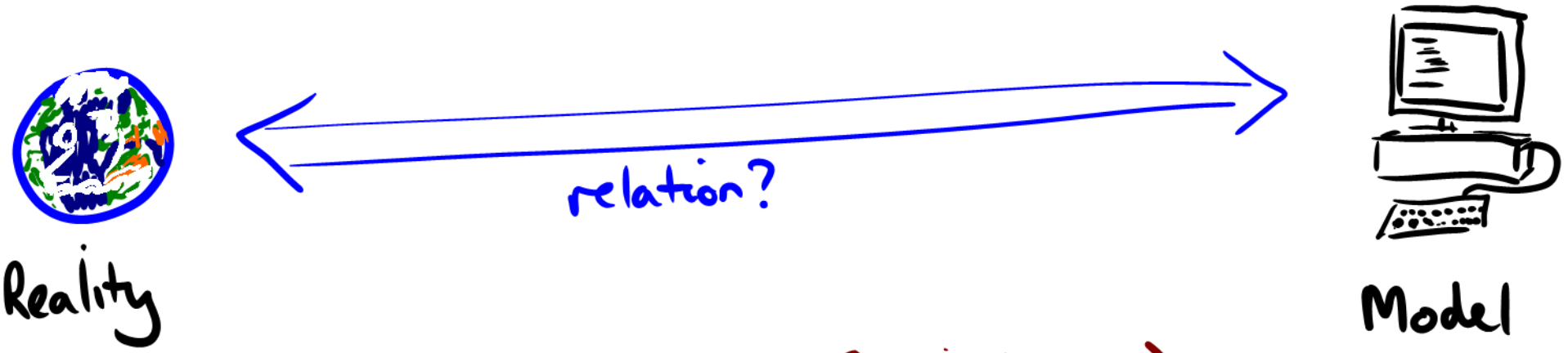
Structural Model Uncertainty



How do we build models? (Simulators)

① Reductionist – break the system down → mechanistic/microscopic components.

② Systems modelling – macroscopic ⇒ maybe derived from ①?
⇒ or observation driven
– empirical models.

BUT → none of these directly address uncertainty.

Stochastic Models are Trendy

Increasing emphasis on stochastic models - but are these all well thought out?

- often aim to increase "dispersion of ensembles".
- not always systematic, often pragmatic.

Source of uncertainty in simulators:

- missing → wrong processes in simulator (known + unknown) } CHAOS?
- unknown parameters in simulator (calibration) "easy"!
- unknown state in simulator (data assimilation)
- truly stochastic processes in simulator (not so common)

Missing process might be due to: incomplete knowledge, lack of resolution, implementation restrictions, ~~code errors~~.

↳ truncation + parametrisation

↳ structure of implementation

Treating simulator error.

Control + Dynamical Systems perspective:

- deterministic view - "learn the model error" but as a bias.
- common view in 4D VAR - adhoc parametrisation of augmented error "state".
- manifolds + attractors - shadowing + mapping (how to determine these)

Statistical perspective:

- model the model error - but how?
- reification (Jonty)? Gives a framework for thinking about it.
- "crud-catcher" (Neil Lawrence) ↔ discrepancy view
  - flexible prior over simulator error - e.g. Gaussian process.

Reductionism has a role here → provides us with a principled framework to debate beliefs ....

A way forward?

Build simulators inherently stochastic:

- reductionist, microscopic descriptions with systematic treatment of any simplifications (difficult!)
- where possible modularise → e.g. radiation, clouds, dynamics, vegetation, ...

} needs new ways of running...

- where this is not possible scientists must build the uncertainty beliefs with model (Jonty already said this!)
- oh + build better simulators → this makes uncertainty specification easier...

..... and the unknown, unknowns? Better do more science!!