MSG-3 Super Rapid Scan study

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Introduction

During the commissioning of the MSG-3 satellite (later renamed to Meteosat-10), EUMETSAT has carried out an experimental 2.5-minute rapid scan test. According to the original commissioning plans for this satellite, a 3-minute rapid scan was initially scheduled; however after suggestion by the Convection Working Group, proposed at the 32nd STG-SWG meeting (13-14 March 2012, Action 32.5), it was decided to modify the test to shorter, 2.5-minute intervals. This interval is exactly half of the present 5-minute RSS (Rapid Scan Service); also it will be the native rapid scan interval of the future Meteosat Third Generation – Imager (MTG-I) satellites. The 2.5-minute rapid scan test started on 11 September 2012, and lasted exactly 24 hours. The data collected during the experiment is available at

ftp://ftp.eumetsat.int/pub/EUM/out/OPS/User/2.5_min_scan_test_files/.

Despite the relatively late time of the year for convective storms, several storms still occurred over various parts of Europe and were captured by the satellite during this test. In the related presentation some of these storms will be shown and commented in detail, with emphasis on the big variability of the storm tops – namely their overshooting tops. An overview of the 24-hour sequence of the collected data and of the meteorological situation over Europe during the test can be gained from the animations available here:

http://oiswww.eumetsat.org/WEBOPS/iotm/iotm/20120912_convection/20120912_convection.html

The shorter periodicity data such as the 2.5-minute rapid scan by MSG-3, or even shorter-period ones such as those from the U.S. GOES-14 satellite, can help improve our understanding of overshooting tops, which are frequently used in nowcasting as one of the satellite-based indicators of possible storm severity.

Technical notes

The area covered by the 2.5-minute super-rapid scan experiment is indicated in Figure 1. The scanned region consisted of approximately 1800 image lines for the HRV band, and about 600 image lines for each of the 11 remaining SEVIRI bands. The image in Fig. 1 doesn't show the full width of the scanned region, the west and east parts are cropped.

Due to technical reasons, it was not possible to perform on-board calibration during the 2.5-minute scans, thus the calibration of the IR brightness temperature (BT) imagery has to be treated as approximate only. Nevertheless, this should not affect significantly the relative BT changes between consecutive images (or detection of "isolated" very cold pixels, typically attributed to overshooting tops), which are of the main concern when studying the overshooting tops.

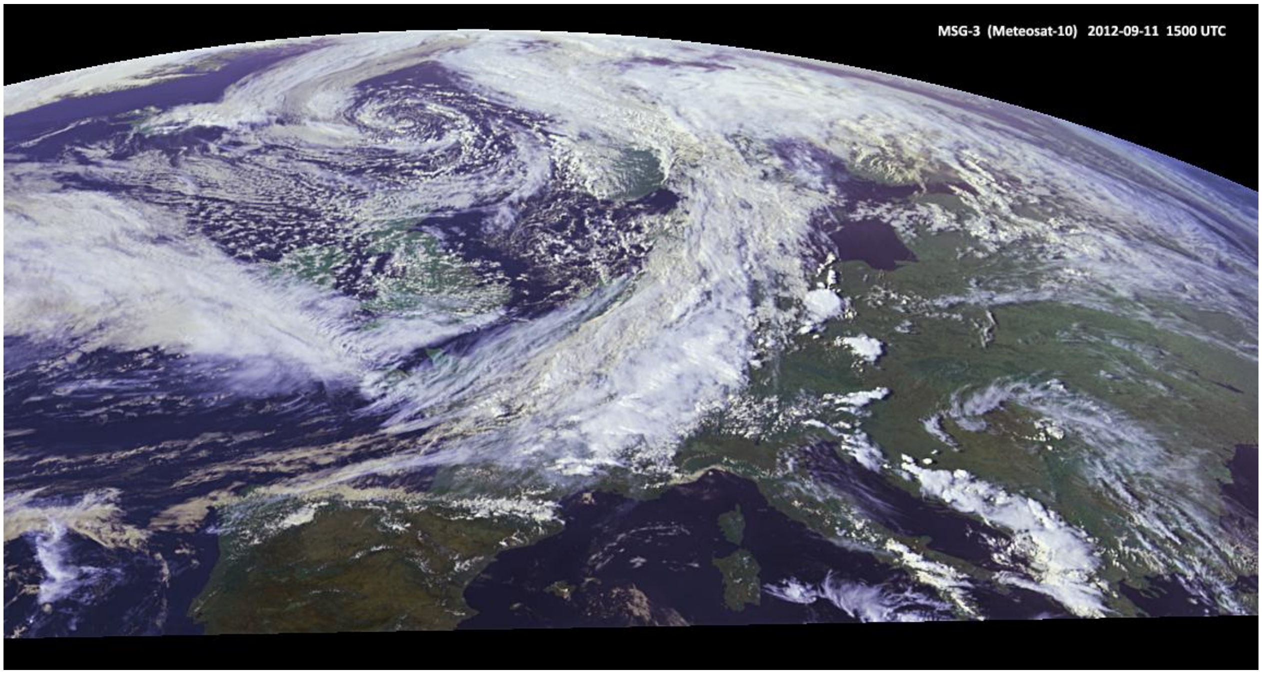

Figure 1. Geographic coverage of the 2.5-minute super rapid scan data. MSG-3, 2012-09-11 1500 UTC. The image shows the full north – south extent of the area covered by this test, while the west and east parts of the original image are cropped. The image also shows the general weather situation over Europe at the time of the experiment.

Selected cases

North Italy, 12 September 2102, 06 – 09 UTC

Definitely, the most interesting storms recorded during the experiment occurred in the morning of 12 September 2012 over northeast Italy (Figure 2). Some of these storms were accompanied by heavy rain and hail; the case is documented in detail at the EUMETSAT Image Library, at

http://oiswww.eumetsat.org/WEBOPS/iotm/iotm/20120912_convection/20120912_convection.html

These storms exhibited distinct overshooting tops (OTs) in HRV imagery, but not all of them were well detectable in the IR10.8 data. This is illustrated e.g. in Fig. 2 – while the OTs can be easily seen in visible band (HRV image) due to shadows they cast, only the southern of the two OT regions is also well expressed in the IR10.8 image as a significant local BT minimum. Most of the OTs can be traced in the HRV imagery for only 2 or 3 consecutive images. This would indicate an average lifetime between 5 to 10 minutes. Also, it appears that in some cases the BT minimum is reached for the individual OTs one image later as compared to the OT "maturity" in HRV. However, given the very small number of OTs captured for this storm before the end of the experiment at 0855 UTC, it is not possible to make any sound conclusions based on this case.

Besides the OTs, the storm also produced a longer-lived embedded warm area, which can be seen at the end of the image series, starting from about 0845 UTC. The warm spot formed in an area downwind of previous OT activity after their decay. No features can be seen in matching HRV images corresponding to the location and extent to the warm spot.

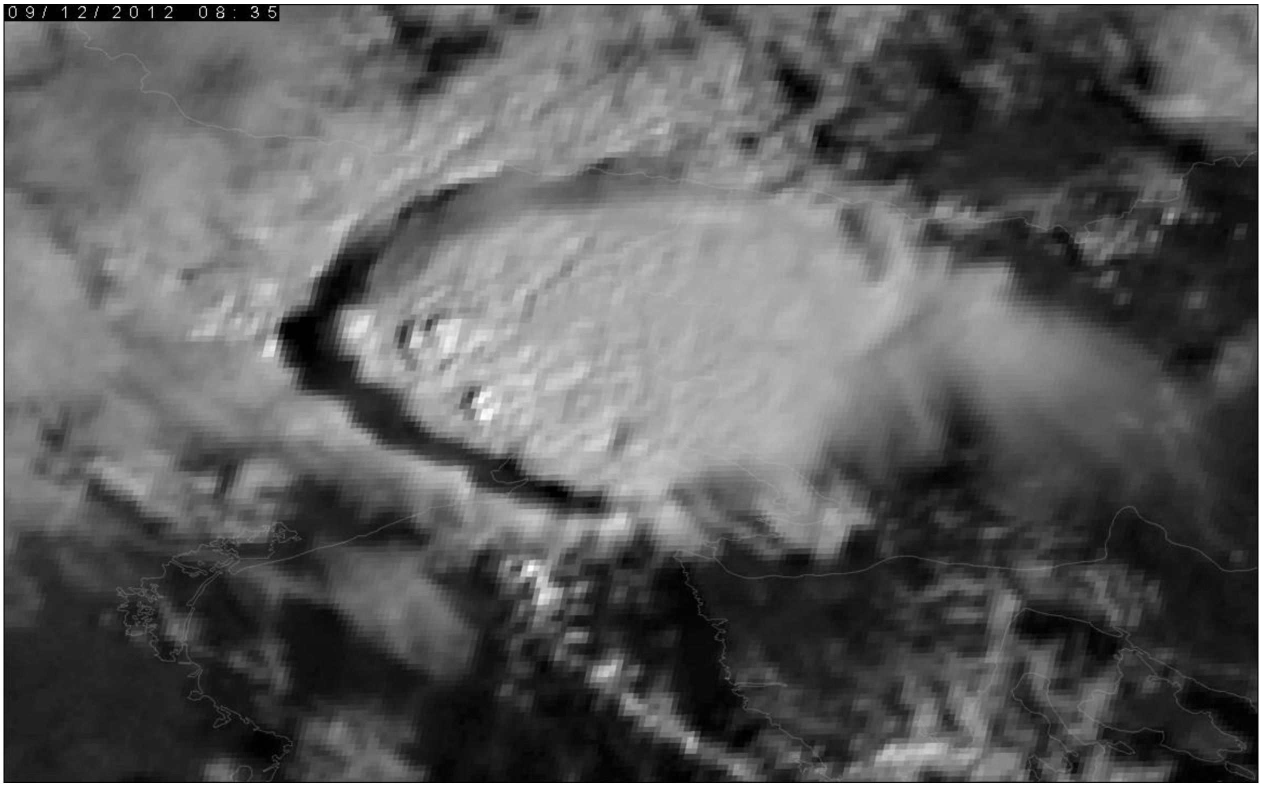

Figure 2a. Storms of the 12 September 2012 (0835 UTC) at northeast Italy, captured by MSG-3 in its HRV band. Several overshooting tops can be seen well at the west and southwest part of the storm anvil.

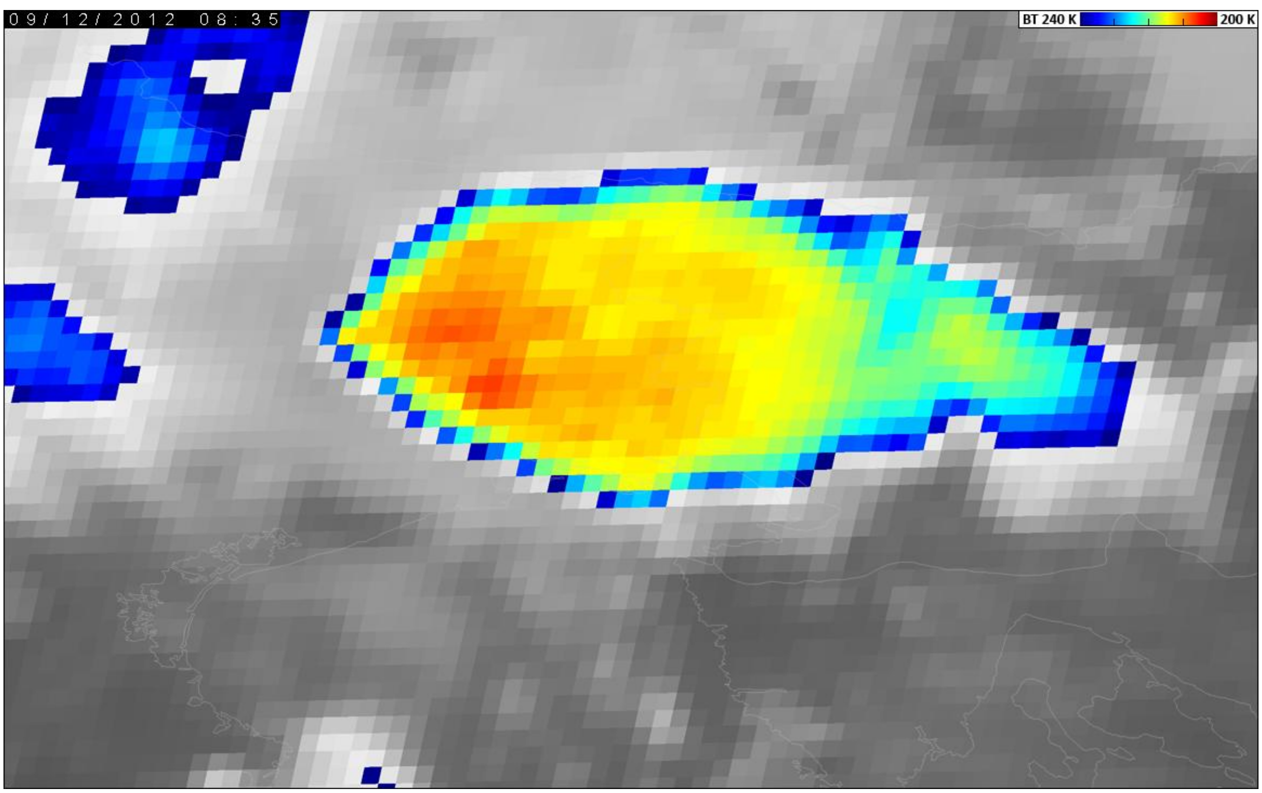

Figure 2b. The same storm, colour-enhanced IR10.8 BT image (showing the BT range 200K - 240K).

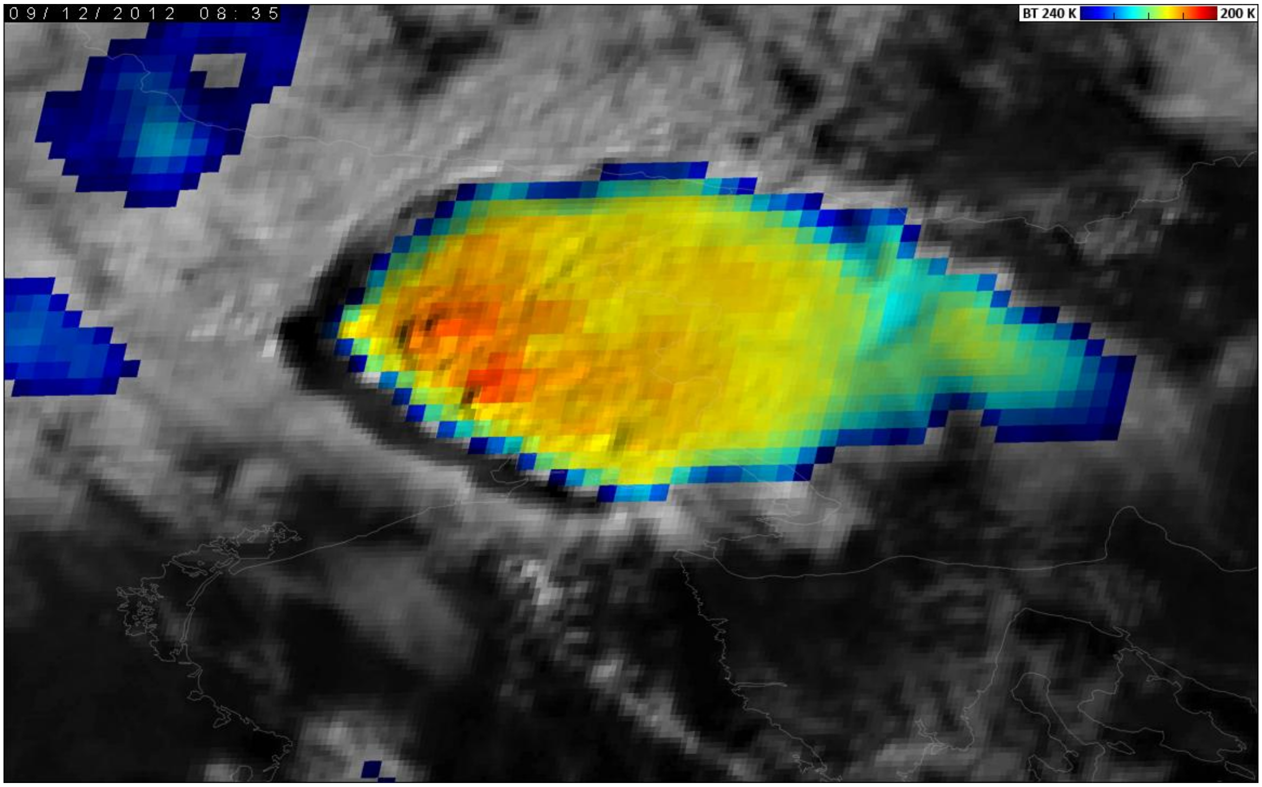

Figure 2c. The same storm, sandwich product of the HRV band and colour-enhanced IR10.8 BT image.

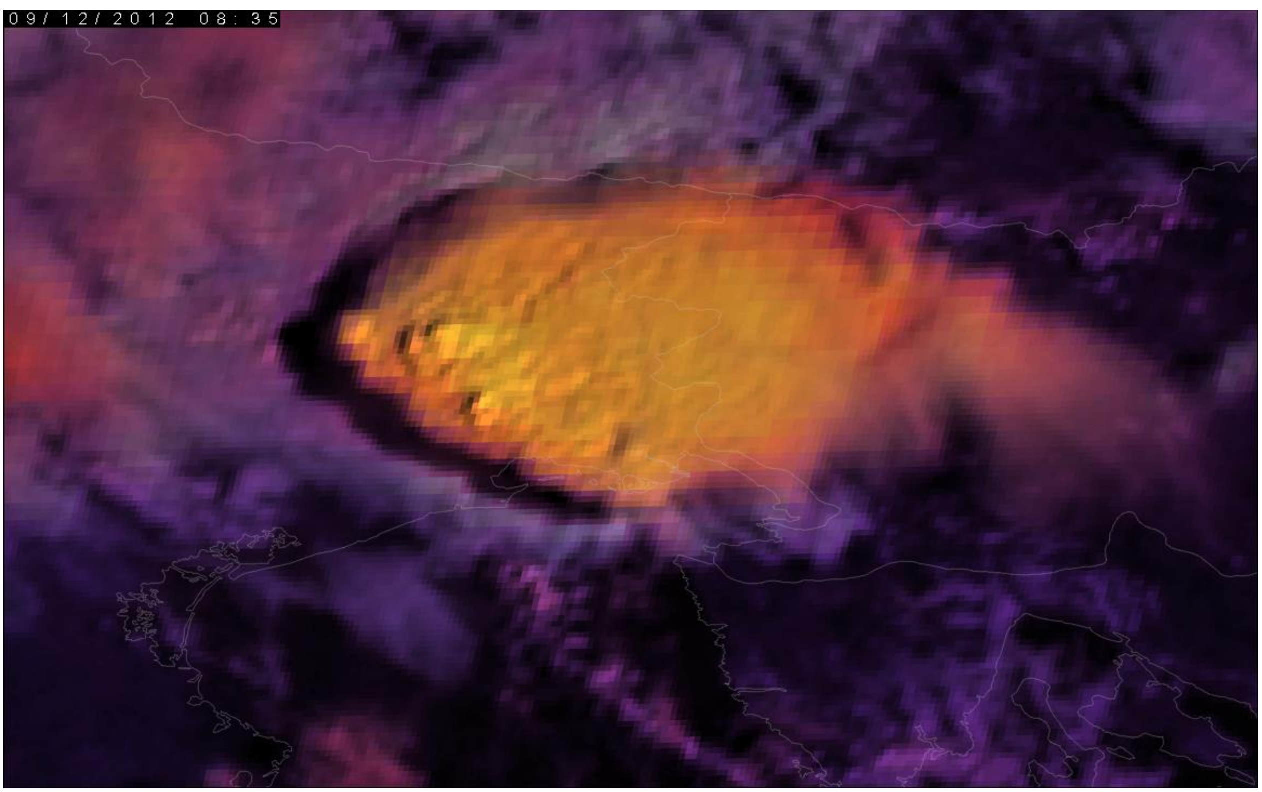

Figure 2d. The same storm, sandwich product of the HRV band and “Storm-RGB” composite image.

The Czech Republic and Austria, 11 September 2012, 1300 – 1730 UTC

Two clusters of storms started to form in this area around 1300 UTC and lasted until sunset. Formation of these storms was preceded by lines of shallow convection that began to form at about 1130 UTC. While the southern of these over Austria was obviously forced by the Alps (being co-located with their ridges), the northern line of convection formed most likely along a local convergence line without any link to orography. Even these storms produced several OTs that are readily apparent in HRV images, but most of these OTs exhibit no notable BT minima in the IR10.8 band. Similar to the north Italy case, these OTs were present in the HRV imagery for about two or three consecutive images; however, several OTs were present in one single image only. None of these OTs could be detected in BTD (WV6.2-IR10.8). Besides the OT themselves, the case might also be of interest from the perspective of RII and CI studies, as these storms formed in originally completely cloud-free area (still within the 2.5-minute rapid scan experiment). The storms over the Czech Republic were accompanied by heavy rain, hail and strong gusts of wind, causing local damage.

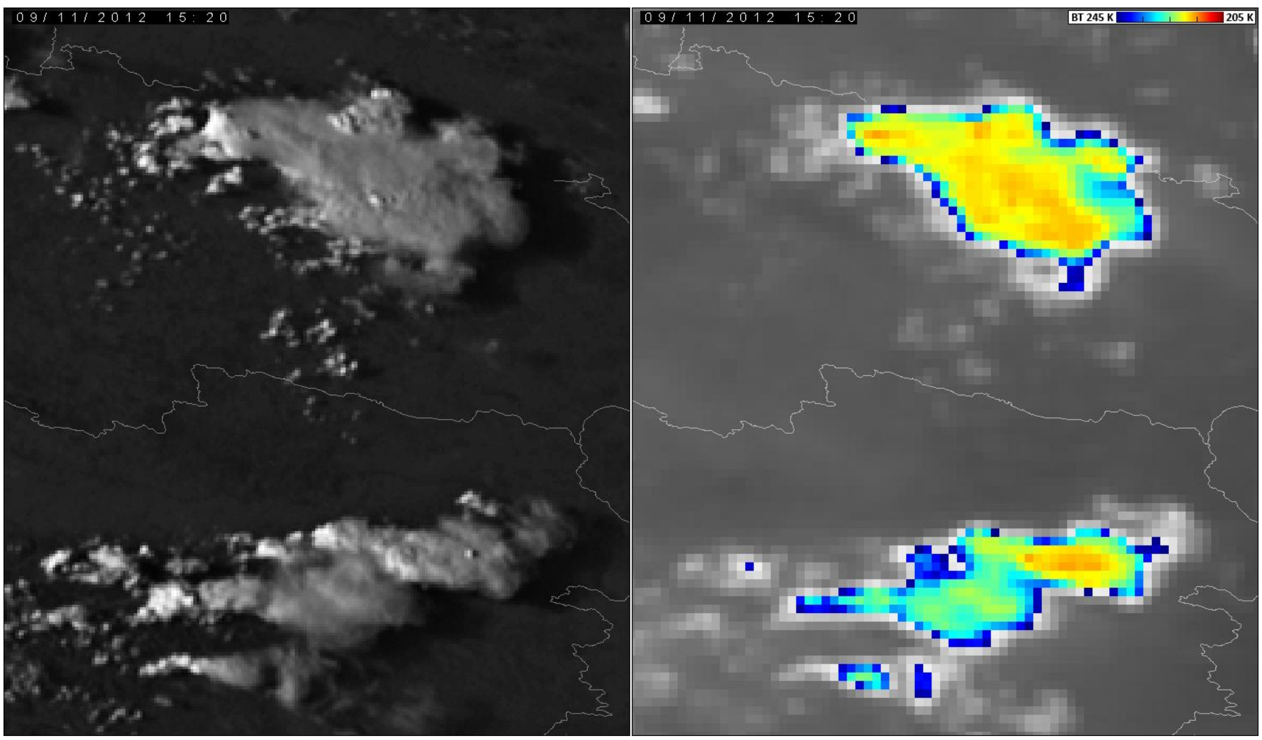

Figure 3. Storms of the 11 September 2012 (1520 UTC) above the Czech Republic and Austria.

Other regions of convective activity

Many other convective storms occurred during the experiment above various other parts of Europe – namely close to the Adriatic coast of the Balkan Peninsula, southern Italy, southwest Poland, as well as embedded within the cold front crossing Central Europe. None of these other storms have been examined in detail by the author of this document so far. In general, the timing of the 2.5-minute scanning experiment was very fortunate, as such convective activity that occurred within it, is rather exceptional over the continental Europe at this time of the year.

Concluding comments and remarks

Despite the short period of the experiment and late time of the year, the data collected within it is a valuable data set for studies of convective storms, namely their overshooting tops. The advantage of the 2.5-minute scanning period over the regular 5-minute rapid scan is obvious – many of the OTs captured by two or three consecutive 2.5-minute images would be captured in one single image only of the regular 5-minute rapid scan. Therefore, if possible due to the condition of the satellite, further similar 2.5-minute experiments carried out with the Meteosat-8 satellite in spring and summer 2013 would be highly appreciated for storm-top studies. These would also contribute to a more efficient exploitation of the future generations of the geostationary satellites, equipped with similar shorter scanning intervals, such as MTG and GOES-R.

Contributions based on the 2.5-minute rapid scan data will be presented at the upcoming ECSS 2013 (Helsinki) and EUMETSAT 2013 (Vienna) conferences. A collection of processed images based on this data will be also published at EUMETSAT Image Library and/or Convection Working Group websites.