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
	NA	0.047	0.047	0.047	0.047	0.047	0.226	0.223
	NA	0.048	0.048	0.048	0.048	0.048	0.041	0.044
NA	NA	0.023	0.027	0.038	0.028	0.023	0.206	0.201
	NA	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	NA	0.052	0.052	0.052	0.052	0.052	0.148	0.145

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
	NA							
	NA	1	1	1	1	1	1	1
NA	NA	0.134	0.01	0.136	0.127	0.092	0.998	0.995
	NA	1	1	1	1	1	1	1
	NA	0.963	0.963	0.963	0.963	0.963	0.962	0.961
	NA	0.999	0.998	0.999	0.999	0.995	1	1

Compound Symmetry - LMM

Table 8: Compound Symmetry - 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
	NA	0.047	0.042	0.042	0.042	0.045	0.046	0.357	0.954	0.357	0.216
	NA	0.048	0.039	0.039	0.039	0.041	0.046	0.063	0.920	0.051	0.038
	NA	0.054	0.066	0.066	0.066	0.066	0.046	0.061	1.000	0.056	0.053
	NA	0.032	0.035	0.035	0.035	0.035	0.032	0.043	0.060	0.032	0.035
NA	NA	0.015	0.050	0.039	0.046	0.041	0.049	0.315	0.088	0.269	0.153
	NA	0.000	0.022	0.022	0.022	0.022	0.043	0.037	0.476	0.002	0.000
	NA	0.053	0.058	0.058	0.058	0.057	0.067	0.165	0.843	0.180	0.135
	NA	0.000	0.068	0.068	0.068	0.070	0.041	0.068	1.000	0.000	0.000
	NA	0.033	0.038	0.038	0.038	0.037	0.033	0.040	0.045	0.036	0.033

Table 9: Compound Symmetry - 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
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.073	0.079	0.071	0.089	0.056	0.068	0.107	0.074	0.116	0.068
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.464	0.464	0.464	0.464	0.464	0.464	0.393	0.465	0.393	0.461
	NA	0.836	0.836	0.836	0.836	0.836	0.836	0.754	0.84	0.777	0.842
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.032	0.872	0.032	0.032	0.176	0.236	0.803	0.837	0.812	0.827
	NA	0.033	0.033	0.033	0.033	0.033	0.033	0.215	0.031	0.214	0.026
	NA										
	NA	1	1	1	1	1	1	1	0.925	1	1
	NA	0.056	0.089	0.084	0.082	0.094	0.064	0.153	0.047	0.087	0.059
	NA	1	1	1	1	1	1	1	0.812	1	1
	NA	0.165	0.322	0.321	0.321	0.322	0.197	0.306	0.004	0.117	0.163
NA	NA	0.751	0.624	0.624	0.624	0.624	0.634	0.488	0.099	0.59	0.731
	NA	0	0	0	0	0	0	0	0.969	0	0
	NA	0	0	0	0	0	0.04	0	0.973	0	0
	NA	0	0	0	0	0	0	0	0.132	0	0
	NA	0	0	0	0	0	0	0	0	0	0
	NA										
	NA	0.997	0.05	0.05	0.05	0.055	0.055	0.309	1	0.999	0.999
	NA	0.021	0.04	0.036	0.042	0.043	0.044	0.305	0.117	0.248	0.163
	NA	0.993	0.055	0.055	0.055	0.057	0.051	0.058	1	0.995	0.993
	NA	0	0.013	0.013	0.013	0.013	0.043	0.015	0.199	0.001	0
	NA	0.047	0.055	0.055	0.055	0.054	0.062	0.161	0.479	0.174	0.133
	NA	1	0.049	0.049	0.049	0.048	0.05	0.044	0.993	1	0.999
	NA	0	0.059	0.059	0.059	0.059	0.047	0.054	0.989	0	0
	NA	0.032	0.035	0.035	0.035	0.036	0.032	0.041	0.056	0.808	0.819
	NA	0.033	0.036	0.036	0.036	0.037	0.033	0.042	0.035	0.036	0.035

Table 10: Compound Symmetry - 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
	NA	0.083	0.091	0.091	0.091	0.093	0.098	0.395	0.980	0.388	0.250
	NA	0.077	0.084	0.084	0.084	0.086	0.098	0.109	0.949	0.093	0.076
	NA	0.104	0.117	0.117	0.117	0.114	0.109	0.111	1.000	0.106	0.109
	NA	0.060	0.075	0.075	0.075	0.073	0.060	0.083	0.099	0.076	0.062
NA	NA	0.046	0.095	0.087	0.097	0.103	0.093	0.341	0.169	0.296	0.180
	NA	0.002	0.062	0.062	0.062	0.062	0.089	0.066	0.577	0.002	0.002
	NA	0.114	0.109	0.109	0.109	0.114	0.132	0.265	0.888	0.257	0.200
	NA	0.000	0.132	0.132	0.132	0.133	0.089	0.120	1.000	0.000	0.000
	NA	0.065	0.069	0.069	0.069	0.069	0.065	0.085	0.088	0.071	0.070

Table 11: Compound Symmetry - 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
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.14	0.15	0.148	0.157	0.143	0.128	0.172	0.156	0.201	0.142
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.569	0.569	0.569	0.569	0.569	0.569	0.504	0.568	0.509	0.566
	NA	0.887	0.887	0.887	0.887	0.887	0.887	0.828	0.893	0.845	0.879
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.06	0.895	0.06	0.06	0.241	0.278	0.851	0.878	0.86	0.884
	NA	0.065	0.065	0.065	0.065	0.065	0.065	0.318	0.071	0.32	0.063
	NA										
	NA	1	1	1	1	1	1	1	0.953	1	1
	NA	0.106	0.184	0.169	0.154	0.167	0.125	0.238	0.096	0.146	0.115
	NA	1	1	1	1	1	1	1	0.875	1	1
	NA	0.291	0.446	0.446	0.446	0.447	0.326	0.442	0.012	0.242	0.279
NA	NA	0.824	0.727	0.727	0.727	0.726	0.737	0.615	0.172	0.7	0.821
	NA	0	0	0	0	0	0	0	0.982	0	0
	NA	0	0	0	0	0	0.092	0.001	0.981	0	0
	NA	0	0	0	0	0	0	0.001	0.173	0	0
	NA	0	0	0	0	0	0	0	0	0	0
	NA										
	NA	0.998	0.108	0.108	0.108	0.11	0.113	0.354	1	0.999	0.999
	NA	0.048	0.078	0.08	0.085	0.071	0.099	0.34	0.161	0.28	0.186
	NA	0.997	0.102	0.102	0.102	0.106	0.093	0.115	1	0.996	0.997
	NA	0.003	0.035	0.035	0.035	0.035	0.075	0.041	0.266	0.003	0.003
	NA	0.108	0.114	0.115	0.115	0.114	0.111	0.249	0.558	0.242	0.21
	NA	1	0.088	0.088	0.088	0.082	0.094	0.083	0.994	1	0.999
	NA	0	0.114	0.114	0.114	0.114	0.103	0.12	0.995	0	0
	NA	0.06	0.073	0.073	0.073	0.072	0.06	0.08	0.104	0.853	0.852
	NA	0.065	0.07	0.07	0.07	0.07	0.065	0.08	0.073	0.085	0.07

Compound Symmetry - GLMM

Table 12: Compound Symmetry - 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
	NA	1.000	0.039	0.038	0.052	0.444	0.492	0.376	0.121
	NA	1.000	0.038	0.039	0.044	0.294	0.424	0.086	0.035
	NA	0.101	0.039	0.040	0.049	0.025	0.909	0.039	0.045
	NA	0.911	0.052	0.052	0.032	0.890	0.088	0.040	0.020
NA	NA	0.985	0.037	0.025	0.055	0.174	0.050	0.216	0.056
	NA	1.000	0.002	0.001	0.017	0.063	0.000	0.006	0.000
	NA	1.000	0.024	0.023	0.030	0.136	0.050	0.120	0.054
	NA	0.000	0.026	0.028	0.039	0.019	0.924	0.000	0.000
	NA	0.911	0.048	0.048	0.029	0.899	0.075	0.019	0.010

Table 13: Compound Symmetry - 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
	NA								
	NA	1	0.711	0.715	0.716	0.938	0.859	0.944	0.856
	NA	0.997	0.027	0.028	0.027	0.43	0.178	0.425	0.198
	NA	1	0.575	0.575	0.563	0.684	0.56	0.699	0.565
	NA	1	0.009	0.009	0.008	0.054	0.007	0.053	0.011
	NA	1	0.094	0.096	0.124	0.354	0.199	0.358	0.212
	NA	0.947	0.939	0.939	0.925	0.891	0.931	0.872	0.932
	NA	0.947	0.935	0.935	0.924	0.896	0.924	0.9	0.922
	NA	0.911	0.479	0.524	0.513	0.366	0.553	0.392	0.567
	NA	0.911	0.184	0.185	0.146	0.234	0.132	0.221	0.121
	NA								
	NA	1	0.99	0.991	0.976	0.946	0.84	1	0.998
	NA	0.912	0.762	0.803	0.799	0.994	0.515	0.998	0.981
	NA	1	0.917	0.908	0.881	0.804	0.74	0.953	0.901
	NA	1	0.866	0.863	0.865	0.871	0.796	0.948	0.891
NA	NA	1	0.46	0.631	0.626	0.843	0.49	0.955	0.908
	NA	0.065	0.032	0.041	0	0.085	0.93	0.089	0.11
	NA	0	0.03	0.033	0	0.073	0.935	0.001	0.005
	NA	0.442	0.598	0.59	0.547	0.858	0.328	0.441	0.561
	NA	0.382	0.625	0.611	0.555	0.919	0.342	0.438	0.527
	NA								
	NA	1	0.274	0.278	0.074	0.857	0.953	0.995	0.979
	NA	1	0.035	0.038	0.041	0.279	0.076	0.237	0.071
	NA	1	0.209	0.218	0.055	0.787	0.941	0.953	0.932
	NA	1	0.005	0.002	0.016	0.099	0.021	0.004	0
	NA	1	0.043	0.041	0.04	0.226	0.156	0.131	0.067
	NA	0.852	0.029	0.038	0.047	0.043	0.822	0.817	0.884
	NA	0	0.03	0.039	0.044	0.024	0.844	0.002	0
	NA	0.837	0.051	0.048	0.045	0.767	0.205	0.485	0.549
	NA	0.837	0.057	0.051	0.051	0.79	0.093	0.031	0.027

Table 14: Compound Symmetry - 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
	NA	1.000	0.095	0.095	0.102	0.529	0.584	0.432	0.160
	NA	1.000	0.089	0.089	0.092	0.398	0.509	0.157	0.095
	NA	0.152	0.086	0.090	0.090	0.042	0.937	0.089	0.079
	NA	0.948	0.098	0.097	0.075	0.935	0.152	0.083	0.058
NA	NA	0.988	0.070	0.063	0.092	0.225	0.088	0.263	0.092
	NA	1.000	0.005	0.005	0.051	0.106	0.002	0.016	0.001
	NA	1.000	0.053	0.054	0.075	0.233	0.100	0.185	0.095
	NA	0.000	0.084	0.091	0.085	0.046	0.945	0.004	0.000
	NA	0.948	0.094	0.092	0.070	0.926	0.147	0.061	0.022

Table 15: Compound Symmetry - 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
	NA								
	NA	1	0.792	0.792	0.791	0.953	0.884	0.959	0.881
	NA	0.999	0.054	0.064	0.063	0.463	0.204	0.455	0.238
	NA	1	0.655	0.655	0.661	0.775	0.654	0.766	0.653
	NA	1	0.015	0.015	0.019	0.094	0.018	0.094	0.02
	NA	1	0.157	0.159	0.183	0.456	0.261	0.467	0.269
	NA	0.962	0.963	0.963	0.949	0.923	0.948	0.925	0.95
	NA	0.962	0.957	0.957	0.954	0.932	0.944	0.931	0.948
	NA	0.948	0.586	0.631	0.622	0.462	0.648	0.493	0.662
	NA	0.948	0.287	0.286	0.25	0.357	0.232	0.325	0.233
	NA								
	NA	1	0.996	0.995	0.987	0.967	0.893	1	0.999
	NA	0.958	0.847	0.882	0.879	0.997	0.602	1	0.986
	NA	1	0.963	0.96	0.931	0.871	0.814	0.975	0.94
	NA	1	0.916	0.911	0.922	0.924	0.879	0.971	0.93
NA	NA	1	0.587	0.74	0.733	0.908	0.628	0.972	0.938
	NA	0.114	0.061	0.071	0.004	0.135	0.951	0.138	0.163
	NA	0	0.056	0.058	0.003	0.112	0.96	0.002	0.011
	NA	0.536	0.7	0.681	0.644	0.907	0.441	0.54	0.658
	NA	0.493	0.719	0.703	0.652	0.947	0.49	0.518	0.636
	NA								
	NA	1	0.403	0.42	0.133	0.899	0.97	0.998	0.985
	NA	1	0.08	0.067	0.09	0.33	0.112	0.278	0.103
	NA	1	0.326	0.332	0.114	0.846	0.967	0.97	0.954
	NA	1	0.011	0.005	0.036	0.152	0.032	0.01	0
	NA	1	0.082	0.088	0.087	0.31	0.208	0.213	0.117
	NA	0.884	0.066	0.079	0.092	0.072	0.856	0.848	0.903
	NA	0	0.076	0.102	0.087	0.049	0.881	0.007	0
	NA	0.882	0.095	0.091	0.088	0.822	0.26	0.575	0.631
	NA	0.882	0.105	0.099	0.088	0.828	0.145	0.067	0.047

Temporal Correlation - LMM

Table 16: 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
	NA	0.061	0.046	0.046	0.046	0.046	0.049	0.341	0.993	0.342	0.234
	NA	0.056	0.042	0.042	0.042	0.041	0.046	0.051	0.988	0.067	0.065
	NA	0.047	0.052	0.052	0.052	0.051	0.051	0.047	1.000	0.057	0.048
NA	NA	0.003	0.024	0.019	0.030	0.032	0.046	0.317	0.314	0.020	0.009
	NA	0.129	0.000	0.000	0.000	0.000	0.034	0.000	0.995	0.079	0.127
	NA	0.051	0.052	0.053	0.052	0.048	0.053	0.163	0.539	0.065	0.055
	NA	0.001	0.003	0.003	0.003	0.003	0.031	0.004	1.000	0.000	0.001

Table 17: 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
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.13	0.13	0.13	0.13	0.13	0.13	0.207	0.279	0.208	0.286
	NA	1	1	1	1	1	1	0.983	0.982	0.981	0.983
	NA	1	1	1	1	1	1	1	1	1	1
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.013	0.003	0.012	0.013	0.019	1	0.978	0.953	0.967	0.955
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.009	0.27	0.27	0.27	0.27	1	0.835	0.889	0.019	0.007
	NA	1	1	1	1	1	1	1	1	0.999	1
	NA	0	0	0	0	0.007	0	0	0.002	0.006	0
NA	NA	0	0	0	0	0	0.226	0	0	0	0
	NA										
	NA	1	1	1	1	1	0.054	1	1	1	1
	NA	0	0.995	0.997	0.998	1	0.057	0.999	1	0	0
	NA	1	1	1	1	1	0.043	1	1	1	1
	NA	1	1	1	1	1	0.04	1	1	1	1
	NA	0.022	0.036	0.036	0.034	1	0.054	0.135	1	0.078	0.081
	NA	1	0.104	0.1	0.1	0.1	0.09	0.141	0.998	0.985	0.986
	NA	0	0	0	0	0.001	0.057	0	1	0.05	0.051
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0	0.034	0.116	0.115	0.821	0.058	0.986	0.315	0	0
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	0.974	0.974	0.977	0.998	0.049	0.886	0.998	1	1
	NA	0.905	1	1	0.997	0.999	0.052	1	0.693	0.078	0.068
	NA	1	0.754	0.967	0.967	0.448	0.075	0.259	0.95	0.983	0.982
	NA	0	0.024	0.029	0.034	0.025	0.056	0.016	1	0.049	0.042

Table 18: 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
	NA	0.107	0.094	0.094	0.094	0.094	0.096	0.377	0.997	0.385	0.271
	NA	0.103	0.084	0.084	0.084	0.084	0.092	0.094	0.993	0.117	0.104
	NA	0.099	0.098	0.098	0.098	0.099	0.108	0.102	1.000	0.105	0.111
NA	NA	0.007	0.055	0.059	0.058	0.079	0.084	0.358	0.405	0.030	0.013
	NA	0.245	0.001	0.001	0.001	0.001	0.085	0.006	0.997	0.148	0.240
	NA	0.105	0.101	0.101	0.101	0.101	0.115	0.249	0.636	0.124	0.102
	NA	0.001	0.007	0.007	0.007	0.006	0.069	0.023	1.000	0.001	0.001

Table 19: 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
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.32	0.32	0.32	0.32	0.32	0.32	0.394	0.563	0.414	0.55
	NA	1	1	1	1	1	1	0.986	0.985	0.984	0.986
	NA	1	1	1	1	1	1	1	1	1	1
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.031	0.022	0.034	0.031	0.033	1	0.978	0.954	0.969	0.955
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0.149	0.683	0.682	0.683	0.682	1	0.909	0.939	0.135	0.154
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0	0	0	0	0.044	0	0	0.03	0.055	0
NA	NA	0	0	0	0	0	0.257	0	0	0	0
	NA										
	NA	1	1	1	1	1	0.095	1	1	1	1
	NA	0	0.999	1	1	1	0.102	1	1	0	0
	NA	1	1	1	1	1	0.089	1	1	1	1
	NA	1	1	1	1	1	0.089	1	1	1	1
	NA	0.062	0.083	0.084	0.088	1	0.11	0.181	1	0.154	0.144
	NA	1	0.17	0.168	0.167	0.164	0.162	0.227	1	0.988	0.987
	NA	0	0	0	0	0.001	0.113	0	1	0.101	0.112
	NA										
	NA	1	1	1	1	1	1	1	1	1	1
	NA	0	0.102	0.217	0.243	0.835	0.114	0.986	0.38	0	0
	NA	1	1	1	1	1	1	1	1	1	1
	NA	1	0.99	0.99	0.992	1	0.103	0.952	0.998	1	1
	NA	0.945	1	1	0.997	1	0.102	1	0.767	0.137	0.145
	NA	1	0.834	0.99	0.99	0.581	0.145	0.353	0.951	0.983	0.982
	NA	0	0.048	0.055	0.059	0.042	0.101	0.037	1	0.104	0.098

Temporal Correlation - GLMM

Table 20: 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
	NA	0.951	0.041	0.040	0.044	0.614	0.980	0.359	0.229
	NA	0.857	0.041	0.039	0.049	0.520	0.968	0.055	0.044
	NA	0.140	0.033	0.036	0.037	0.068	0.900	0.054	0.041
NA	NA	0.828	0.023	0.026	0.062	0.188	0.343	0.166	0.112
	NA	0.787	0.000	0.001	0.044	0.417	0.914	0.001	0.001
	NA	0.967	0.054	0.057	0.059	0.300	0.251	0.145	0.119
	NA	0.034	0.026	0.025	0.037	0.071	0.821	0.008	0.005

Table 21: 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
	NA								
	NA	0.995	0.984	0.985	0.985	0.994	0.993	0.998	0.992
	NA	0.916	0.854	0.866	0.865	0.934	0.911	0.933	0.911
	NA	0.983	0.972	0.97	0.97	0.973	0.97	0.978	0.969
	NA	0.964	0.939	0.934	0.934	0.935	0.934	0.932	0.936
	NA	0.989	0.571	0.536	0.536	0.813	0.789	0.791	0.795
	NA	0.972	0.973	0.979	0.98	0.863	0.935	0.865	0.933
	NA	0.972	0.979	0.98	0.98	0.887	0.97	0.868	0.971
	NA								
	NA	1	0.974	0.977	0.93	0.987	0.998	1	1
	NA	0.01	0.025	0.049	0.111	0.955	0.579	0.866	0.816
	NA	1	0.901	0.893	0.865	0.851	0.996	1	1
	NA	0.678	0.622	0.616	0.54	0.505	0.982	0.605	0.685
	NA	0.96	0.932	0.94	0.849	0.966	0.902	0.966	0.976
	NA	0.765	0.066	0.214	0.037	0.113	0.81	0.168	0.225
NA	NA	0.031	0.067	0.075	0.104	0.14	0.869	0.037	0.035
	NA								
	NA	1	0.221	0.214	0.037	0.77	0.985	1	1
	NA	0.822	0.065	0.064	0.039	0.582	0.719	0.149	0.084
	NA	1	0.174	0.159	0.042	0.72	0.974	1	1
	NA	0.782	0.1	0.087	0.038	0.714	0.965	0.003	0.002
	NA	0.965	0.046	0.049	0.043	0.545	0.508	0.142	0.108
	NA	0.944	0.033	0.031	0.043	0.045	0.935	0.915	0.957
	NA	0.021	0.011	0.011	0.026	0.034	0.941	0	0
	NA								
	NA	1	0.008	0.009	0.056	0.156	1	0.994	0.986
	NA	1	0.028	0.029	0.716	0.466	0.379	0.286	0.153
	NA	1	0.009	0.011	0.058	0.118	1	0.94	0.927
	NA	1	0.002	0.002	0.716	0.387	0.526	0.001	0
	NA	0.97	0.038	0.045	0.09	0.211	0.172	0.16	0.141
	NA	0.943	0.001	0.001	0.021	0.009	0.249	0.889	0.938
	NA	0.113	0.051	0.047	0.219	0.054	0.108	0.046	0.042

Table 22: 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
	NA	0.972	0.084	0.081	0.089	0.696	0.987	0.403	0.264
	NA	0.900	0.073	0.068	0.090	0.605	0.979	0.114	0.089
	NA	0.187	0.079	0.078	0.086	0.118	0.928	0.091	0.090
NA	NA	0.840	0.061	0.060	0.112	0.235	0.414	0.194	0.125
	NA	0.837	0.001	0.001	0.078	0.509	0.936	0.003	0.006
	NA	0.981	0.118	0.111	0.096	0.409	0.340	0.213	0.195
	NA	0.048	0.062	0.062	0.082	0.138	0.889	0.015	0.017

Table 23: 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
	NA								
	NA	0.996	0.989	0.989	0.989	0.997	0.995	0.999	0.996
	NA	0.931	0.886	0.901	0.899	0.951	0.929	0.948	0.935
	NA	0.989	0.981	0.979	0.979	0.982	0.976	0.985	0.977
	NA	0.976	0.948	0.942	0.942	0.946	0.944	0.946	0.944
	NA	0.997	0.663	0.622	0.622	0.858	0.835	0.839	0.839
	NA	0.984	0.987	0.989	0.99	0.914	0.957	0.905	0.959
	NA	0.984	0.988	0.989	0.989	0.925	0.986	0.906	0.986
	NA								
	NA	1	0.989	0.992	0.954	0.994	0.999	1	1
	NA	0.043	0.046	0.098	0.152	0.957	0.647	0.872	0.82
	NA	1	0.933	0.933	0.896	0.893	0.999	1	1
	NA	0.801	0.736	0.722	0.639	0.564	0.991	0.712	0.796
	NA	0.975	0.958	0.966	0.903	0.972	0.932	0.977	0.983
	NA	0.804	0.102	0.278	0.062	0.187	0.85	0.221	0.28
NA	NA	0.048	0.131	0.141	0.153	0.23	0.901	0.063	0.059
	NA								
	NA	1	0.33	0.316	0.088	0.821	0.991	1	1
	NA	0.837	0.116	0.118	0.09	0.637	0.769	0.179	0.106
	NA	1	0.264	0.249	0.088	0.769	0.984	1	1
	NA	0.832	0.197	0.178	0.079	0.757	0.979	0.006	0.009
	NA	0.982	0.095	0.107	0.112	0.656	0.597	0.216	0.172
	NA	0.962	0.075	0.074	0.088	0.085	0.959	0.948	0.98
	NA	0.03	0.026	0.027	0.066	0.087	0.967	0.006	0.004
	NA								
	NA	1	0.034	0.031	0.12	0.277	1	0.997	0.989
	NA	1	0.059	0.064	0.734	0.53	0.441	0.325	0.199
	NA	1	0.036	0.031	0.112	0.192	1	0.962	0.949
	NA	1	0.006	0.006	0.725	0.455	0.6	0.003	0.002
	NA	0.986	0.093	0.103	0.166	0.298	0.24	0.244	0.206
	NA	0.96	0.011	0.012	0.065	0.029	0.359	0.922	0.956
	NA	0.176	0.106	0.106	0.284	0.122	0.184	0.089	0.095

Spatial

Table 24: Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for theoretical residuals using the KS normality test. 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: Lognorm error	C: Misp RE
Anderson-Darling	Pearson	0.044	0.914	1.000	1.000
Anderson-Darling	one-step Generic	0.028	0.913	1.000	0.936
Anderson-Darling	one-step Gaussian	0.028	0.914	1.000	0.952
Anderson-Darling	full Gaussian	0.028	0.914	1.000	0.952
Anderson-Darling	cdf	0.029	0.914	1.000	0.951
Anderson-Darling	MCMC	0.063	0.914	1.000	0.347
Anderson-Darling	Unconditional ecdf, Rotated	0.264	0.986	1.000	0.990
Anderson-Darling	Unconditional ecdf, Not Rotated	0.539	0.965	1.000	0.999
Anderson-Darling	Conditional ecdf, Rotated	0.338	0.989	1.000	1.000
Anderson-Darling	Conditional ecdf, Not Rotated	0.216	0.969	1.000	1.000
Kolmogorov- Smirnov	Pearson	0.046	0.733	1.000	1.000
Kolmogorov- Smirnov	one-step Generic	0.037	0.733	1.000	0.706
Kolmogorov- Smirnov	one-step Gaussian	0.037	0.733	1.000	0.706
Kolmogorov- Smirnov	full Gaussian	0.037	0.733	1.000	0.706
Kolmogorov- Smirnov	cdf	0.037	0.733	1.000	0.711
Kolmogorov- Smirnov	MCMC	0.061	0.733	1.000	0.153
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.036	0.788	1.000	0.782
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.438	0.733	1.000	0.999
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.050	0.802	1.000	1.000
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.039	0.732	1.000	1.000
Spatial Autocorrelation	Pearson	0.059	0.944	0.059	0.618
Spatial Autocorrelation	one-step Generic	0.056	0.944	0.002	0.234
Spatial Autocorrelation	one-step Gaussian	0.056	0.944	0.004	0.288
Spatial Autocorrelation	full Gaussian	0.056	0.944	0.004	0.288
Spatial Autocorrelation	cdf	0.056	0.944	NA	0.232
Spatial Autocorrelation	MCMC	0.068	0.944	0.000	0.117
Spatial Autocorrelation	Unconditional ecdf, Rotated	0.052	0.908	0.003	0.069
Spatial Autocorrelation	Unconditional ecdf, Not Rotated	0.945	0.927	0.182	0.881
Spatial Autocorrelation	Conditional ecdf, Rotated	0.062	0.913	0.062	0.177
Spatial Autocorrelation	Conditional ecdf, Not Rotated	0.054	0.928	0.055	0.203

Table 25: Spatial Model. Type I error rates and Power evaluated for each analytical and simulation method for estimated residuals using the KS normality test. 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: Lognorm error	C: Misp RE
Anderson-Darling	Pearson	0.003	0.031	0.077	0.015
Anderson-Darling	one-step Generic	0.033	0.033	NA	0.000
Anderson-Darling	one-step Gaussian	0.031	0.024	0.065	0.034
Anderson-Darling	full Gaussian	0.041	0.029	0.068	0.027
Anderson-Darling	cdf	0.049	0.031	0.068	0.092
Anderson-Darling	MCMC	0.032	0.027	0.092	0.052
Anderson-Darling	Unconditional ecdf, Rotated	0.286	0.286	0.999	0.791
Anderson-Darling	Unconditional ecdf, Not Rotated	0.133	0.171	0.998	0.759
Anderson-Darling	Conditional ecdf, Rotated	0.058	0.294	0.996	0.287
Anderson-Darling	Conditional ecdf, Not Rotated	0.031	0.152	0.993	0.268
Kolmogorov- Smirnov	Pearson	0.112	0.001	1.000	0.571
Kolmogorov- Smirnov	one-step Generic	0.005	0.001	NA	0.000
Kolmogorov- Smirnov	one-step Gaussian	0.005	0.001	1.000	0.252
Kolmogorov- Smirnov	full Gaussian	0.005	0.001	1.000	0.286
Kolmogorov- Smirnov	cdf	0.018	0.001	1.000	0.292
Kolmogorov- Smirnov	MCMC	0.034	0.001	1.000	0.156
Kolmogorov- Smirnov	Unconditional ecdf, Rotated	0.008	0.001	0.997	0.162
Kolmogorov- Smirnov	Unconditional ecdf, Not Rotated	0.061	0.001	1.000	0.428
Kolmogorov- Smirnov	Conditional ecdf, Rotated	0.092	0.002	0.997	0.495
Kolmogorov- Smirnov	Conditional ecdf, Not Rotated	0.107	0.001	1.000	0.575
Lilliefors	Pearson	0.071	0.066	1.000	0.389
Lilliefors	one-step Generic	0.064	0.066	NA	0.000
Lilliefors	one-step Gaussian	0.064	0.066	1.000	0.478
Lilliefors	full Gaussian	0.064	0.066	1.000	0.470
Lilliefors	cdf	0.076	0.066	1.000	0.494
Lilliefors	MCMC	0.043	0.066	1.000	0.212
Lilliefors	Unconditional ecdf, Rotated	0.175	0.175	1.000	0.705
Lilliefors	Unconditional ecdf, Not Rotated	0.122	0.146	1.000	0.848
Lilliefors	Conditional ecdf, Rotated	0.097	0.159	1.000	0.429
Lilliefors	Conditional ecdf, Not Rotated	0.079	0.135	1.000	0.429
Spatial Autocorrelation	Pearson	0.022	0.944	0.111	0.179
Spatial Autocorrelation	one-step Generic	0.048	0.944	NA	0.000
Spatial Autocorrelation	one-step Gaussian	0.048	0.944	0.105	0.254
Spatial Autocorrelation	full Gaussian	0.048	0.944	0.101	0.269
Spatial Autocorrelation	cdf	0.048	0.944	0.105	0.237
Spatial Autocorrelation	MCMC	0.061	0.944	0.111	0.208
Spatial Autocorrelation	Unconditional ecdf, Rotated	0.051	0.922	0.141	0.211
Spatial Autocorrelation	Unconditional ecdf, Not Rotated	0.950	0.938	0.156	0.938
Spatial Autocorrelation	Conditional ecdf, Rotated	0.022	0.919	0.167	0.176
Spatial Autocorrelation	Conditional ecdf, Not Rotated	0.021	0.934	0.157	0.180

Table 26: 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.