A Fusion Model of Seismic and Hydro-Acoustic Propagation for Treaty Monitoring

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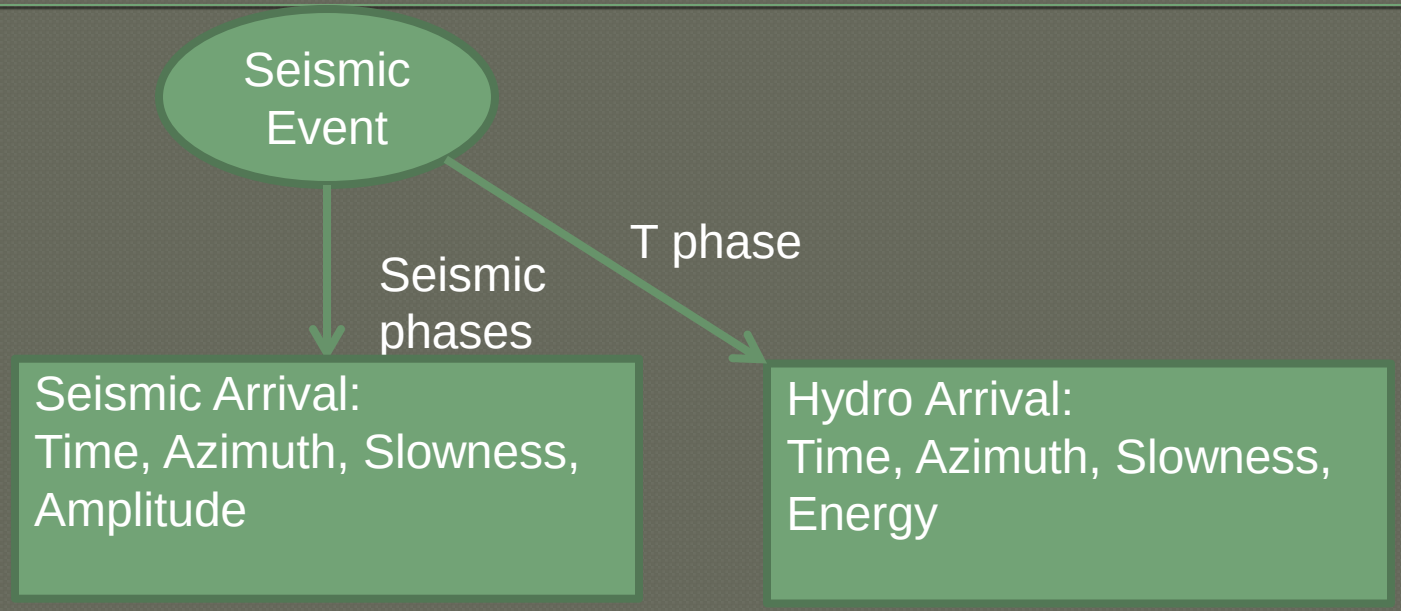
Overview

- Probabilistic Generative Model
  - NET-VISA (NETwork processing Vertically Integrated Seismic Analysis)
  - NET-VISA + Hydro = NET-VIS**H**A
- Learning Model Parameters
- Inference
- Results
- Results on Ahyl Seamount (active underwater Volcano)

The Model

Seismic Event
Seismic phases
Seismic Arrival:
Time, Azimuth, Slowness, Amplitude

The Model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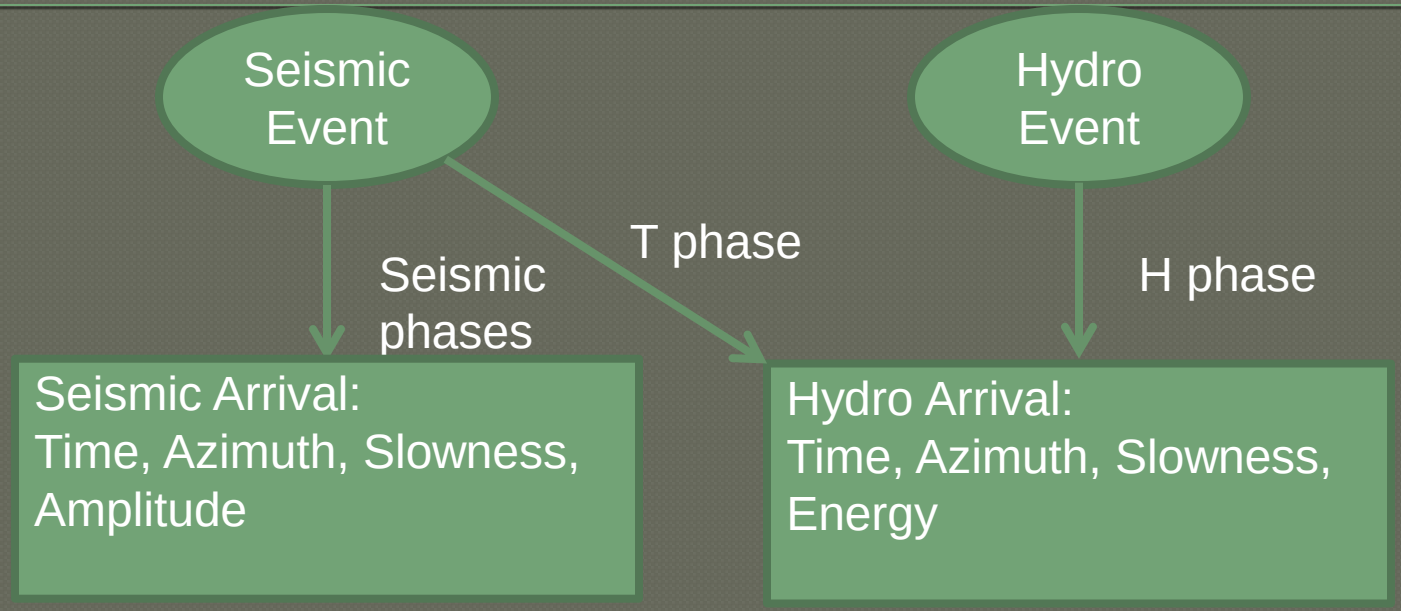
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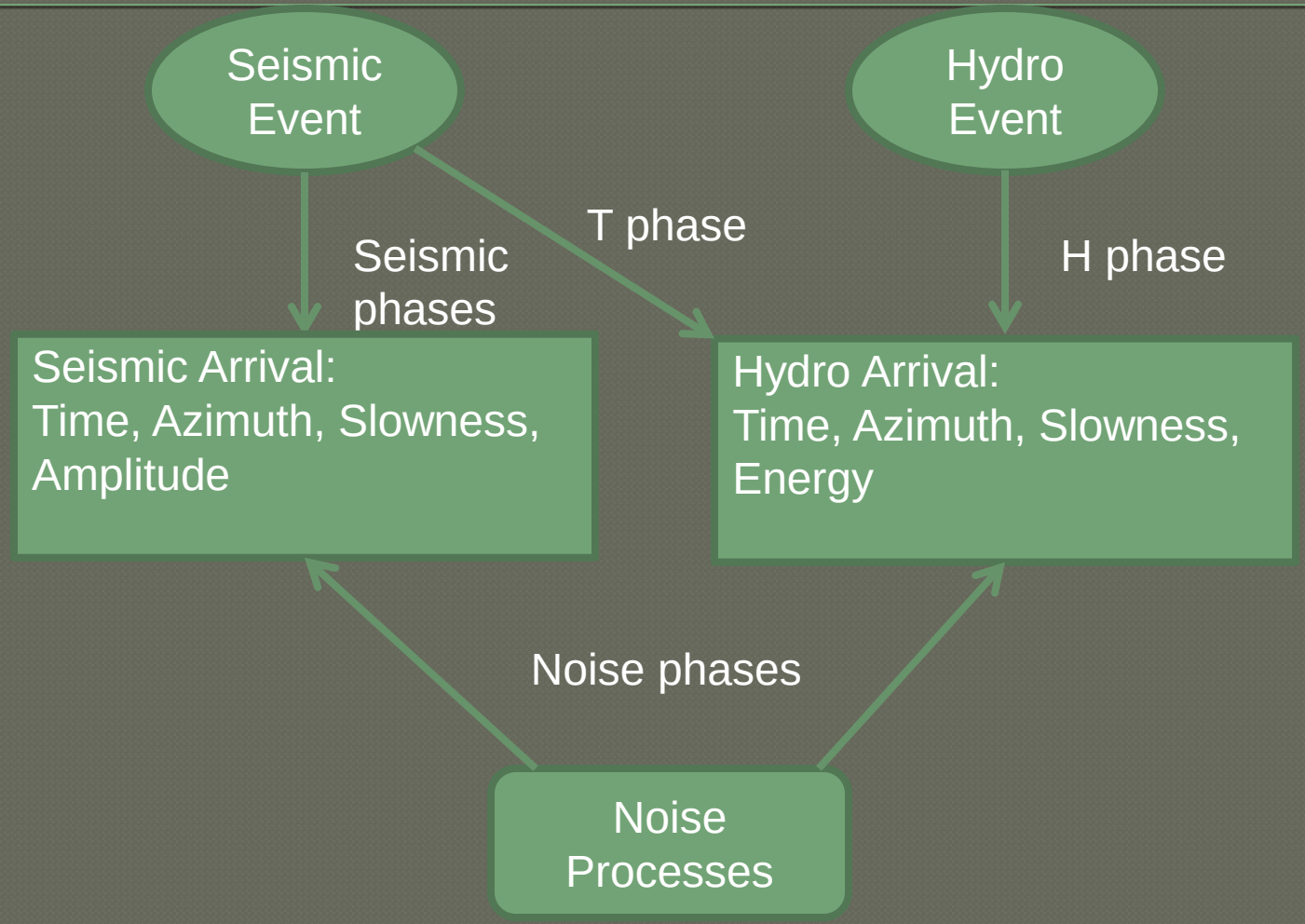
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Noise phases
Noise Processes

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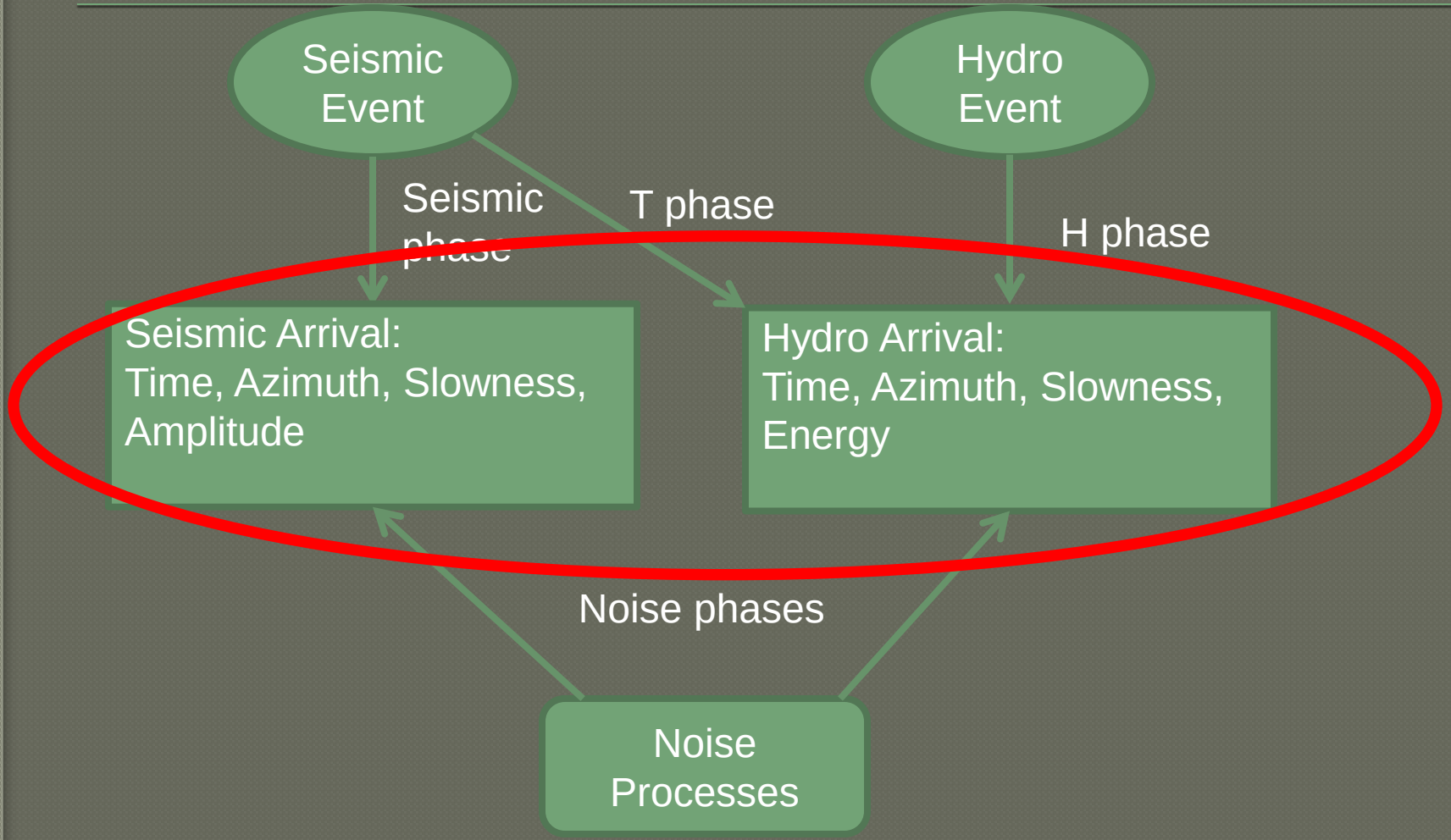
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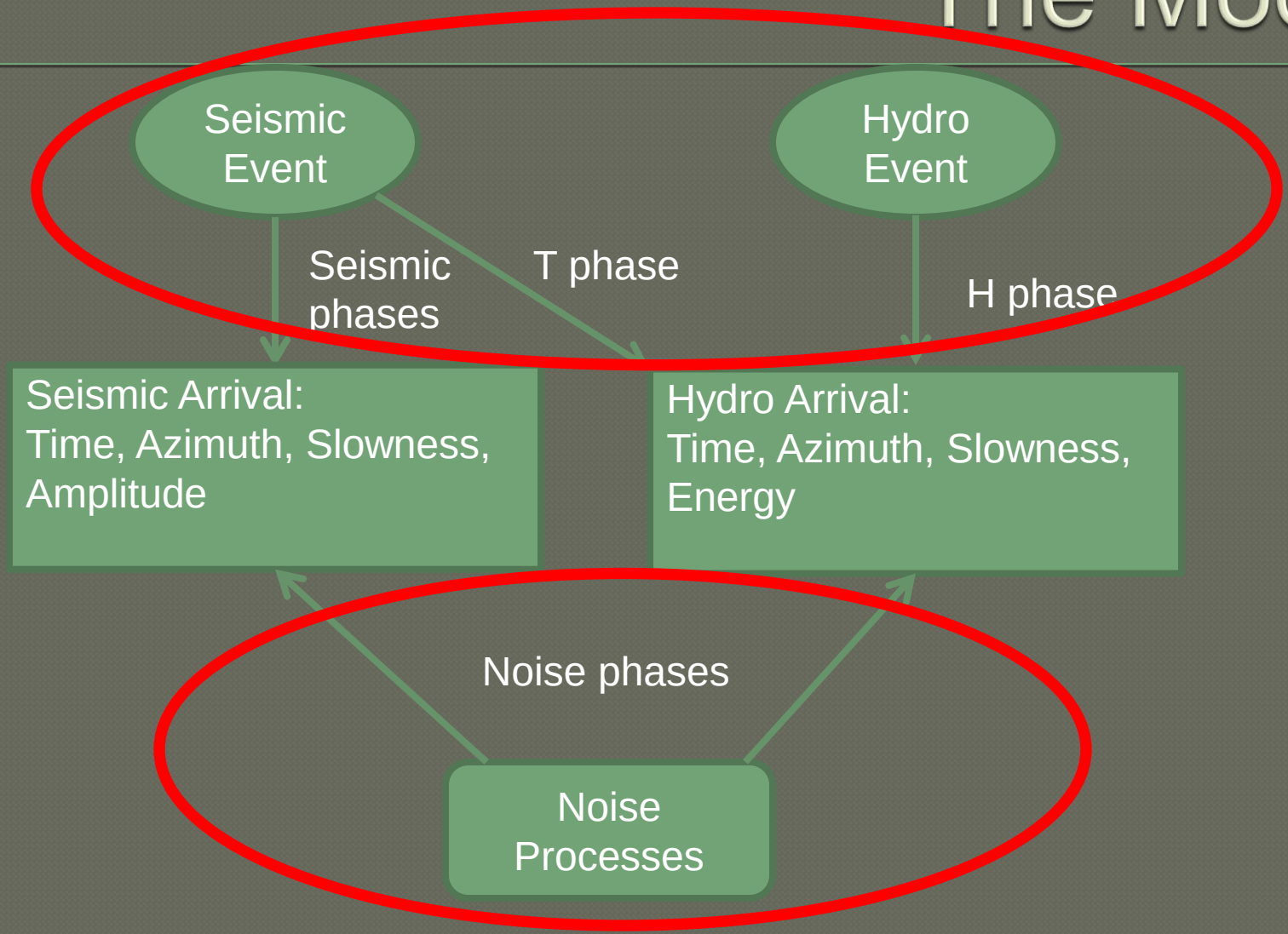
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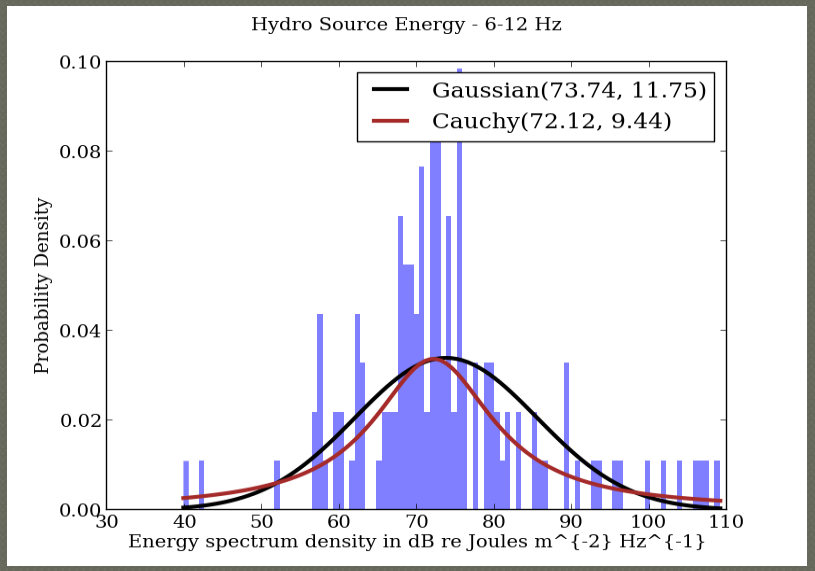
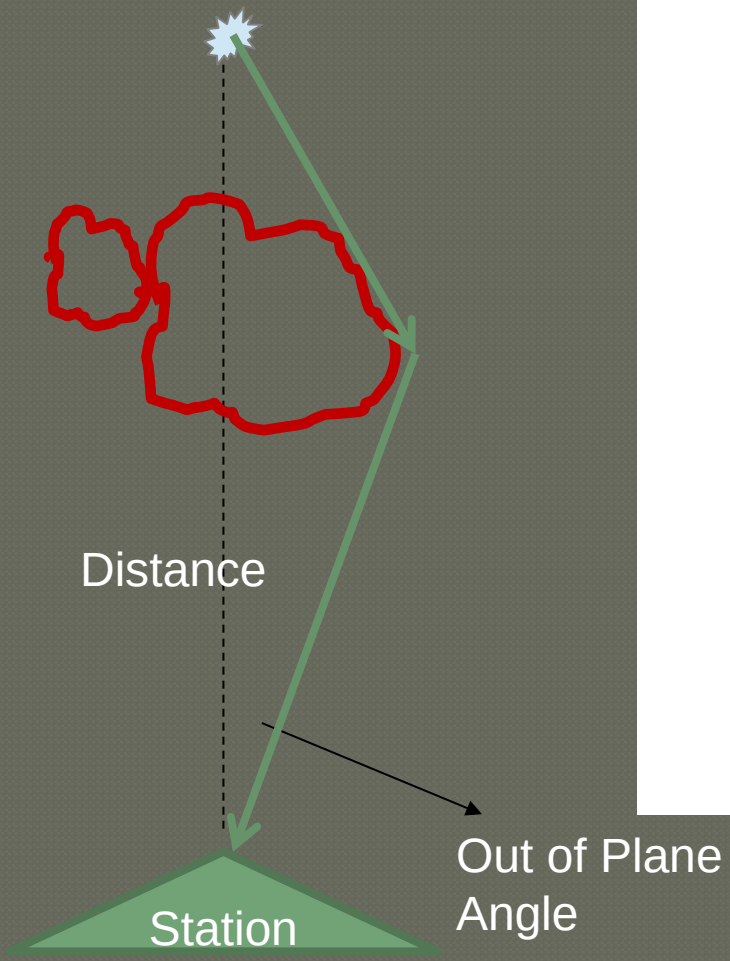
Model Parameters – Event

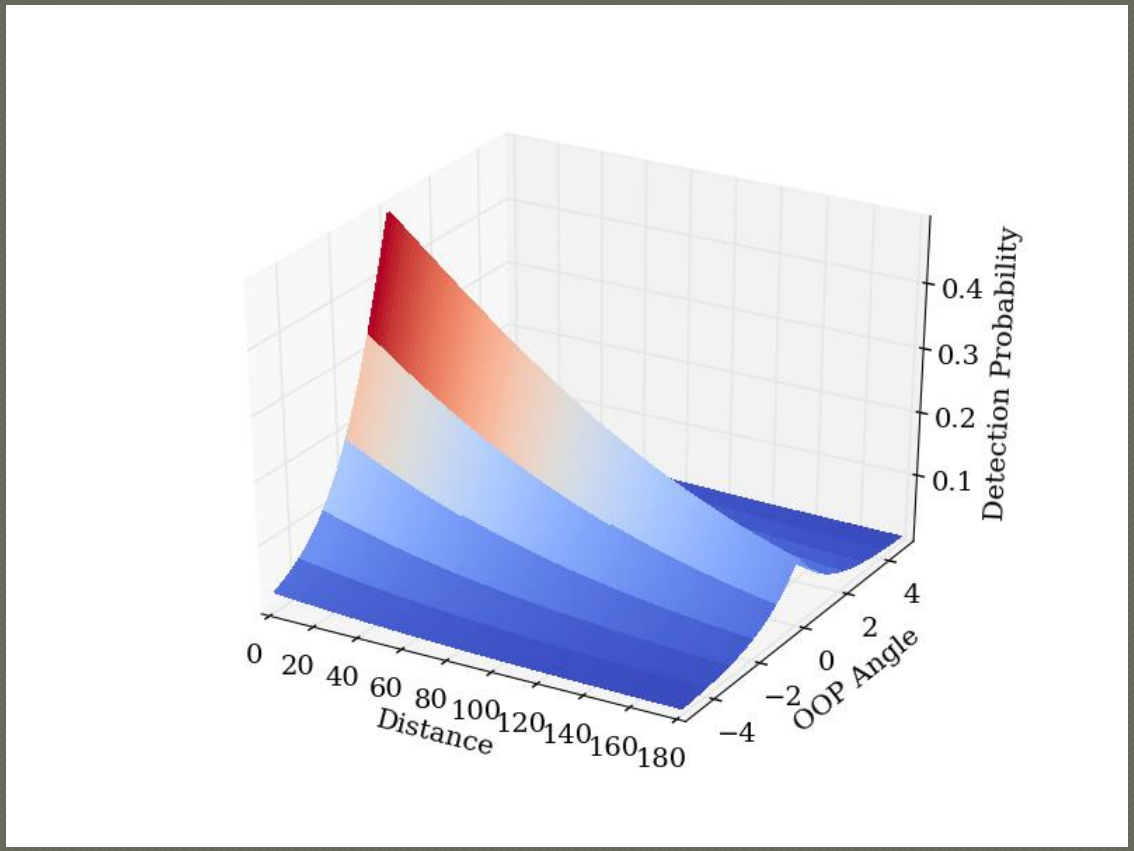
- Hydro Event Locations are uniform over the earth's water surface area at a rate of 1 per hour
- Event Energy has Cauchy(70, 10) distribution

  (units: db re J/m^2/Hz)



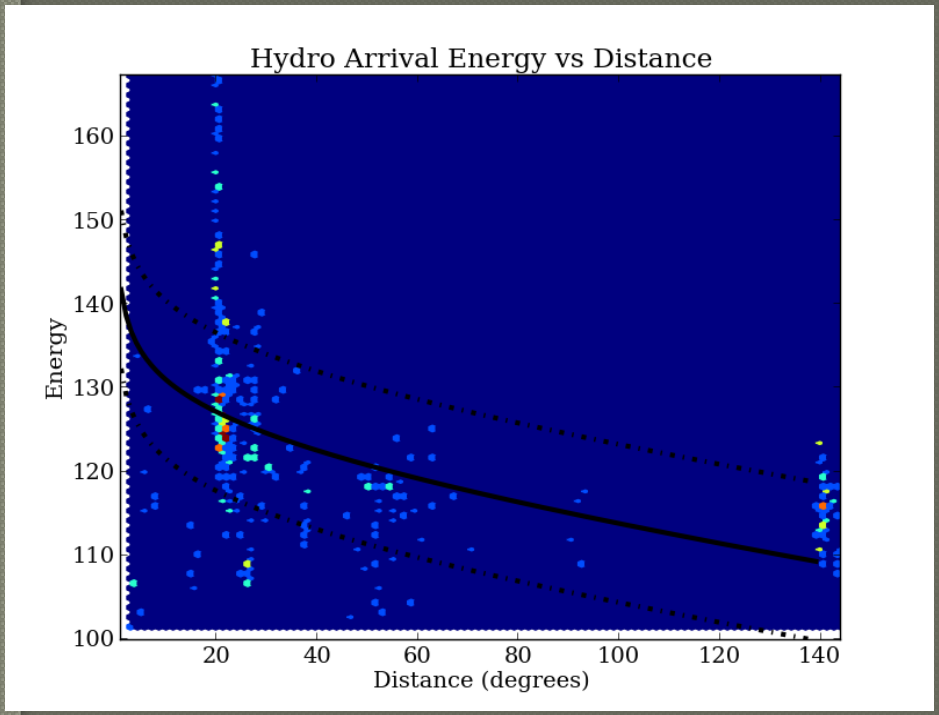
Station Detection Probability

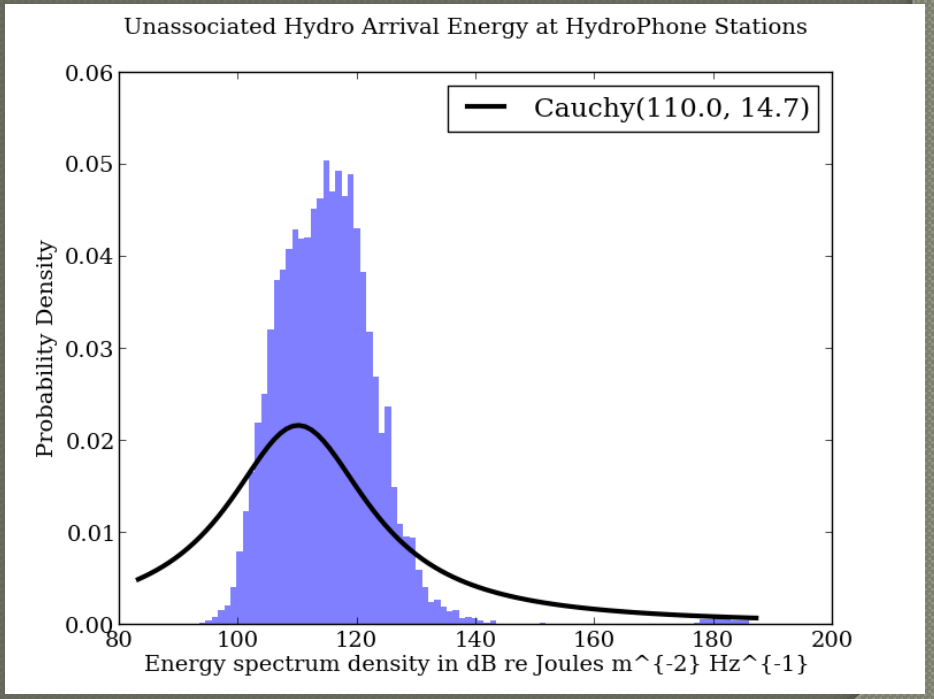




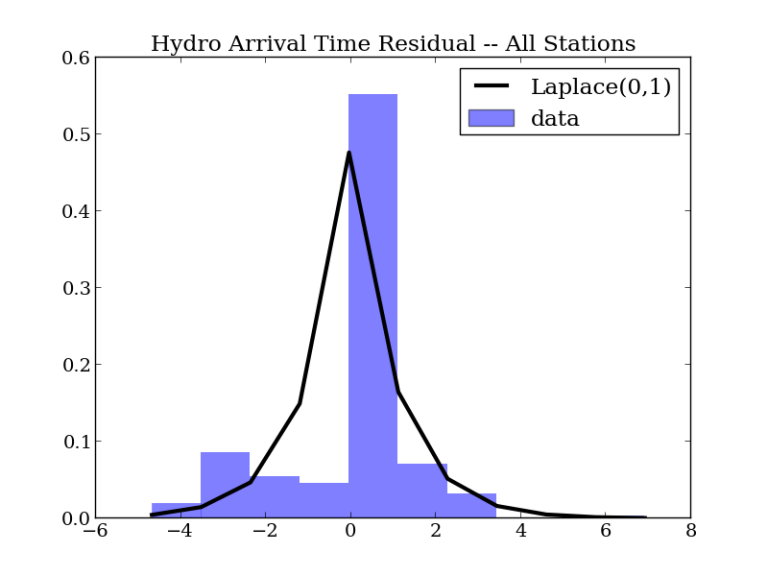
Energy

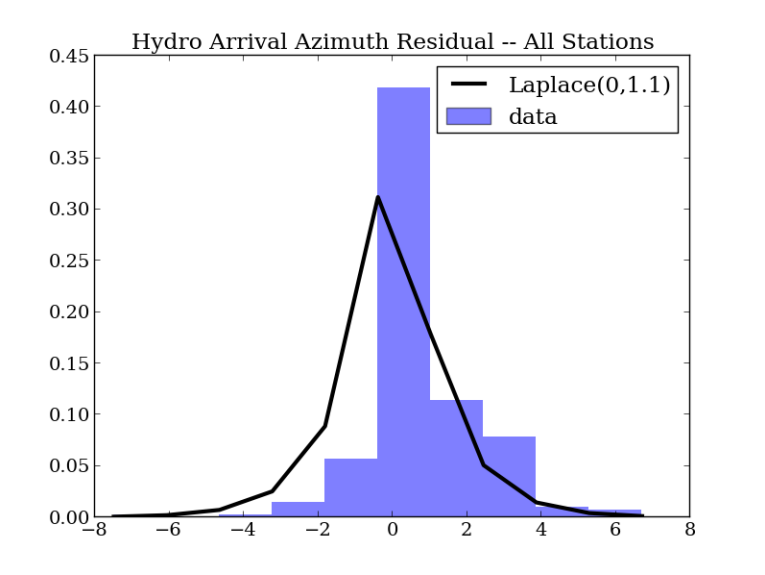
- Energy losses are mainly due to geometric spreading (cylindrical in the deep sound channel) with very little absorption





Azimuth, Time

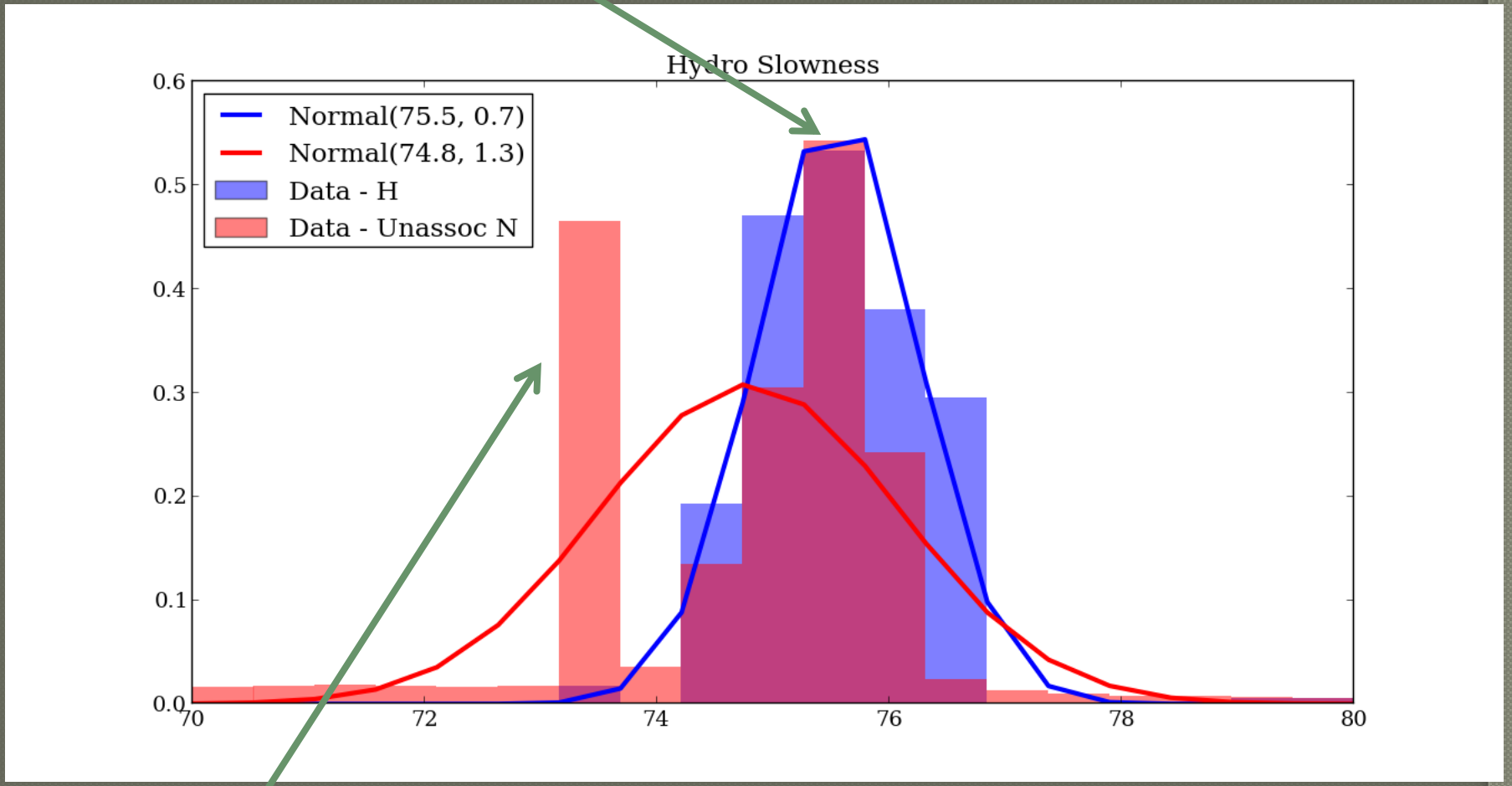




- Arrival Time Residual ~ Laplace(0,1) sec
- Arrival Azimuth Residual ~ Laplace(0,1.1) deg
- Noise is uniform for both

Slowness

1475 m/s



Slowness seconds/degree

Faster noise from nearby sources

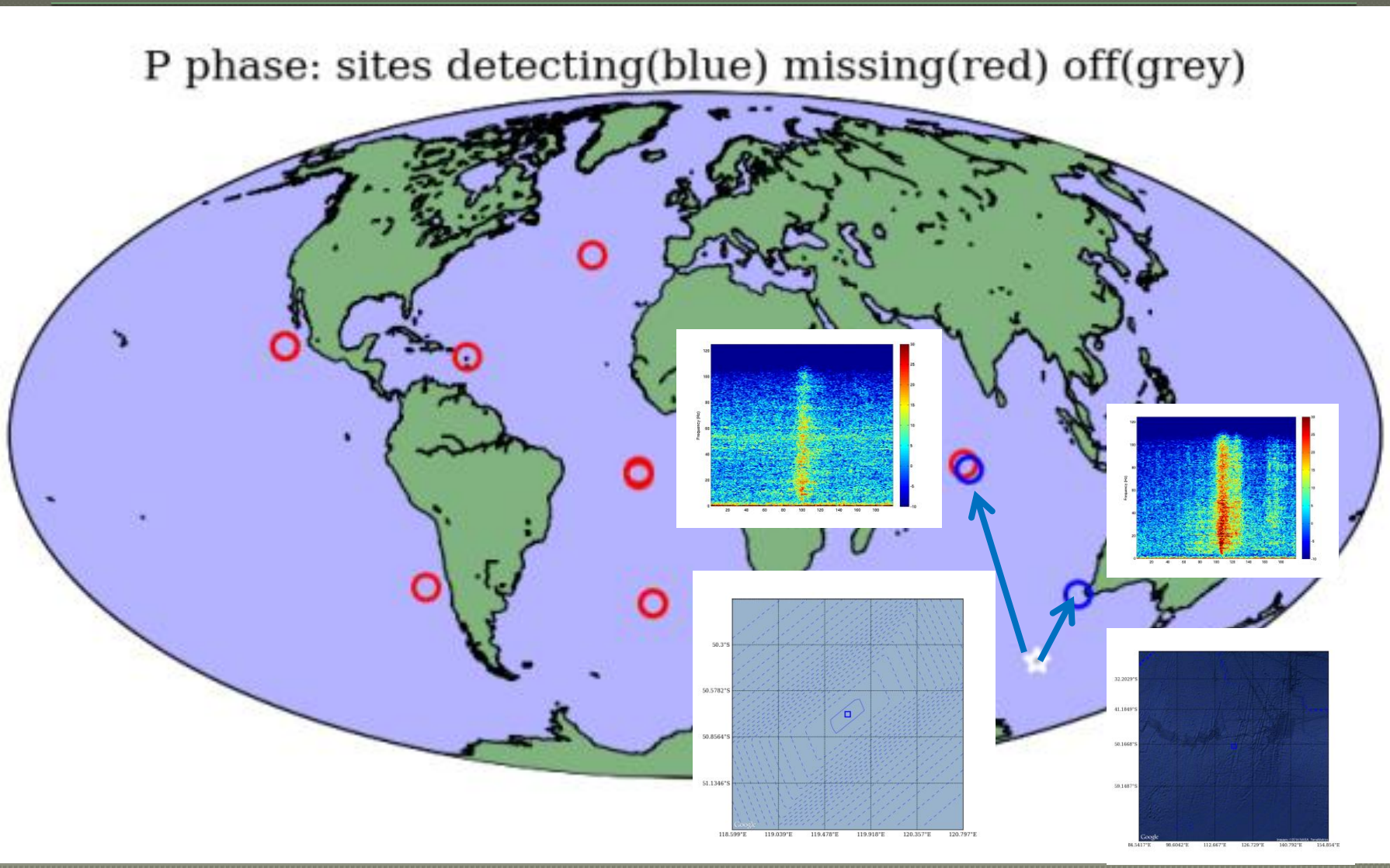
Inference

- We want all events such that:
  - Probability of event being generated plus associated arrivals generated from the event higher than noise generating the same arrivals
- Simple sequence of birth, re-locate, re-associate, and death moves
- The model dictates all choices

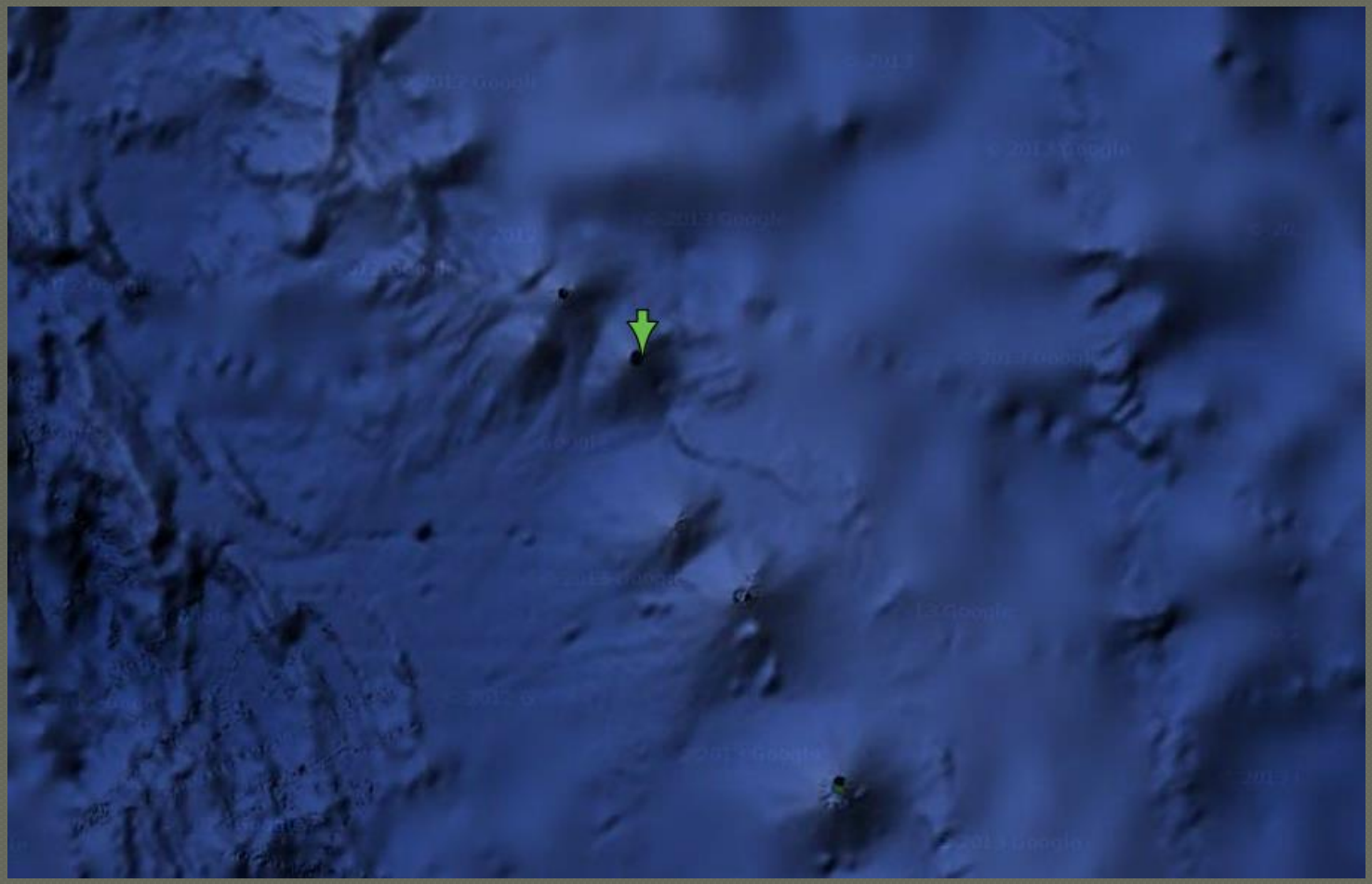
Results on 2010 Events

- NET-VISHA found 12/26 hydro LEB events
- SEL3 found 16/26 (but LEB is built from SEL3)
- 129 “very promising” events vs 54 such events in SEL3
- Seismic Accuracy goes from 89.8% -> 90.0% (small, but consistent)
- T phases 25% missed 20% additional

One of the Promising Events



Ahyl Seamount



Ahyl Seamount

- Currently active underwater volcano (20.43 N 145.04 E). Went active on April 23, 2014
- Experiment conducted on April 24 data
- In 2 degree ball around volcano
  - NET-VISHA found 18
  - SEL3 (GA) found 5
- In the 2 degree ball with 3 stations
  - NET-VISHA found 15
  - SEL3 (GA) found 0

Conclusions

- Seismic model extended to include hydro
- Model parameters heavily influenced by domain expertise, since there is very little data
- No significant changes in inference
- Results on 2010 show high quality events jumped up nearly 3 times high vs SEL3
- Blind test on Ahyl Seamount found 15 new REB-quality events in one day.