4–8 November 2019, Kraków, Poland
ECSS2019-186

A Unified Theory of Storm Top Dynamics and Its Verification

Pao K. Wang
Academia Sinica, Research Center for Environmental Changes, Taipei, Taiwan (pwang1@wisc.edu)

Severe storms pose a serious threat to human society and reliable forecast of them will help mitigate the potential damages by them. They also play an important role in the global climate process. Satellite data can provide the widest coverage and continuous information of storm activities for forecasters and researchers but these data have to be interpreted correctly to render them useful.

In this presentation, I will describe a unified theory of the dynamics of storm tops based on the interaction between the updraft-ambient flow interaction and use the theory to explain the major visible and IR features at storm tops as seen by meteorological satellites and aircraft such as cold-V, jumping cirrus, above anvil cirrus plumes (AACP), and ship waves. The updraft induced severe internal gravity waves at the storm top level which, under suitable conditions, will perform wave breaking and generate jumping cirrus and AACP features as observed. The obstacle effect of the updraft also induces quasi-mountain waves and generate cold-V, warm-cold couplet and ship waves. I will use cloud dynamical model simulations to show that the theory necessarily leads to the storm top conditions as observed. There are also some ground-based observations that serve as additional evidence supporting the theory.

This unified theory leads to a new understanding of the impact of thunderstorms on global atmospheric processes. I will discuss the implications of severe storms on global atmospheric processes (such as climate process and atmospheric chemistry) and suggest future researches in this direction.