

# Writing Bayesian Hierarchical Models

## Models for Socio-Environmental Data

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# Examples of

- ▶ Multi-level models (aka random effects)
- ▶ Sampling error in  $x$ 's and  $y$ 's
- ▶ Calibration error in  $y$ 's

All of these will appear in the exercises.

# Things to watch for today

## Partitioning uncertainty

- ▶ Process variance
- ▶ Sampling variance
- ▶ Calibration variance (aka observation variance)
- ▶ Group level variance

# Steps in writing Bayesian models

1. Write your deterministic model. Be careful about support.
2. Draw Bayesian network (DAG) describing relationships between observed and unobserved quantities.
3. Use the Bayesian network to write proportionality between posterior and joint distributions using bracket notation  $[\ ]$ .
  - 3.1 Posterior distribution:  $[\text{unobserved quantities} \mid \text{data}]$
  - 3.2 Joint distribution
    - 3.2.1 All nodes in Bayesian network at the heads of arrows (children) must be on the left hand side of a conditioning symbol.
    - 3.2.2 All nodes in Bayesian network at the tails of arrows (parents) must be on the right hand side of a conditioning symbol  $\mid$ .
    - 3.2.3 All nodes at the end of an arrow with no arrow coming into them must be expressed unconditionally, i.e., they must have numeric arguments.
4. Assign specific PDF or PMF to each of the brackets.
5. Choose numeric values for parameters of prior distributions.

Do this sensibly! Do not default to vague priors. (Do as I say, not as I do.)