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Comparison of modelled and observed Arctic sea ice

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When considering the climate projections one of the most important issues is how well models reproduce variability and change of the main climate parameters, e.g. sea ice. To address this issue the comparative analysis of observed and modelled sea ice coverage and thickness was performed. Modelled sea ice extent and thickness data for the comparison are represented by results of simulation runs of IPCC AR4 models. Observed data for sea ice coverage – area and extent, are Chapman and Walsh data and data from satellite passive microwave measurements available continuously since November 1978. Observed sea ice thickness data are Kwok and Rothrock data from submarines for 1975-2000 and from ICESat satellite for 2003-2008.

Annual cycle of observed and modelled monthly mean sea ice extent (SIE) showed that, generally, models overestimate SIE. Disagreement between simulated and observed results is larger during late winter, spring and earlier summer. Annual cycle of observed and modelled linear trends of SIE showed that negative trend rates reach their maxima in July-August, revealing significant decreases in summer SIE. Simulated trend rates are two times smaller then observed. Thus, the observed sea ice extent decreases faster than modelled. Comparison of observed and modelled annual cycle of SIE for the different Arctic seas showed that for the Barents sea models overestimate sea ice during the whole year. For other seas models overestimate SIE only for summer and early fall. For all other seasons they underestimate Arctic sea ice. The mean differences between observed and modelled sea ice concentration in the Arctic is the largest in Barents, Kara, Laptev and East-Siberian seas and exceeds 80%.

The comparison of observed and modelled sea ice thickness showed that, generally, observed values lie within the area of the model spread. But the negative trend of observed thicknesses significantly higher than that of models. So, the Arctic sea ice thickness, like its area, decreases faster than model forecasts.

Model projections indicate that to the end of this century there are increasing ice-free areas throughout the Arctic coastal seas in summer. These projections are compared with extrapolated observed September sea ice extent performed by means of “Caterpillar” method of time series analysis and forecasting. There is good coincidence between modelled and extrapolated observed SIE values only for Laptev and East-Siberian seas. So, for these seas models give reliable projections of sea ice. For all other seas there is significant discrepancy between these two types of forecast. The largest discrepancy takes place for Beaufort, Barents and Chukchi seas – from five to ten times. Extrapolated observed data show also that already to the middle of this century Barents, Chukchi and Beaufort seas may be free of ice, significantly earlier than models project. Therewith, model mean indicate very thin ice in summer to the end of a century, whereas extrapolation of observed data shows that sea ice thickness will be close to zero already about 2020-2030.

Thus, the comparison of observed and modelled sea ice coverage and thickness showed significant disagreement between them. This disagreement raises questions on the model projections reliability. Therefore, one should be very careful when developing scenarios of ice conditions in the Arctic over the current century based only on the IPCC model projections.