Newsletter – August 2020

GPR-SLICE Subscribers,

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

1. **Delaware Tribe Historic Preservation, East Stroudsburg University, PA**
2. **Munifex Kft, Hungary**
3. **AMMAQ, Dubai, United Arab Emirates**
4. **RJR Engineering, USA**
5. **Coastal Carolina University, Conway, South Carolina**
6. **Norse Asset Solutions AS, Stavanger, Norway**
7. **IDS, North America**
8. **International Center for Tropical Agriculture , CIAT, Colombia**
9. **International Institute for Tropical Agriculture, IITA, Nigeria**
10. **hyperTunnel Limited, Basingstoke, UK**
11. **AECOM Geophysics, UK**
12. **Statistical Research Inc., Albuquerque, New Mexico**
13. **Australia Federal Police**
14. **Vision Survey Ltd, UK**
15. **Geomative Co, Ltd, Shenzhen, China**
16. **Stevenson Crane, Chicago**
17. **National Research Institute of Astronomy and Geophysics, NRIAG, Egypt**

18. SOCOTEC, Italia, s.r.l.
19. Geodia Industries, Georgetown, Guyana
20. Goodfellow Brothers Inc., Maui, HI
21. Loqate Services, Wellington, New Zealand
22. Dept of Anthropology, Washington State University
23. CGI Co. Ltd., Gyeonggi-do, Korea
24. Florida Department of Transportation
25. Ohio Valley Archaeology Inc, Columbus, Ohio
26. Lost World Cartography, Illinois
27. Tierra Engineering, Tampa, Florida
28. Geofisica Ambiental Servicios, Mexico
29. Datum Archaeology, Auckland, New Zealand
30. Dept of Earth Sciences, University of Florence, Italy
31. Earth Sciences Dept, Dickinson, Pennsylvania
32. Restek UK Ltd., United Kingdom
33. Faculty of Engineering/Applied Science, Memorial Univ. of Newfoundland, Canada
34. Clay Swindell, Merry Hill, North Carolina
35. Pocono Imaging Services, Denver, Colorado
36. BDI Structural Testing, Raleigh, North Carolina
37. Construction Survey Technologies Inc, Albuquerque, New Mexico
38. Everick Heritage, Brisbane, Australia
39. The Manufacturing Technology Center, Coventry, Uk
40. Center for Civil Protection, University of Florence, Italy
41. Coretec, Korea

Multichannel licenses were included to Munifex KFT Hungary, AECOM Geophysics UK, Vision Survey Ltd UK, Geomative Co Ltd Shenshen China, Socotec Italia, Construction Survey Technologies Inc New Mexico, University of Cadiz Spain. Several active organizations upgraded to multichannel licenses including Aero360 Philippines and Target Geophysics Belgium. Of a total of 354 subscriptions across 310 organizations, 76 are now multichannel and comprise 21% of all GPR-SLICE licenses

Bridgedeck licenses were included to Geomative Co Ltd Shenshen China, Socotec Italia, Construction Survey Technologies Inc New Mexico, Dept of History/Geography/Philosophy University of Cadiz Spain.

GPRSIM licenses were delivered to HyperTunnel LTD-UK, Dept of Anthropology Washington State University, and BDI Structural Testing Raleigh North Carolina

Major features and options added to GPR-SLICE include:

- Augmented displays option in OpenGL
- New Radar 2D menu option to show up to 3 information file radargrams with different samples/scan and time windows
- Conversion of WGS84 lat long to British National Grid OSGB36 using the OSTN36 lookup table + Non WGS84 coordinate systems can now have Google Earth maps overlaid in OpenGL Volume
- Overlay analysis now can show progressive separate displays and stores all overlay segments to individual grid files
- New 2D Time Slice Gridblock menu - for splicing all the 3D binary volumes from a gridblock dataset into comprehensive 2D time slice
- Pipe turning juncture option for L to P added to OpenGL Volume Draw menu + L-Edit button added to adjust points on an active line drawing
- New scan scale and constant GPS scan scale option added to 2D radargram displays
- 3D migration speed improvement + angle juncture customized setting

Augmented displays in OpenGL

Several new augmented displays using a ground surface site map or Google Earth map is now available in OpenGL (Figure 1). In the BMP Image menu new radio buttons are available called virtual 1 or virtual 2. With virtual 1 checked on, the active overlay bitmap will automatically be placed on the ground surface (top of the volume) and the XY start/end rectangular volume will be opened for viewing the data "below" the ground surface. The new option can also be viewed with object or utility drawings. With virtual 2 engaged just the outline of the surveyed areas and will be removed from the overlay bitmap. With the radio set to off, the regular sitemap bitmap without any removal will be placed automatically on the bottom of the volume. One can also always adjust manually what the depth level they would like to place the sitemap in the menu.
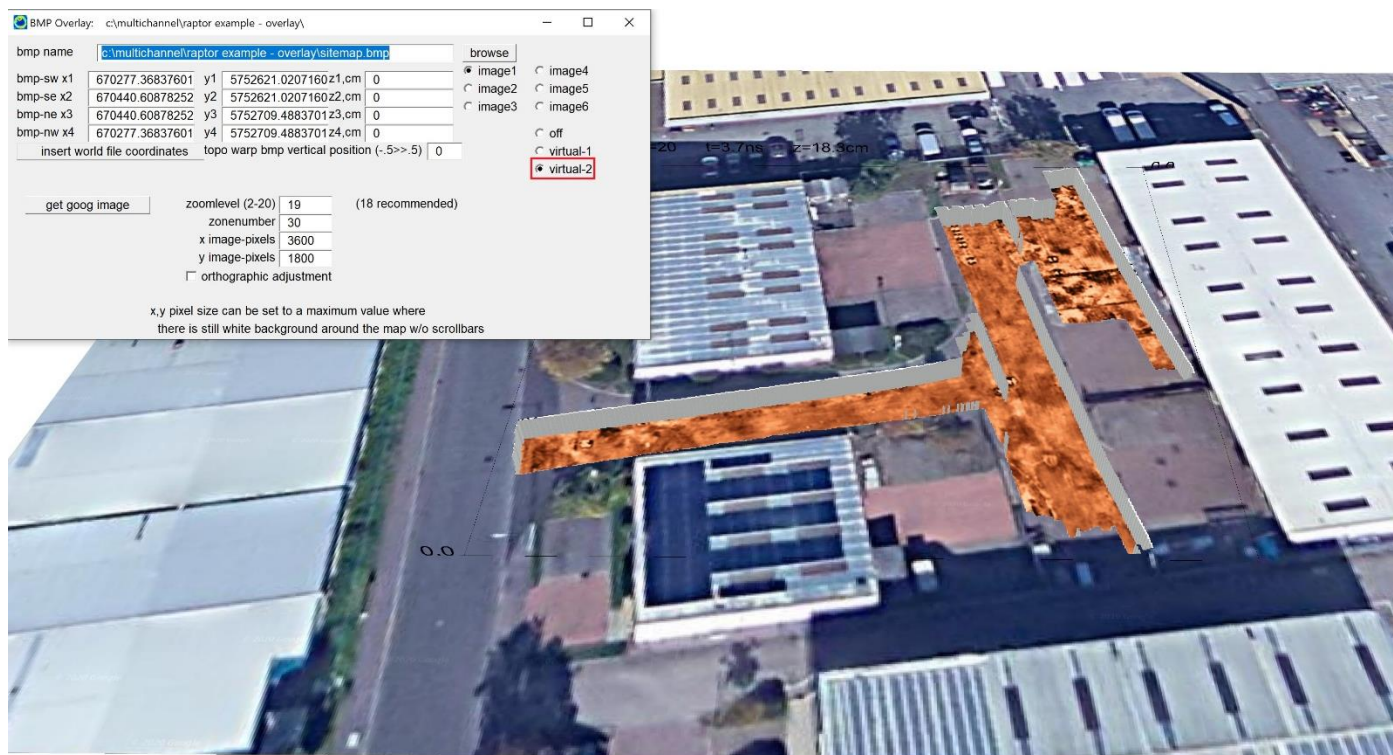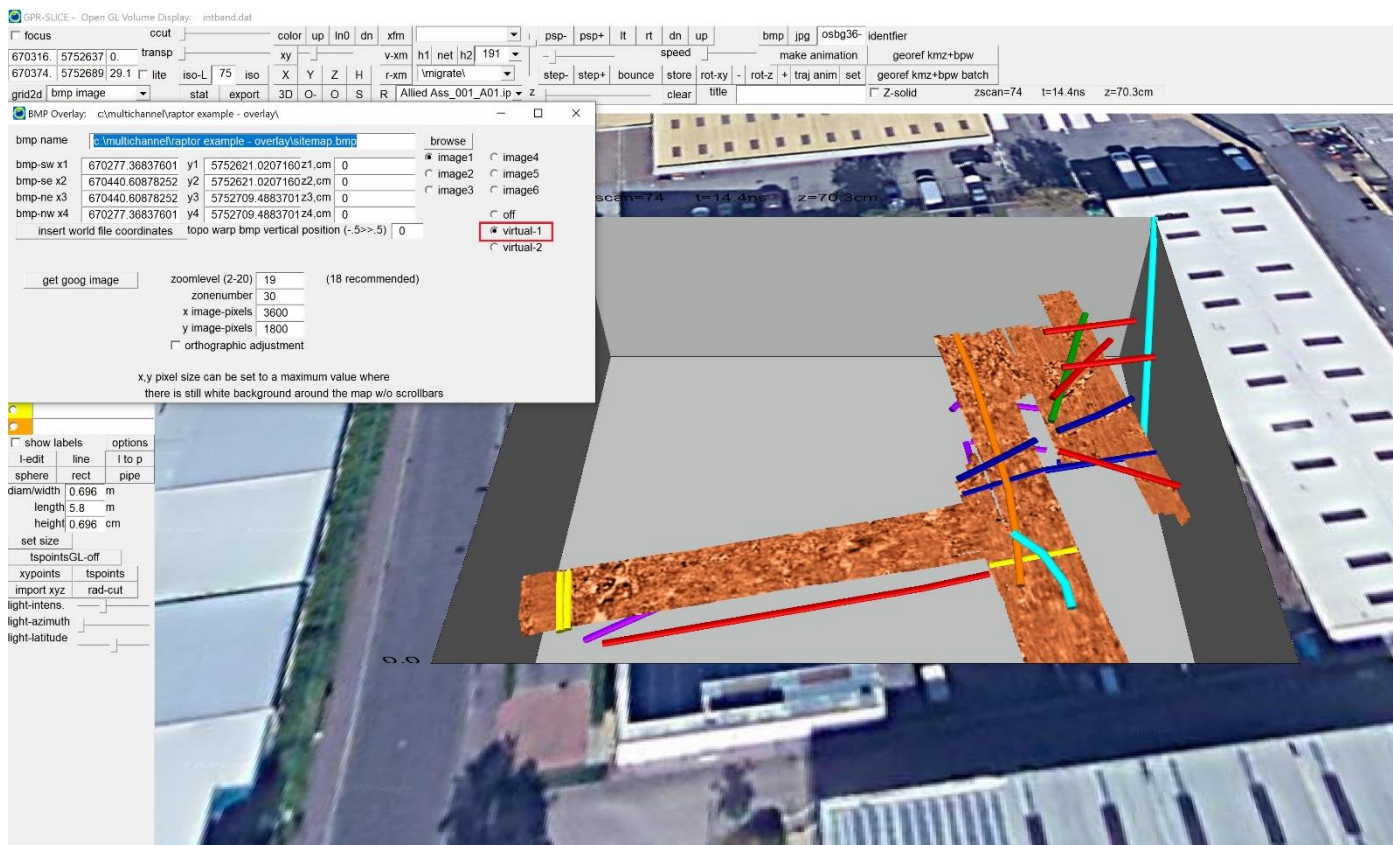
Figure 1. Augmented displays of a rectangular subsurface volume over the survey site (virtual 1) or augmented displays with just the survey outline (virtual 2).

New Radar 2D menu option to show up to 3 information file which can have different samples/scan and time windows

At the request of several users with dual frequency and triple frequency radargrams and wanting to view these different channels in the same graphic dialog, a new menu called 2D+2D+2D Radargrams was developed (Figure 2). This menu will allow displays of up to 3 different info files describing radargrams all of which can have different time windows and samples scan.
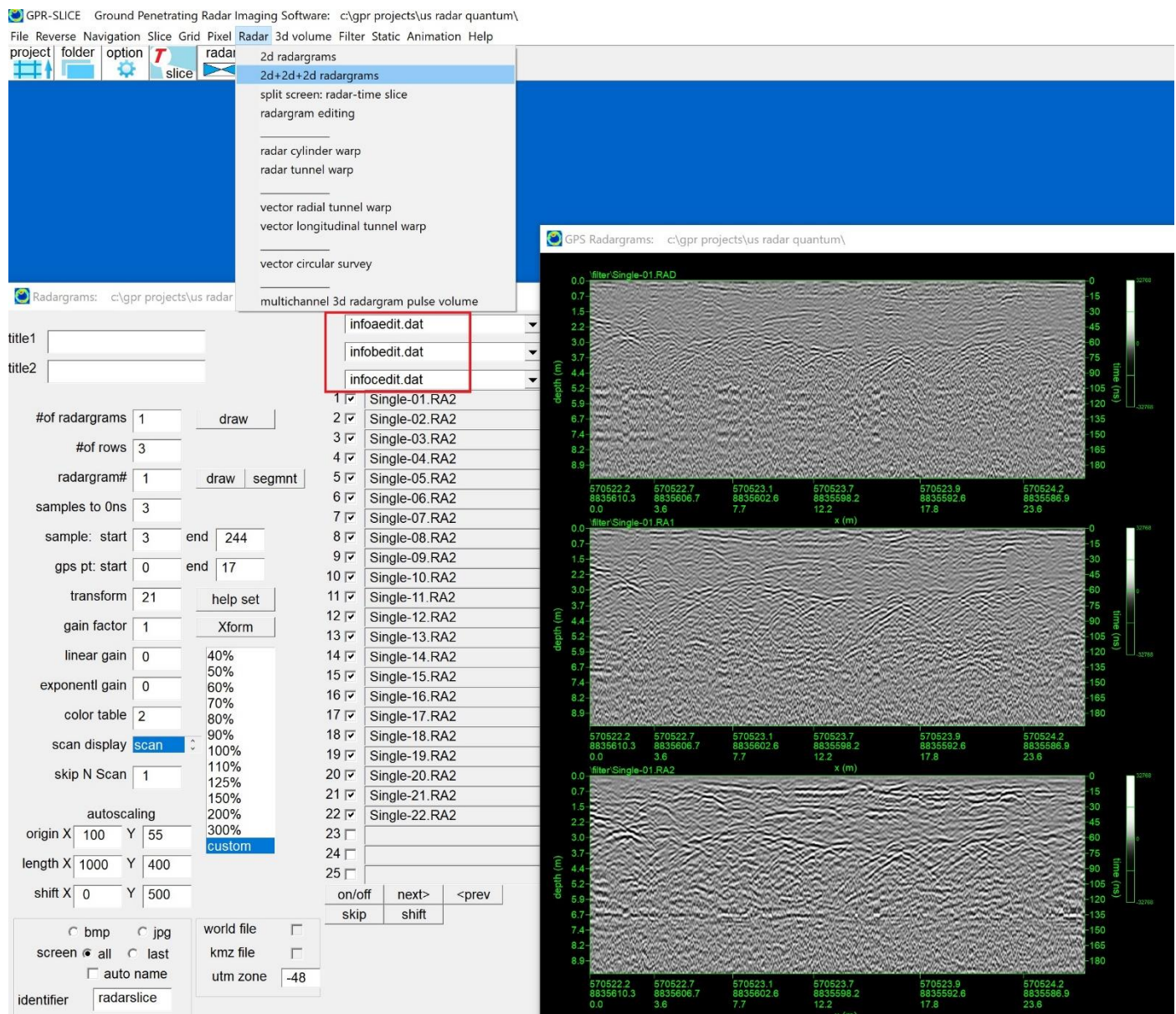

Figure 2. Example of a US Radar triple frequency dataset where all the different channels with different processing, time windows or digitization can be viewed in the new 2d+2d+2d Radargram menu.

Conversion of WGS84 lat lon to British National Grid OSGB36 using the OSTN36 lookup tables + Non WGS84 coordinate systems can now have Google Earth maps overlaid in OpenGL Volume

For those users in the United Kingdom we now provide conversion for the more accurate British National Grid using the OSTN15 lookup tables. Our earlier conversion had the Helmert transformation which would get one close to their location but could still be off 1-5 meters depending on the district surveyed. The new option requires updating new library files as a new dynamic linked library that also contains 4 different *.dat files for performing the coordinate conversion from WGS84 to OSGB36. Interestingly, the OSTN15 tables have corrections for seafloor spreading and other phenomena. Several other coordinate transformations provided for such as Irish National Grid, etc. are also now all executed in the GPS Track menu. GPR-SLICE will store WGS84 coordinates upon conversion so that Google Earth maps and sitemaps can be exported and retrieved in OpenGL. The conversion menu is a one-way operation and you cannot go backwards to WGS84. Should you want these coordinates you will need to recreate those.
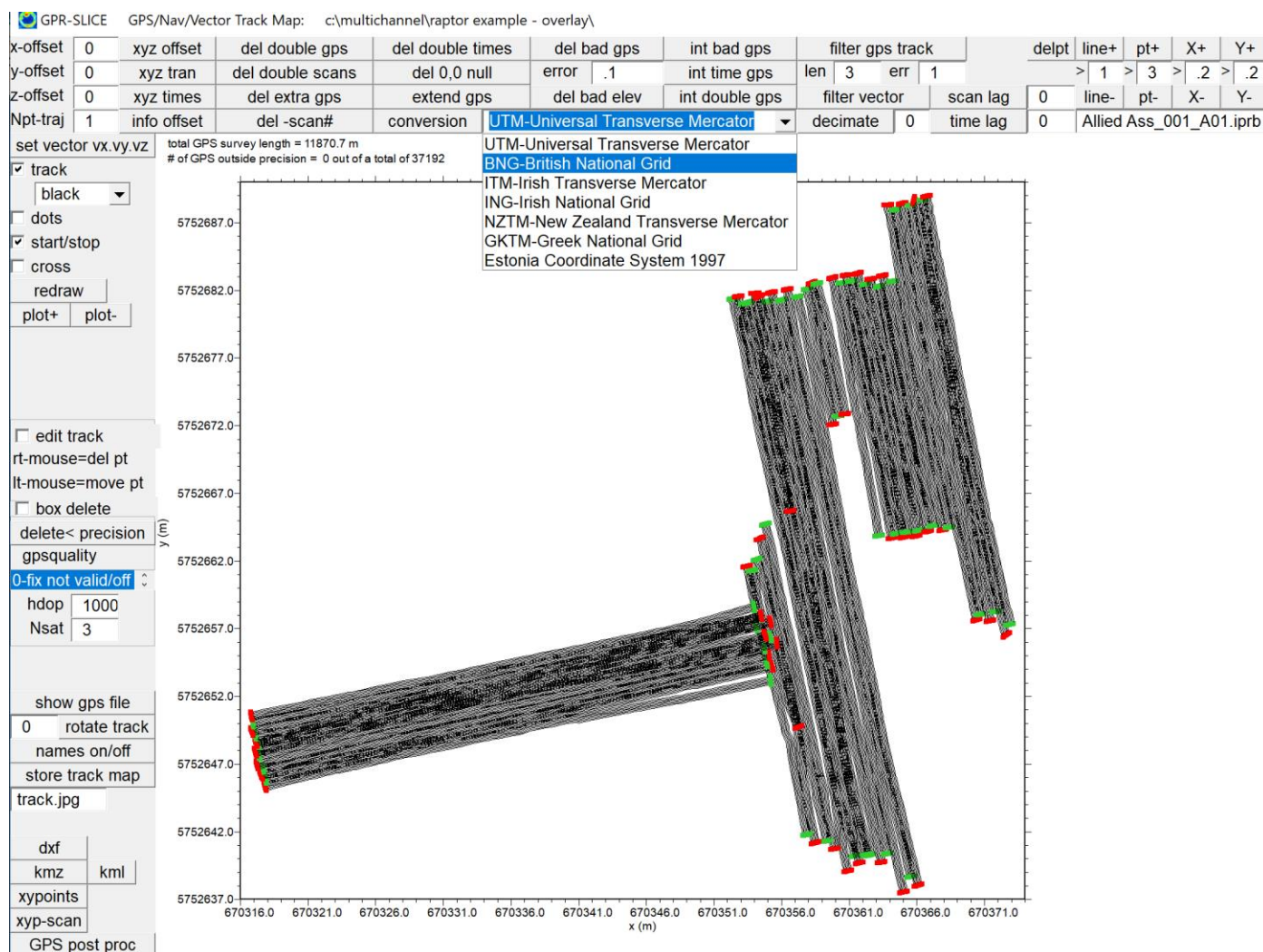

Figure 3. Operations for conversion of WGS84 to British National Grid.

Overlay analysis now can show progressive separate displays and stores all overlay segments to individual grid files

Overlay time slices are especially useful in presenting all the relevant information from a site on a single image. Although the depth information can be lost, the final images are often comprehensive and can be the most important data presented to show all the relevant subsurface reflections. Progressive overlays are now shown when clicking the overlay button. The operation will also write out each consecutive overlay time slice to its own 2D grid file. This new option will allow the user to redisplay in separate maps and also recall the entire overlay dataset as another independent file gridset with its identifier given as ###-overlay1-N.grd. Recently a new Overlay-(minus) button was also programmed into the menu to allow the overlay of the relative-weakest-reflectors, which can also have some possible applications to imaging features of interest that are weak reflectors and not strong.
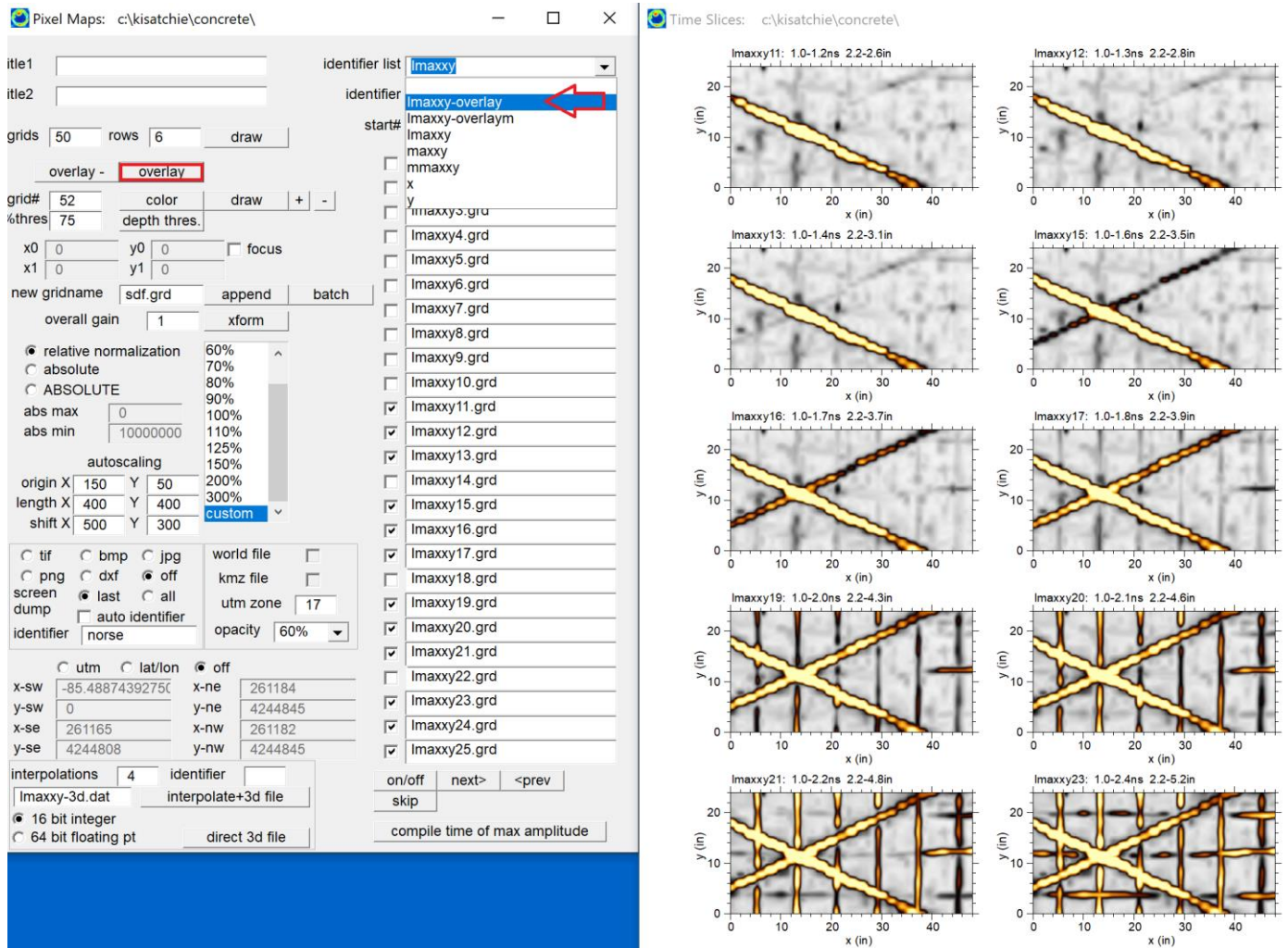

Figure 4. Display of progressive overlays of the relative-strongest-reflector for a concrete dataset. A new button Overlay- is also available for overlays of the relative-weakest-reflector.

New 2D Time Slice Gridblock menu - for splicing all the 3D binary volumes from a gridblock dataset into comprehensive 2D time slice

Recently, a subscriber had a 9 km coarsely spaced multichannel dataset on a roadway. All the viewing capabilities and drawing utilities in the OpenGL Volume Gridblock menu were available. However, the one capability missing was being able to capture the entire site into a Google Earth KMZ file at sufficient resolution. OpenGL is a device context and most output is limited to the available screen size.
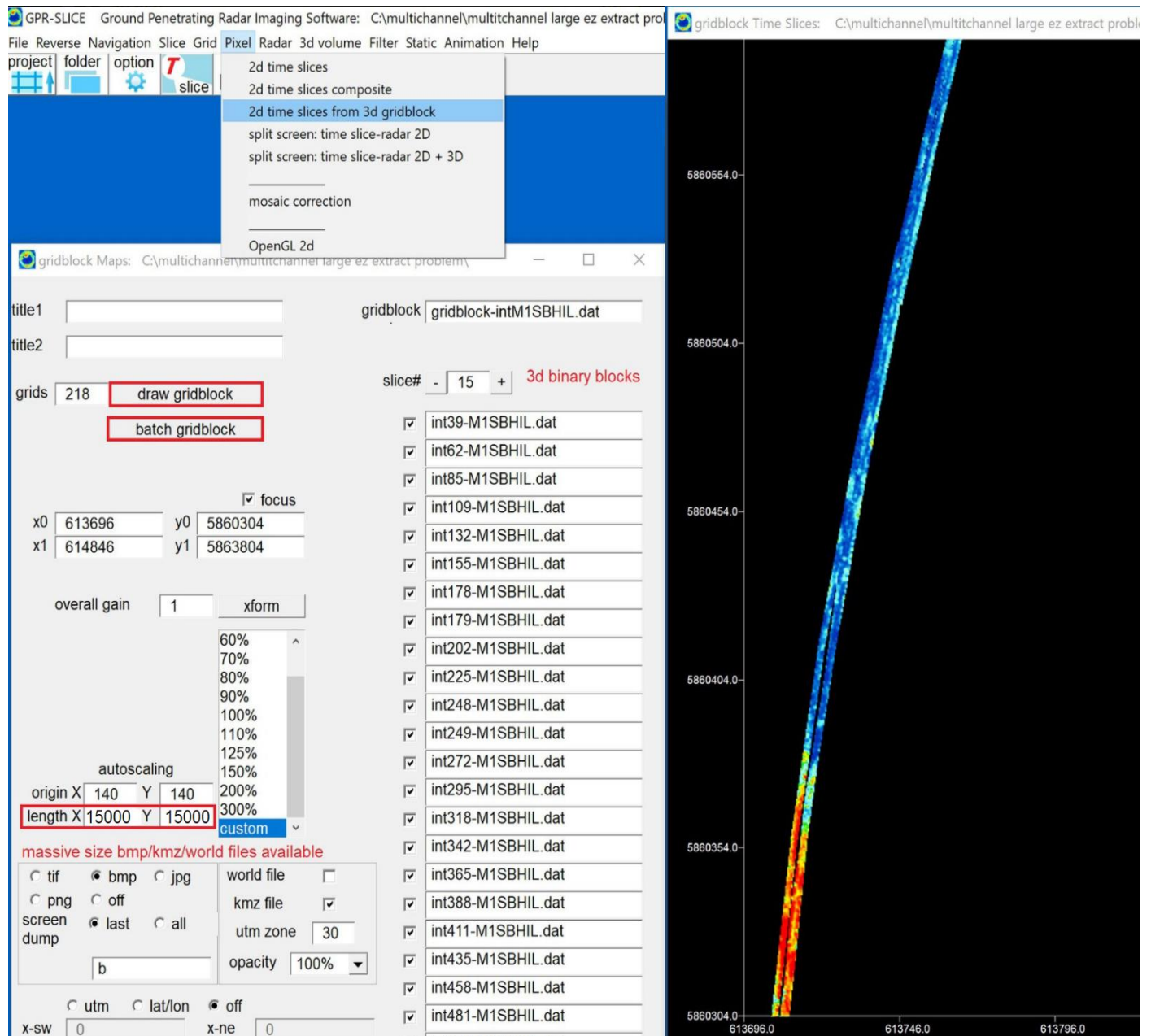

Figure 5. New menu 2D Time Slices from 3D Gridblocks for exporting large areas in georeferenced images.

To be able to make large georeferenced output a new 2d menu title "2D Time Slices from 3D Gridblocks" was developed to handle creating output from large sites (Figure 5). The new menu has as the filename slots showing all the individual 3d binary block volumes contained in the dataset. For this example, 218 gridblocks each 50mx50mx143 were generated for the 9km dataset. Graphic memory in this menu can create massive bitmaps that can be used for making KMZ or World Files. Google Earth currently has a limit of displaying georeferenced bitmaps no larger than 16384x16384. To get a 9km site into sufficient resolution to display in google earth, the users can use the focus settings in the menu to make 4-5 sets of georeferenced imagery at the max resolutions. For bitmaps at 10cm the max resolution might represent 1.6384 km of data. The new menu has batch button to conveniently get out all the images from the entire volume levels. For large sites it may take 5-15 seconds per level to completely render to the screen - so the batch button will save time to at least have everything created automatically.

New scan scale and constant GPS scan scale option added to 2D radargram displays

There are now 4 different ways to output GPS labeling on radargrams. The most recent addition is the option constant scan display. This will place GPS labels at equidistant scans irrespective of the distance between markers and irrespective of whether a marker tag exists. This display will cosmetically look nicer on 2D GPS displays. Additionally, a new scan scale is also available to be shown on the top of the radargram. This option can be used for regular or GPS profile displays.
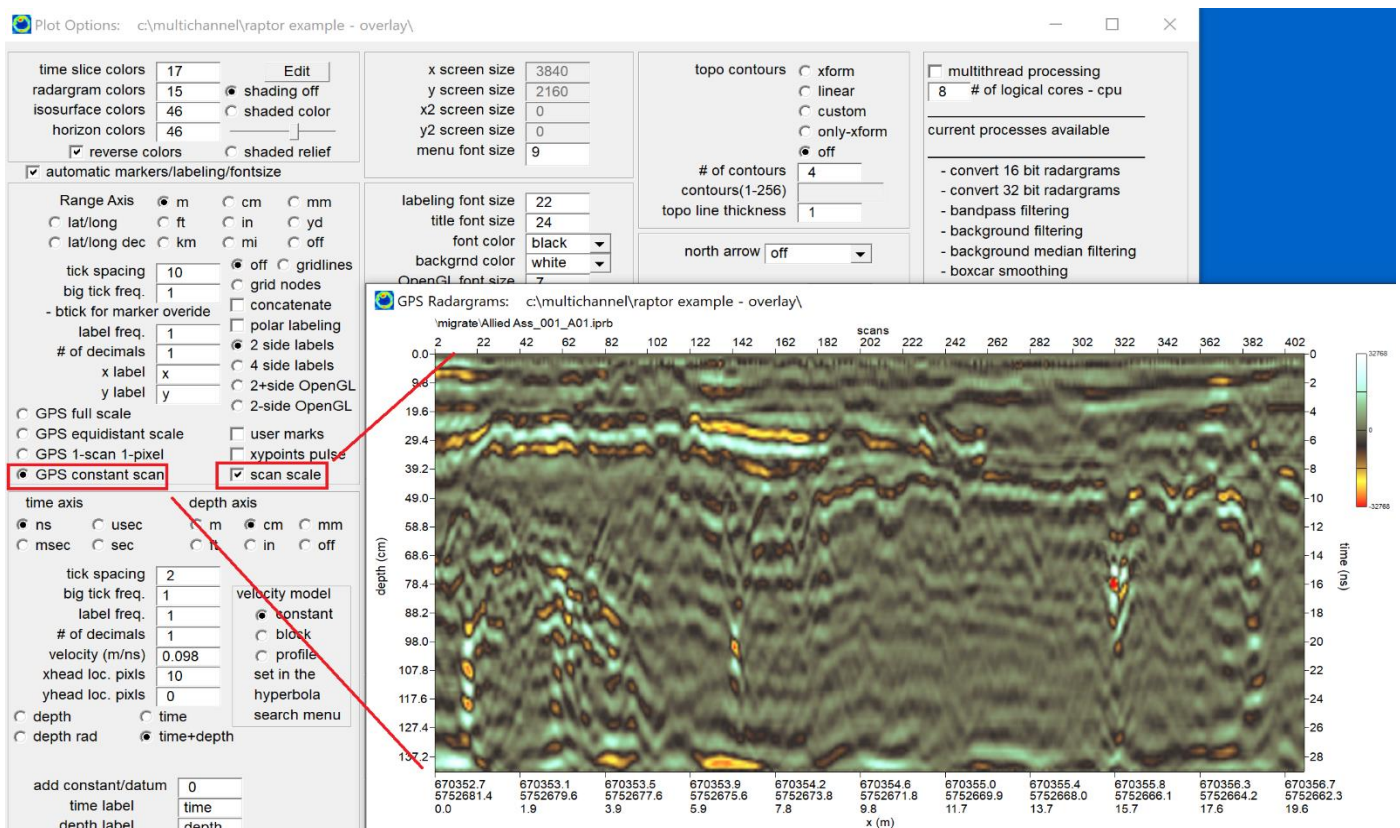

Figure 6. Option menu showing locations where to engaged constant GPS scan labels and to show the scan scale on top of the profiles.

Pipe turning juncture option for L to P added to OpenGL Volume Draw menu + L-Edit button added to adjust points on a active line drawing

Several requests to improve line conversion to pipe objects were addressed in the OpenGL Volume Draw menu.   The L to P button was enhanced to work completely in batch to convert all line functions to pipes. Pipe turning junctions are now modeled with 3D spheres to give smooth appearance of the pipe angles. In addition, new editing options for deleting or adjusting a point were added.   With any drawn object active, the user can right click the object and it will be deleted. To adjust a point on a line with the new L Edit button engage, a right click will move the nearest found point to the new mouse location.
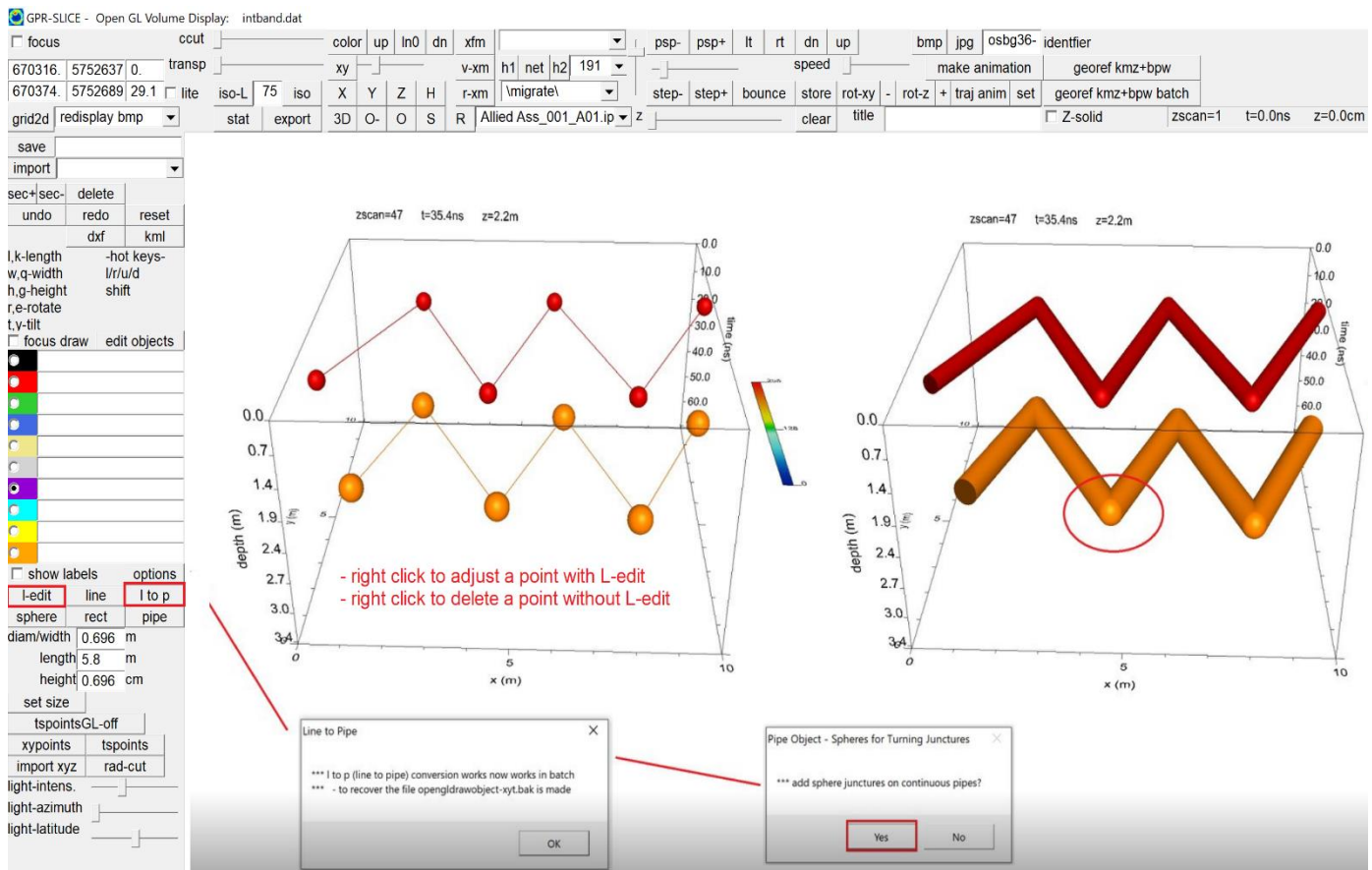

Figure 6. New drawing capabilities for converting lines to pipes and for editing.

3D migration speed improvement + new angle juncture customized setting

Earlier this year significant improvements to 3D migration processing speed was discovered in GPR-SLICE and a benign single source code line was holding back the processing. With the fix to the software, 3D migration speeds were found to be 30-50 times faster.

To allow for further streamline processing an angle juncture setting has been provided in the 3D migration menu. The angle juncture describes the density along the 3D hyperboloid that will be used in the migration process. The angle can be set from a variety of angles (90,60,45,30,20,15,10,8,6,5,4,3,2,1) to perform migration. Comparison examples are shown with the angle juncture over which migration is performed at 90, 45, 10 and 5 degrees. With an angle juncture of 90, which is identical to 2.5D migration, one can see from the imagery for this small multichannel test site, that the 2.5D migration looks insufficient in properly migrating the 3D diffractions. Halving the angle to 45 degree also does not show much improvement. However, at 10 degrees the migration looks good and the 3d hyperbolas seen in the raw data are properly migrated. At 5 degrees or lower, there is no major visible improvement. A 10 degrees angle juncture will make 36 equidistant samplings around of the 3D hyperboloid. For a narrow migrator aperture (cell widths), a 10 degree angle juncture can essentially sample the entire hyperboloid in the migration. For larger migrator aperture widths, less of the hyperboloid would be sampled, but having a larger angle juncture can still significantly reduce processing time without a large loss of resolution.
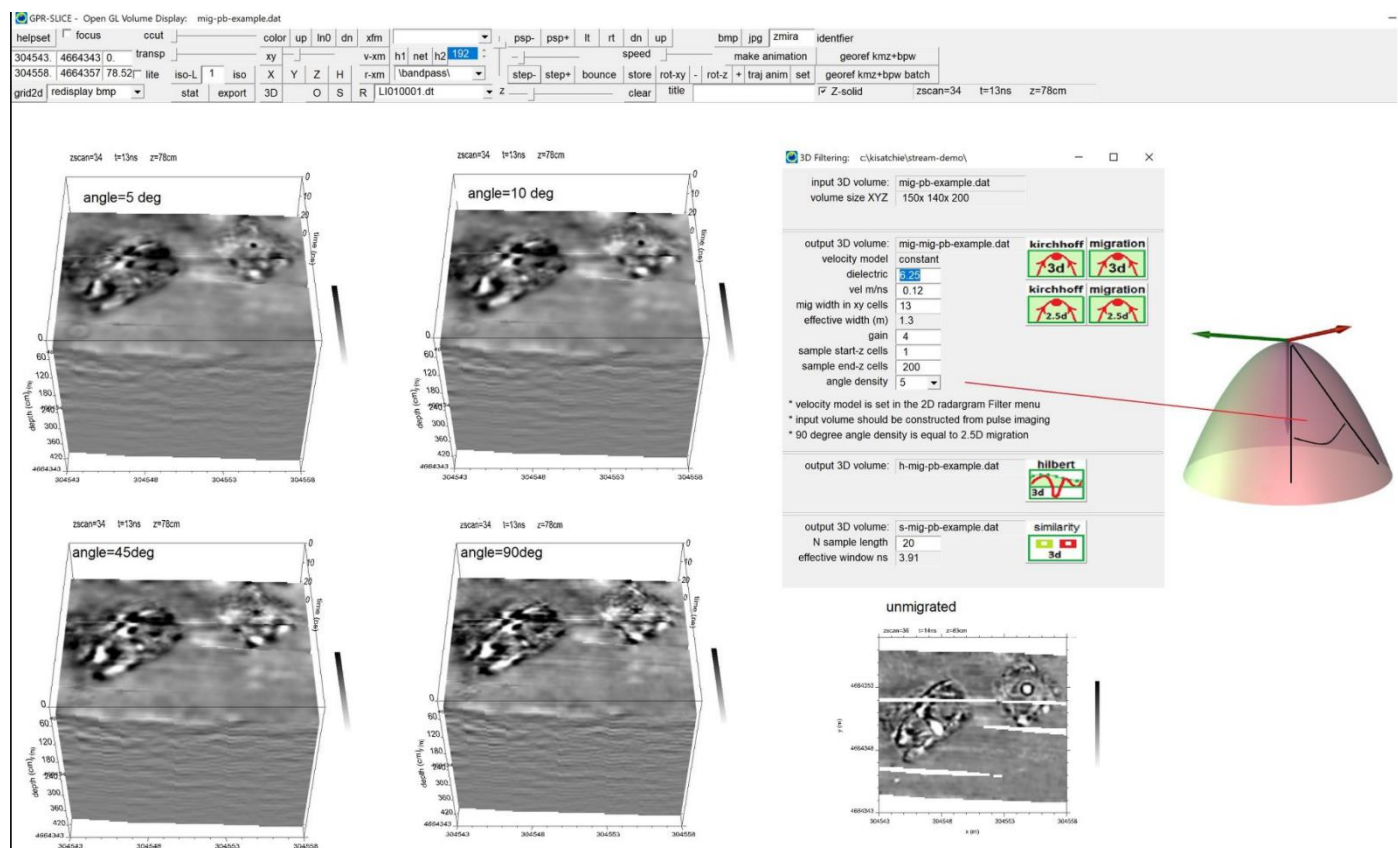

Figure 7. New angle juncture setting to sample the hyperboloid in 3D migration.

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

If you have not been following the updates on the website or our FB group or LinkedIn page then the biggest news since OpenGL was added to the software some 10 years ago is that GPR-SLICE v7.0 is now GPR-SLICE v7.MT!   So, what's new?   Well the MT of course!   GPR-SLICE is now 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!
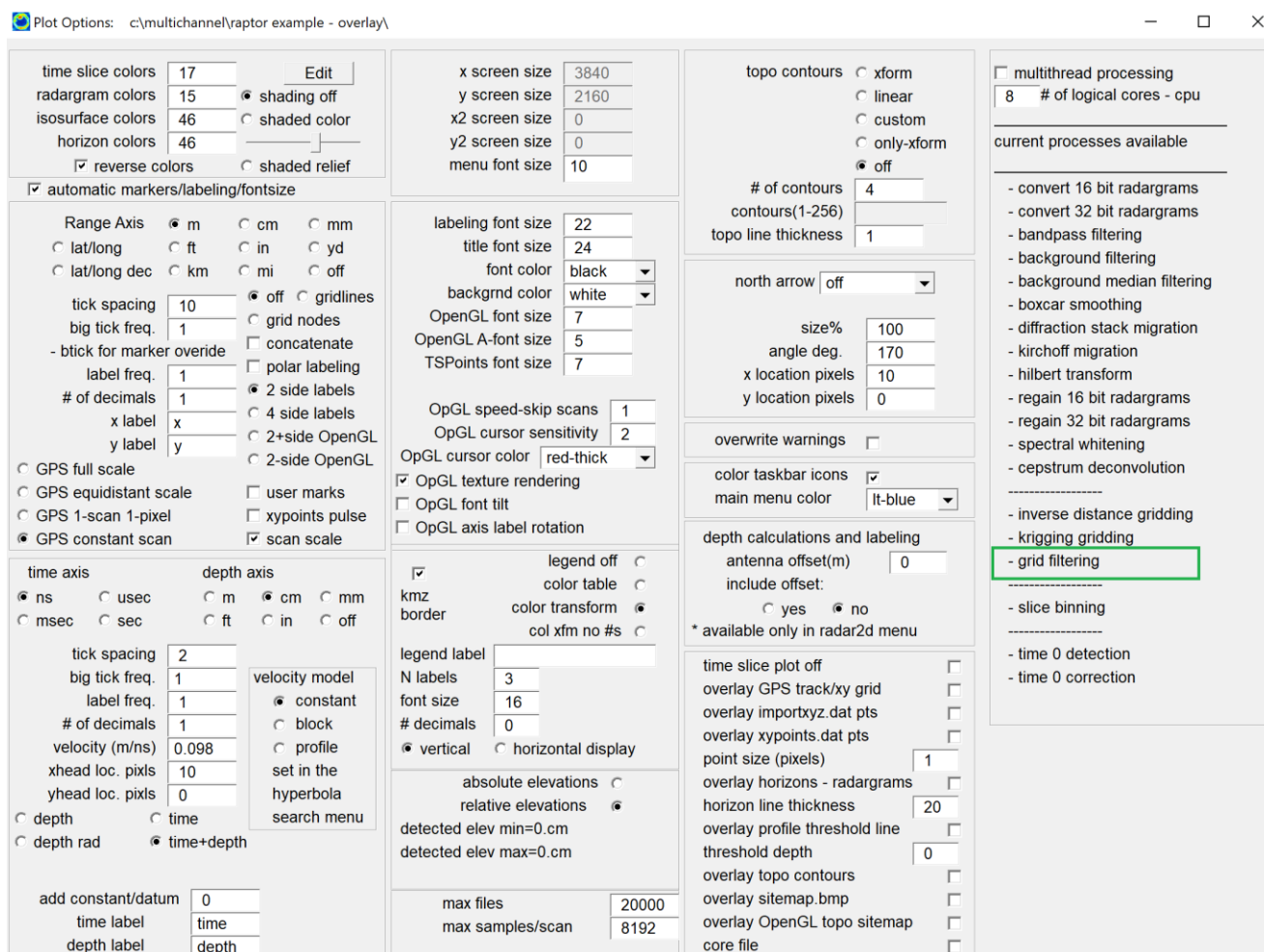

Figure 8. Option menu showing available and updated multithread processes.

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
- -----
- Inverse distance gridding
- Kriging gridding
- **Grid filtering – (just added !!!)**
- -----
- 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.

Note: With MT turned on all processing graphics are disabled.   For quick viewing of radargrams signal processing, radar editing or gridding operations, the same checkbox that is available in the Options menu is conveniently available in these menus as well to shut MT off.

Additional options added to GPR-SLICE Software

7/20/20 Improved navigation/slice binning locations on GPS surveys particularly for GPS surveys where navigation is fixed on each scan from the raw log files

7/20/20 Decimal amplitudes written to time slice data files

7/20/20 Improved GPS radargram display in OpenGL

7/20/20 Makeshift fix for 1 scan on RadarTeam log files starting from scan 0 and not scan 1

7/17/20 Frequency of peak amplitude data reduced by 75% by taken data every 4th scan

7/15/20 Non WGS84 coordinate systems can now have Google Earth maps overlaid in OpenGL Volume

7/13/20 XYZA volume export added to 3D Volume pulldown for x,y,z and the raw binary integer (amplitude) value

7/12/20 4 decimals display in the Edit Info File menu requested

7/12/20 Info-append.dat file automatically made for x or y surveys for radargram appending/stitching in the Radar Edit menu

7/2/20 World files in the Pixel Map menu exported in local coordinates and not WGS84

6/28/20 Terminate processing button for cleaner BlueBox Batch operation cancellation added

6/28/20 Horizon-depthN.grd gridded horizon depth grids based on the velocity used during compilation can now be shown in OpenGL, along with HorizonN.grd files which are the sample number of the horizon detected on the radargrams

6/17/20 3D migration of 32 bit volumes available

6/12/20 Auto read on the Offset File button in the Create New Info menu for the Mala Mira multichannel equipment

6/10/20 Impulse Radar Crossover/PinpointR single baseline auto info file generation added to Create New Info menu

6/9/20 Orthographic correction on bitmap overlay added backing OpenGL menu

6/1/20 Older raster menus, Show Example, Spectra+Gain converted vector graphics

5/23/20 Improved graphic memory for OpenGL by only reading in planes into a 3D color volume and not first into a data array

5/21/20 Full 32 bit integer 3D multichannel -3D direct radar volume generation and filtering

5/20/20 PinPointR and CrossOver Impulse Radar equipment survey wheel reads added to Edit Info File menu

5/14/20 Mala Mira HDR *.rd7 multichannel format added

5/1/20 - Warning message on entering the Radar Edit menu if \radar\ folder radargrams do not have marker detected - i.e navigation applied

4/19/20 Increased speed in exporting volume data to *.xyzirgb and *.xyzg ascii formats; 2-3 times speed increase in writing ascii time slices

4/15/20 Conversion of 3D volume adjusted for topography for the *.xyzirgb format added onto the 3D Volume pulldown main menu identified as *.xydirgb

4/14/20 DXF files with elevation/depth labels, and alternate depth labeling written as ",d" added to OpenGL Topo Volume Warp

4/11/20 Proceq project folder opens up on the \raw\ folder with *.csv extension files for easier import of the information file

4/10/20 OpenGL Topo Volume Warp menu for gridblocks dataset for topography are also made in the Static pulldown menu

4/9/20 Mala GPS format upgraded to represent GPS quality assignment to replace HDOP in the *.cor files

4/8/20 Display lists used in piecemealing isosurface displays to allow for large volume rendering

4/4/20 XZ vector variable profile import added to XYZtoNAV button to automatically make vectors on XZ profiles such as tunnels that are not circular but have unique shapes

3/28/20 Improved mouse action on gridblock datasets with further curson sensitivity controls in addition to arrow controls on placing the drawing cursor and pgup/pgdn for Zscan movement

3/25/20 Import of external 3D geophysical data menu includes a scale factor multiplier option

3/24/20 3D volume min/max for 3D radargram direct compilation now looks at min/max of matrix data and not relegated to the binary resolution of the recorded radargrams.

3/22/20 Additional overall speed improvements of up to 10% on radargram filters and processes

3/13/20 Negative Z isosurface export file for DXF added to OpenGL Volume

3/13/20 Master.gps format changed to time (UTC), x,y,z from previous time (UTC),y,x,z for GPS post processing operations in the track menu

3/1/20 Impulse Radar PinPointR and Crossover format and Bluebox operations added

2/22/20 DXF minus button placed back into OpenGL Volume Draw menu

2/22/20 Composite Pixel Map displays now support overlap on white pixels

2/20/20 Y sample end of radargrams added to Horizon menu to allow truncation of displays

2/12/20 Sensors and Software *.gfp data version 1.2.0 format read added to Create New Info menu for auto infoxy.dat generation

2/5/20 GPS volumes now synced to GPS radargrams on the R-Sync button in OpenGL XYZ-2D