Many of the world’s big cities are built near the ocean. This means that rising sea level caused by climate change threatens the homes and livelihoods of millions of people who live along the coast. According to Professor David Holland, the main sources of water that will lead to elevated sea level are the melting ice sheets of Antarctica and Greenland.

In January 2014, Holland and a member of his team from the Center for Global Sea-Level Change (CGLC) at NYU Abu Dhabi published a paper in *Nature* that found that one of the most sensitive and critical areas of the Earth’s ice in West Antarctica is being affected by changes in the north and tropical Atlantic, which has been warming for over 30 years. Climate change is truly a global phenomenon; changes in one part of the globe can influence climate in another, since ocean currents and winds link distant regions. But the team’s conclusion is surprising because initially there is no reason to think that the far-off north and tropical Atlantic would affect Western Antarctica.
But this seems to be the case, and their analysis demonstrates the complexities of global climate, said Holland, who is professor of math and atmospheric ocean science at NYU New York and head of CSLC. The paper’s lead author, Xichen Li, is a doctoral student at NYU’s Courant Institute of Mathematical Sciences and affiliate of CSLC.

The future of rising sea level will in part be determined by the way the ocean interacts with large ice sheets like the one found in West Antarctica. These massive glaciers flow slowly over land and eventually meet the sea. Where ice sheets meet the ocean, the warm water speeds up the melting of the ice.

“To date, the focus of our work has been studying the melting of ice sheets on location by carrying out field programs in Antarctica and in Greenland,” Holland said. But for the paper published in Nature, the researchers wanted to understand just how warm ocean water was being directed to West Antarctic glaciers in the first place.

They started with a problem.

Scientists have long known that the Antarctic Peninsula in West Antarctica is subject to climate change. Indeed, over the past few decades, the Peninsula has warmed more than anywhere on the planet, and this warming has led to the melting of land-ice in the region. The sea-ice that surrounds the Peninsula, however, has not necessarily declined, but has redistributed itself in odd ways.

Scientists have also known that the climate of this remote region — which lies about 600 miles south of Tierra del Fuego — is affected by changes in the Pacific Ocean, and that changes in the Pacific cause short-term changes to the climate of the Peninsula. But fluctuations in the Pacific couldn’t account for the warming of the Peninsula or the redistribution of sea-ice around it. So, for this paper, researchers focused on the Atlantic, which had been overlooked as a force behind Antarctic climate change.

It is remarkable that the recent 30-year trend in North Atlantic Ocean warming is driving climate change in West Antarctica, Holland said. And it is worrying that “West Antarctica is precisely the most sensitive place on Earth for future sea-level change,” he added. “This opens the possibility of significant sea-level change in the next century, which could have a huge impact on low-lying coastal areas.”

Holland and his team plan to carry on with the work that was done for the recent paper and to expand on their findings: “We plan to do further climate modeling to help us better understand the connection between the north and tropical Atlantic and the waters off West Antarctica. Moreover, we are trying to develop the capability to project sea-level change for the next century and beyond.”

Additional authors of the paper are Edwin Gerber, assistant professor at NYU’s Courant Institute of Mathematical Sciences; and Changhyun Yoo, post-doctoral fellow at the Courant Institute.
GLACIER-FJORD-OCEAN COMPLEX

Over the past two decades, ice loss from Greenland’s shrinking ice sheet has contributed one-quarter of the global rise in sea level. Retreating outlet glaciers were responsible for about half the ice lost. But understanding the dynamics of the calving front — a glacier’s terminus, where icebergs split off — remains limited and “poorly understood for several reasons,” said NYU Abu Dhabi postdoctoral associate and visiting assistant professor Carl Gladish.

For one, access to the environment poses a challenge. For the past five summers, Gladish, who works with the Center for Global Sea-Level Change, led by David Holland Professor of Mathematics, has collected observations at Jakobshavn Glacier, through which 8 percent of the Greenland Ice Sheet ultimately flows into the ocean. Jakobshavn terminates at the head of the long, narrow Ilulissat Icefjord. Icebergs as big as skyscrapers, unable to pass the shallow sill where fjord meets ocean, clutter the way. “But, more intrinsically,” Gladish continued, “the glacier-ocean interface is simply very complex,” involving different systems operating on disparate timescales by little-understood rules.

With temperature and salinity measurements from Ilulissat, Gladish, who received his PhD in atmospheric and ocean science and mathematics, runs numerical models to better understand the interactions between glacier, fjord, and ocean. “It’s a hypothetical world,” he explained. By varying conditions at the fjord boundaries, he can test different “what-if scenarios.” “Modeling cannot substitute for observations,” he said. “However, a numerical model allows us to work out the consequences of our hypotheses about what governs the physical behavior” of the environment.

The team is trying to discover how the retreat of a glacier is being driven by melting at the interface of glacier and ocean, an interaction that should have a relatively small impact on a glacier as a whole. “It is kind of like trying to explain why a person can become ill after eating something small that upsets their system,” he said. “But there is strong evidence that temperature changes of one or two degrees Celsius are indeed responsible for quite large changes at major glaciers around Greenland.”

GENETIC DIVERSITY OF THE DATE PALM

As a traditional staple of the Arab diet, dates have long had a central place in both the agricultural economies and the culinary repertoire of the UAE. Now Khaled Hazzouri, a postdoctoral associate at the Center for Genomics and Systems Biology at NYU Abu Dhabi, is working to discover the genetic origins of this iconic fruit.

A wild ancestor of the date palm was likely cultivated by humans over several thousand years, developing in the process into the many varieties seen around the region today. “Farmers of the past may have seen these wild plants and recognized in them particular traits that they thought were valuable, and they would select the trees that had those traits for further cultivation,” Hazzouri explained.

The team hopes to make a “roadmap” of at least 400 date varieties that correlates the characteristics (color and sweetness, for example) of the different varieties with the genetic markers that code for those particular traits.

This work will help researchers know how genes affect different traits of the tree, such as fruit sweetness and yield and the ability of the trees to tolerate high salinity.

It may even help farmers in the region improve their yields by cultivating varieties that are well-suited to the environment.