

Ice Core Reveals How Quickly Climate Can Change

Weather patterns can permanently shift in as little as a year, according to the records preserved in an ice core from Greenland

By David Biello

Roughly 14,700 years ago the weather patterns that bring snow to Greenland shifted from one year to the next—a pattern of abrupt change that was repeated 12,900 years ago and 11,700 years ago when the earth's climate became the one enjoyed today—according to records preserved in an ice core taken from the northern island. These speedy changes—transitions from warming to cooling and back again—in the absence of changes in greenhouse gas could presage abrupt, catastrophic climate change in our future.

"What made these abrupt climate changes were circulation changes, and these changes took place from one year to the next more or less," says glaciologist Sune Olander Rasmussen of the Centre for Ice and Climate at the University of Copenhagen, who was part of a team that analyzed annual data from ice tubes extracted from as deep as 10,000 feet (3,085 meters) beneath the ice sheet, which were collected by the North Greenland Ice Core Project, a drilling expedition.

The researchers looked at three variables in the core: the amount of dust, the kind of hydrogen and the kind of oxygen in the ice. The amount of dust from year to year reveals that less of the grit traveled all the way to Greenland from the deserts of Asia (where the dust that settles over Greenland originates) around the time these transitions began, the team reports in *Science*.

"If things are starting to change in the dust first then we are looking for a [climate change] trigger somewhere outside of Greenland," Rasmussen says. "That could be monsoon changes," since different rainfall patterns in Asia would affect dust levels in the atmosphere.

Roughly five years after this change in dust levels, the levels of heavy hydrogen ensconced in the ice indicate that weather patterns were shifting and driving precipitation over Greenland that had originated in evaporated water from a different area of the ocean than had previously been the source of the island's rain. And this change happened in as little as a year. "During the glacial period, abrupt warmings show change of the atmospheric circulation from year to year," says glaciologist Dorte Dahl-Jensen, also of the University of Copenhagen, who participated in the study as well.

Following this abrupt shift, as much as 20 degrees Fahrenheit (10 degrees Celsius) of warming occurred over the subsequent decades—a change that ultimately resulted in at least 33 feet (10 meters) of sea-level rise as the ice melted on Greenland.

Greenland can change quickly, even living up to its name, according to another paper in this week's *Science*. Sediment cores from the ocean show that forests of spruce and even fern grew on Greenland just 125,000 years ago. That means Greenland's ice sheet—potentially responsible for as much as 75 feet (23 meters) of sea-level rise if it all melts—has grown and shrunk far more frequently than previously known.

"The question that arises from such findings is: How come the Greenland ice sheet at such a low latitude has remained so stable during the present interglacial [period] until now?" says study co-author and geochemist Claude Hillaire-Marcel of the University of Quebec in Montreal. "In view of the past instability—and sensitivity to temperature—of Greenland ice, serious concerns about its future under global warming stress do emerge."

Understanding that threat may require traveling even farther back in time via ice, to the transition to the last such warm period 130,000 years ago—the Eemian—when it was nine degrees F (five degrees C) warmer across Greenland. An ice core, known as NEEM (for North Greenland Eemian Ice Drilling), that could address that question is being extracted now as part of the ongoing International Polar Year. "The circulation changes in a few years. The temperature change is happening over decades," Rasmussen notes. "The more we force a system, the more likely it is that we will get some kind of response that is violent."