The Cryosphere Discuss., 9, C1336–C1338, 2015
www.the-cryosphere-discuss.net/9/C1336/2015/

The Cryosphere
Discussions
Open Access

Interactive comment on "Improved Arctic sea ice thickness projections using bias corrected CMIP5 simulations" *by* N. Melia et al.

G. Flato (Referee)

greg.flato@ec.gc.ca

Received and published: 29 July 2015

Projecting future Arctic sea-ice thickness, and in particular the timing of an essentially ice-free summer Arctic, is a topic that has received considerable scientific and public attention. Generally, such projections rely on global climate models which simulate sea-ice – historical and future – and its response to external forcing. Although climate models are unanimous in projecting a decline in future sea-ice amount as the climate warms, the timing of an ice-free Arctic depends crucially on the model mean state (the 'unperturbed' value), interannual variability, the simulated response to forcing, and of course the forcing itself. In principle, some of the uncertainty in Arctic sea-ice projections can be reduced by post-processing the 'raw' model output: sub-selecting models based on some criteria; weighting model results based on a performance metric; ap-

plication of some form of bias correction. Various papers have explored these options, and the present paper focuses on the latter. Unlike many previous papers, this one focuses on sea-ice thickness rather than extent. It is a welcome addition to the literature on this subject.

The authors describe several possible bias correction methods, and their pros/cons, and illustrate the effect of each using idealized time series. They propose a new approach, "MAVRIC", which corrects biases in both mean and variance, and apply it to selected CMIP5 climate model results. Although locally and for individual models the corrections have a substantial effect, the effect on the ensemble mean is less pronounced (owing to some cancellation of errors). So, the median projected ice-free date is not changed very much as a result of the correction procedure, but the spread is certainly reduced. They also analyze the effect of the correction procedure on the partitioning of this spread into that associated with model behavior, internal variability, and forcing scenario differences.

I have a slight quibble with the use of the word 'uncertainty' in this paper, and in particular the extent to which reducing 'spread' is equivalent to reducing 'uncertainty'. This may be largely a semantic issue, but it is not obvious to me that reducing spread *necessarily* reduces uncertainty (in the sense of the confidence one has, or should have, in a prediction or projection). Spread is of course directly related to uncertainty, and the partitioning suggested by Hawkins and Sutton yields considerable insight into the sources of uncertainty and how these change over time. But I think one has to be a bit careful in equating reduced spread with reduced uncertainty (and by extension, enhanced confidence) as is done here. One can readily construct schemes that reduce spread (e.g. discarding all models but one), but don't really reduce uncertainty. Perhaps a few sentences on this topic could be added?

Otherwise, I found the paper very clearly written, and I very much appreciated the nice clear example calculations illustrating different potential correction methods. The figures were generally clear and well-explained. I did note two things related to Figure 3 however: – the caption states that 'ice-free' is defined as the "first occurrence ... below 0.15m", but the legend gives a range of years of 'ice-free year'. I didn't understand this. – the legend indicates no change in 'ice-free' year for the high-mean (blue) example when the multiplicative correction is applied (compare Fig 3a and 3c) even though the curve is obviously shifted downward. I suspect a typo in the legend. The same applies to Fig 3b and 3d where again the ice-free year for the blue curve is unchanged.

Overall, this is a nice paper and I recommend it be accepted subject to some small changes as noted above.

Interactive comment on The Cryosphere Discuss., 9, 3821, 2015.