Slant-Range and Area Corrections in GEOCODER™

By Dave Maddock

In this article I will continue the discussion of the many corrections GEOCODER™ can make to your imagery data by focusing on slant-range and area corrections.

SLANT-RANGE DISTORTION EXPLAINED

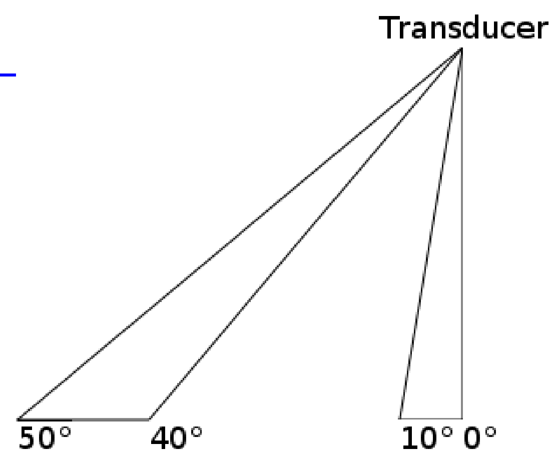
Slant-range distortion is an effect of imagery data being logged by time rather than horizontal distance from the transducer and is geometric in nature (that is, a distortion in position of the imagery). When working with imagery registered in time, we typically assume that each imagery sample has an across-track distance from nadir relative to the sample rate of the sonar. For instance, if a sidescan sonar has a range of 75 meters and operates with a sample rate of 1kHz, then we would expect the sonar to return 100 samples per ping (assuming 1500m/s sound velocity).

$$(75\text{m} * 2) / 1500 * 1000\text{Hz} = 100 \text{ samples} \qquad \textbf{(EQ 1)}$$

A naive display of the sidescan imagery would draw each pixel of the time series at 75cm increments from nadir in the across-track direction.

$$75\text{m} / 100 \text{ samples} = 0.75\text{m per sample} \qquad \textbf{(EQ 2)}$$

FIGURE 1. Sample Footprint Increases with Beam Angle from Nadir

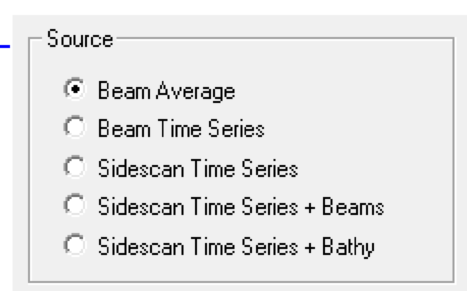


However, we know this is incorrect because geometry shows us that the sample footprint increases with beam angle from nadir. Notice how horizontal resolution decreases as beam angle increases in figure 1.

GEOCODER™ addresses this issue in several ways, depending on the data type and information available to it.

SLANT-RANGE CORRECTION IN SIDESCAN

FIGURE 2. Selecting the Slant-Range Correction Source



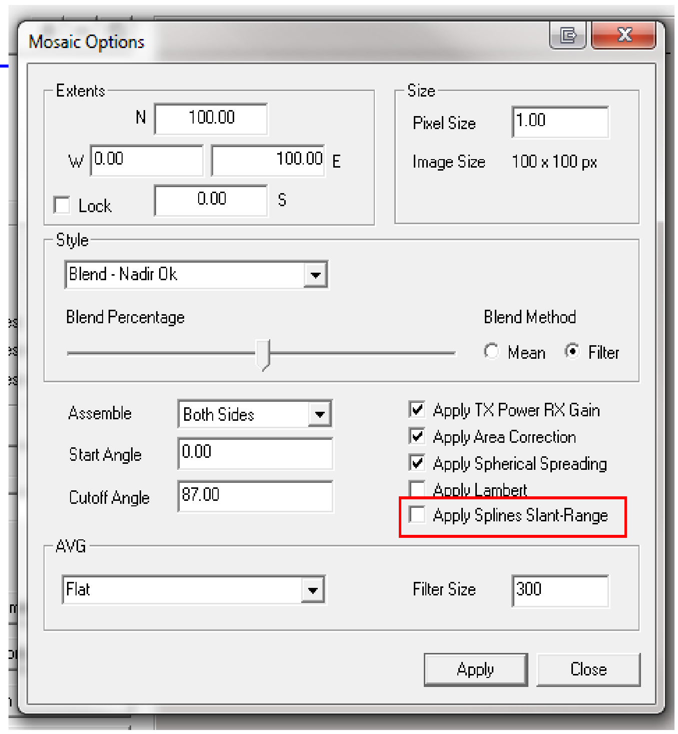
There are three methods available in GEOCODER™ to make this correction to a sidescan time series. Of course, note that in all cases the water column portion of the time series is removed first.

- **Sidescan Time Series:** Given no other information, GEOCODER™ can slant-range correct by assuming a flat bottom and using simple geometry to position the swath at one degree increments, then interpolate between these “artificial beams”.

- **Sidescan Time Series + Bathy:** If a DTM is loaded, select "Sidescan Time Series + Bathy" to calculate the angle of incidence based on the bathymetric model (more on this in the area correction section).
- **Sidescan Time Series + Beams** is the most accurate method, but it is not currently enabled for data logged in HSX format. In this mode, the sidescan must be co-registered to multibeam data, such as with a Reson 8101 with the sidescan option. GEOCODER™ will correlate the sidescan samples to the known position and time of the bathy beams and interpolate between them.

SLANT-RANGE CORRECTION FOR MULTIBEAM

FIGURE 3. Using Spline Calculations in Slant-Range Corrections



Beam Time Series (aka. snippets) make the correction in a very similar fashion to the “Sidescan Time Series + Beams” method. This type of data has a small time series for each beam. Each detect sample is positioned at the beam location and the snippet imagery is interpolated between beams with priority given to samples closer to a detect sample. Though interpolation is usually done linearly in the time domain, this mode also supports interpolation using splines if the corresponding mosaic option is checked (see figure 3).

Beam Average processing works in the same fashion as snippets, though interpolation is not performed since there is only one imagery sample per beam.

AREA CORRECTION

Another correction related to beam geometry is area correction. This correction accounts for the difference in backscatter response from the seafloor depending on the footprint area and slope. If the 'Apply Area Correction' mosaic option is selected, GEOCODER™ will calculate and apply this correction to the backscatter. Across-track and along-track beam widths are a factor here as well as the slope of the insonified area of bathymetry. One “gotcha” is that GEOCODER™ will assume a flat bottom when making this calculation unless an external DTM is loaded. It **will not** calculate bathy slope from the multibeam data. Due to the raw nature of the data, it cumbersome for GEOCODER™ to do so. Instead, it expects you to process and load the bathy model as a gridded XYZ file (or HYPACK® Matrix file in future versions).

If your dataset contains large slopes or an irregular bottom, area correction can make a big difference in the quality of your mosaic. If not, the difference may be visually negligible.

CLOSING REMARKS

I hope this overview has helped explain what GEOCODER™ is doing to your data and what results you can expect. Using a DTM in the slant-range correction with sidescan can lead to improved positioning while improving the clarity of datasets with heterogeneous bathymetry.