

# A 1000-fold Acceleration of Hidden Markov Model Fitting using Graphical Processing Units, with application to Nonvolcanic Tremor Classification.

Marnus Stoltz<sup>1</sup>      Gene Stoltz<sup>2,3</sup>      Kazushige Obara<sup>4</sup>      Ting Wang<sup>1</sup>  
David Bryant<sup>1</sup>

1. Department of Mathematics and Statistics, University of Otago, New Zealand
2. Council for Scientific and Industrial Research of South Africa, Pretoria, South Africa
3. Department of Electronic Engineering, University of Johannesburg, South Africa
4. Earthquake Research Institute, University of Tokyo, Japan

\* Corresponding author. [david.bryant@otago.ac.nz](mailto:david.bryant@otago.ac.nz)

March 10, 2020

## Abstract

Hidden Markov models (HMMs) are general purpose models for time-series data widely used across the sciences because of their flexibility and elegance. However fitting HMMs can often be computationally demanding and time consuming, particularly when the the number of hidden states is large or the Markov chain itself is long. Here we introduce a new Graphical Processing Unit (GPU) based algorithm designed to fit long chain HMMs, applying our approach to an HMM for nonvolcanic tremor events developed by Wang *et al.* (2018). Even on a modest GPU, our implementation resulted in a 1000-fold increase in speed over the standard single processor algorithm, allowing a full Bayesian inference of uncertainty related to model parameters. Similar improvements would be expected for HMM models given

large number of observations and moderate state spaces (<80 states with current hardware). We discuss the model, general GPU architecture and algorithms and report performance of the method on a tremor dataset from the Shikoku region, Japan.

**Keywords**— *Bayesian inference, Computational hardware, Seismology, Algorithm design.*

## 1 INTRODUCTION

Slow slip events (SSEs), a type of slow earthquakes, play an important role in releasing strain energy in subduction zones, the region where one tectonic plate moves underneath another tectonic plate and sinks. It is currently understood that SSEs occur as shear slips on the bottom tip of subduction zones that transition between a fixed region above and slipping region below (Beroza and Ide, 2011). Recent evidence suggest that nonvolcanic tremors are observed in close association with SSEs, however the causal relationship between the two phenomena is not yet well understood. Classifying nonvolcanic tremors helps to better understand this link but can be time consuming when typically done by hand.

Recently, an automated procedure was developed by Wang et al. (2018) to classify spatio-temporal migration patterns of nonvolcanic tremors. The procedure classifies tremor source regions into distinct segments in 2-D space using a Hidden Markov Model. The model is fitted using the Expectation Maximisation algorithm. Here we implement a Bayesian approach. However, fitting the model in either a frequentist or Bayesian framework is extremely demanding computationally, often taking days or weeks for large dataset with moderate state space. Fortunately, technological advances in hardware have the potential to solve this issue. Specifically, we make use of fast and affordable graphic processing units (GPUs).

In recent years HMM algorithms on GPUs have been implemented in various fields. A non-exhaustive list includes implementations in bioinformatics (Yao et al., 2010), speech recognition (Yu et al., 2015), a registered patent in speech matching (Chong et al., 2014) and workload classification (Cuzzocrea et al., 2016), as well as HMMer (Horn et al., 2005) an open-source project for use with protein databases. The HMM implementations are application specific often

with large number of states and mostly focused on increasing throughput of the Verterbi and Baum-Welch algorithms (Zhang et al., 2009; Li et al., 2009; Liu, 2009). This leads to a range of concurrent approaches. Here we focus on the efficient implementation of the forward algorithm of an HMM model given a large number of observations and a moderate number of states.

The outline of the paper is as follows: In Section 2 we describe the HMM for classifying non-volcanic tremors and discuss the likelihood algorithm in a serial and parallel context. Thereafter we give details on the OpenCL implementation of the parallel likelihood algorithm. In Section 3 we discuss performance of the OpenCL implementation and compare it to the standard Forward algorithm. In Section 4 we report our analysis on a large tremor dataset from the Shikoku region, Japan.

## 2 AN HMM FOR CLASSIFYING NONVOLCANIC TREMORS

Nonvolcanic tremor activity is clustered spatially and each spatial cluster seems to recur episodically. To represent this phenomenon using an HMM, Wang et al. (2018) introduce one hidden state for each spatial cluster. The tremors themselves (including the absence of a tremor) are the observations. The frequency and spatial distribution of tremors changes according to the hidden state.

More formally, we suppose that the observations of nonvolcanic tremors are a sample path of a stochastic process

$$\{X_i\}_{i=0,\dots,N}$$

with observations represented in the state space

$$I = \{\emptyset, \mathbb{R}^2\}$$

generated under an HMM with  $K$  numbered hidden states. For each hidden state  $k = 1, \dots, K$  we introduce parameters  $p_k$ ,  $\boldsymbol{\mu}^{(k)}$  and  $\boldsymbol{\Sigma}^{(k)}$ , where  $p_k$  is the probability of observing a tremor and  $\boldsymbol{\mu}^{(k)}$ ,  $\boldsymbol{\Sigma}^{(k)}$  are the mean and variance of a bivariate normal distribution modelling where a tremor is likely to occur, if it does occur.

To simplify notation we introduce for each observation  $\mathbf{x}$  a  $K \times K$  diagonal matrix  $\mathbf{P}(\mathbf{x})$ ,

also called the *emission matrix*, with the  $k$ th diagonal element corresponding to the probability of observing  $\mathbf{x}$  given state  $k$

$$\mathbf{P}(\mathbf{x})_{kk} = \begin{cases} p_k \phi(\mathbf{x} | \boldsymbol{\mu}^{(k)}, \boldsymbol{\Sigma}^{(k)}) \\ 1 - p_k. \end{cases} \quad (1)$$

Here  $\phi(\cdot)$  is the density function of bivariate normal distribution. Let  $\boldsymbol{\Gamma} = (\Gamma_{ij})$  denote the  $K \times K$  transition matrix of the HMM, where  $\Gamma_{ij}$  indicate the the transition probability from hidden state  $K = i$  to  $K = j$ . Also, let  $\boldsymbol{\delta} = \delta_1, \dots, \delta_K$  denote the vector of probabilities for the initial state.

Now the likelihood function for the parameters given the observed data can be written as

$$L(\boldsymbol{\Gamma}, \boldsymbol{\delta}, \{p_k, \boldsymbol{\mu}^{(k)}, \boldsymbol{\Sigma}^{(k)}\}_{k=1,\dots,K} | \mathbf{x}_0, \dots, \mathbf{x}_N) = \boldsymbol{\delta}^T \boldsymbol{\Gamma} \mathbf{P}(\mathbf{x}_0) \dots \boldsymbol{\Gamma} \mathbf{P}(\mathbf{x}_N) \mathbf{1}. \quad (2)$$

### 3 GPU COMPUTING FRAMEWORK

GPUs have had a large impact across statistical and computing sciences due to cost-effect parallelism (Kindratenko, 2014). However in order to translate an algorithm from CPU to GPU some careful consideration is needed in terms of

1. Reducing latency (how to concurrently execute instructions on GPU in order to optimise data throughput.)
2. Managing memory (how to effectively distribute and utilise memory across processors to avoid bandwidth bottlenecks).
3. Designing robust algorithms with respect to varying GPU architecture between models and vendors as well as the rapidly changing landscape of computational hardware.

Frameworks like OpenCL and CUDA, allow programmers to implement GPU algorithms with some level of generality. The implementation we describe here was carried out in the OpenCL framework. OpenCL is an open standard maintained by the non-profit technology consortium Khronos Group, see <https://www.khronos.org> for more details on the non-profit organisation.

The OpenCL framework consists of a *host* (CPU; terms in brackets relate to computation on GPU architecture) controlling one or more *compute devices* (We just used one GPU). Each compute device (GPU) is divided into *compute units* (streaming multiprocessors). Compute units are further divided into *compute elements* (microprocessors or cores). Each compute unit has access to global memory of the compute device. This access though is slow. Each compute unit also has a shared memory to allow efficient data exchange between compute elements. Each compute element has exclusive access to private memory (registers) for computation.

## 4 THE LIKELIHOOD ALGORITHM

### 4.1 Overview

Our implementation will work well on a range of GPU models. For our studies we used a NVIDIA GeForce GTX 1080 Ti GPU with 28 compute units (streaming multiprocessors) each with 48KB of shared memory, 128 compute elements (cores) and a register file that can contain up to 32,768 32-bit elements distributed across the compute elements (cores). For the host we used an Intel Core i7-7700K CPU at 4.20GHz. There are two main limitation for the OpenCL algorithm in terms of hardware specifications

1. The number of registers per compute element.
2. The size of shared memory on a compute unit.

For example given the hardware described above we have  $(32,768/128)=256$  registers per compute element. This implies that we can store up to roughly 200 32-bit matrix elements on a compute element (we also need some registers left to store counters and other meta variables). Our implementation assumes that at least two matrix rows can fit into the registers of a compute element. This gives an upper limit for the number of hidden states of  $K < 100$ . In order to efficiently distribute rows of a matrix and update matrix elements we need space for two matrices in the shared memory of the compute unit. Our configuration has 48KB of shared memory per compute unit. Implying that we can fit a total of  $(48 \cdot 2^{10})/4 = 12288$  32-bit matrix elements per compute unit. This gives a second upperlimit for number of hidden states of  $K < 80$ . To

handle a large number of states, alternative parallel computing strategies should be used (Horn et al., 2005; Yu et al., 2015).

First we consider how the algorithm for the likelihood (2) would be implemented on a single processor unit. To avoid matrix-matrix multiplications we would start with the stationary vector  $\delta$  on the left, and then sequentially multiply that by transition matrices and emission matrices:

---

**Algorithm 1** The Forward algorithm on a CPU

---

```

1: procedure COMPUTE-LIKELIHOOD( $\{p_k, \mu^{(k)}, \Sigma^{(k)}\}_{k=1,\dots,K}, \{\mathbf{x}_0, \dots, \mathbf{x}_N\}$ )
2:    $\mathbf{v} \leftarrow \delta^T$ 
3:   for  $k$  from 0 to  $N$  do
4:     Compute  $\mathbf{P}(x_k)$ 
5:      $\mathbf{v} \leftarrow \mathbf{v}\Gamma$ 
6:      $\mathbf{v} \leftarrow \mathbf{v}\mathbf{P}(x_k)$ 
7:   return  $\mathbf{v}$ 
```

---

Running time will be dominated by the matrix-vector multiplication in steps 5 and 6, taking  $\mathcal{O}(K^2)$  time per iteration. Hence the running time, or work, for this implementation is  $\mathcal{O}(NK^2)$ .

Next we compare it with the parallel implementation.

The overview of our implementation is as follows:

1. We compute all of the emission matrices  $\mathbf{P}(x_0), \dots, \mathbf{P}(x_N)$  in parallel
2. We then multiply the emission matrices by the transition matrices, all in parallel storing  $N$  matrices  $\Gamma\mathbf{P}(x_0), \dots, \Gamma\mathbf{P}(X_N)$ .
3. Instead of computing  $\Gamma\mathbf{P}(x_0), \dots, \Gamma\mathbf{P}(X_N)$  as a single sequence of vector-matrix multiplications, we multiply the matrices  $(\Gamma\mathbf{P}(x_0)), \dots, (\Gamma\mathbf{P}(X_N))$  together.

This *increases* the work done: we are carrying out matrix-matrix multiplications instead of matrix-vector multiplications, but it allows us to spread the computation over multiple processors. We now discuss steps (1) to (3) in greater detail.

## 4.2 Step 1: The emission probability evaluation on GPU

The goal in this step is to compute the emission matrices  $\mathbf{P}(x_i)$  for each observation  $x_i$ . The emission probability is defined by (1) and makes use of the parameters  $p_k, \Sigma_k, \mu_k$  for each hidden state  $k$ . These parameters are initially copied to the registers of each core and remains there

until all the datapoints have been evaluated. The compute elements work in parallel. Each is allocated a data point  $x_i$ , uses the stored values to compute  $\mathbf{P}(x_i)$  and copies the diagonal matrix computed to global memory. Note that a compute element can request and copy the next data point at the same time as it processes the current data point.

For this step there is no data sharing between compute elements, allowing for data-level parallelism. Therefore it is more efficient to allow compute device compiler to optimise the work-load scheduling and data transfer between compute units in order to fully utilise SIMD (Single instruction multiple data) instructions. Output from compute elements are collected and copied to global memory to form the list of new inputs  $\{\mathbf{\Gamma}, \mathbf{P}(x_0), \dots, \mathbf{P}(x_N)\}$  for the next kernel.

### 4.3 Step 2: The transmission-emission matrix multiplication on GPU

During the next step we compute  $\mathbf{\Gamma}\mathbf{P}(x_i)$  for all data points  $x_i$ , again in parallel. At this point we run into limitations with memory. While the register of a single compute element is large enough to store the diagonal matrix  $\mathbf{P}(x_i)$ , it is not large enough to store the full transition matrix  $\mathbf{\Gamma}$  nor the product matrix  $\mathbf{\Gamma}\mathbf{P}(x_i)$ . The solution is to break down the multiplication of  $\mathbf{\Gamma}$  and  $\mathbf{P}(x_i)$  by computing only a few rows at once.

We query the register size for each compute element to determine how many rows of  $\mathbf{\Gamma}$  can be copied. The rows remain in the register until all data points have been evaluated. Thereafter the next set of rows is copied into the registers and the data points is evaluated again until all the rows of  $\mathbf{\Gamma}\mathbf{P}_r$  for  $r = 0, \dots, N$  have been computed. As  $\mathbf{P}(x_i)$  is diagonal, the product of rows of  $\mathbf{\Gamma}$  with  $\mathbf{P}(x_i)$  is computed by simply rescaling the corresponding columns.

The next diagonal matrix subset is requested while scaling subset for current data point. Again, there is no data sharing between compute elements, allowing for optimal data-level parallelism. Output from compute elements are collected and a new list of inputs, namely  $\{(\mathbf{\Gamma}\mathbf{P}_0), \dots, (\mathbf{\Gamma}\mathbf{P}_N)\}$  is compiled for the final GPU kernel.

### Step 3: The Square Matrix-Chain Multiplication on GPU

The third step is the most time-consuming, and also the most involved. The general idea is to avoid the long sequence of matrix vector calculations

$$\delta^T \mathbf{\Gamma} \mathbf{P}(x_0) \dots \mathbf{\Gamma} \mathbf{P}(x_N) \mathbf{1}$$

which cannot be readily parallelized, by instead multiplying the matrices together in parallel. Our algorithm here roughly follows (Masliah et al., 2016).

Recall the general hierarchical structure of a GPU calculations, as described above. The CPU controls the GPU. Each compute GPU is divided into compute units (streamline multiprocessors). Compute units are further divided into compute elements (microprocessors or cores). The CPU is actually faster than the compute units for individual computations, the speed of GPUs being due to parallelism. Our algorithm takes advantage of all three levels: The sequence of matrices (known in computer science as a *matrix chain*) is divided into multiple segments, one for each compute unit. The compute units then carry out matrix multiplication directly, making use of multiple compute elements to share out the rows in each matrix-matrix computation. We then use the CPU to carry out the final sequence of matrix-vector computations, using the matrices returned by the computational units of the GPU.

Note that in practise we compute  $\log L$  rather than  $L$  and shift the registers either up or down using the scale coefficients from compute units to avoid underflow.

## 5 PERFORMANCE ASSESSMENT OF OPENCL IMPLEMENTATION

### 5.1 OpenCL algorithm vs Forward algorithm

One of the factors that influence the use of an algorithm on GPUs is whether it is actually faster than a Forward algorithm. To check this we compare computational times of the GPU algorithm with the Forward algorithm from the software library Tensor flow. First we fixed the number of HMM states to  $K = 25$  while increasing the number of datapoints over a range of magnitude orders  $N = 10^2, \dots, 10^5$ . Thereafter we fixed the number of datapoints to  $N = 100,000$  and

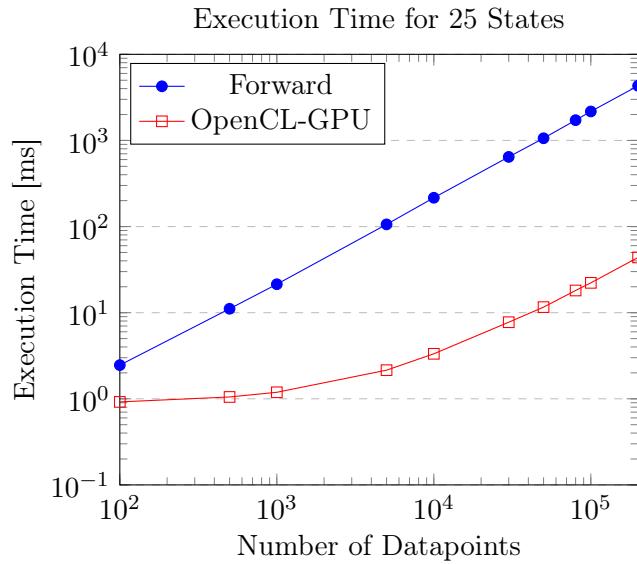


Figure 1: We compare computational time of OpenCL algorithm on GPU with a Forward algorithm on CPU. Computational time is indicated on the y-axis and number of datapoints are indicated by the x-axis. We see that with  $10^5$  datapoints, the GPU algorithm runs  $\sim 10^3$  times faster.

increased the number of HMM states for  $K = 5, 10, \dots, 50$ . In each case model parameters were drawn from the prior distribution (discussed in the next section) and thereafter data was simulated using the R software package in Wang et al. (2018). The results are shown in Figure 1 and Figure 2. We see that the GPU algorithm executes orders of magnitude faster than a Forward algorithm.

## 5.2 Comparing execution time of matrix-chain multiplication

Here we specifically compare computation time of step 3 in the OpenCL algorithm with matrix-chain multiplication using popular GPU BLAS (Basic Linear Algebra Subprograms) libraries. We use subroutines from the CLBlast library as well as the MAGMA BLAS library to do the matrix-chain multiplication. CLBlast is a general BLAS library in OpenCL that automatically tunes subroutines for specific hardware based on compile time. MAGMA BLAS is a CUDA library exclusively available for NVIDIA GPUs. We followed the same procedure as in the previous two experiments except that we fixed the number of HMM states to  $K = 50$ . We show results in Figure 3 and Figure 4. Using the MAGMA library gives roughly the same performance

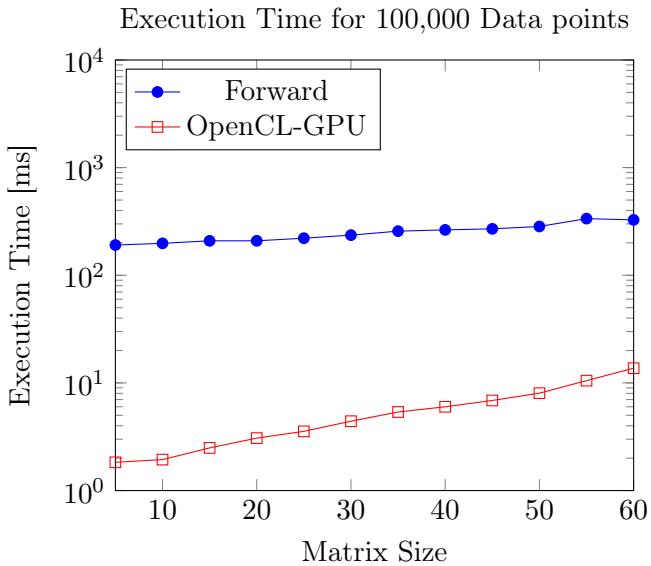


Figure 2: We compare computational time of OpenCL algorithm on GPU with a Forward algorithm on CPU. Computational time is indicated on the y-axis and number of HMM states are indicated by the x-axis. We see that the GPU algorithm slows down as the register capacity of compute elements is reached. However it still outperforms the Forward algorithm by orders of magnitude.

as the OpenCL algorithm for small matrices. We note that using these libraries in the OpenCL algorithm is not straightforward due to small tweaks and scaling coefficients that we keep track of in addition to performing the matrix-chain multiplication. The algorithm became very slow when the HMM had more than 100 states due to memory limitations previously discussed.

## 6 BAYESIAN ANALYSIS OF NONVOLCANIC TREMOR DATA

### 6.1 Monte Carlo Markov Chains

Bayesian techniques have become a popular method of statistical inference across a broad range of sciences (Jóhannesson et al., 2016; Kruschke, 2010; Moore and Zuev, 2005; Stoltz et al., 2019; Turner et al., 2016; Woolrich et al., 2009). This is due to advances in numerical techniques and the affordability of powerful computers (Andrieu et al., 2004). In a Bayesian analysis the aim is to compute the joint posterior distribution of model parameters, simply referred to as the posterior distribution. The posterior distribution summarizes the uncertainty related to model parameters.

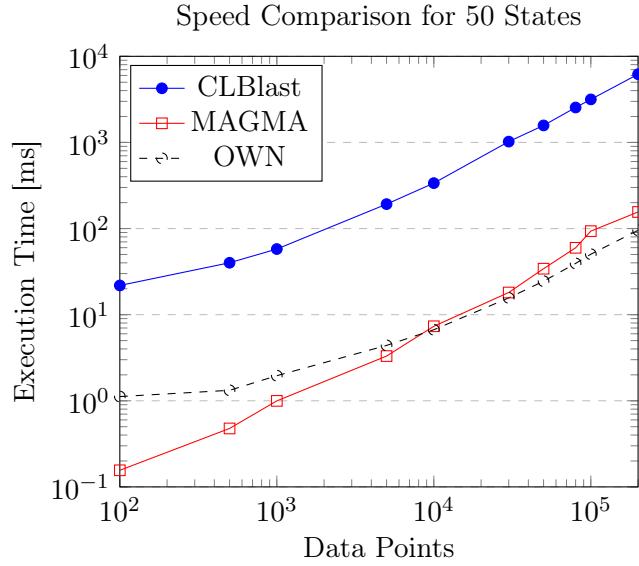


Figure 3: For this computational comparison (in miliseconds) with the BLAS libraries we fix the number of HMM states to  $K = 50$  and increase the number of datapoints over a range of magnitude orders.

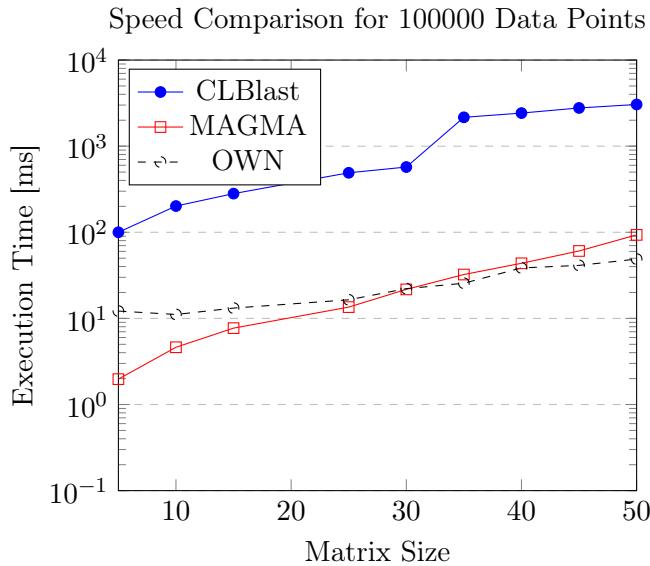


Figure 4: For this computational comparison (in miliseconds) with the BLAS libraries we fix the number of datapoints to  $N = 100,000$  and increase the number of HMM states for  $K = 5, 10, \dots, 50$ .

Typically due to model complexity the posterior distribution is an analytically intractable function. However methods such as Monte Carlo Markov Chains (MCMCs) use random walks to estimate the posterior distribution. The basic concept behind MCMCs is that a Markov chain can be constructed with a stationary distribution, where the stationary distribution is in fact the posterior distribution.

An MCMC is initialized by choosing a random state, typically by drawing a sample from the prior distribution (we discuss prior distributions below). The MCMC is then simulated by accepting or rejecting proposed MCMC states based on a ratio of the likelihood function and prior distribution of both the current and proposed MCMC state. The MCMC is simulated until after the stationary distribution is reached. Stationarity of an MCMC is assessed by looking at trace plots of parameters as well as computing the number of effective independent samples. Samples of the stationary MCMC is then used to approximate the posterior distribution.

## 6.2 Model priors

Using ratios of the likelihood and prior distributions is an elegant way of sampling from the posterior distribution. It sidesteps some nasty calculations if we were to compute the posterior distribution directly instead. Roughly speaking prior distributions is a way to incorporate knowledge about model parameters before looking at the data. However prior distributions can easily be neglected but they are in fact an important part of the model. Therefore choosing prior distributions needs to be carefully considered and requires some justification. For instance, it is known that tremors occur in sequence bursts that cluster around the same area (Wang et al., 2018). This observation we translate into the model by specifying a model prior centred around sparse transition matrices. More formally, we specify a symmetric Dirichlet prior with concentration parameter 0.01 on  $\Gamma$  (formulas for prior densities are given in Appendix A). Furthermore we expect that for some hidden states we are more likely to observe tremors than others. Therefore we specify independent gamma distributions on state probabilities  $\{p_k\}_{k=1,\dots,K}$ , half of the state probabilities with mean 0.1 and variance 0.001 and the other half with mean 0.9 and variance 0.001. Also, we specify a uniform prior on hidden state means  $\{\mu^{(k)}\}_{k=1,\dots,K}$  restricted to a rectangular domain that contains all observations. We have no prior information on the shape of the hidden states therefore we specify an uninformative Inverse-Wishart prior on the

covariance matrices  $\{\Sigma^{(k)}\}_{k=1,\dots,K}$  with degrees of freedom equal to the number of states  $K$  and scale matrix set to a  $K \times K$  identity matrix.

### 6.3 GPUeR-hmmer

In order to simulate MCMCs for the model, we incorporated the GPU likelihood algorithm along with the prior distributions into a general purpose MCMC sampler (Christen et al., 2010). This R package bundle is freely available at <https://github.com/genetica/HMMTremorRecurrencePatterns>. Note that OpenCL 1.2 and Python 3.6 (or later versions) needs to be separately installed on a system in order to support the back-end of the R package. The R package also contains a simple example using simulated data from the HMM described in Section 2. Additionally we provide instructions on how to modify the OpenCL code if an HMM with a different emission function is required. In order to assess convergence of the MCMC chains we used Tracer. For a brief tutorial on how to use Tracer to assess convergence, see [https://beast.community/analysing\\_beast\\_output](https://beast.community/analysing_beast_output). Furthermore if some problems are encountered with convergence of the simulated MCMCs see [https://beast.community/tracer\\_convergence](https://beast.community/tracer_convergence) for some recommendations.

### 6.4 Tremor dataset of the Shikoku region

We use a large tremor dataset from the Shikoku region, Japan to demonstrate the sort of Bayesian analysis that can be done with GPUeR-hmmer. The Shikoku region is one the three major regions in Japan (the other two being the Tokai region and Kii region) in which nonvolcanic tremor occurrences have been repeatedly detected. Tremor activity spans along the strike of the Phillipines Sea plate for about 600km and the depth ranges from 30 to 45 km on the plate interface. The original waveform data is supplied by the High Sensivity Seismograph Network of the National institute for Earth Sciences and Disaster prevention in Japan. The dataset analysed by Wang et al. (2018) was extracted from the waveform data. It consists of 105,000 data point measurements between 2001 and 2012. It is hourly control measurements determined using clustering and correlation methods described in Obara et al. (2010).

## 6.5 Model fitting

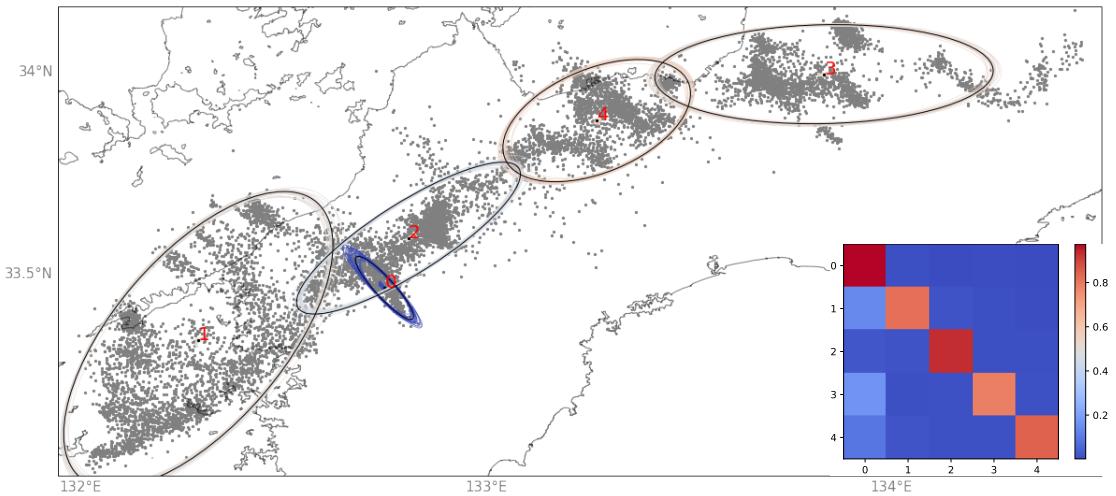
A full Bayesian analysis of the model will sample the number of hidden states along with the rest of the model parameters. However sampling from different parameter spaces is quite challenging and is an active and ongoing area of research (Lunn et al., 2009). Instead we incorporate the choice of number of hidden states  $K$  into the model fitting process.

We start with a small number of hidden states and incrementally increase the number of hidden states, while doing so we assess the posterior distribution for each case. The posterior distribution of each model is estimated by running the MCMC sampler for 1,000,000 iterations. Running each chain took approximately  $\sim 4$  hours.

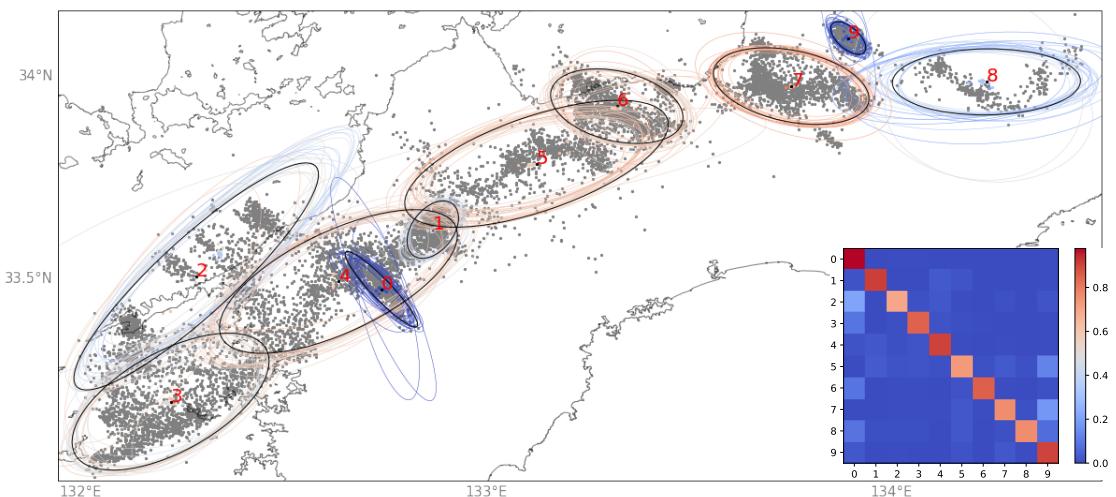
In Figure 5 we summarize the posterior distributions for model fitted with number of hidden states  $K = 5, 10, \dots, 30$ . Typically, the background states (i.e states that cover large areas) have the highest variance in posterior distribution. Whereas states covering smaller areas have considerably less variance in posterior distribution of parameters. We also see in Figure 5(d) that parameters used in Wang et al. (2018) are recovered by the posterior distribution. Typically as we increase the number of states some states are divided into two, with rare new clusters. Furthermore we see for  $K = 30$  that some additional hidden states ( $k = 4, 8, 26$ ) doesn't fit over one particular cluster of points, covers a large area, has a low probability of observing tremors and a low stationary probability (i.e time spent in state). Thereafter we also fitted models with hidden states for  $K = 26, 27$  (see Appendix B) and we find that additional hidden states have the same undesirable properties and therefore use  $K = 25$  as our choice for number of hidden states for the model (see MCMC summary statistics in Appendix C).

## 6.6 Forecasting

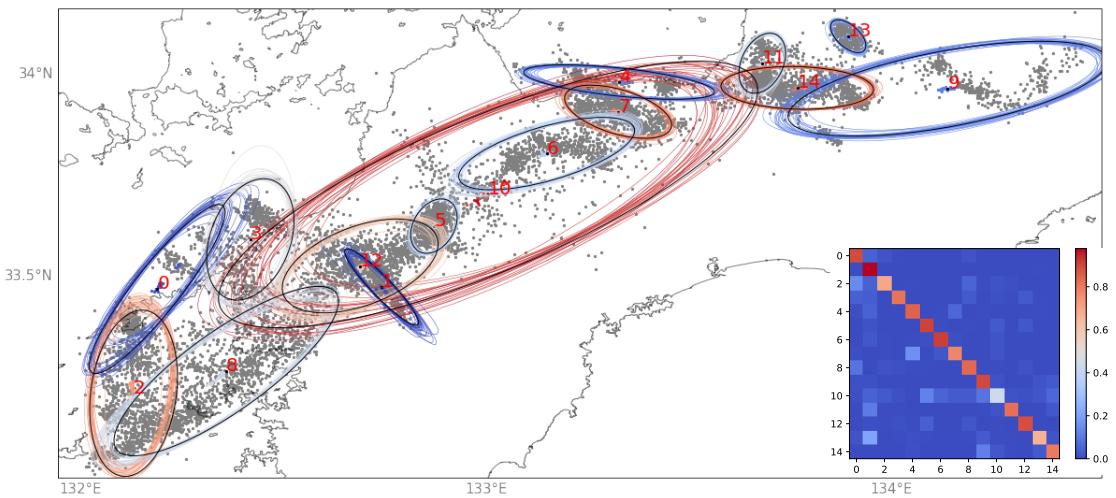
We carry out a Bayesian forecast from the model for a 5 day period (from December 11, 2012 to December 16, 2012). Note that the data for this period was excluded in the model fitting process. In order to forecast tremors we simulated 120 hourly datapoints (i.e for 5 days) from the model (with fixed number of hidden states  $K = 25$ ) for every 1000th MCMC sample (total of 500 simulations) of the approximate posterior distribution. Note that we used the same realization of the MCMC that was generated in the model fitting process (see previous section). We used the HMM simulator in the R package *HMMextra0s* (freely available at <https://rdrr.io/cran/>



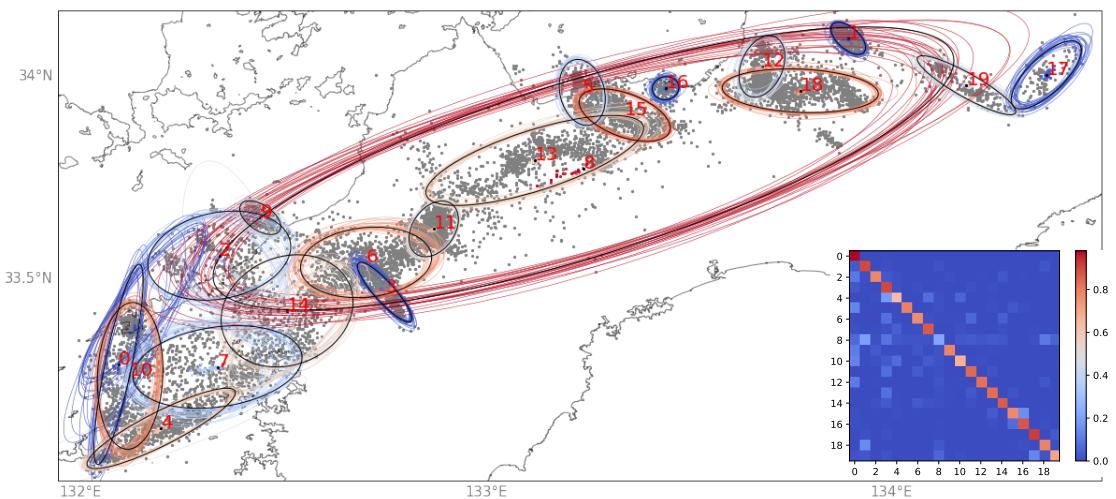
(a)  $K = 5$



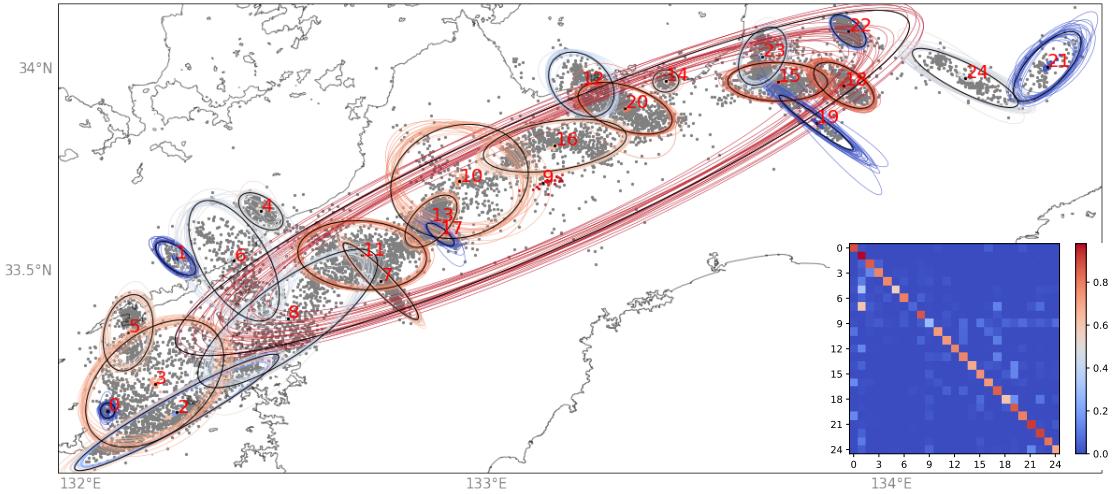
(b)  $K = 10$



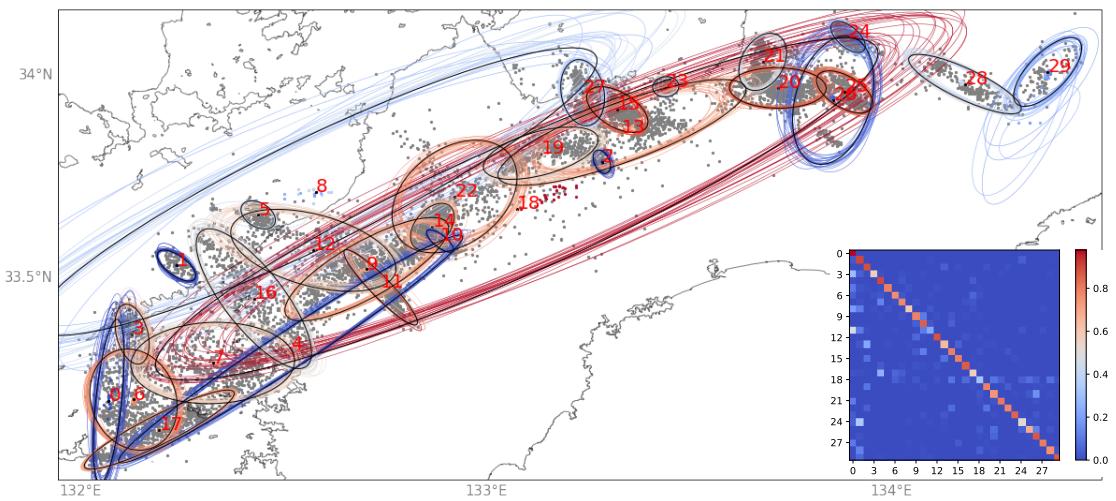
(c)  $K = 15$



(d)  $K = 20$



(e)  $K = 25$



(f)  $K = 30$

Figure 5: Posterior distributions of fitted models with number of hidden states  $K = 5, 10, \dots, 30$  for tremor occurrences in Shikoku region. Ellipses each map represent the 2D normal density of one hidden state for one sample from the posterior distribution. States are numbered in red. Colour of an ellipse indicate how likely a tremor will occur given the process is in the hidden state. In the bottom right corner of each map we give the mean transition matrix of the posterior distribution. Transition probabilities (array entries) and state probabilities (colour of ellipse) both use same colormap given in bottom right corner. Furthermore grey dots represent the Shikoku tremor data points. Black ellipses and -dots represent mean parameters.

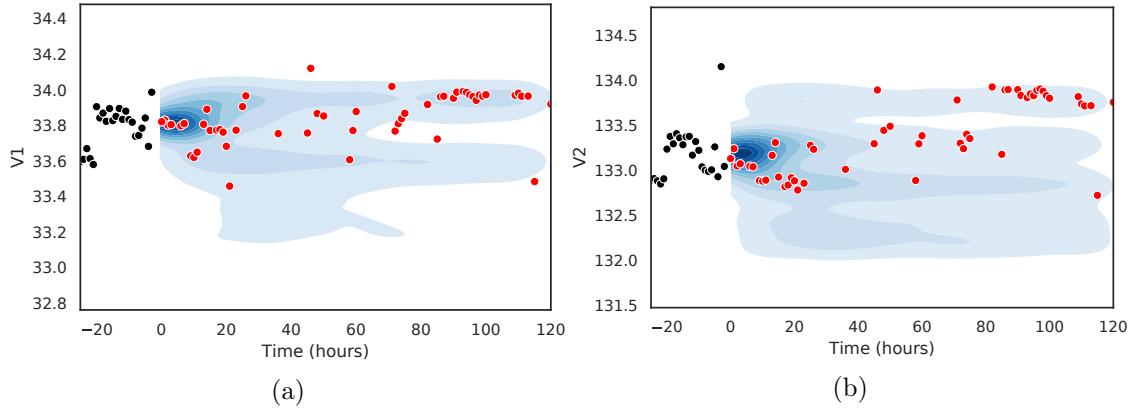


Figure 6: We summarize the forecast simulations as two density plots. (a) Latitude predictions and data plotted against time (in hours). (b) Longitude predictions and data plotted against time (in hours). The red dots in both figures are the hourly Shikoku data for the time period from December 11, 2012 to December 30, 2012 (not included in data used for model fitting). Furthermore black dots in both figures are the hourly Shikoku data for the time period December 10, 2012 (included in data used for model fitting).

[HMMextra0s/man/HMMextra0s-package.html](#)).

We summarize the 500 forecast simulations as a density in a longitude plot over time and a latitude plot over time (Figure 6). Furthermore we plot the actual data as a scatterplot with red datapoints. We also include the last day (December 10, 2012) of the data used for model fitting (as a scatterplot with black datapoints).

We see that the model works well for the first two days. It captures nicely in which area the tremors occur. We also see that we get coverage from the forecast (density plot) for all the data points except for one outlier. Furthermore we see that the variance in the model predictions increase with time. This is not unexpected since the further away our forecasts are from the present the less information our data contains about the future states of the process. It would be very unlikely to make an accurate forecast of more than a week.

## 7 DISCUSSION

In this paper we present an algorithm for evaluating HMM likelihoods that can run several orders of magnitude faster than the traditional Forward algorithm. Our algorithm requires more work, but the high level of parallelization of the likelihood calculation translates into high data

throughput.

We have implemented the algorithm for an HMM model that categorises nonvolcanic tremor data. Furthermore we have integrated the algorithm as part of an R package for Bayesian analysis using the OpenCL framework with Python under the hood. It is however expected that a CUDA implementation for NVIDIA GPUs will achieve higher data throughput but this limits the algorithm to a single vendor. OpenCL on the other hand allows execution of the algorithm on any OpenCL compliant device such as Intel CPUs, AMD CPUs and GPUs, Qualcomm processors, Xilinx FPGAs (Field-programmable gate array) and even NVIDIA GPUs.

We have reported some runtime comparisons with implementations of the Forward algorithm. The efficiency gains in computation of the likelihood allowed us to conduct a detailed Bayesian analysis for tremor data of Shikoku region of Japan.

Lastly, the OpenCL algorithm can be easily modified for other HMM models. In some cases only the evaluation function of the emission matrix needs to be updated.

## 8 ACKNOWLEDGEMENT

Marnus Stoltz received a doctoral scholarship from the NZ Marsden Fund (PIs David Bryant and Steven Higgins).

## REFERENCES

- Andrieu, C., A. Doucet, and C. Robert. 2004. Computational advances for and from bayesian analysis. *Statistical science* Pages 118–127.
- Beroza, G. C. and S. Ide. 2011. Slow earthquakes and nonvolcanic tremor. *Annual review of Earth and planetary sciences* 39:271–296.
- Chong, J., I. R. Lane, and S. W. Buthpitiya. 2014. Utilizing multiple processing units for rapid training of hidden markov models. US Patent 8,886,535.
- Christen, J. A., C. Fox, et al. 2010. A general purpose sampling algorithm for continuous distributions (the t-walk). *Bayesian Analysis* 5:263–281.

- Cuzzocrea, A., E. Mumolo, N. Timeus, and G. Vercelli. 2016. GPU-Aware Genetic Estimation of Hidden Markov Models for Workload Classification Problems. Proceedings - International Computer Software and Applications Conference 1:674–682.
- Horn, D. R., M. Houston, and P. Hanrahan. 2005. ClawHMMER: A streaming HMMer-search implementation. Proceedings of the ACM/IEEE 2005 Supercomputing Conference, SC'05 2005.
- Jóhannesson, G., R. R. de Austri, A. Vincent, I. Moskalenko, E. Orlando, T. Porter, A. Strong, R. Trotta, F. Feroz, P. Graff, et al. 2016. Bayesian analysis of cosmic ray propagation: evidence against homogeneous diffusion. *The Astrophysical Journal* 824:16.
- Kindratenko, V. 2014. Numerical computations with GPUs. Springer.
- Kruschke, J. K. 2010. What to believe: Bayesian methods for data analysis. *Trends in cognitive sciences* 14:293–300.
- Li, J., S. Chen, and Y. Li. 2009. The fast evaluation of hidden Markov models on GPU. Proceedings - 2009 IEEE International Conference on Intelligent Computing and Intelligent Systems, ICIS 2009 4:426–430.
- Liu, C. 2009. cuHMM: a CUDA implementation of hidden Markov model training and classification. *The Chronicle of Higher Education Pages* 1–13.
- Lunn, D. J., N. Best, and J. C. Whittaker. 2009. Generic reversible jump mcmc using graphical models. *Statistics and Computing* 19:395.
- Masliah, I., A. Abdelfattah, A. Haidar, S. Tomov, M. Baboulin, J. Falcou, and J. Dongarra. 2016. High-performance matrix-matrix multiplications of very small matrices. Pages 659–671 in Proceedings of the 22Nd International Conference on Euro-Par 2016: Parallel Processing. Springer-Verlag New York, Inc.
- Moore, A. W. and D. Zuev. 2005. Internet traffic classification using bayesian analysis techniques. Pages 50–60 in Proceedings of the 2005 ACM SIGMETRICS international conference on Measurement and modeling of computer systems.
- Obara, K., S. Tanaka, T. Maeda, and T. Matsuzawa. 2010. Depth-dependent activity of non-volcanic tremor in southwest japan. *Geophysical Research Letters* 37.

- Rannala, B. and Z. Yang. 2017. Efficient bayesian species tree inference under the multispecies coalescent. *Systematic biology* 66:823–842.
- Stoltz, M., B. Bauemer, R. Bouckart, C. Fox, G. Hiscott, and D. Bryant. 2019. Bayesian inference of species trees using diffusion models. arXiv preprint arXiv:1909.07276 .
- Turner, B. M., P. B. Sederberg, and J. L. McClelland. 2016. Bayesian analysis of simulation-based models. *Journal of Mathematical Psychology* 72:191–199.
- Wang, T., J. Zhuang, J. Buckby, K. Obara, and H. Tsuruoka. 2018. Identifying the recurrence patterns of nonvolcanic tremors using a 2-d hidden markov model with extra zeros. *Journal of Geophysical Research: Solid Earth* 123:6802–6825.
- Woolrich, M. W., S. Jbabdi, B. Patenaude, M. Chappell, S. Makni, T. Behrens, C. Beckmann, M. Jenkinson, and S. M. Smith. 2009. Bayesian analysis of neuroimaging data in fsl. *Neuroimage* 45:S173–S186.
- Yao, P., H. An, M. Xu, G. Liu, X. Li, Y. Wang, and W. Han. 2010. CuHMMer: A load-balanced CPU-GPU cooperative bioinformatics application. *Proceedings of the 2010 International Conference on High Performance Computing and Simulation, HPCS 2010* Pages 24–30.
- Yu, L., Y. Ukidave, and D. Kaeli. 2015. GPU-Accelerated HMM for Speech Recognition. *Proceedings of the International Conference on Parallel Processing Workshops 2015-May*:395–402.
- Zhang, D., R. Zhao, L. Han, T. Wang, and J. Qu. 2009. An implementation of viterbi algorithm on GPU. *2009 1st International Conference on Information Science and Engineering, ICISE 2009* Pages 121–124.

## APPENDIX A: FORMULAS FOR PRIOR DISTRIBUTIONS

### Symmetric Dirichlet distributions

$$f(\gamma_1, \dots, \gamma_{K^2}, \alpha) = \frac{\Gamma(\alpha K^2)}{\alpha^{K^2}} \prod_{i=1}^{K^2} \gamma_i^{\alpha-1}, \text{ for } \alpha < 1,$$

we note that probability mass is sparsely distributed among  $\gamma_1, \dots, \gamma_{K^2}$  if  $\alpha < 1$ .

### Inverse-wishart distributions

Suppose  $\Psi$  is the scale matrix and  $\nu$  the degrees of freedom then

$$f(\mathbf{x}, \Psi, \nu) = \frac{|\Psi|^{\nu/2}}{2^{\nu p/2} \Gamma_K(\frac{\nu}{2})} = |\mathbf{x}|^{-(\nu+K+1)/2} e^{-\frac{1}{2} \text{tr}(\Psi \mathbf{x}^{-1})},$$

where  $\Gamma_K$  is a multivariate gamma function

$$\Gamma_K\left(\frac{\nu}{2}\right) = \pi^{(\frac{\nu}{2})(\frac{\nu}{2}-1)/4} \prod_{j=1}^K \Gamma\left(\left(\frac{\nu}{2}\right) + (1-j)/2\right).$$

### Gamma distribution

$$f(x, \alpha, \beta) = \frac{\beta^\alpha x^{\alpha-1} e^{-\beta x}}{\Gamma(\alpha)}, \quad \text{for } x > 0 \quad \alpha, \beta > 0.$$

## APPENDIX B: ADDITIONALS MODEL FITTED FOR NONVOLCANIC TREMOR DATA

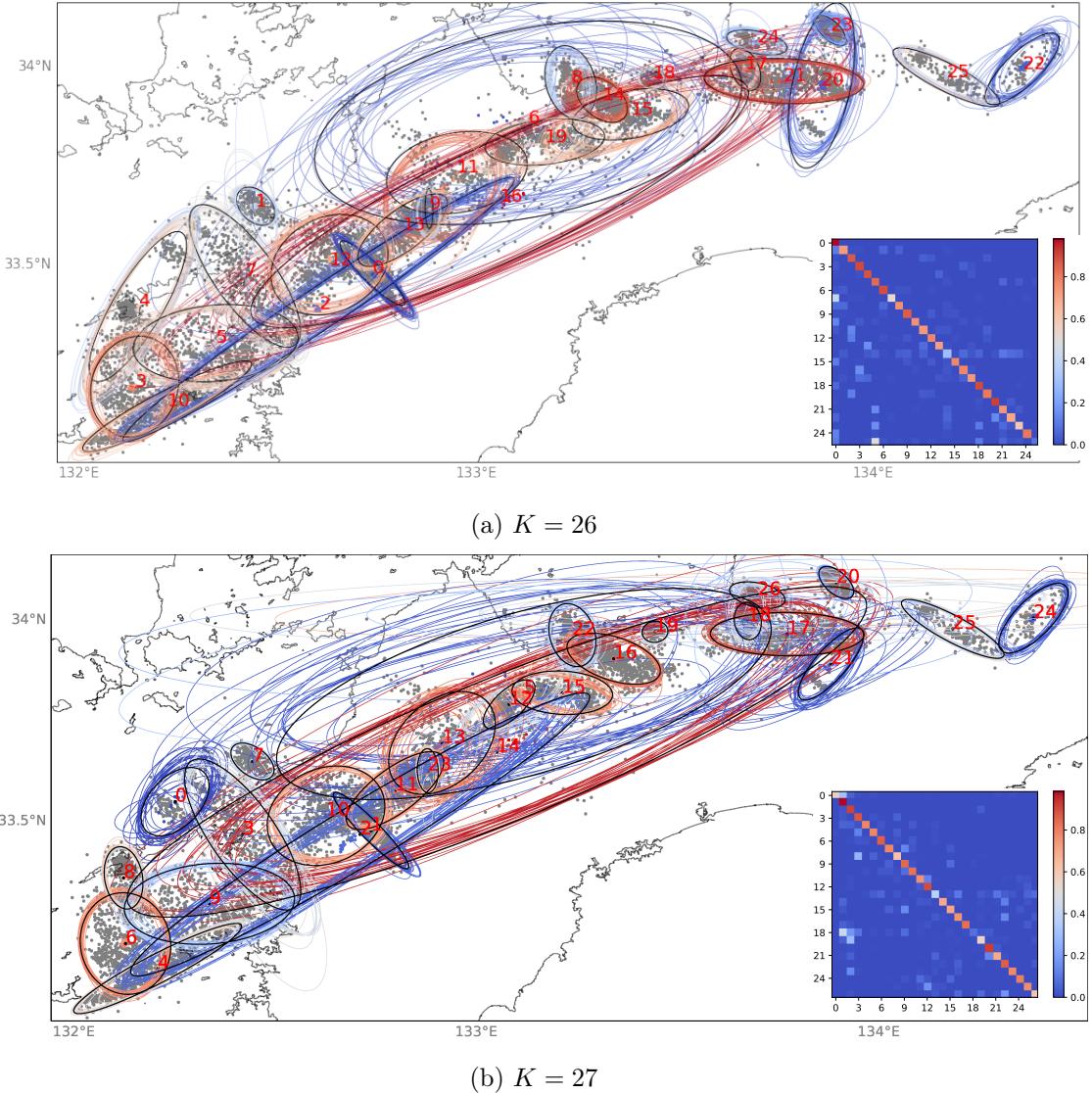


Figure 7: Posterior distributions of fitted models with number of hidden states  $K = 26, 27$  for tremor occurrences in Shikoku region. Ellipses each map represent the 2D normal density of one hidden state for one sample from the posterior distribution. States are numbered in red. Colour of an ellipse indicate how likely a tremor will occur given the process is in the hidden state. In the bottom right corner of each map we give the mean transition matrix of the posterior distribution. Transition probabilities (array entries) and state probabilities (colour of ellipse) both use same colormap given in bottom right corner. Furthermore grey dots represent the Shikoku tremor data points. Black ellipses and -dots represent mean parameters.

**APPENDIX C: TABULATED POSTERIOR STATISTICS FOR NUMBER  
OF HIDDEN STATES K=25**

Table 1: Combined GPU-hmmer parameter summary after 5,000,000 MCMC iterations for soybean dataset

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
posterior	-1.0987E+03	7.6624E+04	-1.6110E+03	-4.0624E+02	35830.8997
Gamma1	8.6710E-01	2.4186E-04	8.3770E-01	8.9248E-01	29571.9564
Gamma2	1.6289E-02	4.7111E-05	3.8358E-03	2.8083E-02	14455.9226
Gamma3	1.8235E-03	8.1549E-06	5.3391E-06	5.9633E-03	31080.9139
Gamma4	1.8604E-03	9.1692E-06	8.0933E-06	6.5181E-03	23964.1982
Gamma5	1.4205E-03	1.2756E-06	4.4740E-05	3.3164E-03	14213.5729
Gamma6	3.4741E-03	7.6753E-06	2.8037E-05	8.2833E-03	21277.4832
Gamma7	2.9676E-03	3.5263E-06	4.7983E-05	5.7603E-03	15272.0127
Gamma8	1.9523E-03	5.1619E-06	1.8840E-05	4.8152E-03	27378.2848
Gamma9	8.8053E-04	1.4839E-06	6.1831E-07	2.6187E-03	15509.9601
Gamma10	4.0934E-03	1.6603E-05	8.1382E-15	1.2107E-02	57380.8895
Gamma11	9.3274E-03	1.4699E-05	1.9398E-03	1.5410E-02	45068.2804
Gamma12	6.1730E-04	3.1284E-07	4.1541E-07	1.7926E-03	14440.9950
Gamma13	3.5715E-03	5.4052E-05	1.2686E-04	8.2704E-03	24168.9799
Gamma14	9.6052E-04	7.1797E-07	8.2637E-06	2.5498E-03	18857.9341
Gamma15	1.3255E-03	1.4142E-06	4.1034E-06	4.0367E-03	31384.2830
Gamma16	1.5935E-03	1.1240E-05	7.3288E-06	4.9660E-03	20798.4511
Gamma17	3.8764E-02	3.7291E-05	2.6857E-02	4.8477E-02	48946.9321
Gamma18	1.0956E-03	1.9142E-06	7.6476E-06	3.7071E-03	45031.8581
Gamma19	1.0625E-03	4.7366E-06	5.9749E-06	2.6002E-03	17168.5493
Gamma20	2.6584E-03	5.6930E-06	2.0232E-05	6.8404E-03	35644.4221
Gamma21	2.9296E-02	2.9234E-05	1.9465E-02	4.0877E-02	42258.6322
					118.3190

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma22	1.9319E-03	3.1337E-06	8.6148E-05	6.0423E-03	16100.7869	310.5438
Gamma23	2.3521E-03	3.8152E-06	3.0464E-05	6.1173E-03	22249.4145	224.7250
Gamma24	2.8243E-03	7.0229E-06	1.4940E-04	7.1177E-03	15713.5026	318.1977
Gamma25	7.5430E-04	1.2261E-06	0.0000E+00	2.8100E-03	33773.0435	148.0471
Gamma26	7.5800E-04	9.2460E-07	2.7447E-06	2.1539E-03	19423.7468	257.4169
Gamma27	9.7455E-01	1.8772E-05	9.6572E-01	9.8144E-01	16385.9590	305.1393
Gamma28	1.1656E-03	5.5348E-07	3.8569E-06	2.4886E-03	433749.2599	11.5274
Gamma29	2.6091E-04	1.4724E-07	6.0330E-07	5.3802E-04	34952.5560	143.0511
Gamma30	1.1413E-03	2.5184E-07	3.8769E-04	1.6722E-03	12690.4915	393.9958
Gamma31	2.5300E-03	2.2597E-07	1.7208E-03	3.7603E-03	62747.9452	79.6839
Gamma32	7.2782E-04	6.3201E-07	8.2677E-05	1.5357E-03	22661.4152	220.6394
Gamma33	4.7610E-03	2.8677E-06	2.1785E-03	7.5344E-03	128377.9942	38.9475
Gamma34	1.4483E-04	3.3611E-07	0.0000E+00	4.4469E-04	18494.6559	270.3484
Gamma35	8.8254E-04	9.1352E-06	1.1430E-179	2.6530E-03	17104.6382	292.3184
Gamma36	2.2049E-04	5.6664E-07	3.2433E-07	8.8779E-04	13504.7449	370.2402
Gamma37	2.8423E-04	1.8785E-06	1.3566E-07	5.3904E-04	16705.1430	299.3090
Gamma38	1.8184E-03	8.9467E-07	1.0682E-03	2.9130E-03	12987.5478	384.9841
Gamma39	1.5827E-04	3.8431E-07	8.2793E-240	5.5617E-04	10408.8774	480.3592
Gamma40	1.5324E-04	5.9919E-08	1.7997E-06	3.9441E-04	35391.8500	141.2755
Gamma41	1.1195E-04	6.7680E-07	4.5519E-07	1.0529E-04	6175.3438	809.6715
Gamma42	1.6970E-04	5.8092E-08	2.3201E-68	4.8800E-04	19975.0180	250.3127
Gamma43	5.4145E-04	1.7014E-06	8.0357E-07	1.2248E-03	12214.7293	409.3419
Gamma44	9.4007E-05	1.2845E-07	0.0000E+00	3.0288E-04	15527.8979	322.0011
Gamma45	5.8817E-04	2.5773E-06	2.6848E-07	1.7851E-03	16773.6991	298.0857
Gamma46	2.7130E-04	1.6124E-06	0.0000E+00	9.7746E-04	12013.6336	416.1938
Gamma47	8.3608E-04	8.7118E-07	8.1343E-06	1.6621E-03	25000.7219	199.9942
Gamma48	6.1769E-03	1.6042E-06	3.7912E-03	8.2029E-03	72454.3676	69.0090

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma49	1.3814E-03	1.2691E-07	8.2454E-04	1.8834E-03	16414.5669	304.6075
Gamma50	2.7088E-04	1.8704E-07	1.9386E-06	8.3363E-04	20676.1070	241.8250
Gamma51	3.8265E-03	1.4101E-05	1.5164E-06	1.1256E-02	54832.1289	91.1874
Gamma52	4.1702E-02	2.7147E-04	1.4143E-02	7.0675E-02	177277.4811	28.2044
Gamma53	6.5895E-01	1.1852E-02	5.3762E-01	8.6165E-01	179266.1419	27.8915
Gamma54	5.2686E-02	1.3514E-04	3.0989E-02	7.5725E-02	20727.5986	241.2243
Gamma55	3.7342E-03	8.7625E-06	4.2153E-06	8.8395E-03	35075.5349	142.5495
Gamma56	3.7250E-03	1.4367E-05	2.1957E-05	1.0399E-02	13703.4629	364.8713
Gamma57	3.4035E-03	7.6310E-06	1.1752E-06	9.5530E-03	60398.7204	82.7832
Gamma58	1.1569E-02	5.7239E-05	1.4684E-03	2.6915E-02	126050.2525	39.6667
Gamma59	8.3384E-03	5.0755E-05	2.4430E-05	1.9246E-02	108972.2649	45.8832
Gamma60	7.5111E-03	1.8539E-05	1.3374E-03	1.5506E-02	35526.5778	140.7397
Gamma61	2.4433E-03	5.7828E-06	3.7794E-05	7.1885E-03	23869.7025	209.4706
Gamma62	2.9865E-03	1.1750E-05	0.0000E+00	9.4605E-03	24301.5009	205.7486
Gamma63	4.6511E-03	1.1309E-05	4.0228E-04	1.1406E-02	17927.0292	278.9085
Gamma64	3.4551E-03	1.0811E-05	8.0421E-06	9.2846E-03	60480.2163	82.6717
Gamma65	1.7704E-03	2.9336E-06	2.0011E-05	5.5824E-03	31567.4252	158.3911
Gamma66	1.8257E-03	5.5040E-06	4.8305E-06	6.7129E-03	21359.3236	234.0898
Gamma67	4.4132E-03	1.0302E-05	2.3097E-04	1.0175E-02	30529.5466	163.7758
Gamma68	3.3537E-03	1.3710E-05	4.6203E-06	1.1097E-02	47189.7634	105.9552
Gamma69	2.5590E-03	1.2021E-05	1.6972E-05	8.6447E-03	17168.6412	291.2286
Gamma70	3.6075E-03	2.1892E-05	1.3317E-05	1.4296E-02	51779.6476	96.5630
Gamma71	2.7341E-03	1.0429E-05	6.6654E-05	9.0064E-03	50454.1729	99.0998
Gamma72	1.6084E-01	8.9549E-03	1.7265E-04	2.6376E-01	52563.5955	95.1229
Gamma73	4.7693E-03	1.3051E-05	9.0943E-04	1.3995E-02	31721.7813	157.6204
Gamma74	3.2346E-03	1.1070E-05	2.3274E-05	8.6432E-03	32056.6747	155.9738
Gamma75	1.9117E-03	3.3446E-06	0.0000E+00	5.6489E-03	15101.7754	331.0869

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma76	4.0374E-03	1.3862E-05	5.6963E-06	1.1135E-02	17448.4236	286.5588
Gamma77	1.8735E-02	1.3793E-04	1.4735E-03	3.7747E-02	153773.7616	32.5153
Gamma78	5.2840E-02	1.4351E-03	8.7997E-03	1.2569E-01	109036.5946	45.8562
Gamma79	7.7194E-01	4.7660E-04	7.3193E-01	8.1135E-01	97858.7582	51.0940
Gamma80	2.3710E-03	6.3079E-06	8.1711E-209	6.0531E-03	40191.5185	124.4044
Gamma81	9.8015E-03	2.1754E-05	2.7665E-03	1.9849E-02	14021.4458	356.5966
Gamma82	8.0723E-03	1.8660E-05	1.5913E-03	1.6722E-02	13912.5818	359.3869
Gamma83	4.2189E-03	1.5787E-05	5.4825E-05	1.2599E-02	17447.4497	286.5748
Gamma84	1.5088E-02	5.6666E-05	2.5035E-03	3.0542E-02	25580.4554	195.4617
Gamma85	9.6710E-03	1.6331E-05	2.9544E-03	1.8682E-02	31452.3565	158.9706
Gamma86	1.6917E-03	2.8601E-06	8.1084E-06	5.7956E-03	8240.6163	606.7507
Gamma87	5.7498E-03	2.7984E-05	2.2783E-04	1.5747E-02	21734.0305	230.0540
Gamma88	6.3461E-03	1.9530E-05	4.5535E-04	1.4662E-02	26108.6270	191.5076
Gamma89	5.2471E-03	1.3105E-05	2.0134E-04	1.0240E-02	13017.1322	384.1092
Gamma90	2.0111E-03	4.2089E-06	1.1327E-05	5.9145E-03	25705.1264	194.5137
Gamma91	1.0309E-03	1.6301E-06	0.0000E+00	3.8256E-03	28956.6968	172.6716
Gamma92	2.2777E-03	3.1269E-06	1.0209E-05	5.9816E-03	14923.2556	335.0475
Gamma93	2.1677E-03	9.3605E-06	0.0000E+00	5.6929E-03	23761.2254	210.4269
Gamma94	1.0397E-03	3.5146E-06	4.8823E-06	4.4321E-03	23742.1096	210.5963
Gamma95	3.3163E-03	5.2410E-06	1.4686E-04	7.9886E-03	30114.5464	166.0327
Gamma96	2.5090E-03	1.6163E-05	2.7992E-05	7.1467E-03	41015.2414	121.9059
Gamma97	5.8867E-02	1.3932E-03	2.0425E-05	1.0662E-01	31943.0005	156.5288
Gamma98	5.7913E-03	2.4696E-05	4.1050E-50	1.4469E-02	35391.9791	141.2749
Gamma99	1.4880E-03	2.3845E-06	0.0000E+00	4.5140E-03	25023.0598	199.8157
Gamma100	3.6941E-03	6.4817E-06	3.0497E-04	7.7939E-03	20250.6950	246.9051
Gamma101	1.0241E-02	7.2072E-05	1.0568E-04	2.7836E-02	20759.9054	240.8489
Gamma102	1.0804E-01	4.6584E-04	6.1602E-02	1.4489E-01	14058.9871	355.6444

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma103	5.6760E-03	2.0145E-05	5.4058E-06	1.4865E-02	82129.7028	60.8793
Gamma104	2.8431E-03	6.8754E-06	1.2424E-04	8.9155E-03	34299.2175	145.7759
Gamma105	7.1477E-01	7.0890E-04	6.6167E-01	7.6297E-01	11826.7772	422.7694
Gamma106	6.5209E-03	1.7024E-05	1.5508E-04	1.4459E-02	18234.4629	274.2060
Gamma107	2.8461E-02	2.2138E-04	7.8455E-03	5.4417E-02	17921.7664	278.9904
Gamma108	3.3291E-03	8.5009E-06	1.2591E-05	9.5390E-03	26847.8163	186.2349
Gamma109	1.0648E-02	4.2232E-05	3.1849E-04	2.3514E-02	37656.6887	132.7785
Gamma110	1.4558E-02	9.6667E-05	1.4384E-03	3.0609E-02	19327.2137	258.7026
Gamma111	2.6155E-03	1.2609E-05	0.0000E+00	1.0664E-02	35246.2265	141.8592
Gamma112	3.1530E-02	9.3212E-05	1.5939E-02	5.2513E-02	21814.3469	229.2070
Gamma113	3.0332E-03	9.1017E-06	2.1723E-05	8.8238E-03	21228.0396	235.5375
Gamma114	2.8459E-03	5.0074E-06	8.5689E-05	8.0017E-03	20882.2793	239.4375
Gamma115	3.2308E-03	1.2224E-05	5.1372E-05	9.8159E-03	26005.5177	192.2669
Gamma116	1.7967E-03	3.4193E-06	5.5578E-06	5.4687E-03	14293.7529	349.8032
Gamma117	5.1239E-03	2.2861E-05	7.6876E-06	1.4478E-02	14718.0883	339.7180
Gamma118	3.9297E-03	1.7284E-05	0.0000E+00	1.0973E-02	30107.3335	166.0725
Gamma119	2.4660E-03	6.7519E-06	3.6767E-05	8.8143E-03	39887.9865	125.3510
Gamma120	5.9192E-03	2.0708E-05	2.1575E-05	1.4863E-02	41440.4025	120.6552
Gamma121	3.3092E-03	7.1388E-06	1.2865E-04	9.1760E-03	19966.6857	250.4171
Gamma122	1.4188E-02	1.4186E-04	1.0583E-04	3.8582E-02	29696.9340	168.3675
Gamma123	6.1469E-03	3.7944E-05	3.5337E-103	2.0600E-02	14266.5070	350.4712
Gamma124	5.3542E-03	6.3464E-05	2.1460E-05	1.3922E-02	16095.5744	310.6444
Gamma125	3.4203E-03	2.1335E-05	0.0000E+00	1.0130E-02	45807.5273	109.1524
Gamma126	1.4618E-02	1.1325E-04	2.8701E-04	3.6125E-02	13691.7749	365.1827
Gamma127	3.2206E-01	1.0197E-03	2.6087E-01	3.7722E-01	49086.4278	101.8612
Gamma128	7.2857E-03	3.1361E-05	1.3948E-04	1.8385E-02	42005.7489	119.0313
Gamma129	1.6891E-02	9.2670E-05	6.3445E-04	3.3494E-02	7378.6105	677.6344

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma130	4.6442E-03	1.3438E-05	1.1728E-04	1.1089E-02	13249.6606	377.3682
Gamma131	4.9890E-01	1.3868E-03	4.2268E-01	5.6160E-01	22054.7456	226.7086
Gamma132	8.1591E-03	2.6096E-05	2.4168E-04	1.6574E-02	11093.0986	450.7307
Gamma133	5.9883E-03	2.4691E-05	0.0000E+00	1.6412E-02	26398.9966	189.4011
Gamma134	7.2804E-03	2.6287E-05	8.8405E-05	1.8001E-02	18358.7256	272.3501
Gamma135	8.7256E-03	2.1526E-05	2.2706E-04	1.7155E-02	23918.9752	209.0391
Gamma136	2.9880E-03	7.3198E-06	2.0184E-06	7.9991E-03	19008.6479	263.0382
Gamma137	4.1896E-03	1.5155E-05	0.0000E+00	1.0915E-02	25792.6040	193.8540
Gamma138	4.0759E-03	1.7561E-05	0.0000E+00	1.2611E-02	26961.9908	185.4462
Gamma139	1.9013E-03	2.7532E-06	3.6100E-06	5.6579E-03	24439.0003	204.5910
Gamma140	3.0420E-03	9.0646E-06	0.0000E+00	9.7842E-03	13533.4384	369.4553
Gamma141	5.9292E-03	9.9349E-05	0.0000E+00	1.8168E-02	26232.0800	190.6063
Gamma142	3.5377E-03	9.6379E-06	0.0000E+00	1.0215E-02	23203.7127	215.4828
Gamma143	1.5168E-02	6.2250E-05	1.9025E-03	3.0656E-02	15722.1103	318.0235
Gamma144	5.7933E-03	4.4980E-05	1.7462E-289	1.6168E-02	22946.4046	217.8991
Gamma145	5.7463E-03	3.2700E-05	2.3855E-05	1.7080E-02	21825.2432	229.0925
Gamma146	2.6456E-03	1.2255E-05	2.5832E-06	9.3531E-03	24569.0253	203.5083
Gamma147	1.4579E-02	1.2048E-04	0.0000E+00	3.9936E-02	16737.9921	298.7216
Gamma148	8.6204E-03	5.7072E-05	2.7282E-06	2.0417E-02	38093.7914	131.2550
Gamma149	1.6937E-02	6.7864E-05	4.1349E-03	3.4704E-02	17925.6478	278.9299
Gamma150	1.0294E-02	4.6247E-05	1.4572E-03	2.1769E-02	18136.6081	275.6855
Gamma151	1.3152E-02	7.3651E-05	4.6341E-05	3.0154E-02	15556.8030	321.4028
Gamma152	3.7244E-02	2.8304E-04	2.8950E-03	6.5610E-02	33478.3899	149.3501
Gamma153	1.3758E-02	6.6246E-05	4.0890E-04	3.0621E-02	29346.9173	170.3756
Gamma154	5.9445E-03	2.1308E-05	1.4043E-04	1.5699E-02	32066.2635	155.9271
Gamma155	2.8742E-02	1.1982E-04	7.3737E-03	5.2091E-02	33898.0279	147.5012
Gamma156	2.5899E-03	7.0253E-06	7.4161E-06	7.8707E-03	18689.6816	267.5273

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma157	7.4292E-01	1.0465E-03	6.7896E-01	7.9747E-01	17523.3619	285.3334
Gamma158	3.7707E-03	1.0295E-05	0.0000E+00	8.9664E-03	39356.2073	127.0448
Gamma159	4.6426E-02	1.6495E-04	1.9526E-02	6.8351E-02	20248.3966	246.9331
Gamma160	9.4584E-03	2.2591E-05	2.0420E-03	1.9575E-02	15479.8442	323.0007
Gamma161	2.4250E-03	6.0102E-06	2.2032E-05	6.5940E-03	24814.9610	201.4914
Gamma162	1.1943E-02	5.1395E-05	1.7040E-03	2.6546E-02	19386.5635	257.9106
Gamma163	2.5954E-03	5.8674E-06	1.6756E-05	7.9368E-03	48028.9088	104.1040
Gamma164	2.1189E-03	4.6098E-06	6.1450E-06	5.7563E-03	21749.6357	229.8889
Gamma165	2.2330E-03	1.8865E-05	8.4136E-06	6.9105E-03	32478.0637	153.9501
Gamma166	3.6582E-03	8.4473E-06	9.5463E-05	9.4273E-03	22048.8286	226.7694
Gamma167	3.6427E-03	1.1416E-05	1.0440E-05	9.4321E-03	28140.4471	177.6802
Gamma168	1.1421E-02	6.9643E-05	4.6150E-04	2.6784E-02	25694.6466	194.5931
Gamma169	5.1223E-03	4.4866E-05	1.0712E-04	1.6117E-02	24383.3685	205.0578
Gamma170	4.9605E-03	2.9550E-05	1.9398E-05	1.4858E-02	19684.0267	254.0131
Gamma171	2.9722E-03	1.0856E-05	0.0000E+00	7.2370E-03	19550.7361	255.7448
Gamma172	1.9379E-02	2.5865E-04	2.0458E-04	5.2602E-02	42800.9521	116.8198
Gamma173	1.3881E-02	7.6848E-05	6.7001E-04	3.1088E-02	23168.4207	215.8110
Gamma174	6.8947E-03	1.6571E-05	1.2776E-03	1.5726E-02	18513.8606	270.0679
Gamma175	2.7526E-03	4.9136E-06	1.9243E-63	7.1387E-03	36917.1373	135.4385
Gamma176	2.6324E-02	2.7210E-04	8.3009E-04	5.7787E-02	34809.0990	143.6406
Gamma177	5.5414E-01	2.2137E-03	4.7383E-01	6.4615E-01	47621.5790	104.9944
Gamma178	2.5632E-02	2.7222E-04	3.2199E-03	6.4055E-02	63701.0484	78.4916
Gamma179	1.3130E-02	9.7449E-05	8.0479E-04	3.2826E-02	19797.6125	252.5557
Gamma180	5.8898E-03	2.2534E-05	1.5316E-04	1.6794E-02	45691.9265	109.4285
Gamma181	7.4855E-03	2.9769E-05	7.2334E-04	1.9642E-02	46600.4791	107.2950
Gamma182	4.8547E-03	1.6843E-05	0.0000E+00	1.3644E-02	15670.4387	319.0721
Gamma183	8.8900E-02	1.2533E-03	2.7782E-02	1.5979E-01	55484.9668	90.1145

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma184	6.7210E-03	6.9651E-05	3.3967E-06	2.5447E-02	22950.5821	217.8594
Gamma185	6.8905E-03	2.4856E-05	2.6100E-05	1.6220E-02	23021.4924	217.1884
Gamma186	1.0912E-02	1.1490E-04	1.9169E-05	2.9730E-02	24510.3336	203.9956
Gamma187	7.3192E-03	7.6226E-05	8.4817E-07	2.4485E-02	59524.0225	83.9997
Gamma188	1.2526E-02	5.8547E-05	7.1780E-04	2.5975E-02	18057.2891	276.8965
Gamma189	7.0914E-03	4.2373E-05	0.0000E+00	1.9989E-02	26258.6102	190.4137
Gamma190	5.6499E-03	2.0119E-05	3.7507E-04	1.5291E-02	18594.2158	268.9008
Gamma191	5.3477E-03	5.5532E-05	1.4105E-214	2.0262E-02	27848.3877	179.5436
Gamma192	1.1914E-02	1.2016E-04	4.8203E-04	4.0740E-02	42037.8420	118.9405
Gamma193	8.6947E-02	1.2275E-03	2.4052E-02	1.4001E-01	65323.2487	76.5424
Gamma194	4.3828E-03	1.4208E-05	5.8816E-05	1.2065E-02	24807.7751	201.5497
Gamma195	6.2229E-03	4.6592E-05	1.5081E-126	2.0269E-02	19968.8234	250.3903
Gamma196	3.9935E-03	1.6995E-05	5.8948E-06	1.1468E-02	22964.2384	217.7298
Gamma197	4.8131E-02	1.0506E-03	1.8951E-03	1.1265E-01	61968.1768	80.6866
Gamma198	3.8953E-02	4.6221E-04	4.3143E-03	7.6449E-02	103496.0248	48.3110
Gamma199	6.8304E-03	3.0269E-05	0.0000E+00	1.6100E-02	23752.2087	210.5067
Gamma200	3.8137E-03	1.2918E-05	0.0000E+00	1.1751E-02	29431.9507	169.8834
Gamma201	2.2061E-03	2.8632E-05	5.1399E-06	4.8039E-03	19079.3054	262.0640
Gamma202	3.9100E-03	1.0463E-05	1.0212E-05	1.0611E-02	42334.9988	118.1056
Gamma203	1.3941E-02	5.6850E-05	4.6010E-03	3.2667E-02	73870.7415	67.6858
Gamma204	8.8065E-03	4.3442E-05	2.1139E-04	1.6809E-02	25373.7124	197.0543
Gamma205	3.5903E-03	6.3083E-06	1.0064E-04	8.4176E-03	26858.5310	186.1606
Gamma206	1.8215E-03	3.9859E-06	0.0000E+00	5.5891E-03	21877.8619	228.5415
Gamma207	2.7125E-02	5.0313E-05	1.2766E-02	3.8572E-02	18578.7242	269.1250
Gamma208	4.5804E-03	1.6699E-05	1.4838E-05	1.1127E-02	36375.1408	137.4565
Gamma209	8.0613E-01	1.7607E-03	7.3269E-01	8.7467E-01	124530.5793	40.1508
Gamma210	8.4669E-03	1.9079E-05	2.2761E-03	1.5011E-02	20560.2395	243.1878

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma211	2.4497E-03	1.0519E-05	0.0000E+00	9.1696E-03	13154.7921	380.0896
Gamma212	2.7867E-02	8.6381E-05	1.1267E-02	4.2506E-02	27908.3662	179.1577
Gamma213	1.4054E-03	2.2605E-06	1.4660E-24	4.9417E-03	18466.9677	270.7537
Gamma214	1.2470E-02	4.7618E-05	1.3578E-03	2.4040E-02	57251.1230	87.3345
Gamma215	1.9740E-03	3.5207E-06	2.6479E-05	5.2427E-03	13247.3981	377.4326
Gamma216	2.5117E-03	2.6384E-05	2.9458E-05	6.2596E-03	19544.4539	255.8271
Gamma217	2.2047E-03	3.0671E-06	2.7441E-05	5.7185E-03	21443.2562	233.1735
Gamma218	2.1137E-02	1.0274E-04	3.6511E-03	3.9757E-02	32932.5392	151.8255
Gamma219	2.2999E-03	1.0651E-05	4.5831E-06	9.0745E-03	42058.9521	118.8808
Gamma220	2.8658E-03	2.5555E-05	1.5123E-05	9.6544E-03	22096.7836	226.2773
Gamma221	1.2031E-03	1.5336E-06	1.4189E-05	4.1287E-03	19430.3636	257.3292
Gamma222	3.4537E-02	5.9361E-04	1.6772E-04	7.8791E-02	189963.0833	26.3209
Gamma223	3.0790E-03	7.7608E-06	1.2559E-05	7.7606E-03	20839.1635	239.9329
Gamma224	1.6715E-03	1.8892E-06	4.5916E-05	4.3769E-03	15313.2087	326.5155
Gamma225	1.7481E-03	7.3093E-06	2.5438E-159	5.0969E-03	12502.8650	399.9083
Gamma226	3.6707E-02	9.9152E-04	3.0241E-04	1.1157E-01	47271.4019	105.7722
Gamma227	6.2283E-02	3.8712E-03	2.9392E-05	2.0028E-01	94429.1491	52.9498
Gamma228	2.7096E-02	2.2985E-04	4.3516E-03	5.4892E-02	26164.9348	191.0955
Gamma229	3.2028E-02	1.4356E-04	1.2579E-02	5.5498E-02	29452.0847	169.7673
Gamma230	1.0139E-02	5.1313E-05	4.9129E-04	2.3844E-02	65162.2063	76.7316
Gamma231	2.1222E-02	2.0195E-04	3.6462E-03	4.7430E-02	22587.0898	221.3654
Gamma232	3.0705E-02	1.8114E-04	8.2274E-03	5.9118E-02	36407.2808	137.3352
Gamma233	1.5053E-02	3.4100E-04	0.0000E+00	4.8016E-02	80339.2098	62.2361
Gamma234	3.7322E-02	1.6725E-04	1.0257E-02	5.9128E-02	12156.2454	411.3112
Gamma235	2.1579E-01	3.2940E-03	1.0663E-01	3.2862E-01	73331.2251	68.1838
Gamma236	1.2151E-02	9.8877E-05	8.8663E-05	3.5255E-02	23871.2828	209.4567
Gamma237	1.8690E-02	7.5997E-05	3.7458E-03	3.5588E-02	13149.2648	380.2494

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma238	6.3248E-03	4.0885E-05	2.4533E-07	2.1520E-02	31778.5257	157.3390
Gamma239	4.9375E-02	6.0725E-04	1.1591E-02	9.9927E-02	45728.0585	109.3421
Gamma240	6.7224E-03	4.2430E-05	0.0000E+00	1.8560E-02	36849.3569	135.6876
Gamma241	9.4317E-02	6.8467E-04	5.8860E-02	1.4398E-01	31663.8131	157.9090
Gamma242	1.7808E-02	2.4746E-04	3.8456E-06	5.3202E-02	45864.0363	109.0179
Gamma243	1.5343E-02	1.2346E-04	1.0887E-03	3.9775E-02	25997.7812	192.3241
Gamma244	5.1805E-02	2.3883E-04	2.8589E-02	8.9097E-02	14533.6772	344.0286
Gamma245	2.0058E-02	3.1468E-04	1.1706E-04	5.0474E-02	42293.9325	118.2203
Gamma246	7.4123E-02	5.8961E-04	3.8454E-02	1.3592E-01	35161.7526	142.2000
Gamma247	1.9739E-02	2.0427E-04	1.2378E-04	4.3046E-02	18502.4938	270.2338
Gamma248	4.6480E-02	7.2386E-04	1.1234E-02	1.0265E-01	31479.8738	158.8316
Gamma249	1.9907E-02	1.7395E-04	1.2233E-03	4.3735E-02	38284.4223	130.6014
Gamma250	5.8817E-02	3.0505E-04	2.9232E-02	8.8807E-02	48014.8455	104.1345
Gamma251	4.8917E-02	9.7887E-04	1.9972E-03	1.0607E-01	36523.3956	136.8986
Gamma252	6.4240E-03	5.2194E-05	8.1154E-06	2.3883E-02	33883.8243	147.5630
Gamma253	8.1575E-03	2.8191E-05	2.8640E-04	1.7617E-02	15709.6296	318.2761
Gamma254	5.3155E-03	2.9752E-05	0.0000E+00	1.2059E-02	28570.1134	175.0081
Gamma255	4.4334E-03	1.9147E-05	0.0000E+00	1.4631E-02	34892.3956	143.2977
Gamma256	5.4825E-03	2.9670E-05	1.3524E-04	1.4669E-02	19045.1706	262.5337
Gamma257	6.8300E-03	4.7635E-05	0.0000E+00	1.8941E-02	29033.1484	172.2169
Gamma258	1.3275E-02	9.1295E-05	7.4201E-04	3.0903E-02	28043.2345	178.2961
Gamma259	3.8815E-03	1.7372E-05	0.0000E+00	1.2537E-02	24454.0425	204.4652
Gamma260	1.0610E-02	5.7112E-05	3.7106E-04	2.4722E-02	31783.3337	157.3152
Gamma261	6.3711E-01	2.6489E-03	5.4235E-01	7.2877E-01	65788.9660	76.0006
Gamma262	8.8268E-03	9.8065E-05	3.1832E-05	2.7775E-02	24850.7622	201.2011
Gamma263	5.9210E-03	1.9170E-05	8.2042E-05	1.4713E-02	20750.6234	240.9566
Gamma264	7.3070E-02	3.7953E-04	4.4710E-02	1.1973E-01	40442.9323	123.6310

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma265	4.1779E-03	2.8985E-05	2.9634E-06	1.1795E-02	27245.2398	183.5183
Gamma266	3.6660E-03	1.0923E-05	0.0000E+00	1.1055E-02	28282.6364	176.7869
Gamma267	8.0333E-02	5.5329E-04	3.7376E-02	1.2613E-01	24671.3012	202.6646
Gamma268	3.5894E-02	5.3182E-04	9.1184E-04	7.6760E-02	22406.7080	223.1475
Gamma269	5.0000E-03	1.6646E-05	8.0503E-06	1.2885E-02	20377.3673	245.3703
Gamma270	6.0987E-03	5.0104E-05	0.0000E+00	1.9194E-02	20392.5245	245.1879
Gamma271	5.9221E-03	4.8925E-05	2.2163E-06	1.9486E-02	26498.4931	188.6900
Gamma272	5.4337E-03	3.5837E-05	3.2224E-05	1.7387E-02	24207.3908	206.5485
Gamma273	5.5041E-03	2.6215E-05	0.0000E+00	1.5638E-02	25953.9721	192.6487
Gamma274	5.7329E-03	1.9426E-05	6.6190E-06	1.4090E-02	13558.9442	368.7603
Gamma275	3.9834E-03	1.6668E-05	8.5724E-05	1.2867E-02	33148.8933	150.8346
Gamma276	2.9681E-03	7.5712E-06	3.9389E-05	7.4899E-03	24184.5647	206.7434
Gamma277	3.7934E-03	2.5369E-05	7.5299E-06	1.0718E-02	21527.6928	232.2590
Gamma278	4.1185E-03	1.0647E-05	0.0000E+00	1.0465E-02	33540.4810	149.0736
Gamma279	4.2983E-03	1.5452E-05	3.3467E-06	1.0948E-02	25237.1937	198.1203
Gamma280	1.0858E-02	2.4034E-05	9.7111E-04	2.0302E-02	13321.8237	375.3240
Gamma281	5.0261E-03	8.7573E-06	1.0469E-03	1.1525E-02	13832.8982	361.4572
Gamma282	6.5803E-03	1.8902E-05	2.3867E-05	1.5060E-02	19289.4499	259.2091
Gamma283	5.0972E-03	2.5601E-05	3.0547E-05	1.6494E-02	20443.3423	244.5784
Gamma284	4.7241E-02	9.0826E-05	2.9230E-02	6.4696E-02	12236.9987	408.5969
Gamma285	5.9855E-03	1.7391E-05	1.7215E-05	1.3667E-02	16319.6658	306.3788
Gamma286	6.7989E-03	4.6773E-05	4.4576E-06	1.2852E-02	37887.2385	131.9706
Gamma287	7.0529E-01	6.5625E-04	6.5503E-01	7.5514E-01	69707.2689	71.7285
Gamma288	4.1422E-03	1.0170E-05	1.0113E-04	1.0852E-02	19079.0956	262.0669
Gamma289	4.8746E-02	1.5836E-04	3.0056E-02	7.2797E-02	26323.2367	189.9462
Gamma290	2.5543E-03	2.4406E-05	2.8525E-05	9.1834E-03	17013.3777	293.8864
Gamma291	1.1412E-03	3.3345E-06	0.0000E+00	2.4611E-03	17679.4058	282.8149

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma292	2.8599E-03	6.6291E-06	1.2848E-04	8.7528E-03	22401.1303	223.2030
Gamma293	1.1679E-01	2.8930E-04	8.4514E-02	1.4702E-01	67755.4724	73.7948
Gamma294	1.9097E-03	3.0563E-06	0.0000E+00	4.9579E-03	24372.6881	205.1477
Gamma295	2.5202E-03	6.4498E-06	0.0000E+00	6.4033E-03	38714.7146	129.1499
Gamma296	1.5994E-03	7.4314E-06	0.0000E+00	4.0390E-03	23306.1716	214.5354
Gamma297	3.7095E-03	6.1932E-05	7.2249E-05	1.0261E-02	17278.2065	289.3819
Gamma298	2.3703E-03	6.8958E-06	0.0000E+00	6.7324E-03	21231.4268	235.5000
Gamma299	1.8840E-03	6.6609E-06	1.8302E-06	6.1451E-03	19788.1064	252.6770
Gamma300	1.7226E-03	3.0834E-06	7.0403E-06	5.5546E-03	44347.4723	112.7460
Gamma301	2.9327E-02	4.2531E-04	3.2592E-03	6.3432E-02	30510.9965	163.8753
Gamma302	1.2290E-01	6.3671E-04	7.8302E-02	1.7072E-01	24623.5504	203.0576
Gamma303	7.1168E-03	2.6278E-05	2.5334E-04	1.8564E-02	15769.2543	317.0727
Gamma304	5.7247E-03	3.1242E-05	5.5859E-05	1.8575E-02	27674.4285	180.6722
Gamma305	4.6415E-03	6.6660E-05	1.1610E-04	1.1787E-02	18508.2806	270.1494
Gamma306	3.0414E-03	7.5922E-06	1.2860E-05	8.4326E-03	18594.0679	268.9030
Gamma307	3.2661E-03	1.1904E-05	2.5661E-06	1.0671E-02	61553.7933	81.2298
Gamma308	3.6162E-03	9.8520E-06	5.5995E-06	9.4542E-03	29464.3761	169.6964
Gamma309	1.8790E-03	3.4469E-06	0.0000E+00	5.8284E-03	28845.1062	173.3396
Gamma310	4.3399E-03	2.5936E-05	3.4381E-06	1.1586E-02	17978.2400	278.1140
Gamma311	4.5431E-03	9.5163E-06	2.4009E-04	9.5250E-03	28937.6912	172.7850
Gamma312	1.5384E-03	2.1657E-06	1.7842E-06	4.4478E-03	25970.4808	192.5263
Gamma313	7.3209E-01	1.1326E-03	6.6362E-01	7.8946E-01	16866.8588	296.4393
Gamma314	1.8622E-03	3.4278E-06	6.9320E-07	5.5181E-03	36575.9053	136.7020
Gamma315	3.1327E-03	4.8260E-06	1.2577E-06	7.2462E-03	16861.5038	296.5335
Gamma316	2.5437E-03	2.2604E-05	3.6101E-05	7.5467E-03	15749.6754	317.4669
Gamma317	9.1956E-03	3.5181E-05	4.3308E-05	2.1015E-02	27536.5460	181.5769
Gamma318	5.6658E-03	2.1964E-05	5.5923E-05	1.5150E-02	16059.1005	311.3499

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma319	4.1368E-03	2.9159E-05	5.8963E-05	1.1556E-02	21005.5369	238.0325
Gamma320	5.5329E-03	1.8947E-05	1.9608E-04	1.5499E-02	16956.3464	294.8748
Gamma321	2.4158E-02	6.8231E-05	1.0261E-02	3.7861E-02	6766.1119	738.9768
Gamma322	3.6947E-03	1.1449E-05	6.7122E-138	9.9310E-03	20442.0729	244.5936
Gamma323	9.9583E-03	5.0129E-05	5.4610E-04	2.2615E-02	24769.9109	201.8578
Gamma324	2.0962E-03	5.0383E-06	0.0000E+00	6.3166E-03	18788.8331	266.1155
Gamma325	4.0082E-03	1.7494E-05	1.9199E-05	1.4044E-02	35960.8150	139.0402
Gamma326	2.4669E-03	6.8498E-06	2.6688E-06	7.8518E-03	30845.1923	162.0998
Gamma327	2.7149E-03	1.0769E-05	2.8700E-246	7.3696E-03	20326.7589	245.9812
Gamma328	4.2796E-03	1.2370E-05	9.5174E-05	1.0872E-02	32612.1957	153.3169
Gamma329	2.5964E-03	7.0825E-06	5.3002E-06	7.6621E-03	20614.7673	242.5446
Gamma330	1.7047E-03	1.7693E-05	9.7357E-06	5.5125E-03	23923.4003	209.0004
Gamma331	1.0921E-03	2.7578E-06	5.4262E-06	3.8869E-03	23087.1659	216.5705
Gamma332	1.5254E-03	4.0615E-06	2.2535E-05	3.9127E-03	8463.8927	590.7447
Gamma333	4.5659E-03	9.2828E-06	1.0744E-04	1.0630E-02	43707.7232	114.3963
Gamma334	8.1321E-03	2.3897E-05	1.5494E-03	1.8872E-02	22710.8803	220.1588
Gamma335	1.6005E-02	4.9995E-05	5.6207E-03	2.8615E-02	64528.7687	77.4848
Gamma336	2.3665E-02	6.6610E-05	1.0211E-02	4.3433E-02	21460.8618	232.9823
Gamma337	4.5288E-02	9.5400E-05	2.6571E-02	6.3111E-02	35760.0416	139.8209
Gamma338	1.9542E-03	2.6936E-06	1.1975E-105	5.3739E-03	16936.6509	295.2178
Gamma339	7.3149E-01	6.6108E-04	6.8932E-01	7.8483E-01	41576.3816	120.2606
Gamma340	1.4309E-03	1.5812E-05	8.7102E-06	3.1581E-03	17139.3611	291.7262
Gamma341	1.5732E-03	4.4854E-06	0.0000E+00	4.3259E-03	24026.0963	208.1070
Gamma342	5.0500E-03	1.5580E-05	2.3646E-04	1.1701E-02	33677.8372	148.4656
Gamma343	1.2851E-01	3.7326E-04	9.3754E-02	1.6243E-01	50482.0442	99.0451
Gamma344	1.1096E-03	1.0636E-05	1.0640E-103	3.2372E-03	20442.1127	244.5931
Gamma345	1.1524E-03	1.5336E-06	2.3512E-05	3.4638E-03	15780.5214	316.8463

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma346	2.6502E-03	7.4835E-06	1.1649E-209	6.1499E-03	23170.2820	215.7937
Gamma347	2.4587E-03	1.0587E-05	2.4929E-66	7.9508E-03	26962.0248	185.4460
Gamma348	2.5180E-03	4.8702E-06	0.0000E+00	7.5496E-03	18700.3745	267.3743
Gamma349	2.8176E-03	9.8475E-06	5.2767E-05	8.0141E-03	20869.7338	239.5814
Gamma350	3.2411E-03	2.9135E-05	2.8385E-06	1.0693E-02	25938.5472	192.7633
Gamma351	2.4793E-02	3.3018E-04	9.0062E-04	5.9350E-02	33327.8158	150.0248
Gamma352	5.1001E-02	6.1874E-04	2.6070E-03	9.2298E-02	37286.2379	134.0977
Gamma353	6.1075E-03	6.7308E-05	0.0000E+00	2.5894E-02	38588.0048	129.5739
Gamma354	3.7852E-03	1.4613E-05	0.0000E+00	1.2001E-02	8916.7918	560.7398
Gamma355	7.7790E-03	6.9994E-05	2.7015E-05	2.5643E-02	31182.7687	160.3450
Gamma356	4.9178E-03	3.2680E-05	0.0000E+00	1.7044E-02	34944.3649	143.0846
Gamma357	6.1894E-03	5.0146E-05	0.0000E+00	1.8185E-02	29584.5974	169.0069
Gamma358	7.1705E-03	6.8995E-05	0.0000E+00	2.7270E-02	24876.9587	200.9892
Gamma359	4.6590E-03	2.1364E-05	6.4461E-06	1.3523E-02	28535.3499	175.2213
Gamma360	9.1733E-03	5.5219E-05	3.8856E-05	2.3279E-02	37390.2793	133.7246
Gamma361	6.2608E-03	7.4079E-05	0.0000E+00	2.5291E-02	40482.6649	123.5097
Gamma362	3.8615E-03	1.0624E-05	7.8225E-06	9.8337E-03	14735.0059	339.3280
Gamma363	7.0250E-03	5.3764E-05	0.0000E+00	2.0566E-02	24005.2184	208.2880
Gamma364	4.3183E-03	2.7370E-05	1.8785E-06	1.2305E-02	29506.0729	169.4566
Gamma365	6.0414E-01	3.5649E-03	4.6988E-01	7.0603E-01	45696.0153	109.4187
Gamma366	1.6645E-02	1.3086E-04	4.1311E-04	3.2876E-02	12823.9967	389.8940
Gamma367	3.3010E-02	3.7879E-04	6.9911E-03	6.6756E-02	28993.9751	172.4496
Gamma368	1.8315E-02	1.6982E-04	3.3724E-04	4.5120E-02	12876.7647	388.2963
Gamma369	6.8801E-03	4.4235E-05	1.1847E-04	2.0388E-02	28752.5357	173.8977
Gamma370	1.0269E-01	1.5614E-03	2.4741E-02	1.7153E-01	36482.7202	137.0512
Gamma371	1.8484E-02	1.1383E-04	1.8662E-04	3.6468E-02	22382.4058	223.3897
Gamma372	1.0651E-02	1.2899E-04	0.0000E+00	3.1775E-02	20097.0589	248.7926

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma373	1.7435E-02	1.5667E-04	3.3653E-04	3.8187E-02	20262.4381	246.7620
Gamma374	8.3769E-03	9.3021E-05	0.0000E+00	3.0907E-02	36945.3840	135.3349
Gamma375	1.6333E-02	1.4734E-04	8.4483E-04	4.1077E-02	27353.5296	182.7918
Gamma376	2.5206E-03	5.0930E-06	2.9205E-05	7.2401E-03	20979.2645	238.3306
Gamma377	3.1381E-03	9.6389E-06	0.0000E+00	9.6390E-03	23175.4021	215.7460
Gamma378	3.2783E-03	4.6262E-06	1.4914E-04	7.0207E-03	18371.5781	272.1595
Gamma379	1.9466E-03	4.3353E-06	1.9932E-05	6.0063E-03	37457.2433	133.4855
Gamma380	1.5848E-03	3.9237E-06	0.0000E+00	4.5166E-03	20140.3158	248.2583
Gamma381	3.8456E-03	2.2601E-05	2.3276E-05	1.4362E-02	28454.7058	175.7179
Gamma382	2.3889E-03	1.7898E-05	5.8433E-06	7.2489E-03	20698.5296	241.5631
Gamma383	1.9750E-03	4.4970E-06	5.0407E-06	5.5307E-03	20741.2644	241.0653
Gamma384	3.1523E-03	6.6443E-06	1.1953E-04	7.5092E-03	20241.7043	247.0148
Gamma385	3.1986E-02	6.3682E-05	1.9275E-02	4.8261E-02	20170.9672	247.8810
Gamma386	1.9295E-03	5.7482E-06	9.4874E-06	6.3732E-03	21484.8529	232.7221
Gamma387	1.3705E-03	2.1416E-06	9.1667E-06	4.3620E-03	30328.2155	164.8630
Gamma388	1.6270E-03	2.5758E-06	1.9328E-07	4.6204E-03	27632.8669	180.9439
Gamma389	1.7055E-03	2.6181E-06	0.0000E+00	5.0687E-03	27168.1551	184.0390
Gamma390	1.0854E-02	2.1510E-05	3.3281E-03	2.0403E-02	29059.2892	172.0620
Gamma391	7.1509E-01	5.9987E-04	6.6839E-01	7.6232E-01	16853.6152	296.6723
Gamma392	2.8702E-03	1.3946E-05	0.0000E+00	1.1007E-02	33926.4352	147.3777
Gamma393	3.2691E-03	1.4818E-05	5.2630E-06	1.2622E-02	12896.3590	387.7063
Gamma394	3.4814E-02	9.0375E-05	1.6997E-02	5.2017E-02	22320.0818	224.0135
Gamma395	1.3375E-01	2.6785E-04	9.8756E-02	1.6443E-01	31435.8188	159.0542
Gamma396	3.6185E-03	1.2274E-05	2.1532E-04	1.0387E-02	17364.7334	287.9399
Gamma397	3.5225E-03	1.0651E-05	0.0000E+00	9.8298E-03	23028.6780	217.1206
Gamma398	1.2023E-02	4.8850E-05	5.7406E-04	2.4273E-02	43936.2306	113.8013
Gamma399	7.1335E-03	2.2365E-05	2.8489E-04	1.5523E-02	19134.3241	261.3105

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma400	1.0605E-02	3.5265E-05	2.2637E-03	1.9447E-02	18513.1736	270.0780
Gamma401	1.4145E-01	5.6709E-04	9.5771E-02	1.8805E-01	46561.6260	107.3846
Gamma402	1.1253E-02	6.0266E-05	8.2796E-06	2.6947E-02	31745.4089	157.5031
Gamma403	1.0800E-02	2.5388E-05	1.8994E-03	2.0844E-02	14008.5219	356.9256
Gamma404	1.4723E-03	2.4668E-06	8.5575E-07	4.0427E-03	27293.1690	183.1960
Gamma405	5.1690E-03	6.1864E-06	8.0014E-04	1.0367E-02	17573.1706	284.5246
Gamma406	2.4912E-03	4.0882E-06	1.5439E-04	6.6381E-03	17474.4905	286.1314
Gamma407	2.6837E-03	5.2157E-06	3.7603E-05	7.0031E-03	25231.3303	198.1663
Gamma408	2.7472E-03	7.4211E-06	4.1349E-05	8.4109E-03	83638.5474	59.7810
Gamma409	2.4838E-03	8.3758E-06	3.0316E-05	8.3449E-03	14372.5505	347.8854
Gamma410	9.7625E-03	3.1184E-05	8.8820E-04	2.0287E-02	23276.3846	214.8100
Gamma411	2.5801E-02	7.9244E-05	6.7707E-03	4.3522E-02	31942.0713	156.5334
Gamma412	3.0284E-03	6.9727E-06	1.9368E-05	7.8618E-03	24849.1321	201.2143
Gamma413	4.9011E-03	1.0844E-05	9.8124E-05	1.0737E-02	12502.6231	399.9161
Gamma414	6.3975E-03	1.7203E-05	1.3161E-03	1.6126E-02	13817.0982	361.8705
Gamma415	5.2195E-03	1.0166E-05	1.4682E-04	1.1186E-02	17327.3056	288.5619
Gamma416	2.4188E-03	3.8366E-06	0.0000E+00	5.6751E-03	13496.7349	370.4600
Gamma417	7.0950E-01	6.3763E-04	6.5662E-01	7.5761E-01	46169.2866	108.2971
Gamma418	1.0090E-02	4.1201E-05	2.1459E-04	1.9922E-02	49123.0598	101.7852
Gamma419	2.8005E-03	7.3404E-06	4.7947E-05	9.7403E-03	25931.2775	192.8173
Gamma420	4.8523E-03	2.1230E-05	1.3610E-05	1.5738E-02	16063.6154	311.2624
Gamma421	2.1635E-02	6.2529E-05	6.5801E-03	3.7325E-02	16900.7761	295.8444
Gamma422	2.8975E-03	6.7063E-06	0.0000E+00	8.1080E-03	27776.0669	180.0111
Gamma423	5.6688E-03	2.0444E-05	6.2900E-05	1.4027E-02	15309.3126	326.5986
Gamma424	2.8593E-03	8.1163E-06	8.5713E-06	8.6236E-03	64005.0544	78.1188
Gamma425	1.6124E-03	2.2344E-06	3.4202E-06	4.5395E-03	25226.5574	198.2038
Gamma426	2.0740E-03	4.0899E-06	2.0857E-05	6.1500E-03	31370.0390	159.3878

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma427	9.9544E-03	2.0338E-05	6.3560E-04	1.6414E-02	43002.3537	116.2727
Gamma428	2.9525E-03	7.1782E-06	2.1226E-04	7.0641E-03	25471.4357	196.2983
Gamma429	1.6369E-03	2.7502E-06	9.2684E-06	4.9787E-03	24336.0265	205.4567
Gamma430	1.3922E-03	3.1853E-06	0.0000E+00	5.0678E-03	32406.8350	154.2884
Gamma431	1.4245E-03	6.8981E-06	5.7031E-06	4.4679E-03	26461.6035	188.9530
Gamma432	1.4795E-03	2.3451E-06	6.7581E-06	3.8377E-03	28039.3865	178.3206
Gamma433	1.5035E-02	6.3199E-05	3.4628E-03	2.6602E-02	43256.3488	115.5900
Gamma434	5.0448E-03	7.4097E-06	3.6836E-04	1.0538E-02	33605.9976	148.7830
Gamma435	1.7197E-03	9.7988E-06	6.9005E-06	4.5959E-03	14081.1043	355.0858
Gamma436	3.7395E-03	1.7747E-05	9.4233E-05	1.1876E-02	17872.4177	279.7607
Gamma437	4.4831E-02	8.2069E-05	2.4317E-02	5.9053E-02	55420.5429	90.2193
Gamma438	2.0099E-03	2.9398E-06	4.0242E-06	5.3215E-03	23310.4666	214.4959
Gamma439	5.7917E-02	5.4776E-05	4.4385E-02	7.1556E-02	18974.4135	263.5128
Gamma440	1.2071E-03	8.7368E-07	2.0884E-05	3.0730E-03	21556.4801	231.9488
Gamma441	7.7877E-04	1.2320E-06	3.9643E-06	2.7132E-03	34442.7165	145.1686
Gamma442	2.8372E-03	6.8045E-06	3.3803E-06	5.9055E-03	14566.5388	343.2524
Gamma443	8.3304E-01	1.6314E-04	8.0840E-01	8.5844E-01	32451.6730	154.0753
Gamma444	7.0302E-04	5.6680E-07	2.1415E-235	1.9467E-03	22644.6403	220.8028
Gamma445	1.2805E-03	1.7479E-06	0.0000E+00	3.6397E-03	22109.1297	226.1509
Gamma446	7.8547E-04	8.4742E-07	1.3043E-05	2.7585E-03	31651.8098	157.9689
Gamma447	2.0870E-03	4.3782E-06	1.0134E-05	6.9000E-03	20642.3162	242.2209
Gamma448	2.9245E-03	1.2113E-05	2.6652E-06	6.9217E-03	13529.3141	369.5679
Gamma449	1.1445E-03	1.0144E-06	1.9544E-05	3.1386E-03	20352.2298	245.6733
Gamma450	2.0047E-03	3.2108E-06	3.2630E-06	5.7242E-03	17725.7266	282.0759
Gamma451	7.1105E-03	4.8820E-05	5.8517E-06	2.3692E-02	26338.7144	189.8346
Gamma452	1.2013E-02	1.0252E-04	1.1897E-05	3.1603E-02	23952.7096	208.7447
Gamma453	4.1419E-03	3.2262E-05	8.8946E-05	1.6086E-02	48457.2786	103.1837

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma454	6.0563E-03	1.1015E-04	0.0000E+00	1.7585E-02	22774.3455	219.5453
Gamma455	5.1958E-03	1.9394E-05	1.4232E-04	1.3593E-02	29107.8441	171.7750
Gamma456	9.3003E-03	3.1841E-05	3.9921E-04	2.1125E-02	24715.7050	202.3005
Gamma457	5.6489E-03	2.3863E-05	0.0000E+00	1.6950E-02	25998.2037	192.3210
Gamma458	2.2142E-03	5.1309E-06	0.0000E+00	7.4352E-03	33010.7600	151.4658
Gamma459	3.2802E-03	1.5509E-05	0.0000E+00	8.8765E-03	11562.4319	432.4350
Gamma460	2.5709E-02	1.0707E-04	7.3453E-03	4.4883E-02	19696.9727	253.8461
Gamma461	3.2744E-03	8.1703E-06	2.0800E-05	8.9429E-03	50279.2180	99.4447
Gamma462	3.7221E-03	1.0454E-05	2.1471E-06	1.1410E-02	21433.3031	233.2818
Gamma463	3.6508E-03	1.4389E-05	1.4977E-05	1.0892E-02	28069.2042	178.1312
Gamma464	4.3139E-03	1.7651E-05	5.4271E-05	1.2524E-02	21386.6295	233.7909
Gamma465	6.8082E-03	2.5981E-05	3.0086E-04	1.5746E-02	15262.2073	327.6066
Gamma466	6.6788E-02	2.5808E-04	3.8270E-02	9.6085E-02	33162.6412	150.7721
Gamma467	4.7363E-03	2.5146E-05	2.1756E-05	1.3580E-02	24894.7832	200.8453
Gamma468	2.5679E-03	1.2170E-05	0.0000E+00	9.7807E-03	45902.5130	108.9265
Gamma469	5.5808E-01	1.4357E-03	4.7133E-01	6.2205E-01	28278.1542	176.8149
Gamma470	1.6805E-01	8.0602E-04	1.2388E-01	2.3427E-01	35056.1824	142.6282
Gamma471	4.1599E-03	2.0401E-05	1.7421E-06	1.2528E-02	17364.7550	287.9396
Gamma472	7.6984E-03	5.7707E-05	1.7294E-66	2.1739E-02	33902.9657	147.4797
Gamma473	5.9583E-02	5.5918E-04	1.4012E-02	9.9320E-02	102335.1947	48.8590
Gamma474	5.1308E-03	3.7137E-05	2.9308E-05	1.9383E-02	18410.6335	271.5822
Gamma475	2.0768E-02	6.8060E-05	6.6840E-03	3.7132E-02	18835.5876	265.4550
Gamma476	4.5246E-03	2.9527E-05	1.2246E-05	1.5367E-02	28418.4006	175.9423
Gamma477	7.9723E-03	3.4245E-05	3.6387E-04	1.6831E-02	28131.9693	177.7337
Gamma478	1.8001E-03	3.8621E-06	3.6605E-06	5.4703E-03	34500.3679	144.9260
Gamma479	2.1294E-03	2.6664E-06	2.6298E-06	5.2907E-03	10274.7777	486.6285
Gamma480	1.8446E-03	3.9387E-06	2.2398E-05	5.2873E-03	45227.5387	110.5521

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma481	1.7509E-03	3.8855E-06	3.6611E-97	4.4719E-03	21426.9780	233.3507
Gamma482	2.7513E-03	1.2285E-05	1.4434E-05	6.9678E-03	25084.5453	199.3259
Gamma483	3.2090E-03	9.4208E-06	6.0894E-05	8.6159E-03	35241.6479	141.8776
Gamma484	1.2637E-03	1.5646E-06	0.0000E+00	3.2678E-03	26065.9621	191.8210
Gamma485	6.6660E-03	1.2467E-05	1.1263E-03	1.3715E-02	21821.2805	229.1341
Gamma486	9.9720E-04	1.2262E-06	0.0000E+00	3.8547E-03	40447.7451	123.6163
Gamma487	1.6581E-03	5.8962E-06	8.4528E-06	5.3982E-03	11862.0810	421.5112
Gamma488	3.1126E-03	6.7946E-06	6.7868E-05	7.3754E-03	23350.4316	214.1288
Gamma489	1.2443E-03	2.4282E-06	6.0437E-06	3.9047E-03	26562.3243	188.2365
Gamma490	1.1049E-02	2.9569E-05	8.7339E-04	1.9780E-02	23895.0789	209.2481
Gamma491	4.8344E-02	1.0015E-04	2.9564E-02	6.9302E-02	25991.7975	192.3684
Gamma492	2.3050E-03	3.3382E-06	9.9957E-05	5.4752E-03	17442.8134	286.6510
Gamma493	1.8940E-03	1.0811E-05	0.0000E+00	4.7140E-03	30163.3613	165.7640
Gamma494	3.2402E-02	5.7514E-05	2.1006E-02	4.7081E-02	24356.8705	205.2809
Gamma495	8.2957E-01	3.3422E-04	7.9682E-01	8.6667E-01	20813.6358	240.2271
Gamma496	1.7734E-03	2.7448E-06	1.5778E-06	5.3464E-03	27772.7873	180.0323
Gamma497	2.8291E-03	7.4174E-06	2.0672E-238	7.7762E-03	66433.4908	75.2632
Gamma498	1.9807E-02	1.1193E-04	4.7007E-03	3.9870E-02	55844.1523	89.5349
Gamma499	3.7384E-03	1.0750E-05	6.1443E-06	9.4147E-03	27539.7138	181.5560
Gamma500	5.3652E-03	9.2246E-06	8.6062E-04	1.1890E-02	72948.9489	68.5411
Gamma501	1.3157E-01	2.7214E-04	1.0350E-01	1.6442E-01	16829.9330	297.0897
Gamma502	3.6686E-03	1.1225E-05	1.7460E-06	1.0535E-02	37864.7786	132.0488
Gamma503	8.1465E-03	1.5319E-05	2.2713E-03	1.5033E-02	16359.8070	305.6271
Gamma504	3.0005E-03	7.1040E-06	2.8331E-07	8.7553E-03	22353.0670	223.6830
Gamma505	2.3504E-03	4.2734E-06	6.3767E-06	6.3886E-03	19613.4301	254.9274
Gamma506	3.4265E-03	6.4921E-06	1.4338E-04	7.8648E-03	28198.0034	177.3175
Gamma507	2.2086E-03	4.2489E-06	6.6654E-06	6.9498E-03	28960.2604	172.6504

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma508	1.8329E-03	3.4288E-06	2.5296E-05	4.4587E-03	20578.9871	242.9663
Gamma509	1.7202E-03	3.1004E-06	0.0000E+00	5.2366E-03	22627.6876	220.9682
Gamma510	2.4846E-02	5.0564E-05	8.7965E-03	3.6573E-02	19652.0538	254.4263
Gamma511	3.0427E-03	7.0590E-06	4.7212E-07	7.9829E-03	24954.0345	200.3684
Gamma512	1.6581E-03	2.4683E-06	5.2152E-07	4.7452E-03	42106.3515	118.7469
Gamma513	2.7028E-03	7.0896E-06	3.5590E-205	8.0023E-03	33245.8452	150.3947
Gamma514	2.5833E-03	8.3656E-06	1.1496E-06	6.5102E-03	21024.7301	237.8152
Gamma515	1.4949E-02	2.1112E-05	7.6734E-03	2.3874E-02	14787.2077	338.1301
Gamma516	4.5785E-03	9.8908E-06	1.4013E-04	9.7391E-03	28731.1410	174.0272
Gamma517	2.1947E-02	1.2392E-04	7.0573E-03	4.2178E-02	11922.9571	419.3591
Gamma518	2.0214E-03	3.1687E-06	1.8265E-05	5.6039E-03	16504.4170	302.9492
Gamma519	1.9063E-03	1.5384E-05	0.0000E+00	5.5721E-03	17525.8421	285.2930
Gamma520	2.5680E-03	1.0041E-05	1.2352E-253	7.7990E-03	17917.6273	279.0548
Gamma521	7.4956E-01	6.0872E-04	7.0241E-01	7.8861E-01	30806.1306	162.3054
Gamma522	2.2303E-03	4.3630E-06	1.5289E-05	5.6639E-03	9786.4206	510.9120
Gamma523	3.3383E-03	2.8680E-05	1.7586E-06	1.4263E-02	31699.7803	157.7298
Gamma524	1.2529E-03	1.4225E-06	0.0000E+00	3.6943E-03	12450.4991	401.5903
Gamma525	2.8892E-03	3.2576E-05	2.7673E-06	1.0769E-02	24567.9091	203.5175
Gamma526	1.0670E-03	1.3093E-06	3.7588E-305	3.7336E-03	25525.8323	195.8800
Gamma527	6.8261E-03	2.3397E-05	2.8033E-04	1.6208E-02	51743.5942	96.6303
Gamma528	3.3637E-02	2.6144E-04	2.8814E-03	5.1314E-02	56874.1537	87.9134
Gamma529	1.2611E-02	3.3020E-05	1.6657E-03	2.2728E-02	169947.5985	29.4208
Gamma530	1.6999E-03	5.2823E-06	1.3537E-05	4.3540E-03	25726.4129	194.3528
Gamma531	3.5967E-03	3.5060E-06	8.3529E-06	7.0724E-03	17345.1166	288.2656
Gamma532	3.1536E-03	5.6114E-06	7.2577E-113	7.7095E-03	33188.7328	150.6535
Gamma533	8.3641E-03	1.9661E-05	1.6485E-03	1.7416E-02	26295.3614	190.1476
Gamma534	8.4514E-03	2.7209E-05	2.8089E-04	1.7232E-02	124216.1730	40.2524

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma535	2.6716E-03	1.3608E-05	4.0078E-06	7.4991E-03	81553.5622	61.3094
Gamma536	9.3193E-04	2.9252E-06	7.9932E-06	3.8403E-03	18179.8773	275.0294
Gamma537	1.1114E-03	1.3498E-06	6.6574E-06	3.2932E-03	19534.9622	255.9514
Gamma538	1.5258E-03	3.8594E-06	2.1416E-06	4.9796E-03	15821.6917	316.0218
Gamma539	1.3697E-03	6.3098E-06	2.7123E-06	5.3163E-03	18226.7989	274.3213
Gamma540	1.8537E-03	8.1875E-06	9.3136E-07	8.5293E-03	103611.6168	48.2571
Gamma541	1.5786E-03	8.1487E-06	8.1707E-06	4.0892E-03	21485.0467	232.7200
Gamma542	1.4865E-03	6.0516E-06	0.0000E+00	5.9249E-03	27535.5807	181.5832
Gamma543	1.1454E-03	2.7441E-06	9.3162E-06	4.0491E-03	28161.6175	177.5466
Gamma544	1.0501E-03	3.8784E-06	9.7212E-238	4.1070E-03	17075.4013	292.8189
Gamma545	1.1498E-03	1.1439E-06	2.2421E-06	3.1272E-03	12510.7885	399.6551
Gamma546	8.7337E-04	2.8368E-06	1.0350E-05	2.3897E-03	12978.9781	385.2383
Gamma547	8.8294E-01	2.7952E-04	8.5074E-01	9.1435E-01	18172.1093	275.1469
Gamma548	5.6532E-03	2.3565E-05	6.5690E-05	1.6203E-02	123254.6503	40.5664
Gamma549	1.4508E-03	1.4327E-05	6.4857E-07	4.0106E-03	10878.6212	459.6171
Gamma550	1.3803E-02	1.8331E-04	2.2917E-03	4.4794E-02	34666.3023	144.2323
Gamma551	6.7310E-03	2.7680E-05	1.1266E-04	1.7192E-02	35142.0623	142.2796
Gamma552	2.4209E-01	8.7090E-03	3.8008E-02	3.7133E-01	162869.1094	30.6995
Gamma553	3.1470E-03	6.9356E-06	2.8290E-05	8.0054E-03	33272.2618	150.2753
Gamma554	3.9453E-03	1.3509E-05	1.0103E-04	1.2127E-02	24520.4763	203.9112
Gamma555	3.6845E-03	9.3521E-06	5.2495E-05	9.5950E-03	24818.6934	201.4610
Gamma556	7.3746E-03	2.0730E-05	1.2310E-03	1.6435E-02	29287.3525	170.7222
Gamma557	4.5495E-03	1.0316E-05	3.0097E-04	1.0594E-02	21781.4116	229.5535
Gamma558	9.9648E-03	5.5931E-05	9.4161E-04	2.7924E-02	32907.5859	151.9407
Gamma559	1.9224E-03	3.7264E-06	1.4318E-05	5.3916E-03	25555.6939	195.6511
Gamma560	8.1419E-03	2.9276E-05	1.1023E-03	1.9852E-02	81626.1404	61.2549
Gamma561	1.9963E-03	7.0339E-06	1.4485E-286	5.6362E-03	39974.1572	125.0808

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma562	1.4446E-03	2.2048E-06	1.4879E-05	4.5418E-03	44515.1380	112.3213
Gamma563	6.0201E-03	5.3759E-05	9.1406E-05	1.8311E-02	43368.0244	115.2923
Gamma564	2.6932E-03	6.5481E-06	8.6165E-05	7.5424E-03	19725.0931	253.4842
Gamma565	4.9005E-03	8.1615E-06	3.5200E-04	1.0600E-02	45810.4813	109.1453
Gamma566	6.7075E-03	6.6712E-05	3.4673E-06	1.4944E-02	50579.6758	98.8539
Gamma567	3.6168E-03	1.1999E-05	1.0541E-04	1.0273E-02	22432.4382	222.8915
Gamma568	5.4354E-03	2.0577E-05	4.0865E-07	1.4374E-02	34782.8385	143.7491
Gamma569	1.3744E-02	4.3454E-05	4.8660E-03	2.7866E-02	89800.7279	55.6788
Gamma570	2.0294E-02	2.9998E-04	2.1426E-03	6.0205E-02	108491.3389	46.0866
Gamma571	1.2219E-03	2.3025E-06	0.0000E+00	3.5279E-03	26854.9602	186.1853
Gamma572	1.0003E-02	3.9214E-05	6.9248E-04	2.2608E-02	70626.9782	70.7945
Gamma573	6.1290E-01	1.9880E-02	3.9848E-01	9.0596E-01	63459.6414	78.7902
Gamma574	7.6587E-03	2.6901E-05	1.7922E-04	1.6135E-02	37523.9088	133.2484
Gamma575	9.8089E-03	4.2591E-05	1.0069E-03	2.3786E-02	63298.2454	78.9911
Gamma576	8.3441E-03	5.9303E-05	1.0641E-04	2.4359E-02	48248.9802	103.6291
Gamma577	1.1359E-01	5.5179E-04	7.9416E-02	1.6391E-01	29470.7144	169.6600
Gamma578	2.0572E-03	4.9978E-06	1.9914E-06	5.1430E-03	19695.0448	253.8710
Gamma579	5.0992E-03	1.8647E-05	1.0823E-05	1.2779E-02	45835.5124	109.0857
Gamma580	3.0145E-03	1.6992E-05	9.0696E-06	9.2287E-03	18390.8363	271.8745
Gamma581	6.3175E-03	2.1863E-05	2.0929E-04	1.5309E-02	37372.7549	133.7873
Gamma582	5.5664E-03	1.5330E-05	2.5135E-04	1.2761E-02	27636.1311	180.9226
Gamma583	7.1495E-03	2.5749E-05	2.6355E-05	1.7411E-02	16700.0796	299.3998
Gamma584	2.3959E-03	9.8418E-06	0.0000E+00	8.6192E-03	31609.9241	158.1782
Gamma585	1.3901E-02	5.7898E-05	1.1593E-04	2.6953E-02	28774.4422	173.7653
Gamma586	4.5053E-03	1.5922E-05	1.3999E-05	1.1896E-02	24670.6474	202.6700
Gamma587	2.3749E-03	4.3713E-06	4.6294E-06	6.3873E-03	18980.6039	263.4268
Gamma588	6.2443E-03	1.9280E-05	6.4128E-04	1.6022E-02	19087.7909	261.9475

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma589	2.6017E-03	7.3585E-06	0.0000E+00	7.6996E-03	29942.2713	166.9880
Gamma590	3.9186E-03	3.8209E-05	8.5562E-07	8.2811E-03	38640.8552	129.3967
Gamma591	3.3120E-02	1.3032E-04	1.4226E-02	5.1841E-02	14839.2761	336.9437
Gamma592	1.1356E-02	6.4249E-05	3.9847E-04	2.5152E-02	36637.9856	136.4704
Gamma593	2.5612E-03	7.2270E-06	1.8899E-05	8.2262E-03	43793.8830	114.1712
Gamma594	4.0829E-03	9.9005E-06	1.9282E-139	9.1253E-03	26159.3926	191.1359
Gamma595	1.6455E-02	1.4091E-04	9.8861E-04	4.0410E-02	25487.0538	196.1780
Gamma596	4.6105E-03	7.1124E-05	1.6447E-05	2.3031E-02	12820.6463	389.9959
Gamma597	1.2425E-02	1.0413E-04	2.9849E-04	3.5192E-02	29425.0675	169.9231
Gamma598	5.9868E-03	2.9668E-05	9.7568E-307	1.4641E-02	19891.5709	251.3628
Gamma599	7.1850E-01	1.4458E-03	6.4775E-01	7.9540E-01	43147.8720	115.8806
Gamma600	3.8137E-03	1.5407E-05	3.7176E-107	1.2743E-02	36807.9025	135.8404
Gamma601	4.5700E-03	2.5936E-05	1.2255E-05	1.4629E-02	61878.8181	80.8031
Gamma602	5.9703E-02	5.4771E-04	8.3209E-03	9.8580E-02	97691.4403	51.1816
Gamma603	3.7547E-03	1.2219E-05	1.3979E-06	1.0969E-02	18740.0983	266.8076
Gamma604	3.3626E-03	3.0958E-05	7.2764E-06	9.5617E-03	23786.6937	210.2016
Gamma605	2.8119E-03	1.2861E-05	1.2029E-05	1.0376E-02	39130.1276	127.7788
Gamma606	8.8095E-03	3.7352E-05	7.7500E-04	2.0562E-02	16802.9664	297.5665
Gamma607	5.9677E-03	2.1292E-05	1.5958E-05	1.4337E-02	26793.4490	186.6128
Gamma608	6.4906E-03	3.8496E-05	8.2154E-05	1.8456E-02	25738.6885	194.2601
Gamma609	3.4075E-03	1.1365E-05	1.9948E-06	9.8028E-03	19701.1370	253.7925
Gamma610	3.7020E-02	1.5706E-04	1.8155E-02	6.0903E-02	30342.1325	164.7874
Gamma611	2.7671E-03	7.2091E-06	1.7110E-06	8.7172E-03	13700.4153	364.9524
Gamma612	2.5592E-03	7.2477E-06	0.0000E+00	7.1332E-03	42692.5417	117.1165
Gamma613	5.1943E-03	1.5530E-05	1.3503E-06	1.2906E-02	51838.7161	96.4530
Gamma614	3.7065E-03	1.0699E-05	2.1408E-06	1.0606E-02	24862.7780	201.1038
Gamma615	4.0503E-03	9.8144E-06	4.5949E-05	1.0229E-02	42991.9561	116.3008

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
Gamma616	1.5509E-02	6.6455E-05	5.7150E-03	3.5507E-02	34656.8095	144.2718
Gamma617	5.9456E-03	2.8665E-05	1.7264E-04	1.7430E-02	31807.6331	157.1950
Gamma618	1.0786E-02	5.9151E-05	5.5395E-05	2.5488E-02	16244.7560	307.7916
Gamma619	8.3767E-03	2.0980E-05	3.4127E-04	1.7033E-02	16412.7446	304.6413
Gamma620	1.8622E-02	2.2345E-04	2.2046E-04	5.1229E-02	134100.5341	37.2855
Gamma621	3.7281E-03	1.7661E-05	0.0000E+00	1.0159E-02	30196.9492	165.5796
Gamma622	9.0645E-02	2.0393E-03	2.7301E-02	1.7825E-01	13895.2991	359.8339
Gamma623	1.4109E-02	1.2263E-04	8.9471E-05	3.6890E-02	39533.6827	126.4744
Gamma624	5.2883E-03	2.2810E-05	0.0000E+00	1.3935E-02	33696.7899	148.3821
Gamma625	6.7281E-01	1.8216E-03	5.8844E-01	7.4477E-01	102972.9902	48.5564
mean00	3.3153E+01	6.2187E-06	3.3148E+01	3.3157E+01	92575.8051	54.0098
mean01	1.3207E+02	2.1123E-05	1.3206E+02	1.3207E+02	40296.2464	124.0810
mean02	3.3530E+01	1.1900E-05	3.3524E+01	3.3535E+01	23306.5483	214.5320
mean03	1.3223E+02	1.5145E-05	1.3223E+02	1.3224E+02	18904.7864	264.4833
mean04	3.3143E+01	3.1642E-05	3.3134E+01	3.3154E+01	312025.9022	16.0243
mean05	1.3222E+02	9.8978E-05	1.3221E+02	1.3224E+02	185982.0670	26.8843
mean06	3.3227E+01	4.6647E-05	3.3215E+01	3.3240E+01	142592.6571	35.0649
mean07	1.3218E+02	3.5168E-05	1.3217E+02	1.3219E+02	45558.0184	109.7502
mean08	3.3646E+01	4.3518E-05	3.3640E+01	3.3660E+01	36341.5325	137.5836
mean09	1.3244E+02	1.0831E-05	1.3244E+02	1.3245E+02	14098.1236	354.6571
mean10	3.3349E+01	2.8868E-05	3.3337E+01	3.3358E+01	42864.7199	116.6460
mean11	1.3212E+02	3.0243E-05	1.3211E+02	1.3213E+02	19599.8797	255.1036
mean12	3.3524E+01	5.5641E-05	3.3512E+01	3.3540E+01	55988.4161	89.3042
mean13	1.3238E+02	4.4698E-05	1.3237E+02	1.3239E+02	40444.0229	123.6277
mean14	3.3468E+01	4.4562E-05	3.3455E+01	3.3476E+01	136234.5080	36.7014
mean15	1.3274E+02	4.3066E-05	1.3274E+02	1.3276E+02	142630.1781	35.0557
mean16	3.3375E+01	9.4142E-05	3.3356E+01	3.3389E+01	113550.4454	44.0333

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
mean17	1.3251E+02	7.9729E-05	1.3249E+02	1.3252E+02	42178.8880	118.5427
mean18	3.3736E+01	6.2646E-04	3.3699E+01	3.3785E+01	214245.2839	23.3377
mean19	1.3315E+02	1.3344E-03	1.3309E+02	1.3322E+02	104416.6575	47.8851
mean20	3.3720E+01	7.8763E-05	3.3704E+01	3.3737E+01	69508.4940	71.9337
mean21	1.3294E+02	9.5506E-05	1.3292E+02	1.3296E+02	108031.1650	46.2829
mean22	3.3536E+01	5.8907E-06	3.3531E+01	3.3541E+01	18076.7866	276.5978
mean23	1.3269E+02	4.6310E-05	1.3268E+02	1.3271E+02	66099.5260	75.6435
mean24	3.3957E+01	2.6005E-05	3.3950E+01	3.3965E+01	4633.3471	1079.1335
mean25	1.3324E+02	1.9592E-05	1.3323E+02	1.3324E+02	13775.2710	362.9693
mean26	3.3621E+01	1.9563E-05	3.3615E+01	3.3627E+01	75168.1397	66.5175
mean27	1.3286E+02	2.7768E-05	1.3285E+02	1.3287E+02	72290.7471	69.1651
mean28	3.3967E+01	1.9263E-06	3.3964E+01	3.3969E+01	7635.2819	654.8547
mean29	1.3344E+02	9.1469E-06	1.3344E+02	1.3345E+02	21692.2676	230.4969
mean30	3.3965E+01	1.7468E-06	3.3962E+01	3.3968E+01	30107.9168	166.0693
mean31	1.3372E+02	2.5383E-05	1.3371E+02	1.3373E+02	29180.7359	171.3459
mean32	3.3807E+01	9.2728E-06	3.3800E+01	3.3811E+01	51407.7307	97.2616
mean33	1.3317E+02	5.2719E-05	1.3316E+02	1.3318E+02	64555.7808	77.4524
mean34	3.3589E+01	1.6618E-05	3.3583E+01	3.3596E+01	24340.1354	205.4220
mean35	1.3289E+02	1.0972E-05	1.3288E+02	1.3289E+02	25239.1536	198.1049
mean36	3.3957E+01	5.4964E-06	3.3953E+01	3.3961E+01	33494.4226	149.2786
mean37	1.3388E+02	1.4084E-05	1.3387E+02	1.3389E+02	19086.3787	261.9669
mean38	3.3869E+01	1.1937E-04	3.3852E+01	3.3888E+01	146107.2442	34.2214
mean39	1.3381E+02	2.1818E-04	1.3379E+02	1.3383E+02	126098.6469	39.6515
mean40	3.3899E+01	6.3637E-06	3.3896E+01	3.3903E+01	29684.1219	168.4402
mean41	1.3334E+02	1.2572E-05	1.3334E+02	1.3335E+02	28284.2642	176.7767
mean42	3.4005E+01	8.7598E-05	3.3990E+01	3.4022E+01	34455.4313	145.1150
mean43	1.3439E+02	7.7585E-05	1.3437E+02	1.3441E+02	44015.9496	113.5952

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
mean44	3.4089E+01	1.0985E-05	3.4087E+01	3.4092E+01	10783.1209	463.6876
mean45	1.3389E+02	2.1354E-06	1.3389E+02	1.3390E+02	16814.1550	297.3685
mean46	3.4030E+01	1.4371E-05	3.4023E+01	3.4037E+01	24344.4476	205.3856
mean47	1.3368E+02	6.3650E-06	1.3368E+02	1.3369E+02	26869.3262	186.0858
mean48	3.3974E+01	1.8305E-05	3.3969E+01	3.3982E+01	16220.0577	308.2603
mean49	1.3418E+02	4.3357E-05	1.3417E+02	1.3419E+02	33984.2140	147.1271
sig0	1.0397E-02	5.1172E-06	7.3910E-03	1.4208E-02	101753.1033	49.1386
sig1	1.1494E-02	2.2762E-05	6.9227E-03	1.6940E-02	89742.0891	55.7152
sig2	2.2147E-02	7.5291E-06	1.7002E-02	2.6493E-02	18702.3423	267.3462
sig3	2.5312E-02	1.3278E-05	2.0509E-02	3.3648E-02	16758.0436	298.3642
sig4	6.7377E-02	3.4771E-05	5.8035E-02	7.7321E-02	90886.8280	55.0135
sig5	1.2037E-01	8.2671E-05	1.0577E-01	1.3751E-01	79241.5240	63.0982
sig6	7.6083E-02	1.2216E-05	6.9972E-02	8.3122E-02	55230.0747	90.5304
sig7	8.9054E-02	1.8748E-05	8.0247E-02	9.5237E-02	33024.4230	151.4031
sig8	2.3056E-02	3.7189E-06	1.8870E-02	2.6342E-02	23756.2145	210.4712
sig9	2.7127E-02	3.8963E-06	2.4081E-02	3.1347E-02	28984.7066	172.5048
sig10	4.4864E-02	1.5913E-05	3.8071E-02	5.1483E-02	21330.6113	234.4049
sig11	2.8569E-02	1.6763E-05	2.2633E-02	3.5289E-02	79364.6376	63.0004
sig12	7.3945E-02	1.4626E-05	6.6090E-02	8.0964E-02	16359.3461	305.6357
sig13	6.0247E-02	4.9425E-05	5.0572E-02	7.5667E-02	45307.7279	110.3564
sig14	4.7560E-02	6.7658E-05	3.7400E-02	5.9961E-02	71546.1485	69.8850
sig15	4.5253E-02	5.1485E-05	3.2712E-02	5.8367E-02	122438.7684	40.8367
sig16	8.1149E-02	6.4461E-05	7.3386E-02	9.7219E-02	35379.4699	141.3249
sig17	9.8157E-02	1.0560E-04	8.1357E-02	1.1856E-01	65447.2037	76.3975
sig18	1.7481E-01	4.9086E-04	1.4254E-01	2.1546E-01	118957.1502	42.0319
sig19	3.7826E-01	2.1703E-03	2.9221E-01	4.5453E-01	98079.9965	50.9788
sig20	6.3216E-02	3.0365E-05	5.2831E-02	7.1833E-02	63138.9261	79.1905

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
sig21	8.3011E-02	3.0218E-05	7.2707E-02	9.3286E-02	67121.1605	74.4922
sig22	4.2591E-02	5.3225E-06	3.8782E-02	4.7331E-02	11863.5828	421.4578
sig23	7.9679E-02	1.6019E-05	7.4067E-02	8.7572E-02	30533.1187	163.7566
sig24	4.0758E-02	1.3113E-05	3.5724E-02	4.5320E-02	18413.7036	271.5369
sig25	3.6311E-02	5.4108E-05	2.5687E-02	4.5761E-02	319437.7767	15.6525
sig26	3.3717E-02	1.8502E-05	2.7022E-02	4.1190E-02	38797.8225	128.8732
sig27	3.2957E-02	1.9160E-05	2.7969E-02	4.3278E-02	85318.1770	58.6042
sig28	1.3705E-02	1.3658E-06	1.1576E-02	1.5649E-02	11658.0919	428.8867
sig29	1.7861E-02	5.2670E-05	1.3820E-02	2.7240E-02	8839.8629	565.6196
sig30	2.3851E-02	4.9658E-06	2.1458E-02	2.6093E-02	20196.0798	247.5728
sig31	6.3047E-02	1.3221E-05	5.5082E-02	6.8559E-02	20046.4462	249.4208
sig32	3.3400E-02	3.7970E-06	2.9305E-02	3.6581E-02	50200.1253	99.6013
sig33	8.9384E-02	1.3365E-05	8.3359E-02	9.6302E-02	40222.3843	124.3089
sig34	1.6552E-02	7.3247E-05	1.2323E-02	2.3667E-02	20320.9017	246.0521
sig35	1.9078E-02	9.0345E-06	1.5246E-02	2.6690E-02	18222.0431	274.3929
sig36	2.9753E-02	3.2640E-06	2.6535E-02	3.3308E-02	12711.3278	393.3499
sig37	3.9156E-02	9.5006E-06	3.3603E-02	4.3555E-02	15530.8432	321.9400
sig38	4.3736E-02	8.1981E-05	3.3489E-02	5.9352E-02	87473.4563	57.1602
sig39	5.6483E-02	7.0326E-05	4.4777E-02	7.5767E-02	44498.5518	112.3632
sig40	3.2181E-02	1.0031E-05	2.9040E-02	3.4087E-02	18767.5229	266.4177
sig41	5.8665E-02	7.4578E-06	5.3512E-02	6.2982E-02	8008.1789	624.3617
sig42	4.3597E-02	2.8268E-05	3.5905E-02	5.3344E-02	35259.9516	141.8039
sig43	4.2660E-02	1.8198E-05	3.4373E-02	5.0306E-02	31057.7121	160.9906
sig44	2.0933E-02	2.7451E-05	1.7862E-02	2.2511E-02	15465.7156	323.2957
sig45	2.1647E-02	1.2810E-06	1.9749E-02	2.4108E-02	18882.7570	264.7918
sig46	3.4843E-02	1.1288E-05	3.0400E-02	4.1280E-02	12880.6637	388.1788
sig47	2.9820E-02	4.6206E-06	2.5811E-02	3.3832E-02	14872.4660	336.1917

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
sig48	3.8268E-02	1.7943E-05	3.2641E-02	4.4989E-02	37424.5456	133.6022
sig49	7.3317E-02	4.4131E-05	6.2792E-02	8.3872E-02	37615.4550	132.9241
rho0	-1.6297E-02	5.2185E-02	-4.6878E-01	3.7495E-01	26512.5997	188.5896
rho1	-6.2773E-01	9.5917E-03	-7.8494E-01	-4.5777E-01	26590.6405	188.0361
rho2	9.3617E-01	1.7745E-04	9.1451E-01	9.5750E-01	230515.6332	21.6905
rho3	3.8187E-01	2.3841E-03	2.6518E-01	4.5914E-01	44177.0986	113.1808
rho4	-4.7966E-01	4.1922E-03	-5.9941E-01	-3.5422E-01	19050.5638	262.4594
rho5	1.1060E-01	1.5303E-02	-1.2180E-01	2.9967E-01	57679.1470	86.6864
rho6	-4.9259E-01	2.0951E-02	-6.5592E-01	-8.0627E-02	116877.5009	42.7798
rho7	-9.3090E-01	3.7978E-04	-9.5990E-01	-8.9145E-01	105535.7505	47.3773
rho8	7.6369E-01	8.3119E-04	6.9430E-01	8.1311E-01	46400.7472	107.7569
rho9	7.9118E-01	1.3539E-02	5.9939E-01	9.1923E-01	145895.9604	34.2710
rho10	2.3060E-02	3.1655E-02	-2.6114E-01	3.6095E-01	144155.6079	34.6847
rho11	-6.2912E-02	7.3775E-03	-1.9036E-01	1.2205E-01	27496.0159	181.8445
rho12	-2.5315E-01	7.2828E-03	-3.9030E-01	-6.6908E-02	38868.7962	128.6379
rho13	5.4412E-01	5.7701E-03	4.2760E-01	7.1766E-01	86363.9160	57.8945
rho14	3.1846E-02	6.8279E-03	-1.2925E-01	1.6057E-01	39234.2156	127.4398
rho15	-4.9963E-03	3.9516E-03	-1.1434E-01	1.0178E-01	42726.6201	117.0231
rho16	3.6540E-01	3.1031E-03	2.8682E-01	4.8095E-01	126902.3632	39.4004
rho17	-7.3498E-01	5.5361E-03	-8.5863E-01	-6.2345E-01	23100.7809	216.4429
rho18	-5.7640E-01	3.0451E-03	-6.7629E-01	-4.8114E-01	29505.4889	169.4600
rho19	-9.6126E-01	1.9381E-04	-9.8534E-01	-9.3612E-01	42478.2570	117.7073
rho20	-4.5866E-01	1.6254E-03	-5.2164E-01	-3.5626E-01	36729.7248	136.1295
rho21	6.6679E-01	6.4360E-03	5.3659E-01	8.0395E-01	25260.9133	197.9343
rho22	-5.5560E-01	1.3427E-03	-6.1193E-01	-4.7605E-01	25955.2914	192.6389
rho23	2.9981E-01	4.8525E-03	1.7641E-01	4.3718E-01	14442.0845	346.2104
rho24	-8.1558E-01	1.4636E-03	-8.8326E-01	-7.4729E-01	51720.3490	96.6737

*Continued on next page*

Table 1 – *Continued from previous page*

<b>hmmer</b>	<b>mean</b>	<b>variance</b>	<b>HPD</b>	<b>HPD</b>	<b>ACT</b>	<b>ESS</b>
p0	9.4841E-03	8.8157E-06	3.7773E-03	1.4609E-02	19695.7896	253.8614
p1	1.3091E-03	5.0283E-07	6.7313E-04	1.9354E-03	19060.7841	262.3187
p2	5.2091E-01	3.1162E-02	2.0918E-01	7.0672E-01	39399.0310	126.9067
p3	6.8907E-01	1.1123E-03	6.3295E-01	7.5842E-01	122348.5804	40.8668
p4	4.8204E-01	1.1005E-03	4.0973E-01	5.4387E-01	25151.2564	198.7972
p5	6.1286E-01	3.2653E-03	5.2855E-01	7.4532E-01	45865.3068	109.0149
p6	4.5864E-01	1.9018E-03	3.7606E-01	5.4930E-01	33871.6865	147.6159
p7	6.4258E-01	3.2882E-02	3.4405E-01	1.0000E+00	257471.7527	19.4196
p8	4.9533E-01	2.1998E-03	4.2800E-01	5.9699E-01	82995.0090	60.2446
p9	9.6980E-01	1.4932E-03	8.9655E-01	9.9985E-01	38433.8119	130.0938
p10	7.1425E-01	3.0174E-03	6.2227E-01	7.9271E-01	15718.6406	318.0937
p11	7.7223E-01	9.7882E-04	7.0868E-01	8.3627E-01	45482.2677	109.9330
p12	4.1091E-01	2.1401E-03	3.2501E-01	4.9506E-01	29664.4736	168.5518
p13	7.0933E-01	8.8617E-04	6.5631E-01	7.6445E-01	47446.1868	105.3825
p14	5.4156E-01	5.2855E-03	4.2643E-01	6.7479E-01	24435.7993	204.6178
p15	8.4811E-01	6.0109E-04	8.0251E-01	8.9474E-01	20822.5178	240.1247
p16	6.0290E-01	8.1748E-04	5.4996E-01	6.6087E-01	22349.5548	223.7181
p17	5.6851E-02	7.7910E-05	3.9254E-02	7.0971E-02	14496.7123	344.9058
p18	8.3788E-01	2.4751E-03	7.5064E-01	9.5049E-01	31895.1454	156.7637
p19	3.6076E-02	7.1633E-05	1.8826E-02	5.1437E-02	48798.1506	102.4629
p20	7.9248E-01	1.0195E-03	7.4217E-01	8.4501E-01	19238.1132	259.9007
p21	2.4458E-02	3.2593E-04	1.0902E-02	6.8324E-02	37652.1742	132.7945
p22	2.1440E-01	7.4085E-03	7.4024E-02	3.8601E-01	108925.6785	45.9029
p23	4.4622E-01	2.4041E-03	3.5150E-01	5.2919E-01	20916.1565	239.0497
p24	4.5593E-01	1.6771E-03	3.7982E-01	5.3879E-01	129941.7537	38.4788