

Importing and using inversion results from Res2DInv and Res3DInv in Aarhus Workbench

This is a guide on how to export inversion results from Res2DIna and Res3DInv for use in Aarhus workbench, and to how the results can be imported and used in Aarhus workbench

Contents

Global coordinates	1
Res2DInv	2
Res3DInv	2
Exporting inversion results from Res2Dinv and Res3Dinv	2
Res2DInv	2
Res3DInv	3
Importing and using Res2Dinv and Res3DInv inversion results in Aarhus Workbench	4
Aarhus Workbench help pages	4
Importing inversion results	4
Creating model selections	6
Adding a background map and plotting the location of inversion results on a map	8
Creating profiles from inversion results	10
Creating horizontal mean resistivity maps, and other horizontal maps based on inversion results	12
Visualizing themes	14
Visualizing results in the 3D viewer	16
Creating a PDF report from template	18

Global coordinates

To make full use of the features in Aarhus Workbench it is necessary to include global coordinates in the .dat files prior to inversion. These coordinates ensure that the inversion results are located correctly on the GIS map, and that the individual inversion results as well as additional information, such as boreholes, are located correctly relatively to each other.

It is recommended to use a coordinate system where the positions are given in meters, such as the UTM system. It is important to note the UTM zone and datum of the coordinates in the .dat files as these must be specified when importing the inversion results in Aarhus Workbench.



Coordinates are included in the .dat files in different ways for Res2DInv and Res3DInv:

Res2DInv

In Res2DInv the coordinates are entered at the end of the file as seen in the example below, see section 7.11 of the Res2DInv manual for further details.

794 795 796 797 798	4 2: 4 2: 4 2: 0 Indicat	35.00 35.00 35.00 35.00 ting no top	4.82 4.82 4.82 4.82 00graphy	355.00 355.00 355.00 355.00 / informatio	7.41 7.41 7.41 7.41 7.41 50 in this	305.00 315.00 325.00 335.00 Case	8.33 8.44 8.28 8.00	315.00 325.00 335.00 345.00	8.44 8.28 8.00 7.72	138.0700 134.3600 138.9900 138.6200	Last data lines, or end of topography section
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806	115.00	572089.07	6222396.61								
807	120.00	572089.23	6222391.62								
808	125.00	572089.39	6222386.60	6							
809	160.00	572090.50	6222351.60	6							
810	165.00	572090.66	6222346.67	7							
811	170.00	572090.82	6222341.68	3							
812	175.00	572090.98	6222336.68								
813	200.00	572091.77	6222311.72								
814	205.00	572091.93	6222306.74								
815	250.00	572093.36	6222261.85								
816	255.00	572093.52	6222256.88								
817	260.00	572093.67	6222251.91								
818	325.00	572098.11	6222187.28								
819	355.00	572100.26	6222157.44	1							
820	End of	me									

Res3DInv

In Res3DInv there are two options for including global coordinates:

- 1. Use the actual UTM coordinates in the electrode definitions and data sections of the file. This is the recommended method as is has less possibilities for coordinate transformation errors.
- 2. Add the coordinates at the end of the file in the same way as for Res2DInv, see the example below.

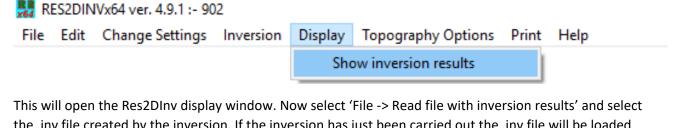
627	20.000,	6.000	10.000,	6.000	30.000,	6.000	40.000,	6.000	31.263	ر Last data
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630	16.000,	6.000	4.000,	6.000	28.000,	6.000	40.000,	6.000	31.759	section
631	Global coord									
632	Type of glob	al coor	dinates inf	ormation	(0=point	-to-point) Header ir	ndication	type of g	lobal coordinates
633	Currently 0									
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638	0.00	00,	6.0000		2390137	.00,	4686637.	00 UTM	X-UTMY c	oordinates
639	40.00	00,	6.0000		2390177	.00,	4686637.	00		
640	40.00	00,	0.0000		2390177	.00,	4686631.	00		
641	• End of file									
642	0									
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Exporting inversion results from Res2Dinv and Res3Dinv

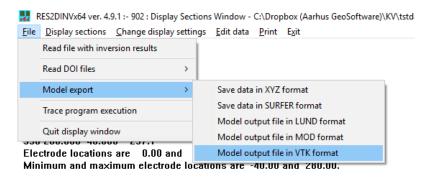
Res2DInv

The format for transferring inversion results from Res2DInv to Aarhus Workbench is the VTK file. To export a VTK file containing inversion results from Res2DInv, open Res2DInv and select 'Display -> Show inversion results':





the .inv file created by the inversion. If the inversion has just been carried out the .inv file will be loaded automatically. Once the reading of the .inv file have been completed select 'File -> Model export -> Model output file in VTK format'



You will then be prompted to select which iteration to export, and where to save the files.

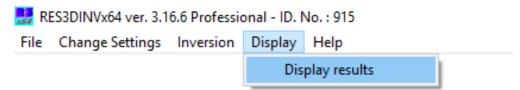
If the inversion result contains global coordinates, four files will be exported: "xxx.vtk", "xxx_Elec.vtk", "xxx_global.vtk" and "xxx_global_Elec.vtk", where xxx is the file name selected by the user (the default is the name of the .inv file).

The "xxx_global.vtk" and ""xxx.vtk" file holds the inversion results and are the ones that are imported into Aarhus Workbench, always use the "_global" version to have the inversion model located correctly.

The "xxx_global__Elec.vtk" and "xxx_Elec.vtk" file includes the electrode positions and can also be imported into Workbench for displaying the electrode positions in the 3D Viewer.

Res3DInv

The format for transferring inversion results from Res3DInv to Aarhus Workbench is the VTK file. To export a VTK file containing inversion results from Res3DInv, open Res3DInv and select 'Display -> Display results':



This will open the Res3DInv display window. Now select 'File -> Read file with inversion results' and select the .inv file created by the inversion. If the inversion has just been carried out the .inv file will be loaded automatically. Once the reading of the .inv file have been completed select 'File -> Model Export -> Export model to Paraview VTK ASCII format'



RES3DINVx64 ver. 3.16.6 Professional - ID. No. : 915 - Display Window : C:\Dropbox (Aarhus GeoSoftware)\KV\tstd

File Display Change display settings Edit data Print Help Exit

Read file with inversion results							
Model Export	>	Export model to XYZ format					
Trace program execution Exit from this option		Export model to XYZ format (without topography) Export model to CTech CSV format					
		Export model to RockWorks XYZG format Export model to Slicer/Dicer format Export model to Slicer/Dicer format with topography					
		Export model to Paraview VTK ASCII format					
		Export model to Voxler XYZC format					
		Export data to Voxler XYZC format					
		Save model with global coordinates					

You will then be prompted to select whether to export resistivity or conductivity values, which iteration to export, and where to save the files.

If option one for adding coordinates to 3D .dat files is used two files will be exported: "xxx.vtk" and "xxx_Elec.vtk", where xxx is the file name selected by the user (the default is the name of the .inv file).

The "xxx.vtk" file is the one that includes the inversion model and is used for import to Aarhus Workbench. The "xxx_Elec.vtk" file includes the electrode positions and can be imported into Workbench 3D Viewer for displaying the electrode positions in the 3D Viewer.

If option two for adding coordinates to 3D .dat files is used four files will be exported: "xxx.vtk", "xxx_Elec.vtk", "xxx_global.vtk" and "xxx_global_Elec.vtk", where xxx is the file name selected by the user (the default is the name of the .inv file). In this case always import "xxx_global.vtk" to Aarhus Workbench.

Importing and using Res2Dinv and Res3DInv inversion results in Aarhus Workbench

Aarhus Workbench help pages

Note that in most parts of Aarhus Workbench it is always possible to press the "F1" key to be taken to the relevant page in the online help wiki: <u>http://www.ags-cloud.dk/Wiki/Workbench</u>

Importing inversion results

After opening the workspace navigate to the 'WORKSPACE' ribbon and select 'External Grid'

			Workb	ench - [C:\Dropb	ox (Aarhus GeoSoftwar	e)\KV\RESxTilWB\Demo	_WS]		_ ¤ ×
FILE WORKSP	ACE GIS	S 3D SEC	TIONS VISU	ALIZATION D	ATA PROCESSING	INVERSION DEBUG	i		۵
🚰 Multiple Deletes	•	↑↓ Move Up	📝 Edit Display	_	i New	# External Grid		-	🛃 Layer
8 Delete	U	🕕 Move Down	G Refresh		Save as Image	levation Model			🕒 Data
E Rename	Properties			Show Hide		🔓 xyz Data	Edit Show	Link to Database	Database
		Node Managem	ent		Map	Add	Color Scale	Model Selection	Export To

Select the VTK file from Res2/3DInv and select 'Open', provide at name for the imported inversion result when prompted and select 'OK', select the coordinates system when prompted:



Select coordinate system WGS 84 UTM zone 7N (epsg:32607) WGS 84 UTM zone 8N (epsg:32609) WGS 84 UTM zone 10N (epsg:32610) WGS 84 UTM zone 11N (epsg:32611) WGS 84 UTM zone 12N (epsg:32612) WGS 84 UTM zone 13N (epsg:32615) WGS 84 UTM zone 16N (epsg:32615) WGS 84 UTM zone 16N (epsg:32616) WGS 84 UTM zone 19N (epsg:32613) WGS 84 UTM zone 19N (epsg:32613) WGS 84 UTM zone 20N (epsg:32620) WGS 84 UTM zone 21N (epsg:32621) WGS 84 UTM zone 22N (epsg:32622) WGS 84 UTM zone 22N (epsg:32622) WGS 84 UTM zone 22N (epsg:32625) WGS 84 UTM zone 22N (epsg:32625) WGS 84 UTM zone 21N (epsg:3262) WGS 84 UTM zone 31N (epsg:3263) WGS 84 UTM zone 31N (ep	🔞 Coordina	ate system selector			_	×
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		Projected systems (Unit=	=meters)			
					ОК	acal

This must be the same as coordinate system as the global coordinates entered in the .dat file prior to inversion. Repeat this for all the VTK files you wish to import in the workspace.

Once imported the grids/VTKs/Inversion results will show up in the workspace explorer under 'External grids', in the below example three 2D inversions and one 3D inversion have been imported:



	w	/orkbench - [C	:\Dropbo	ox (Aarhus GeoSoftwar	e)\KV\RESxTilWB\Demo	_WS]			_ 🗆 X	:
	NS	VISUALIZATIO	N D	ATA PROCESSING	INVERSION DEBUG				۵	
EDelete	Edit Di	0-0	0- ⊡- Hide	New Save as Image	∰ External Grid ॐ Elevation Model ₽ xyz Data	Edit Sh		to Database	▲ Layer➡ Data➡ Database	
Node Management				Мар	Add	Color Scal	e Mo	del Selection	Export To	4
External Grids External Grids 2D_VTK_1 2D_VTK_2 2D_VTK_3 3D_VTK_1	Workspace Explorer Database Explorer Windows Log								>	
Node Info										
NodeText: MyMap DriginalText: MyMap DataType: MAPS InsertUser: knud lassen InsertDate: 27-05-2019 15:43:47 WorkspaceVersion: 83 WorkbenctVersion: 83							Filter: All Layers All	v.	√ ™ √ ™ √ ₩	
Notes		Update ${\scriptstyle \lor}$							0, Y: 0 JTM_zone_32N	

Creating model selections

In order to further work with the imported inversion results they must be turned into model selections. To do this navigate to the 'INVERSION' ribbon, highlight the 'External Grids' group in the workspace explorer and select 'New Model Selection':



	Workbench - [C:\Dropbox (Aarhus GeoSoftware)\KV\RESxTilWB\Demo_WS]	_ 🗆 X
FILE WORKSPACE GIS 3D SECTION	S VISUALIZATION DATA PROCESSING INVERSION DEBUG	۵
Invert Data Show Result	New Add	
Laterally Constrained Spatially Constrained	Model Selection Elevation Model	
MuMap Second S	Workspace Explorer Undows Log	
Node Info V Node Text: External Grids		
Noder Ext. External Glids Original Text. External Glids DataType: EXTGRIDPARENTDT InsertUset: Ravdlassen InsertDate: 28-05-2019 15:11:17 Workspace: 101 Workspace: 101 Workspace: 101 Workspace: 101 Notes & A	Update V	Filter: All Layers X: 0, Y: 0 WGS_84_UTM_zone_32N

In the new window select which grid to turn into a model selection, it is possible to select more than one grid at a time by holding down the 'Ctrl' or 'Shift' key while selecting the grids.

Whether to create one big model selection for all inversion results, or several smaller model selections for each inversion result, depends on which visualizations are to be made. For drawing profiles, it is easier to have one models selection for each inversion result, but to make horizontal maps, like mean resistivity maps, all results must be in the same model selection. It is usually a good idea to keep all imported inversion results in the same database:

🛞 Create Model Selec	🛞 Create Model Selection From External Grids - 🗆 🗙							
2D grid(s) 3D grid	2D_VTK_1 2D_VTK_2 2D_VTK_3							
Import To O Existing database:	Search							
New database:	Models_From_Grid	ОК	Car	ncel				

Once the model selections have been created, they are found in the Workspace explorer:



			Wor	rkbench -	[C:\Dropbox (Aarhı	us GeoSoftv	vare)\KV\RESxTil	WB\Demo_WS]		_ = ×
1	FILE WORKSPACE	GIS 3D SECTION	ONS VI	ISUALIZATI	ON DATA PRO	CESSING	INVERSION	DEBUG		۵
	Invert Data Show Result	米 □ □─□ New	Nev		add 3					
	Laterally Constrained	Spatially Constrained	Model Se	election	Elevation Model					
	Image: Second condition MyMap Image: Second condition External Grid Image: Second condition 2D_VTK Image: Second condition 2D_VTK Image: Second condition Q_2D_VTK Image: Second condition Q_2D_VTK Image: Second condition Q_2D_VTK Image: Second condition Q_2D_VTK Image: Second condition Q_3D_VTK Image: Second condition Second condition Image: Second cond condition		Workspace Explorer Database Explorer Windows Log							
									Filter: All Layers All	مَّا مَا \$
	Notes		~ L	Jpdate ${\scriptstyle\checkmark}$					50 m	X: 572123, Y: 6222300 WGS_84_UTM_zone_32N

Once model selections have been made for all imported inversion results it is possible to do nearly the same things with the results as with inversions carried out with Aarhus Workbench. It is off course also possible to add more inversion results later. In the following a few examples of what can be done with the inversion results in Aarhus Workbench are demonstrated:

- Adding a background map and plotting the location of inversion results on a map (p. 8)
- Creating profiles showing the inversion results, possibly together with other data types such as borehole data or logs (p. 10)
- Creating horizontal mean resistivity maps, and other horizontal maps based on inversion results (p. 12)
- Visualizing results in the 3D viewer (p. 16)
- Creating PDF reports using the report tool (p. 18)

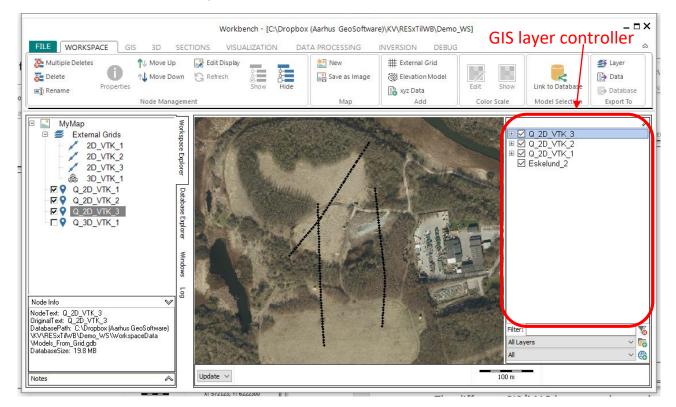
Adding a background map and plotting the location of inversion results on a map

Background maps and other GIS layers are added by selecting the "open folder" button at the lower right corner and selecting the file in the window that opens, The supported formats are: .tab, .mif, .shp, .tif, .jpg, .jp2, .ecw and .kml:



	Workbench - [C:\Dropbox (Aarhus GeoSoftware)\KV\RESxTilWB\Demo_	ws] – 🗆 🗙
FILE WORKSPACE GIS 3D SECTIONS	VISUALIZATION DATA PROCESSING INVERSION DEBUG	۵
Invert Data Show Result	New Add	
Laterally Constrained Spatially Constrained Mo	del Selection Elevation Model	
Image: Second		Filter: Al Layers All
Notes 🔊	Update 🗸	X: 572123, Y: 6222300 50 m WGS_84_UTM_zone_32N

The different GIS/MAP layers can be toggled on and off in the GIS layer controller to the right on the screen, it is also possible to edit the order of the layers by dragging and dropping the layers in the GIS layer control. To add the locations of the models in the model selections to the GIS map check the checkbox next to the model selection in the Workspace Explorer, here an aerial photo and the three imported 2D inversions are shown on the map:

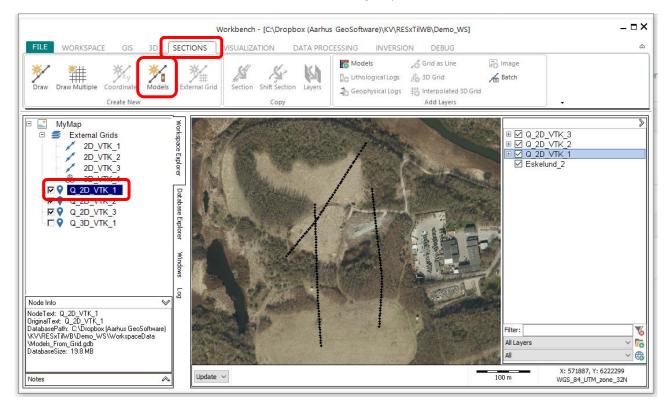




It is also possible to use a web map service (WMS) as a background map instead of an offline image file, to do this select the little globe ^G in the lower right of the screen and either select the default WMS or press "F1" for further instructions.

Creating profiles from inversion results

In Aarhus workbench a profile/section is the main way of displaying a 2D inversion result, to create a section from a model selection highlight the model selection in the Workspace Explorer, navigate to the 'SECTIONS' ribbon and select 'Models' in the 'Create New' group:



In the new window select the name and direction of the profile, as well as whether to plot results in resistivity or conductivity:

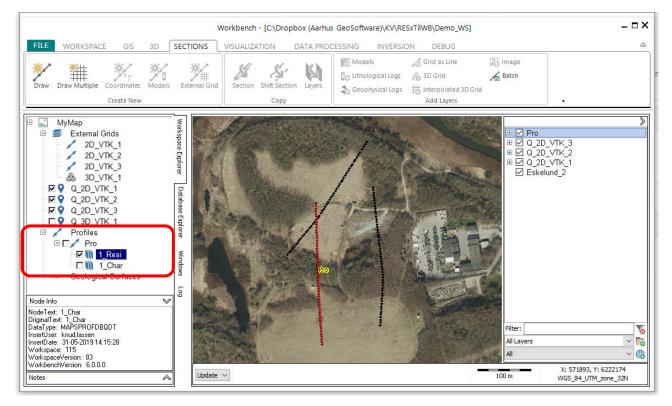
Profile Settings
Profile Name (Prefix)
Pro
Profile Direction
Data Recording Order 🗸 🗸
Plot Bars as
Resistivity [Ohm-m]
O Conductivity [mS/m]
O Conductivity [mS/cm]
Merge SkyTem Lines for different Dataset
<u>O</u> K <u>C</u> ancel

In the next window select from which model selection to add models to the profile, specify the color scale for the different parameters (resistivity and possibly chargeability) and whether to select the models as bars or interpolated sections:



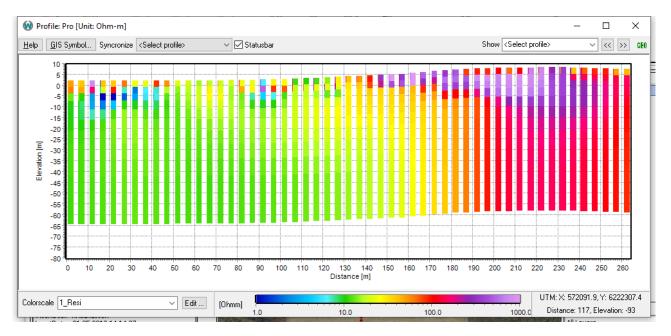
Add Models to Section: Pro				
Model Parameters Resistivity Chargeability	C:\Dropbox (Aarhus GeoSoftware)\KV	\Builds\Workbench64_26-C	04-19\Colorscales\Resistivity.av	vc Open Edit Save
Models/Inversions Model Selection Nodes Inversion Nodes Filter	1.0 Q_2D_VTK_1 Q_2D_VTK_2 Q_2D_VTK_3 Q_3D_VTK_1	10.0 Model Display Search Distance	Show Interpolated Bars	1000.0 Model Display Settings
				OK Cancel

Once the profile is created it can be found in the workspace explorer under 'Profiles', the different parameters can be toggled on and off under the individual profiles:



To display the profile, check the checkbox next to it in the 'workspace explorer':





It is also possible to draw "freehand sections" and adding models, boreholes etc. to them afterwards. To do this select 'Draw' in the 'Create New' group instead of 'models ', and draw the section in the GIS map. To add content to the drawn section, highlight the profile in the 'Workspace Explorer' and select either 'Models', 'Lithological logs' or 'Geophysical Logs' in the 'Add layers' group. It is now possible to select a search radius defining what is added to the profile, this is especially useful for creating 2D profiles from 3D inversion results.

For information about how to import lithological and geophysical logs please refer to the online help pages: <u>http://www.ags-cloud.dk/Wiki/Workbench</u>.

Creating horizontal mean resistivity maps, and other horizontal maps based on inversion results

Themes are the tool for visualizing results on the map e.g. the mean resistivity of a given depth interval, the depth to a good conductor, the resistivity of the third layer in the model, or thickness of a body with a given resistivity.

A theme contains these values in the discrete points at which the models are located, they can be visualized either as colored icons at these points (See: Point themes) or as surface covering interpolated grids (See: 2D grids).

A theme is created from a model selection. After creating the model selection, the actual theme can be created by highlighting the model selection in the workspace explorer and selecting "Theme" in the "Visualization" ribbon:

		Workbench - [C:\Users\knud.la	assen\Documents\test_data\skyTEM\Kasted_big]	_ 🗆 ×
FILE WORKSPACE	GIS 3D SECTIONS	VISUALIZATION DATA PRO	CESSING INVERSION DEBUG	۵
* : Theme Model Quality	Point Theme Image 2D	Grid 3D Grid Batch Gridding	Images New Template Edit Template New Report	
Create New	Vis	ualization	Quick Review Report Tools	J

The following dialog box will then appear:



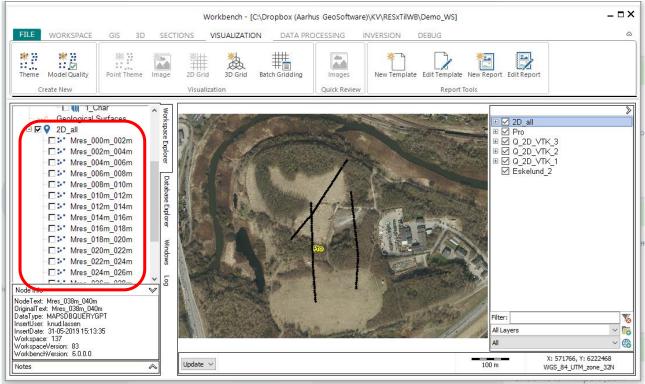
🛞 Geophysical Ther	ne for ModSec_1	_	
Theme Type Settings	Theme Type Mean Parameters Layer Parameters General Layer Search Cumulative Layer Search Logw Resistivity Layer Cday Inideness DOI (Depth of Investigation)		
	<< Back	Next>>	Cancel

From this list the type of theme must be selected, the simplest theme is the "Layer Parameters" theme, this theme simply contains the value of the selected layer at the different positions, we will continue by creating a mean resistivity theme by selecting "Mean Parameters". For a comprehensive walkthrough of the different types of themes use the F1 help from this window. In the next menu the property to be extracted, the number of intervals and the thickness of the layers must be specified:

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Property to Extract Vertical Resistivity		 Blind at DO: Blind at DO: 	I Conserva	8
Bevation Depth Top Interval Length No of Intervals 0 2 20 Surface Slope Correction (by DEM) No DEM nodes> Interval 0:1: Top: 000m Bottom: 004m Interval 0:3: Top: 004m Bottom: 004m Interval 0:5: Top: 006m Bottom: 010m Interval 0:5: Top: 006m Bottom: 014m Interval 0:5: Top: 010m Bottom: 014m Interval 0:7: Top: 014m Interval 0:7: Top: 014m Interval 0:7: Top: 012m Interval 0:7:		Blind at DO	I Standard	8
Top Interval Length No of Intervals 0 2 20 Surface Slope Correction (by DEM) <no dem="" nodes=""> Interval 01: Top: 000m Bottom: 004m Interval 02: Top: 002m Bottom: 004m Interval 03: Top: 004m Bottom: 006m Interval 04: Top: 006m Bottom: 006m Interval 05: Top: 008m Bottom: 010m Interval 06: Top: 010m Bottom: 014m Interval 07: Top: 012m Bottom: 014m Interval 09: Top: 016m Bottom: 018m Interval 10: Top: 018m Bottom: 022m Interval 11: Top: 020m Bottom: 022m Interval 13: Top: 022m Bottom: 022m Interval 13: Top: 024m Bottom: 024m</no>		Blind at DO	I Standard	d
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Interval 17: Top: 032m Bottom: 034m				····,
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The themes are created by selecting "Apply" and providing a name for the theme, once created the theme can be found under model selection in the Workspace Explorer:



The themes can now be visualized as points or 2D grids.

Visualizing themes

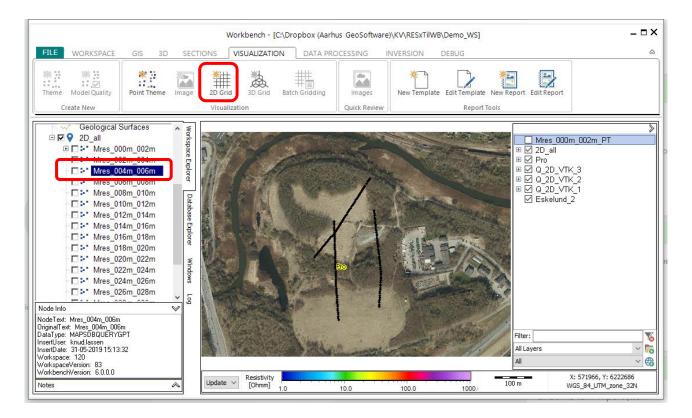
Points

To plot the gridded values as colored points in the GIS window highlight the theme and press "Point Theme". Select the color scale, point size and point shape in the dialog box and press "OK" and select the name of the theme, the point theme can now be found in the workspace explorer under the theme, and can be plotted in the GIS map by checking the checkbox next to it.

2D Grids

The other way of presenting themes are as surface covering interpolated grids, these are created by highlighting the theme and pressing "2D Grid" :



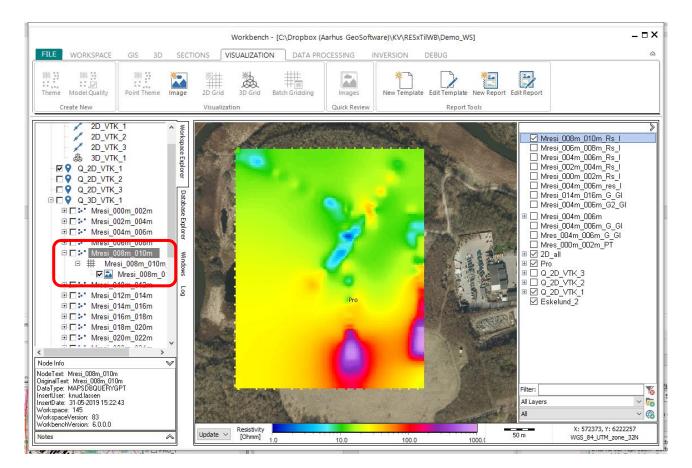


The following menu box will appear:

Grid Settings [ModSec_1-	>MeanResTheme_	000m_020m]	×
Search Grid Interpola	ation		
 ✓ Min number of data: Max number of data: ✓ Search radius: Max number per sector 	1 10 100 (m) 5	Eorce minimum	
		ОК	Cancel

In this the search radius, grid spacing, and interpolation routine must be selected, refer to the F1 help for further specification, after pressing "OK" the grid must be named, after the grid is calculated an image must be created to display the grid. The first image is automatically created after calculating the grid, the color scale and name for the image must be selected and the image can then be found in the workspace explorer. Subsequent images e.g. with different color scales can be created by highlighting the grid and selecting "Image" in the visualization ribbon. Once created the grid and image can be found in the workspace explorer, and be to the map by checking the checkbox:





It is also possible to make 2D grids and images for several themes in a model selection in one go by highlighting the model selection and selecting "Batch Gridding".

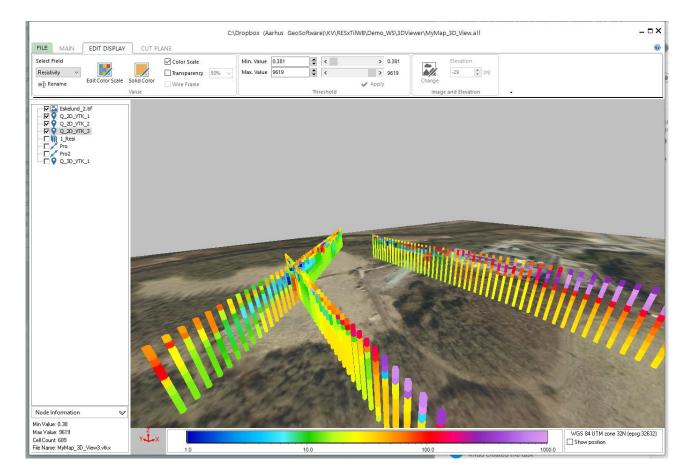
Visualizing results in the 3D viewer

Most of objects created in Aarhus Workbench can be added to the 3D viewer for intuitive visualization in 3D. To create a 3D view, navigate to the '3D' ribbon, select 'Create', and provide a name for the 3D view when prompted:



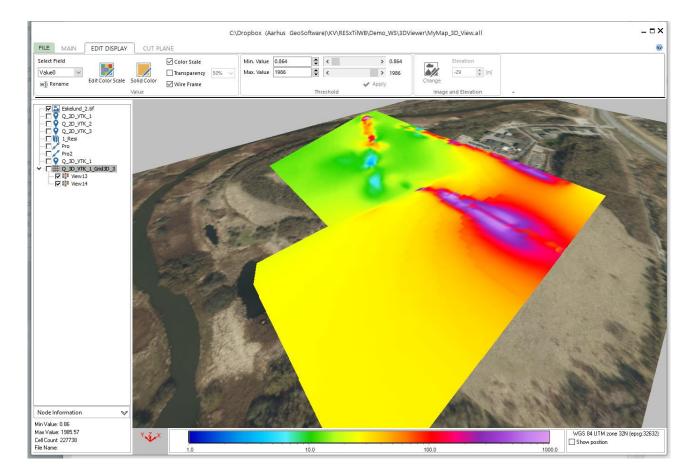
The new 3D view can be found in the Workspace Explorer and opened in a separate window by checking the checkbox next to the name. Objects from the workspace can be added by highlighting them in the Workspace Explorer, navigating to the 3D ribbon and selecting 'Add GIS Map' (for GIS maps) or 'Add Layer' for everything else. In the below example the background map and 3 model selections have been added to the view:





In the example below an inversion result from Res3DInv have been gridded in 3D (Visualization -> 3D grid), added to the 3D viewer and two dipping cut planes have been added. For a full walkthrough of the features of the 3D viewer please visit our online help by pressing "F1" within the 3D viewer or by following this link: http://www.ags-cloud.dk/Wiki/WH_3DViewerOverview.



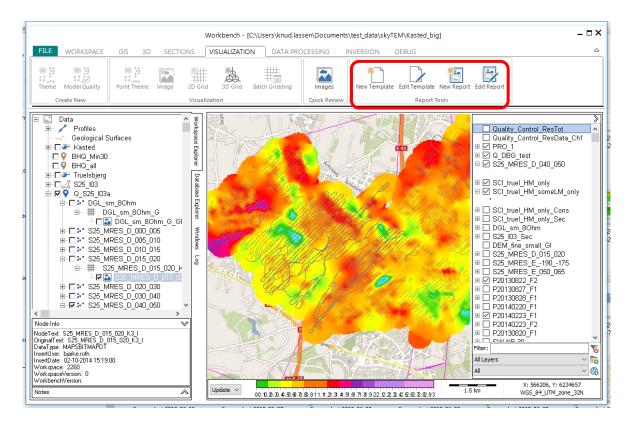


Creating a PDF report from template

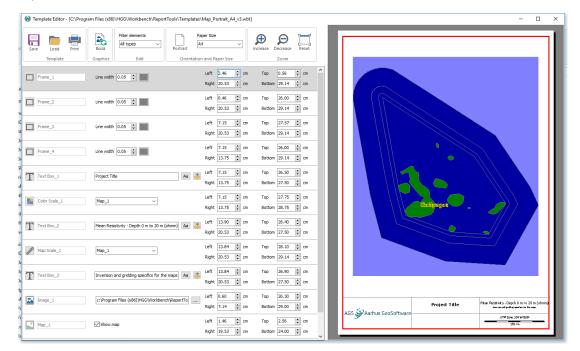
The report tool is a tool to create high resolution, professional looking reports from the different data found in the workspace, the reports can include maps, profiles, themes etc. The reports are generated from predefined templates that defines the layout of the report e.g. paper format, location of logos, overview maps, profiles and other objects. Once a template is created it is easy to recreate reports of the same type for surveys at different locations, or to e.g. make a daily report from a long field campaign.

Templates and reports can be created and edited from the Visualization ribbon in the report tools box:





Each report page is built from the following elements: frames, text boxes, maps, legends, map scales, north arrows, images, profiles and color scales. By selecting either new template or edit template the template editor is opened:



To the left the editor is shown, to the right a preview is displayed. It is possible to edit the size, location and appearance of each element. New elements are added by selecting the icon to the left of an element and selecting "Copy item". It is also possible to change the type of the element or to delete elements in this



way. The preview is updated by pressing "Build." For further explanation of the different options use the "F1" help. To use the template to create a report, save the template and select "New Report".

The report editor is very similar to the template editor, but instead of editing the type and location of the object it is now possible to edit the content e.g. which profiles are displayed and the text in the textboxes. Changes take effect once "page" of "all pages" is selected in the "Build graphics" menu. It is also possible to add or remove pages. A report can be saved and edited later. To create a PDF of the report, select "print" and print the report to a PDF printer. Use the "F1" help for explanation of the individual features.

🛞 Re	port Editor - [2018-07-02_knud.lassen] - New report, not saved	×
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