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Shear wave near-surface corrections in the tau-p domain: a case study

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Xiucheng Wei
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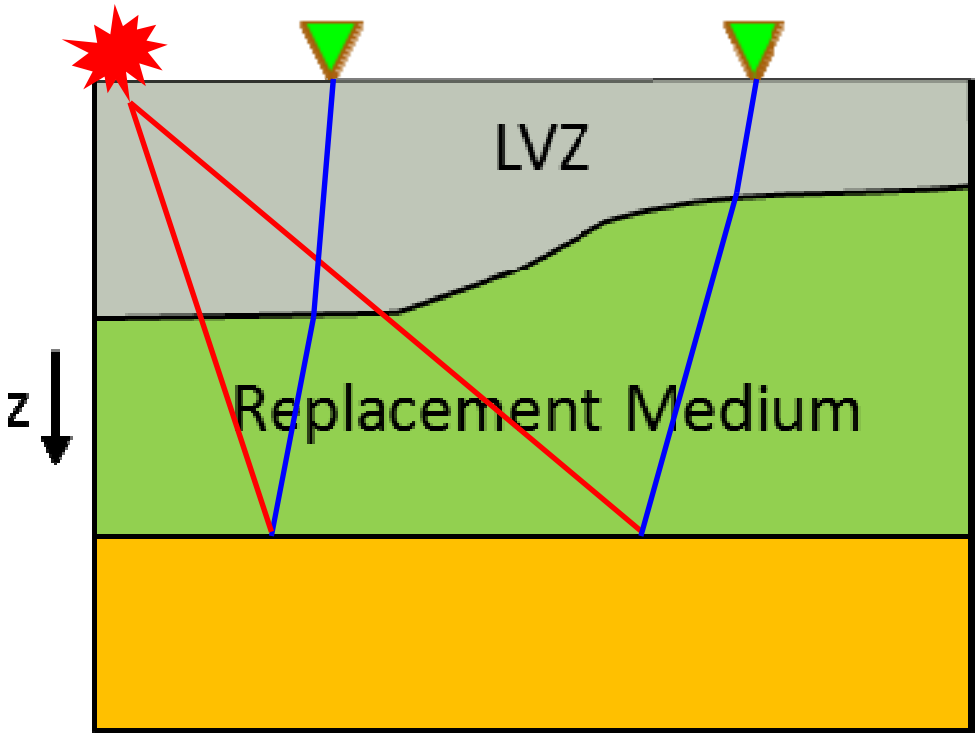
Banff, December 3rd, 2015

Introduction

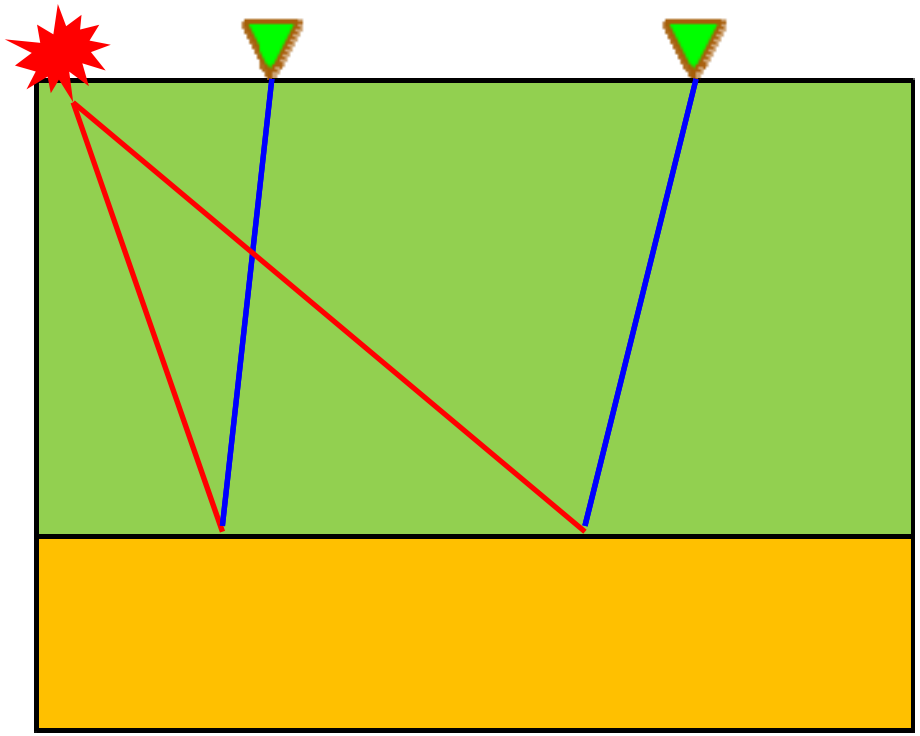
- Henley (2012) introduced a method to remove S-wave near-surface effects by using interferometric principles applied in the radial-trace (RT) domain.
- Cova et al. (2014) extended this idea to the τ-p domain, where no assumptions about the velocity model underlying the wave propagation are imposed.
- An important feature of this method is that near-surface effects are extracted from the reflected data (no first break picking is required).
- Can we use this method in fairly complex geological settings?

Near-surface effects

Near-surface effects



No near-surface effects



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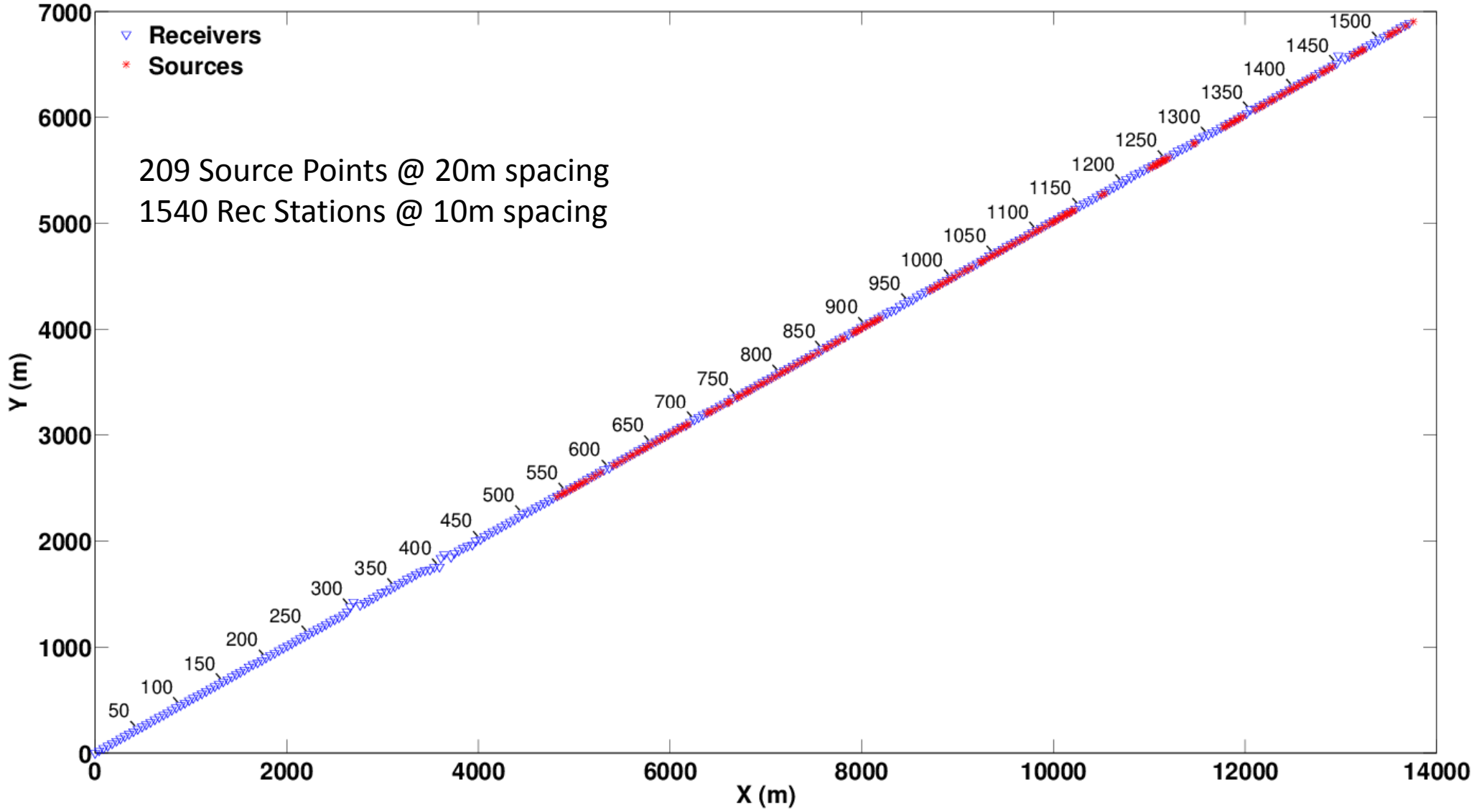
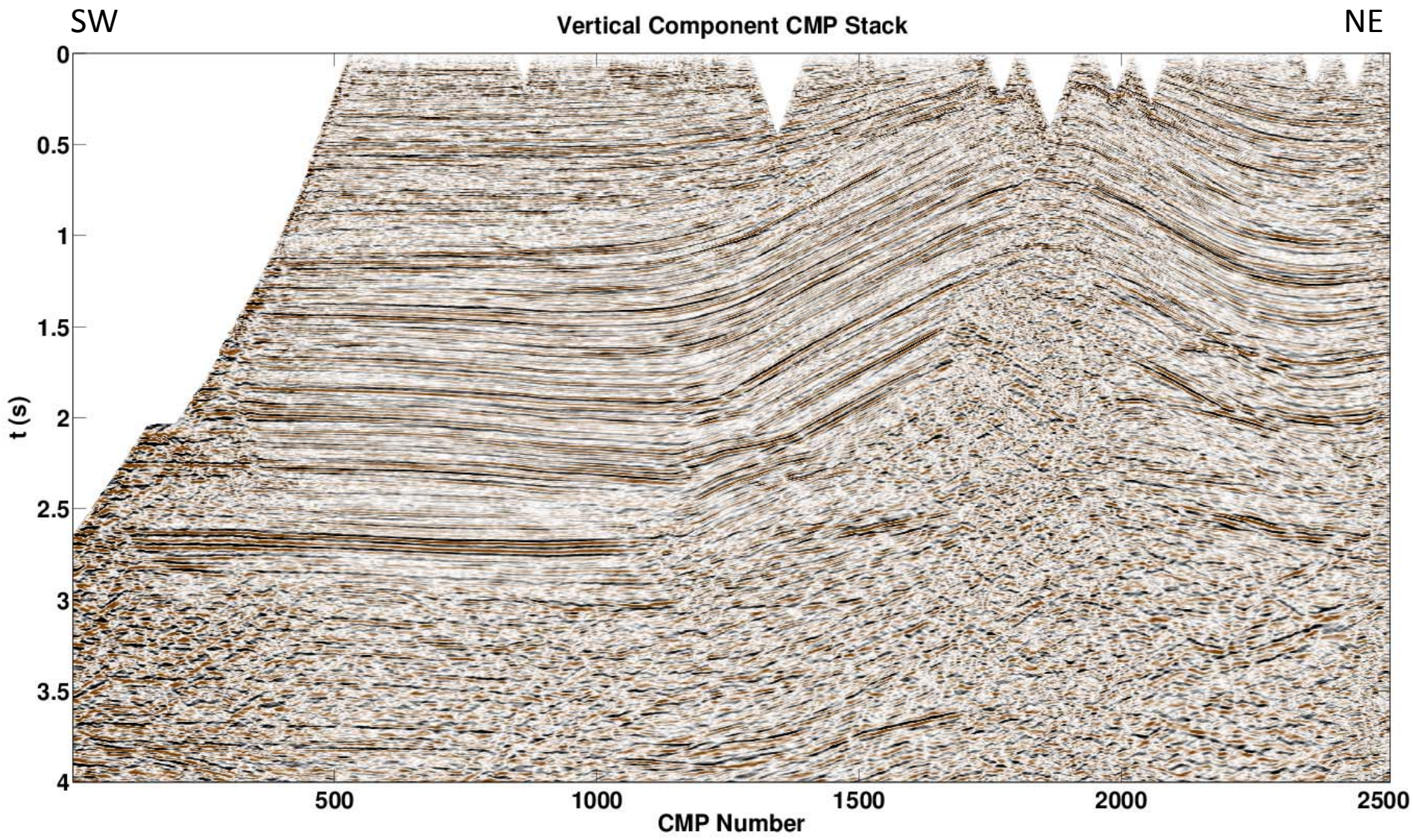
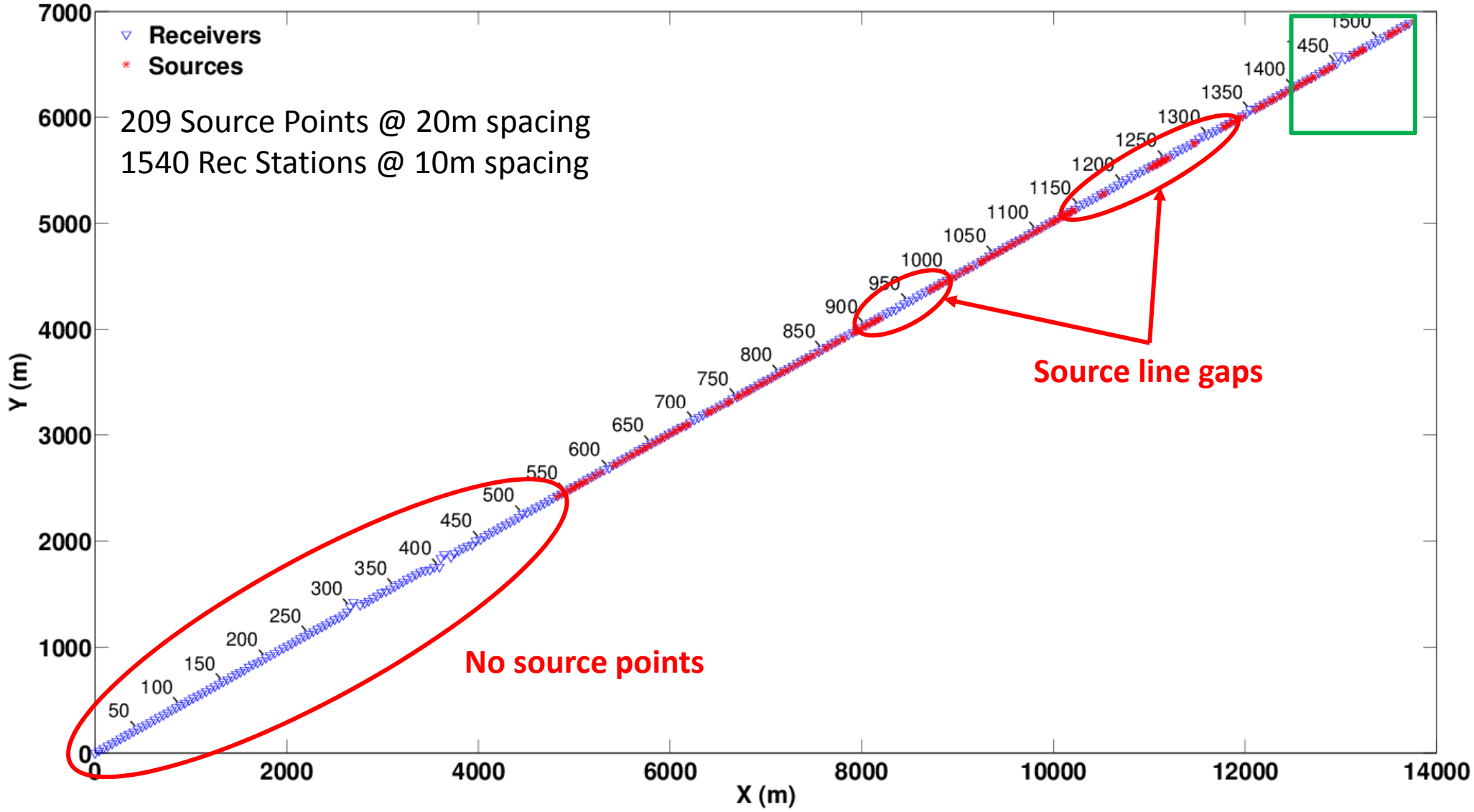
Survey Geometry



Vertical Component Stacked Section



Survey Problems



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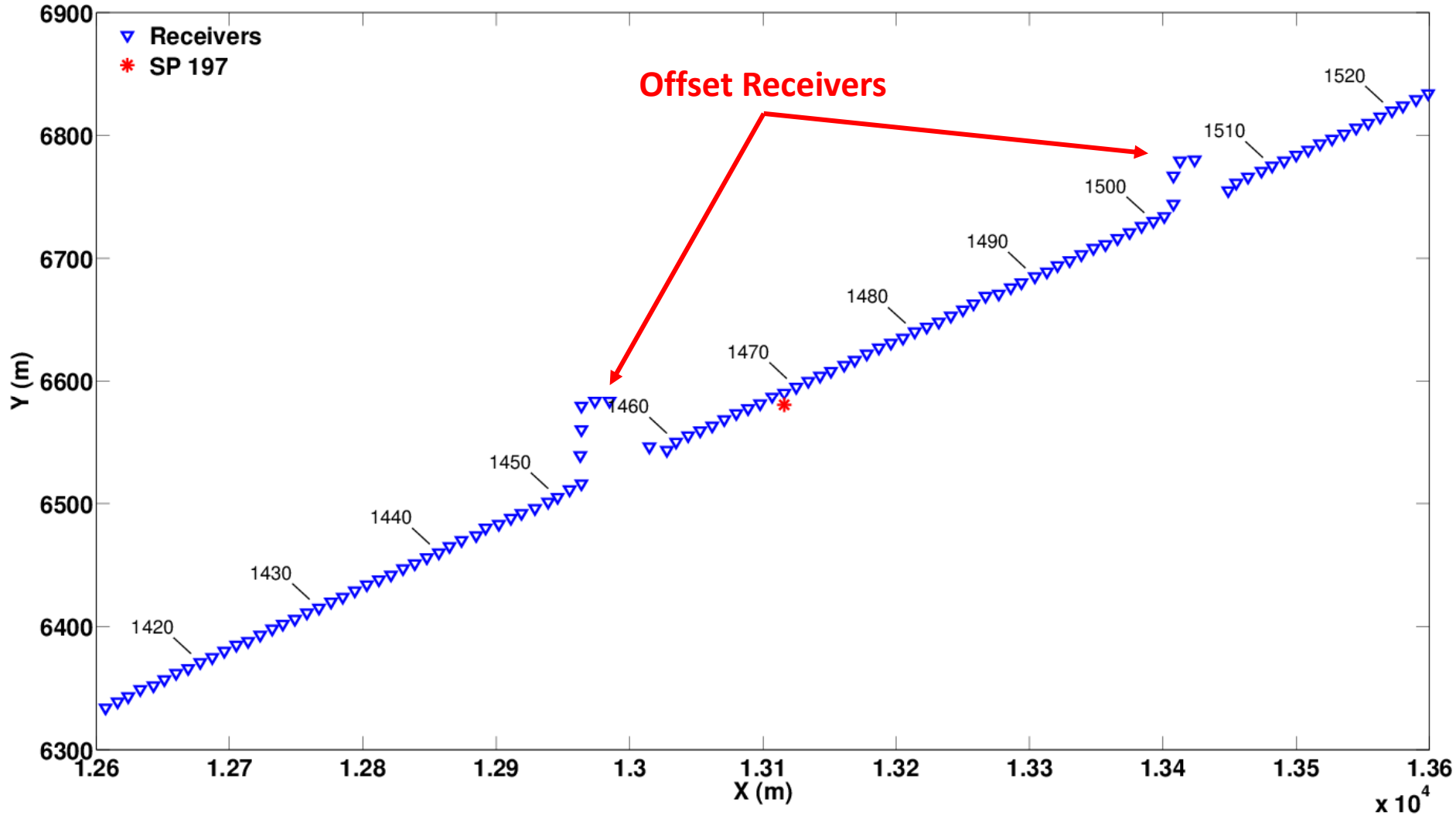
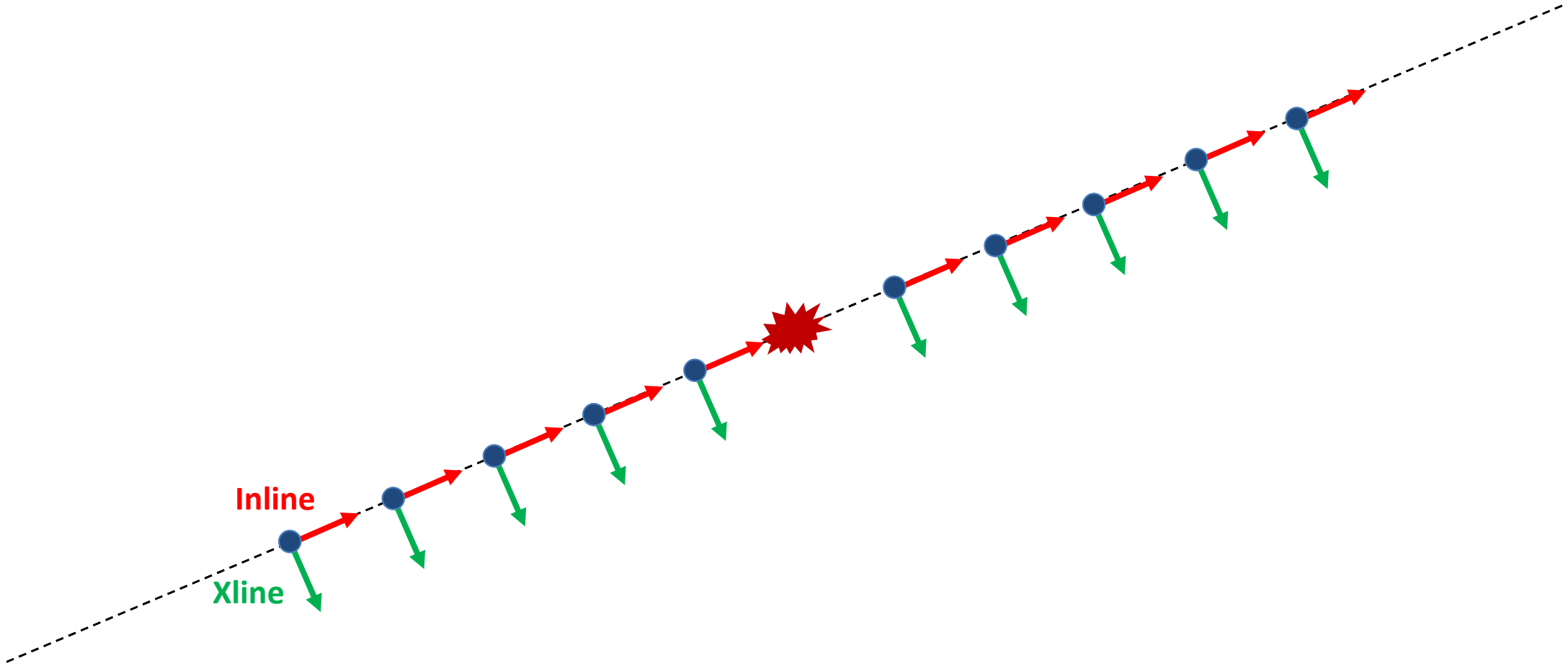
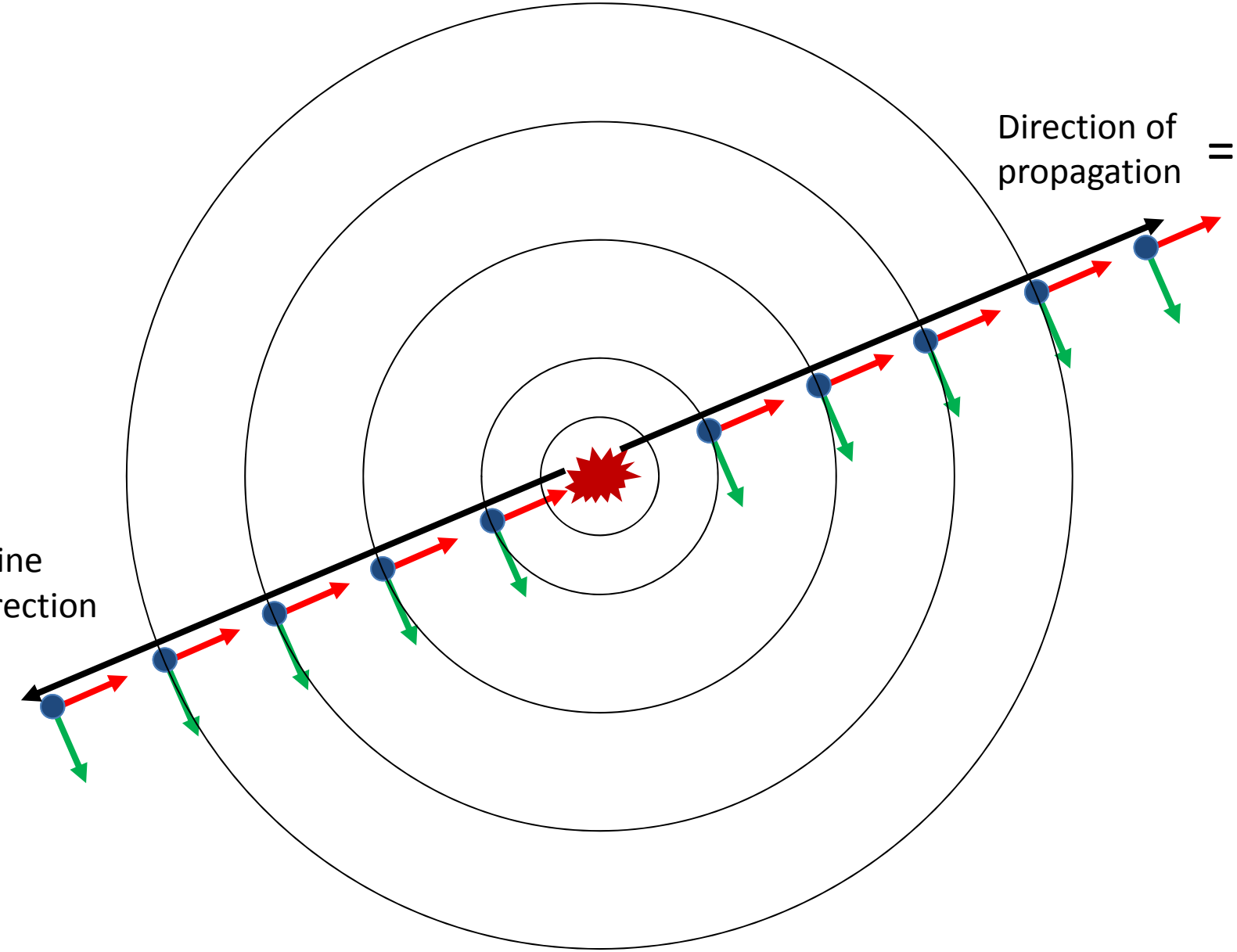
Survey Problems



Rotation into the Radial Direction



Rotation into the Radial Direction



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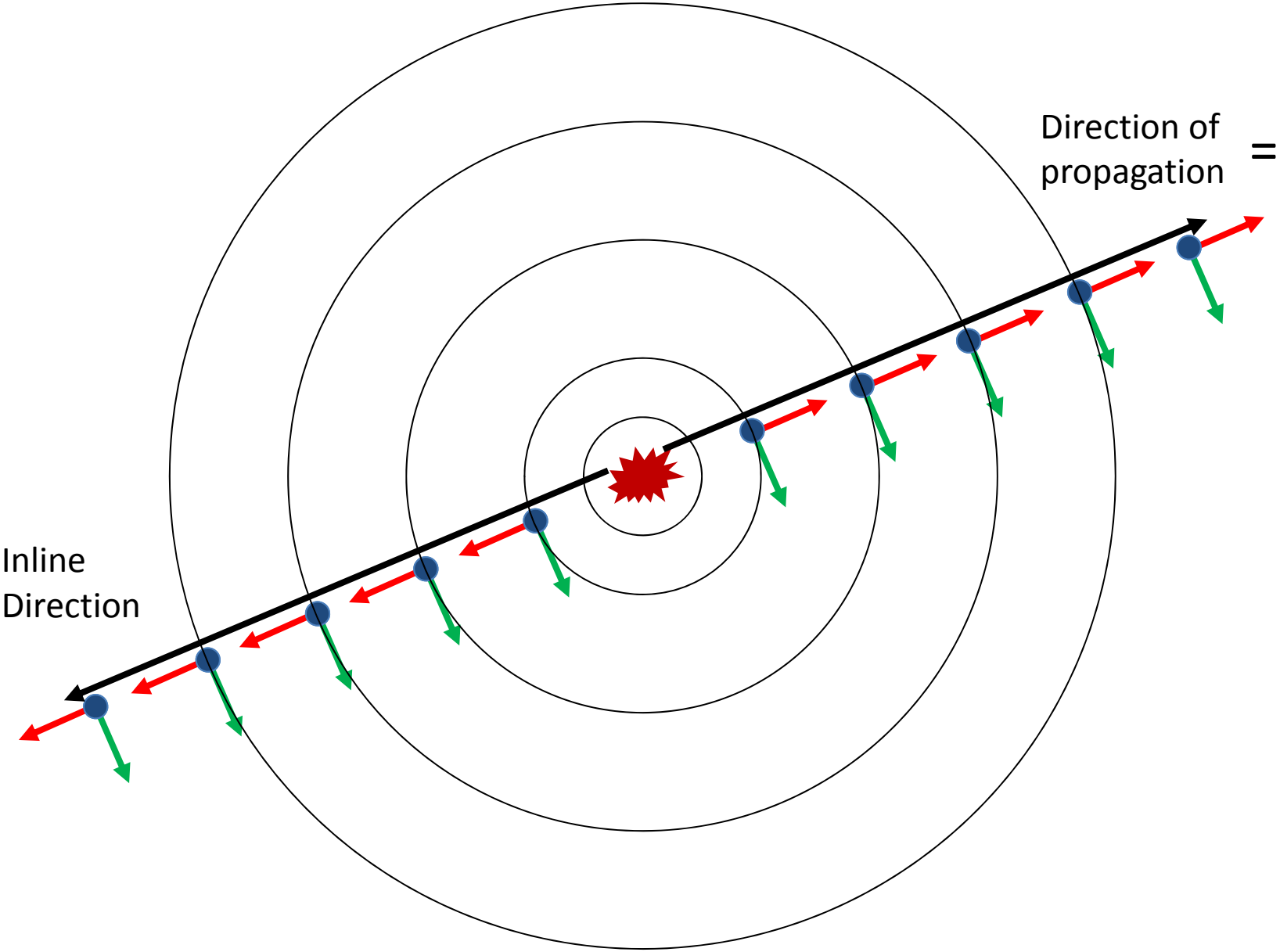
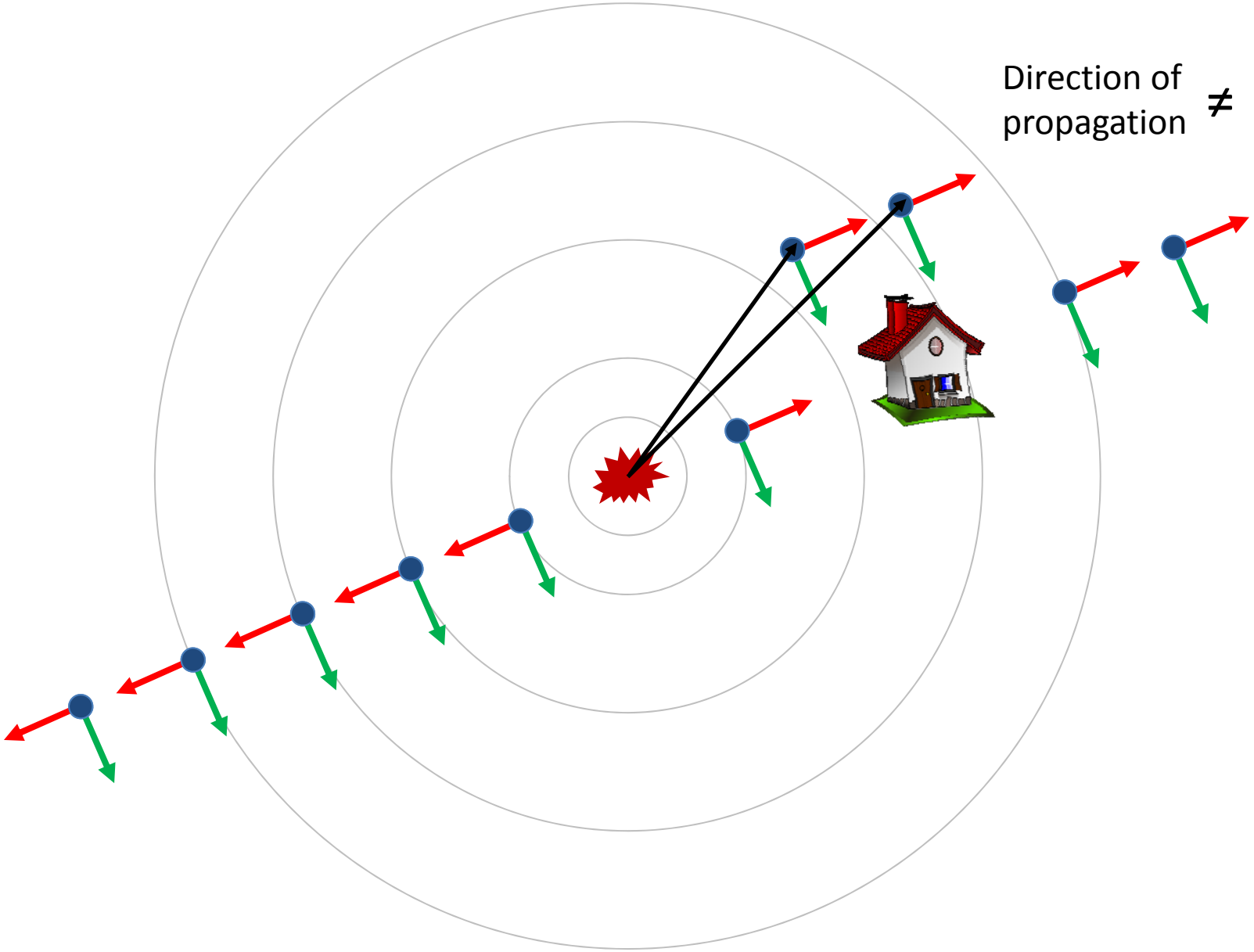


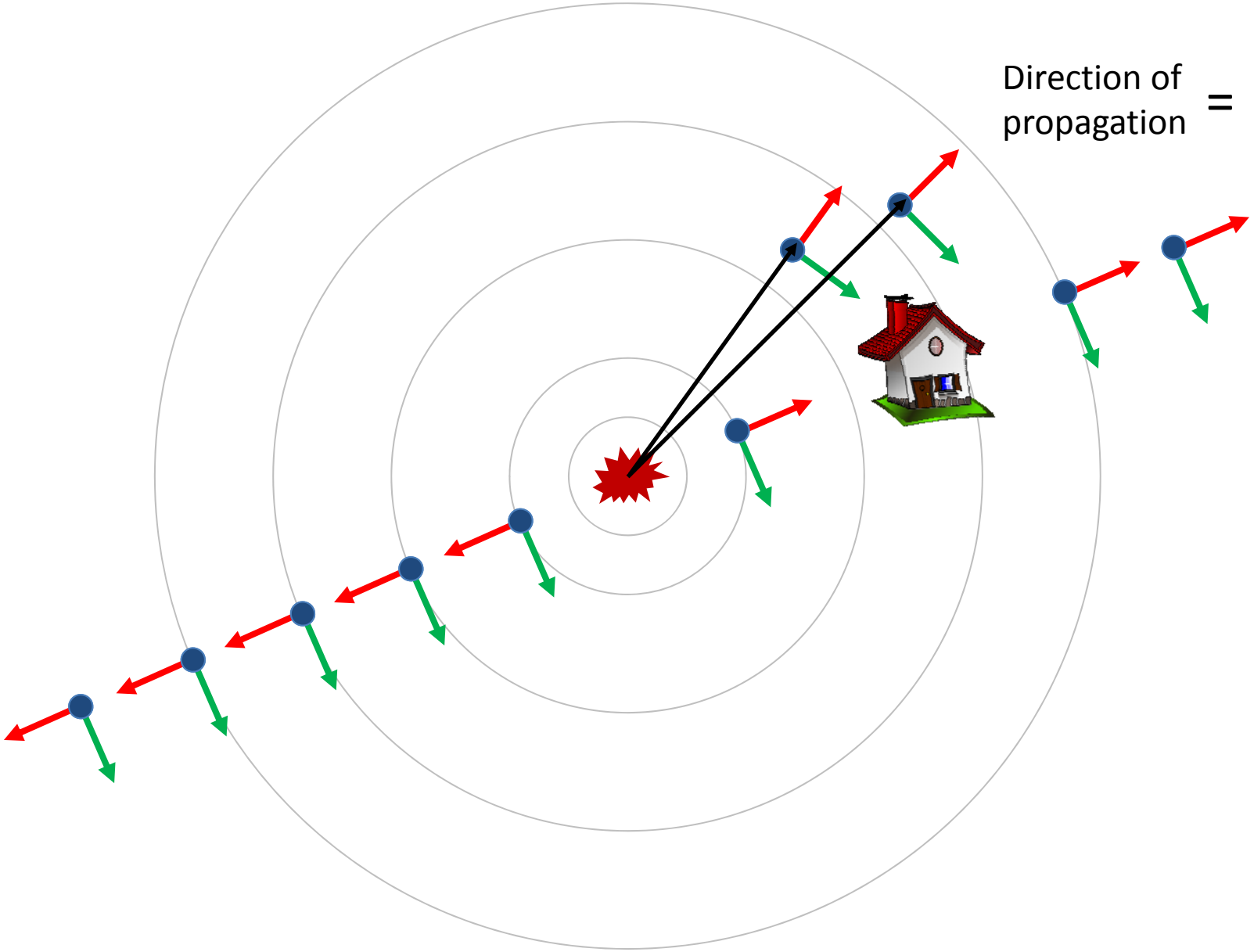
Rotation into the Radial Direction

Direction of propagation ≠ Inline Direction



Rotation into the Radial Direction

Direction of propagation = Inline Direction



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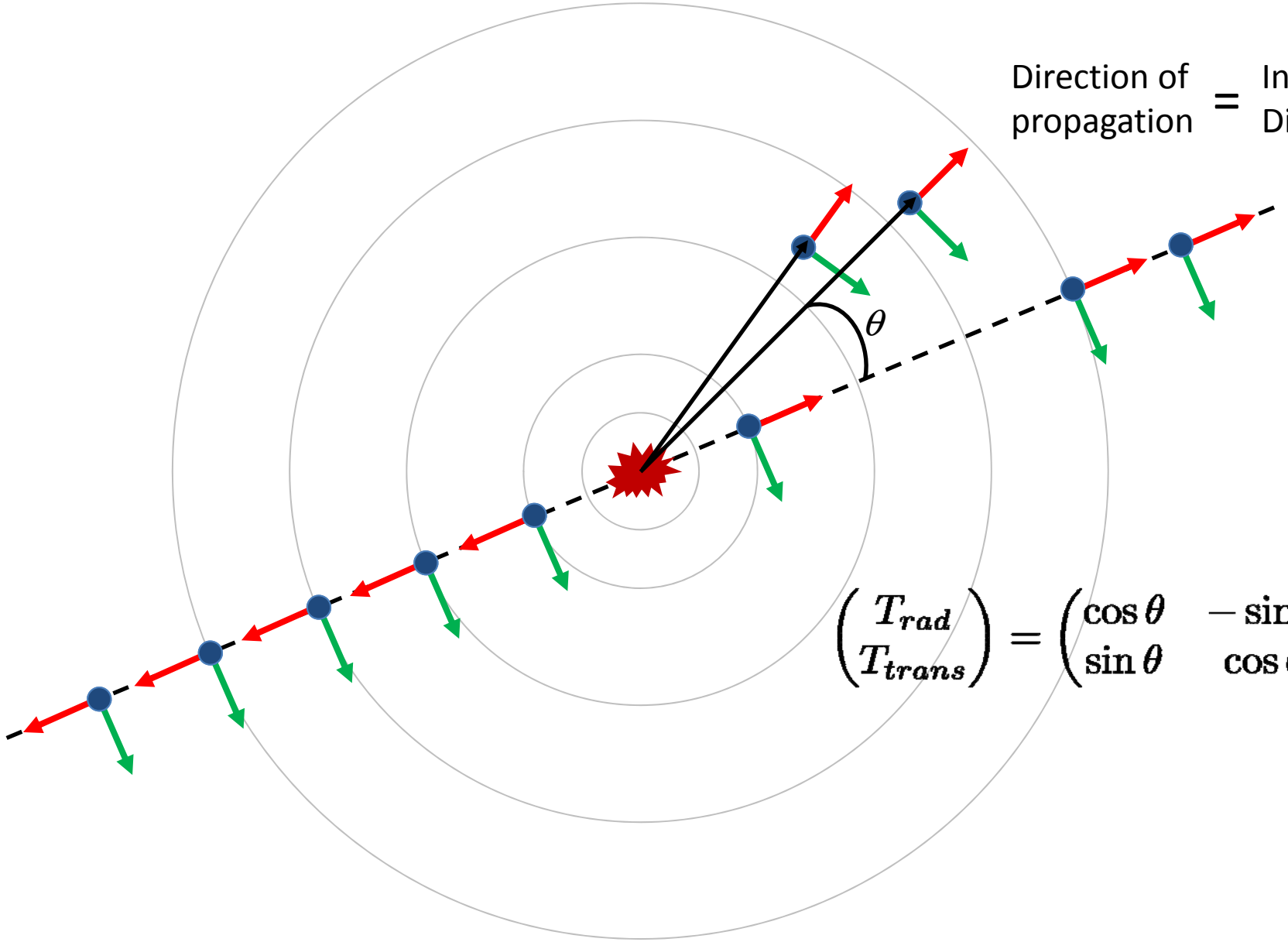

$$\begin{pmatrix} T_{rad} \\ T_{trans} \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} T_{inline} \\ T_{xline} \end{pmatrix}$$

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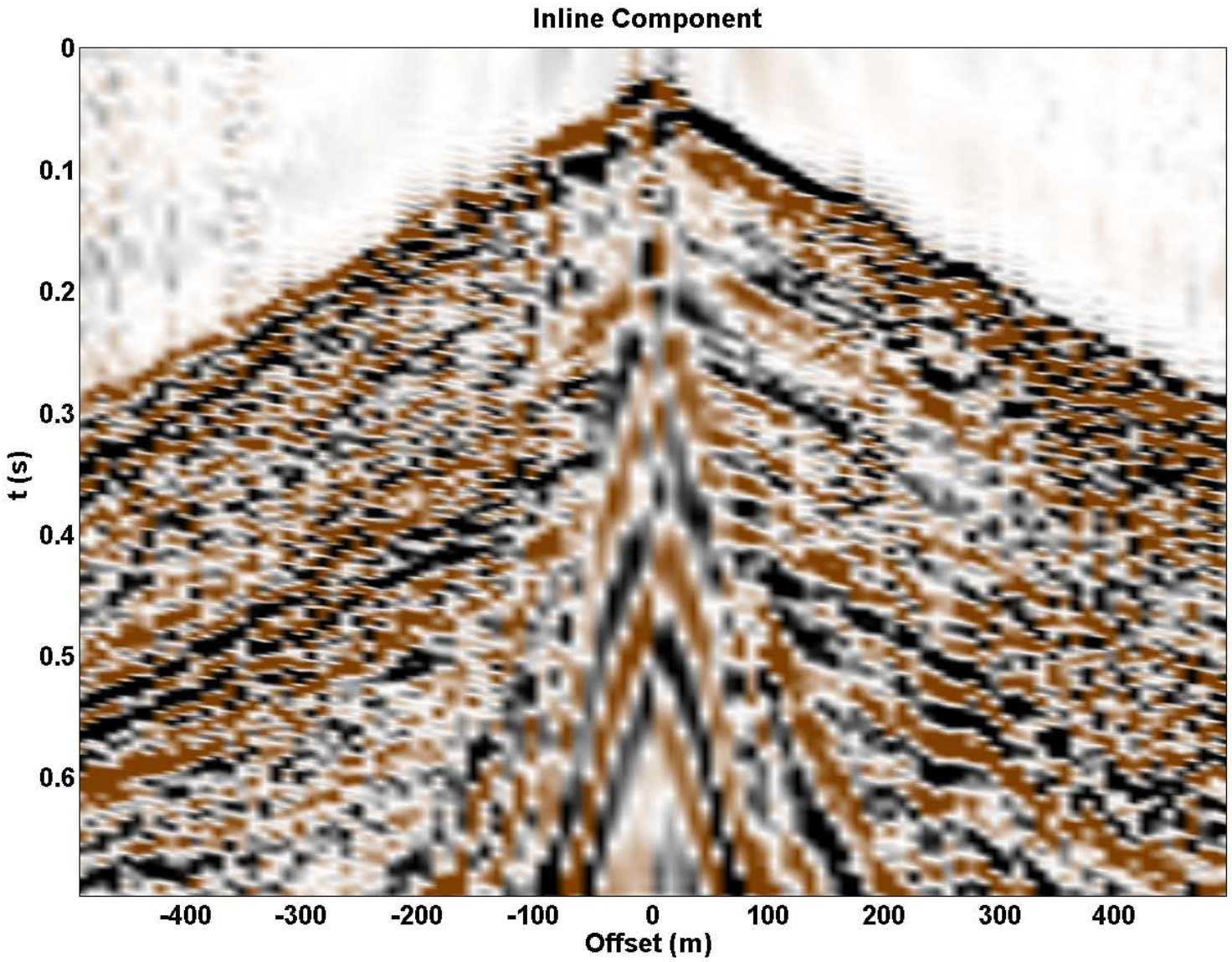
Rotation into the Radial Direction



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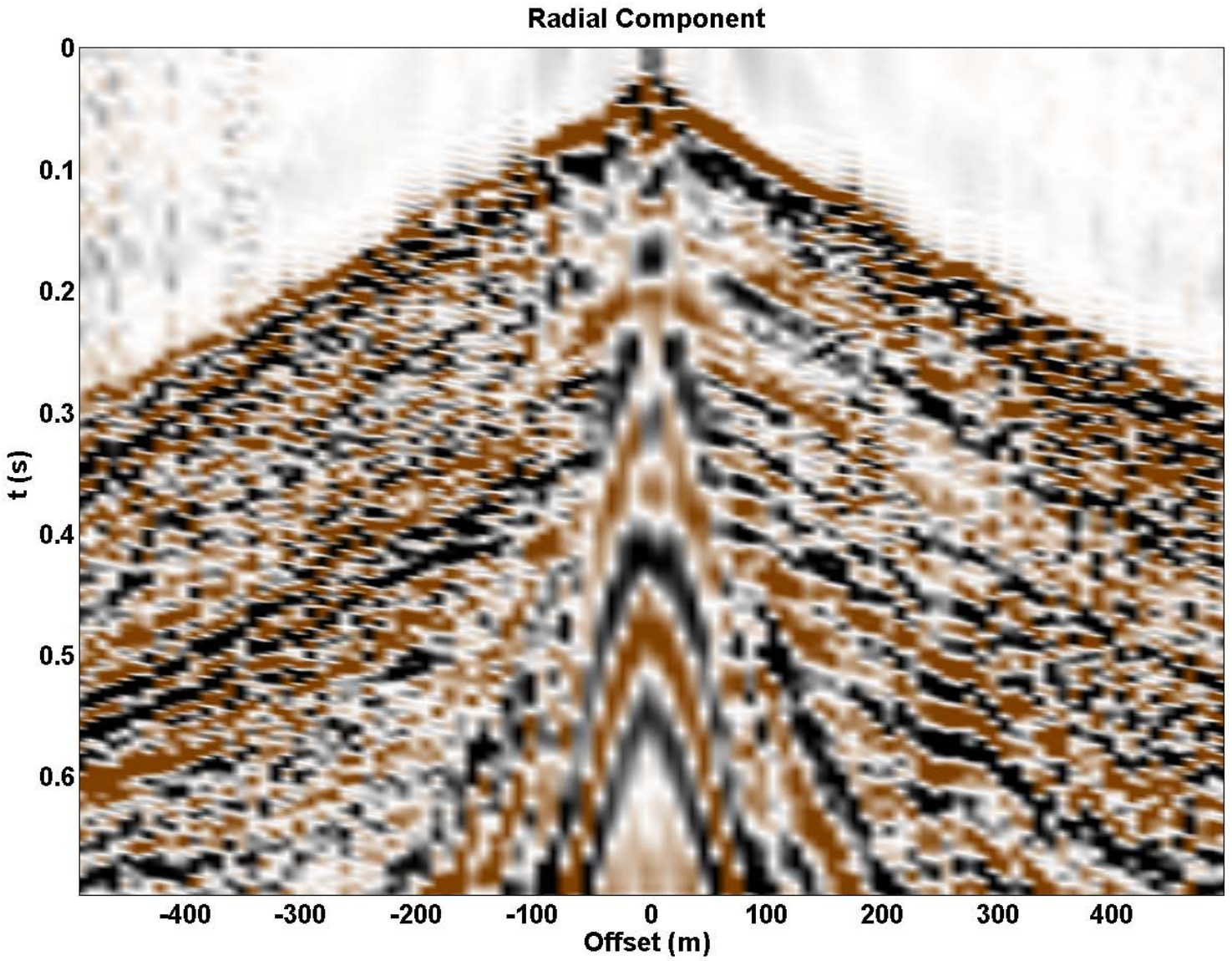
Rotation Toward the Source



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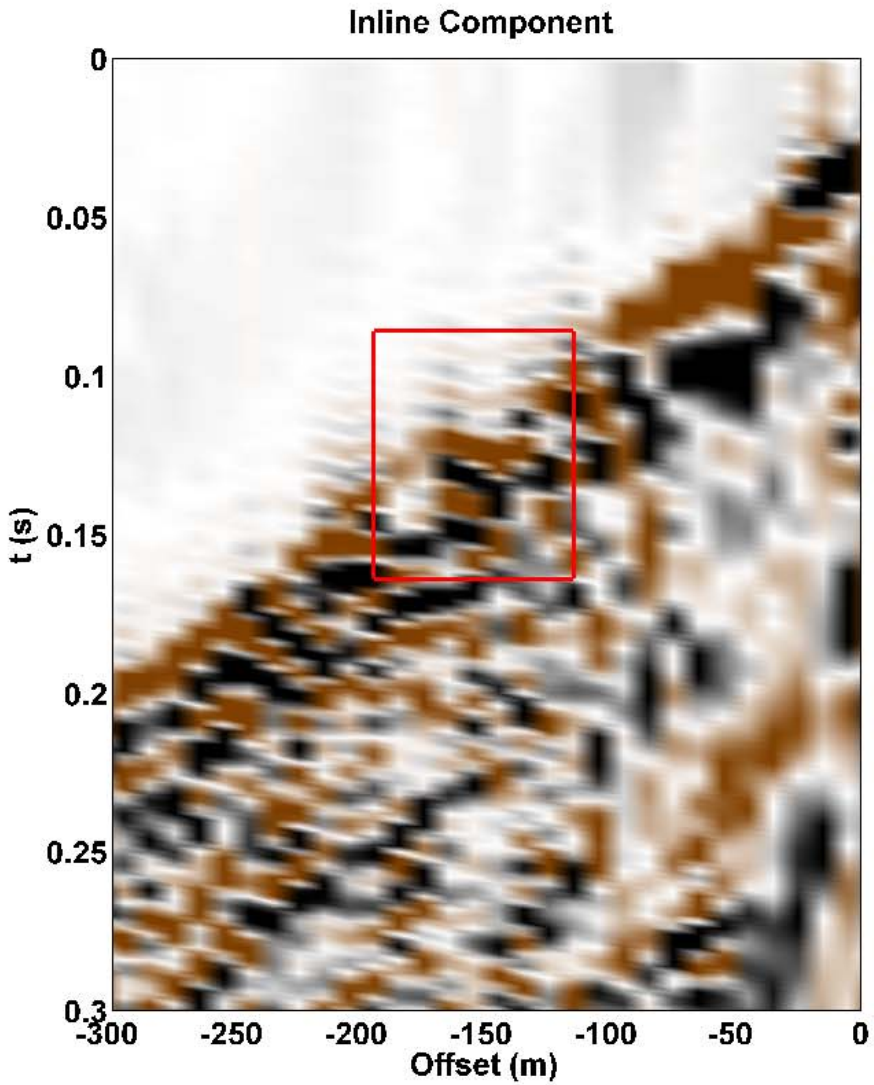
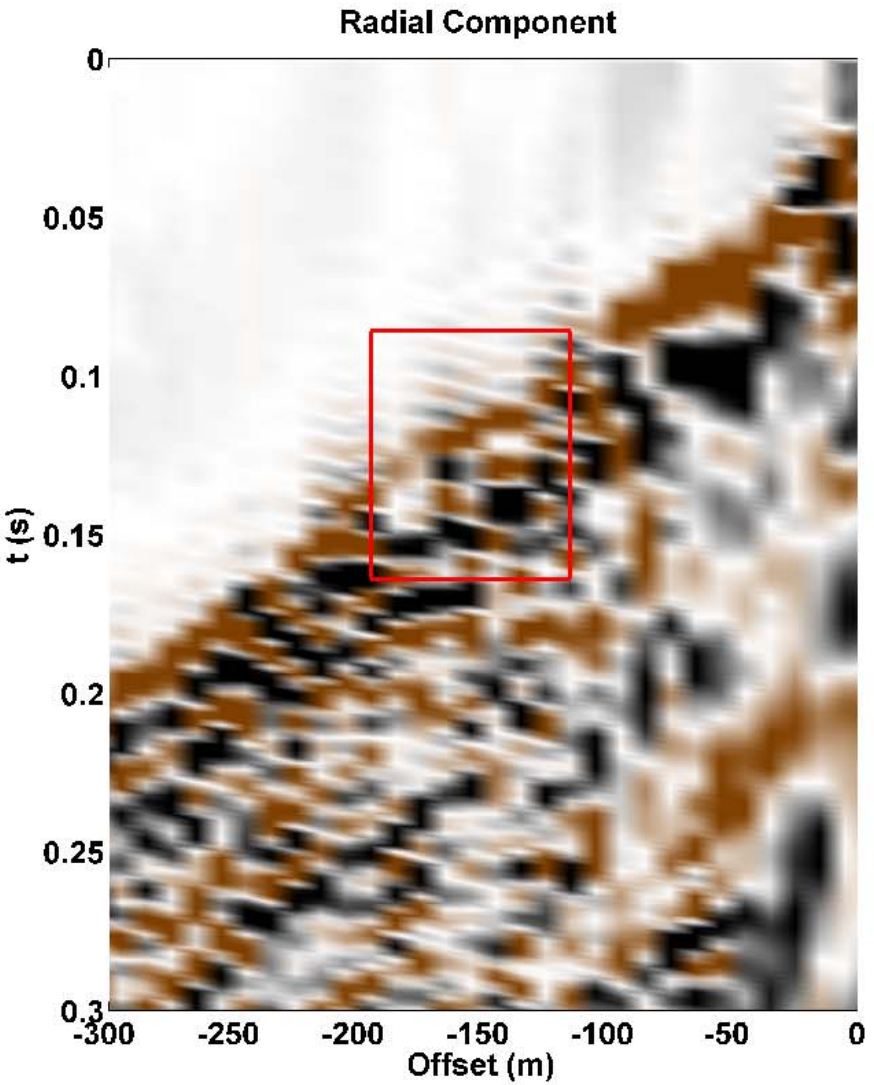
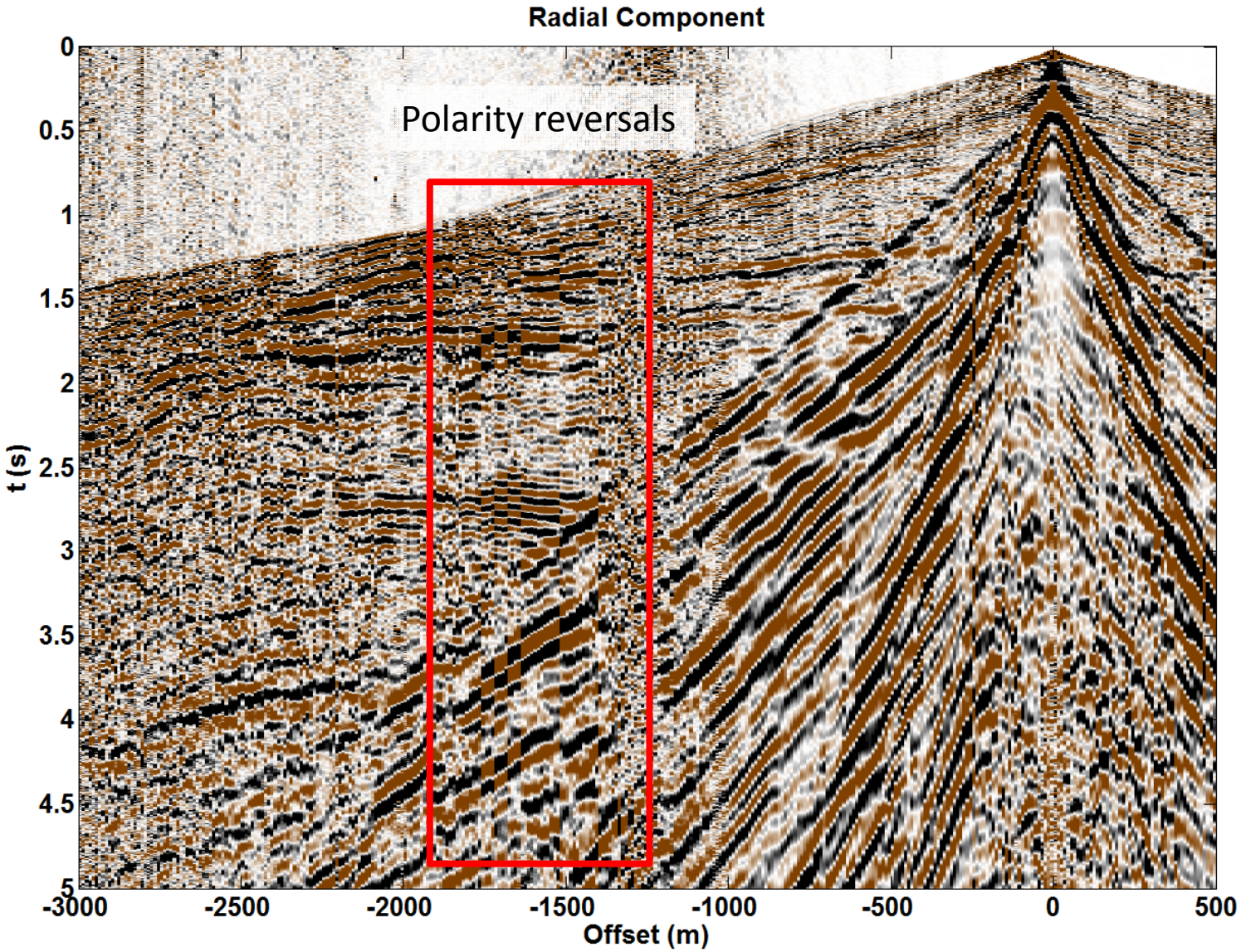
Rotation into the Radial Direction





Polarity Reversals



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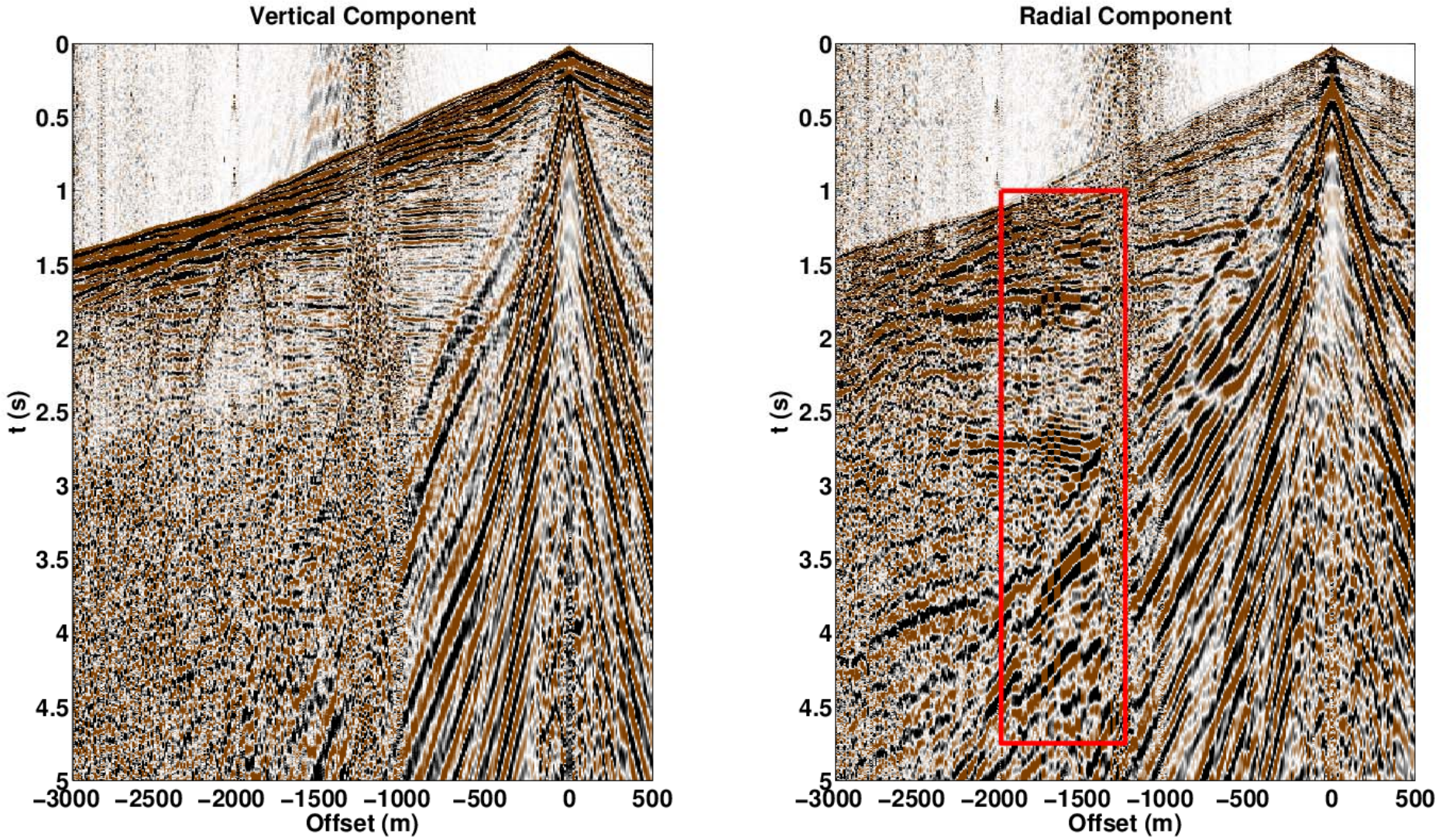
Polarity Reversals



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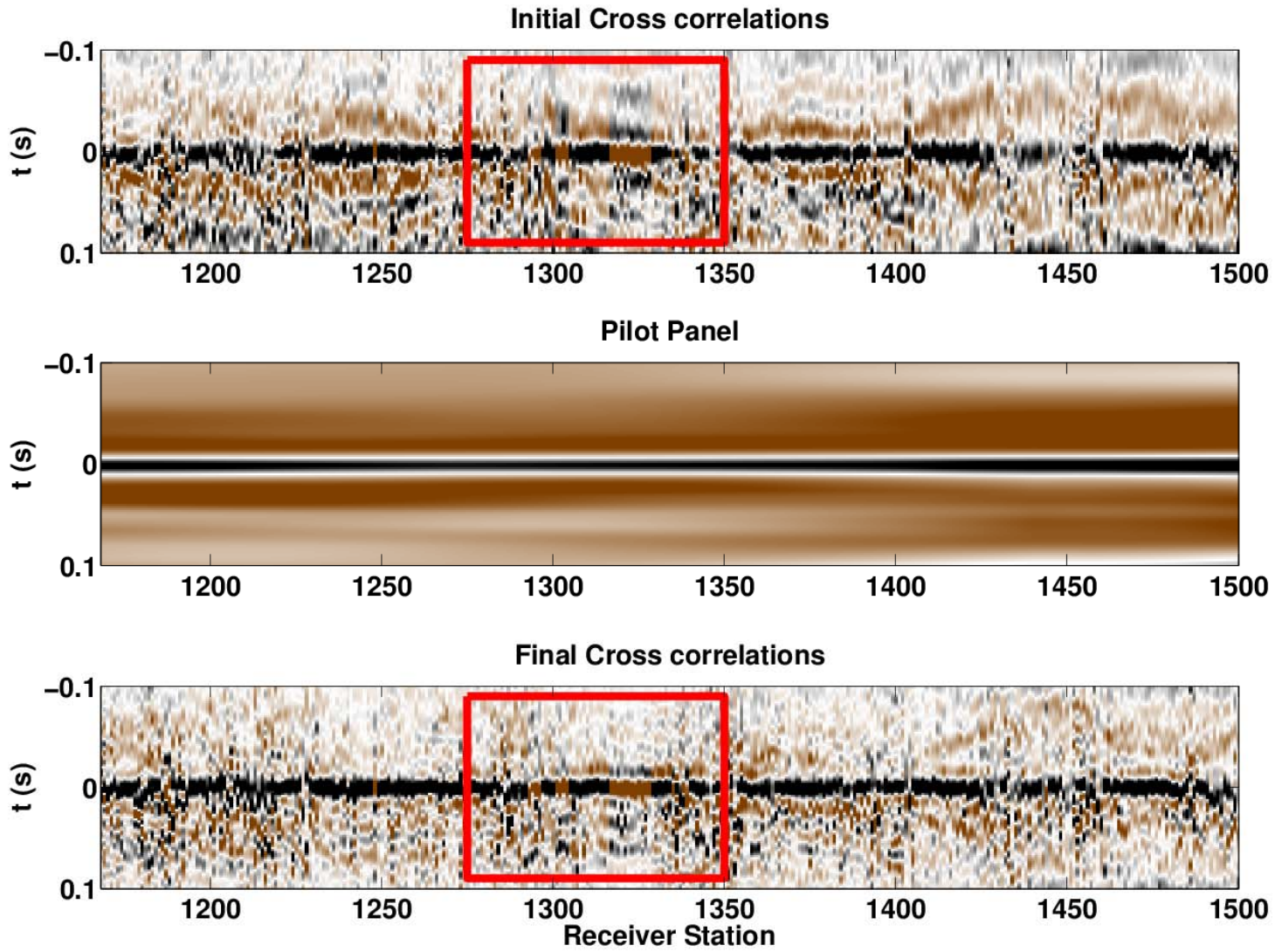
Polarity Reversals



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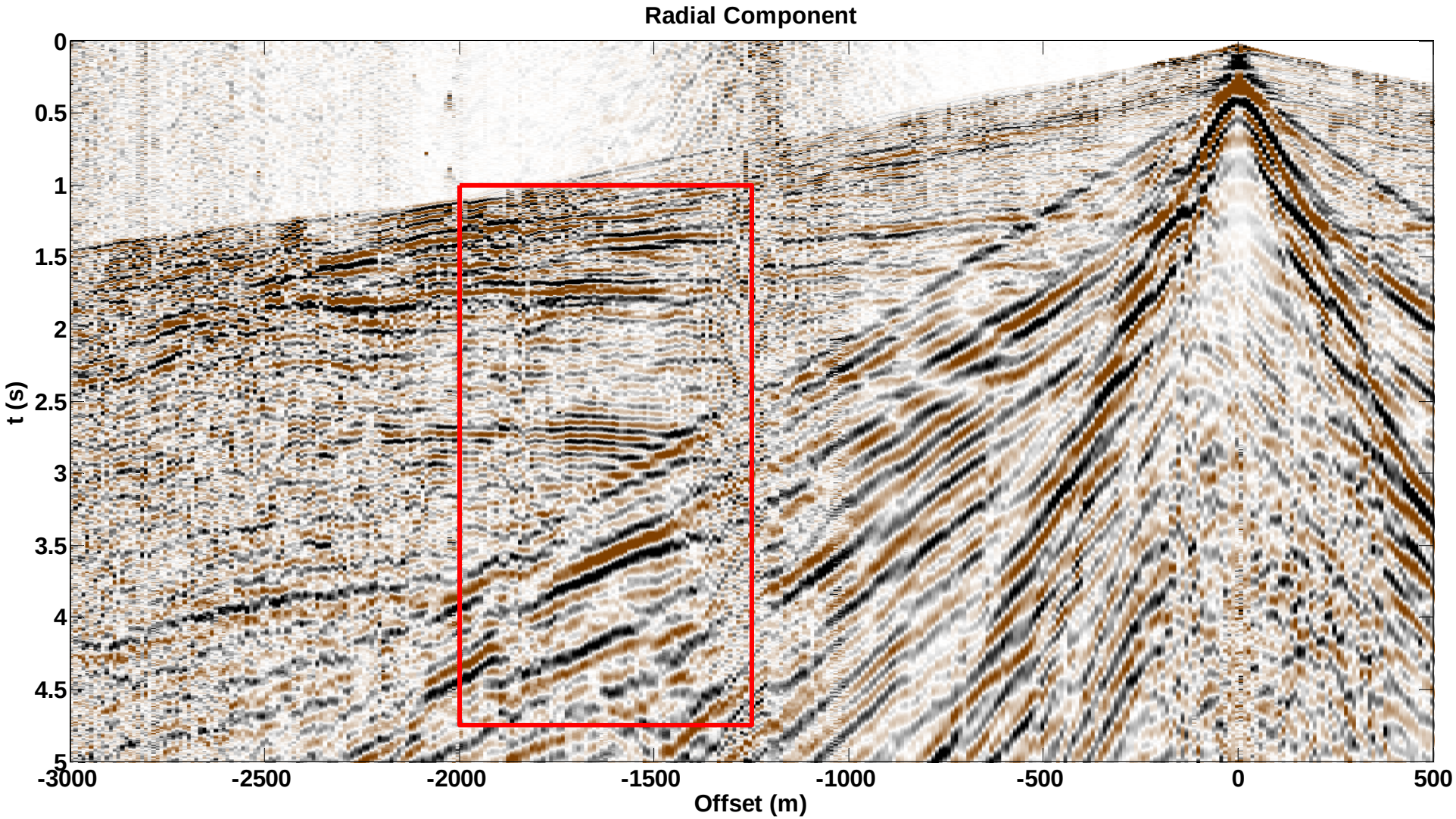
Polarity Reversals



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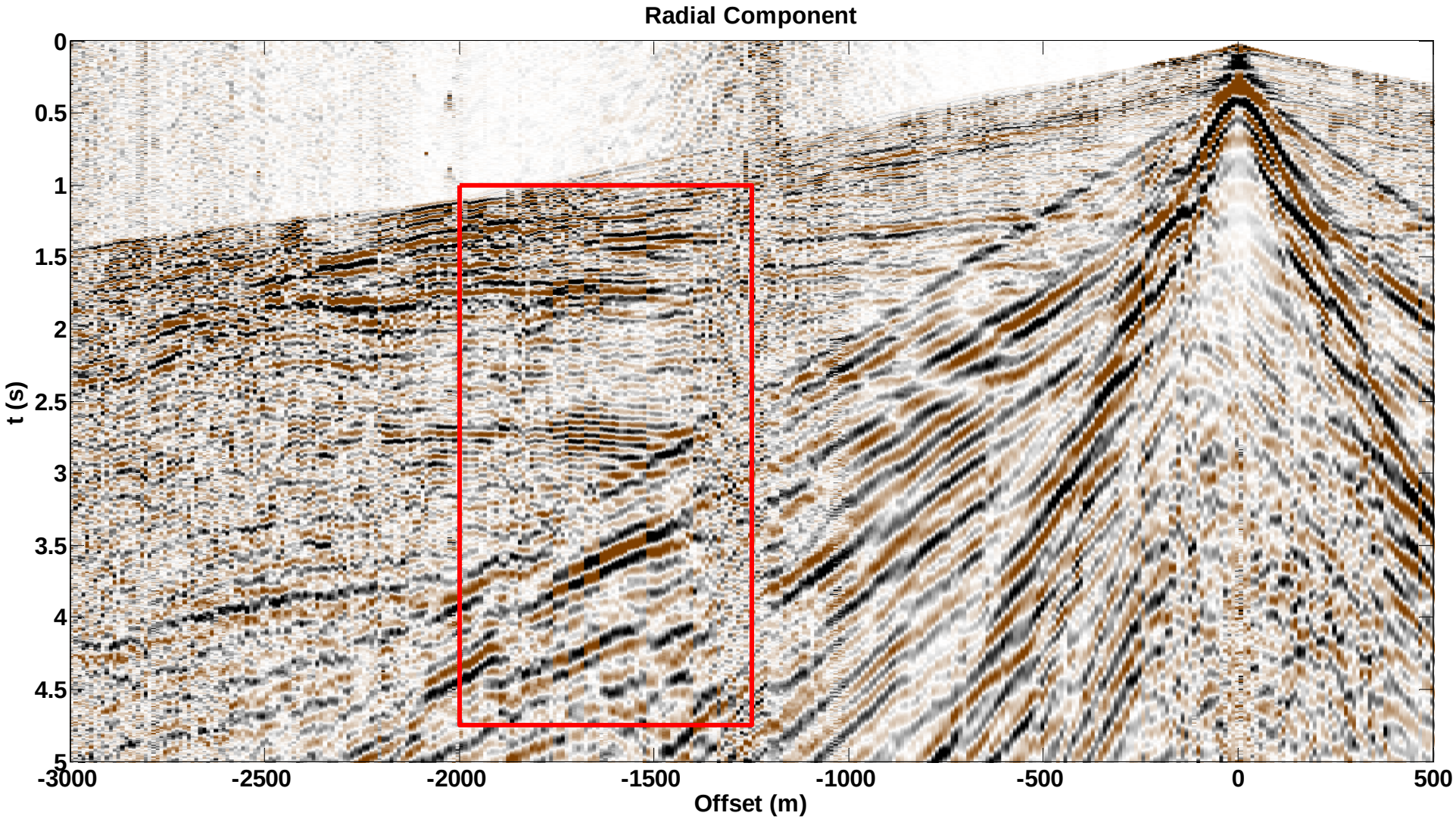
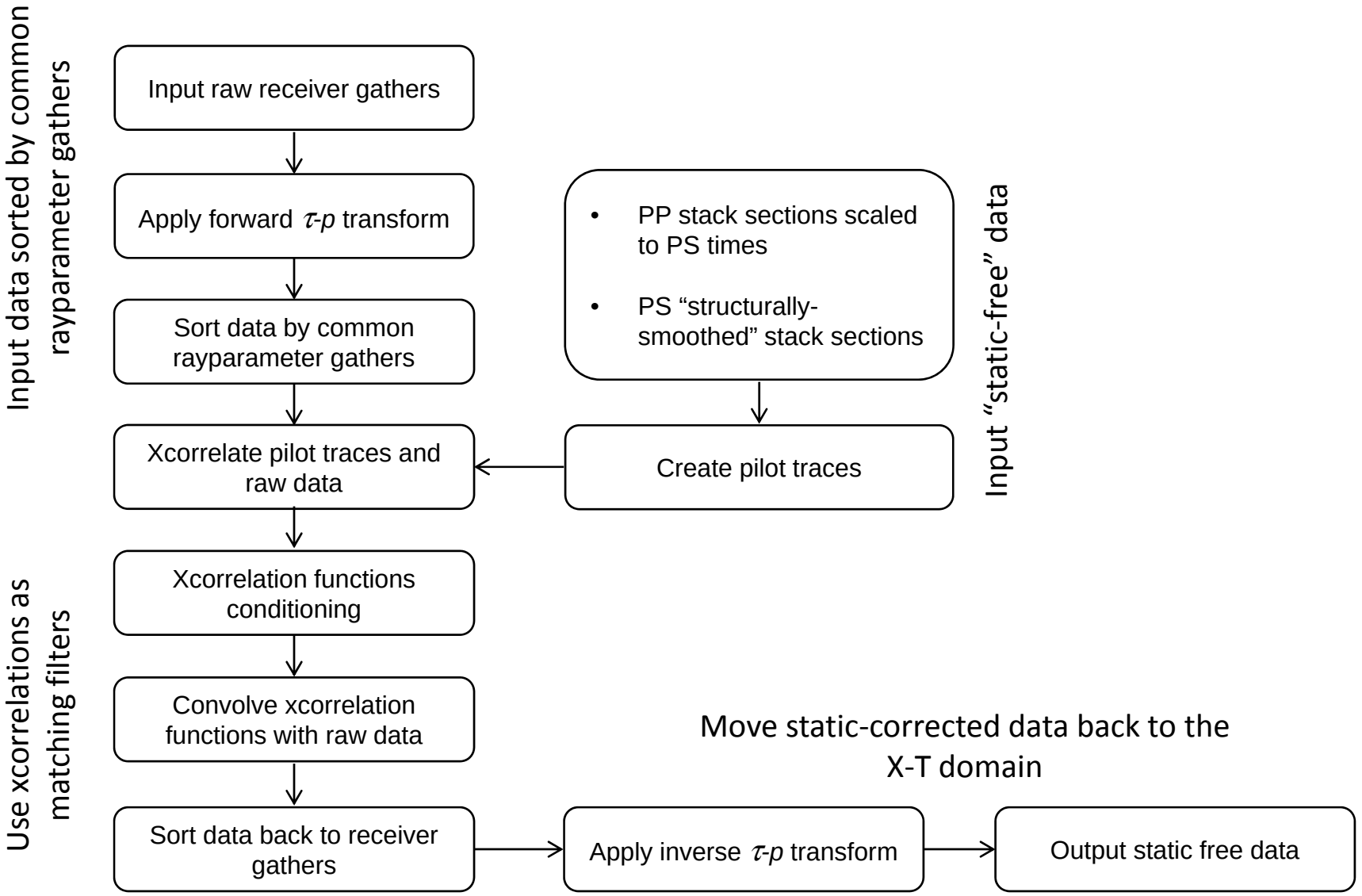
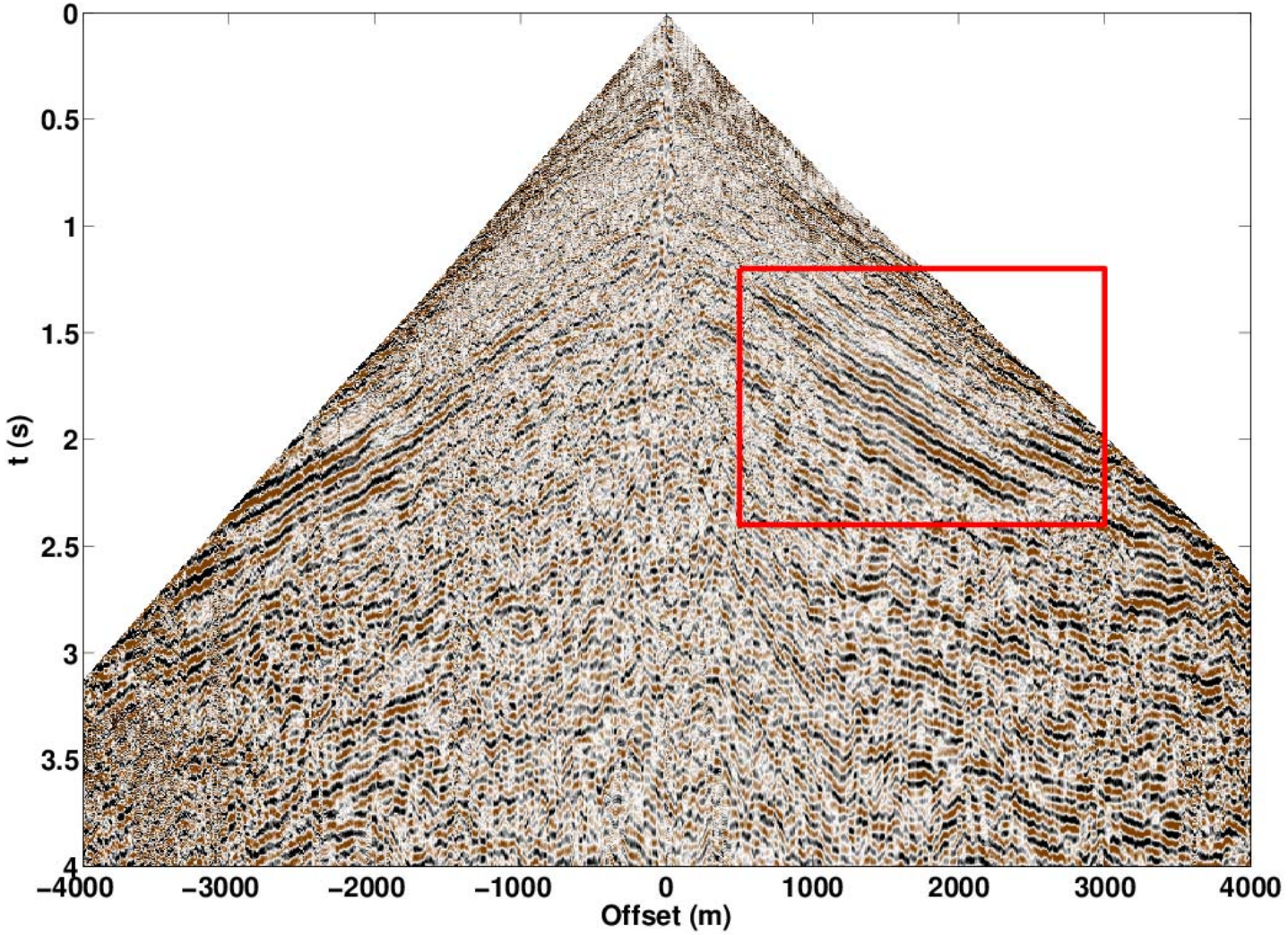
Polarity Reversals



Near-surface Effects Removal



Radial Component Source Gather



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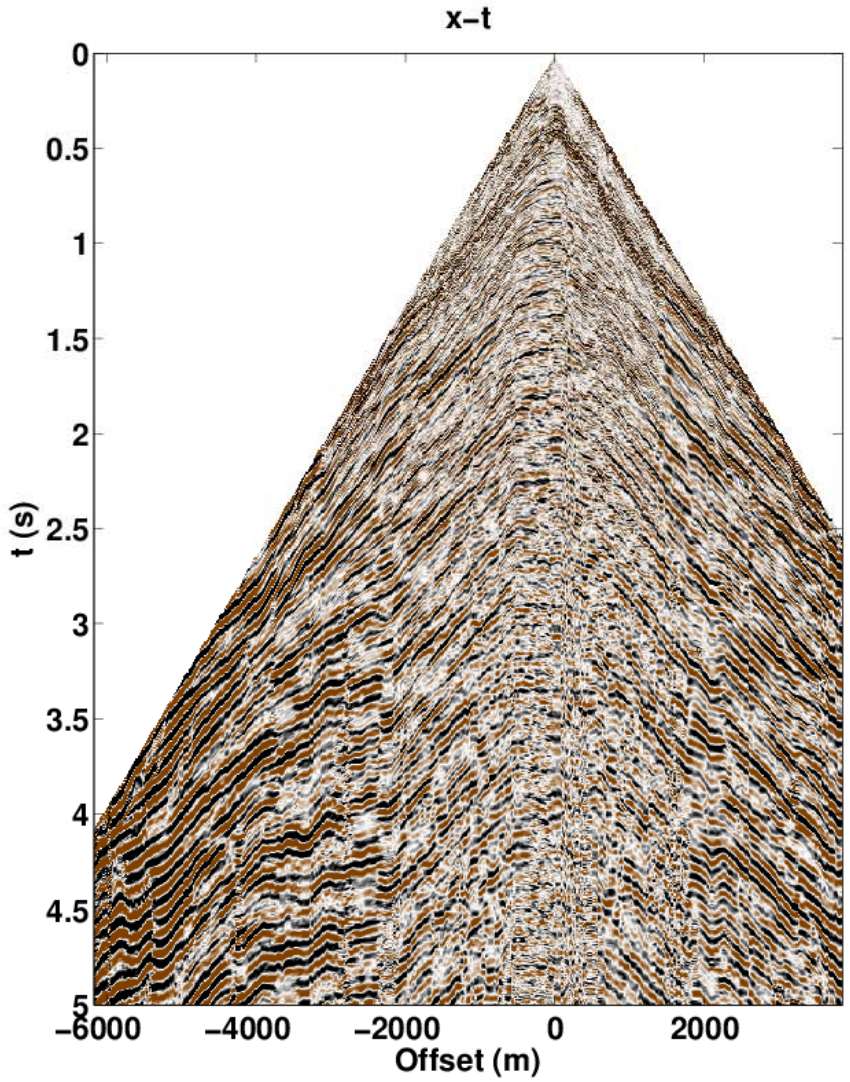
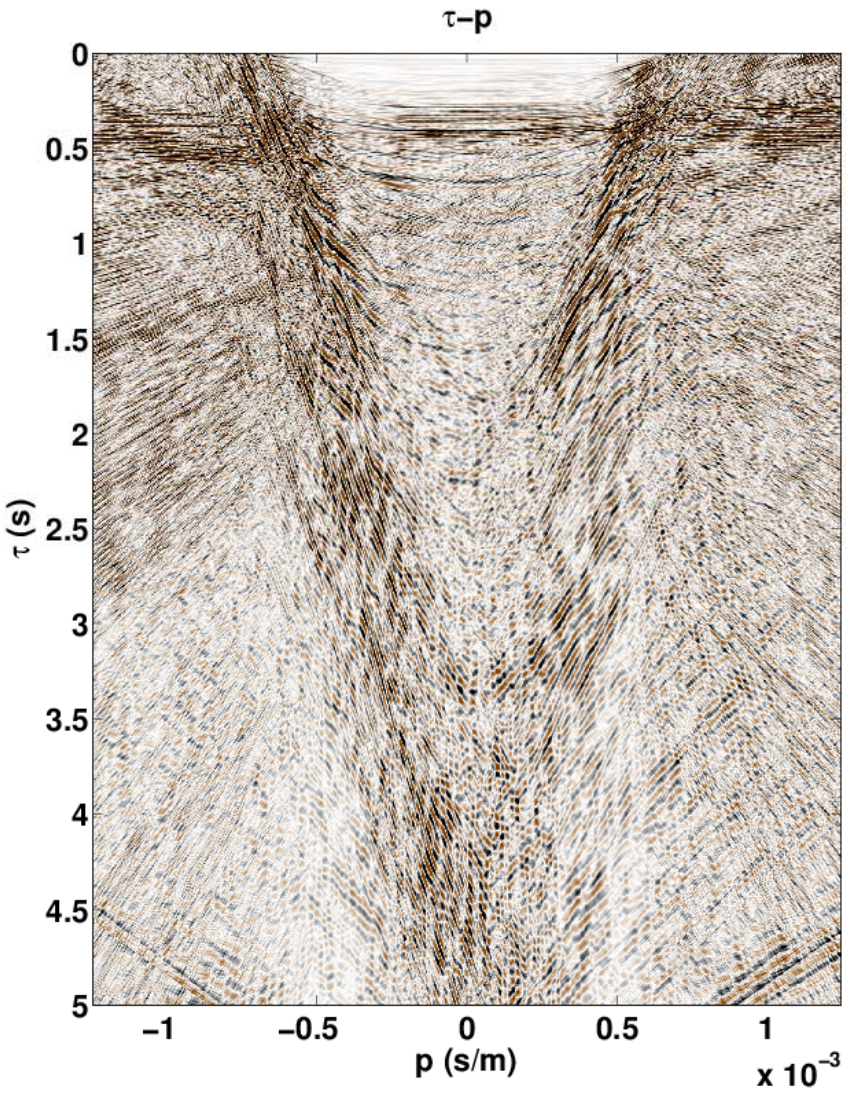
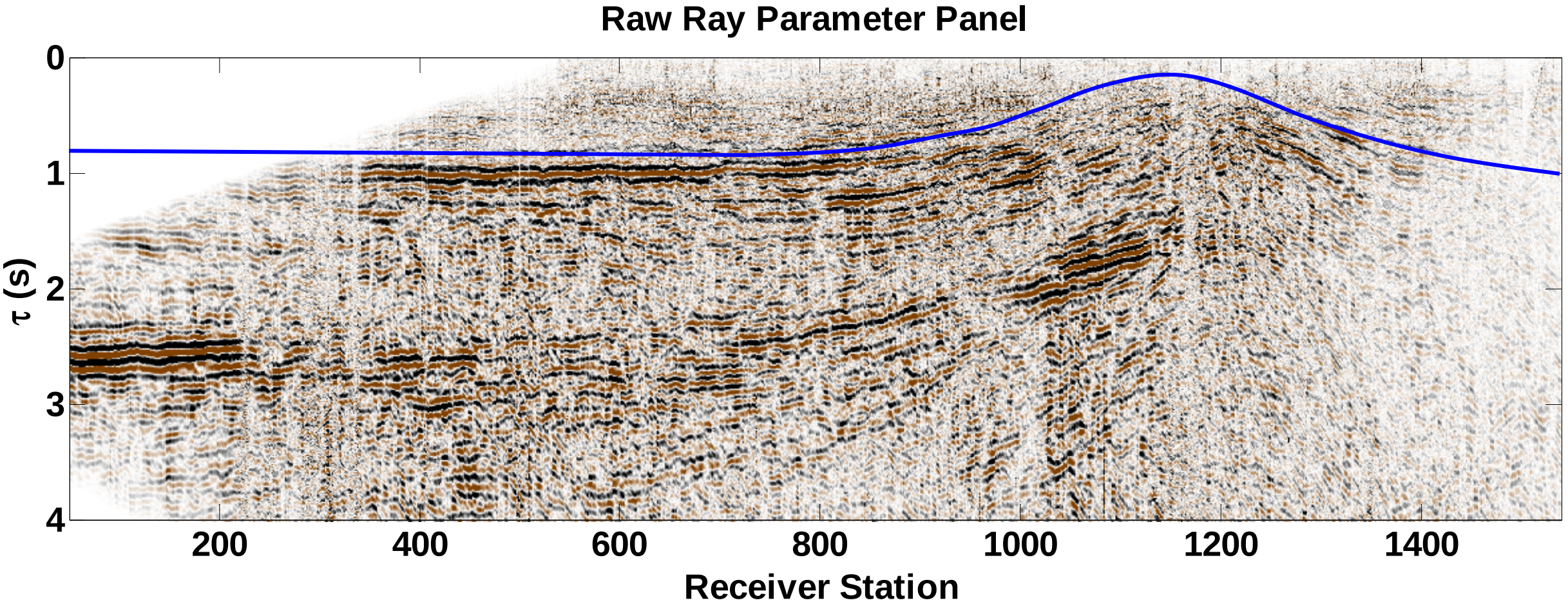
Receiver Gathers

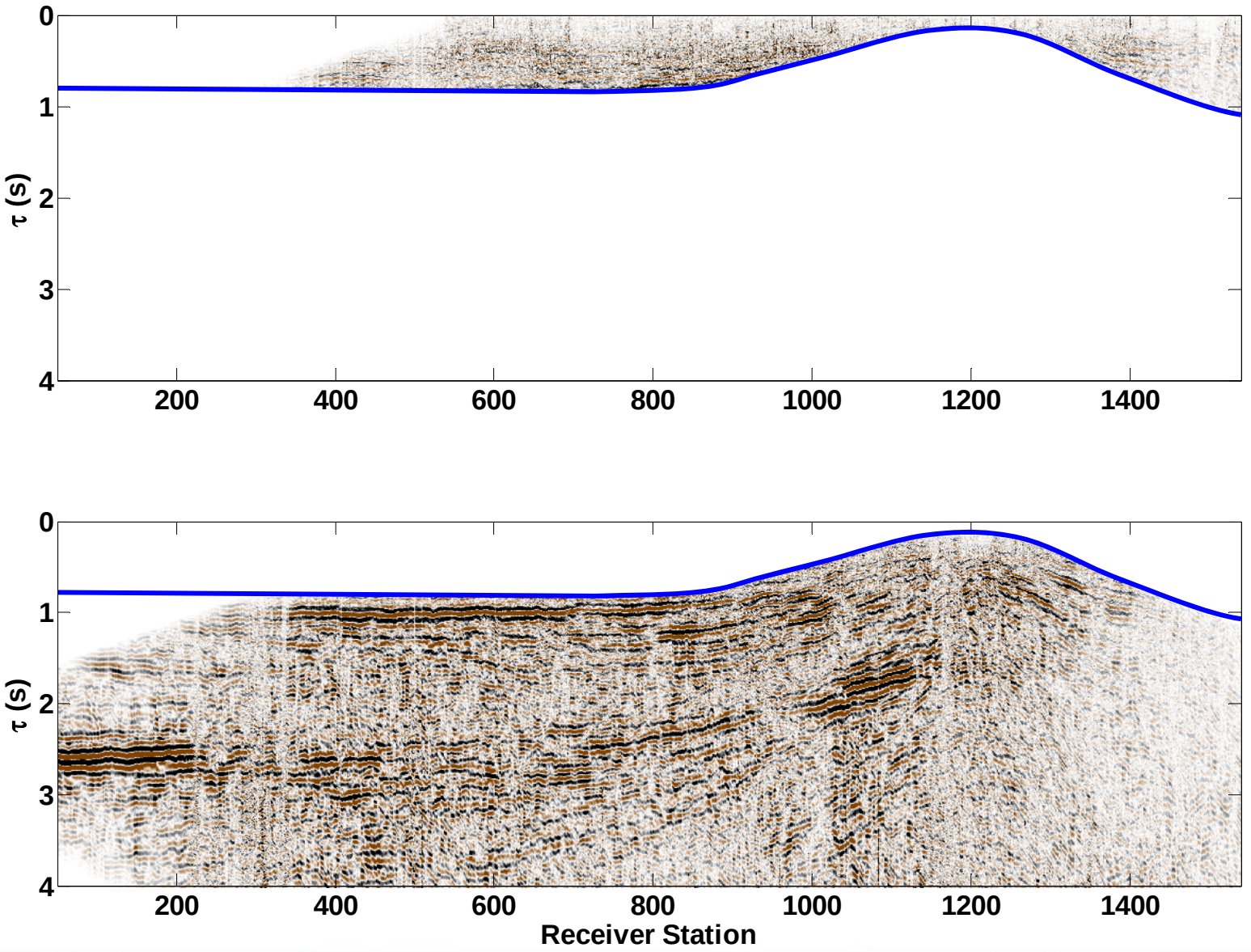




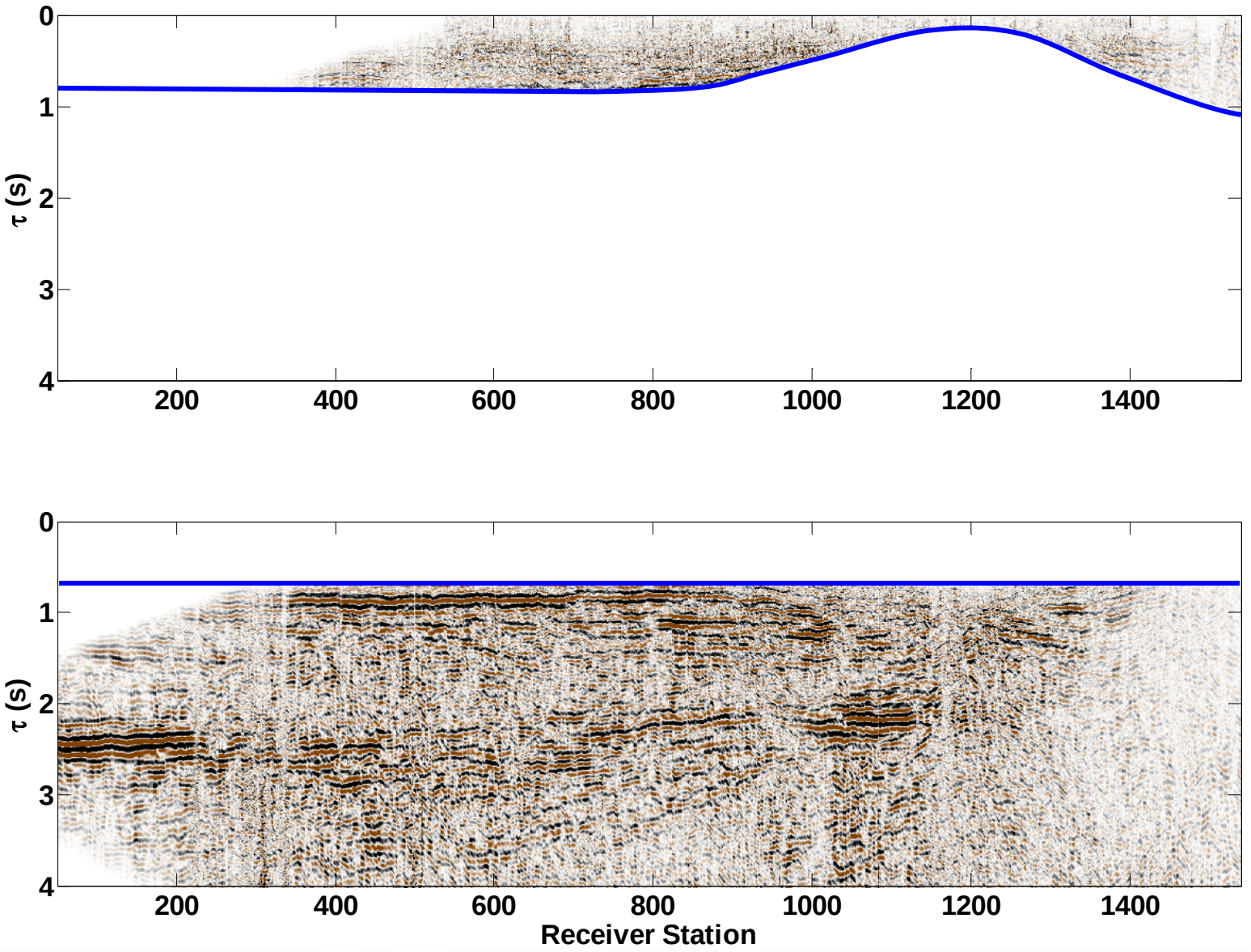
Common Ray-parameter Panel (p=-3x10^{-4} s/m)



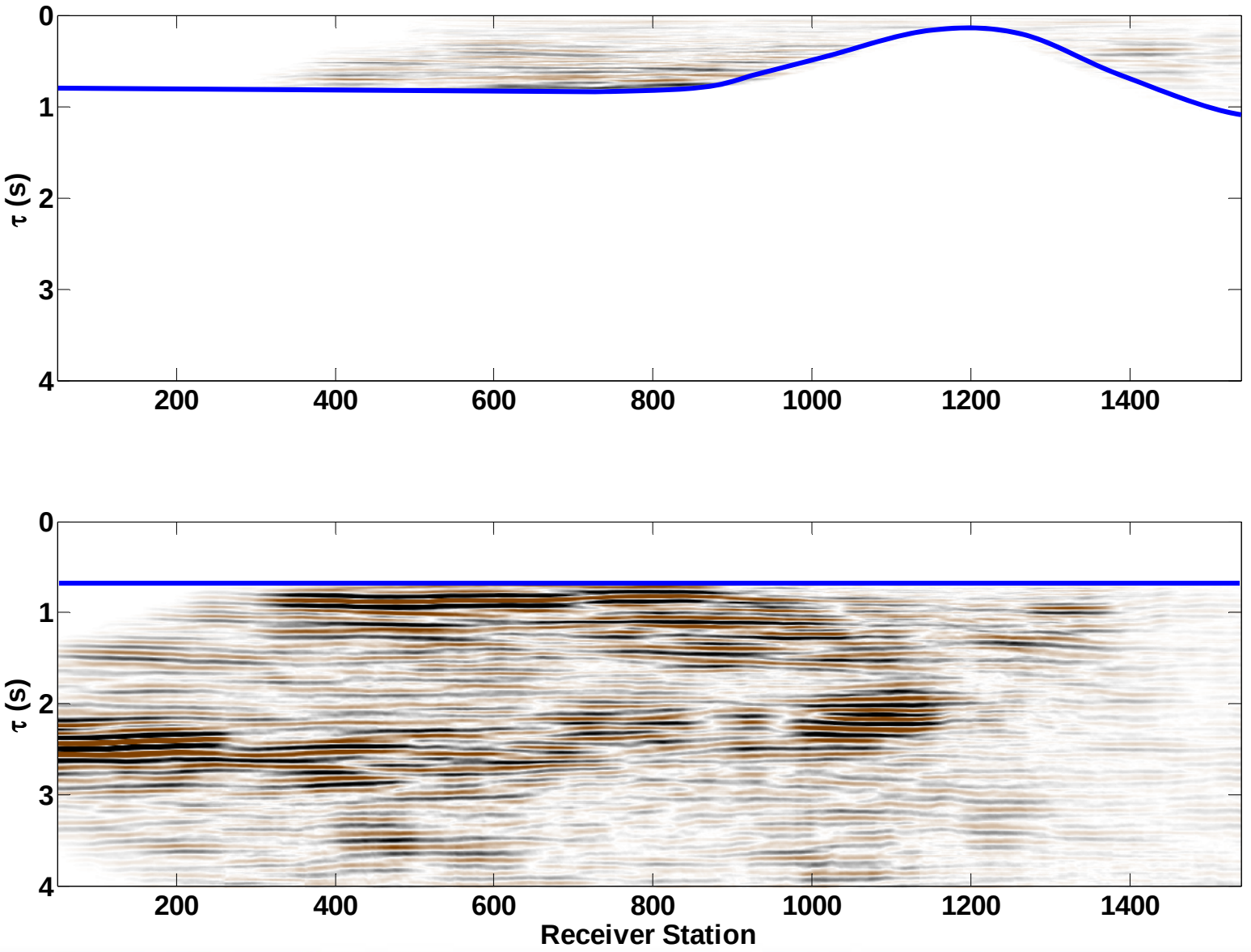
CRP Pilot Panel Computation



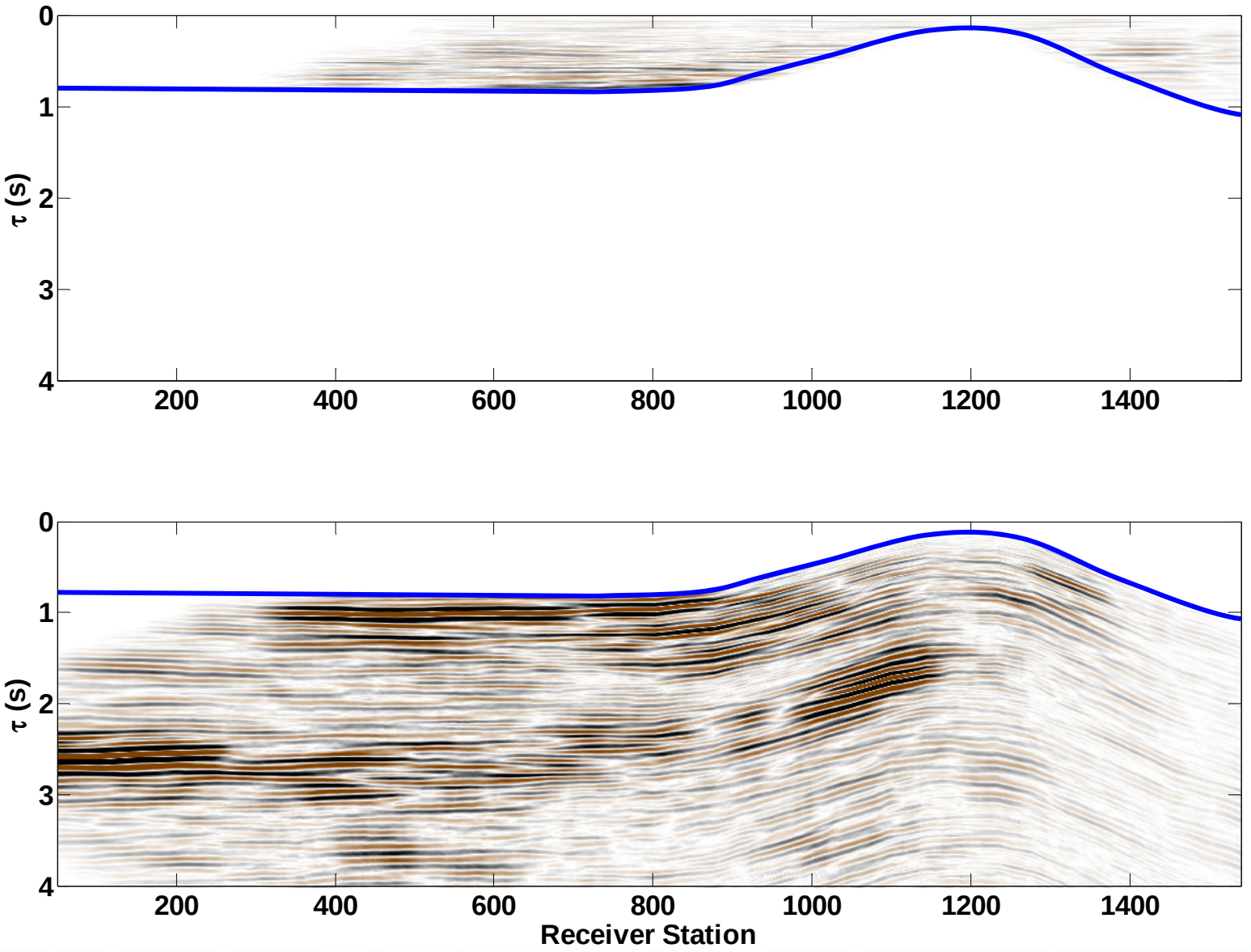
CRP Pilot Panel Computation



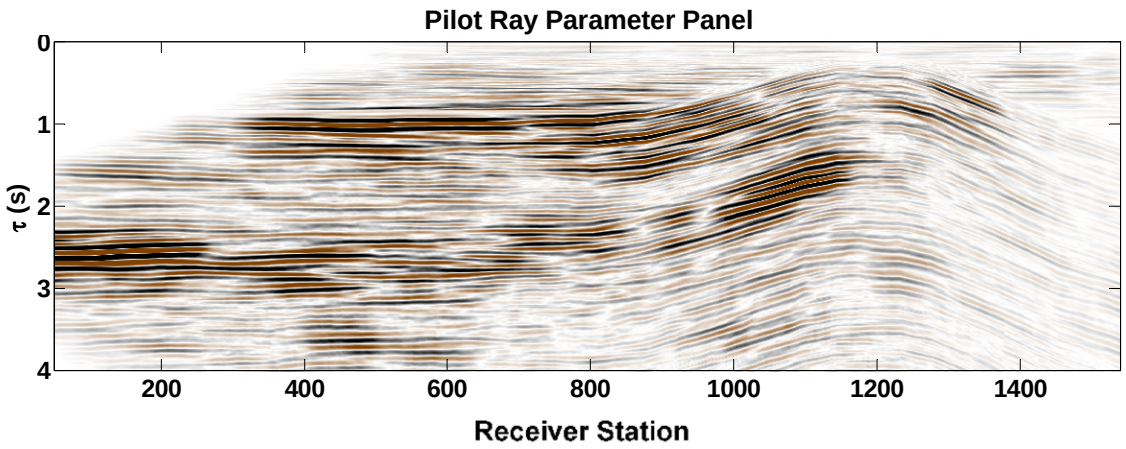
CRP Pilot Panel Computation

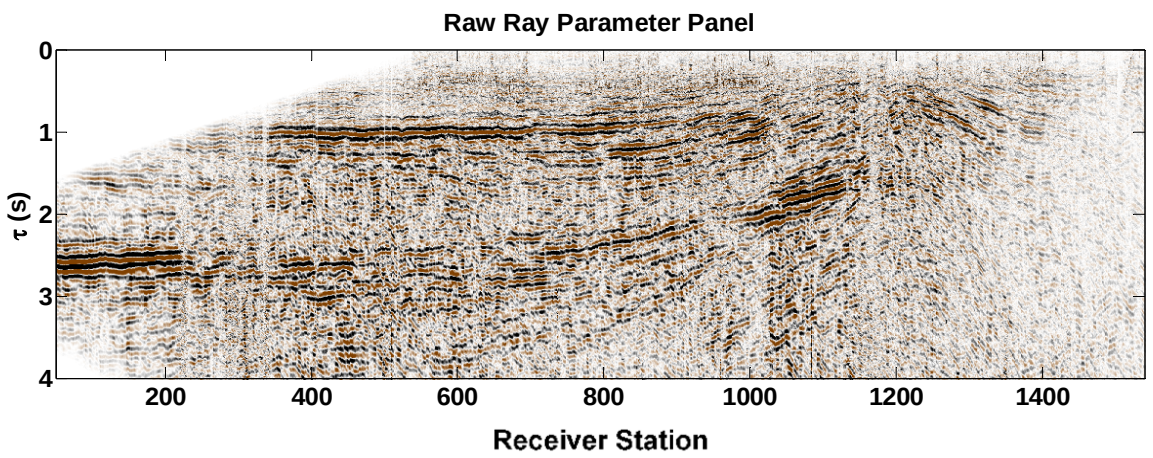


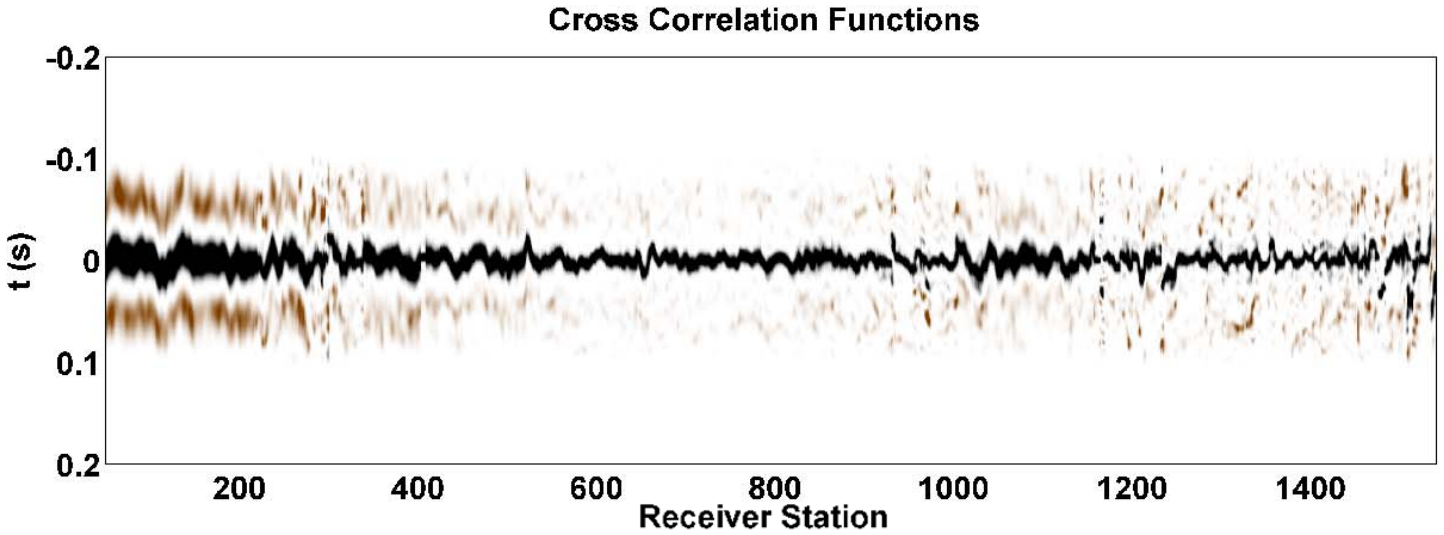
CRP Pilot Panel Computation



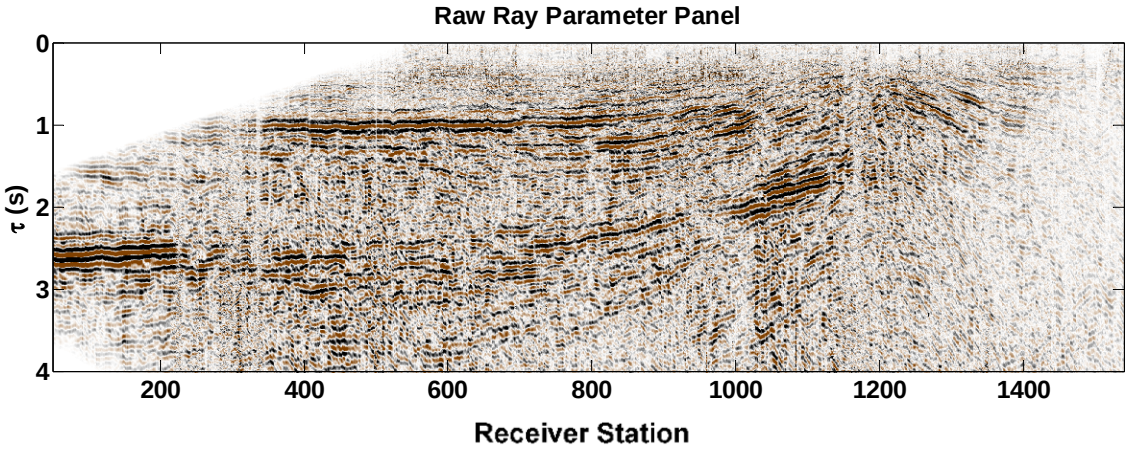
Computing Cross correlation Functions







Removing the Near-surface Effects by Convolution



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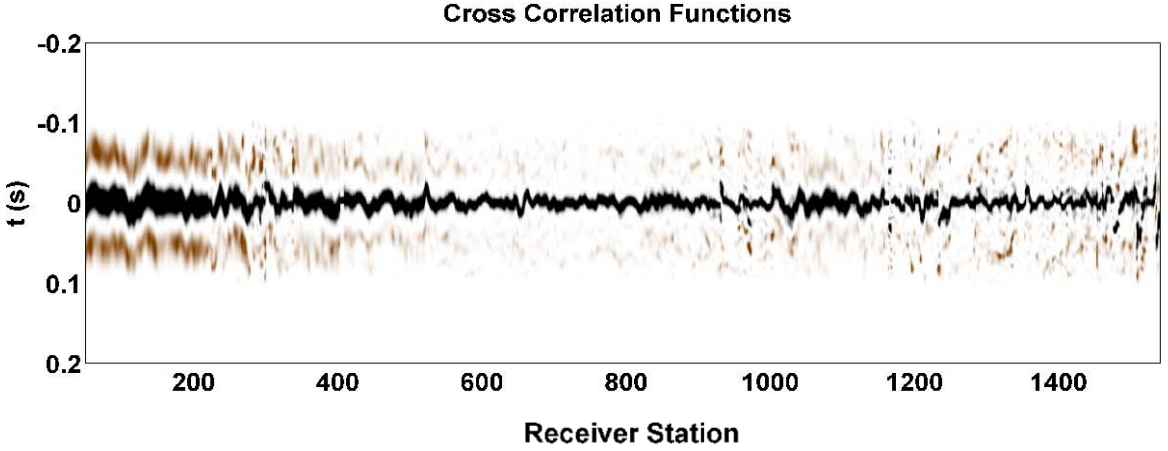
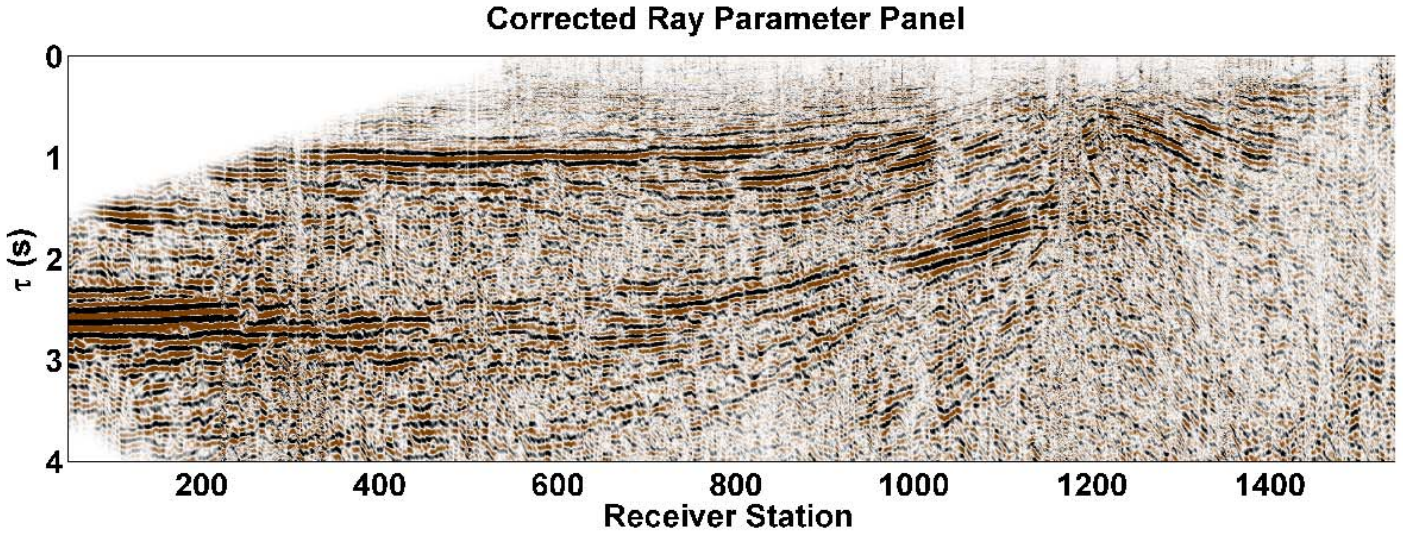
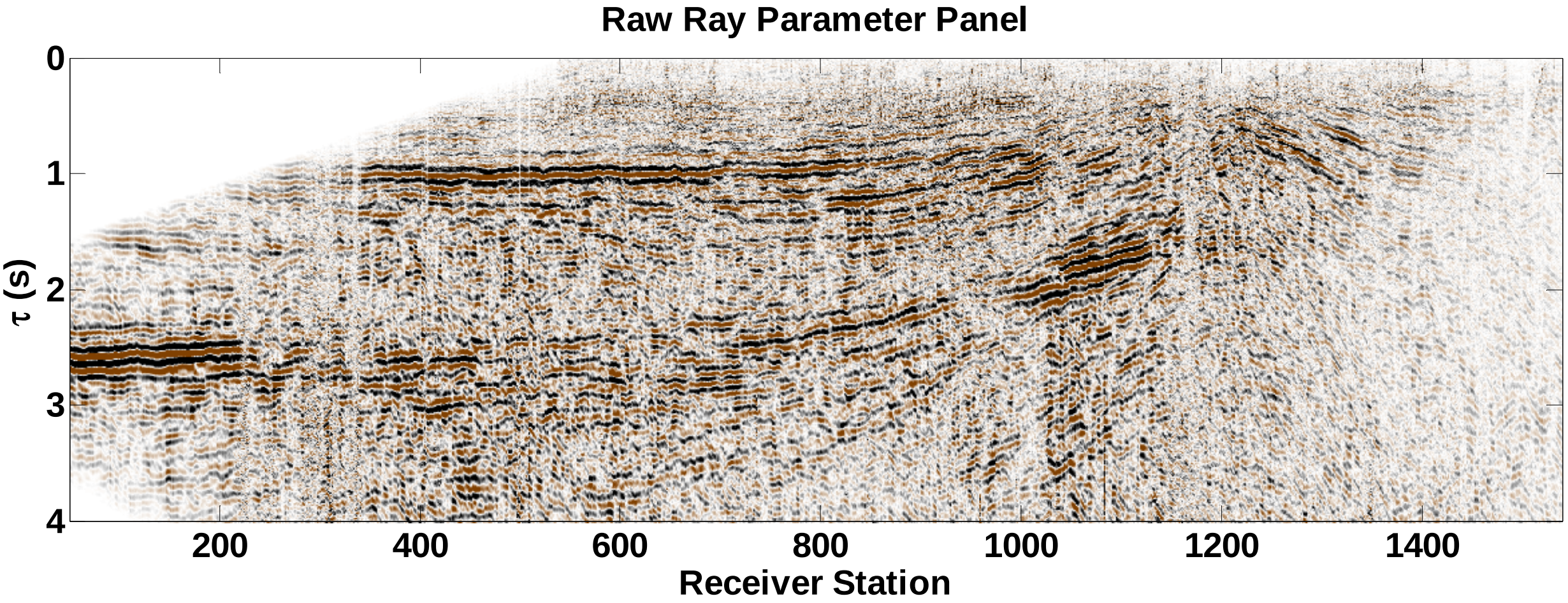
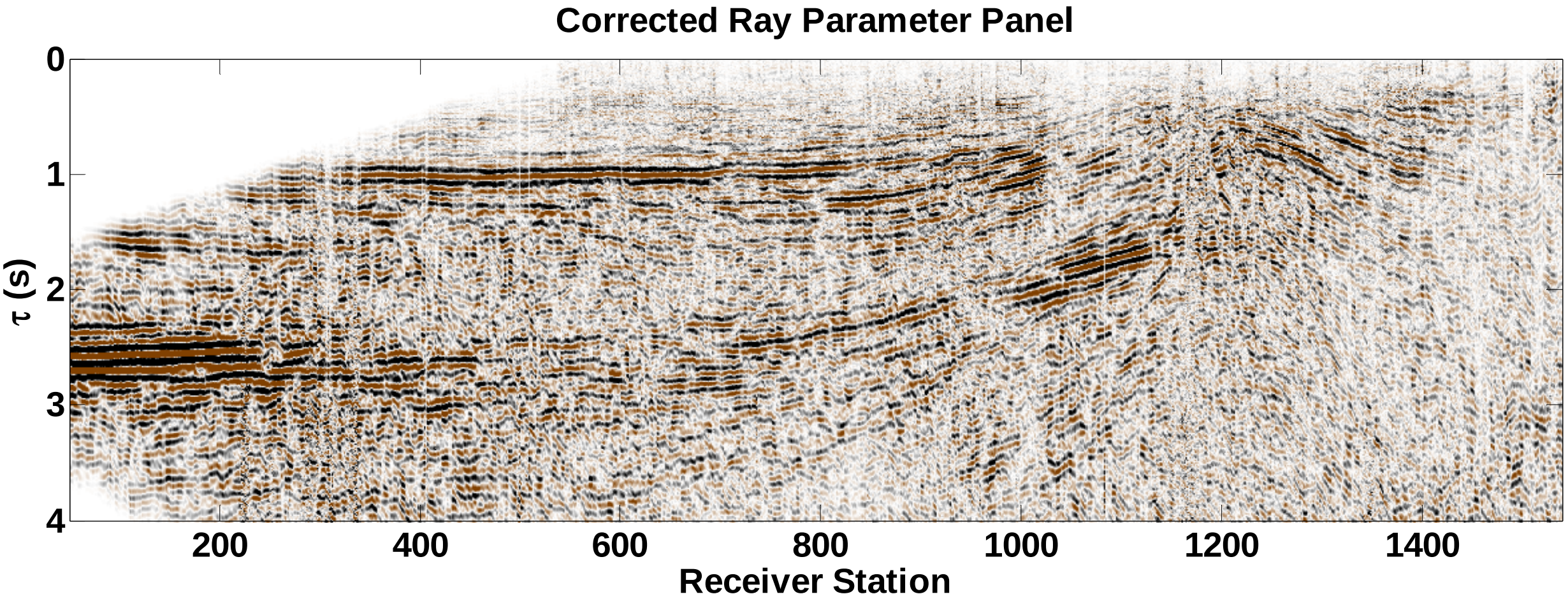




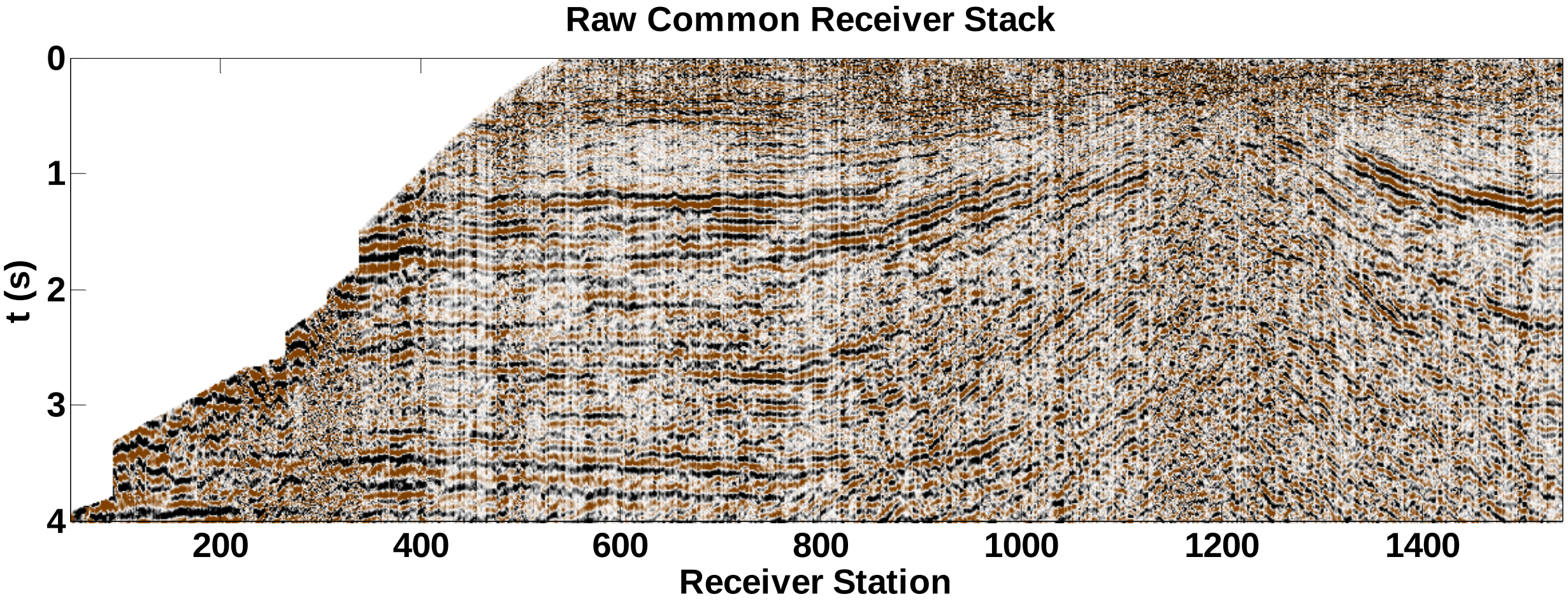
Raw Common Ray-parameter Panel



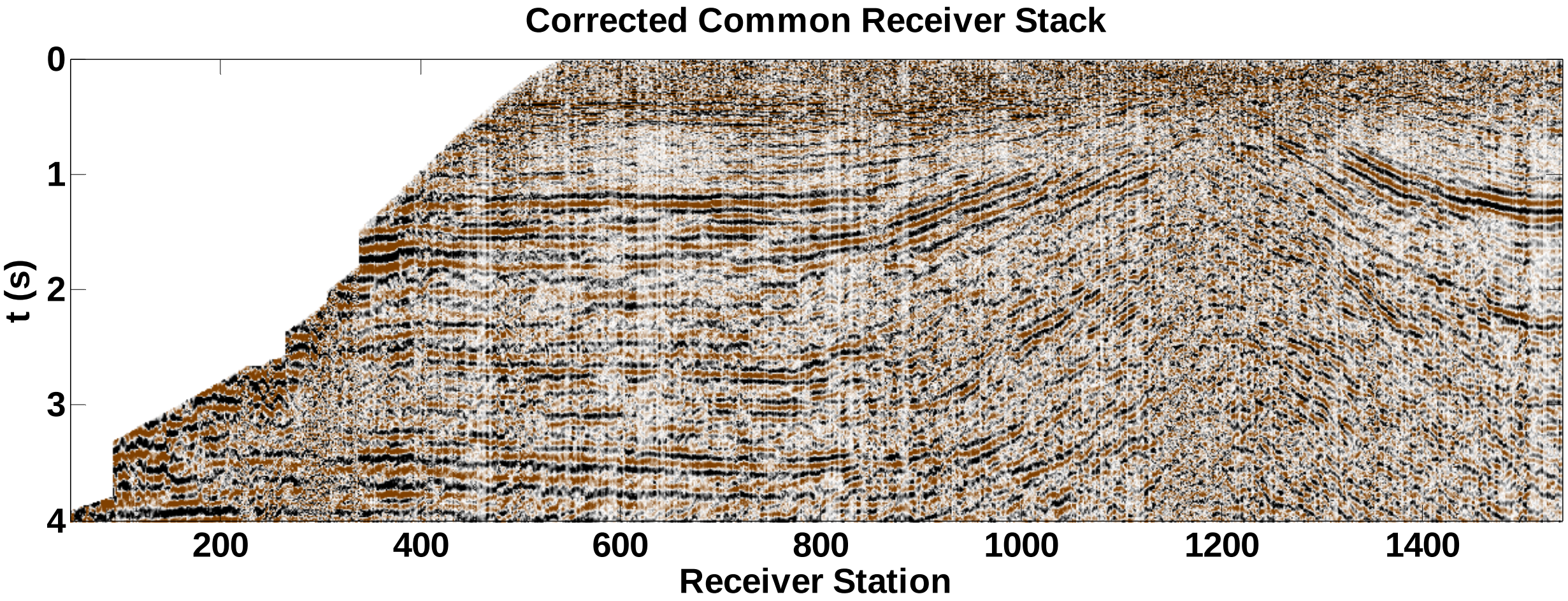
Processed Common Ray-parameter Panel



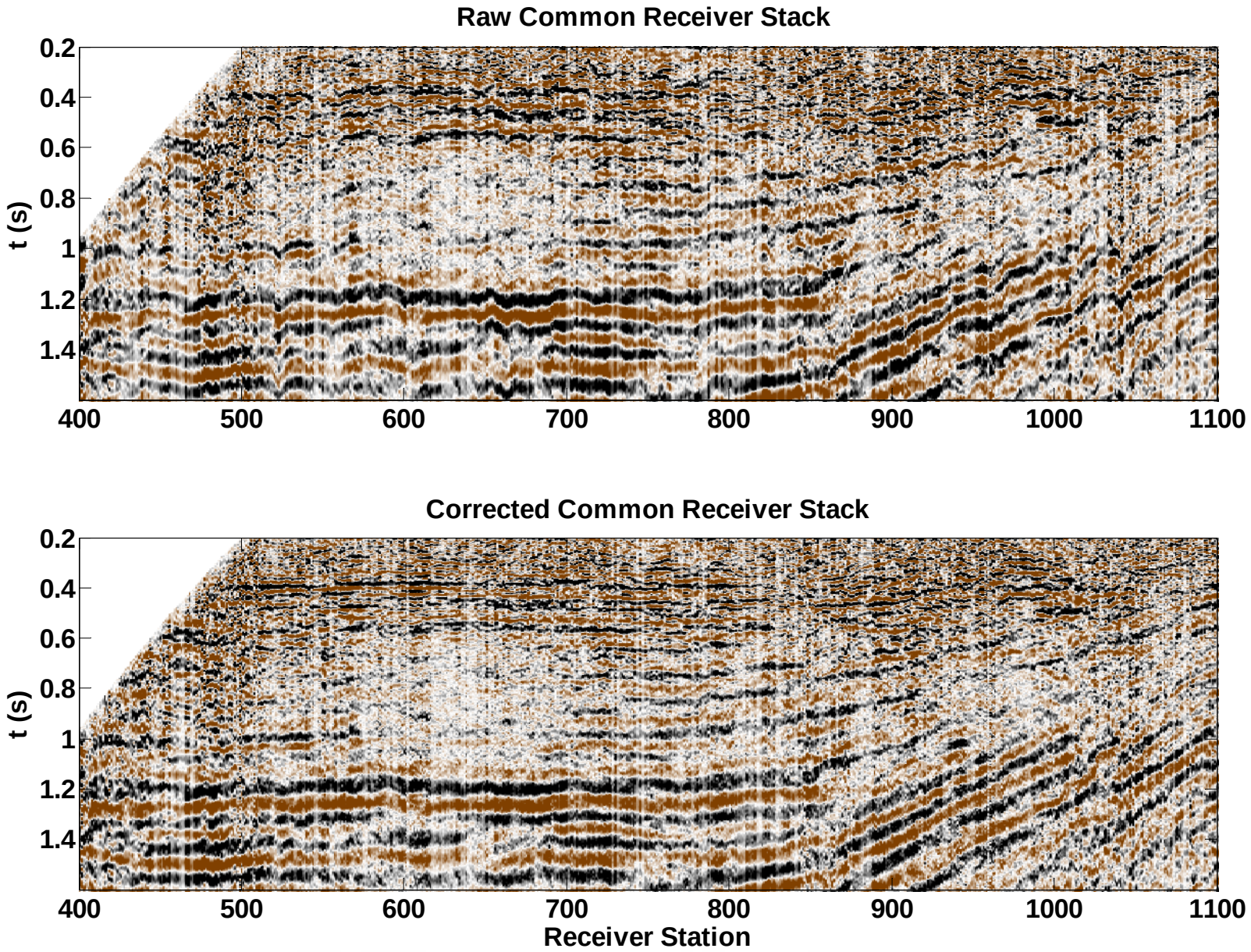
Common Receiver Stack Before Near-Surface Corrections



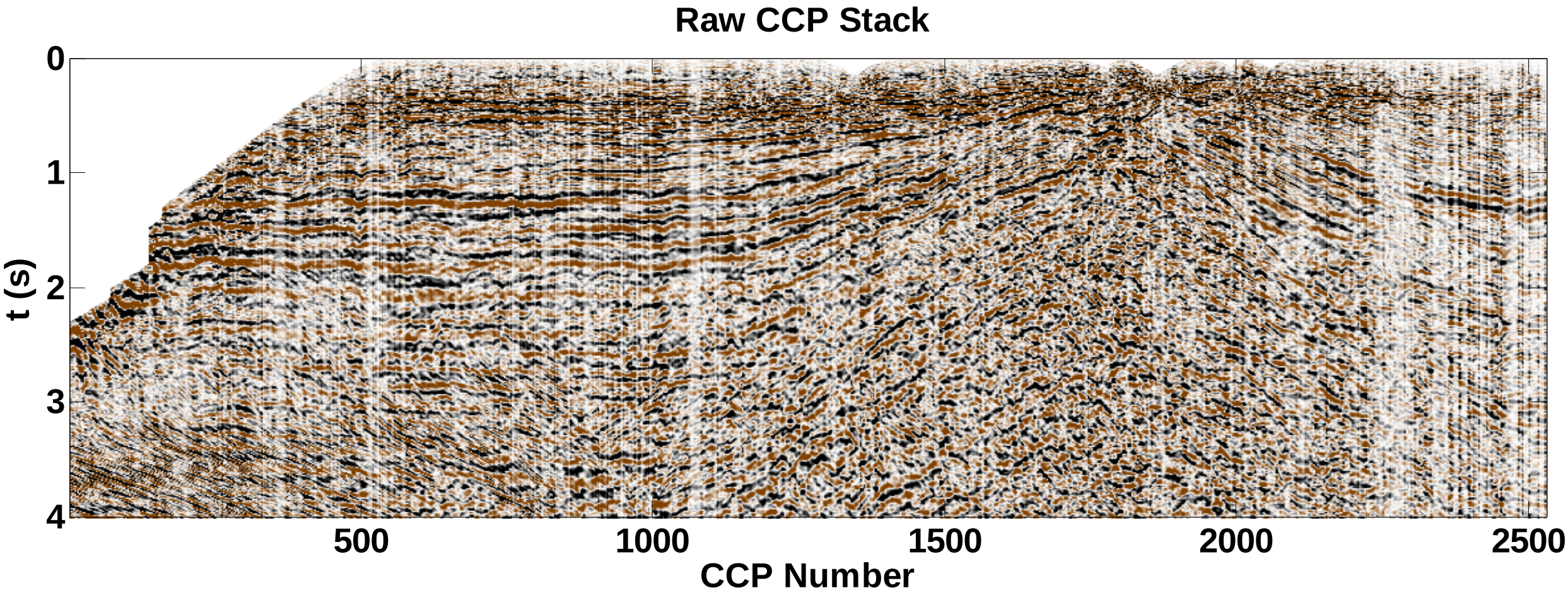
Common Receiver Stack After Near-Surface Corrections



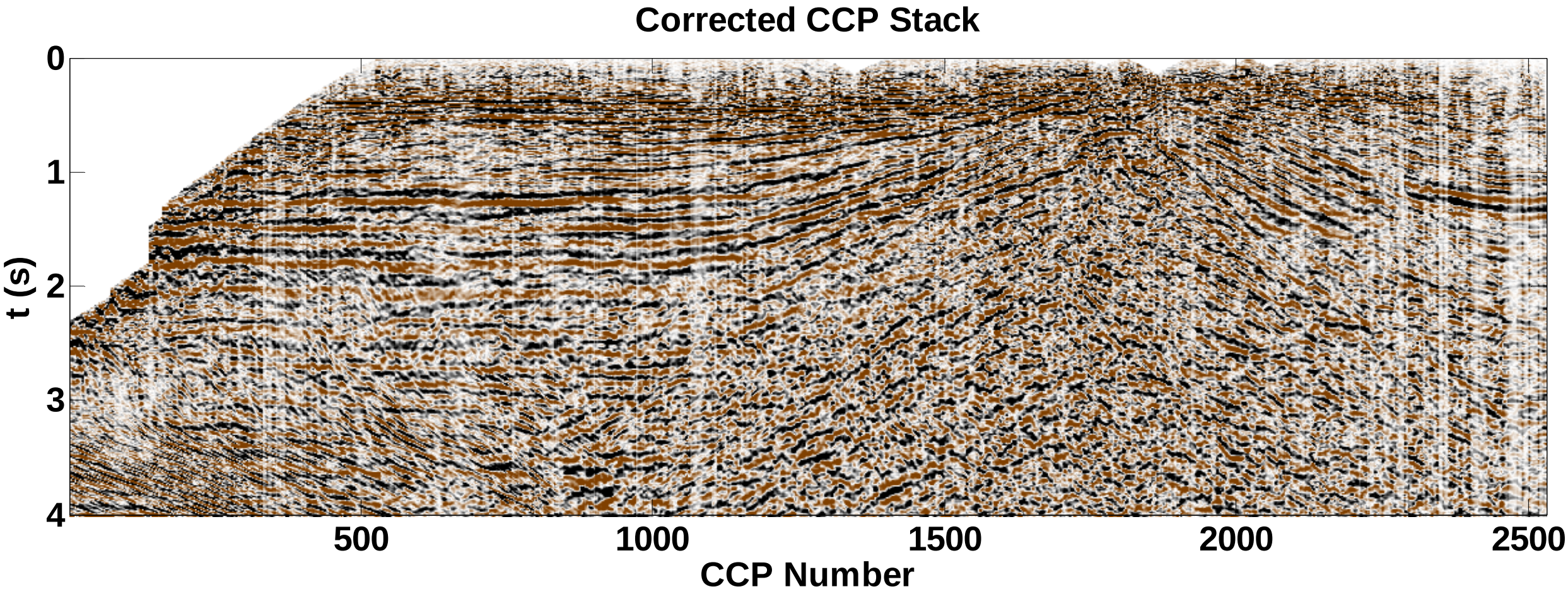
Common Receiver Stacks



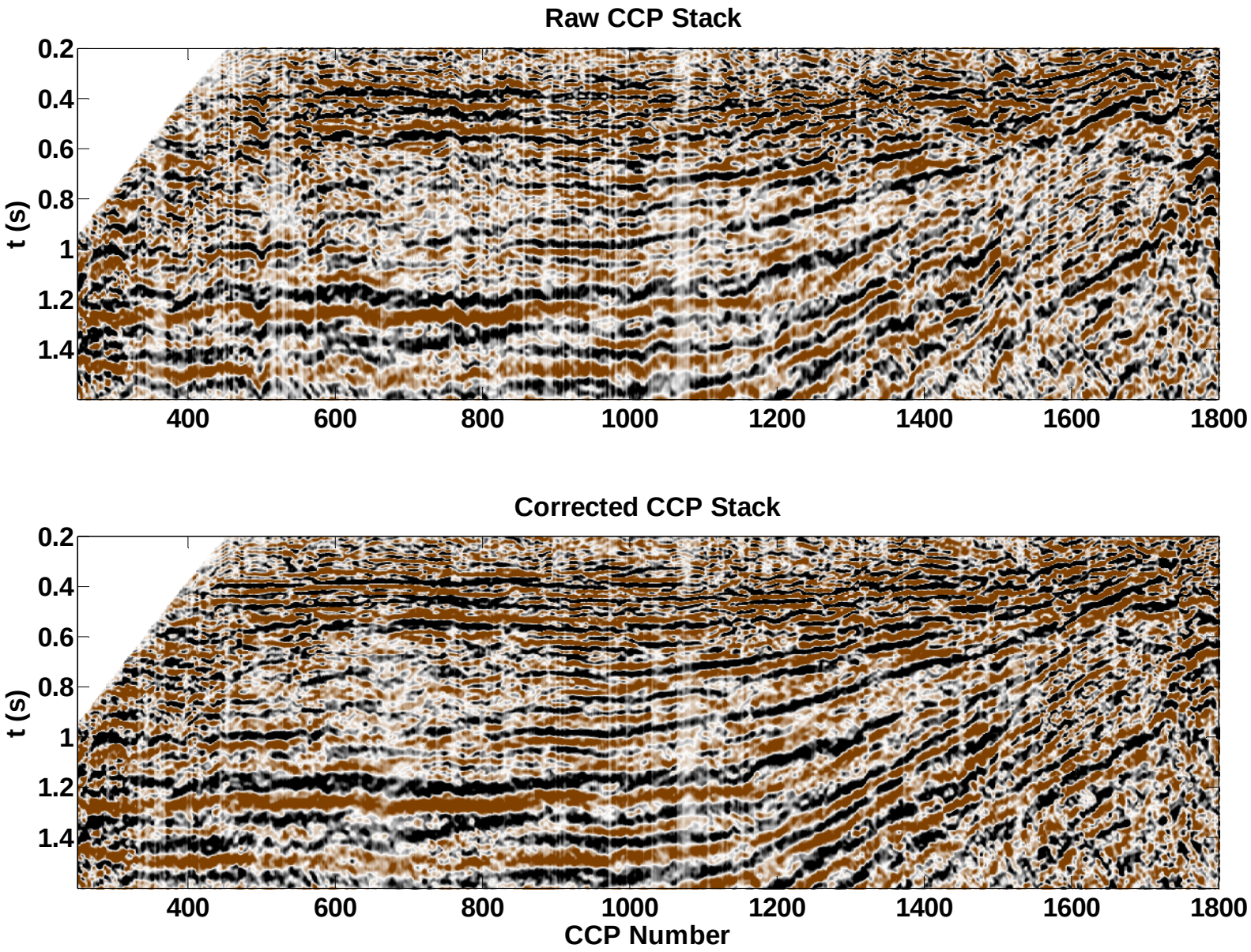
Common Conversion Point Stack Before Near-Surface Corrections



Common Conversion Point Stack After Near-Surface Corrections



Common Conversion Point Stacks



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Conclusions

- Changing the polarity of the receivers in one end of the spread does not consider the fact that some receivers may be outside of the plane defined by the survey.
- A full 2D rotation was needed to properly distribute the recorded amplitudes into the radial and transverse direction.
- In the processing of deep reflection data the assumption of vertical raypath angles may be sufficient for the use of a surface consistent approach.
- However, the very low velocity of S-waves and the ability of shallow events to reach wider reflection angles requires a ray-path dependent framework.
- Processing the statics in a raypath-consistent framework enabled us to remove near-surface effects for shallow and deep events simultaneously.

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Acknowledgements

- SINOPEC
- David Henley
- NSERC (Grant CRDPJ 461179-13)
- CREWES sponsors
- CREWES faculty, staff and students.

Thanks!!!