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**CONTROL ID:** 1799628

**TITLE:** A Probabilistic Model of Global-Scale Seismology with Veith-Clawson Amplitude Corrections

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**ABSTRACT BODY:** We present a probabilistic generative model of global-scale seismology, NET-VISA, that is designed to address the event detection and location problem of seismic monitoring. The model is based on a standard Bayesian framework with prior probabilities for event generation and propagation as well as likelihoods of detection and arrival (or onset) parameters. The model is supplemented with a greedy search algorithm that iteratively improves the predicted bulletin with respect to the posterior probability.

Our prior model incorporates both seismic theory and empirical observations as appropriate. For instance, we use empirical observations for the expected rates of earthquake at each point on the earth, while we use the Gutenberg-Richter law for the expected magnitude distribution of these earthquakes. In this work, we describe an extension of our model where we include the Veith-Clawson (1972) amplitude decline curves in our empirically calibrated arrival amplitude model. While this change doesn't alter the overall event-detection results, we have chosen to keep the Veith-Clawson curves since they are more seismically accurate.

We also describe a recent change to our search algorithm, whereby we now consider multiple hypotheses when we encounter a series of closely spaced arrivals which could be explained by either a single event or multiple co-located events. This change has led to a sharp improvement in our results on large after-shock sequences.

We use the analyst-curated LEB bulletin or the REB bulletin, which is the published product of the IDC, as a reference and measure the overlap (percentage of reference events that are matched) and inconsistency (percentage of test bulletin events that don't match anything in the reference) of a one-to-one matching between the test and the reference bulletins. In the table below we show results for NET-VISA and SEL3, which is produced by the existing GA software, for the whole of 2009. These results show that NET-VISA, which is restricted to use arrivals with a 6 hour lag (in order to be comparable to SEL3), reduces the number of missed events by a factor of 2.5 while simultaneously reducing the rate of spurious events. Further, these "spurious" NET-VISA events, in fact, include many real events which are missed by the human analysts. When we compare the NET-VISA events, with arrivals from at least 3 stations (to be comparable to LEB), with NEIC events (in the ISC catalog) over the continental United States, as well as NNC events over Central Asia, we find that NET-VISA identifies 1.5 to 2 times the number of events that the IDC analysts find. Most of these additional events are in the 2--4 mb or

ML range.

Our experiments also confirm that NET-VISA accurately located each of the recent nuclear explosions to within 5 km of the LEB location. For large after-shock sequences, NET-VISA has been shown to be very efficient as well as accurate. For example on the Tohoku sequence (March 10 -- 14, 2011), NET-VISA (running time 2.57 days) had an overlap of 82.7 % with LEB and inconsistency of 26.8 % versus SEL3's overlap of 71.9 % and inconsistency of 40 %.

**INDEX TERMS:** 7219 SEISMOLOGY Seismic monitoring and test-ban treaty verification, 1942 INFORMATICS Machine learning, 7200 SEISMOLOGY, 1990 INFORMATICS Uncertainty.

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	Earth (REB as reference)		Earth (LEB as reference)		Continental US (NEIC as reference)	Central Asia (NNC as reference)
	Overlap	Inconsistency	Overlap	Inconsistency	Overlap	Overlap
VISA	90.7 %	46.4 %	89.2 %	37.3 %	5.3 %	7.3 %
SEL3	78.1 %	50.5 %	75.0 %	43.6 %	2.5 %	3.6 %
LEB	100 %	20.3 %	100 %	0.0 %	2.4 %	5.2 %

#### **Additional Details**

**Previously Presented Material:** 25% of the material was presented in S&T 2013.

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**TITLE OF TEAM:**

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