



Newsletter – February 2021

GPR-SLICE Subscribers,

We would like to welcome the following organizations to the GPR-SLICE community:

1. Dept of History, Geography and Philosophy, University of Cadiz, Spain
2. Everick Heritage, Brisbane, Australia
3. The Manufacturing Technology Center, Coventry, UK
4. Center for Civil Protection, University of Florence, Italy
5. Coretec, Korea
6. Institute of Ecology, University of Tallinn, Estonia
7. Dept of Geophysics, Chungnam National University, Korea
8. Geophysx Jamaica Ltd., Kingston
9. Edwards-Pitman, US
10. Hydrogeophysics Branch, United States Geological Survey, Menlo Park, CA
11. Freelance Geoscience Consultant, Bandung, Indonesia
12. United States Army Corps of Engineers, Ft Worth, Texas
13. UXOMAP, Paris, France
14. International Atomic Energy Agency, Vienna
15. Ryobi Geosystem Pte Ltd, Singapore
16. Fukada Geological Institute, Kyoto University, Japan

17. Applied Geotechnologies Research Group, University of Vigo, Spain
18. University of Science and Technology, China
19. GPRS, Toledo, Ohio
20. Inner Mongolia University, China
21. Hirani Group, New York
22. IAC Surveying and Contracting, Dubai, United Arab Emirates
23. Dept of Anthropology, University of Illinois at Urbana-Champaign
24. Dept of Energy and Mineral Resource Engineering, Sejong University, Korea
25. 2 Ladies Locating and GPR in Kirkland, Washington
26. Space X
27. Exploracion Perforacion y Estudios del Subsuelo, Mexico
28. Research Center for Humanities, Hungary
29. Tennessee Valley Archaeological Research, Huntsville, Alabama
30. More og Romsdal fylkeskommune, Norway
31. OSL Hungary Ltd
32. Geoarch Solutions LLC, Knoxville, Tennessee
33. Geomines, France
34. ENC d.o.o., Serbia
35. Dept of Earth Sciences, Montana State University
36. LVR - Amt fur Bodendenkmalpflege im Rheinland

Multichannel licenses were included to the University of Cadiz, The Manufacturing Technology Center, Chungnam National University, UXOMAP, Kyoto University, GeoMines and LVR. Bridgedeck license were included to the University of Cadiz, University of Tallinn, Chungnam National University and OSL Hungary. GPRSIM licenses were delivered to the United States Geological Survey in Menlo Park.

Major features and options added to GPR-SLICE include:

- Amplitude equalization filter
- Line drawing on multi-display radargrams using XYpoints
- Bridgedeck module improved with multiple layer detection/retrieval/editing
- ANG survey displays with 3-tiered labeling
- Display and compilation of all user marks in OpenGL Volume Draw menu
- Scrolling and selection of (long) GPS radargrams in OpenGL with a user set scan length
- Number of units to extend time slice grid and to preserve fractional start/end
- Parsing long GPS radargrams

Amplitude Equalization

A new option for regaining radargrams based on the inverse root mean square across a moving sample length has been added to the Filter menu (Figure 1). The method works on every scan individually and creates a unique gain based on a sample window length centered on each pulse value on the radar scan. The gain value applied to the pulse is the binary resolution of the radargram divided by the root mean square of all the data values in the sample window. The effect of the filter is to equally amplify all parts of the radar scan. The gaining even works in areas where there is no data essentially seen. Here the application of the filter is made on a dc/drift - wobble removed radargram only without any range gain or bandpass.

The sample length has a strong influence in the outcome of the filter. The longer the filter the closer a bandpassed+agc radargram looks like the amplitude equalized radargram. Figure 2 shows comparison of an original radargram, and equalization lengths of 20, 120, and 220 samples. From a dataset provided by Aero 360 from the Philippines for a drone GPS survey with zig-zag lines, the initial areas at the beginning and the end of the original bandpassed+agc radargram, no measurable reflectors can be seen; the amplitude equalization filter nonetheless "discovers" and amplifies even the smallest digital reflections recorded. (These areas may be where the drone is way above ground and flying to and from the start/end programmed GPS path and thus do not have subsurface reflections recorded). The effect of the filter on time slices can be dramatic. In the example shown amplitude equalization can highlight weaker features as well de-amplify features which are dominate. The motivation for this filter was primarily developed for the seismic industry in which mapping all the stratigraphy horizons is crucial to discover all the horizon layers where reserves are present. The filter might be used to enhance imagery made for large multichannel dataset areas where significant ground changes between large areas show significantly different soil contrasts from simple amplitude maps. Amplitude equalization filtering can help to equalize contrast across the entire datasets. With all filtering some benefits and detriments will always exist even with the most common filters we apply to GPR data including background filtering, migration etc.

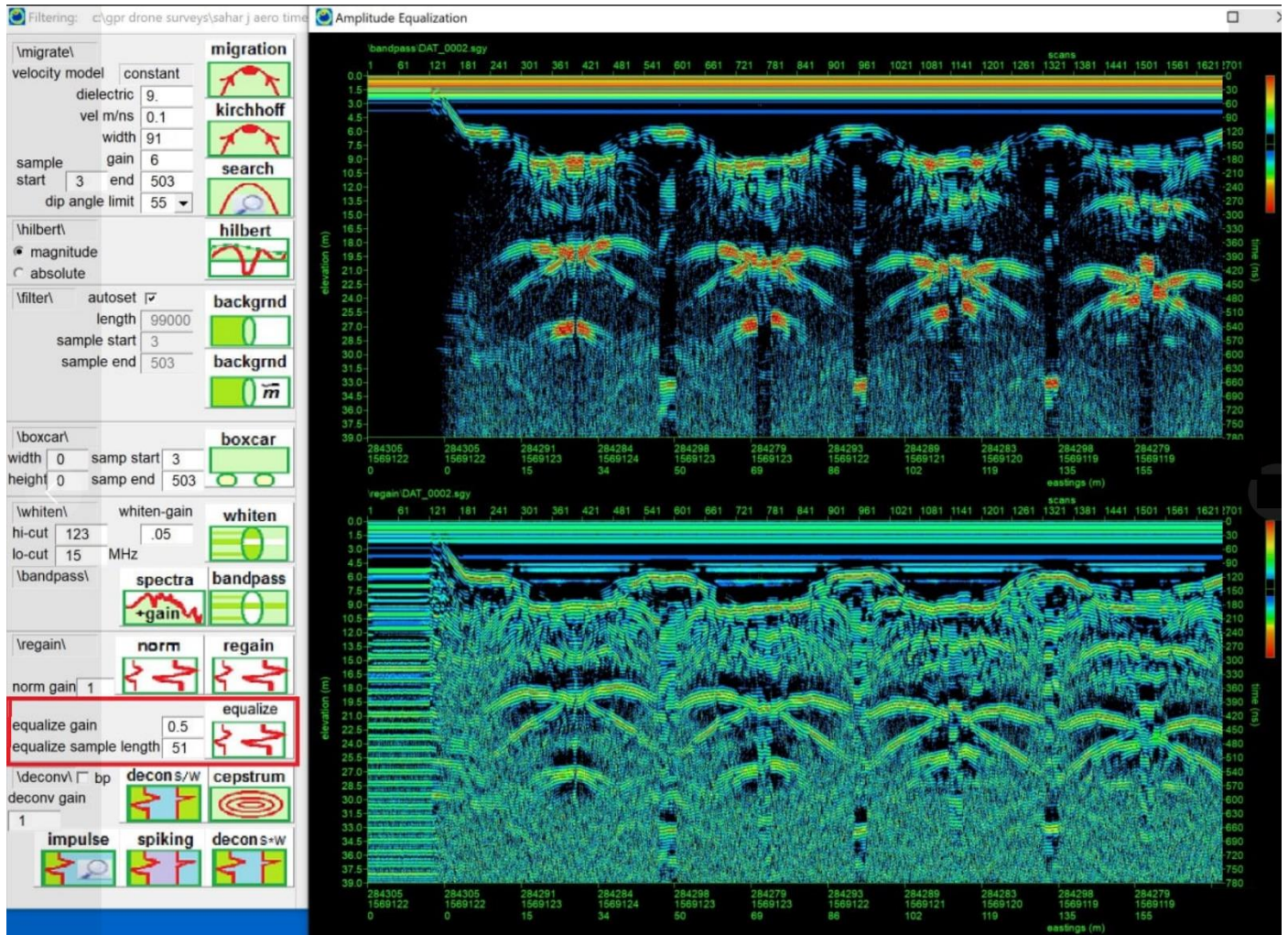


Figure 1. Location of the new Amplitude Equalization filter. An overall gain value and the scan sample length can be set to create an RMS gain curve that is unique to each pulse.

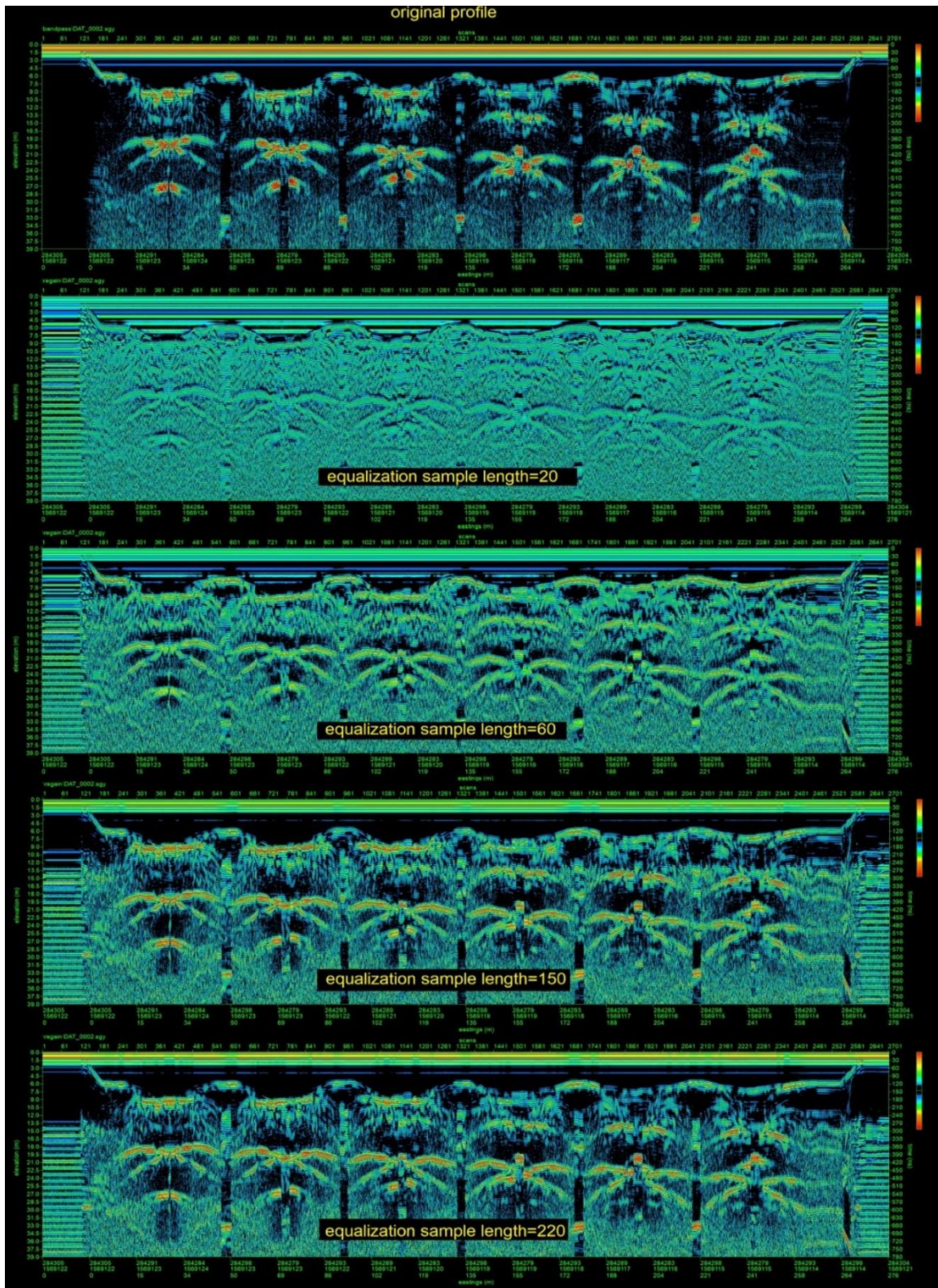


Figure 2. A comparison showing different sample lengths used for the amplitude equalization filter. The larger the sample length, the closer the filtered data can look similar to a single AGC gained radargram.

Basic drawing functions on multi-display radargrams via XYpoints

After receiving multiple requests for drawing capabilities on radargrams, we placed in some very basic drawing capabilities. Launching the XYpoints menu, and then choosing the line checkbox, one can begin drawing lines on any radargram in the multi-radargram display (Figure 3). To end a line and start another line, one simply toggles the line checkbox off/on again to start a new line. Shutting off the line checkbox completely gives the traditional look of just showing the chosen points in the XYpoints dialog on top of the radargrams. One can choose a color for each drawn line as well as the line thickness which can vary from 1-100. With the dots checkbox highlighted and the line checkbox off, the user can draw dots on the profiles. Clicking the Save button is necessary to keep all the drawn objects and update the XYpoints.dat file. The drawings can be retrieved as all the drawing information resides in the XYpoints information file and resized if needed.

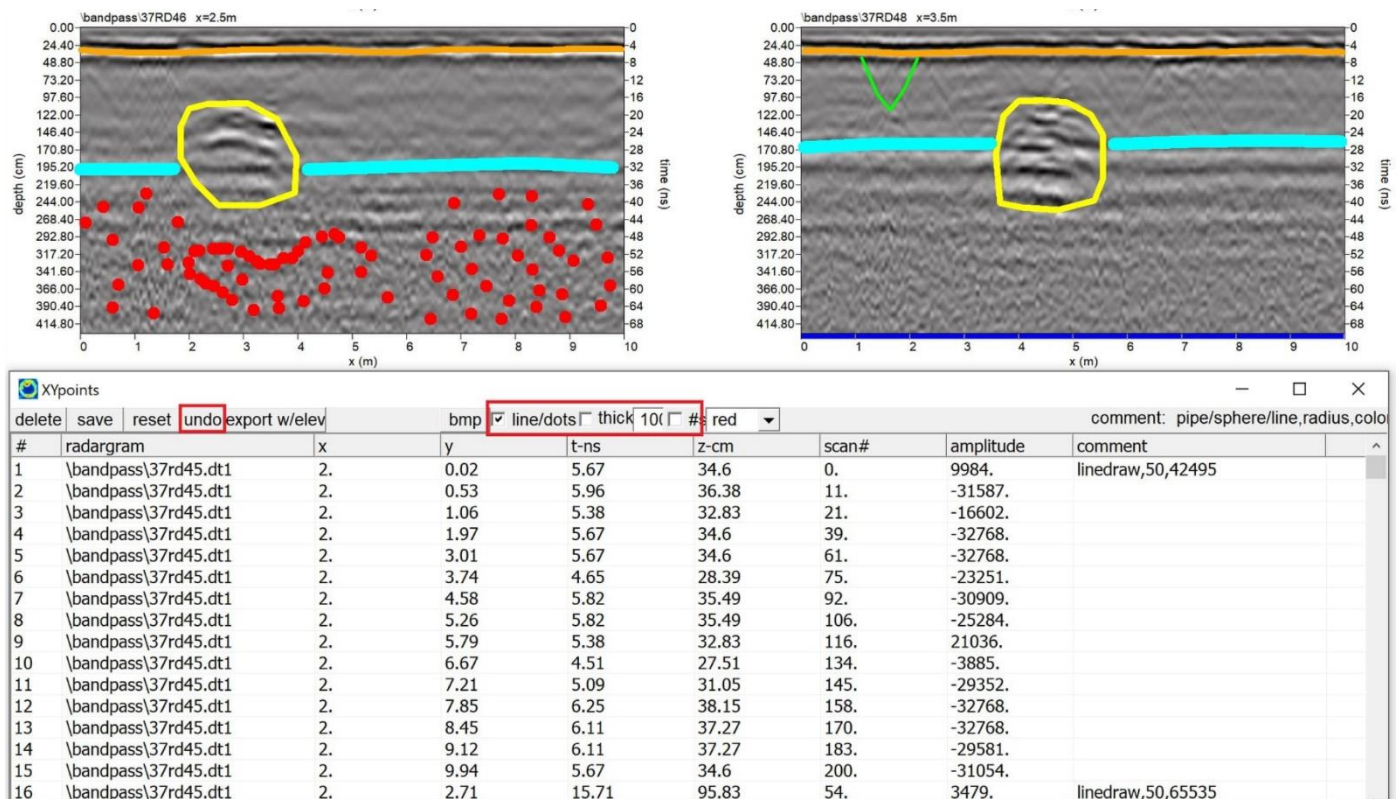


Figure 3. Examples of using the XY points menus to perform basic line drawings on the radargrams. Individual line thicknesses and point number displays can be included in the drawings.

Bridgedeck module improved with up to 5 multiple layer detection/retrieval/editing /compilation

For those that have the Bridgedeck module addition to GPR-SLICE, this menu has been enhanced to store up to 5 user defined layers (Figure 4). One can set the descriptor for 5 layers, and using the radio button next to the descriptor, begin the autodetection. The software will remember all the autodetection settings used to discover the desired hyperbolas or anomalies for each layer independently. The editing dialog has also been improved by allowing either insertion or deletion of the shown picks by clicking the desired action button, then right clicking to insert or delete the hyperbolas.

To get all the detected layers to appear in the dialog one checks on those layers desired to overlay and then the Import Layer button is clicked. On compilation of the detected layer the customized descriptor name is given to all the output filenames. In the example, the XYZ-RebarA1.dat file made is the detection for layer 1 of the depth to the rebar. These files and for every unique layer can then be gridded in the Grid menu.

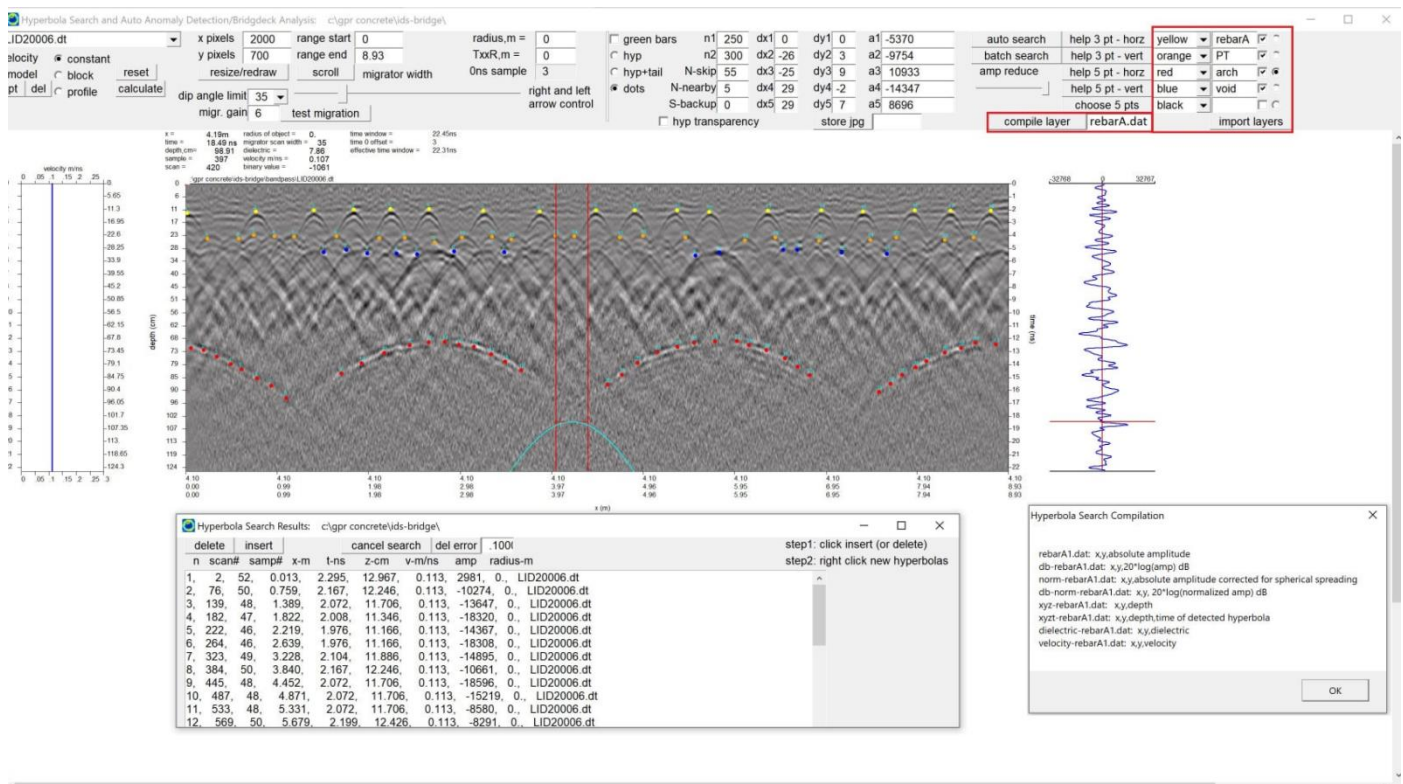


Figure 4. Improved Bridgedeck module showing up to 5 layers detections with unique naming and compilations. The menu will also remember the detection settings for each layer that is active.

ANG survey displays with 3-tiered labeling

As more and more surveys are being done in local grids and then converted to georeferenced ones, we have made it more convenient to generate imagery without having to convert to artificial GPS survey format. All "ANG" surveys are now shown with 3-tiered labeling - x, y and total range (Figure 5). In addition, the limitation of the requirement of converting ANG surveys to GPS ones prior to using the Horizon menu has been lifted.

Note: X or Y or XY surveys can even be redefined as ANG surveys should one want 3-tiered labeling for this regular surveys.

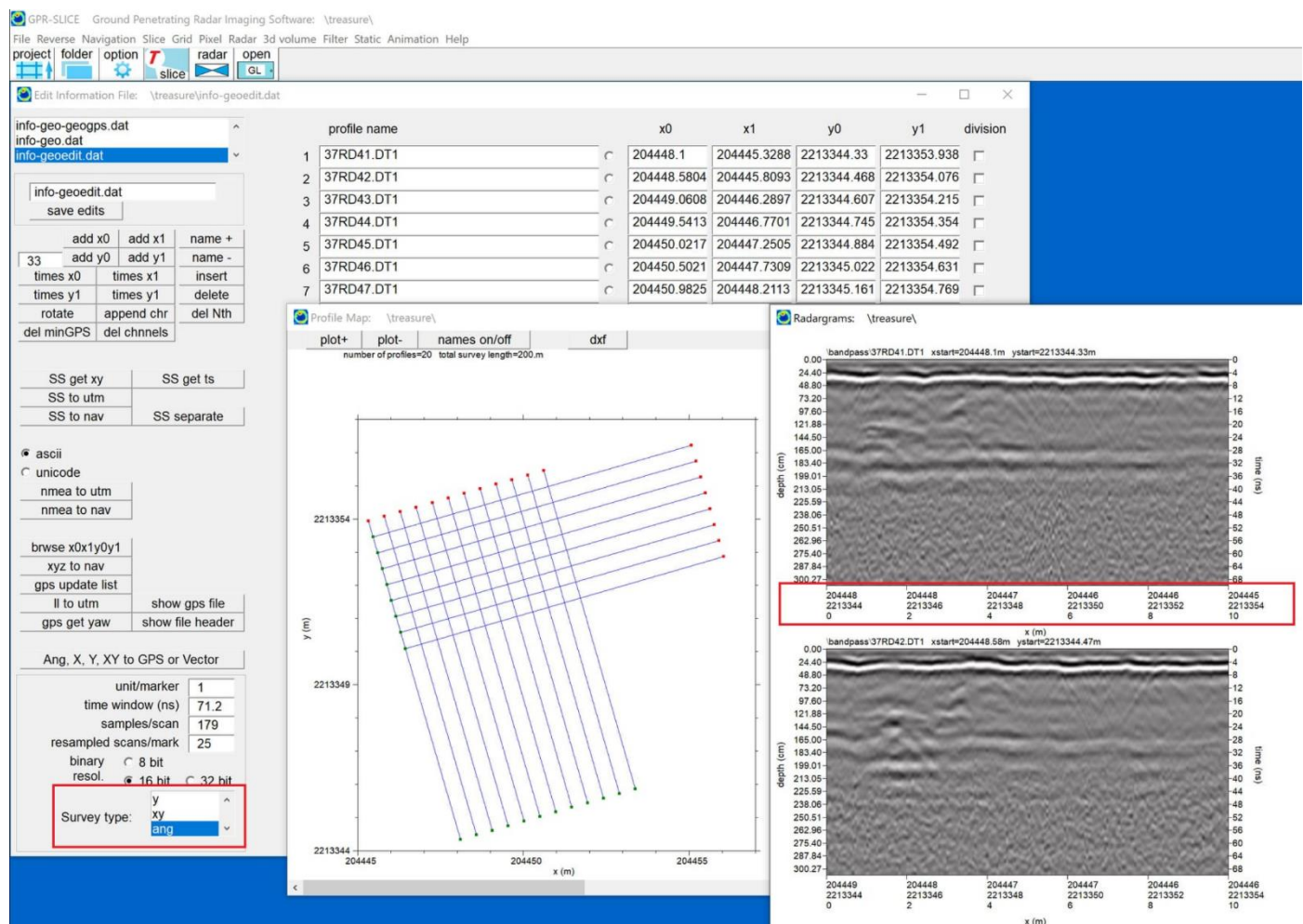


Figure 5. 3-tiered radargram labeling with x, y and total range is now active for all ANG surveys.

Display and compilation of all user marks in OpenGL Volume Draw menu

A subscriber – Dan Keininger with Texas Cemetery Restoration - uses GPR on historic cemeteries and asked if it was possible to have all the user marks he inserted during his survey be shown in OpenGL. During the survey he stores user marks in front of known burials with headstones, and he wanted to be able to see these to better help him interpret all the data and particularly how the unmarked burials look in comparison. Currently, one can show the user marks on individual radargrams using the User Mark checkbox in the Options menu. A new option was added to the Grid 2D button in the listbox called User Marks which will compile all the user marks to sphere objects and display them in the OpenGL menu (Figure 6). The user can set the size of the spheres (diameter) as well as the desired color before importing the users marks into the drawing menu. Remember, one can always back up their current drawing with a unique name so that user marks or other drawn features can be imported into the menu as separate layers.

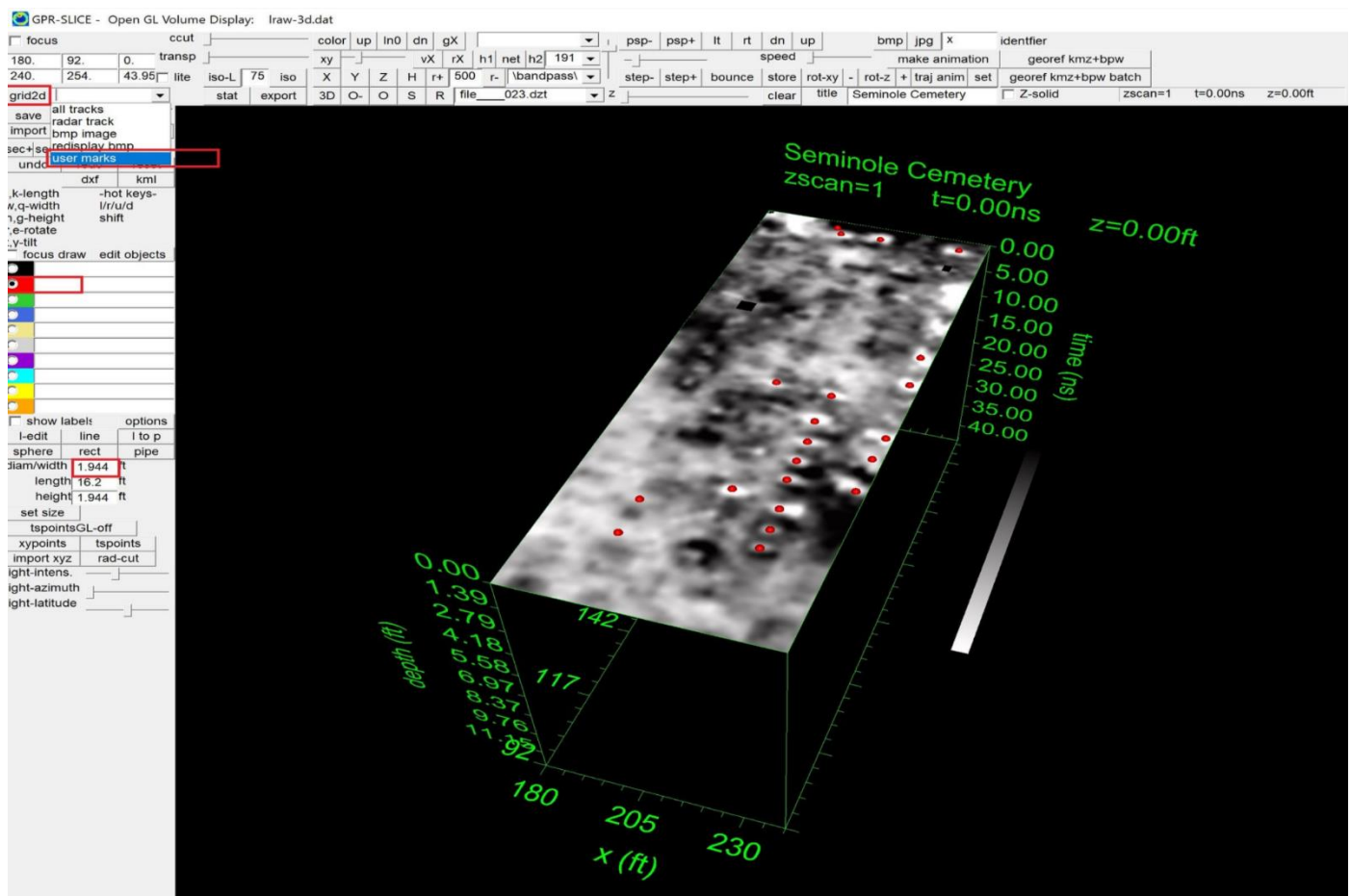


Figure 6. New option to compile all the user inserted marks into sphere objects using the Grid2D function and the User Mark listbox item.

Scrolling of GPS radargrams in OpenGL with a user set scan length

GPR/GPS surveying is becoming more commonplace and users are often collecting longer and longer single-track GPS datasets. An example of a super long GPS (drone) track collected by Aero Solutions 360 in the Philippines is shown in Figure 7. One issue in displaying GPS radargrams in their full 3D extent is zig-zag single track surveys are difficult to look inside the track as front or rear portions block the visualization. For this reason, a new scrolling 3D option was developed in OpenGL for GPS radargrams. The user can set the number of scans to examine and then clicking the r+/r- buttons one can increment and display that number of scans into the single track. The Store button can also be used to keep display lists of any number of desired portions of the track. The Bounce button can be engaged and will allow an "animation" of the GPS track. The animation will reverse itself after getting to the end of the track.

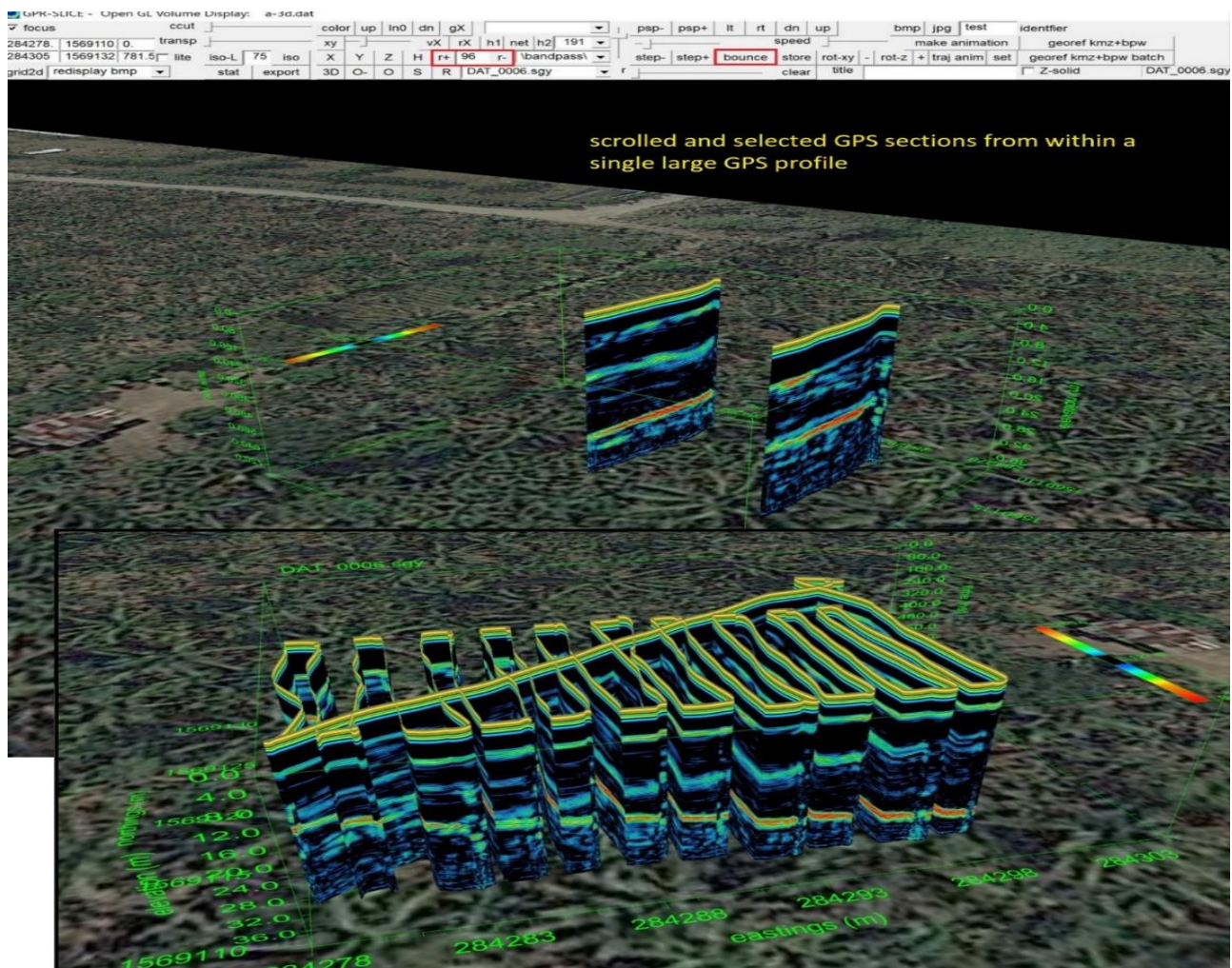


Figure 7. New options to set a user defined scan length for GPS radargrams and using the r+ and r- buttons to scroll that many scans into the profile.

Number of units to extend time slice grid and to preserve fractional start/end

Recently we were asked by Dan Bigman with www.LearnGPR.com if we could preserve the original xstart/ystart xend/yend values for a time slice grid set. Typically, when you are in the Grid menu and click the Help Set button the software will set the nearest lowest/highest integer so the grids start and end on integral locations. To allow for fractional grid start/end points a new option was added to the Grid menu call XY Round#. With this option checked on and clicking Help Set the original fractional grid start/end points will fill the slots in the menu (Figure 8).

We have also gotten inquiries from users often with GPS datasets, why is GPR-SLICE cutting off the edges of gridmaps (Figure 9). The answer we normally give is because you are interpolating beyond the original track map! If one wants to avoid that they can either reduce the Blanking Radius in the menu to prevent interpolation beyond that distance where data does not exist. Alternatively, if one is interpolating for instance out 3 meters on a GPS coarsely spaced grid, they can also set the total number of units to add onto the grid map start/end points using the slot next to the XY Round# checkbox. In this example an additional 3 meters is subtracted/added onto the start/end points of the grid to insure there is no cutoff on the map edges, should this be desired. One can also manually set the start/end points to any customized values without using the Help Set button.

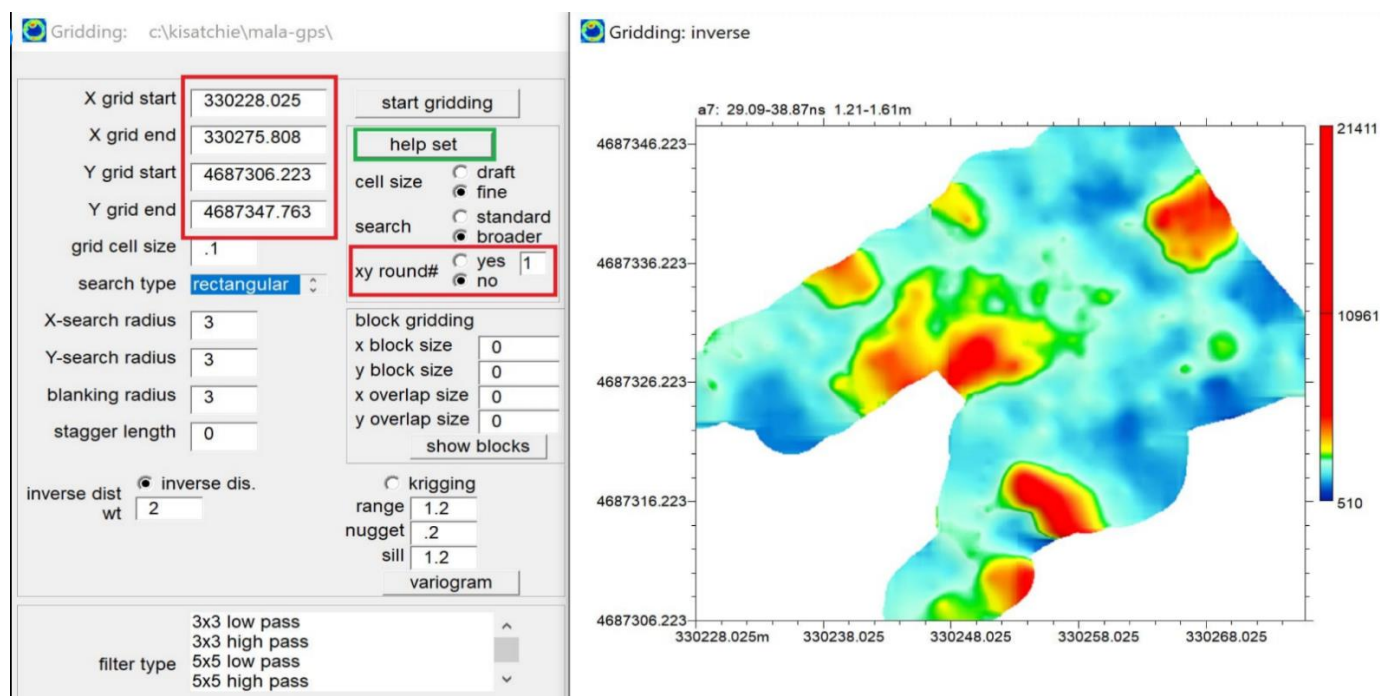


Figure 8. New options to control grid start/end rounding and data unit additions.

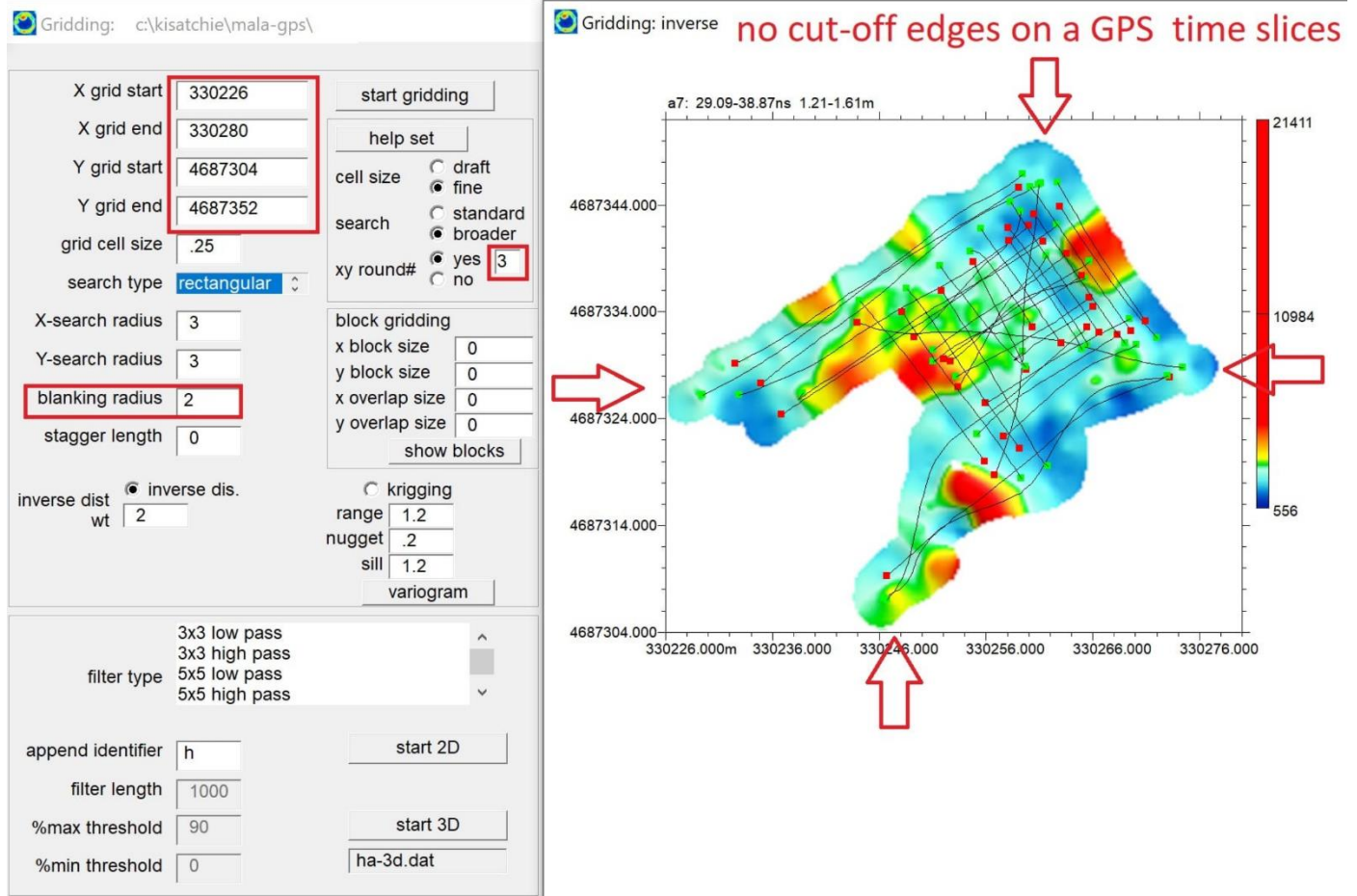


Figure 9. An example GPS time slice with the XYround# engaged and via the Help Set button will automatically adjust grid locations to insure no cutoff edges.

Parsing of long GPS radargrams

A new option to break up a long GPS radargram into smaller GPS radargrams is now available in the Radar Edit menu (Figure 10). The user will set the number of GPS points to parse the profile. Clicking the Parse GPS Profiles button will make radargrams which have N GPS points each. The last radargram will contain the remaining GPS points and will usually be a different size.

For an example, a radargram with 330 initial GPS points is broken up into segments that are 100 GPS points long. A total of 4 GPS profiles are generated with 3 being 100 GPS listings and the last having 30 GPS listings (Figure 11). The segmented GPS radargrams are all shown to be along a continuous track in the 3D display. Breaking up long GPS radargrams is not a requirement for processing but it is now available for those that may want to deal with shorter segments.

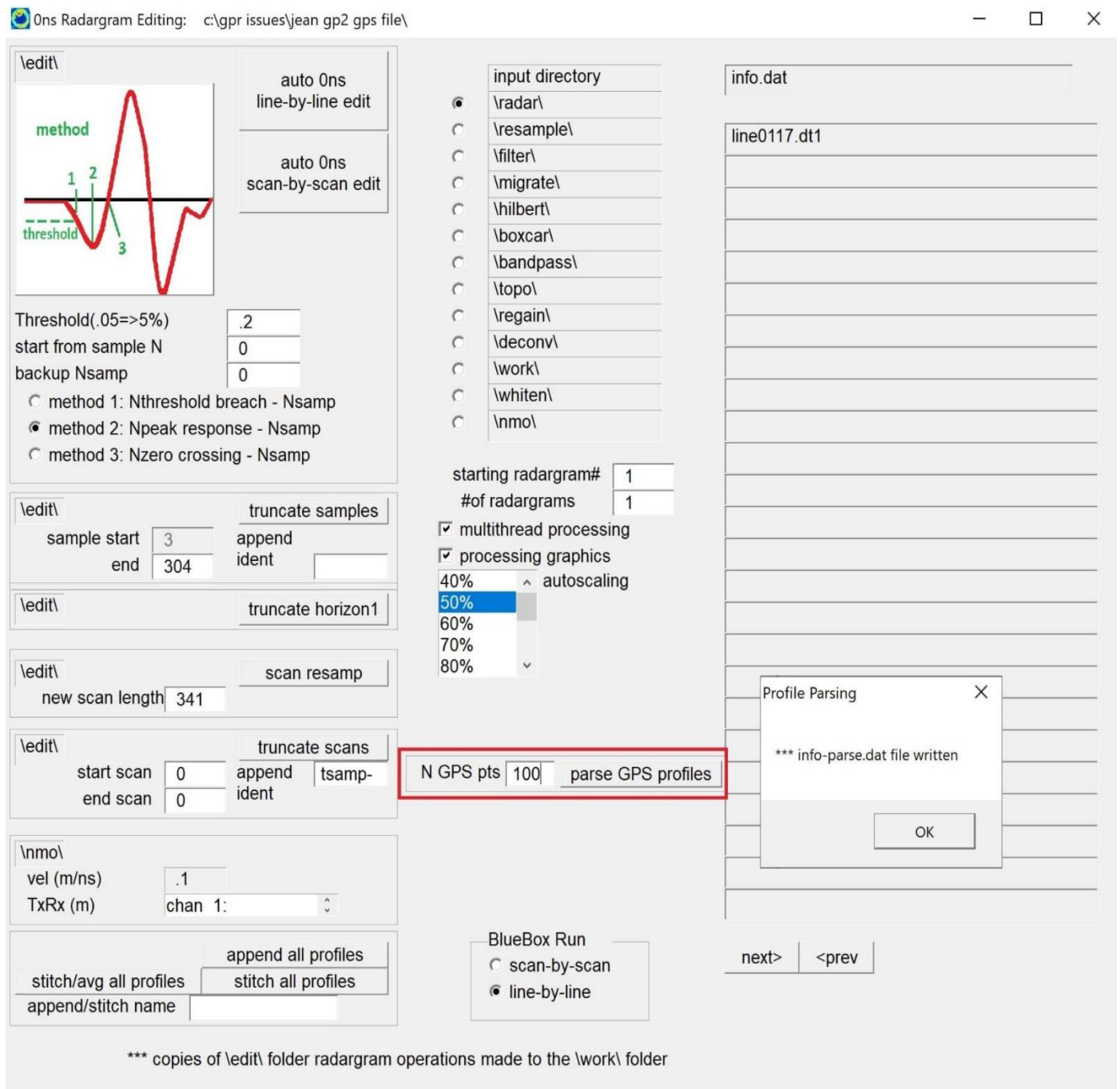


Figure 10. Location of the new option to parse a long GPS profile into independent profiles with N GPS points each. The option can also be run in batch on an entire list of profiles within the information file.

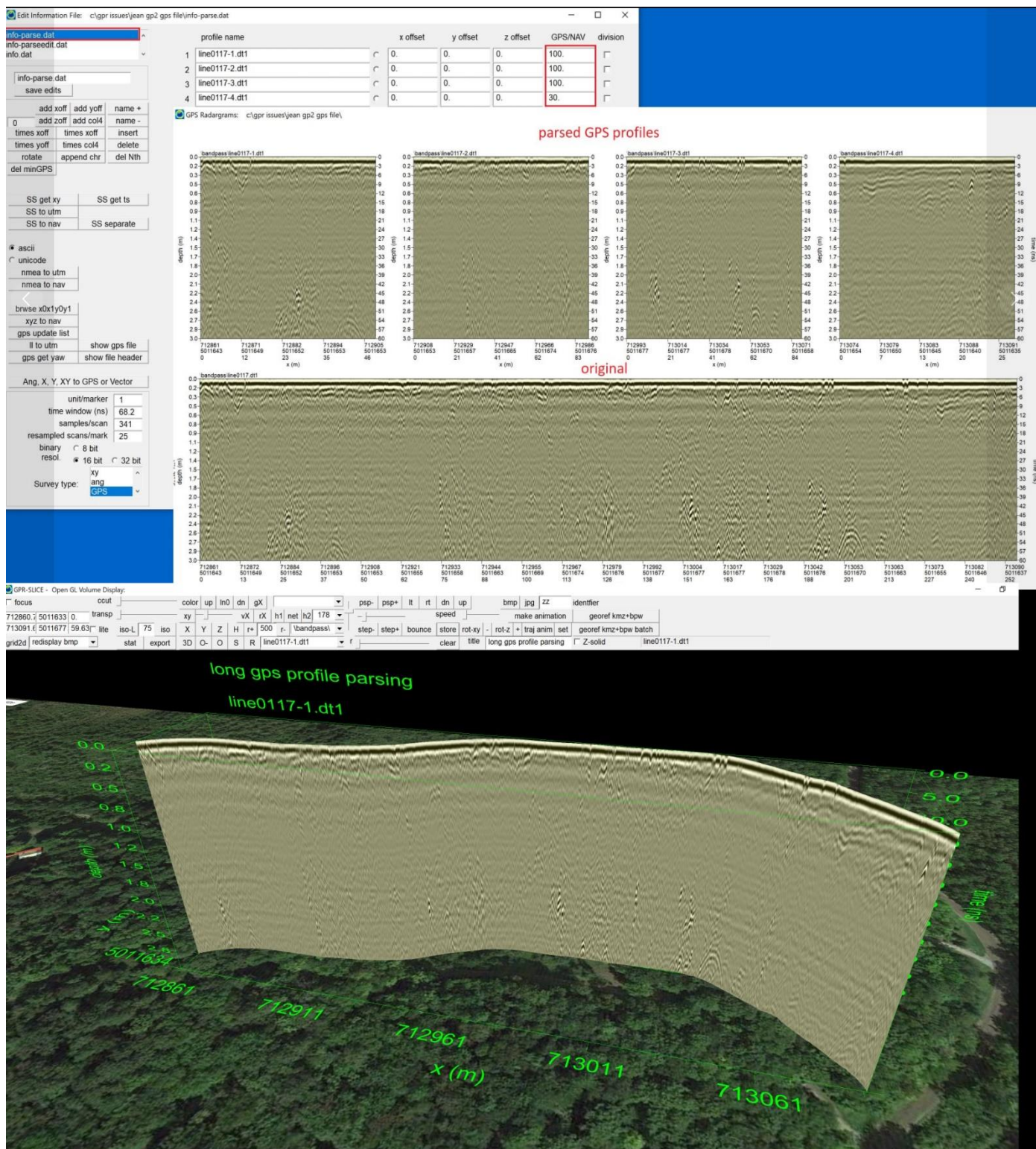


Figure 11. An example of a GPS profile with 330 GPS points and is parsed into 100 GPS point sections generating 4 profiles – 3 with 100 GPS point and the last with 30 GPS points. The 4 parsed profiles display seamlessly in OpenGL.

Software Update - Release of **GPR-SLICE v7.MT** (reposted and updated)

GPR-SLICE is a MultiThreaded – MT - application! If you have multiple cores on your computer, you can speed up processing by almost N times – where N is the number of logical cores! On many computers one can send 2 threads per core for processing - where the number of logical cores can be 2 times the number of actual cores. When one processes a set of radargrams, GPR-SLICE will send out each radargram process as a separate thread to be executed in Windows and to be run simultaneously on as many cores as exist on a computer. All-in-all, the speed of processing a set of radargrams can be increased almost by the number of logical cores one has on their computer!

Plot Options: c:\kisatchie\mala-gps\

time slice colors: 8 Edit radargram colors: 1 shading off isosurface colors: 47 shaded color horizon colors: 46 <input type="checkbox"/> reverse colors shaded relief	x screen size: 3840 y screen size: 2160 x2 screen size: 0 y2 screen size: 0 menu font size: 9	topo contours: <input type="radio"/> xform <input type="radio"/> linear <input type="radio"/> custom <input type="radio"/> only-xform <input checked="" type="radio"/> off # of contours: 4 contours(1-256): topo line thickness: 1	<input checked="" type="checkbox"/> multithread processing 16 # of logical cores - cpu current processes available <ul style="list-style-type: none"> - convert 16 bit radargrams - convert 32 bit radargrams - bandpass filtering - background filtering - background median filtering - boxcar smoothing - diffraction stack migration - kirchoff migration - hilbert transform - regain 16 bit radargrams - regain 32 bit radargrams - spectral whitening - cepstrum deconvolution - amplitude equalization
<input checked="" type="checkbox"/> automatic markers/labeling/fontsize Range Axis: <input checked="" type="radio"/> m <input type="radio"/> cm <input type="radio"/> mm <input type="radio"/> lat/long <input type="radio"/> ft <input type="radio"/> in <input type="radio"/> yd <input type="radio"/> lat/long dec <input type="radio"/> km <input type="radio"/> mi <input type="radio"/> off tick spacing: 2 off gridlines big tick freq: 10 - b tick for marker override label freq: 10 concatenate # of decimals: 0 polar labeling x label: x 2 side labels y label: y 4 side labels <input type="radio"/> GPS full scale 2+side OpenGL <input type="radio"/> GPS equidistant scale 2-side OpenGL <input type="radio"/> GPS 1-scan 1-pixel user marks <input checked="" type="radio"/> GPS constant scan xypoints pulse scan scale	labeling font size: 22 title font size: 22 font color: black backgrnd color: white OpenGL font size: 7 OpenGL A-font size: 5 TSPoints font size: 8 OpenGL speed-skip scans: 1 OpenGL cursor sensitivity: 5 OpenGL cursor color: black <input checked="" type="checkbox"/> OpenGL texture rendering <input type="checkbox"/> OpenGL font tilt <input type="checkbox"/> OpenGL axis label rotation	north arrow: off size%: 100 angle deg.: 170 x location pixels: 0 y location pixels: 0 overwrite warnings: <input type="checkbox"/> color taskbar icons: <input checked="" type="checkbox"/> main menu color: lt-blue	depth calculations and labeling antenna offset(m): 0 include offset: <input type="radio"/> yes <input checked="" type="radio"/> no * available only in radar2d menu time slice plot off: <input type="checkbox"/> overlay GPS track/xy grid: <input type="checkbox"/> overlay importxyz.dat pts: <input type="checkbox"/> overlay xypoints.dat pts: <input type="checkbox"/> point size (pixels): 1 overlay horizons - radargrams: <input type="checkbox"/> horizon line thickness: 40 overlay profile threshold line: <input type="checkbox"/> threshold depth: 0 overlay topo contours: <input type="checkbox"/> overlay sitemap.bmp: <input type="checkbox"/> overlay OpenGL topo sitemap: <input type="checkbox"/> core file: <input type="checkbox"/>
time axis: <input checked="" type="radio"/> ns <input type="radio"/> usec <input type="radio"/> msec <input type="radio"/> sec depth axis: <input checked="" type="radio"/> m <input type="radio"/> cm <input type="radio"/> mm <input type="radio"/> ft <input type="radio"/> in <input type="radio"/> off tick spacing: 25 big tick freq: 1 label freq: 1 # of decimals: 2 velocity (m/ns): 0.1 xhead loc. pixls: 10 yhead loc. pixls: 0 <input type="radio"/> depth <input type="radio"/> time <input type="radio"/> depth rad <input checked="" type="radio"/> time+depth add constant/datum: 0 time label: time depth label: depth	<input checked="" type="checkbox"/> legend off color table: <input type="radio"/> kmz border: <input type="radio"/> color transform <input type="radio"/> col xfm no #s legend label: N labels: 3 font size: 22 # decimals: 0 <input checked="" type="radio"/> vertical <input type="radio"/> horizontal display absolute elevations: <input type="radio"/> relative elevations: <input checked="" type="radio"/> detected elev min=-1.64m detected elev max=32.15m max files: 20000 max samples/scan: 8192	velocity model: <input checked="" type="radio"/> constant <input type="radio"/> block <input type="radio"/> profile set in the hyperbola search menu	- inverse distance gridding - krigging gridding - grid filtering - slice binning - time 0 detection - time 0 correction

Figure 8. Option menu showing available and updated multithread processes.

The list of processes currently available are outlined in the Options menu (Figure 8) and include radargram filtering, radargram conversion, radargram editing, time slice binning and gridding operations. Specifically:

- Convert 16 bit radargrams
- Convert 32 bit radargrams
- Bandpass filtering
- Background filtering
- Diffraction stack migration
- Kirchhoff Migration • Hilbert Transform
- Spectral Whitening
- Boxcar Smoothing
- Regain 16 bit radargrams (newly added MT operations)
- Regain 32 bit radargrams
- Spectral whitening
- Cepstrum deconvolution
- **Amplitude equalization (just added!)**
- -----
- Inverse distance gridding
- Kriging gridding
- Grid Filtering
- -----
- Slice binning
- -----
- Time 0 detection
- Time 0 correction

These operations are the most fundamental processes and have been included in the recent MT release. The desired number of cores can also be set and is available in the Options menu. If you are running other applications, you can limit GPR-SLICE to any portion of the available logical cores so all active applications will run smoothly. In addition, there can be a limit to the speed of operations such as when disk writing, so the user may want to test how many cores assigned improves the final speed of operations. This can also be different with some of the processes that require different kinds of computer resources.

Additional options added to GPR-SLICE Software

1/9/21/ World file formats import of coordinates adjusted to handle files without carriage return + line feeds

1/8/21 New Proceq GPS format for GS8000 integrated

1/8/21 Adjustment to import Proceq dual frequency *.csv infoxy information file

12/28/20 3D Radar SEG Y multiplex format with demultiplex button operation for multichannel licenses added to Edit Info File menu

12/19/20 Beta - UTM zone change along a GPS survey - fixing all UTM zones to first UTM zone calculation

12/17/20 Mala CX11 and CX12 extract/demultiplex buttons moved to the Edit Info File menu (with infomain.dat active)

12/16/20 Explicit Mala Mira 8 multichannel systems with just *.cor file (and no *.pos files) format added

12/15/20 Border removed from KMZ file in GPS Track menu as requested

12/14/20 Real time mouse pointer position updated above the active radargram on multi-radargram displays for XYpoints

12/10/20 New *.GPS file format from Impulse Radar and using the *.time files and the *.gps files to interpolate synced scans (when *.cor files are not provided)

11/30/20 Grid Help Set option to round off or not round off xy start/end points added

11/25/20 Import of customized navigation on the XYZ to NAV button in the Edit Info File menu adjusted to handle files with line feed but no carriage returns written

11/23/20 GPS track point editing option for one point, till end of track line, till start of track options added to GPS Track menu

11/19/20 Appending of *.dat time slice ascii files added to the Grid menu

11/13/20 Proceq Dual Frequency info-HF.dat and info-LF.dat auto xy information generated in the Create New Info menu on the Proceq infoxy2.dat listbox settings

11/12/20 FK spectra plot axis labels added

10/31/20 DPI aware manifests added to GPRSLICEv7.exe and GPRSLICE-animations.exe to auto recognize the native screen resolution without regard to Windows HI DPI setting engaged

10/30/20 Improvements to Bridgedeck module where detected hyperbolas can be inserted/removed with the mouse

10/28/20 Store JPG button added to the Bridgedeck module

10/24/20 Tilted circles vector import adjusted to remove roll angle column

10/24/20 ANG surveys now supported in the Horizon menu without having to convert to artificial "GPS" surveys

10/21/20 New vector import in the Create New Info file menu for tilted circles

10/11/20 Impulse Radar GPS log files with line feeds only and not carriage returns format option added

10/7/20 Impulse Radar multichannel offsets auto-read added on the Offset File button in the Create New Info menu

9/30/20 Interpolation of radargrams with unequal total number of scans - fixing to the least scan density profile

9/20/20 Improved detection of active composite block turned on for transform adjustment in the Composite Time Slice menu

9/9/20 Background median filter now programmed for custom filter lengths - prior was limited to full profile length

9/7/20 Ditchwitch, Subsite equipment manufacturers name added to Newproject menu

9/6/20 Custom filename import and export vector_survey_user_set.dat data in the Create New Info File menu

9/1/20 Topo warped volume now synced to volume time range and auto-cuts info files with longer/short time windows

8/27/20 Normalization gain factor added to Filter menu

8/25/20 Enhancement to Import 2D Geophysical Data for both browsing for a single input file or batch import via an identifier

8/25/20 Option to convert from any manufacturers import format to GPR-SLICE format then in to *.dzt format in Filter menu

8/24/20 32 to16 bit conversion buttons removed to encourage native resolution processing.

8/19/20 Before L_to_P conversion a backup file draw_L_to_P.dat is created and can be used to recover lines before pipe object conversion

8/16/20 Improved gridding and grid filtering multithread - number of active thread testing - and progressbar action

8/15/20 RadarTeam to UTM button update of SEG Y auto read and conversion lat/lon from double precision header location

8/11/20 Unicode filenames conversion option in the Transfer Utility menu (to handle import of foreign filenames)

8/2/20 Underscore append character identification for project import for IDS multichannel datasets added