



A Newly Recognized Large-scale Circulation System Governing the Western Tibetan Climate — the Western Tibetan Vortex

Xiaofeng Li, Hayley Fowler, Nathan Forsythe, Jingjing Yu, David Pritchard, and Stephen Blenkinsop
Newcastle University, School of Civil Engineering and Geosciences, Newcastle upon Tyne, United Kingdom
(xiaofeng.li@newcastle.ac.uk)

The “Western Tibetan Vortex” (WTV) – also termed the Karakoram Vortex – is recognized as a new anomalous large-scale deep vortex system which prevails over the western Tibetan Plateau (TP) in all four seasons, spanning 3–4 times the west–east breadth of the Indian Peninsula. Its intensity is measured by the Karakoram Zonal Index (KZI), which is defined as the normalized zonal wind difference between the north and south branch of the WTV; positive (negative) KZI values indicate an anomalous anti-cyclonic (cyclonic) WTV.

The WTV provides a dominant driver of circulation variability over the western TP, explaining over 50% variance of the western TP circulation on multiple levels throughout the troposphere in most seasons. In particular, it dominates middle-to-lower troposphere and near-surface air temperature variability and also causes opposing temperature changes in the lower stratosphere above the western TP, resulting in an anomalous temperature “dipole” structure in the vertical temperature profile. Our theoretical approach demonstrates that adiabatic sinking-compression (rising-expansion) provides the overwhelming control on both the middle-to-lower tropospheric and lower stratospheric temperature increases (decreases) under anti-cyclonic (cyclonic) WTV conditions over the western TP high mountain area in all four seasons. This also explains the mechanisms behind the anomalous temperature “dipole” found between the mid-lower troposphere and lower stratosphere. We also find that the WTV significantly modulates changes in precipitation patterns and total column ozone surrounding the western TP. As such, the WTV has important implications for the understanding of atmospheric, hydrological and glaciological variability over the TP.

Keywords: Karakoram Vortex, Western Tibetan Vortex, Precipitation, Ozone, Temperature, Tibetan Plateau