

Relationship between two groups of winds and precipitation over northern Vietnam in summer

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1. Introduction

The climate over northern Vietnam is characterized by climatologically southwestern monsoonal wet flow in the lower troposphere in summer (Matsumoto 1992). The summer also corresponds to the rainy season. This region is surrounded by high mountains in the southern and western sides, therefore, it is located at a rain shadow of the southwesterly wind and the mountains. It is difficult to explain why the annual precipitation mainly occurs in northern Vietnam in terms of the moisture flow. We revealed that the climatological southwestern flow consists of two groups of winds, southerly and westerly. Moreover, the southerly wind days can be related to a substantial part of the summer precipitation.

2. Data and method

We used Vietnam Gridded Precipitation (VnGP) dataset (Nguyen-Xuan et al. 2016) and operational rawinsonde observation at Hanoi from 1993 to 2010. Analyzed months were May, June, July and August with climatological daily precipitation over 3 mm day⁻¹ (Nguyen-Le et al. 2015) over northern Vietnam.

3. Results

The wind directions at the 925-hPa level mainly consist of southerly and westerly winds (Fig. 1). Such a feature with two wind groups is not observed at the southward stations in Vietnam, Da Nang and Ho Chi Minh. Regional mean daily precipitation is larger on southerly wind days than on westerly wind days. 44.5% of the total precipitation is brought on the southerly wind days in the analyzed months. This large percentage is brought by not only the larger daily precipitation, but also more frequent southerly winds than westerly winds. Over most areas in northern Vietnam, mean precipitation is generally larger on the southerly wind days (Fig. 2a) than on the westerly wind days (Fig. 2b). Exceptions are seen in the north-western and -eastern edges and lower mean precipitation on the southerly wind days can be clearly seen in a ratio of precipitation on the southerly wind days to that on the westerly wind days (Fig. 2c). These two regions have mountains eastward. On the other hand, there is a region where the precipitation is twice on the southerly wind days as much as on the westerly wind days in the eastern foot of Hoang Lien Son Mountains. These results can be related to a strong rain shadow effect in the westerly wind.

4. Discussion and Conclusion

The above results explain a cause of heavier rainfall in northern Vietnam in summer with climatologically monsoonal southwesterly flows despite the rain shadow location; a large part of the precipitation is brought in the southerly wind which can transport moisture from the South China Sea. Such a moisture transport route is partly shown over northern Vietnam in the previous studies (Yoshimura et al. 2004; van der Ent and Savenije 2013), however, it has not been clearly shown in the southerly or westerly wind cases in this region. We will, therefore, investigate moisture transport in these wind direction cases. We will also investigate the horizontal extent of the two wind direction modes, the difference in meteorological fields over whole the Asian monsoon region and the relationship with intraseasonal and interannual variations.

References

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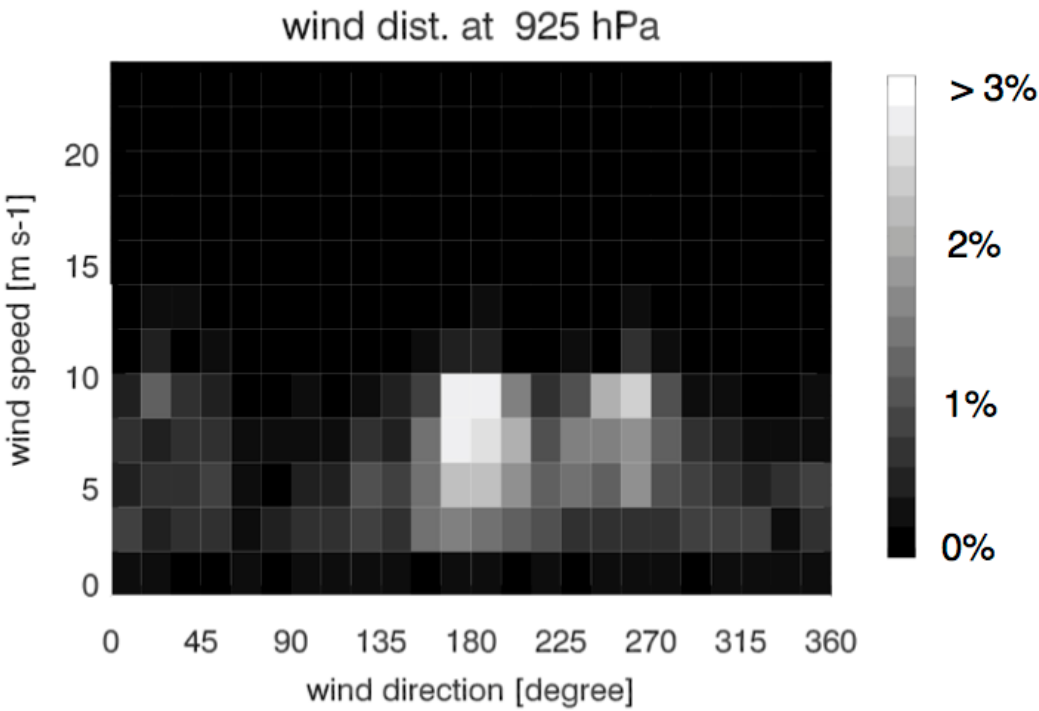


Fig. 1: Frequency distribution of wind direction and speed at the 925-hPa level in months from May to August in 1993–2010 for morning (00Z) observations at Hanoi. The frequency is defined as the ratio to the number of all observations. Modified from Fig. 4a in Nodzu et al. (2018) in revision.

