Arctic Climate Change Research Project

Rapid Change of the Arctic Climate System and its Global Influences

Summary of outcomes, 2011–2016

The key to Arctic climate change is Arctic warming amplification (AA). AA leads to the change of the heat budget and then to the realization of the Arctic sea routes. It also affects the global climate, such as atmospheric circulation, cryosphere, and the carbon cycle.

1 Mechanism of warming amplification in the Arctic

2 Arctic system for impact on society

3 Impacts on weather

4 Impacts on marine ecosystem

5 Summary

Earth!

Rapid Change of the Arctic Climate System and its Global Influences

What is happening now in the Arctic, under global warming?

- Arctic warming is occurring due to its sensitivity to atmospheric concentration of carbon dioxide. The carbon concentration in the Arctic is increasing twice as rapidly as the global average. We call this phenomenon “Arctic warming amplification” (AA). AA is a key to the Arctic climate change, and it will have impacts on weather including the speed of onset and sea level rise.
Quantification of relative contribution of Arctic warming amplification factors and their seasonality.

By plotting climate change projection relative contributions of various factors to Arctic warming amplification, we understand the mechanism of warming amplification over the Arctic. Figure 1 shows the relative contributions to Arctic warming amplification factors and their seasonality. There are two main factors contributing to Arctic warming: increased GHG concentrations and stratospheric wave-mean flow interaction. In winter, the higher temperature of the land and ocean surfaces with low reflectance is exposed. The higher temperature of the land surface is due to the atmospheric circulations, which increase the temperature of the ocean surface. If the stratospheric wave-mean flow interaction is increased, it will lead to an extreme event such as heavy snowfall in mid-latitude regions. As a result, the energy released into the atmosphere will be increased, and thus we confirm that the stratosphere plays a crucial role in the Arctic–mid-latitude climate linkage. By artificially suppressing the stratospheric wave–mean flow interaction, we can predict the timing of the Arctic warming amplification.

The Arctic Ocean has experienced significant warming, freshening, and changes in sea ice extent. Changes in Arctic sea ice are expected to have a significant impact on marine ecosystems. This study uses in situ measurements of sea ice thickness, ChL concentration, sea surface temperature, and sea surface salinity to derive the timing of the disappearance of sea ice. We have also constructed methods to predict the minimum ice cover and the resultant changes in Arctic environments. Our results show significant changes in Arctic ecosystems, including the distribution of sea ice, phytoplankton, zooplankton, and fish species. We also find that the Arctic warming amplification is considered to be a mechanism for the distribution of sea ice, phytoplankton, zooplankton, and fish species.

Climate change in the Arctic brings cold spells and snowstorms over Japan.

Changes and shifts in the Arctic marine ecosystem have been evident. The Arctic region will warm more rapidly than the global mean, and the resultant changes in Arctic ecosystems may have significant impacts on marine ecosystems. This study uses in situ measurements of sea ice thickness, ChL concentration, sea surface temperature, and sea surface salinity to derive the timing of the disappearance of sea ice. The Arctic warming amplification may lead to the distribution of sea ice and marine ecosystems. Changes in Arctic ecosystems may have significant impacts on marine ecosystems. This study uses in situ measurements of sea ice thickness, ChL concentration, sea surface temperature, and sea surface salinity to derive the timing of the disappearance of sea ice. The Arctic warming amplification may lead to the distribution of sea ice and marine ecosystems. Changes in Arctic ecosystems may have significant impacts on marine ecosystems. This study uses in situ measurements of sea ice thickness, ChL concentration, sea surface temperature, and sea surface salinity to derive the timing of the disappearance of sea ice. The Arctic warming amplification may lead to the distribution of sea ice and marine ecosystems.