DETECTION OF THE MEDITERRENEAN STORMS USING MSG SEVIRI IMAGES

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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 MSG SEVIRI imagery in detecting storms as well as in storm detection and monitoring.

MSG SEVIRI Channels and Applications

MSG SEVIRI with its high spectral (12 spectral channels) and high temporal (15 minute cycles) data sources give a very good opportunity for nowcasting applications. Physical properties and main applications are given at Table 1.

Channel No	Spectral Band (μm)	Characteristics of Spectral Band (μm)			Main observational application
		λ_{cen}	λ_{min}	λ_{max}	
1	VIS0.6	0.635	0.56	0.71	Surface, clouds, wind fields
2	VIS0.8	0.81	0.74	0.88	Surface, clouds, wind fields
3	NIR1.6	1.64	1.50	1.78	Surface, Cloud phase
4	IR3.9	3.90	3.48	4.36	Surface, clouds, wind fields
5	WV6.2	6.25	5.35	7.15	Water vapor, high level clouds, atmospheric instability
6	WV7.3	7.35	6.85	7.85	Water vapor, atmospheric instability
7	IR8.7	8.70	8.30	9.1	Surface, clouds, atmospheric instability
8	IR9.7	9.66	9.38	9.94	Ozone
9	IR10.8	10.80	9.80	11.80	Surface, clouds, wind fields, atmospheric instability
10	IR12.0	12.00	11.00	13.00	Surface, clouds, atmospheric instability
11	IR13.4	13.40	12.40	14.40	Cirrus cloud height, atmospheric instability
12	HRV	Broadband (0.4-1.1)			Surface, clouds.

Table 1. SEVIRI channels and main applications.

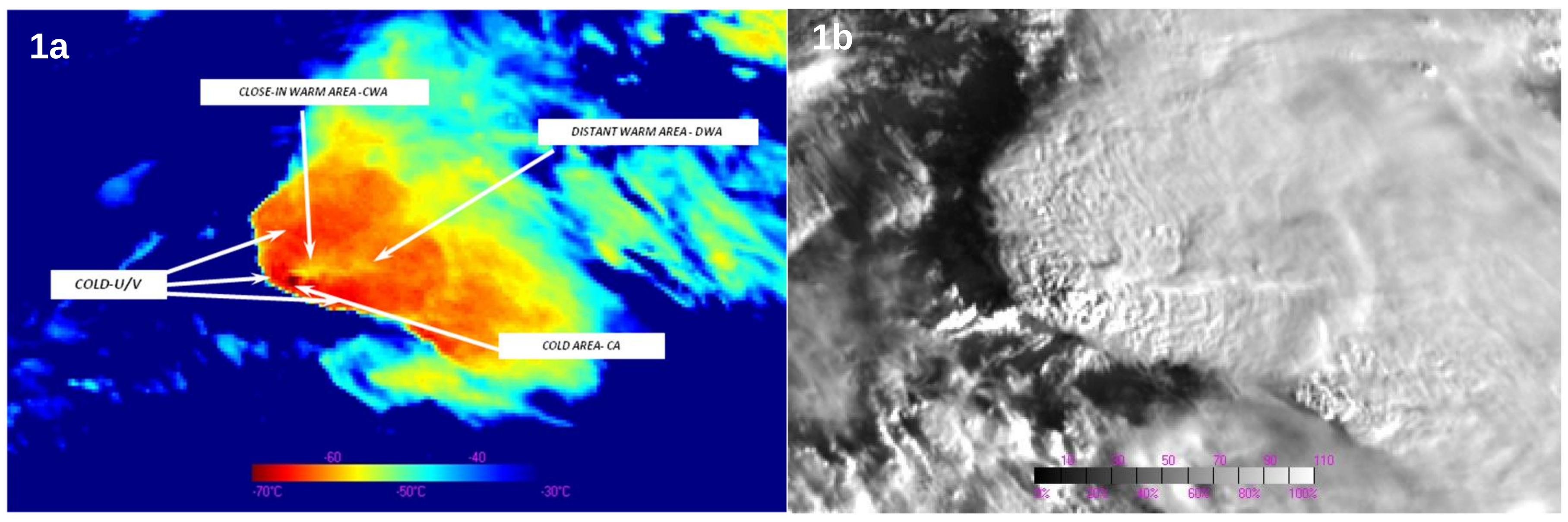


Figure 1. Cold U/V storm over the Southwestern of Turkey, 5 November 2007, 06.00 UTC (a) METEOSAT 9 IR10.8 , (b) HRV image .

Case Studies

First example is a severe thunderstorm occurred at 5th of November 2007 at the western part of Turkey. Figure 1a is an enhanced IR10.8 image and shows that is a Cold U/V shaped (or enhanced-V) storm 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) is another very important feature of the storms and it is well seen from the High Resolution Visible (HRV) image (Figure 1b). Second example is a cold ring shape storm over Cyprus. The main futures of this storms; cold ring and Central Warm Spot (CWS) which is documented by Setvak et. al. (2010) are detectable from color enhanced IR image (Figure 2a). Gravity waves indicate storm severity (Wang, 2007) and it can be detected by using HRV image (Figure 2b).

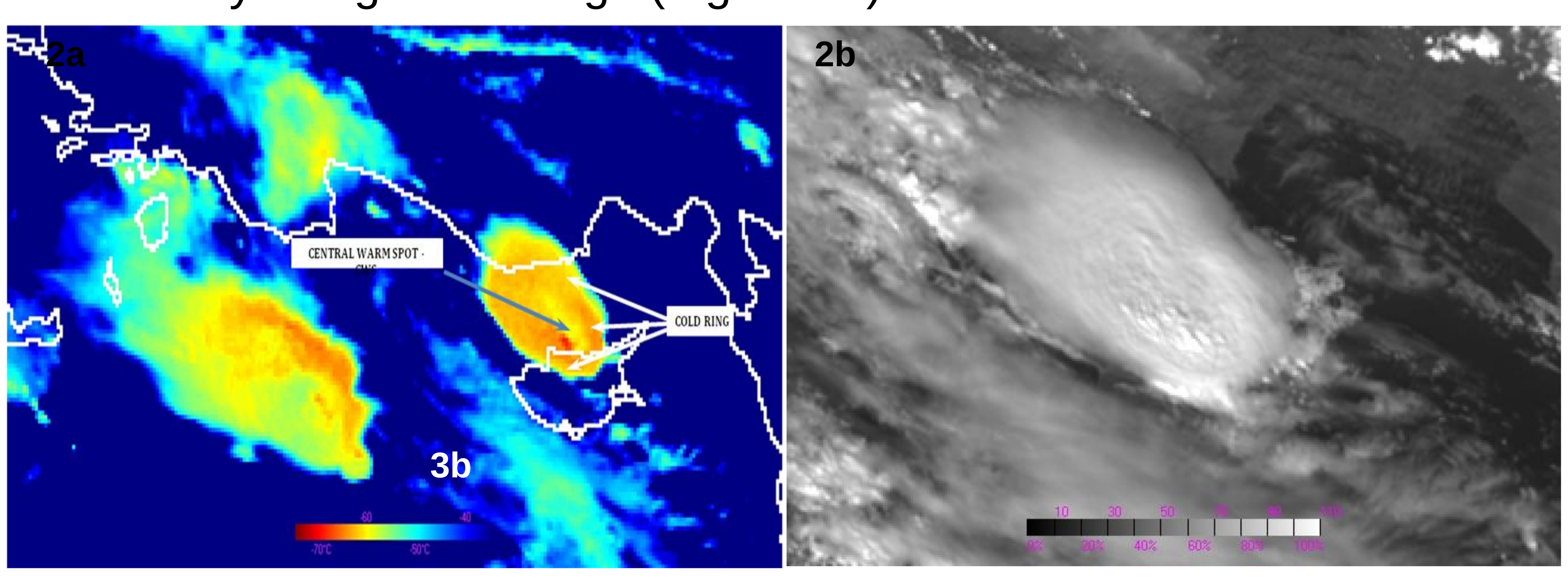


Figure 2. Cold ring shape storm over Cyprus, 26th of October 2010, 11:30 UTC.

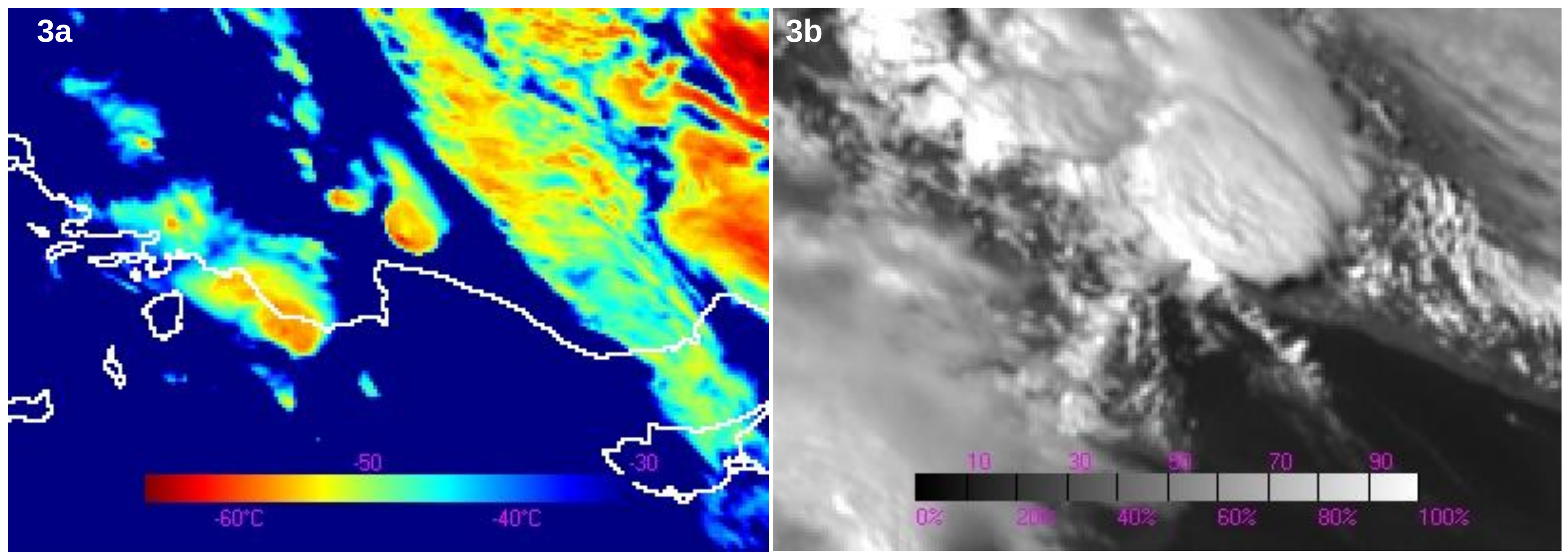
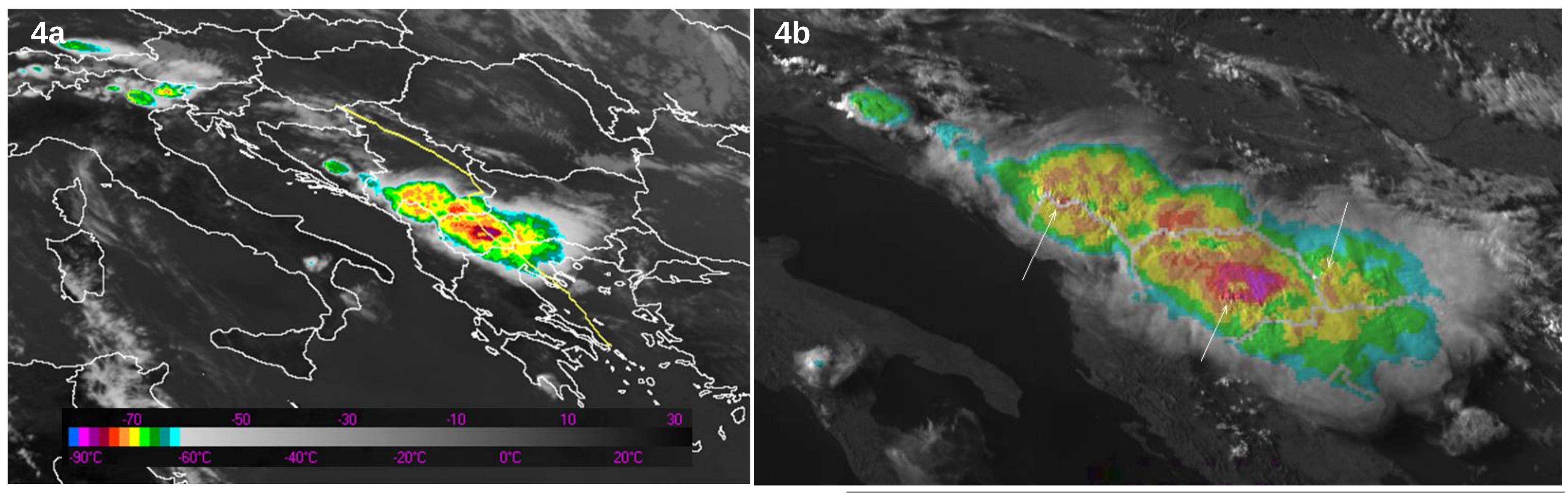


Figure 3. Cold ring shape storm over the Mediterranean coast of Turkey, 2 April 2010, 14:00 UTC.

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 (<-52° C) (Maddox, 1980). The interior cold cloud region (<-52° 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).

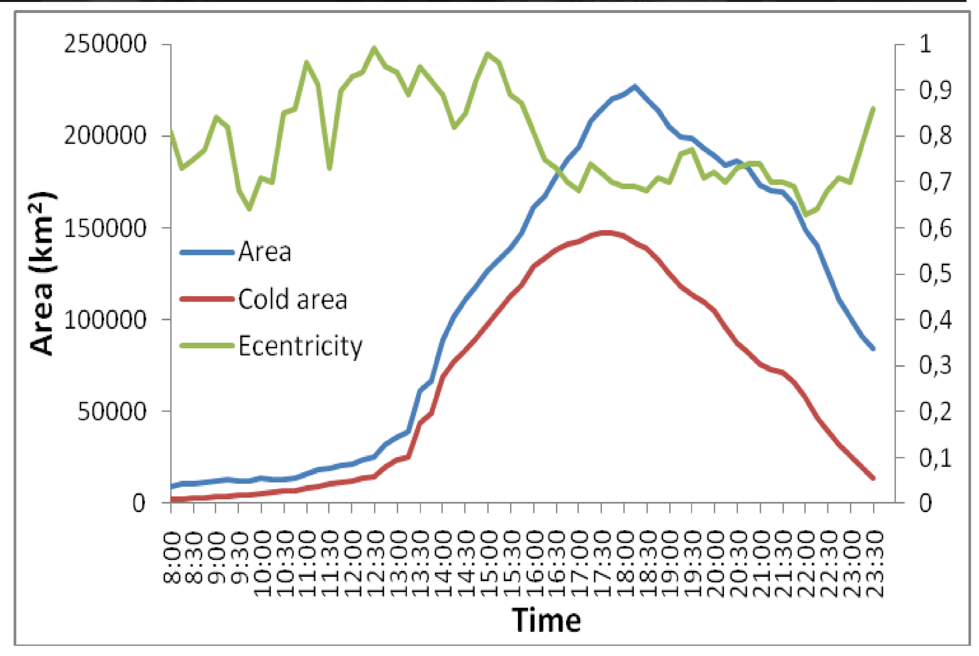


Figure 4 (a) IR 10.8 enhanced MSG image of the MCC, at 1600 UTC. The yellow line indicates the MCC trajectory as detected by the tracking algorithm. (b) Merged HRV and enhanced-IR10.8 channels with arrows pointing to the overshooting tops. (c) Time evolution of cloud shield area, internal cold cloud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

Conclusion

MSG SEVIRI channels and their applications are very good resources while detecting storms at the mid latitudes. 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. Last but not least, HRV images are also very important to show Cirrus plumes and gravity waves.

References

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Acknowledgment

This study was partly supported by Turkish Water Foundation (www.turkwater.com).