Intro	Practice	Conclusion	References

Against "Possibilist" Interpretations of Climate Models

Corey Dethier

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Nov. 11, 2022

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What do the models tell us?



- Intergovernmental Panel on Climate Change Working Group 1 (IPCC 2013, 1110, Box 12.2)

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Intro	Practice	Bias	Conclusion	References
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Standard practice is *probabilistic*:

Each model potentially represents the real world.

Ensemble as a whole is a sample: the distribution of models is meaningful.

Dethier (2022b) and Parker (2010a,b).

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orey Dethier	1 ₀	
	Whose Probabilities? Predicting Climate	
	Change with Ensembles of Models	
	Wendy S. Parker ^{*1}	
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This probabilistic approach has been widely criticized.

Roughly: extant ensembles are too idealized to warrant adopting the use of *precise* probability distributions.

Betz (2007, 2015), Carrier and Lenhard (2019), Katzav (2014),

Katzav et al. (2021), Parker (2010a,b), Parker and Risbey (2015),

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Stainforth et al. (2007), and Winsberg (2018)

Intro Practice Bias Conclusion References

One alternative is a *possibilistic* interpretation:

Each model represents of a "real possibility," but is not a potential representation of the real world.

The distribution of models is *not* meaningful.

Betz (2007, 2015), Katzav (2014), and Katzav et al. (2021)

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Intro	Practice	Bias	Conclusion	References
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Should we prefer the possibilist interpretation in all contexts?



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Should we prefer the possibilist interpretation in all contexts?

No

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Should we prefer the possibilist interpretation in all contexts?

No: it might be preferable in some contexts, but there are at least some cases where we should prefer a probabilistic interpretation.

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One possibility: the empirical literature could establish that ensemble-based probabilities are generally untrustworthy.

That is: the distribution is consistently *and* unpredictably misleading.

I don't think the empirical literature supports this reading.

Annan and Hargreaves (2011), Hausfather et al. (2020), Knutti, Allen, et al. (2008), Knutti, Furrer, et al. (2010), and Yokohata et al. (2013)

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Enesemble-generated probabilities are used in successful practices

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Ensemble-generated probabilities are often used as intermediate steps in estimating other quantities.

This practice has (sometimes) proven successful when tested against known data.

Abandoning the probabilistic interpretation would require us to abandon these practices.

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Climate change attribution



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- adapted from IPCC (2013, 888, Fig. 10.6)

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Two options for representing the signatures:

- Point-estimates
- Probability distributions

For extended discussion, see Dethier (2022a,b).



Theory: a point-estimate is essentially equivalent to assigning 100% of your confidence to a single value.

Practice: probability distributions yield more accurate estimates for the contribution terms.

Hannart, Ribes, and Naveau (2014) and Schurer et al. (2018)

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Example may not be representative.

The climate is changing; an ensemble might be well-calibrated relative to the present but not to the future.

But: no reason to think that the *distribution* of models is more unreliable than the models themselves.

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When possibilism is counter-productive

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Recall: motivation is that the distribution of models is unreliable or misleading.

This is a problem regardless of how we interpret the models.

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We can evaluate the bias in an ensemble by comparing the distribution to the current climate.



- Annan and Hargreaves (2011, 4531, Fig. 2)

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Treating the distribution as meaningful allows to (detect and) correct for the ensemble's biases biases.

If we deny that the distribution is meaningful, then we're stuck with the ensemble we have.

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Where ensembles are biased, a possibilistic interpretation isn't guaranteed to remove that bias.

And the probabilistic interpretation gives us tools for correcting for the bias that the possibilistic approach doesn't.

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(Though similar caveats to the last section's apply.)

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What do the models tell us?



- Intergovernmental Panel on Climate Change Working Group 1 (IPCC 2013, 1110, Box 12.2)

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What do the models tell us?



- Intergovernmental Panel on Climate Change Working Group 1 (IPCC 2013, 1110, Box 12.2)

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We can *interpret* the ensembles probabilistically for intra-scientific purposes and then *present* that information in whatever way is best for the audience we're working with.

- Intergovernmental Panel on Climate Change Working Group 1 (IPCC 2013, 1110, Box 12.2)

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Eventually we want to leave "model land."

When determining what conclusions to draw about the real world, we should be looking at the distribution of models.

Even if the ultimate conclusions won't be probabilistic!

Thompson and Smith (2019)

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Escape from model-land

Erica L. Thompson and Leonard A. Smith

Abstract

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Takeaways				

There are good reasons to interpret climate ensembles probabilistically in at least some contexts.

This is true even if we ultimately want to present the information in a non-probabilistic way.

Thanks to: Matthias Ackermann, Markus Ahlers, Irene Buchholz, Mathias Frisch, Joel Katzav, Jan-Felix Müller, Johannes Müller-Salo, James Risbey, Joe Roussos, Lenny Smith, Lukas Steinbrink, Erica Thompson, Philippe van Basshuysen, and Jannik Zeiser.

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