

Compensation between 2 groups

May 17, 2021

We want to emulate the dynamics of the subset Cormorant vs. HeronEgret. The HeronEgret (HE) group is, on average, more abundant ($\mu_{HE} = 473$ vs $\mu_C = 203$), more variable ($\sigma_{HE} = 729$ vs $\sigma_C = 191$) and has a wider amplitude of variation ($r_{HE} = [0; 4000]$ vs $r_C = [0; 1150]$) than the Cormorant group. We want to make sure that wavelet analyses can detect compensation even in those cases. Compensation is simulated by species being in antiphase.

Simulations

Raw value

We use simulations similar to those in the 2nd review for JAE, i.e. : at each time step, abundances are drawn from $\mathcal{N}(\mu_t, \Sigma)$ with $\mu_{t,i} = \mu_i \mu_{\min} + \mu_i (\mu_{\max} - \mu_{\min})(1 + 0.5 \sin(\frac{2\pi t}{P}) + \phi_i)$ with $\boldsymbol{\mu} = (200, 500)$, $\mu_{\max} = 0.9$, $\mu_{\min} = 0.1$, $\phi = (0, \pi)$ and $P = 12$. The variance-covariance matrix $\Sigma_{ii} = \sigma_i^2$ with $\sigma_1 = 0.5\mu_1$ (in line with the previous simulations) and $\sigma_2 = 4\sigma_1$ and $\Sigma_{ij} = 0 \forall i \neq j$.

The corresponding time series are the following :

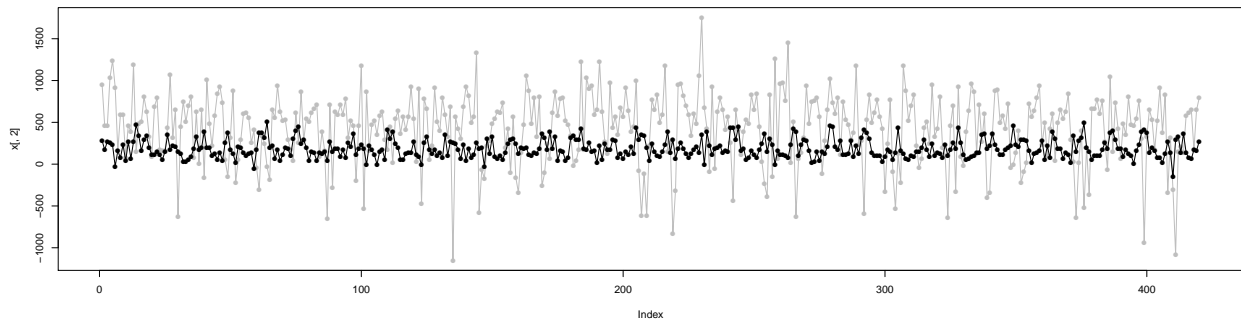


Figure 1: Simulated time series for a 2-species subset

The problem with this simulation is that we have negative values and are far from the skewed distribution of abundance that is observed in reality.

Using 1000 surrogates, we obtain the following wavelet analysis.

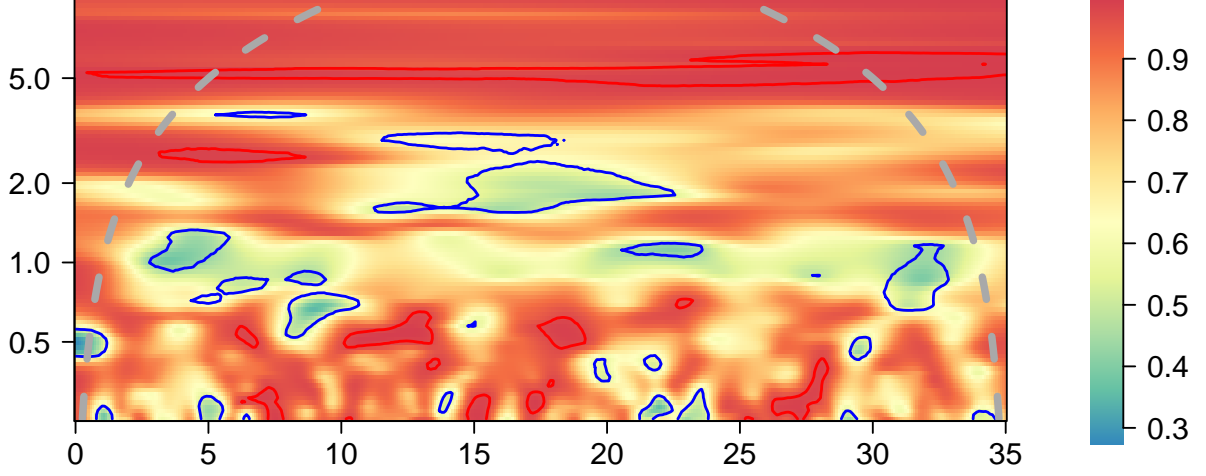


Figure 2: Wavelet analysis

Logged abundance

To keep positive values, we can use a logscale throughout the simulations.

In this case, μ_t follows $\exp(\mathcal{N}(\log(\mu_{t,i}), \Sigma'))$, with $\log(\mu_{t,i}) = \log(\mu_i \mu_{\min} + \mu_i (\mu_{\max} - \mu_{\min})(1 + 0.5 \sin(\frac{2\pi t}{P}) + \phi_i))$ and $\sigma'_1 = \sigma'_2 = 1$ (extracted through trial error, this leads to standard deviations with a ratio similar to the one observed in the actual dataset, i.e. $\sigma_1 = 243$ and $\sigma_2 = 827$)

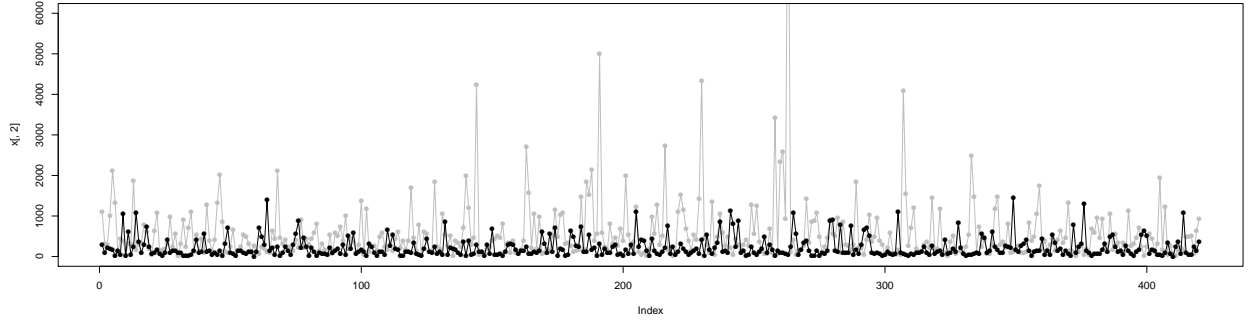


Figure 3: Simulated time series for a 2-species subset, simulation in logscale

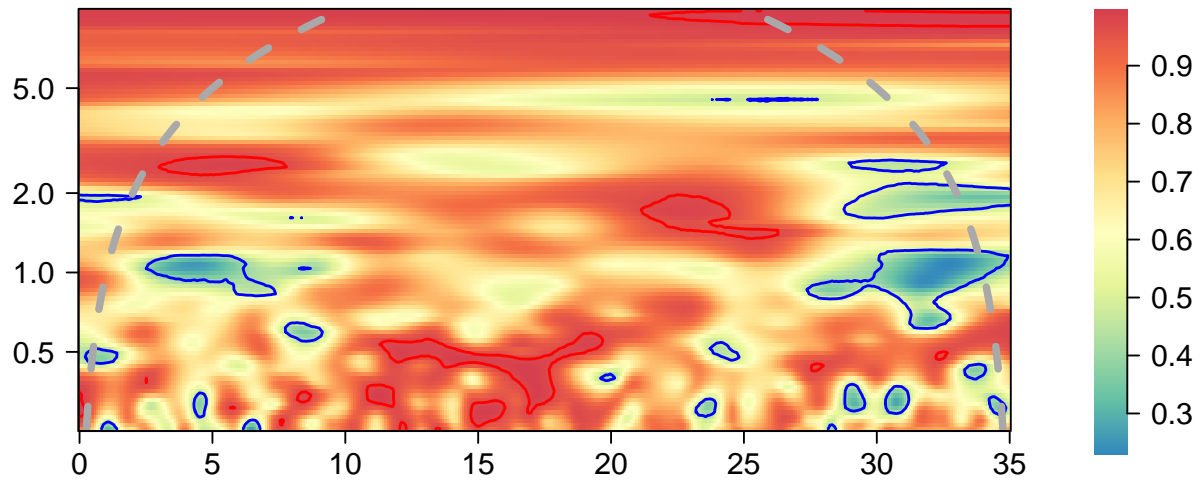


Figure 4: Wavelet analysis, simulation in logscale