Ian Turnbull, Ryan Crawford, and Erik Veitch

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MUN Team Activities at UNIS

As part of the SITRA project collaboration between MUN and UNIS, a team of three people from MUN travelled to Svalbard during April 17 – May 3, 2017 to participate in a week of lectures and the Barents Sea ship cruise portion of the UNIS course Arctic Technology (AT) – 211: Ice Mechanics, Loads on Structures and Instrumentation, which is led by Dr. Aleksey Marchenko, Professor of Ice Mechanics. During April 18-21, Dr. Ian Turnbull delivered four guest lectures to the students on a range of topics including: a brief history of ice and ocean dynamics science, sea ice drift patterns in the Arctic Basin and sub-Arctic regions, physics and models of sea ice dynamics, operational sea ice observation and drift forecasting, sea ice management and icebreaking, physics and energy balance models of sea ice thermodynamics, iceberg formation and source regions, iceberg drift patterns, models of iceberg deterioration, physics and models of iceberg dynamics, operational iceberg observation and drift forecasting, iceberg management and towing, field instrumentation to be used during the Barents Sea cruise and analysis of the measurements, and finally, a brief introduction to models of waves in sea ice. In addition to providing the students with a broad overview of the science of sea ice and iceberg dynamics, the lectures allowed Dr. Turnbull to share some of his own research and results in this area of study with the students, and prepared the students for many of the activities which would take place during the Barents Sea field cruise.

Barents Sea Cruise aboard the MV Polarsyssel

During April 22-30, the MUN team participated in the Barents Sea research cruise aboard the MV Polarsyssel and assisted Dr. Marchenko with a number of the field activities which were part of the AT-211 course, as well as carried out additional activities which were beyond the scope of the course. For the on-ice work, the science team led by Dr. Marchenko selected a sea ice floe approximately 4m thick and about 40m×25m in horizontal plan dimensions, with a significant pressure ridge along one edge of the floe. Work was carried out on this floe during April 24-26. The floe drifted through a broad range of surrounding sea ice concentration and average thickness regimes during this two-day period, and was in about 100m water depth.

The MUN team focused on assisting Dr. Marchenko with the deployment and recovery of instruments which measured the ice floe drift, surface wind speed and direction, ocean temperature, and horizontal (currents) and vertical ocean motion. This included the deployment of satellite-linked ice tracking buoys, an anemometer, an Acoustic Doppler Current Profiler (ADCP), an Acoustic Doppler Velocimeter (ADV) with a Sea-Bird for measuring seawater temperature, and a wave buoy which measured ice floe heave response to waves. The ADV, Sea-Bird, and ADCP recorded data internally. Ian Turnbull and Erik Veitch also assisted the Autonomous Underwater Vehicle (AUV) team led by Dr. Peter Wadhams with the deployment and recovery of this instrument, which was used to obtain data on the geometry of the underside of the sea ice.

The MUN team brought with them from Canada eight small ice tracking buoys contained in waterproof pelican cases. These buoys were designed to be deployed by hand on the surfaces of ice floes, and transmitted time and latitude-longitude coordinates every 30 minutes via Iridium satellite to a remote server. They had enough battery power to last about one month. The MUN team deployed two of these buoys at opposite ends of the longer axis of the main on-ice work floe, such that both ice drift and floe rotation data could be obtained. An additional two tracking buoys were deployed on another ice floe by Erik Veitch, via small boat. The remaining four other buoys were each deployed on an ice floe. The goal of the MUN team's deployments of the eight ice tracking buoys was to obtain data to study the drift patterns, rotation, and dispersion of the ice floes within the pack, as well as the metocean forcing mechanisms (*e.g.*, wind, ocean current, sea surface tilt, internal ice stress, and Coriolis) driving the dynamics of the floes. Another major goal of the ADV and Sea-Bird deployment was to infer the upward ocean heat flux into the base of the ice floe, as these instruments measure vertical ocean water velocity and seawater temperature fluctuations, respectively.

The 40m×25m ice floe selected for on-ice work during the Barents Sea cruise. The floe was allowed to drift freely during the overnight hours when the vessel would unmoor from the floe and follow it until on-ice work recommenced the following morning. One of the MUN team's small gray pelican case ice tracking buoys can be seen deployed on the extreme right-hand side of the floe in the photograph. The red poles mark locations at which the students drilled holes to measure ice thickness. Note the pressure ridge along the closer edge of the floe in the photograph.

A close-up of one of the MUN team's pelican case ice trackers deployed near one edge of the main on-ice work floe. The ice trackers were secured to the ice with an ice screw.

Erik Veitch deploying two of MUN's ice trackers on both ends of the longer axis of this ice floe, so that floe rotation can be measured in addition to drift. The small boat which transported Erik can be seen on the extreme left-hand side of the photograph. This floe was about 15m×10m in horizontal plan dimensions, and about 1.5m thick.

An ice tracking buoy with an anemometer deployed on one end of the main on-ice work floe. This buoy belonged to Dr. Marchenko, and Ian Turnbull and Ryan Crawford assisted with its deployment. This buoy transmitted time, position, and wind speed and direction every 10 minutes via satellite.

Dr. Marchenko's ADV and Sea-Bird were deployed hanging over the edge of the main on-ice work floe in the water, and were secured to a post in the ice via a metal wire. A battery and data-recording computer (yellow cylinder) are shown connected to the ADV and Sea-Bird. Dr. Marchenko's ADCP (not shown) was deployed in a similar fashion. Ian Turnbull, Ryan Crawford, and Erik Veitch assisted Dr. Marchenko with the deployment and recovery of the ADV and ADCP.

Measurement of Ice Response to Wave Propagation

The MUN team and Dr. Marchenko coordinated with Jean Rabault, a PhD student at the University of Oslo, to deploy Mr. Rabault's 10 Inertial Motion Units (IMUs) during the Barents Sea cruise to measure the dynamic response of sea ice to wave propagation through the ice pack. The IMUs were accelerometers contained in small pelican cases, and were deployed on the surface of the ice, similar to MUN's ice trackers. One of these IMUs was deployed on the main on-ice work floe during April 24-26, and was subsequently retrieved. Another IMU was deployed on one of the floes on which one of MUN's ice trackers was deployed, but the floe subsequently drifted too far away from the vessel and could not be retrieved. The IMUs recorded time, motion, and Global Positioning System (GPS) position data internally on SD cards but did not transmit the data via satellite. On April 29, the vessel arrived at the terminus of the Sveabreen tidewater glacier to the north of Longyearbyen, and the MUN team, Dr. Marchenko, Peter Chistyakov, and Sebastian Sikora carried out an experiment on 6cm thick nilas ice which extended out from the glacier terminus.

The remaining eight IMUs were placed along the edge of the nilas ice, with four of the units placed about 1m further inward past the ice edge, and four along the outer edge. The four pairs of IMUs were placed about 15m apart from one another. The team then had the small boat from which the units were deployed drive along the ice edge so as to force wave propagation into the ice edge from the boat wake. When the ice edge began to break and the units began to drift, they were retrieved. The goal of the experiment was to measure the energy required to break the ice edge. The water depth was approximately 70m-80m, so the waves were deep-water waves. The ice internal temperature (-2°C), salinity, and flexural strength were also measured, as well as the water temperature directly beneath the ice (-1°C).

A sheet of 6cm thick nilas ice extends from the terminus of the Sveabreen glacier on April 29. Eight IMUs were deployed along the ice edge to measure the characteristics of waves sent propagating into the ice edge from the small boat wake, until the ice edge broke and the IMUs drifted free.

Conclusions and General Impressions

Upon returning to UNIS, the MUN team helped to download and organize data from the ADV, ADCP, and IMUs. The MUN team thoroughly enjoyed their collaboration with the UNIS team through the SITRA project. The graduate students, Erik and Ryan, both had their first experiences with High Arctic field work and learned a great deal through this experience. Both of them and Ian Turnbull all hope to return to UNIS in the future for further field work and collaboration with UNIS researchers.