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Attribution of Recent Arctic Sea Ice Melting to Human Influence

Joonghyeok Heo and Seung-Ki Min

School of Environmental Science and Engineering, Pohang University of Science and Technology (POSTECH), Pohang, Republic of Korea (heo1129@postech.ac.kr)

During recent three decades Arctic sea ice extent (SIE) has been decreasing with its rate accelerating. There have been, however, limited studies which have identified human influence on the Arctic sea ice using a formal detection approach. This study conducts an updated detection analysis of recent Arctic SIE during 1979-2012 by comparing observed changes with those from CMIP5 (Coupled Model Intercomparison Project Phase 5) multi-model simulations. We use the NSIDC (National Snow and Ice Data Center) sea ice index as observations. The simulated Arctic SIEs are calculated from available ensembles of CMIP5 multi-models which have been performed under natural plus anthropogenic forcing (ALL: historical combined with RCP4.5, 112 runs from 40 models), natural forcing only (NAT: historicalNat, 48 runs from 10 models) and greenhouse gas forcing only (GHG: historicalGHG, 35 runs from 9 models). Anthropogenic forcing (ANT) responses are estimated from differences between ALL and NAT. We apply an optimal fingerprinting method where observations are regressed onto model-simulated signals (multi-model means of ALL, NAT, and GHG). Here the internal variability noise is estimated from historical simulations after removing multi-model averages. The observations display decreasing trends across all months with stronger amplitude in summer than other seasons, which is reasonably reproduced by CMIP5 simulations. Results from one-signal analyses show that the ALL, ANT, and GHG signals are all detected when considering four months (Mar, Jun, Sep, and Dec) together and also from September to January when looking at individual months. Results from two-signal analyses show that ANT is separable from NAT and also that GHG is separable from other non-GHG forcings. Scaling factors of the detected ANT and GHG signals include unity, indicating that observed Arctic sea ice melting during the satellite period is largely attributable to human-induced increases in GHGs.