S1–O1

Does polar amplification have a maximum in present day climate?

Vladimir A.Alexeev[1], and Craig H. Jackson[2]

[1]International Arctic Research Center, University of Alaska Fairbanks

[2]Ohio Wesleyan University

Polar amplification (PA) is a prominent feature of currently observed and predicted future climate change suggested by both observations and models. Surface albedo feedback (SAF) has been shown to contribute prominently to the currently observed PA along with other mechanisms, e.g. involving atmospheric heat transport. However, significant PA can also be obtained in models without any surface albedo feedbacks, although the PA obtained in these models is typically smaller than the PA in models taking SAF into account. From the conceptual point of view, PA due to SAF should be relatively weak in the two extremes where the whole earth is covered by ice, on one hand, and where all the sea ice is gone, on the other. Therefore it is reasonable to assume that PA reaches a maximum at some point between the icehouse and hothouse climates. A simple conceptual model is used together with observational data to find the point at which PA could be at its maximum, which according to the analysis, appears to be close to the present day climate.

S1–O2

ON PROCESSES AND FEEDBACKS OF RELEVANCE TO ARCTIC AMPLIFICATION AND CLIMATE CHANGE

Wieslaw Maslowski[1], Jaclyn Clement Kinney[1], Robert Osinski[2], Andrew Roberts[1]
[1]*Naval Postgraduate School, Monterey, California 93943, USA*
[2]*Institute of Oceanology, Polish Academy of Sciences, Sopot 81-712, Poland*
maslowsk@nps.edu

The Arctic System has experienced major changes including declining cryosphere, warmer air and ocean temperatures and ecosystem shifts. Understanding and prediction of these changes is critical since this region is a key player of the Earth System and an early indicator of the state of global climate because of both its sensitivity to warming and its role in amplifying climate change. Such changes influence the global surface energy and moisture budget, atmospheric and oceanic circulation and feedbacks.

However, a system-level understanding of critical Arctic processes and feedbacks is still lacking. Moreover, large natural variability and sensitivity of Arctic climate to global change make the attribution of those changes difficult. Yet, such changes could have significant ramifications for global sea level and future climate change, native communities, natural resource exploration, transportation and international diplomacy.

This talk will focus on some oceanic and sea ice processes and ocean-sea ice/atmosphere feedbacks that might significantly contribute to both an amplified warming of arctic climate and an accelerated melting of the Arctic sea ice cover. Examples based on observational and modeled results will be provided.

Maslowski, W., J. Clement Kinney, M. Higgins and A. Roberts (2012): The Future of Arctic Sea Ice, Annu. Rev. Earth Planet. Sci. 2012. 40:625–54.

S1–O3

Contributing Processes to Arctic Temperature Amplification for a Range of Forcing in MIROC GCM

Masakazu Yoshimori[1], Masahiro Watanabe[1], Ayako Abe-Ouchi[1,2], Hideo Shiogama[3], and Tomoo Ogura[3]

[1]*Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan*

[2]*Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan*

[3]*National Institute for Environmental Studies, Tsukuba, Japan*

masakazu@aori.u-tokyo.ac.jp

The finding that surface warming over the Arctic exceeds that over the rest of the world under global warming is a robust feature among general circulation models (GCMs). While various mechanisms have been proposed, their contributions have not been systematically quantified. Such diagnosis is an important task in order to understand model behavior and operating mechanisms. Here we apply a recently proposed feedback analysis technique to a GCM under different external forcings. The contribution of individual feedbacks to enhanced Arctic temperature change relative to low latitudes, an essential feature of Arctic amplification, is quantified. Surface temperature response in the Arctic is amplified by radiative feedbacks of albedo, water vapor and clouds, and large-scale condensation heating. This diagnosis is consistent with increased moisture transport from lower latitudes, and reduced sea ice cover and consequent increased evaporation under warming. Albedo feedback is not always a predominant factor and the change in evaporative cooling equally contributes or exceeds it in some cases in maintaining the anomalous meridional temperature contrast. As a consequence, the sign of the total radiative feedback contribution to the contrast depends on the forcing, but the total non-radiative feedback contribution is consistently positive. An important contribution to the contrast is also made not via the 'dry' heat transport process but through the hydrological cycle.

S1–O4

SIMULATION FOR 20TH AND 21ST CENTURIES WITH A 60KM-MESH GLOBAL ATMOSPHERIC MODEL

Shoji KUSUNOKI[1], Ryo MIZUTA[1]

[1]Meteorological Research Institute (MRI), Tsukuba, Japan

E-mail: skusunok@mri-jma.go.jp

Climate of the 20th and 21th century simulation was conducted with a 60km-mesh global atmospheric model (MRI-AGCM3.2H) from year 1872 to 2099. For the historical simulation for 1872-2005, the model was forced with observed historical sea surface temperature (SST) and concentrations of green house gases such as CO2. For the future simulation for 2006-2099, the model was forced with SST changes projected by the average of Couple Model Intercomparison Project3 (CMIP3) multi-model ensemble. The A1B emission scenario is assumed. In order to evaluate uncertainty simulations, three member ensemble simulations with different atmospheric initial conditions were conducted. Annual precipitation over Arctic region increases during the whole period (Fig. 1).

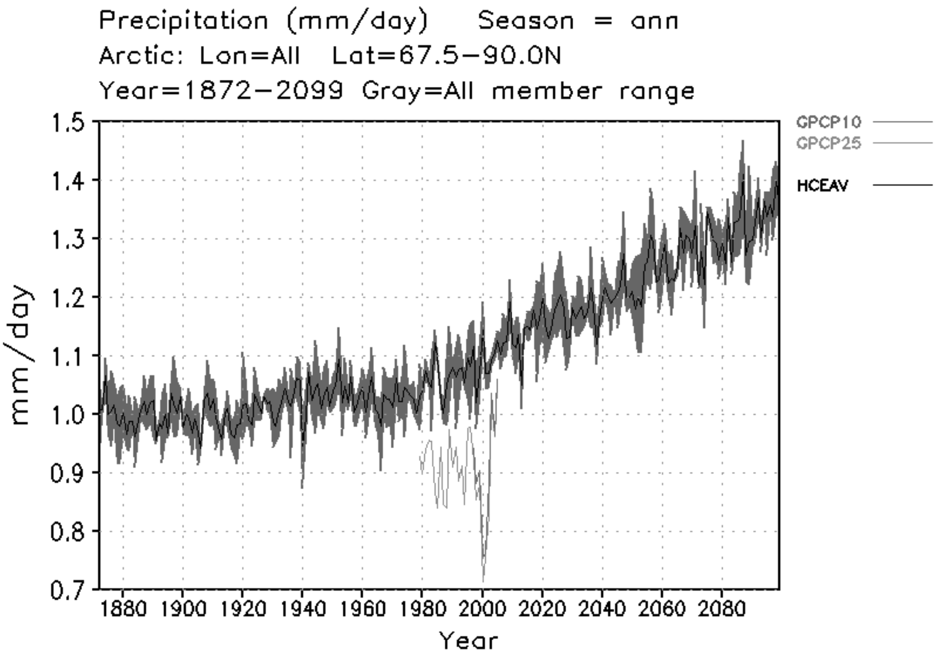


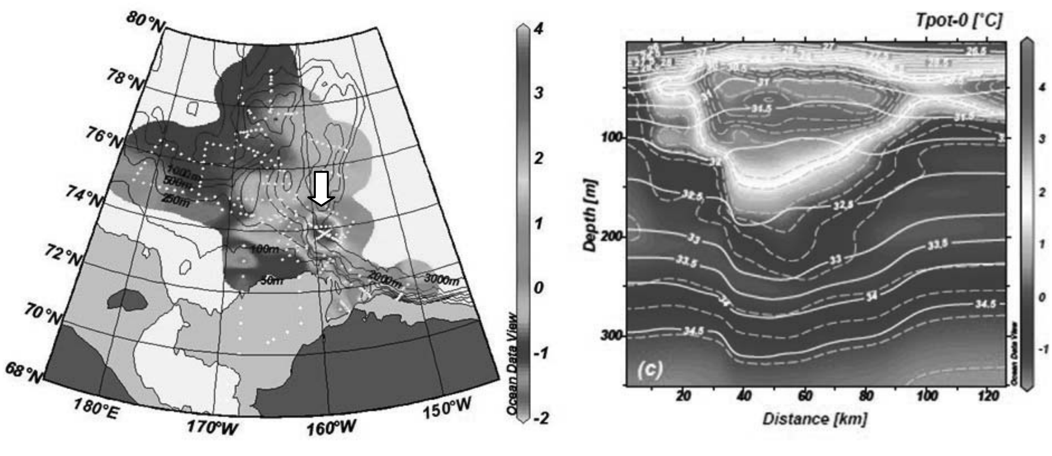
Figure 1 Annual mean precipitation averaged over the arctic (67.5-90°N) from 1872 to 2099 (228 years). Orange: GPCP 2.5 deg observation (1979-2005), Red: GPCP 1.0 deg observation (1997-2005), Thick black: Model ensemble average, Gray: Range of individual runs.

S1–O5

DETAILED SURVEY OF A LARGE BAROCLINIC EDDY WITH EXTREMELY HIGH TEMPERATURES IN THE WESTERN CANADA BASIN

Yusuke Kawaguchi[1], Nishino Shigeto[1], Motoyo Itoh[1]
[1]Arctic Research Team, Japan Agency for Marine-Earth Science and Technology
yusuke.kawaguchi@jamstec.go.jp

This study documents detailed hydrographic survey of a large anticyclone eddy that was found in October 2010 during a *Mirai* Arctic cruise at east flank of North Wind Ridge in the Canada Basin (left panel). The eddy measured 60-70 km in diameter, roughly twice previous eddies. The eddy is also pronounced by unusually high temperature, being 6^{o} C, at its upper segment even though it located adjacent sea-ice zone to the north. The eddy has a shape like convex lens, associated with its low PV, resulting in the anti-cyclonic circulation. We also found that the eddy was tightly embedded within a strong jet flow that established over Chukchi Sea shelf slope, which is considered to be a branch of Beaufort circulation that has been enhancing lately. The eddy's unusually warm waters are likely to be provided from the jet. Our microstructure measurements at eddy vicinity reveal significance of pronounced interleaving structures, particularly at depths of PSW intrusion, at which the warm temperatures are dissipated to the ambient waters through double diffusive convection. This means that significant amount of heat is transported upward, entering overlying mixed layer and eventually resulting in localized sea-ice melt.
(Kawaguchi, et al., 2012, Deep-Sea Res., 66, p.90–102.; Nishino, et al., 2011, GRL, 38, L16602)



(Left) eddy location and temperature at 50 m depth, and (right) vertical section of eddy temperature (shade) and salinity (contour). After Nishino et al. (2011) and Kawaguchi et al. (2012)

S1–O6

Dynamical Origin of the Arctic Oscillation

Hiroshi L. Tanaka

University of Tsukuba, Japan

In this study, a linear baroclinic model (LBM) is developed using the 3D spectral primitive equation model. With this LBM we investigated the linear stability problem for various 3D basic state on a sphere. For a zonal climate basic state, we confirm that the traditional Charney mode and dipole-Charney mode appear as the most dominant unstable modes in the synoptic to planetary scales. For a zonally varying basic state, we find that these unstable modes are modified by the regionality of the local baroclinicity of the basic state. Given the zonally varying barotropic basic state, we find that the barotropically most unstable standing mode appears to be the Arctic Oscillation (AO) mode. The LBM in this study is regarded as an generalized extension of the 3D normal mode at the motionless atmosphere to arbitrary climate basic state. It is concluded that the dynamical origin of the Arctic Oscillation is a baroclinically most unstable mode for the zonally varying basic state.