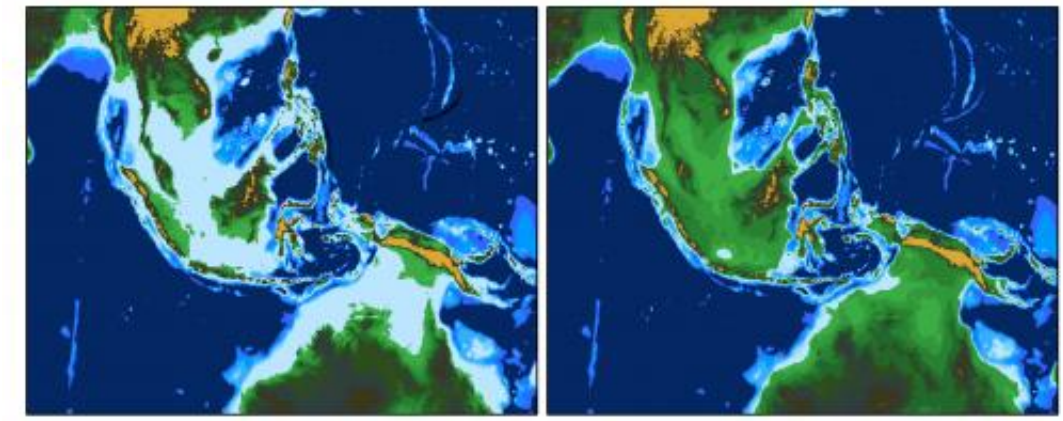
Sea level influenced tropical climate during the last ice age

May 19 2013



The exposed Sunda Shelf during glacial times greatly affected the atmospheric circulation. The shelf is shown on the left for present-day as the light-blue submerged areas between Java, Sumatra, Borneo, and Thailand, and on the right for the last ice age as the green exposed area. Credit: Pedro DiNezio

Scientists look at past climates to learn about climate change and the ability to simulate it with computer models. One region that has received a great deal of attention is the Indo-Pacific warm pool, the vast pool of warm water stretching along the equator from Africa to the western Pacific Ocean.

In a new study, Pedro DiNezio of the International Pacific Research Center, University of Hawaii at Manoa, and Jessica Tierney of Woods Hole Oceanographic Institution investigated preserved geological clues

(called "proxies") of rainfall patterns during the last ice age when the planet was dramatically colder than today. They compared these patterns with computer model simulations in order to find a physical explanation for the patterns inferred from the proxies.

Their study, which appears in the May 19, online edition of *Nature Geoscience*, not only reveals unique patterns of rainfall change over the Indo-Pacific warm pool, but also shows that they were caused by the effect of lowered sea level on the configuration of the Indonesian archipelago.

"For our research," explains lead-author Pedro DiNezio at the International Pacific Research Center, "we compared the climate of the ice age with our recent warmer climate. We analyzed about 100 proxy records of rainfall and salinity stretching from the tropical western Pacific to the western Indian Ocean and eastern Africa. Rainfall and salinity signals recorded in geological sediments can tell us much about past changes in atmospheric circulation over land and the ocean respectively."

"Our comparisons show that, as many scientists expected, much of the Indo-Pacific warm pool was drier during this glacial period compared with today. But, counter to some theories, several regions, such as the western Pacific and the western Indian Ocean, especially eastern Africa, were wetter," adds co-author Jessica Tierney from Woods Hole Oceanographic Institute.

In the second step, the scientists matched these rainfall and salinity patterns with simulations from 12 state-of-the-art climate models that are used to also predict future climate change. For this matching they applied a method of categorical data comparison called the 'Cohen's kappa' statistic. Though widely used in the medical field, this method has not yet been used to match geological climate signals with climate model

simulations.

"We were taken aback that only one model out of the 12 showed statistical agreement with the proxy-inferred patterns of the rainfall changes. This model, though, agrees well with both the rainfall and salinity indicators – two entirely independent sets of proxy data covering distinct areas of the tropics," says DiNezio.

The model reveals that the dry climate during the glacial period was driven by reduced convection over a region of the warm pool called the Sunda Shelf. Today the shelf is submerged beneath the Gulf of Thailand, but was above sea level during the glacial period, when sea level was about 120 m lower.

"The exposure of the Sunda Shelf greatly weakened convection over the warm pool, with far-reaching impacts on the large-scale circulation and on rainfall patterns from Africa to the western Pacific and northern Australia," explains DiNezio.

The main weakness of the other models, according to the authors, is their limited ability to simulate convection, the vertical air motions that lift humid air into the atmosphere. Differences in the way each model simulates convection may explain why the results for the glacial period are so different.

"Our research resolves a decades-old question of what the response of tropical climate was to glaciation," concludes DiNezio. "The study, moreover, presents a fine benchmark for assessing the ability of climate models to simulate the response of tropical convection to altered land masses and global temperatures."

More information: *Nature Geoscience*, May19. doi: 10.1038/NGEO1823.

Provided by University of Hawaii at Manoa