An application of the detection method for atmospheric fronts to a large ensemble climate data

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In recent years, heavy rainfall disasters attributed to atmospheric fronts often occur in Japan, such as the heavy rain event of July 2018 in western Japan and 2017 in northern Kyushu. A forecasting of the fronts as well as rainfall associated with them make impacts on society in disaster prevention such as risk avoidance due to heavy rainfall. To give an example, a weather forecast for short-term within 1 week, is useful to take refuge and for yearly long term is helpful to determine an evacuation plan.

A previous study made normalized parameter of thermal and dynamical variables, horizontal temperature gradient and isobaric relative vorticity. There is an atmospheric front at isobaric surface of 900hPa where the parameter is over threshold value. Around an atmospheric front, horizontal temperature gradient is larger than other regions. The wind converges in the boundary between warm air mass and cold air mass with rotation. Therefore, horizontal wind fields of the fronts have positive relative vorticity compared to others. This diagnostic detected the front accompanying passing of extratropical cyclone across the North Atlantic.

In this study, a thermal variable of the parameter used by the diagnostic is equivalent potential temperature and the objective diagnostic is specialized for the climate of north-western Pacific Ocean region around Japan. The equivalent potential temperature means the temperature and quantity of water vapor. Thus, the new diagnostic would detect the boundary between air masses which has the difference in quantity of water vapor as fronts. It called as water vapor front. It appears on East China Sea at south side of Baiu front. In the case of the heavy rain from June 28th to July 8th, 2018, nine o’ clock (Japan standard time) each day, the diagnostic detected a part of Baiu front in four days and all part of it in seven days. In addition, it detected water vapor fronts in the term of heavy rain in 2018. In other cases, it detected cold fronts, warm fronts, occluded fronts embedded with an extratropical depression. The parameter value increases with improvement of the depression.

This diagnostic would be used to detect the fronts in future climate. The used data is d4PDF, a database composed of the results from model experiments for 3,000 years in past climate and 5,400 years in future climate. We apply the method to the data for climate of the past and future. These application results would be compared and used to examine the variation of the frontal distribution with climate change.

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