Presenter:

Andy Wickert (University of Colorado)

Date:

July 15th

Title:

Impacts of Pleistocene Glaciation and its Geophysical Effects on North American River Systems

Abstract:

During Pleistocene glacial cycles, ice sheets advanced into the drainage basins of North America, warping the lithosphere beneath them, rerouting river systems, and sending meltwater to the oceans. Here I reconstruct the history of North American rivers and drainage patterns since the Last Glacial Maximum (LGM), use isotopic tracers to reconstruct the volume of meltwater sent down the Mississippi River since the LGM, and combine geophysical models and subsurface field observations to show that the Upper Mississippi River incised through the forebulge of the Laurentide Ice Sheet. The river histories form a new background of knowledge on ice-sheet--fluvial-system interactions. I first present a data-driven and largely model-ignorant review and synthesis of the literature on river systems and deglaciation across North America, which is intended as reference work for communities interested in Quaternary geology, glacial and fluvial geomorphology, and related fields. This is followed by modeled drainage history of North America, computed as a result of established ice sheet and glacial isostatic adjustment (GIA) models; here I retrodict North American drainage patterns, for comparison with the data-driven drainage basins, and river discharge histories, quantified and partitioned into meltwater and seasonal precipitation minus evapotranspiration. I then use these modeled drainage histories with a simple oxygen isotope mixing model and a compiled high-resolution chronology of oxygen stable isotope ratios ($\delta^{18}O$) in the Gulf of Mexico to show that most models of North American deglaciation -- and all in our study that were not based on ice physics -- overpredict net meltwater discharge down the Mississippi since the LGM. This data compilation and a reinterpretation of the sedimentary record further shows that the southern Laurentide ice sheet (LIS) was not a significant contributor to Meltwater Pulse 1A (MWP-1A), in which sea level rose 14-18 m between 14.65 and 14.31 ka. Finally, I turn my attention to the longer-term Quaternary history of the Mississippi River System, and show that subsurface data record $\sim$40 m excess alluvium thickness in the Upper Mississippi Valley that closely matches the geometry of a model of the LGM Laurentide forebulge and likely formed over one or more pre-LGM glaciations; here, Mississippi River incision kept pace with forebulge uplift, and subsequent subsidence led to deep alluviation of the river profile. Together, these show the dynamism of river systems -- the threads that tie the ice sheets to the sea -- and how they record and respond to Quaternary glaciation.