# A CLOUD MODEL STUDY OF WIND SHEAR EFFECT ON THE SATELLITE OBSERVED STORM TOP IR FEATURES

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## I. INTRODUCTION

Satellite observations are very useful for thunderstorm studies and forecasting or nowcasting. They can provide information about storms that occur in locations where no ground observations are available. They can cover a very wide area over the earth, even global and be continuous in time if necessary.

But because satellite observation is a remote sensing technique, it must be correctly interpreted in order to be effective in its usage. Because a satellite views a storm system from the top, it mainly sees the top layer of the storm. While it is possible to use some features on the storm top purely as indicators of the storm behaviour (through, for example, purely correlation studies), it is much better if we can understand the physical mechanisms responsible for the generation of these features. Such understandings will eventually lead to much better and more reliable forecasts of storms.

One way to understand such physical mechanisms is to perform numerical storm model studies to simulate certain storms to see if the model can reproduce the features observed. If this is successful, then one can use the physics built in the model to track the responsible mechanisms. This is the approach of the present paper.

The present paper will focus on the infrared features on top of storms as observed by satellites. Infrared images are available day and night, and thus can provide information when visible data are not available. Important major IR features atop thunderstorms have been studied previously (see, for example, Heymsfield and Blackmer, 1988; Wang et al., 2001; Setvak et al., 2007).

## II. SATELLITE OBSERVED STROM TOP IR FEATURES

The storm top IR features observed by meteorological satellites include the enhanced-V/U or cold-V/U, close-in warm area (CWA), distant warm area (DWA), warm-cold couplet, and cold area (CA) (see heymsfield and Blackmer, 1988). A new feature, called the cold ring (CR), was reported by Setvak et al. (2008). In some storms, the CR eventually evolved into the cold-V. It is this behaviour that motivated the present study.

We propose that this behaviour is mainly due to the wind shear. The different wind shear that is present at different level and different time causes the storm top IR features to change their characteristics. We hypothesize that the cold ring feature occurs when the storm top is located at a level where the wind shear is relatively weak, whereas the cold-V/U appears when the wind shear is stronger.

In this paper, we will use a cloud resolving model WISCDYMM to perform simulations of storms under different wind shear conditions and analyze the cloud top temperature field to see if this field exhibit the observed IR features. We will compare these temperature fields to study the effect of wind shear.

The model we will use is the same as that used in some of our previous studies (Wang, 2003, 2004, 2007a, b) and the details can be found in these references.

## III. RESULTS AND CONCLUSIONS

We have obtained preliminary results that basically confirm positively the hypothesis made in the previous section, namely, the cold ring feature is associated with weak wind shear conditions whereas the cold-V/U is associated with the higher wind shear condition. Fig. 1 and 2 show the examples of the storm top temperature field corresponding to these two wind shear scenarios.

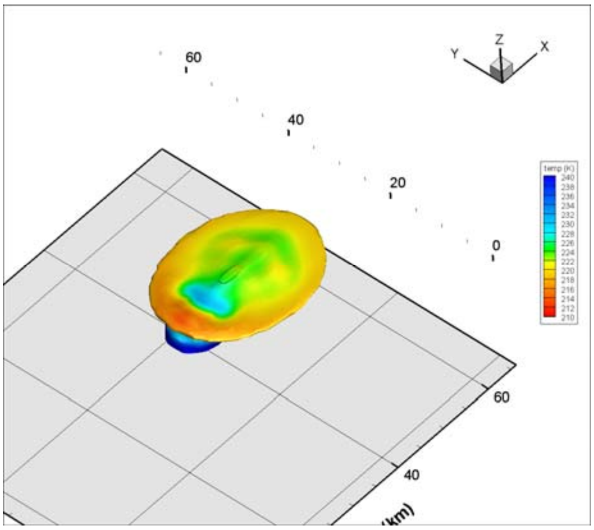


Fig. 1 Cloud top temperature field of a simulated thunderstorm at t = 1800 sec. The storm is initialized by an idealized sounding with the assumption that the wind increases from zero at the surface to 20 m/s at z >= 13 km. The cloud top temperature field reveals an elongated cold ring along the outer edge of the anvil with warmer temperature inside. The coldest point is at the upstream "apex" whereas the warmest point is located in the downstream part of the anvil but close to the coldest point. The temperature inside the ring is not uniform but is apparently associated with the cloud top wave motions.

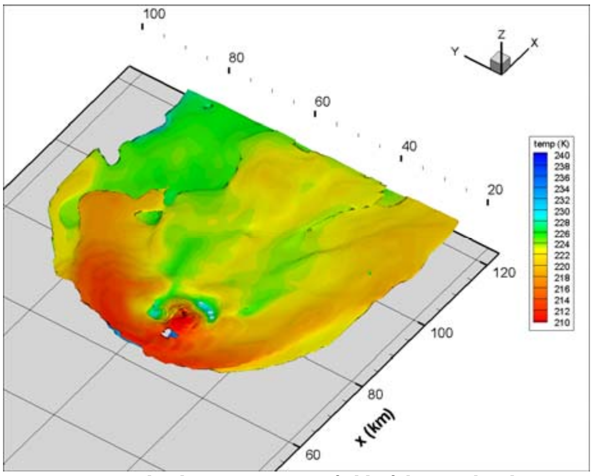


Fig. 2 Cloud top temperature field of the simulated CCOPE supercell at thunderstorm at t = 7200 sec. The storm is initialized by a sounding as reported by Wang (2003). The cloud top temperature field reveals an enhanced-V/U (cold-V/U) at the upstream and a general warm area in the downstream part of the anvil. The CA, CWA, DWA and the warm-cold couplet features as described in Heymsfield and Blackmer (1988) are also reproduced well.

Currently, we are making more detailed analysis of the model results and the comparison of the modelled cloud top temperature fields with that observed by satellites. These results will be reported in the conference.

## IV. AKNOWLEDGMENTS

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