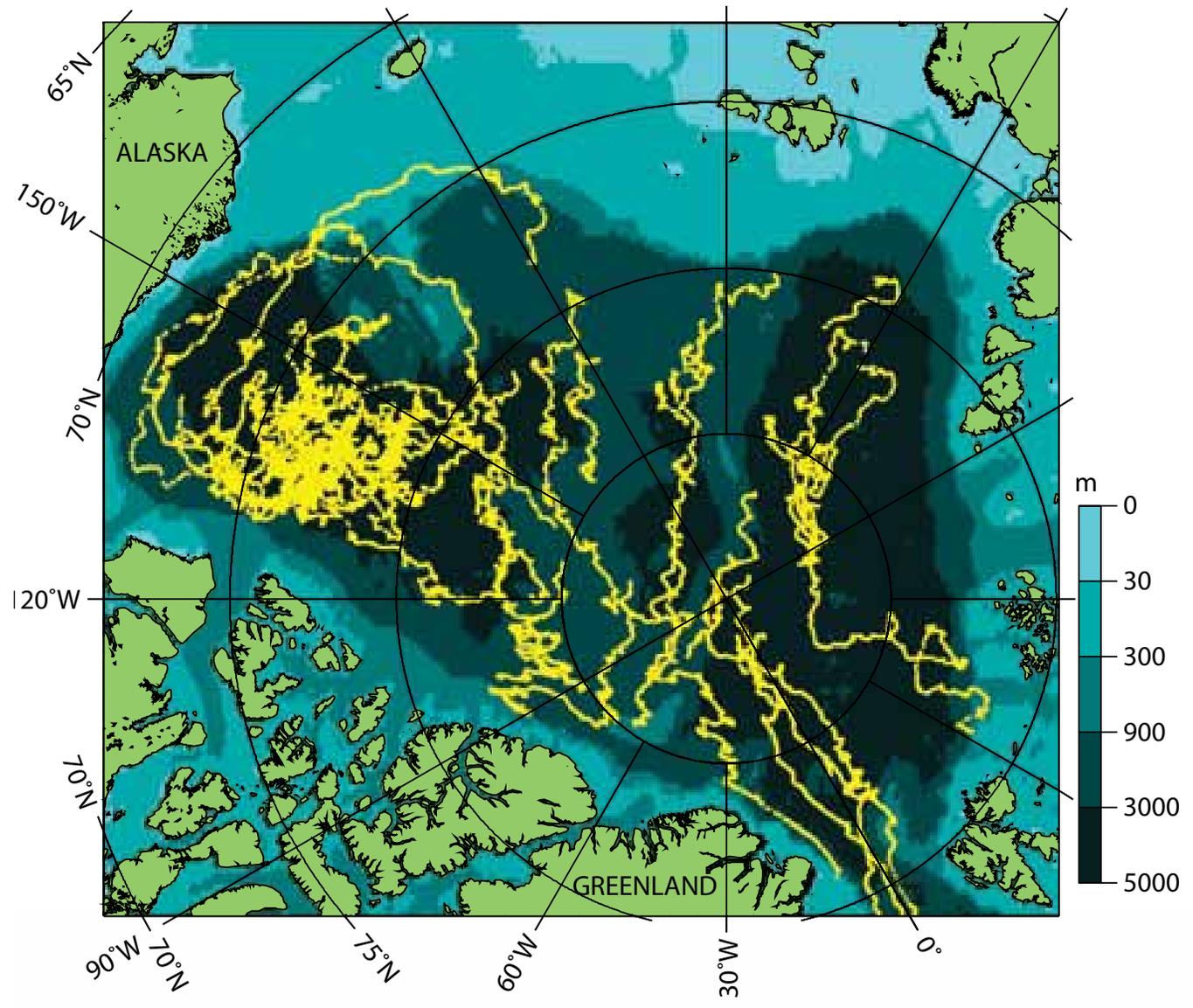
Figure 1. (a) Schematic drawing of the Ice-Tethered Profiler system with components labeled. Photographs of (b) the underwater profiling module being attached to the wire-rope tether during deployment and (c) the final buoy installation (present surface buoy design), the latter with CCGS *Louis S. St-Laurent* in the background.



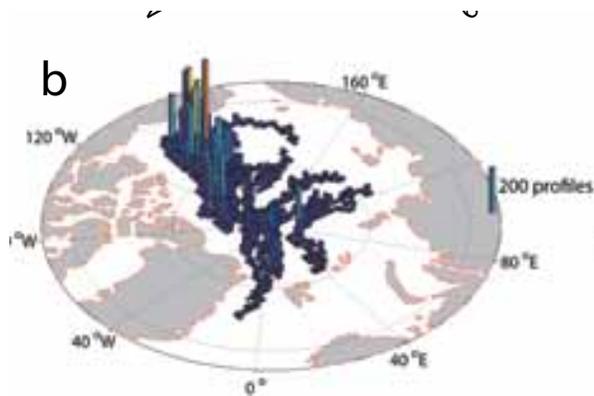
... and many more buoys

a

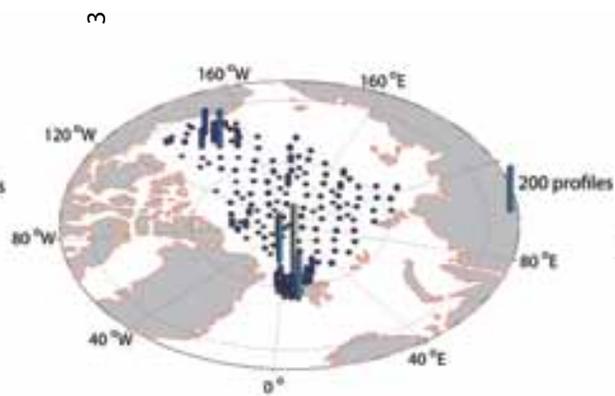
All ITP Profiles: 2004-2010



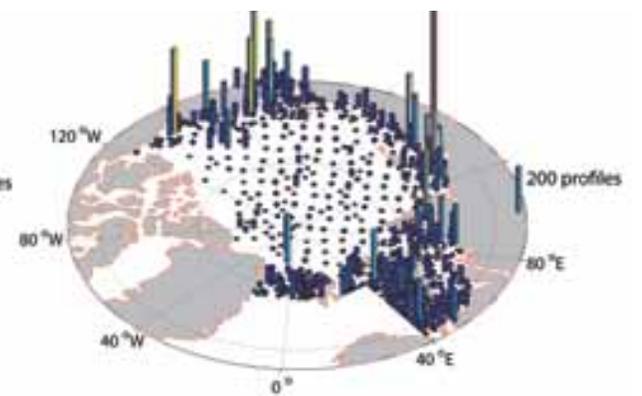
Toole et al. (2011)



ITP Profiles

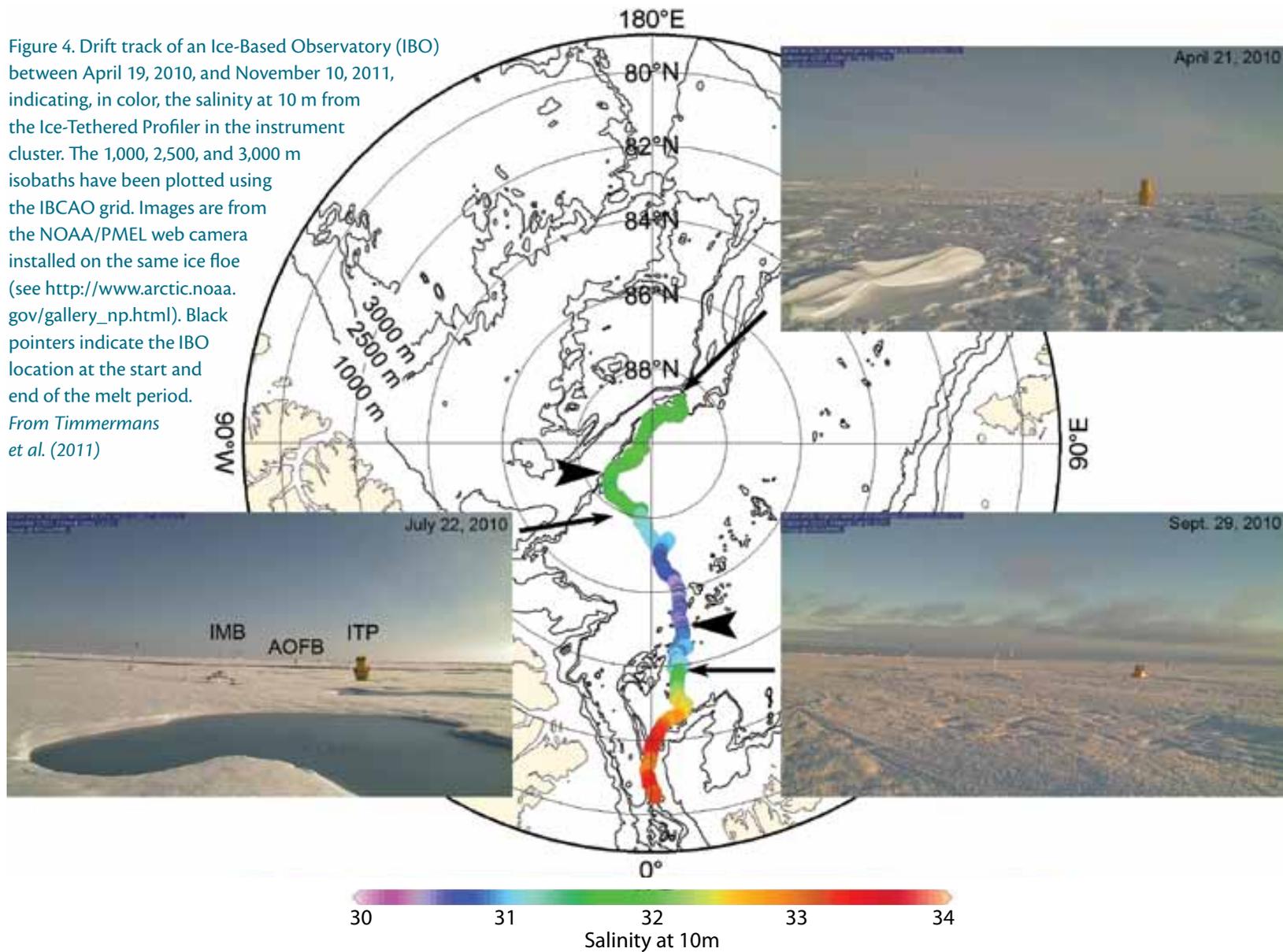


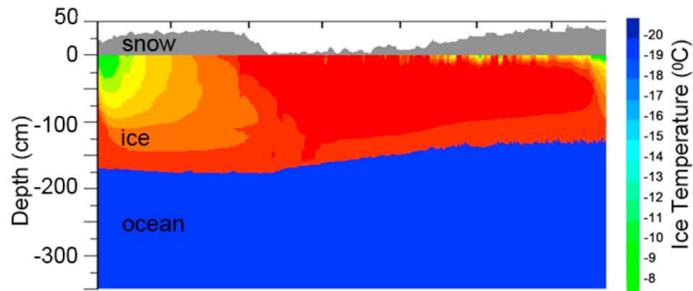
CTD Profiles 1970s
Deeper than 760-m



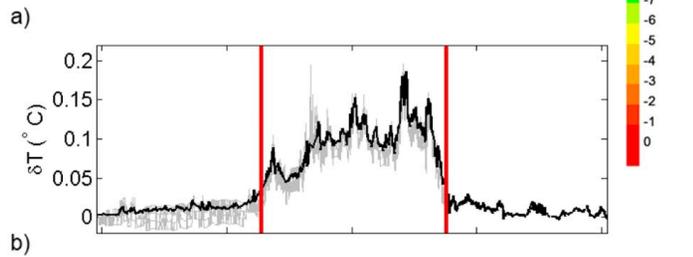
CTD Profiles 1970s

Figure 4. Drift track of an Ice-Based Observatory (IBO) between April 19, 2010, and November 10, 2011, indicating, in color, the salinity at 10 m from the Ice-Tethered Profiler in the instrument cluster. The 1,000, 2,500, and 3,000 m isobaths have been plotted using the IBCAO grid. Images are from the NOAA/PMEL web camera installed on the same ice floe (see http://www.arctic.noaa.gov/gallery_np.html). Black pointers indicate the IBO location at the start and end of the melt period. From Timmermans et al. (2011)

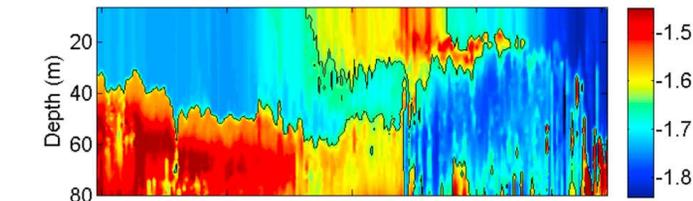




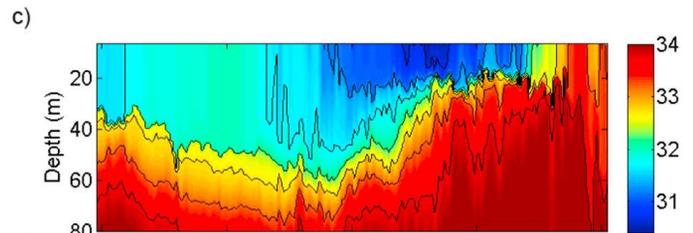
Ice Temperature (IMB2010A)



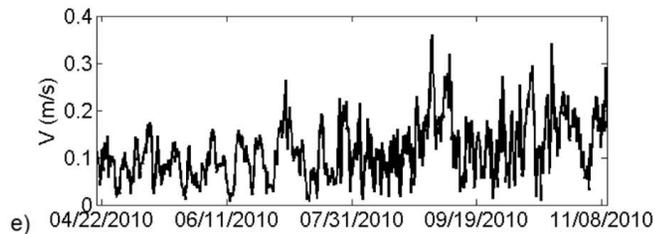
Water Temperature above Freezing

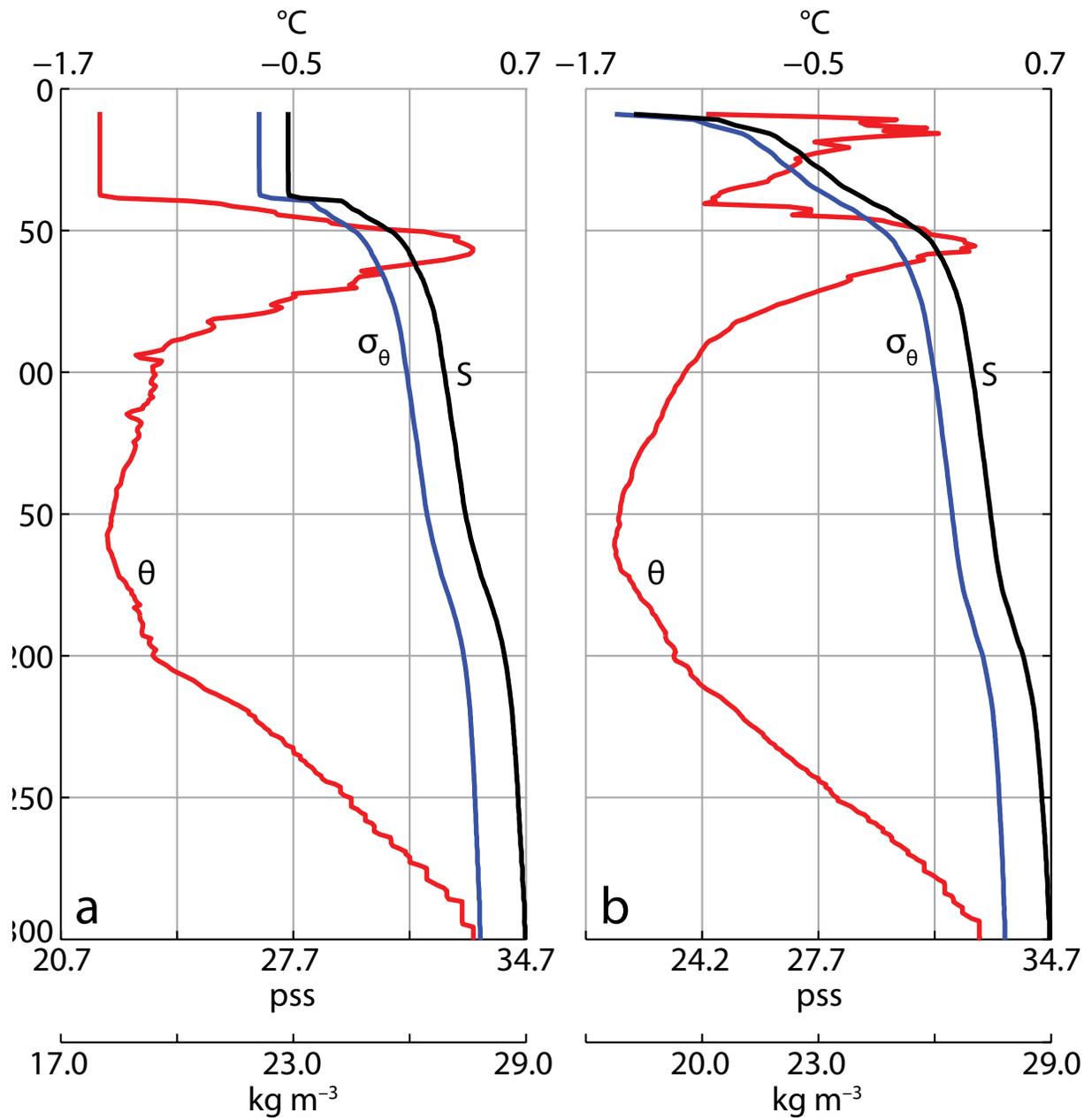


ITP-38 Temperature



ITP-38 Salinity



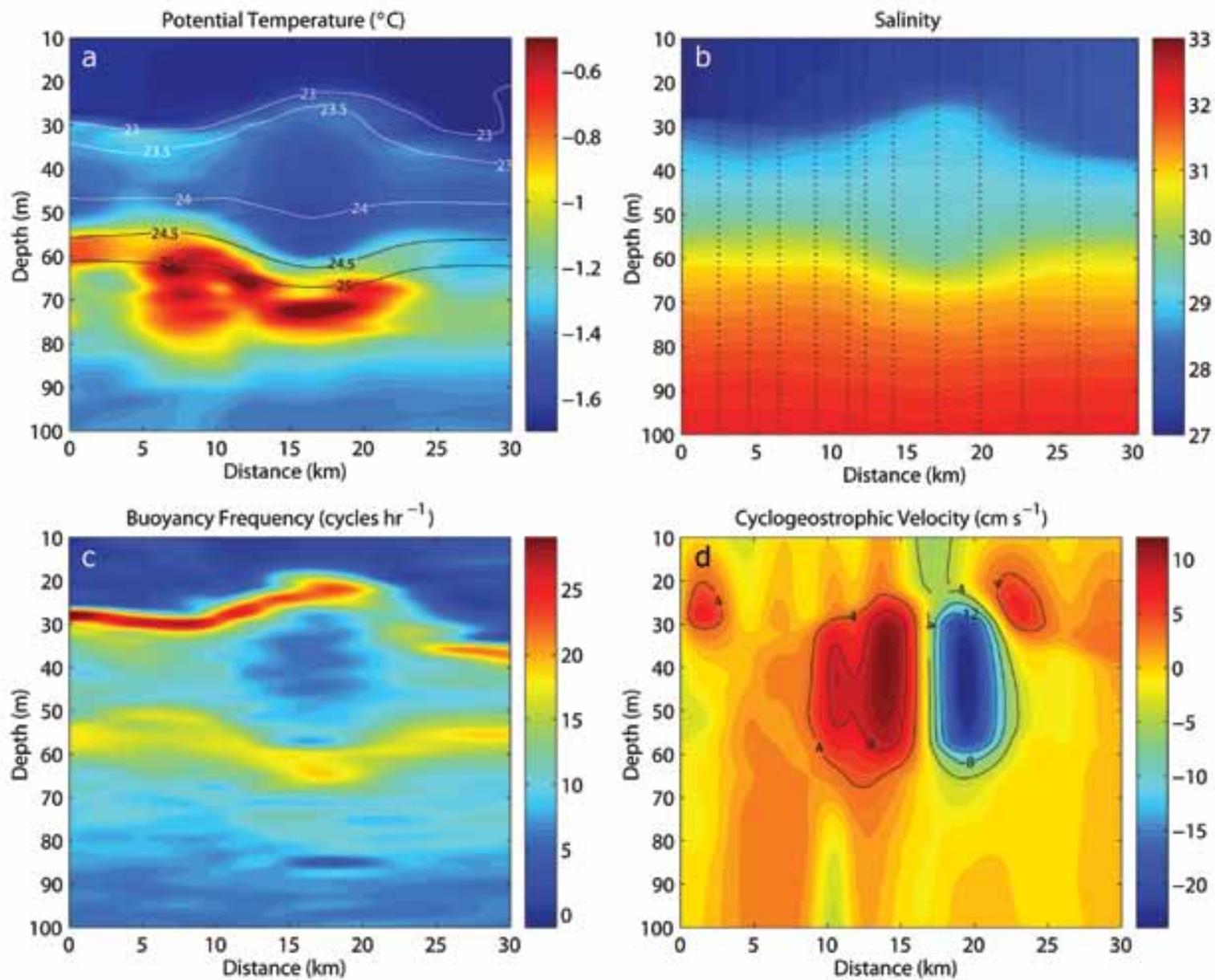


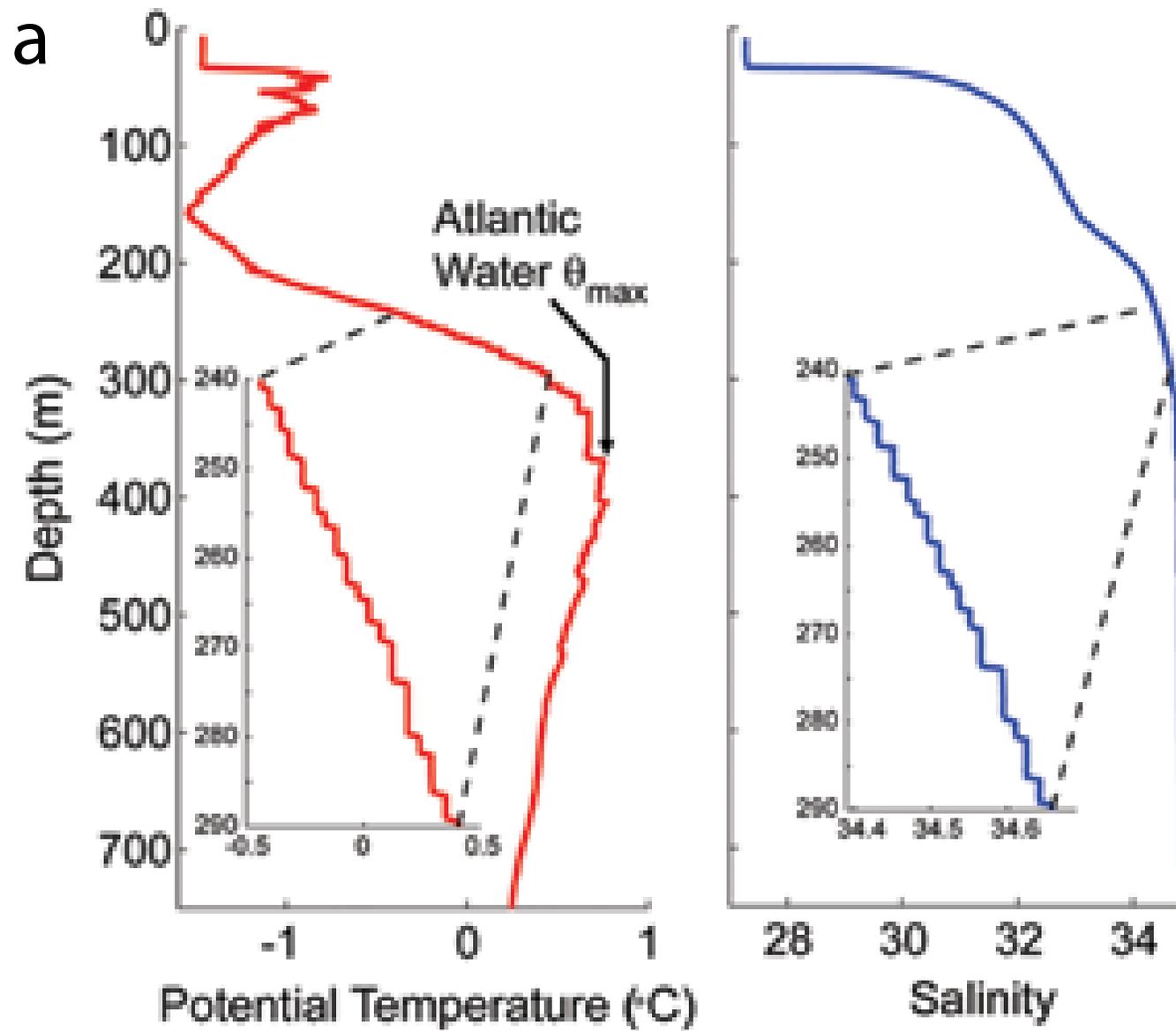
ITP-6
 within 50-km
 winter vs summer

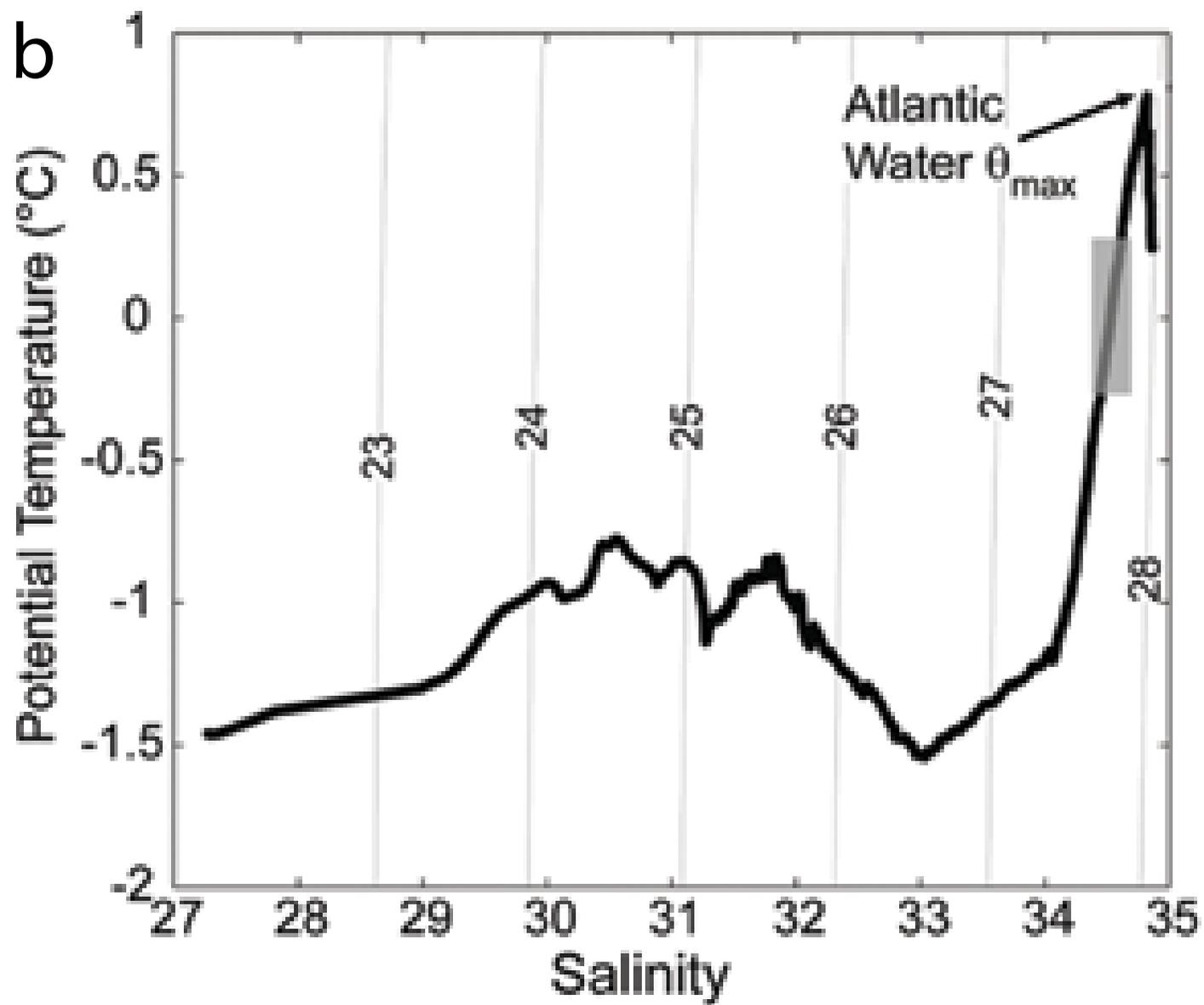
April-30, 2007

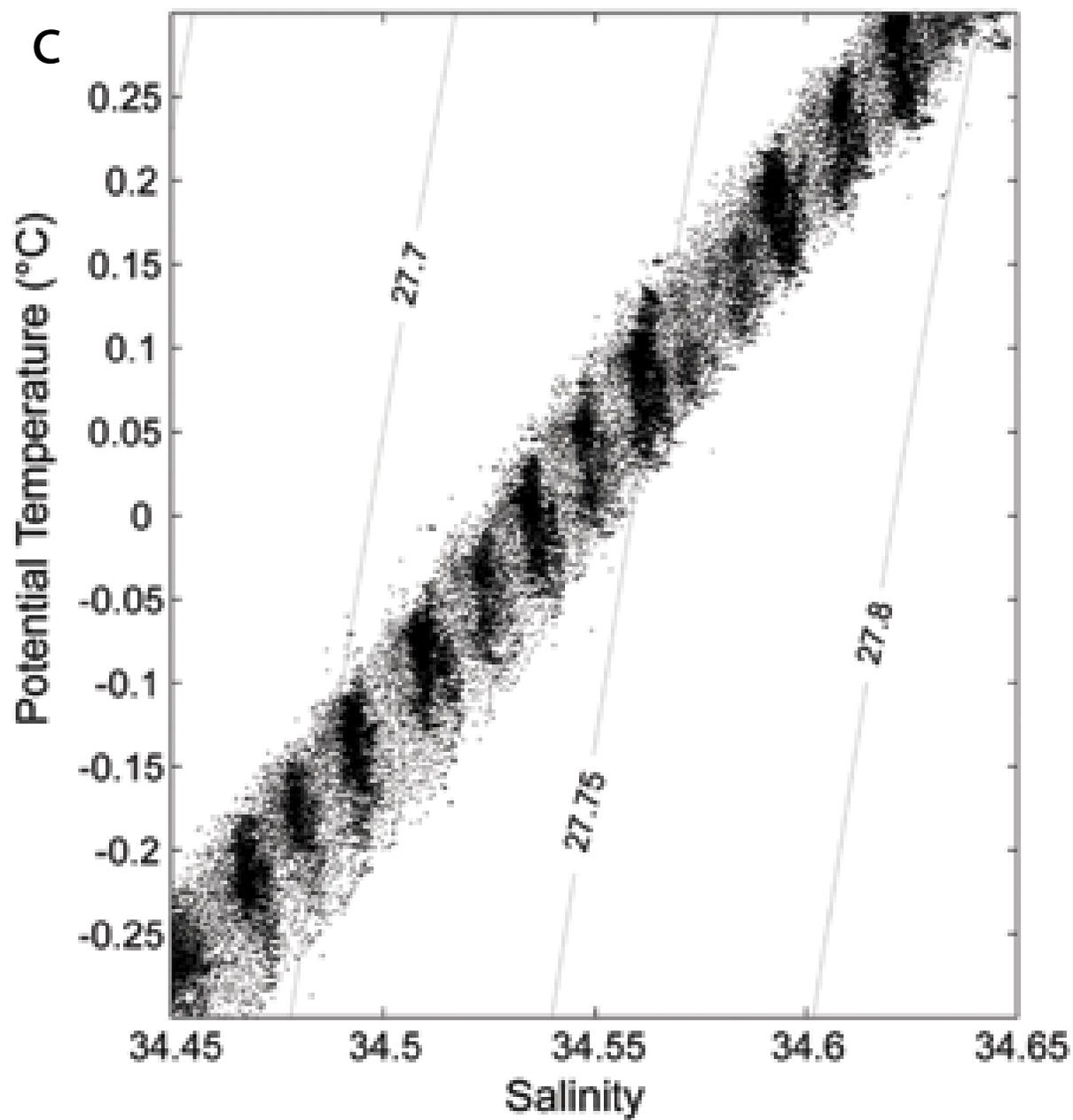
Sept.-13, 2007

Toole et al. (2010)



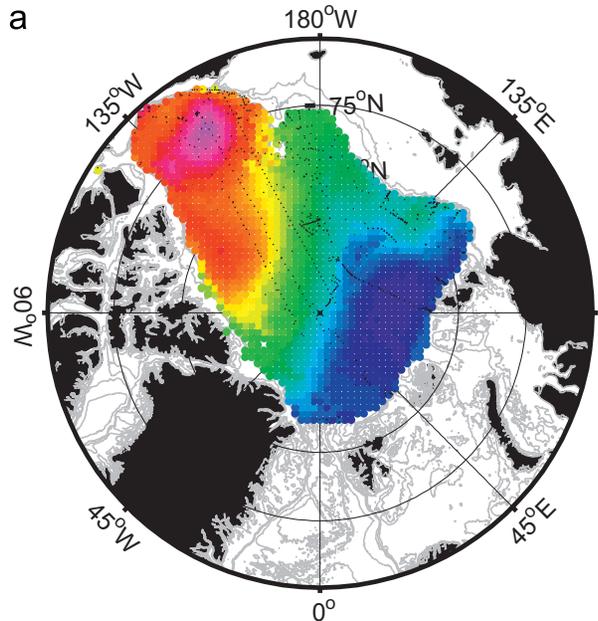






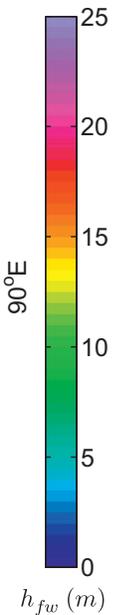
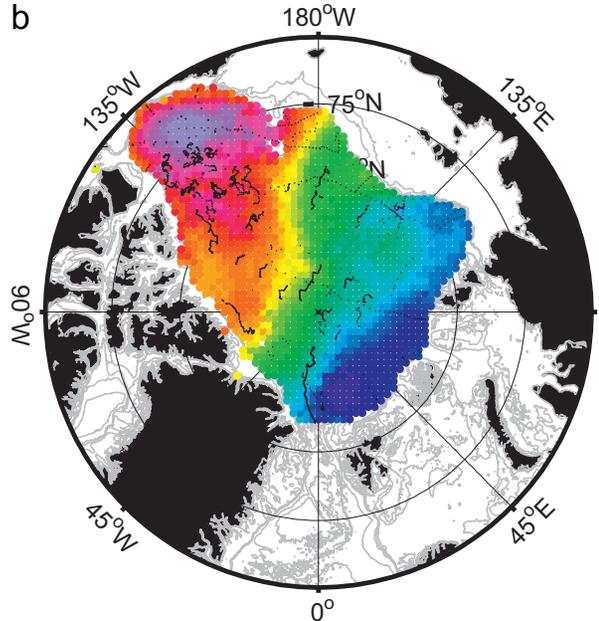
1992-99

a



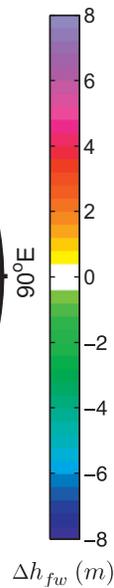
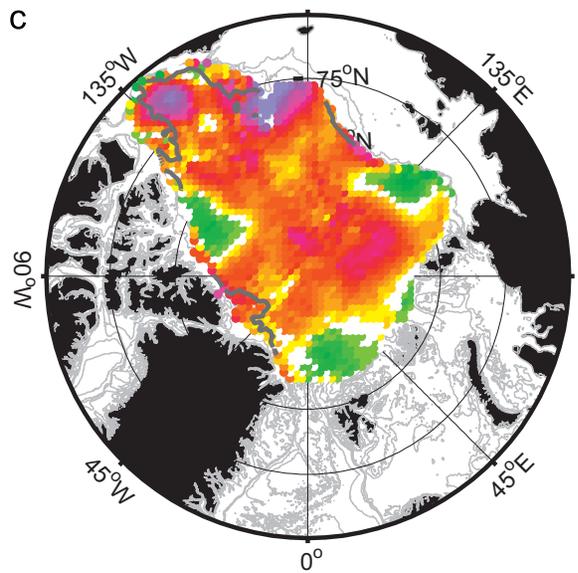
2006-08

b



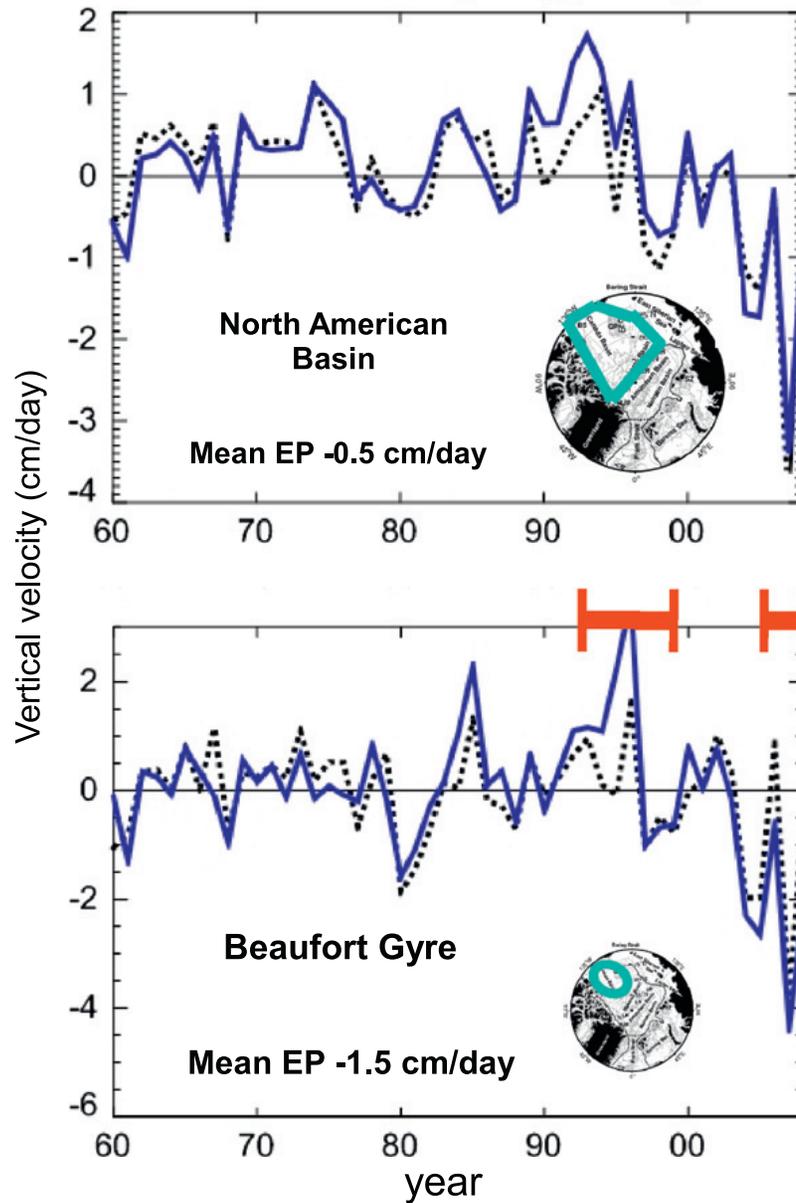
Freshwater
Content Change

c

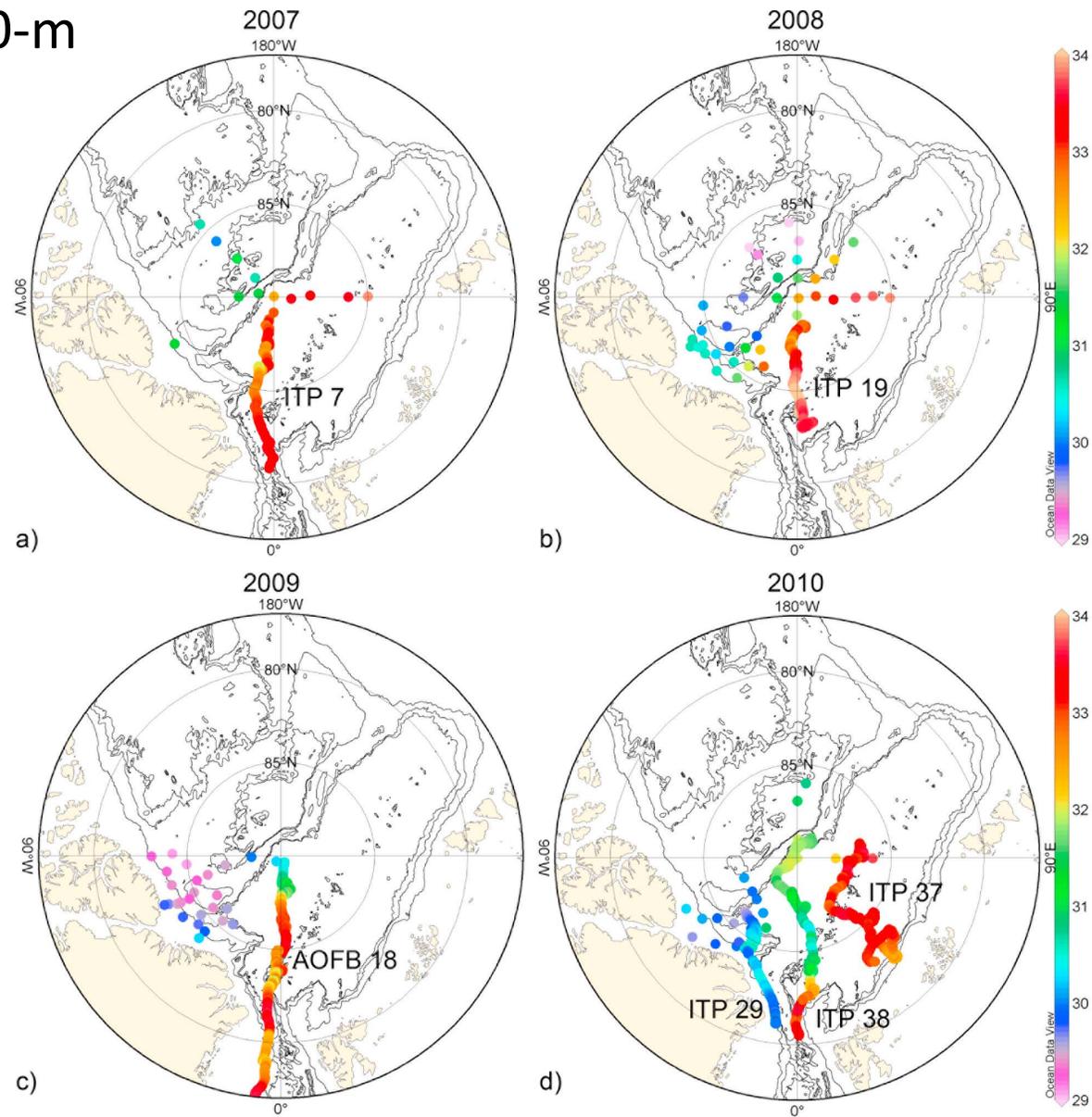


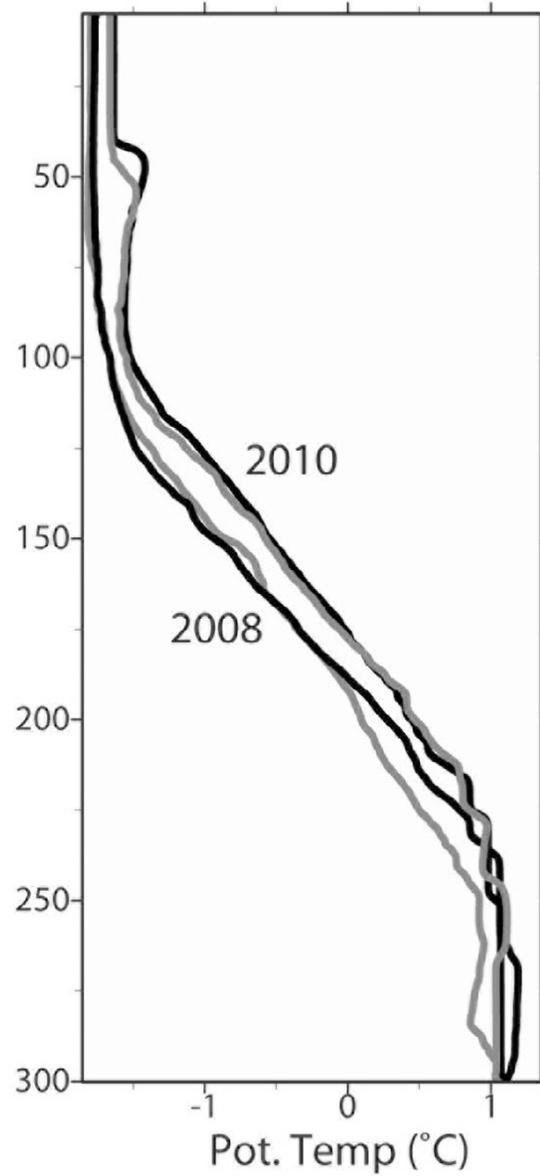
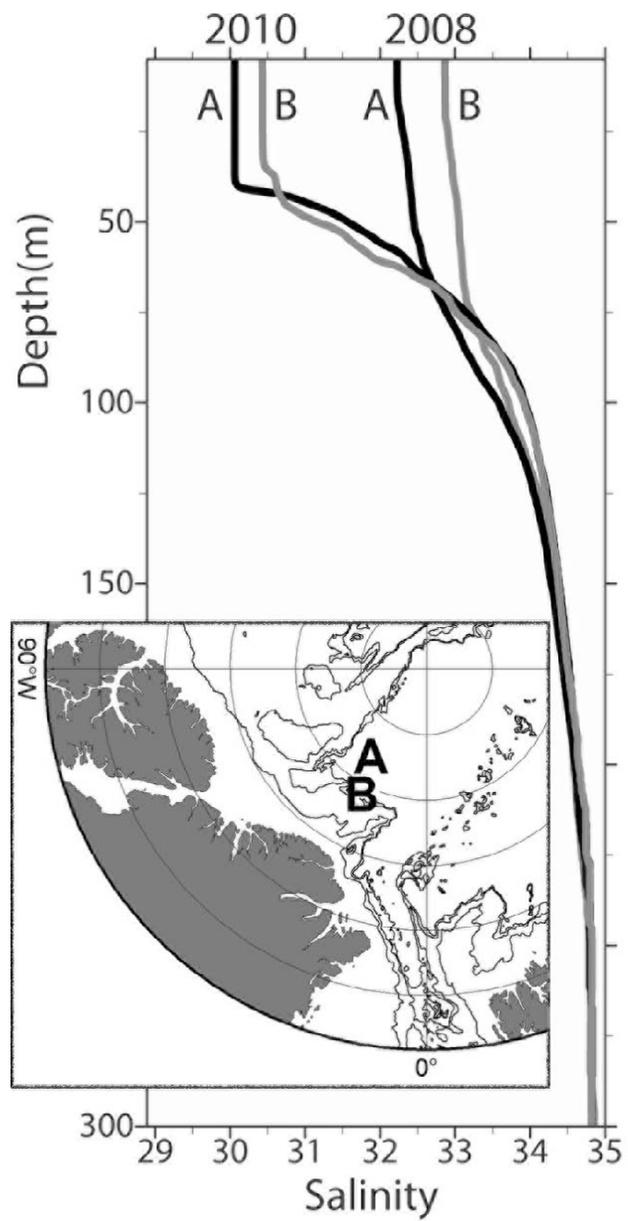
Difference of b-a

Vertical velocities of Ekman Pumping (dotted) based on curl of wind + ice stress and the 34.0 isohaline (solid) [cm/day]

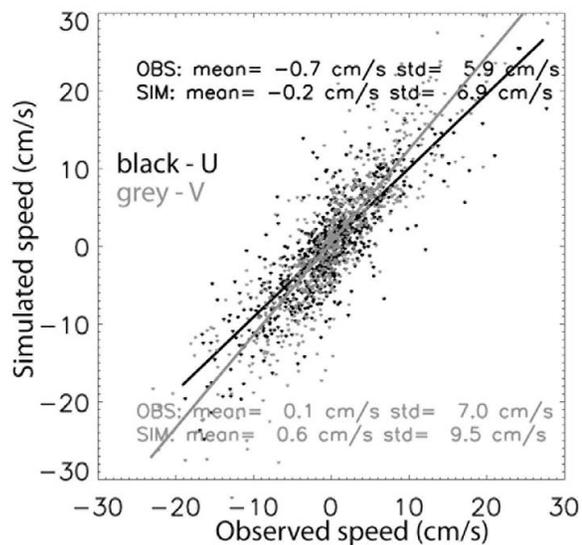
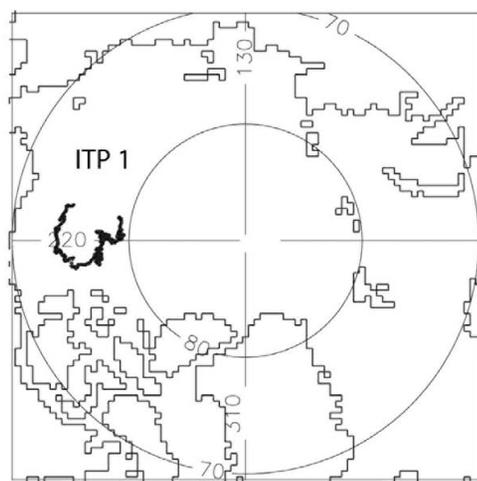


Salinity at 10-m

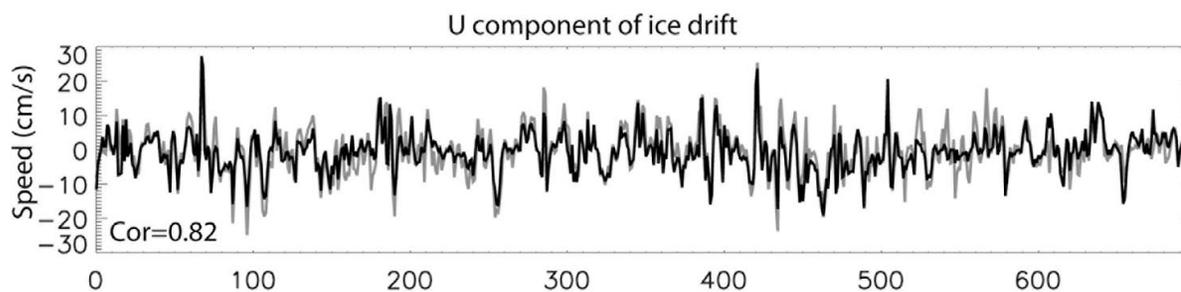




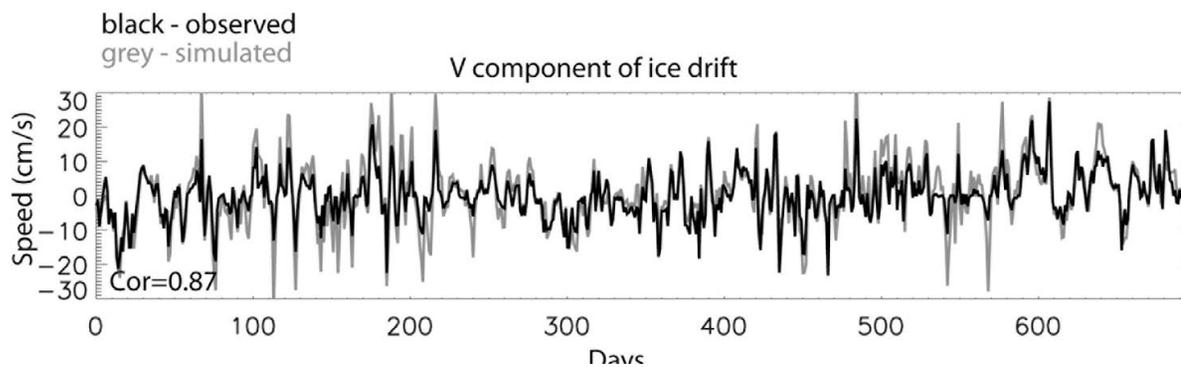
ITP-1



Correlation of
ice Drift
with
wind

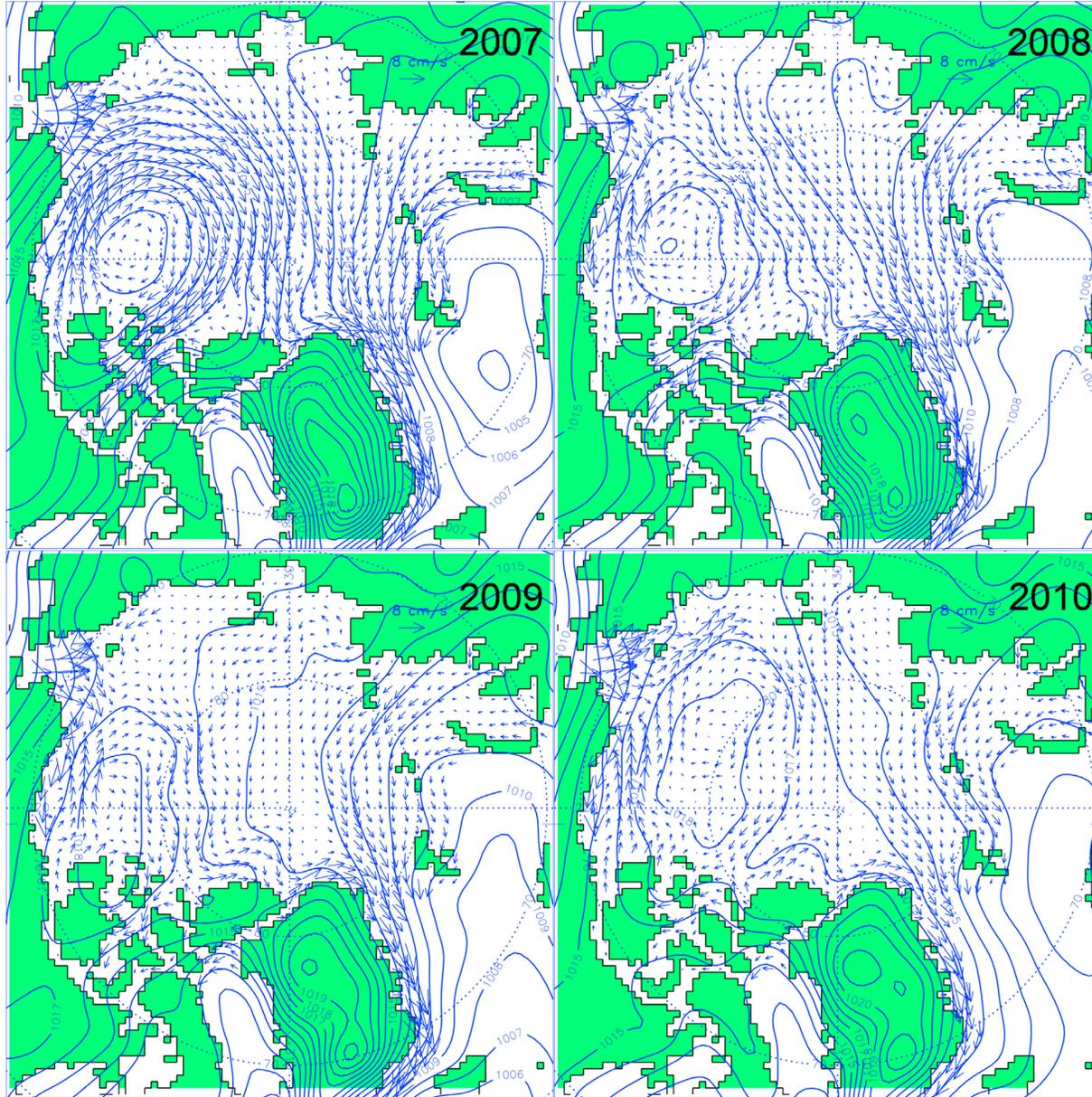


U



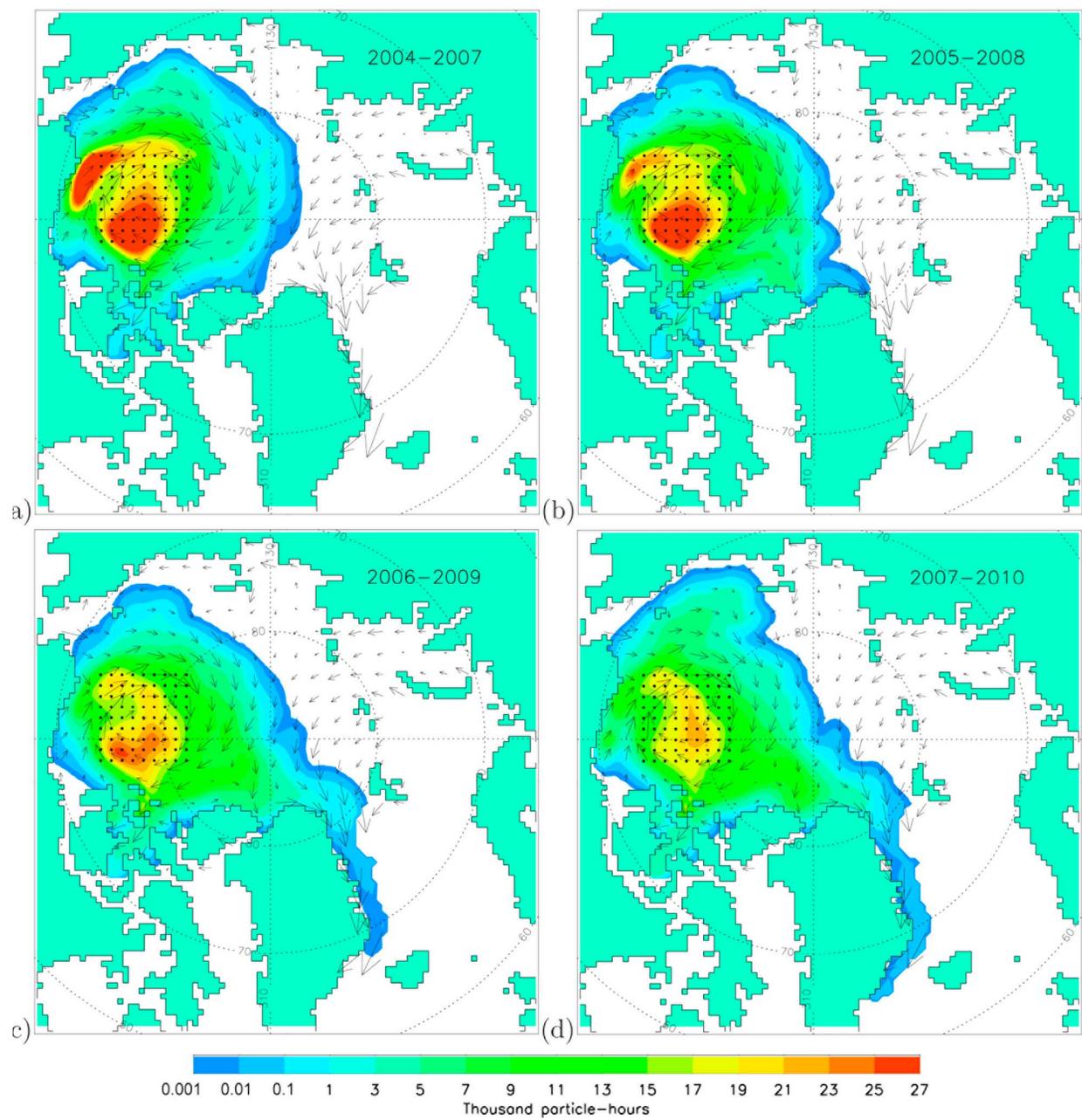
Ice Drift Velocity

V

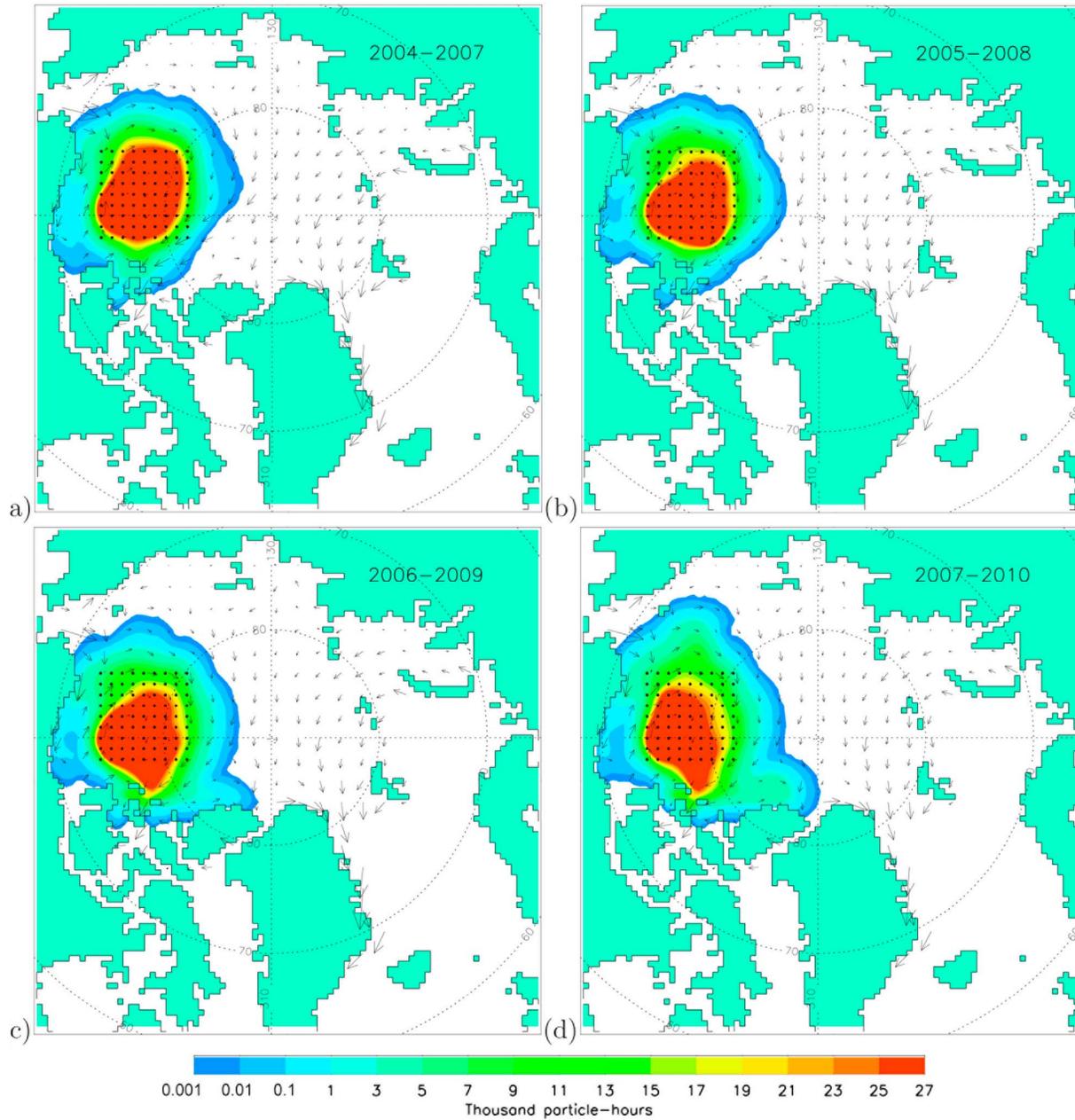


Model Winds

Ice Tracers Released into Beaufort Gyre

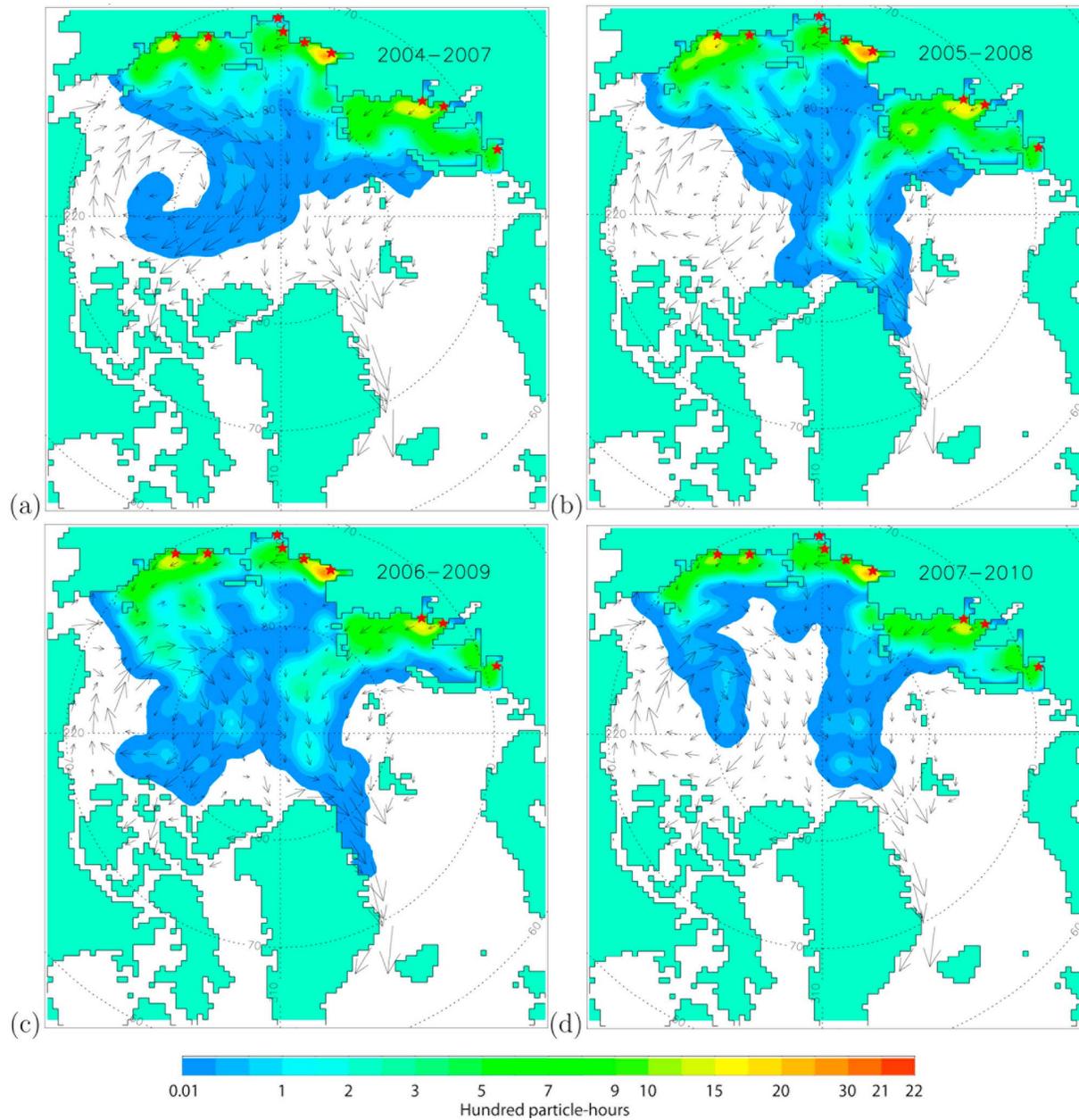


Water Tracers Released into Beaufort Gyre



Timmermans et al. (2011)

Water Tracers Released at Siberian Rivers



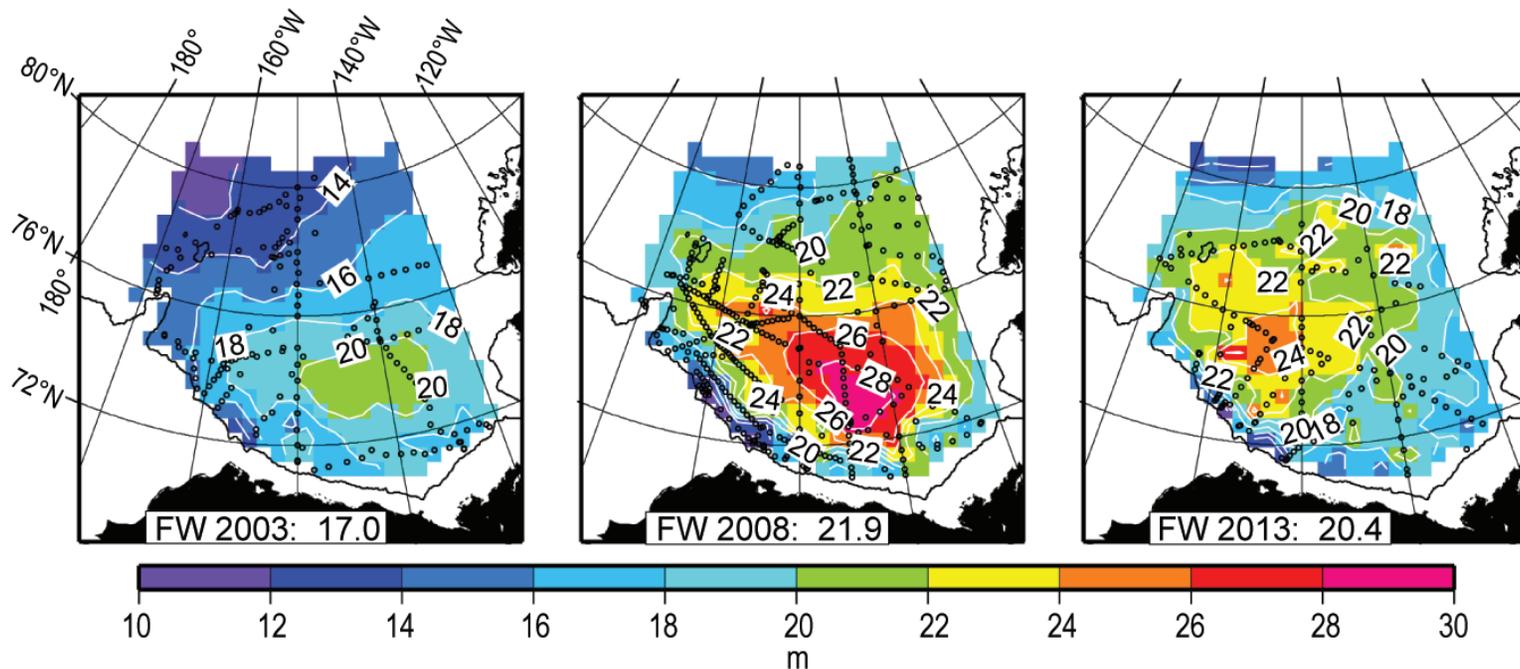


FIG. 5.17. Freshwater content (m, calculated relative to a reference salinity of 34.8) in the Beaufort Gyre of the Canada Basin based on hydrographic surveys in 2003, 2008, and 2013. Inset numbers at the bottom of each panel give total freshwater volume ($\times 1000 \text{ km}^3$) in the region. Black dots depict hydrographic station locations. Data are from the Beaufort Gyre Observing System (BGOS)/Joint Ocean Ice Studies (JOIS) project (<http://www.whoi.edu/beaufortgyre>) and other Canada Basin expeditions.

2013 Arctic Ocean Salinity Data at 20-m

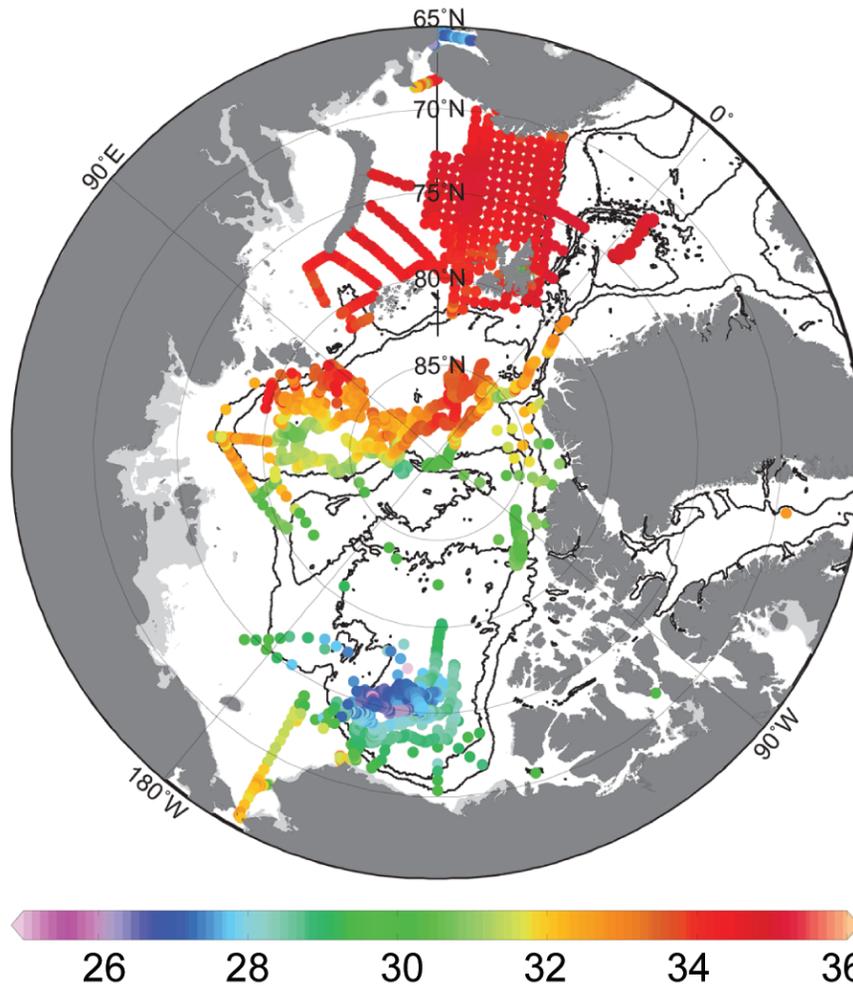


FIG. 5.16. Average salinity at 20-m depth in 2013. Contour lines show the 500-m and 2500-m isobaths. Salinities are reported using the Practical Salinity Scale (unitless). Data are from multiple sources, including various hydrographic expeditions by different countries and institutions, and ice-tethered profilers (<http://www.who.edu/itp>).