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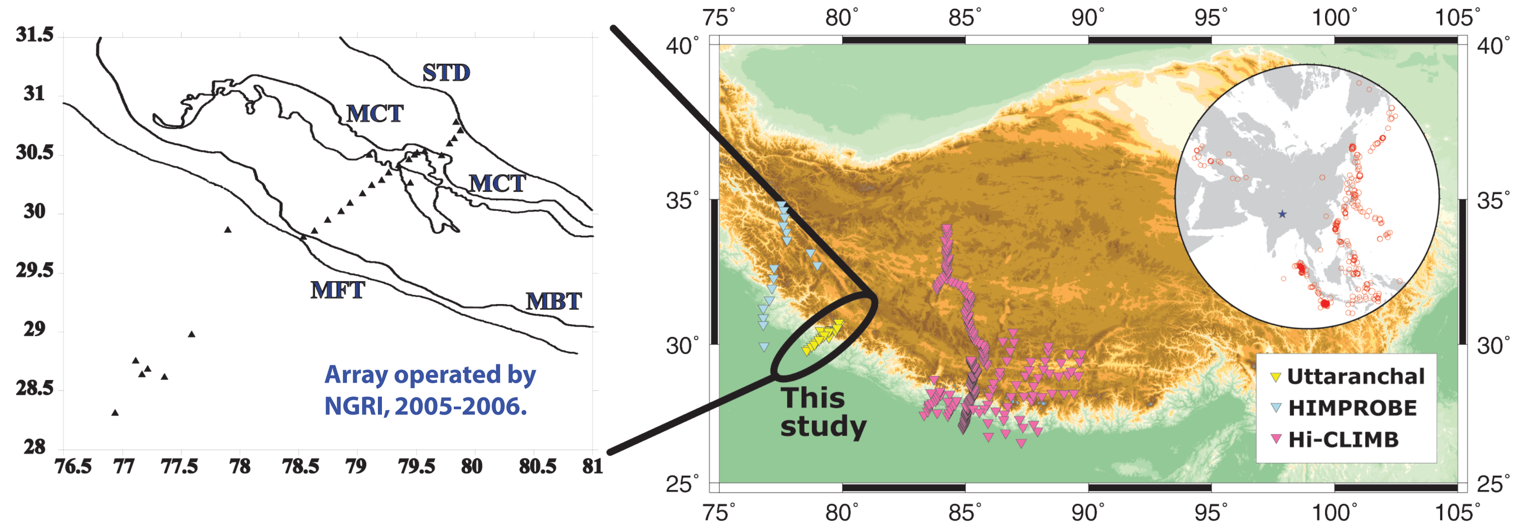
Imaging the Himalayan megathrust in northwest India:
wave equation migration and receiver function CCP-stacking compared

Warren Caldwell[1], Simon Klemperer[1], Jesse Lawrence[1], Ashish[2], Shyam Rai[2,a], Jeffrey Shragge[1,b]

[1] Stanford University, Stanford, CA 94305-2215 [2] National Geophysical Research Institute, Uppal Road, Hyderabad 500 007, India
[a] Now at: IISER, Kolkata, India [b] Now at: School of Earth and Environment, University of Western Australia, Perth

Introduction: Wave-equation migration (WEM) generates images of crustal structure by correlating the scattered coda from teleseismic waves. It was used to image the subducting Juan de Fuca slab (Bostock et al., 2002), but has not yet been successfully applied in the Himalaya. The most prevalent approach to imaging with teleseismic data in this region has been common conversion point (CCP) stacking of receiver functions (RF) (e.g. Schulte-Pelkum et al., 2005, Hetenyi, 2007, Nabelek et al., 2009). In the present work, we compare the two methods with the aim of obtaining better constraints on subsurface structure with WEM images.

Data: As with any teleseismic imaging method, array geometry plays a crucial role in WEM. Short arrays will have limited aperture, and sparsely-spaced arrays will be subject to aliasing. It is unclear at present whether the array used for this work (21 stations over 200 km) is sufficiently long and sufficiently dense for WEM to yield meaningful improvements over existing methods.



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Overview

WEM: Wave Equation Migration

1. **Data used:** Full waveforms consisting of all combinations of converted and scattered phases (forward-scattered P-P and P-S; back-scattered P-P, P-S, S-P, and S-S), as well as free surface reflections.
2. **Back-projection:** A wave equation is utilized to correctly locate energy.

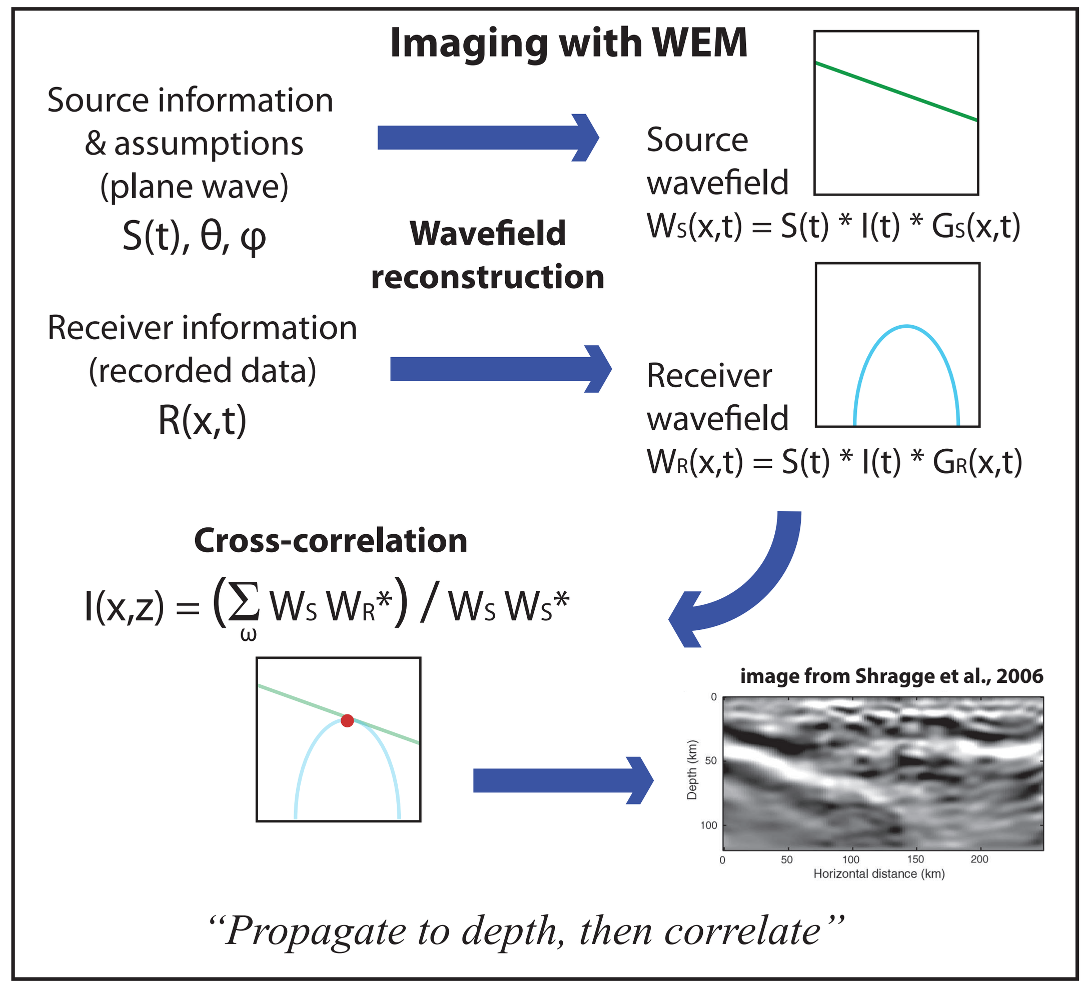
> ***Wave equation migration exploits more of the recorded signal and utilizes more physics than receiver functions, so offers the potential for higher-resolution images, but demands spatially-dense data.***

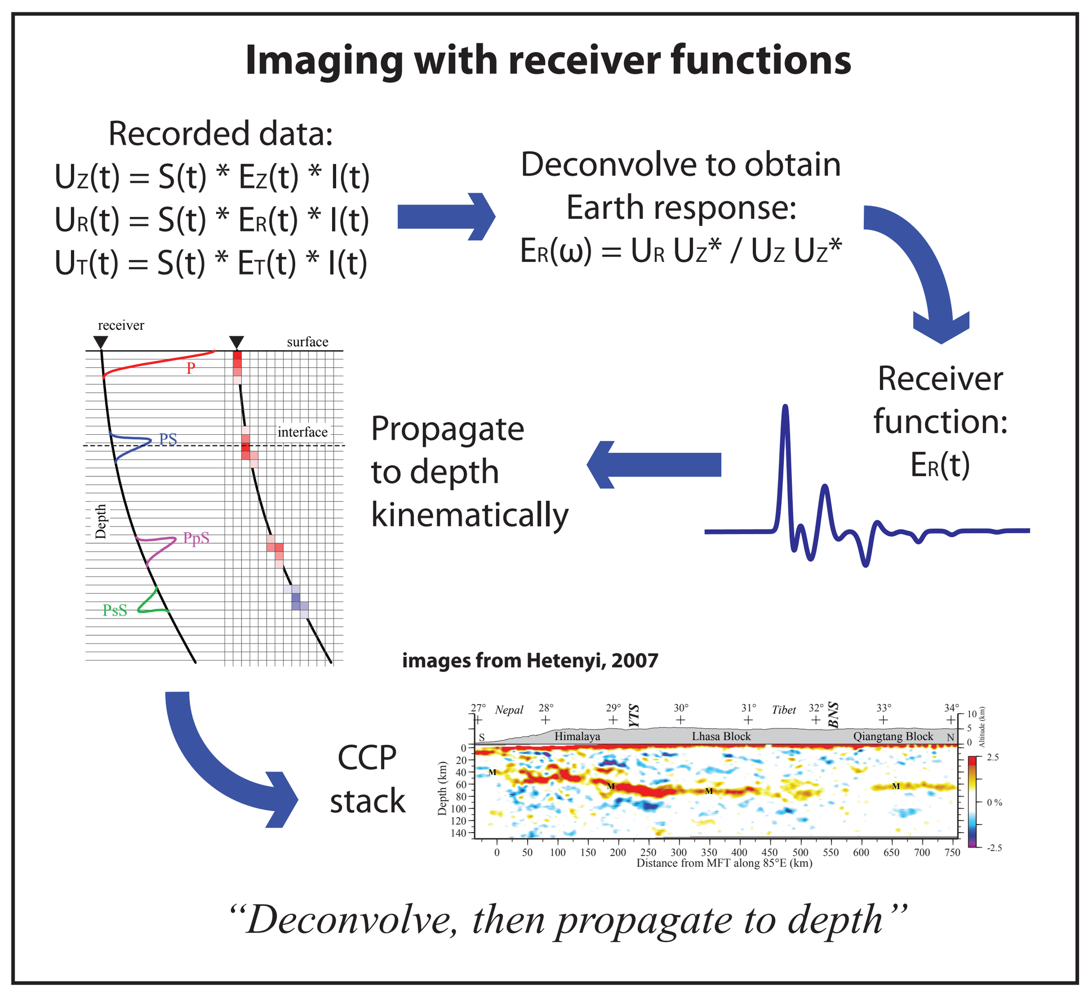
RF CCP: Receiver Function CCP-stack

1. **Data used:** PS or SP phase conversions, sometimes with free surface multiples, such as PpS or PsS, and sometimes with more complex phases.
2. **Back-projection:** Purely kinematic.

> ***Receiver function CCP-stacking is a kinematic and additive approach, so is more robust for noisy or sparsely-sampled data.***

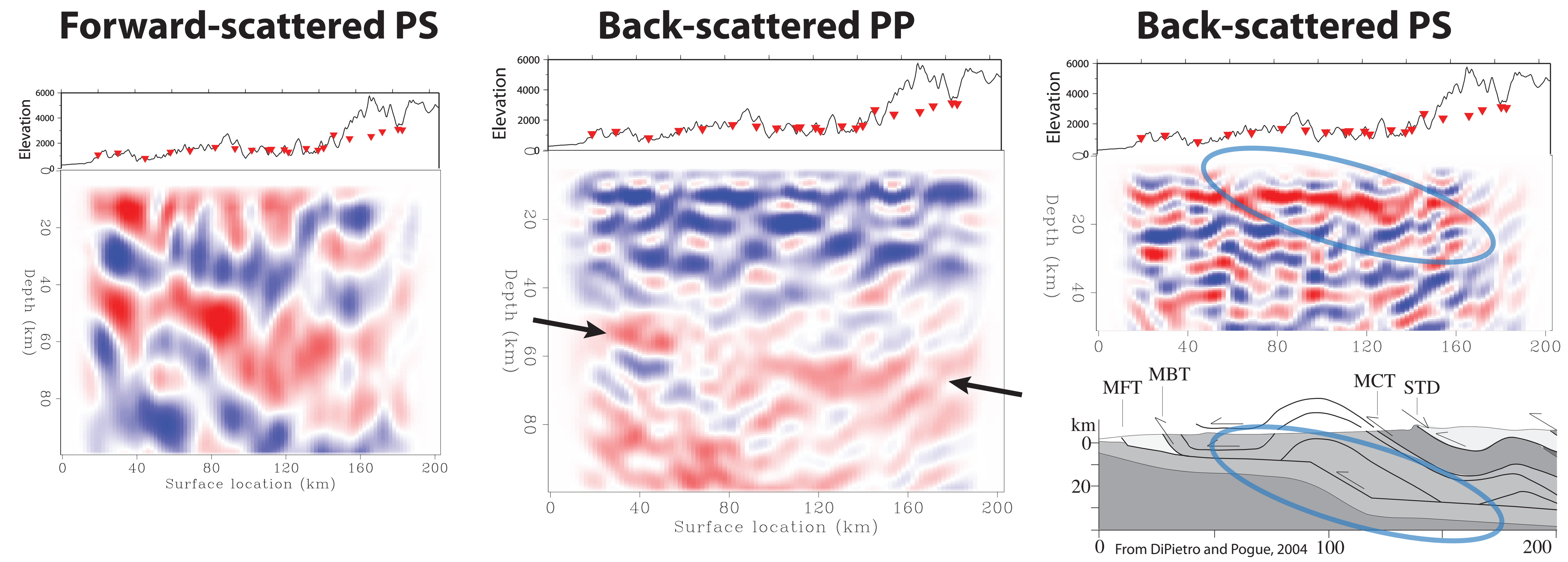
Implementation





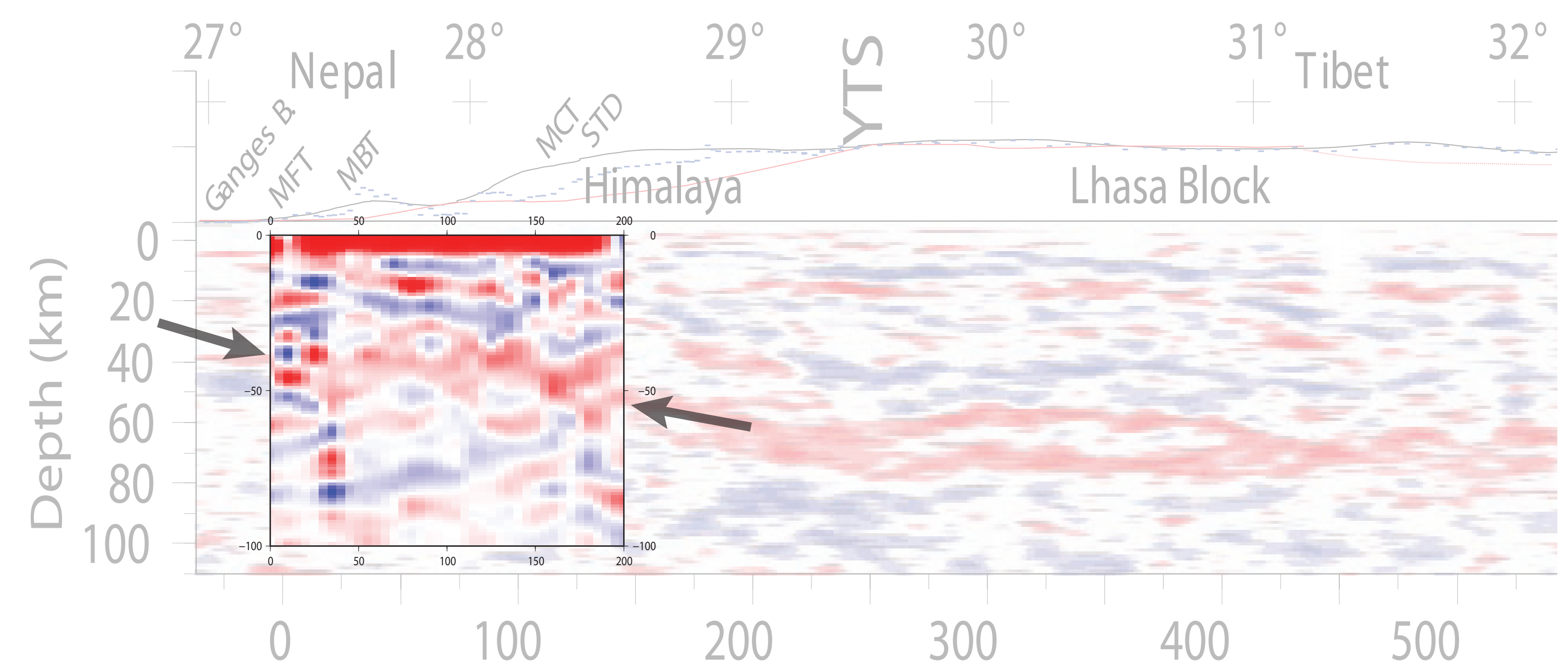
Results

Different scattering and converting modes reveal information at different scales: back-scattered PP (below center) shows a dipping Moho (arrows), while back-scattered PS (below right) captures energy from crustal features (possibly the Main Himalayan Thrust, circled). Forward-scattered modes (PS, below left) have poorer resolution, illustrating the improvement obtained by including free-surface reflections in imaging.



Our RF CCP image (right, central panel) shows similar Moho depths and upper-crustal features as our WEM images, but in less detail.

Background image (Hi-CLIMB; Nabelek et al., 2009) shows a similar Moho to our results (arrows).



Conclusion: Wave equation migration has the potential to generate higher-resolution images than CCP stacking of receiver functions, but requires spatially-dense data. At the present time we have not yet conclusively shown an improvement in interpreting this data set by using WEM, but work is still ongoing.