

Quantifying Uncertainties Using Earth System Models to Inform Decision Making

“all models are wrong, but some are useful”
(George Box)

“It is better to be roughly right than precisely wrong.”
(John Maynard Keynes)

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with inputs from A. Bakker, T. Wong, K. Ruckert, G. Garner, R. Lempert, P. Oddo, R. Nicholas, ...

Outline

1. What are current challenges?
2. How can we overcome these challenges?
3. What are example projects?

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 - > Begin with real question to be addressed (Dorothy Koch)
2. How can we overcome these challenges?
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One real-world question informed by ESM results: How to design strategies to manage flood risks?



How did
predictions
inform this
decision?

This design problem is informed by predictions.

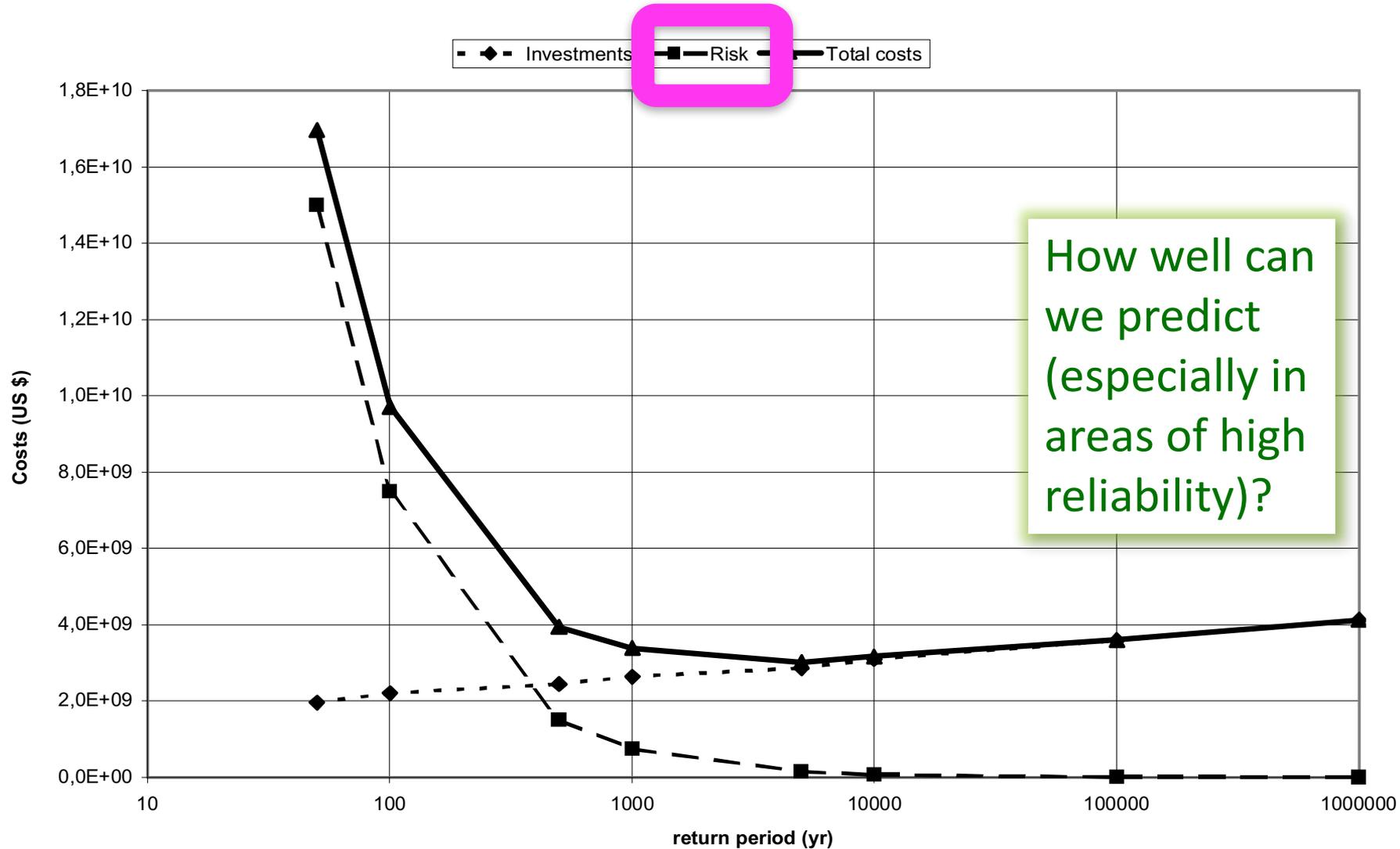
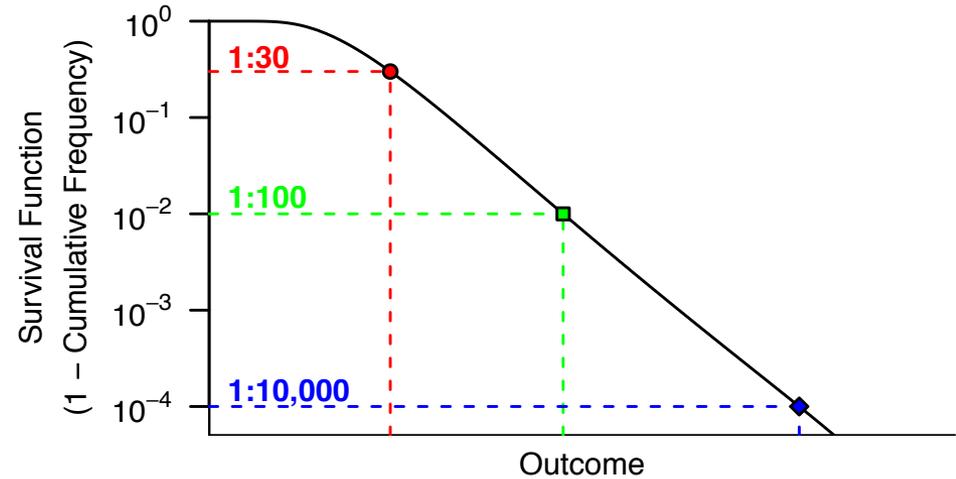
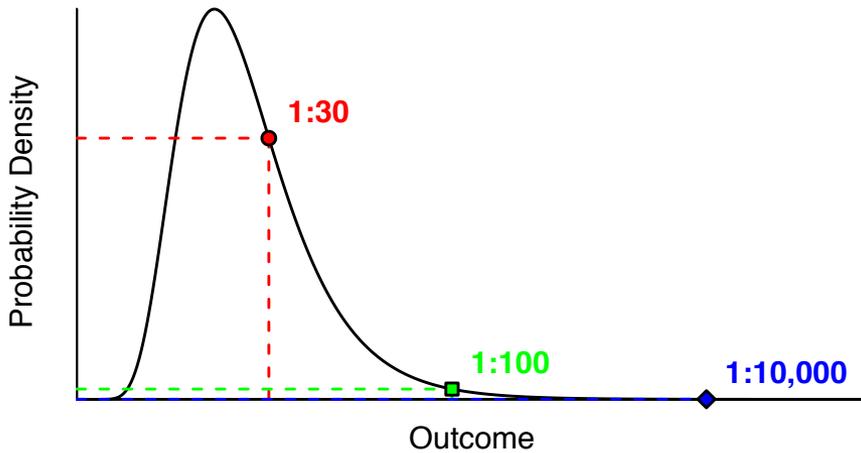


Figure 97 Results of economic optimization for the Northern levee ring, central part of New Orleans

High reliabilities require information about the upper tails of the probability density function.

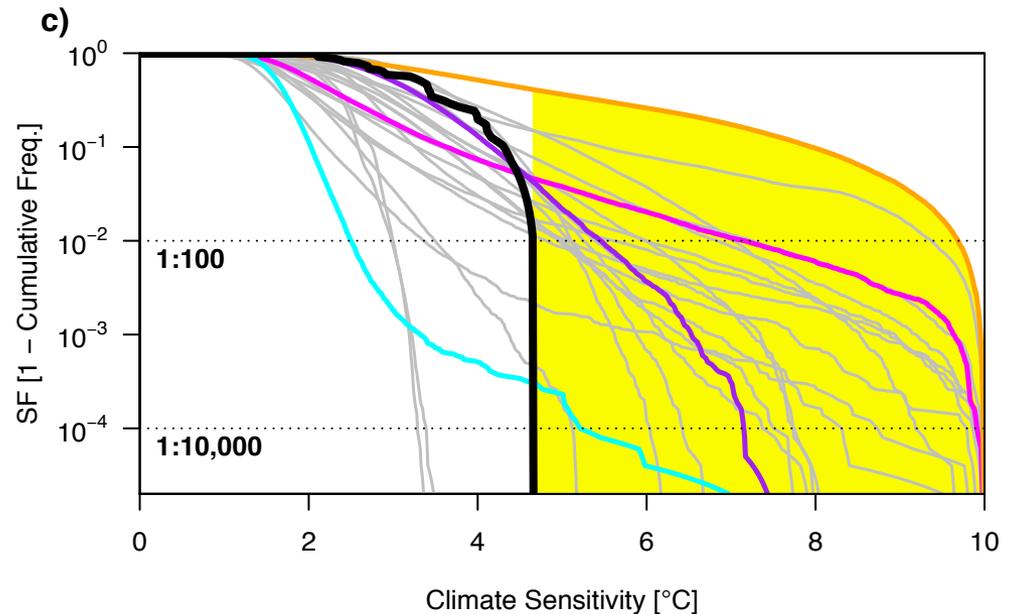
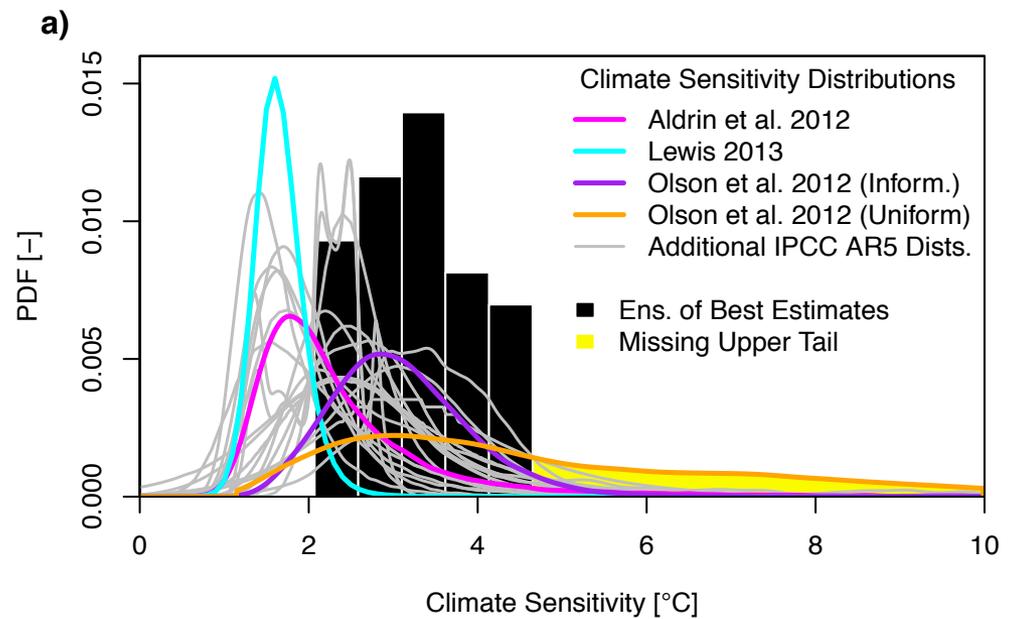
Examples of reliability requirements from decision makers



Are these tails provided or cut off?

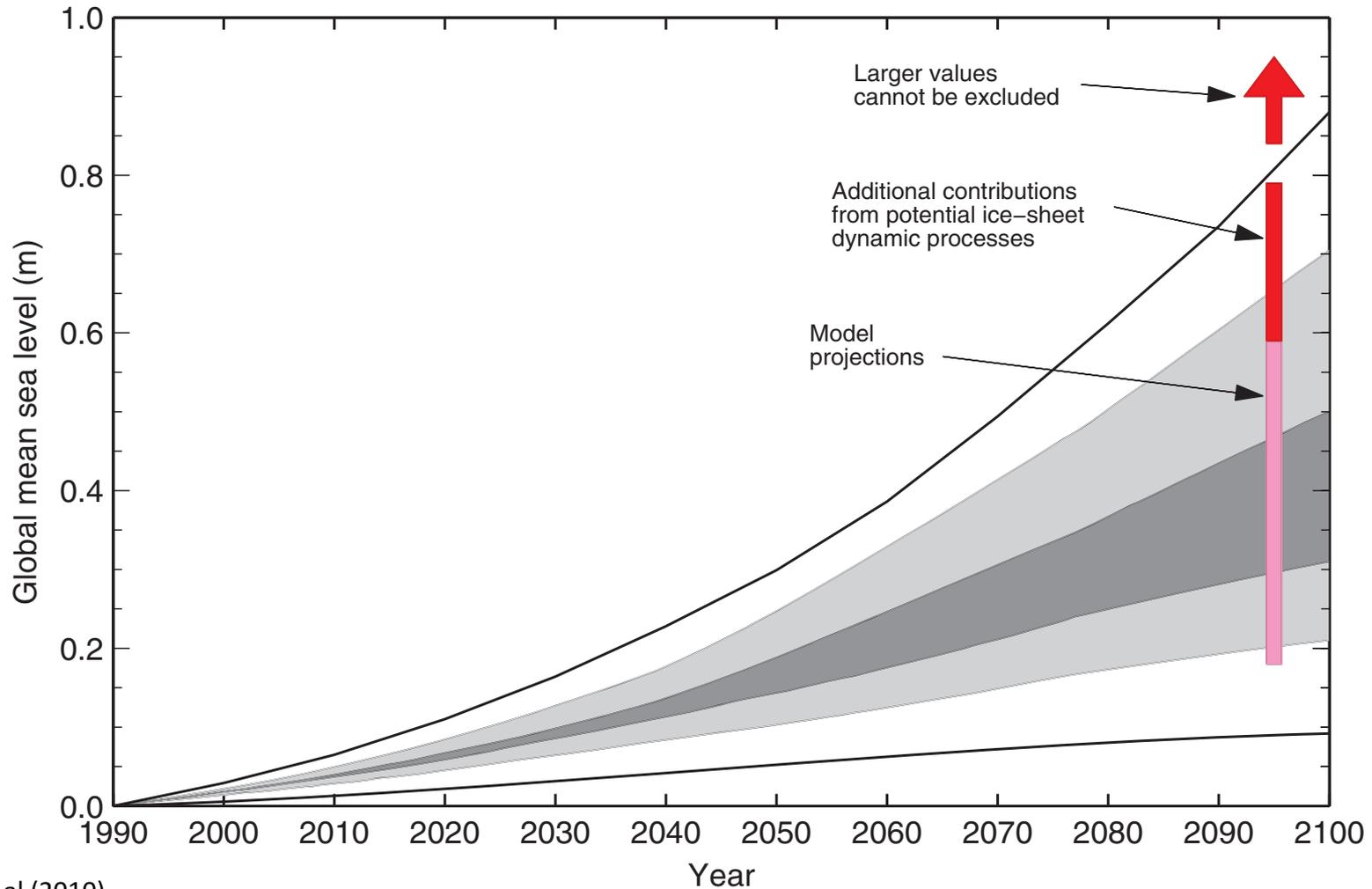


Scenarios based on ensembles of opportunity can miss decision-relevant tails.

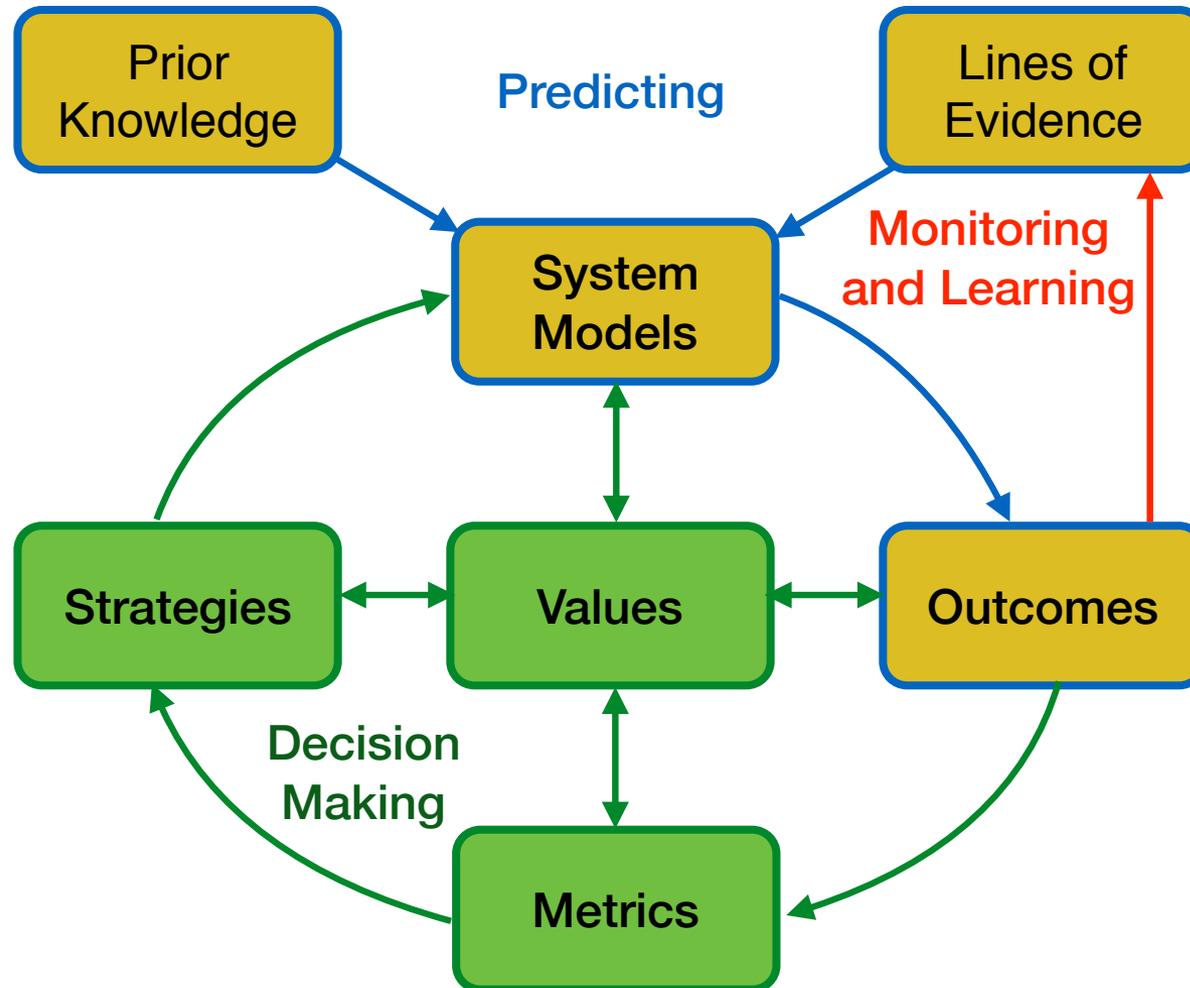


Earth system models can provide insights about the stakes. (There may be **dragons** =>).

ESM runs are difficult to interpret to estimate odds.



How to represent and quantify natural - human feedbacks in Earth System Models?

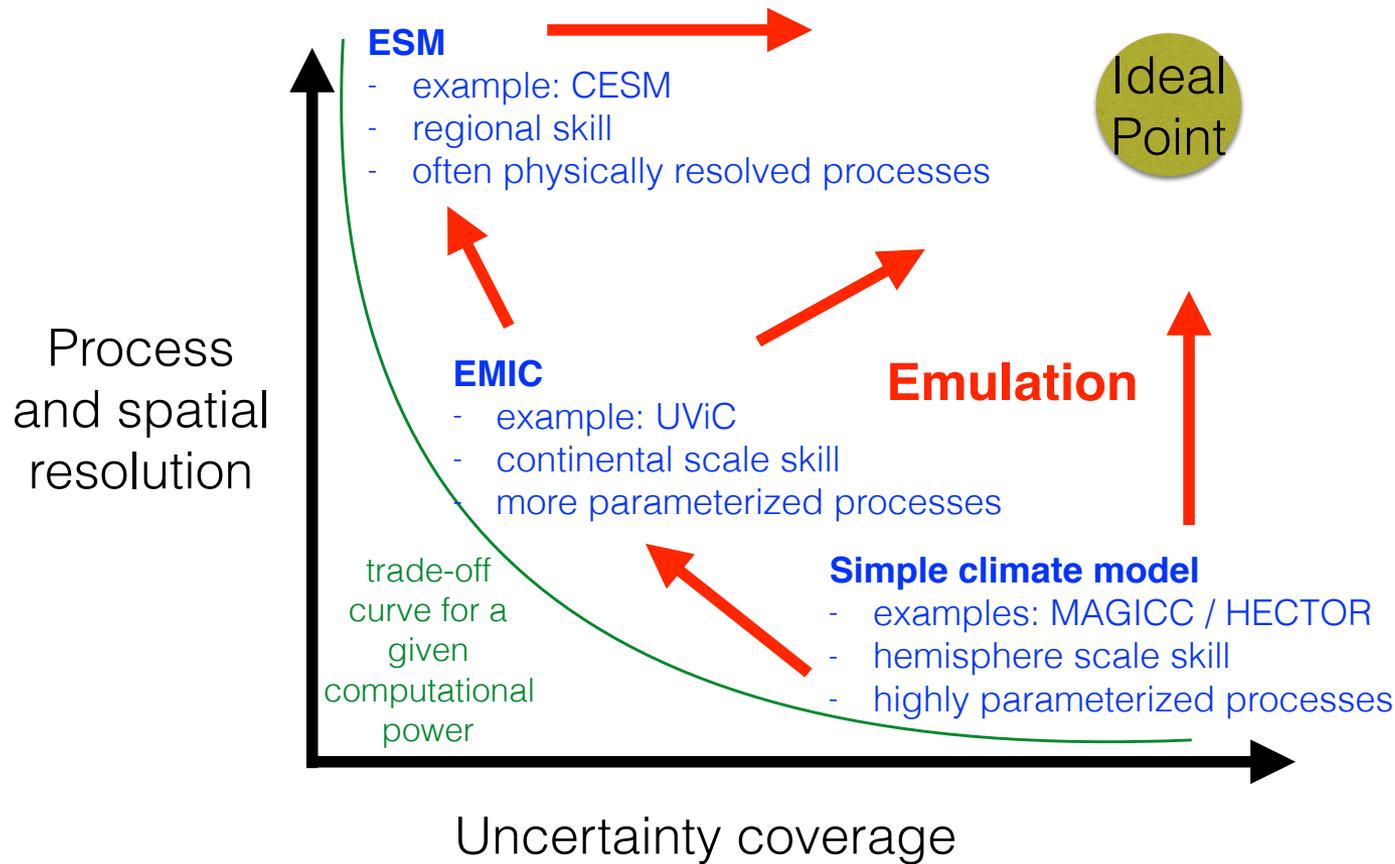


How important are these feedback loops (cf. discussion in Detlef's talk)? -> WIP

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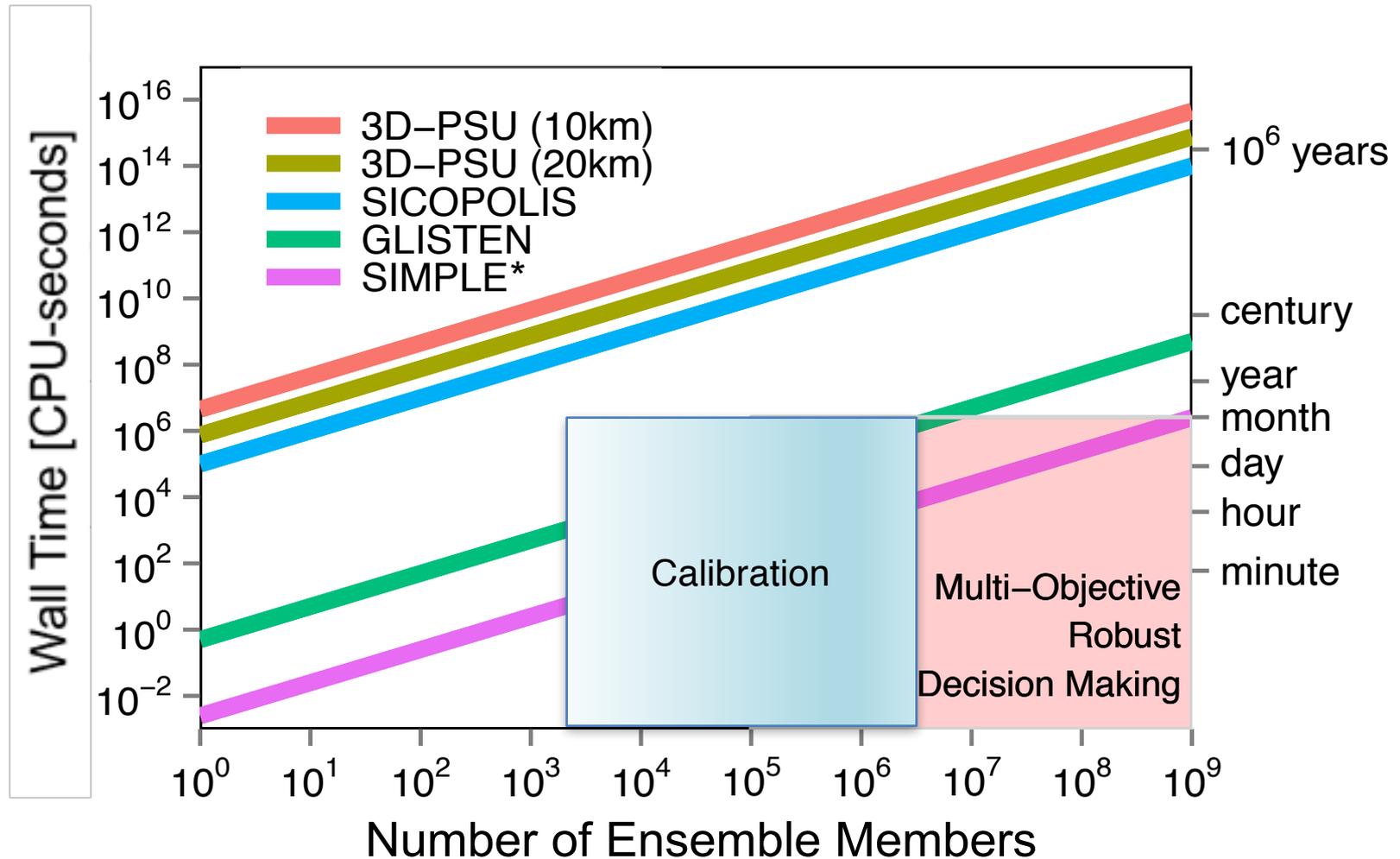
Emulation can facilitate the information exchange between a suite of model complexities.



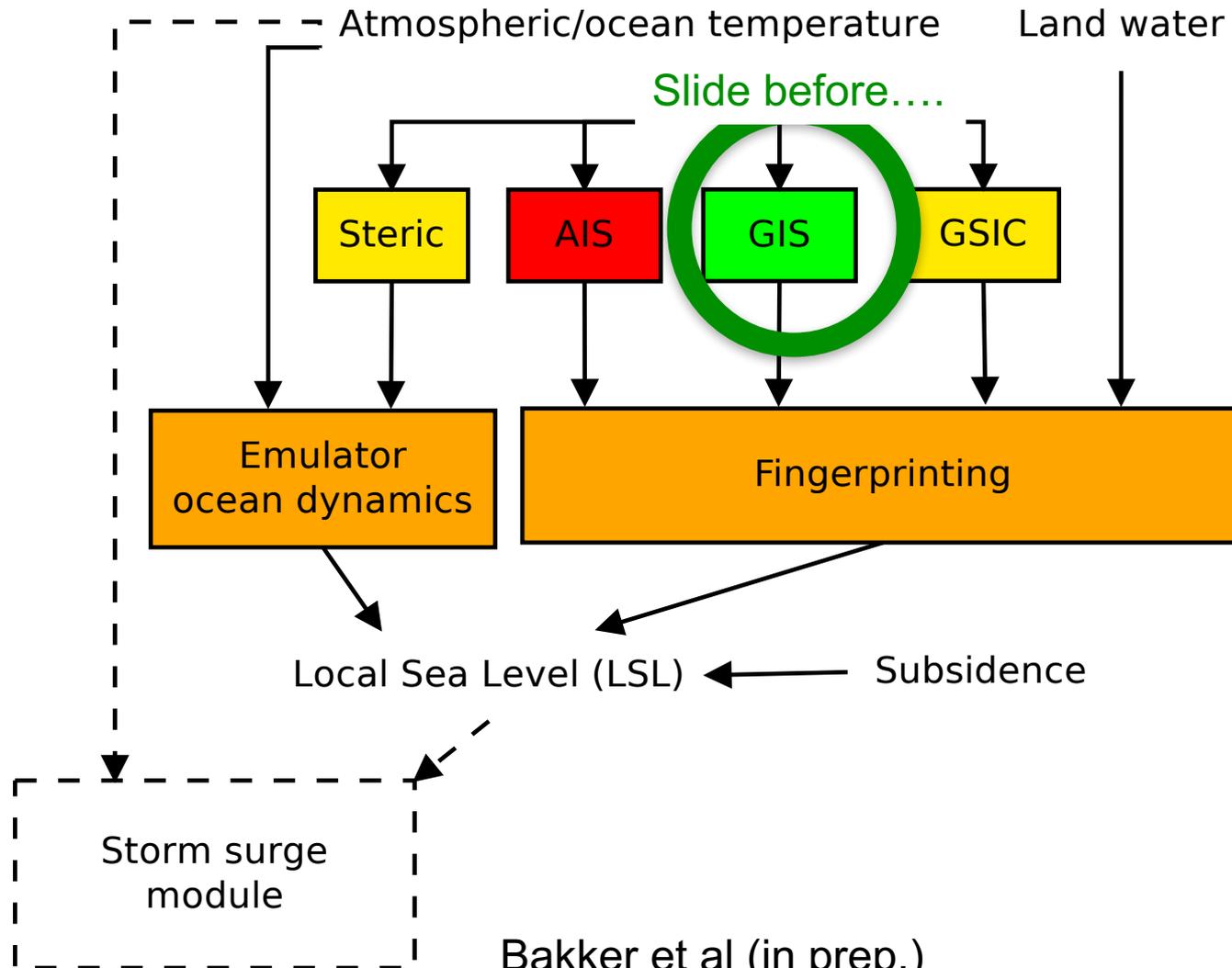
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We have build emulators that enable careful uncertainty quantification and representation in IAMs and IAVMs.



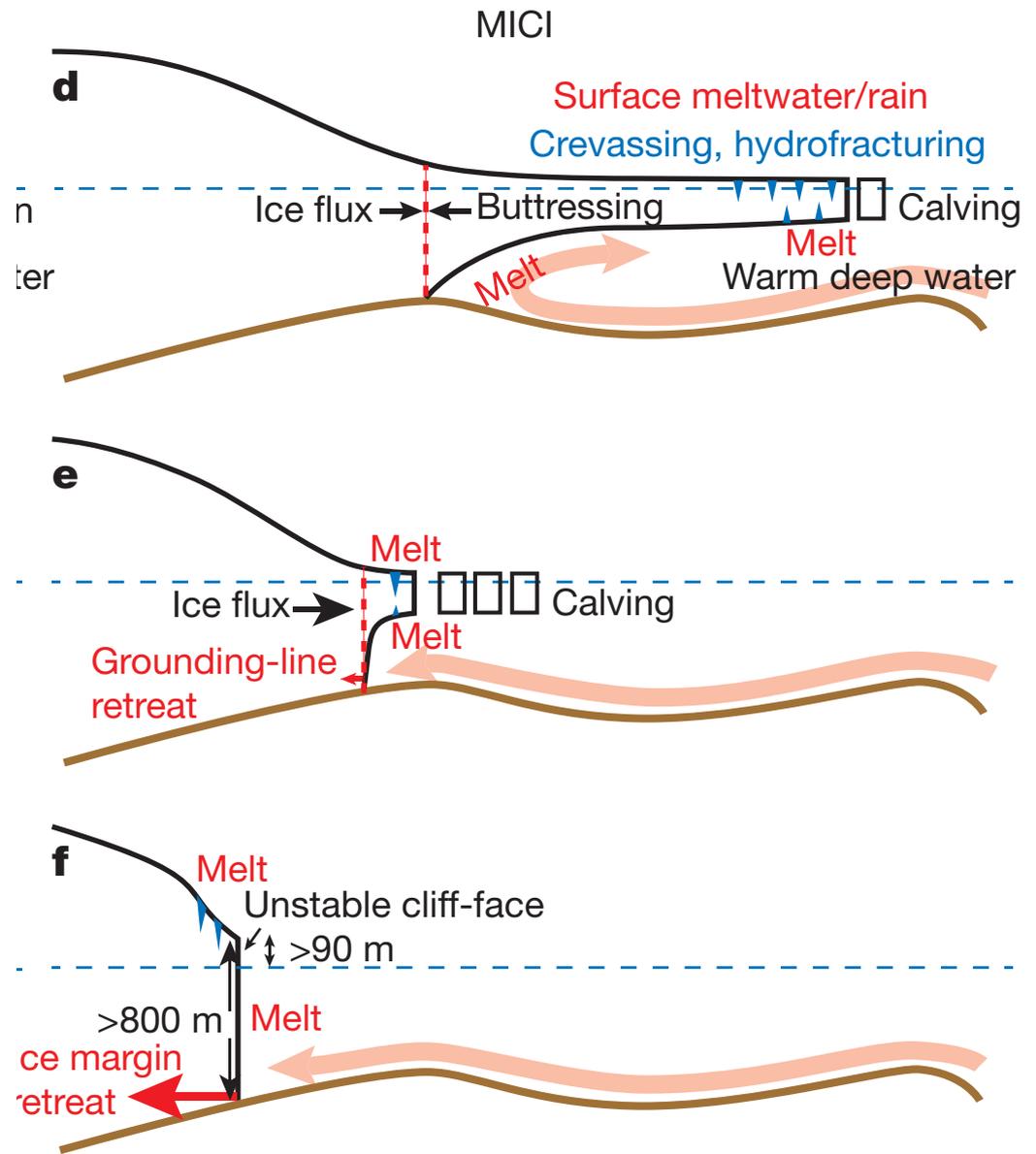
Putting it all together: The BRICK Model



Bakker et al (in prep.)

Building blocks for **R**elevant **I**ce and **C**limate **K**nowledge

One new scientific finding: ice cliff instability.



Cf. Pollard et al (2015)
DeConte and Pollard (2016) (figure)

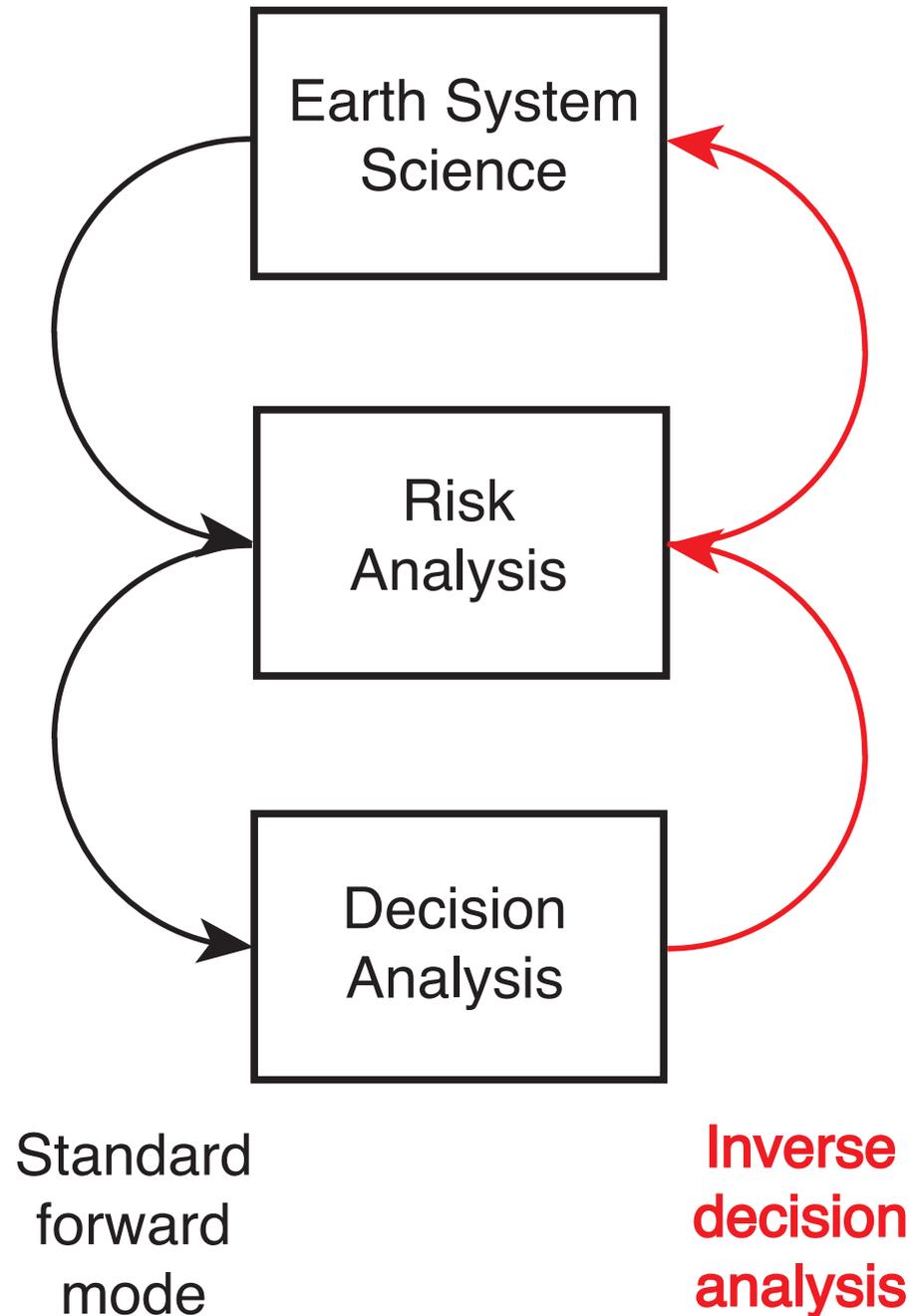
How to pick the right tree to bark at?



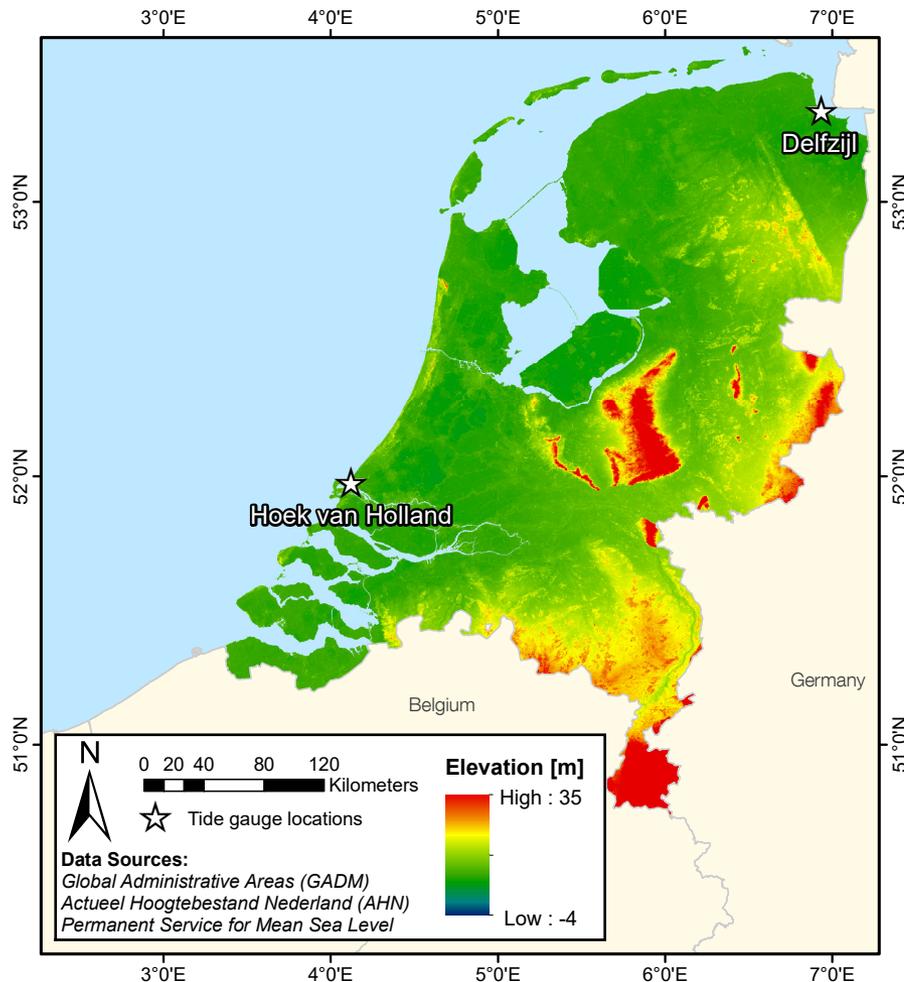
Inverse
decision
analysis can help
to close the loop.

What are decision-
relevant
uncertainties?

What are
important
interactions?



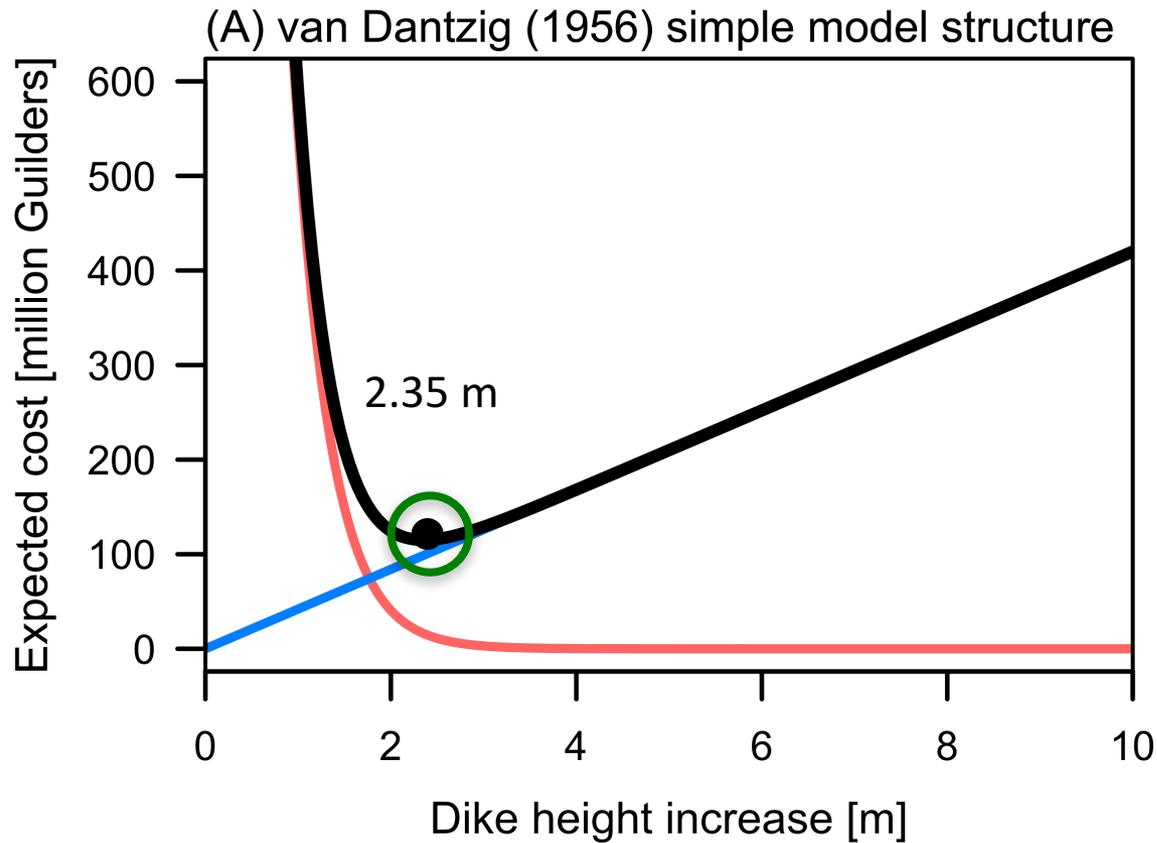
Demonstrating inverse decision analyses using a real (and classic) climate risk management problem.



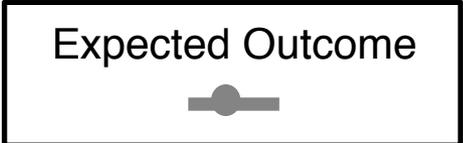
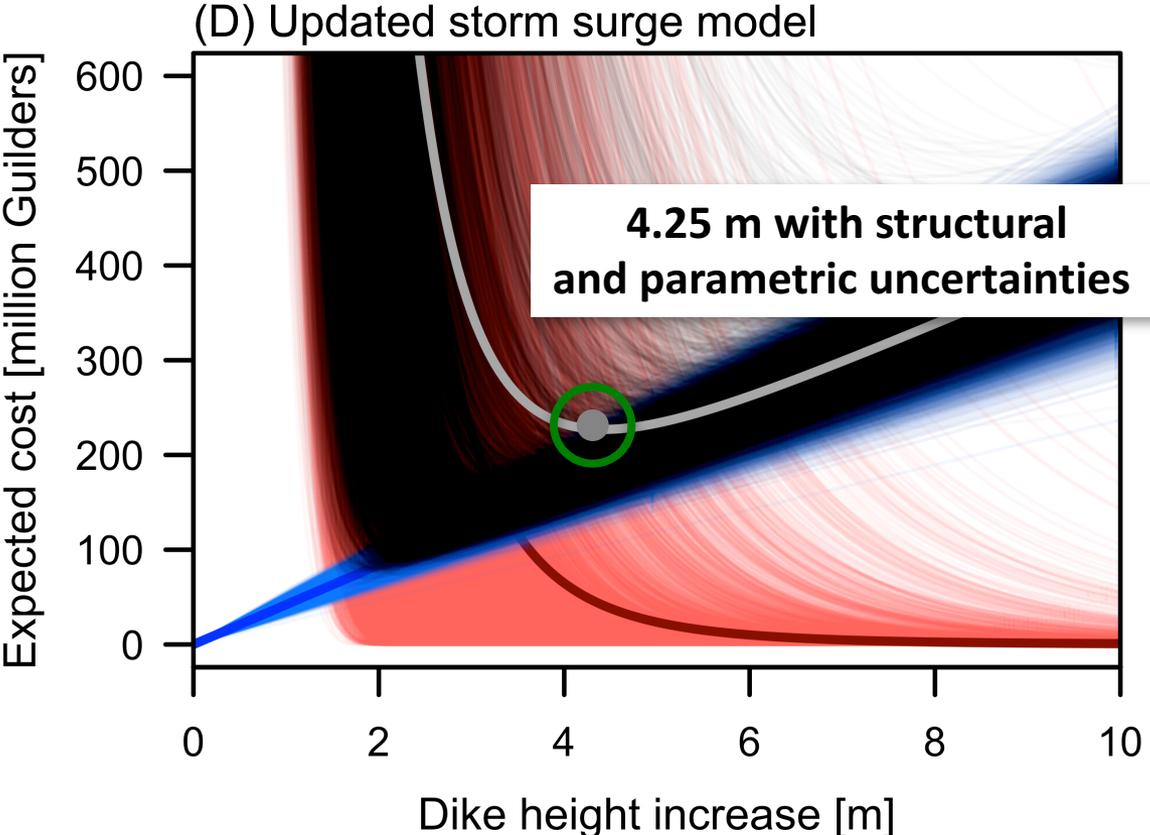
How high to build the dikes in the Netherlands in the 1960s? (van Dantzig, 1956)

Left: Map showing land surface elevation above mean sea level, the Netherlands.

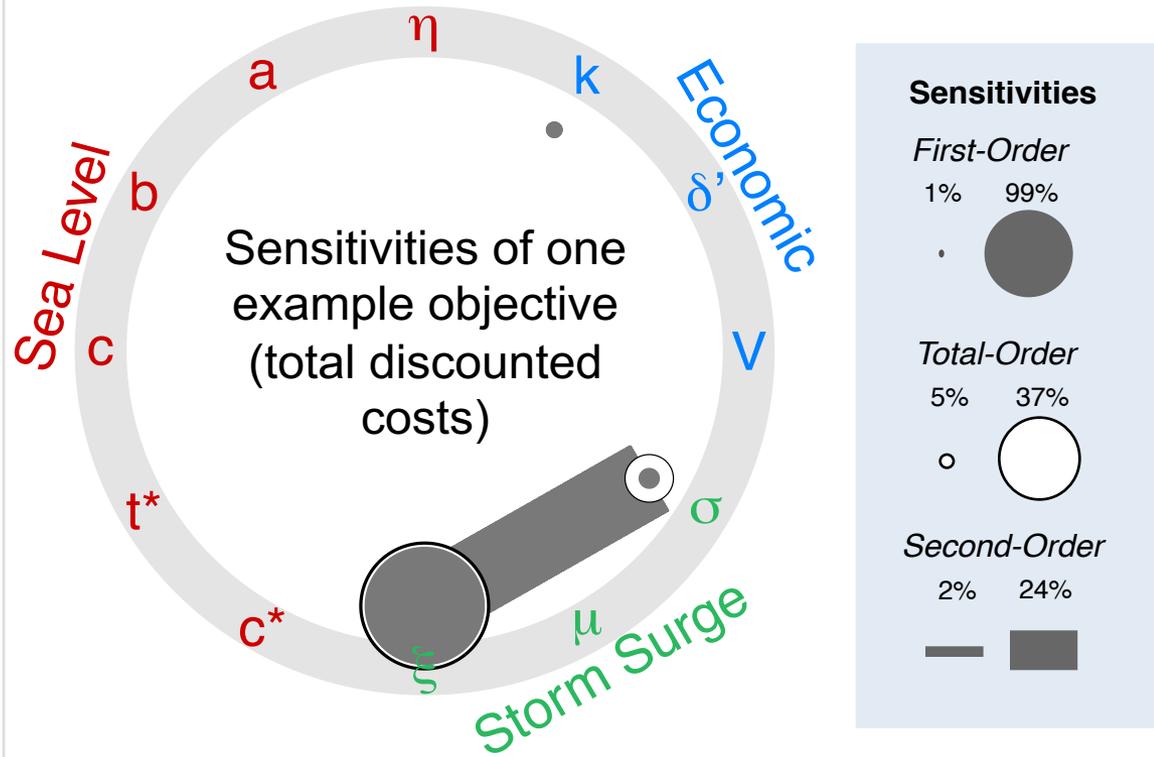
The basic set-up (remember the New Orleans analysis in the NAS report)



Step 1: Update science models and add uncertainties



Step 2: Towards closing the feedback loop.



K = cost rate of heightening	a = SLR in 2015
δ' = effective discount rate	b = SLR rate
V = value of goods	c = SLR acceleration
σ = GEV scale parameter	t^* = year of abrupt SLR
μ = GEV location parameter	c^* = rate of abrupt SLR
ξ = GEV shape parameter	η = subsidence rate

Some of the open questions...

- How to communicate results given the deep uncertainty and the known unknowns?
- How to navigate the trade-offs between model realism, resolution, and uncertainty coverage?
- How to achieve the required integration within the ESM, IAV, and IAM communities and beyond?

Thanks



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- Michael Oppenheimer
- ...

All errors and opinions are (unless cited) mine.

