

# Episodic Satellite-Derived Depth Change from a Single Model Based on “Stacking” Multi-temporal Images

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The output of the combination of “complete coverage” remote sensing imagery and geographically sparser high-quality bathymetric data – usually LiDAR – to produce wall-to-wall bathymetric maps is known as “satellite-derived bathymetry” or simply SDB. Considerable effort continues to be made to improve SDB techniques and define where they produce the most accurate maps. Most efforts are focussed on producing SDB at a single time. Research on estimating “satellite-derived depth change” (SDDC) is much more limited. Where it has been studied, the general approach is to produce and apply separate models for  $t_1$  and  $t_2$  using time-appropriate imagery and LiDAR data. SDDC is then obtained by differencing the outputs of the two models. Uncertainty is often inferred from the accuracy of the SDB models for the two time periods and summarised using a metric such as root-mean-square error.

In this study, pre- and post-hurricane Landsat imagery (30 m pixels) and airborne LiDAR data were obtained for an area centred on Key West, Florida (United States) that experienced Category 5 hurricane Irma in September 2017. SDDC was produced using the conventional approach described in the preceding paragraph. In addition, however, instead of fitting separate models for pre- and post-hurricane depths, the two Landsat images employed were “stacked” into a single multi-temporal image. That is, Bands 1 to 8 came from the pre-hurricane imagery and Bands 9 to 16 came from the post-hurricane imagery. “True” depth difference for each pixel was obtained using the pre- and post-hurricane LiDAR data and used to fit and apply an SDDC model.

Accuracy of both approaches was evaluated in geographic and statistical/feature space. The accuracy of SDDC for both methods was poor. Subsequent uncertainty characterisation analysis indicated this was due to the episodic and localised nature of the depth change and the spatial resolution of the Landsat imagery.