This is a quick orientation to the MATLAB codes used to develop models for nutrient (Phosphorus) release by dust and uptake/growth of *Scenedesmus* algae in response to temperature, pH and dust. These models are presented in the paper “Dust storms increase the tolerance of phytoplankton to thermal and pH changes,” by

Juan Manuel González-Olalla, James A Powell and Janice Brahney. The MATLAB code was written by James Powell in May, 2023.

There are four interrelated MATLAB files, including two scripts and two functions called by the scripts. These were developed on MATLAB 2021a and 2022a but should be pretty backward/forward compatible because it’s all vanilla MATLAB. Here’s a quick run-down on the files:

**Nut\_model.m** – The purpose of this script is to parameterize a model for nutrient release from dust in response to varying temperature and pH. The model is assumed to be logistic with a background P offset (*KP*) and multiplier (*a*), and assumes log-normal multiplicative variance.

* In the first cell of the script appears the experimental data.
* The second cell of the script finds best fit parameters by doing a grid search in *a* and *KP*. For each *a, KP* logistic regression is used to find best parameters and resulting negative log log-normal error. The best of these is chosen as the final estimate of parameters.
* The third cell plots the error surface as a density plot, with `best’ parameter location indicated. Also a performance curve (predicted vs. observed) is plotted.

**Scened\_GR.m** – The purpose of this script is to parameterize a model for the net growth of *Scenedesmus* for inputs of temperature, pH and Dust addition. It includes a Briere thermal response in growth (with upper threshold changing according to nutrient availability), a type II model for nutrient uptake (with half-sat constant sensitive to pH and temperature), and a death rate which increases with temperature and displacement from optimal pH. Nutrient production assumes best-fit values from Nut\_model. For this script to run the two additional functions **nllGR.m** and **aGR3.m** must be in the same directory. NOTE: the roles of the parameters c2/c3 and d2/d3 are switched between the code and the paper.

* In the first cell of the script appears the experimental data.
* In the second cell parameters are estimated by directed minimization of posterior log likelihood. Log likelihood for given parameters is calculated by the function nllGR (which itself depends on the rate function aGR3).
* The third cell plots resulting net rate curves as line graphs across Dust, pH and temperature regimes, as well as a performance graph (predicted vs. observed) for the model.
* The fourth cell plots a density plot of rates across temperature and dust inputs for a given pH. Optimal temperature and thermal limits are also plotted.

**nllGR.m** – This is a function that calculates the negative log posterior likelihood for the data, given parameter inputs. Errors are assumed to be distributed normally (sum squared) or according to Laplace (sum absolute). Better AIC result from sun squared error. Priors are weakly informative, a power law with exponent -2. This function needs to have access to **aGR3** to calculate the actual net growth rate for the given parameters.

**aGR3.m** – This function calculates the net growth rate of Scenedesmus for given parameters and inputs of temperature, pH and dust. It includes a Briere thermal response in growth (with upper threshold changing according to nutrient availability), a type II model for nutrient uptake (with half-sat constant sensitive to pH and temperature), and a death rate which increases with temperature and displacement from optimal pH. Nutrient production assumes best-fit values from Nut\_model. NOTE: the roles of the parameters c2/c3 and d2/d3 are switched between the code and the paper.