Types of Models: WHAT's in the BOX

Conceptual.............Mathematical

Static………….Dynamic :*TIME*

Lumped.............Spatially Distributed: *SPACE*

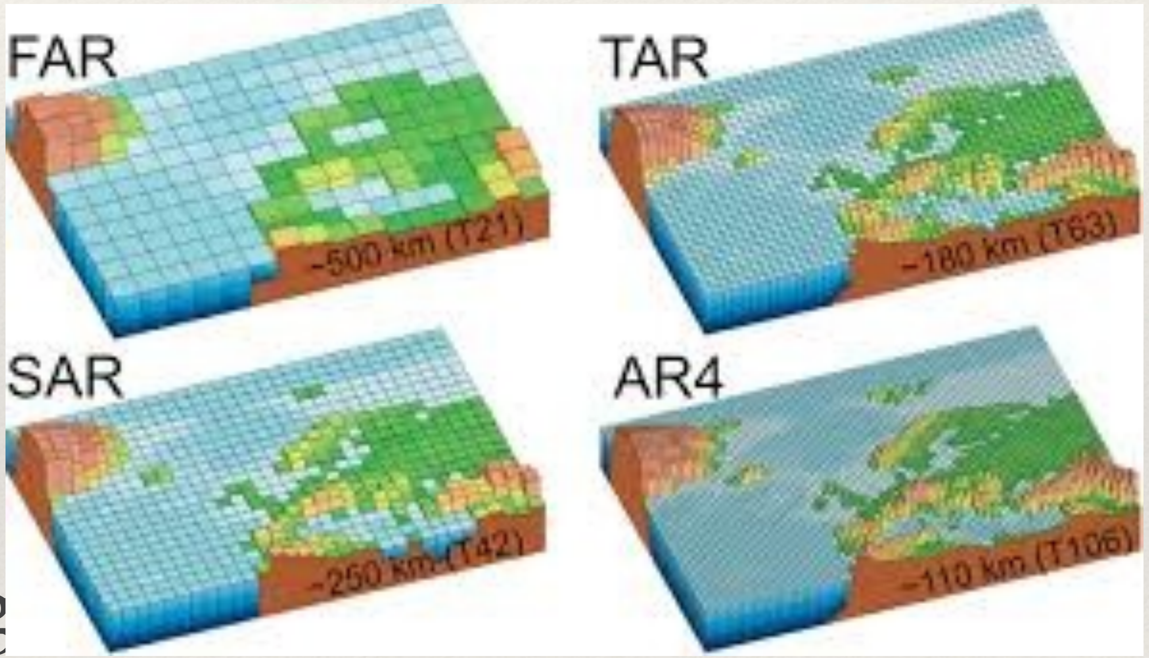
Stochastic.............Deterministic

Abstract………….Physically/Process Based

but biggest differences may often be the degree specific processes/parameters are accounted for

Lumped …Spatially distributed

- Lumped - single point in space, or space doesn't matter
- Spatially distributed - model is applied to different "patches" in space
    - spatial units are independent
    - spatial units interact with each other - usually through time (spatial AND dynamic)



http://eo.ucar.edu/staff/rrussell/climate/modeling/climate_model_resolution.html

Spatially distributed (dynamics) - Implementation

- Spatial units interact with each other - usually through time (spatial AND dynamic)
- Considerations that we thought about with dynamic models apply here
  - Differential or difference equation
    - Analytic solution (rare)
    - Solve by iteration
      - Time AND space "steps" matter
      - Different technique for reducing error

Spatially distributed (dynamics) - Sensitivity Analysis

- Sensitivity analysis - parameters maybe spatial or may not be (e.g think of sensitivity of fire spread to wind speed - this may be the same parameter everywhere - so the parameter is not spatial - but results of the model are)
  - In this case - sensitivity analysis that we've covered in class works
  - Response metrics - be creative here
    - Spatial summary statistics
      - Mean, spatial variance
      - Aggregation through time (e.g total forest carbon/ET through time)
- For spatially varying parameters - too many to do formal sensitivity analysis of each - but you can apply random variation to parameter (e.g add noise +- 10% variation to soil depth in a hydrologic model)

Spatially distributed (dynamics)

- Evaluation - Calibration
  - Summary statistics (e.g. mean fire return interval, aggregate nitrate flux, change in 95th percentile peak flow with 30% increase in impervious area)
  - Spatial comparison - error between observed and modeled map
    - Autocorrelation is often an issue here
      - Sample locations - compute the error

What are models?

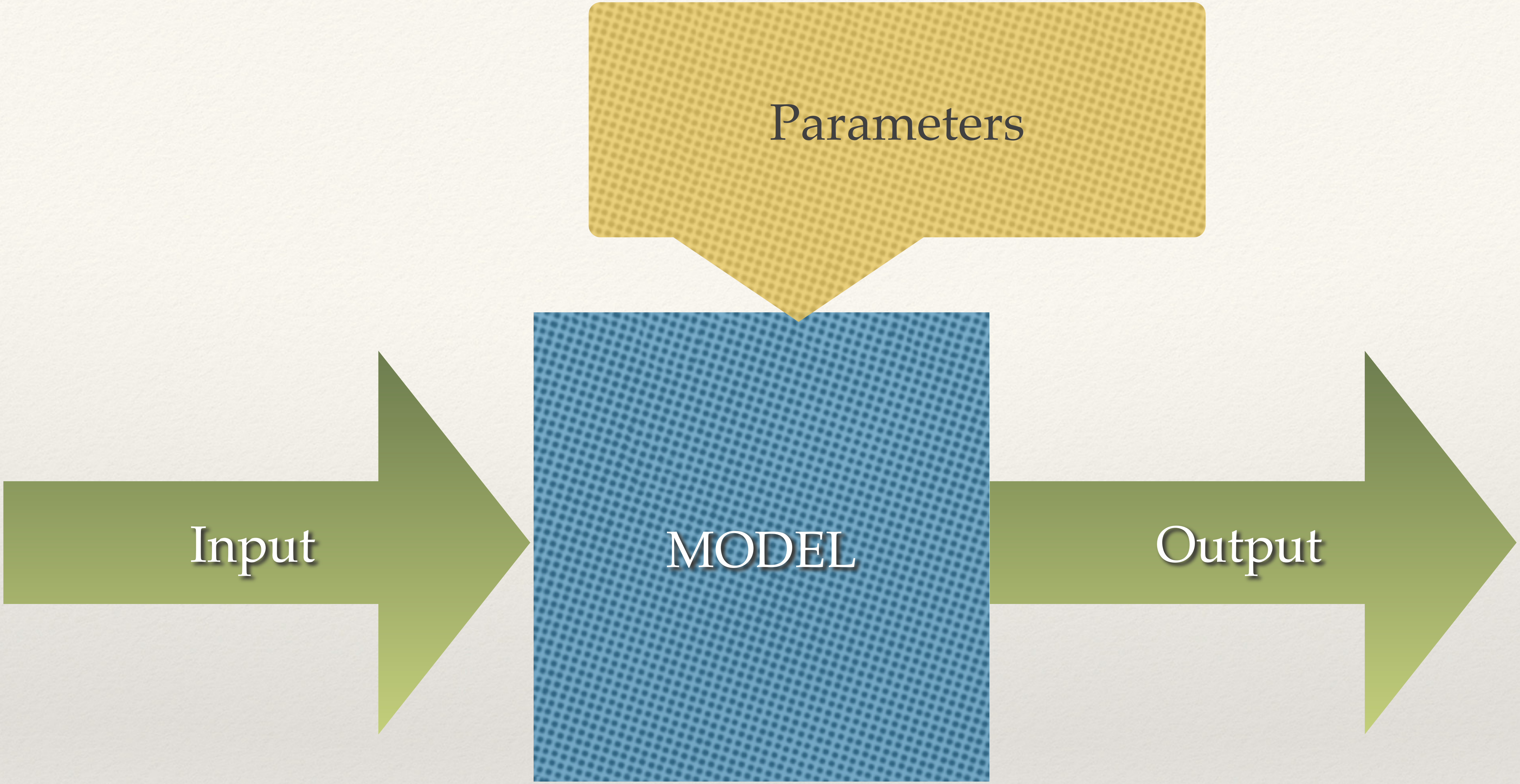
- A set of ideas that describe a process/phenomena
- A simplified representation of some aspect of the world
  - Uses
    - understanding a pattern, process, phenomena in the world - especially when there are many interacting elements/controls on this phenomena
    - estimation of what might happen to a phenomena in the future (or if something changes) “what if” scenarios

Model Goals

- *Understanding* (how does something work, what are key drivers of responses, how do different drivers interact)
- *Estimation/Scenario* (what might be the consequences of decisions we make about the environment)
- *Communication* - contribute to education and broader understanding

GOALs: Modeling for Problem Solving in Environmental Science

- There is something you need to know in order to solve the problem
    - Answer to a question -
      what if?
      how much?
      which alternative?
    - Test of a hypothesis
- **Start by clearly defining what that question is!!**
- Examples?



Basic components of models

Inputs: Varying; think x of a x vs. y regression
Parameters: single values that influence relationships in the model
Outputs: what you want to estimate

STEPS: Modeling for Problem Solving in ES

1. **Clearly define your goal (a question you want to answer, hypothesis you want to test, prediction you want to make) - as precisely as possible**
2. Design or Select your model
3. Implement the model
4. Evaluate the model and quantify uncertainty
5. Apply the model to the goal
6. Communicate model results