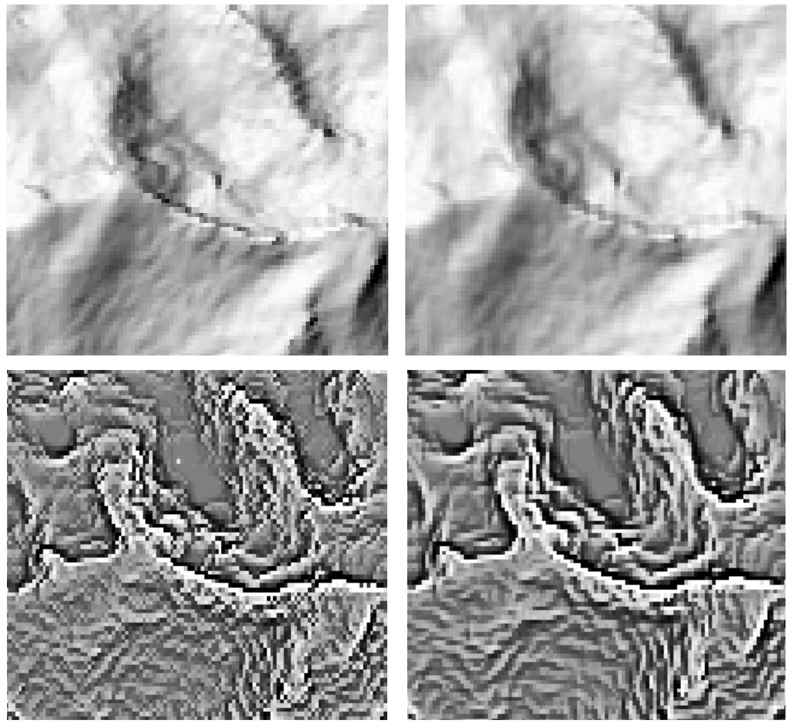
Methods for Computing Topographic Properties

The TNTmips Topographic Properties process computes local topographic characteristics for each cell of a digital elevation model (see the Technical Guide entitled *Terrain Analysis: Computing Topographic Properties*). These computations use a moving 3 by 3 kernel of cells to sample the local topography surrounding each cell. The selection of cells within this kernel and the weighting factors applied to these cells during the computations can be varied to fit different mathematical surfaces to the elevation values. The five surface-fitting methods listed in the table to the right are available in the process; the method you select is applied to all of your chosen topographic property computations (slope, aspect, shading, and curvatures).

Surface-fitting methods for the 3 x 3 processing kernel

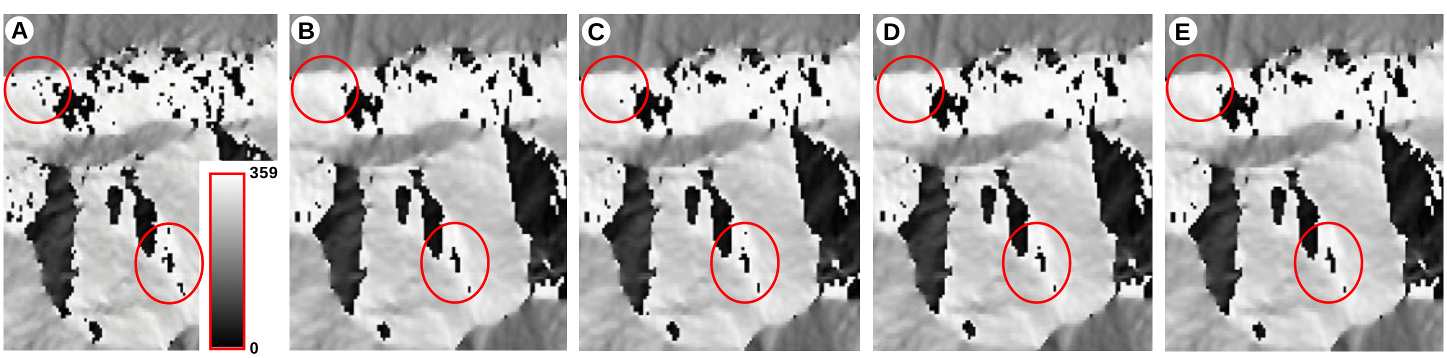
A: Exact fit to 4 nearest neighbors and center cell
B: Quadratic surface, least-squares fit
C: Quadratic surface, least-squares fit, weighted by $1/distance^2$
D: Quadratic surface, least-squares fit, weighted by 1/distance
E: Quadratic surface, least-squares fit, match central cell

The simplest surface-fitting method uses a surface that passes exactly through the central cell and its four closest neighbors (left, right, up, and down in raster line-column space). Research studies have shown that, for highly-accurate digital elevation rasters, this model provides the most accurate topographic parameters. However, most digital elevation models contain elevation errors. For example, elevation models created using remote sensing methods (radar interferometry and LIDAR) contain random and nonrandom noise and other processing artifacts, and those created by interpolating from contour lines commonly have too many cells matching the contour line elevations, creating a stair-step or terraced effect on slopes. To mitigate the effect of these errors, four additional surface-fitting methods are provided that use variations of a local quadratic (second-order) surface to provide a "best fit" for the elevations of the central cell and all eight of its immediate neighbors. The quadratic methods all provide a degree of smoothing of the surface in comparison to the "exact fit" method, as shown by the examples on this page of topographic parameters computed from elevation models produced by the Shuttle Radar Topography Mission (SRTM). The four quadratic methods differ from each other in how the elevation values in the more distant, diagonally-adjacent cells are weighted in comparison to the the side-to-side adjacent cells in the kernel. In addition, only one of the quadratic surface-fitting models (match central cell) forces the local mathematical surface to pass exactly through the center cell elevation; the others allow the best-fit surface to deviate from the central cell elevation. Differences between the topographic products created using the four quadratic surface-fitting methods are slight, but can be locally significant.



Exact fit to 4 nearest neighbors **Quadratic, least-squares fit**

Comparison of shading (top) and profile curvature (bottom) results for two surface-fitting methods. All of the quadratic methods provide some smoothing, which helps filter out noise in SRTM and LIDAR digital elevation models.



Samples comparing aspect results (the azimuth of the down-slope direction for each cell) for the 5 surface-fitting methods. Differences are most noticeable for cells facing close to due north, where the choice of surface-fitting method can cause the slope direction to change between just east of north (aspect 0 or higher, black display color) and just west of north (aspect 359 or less, white display color). The red circles and ellipses indicate areas where differences between methods are most noticeable. Letter labels for the aspect samples are keyed to the list of surface-fitting methods at the top of the page.