SVP Adjustments in MBMAX 64

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This is a refresh of a Sounding Better article from May, 2009, using MBMAX 64 instead of 32 bit MBMAX to adjust sound velocity profiles.

INTRODUCTION:

We need accurate knowledge of water column SV (Sound Velocity) when doing multibeam surveys. Without accurate SV, survey results range from slightly inaccurate to wrong and misleading.

How it's supposed to work: A sensor at the sonar head accurately measures SV in real time. A cast is done periodically to find water column SV; the Sound Velocity Profile (SVP). Casting is done often enough so that naturally occurring changes are accurately reflected in the profiles.

What sometimes happens: The sensor at the head fails. The profiler fails. Casting is not frequently enough. All leading to multibeam survey errors.

Our adjustments can't fix everything. For example, we have no fix if the sensor at the sonar head fails. Beam angles are strongly dependent on sound velocity at the sonar head and we don't adjust angles. But SVP adjustments in MBMAX64 *can* help with other common errors.

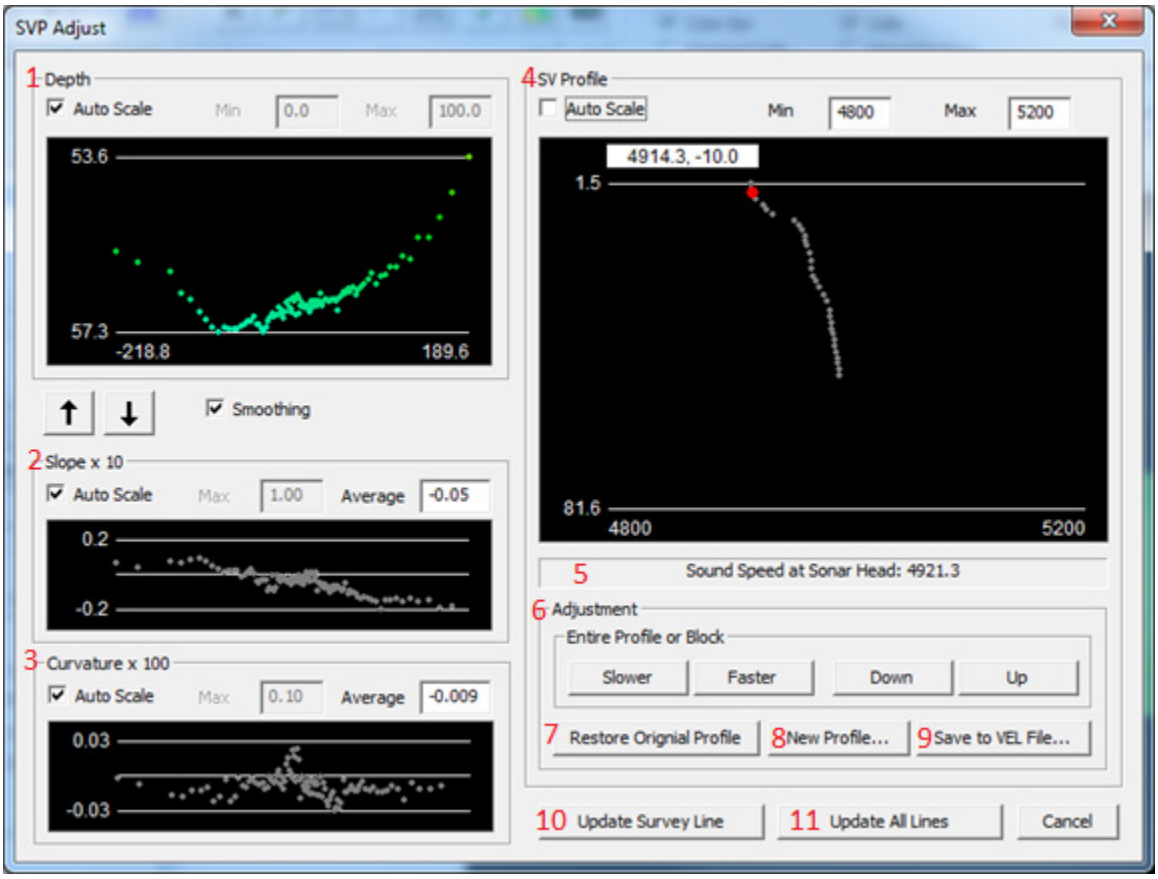
The following sections give (1) a brief overview of the adjustment module and (2) a couple of examples showing how adjustments can salvage a multibeam survey.

SVP ADJUSTMENTS:

Adjustments are done in MBMAX64 edit stage 2. After data cleaning, select Tools menu, SVP Adjust. This module has a number of sections to aid in finding a correct SVP. Well, nearly correct. Correct enough? You need to use judgment on that.

The adjustment tool is shown in figure 1. While the value of some sections (slope and curvature graphs) may not be immediately obvious, the examples should help to clarify.

FIGURE 1. *MBMAX64 SVP Adjustments Tool*



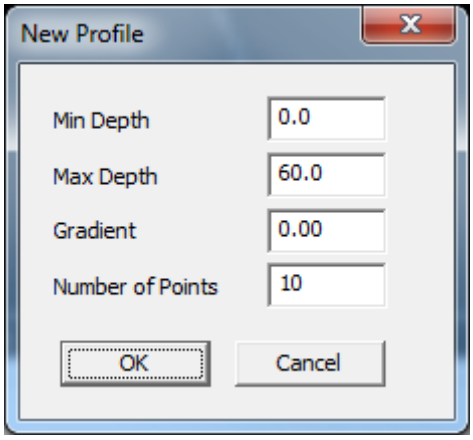
1. **Depth**: This shows all valid depths in the current sweep. Without tide corrections. You may ente min and max depth scaling or allow the program to auto scale based on the range of depths. In the sample, a flat bottom area shows as a U shape or smiley face, which is indicative of SV errors. The adjustment goal is to flatten out the depth points.
2. **Slope**: Graph showing the slope (1st depth derivative) at all points across the sweep. Average is simply the average slope of all points.
3. **Curvature**: Graph showing curvature (2nd depth derivative) at all points across the sweep. Average is the average curvature taken over all points.
4. **SV Profile**: Shows water column sound velocity to end of cast.
5. **Sound Speed at Sonar Head**: For reference only.
6. Adjustments: Profile points may be shifted left / right (slower or faster) or up / down. The mouse may be used to draw a block rectangle in the profile graph, in which case only points inside the rectangle are shifted.
7. **Restore Original Profile**: Useful for trial and error.
8. **New Profile**: Replaces the original profile with one based on user parameters.
9. **Save to VEL file**: Saves adjusted SVP to HYPACK VEL format. Multiple VEL files are useful in complicated environments where SV profiles change quickly and time interpolation becomes useful.
10. **Update Survey Line:** Applies the adjusted SVP to the current file.

11. **Update All Lines**: Applies the adjusted SVP to all loaded files.

New Profile:

- Minimum and maximum profile depth.
- Gradient = SV change with depth.
- Number of Points in the new profile.

FIGURE 2. *New profile parameters*

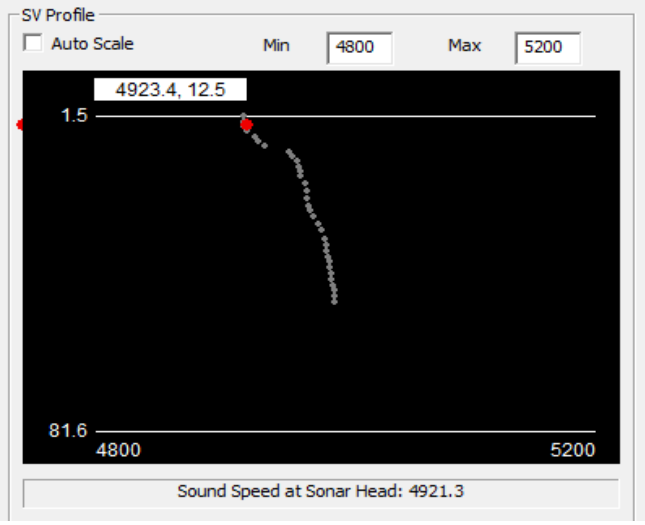


Note: SVP Adjustments work best over a flat bottom. If the survey does not include a flat bottom, find the closest you can.

EXAMPLE 1: A SURVEY IN AN ESTUARY WITH INFREQUENT CASTING.

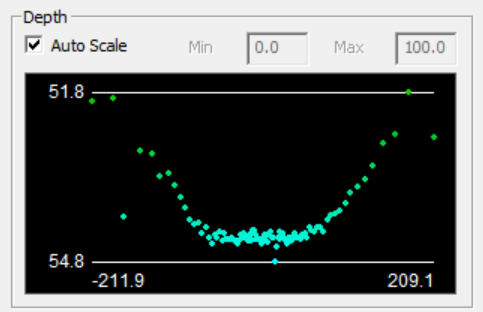
Estuaries are difficult areas; there are distinct sound speed zones in the water column. Denser salt water forms a wedge under fresh water, with a mixed area between. Furthermore, the profile changes over time, depending on tide stage. A typical profile is shown in Figure 3.

FIGURE 3. *Figure 3 – Estuarine SVP showing fresh water to brackish to salt water transitions. The red dot gives SV at sonar head, which in this case matches the SVP closely. A good thing!*



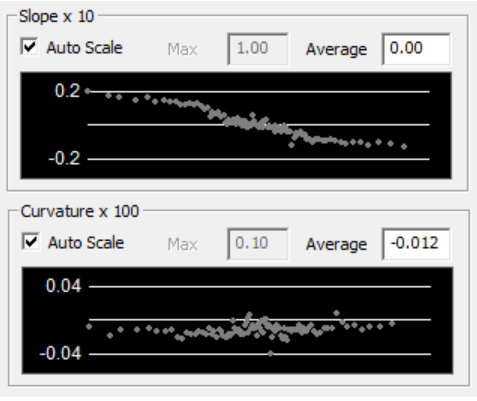
Consider a case where casts are done every 3 hours but there are significant tidal changes over that period. It's easy to collect bad data. The depth graph of Figure 4 shows a single sweep with the characteristic smiley face.

FIGURE 4. *Depth profile showing the error (smiley face) due to a bogus SVP.*



The slope and curvature graphs reinforce this (figure 5). The slope is at a maximum at the port end of the sweep, transitions to zero slope at nadir and is a minimum at the starboard end. There is negative curvature across the sweep and an average value of -0.012 x scaling. The average value helps quantify our adjustments. We are looking to bring the average close to zero.

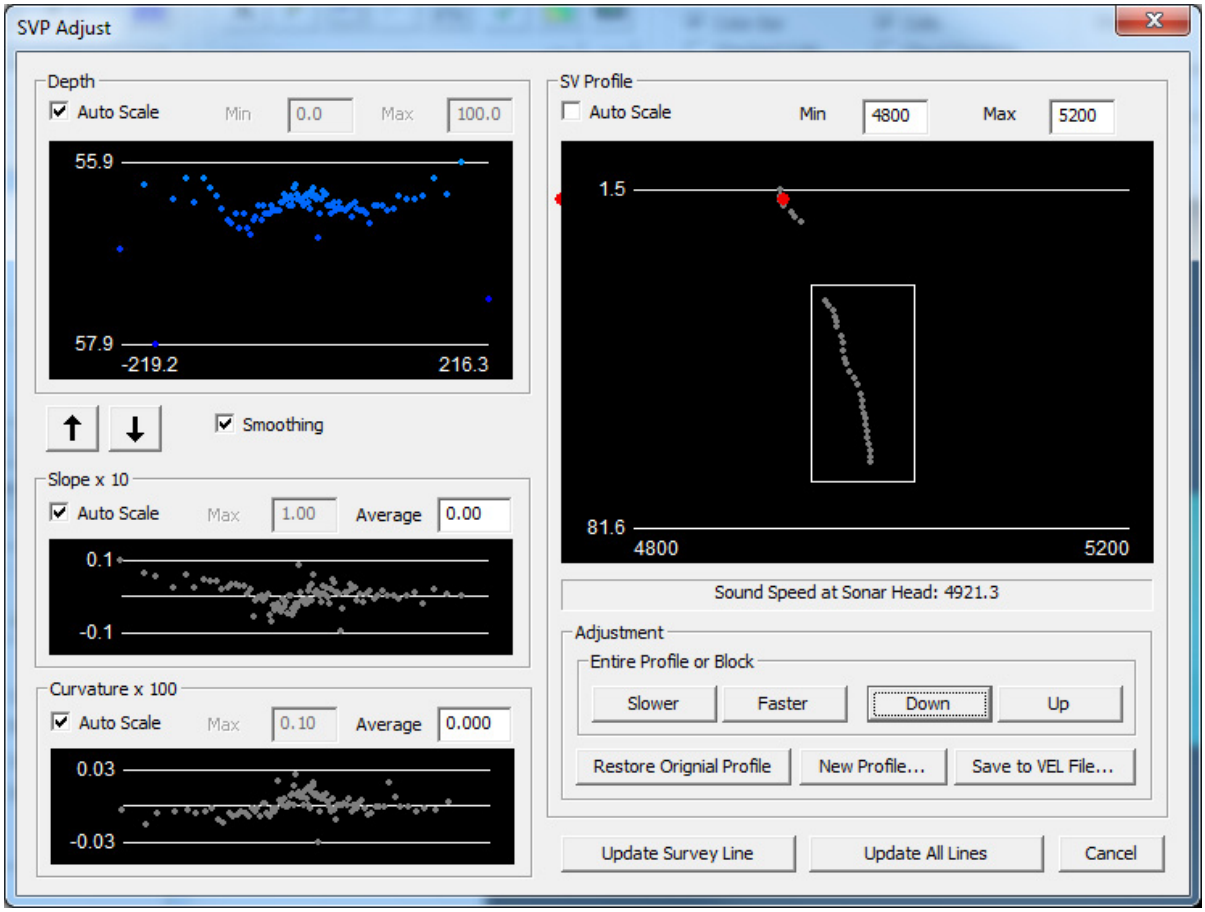
FIGURE 5. *Depth profile slope and curvature.*



How to fix it? We know the tide was going out, so our suspicion is that the salt water wedge would be smaller at data collection time than at cast time. So we simply block out the wedge and adjust it downward. Voila! The sweep flattened and average curvature went to zero.

All that's left now is to replace the file profile with our adjustments. We've improved our survey significantly as shown in figure 6.

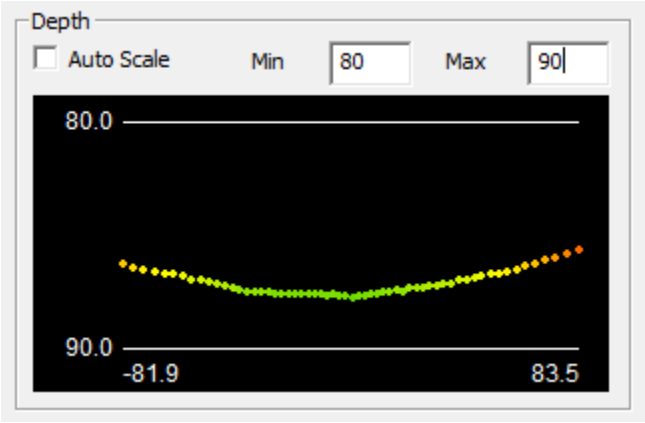
FIGURE 6. *Depth Profile Improves Dramatically by Shifting the Salt Wedge Downward.*



EXAMPLE 2: A SURVEY WITH NO SVP

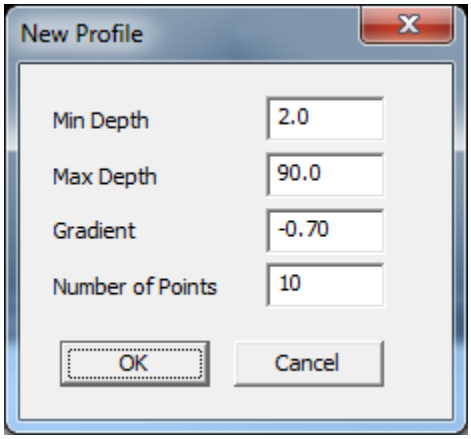
You did a cast but the probe didn't come back - oops. Or the batteries died. Or something … end result is you know SV at the sonar head (from the sensor) and nothing else. But the survey continued, and this is the result. Darn smiley faces.

FIGURE 7. *Depth Error Due to Missing SVP*



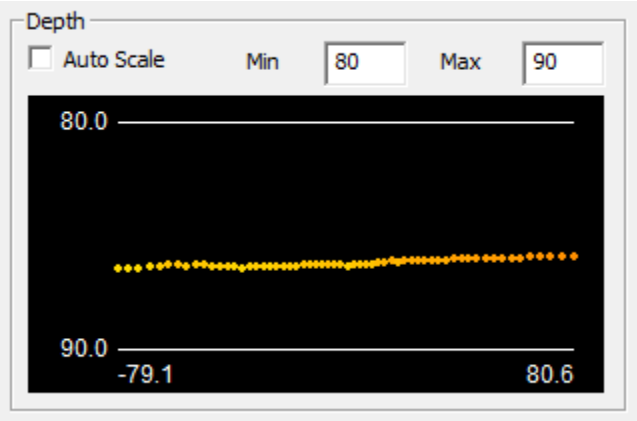
To fix this one, we click “New Profile” and make a best guess estimation of the correct profile. Surface sound speed is taken from the sensor and extended down to about 2 meters to account for surface conditions. The profile extends to 100 meters, which is the area depth. Some gradients are chosen (trial and error) and -0.7 seems to work the best. 10 profile points is sufficient.

FIGURE 8. *New Profile Definition.*



The resulting depths are shown in figure 9. Again, quite an improvement.

FIGURE 9. *Improved Depth Profile Owing to the Estimated SVP.*



SUMMARY:

SVP Adjustments in MBMAX64 can improve multibeam data collected with incorrect or no water column data. This is done by creating a new profile or adjusting an existing profile until artifacts are removed. A target sweep is available for visual examination at each adjustment step. Sweep curvature calculations are useful when the seafloor is quite flat – we are looking for zero curvature.

Two examples show how multibeam surveys may be improved substantially (and easily!) using the adjustment tool.