

Clue to sudden climate change found in Arctic: study

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Climate could change extremely rapidly with very dramatic effects

The sudden deep freeze of the northern hemisphere that occurred 13,000 years ago has been traced to events originating in northern Canada, according to University of Toronto research. The findings could shed light on the future of climate change due to greenhouse gases.

The study, published in the June 2 issue of *Nature*, pinpoints the exact location where freshwater generated by the melting of the massive Canada-wide Laurentide ice sheet entered the global ocean and caused the Younger Dryas cold reversal, a frigid period where the planet temporarily plunged into ice age conditions. Contrary to previous thinking, the study shows that this meltwater entered the Arctic Ocean rather than the Atlantic and the point of entry was through the MacKenzie River. As the freshwater - lighter due to its lack of salt content - flowed into the ocean it was transported across the pole into the North Atlantic where it shut down the process whereby heavy surface water sinks into the abyss and leads to a warming of the northern hemisphere.

While the Younger Dryas cold reversal occurred just as the Earth was emerging from the most recent ice age, a rapid meltback of the Greenland ice sheet - another large accumulation of land ice adjacent to the North Atlantic Ocean - could theoretically contribute to another such shutdown.

"Greenland contains enough ice to raise sea level by about seven metres if it were all to melt," says the study's co-author University Professor Richard Peltier of U of T's Department of Physics. "If it were to melt very quickly we could easily have a similar event, so the question is just how Greenland will react to the ongoing warming due to the increasing concentration of atmospheric greenhouses gases. How probable this is remains an open question."

To pinpoint the location of where the Younger Dryas event occurred, Peltier and his co-author, physics research associate Lev Tarasov, used the University of Toronto Glacial Systems Model (GSM) - a model that produces a three-dimensional view of the evolving ice-sheet as it expands and contracts over the North American continent in response to climate variations. The model also analyses how the shape of the Earth is affected by the evolution of the heavy ice loads. As the continental ice melted, a huge amount of deglaciation derived freshwater was added to the oceans. At the time of Younger Dryas onset the routing of this meltwater was into the Arctic Ocean.

"In considering the issue of climate change, many people imagine that this could only happen very gradually," says Peltier. "This event shows that our climate could change extremely rapidly and with very dramatic effect."

Peltier stresses that climate changes, such as a massive Greenland melt, are very difficult to predict as Earth's climate system is highly non-linear, involving the interactions between a number of distinct and individually complex components such as sea ice and land surface processes as well as the atmosphere and oceans. "These systems are capable of responding in a way that is out of proportion to the stimulus," he says. "You can push them just a little bit and cause them to cross a threshold, such that the response is extremely surprising. From a physics standpoint, the climate system of the planet is a beautiful example of

such non-linear systems."

The research was supported by the Natural Sciences and Engineering Research Council of Canada and by the Canadian Foundation for Climate and Atmospheric Science through a new collaborative research network called Polar Climate Stability which is led by Peltier. The network involves researchers from seven different Canadian universities.

Source: University of Toronto

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