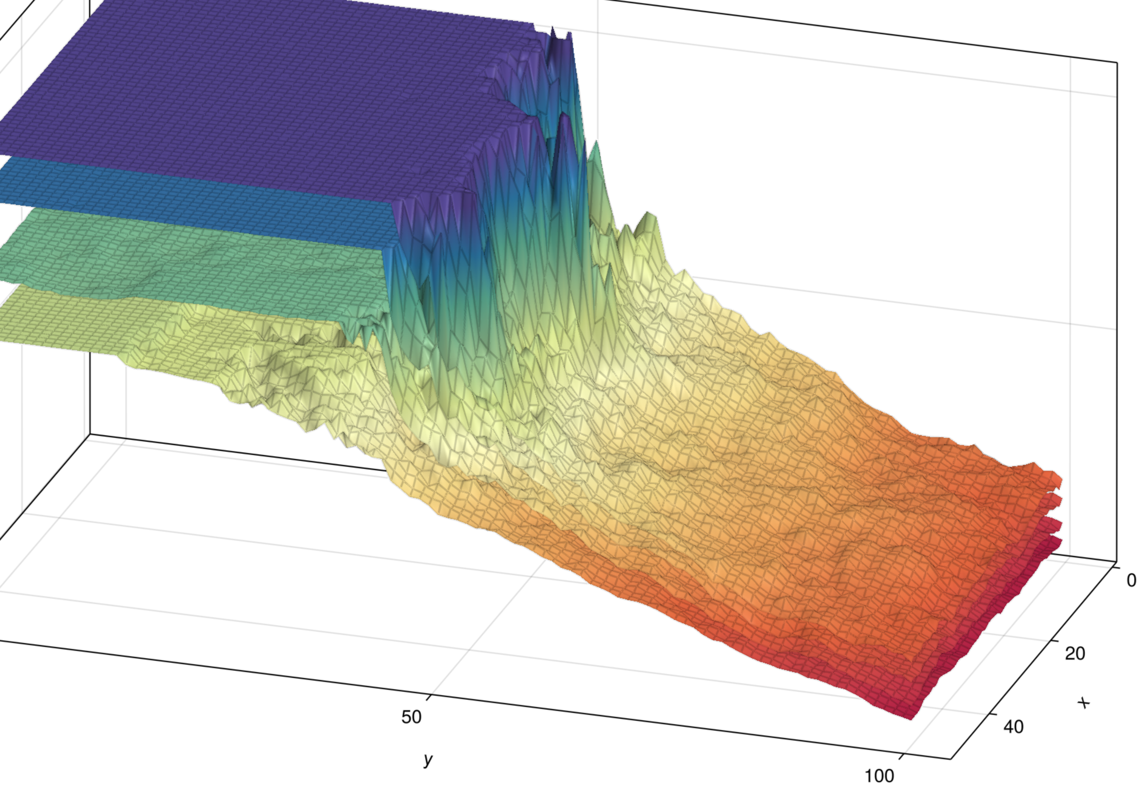
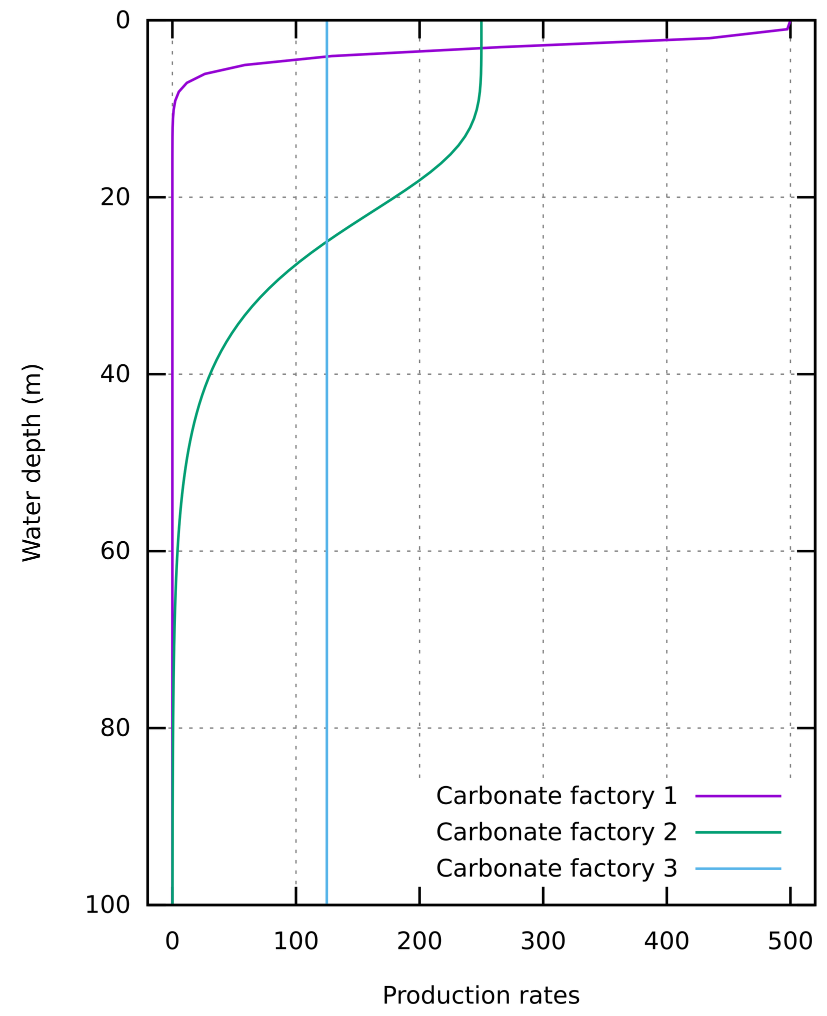


CarboKitten.jl

https://mindthegap-erc.github.io/CarboKitten.jl

Johan Hidding (Netherlands eScience Center)
Xianyi Liu (Utrecht University)
Peter Burgess (University of Liverpool)
Emilia Jarochowska (Utrecht University)



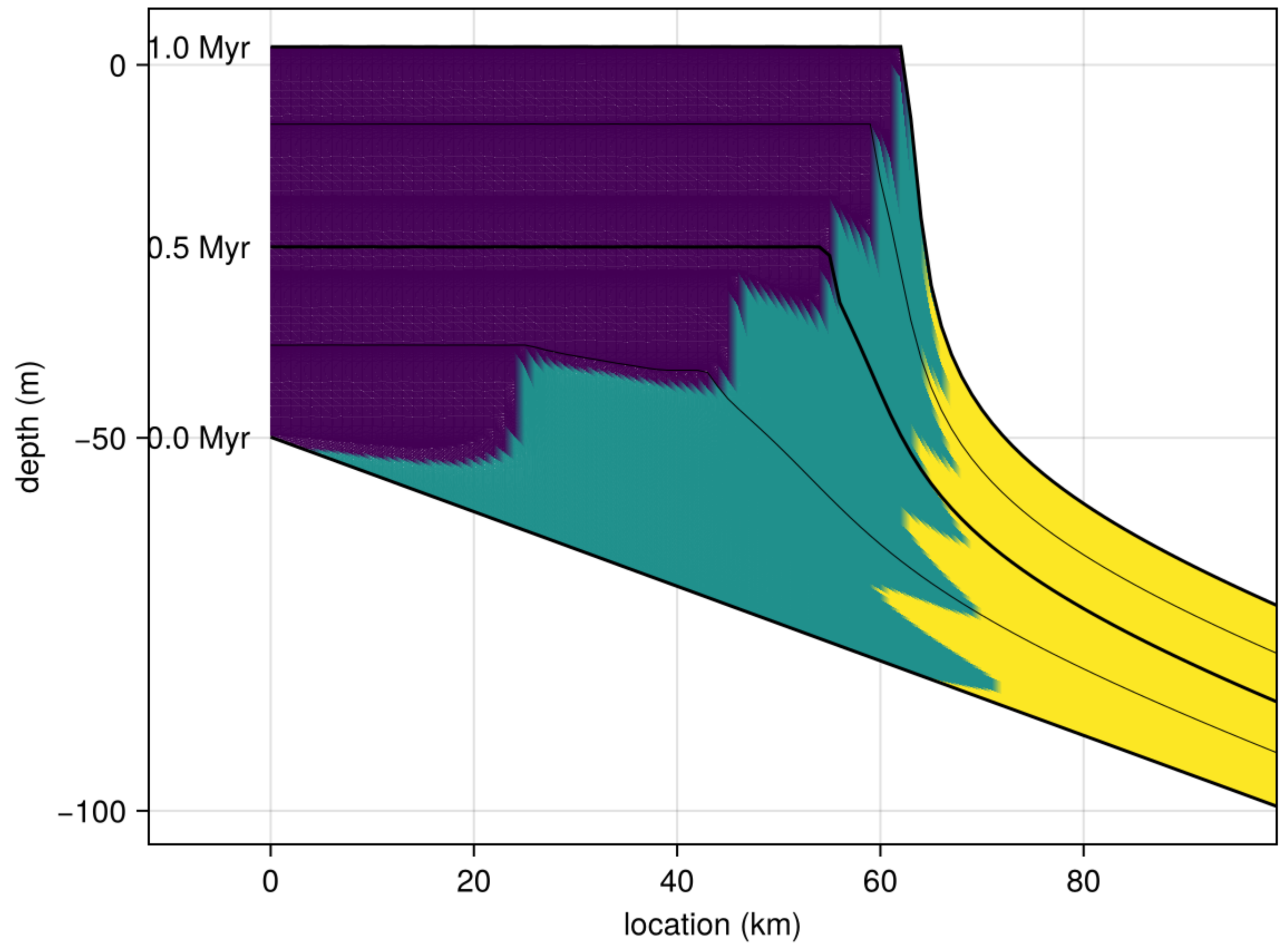
Abstract

Carbonate Platforms form an important source of information on the past evolution of species as well as the climate conditions they lived in. However, stratigraphic records are often considered unreliable tracers of evolution, since they contain many gaps.

These gaps are often on a time scale too short to measure, but may significantly affect further studies of biodiversity and climate change. This is why we use forward modelling to estimate the statistics of gap distributions under a wide variety of environmental parameters. Forward modelling can be used to test hypotheses at time scales that are not available for experimentation. The dominant driver for generating different stratigraphic architectures is the input sea-level curve, balancing periodic (Milankovich), stochastic and subsidence only effects. Added to that are varying degrees self-organisation, sediment transport and subarial erosion.

The basis of our model is sediment production following the model by Bosscher and Schlager (1992), with biological self-organisation modeled after the cellular automaton approach (CarboCAT) by Burgess (2013) and a sediment transport model inspired on Warrlich (2000).

CarboKitten is fully Open Source, written in Julia, aiming for performance, modularity and ease of use. We will show preliminary results produced by CarboKitten and also explain how they are generated.

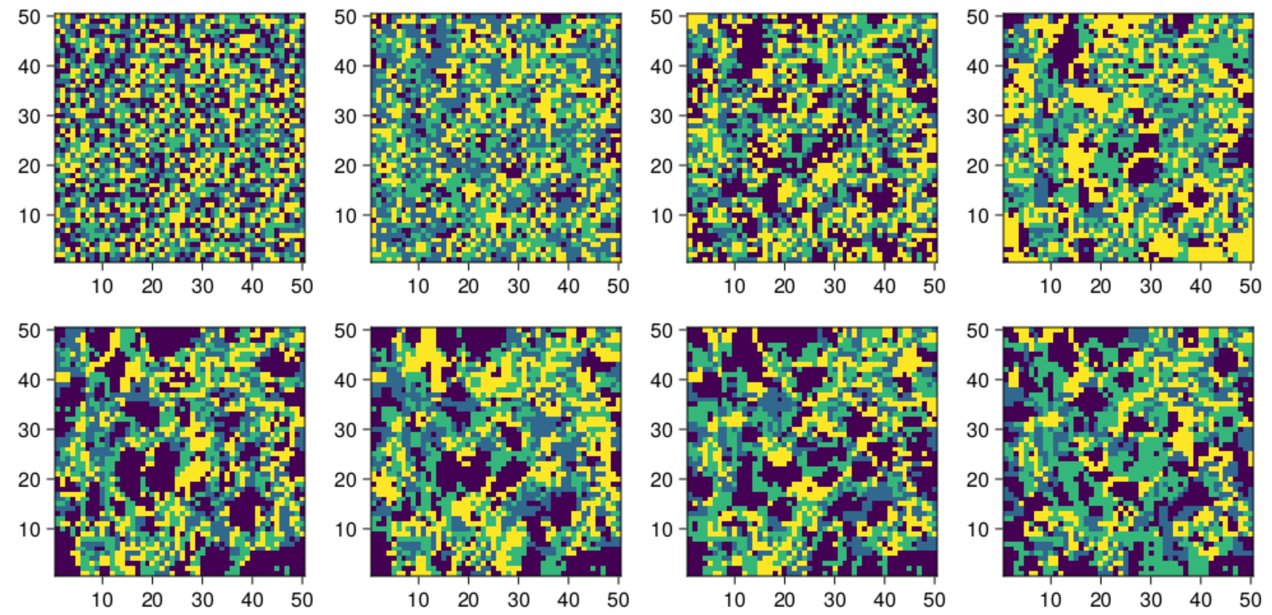


Production

Each carbonate factory produces sediment at a different maximum rate, attenuated by the exponential decay of light passing through the water column above, following the recipe by Bosscher & Schlager (1992).

Sealevel

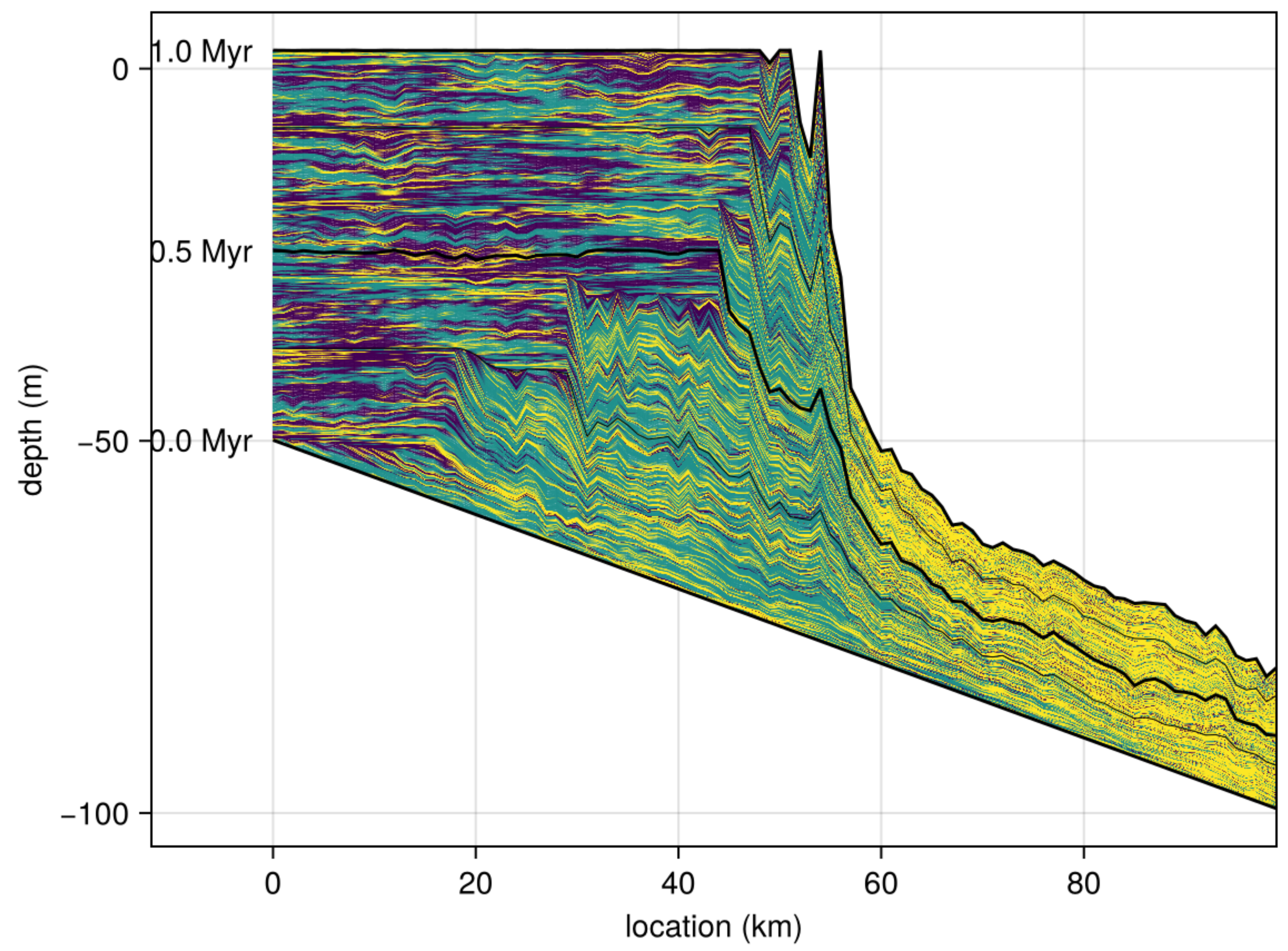
Here we vary the sealevel using a sinus with period of 0.2Myr and 4m amplitude. Subsidence is set at 50m/Myr. For uniform and constant biology we find three regions where different factories dominate.



Cellular Automata

To simulate biological self-organisation, we use cellular automata (CA), following recipes by Burgess (2013) and subsequent publications.

Here we show a sequence of eight states for three facies, starting from uniform random initial conditions.



Stratigraphy

We insert the CA into the previous model to determine which carbonate factory is active on each grid point. We still recognize the different regions where each factory is dominant.

From CarboKitten's output we can extract stratigraphies and age-depth models including gap distributions.

Under development

CarboKitten is still under development. In light of our science use-case, run-time efficiency is one of our main requirements.

Simulation input is specified as a human-friendly Julia file, while output is written to HDF5 for further analysis.

CarboKitten is fully Open Source, and documented by means of Literate Programming. The use of the Julia programming language gives us the performance of a machine native language like C or Fortran, while remaining accessible to beginners like Python.

Features that are still under development include:
- Transport
- Submarine erosion
- Subaerial denudation

After first release, CarboKitten will be open for contributions

Funded by the European Union

European Research Council
Established by the European Commission

Funded by the European Union (ERC, MindTheGap, StG project no 101041077). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council. Neither the European Union nor the granting authority can be held responsible for them.

Photography encouraged

Utrecht University

netherlands eScience center