TEXAS A&M UNIVERSITY
DEPARTMENT OF OCEANOGRAPHY
COLLEGE STATION, TEXAS

ERS MOORING DEPLOYMENT CRUISE

ATMOSPHERE-ICE-OCEAN INTERACTIONS IN THE EASTERN ROSS SEA

expedition aboard ODEN

in the south Pacific Ocean

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and

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Field Project Overview

Four US science teams participated in this cruise in addition to sixteen Swedish collaborators.

History of, and Mechanisms Leading to, Post-LGM Retreat of the West Antarctic

The **Anderson ANT-0837925** project will investigate mechanisms that led to the retreat of the ice sheet from the West Antarctic continental shelf since the Last Glacial Maximum. The field season objectives include collection of swath bathymetry data within troughs, especially in locations where existing seismic data suggest the presence of grounding line wedges. These data will be integrated with existing bathymetry data to map key geomorphic features on the shelf within troughs, identify former grounding line locations, determine iceberg keel depths and determine core sites. Another objective is to collect Kasten cores in areas where geomorphic data indicated minimal iceberg turbation and/or where existing cores indicate the presence of carbonate sediments. Glacimarine sediments will be radiocarbon dated to constrain the timing of the ice sheet retreat from the shelf. New and existing sediment cores from Marguerite Bay and Pine Island Bay will be analyzed.

Measurement of Cosmic Ray Response Functions for an Ice Cherenkov Detector

The **Evenson ANT-0838838** project proposes to determine a complete set of cosmic ray response functions for the ice Cherenkov detector used in the surface air shower array that is part of the IceCube neutrino observatory now under construction at the South Pole. This would be accomplished by installing a detector mounted in a portable freezer van that would then be placed on the icebreaker ODEN. The van would transit from Sweden to McMurdo and then back to Sweden collecting data. One technician will accompany the detector at all times during the transits.

Ice Sheet Dynamics and Processes along the West Antarctic Continental Shelf

The **Nitsche ANT-0838735** project proposes to map and analyze the distribution of cross-shelf troughs along the West Antarctic continental margin. This will be accomplished using swath bathymetry during the ODEN's science mission from McMurdo Station to Punta Arenas, Chile in 2009/2010.

Atmosphere-Ice-Ocean Interactions in the Eastern Ross Sea

The **Orsi ANT-0839005** project will investigate what processes control the flow of warm Circumpolar Deep Water onto the Antarctic continental shelf in the eastern Ross Sea. This will occur using a moored time series deployed during the 09/10 ODEN cruise. Two moorings will be deployed to record current, temperature, salinity (conductivity) and pressure in the interior of the Sulzberger and Little America Troughs. High resolution conductivity/temperature/depth (CTD) measurements will be taken to characterize the summer regional water mass stratification and circulation and to describe the boundaries and spreading of water masses, infer their mixing histories and interactions with the sea-ice and continental ice. The moorings will be left out for one year and multiple options for retrieval have been discussed and will be decided upon once vessel schedules are agreed upon.

Moorings

Two moorings were deployed in the Little America Trough of the eastern Ross Sea. The moorings are identical in design and each consists of dual Benthos acoustic release, 3 Sea-Bird SBE-37 Microcats, and 2 Nortek Aquadopps 3000 (Figure 1). The acoustic releases were tested and armed using a Benthos Universal Deck Box UDB-9000M provided by the University of Gothenburg.

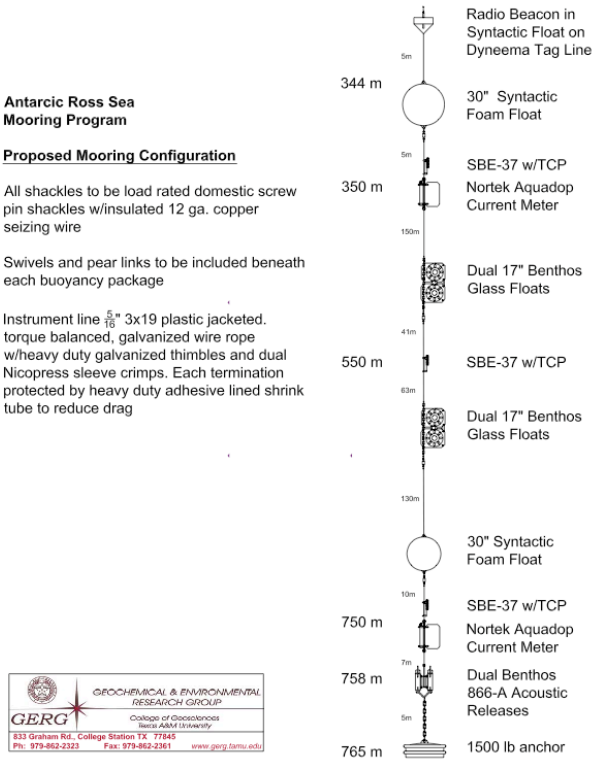

Figure 1: Schematic of mooring design.

CTD/LADCP measurements

Profiles of temperature, conductivity, dissolved oxygen, and currents were measured using equipment property of Texas A&M University. The basic CTD package consisted of a Sea-Bird Electronics SBE911+ CTD body and deck unit system fitted with dual ducted conductivity-temperature sensors paired with pumps, and a single SBE-43 dissolved oxygen sensor. A downward-looking Teledyne RD Instruments 300 kHz Workhorse Sentinel Lowered ADCP was used to profile currents. This instrument comes with its own internal compass and tilt sensors and was calibrated in McMurdo with the same battery pack used during the cruise. Water samples were drawn from 12 10-liter Niskin bottles using a 24-position SBE-32 Carousel sampler triggered through the Sea-Bird 11+ deck unit. To guide the approach to the ocean floor a Teledyne Benthos 200 kHz sonar altimeter was mounted on the lower frame of the rosette. Most profiles reached to within 10 m of the bottom.

CTD data were acquired and processed using Sea-Bird Seasave software, version 7.18c on a laptop computer running Windows XP Professional. Immediately after each

cast all CTD/LADCP raw data outputs were copied over to the ships network. Processed CTD data files were made available to all science staff generally within an hour of each cast completion.

Table 1: Details of the CTD 911+ sensor set.

Sensor	Serial number	Calibration date
Pressure (on SBE9 body)	40371	27-Feb-95
Temperature (SBE3)	783, 800	6-Jan-06
Conductivity (SBE4)	101, 382	6-Jan-06
Dissolved Oxygen (SBE 43)	431498	9-Sept-08

The surface pressure readings from CTD sensor was recorded on the log sheet before each deployment. The rosette was initially lowered to 10 meters for approximately 2 minutes to soak the CTD sensors, and after the pumps turned on and the oxygen sensor signal stabilized, it was returned to the surface before starting the actual cast. To best accommodate LADCP and CTD descent rates, the winch payout and hauling rate was 60 m/min for most of the down cast. On approaching within ~25 m off the bottom, as determined from altimeter, the winch was slowed to 30 m/min. On the way up, the rosette was stopped to close the Niskin bottles at depths selected during the down-cast to resolved main water column features. E.g. target levels included extreme values in T and S, regions with homogeneous layers for salt control, and layers near the sea surface and sea floor. Once on deck, water samples were collected from the Niskin bottles for salinity and oxygen-18 isotopes measurements. Salinity analysis was done primarily to standardize conductivity measurements derived from the CTD sensors. Analysis of oxygen-18 samples will be carried out at TAMU.

Salinity calibration:

118 water samples were drawn from the rosette for onboard analyses of salinity. Autosal Model 8400B provided by the University of Gothenburg located in highly a stable air-conditioned lab, was used for salinity measurements. Calibration was performed at the beginning of each run with batch P149 of IAPSO Standard Seawater from October 2007.

Error in salinity remained constant throughout the cruise (Figure 2). Salinity error, denoted as DeltaS, is reported as rosette salinity minus CTD salinity. Mean Delta S was --0.0099 with a standard deviation of 0.0066. For the estimation of this error, 112 points out of 118 (95%) were used. Points excluded were greater than 2 times the standard deviation of the mean error.

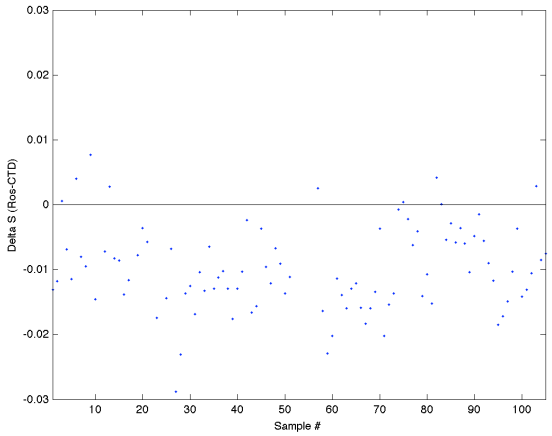

Figure 2: Salinity difference, DeltaS (Rosette-CTD), vs. Sample number for conductivity sensor.

Preliminary Results

Moorings

During this cruise we deployed 2 moorings in the Little America Trough of the eastern Ross Sea (Figure 3). The final location of each mooring was established at the ship GPS position when the anchor weight was slipped at the end of the deployment. XCTDs were launched within a mile of each mooring site. The moorings are to be retrieved in February 2011.

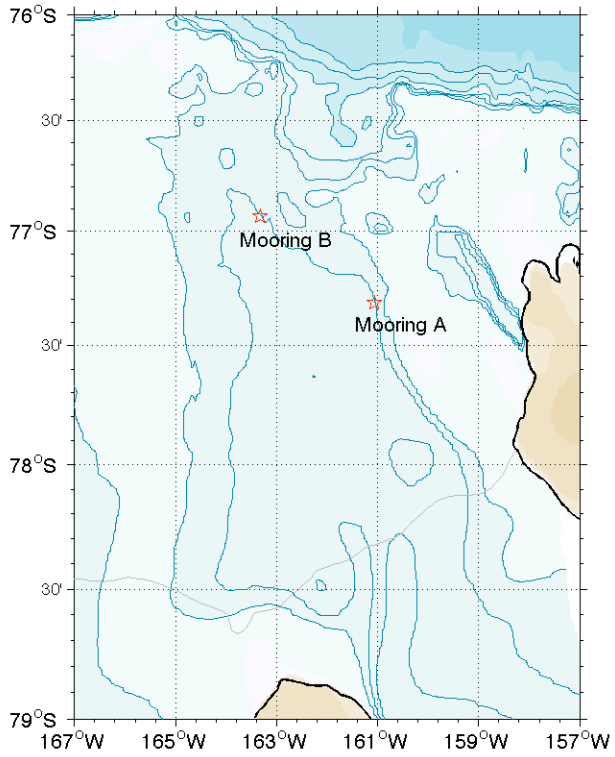

Figure 3: Locations of the two moorings in the Little America Trough.

Table 2: Mooring locations and details.

Mooring	Location	Location	Longitude	Date	Water Depth
A	Mid Little America Trough	-77.3169	-161.0682	10 Feb 10	656 m
B	Outer Little America Trough	-76.9347	-163.3263	10 Feb 10	602 m

CTD/LADCP

A total 10 CTD cast were occupied (Table 3, Figure 4) during this cruise in the main trough leading to Pine Island Glacier. CTD data from these casts confirm the inflow of relative warm and saline bottom water along this trough, as well as in Ferrero Bay.

While the rosette was at the sea surface during the first 3 casts, the pressure sensor on the CTD was reading -9 m. Because of this, the pressure offset in the configuration settings was increased by +9 m after station s003c1 to force the pressure at the sea surface to be approximately 0 m. The pressure sensor will be sent off for calibration upon immediate arrival at TAMU to investigate this offset.

Serious problems with the CTD winch reoccurred throughout the cruise. This resulted in multiple missed opportunities to collect key hydrographic (CTD/LADCP) data, in particular a broken winch prevented us from taking CTD stations at the mooring locations. Other missed opportunities were due to regular servicing of the CTD winch and the breaking of the hydraulics on the A-frame.

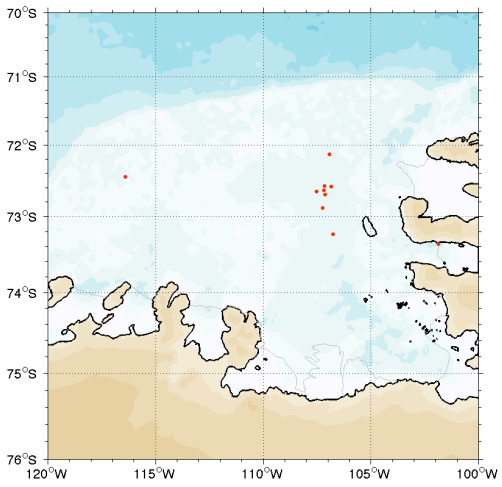

Figure 4. Locations of the CTD stations.

Table 3: CTD stations

Station	Location	Latitude	Longitude	Date	Depth m	CTD depth m
s001c1	UGOT mooring	-72.4480	-116.4179	15 Feb 10	557	311
s002c1	Pine Island	-72.6980	-107.1167	18 Feb 10	706	697
s003c1	Pine Island	-72.1346	-106.9356	18 Feb 10	596	586
s004c1	Pine Island	-72.5756	-107.1596	22 Feb 10	728	717
s005c1	Pine Island	-72.6397	-107.1743	22 Feb 10	738	728
s006c1	Pine Island	-72.6502	-107.5140	22 Feb 10	637	627
s007c1	Pine Island	-72.5873	-106.8324	23 Feb 10	702	694
s008c1	Pine Island	-73.3643	-101.8568	24 Feb 10	1186	1177
s009c1	Pine Island	-73.2363	-106.7478	27 Feb 10	790	781

s010c1	Pine Island	-72.8800	-107.2280	28 Feb 10	663	653

XBTs/XCTDs

XBTs/XCTDs were launched at sites where CTD stations were originally planned, or unobtainable due to weather, winch problems, and time constraints. In total, 127 XBT and 5 XCTD probes were launched (Table 4). XBTs were provided by TAMU, University of Stockholm, and Lamont Doherty Earth Observatory and XCTDs provided by University of Stockholm.

Table 3: XBT/XCTD locations

Date	Probe	Latitude	Longitude	Depth m
2/5/10	T-7	-77.7539	166.2408	168
2/8/10	T-5	-77.0770	167.5406	320
2/8/10	Deep Blue	-77.0424	168.8466	None
2/8/10	Deep Blue	-77.1284	173.8462	498
2/8/10	Deep Blue	-77.1560	175.4130	626
2/9/10	Deep Blue	-77.2419	179.0279	724
2/9/10	Deep Blue	-77.2745	-179.4930	651
2/9/10	Deep Blue	-77.3050	-177.4304	611
2/9/10	Deep Blue	-77.3359	-175.3890	549
2/9/10	Deep Blue	-77.3457	-173.9940	528
2/9/10	Deep Blue	-77.3541	-173.0863	509
2/9/10	Deep Blue	-77.3350	-171.7880	456
2/9/10	Deep Blue	-77.4092	-170.2621	542
2/9/10	Deep Blue	-77.4647	-166.4530	423
2/10/10	Deep Blue	-77.4929	-164.4911	493
2/10/10	Deep Blue	-77.4090	-162.4914	661
2/10/10	Deep Blue	-77.3974	-162.2987	646
2/10/10	Deep Blue	-77.3849	-162.0991	630
2/10/10	XCTD-1	-77.3283	-161.1269	629
2/10/10	T-5	-77.3283	-161.1269	648
2/10/10	Deep Blue	-77.3283	-161.1269	621
2/10/10	Deep Blue	-77.3283	-161.1269	581
2/10/10	Deep Blue	-77.1756	-161.4797	579
2/10/10	Deep Blue	-77.1402	-161.6013	570
2/10/10	Deep Blue	-77.1042	-161.7184	557
2/10/10	Deep Blue	-77.0665	-161.8350	540
2/10/10	Deep Blue	-77.0291	-161.9563	530
2/10/10	Deep Blue	-76.9911	-162.0866	528
2/10/10	Deep Blue	-76.9532	-162.2181	531
2/10/10	Deep Blue	-76.9508	-162.2254	531
2/10/10	Deep Blue	-76.9161	-162.4236	545
2/10/10	XCTD-1	-76.9167	-162.4783	550

Date	Probe	Latitude	Longitude	Depth m
2/10/10	Deep Blue	-76.9165	-162.5615	564
2/10/10	Deep Blue	-76.9165	-162.7342	577
2/10/10	XCTD-1	-76.9165	-162.9355	591
2/10/10	Deep Blue	-76.9161	-163.0445	579
2/10/10	XCTD-1	-76.9161	-163.1367	584
2/10/10	XCTD-1	-76.9243	-163.2718	596
2/11/10	T-7	-76.7014	-158.4054	308
2/11/10	Deep Blue	-76.6335	-157.0372	390
2/11/10	Deep Blue	-76.6335	-156.3859	742
2/11/10	T-5	-76.6458	-156.0754	617
2/11/10	Deep Blue	-76.5627	-154.8404	552
2/11/10	Deep Blue	-76.5532	-154.8325	587
2/11/10	T-5	-76.4771	-154.5950	539
2/11/10	Deep Blue	-76.2382	-153.8791	466
2/11/10	Deep Blue	-76.2313	-153.8513	595
2/11/10	Deep Blue	-76.1904	-153.6431	1926
2/11/10	T-5	-76.1220	-153.4518	2898
2/11/10	T-5	-75.6393	-151.8657	3417
2/12/10	T-5	-74.9523	-151.1089	3770
2/12/10	T-5	-73.8507	-150.6956	4097
2/12/10	T-5	-73.8466	-150.6897	4097
2/12/10	T-5	-73.8137	-150.6774	4111
2/13/10	T-5	-72.8510	-142.4203	4096
2/13/10	T-5	-72.8492	-142.3993	4096
2/15/10	T-5	-71.9717	-119.9747	1932
2/15/10	T-5	-71.9820	-119.9474	1905
2/15/10	T-5	-71.9849	-119.9446	1893
2/15/10	T-5	-71.9866	-119.9410	1885
2/15/10	T-5	-71.9954	-119.8719	1825
2/15/10	T-5	-72.0245	-119.6784	1627
2/15/10	T-5	-72.0826	-119.3965	1296
2/15/10	T-5	-72.1228	-119.2082	1052
2/15/10	T-5	-72.1671	-119.0080	782
2/15/10	T-5	-72.1990	-118.8977	532
2/16/10	T-7	-73.4528	-107.8999	669
2/16/10	T-5	-73.1271	-106.2034	631
2/16/10	T-5	-73.1365	-106.5095	658
2/16/10	T-5	-73.1571	-106.7914	766
2/16/10	T-5	-73.1795	-107.0957	782
2/16/10	T-5	-73.2014	-107.4019	757
2/17/10	T-5	-73.2197	-107.6945	662
2/17/10	T-7	-73.1858	-107.4070	747
2/17/10	T-7	-72.7834	-106.2390	528
2/18/10	T-7	-72.6572	-107.7164	583

Date	Probe	Latitude	Longitude	Depth m
2/18/10	Deep Blue	-72.5355	-107.6921	624
2/18/10	Deep Blue	-72.5201	-107.3832	662
2/18/10	Deep Blue	-72.5051	-107.0472	724
2/18/10	Deep Blue	-72.4933	-106.7619	671
2/18/10	Deep Blue	-72.4754	-106.4332	505
2/20/10	Deep Blue	-72.4818	-106.5810	963
2/20/10	Deep Blue	-72.3757	-106.9251	705
2/20/10	T-7	-72.3757	-106.9251	705
2/20/10	T-7	-72.4581	-106.9788	728
2/20/10	T-7	-72.4581	-106.9788	728
2/21/10	T-7	-72.4785	-107.1001	720
2/21/10	T-7	-72.4785	-107.1001	720
2/21/10	T-7	-72.6366	-107.2737	695
2/21/10	T-7	-72.6366	-107.2737	695
2/21/10	T-7	-72.6366	-107.2737	695
2/21/10	T-7	-72.3958	-106.6167	609
2/22/10	T-7	-72.5649	-107.2378	711
2/22/10	T-7	-72.5649	-107.2378	711
2/22/10	T-7	-72.5614	-107.2306	616
2/23/10	T-7	-72.6371	-106.9069	709
2/23/10	T-7	-72.6768	-106.8582	611
2/23/10	Deep Blue	-72.9824	-106.5716	618
2/23/10	Deep Blue	-73.0430	-106.3074	609
2/23/10	Deep Blue	-73.0474	-106.2848	611
2/23/10	Deep Blue	-73.1029	-105.9189	577
2/23/10	Deep Blue	-73.1054	-105.8872	570
2/24/10	Deep Blue	-73.2482	-105.6206	447
2/24/10	Deep Blue	-73.2684	-105.1541	398
2/24/10	Deep Blue	-73.3508	-104.5920	524
2/24/10	Deep Blue	-73.3887	-104.0534	627
2/24/10	Deep Blue	-73.3526	-103.5078	850
2/24/10	T-7	-73.4609	-102.7705	564
2/25/10	T-5	-73.4546	-102.0886	760
2/25/10	Deep Blue	-73.4384	-103.0218	752
2/26/10	T-5	-72.8352	-106.9035	652
2/27/10	T-5	-72.9435	-106.8545	662
2/27/10	T-5	-72.9702	-106.8434	671
2/27/10	T-5	-73.1165	-106.7777	734
2/27/10	T-5	-73.2398	-106.7521	792
2/28/10	Deep Blue	-72.8864	-107.2019	654
2/28/10	Deep Blue	-73.1575	-107.1797	763
3/1/10	Deep Blue	-71.9060	-104.3297	670
3/1/10	Deep Blue	-71.8579	-103.7090	744
3/2/10	Deep Blue	-71.8342	-103.3927	758

Date	Probe	Latitude	Longitude	Depth m
3/2/10	Deep Blue	-71.8307	-103.3465	735
3/2/10	Deep Blue	-71.8102	-103.0809	743
3/2/10	Deep Blue	-71.7874	-102.8100	535
3/2/10	Deep Blue	-71.7537	-103.0781	730
3/2/10	Deep Blue	-71.7095	-103.4544	689
3/2/10	Deep Blue	-71.6772	-103.7351	638
3/2/10	Deep Blue	-71.6314	-104.1196	626
3/3/10	Deep Blue	-70.8295	-94.8437	510
3/3/10	Deep Blue	-70.6146	-94.6144	693
3/3/10	T-5	-70.5806	-94.5773	925
3/3/10	T-5	-70.5473	-94.5420	1114
3/3/10	T-5	-70.5048	-94.4971	1428