Ice-tethered Instruments: History and Future Development

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Ice-Tethered Platform Workshop
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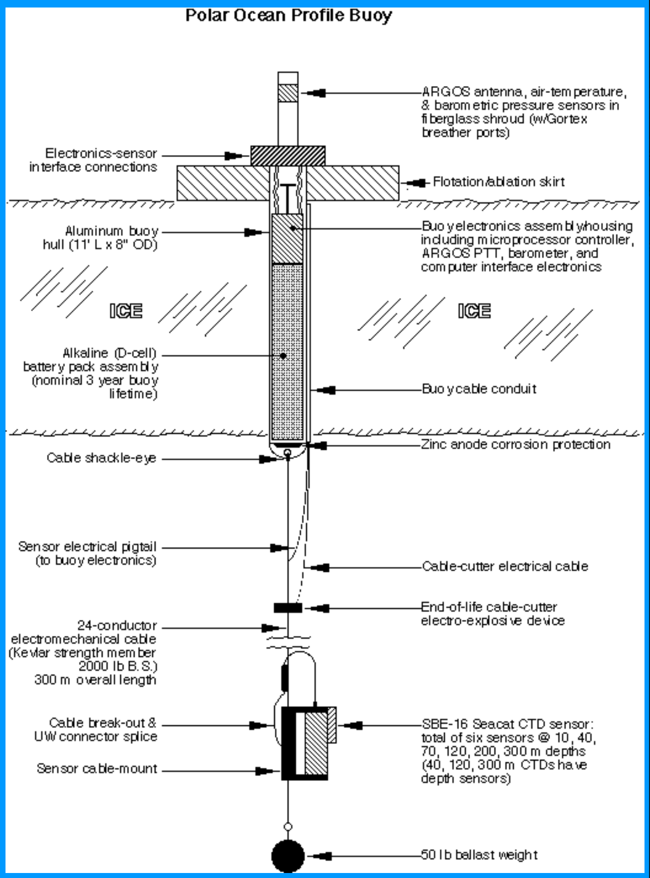
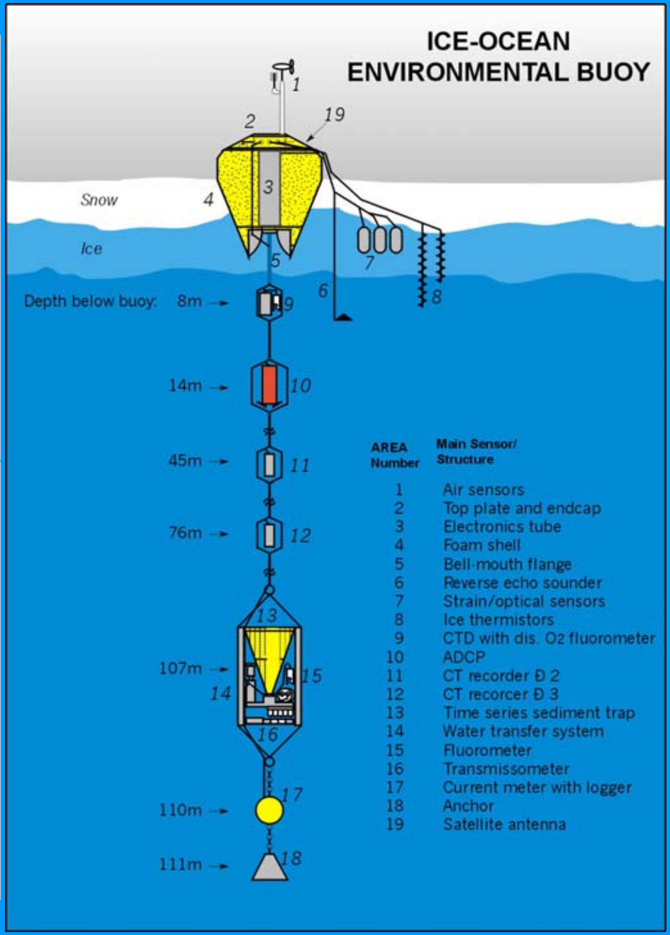
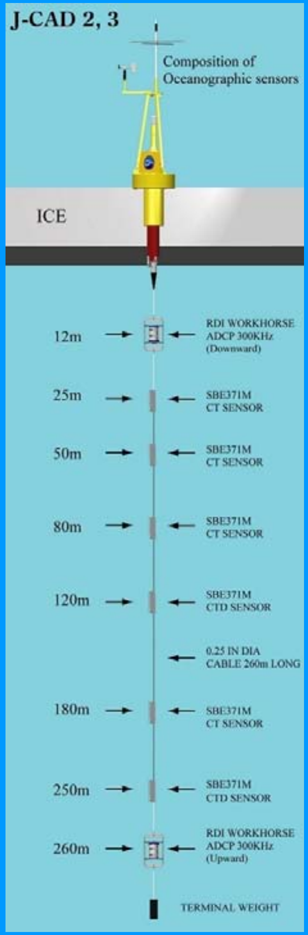
Woods Hole Oceanographic Institution

Since the 1980s, Arctic drifting buoys with subsurface instrumentation have acquired unattended data on the surface air, ice, and upper ocean.





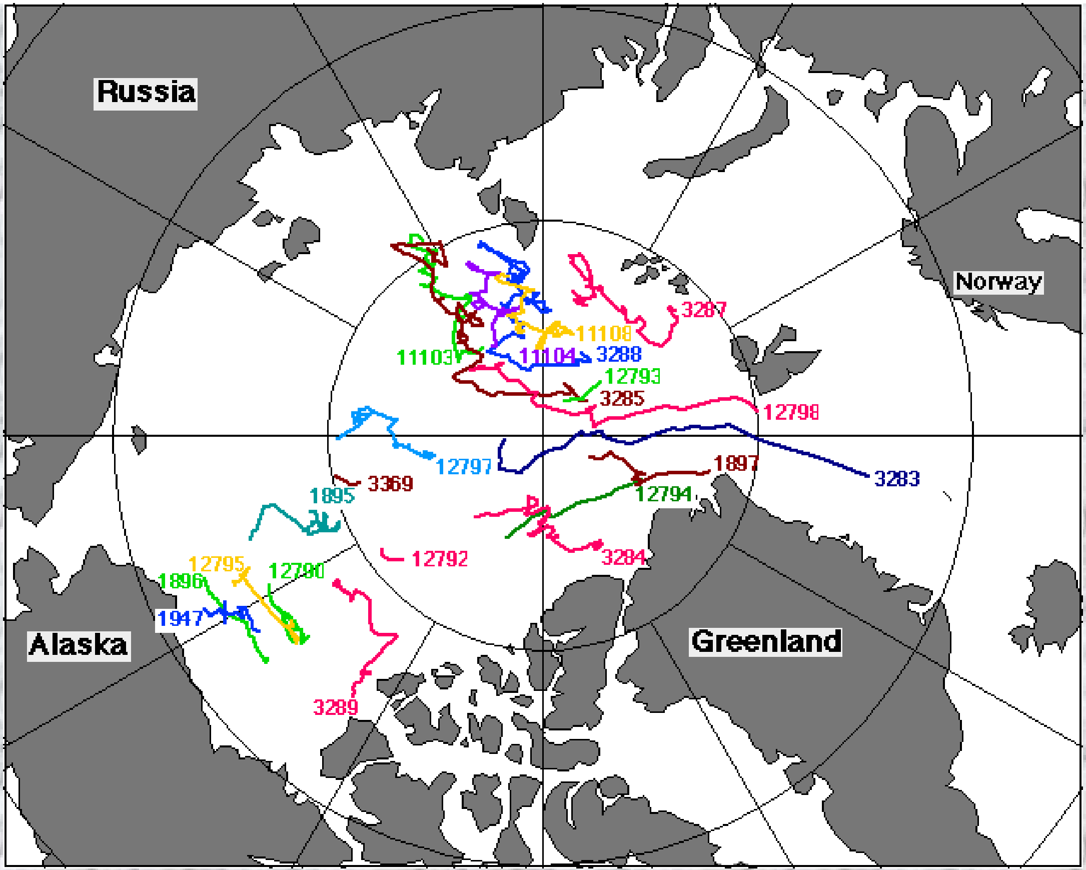


Specifications:

	POP (SALARGOS)	IOEB	J-CAD	ITP
Developer	PSC	WHOI/JAMSTEC	JAMSTEC	WHOI
Deployments	24 (1985-1994)	6 (1992-1998)	4 (2000-present)	
Lifetime	3 years	3 years	>2 years	2.75 years
Length	300m	110-165m	260m	200-800m
Communications & locs.	ARGOS	ARGOS	ORBCOMM/GPS	Iridium/GPS
CTDs	6	4	6	profiler
Frequency	12 min.	2 hour	1 hour	1-2 daily
Other sensors	Baro., Air T	Baro., Air T, Wind	Baro., Air T, Wind	interface for external
		150khz ADCP	300 kHz ADCP(s)	
		Ice thermistors	SST	
		Trap, Fluoro., Trans.		
Hardware costs	$40,000	$250,000	$150,000	$40,000
Expendable	yes	no	yes	yes

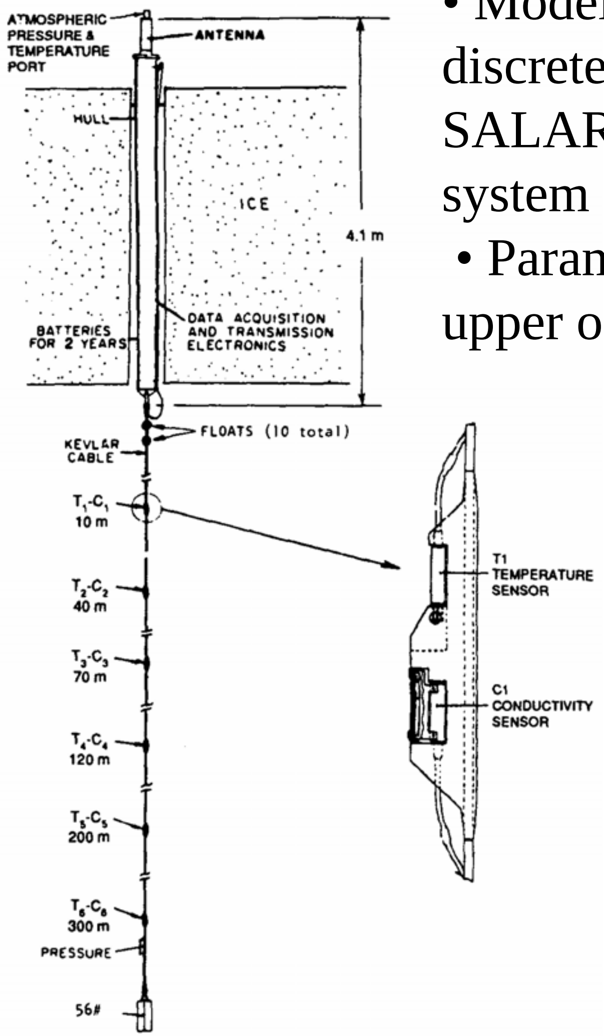
The vertical resolution of the T & S observations from conventional systems has been limited to only a few depths due to the costs associated with outfitting multiple sensors on a single package.

Between 1985 and 1994, the Polar Science Center, APL/UWASH, deployed 24 Polar Ocean Profiler (or SALARGOS) data buoys in the Arctic Ocean. These data were incorporated into the US-Russian Environmental Working Group Atlas.



http://iabp.apl.washington.edu/

- Models are needed to account for depth changes of the discrete conductivity and temperature sensors on the SALARGOS buoys due to shoaling of the mooring system from the ice drift.
- Parameterizations are relied upon to reconstruct the upper ocean profiles from the discrete measurements.



From Steele and Morison, 1992

824 JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY VOLUME 9

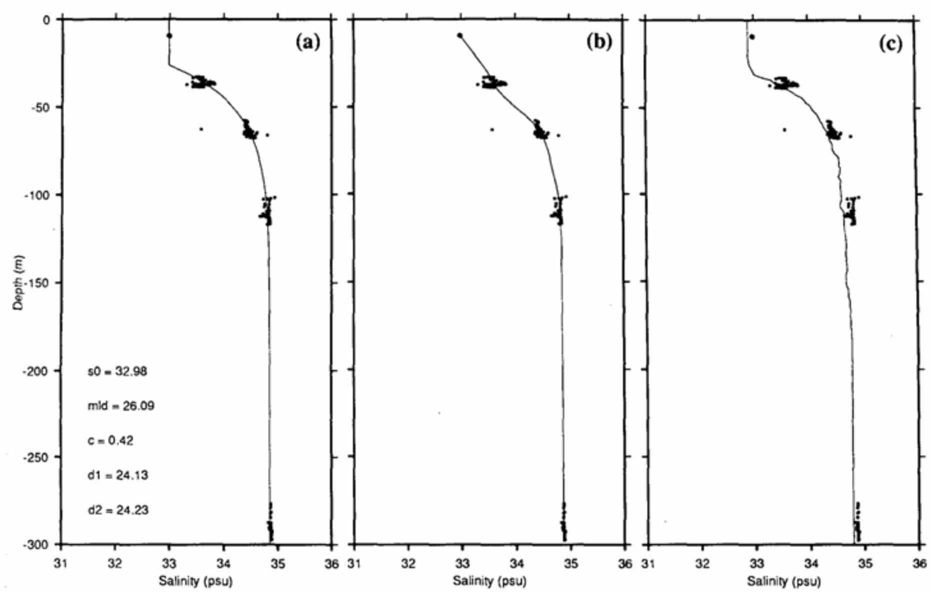
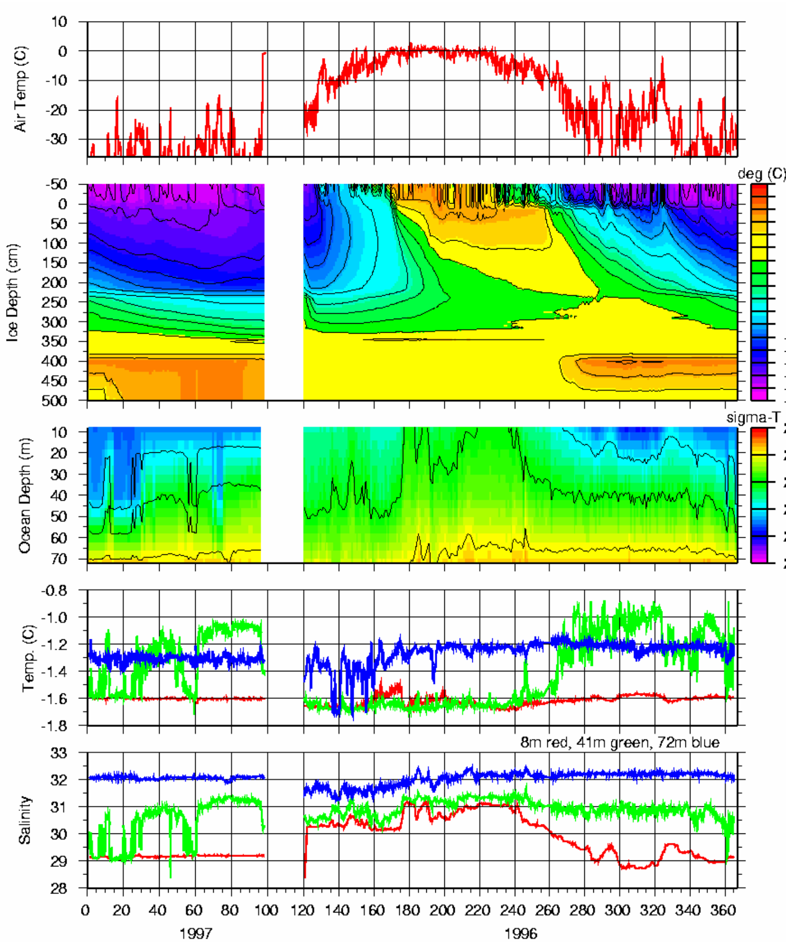


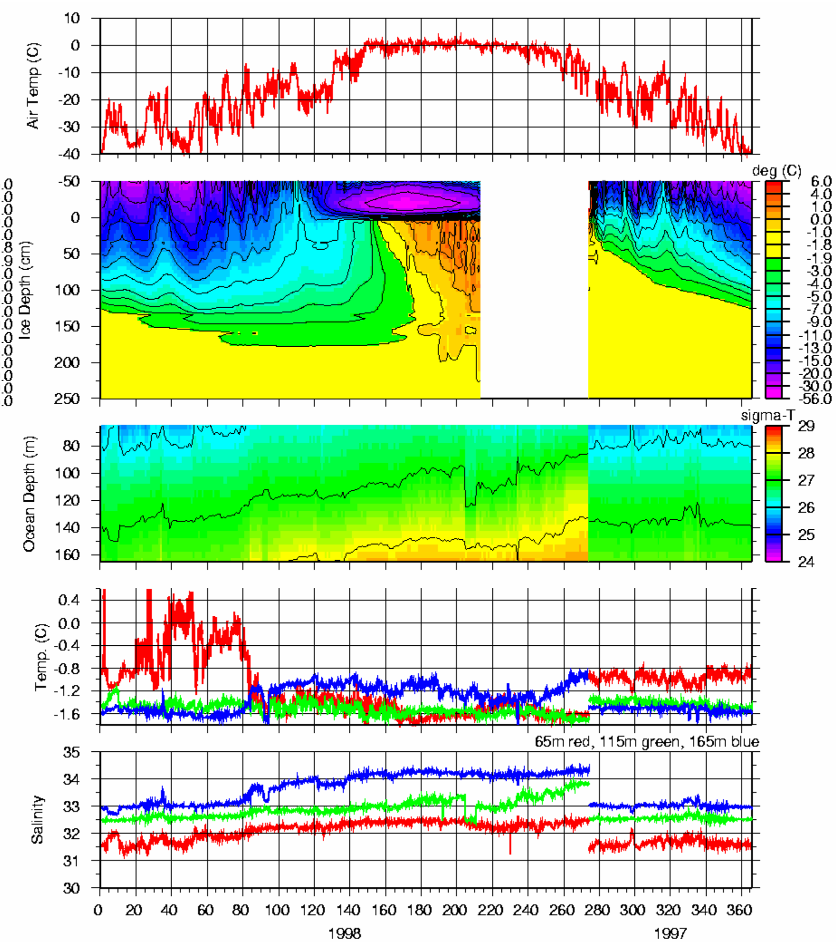
FIG. 11. A scatterplot from the latter half of the data record (days 296.5–297) and (a) the two-exponential parametric fit, (b) the nonparametric fit, and (c) a CTD cast at day 296.88. The parametric fit reproduces the mixed layer that is evident in the CTD cast.

Simultaneous air, ice, and upper ocean observations from sensors on Ice-Ocean Environmental Buoys (IOEBs) deployed in the Beaufort Sea provide a column of environmental data along the drift track.

1996-97 BGY



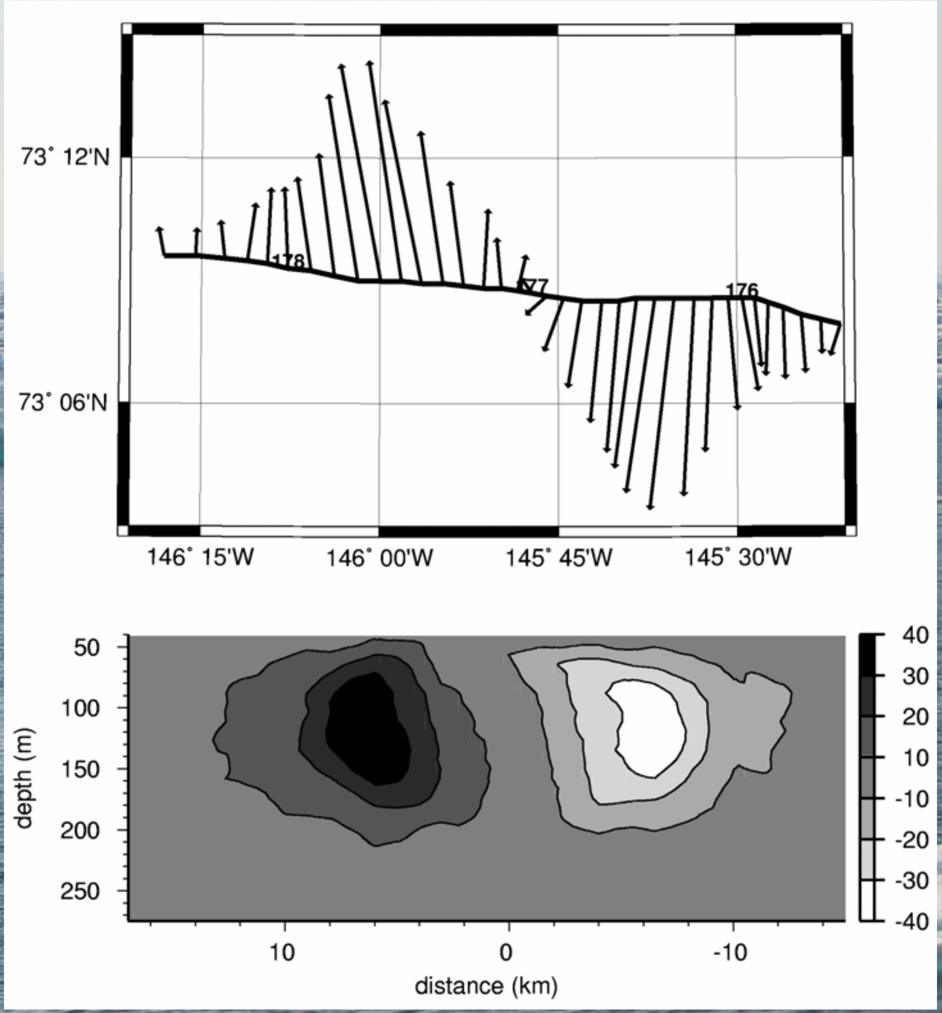
1997-98 SHEBA



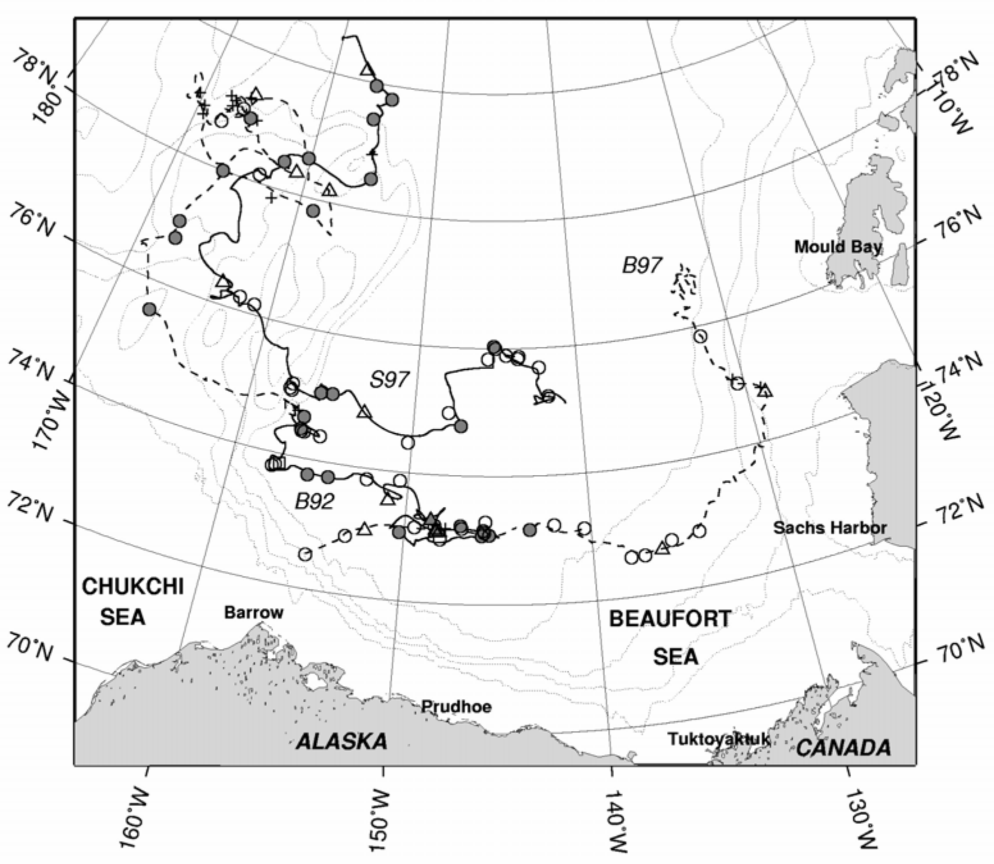
http://www.whoi.edu/ioeb

Halocline eddy from IOEB ADCP data

Top: Current vectors at depth of eddy center (104 m) are superimposed on the IOEB drift (top panel). Bottom: Contours of current velocities relative to the background (cm/s) by depth and radius from the eddy center (bottom panel).

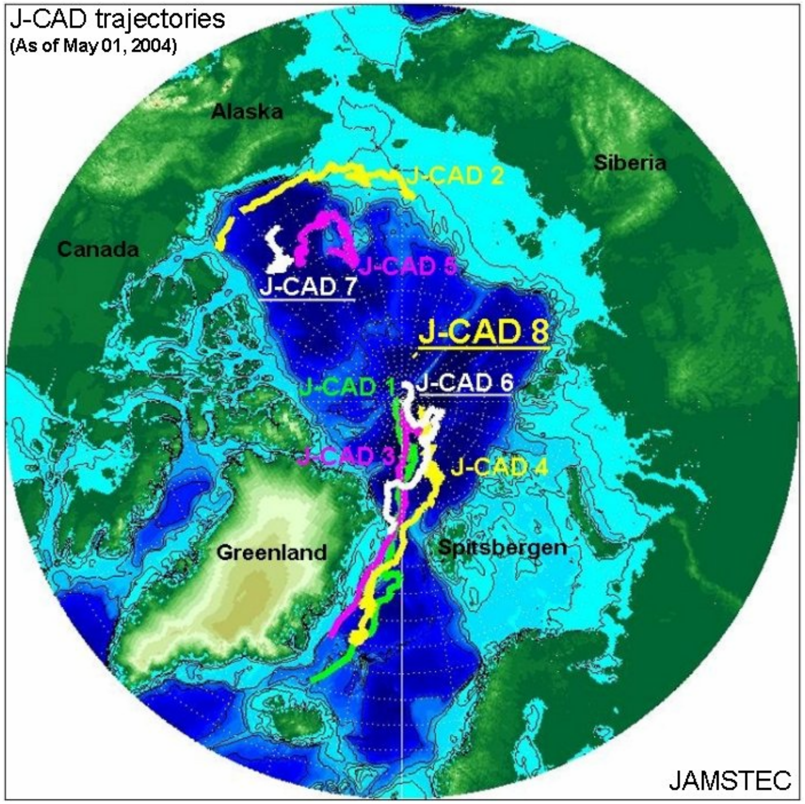


Eddys from IOEB ADCP data



Drift tracks of IOEBs with ADCP data with locations of subsurface anticyclonic eddy encounters (66) indicated by circles, cyclonic eddy encounters (14) indicated by triangles, one eddy encounter of indeterminate sense by a square, and unconfirmed encounters by crosses (14). Filled symbols denote encounters within the eddy cores (29).

Since 2000, JAMSTEC Compact Arctic Drifter (J-CAD) Buoys have been measuring the structure of upper-ocean currents and water properties under the multi-year ice of the Arctic Ocean for a better understanding of the role of the Arctic Ocean in global climate .



http://www.jamstec.go.jp/arctic/J-CAD_e/jcadindex_e.htm

When compared to climatological data, the time series data at discrete depths indicate changes in the upper ocean, as is apparent in this data from a J-CAD deployed at the North Pole in 2000.

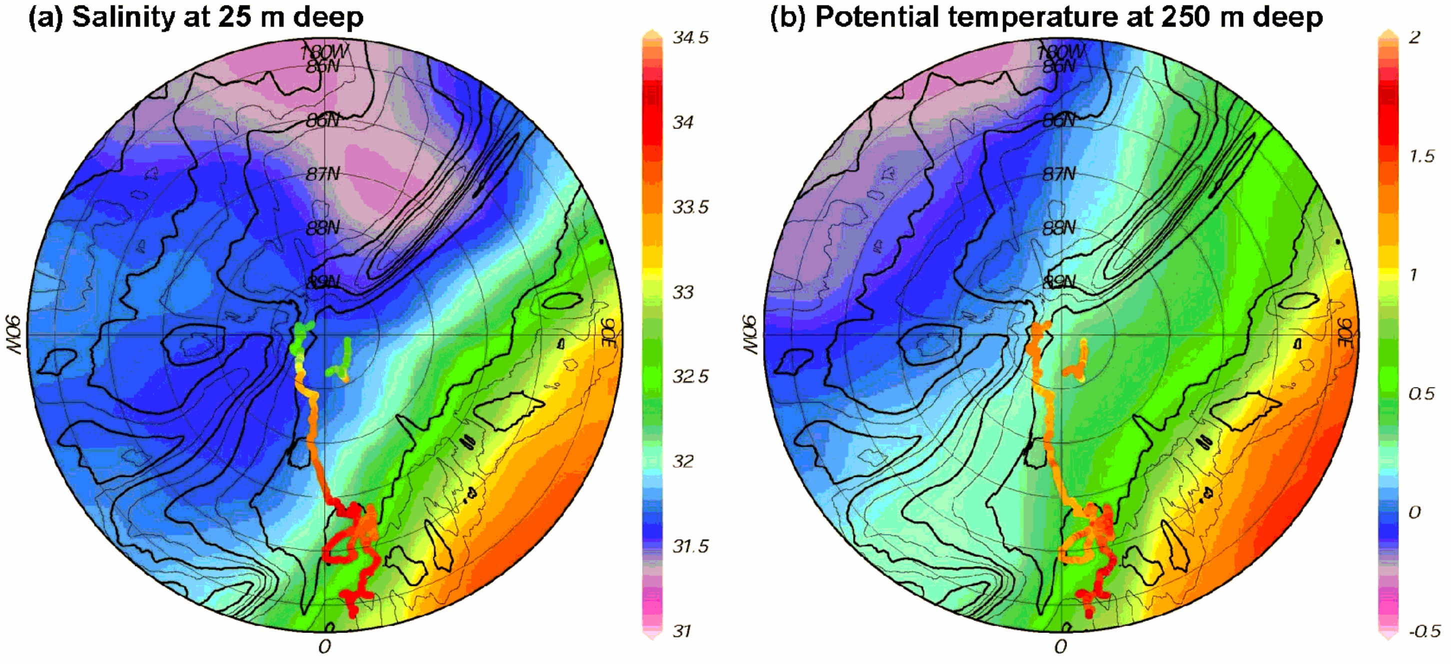
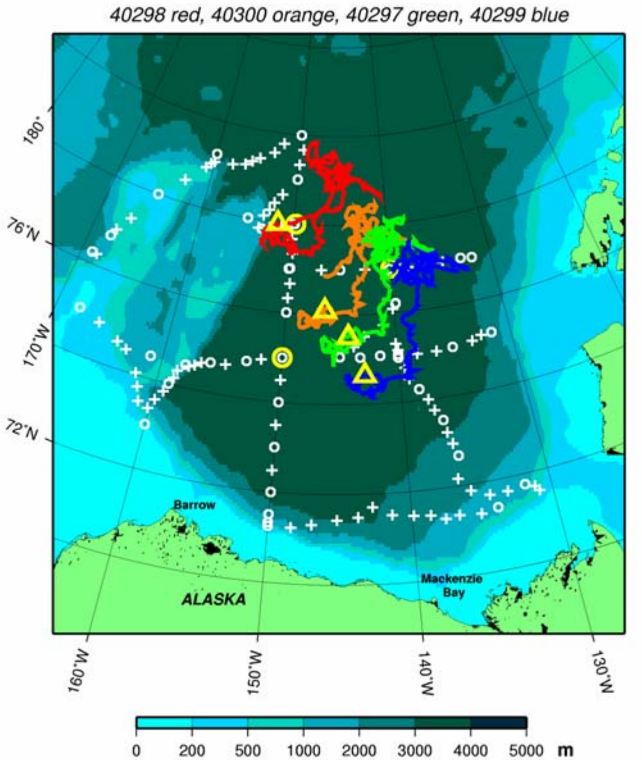


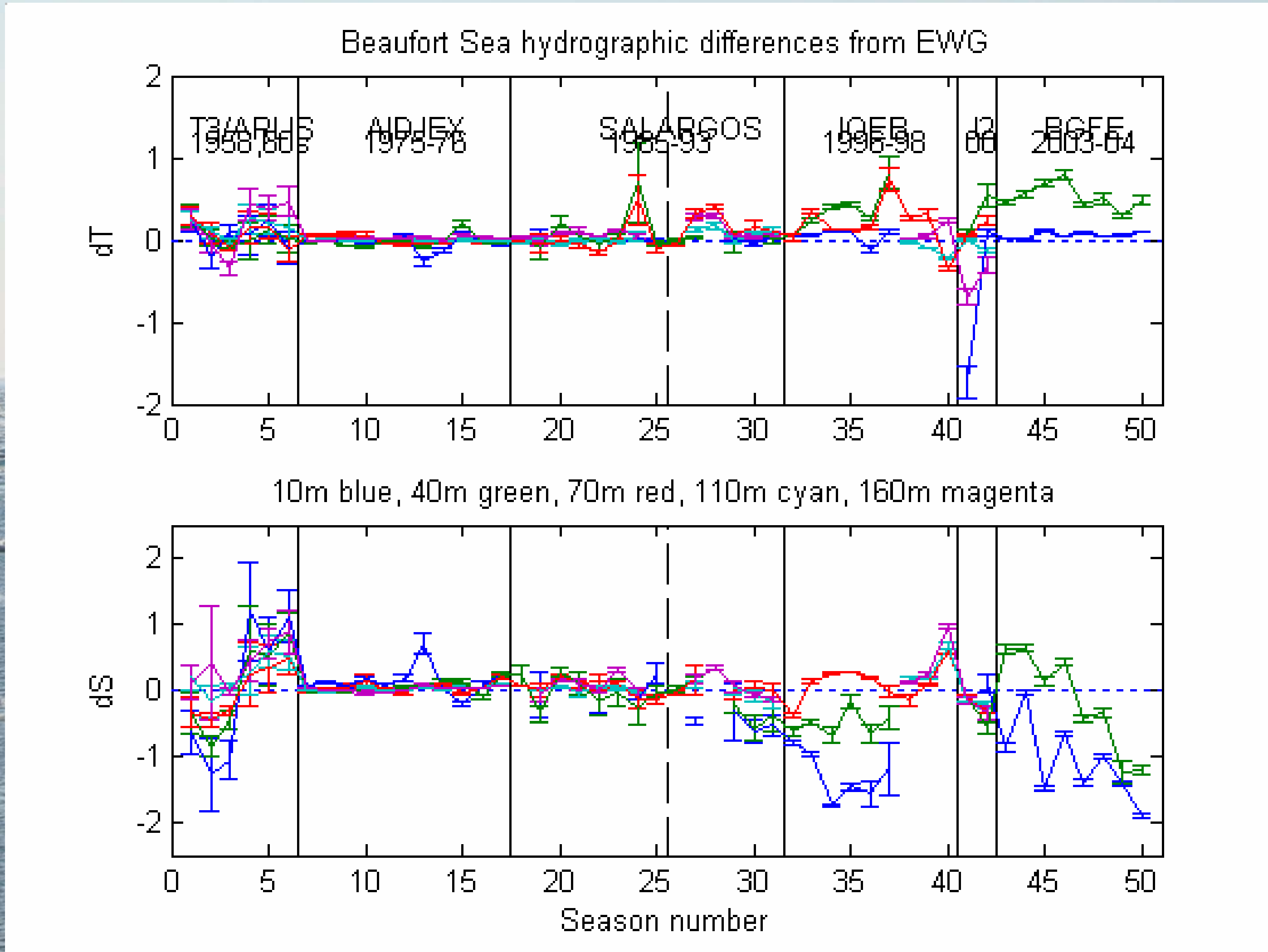
Figure 5. Horizontal distributions of (a) salinity at 25m deep and (b) potential temperature at 250m deep around the North Pole. Note that the data along the trajectories is observed by J-CAD and the background describes the EWG winter climatological (1948-1993) data.

Metocean Ice Beacons with CTDs at 10, 25 and 40m drifting in the Beaufort Gyre since August 2004



BGFE buoy drift tracks (solid lines) and latest locations (triangles) superimposed on IBCAO bathymetry (shading). Also indicated are BGFE moorings (yellow circles), JWACS 2003 CTD (white circles) and XCTD (white crosses) stations, and mean annual ice drift vectors from IABP climatology (grey vectors).

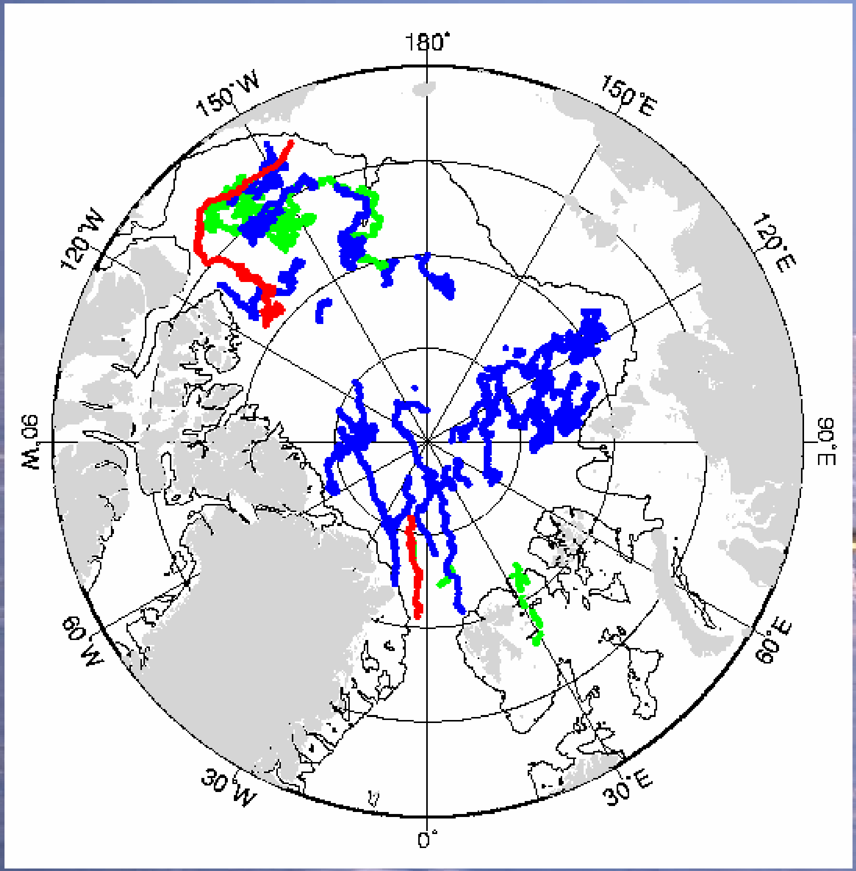
http://www.whoi.edu/beaufortgyre



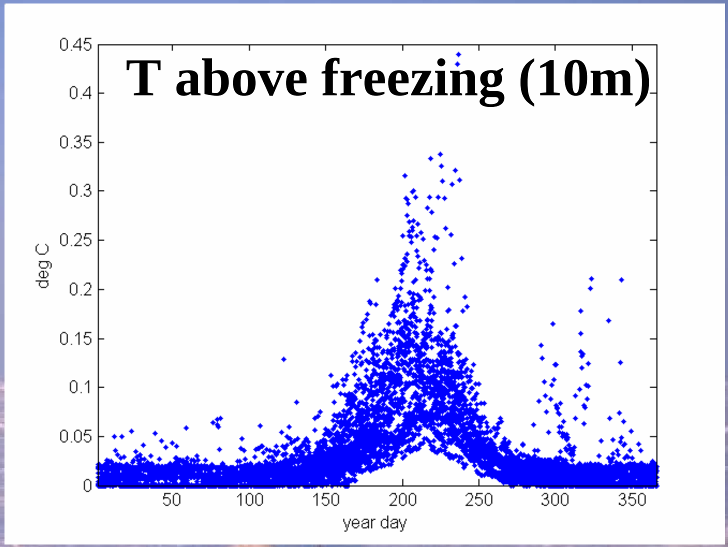
Errorbars indicate 95% statistical confidence limits.

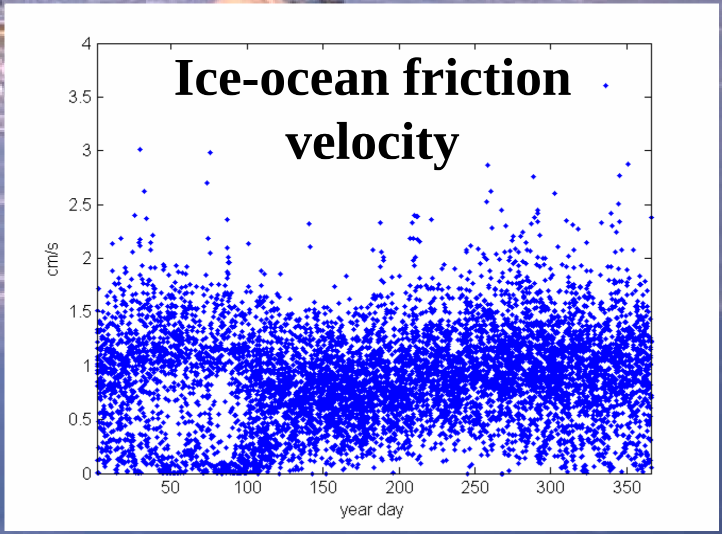
Climatological anomalies of temperature and salinity at 5 depths from ice camps and buoys deployed in the Beaufort Sea indicate significant mixed layer freshening and halocline warming in the late 1990s and 2000s.

Long-term drifting platform observations of the Arctic mixed layer



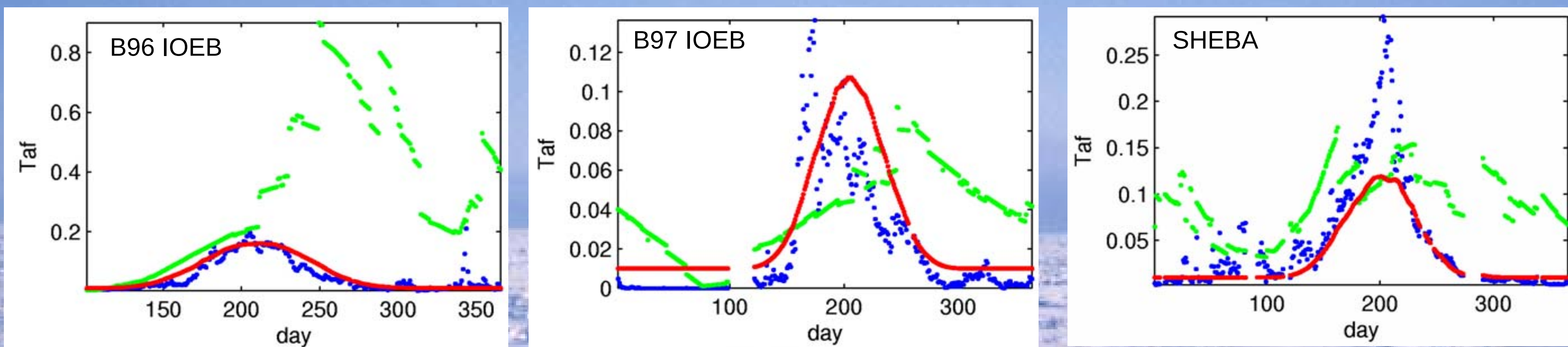
Drift tracks of SALARGOS (blue) and IOEB (red) buoys and ice camps (green).



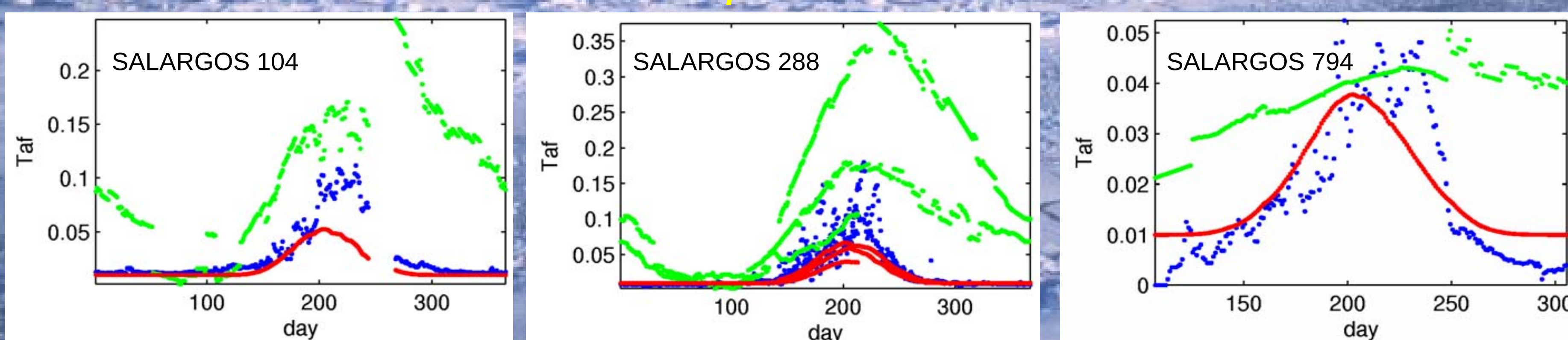


Annual cycle of *Taf* from drifting observations (blue), climatology (green), and parameterization (red)

Beaufort Gyre



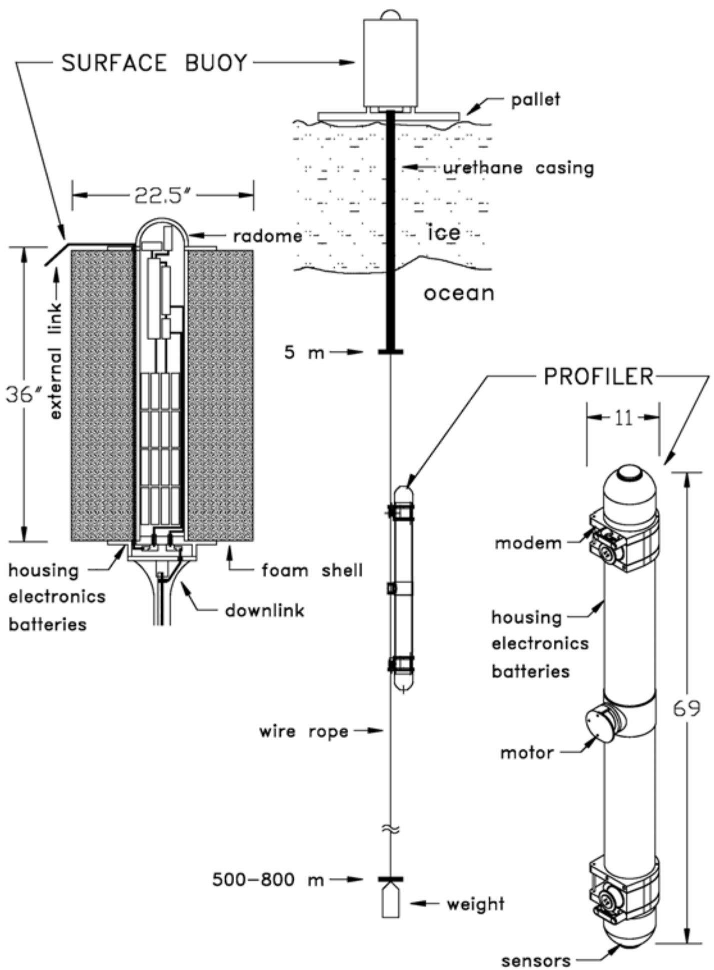
Transpolar Drift



Summary

- Ice-tethered platforms are a proven means of acquiring unattended high quality air, ice, and ocean time series data from the Arctic Ocean during all seasons.
- Development of automated profiling instruments will overcome the limitations of discrete depth systems.
- For climate variability studies, arrays of platforms are needed to better account for the spatial and temporal variability of the data from individual drifters.

An Ice-tethered Profiler for Sustained Observation of the Arctic Ocean



Mooring length: 800 m or less

Profiling range: 1,060,000 m

Duration: 3 years for one profile per day

Temperature specification: -40° C

Data telemetry: up to 150 kbytes per day

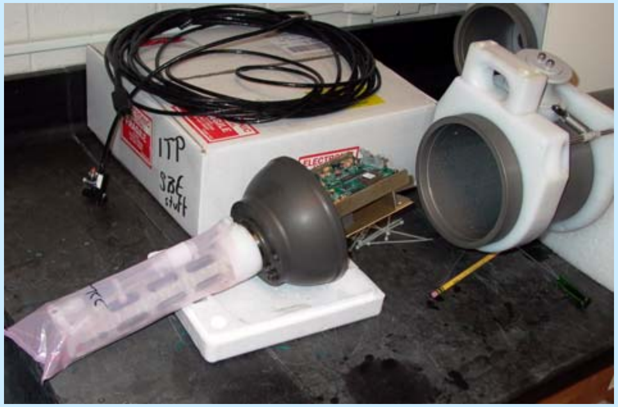
Sensors: FSI EMCTD or Seabird CP-41
(same as ARGO floats)

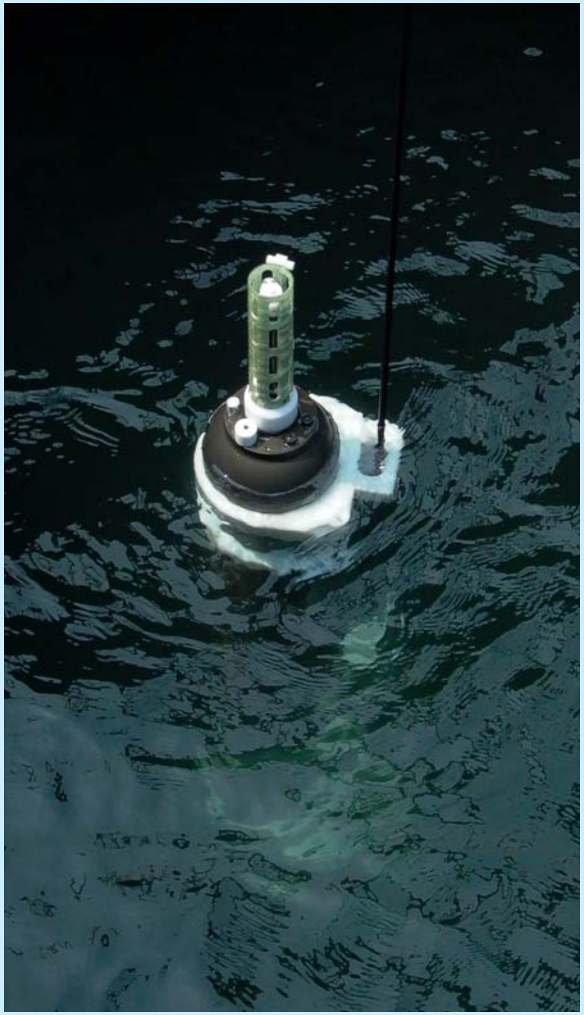
Telemetry: Seabird inductive link from
profiler to surface unit;
Iridium link to shore

Power: lithium "DD" battery packs

Size: Profiler fits through an 11-12 inch
hole in the ice

ITP Profiler with SeaBird CTD





ITP Surface Buoy and Controller