Observations to support industry needs for sea ice information and predictions

- Statement for the 3rd Arctic Observing Summit -

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A key rationale for ocean observing is to support real-time data products and forecasts for stakeholders (Calder et al., 2013). A wide range of practitioners are dealing with sea ice as part of their profession. Users include planners, managers and mariners on ships and offshore platforms. In this context sea ice information and predictions are used to make both strategic and tactical decisions. Aligning observing systems with stakeholder desired outcomes (data and forecast products) is a challenge; moving towards this goal, the first step is a clear understanding of stakeholder needs.

The needs of the offshore oil and gas and shipping industries summarized in this statement are based on a series of interviews with key industry stakeholders in Canada that were conducted by Adrienne Tivy and a 2-day workshop with Canadian Coast Guard icebreaker captains organized by Chris Petrich. As part of the Sea Ice Prediction Network (SIPN) project and to help meet the mandate of the Canadian Ice Service, key industry stakeholders are being interviewed to understand what sea ice information and forecasts are needed to inform decisions. Eight sea ice experts have been interviewed so far and were drawn from oil and gas companies (Husky, Chevron), shipping (FEDNAV, retired coast guard captains) and industry consultants with over 25 years of experience. The workshop was part of the network on Safe and Economic Operations in Seasonally Sea Ice-Covered Waters (OpSIce). Two icebreaker captains and nine researchers from five countries with Arctic interests participated in the workshop where a presentation of tactical challenges during operations at sea was followed by discussions in break-out groups that focussed on information needs in specific situations. Interviews and the workshop addressed user needs for ice information and forecasts, and the workshop also covered the translation of observations into practical products.

Sea ice information and predictions: desired outcomes

The most common desired outcome that emerged from these discussions is information and predictions related to trafficability in sea ice. Whether or not the ice cover is easy or difficult to navigate will obviously depend on the ice class of the ship but with respect the icescape there are two key parameters that emerged from the discussions that are often not considered: ice strength and ice pressure**.** There was a consensus that ice strength and ice pressure are as important, in some instances more important, than ice thickness and ice type.

To inform tactical decisions all users wanted as much detailed information as possible regarding the surrounding icescape and any predicted changes. The exact forecast lead time and spatial scale depended on the type of operation but in general 24-48 hours forecasts within the area of operation are required. It was acknowledged by most that good information is available for current ice conditions from government ice services. For short-term ice forecasts, most practitioners generated them in-house and reported good accuracy.

To inform planning decisions users wanted forecasts on much longer lead times, the length of the time is strongly dependent on the particular planning decision. For example forecasts of ice conditions along shipping routes 3-5 weeks in advance could trigger the decision to add another ship transit at the end of the season. Longer terms forecast on the order of months would impact ice management resource planning for offshore oil and gas platforms i.e. severity of the ice season will dictate how many icebreakers to have on stand-by. In general accurate and detailed forecasts are highly desired for planning purposes but there was a general acknowledgement that it is a challenging problem and may reach beyond the limits of predictability.

Key sea ice parameters: ice concentration (tactical/planning), ice type (tactical/planning), ice thickness (tactical/planning), ice strength (tactical), ice pressure (tactical), ice deformation and ice drift (tactical), break-up and freeze-up (planning), length of open water season (planning), floe size (tactical)*

*floe size came up as a key sea ice parameter for ice management, targeted icebreaking around a ship or platform to reduce the severity of ice conditions

Comments on observations

It was generally acknowledged that the cost of observing in the Arctic is a barrier but that observation efforts should target areas with high shipping/industry activity.

Using observations to inform tactical decisions often requires now-casting, particularly when it comes to satellite data products where there is latency up to a few hours. The lack of tools available for now-casting recent observations became one of the themes of the workshop. The usefulness of observations with latency could be greatly enhanced with *in situ* observations to assist in now-casting. The scientific challenge is similar to short-term ice forecasting.

A suggestion for an observing system experiment (OSE) (e.g. Fairell et al., 2013) that came out of the discussions is to assess the benefit of assimilating industry (ship/platform) met-ocean data into coupled models to provide short-term, high resolution sea ice forecasts that meet industry user needs. Although discussions of an observation strategy to support the desired outcomes for ice information and ice forecasts was well beyond the scope of the interviews and the workshop, many practitioners suggested that short-term sea ice forecasts, similar to short-term weather

forecasts, could be generated by government agencies for their area of interest and would likely be accurate if they assimilated local observations. Many practitioners are generating their own short-term sea ice forecasts to inform tactical decisions. These forecasts are generated by looking at the impact of weather on sea ice over the past few days and using the weather forecast to predict into the future. The degree of complexity ranges from simple numerical modeling, using some form of the momentum equation for sea ice with data assimilation (nudging) of *in situ* observations, to more heuristic approaches. All practitioners who reported generating short-term forecasts also reported good accuracy.

Calder, J. et al. (2010). "An Integrated International Approach to Arctic Ocean Observations for Society (A Legacy of the International Polar Year)" in *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 2)*, Venice, Italy, 21-25 September 2009, Hall, J., Harrison D.E. & Stammer, D., Eds., ESA Publication WPP-306.

Fairall, C., *et al.*, 2013: Observational Aspects of the WWRP Polar Prediction Project. *Proceed. Arctic Observing Summit*, Vancouver, CA, 30 April – 2 May.