An Investigation of Eastern North America Ground Motions Scaling Relations Using Recent Earthquake Data

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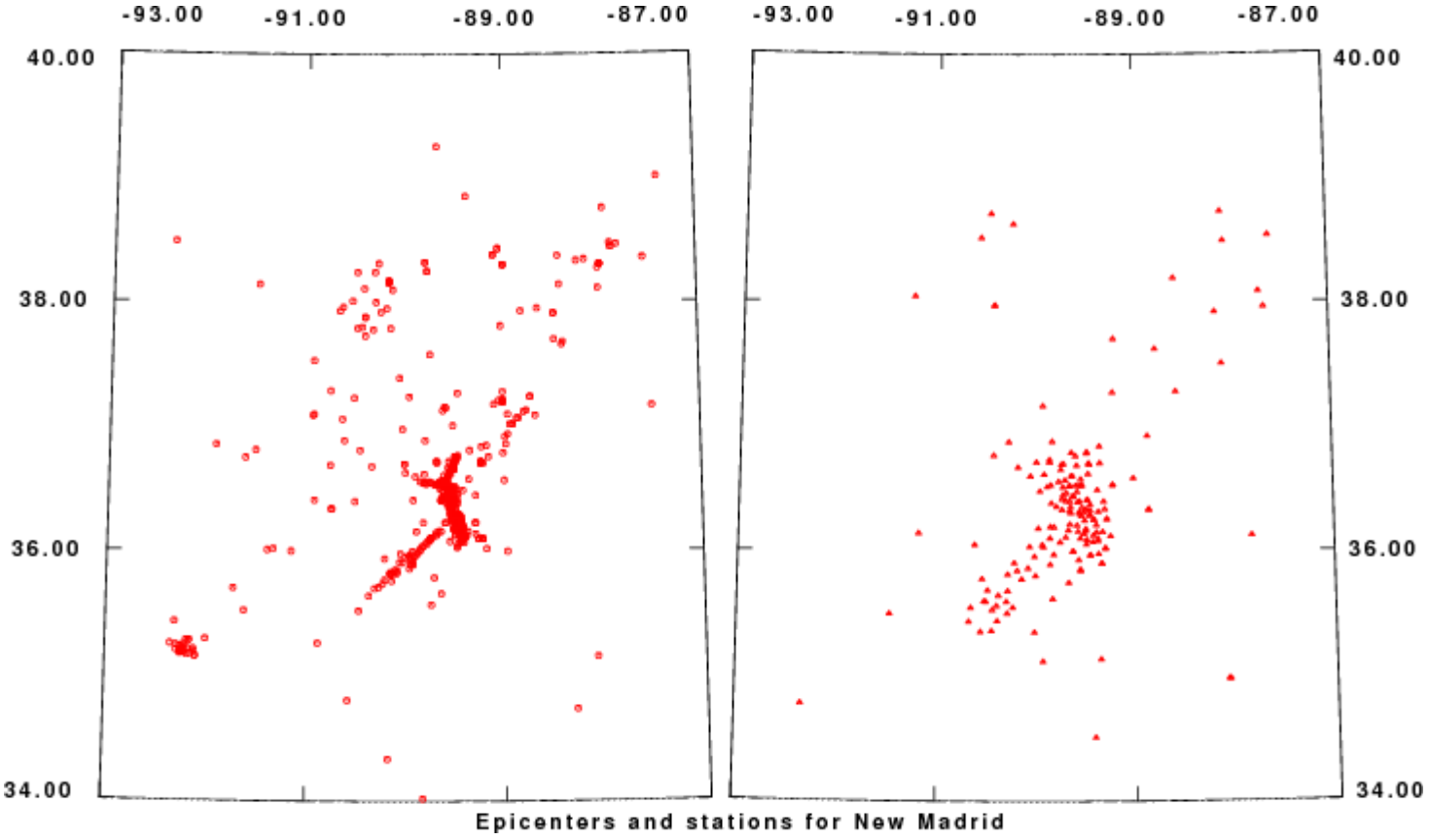
- Objectives
- Data Sets
  - 1982-2006 – analog telemetry
  - 2010-2011 – digital recordings
- Regressions
- Recent Earthquakes
- Strategies

Objectives

- Use existing data sets to
  - Define ground motion scaling relations
  - Evaluate proposed scaling relations

Central US 1982-2006



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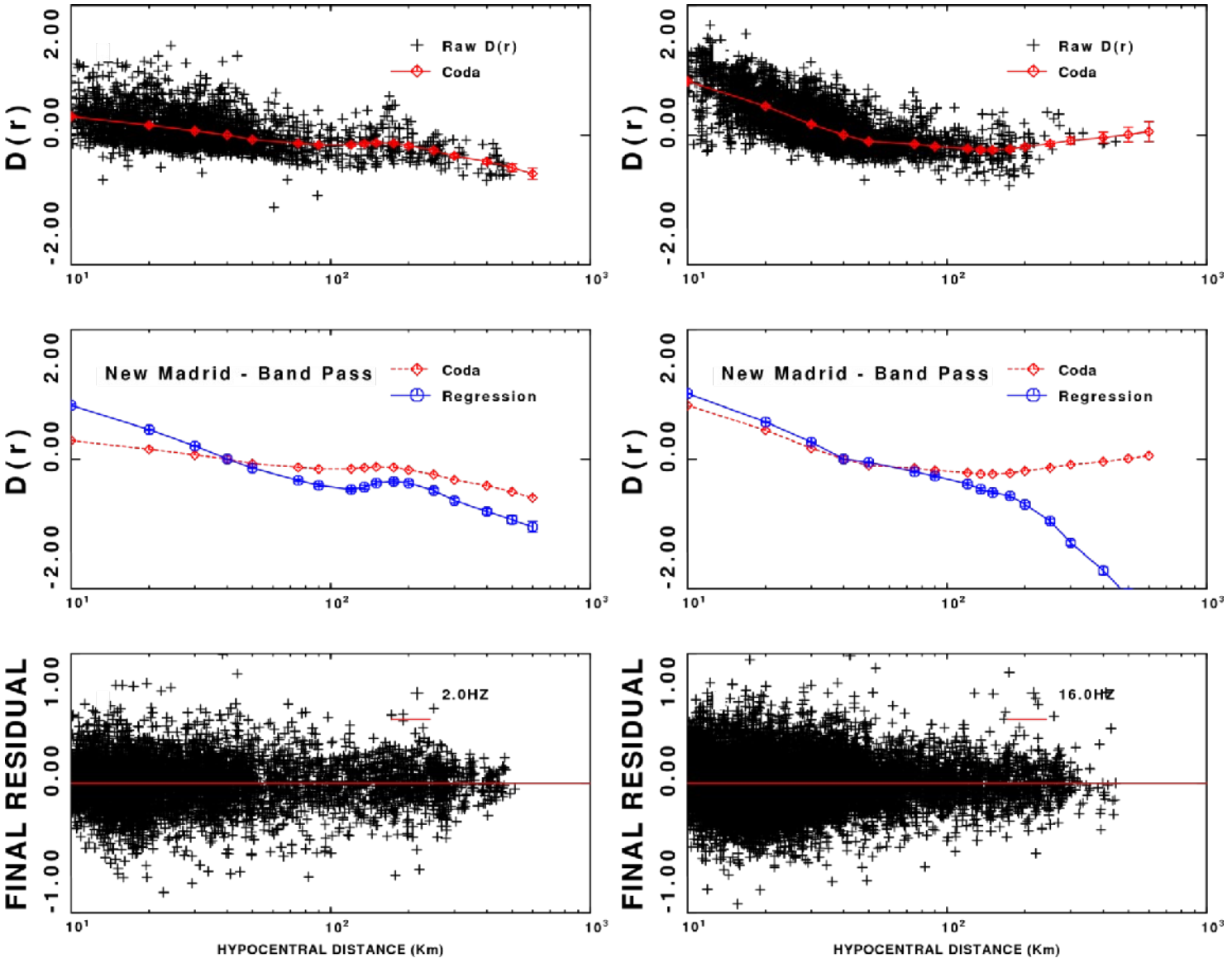
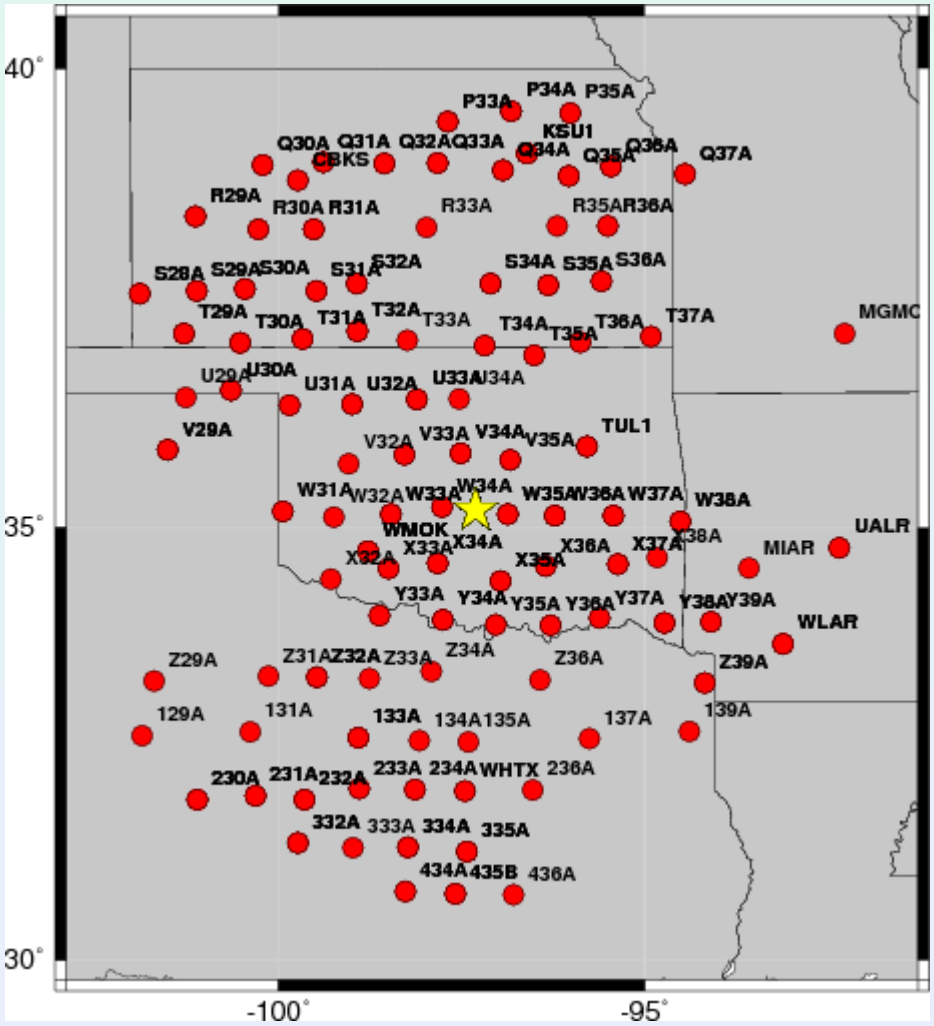


- **Problems**
  - **Small earthquakes**
  - **Many vertical observations**
  - **Depth and location**

New Digital Data Sets

- TA deployment
- Special research studies
- Repeated earthquakes
- Moment tensor solutions
  - 3 < Mw < 5.3

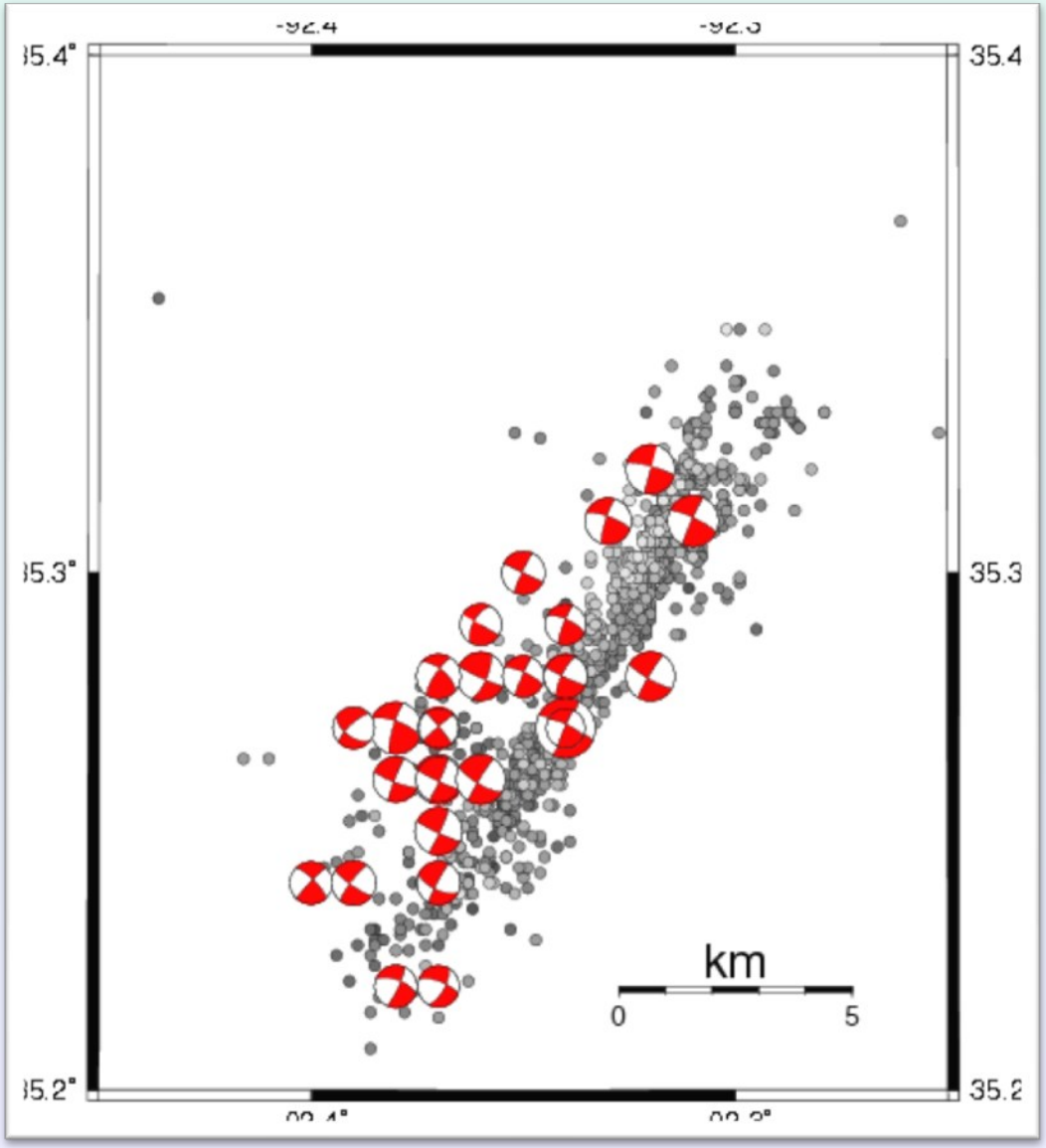
20101013140629
Mw=4.33 Oklahoma



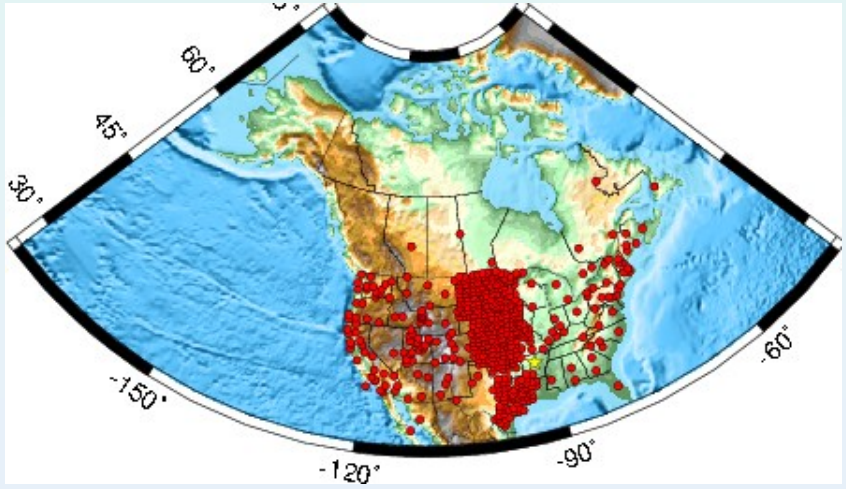
12 moment tensors (SLU/USGS)

3.0 < Mw < 4.3

Arkansas Swarm
02 SEP 2010 – 08 APR 2011



20110228050050
Mw=4.65 Arkansas

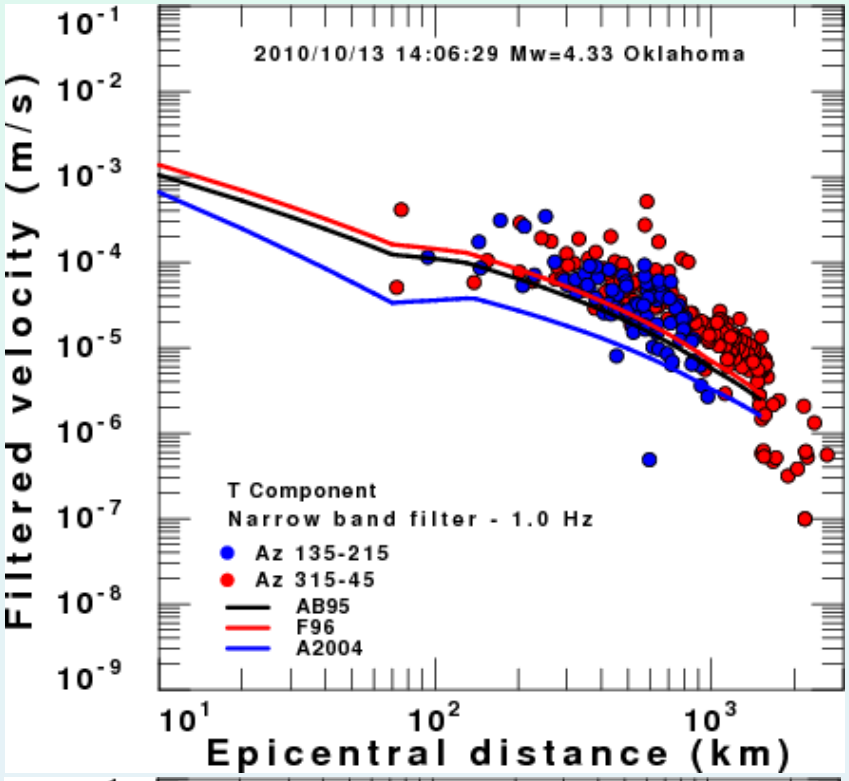


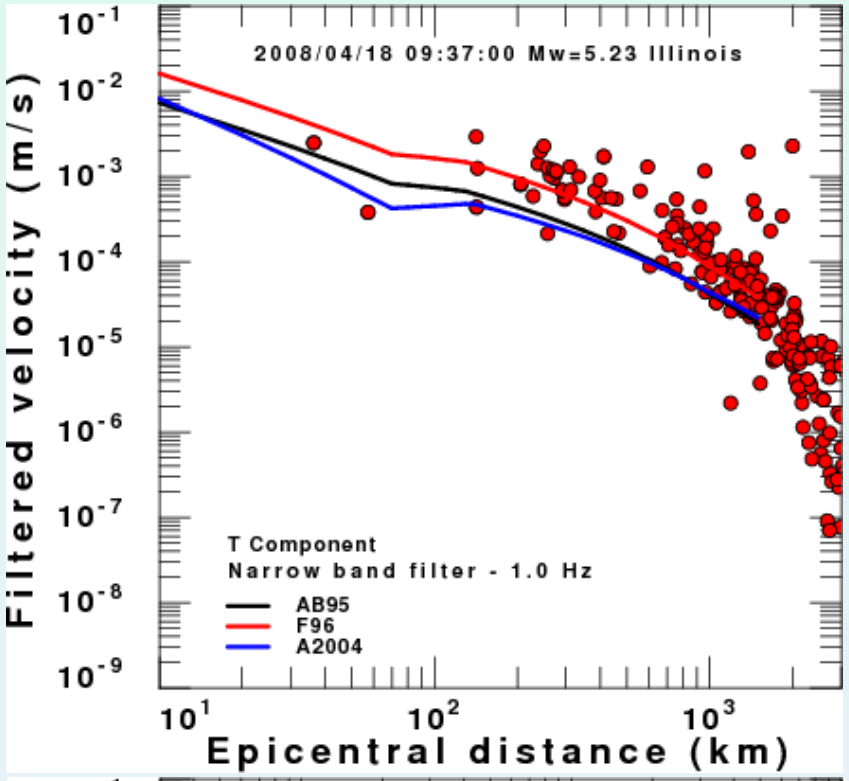
1105 earthquakes (CERI/ANSS)

28 moment tensors (SLU/USGS)

Forward Modeling

- Narrow band pass filter waveforms for selected events – select peaks,
- Use propagational models with random vibration theory to predict the same filtered waveforms,
- In order to view model performance and to assess data set inadequacies


2010/10/13 14:06:29 Mw=4.33 Oklahoma
Filtered velocity (m/s)
Epicentral distance (km)
T Component
Narrow band filter - 1.0 Hz
Az 135-215
Az 315-45
AB95
F96
A2004


2008/04/18 09:37:00 Mw=5.23 Illinois
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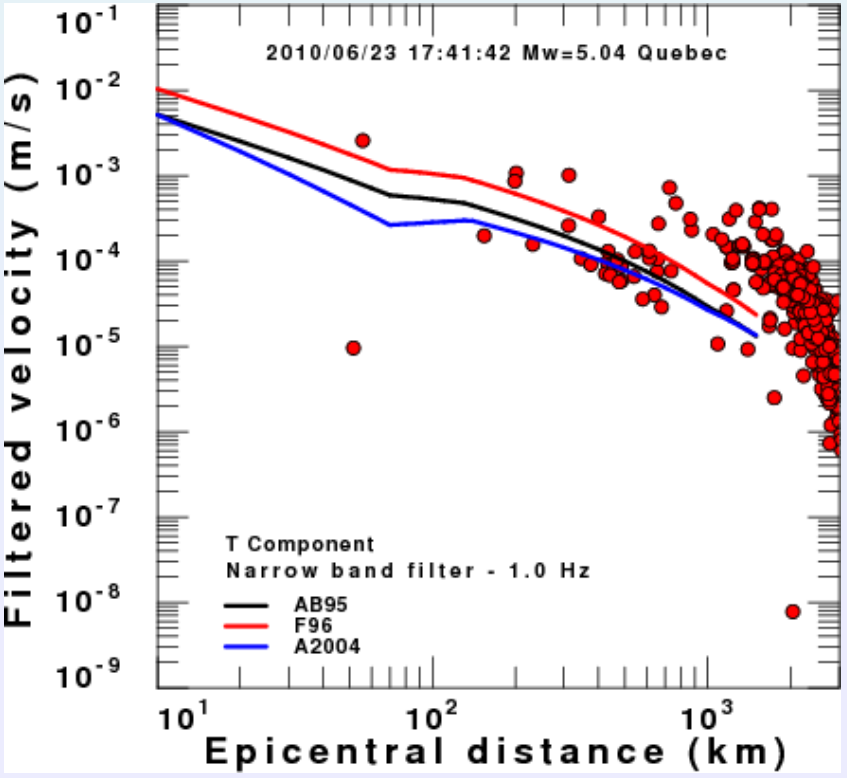
2010/06/23 17:41:42 Mw=5.04 Quebec
Filtered velocity (m/s)
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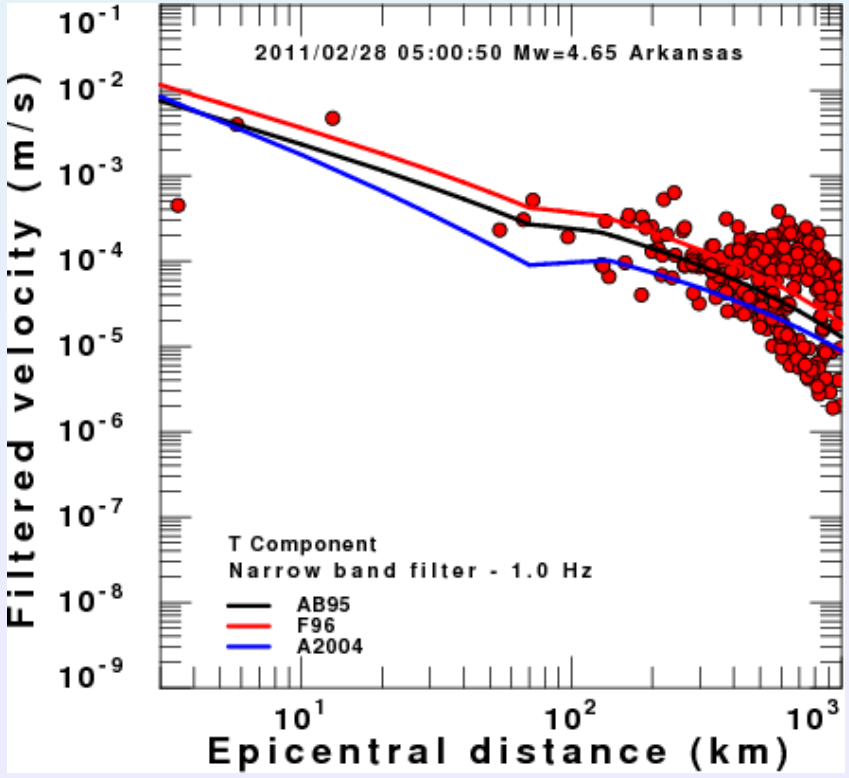
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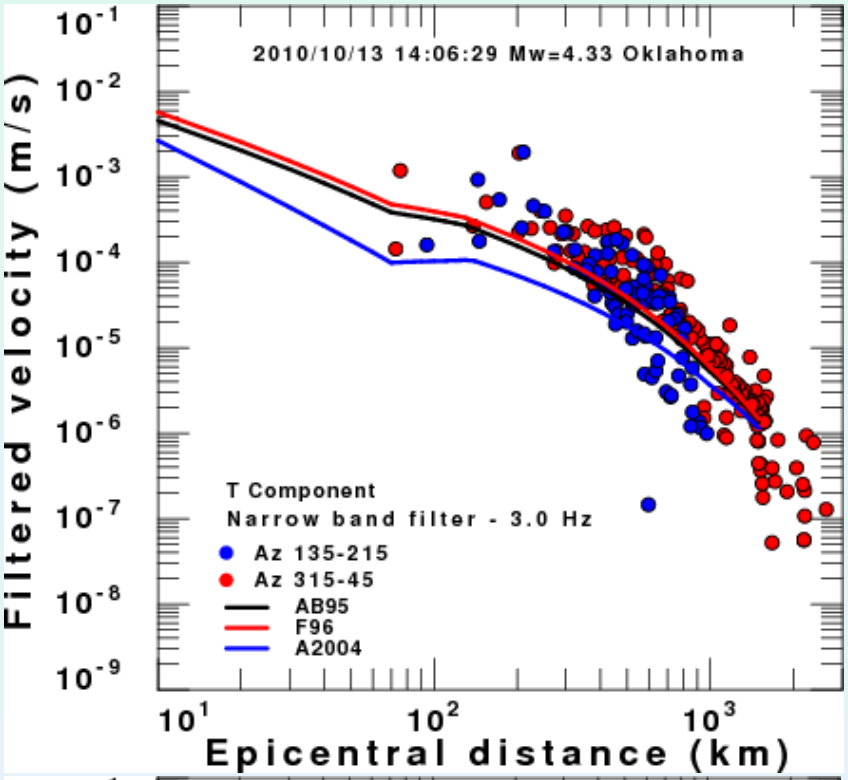
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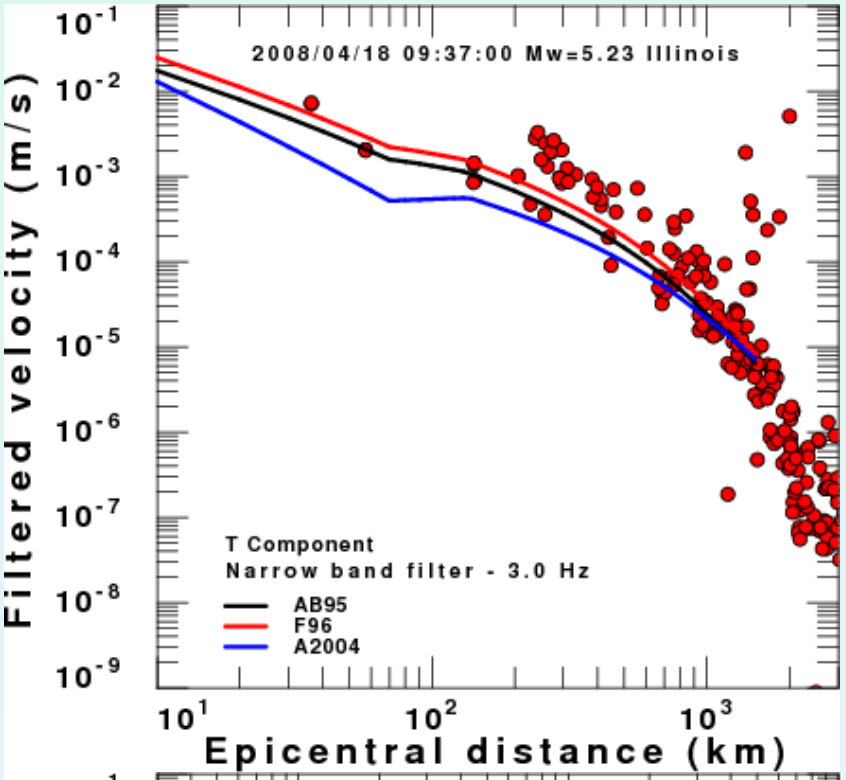
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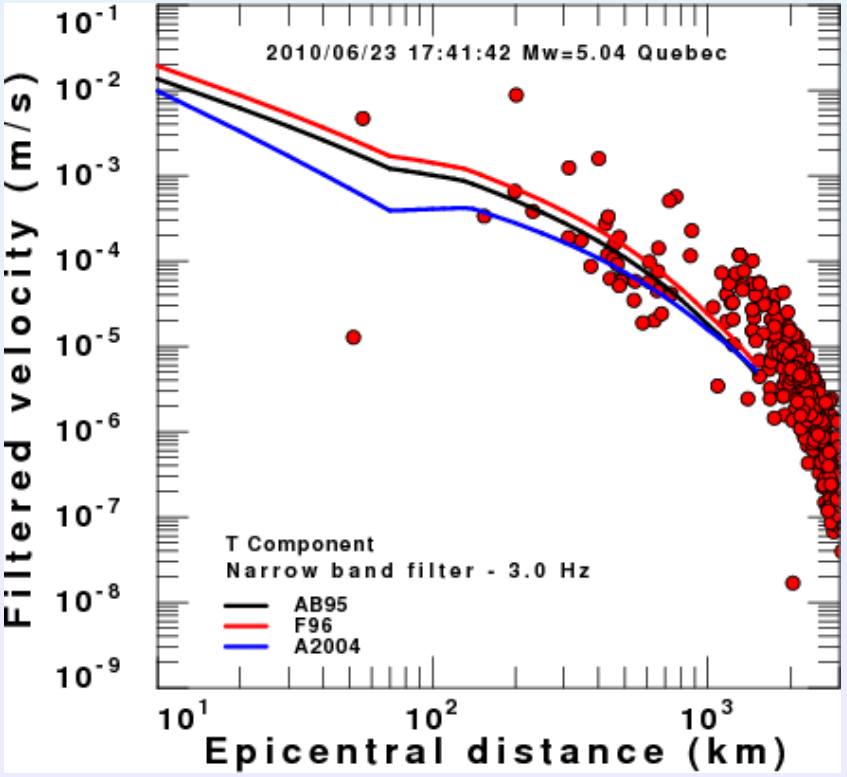
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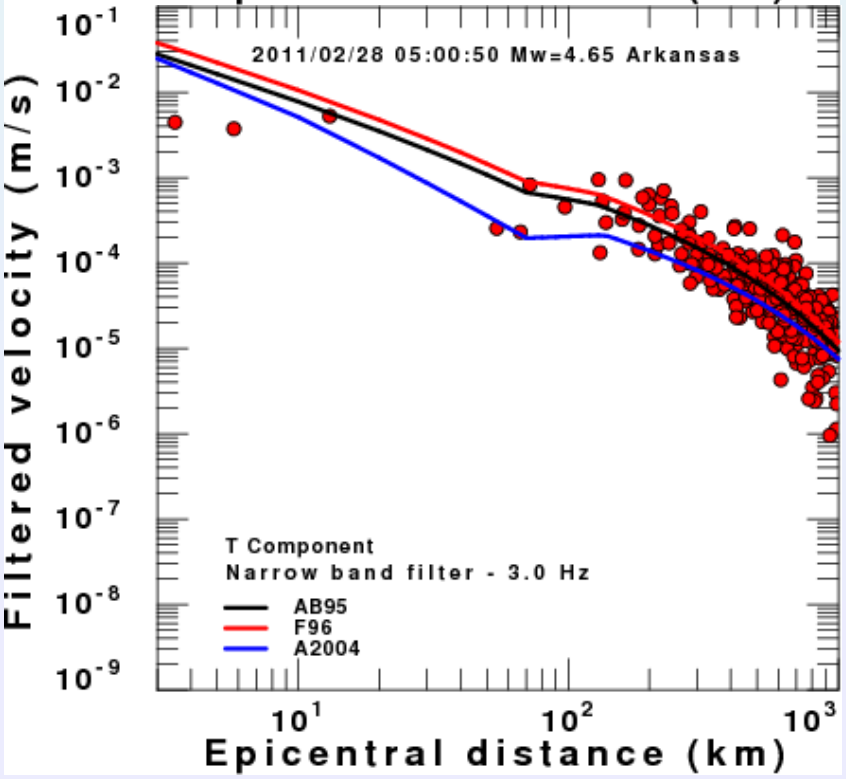
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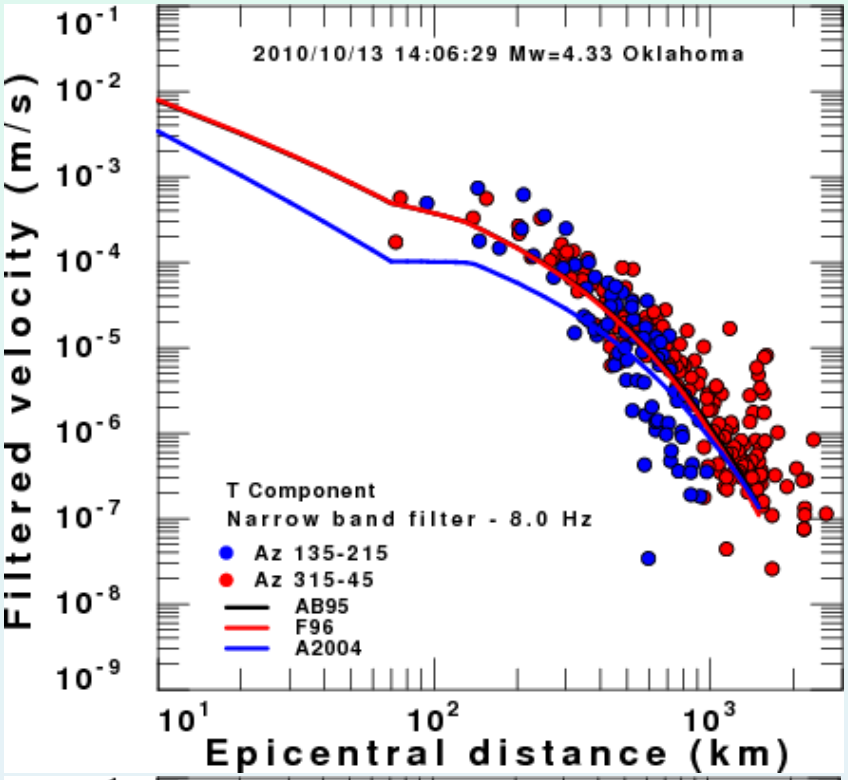
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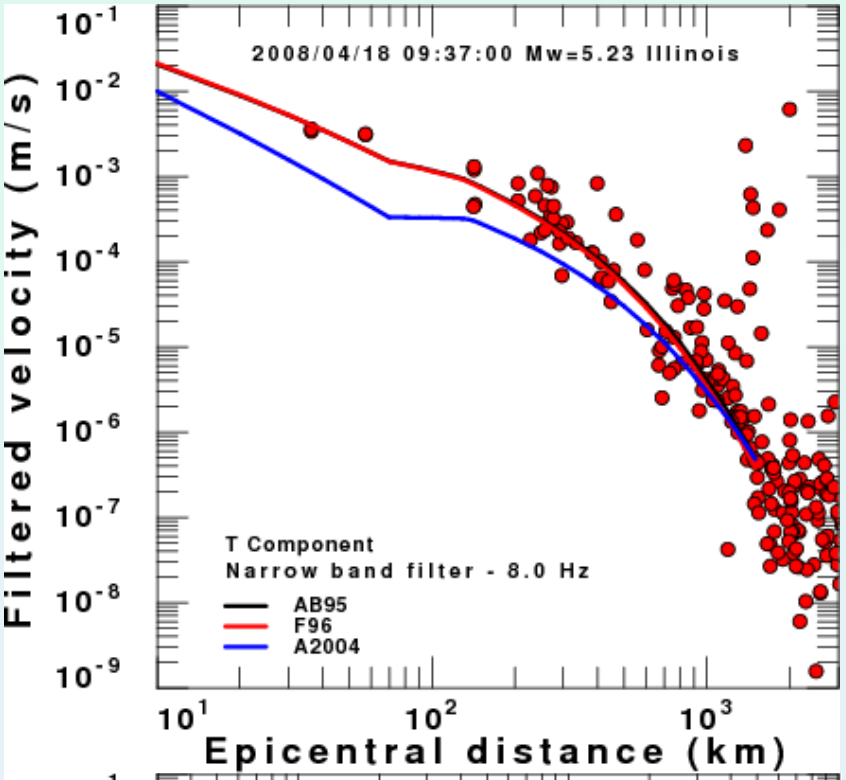
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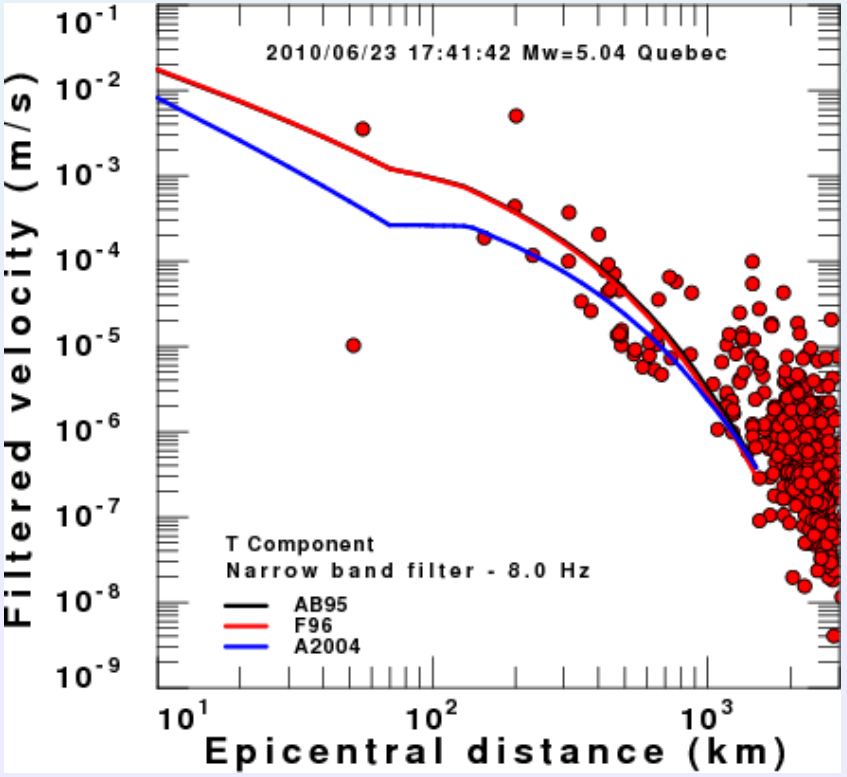
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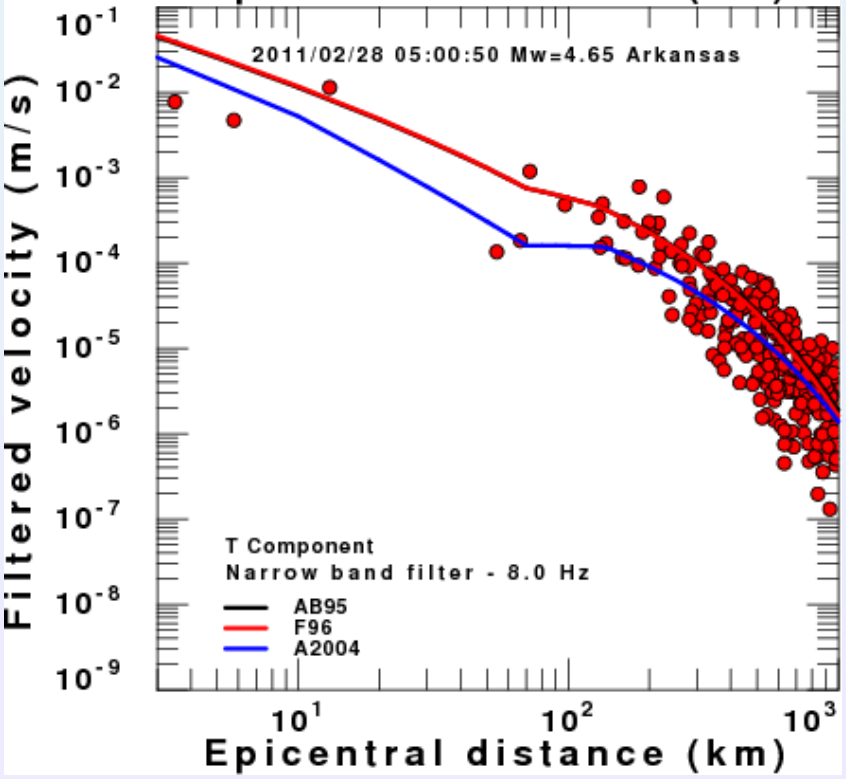
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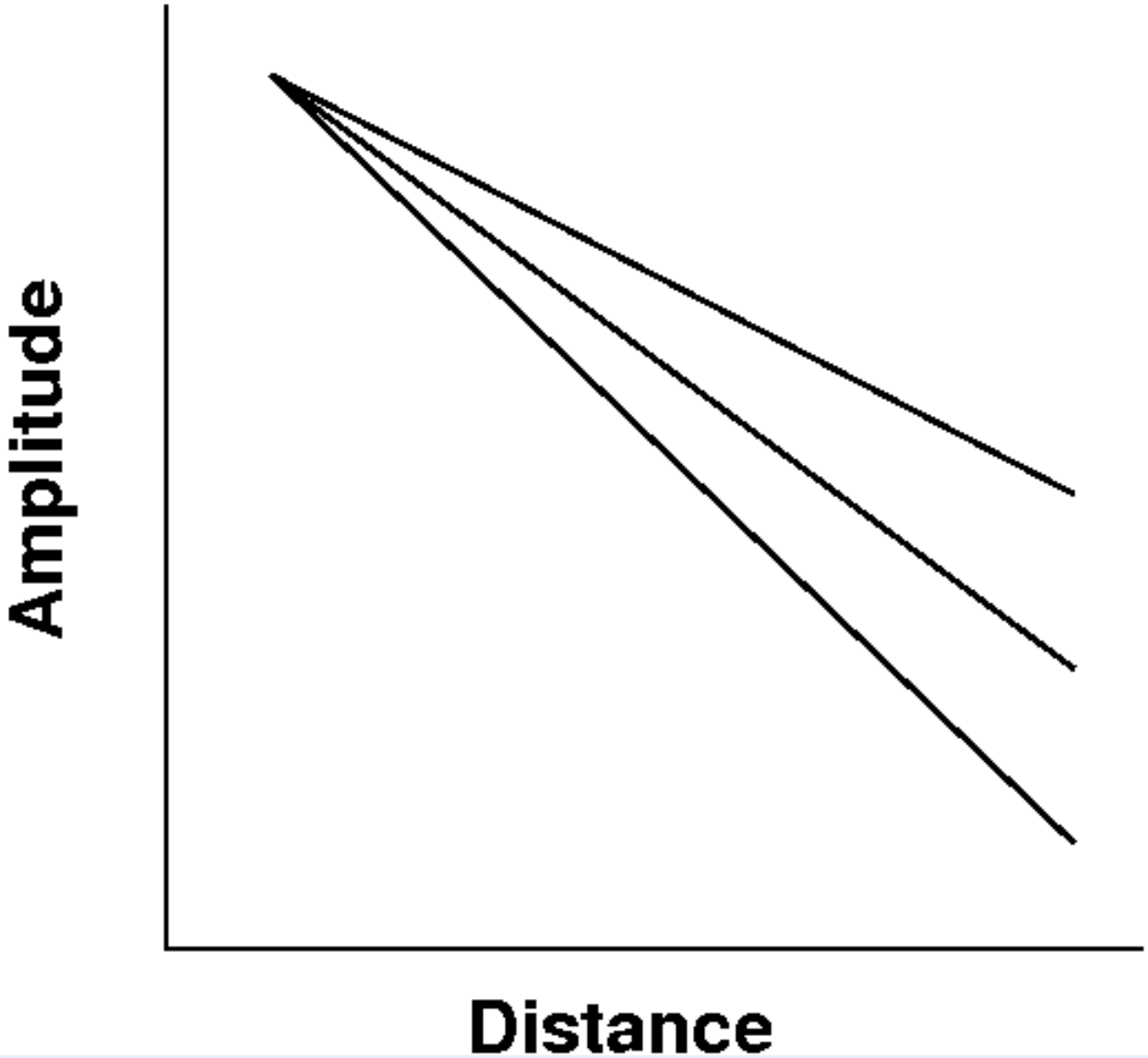
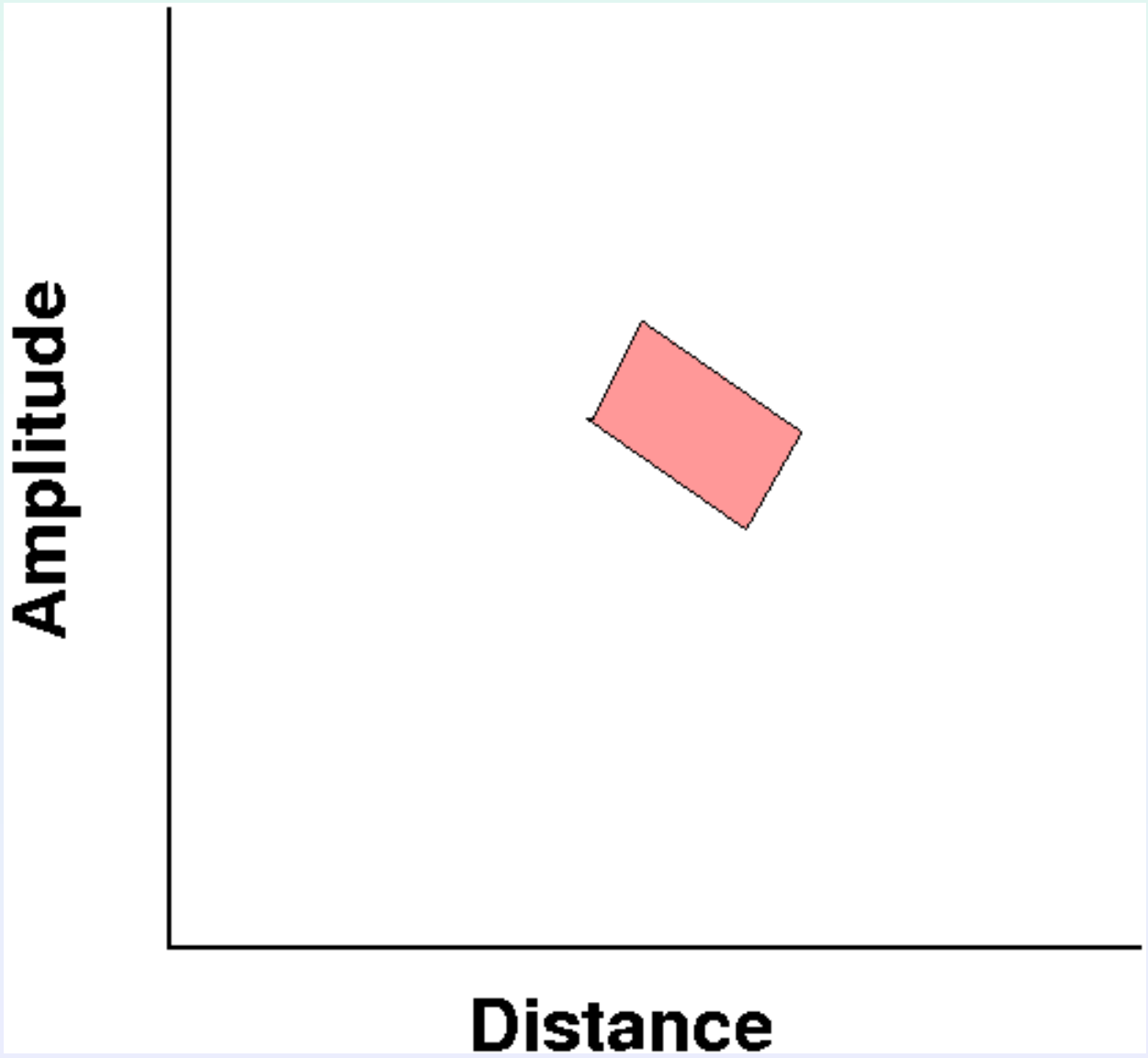
Cautions

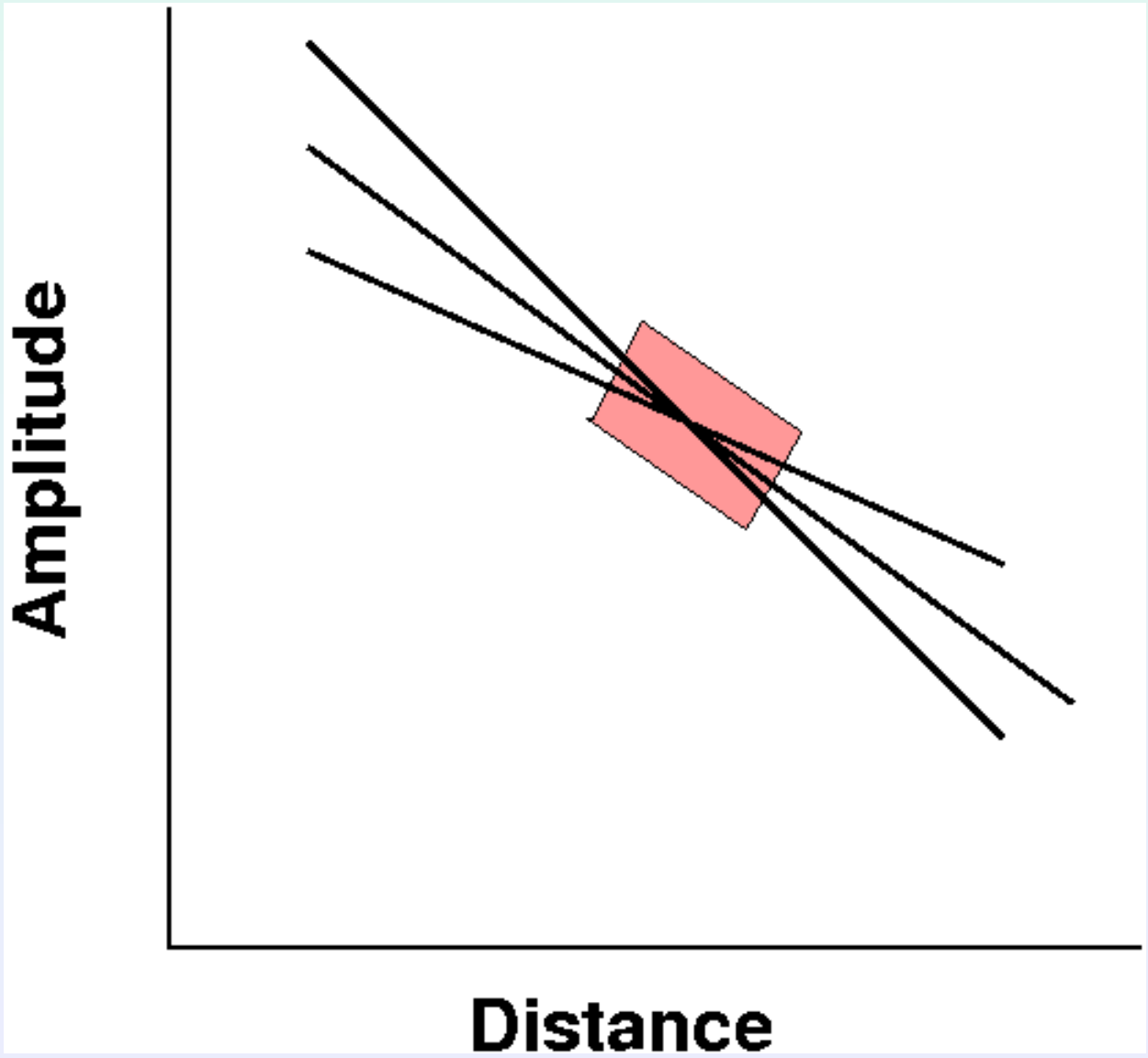
- 2-D wave propagation
  - Strong site effects, e.g., Mississippi Embayment, some Gulf Coast sites
  - Spatial variation of crustal structure – affects Moho bump
  - Path dependent Q effects – recent TA data is appropriate to Great Plains paths

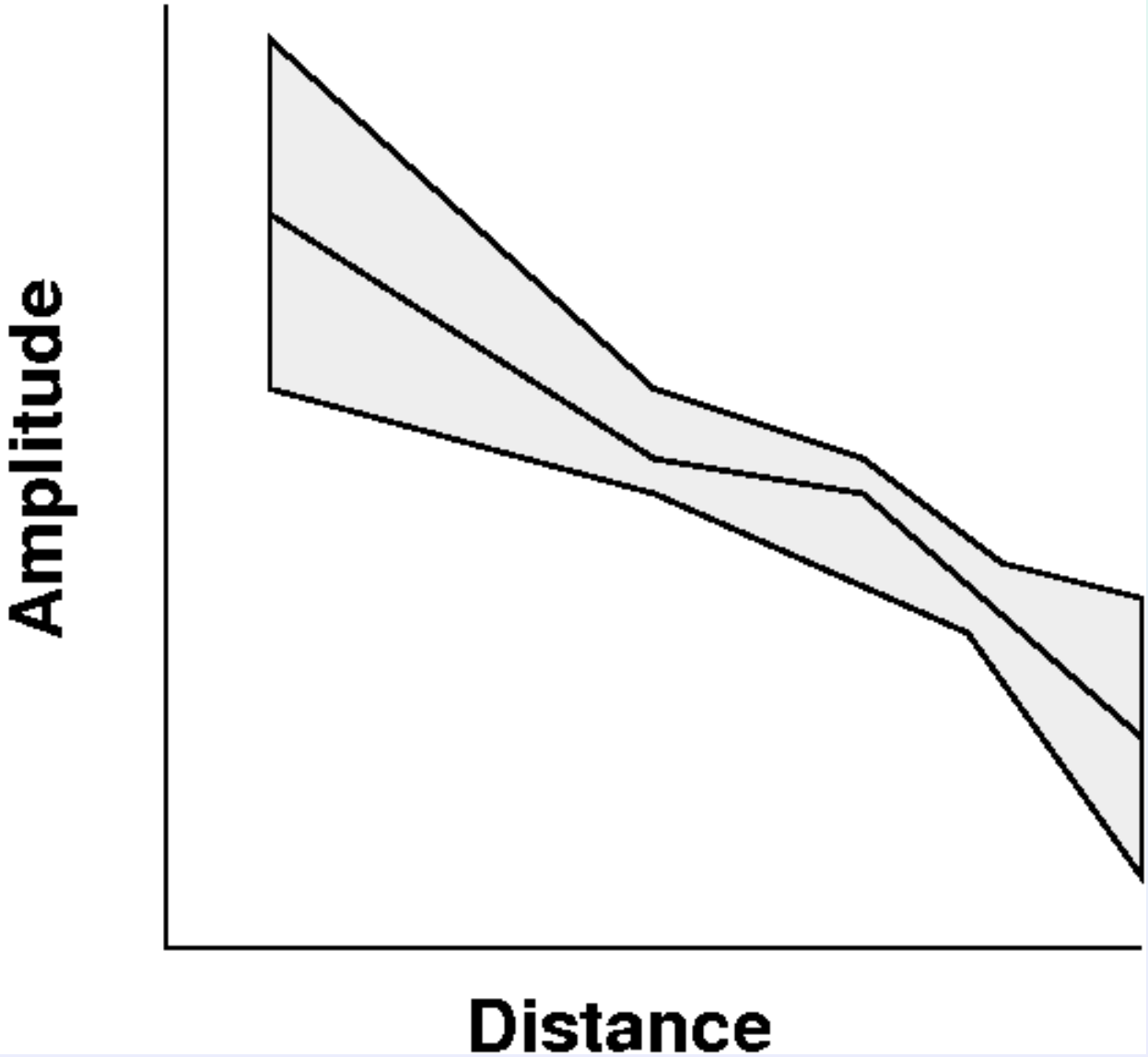


Emphasis on model



Data


Amplitude
Distance



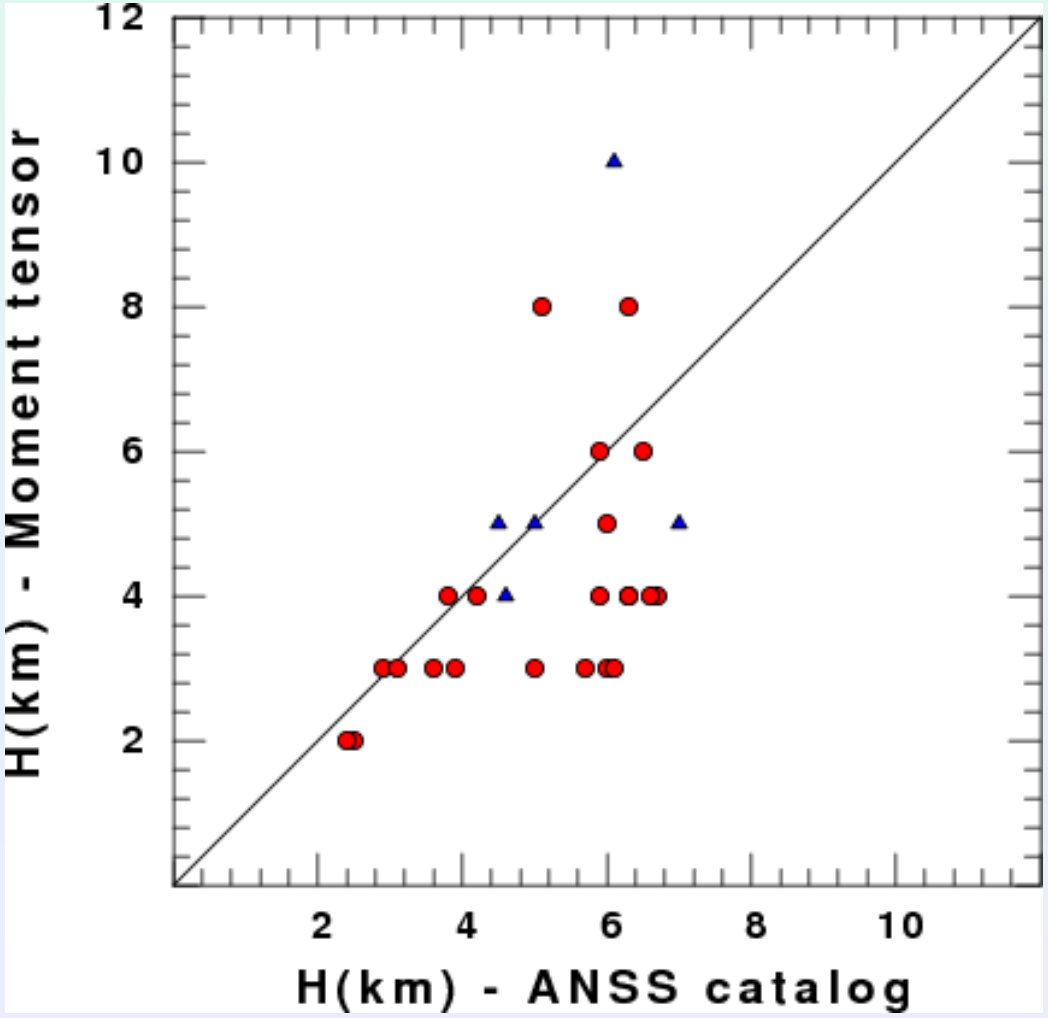
Model view that accounts for observations and source scaling constraints

Strategies

- Although recent data sets are an improvement, there are significant inadequacies, so
- Aggressively instrument swarm activity and large earthquake to
  - Quantify the source (Moment tensor)
  - Provide precise locations for source depth and distance
  - Provide data sets to address distance scaling relations

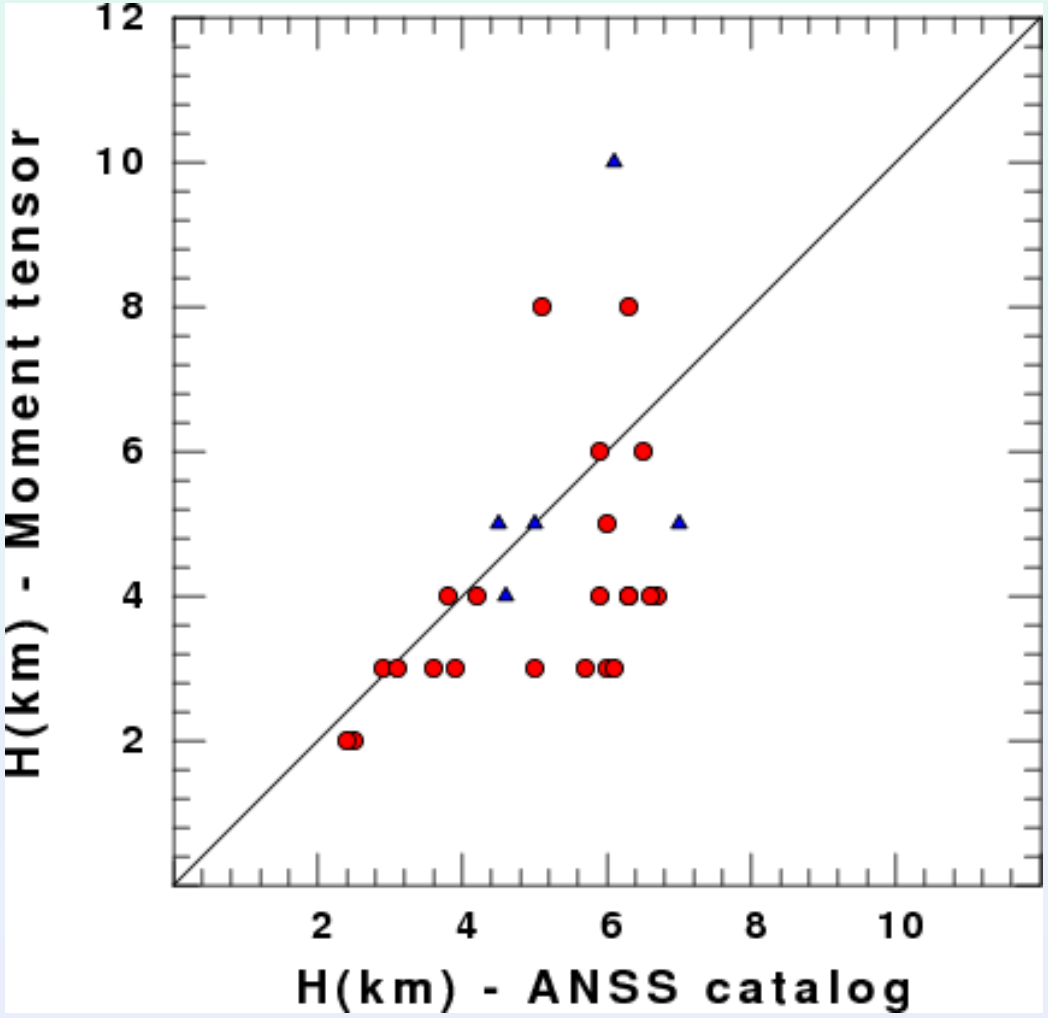
Finally

- There are now significant data sets for
  - Strike-slip earthquakes, and
  - 45 Dip-slip earthquakes,
  - with broadband determinations of moment magnitude and source depth



Comparison of regional moment tensor depths to catalog depths

Blue – 2010 earthquakes
Red – 2011 earthquakes



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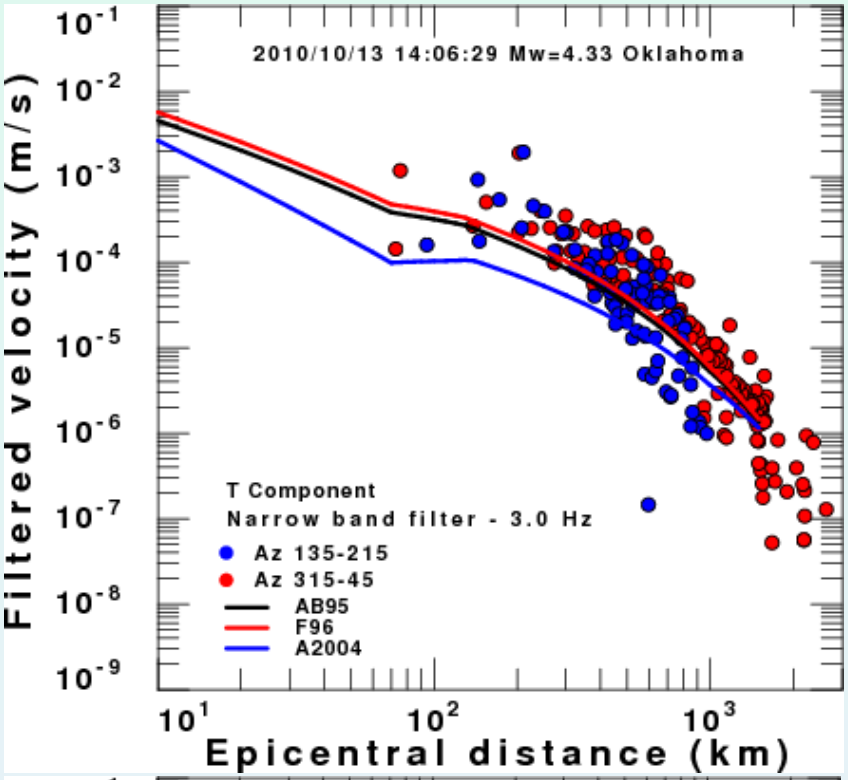
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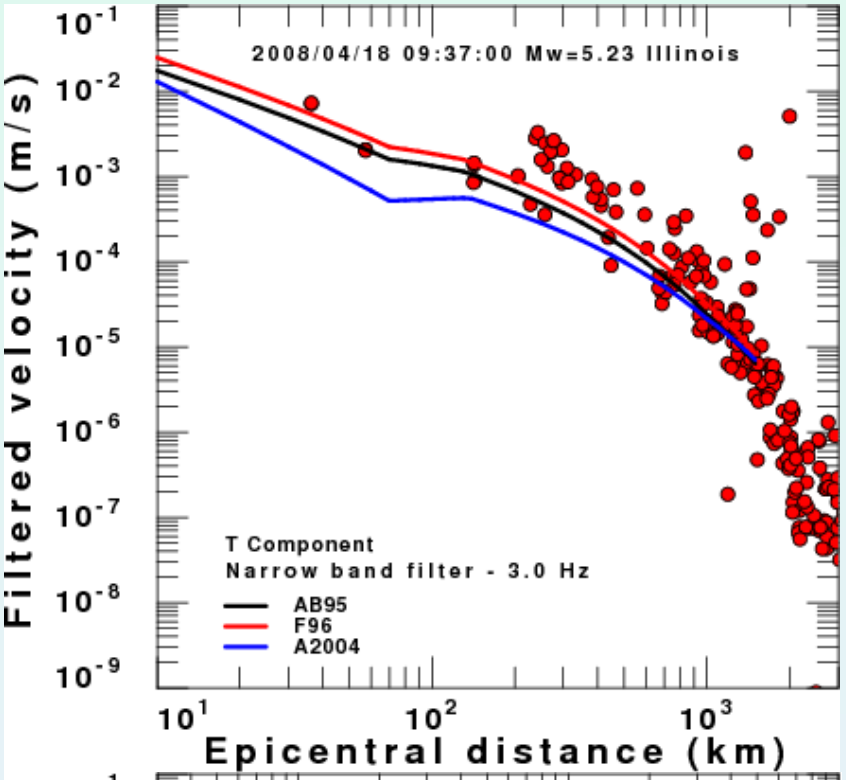
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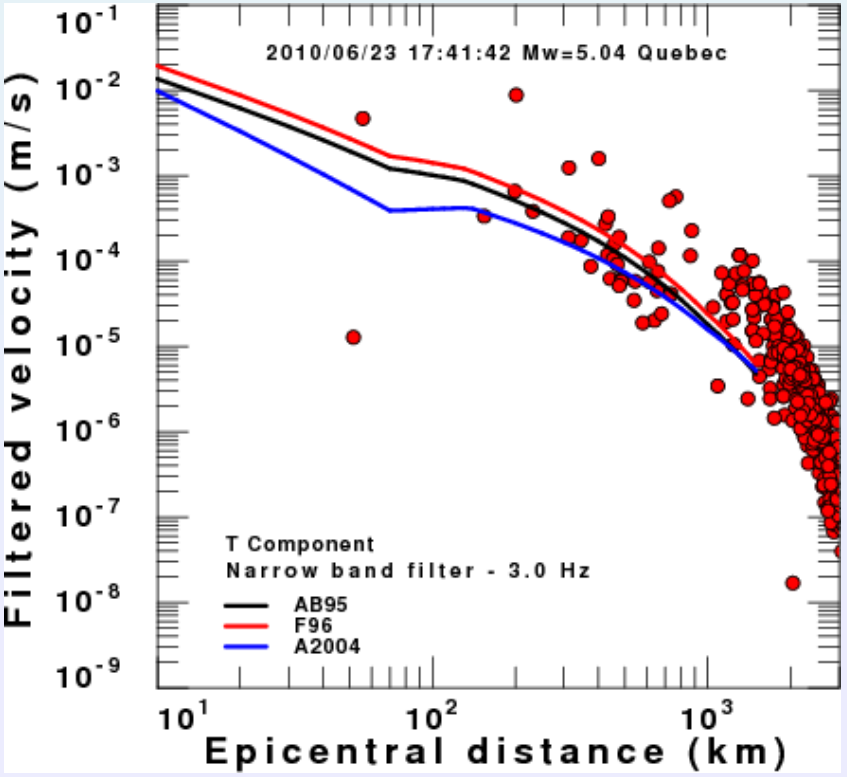
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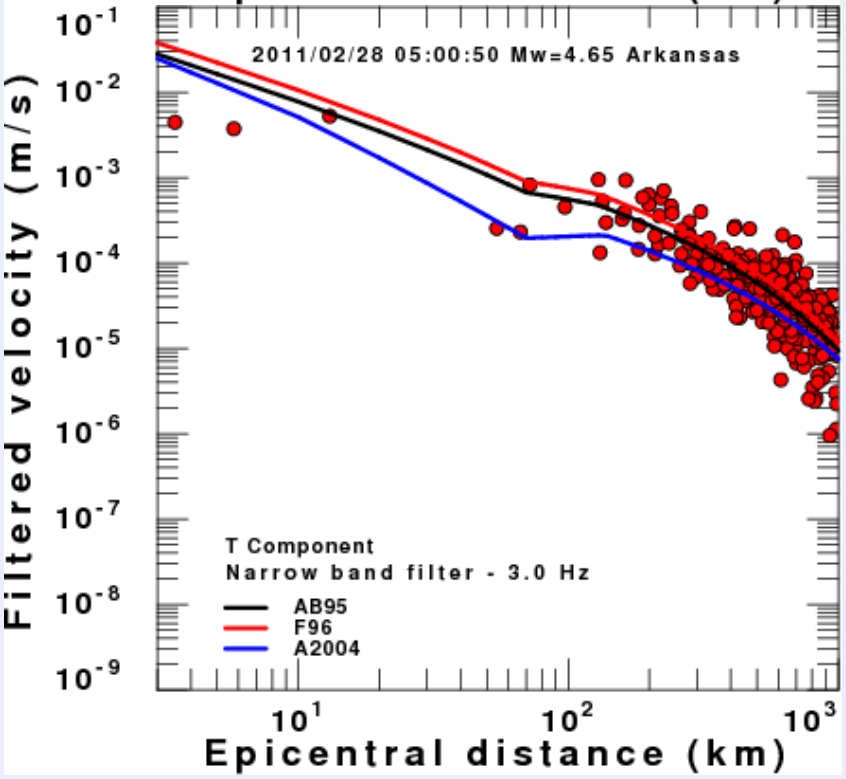
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