



Rise of Insolation of Low Latitudes Affects Arctic Warming

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Opinion

Global numerical models of the Earth's climate system are the main tool for obtaining quantitative estimates of changes in the Earth's climate caused by anthropogenic activities. New findings from these models are regularly discussed and summarized in the Assessment reports of the Intergovernmental Panel on Climate Change (IPCC). The Sixth report is currently being prepared for release and is expected to be completed this year. The release is preceded by an analysis of numerical experiments performed in accordance with the agreed list of global models for the CMIP6 ensemble. The previous ensemble of CMIP5 calculations was used in the preparation of the IPCC report issued in 2014. Since then, the models have been improved and refined taking into account the recommendations based on the analysis of CMIP5 calculations.

The first calculations for the new ensemble showed a higher equilibrium sensitivity to a doubling of CO₂ concentration relative to pre-industrial levels compared to CMIP5 models (5°C instead of 4.5°C),¹ which has not yet been explained. However, past climate changes recorded in ice cores do not confirm the high climate sensitivity, as well as the rate of current warming. On February 2020,² the WCRP High-level Science Questions and Flagship Workshop was held in Hamburg, Germany, which discussed scientific issues for the next decade and knowledge gaps that should be taken into account when preparing the IPCC reports. Among the challenges highlighted for the next decade were the climate sensitivity to greenhouse gas emissions and the effects of warming in excess of the Paris Agreement levels (Guy Brasseur). It was pointed out an

unacceptable bias of the model estimates, which does not allow moving on (Mojib Latif). As noted in the discussion, in some areas the same issues remain as they were 20 years ago. For example, the problem of climate sensitivity has not been solved in 40 years. Jochem Marotzke indicated that many of the knowledge gaps sections in the forthcoming IPCC assessment are still under development. Bjorn Stevens noted that models are a tool that can be used in conjunction with other tools and that various assessment methods should be used.

The analysis of model calculations from the CMIP5 ensemble³ showed that the models underestimate the magnitude of the observed interdecadal variability and distort its spatial character. Noteworthy is the underestimation in the models of the positive trends in ocean warming at low latitudes, where most of the heat of solar radiation is accumulated.⁴⁻⁷ As a result, global coupled models are less likely to reproduce climate change features in selected regions in mid and high latitudes than atmospheric circulation models with observed warming in tropical oceans.⁸⁻¹⁰ Meanwhile, the influence of tropical oceans on climate change in mid and high latitudes was noted in.^{11,12}

As it is shown in¹³ the global coupled models from CMIP5 largely underestimate the interannual temperature variability in the Atlantic water layer in the Arctic Ocean, and underestimate its trend observed since the late 1970s. In the new generation of global models from CMIP6, the largest discrepancy between the observed and modeled distribution of sea ice in the Arctic is still observed

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in September and has been increasing since the beginning of the twenty-first century. Most of the models from CMIP6 show less September ice loss per degree of warming compared to observations.¹⁴

From the viewpoint of authors of the peer-reviewed papers, the reasons for the discrepancy between simulated and observed warming in the tropical oceans is that the radiative forcing on warming in recent decades has been rather small or some important processes in the tropics have not been taken into account in coupled models,⁸ or models underestimate internal variability.⁶

In our studies of the influence of the tropics on climate change in the Arctic, one more, in our opinion, the main reason for the discrepancies was found, namely, the absence in global models of a positive insolation trend in the radiative forcing at the top of the

Table 1: Trends of average insolation for the region 0-25° N ($\text{Wm}^{-2}\text{yr}^{-1} \times 100$) for 1979-2018 calculated on data obtained from <http://www.solar-climate.com/>. Positive trends are highlighted in bold.

Month	January	February	March	April	May	June	July
Trend	0.056	0.23	0.344	0.422	0.398	0.26	0.04
Month	August	September	October	November	December	$\sum_1^7 tr_m$	$\sum_1^{12} tr_m$
Trend	-0.19	-0.359	-0.388	-0.282	-0.109	1.75	0.30

Thus, global warming develops with the participation of an increase in insolation of TOA at low latitudes and intensifies in the Arctic under the influence of atmospheric and oceanic transport of heat and moisture. Global climate models simulate ocean warming at low-latitudes insufficiently correct due to underestimation of rise in insolation of the top of the atmosphere and, thereby do not take into consideration one of the factors of climate warming.

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Conflicts of Interest

Author declares that there is no conflict of interest.

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