

Template

Satellite-derived bathymetry and its application to update two charts in northern Canada

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Many Canadian charts, especially in the Arctic, have large areas covered by white space and other areas where the data shown on the charts are decades, sometimes centuries, old. Satellite-derived bathymetry (SDB) can provide hydrosatial information to update such charts by identifying previously unknown hazards to navigation and providing more complete and up-to-date information to mariners. We demonstrate the application of SDB to estimate bathymetry in optically shallow waters, detect and map shoals, and update coastline information for two charts (CHS charts 7185 and 7193) in southern Baffin Bay, Canada.

We apply two SDB approaches to Sentinel-2 satellite imagery: 1) an empirical approach where the relationship between water depth and pixel colour in composite imagery is calibrated with ICESat-2 bathymetric photon depths, and 2) a physics-based approach that identifies this relationship by modeling radiative transfer through the atmosphere and water column. The core product of both methods is per-pixel depth estimates accompanied by 95% confidence intervals, from which additional products are derived.

The results are broadly similar for both charts. SDB performs well and meets IHO Survey Order 2 specifications in shallow waters. Performance gradually degrades with depth until signal extinction at around 13m depth. Shoals are easily identifiable in the SDB products, and their location and extent is verified with visual inspection of the satellite imagery. Numerous previously unknown shoals were mapped in both chart areas. Coastlines are easily identifiable, except where in persistent shadow during the ice-free period.

Use of SDB for chart updates is not limited to putting depth points on charts, but can include outlining previously unknown shoals and updates to coastline locations. For the Canadian Arctic, which is experiencing a rapid increase in shipping, shoal detection in otherwise unmapped areas is crucial to the safety of navigation. SDB is a cost-efficient technology for shoal detection.