```
/*
 * Code is of the file DepdenetPartitionsAR1LikeAR1Theta_sPPM2.c
 * that one since the R function drpm_fit calls the function which
 * is defined there:
     initial_partition <- 0
     C.out <- .C("drpm_ar1_sppm", // defined in that file
                 as.integer(draws), as.integer(burn),as.integer(thin),
                 as.integer(nsubject),as.i)
 * so it should be the "main" file
 */


/*************************************************************
 * Copyright (c) 2018 Garritt Leland Page
 *
 * This file contains C code for an MCMC algorithm constructed
 * to fit a hierarchical model that incorporates the idea of
 * temporally dependent partitions.
 *
 * I will include model details at a later date
 *
 *************************************************************/
#include "matrix.h"
#include "Rutil.h"
#include <R_ext/Lapack.h>
#include <R.h>
#include <Rmath.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
/*****************************************************************************************
* The following are the inputs of the function that are read from R
*
* draws = total number of MCMC draws
* burn = number of MCMC draws discarded as burn-in
* thin = indicates how much MCMC chain should be thinned
*
* nsubject = integer for the number of subjects in data set
* ntime = integer for the number of time points
* y = double nsubject x ntime matrix containing response for each subject at time t
* s1 = nsubject x 1 vector containing spatial coordinate one
* s2 = nsubject x 1 vector containing spatial coordinate two
*
* M = double indicating value of M associated with cohesion (scale parameter of DP).
* alpha = double - prior probability of being pegged, starting value only if
update_alpha is TRUE
* priorvals = vector containing values for prior distributions as follows
*
* time_specific_alpha = integer - logical indicating wether to make alpha time-
specific or one global alpha.
* update_alpha = integer - logical indicating wether to update alpha or not.
* update_eta1 = integer - logical indicating whether to update eta1 or set it to
zero for all subjects.
* update_phi1 = integer - logical indicating whether to update phi1 or set it to
zero.
* sPPM = integer - logical indicating whether to use spatial information or not
*
* SpatialCohesion = integer indication which cohesion to use
* 1 -Auxiliary
* 2- Double dipper
*
* cParms - vector holding values employed in the cohesion
*
* OUTPUT
* Si -
* mu -
* sig2 -
* eta1
* theta -
* tau2 -
* phi0 -
* phi1
* gamma -
* alpha.out -
* like
* lpml -
* waic -
*****************************************************************************************/
void drpm_ar1_sppm(int *draws, int *burn, int *thin, int *nsubject, int *ntime,
        double *y, double *s1, double *s2, double *M,
        double *alpha, double *modelPriors, double *alphaPriors,
        int *time_specific_alpha,
        int *update_alpha, int *update_eta1, int *update_phi1,
        int *sPPM, int *SpatialCohesion, double *cParms, double *mh,
        int *space_1, int *simpleModel, double *theta_tau2,
        int *Si, double *mu, double *sig2, double *eta1, double *theta, double
*tau2,
        double *phi0, double *phi1, double *lam2, int *gamma, double *alpha_out,
        double *fitted, double *llike, double *lpml, double *waic){

  // i - MCMC iterate
  // ii - MCMC iterate that is saved
  // j - subject iterate
  // jj - second subject iterate
  // t - time iterate
  // k - cluster iterate
  // kk - second cluster iterate
  // p - prediction iterate

  int i, ii, j, jj, t, k, kk;
  ii = 0;

  int nout = (*draws - *burn)/(*thin);
  Rprintf("nsubject = %d\n", *nsubject);
  Rprintf("ntime = %d\n", *ntime);
  Rprintf("nout = %d\n", nout);
  Rprintf("update_alpha = %d\n", *update_alpha);
  Rprintf("update_eta1 = %d\n", *update_eta1);
  Rprintf("update_phi1 = %d\n", *update_phi1);



  //
=============================================================================
  //
```

```
  // Memory vectors to hold MCMC iterates for non cluster specific parameters
  //
  //
================================================================================
  // This variable is used to create a "buffer" zone of memory so that updating
  // things on time boundary do not need special attention in the algorithm since
  // I have to look at time period before and after when updating partitions
  int ntime1 = *ntime + 1;
  // I am adding one more year as an empty vector
  // so that the C program does not crash.
  int gamma_iter[(*nsubject)*(ntime1)];
  int Si_iter[(*nsubject)*(ntime1)];
  int nclus_iter[ntime1];
  double *eta1_iter = R_VectorInit(*nsubject, runif(0,1));
  double *theta_iter = R_VectorInit(ntime1, rnorm(0,3));
  double *tau2_iter = R_VectorInit(ntime1, runif(0, modelPriors[3]*modelPriors[3]));
  double phi0_iter = rnorm(0,3);
  double phi1_iter = runif(0,1);
  double lam2_iter = runif(0, modelPriors[4]*modelPriors[4]);
  double *alpha_iter = R_VectorInit(ntime1, *alpha);

  //
================================================================================
  //
  // Memory vectors to hold MCMC iterates for cluster specific parameters
  //
  //
================================================================================
  double *muh = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *sig2h = R_VectorInit((*nsubject)*(ntime1), 1.0);
    if(*simpleModel==1){
      for(t = 0; t < ntime1; t++){
        theta_iter[t] = theta_tau2[0];
        tau2_iter[t] = theta_tau2[1];
      }
    }
  int nh[(*nsubject)*(ntime1)];
  //
================================================================================
  //
  // Initialize a few parameter vectors
  //
  //
================================================================================
  // Initialize Si according to covariates
  // I am adding one time period here to have
  // scratch memory (never filled in) so that
  // I can avoid dealing with boundaries in algorithm
  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < ntime1; t++){ // Note I am not initializing the "added time
memory"
      Si_iter[j*(ntime1) + t] = 1;
      gamma_iter[j*(ntime1) + t] = 0;
      nh[j*(ntime1) + t] = 0;
      if(t==1) Si_iter[j*ntime1 + t] = 1;
      if(t==*ntime) Si_iter[j*(ntime1) + t] = 0;
    }
  }
```

```
  // Initial enumeration of number of subjects per cluster;
  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < *ntime; t++){
      nh[(Si_iter[j*(ntime1)+t]-1)*(ntime1) + t] = nh[(Si_iter[j*(ntime1)+t]-1)*
(ntime1) + t] + 1;
    }
  }
  // Initialize the number of clusters
  for(t = 0; t < *ntime; t++){
  nclus_iter[t] = 0;
    for(j = 0; j < *nsubject; j++){
      if(nh[j*(ntime1) + t] > 0) nclus_iter[t] = nclus_iter[t] + 1;
    }
  }
  nclus_iter[*ntime] = 0;

  //
================================================================================
  //
  // scratch vectors of memory needed to update parameters
  //
  //
================================================================================
  // stuff needed to update gamma vectors
  int nclus_red=0, nh_red[*nsubject], n_red=0, gt, n_red_1=0, cit_1;
  int nh_redtmp[*nsubject], nh_tmp[*nsubject];
  int nh_redtmp_no_zero[*nsubject],
nh_tmp_no_zero[*nsubject],nh_red_no_zero[*nsubject];
  int nh_red_1[*nsubject];
  // int nclus_red_1;
  int nh_redtmp_1[*nsubject], nh_tmp_1[*nsubject];
  int nh_redtmp_no_zero_1[*nsubject],
nh_red_no_zero_1[*nsubject],nh_tmp_no_zero_1[*nsubject];
  double *s1_red = R_VectorInit(*nsubject, 0.0);
  double *s2_red = R_VectorInit(*nsubject, 0.0);
  for(j=0; j<*nsubject; j++){
    nh_tmp[j] = 0; nh_red[j] = 0; nh_redtmp[j] = 0;
    nh_redtmp_no_zero[j] = 0;  nh_tmp_no_zero[j] = 0;
    nh_red_no_zero[j] = 0; nh_red_no_zero_1[j] = 0;

    nh_tmp_1[j] = 0; nh_red_1[j] = 0; nh_redtmp_1[j] = 0;
    nh_redtmp_no_zero_1[j] = 0; nh_red_no_zero_1[j] = 0; nh_tmp_no_zero_1[j] = 0;
  }
  // stuff that I need to update Si (the parition);
  int
comp1t[(*nsubject)],comptm1[(*nsubject)],comp2t[(*nsubject)],comptp1[(*nsubject)];
  int rho_tmp[*nsubject], Si_tmp[*nsubject], Si_tmp2[*nsubject];
  int Si_red[*nsubject], Si_red_1[*nsubject];
  int oldLab[*nsubject], reorder[*nsubject];
  int iaux, Rindx1, Rindx2, n_tmp, nclus_tmp, rho_comp, indx;
  double auxm, auxs, mudraw, sigdraw, maxph, denph, cprobh, uu, lCo, lCn, lCn_1,
lpp;
  double *ph = R_VectorInit(*nsubject, 0.0);
  double *phtmp = R_VectorInit(*nsubject, 0.0);
  double *probh = R_VectorInit(*nsubject, 0.0);
  double *lgweight = R_VectorInit(*nsubject, 0.0);
  double *s1o = R_Vector(*nsubject);
  double *s2o = R_Vector(*nsubject);
```

```
  double *s1n = R_Vector(*nsubject);
  double *s2n = R_Vector(*nsubject);
  for(j=0; j<(*nsubject); j++){
    comp1t[j] = 0; comptm1[j] = 0, comp2t[j]=0, comptp1[j]=0;
  }
  // stuff I need to update eta1
  double e1o, e1n, logito, logitn, one_phisq;
  // stuff I need to update muh and sig2h
  double mstar, s2star, sumy, sume2;
  double nsig, osig, llo, lln, llr;
  double *mu_tmp = R_VectorInit(*nsubject, 0.0);
  double *sig2_tmp = R_VectorInit(*nsubject, 1.0);

  // stuff that I need for theta and lam2
  double summu, nt, ot, lam2tmp, phi1sq, sumt, op1, np1, ol, nl;
//  double ssq;

  // stuff that I need to update alpha
  int sumg;
  double astar, bstar,alpha_tmp;

  // Stuff to compute lpml, likelihood, and WAIC
  int like0, nout_0=0;
  double lpml_iter, elppdWAIC;
  double *CPO = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *like_iter = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *fitted_iter = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *mnlike = R_VectorInit((*nsubject)*(ntime1), 0.0);
  double *mnllike = R_VectorInit((*nsubject)*(ntime1), 0.0);
  // stuff to predict
  // int gpred[*nsubject], nh_pred[*nsubject];
  //
//============================================================================
  //
  // Prior parameter values
  //
  //
//============================================================================
  // prior values for sig2
  double Asig=modelPriors[2];
  double Atau=modelPriors[3];
    double Alam=modelPriors[4];
  // priors for phi0
  double m0 = modelPriors[0], s20 = modelPriors[1];
  // priors for alpha
  double a = alphaPriors[0], b = alphaPriors[1];
  //priors for eta1
  double b_eta1 = modelPriors[5];

  // DP weight parameter
  double Mdp = *M;
    Rprintf("Prior values: Asig = %.2f, Atau = %.2f, Alam = %.2f, \n m0 = %.2f, s20
= %.2f\n\n", Asig, Atau, Alam, m0, s20);
  // Cohesion auxiliary model paramaters for Cohesions 3 and 4
  double k0=cParms[1], v0=cParms[2];
  double *mu0 = R_VectorInit(2,cParms[0]);
  double *L0 = R_VectorInit(2*2,0.0);
  L0[0] = cParms[3]; L0[3] = cParms[3];

    if(*sPPM==1){
    RprintVecAsMat("mu0", mu0, 1, 2);
    Rprintf("k0 = %f\n", k0);
    Rprintf("v0 = %f\n", v0);
    RprintVecAsMat("L0", L0, 2, 2);
    }
  // M-H step tunning parameter
  double csigSIG=mh[0], csigTAU=mh[1], csigLAM=mh[2], csigETA1=mh[3],
csigPHI1=mh[4];
  GetRNGstate();
  //
//============================================================================
  //
  // start of the mcmc algorithm;
  //
  //
//============================================================================

  for(i = 0; i < *draws; i++){
    if((i+1) % 10000 == 0){
      time_t now;
      time(&now);
      Rprintf("mcmc iter = %d ========================================== \n", i+1);
      Rprintf("%s", ctime(&now));
    }
    // Start updating gamma and partition for each time period
    for(t = 0; t < *ntime; t++){
      ////////////////////////////////////////////////////////////////////////////
      //
      // begin by updating gamma (pegged) parameters
      //
      ////////////////////////////////////////////////////////////////////////////
      for(j = 0; j < *nsubject; j++){
        // at time period one, all gammas are zero (none are ``pegged'')
        if(t == 0){
          gamma_iter[j*(ntime1) + t] = 0;
        } else {
          ////////////////////////////////////////////////////////////////////
          // find the reduced partition information
          // i.e., vector of cluster labels;
          ////////////////////////////////////////////////////////////////////
          Rindx1 = 0;
          for(jj = 0; jj < *nsubject; jj++){
            if(gamma_iter[jj*ntime1 + (t)] == 1){
              if(jj != j){
                Si_tmp[Rindx1] = Si_iter[jj*ntime1 + (t)];
                Si_tmp2[Rindx1] = Si_iter[jj*ntime1 + (t)];
                comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
                // Also get the reduced spatial coordinates if
                // space is included
                if(*sPPM==1){
                  if((*space_1==1 & t == 0) | (*space_1==0)){
                    s1_red[Rindx1] = s1[jj];
                    s2_red[Rindx1] = s2[jj];
                  }
                }
                Rindx1 = Rindx1 + 1;
```

```
            }
          }
        }
        Si_tmp2[Rindx1] = Si_iter[j*ntime1 + (t)];
        comptm1[Rindx1] = Si_iter[j*ntime1 + (t-1)];
        n_red = Rindx1;
        n_red_1 = Rindx1 + 1;
        relabel(Si_tmp, *nsubject, Si_red, reorder, oldLab);
        relabel(Si_tmp2, *nsubject, Si_red_1, reorder, oldLab);
        // I need to keep the relabeled cluster label for the pegged
        // individual so that I know what lgweight to keep in the
        // full conditional.
        cit_1 = Si_red_1[Rindx1];


        for(jj = 0; jj < n_red_1; jj++){
          nh_red[jj]=0; nh_red_1[jj]=0;
        }
        nclus_red = 0;
        for(jj = 0; jj < n_red; jj++){
          nh_red[Si_red[jj]-1] = nh_red[Si_red[jj]-1] + 1;
          nh_red_1[Si_red_1[jj]-1] = nh_red_1[Si_red_1[jj]-1] + 1;
          if(Si_red[jj] > nclus_red) nclus_red = Si_red[jj];
        }

        nh_red_1[Si_red_1[n_red]-1]= nh_red_1[Si_red_1[n_red]-1] + 1;
        // this may need to be updated depending on if the value of gamma changes
        //nclus_red_1 = nclus_red;
        //if(Si_red_1[n_red] > nclus_red) nclus_red_1 = Si_red_1[n_red];
        lCo=0.0, lCn=0.0;
        for(k = 0; k < nclus_red; k++){
          if(*sPPM==1){
              // Note that if space is only included for first time point
              // then it does not inform gamma.
             if((*space_1==1 & t == 0) | (*space_1==0)){
              indx = 0;
              for(jj = 0; jj < n_red; jj++){
                if(Si_red[jj] == k+1){
                  s1o[indx] = s1_red[jj];
                  s2o[indx] = s2_red[jj];

                  s1n[indx] = s1_red[jj];
                  s2n[indx] = s2_red[jj];
                  indx = indx+1;
                }
              }
              s1n[indx] = s1[j];
              s2n[indx] = s2[j];

              lCo = Cohesion3_4(s1o, s2o, mu0, k0, v0, L0, nh_red[k],
*SpatialCohesion, 1);
              lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_red[k]+1,*SpatialCohesion, 1);
            }
          }

          lgweight[k] = log(nh_red[k]) + lCn - lCo;
          Si_red_1[Rindx1] = k+1;
            rho_comp = compatibility(Si_red_1, comptm1, Rindx1+1);
//            if(rho_comp==0) lgweight[k] = log(0);
        }


        // What if pegged subject creates a singleton in the reduced partition?
        lCn_1=0.0;
        if(*sPPM==1){
          if((*space_1==1 & t == 0) | (*space_1==0)){

            s1o[0] = s1[j];
            s2o[0] = s2[j];
            lCn_1 = Cohesion3_4(s1o, s2o, mu0, k0, v0, L0, 1,*SpatialCohesion, 1);
          }
        }
        lgweight[nclus_red] = log(Mdp) +  lCn_1;

        Si_red_1[Rindx1] = nclus_red+1;
        rho_comp = compatibility(Si_red_1, comptm1, Rindx1+1);
//          if(rho_comp == 0) lgweight[nclus_red] = log(0);


        denph = 0.0;
        for(k = 0; k < nclus_red + 1; k++){
          phtmp[k] = lgweight[k] ;
        }

        R_rsort(phtmp,  nclus_red + 1) ;


        maxph = phtmp[nclus_red];
        denph = 0.0;
        for(k = 0; k < nclus_red + 1; k++){

          lgweight[k] = exp(lgweight[k] - maxph);
          denph = denph + lgweight[k];
        }

        for(k = 0; k < nclus_red + 1; k++){
          lgweight[k] = lgweight[k]/denph;
        }


        probh[1] = alpha_iter[t]/(alpha_iter[t] + (1-
alpha_iter[t])*lgweight[cit_1-1]);
        // If gamma is 1 at current MCMC iterate, then there are no
        // concerns about partitions being incompatible as gamma changes
        // from 1 to 0.
        //
        // However, if gamma's current value is 0, then care must be taken when
        // trying to change from gamma=0 to gamma=1 as the partitions may
        // no longer be compatible
        if(gamma_iter[j*(ntime1) + t] == 0){

          // To determine compatibility, I need to make sure that
          // comparison of the reduced partitios is being made with
          // correct cluster labeling.  I try to do this by identifying
          // the sets of units and sequentially assigning "cluster labels"
```

```
          // starting with set that contains the first unit. I wonder if
          // there is a way to do this in C with out using loops?  Who
          // can I ask about this?
          // Get rho_t | gamma_t = 1 and rho_{t-1} | gamma_t = 1
          // when gamma_{it} = 1;
          Rindx1 = 0;
          for(jj = 0; jj < *nsubject; jj++){
            if(gamma_iter[jj*ntime1 + (t)] == 1){
              comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
              comp1t[Rindx1] = Si_iter[jj*ntime1 + (t)];
              Rindx1 = Rindx1 + 1;
            }
            // I need to include this because determine what happens when
            // gamma goes from 0 to 1;
            if(jj == j){
              comptm1[Rindx1] = Si_iter[jj*ntime1 + (t-1)];
              comp1t[Rindx1] = Si_iter[jj*ntime1 + (t)];
              Rindx1 = Rindx1 + 1;
            }
          }
          rho_comp = compatibility(comptm1, comp1t, Rindx1);
          // If rho_comp = 0 then not compatible and probability of
          // pegging subject needs to be set to 0;
          if(rho_comp==0){
            probh[1] = 0;
          }

        }

        gt = rbinom(1,probh[1]);

        gamma_iter[j*(ntime1) + t] = gt;
      }
    }
    ////////////////////////////////////////////////////////////////////////////
    //
    // update partition
    //
    ////////////////////////////////////////////////////////////////////////////
    // The cluster probabilities depend on four partition probabilities
    //
    // rho_t
    // rho_t.R
    // rho_t+1
    // rho_t+1.R
    //
    // I have switched a number of times on which of these needs to be computed
    // and which one can be absorbed in the normalizing constant.  Right now I am
    // leaning towards Pr(rho_t+1) and Pr(rho_t+1.R) can be absorbed.  But I need
    // to use rho_t.R and rho_t+1.R to check compatibility as I update rho_t.
    //

////////////////////////////////////////////////////////////////////////////
    for(jj = 0; jj < *nsubject; jj++){

      rho_tmp[jj] = Si_iter[jj*(ntime1) + t];
    }
    // It seems to me that I can use some of the structure used to carry
    // out Algorithm 8 from previous code to keep track of empty clusters
    // etc.
    for(j = 0; j < *nsubject; j++){
      // Only need to update partition relative to units that are not pegged
      if(gamma_iter[j*(ntime1) + t] == 0){
        if(nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] > 1){

          // Observation belongs to a non-singleton ...
          nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = nh[(Si_iter[j*(ntime1) +
t]-1)*(ntime1) + t] - 1;

        }else{

          // Observation is a member of a singleton cluster ...

          iaux = Si_iter[j*(ntime1) + t];
          if(iaux < nclus_iter[t]){

            // Need to relabel clusters. I will do this by swapping cluster labels
            // Si_iter[j] and nclus_iter along with cluster specific parameters;


            // All members of last cluster will be assigned subject j's label
            for(jj = 0; jj < *nsubject; jj++){

              if(Si_iter[jj*(ntime1) + t] == nclus_iter[t]){

                Si_iter[jj*(ntime1) + t] = iaux;

              }

            }


            Si_iter[j*(ntime1) + t] = nclus_iter[t];
            // The following steps swaps order of cluster specific parameters
            // so that the newly labeled subjects from previous step retain
            // their correct cluster specific parameters
            auxs = sig2h[(iaux-1)*ntime1 + t];
            sig2h[(iaux-1)*ntime1 + t] = sig2h[(nclus_iter[t]-1)*(ntime1)+t];
            sig2h[(nclus_iter[t]-1)*(ntime1)+t] = auxs;
            auxm = muh[(iaux-1)*ntime1 + t];
            muh[(iaux-1)*ntime1 + t] = muh[(nclus_iter[t]-1)*(ntime1)+t];
            muh[(nclus_iter[t]-1)*(ntime1)+t] = auxm;

            // the number of members in cluster is also swapped with the last
            nh[(iaux-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*(ntime1)+t];
            nh[(nclus_iter[t]-1)*(ntime1)+t] = 1;

          }


          // Now remove the ith obs and last cluster;
          nh[(nclus_iter[t]-1)*(ntime1)+t] = nh[(nclus_iter[t]-1)*(ntime1)+t] - 1;
          nclus_iter[t] = nclus_iter[t] - 1;


        }
```

```
        for(jj = 0; jj < *nsubject; jj++){

          rho_tmp[jj] = Si_iter[jj*(ntime1) + t];
        }

        for(k = 0; k < nclus_iter[t]; k++){
          rho_tmp[j] = k+1;

          // First need to check compatability
          Rindx2=0;
          for(jj = 0; jj < *nsubject; jj++){
            if(gamma_iter[jj*ntime1 + (t+1)] == 1){
              comp2t[Rindx2] = rho_tmp[jj];
              comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
              Rindx2 = Rindx2 + 1;
            }
          }
          // check for compatibility
          rho_comp = compatibility(comp2t, comptp1, Rindx2);
          if(rho_comp != 1){
            ph[k] = log(0); // Not compatible
          } else {
            // Need to compute Pr(rhot), Pr(rhot.R), Pr(rhot+1), Pr(rhot+1.R)

            for(jj = 0; jj < *nsubject; jj++){
              nh_tmp[jj] = 0;
            }
            n_tmp = 0;
            for(jj = 0; jj < *nsubject; jj++){
              nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
              n_tmp=n_tmp+1;
            }

            nclus_tmp=0;
            for(jj = 0; jj < *nsubject; jj++){
              if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;

            }


            lpp = 0.0;
            for(kk = 0; kk < nclus_tmp; kk++){
              // Beginning of spatial part
              lCn = 0.0;
              if(*sPPM==1){
                if((*space_1==1 & t == 0) | (*space_1==0)){
                  indx = 0;
                  for(jj = 0; jj < *nsubject; jj++){

                    if(rho_tmp[jj] == kk+1){

                      s1n[indx] = s1[jj];
                      s2n[indx] = s2[jj];
                      indx = indx+1;
                    }

                  }
//
```

```
                    lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_tmp[kk],*SpatialCohesion, 1);
                  }
                }
                // End of spatial part

//                lpp = lpp + nclus_tmp*log(Mdp) + lgamma((double) nh_tmp[kk]) +
lCn;
//                lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double) nh_tmp[kk]) +
lCn;
                lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn);

              }
              if(t==0){
//                                muh[k*(ntime1) + t],
//                                sqrt(sig2h[k*(ntime1) + t]), 1));
                ph[k] = dnorm(y[j*(*ntime) + t],
                              muh[k*(ntime1) + t],
                              sqrt(sig2h[k*(ntime1) + t]), 1) +
                      lpp;
              }
              if(t > 0){
//                                muh[k*(ntime1) + t] +
//                                  eta1_iter[j]*y[j*(*ntime) + t-1],
//                                sqrt(sig2h[k*(ntime1) + t]*
//                                  (1-eta1_iter[j]*eta1_iter[j])), 1));
                ph[k] = dnorm(y[j*(*ntime) + t],
                              muh[k*(ntime1) + t] +
                                eta1_iter[j]*y[j*(*ntime) + t-1],
                              sqrt(sig2h[k*(ntime1) + t]*
                                (1-eta1_iter[j]*eta1_iter[j])), 1)+
                      lpp;
              }
              // use this to test if MCMC draws from prior are correct
//              ph[k] = lpp;

            }
          }


          // Determine if E.U. gets allocated to a new cluster
          // Need to check compatibility first

          rho_tmp[j] = nclus_iter[t]+1;

          // First need to check compatability
          Rindx1 = 0, Rindx2=0;
          for(jj = 0; jj < *nsubject; jj++){
            if(gamma_iter[jj*ntime1 + (t+1)] == 1){
              comp2t[Rindx2] = rho_tmp[jj];
              comptp1[Rindx2] = Si_iter[jj*ntime1 + (t+1)];
              Rindx2 = Rindx2 + 1;
            }
          }
          // check for compatibility
          rho_comp = compatibility(comp2t, comptp1, Rindx2);
          if(rho_comp != 1){
            ph[nclus_iter[t]] = log(0); // going to own cluster is not compatible;
```

```
        } else {

          mudraw = rnorm(theta_iter[t], sqrt(tau2_iter[t]));
          sigdraw = runif(0, Asig);

          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[jj] = 0;
          }
          n_tmp = 0;
          for(jj = 0; jj < *nsubject; jj++){
            nh_tmp[rho_tmp[jj]-1] = nh_tmp[rho_tmp[jj]-1]+1;
            n_tmp=n_tmp+1;
          }

          nclus_tmp=0;
          for(jj = 0; jj < *nsubject; jj++){
            if(nh_tmp[jj] > 0) nclus_tmp = nclus_tmp + 1;

          }

          lpp = 0.0;
          for(kk = 0; kk < nclus_tmp; kk++){
            // Beginning of spatial part
            lCn = 0.0;
            if(*sPPM==1){
              if((*space_1==1 & t == 0) | (*space_1==0)){
                indx = 0;
                for(jj = 0; jj < *nsubject; jj++){

                  if(rho_tmp[jj] == kk+1){

                    s1n[indx] = s1[jj];
                    s2n[indx] = s2[jj];
                    indx = indx+1;
                  }

                }
                lCn = Cohesion3_4(s1n, s2n, mu0, k0, v0, L0,
nh_tmp[kk],*SpatialCohesion, 1);
              }
            }
            // End of spatial part

            lpp = lpp + (log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn);
//            lpp = lpp + nh_tmp[kk]*log(Mdp) + lgamma((double) nh_tmp[kk]) + lCn;
          }

          if(t==0){
            ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t], mudraw, sigdraw, 1) +
                        lpp;
          }
          if(t > 0){

            ph[nclus_iter[t]] = dnorm(y[j*(*ntime) + t],
                                      mudraw + eta1_iter[j]*y[j*(*ntime) + t-1],
                                      sigdraw*sqrt(1-eta1_iter[j]*eta1_iter[j]),
1) +
                                lpp;
            }
//            ph[nclus_iter[t]] =  lpp;

          }
          // Now compute the probabilities
          for(k = 0; k < nclus_iter[t]+1; k++) phtmp[k] = ph[k];


          R_rsort(phtmp,  nclus_iter[t]+1) ;



          maxph = phtmp[nclus_iter[t]];


          denph = 0.0;
          for(k = 0; k < nclus_iter[t]+1; k++){

            ph[k] = exp(ph[k] - maxph);
            denph = denph + ph[k];

          }
          for(k = 0; k < nclus_iter[t]+1; k++){
            probh[k] = ph[k]/denph;
          }

          uu = runif(0.0,1.0);
          cprobh= 0.0;;
          for(k = 0; k < nclus_iter[t]+1; k++){
            cprobh = cprobh + probh[k];
            if (uu < cprobh){

              iaux = k+1;
              break;
            }
          }

          if(iaux <= nclus_iter[t]){
            Si_iter[j*(ntime1) + t] = iaux;
            nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] = nh[(Si_iter[j*(ntime1) +
t]-1)*(ntime1)+t] + 1;
            rho_tmp[j] = iaux;
          }else{

            nclus_iter[t] = nclus_iter[t] + 1;
            Si_iter[j*(ntime1) + t] = nclus_iter[t];
            nh[(Si_iter[j*(ntime1) + t]-1)*(ntime1)+t] = 1;
            rho_tmp[j] = nclus_iter[t];

            muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = mudraw;
            sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] = sigdraw*sigdraw;
                    if(*simpleModel==1) sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) +
t] = 1.0;
          }
        }
        for(jj = 0; jj < *nsubject; jj++){
          Si_tmp[jj] = Si_iter[jj*(ntime1) + t];
          Si_tmp2[jj] = 0;
```

```
          reorder[jj] = 0;
        }
        // I believe that I have to make sure that groups are order so that
        // EU one is always in the group one, and then the smallest index not
        // with group 1 anchors group 2 etc.

        relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);

        for(jj=0; jj<*nsubject; jj++){
          Si_iter[jj*(ntime1) + t] = Si_tmp2[jj];
        }
        for(k = 0; k < nclus_iter[t]; k++){
          mu_tmp[k] = muh[k*(ntime1)+t];
          sig2_tmp[k] = sig2h[k*(ntime1)+t];
        }
        for(k = 0; k < nclus_iter[t]; k++){
          nh[k*(ntime1)+t] = reorder[k];
          muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
          sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
        }
      }
      for(j = 0; j < *nsubject; j++){
        Si_tmp[j] = Si_iter[j*(ntime1) + t];
        Si_tmp2[j] = 0;
        reorder[j] = 0;
      }
      // I believe that I have to make sure that groups are order so that
      // EU one is always in the group one, and then the smallest index not
      // with group 1 anchors group 2 etc.

      relabel(Si_tmp, *nsubject, Si_tmp2, reorder, oldLab);

      for(j=0; j<*nsubject; j++){
        Si_iter[j*(ntime1) + t] = Si_tmp2[j];
      }
      for(k = 0; k < nclus_iter[t]; k++){
        mu_tmp[k] = muh[k*(ntime1)+t];
        sig2_tmp[k] = sig2h[k*(ntime1)+t];
      }
      for(k = 0; k < nclus_iter[t]; k++){
        nh[k*(ntime1)+t] = reorder[k];
        muh[k*(ntime1)+t] = mu_tmp[(oldLab[k]-1)];
        sig2h[k*(ntime1)+t] = sig2_tmp[(oldLab[k]-1)];
      }

//      for(k = 0; k < nclus_iter[t]; k++) sig2h[k*(ntime1)+t] = 1.0;
      for(k = 0; k < nclus_iter[t]; k++){
        ////////////////////////////////////////
        //                    //
        // udate muh                //
        //                    //
        ////////////////////////////////////////

        if(t==0){
          sumy = 0.0;
          for(j = 0; j < *nsubject; j++){
            if(Si_iter[j*(ntime1) + t] == k+1){
              sumy = sumy + y[j*(*ntime)+t];
            }

          }
          s2star = 1/((double) nh[k*(ntime1)+t]/sig2h[k*(ntime1) + t] +
1/tau2_iter[t]);
          mstar = s2star*( (1/sig2h[k*(ntime1) + t])*sumy +
(1/tau2_iter[t])*theta_iter[t]);
        }
        if(t > 0){
          sumy = 0.0;
          sume2 = 0.0;
          for(j = 0; j < *nsubject; j++){
            if(Si_iter[j*(ntime1) + t] == k+1){
              sume2 = sume2 + 1.0/(1-eta1_iter[j]*eta1_iter[j]);
              sumy = sumy + (y[j*(*ntime)+t] - eta1_iter[j]*y[j*(*ntime)+t-1])/
                            (1-eta1_iter[j]*eta1_iter[j]);
            }

          }
          s2star = 1/( (1.0/sig2h[k*(ntime1) + t])*sume2  + 1/tau2_iter[t]);
          mstar = s2star*( (1.0/sig2h[k*(ntime1) + t])*sumy +
(1/tau2_iter[t])*theta_iter[t]);

        }

        muh[k*(ntime1) + t] = rnorm(mstar, sqrt(s2star));
//        muh[k] = 0.0;
        ////////////////////////////////////////
        //                    //
        // udate sig2h                //
        //                    //
        ////////////////////////////////////////
        osig = sqrt(sig2h[k*(ntime1) + t]);
        nsig = rnorm(osig,csigSIG);
        if(nsig > 0.0 & nsig < Asig){

          lln = 0.0;
          llo = 0.0;
          if(t == 0){
            for(j = 0; j < *nsubject; j++){
              if(Si_iter[j*(ntime1) + t] == k+1){
                llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t], osig,1);
                lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t], nsig,1);
              }
            }
          }
          if(t > 0){
            for(j = 0; j < *nsubject; j++){
              if(Si_iter[j*(ntime1) + t] == k+1){
                llo = llo + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t] +
                                  eta1_iter[j]*y[j*(*ntime) + t-1],
                                   osig*sqrt(1-eta1_iter[j]*eta1_iter[j]),1);
                lln = lln + dnorm(y[j*(*ntime)+t], muh[k*(ntime1) + t] +
                                  eta1_iter[j]*y[j*(*ntime) + t-1],
                                   nsig*sqrt(1-eta1_iter[j]*eta1_iter[j]),1);
              }
            }
          }
```

```
        llo = llo + dunif(osig, 0.0, Asig, 1);
        lln = lln + dunif(nsig, 0.0, Asig, 1);



        llr = lln - llo;
        uu = runif(0,1);

        if(log(uu) < llr){
          sig2h[k*(ntime1) + t] = nsig*nsig;
        }
              if(*simpleModel==1) sig2h[k*(ntime1) + t] = 1.0;
      }
    }

    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // update theta (mean of mh)                          //
    //                                        //
    ////////////////////////////////////////////////////////////////////////////
    summu = 0.0;
    for(k = 0; k < nclus_iter[t]; k++){
      summu = summu + muh[k*(ntime1) + t];
    }

    phi1sq = phi1_iter*phi1_iter;
    lam2tmp = lam2_iter*(1.0 - phi1sq);

    if(t==0){
      s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + 1.0/lam2_iter +
phi1sq/lam2tmp);
      mstar = s2star*( (1.0/tau2_iter[t])*summu +
                       (1.0/lam2_iter)*phi0_iter +
                       (1.0/lam2tmp)*phi1_iter*(theta_iter[t+1]-phi0_iter*(1-
phi1_iter)));

    } else if(t==(*ntime-1)){

      s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + 1.0/lam2tmp);
      mstar = s2star*((1.0/tau2_iter[t])*summu +
                      (1.0/lam2tmp)*(phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]));

    } else {
      s2star = 1.0/((double) nclus_iter[t]/tau2_iter[t] + (1.0 + phi1sq)/lam2tmp);
      mstar = s2star*( (1.0/tau2_iter[t])*summu +
                       (1.0/lam2tmp)*(phi1_iter*(theta_iter[t-1] +
theta_iter[t+1]) +
                                      phi0_iter*(1.0 - phi1_iter)*(1.0 -
phi1_iter)));
    }

    theta_iter[t] = rnorm(mstar, sqrt(s2star));
        if(*simpleModel==1) theta_iter[t] = 0.0;
    ////////////////////////////////////////////////////////////////////////////
    //                                        //
    // update tau2 (variance of mh)                       //
```

```
    //                                        //
    ////////////////////////////////////////////////////////////////////////////
    ot = sqrt(tau2_iter[t]);
    nt = rnorm(ot,csigTAU);
    if(nt > 0){

      lln = 0.0;
      llo = 0.0;
      for(k = 0; k < nclus_iter[t]; k++){

        llo = llo + dnorm(muh[k*(ntime1) + t], theta_iter[t], ot,1);
        lln = lln + dnorm(muh[k*(ntime1) + t], theta_iter[t], nt,1);
      }

      llo = llo + dunif(ot, 0.0, Atau, 1);
      lln = lln + dunif(nt, 0.0, Atau, 1);



      llr = lln - llo;
      uu = runif(0,1);

      if(log(uu) < llr){
        tau2_iter[t] = nt*nt;
//          tau2_iter[t] = 5*5;
      }
            if(*simpleModel==1) tau2_iter[t] = theta_tau2[1];
    }


  }
  ////////////////////////////////////////////////////////////////////////////
  //                                        //
  // update eta1 (temporal correlation parameter at likelihood)       //
  //                                        //
  ////////////////////////////////////////////////////////////////////////////
  if(*update_eta1==1){
    for(j = 0; j < *nsubject; j++){
      e1o = eta1_iter[j];
      e1n = rnorm(e1o, csigETA1);


      if(e1n < 1 & e1n > -1){

        llo=lln=0.0;
        for(t=1; t<*ntime; t++){

          llo = llo + dnorm(y[j*(*ntime)+t],
                            muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] +
                                        e1o*y[j*(*ntime)+t-1],
                                    sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1)
+ t]*
                                                (1-e1o*e1o)), 1);
          lln = lln + dnorm(y[j*(*ntime)+t],
                            muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t] +
                                        e1n*y[j*(*ntime)+t-1],
                                    sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1)
+ t]*
```

```
                                    (1-e1n*e1n)), 1);

      }
      logito = log(0.5*(e1o + 1)) - log(1 - 0.5*(e1o+1));
      logitn = log(0.5*(e1n + 1)) - log(1 - 0.5*(e1n+1));



      llo = llo + -log(2*b_eta1) - (1/b_eta1)*fabs(logito - 0.0);
      lln = lln + -log(2*b_eta1) - (1/b_eta1)*fabs(logitn - 0.0);

      llr = lln - llo;
      uu = runif(0,1);
      if(llr > log(uu)) eta1_iter[j] = e1n;
    }
  }
}
////////////////////////////////////////////////////////////////////////////
//                                        //
// update alpha                                 //
//                                        //
////////////////////////////////////////////////////////////////////////////
if(*update_alpha == 1){
  if(*time_specific_alpha != 1){
    sumg = 0;
    for(j = 0; j < *nsubject; j++){
      for(t = 1; t < *ntime; t++){

        sumg = sumg + gamma_iter[j*ntime1 + t];

      }
    }
    astar = (double) sumg + a;
    bstar = (double) ((*nsubject)*(*ntime-1) - sumg) + b;


    alpha_tmp = rbeta(astar, bstar);
    for(t=0;t<*ntime;t++){alpha_iter[t] = alpha_tmp;}

  } else {

    for(t = 0; t < *ntime; t++){
      sumg = 0;
      for(j = 0; j < *nsubject; j++){
        sumg = sumg + gamma_iter[j*ntime1 + t];
      }



      astar = (double) sumg + a;
      bstar = (double) ((*nsubject) - sumg) + b;

      alpha_iter[t] = rbeta(astar, bstar);

    }

  }
  alpha_iter[0] = 0.0;
```

```
  }

  ////////////////////////////////////////////////////////////////////////////
  //                                        //
  // update phi0                                  //
  //                                        //
  ////////////////////////////////////////////////////////////////////////////
  phi1sq = phi1_iter*phi1_iter;
  one_phisq = (1-phi1_iter)*(1-phi1_iter);
  lam2tmp = lam2_iter*(1.0 - phi1sq);
  sumt = 0.0;
  for(t=1; t<*ntime; t++){
    sumt = sumt + (theta_iter[t] - phi1_iter*theta_iter[t-1]);
  }

  s2star = 1.0/((*ntime-1)*(one_phisq/lam2tmp) + (1/lam2_iter) + (1/s20));
  mstar = s2star*(((1.0-phi1_iter)/lam2tmp)*sumt + (1/lam2_iter)*theta_iter[0] +
(1/s20)*m0);



  phi0_iter = rnorm(mstar, sqrt(s2star));
  ////////////////////////////////////////////////////////////////////////////
  //                                        //
  // update phi1                                  //
  //                                        //
  ////////////////////////////////////////////////////////////////////////////

  if(*update_phi1==1){
    op1 = phi1_iter;
    np1 = rnorm(op1, csigPHI1);


    if(np1 > -1 & np1 < 1){
      llo = 0.0, lln = 0.0;
      for(t=1; t < *ntime; t++){
        llo = llo + dnorm(theta_iter[t], phi0_iter*(1-op1) + op1*theta_iter[t-1],
                                         sqrt(lam2_iter*(1.0 - op1*op1)), 1);
        lln = lln + dnorm(theta_iter[t], phi0_iter*(1-np1) + np1*theta_iter[t-1],
                                         sqrt(lam2_iter*(1.0 - np1*np1)), 1);

      }
      llo = llo + dunif(op1, -1,1, 1);
      lln = lln + dunif(np1, -1,1, 1);

      llr = lln - llo;
      if(llr > log(runif(0,1))) phi1_iter = np1;
    }
  }
  ////////////////////////////////////////////////////////////////////////////
  //                                        //
  // update lam2                                  //
  //                                        //
  ////////////////////////////////////////////////////////////////////////////
  // Update lambda with a MH step
  phi1sq = phi1_iter*phi1_iter;
  ol = sqrt(lam2_iter);
  nl = rnorm(ol, csigLAM);
```

```
    if(nl > 0.0){
      lln = 0.0;
      llo = 0.0;
        for(t=1; t<*ntime; t++){
        llo = llo + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1],
ol*sqrt(1-phi1sq),1);
        lln = lln + dnorm(theta_iter[t],
                          phi0_iter*(1-phi1_iter) + phi1_iter*theta_iter[t-1],
nl*sqrt(1-phi1sq),1);
      }
      llo = llo + dnorm(theta_iter[0], phi0_iter, ol, 1) + dunif(ol, 0.0, Alam, 1);
      lln = lln + dnorm(theta_iter[0], phi0_iter, nl, 1) + dunif(nl, 0.0, Alam, 1);
      llr = lln - llo;
      uu = runif(0,1);
      if(log(uu) < llr){
        lam2_iter = nl*nl;
      }
    }
/*
    phi1sq = phi1_iter*phi1_iter;
    ssq = 0.0;
    for(t=1; t<*ntime; t++){
      ssq = ssq + (theta_iter[t] - (phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]))*
                  (theta_iter[t] - (phi0_iter*(1-phi1_iter) +
phi1_iter*theta_iter[t-1]));
    }
    ssq = 1.0/(1.0 - phi1sq)*ssq + (theta_iter[0]-phi0_iter)*(theta_iter[0]-
phi0_iter);
    astar = 0.5*(*ntime) + 1;
    bstar = 0.5*ssq + 1/1;

    lam2_iter = 1.0/rgamma(astar, 1/bstar);
*/
    ////////////////////////////////////////////////////////////////////////
    //                                    //
    // predict partition for new time period                  //
    //                                    //
    ////////////////////////////////////////////////////////////////////////
/*
    for(p = 0; p < *npred; p++){

      for(j=0; j<*nsubject; j++){
        nh_pred[j] = 0;
        predSi_iter[j*(*npred) + p] = 0;
      }
      if(*update_alpha == 0){
        n_red = 0;
        for(j=0;j<*nsubject;j++){

          gpred[j] = rbinom(1,*alpha);

          if(gpred[j] == 1){
            nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] = nh_pred[Si_iter[j*
(ntime1)+(*ntime)-1] - 1] + 1;
            n_red = n_red + 1;
            predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+(*ntime)-1];
          }
        }
      }
      if(*update_alpha == 1){
        if(*time_specific_alpha == 1){


          n_red = 0;
          for(j=0;j<*nsubject;j++){

            gpred[j] = rbinom(1,alpha_iter[1]);
            if(gpred[j] == 1){
              nh_pred[Si_iter[j*(ntime1)+(*ntime)-1] - 1] = nh_pred[Si_iter[j*
(ntime1)+(*ntime)-1] - 1] + 1;
              n_red = n_red + 1;
              predSi_iter[j*(*npred) + p] = Si_iter[j*(ntime1)+(*ntime)-1];
            }
          }

        }else {

        }
      }
      remove_zero(nh_pred, *nsubject, nh_tmp_no_zero);
      nclus_tmp = 0;
      for(j=0; j<*nsubject;j++){
        if(nh_tmp_no_zero[j] > 0){
          nclus_tmp = nclus_tmp + 1;
        }else{
          break;
        }
      }

      for(j=0;j<*nsubject;j++){
        if(gpred[j] == 0){
          for(k = 0; k < nclus_tmp; k++){
            probh[k] = nh_pred[k]/(n_red + Mdp);
          }
          probh[nclus_tmp] = Mdp/(n_red + Mdp);

          uu = runif(0.0,1.0);
          cprobh= 0.0;;
          for(k = 0; k < nclus_tmp+1; k++){
            cprobh = cprobh + probh[k];

            if (uu < cprobh){

              iaux = k+1;
              break;
            }
          }

          if(iaux <= nclus_tmp){
            predSi_iter[j*(*npred) + p] = iaux;
            nh_pred[iaux-1] = nh_pred[iaux-1] + 1;
          }else{

            nclus_tmp = nclus_tmp + 1;
```

```
            predSi_iter[j*(*npred) + p] = nclus_tmp;
            nh_pred[(predSi_iter[j*(*npred) + p]-1)*(*npred)+p] = 1;

          }
          n_red = n_red + 1;
        }
      }
    }
*/

////////////////////////////////////////////////////////////////////////////////////////
    //
    // evaluating likelihood that will be used to calculate LPML and WAIC?
    // (see page 81 Christensen Hansen and Johnson)
    //

////////////////////////////////////////////////////////////////////////////////////////
    if(i > (*burn-1) & i % (*thin) == 0){

      like0=0;
      for(j = 0; j < *nsubject; j++){
        for(t = 0; t < *ntime; t++){
          mudraw = muh[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t];
          sigdraw = sqrt(sig2h[(Si_iter[j*(ntime1) + t]-1)*(ntime1) + t]);
          if(t == 0){
            like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t], mudraw, sigdraw, 1);
            fitted_iter[j*(*ntime)+t] = mudraw;

          }
          if(t > 0){
            like_iter[j*(*ntime)+t] = dnorm(y[j*(*ntime)+t],
                          mudraw + eta1_iter[j]*y[j*(*ntime)+t-1],
                          sigdraw*sqrt(1-eta1_iter[j]*eta1_iter[j]), 1);

            fitted_iter[j*(*ntime)+t] = mudraw + eta1_iter[j]*y[j*(*ntime)+t-1];
          }


          // These are needed for WAIC
          mnlike[j*(*ntime)+t] = mnlike[j*(*ntime)+t] + exp(like_iter[j*
(*ntime)+t])/(double) nout;
          mnllike[j*(*ntime)+t] = mnllike[j*(*ntime)+t] + (like_iter[j*
(*ntime)+t])/(double) nout;

          if(exp(like_iter[j*(*ntime)+t]) < 1e-320) like0=1;


        }
      }
      if(like0==1) nout_0 = nout_0 + 1;
      if(like0==0){
        for(j = 0; j < *nsubject; j++){
          for(t = 0; t < *ntime; t++){
            CPO[j*(*ntime)+t] = CPO[j*(*ntime)+t] + (1/exp(like_iter[j*
(*ntime)+t]));
          }
        }
      }
    }

////////////////////////////////////////////////////////////////////////////////////////
    //                                                //
    // Save MCMC iterates                                    //
    //                                                //

////////////////////////////////////////////////////////////////////////////////////////
    if((i > (*burn-1)) & ((i+1) % *thin == 0)){
      for(t = 0; t < *ntime; t++){
        alpha_out[ii*(*ntime) + t] = alpha_iter[t];
        theta[ii*(*ntime) + t] = theta_iter[t];
        tau2[ii*(*ntime) + t] = tau2_iter[t];
        for(j = 0; j < *nsubject; j++){
          sig2[(ii*(*nsubject) + j)*(*ntime) + t] = sig2h[(Si_iter[j*(ntime1) +
t]-1)*(ntime1) + t];
          mu[(ii*(*nsubject) + j)*(*ntime) + t] = muh[(Si_iter[j*(ntime1) + t]-1)*
(ntime1) + t];
          Si[(ii*(*nsubject) + j)*(*ntime) + t] = Si_iter[j*ntime1 + t];
          gamma[(ii*(*nsubject) + j)*(*ntime) + t] = gamma_iter[j*ntime1 + t];
          llike[(ii*(*nsubject) + j)*(*ntime) + t] = like_iter[j*(*ntime)+t];
          fitted[(ii*(*nsubject) + j)*(*ntime) + t] = fitted_iter[j*(*ntime)+t];
        }
      }
      for(j=0; j<*nsubject; j++){

        eta1[ii*(*nsubject) + j] = eta1_iter[j];
      }
      phi1[ii] = phi1_iter;
      phi0[ii] = phi0_iter;
      lam2[ii] = lam2_iter;
      ii = ii+1;
    }
/**/
  }

  lpml_iter=0.0;
  for(t = 0; t < *ntime; t++){
    for(j = 0; j < *nsubject; j++){

      lpml_iter = lpml_iter - log((1/(double) nout-nout_0)*CPO[j*(*ntime)+t]);

    }
  }
  lpml[0] = lpml_iter;
  elppdWAIC = 0.0;

  for(j = 0; j < *nsubject; j++){
    for(t = 0; t < *ntime; t++){
      elppdWAIC = elppdWAIC + (2*mnllike[j*(*ntime)+t] - log(mnlike[j*(*ntime)+t]));
    }
  }
  waic[0] = -2*elppdWAIC;
  PutRNGstate();

}
```