# DETECTION OF THE MEDITERRENEAN STORMS USING MSG SEVIRI IMAGES

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## I. INTRODUCTION

Mediterranean Sea is one of the sources of development of small-scale storms. Thunderstorms and tornados originated from Mediterranean Sea affect Turkey and Greece several times a year. They do not only destroy structures but also cause loss of life and property. The severe weather conditions also affect navigation and maritime business in this region. Geostationary meteorological satellites act like primary source for monitoring storms especially for an area which is not well covered by any ground observation system or meteorological radars. This study presents the potential of the high spectral resolution offered by the METEOSAT Second Generation (MSG) SEVIRI (Spinning Enhanced Visible and Infrared Imager) imagery in detecting storms as well as in storm detection and monitoring.

Multispectral satellite analysis has demonstrated its important role in increasing our understanding of the properties of convective storm tops (Schmetz et al., 1997; Setvak et al., 2007). Heymsfield and Blackmer (1987) made a comprehensive study to understand the mechanisms responsible for the formation of the so-called enhanced-V feature (recently referred to as cold-U/V feature), found at tops of some of the deep convective storms, analysing nine convective cases with different features from 1979 to 1982 to describe the phenomenon. The cold-U/V shape occurred for all the storms, except one.

In some cases, even a single SEVIRI image - either visible (VIS) or infrared (IR) - is helpful in detecting storms. In addition, multi-spectral RGB applications provide beneficial help in the recognition of thunderstorms. Looping 15-min SEVIRI cycles also enables monitoring of the storms. In this study, we have analyzed single channel (Visible, Near Infrared, High Resolution Visible and Infrared 3.9, 10.8 and 12.0 microns) images and RGB colour combinations (Day Microphysics, Air Masses and Convective Storm RGBs) to detect the storms as recommended in MSG Interpretation Guide. Four different storms cases are analyzed for the period of 2003-2010 originated over the Mediterranean Sea. We found out that SEVIRI IR channels, HRVIS channel and RGB applications can be used to recognize and monitor small-scale tornados.

## II. DATA & METHOD

The second generation imaging radiometer on board of the European geostationary satellite METEOSAT, the Spinning Enhanced Visible and Infrared Imager (SEVIRI), has been used to support detection and forecasting of four cases of severe convective storms in eastern Mediterranean. The spectral features of these channels are given in Table 1.

| Channel No. | Spectral Band (μm) | Main observational application |
|---|---|---|
| 1 | VIS0.6 | Surface, clouds, wind fields |
| 2 | VIS0.8 | Surface, clouds, wind fields |
| 3 | NIR1.6 | Surface, Cloud phase |
| 4 | IR3.9 | Surface, clouds, wind fields |
| 5 | WV6.2 | Water vapor, high level clouds, atmospheric instability |
| 6 | WV7.3 | Water vapor, atmospheric instability |
| 7 | IR8.7 | Surface, clouds, atmospheric instability |
| 8 | IR9.7 | Ozone |
| 9 | IR10.8 | Surface, clouds, wind fields, atmospheric instability |
| 10 | IR12.0 | Surface, clouds, atmospheric instability |
| 11 | IR13.4 | Cirrus cloud height, atmospheric instability |
| 12 | HRV | Surface, clouds. |

TABLE I: The spectral features of SEVIRI channels and main applications.

MSG images are collected via EUMETCast system and processed by using MSGView (Ertürk, 2010) software at Turkish State Meteorological Service and at Aristotle University of Thessaloniki.

IR and Convective Storms RGB images were used to qualitatively identify the cloud top characteristics. IR10.8 MSG images (IR channel centred at the 10.8 μm) are enhanced using special temperature scale (-70$^{o}$C to -30 $^{o}$C) and special color table to make the storms recognizable. Convective Storm RGB images were produced based on the RGB combination of channels (5-6, 4-9, 3-1) using the recomendations of the MSG Interpretation Guide.

## III. RESULTS AND CONCLUSIONS

The first case is a severe thunderstorm occurred on November 5$^{th}$, 2007 at the western part of Turkey. Figure 1 is an enhanced IR10.8 image showing a Cold U/V shaped (or enhanced-V) storm as documented by Heymsfield & Blackmer (1988). Cold Area (CA), Close-in Warm Area (CWA) and Distant Warm Area (DWA) are easy to detect from the infrared image. Cirrus plumes (Wang et. al, 2007) are another very important feature of the storms being well seen from the High Resolution Visible (HRV) image. (Figure 1b)

The second case is a cold ring shape storm over Cyprus. The main futures of this storms, such as cold ring and Central Warm Spot (CWS) as documented by Setvak et. al. (2010), are detectable in the color enhanced IR image (Figure 2). Convective Storm RGB image is also (Figure 1c) efficient in monitoring severity of storms. Yellow color indicates high level ice cloud with small particle (Cb) and also active parts of the storms

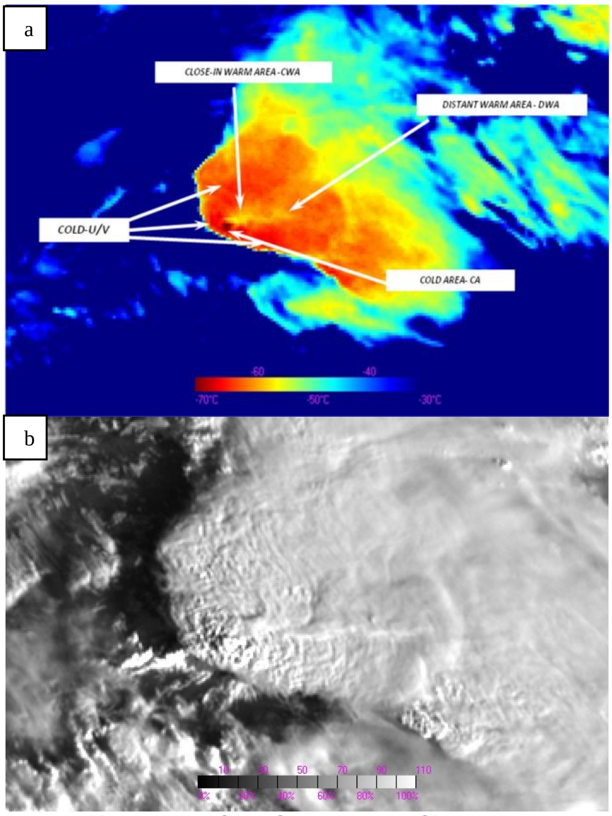


FIG. 1: (a) IR 10.8 enhanced MSG image (b) HRV image, 5 November 2007, 0600 UTC.

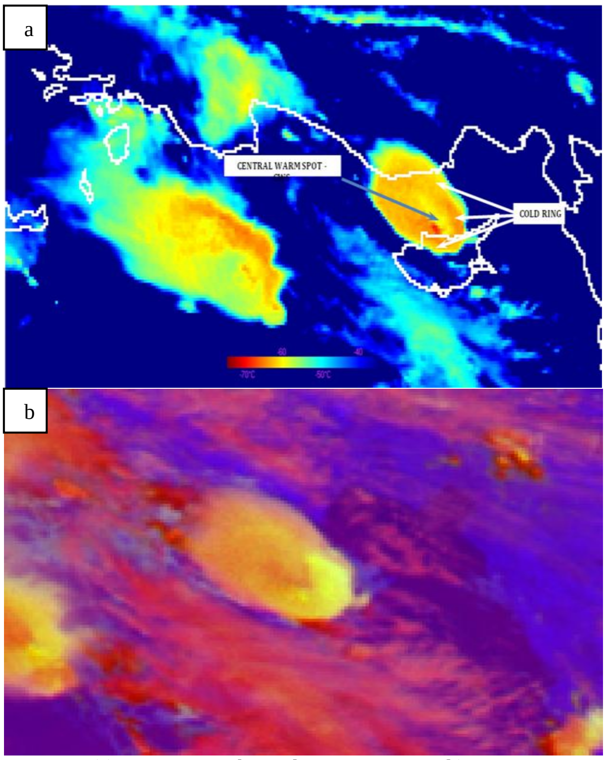


FIG. 2: (a) IR 10.8 enhanced MSG image (b) Storm RGB composite, 26 October 2010, 1130 UTC.

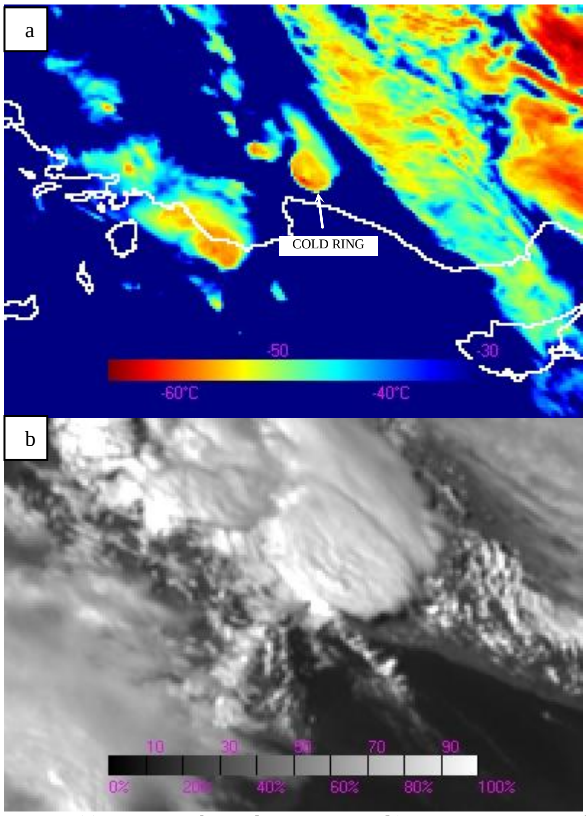


FIG. 3: (a) IR 10.8 enhanced MSG image (b) HRV image, 2 April 2011, 1400 UTC.

The third case is a cold ring shape storm developed over the Mediterranean coast of Turkey. A severe storm effected over Aksu town near Antalya city at April 2nd, 2011 around 13:00 GMT, causing the death of a person, the destruction of many green-houses and economic loses of around hundreds of millions USD. Hailstones (over 2 cm diameter) were covered the land at a height of around 10 cm. Warm spot and cold ring shape is well recognizable from the IR10.8 enhanced image (Figure 3a). Gravity waves detected in the HRV image (Figure 3b) indicate storm severity (Wang, 2007) .

Last case presents a Mesoscale Convective Complex (MCC) crossing the Balkan Peninsula on May 24, 2009. MCCs are very rare for Europe. They are large (> 100000 km$^2$), long-lived (> 6 hours) convective systems with a quasi-circular (eccentricity > 0.7) cold cloud shield (<-32$^o$ C) (Maddox, 1980). The interior cold cloud region (<-32$^o$ C) must have an area larger than 50000 km$^2$. The application of a tracking algorithm (Feidas, 2002) showed that this large convective cluster over the Balkans met the previous criteria (Figure 4a). This system began as a single mesoscale convective system (MCS) which was merged with 3-4 neighboring MCSs to form a complex of convective cells moving towards SSE and dissipating as a vortex over the southern Aegean Sea (Figure 4b). A cold ring and a CWS are discernable in two of these cells in the enhanced IR image (Figure 4b). An image merging the HRV and IR108 channels allows documenting the relative position of the overshooting tops with respect to the color enhanced IR108 temperature field (Figure 4c).

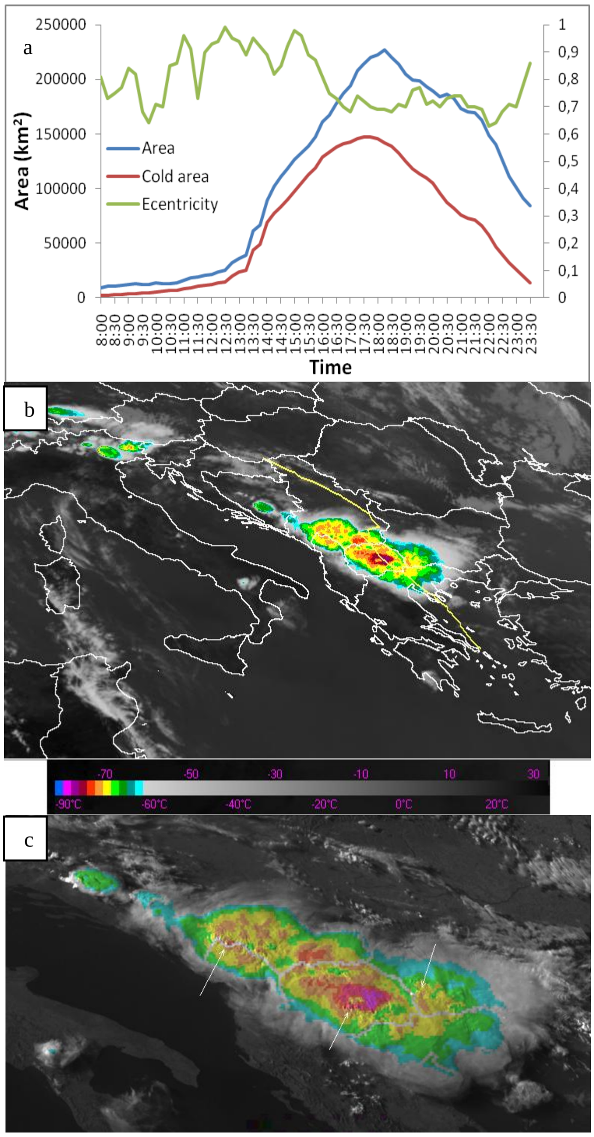


FIG. 4: (a) Time evolution of cloud shield area, internal cold cloud area and eccentricity of the MCC, 29 May 2009 (b) IR 10.8 enhanced MSG image of the MCC, at 1600 UTC. The yellow line indicates the MCC trajectory as detected by the tracking algorithm. (c) Merged HRV and enhanced-IR10.8 channels with arrows pointing to the overshooting tops.

## V. REFERENCES


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