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Climate of the Past Discussions

Interactive comment on "Tropical cooling and the onset of North American glaciation" *by* P. Huybers and P. Molnar

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The authors ask us to take this paper in the spirit of a back-of-the-envelope calculation. Fair enough, though it is an unusually creative, complex, and provocative example. This calculation is a valuable contribution to a most important problem.

The basic idea is that (1) there has been a gradual cooling of the eastern equatorial Pacific (EEP) since the Pliocene; (2) in the modern record a warmer EEP induces a warmer summer over northern North America (NNA), increasing the potential for

ablation; (3) therefore, the cooling in the EEP could be the critical secular change allowing the onset of widespread northern hemisphere glaciation. (4) A key component of the argument is the estimate that the EEP effect is ~ twice the size of the direct effect of obliquity on ablation, and that since obliquity changes have been sufficient to initiate glaciations during the Pleistocene, a warming twice as big as the obliquity effect is sufficient to prohibit glaciation.

The EEP to NNA connection is estimated from large El Niño events in the instrumental record. Though, as the authors state, most of the literature focuses on the winter, there is a spring/summer connection as well. (One place to see this is in the US corn crop; e.g. Phillips, et al, 1999, Inter. J. of Climatol., 19, 877-888.) They isolate the "ablation season" effect using an SVD (EOF/PC) analysis of what they regard as the ten largest El Niño events in the record, as well as by simply looking at the relationship between equatorial Pacific SSTs (NINO3.4) and an average of NNA surface air temperatures. Their top ten are slightly non-standard (most scoring systems, e.g. Quinn, would put 1918 and 1925 ahead of 1986 or 1991), but this is probably not important.

Though it is not entirely clear from the text, I believe the NNA/NINO3.4 analysis uses the entire time series from 1885-2005. They find a statistically significant correlation, with a regression slope of NNA on NINO3.4 of 0.51. They then, quite correctly, point out that this is necessarily biased low because of noise in the time series. They inflate this slope by a factor of ~ 2 to be 1° of NNA surface temperature change for 1° of NINO3.4 change. This large factor is justified by appeal to the cross-correlation method of Frost and Thompson, 2000 (FT). I do not understand what was done. In FT, an interclass correlation is used to estimate the correction factor, and it is not obvious how that applies in this situation. I suspect the proper inflation factor is closer to 1 than to 2, but perhaps I am missing something.

Then again, it is not at all certain that the same factor would hold in the warmer world of the Pliocene.

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It is a good idea to focus on summer and ablation, but the argument would be strengthened by a consideration of winter. Others (e.g. Kukla, et al, 2002: Quaternary Research, 58, 27-31) have argued that an El Niño-like state will enhance the fall/winter moisture supply and thus enhance glacial accumulation. I suspect this loses to the enhanced ablation effect, but it may not be negligible.

If this idea is correct, it leaves us with the puzzle of what caused the EEP to cool off on a timescale too long to invoke the atmosphere-ocean-cryosphere system by itself.

Interactive comment on Clim. Past Discuss., 3, 771, 2007.