Weakened Siberian High a Most Important Reason for Sharper Temperature Rise in Arid Northwestern China

A team of scientists at the Xinjiang Institute of Ecology and Geography (XIEG), CAS recently reported in the *Journal of Geophysical Research* that the weakening of the Siberian High contributed the most to the sharper rise in temperature of the arid region in northwestern China compared with the overall warming trend of the country or even that of the globe, highlighting the role played by natural factors, like atmospheric circulation features, in regional climate change.

Global climate change has become a generally accepted fact, supported by many studies on global climate. And recent research has revealed that regional climate change may, to a considerable extent, deviate from the national or global trends. Greater attention has been paid to such regional deviations due to their importance in accurate and comprehensive formulation of regional counter measures and strategies. As a particular case, many previous studies showed that air temperature in the arid region of northwest China had been increasing at a rate of 0.33–0.39°C/decade through the recent 50 years, obviously higher than the average level in China (0.25–0.29°C/10a) and the entire globe (0.13°C/10a).

The sharper rise of temperature in northwestern China during the period from 1960 to 2010 has been puzzling scientists, because according to a hypothesis called "runaway greenhouse theory", warming effects from greenhouse gases could be amplified by increased evaporation or atmospheric water vapor. In other words, wet regions, where the atmosphere contains more water vapor, should warm faster than arid ones. Therefore what has caused this "abnormal" deviation has been an issue eagerly pursued in this field.

The team led by Prof. CHEN Yaning at the State Key Laboratory of Desert and Oasis Ecology, XIEG hence carried out in-depth research on the above scientific issue during 2011 and 2012. At first they analyzed the rise of temperature in the arid region of northwest China at an interannual scale, and endeavored to reveal its relationships with natural factors and anthropogenic factors, without much encouraging progress. After reexamination of their own methodology they decided on a renewed strategy, which focused on temperature change of a smaller scale, to highlight particular climate change characteristics of certain time. Therefore they moved on to the seasonal change in temperature rise of this region, and attempted to explore and identify the causal relationships between the climate change and possible driving factors. They calculated the contributions of the temperature change in different seasons to the yearly change for the years from 1981 to 2010. Over this period, they found that, the mean contributions of local temperature change in spring, summer, autumn, and winter were 19.3%, 13.7%, 23.6%, and 43.4%, respectively. Particularly for the period from 1984 to 1995, the contribution of winter change was as high as 57.01%. These results suggested that the temperature change in winter could be the most important factor for the unusually sharper rise in annual air temperature in the arid region of northwest China compared with other areas.

Following this clue, the team furthered their research and explored the possible factors influencing winter temperature change in northwestern China. After analyzing the influence from some atmospheric circulation features, including the Siberian High, the Arctic Oscillation, the North Atlantic Oscillation, the Pacific-North American pattern, the Antarctic Oscillation, the Southern Oscillation and the Westerly Circulation Index, as well as that from carbon dioxide emissions on winter temperature change, the team discovered that the weakening of the Siberian High during the period from 1980s to 1990s could be one of the most important reasons for the higher rate of the

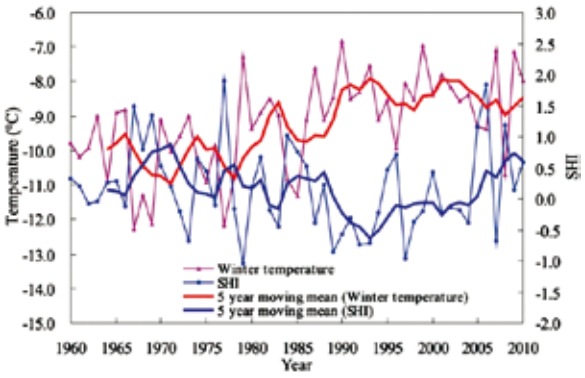

Figure 1: Analysis shows a strong correlation between the weakening of the Siberian High Intensity (SHI) and the rise in winter temperature in the arid region of northwest China.

temperature rise in the arid region of the northwest China (Fig.1).

The Siberian High is a cold or very cold dry air mass in the Mongolian-Siberian region having immense influence on the weather patterns in most parts of the Northern Hemisphere. It reaches its highest intensity and invades the East Asia in winter, often resulting in cold waves. In spring this cold air mass moves to the east and gradually weakens until disappearing in about April.

The intensity of the Siberian High, as found by the team, experienced an apparent decrease over the period between 1960 and 2010, showing a strong correlation with the temperature rise during the same period – "in general, the Siberian High and the winter temperature in the region have an almost perfect 'mirroring' relationship during 1960–2010, suggesting a direct impact of the former on the latter", the authors reported in the paper.

The team also found that the winter temperature of the region of interest had a strong and significant association with greenhouse gas emissions, though seemingly at a slightly weaker confidence. "We'd better be cautious in comparing the two in terms of their contributions to the abnormal rise of temperature," commented LI Baofu, a PhD student with the team and coauthor of the paper: "The key point is, influence from natural factors deserves our keen attention when investigating the warming mechanism," he emphasizes.

In their paper, the authors suggest taking into account the Siberian High as a major factor when predicting the climate of the arid region of northwest China or the East Asia region. Noting the newly detected increase of snow cover in Eurasian, which contributes to the recovery of the Siberian High, the authors propose that this trend, if continues on, may result in a decrease in the rate of temperature rise of this region. "Climate change is a result from many different factors as well as their complicated interactions," they warn of the complication of the issue and the need of more comprehensive, localized and in-depth analysis in the future.Since its publication, the discovery has gained extensive attention from the international community. The Global Warming Policy Foundation (GWPF) published a special report on this discovery, and subsequently held a discussion on the main reasons for climate change in wet and dry areas. (http://www.thegwpf.org/new-evidence-that-water-vapor-is-a-negative-feedback/)

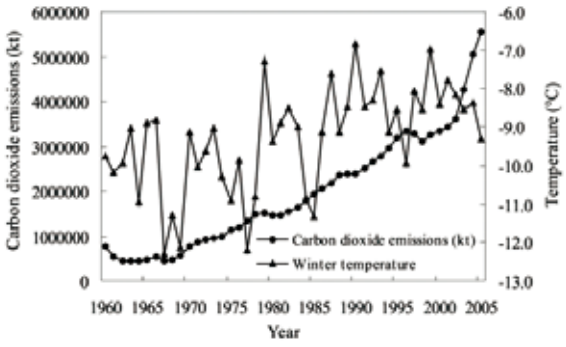

Figure 2: The team also found association between the abnormal rise in temperature and greenhouse emissions.