Ice sheet contributions to future sea level rise from a structured expert judgement approach

Attributing global sea level rise to its component parts

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1. Introduction

- Despite considerable advances since the IPCC AR5 in numerical modeling and the observational record of ice sheet contributions to global-mean sea level rise (SLR), severe limitations remain in the predictive capability of ice sheet models.
- Consequently, the potential contributions of ice sheets remain the largest source of uncertainty in projecting future SLR.
- Structured Expert Judgement (SEJ) provides a formal, rigorous approach for estimating uncertainties based on the current state of the art.
- We build on a proof of concept study published in 2013 (Bamber & Aspinall, 2013; B&A13).
- Here, we combine judgements from 22 experts to investigate uncertainties in ice sheet projections for two prescribed temperature scenarios (Fig 1).
- **"SEJ is for quantifying uncertainty, not removing it. For that we must make measurements"**

2. Scenarios considered

• We considered two temperature scenarios: a low (L) one which stabilises at 2° C above preindustrial ~consistent with Paris COP21 accord and a business as usual scenario (H) which reaches 5° C by 2100. Projections were elicited for 4 time periods shown below.

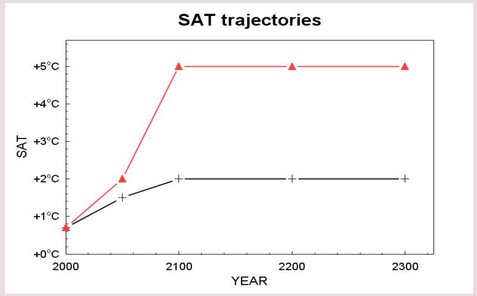


Fig 1. Temperature scenarios used

3. Approach

We used the Classical Model (Cooke 1991) to score ice-sheet experts' 'informativeness' and 'statistical accuracy' from a set of 'seed questions', and to weight their estimates of plausible contributions of the Antarctic and Greenland ice-sheets — in order to quantify policy-critical climate change SLR impacts under different climate change scenarios.

The experts' medians and 90% uncertainty ranges for factors controlling ice-sheet melting allow us to simulate *pdfs* expressing uncertain projections of individual and combined ice-sheet contributions (Results panel).

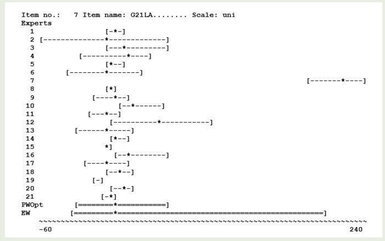


Fig 2. Example "Range Graph" showing each experts' 5, 50 and 90%ile estimate of the accumulation anomaly at 2100 for Greenland. Bottom lines show equal weight (EW) and performance weight (PW) 90%ile ranges, obtained from pooling expert values, weighted by their calibration score

4. RESULTS. PDFs for the two temperature scenarios (H and L) for all ice sheets combined and separately:

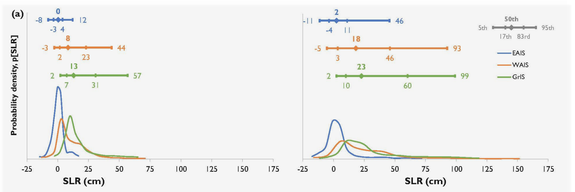


Fig 3. SLR at 2100 for each ice sheet (EAIS, WAIS GrIS) with percentile ranges shown on horizontal bars. 17-83% is the likely range used by the IPCC.

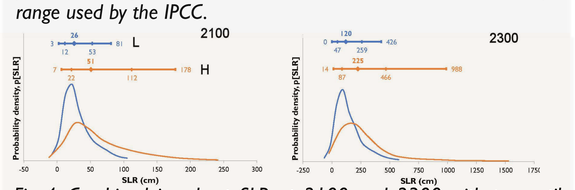
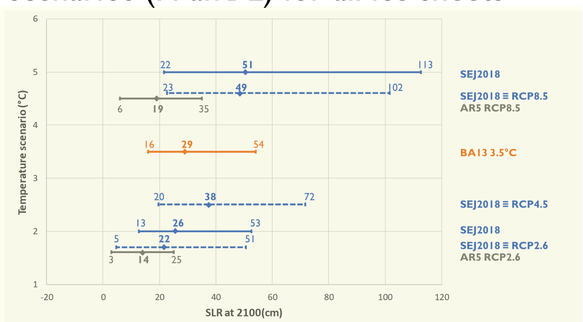


Fig 4. Combined ice sheet SLR at 2100 and 2300 with percentile ranges shown for both L and H temperature scenarios.



Median and likely range (17-83rd %ile as used in the AR5) estimates of the ice-sheet SLR contributions for different temperature scenarios and different studies. AR5 RCP ice-sheet contributions are shown for RCP2.6 and 8.5 by combining contributions from the different sources (grey bars). BA13 is shown for the elicited temperature increase of 3.5° C by 2100 (orange bar). This study (SEJ2018, in blue) is shown for the L and H temperature scenarios using solid lines. Dashed lines are interpolated from the L and H results.

5. DISCN & CONCLUSIONS.

Since the AR5, expert uncertainty has grown, in particular, due to uncertain ice dynamic effects. For a 2°C temperature scenario, we obtain a median estimate of 26 cm SLR contribution by 2100, with a 95th percentile value of 81 cm. For a 5°C temperature scenario more consistent with unchecked emissions growth, the corresponding values are 51 cm and 178 cm, respectively. Inclusion of ocean thermal expansion and glacier contributions, results in a total SLR estimate that exceeds 2 m at the 95th percentile.

Our findings support the use of scenarios of 21st century total SLR exceeding 2m for planning purposes. Beyond 2100, uncertainty and projected SLR increase rapidly. The 95th percentile ice sheet contribution by 2200, for the 5° C scenario, is 7.5 m as a result of instabilities coming into play in both West and East Antarctica. Introducing process correlations and tail dependences increase this value by roughly 15%.

Consideration of the upper tail behavior of our SLR estimates is crucial for robust decision making. Limiting attention to the likely range, as was the case in the IPCC AR5, may be misleading and will likely lead to a poor evaluation of the true risks

References

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