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Arctic Regional Hydrographic Commission (ARHC)
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Continuous Vertical Datum Solution for Canada's Arctic Waters

Submitted by:	Canada,
Executive Summary:	The Canadian Arctic is vast and has not been serviced at optimal levels in regards to the long-term monitoring or modelling of tide and water levels. Using traditional permanent water level station networks in the North with the remote access and the harsh weather conditions makes the physical infrastructure investment less attractive than a modelled vertical separation model from the geoid. CHS is investing in this approach and shares its experiences and project goals as information for the ARHC membership.
Related Documents:	none
Related Projects:	**The Canadian Hydrographic Continuous Vertical Datum: Methodology and Accuracy** http://www.hydrography.ca/assets/files/2012conference/Robin_CHC2012.pdf

Introduction / Background

The Continual Vertical Datum (CVD) project's primary goal is to develop continuous separation surfaces (SEPs) between traditional Hydrographic datums, such as Chart Datum, and Canadian Spatial Reference Systems (e.gNAD83(CSRS)). These SEPs will interconnect the CHS's existing array of individual datums already established at all CHS tide stations. However, for these new SEPs to be accurate representations their behaviours must reflect the variations in the geoid, tidal dynamics, and dynamic ocean topography that exist throughout the space between the tide stations.

Analysis/Discussion

In July 2013, the first version of the Arctic geographic region was calculated and is now in a validation phase showing promising results in the test areas examined to date. The epoch of this datum is currently January 1, 2010, in line with version 6 of NAD83(CSRS) and the ITRF2008 reference frames. The datum currently has approximately 300 control stations with 45 of those having a complete set of GPS observations to accompany it. These stations have been collected throughout the years in a very opportunistic manner, usually a sub-project of an occurring hydrographic survey in a particular area. Starting in 2013, there has been increased effort and resources in the Arctic to focus on data collection to densify the model control as well as validate the first calculated version in

the form of dedicated 1 year tide gauge deployment and GPS observation campaigns to tie in as many datum benchmarks as possible. There are scheduled to be 8 one year gauge deployments and as many as 15 GPS observation campaigns. This does not sound high, but given the vast area and the logistics of working in the Arctic this is a remarkable amount of work. Figure 1 shows a gridded representation of the Arctic Continuous Vertical Datum (V1).

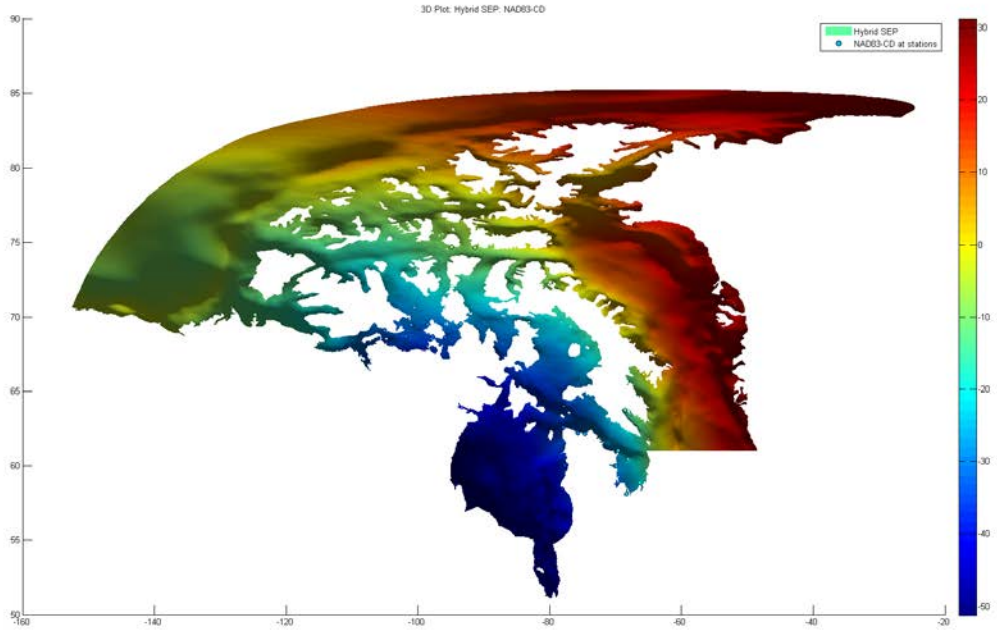

Figure 1: Version 1 Arctic Continuous Vertical Datum. The graphic shows the gridded separation, in metres, between GRS80 ellipsoid (for what the NAD83(CSRS) reference frame is based on) and the chart datum target of Lower Low Water Large Tide (LLWLT). A separation of -50m implies that the Chart Datum is 50 metres below the ellipsoid. Future surveys would collect their survey data referenced to the ellipsoid, and in a one step process be able to transform this data directly to chart datum anywhere in the Arctic.

Project Outlook

Over the next two to three years, the increased acquisition effort is planned to continue. The first (and any subsequent temporary versions) will be used as a guide to focus acquisition/validation efforts. Other Arctic initiatives (i.e. transportation corridor development, community re-supply, and resource extraction) will also be considered when determining densification projects. Although we have considered this first version an adequate reduction strategy for most survey activities, the expectation is that the control densification happening in the next few years will result in a fairly static version from about year 2015 onward. The Arctic region will be looking at 2014 as the official adoption of this datum for nautical publications. Aside from determining the separation to chart datum for nautical products, we will also be focusing on developing separations to other datums, i.e. High Water Line which will subsequently be used for infrastructure studies and coastal zone management. The final piece of the puzzle for the technical team will be to design and compute the uncertainty of the model so it can be properly

incorporated into survey data, and subsequently into data quality representation in the next generation ENC's.

There has been some discussion with our American counterparts in the Pacific coast region on how to combine our two models to ensure a seamless transition between the two. Once technical details are determined they can apply to all boundary areas between the two countries. To date, we are unaware of any similar work happening in the boundary areas between Canada and Greenland but it is important to note that our current model does extend to the coast of Greenland.

Conclusions
Canada will continue its efforts in this innovative approach to the provision of accurate and cost-effective tidal prediction in Arctic waters and inform ARHC at future opportunities.

Recommendations
That ARHC note the Information Paper.

Justification and Impacts
ARHC draft Strategic Plan supports and encourages exploration of innovative methods to increase knowledge of hydrography in the Arctic region to improve efficiency of navigation and maritime engineering.

Action Required of ARHC

The ARHC is invited to note the Information Paper