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Imprecise probabilities of triggering tipping points in the earth system under various stabilisation policies

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The subject of abrupt climate change is of growing importance in the climate policy debate, but its recognition is still hampered by the speculative and fragmented knowledge about the probability of its occurrence under global warming. In the work presented here, we try to identify imprecise (due to the weak knowledge base) subjective (due to the incorporation of expert opinions) probabilities for triggering critical transitions ("tipping points") in the earth system that have the potential to be qualified as dangerous climate change under Article 2, UNFCCC. Thereby, we focus on (1) reorganisation of the Atlantic meridional overturning circulation, (2) complete melt of the Greenland ice sheet, (3) disintegration of the West Antarctic ice sheet, (4) dieback of the Amazon rainforest, (5) dieback of boreal forests, (6) shift to a persistent El Nino regime, and (7) decline of ocean carbon sink.

The problem of obtaining the probability of triggering these events under given GHG stabilisation scenarios can be separated into the following two logical steps: 1. Estimating the probability of climate change (in terms of increase in global mean temperature (GMT)) for given GHG stabilisation scenarios. 2. Estimating the probability of triggering a tipping point for given increases in GMT.

In the first of these two steps, we have used the energy balance climate model MAGICC to calculate the GMT response to various stabilisation scenarios, for given climate sensitivities and vertical ocean heat diffusivities. Parameter uncertainty is addressed in climate sensitivity and vertical ocean heat diffusivity. An imprecise probability measure of climate sensitivities is employed, constructed from the set of probability es-

timates published in the recent literature. For any given stabilisation scenario, this analysis generates a lower and upper probability of the future temperature lying in one or more temperature corridor representing low, medium and high climate change scenarios.

In the second step, we have queried around 50 experts from the various fields to elicit their intuition about the probability of triggering the selected tipping points conditional on the three corridors for low, medium and high temperature change. Participating experts were offered an interpretation of the probability of triggering based on the betting paradigm of subjective probabilities, and were asked to be conservative in their assessment, i.e. to choose their range of plausible probability values not too narrow given their (possibly weak) intuition about the prospect of triggering.

We will present an overview of the experts' ranges for the probability of triggering, and compare them across different temperature change scenarios and tipping points. We then combine the expert information with the estimates about future temperature change to calculate imprecise probabilities for triggering the selected tipping points under various CO2 stabilization policies. On the basis of these results, we discuss the implications that the expert opinions about the tipping points entail for climate policies which aim to avoid dangerous climate change.