

Arctic Ocean becomes ice free before 2050 in new, international climate simulations

Objective: To analyze the evolution of Arctic sea-ice state, variability, and sensitivity to imposed future forcing scenarios in CMIP6 simulations.

Approach:

- Use newly defined set of sea-ice variables from CMIP6 models to perform a process-based evaluation of sea ice evolution.
- Compare with observations and previous model intercomparison results.
- Estimate the time range in which the Arctic Ocean becomes largely sea-ice free.

Results:

- CMIP6 model simulations of sea-ice area capture the observational record in the ensemble spread.
- The sensitivity of Arctic sea ice to changes in the forcing is better captured by CMIP6 models than in CMIP3 or CMIP5.
- In most simulations, the Arctic Ocean becomes practically sea-ice free in September at future anthropogenic CO₂ emissions of less than 1000 Gt CO₂, before the year 2050.

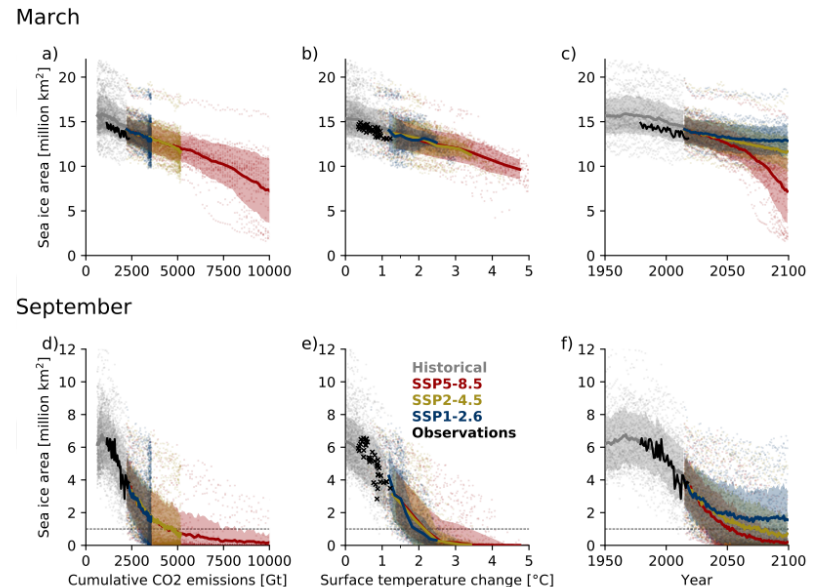


Figure: Evolution of Arctic sea-ice area over the historical period and following three scenario projections in (a-c) March and (d-f) September as a function of (a,d) cumulative anthropogenic CO₂ emissions, (b,e) global annual mean surface temperature anomaly and (c,f) time for all available CMIP6 models. Thick lines denote the multi-model ensemble mean, where all models are represented by their first ensemble member, and the shading around the lines indicates one standard deviation around the multi-model mean. .

Impact: The ability of climate models to plausibly simulate the observed changes in Arctic sea-ice coverage has become a central measure of model performance in climate model intercomparison projects. This study provides an initial overview of some large-scale metrics of model performance and a first analysis of future sea-ice evolution as indicated by CMIP6 simulations.