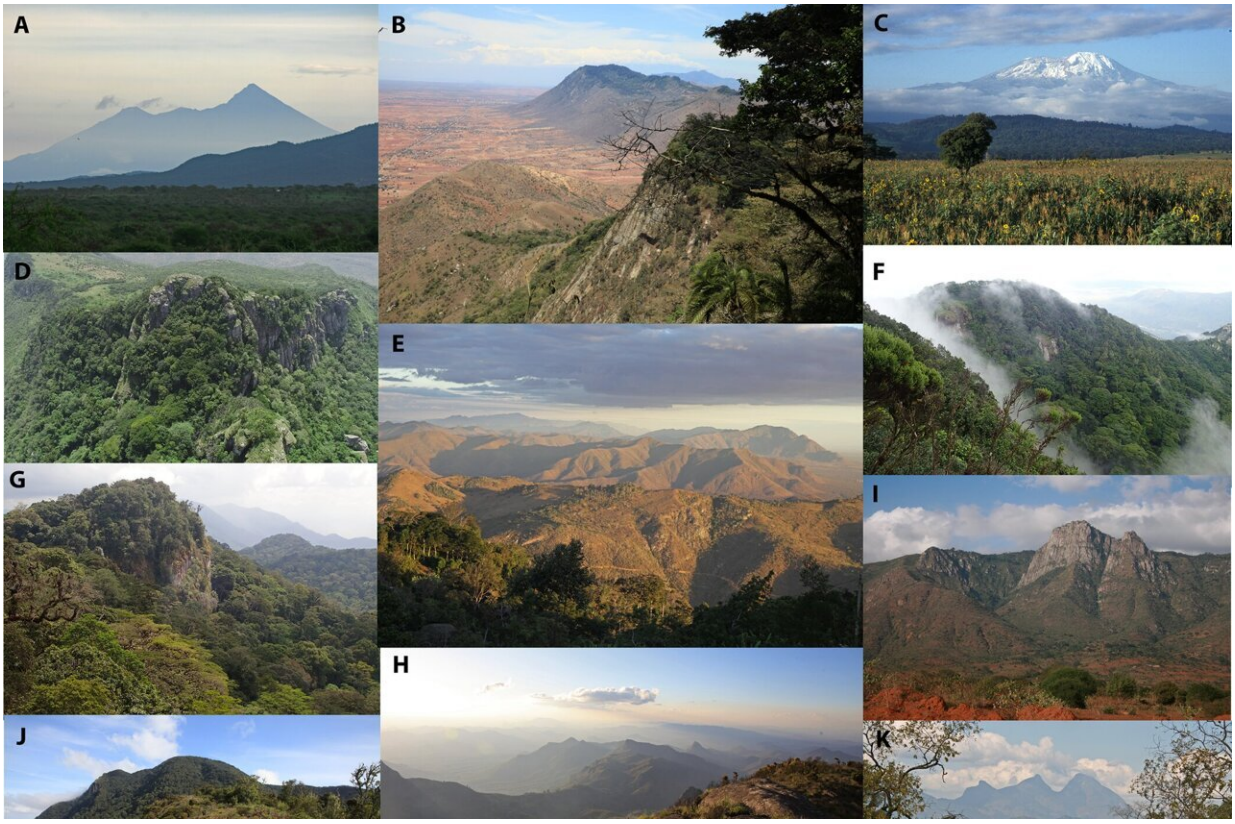
Global climate databases work with incorrect data for the tropics, study shows

March 15 2024, by Anja-Maria Meister



The studied Tanzanian mountain ranges. (A) Meru. (B) North Pare with Kindoroko in the background. (C) Kilimanajaro. (D) Vumari in South Pare. (E) South Pare with Shengena in the background. (F) Mwala in South Pare. (G) Nilo ind east Usambara. (H) Nguru. (I) West Usambara. (J) Makunguru in Nguru. (K) Kanga in Nguru. Whereas Kilimanjaro and Meru reach into the alpine zones, only the highest peaks of the other mountains are covered by remnants of montane (cloud) forest. Credit: *PLOS ONE* (2024). DOI: 10.1371/journal.pone.0299363

Accurate climate data is immensely important for climate change predictions and modeling. Using a unique climate data set of 170 stations, mainly from the mountains of Tanzania including Kilimanjaro, Dr. Andreas Hemp, researcher at the Chair of Plant Systematics at the University of Bayreuth, shows that the commonly used data sets are inaccurate.

Hemp shows which data is more suitable in a publication in the journal *PLOS ONE*.

In order to understand the distribution of species, but also ecosystem functions and services, climate data is required. The collection of such climate data is not an end in itself, but a prerequisite for other research on climate change.

For this reason, Dr. Hemp and colleagues from the Senckenberg research network Kili-SES, in which the University of Bayreuth is also involved, have set up a unique network of climate measuring stations for remote tropical mountain regions. This makes it possible to estimate more precisely which climate change will have which consequences.

Global climate data sets such as WorldClim and CHELSA, which are widely used in research, are based on interpolation, i.e. the estimation (modeling) of unknown values on the basis of known data. And they are based on little data, as weather stations in tropical mountains are rare.

As a result, not only is the maximum amount of average annual precipitation in the tropics drastically underestimated, but the altitude of the precipitation maximum also deviates greatly from the actual conditions. For example, the precipitation maximum on Kilimanjaro is 3,300 mm at 1,920 m above sea level (average value from over 10 years

of measurements). The corresponding modeled values of the two climate databases deviate drastically from this with 1,900 mm and 1,500 mm at 1,400 m and 2,770 m above sea level.

Similarly high discrepancies were found on the 15 other mountains surveyed in Tanzania. This is significant for research into the causes of species distribution patterns. For example, the distribution of certain species groups on Kilimanjaro, such as ferns or epiphytes, clearly follows the measured precipitation distribution with the maximum at 1,900–2,000 m above sea level. Using the modeled data with their false maxima, this correlation is not recognizable.

"Similarly, models of future range shifts of species in connection with impending climate changes along this altitudinal gradient are completely off the mark," says Dr. Andreas Hemp, researcher at the Chair of Plant Systematics at the University of Bayreuth.

"Calculations of the total amount of precipitation that the forest belt, for example, receives and makes available as groundwater and surface runoff to the lower-lying cultivated land zone with its 1.4 million people also come to completely wrong results with the WorldClim or CHELSA data: This is fatal, given the importance of such data."

As it can be assumed that there are similar deviations in the other tropical mountain ranges, where global climate data sets are mostly used due to a lack of existing measuring points—as can be seen from the many hundreds of publications in recent years—the validity of such studies must be questioned, at least in part.

"Our results show that global climate data sets should be used with greater caution than in the past, at least in tropical regions," says Dr. Hemp.

"The tropics are hotspots of biodiversity and are therefore of great ecological interest. In the *PLOS ONE* publication, we show that especially in mountains with strong altitudinal gradients—i.e. with steep slopes and deep valleys as well as large differences in altitude—along which the climate changes very quickly and on a small scale, it is very important to collect our own data, as modeled data obviously fail here."

Since 1996, Hemp and his colleagues have been researching the biodiversity of Kilimanjaro and its surrounding areas in East Africa in numerous DFG projects, since 2010 as part of an interdisciplinary research group.

He has established a network of climate measuring stations that is unique for remote tropical mountain regions. Together with Katrin Böhning-Gaese (Senckenberg Biodiversity and Climate Research Center) and Markus Fischer (University of Bern), Andreas Hemp heads the research group "Kili-SES," which analyzes the interactions between humans and nature in the Kilimanjaro region. Judith Hemp was also involved in the data analysis for this study.

More information: Andreas Hemp et al, Weather or not—Global climate databases: Reliable on tropical mountains?, *PLOS ONE* (2024). DOI: 10.1371/journal.pone.0299363

Provided by Bayreuth University