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Interactive comment on "Assessment of sea ice simulations in the CMIP5 Models" *by* Q. Shu et al.

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Overall assessment:

The authors present a broad overview assessment of the performance of the CMIP5 simulations of sea ice extent and sea ice volume in both the Antarctic and Arctic regions. 49 different CMIP5 models are used in this assessment and comprises the most inclusive set of CMIP5 results for sea ice in publications to date and represents a significant effort. Beyond this however, the paper lacks a clear focus or purpose, and fails to provide new insight or information beyond that already contained in previous assessments of CMIP5 results from a subset of the models evaluated here, (e.g. Stroeve et al, 2012, Massonnet et al, 2012). The introduction is missing citations for key references for previous assessments of sea ice in the Arctic (e.g. Massonnet et. al., 2012) and the Antarctic (e.g. Zunz et al., 2013), and these are listed in Chapters 9 and 12 of the IPCC AR5 report published in Fall 2013.

Scientifically, the analysis focuses on a simple comparison of the multi-model ensemble mean to the satellite observed sea ice extent, as well as reanalyzed sea ice volume from the GIOMAS model. The strategy of assessing the multi-model ensemble mean to observations yields no insights into the behavior of any particular models, or assessment of which models do a better job at producing the mean state and trends over the satellite era based only on the historical period of CMIP5 (1979-2005). Though tedious, a more detailed evalutation of the model mean state, seasonal cycle, trends, and variability, would actually be a more useful reference for the community. This might involve expanding the number of fields in Table 1 to include more metrics, and indicating an assessment of model performance for each metric.

My comments below contain some ideas that might lead to a more useful paper, and would expect that an expanded discussion of these would lead to a completely revised manuscript.

Suggestions:

If the goal of the paper is to identify CMIP5 models that do a reasonable job of reproducing sea ice characteristics, then it would be helpful to have (a) a clear set of criteria that can be evaluated for each model, and (b) the assessment of each model performance against those criteria. Massonnet et al, (2012), does this to answer a specific question related to the timing of the disappearance of Arctic ice. The idea might be not to find the best sea ice models, but rather the best models to address a particular question.

GIOMAS sea ice volume data for the Antarctic has not been tested against the limited set of observations, but is the best available time series available now. Whether it represents a useful set of 'observations' to test model performance is another question. For the Arctic, I suggest use of the PIOMAS data, which has been more extensively investigated (e.g., Schweiger et al, 2011). Since SIV is a poorly observed quantity, It would be also be worth mentioning how PIOMAS/GIOMAS SIV estimates compare against independent satellite estimates of SIV (e.g. Kurtz and Markus, 2013), especially for the Antarctic.

One of the more interesting points in the paper is contained in the final paragraph, which assesses the number of models necessary to reduce the error between multi-model ensemble mean and observations. As the authors point out, the RMS error between the MME of both SIE and SIV compared to observations is minimized by the inclusion of about 22 models, which indicates that previous assessments of the MME (e.g., Turner et al, 2013) are not enhanced by the inclusion of additional ensemble members.

An understanding of what causes the spread in SIV estimates in CMIP5 models would be a potentially useful line of inquiry. Perhaps models with a more realistic mean state or seasonal cycle results in a convergence of estimates of SIV.

There is no reason one would expect the models to capture the observed trends in the exact time period 1979-2005 given the contribution of natural variability (roughly half) to the observed trend (see Kay et al 2011). The authors could explore the ability of the models to reproduce the observed 27 year trends in the vicinity of the same time period in the models. They would still need to address the potential confounding influence of differing sensitivity of Arctic/Antarctic sea ice loss per degree global warming.

Specific comments:

Observed Antarctic SIE trends (P3417 L21) of 1.56 x 10ˆ5 km2/decade are not consistent with other literature, and it's not clear where this value comes from. My estimate using NSIDC sea ice index is trends of 1.12 x 10ˆ5 km2/dec if based on annual mean SIE or 1.29x10ˆ5 km2/dec if based on monthly anomalies for 1979-2005 (crudely ignoring missing data values). Turner et al (2013) quotes 1.27x10ˆ5 km2/decade. Uncertainties should be calculated for all trends. See Stroeve et al, 2012 for suggestions. Further discussion of the increase in Antarctic SIE should incorporate the recent revelation of Eisenman et al, (2014), which suggests that the trend may not be as strong

as quoted recently.

Correlations of the seasonal cycle of the MME compared to observations are not informative unless they are not highly correlated and would therefore indicate a substantial problem. (P3417 L10).

In Table 1, it should be made clear how the RMS error of climatologies is computed. It would be useful to distinguish the error on on the winter/summer means from the annual mean error.

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