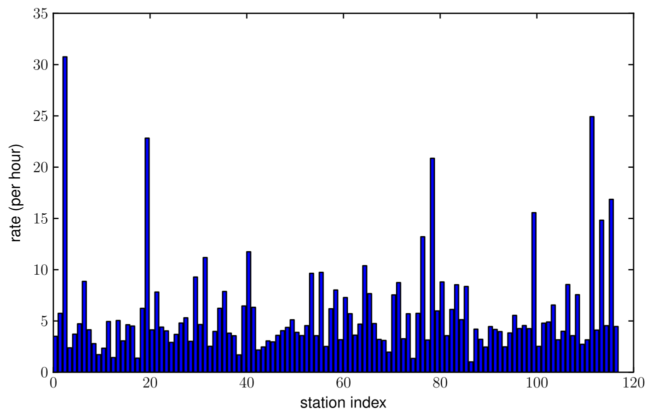

Figure 11. The average false arrival rate per hour at all the stations. The color version of this figure is available only in the electronic edition.

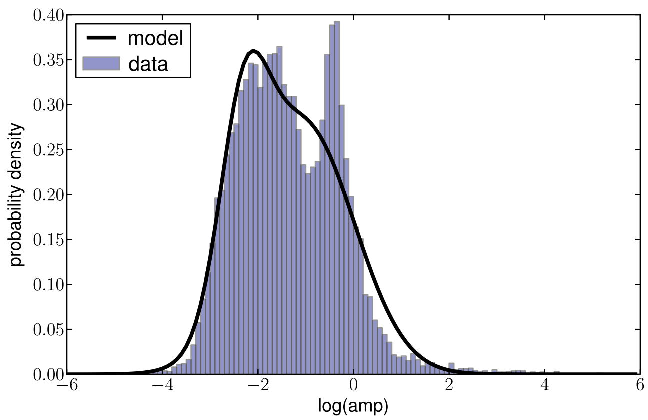

Figure 12. Amplitude distribution for false arrivals at station ASAR. The color version of this figure is available only in the electronic edition.

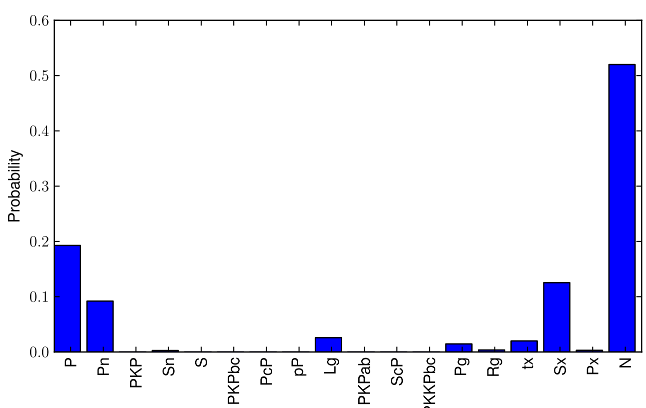

Figure 13. Phase distribution for all false arrivals. The color version of this figure is available only in the electronic edition.

The values of λ_f^k are displayed in Figure 11. If ξ^{kl} is one of this set of false arrivals, its time ξ_t^{kl}, azimuth ξ_z^{kl}, and slowness ξ_s^{kl} are generated uniformly over their respective ranges:

$$P_{\omega,t}^k(\xi_t^{kl}) = \frac{1}{T}, \qquad P_{\omega,z}^k(\xi_z^{kl}) = \frac{1}{M_z}, \qquad P_{\omega,s}^k(\xi_s^{kl}) = \frac{1}{M_s},$$

where M_z and M_s are the range of values for azimuth and slowness, respectively. The log amplitude $\log(\xi_a^{kl})$ of the false arrival is generated from either a uniform distribution with probability 0.1 or a mixture of two Gaussians, which is estimated from the data with a standard expectation maximization procedure. This distribution, $f_{\omega,a}^k(\cdot)$, at one station is displayed in Figure 12.

False Arrivals

The resulting distribution on the false arrival amplitude is given by

$$P_{\omega,a}^k(\xi_a^{kl}) = f_{\omega,a}^k[\log(\xi_a^{kl})]\frac{1}{\xi_a^{kl}}.$$

Finally, the phase label ξ_h^{kl} assigned to the false arrival follows a categorical distribution, $P_{\omega,h}^k(\xi_h^{kl})$. This is estimated via the posterior mean under a uniform Dirichlet prior (see Fig. 13).

Overall, assuming the false arrival attributes are independently generated, we have

$$P_\omega^k(\xi^{kl}) = P_{\omega,t}^k(\xi_t^{kl})P_{\omega,z}^k(\xi_z^{kl})P_{\omega,s}^k(\xi_s^{kl})P_{\omega,a}^k(\xi_a^{kl})P_{\omega,h}^k(\xi_h^{kl}).$$

Because the false arrivals at a station are exchangeable, the probability for the set ξ^k is

$$P_\omega^k(\xi^k) = P_{\omega,n}^k(|\xi^k|)\cdot|\xi^k|!\prod_{l=1}^{|\xi^k|}P_\omega^k(\xi^{kl})$$

$$= \exp(-\lambda_f^k T)\prod_{l=1}^{|\xi^k|}\frac{\lambda_f^k}{M_z M_s}P_{\omega,a}^k(\xi_a^{kl})P_{\omega,h}^k(\xi_h^{kl}).$$

As before, we have overloaded P_ω^k to refer to a distribution over a set of arrivals as well as a single arrival. As before, we can simplify the equations by defining

$$\hat{P}_\omega^k(\xi^{kl}) = \frac{\lambda_f^k}{M_z M_s}P_{\omega,a}^k(\xi_a^{kl})P_{\omega,h}^k(\xi_h^{kl}).$$

Now, assuming that the false arrivals at different stations are independent of each other, the probability for the complete set ξ of all false arrivals at all stations is

$$P_\omega(\xi) = \exp\left(-\sum_{k=1}^{K}\lambda_f^k T\right)\prod_{k=1}^{K}\prod_{l=1}^{|\xi^k|}\hat{P}_\omega^k(\xi^{kl}). \qquad (9)$$

Coda Arrivals

Following the initial onset and peak, the arriving energy from a seismic phase does not decay smoothly, but exhibits many subsidiary peaks, some of which may even be larger than the initial peak. These subsidiary peaks may fool the STA/LTA detector into announcing additional arrivals, called coda arrivals; in the IMS data, up to half of all arrivals are of