CAN THE WIND IN THE PACIFIC OCEAN INFLUENCE THE RAINFALL ACROSS THE HIMALAYA MOUNTAINS?

The answer is, yes.

You might have heard that the wind of a butterfly vibrating its wings can bring a storm a thousand miles away. This is somehow true in the meteorology sense, which we call teleconnection. Teleconnection refers to climate events being related to each other across large distances (typically thousands of kilometers). It can give us more information especially for some areas that are not easy to reach. Across the Himalaya mountains, in the inner land of the Tibet Plateau, here we find the source region of the Yangtze River, the origin of the third longest river in the world. It is a cold, barren, isolated area in the mountains where it is difficult for plant, animal, human or even observational equipment to survive. To be able to take actions to prevent losses against natural hazards, like flooding or landslide, we first need to know about the key factor of it: the rainfall. This is where teleconnections can help.

Teleconnections Influence the Rainfall Amount

In a project at Lund University, we have found that two teleconnection patterns show a close relation with summer rainfall in the Yangtze River Area: El Niño–Southern Oscillation (ENSO) and

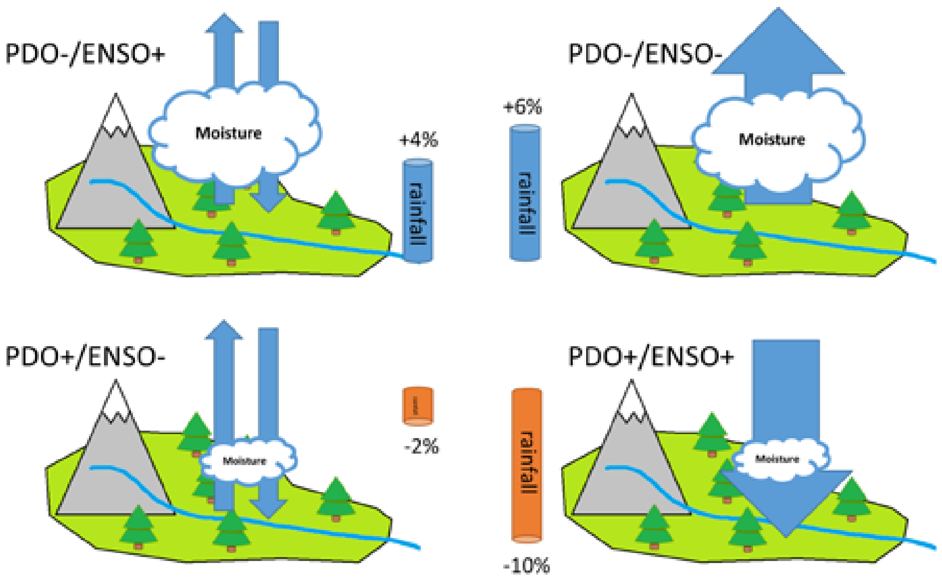

Figure. Illustration of rainfall change under four combinations of ENSO and PDO, together with moisture content and moving tendency. The change of rainfall is presented in a cylinder with blue representing more rainfall and red representing less rainfall. Warm ENSO is well known as El Niño and accompanies high air surface pressure in the western Pacific. Cold ENSO phase is called La Niña and accompanies low surface air pressure. The warm PDO phase means cool temperatures in the western Pacific and warm temperatures in the eastern Pacific, while the opposite pattern occurs in the cold PDO phase. Different surface condition on the Pacific will lead to different circulation pattern and therefore influence climate conditions. For this area, ENSO and PDO together influence moisture content, and ascending movement. Those are the two essential factors which lead to condensation of the moisture, which finally falls onto the ground as rain.

Pacific Decadal Oscillation (PDO). These patterns are indices for the surface thermal condition of the Pacific Ocean. Both ENSO and PDO have two phases: warm and cold. If we group the past 50 years based on the warm (+) or cold (-) phases of ENSO and PDO, we get four combinations: PDO-/ENSO+, PDO-/ENSO-, PDO+/ENSO- and PDO+/ENSO+. Once we have these combinations, we can analyze what the rainfall patterns look like during the years of each combination, and compare with the average rainfall (as illustrated in the Figure).

Using the combinations, we found that more rainfall occurs in our study area in the cold PDO years, particularly in the years of cold PDO and cold ENSO, when there was 6% more rainfall than normal. In contrast, warm PDO brings dryness to the area, and warm ENSO makes it even drier, with up to 10% less than average rainfall. When cold PDO occurs with warm ENSO or the opposite happens, warm PDO with cold ENSO, their influence compensates, and the change in rainfall is marginal. So, you can see that ENSO and PDO have really long arms that can alter the rainfall a thousand miles away.

Teleconnections Influence the Moisture Movement

How is this possible, you might ask? We found that the combination of ENSO and PDO affects the strength of the wind that transports moisture to the study area and also the intensity of ascending movement. As shown in the figure, in a PDO-/ENSO- scenario, a large quantity of moisture is accompanied with strong ascending movement, and this gives more opportunity for the moisture to condense and fall as rain. In PDO+/ENSO+, there is less moisture with a strong subsidence movement, which means that not much moisture condenses. Therefore, there is much less rainfall. For the other two groups (PDO-/ENSO+ and PDO+/ENSO-), either the moisture content is not sufficient or the ascending movement is not strong.

Teleconnections Can Help to Predict Future Rainfall

Such information can be extremely useful since it offers us a way of predicting a potentially dangerous future. According to many studies, a cold PDO phase may continue until 2050. Also, extreme El Niño and La Niña events both tend to increase due to greenhouse gas emission. This means that we can expect more extreme ENSO years combined with a cold PDO phase in the future. In this scenario, more rainfall is likely to fall in the Himalaya mountains, especially in Extreme La Niña years. By knowing this, we will have a better chance of helping people in this area protect themselves against flooding, which ultimately means that we can save lives and prevent large scale damage from a thousand miles away.

Yiheng Du is a PhD student working on hydrological process under climate change. Currently she is analyzing rainfall characteristics in case study areas in China and Sweden. If you are interested in the study above, you can get more information from the publication here:

Yiheng Du, Ronny Berndtsson, Dong An, Linus Zhang, Feifei Yuan and Zhenchun Hao. Integrated large-scale circulation impact on rainy season precipitation in the source region of the Yangtze River. International Journal of Climatology, 2019.