令和３年度　環境科学院　修士論文内容の要旨

A mechanism of Eurasian winter temperature variability linked to Arctic change investigated using large ensemble experiments

(北極変動に関連したユーラシアの冬季気温変動のメカニズム −大規模アンサンブル実験を用いた調査−)

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Despite the ongoing global warming and sea ice loss over the Arctic region, severe winters occurred frequently over Eurasia in recent decades. The recent Eurasian winter temperature variability is explained by two major factors: the positive phase of Arctic oscillation which favors a continental warming pattern, and sea ice decline over the Barents-Kara Seas (BKS) which favors the Warm Arctic-Cold Eurasia (WACE) pattern. Historical global warming has caused side effects on climate in the Arctic region, which motivate scientists to study winter temperature over Eurasia. However, the formation mechanism of the WACE pattern is still in debate. In this study 100-member ensemble experiments, historical climate simulation and non-warming simulation, are analyzed to investigate the influences of historical global warming and natural variability on Eurasian winter temperature. It is revealed that the cooling trend in winter temperature over central Eurasia is more dominantly regulated by internal variability. Historical global warming has strengthened both the continental warming pattern and the WACE pattern after the 1990s.

To better understand the formation mechanism of the WACE pattern, the historical simulation is further analyzed with focus on atmospheric circulation and turbulent heat flux. It is revealed that interannual variations of the WACE pattern, obtained as the second mode of the principal component analysis for Eurasian winter surface air temperature, in historical climate simulation have correlation coefficients ranging from -0.02 to 0.57 against reanalysis-based WACE pattern. Out of 100 ensemble members, those having realistic interannual variation of the WACE pattern are selected to investigate a key factor for generating a realistic WACE pattern. It is found that the members with strong turbulent heat flux over the BKS in the preceding autumn tend to generate a strong Eurasian cooling in the following winter. Since the variance of turbulent heat flux among members is mostly regulated by internal atmospheric variability, the atmospheric condition in autumn, specifically the cold and dry air advection over BKS, is an essential factor for generating cold Eurasia and the WACE pattern. It is suggested that the monitoring of autumn turbulent heat flux over the BKS and internal atmospheric variability helps improve the seasonal prediction of cold winter over central Eurasia during the decades of rapid Arctic warming.