Using W phase for regional tsunami warning and rapid earthquake hazard assessment

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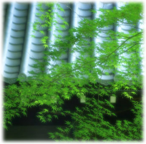
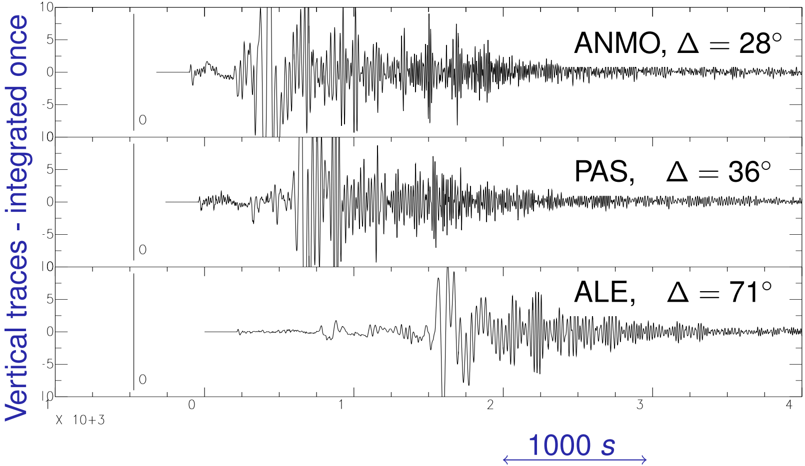


Introduction

- We have recently developed a source inversion technique based on the waveform modeling of W-phase.
- W-phase is a very long period (200s-1000s) phase arriving right after the P.
- It was first recognized after the 1992 Nicaragua earthquake.
- The inversion technique was originally devised to work for large events (Mw$>\sim$7.5) with teleseismic data and it provideas a VLP characterization of the source (e.g. Tsunami earthquakes).
- We explore here the possibility of an application with regional data and with smaller magnitudes.

Example: Nicaragua, 1992



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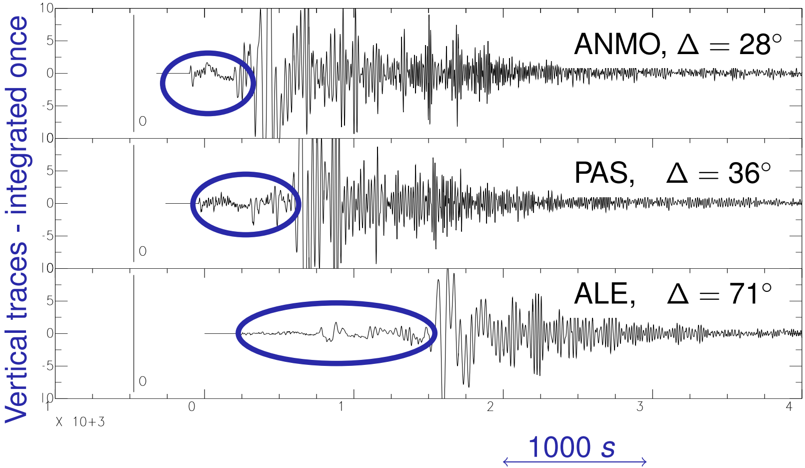
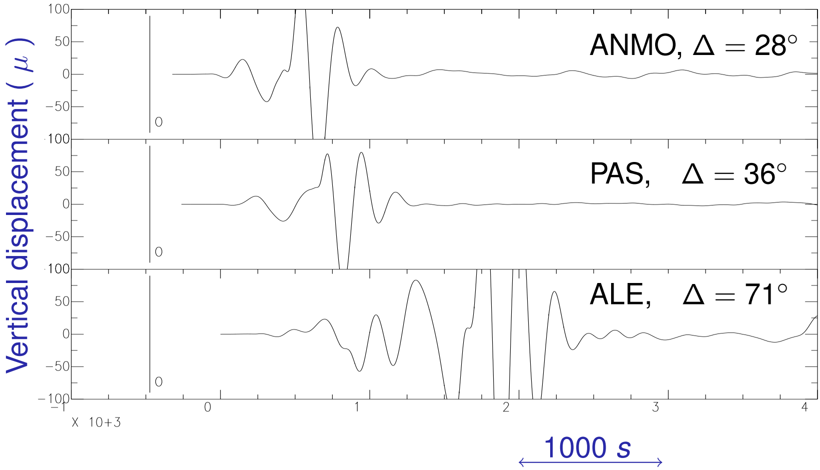


W-phase: Example: Nicaragua, 1992

Deconvolved + bp 200s-1000s



W-phase: Example: Nicaragua, 1992

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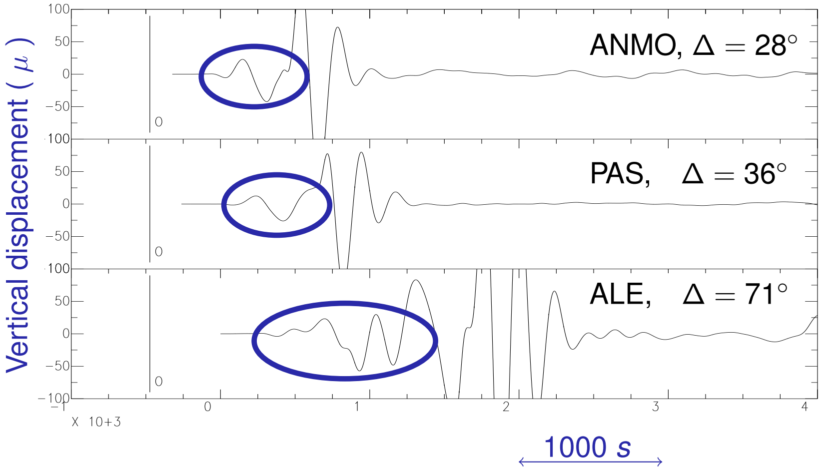
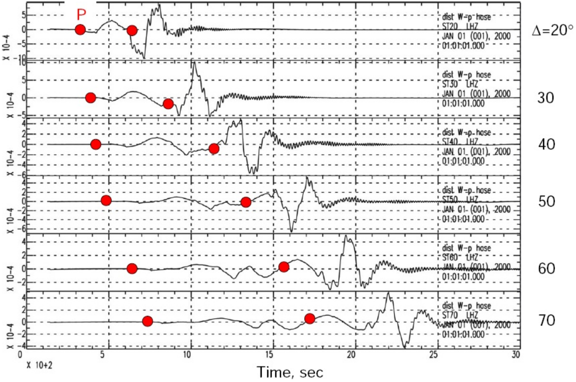


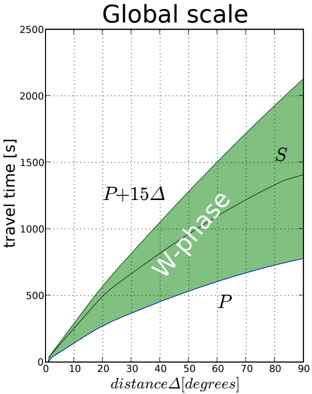
Time window

W-phase time-window

$P, P + 15\Delta\ s/\circ$



W-phase in the global context



Definition

- Time window: P, P+15Δ
- Bandpass: .001 Hz - .005 Hz

Properties

- Fast group velocity: 4.5-9 km/s
- Fairly insensitive to:
  - shallow lateral heterogeneities
  - source second order details
- Avoid large amplitude surface waves

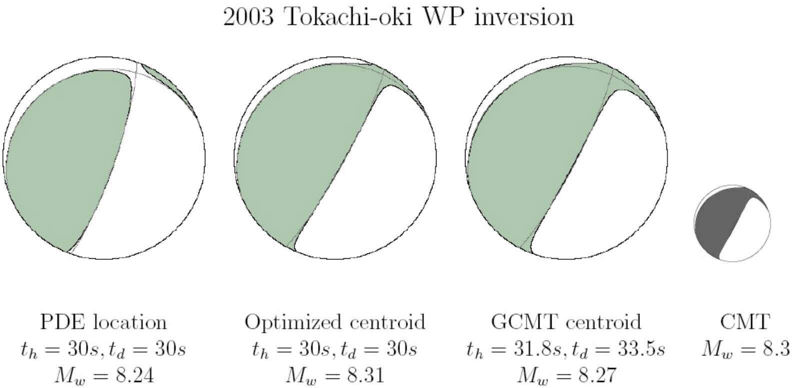
Source retrieval from W-phase

Inversion: main features

- Time domain
- Point source (VLP data)
- Need a preliminary source location: PDE, JMA
- Library of precomputed Green's functions
- Linear inversion –> Moment tensor components
  - PDE ($\Delta < 50°$): $t_0 + 20$ min
  - Grid search ($\Delta < 90°$): $t_0 + 35$ min
- RT implementation: β-test at NEIC-USGS, (Gavin Hayes)

Example: global data

Tokachi-Oki-2003



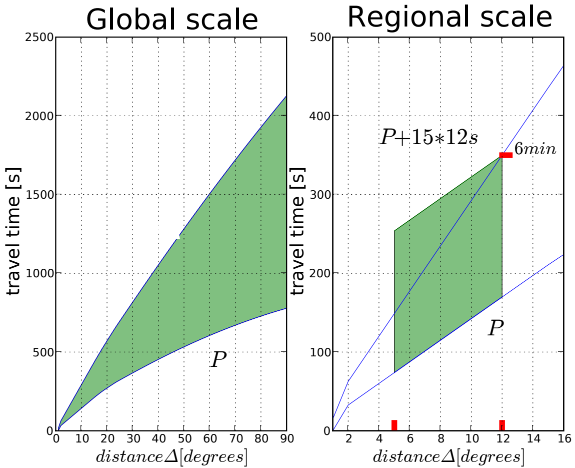
$t_0 + 20$ min $\quad t_0 + 35$ min

Regional data

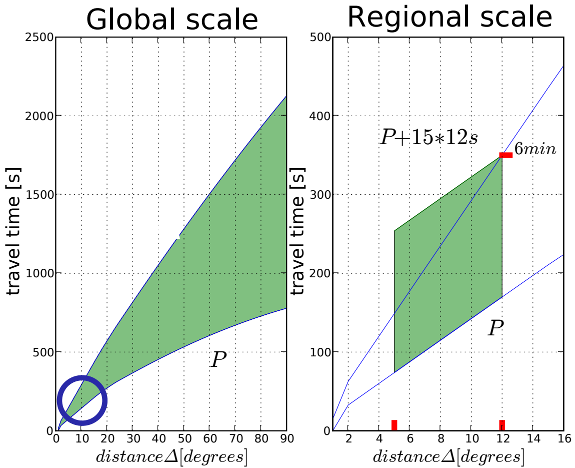
Extension to regional data and lower magnitudes

- Target: Mw $>\sim$ 6.5
- Data distribution:
  - $\Delta < 12^{\circ} \rightarrow$ 6 min.
  - $\Delta > 5^{\circ}$: high gain data, nonlinearity.
- Modifications:
  - Time window: (P, P+15Δ) inappropriate
  - Frequency band: signal/noise ratio

W-phase time window

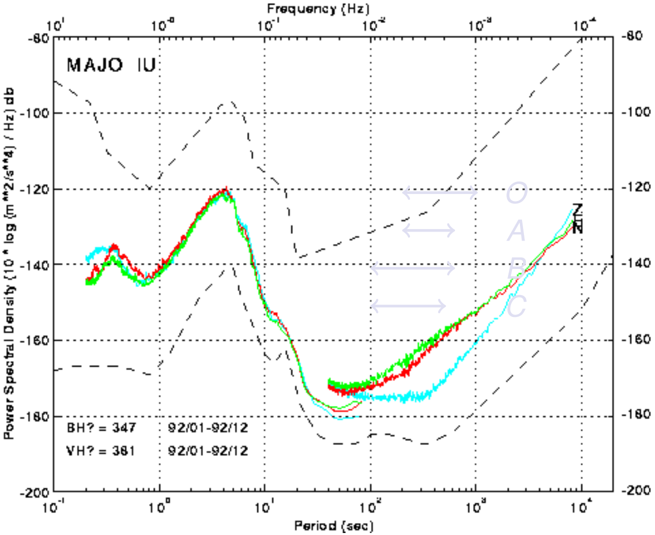


W-phase time window



Extension to lower magnitudes

Acceleration noise spectrum at MAJO



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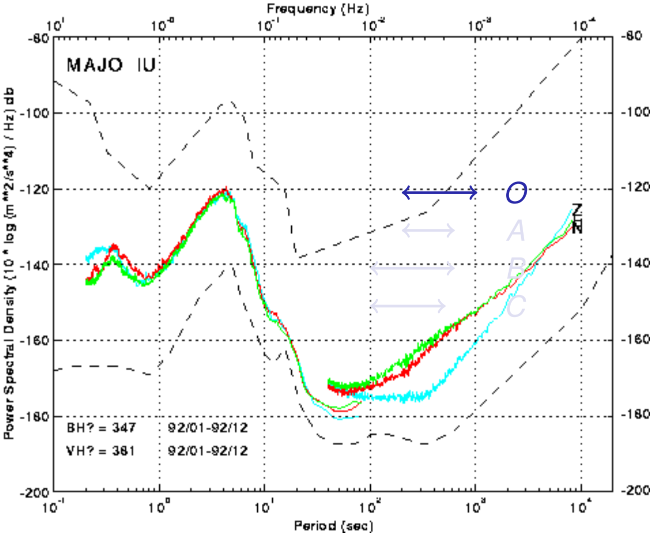

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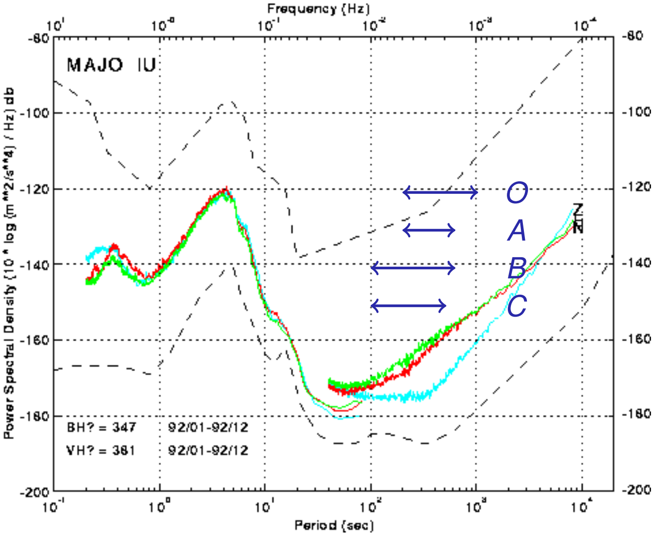
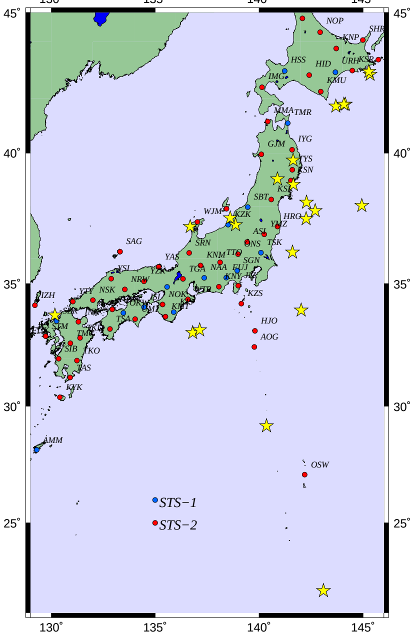
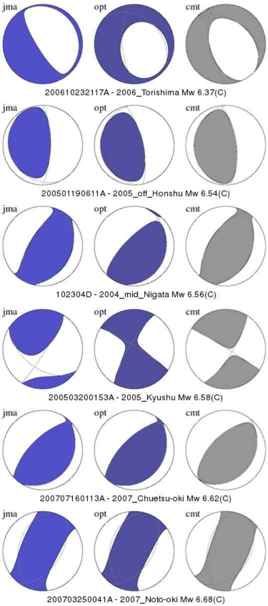


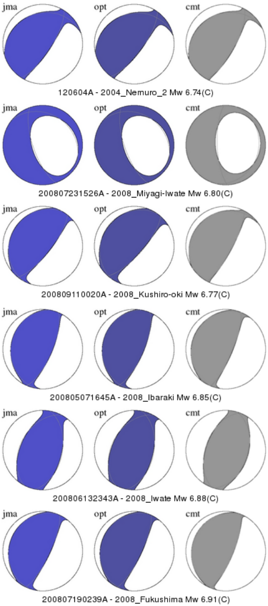
Data:
Japanese broadband network (F-net)
Events:
$M_{jma} > 6.7$
2003-2008



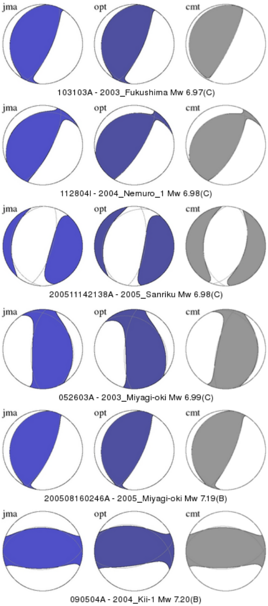
F-net, 2003-2008, $M_{jma} > 6.7$ (1/4)



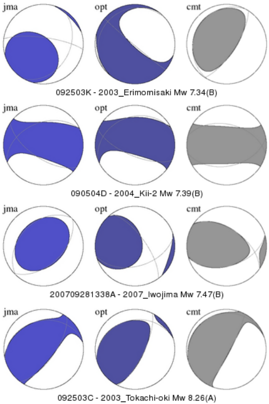
F-net, 2003-2008, $M_{jma} > 6.7$ (2/4)



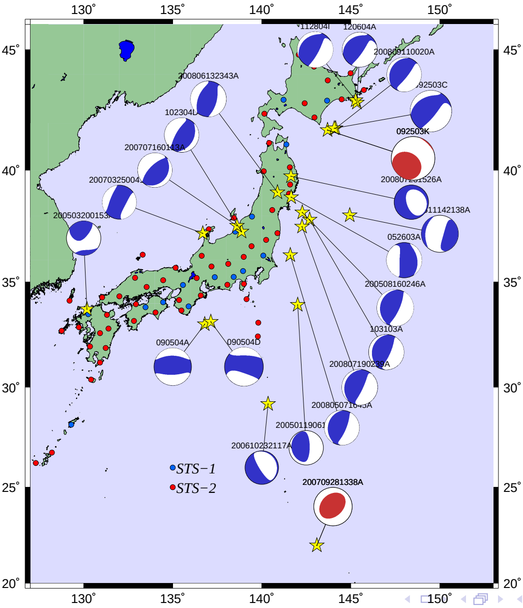
F-net, 2003-2008, $M_{jma} > 6.7$ (3/4)



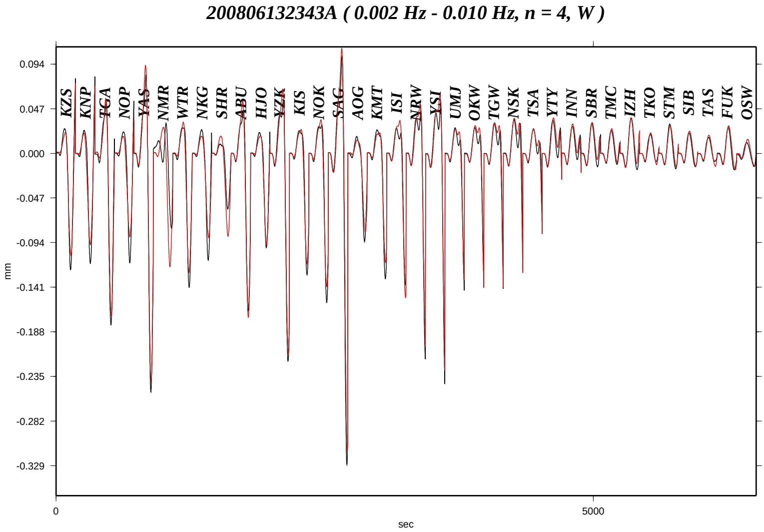
F-net, 2003-2008, $M_{jma} > 6.7$ (4/4)



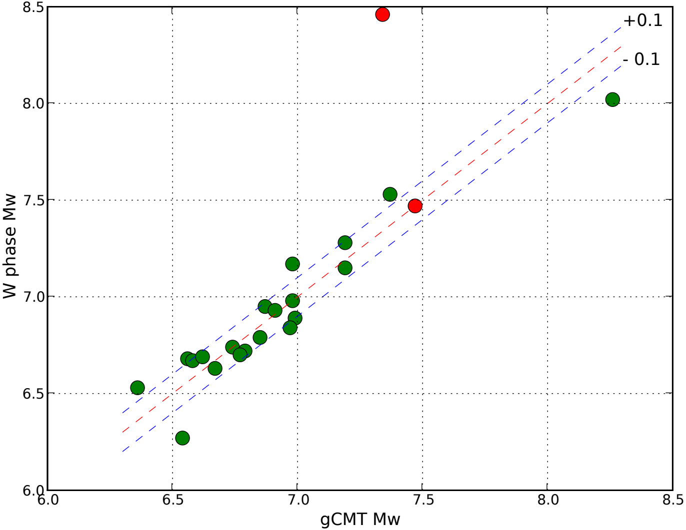
Regional W phase focal mechanisms ($t_0 + 6min$)



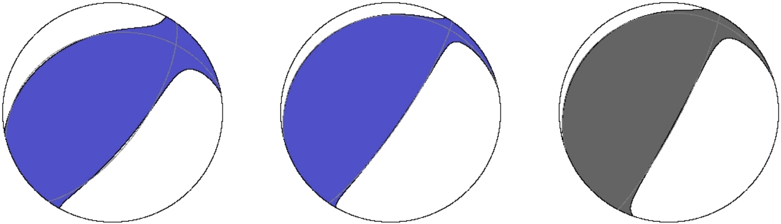
Regional W-phase, example of fit: 2008 Iwate



Moment Magnitude: gCMT - W-phase



2003 Tokachi-oki: depth effect



$H = 45km$	$H = 28km$	$HVD(H = 28km)$
$\delta = 29°$	$\delta = 14°$	$\delta = 11°$
$M_w = 8.02$	$M_w = 8.15$	$M_w = 8.26$

Conclusions

- We use F-net data in the range ($5^\circ < \Delta < 12^\circ$)
- Time window: $t_P, t_P + 180s$
- Variable frequency band:
  $(.00167Hz - .005Hz) \rightarrow (.005Hz.010Hz)$
- Moment tensor solution available at $t_0 + 6min$
- Can be done completely automatic and
- Provide a solution 6 min after the origin time.