

Detection of meteotsunami favorable conditions by operational meteorological satellites

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Outline

- Conditions for meteotsunami development
- Cases in the Adriatic
- Driving energy – CONVECTION???
- Detection and tracking of convective cells
- Possible forecast (nowcast) of favourable conditions

Conditions for meteotsunami development

- Propagating atmospheric pressure and/or wind disturbance
- Critical phase speed of the atmospheric disturbance in the Adriatic ~ 22 m/s
- Inlet, bay or harbor willing to resonate with the incoming wave (rare, but it happens...)

Cases in the Adriatic



1. case: 20 June 1978 → Vela Luka

No satellite images!

WRF ARW model simulations:

86 x 86 @ 9 km

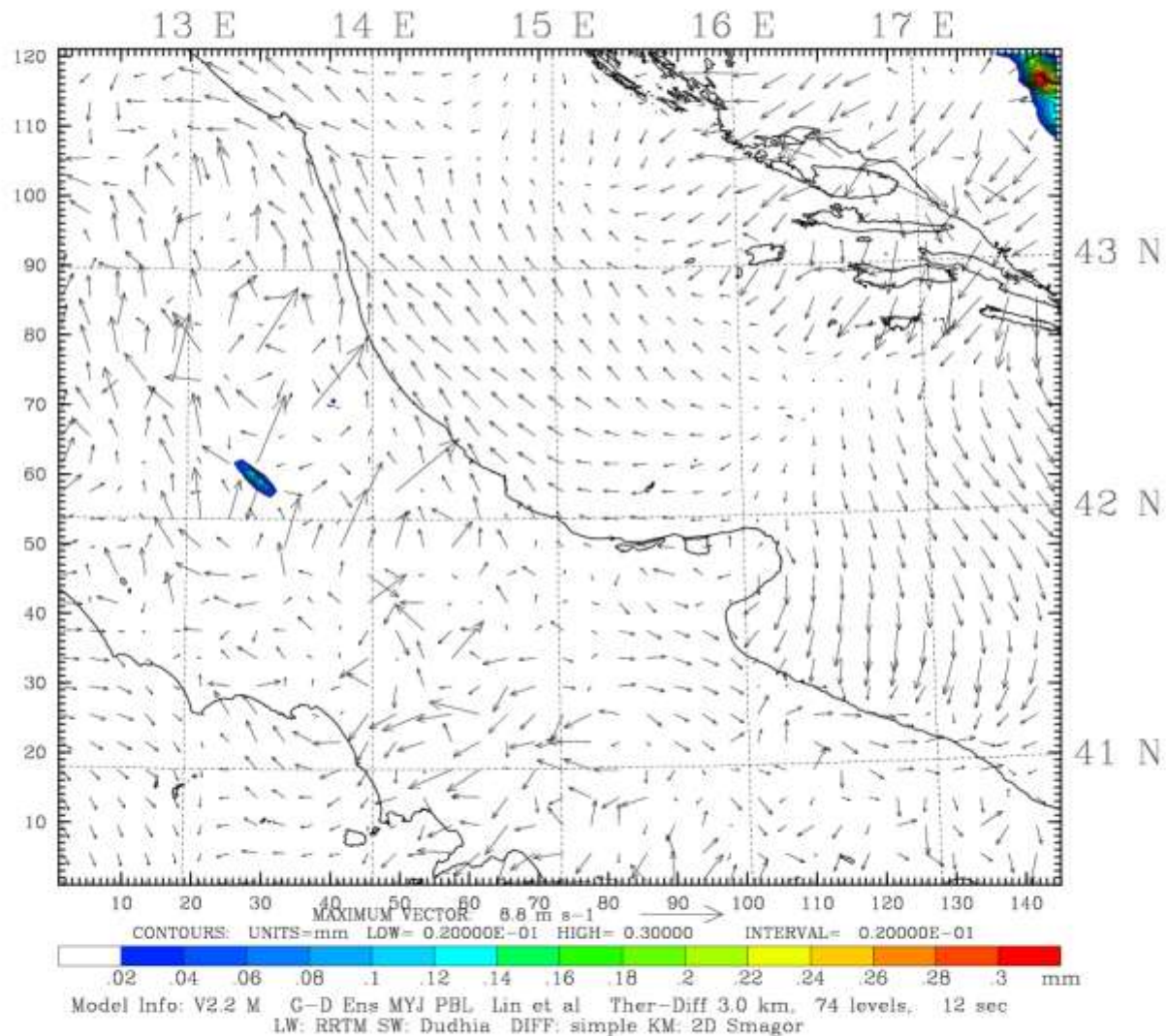
145 x 121 @ 3 km

75 vertical levels

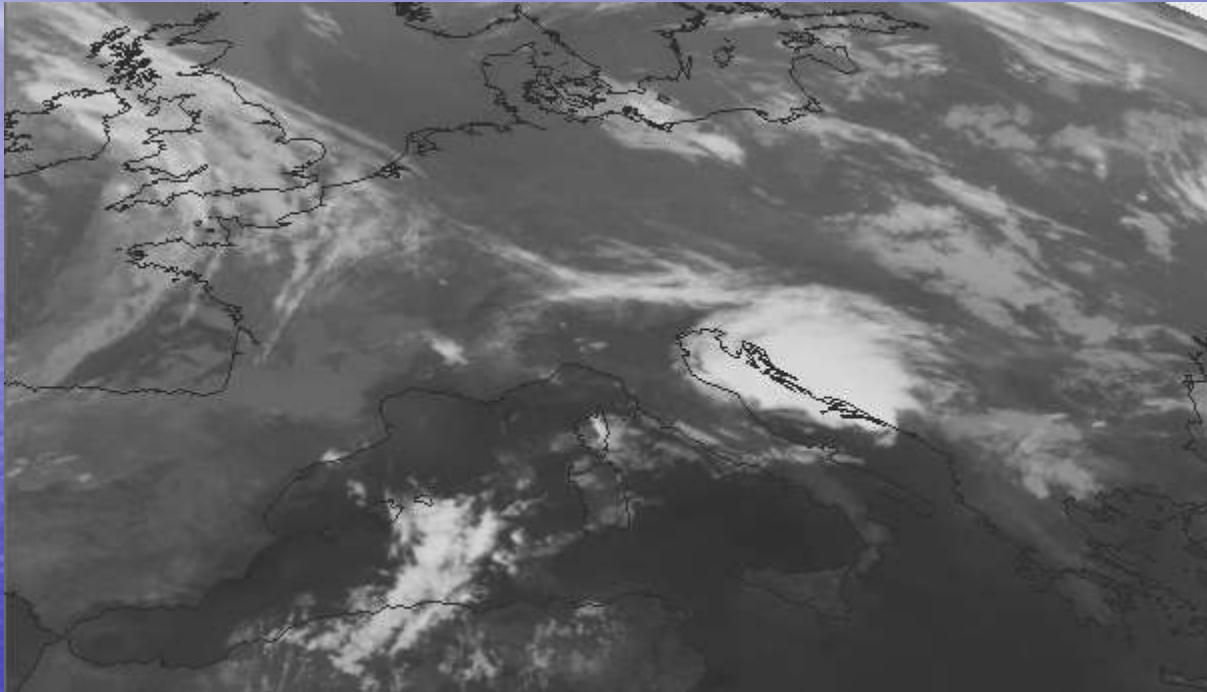
- convective precipitation forecast

Dataset: dom2 RIP: rip VL78
Fcst: 13.00 h
Column-integ. cloud hydrometeors
<U10,V10> Vectors

Init: 1200 UTC Tue 20 Jun 78
Valid: 0100 UTC Wed 21 Jun 78 (0200 LST Wed 21 Jun 78)

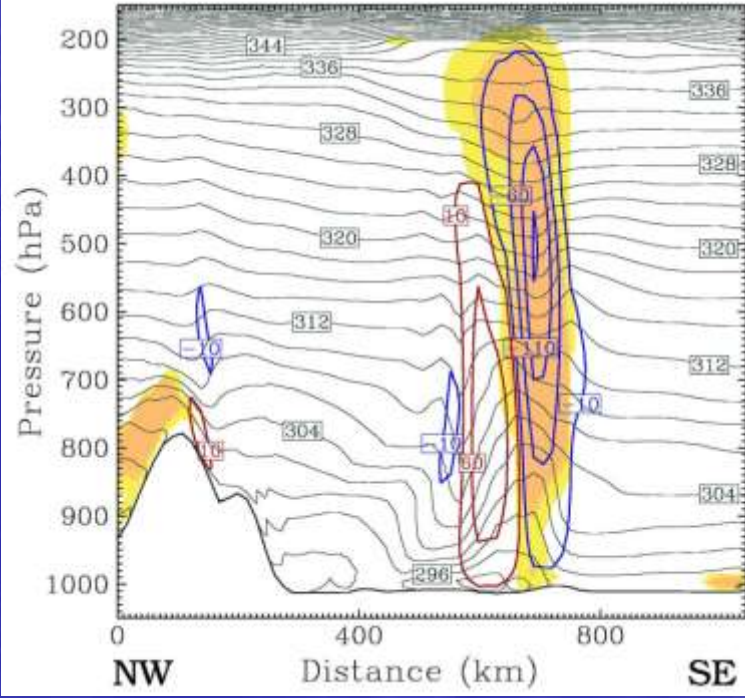
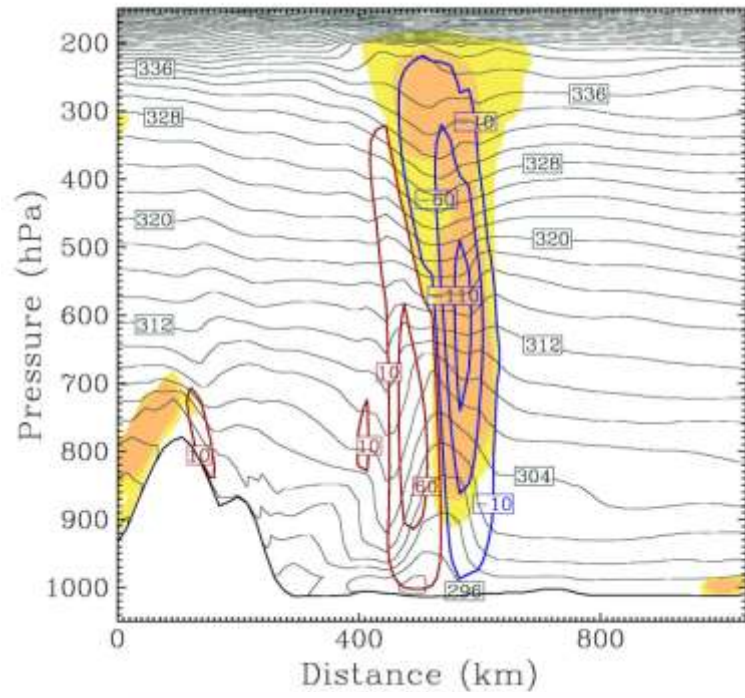
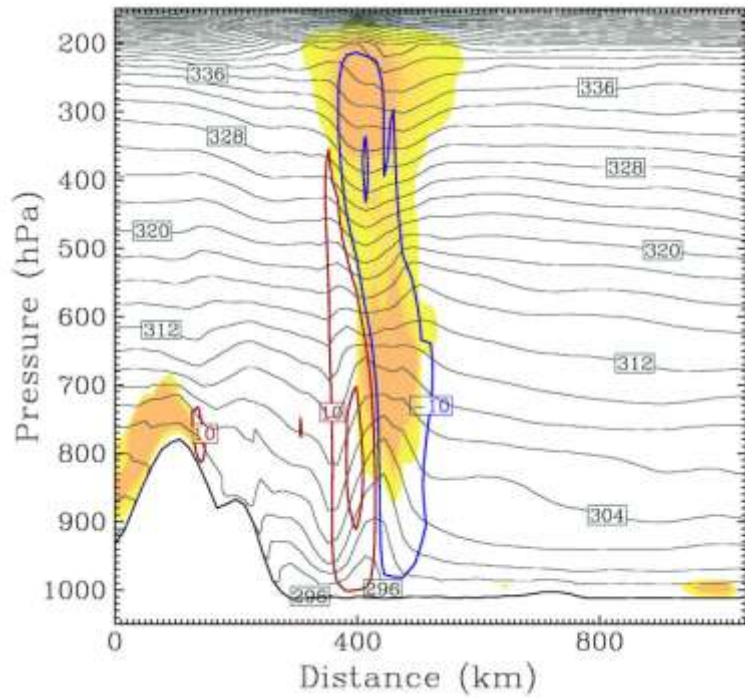


2. case: 27 June 2003 → Hvar



05 UTC

Convective system present!

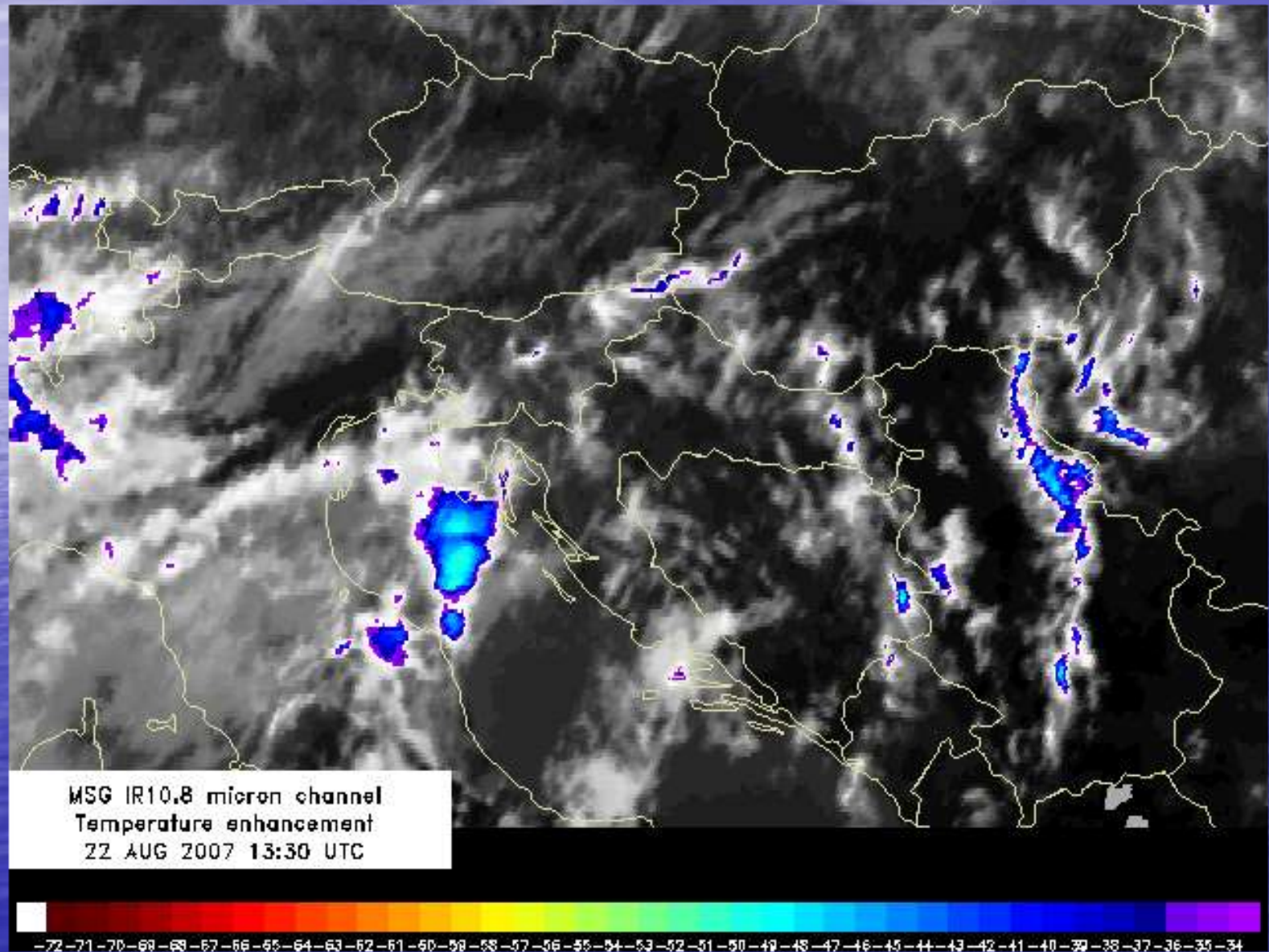


MM5 model:

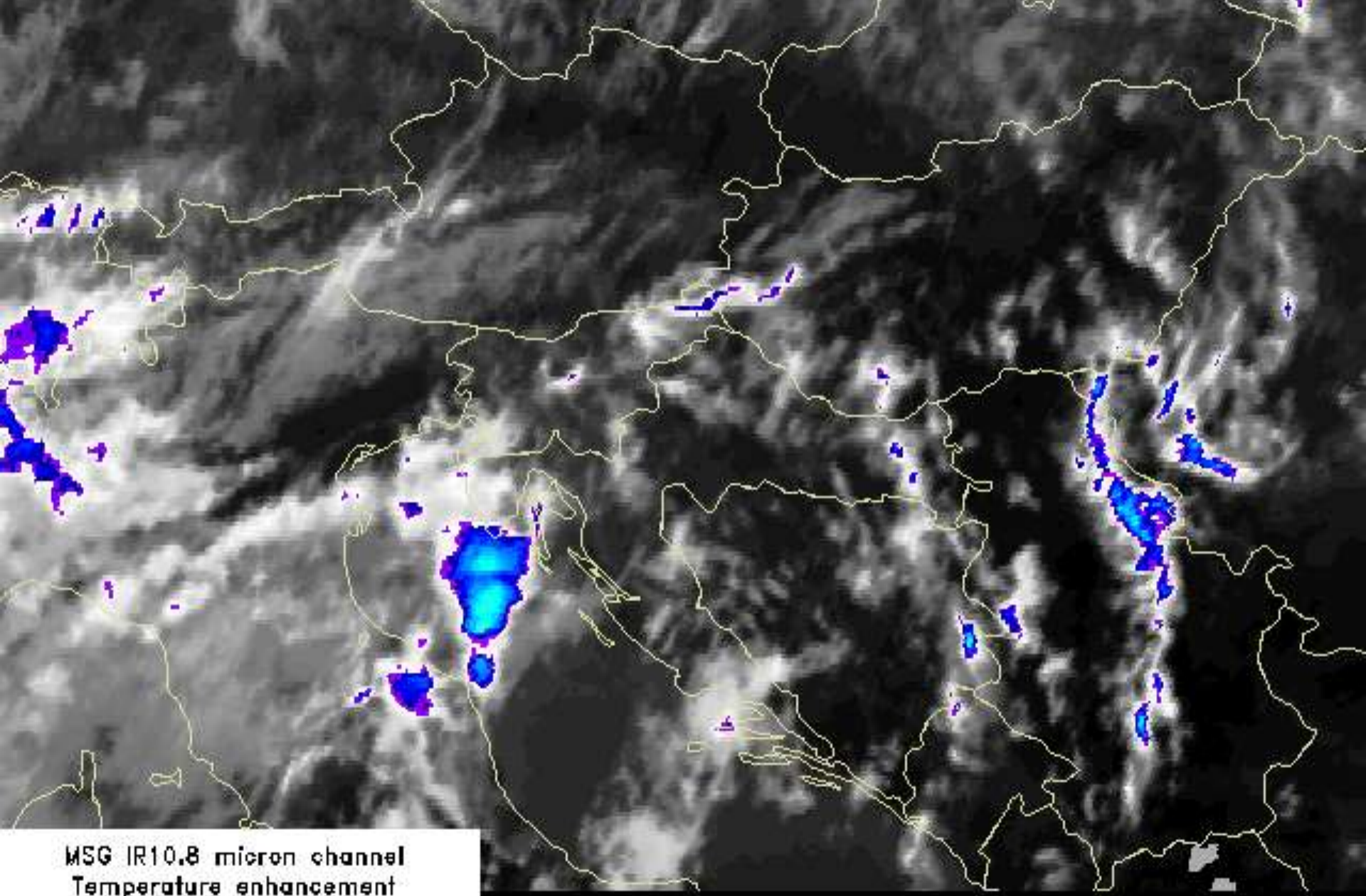
θ , ω & cloud water/ice
mixing ratio.

22 UTC 26 June, 00 &
02 UTC 27 June.

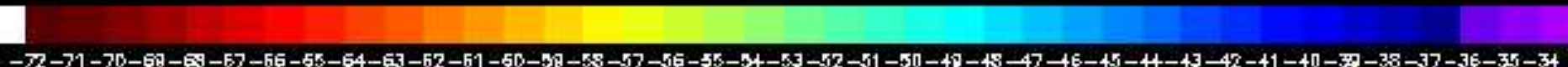
3. case: 22 August 2007 → Ist

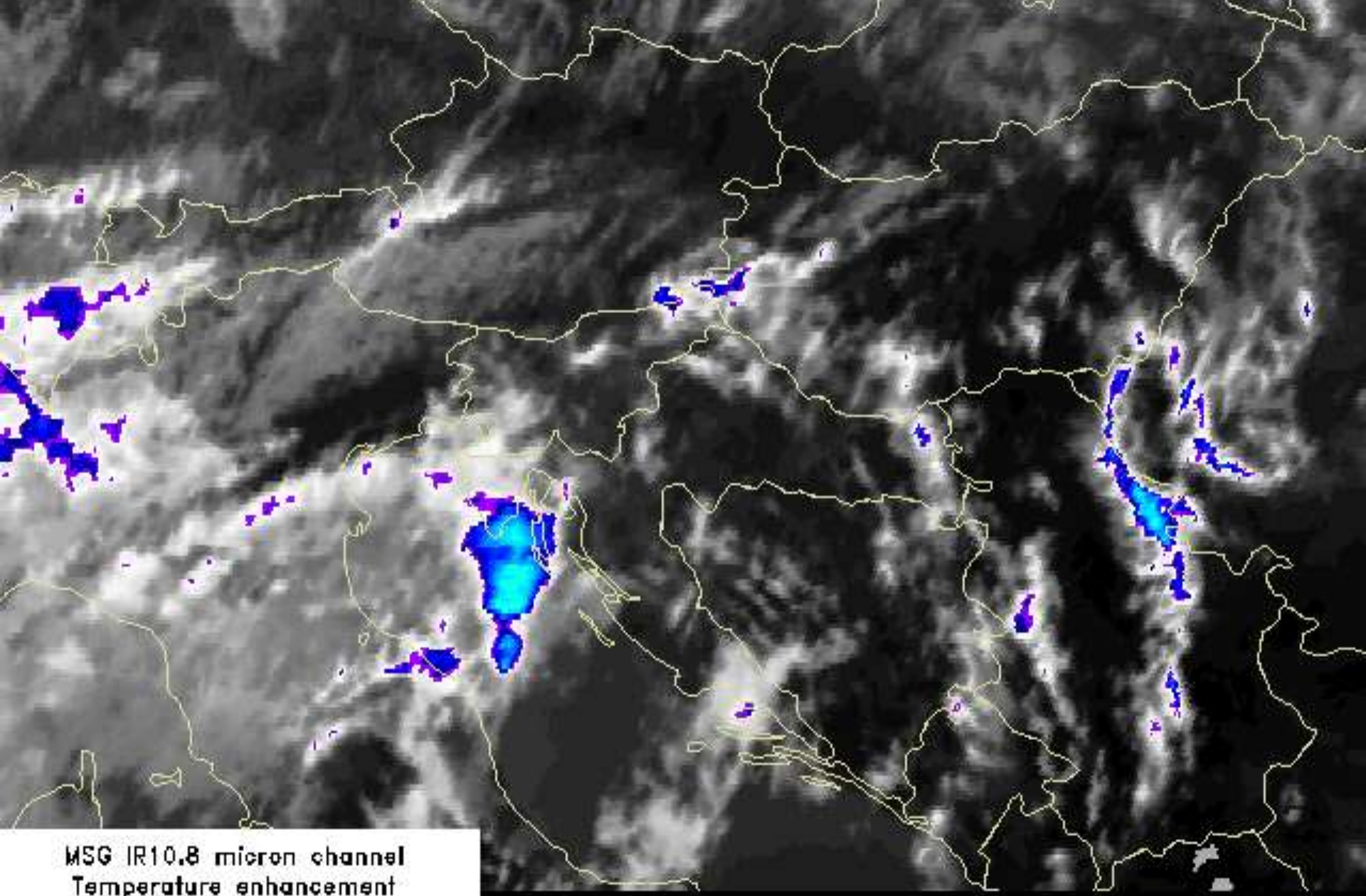




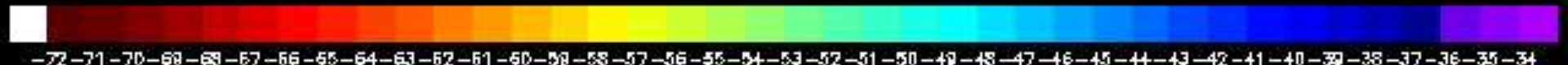


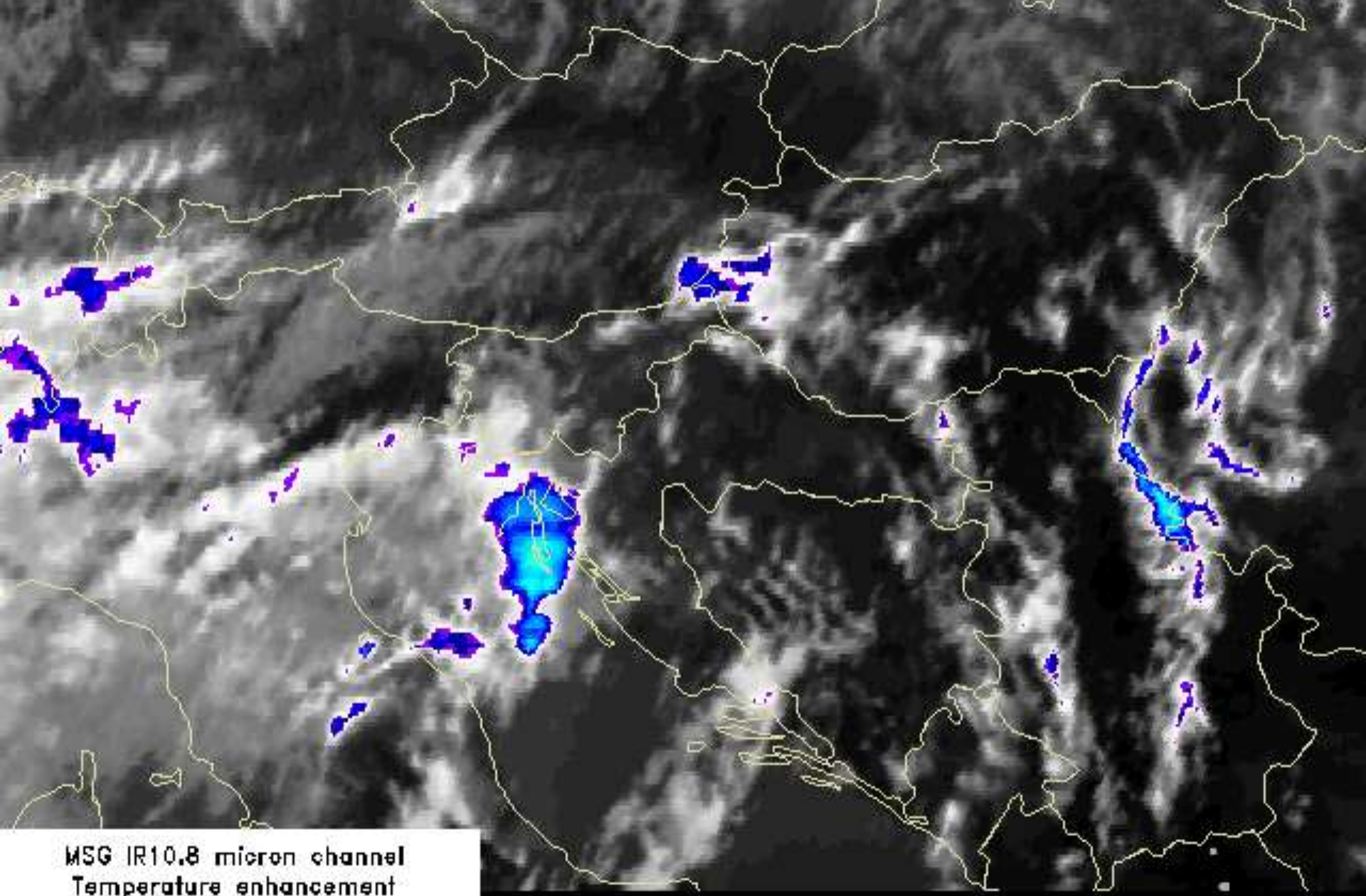
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 13:30 UTC



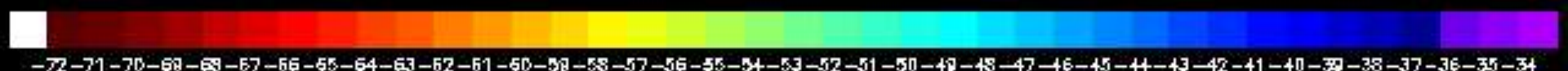


MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 13:45 UTC

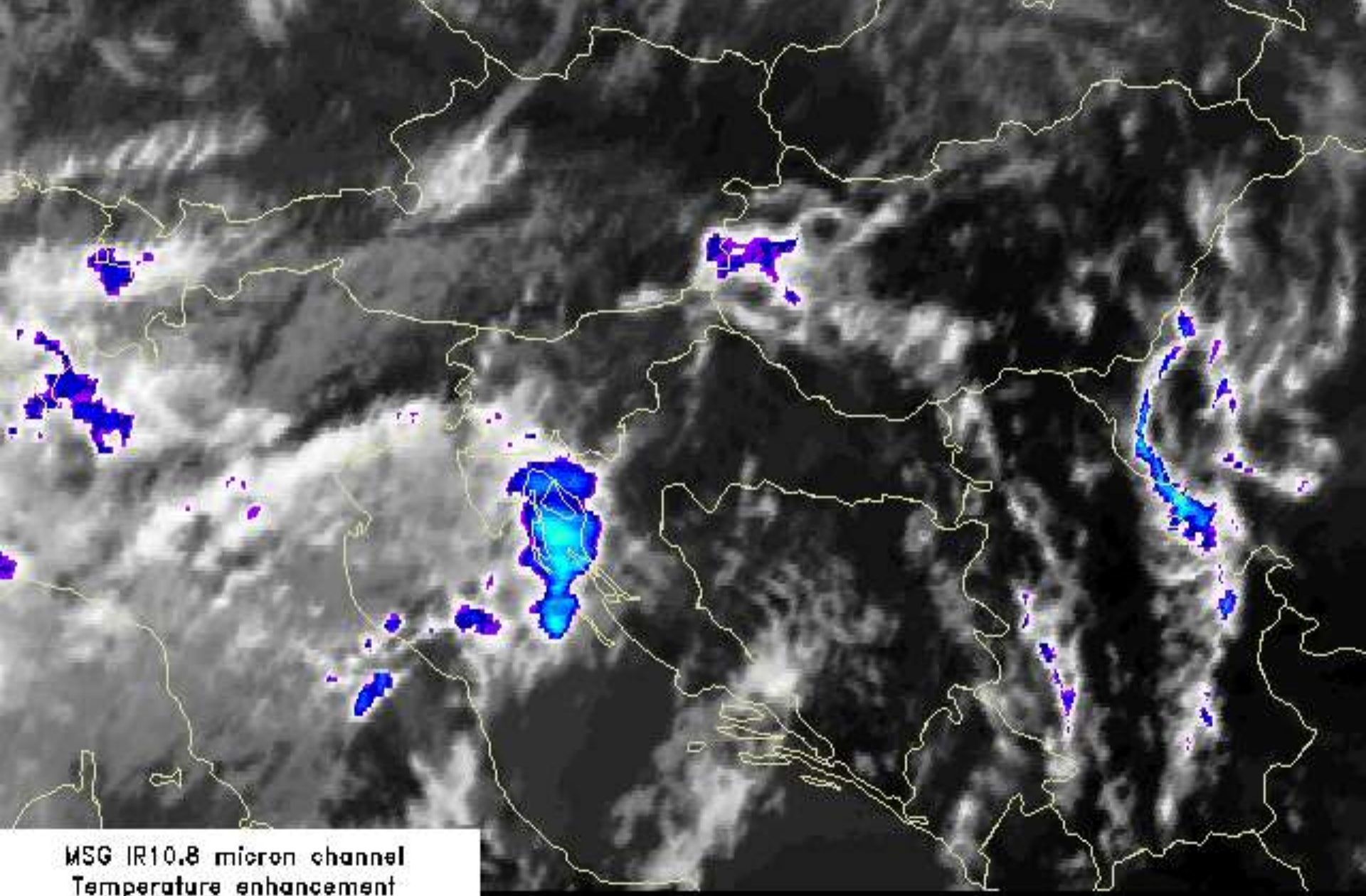




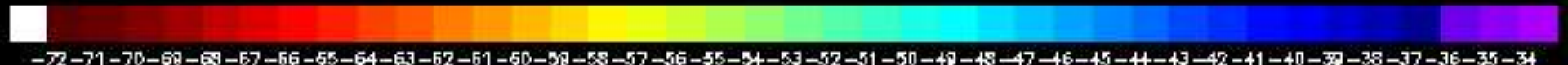
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 14:00 UTC

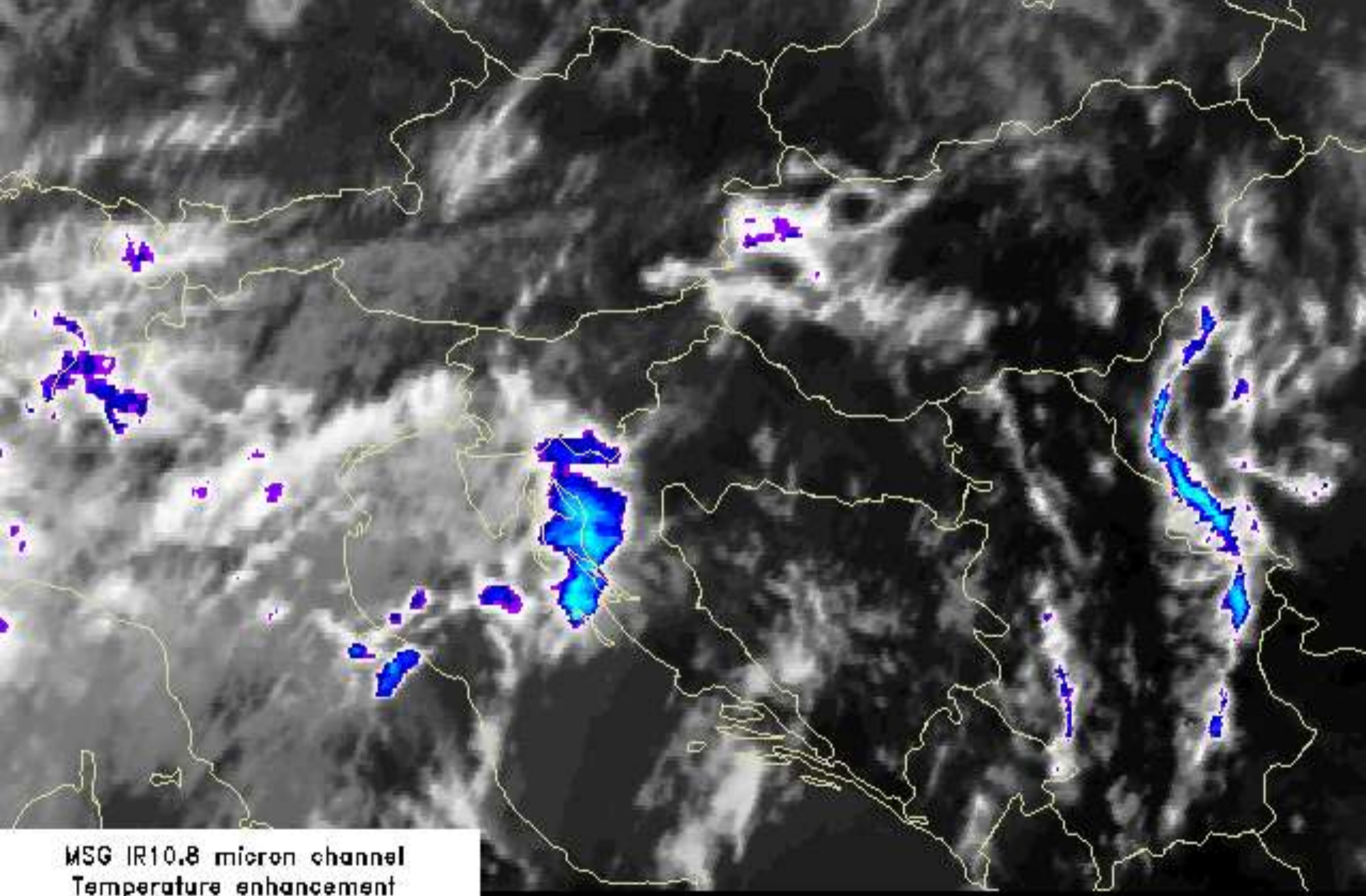


-22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

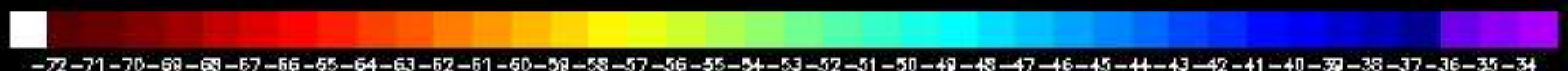


MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 14:15 UTC



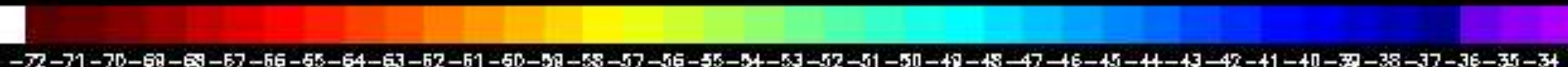


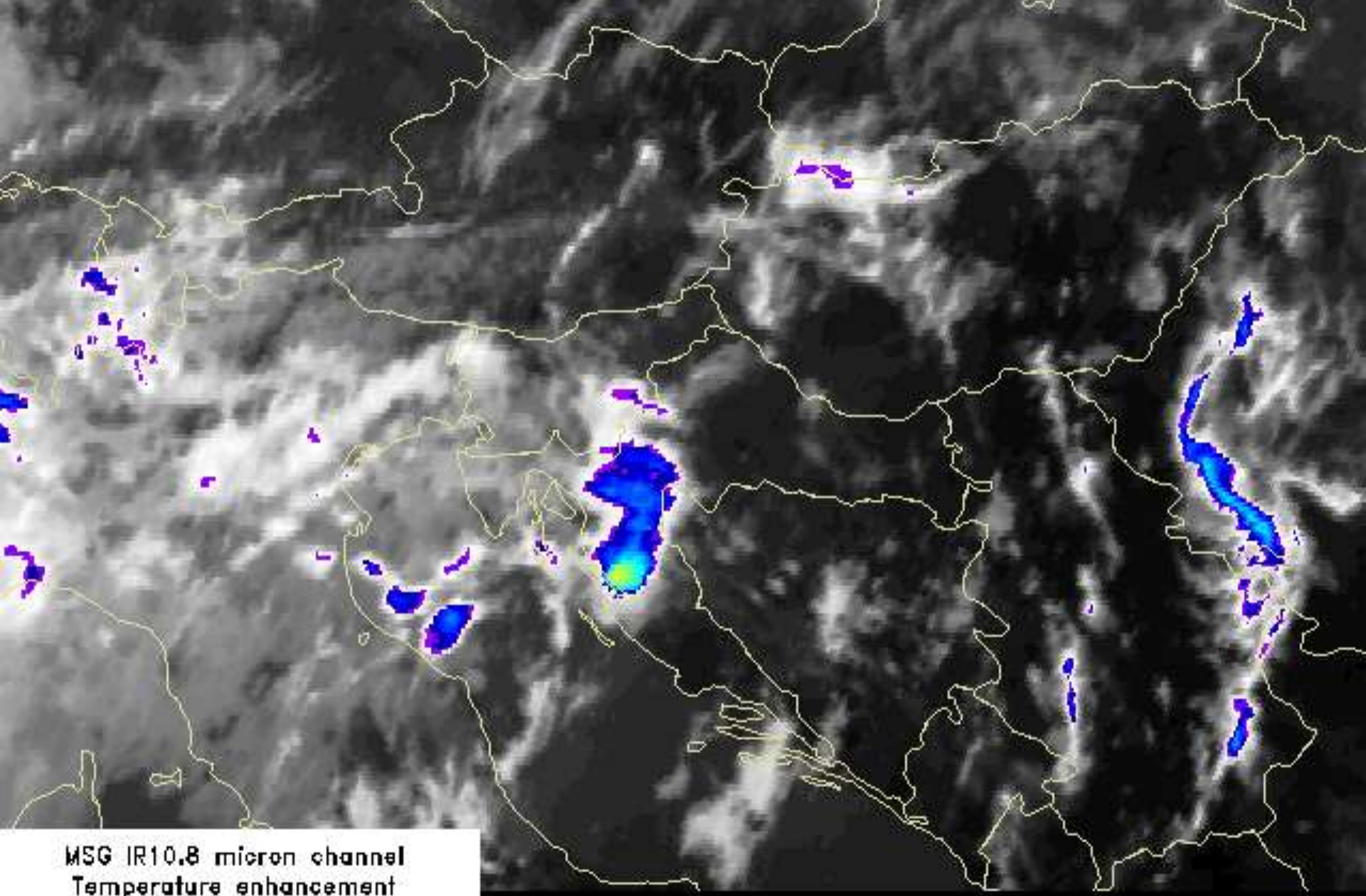
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 14:30 UTC



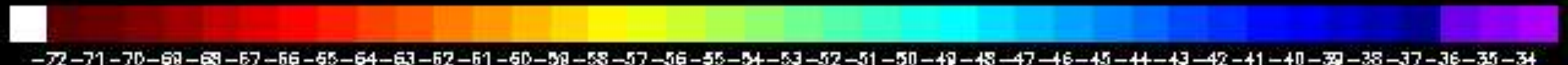


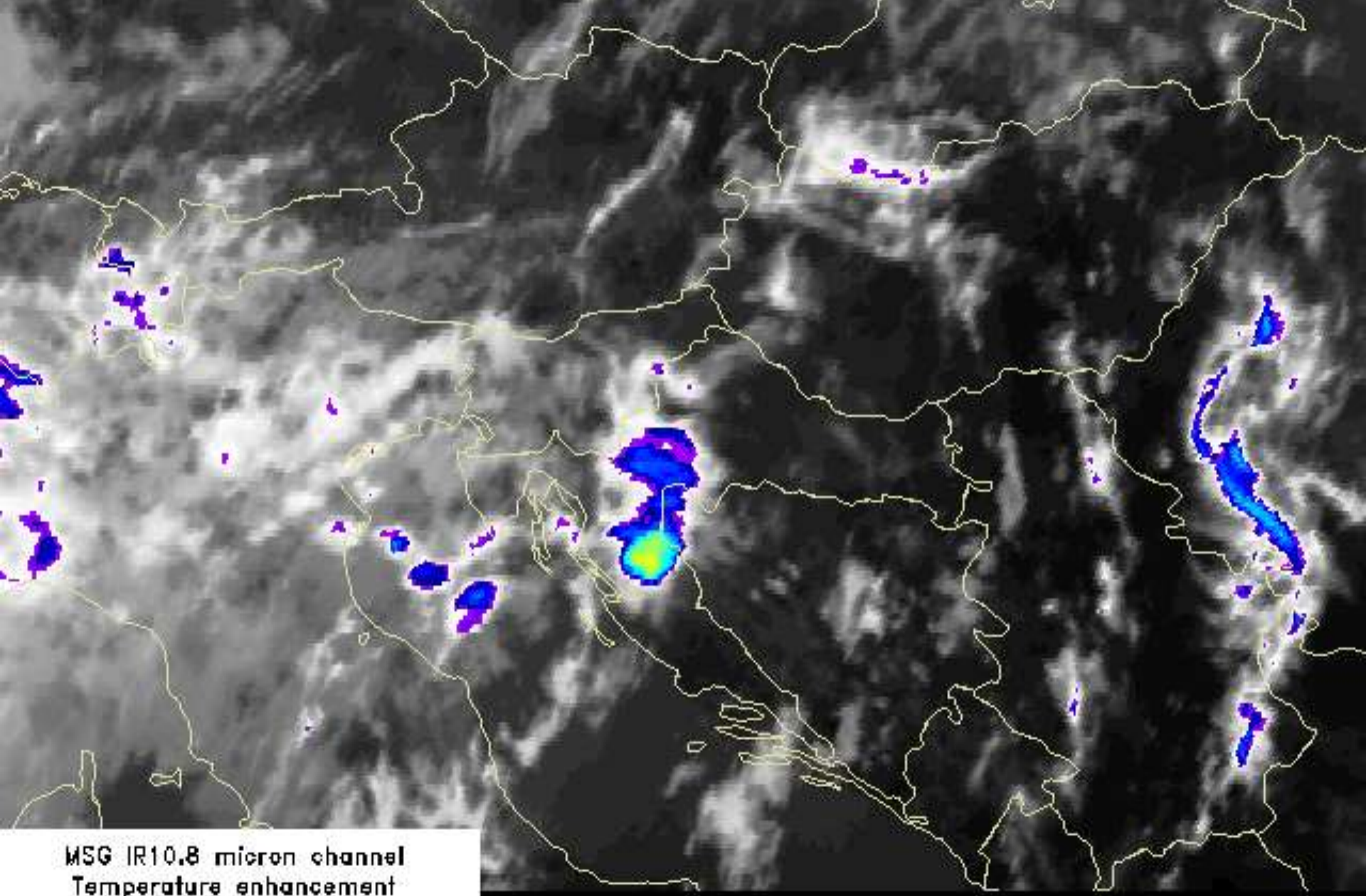
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 14:45 UTC



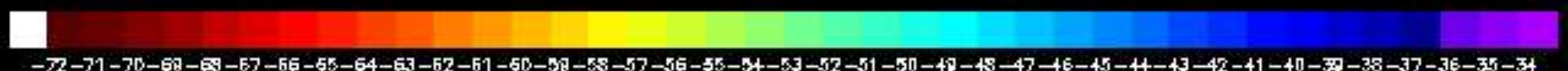


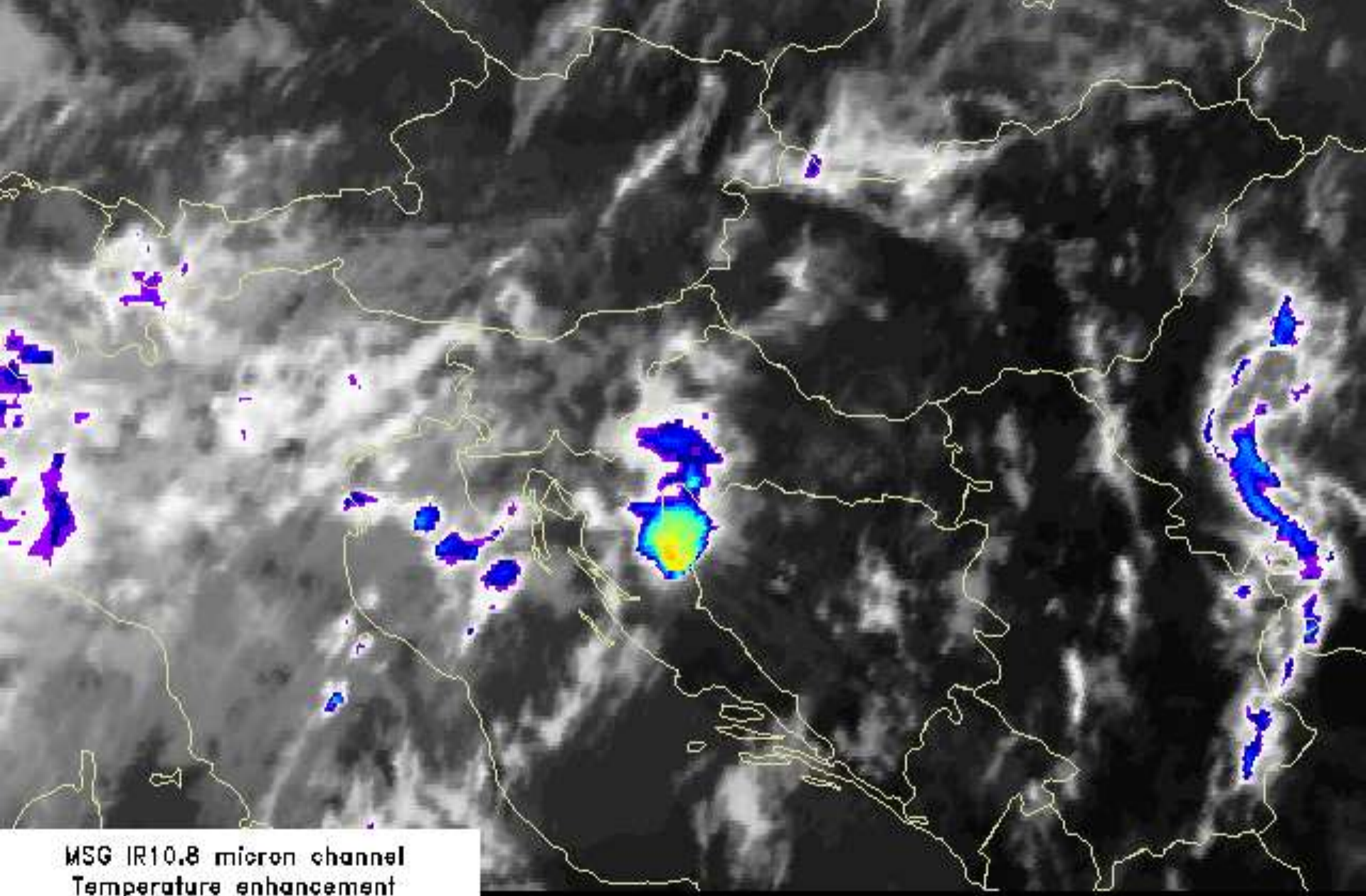
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 15:00 UTC



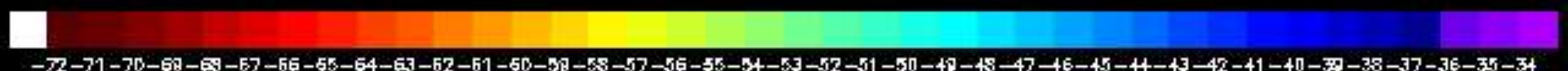


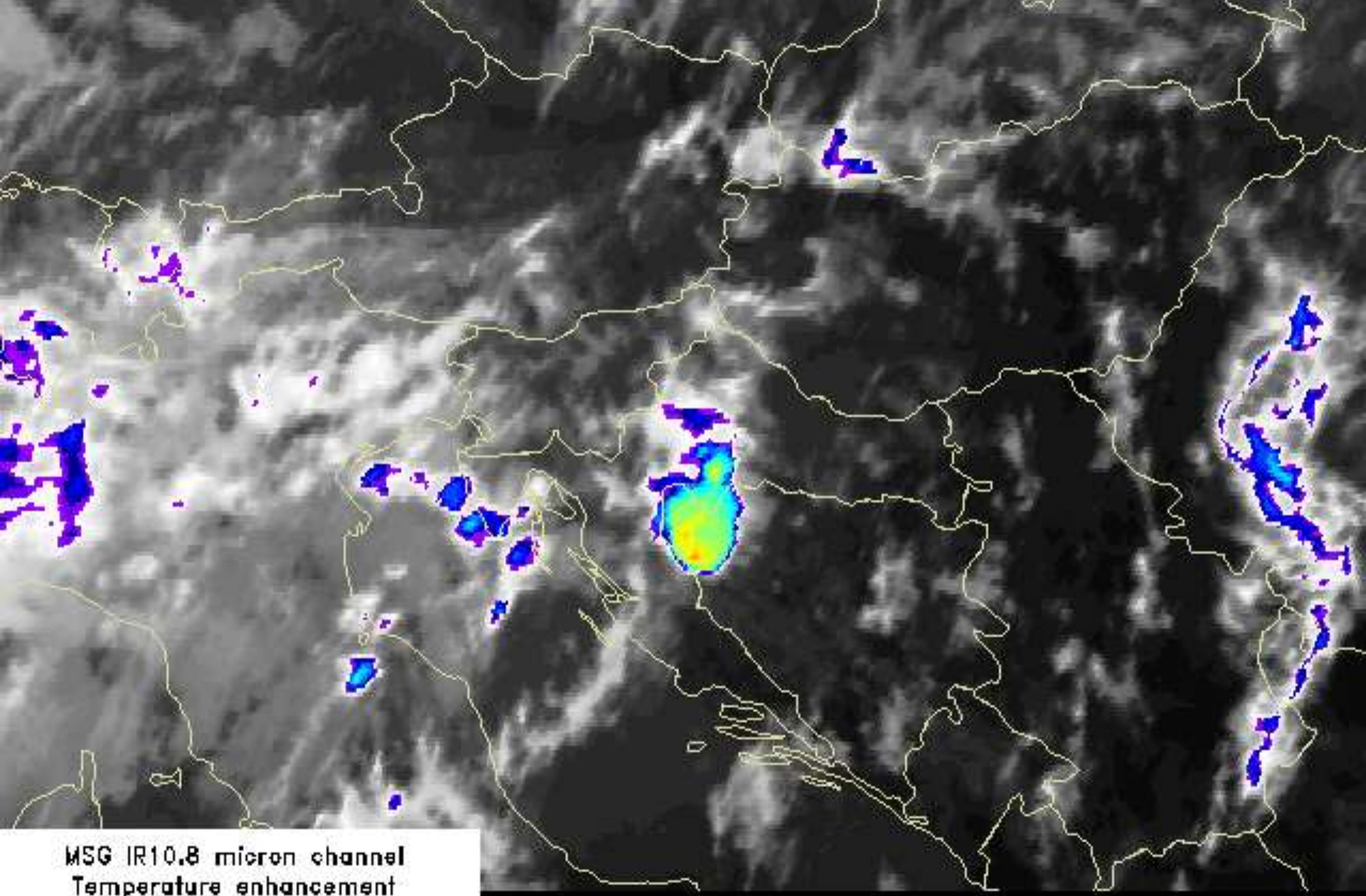
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Temperature enhancement
22 AUG 2007 15:15 UTC



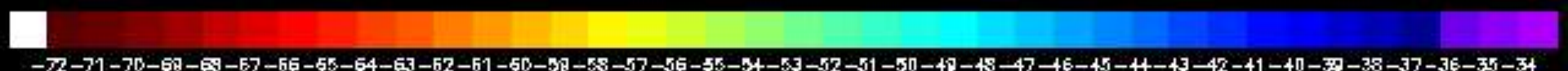


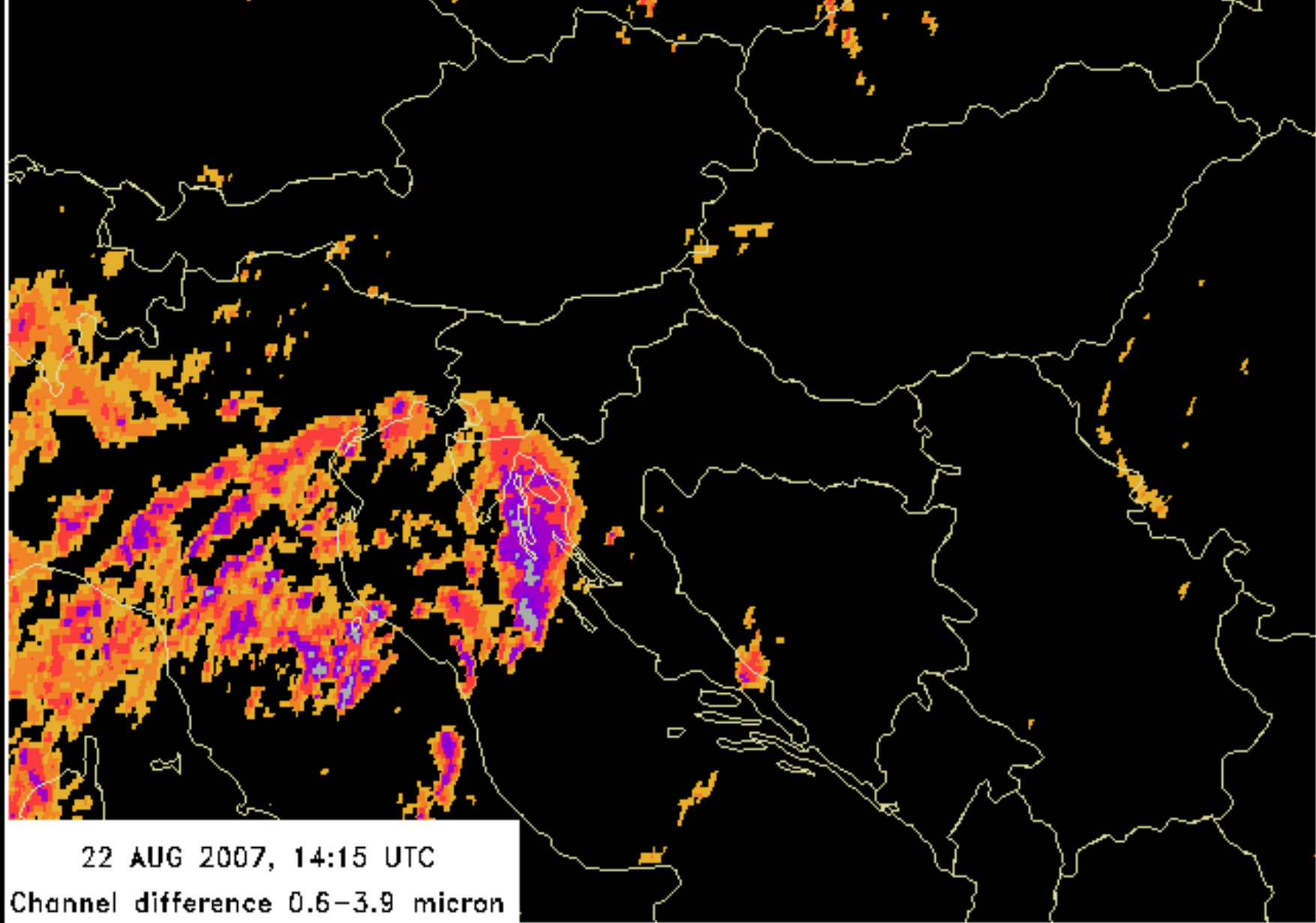
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 15:30 UTC

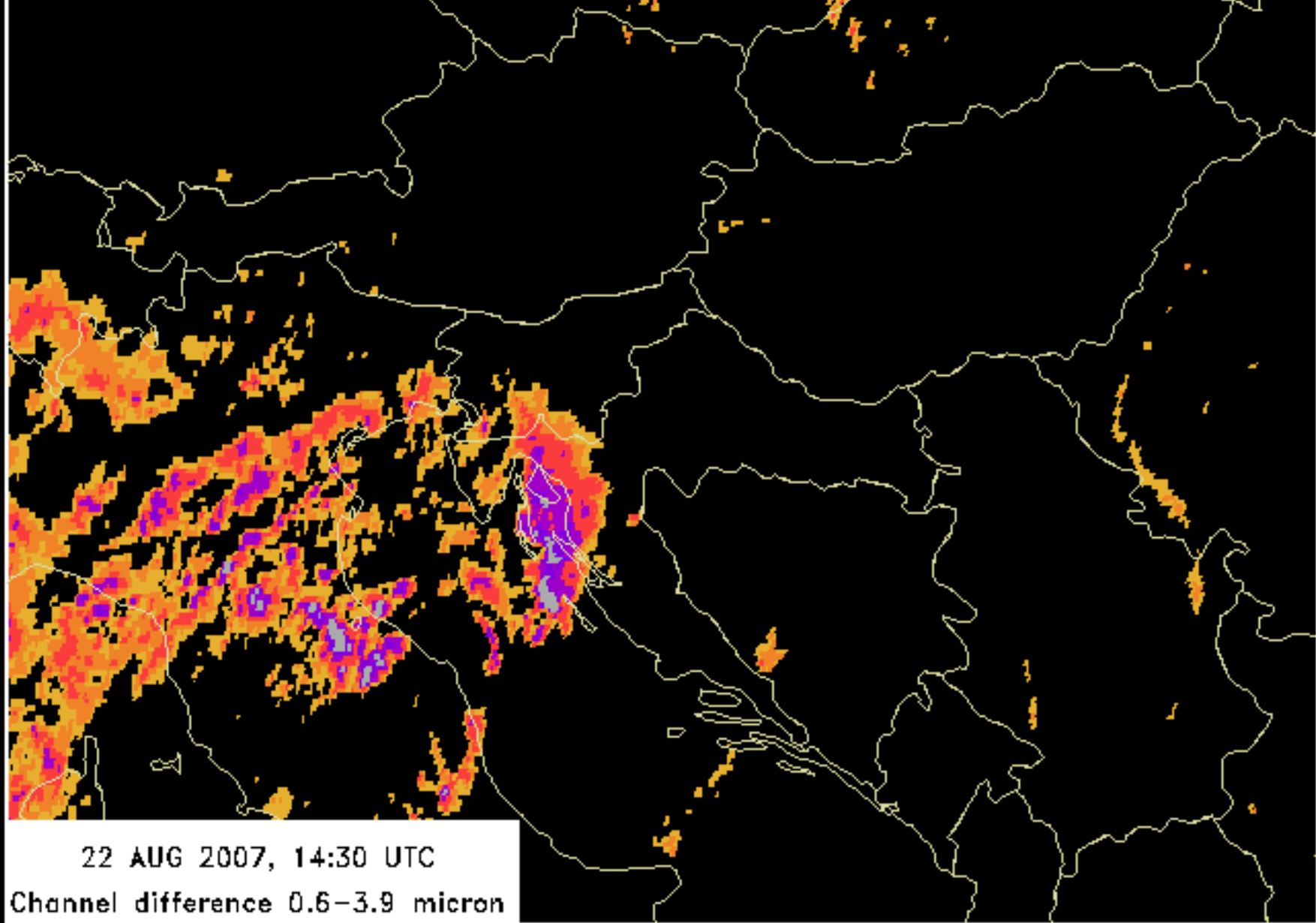


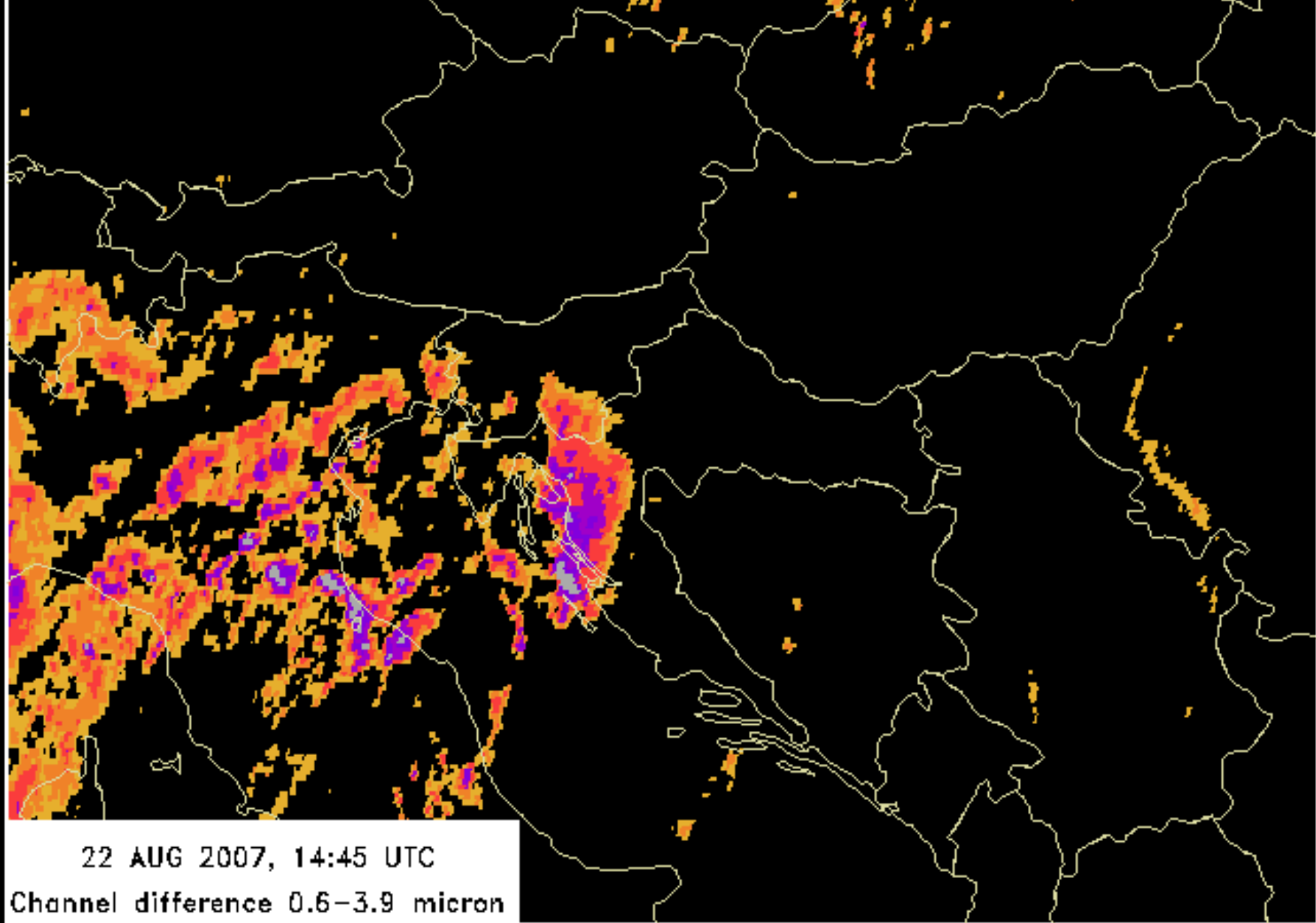


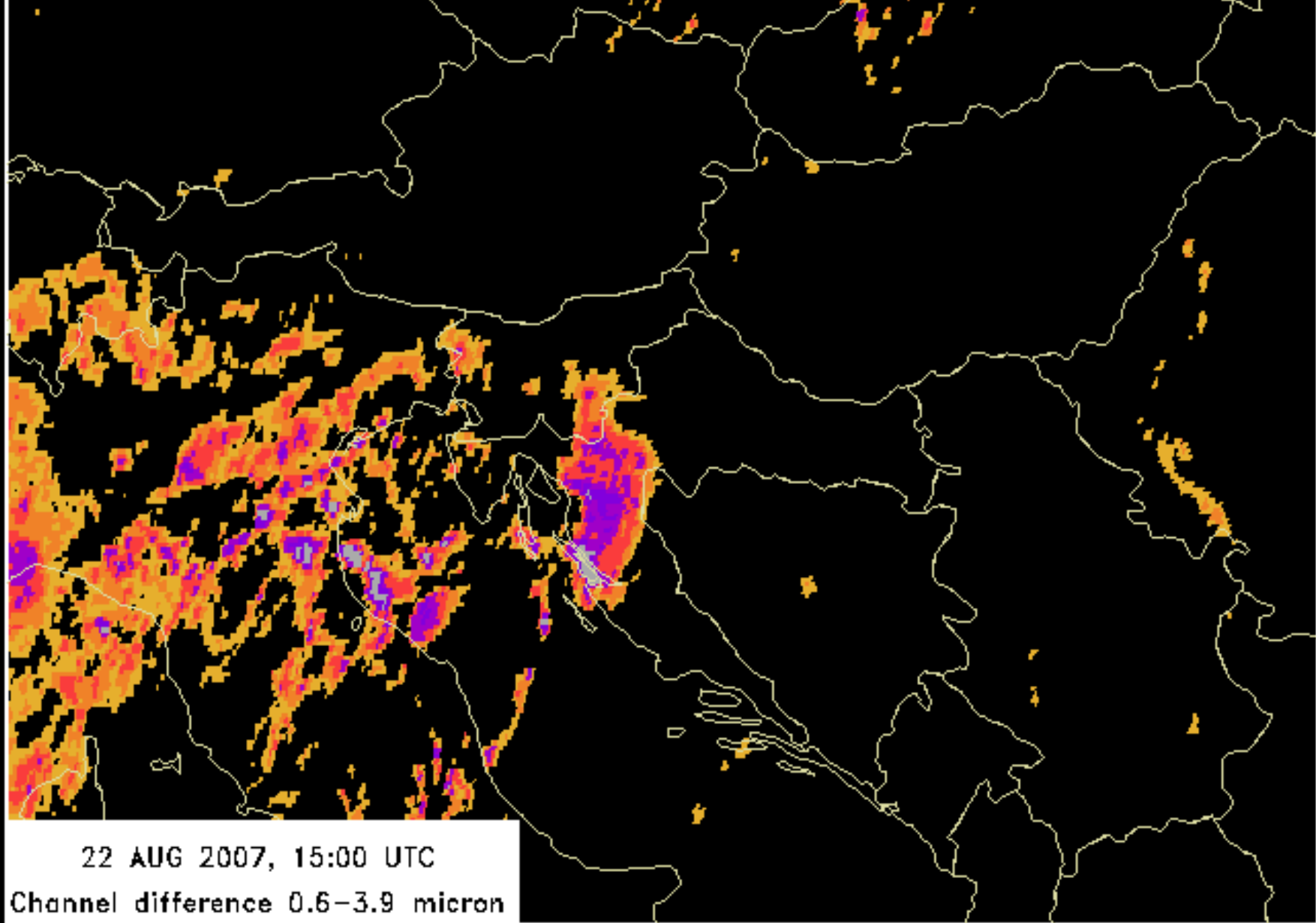
MSG IR10.8 micron channel
Temperature enhancement
22 AUG 2007 15:45 UTC

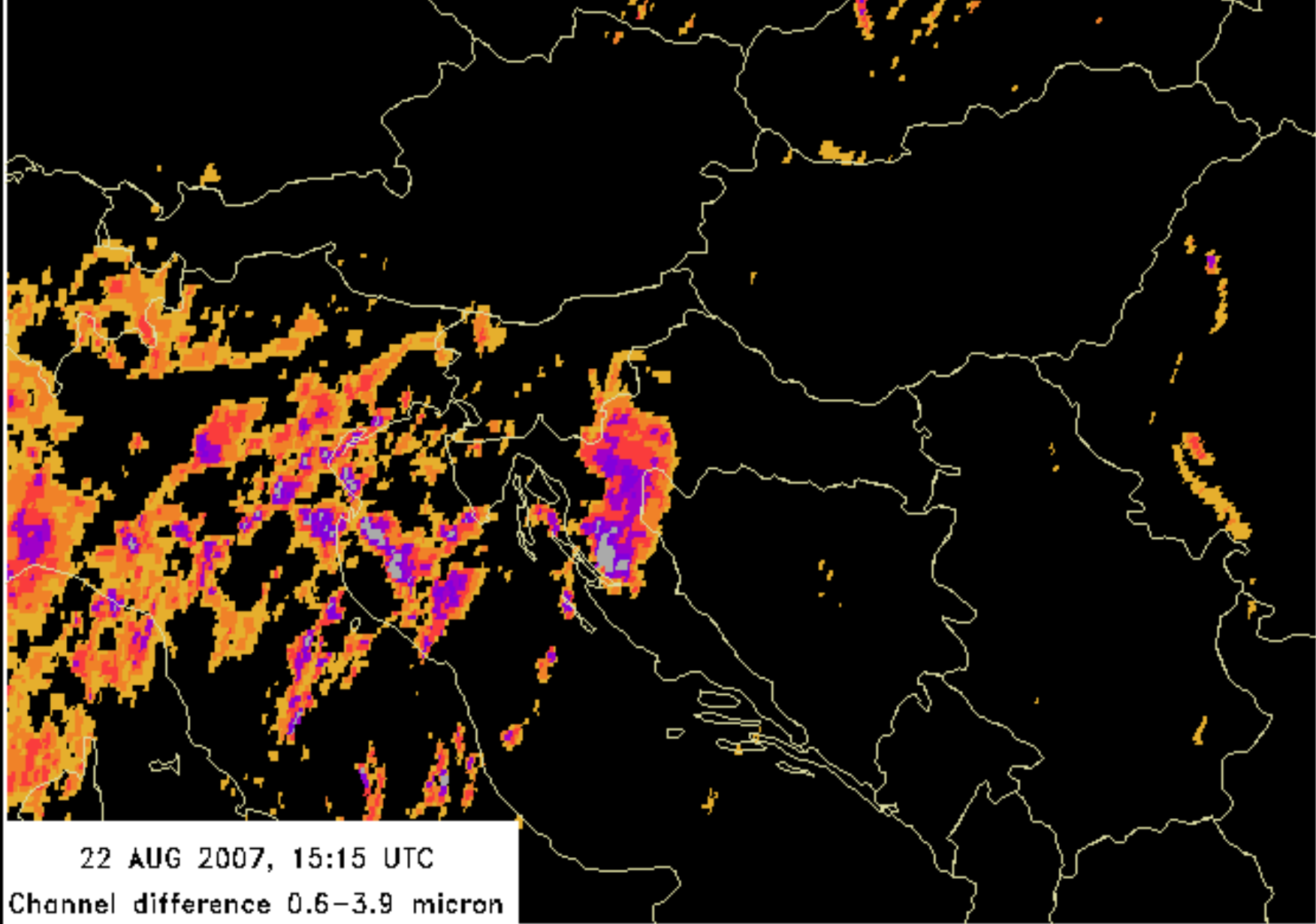




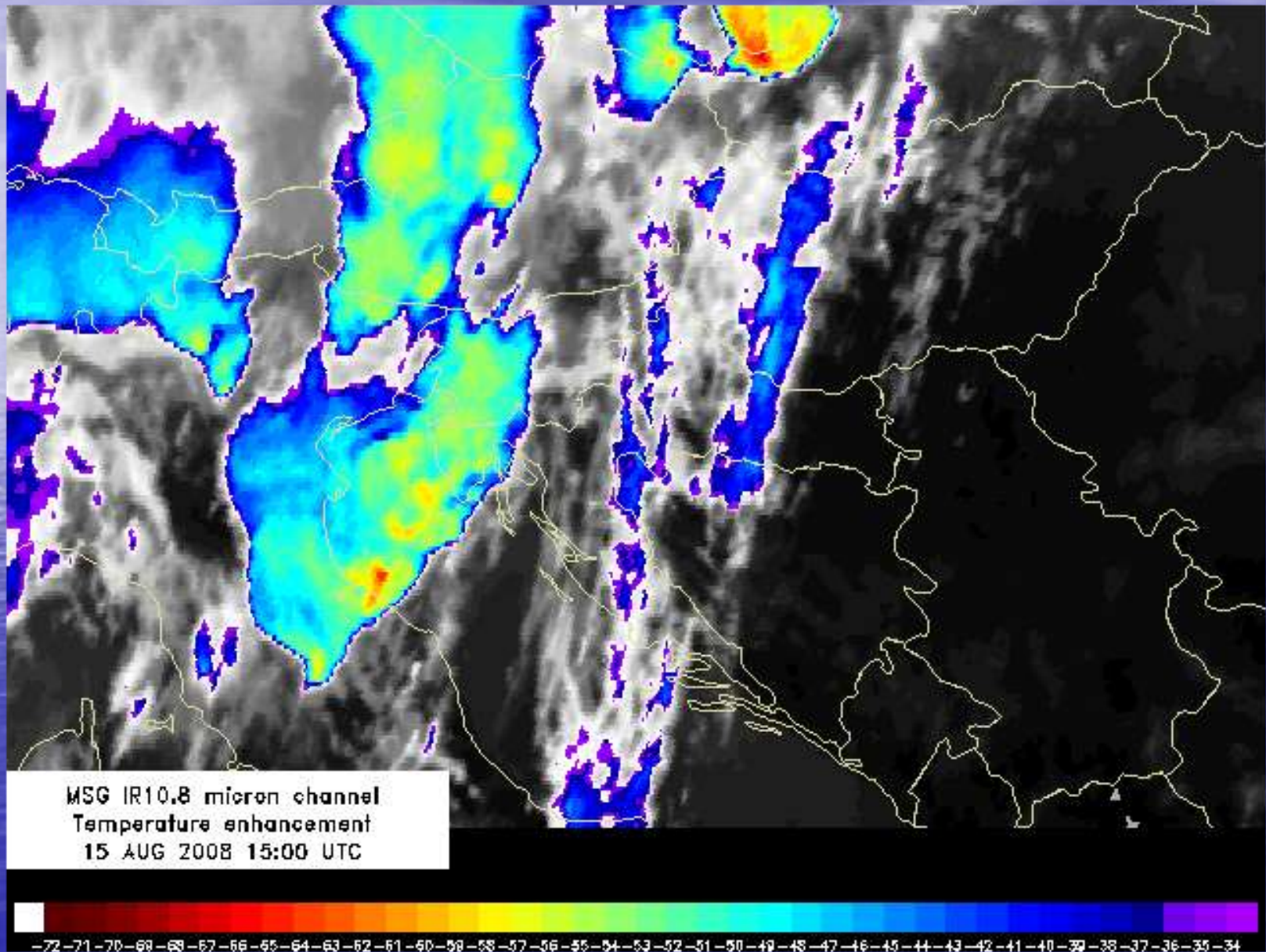








4. case: 15 August 2008 → Mali Lošinj



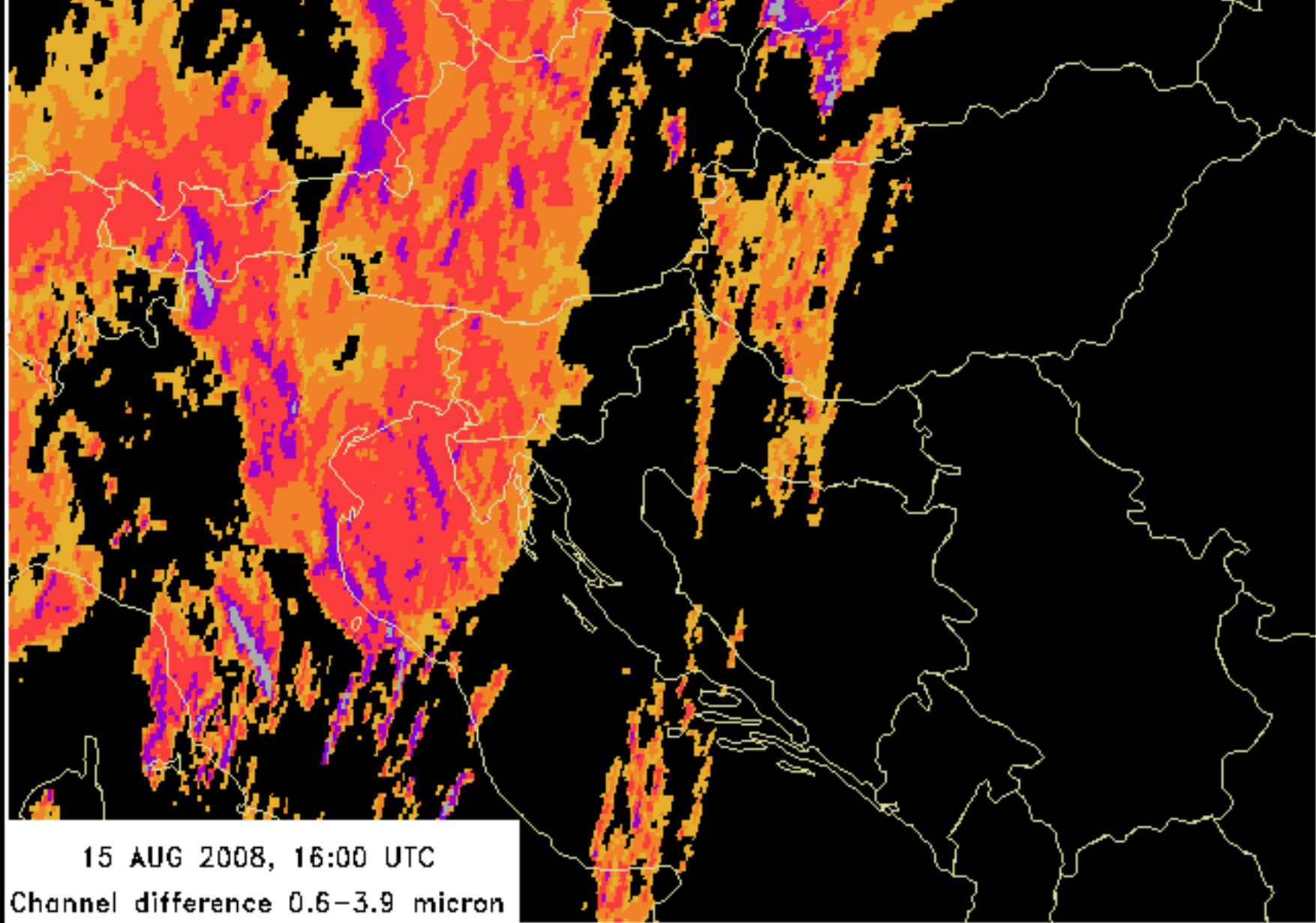


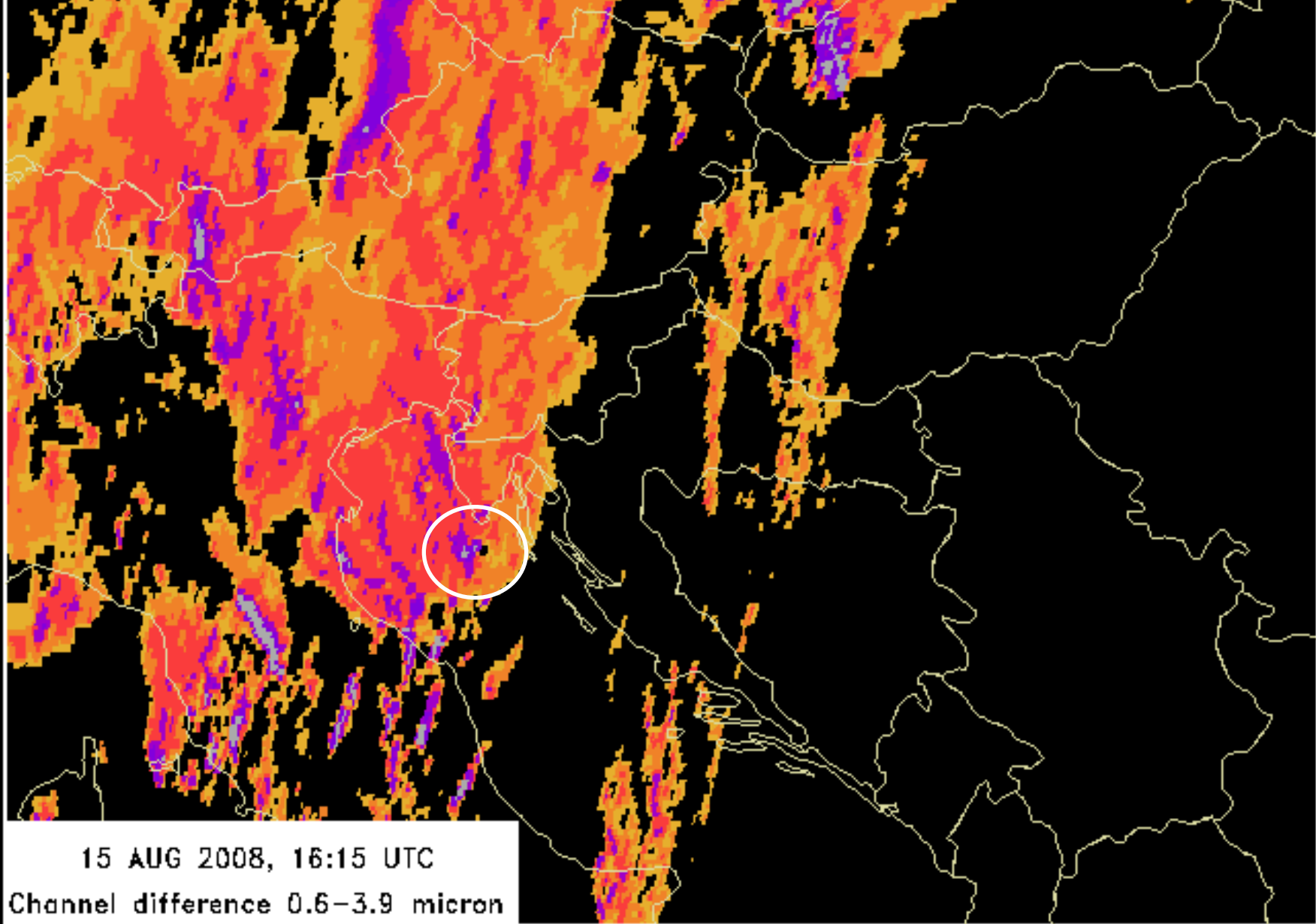


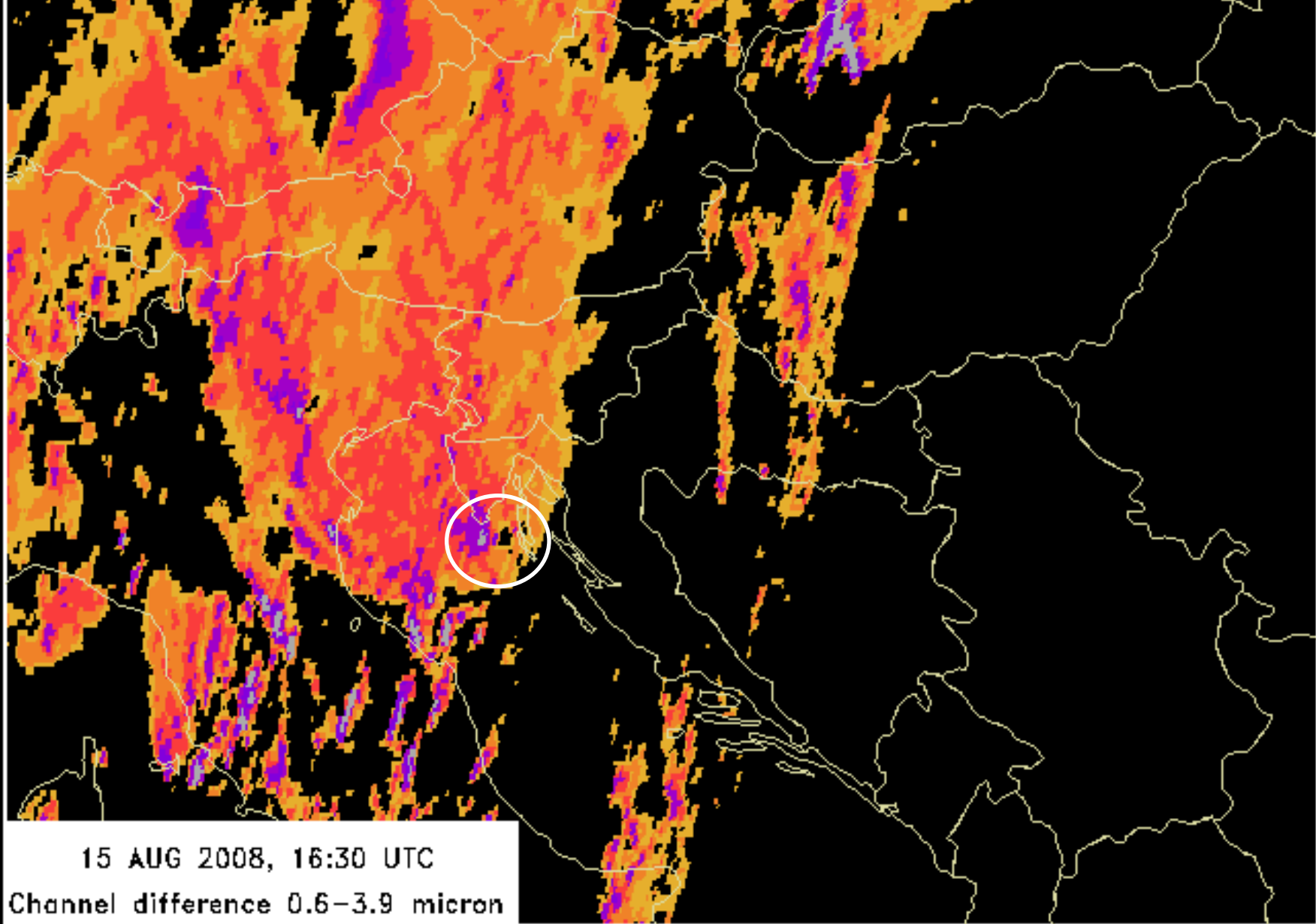


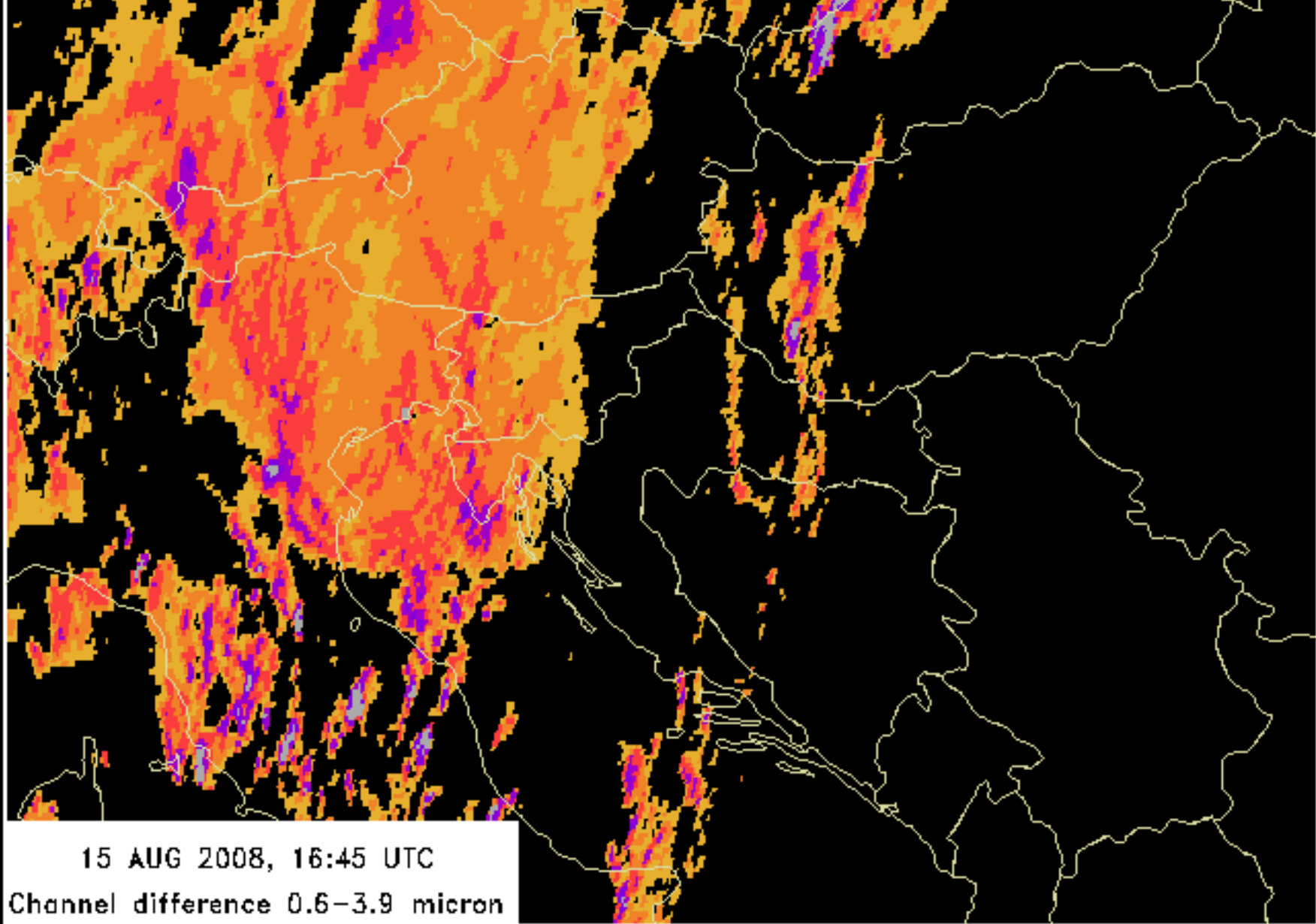












Driving energy – CONVECTION???

- 4 strongest recorded meteotsunami events in the Adriatic are related to propagating **convective clouds** (Vela Luka, Hvar, Ist & Mali Lošinj)

Conditions for meteotsunami development

☺ Propagating atmospheric pressure and/or
wind disturbance ✓

- Critical phase speed of the atmospheric disturbance ~ 22 m/s
- Inlet, bay or harbour willing to resonate with the incoming wave

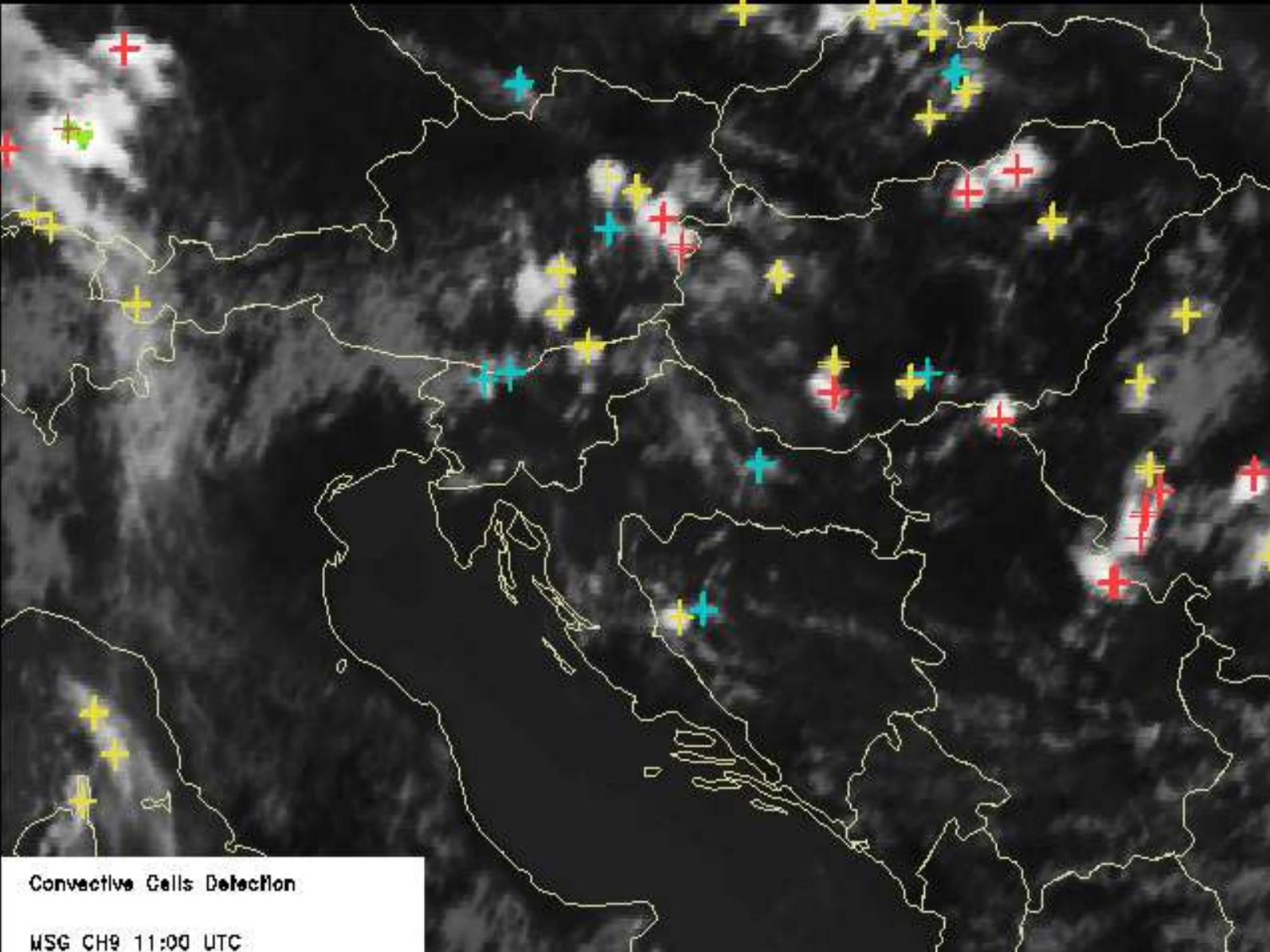
However...

- Clouds is all that is in common; otherwise, the synoptic setup is different → Limited predictability from “simple” (i.e. usual) weather data
- Atmospheric numerical models have difficulties with reproducing convective events

Can satellites offer more?

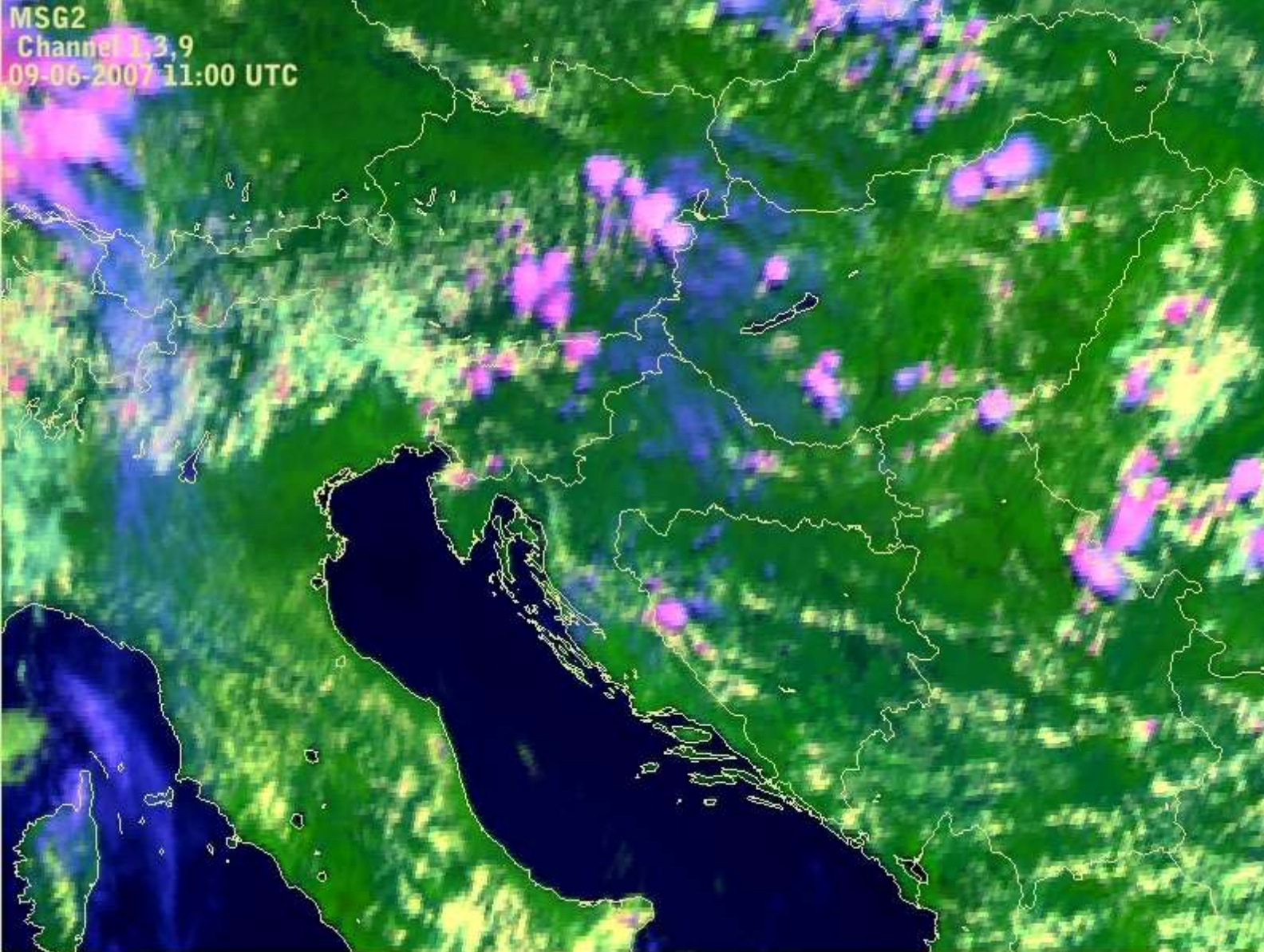
Detection of the convective cells

- Convective elements detection based on IR 10.8, combination of 0.6, 1.6 and 10.8 μm and difference between 0.6 and 1.6 μm or 0.6 and 3.9 μm
- Other convection detection methods (Convective storm RGB, Rapid Developing Thunderstorm, overshooting top detection methods) can be used

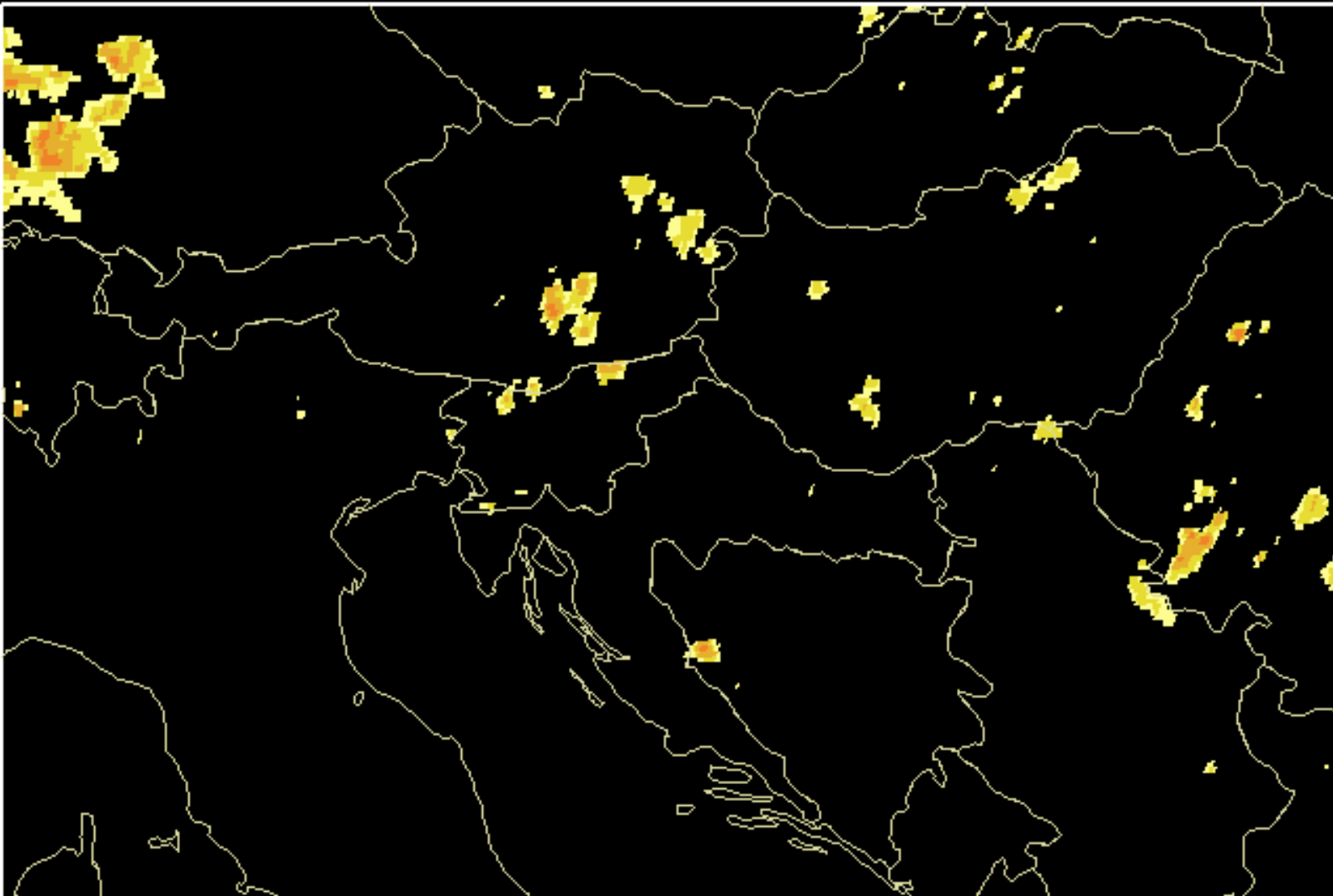


+ T-top -33 to -42 °C **+ T-top -42 to -55 °C** **+ T-top < -55 °C**

MSG2
Channel 1,3,9
09-06-2007 11:00 UTC

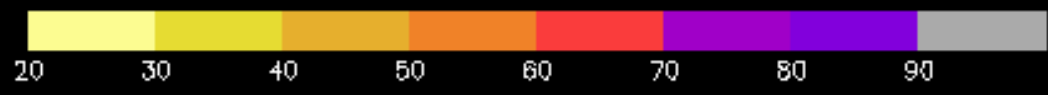


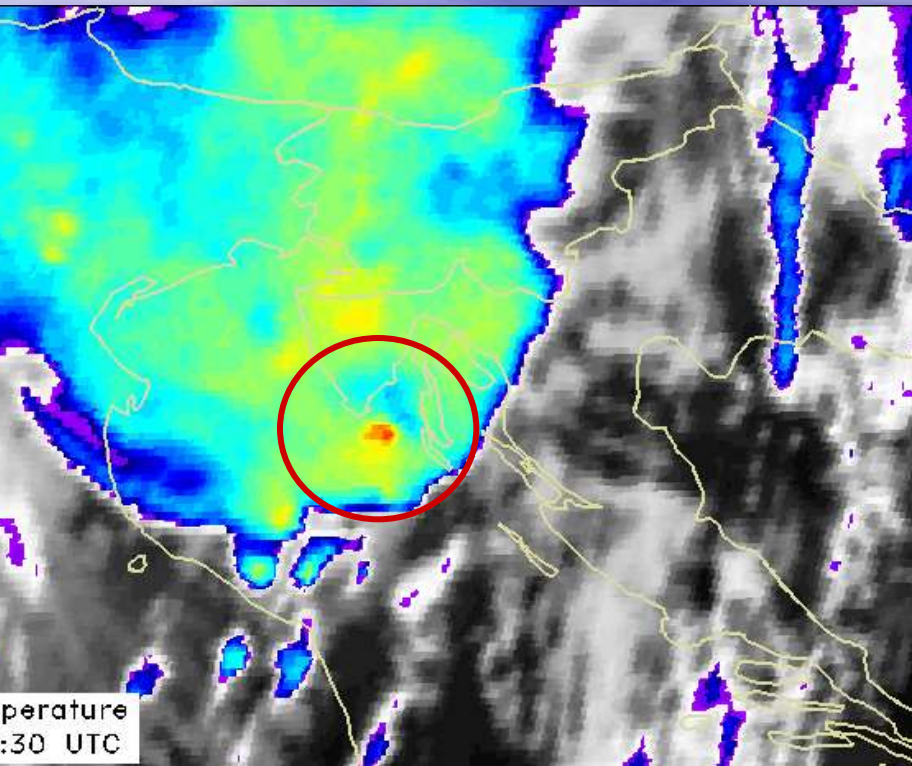
09 June 2007, RGB 0.6,1.6,10.8 μm



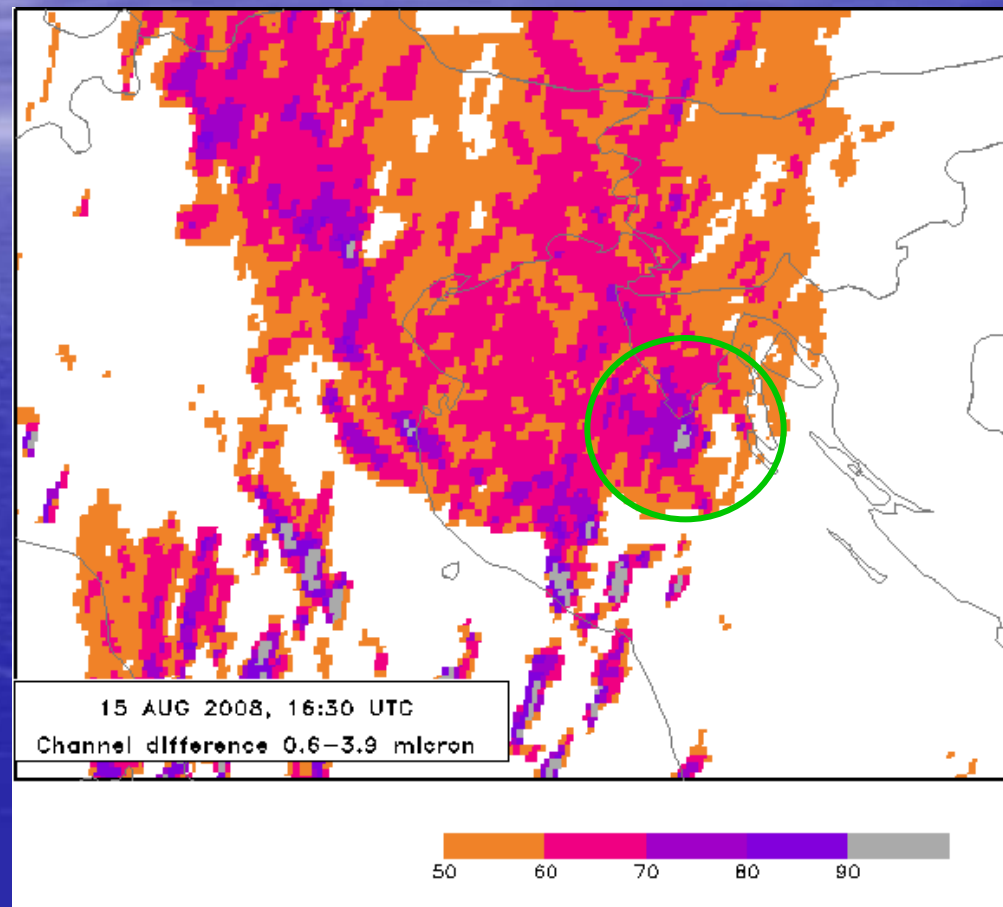
09 JUN 2007, 11:00 UTC
Channel difference 0.6-1.6 micron

0.6 - 1.6 μm





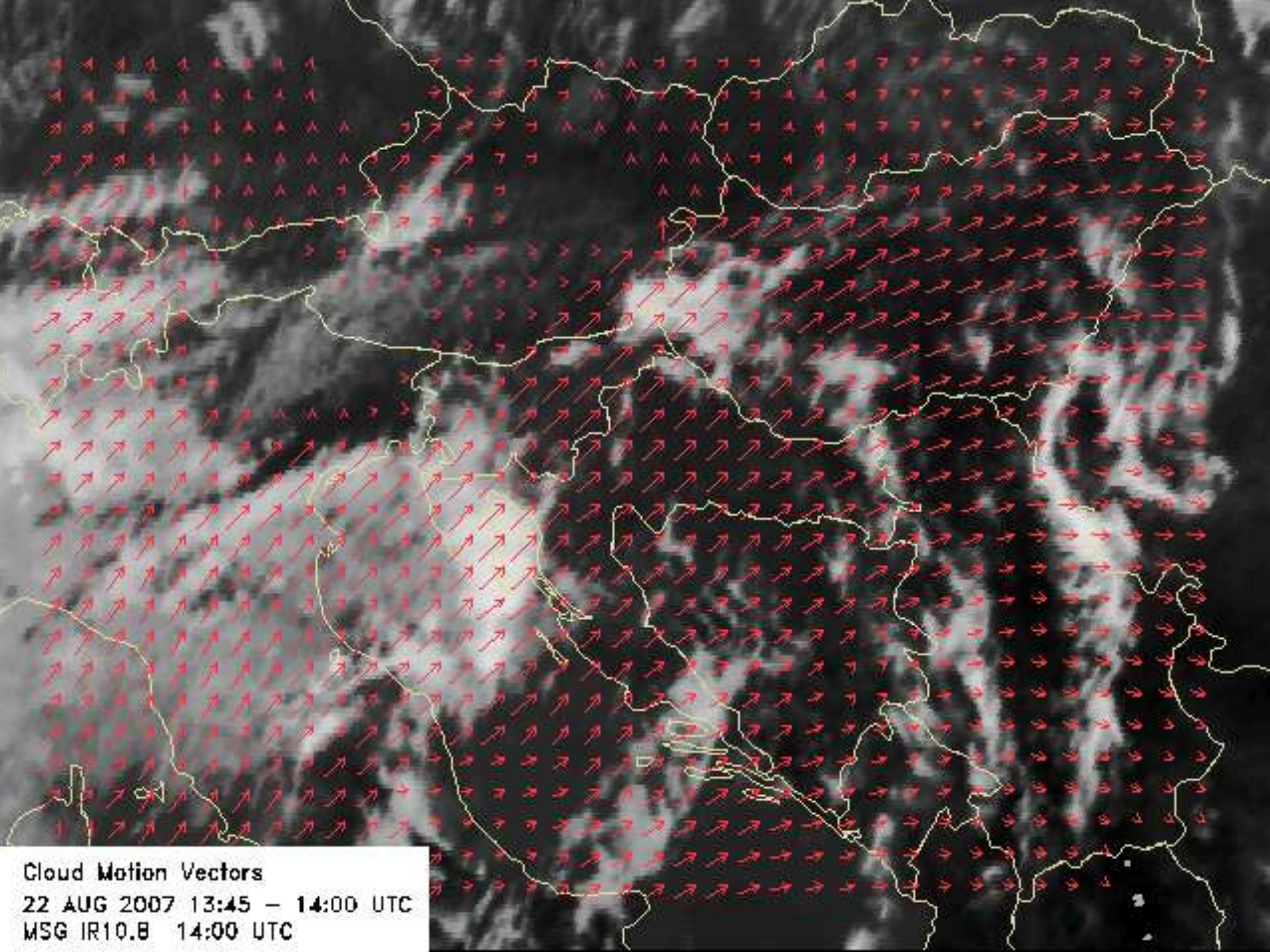
Colour enhanced IR 10.8 μm



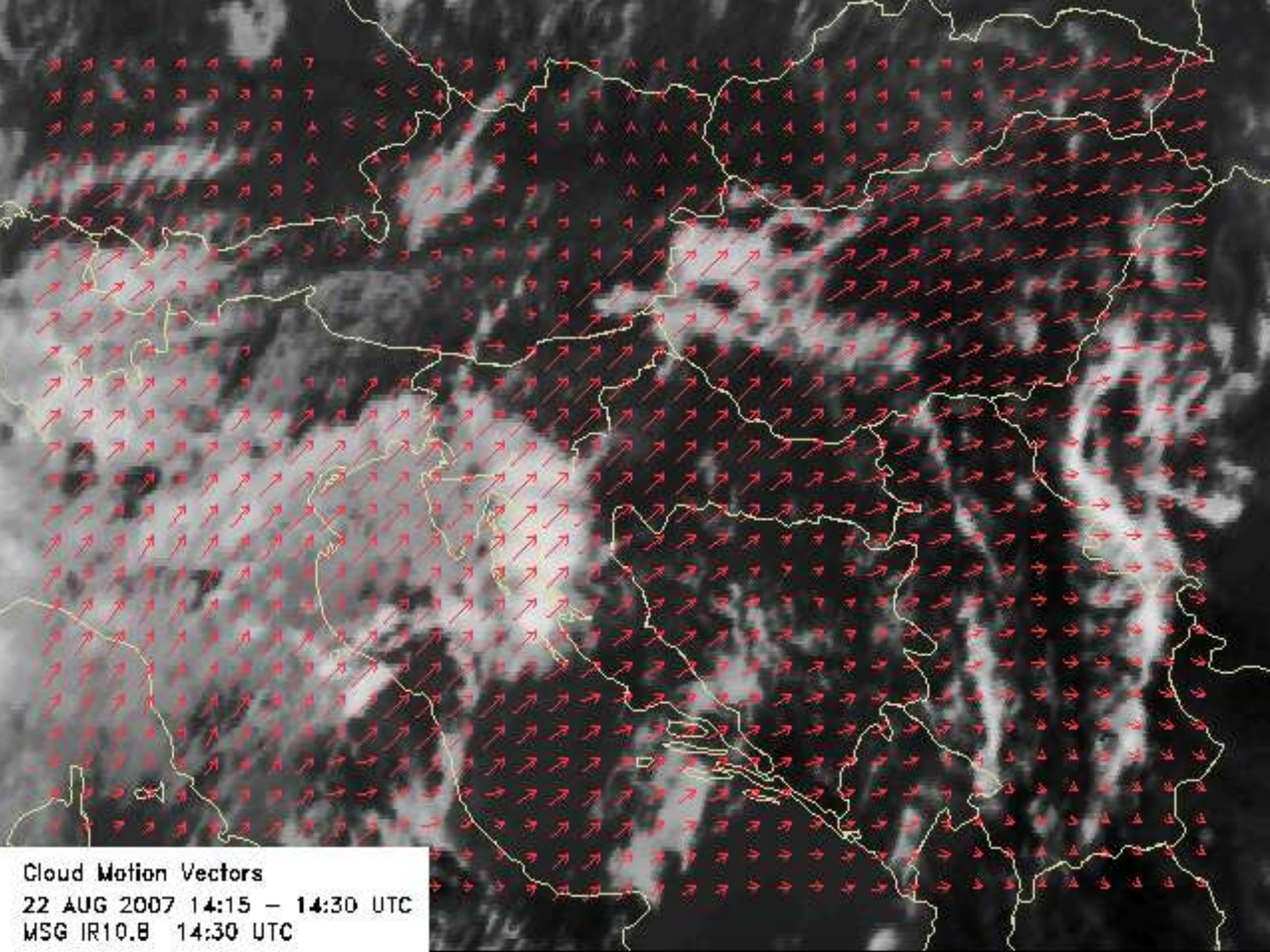
Channel difference 0.6-3.9 μm

Tracking of the convective cells

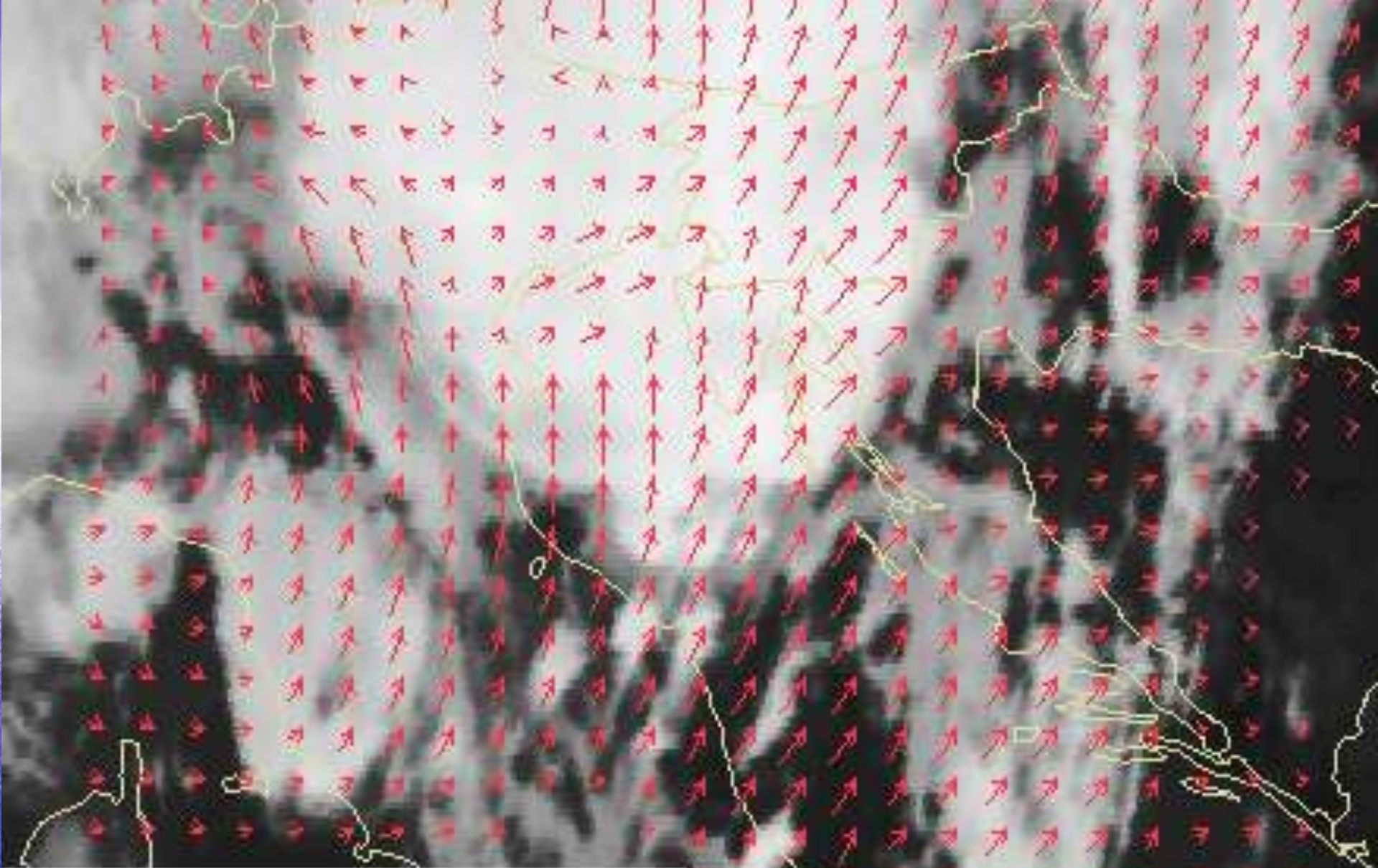
- Cloud Motion Vectors from IR10.8 μm consecutive images
- Wind vector MPEF product (based on WV images)



Cloud Motion Vectors
22 AUG 2007 13:45 - 14:00 UTC
MSG IR10.8 14:00 UTC



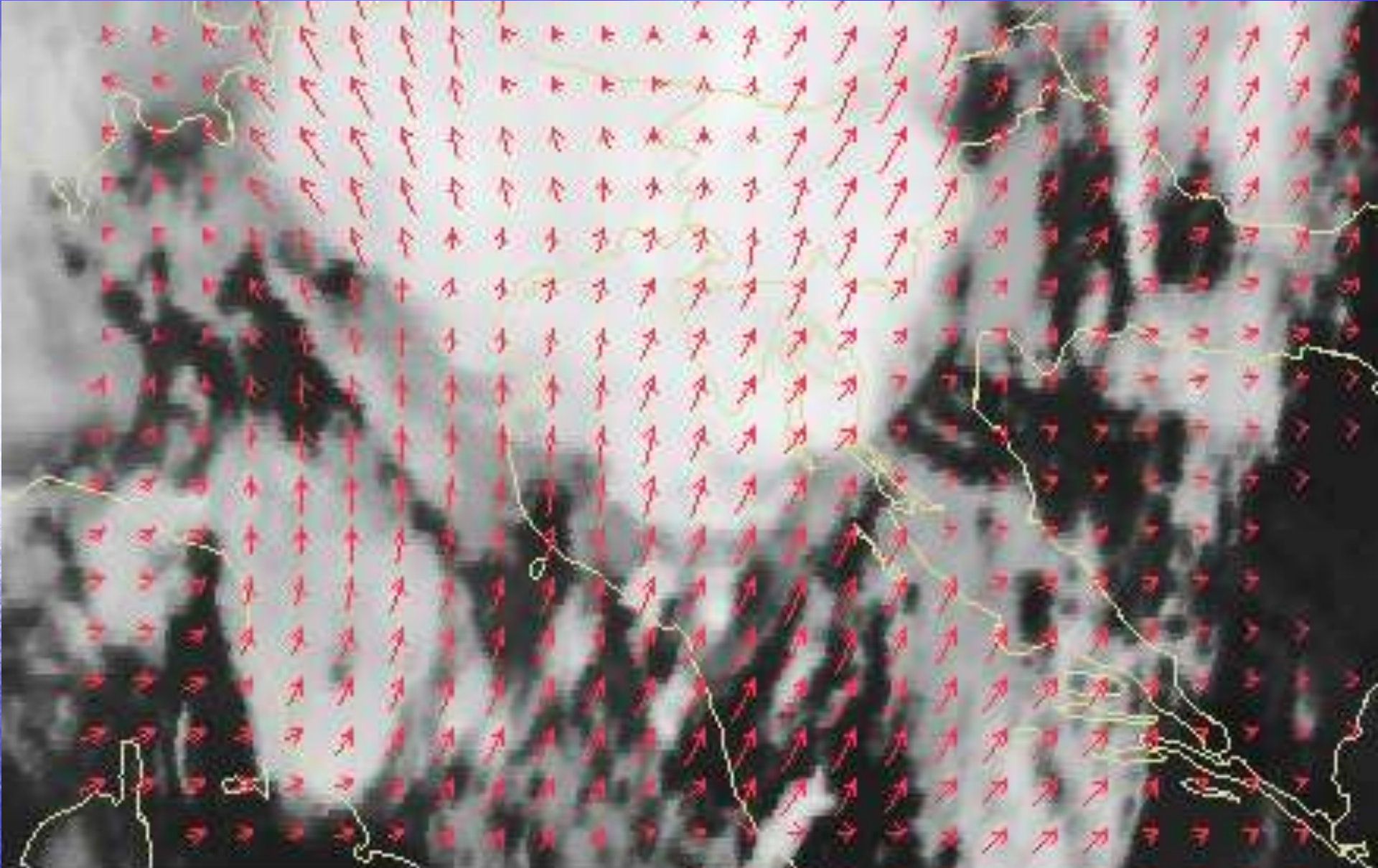
Cloud Motion Vectors
22 AUG 2007 14:15 - 14:30 UTC
MSG IR10.8 14:30 UTC



Cloud Motion Vectors

15 AUG 2008 16:30 - 16:45 UTC

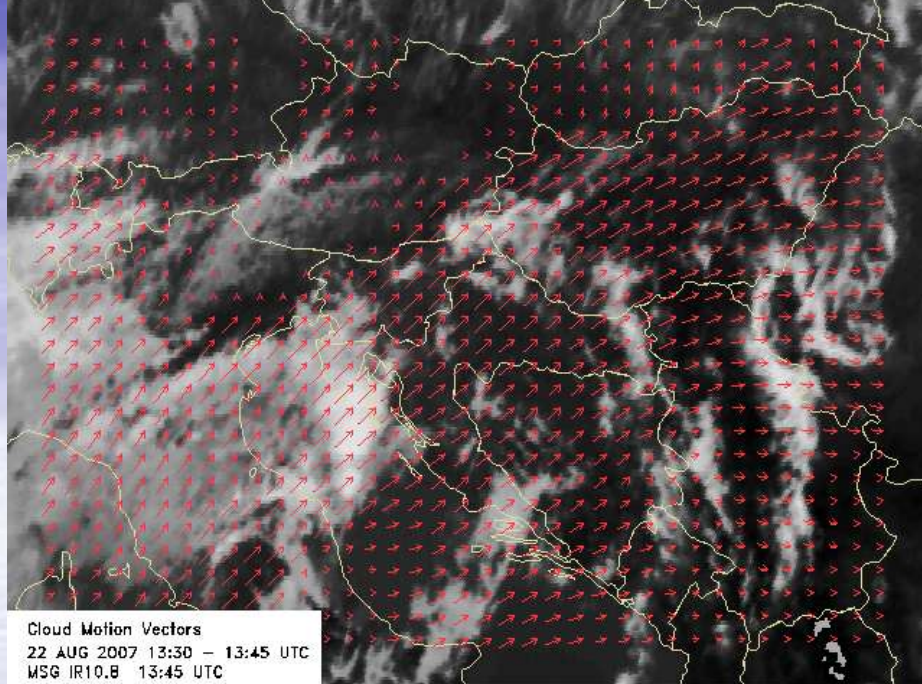
MSG IR10.8 16:45 UTC



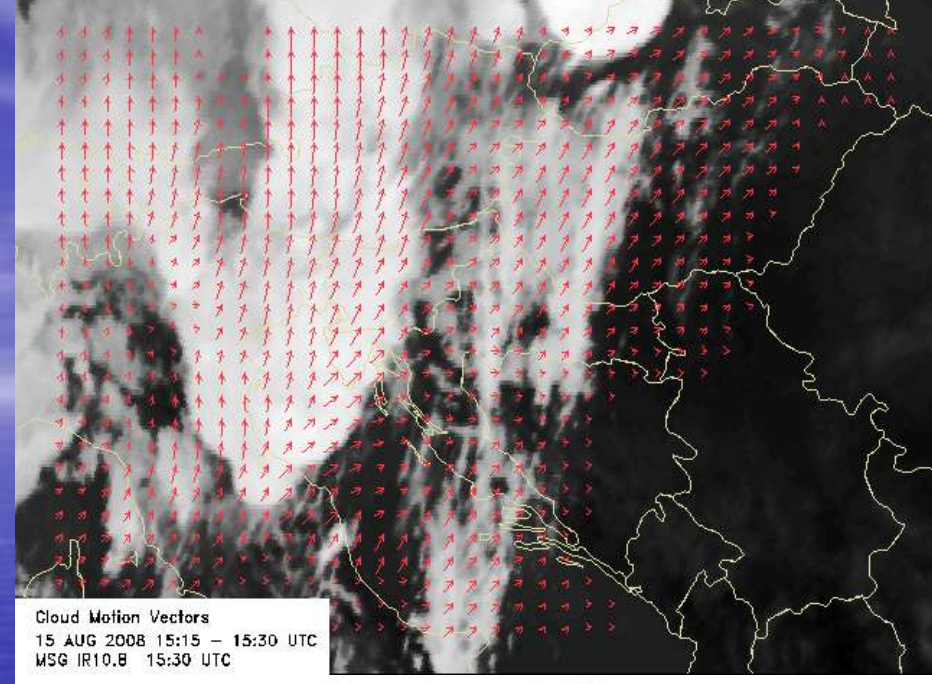
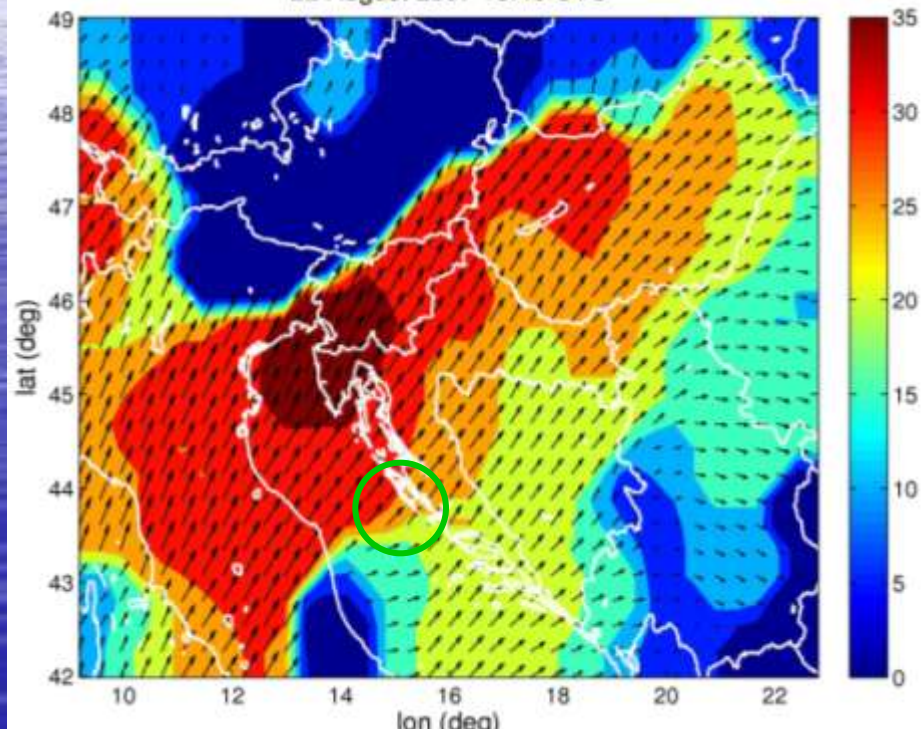
Cloud Motion Vectors

15 AUG 2008 16:45 - 17:00 UTC

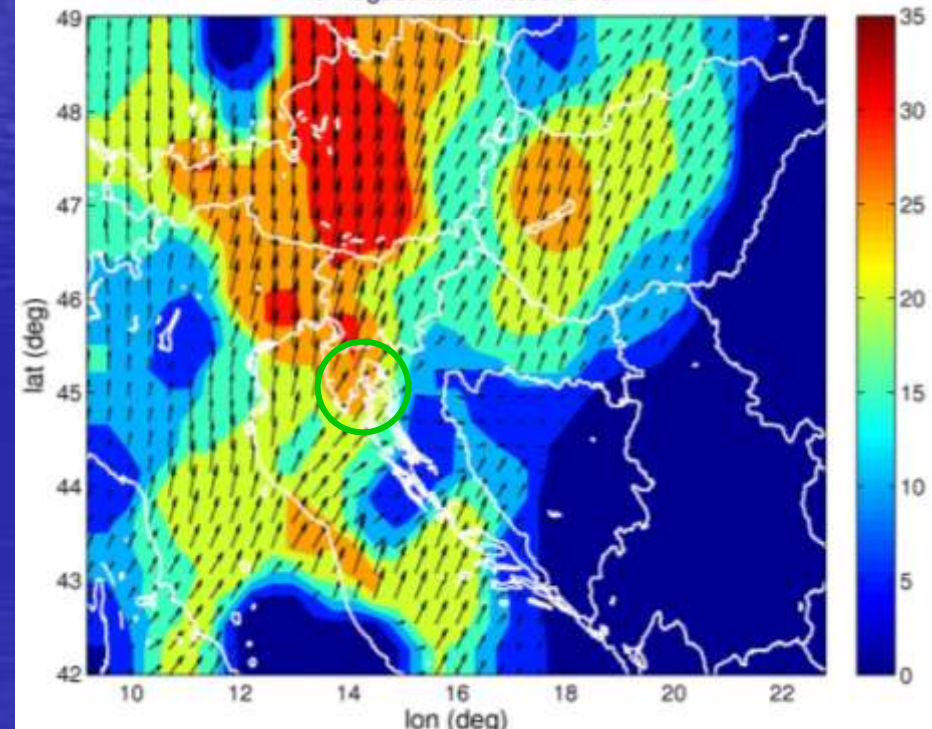
MSG IR10.8 17:00 UTC



22 August 2007 13:45 UTC



15 August 2008 15:30 UTC



Conditions for meteotsunami development

- ☺ Propagating atmospheric pressure and/or wind disturbance ✓
 - ☺ Critical phase speed of the atmospheric disturbance ~ 22 m/s ✓
-
- Inlet, bay or harbour willing to resonate with the incoming wave

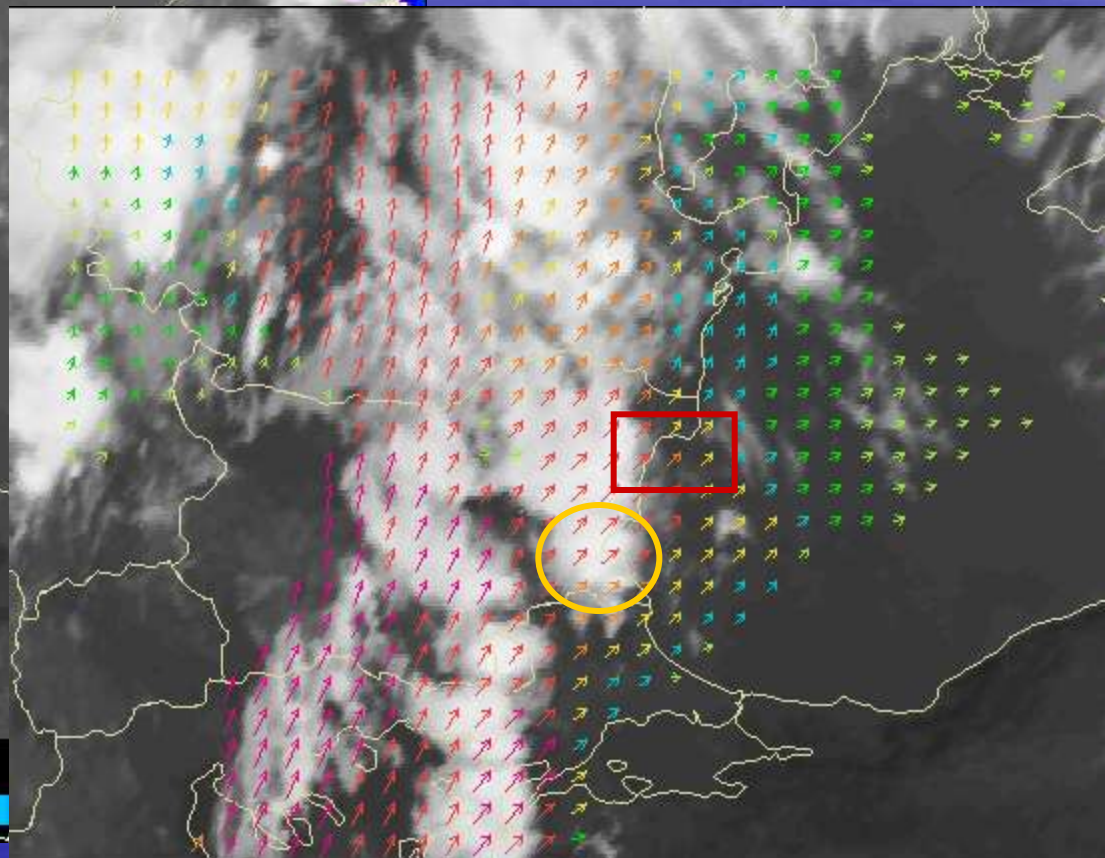
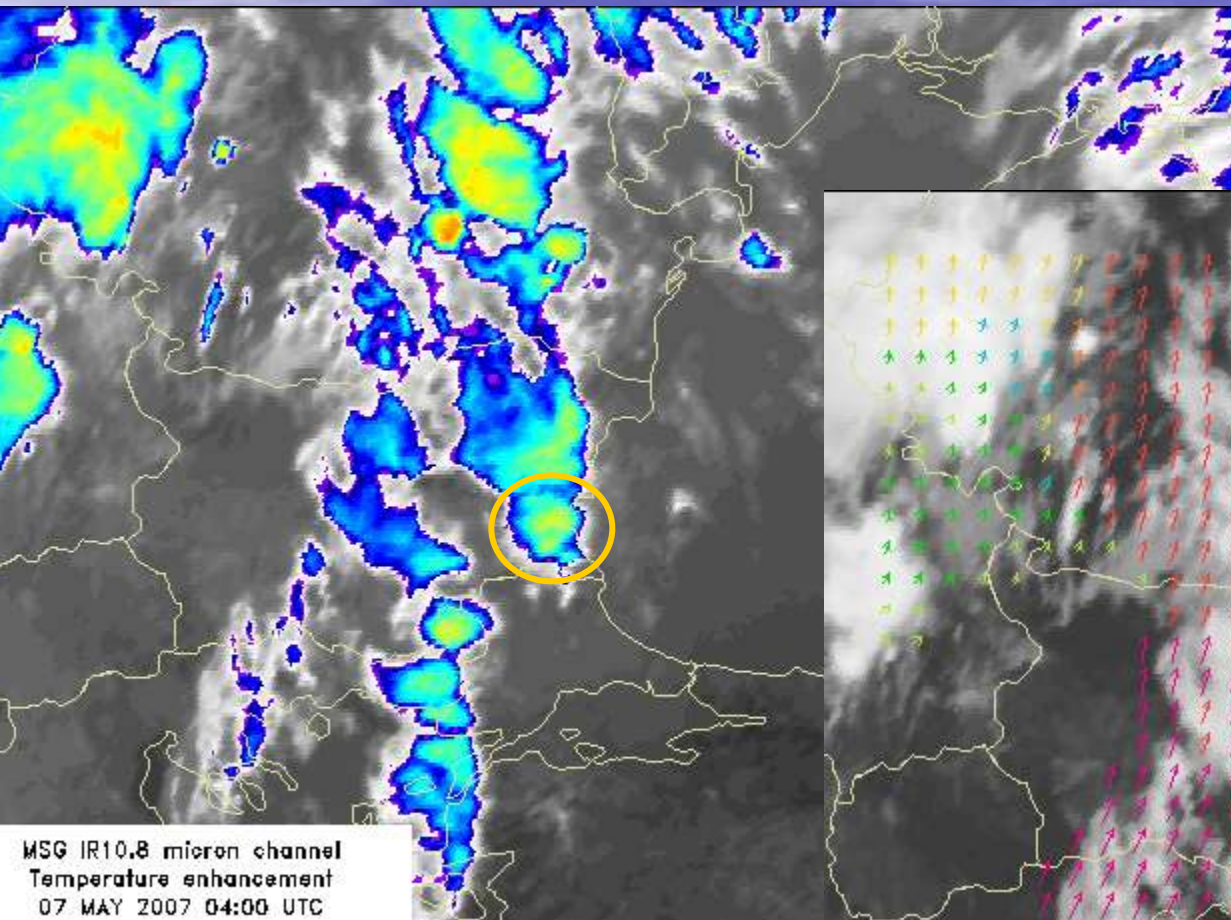
Summary

- The strongest Adriatic inundation events were related to propagating convective cloud systems
- Difficult to forecast by usual methods (numerical models not reliable, data too sparse)
- Possibility of nowcasting these events using satellite data

Future work

- Analysis of the cases outside the Adriatic
- Comparison of the results
- Possible development of the prediction method

Black Sea case – 07 May 2007



Cloud Motion Vectors
07 MAY 2007 03:45 - 04:00 UTC
MSG IR10.8 04:00 UTC