Assessing ice sheet driven sea level rise using a probabilistic, bottom-up approach

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Sea level rise (SLR) projections are clouded by the deeply uncertain century-timescale dynamics of ice sheets[1–3]. Semi-empirical[4–6] and kinematic[7,8] methods, introduced to account for these "rapid" changes, generate far higher upper bounds on 21st century SLR (140-200 cm) than earlier estimates[9]. Although these projections have been incorporated into planning efforts[8,10], their wide range, and the absence of a means to gauge their uncertainty, limits their decision-making utility. Here, we introduce a probabilistic framework that facilitates: 1) the comparison of SLR projections and 2) the inclusion of data constraints. We then assess ice discharge scenarios ("pathways") that reach previously published upper bounds on the Antarctic SLR contribution by 2100. Exceeding 40 cm SLR equivalent requires extremely aggressive projections of ice discharge: for example, high quadratic growth rates in Pine Island (PIG) and Thwaites (THW) Glaciers; a mean growth rate of $>1.5\%y^{-1}$ in all ice sheet drainages; or growth rate uncertainty of $>1\%y^{-1}$ and a continent-wide correlation coefficient of 0.50. In this framework, the presumably remote likelihood of these pathways is quantified, and the upper bound may be updated using expert elicitation[11,12], observations[13,14], and/or models[15–17]. To illustrate the updating process, we apply a constraint on discharge growth rates derived from numerical models.