CRUISE REPORT FOR UW/UAF BERING STRAIT MOORING PROJECT 2006

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CCGS Sir Wilfrid Laurier – SWL2006-01
Victoria, 1st July 2006 – Dutch Harbor, 9th July 2006 – Wainwright, 22nd July 2006

Science Coordinator: Bon Van Hardenberg, Institute of Ocean Sciences, BC, Canada
Chief Scientists (Victoria to Dutch Harbor): Bill Williams, IOS, Canada
(Dutch Harbor to Wainwright):John Nelson, University of Victoria, Canada
Lead for Canadian Science Team: Ed Carmack, IOS, Canada
Lead for US Science Team: Jackie Grebmeier, University of Tennessee, USA

IOS cruise SWL2006-01 on the Canadian Coastguard icebreaker Sir Wilfrid Laurier is part of a on-going Canadian-US collaboration to investigate the ecology and climate of the northern Bering Sea, the Bering Strait and the Chukchi Sea. For full details, see Williams/Nelson/Grebmeier Cruise Report.

In 2006, this research cruise also recovered and redeployed 3 moorings in the Bering Strait region, *PIs Rebecca Woodgate and Tom Weingartner, University of Washington and University of Alaska, Fairbanks*, and performed a high resolution CTD section across the Bering Strait and medium resolution CTD lines across the Alaskan Coastal Current in the vicinity of mooring A3, Point Hope and Cape Lisburne. The Bering Strait line has been occupied for several years by Canadian and US researchers. The other three lines have been occupied once a year since 2000 under NSF SBI funding.

Cruise Participants

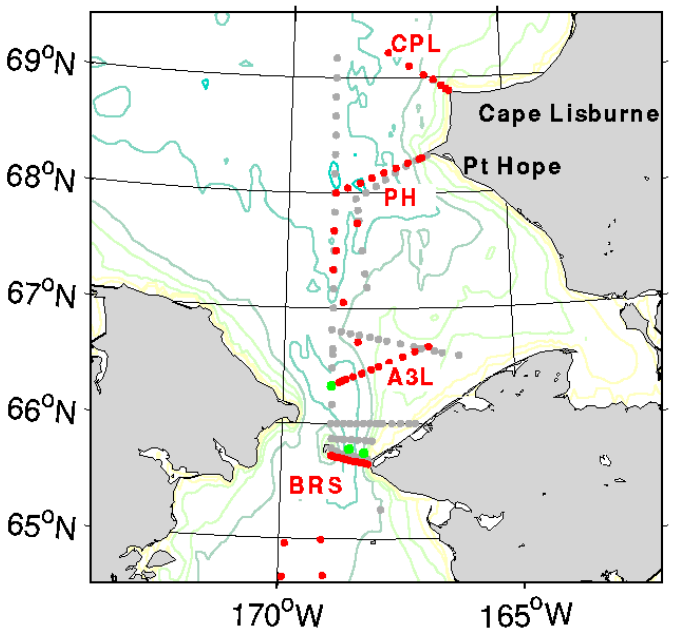
1. (a) Dr. Bill Williams (M), DFO/IOS, Canada (Chief Scientist to Dutch Harbor) - CTD
   (b) Dr. John Nelson (M), U Vic/IOS, Canada (Chief Scientist from Dutch Harbor) – Bongo nets
2. Dr. Jackie Grebmeier (F), U Tennessee, USA (Co-Chief Scientist) – benthic sampling
3. Dr. Lee Cooper (M), U Tennessee, USA – benthic sampling and O18 isotopes
4. Dr. Peter Lee (M), U Charleston, USA – DMSP sampling
5. Dr. Rebecca Woodgate (F), U Washington, USA – Bering Strait moorings
6. Dr. Koji Shimada (M), JAMSTEC, Japan – Chukchi moorings
7. Dr. Kate Darling (F), U Edinburgh, UK – Foram genetics
8. Stephanie King (F), DFO/IOS, Canada – CTD, XBT and underway data
9. Rebecca Pirtle-Levy (F),-U Tennessee, USA – benthic sampling
10. Betty Carvellas (F), Essex High School, Vermont, USA – benthic sampling and outreach
11. Ian Darling (M), UK – Bird observer
12. Hirokatsu Uno (M), JAMSTEC, Japan – Chukchi moorings
13. Caitlin O'Neill (F), U Vic/IOS, Canada – CTD, bioacoustics, TS and gas sampling
14. Brianne Kelly (F), U Vic/IOS, Canada – CTD, silicate primary productivity
15. Ted Fathauer (M), UAF, USA – CTD, XBT

Cruise Map of Stations relevant to UW Mooring work

SWL2006-01
Sir Wilfrid Laurier
July 2006

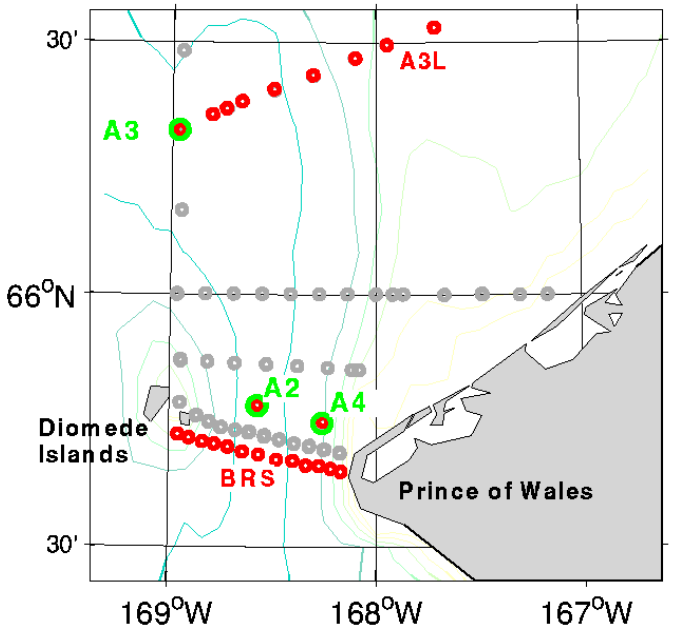
● = mooring
● = 2006 CTD
● = prior CTD

(depth contours 10m, IBCAO)



extract of cruise track near Bering Strait

(depth contours 10m, IBCAO)



Map of region most relevant to UW Mooring Project. Green = mooring locations A2, A3 and A4 for recoveries and redeployments. Red = CTD stations taken this cruise. Grey = CTD stations taken in previous years. Note that in 2006, the Bering Strait line was run ca. 2 nm south of the prior UW line and the Point Hope line was run slightly north (7 nm or less) of the prior UW line. CTDs were also taken at mooring positions.

Mooring recovery and redeployment

Three physical/biogeochemical Bering Strait moorings were recovered and redeployed during this cruise.

These moorings are part of a multi-year time-series (now 16 years long) of measurements of the flow through the Bering Strait. This flow acts as a drain for the Bering Sea shelf, dominates the Chukchi Sea, influences the Arctic Ocean, and can be traced across the Arctic Ocean to the Fram Strait and beyond. The long-term monitoring of the inflow into the Arctic Ocean via the Bering Strait is important for understanding climatic change both locally and in the Arctic. The last 4 years of data suggest that heat and freshwater fluxes are increasing through the strait - the work completed this summer should tell us if this is a continuing trend.

Three moorings (A2 and A4, in the eastern channel of Bering Strait; and A3, ca. 35nm north of Bering Strait), deployed from the CCGS Laurier last year, were funded by an SGER project from NSF *(Woodgate, UW, http://psc.apl.washington.edu/BeringStrait.html)* to compare the Bering Strait eastern and western channel flows. The three moorings deployed this year are funded by the Alaska Ocean Observing System (AOOS, http://www.aoos.org, grant to *Woodgate and Weingartner, UW/UAF)*. All the moorings carry conventional instrumentation - current meters (RCM or ADCP), temperature and salinity sensors (SBE16). In addition, moorings A2 and A3 carry Upward-Looking-Sonars (ULS) *(Moritz, UW).* The mooring A4 carries an upward-looking ADCP (instead of the RCM) to study the coastal jet. In 2005-2006, mooring A2 also supported a transmissometer, a fluorometer and a PAR sensor connected to the SBE16, and an ISUS nitrate sensor *(Whitledge and Weingarter, UAF)*. Mooring A2 in the 2006 redeployment also carries an ISUS nitrate meter, and an SBE16 supporting a combined chlorophyll and turbidity bio-wiper sensor. The current meters and ULSs allow the quantification of the movement of ice and water through the strait. The nutrient sampler, the transmissometer and fluorometer time-series measurements should advance our understanding of the biological systems in the Bering Strait and Chukchi Sea.

Maintaining the time-series measurements in Bering is important to several national and international programs, e.g. NSF's Freshwater Initiative (FWI) and Arctic Model Intercomparison Project (AOMIP), and the international Arctic SubArctic Ocean Fluxes (ASOF) program. The mooring work also supports regional studies in the area, by providing key boundary conditions for the Chukchi Shelf/Beaufort Sea region; a measure of integrated change in the Bering Sea, and an indicator of the role of Pacific Waters in the Arctic Ocean. Furthermore, the Bering Strait inflow may play a role in Arctic Ocean ice retreat and variability (especially in the freshwater flux) is considered important for the Atlantic overturning circulation and possibly world climate.

In 2004-2007, the mooring work is also in collaboration with the RUSALCA project led by John Calder of NOAA in collaboration with AARI, St. Petersburg, who are maintaining moorings in the western channel of the Bering Strait (*Whitledge and Weingartner, UAF*).

Despite fog, the three mooring recoveries and redeployments were accomplished without any problems on the 15th and 16th of July 2006. The moorings were ranged on and released from the USCGC Laurier, and a small boat was used to attach a line to the moorings, which was passed to the ship. Since the moorings are short (~ 10m), with the long boom of the Laurier, the entire mooring could be recovered or deployed in one pick, making for very speedy work. All operations went smoothly, due to skilled small boat and deck operations. Details of mooring positions and instrumentation and preliminary results are given in the Table and Figures below. Although significant amounts of silt had collected in the mooring floatation, especially at site A4 in the Alaskan Coastal Current, biofouling was only moderate (see photographic appendix).

Although detailed, quantitative analysis is still to be done, the mooring data suggests a warming and freshening of the main channel flow in 2005 compared to previous years, while the Alaskan Coastal Current in 2005 is slightly cooler than in 2004 but still warmer than in previous years since records began in 2002.

Bering Strait and Alaska Coastal Current CTD lines

Four CTD lines were taken as per the map above. Preliminary results are shown in Figures below. In 2006, the CTD package also carried transmissivity, fluourescence and dissolved oxygen sensors,

although the version of these data included in Figures below should viewed as uncalibrated and with caution.

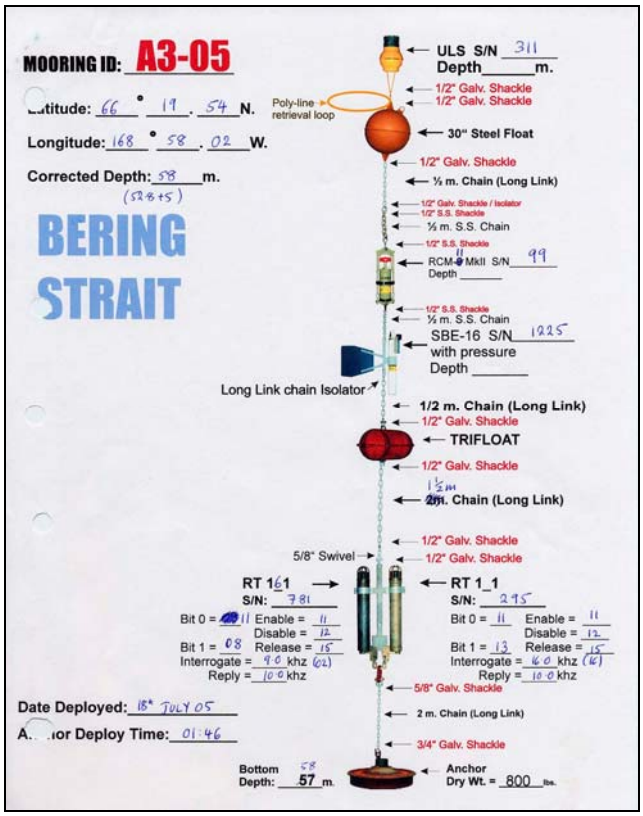
Most remarkably this year in the Chukchi was the anomalous extent of sea-ice. Ice retreat appeared to be ~ 1 month delayed from last year and ~ 2 weeks delayed from the average. The pattern of ice melt also appears anomalous, with melt occurring first in the western rather than the eastern Chukchi. The extensive ice along the Alaskan Coast from ~ Wainwright north prevented the Laurier making her usual schedule to Barrow and necessitated transferred the science party via Wainwright rather than the original plan of Barrow. It is thus to be expected that water temperatures in the Chukchi, especially in the surface waters, are likely cooler than in 2005. Although the near-bottom temperatures of the moorings do not show this, the CTD sections do indicate surface waters are cooler in 2006 than 2005 (see figures). This is particularly marked in the northern PH and CPL lines. Initial analysis of the data suggests also that while the PH line is perhaps slightly saltier than in 2005, the CPL line is fresher in 2006 than in 2005, consistent perhaps with recent ice melt in the region. These tentative conclusions need to be investigated more thoroughly.

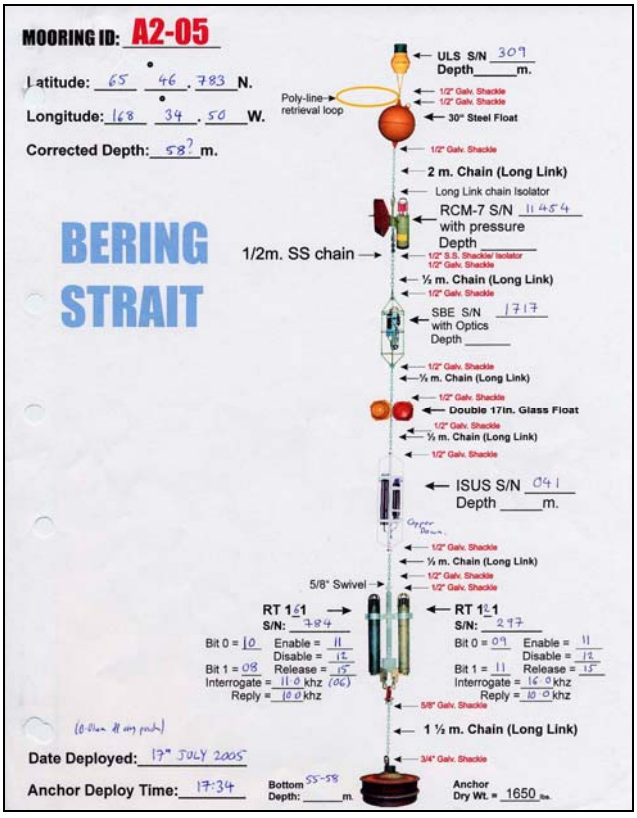
Table of Bering Strait Mooring Positions and Instrumentation

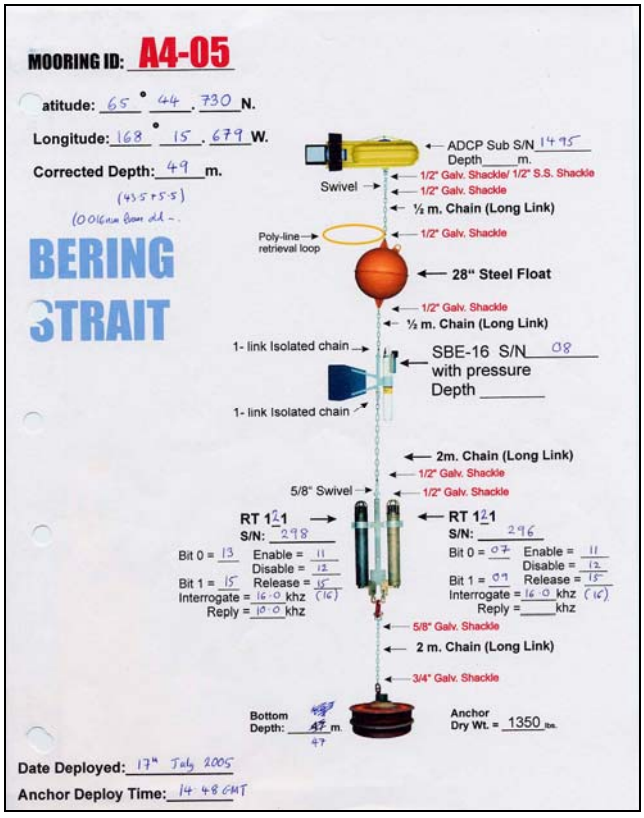
ID	LATITUDE (N)	LONGITUDE (W)	WATER DEPTH /m	INST.
Recover				
A2-05	65° 46.78'	168° 34.50'	55-58 (uc 50-53)	ULS RCM7 SBE/TFP ISUS
A3-05	66° 19.54'	168° 58.02'	58 (uc 53)	ULS RCM11 SBE16
A4-05	65° 44.73'	168° 15.68'	49 (uc 44)	ADCP SBE16
Deploy				
A2-06	65° 46.78'	168° 34.47'	56 (uc 50)	ULS RCM9LW SBE/TF ISUS
A3-06	66° 19.54'	168° 58.01'	58 (uc 52)	ULS RCM9LW SBE37
A4-06	65° 44.73'	168° 15.67'	49 (uc 43)	ADCP SBE37

ULS = APL Upward Looking Sonar
RCM7 = Aanderaa Mechanical Recording Current Meter
RCM9LW and RCM11 = Aanderaa Acoustic Recording Current Meter
SBE/TFP = Seabird CTD recorder with transmissometer, fluorometer and PAR sensor
SBE16 = Seabird CTD recorder
SBE/TF = Seabird CTD recorder with transmissometer and fluorometer
SBE37 = Seabird Microcat CTD recorder
ISUS= Nutrient Analyzer
ADCP = RDI Acoustic Doppler Current Profiler
uc = uncorrected for ship's draft (5 m for Laurier05; 5.5m for Laurier06)

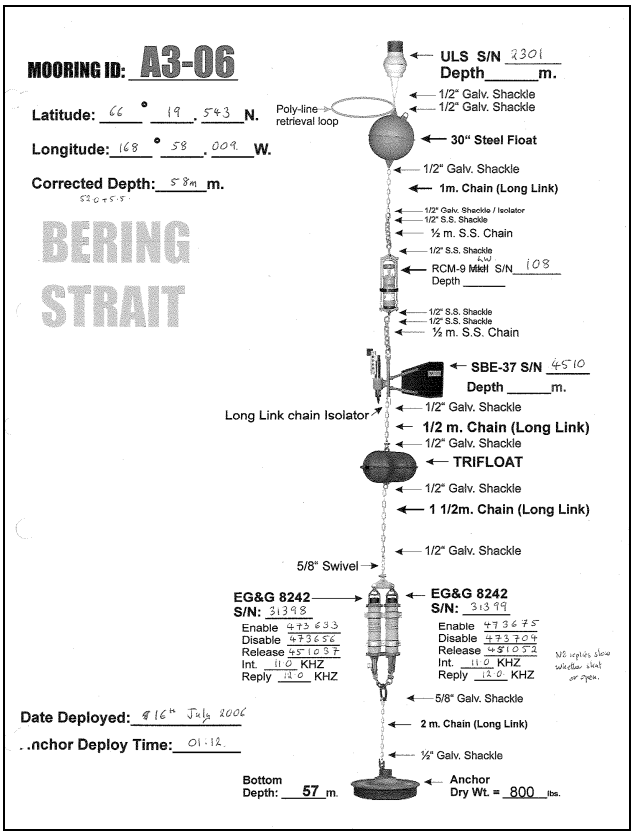
Schematics of Mooring Recoveries

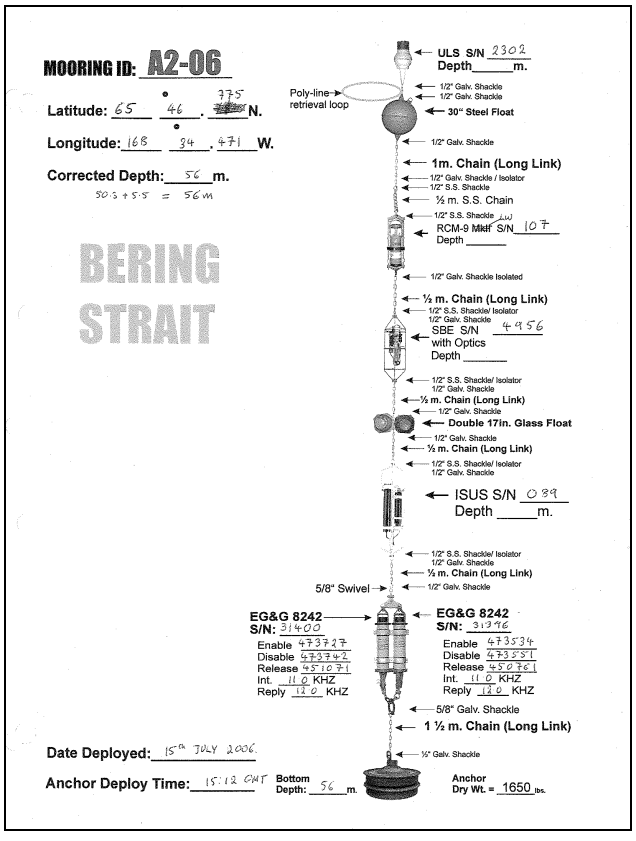


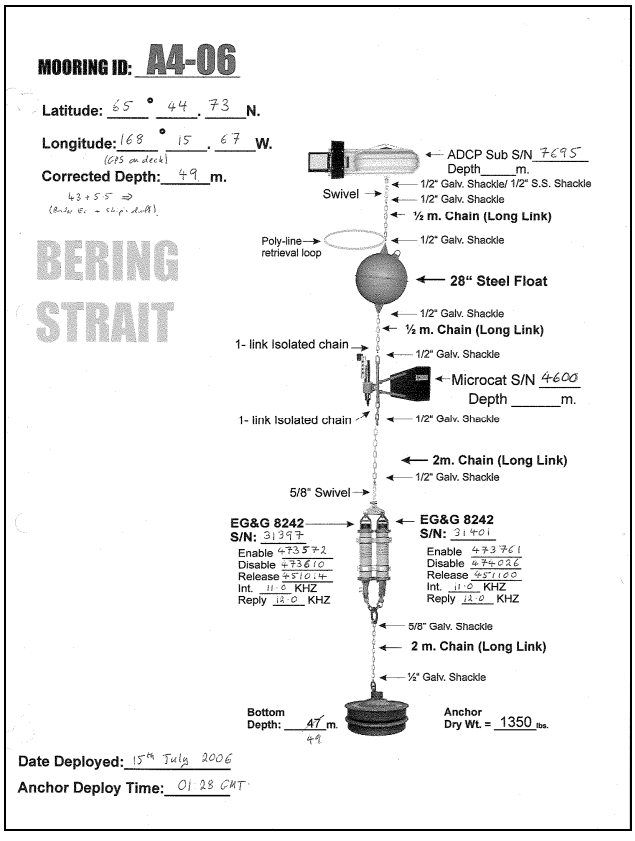




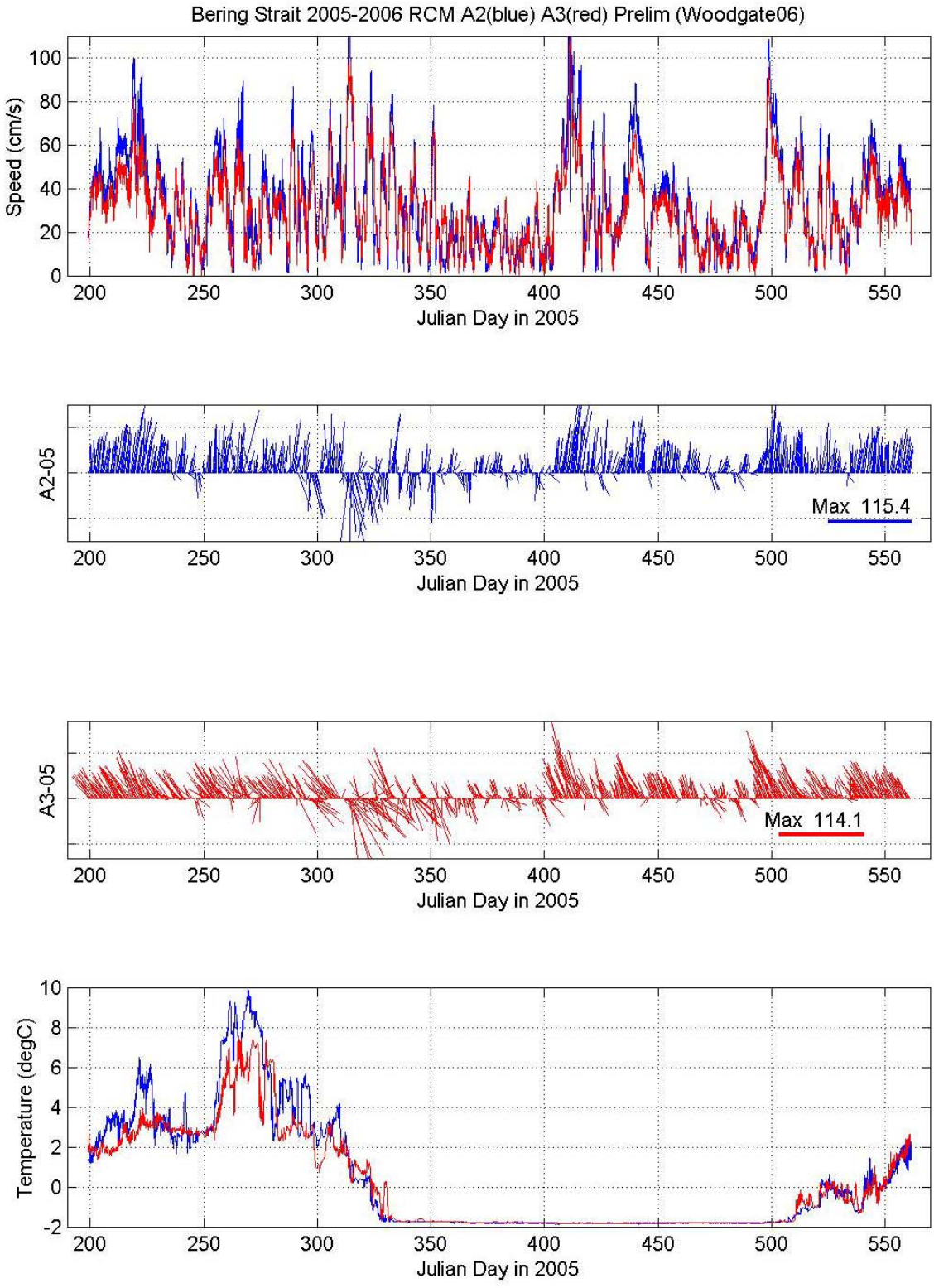
Schematics of Mooring Deployments



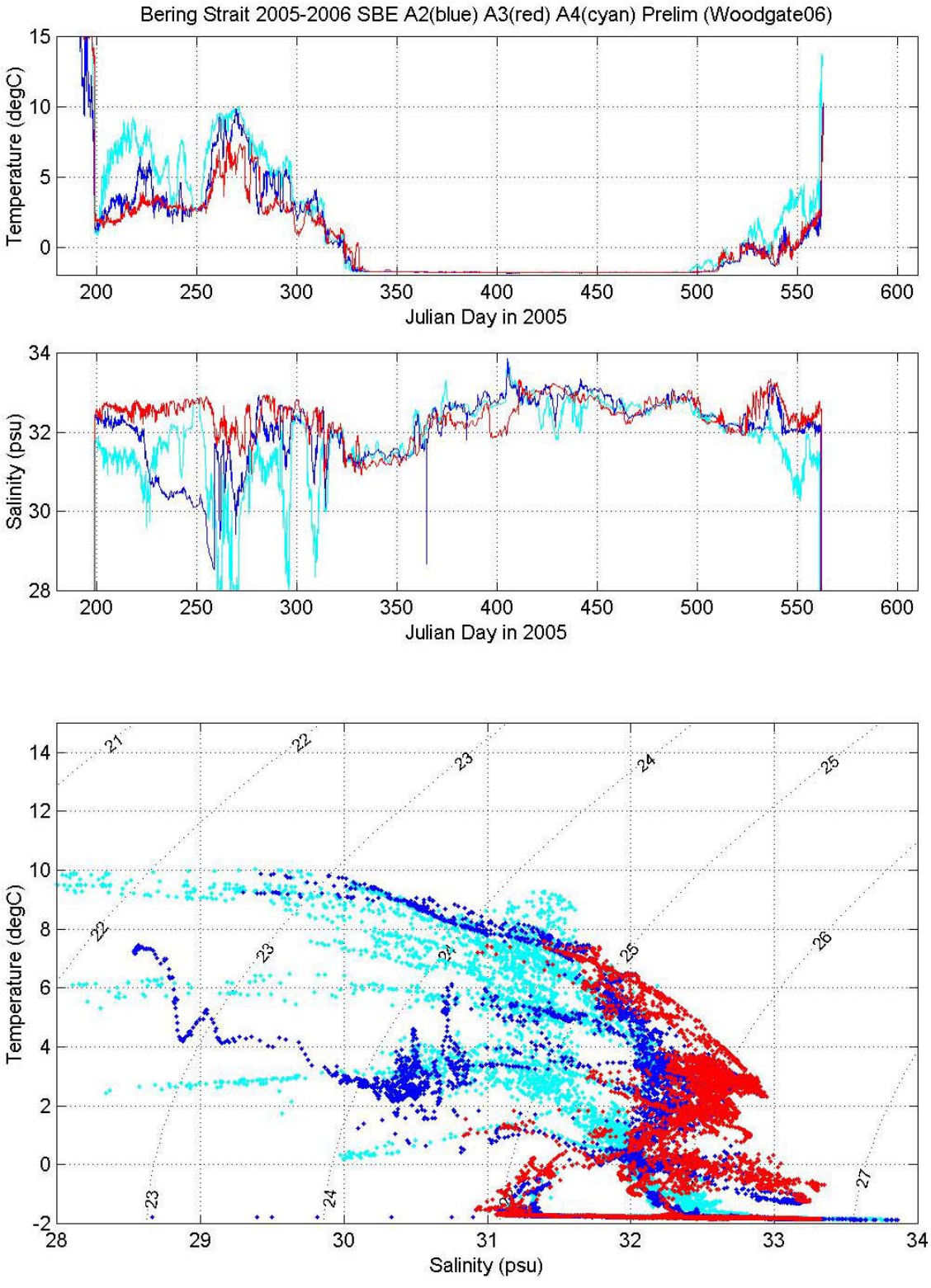




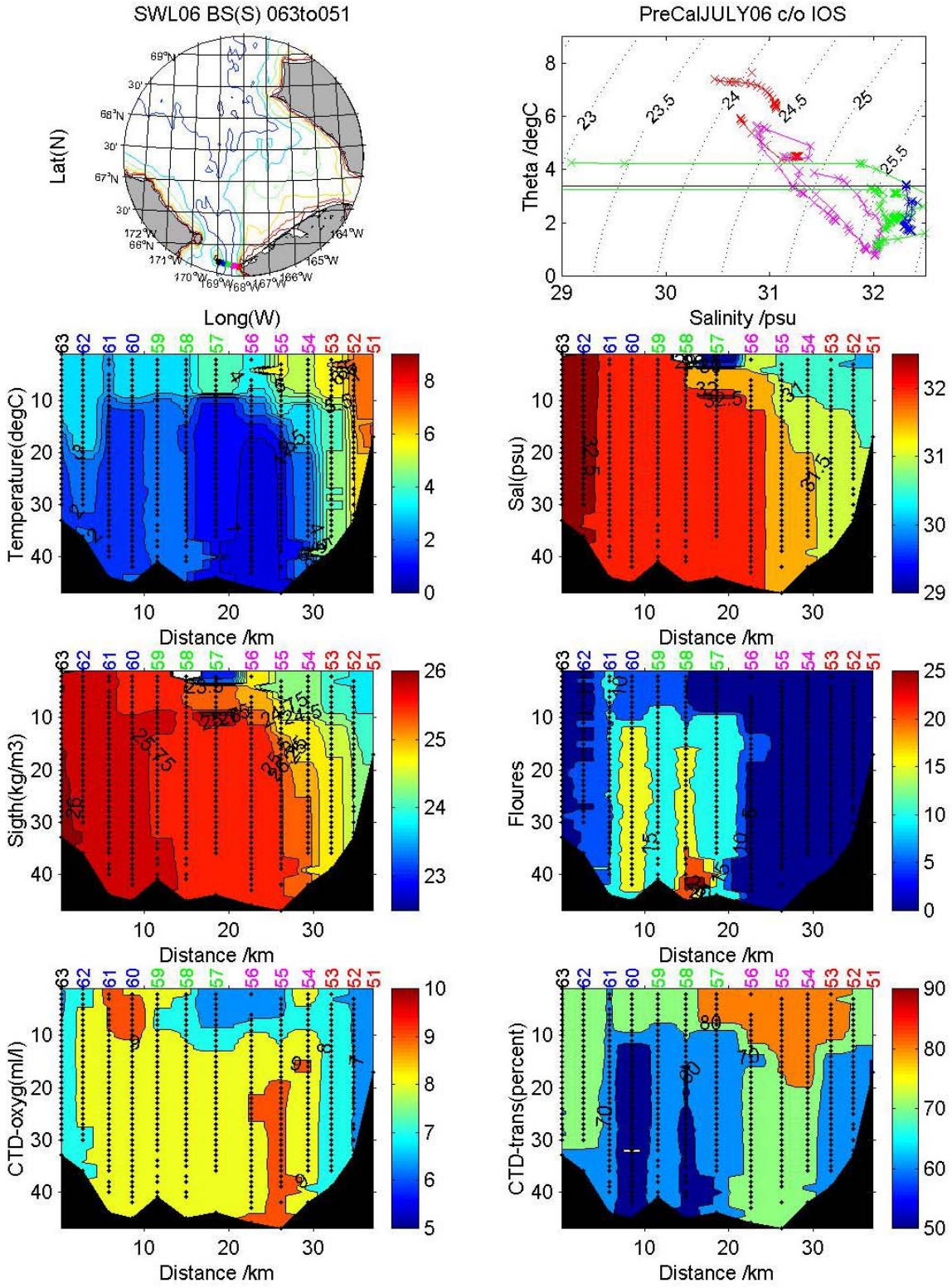
Preliminary Current Meter Results



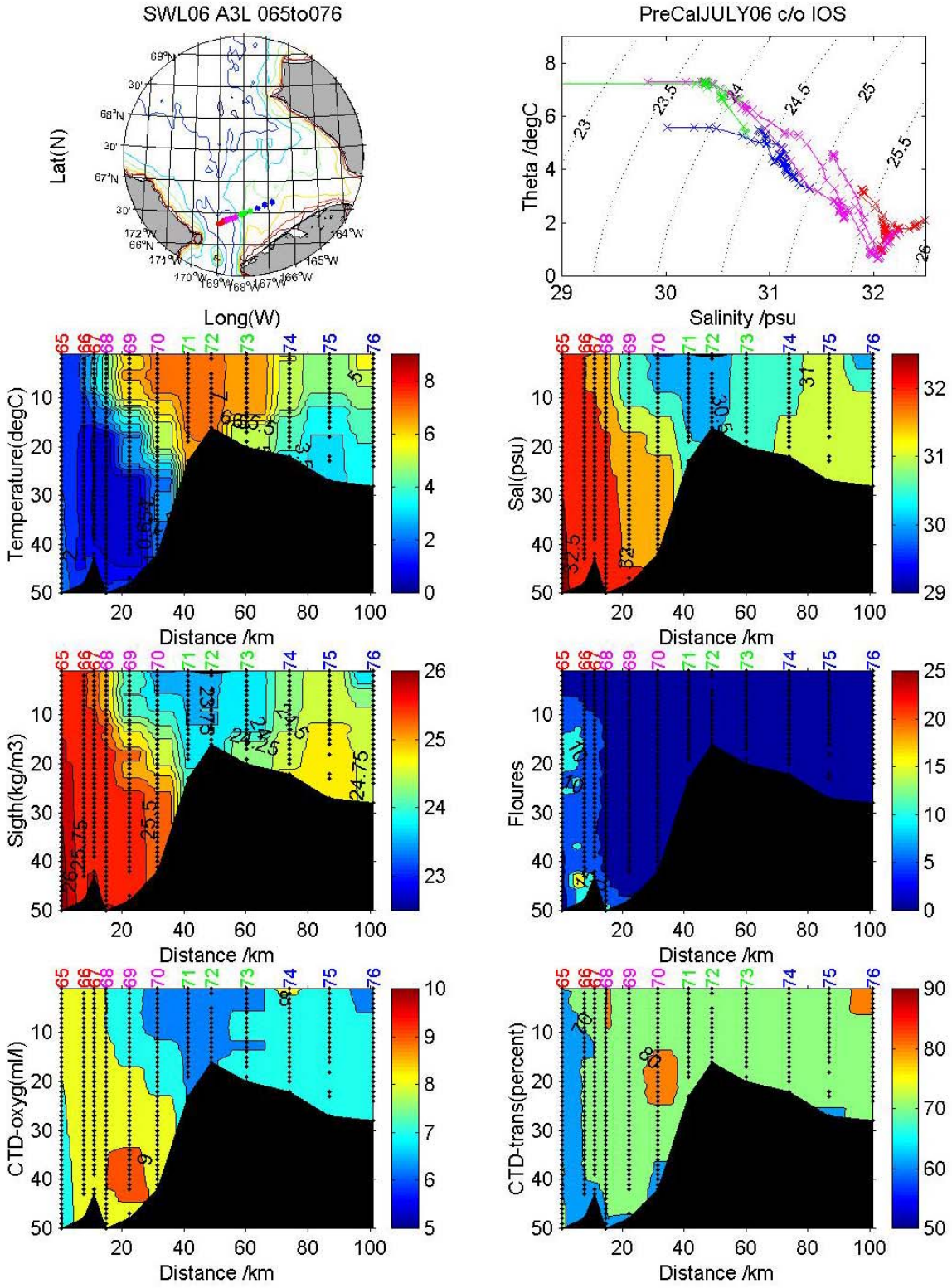
Preliminary Seacat Results



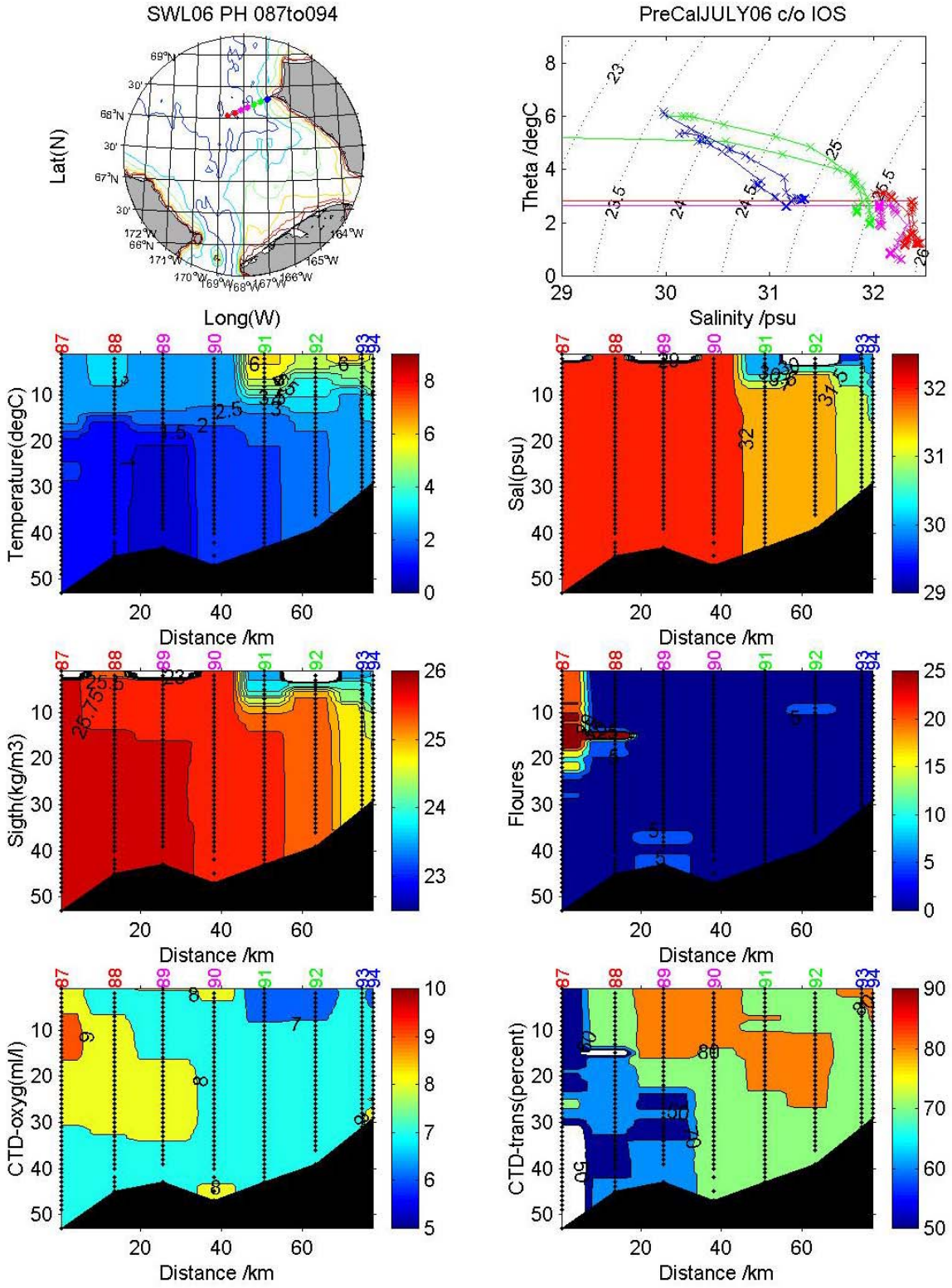
Preliminary CTD Sections - BERING STRAIT (ca. 2 nm S of prior location)



Preliminary CTD Sections - A3-L LINE



Preliminary CTD Sections - POINT HOPE LINE (7 nm-0 nm N of previous location)



Preliminary CTD Sections - CAPE LISBURNE LINE