Oh Crap! An Exam!

- First Takehome Exam (this is the Feb + March Exams).
- Issued Monday
- Due “Next Wednesday” (after Spring Break, 14 MAR) NO LATE EXAMS!
- It Will involve Math.
- It Will involve Writing
- See and Live my guidelines to writing an essay exam answer.

Lecture 13: Endogenous and Exogenous Processes

“Bull’s Eye Diagrams”

Accounting for Knowns and Unknowns...
And what you want from the Data Shoppe

Agenda

- The Bull’s Eye Diagram
  - Endogenous vs Endogenous Inventories
- External Data
  - Data Assimilation
  - Data Forcing
- External Processes
  - "Parameterizations"

So far...

- Our models have been very simple in that we need only give them a small push and off they go.
- Initial Value Problems.
- Most science applications fall beyond this spectrum.

Example: Mono Lake

- Our simulation “assumed” that many variables that we know change from year to year change with time.
  - Potential Evaporation
  - Precipitation
  - Stream flow
  - Regional Water Demands...

Example: Mono Lake

- Physical Processes were also ignored
  - Basin Evaporation from Exposed Lakebed
  - Groundwater Fluxes
- At the time, these rug-sweepings were necessary to create a scenario.
- Similarly, other applications, other approximations will be needed
When I first got into this.

- Susquehanna River Basin Experiment.
  - Multiple Models
  - Different Problem Domains
  - Different Inputs
  - Different Outputs
  - Different Scales
  - And no common interface!

And how I came here...

- Numerical Weather Prediction Model
- Surface Hydrology Component
- LSM
- MODFLOW
- SWALLOW
- HOLE
- LOSS & SEEPAGE
- SPRING
- FLOW & SWALLOW HOLES
- GROUNDWATER RECHARGE
- CHANNEL FLOW
- INFILTRATION
- RESERVOIR
- WATER FLUXES
- HEAD DIFFERENCES

The “Bullseye Diagram”

- Meadows and Robinson (’85)
  - An inventory of processes explicitly calculated in a model, those provided externally and those totally outside of the model’s mission parameters.

- Do NOT confuse this with the term “Boundary Conditions”

The “Bullseye Diagram”

- The model (this data organizing model, that is) is divided into three categories:
  - Endogenous
  - Exogenous
  - Excluded
The “Bullseye Diagram”

- **Endogenous**
  - Model entities that are simulated completely within the simulation
  - Examples (From our previous adventures)
    - Transient Carbon Stocks
    - Bucket and Lake Volumes
    - Wabbits and Fudds (and sometimes carrots!)

- **Exogenous**
  - Model entities prescribed outside of the computational realm
  - “Forcings”
  - Examples
    - An imposed transition rate
    - Carbon Entry Rate (a boundary condition)
    - Incoming Energy Rate (solar radiation, and sometimes carrots!)
    - Precip and PE
    - [Initial Conditions of Endogenous values]

- **Excluded**
  - Entities that are not included in the model at all.
  - Examples
    - LA Lifestyle
    - Climate Variability
    - Wabbit vs Duck “issues”

The “Bullseye Diagram”

- **Endogenous vs Exogenous**
  - The “How” Test
    - How do we calculate net profits?
    - How do we calculate rabbit birth rates?
    - How do we represent interannual climate variability?
    - How do we determine predation rates?

- **Exogenous vs Exogenous**
  - Here, we are asking ourselves the manner in which a model entity is calculated.
  - Notice the alternatives we have before us:
Endogenous vs. Exogenous

- We can prescribe a value based on reasoned assumptions (Ex)
- We can calculate it on-the-fly from other variables (En)
- We can force it externally by either fixed data or data from a coupled model (Ex)

Exogenous vs. Excluded

- These are the questions of keeping a process in a model or ignoring it all together
- [These are also the questions you need to be ready to answer!]

Always remember that a model is an hobbled approximation to reality by necessity!
The degree of that hobbling is a different matter.

Notebook Assignment

- Do an inventory of your pet modeling problems
  - Exogenous
    - Why you need it on-the-fly?
  - Endogenous
    - Criteria for "stepping" it down when there is an option to do it explicitly?
    - Excluded
      - Ditto for the criteria: Why are you excluding/including it?
      - Be reasonable & honest here
      - Cover the obvious issues, not spurious road spikes.
      - Butterflies in Bali are not an item to include.

Onto "Forcing"

- What is External Forcing
  - Forcing is the injection of "foreign" data into your model environment.
  - Can be injected across the domain or at the "boundaries" (These are Boundary Conditions)
  - This is often restricted to Dynamic Information, not held constant at initialization but not always
  - Keep you eyes on the user’s context
Onto “Forcing”

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Exogenous Model Forcing

- What is External Forcing
  - Forcings can be imported from a separate model (a coupled model system)
    - This can draw the line between exogenous and endogenous data.
  - How to draw the line?
    - Difficult Question
    - Difficult Example:

Coupled Hydrologic Modeling

Exogenous Model Forcing

- When is Exogenous Forcing from an “external” model an Endogenous Coupling?
  - Good Rule of Thumb for an Exogenous Forcing of an adjacent running model
    - Disparate Time Steps?
      - Is the subroutine in question called periodically? (debatable)
    - Disparate Spatial Scales?
      - Do you have to aggregate or disaggregate dataset?
    - Stop/Start Data Exchanges?
      - Does the execution of a model shell terminate and hold while a “coupled” component’s process is spawned and run? Can be automatic or user-interrupted
Exogenous Forcing?

Endogenous Coupling!

Does this matter?

Notebook Assignment II
Figure 1