A hierarchical compression-based geomodelling workflow for Petrel

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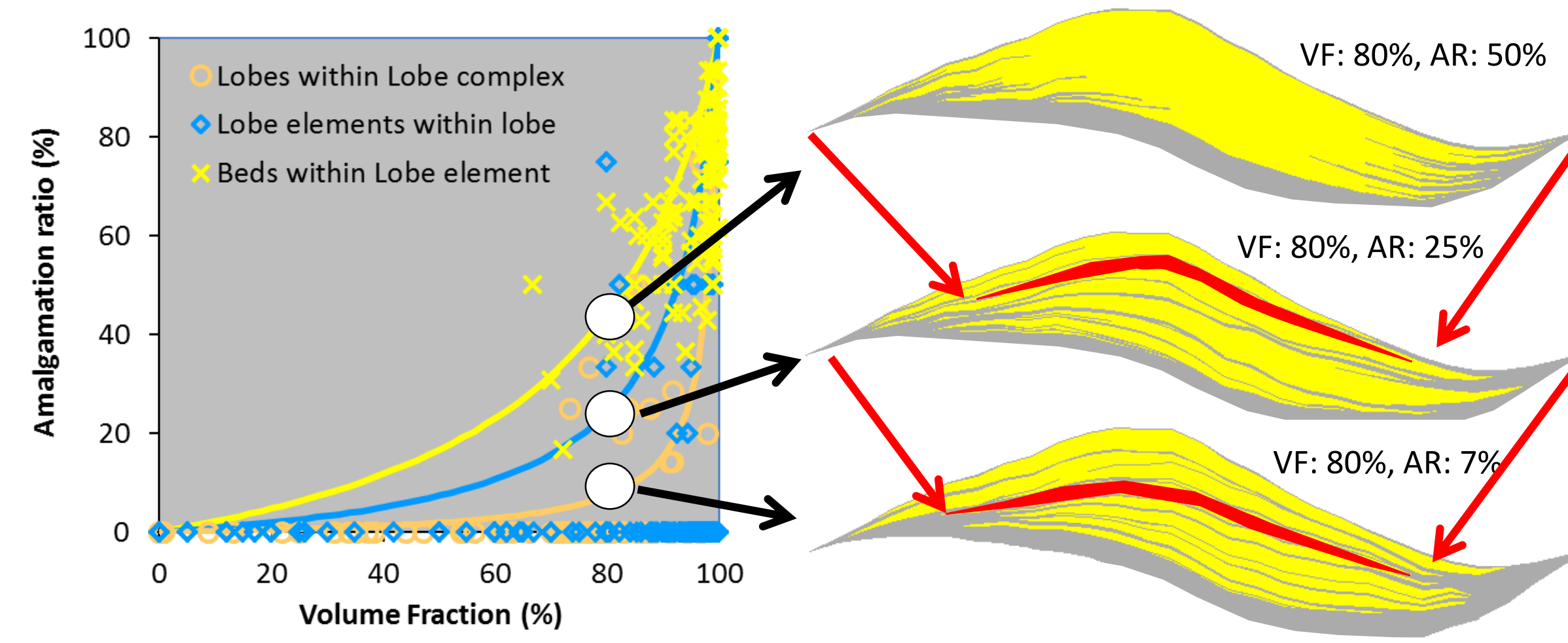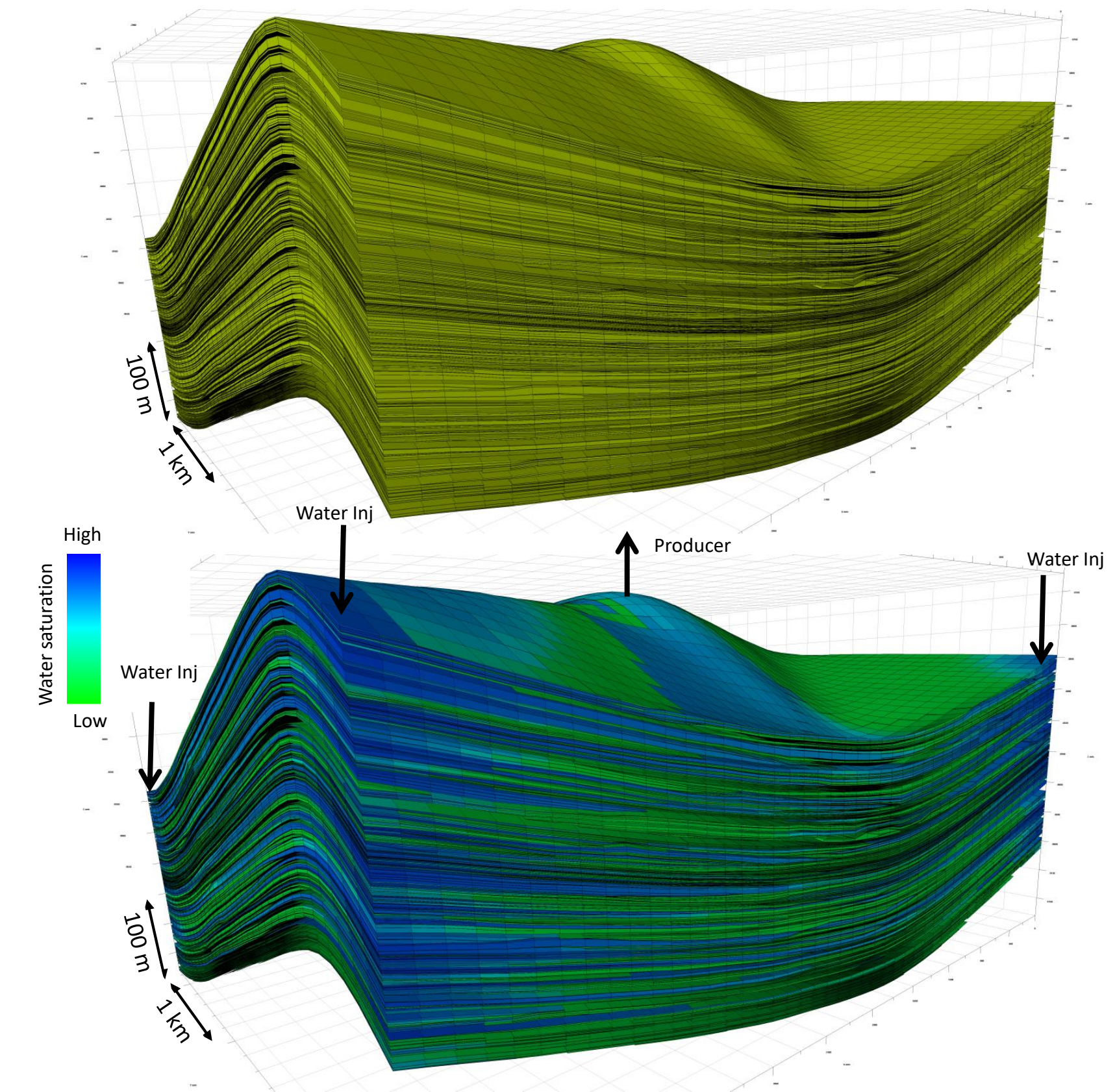*mvcmartins@icrag-centre.org

Introduction

The compression-based modelling approach was developed to overcome the limitation of conventional object-, variogram- or MPS-based facies models in which geobody connectivity is an unconstrained model output determined primarily by the volume fraction of the geobodies. The standalone vbFIFT package was developed to implement compression-based modelling in a hierarchical, object-based framework, and has proven the approach to be robust. It is, however, very difficult to use.
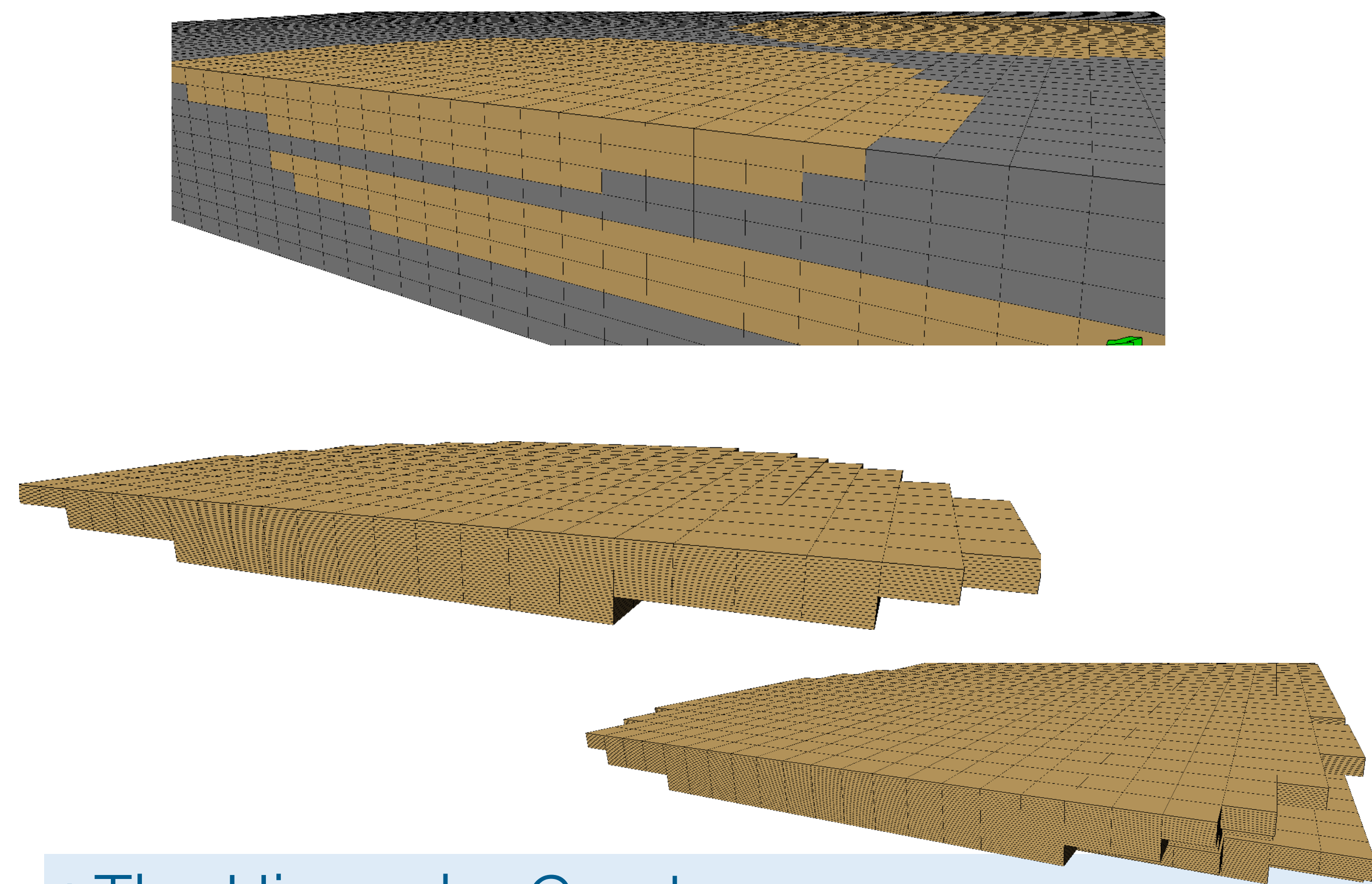
The current project aims to make the approach more generally accessible to industry geomodellers, through its implementation as plugins and workflows accessible within the industry-standard Petrel Geomodelling software. The work is at an early stage of development, but we outline here the main developments so far.

Above: Principal of the modelling approach: Independent honouring of both amalgamation and net:gross ratios in compressed object-based models at each hierarchical level. Right: Hierarchical full-field scale (4.3 km *3 km *250m) but bed resolution (ca 15 cm) model of a deep-water lobe reservoir build and upscaled in vbFIFT, and flow-simulated in Eclipse. After Zhang (2015), Manzocchi et al. (2016).
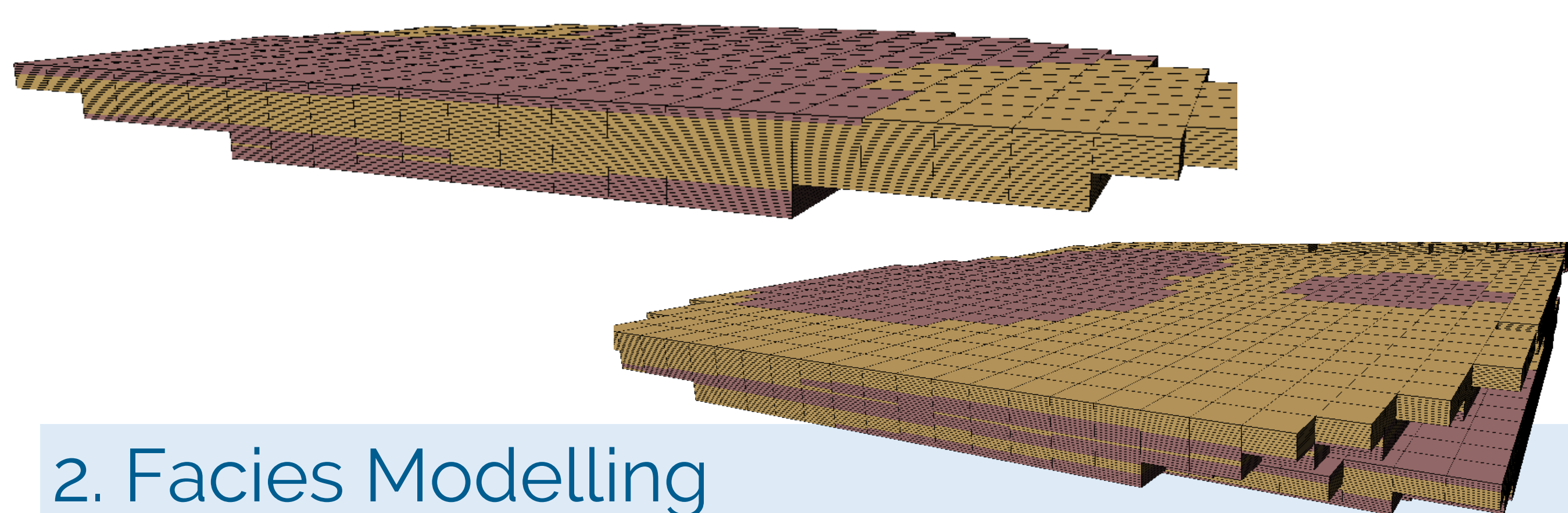
The Workflow

1.The Hierarchy Creator

This plug-in creates separate, locally refined grids for each object within a facies model. Objects can be defined either on the basis of their geobody ID for object-based models, or on the basis of a built-in clustering algorithm which identifies connected volumes and can be applied to either object-or pixel-based (including MPS) facies models. The plug-in copies the property of each container to the cells in independent Petrel grids, and de-activates the background cells.

2. Facies Modelling

We currently use the existing Petrel object-based facies modelling functionality to generate our models. However, Facies Modelling functionality was not designed to run sequentially for mutliple grids in an automatized workflow. A new facies modelling functionality is now under development for the new vbFIFT plug-in. This new functionality can create models for sheet and channels and also include object placement conditioning functions that are currently unavailable in Petrel.

3. The Upscaler

The Upscaler plug-in not only assembles the models of each grid into one model, but also reduces the number of cells of the final grid. For each coarse cell of the object containers, the Upscale Algorithm recursively searches for low-level models in local grids. When the algorithm identifies the local grid corresponding to that container, it copies the properties of the refined cells to the final grid. In case the grid cell contains a background value or no local grid is found, the property of the coarse cell is copied to the final grid. Finally, the algorithm merges the neighbouring cells that vertically have the same property. At the current stage of the algorithm, the plug-in only upscales cells stacks (z-direction) and maintains the number of cells in x- and y-direction.

4. The Compressor

Net:Gross Ratio and Amalgamation Ratio are two input parameters used to calculate expansion factors that modifies the volume of grid cells, and consequently, change the volume fraction of geo-models without changing their connectivity. In the Compressor Plug-in, thickness of grid cells are expanded or compressed according to expansion factors defined for each facies in the upscaled hierarchical model. For upscaled grids, before compressing each pillar grid in the input grid, the compression algorithm creates a regular pillar grid from the upscaled one and resample the facies in the new points. The compression algorithm proceeds similarly as in the regular grids. A final stage of the algorithm re-upscales the compressed grid for output. The compression algorithm does not modified external boundary shape of non-rectangular models, such as channels.

Future steps

- **Plug-in usability:** Improvement of the user interface aiming to minimize potential user errors; Improvement of the plug-in capabilities as they were initially designed for very specific tasks.

- **Conclusion of the first version of the plug-in for facies modelling:** Implementation of object-based modelling for sheets and channels.

- Development of a in plugin that manages the workflow of all plug-ins created for geomodelling. Design of alternative workflows that use other modelling techniques.

References

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