NET-VISA

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Bayesian Logic, Inc.

Sponsored by the CTBTO
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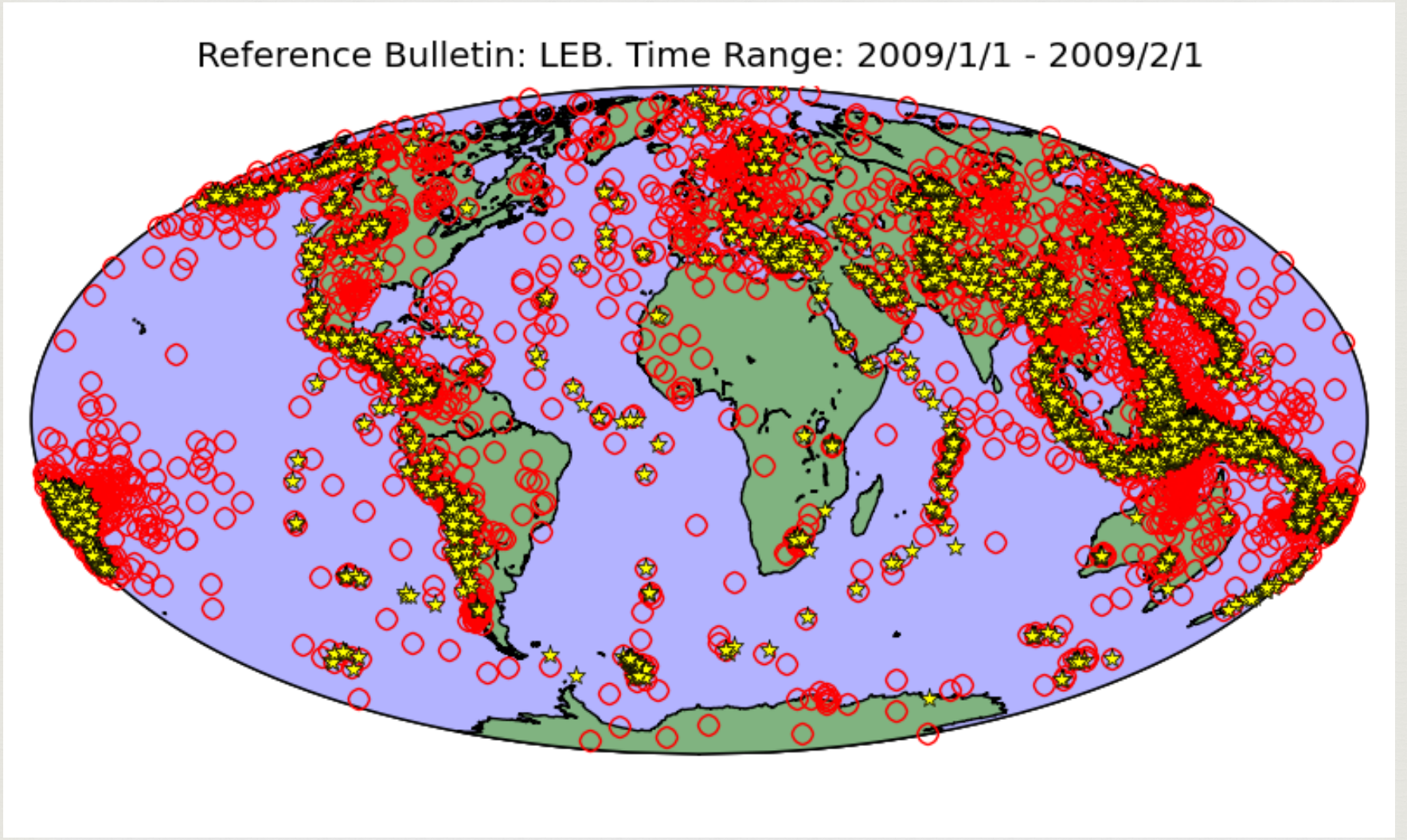
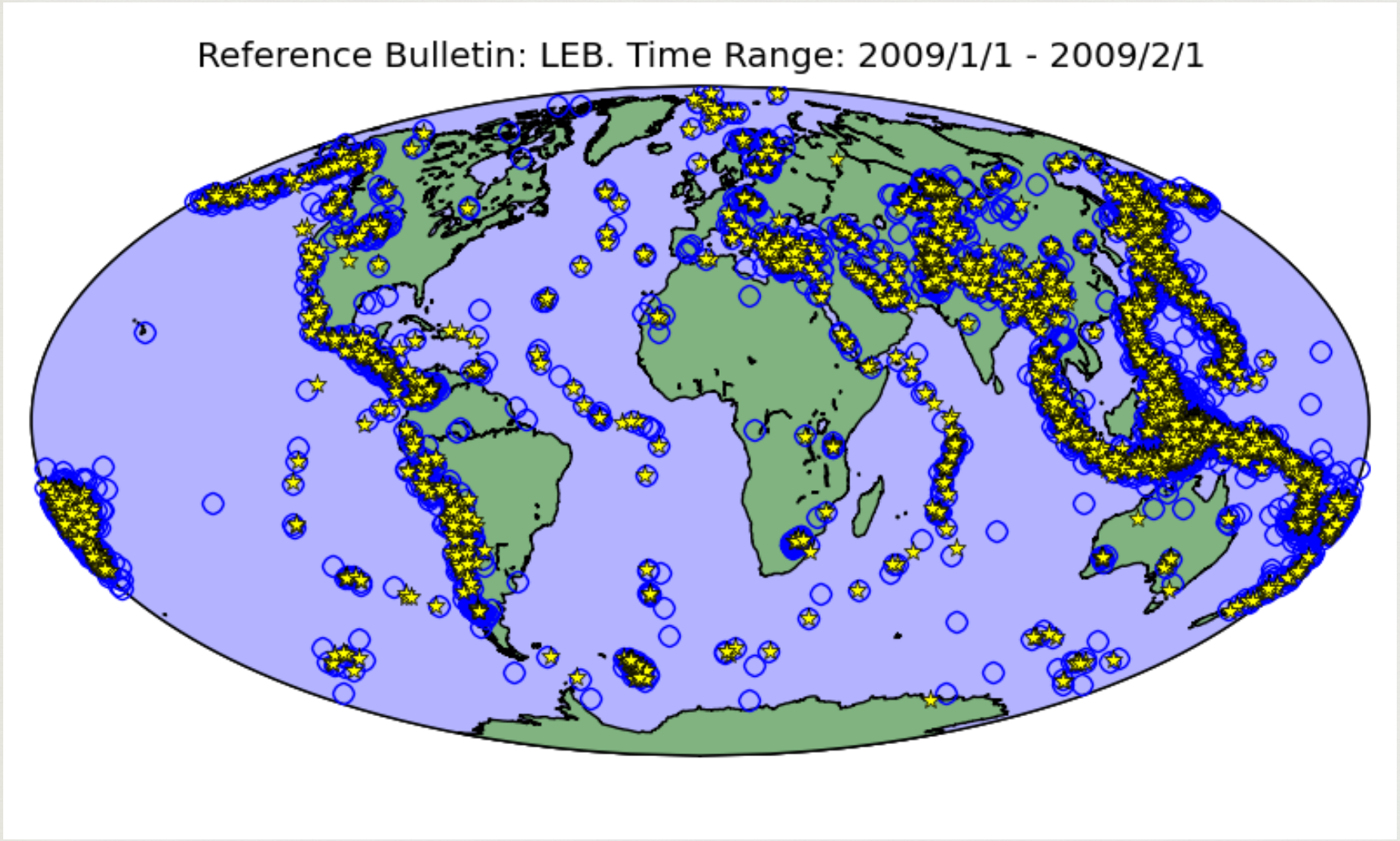
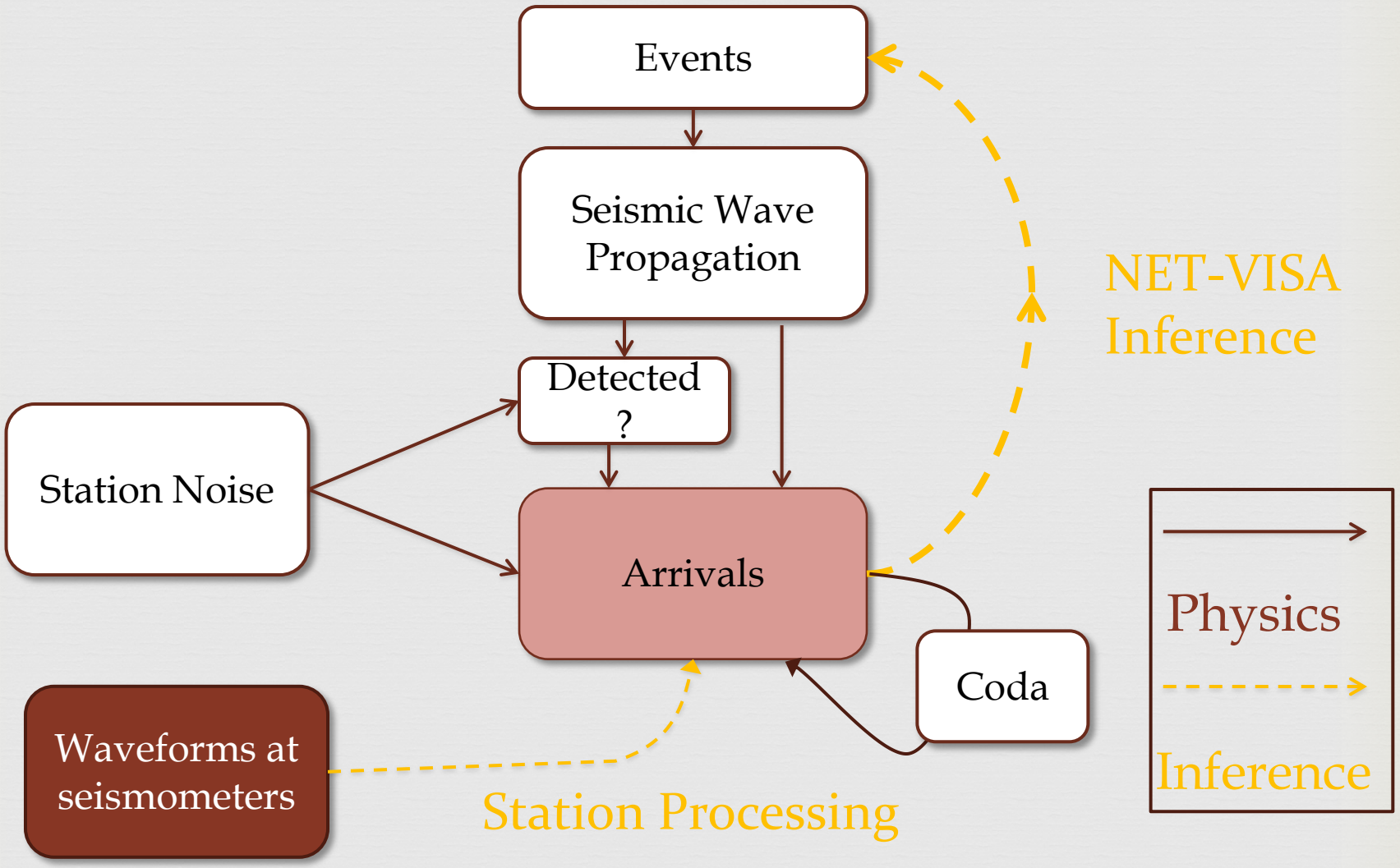
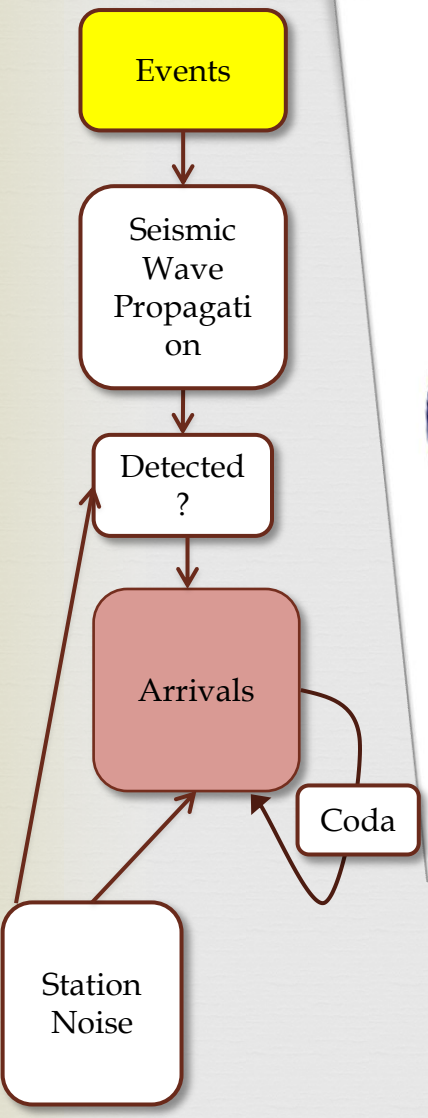

Reference Bulletin: LEB. Time Range: 2009/1/1 - 2009/2/1

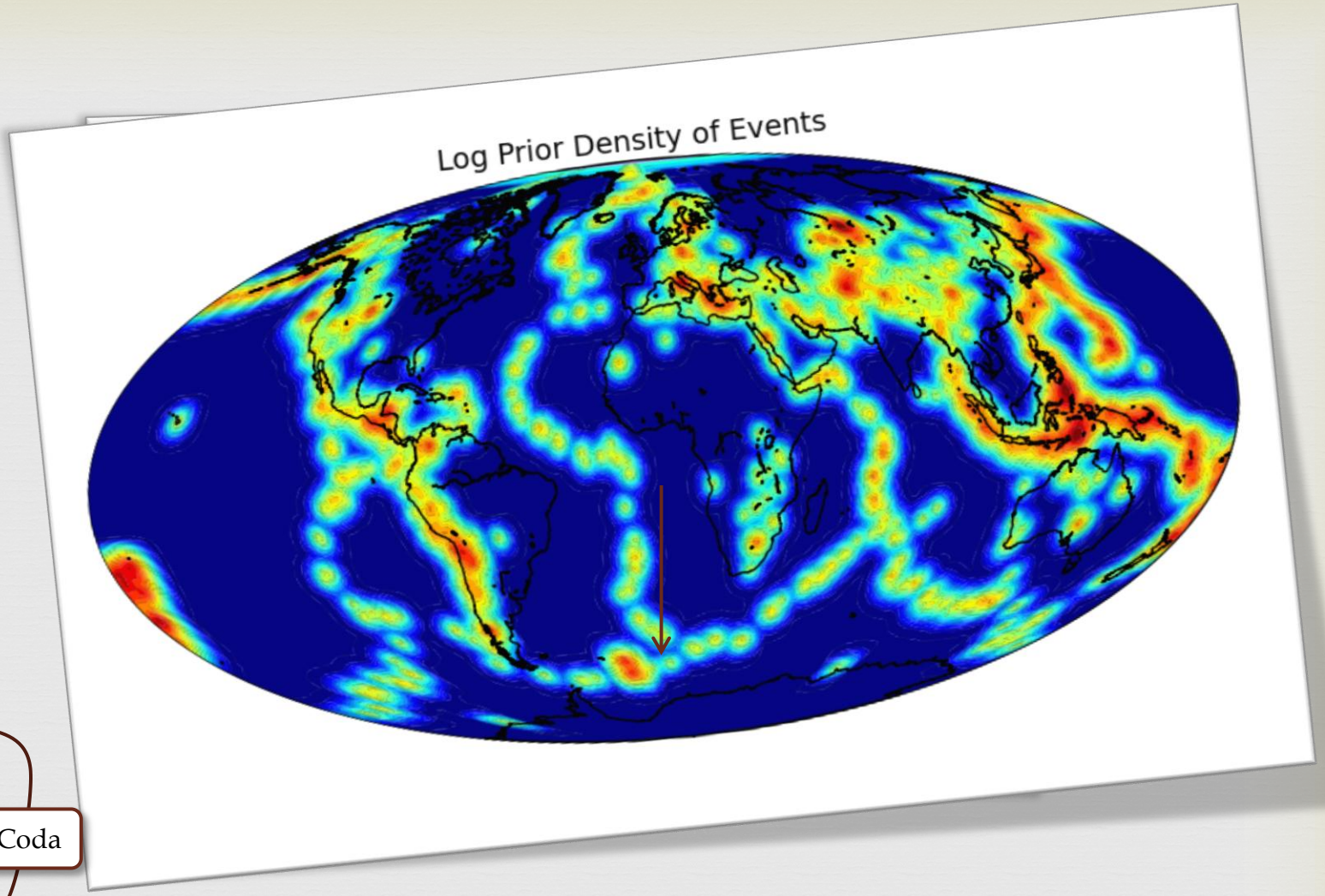

Reference Bulletin: LEB. Time Range: 2009/1/1 - 2009/2/1

Overview

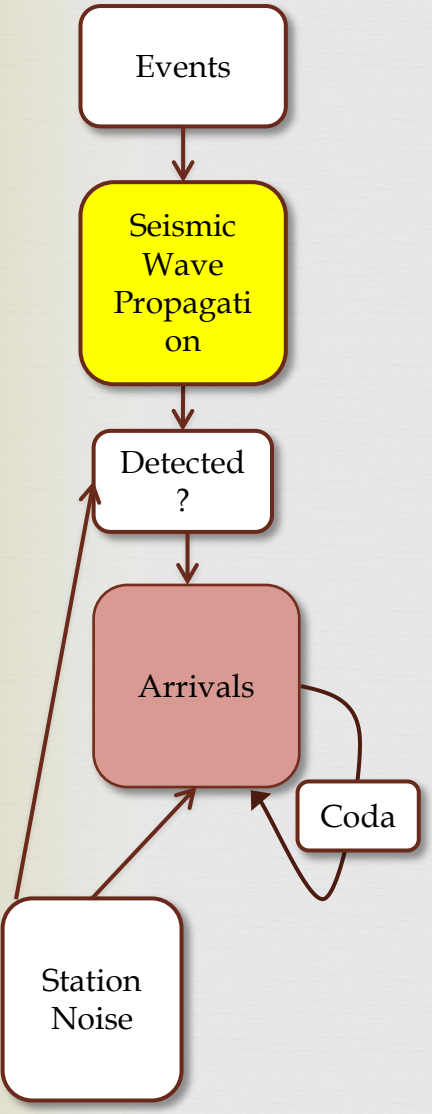
- Generative Probabilistic Model
- Inference
- Normal events
- Large aftershock sequences
- Future Improvements


Events
Seismic Wave Propagation
Detected ?
Station Noise
Arrivals
Coda
Waveforms at seismometers
NET-VISA Inference
Station Processing
Physics
Inference





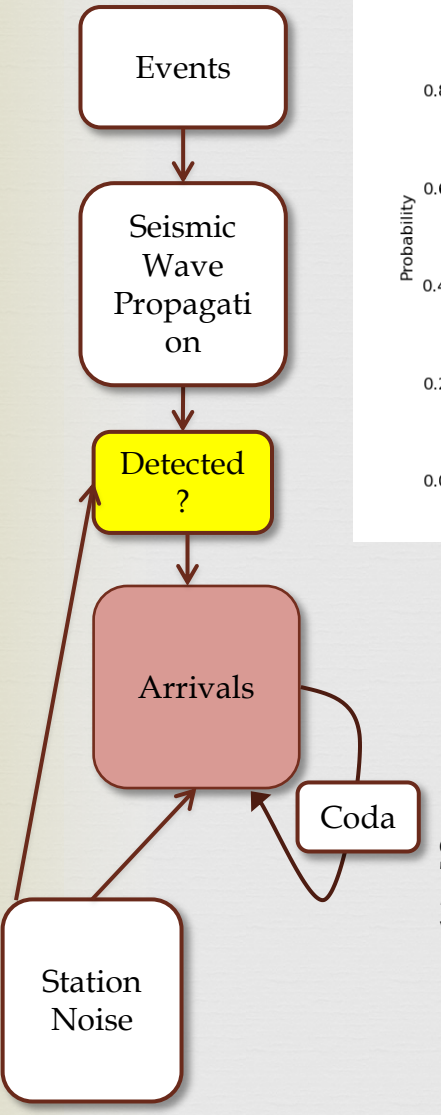
Seismic Event Location Prior

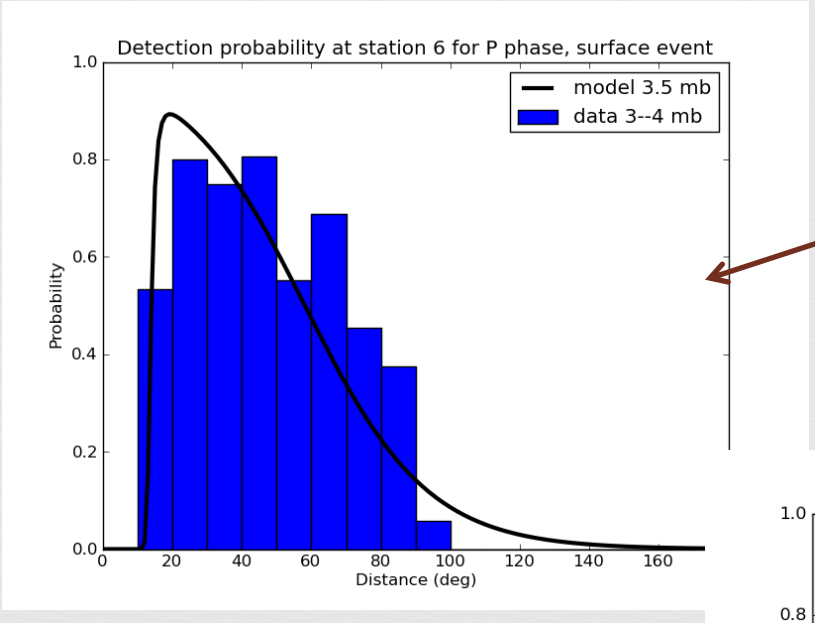


IASPEI
- Travel Time
- Slowness
- Azimuth

Phase Relative Order
- P before S
- P has higher slowness than S
- etc.

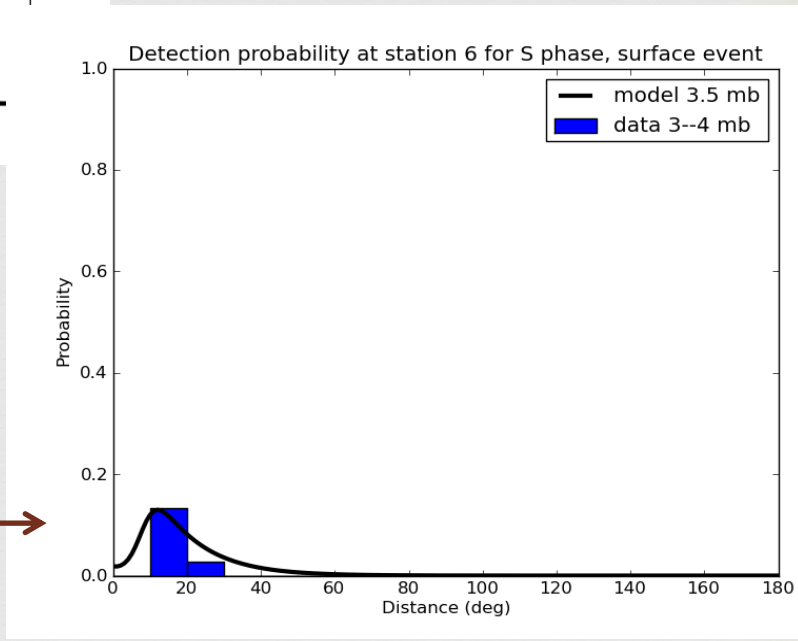
Seismic Wave Propagation



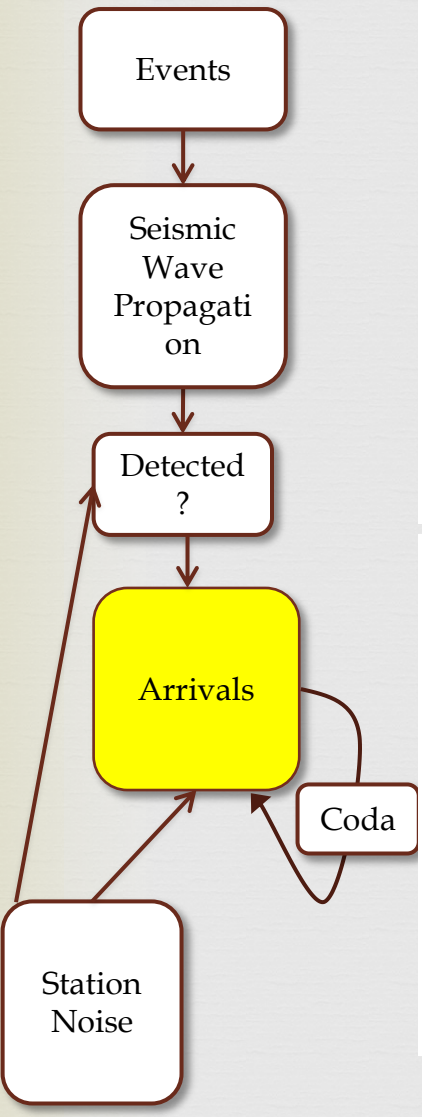


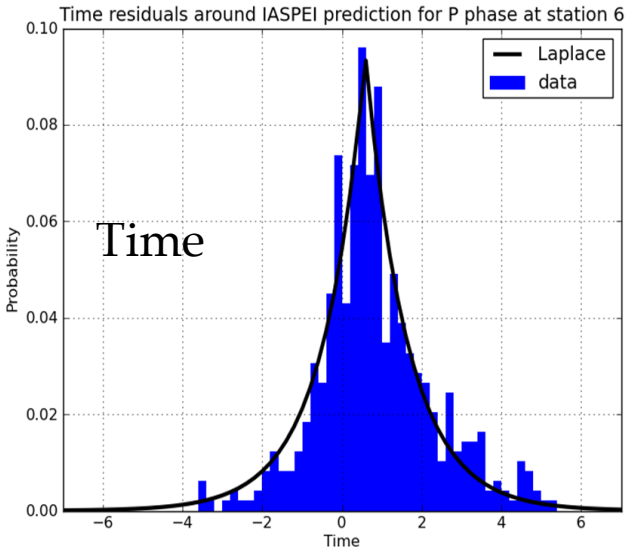
P Phase for surface event 3.5 mb

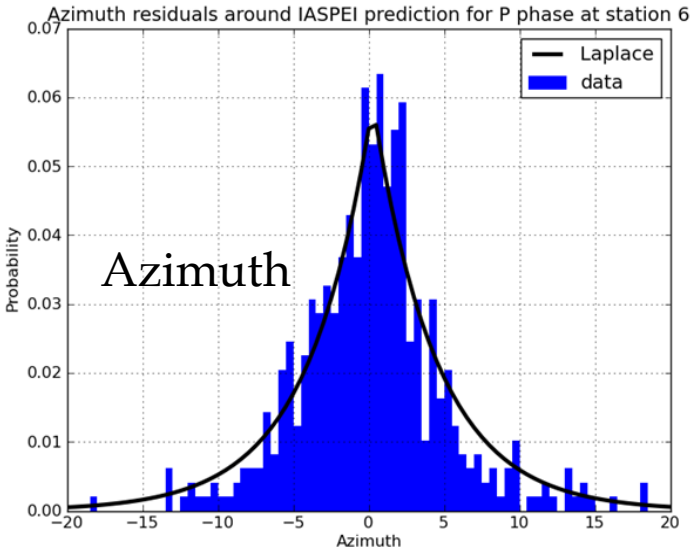
S Phase for surface event 3.5 mb

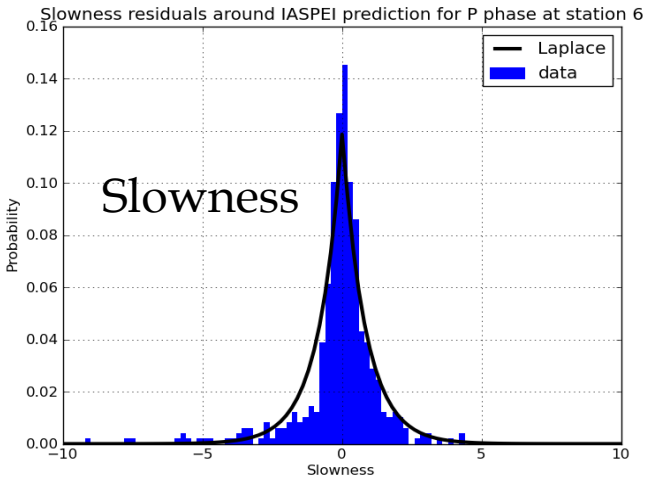


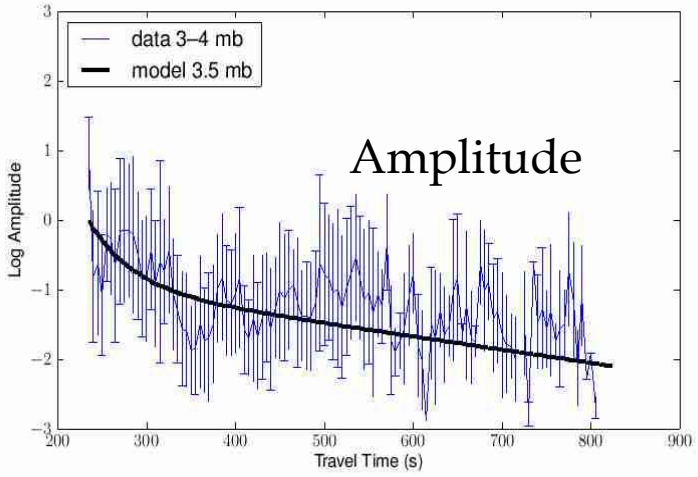
Phase Detection Probability



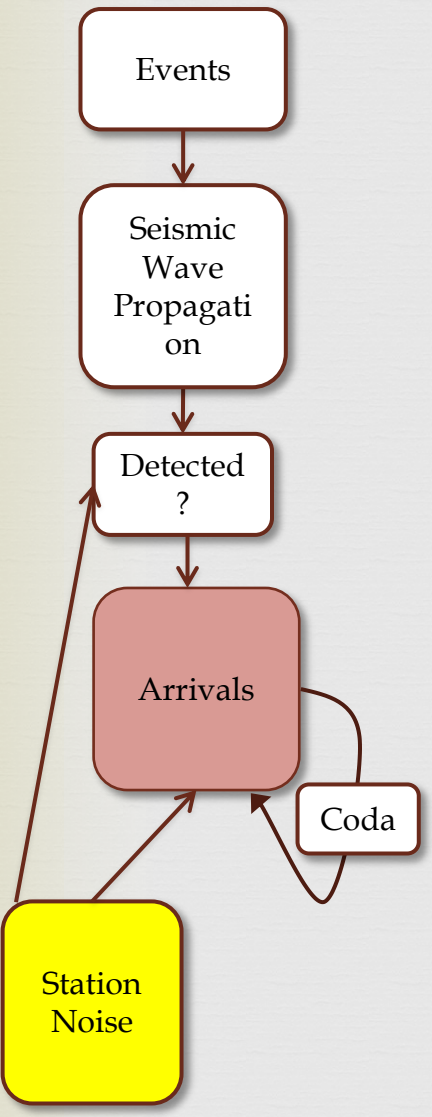




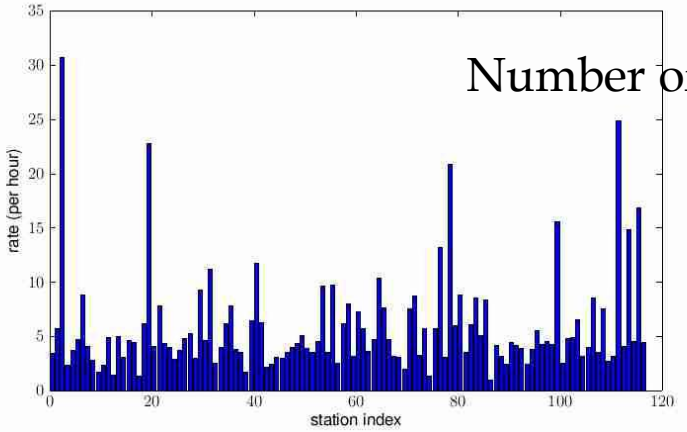




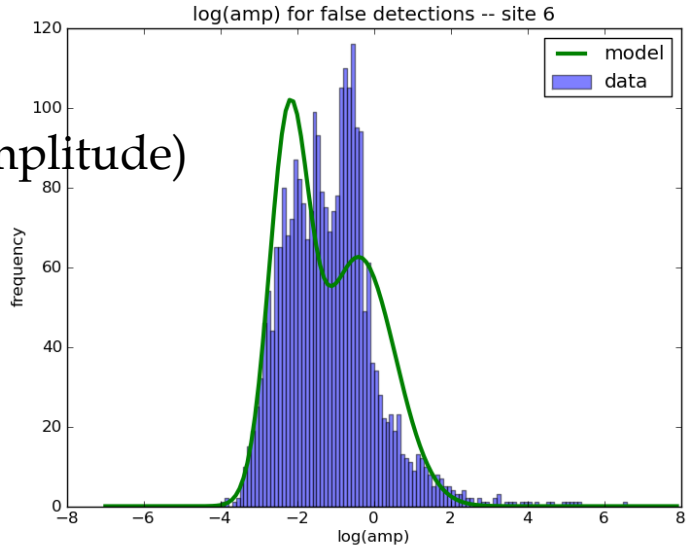
Arrival Parameters



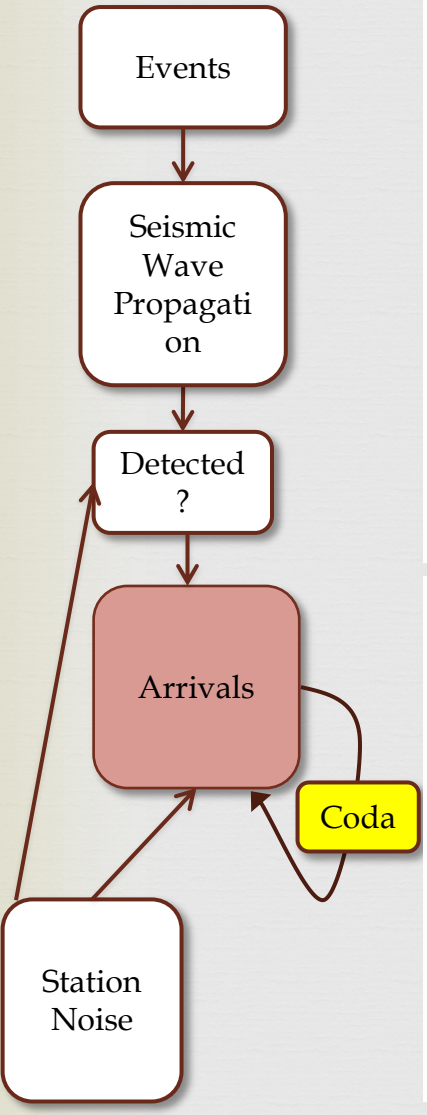
Number of False Arrivals by Station

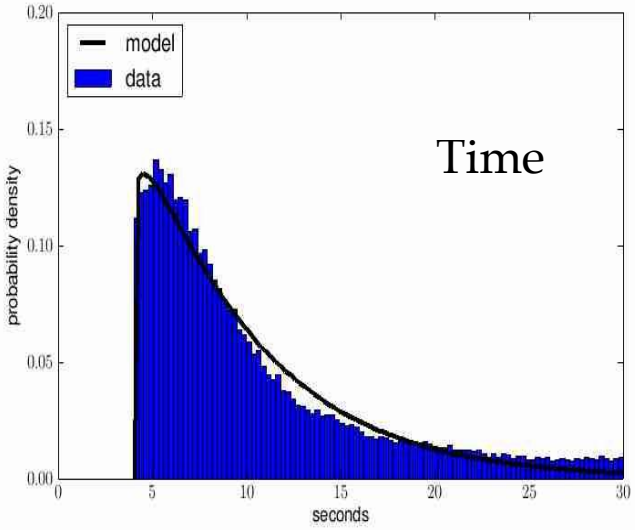


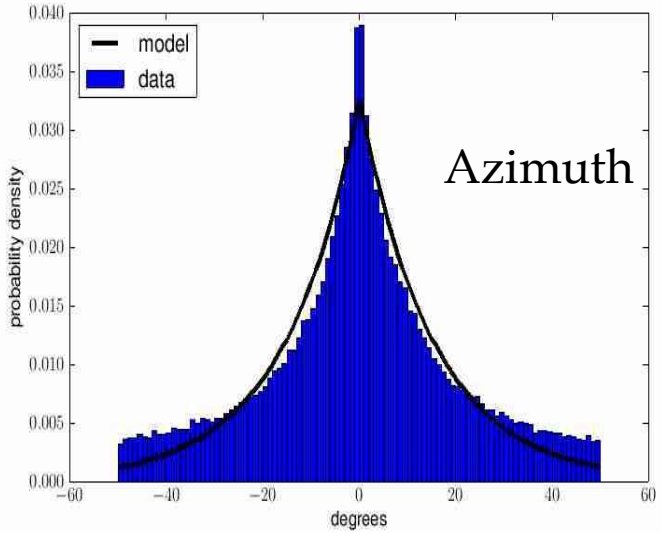
False Arrival log(amplitude)

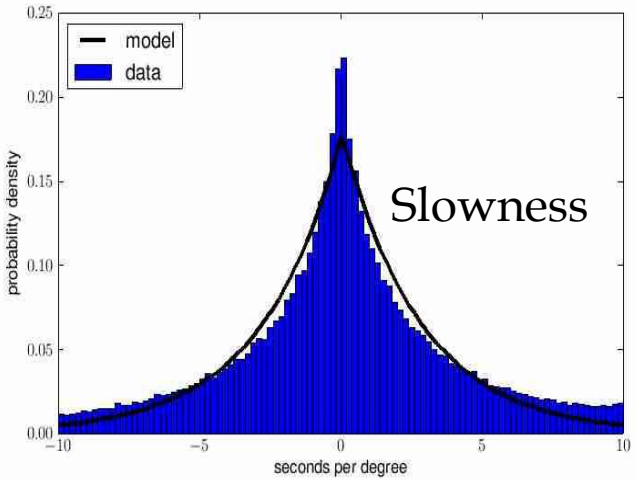


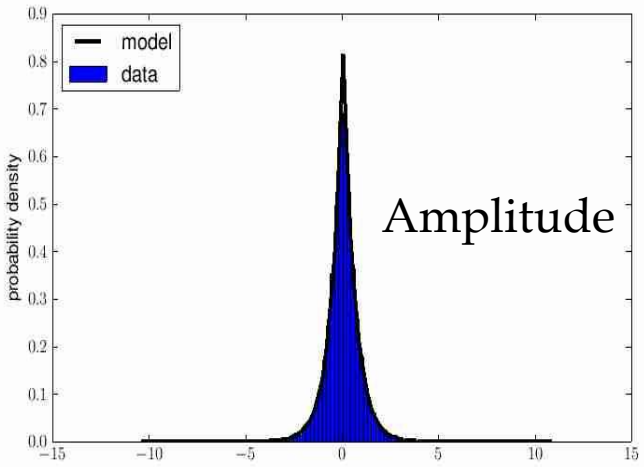
Station Noise











Coda (Relative) Attributes

Calibration

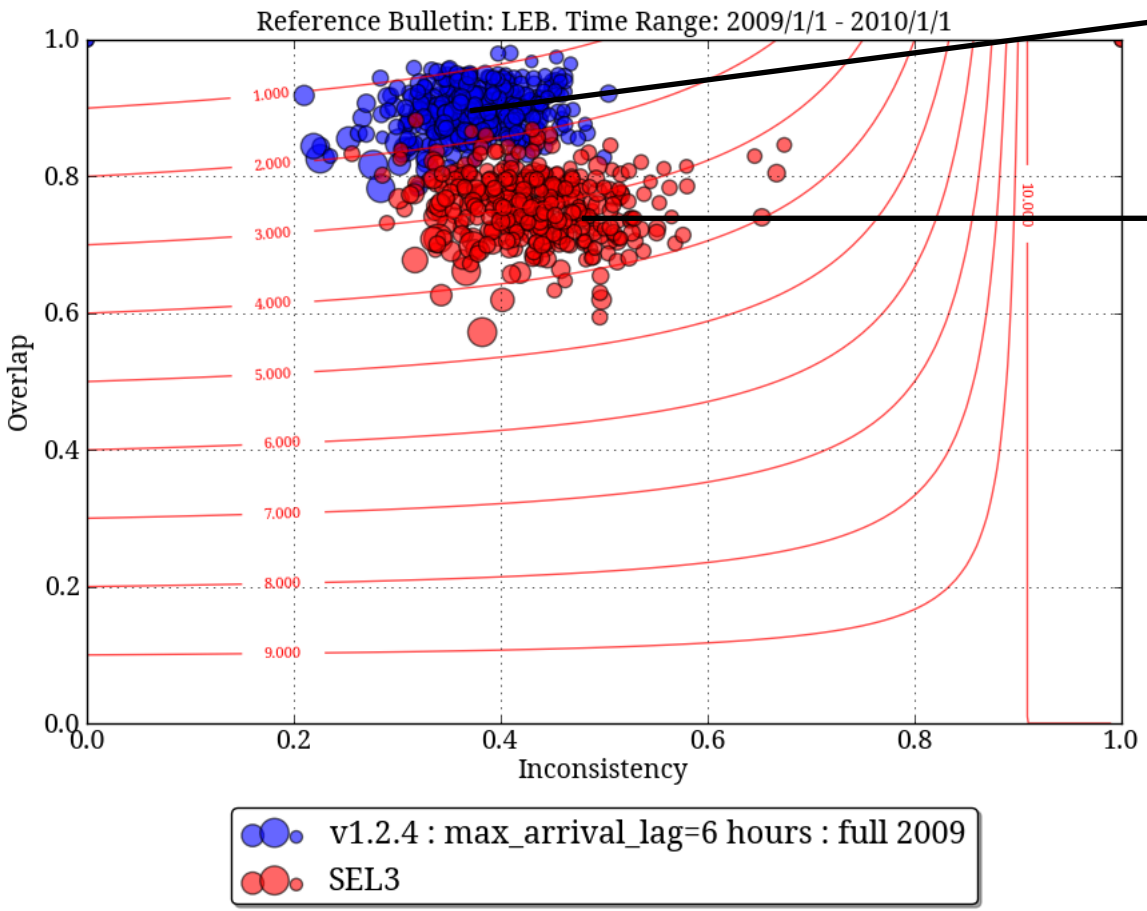
- P(Events, Arrivals, False Arrivals, Coda Arrivals)
  - P(Events)
    - A complete LEB would help train this better.
  - P(Arrivals | Events)
    - This part can be trained with whatever events are in LEB
  - P(False Arrivals)
  - P(Coda Arrivals)
    - These two could sub-models could be mistaking true arrivals for false arrivals
    - Smoothing to avoid overtraining.

Inference Moves

- Birth Move
  - Invert individual arrivals to get candidate locations
  - Validate candidates by associating with the best set of arrivals
- Re-Associate Move
  - Associate each arrival to the best event
- Re-Locate Move
  - Locate the event given its current associated arrivals
- Death Move
  - Kill Events whose loss improves the hypothesis

Evaluating Results

- *Mark Prior* introduced the following terminology:
- Overlap : percentage of reference events that match with test events
- Inconsistency : percentage of test events that don't match any reference event
- Solution Cost : 10 times missed events plus inconsistent events normalized by number of reference events (or use 20 times etc.)
- Events match if they share two arrivals with similar phase



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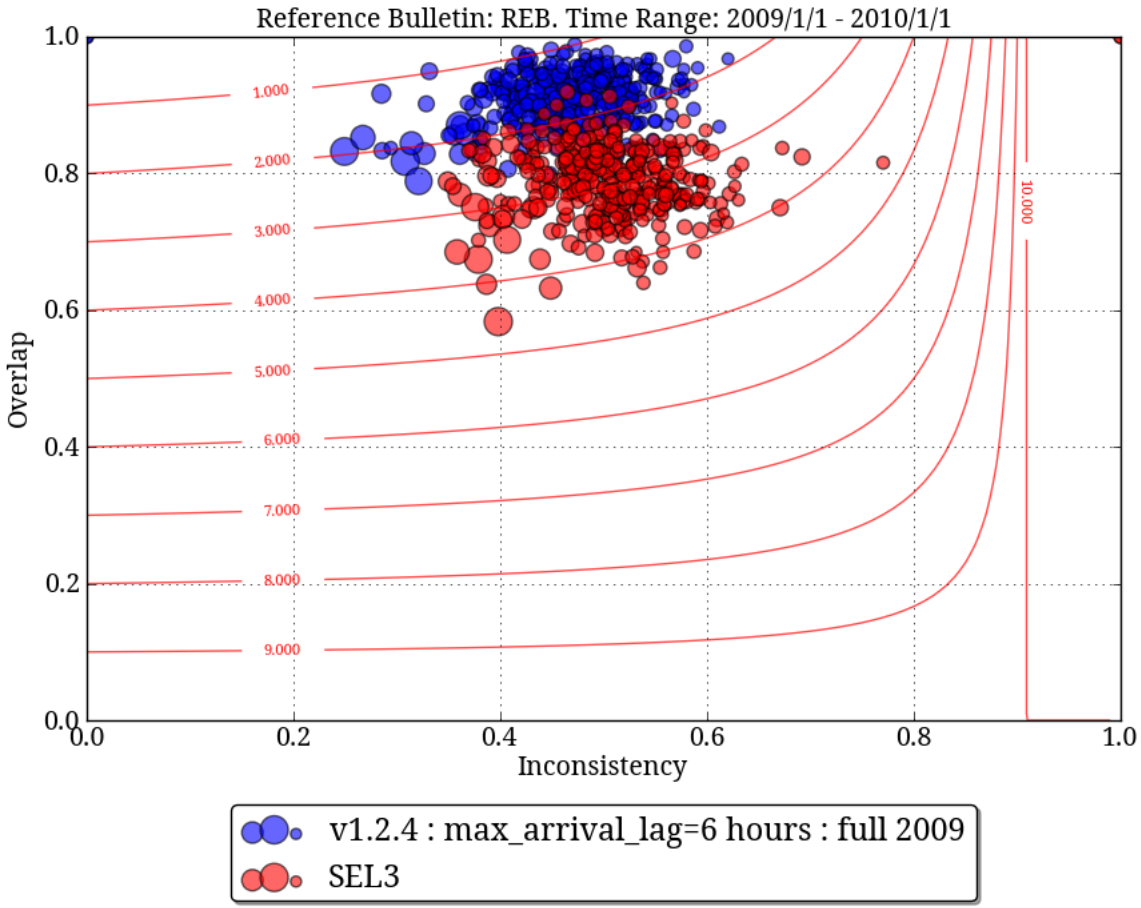
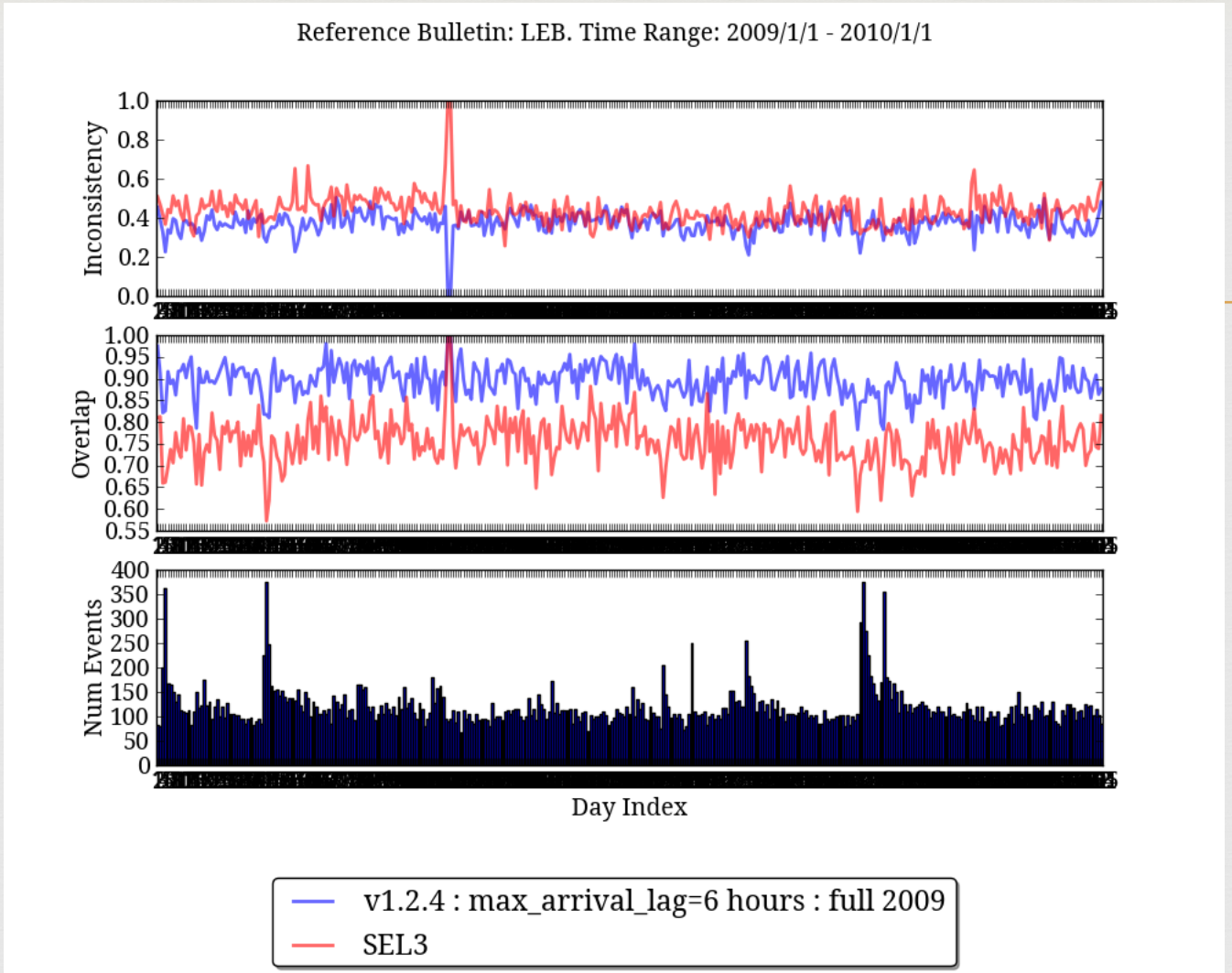
GA

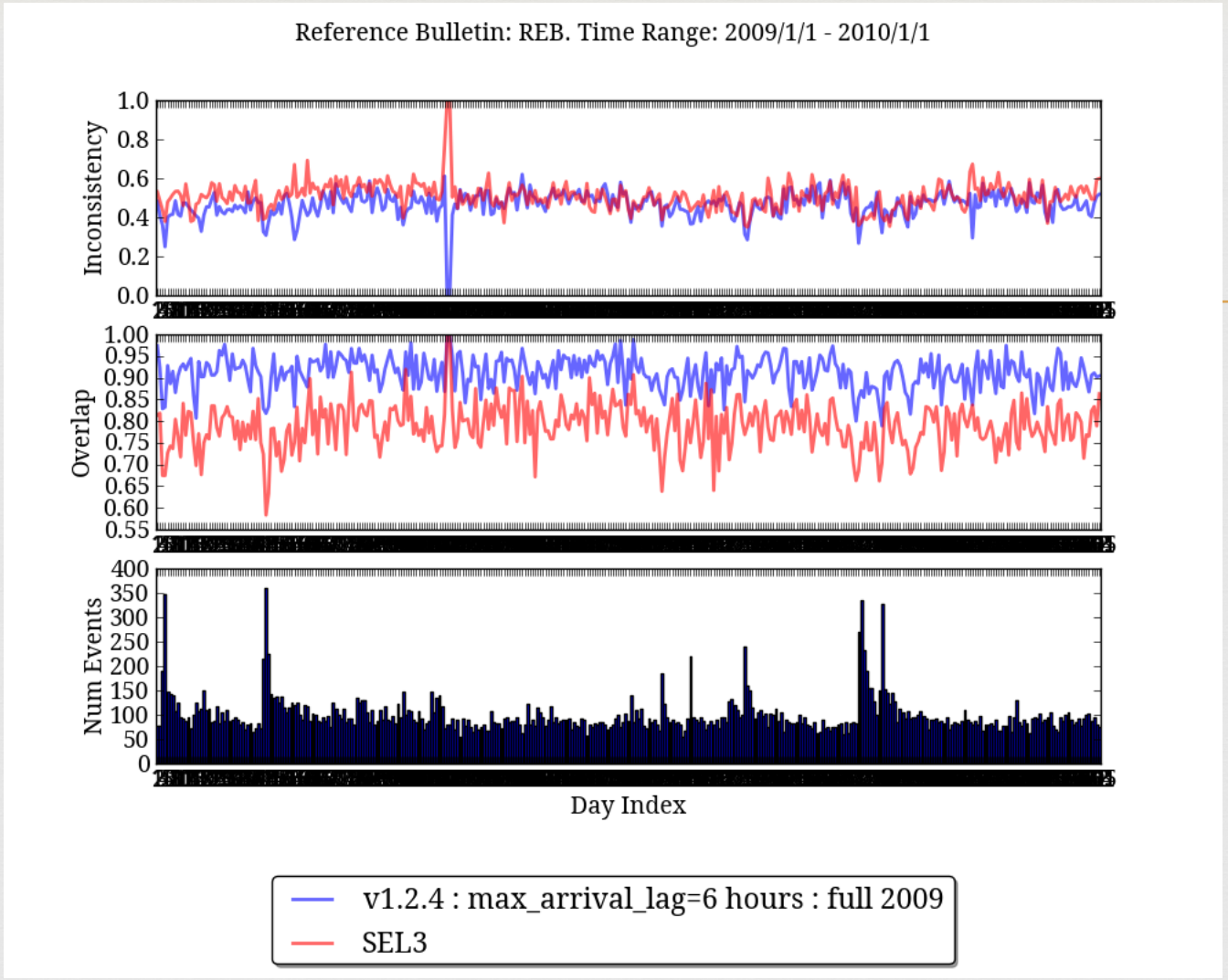
Cost Visualization



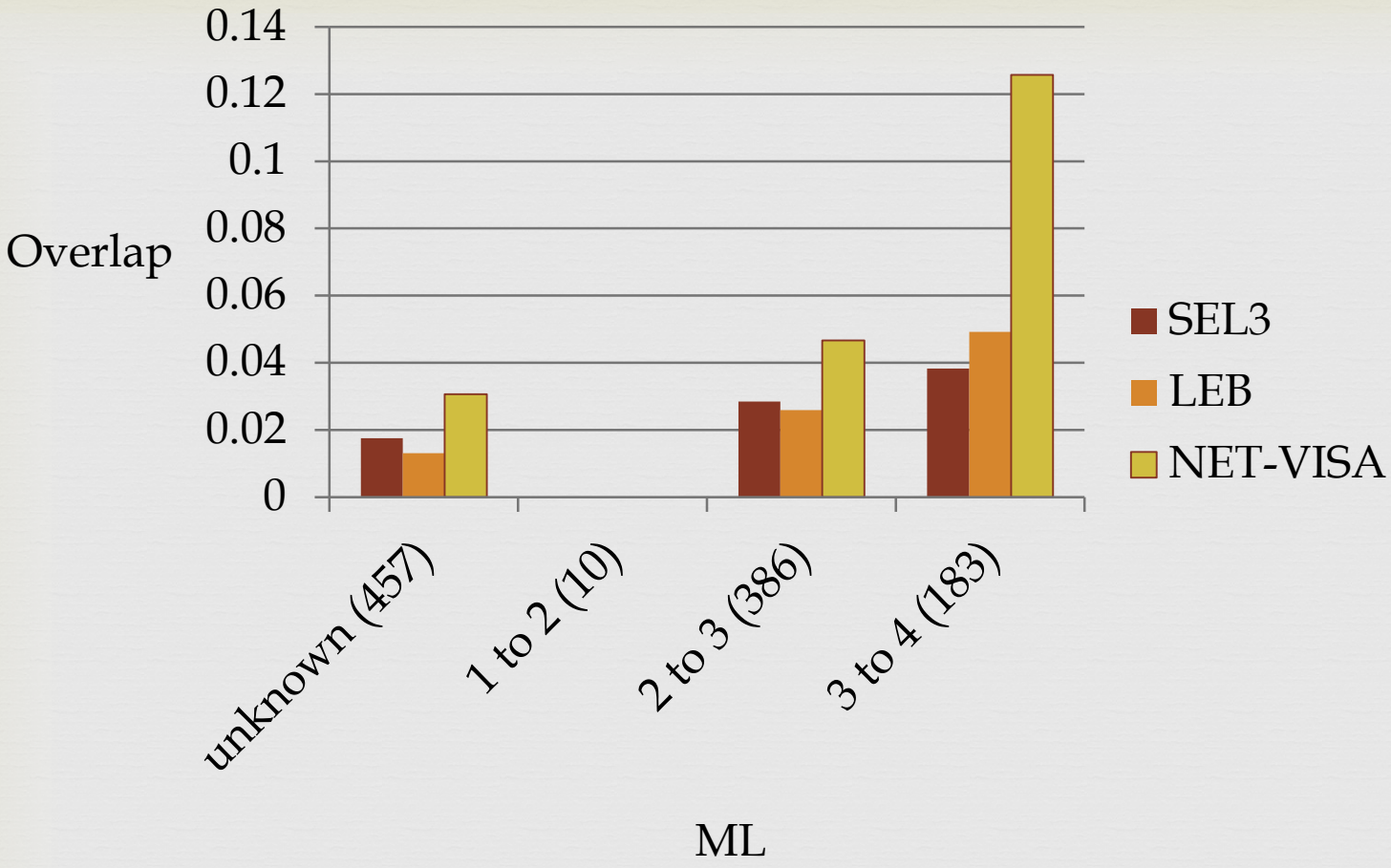
REB as reference



Daily Results



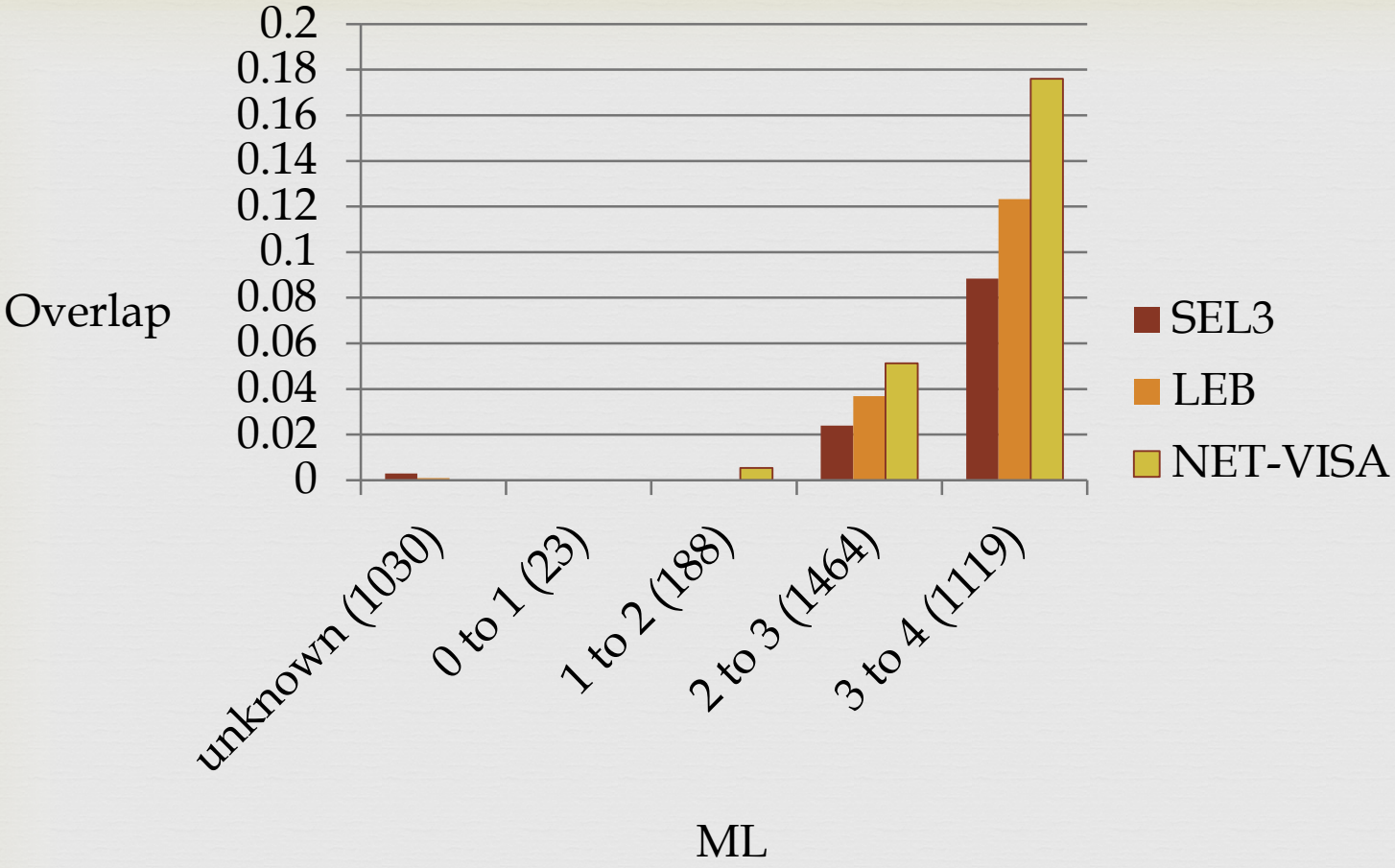
REB as reference



Comparison with NEIC over continental US

2009

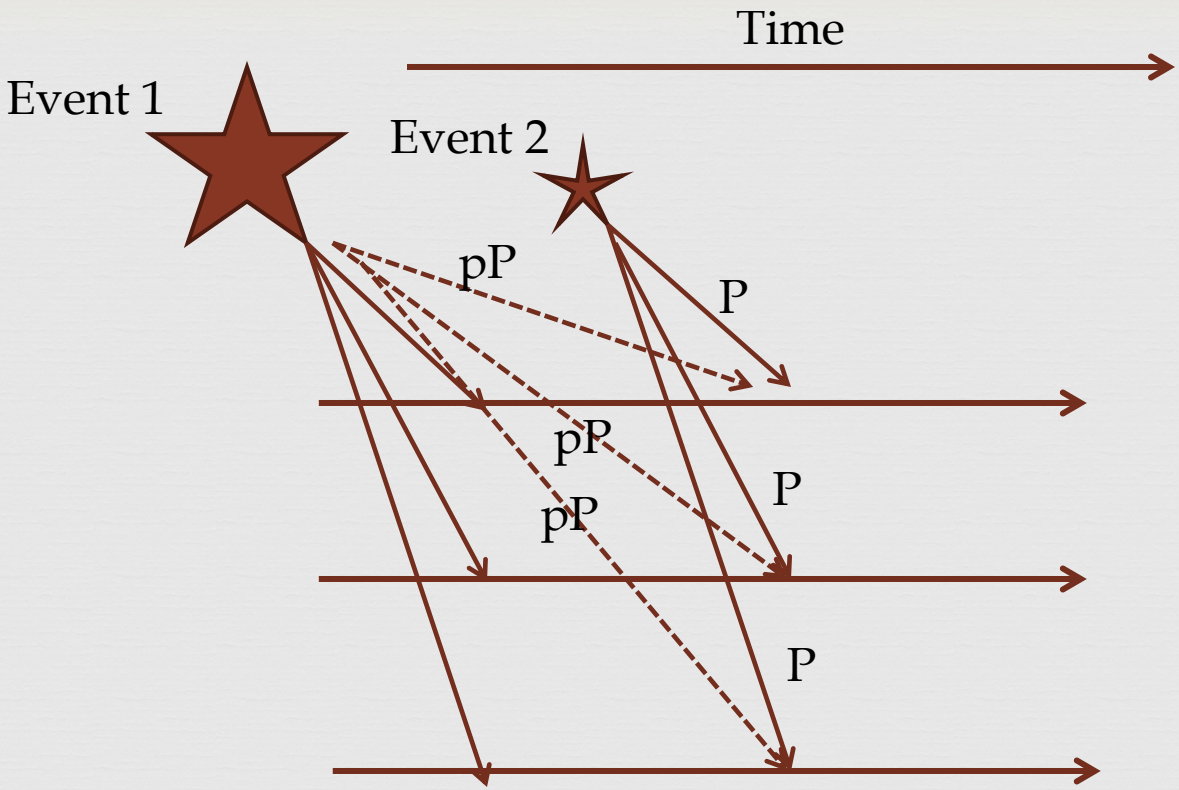
Data made available from ISC (International Seismological Center)



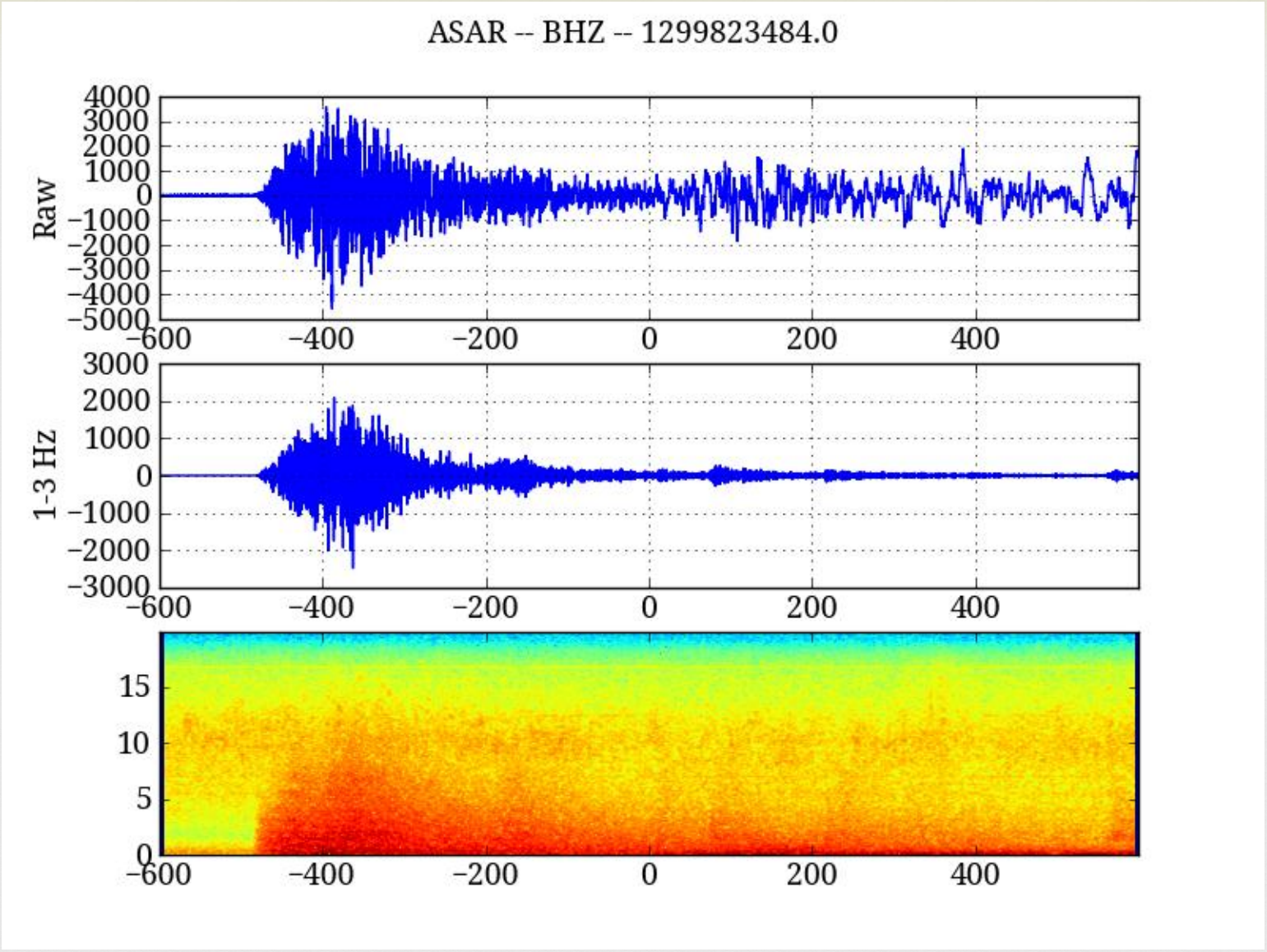
Comparison with NNC (Kazakhstan) over Central Asia (events less than ML 4)

2009

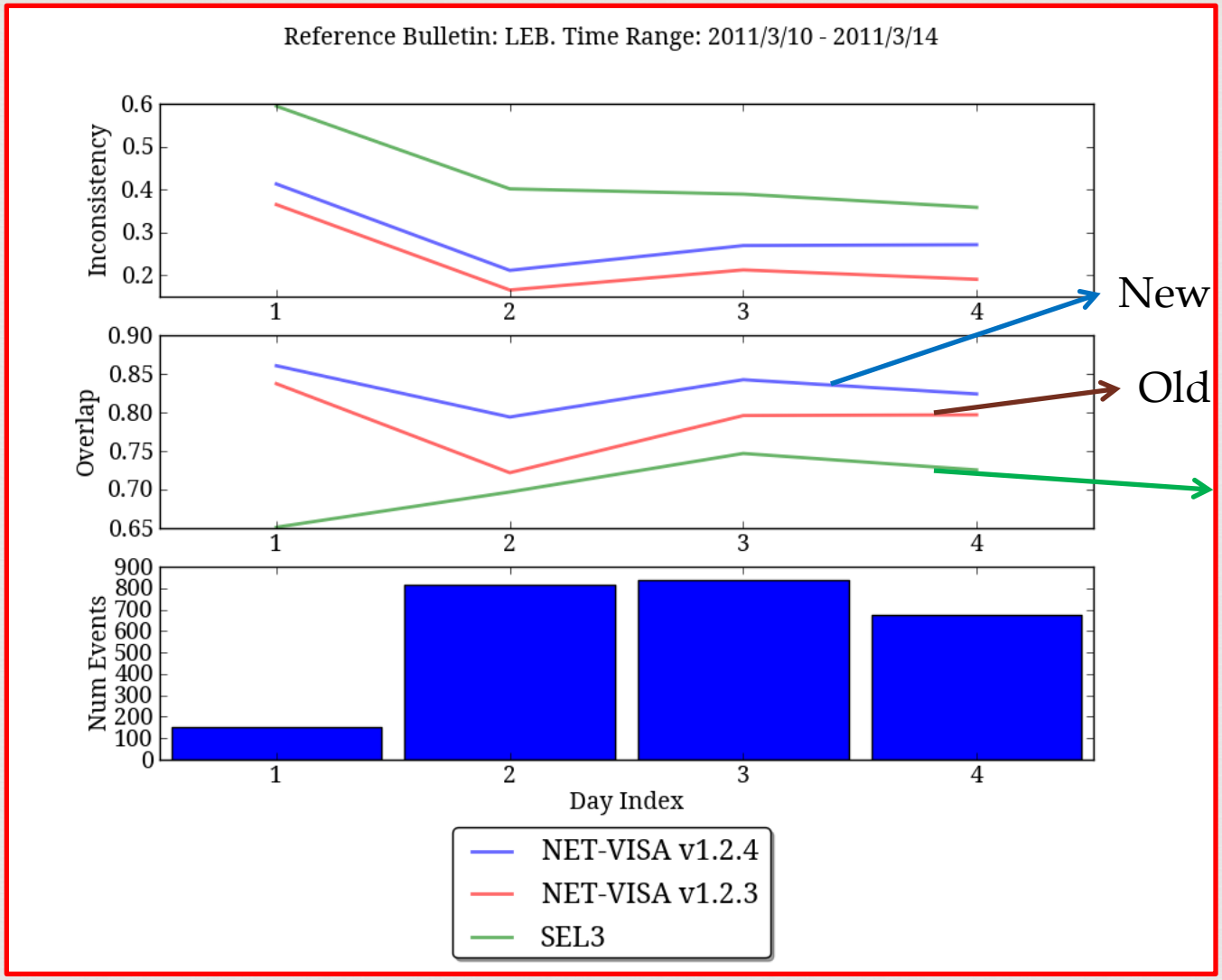
Data made available from ISC (International Seismological Center)



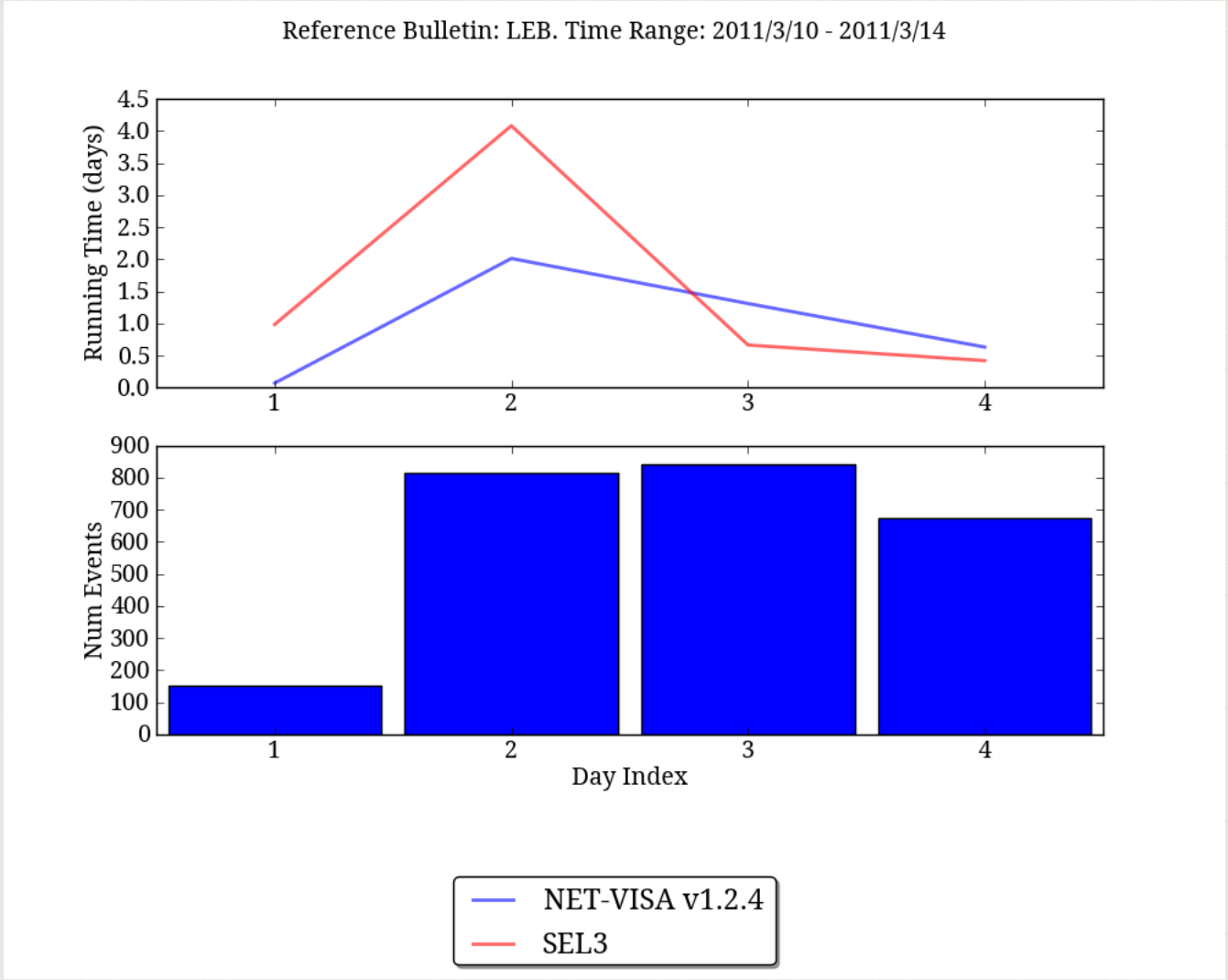
Challenges with Large Aftershocks (phase confusion)



Missed Events Due to Missed Detections



Accuracy Improvement on Tohoku (day 2, 5:46)



Running on Tohoku (day 2, 5:46)

Conclusion

- Generative probabilistic model of global-scale physics.
  - Motivated by physics and calibrated by empirical observations
- More accurate results
  - Better overlap with REB and LEB than GA/SEL3
  - Better overlap with regional bulletins
- Improved accuracy on large aftershocks
- Fast, Parallel inference