Understanding the Limits of Climate Prediction When Assessing Risk

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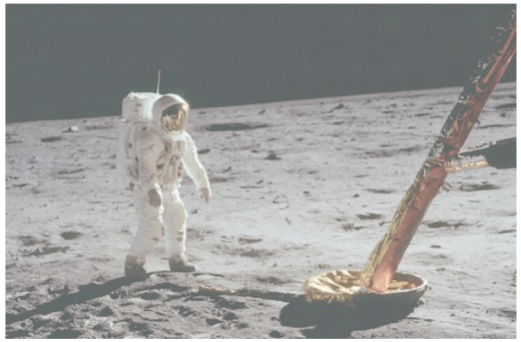
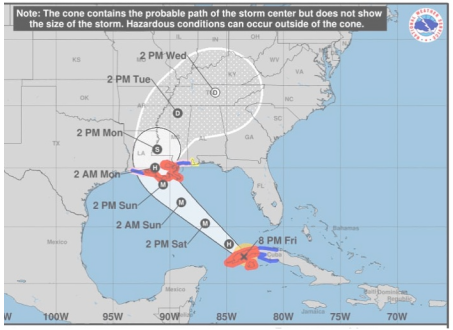
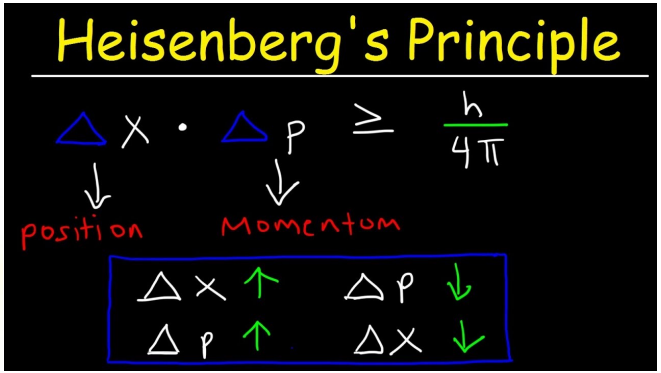
Metamodel.blog

Science is about possibilities





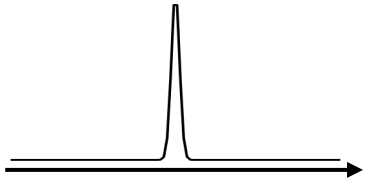
Science is also about impossibilities (or limits)



~~Great~~ Expectations of Climate Modeling

Naïve?

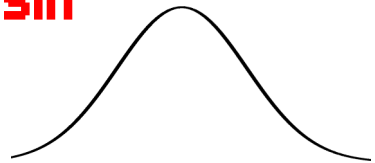
X Predict climate in the year 2100 with certainty



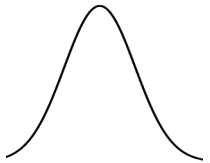
~~Digital Twin~~

Digital Sibling/Cousin

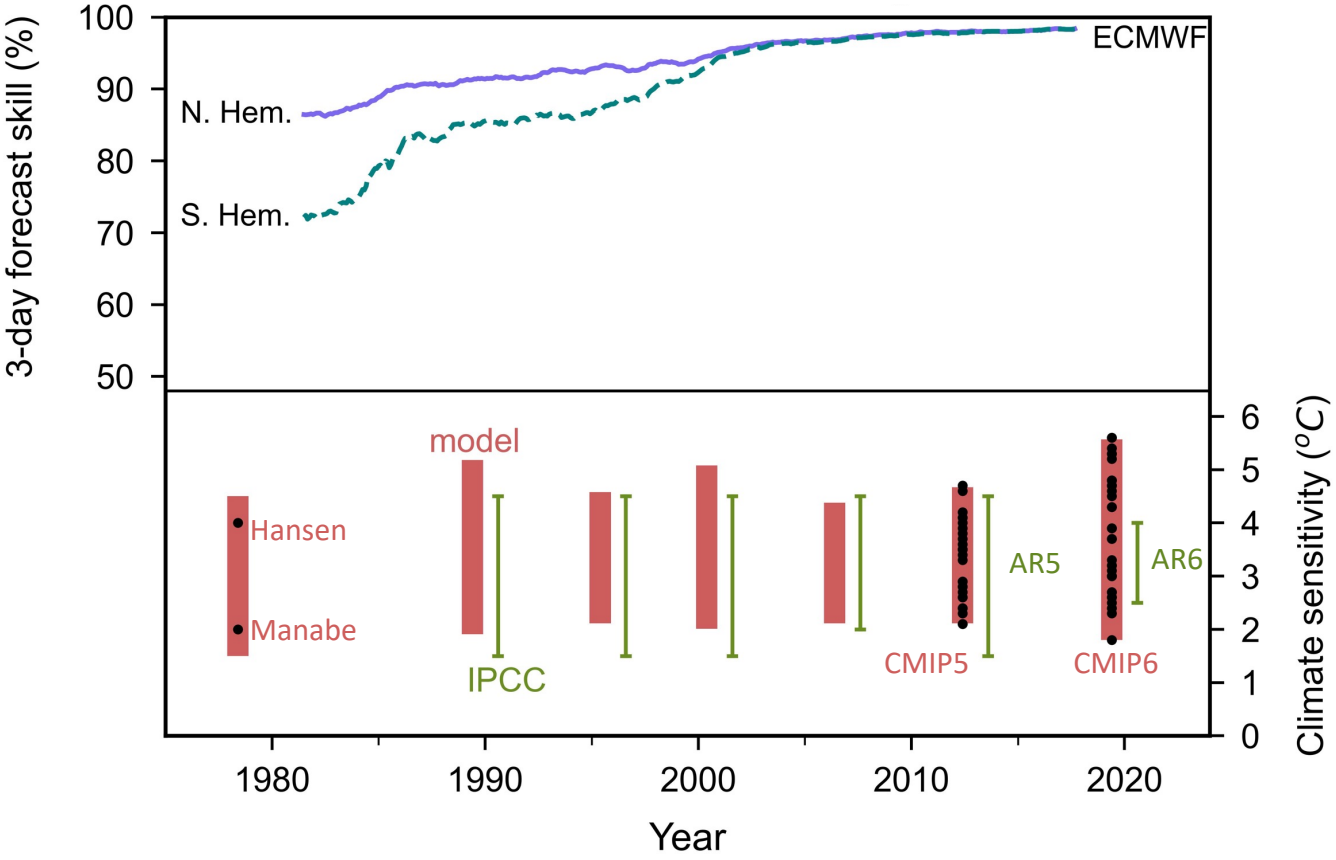
? Predict it probabilistically



? Narrow probabilistic predictions with better models



Progress in Weather vs. Climate Prediction



Accuracy
vs.
Precision

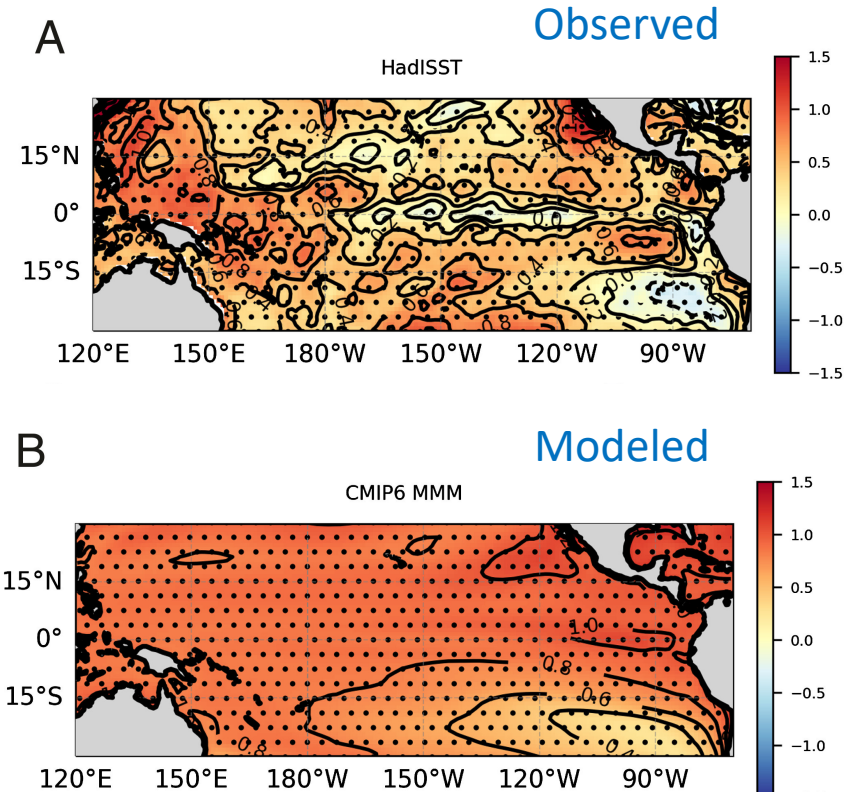
All models are wrong, but some models are useful.

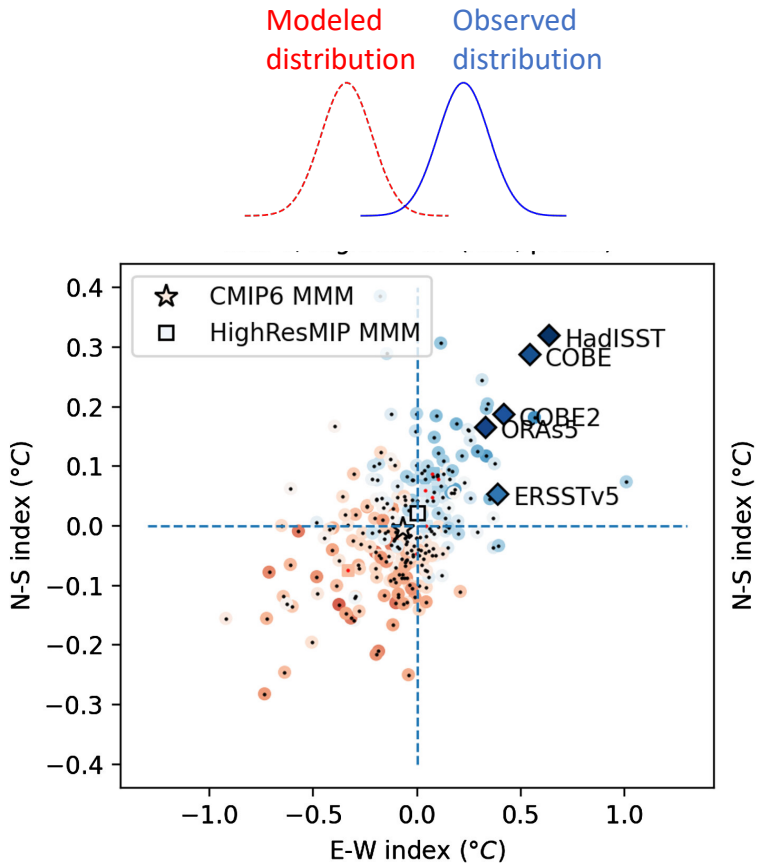
George Box

When *all* models are *actually* wrong!

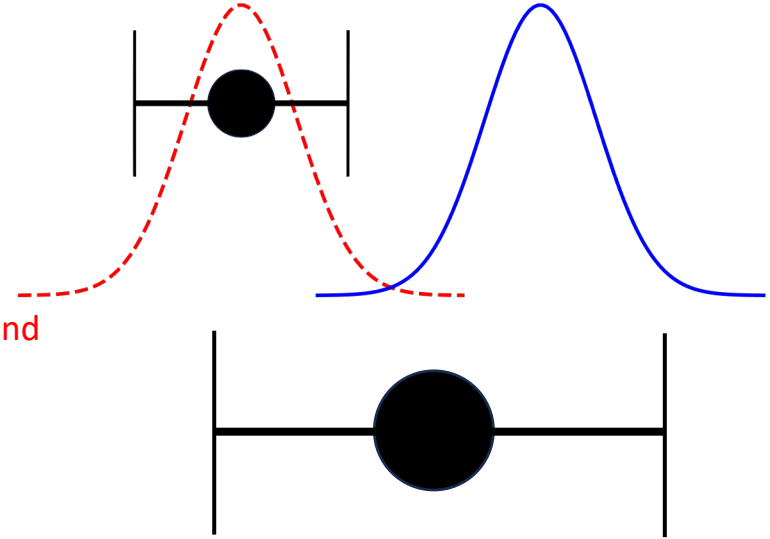
Tropical Pacific SST Trends

Sobel et al. (2023)





Precision
(model spread)



Modeled
Trop. Pac. SST trend

Observed (1958-2020)
Trop. Pac. SST trend

Accuracy
(true model error)

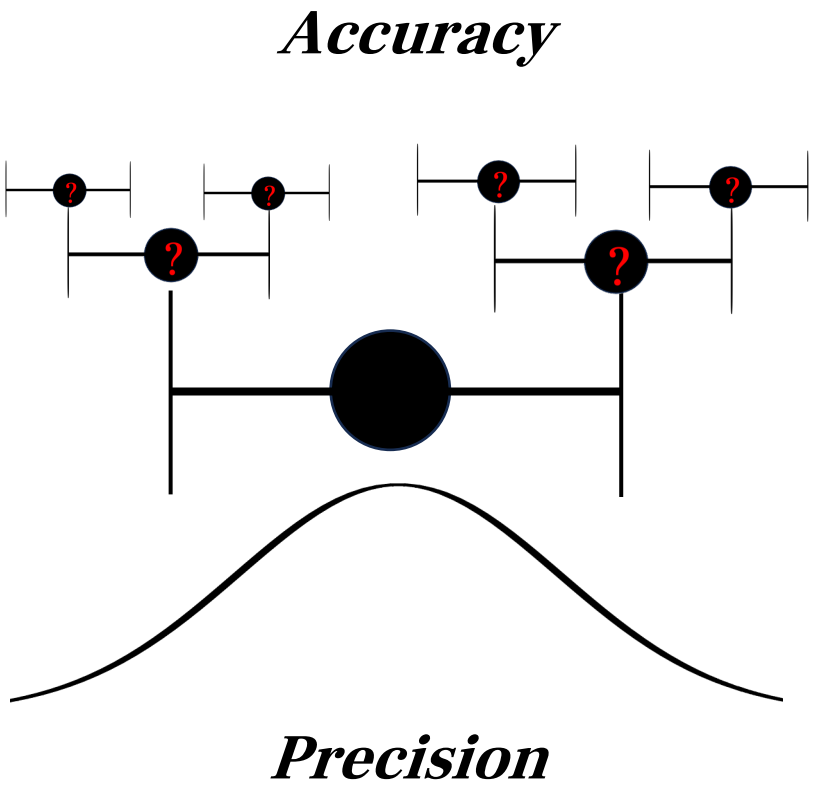
climate is what you expect
… *weather* is what you get

For long-term climate risk:

accuracy is what you want
… *precision* is what you get

Meta Error Bars

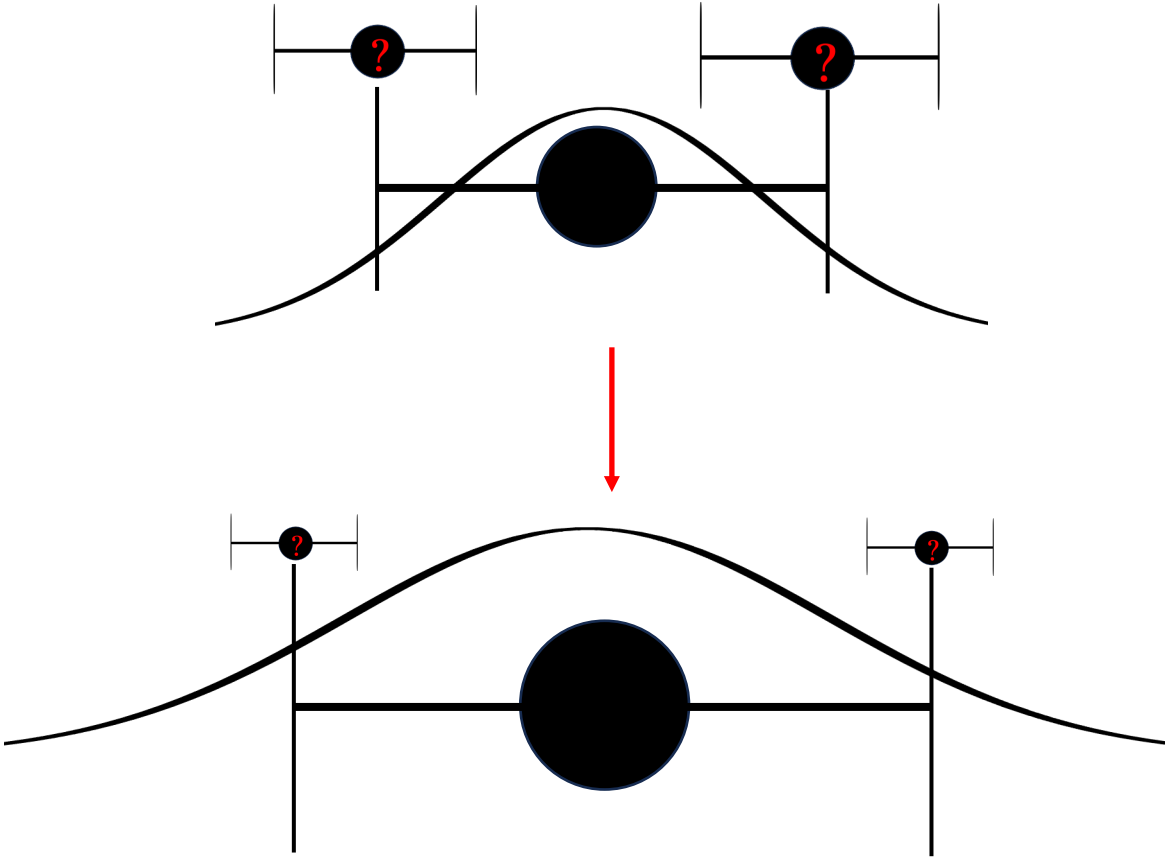
DEEP UNCERTAINTY



Meta Meta Error Bar

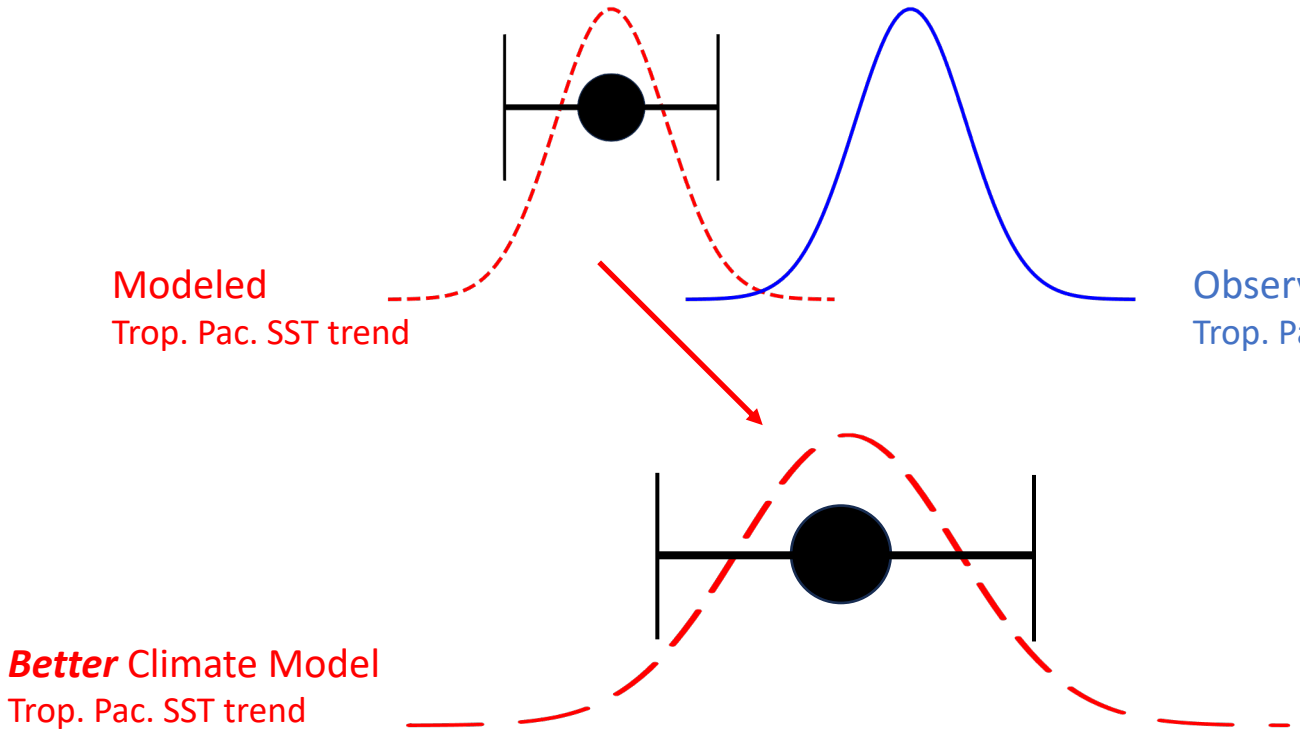
Meta Error Bar (IPCC: confidence)

Error Bar



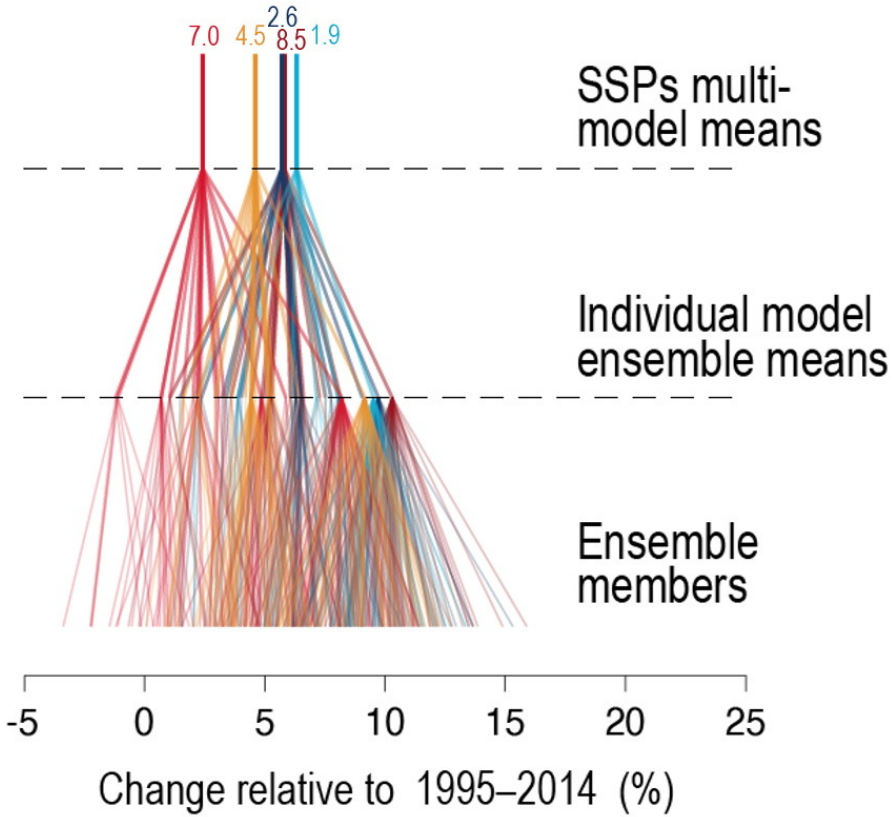
The goal climate model improvement is to reduce the Meta Error Bars - more credible even if less precise

Tropical Pacific SST Trend



Societal Butterfly Effect

2081-2100 East Asia Summer Rainfall “Prediction” (IPCC AR6)



From Figure 1.15 of IPCC AR6 WG1 report

Meteorological Butterfly Effect

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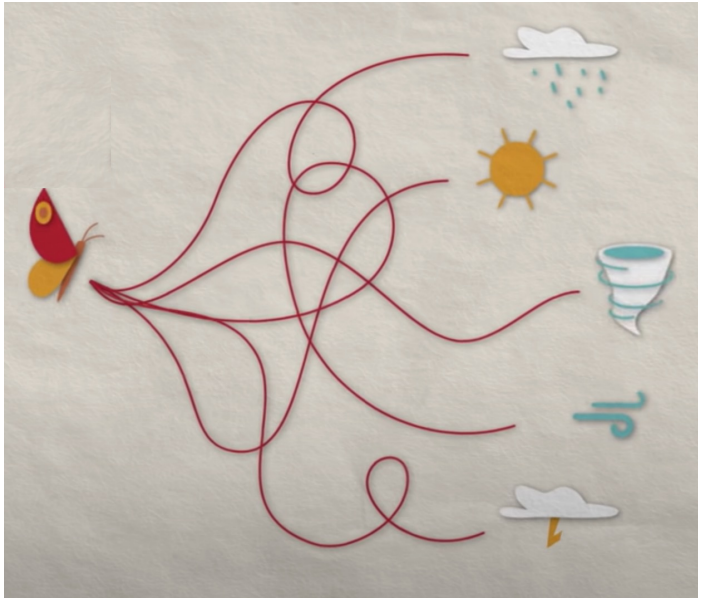
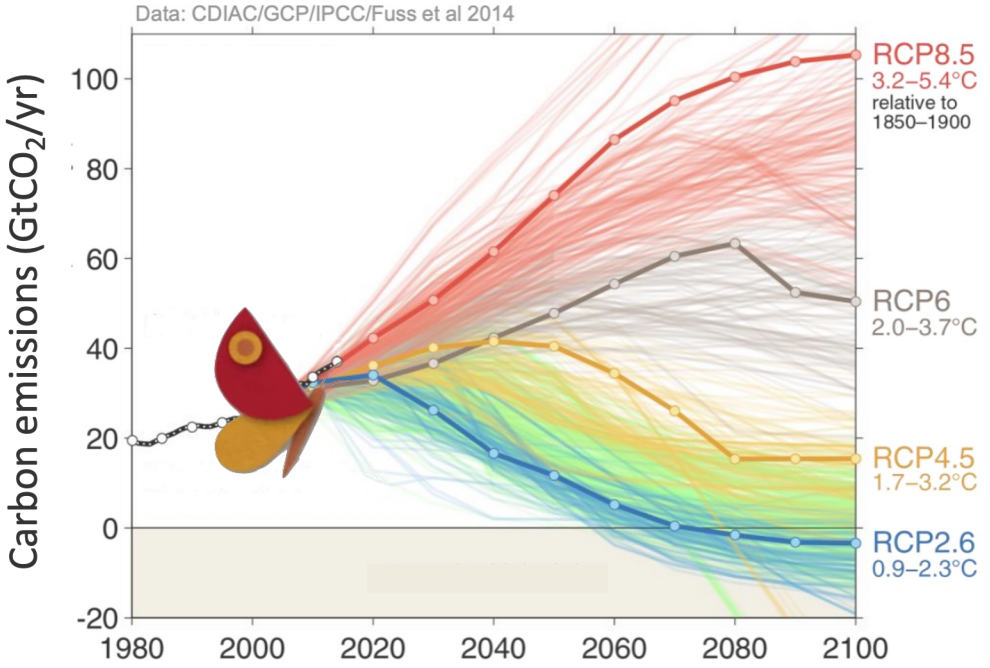


Societal Butterfly Effect

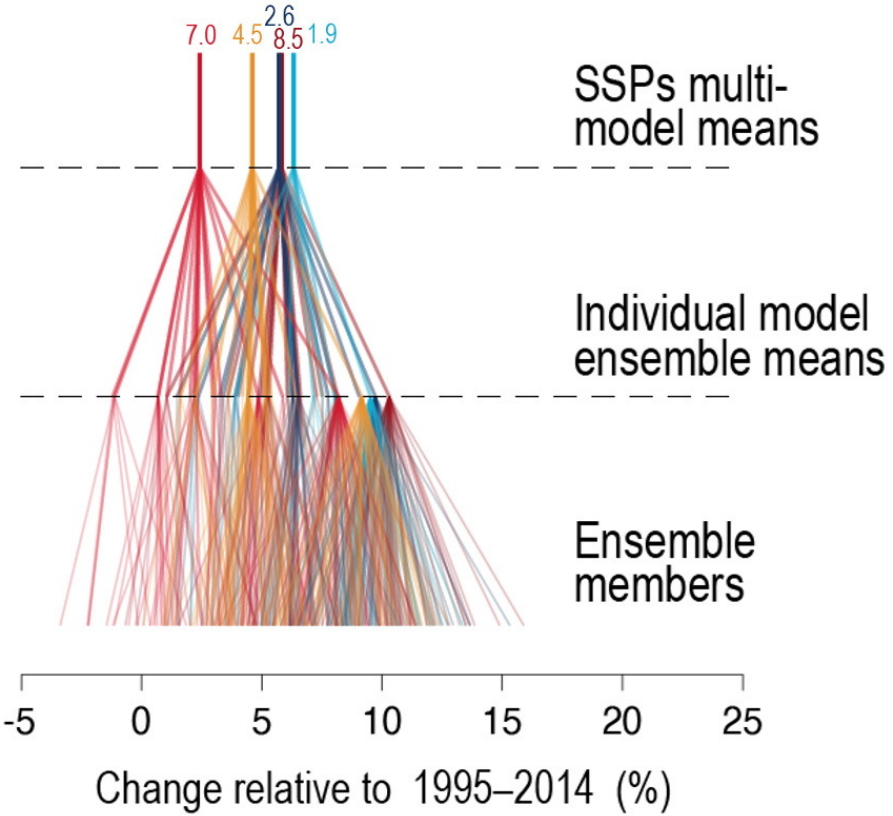


2081-2100 East Asia Summer Rainfall “Prediction” (IPCC AR6)

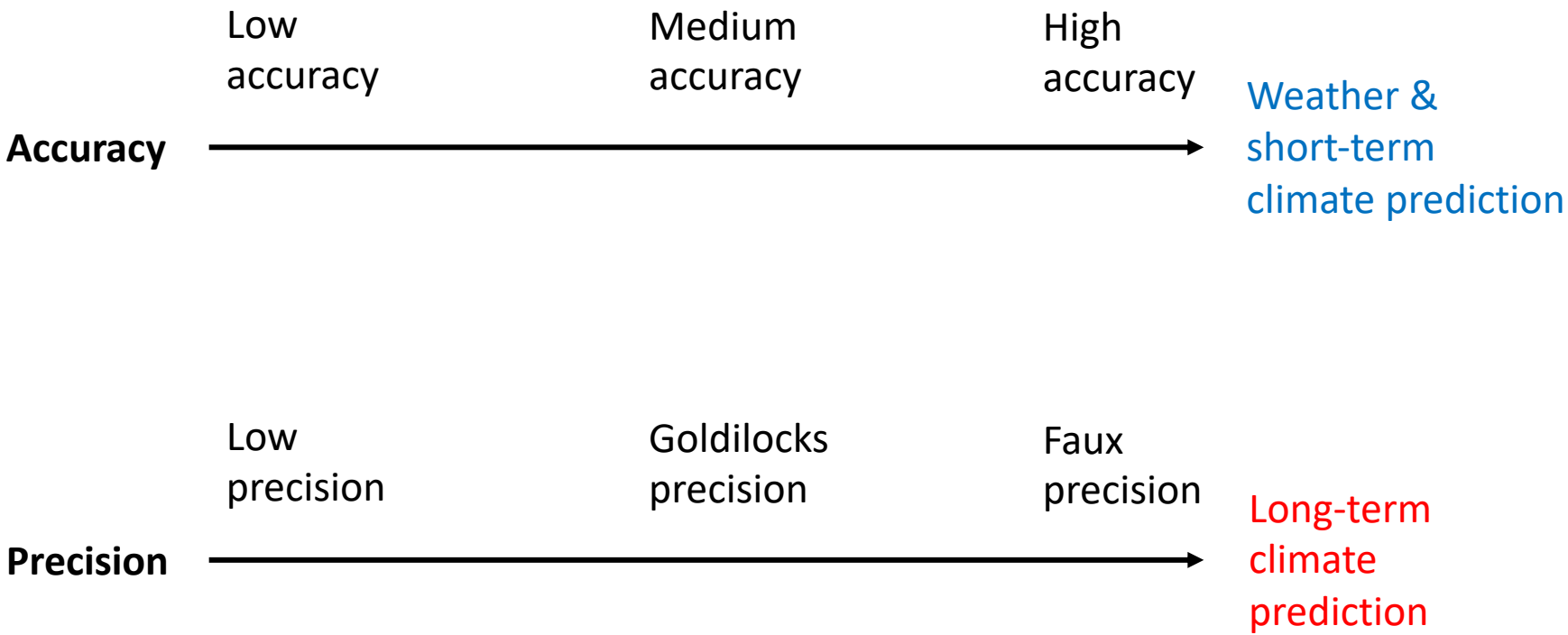
Subjective probabilities

Unknown probabilities

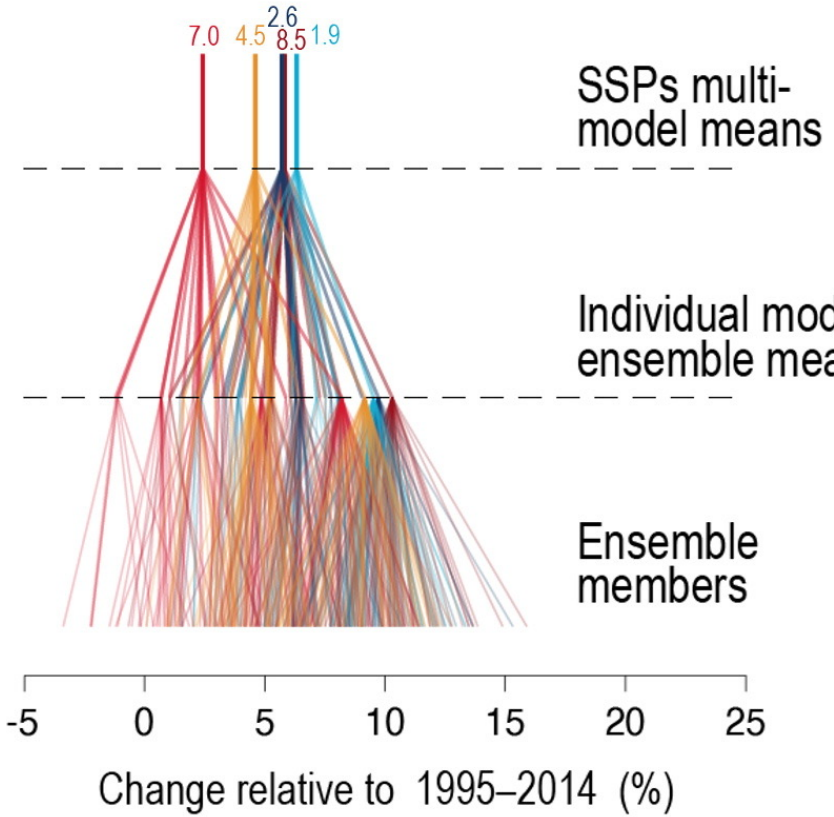
Objective (reproducible) probabilities



Goldilocks Precision


Low accuracy
Medium accuracy
High accuracy
Accuracy
Weather & short-term climate prediction
Low precision
Goldilocks precision
Faux precision
Precision
Long-term climate prediction

2081-2100 East Asia Summer Rainfall “Prediction” (IPCC AR6)



Never rely on a single scenario
(At least 2, high + low emission, but not more than ~5)

Never rely on a single model
(Need a handful of “independent” and “good” models)

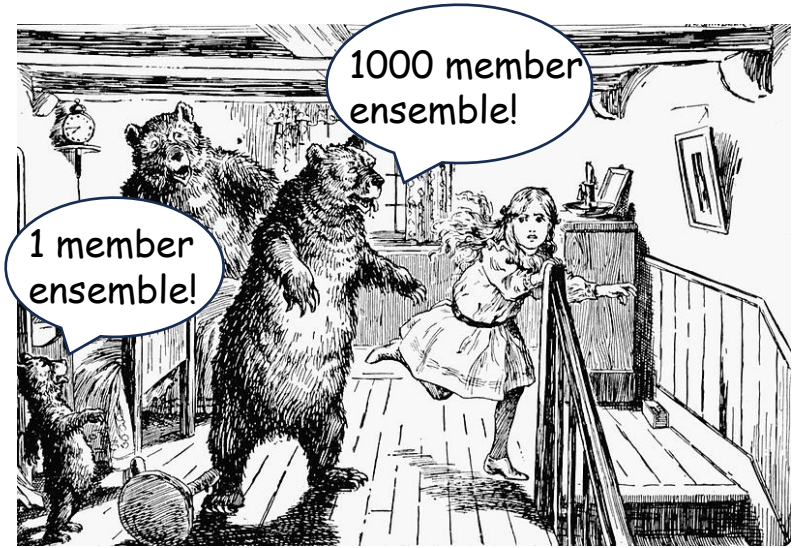
Never rely on a single realization
(Need ~50 member ensemble, *but not much more*)

Conclusions

Meta Error Bars

An error bar, a confidence interval, and a p-value walk into The Error Bar …

Goldilocks Precision



ClimateDemon.com, Metamodel.blog