Insights on past and future sea-ice evolution from combining observations and models

Julienne Stroeve, Dirk Notz

PII: S0921-8181(15)30093-X
DOI: doi: 10.1016/j.gloplacha.2015.10.011
Reference: GLOBAL 2347

To appear in: *Global and Planetary Change*

Received date: 24 June 2015
Revised date: 12 October 2015
Accepted date: 22 October 2015

Please cite this article as: Stroeve, Julienne, Notz, Dirk, Insights on past and future sea-ice evolution from combining observations and models, *Global and Planetary Change* (2015), doi: 10.1016/j.gloplacha.2015.10.011

Insights on past and future sea-ice evolution from combining observations and models

Julienne Stroeve[1,2] and Dirk Notz[3]

[1]National Snow and Ice Data Center (NSIDC), University of Colorado (CU), Boulder, CO, USA
[2]University College London, London, UK
[3]Max Planck Institute for Meteorology, Hamburg, Germany

Key words: Arctic sea ice, future climate change, sea ice predictability

Abstract

We discuss the current understanding of past and future sea-ice evolution as inferred from combining model simulations and observations. In such combined analysis, the models allow us to enhance our understanding behind the observed evolution of sea ice, while the observations allow us to assess how realistically the models represent the processes that govern sea-ice evolution in the real world. Combined, observations and models thus provide robust insights into the functioning of sea ice in the Earth's climate system, and can inform policy decisions related to the future evolution of the ice cover. We find that models and observations agree well on the sensitivity of Arctic sea ice to global warming and on the main drivers for the observed retreat. In contrast, a robust reduction of the uncertainty range of future sea-ice evolution remains difficult, in particular since the observational record is often too short to robustly examine the impact of internal variability on model biases. Process-based model evaluation and model evaluation based on seasonal-prediction systems provide promising ways to overcome these limitations.

1. Introduction

Insights into the functioning of the Earth's climate system can be derived from either observations or from model simulations. However, in both cases an isolated analysis of just one of these two sources of climate data has severe limitations: An isolated analysis of climate-model simulations does not usually allow one to assess whether these simulations capture the main processes that govern the evolution of the Earth's climate system. An isolated analysis of observations does not usually allow one to understand the processes that are responsible for the observed evolution. Both these limitations can be overcome by examining specific aspects of the Earth's climate system in a combined analysis of both observations and model simulations. We here discuss how such combined analysis allows for robust insights related to the past and future evolution of Arctic sea ice, and where the combined approach is still limited by shortcomings of either models or observations.

This study is motivated by the severe impacts that the observed rapid loss of Arctic sea ice is having not only on the Earth's climate system, but also on the Arctic's ecology, communities and economy. For example, in regards to the Earth's climate system, the sea-ice retreat has clearly changed the surface energy budget in the Arctic [*Porter et al.*, 2012]. Through these changes, the ice loss contributes to amplified