A unified approach to quantify uncertainties in sea level projections

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Abstract Text:

By 2100, between 0.2 and 4.6% of the global population is expected to be flooded annually. The uncertainties of this statement originate from climate change scenarios, coastal impact models as well as different sea level projections. In the most recent research, uncertainties in sea level projections have been provided in a probabilistic form, in resonance with the common practice in coastal engineering. However, because the physical processes affecting land-ice melting remain still incompletely understood today, different probabilistic projections can be provided. The co-existence of various credible physical mechanisms defines a higher level of uncertainty beyond probabilities, which is referred to as “ambiguity” in the literature. Here, we build on extra-probabilistic theories of uncertainties to provide a unified approach to quantify ambiguity in sea level projections. We show that the knowledge gained regarding ice sheets melting since the AR5 allows to quantify the relationship between ambiguity in sea level projections and greenhouse gas emissions scenarios, both globally and regionally: limiting climate change to RCP 4.5 instead of RCP 8.5 reduces ambiguity by 40% globally, and even 70% for RCP 2.6. Europe and Northern America benefit the most from a policy limiting climate change to RCP 2.6 instead of RCP 4.5. For adaptation planning, this means that mitigation of climate change strongly reduces the risks of high-impact high end scenarios along most of the coasts. Our results provide a baseline to select regional high end scenarios, whose probability is difficult to quantify, but which are associated with high risks of impacts and are therefore particularly relevant for adaptation planning.

Plain-Language Summary:
Over the coming century, sea level will continue rising to an amount which remains highly uncertain. This is summarized by the AR5 IPCC report using a likely range between 30cm and 1m depending on future greenhouse gas emissions. Probability, though a powerful tool for uncertainty treatment, remains however a poor descriptor of this situation, which encompasses lack of knowledge and of consensus in the scientific community on numerous physical processes with different kinematics, and particularly its ice melting component. Consequently, a unique probability model can hardly and unambiguously be provided to represent the uncertainties of future sea level rise. In this contribution, we show how this level of uncertainties, which is termed ambiguity in the literature, can be understood, quantified, and communicated with extra-probabilistic theories of uncertainties.

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