Ambient noise tomography of Southern California

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[1]University of Toronto

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[3]Macquarie University

May 20, 2013

Outline

Introduction

- Area of interest: southern California;
- previous study: Tape et al. (2009),Tape et al. (2010)
- what else can be done to improve the knowledge of this area?

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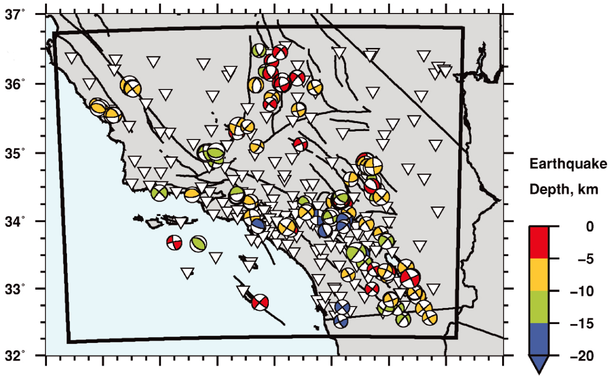

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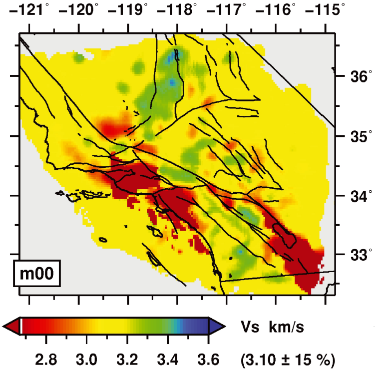

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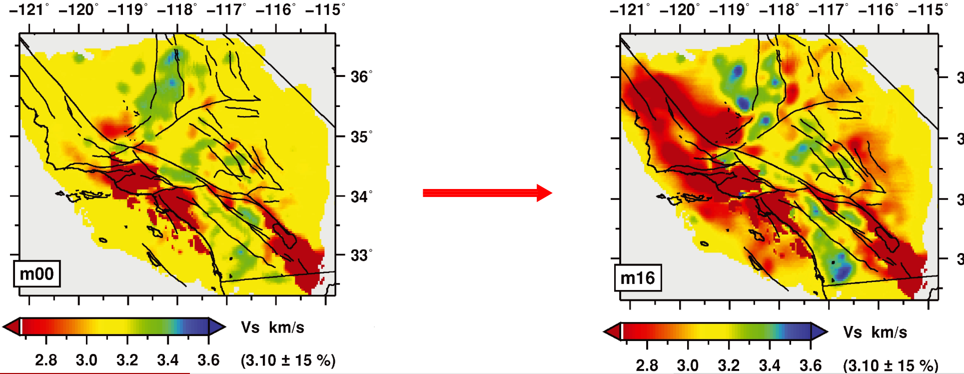

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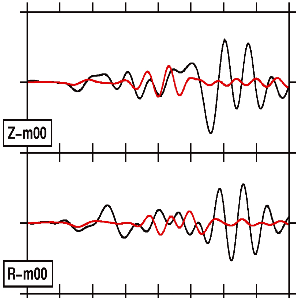

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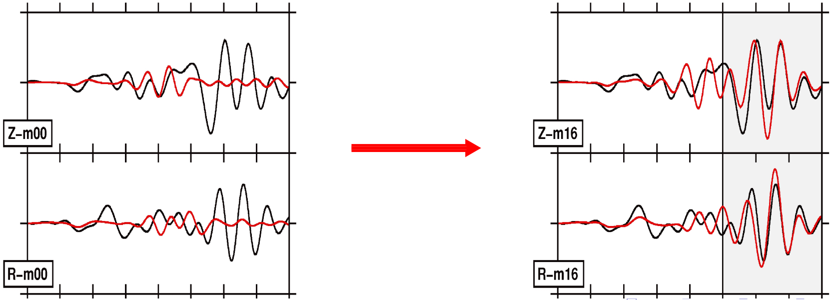

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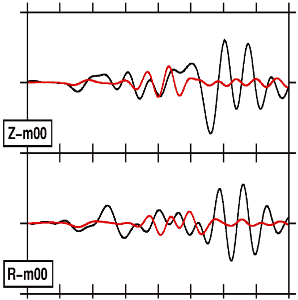

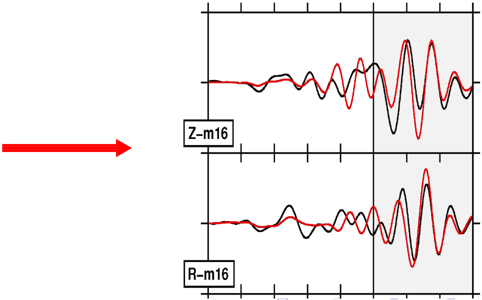

Why ambient noise?

- The cross-correlation of two diffuse wavefields recorded at two different seismic stations contains coherent signals that travel between the two stations;
- from this signal it is possible to extract the Greens function associated with the two receivers;
- thanks to the dense instrumental coverage in southern California, we have at our disposal a high number ($\sim$ 13000 Vertical-Vertical) of NCFs for 147 seismic stations;
- given the penetrating power of the ambient noise we will be able to obtain high imaging resolution, especially between 10 and 50 km depth.

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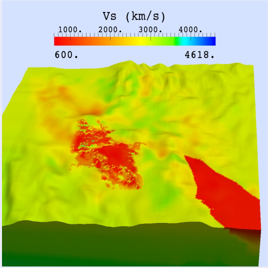

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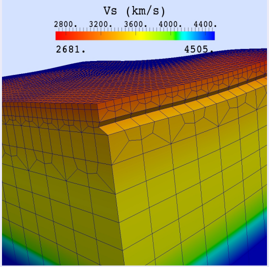

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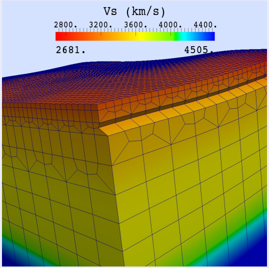

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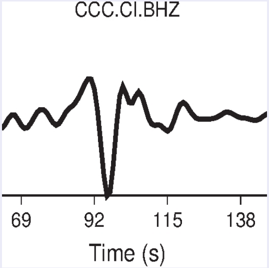

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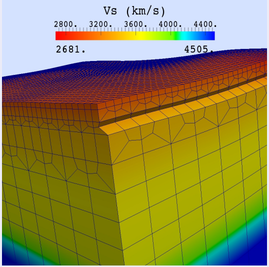

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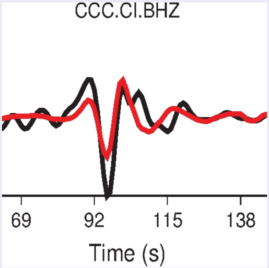

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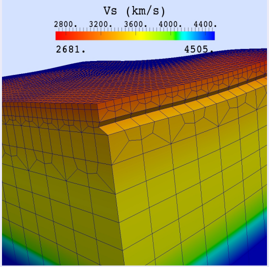

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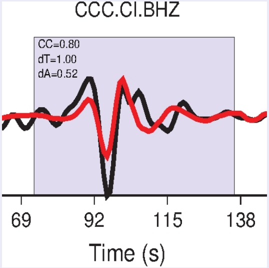

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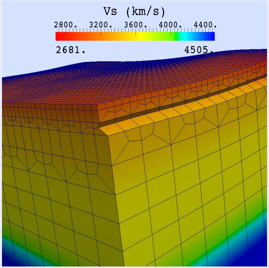

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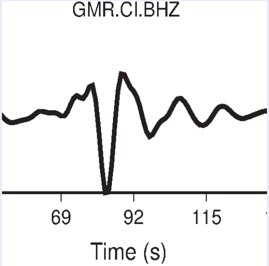

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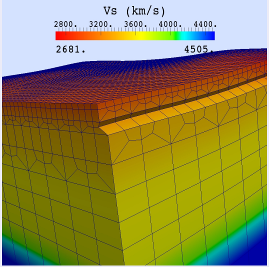

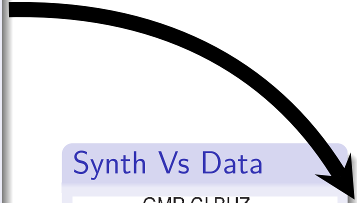

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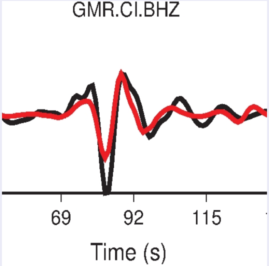

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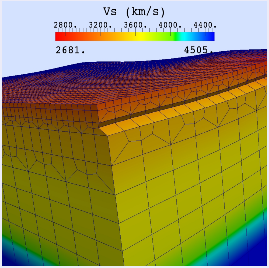

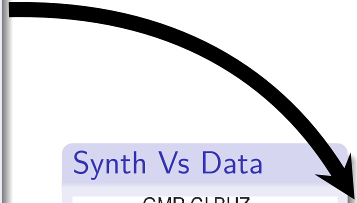

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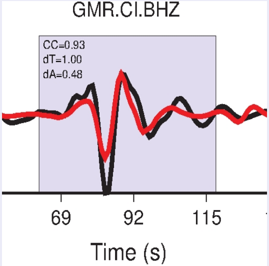

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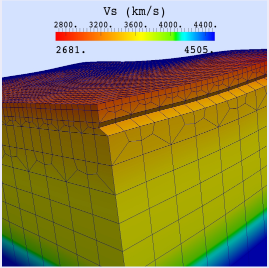

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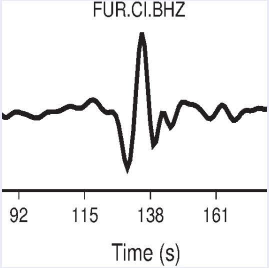

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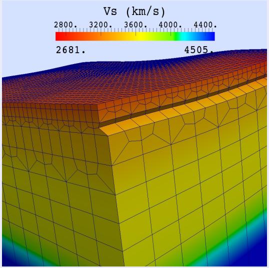

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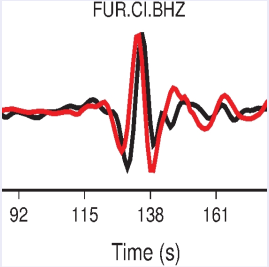

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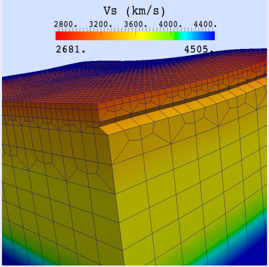

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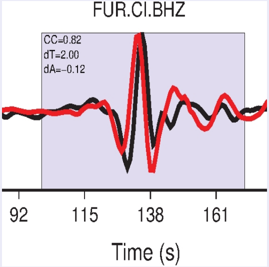

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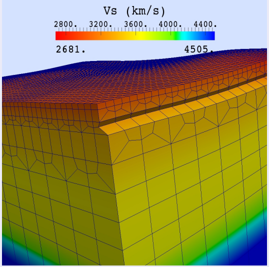
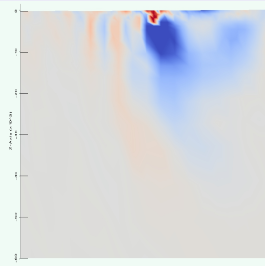


Kernels 5-50 s



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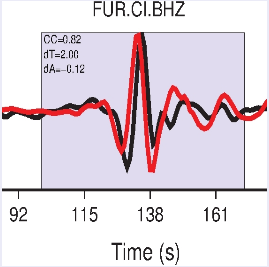

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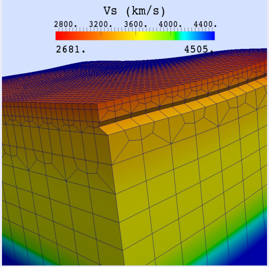
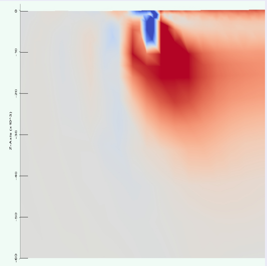


Kernels 10-50 s



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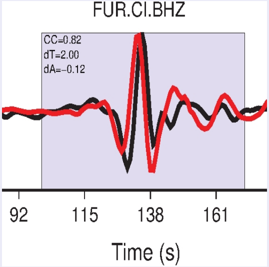

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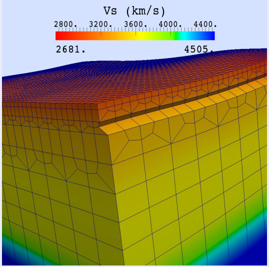
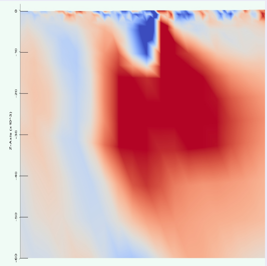


Kernels 20-50 s



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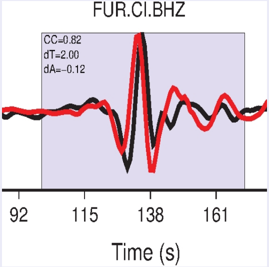

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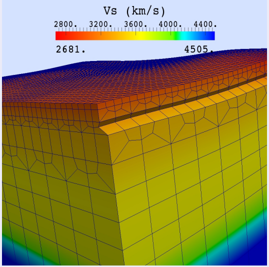

Subspace Method

$$\delta\phi_i = \int K_S^i(x)\frac{\delta V_S(x)}{V_S(x)}d^3x$$

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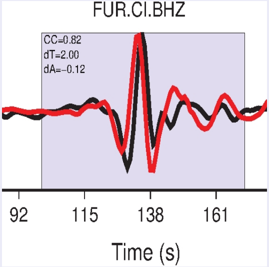

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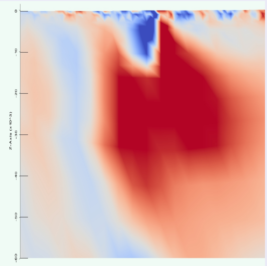

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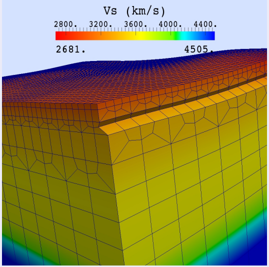

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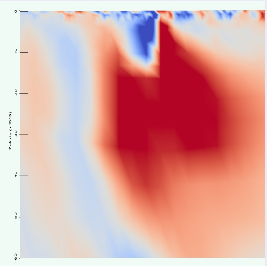

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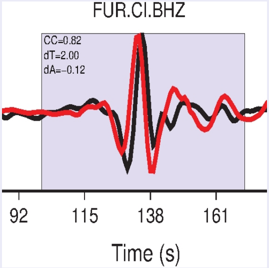

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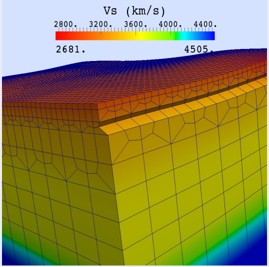

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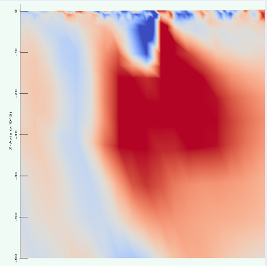

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$$C = N^{-1}\phi$$

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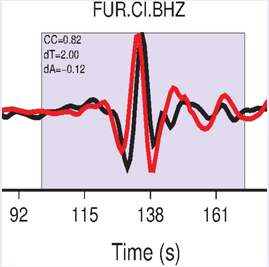

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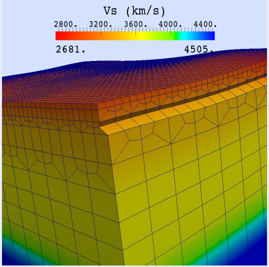

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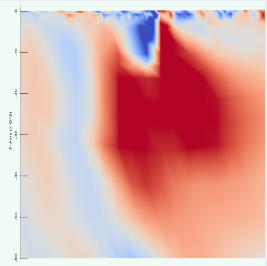

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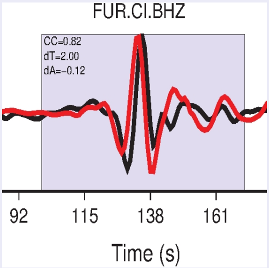

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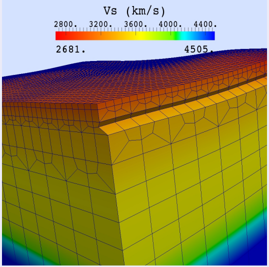

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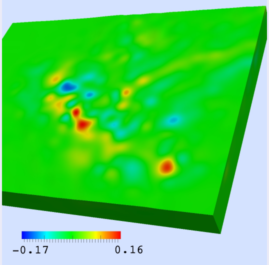

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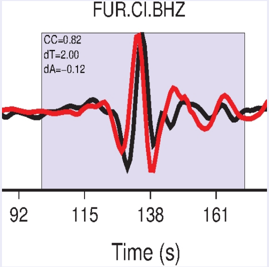

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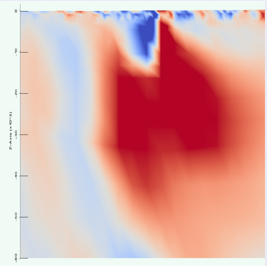

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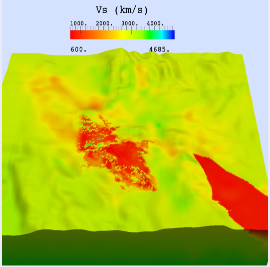

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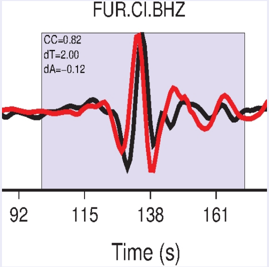

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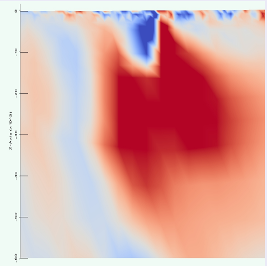

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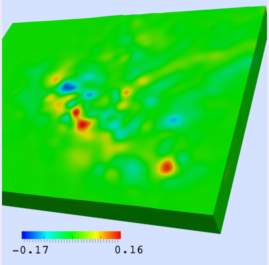

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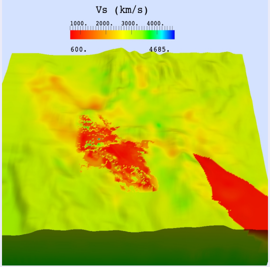

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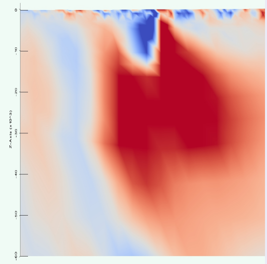

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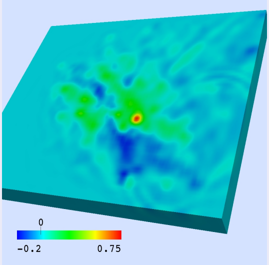

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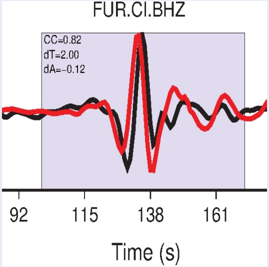
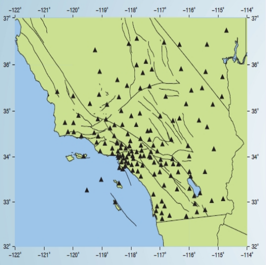
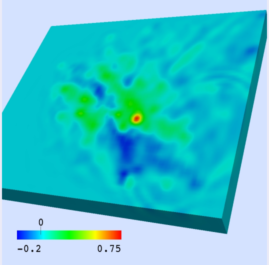


Computational Procedure

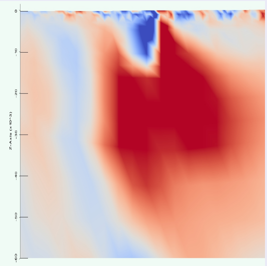
Study area: stations



Subspace Method



Kernels



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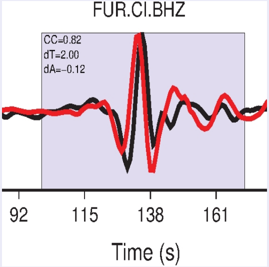

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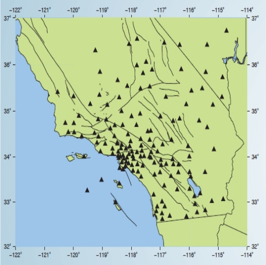

Subspace Method

$$\delta\phi_i = \int K_S^i(x)\frac{\delta V_S(x)}{V_S(x)}d^3x$$

$$\frac{\delta V_S(x)}{V_S(x)} = \sum_j K_S^j C_j$$

$$C = N^{-1}\phi$$

$$N_{ij} = \int K_S^j K_S^i d^3x$$

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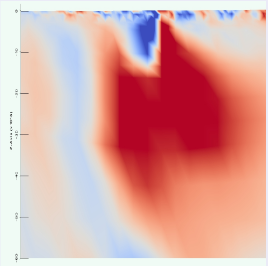

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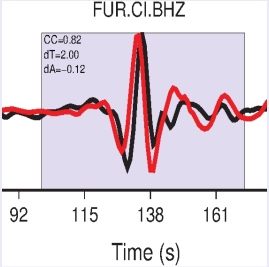

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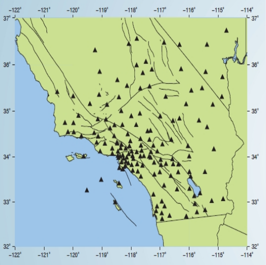

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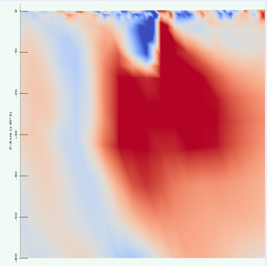

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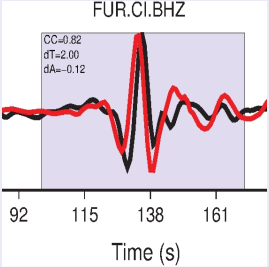

Selection of damping parameter λ

We consider three different bandwidths:

$5 - 50(s)$

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10^{-4} $\quad$ 10^{-5} $\quad$ 10^{-6} $\quad$ 10^{-7} $\quad$ 10^{-8} $\quad$ 10^{-9} $\quad$ 10^{-10}

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- for each model update we perform the forward simulation for a subset of 20 seismic "master" stations;

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- for each bandwidth we consider 7 different λ and we compute the corresponding model update;
- for each model update we perform the forward simulation for a subset of 20 seismic "master" stations;
- the curve of the misfit will help us in deciding which λ is the most appropriate;

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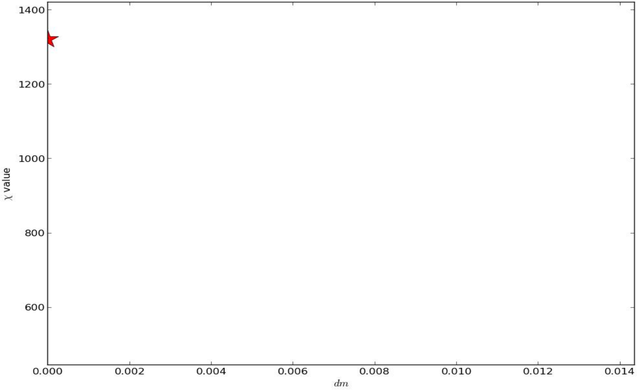

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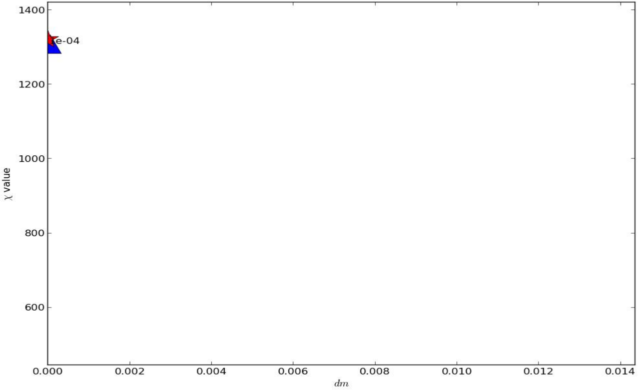

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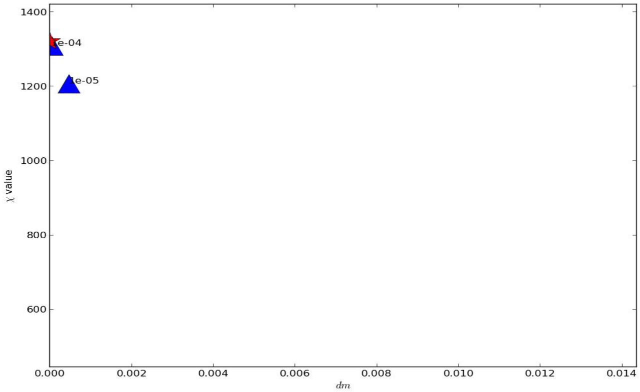

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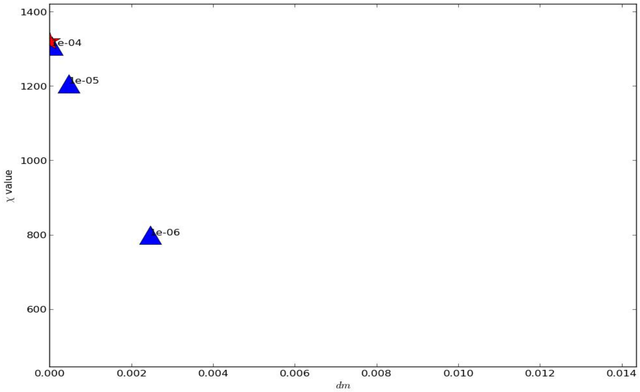

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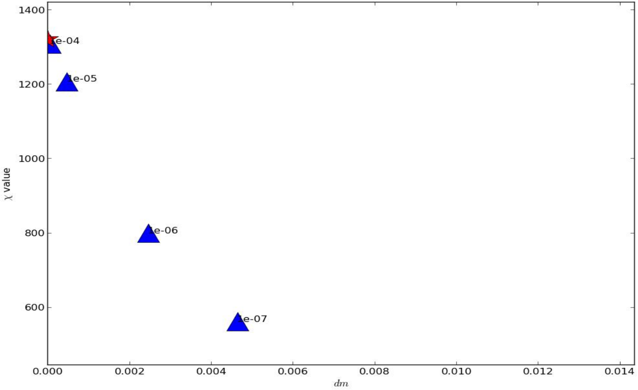

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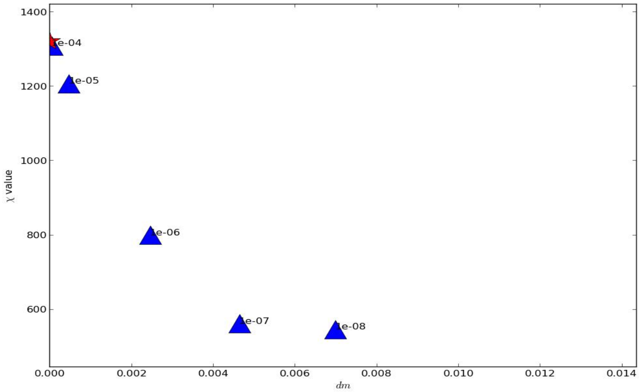

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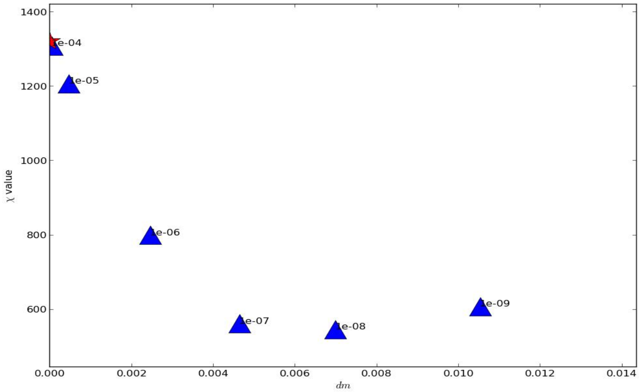

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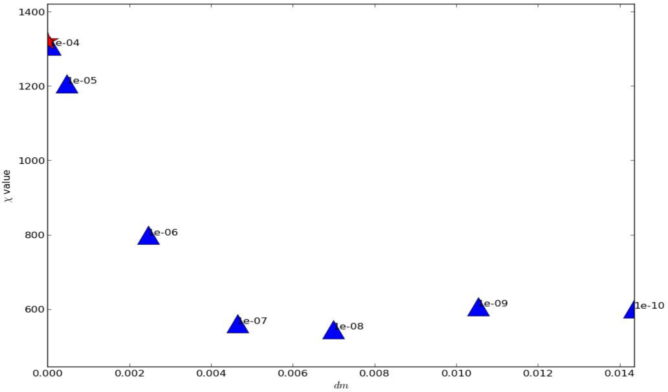

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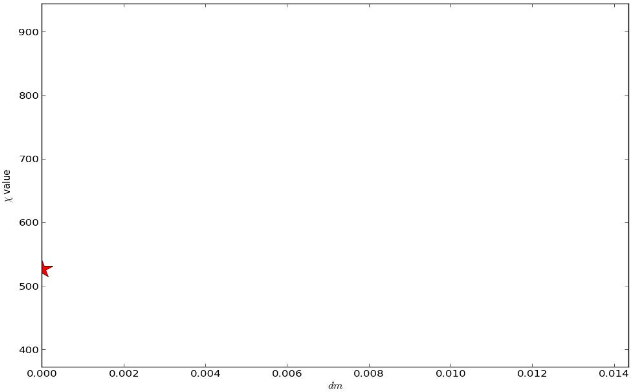

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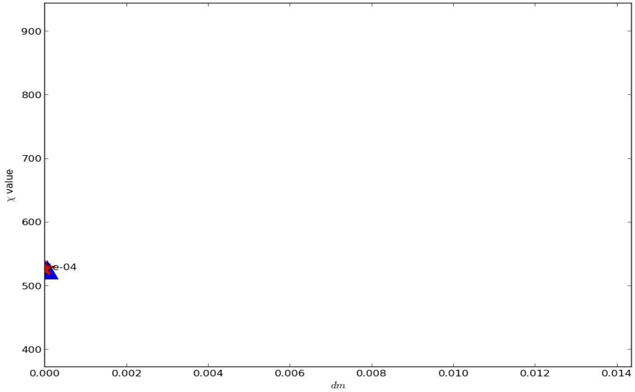

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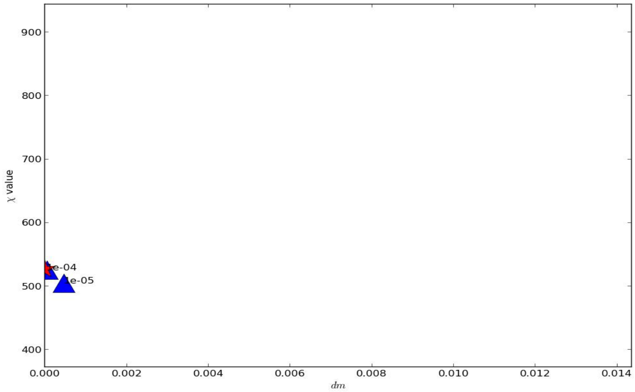

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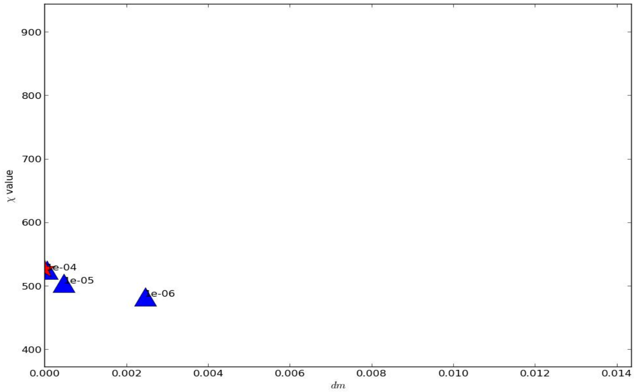

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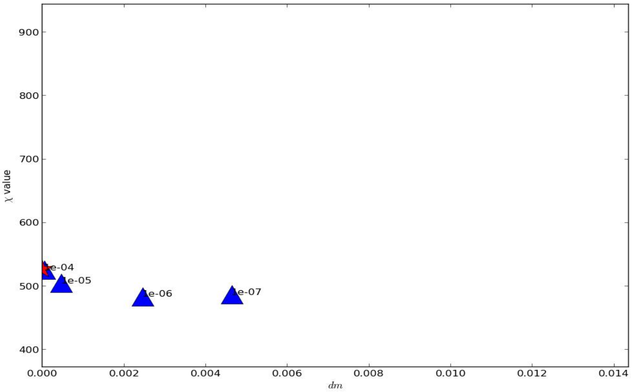

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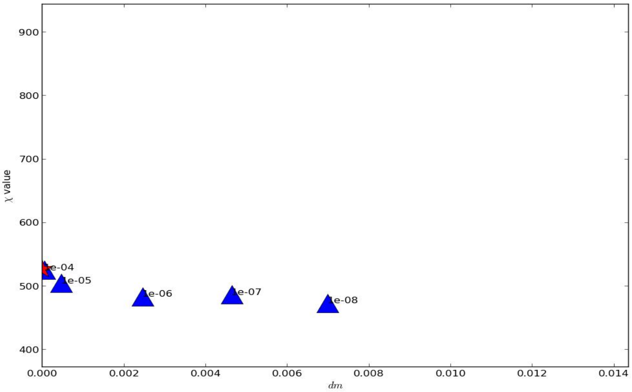

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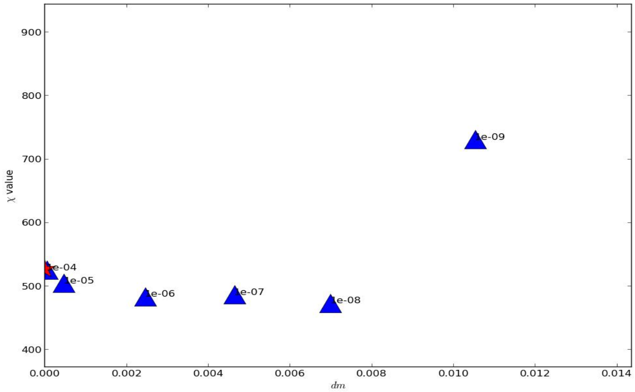

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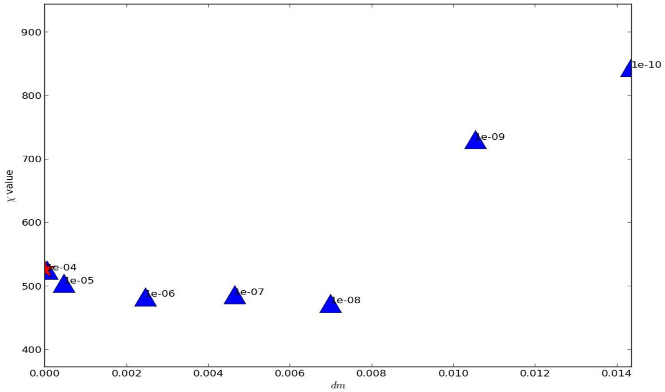

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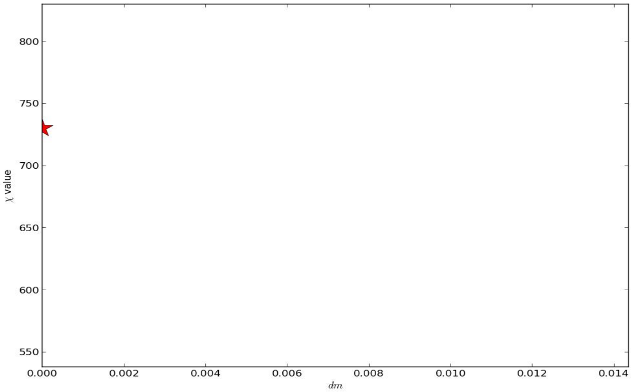

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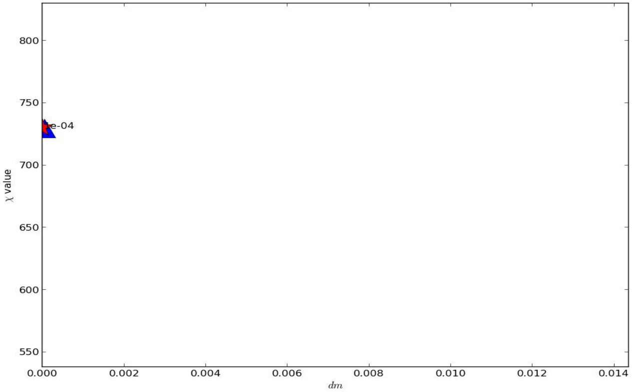

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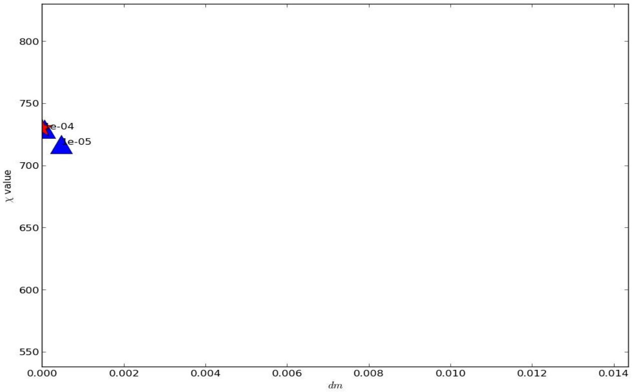

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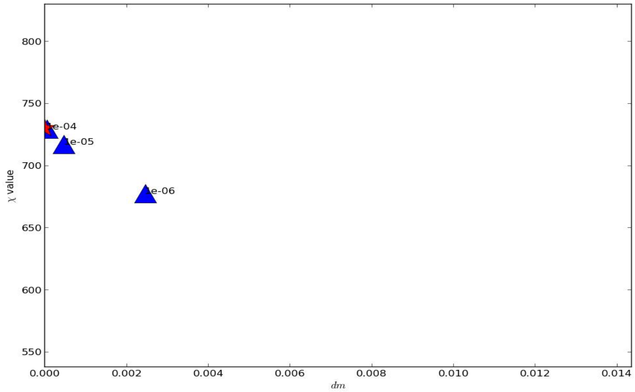

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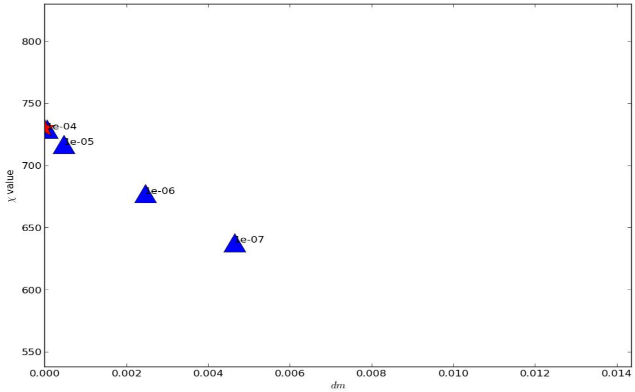

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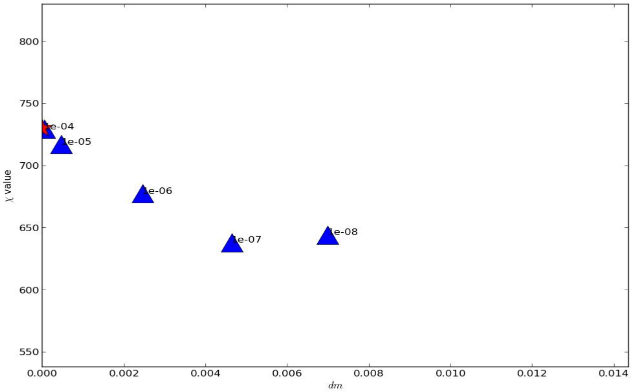

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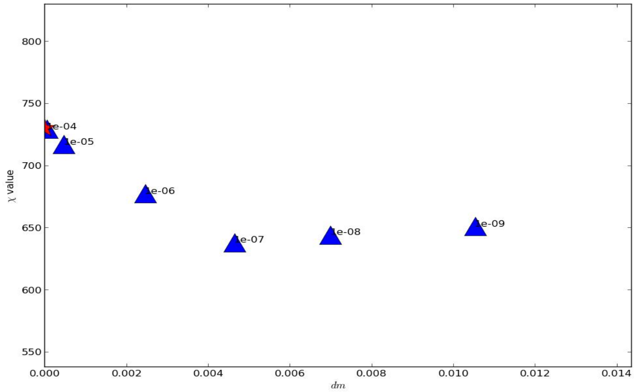

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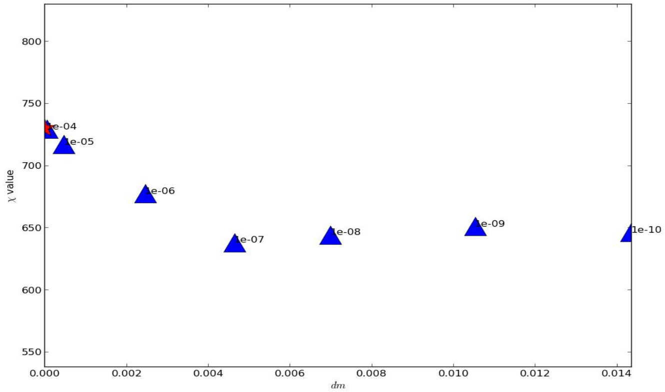

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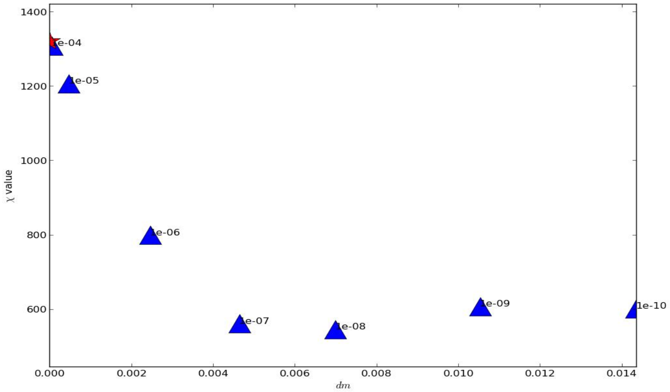
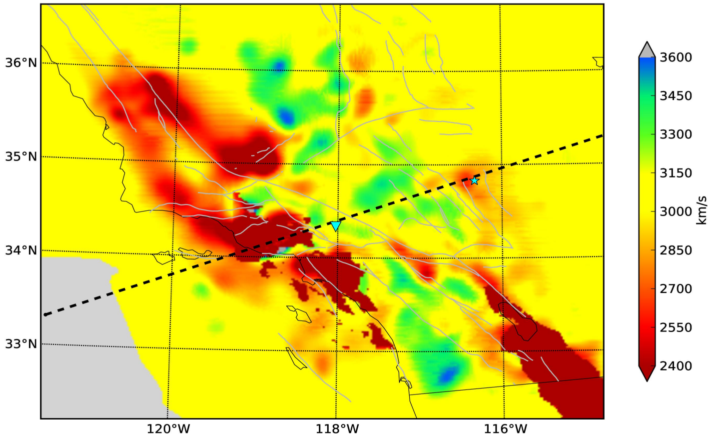


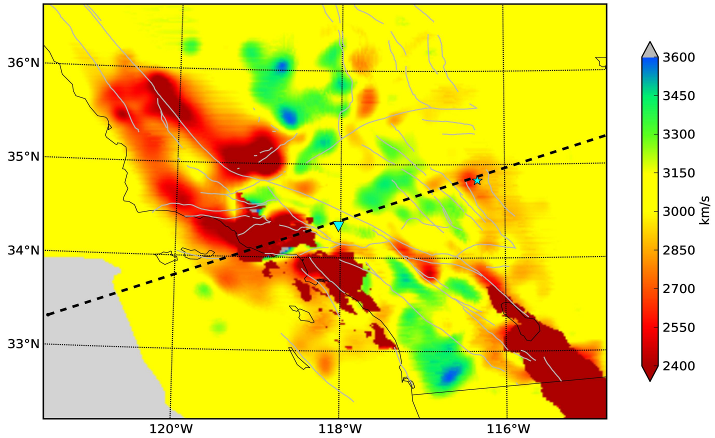
First iteration (m16 - m17) - Horizontal Slices

First we consider an horizontal slice of model m16 taken at 2 km depth.



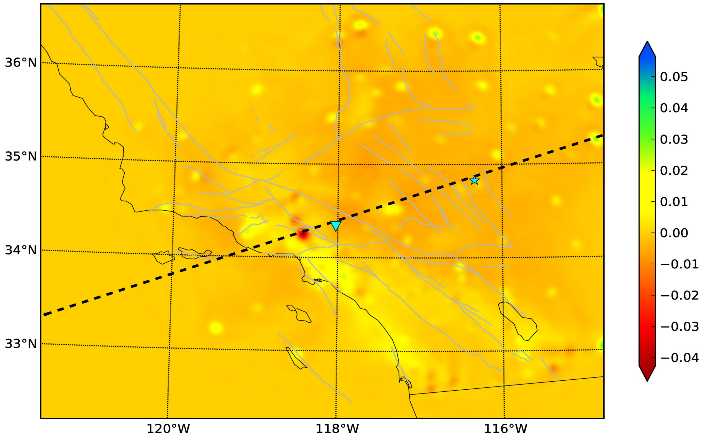
First iteration (m16 - m17) - Horizontal Slices

Model m17 shows no differences at a first glance!



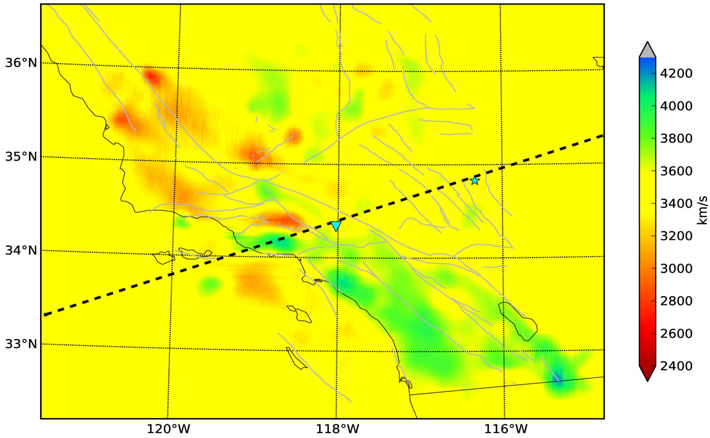
First iteration (m16 - m17) - Horizontal Slices

But if we look at the model update...

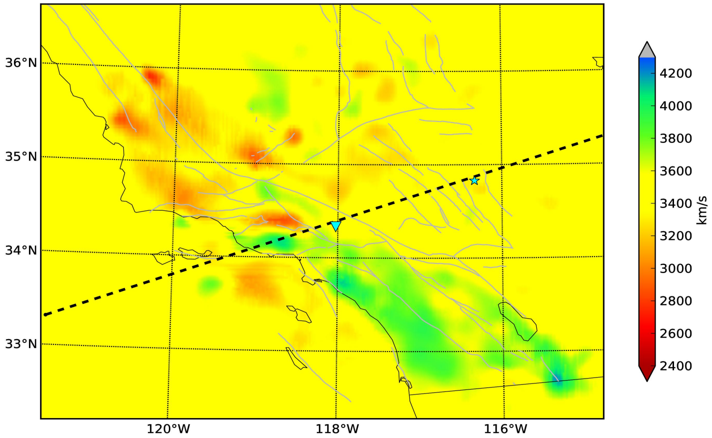


First iteration (m16 - m17) - Horizontal Slices

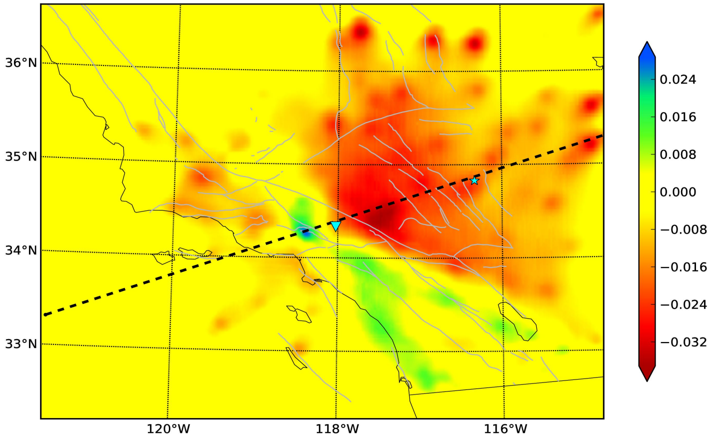
The same behavior can be observed at 10 km depth: this is model m16



The same behavior can be observed at 10 km depth: this is model m17

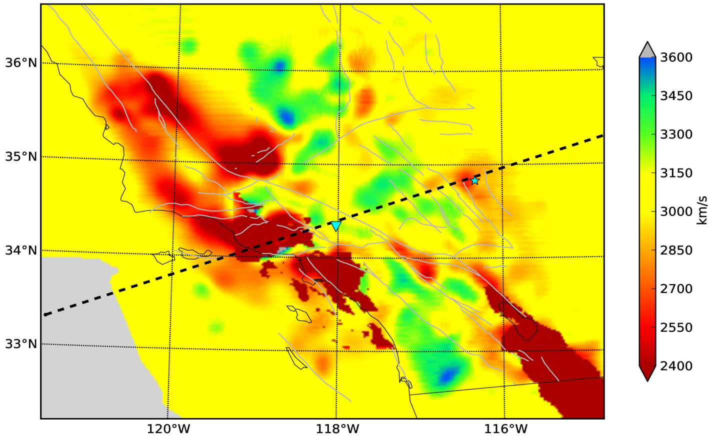


The same behavior can be observed at 10 km depth: this is the update.



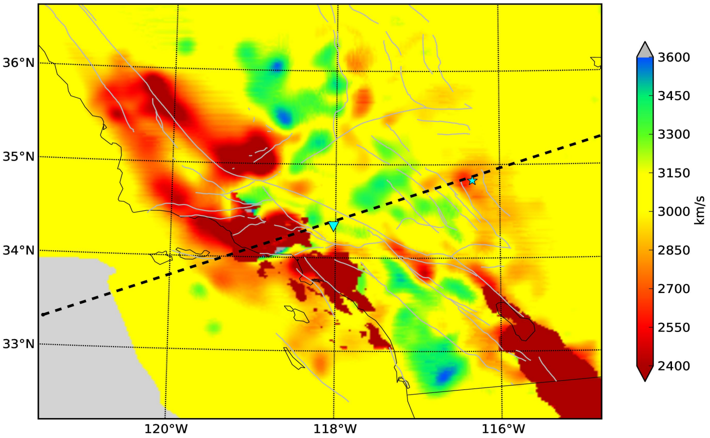
Second iteration (m17 - m18) - Horizontal Slices

Horizontal slice of m17 taken at 2 km depth.



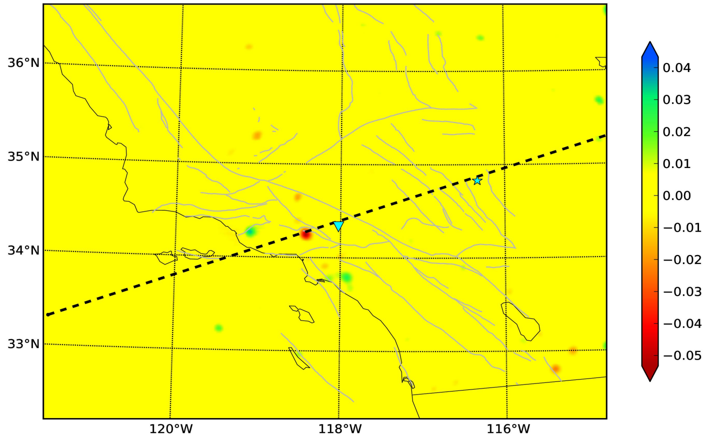
Second iteration (m17 - m18) - Horizontal Slices

Horizontal slice of m18 taken at 2 km depth.



Second iteration (m17 - m18) - Horizontal Slices

Model update...



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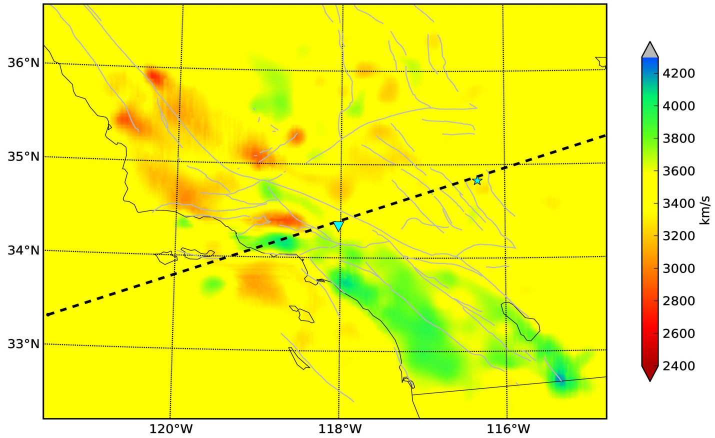

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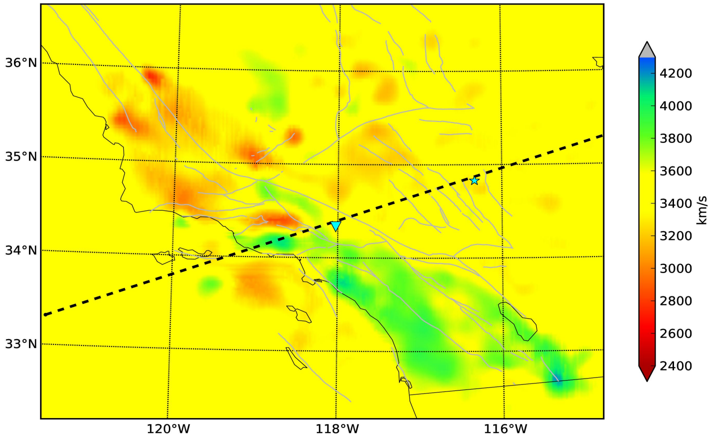

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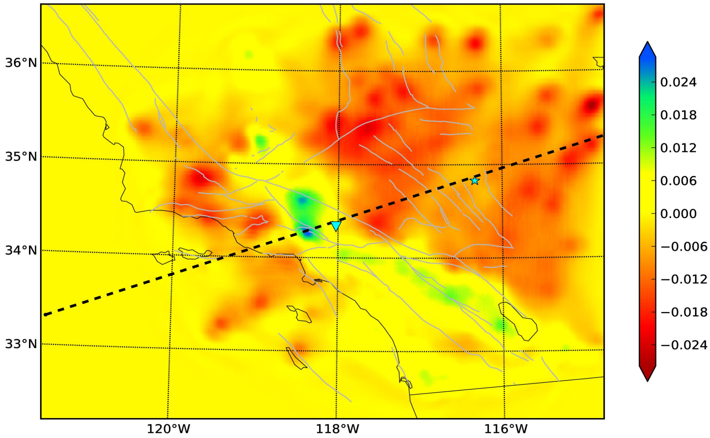

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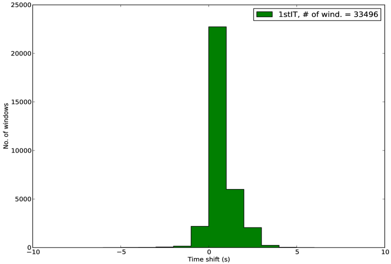

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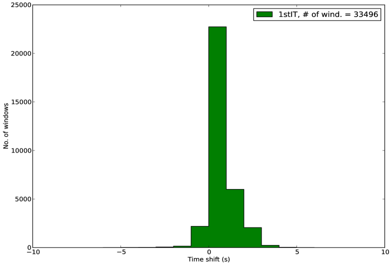

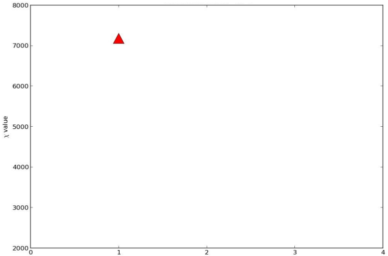

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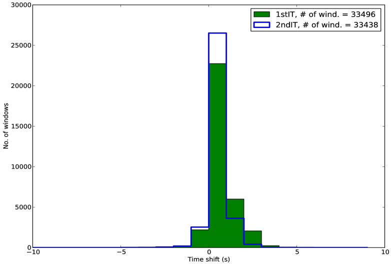

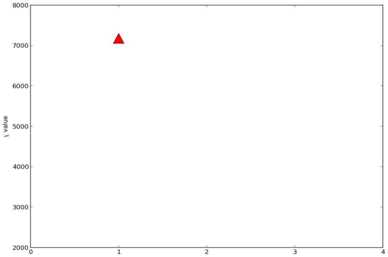

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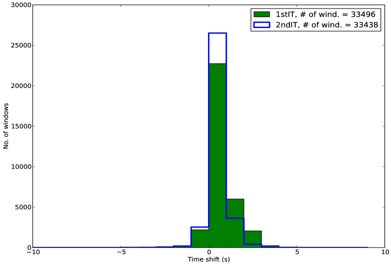

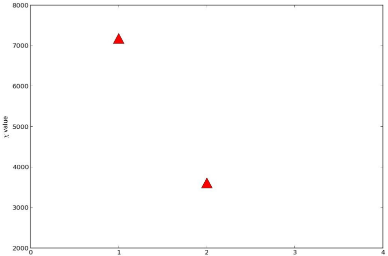

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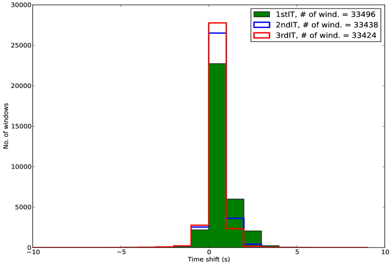

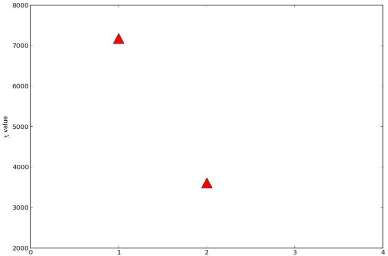

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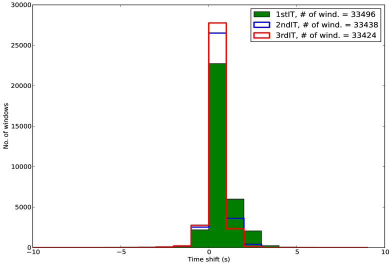

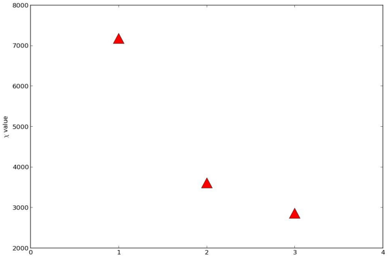

Conclusions

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- improve depth coverage;
- image the lower crust;
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Thank you for the attention!