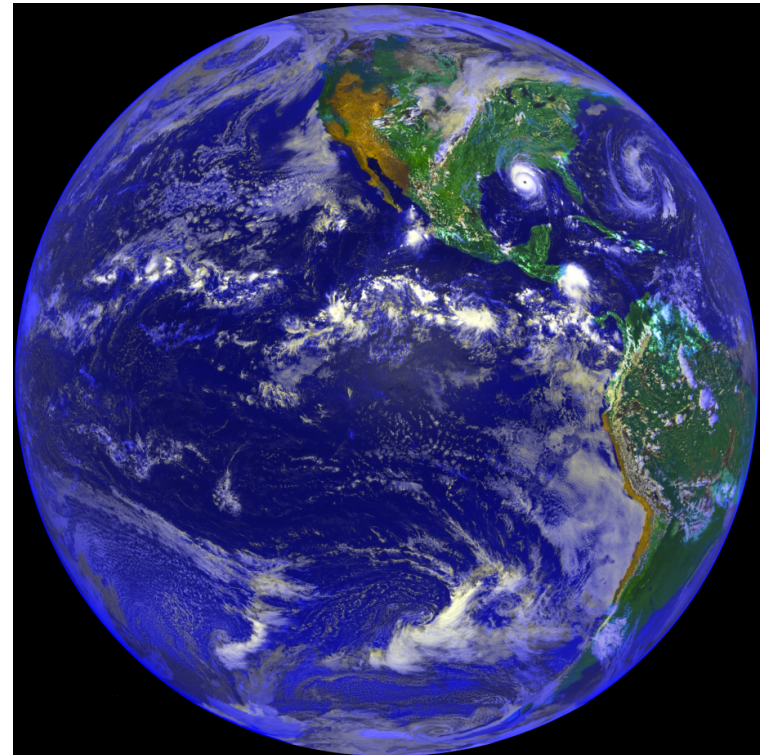
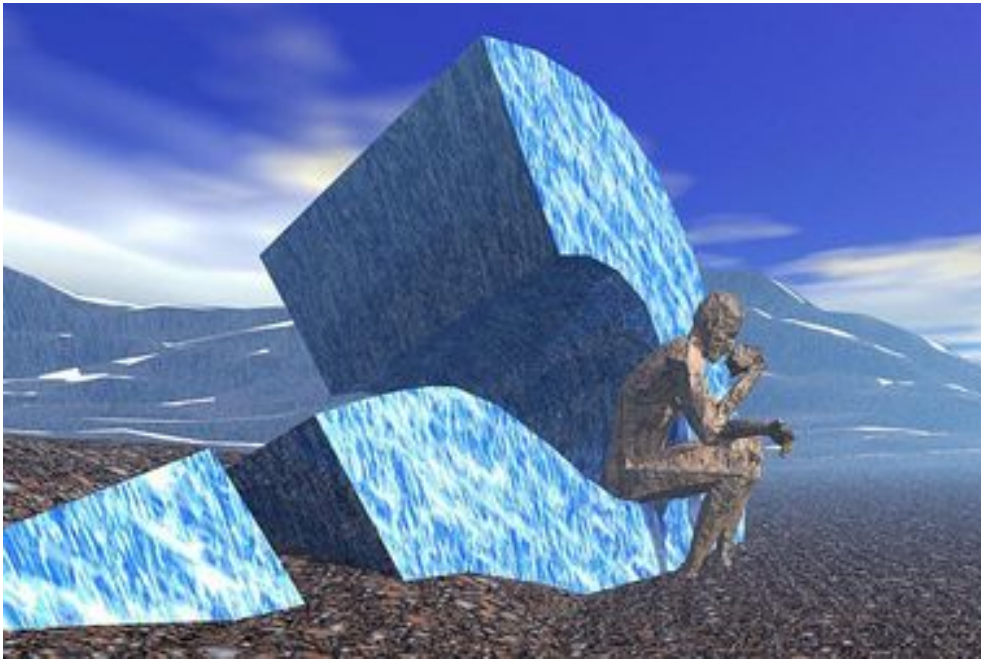


Climate Science and the Uncertainty Monster

Judith Curry



Climate Uncertainty Monster

The “monster” is a metaphor used in analysis of the response of the scientific community to uncertainties at the climate science-policy interface.

Confusion and ambiguity associated with:

- knowledge versus ignorance
- objectivity versus subjectivity
- facts versus values
- prediction versus speculation
- science versus policy



Genealogy of the Uncertainty Monster

Monster theory: monster as symbolic expressions of cultural unease that pervade a society and shape its collective behavior

Monster metaphor of Dutch philosopher Martijntje Smits: co-existence of public fascination and discomfort with new technologies

Uncertainty monster of Dutch social scientist Jeroen van der Sluijs: ways in which the scientific community responds to the monstrous uncertainties associated with environmental problems

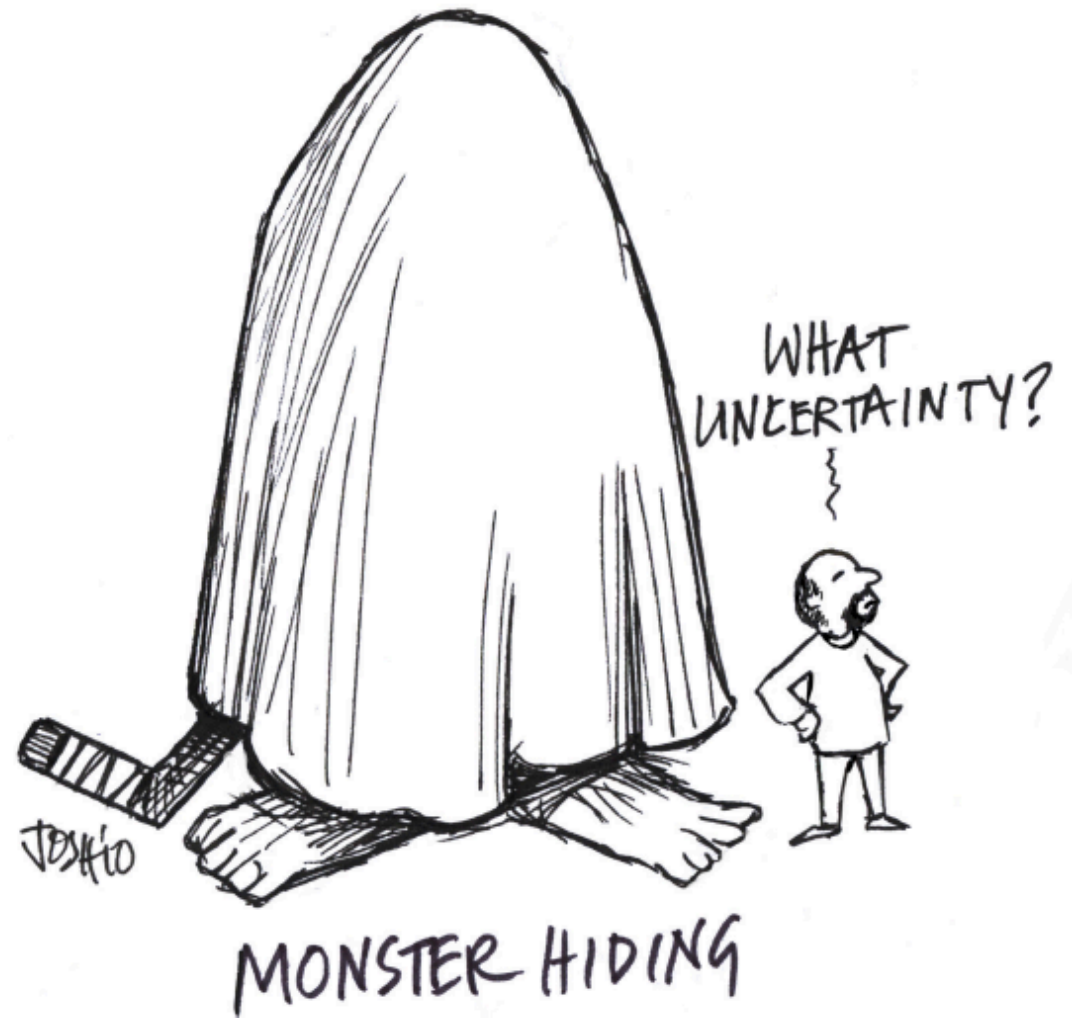
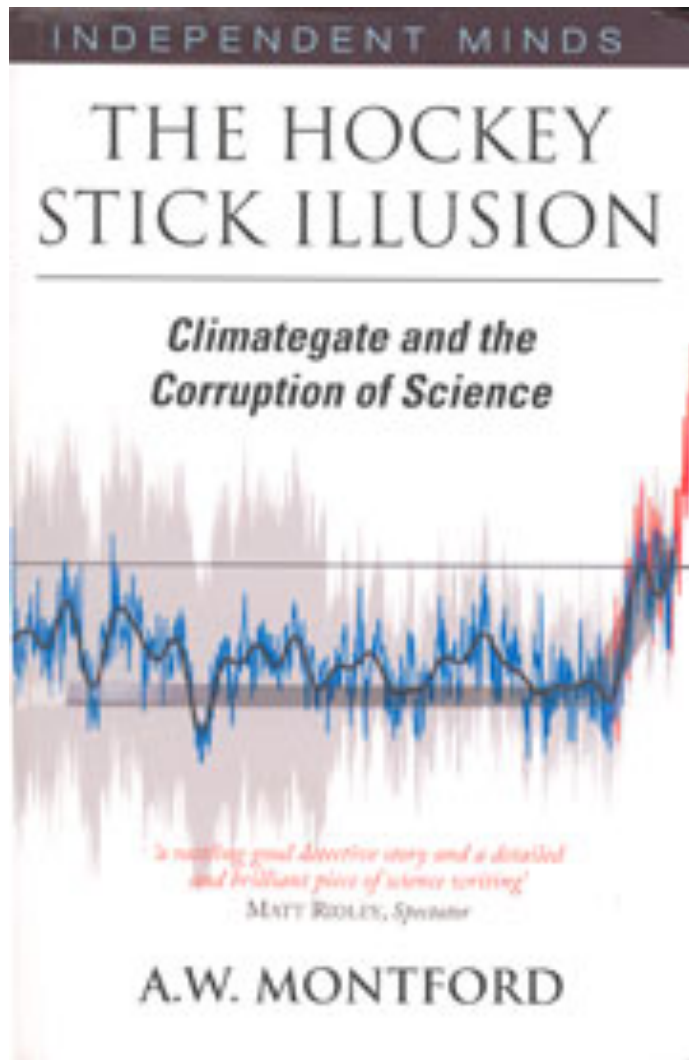


Uncertainty monster coping strategies

after van der Sluijs



Uncertainty Monster Hiding



Ignoring the monster

CALL OUT THE CLIMATE CHANGE DENIERS



97%

OF CLIMATE SCIENTISTS AGREE

that climate change is real and man-made, and affecting communities in every part of the country.

Yet too many of our elected officials deny the science of climate change. Along with their polluter allies, they are blocking progress in the fight against climate change.

Find the deniers near you—and call them out today.

barackobama.com

Uncertainty Monster Simplification



Uncertainty Monster Exorcism

Van der Sluijs 2005: “For each head climate science chops off the uncertainty monster, several new monster heads tend to pop up.”

Houghton et al. (1990):
“confident that that the
uncertainties can be
reduced by further
research”

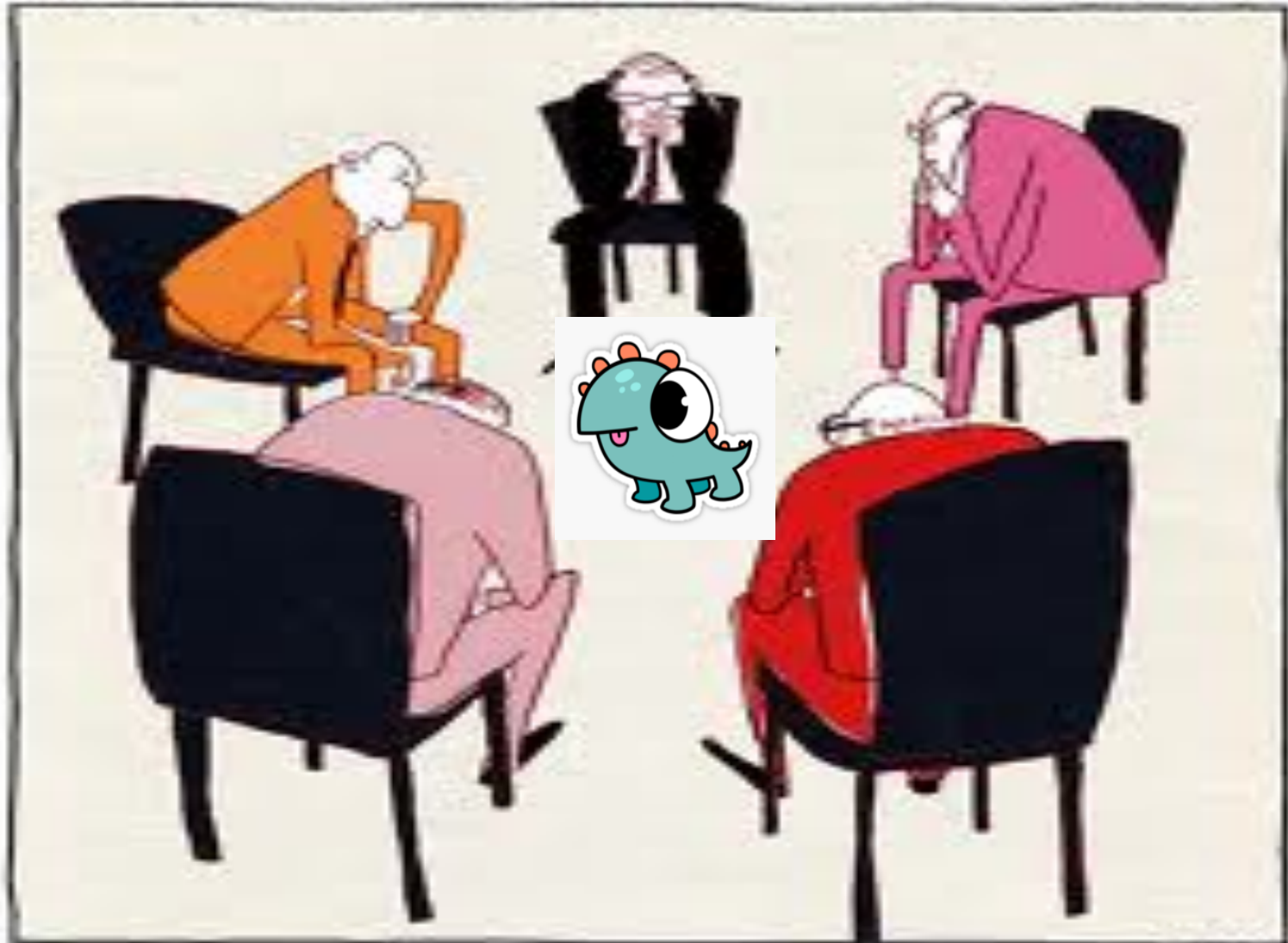


Uncertainty Monster Detection



Uncertainty Monster Assimilation

THE MOST POWERFUL MEN ON THE PLANET ONCE AGAIN FAILING TO FIGURE OUT A WAY TO MAKE SAVING THE WORLD COST EFFECTIVE.

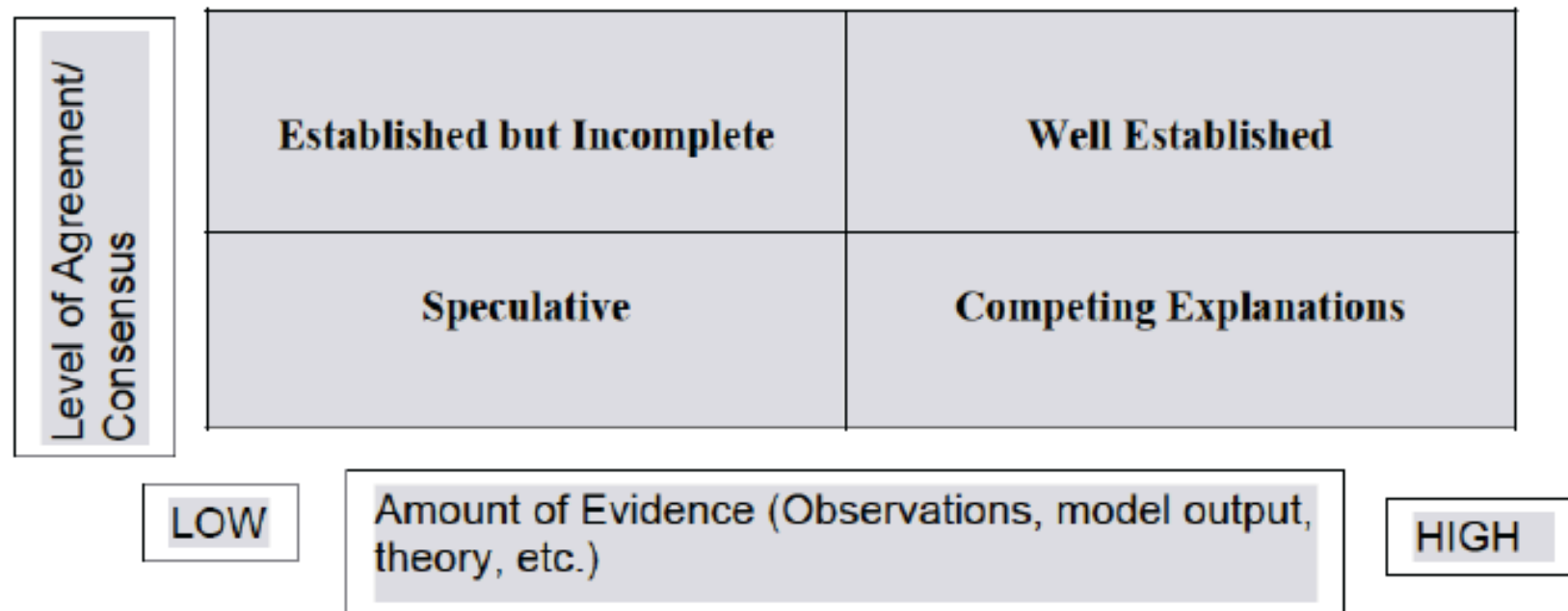


MR. FISH

IPCC Characterization of Uncertainty

Moss & Schneider 2000

expert judgment in the context of a subjective Bayesian analysis



IPCC Characterization of Uncertainty

Moss & Schneider 2000

Terminology	Degree of confidence in being correct
Virtually certain	> 99% probability of occurrence
Very likely	> 90% probability
Likely	> 66% probability
About as likely as not	33% to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Exceptionally unlikely	< 1% probability

IPCC Consensus Building

Given the complexity of the climate problem, expert judgments about uncertainty and confidence levels are made on issues that are dominated by unquantifiable uncertainties.

Consensus building process: exercise in collective judgment in areas of uncertain knowledge.

Consilience of evidence: combines a compilation of evidence with subjective Bayesian reasoning -- independent lines of evidence that are explained by the same theoretical account.



Why do scientists disagree?

- Insufficient observational evidence
- Disagreement about the value of different classes of evidence (e.g. models)
- Disagreement about the appropriate logical framework for linking and assessing the evidence
- Assessments of areas of ambiguity and ignorance
- Belief polarization as a result of politicization of the science



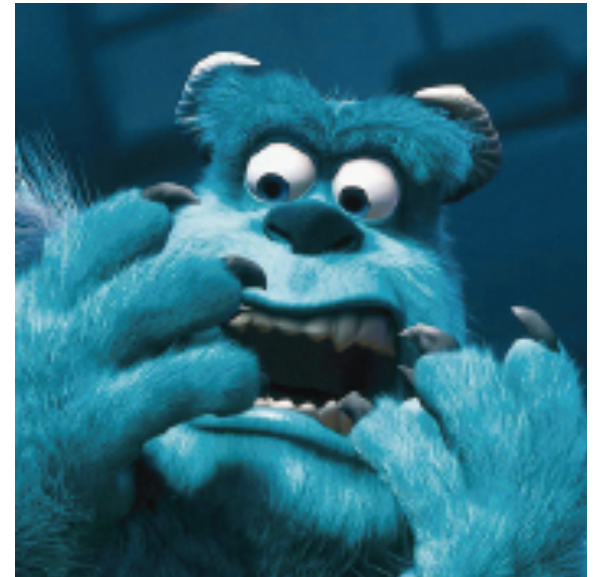
Understanding the uncertainty monster

Curry, JA 2011: Reasoning about climate uncertainty.
Climatic Change

Curry, JA and Webster PJ 2011: Climate science and the uncertainty monster. *Bull Amer Meteorol. Soc.*

Curry, JA 2011: Nullifying the climate null hypothesis.
WIRES Climate Change

Curry JA, 2013: Climate change: No consensus on consensus. *CAB Reviews*



Critique of the IPCC process

- Consensus building process introduces biases
- Ignorance and ambiguity is unaccounted for
- Politicization acts to marginalize skeptical perspectives
- Leads to overconfident conclusions



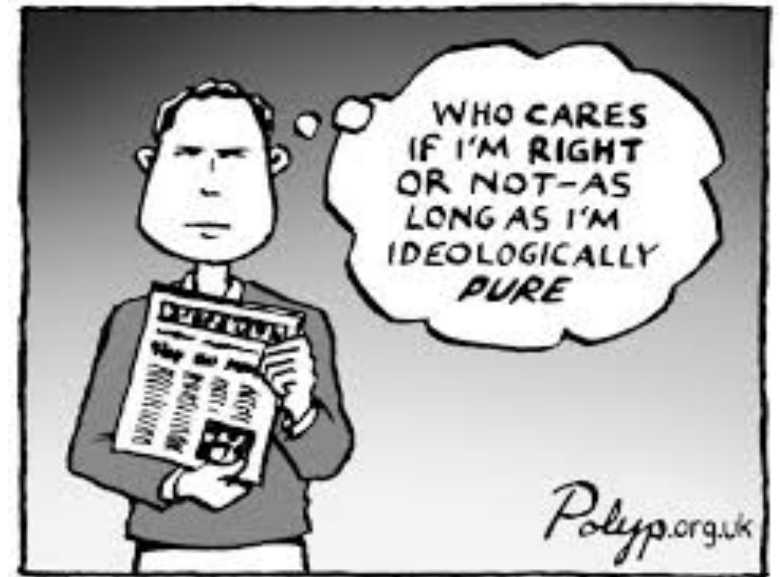


IPCC/UNFCCC Ideology

1. Anthropogenic climate change is real
2. Anthropogenic climate change is dangerous
3. Action is needed to prevent dangerous climate change
4. Deniers are attacking climate science and scientists
5. Deniers and fossil fuel industry are delaying UNFCCC CO2 stabilization policies.

Attributes of ideologues

1. Absence of **doubt**
2. Intolerance of debate
3. Appeal to authority
4. A desire to convince others of the ideological truth
5. A willingness to punish those that don't concur

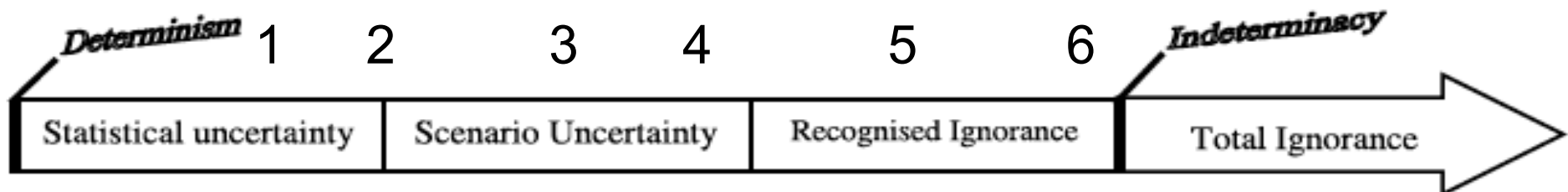


**Some better ideas for reasoning
about climate uncertainty**

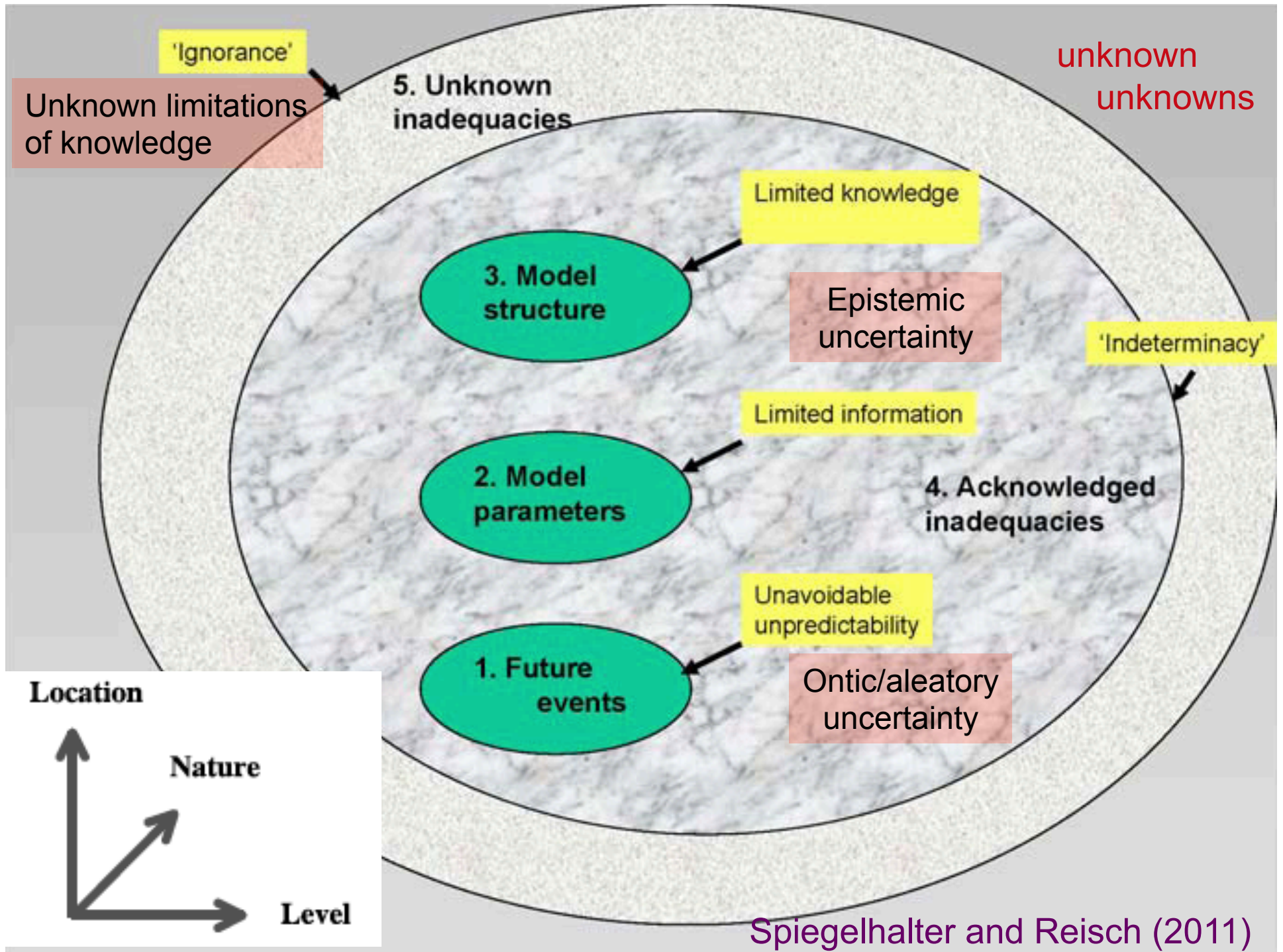
Levels of uncertainty / ignorance

Measure of likelihood	Justification	(Kandlikar and Risbey 2007)
1 Full PDF	Robust, well defended distribution	
2 Bounds	Well defended percentile bounds	
3 First order estimates	Some estimate of likelihood	
4 Expected sign or trend	Well defended trend expectation	
5 Ambiguous sign/trend	Equally plausible contrary trend expectations	
6 Effective ignorance	Lacking or weakly plausible expectations	

“Uncertainty should be expressed using the most precise means that can be justified, but unjustified more precise means should not be used.”



Walker et al. 2003



Quality of Evidence

Guyatt et al. 2008

High quality	Further research is very unlikely to change our confidence in the estimate of effect
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
Low quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate
Very low quality	Any estimate of effect is very uncertain

Reasoning about Uncertainty

Italian Flag: TESLA

Classical probabilistic 2-value logic

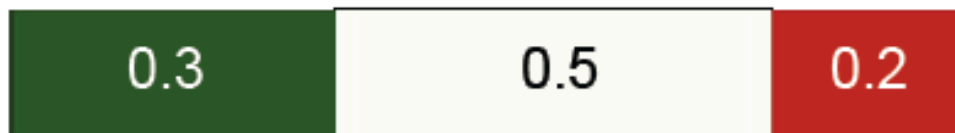


Probability
hypothesis
is true

Probability hypothesis
Is false

- Unknowns undifferentiated
- May lead to false assertions

Evidence based 3-value logic



Evidence for
hypothesis

Ignorance
Uncommitted belief

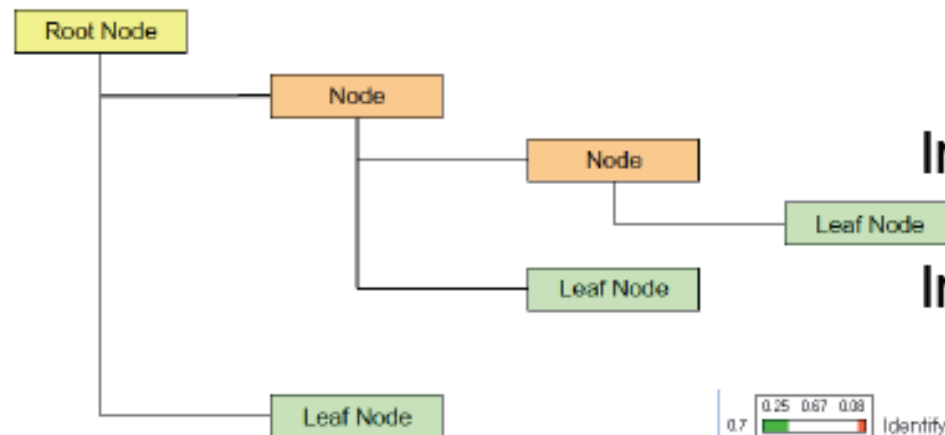
Evidence
against
Inhypothesis

- Honest about unknowns
- Allows better analysis of uncertainty
- Represents potential for improvement

Evidence For + Evidence Against + Uncertainty = 1

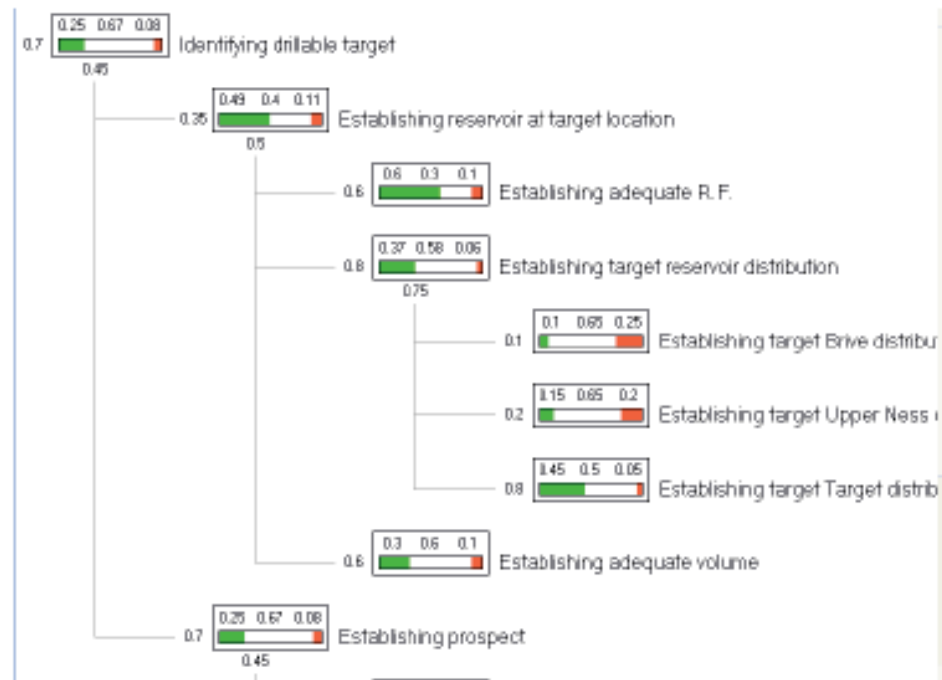
Reasoning about Uncertainty

Propagating Information: TESLA

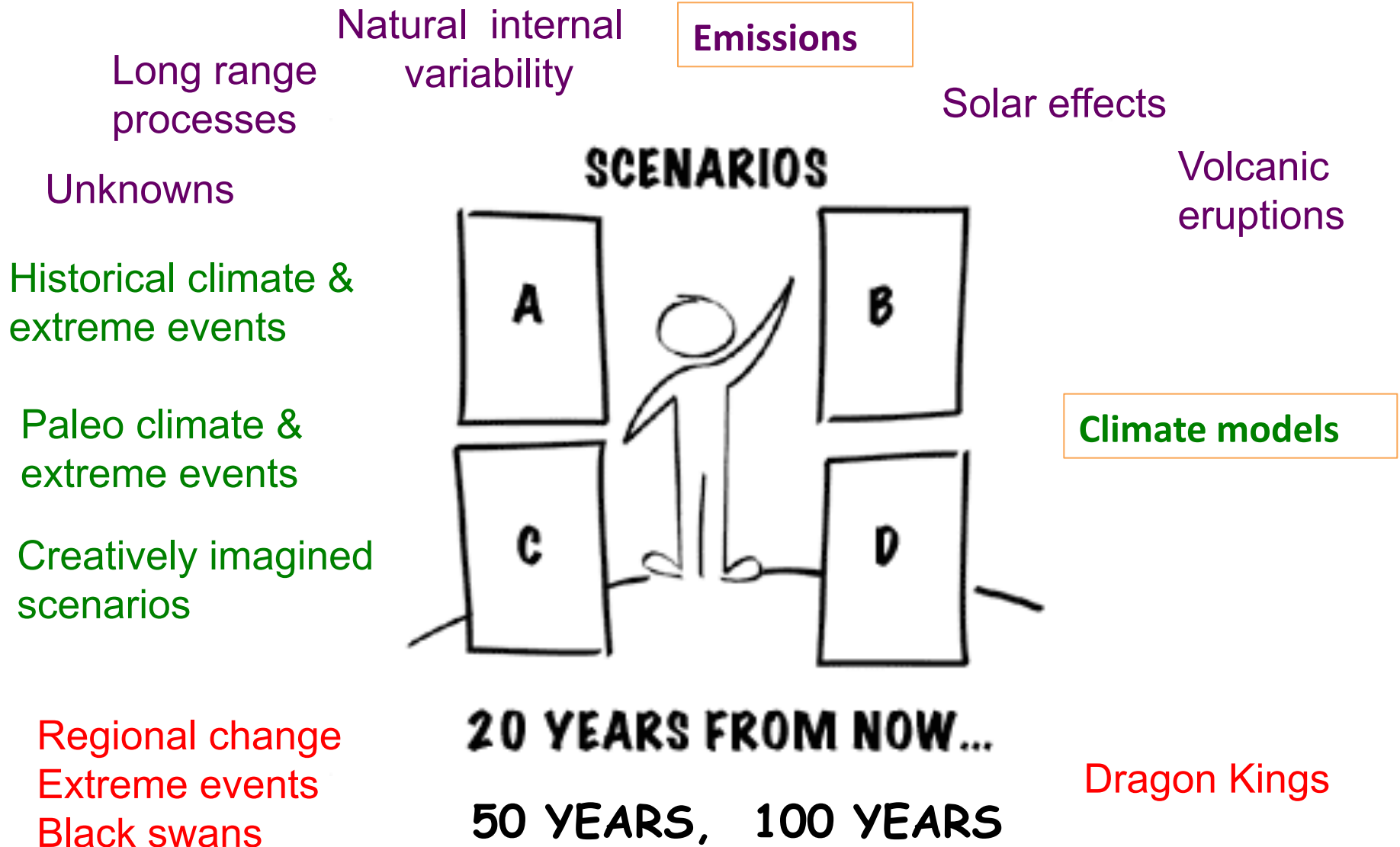


Influence diagrams
Tree logic
Interval probability methods

Break down
and formalize
expert reasoning



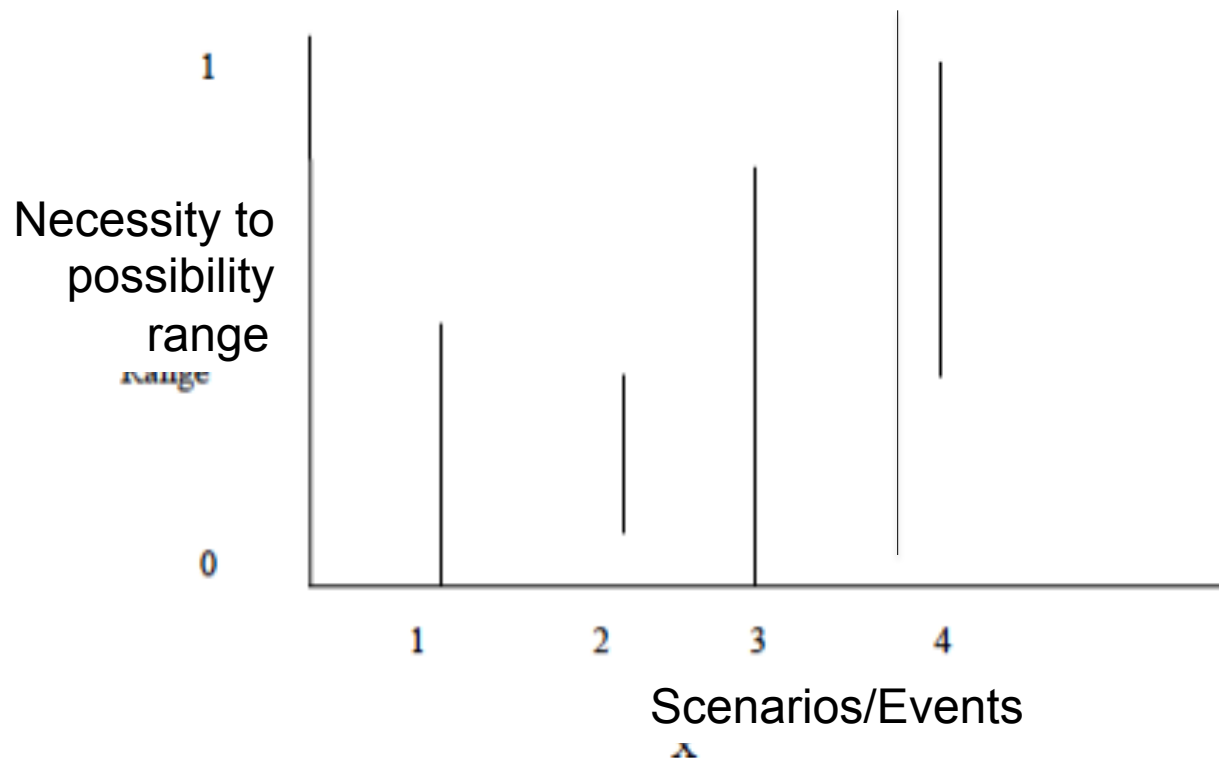
Scenarios of future climate



Possibility distribution

Likelihoods can be developed by:

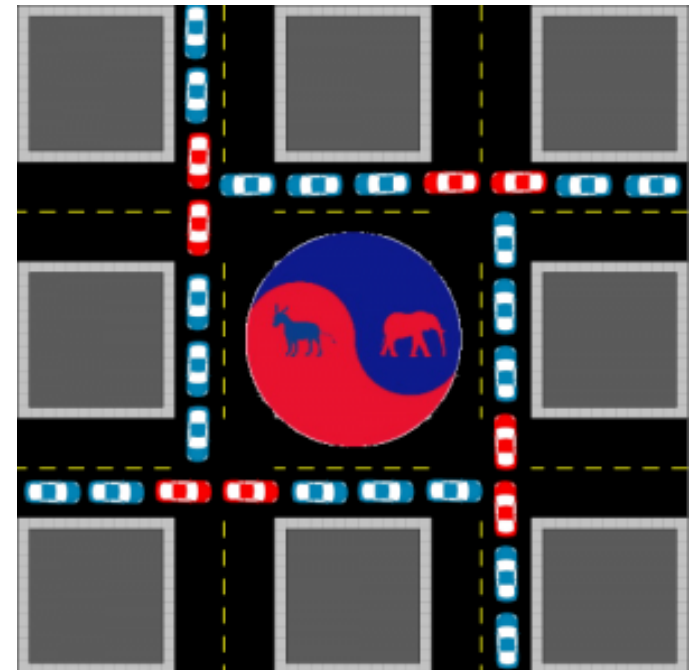
- Weighting preference for scenario generation method
- Historical precedent
- Expert judgment
- Number of independent paths for reaching a particular scenario event



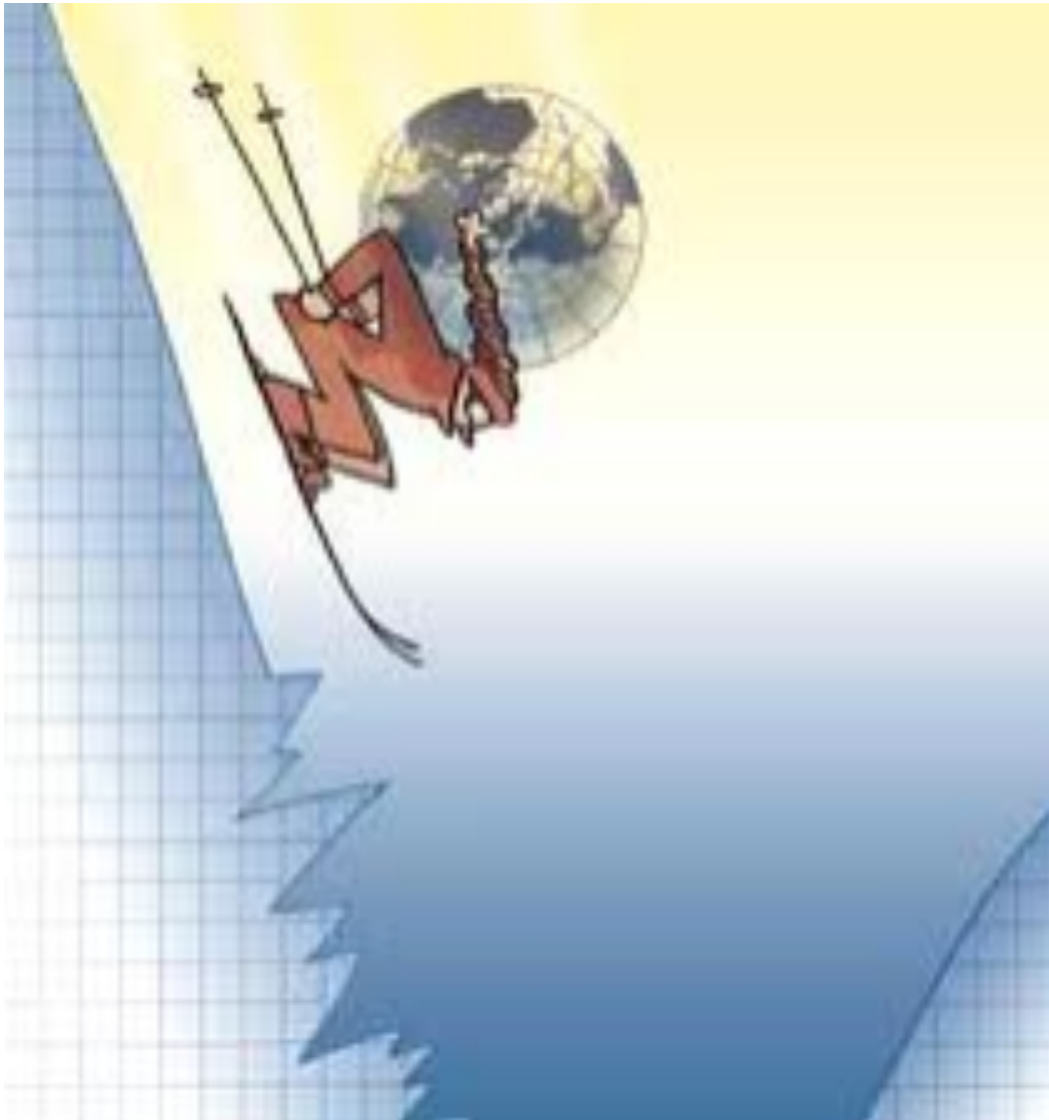
The problem as I see it . . .

The drive to reduce scientific uncertainty in support of precautionary and optimal decision making strategies regarding CO2 mitigation has arguably resulted in:

- unwarranted high confidence in assessments of climate change attribution, sensitivity and projections
- relative neglect of black swans and dragon kings
- relative neglect of decadal and longer scale modes of natural climate variability
- conflicting “certainties” and policy inaction



Decision making under uncertainty



The decision-analytic framework influences how climate models are used and developed.

The current focus on the precautionary principle and optimal decision making is driving climate model development & applications in directions for which they are not fit.

Optimal decision making: linear model

more research → less uncertainty →
political consensus → meaningful action

Classical decision analysis can suggest statistically optimal strategies for decision makers when:

- uncertainty is well characterized
- model structure is well known



Key climate policy dilemma

Whether betting big today with a comprehensive global climate policy targeted at stabilization will:

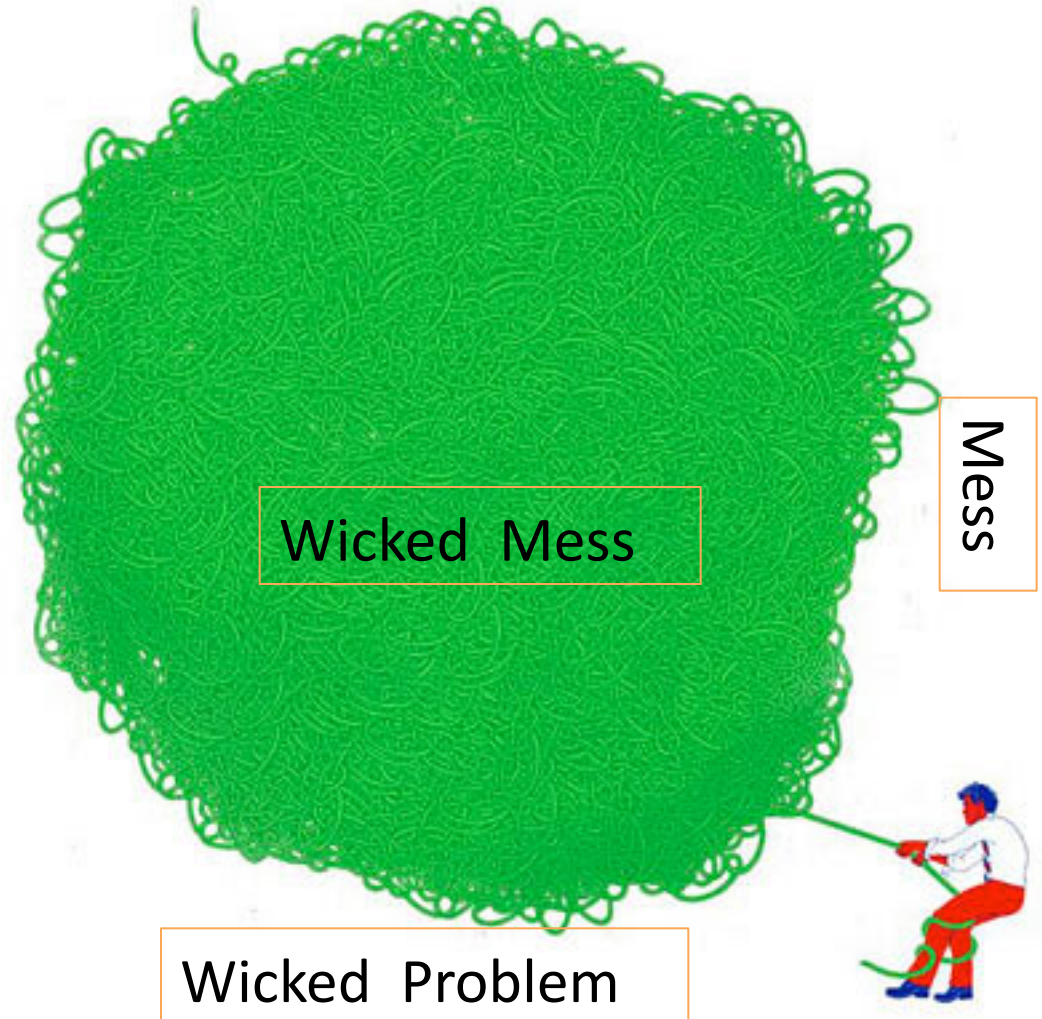
- fundamentally reshape our common future on a global scale to our advantage
- OR -
- quickly produce losses that throw mankind into economic, social, & environmental bankruptcy



Tame Problem



versus



Wicked Mess

Mess

Wicked Problem

Options for decision makers confronted with deep uncertainty:



"OK, all those in favour of delegating decision-making, shrug your shoulders"

- Wait and see
- **Delay, gather more info**
- **Target critical uncertainties**
- Enlarge the knowledge base for decisions
- **Precautionary principle**
- Adaptive management
- Build a resilient society

A tamed uncertainty monster



“Being open about uncertainty should be celebrated: in illuminating where our explanations and predictions can be trusted and in proceeding, then, in the cycle of things, to amending their flaws and blemishes.” - Bruce Beck

<http://judithcurry.com>

Climate Etc.

- Climate science
- Uncertainty
- Communications
- Social psychology
- Philosophy of science
- Policy and politics
- Skepticism

