Swift FWI

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2013. 12. 04

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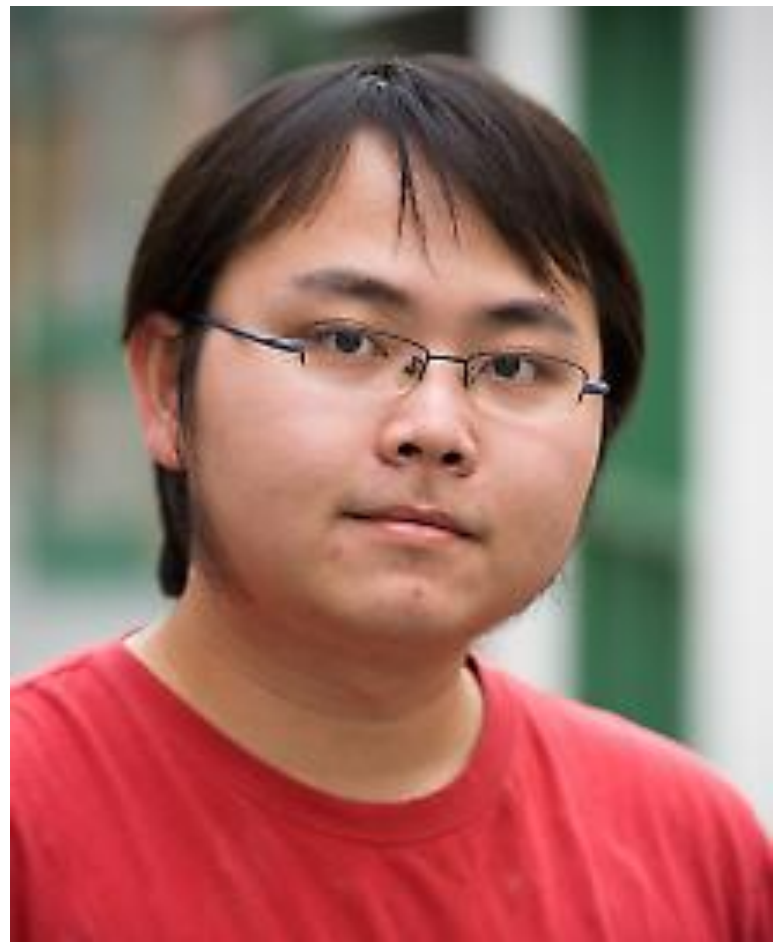

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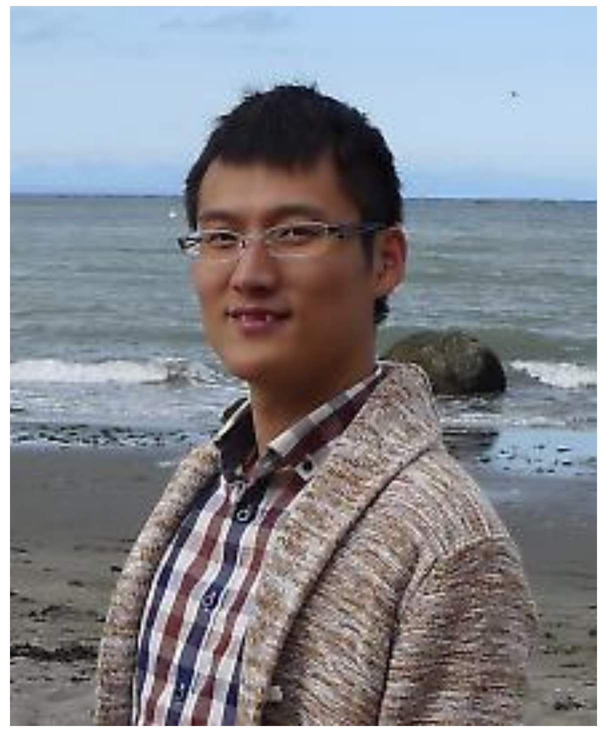


Zhilong Fang

Motivation

Matlab Parallel Computing Toolbox

- forward modeling
- linearized modeling
- full waveform inversion
- ……

Bottleneck licenses

Domain Decomposition

Parallel Over Shots

price = $$$ * nlabs

Motivation

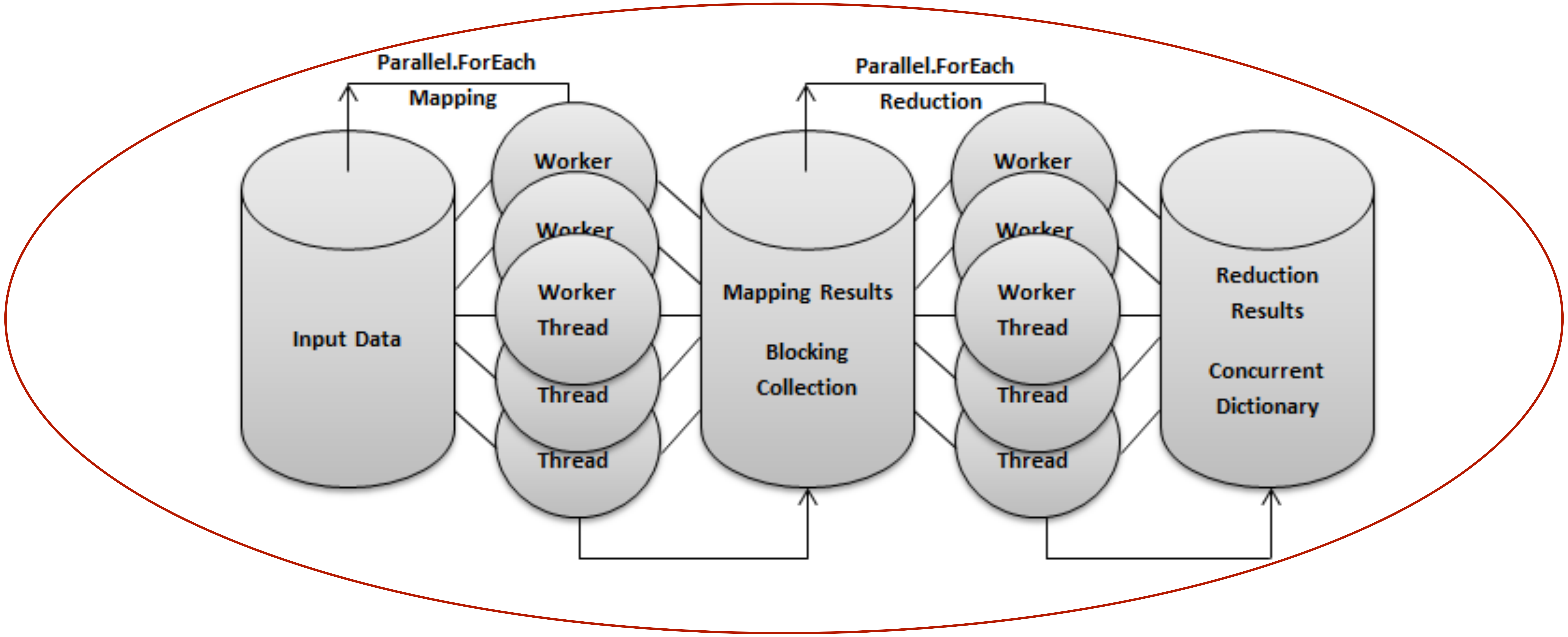
Solution:

+ MapReduce

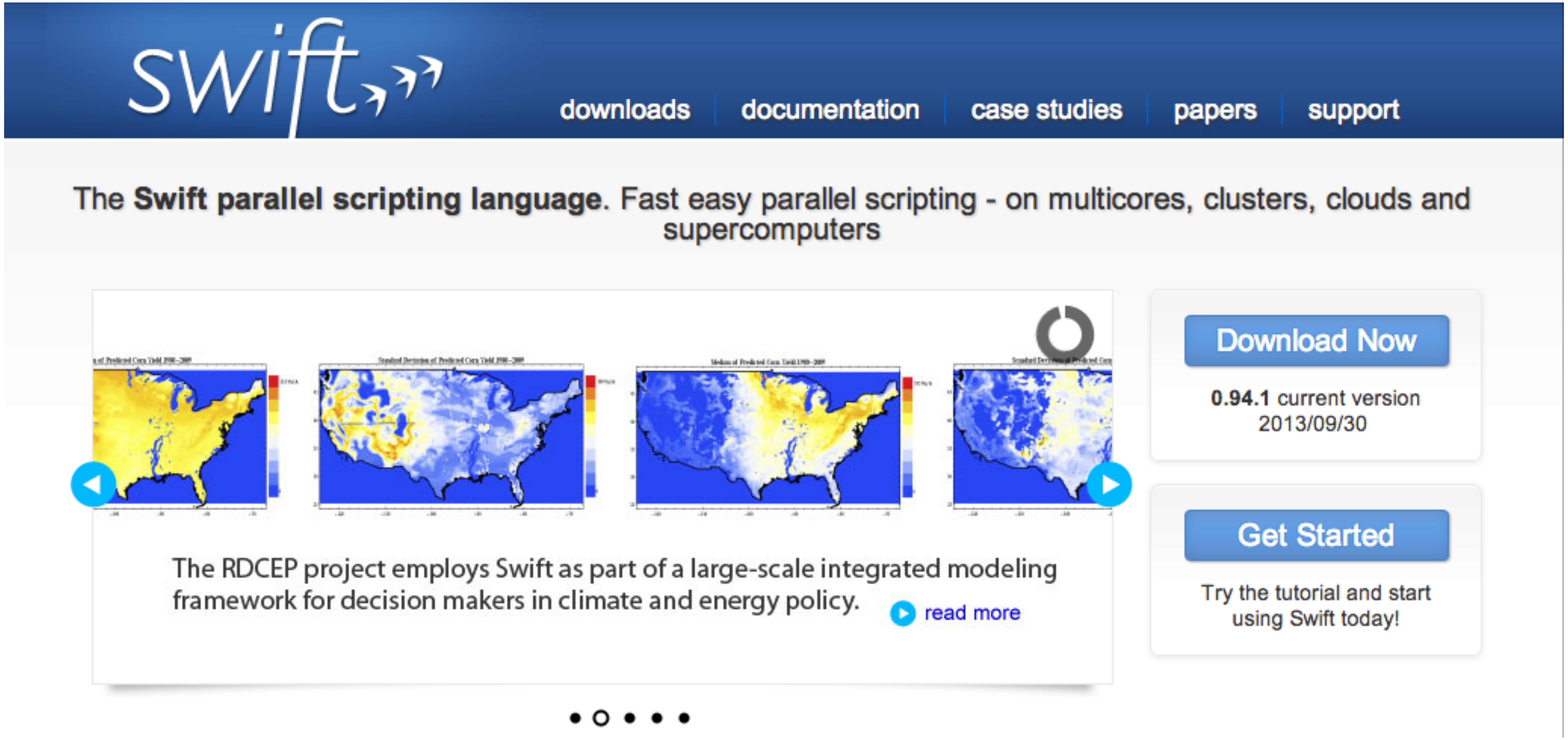
MapReduce

MapReduce: MapReduce is a programming model for processing large data sets with a parallel, distributed algorithm on a cluster.

Swift



Swift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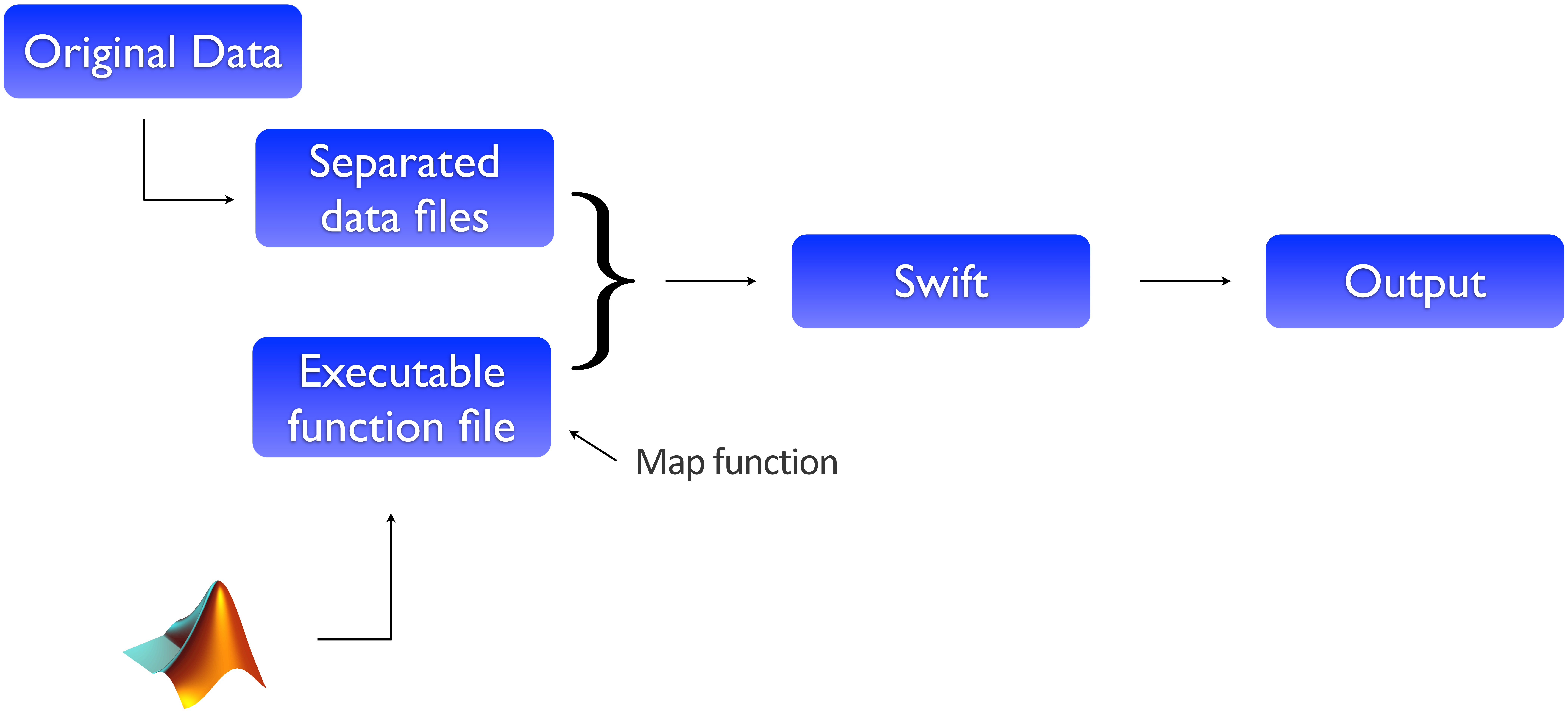
Swift


Original Data
Separated data files
Executable function file
Swift
Output
Map function

3D Full waveform inversion

Optimization problem:

$$\min_{\mathbf{m}} f(\mathbf{m}) = \sum_{i=1}^{M} f_i(\mathbf{m}) = \sum_{i=1}^{M} \|F_i(\mathbf{m}) - \mathbf{d}_i\|_2^2$$

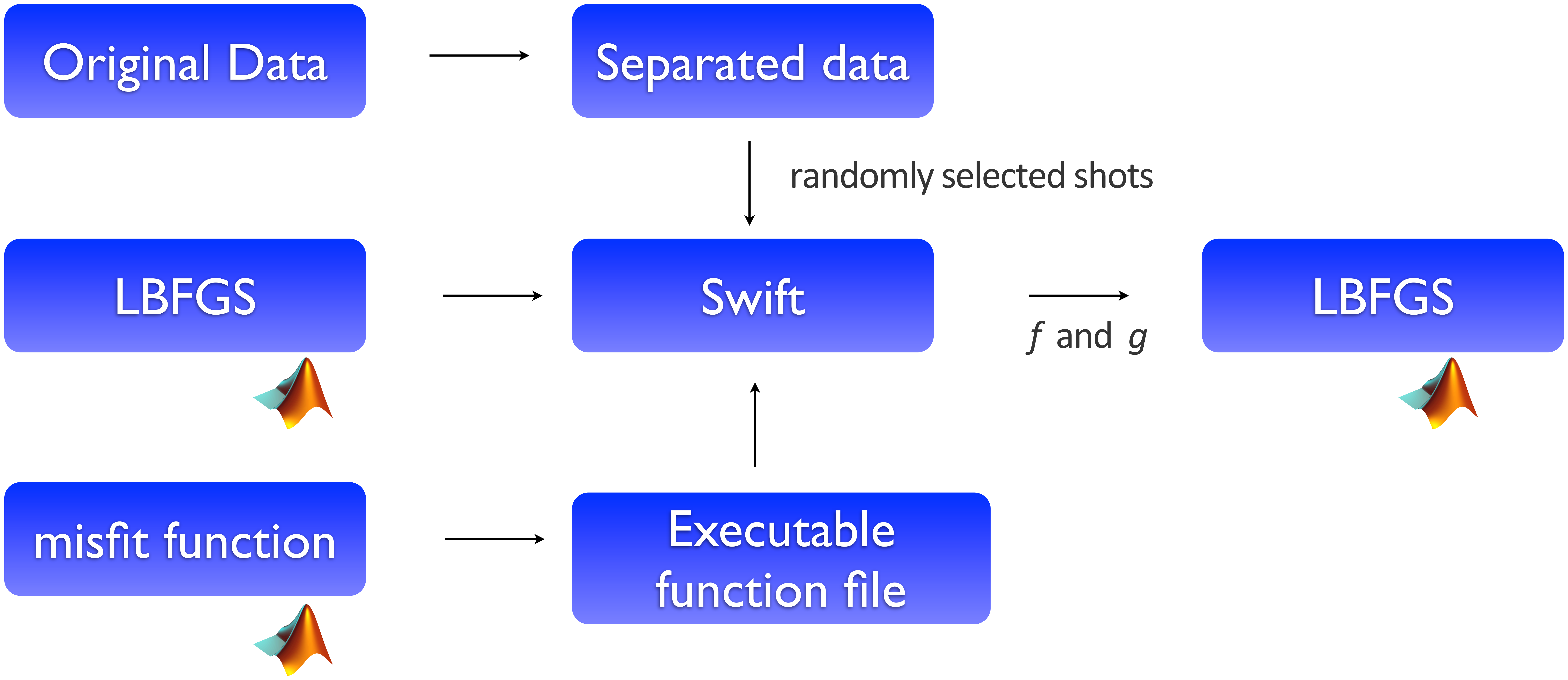
Gradient: $g(\mathbf{m}) = \sum_{i=1}^{M} g_i(\mathbf{m})$

Map: $(\mathbf{m}, \mathbf{d}_i) \rightarrow (f_i, g_i)$

Reduce: $(f_i, g_i)_{1 \leq i \leq M} \rightarrow f(\mathbf{m}) = \sum_{i=1}^{M} f_i(\mathbf{m}), g(\mathbf{m}) = \sum_{i=1}^{M} g_i(\mathbf{m})$

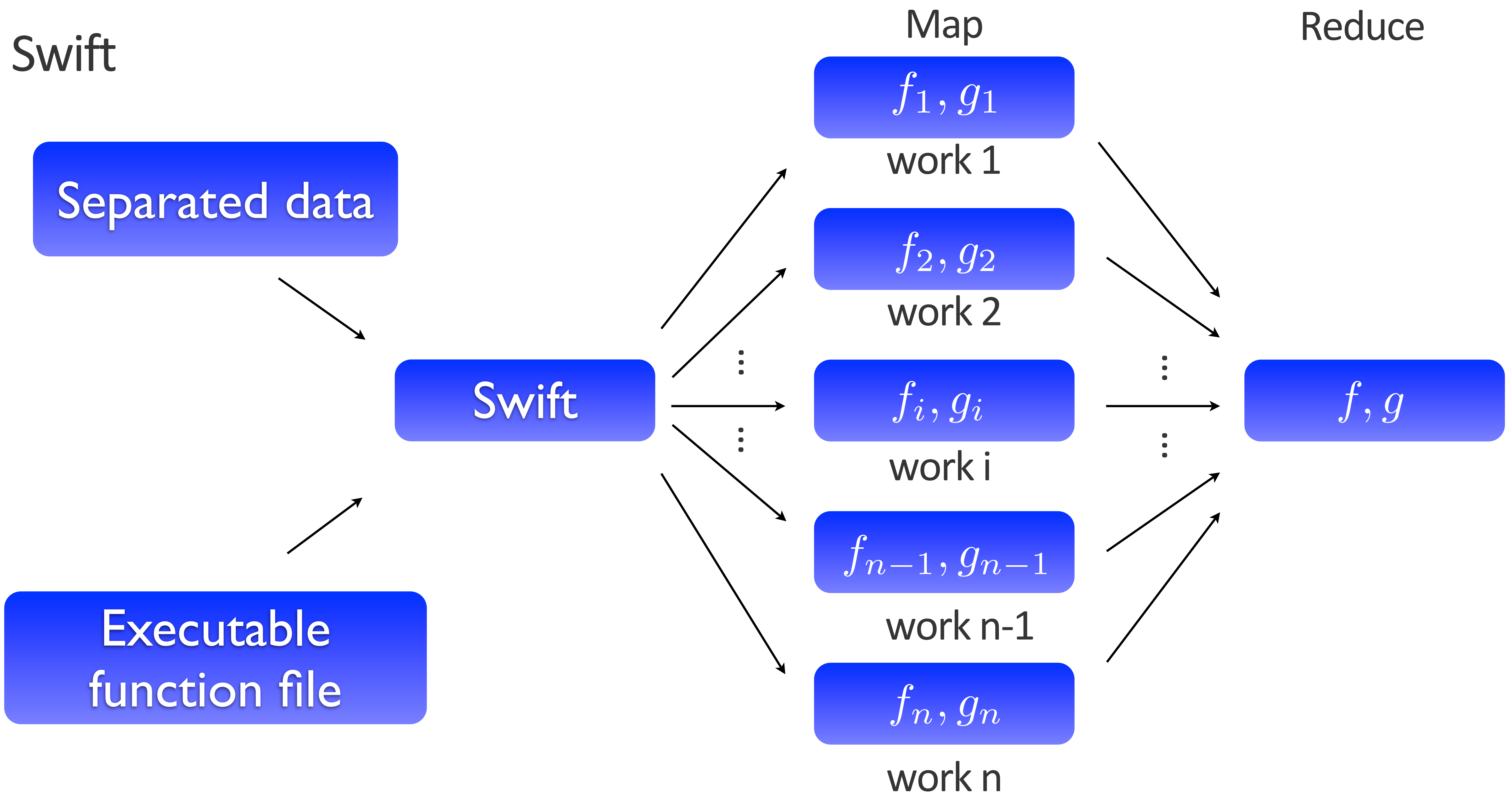
3D full waveform inversion with Swift

Workflow



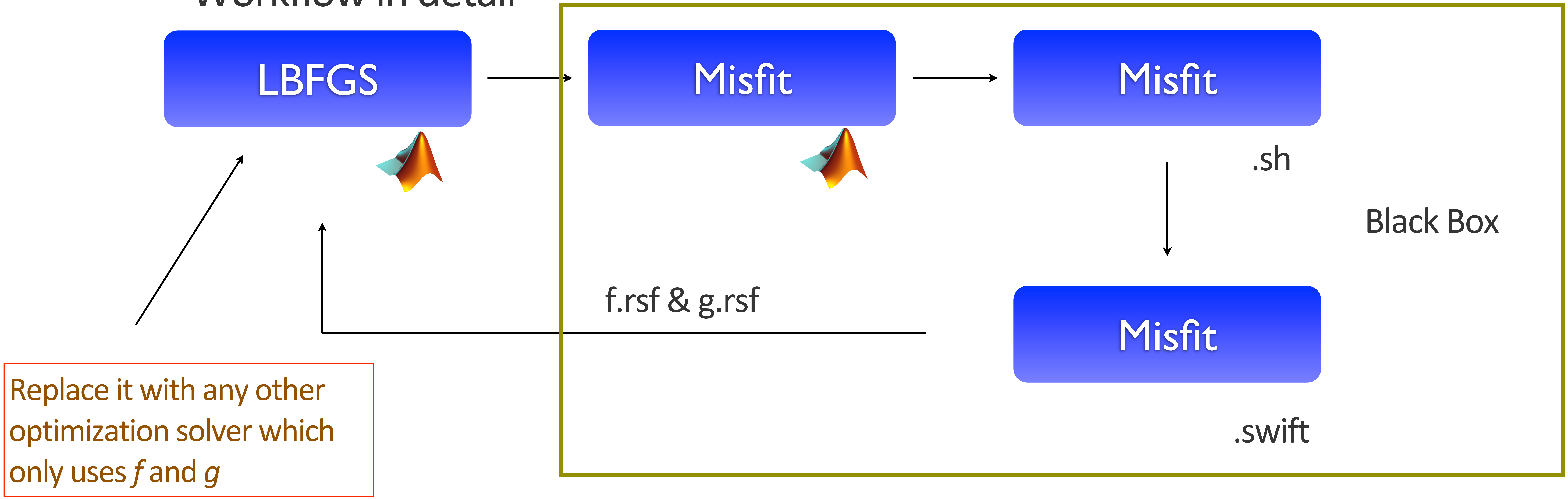
3D full waveform inversion with Swift

Swift



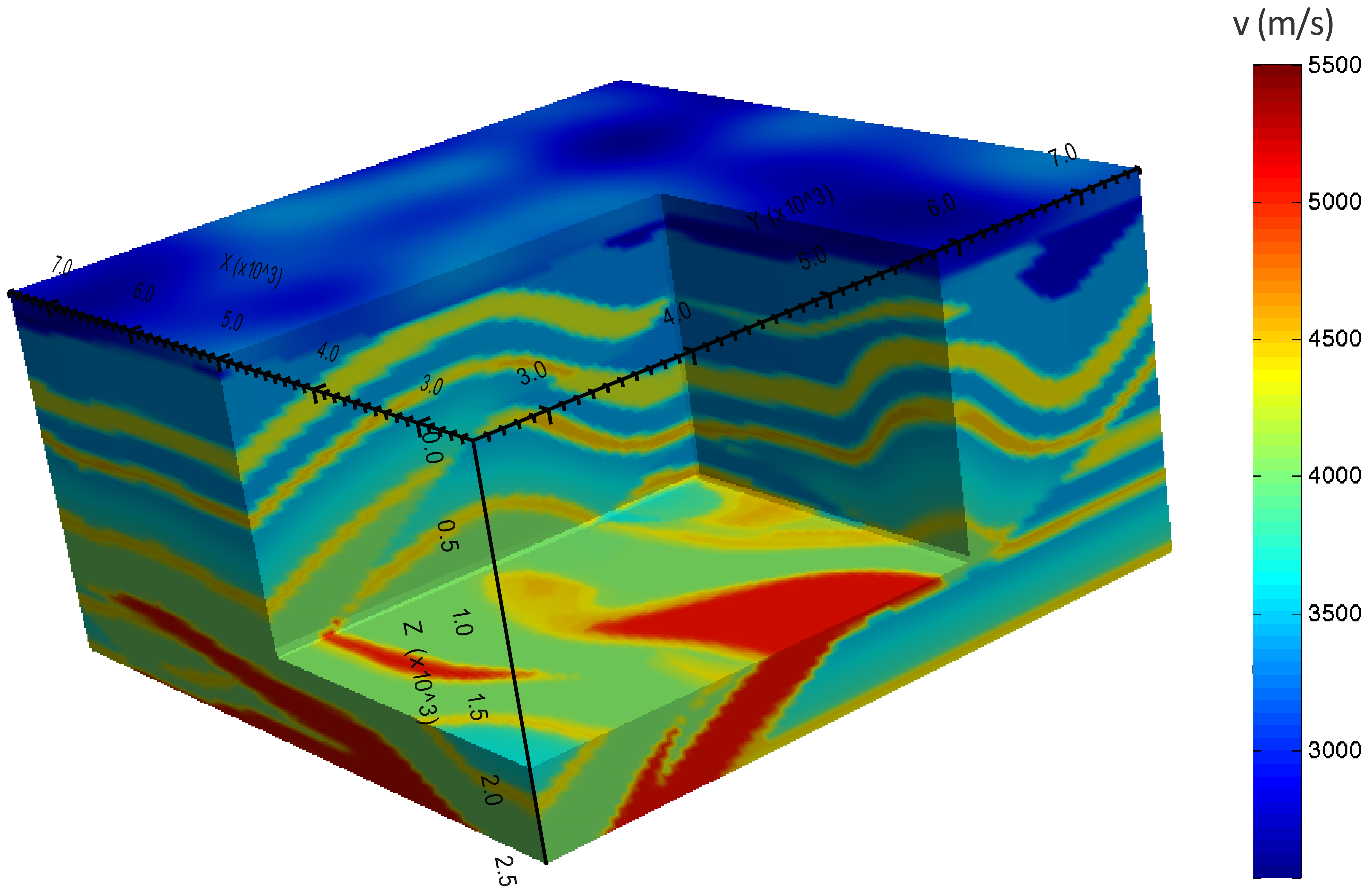
3D full waveform inversion with Swift

Workflow in detail



Numerical Experiment

Overthrust model



Model Infomation:

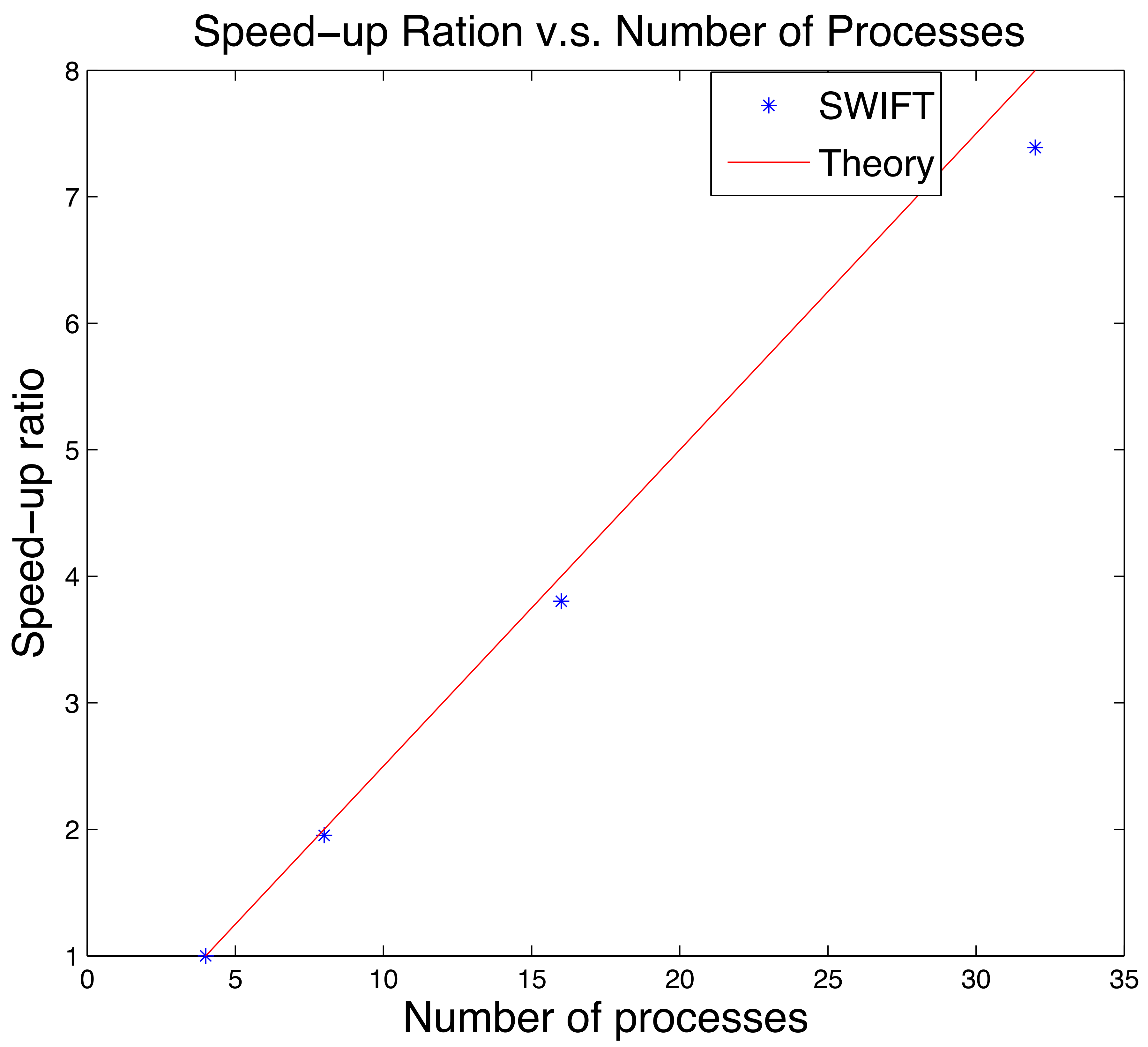
model size	- 26*51*51
	2.5* 5 *5 km
d	- [100 100 100] m
# of shots	- 121
# of receivers	- 2601
frequency	- 4 Hz
source depth	- 100 m
receiver depth	- 100 m

Parallel performance

Number of shots: 121

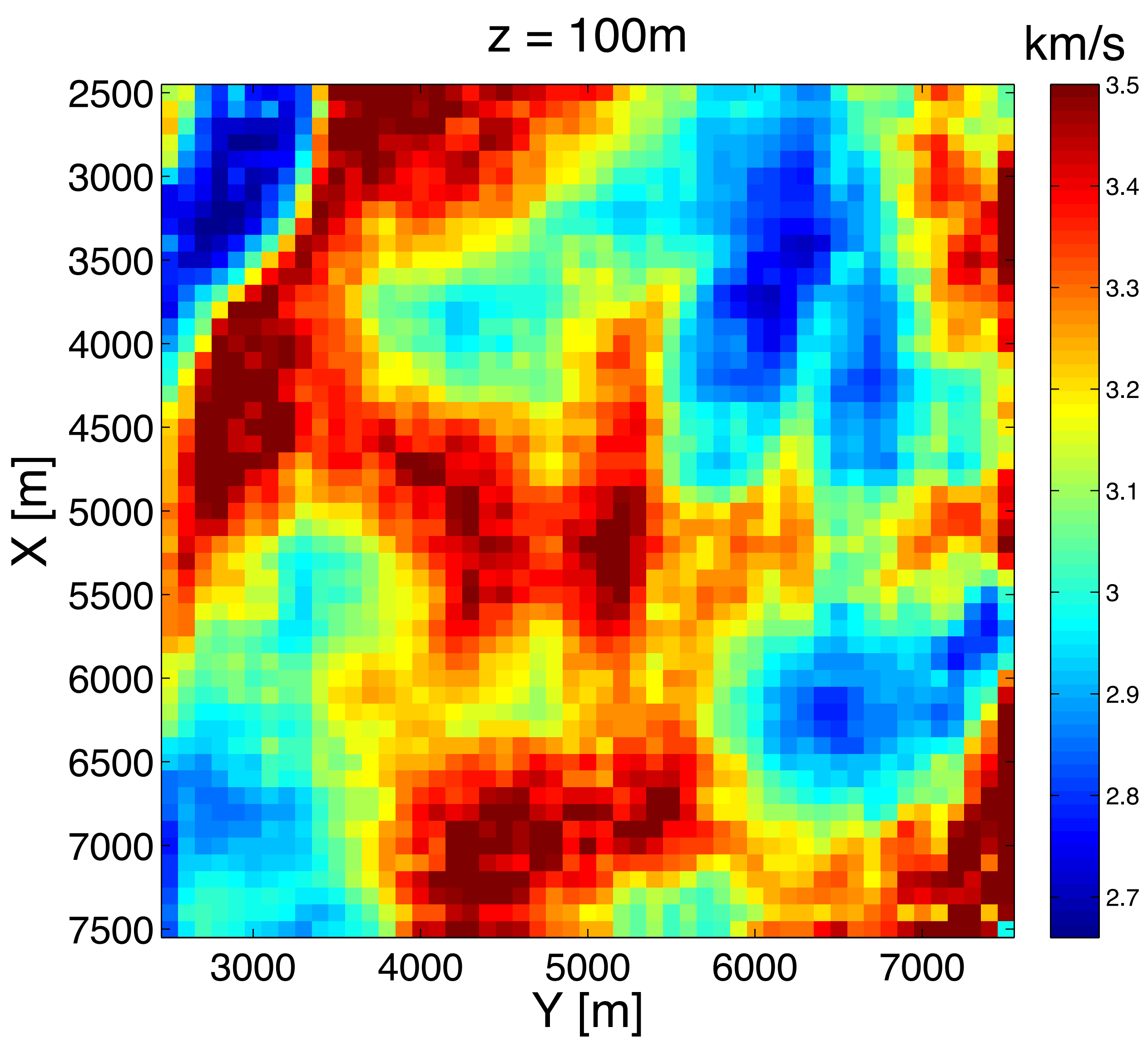
Number of processes:

4, 8, 16, 32

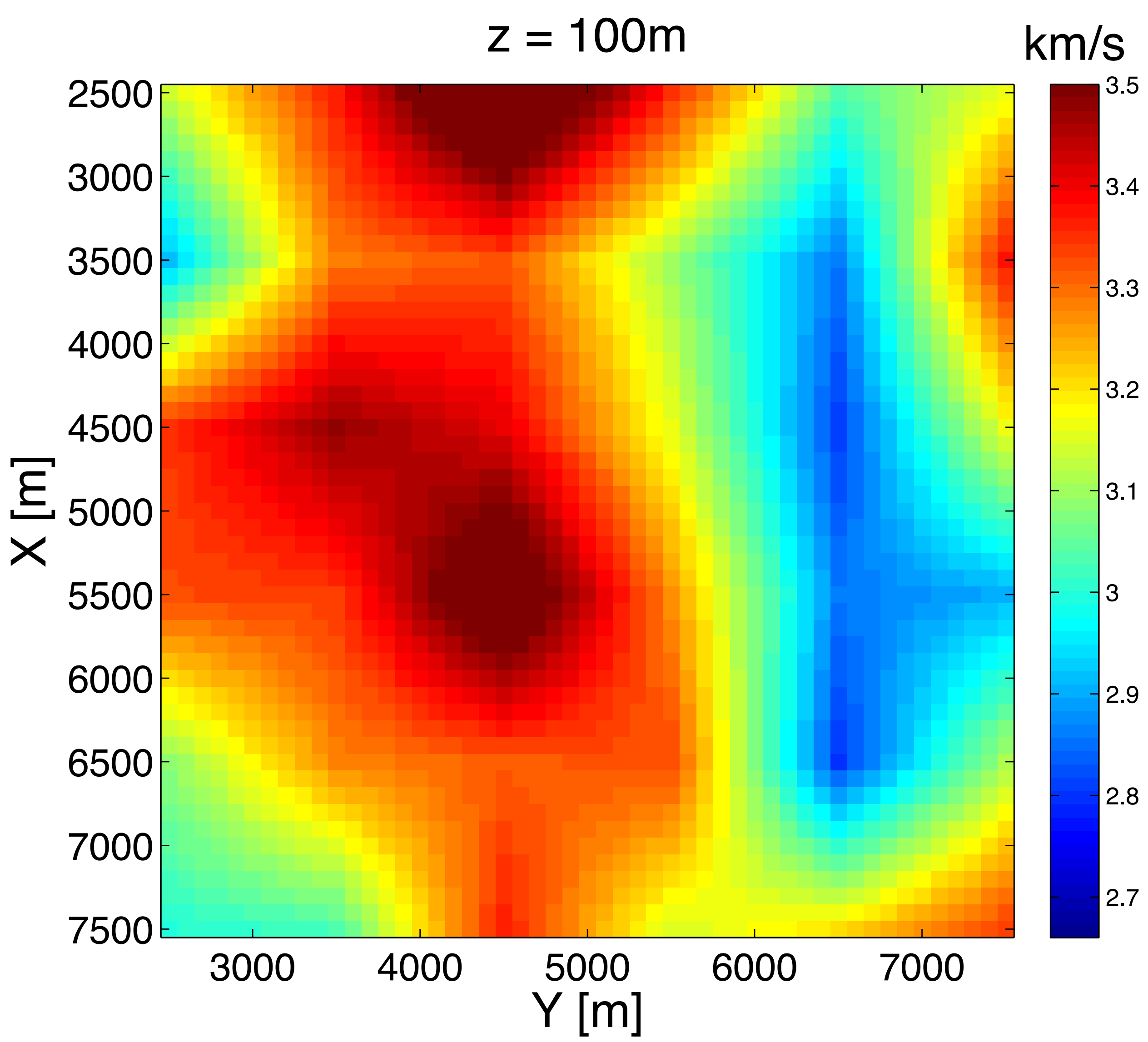


z = 100m

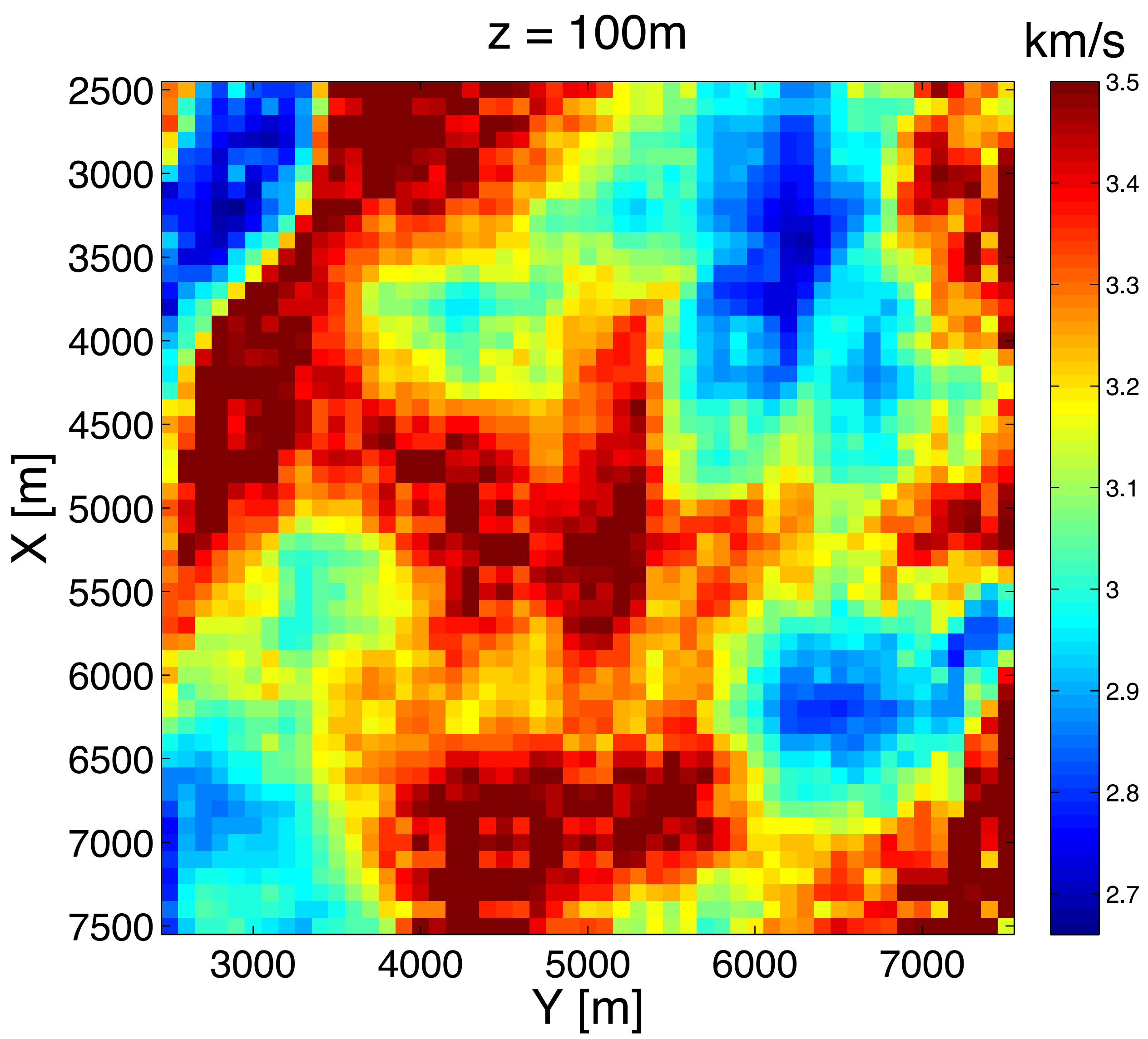
Randomly Selected Shots



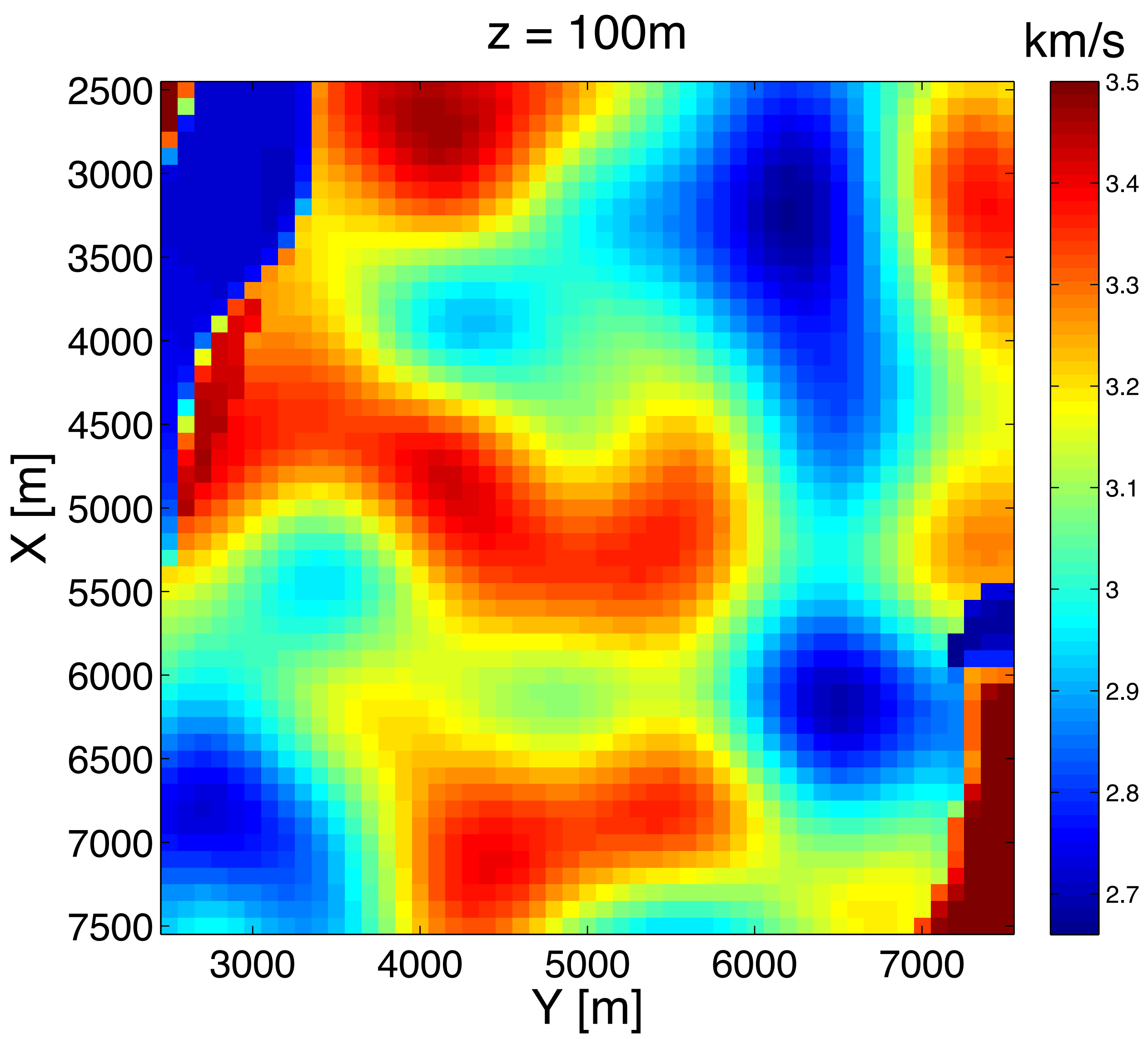
Initial model



All Shots

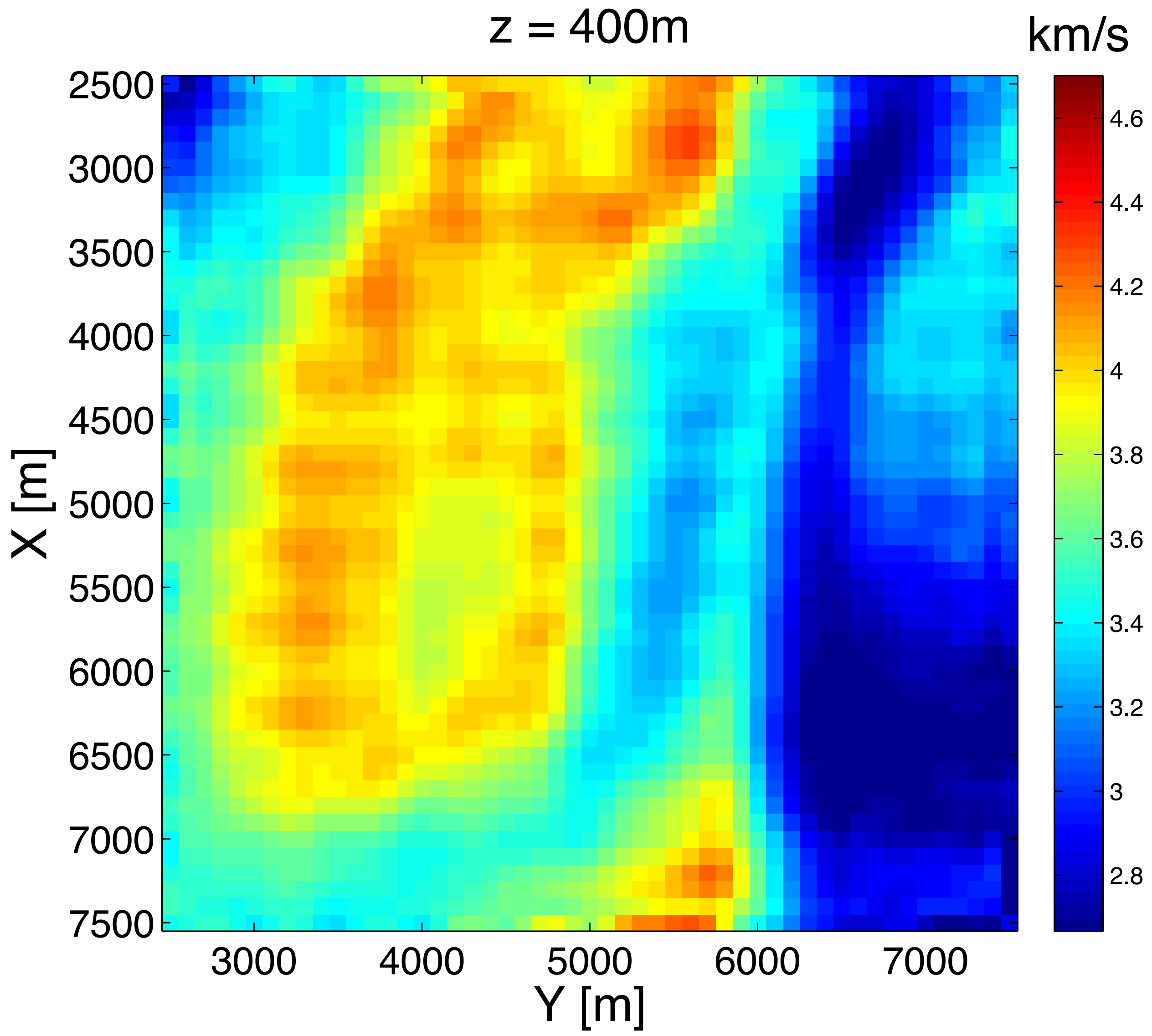


True model

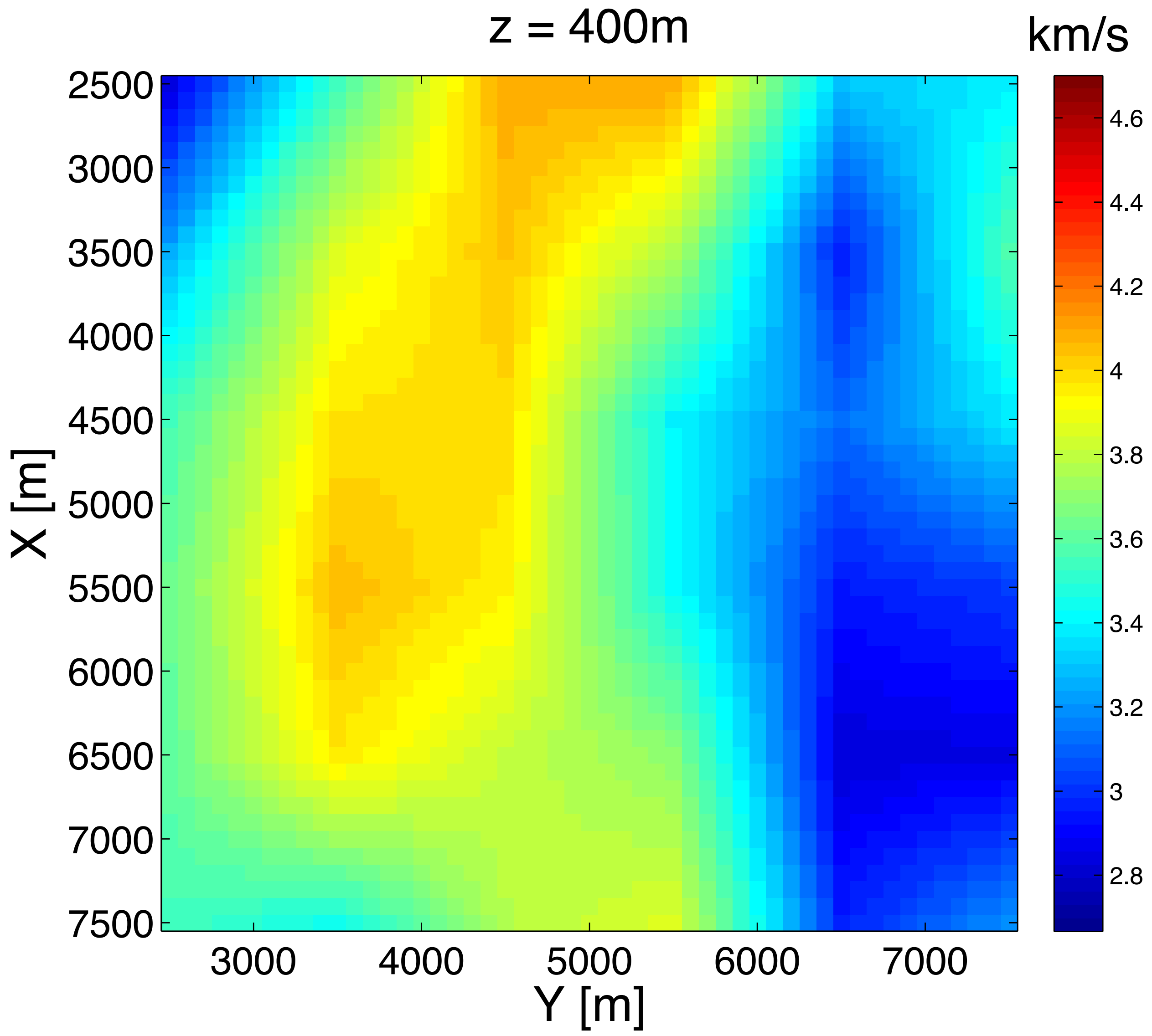


z = 400m

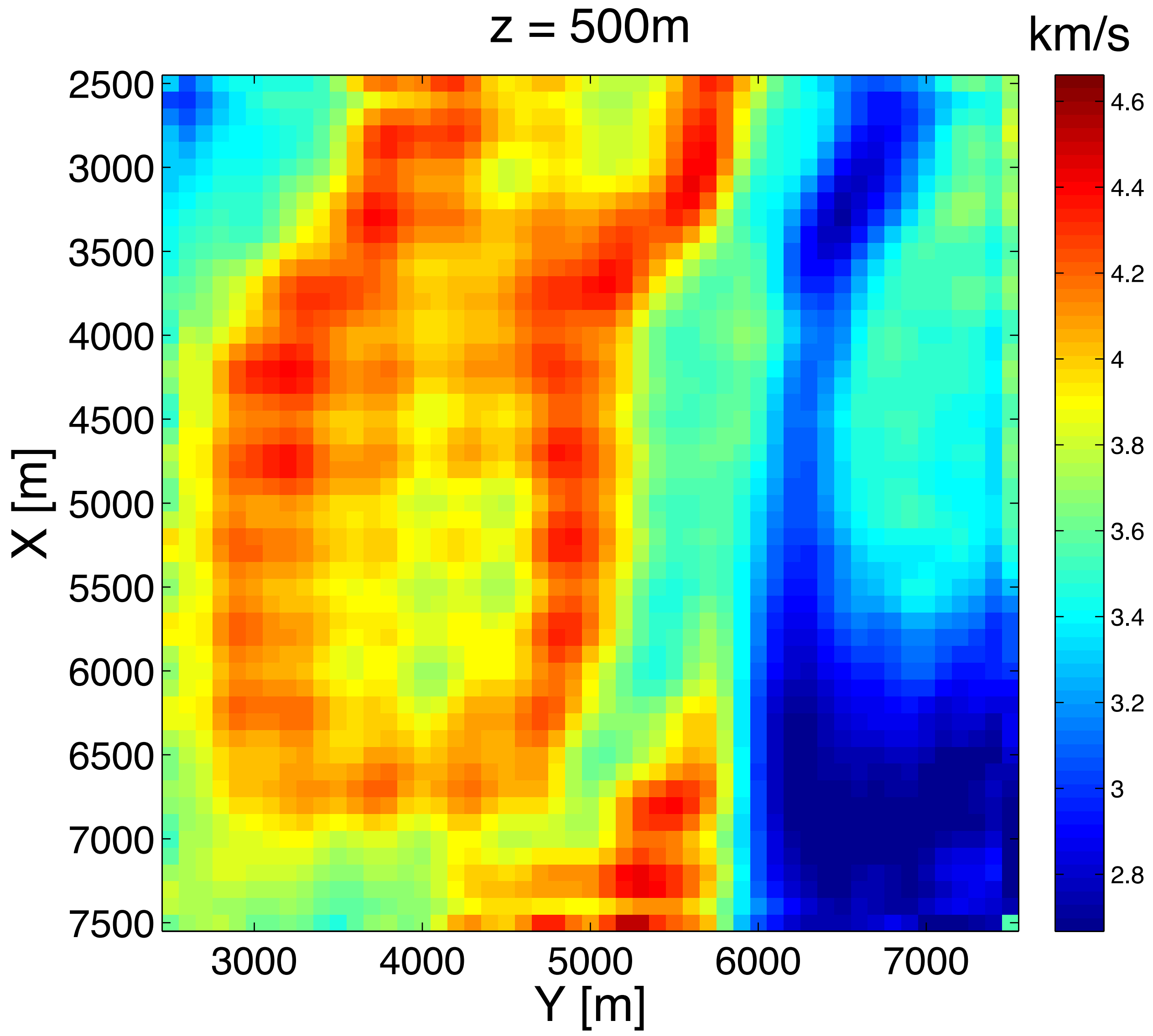
Randomly Selected Shots



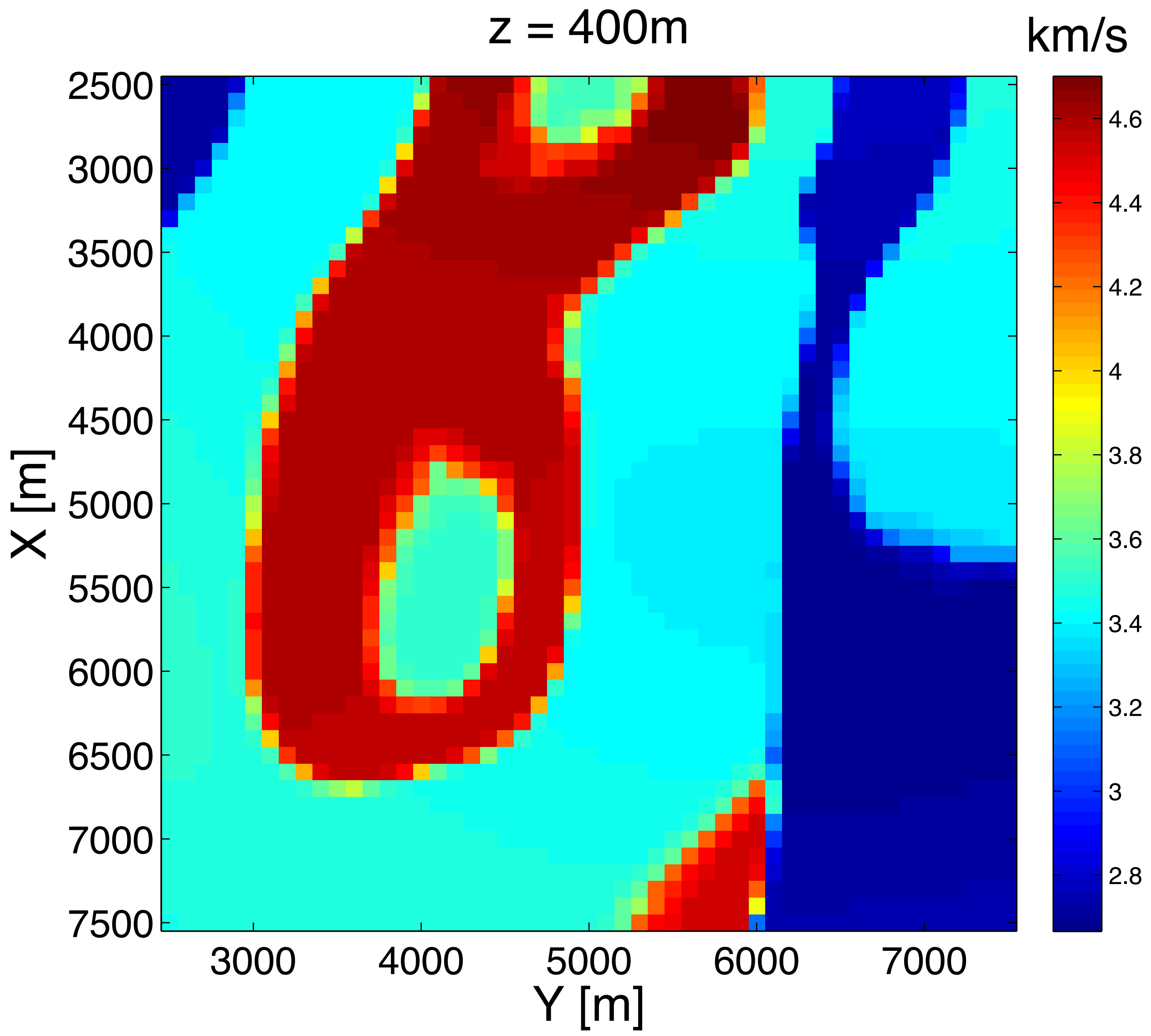
Initial model



All Shots

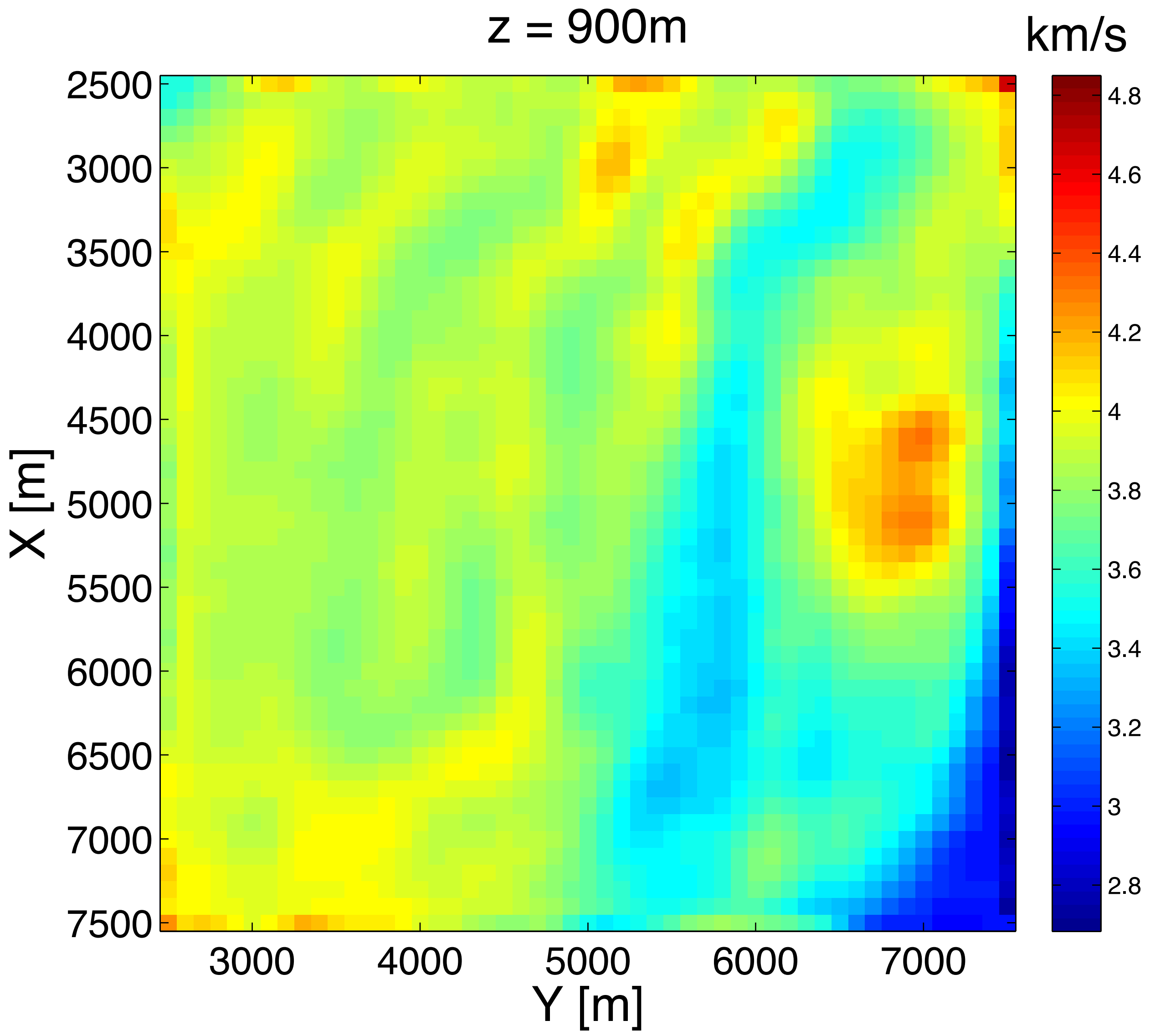


True model

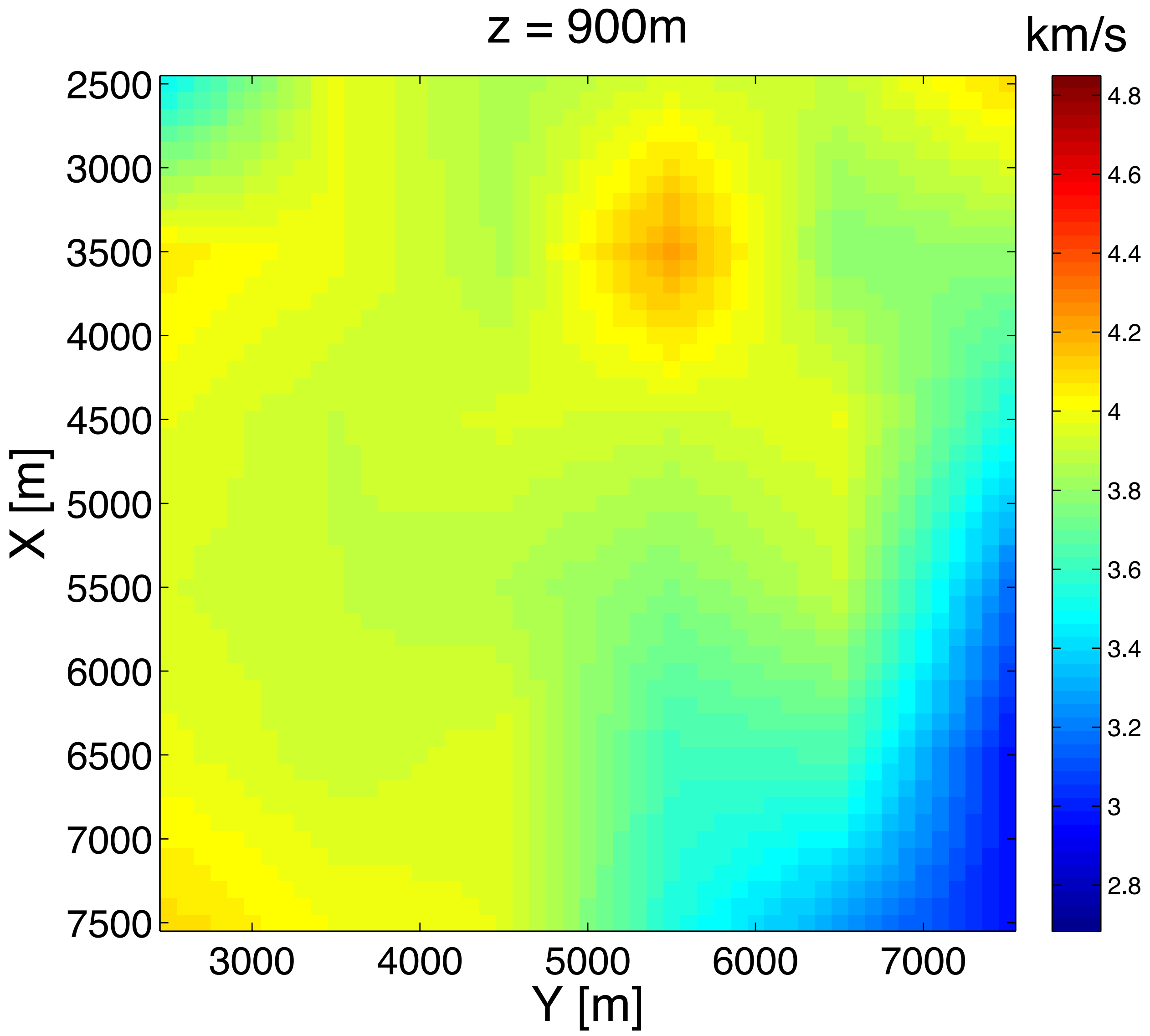


z = 900m

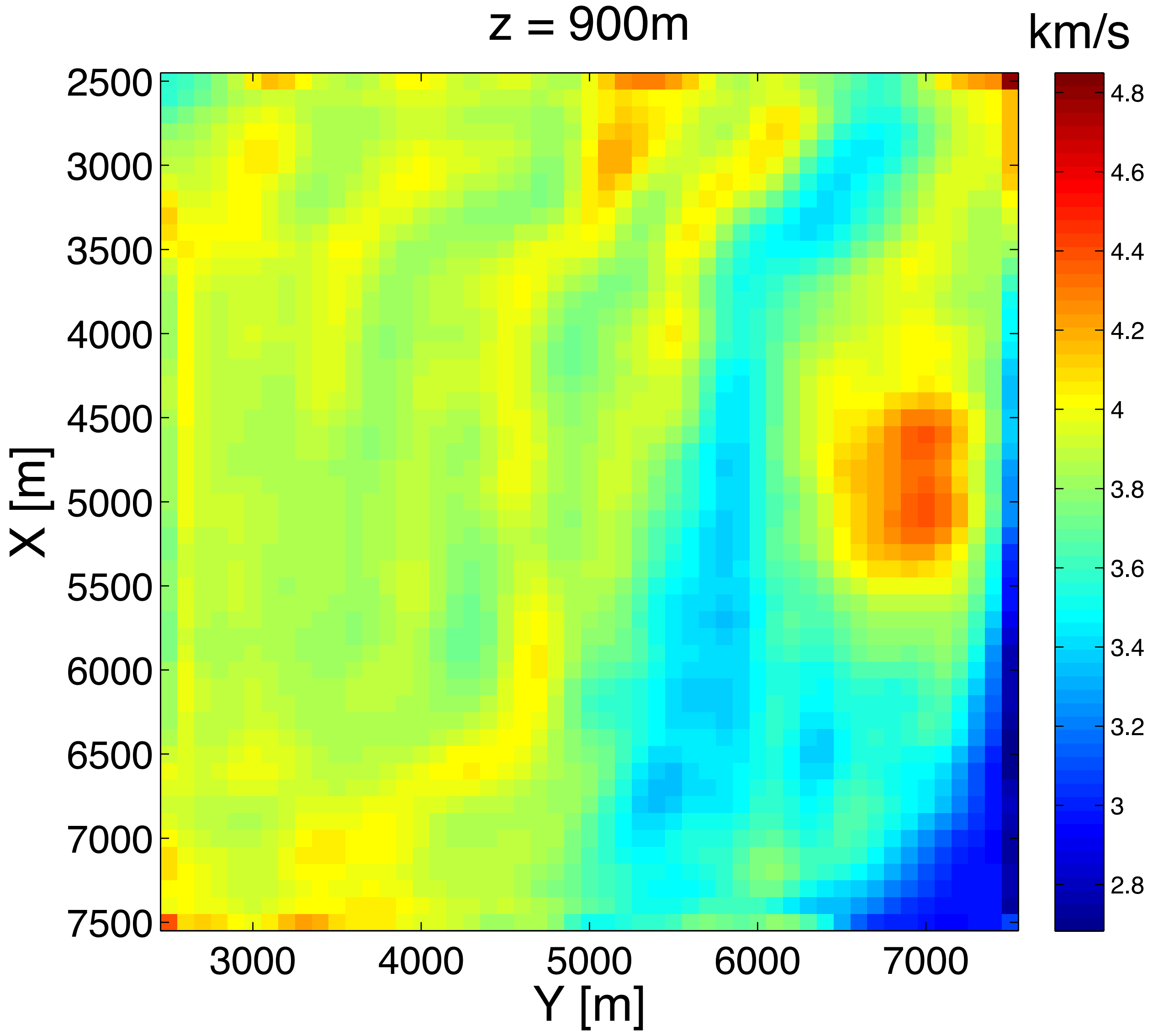
Randomly Selected Shots



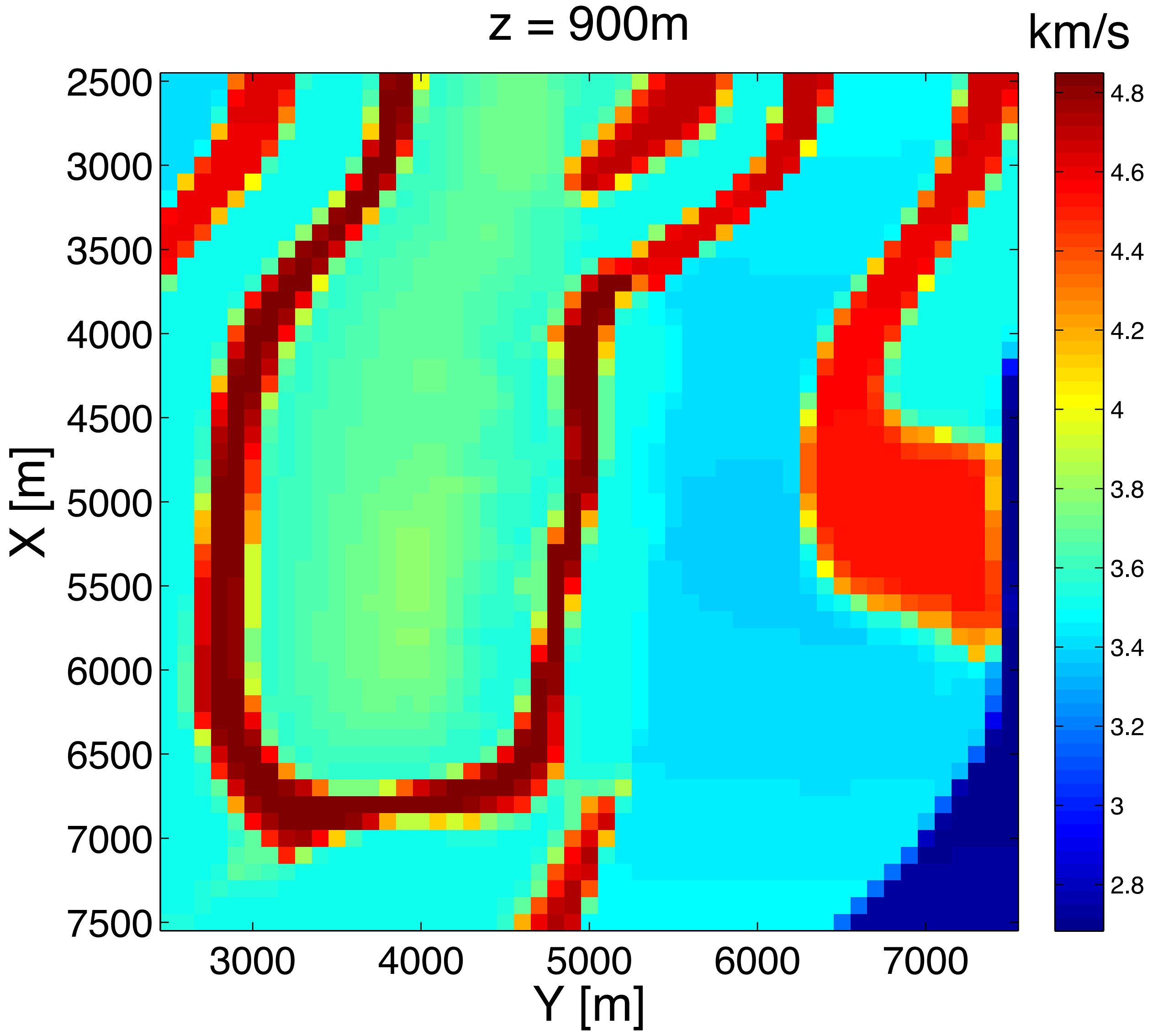
Initial model



All Shots

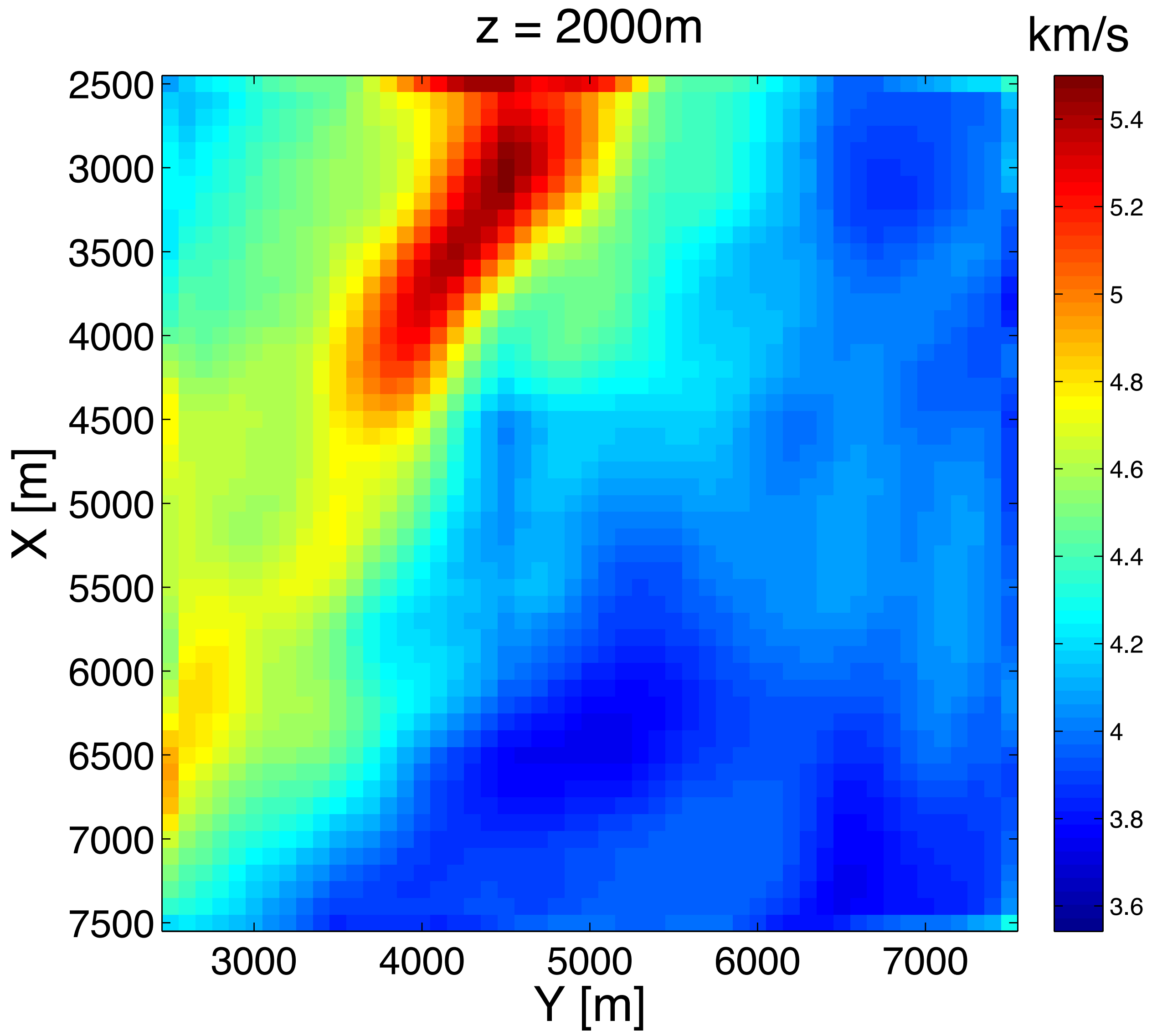


True model

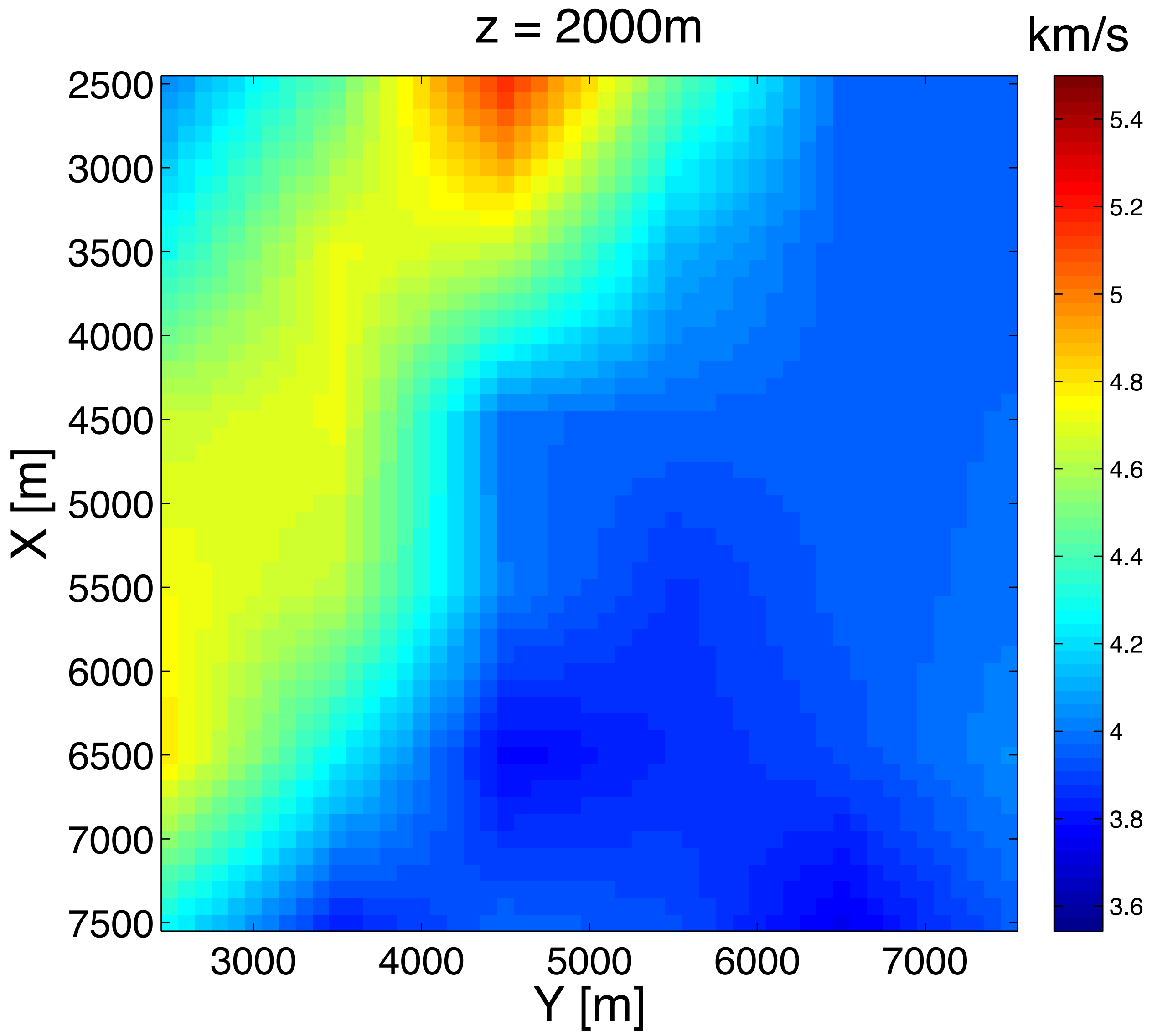


z = 2000m

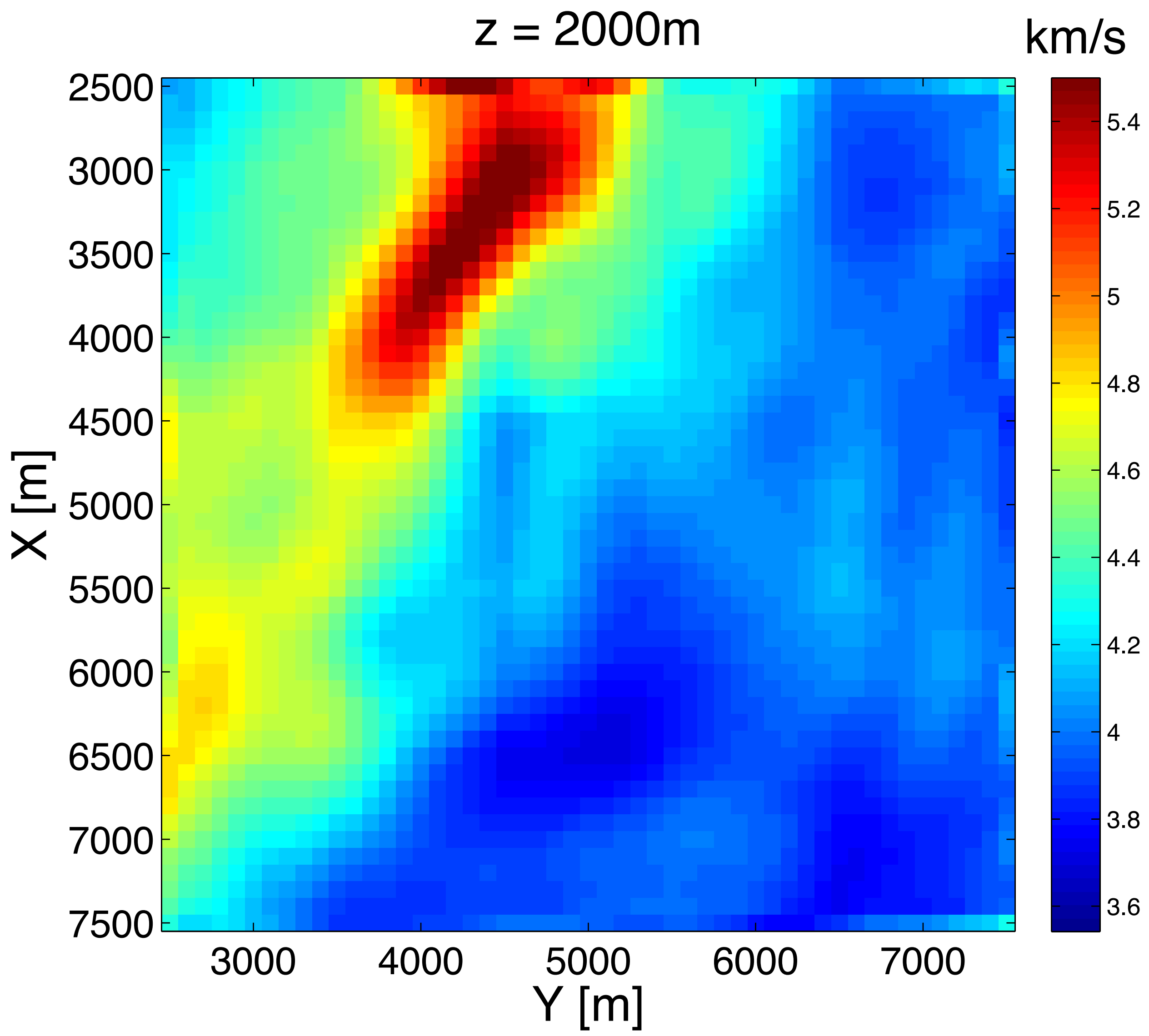
Randomly Selected Shots



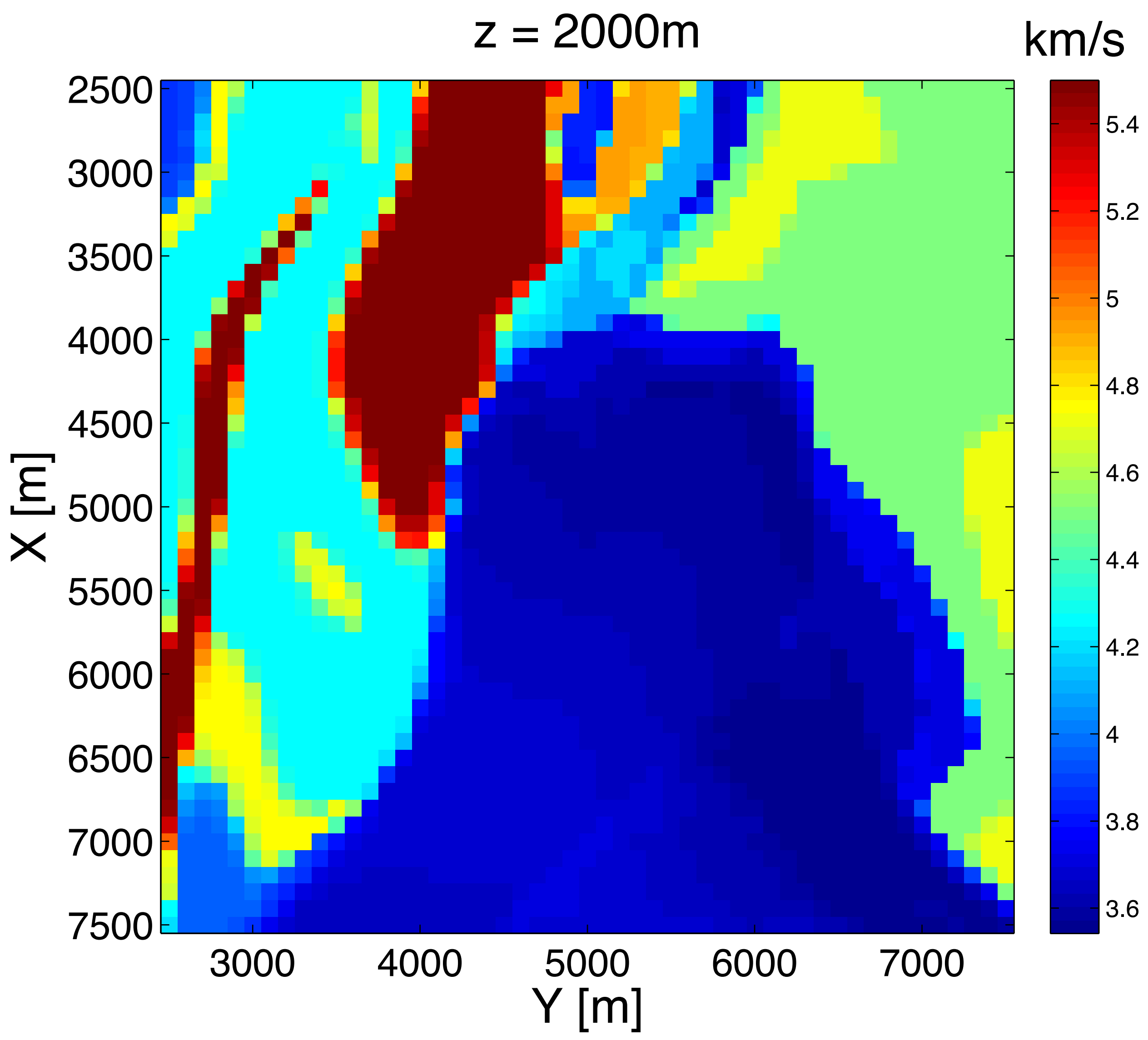
Initial model



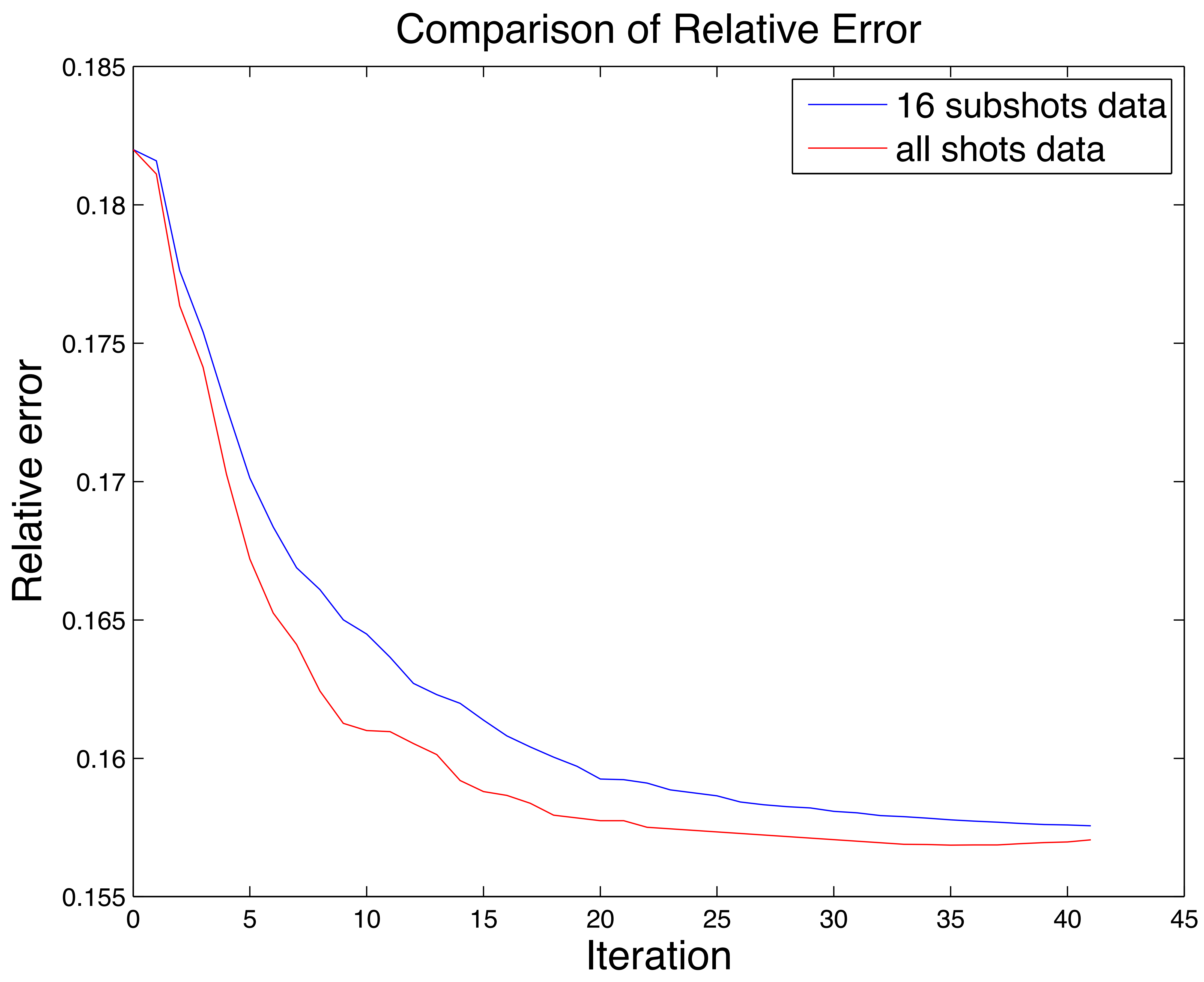
All Shots



True model



Comparison of Model Relative Error



Conclusion

- Swift is a powerful parallel computing tool which can be combined with matlab perfectly.

- Using swift, we can run matlab code on large cluster without the requirement of huge number of licenses.

Future work

- Test 3D FWI using swift with larger problem;
- Apply simultaneous shots for 3D FWI using swift;
- Combine adaptive 3D FWI with swift.

Acknowledgements

Thank you for your attention !

https://www.slim.eos.ubc.ca/

This work was in part financially supported by the Natural Sciences and Engineering Research Council of Canada Discovery Grant (22R81254) and the Collaborative Research and Development Grant DNOISE II (375142-08). This research was carried out as part of the SINBAD II project with support from the following organizations: BG Group, BGP, BP, CGG, Chevron, ConocoPhillips, ION, Petrobras, PGS, Total SA, WesternGeco, and Woodside.