

# Seismic Event Bulletin Construction for a Global Sparse Network Using Waveform Correlation

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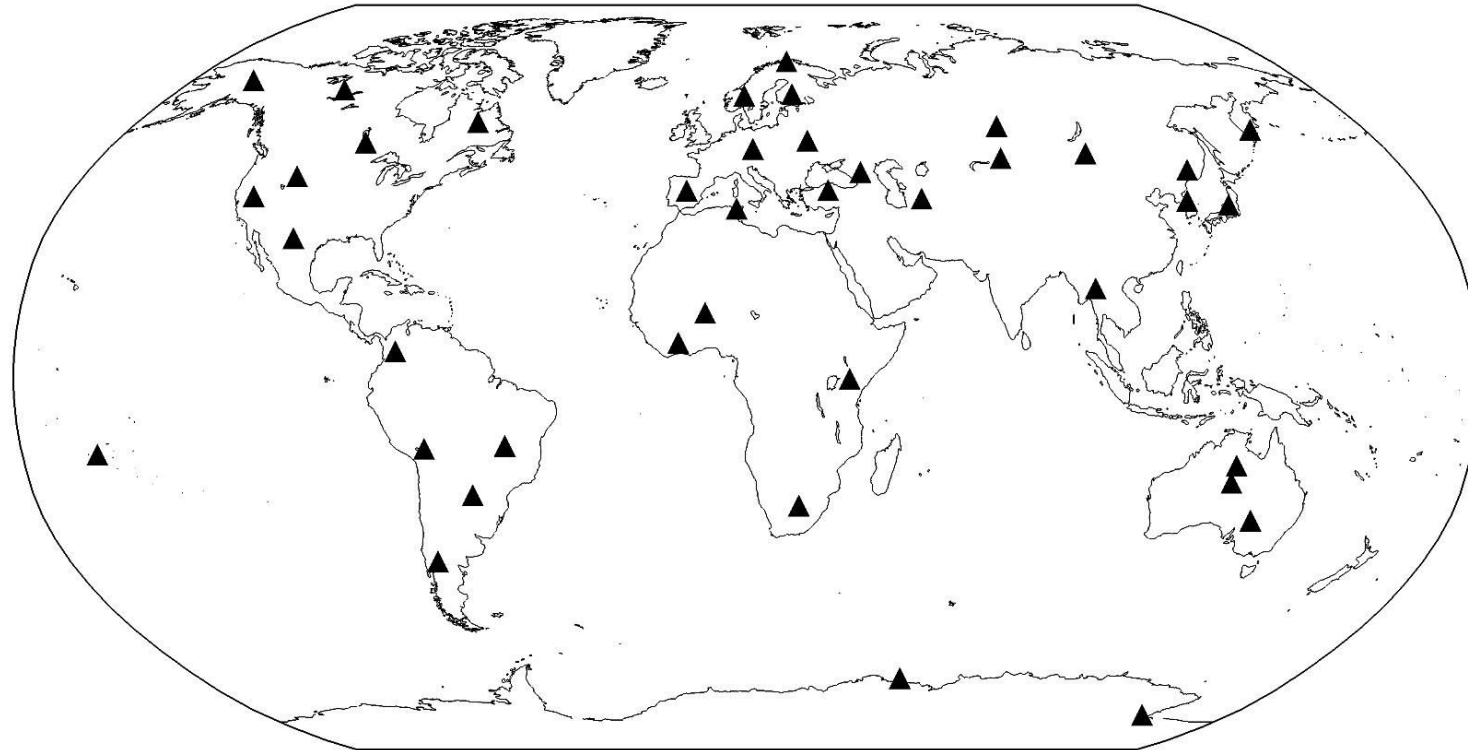
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# Introduction

- Waveform correlation has been shown to be very successful at identifying repeating seismicity
  - Mining explosions
  - Aftershock sequences
- There have been fewer investigations into its ability to contribute to catalog construction on a global scale.
- Our ultimate goal is to introduce events detected with waveform correlation into traditional signal association algorithms.
- As a first step toward that goal we construct a catalog for the IMS Primary network using only waveform correlation.
- Our interim goal is determine what fraction of the events in the LEB bulletin can be discovered using waveform correlation alone.

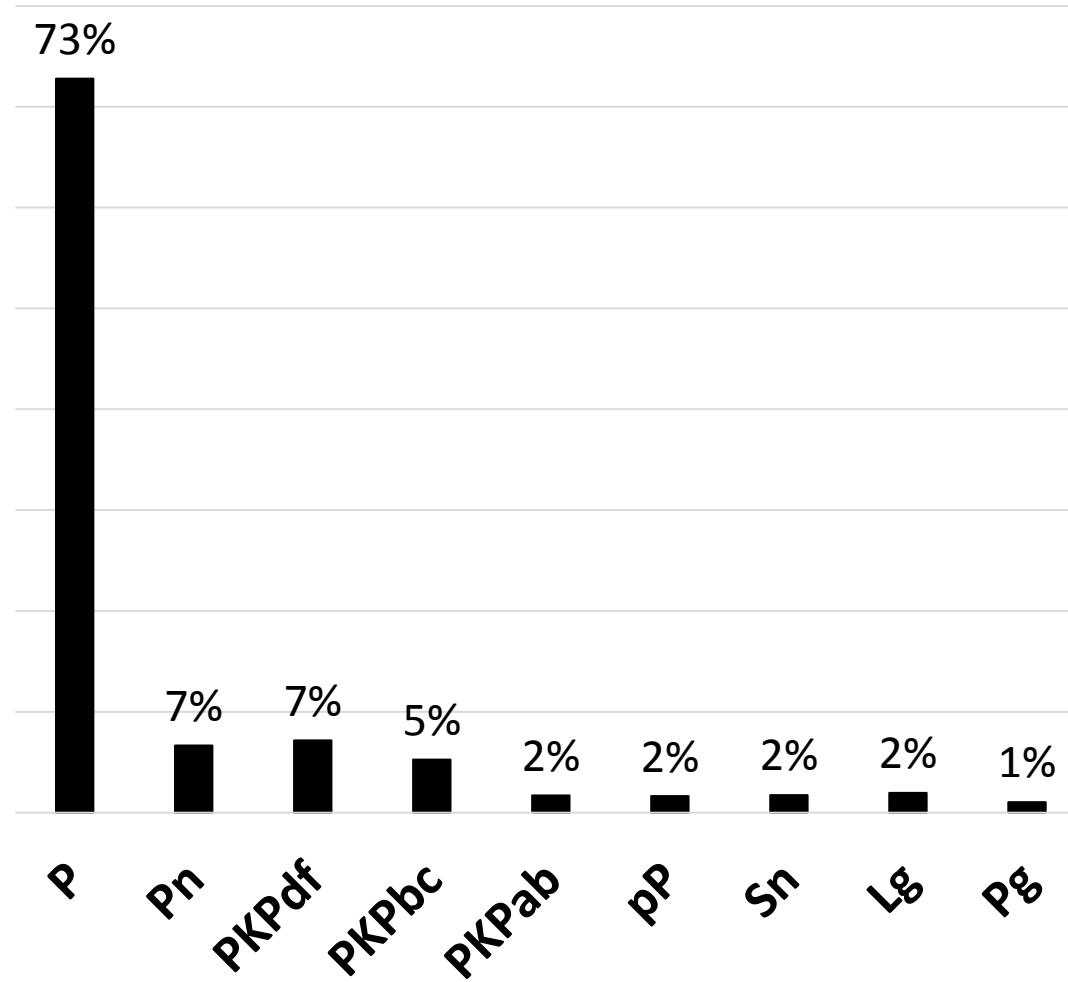
# Template Library

- To build our template library, we selected all arrivals from the International Data Centre (IDC) Late Event Bulletin (LEB) that satisfied the following criteria:
  - The arrival came from one of the 40 stations in the International Monitoring System (IMS) Primary Seismic Network that was operating in May 2010.
  - had a signal to noise ratio greater than or equal to 4,
  - had an association phase in (Lg, Sn, Pg, Pn, P, PKP, PKPab, PKPbc, pP)
  - 10 years of data; arrivals from May 2010 were omitted for testing.

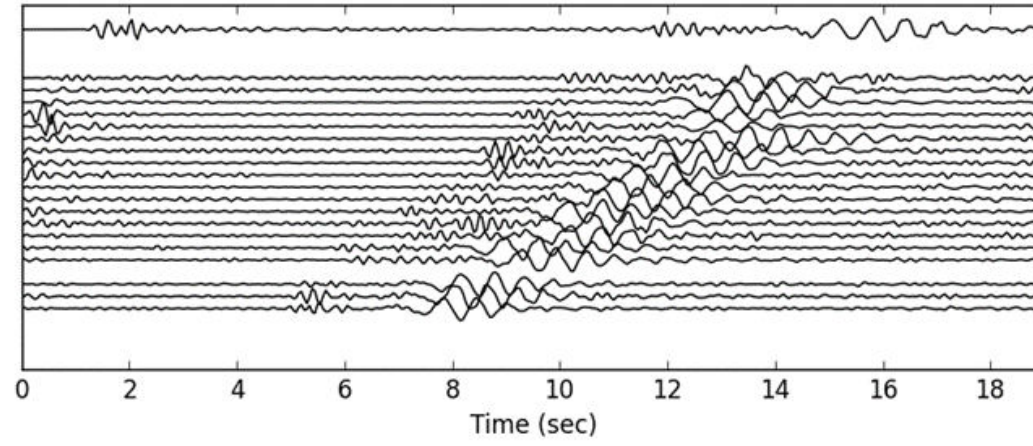


# Templates by Phase

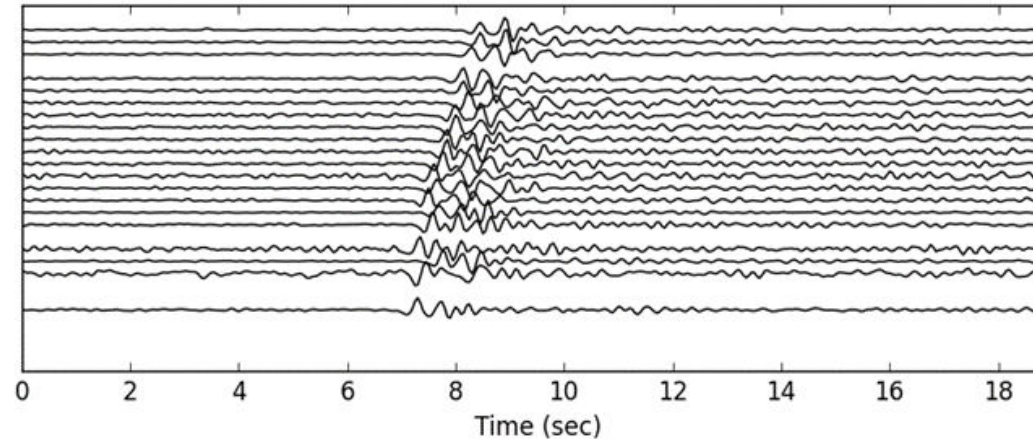
N = 2.6 M templates



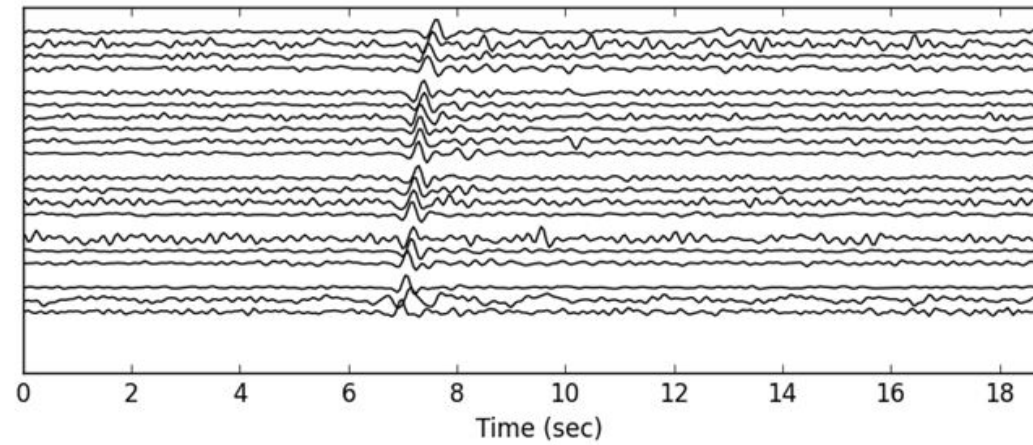
**Lg**



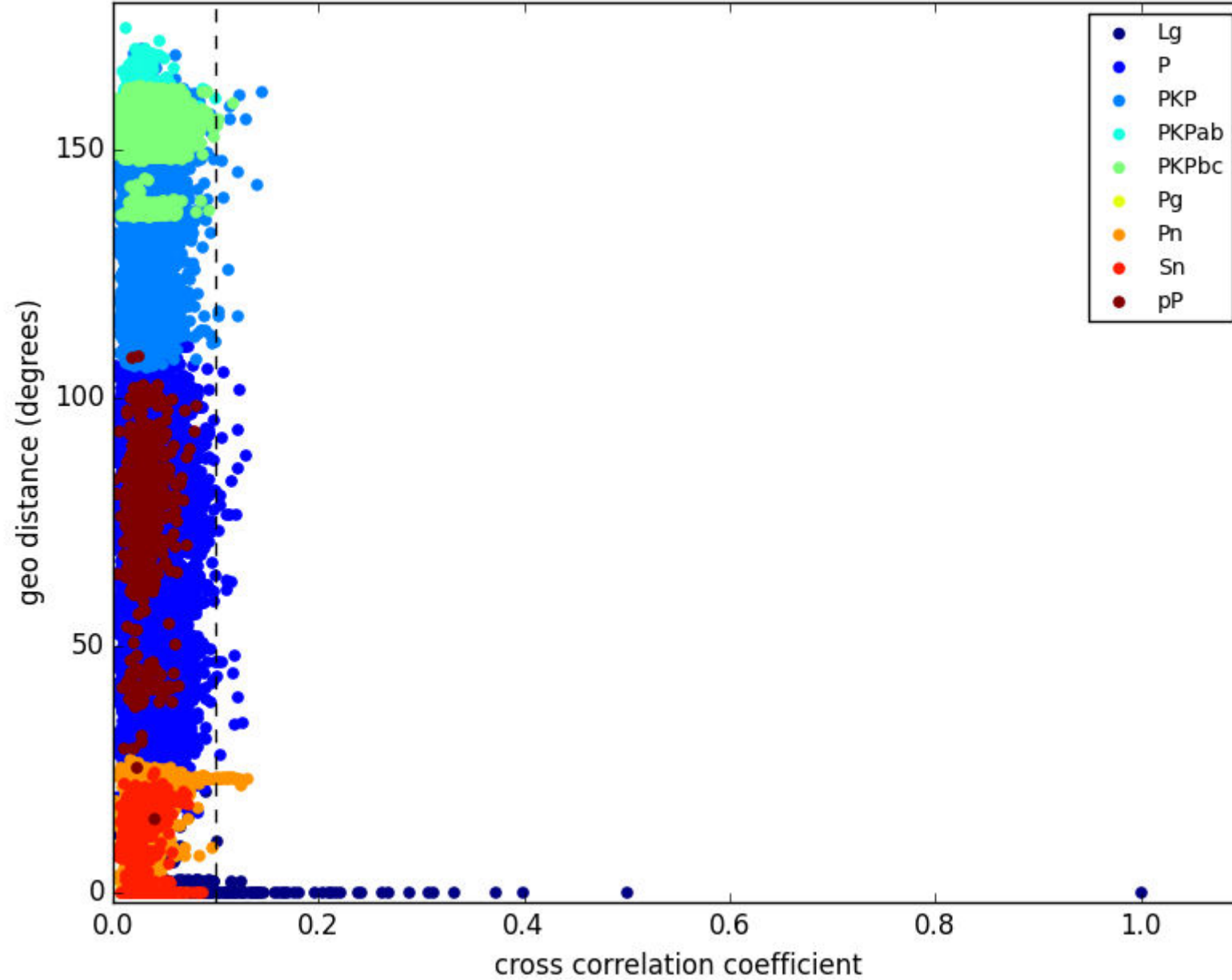
**P**



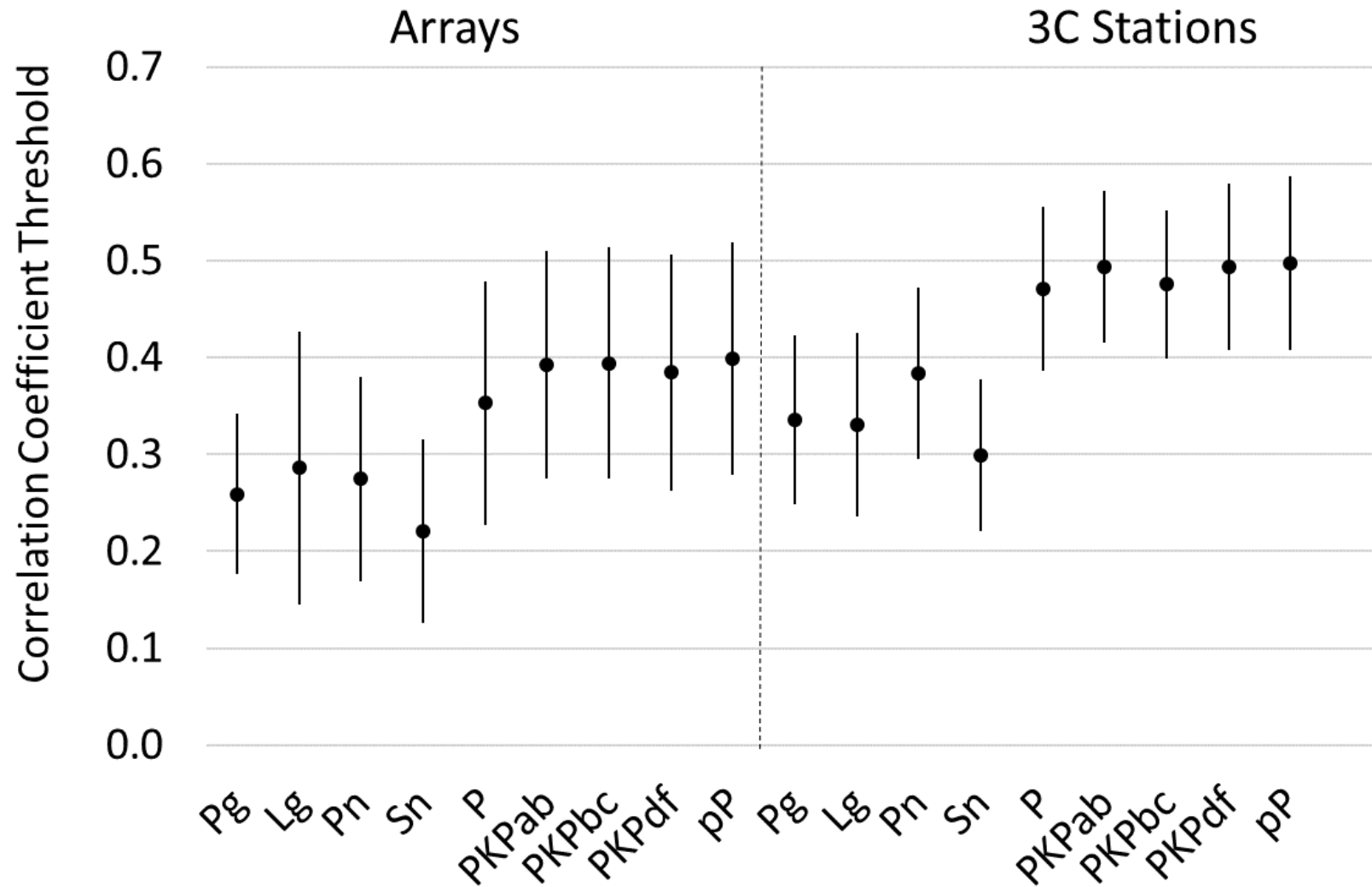
**PKPdf**



# Custom Correlation Threshold for each Template



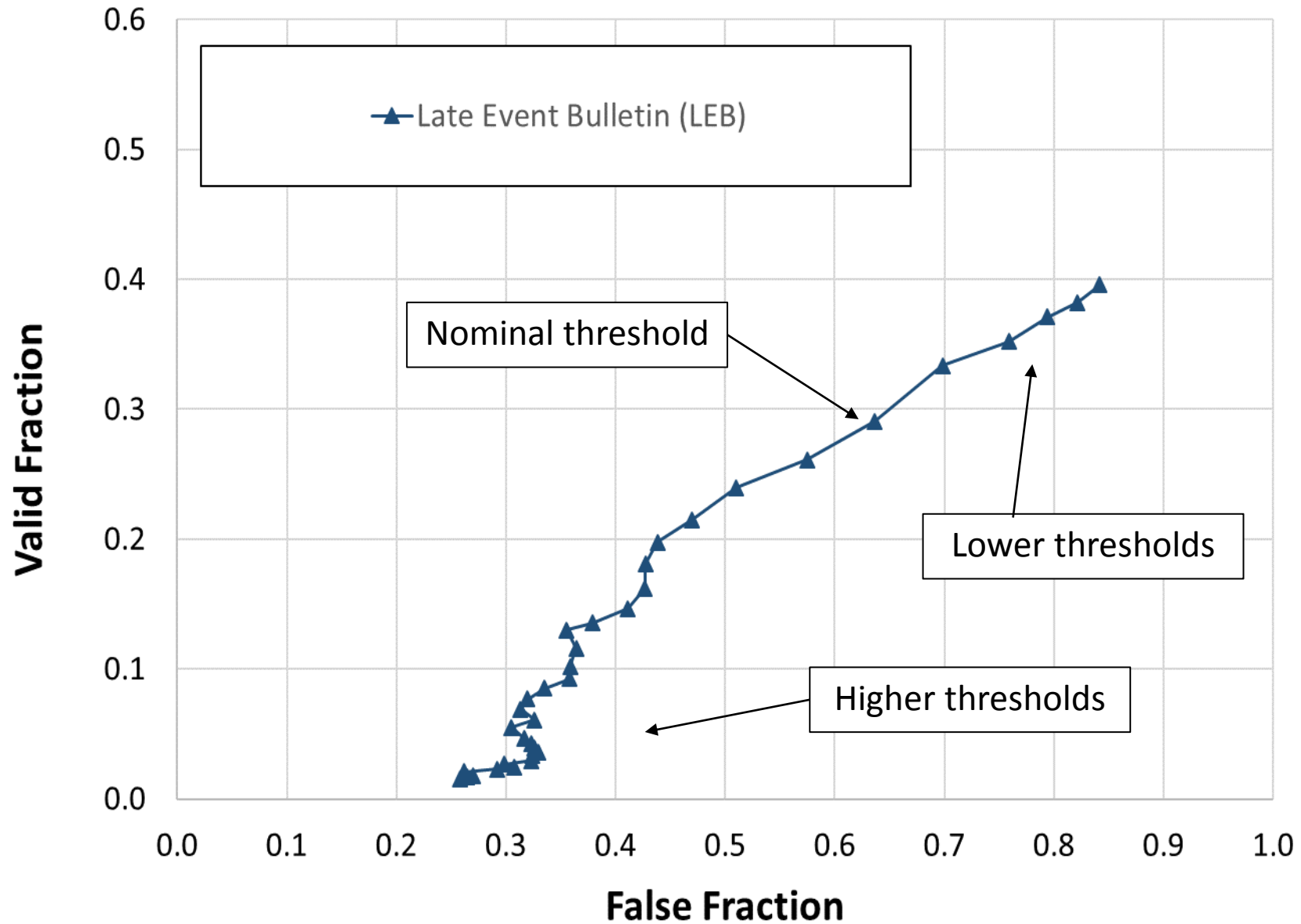
# Custom Correlation Thresholds



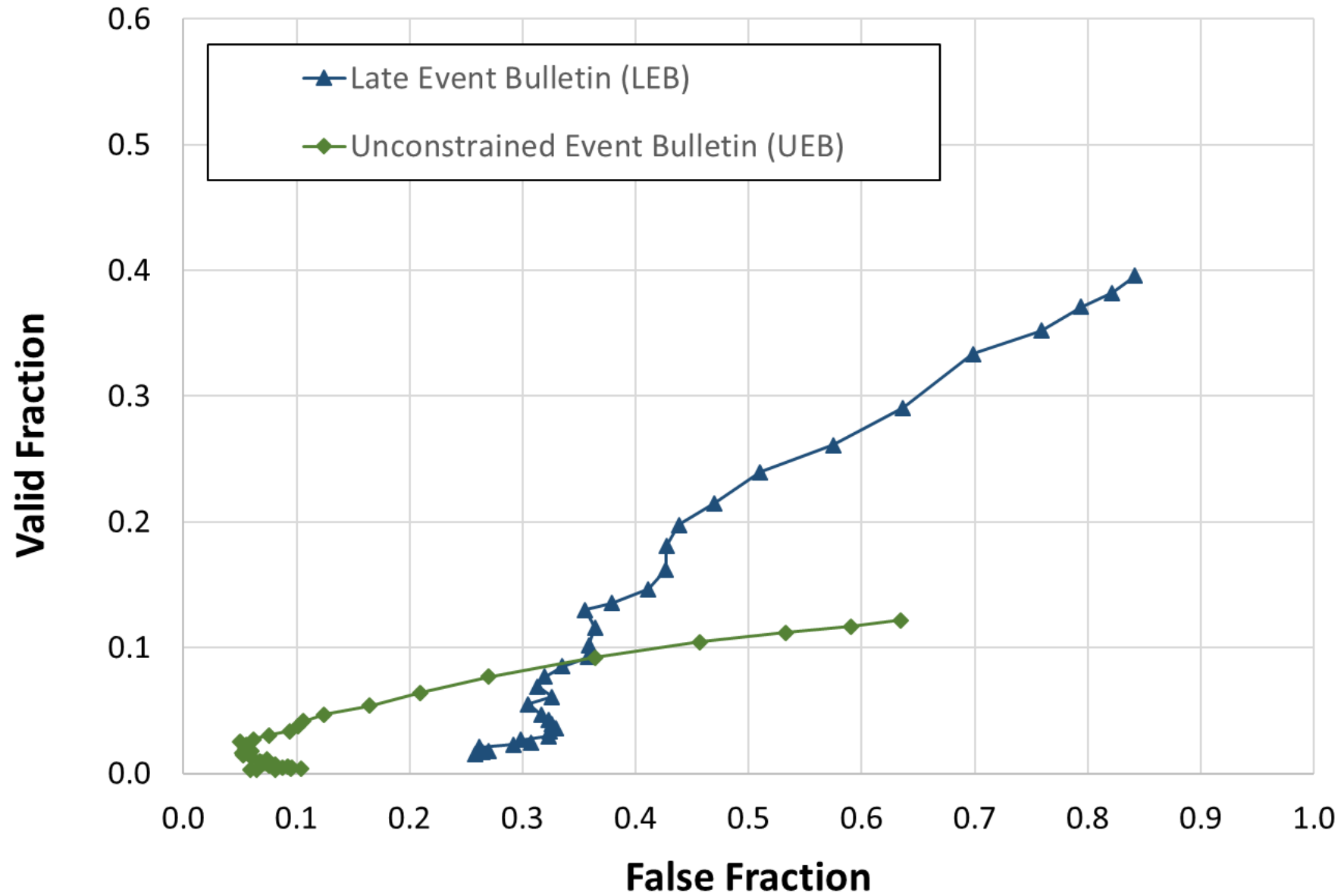
# Bulletin Construction

- Apply an STA/LTA signal detector to waveform data for two weeks in May 2010 (IDCX arrival table).
- Build a query waveform for each of the 136K arrivals produced.
- Compare the query waveforms to the template library and form events from the matches.
  - Our event definition criterion requires matches from at least two stations to declare a valid event.
- Compare WC events to events in a ground truth catalog.
- Valid events are WC events for which there is a GT event within 2 degrees and 60 seconds.
- All WC events that are not valid are false.
- Valid Fraction is the number of Valid events / number of GT events.
- False Fraction is the number of False events / number of WC events.

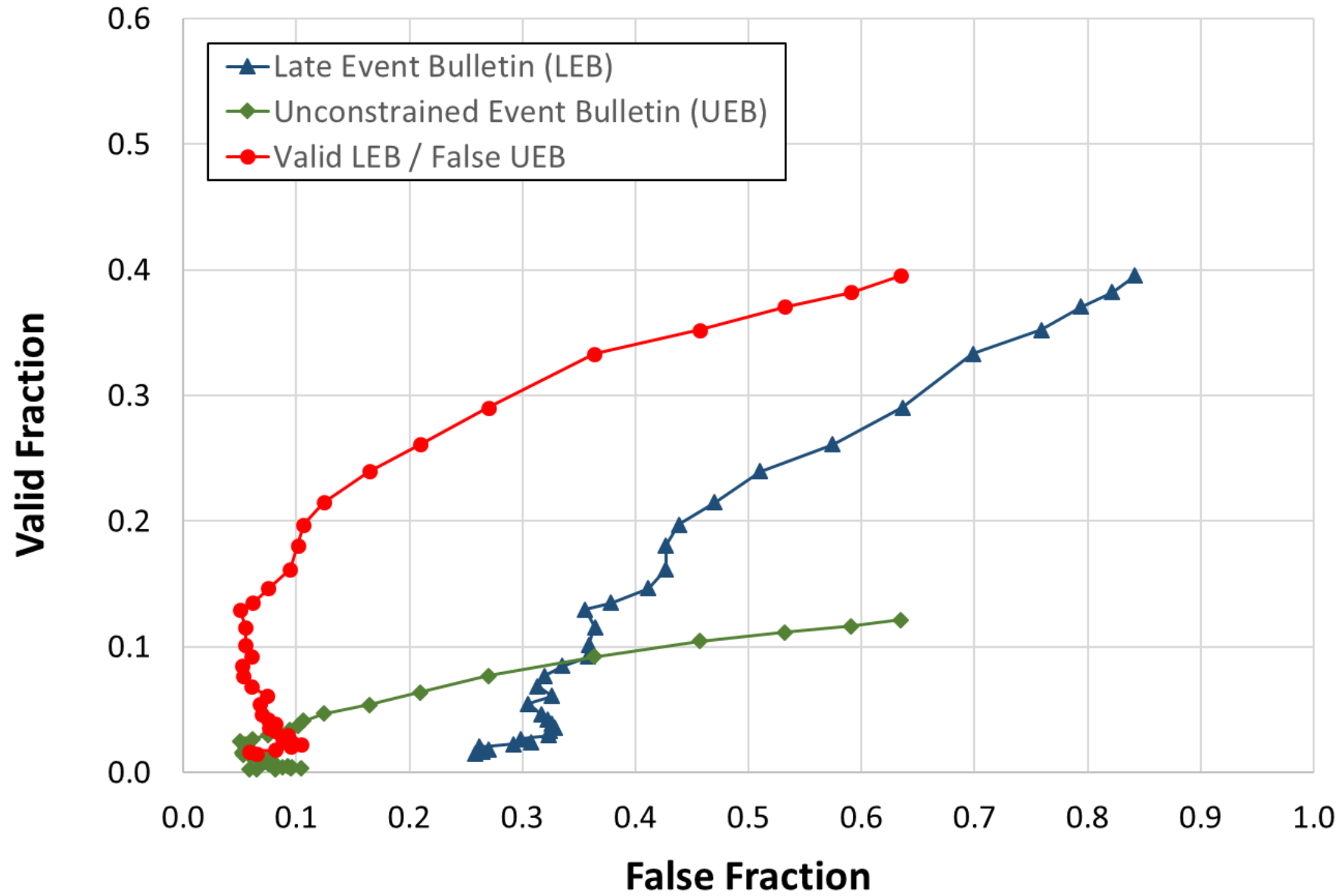
# Comparison with Ground Truth Bulletin



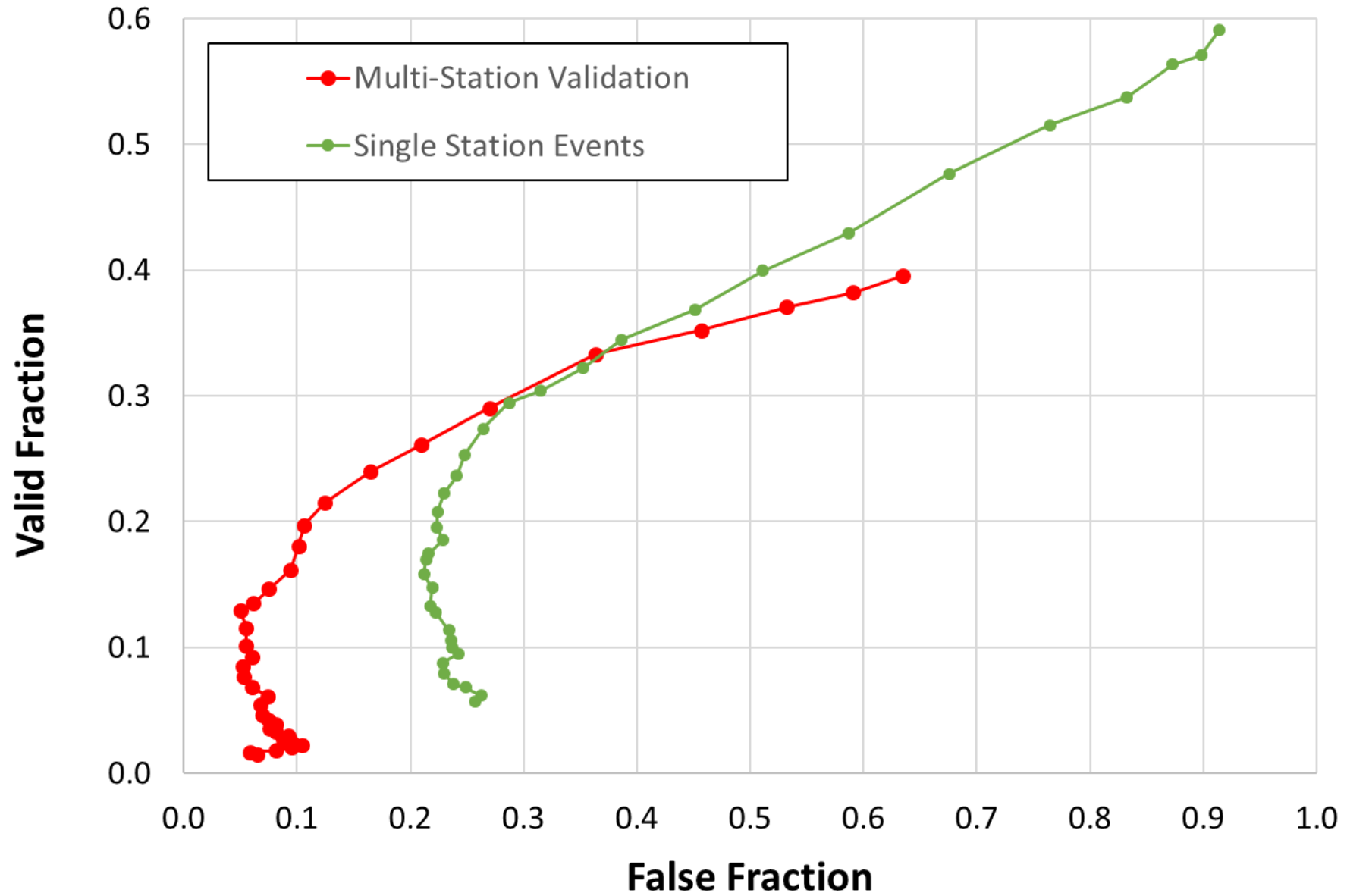
# Comparison with Ground Truth Bulletin



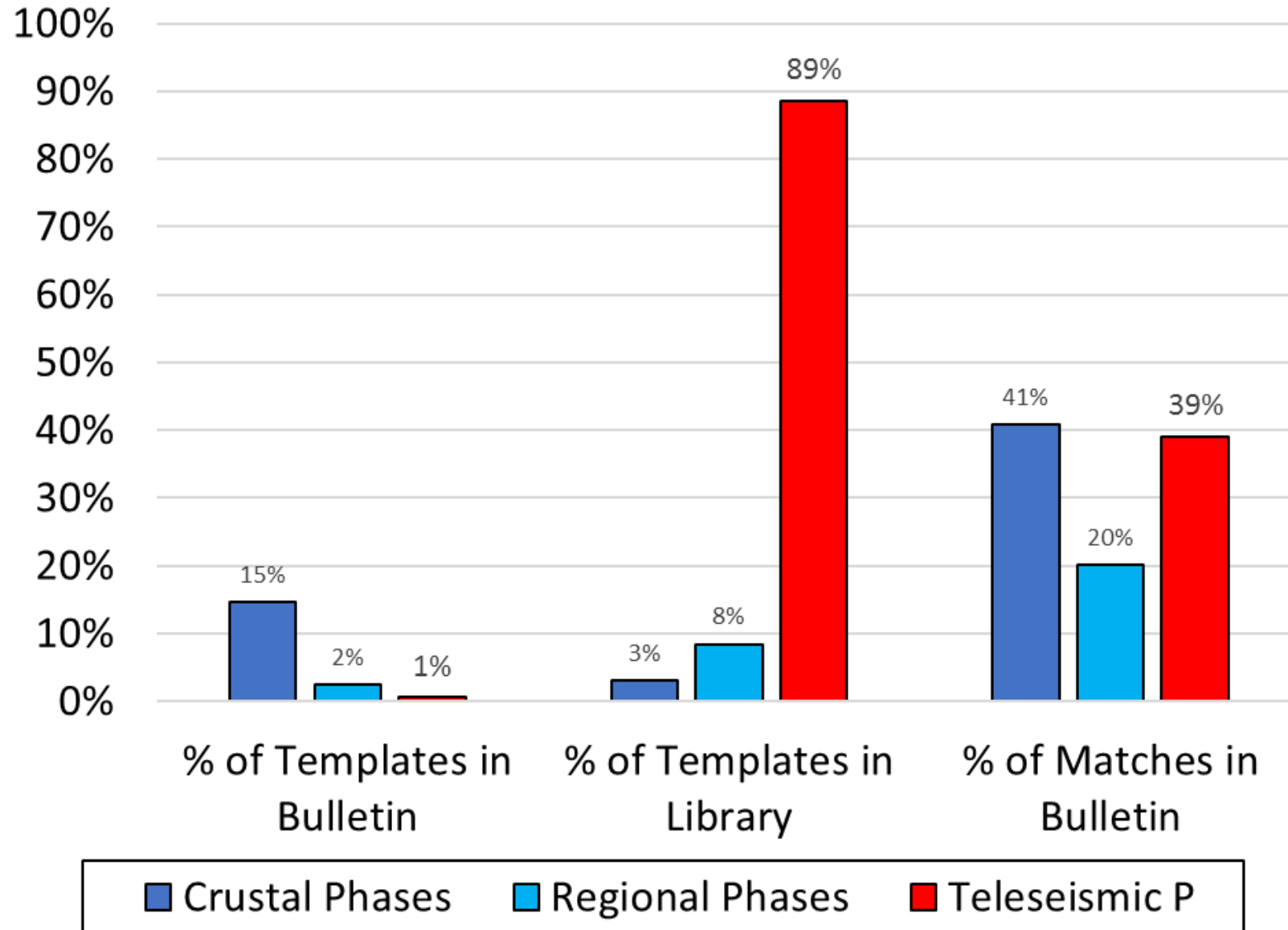
# Comparison with Ground Truth Bulletin



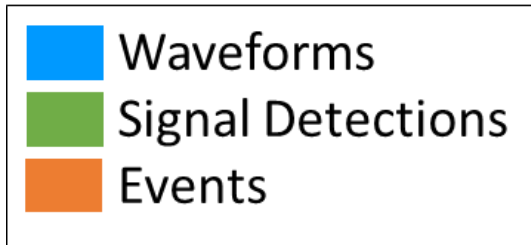
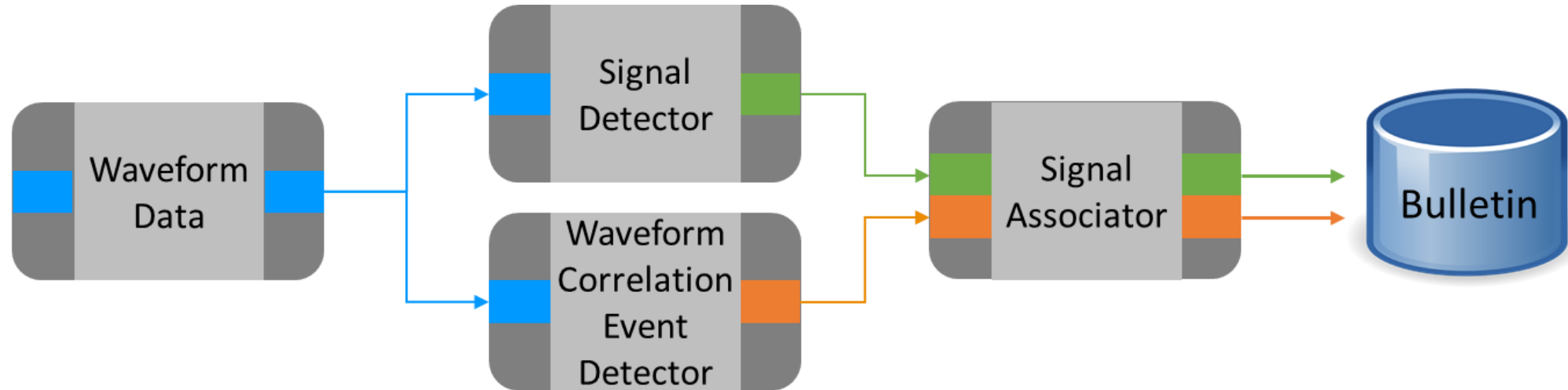
# Comparison with Ground Truth Bulletin



# Template Importance by Phase



# Role of Waveform Correlation in Signal Association



# Summary and Future Work

- We have built a large template library for the IMS Primary network using crustal, regional and teleseismic phases.
- Using signal detections produced by the IDC's STA/LTA detector (IDCX arrivals), we built a seismic event bulletin using only waveform correlation.
- We were able to discover up to 60% of the events in the LEB, but that number is highly dependent on one's tolerance for false event detections.
- We discovered many valid events that were not in the LEB.
- Our next step will be to insert the events discovered with waveform correlation into a traditional signal association algorithm to see if we can improve bulletin quality and reduce analyst workload.