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

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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 \(^{[} {\text{Beroza and Ide}} \, 2011 {]} ^{\text{)}}. 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 \(^{[} {\text{Wang et al.}} \, 2018 {]} ^{\text{)}} 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 frequentest 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 \(^{[} {\text{Yao et al.}} \, 2010 {]} ^{\text{)}, speech recognition \(^{[} {\text{Yu et al.}} \, 2015 {]} ^{\text{)}, a registered patent in speech matching \(^{[} {\text{Chong et al.}} \, 2014 {]} ^{\text{)} and workload classification \(^{[} {\text{Cuzzocrea et al.}} \, 2016 {]} ^{\text{), as well as HMMer \(^{[} {\text{Horn et al.}} \, 2005 {]} ^{\text{)} 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

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

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 $k = 1, \ldots, K$ we introduce parameters $p_k$, $\mu^{(k)}$ and $\Sigma^{(k)}$, where $p_k$ is the probability of observing a tremor and $\mu^{(k)}$, $\Sigma^{(k)}$ 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 $x$ a $K \times K$ diagonal matrix $P(x)$,
also called the emission matrix, with the $k$th diagonal element corresponding to the probability of observing $x$ given state $k$

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

Here $\phi(.)$ is the density function of bivariate normal distribution. Let $\Gamma = (\Gamma_{ij})$ 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 $\delta = \delta_1, \ldots, \delta_K$ denote the vector of probabilities for the initial state.

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

$$L(\Gamma, \delta, \{p_k, \mu^{(k)}, \Sigma^{(k)}\}_{k=1,\ldots,K}|x_0, \ldots, x_N) = \delta^T \Gamma P(x_0) \cdots \Gamma P(x_N) 1. \quad (2)$$

### 3 GPU COMPUTING FRAMEWORK

GPUs have had a large impact across statistical and computing sciences due to cost-effective parallelism ([Kindratenko 2014](https://www.khronos.org)). 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](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 upper limit 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 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(\( \{ p_k, \mu^{(k)}, \Sigma^{(k)} \}_{k=1,...,K}, \{ x_0, \ldots, x_N \} \))
2: \( v \leftarrow \delta \Gamma \)
3: for \( k \) from 0 to \( N \) do
4: Compute \( P(x_k) \)
5: \( v \leftarrow v \Gamma \)
6: \( v \leftarrow v P(x_k) \)
7: return \( v \)

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

Next we compare it with the parallel implementation.

The overview of our implementation is as follows:

1. We compute all of the emission matrices \( P(x_0), \ldots, P(x_N) \) in parallel

2. We then multiply the emission matrices by the transition matrices, all in parallel storing \( N \) matrices \( \Gamma P(x_0), \ldots, \Gamma P(X_N) \).

3. Instead of computing \( \Gamma P(x_0), \ldots, \Gamma P(X_N) \) as a single sequence of vector-matrix multiplications, we multiply the matrices \( (\Gamma P(x_0)), \ldots, (\Gamma P(X_N)) \) 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 \( P(x_i) \) 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 \( P(x_i) \) 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 \( \{ \Gamma, P(x_0), \ldots, P(x_N) \} \) for the next kernel.

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

During the next step we compute \( \Gamma P(x_i) \) 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 \( P(x_i) \), it is not large enough to store the full transition matrix \( \Gamma \) nor the product matrix \( \Gamma P(x_i) \). The solution is to break down the multiplication of \( \Gamma \) and \( P(x_i) \) by computing only a few rows at once.

We query the register size for each compute element to determine how many rows of \( \Gamma \) 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 \( \Gamma P_r \) for \( r = 0, \ldots, N \) have been computed. As \( P(x_i) \) is diagonal, the product of rows of \( \Gamma \) with \( P(x_i) \) 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 \( \{(\Gamma P_0), \ldots, (\Gamma P_N)\} \) 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

$$\delta^T \Gamma P(x_0) \ldots \Gamma P(x_N) 1$$

which cannot be readily parallelized, by instead multiplying the matrices together in parallel. Our algorithm here roughly follows [Masliiah 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 $N = 10^2, \ldots, 10^5$. Thereafter we fixed the number of datapoints to $N = 100,000$ and
increased the number of HMM states for $K = 5, 10, \ldots, 50$. 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 milliseconds) 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 milliseconds) with the BLAS libraries we fix the number of datapoints to $N = 100,000$ and increase the number of HMM states for $K = 5, 10, \ldots, 50$. 
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 \( \{p_k\}_{k=1,\ldots,K} \), 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 \( \{\mu^{(k)}\}_{k=1,\ldots,K} \) 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 \( \{ \Sigma^{(k)} \}_{k=1, \ldots, K} \) 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](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](https://www.jstage.jst.go.jp/article/natapap1/78/1/78_72020088055_7202008805526448) 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](https://www.jstage.jst.go.jp/article/natapap1/78/1/78_72020088055_7202008805526448).
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 $K = 5, 10, \ldots, 30$. 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) $K = 20$
Figure 5: Posterior distributions of fitted models with number of hidden states $K = 5, 10, \ldots, 30$ 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).

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
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.

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APPENDIX A: FORMULAS FOR PRIOR DISTRIBUTIONS

Symmetric Dirichlet distributions

\[ f(\gamma_1, \ldots, \gamma_K^2, \alpha) = \frac{\Gamma(\alpha K^2)}{\alpha K^2} \prod_{i=1}^{K^2} \gamma_i^{\alpha - 1}, \text{ for } \alpha < 1, \]

we note that probability mass is sparsely distributed among \( \gamma_1, \ldots, \gamma_K \) if \( \alpha < 1 \).

Inverse-wishart distributions

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

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

where \( \Gamma_K \) is a multivariate gamma function

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

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

| hmmer     | mean        | variance    | HPD         | ACT       | ESS        |
|-----------|-------------|-------------|-------------|-----------|------------|
| posterior | -1.0987E+03 | 7.6624E-04  | -1.6110E+03 | -4.0624E+02 | 35830.8997 | 239.5444   |
| Gamma1    | 8.6710E-01  | 2.4186E-04  | 8.3770E-01  | 8.9248E-01  | 29571.9564 | 169.0791   |
| Gamma2    | 1.6289E-02  | 4.7111E-05  | 3.8358E-03  | 2.8083E-02  | 14455.9226 | 345.8790   |
| Gamma3    | 1.8235E-03  | 8.1549E-06  | 5.3391E-06  | 5.9633E-03  | 31080.9139 | 160.8704   |
| Gamma4    | 1.8604E-03  | 9.1692E-06  | 8.0933E-06  | 6.5181E-03  | 23964.1982 | 208.6446   |
| Gamma5    | 1.4205E-03  | 1.2756E-06  | 4.4740E-05  | 3.3164E-03  | 14213.5729 | 351.7764   |
| Gamma6    | 3.4741E-03  | 7.6753E-06  | 2.8037E-05  | 8.2833E-03  | 21277.4832 | 234.9902   |
| Gamma7    | 2.9676E-03  | 3.5263E-06  | 4.7983E-05  | 5.7603E-03  | 15272.0127 | 327.3963   |
| Gamma8    | 1.9523E-03  | 5.1619E-06  | 1.8840E-05  | 4.8152E-03  | 27378.2848 | 182.6265   |
| Gamma9    | 8.8053E-04  | 1.4839E-06  | 6.1831E-07  | 2.6187E-03  | 15509.9601 | 322.3735   |
| Gamma10   | 4.0934E-03  | 1.6603E-05  | 8.1382E-15  | 1.2107E-02  | 57380.8895 | 87.1370    |
| Gamma11   | 9.3274E-03  | 1.4699E-05  | 1.9398E-03  | 1.5410E-02  | 45068.2804 | 110.9428   |
| Gamma12   | 6.1730E-04  | 3.1284E-07  | 4.1541E-07  | 1.7926E-07  | 14440.9950 | 346.2365   |
| Gamma13   | 3.5715E-03  | 5.4052E-05  | 1.2686E-04  | 8.2704E-03  | 24168.9799 | 206.8767   |
| Gamma14   | 9.6052E-04  | 7.1797E-07  | 8.2637E-06  | 2.5498E-03  | 18857.9341 | 265.1404   |
| Gamma15   | 1.3255E-03  | 1.4142E-06  | 4.0340E-06  | 4.0367E-03  | 31384.2830 | 159.3154   |
| Gamma16   | 1.5935E-03  | 1.1240E-05  | 7.3288E-06  | 4.9660E-03  | 20798.4511 | 240.4025   |
| Gamma17   | 3.8764E-02  | 3.7291E-05  | 2.6857E-02  | 4.8477E-02  | 48946.9321 | 102.1514   |
| Gamma18   | 1.0956E-03  | 1.9142E-06  | 7.6476E-06  | 3.7071E-03  | 45031.8581 | 111.0325   |
| Gamma19   | 1.0625E-03  | 4.7366E-06  | 5.9749E-06  | 2.6002E-03  | 17168.5493 | 291.2302   |
| Gamma20   | 2.6584E-03  | 5.6930E-06  | 2.0232E-05  | 6.8404E-03  | 35644.4221 | 140.2744   |
| Gamma21   | 2.9296E-02  | 2.9234E-05  | 1.9465E-02  | 4.0877E-02  | 42258.6322 | 118.3190   |

Continued on next page
| hmmer | mean          | variance       | HPD            | HPD            | ACT          | ESS         |
|-------|---------------|----------------|----------------|----------------|--------------|-------------|
| 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     | 22249.415    | 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     | 43374.2599   | 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     | 12837.9942   | 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     |
| Gamma   | Minimum | Mean   | Standard Deviation | HPD Mean | HPD Lower | HPD Upper | Act | ESS  |
|---------|---------|--------|--------------------|----------|-----------|-----------|-----|------|
| Gammas  |         |        |                    |          |           |           |     |      |
| 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 | 24391.5009 | 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 | 3.0011E-05 | 7.5824E-03 | 31567.4252 | 158.3911 |     |      |
| Gamma66 | 1.2575E-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 |     |      |

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| hmr | mean       | variance   | HPD        | HPD       | ACT      | ESS     |
|-----|------------|------------|------------|-----------|----------|---------|
| 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-05 | 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 | 2.8010E-06 | 8.1084E-05 | 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 | 3.1461E-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 | 2.7929E-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-05 | 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 |
| hmmer     | mean     | variance | HPD       | ACT       | ESS          |
|-----------|----------|----------|-----------|-----------|--------------|
| Gamma103  | 5.6760E-03| 2.0145E-05| 5.4058E-06| 1.4865E-02| 82129.7028   |
| Gamma104  | 2.8431E-03| 6.8754E-06| 1.2424E-04| 8.9155E-03| 34299.2175   |
| Gamma105  | 7.1477E-01| 7.0890E-04| 6.6167E-01| 7.6297E-01| 11826.7772   |
| Gamma106  | 6.5209E-03| 1.7024E-05| 1.5508E-04| 1.4459E-02| 18234.4629   |
| Gamma107  | 2.8461E-02| 2.2138E-04| 7.8455E-03| 5.4417E-02| 17921.7664   |
| Gamma108  | 3.3291E-03| 8.5009E-06| 1.2591E-05| 9.5390E-03| 26847.8163   |
| Gamma109  | 1.0648E-02| 4.2232E-05| 3.1849E-04| 2.3514E-02| 37656.6887   |
| Gamma110  | 1.4558E-02| 9.6667E-05| 1.4834E-03| 3.0609E-02| 19327.2137   |
| Gamma111  | 2.6155E-03| 1.2609E-05| 0.0000E+00| 1.0664E-02| 35246.2265   |
| Gamma112  | 3.1530E-02| 9.3212E-05| 1.5939E-02| 5.2513E-02| 21814.3469   |
| Gamma113  | 3.0332E-02| 9.1017E-06| 2.1723E-05| 8.8238E-03| 21228.0396   |
| Gamma114  | 2.8459E-03| 5.0074E-06| 8.5689E-05| 8.0017E-03| 20882.2793   |
| Gamma115  | 3.2308E-03| 1.2224E-05| 5.1372E-05| 9.8159E-03| 26005.5177   |
| Gamma116  | 1.7967E-03| 3.4193E-06| 5.5578E-06| 5.4687E-03| 14293.7529   |
| Gamma117  | 5.1239E-03| 2.2861E-05| 7.6876E-06| 1.4478E-02| 14718.0883   |
| Gamma118  | 3.9297E-03| 1.7284E-05| 0.0000E+00| 1.0973E-02| 30107.3335   |
| Gamma119  | 2.4660E-03| 6.7519E-06| 3.6767E-05| 8.8143E-03| 39887.9865   |
| Gamma120  | 5.9192E-03| 2.0708E-05| 2.1575E-05| 1.4863E-02| 41440.4025   |
| Gamma121  | 3.3092E-03| 7.1388E-06| 1.2865E-04| 9.1760E-03| 19966.6857   |
| Gamma122  | 1.4188E-02| 1.4186E-04| 1.0583E-04| 3.8582E-02| 29696.9340   |
| Gamma123  | 6.1469E-03| 3.7944E-05| 3.5337E-103| 2.0600E-02| 14266.5070   |
| Gamma124  | 5.3542E-03| 6.3464E-05| 2.1460E-05| 1.3922E-02| 16095.5744   |
| Gamma125  | 3.4203E-03| 2.1335E-05| 0.0000E+00| 1.0130E-02| 45807.5273   |
| Gamma126  | 1.4618E-02| 1.1325E-04| 2.8701E-04| 3.6125E-02| 13691.7749   |
| Gamma127  | 3.2206E-01| 1.0197E-03| 2.6087E-01| 3.7722E-01| 49086.4278   |
| Gamma128  | 7.2857E-03| 3.1361E-05| 1.3948E-04| 1.8385E-02| 42005.7489   |
| Gamma129  | 1.6891E-02| 9.2670E-05| 6.3445E-04| 3.3494E-02| 7378.6105    |

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Table 1 – Continued from previous page

| hmmer | mean     | variance | HPD   | HPD     | ACT    | ESS       |
|-------|----------|----------|-------|---------|--------|-----------|
| 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 | 23918.9752 | 209.0391 |
| Gamma135 | 8.7256E-03 | 2.1526E-05 | 2.2706E-04 | 1.7155E-02 | 19008.6479 | 263.0382 |
| Gamma136 | 2.9880E-03 | 7.3198E-06 | 2.0184E-06 | 7.9991E-03 | 24439.0003 | 204.5910 |
| Gamma137 | 4.1896E-03 | 1.5155E-03 | 9.7842E-03 | 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 | 24569.0253 | 203.5083 |
| Gamma140 | 3.0420E-03 | 9.0646E-06 | 0.0000E+00 | 1.0215E-02 | 23203.7127 | 215.4828 |
| Gamma141 | 5.9292E-03 | 9.3499E-05 | 0.0000E+00 | 1.8168E-02 | 26323.0800 | 190.6063 |
| Gamma142 | 3.5377E-03 | 9.6379E-06 | 0.0000E+00 | 1.2152E-02 | 23609.7127 | 214.8282 |
| 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 | 5.0702E-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 | 38488.0279 | 147.5012 |
| Gamma156 | 2.5899E-03 | 7.0253E-06 | 7.4161E-06 | 7.8707E-03 | 18689.6816 | 267.5273 |

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| Index |        |        |        |        |        |        |
|-------|--------|--------|--------|--------|--------|--------|
| Gamma157 | 7.429E-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 | 2.2519E-05 | 2.0420E-03 | 1.9575E-02 | 15479.8442 | 323.0007 |
| Gamma161 | 2.4250E-03 | 6.0102E-06 | 2.3023E-05 | 6.7436E-03 | 24814.9610 | 201.4914 |
| Gamma162 | 1.9433E-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-03 | 7.1387E-03 | 36917.1373 | 135.4385 |
| Gamma176 | 2.6324E-02 | 7.2710E-04 | 8.3099E-04 | 5.7787E-02 | 34809.0990 | 143.6406 |
| Gamma177 | 5.5141E-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 |

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Table 1 – Continued from previous page

| hmmer   | mean       | variance | HPD         | HPD         | ACT        | ESS        |
|---------|------------|----------|-------------|-------------|------------|------------|
| 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 | 1.9159E-05 | 2.9730E-02 | 24510.3336 | 203.9596   |
| 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| 6.2299E-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 | 26558.5310 | 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   

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| Gamma | mean    | variance | HPD    | HPD    | ACT     | ESS     |
|-------|---------|----------|--------|--------|---------|---------|
| 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 | 2.6479E-05 | 5.2427E-03 | 57251.1230 | 87.3345 |
| Gamma215  | 1.9740E-03 | 3.5207E-06 | 1.3578E-03 | 2.4040E-02 | 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 | 7.7660E-06 | 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 |

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| mmmer | mean       | variance | HPD        | HPD        | ACT          | ESS       |
|-------|------------|----------|------------|------------|--------------|-----------|
| 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 | 4.3064E-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 | 33833.8243   | 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-01 | 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 | 28034.2345   | 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  |

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| hmmer | mean    | variance      | HPD            | HPD            | ACT     | ESS     |
|-------|---------|---------------|----------------|----------------|---------|---------|
| 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 | 5.3292E-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     | 21527.6928 | 232.2590 |
| 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     | 25377.1937 | 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 |

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| hmmer   | mean         | variance       | HPD           | HPD          | ACT          | ESS        |
|---------|--------------|----------------|---------------|--------------|--------------|------------|
| 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     | 6.0000E-03    | 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-02   | 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  | 270.1492   |
| 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-02   | 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   |

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|       |        |        |        |        |        |        |
|-------|--------|--------|--------|--------|--------|--------|
| name  | mean   | variance | HPD    | HPD    | ACT    | ESS    |
| 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-06 | 5.4262E-06 | 3.8869E-03 | 23087.1659 | 216.5705  |
| 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 | 1.0005E-02 | 4.9995E-05 | 5.6207E-05 | 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  |

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| hmmer  | mean          | variance          | HPD            | HPD            | ACT              | ESS   |
|--------|---------------|-------------------|----------------|----------------|-------------------|-------|
| 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     | 3327.8158        | 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     | 1.2563E-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 |
### Table 1 – *Continued from previous page*

| hmmer | mean     | variance     | HPD         | HPD         | ACT         | ESS        |
|-------|----------|--------------|-------------|-------------|-------------|------------|
| 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 | 2.601E-05    | 2.3726E-05  | 1.4362E-02  | 28454.7058  | 175.7179   |
| Gamma382 | 2.3889E-03 | 1.789E-05    | 5.8433E-06  | 7.2489E-03  | 20698.5296  | 241.5631   |
| Gamma383 | 1.9750E-03 | 4.497E-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  | 22320.8018  | 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   |

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Table 1 – Continued from previous page

| hmm  | mean    | variance | HPD     | HPD     | ACT      | ESS     |
|------|---------|----------|---------|---------|----------|---------|
| 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 | 25231.3303 | 198.1663 |
| Gamma410 | 7.625E-03  | 3.1184E-05 | 8.8820E-04 | 2.0287E-02 | 23276.3846 | 214.1800 |
| 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 | 2.8065E-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 | 311.2462 |
| 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 | 2.3444E-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 |

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| hmer | mean         | variance | HPD        | HPD        | ACT        | ESS       |
|------|--------------|----------|------------|------------|------------|-----------|
| 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 | 7.8777E-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  |

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| hmmer    | mean       | variance | HPD        | HPD        | ACT       | ESS       |
|----------|------------|----------|------------|------------|-----------|-----------|
| 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-06 | 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 | 5.3737E-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  |
| hmmr   | mean     | variance   | HPD     | HPD     | ACT   | ESS     |
|--------|----------|------------|---------|---------|-------|---------|
| 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 | 1.2467E-05 | 1.1263E-03 | 3.2678E-03 | 21821.2805 | 229.1341 |
| Gamma485 | 6.6660E-03 | 1.2262E-06 | 0.0000E+00 | 3.8547E-03 | 40447.7451 | 123.6163 |
| Gamma486 | 9.9720E-04 | 1.2628E-06 | 6.7868E-05 | 7.3754E-03 | 23350.4316 | 214.1288 |
| Gamma487 | 1.2443E-03 | 2.4282E-06 | 6.0437E-05 | 3.9047E-03 | 11862.0810 | 421.5112 |
| Gamma488 | 1.0490E-02 | 2.9569E-05 | 8.7339E-04 | 1.9780E-02 | 23956.0789 | 209.2481 |
| Gamma489 | 4.8344E-02 | 2.9564E-02 | 6.9302E-02 | 4.7140E-03 | 30163.3613 | 165.7640 |
| Gamma490 | 2.3050E-03 | 3.382E-06  | 9.9575E-05 | 5.4752E-03 | 17442.8134 | 286.6510 |
| Gamma491 | 1.8940E-03 | 1.0811E-05 | 0.0000E+00 | 4.7140E-03 | 30163.3613 | 165.7640 |
| Gamma492 | 3.2402E-02 | 7.448E-06  | 1.5778E-06 | 5.3464E-03 | 27772.7873 | 180.0323 |
| Gamma493 | 2.8291E-03 | 7.4174E-06 | 2.0672E-238 | 7.7762E-03 | 6433.4908 | 75.2632 |
| Gamma494 | 1.9807E-02 | 1.1193E-04 | 4.7007E-03 | 3.9870E-02 | 55844.1523 | 89.5349 |
| Gamma495 | 8.2957E-01 | 3.3422E-04 | 7.9682E-01 | 8.6667E-01 | 20813.6358 | 240.2271 |
| Gamma496 | 1.7734E-03 | 2.7424E-06 | 1.5778E-06 | 5.3464E-03 | 27772.7873 | 180.0323 |
| Gamma497 | 2.8291E-03 | 7.4174E-06 | 2.0672E-238 | 7.7762E-03 | 6433.4908 | 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 | 2.2714E-03 | 1.5033E-02 | 16359.8070 | 305.6271 |
| Gamma504 | 2.0005E-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 |

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Table 1 – Continued from previous page

| hmmer | mean     | variance   | HPD       | HPD       | ACT       | ESS       |
|-------|----------|------------|-----------|-----------|-----------|-----------|
| 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 | 3.1112E-05 | 7.6734E-03 | 2.3874E-02 | 17758.2077 | 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 | 16004.4170 | 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 | 7.0214E-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  |

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| hmmr  | mean       | variance   | HPD        | HPD        | ACT       | ESS        |
|-------|------------|------------|------------|------------|-----------|------------|
| 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-06 | 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-05 | 5.6362E-03 | 39974.1572 | 125.0808   |

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| hmmer  | mean       | variance     | HPD        | HPD        | ACT        | ESS        |
|--------|------------|--------------|------------|------------|------------|------------|
| 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   

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| hmmer | mean     | variance | HPD         | HPD         | ACT         | ESS          |
|-------|----------|----------|-------------|-------------|-------------|--------------|
| Gamma589 | 2.6017E-03 | 7.3585E-06 | 0.0000E+00 | 7.6996E-03 | 29942.2713 | 166.9880     |
| Gamma590 | 3.9186E-03 | 8.5562E-07 | 8.2811E-03 | 38640.8552 | 129.3967   |              |
| Gamma591 | 3.3120E-02 | 1.4226E-02 | 5.1841E-02 | 14839.2761 | 336.9437   |              |
| Gamma592 | 1.1356E-02 | 3.9847E-04 | 2.5152E-02 | 36637.9856 | 136.4704   |              |
| Gamma593 | 2.5612E-03 | 1.8899E-05 | 8.2262E-03 | 43793.8830 | 114.1712   |              |
| Gamma594 | 4.0829E-03 | 1.9282E-139 | 9.1253E-03 | 26159.3926 | 191.1359   |              |
| Gamma595 | 1.6455E-02 | 9.8861E-04 | 4.0410E-02 | 25487.0538 | 196.1780   |              |
| Gamma596 | 4.6105E-03 | 1.6447E-05 | 2.3031E-02 | 12820.6463 | 389.9959   |              |
| Gamma597 | 1.2425E-02 | 2.9849E-04 | 3.5192E-02 | 29425.0675 | 169.9231   |              |
| Gamma598 | 5.9868E-03 | 9.7568E-03 | 1.4641E-02 | 19891.5709 | 251.3628   |              |
| Gamma599 | 7.1850E-01 | 6.4775E-01 | 7.9540E-01 | 43147.8720 | 115.8806   |              |
| Gamma600 | 3.8137E-03 | 3.7176E-06 | 1.2743E-02 | 36507.9025 | 135.8404   |              |
| Gamma601 | 4.5700E-03 | 1.2255E-05 | 1.4629E-02 | 61878.8181 | 80.8031    |              |
| Gamma602 | 5.9703E-02 | 8.3209E-03 | 9.8580E-02 | 97691.4403 | 51.1816    |              |
| Gamma603 | 3.7547E-03 | 1.3979E-06 | 1.0969E-02 | 18740.0983 | 266.8076   |              |
| Gamma604 | 3.3626E-03 | 7.2764E-06 | 9.5617E-03 | 23786.6937 | 210.2016   |              |
| Gamma605 | 2.8119E-03 | 1.2029E-05 | 1.0376E-02 | 39130.1276 | 127.7788   |              |
| Gamma606 | 8.8095E-03 | 7.7500E-04 | 2.0562E-02 | 16802.9664 | 297.5665   |              |
| Gamma607 | 5.9677E-03 | 1.5958E-05 | 1.4337E-02 | 26793.4490 | 186.6128   |              |
| Gamma608 | 6.4906E-03 | 8.2154E-05 | 1.8456E-02 | 25738.6885 | 194.2601   |              |
| Gamma609 | 3.4075E-03 | 1.9948E-06 | 9.8028E-03 | 19701.1370 | 253.7925   |              |
| Gamma610 | 3.7020E-02 | 1.8155E-02 | 6.0903E-02 | 30342.1325 | 164.7874   |              |
| Gamma611 | 2.7671E-03 | 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 | 1.3503E-06 | 1.2906E-02 | 51838.7161 | 96.4530    |              |
| Gamma614 | 3.7065E-03 | 1.0699E-05 | 1.0606E-02 | 24862.7780 | 201.1038   |              |
| Gamma615 | 4.0503E-03 | 4.5949E-05 | 1.0229E-02 | 42991.9561 | 116.3008   |              |

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Table 1 – Continued from previous page

| hmmer  | mean   | variance | HPD      | HPD      | ACT    | ESS    |
|--------|--------|----------|----------|----------|--------|--------|
| 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 | 2.3456E-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 | 31205.9022 | 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 |

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| hmmer | mean     | variance | HPD      | HPD      | ACT      | ESS     |
|-------|----------|----------|----------|----------|----------|---------|
| 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  | 166.0963 |
| 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 |

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| hmmr   | mean         | variance       | HPD          | HPD          | ACT          | ESS         |
|--------|--------------|----------------|--------------|--------------|--------------|-------------|
| mean44 | 3.4089E+01   | 1.0985E-05     | 3.4087E+01   | 3.4092E+01   | 10783.1209   | 463.6876    |
| mean45 | 1.3389E+02   | 2.1354E-06     | 1.3390E+02   | 1.3390E+02   | 16814.1550   | 297.3685    |
| mean46 | 3.4034E+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     

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|     | hmr | mean   | variance | HPD      | HPD      | ACT      | ESS     |
|-----|-----|--------|----------|----------|----------|----------|---------|
| 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 | 31943.7767 | 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 | 1.3658E-02 | 1.5649E-02 | 11658.0919 | 428.8867 |
| sig30 | 2.3851E-02 | 4.9658E-06 | 2.1458E-02 | 2.6093E-02 | 20196.0798 | 247.5728 |
| sig31 | 6.3047E-02 | 1.3365E-05 | 8.3359E-02 | 9.6302E-02 | 40222.3843 | 124.3089 |
| sig32 | 8.9384E-02 | 1.3365E-05 | 8.3359E-02 | 9.6302E-02 | 40222.3843 | 124.3089 |
| sig33 | 1.6552E-02 | 7.3247E-05 | 1.2323E-02 | 2.3667E-02 | 20320.9017 | 246.0521 |
| sig34 | 1.9078E-02 | 9.0345E-06 | 1.5246E-02 | 2.6690E-02 | 18222.0431 | 274.3929 |
| sig35 | 2.9753E-02 | 3.2640E-06 | 2.6535E-02 | 3.3308E-02 | 12711.3278 | 393.3499 |
| sig36 | 3.9156E-02 | 3.3400E-05 | 3.3400E-02 | 3.3400E-02 | 50200.1253 | 99.6013 |
| sig37 | 4.2836E-02 | 8.1981E-05 | 3.3489E-02 | 5.9352E-02 | 87473.4563 | 57.1602 |
| sig38 | 5.6483E-02 | 7.0326E-05 | 4.4777E-02 | 7.5767E-02 | 44498.5158 | 112.3632 |
| sig39 | 3.2181E-02 | 1.0031E-05 | 2.9040E-02 | 3.4087E-02 | 18767.5229 | 266.4177 |
| sig40 | 5.8665E-02 | 7.4578E-06 | 5.3512E-02 | 6.2982E-02 | 8008.1789 | 624.3617 |
| sig41 | 4.3597E-02 | 2.8268E-05 | 3.5905E-02 | 5.3344E-02 | 35259.9516 | 141.8039 |
| sig42 | 4.2660E-02 | 1.8198E-05 | 3.4373E-02 | 5.0306E-02 | 31057.7121 | 160.9906 |
| sig43 | 2.0933E-02 | 2.7451E-05 | 1.7862E-02 | 2.2511E-02 | 15465.7156 | 323.2957 |
| sig44 | 2.1647E-02 | 1.2810E-06 | 1.9749E-02 | 2.4108E-02 | 18882.7570 | 264.7918 |
| sig45 | 3.4843E-02 | 1.1288E-05 | 3.0400E-02 | 4.1280E-02 | 12880.6637 | 388.1788 |
| sig46 | 2.9820E-02 | 4.6206E-06 | 2.5811E-02 | 3.3832E-02 | 14872.4660 | 336.1917 |

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Table 1 – Continued from previous page

| hmp         | mean          | variance      | HPD        | HPD        | ACT        | ESS         |
|-------------|---------------|---------------|------------|------------|------------|-------------|
| 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        | 7.3900E-01    | 3.7978E-04    | -9.5990E-01| -8.9145E-01| 105355.7505| 57.3973     |
| rho8        | 3.6369E-01    | 8.3119E-04    | 6.9430E-01 | 8.1311E-01 | 46400.7472 | 187.7569    |
| rho9        | 7.9118E-01    | 1.3539E-02    | 5.9939E-01 | 9.1923E-01 | 145895.9604| 34.2710     |
| rho10       | 3.9600E-02    | 3.1655E-02    | -2.6114E-01| 3.6095E-01 | 141555.6079| 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 | 57.9845     |
| 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       | 6.5560E-01    | 1.3427E-03    | -8.1193E-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
| hmmr  | mean       | variance   | HPD        | HPD        | ACT              | ESS     |
|-------|------------|------------|------------|------------|------------------|---------|
| 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    | 5.2093E-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    | 9.6908E-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 | 31895.1545       | 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  |