Diurnal cycle of precipitation over maritime continent using different in-cloud parameterizations

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Some cumulus parameterizations are known to be poor at reproducing diurnal cycle of precipitation. One of the reasons for this feature is considered to be derived from convective adjustment closure employed in cumulus parameterization. In general, the convective adjustment closure has been constructed assuming an equilibrium between forcing in free-troposphere and convection stabilization, thus it cannot consider several hours' time scale forcing below boundary layer which is dominant force for diurnal cycle of convection. Bechtold et al. (2014) recently developed non-equilibrium closure considering forcing from boundary layer, and succeeded in reproducing the diurnal cycle of precipitation over continents. However, Sratton and Stirling (2012) showed improvement of diurnal cycle of precipitation by using different entrainment parameterization. Therefore, non-equilibrium closure is not only one solution for improving diurnal cycle of convection (and thus precipitation), and improving in-cloud parameterization such as entrainment can be another solution.

To validate effect of in-cloud parameterization in cumulus parameterization on the diurnal cycle of precipitation, two different in-cloud parameterizations (new scheme developed in Baba 2017 and one used in IFS/ECMWF) were used, and regional atmospheric simulations focusing on the precipitation over maritime continent were performed. The results showed that phase of the diurnal cycle was well reproduced compared to the reanalysis data regardless of in-cloud parameterizations, however, amplitude of the diurnal cycle was greatly affected by the difference in the in-cloud parameterization. Further analysis on the convective structure revealed that IFS's parameterization simulated deeper convection than the new scheme simulated, and the new scheme simulated more coexistence of deep and shallow convection. These results suggested that phase of diurnal cycle is independent of the in-cloud parameterization but is considered to be dependent on other physical parameterizations, and dependence of the amplitude on the parameterization is significant because of the change in convective structure.

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