APPLICATION OF CHANNEL DIFFERENCE 0.6 μM - 1.6 μM AND 3.9 μM CHANNEL IN AUTOMATIC CONVECTIVE CELLS DETECTION

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I. INTRODUCTION

Automatic convective cloud detection methods, used operationally in many weather services, are often based only on infra-red satellite data. However, such methods have proven to be unsuccessful in many cases. Misdetection occurs mostly due to detecting cirrus shields, large frontal areas or parts of fronts as convective clouds. If cloud-top temperature thresholds are set to lower values than low water clouds and sometimes even fog patches are detected as convective clouds. This can cause many problems in operational forecasting process.

Due to the properties of visible channels and that of 3.9 μm channel, enabling the differentiation of cloud phase and particle size and giving insight into the optical depth of clouds, an attempt has been made to reinforce the automatic convection detection method by introducing data from Meteosat SEVIRI channels 0.6, 1.6, and 3.9 μm.

II. DIFFERENCE OF VISIBLE CHANNELS 0.6 AND 1.6 μM

The usage of visible channels in defining cloud phase and cloud particle size has been well documented and the properties of these channels are often exploited in composite images (Rosenfeld et al., 2004, MSG Interpretation Guide). Reflectivity in visible channel 0.6 μm is the measure of the optical depth or albedo, therefore the highest reflectivity in 0.6 μm channel comes from optically thick water clouds and snow. Reflectivity of very thick clouds can sometimes even be close to 100 %. On the other hand, transparent clouds (such as cirrus clouds) have much lower reflectivity. In FIG. 1 reflectivity in 0.6 μm channel is shown.

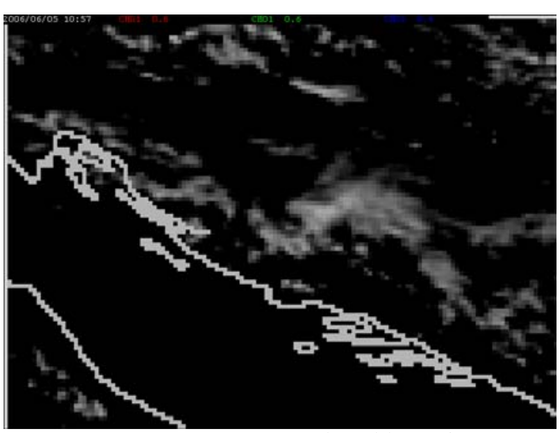

FIG. 1: Meteosat 8 SEVIRI 0.6 μm channel image from 05 June 2006, 10:57 UTC. Reflectivity from 50 to 100% is shown.

In the case selected here, convection started over the Dinaric Alps, but the cells cannot be identified in the 0.6 μm data only.

Apart from enabling distinction between thick and thin clouds reflectivity in 1.6 μm channel (FIG. 2) enables distinction between ice and water clouds, since water clouds have much higher reflectivity in 1.6 μm channel than ice clouds. However, if reflectivity values, shown in FIG 2. are analyzed, convective cells cannot be found easily.

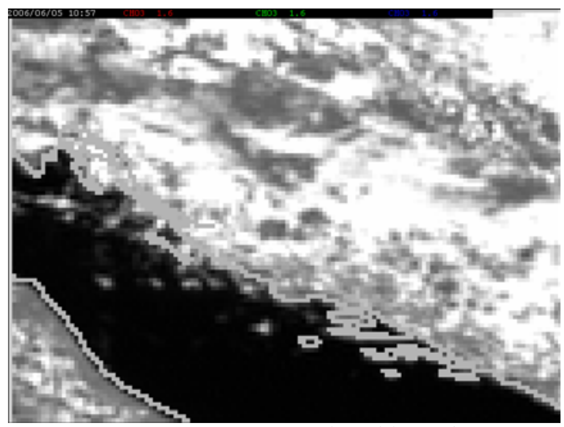

FIG. 2: Meteosat 8 SEVIRI 1.6 μm channel image from 05 June 2006, 10:57 UTC. Reflectivity from 0 to 50% is shown.

In other words by looking at FIGs 1. and 2. it can be clearly seen that automatic detection of convective clouds would not be possible by using only 0.6 or only 1.6 μm channel data, even if the reflectivity threshold is set to values that can be expected in convective clouds. If 1.6 μm channel data are looked at, grey scales characteristic for convective clouds, are also characteristic for other cloud features like transparent clouds, dissipating clouds etc. There can be no threshold set that would clearly point out only convective cells.

In order to utilize properties of both channels at the same time, difference of reflectivity in 0.6 and 1.6 μm channel is used. The properties of this difference are often used in composite images. High value of the difference means that reflectivity in 0.6 μm channel is very high, meaning the clouds are dense and thick, whereas the reflectivity in 1.6 μm channel is very low because of the ice particles on top of the clouds. Therefore, very high values of difference are found only at convective cells.

On the other hand, the areas which have low reflectivity in 1.6 μm channel due to small vertical depth have also low values in 0.6 μm channel, and can therefore be easily discriminated in the difference image. If the threshold is set properly the difference of reflectivity in 0.6 and 1.6 µm channels can be used in automatic convective cells detection.

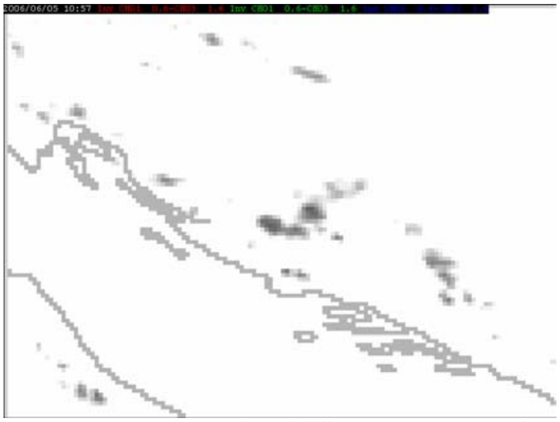

FIG. 3: Meteosat 8 SEVIRI channel difference 0.6µm – 1.6µm from 05 June 2006 10:57 UTC (inverted image is shown) with reflectivity threshold set to 20 – 80 %.

FIG. 3 shows the difference image of channels 0.6 µm and 1.6 µm. The positions of convective cells are clearly seen. It has been noticed that this method enables also the detection of small cells in early development phase, which is a great advantage compared to the methods based on infra-red channels data.

Additional tuning and testing of the method will be done before its operational use, but according to preliminary results it seems to be promising as an operational technique.

III. REFLECTED COMPONENT OF 3.9 µM

The 3.9 µm channel is located in the spectral region that includes both emitted and reflected components. Reflectivity at 3.9 µm is sensitive to cloud phase and very sensitive to particle size. The channel can be used for the detection of ice particles in cloud tops, since ice is very absorbent at these wavelengths (Levizzani and Setvák, 1996). These properties enable distinction of the stage in the development of a convective cell.

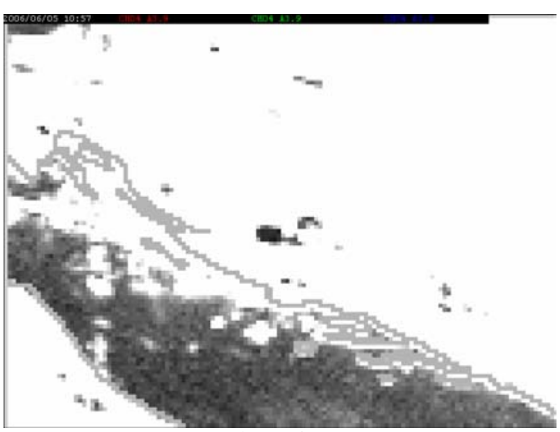

FIG. 4: Meteosat 8 SEVIRI image from 05 June 2006 10:57 UTC. Reflected component of 3.9 µm channel values from 0 to 5 % are shown (inverted image).

However, as seen in the image in FIG. 4, even if the threshold is set to very low reflectivity values, 0 to 5 %, there are still many areas, besides convective clouds, that are pointed out in the image. Therefore, low reflectivity in 3.9 µm channel can be used only as the additional information, after the locations of convective cells have already been determined. It can then give the identification of the development stage.

IV. RESULTS, CONCLUSIONS AND FUTURE WORK

The aim of this research was to use reflectivity information from satellite data in order to catch the first signs of convection and improve the operational automatic convection detection scheme. Investigation of numerous convective cases showed that the difference of reflectivity in 0.6 and 1.6 µm channels gives good indication of convective cells and can be used in automatic convective clouds detection schemes, provided that thresholds are set properly. Additionally, reflectivity in 3.9 µm channel can give the information about the stage in convective development and therefore the possibility to recognize potentially dangerous developments.

The method will be further tested on a variety of convective cases, especially summertime convection, and the results will be presented. The thresholds found will be utilized in constructing a scheme for automatic detection of convective cells and isolating potentially severe convection, which will also be presented at the conference.

V. AKNOWLEDGMENTS

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VI. REFERENCES

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MSG channels Interpretation Guide: http://oiswww.eumetsat.org/WEBOPS/msg_interpretation /index.html