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Design of a Software Framework Prototype for Scientific Model Interoperability

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TOWARDS A SOFTWARE FRAMEWORK PROTOTYPE FOR SCIENTIFIC MODEL INTEROPERABILITY

By
Eric Fritzinger
Sohei Okamoto
What are Models?

- Mathematical models used to describe a system
  - E.g. Atmospheric, Oceanic, Ecological, etc…

- Algorithmic calculations which take input and produce estimated results
  - Weather forecasting, global warming predictions, sea level estimations, etc…

- Models are invaluable
What is Model Coupling?

- Different models for different problems
  - Global Circulation Models
  - Isopycnal models
  - Atmospheric models
  - Ecological models
  - Hydrological models
  - Etc…
What is Model Coupling?

- Output of one model could provide valuable input for another model
  - E.g. Coupling an Atmospheric model with an Isopycnal model

- How do we get the output of one model to work as the input of another model (i.e. coupling the models)?
Challenges of Model Coupling

- **Data formats**
  - E.g. Different file formats

- **Data structures**
  - E.g. Different types/amounts of data from one model to the other

- **Data units**
  - E.g. Temperature could be in Fahrenheit or Celsius

- Usually requires programming knowledge
Methods of Model Coupling

- Monolithic – Take the source code from two models and compile them into a single program
Methods of Model Coupling

- Scheduled – Models are kept as separate programs and the output dataset from one is used as the input dataset to the other.
Methods of Model Coupling

- Component – Similar to monolithic, except the models are components of the main program (e.g. DLLs, libs, etc…)

![Diagram of model coupling]

- Model A Component
- Coupling Source Code
- Model B Component
- Executable
Methods of Model Coupling

- Communication – Requires sending messages between two independent running models, usually with an intermediary program to monitor the exchanges and perform data transformations as necessary.
A Selection of Coupled Models

- HadCM3 – Coupled atmospheric-oceanic model
  - Component method (can swap ocean model)
- WRF/ROMS – Coupled weather and ocean model to predict hurricanes
  - Messaging method (uses MCT)
- RHESSys – Coupled hydro-ecological models
  - Monolithic method
Existing Work

- **MapWindow**
  - Dan Ames, Ph.D, Idaho University
  - Extensible GIS Framework

- **Model Coupling Toolkit**
  - A software library “used to couple message-passing parallel models”
    - i.e. Communication-based method

- **Support for Model Coupling: An Interface Based Approach**
  - Communication-based method
  - Ph. D dissertation by Thomas F. Bulatewicz
Goals for the Software Framework

- User Interface-based approach
  - Possibly incorporating a visual programming language for intermediate data conversions

- Reduce need for source code modification
  - Source code modification is difficult, at best

- Allow for saving coupled model scenarios for later use
Goals for the Software Framework

- Web-based Application using Silverlight
  - Cross-Platform – Windows, Mac OS, Linux
  - One project, one user interface, one application
  - Directly interface with data portal
- Maintain common models on the server, and allow users to register additional models to be run
User Interface Prototype
User Interface Prototype
Questions?
References

References

- **NOAA Center for Tsunami Research; WRF/ROMS Couple Vortex Model;** [http://nctr-people.pmel.noaa.gov/cmoore/wrf-roms/index.html](http://nctr-people.pmel.noaa.gov/cmoore/wrf-roms/index.html);
- **Donald Bren; RHESSys Homepage;** [http://fiesta.bren.ucsb.edu/~rhessys/](http://fiesta.bren.ucsb.edu/~rhessys/); February 2009