BERING STRAIT NORSEMAN II 2015 MOORING CRUISE PLAN

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 1st July to 9th July 2015

Rebecca Woodgate, University of Washington (UW), *woodgate@apl.washington.edu*
and the Bering Strait 2015 Science Team

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(Photo from www.norsemanmartime.com)

Chief Scientist: *Rebecca Woodgate, University of Washington (UW), USA.*
1013 NE 40th Street, Seattle WA, 98105
Email: woodgate@apl.washington.edu
Tel: +1-206-221-3268; Fax: +1-206-543-6785

Co-PIs: *Patrick Heimbach, Massachusetts Inst. of Technology (MIT), USA*
An Nguyen, MIT, USA

Related PIs: *Kate Stafford, UW, USA*
Terry Whitledge, University of Alaska, Fairbanks (UAF), USA
Laurie Juranek and Burke Hales, Oregon State University (OSU) USA

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in July 2015 a team of US scientists will undertake a ~ 8 day cruise in the Bering Strait and southern Chukchi Sea region on the US vessel Norseman II, operated by Norseman Maritime Charters.

The primary goals of the expedition are:

1) recovery of 3 moorings carrying physical oceanographic (Woodgate-NSF), bio-optical (Whitledge) and whale acoustic (Stafford) instrumentation. These moorings were deployed in the Bering Strait region in 2014 from the Norseman II. The funding for the physical oceanographic components of these moorings comes from NSF-AON.

2) deployment of 3 moorings in the Bering Strait region, carrying physical oceanographic (Woodgate), ocean acidification (Juranek and Hales) and whale acoustic (Stafford) instrumentation. The funding for the physical oceanographic components of these moorings comes from NSF-AON.

3) accompanying CTD sections (without water sampling).

4) collection of accompanying ship's underway data (surface water properties, ADCP, meteorological data).

The cruise will load and offload in Nome, Alaska.

SCIENCE BACKGROUND

The ~50m deep, ~ 85km wide Bering Strait is the only oceanic gateway between the Pacific and the Arctic oceans.

The oceanic fluxes of volume, heat, freshwater, nutrients and plankton through the Bering Strait are critical to the water properties of the Chukchi [*Woodgate et al.*, 2005a]; act as a trigger of sea-ice melt in the western Arctic [*Woodgate et al.*, 2010]; provide a subsurface source of heat to the Arctic in winter, possibly thinning sea-ice over about half of the Arctic Ocean [*Shimada et al.*, 2006; *Woodgate et al.*, 2010]; are ~ 1/3rd of the freshwater input to the Arctic [*Aagaard and Carmack*, 1989; *Woodgate and Aagaard*, 2005]; and are a major source of nutrients for ecosystems in the Arctic Ocean and the Canadian Archipelago [*Walsh et al.*, 1989]. In modeling studies, changes in the Bering Strait throughflow also influence the Atlantic Meridional Circulation [*Wadley and Bigg*, 2002] and thus world climate [*De Boer and Nof*, 2004].

Quantification of these fluxes (which all vary significantly seasonally and interannually) is critical to understanding the physics, chemistry and ecosystems of the Chukchi Sea and western Arctic, including sea-ice retreat timing and patterns, and possibly sea-ice thickness. Understanding the processes setting these fluxes is vital to prediction of future change in this region and likely in the Arctic and beyond.

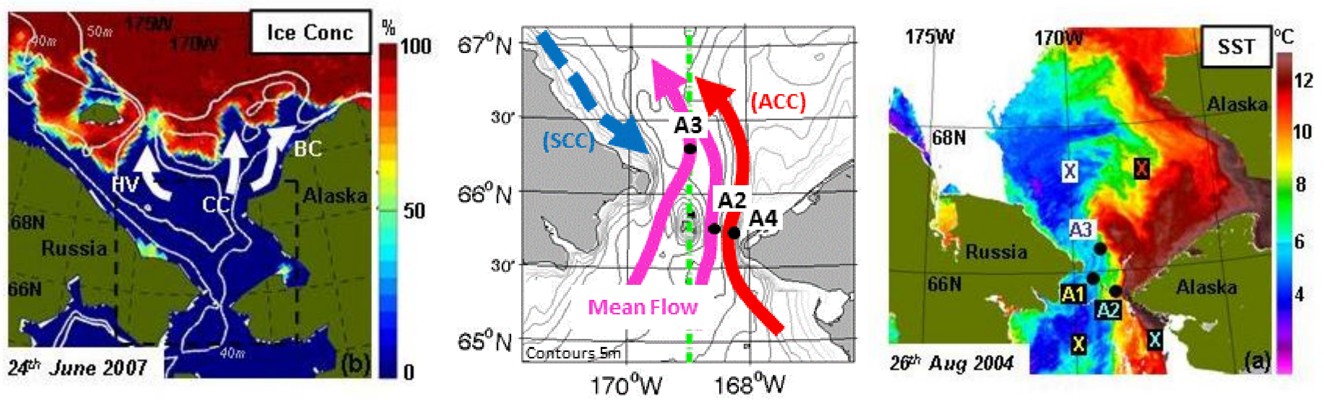


***Figure 1: (Left)** Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
***(Middle)** Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward flow passes through both channels (magenta arrows). Topography diverts the western channel flow eastward near site A3. The warm, fresh Alaskan Coastal Current (ACC) (red arrow) is present seasonally in the east. The cold, fresh Siberian Coastal Current (SCC) (blue dashed arrow) is present in some years seasonally in the west. Green dashed line at 168º58.7'W marks the US-Russian EEZ (Exclusive Economic Zone) boundary. Note all moorings are in the US EEZ. Depth contours are from IBCAO [Jakobsson et al., 2000]. The Diomede Islands are in the center of the strait, seen here as small black dots on the green dashed line marking the US-Russian boundary.*
***(Right)** Sea Surface Temperature (SST) MODIS/Aqua level 1 image from 26th August 2004 (courtesy of Ocean Color Data Processing Archive, NASA/Goddard Space Flight Center). White areas indicate clouds. Note the dominance of the warm ACC along the Alaskan Coast, and the suggestion of a cold SCC-like current along the Russian coast [Woodgate et al., 2006].*

Since 1990, year-round moorings have been maintained almost continually year-round in the Bering Strait region, supported by typically annual servicing and hydrographic cruises [*Woodgate et al.*, submitted]. These data have allowed us to quantify seasonal and interannual change [*Woodgate et al.*, 2005b; *Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012], and assess the strong contribution of the Alaskan Coastal Current (ACC) to the fluxes through the strait [*Woodgate and Aagaard*, 2005]. These data also show that the Bering Strait throughflow increased ~50% from 2001 (~0.7Sv) to 2011 (~1.1Sv), driving heat and freshwater flux increases [*Woodgate et al.*, 2012]. While ~ 1/3rd of this change is attributable to weaker local winds, 2/3rds appears to be driven by basin-scale changes between the Pacific and the Arctic. Remote data (winds, SST) prove insufficient for quantifying variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012]. Indeed, data from 2013 indicate a surprisingly low flow year.

The work to be accomplished/started on this cruise will extend this mooring time-series to summer 2016.

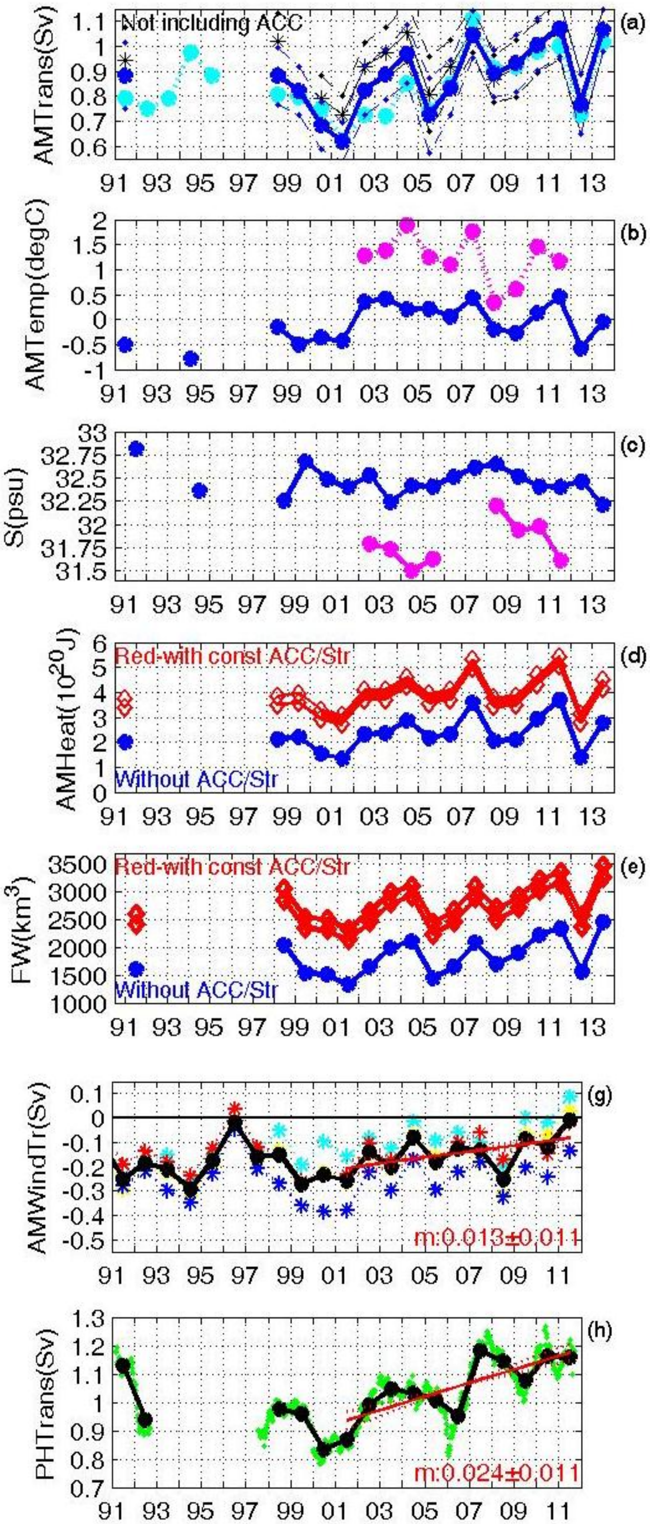


Figure 2, adapted from [Woodgate et al., 2012; Woodgate et al., submitted]

a) *transport calculated from A3 (blue) or A2 (cyan), with error bars (dashed) calculated from variability; including adjustments estimated from 2007-2009 Acoustic Doppler Current Profiler data for 6-12m changes in instrument depth (black);*

b) *near-bottom temperatures from A3 (blue) and A4 (magenta-dashed);*

c) *salinities from A3 (blue) and A4 (magenta);*

d) *heat fluxes: blue - from A3 only; red – including ACC correction (1×10^{20}J) and contributions from surface layer of 10m (lower bound) or 20m (upper bound) at SST, with black x indicate heat added from 20m surface layer;*

e) *freshwater fluxes: blue – from A3 only; red – including 800-1000km^3 (lower and upper bounds) correction for stratification and ACC;*

g) *to 2011, transport attributable to NCEP wind (heading 330º, i.e., northwestward) at each of 4 points (coloured X in Figure 1) and the average thereof (black); and*

h) *to 2011, transport attributable to the pressure-head term from the annual (black) or weekly (green) fits.*

*Uncertainties are order 10-20%. Red lines on **(g)** and **(h)** indicate best fit for 2001-2011 (trends=m±error, in Sv/yr, error being the 95% confidence limit from a 1-sided Student's t-test).*

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 Model Intercomparison Project (AOMIP), and the international Arctic SubArctic Ocean Fluxes (ASOF) program. For several years, the work was part of the RUSALCA (Russian-US Long Term Census of the Arctic). Some of the CTD lines are part of the international Distributed Biological Observatory (DBO) effort. 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.

SCIENCE GOALS FOR THE 2015 BERING STRAIT MOORING CRUISE

Figure 3 shows the locations of the moorings and the possible CTD sections for the 2015 cruise.

There are 3 moorings to be recovered, viz:
- moorings A2, A4, in the eastern channel of the Bering Strait; and
- mooring A3, ~ 35nm north of the strait.

To provide an *in situ* test of the moorings to be recovered, we would like to take a CTD cast at each mooring site sometime before the mooring is recovered. (This may be immediately before recovery, or some time before recovery.)

There are 3 moorings to be deployed, viz:
- mooring A3, ~ 35nm north of the strait; and
- moorings A2 and A4 in the eastern channel of the Bering Strait.

Again, to provide an *in situ* test, we would like to take a CTD cast at each site post deployment.

Once mooring operations are complete, we will sample as many CTD lines as possible in the remaining time. These CTD lines are taking profile data only, i.e., there is no rosette and no water samples will be taken.

Summary of CTD lines.
CTD lines will be run as time and weather allow, and will likely be taken from the following set of historic lines which have been run several times in the past. The order and direction of the lines may change, and new lines may be introduced, as dictated by science, weather or timing needs. Some lines may be repeated during the cruise. All sections are confined to US waters.
All positions are given in an Appendix.
Highest priority lines
- **BS** – the main Bering Strait line, providing a context for the in-strait moorings, run every year since 2000. Often occupied more than once in a cruise.
- **AL** – from the mooring site A3, to where the main channel of the strait shallows on the eastern (US) side, providing a context for mooring A3. Also sometimes repeated during a cruise.

Other lines (in no priority order)
- **CS** – a cross strait line, from the central Chukchi DBO site to Point Hope.
- **DL** – a high resolution line running north from the Diomede Islands to study an hypothesized eddy and mixing region north of the islands. Often repeated during a cruise.
- **DLA and DLB** – two high resolution lines offset ~ 2nm from DL to provide a mapping of the hypothesized eddy and mixing region north of the islands.
- **AS** – a section across the Alaskan Coastal Current towards the central Chukchi (rarely run).
- **LIS** – from Cape Lisburne towards the WNW, a previous RUSALCA line and close to the CP line occupied in previous Bering Strait cruises in 2003, 2004. LIS has been occupied in 2011, 2012, 2013.
- **CCL** – a line running down the convention line from the end of the LIS line towards the Diomedes (also run in 2003, 2004 and 2011, 2012, 2013), incorporating a rerun of the high resolution DI line at the southern end.
- **NBS** – a high resolution line run across the northern part of the strait crossing the northward branch of the ACC.
- **MBS** – a high resolution line run across the middle part of the strait crossing the northward branch of the ACC.

Figure 3: Bering Strait 2015 Plan: *Black dots with blue centers – moorings to be recovered and redeployed (A2, A3, A4). Red dots – historic CTD stations. Depth contours every 10m from the International Bathymetric Chart of the Arctic Ocean [Jakobsson et al., 2000].*

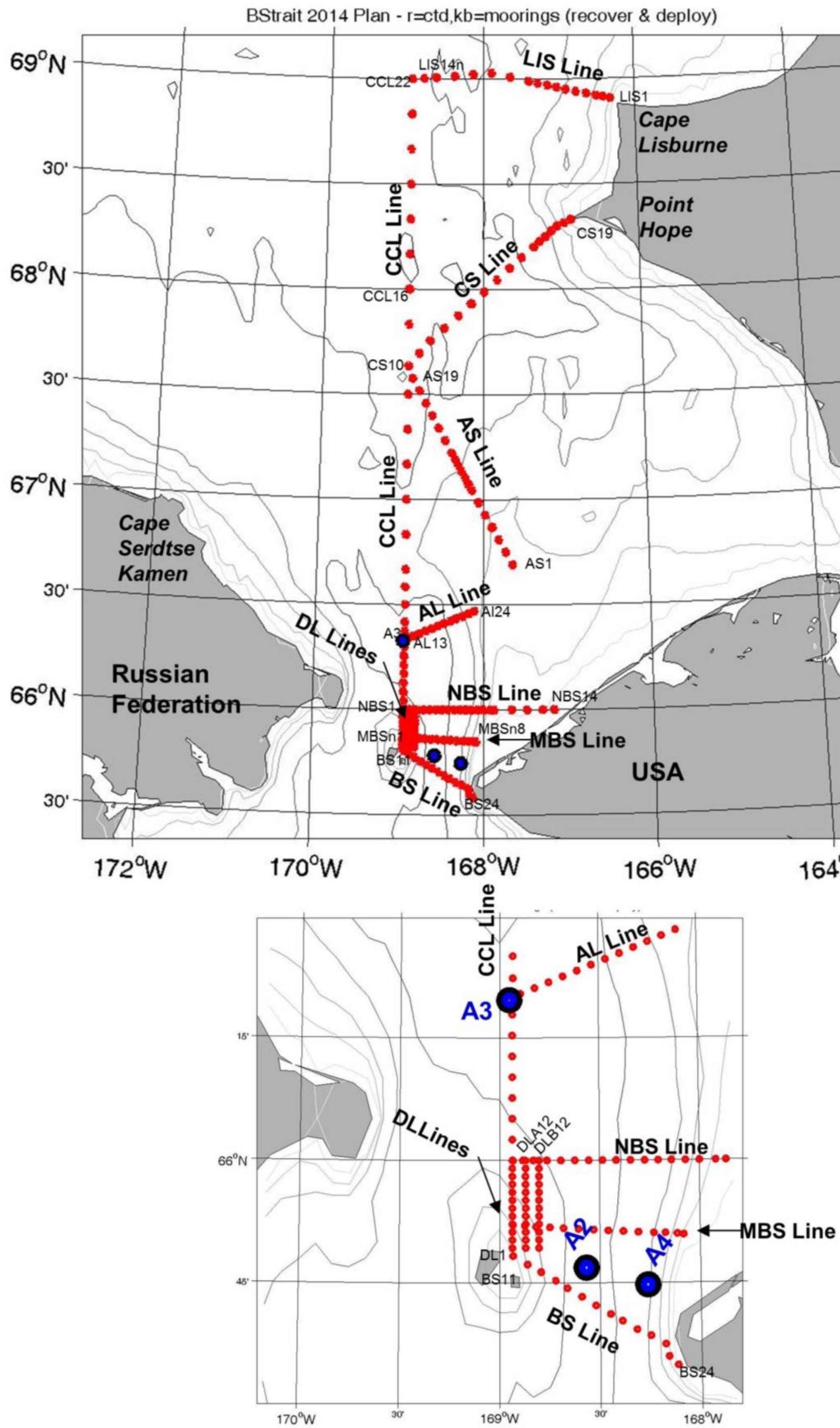
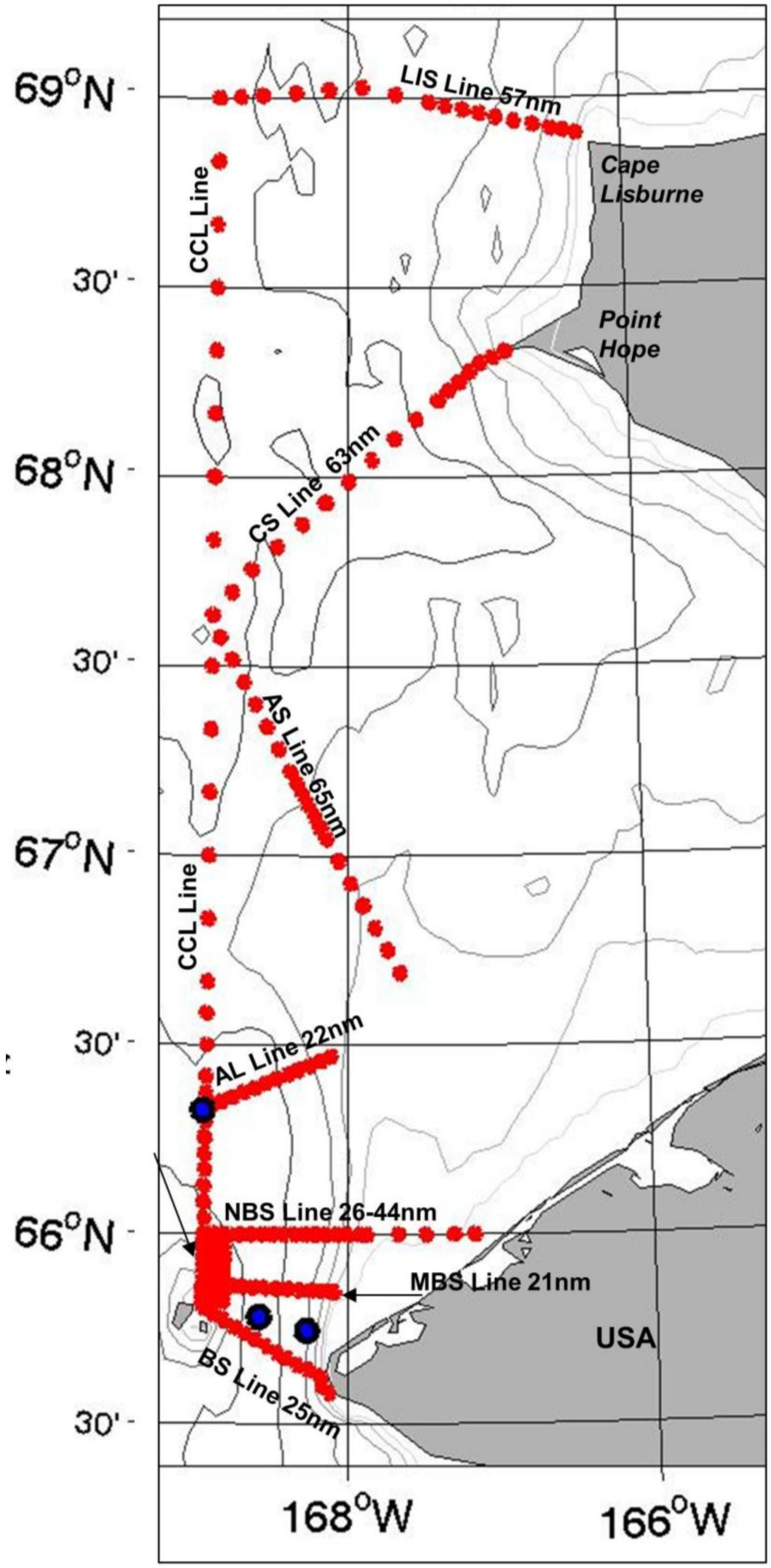


Figure 4: Bering Strait 2015 Plan with key distances in nautical miles (nm)



BS11 - DL1= 1nm
BS11 - MBSn1 = 4nm
BS11 - MBSn8 = 21nm
BS11 - NBS1 = 12nm
BS11 - NBS9 = 28nm
BS11 - A3 = 31nm
BS11 - Al24 = 45nm
BS11 - AS1 = 62nm
BS11 - CS10 = 110nm
BS11 - CS18 = 158nm
BS11 - CCL22 = 193nm

MBSn1 - NBS1 = 8nm

A3 - MBSn1 = 27nm
A3 - NBS1 = 20nm
A3 - AS1 = 38nm
A3 - CS10 = 79nm
A3 - CS18 = 128nm
A3 - LIS1 = 167nm
A3 - CCL22 = 161nm

CS10 - AL24 = 73nm
CS10 - LIS1 = 96nm
CS10 - CCL22 = 82nm

BERING STRAIT 2015 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate (F)	UW	*Chief Scientist and UW PI*
2.	Jim Johnson (M)	UW	*UW Mooring lead*
3.	Robert Daniels (M)	UW	*UW Undergrad-student*
4.	Max Showalter (M)	UW	*UW Grad-student*
5.	An Nguyen (F)	MIT	*MIT Co-PI*
6.	Kate Stafford (F)	UW	*UW Co-PI Marine Mammal moorings/observations*
7.	Melania Guerra (F)	UW	*UW Postdoc Marine Mammal moorings/observations*
8.	Maggie Buktenica (F)	OSU	*OSU Grad-student, Ocean Acidification moorings*

UW – University of Washington, US
MIT – Massachusetts Institute of Technology, US
OSU – Oregon State University, US

Dietary/Allergy issues:
Daniels = vegetarian
Stafford = vegetarian
Buktenica = vegetarian

EMERGENCY CONTACTS:
UW:
Pascal Schuback, International Travel Security Manager, Tel: 206-616-7927, Email: schuback@uw.edu
Dian Gay, APL Director of Resources, Tel: 206-543-1525, Email: dian@apl.washington.edu
CPS
CPS Main Office for Alaska Operations, Tel: 907-455-4214 (24hr paging service)
Anna Schemper, Cell: 907-978-1110, Email: anna@polarfield.com
Marin Kulzenga, Cell: 907-590-0755, Email: marin@polarfield.com
Elizabeth Kendal, Satellite Phones and Comms, Cell: 650-906-6982, Email: Elizabeth.Kendall@sri.com
Kim Derry, Remote Medical, Cell: 303-349-6382, Email: kim@polarfield.com

BERING STRAIT 2015 PRELIMINARY CRUISE SCHEDULE

Saturday 27th June 2015 — *Science Party arrives in Nome.*

Sunday 28th June 2015 onwards — *Science Party preps mooring gear in Nome at Northland Services*

Wednesday 1st July 2015 — Ship in Nome ?time? On load, sail by afternoon/evening

Likely order of work:

Mooring operations (~1-3 days + weather + issues)
- *Recover all moorings (dragging if necessary), with CTD casts pre recovery (likely order A4CTD, A4 recovery, A2CTD, A2 recovery, A3CTD, A3 recovery)*
- *Deploy all moorings, with CTD casts post deployment (likely order A3, A2, A4)*

CTD sections (rest of time)
- *CTD starting with BS line*

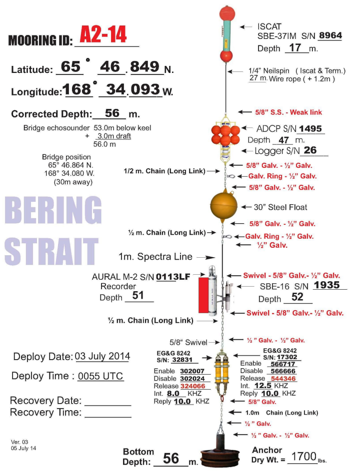
Thursday 9th July 2015 — Ship arrives Nome, off-load, clear ship by ?time? afternoon?

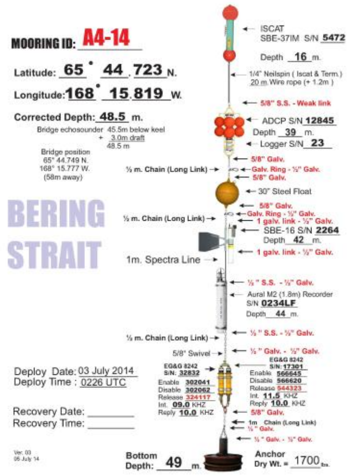
Thursday 9th July 2015 — *Science party leaves Nome on the 8:29pm Alaska Air flight.*

MOORING SCHEMATICS
(see appendix for positions and larger figures)

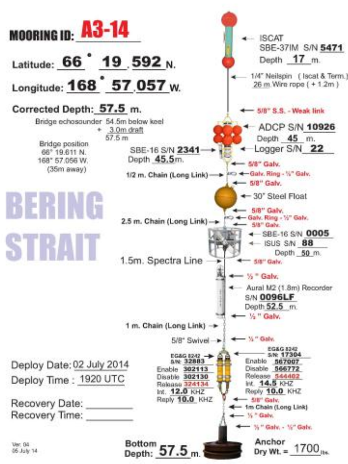
RECOVERIES

= in the eastern channel of the Bering Strait



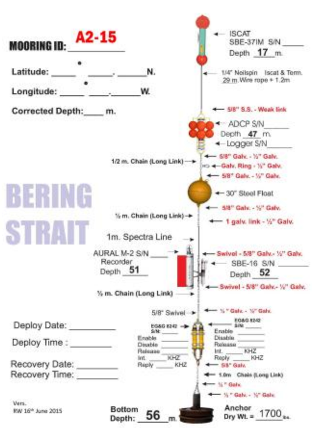


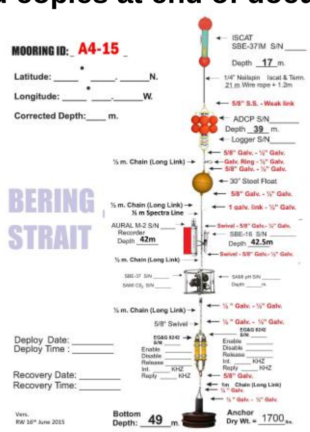
= at the climate site, ~ 60km north of the Strait

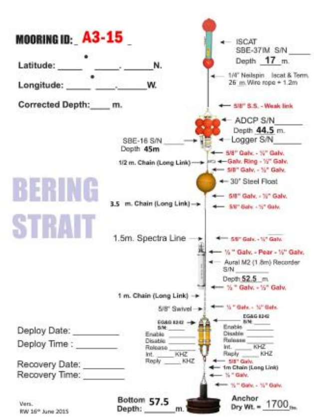


DEPLOYMENTS

(Full sized copies at end of document)







MOORING OPERATIONS

We anticipate mooring operations proceeding as last year (see 2014 cruise report at http://psc.apl.washington.edu/BeringStrait.html). All moorings carry acoustic releases which, on command, separate the mooring instruments from the anchor, allowing the mooring instruments to rise to the surface for recovery. If the acoustic release fails to release the mooring, then dragging operations will be required. **We understand the Norseman II is providing dragging grapples, etc., for such operations.**

Recovered moorings also contain instrumentation from Terry Whitledge, UAF.

CTD OPERATIONS

The CTD system to be used in 2015 is the same as that used in 2014. There is no water sampling rosette on this system. Indeed, no water samples will be taken during the cruise. The 2015 CTD package contains the following items:

- one Seabird SBE9+ instrument with pressure sensor (SN5915)
- two Seabird SBE3 temperature sensors (SN0843, SN0844)
- two Seabird SBE4 conductivity sensors (SN0484, SN0485)
- two Seabird SBE43 oxygen sensors (SN1753, SN1754)
- one Wetlabs FLNTURT fluoresence/turbidity sensor (SN1622)
- one Benthos Altimeter (SN50485)
- two Seabird pumps (SN0340, SN5236)
- one EG&G (ORE Offshore) Model D-CAT transponder (SN31892)

This is all housed in one frame, and will be connected to the new conducting cable winch on the Norseman II.

Once mooring work is completed, we would like to work 24hr CTD operations (weather permitting). Since there is no water sampling, we would like the Norseman II to provide all the manning necessary on deck for deployment and recovery of the CTD. The Science party will provide 24hr CTD console driving personnel (1 person per shift).

MARINE MAMMAL WATCH

When the marine mammal personnel are not engaged in mooring activities, they would like to maintain a bridge watch for marine life.

HAZMAT

None

OTHER POSSIBLE OPERATIONS

1) Glider deployment. Via a collaboration with Peter Winsor and Mark Baumgartner, Kate Stafford may wish to deploy a glider near A3 or CS10. The operation would consist of putting the glider over the side. No follow-up is required. This operation is still to be confirmed, and relies on several things, including the glider reaching Nome in a timely manner

2) Ocean Acidification water sampling at mooring site A4. Discussions are still on-going concerning the possible collection of a few water samples at moorings site A4, as calibration for moored ocean acidification sensors from OSU.

ISSUES STILL TO BE RESOLVED

Berthing – Woodgate to discuss with ship.

Planned time of arrival of ship into Nome at the start of the cruise (weather and schedule permitting)
Planned time of science clearing the ship in Nome at the end of the cruise.

APPENDIX – POSITION INFORMATION FOR BERING STRAIT 2015 CRUISE

```
%=========================================================
% Stations for BStrait Mooring Cruise 2015 NorsemanII
%=========================================================
%
% US-Russian convention line is at 168deg 58.7'W.
% All stations in this file are in US waters.
% (Let me know if any points are too close to border for you.)
%
% Time estimates are based on the 2013 NorsemanII cruise.
%=========================================================
%
%=========================================================
% *****   MOORING POSITIONS *****
%=========================================================
% In likely order of servicing, i.e.,
% - recoveries from east to west in strait, then northern site;
% - deployments northern site, the west to east in strait.
% == 3 moorings to recover
% == 3 moorings to deploy
%-----------------------------------------
% RECOVERIES of moorings deployed in 2014
%-----------------------------------------
%NAME        Lat(N)          Long (W)      Water   Top
%            deg min         deg min       depth   Float
% A3-14     66  19.59      168  57.06     58m     15m
% A2-14     65  46.85      168  34.09     56m     15m
% A4-14     65  44.72      168  15.82     49m     15m
%---------------------------------
% DEPLOYMENTS for this 2015 cruise
%---------------------------------
% Target same as 2012 positions.
%NAME      Lat(N)         Long (W)      Water
%          deg min        deg min       depth
% A3-15    66  19.61      168  57.05     58m
% A2-15    65  46.86      168  34.07     56m
% A4-15    65  44.75      168  15.77     49m
%
%-----------------------
% INTERMOORING DISTANCES
%-----------------------
% A2 - A4 ~ 8nm
%------------
% To A3 from
%------------
%   A2  - 34nm
%   A4  - 39nm
%-------------
% To Nome from
%-------------
%   A4 - 120nm
%   CS1 - 200-220nm
%=========================================================
```

```
%
%=========================================================
% *****   HISTORIC CTD SECTIONS *****
%=========================================================
% There are 11 historic CTD lines here.
% We may not have time for all of these, in which case
% we will do a subset.  But I've included
% them all, so you have the positions in advance.
% If operations/science dictate, then there
% might be different lines proposed while at sea.
%
% Naming is based on historic data.
% "+net" also refers to historic operations and
% is not relevant for this cruise.
% "no bottles" refers to historic operations and
% is not relevant for this cruise.  (No bottles
% will be taken on any CTD casts of the 2015 cruise.)
% Known Hazards are indicated.
%
% Stay a safe distance (300m?) from all deployed
% moorings.
%
% Except for around moorings or for mooring work,
% within 200m is ok for positions.
%
%======================================
% BS = Bering Strait Line (US portion)
%======================================
% - 15 stations
% - station spacing generally ~ 2nm
% Distances: - BS11-BS22 21.7nm
%            - BS22-BS24  3.1nm
% Total length 24.8nm
%--
% Time from NorsemanII, 6 hrs running W, 5 hrs running E
% Time from Khromov 10.5hrs
%-----------------------------------------------
% Lat (N) Long (W)   Lat (N)     Long (W)    Name
%                   deg min     deg   min
  65.805  168.933   65  48.31   168  55.96  % BS11
  65.788  168.860   65  47.26   168  51.62  % BS12
  65.772  168.794   65  46.33   168  47.64  % BS13
  65.755  168.721   65  45.28   168  43.29  % BS14
  65.739  168.663   65  44.35   168  39.80  % BS15
  65.722  168.591   65  43.29   168  35.46  % BS16 + net
  65.704  168.521   65  42.23   168  31.28  % BS17
  65.695  168 486   65  41.70   168  29.16  % BS17S
  65.686  168.449   65  41.18   168  26.94  % BS18
  65.672  168.391   65  40.35   168  23.44  % BS19
  65.655  168.318   65  39.29   168  19.09  % BS20
  65.642  168.250   65  38.53   168  14.97  % BS21
  65.625  168.177   65  37.48   168  10.63  % BS22 + net
  65.599  168.161   65  35.96   168   9.66  % BS23
  65.582  168.117   65  34.91   168   7.00  % BS24
```

```
%
%This might also be run at the extra high resolution
% of 2014, viz:
65.805     168.933    65   48.31 168   55.96 %     BS11
65.797     168.897    65   47.79 168   53.79 %     BS11J Jim
65.788     168.86     65   47.26 168   51.62 %     BS12
65.780     168.827    65   46.8  168   49.63 %     BS12AJ     AJ
65.772     168.794    65   46.33 168   47.64 %     BS13
65.764     168.758    65   45.81 168   45.47 %     BS13Z Zack
65.755     168.721    65   45.28 168   43.29 %     BS14
65.747     168.692    65   44.82 168   41.55 %     BS14J Jorin
65.739     168.663    65   44.35 168   39.8  %     BS15
65.731     168.627    65   43.82 168   37.63 %     BS15J Jack
65.722     168.591    65   43.29 168   35.46 %     BS16
65.713     168.556    65   42.76 168   33.37 %     BS16J Jim
65.704     168.521    65   42.23 168   31.28 %     BS17
65.695     168.486    65   41.7  168   29.16 %     BS17S Scotty
65.686     168.449    65   41.18 168   26.94 %     BS18
65.679     168.42     65   40.77 168   25.19 %     BS18J Joanne
65.672     168.391    65   40.35 168   23.44 %     BS19
65.664     168.355    65   39.82 168   21.27 %     BS19H Harry
65.655     168.318    65   39.29 168   19.09 %     BS20
65.649     168.284    65   38.91 168   17.03 %     BS20J John
65.642     168.25     65   38.53 168   14.97 %     BS21
65.634     168.214    65   38.01 168   12.8  %     BS21A Andy
65.625     168.177    65   37.48 168   10.63 %     BS22
65.599     168.161    65   35.96 168   9.66  %     BS23
65.582     168.117    65   34.91 168   7     %     BS24
%
%
%============================
% AL = A3 Line (US portion)
%===========================
% Hazards on this line:
% == First station on this line is at mooring A3-15, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-15 site.
%-----------------------------------------------------
% - 13 stations including cast at A3mooring site
% - station spacing ~ 1.9nm
% Distance: - A3 to AL24 = 22.2nm
% --
% Time from NorsemanII ~5.5hrs
% Time from Khromov ~9hrs
%-----------------------------------------------------
% Lat (N) Long (W)   Lat (N)      Long (W)     Name
%                    deg min      deg   min
   66.327  168.951   66  19.61    168   57.05  % A3-14
% *** Adjust this first position to be safe distance (300m?) from A3-15
   66.340  168.895   66  20.39    168   53.71  % AL13
   66.352  168.823   66  21.09    168   49.40  % AL14
   66.363  168.752   66  21.80    168   45.09  % AL15
   66.375  168.680   66  22.51    168   40.78  % AL16
   66.387  168.608   66  23.21    168   36.47  % AL17 + net
```

```
   66.399  168.536   66  23.92    168   32.16  % AL18
   66.410  168.464   66  24.63    168   27.84  % AL19
   66.422  168.392   66  25.33    168   23.53  % AL20
   66.434  168.320   66  26.04    168   19.22  % AL21
   66.446  168.249   66  26.75    168   14.91  % AL22 + net
   66.458  168.177   66  27.45    168   10.60  % AL23
   66.469  168.105   66  28.16    168    6.29  % AL24
%
%
%=========================================================
% CS = Cape Serdtse Kamen to Point Hope Line (US portion)
%=========================================================
% Hazards on this line:
% == Final station CS19 is shallow.  Check on
% modern charts to see if deep enough for NorsemanII.
% (this station was too shallow for the Khromov, but
% was ok for the NorsemanII in 2013).
%------------------------------------------------------------
% - 16 or 17 stations
% - station spacing ~ 5nm in the central Chukchi,
%                    ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%            - CS18 to CS19    2.2nm
%--
% Time from NorsemanII (toCS19) ~ 10.5 hrs
% Time from Khromov (toCS18) ~12hrs
%-----------------------------------------------------------
%     Lat (N)     Long (W)       Name
%     deg min     deg   min
0 0   67   38.1   168   56.0     % CS10US + net
0 0   67   41.7   168   48.1     % CS10.5  - no bottles
0 0   67   45.3   168   39.9     % CS11
0 0   67   48.9   168   29.4     % CS11.5  - no bottles
0 0   67   52.5   168   18.8     % CS12 + net
0 0   67   55.9   168    9.1     % CS12.5  - no bottles
0 0   67   59.3   167   59.4     % CS13
0 0   68    2.7   167   49.7     % CS13.5  - no bottles
0 0   68    6.1   167   39.9     % CS14 + net
0 0   68    9.1   167   30.7     % CS14.5  - no bottles
0 0   68   12.1   167   21.4     % CS15
0 0   68   13.6   167   16.8     % CS15.5  - no bottles
0 0   68   15.0   167   12.2     % CS16
0 0   68   16.6   167    7.6     % CS16.5  - no bottles
0 0   68   18.0   167    2.9     % CS17 + net
0 0   68   18.9   166   57.6     % CS18
0 0   68   19.9   166   52.3     % CS19 *** SHALLOW **
%                 CS19 too shallow for Khromov.
%
%
```

```
%==================================================
% DL = Diomede Line (US only, 1nm east of border)
%==================================================
% This line is to map eddying area north of the Diomedes
% - 19 stations
% - station spacing ~ 1nm in South,
%                   ~ 2.5nm in north
% Distance: - DL1 to DL19  28.7nm
%--
% Time from NorsemanII - 5.5 hrs running N; 9hrs running S
% Time from Khromov to DL19 ~10hrs
%---------------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg   min
0 0  65   49.28    168   56.2  % DL1
0 0  65   50.26    168   56.2  % DL2
0 0  65   51.23    168   56.2  % DL3
0 0  65   52.21    168   56.2  % DL4 + net
0 0  65   53.18    168   56.2  % DL5 - no bottles
0 0  65   54.15    168   56.2  % DL6
0 0  65   55.13    168   56.2  % DL7 - no bottles
0 0  65   56.10    168   56.2  % DL8
0 0  65   57.08    168   56.2  % DL9 - no bottles
0 0  65   58.05    168   56.2  % DL10
0 0  65   59.03    168   56.2  % DL11- no bottles
0 0  66    0.00    168   56.2  % DL12
0 0  66    2.55    168   56.2  % DL13- no bottles
0 0  66    5.10    168   56.2  % DL14
0 0  66    7.65    168   56.2  % DL15- no bottles
0 0  66   10.19    168   56.2  % DL16
0 0  66   12.74    168   56.2  % DL17- no bottles
0 0  66   15.29    168   56.2  % DL18
0 0  66   17.84    168   56.2  % DL19- no bottles
%
%
%==========================================
% DL A and B lines (Diomede A and B lines)
%==========================================
% These lines, with DL, form a grid to map
% eddying N of the Diomedes.
% - each line 12 stations
% - station spacing ~ 1nm
% Distances: - each line ~ 11nm
%--
% Estimate for NorsmanII for each line ~3.5hrs
% Time from Khromov for each line ~5hrs
%------------------------------------------
%     Lat (N)       Long (W)     Name
%     deg min       deg   min
% Northbound leg
0 0   65   49.30    168   52.2  % DLa 1
0 0   65   50.27    168   52.2  % DLa 2
0 0   65   51.25    168   52.2  % DLa 3
0 0   65   52.22    168   52.2  % DLa 4
```

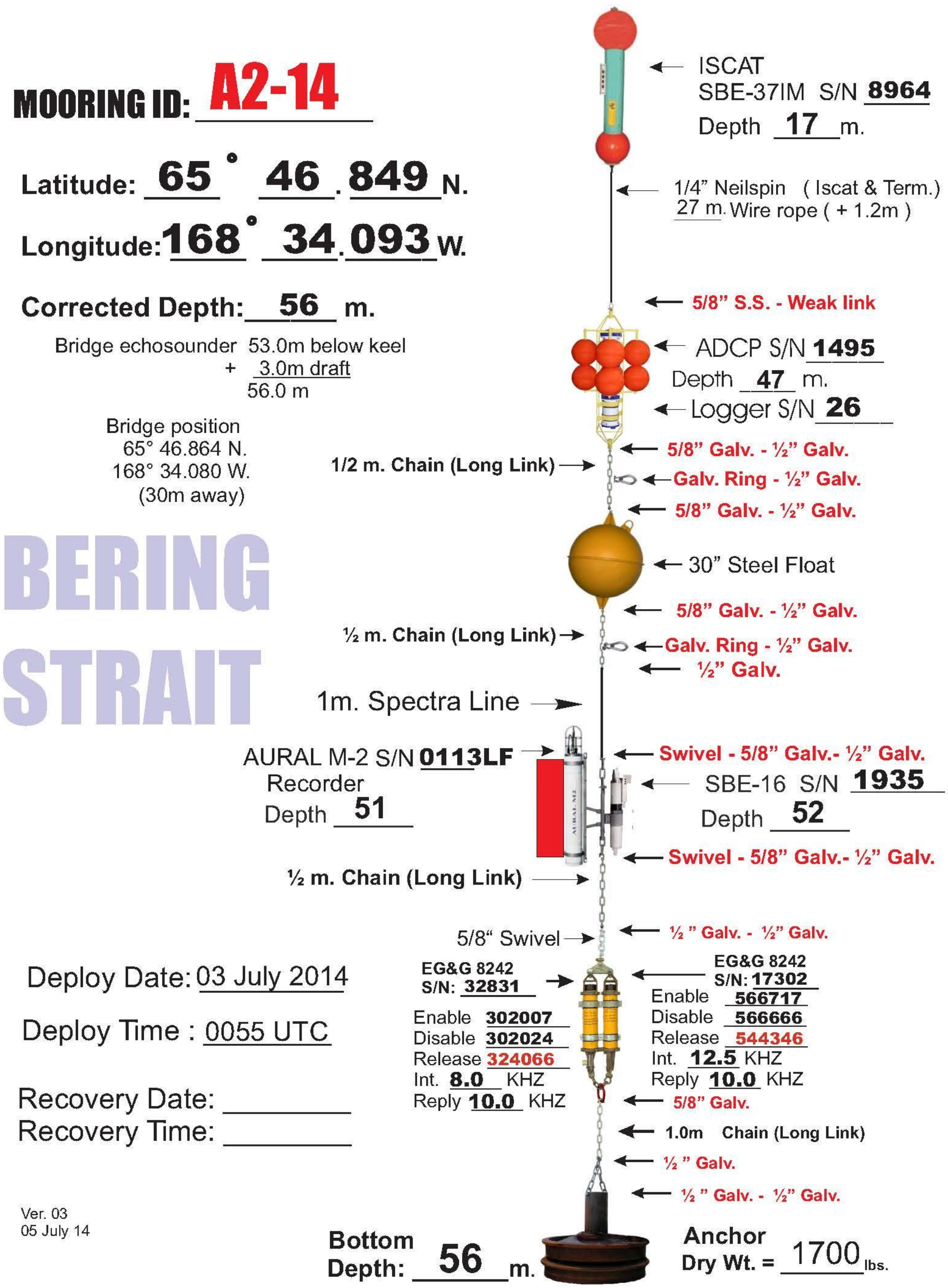
```
0 0   65   53.19    168   52.2  % DLa 5
0 0   65   54.16    168   52.2  % DLa 6
0 0   65   55.14    168   52.2  % DLa 7
0 0   65   56.11    168   52.2  % DLa 8
0 0   65   57.08    168   52.2  % DLa 9
0 0   65   58.05    168   52.2  % DLa 10
0 0   65   59.03    168   52.2  % DLa 11
0 0   66    0.00    168   52.2  % DLa 12
% Southbound leg
0 0   66    0.00    168   48.2  % DLb 12
0 0   65   59.03    168   48.2  % DLb 11
0 0   65   58.05    168   48.2  % DLb 10
0 0   65   57.08    168   48.2  % DLb 9
0 0   65   56.11    168   48.2  % DLb 8
0 0   65   55.14    168   48.2  % DLb 7
0 0   65   54.16    168   48.2  % DLb 6
0 0   65   53.19    168   48.2  % DLb 5
0 0   65   52.22    168   48.2  % DLb 4
0 0   65   51.25    168   48.2  % DLb 3
0 0   65   50.27    168   48.2  % DLb 2
0 0   65   49.30    168   48.2  % DLb 1
%
%
%============================================
% AS = from AL to CS Line
%============================================
% Across-topography line linking Al line with CS
% - 20 stations (counting first of CS line)
% - station spacing
%        AS1-7 at ~ 4nm spacing.
%        AS7-14 at 2nm spacing,
%        A14 to end 4nm
% Distances: - AS1 to CS10 64.7nm
%--
% Time from Khromov (12casts, odds+2&18) ~11hrs
% Estimate for NorsmanII 20 casts ~ 12hrs
% Estimate for Khromov 20 casts ~ 14hrs
%--------------------------------------------
%     Lat (N)        Long (W)       Name
%     deg min        deg   min
0 0   66   41.47     167   38.86   % AS 1
0 0   66   45.01     167   43.78   % AS 2-no bottles
0 0   66   48.55     167   48.70   % AS 3
0 0   66   52.09     167   53.62   % AS 4-no bottles
0 0   66   55.63     167   58.55   % AS 5
0 0   66   59.17     168    3.47   % AS 6-no bottles
0 0   67    2.71     168    8.39   % AS 7
%                           (2nm spacing over slope)
0 0   67    4.48     168   10.85   % AS 8-no bottles
0 0   67    6.25     168   13.31   % AS 9
0 0   67    8.02     168   15.77   % AS 10-no bottles
0 0   67    9.78     168   18.23   % AS 11
0 0   67   11.55     168   20.69   % AS 12-no bottles
0 0   67   13.32     168   23.15   % AS 13
```

```
0 0   67   16.86     168   28.07   % AS 14
%                          (back to 4nm spacing)
0 0   67   20.40     168   32.99   % AS 15-no bottles
0 0   67   23.94     168   37.92   % AS 16
0 0   67   27.48     168   42.84   % AS 17-no bottles
0 0   67   31.02     168   47.76   % AS 18
0 0   67   34.56     168   52.68   % AS 19-no bottles
0 0   67   38.10     168   56.00   % CS10US
%
%
%==============================
% LIS = Cape Lisburne Line
%==============================
% - 17 stations (including first of CCL line)
% - station spacing ~ 2nm near coast,
%              ~ 3nm and ~ 5nm away from coast
% Distances: - LIS1 to CCL22 57.2nm
%--
% Time from NorsemanII, ~ 10hrs
% Time from Khromov ~11hrs
%-------------------------------
%     Lat (N)        Long (W)     Name
%     deg min       deg   min
0 0   68   54.40    166   19.80  % LIS 1 + net
0 0   68   54.80    166   25.15  % LIS 2
0 0   68   55.20    166   30.51  % LIS 3
0 0   68   55.80    166   38.54  % LIS 4
0 0   68   56.40    166   46.57  % LIS 5
0 0   68   57.00    166   54.60  % LIS 6 + net
0 0   68   57.60    167    1.95  % LIS 6.5 - no bottles
0 0   68   58.20    167    9.30  % LIS 7
0 0   68   58.80    167   16.65  % LIS 7.5 - no bottles
0 0   68   59.40    167   24.00  % LIS 8
0 0   69    0.60    167   38.70  % LIS 9
0 0   69    1.80    167   53.40  % LIS 10 + net
0 0   69    1.35    168    7.95  % LIS 11
0 0   69    0.90    168   22.50  % LIS 12
0 0   69    0.45    168   37.05  % LIS 13
0 0   69    0.23    168   46.62  % LIS 14n + net
0 0   69    0.00    168   56.00  % CCL22n % was 56.2
%
%
%==============================
% CCL = Chukchi Convention Line
%==============================
% Hazards on this line:
% == First station on this line is the same as last station
% included in the LIS line above.  It does not need to be
% repeated.
% == Last station on this line is at mooring A3-14, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-14 site.
% == There are 2 JAMSTEC moorings ~ 3nm east of station
% CCL16 on this line.  Those positions are:
```

```
% SCH13  68 2.002N   168 50.028W
% SCH13w 68 3.006N   168 50.003W
%---------------------------------------
% Line running from northern most point
% due south, ~ 1nm US side of conventionline
% - 20 stations (counting arriving at A3-14)
% - station spacing ~ 10nm until CCL8,
%      then reducing to ~5nm and ~2.5nm
% Distances: - CCL22 to A3-13 ~ 161nm
%--
% Time from NorsemanII, 21.5hrs
% Time from Khromov ~26hrs
%----------------------------------------
%      Lat (N)        Long (W)      Name
%      deg   min      deg   min
0 0    69     0.0     168  56.0   % CCL22
0 0    68    50.0     168  56.0   % CCL21
0 0    68    40.0     168  56.0   % CCL20
0 0    68    30.0     168  56.0   % CCL19
0 0    68    20.0     168  56.0   % CCL18 + Net
0 0    68    10.0     168  56.0   % CCL17
0 0    68    00.0     168  56.0   % CCL16
0 0    67    50.0     168  56.0   % CCL15
0 0    67    38.1     168  56.0   % CCL14 (same as CS10US) + Net + Prod
%
0 0    67    30.0     168  56.0   % CCL13
0 0    67    20.0     168  56.0   % CCL12
0 0    67    10.0     168  56.0   % CCL11
0 0    67    00.0     168  56.0   % CCL10 + Net
0 0    66    50.0     168  56.0   % CCL9
0 0    66    40.0     168  56.0   % CCL8
%          - spacing now 5nm
0 0    66    35.0     168  56.0   % CCL7
0 0    66    30.0     168  56.0   % CCL6
0 0    66    25.0     168  56.0   % CCL5
%          - spacing now 2.5nm
0 0    66    22.3     168  56.0   % CCL4
0 0    66    19.61    168  57.05  % A3-13
% *** Adjust this position to be safe distance (300m?) from A3-13
%
%
%=======================================
% NBS - North Bering Strait line
%=======================================
% Hazards on this line:
% == Section crosses shallow waters.
% Beware of shallows from NBS9 and eastwards.
% (Helix diverted N to avoid shallows between
% stations NBS10 and NBS11)
% == Consider terminating line at NBS9
%-----------------------------------------
% Another cross strait line, run previously
% at lower resolution (i.e. without the 0.5 stations).
% - stations 9 (NBS1-9) to 16 (NBS1-9 with 0.5s)
```

```
%    to 21 (full section, including shallows).
% - station spacing (with 0.5s) ~ 1.7nm
% Distance: - NBS1-9  25.8nm
%           - NBS1-14 44.1nm
%--
% Time from Helix to NBS9, 9 casts ~5.5hrs
% - Estimate for NorsemanII to NBS9, 9 casts, 6hrs
% - Estimate for NorsemanII to NBS9, 16 casts, 7.5hrs
% - Estimate Khromov to NBS9, 9 casts ~6.5hrs
% - Estimate Khromo to NBS9, 16 casts ~8hrs
% Time from Helix to NBS14, 14 casts ~8.5hrs
% - Estimate for NorsemanII to NBS14, 14 casts, 9hrs
% - Esimate for NorsemanII to NSB14, 21 casts, 10.5hrs
% - Estimate Khromov to NBS14, 14 casts ~10hrs
% - Estimate Khromov to NBS14, 21 casts ~13hrs
%------------------------------------------
%      Lat (N)        Long (W)     Name
%      deg   min      deg   min
0 0    66     0.0     168  56.0   % NBS1 % was 58.1
0 0    66     0.0     168  53.0   % NBS1.5
0 0    66     0.0     168  49.9   % NBS2
0 0    66     0.0     168  45.8   % NBS2.5
0 0    66     0.0     168  41.6   % NBS3
0 0    66     0.0     168  37.4   % NBS3.5
0 0    66     0.0     168  33.2   % NBS4
0 0    66     0.0     168  29.1   % NBS4.5
0 0    66     0.0     168  25.0   % NBS5
0 0    66     0.0     168  20.7   % NBS5.5
0 0    66     0.0     168  16.4   % NBS6
0 0    66     0.0     168  12.4   % NBS6.5
0 0    66     0.0     168   8.4   % NBS7
0 0    66     0.0     168   4.2   % NBS7.5
0 0    66     0.0     168   0.0   % NBS8 - 34m water
0 0    66     0.0     167  55.1   % NBS9 - 20m water
%  (consider terminating line here)
0 0    66     0.0     167  52.0   % NBS10 - 12m water
% (Helix diverted N to avoid shallows between these stations)
0 0    66     0.0     167  40.1   % NBS11 - 15m water
0 0    66     0.0     167  29.1   % NBS12 - 18m water
0 0    66     0.0     167  18.1   % NBS13 - 13m water
0 0    66     0.0     167  10.2   % NBS14 - 10m water
%
%
```

```
%======================================
% MBSn = Mid Bering Strait line (new)
%======================================
% Just north of the Bering Strait line
% - 14 stations
% - station spacing 1.7nm, less near coast
% Distance: - 21.0nm total
%--
% Time from Helix (8casts only) ~2.5hrs
% - Estimate NorsemanII (8 casts only) ~ 4hrs
% - Estimate NorsemanII (14 casts)  ~ 6hrs
% - Estimate Khromov (8casts only)~5.5hrs
% - Estimate Khromov (14casts) ~7hrs
%-------------------------------------
%      Lat (N)        Long (W)     Name
%      deg   min      deg   min
0 0    65    52.1     168  56.0   % MBSn1 % was 57.0
0 0    65    52.0     168  52.5   % MBSn1.5
0 0    65    51.9     168  49.1   % MBSn2
0 0    65    51.8     168  45.0   % MBSn2.5
0 0    65    51.7     168  40.9   % MBSn3
0 0    65    51.6     168  36.4   % MBSn3.5
0 0    65    51.5     168  31.9   % MBSn4 % was 51.6
0 0    65    51.4     168  27.5   % MBSn4.5
0 0    65    51.3     168  23.0   % MBSn5 % was 51.4
0 0    65    51.2     168  18.5   % MBSn5.5
0 0    65    51.1     168  13.9   % MBSn6
0 0    65    51.1     168  10.4   % MBSn6.5
0 0    65    51.0     168   6.9   % MBSn7
0 0    65    50.9     168   5.0   % MBSn8
%
%
%=========================================================
%=========================================================
```


MOORING ID: A2-14
Latitude: 65 ° 46 . 849 N.
Longitude: 168 ° 34 . 093 W.
Corrected Depth: 56 m.
Bridge echosounder 53.0m below keel
+ 3.0m draft
56.0 m
Bridge position
65° 46.864 N.
168° 34.080 W.
(30m away)
BERING STRAIT
ISCAT
SBE-37IM S/N 8964
Depth 17 m.
1/4" Neilspin (Iscat & Term.)
27 m. Wire rope (+ 1.2m)
5/8" S.S. - Weak link
ADCP S/N 1495
Depth 47 m.
Logger S/N 26
5/8" Galv. - ½" Galv.
1/2 m. Chain (Long Link)
Galv. Ring - ½" Galv.
5/8" Galv. - ½" Galv.
30" Steel Float
5/8" Galv. - ½" Galv.
½ m. Chain (Long Link)
Galv. Ring - ½" Galv.
½" Galv.
1m. Spectra Line
AURAL M-2 S/N 0113LF
Recorder
Depth 51
Swivel - 5/8" Galv.- ½" Galv.
SBE-16 S/N 1935
Depth 52
Swivel - 5/8" Galv.- ½" Galv.
½ m. Chain (Long Link)
5/8" Swivel
½ " Galv. - ½" Galv.
Deploy Date: 03 July 2014
Deploy Time : 0055 UTC
Recovery Date:
Recovery Time:
EG&G 8242
S/N: 32831
Enable 302007
Disable 302024
Release 324066
Int. 8.0 KHZ
Reply 10.0 KHZ
EG&G 8242
S/N: 17302
Enable 566717
Disable 566666
Release 544346
Int. 12.5 KHZ
Reply 10.0 KHZ
5/8" Galv.
1.0m Chain (Long Link)
½ " Galv.
½ " Galv. - ½" Galv.
Ver. 03
05 July 14
Bottom Depth: 56 m.
Anchor Dry Wt. = 1700 lbs.

MOORING ID: A4-14

Latitude: 65° 44 . 723 N.

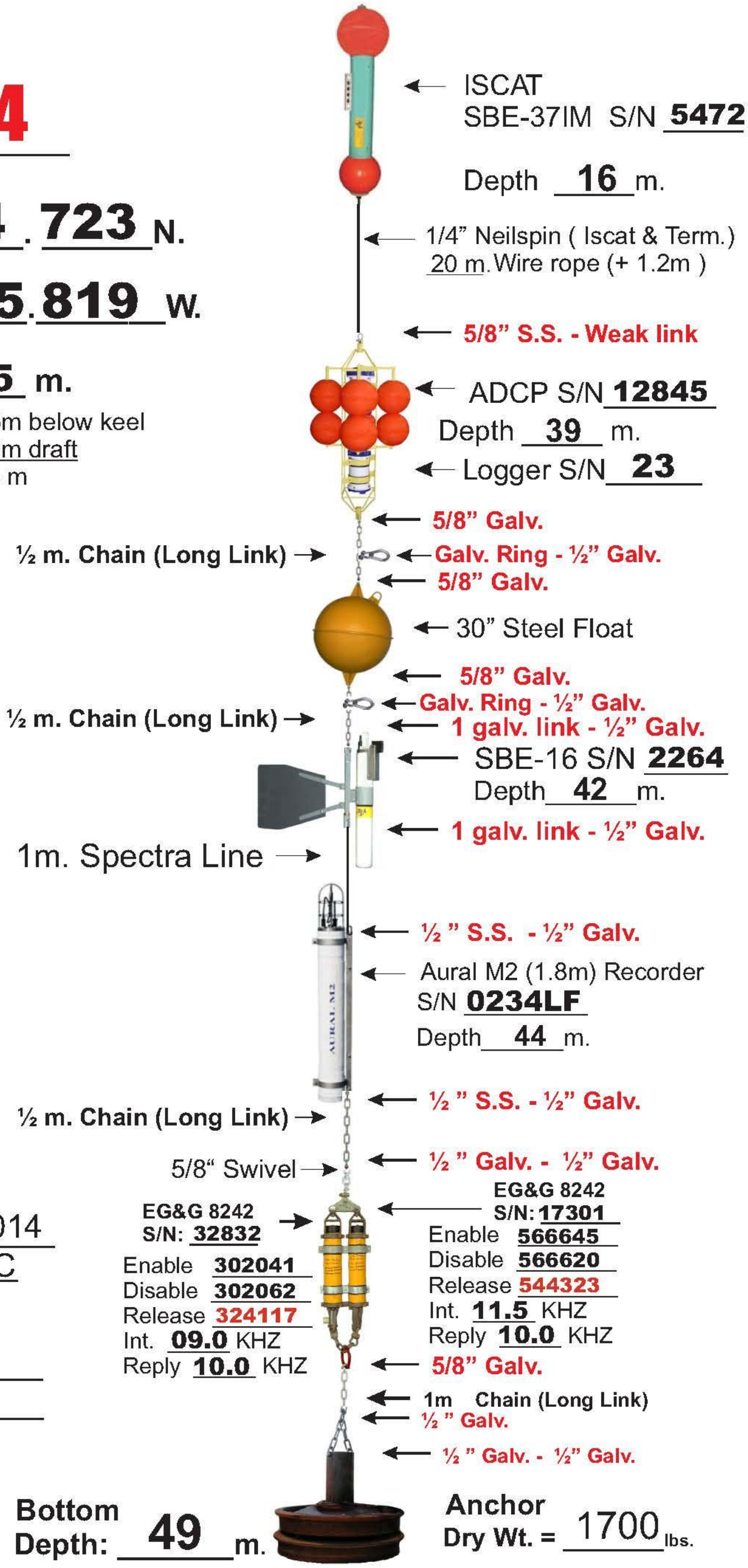
Longitude: 168° 15 . 819 W.

Corrected Depth: 48.5 m.

Bridge echosounder 45.5m below keel
+ 3.0m draft
48.5 m

Bridge position
65° 44.749 N.
168° 15.777 W.
(58m away)

BERING STRAIT



Deploy Date: 03 July 2014
Deploy Time : 0226 UTC

Recovery Date: ________
Recovery Time: ________

Ver. 03
05 July 14

MOORING ID: A3-14

Latitude: 66 ° 19 . 592 N.

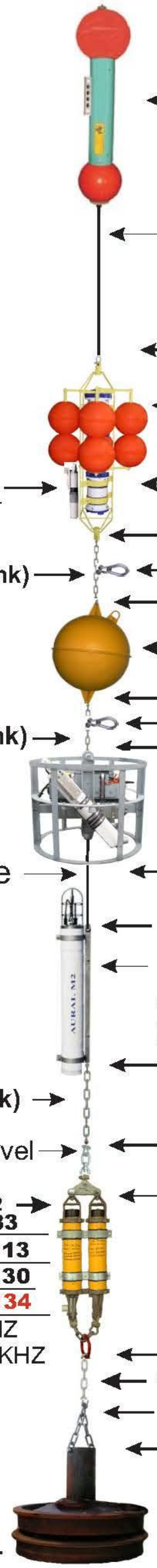
Longitude: 168 ° 57 . 057 W.

Corrected Depth: 57.5 m.

Bridge echosounder 54.5m below keel
\+ 3.0m draft
57.5 m

Bridge position
66° 19.611 N.
168° 57.056 W.
(35m away)

BERING STRAIT



Deploy Date: 02 July 2014
Deploy Time : 1920 UTC

Recovery Date: ________
Recovery Time: ________

Ver. 04
05 July 14

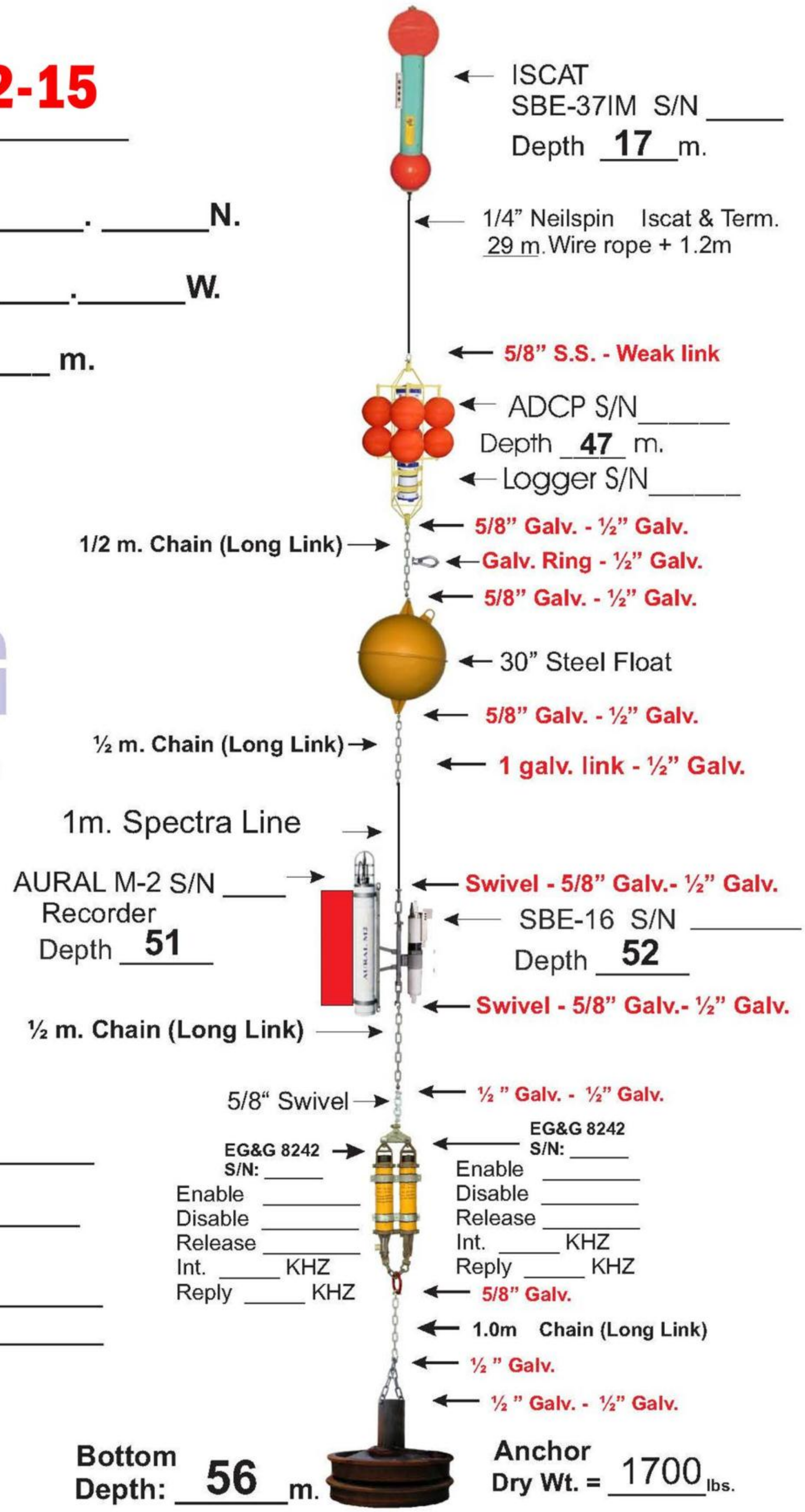
MOORING ID: A2-15

Latitude: _____ ° _____. ______N.

Longitude: _____ ° ____.______W.

Corrected Depth:____ m.

BERING STRAIT



Deploy Date: __________

Deploy Time : _________

Recovery Date: ________

Recovery Time: _________

Vers.
RW 16th June 2015

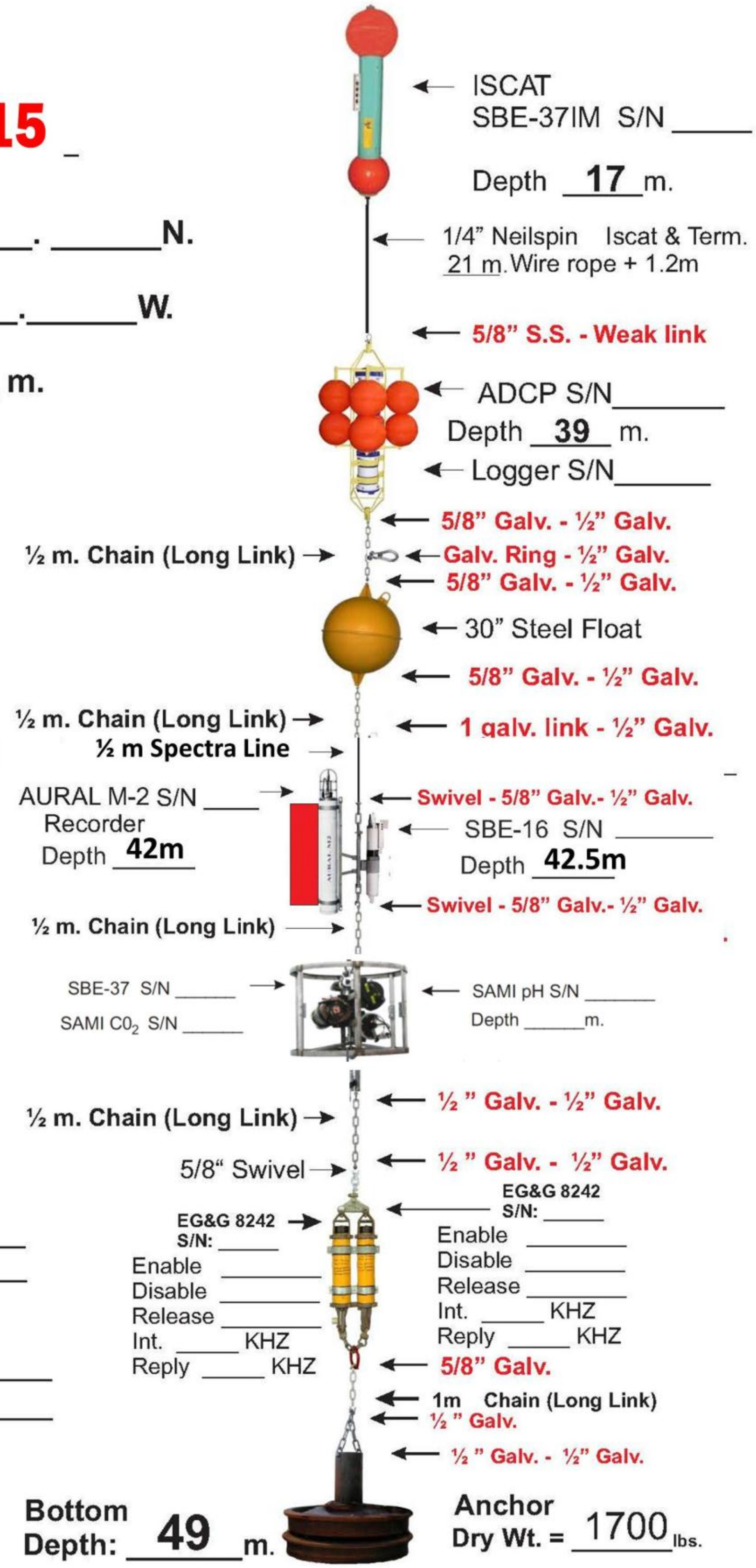
MOORING ID:_ A4-15 _

Latitude: _____ ° _____. ______N.

Longitude: _____ ° ____.______W.

Corrected Depth:____ m.

BERING STRAIT



Deploy Date: _________
Deploy Time : _________

Recovery Date: _________
Recovery Time: _________

Vers.
RW 16th June 2015

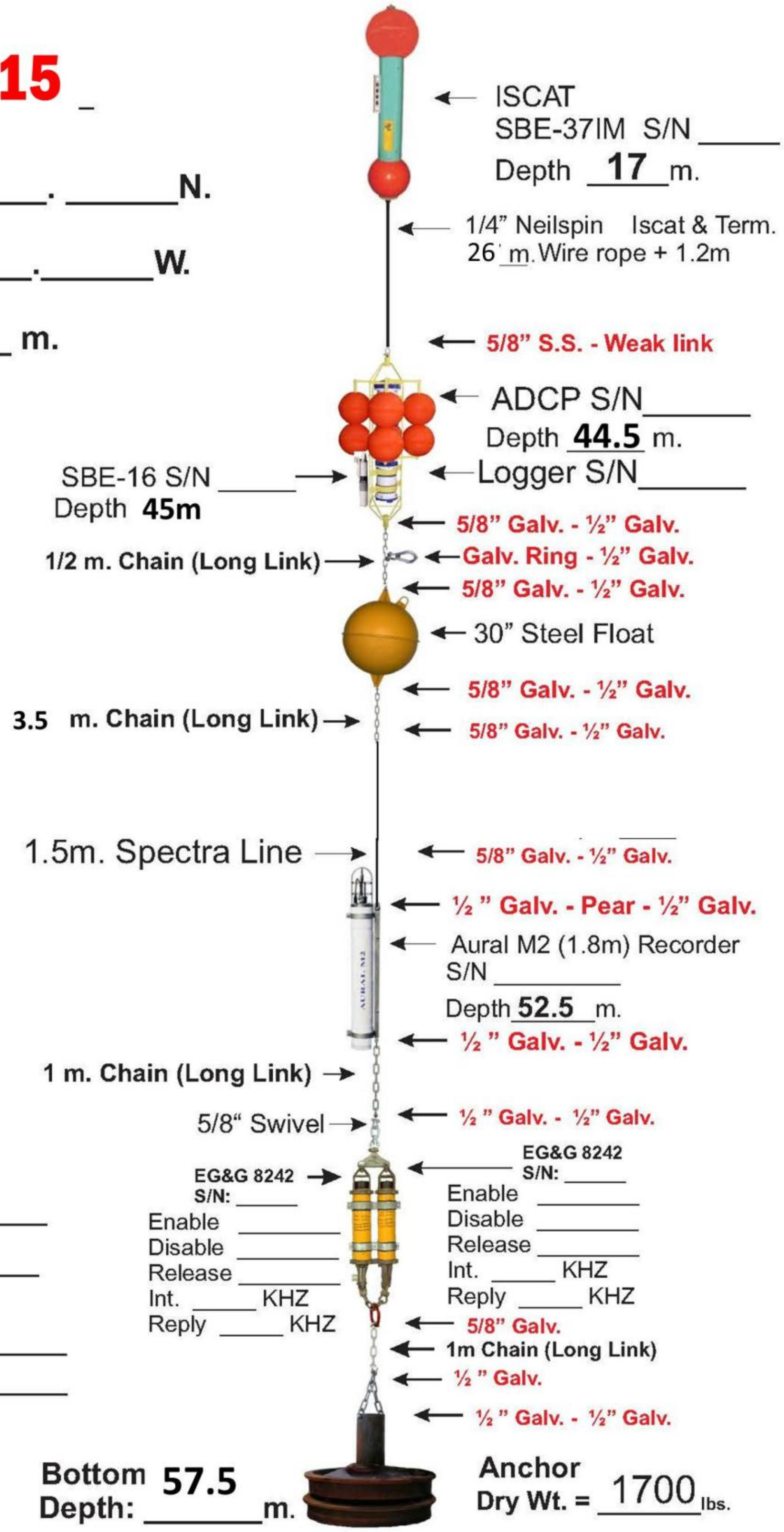
MOORING ID:_ A3-15 _

Latitude: _____ ° _____. ______N.

Longitude: _____ ° ____.______W.

Corrected Depth:____ m.

BERING STRAIT



Deploy Date: __________

Deploy Time : _________

Recovery Date: ________

Recovery Time: ________

Vers.
RW 16th June 2015

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