POLITECNICO
MILANO 1863

GEOPHYSICAL IMAGING

ELECTRICAL METHOD

Qixun Dan

Step1

1.1. Download SW

Download RES2DMOD and RES2DINV from BEEP (SW folder)

GB Giancarlo Bernasconi > Gianca > mybeep_shared > GI_SID > **software**

Nome ↑	Data/ora m...	Modificato ...	Dimensioni de...	Condivisione	Attività
Acu2DPro_V06	28 settembre 2...	Giancarlo Bernasco	19 elementi	Condiviso	
migdemo	28 settembre 2...	Giancarlo Bernasco	6 elementi	Condiviso	
reflexw	28 settembre 2...	Giancarlo Bernasco	2 elementi	Condiviso	
propagate.m	5 novembre 2020	Giancarlo Bernasco	12,6 KB	Condiviso	
Res2DInv.zip	16 novembre 2...	Giancarlo Bernasco	5,89 MB	Condiviso	
Res2dmod.zip	14 ottobre 2013	Giancarlo Bernasco	1,75 MB	Condiviso	
source_detector.m	16 novembre 2...	Giancarlo Bernasco	5,82 KB	Condiviso	
time_tomography_V10.zip	6 novembre 2022	Giancarlo Bernasco	30,8 KB	Condiviso	

Step2

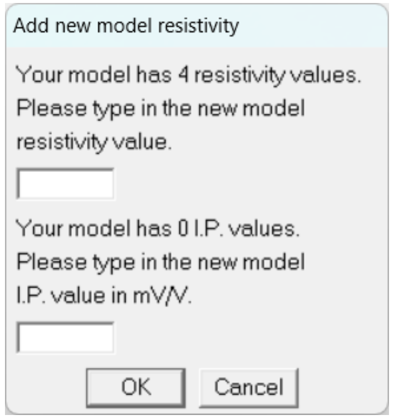
1.2. Simulation of an electrical acquisition

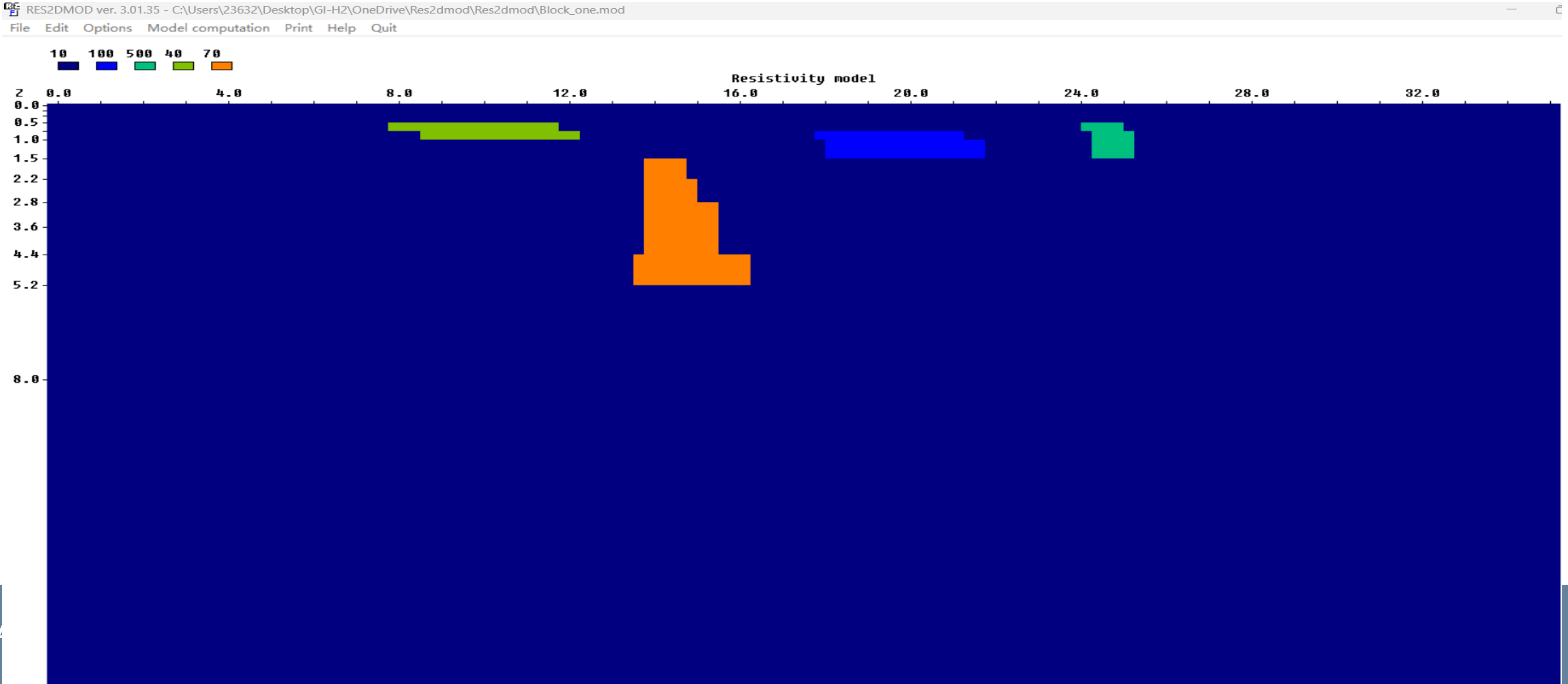
Use the SW RES2DMOD (RESistivity 2D MODeling) to compute a synthetic pseudosection for a given user model.

Enter the RES2DMOD folder, start the SW by running RES2DMOD.EXE, Load (FILE menu) a model: I suggest BLOCK_ONE.MOD.

Use EDIT to modify the model by deleting and assigning new resistivity values with the mouse, and to build a simulation scenario (e.g. a cavity, a layer, a localized anomaly, a specific shape anomaly, …).

Save the new model (res2dmod format) with another name.





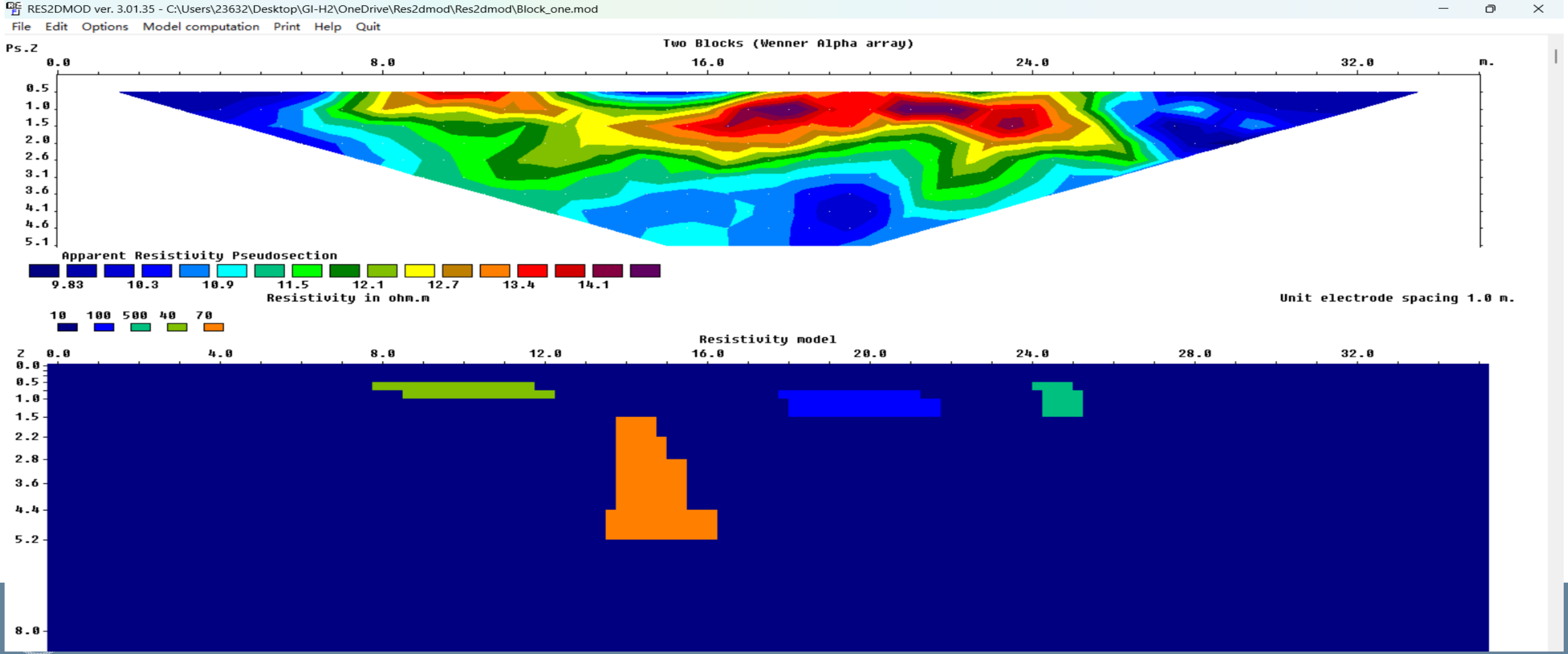
Step2

This plot shows the apparent resistivity pseudosection. Each color cell is one ρ_a measurement from a Wenner-α setup. The software calculates ρ_a using $\rho_a = K \cdot \Delta V/I$; for Wenner, $K = 2\pi a$. I exported the .DAT file from RES2DMOD (RES2DINV format) to get the numbers. In my figure the values are about 9.8–14.1 Ω·m. A pseudosection is only a data display; we need inversion to estimate the true resistivity.

1.2. Simulation of an electrical acquisition- Run an electrical acquisition simulation on the model. Check the result – we chose … Save a screen dump

Parameters:

Apparent Resistivity Pseudosection / Werner Alpha Array / 36 electrodes on the Surface / Separation between electrodes: 1m / The values are about 9.8–14.1 Ω·m.



Step3

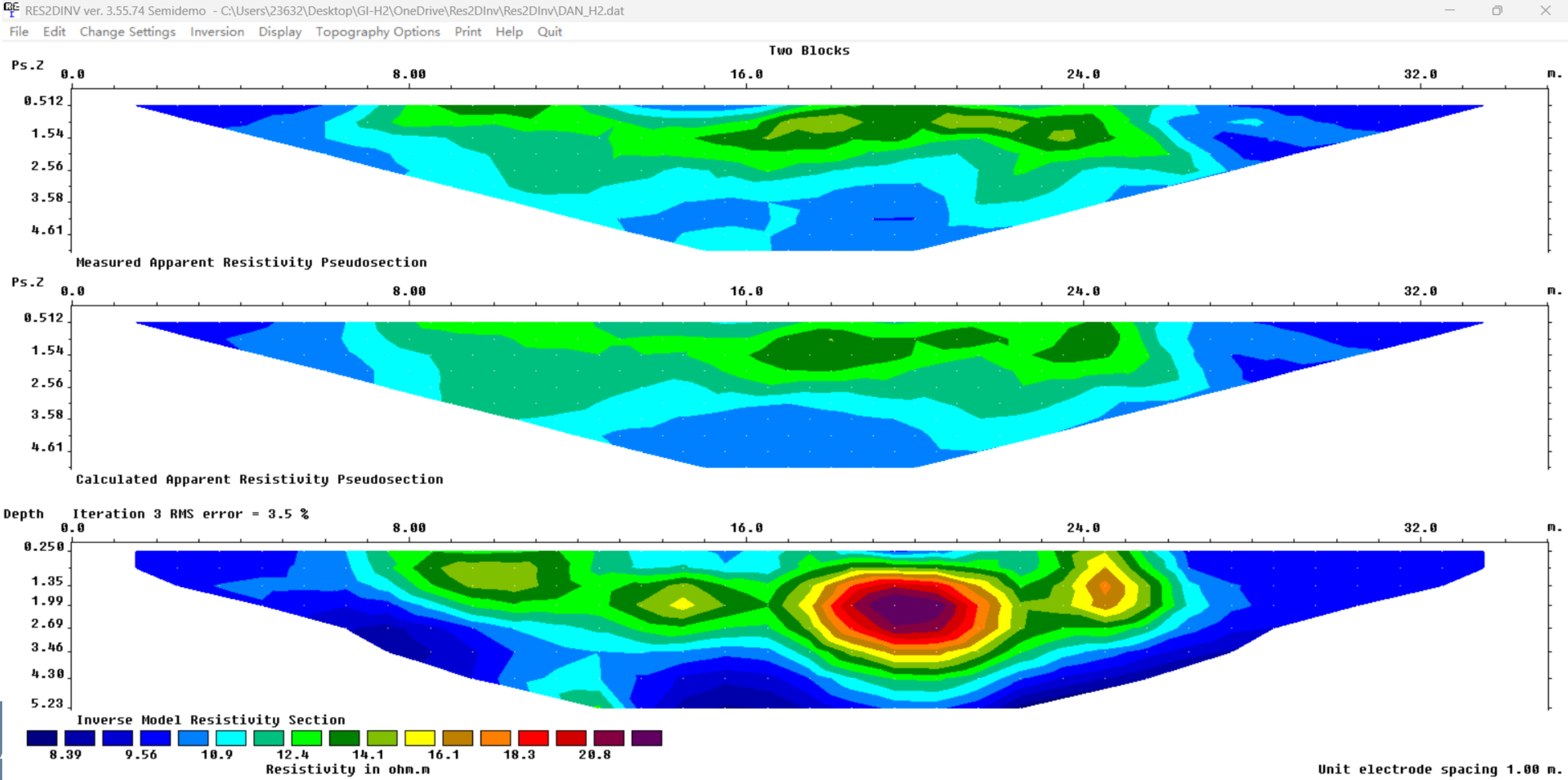
1.3. Resistivity inversion of an electrical acquisition

Use the SW RES2DINV (RESistivity 2D INVersion) to invert the true resistivity from the apparent resistivity in a pseudosection: we are using here our "simulated" acquisition. Enter the RES2DINV folder, start the SW by running RES2DINV.EXE. Load (FILE menu) the data generated in the previous section. Run the "standard" inversion. Check the result, save a dump screen in the POWERPOINT presentation, compare with the starting model, put comments in the presentation.

1. **Measured apparent resistivity pseudosection from my data**. It is only a **data display**, not the true subsurface.

2. **Calculated apparent resistivity pseudosection.** These are the **predicted** ρ_a values from the **current inversion model** at that iteration.
We compare it to the measured panel to see the **misfit**.

3. **Inverse model resistivity section.** This is the recovered **true-resistivity image** after iterative inversion. **"Iteration 3 RMS error = 3.5%"**. That is the data misfit after 3 iterations. Shows model with a small average error, close to the expected noise level.
Colorbar shows about **8.4 → 20.8 Ω·m**; (an estimate of "true" resistivity after inversion).The **central red area** is the **more resistive** body, surrounded by lower-resistivity background.

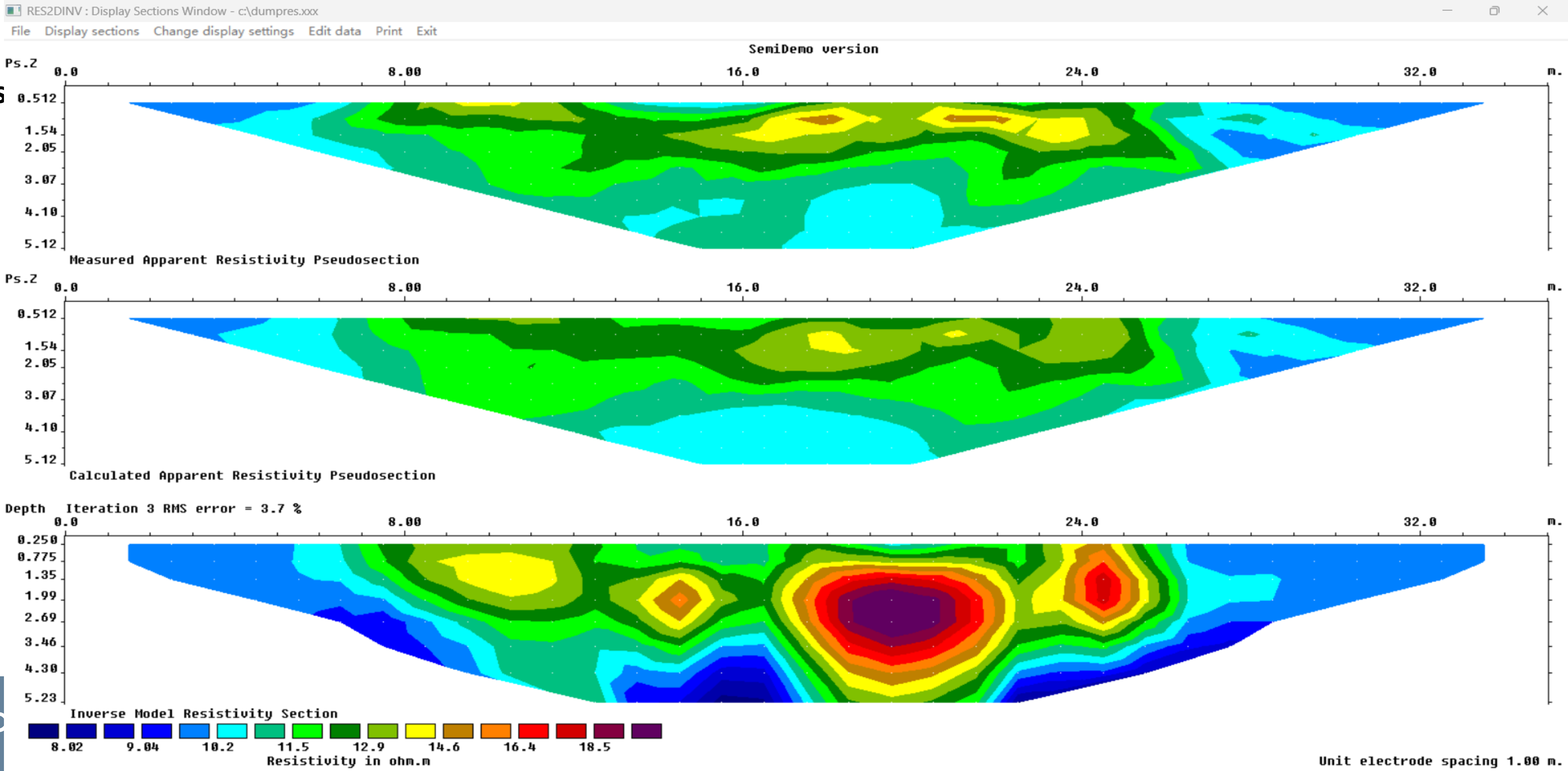


Step4

Perform other inversions by modifying the inversion settings.
Dump screen in presentation and comment. Suggestion: try to use same color scale for all graphics. In res2dinv, after running the inversion, you have to enter the “DISPLAY” interface to set the colormap.

Vertical-to-horizontal flatness filter ratio: 3

I increased the vertical-to-horizontal flatness ratio to 3, which smooths the model more in the vertical direction; as a result the main anomaly looks taller with a deeper tail, while the data fit remains good at about 3.7% RMS.

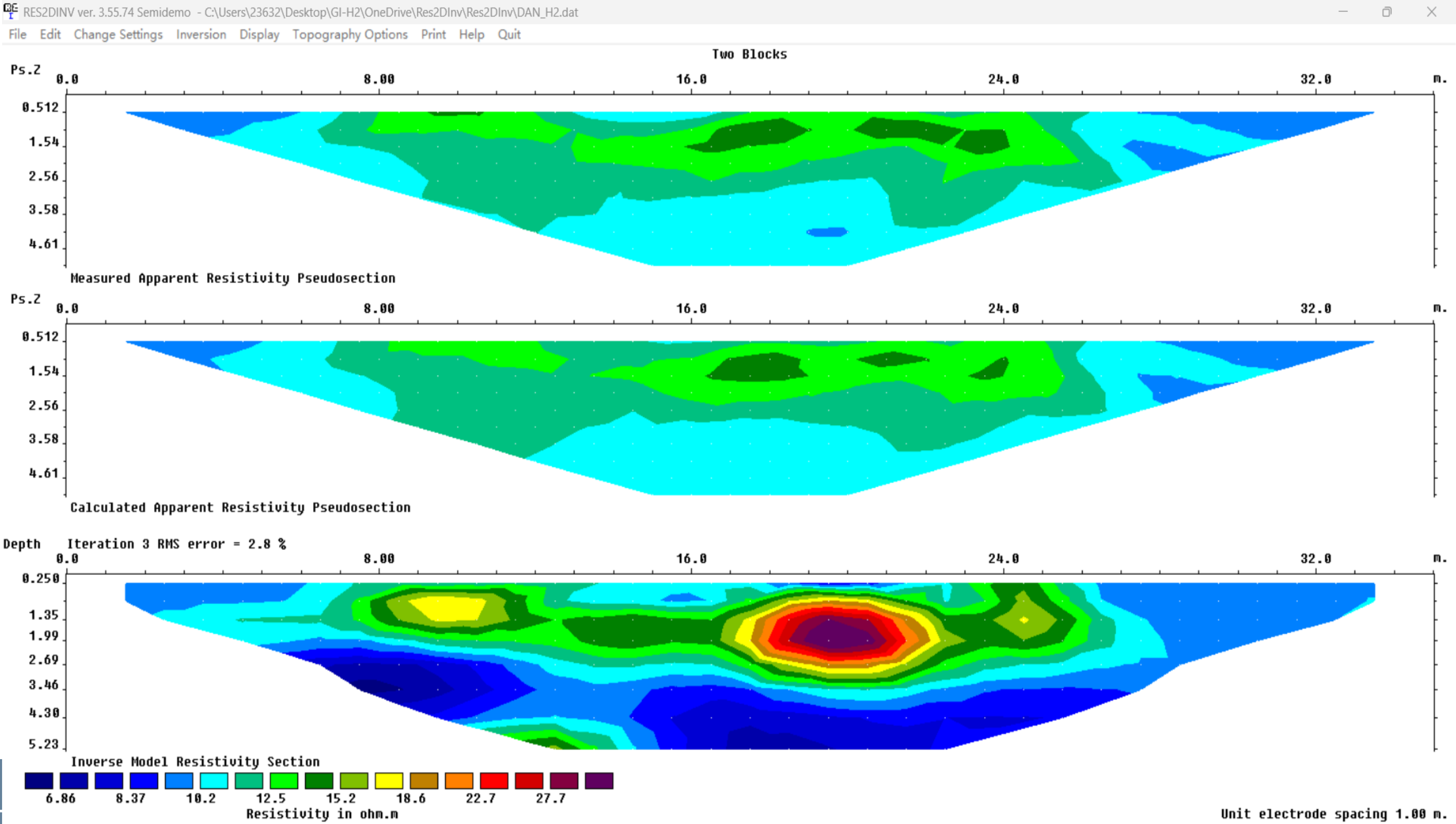


Step5

Perform other inversions by modifying the inversion settings.

Vertical-to-horizontal flatness filter Ratio
0.3

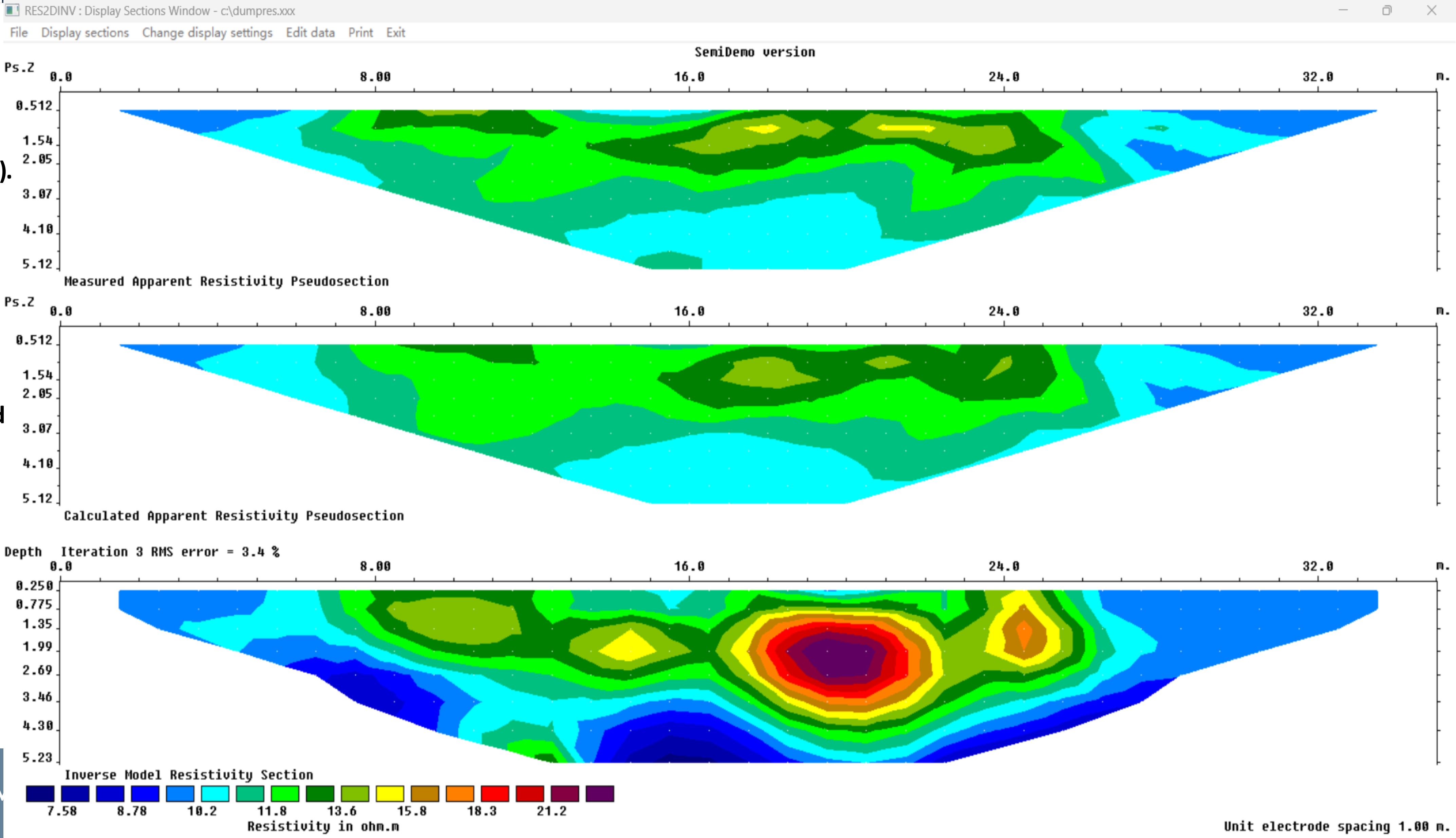
With V over H = 0.3 the inversion helps horizontal smoothing, so my resistive body spreads laterally and looks flatter; the fit is good at about 2.8% RMS.



Step6

Damping factor with Depth: 0.04

Depth damping test (0.04). Adding a depth-dependent damping stabilizes the **deep cells** where sensitivity is low. The **deep background becomes smoother**, and the **main resistive body** appears **slightly wider and shallower**. The **measured vs. calculated** pseudosections still agree well (**RMS ≈ 3.4%**). Thus, this setting mainly improves **deep stability** while mildly **spreading** anomalies horizontally.



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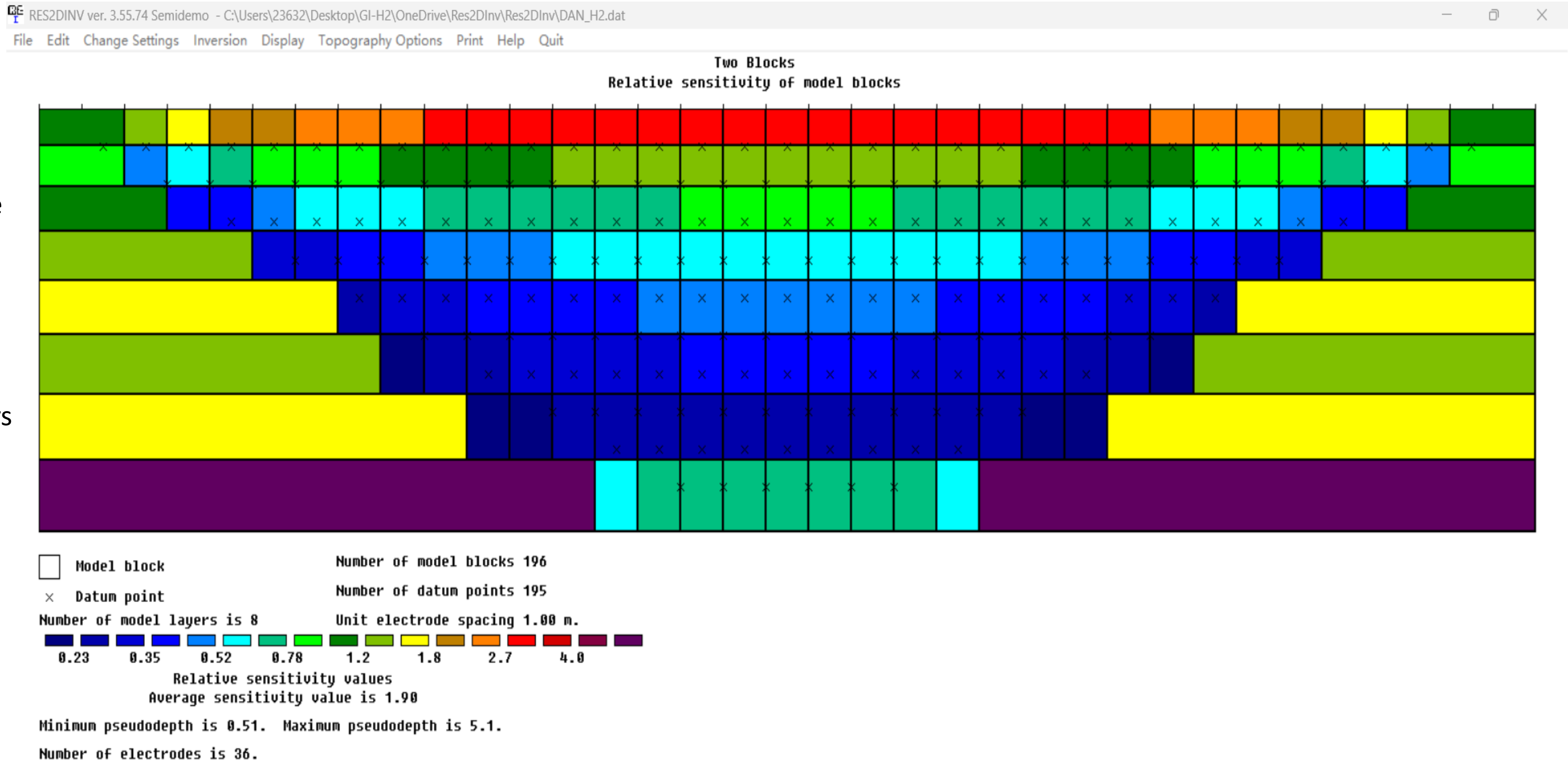
Step7

Relative Sensitivity of model blocks:

Relative sensitivity map (Wenner-α, 36 electrodes, a = 1 m). Sensitivity is highest under the line near the surface and decreases with depth (trapezoid). Avg. sensitivity = **1.90**; pseudo-depth range = **0.51–5.1 m**. This coverage justifies using **depth damping** to stabilize the deep model and shows where the inversion is **well** vs **poorly** constrained.



Comments

1. **Survey & data:** **I** used a **Wenner-alpha** array with **36 electrodes** and **1 m** spacing. The top panel is an **apparent-resistivity pseudosection**; each cell is one measurement computed by **ρ_a = K·ΔV/I**. A pseudosection is **data display**, not the true subsurface.
2. **Inversion triplet:** **Top** = **Measured ρ_a**, Middle = **Calculated ρ_a** from the current model, Bottom = **Inverse model resistivity**. I compare the first two to evaluate the **RMS misfit**.
3. **Baseline fit:** **My** inversions reach **~3.5% / 2.8% / 3.4% RMS** in different tests, which indicates a **good data fit** (close to expected noise).
4. **Physics of current flow:** Current prefers **low-resistivity paths**; **high-resistivity bodies** deflect current. This is why the pseudosection shows higher ρ_a over resistive targets and lower ρ_a over conductive zones.
5. **Result vs data:** My measured pseudosection is around **10–14 Ω·m**. The inverted model spans about **8–20.8 Ω·m**, which is an **estimate of true resistivity** after regularization; values are not expected to match ρ_a directly.
6. **Anisotropy test (V/H = 3):** Stronger **vertical smoothing** makes the main resistive body **taller with a deeper root**; misfit stays good (**≈3.7% RMS**).
7. **Anisotropy test (V/H = 0.3):** Stronger **horizontal smoothing** spreads the anomaly **laterally** and makes it **flatter**; misfit improves (**≈2.8% RMS**).
8. **Depth damping (0.04):** Adding **damping with depth** stabilizes **deep cells** where sensitivity is low; the deep background becomes **smoother**, and the main body appears **slightly wider and shallower**; fit remains **≈3.4% RMS**.
9. **Sensitivity map:** Coverage forms a **trapezoid**: **high sensitivity** near the surface, **low** at depth and line ends. I trust features **inside** the high-sensitivity zone more than at the edges/depth, which supports using **depth damping**.

Thank you for your attention