A climate-change amplifying mechanism

February 26 2007

During the past ninety thousand years there were alternating hot and cold periods lasting several thousand years each which resulted in a modification of global oceanic circulation. With the help of paleoclimatic and paleooceanographic indicators, scientists at CEREGE have highlighted a feedback mechanism of ocean circulation on the climate which reinforces this heating or cooling. This mechanism relies on a close link between the circulation of the North Atlantic and the tropical hydrology of Central America.

This study, published in the February 22, 2007 edition of the review *Nature*, should allow us to better understand and therefore better predict the effects of climate change on oceanic circulation.

In the past, major and rapid climatic variations which took place notably during the last glacial period (Heinrich period) disturbed ocean circulation. Climatic archives (marine and lake sediment, polar ice, stalagmites) show the close relationship existing between climatic variations and oceanic circulation. Changes in oceanic circulation in the North Atlantic have influence on a planetary level by affecting, in particular, the water cycle. These changes are accompanied by a shift in the climatic equator which separates the trade wind systems of the two hemispheres: southwards during cold events and northwards during hot ones.

Central America, a narrow continental strip which separates the Atlantic and Pacific oceans, plays a key role in this system. On the Atlantic side surface waters evaporate, which increases salinity. The water vapour is

transferred by the trade winds to the Pacific where it is deposited as rain, thus lowering salinity there. This enormous transfer of water (several hundred thousand cubic meters per second) maintains a contrast in salinity between the two oceans. The surface waters of the tropical Atlantic are then transported, via the Gulf Stream, towards the high latitudes where they warm the atmosphere before plunging into the abysses in the convection zones situated in the seas of Norway, Greenland and Labrador. The deep waters formed by this process then flow into the world ocean, purging the North Atlantic of part of its excess salt.

The scientists at CEREGE reconstituted the variations in surface water salinity in the area where the water vapour coming from the Atlantic is deposited. To do this they worked on the measurements taken in marine sediments collected in 2002 west of the Isthmus of Panama by the French oceanographic ship the Marion Dufresne. This study shows that the cold Heinrich periods correspond to increases in salinity in the east Pacific. This is synonymous to a decrease in the transfer of water vapour. By comparing their results to other studies done in the Atlantic sector and in South America, the scientists were able to describe a feedback mechanism which amplified the climatic disturbance. During cold periods the trade winds, loaded with humidity, migrated southwards. Unable to cross the Andes part of the rain, which would normally have lowered the salinity of the East Pacific, fell in the Amazon basin. This feedback had the effect of re-injecting rainwater into the Atlantic, thereby decreasing the ocean's salinity. This water was then transported to the higher latitudes, contributing to the weakening of deep oceanic circulation, thereby reinforcing the cooling above and around the North Atlantic.

Today, the fact that global warming could disturb the water cycle and lead to a slowing down of the North Atlantic circulation is a real subject of concern. Oceanographic data from the last 50 years suggest that

hydrographic changes (temperature and salinity) as well as a lessening of the flow of water transported by certain surface and deep-sea marine currents have already occurred in the North Atlantic. The risk of an even greater variation of oceanic circulation by the end of this century or the beginning of the next needs to be taken seriously and actively studied.

Citation: Moisture transport across Central America as a positive feedback on abrupt climatic changes, Leduc G., Vidal L., Tachikawa K., Rostek F., Sonzogni C., Beaufort L., Bard E., *Nature*, 22 February 2007.

Source: CNRS