The monitoring completeness of seismic networks is heterogeneous in space and time. It strongly depends on station distribution and recording quality per station. We present a probabilistic method to estimate detection capabilities of seismic networks over space and time, based only on phase data, station information, and the network specific attenuation relation.

We derive probability distributions in the magnitude-distance space for each station. From these, we compute either maps of detection probabilities of events with a particular magnitude or of probabilistic magnitude of completeness, \( \text{M}_P \).

This approach has several advantages over alternative methods: Contrary to estimating completeness based on the Gutenberg-Richter distribution, our approach does not assume any event-size distribution and is based solely on empirical data. Because the method does not rely on earthquake samples, no averaging over space and time occurs. Scenario computations are possible by either removing stations from the computation or adding stations with specific probability distributions. It also offers the possibility of estimating the completeness in low-seismicity areas where methods based on parametric earthquake catalogs fail due to sparse data. The probability distributions per station allow analyzing single station performances, intrinsically including site effects.

We present our case study from southern California and compare them with estimated completeness levels of other methods. We provide uncertainty estimates based on bootstrap simulations. Because the only ingredients to this method are phase data, station lists, and attenuation relation, this approach is easy to adopt to other seismic networks. We envision this method to become a viable additional tool for the design and management of seismic networks from local to global scales.

**Outlook**
- Create living SCEC resource (History of completeness).
- Develop full 3D-ray path approach for global studies.
- Combine method with station site characterization.
- Further case studies: Northern California (see poster), Switzerland (AGU 2006), Alaska, global networks, Japan, New Zealand & Italy (in preparation)

**Results**

**Method**

- Raw Data
- Detection Probability
- Complete
- Uncertainty
- Probabilistic Method

**Abstract**

The monitoring completeness of seismic networks is heterogeneous in space and time. It strongly depends on station distribution and recording quality per station. We present a probabilistic method to estimate detection capabilities of seismic networks over space and time, based only on phase data, station information, and the network specific attenuation relation.

We derive probability distributions in the magnitude-distance space for each station. From these, we compute either maps of detection probabilities of events with a particular magnitude or of probabilistic magnitude of completeness, \( \text{M}_P \).

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We present our case study from southern California and compare them with estimated completeness levels of other methods. We provide uncertainty estimates based on bootstrap simulations. Because the only ingredients to this method are phase data, station lists, and attenuation relation, this approach is easy to adopt to other seismic networks. We envision this method to become a viable additional tool for the design and management of seismic networks from local to global scales.

**Summary**

**PROS**
- No model assumption (Gutenberg-Richter distribution) → Volcanoes
- No averaging over space and time
→ Statement for a particular network configuration
- Full description of completeness changes over space and time
- Works in low-seismicity areas
- More “complete” description (Prob. per magnitude)
- Takes site conditions into account
- Takes localization procedure into account

**CONS**
- Computationally more intensive than GR-methods
- Imaging of completeness above magnitude threshold
- No averaging over space and time
- Requires higher quality data