



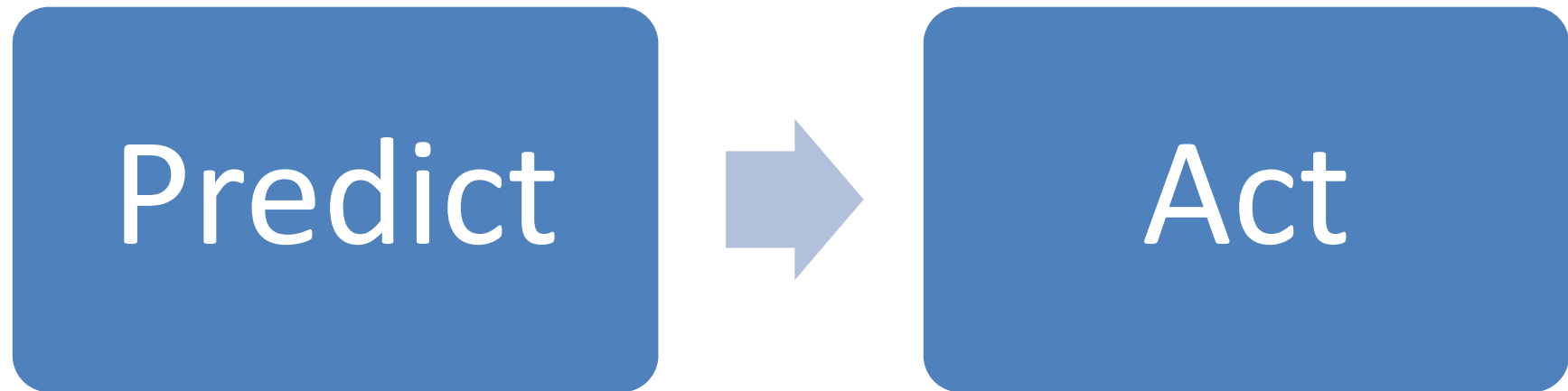
# Decision making under uncertainty

## The case of climate change adaptation

Stéphane Hallegatte

many decisions have very long-term  
consequences and are climate dependent

# The traditional way of making decisions



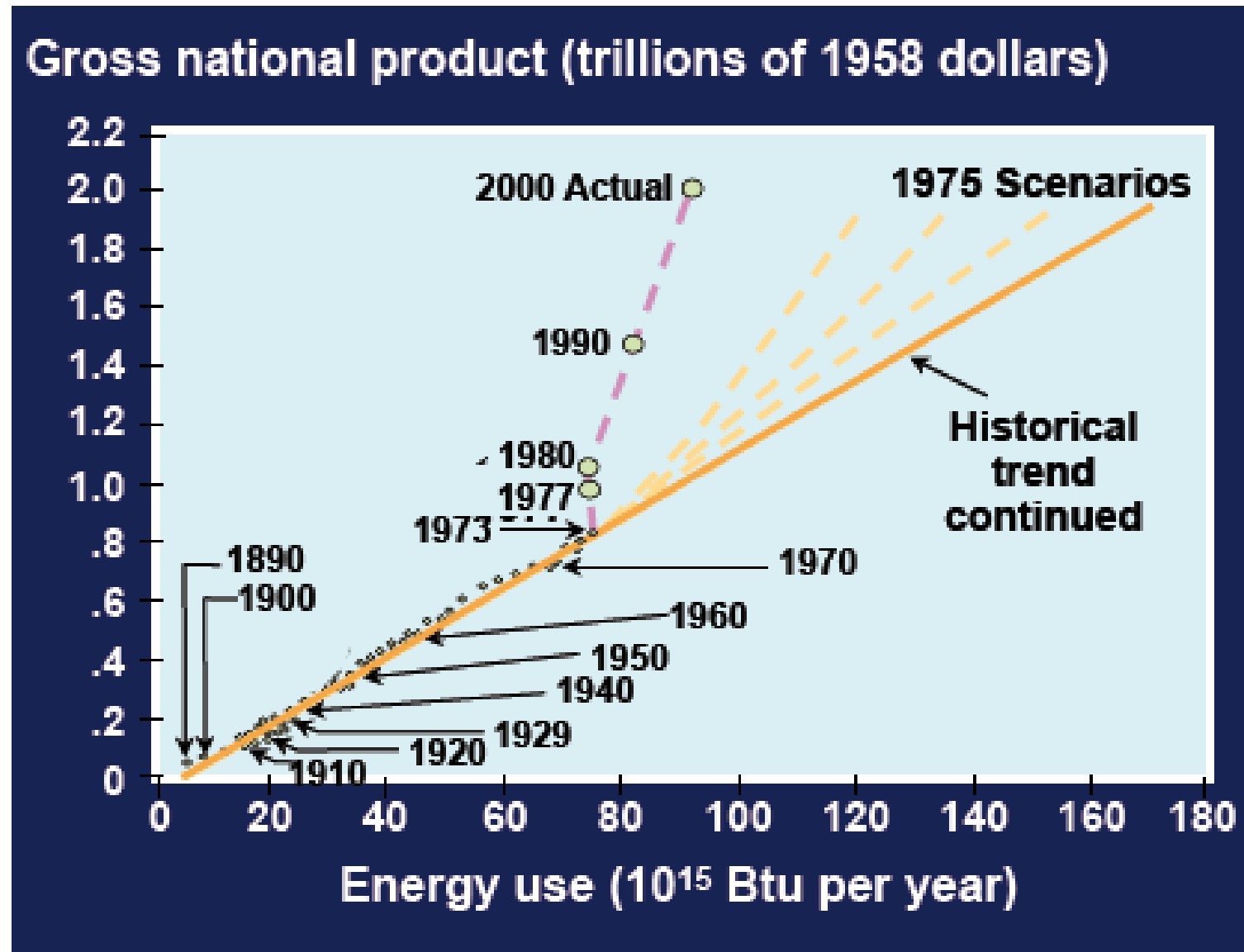
... and “prediction is very difficult, especially about the future” (N. Bohr)



Year 2000, seen from 1900...

(From Hildebrands)

And we are not getting better...

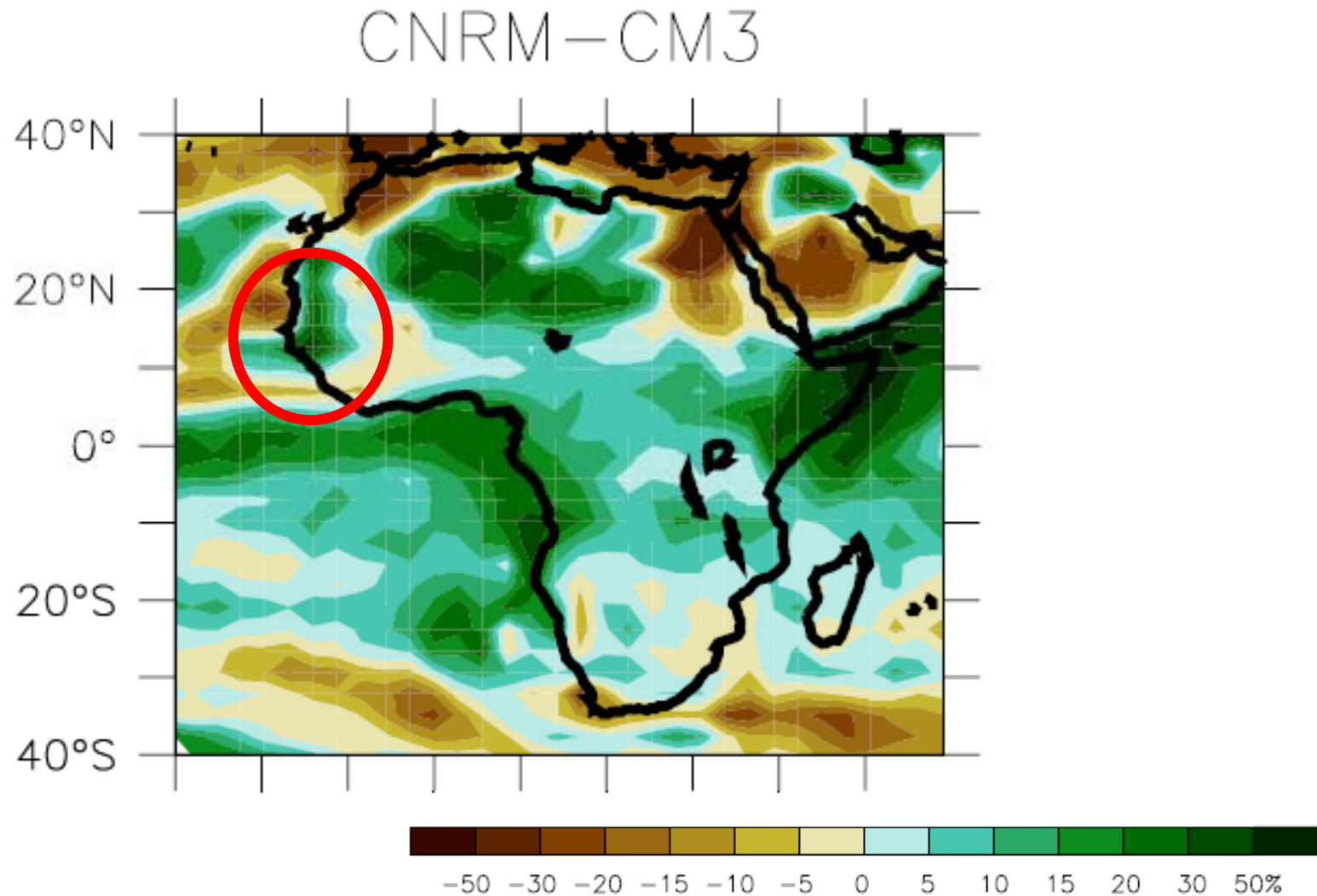


What will people want/like?

What technologies will we have?

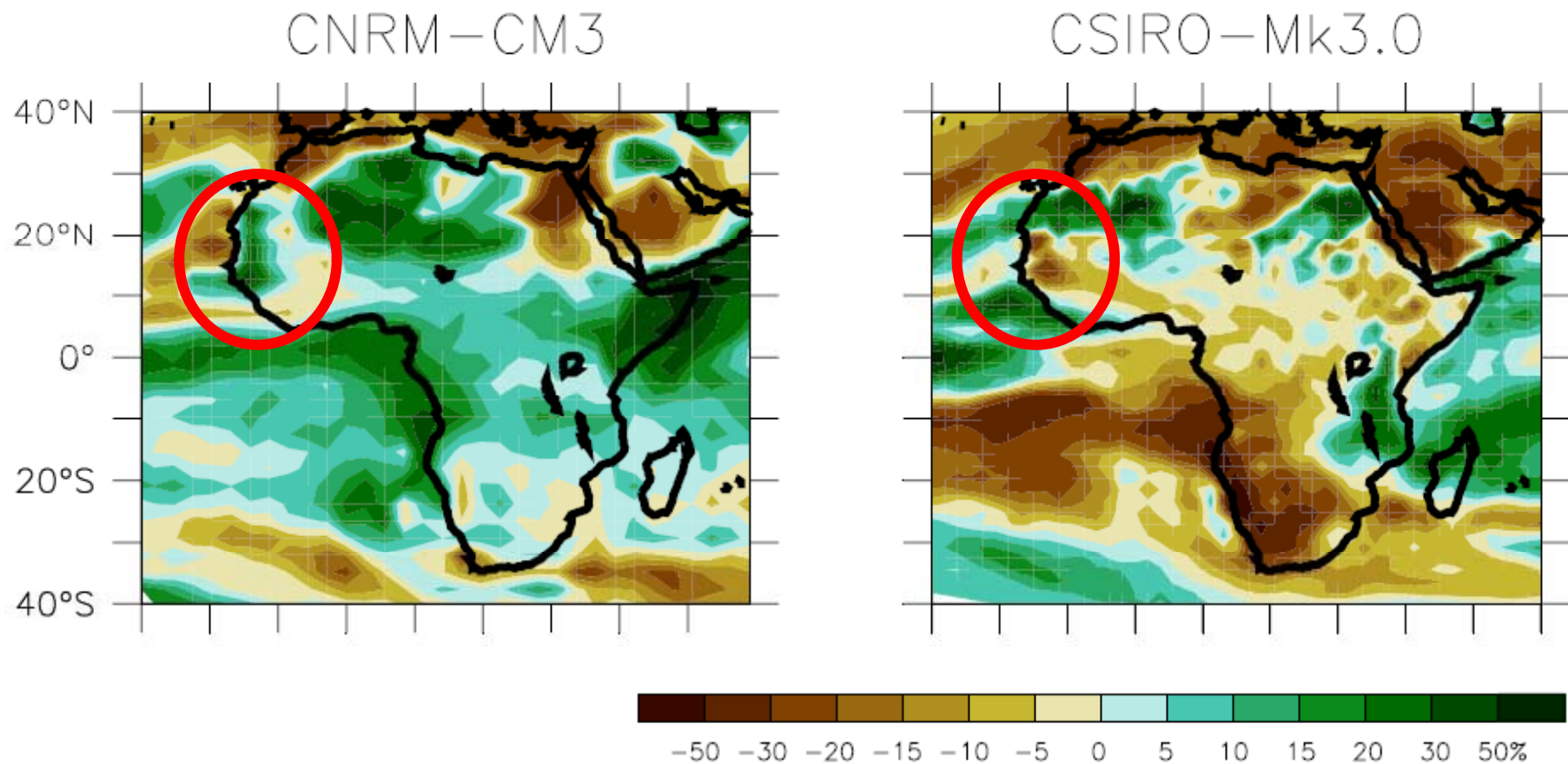
**What climate will we have?**

# Climate models try to guess that...



The Meteo-France model, from IPCC

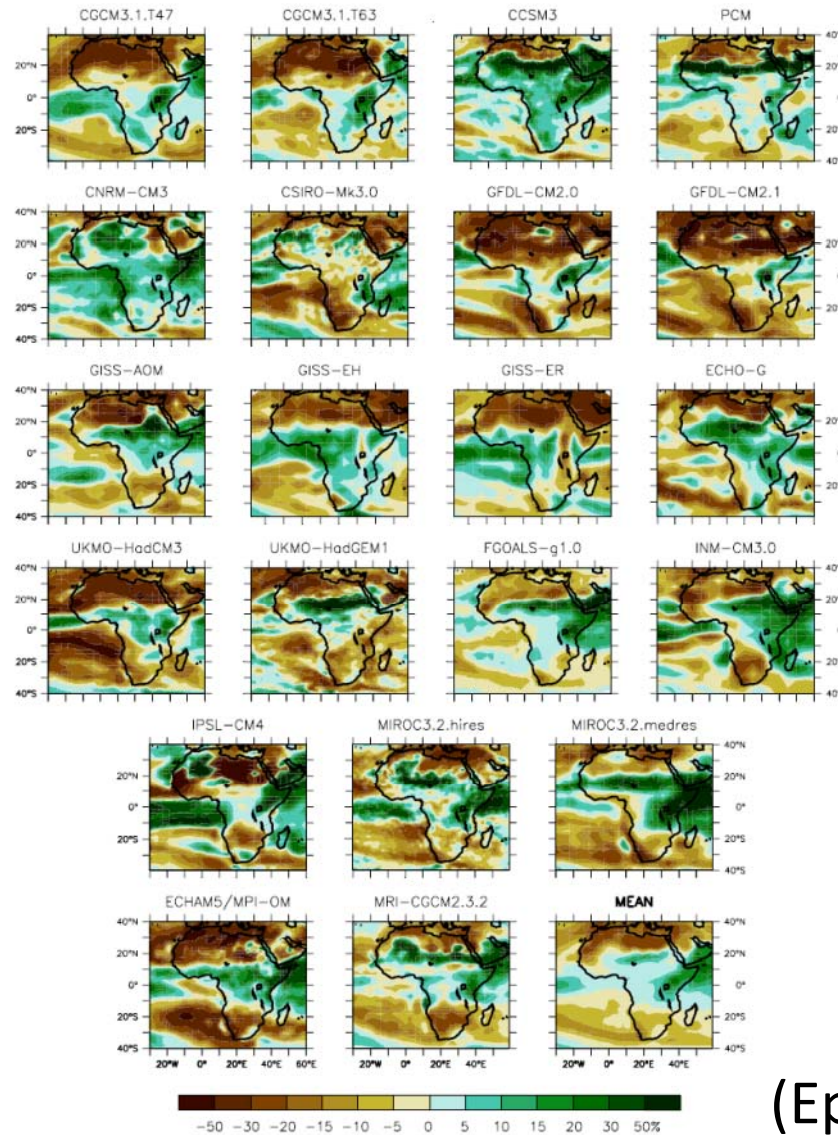
# But they disagree with each other



The Meteo-France and the Australian model, from IPCC

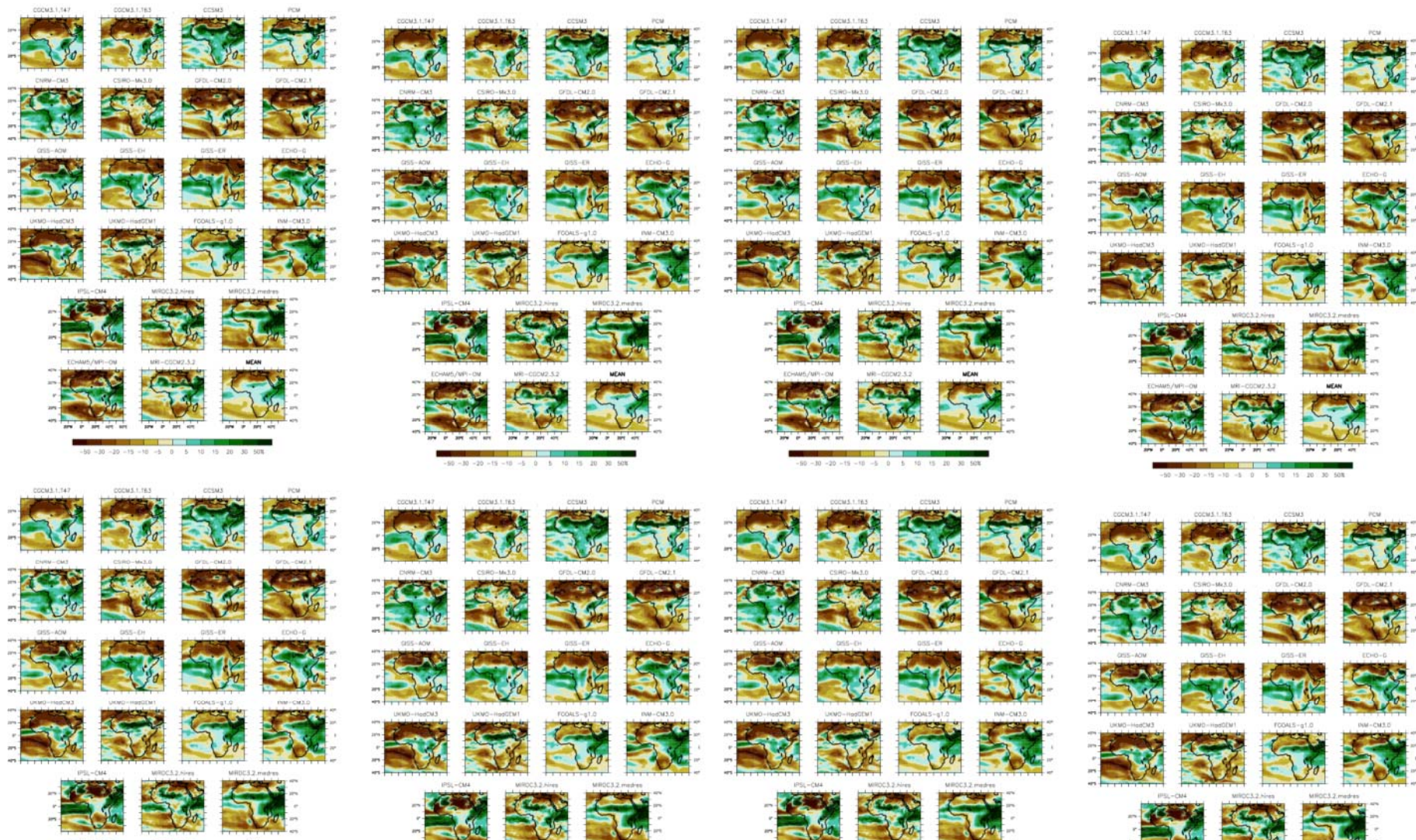


# ... and we have a lot of models...

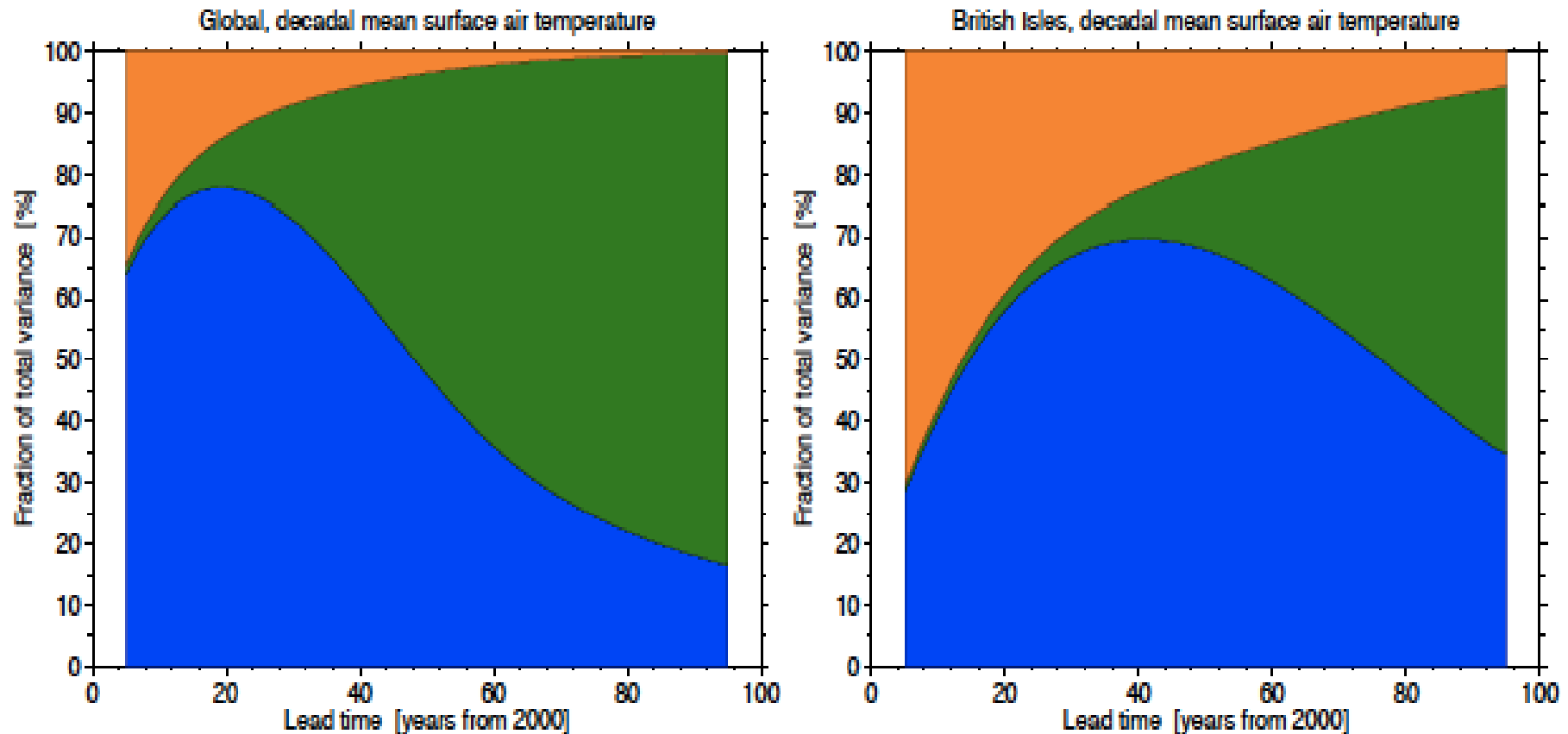


(Epistemic uncertainty)

# ... and future climates depend on future climate policies...



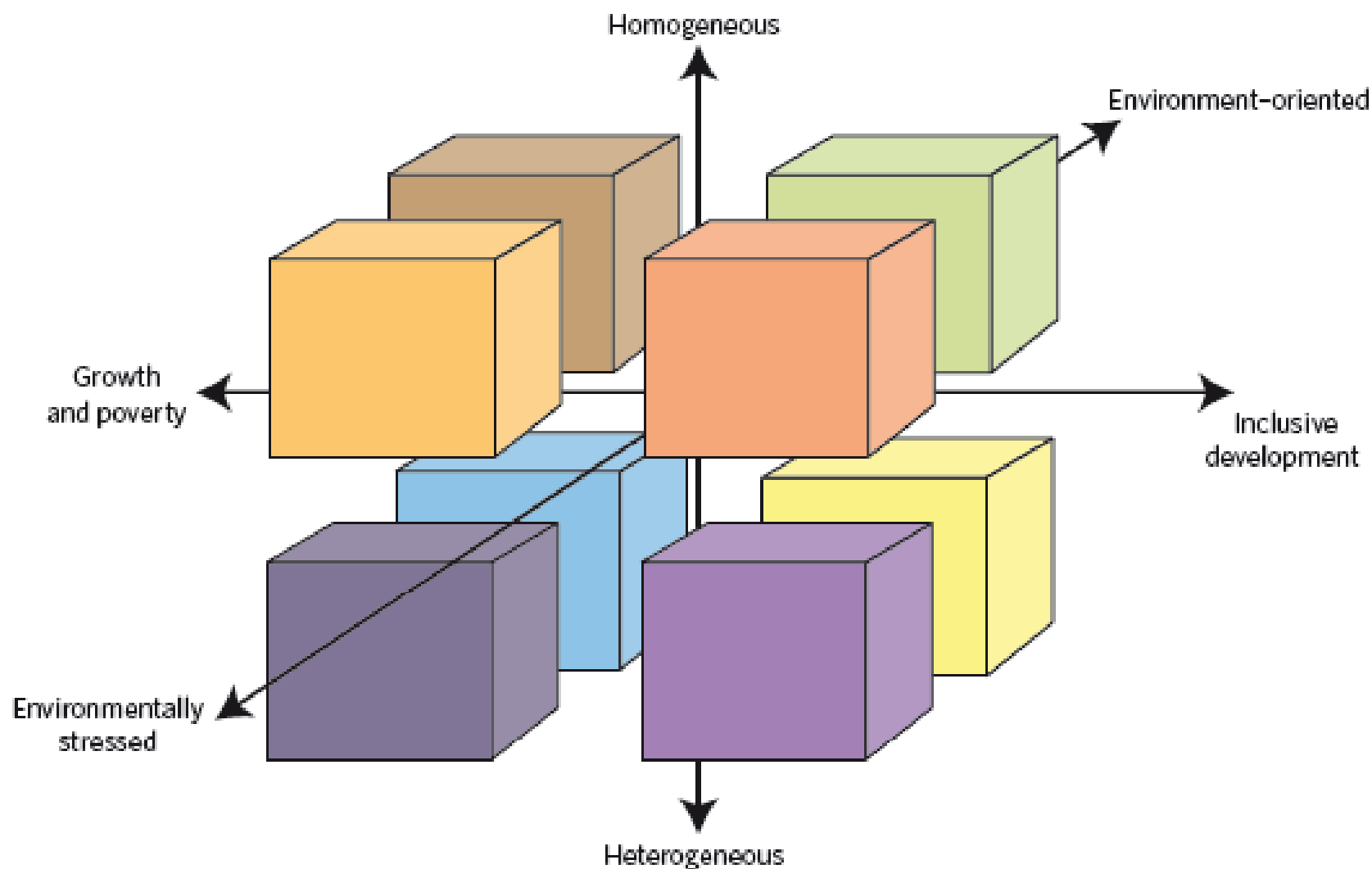
# Plus some aleatory uncertainty...



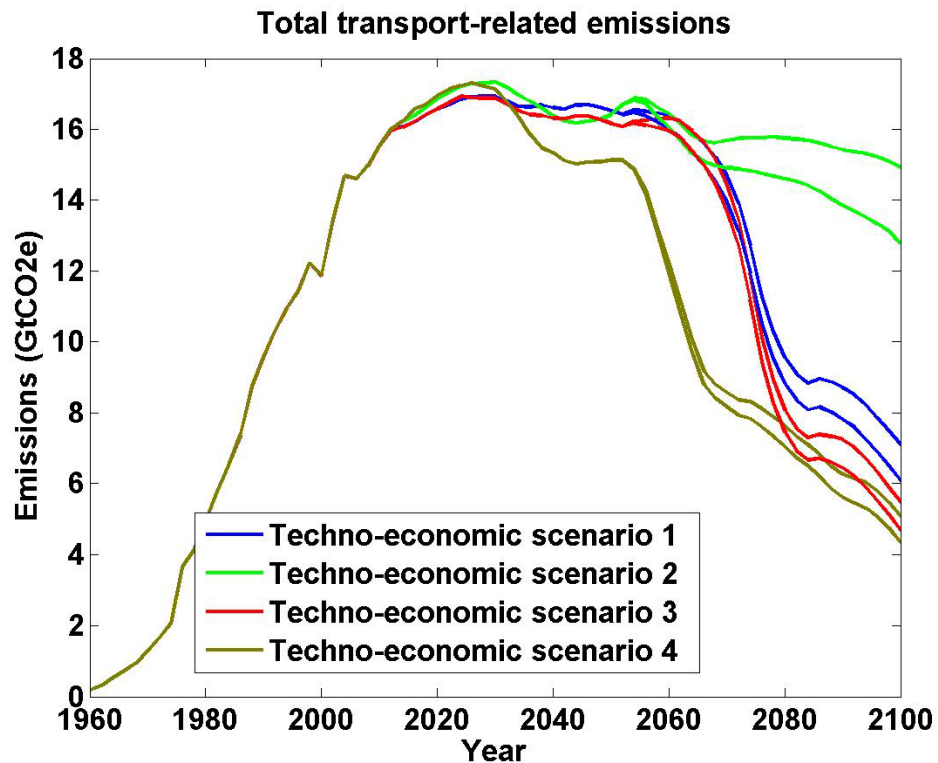
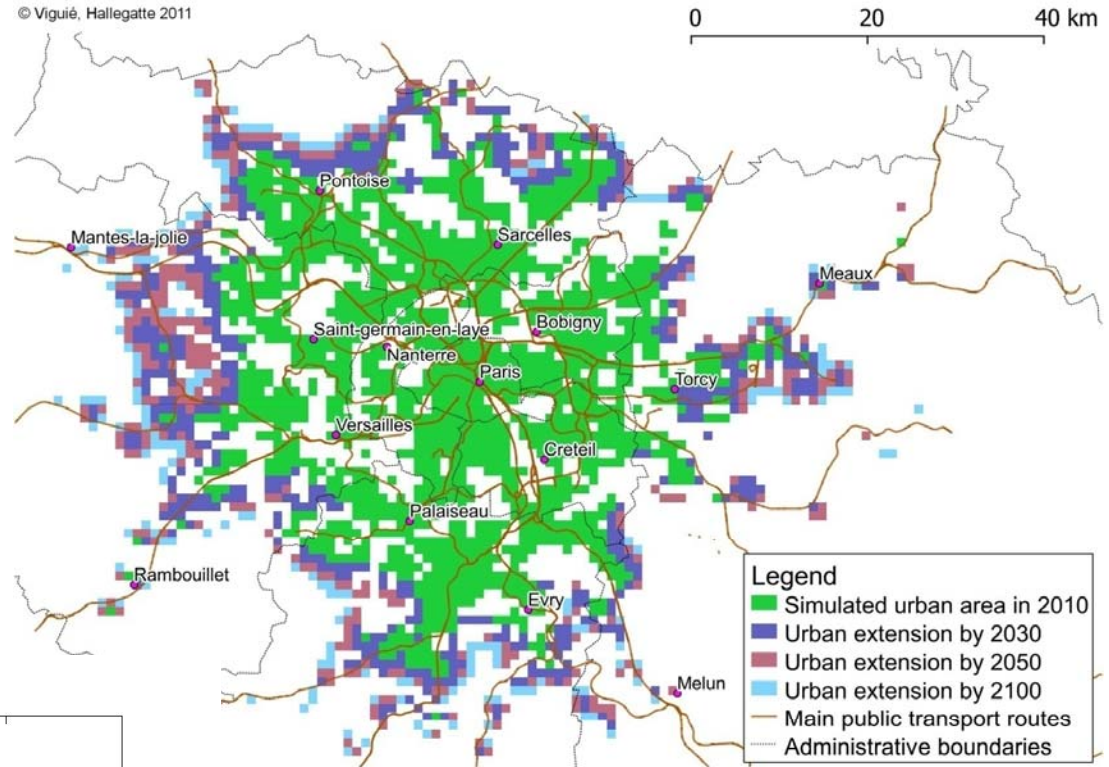
*The green is emission uncertainty, the orange is natural variability, and the blue is (climate) model uncertainty; the variable is temperature change. Source: Hawkins and Sutton, BAMS, 2009.*

## Building world narratives for climate change impact, adaptation and vulnerability analyses

Stephane Hallegatte<sup>1,2\*</sup>, Valentin Przulski<sup>1</sup> and Adrien Vogt-Schilb<sup>1</sup>

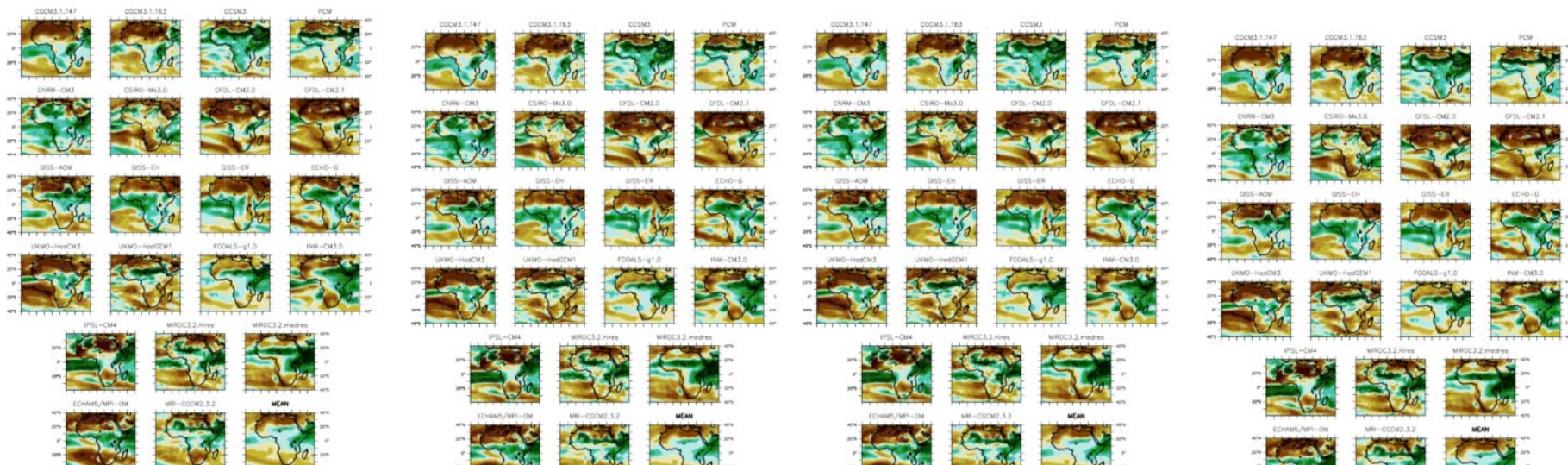


# Socio-economic uncertainty is even worse at local scale. The case of Paris

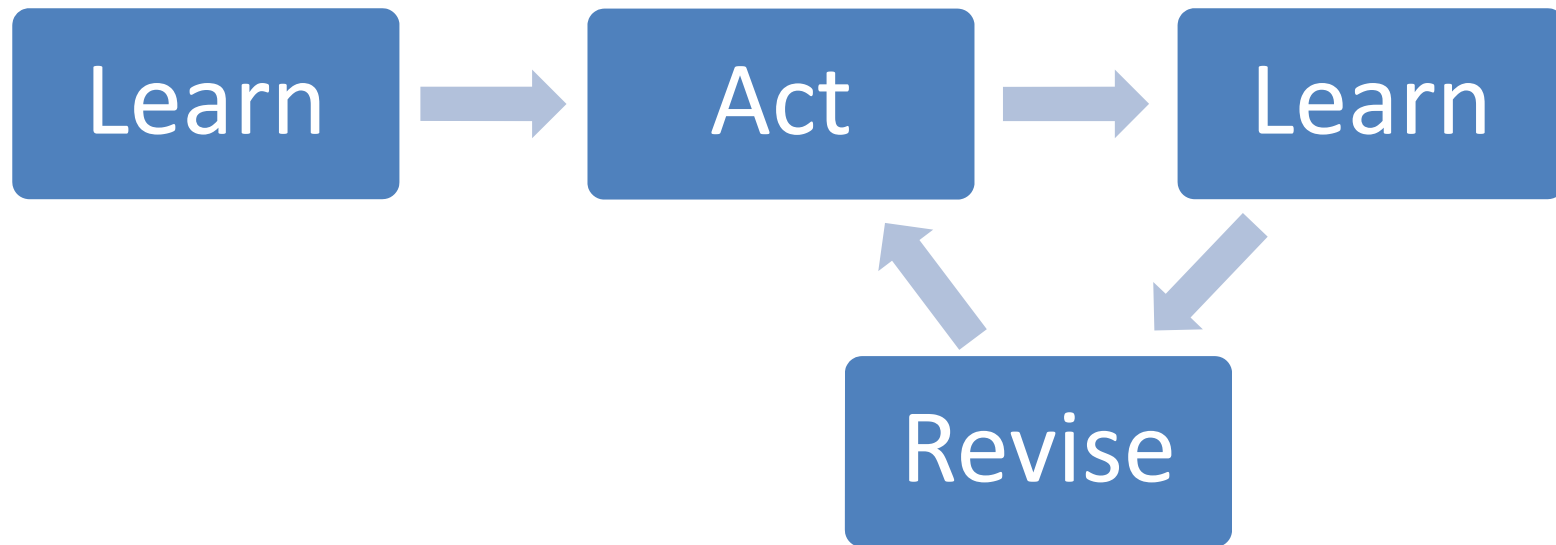


# Is it hopeless ?

**Instead of optimizing in one most likely scenario, look for robustness to the many possible scenarios...**



**... and allow for revisions over time.**



# Methodologies



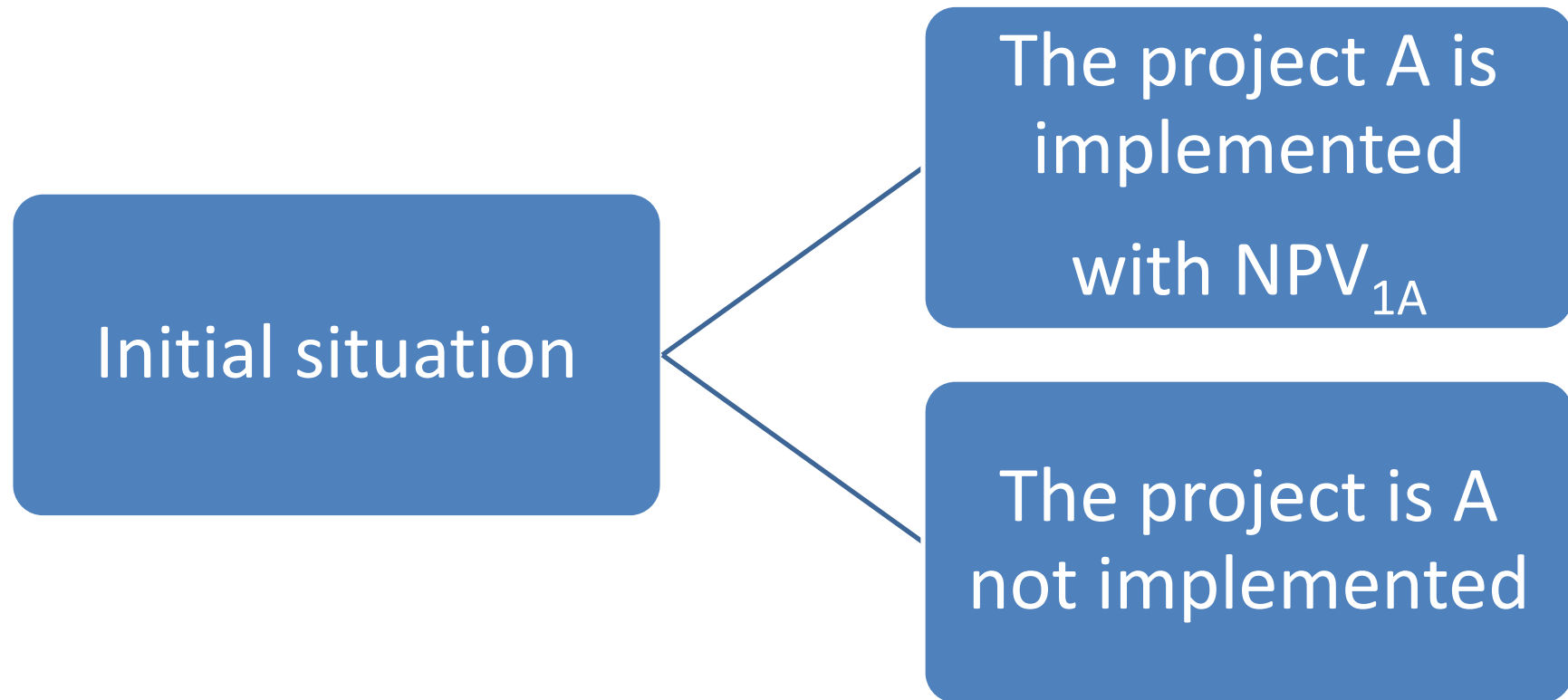
# Cost-benefit analysis under uncertainty

- Different “**states of the world**” associated with different **probabilities**.
- The project is implemented when expected benefits exceed expected costs.
- Probabilities can be **frequentist probabilities** (especially when aleatory uncertainty)
- Probabilities can be **subjective probabilities** (when epistemic uncertainty)
- With concave “utility” (or basic needs), higher weight to worst-case scenarios.
- With concave “social and individual utility” (or basic needs), higher weight to the poorest.

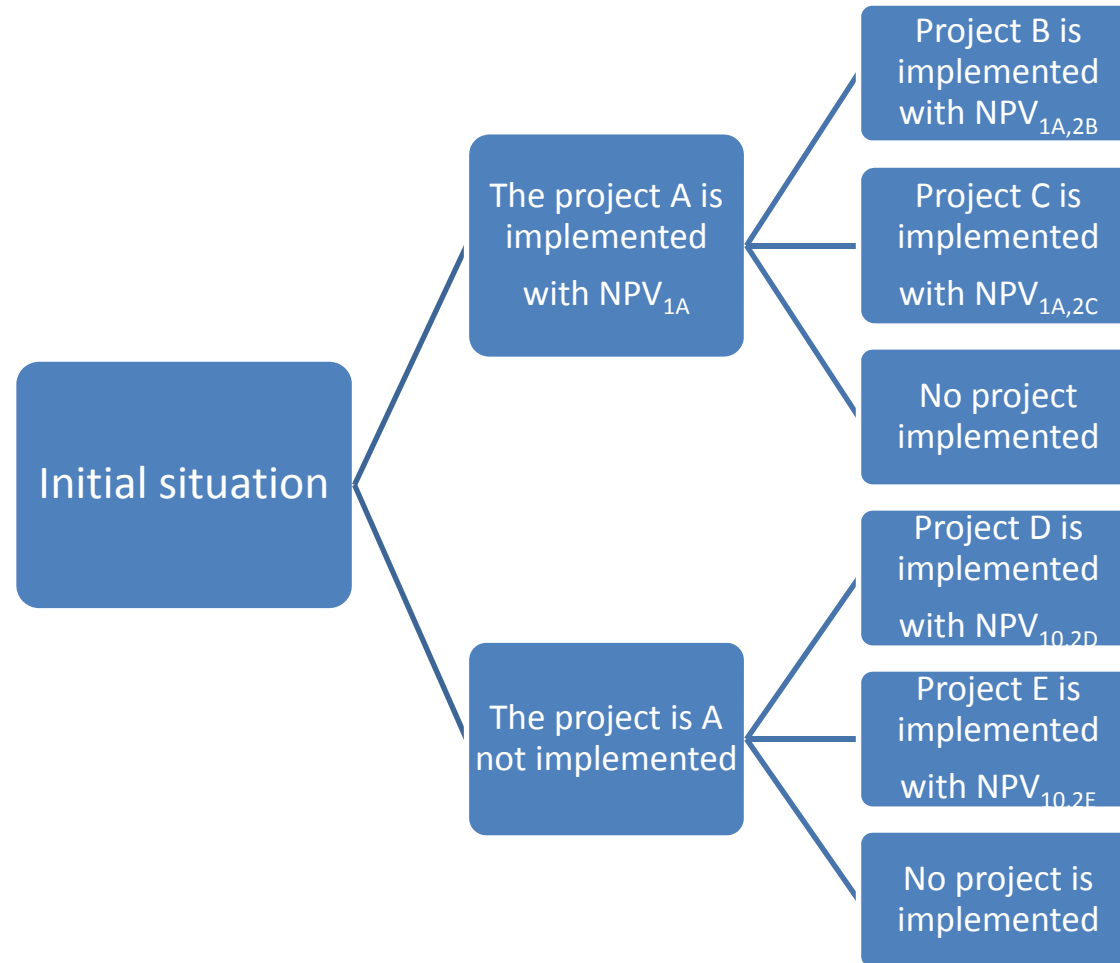
# Real option approach

- A context of increasing knowledge – and thus decreasing uncertainty.
- The decision on an investment project is not between “investing” and “not investing”
- It is between “investing now” and “investing later with more information.”

# Real option approach



# Real option approach



Complexity grow exponentially!  
Real-world applicability is questioned...

# Robust decision-making

