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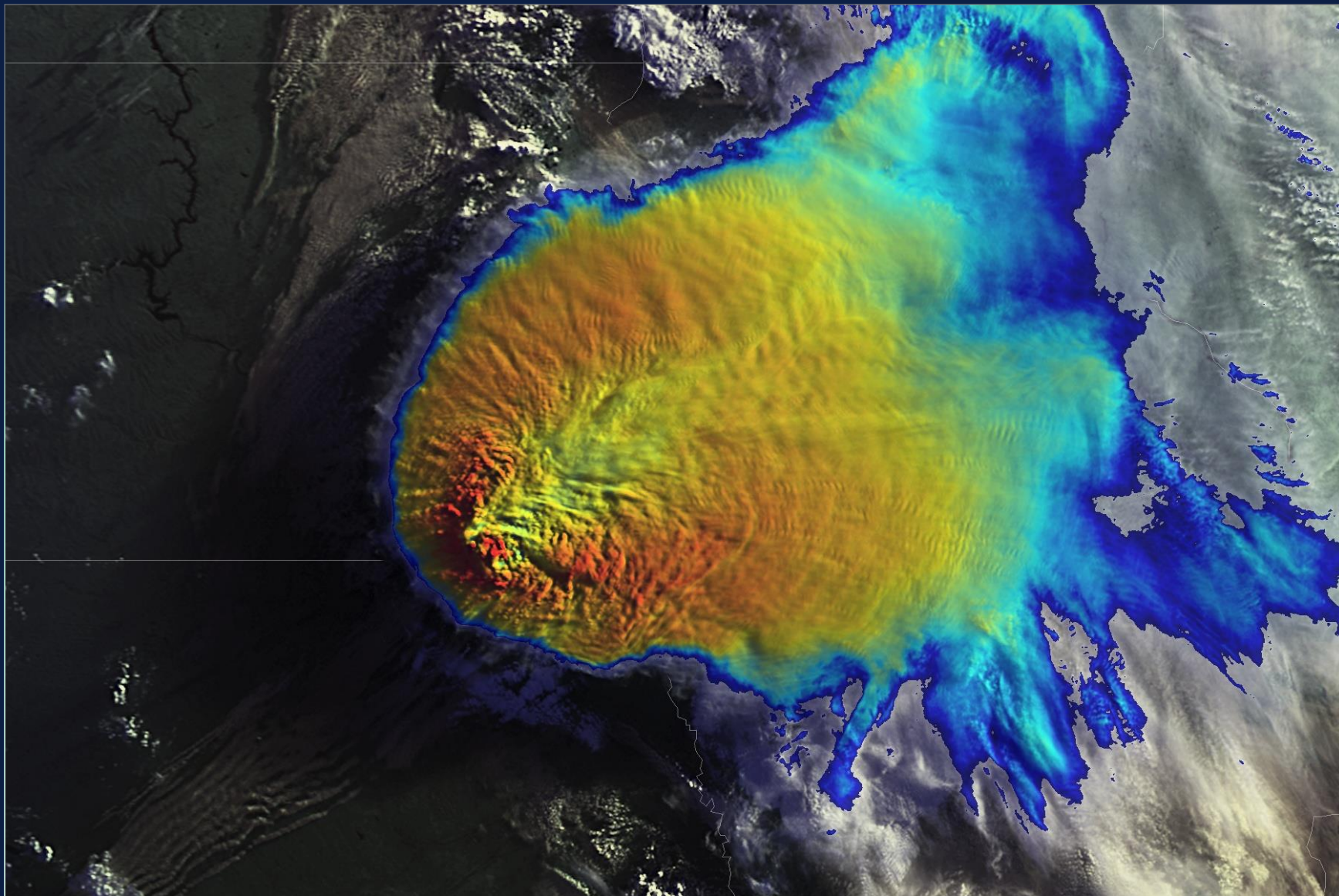
Advanced satellite image products for monitoring and nowcasting of (severe) convective storms

32nd STG Science Working Group meeting, 13 – 14 March 2012, Darmstadt

Related document: EUM/STG-SWG/32/12/DOC/14

REDUCED VERSION!

Example of the visible – color enhanced IR-BT sandwich product



2009-07-09 11:35 UTC AVHRR - NOAA 15 (South Dakota, Minnesota, Nebraska, Iowa, U.S.A.)

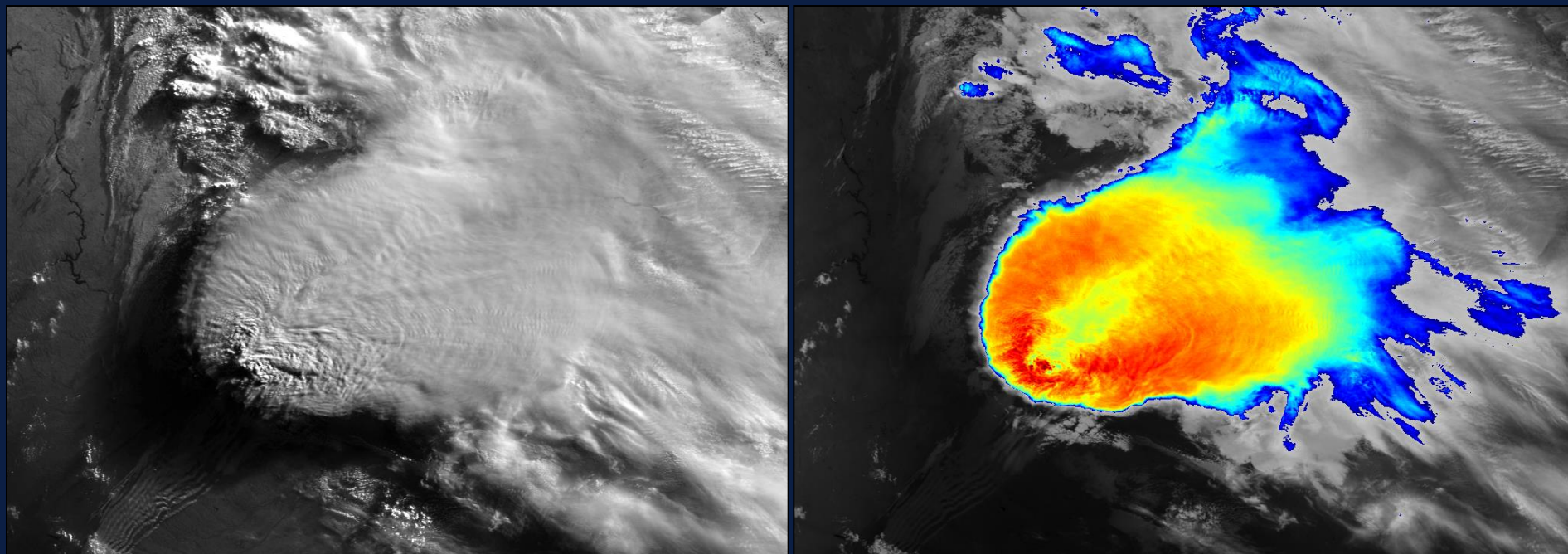
Visible – color enhanced IR-BT sandwich product

Origins (background) of the sandwich product(s)

- When studying certain cloud top phenomena or features in satellite imagery, it is crucial to know as accurately as possible their spatial arrangement across various spectral bands (or products based on these bands).
- Typical examples are the location of overshooting tops of convective storms in visible versus the IR-window brightness temperature (BT) imagery, plumes versus cold-U/V shapes, regions of higher cloud-top 3.7/3.9 μm reflectivity versus VIS or IR-window BT, or various BT differences (BTD), etc.

Visible – color enhanced IR-BT sandwich product

One possibility – placing the images side-by-side (multi-panel mosaics) and comparing the various features of interest in these ...

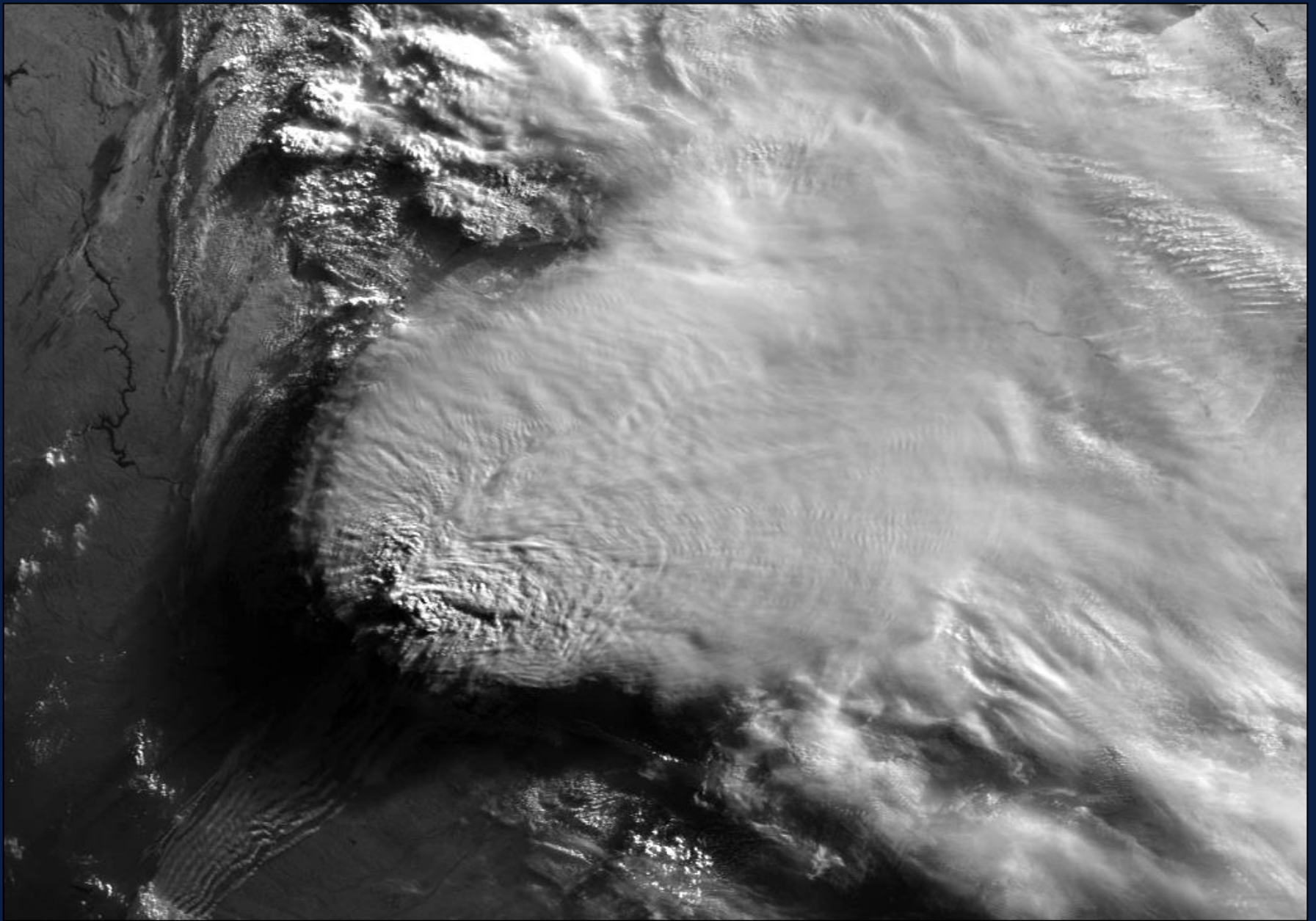


Disadvantage – human eye is a very poor tool for such comparison, too subjective!

Moreover, typically the multi-panel mosaics require smaller size of the individual images (frames), thus decreasing the resolution of these ...

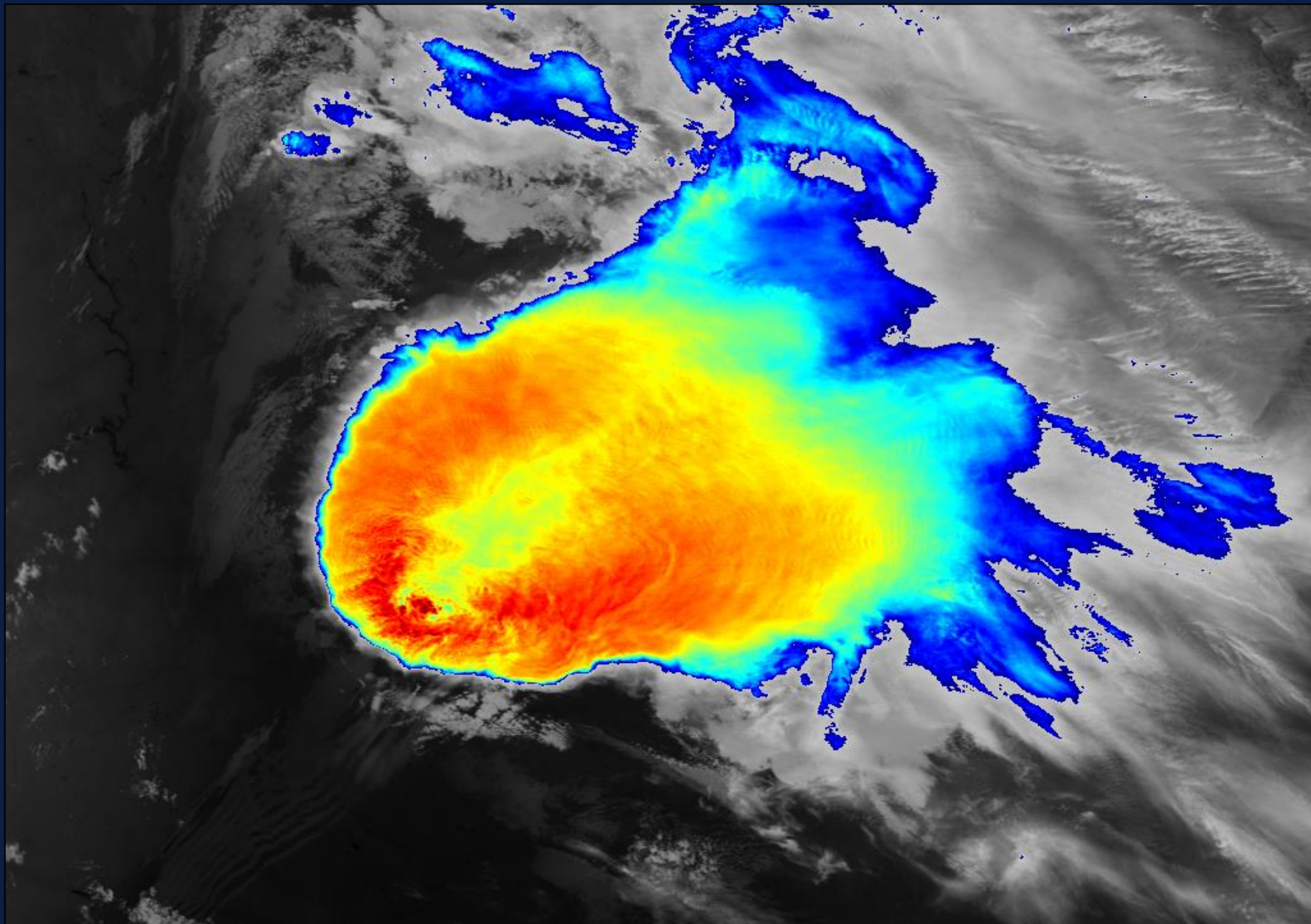
Visible – color enhanced IR-BT sandwich product

Better option – fast toggling between the images from various spectral bands or products, forward and backward ...



NOAA15 2009-07-09 1134 UTC (South Dakota) AVHRR band 2





NOAA15 2009-07-09 1134 UTC (South Dakota) AVHRR band 4 BT (198–233 K)

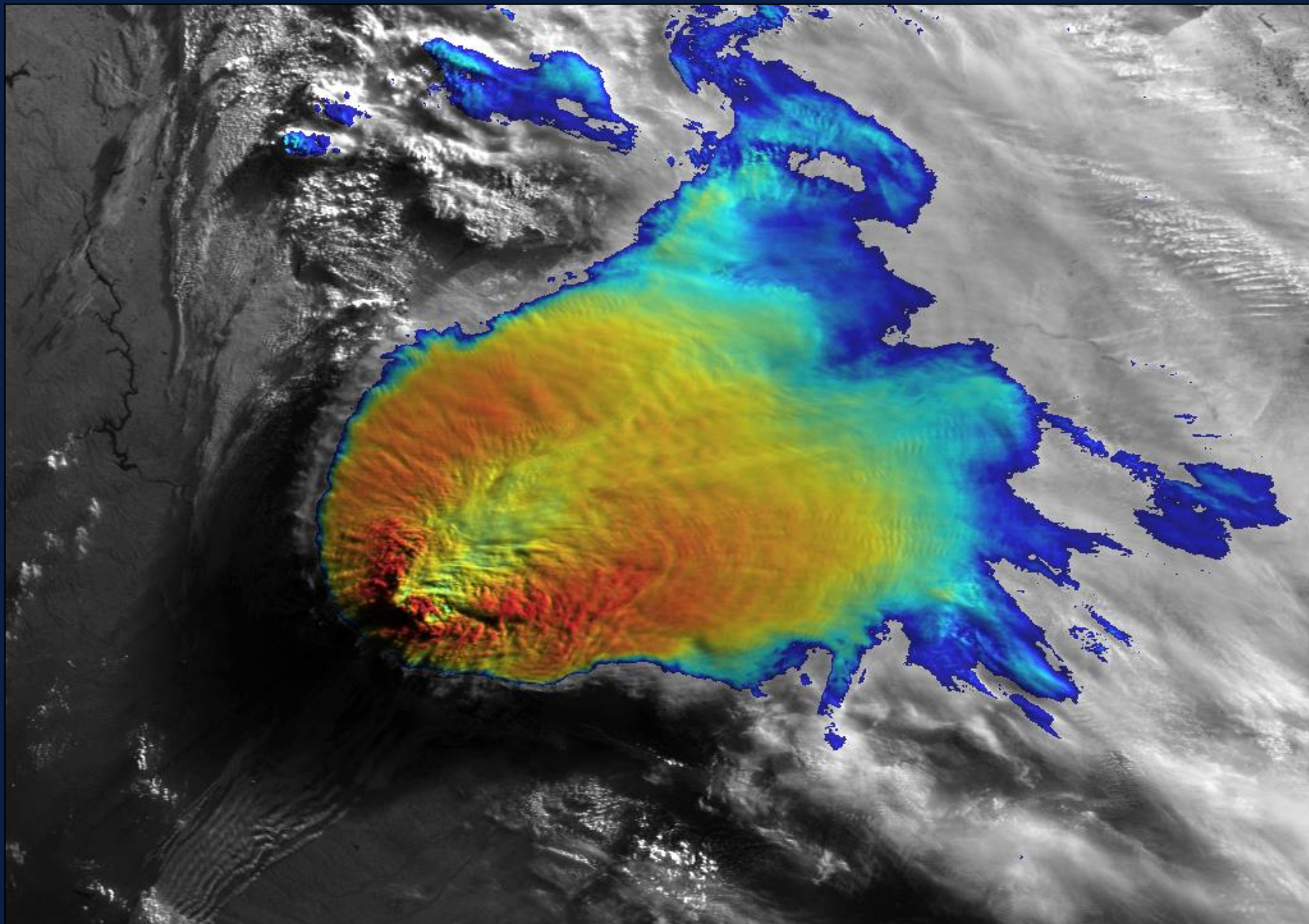


Visible – color enhanced IR-BT sandwich product

Disadvantage – toggling the images can't be used in satellite loops, showing the evolution of the storm tops ...



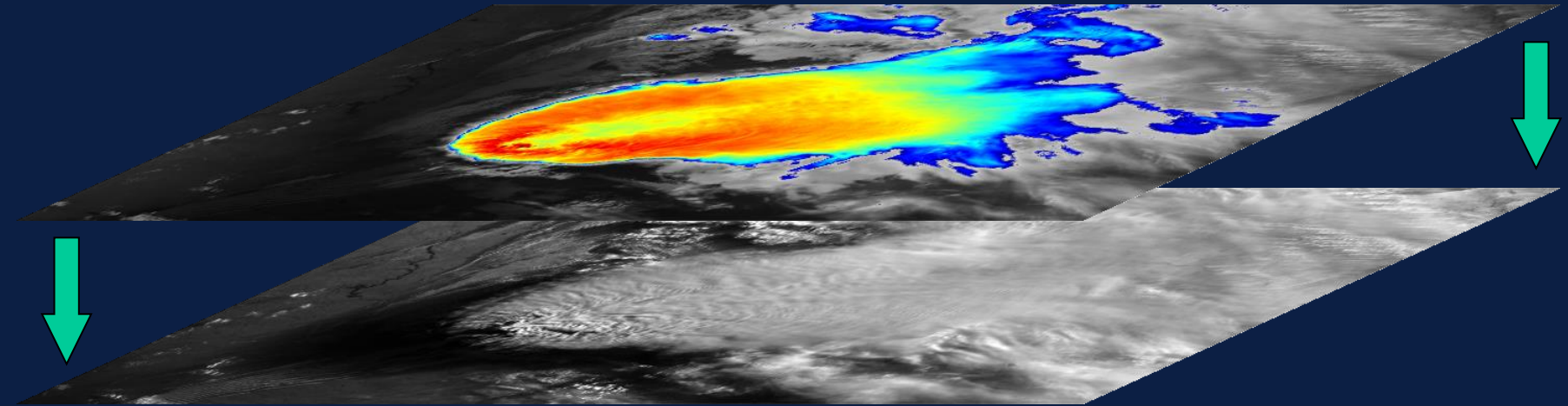
Blending (sandwiching) of the individual images or products together, to show the location of various features in one single image (and loops of these).



NOAA15 2009-07-09 1134 UTC (South Dakota) AVHRR band 2 & band 4 BT (blending: multiply, 80%)

Visible – color enh. IR-BT sandwich product – principle of the method

Upper layer: IR-window BT image

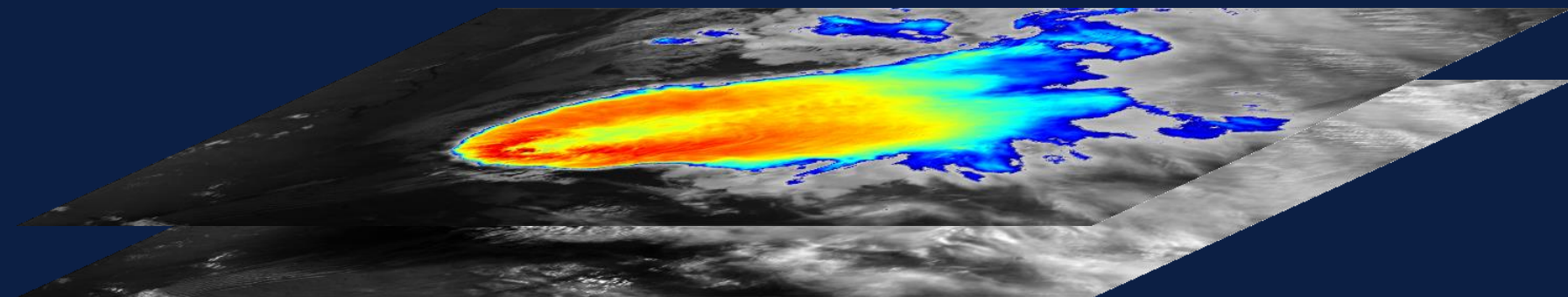


Bottom layer (background image): visible or near-IR high-resolution image, typically single-band black-and-white image, alternatively true-color image (or any other similar RGB).

Visible – color enh. IR-BT sandwich product – principle of the method

Upper layer: IR-window BT image

Bottom layer (“background”): VIS image

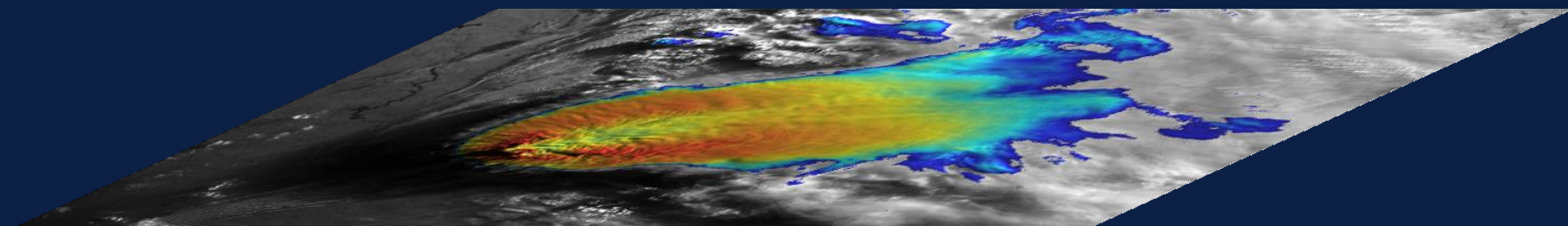


Multi-layer image (in this case 2 layers) ... e.g. PSD format (Photoshop)

Visible – color enh. IR-BT sandwich product – principle of the method

Upper layer: IR-window BT image

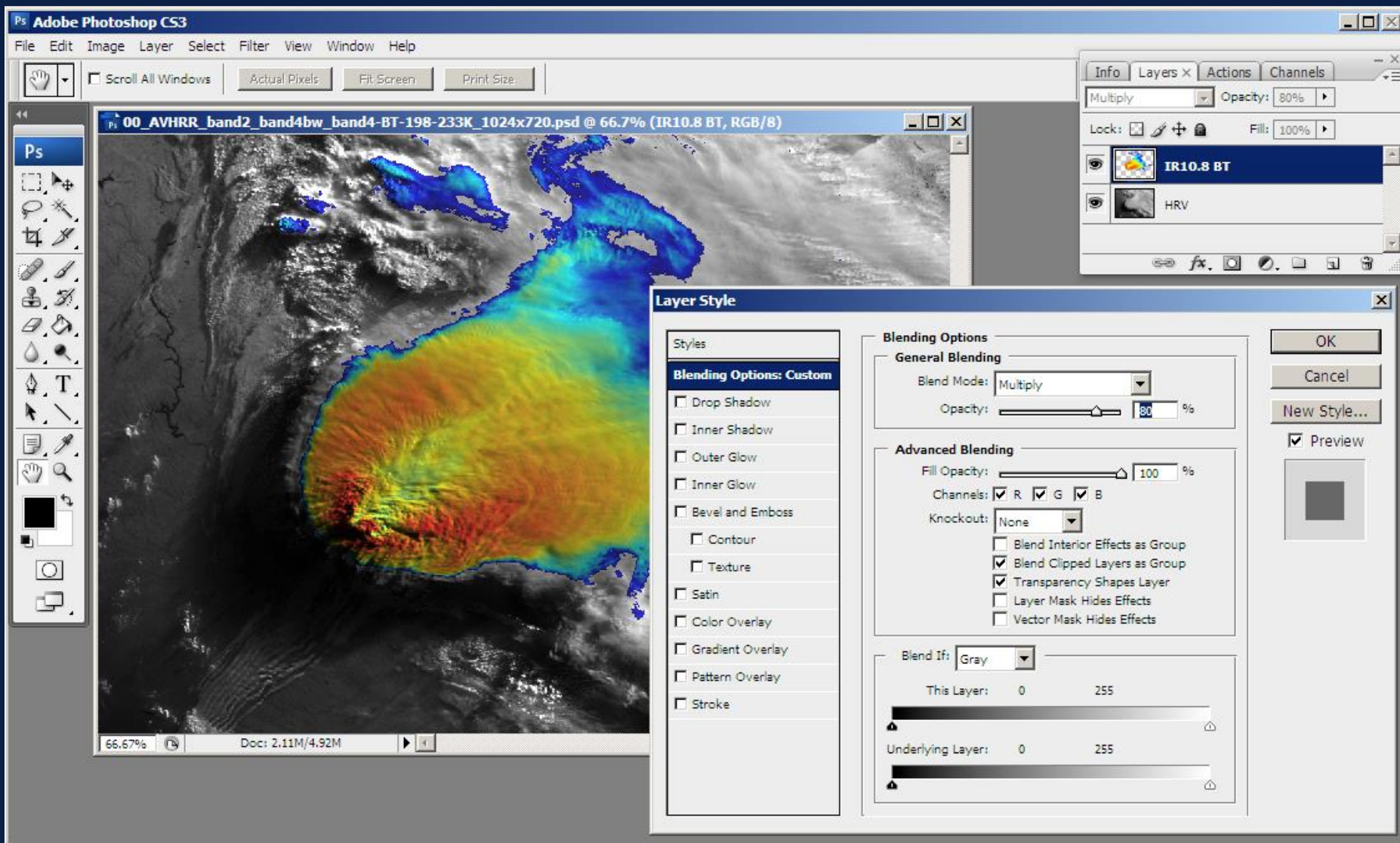
Bottom layer (“background”): VIS image



Blending options – applied to the upper layer !!!

Multi-layer image (in this case 2 layers) ... e.g. PSD format (Photoshop)

Visible – color enh. IR-BT sandwich product – principle of the method



In the Adobe Photoshop: Layers >>> Blending Options >>> General Blending >>> Multiply or Linear Burn, Opacity 80 – 100%

Visible – color enhanced IR-BT sandwich product

Alternative to the Adobe Photoshop (namely for interactive processing):

GIMP (*GNU Image Manipulation Program*) – freeware

<http://www.gimp.org/>

For operational, fully automatic processing:

ImageMagick (freeware): <http://www.imagemagick.org/>

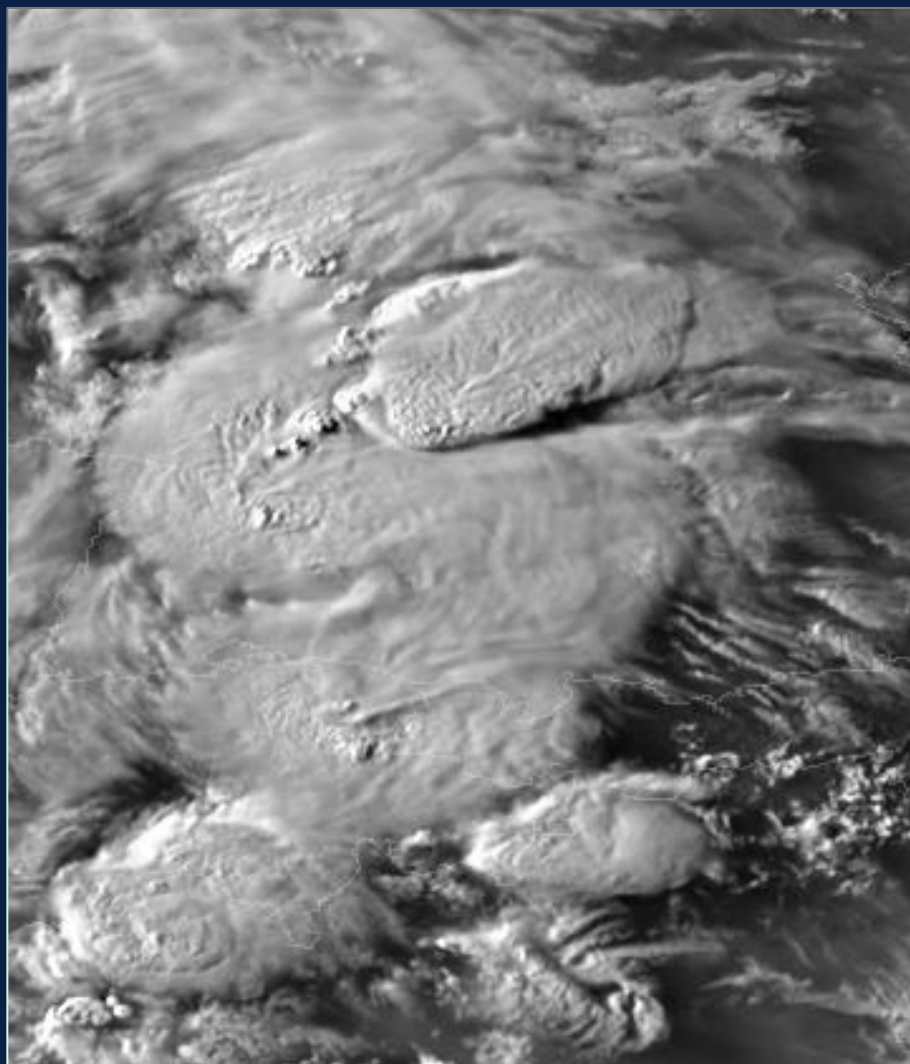
```
# alpha blending of the IR-BT layer  
alpha=70
```

```
# sets the alpha blending of the IR-BT layer  
convert  $\{ir\_bt\}$  -alpha On -channel Alpha -evaluate set  $\{alpha\}\%$   $\{ir\_bt\_png\}$ 
```

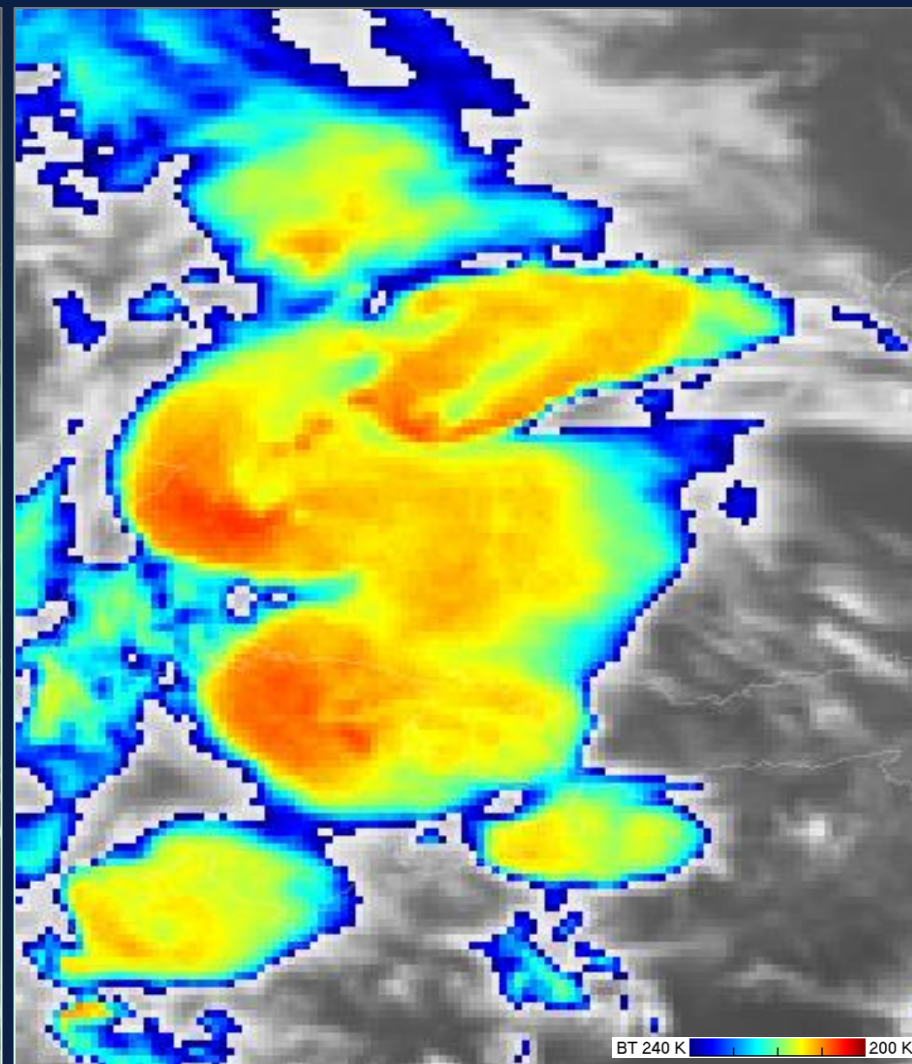
```
# merging (blending) the two images together  
composite  $\{hrv\}$   $\{ir\_bt\_png\}$  -compose Multiply -quality 90  $\{output\}$ 
```

(further details: [Jindřich Štáštka](#) or [Lukáš Ronge](#))

Visible – color enhanced IR-BT sandwich product



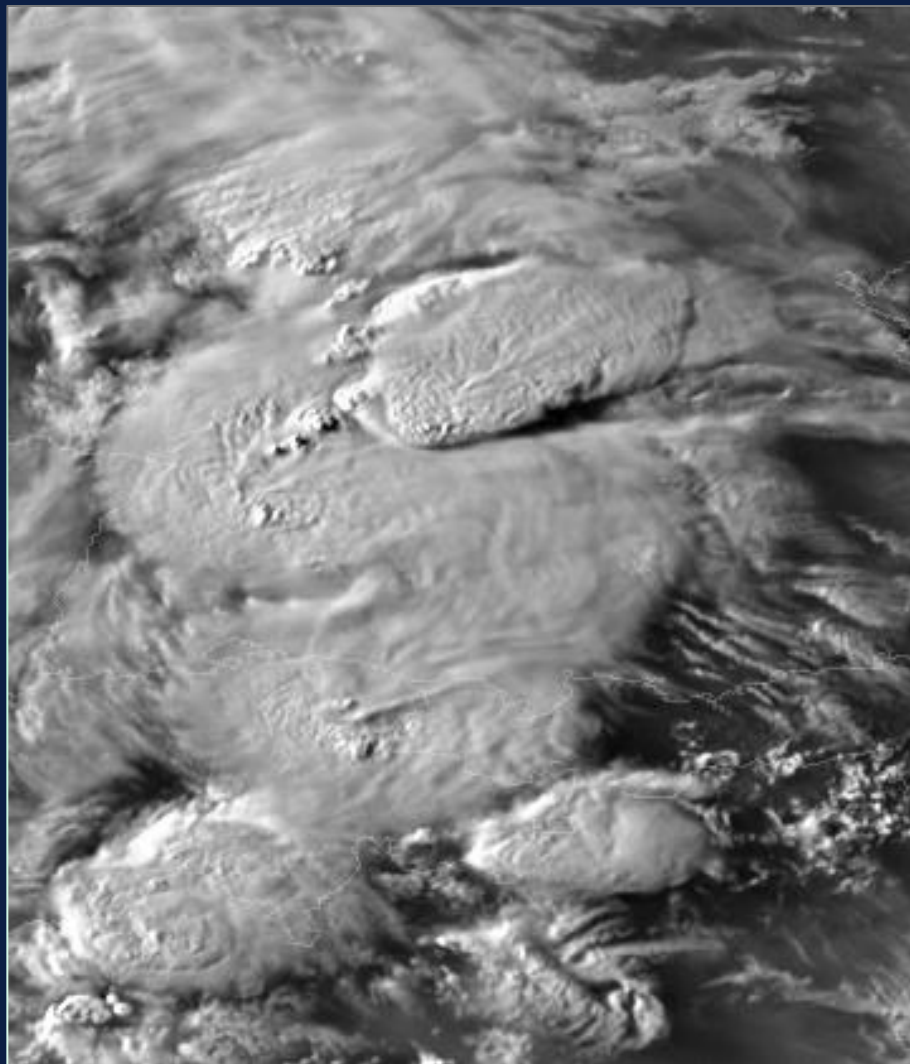
HRV



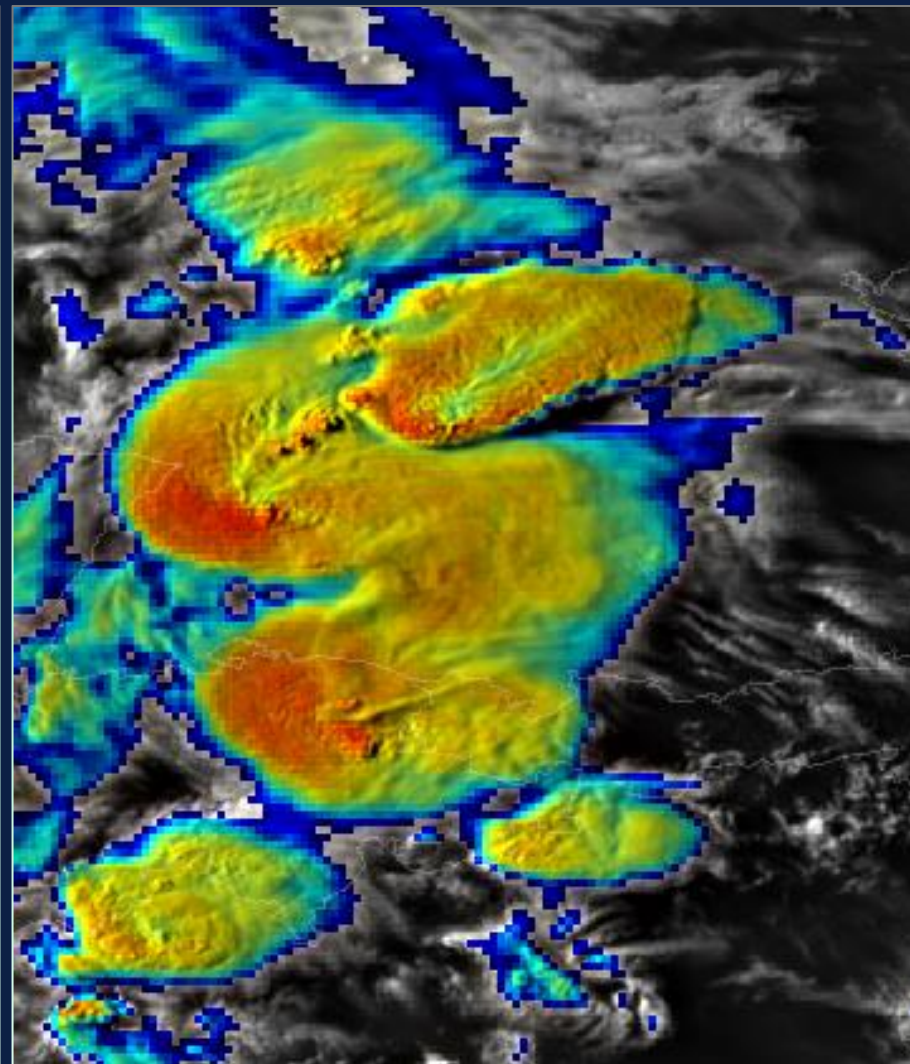
IR10.8-BT

12 July 2011 17:40 UTC MSG-1, Germany

Visible – color enhanced IR-BT sandwich product



HRV



sandwich HRV & IR10.8-BT

12 July 2011 17:40 UTC MSG-1, Germany

Visible – color enhanced IR-BT sandwich product

The primary advantage of sandwich products is that they merge the features of the two input images into one single image, thus enabling one to observe the characteristics of both images simultaneously in one single product. In the case of the visible – IR-window sandwich combination (VIS/IR-BT), the visible band brings to the final image the cloud-top “morphology” (shadows and textures), while the color-enhanced IR-window band adds the BT information.

Also, it is much easier to follow the evolution of convective storms (or any other weather phenomenon) in one single sandwich product, rather than in two windows, showing the two input bands separately. This makes the sandwich products very attractive for operational applications.

Visible – color enhanced IR-BT sandwich product

Described in detail also at the EUMETSAT's "Case Studies" web site:

http://oiswww.eumetsat.org/WEBOPS/iotm/iotm/20090923_convection/20090923_convection.html

and at the *Convection Working Group* website:

<http://www.convection-wg.org/sandwich.php>

Besides being used for various case studies (either as still, stand-alone images, or being composed into loops), this sandwich product is already operationally used by some of the European weather services (Czech Republic, Poland, ???), and for various training activities. Where used, the feedback from forecasters is usually very positive, namely during the convective seasons.

Disadvantage: can be used at daytime only.

Visible – color enhanced IR-BT sandwich product

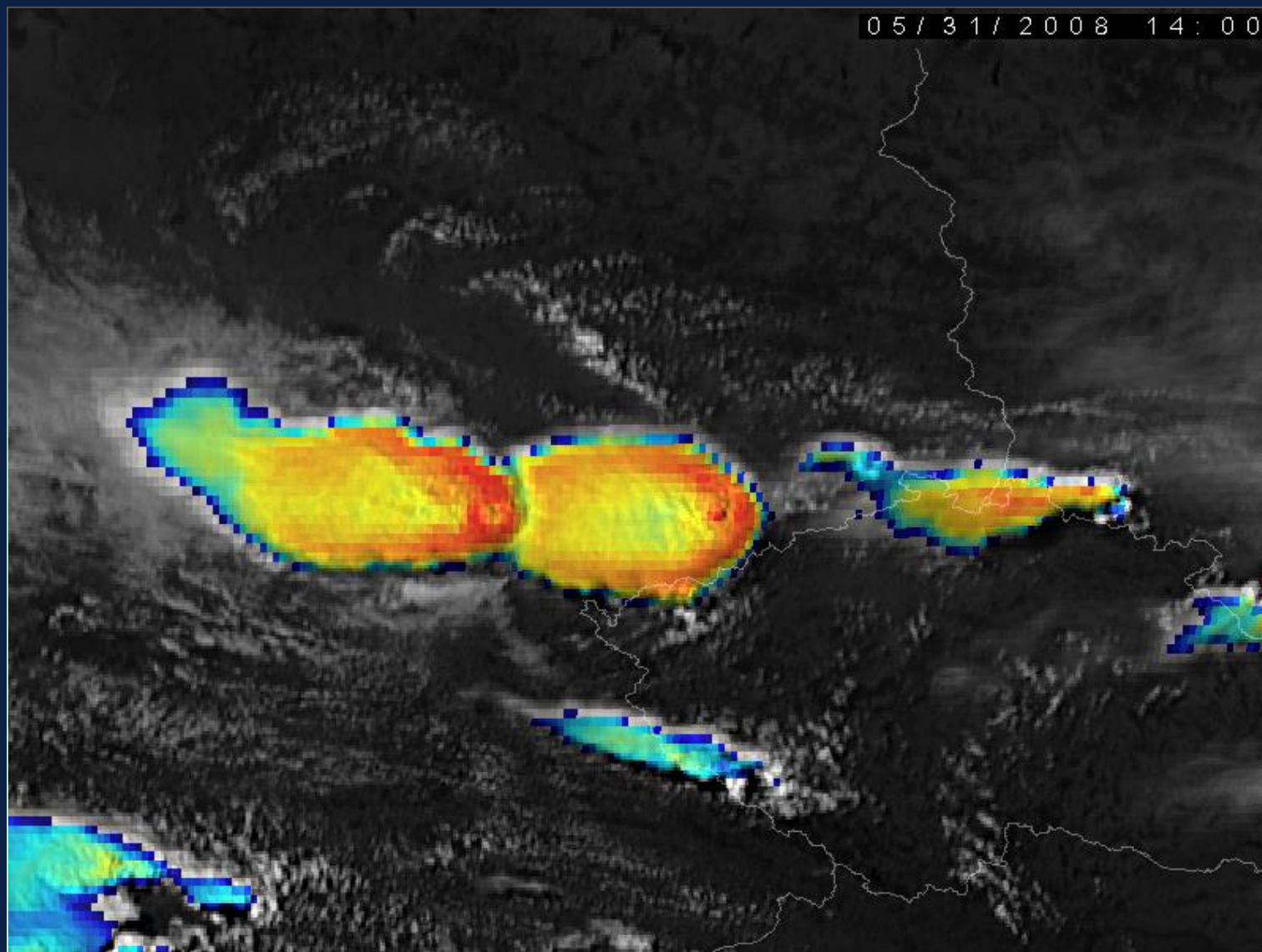
Examples of typical combinations:

- MSG SEVIRI: HRV & IR10.8 (1 km & 3 km)
- GOES 8-15 Imager: band 1 & band 4 (1 km & 4 km)
- AVHRR: band 1 or 2 & band 4 (all 1 km)
- MODIS: band 1 & band 31 (0.25 km & 1 km)
- NPP VIIRS: bands I1 & I5 (both 0.4 km)

Future satellites:

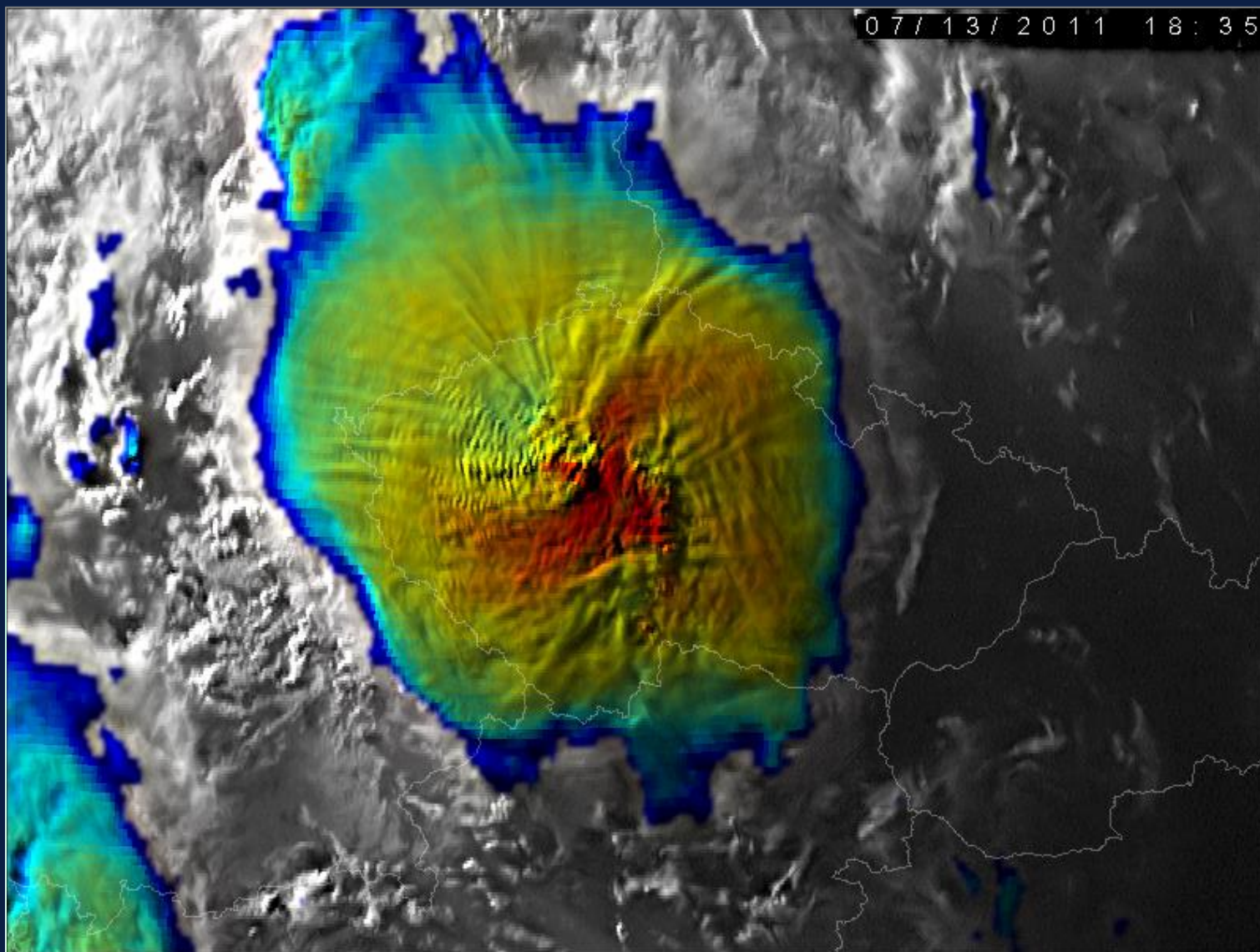
- MTG FCI: VIS 0.6 & IR 10.5 (0.5 km & 1 km)
- GOES-R ABI: band 2 & band 13 (0.5 km & 2 km)

Examples of the visible – color enhanced IR-BT sandwich products



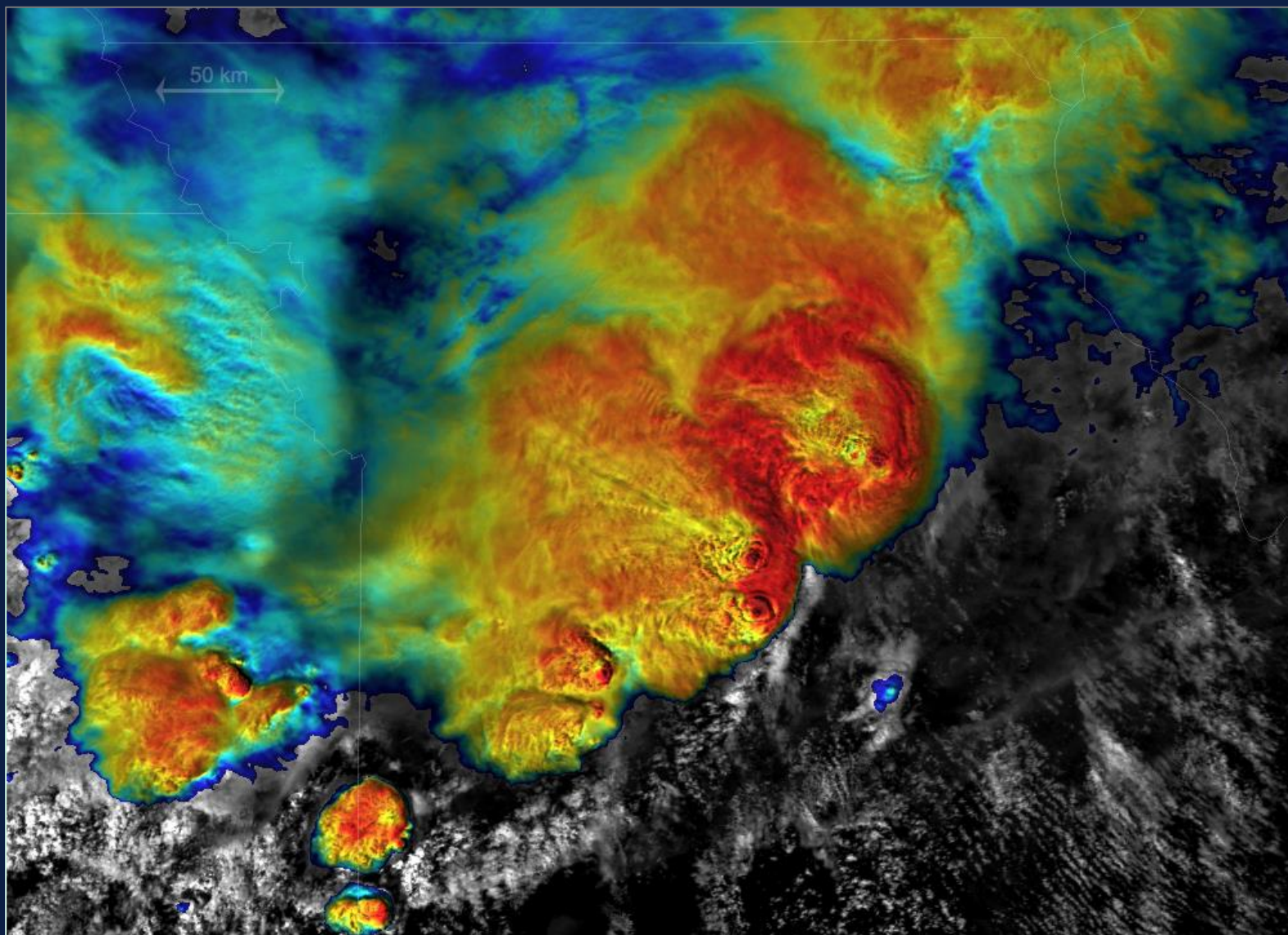
31 May 2008 14:00 UTC MSG-1, sandwich product (HRV + IR10.8 BT), Germany and Czech Republic [\[movie\]](#)

Examples of the visible – color enhanced IR-BT sandwich products



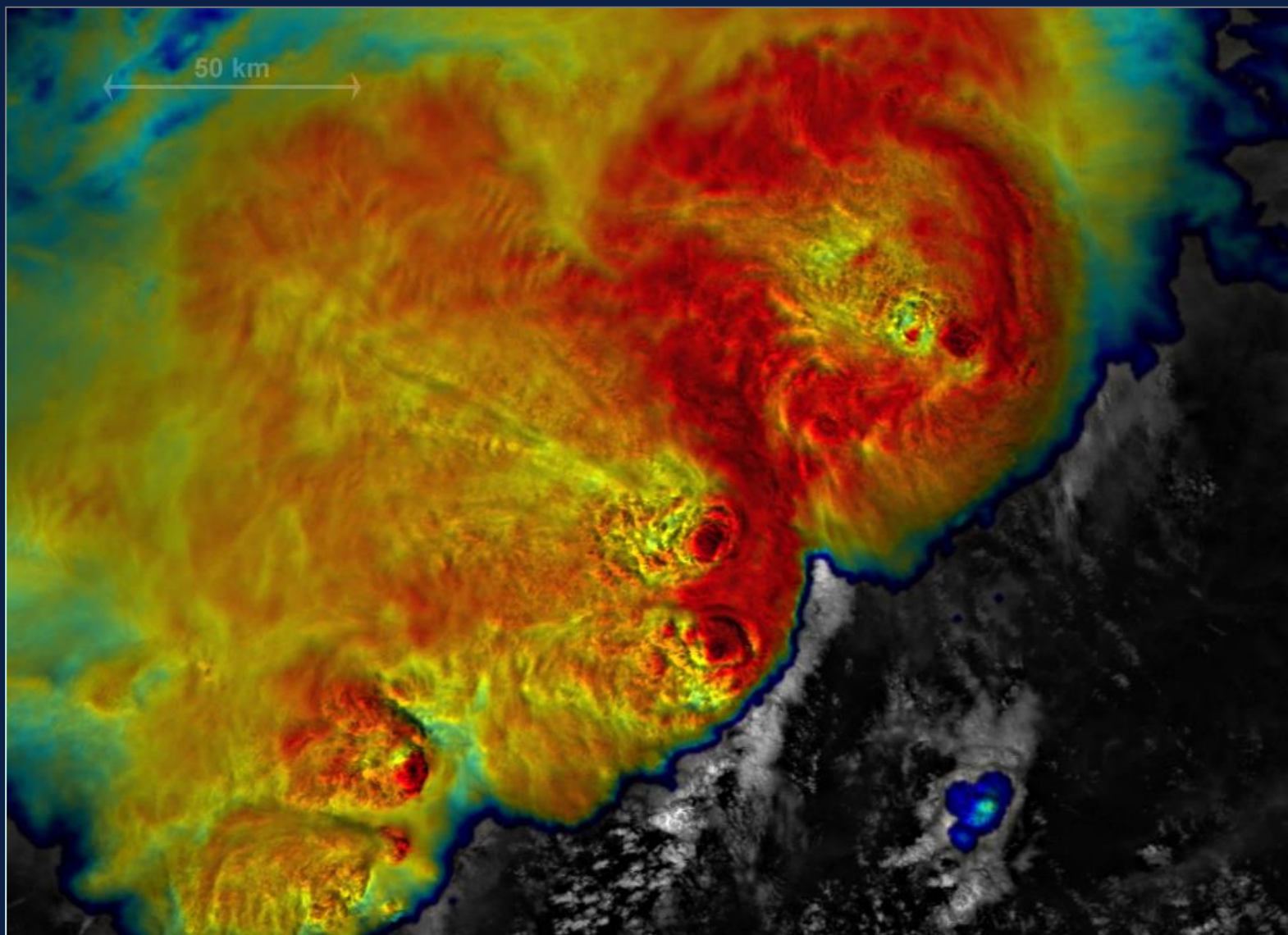
13 July 2011 18:35 UTC MSG-1, sandwich product (HRV + IR10.8 BT), Czech Republic and Germany [\[movie\]](#)

Examples of the visible – color enhanced IR-BT sandwich products



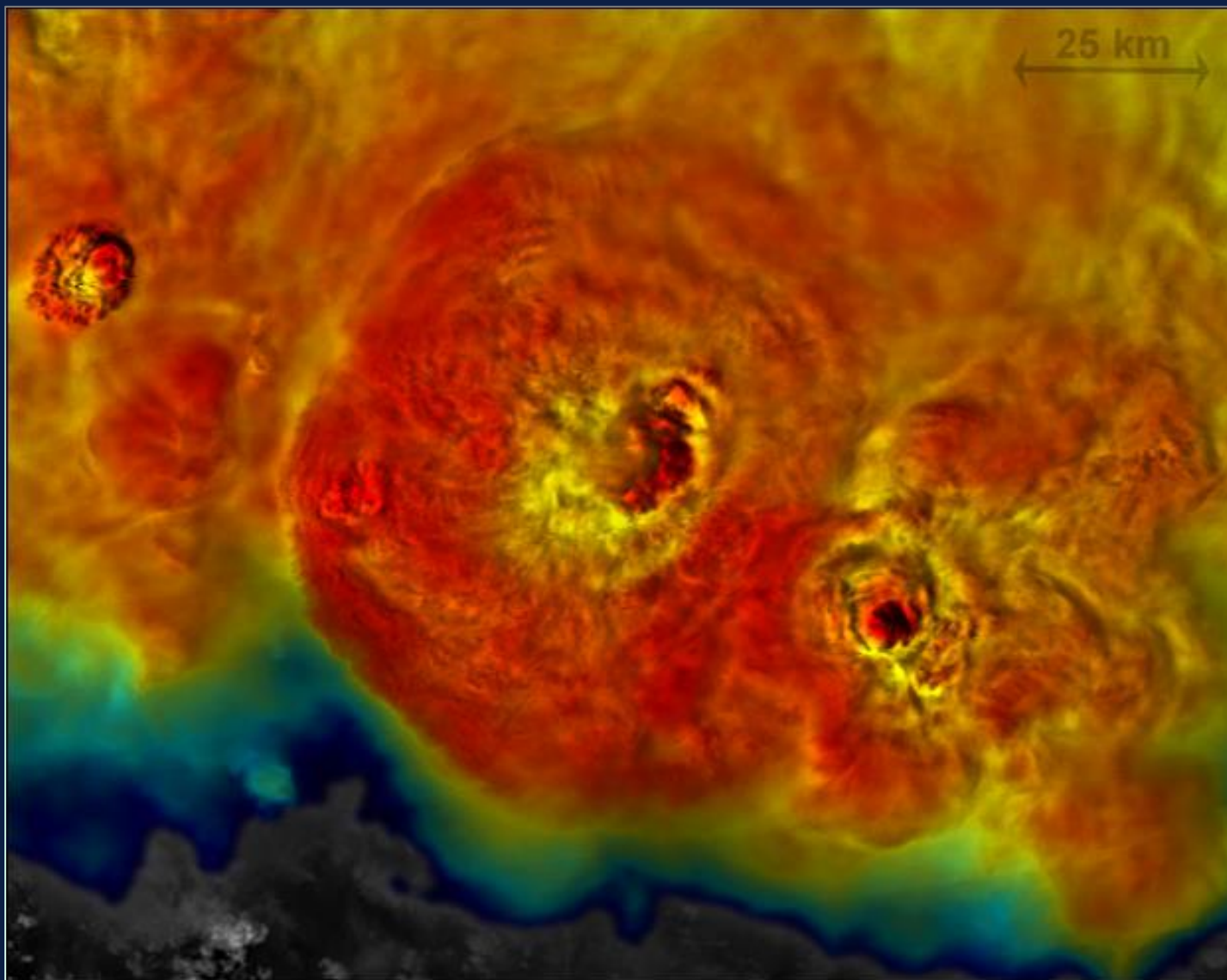
6 May 2007 19:28 UTC MODIS Aqua, sandwich product (500 m band 1 & 1000 m band 31 BT), Missouri, USA

Examples of the visible - color enhanced IR-BT sandwich products



6 May 2007 19:28 UTC MODIS Aqua, sandwich product (250 m band 1 & 1000 m band 31 BT), Missouri, USA

Examples of the visible – color enhanced IR-BT sandwich products



22 December 2007 18:37 UTC MODIS Aqua, sandwich product (250 m band 1 & 1000 m band 31 BT), Brazil

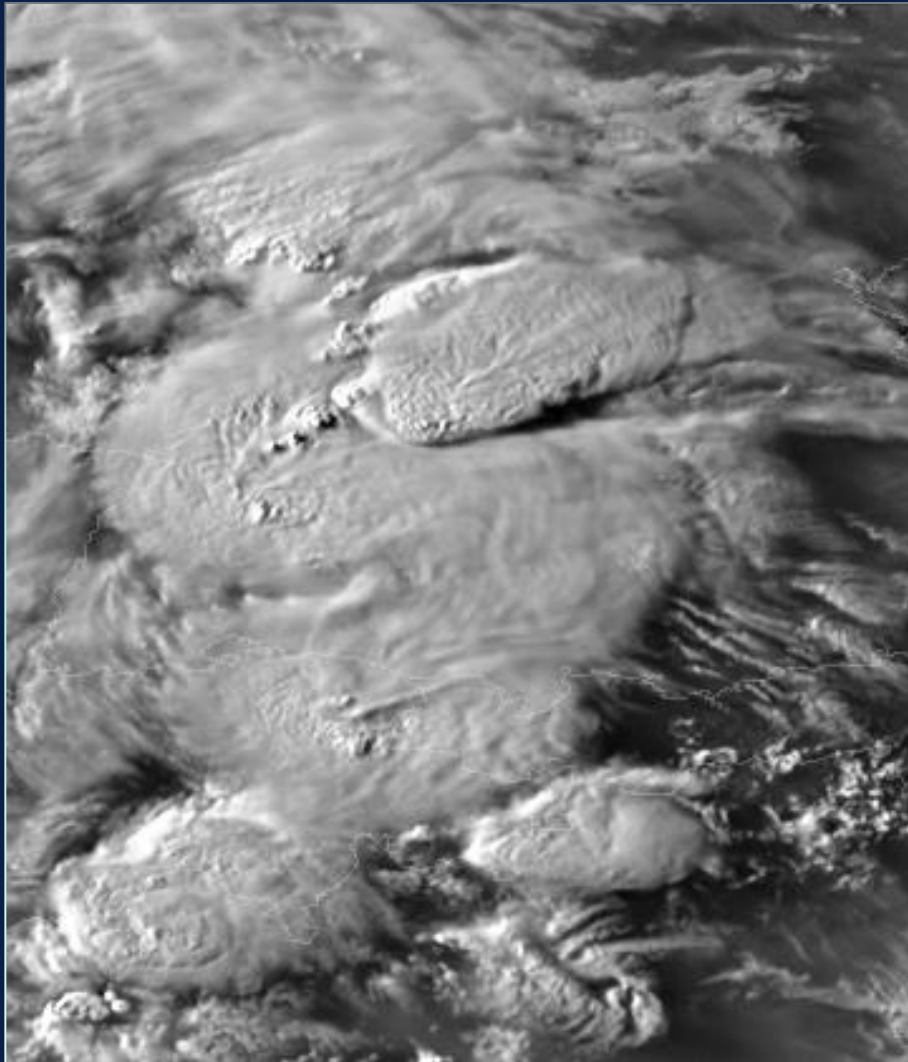
Other possible combinations of sandwich products

Besides the VIS/IR-BT sandwich product show in previous slides, it is possible to combine the background visible image (or true-color image) with any other processed single-band image, or even better with one of the RGB composite products (images). The use of these sandwich combinations is not restricted to storm monitoring only, but supports nowcasting in general.

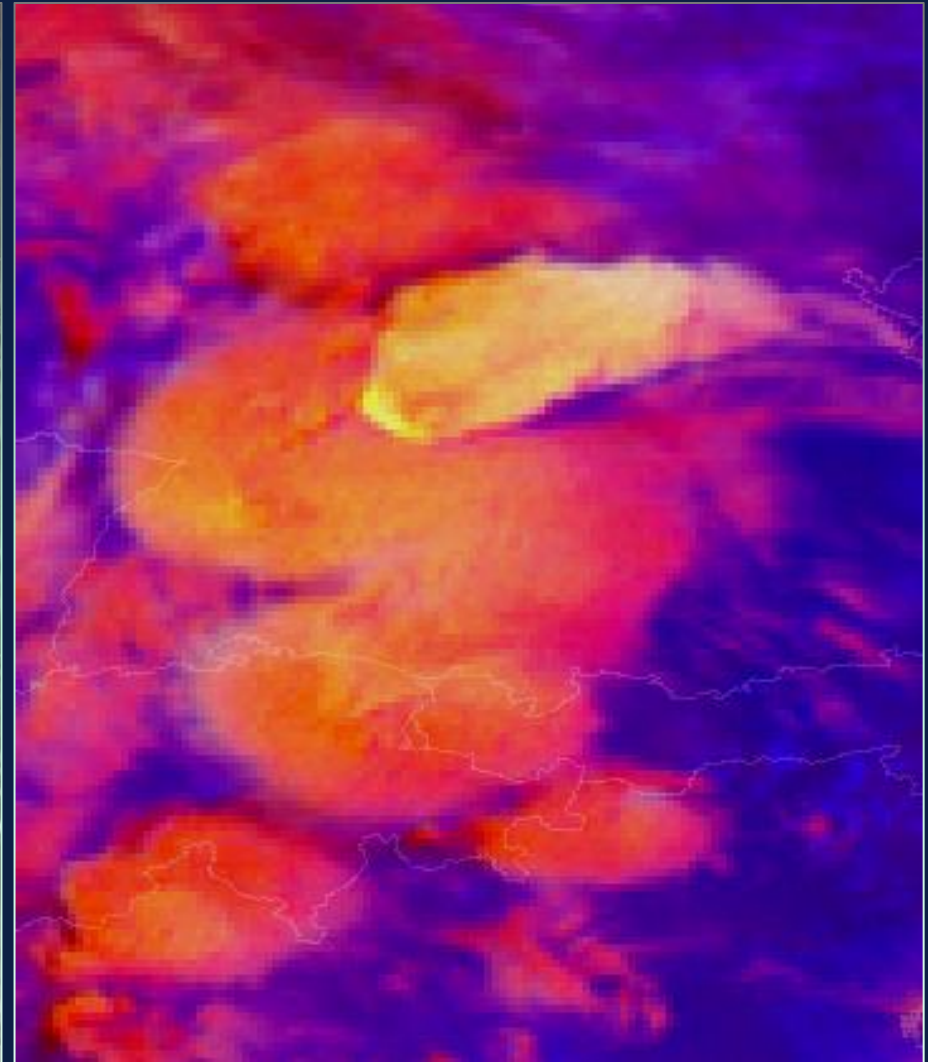
Among the other sandwich combinations which have been recently tested, are the following ones:

- **HRV and storm RGB composite product** (operationally available in CHMI, RSS)
- HRV and the 24h-microphysical RGB product (operationally available in CHMI, RSS)
- HRV and the BTD(WV6.2-IR10.8) product (research paper, Maria Putsay)

Other possible combinations of sandwich products – examples



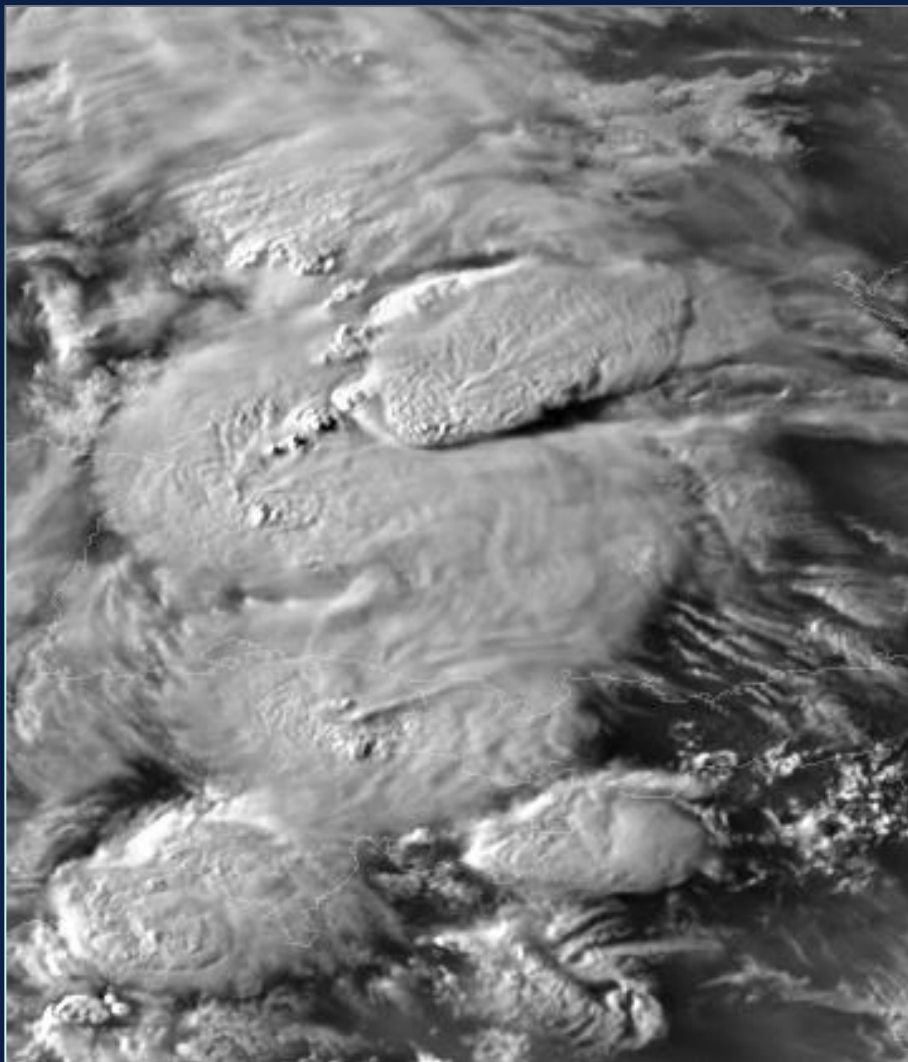
HRV



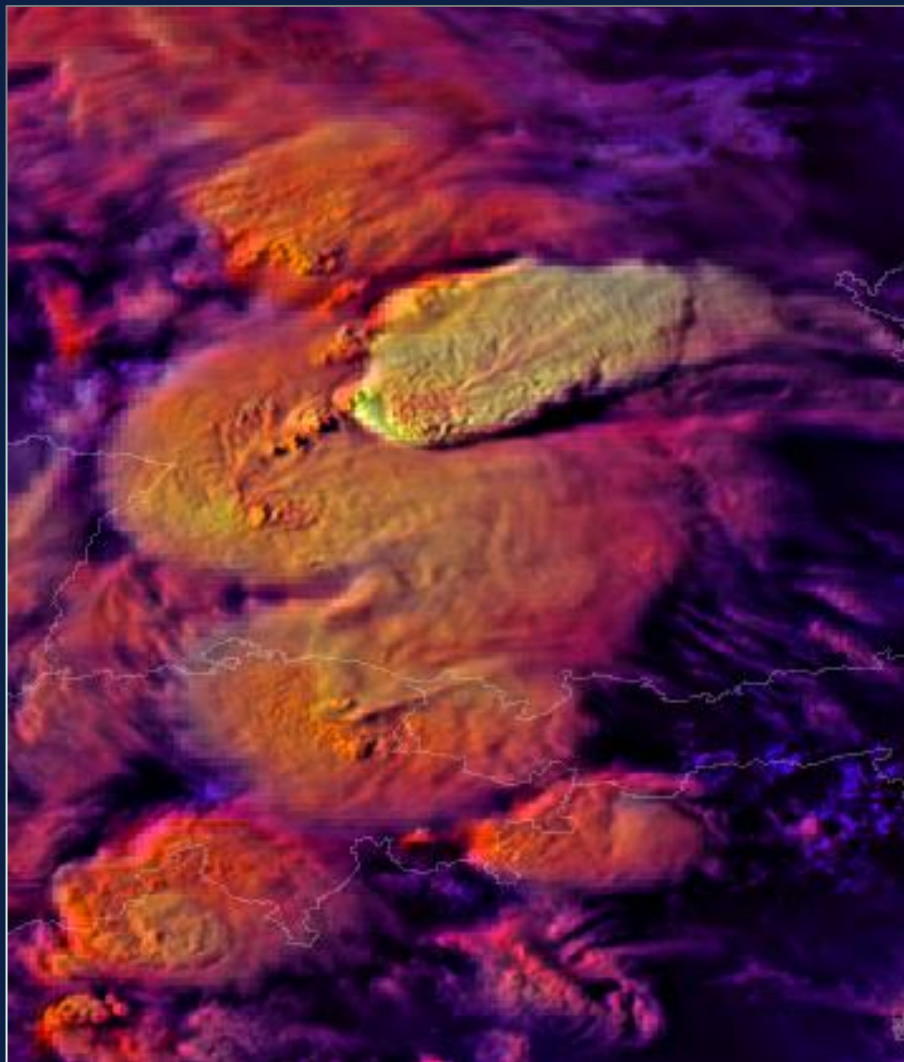
storm RGB

12 July 2011 17:40 UTC MSG-1, Germany

Other possible combinations of sandwich products – examples



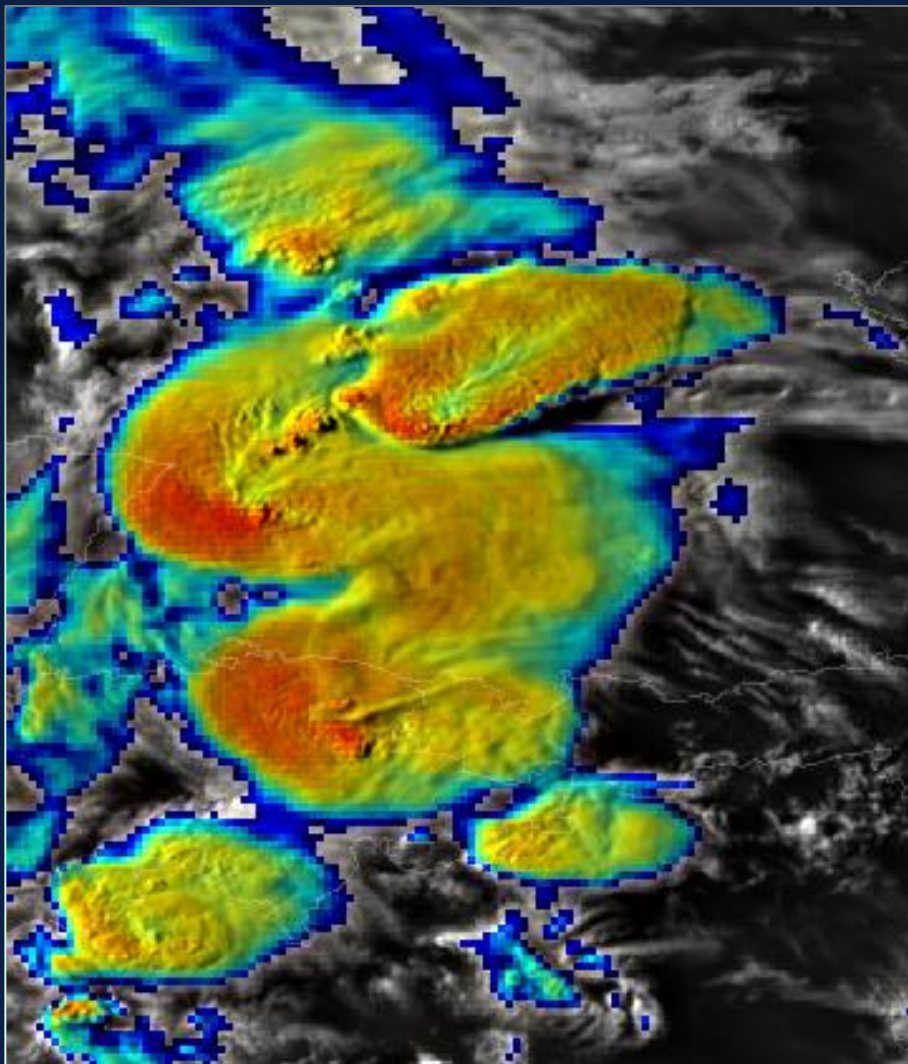
HRV



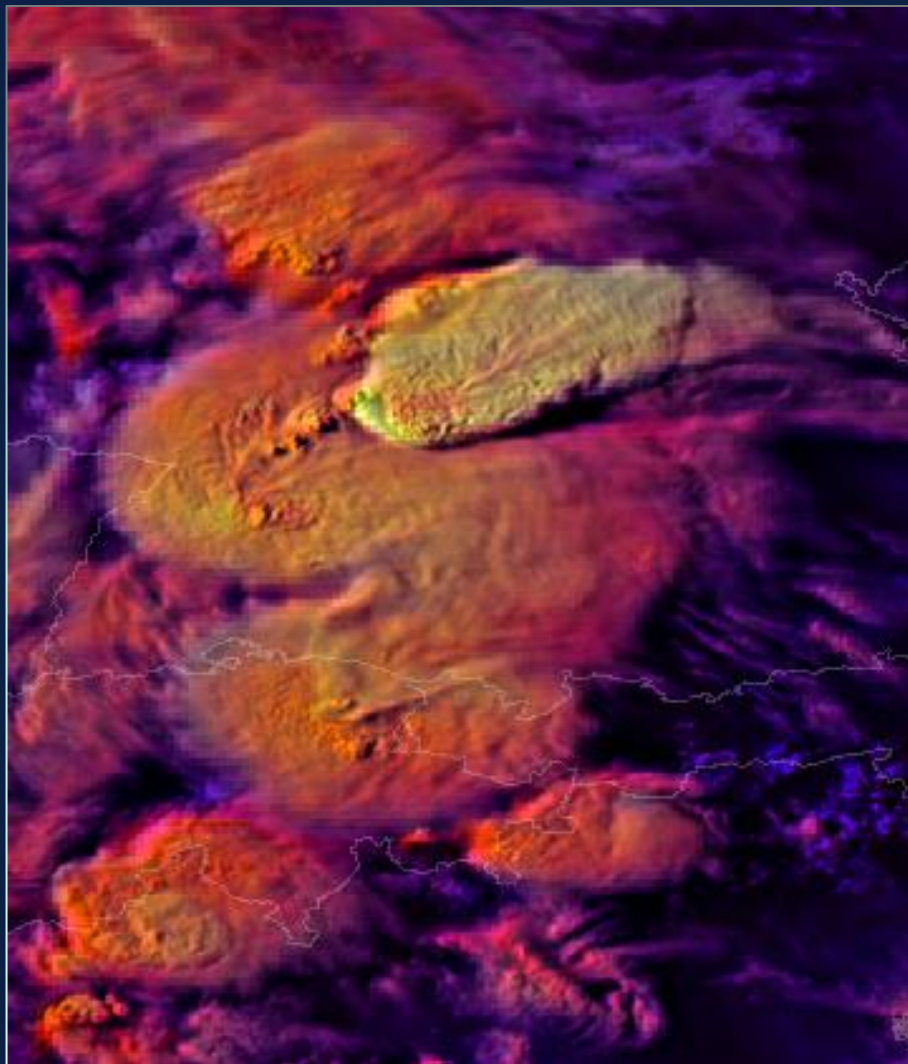
sandwich HRV & storm RGB

12 July 2011 17:40 UTC MSG-1, Germany

Other possible combinations of sandwich products – examples



sandwich HRV & IR10.8-BT



sandwich HRV & storm RGB

12 July 2011 17:40 UTC MSG-1, Germany