



Determining the Optimal Grid Resolution for Topographic Analysis on an Airborne Lidar Dataset

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Digital Elevation Models (DEMs) are a gridded representation of the surface of the earth and typically contain uncertainties due to data collection and processing. The topographic metrics slope and aspect contain errors and uncertainties inherited both from the representation of a continuous surface as a grid (referred to as truncation error, TE), and from any DEM uncertainty. We analyze in detail the impacts of TE and propagated elevation uncertainty (PEU) on slope and aspect.

Using synthetic data as a control, we define functions to quantify both TE and PEU for arbitrary grids. We then develop a quality metric which captures the combined impact of both TE and PEU on the calculation of topographic metrics. Our quality metric allows us to examine the spatial patterns of error and uncertainty in topographic metrics, and to compare calculations on DEMs of different sizes and accuracies.

Using lidar data with point density of ~ 10 pts/m² covering Santa Cruz Island in southern California, we are able to generate DEMs and uncertainty estimates at several grid resolutions. Slope (aspect) errors on the one-meter dataset are on average 0.3° (0.9°) from TE, and 5.5° (14.5°) from PEU. We calculate an optimal DEM resolution for our SCI lidar dataset of four meters that minimizes the error bounds on topographic metric calculations due to the combined influence of TE and PEU for both slope and aspect calculations over the entire SCI. Average slope (aspect) errors from the four meter DEM are 0.25° (0.75°) from TE and 5° (12.5°) from PEU. While the smallest grid resolution possible from the high-density SCI lidar is not necessarily optimal for calculating topographic metrics, high point-density data are essential for measuring DEM uncertainty across a range of resolutions.