Impact of the Atlantic Warm Pool on the climate in Florida during North Atlantic cold spells

Universiteit Utrecht

H.J. de Boer*, T.H. Donders, W. Finsinger, E.C. Grimm, S.C. Dekker*, G.J. Reichart, F. Wagner-Cremer

*Copernicus, institute for Sutainable Devlopment and Innovation, Environmental sciences, Faculty of Geosciences, Utrecht University, P.O. Box 80.115, 3508 TC Utrecht, The Netherlands

H.deBoer@geo.uu.nl

Problem

We quantified climate change at Lake Tulane, Florida (figures 2&5) using a pollen-climate inference model and found increases in summer precipitation and November temperatures during North-Atlantic colds spells. This contrasts the concept of northern hemispheric cooling during Heinrich Events and the Younger Dryas[1,2,3]. Increased Sea Surface Temperatures (SSTs) in the Florida region could provide the heat and moisture to explain our reconstruction. However, regional SST records show contrasting signals during the North Atlantic cold spells (figure 2).

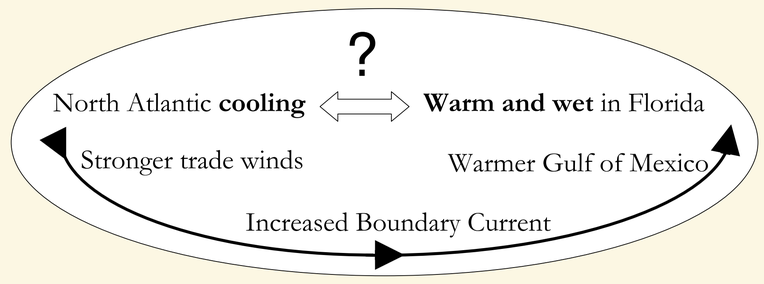

Figure 1: How can we explain the apparent contrast between increased temperature and precipitation in Florida and North-Atlantic cooling?

Conclusions

A persistent Atlantic Warm Pool[8] could explain the pollen-inferred warming and wetting of Florida during North Atlantic cold spells. Climate modelling indicates that Florida is insensitive to North Atlantic cooling, if the Gulf of Mexico warms (figures 3&4). A warming of the Gulf during the North-Atlantic cold spells can only be explained by an increased Loop Current and enhanced Boundary Current circulation, driven by the trade winds north of the equator (figures 1,2&5).

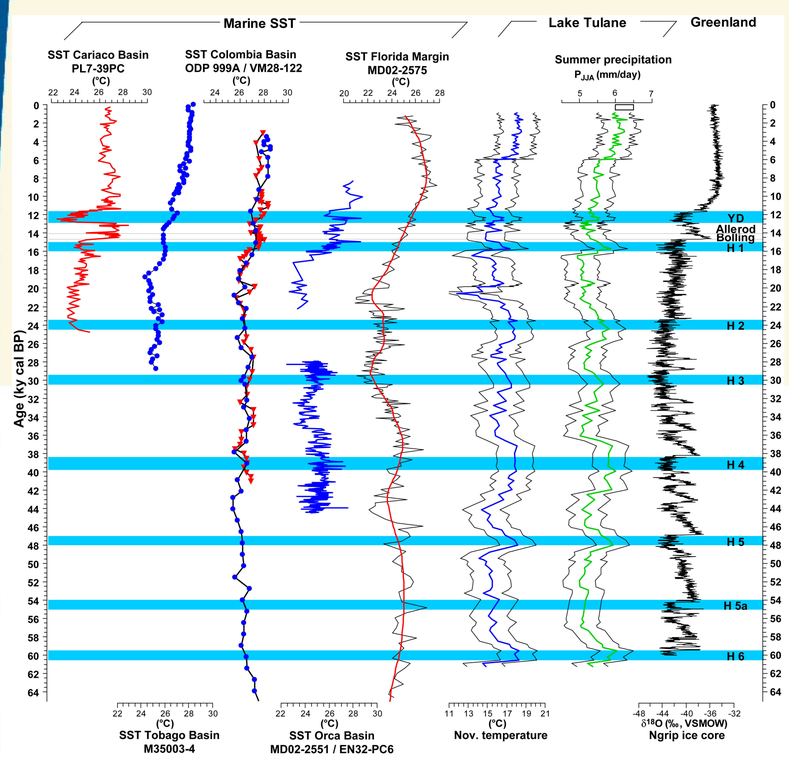

Figure 2: Paleoclimate reconstruction from Lake Tulane (figure 5) based on the pollen climate inference model. Data is compared to regional marine SST records from the Cariaco Basin[3], Tobago Basin[4], Colombia Basin[5], Orca Basin[6,7] and Florida Margin[8] and the GISP2 Greenland ice core record[9].

Climate model sensitivity results

The Florida climate is independently controlled by North Atlantic and (sub)tropical Atlantic temperatures (figures 2&3). Cooling of the North Atlantic (figure 3A) forces the Inter Tropical Convergence Zone (ITCZ) southwards and dries Florida during summer. An additional warming in the (sub)tropics (figure 3B) reduces the imprint of the North Atlantic cooling on the climate in Florida. Only an additional warming of the Gulf of Mexico (figure 3C) explains our pollen-inferred climate reconstruction.

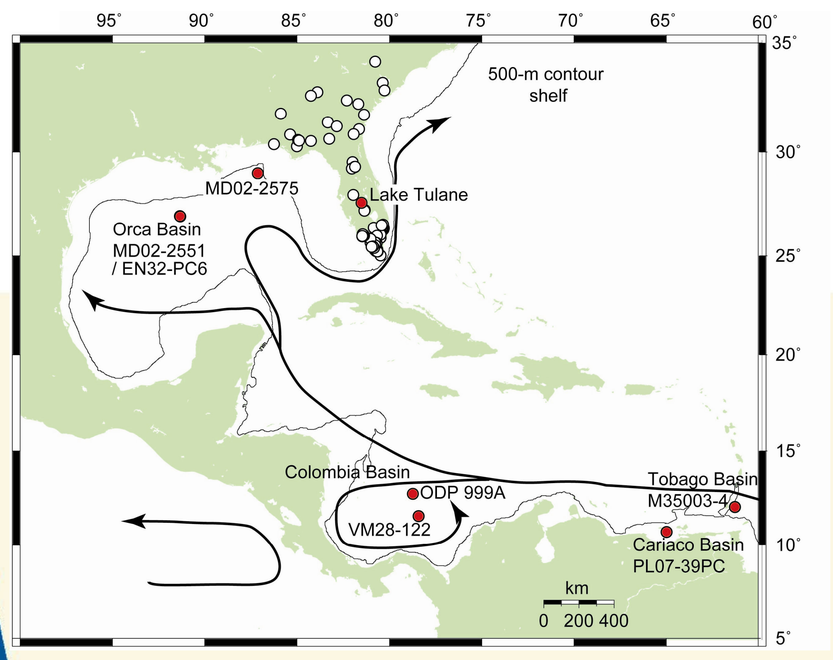

Figure 5: Location of Lake Tulane, surface sediment samples (empty circles) used to calibrate the pollen-climate inference model and marine core sites. Arrows indicate the warm Boundary Current and Loop Current circulation.

Figure 3: Climate model boundary conditions to investigate the climate sensitivity in Florida to regional changes in Atlantic SSTs. Anomalies are calculated relative to a Last Glacial Maximum (LGM) simulation.

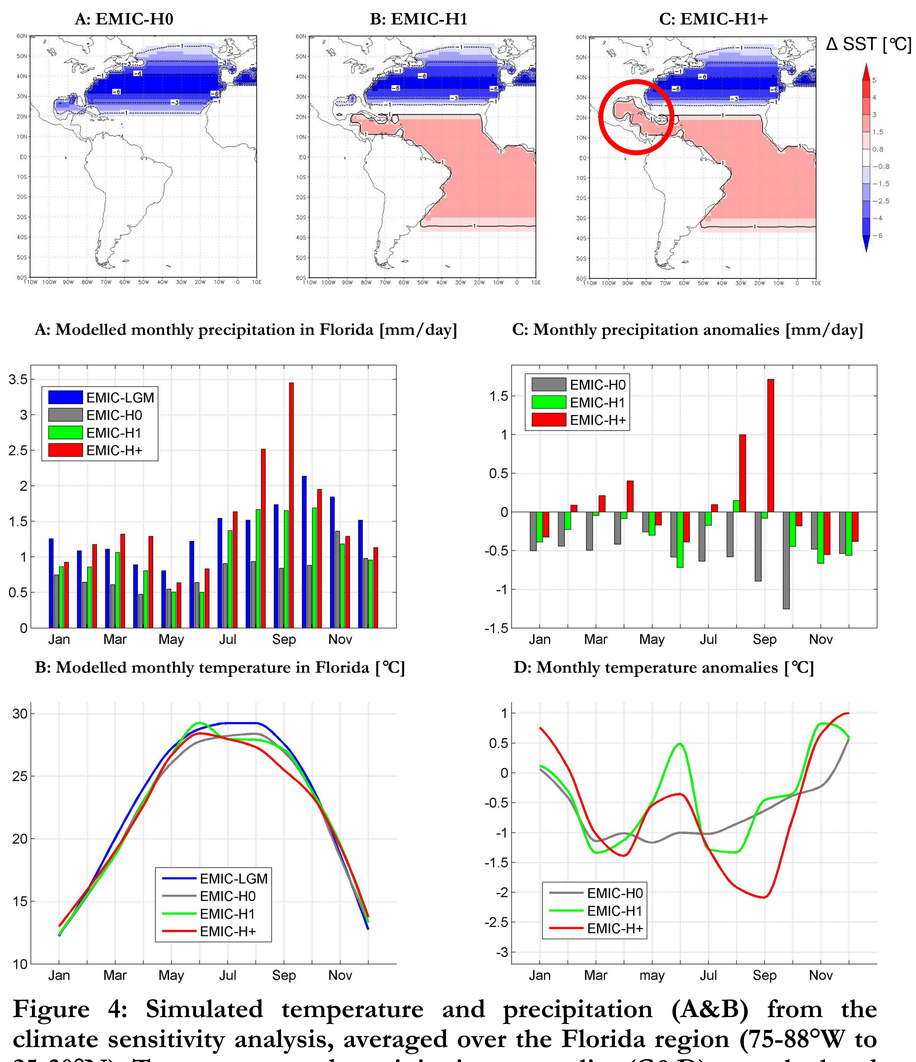

Figure 4: Simulated temperature and precipitation (A&B) from the climate sensitivity analysis, averaged over the Florida region (75-88°W to 25-30°N). Temperature and precipitation anomalies (C&D) are calculated relative to the LGM reference simulation.

Discussion

Contrasting tropical Atlantic SST signals (figure 2) could be explained by invoking a seasonally biased climate response to North-Atlantic cold spells[8]. Our climate reconstruction indicates summer precipitation and November temperature, which are controlled by the ITCZ position and the Atlantic Warm Pool during summer. This could be evidence for increased seasonality in the northern hemispheric (sub)tropical region during North Atlantic cold spells.

References

[1]Heinrich, 1988. Quartenary Research, 29: 142-152
[2]Bond et al., 1993. Nature, 365:143:147
[3]Lea et al., 2003. Science, 301(5638):1361-1364
[4]Rühlemann et al., 1999. Paleoceanography, 18(4): 1077
[5]Schmidt et al., 2004. Nature, 428: 160-163
[6]Hill et al., 2006. Paleoceanography, 21, PA1006
[7]Flower et al., 2004. Geology, 32(7): 597-60
[8]Ziegler et al., 2008. Nature Geoscience, 1(9): 601-605
[9]Stoner et al., 2000. Earth and Planetary Science Letters, 183: 161-177

Geosciences

Darwin Days 2009