Figure 1. (corresponding to Figure 4 in the original manuscript) Histogram of selected cell properties at peaks (a) and the corresponding growth/decay rates (b) fitted probability distributions.
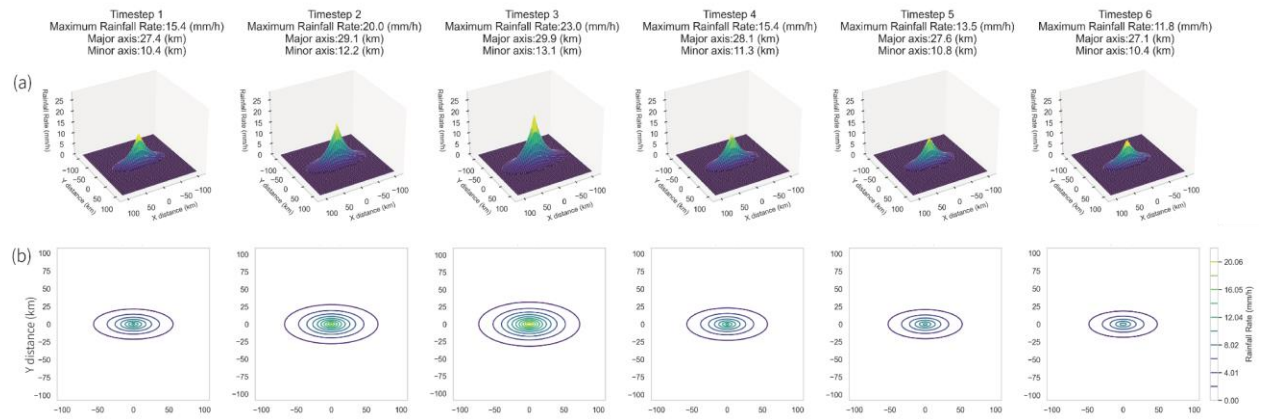
Figure 2. (new figure will be added to the revised manuscript) An illustrative example of a convective cell lifecycle sampled from the proposed algorithm. Here, the EXCELL model is incorporated to further generate convective cells with spatially-distributed rainfall intensities at each time step based on the sampled properties.
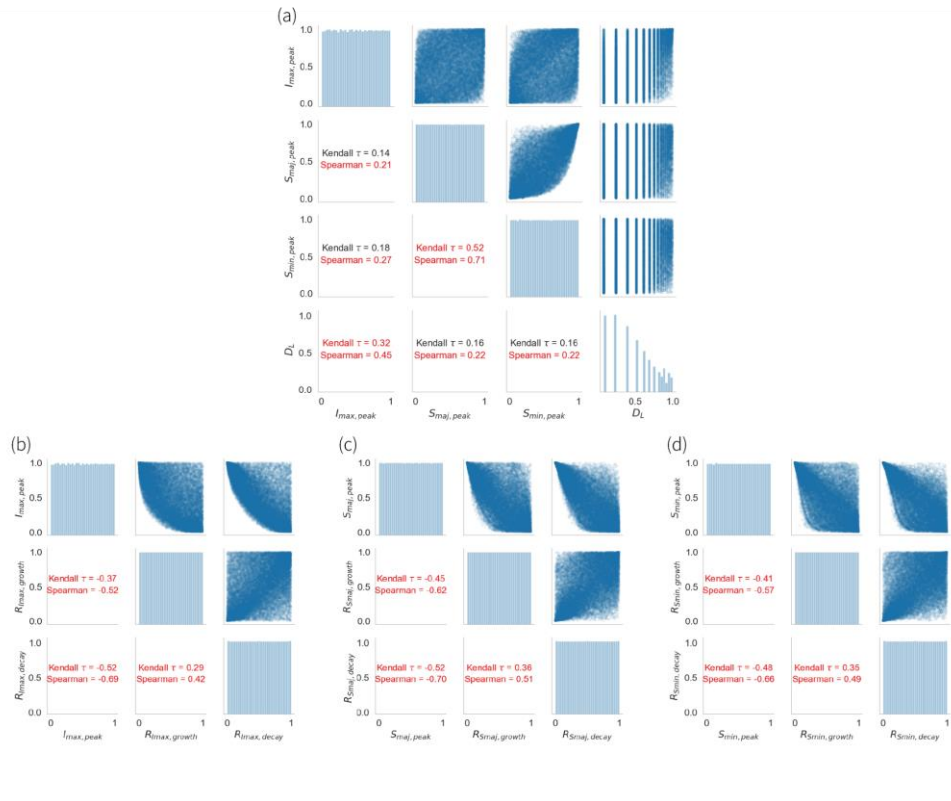
Figure 3. (corresponding to Figure 5 in the original manuscript) Correlation analyses amongst selected cell properties: (a) between peak properties; (b)-(d) between each peak property and the associated growth and decay rates.
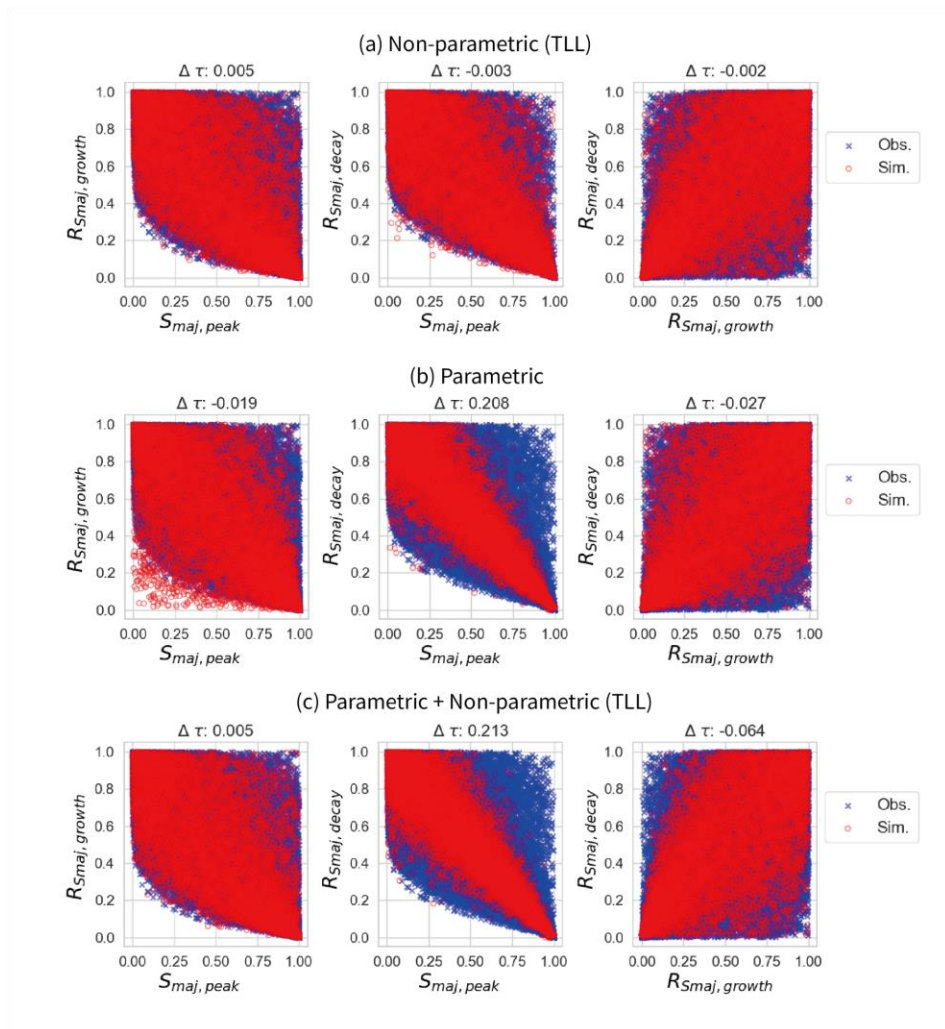
Figure 4. (new figure to be added in the Supplement S2) Visual inspection of the fitting results of parametric, non-parametric and mixed copula models.
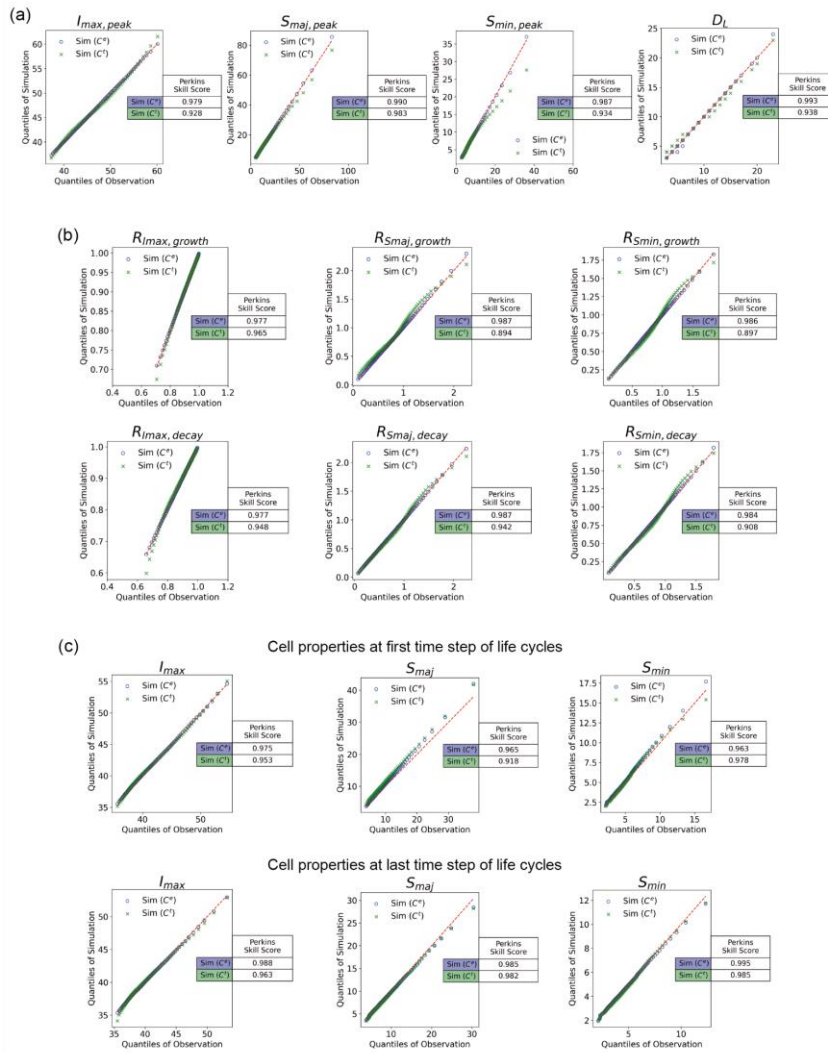
Figure 5. Q-Q plots for the comparisons between the observed and simulated cell properties. Plots in (a), (b) and (c) correspond to Figures 8, 10 and 13 in the manuscript respectively.
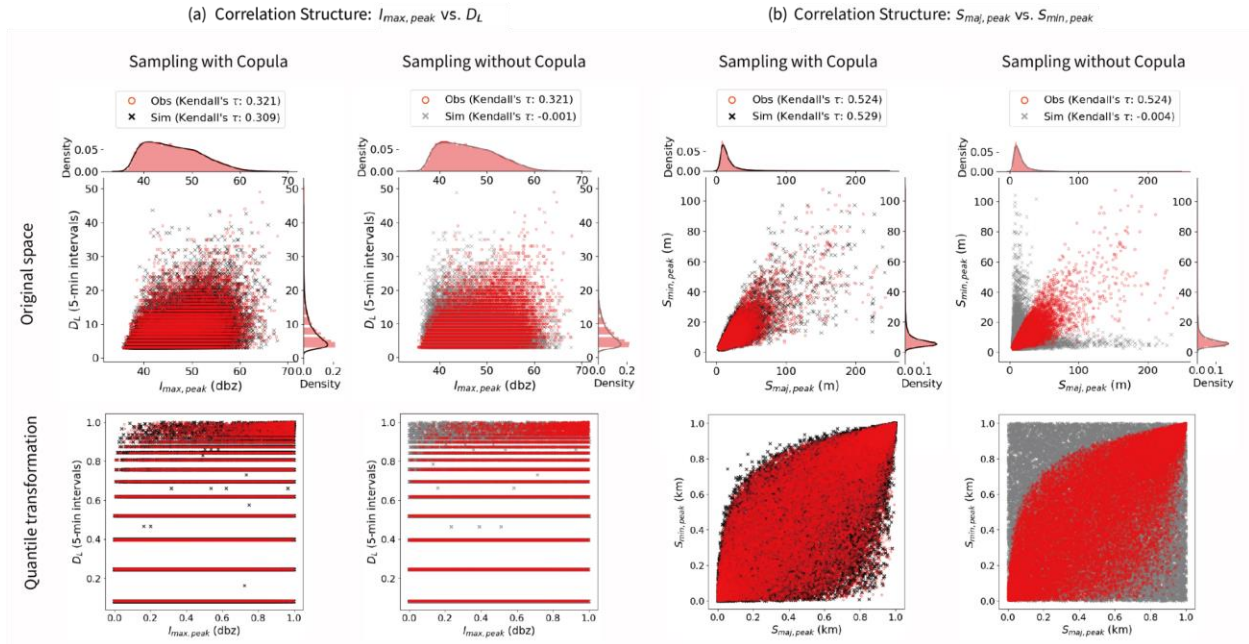
Figure 6. (corresponding to Figure 9 in the original manuscript) A Comparison of dependence structures between observed and simulated cell lifecycle samples: (a) $I_{max, peak}$ vs. D_L and (b) $S_{maj, peak}$ vs. $S_{min, peak}$. The left column in (a) and (b) presents results incorporating copula modelling (black crosses: observed, red dots: simulated), and the right column shows results without copula modelling (grey crosses: observed, red dots: simulated). The upper row displays dependence structure in the original variable space, while the lower row shows after applying the quantile transformation.
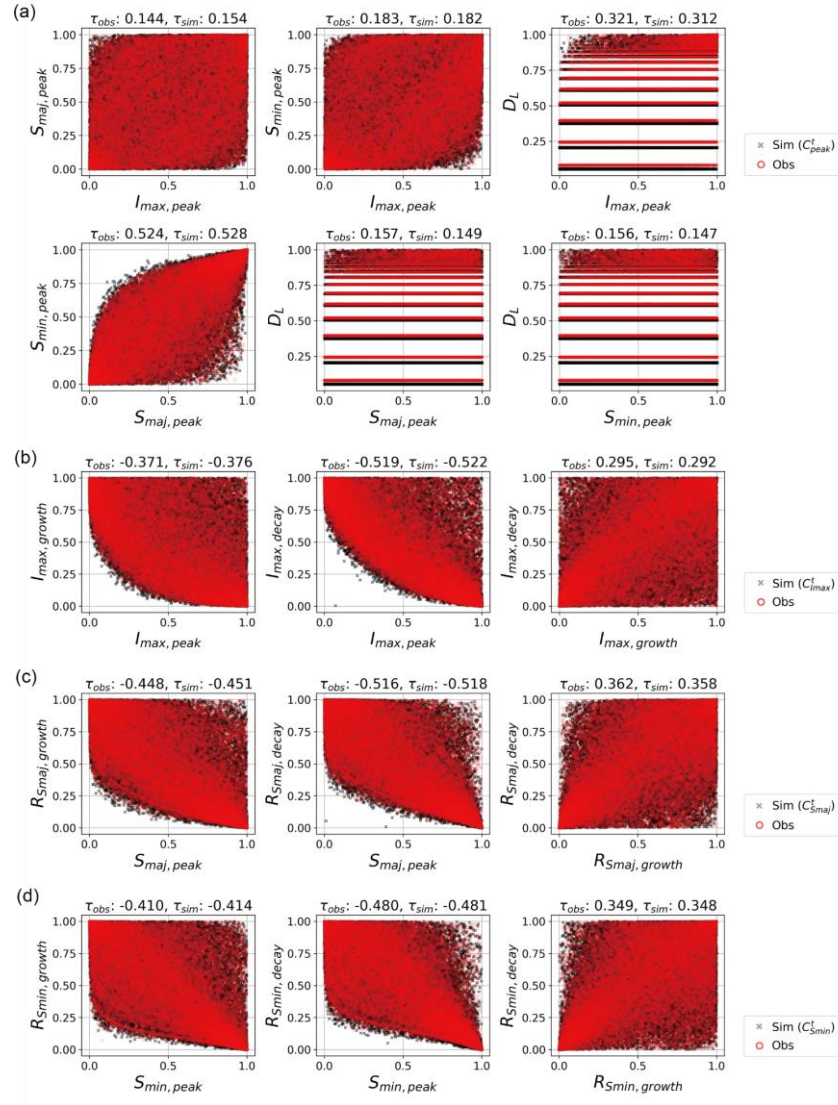
Figure 7. (corresponding to Figure 11 in the original manuscript) Comparisons of the dependence structure between observed (red round markers) and simulated properties obtained from an arbitrary ensemble member. From top to bottom, each row represents results derived from a specific copula model (C_{peak}, C_{Imax}, C_{Smaj}, and C_{Smin}).

Table 1. (corresponding to Table 1 in the original manuscript) Summary of key properties to conceptualise the lifecycle model and the corresponding optimal probability distribution and parameters.

Property	Description	Fitted distribution	Distribution parameters	AIC
Duration				
D_L	Total time duration of the cycle (5-min intervals)	Exponential	$\lambda=0.239, \gamma=3.000$	1.33E+05
Peak				
$I_{max,peak}$	Maximum intensity at peak (km)	Weibull	$\alpha=12.029, \beta=1.972, \gamma=35.528$	1.71E+05
$S_{maj,peak}$	Major axis length at peak (km)	Loglogistic	$\alpha=9.807, \beta=2.261, \gamma=3.216$	1.93E+05
$S_{min,peak}$	Minor axis length at peak (km)	Loglogistic	$\alpha=4.524, \beta=2.599, \gamma=1.915$	1.43E+05
Temporal variation				
$R_{Imax,growth}$	The ratio of the initial to the peak maximum intensity (dbz/dbz)	Beta	$\alpha=13.373, \beta=1.329$	-7.93E+04
$R_{Imax,decay}$	The ratio of the last to the peak maximum intensity (dbz/dbz)	Beta	$\alpha=10.636, \beta=1.44$	-6.53E+04
$R_{Smaj,growth}$	The ratio of the initial to peak major axis length (km/km)	Gamma	$\alpha=0.255, \beta=3.074, \gamma=0$	2.75E+04
$R_{Smaj,decay}$	Ratio of the last to peak major axis length (km/km)	Weibull	$\alpha=0.830, \beta=1.654, \gamma=0.016$	2.95E+04
$R_{Smin,growth}$	Ratio of the initial to peak minor axis length (km/km)	Weibull	$\alpha=0.901, \beta=2.374, \gamma=0$	1.94E+04
$R_{Smin,decay}$	Ratio of the last to peak minor axis length (km/km)	Weibull	$\alpha=0.857, \beta=2.132, \gamma=0$	2.19E+04

Table 2. (corresponding to Table 2 in the original manuscript) Comparative evaluation of different copula models based on Akaike Information Criterion (AIC) and log-likelihood metrics.

Vine-copula model	Control of Bivariate Family	AIC	log-likelihood
C_{peak}	TLL	-37314.823	18912.031
	Parametric	-32815.206	16416.603
	TLL and Parametric	**-37362.077**	**18893.488**
C_{Imax}	**TLL**	**-46064.656**	**23172.394**
	Parametric	-92409.25	46210.625
	TLL and Parametric	-95783.66	47942.412
C_{Smaj}	**TLL**	**-40263.157**	**20269.259**
	Parametric	-29212.414	14611.207
	TLL and Parametric	-40262.747	20269.104
C_{Smin}	**TLL**	**-42428.612**	**21353.235**
	Parametric	-39033.233	19521.616
	TLL and Parametric	-42427.892	21352.897