Diffracted P-wave Measurements for Waveform Tomography

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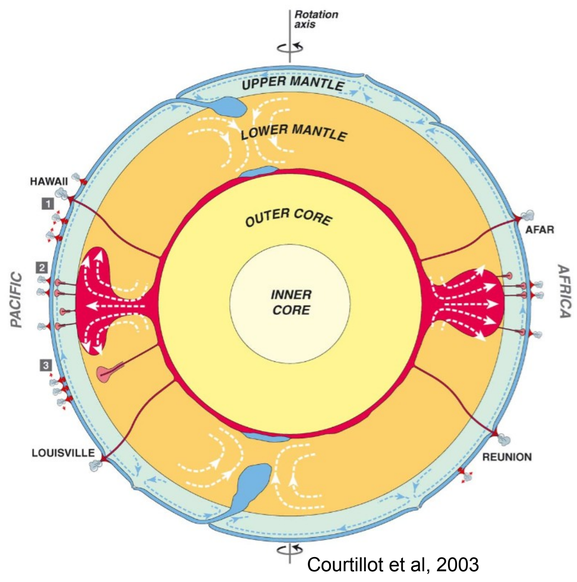
Motivation:

Lower mantle structures and processes:
- Heat flow across the CMB
- Mantle up/down-wellings

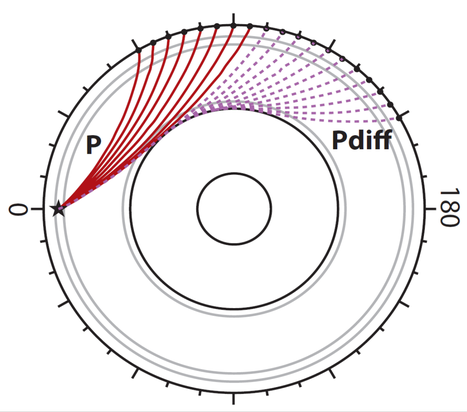
Goal:
- Extract maximum information from broadband waveform data
- Core-diffracted waves
- Embed core-diffracted waveform data into inversion of P and PP waveforms

Why diffracted P-waves?
- Core-grazing waves extensively sample the deepest part of the mantle
- Better information on the “footing” of mantle plumes and structure of lowermost mantle

Highlights:
- Pdiff requires multi-frequency waveform measurements up to considerably high frequency
- Cannot be modeled satisfactorily using conventional ray theory and too expensive for full 3D adjoint tomography

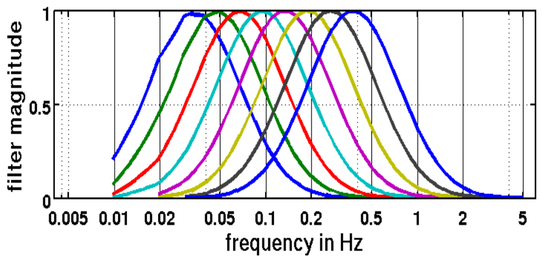


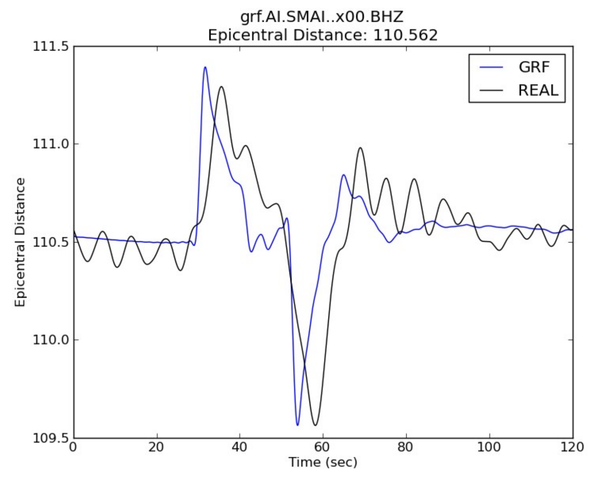
Courtillot et al, 2003

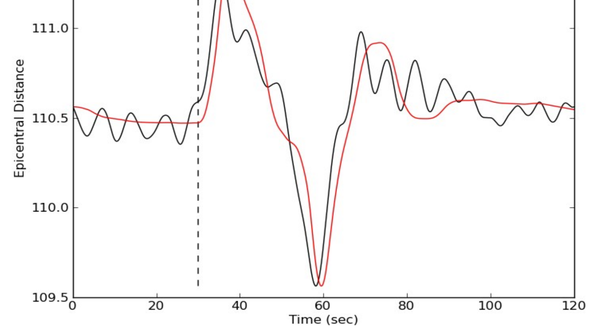


Measurement method:

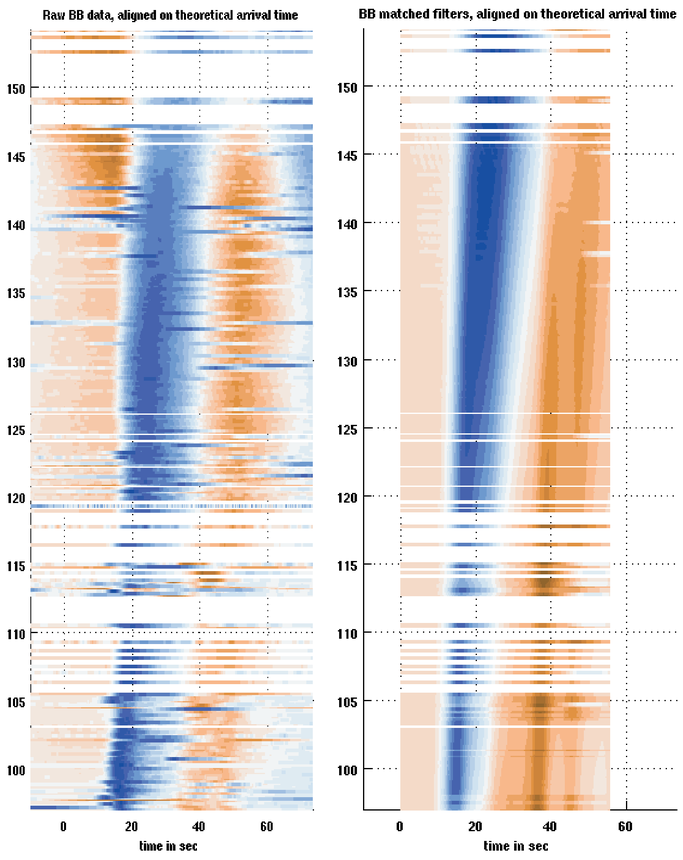
- Load all the relevant (real) seismograms from the archive.
- Reject seismograms based on a priori criteria (epicentral distance and basic quality control).
- Load synthetic seismograms from the archive (generated by **YSPEC** [Al-Attar & Woodhouse (2008)] and **AXISEM** [Nissen-Meyer et al. (2007)]).
- Convolve synthetic seismograms with Source Time Function(s).
- Apply bandpass filters.
- Measurements of dT and dA for all 8 bandpass filters.



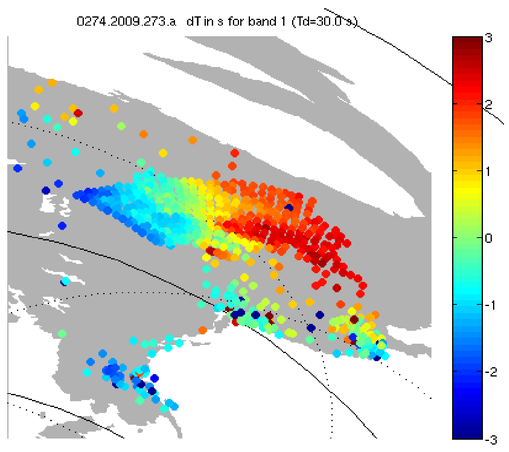




Measurements for Mag: 7.5, depth: 81.0, Sumatra 2009/09/30 10:16:09.249 Earthquake:

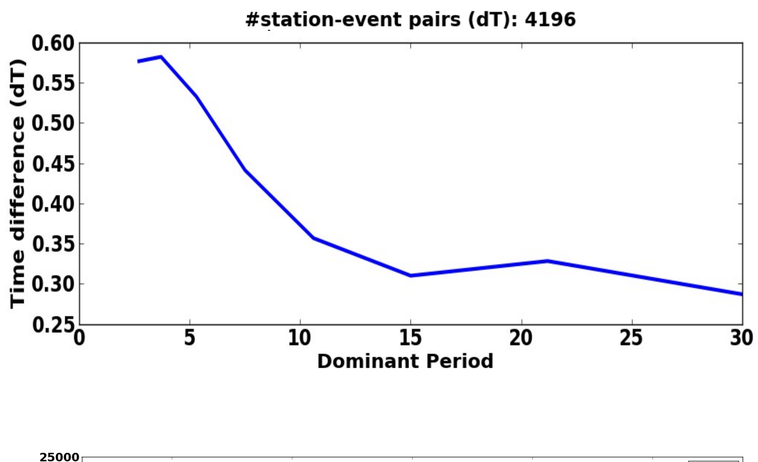


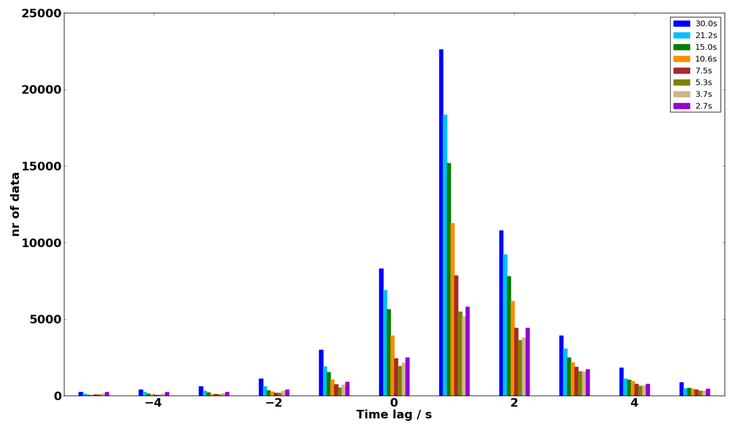
- Left: broadband data and broadband matched filters (convolution of synthetic seismograms with source time function) aligned on theoretical arrival time.
- Bottom: measured travel-time anomalies for stations in North America. (view from NW)



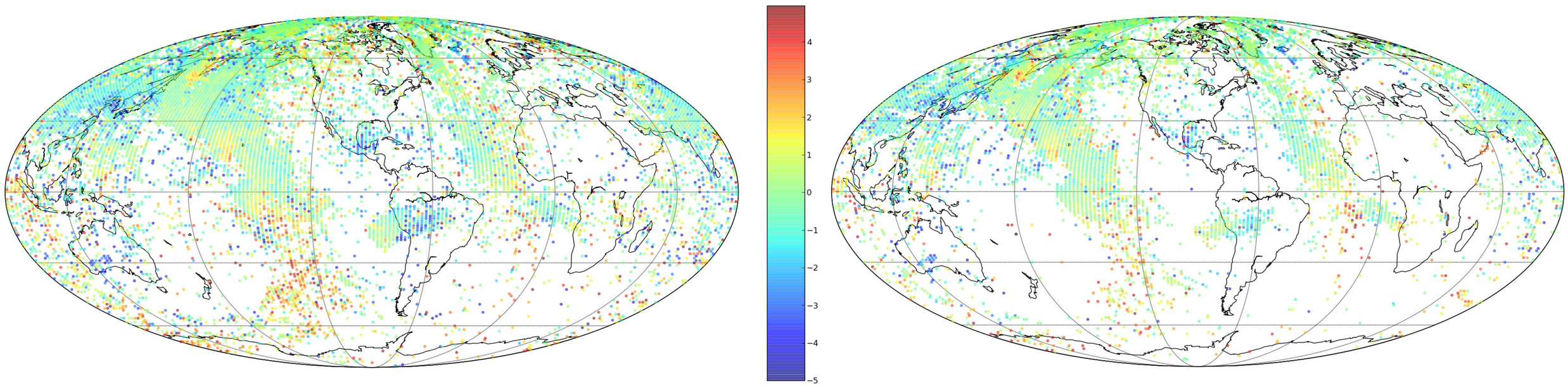
Measurement statistics for 593 events:

- Plots are created for all waveforms with cross correlation coefficient exceeding 0.85.
- Top: mean values of all dT measured for different dominant periods. Only those station-event pairs are considered that have cross correlation coefficient exceeding 0.85 in all frequency bands. Travel time deviation, especially for high frequencies, shows the shortcomings of background model in resolving the lowermost mantle.
- Bottom: measured travel-time anomalies in all 8 frequency bands (distinguished by colour). Total number of event-station pairs for 30sec dominant period is 55477.





CMB travel-time anomalies:



Measured travel time anomalies for **55477** station-event pairs in **30.0sec** dominant period (cross correlation coefficient >= **0.85**). The red circles show low velocity and blue ones high velocity deviations from the background model (IASP91). Each circle is the projection of the middle point of the ray path between each station-event pair. Raw measurements not yet corrected for ellipticity, topography and event relocation.

Measured travel time anomalies for **27450** station-event pairs in **10.6sec** dominant period (cross correlation coefficient >= **0.85**). The red circles show low velocity and blue ones high velocity deviations from the background model (IASP91). Each circle is the projection of the middle point of the ray path between each station-event pair. Raw measurements not yet corrected for ellipticity, topography and event relocation.