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DeepBedMap: Using a deep neural network to better resolve the bed topography of Antarctica

Wei Ji Leong and Huw Horgan
Antarctic Research Centre, Victoria University of Wellington, New Zealand (weiji.leong@vuw.ac.nz)

To better resolve the bed elevation of Antarctica, we present a novel deep convolutional neural network that produces realistic terrain given multiple remote sensing data inputs. Our super-resolution DeepBedMap neural network model is trained on scattered regions in Antarctica where high resolution groundtruth bed elevation grids are available, and later used to generate high resolution bed topography in less well surveyed areas. DeepBedMap improves on previous interpolation methods by not restricting itself to a low spatial resolution (1000m) BEDMAP2 raster image as its prior. It takes in additional high spatial resolution datasets, such as Antarctic ice surface velocity and surface elevation maps, which can be used to better inform the bed topography even in the absence of direct ice-penetrating radar survey data. Our DeepBedMap model is based on an adapted Enhanced Super Resolution Generative Adversarial Network architecture, chosen to minimize the per-pixel elevation error while producing realistic topography. The final product is a four times upsampled (250m) bed elevation model of Antarctica that can be used by glaciologists interested in the subglacial terrain, and also ice sheet modellers wanting to run catchment or continent-scale ice sheet model simulations. We show that DeepBedMap produces a more accurate digital elevation model than a baseline bicubic interpolation product, and also compare it with other synthetic bed elevation models on reference groundtruth survey tracks.