Sea level information for coastal adaptation decision making

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Three perspective on decision-making

Decision-analytical	Empirical	Transdisciplinary
Prescriptive	Descriptive	Normative
How to make the “best” decision, given some criteria?	How are decisions actually made and why?	How to design a fair, inclusive and effective decision making process?
• Compute the “best” option • Formalisation of decisions and subjective preference	• Systematic cognitive biases (Tversky and Kahneman, 1972) • Power, regulatory capture, opportunistic behaviour (Levine & Forrence, 1990)	• Avoid power: powerless discourse (Habermas 1981), deliberative democracy” (Besette 1980, Dryzek 2000)

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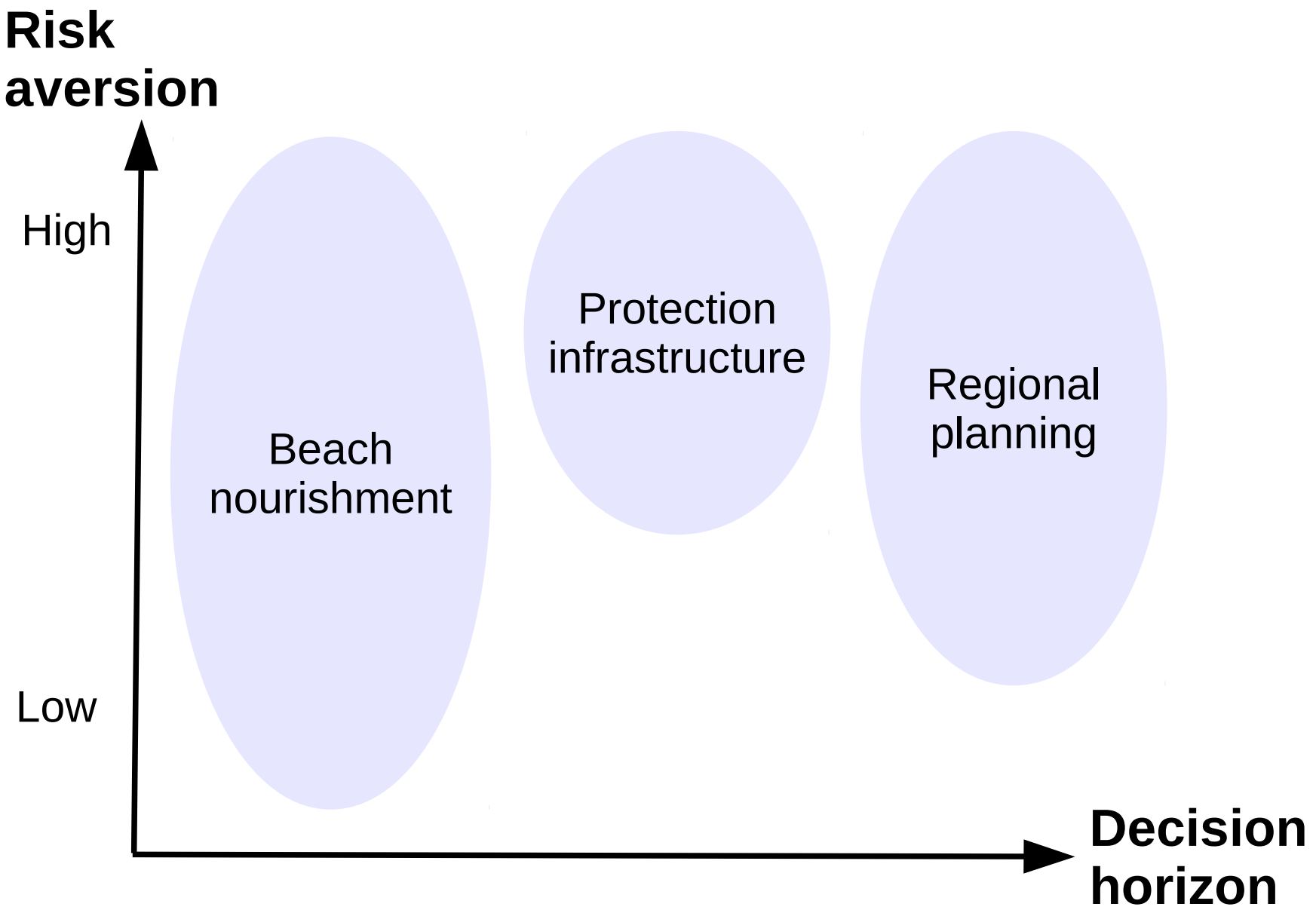
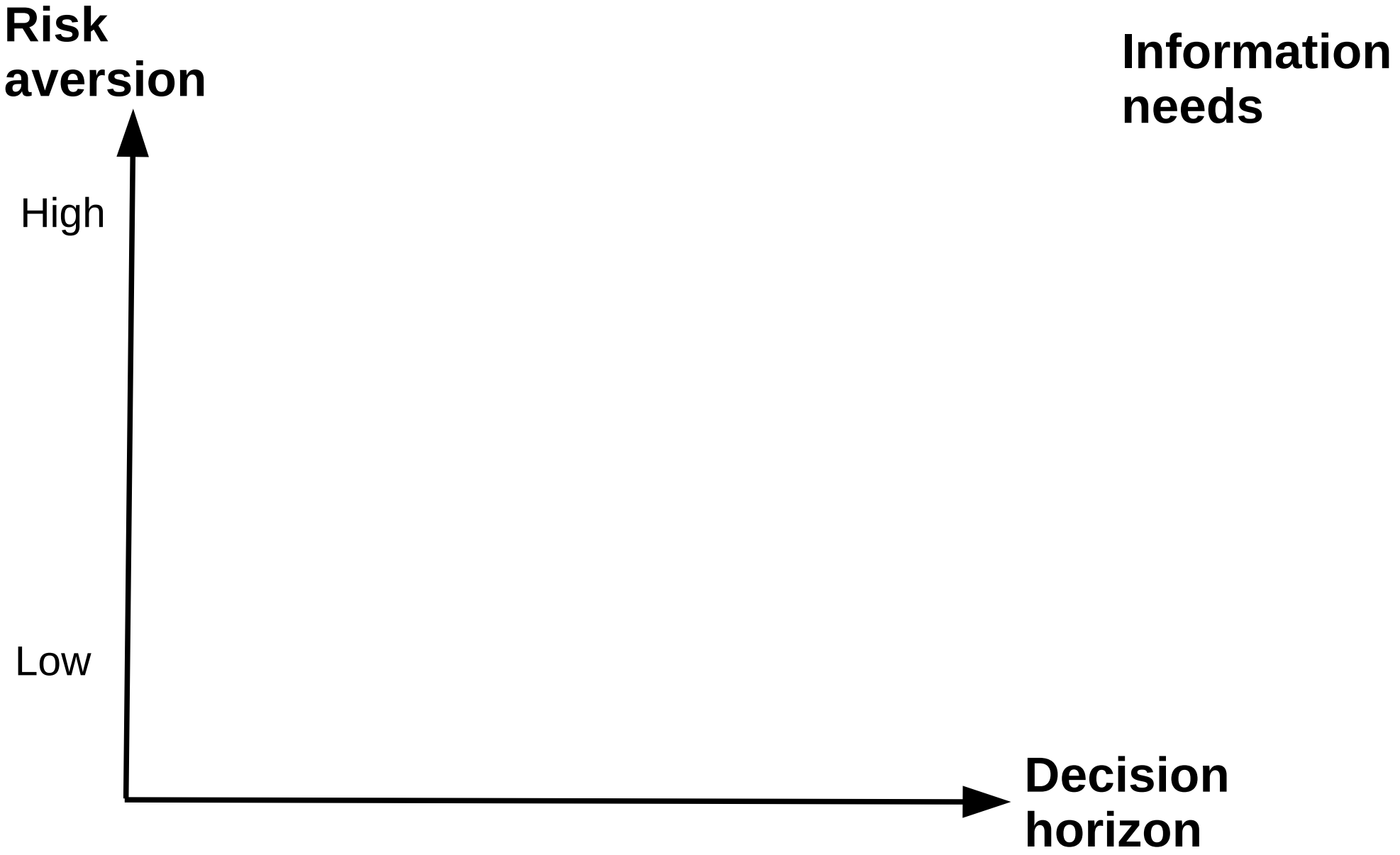
Coastal decision context



Decision analytical method and corresponding information needs



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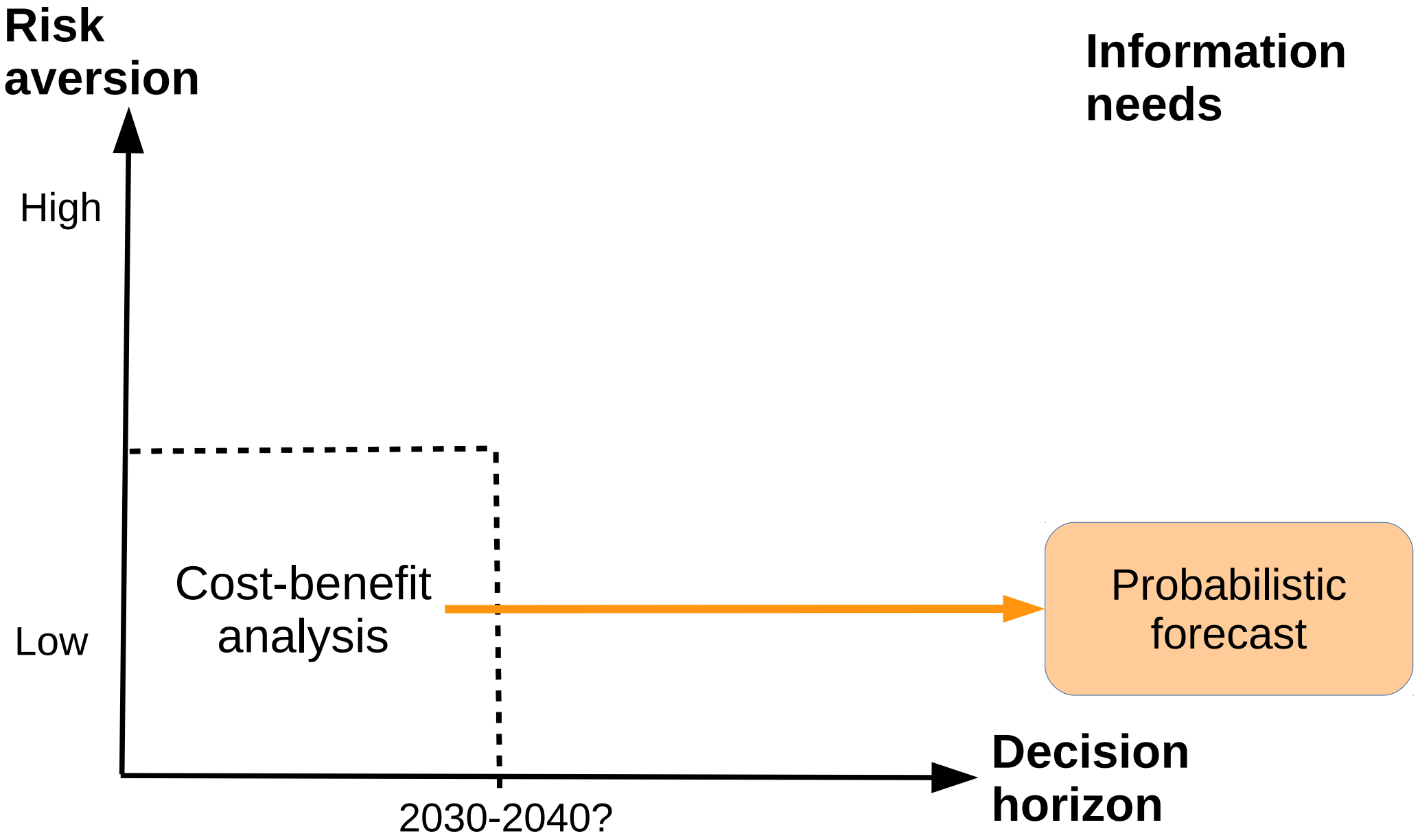

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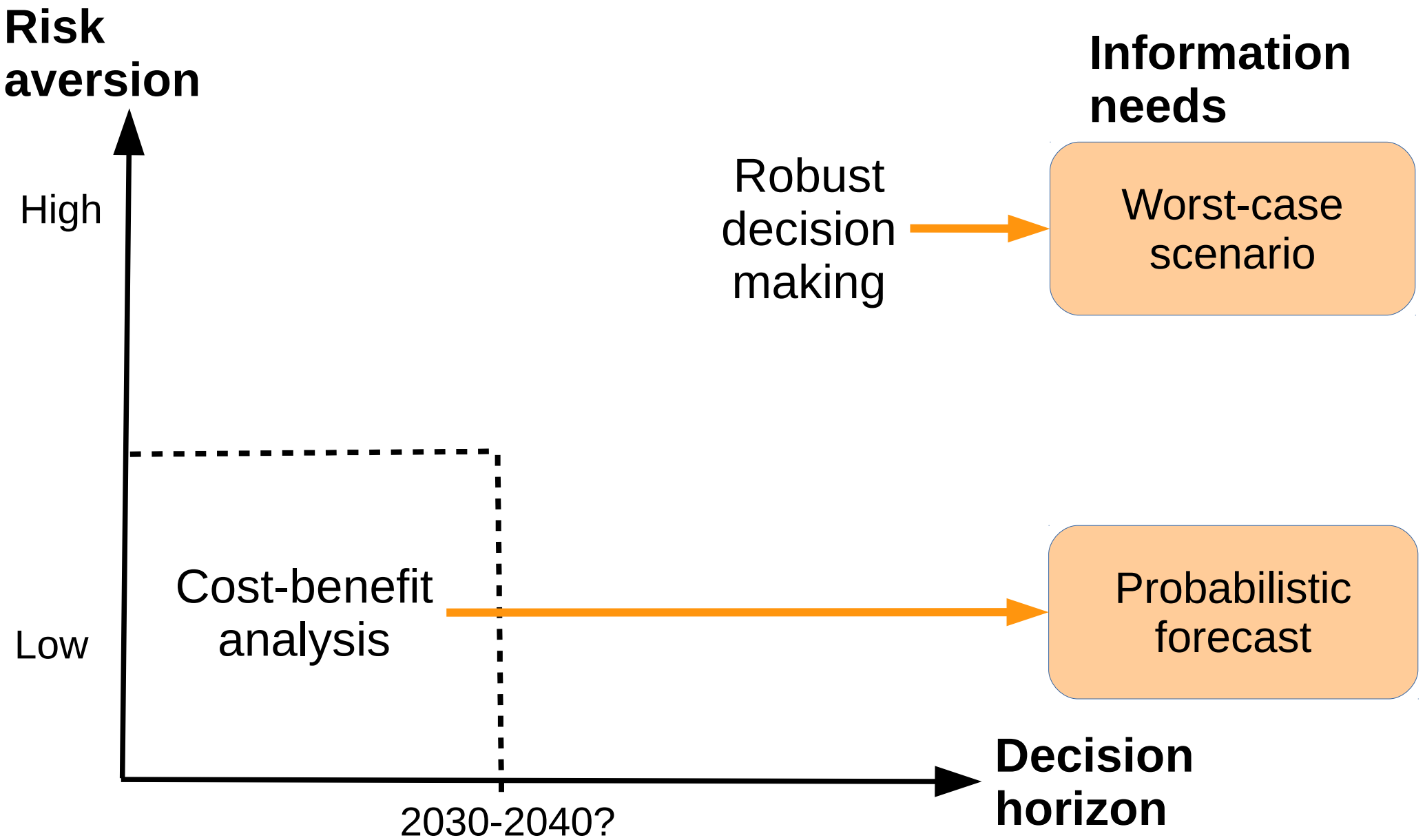

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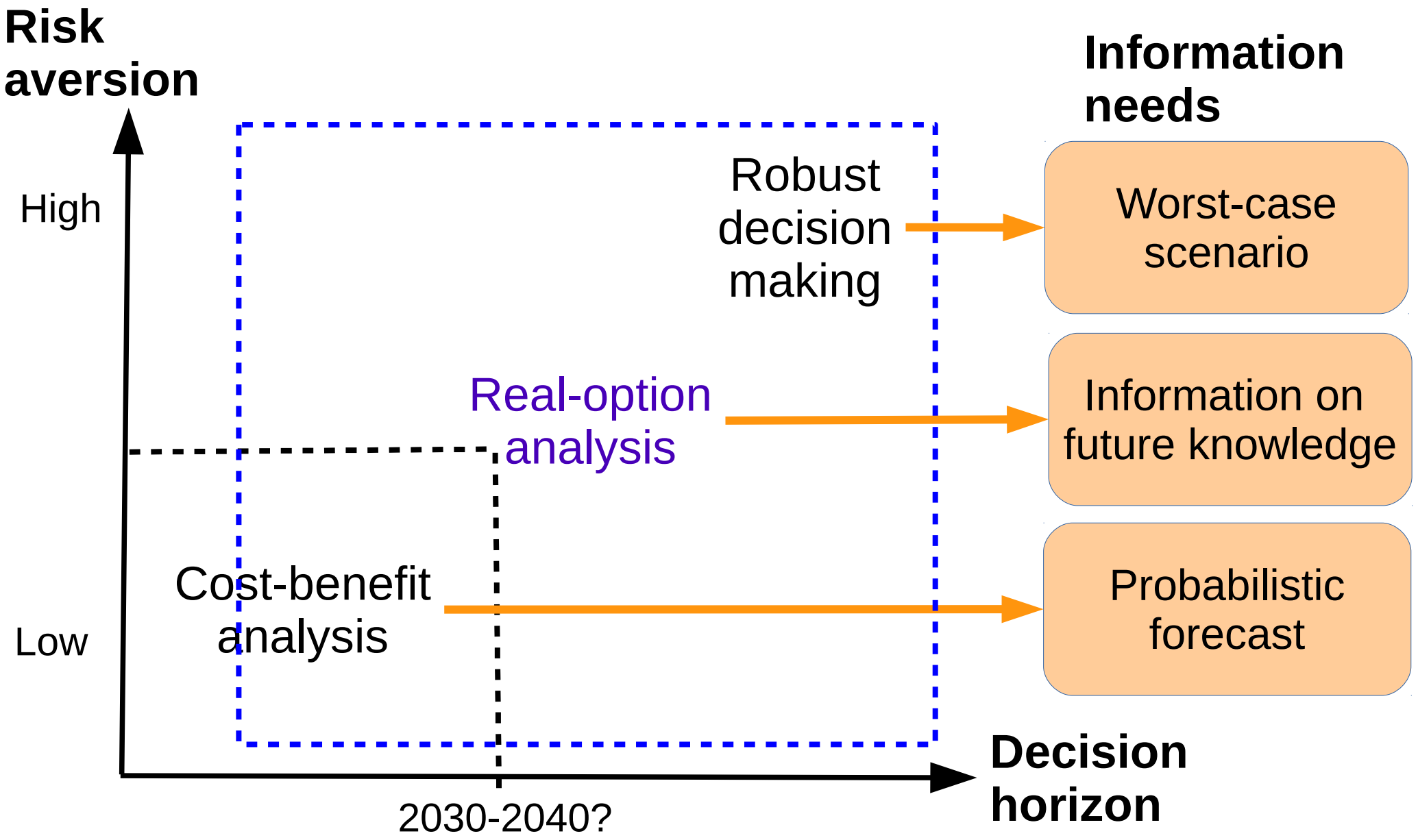


Meeting need #2:

Worst case scenarios

Option 1: Physical limit

- e.g., Pfeffer et al. (2008) write that glaciological conditions required for sea-level rise **above 2m** by 2100 are ***physically untenable***
- Can this be defined unambiguously?
- And if yes, is the physical limit low enough to be useful in decision making?
  - Physical limit of 10 or more meters of SLR by 2100 is not useful for decision making.

Option 2: Probabilistic aggregation of model runs and expert opinions

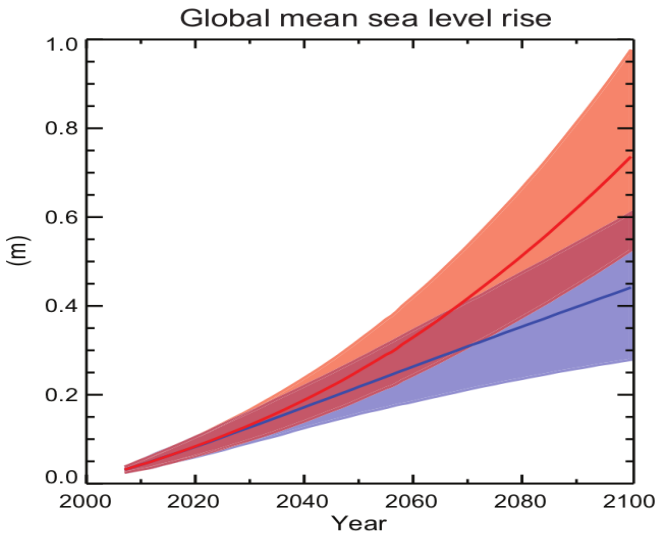
Ambiguity amongst models and expert opinions

→

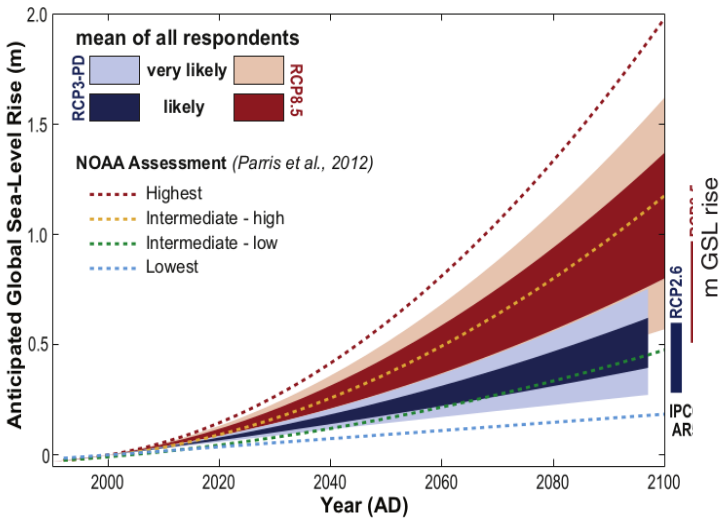
Probabilistic aggregation of
- model runs
- expert opinions
- SLR components

→

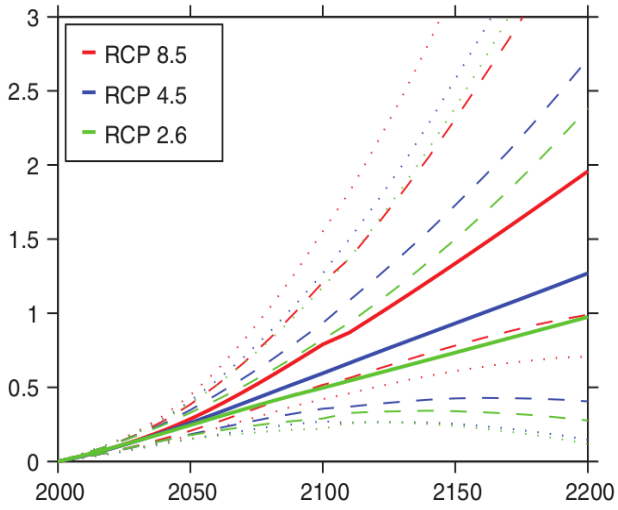
Probabilistic Scenarios (partial or complete)



Church et al. (2013)

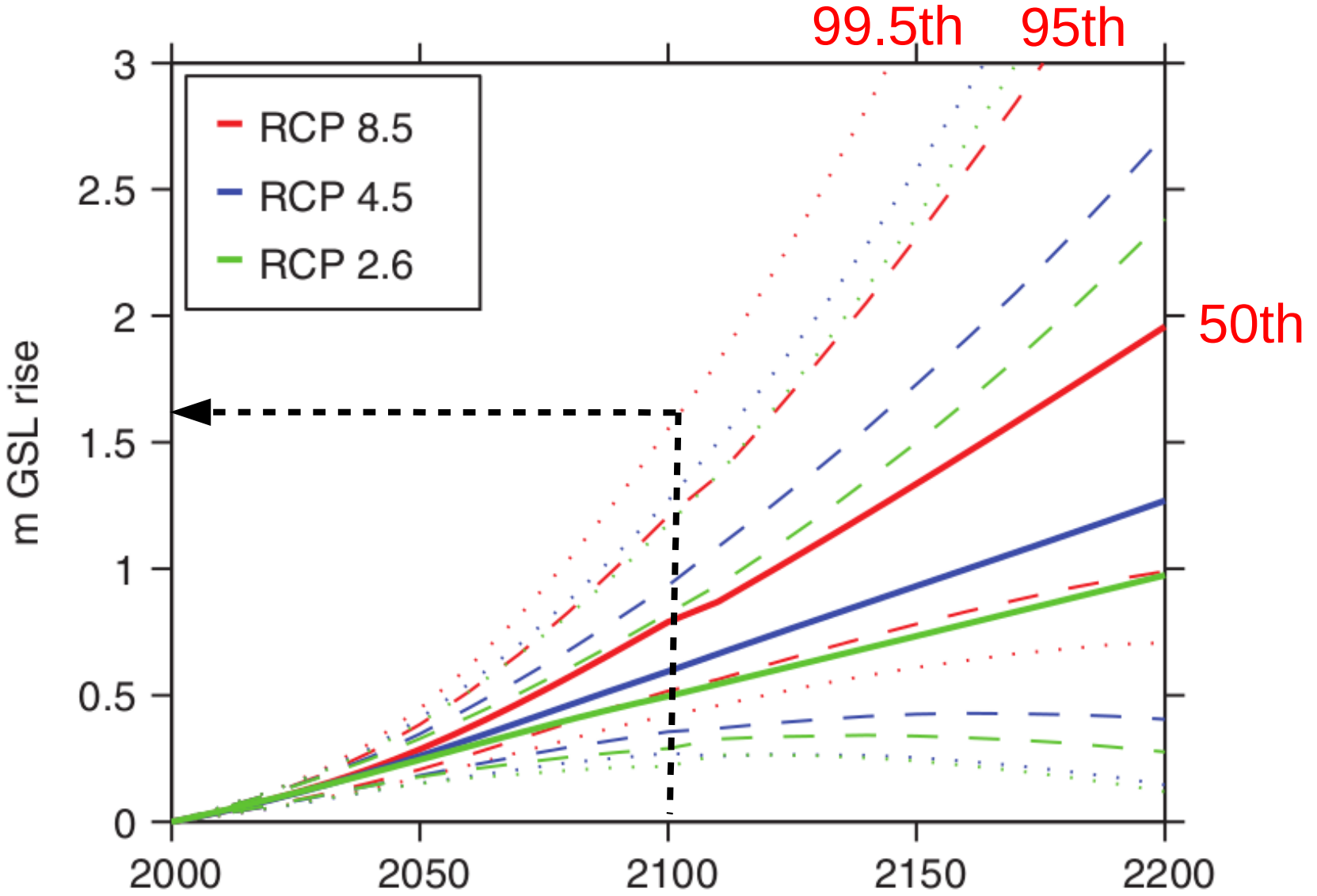


Horton et al. (2014)



Kopp et al. (2014)

Worst case scenario = choice of RCP and choice of percentile



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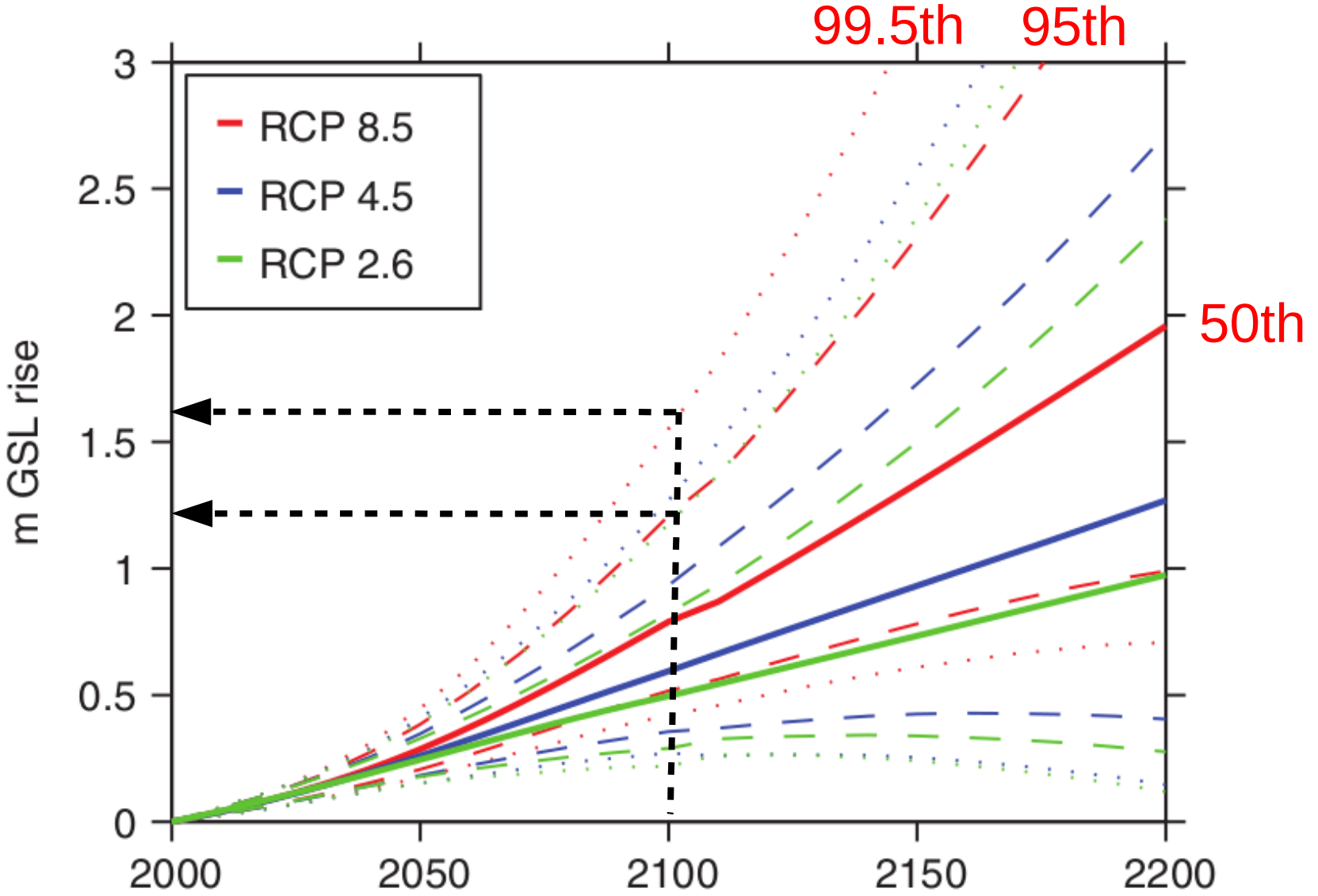

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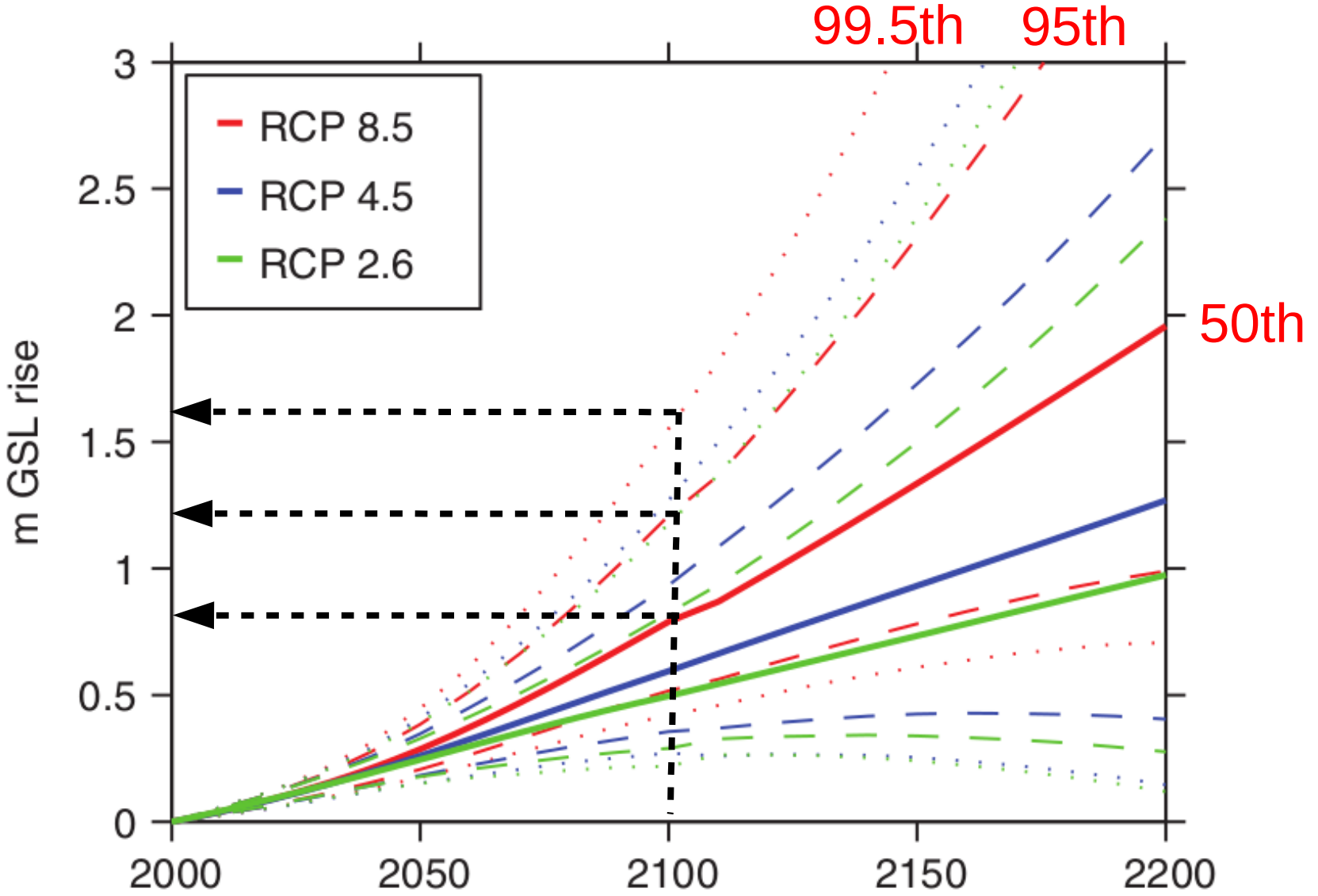


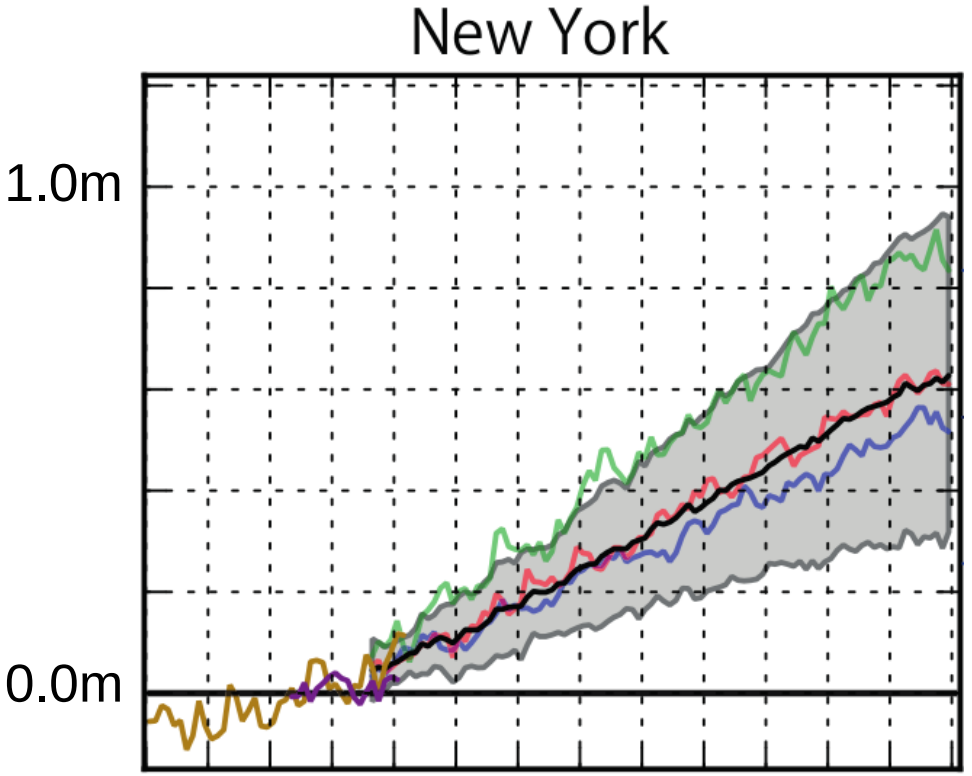
Kopp et al. (2014)

Some issues

- Is RCP8.5 the worst case?
- Probabilistic aggregation involves a lot of assumptions (expert judgement), which makes the percentiles themselves uncertain
  - Choice of the functional form of the distribution
  - Different methods for aggregating model runs/expert opinions (de Vries and van der Wal 2015; Bakker et al. 2017)
  - Statistical dependence of SLR components
- Percentiles attained have no “real-world” meaning and may misguide decision making
  - Available information: $P(SLR<x \mid RCP=8.5) = 95\%$
  - Needed information: $P(SLR<x) = ?$

Option 3: No aggregation

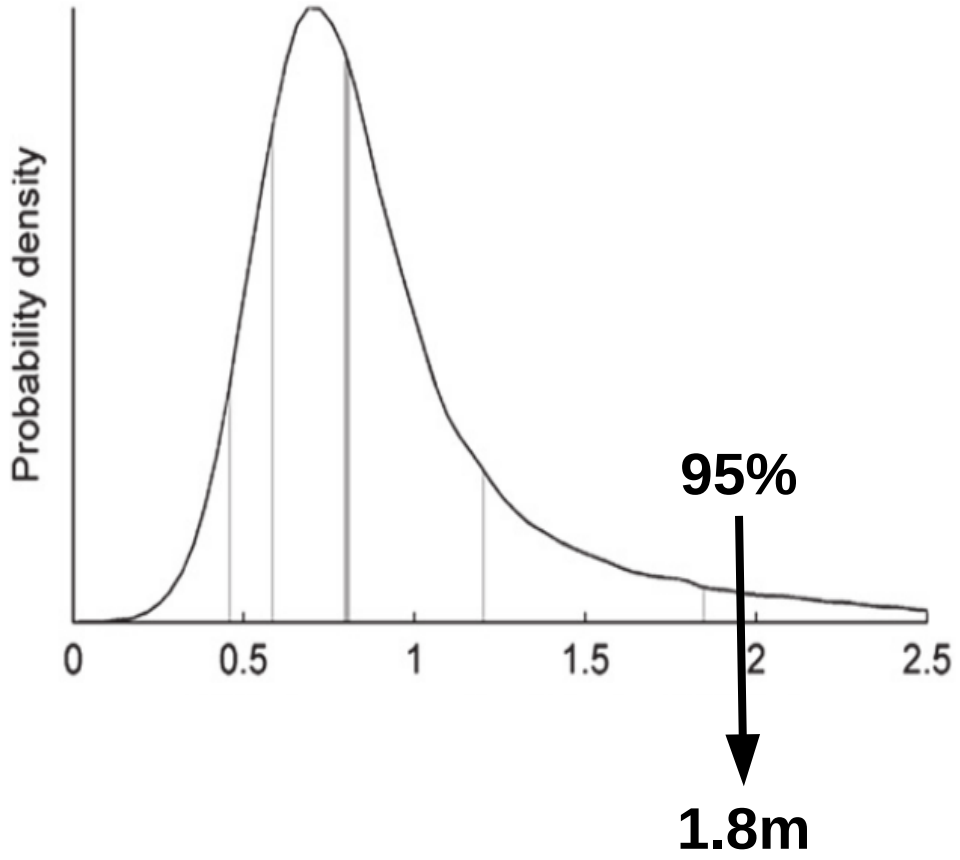
- Empirical evidence shows that, in situations of deep uncertainty and ambiguity, communicating individual results, and documenting why they differ, is generally more effective than trying to aggregate (Stirling 2009)



Church et al. (2013)

Option 4: possibilistic aggregation

Probabilistic aggregation (RCP8.5, 2100)



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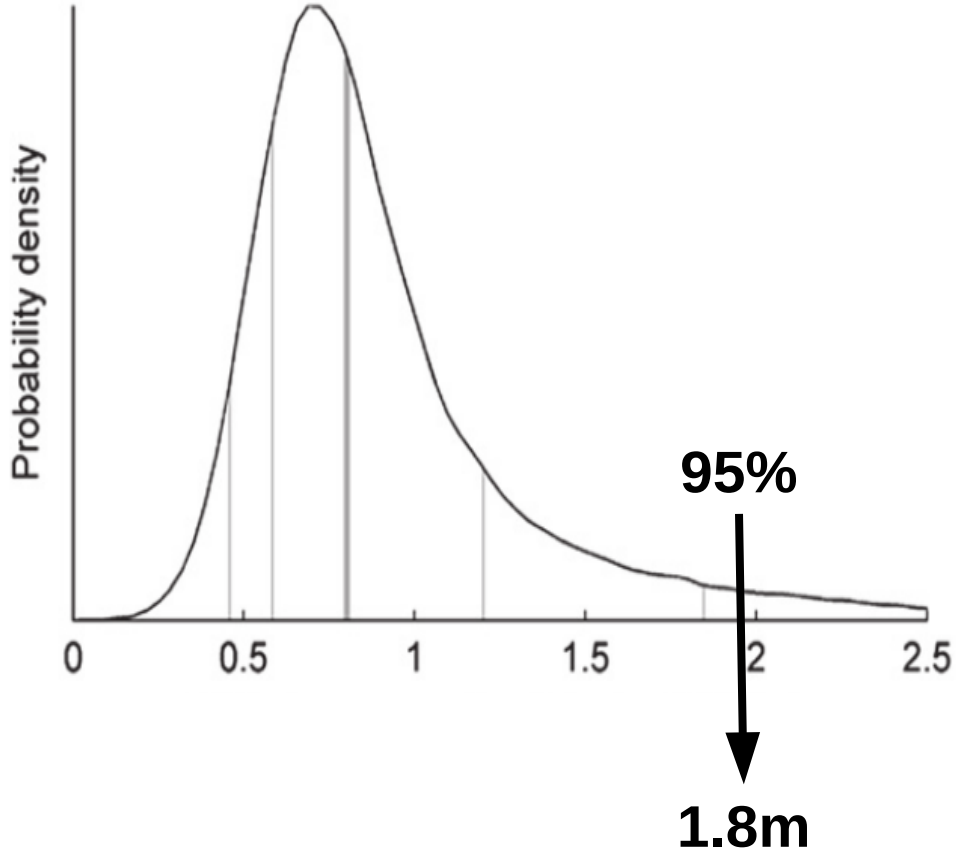

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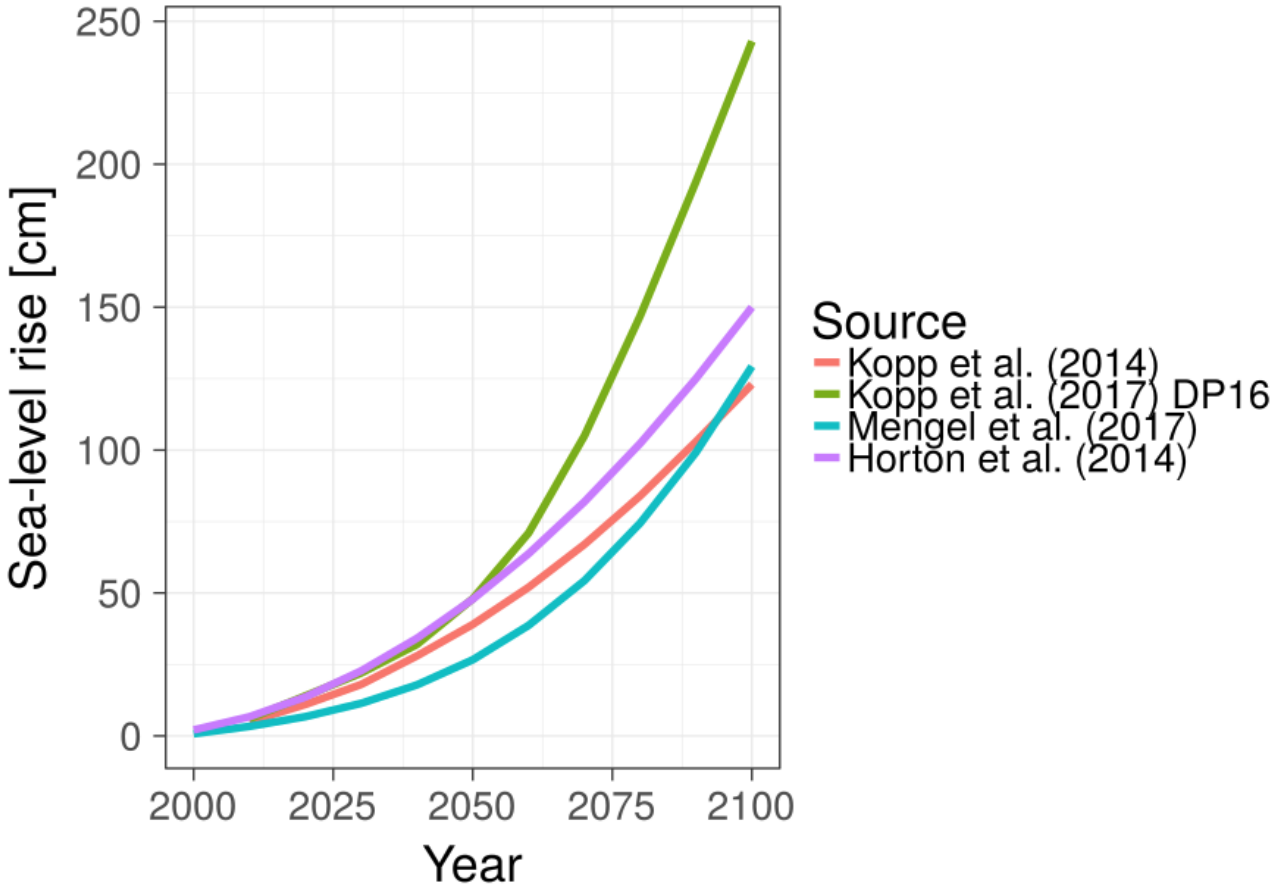
Possibilistic aggregation Sum of maxima of each component (RCP8.5, 2100)

Component	Max (m)
Thermal expansion (Yin 2012)	.39
Glaciers, SMB (Marzeion et al 2012)	.35
Greenland SMB (Fettweis et al 2013)	.20
Greenland dynamics (Bindschandler et al 2013)	.44
Antarctica SMB (Church et al 2013a)	−.2
Antarctica dynamics (Hinkel et al 2014)	.41
Land water (Church et al 2013a)	.11
SUM	**1.9m**

How do we aggregate across multiple studies?

95th percentiles for RCP8.5 of some recent studies



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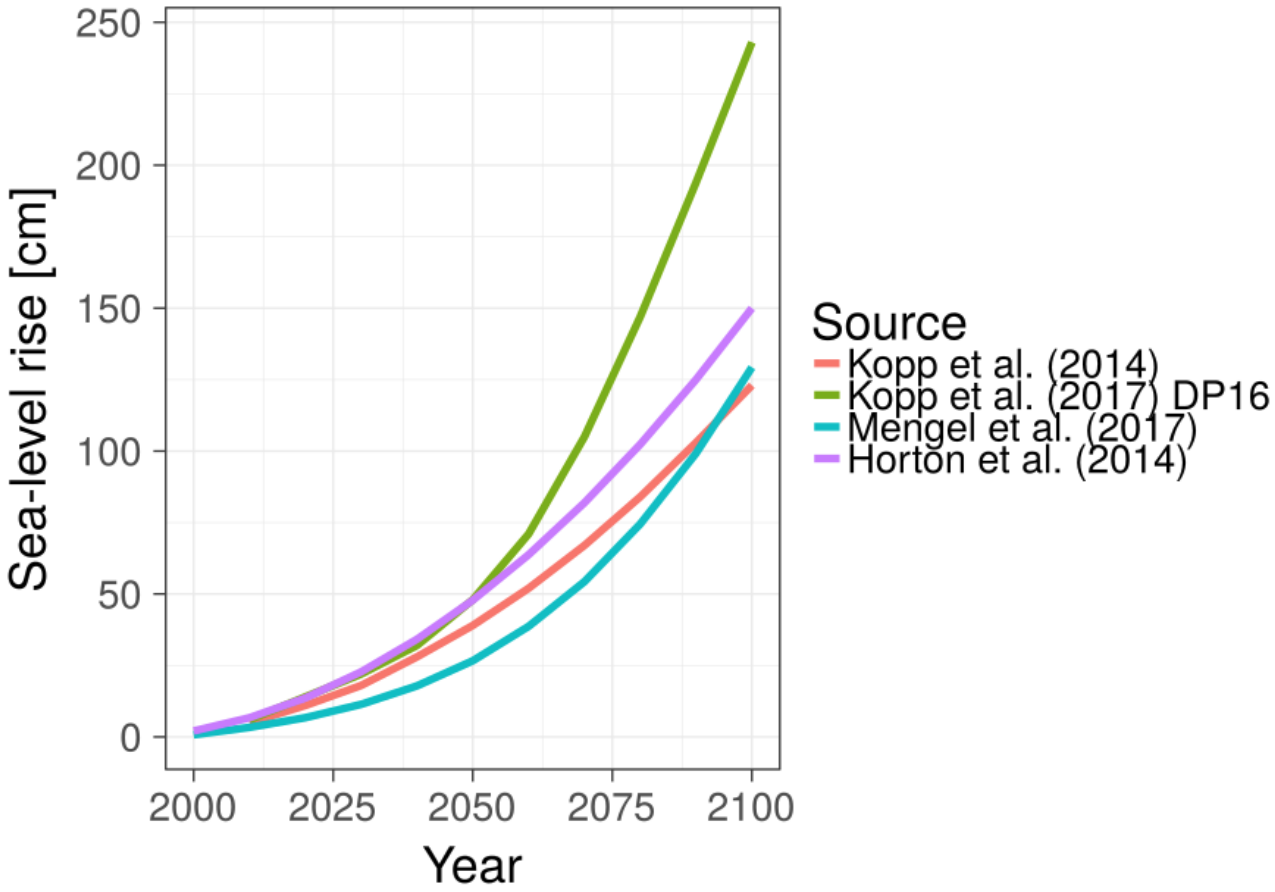

Assigning different levels of confidence to different studies is crucial

Le Cozannet et al. (2017): Possibility theory for aggregating across studies

Meeting need #3:

Information about what we will know in the future

Information about what we will know in the future

- Based on observations
  - Time of emergence (Lyu et al. 2014; Haigh et al. 2014)
- Based on better understanding the physics?
  - E.g. physics of ice-sheet discharge, ocean-heat uptake, decadal variability, etc.
  - Can we reduce uncertainty and if so, can we quantify by when how much uncertainty will be reduced?

Conclusions

Conclusions (1)

- Different decision context require different decision-making methods, which in turn require different kinds of sea-level information:
  - Probabilist forecasts for the short term
  - Worst case scenarios for the longer-term and the risk averse
  - Information on what we will know in the future
- There is no objective way of deriving probabilistic and/or worst case sea-level rise scenarios.
  - All approaches rely on expert judgement
  - It is wise to minimize assumptions made in the aggregation of ambiguous results: Possibilities instead of probabilities
- The confidence that physical scientists place on results is an essential piece of information.

Conclusions (2)

- I only scratched the surface
  - This needs to consider all components of mean and extreme sea-levels from global to local scales
- A close co-operation between sea-level and decision science is needed for further developing decision making.
- Let's not forget Perspectives 2 and 3
  - We need empirical research on how coastal decisions/policies are currently made, otherwise we are not likely to see much progress in using SL information in decisions and policy making.