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The Influence of High Frequency Climate Variability on Paleoclimate Interpretation

Martin Perlmutter
United States (mprl@chevron.com)

Understanding past long term climates states & their higher frequency variability can play an important role in helping to forecast future climate changes. The insolation cycles which drive high frequency climate variability & their interference patterns have been mathematically resolved for the last 50 my. Inferences can be drawn on these patterns back through at least the Paleozoic. However, different regions of the Earth have different climatic responses to the same insolation cycles & record the changes differently. In some locations, the stratigraphic record offers climate cycles up easily to be recognized & measured. In other areas, it's more difficult because the climate does not change much or stratigraphers who interpret climate ignore changes to sedimentary delivery systems & environments of deposition caused by the specific climate response, don't recognize preservation bias caused by climate cycles & fail to include the phase relationship of sediment supply & sea or lake level cycles. These issues can cause the paleoclimatologist to misinterpret the actual temporal scales of climate change because they are looking for similar stratigraphic responses to the same climate cycle in areas that just don't preserve them the same way.

Presently, most paleoclimate analyses & interpretations are resolved only for mean annual conditions for time intervals ranging from 0.1 to 1 my. However, the greatest insolation changes occur seasonally at the scale of precession ($\sim$20 kyrs) during periods of high eccentricity. Similar to the condition that causes summer in one hemisphere & winter in the other at the same time in the orbit, precession cycles cause Northern & Southern Hemisphere insolation to be about 10,000 years out of phase. Hot summers & cold winters in one hemisphere correspond to mild summers & mild winters in the other. The pattern reverses itself over a precession cycle so that similar climatic successions in opposite hemisphere, & their associated sediment yield cycles, will be 10,000 years out of phase, as well. These changes occur regardless of whether the earth is in a greenhouse or an icehouse state.

Until the Plio-Pleistocene, glaciations, when they occurred, were unipolar. Under this condition, precession-scale eustasy tended to track the insolation cycle of the glaciated hemisphere. Consequently, similar climatic successions in opposite hemispheres would have had sediment yield cycles with distinctly different phase relationships to glacioeustasy. Such differences would not exist in an ice-free world. The regional & temporal variations in the phase relationships between sediment & glacioeustatic cycles may not be consistent with basic assumptions about stratigraphy & can impact how we interpret the causes and frequencies of the stratigraphic cycles themselves. This talk is a discussion of how these issues affect our understanding & interpretation of paleoclimate.