Methods

Table 1: Simulation mis-specification design matrix. Outer dimensions describe the unique correct models (6) while inner dimensions (18) describe the unique mis-specifications run for each simulation.

Covariance Matrix	**Autocorrelation**	**Matern Correlation**	**Phylogenetic Correlation**
Type	Mis-specification		
LMM	Data Model	Data Model	Data Model
	Missing RE	Missing RE	Missing RE
	Mis-specified RE	Mis-specified RE	Mis-specified RE
GLMM	Data Model	Data Model	Data Model
	Missing RE	Missing RE	Missing RE
	Mis-specified RE	Mis-specified RE	Mis-specified RE

Table 2: Linear Model Simulation: data generating models, parameter values, and mis-specifications.

	Data Generating Model	Parameters	Data Fitting Model
Correct	$X_i \sim N(0,1)$ $\mu_{i,j} = X_i\beta$ $y_{i,j} \sim N(\mu_{i,j}, \sigma_y)$	$\beta = (4,-5)$ $\sigma_y = 1$	$X_i \sim N(0,1)$ $\mu_{i,j} = X_i\beta$ $y_{i,j} \sim N(\mu_{i,j}, \sigma_y)$
Mis-specified	$X_i \sim N(0,1)$ $\mu_{i,j} = X_i\beta$ $y^{'}_{i,j} \sim N(\mu_{i,j}, exp(\sigma_y))$		$X_i \sim N(0,1)$ $\mu_{i,j} = X_i\beta$ $y^{'}_{i,j} \sim N(\mu_{i,j}, \sigma_y)$

Table 3: Temporal Model Simulation: data generating models, parameter values, and mis-specifications.

	Linear Mixed Model			**Generalized Linear Mixed Model**		
	Data Generating Model	Parameters	Data Fitting Model	Data Generating Model	Parameters	Data Fitting Model
Correct	$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$	$a = 2$ $u[1] = 0$ $\sigma_u = 1$ $\sigma_y = 1$	$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$	$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim Gamma(\frac{1}{CV}^2, e^{u_i} CV^2)$	$a = .02$ $u[1] = 0$ $\sigma_u = 0.1$ $CV = 0.3$	$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim Gamma(\frac{1}{CV}^2, e^{u_i} CV^2)$
Mis-specified	Missing Random Effects $\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$		$y_i \sim N(a(1:n), \sigma_y)$	Missing Random Effects $\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim Gamma(\frac{1}{CV}^2, e^{u_i} CV^2)$		$y_i \sim Gamma(\frac{1}{CV}^2, e^{a} CV^2)$
	Mis-specified Data Model $\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $\sigma_y^2 = c(rep(35, n/4), rep(0.5, n/4),$ $rep(35, n/4), rep(0.5, n/4)$ $y_i^{'} \sim N(u_i, \sigma_y)$		$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i^{'} \sim N(u_i, \sigma_y)$	Misp-specified Data Model $\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim Gamma(\frac{1}{CV}^2, e^{u_i} CV^2)$		$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$
	Mis-specifed Random Effects $\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$		$\mu_i = u_{i-1}$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i \sim N(u_i, \sigma_y)$	Mis-specified Random Effects $u_i^{'} = u_{i-1} + Gamma(0.5, 20)$ $y_i^{'} \sim Gamma(\frac{1}{CV}^2, e^{u_i^{'}} CV^2)$		$\mu_i = u_{i-1} + a$ $u_i \sim N(\mu_i, \sigma_u)$ $y_i^{'} \sim Gamma(\frac{1}{CV}^2, e^{u_i} CV^2)$

Table 4: Spatial Model Simulation: data generating models, parameter values, and mis-specifications.

	Linear Mixed Model			**Generalized Linear Mixed Model**		
	Data Generating Model	Parameters	Data Fitting Model	Data Generating Model	Parameters	Data Fitting Model
Correct	$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $y \sim N(\eta, \sigma_y)$	$\beta_0 = 2$ $\sigma_y^2 = 1$ $\phi = 50$ $\kappa = \sqrt{8}/\phi$ $\sigma_\omega^2 = 2$	$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $y \sim N(\eta, \sigma_y)$	$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = exp(\beta_0 + \omega_i)$ $y \sim Pois(\eta, \sigma_y)$	$\beta = 2$ $\phi = 30$ $\kappa = \sqrt{8}/\phi$ $\sigma_\omega^2 = 0.25$	$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = exp(\beta_0 + \omega_i)$ $y \sim Pois(\eta, \sigma_y)$
Mis-specified	Missing Random Effects $\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $y \sim N(\eta, \sigma_y)$		$\eta_i = \beta_0$ $y \sim N(\eta, \sigma_y)$	Missing Random Effects $\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = exp(\beta_0 + \omega_i)$ $y \sim Pois(\eta)$		$\eta_i = exp(\beta_0)$ $y \sim Pois(\eta)$
	Mis-specified Data Model $\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $y \sim N(\eta, \sigma_y)$		$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $\sigma_y = exp(N(0, 1))$ $y \sim N(\eta, \sigma_y)$	Mis-specified Data Model $\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = exp(\beta_0 + \omega_i)$ $y^{'} \sim B(1, 0.7) * Pois(\eta)$		$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = exp(\beta_0 + \omega_i)$ $y \sim Pois(\eta)$
	Mis-specified Random Effects Model $\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + exp(\omega_i)$ $y^{'} \sim N(\eta, \sigma_y)$		$\omega \sim GMRF(Q[\kappa, \sigma_\omega^2])$ $\eta_i = \beta_0 + \omega_i$ $y^{'} \sim N(\eta, \sigma_y)$	Mis-specified Random Effects Model		

Table 5: Phylogenetic Model Simulation: data generating models, parameter values, and mis-specifications.

	Linear Mixed Model			**Generalized Linear Mixed Model**		
	Data Generating Model	Parameters	Data Fitting Model	Data Generating Model	Parameters	Data Fitting Model
Correct	$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + u$ $y \sim Normal(\eta, \sigma_y)$	$a = 0$ $r = 0$ $\sigma_u^2 = 2$ $\beta = (0, 1)$ $\sigma_y = 1$	$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + u$ $y \sim Normal(\eta, \sigma_y)$	$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y \sim NegBinom(\mu = \eta, size = \theta)$	$a = 0$ $r = 0$ $\sigma_u^2 = 1$ $\beta_0 = 3$ $\theta = 0.5$	$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y \sim NegBinom(\mu = \eta, size = \theta)$
Mis-specified	Missing Random Effects $tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + u$ $y \sim Normal(\eta, \sigma_y)$		$X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta$ $y \sim Normal(\eta, \sigma_y)$	Missing Random Effects $tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y \sim NegBinom(\mu = \eta, size = \theta)$		$\eta = exp(\beta_0)$ $y \sim NegBinom(\mu = \eta, size = \theta)$
	Mis-specified Data Model $tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + u$ $y \sim Normal(\eta, \sigma_y)$		$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = exp(X\beta + u)$ $y \sim Normal(\eta, \sigma_y)$	Misp-specified Data Model $tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y \sim NegBinom(\mu = \eta, size = \theta)$		$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y \sim Poisson(\mu = \eta)$
	Mis-specifed Random Effects $tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + exp(u)$ $y^{'} \sim Normal(\eta, \sigma_y)$		$tree \sim randomTree(n)$ $\Sigma = BM(tree, a, r, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $X_i \sim Unif(-0.5, 0.5)$ $\eta = X\beta + u$ $y^{'} \sim Normal(\eta, \sigma_y)$	Mis-specified Random Effects $tree \sim randomTree(n)$ $\Sigma = OU(tree, a = 1, r = -2, \sigma_u^2)$ $u^{'} \sim MVNORM(\Sigma)$ $\eta^{'} = exp(\beta_0 + u^{'})$ $y^{'} \sim NegBinom(\mu = \eta^{'}, size = \theta)$		$tree \sim randomTree(n)$ $\Sigma = BM(tree, a = 0, r = 0, \sigma_u^2)$ $u \sim MVNORM(\Sigma)$ $\eta = exp(\beta_0 + u)$ $y^{'} \sim NegBinom(\mu = \eta, size = \theta)$

Results

LM

Table 6: Linear Model. Type I error rates at the 0.05 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	Unconditional ecdf, Not Rotated	Conditional ecdf, Not Rotated
Kolmogorov-Smirnov	theoretical	0.048	0.048	0.048	0.048	0.048	0.041	0.044
	estimated	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 7: Linear Model. Power at the 0.95 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	Unconditional ecdf, Not Rotated	Conditional ecdf, Not Rotated
Kolmogorov-Smirnov	theoretical	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	estimated	0.963	0.963	0.963	0.963	0.963	0.962	0.961

Temporal Correlation - LMM

Table 8: Temporal Correlation - LMM. Type I error rates at the 0.05 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
Anderson-Darling	theoretical	0.061	0.046	0.046	0.046	0.046	0.048	0.335	0.993	0.352	0.228
	estimated	0.002	0.024	0.022	0.027	0.030	0.053	0.315	0.315	0.015	0.010
Kolmogorov-Smirnov	theoretical	0.056	0.042	0.042	0.042	0.041	0.041	0.060	0.987	0.065	0.057
	estimated	0.129	0.000	0.000	0.000	0.000	0.054	0.001	0.996	0.077	0.129
Lilliefors	estimated	0.051	0.052	0.053	0.052	0.048	0.050	0.169	0.528	0.047	0.051
Autocorrelation	theoretical	0.047	0.052	0.052	0.052	0.051	0.048	0.043	1.000	0.053	0.049
	estimated	0.001	0.003	0.003	0.003	0.003	0.027	0.006	1.000	0.001	0.001

Table 9: Temporal Correlation - LMM. Power at the 0.95 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
A: Missing RE											
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	1	1	1	1	1	1	1	1	1	1
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	1	1	1	1	1	1	1	1	1	1
Lilliefors	estimated	0.13	0.13	0.13	0.13	0.13	0.13	0.204	0.278	0.21	0.289
Autocorrelation	theoretical	1	1	1	1	1	1	0.982	0.984	0.983	0.983
	estimated	1	1	1	1	1	1	1	1	1	1
B: Heterosck.											
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	0.01	0.016	0.014	0.022	0.016	0.117	0.912	0.453	0.78	0.672
Kolmogorov-Smirnov	theoretical	1	0.867	0.867	0.867	0.889	0.814	1	0.96	1	1
	estimated	0.668	0.365	0.365	0.37	0.362	0.467	0.141	0.964	0.183	0.657
Lilliefors	estimated	0.992	0.98	0.98	0.982	0.98	0.87	0.971	0.836	0.98	0.995
Autocorrelation	theoretical	0	0	0	0	0	0	0	0.923	0.11	0
	estimated	0	0	0	0	0	0.104	0.177	0.905	0.043	0.048
C: Missing Drift											
Anderson-Darling	theoretical	1	1	1	1	1	0.05	1	1	1	1
	estimated	0	0.995	0.996	0.997	1	0.051	0.999	1	0	0
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	0.047	1	1	1	1
	estimated	1	1	1	1	1	0.051	1	1	1	1
Lilliefors	estimated	0.022	0.036	0.036	0.034	1	0.054	0.14	1	0.083	0.078
Autocorrelation	theoretical	1	0.104	0.1	0.1	0.1	0.069	0.132	1	0.985	0.986
	estimated	0	0	0	0	0.001	0.059	0	1	0.045	0.051

Table 10: Temporal Correlation - LMM. Type I error rates at the 0.10 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
Anderson-Darling	theoretical	0.107	0.094	0.094	0.094	0.094	0.090	0.371	0.997	0.384	0.268
	estimated	0.008	0.053	0.061	0.056	0.070	0.099	0.352	0.411	0.022	0.015
Kolmogorov-Smirnov	theoretical	0.103	0.084	0.084	0.084	0.084	0.080	0.105	0.992	0.113	0.100
	estimated	0.245	0.001	0.001	0.001	0.001	0.095	0.002	0.997	0.143	0.233
Lilliefors	estimated	0.105	0.101	0.101	0.101	0.101	0.096	0.261	0.628	0.107	0.099
Autocorrelation	theoretical	0.099	0.098	0.098	0.098	0.099	0.085	0.098	1.000	0.111	0.116
	estimated	0.001	0.007	0.007	0.007	0.006	0.073	0.016	1.000	0.001	0.001

Table 11: Temporal Correlation - LMM. Power at the 0.90 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	one-step Gaussian	full Gaussian	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
A: Missing RE											
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	1	1	1	1	1	1	1	1	1	1
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	1	1	1	1	1	1	1	1	1	1
Lilliefors	estimated	0.32	0.32	0.32	0.32	0.32	0.32	0.399	0.563	0.411	0.545
Autocorrelation	theoretical	1	1	1	1	1	1	0.984	0.985	0.986	0.988
	estimated	1	1	1	1	1	1	1	1	1	1
B: Heterosck.											
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1	1	1
	estimated	0.023	0.035	0.031	0.045	0.036	0.15	0.914	0.522	0.786	0.676
Kolmogorov-Smirnov	theoretical	1	0.998	0.998	0.998	1	0.953	1	0.973	1	1
	estimated	0.861	0.602	0.602	0.604	0.598	0.628	0.217	0.983	0.364	0.83
Lilliefors	estimated	0.997	0.997	0.997	0.998	0.997	0.941	0.981	0.902	0.991	0.997
Autocorrelation	theoretical	0	0	0	0	0	0	0	0.958	0.284	0.791
	estimated	0.004	0.007	0.007	0.007	0.007	0.128	0.359	0.955	0.096	0.106
C: Missing Drift											
Anderson-Darling	theoretical	1	1	1	1	1	0.093	1	1	1	1
	estimated	0	0.999	1	1	1	0.105	1	1	0	0
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	0.086	1	1	1	1
	estimated	1	1	1	1	1	0.104	1	1	1	1
Lilliefors	estimated	0.062	0.083	0.084	0.088	1	0.102	0.183	1	0.155	0.138
Autocorrelation	theoretical	1	0.17	0.168	0.167	0.164	0.14	0.234	1	0.988	0.986
	estimated	0	0	0	0	0.001	0.105	0	1	0.086	0.106

Temporal Correlation - GLMM

Table 12: Temporal Correlation - GLMM. Type I error rates at the 0.05 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
Anderson-Darling	theoretical	0.976	0.041	0.097	0.048	0.819	0.994	0.318	0.227
	estimated	0.619	0.039	0.115	0.043	0.148	0.307	0.001	0.000
Kolmogorov-Smirnov	theoretical	0.875	0.033	0.077	0.056	0.724	0.990	0.071	0.049
	estimated	0.878	0.000	0.115	0.037	0.658	0.995	0.878	0.924
Lilliefors	estimated	0.993	0.049	0.184	0.036	0.596	0.651	0.053	0.051
Autocorrelation	theoretical	0.217	0.053	0.054	0.048	0.486	1.000	0.045	0.051
	estimated	0.005	0.000	0.001	0.045	0.400	1.000	0.000	0.000

Table 13: Temporal Correlation - GLMM. Power at the 0.95 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
A: Missing RE									
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1
	estimated	0.911	0.886	0.83	0.841	0.89	0.869	0.909	0.861
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	1	1	1
	estimated	0.986	0.965	0.958	0.958	0.945	0.954	0.95	0.951
Lilliefors	estimated	0.983	0.779	0.779	0.779	0.791	0.865	0.8	0.87
Autocorrelation	theoretical	1	0.993	0.995	1	0.92	0.976	0.933	0.975
	estimated	1	1	1	1	0.882	0.999	0.88	0.999
B: Gamma - Normal									
Anderson-Darling	theoretical	1	0.959	0.961	0.684	0.997	1	1	1
	estimated	0.001	0.02	0.289	0.057	0.974	0.457	0.238	0.226
Kolmogorov-Smirnov	theoretical	1	0.88	0.874	0.581	0.852	1	1	1
	estimated	0.982	0.795	0.797	0.086	0.608	0.999	0.977	0.979
Lilliefors	estimated	0.966	0.961	0.956	0.162	0.983	0.957	0.697	0.696
Autocorrelation	theoretical	1	0.092	0.331	0.027	0.091	0.992	0.585	1
	estimated	0.021	0.122	0.107	0.087	0.18	1	0.035	0.036
D: Misp RE									
Anderson-Darling	theoretical	1	1	1	0.063	0.741	1	1	1
	estimated	1	0.02	0.025	0.051	0.353	0.366	0.073	0.041
Kolmogorov-Smirnov	theoretical	1	1	1	0.055	0.553	1	1	1
	estimated	1	0.002	0.002	0.047	0.316	0.99	0.022	0.04
Lilliefors	estimated	1	0.123	0.126	0.048	0.148	0.529	0.115	0.075
Autocorrelation	theoretical	1	0	0	0.12	0.1	1	0.903	0.986
	estimated	0.034	0.005	0.004	0.033	0.041	0.997	0	0

Table 14: Temporal Correlation - GLMM. Type I error rates at the 0.10 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
Anderson-Darling	theoretical	0.986	0.093	0.184	0.093	0.891	0.998	0.370	0.269
	estimated	0.630	0.079	0.168	0.087	0.198	0.399	0.001	0.001
Kolmogorov-Smirnov	theoretical	0.908	0.077	0.146	0.086	0.809	0.994	0.123	0.092
	estimated	0.919	0.000	0.139	0.084	0.747	0.998	0.926	0.958
Lilliefors	estimated	0.996	0.123	0.259	0.074	0.704	0.750	0.099	0.106
Autocorrelation	theoretical	0.286	0.114	0.112	0.099	0.578	1.000	0.102	0.102
	estimated	0.006	0.004	0.005	0.085	0.479	1.000	0.001	0.001

Table 15: Temporal Correlation - GLMM. Power at the 0.90 significance level evaluated for each method for theoretical and estimated residuals.

test	residual type	Pearson	one-step Generic	cdf	MCMC	Unconditional ecdf, Rotated	Unconditional ecdf, Not Rotated	Conditional ecdf, Rotated	Conditional ecdf, Not Rotated
A: Missing RE									
Anderson-Darling	theoretical	1	1	1	1	1	1	1	1
	estimated	0.944	0.918	0.885	0.886	0.922	0.902	0.932	0.907
Kolmogorov-Smirnov	theoretical	1	1	1	1	1	1	1	1
	estimated	0.991	0.978	0.966	0.966	0.961	0.968	0.963	0.969
Lilliefors	estimated	0.988	0.845	0.843	0.843	0.83	0.903	0.836	0.907
Autocorrelation	theoretical	1	0.995	0.997	1	0.939	0.98	0.947	0.98
	estimated	1	1	1	1	0.892	0.999	0.894	0.999
B: Gamma - Normal									
Anderson-Darling	theoretical	1	0.973	0.973	0.72	0.997	1	1	1
	estimated	0.003	0.053	0.335	0.103	0.975	0.54	0.238	0.226
Kolmogorov-Smirnov	theoretical	1	0.906	0.907	0.634	0.886	1	1	1
	estimated	0.985	0.872	0.849	0.14	0.686	1	0.979	0.985
Lilliefors	estimated	0.982	0.977	0.971	0.236	0.99	0.973	0.732	0.734
Autocorrelation	theoretical	1	0.15	0.418	0.04	0.168	0.993	0.599	1
	estimated	0.021	0.162	0.148	0.137	0.285	1	0.042	0.052
D: Misp RE									
Anderson-Darling	theoretical	1	1	1	0.131	0.862	1	1	1
	estimated	1	0.05	0.06	0.094	0.403	0.437	0.093	0.049
Kolmogorov-Smirnov	theoretical	1	1	1	0.121	0.671	1	1	1
	estimated	1	0.008	0.008	0.078	0.407	0.996	0.057	0.089
Lilliefors	estimated	1	0.205	0.217	0.1	0.226	0.623	0.166	0.132
Autocorrelation	theoretical	1	0	0	0.225	0.154	1	0.926	0.989
	estimated	0.056	0.019	0.017	0.069	0.094	0.999	0.001	0.001

Spatial

Table 16: LMM Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for theoretical residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.044	0.999	1.000	1.000
Anderson-Darling	one-step Generic	0.011	0.999	1.000	0.778
Anderson-Darling	one-step Gaussian	0.011	0.999	1.000	0.889
Anderson-Darling	full Gaussian	0.011	0.999	1.000	0.889
Anderson-Darling	cdf	0.009	0.999	1.000	0.883
Anderson-Darling	MCMC	0.050	0.999	1.000	0.761
Anderson-Darling	Unconditional ecdf, Rotated	0.225	1.000	1.000	0.974
Anderson-Darling	Unconditional ecdf, Not Rotated	0.762	1.000	1.000	1.000
Anderson-Darling	Conditional ecdf, Rotated	0.338	1.000	1.000	1.000
Anderson-Darling	Conditional ecdf, Not Rotated	0.216	1.000	1.000	1.000
Kolmogorov- Smirnov	Pearson	0.046	0.992	0.977	1.000
Kolmogorov- Smirnov	one-step Generic	0.012	0.992	0.973	0.538
Kolmogorov- Smirnov	one-step Gaussian	0.012	0.992	0.973	0.538
Kolmogorov- Smirnov	full Gaussian	0.012	0.992	0.973	0.538
Kolmogorov- Smirnov	cdf	0.012	0.992	0.978	0.536
Kolmogorov- Smirnov	MCMC	0.038	0.992	0.948	0.487
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.016	0.996	0.992	0.649
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.687	0.992	0.901	1.000
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.050	0.998	0.998	1.000
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.039	0.992	0.980	1.000
Autocorrelation	Pearson	0.059	0.998	0.148	0.958
Autocorrelation	one-step Generic	0.050	0.998	0.012	0.334
Autocorrelation	one-step Gaussian	0.050	0.998	0.011	0.314
Autocorrelation	full Gaussian	0.050	0.998	0.011	0.314
Autocorrelation	cdf	0.050	0.998	0.027	0.175
Autocorrelation	MCMC	0.043	0.998	0.001	0.147
Autocorrelation	Unconditional ecdf, Rotated	0.045	0.996	0.013	0.130
Autocorrelation	Unconditional ecdf, Not Rotated	0.999	0.998	0.923	0.982
Autocorrelation	Conditional ecdf, Rotated	0.062	0.995	0.055	0.363
Autocorrelation	Conditional ecdf, Not Rotated	0.054	0.998	0.057	0.515

Table 17: LMM Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for estimated residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.002	0.033	0.054	0.197
Anderson-Darling	one-step Generic	0.043	0.037	NA	NA
Anderson-Darling	one-step Gaussian	0.041	0.033	0.055	0.189
Anderson-Darling	full Gaussian	0.042	0.040	0.055	0.188
Anderson-Darling	cdf	0.038	0.021	0.055	0.181
Anderson-Darling	MCMC	0.053	0.035	0.062	0.222
Anderson-Darling	Unconditional ecdf, Rotated	0.304	0.256	0.999	0.976
Anderson-Darling	Unconditional ecdf, Not Rotated	0.111	0.137	0.992	0.965
Anderson-Darling	Conditional ecdf, Rotated	0.025	0.253	0.995	0.880
Anderson-Darling	Conditional ecdf, Not Rotated	0.016	0.154	0.993	0.874
Kolmogorov- Smirnov	Pearson	0.139	0.004	0.985	0.935
Kolmogorov- Smirnov	one-step Generic	0.013	0.004	NA	NA
Kolmogorov- Smirnov	one-step Gaussian	0.013	0.004	0.982	0.868
Kolmogorov- Smirnov	full Gaussian	0.013	0.004	0.981	0.896
Kolmogorov- Smirnov	cdf	0.019	0.004	0.982	0.871
Kolmogorov- Smirnov	MCMC	0.039	0.004	0.983	0.846
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.026	0.002	0.931	0.851
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.329	0.004	0.983	0.939
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.090	0.007	0.925	0.925
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.146	0.002	0.986	0.940
Lilliefors	Pearson	0.054	0.124	0.999	0.916
Lilliefors	one-step Generic	0.048	0.122	NA	NA
Lilliefors	one-step Gaussian	0.048	0.124	0.999	0.947
Lilliefors	full Gaussian	0.048	0.124	0.998	0.954
Lilliefors	cdf	0.054	0.124	0.999	0.943
Lilliefors	MCMC	0.067	0.124	0.999	0.860
Lilliefors	Unconditional ecdf, Rotated	0.145	0.191	1.000	0.971
Lilliefors	Unconditional ecdf, Not Rotated	0.153	0.168	1.000	0.982
Lilliefors	Conditional ecdf, Rotated	0.076	0.184	1.000	0.925
Lilliefors	Conditional ecdf, Not Rotated	0.064	0.172	0.999	0.927
Autocorrelation	Pearson	0.004	0.998	0.753	0.854
Autocorrelation	one-step Generic	0.046	0.998	NA	NA
Autocorrelation	one-step Gaussian	0.046	0.998	0.738	0.861
Autocorrelation	full Gaussian	0.046	0.998	0.758	0.880
Autocorrelation	cdf	0.045	0.998	0.737	0.859
Autocorrelation	MCMC	0.038	0.998	0.753	0.864
Autocorrelation	Unconditional ecdf, Rotated	0.039	0.998	0.826	0.851
Autocorrelation	Unconditional ecdf, Not Rotated	0.998	0.998	0.864	0.982
Autocorrelation	Conditional ecdf, Rotated	0.004	0.998	0.826	0.849
Autocorrelation	Conditional ecdf, Not Rotated	0.004	0.998	0.860	0.850

Table 18: GLMM Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for theoretical residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.099	0.995	1.000	0.099
Anderson-Darling	one-step Generic	0.037	0.991	1.000	0.130
Anderson-Darling	cdf	0.040	0.991	1.000	0.140
Anderson-Darling	MCMC	0.060	0.991	1.000	0.082
Anderson-Darling	Unconditional ecdf, Rotated	0.197	1.000	0.966	0.392
Anderson-Darling	Unconditional ecdf, Not Rotated	0.541	0.998	1.000	0.550
Anderson-Darling	Conditional ecdf, Rotated	0.325	1.000	1.000	0.344
Anderson-Darling	Conditional ecdf, Not Rotated	0.139	0.997	1.000	0.129
Kolmogorov- Smirnov	Pearson	0.085	0.979	1.000	0.085
Kolmogorov- Smirnov	one-step Generic	0.037	0.916	1.000	0.083
Kolmogorov- Smirnov	cdf	0.040	0.916	1.000	0.084
Kolmogorov- Smirnov	MCMC	0.044	0.912	0.986	0.061
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.062	0.944	0.812	0.128
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.469	0.911	1.000	0.467
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.064	0.938	1.000	0.074
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.052	0.912	1.000	0.057
disp	Pearson	0.065	1.000	1.000	0.065
disp	Unconditional ecdf, Rotated	0.033	0.994	0.071	0.039
disp	Unconditional ecdf, Not Rotated	0.033	0.993	0.066	0.035
disp	Conditional ecdf, Rotated	0.030	0.994	0.586	0.029
disp	Conditional ecdf, Not Rotated	0.027	0.993	0.586	0.029
Autocorrelation	Pearson	0.064	0.988	0.094	0.064
Autocorrelation	one-step Generic	0.055	0.989	0.001	0.618
Autocorrelation	cdf	0.055	0.990	0.000	0.620
Autocorrelation	MCMC	0.071	0.988	0.000	0.265
Autocorrelation	Unconditional ecdf, Rotated	0.020	0.975	0.003	0.518
Autocorrelation	Unconditional ecdf, Not Rotated	0.986	0.984	0.588	0.988
Autocorrelation	Conditional ecdf, Rotated	0.053	0.978	0.047	0.064
Autocorrelation	Conditional ecdf, Not Rotated	0.063	0.985	0.060	0.062

Table 19: GLMM Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for estimated residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.005	0.829	0.007	0.003
Anderson-Darling	one-step Generic	0.036	0.759	0.129	0.038
Anderson-Darling	cdf	0.027	0.751	0.221	0.049
Anderson-Darling	MCMC	0.049	0.753	0.096	0.045
Anderson-Darling	Unconditional ecdf, Rotated	0.237	0.996	0.041	0.301
Anderson-Darling	Unconditional ecdf, Not Rotated	0.094	0.981	0.145	0.079
Anderson-Darling	Conditional ecdf, Rotated	0.047	0.990	0.008	0.047
Anderson-Darling	Conditional ecdf, Not Rotated	0.009	0.970	0.005	0.006
Kolmogorov- Smirnov	Pearson	0.253	0.984	1.000	0.555
Kolmogorov- Smirnov	one-step Generic	0.007	0.820	0.745	0.001
Kolmogorov- Smirnov	cdf	0.006	0.820	0.931	0.001
Kolmogorov- Smirnov	MCMC	0.038	0.820	0.089	0.022
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.018	0.872	0.131	0.002
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.063	0.814	0.807	0.010
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.086	0.880	0.999	0.366
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.144	0.813	1.000	0.473
Lilliefors	Pearson	0.062	0.972	1.000	0.129
Lilliefors	one-step Generic	0.047	0.270	0.994	0.039
Lilliefors	cdf	0.047	0.309	0.996	0.044
Lilliefors	MCMC	0.046	0.318	0.074	0.042
Lilliefors	Unconditional ecdf, Rotated	0.124	0.822	0.746	0.147
Lilliefors	Unconditional ecdf, Not Rotated	0.096	0.694	0.998	0.081
Lilliefors	Conditional ecdf, Rotated	0.172	0.840	1.000	0.267
Lilliefors	Conditional ecdf, Not Rotated	0.153	0.696	1.000	0.292
disp	Pearson	0.000	1.000	0.000	0.000
disp	Unconditional ecdf, Rotated	0.002	1.000	0.000	0.001
disp	Unconditional ecdf, Not Rotated	0.001	1.000	0.000	0.001
disp	Conditional ecdf, Rotated	0.053	1.000	0.000	0.396
disp	Conditional ecdf, Not Rotated	0.054	1.000	0.000	0.395
Autocorrelation	Pearson	0.001	0.988	0.001	0.348
Autocorrelation	one-step Generic	0.079	0.989	0.008	0.824
Autocorrelation	cdf	0.079	0.990	0.009	0.829
Autocorrelation	MCMC	0.062	0.989	0.024	0.298
Autocorrelation	Unconditional ecdf, Rotated	0.050	0.984	0.081	0.744
Autocorrelation	Unconditional ecdf, Not Rotated	0.990	0.990	0.234	0.990
Autocorrelation	Conditional ecdf, Rotated	0.001	0.986	0.003	0.317
Autocorrelation	Conditional ecdf, Not Rotated	0.001	0.989	0.004	0.335

Phylogenetic

Table 20: LMM Phylogenetic Model. Type I error rates and Power evaluated for each analytical and simulation method for theoretical residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.055	1.000	1.000	1.000
Anderson-Darling	one-step Generic	0.047	1.000	0.924	0.937
Anderson-Darling	one-step Gaussian	0.047	1.000	0.986	0.994
Anderson-Darling	full Gaussian	0.047	1.000	0.986	0.994
Anderson-Darling	cdf	0.052	1.000	0.980	0.989
Anderson-Darling	MCMC	0.042	1.000	0.916	0.905
Anderson-Darling	Unconditional ecdf, Rotated	0.335	1.000	0.997	0.999
Anderson-Darling	Unconditional ecdf, Not Rotated	0.759	1.000	1.000	1.000
Anderson-Darling	Conditional ecdf, Rotated	0.327	1.000	1.000	1.000
Anderson-Darling	Conditional ecdf, Not Rotated	0.229	1.000	1.000	1.000
Kolmogorov- Smirnov	Pearson	0.047	1.000	1.000	1.000
Kolmogorov- Smirnov	one-step Generic	0.042	1.000	0.739	0.752
Kolmogorov- Smirnov	one-step Gaussian	0.042	1.000	0.740	0.752
Kolmogorov- Smirnov	full Gaussian	0.042	1.000	0.740	0.752
Kolmogorov- Smirnov	cdf	0.043	1.000	0.738	0.750
Kolmogorov- Smirnov	MCMC	0.042	1.000	0.758	0.737
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.052	1.000	0.835	0.840
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.679	1.000	1.000	1.000
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.058	1.000	1.000	1.000
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.043	1.000	1.000	1.000
Autocorrelation	Pearson	0.045	0.999	0.850	0.872
Autocorrelation	one-step Generic	0.042	0.999	0.321	0.326
Autocorrelation	one-step Gaussian	0.042	0.999	0.434	0.442
Autocorrelation	full Gaussian	0.042	0.999	0.434	0.442
Autocorrelation	cdf	0.041	0.999	0.622	0.621
Autocorrelation	MCMC	0.051	0.999	0.337	0.329
Autocorrelation	Unconditional ecdf, Rotated	0.045	0.992	0.093	0.087
Autocorrelation	Unconditional ecdf, Not Rotated	0.999	0.997	0.979	0.983
Autocorrelation	Conditional ecdf, Rotated	0.049	0.996	0.408	0.400
Autocorrelation	Conditional ecdf, Not Rotated	0.051	0.997	0.354	0.363

Table 21: LMM Phylogenetic Model. Type I error rates and Power evaluated for each analytical and simulation method for estimated residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.000	0.034	0.221	0.201
Anderson-Darling	one-step Generic	0.037	0.034	0.016	0.006
Anderson-Darling	one-step Gaussian	0.029	0.029	0.447	0.430
Anderson-Darling	full Gaussian	0.028	0.028	0.451	0.436
Anderson-Darling	cdf	0.068	0.038	0.610	0.610
Anderson-Darling	MCMC	0.038	0.038	0.216	0.215
Anderson-Darling	Unconditional ecdf, Rotated	0.290	0.293	0.999	1.000
Anderson-Darling	Unconditional ecdf, Not Rotated	0.261	0.165	0.967	0.963
Anderson-Darling	Conditional ecdf, Rotated	0.004	0.293	0.538	0.504
Anderson-Darling	Conditional ecdf, Not Rotated	0.003	0.151	0.530	0.496
Kolmogorov- Smirnov	Pearson	0.638	0.005	0.991	0.993
Kolmogorov- Smirnov	one-step Generic	0.013	0.005	0.987	0.981
Kolmogorov- Smirnov	one-step Gaussian	0.013	0.005	0.987	0.981
Kolmogorov- Smirnov	full Gaussian	0.013	0.005	0.986	0.980
Kolmogorov- Smirnov	cdf	0.046	0.005	0.979	0.972
Kolmogorov- Smirnov	MCMC	0.043	0.005	0.446	0.416
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.014	0.007	0.973	0.969
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.536	0.004	0.996	0.995
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.538	0.006	0.989	0.986
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.629	0.005	0.992	0.992
Lilliefors	Pearson	0.049	0.122	0.995	0.994
Lilliefors	one-step Generic	0.042	0.122	0.993	0.991
Lilliefors	one-step Gaussian	0.042	0.122	0.997	0.995
Lilliefors	full Gaussian	0.042	0.122	0.997	0.995
Lilliefors	cdf	0.075	0.122	0.987	0.987
Lilliefors	MCMC	0.044	0.122	0.524	0.474
Lilliefors	Unconditional ecdf, Rotated	0.154	0.220	0.998	0.999
Lilliefors	Unconditional ecdf, Not Rotated	0.172	0.206	0.998	1.000
Lilliefors	Conditional ecdf, Rotated	0.059	0.230	0.595	0.577
Lilliefors	Conditional ecdf, Not Rotated	0.048	0.201	0.605	0.578
Autocorrelation	Pearson	0.935	0.999	0.798	0.805
Autocorrelation	one-step Generic	0.021	0.999	0.473	0.478
Autocorrelation	one-step Gaussian	0.021	0.999	0.484	0.488
Autocorrelation	full Gaussian	0.021	0.999	0.484	0.485
Autocorrelation	cdf	0.019	0.999	0.391	0.387
Autocorrelation	MCMC	0.035	0.999	0.292	0.278
Autocorrelation	Unconditional ecdf, Rotated	0.021	0.999	0.357	0.344
Autocorrelation	Unconditional ecdf, Not Rotated	1.000	0.999	0.972	0.977
Autocorrelation	Conditional ecdf, Rotated	0.883	0.999	0.369	0.339
Autocorrelation	Conditional ecdf, Not Rotated	0.902	0.999	0.424	0.407

Table 22: GLMM Phylogenetic Model. Type I error rates and Power evaluated for each analytical and simulation method for theoretical residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	1.000	1.000	1.000	1.000
Anderson-Darling	one-step Generic	0.035	0.985	0.999	0.330
Anderson-Darling	cdf	0.053	0.991	1.000	0.339
Anderson-Darling	MCMC	0.067	0.989	0.748	0.149
Anderson-Darling	Unconditional ecdf, Rotated	0.671	0.999	0.711	0.561
Anderson-Darling	Unconditional ecdf, Not Rotated	0.603	0.999	0.925	0.945
Anderson-Darling	Conditional ecdf, Rotated	0.351	0.999	1.000	1.000
Anderson-Darling	Conditional ecdf, Not Rotated	0.131	0.999	1.000	1.000
Kolmogorov- Smirnov	Pearson	1.000	1.000	1.000	1.000
Kolmogorov- Smirnov	one-step Generic	0.037	0.844	0.986	0.330
Kolmogorov- Smirnov	cdf	0.049	0.849	0.992	0.339
Kolmogorov- Smirnov	MCMC	0.055	0.848	0.545	0.158
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.588	0.972	0.644	0.489
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.549	0.843	0.844	0.925
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.161	0.975	1.000	0.992
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.035	0.855	1.000	0.931
Autocorrelation	Pearson	0.211	0.670	0.211	0.622
Autocorrelation	one-step Generic	0.054	0.903	0.428	0.222
Autocorrelation	cdf	0.063	0.895	0.436	0.208
Autocorrelation	MCMC	0.044	0.904	0.315	0.054
Autocorrelation	Unconditional ecdf, Rotated	0.070	0.460	0.090	0.071
Autocorrelation	Unconditional ecdf, Not Rotated	0.874	0.880	0.891	0.205
Autocorrelation	Conditional ecdf, Rotated	0.042	0.460	0.060	0.188
Autocorrelation	Conditional ecdf, Not Rotated	0.038	0.878	0.054	0.680

Table 23: GLMM Phylogenetic Model. Type I error rates and Power evaluated for each analytical and simulation method for estimated residuals. Results are partitioned out by model mis-specification (from left to right) and residual type (top to bottom).

		Type I Error	Power		
test	method	Correct	A: Missing RE	B: Misp Data	C: Misp RE
Anderson-Darling	Pearson	0.999	1.000	0.000	1.000
Anderson-Darling	one-step Generic	0.027	0.011	0.053	0.031
Anderson-Darling	cdf	0.043	0.013	0.422	0.025
Anderson-Darling	MCMC	0.030	0.011	0.076	0.044
Anderson-Darling	Unconditional ecdf, Rotated	0.260	0.835	0.005	0.259
Anderson-Darling	Unconditional ecdf, Not Rotated	0.179	0.633	0.048	0.121
Anderson-Darling	Conditional ecdf, Rotated	0.045	0.811	0.008	0.181
Anderson-Darling	Conditional ecdf, Not Rotated	0.024	0.634	0.004	0.060
Kolmogorov- Smirnov	Pearson	1.000	1.000	1.000	1.000
Kolmogorov- Smirnov	one-step Generic	0.005	0.524	0.006	0.008
Kolmogorov- Smirnov	cdf	0.002	0.330	0.814	0.000
Kolmogorov- Smirnov	MCMC	0.024	0.328	0.051	0.009
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.397	0.528	0.863	0.097
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.275	0.322	0.907	0.060
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.055	0.513	1.000	0.012
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.156	0.319	1.000	0.001
Lilliefors	Pearson	1.000	1.000	0.992	1.000
Lilliefors	one-step Generic	0.039	0.647	0.121	0.059
Lilliefors	cdf	0.037	0.623	0.620	0.038
Lilliefors	MCMC	0.053	0.634	0.051	0.046
Lilliefors	Unconditional ecdf, Rotated	0.443	0.792	0.267	0.185
Lilliefors	Unconditional ecdf, Not Rotated	0.087	0.772	0.699	0.075
Lilliefors	Conditional ecdf, Rotated	0.132	0.776	0.989	0.112
Lilliefors	Conditional ecdf, Not Rotated	0.216	0.780	1.000	0.062
Autocorrelation	Pearson	0.214	0.670	0.899	0.057
Autocorrelation	one-step Generic	0.044	0.884	0.514	0.024
Autocorrelation	cdf	0.047	0.890	0.498	0.029
Autocorrelation	MCMC	0.038	0.884	0.077	0.040
Autocorrelation	Unconditional ecdf, Rotated	0.067	0.573	0.320	0.039
Autocorrelation	Unconditional ecdf, Not Rotated	0.885	0.889	0.833	0.253
Autocorrelation	Conditional ecdf, Rotated	0.100	0.566	0.832	0.042
Autocorrelation	Conditional ecdf, Not Rotated	0.132	0.888	0.585	0.036

Table 24: Overview of issues and recommendations for common classes of models. Correlation and distributions refer to predicted data from a fitted model, against which observed points are compared. A linear rotation refers to a multiplication of the simulated and observed data by a Cholesky decomposition of the estimated covariance matrix of the observed data, z'=Lz, as available in DHARMa.

Model class	Case studies	Issues and causes	Recommendation
Linear model	Linear model	No issues	Pearson residuals
Generalized linear model (GLM)	Skewed Gamma	Non-normality resulting from response variable. Quantile residuals are needed if not approximately normal.	Quantile residual
Linear mixed model (LMM), Multivariate model	Random walk, Spatial LMM, Multinomial	Linear correlations caused by non-independence in observations.	Use a method that linearly decorrela order to transform to a unit iid no OSA Full Gaussian, OSA one-step sian, or simulation residuals with rot
Generalized linear mixed model (GLMM)	Spatial Poisson, Repeated measures Tweedie	Non-normality and non-linear correlations caused by response variable and non-independence in observations.	Needs non-linear decorrelation and tiles. Needs non-linear decorrelatio quantiles. Best approach depends o study and sample size.