Warmer means windier on world's biggest lake

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Rising water temperatures are kicking up more powerful winds on Lake Superior, with consequences for currents, biological cycles, pollution and more on the world's largest lake and its smaller brethren.

Since 1985, surface water temperatures measured by lake buoys have climbed 1.2 degrees per decade, about 15 percent faster than the air above the lake and twice as fast as warming over nearby land.

"The lake's thermal budget is very sensitive to the amount of ice cover over the winter," says Ankur Desai, atmospheric and oceanic sciences professor at the University of Wisconsin-Madison. "There is less ice on Lake Superior during the winter, and consequently the water absorbs more heat."

A wide temperature differential between water and air makes for a more stable atmosphere with calmer winds over the relatively cold water. However, as warming water closes the gap, as in Lake Superior's case, the atmosphere gets more turbulent.

"You get more powerful winds," Desai says. "We've seen a 5 percent increase per decade in average wind speed since 1985."

Those findings will be published today (Nov. 15) in the journal *Nature Geoscience*.

Desai, fellow atmospheric and oceanic sciences professor Galen

McKinley and graduate research assistant Val Bennington of UW-Madison and physics professor Jay Austin of the University of Minnesota-Duluth used more than 20 years of temperature and wind data collected by three lake buoys and Earth-observing satellites to model Superior's water and wind system in three dimensions.

"We can look at how the currents are changing based on changes in the wind," McKinley says. "What we saw was a significant increase in the speed of the currents, nearly 10 percent per decade."

In theory, that increase in wind and current strength would make for more mixing within the lake and, in turn, a boost in the growth of organisms that make up the earliest links in the food chain.

But Lake Superior's chlorophyll levels — a measure of the presence of phytoplankton —have been falling. The effect went largely without explanation until the researchers' modeling showed that the period of temperature stratification (well-defined separation of cold, deep water and warm surface water) was growing alongside surface temperatures and wind and current speed.

"The warming of the lake is counteracting the mixing we would expect," says McKinley, as the annual period warm water "shoals," or remains shallow, grows longer by a few days every decade.

A warmer Lake Superior may also have consequences for the movement of airborne pollutants to and from lakeshore communities.

"If you look at an area like Door County, they have issues with pollution in the air, but not the industries that produce it," Desai said. "What they have is Lake Michigan, which has a weaker temperature differential and higher along-shore wind speeds that bring in air from industrialized areas."

Changes in the lake winds may also play out over neighboring land, Desai says, possibly in the way Superior drives fall's lake-effect snowstorms.

Lake Superior may be the anchor for a chain of lakes that hold one-fifth of the world's fresh surface water, but the impact of steadily rising temperatures has been poorly understood, according to Desai.

"Large lakes are very interesting," he says. "They behave sometimes like an ocean and sometimes like a small lakes, but they're not studied as much as either."

That may change with the arrival of more than half a billion dollars promised by the federal government to Great Lakes programs. McKinley sees the group's continuing research as vital to a reasoned approach to mitigating the effects of pollution and invasive species.

"We have more to do," McKinley says, pointing to Austin's mooring of underwater instruments and the researchers' continuing assessment of the carbon cycling in and out of Lake Superior as part of a four-year grant funded by the National Science Foundation.

"The new federal money is good, but it can't only be for remediation," she says. There's got to be some of that science to understand how these lakes work."

Source: University of Wisconsin-Madison (news : web)