Cruise Report For Bering Strait Mooring Project 2008, RUSALCA 2008
Russian Vessel Lavrentiev - *Nome, 1st October 2008 – Nome, 10th October 2008*

Rebecca Woodgate[1], Kathleen Crane[2], Mikhail Zhdanov[3], Kevin Wood[4], Vladimir Smolin[5], Terry Whitledge[6]
[1]Applied Physics Laboratory, University of Washington, Seattle WA
[2]NOAA Climate Program Office, Arctic Research Program, Silver Spring MD
[3]Group Alliance, Moscow, Russian Federation
[4] Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, Seattle WA
[5]State Research Navigational Hydrographical Institute (SRNHI), Russian Federation
[6]School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks AK

(Photo by Dan Naber, UAF)

1. PROJECT SUMMARY

As part of the joint US-Russian RUSALCA (Russian US Long-term Census of the Arctic Ocean) Program, a team of US and Russian scientists undertook an oceanographic cruise in October 2008 on board the Russian vessel 'Lavrentiev'.

The major objective of the cruise was mooring work in the Bering Strait region, i.e., the recovery and redeployment of 8 moorings, a joint project by University of Washington (UW) and University of Alaska, Fairbanks (UAF), and the Arctic and Antarctic Research Institute (AARI). The US work is supported by an NSF-IPY grant (PIs: Woodgate, Weingartner, Whitledge and Lindsay). The moorings measure water velocity, temperature, salinity, ice motion, ice thickness (crudely) and some bio-optics.

Despite the expected bad weather and darkness, the moorings were successfully recovered and redeployed during the cruise. Unfortunately, weather prevented the taking of the related high resolution CTD sections, although surface bucket samples were taken for salinity and nutrients at the mooring sites, and some benthic grab work was done opportunistically. Also, underway temperature and pCO2 data was collected for the Bermuda Institute of Ocean Sciences (BIOS). This cruise report concerns the mooring and bucket sample work - for details of other programs, please contact the Chief Scientist.

The cruise started in Anadyr, Russian Federation, at the end of September. The ship arrived in Nome, USA, on the evening of 30th Sept. There, it picked up the US science team and equipment on 1st Oct, and sailed for the Bering Strait that evening. For the 2nd-4th October, high seas and strong southward winds in the Bering Strait prevented mooring operations, and the ship sheltered at the north end of Puoten Bay, just under Cape Dezhneva, on the western side of the strait. A 4-day lull in the weather allowed us to recover and redeploy the moorings on the 5th-8th Oct. On the 9th Oct, the final mooring was deployed, and around midday with a forecast of 12 foot seas and freezing spray, the ship turned for Nome. The ship docked in Nome on the morning of 10th Oct, off-loaded, and left for Anadyr that evening.

2. RUSALCA 2008 MAP OF STATIONS

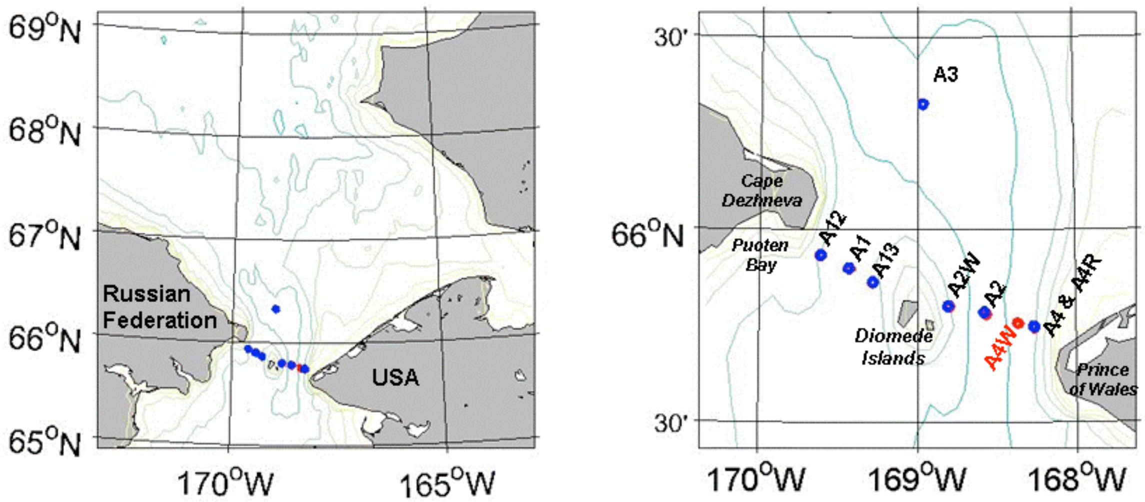


Figure 1. Map of the Bering Strait region (left) and detail of the Strait (right) showing Lavrentiev RUSALCA 2008 mooring locations for the eight moorings deployed in 2008 (A12, A1, A13, A2W, A2, A4, A4R and A3) and the eight moorings recovered in 2008 (A12, A1, A13, A3, A2W, A2, A4W, A4, and A3). Blue dots indicate a site of recovery and deployment. Red dot (A4W) indicates recovery only. Depth contours are every 10m from International Bathymetric Chart of the Arctic Ocean.

3.RUSALCA 2008 CRUISE PARTICIPANTS

- United States:

1. Terry Whitedge (M), UAF, USA – *Chief Scientist, nutrients, moored nutrient sampler*
2. Kathy Crane (F), NOAA – *Program Manager, NOAA; NOAA-Group Alliance Liaison*
3. Kevin Wood (M), NOAA/UW – *Science Liaison*
3. Rebecca Woodgate (F), UW – *Moorings, UW Mooring lead*
4. Wendy Ermold (F), UW – *Moorings*
5. David Leech (M), UAF – *Moorings, UAF Mooring lead*
6. Markus Janout (M), UAF – *Moorings*
7. Jeremy Kasper (M), UAF – *Moorings*
8. Dan Naber (M), UAF – *Mooring, moored nutrient sampler, nutrients*
9. Marlene Jeffries, BIOS – *Underway temperature and pCO2 data, bucket samples*

- Russian (directly part of RUSALCA mooring work):

10. Vladimir Smolin (M), SRNHI, RF – *Expedition Leader, Science Liaison and translator*
11. Vladimir Bakhmutov (M) - *Vladimir's assistant*
12. Alexey Ostrovskiy (M), Group Alliance – *Liaison and translator*
13. Valerian Golavsky (M), Arctic and Antarctic Research Institute (AARI), RF – *Moorings*

- Other Russian Scientists:

Maxim Ivanov, Alexander Kolesnik, Alexander Merezhko, Ildar Dolotkazin, Anatoly Berezka, Petr Vasilyev, Sergey Novoseltsev, Roman Antonov, Denis Benyukh, Lev Pautov, Dmitry Voronov, Renat Shakirov.

4. RUSALCA 2008 CRUISE SCHEDULE

(Aug 2008 – Jim Johnson and Rebecca Woodgate prep gear in Nome for 3 days)

Monday 29th Sept 2008	*mooring team arrive Nome*
Tuesday 30th Sept 2008	*Lavrentiev arrives Nome ~ 1800 local time; US Customs inspections*
Wednesday 1st Oct 2008	*Onload; ship away from dock ~ 1800 local time*
	steam to Bering Strait overnight
Thursday 2nd Oct 2008	*Strong southward winds and high seas – wait out in Puoten Bay*
Friday 3rd Oct 2008	*Strong southward winds and high seas – wait out in Puoten Bay*
Saturday 4th Oct 2008	*Strong southward winds and high seas – wait out in Puoten Bay*
	~ 1700 local, transit into strait, but too rough to work
	Siberian Coastal Current visible (by water colour) along Russian Coast
Sunday 5th Oct 2008	*Winds drop;* Recover A12-07 without hitch
	Recover A11-07 on 2nd dragging attempt
	Recover A13-07 without hitch
	Anchor south of Diomede Islands overnight
Monday 6th Oct 2008	Recover A4-07 without hitch
	Recover A4W-07 without hitch
	Recover A2-07 without hitch
	Recover A2W-07 on 3rd dragging attempt
,	*Benthic work overnight, wait at A3-07 for light*
Tuesday 7th Oct 2008	Recover A3-07 without hitch
	Deploy A3-08 without hitch
	Steam to A4-08
	Deploy bottom half of A4-08, (top half breaks free during deployment)
	Recover drifting part of A4-08
Wednesday 8th Oct 2008	Deploy A2-08 ~ 700m N of usual position due to deployment issues
	Deploy A4R-08 (~200 yards from A4-08) without hitch
	Deploy A2W-08 without hitch
	Deploy A1-08 without hitch
	Deploy A13-08 without hitch
Thursday 9th Oct 2008	Deploy A12-08 without hitch
	Weather worsening and forecast for 12ft seas and freezing spray
	Ship returns to Nome
Friday 10th Oct 2008	*Dock ~ 11am; Offload with shore-based crane (as port side to)*
	Complete off-load around 5pm, all freight to air cargo
	Ship sails late evening

Total: 8.5 days at sea

5. BACKGROUND TO MOORING AND CTD PROGRAM

5.1. Moorings

The moorings serviced on this cruise are part of a multi-year time-series (started in 1990) 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. Data from 2001 to 2004 suggest that heat and freshwater fluxes are increasing through the strait [*Woodgate et al.*, 2006]. The work completed this summer should tell us if this is a continuing trend.

An overview of the Bering Strait mooring work (including access to mooring and CTD data) is available at http://psc.apl.washington.edu/BeringStrait.html.

Eight moorings were recovered on this cruise.

These moorings (three in Russian waters – A1-1-07, A1-2-07, A1-3-07, five in US waters – A2W-07, A2-07, A4W-07, A4-07, A3-07) were deployed in another joint US-Russian venture supported by NSF-OPP (*Woodgate, Weingartner, Whitledge, Lindsay, NSF-OPP-ARC-0632154*) and the NOAA-led RUSALCA (Russian-American Long-term Census of the Arctic, http://www.arctic.noaa.gov/aro/russian-american/) program.

Eight moorings were redeployed on this cruise under the same funding. These moorings (three in Russian waters – A11-08, A12-08, A13-08, five in US waters – A2W-08, A2-08, A4-08, A4R-08, A3-08) are almost entirely direct replacements of the recoveries. However, a chain on mooring A4-08 broke on deployment, resulting in only the bottom instrumentation being deployed at that site. Since this is a key, long-term site, a second complete mooring A4R-08 was deployed within ~ 200m of A4-08, and mooring A4W-08 was not deployed in 2008.

This is the 2nd year of the highest resolution array ever deployed in the Bering Strait, (see map above). Three moorings were deployed across the western (Russian) channel of the strait (from west to east - A12-08, A1-08, A13-08). Four moorings were deployed across the eastern (US) channel of the strait (from west to east - A2W-08, A2-08, A4-08, A4R-08). A final 8th mooring (A3-08) was deployed ca. 35 nm north of the strait at a site proposed as a “climate” site, hypothesized to measure a useful average of the flow through both channels [*Woodgate et al.*, 2007]. Testing this hypothesis is a main aim of this work. All moorings (recovered and deployed) measure water velocity, temperature and salinity near bottom (as per historic measurements). Additionally, 6 of the 8 moorings (i.e., all eastern channel moorings, the climate site mooring A3, and the mooring central in the western channel) also carried upward-looking ADCPs (measuring water velocity in 1-2 m bins up to the surface, ice motion, and medium quality ice-thickness) and ISCATS (upper level temperature-salinity-pressure sensors in a trawl resistant housing designed to survive impact by ice keels). Bottom pressure gauges were also deployed on the moorings at the edges of the eastern channel (A2W-08 and A4-08). Two moorings (A2-08, central eastern channel; and A1-2, western part of western channel) also carried ISUS nitrate sensors and optical sensors for fluorescence and turbidity. For a full instrument listing, see the table below.

This coverage should allow us to assess year-round stratification in the strait and also to study the the physics of the Alaskan Coastal Current, a warm, fresh current present seasonally in the eastern channel, and suggested to be a major part of the heat and freshwater fluxes [*Woodgate and Aagaard*, 2005; *Woodgate et al.*, 2006]. The current meters and ADCPs (which give a estimate of ice thickness and ice motion) 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 region.

5.2. CTD

The moorings are usually supported by annual CTD sections, with water samples for nutrients. Regretably, the bad weather at the time of year of this cruise precluded running these CTD sections, however surface bucket samples were taken for salinity and nutrients at the mooring sites, and an underway temperature and pCO2 system was logged by the Bermuda Institute of Ocean Science during the cruise.

5.3. International links

Maintaining the time-series measurements in Bering is important to several national and international programs, e.g. the Arctic Observing Network (AON) started as part of the International Polar Year (IPY) effort; NSF's Freshwater Initiative (FWI) and Arctic Ocean 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 [*Woodgate et al.*, 2005].

6. MOORING OPERATIONS DURING 2008 LAVRENTIEV CRUISE

The RUSALCA 2008 mooring cruise was originally planned for August. When the cruise was moved to October, it was clear there would be substantial challenges with light and weather (and related icing) issues. By October, there is only ~ 12hrs light per day and (as verified by experience) storms are long and intense. However, a break in the weather allowed us to complete the mooring work, if not the CTD sections.

For recoveries, a spectra line was loaded onto the forward winch and fair-led to the block on the forward A-frame, forward of the bridge. The acoustic hydrophone was deployed from the forward lab, just forward of the A-frame (and close to the bowthruster). Once the mooring was released, the ship brought the floating mooring along the starboard side to the forward A-frame, where it was grappled by hook and brought aboard onto the foredeck using the A-frame and winch. An electric-powered pressure washer was successfully connected to the ship's supplies in the forward lab, greatly facilitating the mooring clean-up operation. Deployments were done off the aft-deck, using the ship's trawl wire and stern A-frame for lifting. Most success was obtained with the ship steaming slowly (1.5 knots) into the wind, and the mooring being deployed anchor last from the aft deck. The following issues are noteworthy:

1) The deck height above water is ~12ft, making grappling the mooring with a hook and pole challenging. ***Plan accordingly.***

2) The gangways from the foredeck to the aft-deck are smaller than the floats, and thus floats had to be put back into the ocean and floated around to the stern for deployment and packing/offload. ***Bring extra line for this operation.***

3) Two moorings required dragging. ***Prepare for dragging on all Bering Strait cruises.***

- A11-07 was recovered on the 2nd drag. A possible cause of the release not opening was the cold water making grease on the release mechanism too stiff. This 2nd dragging operation also recovered a mooring anchor (separate from the released mooring). ***Remove grease from release mechanisms.***

- A2W-07 was recovered on the 3rd drag. This mooring carried double releases and a bottom pressure gauge, and the reason for failure to release is not clear. Both releases confirmed release, but one release was jammed shut with small mussels when the mooring finally came on deck. Although the second release was open on final recovery, it is possible it too was jammed with biology and only released when caught by the drag. Another possibility is that the bottom-pressure gauge was jammed in its housing in the anchor, either by geometry, some issue during deployment, or biology. The setup has a fairly tight fit between the gauge and a rubber housing, and there was some evidence of barnacle growth below the housing which could have impeded the gauge being removed from its housing on the anchor. (The identical set up on A4-07 released without hitch, although we note the fouling was less on A4-07 and the currents are usually stronger at A4-07, helping to pull the gauge out from the anchor.) For the redeployments, all releases on all US moorings (which had significantly more fouling than the Russian side moorings) have their ***release mechanisms painted with antifouling paint.*** Additionally, ***the bottom pressure gauges were wrapped in plastic wrap*** (saran-wrap, cling-film), such that the gauge can slip free of this covering on recovery. ***Also, the rubber piping connecting the gauge to the anchor was loosened.***

4) As per last year, two releases were known to require a special deckset, since a manufacturer's error made the acoustic circuits temperature dependent. With this deckset, codes normally starting with 4 can be retuned by changing the initial digit of the code, by trial and error. This was successful and these releases have not been redeployed. It appears that some of the usual decksets can also send these special codes.

5) The ***moorings in the eastern channel and at the northern site showed significantly more biofouling than instrumentation in the western channel.*** This is curious since the accepted wisdom is that the western channel is the most productive. Possibly this reflects the warmer waters. The most fouling was found at site A2W, which also had large collections of sea-birds and whales. This may also relate to the high SeaWifs signal often seen around the island. Barnacles up to 3 cm were common on these moorings – barnacle growth has become the dominant form of biofouling in the strait in recent years. This year, small mussels were also in evidence more than in the past. One mooring also carried a hand-size sea-star. In all cases, salinity cells remained clear, with the possible exception of the iscat, where fouling with small mussels was a big problem.

6) Only 1 of the 6 iscats was recovered, although there is good data on the loggers for all the iscats up to the time of loss. Data show the upper iscats were generally at between 14 and 17m depth. One strong (presumably) storm event in late November has all iscats pulled down to almost 30m, at the same time as strong northward flow. The iscat on A4W became disconnected from its logger at this stage, although the iscat itself remained and is the one iscat to have been recovered. Data from the other 5 iscats ceases in mid February (A3-07 and A1-07), late March (A2-07 and A4-07, within a day of each other) and late April (A2W-07). In all cases, the temperatures are at freezing, suggesting ice damage, although this must be checked against ice-charts. The 2008 deployments have ***put the iscats all at 17m,*** and ***strengthened the plugged link between the iscat and the logger***. We should ***consider making stronger weak links, and revisit the iscat shape in light of pull down information.***

7) The deployments of A4-07 and A2-07 had many issues.

- Firstly, a combination of the ship drifting (rather than towing the mooring), the shortness of the mooring and the location of the anchor on deck, left the ADCP banging against the aft of the ship. This resulted in bending of the "banana" bars holding the viny floats into the frame and loss of 4 vinys. The instrument was recovered and rerigged, but ***the banana bars should be strengthened, and all bars on the frame cotter pinned or screwed.***

- Secondly, when the anchor was dropped, only the steel float of the mooring, the SBE-16 and the bottom pressure gauge went down. It turns out the last link of the chain below the viny ADCP frame broke somehow, possibly due to the rough treatment on deployment, but more likely (given what follows) due to faulty chain. For the remaining deployments, ***at the top of the mooring the chain links were taped***, to keep them straight during deployment.

- Thirdly, on recovery of the Iscat and ADCP that broke off A4-08 on deployment, the iscat tether became hooked underneath the ship. ***Bring grapples to aid in recovery, recover Iscat first, bring extra tether.***

- Fourthly, on the anchor pick for deployment of A2-07, it was noted the bottom link of the chain was cracked and opening. All accessible chain was replaced with chain from recovered moorings. ***Beware all chain on A4-07 and A2-07 on recovery.*** The broken chain carries the marking KX and CCL.

- Fifthly, a combination of the chain issue, plus a tangling issue caused by the ship losing forward way during the deployment, meant A2 has been deployed ~ 700m north of its usual position. (It was not deemed worth the equipment risk to turn the ship while towing the mooring to reposition.) ***In 2009, A2 should be placed in its usual position, not in its 2008 position.***

8) During this cruise, all deck operations (including driving of winches and A-frames) were done by the US science party. Although Russian scientists were likely available to help, it was deemed safer to keep one-common language on deck. ***Ensure the manning of the ship is clear before the cruise.***

Very preliminary analysis of the mooring data show very good data return from all instrumentation. Preliminary plots are given below.

The data show the usual large annual cycle in temperature and salinity. Many of the usual features are present, i.e. high variability in autumn, generally with freshening and cooling; salting (at the freezing point) in the winter; freshening and warming in the spring [*Woodgate et al.*, 2005]. Moorings A4 and A4W sample the Alaskan Coastal Current (ACC), and in general the eastern channel is warmer and fresher than the western channel. The Iscat data also shows more stratification on the eastern side, although there is significant and (interestingly) episodic stratification on the western side. The Iscat data indicate that although the iscats were lost in the winter, the autumn stratification is well caught by these data. The flow fields are strongly barotropic, other than in the ACC, although some velocity shear is evident at other sites also. Also, interestingly, there are hardly any strong southward flow events. It will be informative to integrate flux measurements for these time periods. The flow through the strait is believed to be driven by a sea-level difference between the Pacific and the Arctic, which drives a flow northwards towards the Arctic. Local winds (usually southward in the annual mean) tend to oppose this flow and may reverse it on timescales of days [*Woodgate et al.*, 2005b]. However, the recovered data suggest that reversals have been unusually uncommon this summer, as in last year's data. Since the variability of northward fluxes of heat and freshwater are dominantly dependent on the variability of the volume transport [*Woodgate et al.*, 2006], this may imply further increases in this fluxes, with possible implications for the Arctic and beyond.

Details of mooring positions and instrumentation are given below, along with schematics of the moorings, photos of the mooring fouling and preliminary plots of the data.

7. WATER SAMPLING OPERATIONS DURING 2007 SEVER CRUISE

Bad weather and the large amount of mooring work to be done precluded the taking of CTD sections. However, surface bucket samples were taken for salinity and nutrients at the mooring sites, and at 1 extra site (65º 58.567'N, 169º 47.684'W, in 45m of water, corrected for ship draft) believed (from observation of surface water colour) to be in the Siberian Coastal Current, which on a steam from 65º 57.2'N 169º 39.8'W to 65º 58.6'N 169º 42.2'W appeared as a sharp change in surface colour (lighter brown hear the coast) and extending ~ 3nm from the coast.

These samples will be analysed for nutrients by Terry Whitledge, and for salinity and pCO2 by Bermuda Institute of Ocean Science (BIOS), who also collected underway temperature and pCO2 data from the ship's underway seawater intake.

Table 1. RUSALCA 2008 Bering Strait mooring positions and instrumetation (US GPS).

ID	LATITUDE (N)	LONGITUDE (W)	WATER DEPTH /m (corrected)	INST.
RECOVERIES				
- Russian EEZ				
A1-1-07	65 53.994	169 25.877	52	ISCAT, ADCP, SBE37
A1-2-07	65 56.019	169 36.763	53.3	ISUS, SBE/TF, RCM9T
A1-3-07	65 51.908	169 16.927	49	AARI, RCM9, SBE37
- US EEZ				
A2W-07	65 48.07	168 47.95	52	ISCAT, ADCP, SBE16, BPG
A2-07	65 46.87	168 34.07	56	ISCAT, ADCP, SBE/TF, ISUS
A4W-07	65 45.42	168 21.95	54	ISCAT, ADCP, SBE16
A4-07	65 44.77	168 15.77	50	ISCAT, ADCP, SBE16, BPG
A3-07	66 19.60	168 57.92	58	ISCAT, ADCP, SBE37

DEPLOYMENTS				
- Russian EEZ				
A11-08	65 54.033	169 26.174	52	ISCAT, ADCP, SBE37
A12-08	65 56.060	169 36.738	51	ISUS, SBE/TF, RCM9
A13-08	65 51.897	169 16.907	50	AARI, RCM9, SBE37
- US EEZ				
A2W-08	65 48.124	168 48.371	53	ISCAT, ADCP, SBE16, BPG
A2-08	65 47.195	168 34.691	56	ISCAT, ADCP, SBE/TF, ISUS
A4R-08	65 44.946	168 15.964	50	ISCAT, ADCP, SBE16
A4-08	65 44.882	168 15.761	50	SBE16, BPG
A3-08	66 19.595	168 57.875	58	ISCAT, ADCP, SBE37

AARI = AARI Current meter and CTD
ADCP = RDI Acoustic Doppler Current Profiler
BPG=Seabird Bottom Pressure Gauge
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
ISUS= Nutrient Analyzer
RCM9= Aanderaa Acoustic Recording Current Meter
RCM9T = Aanderaa Acoustic Recording Current Meter with Turbidity
SBE/TF = Seabird CTD recorder with transmissometer and fluorometer
SBE16 = Seabird CTD recorder
SBE37 = Seabird Microcat CTD recorder

Table 2. RUSALCA 2008 Bering Strait bucket data positions (US GPS).

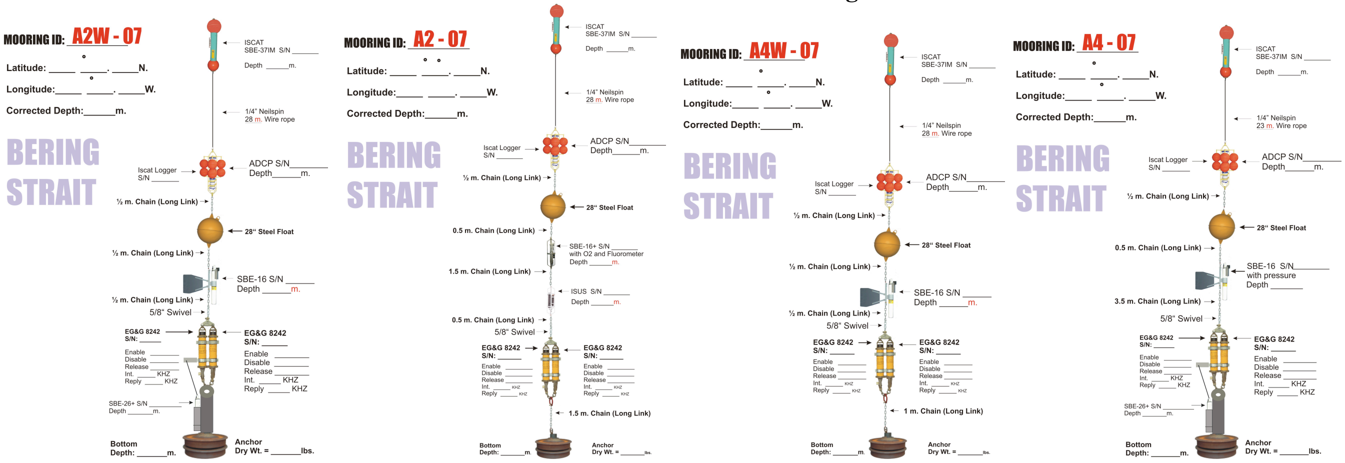
Sample Number	Year	Month	Day	Time Name	Depth (m)	Latitude (N) (deg min)	Longitude (W) (deg min)
1	2008	5	1714	SCC	45	65 58.567	169 47.684
2	2008	5	1751	A12-07	51	65 55.952	169 36.941
3	2008	5	2016	A11-07	52	65 53.992	169 25.88
4	2008	6	0127	A13-07	50	65 51.95	169 16.71
5	2008	6	1720	A4-07	50	65 44.891	168 15.662
6	2008	6	1844	A4W-07	54	65 45.42	168 21.95
7	2008	6	2009	A2-07	56	65 46.891	168 33.886
8	2008	6	2214	A2W-07	53	65 48.11	168 47.351
9	2008	7	1755	A3-07	58	66 19.768	168 58.007
10	2008	8	0246	A4-08	50	65 44.771	168 15.902
11	2008	8	1704	A2-08	56	65 46.901	168 33.524
12	2008	8	2240	A2W-08	53	65 48.034	168 47.28
13	2008	9	0119	nrA11-08	52	65 53.634	169 22.681
14	2008	9	0412	A13-08	50	65 51.901	169 15.038
15	2008	9	1753	-08	51	65 56.033	169 36.87

All dates and times are GMT.
Names are as per nearest mooring location (nrA11 is near A11, not at A11).
Water depths in () are approximate from mooring locations.

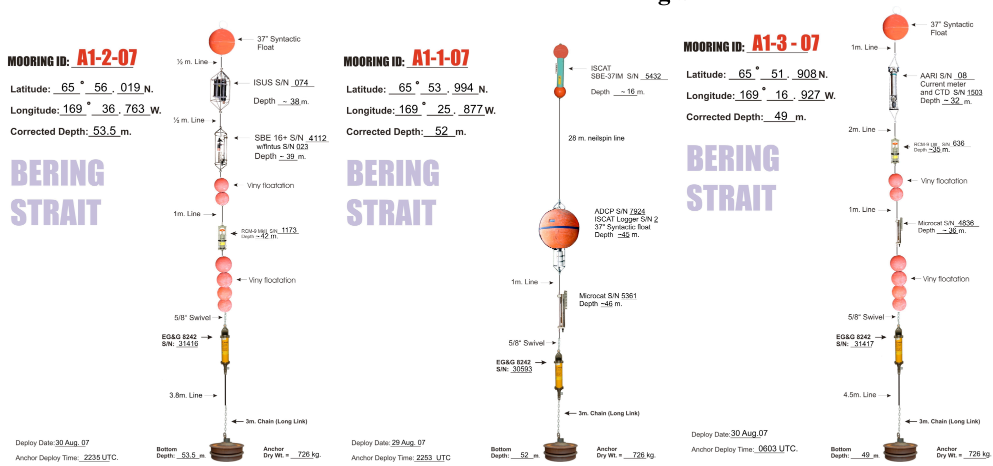
SCC is a non-mooring site, believed (from ship observation of water colour) to lie within the Siberian Coastal Current.

Nutrients and salinity will be analyzed from these samples.

In the eastern channel of the Bering Strait



In the western channel of the Bering Strait



At the climate site, ~ 60km north of the Strait

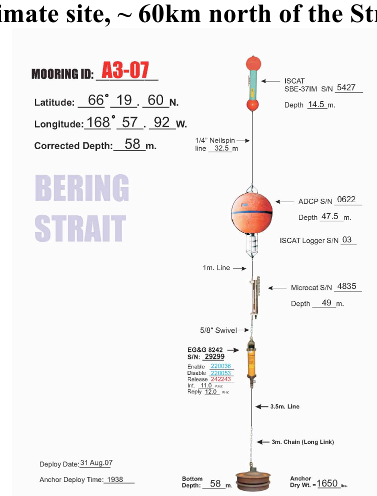
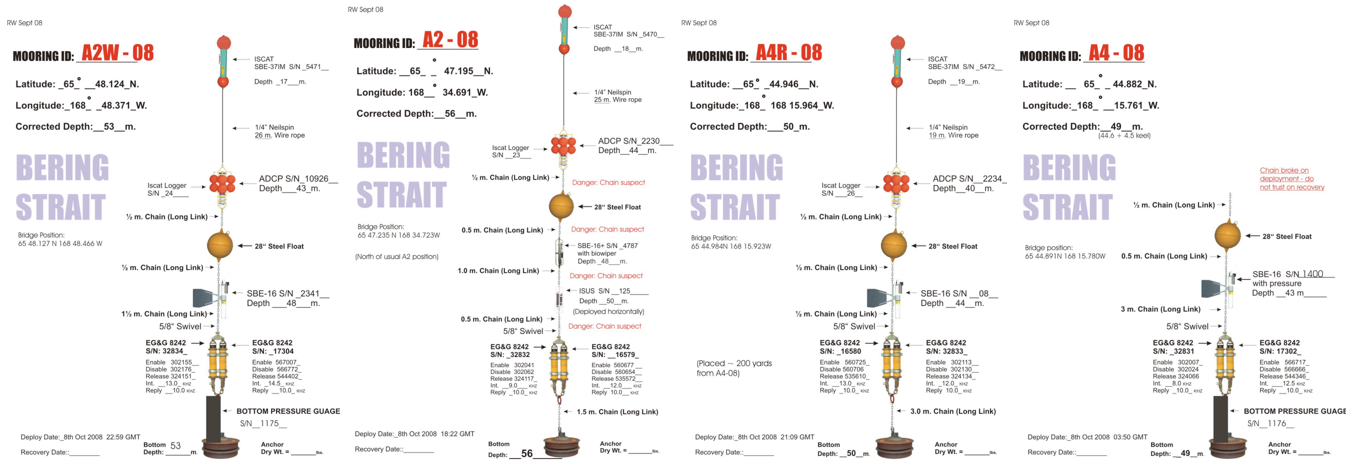
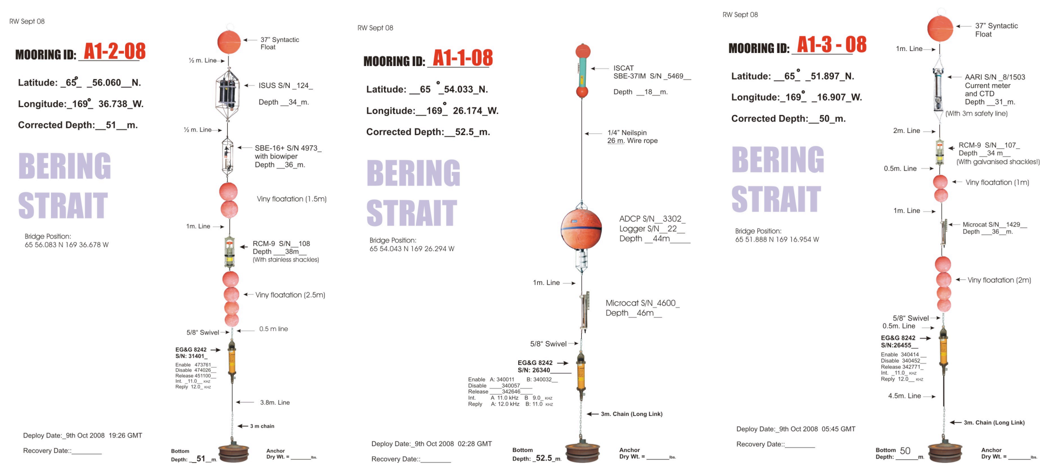


Figure 2. RUSALCA 2008 schematics of mooring recoveries.

In the eastern channel of the Bering Strait



In the western channel of the Bering Strait



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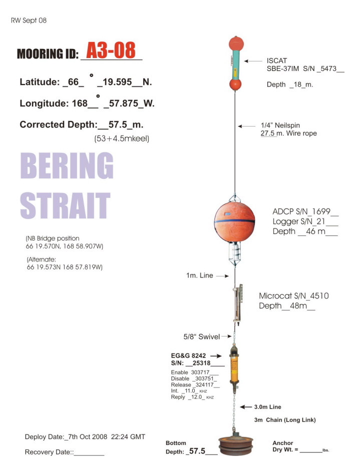
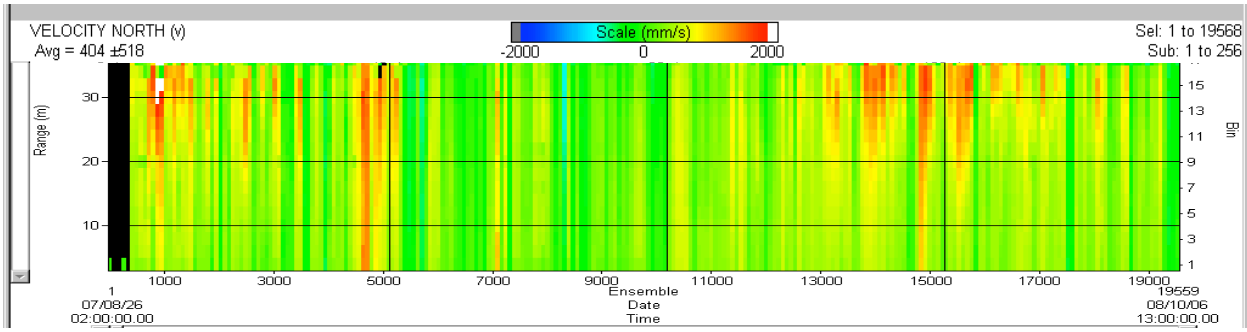
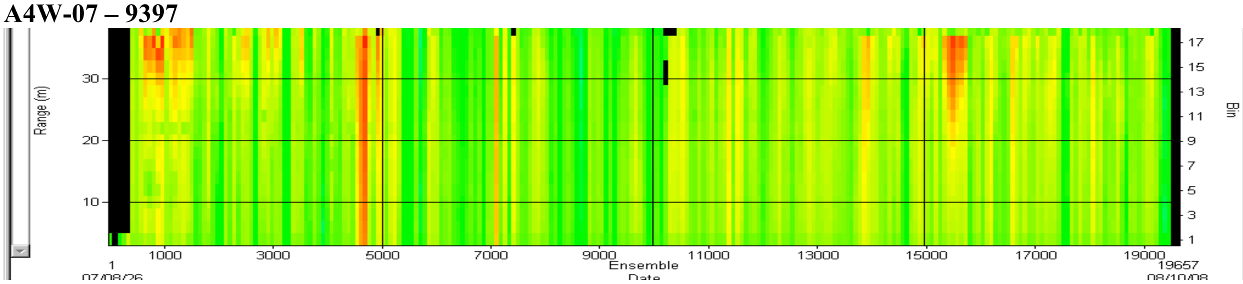


Figure 3. RUSALCA 2008 schematics of mooring Deployments.

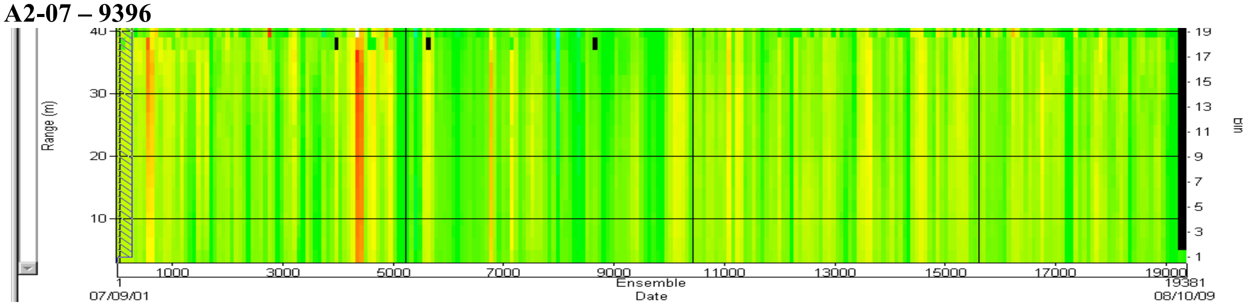
A4-07 - 2270



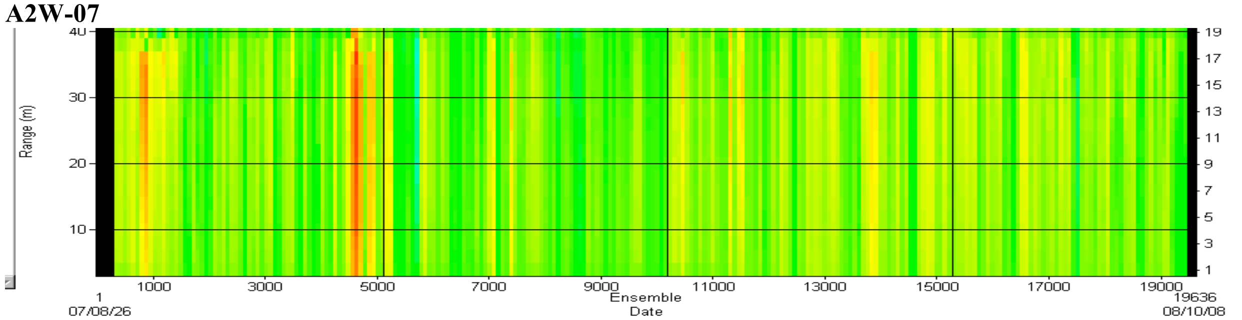
A4W-07 – 9397



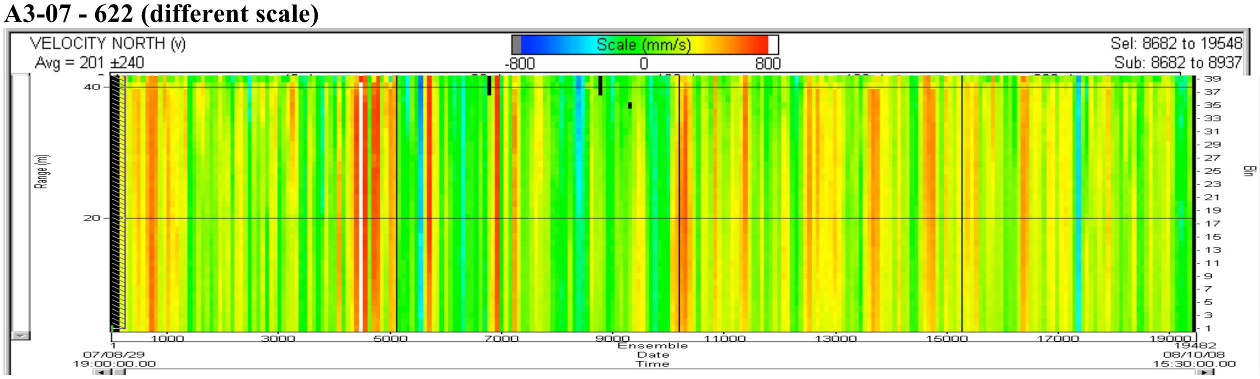
A2-07 – 9396



A2W-07



A3-07 - 622 (different scale)



A2-07 – 9396 northward only

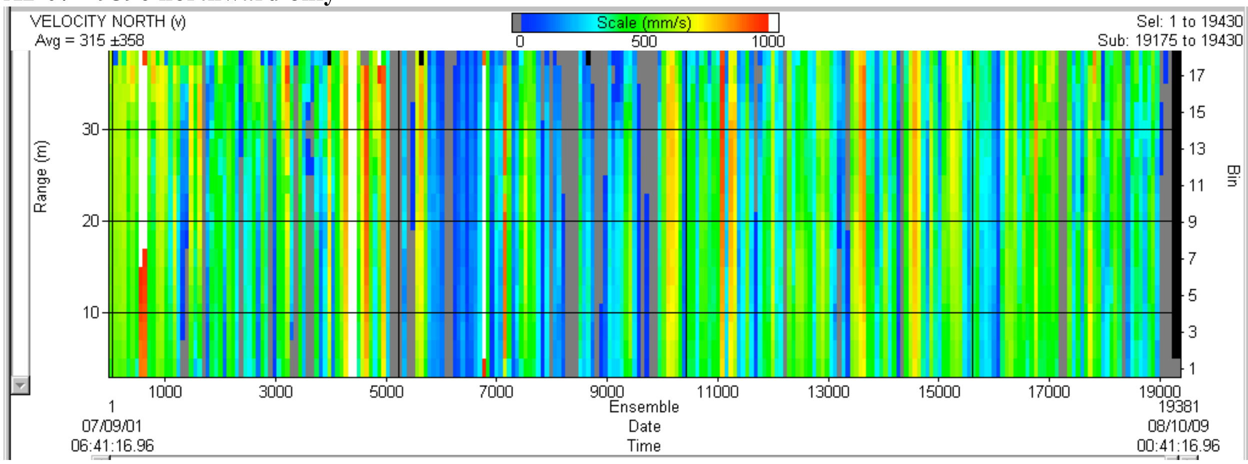


Figure 4. RUSALCA 2008 preliminary ADCP results (A1 data not included).

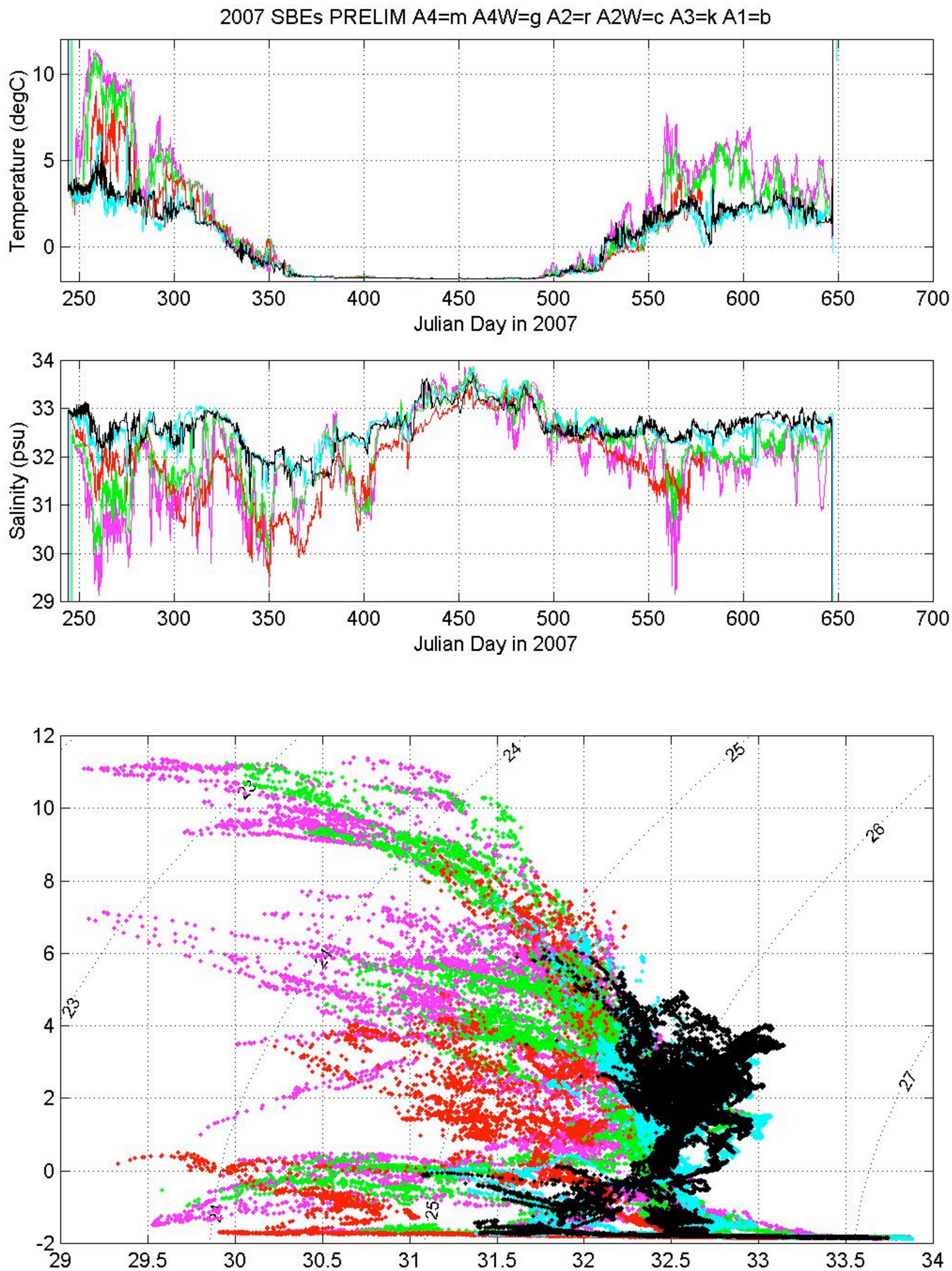


Figure 5. RUSALCA 2008 preliminary SEACAT results (A1, A12, A13 data not included).

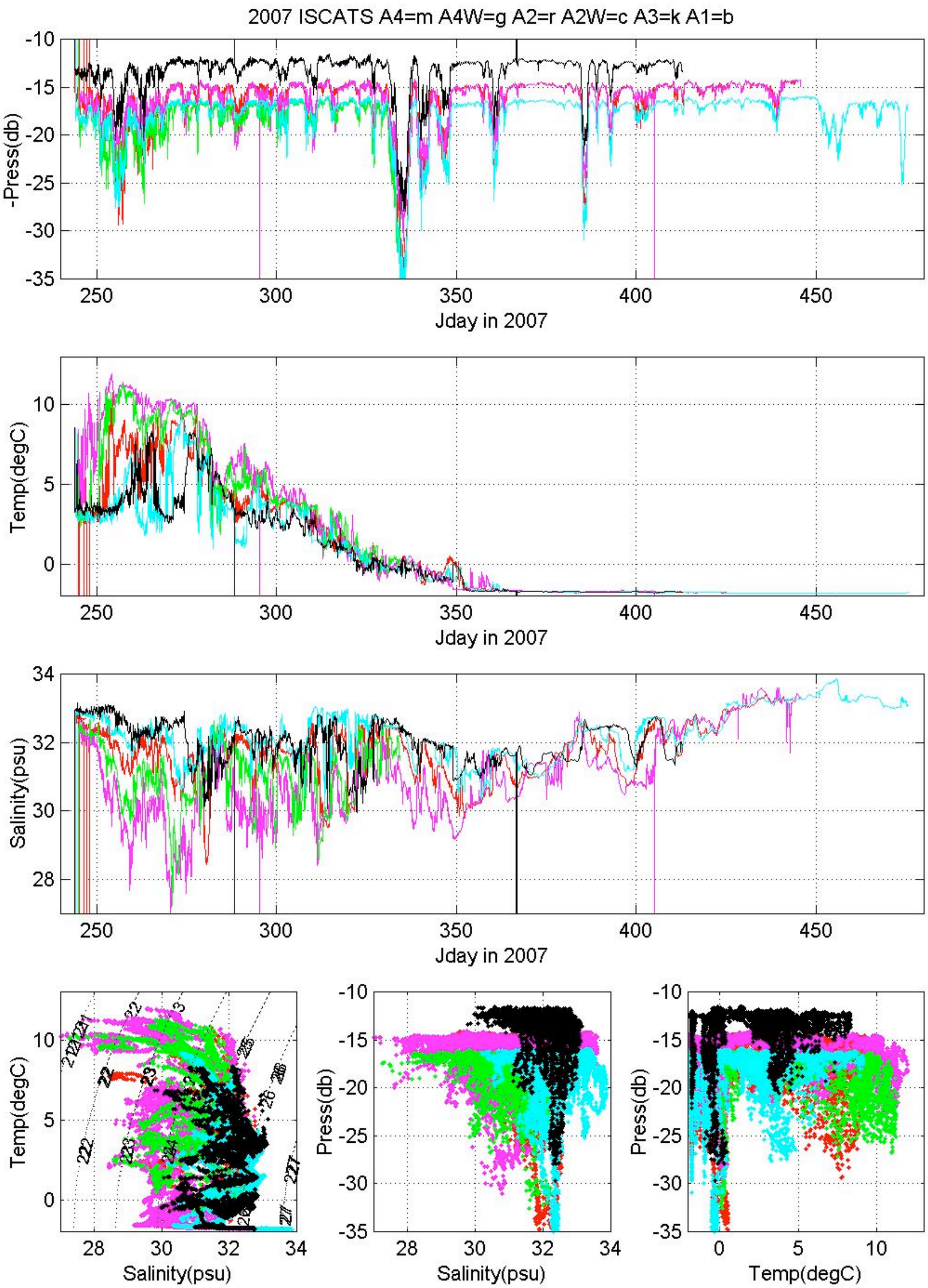


Figure 6. RUSALCA 2008 preliminary ISCAT results (A1 data not included).

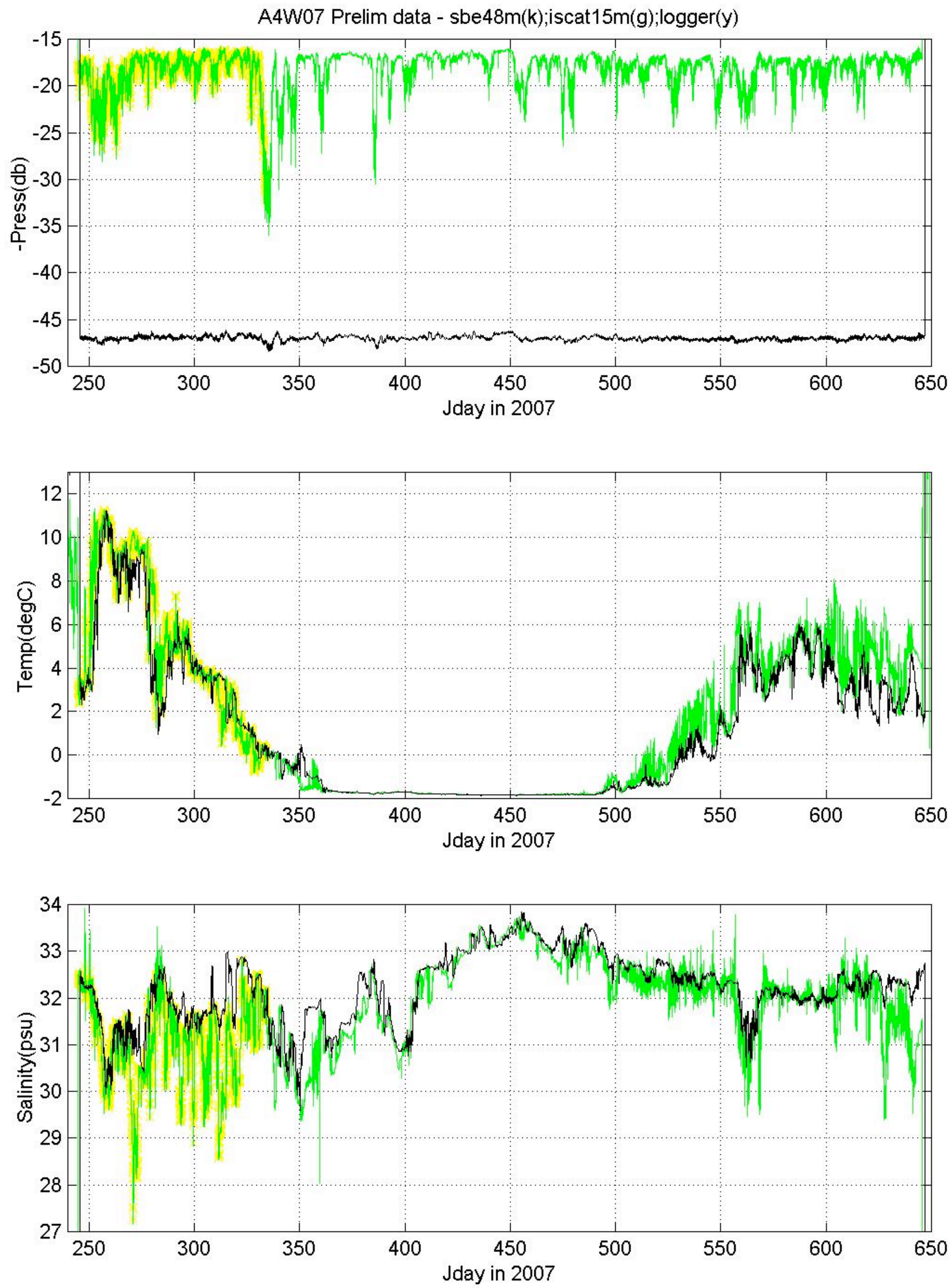


Figure 7. RUSALCA 2008 preliminary ISCAT-SBE comparison – for A4W07 (iscat survived all year).

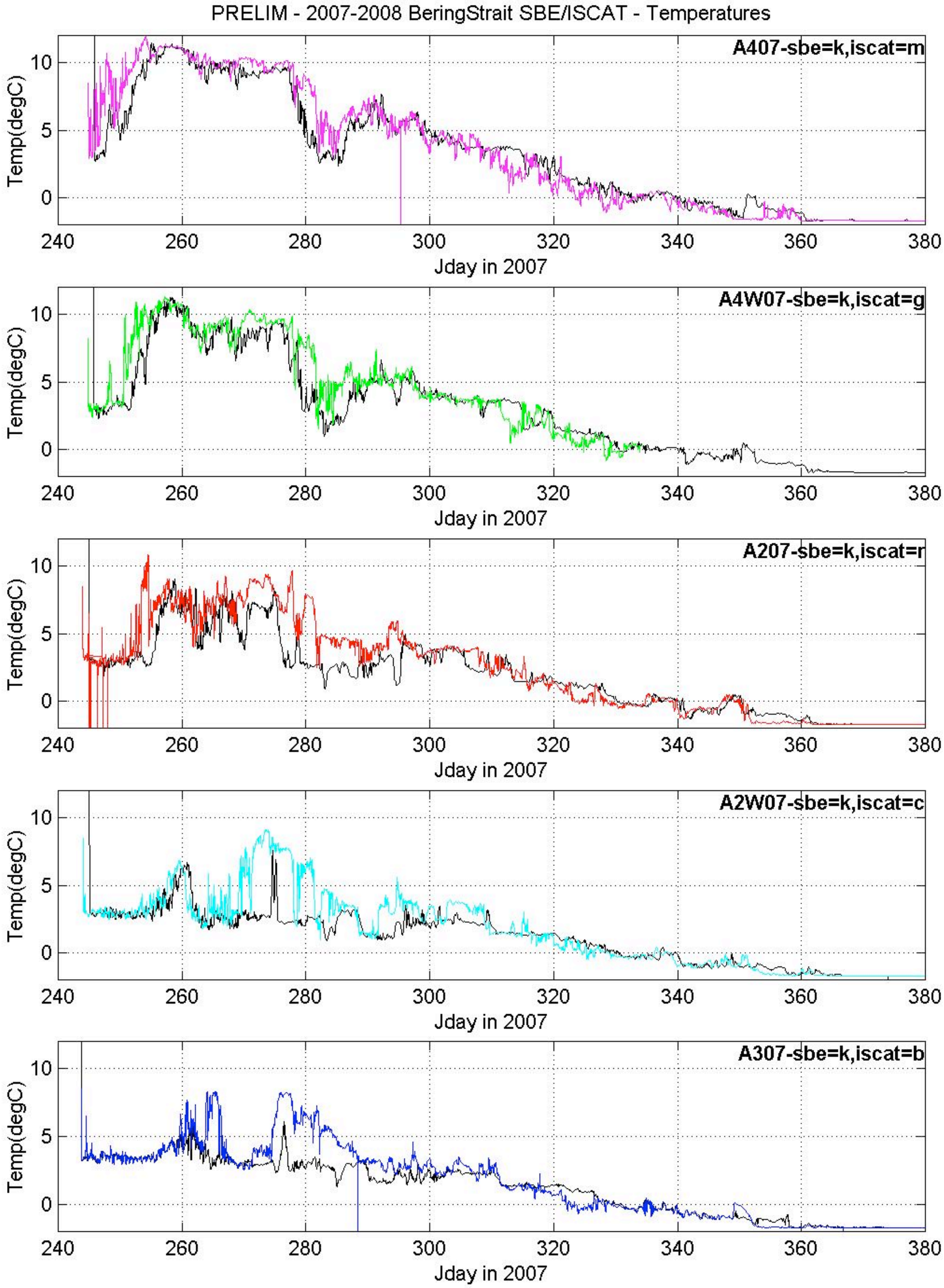


Figure 8. RUSALCA 2008 preliminary ISCAT-SBE comparison all sites - Temperatures (A1 data not included).

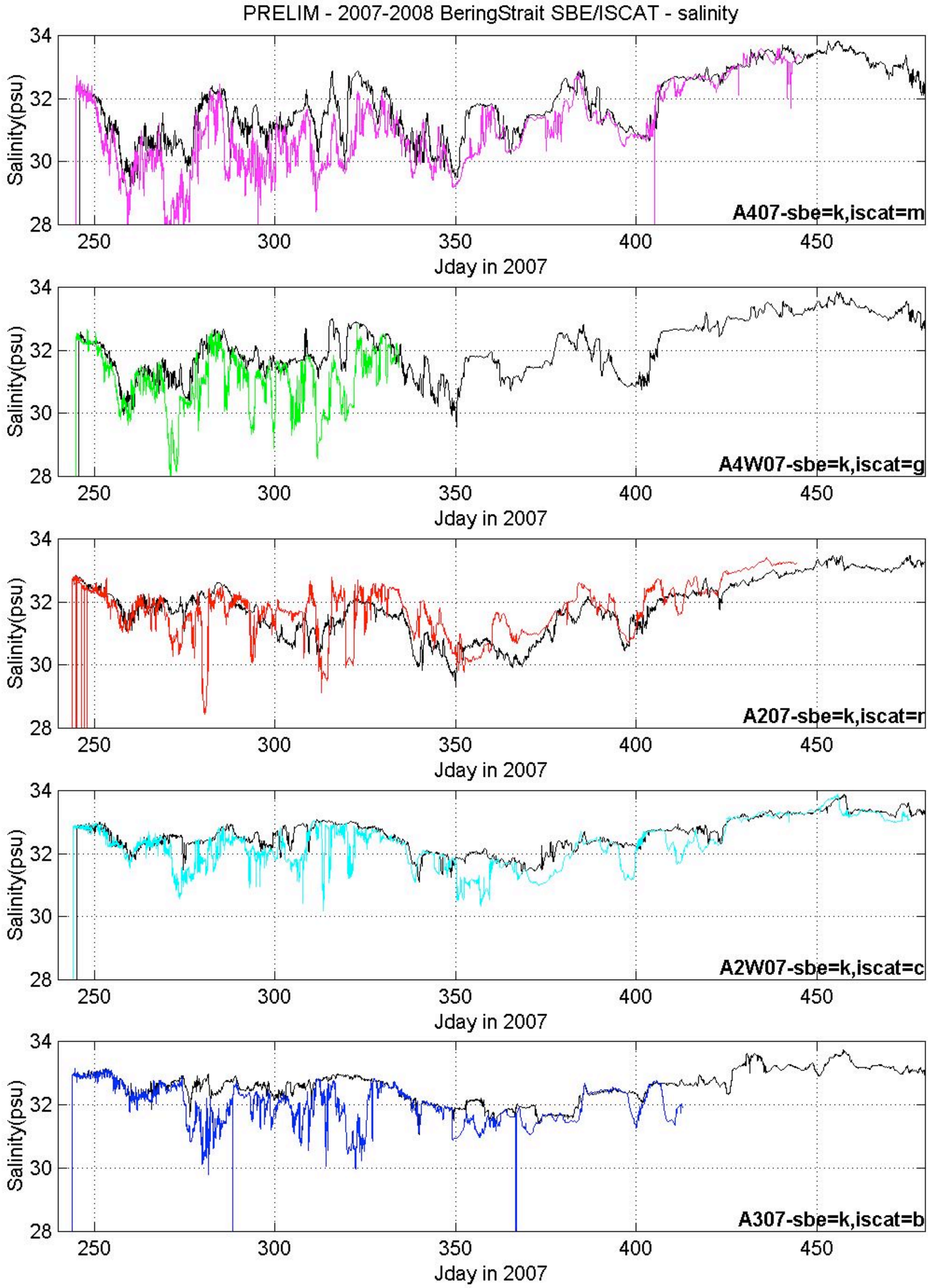


Figure 9. RUSALCA 2008 preliminary ISCAT-SBE comparison all sites – Salinities (A1 data not included. Note likely calibration issue with A207 SBE).

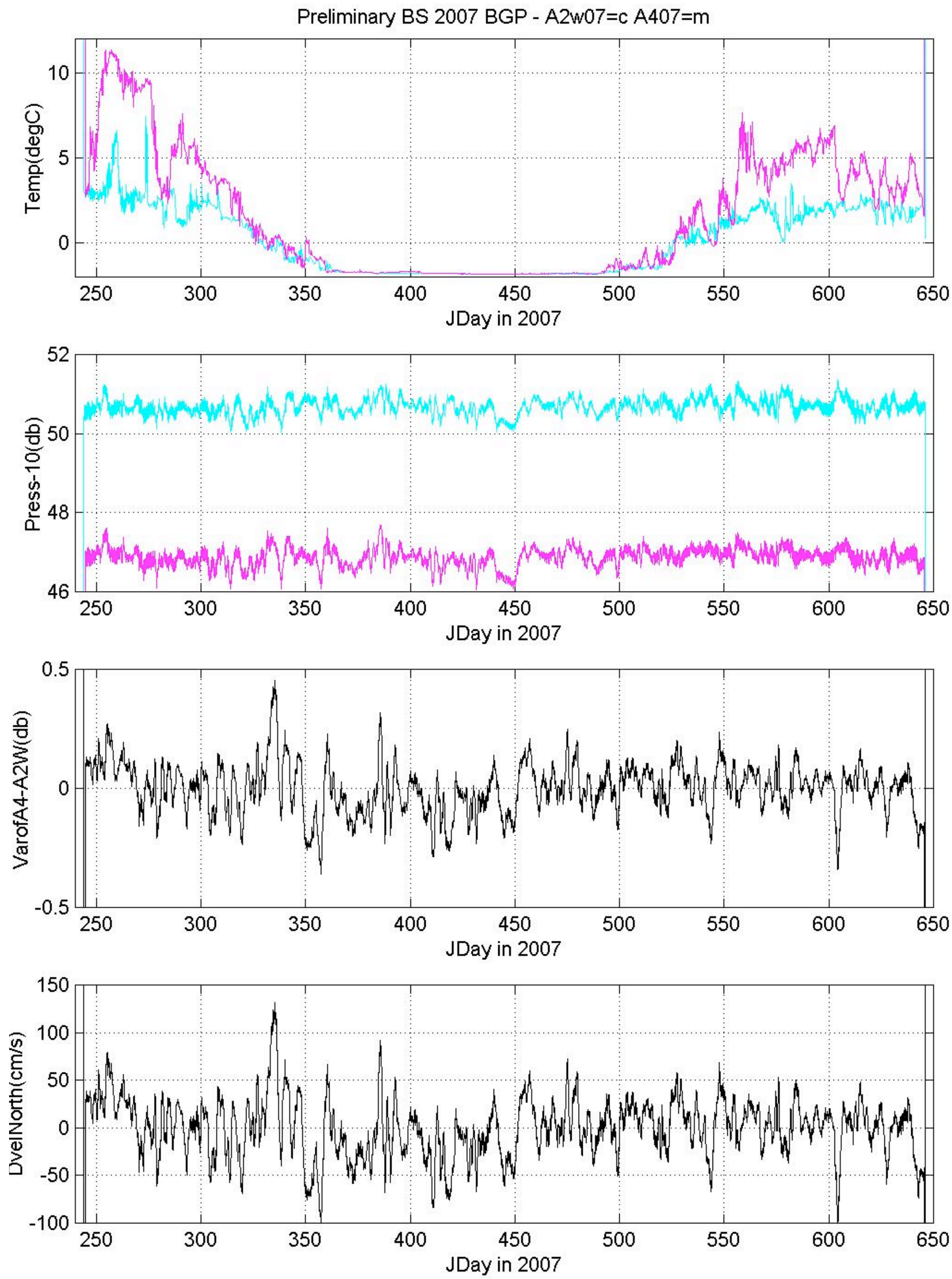


Figure 10. RUSALCA 2008 preliminary Pressure Gauge results**.**

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