Scientists detect trends in rainfall traits from drizzles to downpours

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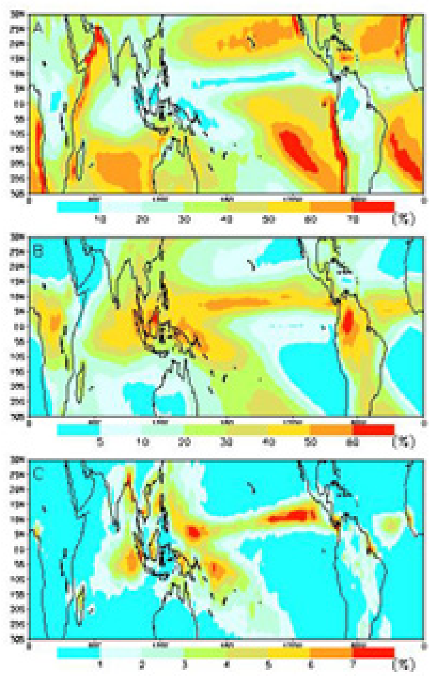

Changes in the geographic distribution of light, moderate and heavy rain are depicted above using GPCP. The greater the frequency of rain, the deeper the red coloring appears on the charts. Courtesy: NASA

Breaking news in recent years has been swamped with stories of extreme weather -- flash floods in East Asia, prolonged drought in Africa, destructive hurricanes like Hurricane Katrina, heavy monsoon rainfall in South Asia, and an historic heat wave in Europe. The effects of these weather crises have been devastating, and their frequency seemingly on the rise. With an understanding that the societal effect of increased rainfall is huge, researchers have had a key question at the center of a debate among them: Are rain-producing weather events increasing worldwide, and if so, what is the relationship, if any, between their growth and climate change?

To detect long-term global rainfall trends, scientists have to overcome major challenges. Since two-thirds of the Earth is covered by oceans, estimating oceanic rainfall relies on satellite remote sensing. However satellite rainfall estimates are well known to have large uncertainties, because it depends on algorithms derived from assumptions based on incomplete knowledge of the physics of rainfall. Also, long-term rainfall records may have consistency problems because they are made up of segments from different sensors on different satellite orbits, each having their own measurement features.

Therefore, up to now, detection of long-term global rainfall has been considered a “mission impossible,” yet the need to know whether trends in rainfall exist is urgent because of how enormously it affects people everywhere. A recent NASA study published in the International Journal of Climatology last September resolves this problem by using a new technique to confirm that extremely heavy rainfall in the tropics is indeed on the rise as suspected.

Researchers a technique based on the concept of a "probability distribution function" (PDF), a measure of the likelihood that rain will fall with a given intensity over a given area and for a chosen period of time (for example, the entire tropics over 25 years from 1979 to 2003 for this study. The authors then computed the trend for each rain intensity level, ranging from very light to extremely heavy rain. What they found was that the trends showed a systematic pattern, i.e., positive for heavy and light rain, and negative for moderate rain. Essentially, they found there is a noticeable change in the PDF, even though the mean rainfall does not change very much.

"This study makes for a very compelling story in solving a science puzzle," said William Lau, Chief of the Laboratory for Atmospheres at NASA's Goddard Space Flight Center, Greenbelt, Md., and a climatologist who is the senior author of the study. "We did this by simply asking the right question. The technique is actually very simple. Instead of looking at trends in total rain, we look for possible signals in different categories of rain, defined by its intensity. It's changes in the traits that make up total rainfall that are most telling, not necessarily total rainfall itself."

Lau and his coauthor used data from both the Climate Precipitation Center's Merged Analysis of Precipitation (CMAP) and the Global Precipitation Climatology Project (GPCP), which blends outdoor rain gauges and rainfall estimates culled from satellite algorithms. They also used data from independent historical gauge records, and from NASA's Tropical Rainfall Measuring Mission (TRMM) satellite to confirm and interpret their results. Their study is focused on the tropics. Their results show that even though there are discrepancies in total rainfall, the change in the characteristics of rainfall are consistent among all the sets of data they looked at.

"Simply put, I'd compare this problem to trying to figure out why your bank account has an apparent error compared to your own records. You'd review the individual items affecting the total balance to see whether certain withdrawal or deposit items were smaller or larger than you'd believed," said Lau, an expert in atmospheric dynamics with an emphasis on tropical climates. "By doing so, you may be able to find a 'pattern' that tells you whether it is your income, your spending habits, or whether it is the bank that actually messed up your balance. Our goal has been to find out what causes the large credits and debits that that are throwing the balance off. We must use this itemized approach to solve the rainfall estimation problem, because we know the rain total (the net balance) is wrong.

"The individual items count in solving this puzzle," Lau added. "Because drizzles occur more frequently, and are associated with clouds that cover large areas, they can control the radiance energy from the sun more effectively. That makes drizzles just as important as downpours and the range of rainfall in between."

Taken separately, TRMM data alone, available for only the last 10 years, nor data from other satellites available only as far back as 1979, are not long enough to confirm a relationship between rainfall and climate change, which requires at least 30-40 years of consistent data. According to Lau, it's asking the right question, using the right methodology, and a combination of information sources that has given researchers a clear picture of how rainfall is changing in a warmer climate.

"It's the small signals in rainfall that tell us the big things," said Lau.

Source: Goddard Space Flight Center