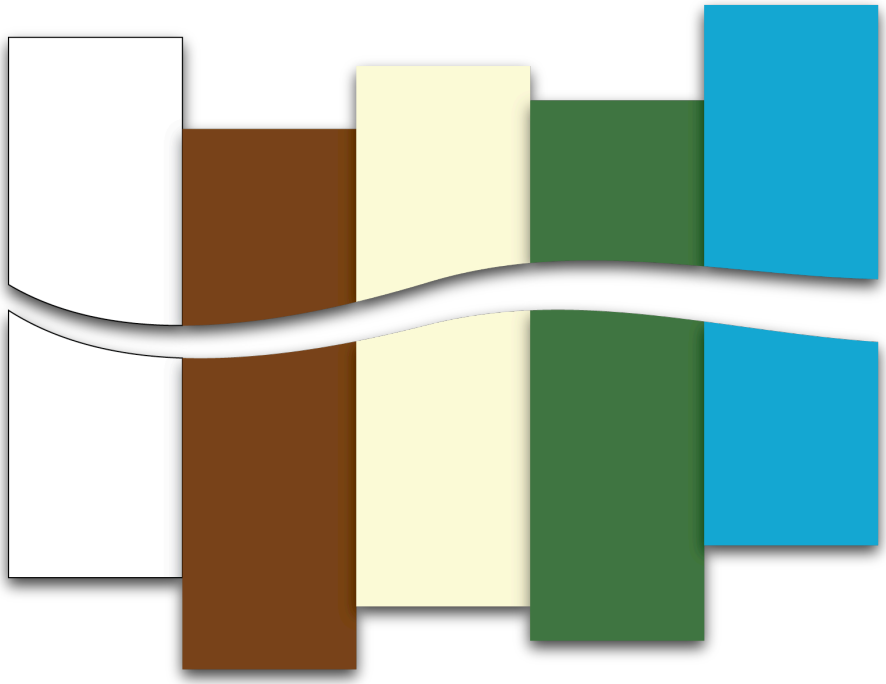
Linking Models: new componentized versions of CSDMS models

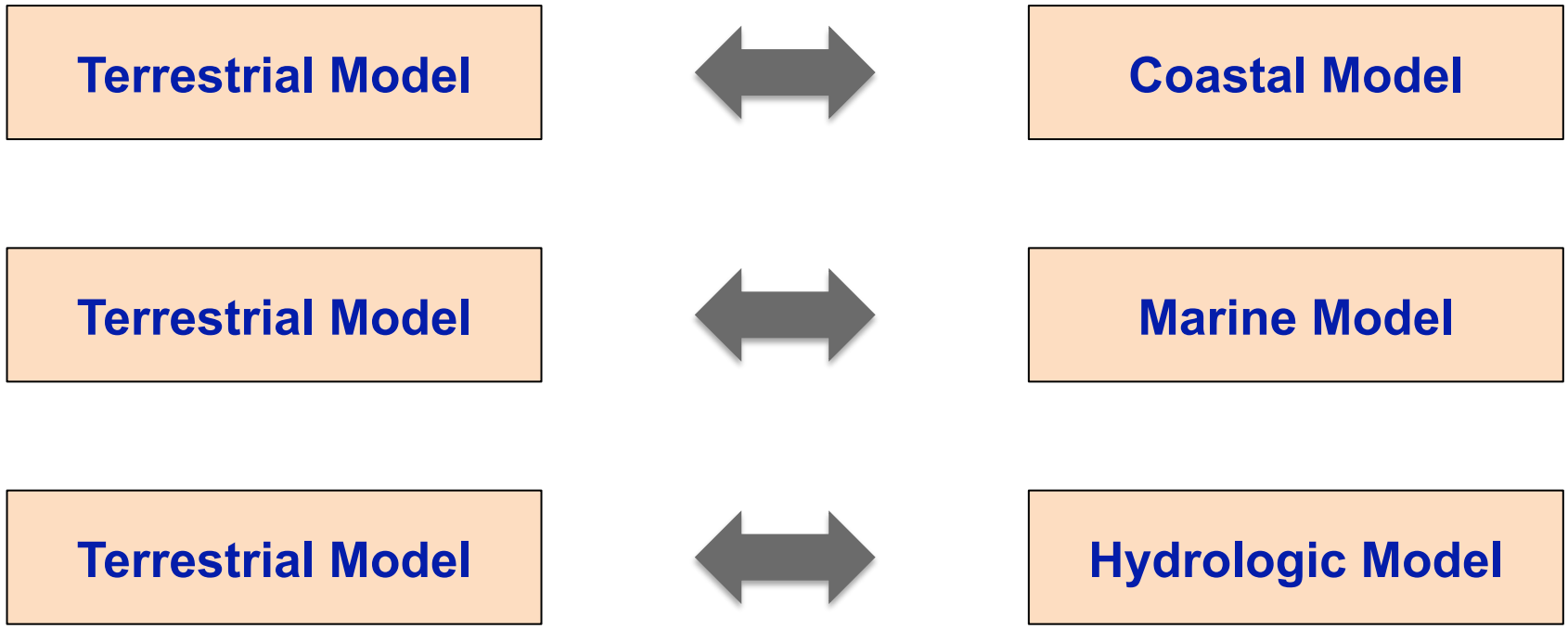
By: **Eric Hutton**

CSDMS is the *Community Surface Dynamics Modeling System*

(pronounced ˈsɪstəms)



Some proof of concept projects that are underway



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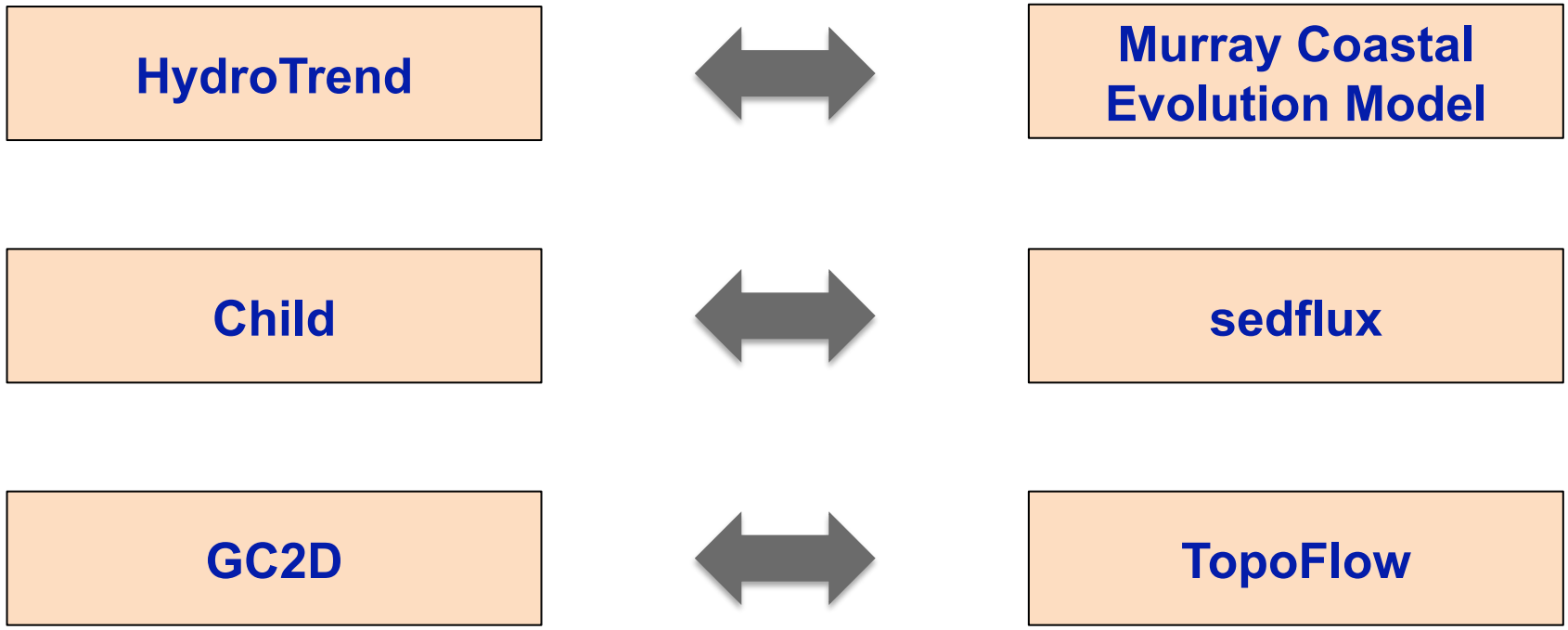

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These models reflect the wide range of models in our community

These 6 models represent:

- 6 authors
- 4 languages
- 4 domains
- 140,000 lines of source code
  - of a total of 215,000 in our repository
- 3 different grids
  - raster, non-uniform mesh, spatially averaged
- 2 different levels of model granularity
  - process and model

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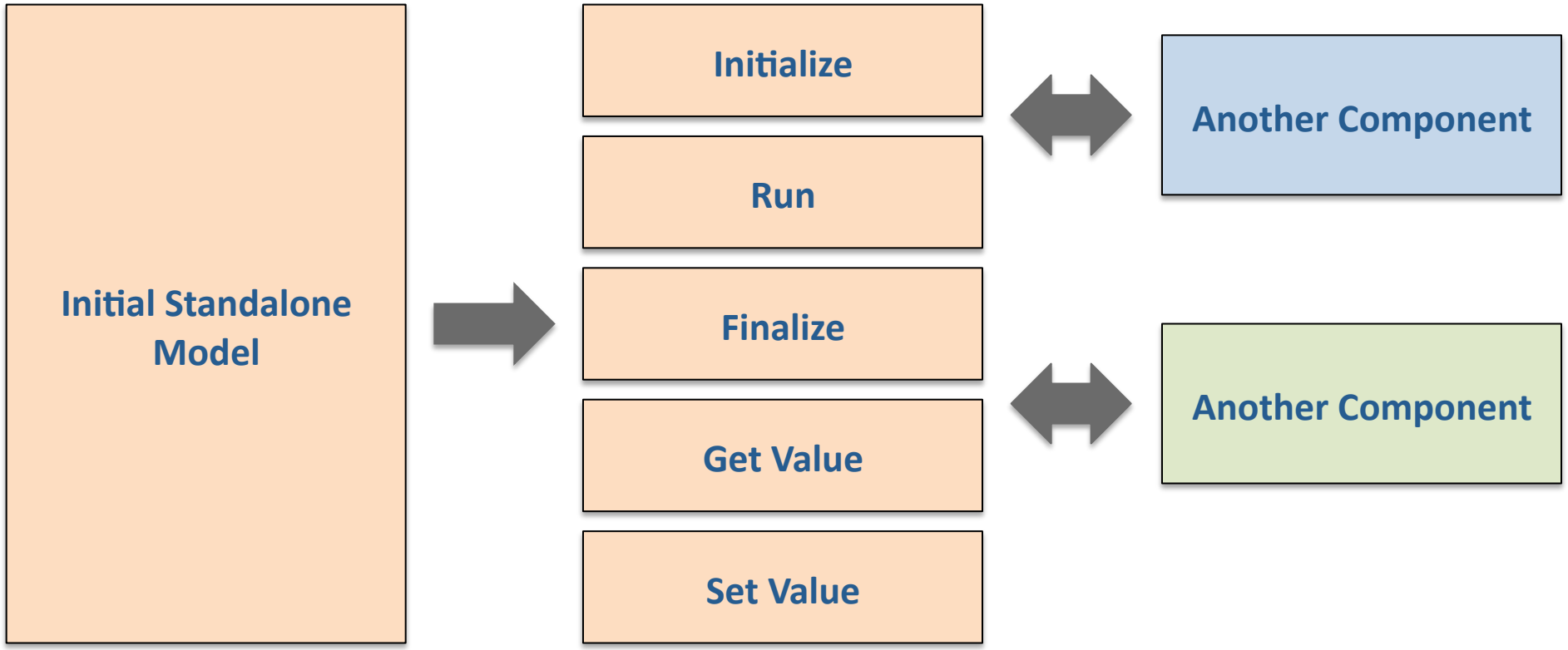
A standalone model is componentized by dividing it into bits that perform tasks that other components can use



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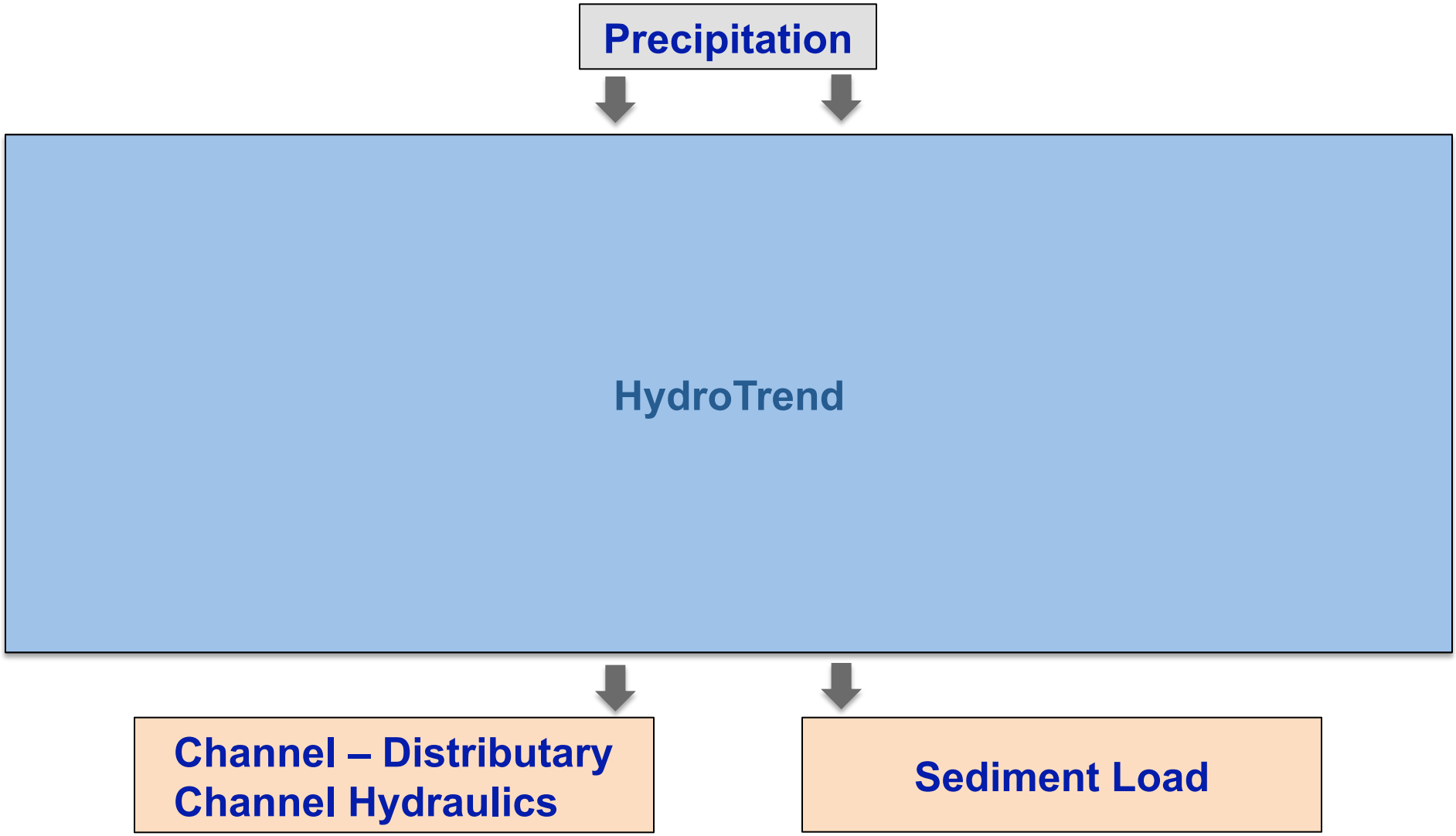
HydroTrend predicts the flux of water and sediment at a river mouth



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HydroTrend predicts the flux of water and sediment at a river mouth

HydroTrend:

- 10,500 lines of C code
- Minimal command line interface
- Input precipitation statistics
- Output river discharge as binary hydrotrend file

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HydroTrend still predicts the flux of water and sediment at a river mouth

HydroTrend:

- 11,300 lines of C code (8% increase – mostly new files)
- API (IRF, and getters and setters)
- Expanded CLI
- GUI (within CCA)
- CCA component

Checkout a version from our model repository:

```
> svn checkout https://csdms.colorado.edu/svn/hydrotrend
```

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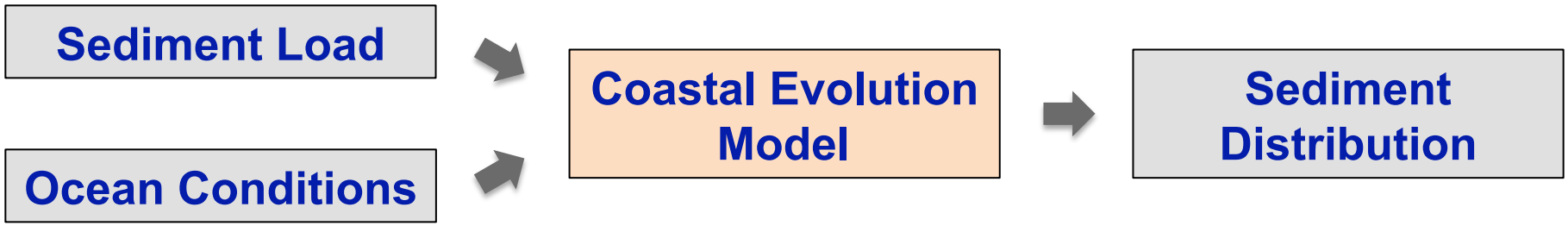
CEM predicts the distribution of sediment after it enters the ocean



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CEM predicts the distribution of sediment after it enters the ocean

CEM:

- 4,300 lines of C code
- No command line interface
- No input files (hardcoded variables)
- Constant sediment supply, wave angle characteristics
- Output bathymetry as text file

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CEM still predicts the distribution of sediment after it enters the ocean

CEM after:

- 4,500 lines of C code (8% increase – mostly new files)
- API (IRF, and getters/setters) – C, and Python
- Library
- Command line interface
- GUI (within CCA)
- CCA component
- Output format CSV, BOV, netcdf

Checkout a version from our model repository:

```
> svn checkout https://csdms.colorado.edu/svn/deltas
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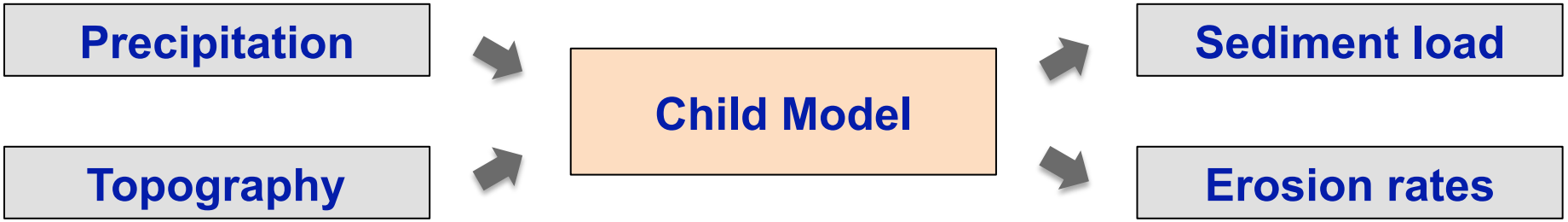
Child is a landscape evolution model that delivers sediment to the ocean



Child details:

- 39,000 lines of C++ code
- Component model
- User interface through input file
- Lots of output variables as ASCII files
- Calculations done on a non-uniform mesh

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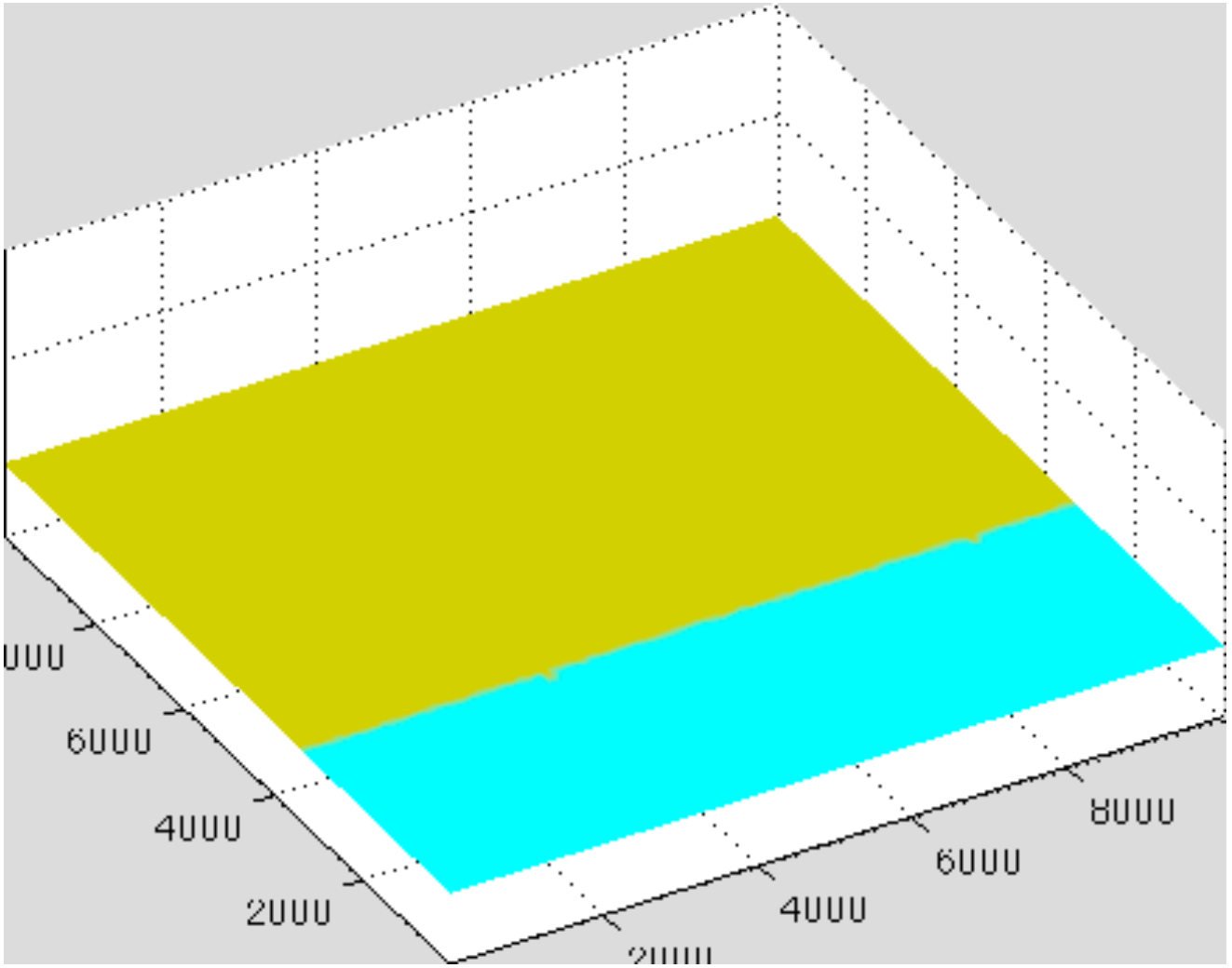
As the land rises, water erodes the landscape and carries sediment to the ocean where it's dumped



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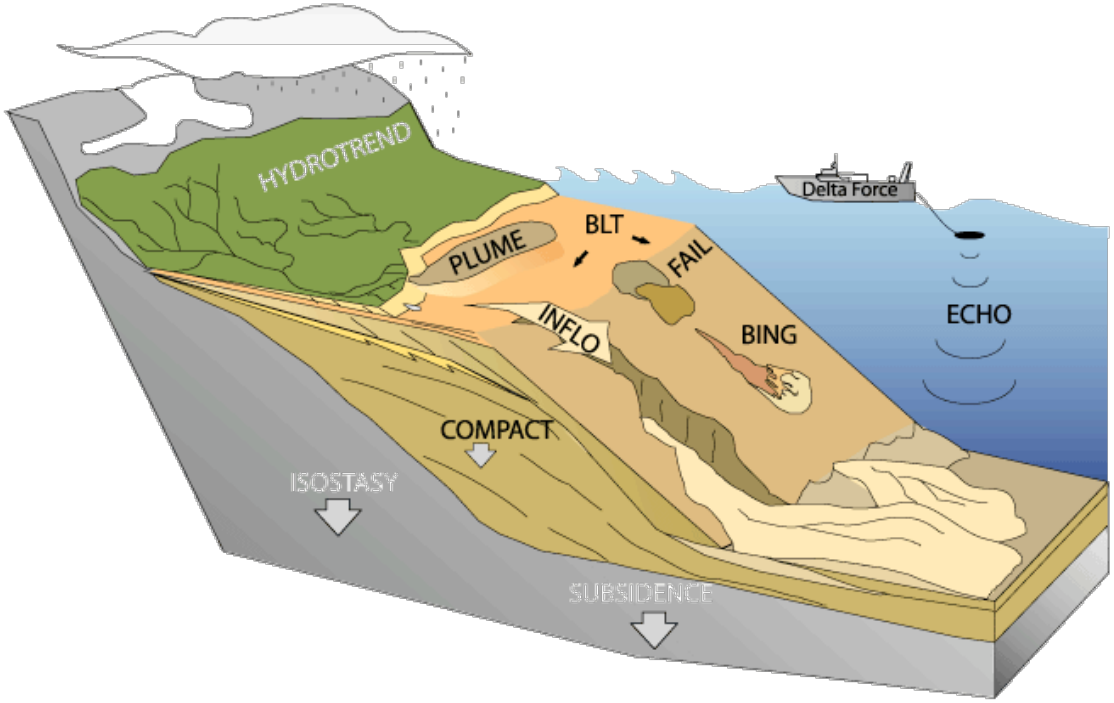
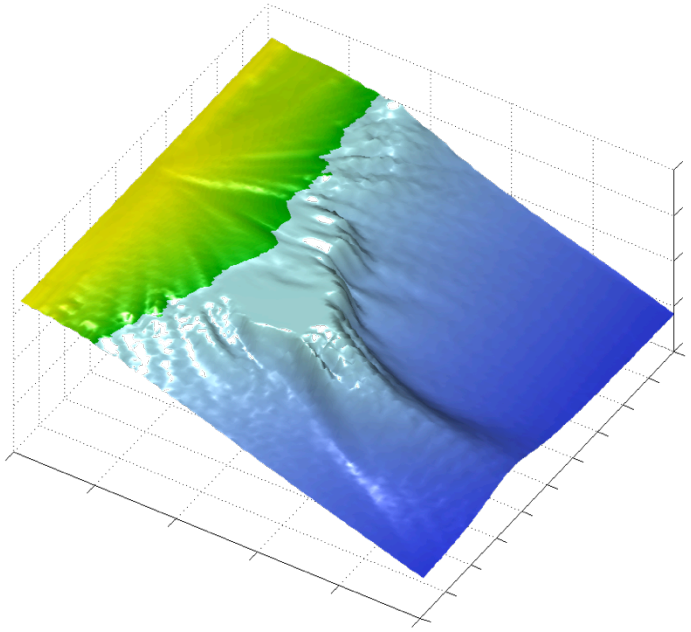
sedflux links component models to simulate the growth of a continental margin.





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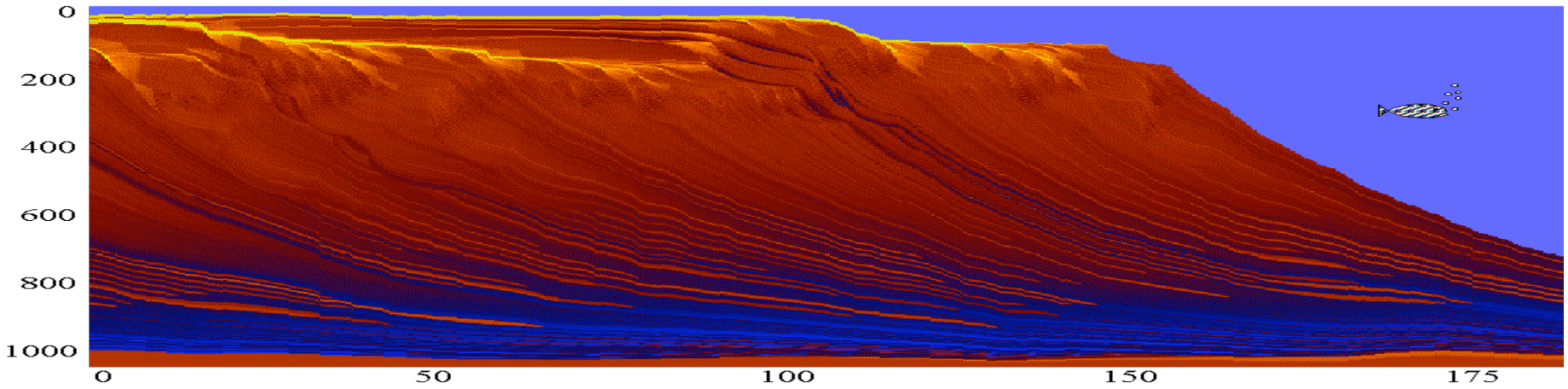
sedflux provides a framework that keeps track of stratigraphy



sedflux details:

- 70,000 lines of C code
- Component model
- User interface through input file, and command line
- Lots of output variables as confusing binary data
- Calculations done on a uniform mesh

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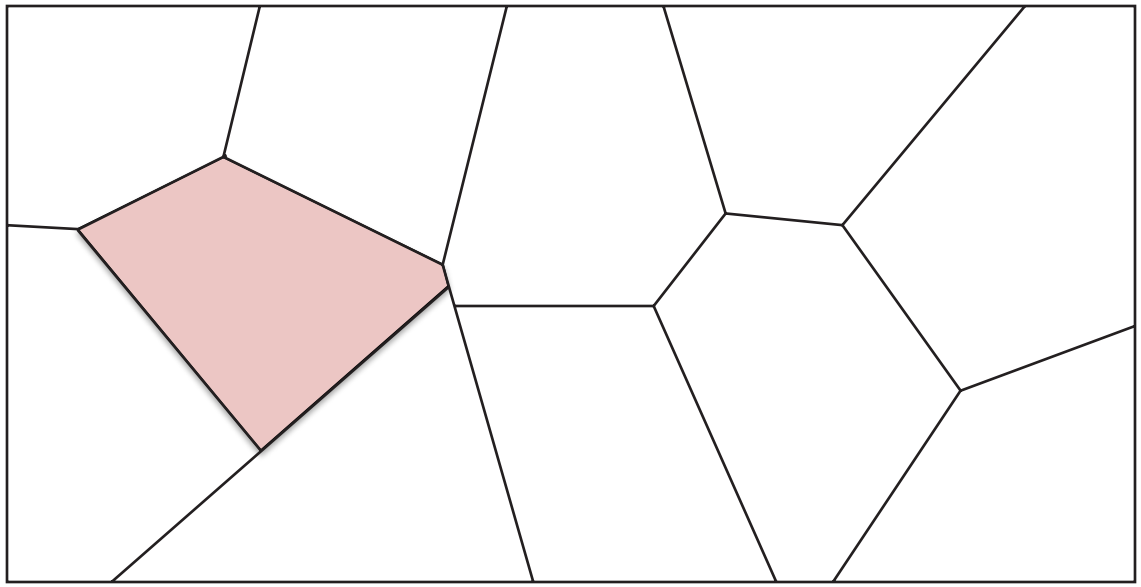
Child does its calculations on an unstructured mesh



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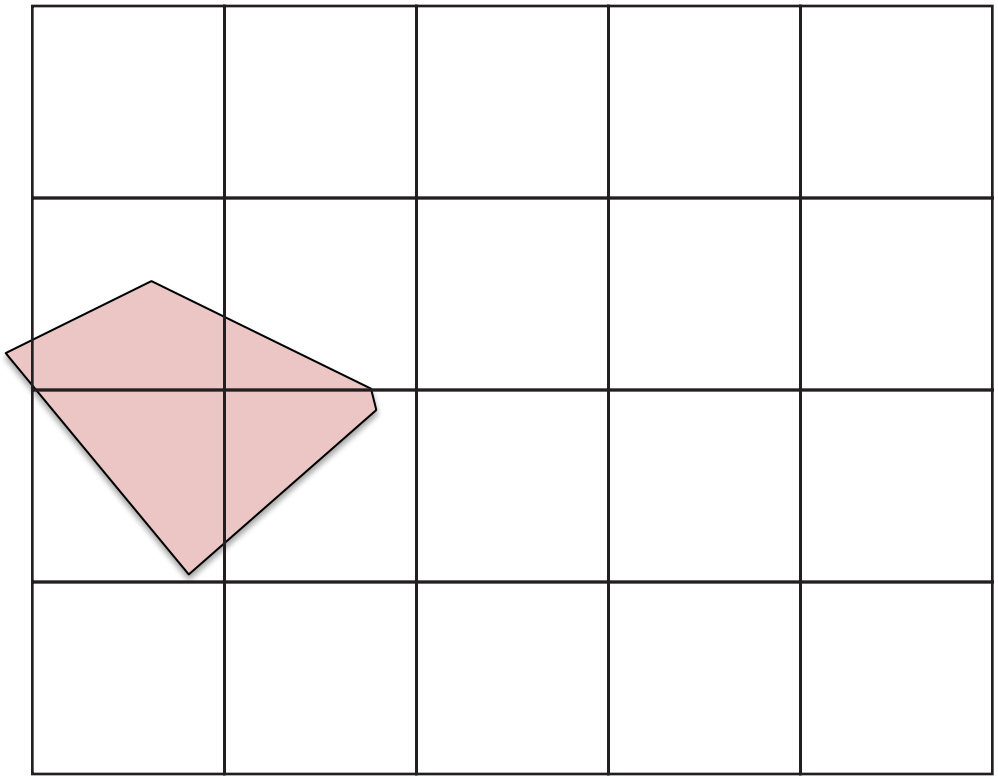
Sedflux, like most of our models, uses a uniform mesh



Perhaps the biggest challenge in this particular coupling will be grid mapping.

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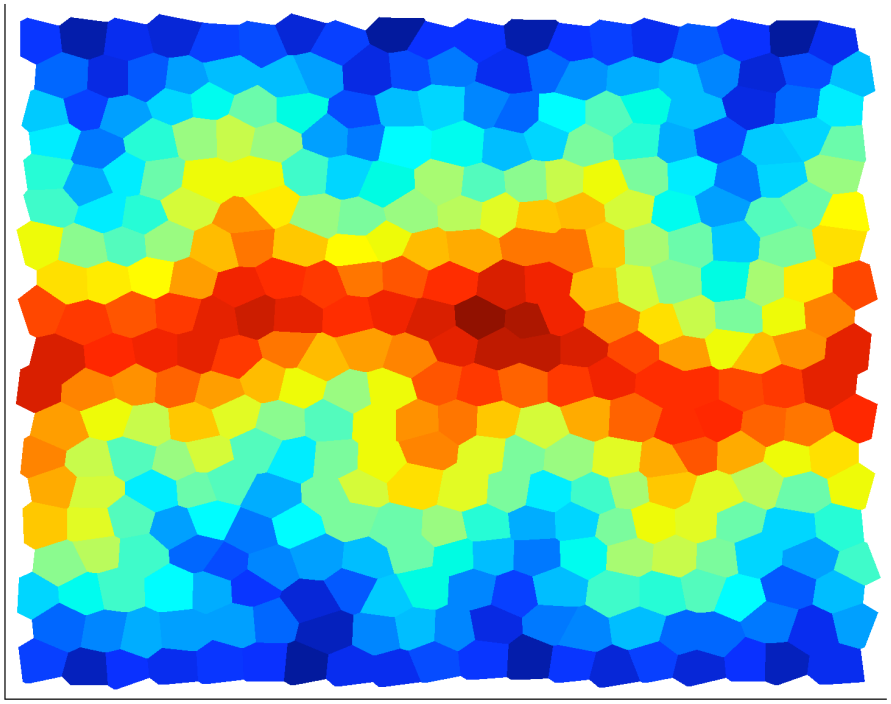
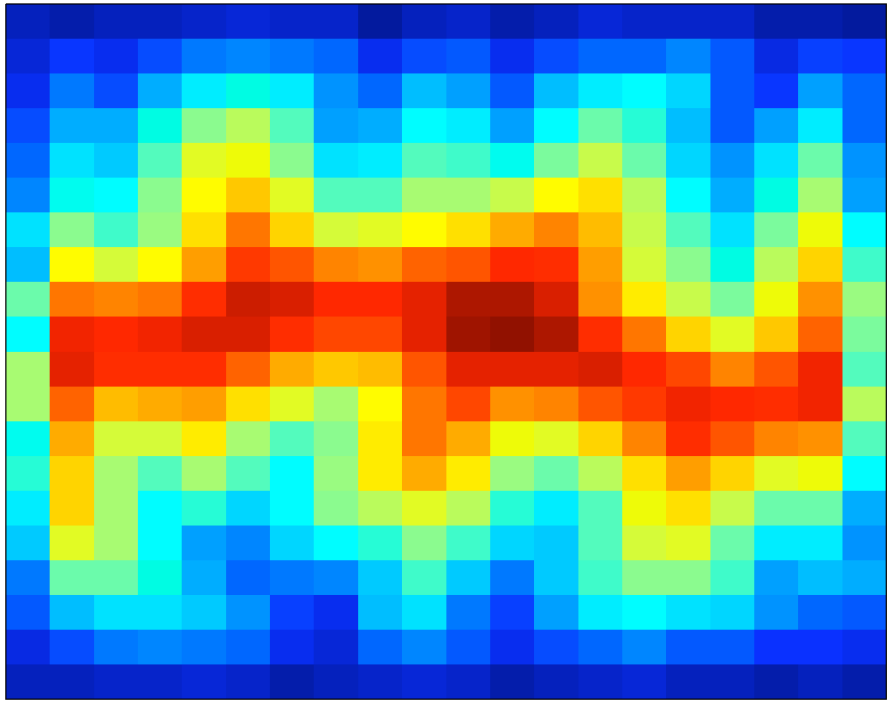
Mapping from a Child grid to a sedflux grid with similar resolution





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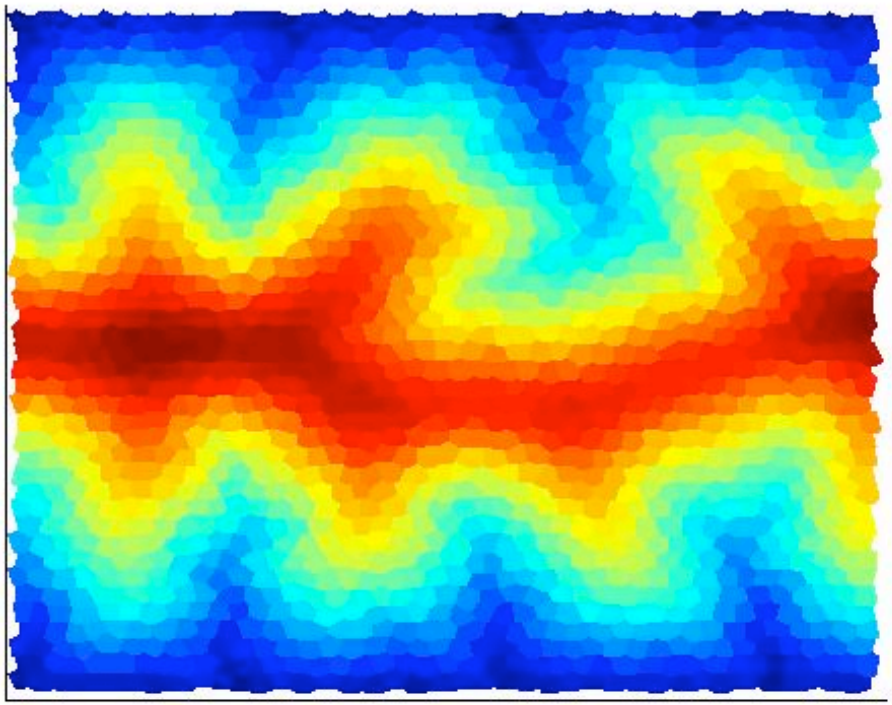
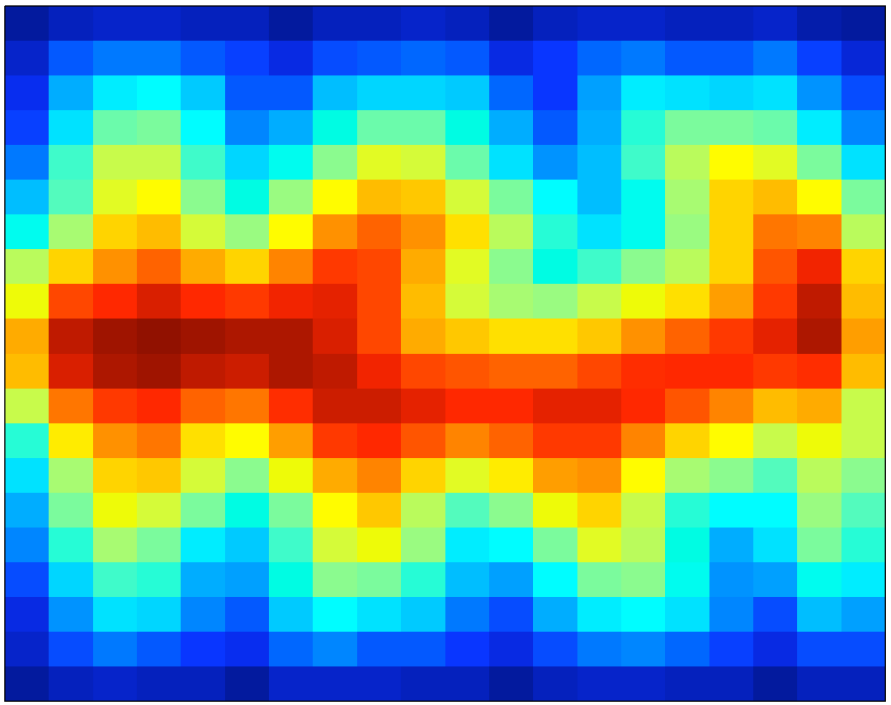
Mapping from a Child grid to a sedflux grid with a coarser resolution





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Both Child and sedflux are components but they have not been linked quite yet

As with our other components, both models:

- Have an API (and so a library)
- Can be run by CSDMS members remotely on beach
- Can be run as a standalone model or as a component
- Can be linked to other components (in other languages)

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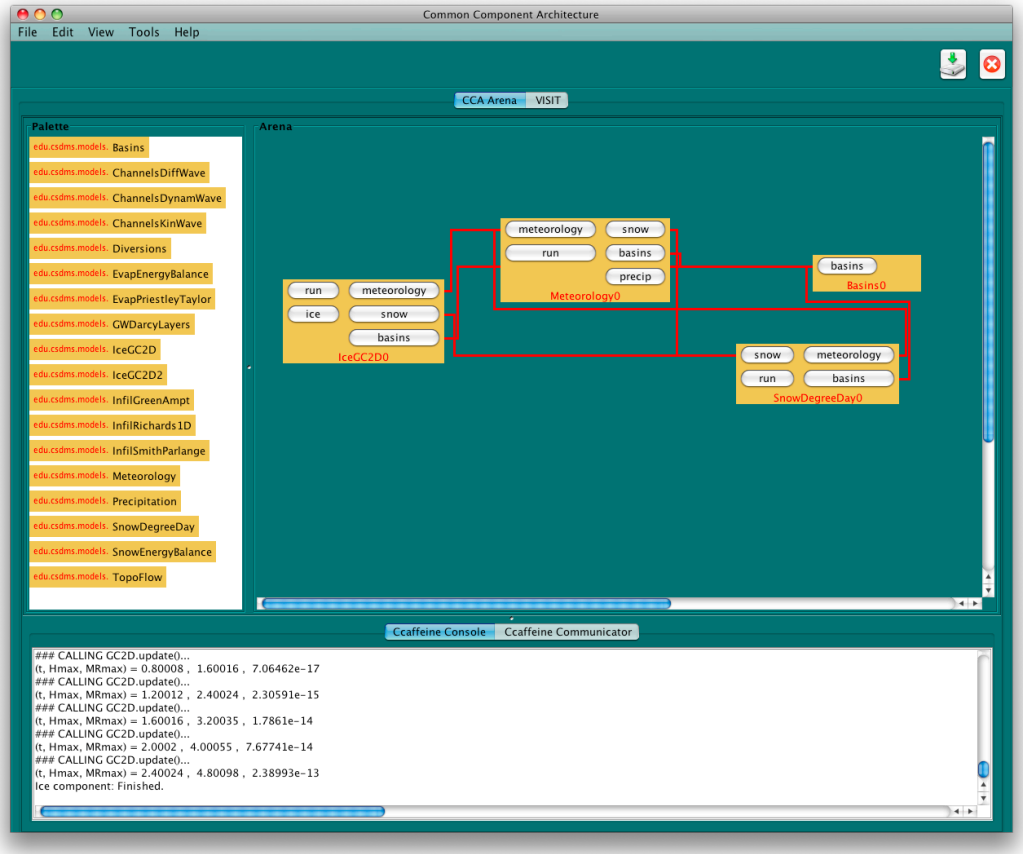
The CSDMS Modeling tool allows users to link models through a graphical interface

Using this GUI, they can choose components from available palettes to create their own, customized applications, and then run them on our cluster. We have linked our GUI with VisIt to provide run-time visualization.



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Process components seem to be the most natural level of granularity for model componentization.

Processes (such as infiltration) represent the "scale" at which modelers are most likely to want to replace one approach with another. For example, modelers very often want to compare different approaches and algorithms with respect to speed, accuracy, scalability or realism.

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Lost in translation…

Converting models from one language to another is a complex task that should be avoided whenever possible. Conversion tools usually cannot fully automate the conversion process.

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In conclusion,

Questions?

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