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Can FWI replace everything?

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Outline

- FWI algorithm
- Build a velocity model
- Build a full-bandwidth PSDM
- Conclude

Outline

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} entirely via FWI on raw field data

Reflection Adaptive Waveform Inversion

AWI:

FWI drives **p** – **d** towards zero

AWI drives **p** / **d** towards one

Provides immunity to cycle skipping

RWI:

Migration-like FWI to add reflectors to Vp model

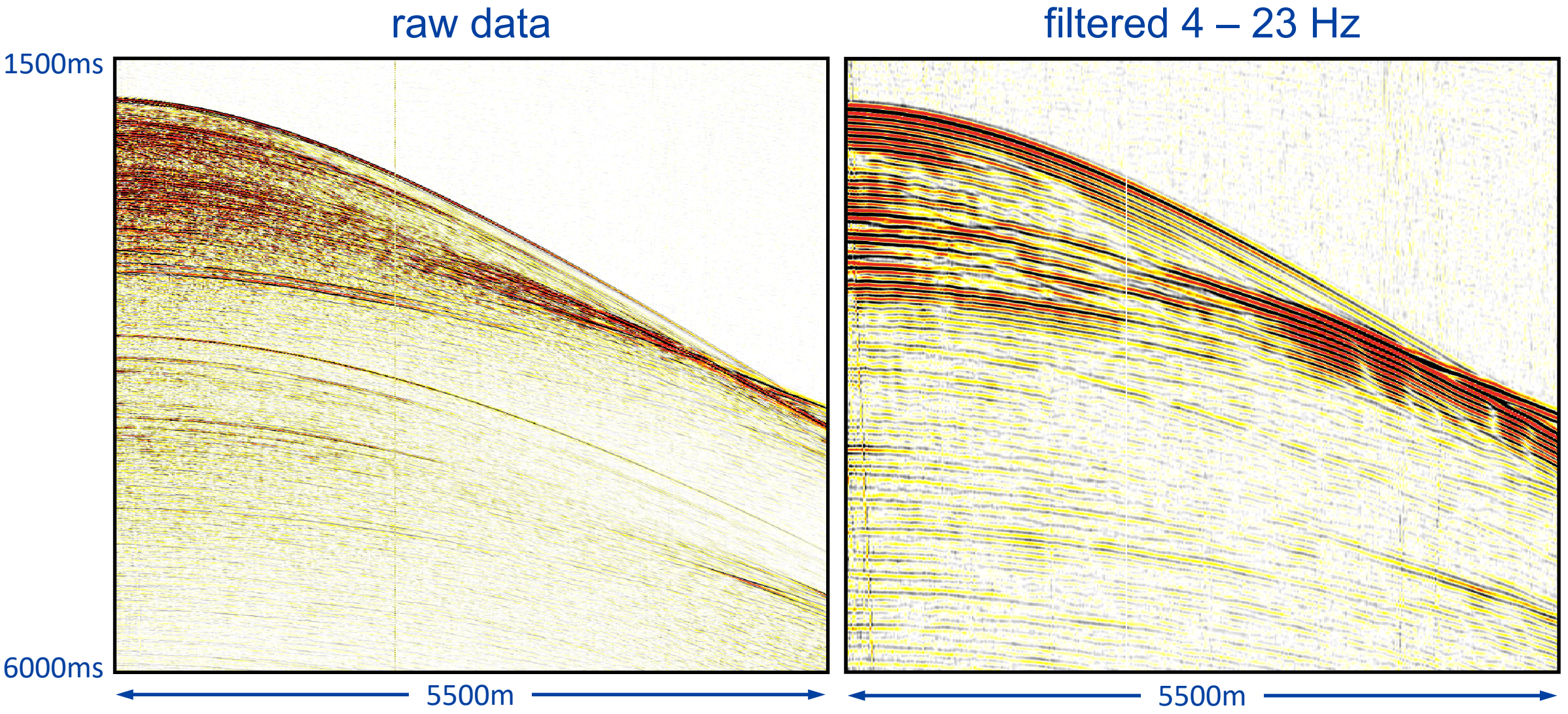
Tomography-like FWI to match reflection moveout

Conventionally builds only the Vp macro model

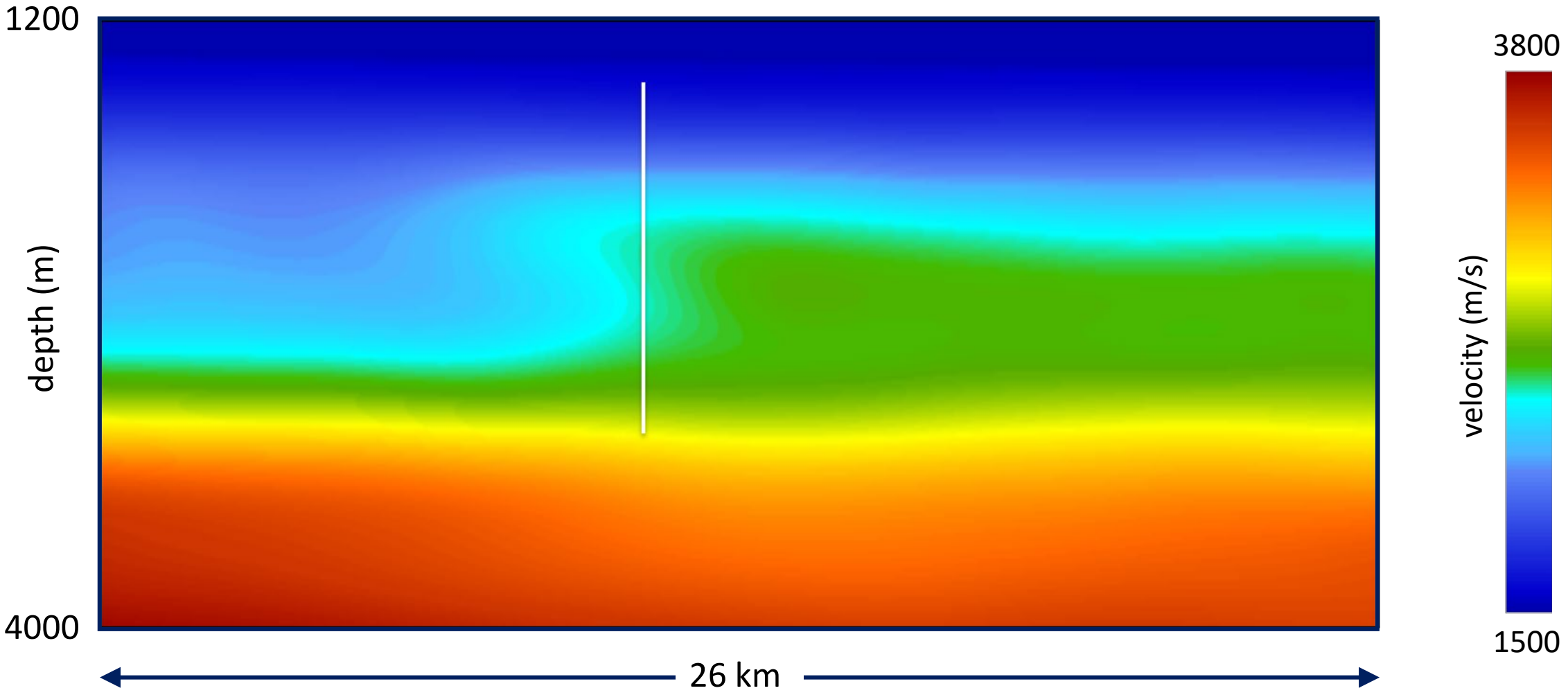
Reflection Adaptive Waveform Inversion

- Merges AWI and RWI into a single algorithm
- Builds both macro-model and fine structure
- Run at true amplitude to generate true reflectivity
- Can begin from almost any reasonable model

Field record – build a velocity model

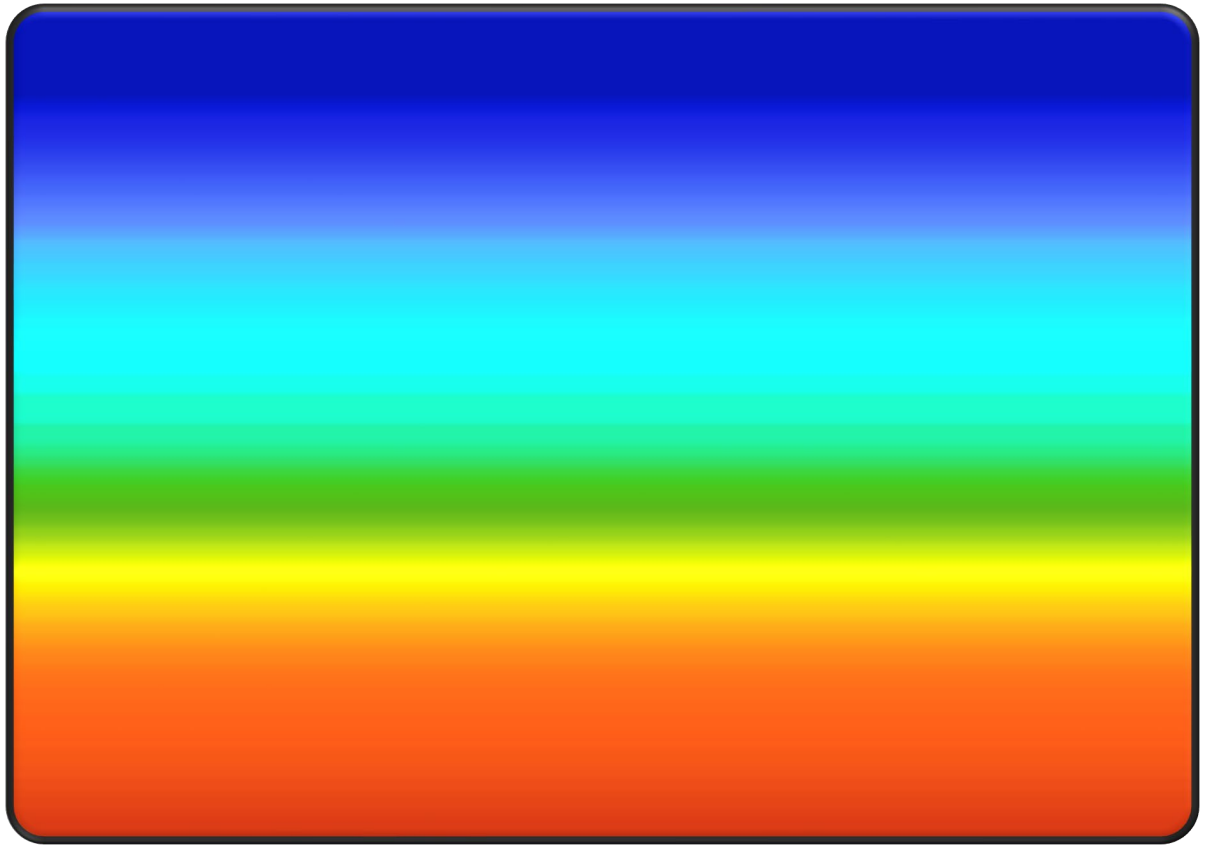


Start model

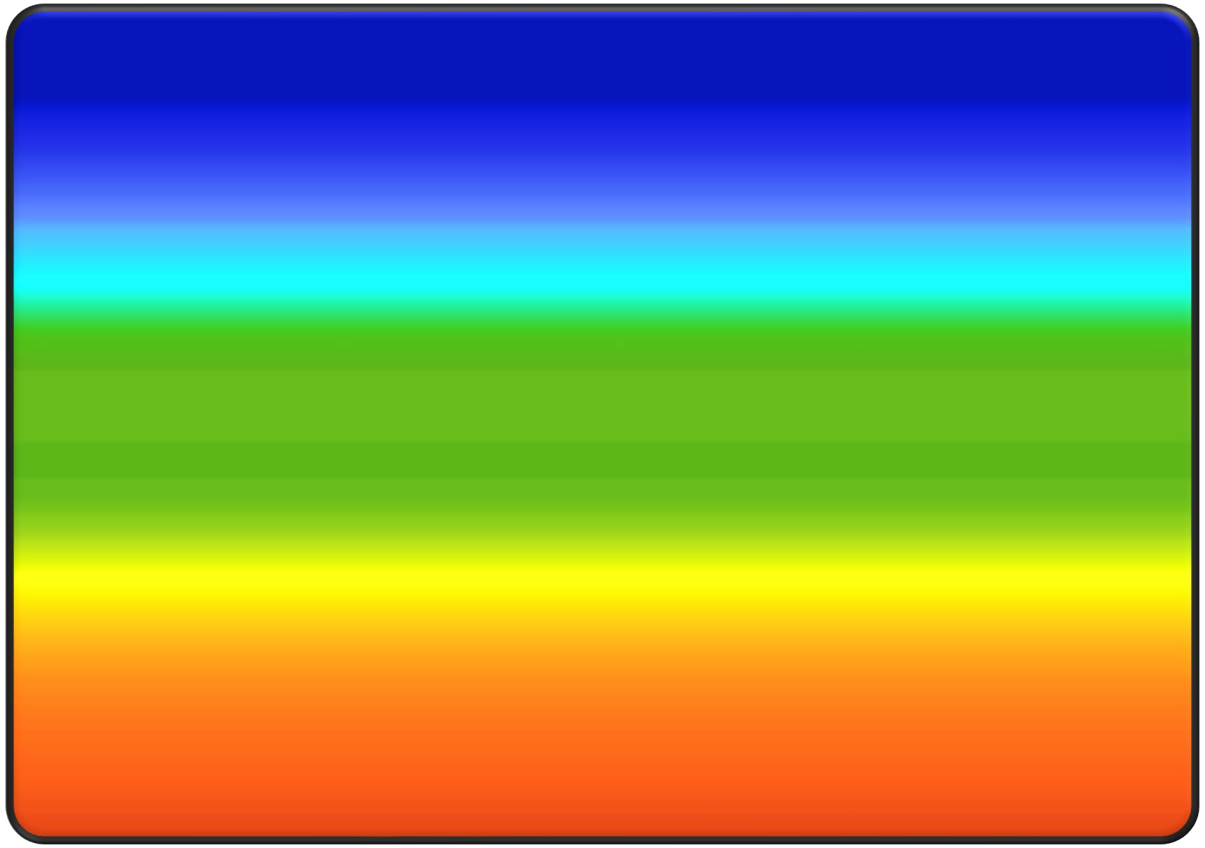


Different start models

slow start

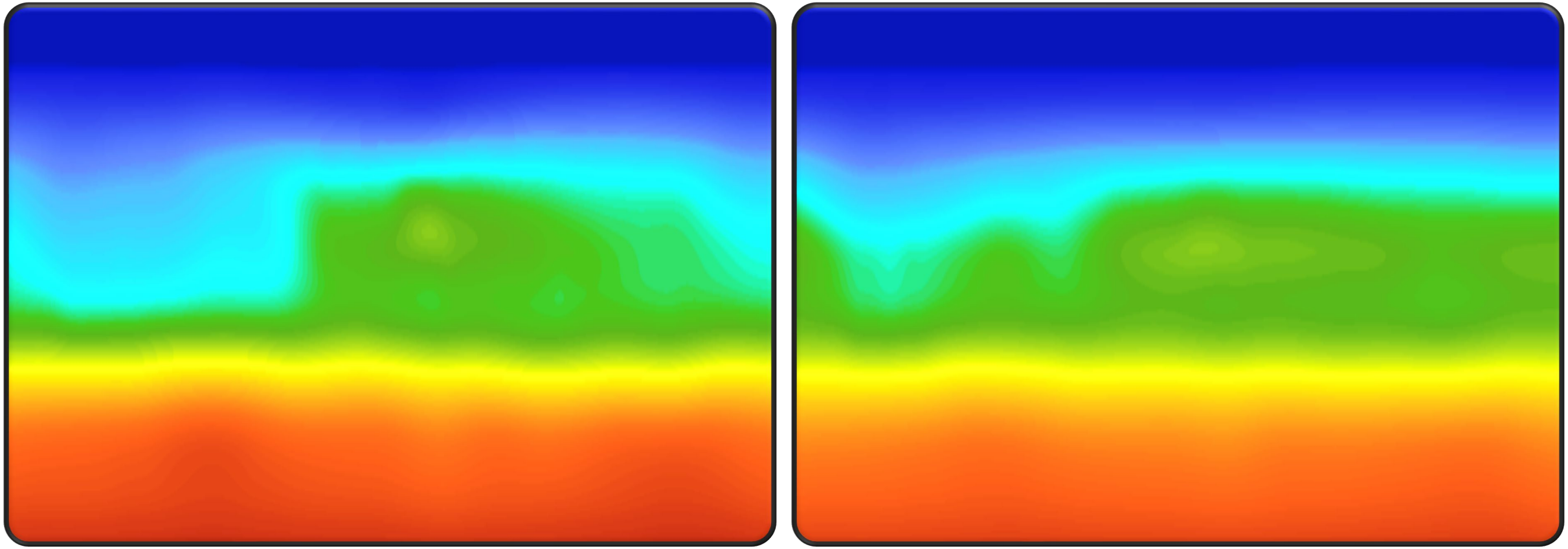


fast start



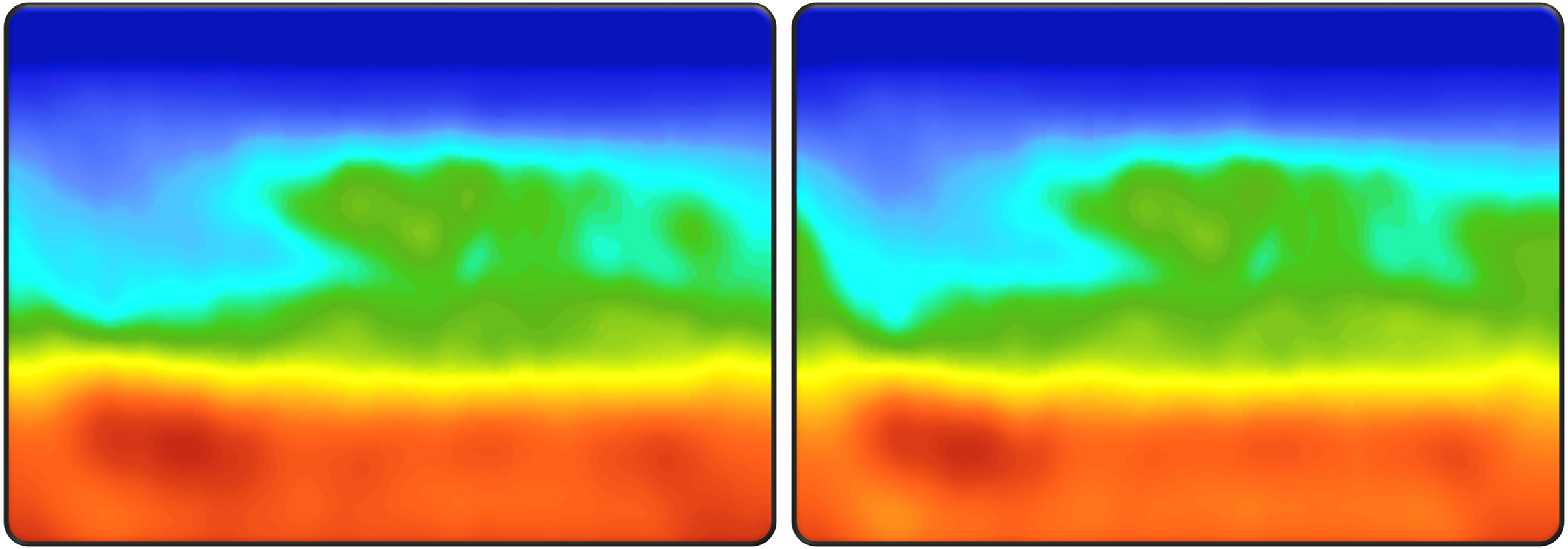
Different start models

slow start 4 Hz fast start



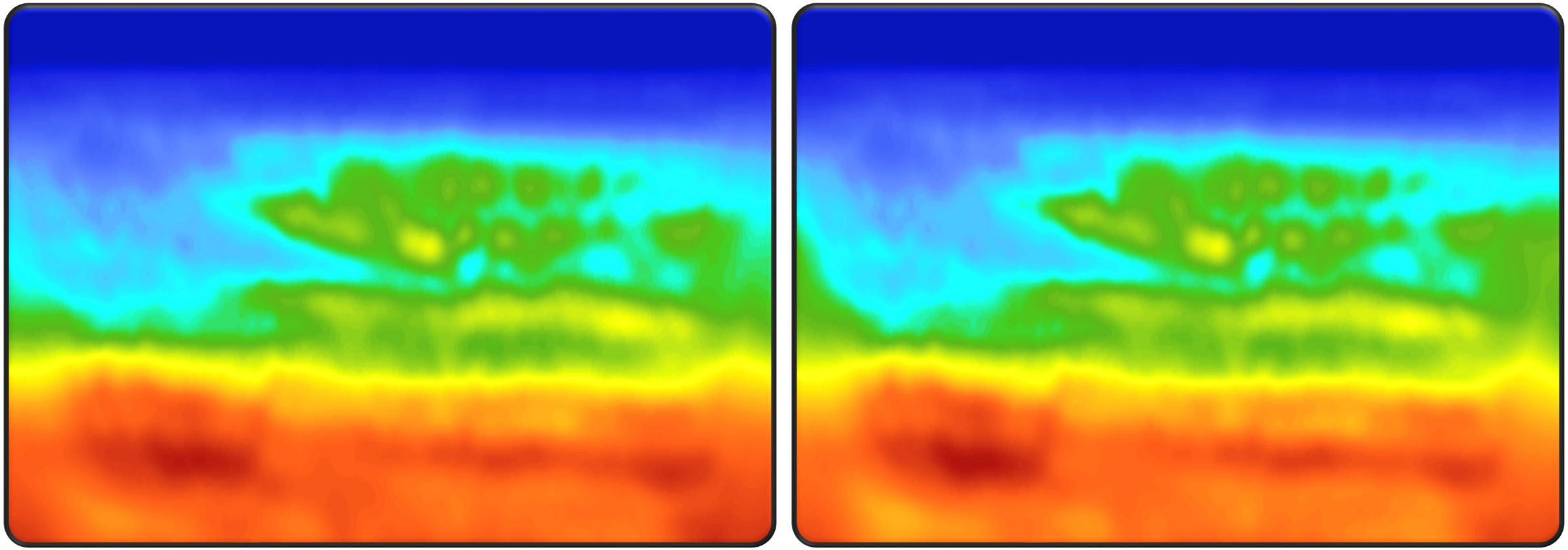
Different start models

slow start 5 Hz fast start

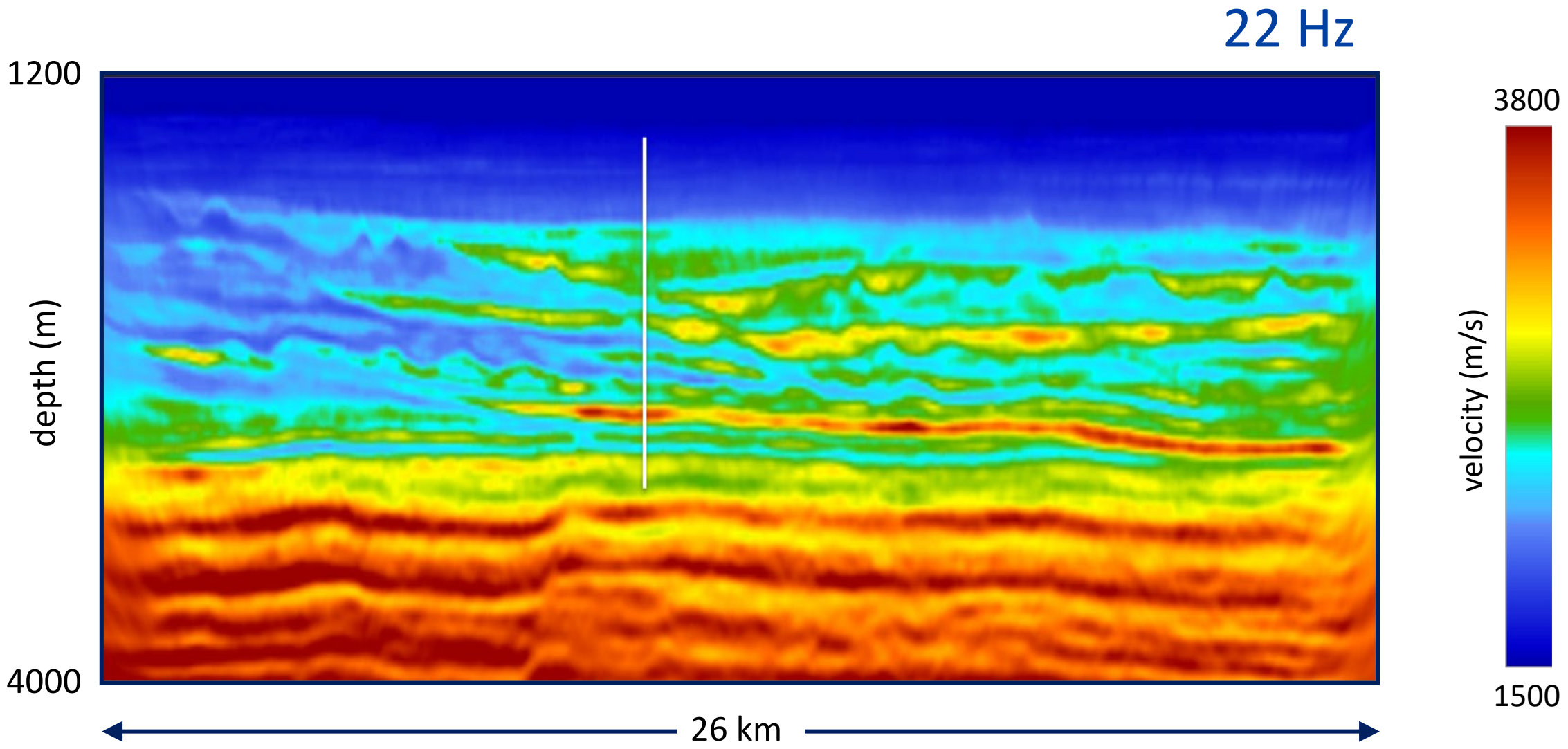


Different start models

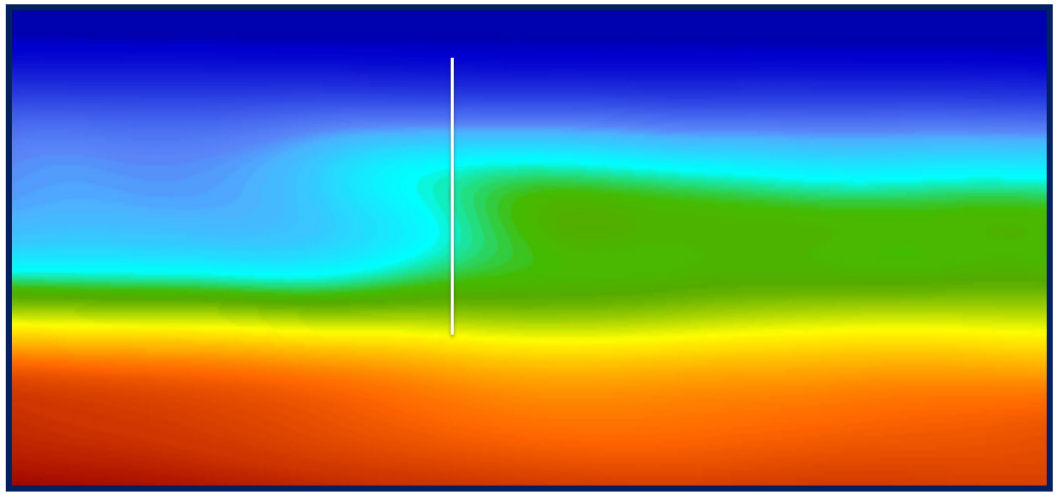
slow start 7 Hz fast start

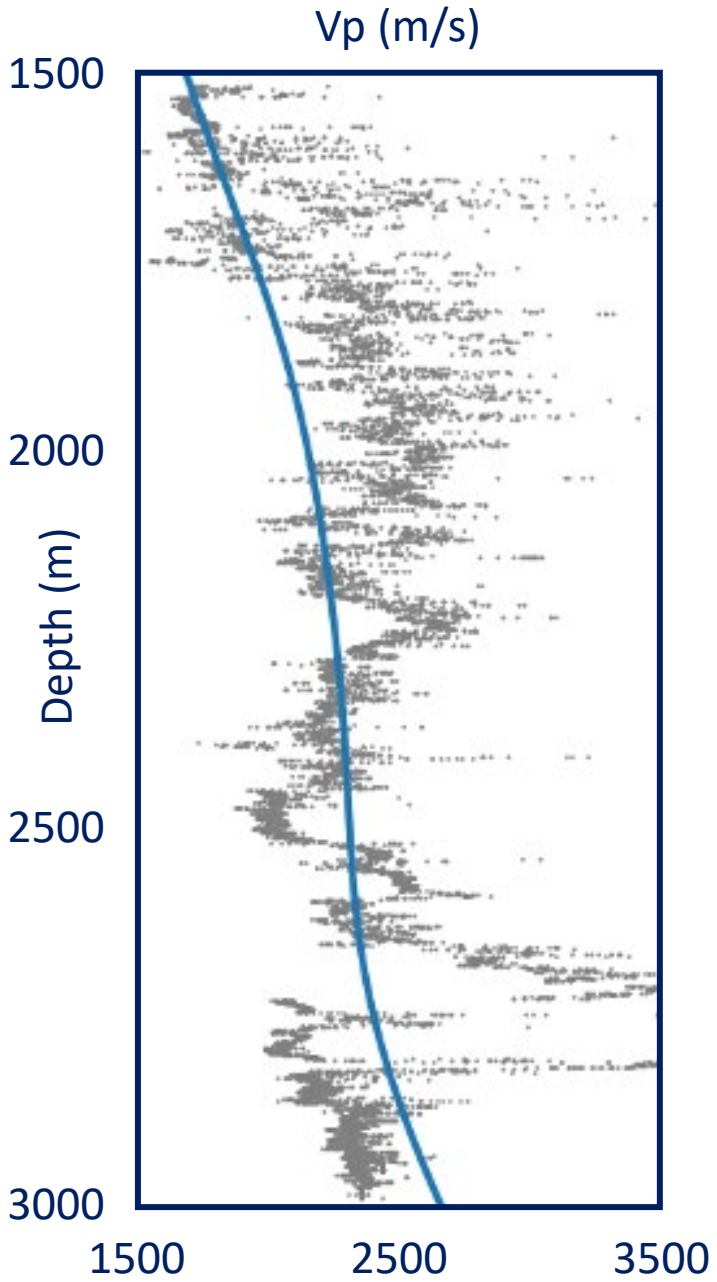


Final reflection AWI model

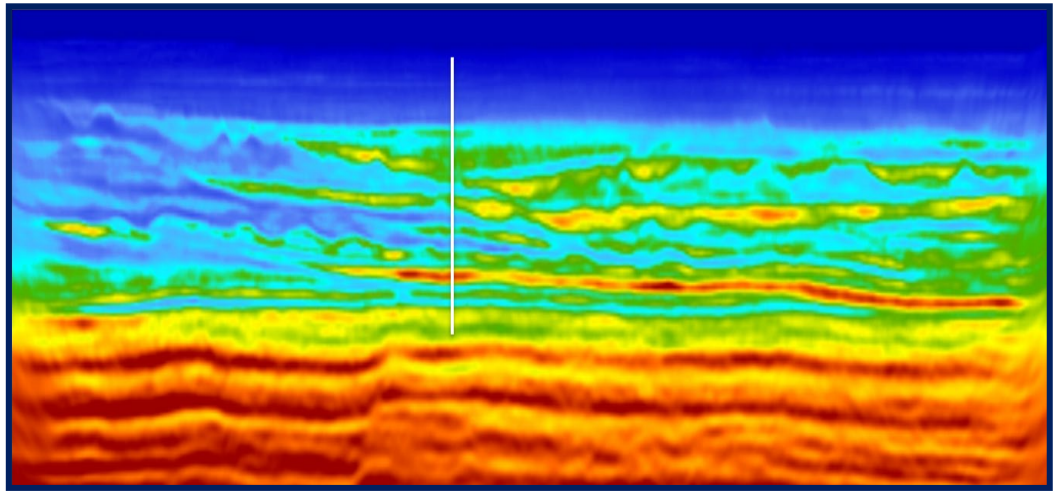


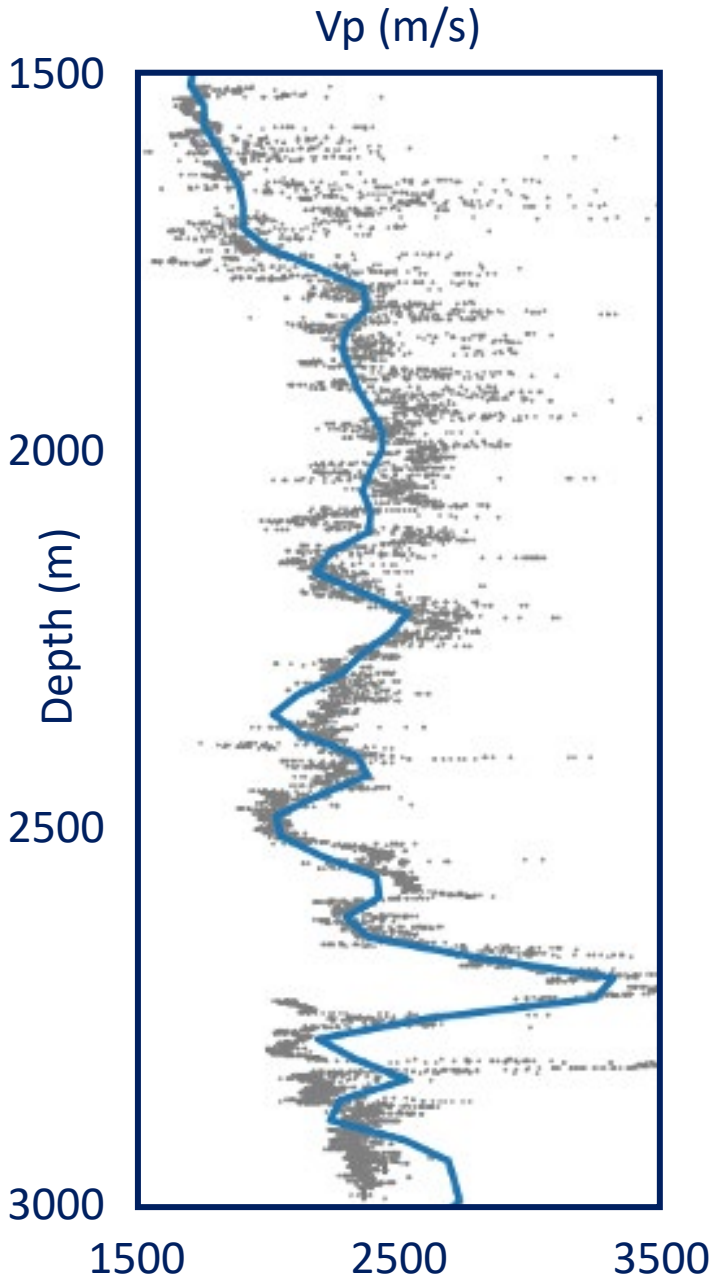
Compromise start model





Reflection AWI

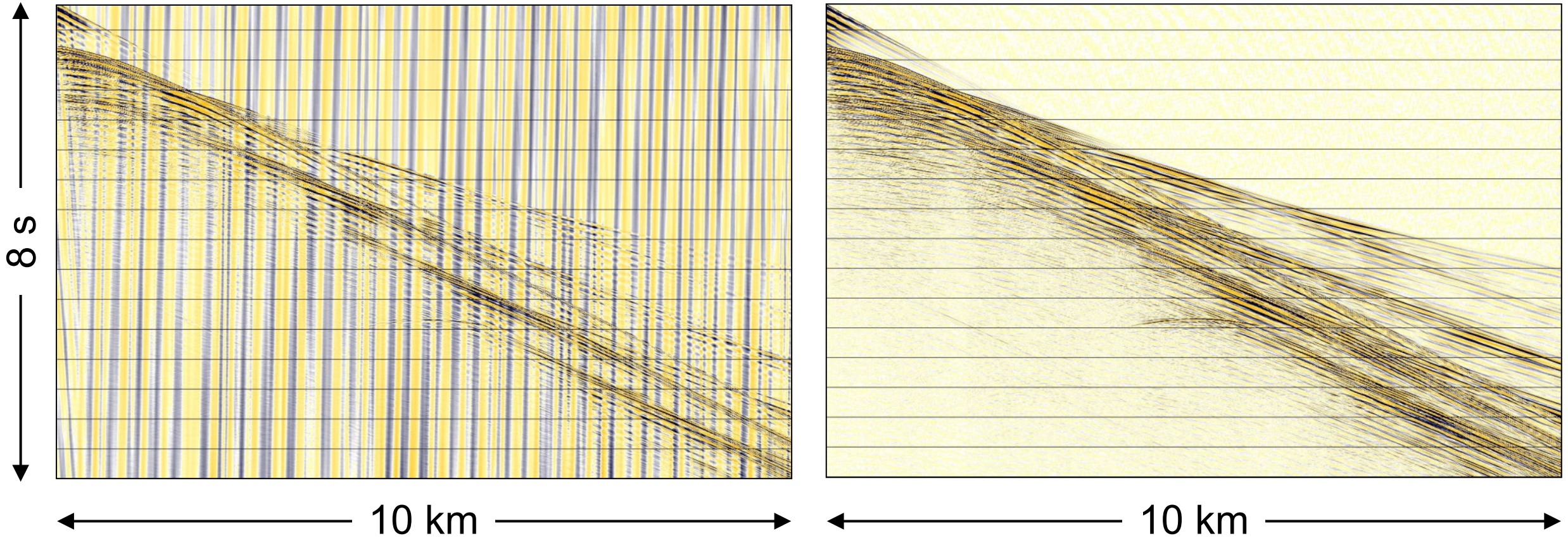




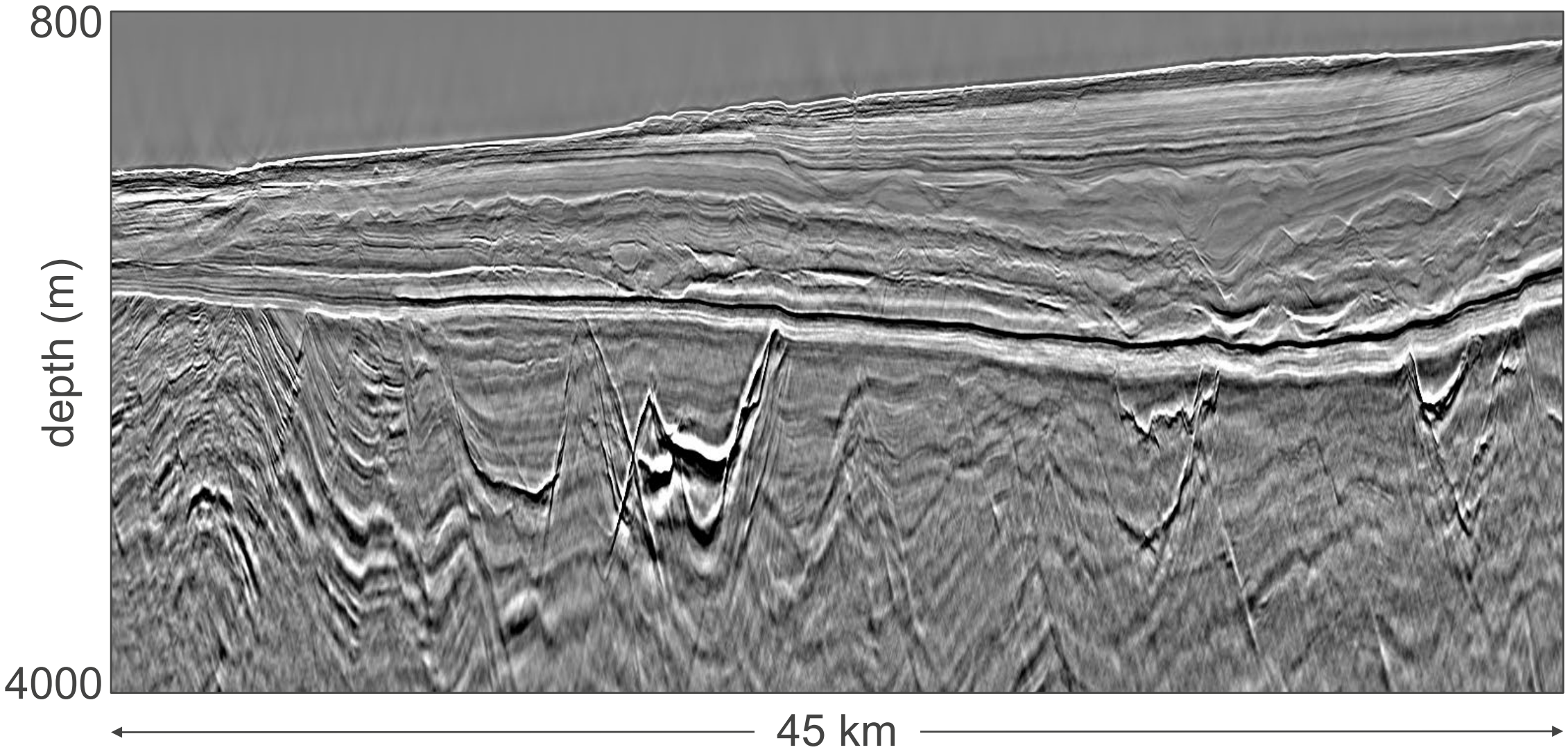
Field record – build an RTM image

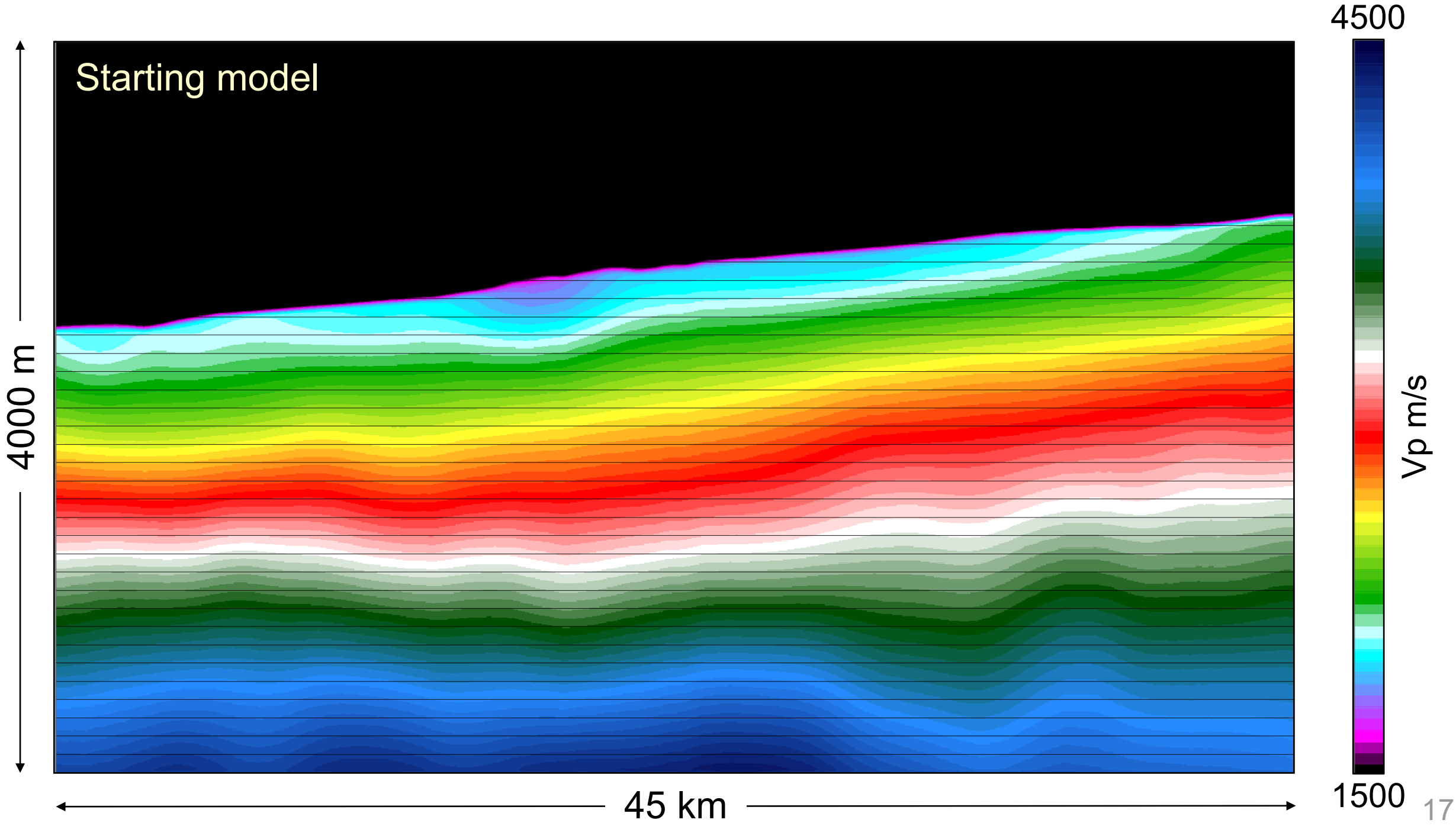
raw data

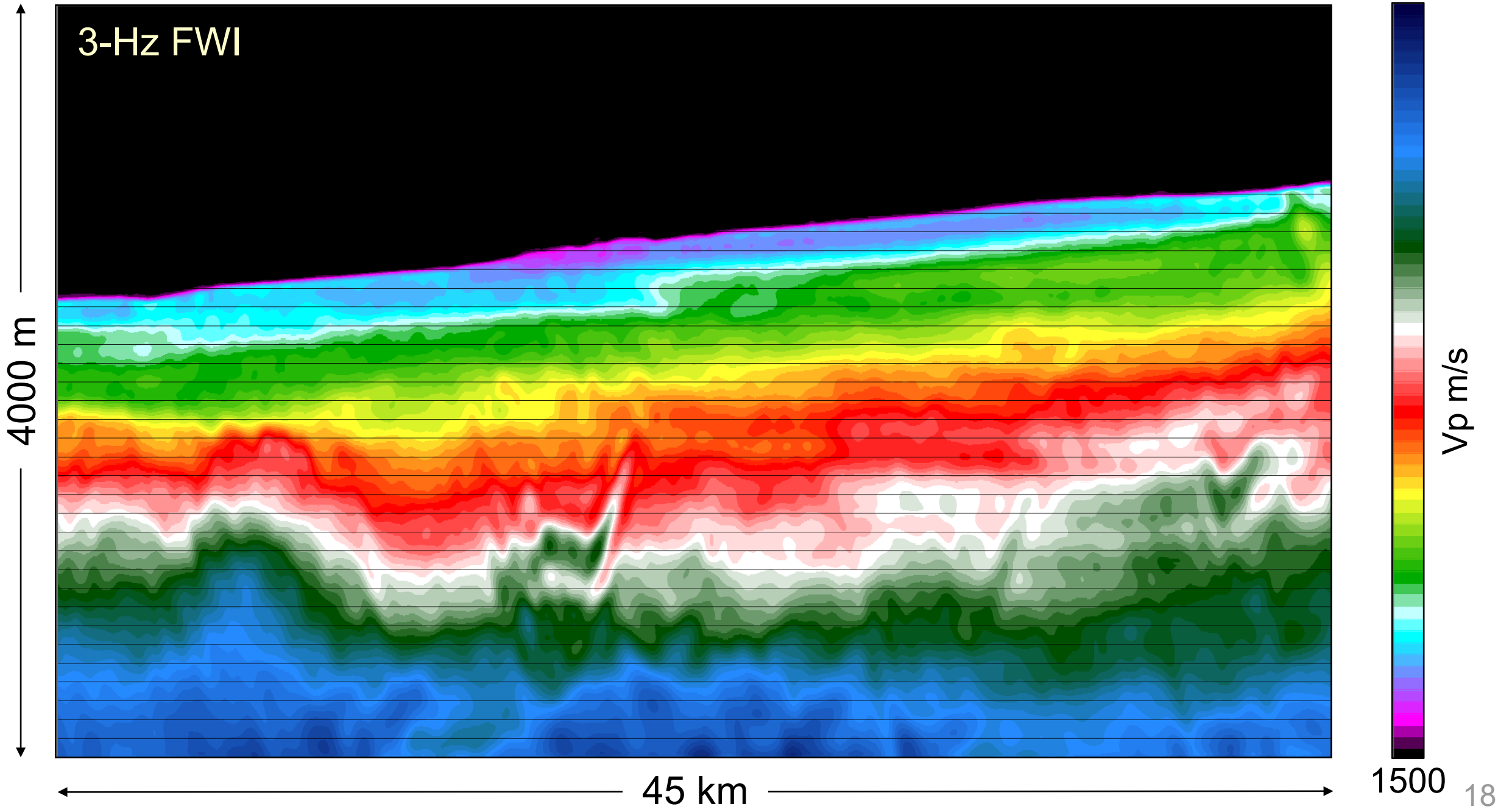
filtered 2 – 100 Hz

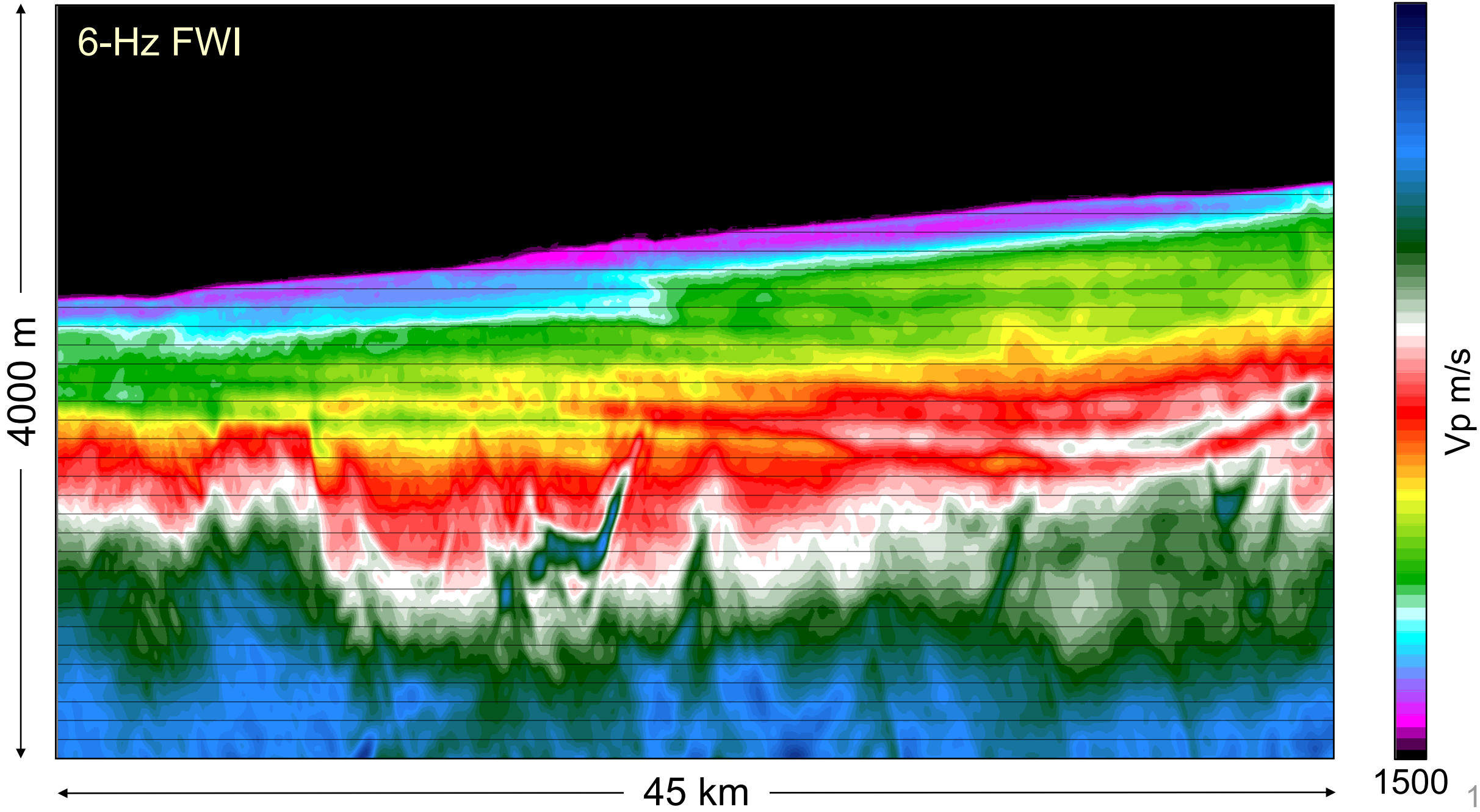


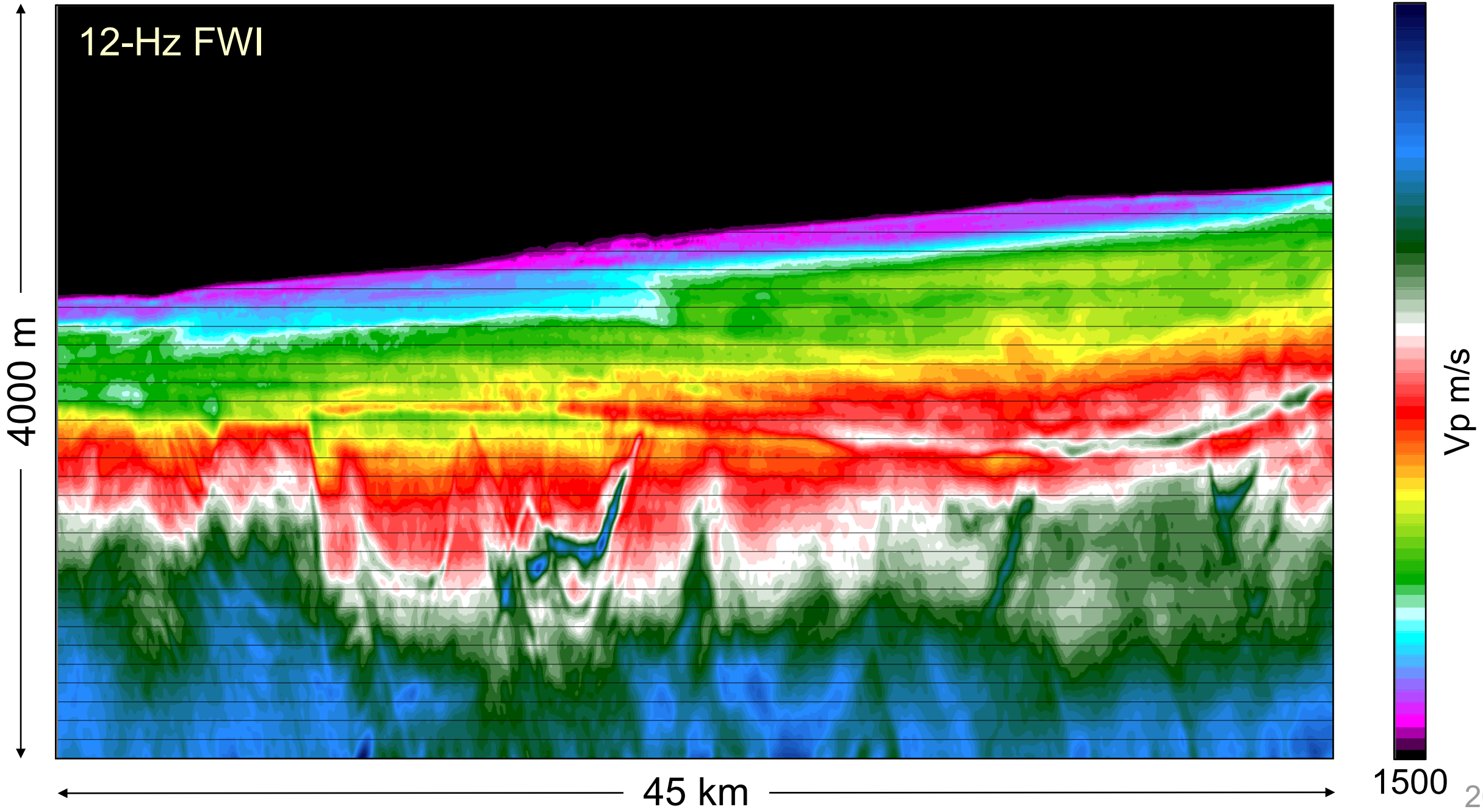
Conventional PSDM

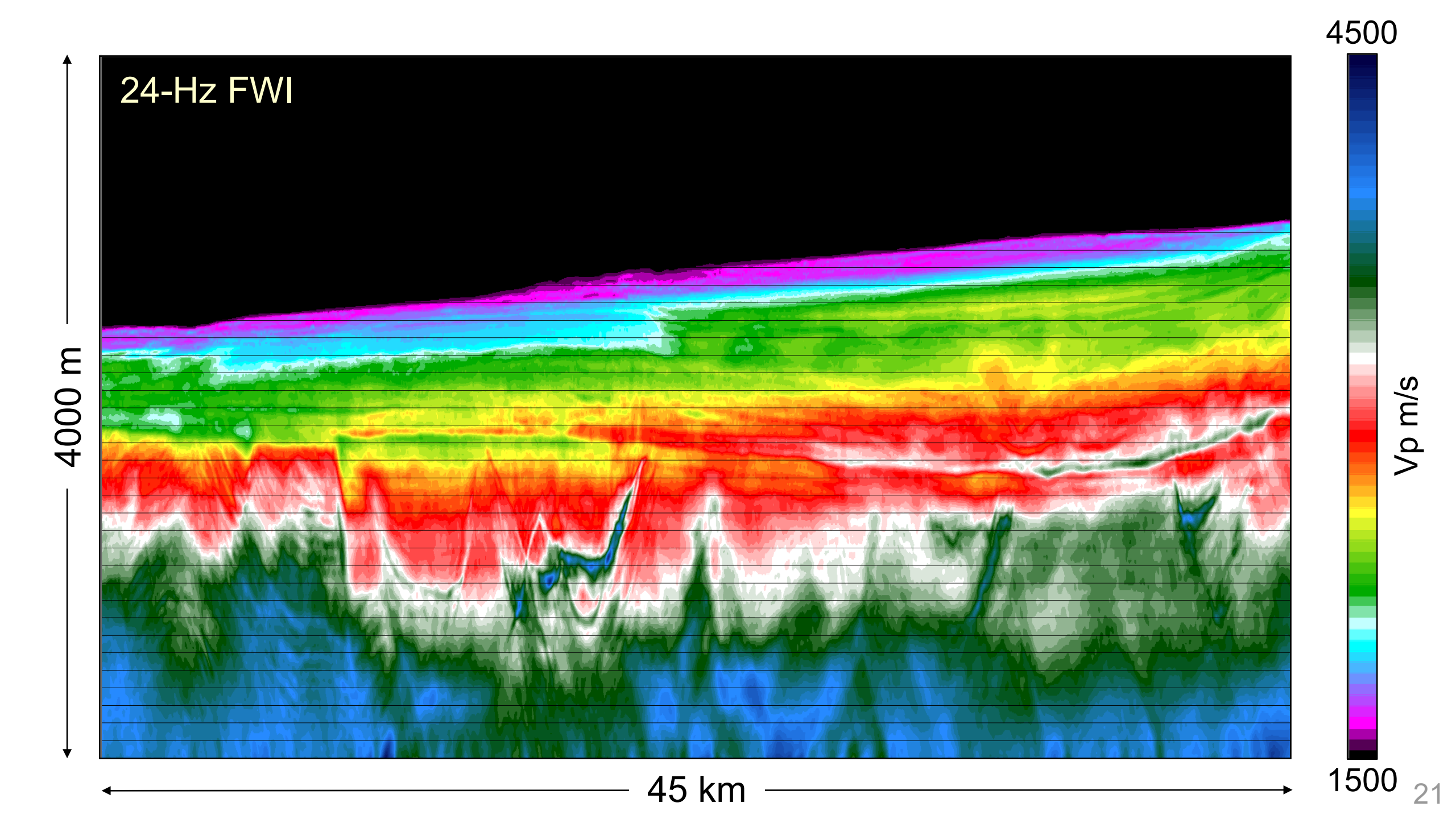


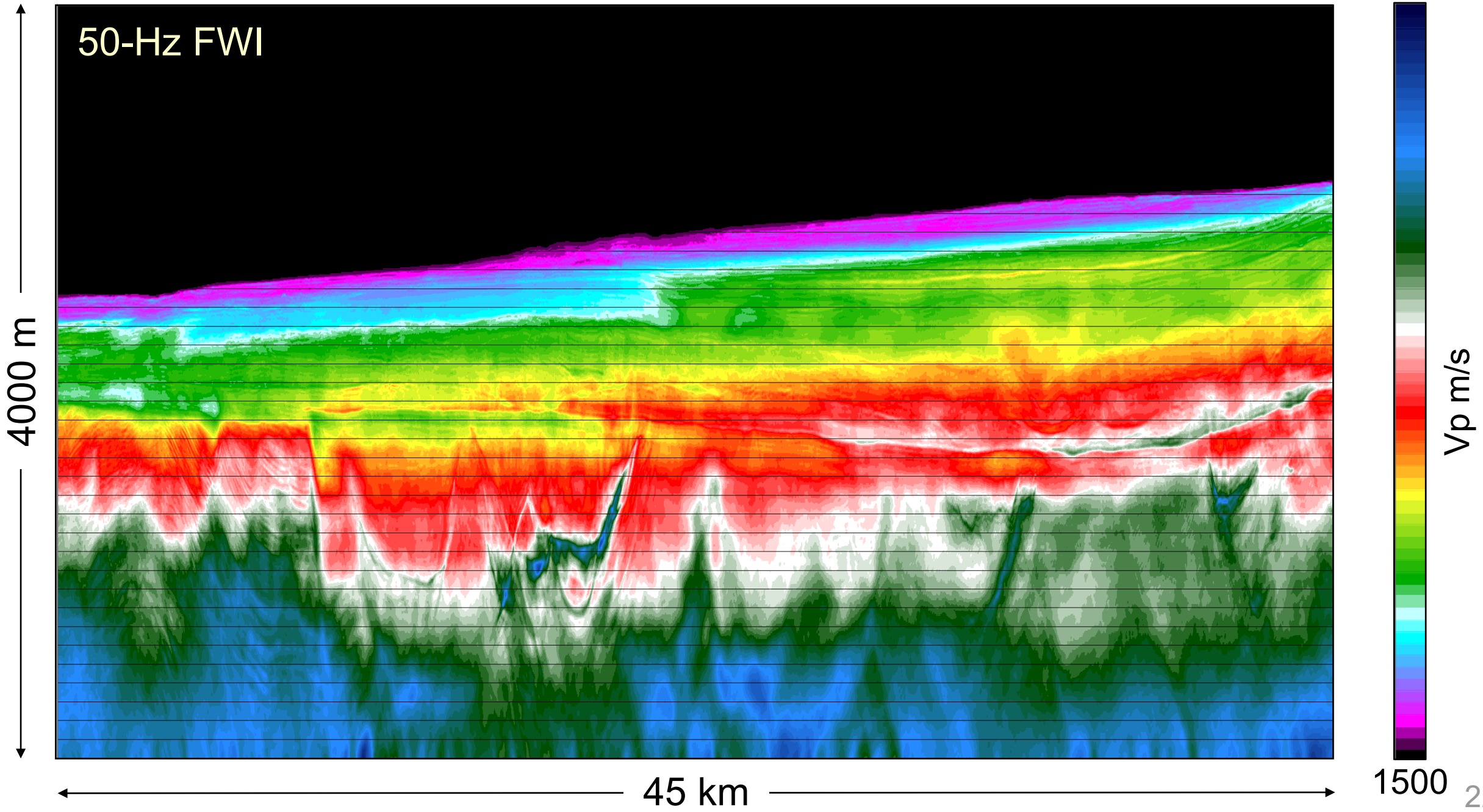

Starting model
4000 m
45 km
4500
1500
Vp m/s

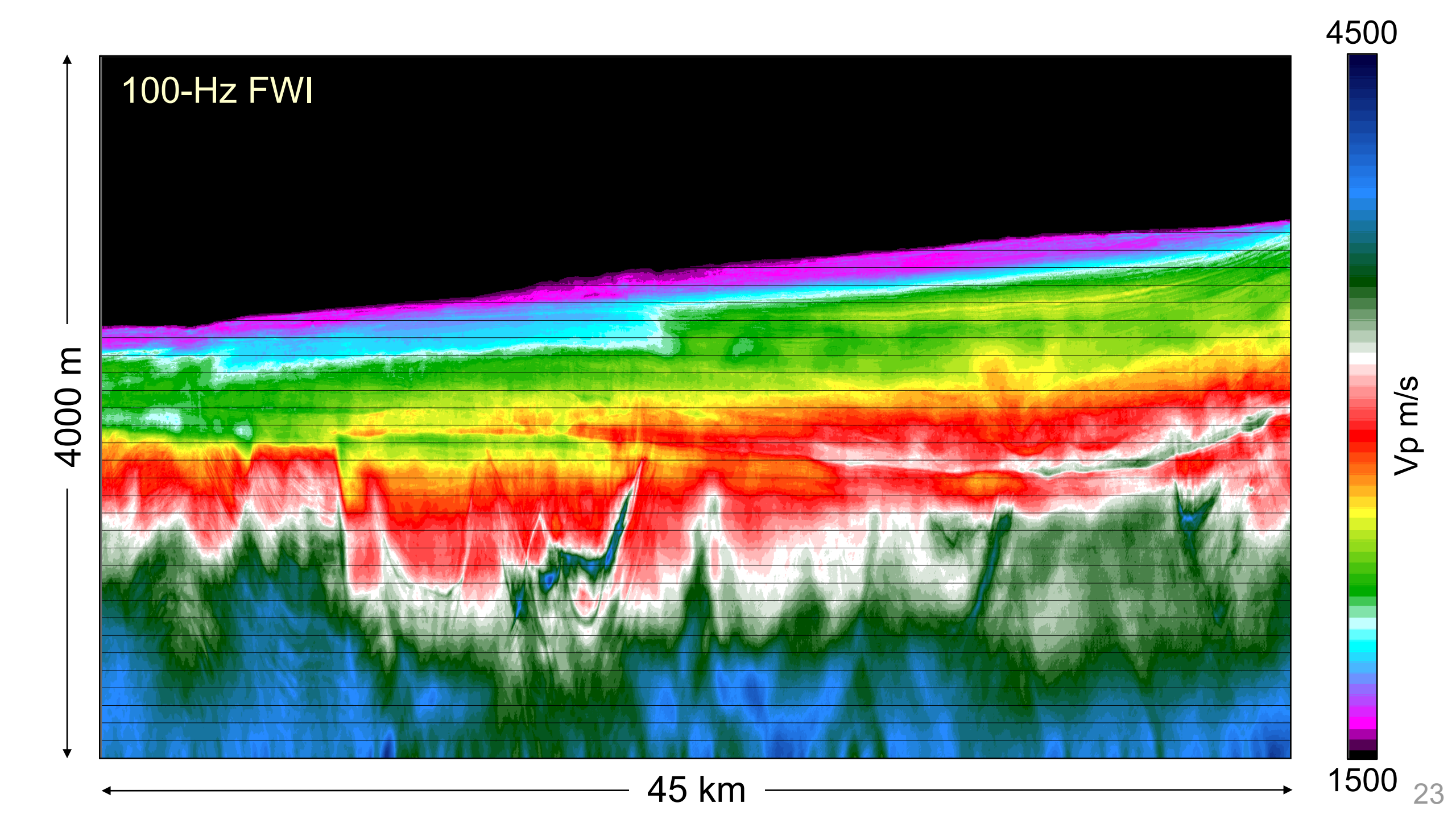

3-Hz FWI
4000 m
45 km
4500
1500
Vp m/s


6-Hz FWI
4000 m
45 km
4500
1500
Vp m/s


12-Hz FWI
4000 m
45 km
4500
1500
Vp m/s

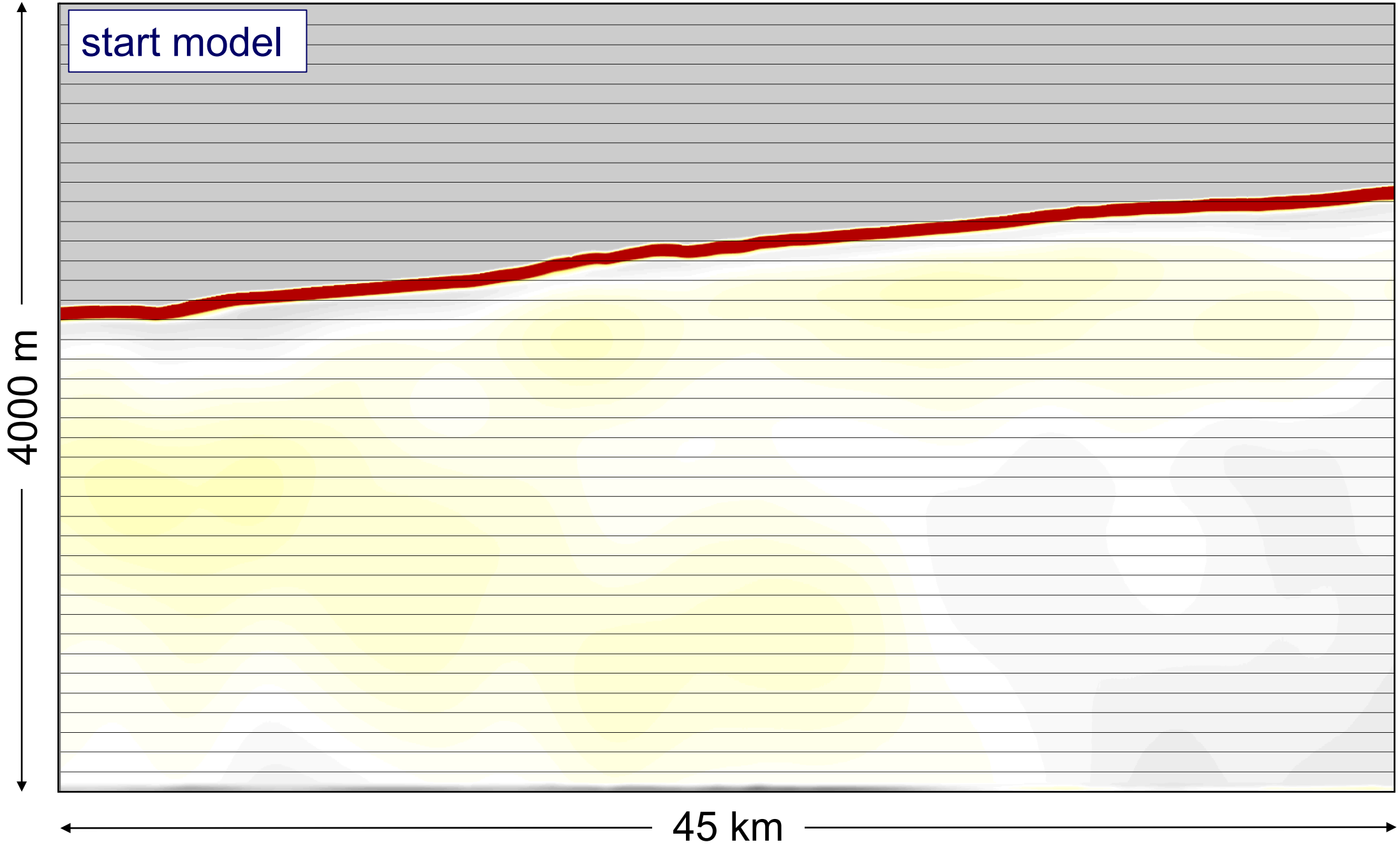

24-Hz FWI
4000 m
45 km
4500
1500
Vp m/s

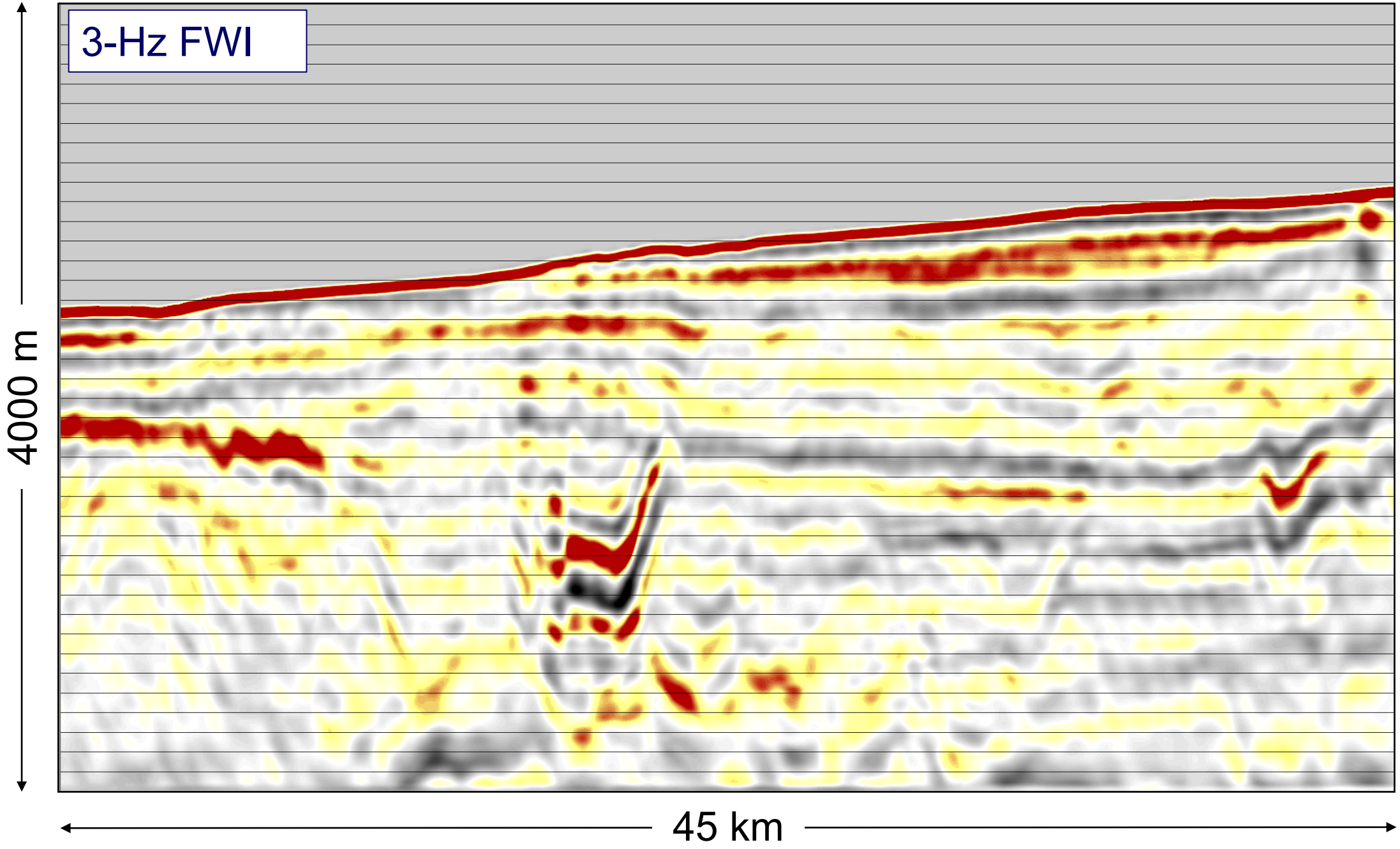

50-Hz FWI
4000 m
45 km
4500
1500
Vp m/s

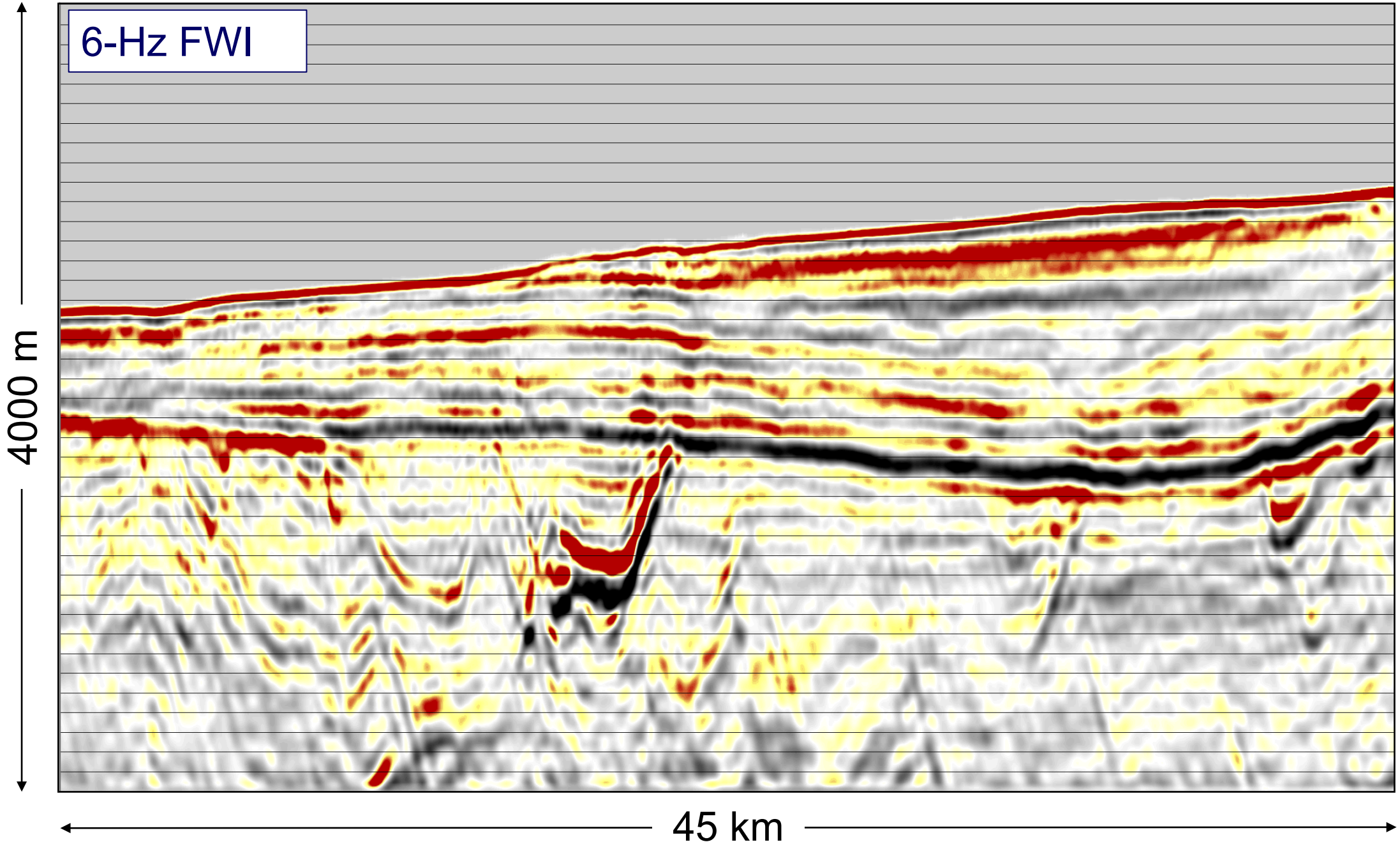

100-Hz FWI
4000 m
45 km
4500
1500
Vp m/s

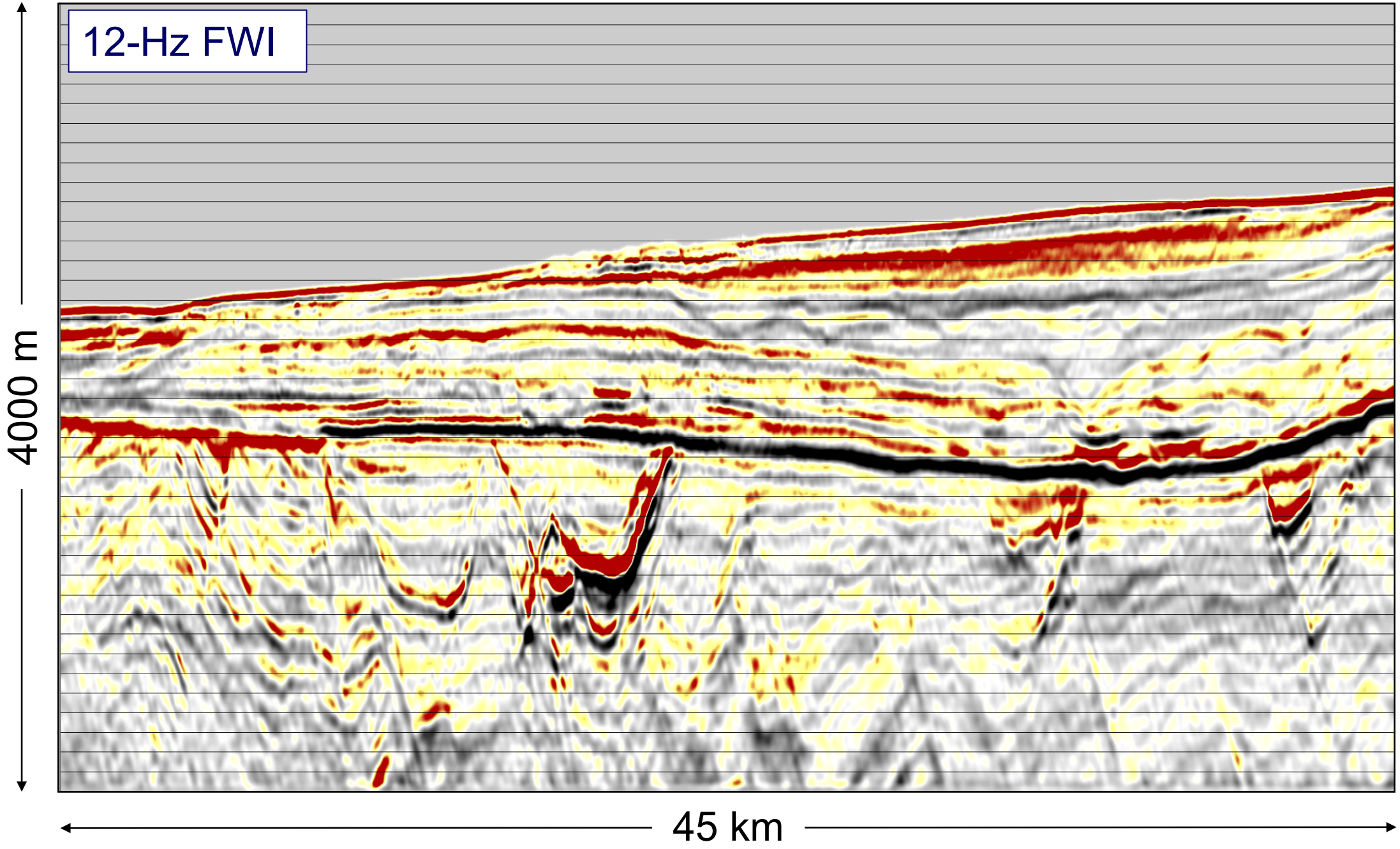
FWI – Reflectivity

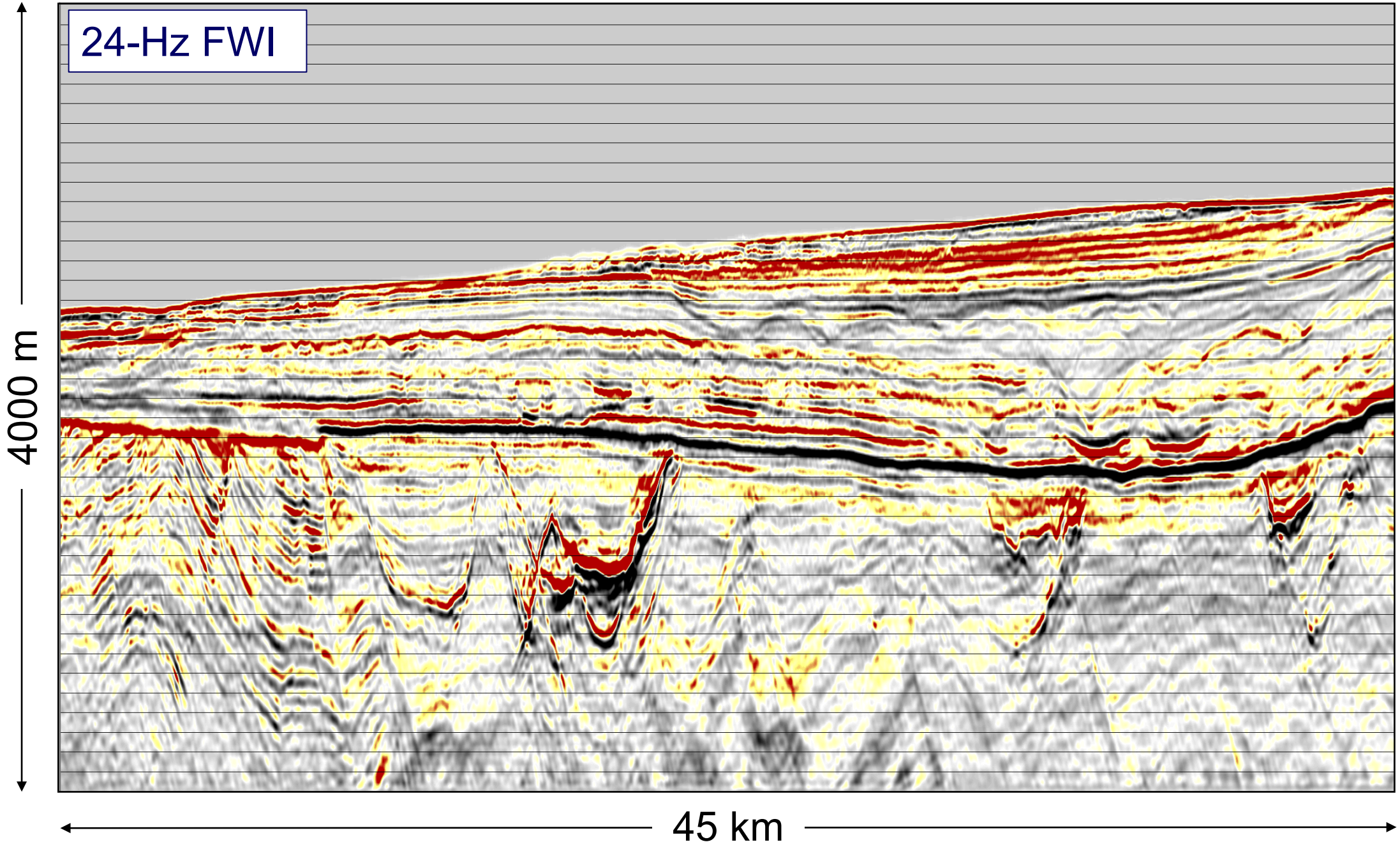
- Differentiate Vp model vertically

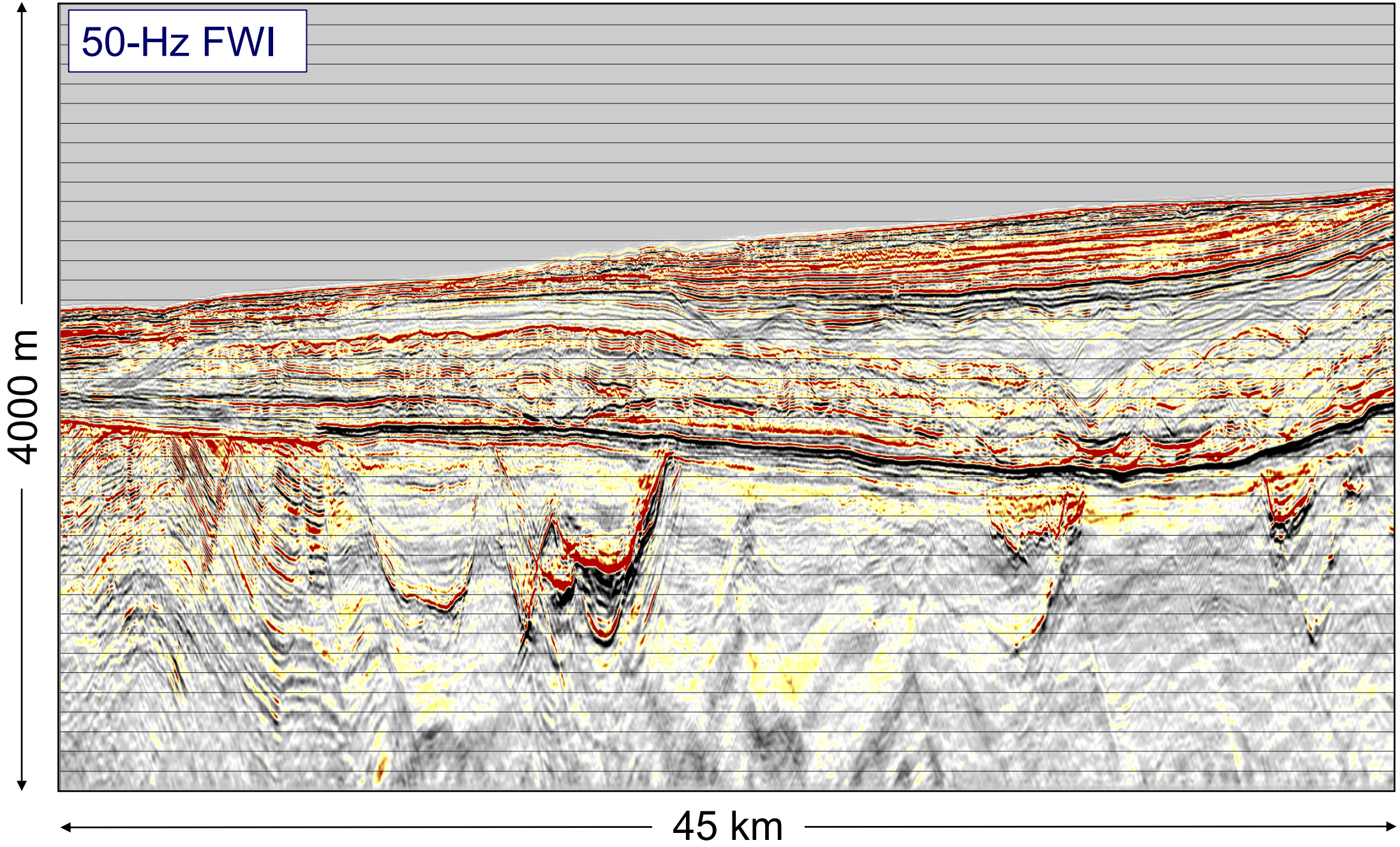

start model
4000 m
45 km

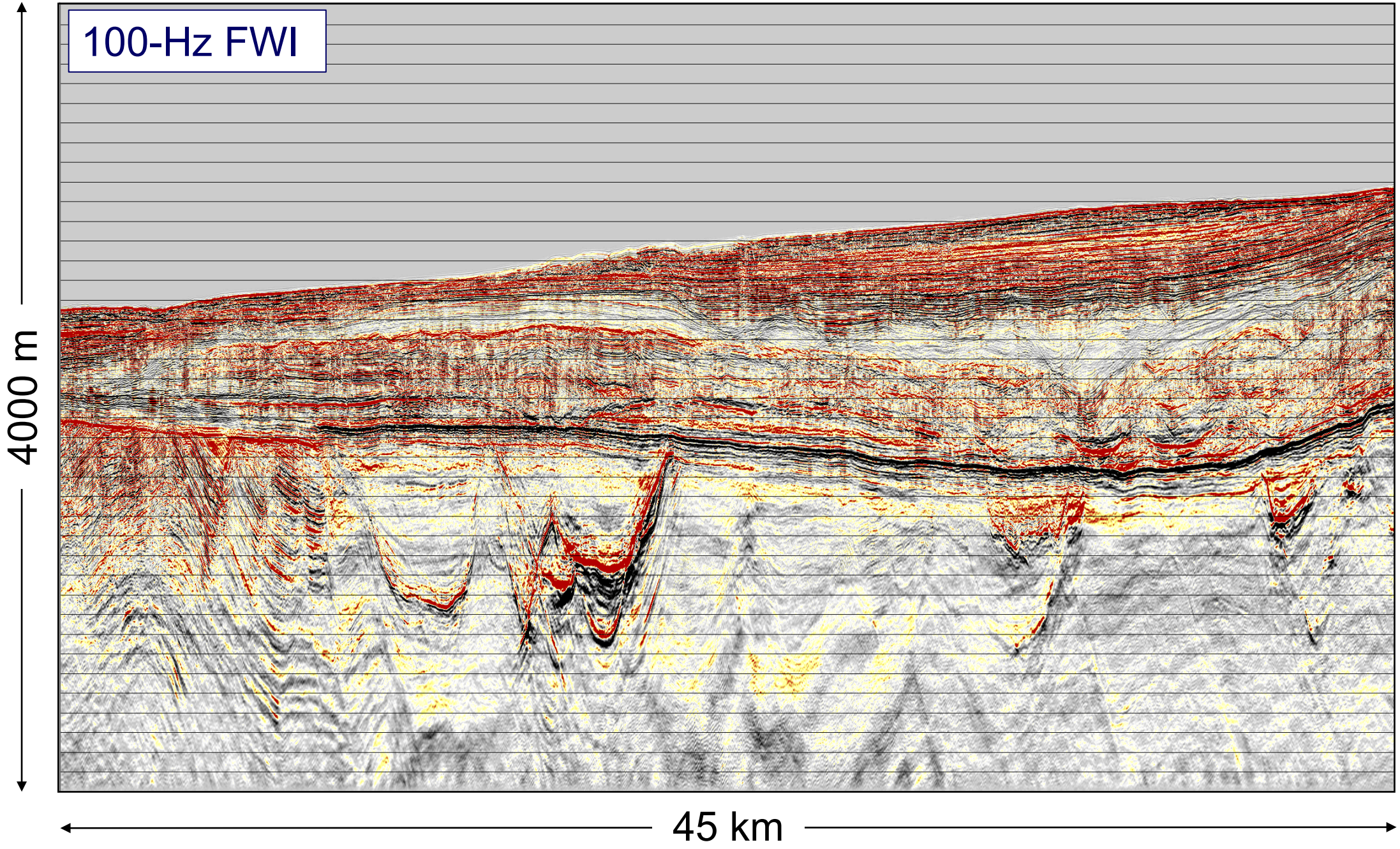

3-Hz FWI
4000 m
45 km

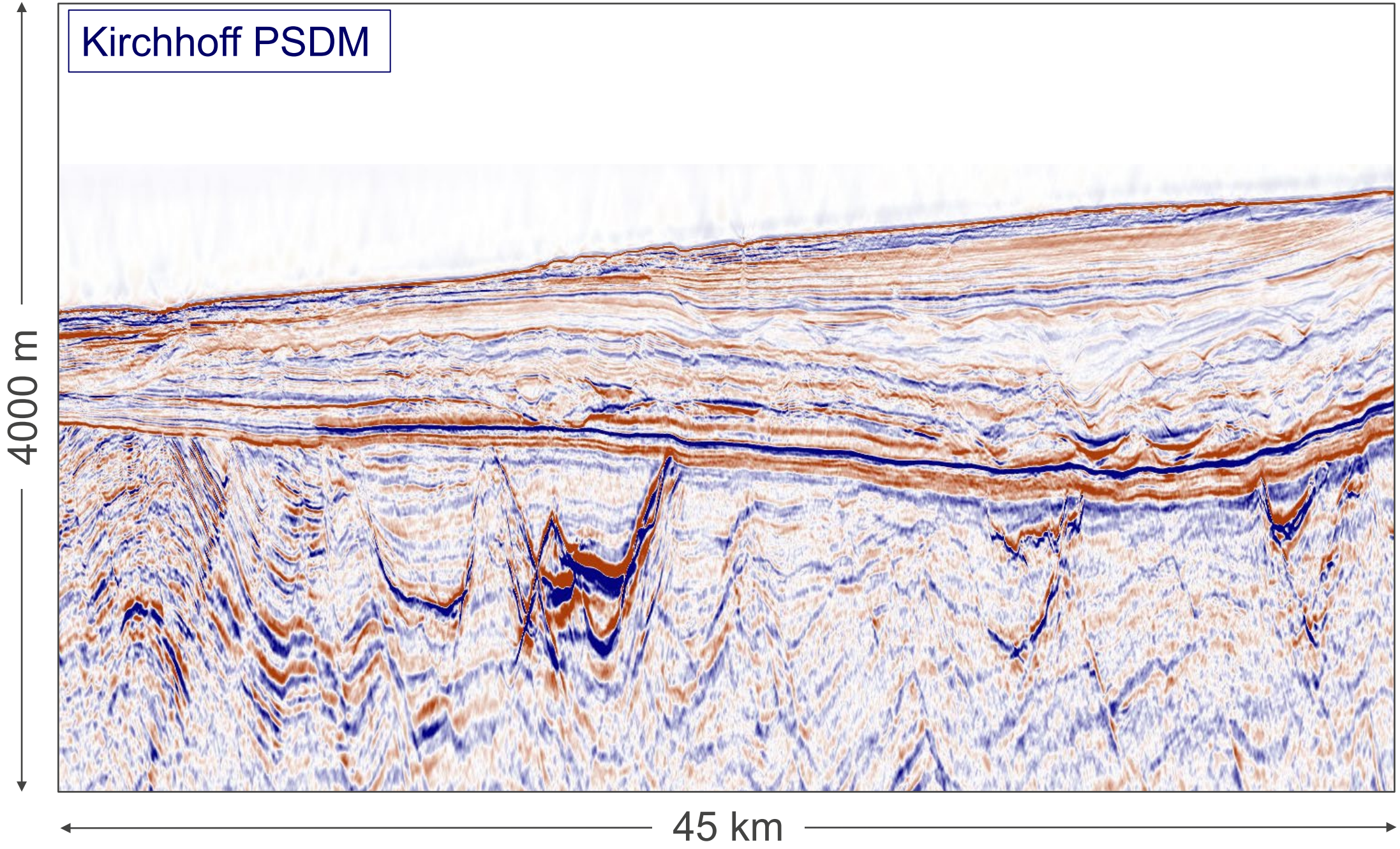

6-Hz FWI
4000 m
45 km

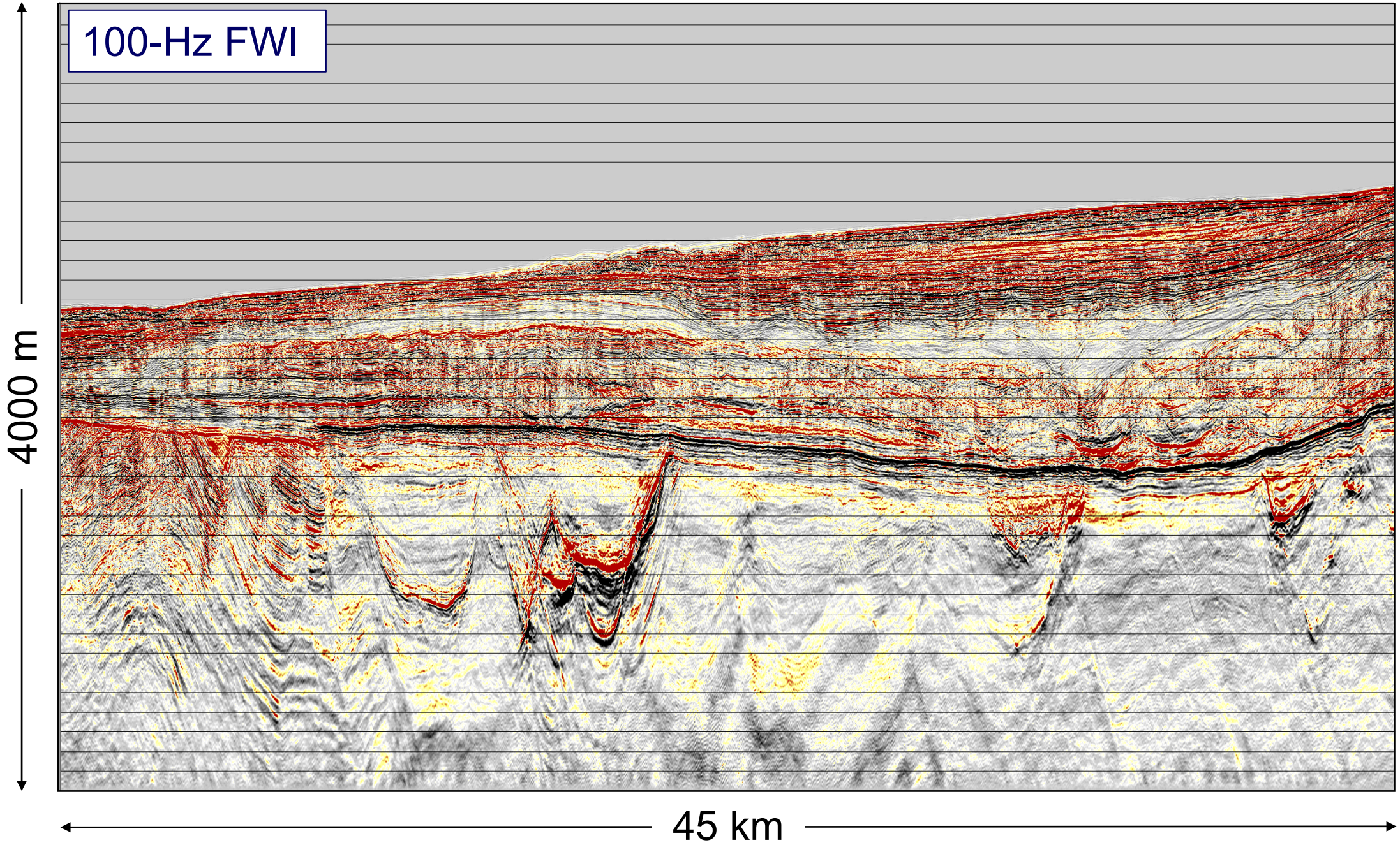

12-Hz FWI
4000 m
45 km

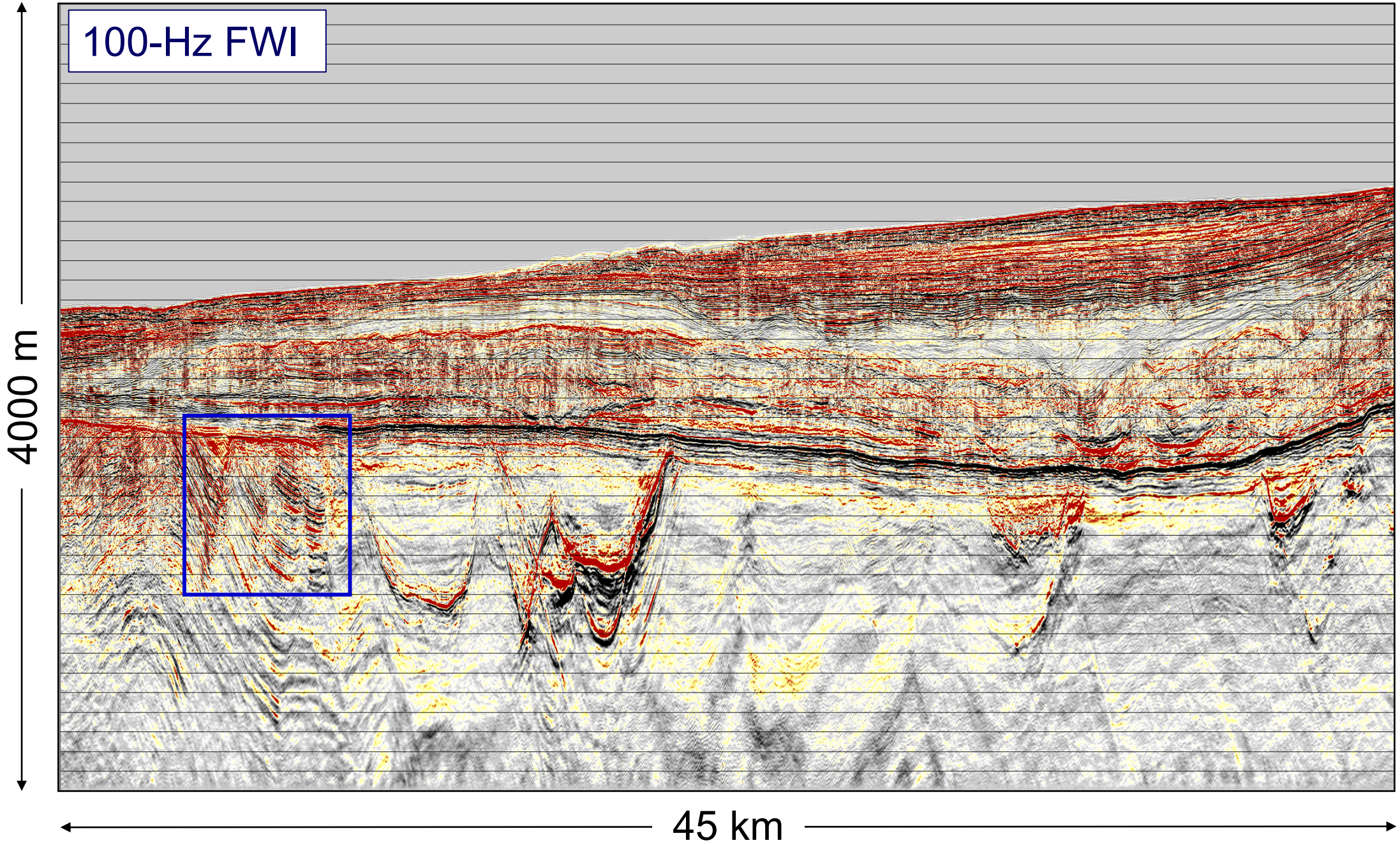

24-Hz FWI
4000 m
45 km

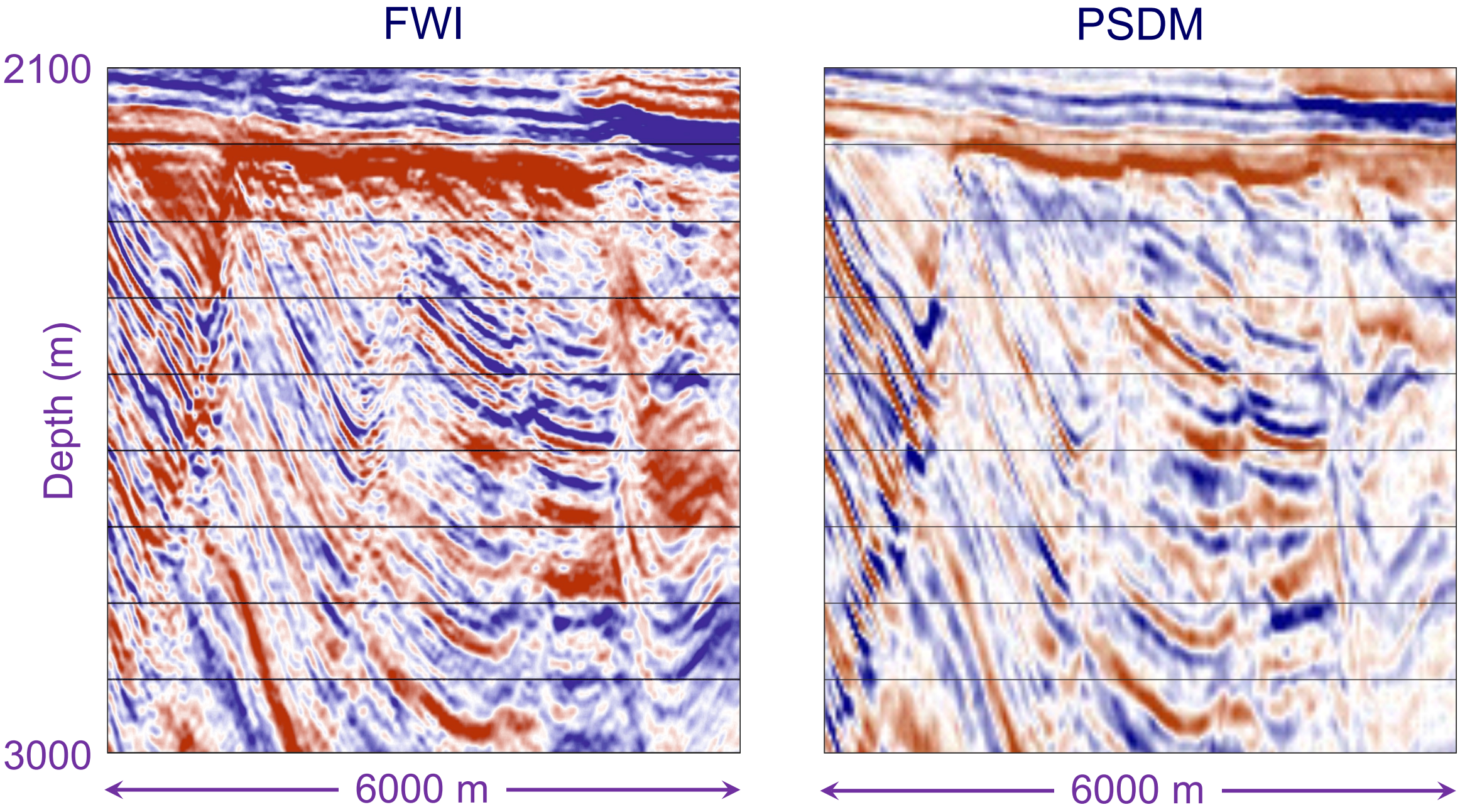

50-Hz FWI
4000 m
45 km

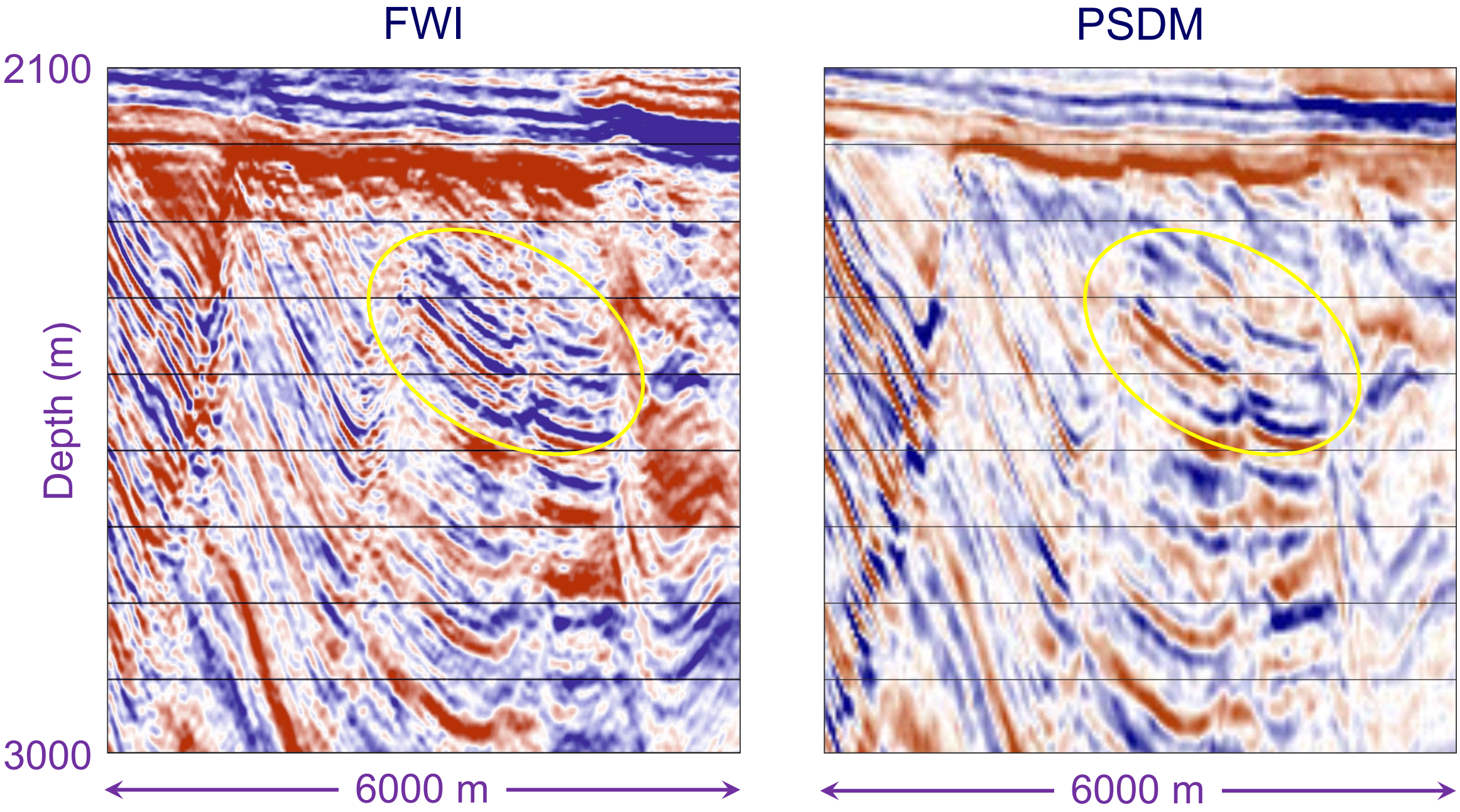

100-Hz FWI
4000 m
45 km

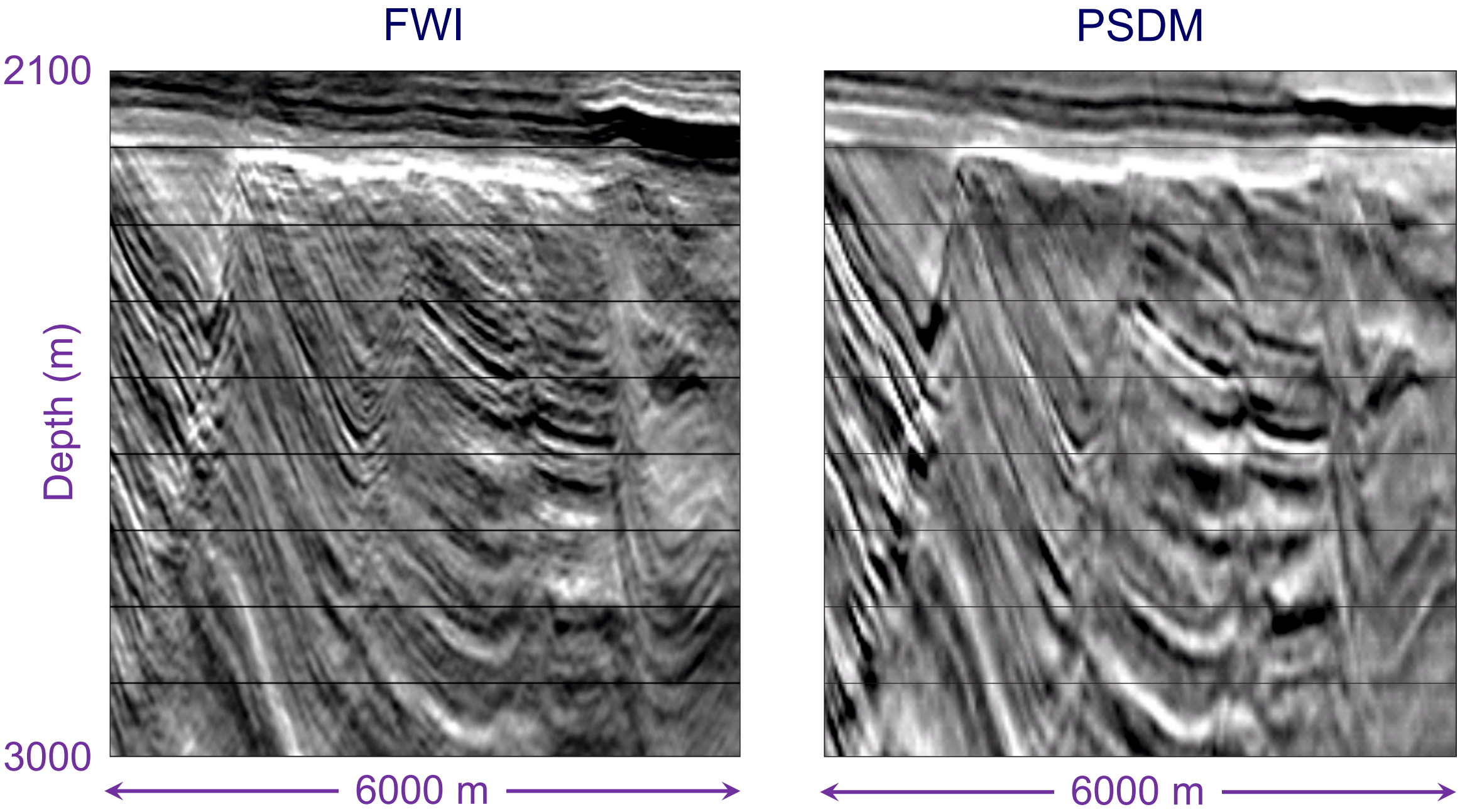

Kirchhoff PSDM
4000 m
45 km

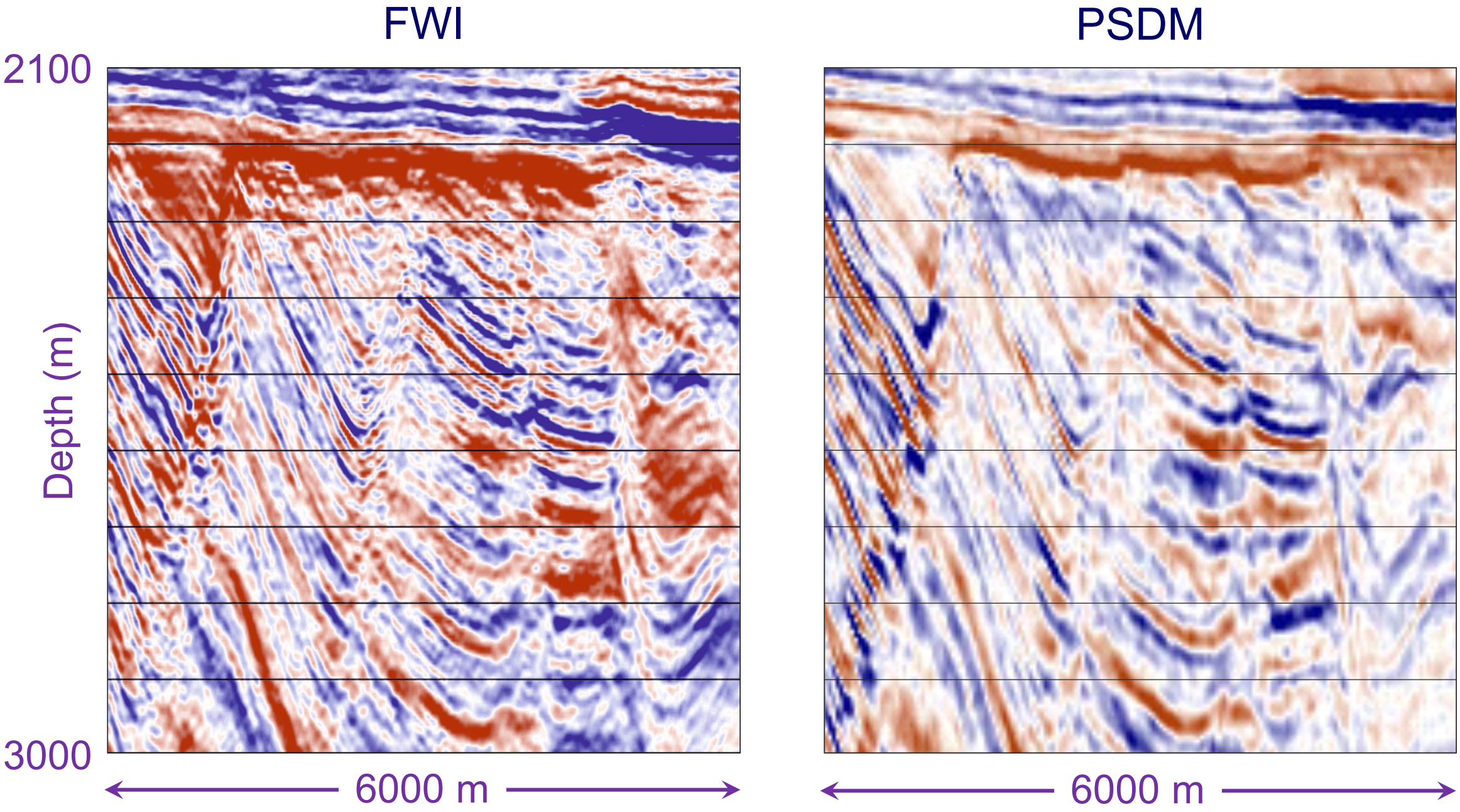

100-Hz FWI
4000 m
45 km


100-Hz FWI
4000 m
45 km


FWI
PSDM
2100
3000
Depth (m)
6000 m
6000 m


FWI
PSDM
2100
3000
Depth (m)
6000 m
6000 m


FWI
PSDM
2100
Depth (m)
3000
6000 m
6000 m


FWI
PSDM
2100
3000
Depth (m)
6000 m
6000 m

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Conclusions

- Advanced FWI run to full bandwidth on raw field data can replace conventional processing, tomography and LS-RTM
- At least as well resolved as conventional PSDM
- Fast, efficient, repeatable

FWI + cloud: from boat to final PSDM in days