Hydrographic, Velocity, and Video Plankton Recorder Measurements

R.S. Pickart, H.M Swartz, and D.J. Torres, *Woods Hole Oceanographic Institution*
E. Bondareva, *Arctic and Antarctic Research Institute*

Introduction

The physical oceanographic component of RUSALCA-2009 leg II consisted of an investigation of the circulation and water masses of the Chukchi Sea using vertical profile measurements, with particular emphasis on Herald Canyon. The flow of Pacific water into the Chukchi Sea is of fundamental importance to the western Arctic ocean-atmosphere-ice system, with consequences for ice-cover, carbon cycling, and ventilation of the interior halocline. A major, yet largely unexplored, conduit through which the Pacific water enters the Arctic basin is Herald Canyon. The primary goals of the physical oceanographic component are to (1) quantify the dynamics in the canyon, (2) explore the relationship between conditions in the canyon and interannual climate variability, and (3) understand the impact of the canyon flow on the distribution of nutrients, zooplankton and fish entering the Arctic. In addition to this, the circulation and water masses of the broad Chukchi shelf, and part of the East Siberian shelf, are being examined in support of the biogeochemical measurements of RUSALCA-2009.

CTD/Rosette System

A WHOI-provided rosette mounted with twenty-one 10-liter bottles, Sea-Bird model SBE911+ CTD profiler, upward- and downward-looking RDI Workhorse 300kHz lowered ADCPs (LADCP) and a SeaScan Video Plankton Recorder (VPR) were used for hydrographic stations on RUSALCA-2009 leg II. Due to depth limitations, the VPR was removed from the rosette on 17 September, prior to transiting to the northern stations in deep water. The CTD sensor suite included dual temperature and conductivity sensors, dissolved oxygen, 660-nm transmissometer, chlorophyll-α and CDOM fluorometers, underwater and surface PAR sensors, and an altimeter. Details of the hydrographic equipment used and the associated data products are given in the appendix.

A total of 134 CTD stations were occupied on leg II, counting both normal hydrographic and primary productivity sampling casts at the same station locations. No significant problems were encountered with the CTD system other than a failure of the oxygen probe near the end of the cruise. The sensor was quickly swapped out and only a couple of stations were impacted. During two stations in the Alaska Coastal Current on the CL line the air vent purge hole of the primary pump became clogged with silt. The secondary sensors worked fine however, and the purge hole was successfully cleaned out. At the northern stations (series GD and IE), air temperatures of -5˚C caused icing of the sensors, which required significant time to thaw in the water column. Cold conditions contributed to several failures of the PVC sampling bottles, reducing the total available rosette positions to 19 bottles by the end of the northern stations. Evaluation of primary and secondary salinity showed that the temperature and conductivity channel differences remained nil through most of the cruise, lending confidence to the readings as taken.

The lowered ADCP system was deployed on essentially all of the CTD lowerings except for the primary productivity casts, for a total of 121 stations. No operational problems were encountered with the lowered ADCP, and data were recovered from all attempted stations, losing only part of one profile due to an operator error.

The VPR was deployed on 90 stations. Recharge time for the VPR batteries resulted in skipping deployments when working on lines with closely spaced CTD stations. Consequently, the VPR was used on every other station during the high-speed Herald Canyon survey. VPR operations were made more difficult by several factors, including unstable Ethernet connection to the on-deck VPR to download data, uncertain power switch behavior on the VPR underwater unit, the requirement to physically change out and uncase the batteries for the VPR, and the erratic behavior of the charger for the VPR batteries.

Preliminary Results

Over the course of the 27-day cruise, 11 hydrographic/velocity/VPR transects were completed (Fig. 1). The three southern Chukchi Sea transects were repeat occupations from the 2004 cruise. In addition, another high speed survey of Herald Canyon was carried out. New elements of the 2009 survey included: (1) an investigation of the area surrounding Wrangel Island, including stations in the East Siberian Sea; (2) extension of the Herald Canyon survey into the mouth of the canyon; (3) measurements taken on the Chukchi Cap and at the edge of the ice pack.

The hydrographic conditions in the Chukchi Sea were vastly different than in 2004. There was a smaller volume of weakly-stratified Anadyr water in the southern Chukchi Sea, confined to the middle portion of the shelf. This may be largely a seasonal effect since the 2009 cruise occurred roughly a month later than the 2004 cruise (September vs. August). Detailed analysis of the hydrographic data in conjunction with the meteorological conditions will allow the relative influences of seasonal versus interannual variability to be sorted out. The water masses on the western side of Herald Canyon were considerably warmer than in 2004, likely because the resident Chukchi winter water had already drained from the canyon by the time of the survey. On the eastern side of the canyon the Chukchi summer water was present farther north into the canyon than observed in 2004. The reasons for this are not entirely obvious and require further investigation. In general, the hydrography of the canyon was surprisingly different from RUSALCA-2004.

Another notable difference during RUSALCA-2009 was the presence of the Siberian Coastal Current, whose influence extended more than 70 km offshore. Again, the meteorological data should prove useful in understanding why the current was present this year but not in 2004. A full-scale analysis of the hydrographic and velocity data will not only provide context for the biogeochemical measurements, but enable us to better understand the circulation and water mass structure of the Chukchi shelf and why it was so different from RUSALCA-2004.

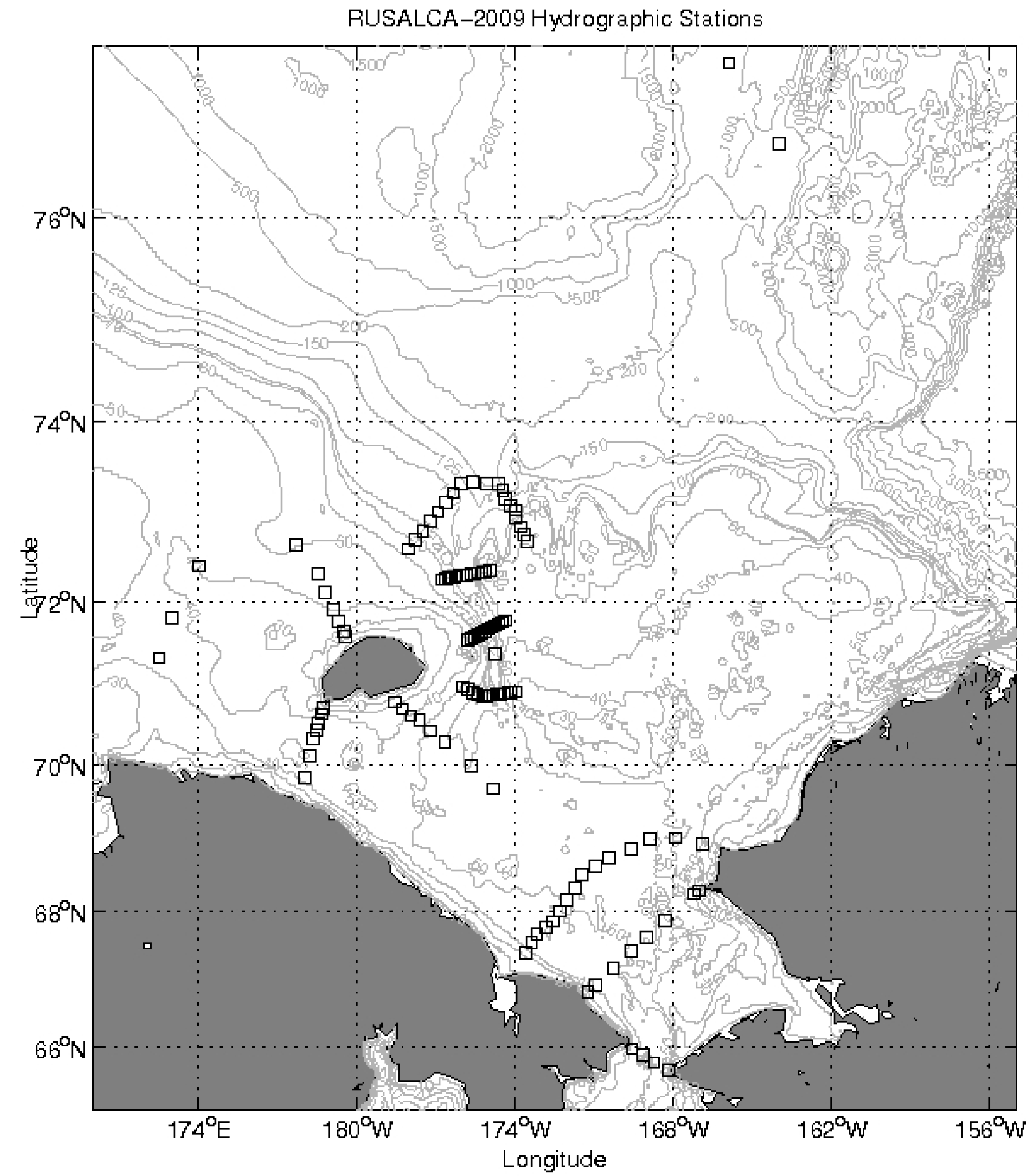

Figure 1: CTD/LADCP stations occupied during leg II of RUSALCA-2009. VPR data were collected at most stations except for the four Herald Canyon transects where every other station included the VPR. The bathymetric contours are from IBCAO-v2.

Appendix: RUSALCA 2009 Hydrographic Support – Equipment Summary

Compiled by Marshall Swartz, WHOI 29 Sept 2009-09-29

For RUSALCA 2009 cruise aboard Prof. Khromov, WHOI supplied and operated the equipment described below to enable hydrographic measurements for the RUSALCA program.

ROSETTE:
A custom built stainless-steel rosette with 21 10-liter bottles was used on every CTD station. This included a SBE32 24-position release pylon.

CTD:
The CTD equipment on the rosette:
(Note: specific details of serial number, channel assignment and calibration data are in the configuration file for each station.)
SBE9+ CTD rated to 7000m
SBE11+ CTD Deck unit, ver V2.
Dual SBE3 (temperature) and SBE4 (conductivity) sensors with two SBE5 pumps.
SBE43 oxygen sensor on the primary pump.
WETLabs Cstar 660nm, 25cm pathlength transmissometer
WETLabs ECO-FLRTD chlorophyll-α fluorometer
WETLabs ECO- CDOM fluorometer.
Biospherical QSP-2300 underwater PAR sensor
Benthos PSA-916 altimeter
Biospherical QSP-2200 surface PAR sensor

LADCP:
Two RD Instruments WHS-300 300kHz lowered ADCP systems with WHOI 48-volt underwater battery mounted on rosette.

VPR:
SeaScan AVPR with SeaScan battery mounted on rosette.
Data downloaded after each VPR station with Cat-5 cable attached from deck to lab.
Computer in lab connects to VPR as a mapped network drive. Data is transferred by windows copy.
Data is backed up from lab computer to external hard drive.

GPS:
Garmin GPSMap182 with Garmin GA29 external antenna mounted on the 500 (bridge-level) deck. GPS serial port is setup to deliver 2-second NMEA GPGGA sentences.

GPS logging PC and capture software:
An Acer One 160GB 1.6GHz laptop running Win XP-Pro SP3 OS was dedicated to acquire the NMEA data from the Garmin GPSMap182. A Keyspan USA49WG serial-USB adapter provided the required serial port, with a Keyspan version 3.6 driver installed on the PC. Hyperterminal software was used to open the serial port and capture the NMEA data at 4800baud to a capture file. The capture file was kept open continuously until it grew large enough to be gracefully

ended and a new capture file started. The capture file is ASCII text readable with Notepad. The files were not concatenated into one file.

Depth logging PC and capture software

An Acer One 160GB 1.6GHz laptop running Win XP-Pro SP3 OS was dedicated to acquire depth data from the NMEA depth output of the Khromov bridge depth finder. Unfortunately, it was not possible to attach our serial cable to the unit, since the only output port of the depth sounder was attached to the ship's Sperry data management system. A solution was found by which we ran a Cat-5 cable from the Bridge to the CTD lab, one end attached to the Sperry ship data system network port, and the other to the Ethernet RJ45 connector on the Acer PC.

On the Acer PC we installed software provided by the Khromov Radio Operator to link to the Sperry Vessel Data Recorder (VDR) Explorer software, by Danelec Marine A/S, version 1.40.00. This linked to the VDR via a TCP/IP port and provided a graphical interpretation of the seafloor depth using the $SDDBK (Depth below keel) NMEA sentence, as well as GMT time, date, latitude, longitude, COG, heading and other parameters. Every 30 seconds the software display was captured using Snag-it version 6 software, writing a .BMP file with sufficient resolution to enable reading the depth display.

The resulting space taken on the laptop hard drive is about 66 GB. We will attempt to reduce the required file space by importing the files into IView Media Pro 3 software to create a Quicktime version 3 .MOV file, to enable rapid viewing of the depth field along with time, date and position by manual viewing and transcription.

Data Products - RUSALCA 2009 CTD/LADCP/VPR/Underway

CTD Data

- First and second leg
- Total size ~310MB
- Data readable by SeaSave 7 software.
- Five types of raw files:
    - .CON
    - .HDR
    - .HEX
    - .NAV
    - .BTL
- Three types of processed files:
    - BTL,
    - _PAVG.CNV, 1-decibar pressure averaged data.
    - _TAVG.CNV, 1 second averaged data.

LADCP Data

- Second leg only
- Total size 560MB
- Data readable by ADCP software.

VPR Data

- Second leg only.
- ~1GB per station.
- Total size ~48GB.
- Not human-readable, requires special software.
- Two external hard drives for data backup.

Underway Data

- Second leg only

Depth screen captures

- Total size
- 30 second screen grab from Khromov Sperry bridge data.
- Made into quicktime movie to reduce size.
- Shows GMT date, time, GPS lat, lon, depth (m) under keel.

GPS data capture

- Total size ~600MB
- 2 second update on NMEA data from WHOI GPS in lab.
- Nearly continuous data on leg 2

CTD station logbook
LADCP station logbook

- Separate books
- Original paper.
- One sheet per station each book.