Expanding bathymetric lidar survey coverage using a novel random forest satellite-derived bathymetry (SDB) algorithm: a case study for Arctic waters

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Background

Bathymetric lidar surveys are a critical component in the generation of high-quality hydrographic data but can be limited due to excess suspended particles in the water column that can reduce the overall extent of a planned survey. This is compounded in highly dynamic regions such as coastal Alaska by other factors including weather and terrain that can negatively impact survey operations.

Objectives

The primary objective of this study was to produce satellite-derived bathymetry (SDB) from multiple image sources and resolutions in an Arctic region using a novel random forest (RF) algorithm trained with bathymetric lidar depth measurements to fill hydrographic survey gaps and extend coverage.

Methods

A novel random forest SDB algorithm was trained with either a multi-temporal 10-meter resolution image composite created from 90+ Sentinel-2 images, Planet 3-meter imagery, or Maxar 2-meter imagery and a bathymetric lidar survey from 2019 to produce three independent bathymetric surfaces in Golovin, Alaska. Resulting SDB data was assessed for accuracy by comparing it to ground truth depth measurements.

Results

The SDB data produced depths down to 5 meters and an RMSE of less than 1 meter. In other littoral regions around the world this combination of imagery sources and SDB algorithm has produced accurate depths in excess of 25 meters deep and RMSE as low 0.5 meters compared to ground truth measurements.

Discussion

The primary limitation of machine learning (ML) SDB algorithms such as the RF one used in this study is that they require significant amounts of training data to provide accurate results. The technique outlined here takes advantage of dense bathymetric lidar survey data to produce robust SDB from multiple image sources.

Conclusion

SDB data produced by machine learning algorithms trained with lidar depth data can be used to fill bathymetric survey gaps that were either not collected or removed due to poor data quality as well as extend survey coverage.