PRODUCT NAME: **PR-OBS-3 v1.4 (H03)**		
CASE STUDY PERIOD: 8 - 9 Jun 2012 from 20:00 to 02:00 UTC	METEOROLOGICAL EVENT: Night time thunderstorms over Slovakia formed on a cold front	
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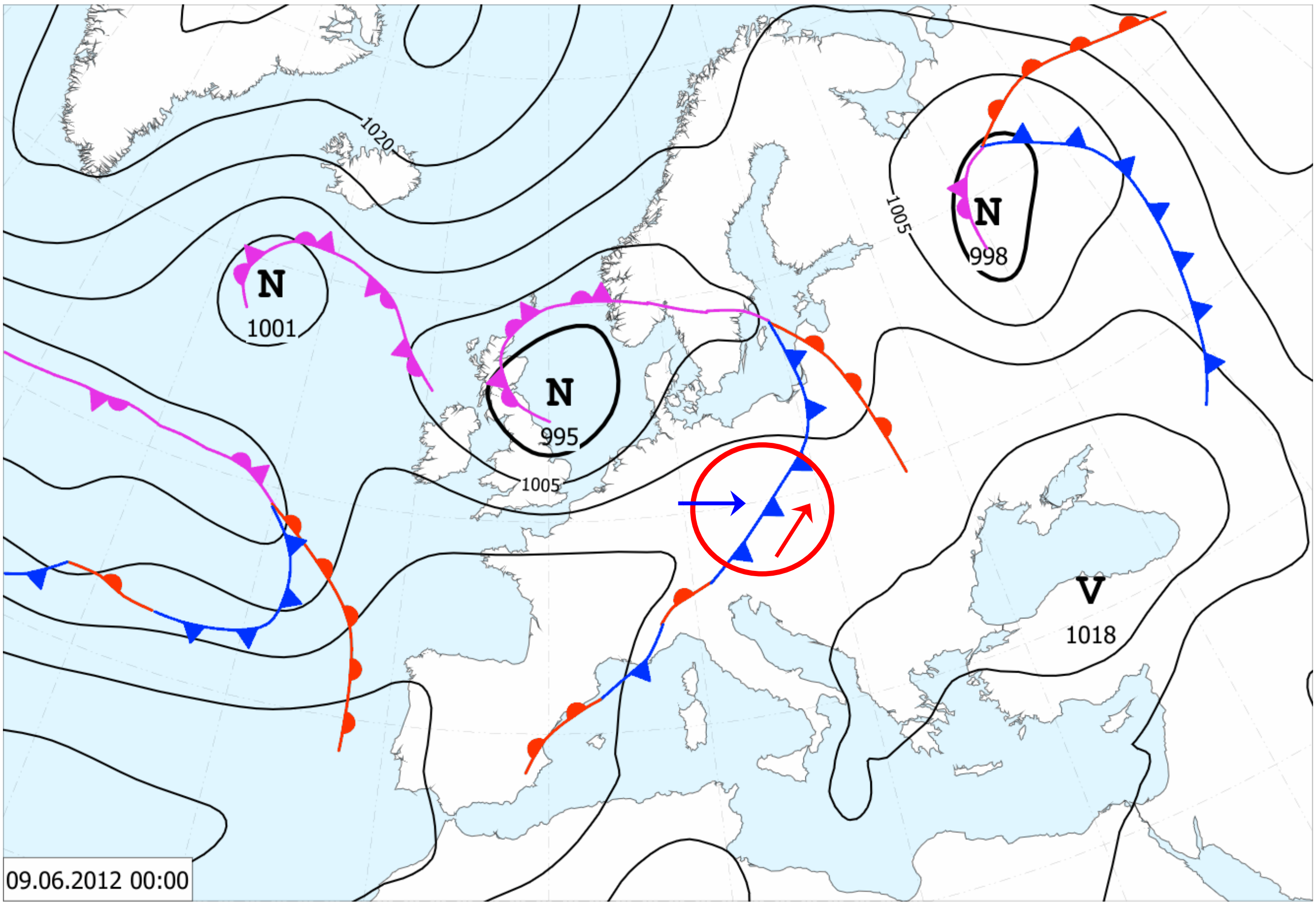
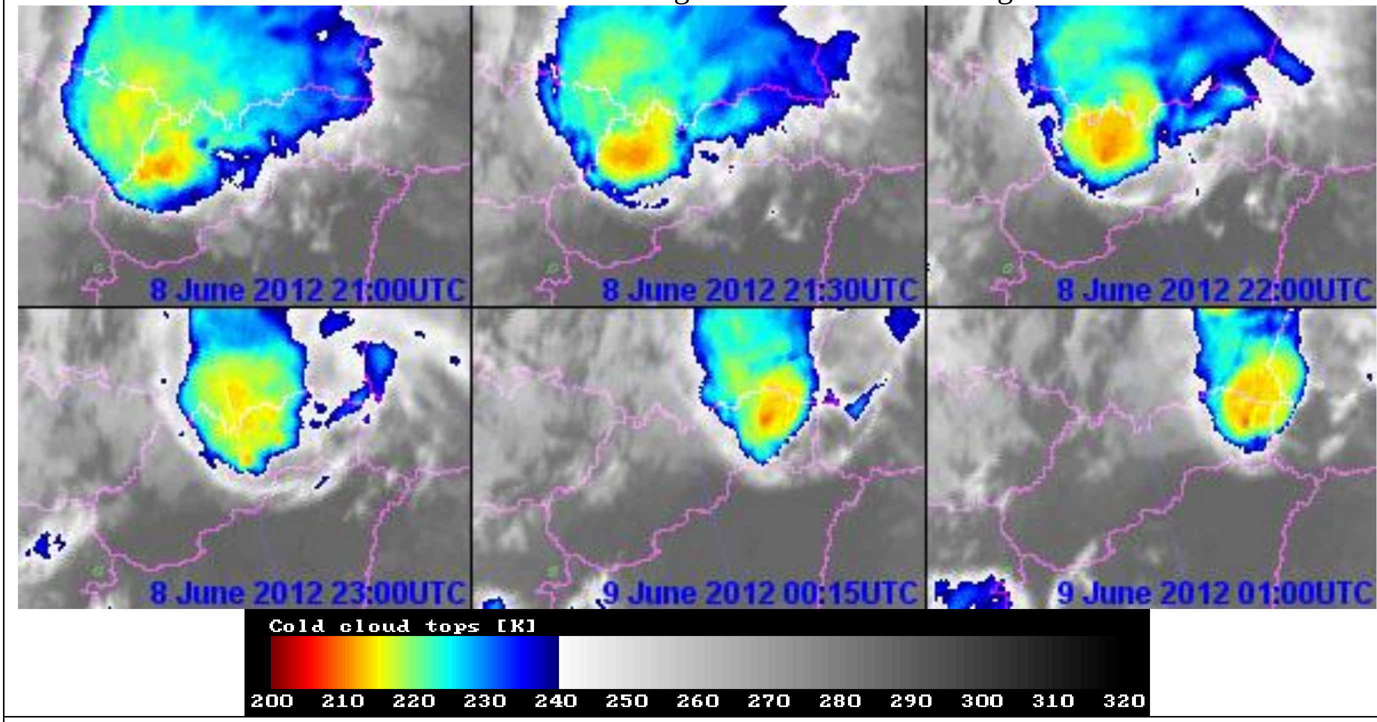
METEOROLOGICAL EVENT DESCRIPTION

Area of interest (depicted by red circle) is located between high pressure with centre over Black Sea and low pressure over North Sea. Cold air flowing from the west Europe (blue arrow) along the low depression to the central Europe induced cold frontal line with high contrast in temperatures due to warm air over the eastern Europe. Direction of hot air mass flow is depicted by red arrow. Strong convection with thunderstorms growing along the frontal line was observed during 8 June evening up to early morning hours 9 June over Slovak region.



MSG IR 10.8μm colour enhanced image time sequence shows development of convection from 8 June 2012 21:00 UTC to 9 June 2012 01:00 UTC moving from west to the east regions of Slovakia.



DATA/PRODUCTS USED

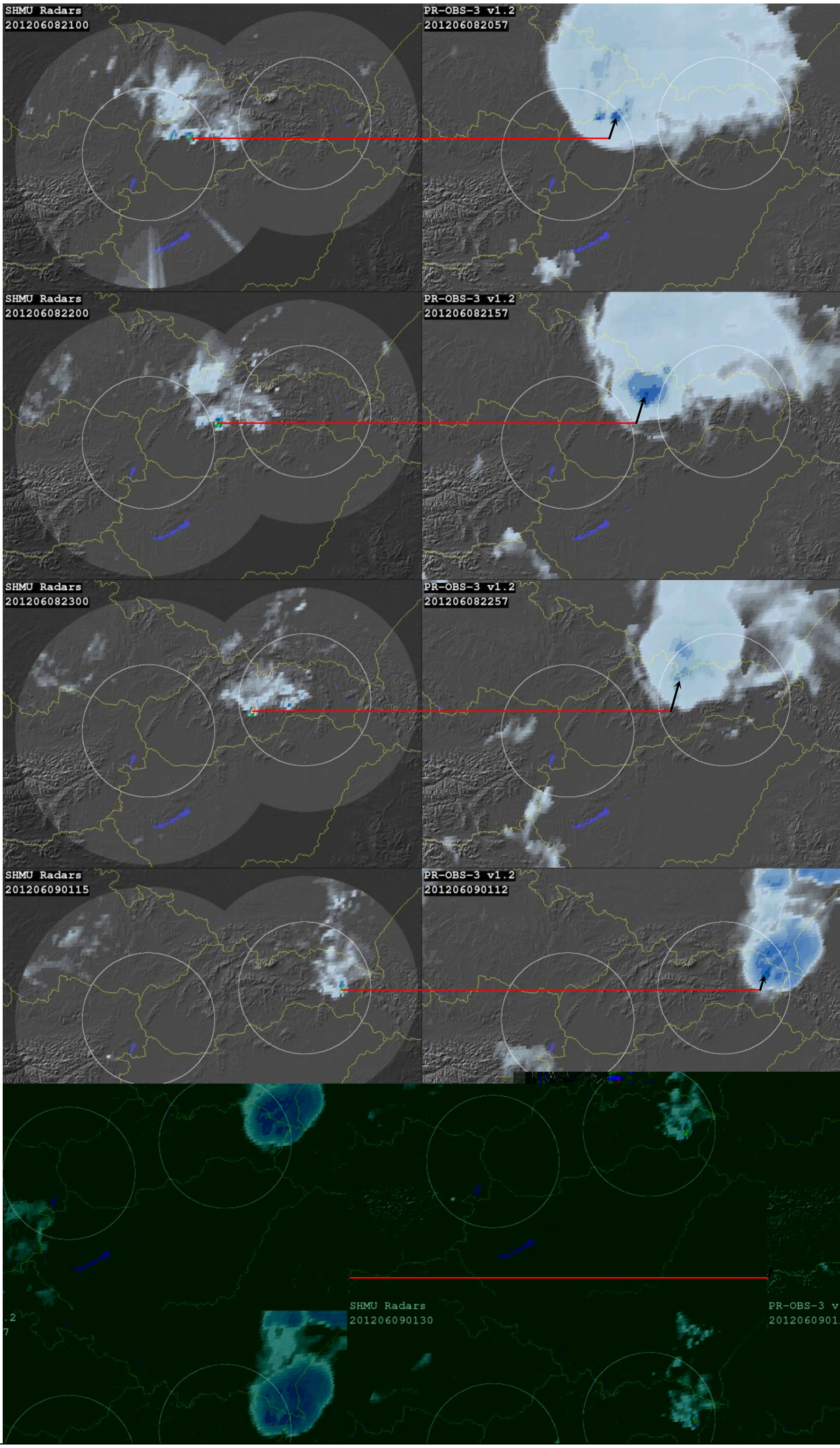
Time sequence of:
precipitation intensity from Slovak radar network upscaled to the satellite product (H03) resolution (left)
precipitation intensity from PR-OBS-3 (H03) product (right panels)

The aim of this case study is to show that localization of precipitation from severe storms using MSG IR imagery is strongly affected by wind direction and speed in high troposphere/low stratosphere layers. Red horizontal lines in next image sequence indicate real position of precipitation cores detected by radars close to the ground surface (left image). Black arrows indicate horizontal shift of precipitation cores detected by H03 satellite product (right image).
It is important to note that for 10 km cloud tops typical value of parallax shift in the region of Slovakia in case of MSG 0° satellite is about 17 km. But horizontal shifts in this case study varies too much in time in spite of similar cloud top brightness temperatures and consequently similar cloud top heights.
Table 1 below contains horizontal shifts of precipitation cores for several time slots (length of the shift was measured by mapping radar and satellite imagery into Google Earth software):

Table 1 Horizontal shift of precipitation cores between radar and H03 locations

Date	Time	km
20120608	21:00	34.4
20120608	22:00	44
20120608	23:00	53.6
20120609	1:15	24
20120609	1:30	19.2

It is evident that values of shifts in table 1 do not correspond to parallax of the satellite. The direction of the shift is parallel with frontal line and wind directions of warm air in high layers before cold front in central Europe are also parallel with frontal line. According this assumption observed horizontal shifts are proportional to wind speed and speed (time) of vertical development of the storm.


SHMU Radars
201206082100
PR-OBS-3 v1.2
201206082057
SHMU Radars
201206082200
PR-OBS-3 v1.2
201206082157
SHMU Radars
201206082300
PR-OBS-3 v1.2
201206082257
SHMU Radars
201206090115
PR-OBS-3 v1.2
201206090112
SHMU Radars
201206090130

Common colour scale is used for both radar and satellite rain rates.

RESULTS OF COMPARISON

Results of statistical processing of radar and satellite data are shown in following tables 2 and 3.

Table 2 Selected scores of continuous statistics

Precipitation class (mm)	1	2 – 10	≥ 11	≥ 1
Mean error (mm)	2.81	1.84	-13.9	2.28
Multiplicative bias	6.08	1.81	0.17	2.64
Correlation coefficient	0.14	-0.12	-0.19	0.01
URD-RMSE (%)	869%	252%	82%	684%

Table 3 Selected scores of dichotomous statistics

Precipitation threshold (mm)	≥ 1	≥ 2
POD	0.856	0.837
FAR	0.662	0.822
CSI	0.320	0.172

Probability of detection is around 85% for both evaluated precipitation classes but false alarms are higher when precipitation intensity is higher.

Mean error is lower and reasonable for medium but too big for high precipitation intensities. Intensities >11mm/h are underestimated by 14mm/h. This result corresponds also to distribution of relative RMSE, where overall relative RMSE is too high (684%). Correlation is positive only in case of low intensities.

COMMENTS

In this case study we paid attention to localisation of extreme precipitation which covers usually small areas, but produce often flash floods in mountainous terrain of Slovakia. Another ineligible effect evident from this case study is that product H03 based on IR channels of MSG produces lot of false alarms over big regions of storm anvils comprising only from high cirrus clouds.

INDICATION TO DEVELOPERS

Not only parallax shift caused by satellite zenith angle but also brightness temperature anomalies atop of severe convection can cause major dis-locations of heavy precipitation areas. Observed horizontal shifts can be more then 50 km due to high troposphere and low stratosphere winds and dynamical processes inside the storms.