

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

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### **Response to Referee #1**

*(Note: referee comments in black and our reply in blue)*

Comment: This manuscript evaluated the sea ice simulations by 49 CMIP5 models over the Arctic and Antarctic for the period of 1979–2005. The authors compared the model simulated sea ice extent (SIE) with that derived from satellite-based observations (NASA algorithm), and sea ice volume (SIV) with output from the Global Ice-Ocean Modeling and Assimilation System (GIOMAS). The assessment was done for both the Arctic and Antarctic region. Annual cycle and linear trend from multi-model ensemble means are compared with the observation. This is a nice summary about the

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CMIP5 model sea ice simulations, and could have added value to the pile of publications in this research area, especially considering that most of the preciously published paper deal with part of the CMIP5 models due to their publication date. The work in the manuscript is very similar to what Parkinson et al. published in 2006 about CMIP3 models. However only the “multi-model ensemble mean” (MME) were presented in the manuscript. It would be nice to show each individual model’s performance as other peoples do, for example, Massonnet et al. (2012), Stroeve et al. (2012), Wang and Overland (2012) and Liu et al. (2013). While most previous studies focused their discussion on SIE simulations, this manuscript also evaluated SIV, which is an importance variable to be considered. This is an very important addition.

**Reply:** We are very grateful to the above comments and all the following thoughtful suggestions. The quality of this manuscript is much improved through considering these comments. The revised manuscript has been modified according to the reviewer’s suggestions.

Comment: In the introduction the authors state “assessment of the performance of CMIP5 model outputs is necessary for scientists to decide which model outputs to use in their research”. Yet throughout the text we could not tell which model(s) perform better in their standard since only the MME were presented. We should NOT compare the MME with observation as observation represents only ONE-single realization.

**Reply:** Thank you for the suggestion. We agree with you that observation is only ONE-single realization and we should compare each model simulation with the observation and give the performance of each CMIP5 model. The performance of each CMIP5 model is listed in Table 1. But detail information of Table 1 in the old version of manuscript is not enough as mentioned in your next suggestion. In the revised manuscript we added more description of Table 1. The performance of each model is evaluated by climatological sea ice extent (SIE) bias (root mean square (RMS) error) compared with satellite observation, simulated SIE linear trend, climatological sea ice

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volume (SIV) bias (RMS error) compared with GIOMAS output, and simulated SIV linear trend for both Arctic and Antarctic. Climatological SIE and SIV biases can evaluate the performance of long-term mean state of sea ice. SIE and SIV linear trends can evaluate the performance of sea ice changing speeds.

Revision in manuscript:

Line 25 of P.8: "From Table 1 we can conclude that the performance of each model is different. For the Antarctic, BCC-CSM1.1, CESM1-CAM5-1-FV2, CMCC-CESM, CMCC-CM, CMCC-CMS, GISS-E2-H-CC, MIROC-ESM, MIROC-ESM-CHEM, MRI-CGCM3 and MRI-ESM1 can give better climatological SIE and SIV. For the arctic, ACCESS1.3, CCSM4, CESM1-BGC, CESM1-CAM5, CESM1-CAM5-1-FV2, CESM1-FASTCHEM, EC-EARTH, FIO-ESM, HadGEM2-ES and IPSL-CM5A-LR can give better climatological SIE and SIV. The Arctic SIE linear trends of BCC-CSM1-1-M, CanCM4, CESM1-CAM5-1-FV2, CMCC-CM, CSIRO-Mk3.6, GISS-E2-H, HadCM3, MIROC-ESM-CHEM, MPI-ESM-MR and MRI-ESM1 are closed to the observations."

Comment: In Table 1, CMIP5 simulated errors and trends are listed for each individual model. What are these RMS errors and linear trend? Annual mean? Seasonal mean? or what? It is unclear from the text. In Stroeve et al. paper, 20 CMIP5 models' trends were presented already. How does your result compare with their result?

Reply: Thank you for your valuable suggestion. In Table 1, RMS errors are seasonal mean RMS errors. Linear trends are the trends of the monthly anomalies. We added these two sentences in the revised manuscript. In Stroeve et al. paper, Arctic SIE trends are for the period of 1979-2011, but here the SIE trends are for the period of 1979-2005 since CMIP5 historical run is from 1850 to 2005. So it is hard to compare these trends for two different periods.

Revision in manuscript:

Line 1 of P.12: "RMS errors are seasonal mean RMS errors. Linear trends are the  
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trends of the monthly anomalies."

Comment: Comparing CMIP5 model simulated SIV with output from GIOMAS is fine since we do not have systematic pa-Arctic observed ice thickness yet. But please do remember that those are model simulations, and therefore it is not true "observation".

Reply: Thank you for your reminding.

Revision in manuscript:

Line 4 of P.2: changed "Global Ice–Ocean Modeling and Assimilation System (GIOMAS) data in this study" to "Global Ice–Ocean Modeling and Assimilation System (GIOMAS) output data in this study".

Line 20 of P.4: "SIV data from GIOMAS are not observations but model simulations with data assimilation."

Finally, we hope to express our sincere thanks again for all these valuable comments and suggestions.