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Clear Air Turbulence Caused by Storm Top Internal Gravity Wave Breaking Based on Satellite Data

Pao Wang (1,2), Kai-Yuan Cheng (1), and Scott Bachmeier (1)

(1) University of Wisconsin-Madison, Atmospheric and Oceanic Sciences, Madison, United States (pao@windy.aos.wisc.edu), (2) Research Center fro Environmental Changes, Academia Sinica, Taipei, Taiwan

Satellite data are extremely important in providing information of the atmospheric conditions, and one of the most useful of these data is that they cover wide areas that include locations where there is no other types of data available. This is true for the case of severe storms and it is important for forecasters and researchers to obtain satellite storm information if they wish to perform accurate forecasts and research. This paper will report on the plausibility of using satellite storm data for forecasting clear air turbulence.

Recent studies indicate that clear air turbulence (CAT) phenomenon, which poses serious aviation threat, is closely associated with severe thunderstorms. It is desirable to understand how such storms generate CAT and how CAT spreads in time. Moreover, it will be highly beneficial if a forecast technique can be developed based on satellite data, especially those from the geosynchronous satellites, so that storm activity can be monitored continuously.

Recently a few satellite-observed cloud top features of some severe storms in both visible and infrared channels have been identified. These include enhanced-V (cold-V), warm-cold couplet, above anvil plumes and jumping cirrus. In order to understand the physical mechanisms responsible for producing these feature, we conducted cloud model simulation studies and showed that all these features are basically the result of the interaction between the strong updraft due to the deep convection and the ambient winds. The updraft produces vigorous internal gravity waves which breaks under suitable interaction condition with the ambient wind. The wave breaking is mainly responsible for CAT. With this main understanding, it is now possible to come up with a unified theory how all such features occur and how they are related to CAT. Such an understanding will be beneficial to CAT forecast.

In the present paper, we will report on the observed phenomena and use model simulation to illustrate the physical mechanisms responsible for their generation. We will also show that these phenomena are all interrelated and can be used an indicators of CAT potential.