PROFILE

Profile of Eric Rignot

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Sometimes taking a step back helps to see things more clearly. Eric Rignot, a glaciologist at the University of California, Irvine, has found that when studying the behavior of glaciers and ice sheets, it helps to take a giant step back, all of the way into space. His use of satellite radar imaging has provided extraordinarily detailed information about how fast the ice sheets are melting and how much they contribute to sea-level rise. Rignot's findings have shown the impact of climate change on the ice sheets and how little time there may be to stop it. His work has earned him numerous honors, including fellowship in the American Geophysical Union in 2013 and membership in the National Academy of Sciences in 2018.

Finding His Calling

Eric Rignot grew up in what he describes as a rugged part of the French countryside, near the city of St. Etienne. Rignot partly attributes his interest in polar environments to the rough winter weather he experienced growing up. As a child, he enjoyed reading novels about polar adventures. He also recalls reading about Nobel Prize winners in an encyclopedia as a kid, which exposed him to the explosion of scientific knowledge that emerged in the early 20th century. This kindled a lifelong fascination with science and the natural world.

As a student, Rignot pursued studies in mathematics, in part because in the French educational system, math promised to open up the most doors. "If you're good in math," he explains, "you can basically do whatever you want." Nevertheless, Rignot was not introduced to physics until high school and for a long time wanted to become a veterinarian. At age 17, Rignot met an engineer who encouraged him to go to engineering school. "He seemed so sure, expressing no doubt that I could be successful, that I thought, 'well, maybe I should try that,'" Rignot recalls.

Rignot studied engineering at the École Centrale Paris, where he took classes in physics, chemistry, math, and economics. At the time, Rignot says, he was skeptical about the multidisciplinary curriculum. He thought, "I'm going to come out of this engineering school not having any specific skills." Later, he came

Eric Rignot. Image credit: Ian Fenty (NASA/JPL-Caltech, Pasadena, CA).

to realize the value of having an education with a broad foundation, because it gave him the flexibility to branch out into new fields.

At the École Centrale, Rignot found a scientific mentor in Sébastien Candel, currently the president of the French Academy of Sciences, who encouraged Rignot to pursue research. After graduating from the École Centrale in 1985, Rignot was faced with a conundrum. He was interested in aeronautics, but not in working for the defense industry, where most of the jobs in aeronautics were. Instead, Rignot studied astronomy and astrophysics at Paris-Sorbonne University, obtaining a Master's degree in 1986. However, Candel persuaded him not to pursue a career in astronomy. "He told me, 'Eric, you're going to compete with the top, brightest minds in the country [for] maybe one or two spots every year,'" recalls Rignot, who did not consider his odds of success to be good.

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This is a Profile of a member of the National Academy of Sciences to accompany the member's Inaugural Article on page 1095 in issue 4 of volume 116. Published online February 11, 2019.

Rignot turned to another of his interests: remote sensing, then an emerging field. Although the Landsat program had been acquiring satellite imagery of Earth for more than a decade, many significant developments were still in the future. Remote sensing would take advantage of Rignot's background in aeronautics and fluid mechanics.

To help prepare for remote sensing research, Rignot came to the University of Southern California, where he obtained additional Master's degrees in aeronautical and electrical engineering. Rignot particularly enjoyed the freedom that his mentor, Frederick Browand, offered for him to solve problems in his own way and at his own pace. Rignot believes that some of the most influential people throughout his career were the ones who gave him this kind of freedom.

Through Candel, Rignot was introduced to Charles Elachi, then an assistant director at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. Rignot got a job at JPL as a radar engineer in 1988. He quickly realized that what he really wanted was to be in charge of his own research program—to "be his own boss"—and that to do so, he would need to get a doctorate. Fortunately for Rignot, JPL had a program that would fund his doctoral education, and for two and a half years he continued to work at JPL while pursuing his doctorate in electrical engineering at the University of Southern California, which he received in 1991. An article Rignot published in 1993 with Jakob van Zyl based on his doctoral research on detecting changes in radar images remains among his most highly cited papers (1).

Observing Glaciers from Space

At JPL, Rignot worked on a remote sensing technique known as synthetic-aperture radar, in which a radar antenna is mounted on a moving platform, such as a satellite. The continuous motion of the radar antenna increases the effective size of the antenna, thereby increasing the resolution of the image relative to a stationary antenna. A major advantage of radar for remote sensing is the ability to see through clouds. As Rignot puts it, "every day is a sunny day." At the same time, NASA happened to be developing a program to study glaciers and sea ice in the polar regions, and Rignot used synthetic-aperture radar to study changes in the polar ice. At the time, there was little observational data available. "It was clear that nobody knew for sure what the Greenland Ice Sheet was doing in response to climate warming," he explains. As a result, Rignot felt that it was an area where relatively little investment in effort could yield large returns. "I think that's something that's stuck for me throughout my career," says Rignot, "to identify the areas that seem important but where our knowledge was especially poor and we needed to explore." In the beginning, it was not exactly clear how remote sensing would be useful in studying polar ice. "Pretty soon I realized I'd stepped on a gold mine of information about polar regions from remote sensing techniques that were changing completely the way we were looking at

them," says Rignot. "I was fortunate to be there at that time, have the right push from the right people, such as future assistant JPL director Jakob van Zyl, to go into that direction."

In the early 1990s, the technique of radar interferometry emerged at JPL, led by pioneers, such as radar astronomer Richard Goldstein. In this technique a single location is imaged at different times, and the phase of the reflected radar pulses is recorded. Changes in the height or angle of the ice surface show up as changes in the phases. The technique is sensitive enough to measure millimeter-sized deformations of the ice and provides measurements of the ice velocity, thickness, and rate of discharge into the ocean.

In 1998, Rignot published an analysis of satellite radar interferometry data from the Pine Island Glacier in West Antarctica (2). As early as the 1970s, researchers had suggested that this region of Antarctica might be vulnerable to climate change. However, Pine Island Glacier is remote even by Antarctic standards; it is one of the farthest points from any manned station, so observational data on the glacier were minimal.

Rignot measured the location of the grounding line—the boundary between ice resting on solid ground and ice floating on water—to within 100 meters, compared with the many tens of kilometers-scale accuracy with which it had been previously known. He further found that between 1992 and 1996, the grounding line retreated by more than a kilometer per year, suggesting that the ice was thinning much more rapidly than thought. At the time, conventional wisdom held that ice sheets and glaciers changed on a timescale of centuries, but Rignot's results revealed that large changes could occur on time scales of decades to years. In honor of Rignot's contributions to glacier dynamics, a glacier in Antarctica near Pine Island Glacier was named the Rignot Glacier in 2003.

From NASA Engineer to University Professor

Rignot remained at JPL until 2007, when he moved to the University of California, Irvine. Although he had been successful at JPL, Rignot felt isolated intellectually, working mostly by himself. Moreover, it was difficult to form a research group with competitive funding, and many regulations restricted his scientific freedom. In contrast, the University of California, Irvine offered him a guaranteed salary, academic freedom, and the opportunity to form his own research group. "Coming to [University of California, Irvine] made me reach a completely different level," says Rignot. "It broadened my view of Earth science in general, on the connectivity between what I was working [on] and the bigger picture of the Earth as a system."

Rignot continues to work for JPL as a consultant. He was a contributing author to the Fourth Assessment Report (AR-4) of the United Nations Intergovernmental Panel on Climate Change (IPCC). "I was very excited about AR-4," he says. "AR-4 was a turning point in the IPCC story, where the report came out very strongly as saying the signal from anthropogenic emissions in the climate system was unequivocal."