Characteristics of cloud radiative forcing over the Asian summer monsoon regions: Contrasts between the Tibetan Plateau and the tropical western North Pacific

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Abstract

Both of the convective activity over the tropical western Pacific and Tibetan Plateau (TP) heating significantly connect to the interannual variability of East Asian summer monsoon (EASM) rainfall. The former is known to influence the extratropical circulation over the EASM regions in the form of teleconnection, called "Pacific-Japan (PJ) pattern" and suggested that this pattern is forced by the anomalous sea surface temperature. The latter occurs from spring to summer and forces anomalous circulation propagating like a Rossby wave which in turn affects the EASM regions.

With the highest mountains where little water vapor from the tropics can reach, the TP could provide a natural laboratory to study cloud formation and microphysical properties, in particular, for high clouds (a great amount of high clouds exists over the TP and its seasonal cycle is evident with the largest amount and highest frequency in spring and summer). The vertical distribution of clouds, changes of cloud amount and the related radiation flux on TP play a key role in determining diabatic heating profiles of the atmosphere. In other words, the cloud radiative forcing over the TP could be as important as the role of latent heat release over the western North Pacific and maybe can be a tracer to the EASM regions.

Based on cloud types and cloud distributions, this work initially compares cloud radiative forcing over the TP to western North Pacific, and will focus their probable effect on the EASM regions in proceeding work.

References

Hsu, H. H. and X. Liu, 2003: Relationship between the Tibetan Plateau heating and East Asian summer monsoon rainfall, *Geophys. Res. Lett.*, **30**(20), 2066, doi:10.1029/2003GL017909.

Krishnan, R. and M. Sugi, 2001: Notes and correspondence: Baiu rainfall variability

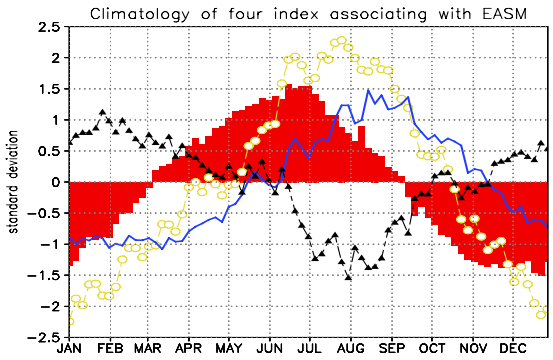
and associated monsoon teleconnections, *J. Meteor. Soc. Japan*, **79**, 851-860.

Wang, B., R. Wu, and K. M. Lau, 2001: Interannual variability of the Asian summer monsoon: Contrasts between the Indian and the western North Pacific-East Asian monsoons, *J. Clim.*, **14**, 4073-4090.

Zhu, C., W. S. Lee, H. Kang, and C. K. Park, 2005: A proper monsoon index for seasonal and interannual variations of the East Asian monsoon, *Geophys. Res. Lett.*, **32**, L02811, doi:10.1029/2004GL021295.

Figures

(a)



(b) (c)

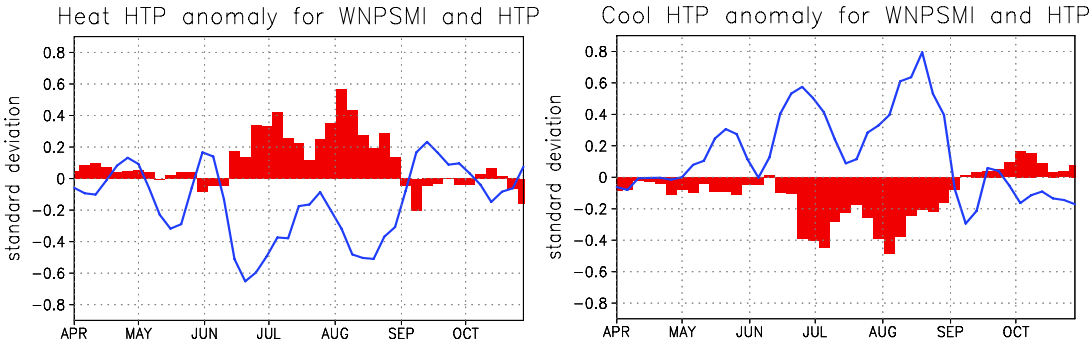
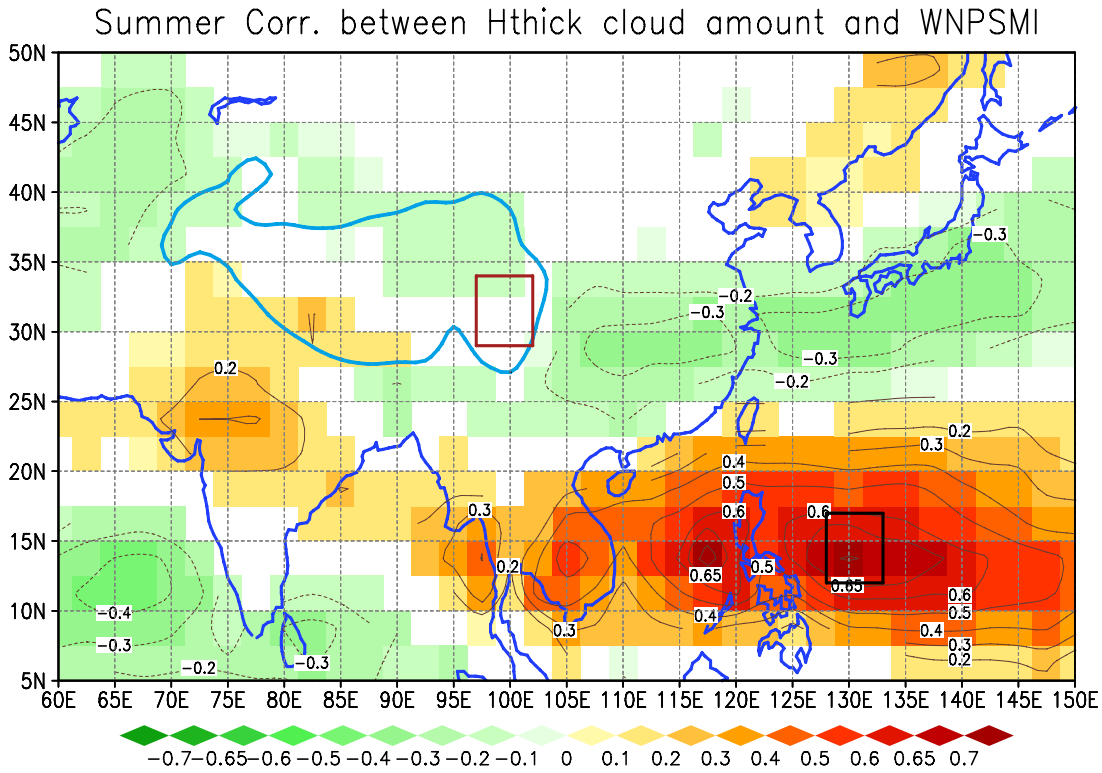


Figure 1. (a) Seasonal variation in four indexes: western North Pacific summer monsoon index (WNPSMI —, Wang et al. 2001), Tibetan Plateau heating (HTP ■, Hsu and Liu 2003), East Asia monsoon index (EAMI ○, Zhu et al. 2005) and Asian continental pattern index (ACPI ▲, Krishnan and Sugi 2001). The unit has been normalized. (b) Composite of positive HTP anomaly (heating anomaly, 1991, 1995, 1998 and 1999) in WNPSMI and HTP. (c) The same as (b) but for cooling anomaly years (1984, 1986, 1990, 1994, 1997 and 2001).

(a)



(b)

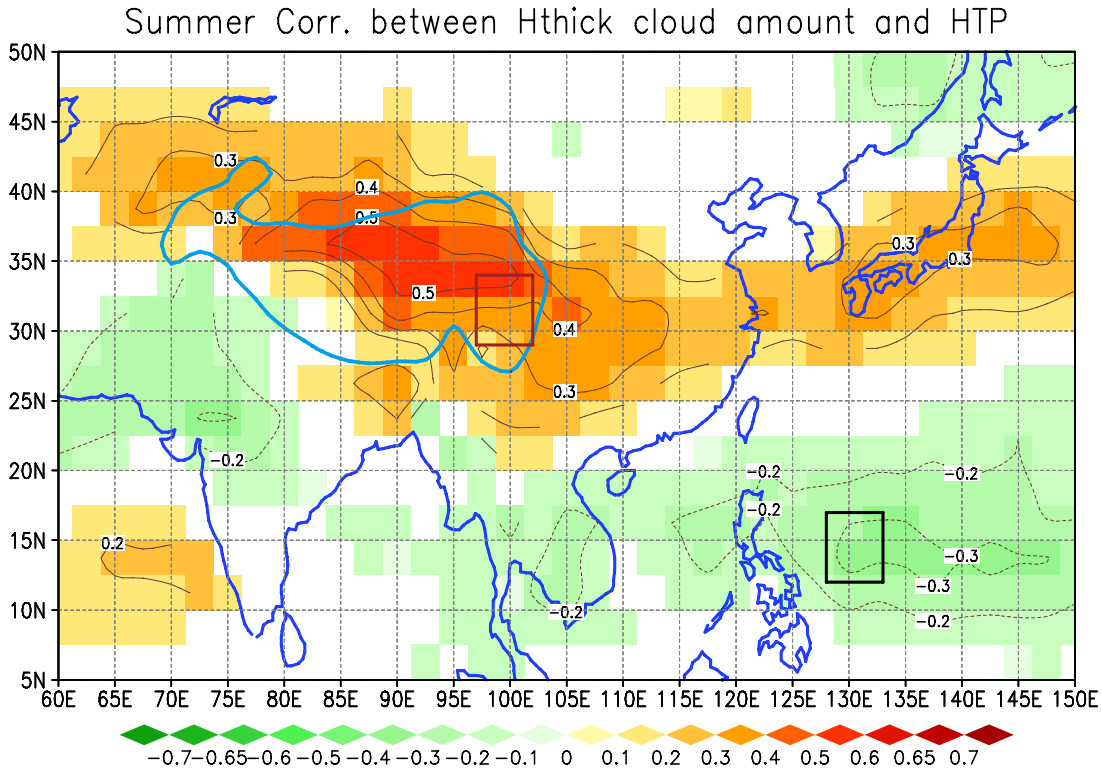
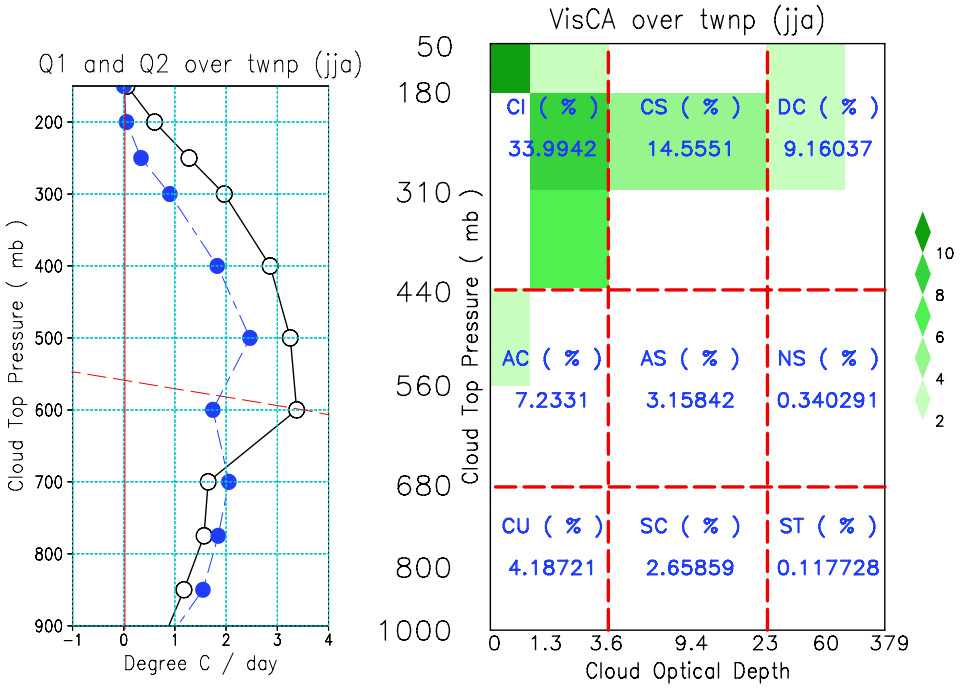


Figure 2. Pentad correlation coefficient in summer between (a) High-thick cloud amount and WNPSMI and (b) High-thick cloud amount and HTP.

(a)



(b)

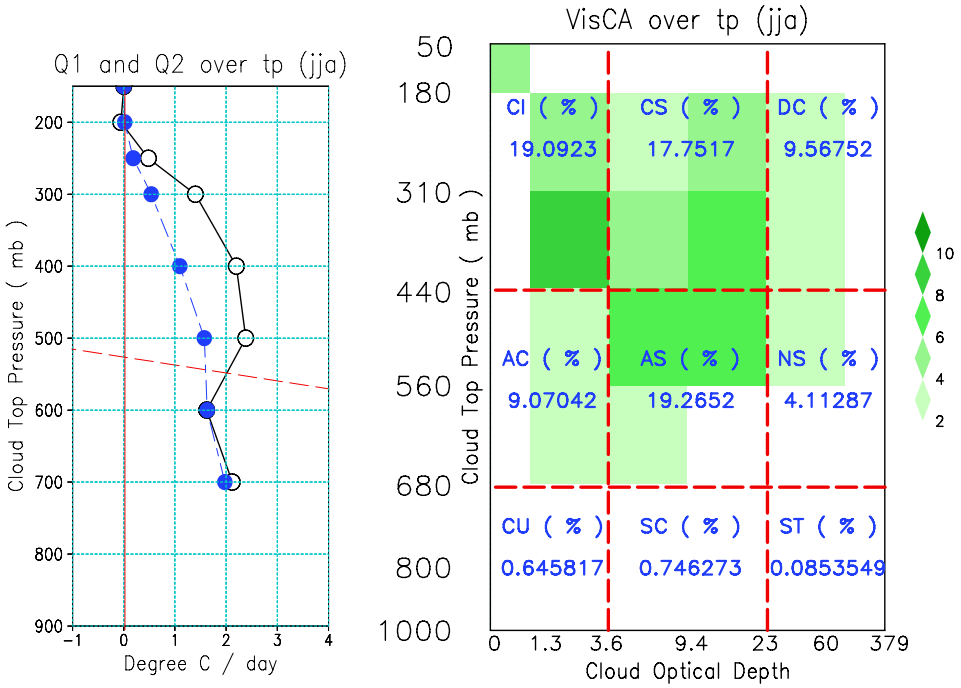


Figure 3. (Left) Vertical profile of Q1 (℃/day, black line with symbol ○), Q2 (℃/day , blue line with symbol ●) and atmospheric temperature (℃, red dash line). (Right) Vertical profile of visible cloud amount (%, based on the classification in ISCCP). The data is average in summer in the area-mean of (a) TWNP (128°E~133°E, 12°N~17°N) and (b) TP (97°E~102°E, 29°N~34°N).