Atmospheric scientists offer climate change clues in new studies

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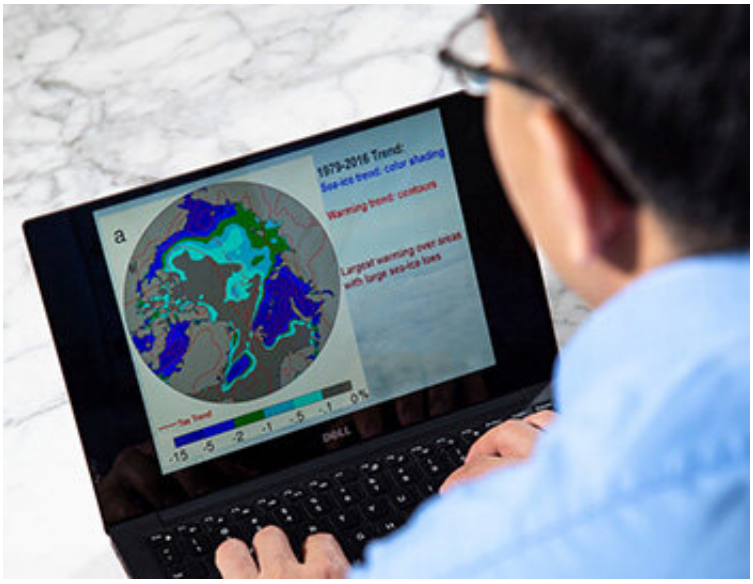

Dai's historical trends from 1976 to 2016 show the Arctic region's largest surface warming is over areas with significant sea ice loss. Credit: Patrick Dodson

Two new studies authored by atmospheric scientists at UAlbany and published in *Nature Communications* may offer us clues for future climate change projections.

Arctic Warming

Arctic temperatures are warming at a rate more than twice as fast as the overall planet and the trend is not letting up, according to NOAA's most

recent Arctic Report Card. Sea ice in the region is also now declining at an average rate of 12.8 percent per decade, relative to the 1981 to 2010 average.

Though most scientists agree that human-induced global warming is the culprit of the Arctic's transformation, the cause of its faster warming rates than the rest of the world – known as Arctic Amplification (AA) – is still under great debate.

UAlbany's Aiguo Dai turned to historical data and future climate model projections for answers. His analyses showed that AA would not diminish until the 22nd and 23rd centuries, after nearly all of the Arctic's sea ice has melted away due to increasing CO2 emissions over time.

"Rapid Arctic warming and sea ice loss are attracting a lot of attention in the media, public and scientific community. Our study links the two together and suggests that the sea ice loss is causing the rapid warming in the Arctic," said Dai, a professor in the Department of Atmospheric and Environmental Sciences (DAES).

"When the sea ice melts away completely, this elevated warming will also disappear and the warming rate in the Arctic will be similar to the rest of the world," he concluded.

According to the study, large AA occurs from about October to April—when the Arctic Ocean becomes a heat source to the atmosphere—and only in areas that experienced significant sea ice loss during these months. In addition, their new model simulations showed that AA would not exist if surface fluxes were calculated with a fixed sea ice cover, again suggesting that sea ice loss is necessary for AA to occur.

"The take-home message here is that the melting of Arctic sea ice will

not only reduce the habitat for polar bears and open new waterways for ships, but also greatly enhance warming in the region for the coming decades," Dai said. "This could also impact weather patterns in middle latitudes, causing more frequent intrusions of winter polar vortex into the continental U.S."

DAES Professor Aiguo Dai (left) and ASRC Senior Research Associate Fangqun Yu. Credit: Patrick Dodson

DAES Associate Professor Jiping Liu is a co-author on the study, along with researchers from the Chinese Academy of Sciences.

Aerosols and Climate

Greenhouse gases are known for their warming effect on the Earth's surface. Lesser known is that aerosol particles associated with both anthropogenic and biogenic emissions can disrupt our climate too. These microscopic pollutants cool the environment by modifying properties of clouds that reflect sunlight back to space.

Fangqun Yu, a senior research associate at the Atmospheric Sciences Research Center (ASRC), is an aerosols expert and uses advanced climate modeling to investigate their formation and evolution.

He recently collaborated with a group of leading climate scientists to determine how changes to climate and human modifications to natural environments or "land use" influence the formation of new aerosol particles from plant emissions through a process called organic nucleation.

When factoring in climate and land use in their simulations, the researchers calculated a 16 percent decrease in radiative forcing associated with aerosols, which is the difference between sunlight absorbed by the Earth and energy radiated back to space.

"The formation of organic aerosols in the atmosphere is a complex process that involves hundreds of organic compounds and reactions," said Yu. "The effects of atmospheric particles – both organic and inorganic – is the largest uncertainty in our understanding of climate change and projected levels of increasing global temperatures by the end of this century."

"Our study demonstrates that by accounting for the change in organic aerosol nucleation associated with climate change and land use, we can reduce uncertainty in future climate change projections."

Yu also reviewed a study last month in *Nature*'s News & Views that

challenges our understanding of the organic aerosol formation processes that impact air quality and climate.

More information: Jialei Zhu et al. Decrease in radiative forcing by organic aerosol nucleation, climate, and land use change, *Nature Communications* (2019). DOI: 10.1038/s41467-019-08407-7

Aiguo Dai et al. Arctic amplification is caused by sea-ice loss under increasing CO2, *Nature Communications* (2019). DOI: 10.1038/s41467-018-07954-9

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