

DETECTING V-STORMS USING METEOSAT SECOND GENERATION SEVIRI IMAGE AND ITS APPLICATIONS: A CASE STUDY OVER WESTERN TURKEY

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I. INTRODUCTION

Multispectral satellite analysis has demonstrated an important role in increasing our understanding of the properties of convective storm tops. Previous studies have been identifying outbreaks of convective storm tops from satellite images by combining water vapor and infrared window channels (Schmetz et al. 2007, Setvák et al. 2007). Heymsfield and Blackmer (1988) made a more comprehensive study to understand the mechanisms responsible for the formation of the V-Shaped and proposed nine different convective systems with different features from 1979 to 1982 to describe the phenomenon. The V-Shaped was matched for all the storms, except one.

The second generation imaging radiometer on board the European geostationary satellite METEOSAT, the Spinning Enhanced Visible and Infrared Imager (SEVIRI), has been used to support forecasting of the possible occurrence of severe convective storms. Each imaging radiometer is a composite of eleven narrow channels in the in the visible (VIS), near infrared (NIR), water vapor (WV) and thermal emitted infrared (IR) in addition to one high resolution visible broad-band channel (HRV) with a sampling distance of 1km at sub-satellite point (EUMETSAT, 2004).

The present study attempts to use multispectral SEVIRI images to investigate a severe storm which occurred in Western Turkey on November 5th, 2007. It is worthwhile to analyze whether the V feature and other important cloud top signatures are associated with severe thunderstorms as outlined by previous investigators above.

II. THE 5 NOVEMBER 2007 CASE STUDY

The thunderstorm over the Çameli town was investigated. Çameli is located in western part of Turkey and 100 km far away from the southern coast of the Mediterranean Sea. Due to its particular geographical situation, surrounded by high mountains, Çameli is an area with high humidity and rather light winds at lower atmospheric levels, which provides favorable conditions for the formation of offline storms and Mesoscale Convective Systems (MCS). The cloud development is illustrated in Fig. 2 by the 06:00 UTC IR Meteosat image. Hail, rain and severe wind damage were reported.

III. APPLICATION OF SEVIRI IN TURKEY STORM DETECTING

SEVIRI data from 5 November 2007 with a temporal resolution of 15 minutes were retrieved from the EUMETCast service through the reception station in the Turkish State Meteorological Service (TSMS). They were processed and displayed into reflectivity (channels 1, 3 and 12) and BT (Brightness Temperature) (channels 5, 6, 9 and 10) by exploiting the MSGView software from the TSMS. The determination of cloud top radiances obtained from these channels relied on the following two assumptions; 1) that clouds were cumulonimbus so they can be considered optically thick; and 2) that they were considered blackbodies. Schmetz et al. (2007) suggested that positive BT differences between WV – IR are only possible when deep convective clouds inject moisture in the stratosphere. These positive differences can be used as a proxy for very deep convection clouds (overshooting cases).

Fig. 1 exhibits the model of “cold-U/V” shape storms (Heymsfield & Blackmer 1988) and Fig. 2 and Fig. 3 shows concordant patterns at the top of intense storm.

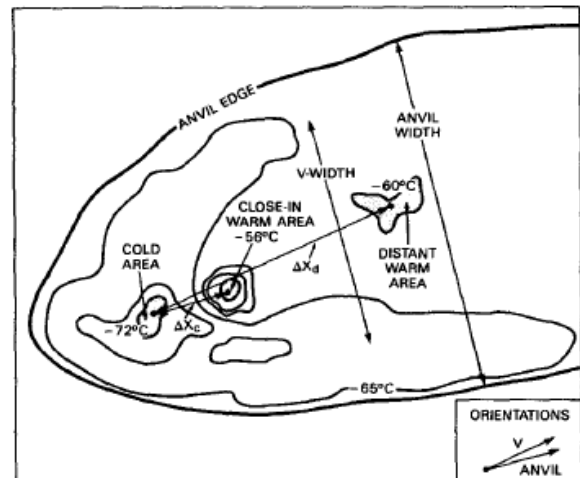


FIG 1. The model of “cold-U/V” shape storms (Heymsfield & Blackmer 1988).

These results are also in good agreement with studies done by (Heymsfield and Blackmer 1988, McCann, 1983). In the Fig. 3, it is shown the formation of several “ring” signatures found in the cloud tops. A minimum of 206 K (around -66°C) indicates that the updrafts in this thunderstorm must have been very strong

with significant overshooting of the tops into the stratosphere. In addition, a visual inspection of the cloud top structures from the HRV image (Fig. 3) illustrates a typical V-shaped feature.

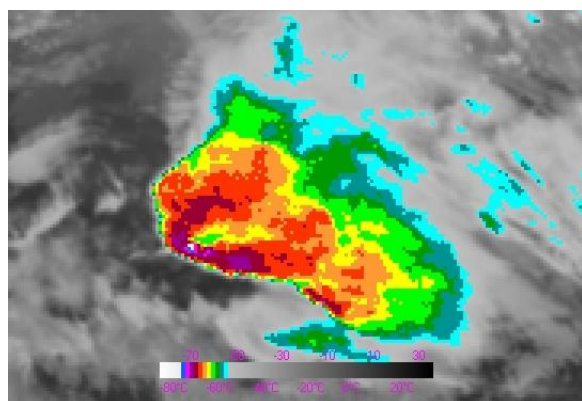


FIG. 2. Zoomed-in IR 10,8 image

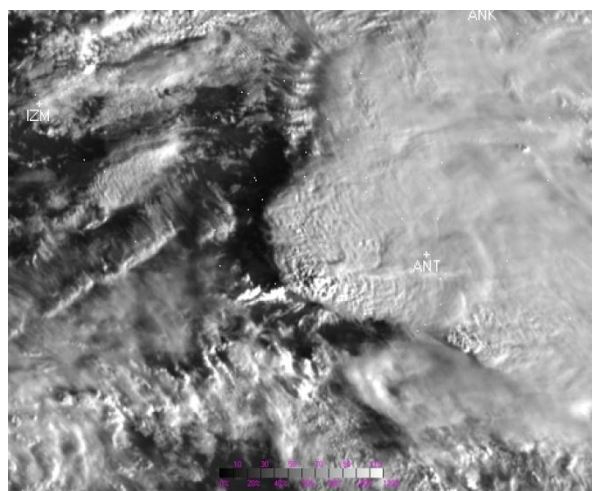


FIG. 3. HRV image.

There is a strong link between ice particles sizes and water vapor anomalies in deep convective clouds. Using this link between microphysical properties and cloud dynamic, we employed the multi-spectral RGB applications.

They are excellent tools for the study of convective cloud with their use of air masses and storms RGBs. Based upon the RGB combination of channels (WV 6.2 μm – WV 7.2 μm ; IR 3.9 μm – IR 10.8 μm ; NIR 1.6 μm – VIS 0.6 μm), the red color appears in clouds with larger icing with darker orange for smaller ice particles, whereas the combination of RGB (WV 6.2 μm – WV 7.3 μm ; IR 9.7 μm – IR 10.8 μm ; WV 6.2 μm) appears for warmer air mass in green, colder air mass as in blue and thick high-level clouds in white.

IV. RESULT AND CONCLUSION

Fig. 4, scatter plot diagram shows that reflectance differences of VIS06 and NIR16 are around 35-50%, BT differences of WV62 and WV73 are between -5 to 2 $^{\circ}\text{C}$ within the storm. Not a completely unexpected outcome as the total ice concentration within the clouds increases with increasing flash rate. Nevertheless, severe storm is rather related to tornados and large hail, not precipitation.

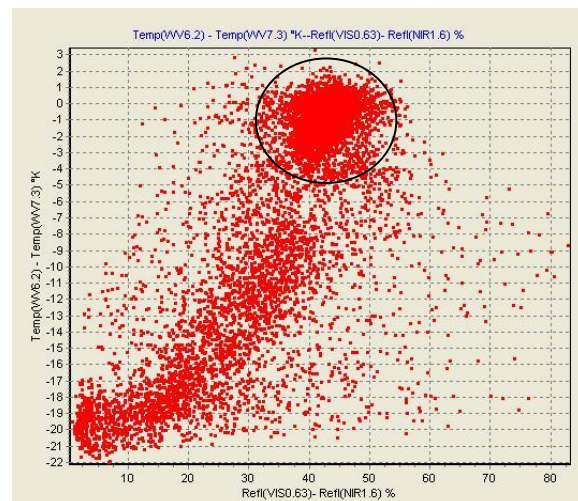


FIG. 4. Scatter plot diagram, WV channel diff. versus VIS0.6 and NIR1.6 diff.

We used a combination of the multispectral MSG SEVIRI data to evaluate cloud top conditions in the thunderstorm event of 5 November 2007 over the Çameli town in Western Turkey. The results shown above demonstrate the use of MSG to provide the possibility of detection of lower stratospheric water vapor above cold convective storm tops.

V. ACKNOWLEDGEMENTS

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VI. REFERENCES

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