Shallow and deep latent heating modes over tropical oceans observed with TRMM PR spectral latent heating data

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Popular Summary

The global hydrological cycle is central to the Earth's climate system,
with rainfall and the physics of its formation acting as the key links
in the cycle. Two-thirds of global rainfall occurs in the Tropics.
Associated with this rainfall is a vast amount of heat, which is known
as latent heat. It arises mainly due to the phase change of water vapor
condensing into liquid droplets; three-fourths of the total heat energy
available to the Earth's atmosphere comes from tropical rainfall. In
addition, fresh water provided by tropical rainfall and its variability
exerts a large impact upon the structure and motions of the upper ocean
layer.

Three-dimensional distributions of latent heating estimated from
Tropical Rainfall Measuring Mission Precipitation Radar (TRMM PR)utilizing the Spectral Latent Heating (SLH) algorithm are analyzed. Mass-weighted and vertically integrated latent heating averaged over the tropical oceans is estimated as ~72.6 J s-1 (~2.51 mm day-1), and that over tropical land is ~73.7 J s-1 (~2.55 mm day-1), for 30N-30S. It is shown that non-drizzle precipitation over tropical and subtropical oceans consists of two dominant modes of rainfall systems, deep systems and

congestus. A rough estimate of shallow mode contribution against the total heating is about 46.7 % for the average tropical oceans, which is substantially larger than 23.7 % over tropical land.

While cumulus congestus heating linearly correlates with the SST, deep mode is dynamically bounded by large-scale subsidence. It is notable that substantial amount of rain, as large as 2.38 mm day-1 in average, is brought from congestus clouds under the large-scale subsiding circulation. It is also notable that even in the region with SST warmer than 28 oC, large-scale subsidence effectively suppresses the deep convection, remaining the heating by congestus clouds.

Our results support that the entrainment of mid-to-lower-tropospheric dry air, which accompanies the large-scale subsidence is the major factor suppressing the deep convection. Therefore, representation of the realistic entrainment is very important for proper reproduction of precipitation distribution and resultant large-scale circulation.