

# Imaging the structure of the Tien Shan using receiver functions and seismic ambient noise

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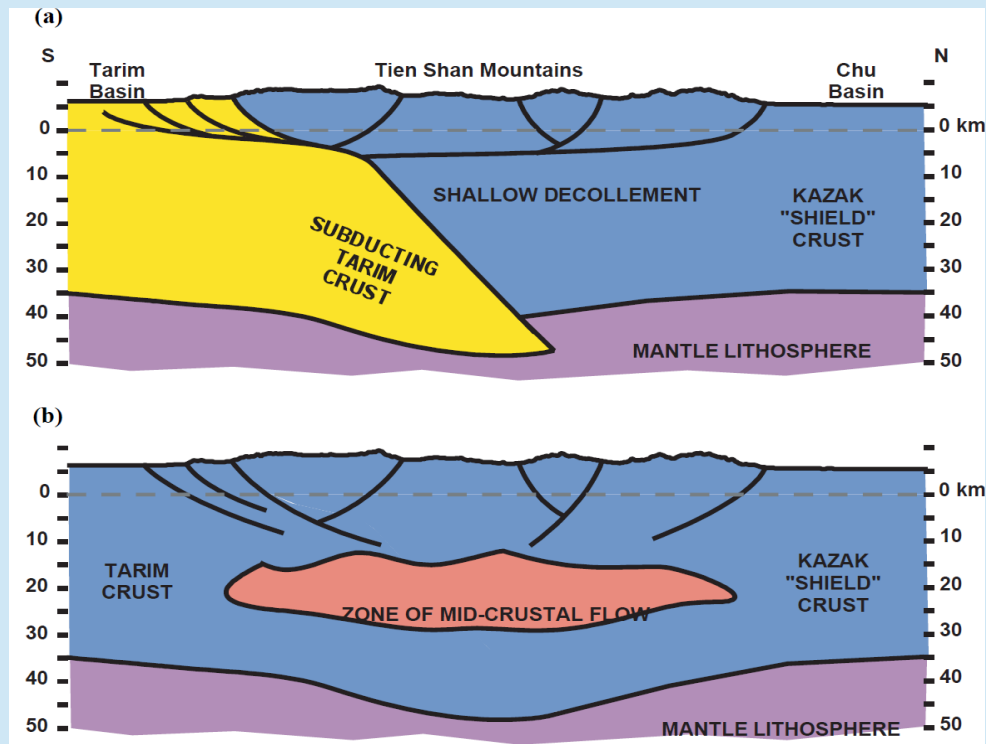
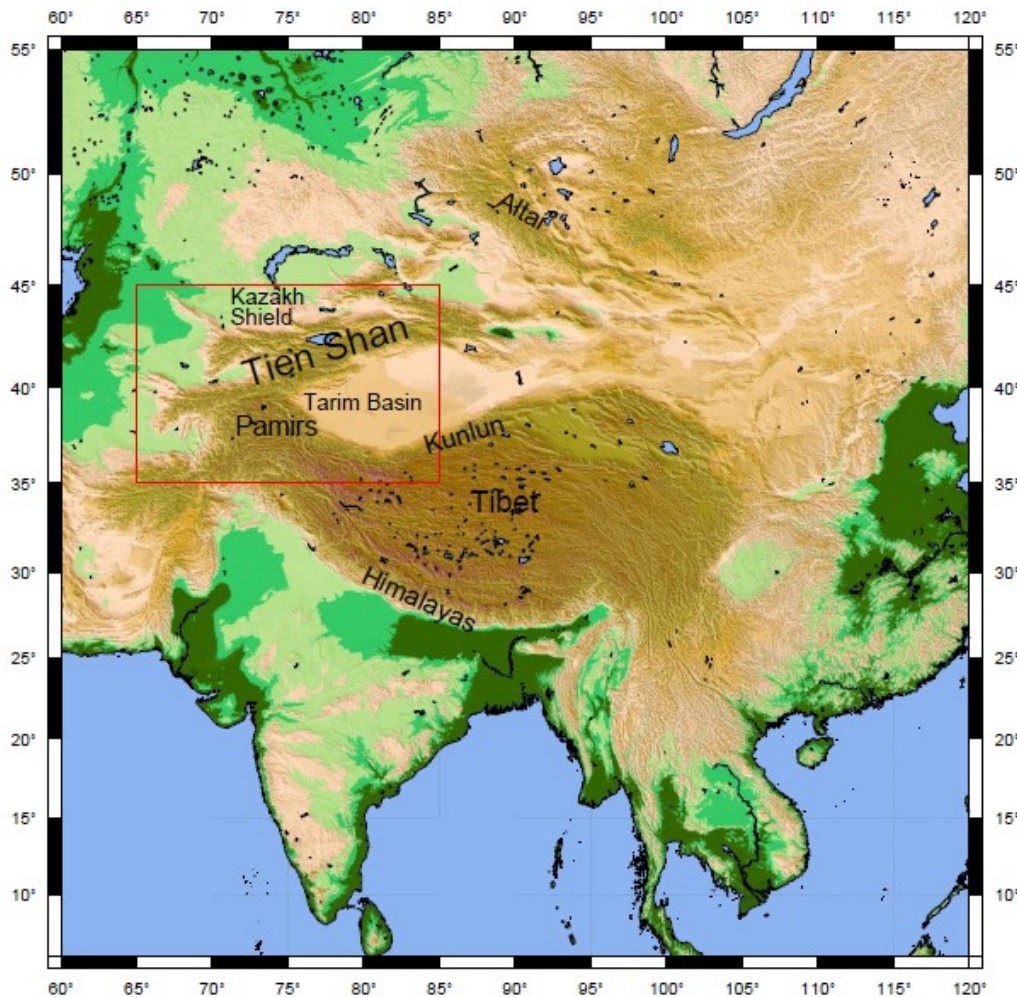
With: Keith Priestley (Bullard Labs, University of Cambridge), Steven Roecker (RPI)

# Overview

- The Tien Shan
- Receiver Functions
- Ambient noise cross-correlation
- Joint inversion of ambient noise and receiver function data

# The Tien Shan

## Why are they interesting?

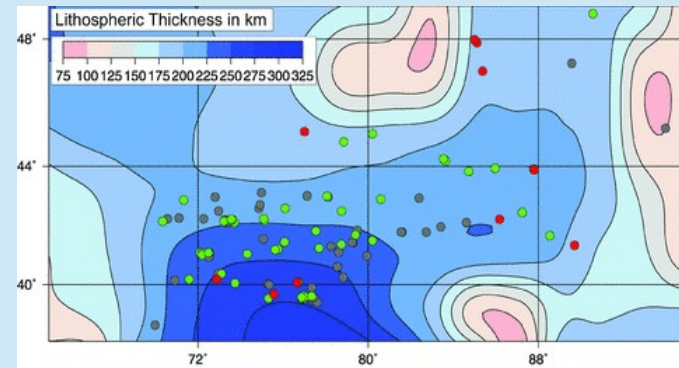


<http://gretchen.geo.rpi.edu/roecker/TS/prop/figures.htm>

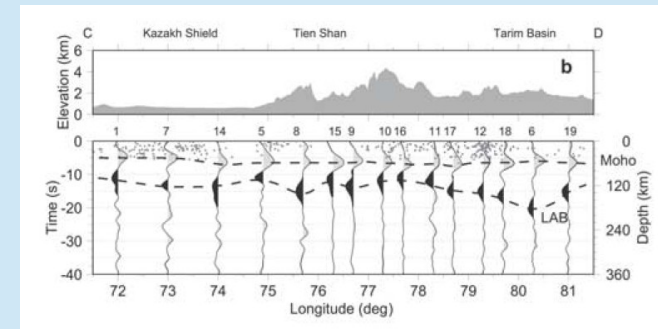
# The Tien Shan

## What are we investigating?

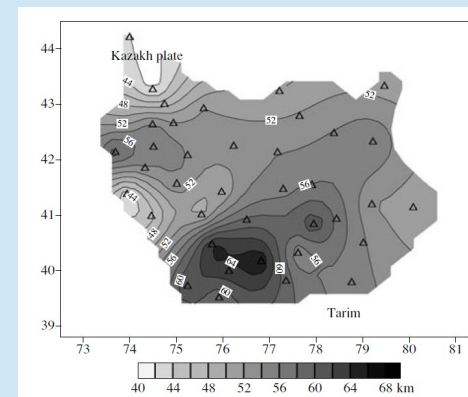
- What is the thickness of the lithosphere?
- How does crustal thickness change?
- Use receiver functions to investigate the presence of boundaries with velocity changes
- Use surface-wave observations made using ambient noise to investigate velocity structure
- Use joint inversion to overcome the limitations of the two data sets



Sloan et al., 2011

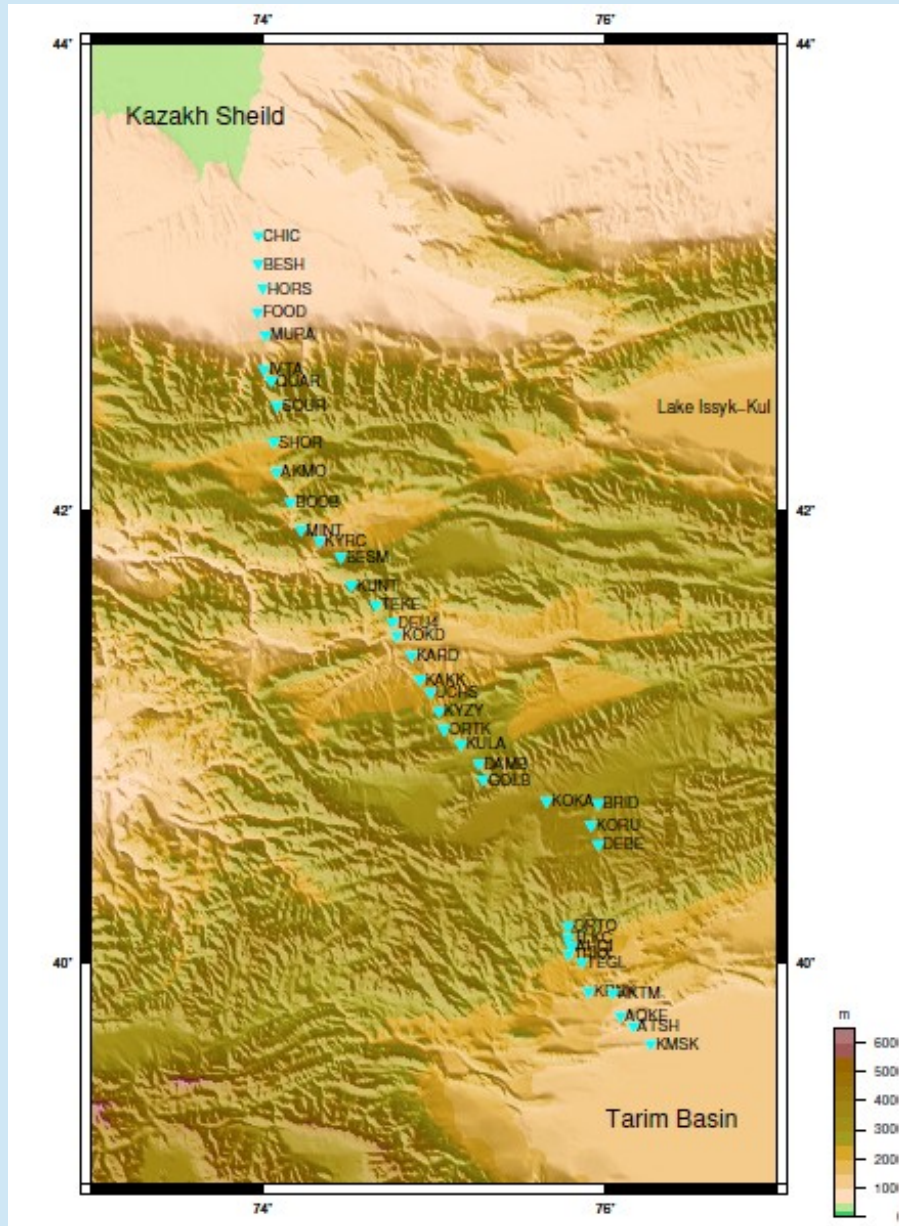


Kumar et al., 2005



Vinnik et al., 2006

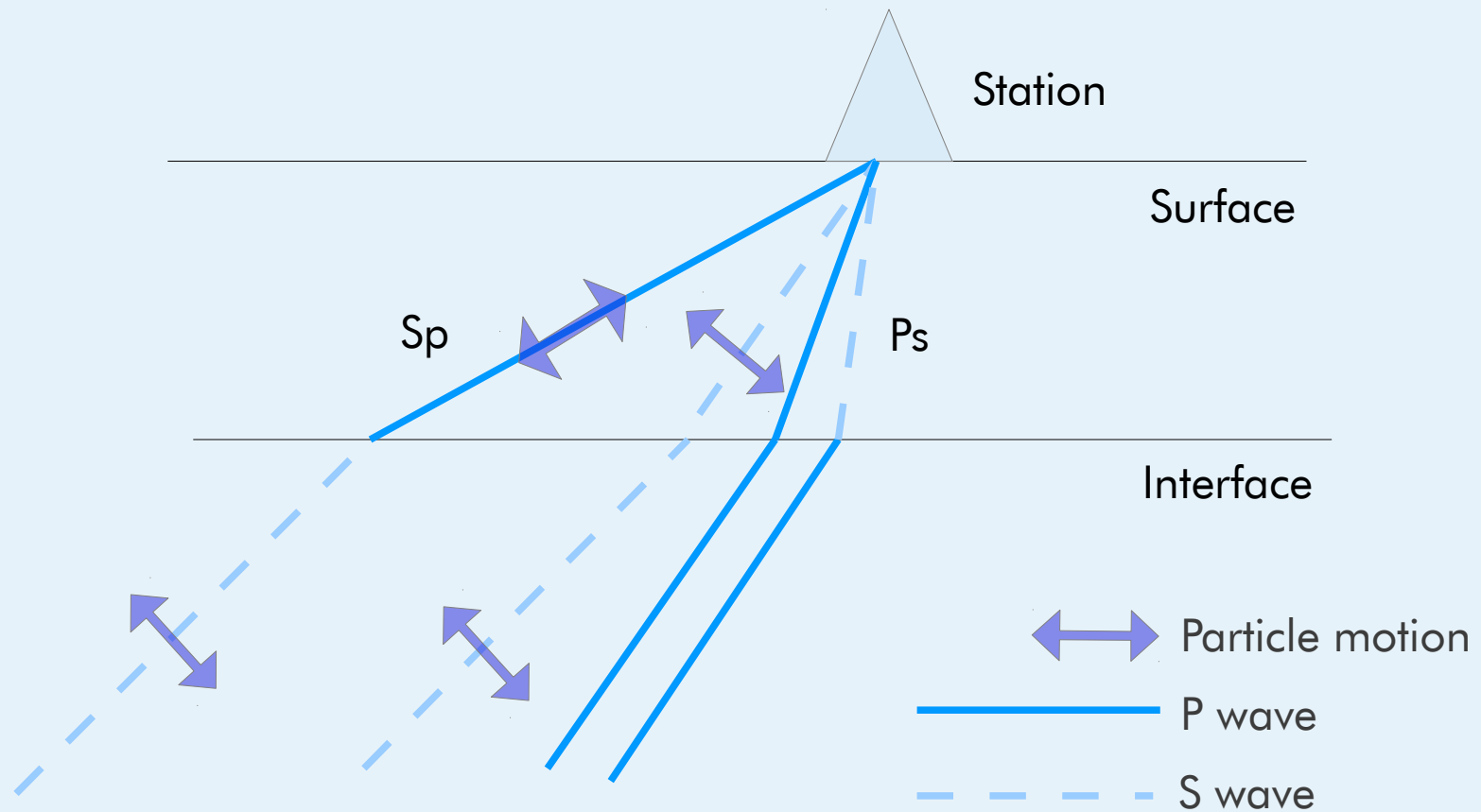
# The Data



- 40 broadband stations deployed as part of the MANAS project
- Operational between July 2005 and July 2007
  - Cuts across the Kyrgyz Tien Shan through areas of interest

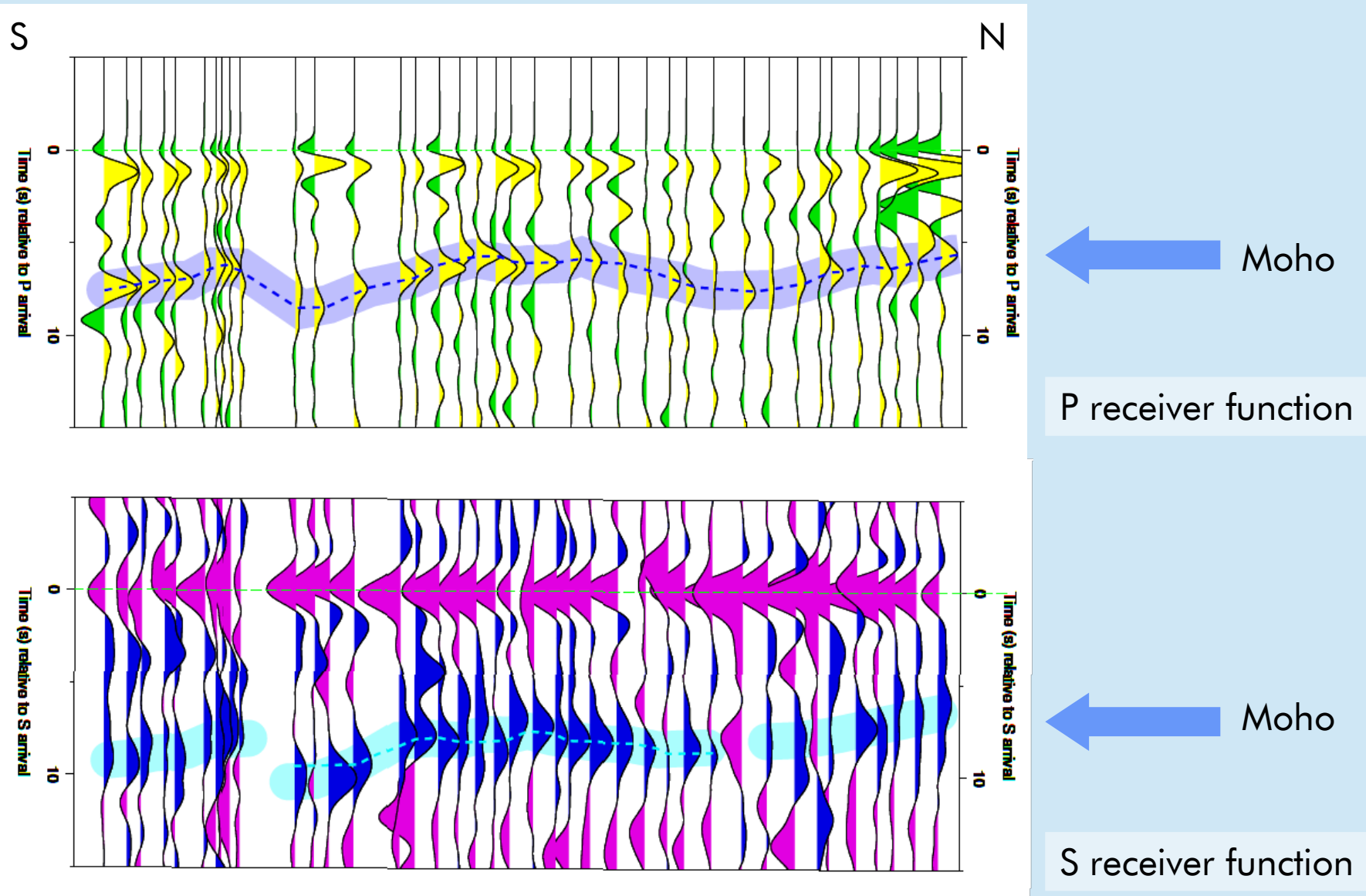
# Receiver functions

## A brief introduction



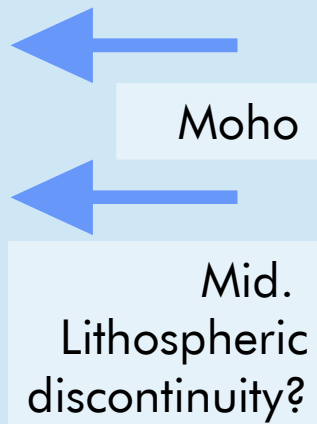
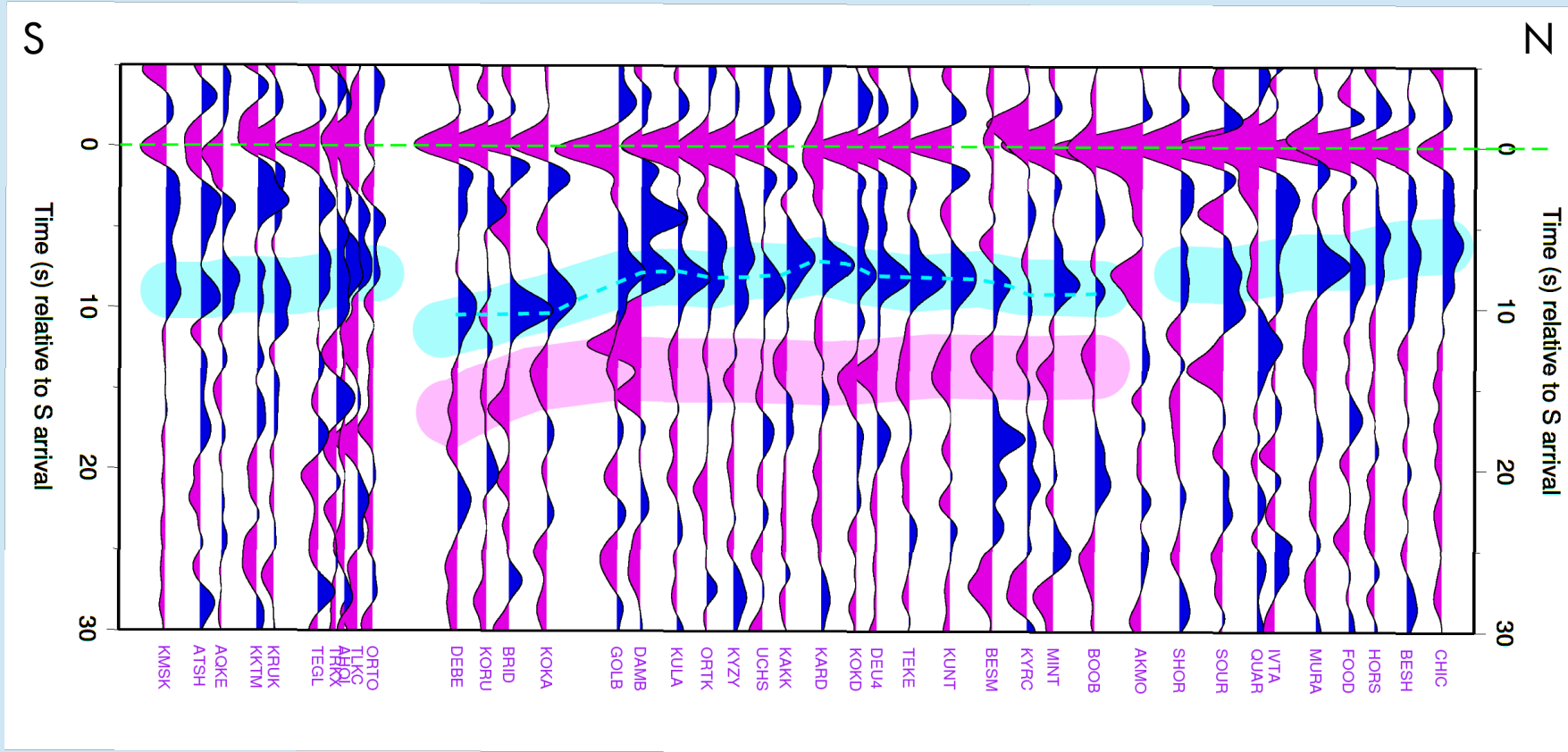
# Receiver functions

## Results



# Receiver functions

## Results



S receiver function



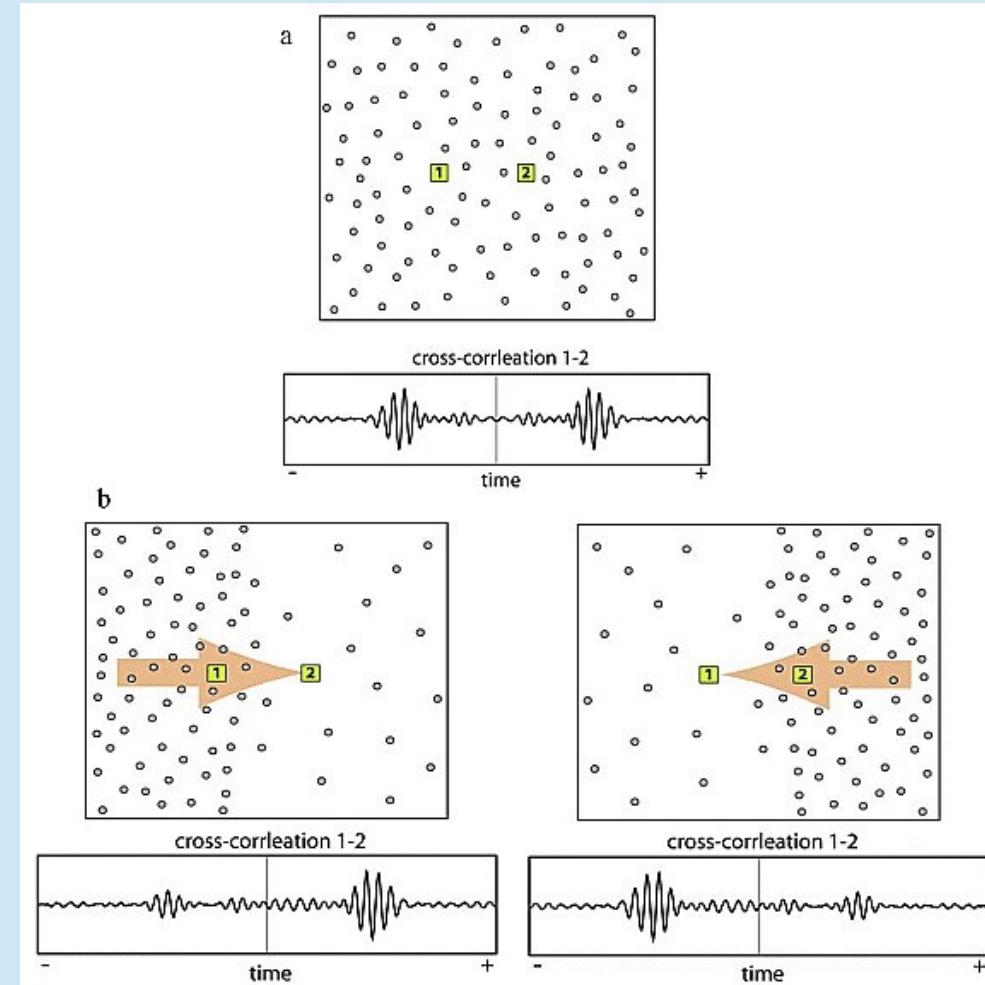
# Ambient noise cross-correlation

## A Brief introduction



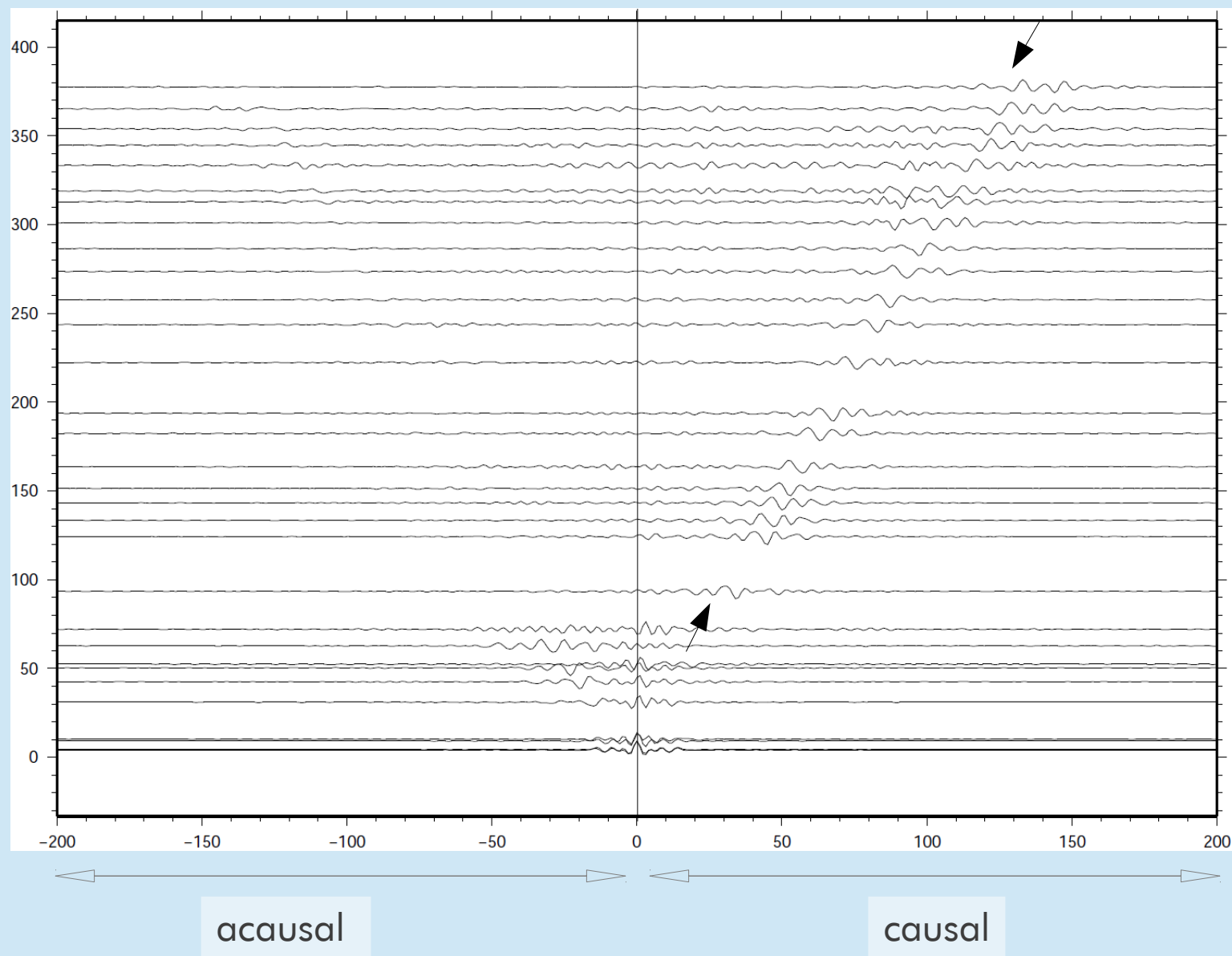
### Advantages

- Obtain measurements for new paths
- Can make short period measurements
- Improved resolution



# Ambient noise cross-correlation

## Cross-correlograms

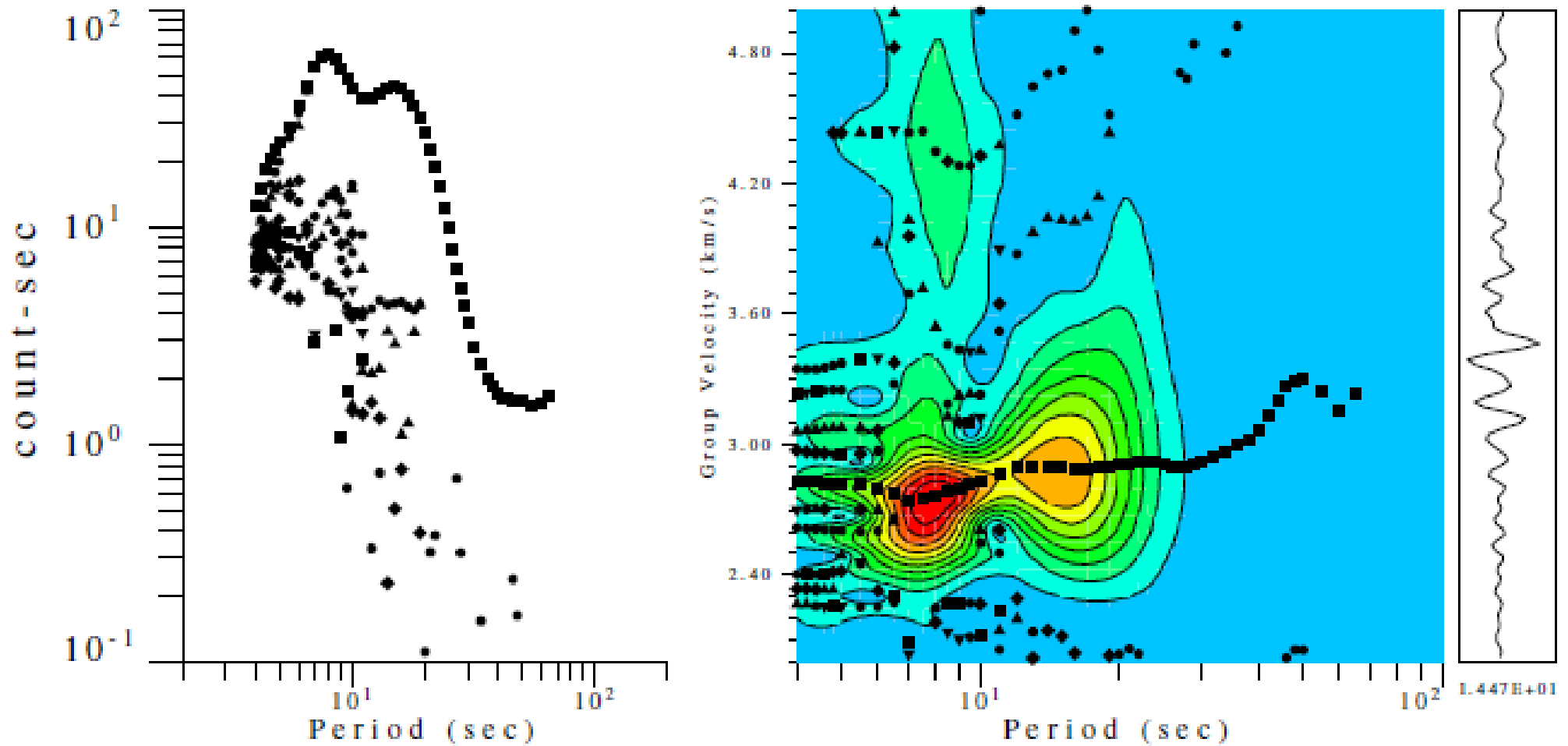


Stations N of AHQI

Cross-correlograms from station AHQI to the other stations in the MANAS array

# Ambient noise cross-correlation

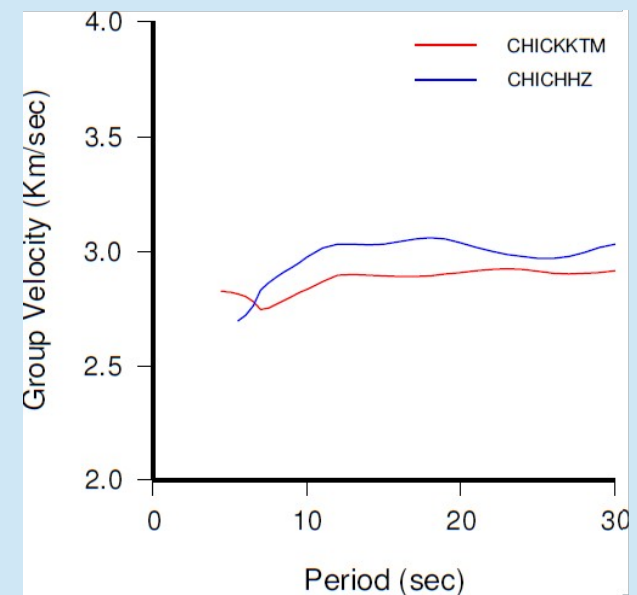
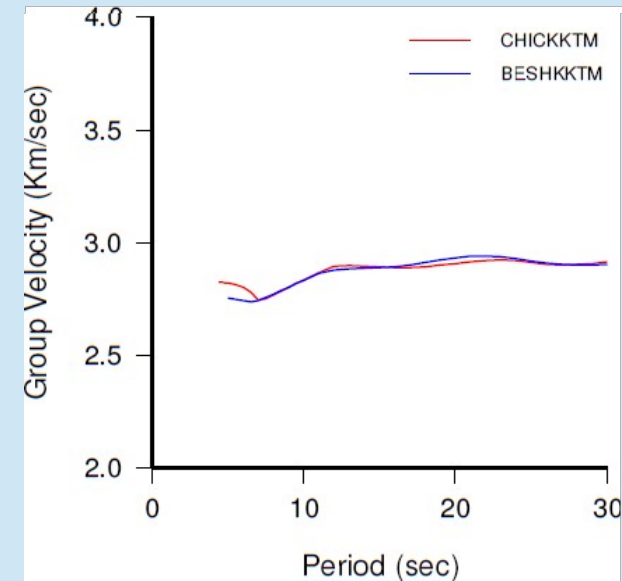
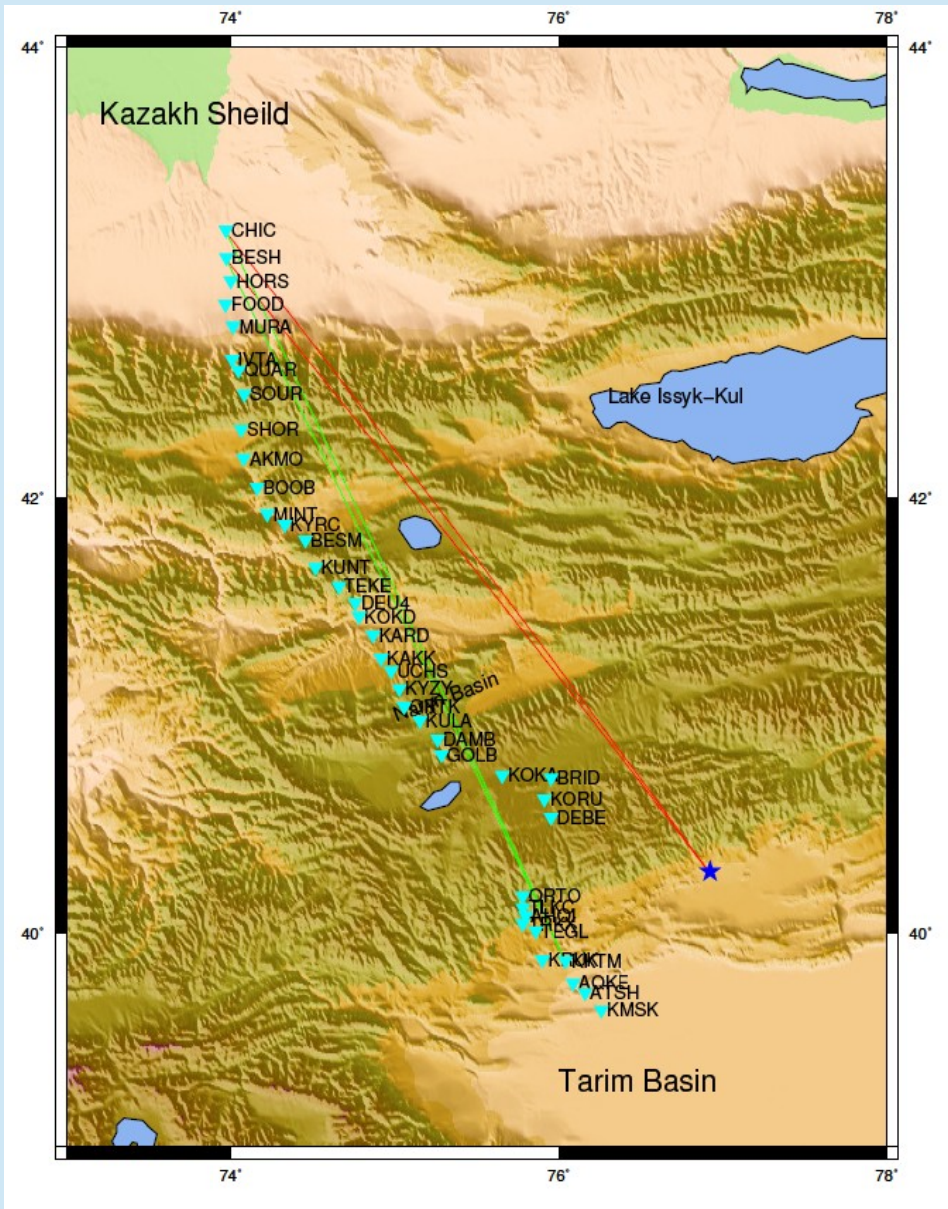
## Calculating rayleigh-wave group velocities



Plot from mft96 Herrmann program showing group velocity vs period for CHIC-KKTM

# Ambient noise cross-correlation

## Checking results against earthquake data



# Joint inversion of receiver functions and seismic ambient noise

## Limitations of Receiver Functions

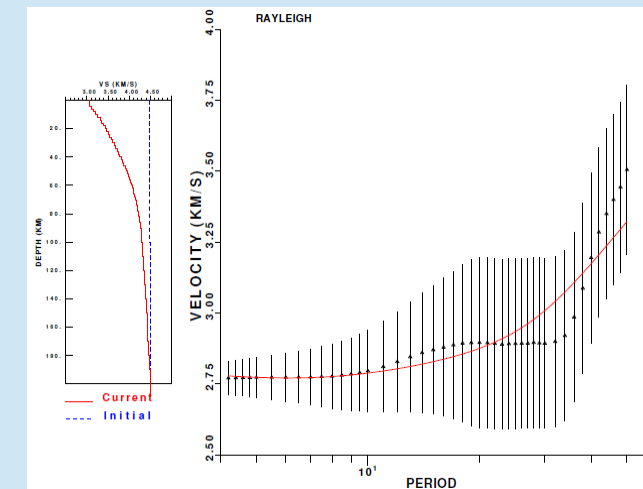
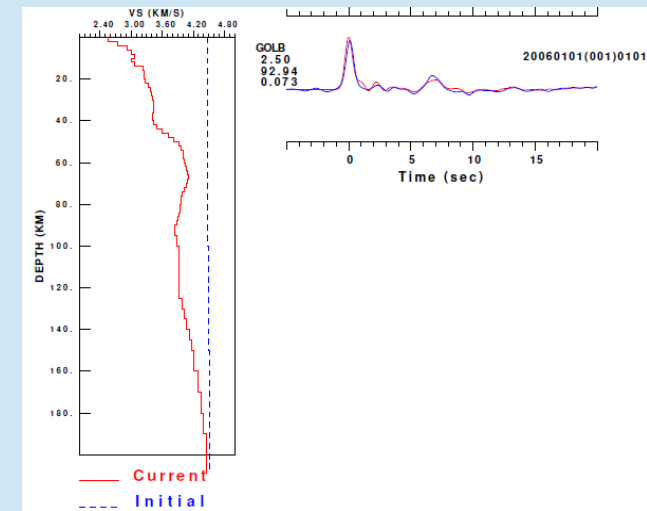
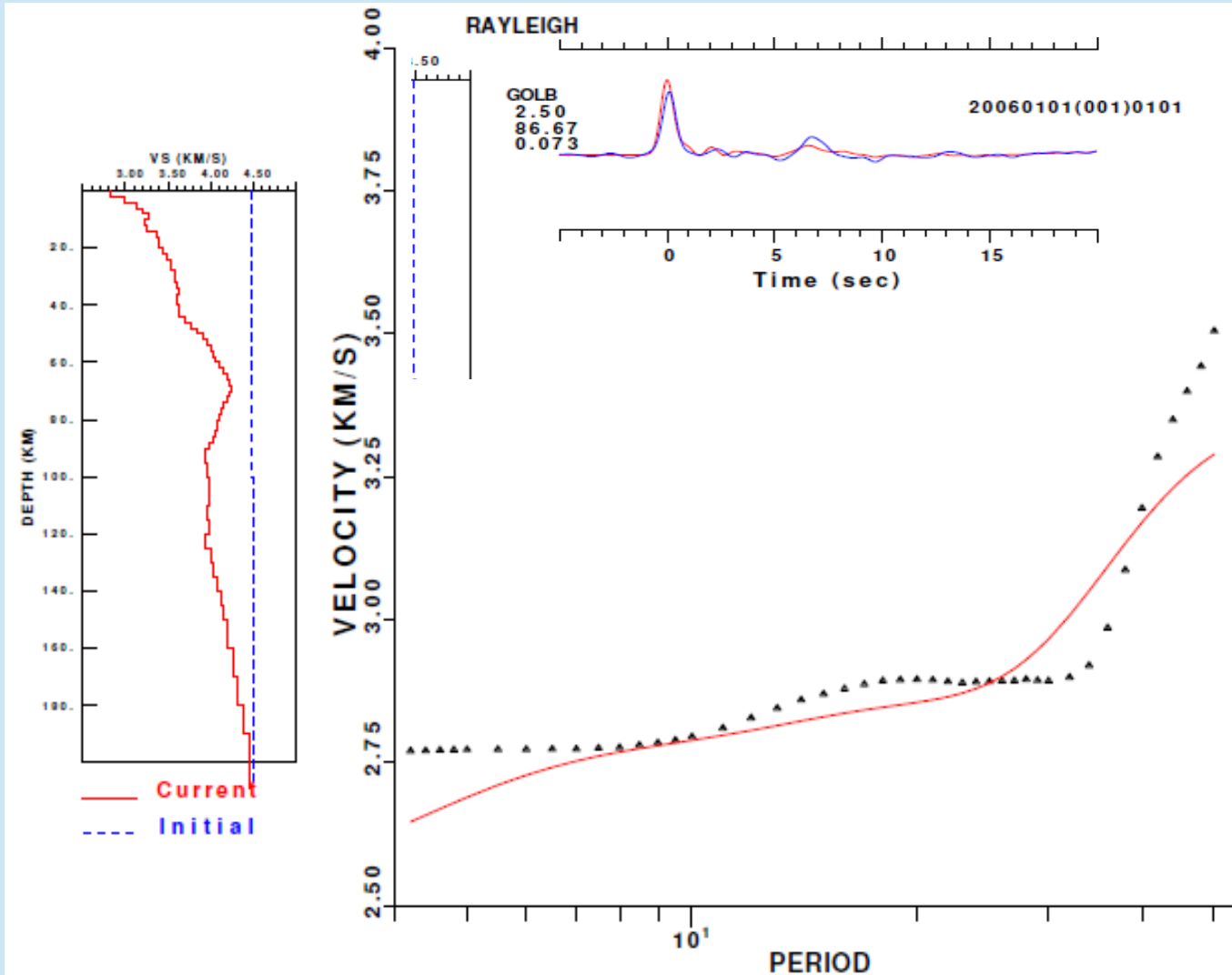
- Receiver functions are sensitive to shear velocity contrasts and vertical travel times
- They are non unique - velocity-depth trade off.

## Limitations of Surface Waves

- Fundamental mode surface waves are sensitive to absolute vertical velocity averages, not velocity contrasts.

Joint inversion offers tighter constraints on the shear velocity structure and limits the likelihood that will over interpret a feature seen in one set of data.

# Results from a joint inversion



# Summary

- Both receiver functions and seismic ambient noise can be used to image the crust and upper mantle
- Joint inversion of these two data sets is useful as it overcomes the limitations of each one individually
- With receiver function data from the *MANAS* array we can potentially see variation in the depth of the Moho and a mid-lithospheric discontinuity
- Group velocities can be obtained from seismic ambient noise cross-correlograms and inverted for crustal structure.
- There is similarity between group velocities obtained from earthquake and ambient noise data
- It is possible to perform joint inversions of ambient seismic noise and receiver function data.

# Thank you

