Climate evolution

Geoscience researchers identified orbital forcing-controlled East Asian-Australian monsoon variability

The Intertropical Convergence Zone (ITCZ), the most important realm for the global ecosystem and human population, encompasses the heaviest belt of tropical seasonal rainfall on Earth. Due to its large rainfall gradient, a small displacement can cause dramatic changes in hydroclimate. The lack of direct long-term records, especially in the Pacific, limits our understanding of the long-term natural variability necessary to predict future ITCZ changes. A recent study by Prof. Chuan-Chou Shen of the High-Precision Mass Spectrometry and Environment Change Laboratory (HISPEC), Department of Geosciences, and his team identified the history of the western Pacific ITCZ over the past 282 thousand years. This rainfall record was published in Nature Communications on November 25, 2015, and highlighted in the journal Science on November 27.

In the study, Prof. Shen and his team generated a tropical rainfall record in the Australian monsoon territory covering the past three glacial-interglacial cycles. This record was derived from a depth profile of trace elements in the calcite shells of a shallow-water marine organism called planktonic foraminifer in a sedimentary core MD05-2925 (9°20.60' S, 151°27.54' E), which was drilled off the eastern coast of Papua New Guinea in the Southern Hemisphere.

The research demonstrates that the migration of the western Pacific tropical rainfall belt was surprisingly influenced by combined solar precession and obliquity changes, unlike the precession paradigm expressed by its East Asian counterpart. This obliquity forcing could be primarily associated with a cross-hemispherical thermal/pressure contrast resulting from the asymmetric continental configuration of Asia and Australia in a coupled East Asian-Australian monsoon system, as supported by model simulations.

Figure 1. Taiwanese and international researchers on board the RV Marion Dufresne.

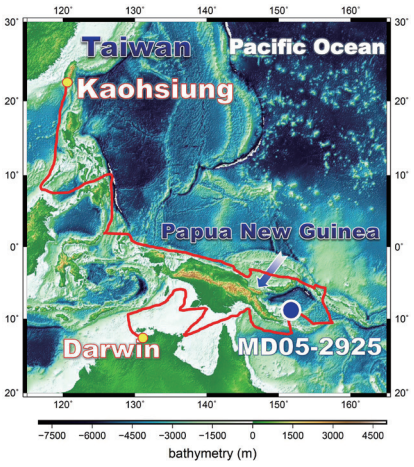

Figure 2. A 15000-km research cruise from Kaohsiung to Darwin during June 1-July 8 2005.

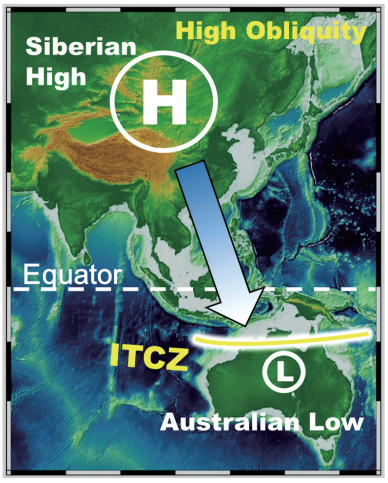

Figure 3. Illustration of the pressure-push mechanism driving the southern branch of the western Pacific ITCZ in the Asia-Pacific realm.

Figure 4. Foraminiferal carbonate shells one of natural archives documenting recent and geological-scale ocean and climate histories.

Their findings suggest that obliquity forcing may play a more important role in global hydroclimate cycles than previously thought. It also provides an in-depth understanding of the past precipitation distribution and dynamics and may offer valuable clues for future climate prediction.

Reference

Yi Liu[#], Li Lo[#], Zhengguo Shi, Kuo-Yen Wei, Chien-Ju Chou, Yi-Chi Chen, Chih-Kai Chuang, Chung-Che Wu, Horng-Sheng Mii, Zicheng Peng, Hiroshi Amakawa, George S. Burr, Shih-Yu Lee, Kristine L. DeLong, Henry Elderfield and Chuan-Chou Shen. (2015). Evolution of the Pacific Intertropical Convergence Zone over the past 282,000 years. *Nature Communications*, 6:10018. DOI: 10.1038/ncomms10018. #These authors contributed equally to this work.

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Influences of rapid and chronic meteorological fluctuations on species elevational range size

The spatial distribution of wildlife is sensitive to climate variabilities. Classic ecological hypotheses have suggested that to adapt and become tolerant to high seasonal climatic variabilities, species in temperate mountains must survive over a greater spatial extent. Therefore, highly diverse organisms that inhabit rugged terrain in tropical and near-tropical areas have been considered more vulnerable to climate change due to the less distinct seasonality in these regions. Additionally, these organisms occupy narrower elevational ranges. However, animals are subjected not only to seasonality but also to diurnal weather fluctuations, and the latter have rarely been studied. A collaborative study conducted by researchers from Academia Sinica, National Cheng Kung University, the University of Connecticut (USA) and National Taiwan University implemented new technologies to analyze a global dataset of species distributions and to assess the