EGU22-3294, updated on 16 Aug 2022
https://doi.org/10.5194/egusphere-egu22-3294
EGU General Assembly 2022

A case study of heavy rainfall event in July 2020 over western Japan focusing on free-tropospheric moisture

Hiroki Tsuji and Yukari N. Takayabu
The University of Tokyo, Atmosphere and Ocean Research Institute, Kashiwa, Japan (h-tsuji@aori.u-tokyo.ac.jp)

Recent studies indicate that precipitation systems causing heavy rainfall affecting a wide area in Japan show similar characteristics as organized precipitation systems with deep inflow layers (Hamada and Takayabu 2018; Tsuji et al. 2021). Free-tropospheric moisture is a key factor for organizing such precipitation systems (e.g., Holloway and Neelin 2009). However, less attention has been paid to the roles of free-tropospheric moisture on precipitation systems causing heavy rainfall events around Japan.

In this study, contributions of each term in the water vapor budget equation are investigated for an extreme rainfall event that occurred in July 2020 over Kyushu, Japan. To focus on the roles of free-tropospheric moisture, the vertically integrated water vapor flux convergence (IVFC) term is divided into the boundary-layer and free-troposphere by 900 hPa.

The free-tropospheric IVFC starts to increase over one day before the rainfall peak time. Change in the precipitable water tendency follows the increase of the free-tropospheric IVFC. Further analyses with dividing the IVFC into an advection term (V□q) and a divergence term (q□V) clarify that the change in the advection term corresponds to that in the precipitable water tendency. A synoptic disturbance is developed over China and propagated eastward when the precipitable water tendency increases. This synoptic disturbance enhances the moisture advection, moistening the atmosphere over Kyushu before the rainfall event. Under the moistened environment, a mesoscale convective system (MCS) starts to develop nine hours before the rainfall peak time. The MCS covers Kyushu Island at the rainfall peak time, and intense precipitation areas appear to the southern edge of the MCS, causing disastrous rainfall. Vertical cross-sections of the MCS show a slantly ascending deep inflow layer with moist absolutely unstable layer (MAUL), consistent with organized precipitation systems shown in previous studies (Bryan and Fritsch 2000).

These results indicate that the free-tropospheric IVFC contributes to the heavy rainfall event by providing environments favorable for producing and maintaining deep inflow structure and MAUL, which characterize organized precipitation systems.

Acknowledgments
This research is supported by Japan Aerospace Exploration Agency (JAXA) Precipitation Measuring Mission science, the University of Tokyo through a project “Research hub for the big data analysis of global water cycle and precipitation in changing climate”, and the Environment Research and

Technology Development Fund (JPMEERF20192004) of the Environmental Restoration and Conservation Agency of Japan.

References

Bryan, G. H., and J. M. Fritsch, 2000: Moist absolute instability: The sixth static stability state, *Bull. Amer. Meteor. Soc.*, **81**(6), 1207-1230, doi:10.1175/1520-0477(2000)081<1287:MAITSS>2.3.CO;2

Hamada, A., and Y. N. Takayabu, 2018: Large-scale environmental conditions related to midsummer extreme rainfall events around Japan in the TRMM region. *J. Climate*, **31**(17), 6933–6945. doi:10.1175/JCLI-D-17-0632.1

Holloway, C. E., and J. D. Neelin, 2009: Moisture vertical structure, column water vapor, and tropical deep convection. *J. Atmos. Sci.*, **66**(6)**,** 1665–1683. doi:10.1175/2008JAS2806.1

Tsuji, H., Y. N. Takayabu, R. Shibuya, H. Kamahori, and C. Yokoyama, 2021: The role of free-tropospheric moisture convergence for summertime heavy rainfall in western Japan. *Geophys. Res. Lett.*, **48**, e2021GL095030. doi:10.1029/2021GL095030