Researchers Develop New Model of Ice Volume Change Based on Earth's Orbital Patterns

June 23 2006

Through dated geological records scientists have known for decades that variations in the Earth's orbit around the sun – subtle changes in the distance between the two – control ice ages. But, for the first 2 million years of the Northern Hemisphere Ice Age there has always been a mismatch between the timing of ice sheet changes and the Earth's orbital parameters.

A new model of ice volume change developed by Maureen Raymo and Lorraine Lisiecki, researchers in Boston University's Department of Earth Sciences, proposes a reason for this discrepancy. Like other models, it is consistent with traditional Milankovitch theory – which holds that the three cyclical changes in the Earth's orbit around the Sun (obliquity, precession, and eccentricity) influence the severity of seasons and high latitude temperatures over time. However, the new model differs from earlier ones in that it allows for a much more dynamic Antarctic ice sheet.

According to the researchers, from 3 million years ago to about 0.8 million years ago, Northern Hemisphere ice volume appears to have varied mostly with the 41,000 year period of obliquity – the periodic shift in the direction or tilt of Earth's axis. However, summer insolation (incoming solar radiation), which is widely believed to be the major influence on high-latitude climate and ice volume change, is typically dominated by the 23,000 year precessional period – the slow "wobble"

of the Earth on its axis.

“Because summer insolation is controlled by precession, and summer heating controls ice sheet mass balance, it is difficult to understand why the ice volume record is dominated by the obliquity frequency,” said Dr. Raymo. “It’s not a complete mismatch, but the precession frequency we think should be strong in geological records is not.”

Raymo and Lisiecki are proposing that during this time, ice volume changes occurred in both the Northern Hemisphere and Antarctica, each controlled by different amounts of local summer insolation paced by precession.

“The reason the frequency is not observable in records is because ice volume change occurred at both poles, but out of phase with each other. When ice was growing in the Northern Hemisphere, it was melting in the Southern,” said Raymo.

The team believes scientists have been operating under the assumption that Antarctica has been exceptionally stable for 3 million years and very difficult to change climatically.

“We don’t tend to think of ice volume in that region as varying significantly, even on geologic time scales,” said Raymo. “However, only a modest change in Antarctic ice mass is required to “cancel” a much larger Northern ice volume signal.”

Records used to measure the ice volume, such as sea levels, integrate the whole world. According to Raymo, the new model demonstrates that while the precession frequency is actually strong in ice volume changes at each pole, in geologic records, Northern and Southern hemisphere ice volume trends act to cancel each other out at this frequency.

The paper, which was published online today and will appear in an upcoming issue of the journal Science, proposes that the Antarctic ice sheet is more dynamic and far more capable of change than previously believed.

“If our theory holds true, it is a cause for concern with regard to climate changes not associated with orbital patterns as well,” said Raymo.

Founded in 1839, Boston University is an internationally recognized institution of higher education and research. With more than 30,000 students, it is the fourth largest independent university in the United States. BU contains 17 colleges and schools along with a number of multi-disciplinary centers and institutes which are central to the school’s research and teaching mission.

Source: Boston University