Intense thunderstorms and their large-scale environments over different regions

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During the past decades, the global precipitation systems has been extensively studied with ground based, ship based, airborne, and space borne radars. Especially with TRMM precipitation radar, Houze and his research group have examined convection over various selected regions, including the South Asian (Romatschke et al.2010; Medina et al. 2010), the South America (Rasmussen and Houze 2011), the Central Africa (Zuluga and Houze 2015), the indian and west Pacific oceans (Zuluaga and Houze 2013, Barnes et al. 2015), the Atlantic and east Pacific (Zuluaga and Houze 2015), as well as global (Houze et al. 2015). A general impression from these studies is that convection over various regions not only has their own special dynamic environment setups, but also shares some common features. For example, the most intense convection often occurs over basins downstream of mountains when dry warm air at mid troposphere is above a warm moist air continuously being replenished by a low level jet, which appears locally as a famous storm favoring “onion shape sounding”. The question is whether we can/ how to utilize these common features to improve the numerical models, such as cumulus parameterization. To answer this question, first we examine the relationships between large-scale thermodynamic parameters and sub grid scale convective properties, such as intensity. Then we attempt to understand the importance of specific thermodynamic factors favoring intense convection over various regions. The properties of 16-year of TRMM Precipitation Features are analyzed along with the large-scale parameters from 0.75° ERA-Interim reanalysis. The environment variables, including CAPE, CIN, low level wind shear, lift condensation level, among many others, are individually as well as jointly correlated with fractional occurrence of strong convection with high lightning flash rates. Using these relationships, the global distribution of fractional occurrences of convection with high lightning rates are estimated from ERA-Interim variables and compared to the TRMM derived climatologies. Results suggest that regions favoring the intense convection may be partially explained by the combinations of several important thermodynamic environment factors. This work implies the potential of introducing the convective intensity into the cumulus parameterizations.

Keywords: intense thunderstorm, large-scale environment

