Profile of Claire L. Parkinson

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When people think of research at the National Aeronautics and Space Administration (NASA), sea ice may not be the first thing that comes to mind. Yet Claire Parkinson, a climate scientist at NASA's Goddard Space Flight Center in Maryland, has spent 4 decades studying sea ice. Parkinson's use of satellite data has revealed clear and sometimes unexpected long-term changes in Arctic and Antarctic sea-ice coverage. Meanwhile, as project scientist for NASA's Aqua satellite, she oversees the collection of data used by scientists around the world. Parkinson has received numerous honors for her accomplishments, including election to the US National Academy of Engineering in 2009 and the National Academy of Sciences in 2016.

Complicated Route to the Antarctic

Parkinson spent the first 12 years of her life on Long Island, New York, after which her family moved to central Vermont. She recalls not knowing any scientists while growing up, particularly when she lived in Vermont, where there was no university nearby. Parkinson's early love of mathematics started her on the path to a scientific career. She admired how math could "turn something that sounds like a really complicated problem into something so simple, simply by putting it in an appropriate symbolism." Her teacher in the fifth and sixth grades encouraged her math studies.

Building on this early interest, Parkinson majored in math at Wellesley College in Massachusetts. At the same time, political events in the wider world, such as the Civil Rights movement and the Vietnam War, instilled in her a desire to do something of value to society. Shortly before graduating college, she participated in an act of organized civil disobedience, for which she spent 20 days in jail and missed her college graduation. By the time she graduated in 1970, Parkinson had decided not to pursue a career in theoretical mathematics. "Even though I loved it," Parkinson explains, "I felt like it would leave me too divorced from the real world." She tried to find a job instead. Parkinson worked part-time for the Burlington, Vermont probation department, tutoring delinquent teenage boys. Her attempts to find full-time employment met with little success.

Claire Parkinson speaking at the Maryland Women's Heritage Center. Image courtesy of Steve Graham (photographer).

The search for a long-term career became all the more imperative when funding for Parkinson's part-time job ran out in the second year. She had begun to develop an interest in Antarctica, inspired by the 1959 Antarctic Treaty, which preserves Antarctica for scientific research and bans military activity on the continent. "The fact that the Antarctic Treaty preserves an entire continent for peaceful purposes—that was just incredibly appealing," says Parkinson, who resolved to go to Antarctica to do research. This desire led her to the Institute for Polar Studies at The Ohio State University, which accepted her as a graduate student. There, Parkinson participated in an expedition to Deception Island, off the coast of the Antarctic Peninsula, led by Ohio State glaciologist Terry Hughes, who fought to retain her on the expedition after the funding agency originally rejected her because she passed out during the physical. The expedition studied the dynamics of ice flow into a crater produced by a recent volcanic eruption.

Modeling Sea Ice

One day at The Ohio State University, Parkinson attended a talk by Warren Washington, an atmospheric scientist

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Claire Parkinson near Thule Air Base, Greenland, in March 2018. Image courtesy of Jeremy Harbeck/NASA.

from the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. Washington spoke about computer modeling of Earth's atmosphere, an emerging field of research at the time. Parkinson was fascinated and thought that computer modeling could be a way to incorporate her interest in math into her graduate research. After the talk, Parkinson approached Washington, who asked, "Well, how would you like to model sea ice?" Parkinson recalls.

Washington arranged for Parkinson to spend a summer working at NCAR. Afterward, Parkinson, Washington, and her adviser decided that computer modeling of sea ice would be a suitable topic for her doctoral dissertation. After completing her graduate coursework, Parkinson spent 2 years at NCAR developing a model of polar sea ice. The model, which was published in 1979 (1), incorporated both thermodynamic processes—the energy fluxes into the ice from the air and the ocean—and dynamic processes: Wind, ocean currents, and other forces acting on the ice. By calculating at 8-hour time-steps throughout the year, the model could simulate the annual cycle of sea ice in both hemispheres. Parkinson recalls that the model initially reproduced Arctic sea ice fairly well, but wildly overestimated the amount of Antarctic ice. A chance conversation with Arnold Gordon, a visiting oceanographer from the Lamont–Doherty Earth Observatory at Columbia University, gave her the idea to use a larger value for the ocean heat flux in the Antarctic. "I did that one change in the model, just for the Antarctic portion," says Parkinson, "and the ice cover, remarkably, came out looking reasonably close to the observations." Once the model was completed, Parkinson and NCAR climatologist Will Kellogg used it to simulate Arctic sea-ice conditions in the event of a doubling of atmospheric CO_2, obtaining ice-free conditions in August and September, in what was one of the first studies to examine the impact of increased CO_2 on a geophysical variable beyond temperature (2). Parkinson would later use her model to explore the formation of the Weddell Polynya, a region of open water surrounded by sea ice in the Weddell Sea off Antarctica (3).

Satellites and Sea Ice

Parkinson received her Master's degree in 1974 and doctorate in 1977, both from The Ohio State University, in geography and climatology. Shortly before completing her doctorate, Parkinson gave a talk at a conference attended by Jay Zwally, a physical scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Zwally was impressed, because he approached Parkinson after the talk and asked her if she had a job lined up. Having grown up during the space race, NASA's work had left a deep impression on Parkinson. She was inspired not just by the technological achievement of landing people on the moon and returning them safely but also by the values underlying those achievements, as expressed on the commemorative plaque that the Apollo 11 astronauts left behind on the moon: "We came in peace for all mankind." So when Zwally asked if Parkinson wanted to work at NASA, she jumped at the opportunity. Parkinson says, "NASA, in my mind, was just so beyond any of my dreams of where I could work. It was immediately my top choice."

Parkinson began working at NASA's Goddard Space Flight Center in 1978. At NASA, Parkinson monitors sea ice using passive microwave satellite data, in which a satellite-based instrument detects microwaves emitted from Earth. "Everything is always emitting," Parkinson explains. "You are, I am, a table is, ice, water, everything's emitting some radiation." Ice and liquid water emit distinct microwave signatures, allowing observers to tell from the passive microwave satellite data where the sea ice ends and the open water begins. Compared with visible light, microwaves have the advantage of being detectable during the day or at night, and whether or not there are clouds in the sky. This is especially important when studying the polar regions, which lack sunlight for months at a time. Parkinson initially worked with data from the Nimbus 5 satellite, which launched in late 1972 and collected data for most of the next 4 years. The microwave instrument on Nimbus 5 was a proof-of-concept instrument, intended to give an indication of what the microwave data could show. The results were promising, particularly for sea ice, despite the fact that the instrument had only one channel. In October 1978, months after Parkinson arrived at Goddard, NASA launched the Nimbus 7 satellite, which carried a more sophisticated microwave radiometer than that on Nimbus 5, with multiple recording channels. In 1987 the Nimbus 7 instrument was superseded by a series of further enhanced instruments

flown aboard satellites from the Air Force's Defense Meteorological Satellite Program. Parkinson and colleagues standardized the data across the instruments, producing a continuous, 40-years record of sea ice that is still being extended today.

The satellite sea-ice record has provided valuable insights into Earth's climate. Analysis of the Nimbus 7 data in the late 1980s indicated a slight decrease in Arctic sea-ice cover (4). This was at a time when concerns about global warming from excess CO_2 were increasing. Although the large interannual variability in the data prevented any definitive conclusions about long-term trends, the results underscored the need to continue collecting data, to see if the trend became significant. By 1996, enough data had been collected to show that the Arctic sea ice was decreasing, by more than 30,000 square kilometers per year on average, consistent with expected decreases under global warming (5).

Parkinson's Inaugural Article (6) examines 40 years' worth of Antarctic sea-ice observations, from 1979 to 2018. Unlike in the Arctic, sea ice in the Antarctic increased throughout most of the period covered by the satellite record, for reasons that are still being debated (7). That changed abruptly after 2014, when the Antarctic sea-ice cover began a dramatic decline. Between 2014 and 2017, the Antarctic lost more ice than did the Arctic in 30 years. What caused the abrupt reversal is unknown. Parkinson notes that it is too early to tell if the decline is temporary or the start of a new long-term trend. Nevertheless, it should stimulate further research into the drivers of Antarctic sea ice decline.

Project Scientist and Author

Since 1993 Parkinson has also been the project scientist for NASA's Aqua satellite. Aqua launched in 2002 and carries instruments for collecting data about Earth's climate, particularly the water cycle. These include measures of sea-ice and land-ice cover, atmospheric ozone and CO_2, clouds, vegetation cover, and sea-surface temperatures. Parkinson acted as a liaison between the scientists planning the mission and the engineers in charge of building the satellite and its Earth-observing instruments. Since Aqua's launch in 2002, Parkinson has served as an intermediary between scientists using the satellite data and mission operations personnel at Goddard. "The Aqua satellite data are being used by many hundreds, probably thousands, of scientists and others around the world," says Parkinson. "And so it gives me this huge opportunity to be doing something that is of value to other people."

Parkinson has also written several books for general audiences. She says, "I like being able to develop the subject matter in much greater detail than what you're able to do in a journal article, where there's a severe page limit." In one of her books, published in 2010, Parkinson reviews the history of Earth's climate and the impact of human activities on the current climate (8). She also cautions against some of the large-scale geoengineering projects proposed to combat climate change, such as putting aerosols into the atmosphere to reflect sunlight, which might have unintended consequences. Parkinson has also written or contributed to books about satellite Earth observations and what they reveal about our planet (9, 10), and was the lead editor of a book profiling more than 100 women who work at Goddard in various capacities (11).

Parkinson notes how much the study of sea ice has changed in the 4 decades she has been working on it. The upgrades to the instrumentation have improved data quality, while increasing computing power speeds data processing. Additionally, sea ice receives a lot more attention today than it did when Parkinson started her research. "When I started at NASA," says Parkinson, "somebody asked me, what am I working on? I said, 'I'm working on sea ice.' And the response was, 'what's that an acronym for?'" Since then, however, interest in sea ice has grown dramatically, driven in part by concerns over global climate warming. As for herself, Parkinson feels she may be ready to move on. "This 40-year record is something that I'm really pleased to have been a part of. But I'd be ready to move on to something entirely different if something comes up."

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