carbo*

Carbonate Models Converging to a Workbench through CMT

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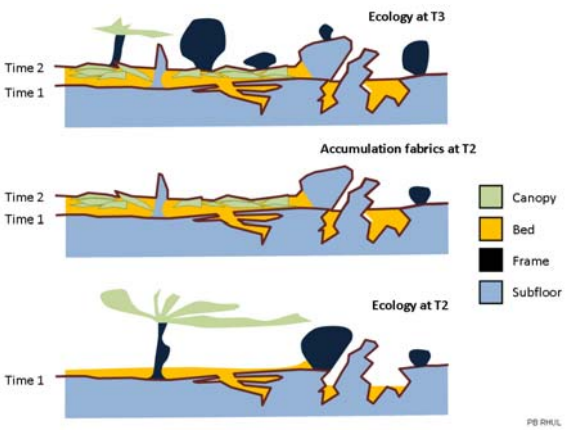
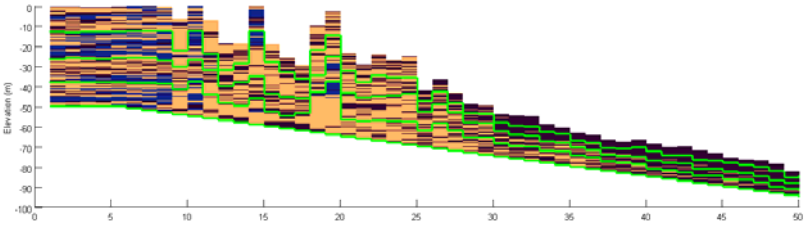
We report on progress of the Carbonate Focus Research Group for 2011. We do this by brief descriptions and graphics from the last year's work.

While individual model development has proceeded, we are positioning for the task of their componentization through CMT.



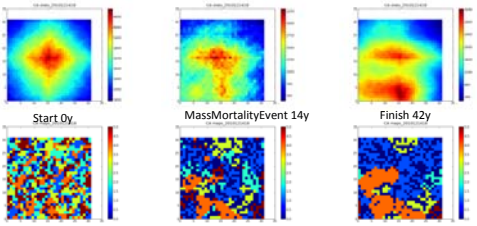
An example from the modeling zonal scheme. The carbonate production is distributed post-mortem into sub-cell zones where different processes operate (e.g. seawater vs groundwater). A geological virtual rock fabric can be constructed.

carboCAT – a cellular automaton modelling of the spatial and environmental growth-accretion relationships of living and material carbonate facies. carboCAT is very good at representing facies geometries and growth patterns. It is able to do that at geographic (e.g.. reef/atoll) and footprint (e.g., transect) scales at yearly to geological timescales.

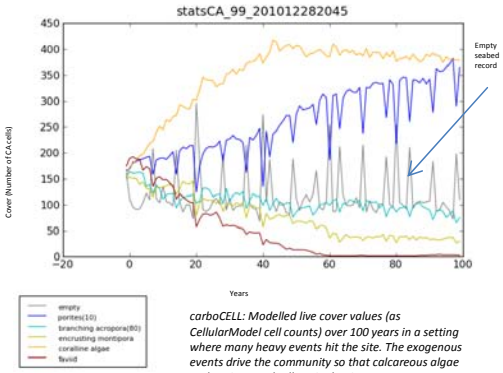


Modelling a Carbonate Platform and ramp with carboCAT. This is a thickness section. The facies have light-growth characteristics and compete for space. Bank, reef and basin geometries emerge from the modelling. Reefs/atolls grow from roughnes elements. Facies: blue, pink, black, red; time lines – green.

carboCELL – a cellular modelling of the spatial and organism competition of living carbonate-producing communities. carboCELL is fashioned on carboCAT but has stochastic methods and exogenous events that mean it is not purely an automaton. The two modules share their data visualization methods.

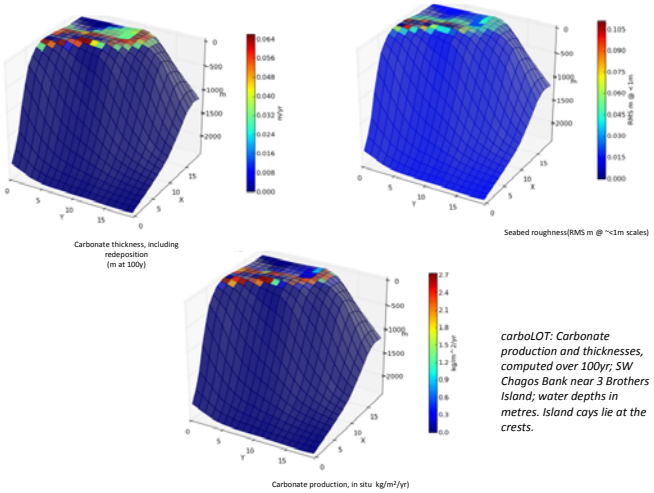


carboCELL: Space and growth competition between organisms leads to varying statistics of sediment/rock heterogeneity, here on scales of 1-100m. Graphics: top are 2D spectra of the sediment classes; bottom are the maps of those classes.

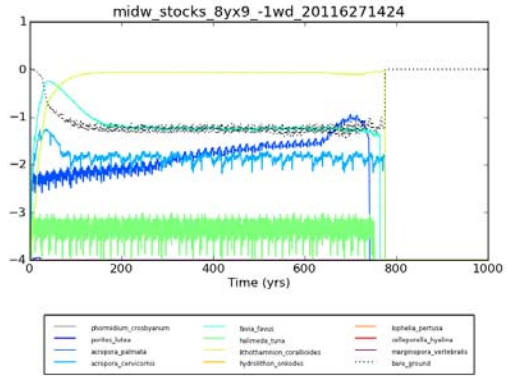


carboCELL: Modelled live cover values (as CellularModel cell counts) over 100 years in a setting where many heavy events hit the site. The exogenous events drive the community so that calcareous algae and Porites gradually gain dominance.

carboLOT – a spatially explicit forward process model of the growth and competition of carbonate producing organisms, based on population ecology and niche suitability principles.



carboLOT: Carbonate production and thicknesses, computed over 100yr; SW Chagos Bank near 3 Brothers Island; water depths in metres. Island cays lie at the crests.



carboLOT: Long-term runs are now being extended, in this case tracking a shallowing-up sequence to emergence at ~800y. Short-period events are visible and affect the space-competition of the organisms.
Here a time-sequence community changes to upwards-shallowing is shown, ending with emergence of the seafllor at this location and cessation of accretion.

- Competition Lotka-Volterra population (calculus) model
- Knowledge base inputs of organism traits and behaviours
- Annual time-steps up to 10,000y in short runs
- Carbonate products are distributed to framework and bed zones to make virtual outcrop/core
- 'Numerical aquarium' selection of the organisms reduces the information-input requirements yet represents the ecosystem processes and structure

Supporting packages now exist for visualization, data transfer and information inputs.

carboKB – a knowledge base (i.e. a database with internal inferencing methods) which provides the necessary inputs on organism growth and reproduction patterns, habitat suitabilities, and geometries. **carboSETUP** – a computed solution for rapid (10 minute) model setup by drawing on global dataset resources such as bathymetry, chlorophyll, irradiance, temperatures, oxygen. **carboKML** – a set of tools for displaying the model outputs in a Google Earth mapping environment. This choice of deliver (only one among several, including GIS) is directed at K12 and university education dispersal of the modelling outcomes.