Summer Extreme Cyclone Impacts on Arctic Sea Ice

An evaluation of extremes can inform decisions and planning in a world now bearing witness to—and ravaged by—the impacts of a changing climate and accompanying environmental, economic, and social instability. In the Arctic, these impacts are most clearly evident in sea ice loss, and in a thinner, weaker, more mobile and thus increasingly responsive ice cover to local atmospheric forcing and extreme events, including storms. The Sea Ice Prediction Network (SIPN) is dedicated to forecasting and predicting the rapid decline in the world’s northern insulator and ice blanket by exploring mechanisms that contribute to record minima in Arctic summertime sea ice extent in September. A recent study led by SIPN explores the impact of extreme cyclones on Arctic sea ice in summer.

Examined in particular are changes in sea ice thickness, and thus volume, in the vicinity of Arctic summer cyclones in 2012 and 2016. Changes can be in the form of melting (thermodynamic processes) or in sea ice motion, rafting, and ridging (dynamic processes). Whereas 2012 and 2016 both experienced and were characterized by extreme Arctic cyclones (low-pressure systems or storms) in summer, 2012 stands out as having attained a record minimum in sea ice extent in September that year. In our current research, these differences in sea ice response are attributed to timing and location of extreme storms in the Arctic relative to the sea ice edge.

Results from this investigation in particular illustrate that sea ice loss in the vicinity of the cyclone paths during each year has been associated with different dominant processes: thermodynamic processes in the Pacific sector of the Arctic in 2012, and both thermodynamic and dynamic processes in the Pacific sector of the Arctic in 2016. Comparison of both years further suggests that the Arctic minimum sea ice extent is influenced by not only the strength of the cyclone, but also by the timing and location relative to the sea ice edge. Located near the sea ice edge in early August in 2012, and over the central Arctic later in August in 2016, extreme cyclones contributed to comparable sea ice area loss both years, yet enhanced the loss of sea ice thickness (volume) near the sea ice edge in 2012 versus 2016.

Also developed in our evaluation was an index describing relative thermodynamic and dynamic contributions to sea ice volume changes. This index helps to quantify
Project Atmosphere is an online and in-residence teacher professional development course with a one-week residence experience offered by the American Meteorological Society’s Education Program in partnership with California University of Pennsylvania and the National Weather Service. This course is specifically designed for K-12 teachers who desire to include weather content in their curriculum.

PARTICIPANTS WILL HAVE THE OPPORTUNITY TO

• Learn to interpret and analyze weather information acquired through direct and remote sensing of the environment
• Gain an understanding of significant weather systems
• Help promote atmospheric education by peer training fellow teachers in their community
• Gain access to scientifically accurate and pedagogically robust instructional resource materials designed for teachers
• Earn three graduate credits from California University of Pennsylvania upon completion of program requirements

ELIGIBILITY

To be eligible for Project Atmosphere, teachers including earth science in their curriculum should:
• Have sufficient college-level training to benefit from the material
• Teach or supervise the instruction of weather or a similarly applicable course
• Demonstrate interest in teaching, curriculum development, and/or the training of fellow teachers
• Demonstrate willingness to promote the teaching of weather and climate in their home region through a minimum of one training session for colleagues upon completion of the summer course.

Expansion of this diagnostic to climate modeling, operational forecasting, and community-driven questions can also help inform decisions in emergency preparedness and planning.
Message diffusion and message persuasion are two important aspects of success for official risk messages about hazards. Message diffusion enables more people to receive lifesaving messages, and message persuasion motivates them to take protective actions. What factors influence message diffusion on Twitter, though? In the context of natural hazard events, previous studies have found that some factors, such as the number of followers of the sending account and the inclusion of the broad theme of hazard information, positively influence the retweet counts of official warning messages. However, little research attention has been paid to linking message diffusion with another critical aspect of message success: message persuasion. In other words, little is known about how factors of message persuasion influence message diffusion.

To help identify such win-win message strategies, we investigated the effects of four types of persuasive messaging content on message diffusion using a dataset of official
Project Ocean is an online and in-residence teacher professional development course with a one-week residence experience offered by the American Meteorological Society’s Education Program in partnership with California University of Pennsylvania and Washington College. This course is specifically designed for K-12 teachers who desire to include ocean content in their curriculum.

**Stipend and Expenses Paid Resident Week at Washington College, Chestertown, Maryland**

17 - 22 July 2022

**PARTICIPANTS WILL HAVE THE OPPORTUNITY TO:**

- Gain an understanding of the physical foundations of oceanographic topics and issues
- Help promote oceanographic education by peer training fellow teachers in their community
- Gain access to scientifically accurate and pedagogically sound instructional resource materials designed for teachers.
- Earn three graduate credits from California University of Pennsylvania upon completion of program requirements

**ELIGIBILITY**

To be eligible for Project Ocean, teachers including earth science in their curriculum should:

- Have enough background knowledge or practice/experience with content to benefit from the course
- Teach or supervise the instruction of an ocean related course or relevant subject area
- Demonstrate interest in teaching, curriculum development, and/or the training of fellow teachers
- Demonstrate willingness to promote the teaching of oceanography in their home region through a minimum of one training session for colleagues upon completion of the summer course.

Complete Application Online: www.ametsoc.org/ProjectOcean

tweets about heat hazards. Heat hazards are one of the deadliest weather-related hazards in the United States. Persuasive message content refers to message content that is theoretically effective in persuading people to take protective actions during natural hazards. The four types of persuasive message content were hazard intensity (e.g., the value of the temperature), health risk susceptibility (i.e., who or which behavior is at risk), health impact (e.g., heat-related illnesses), and response instruction (i.e., heat-safety tips). The dataset contains 904 heat-related tweets posted by 18 sampled U.S. National Weather Service accounts in the summer of 2016. Message diffusion was measured as retweet counts. Using multilevel negative binomial regression models, the respective and cumulative effects of the persuasive message content were analyzed for not only heat-related tweets but also two subsets of heat-related tweets. The two subsets were tweets about extreme and nonextreme heat events.

We found that heat-related tweets that stated more types of persuasive message content predicted more retweet counts; so did two subsets of heat-related tweets. For heat-related tweets, the inclusion of hazard intensity and the inclusion of health impact were respectively associated with higher retweet counts. For the subset of tweets that alerted extreme heat conditions, mentioning hazard intensity and mentioning response instruction positively influenced retweet counts, respectively. For the subset of tweets about nonextreme heat events, tweets stating hazard intensity, tweets stating health risk susceptibility, and tweets stating health impact were retweeted more frequently.

In the context of heat hazards, we inform practitioners with evidence-based message content to enable more people to receive lifesaving messages on Twitter. Such message content also has the potential to motivate people to take protective actions before and during heat events. Future research should examine how persuasive message content influences message diffusion for other types of natural hazards (such as flooding and winter storms) and for other channels (such as Facebook). —YAJIE LI (UTAH STATE UNIVERSITY), A. L. HUGHES, AND P. D. HOWE, “Toward win–win message strategies: The effects of persuasive message content on retweet counts during natural hazard events,” in the July issue of *Weather, Climate, and Society.*
Artificial Intelligence for the Earth Systems publishes research on the development and application of methods in Artificial Intelligence, Machine Learning, data science, and statistics that is relevant to meteorology, atmospheric science, hydrology, climate science, and ocean sciences.

Editorial Board

Amy McGovern, University of Oklahoma
(Chief Editor)
John T. Allen, Central Michigan University
William F. Campbell, U.S. Naval Research Laboratory
Scott M. Collis, Argonne National Laboratory
David John Gagne II, NCAR
Ruoying He, North Carolina State University
Michael Scheuerer, Norwegian Computing Center, NR
Haruko Murakami Wainwright, Lawrence Berkeley National Laboratory

Artificial Intelligence for the Earth Systems is a fully open access journal.

American Meteorological Society

Artificial Intelligence for the Earth Systems (AIES) ISSN: 2769-7525
It’s the Tops for These Storms

CAUSE:
The intense updraft of a supercell thunderstorm pushes the tropopause upward into the stratosphere, creating an overshooting top.

…Winds flowing over and around the top can sometimes initiate streams of water vapor and ice several kilometers above the storm into the stratosphere, creating an Above-Anvil Cirrus Plume (AACP).

…AACPs spread downwind, while air flows over the stratospheric dome and speeds down its sheltered side.

…A downslope windstorm, similar to a topographic windstorm, is energized at the tropopause in the lee of the top, with winds becoming extremely strong.

“Dry air descending from the stratosphere and moist air rising from the troposphere join in this very narrow, crazy-fast jet,” says Morgan O’Neill of Stanford University.

…In a process known as a hydraulic jump, the extremely fast jet becomes unstable “and the whole thing mixes and explodes in turbulence,” O’Neill explains.

EFFECT:
Such supercell storms have a “high correspondence with the most” dangerous tornadoes, high winds, and hail.

O’Neill and colleagues utilized computer simulations of supercell thunderstorms fed by idealized wind profiles aloft to reveal previously unknown details of AACPs. They found that a supercell extending into the stratosphere acts as a physical barrier that deflects windstreams and drives the hydraulic jump downstream at the tropopause. This prompts an injection of water vapor deep into the stratosphere at a rate that can exceed 7 tons per second. The extreme downslope winds at the tropopause can reach speeds of more than 240 miles per hour, and O’Neill notes that “[t]hese speeds at the storm top have never been observed or hypothesized before.” The study, which was published in Science, not only provides valuable insight into the dynamics of AACPs, but could also help in forecasting severe weather, which is currently hampered by the limitations of Doppler radar (e.g., a vulnerability to severe weather and a lack of worldwide coverage). “If there’s going to be a terrible hurricane, we can see it from space,” O’Neill says. “We can’t see tornadoes because they’re hidden below thunderstorm tops. We need to understand the tops better.” [SOURCE: Stanford University]
The Harsh Toll of Pollution in India

YEARS OF LIFE EXPECTANCY that residents of India’s capital, Delhi, could add to their lives if pollution there was reduced to meet World Health Organization (WHO) air quality standards, according to a new report by the Energy Policy Institute at the University of Chicago. While the report takes a global scope, it notes that India “is the most polluted country in the world”: in 2019, the country’s average particulate matter concentration of 70.3 micrograms per cubic meter was not only the highest worldwide, but was 7 times the WHO’s guideline. Additionally, all of India’s 1.3 billion residents live in areas that exceed that guideline, close to 40% are exposed to levels higher than in any other country on Earth, and 21 of the world’s 30 most air-polluted cities are in India. The report noted that along with India, three bordering countries—Bangladesh, Nepal, and Pakistan—are consistently among the five most polluted countries on Earth; collectively, those four countries account for about one-quarter of the world’s population. The report also states that clean air initiatives started by the Indian government in 2019 could improve the life expectancy of some Indians by as much as 3.1 years if its standards are met, although pollution has only gotten worse since they took effect. The report cites a surge in energy demands and fossil fuel use driven by industrialization, economic development, and population growth as key contributors to increasing air pollution in South Asia, and also highlights how climate change contributes to worsening air quality worldwide. The full report can be found at https://aqli.epic.uchicago.edu/wp-content/uploads/2021/08/AQLI_2021-Report.EnglishGlobal.pdf.
A group of scientists led by Cynthia Twohy of NorthWest Research Associates and Scripps Institution of Oceanography

The summer of 2018, while wildfires burned across the western United States

To study the impacts of wildfires on small, midaltitude altocumulus clouds

Over the western United States inside a C-130 Hercules plane, which was equipped to measure gases and particles given off by the fires and sample cloud droplets

Wildfire smoke carries tiny particles up into clouds, where water droplets condense on the particles. The researchers discovered that when compared with clean clouds, the number of water droplets that formed in the smoky clouds was larger than they expected: the dirty clouds had about five times as many droplets as the untainted clouds. Additionally, the smoky water droplets were about half the size of their clean counterparts, and this small size means that smoky clouds will reflect more light and generate less rain than the clean clouds, since larger droplets are more likely to grow and fall as rain. “We were surprised at how effective these primarily organic particles were at forming cloud droplets and what large impacts they had on the microphysics of the clouds,” Twohy says. “I started thinking, ‘What are the long-term effects of this? We have drought, and we have a lot of wildfires, and they’re increasing over time. How do clouds play into this picture?’” The ultimate outcome could be a feedback loop in which smoke from increasingly intense wildfires stifles rainfall and makes dry conditions even drier, leading to more fires. The study was published in Geophysical Research Letters. [Source: American Geophysical Union]
Peak Rain—Unprecedented

“That’s not a healthy sign for an ice sheet.”

— Indrani Das of the Lamont-Doherty Earth Observatory, after it rained on Greenland’s summit for the first time on record, according to the National Snow and Ice Data Center (NSIDC). It’s another worrisome signal of climate change impacting the world’s second largest extent of glacial ice. The August 14 rain fell for several hours at an elevation of 10,551 feet and was part of a 3-day event on Greenland during which 7 billion tons of rain fell—which the NSIDC said was an all-time high for the island since record-keeping began in 1950. All that rain caused a loss of ice seven times greater than the daily average for that time of year and is more evidence of a larger trend of warming temperatures intensifying melting in the region; in 2019, a record 532 billion tons of ice or so melted off Greenland into the sea. “What is going on is not simply a warm decade or two in a wandering climate pattern,” says the NSIDC’s Ted Scambos. “This is unprecedented.” [Sources: Reuters, CNN]
Got Milk? These Seas Do…

Ocean travelers have long told tales of “milky seas”—brightly glowing whitish patches of water that can only be seen at night. This bioluminescence can cover almost 40,000 square miles and linger for days or even weeks, and mostly occurs in the northwest Indian Ocean off the Horn of Africa and around Indonesia. Depictions have appeared in novels like *Moby-Dick* and *Twenty Thousand Leagues Under the Sea*, but scientific research on the phenomenon—including predicting their occurrence and understanding their cause—has been limited, partly because of the rarity of these events (there were 235 recorded sightings by mariners between 1915 and 1993). This should change with the help of a new satellite-borne instrument known as the Day/Night Band, which can detect faint amounts of nighttime visible light. In research published recently in *Scientific Reports*, Steve Miller of Colorado State University and colleagues utilized observations from the Day/Night Band to identify 12 occurrences of milky seas in 3 locations between 2012 and 2021.

“The Day/Night Band continues to amaze me with its ability to reveal light features of the night,” Miller says. “Like Captain Ahab of *Moby-Dick*, the pursuit of these bioluminescent milky seas has been my personal ‘white whale’ of sorts for many years.”

[Source: Colorado State University; Image Credit: Miller et al. (2021)]
When it comes to making plans, you’re the best. Make a plan to protect you and your loved ones from a natural disaster.

- Sign up for local weather and emergency alerts.
- Prepare an emergency kit.
- Make a family communications plan.

Get started at ready.gov/plan.
The Journal of Climate (JCLI) publishes research that advances basic understanding of the dynamics and physics of the climate system on large spatial scales, including variability of the atmosphere, oceans, land surface, and cryosphere; past, present, and projected future changes in the climate system; and climate simulation and prediction.

Open Access option for authors. All papers publicly accessible 12 months after publication.

2019 Impact Factor: 5.707 (2019 Journal Impact Factors by Clarivate Analytics: Meteorology and Atmospheric Science category)

Editorial Board

Timothy DelSole, George Mason University and Center for Ocean-Land-Atmosphere Studies (Co-Chief Editor)
Mingfang Ting, Lamont-Doherty Earth Observatory (Co-Chief Editor)
Matthew Collins, University of Exeter
Yi Deng, Georgia Institute of Technology
Dietmar Dommenget, Monash University
Jason Evans, University of New South Wales
Michael Neil Evans, University of Maryland, College Park
Isaac Held, Princeton University
Andy Hoell, NOAA/Physical Sciences Laboratory
Xianglei Huang, University of Michigan
Charles Koven, Lawrence Berkeley National Laboratory
Tim Li, University of Hawaii at Manoa
Wenhong Li, Duke University
Xin-Zhong Liang, Earth System Science Interdisciplinary Center, University of Maryland

Benjamin R. Lintner, Rutgers, The State University of New Jersey
Shawn Marshall, University of California, San Diego
Seung-Ki Min, Pohang University of Science and Technology
Hisashi Nakamura, The University of Tokyo
Joel Norris, University of California, San Diego
Yuko Okumura, The University of Texas at Austin
Oleg A. Saenko, Canadian Centre for Climate Modelling and Analysis
Agus Santoso, University of New South Wales
James Screen, University of Exeter
Isla Simpson, University Corporation for Atmospheric Research
Darryn Waugh, The Johns Hopkins University
Baoqiang Xiang, Geophysical Fluid Dynamics Laboratory
Laure Zanna, New York University
Rong Zhang, Geophysical Fluid Dynamics Laboratory

Journal of Climate (JCLI)
ISSN: 0894-8755; eISSN: 1520-0442