GO_3D_OBS

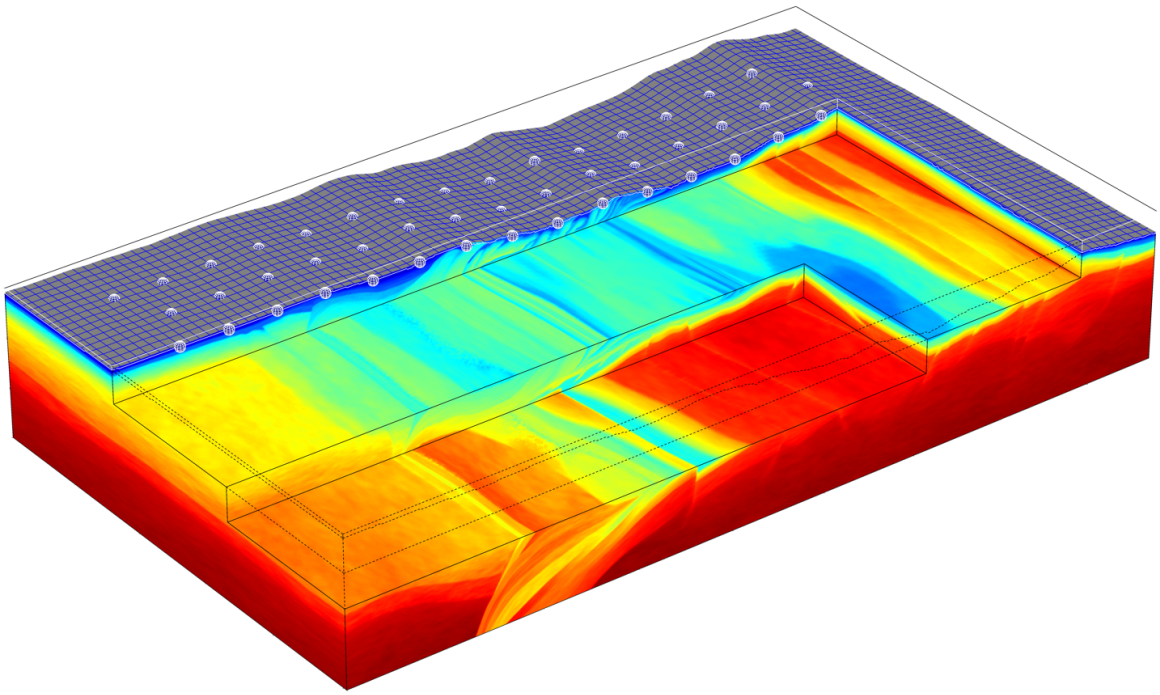
The multi-parameter benchmark geomodel
for seismic imaging methods assessment
and next generation 3D surveys design

User manual

Version 1.0

Andrzej Górszczyk & Stéphane Operto

agorszczyk@igf.edu.pl
stephane.operto@geoazur.unice.fr



1 Introduction

GO_3D_OBS is a 3D high-resolution geomodel representing a subduction zone environment, inspired by the geology of the Nankai Trough. It was created by Andrzej Górszczyk and Stéphane Operto (2020) for the purpose of evaluating different crustal-scale seismic tomographic and inversion methods, as well as for the seismic surveys design. The geomodel is visco-elastic and isotropic. It is parametrized by compressional and shear wavespeeds (V_p, V_s), density (rho) and quality factors (Q_p, Q_s). The model is freely available to the scientific community as a benchmark tool.

2 Model discretization

The model is discretized in a 3D uniform Cartesian grid with dimensions 1201 $\times$ 7001 $\times$ 4001 containing 33.6e^9 degrees of freedom. The grid interval is 25 m leading to the physical model size of 30 km $\times$ 175 km $\times$ 100 km. Such discretization in the idela shall allow for an accurate finite difference wavefield modeling up to 15 Hz (assuming acoustic modeling with at least 4th order accuracy of a stencil in space). The size of the model allows for extraction of 3D or 2D target models for the purpose of a desired synthetic test. User can downscale/upscale the model at his convenience, however too coarse spatial sampling will degrade the high-resolution details implemented in the model.

3 Files description

Each physical property of the geomodel is stored in a separate archive:

- VP_W_SU.tar
- VS_W_SU.tar
- RHO_W_SU.tar
- QP_W_SU.tar
- QS_W_SU.tar

The size of each archive is ~132 GB, therefore HPC platform is advised for managing the model. Each of the archive contains 4001 2D inline models stored in .su files associated with the open source Seismic Unix package (https://github.com/JohnWStockwellJr/SeisUnix/wiki). To access the files one needs to un-tar the archive:

tar -xvf VP_W_SU.tar

which will create the directory ./VP_W_SU containing 4001 files vp_ws_*.su files where * corresponds to the inline number.
Each .su file has a necessary header information included. For example, executing:

surange < vp_ws_1001.su

will give the following output:

```
7001 traces:
tracl    1 7001 (1 - 7001)
trid     1
swdep    2016 7620 (2620 - 4424)
scalel   1
scalco   1
sx       0 175000 (0 - 175000)
sy       25000
gx       1 7001 (1 - 7001)
gy       1001
ns       1201
dt       25
d1       25.000000
d2       25.000000
```

The **swdep** field contains the bathymetry in meters for a given **sx**,**sy** spatial position also in meters. The bathymetry of the full 3D model is presented in Figure 3.1(a). The **gx**,**gy** fields are crossline and inline numbers respectively, while **ns** field is the number of depth-samples. Cell interval in each spatial direction is stored in **dt**,**d1** and **d2** fields (25 m in this case).
User can concatenate a given number of 2D inline models to obtain a 3D model. Concatenating all 4001 inlines will lead to the full 3D cube model of a given parameter (∼132 GB). Extracting of a desired target-model from the 2D or 3D models based on the header-words can be also performed using *suwind* command. For example executing:

suwind < *3D_model*.su itmin=401 itmax=401 > *depth-slice_401*.su

will produce the depth-slice section at 10 km depth presented for V_p parameter in Figure 3.1(b).

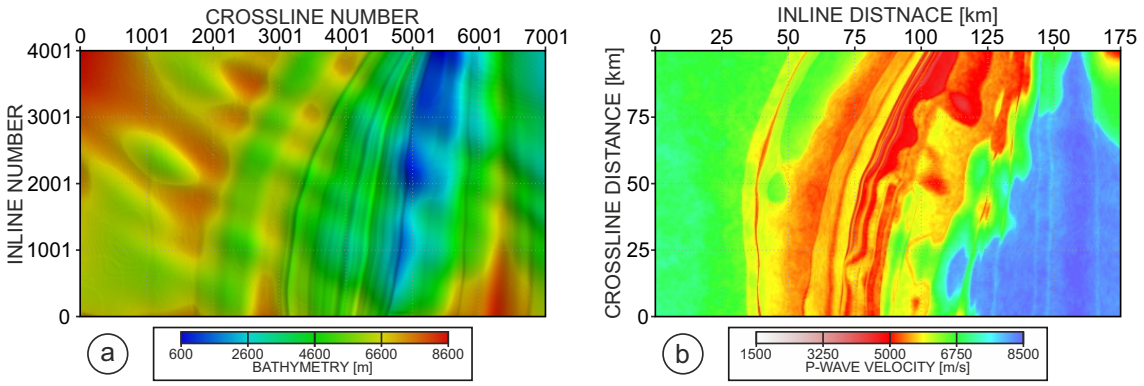


Figure 3.1: (a) Bathymetry variations; (b) Depth-slice section extracted from the 3D V_p cube at 10 km depth.

In Figure 3.2 we show a perspective view on the the full V_p model. With white lines we mark the 3D V_p target model of dimension 30 km × 100 km × 20 km. To obtain this this target model on can concatenate 2D inline models from vp_ws_2200.su

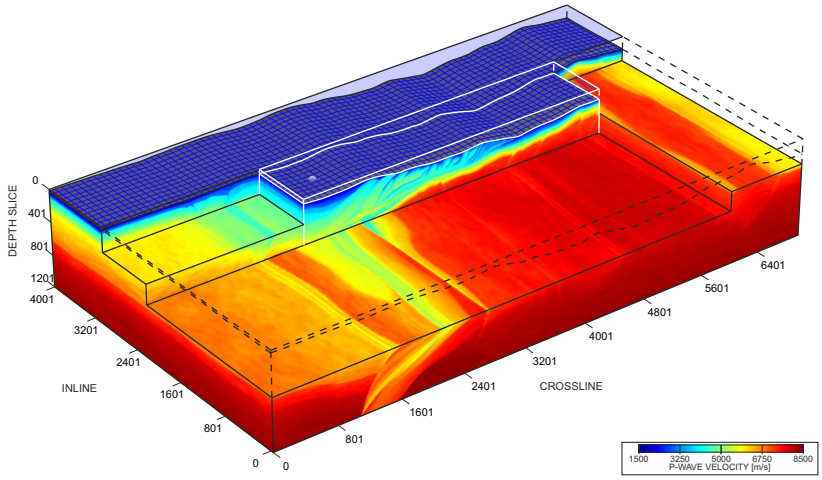


Figure 3.2: The perspective view on the chair-plot of the 3D V_p cube.

to vp_ws_3000.su and window the resulting 3D model according to **gx** header-word (crossline number) with *suwind*:

suwind < *input_3D_model*.su key=gx min=2000 max=6000 > *output_3D_model*.su

The GO_3D_OBS_SAMP.tar archive contains five inline sections for each parameter extracted at each 25 km of crossline distance. Figure 3.3 shows corresponding V_p sections. They can be used for 2D synthetic tests if user wants to avoid downloading rather large full 3D models.

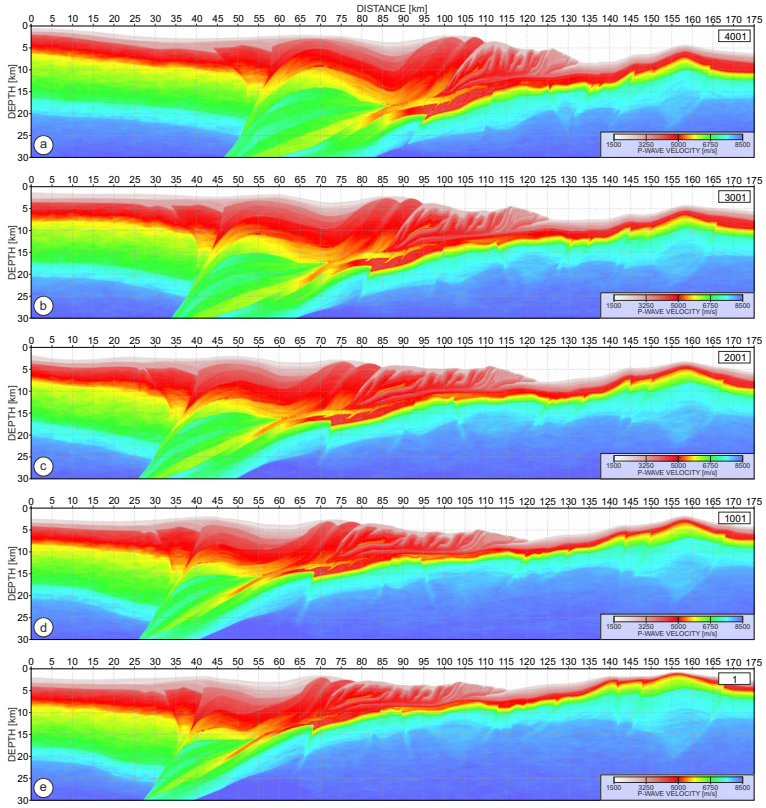


Figure 3.3: 2D inline V_p sections stored in the GO_3D_OBS_SAMP.tar archive.

Any .su file can be converted to .sgy format using *segywrite* command. Headers can also be discarded from the .su file with *sustrip* command.

4 Summary

User is strongly advised to read the following reference article:

Górszczyk, A. and Operto, S. [2020] GO_3D_OBS - The multiparameter crustal-scale benchmark for the next generation 3D seismic surveys design and the imaging methods validation. Geoscientific Model Development, (submitted)

describing in details the procedure of model-building, and presenting examples of the wavefield modelling.
The authors are open for a feedback from the users which can contribute to further improve the model.