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Use cases for FCI data in nowcasting severe weather: MODIS and VIIRS-based MTG FCI pixel size simulations

EUMETSAT MTG+ EPS-SG User Days, Darmstadt, 12-14 November 2019

MTG-I Flexible Combined Imager (FCI)

band name (label)	central wavelength	pixel resolution (size) at nadir
*	VIS 0.4	0.444 µm 1 km
*	VIS 0.5	0.510 µm 1 km
*	VIS 0.6	0.640 µm 1 km FDS / 0.5 km RSS
*	VIS 0.8	0.865 µm 1 km
*	VIS 0.9	0.914 µm 1 km
*	NIR 1.3	1.380 µm 1 km
*	NIR 1.6	1.610 µm 1 km
*	NIR 2.2	2.250 µm 1 km FDS / 0.5 km RSS
	IR 3.8	3.800 µm 2 km FDS / 1.0 km RSS
	WV 6.3	6.300 µm 2 km
	WV 7.3	7.350 µm 2 km
	IR 8.7	8.700 µm 2 km
	IR 9.7 (O3)	9.660 µm 2 km
	IR 10.5	10.50 µm 2 km FDS / 1.0 km RSS
	IR 12.3	12.30 µm 2 km
	IR 13.3 (CO ₂)	13.30 µm 2 km

solar bands

thermal emission bands

FDS = Full Disk Service

RSS = Rapid Scan Service

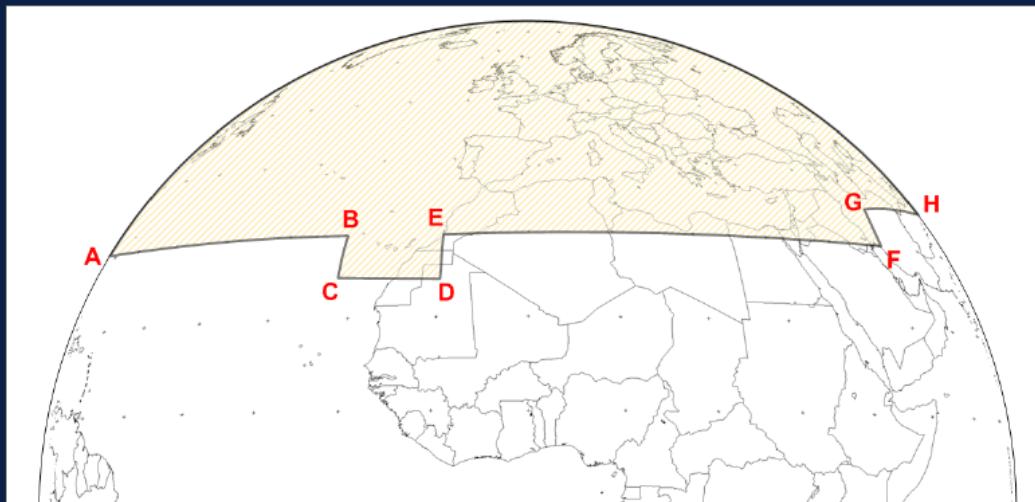
NR = Normal Resolution bands

HR = High Resolution bands

* new bands, not available on SEVIRI

10 min FDS NR / 2.5 min RSS HR

MTG-I Flexible Combined Imager (FCI) – 2.5 min Rapid Scan Service (RSS)



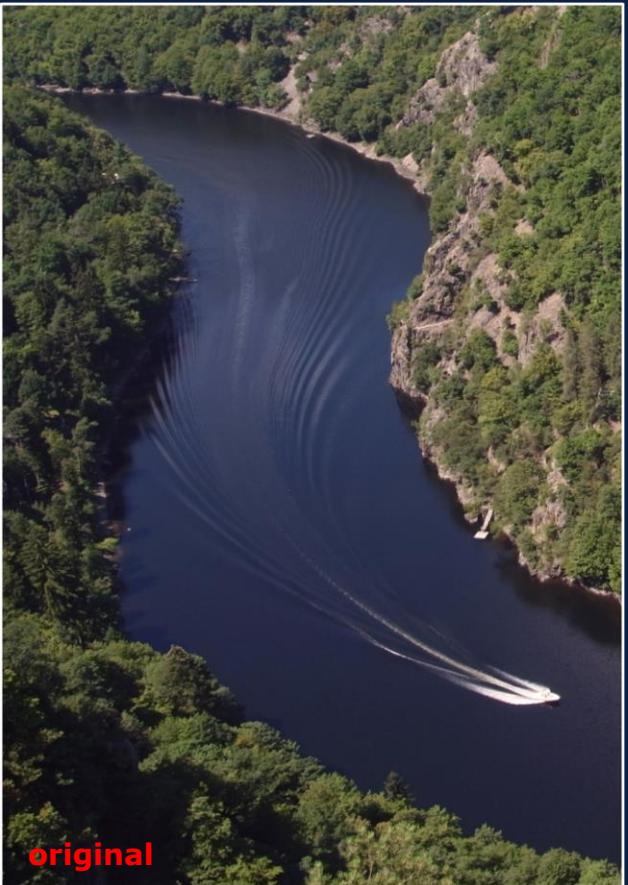
Present plans (Nov 2019):

RSS at NR available via the EUMETCast Europe main telecommunication satellite (restorable transponder)

RSS at HR available via the EUMETCast Europe backup telecommunication satellite (non-restorable transponder), and via EUMETCast Terrestrial and Internet service

RSS available on MTG-I2 (from ~2024 on)

Why the high resolution matters ?



original

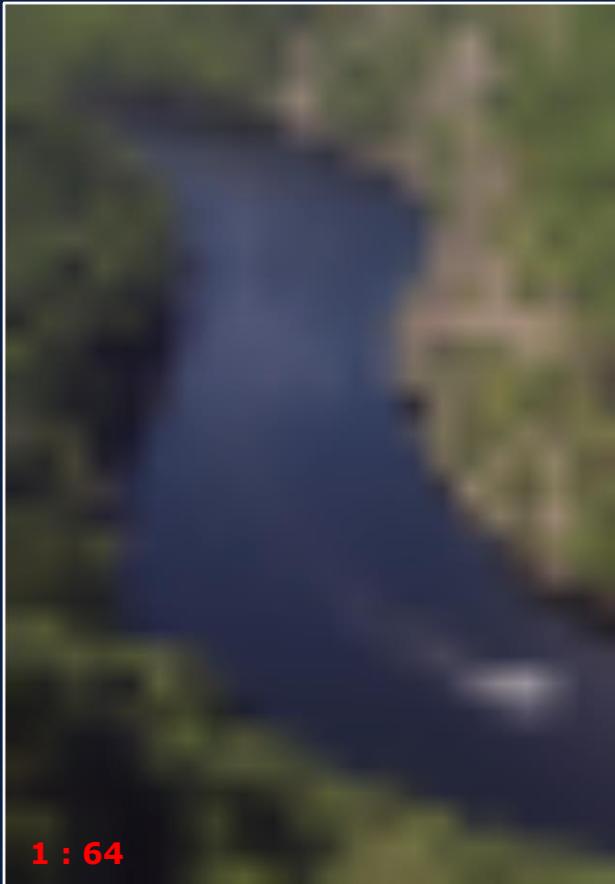
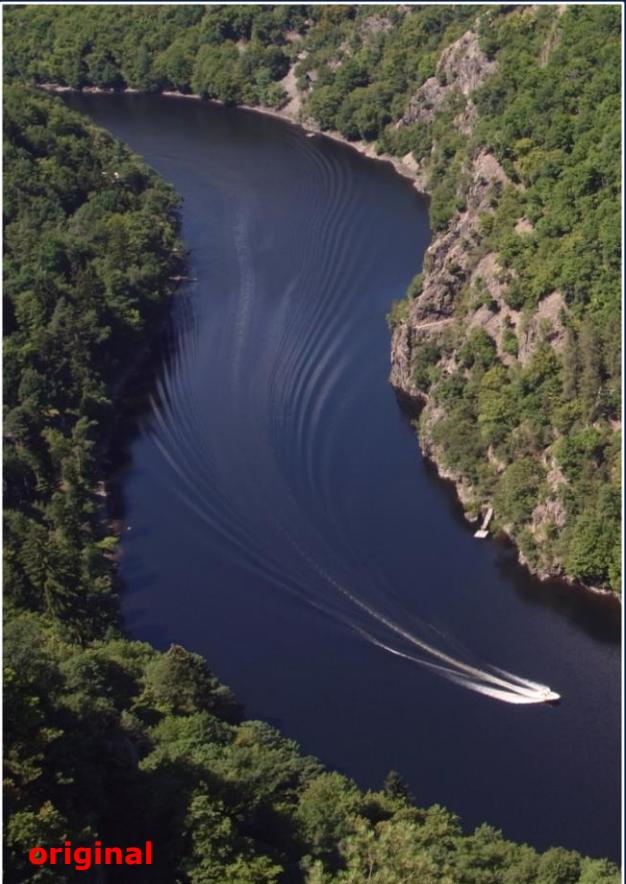


1 : 4

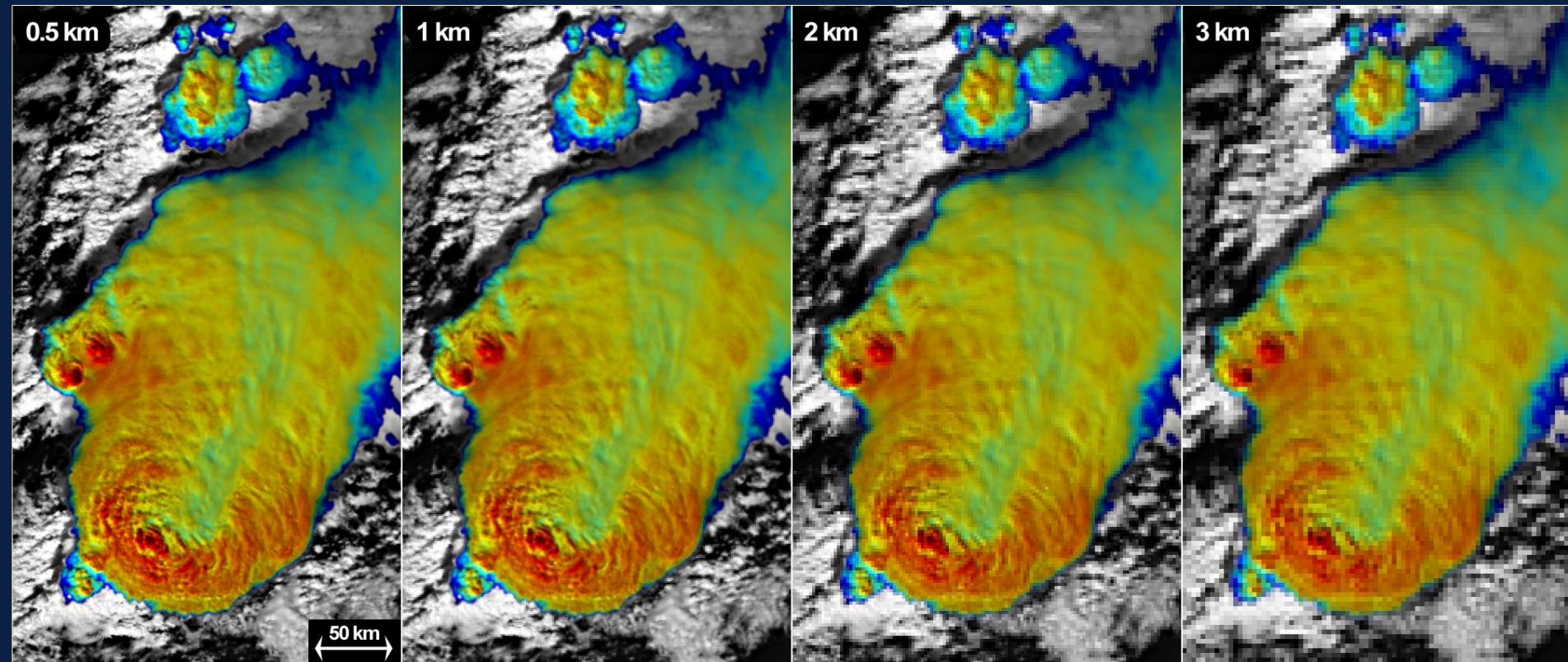


1 : 16

Why the high resolution matters ?

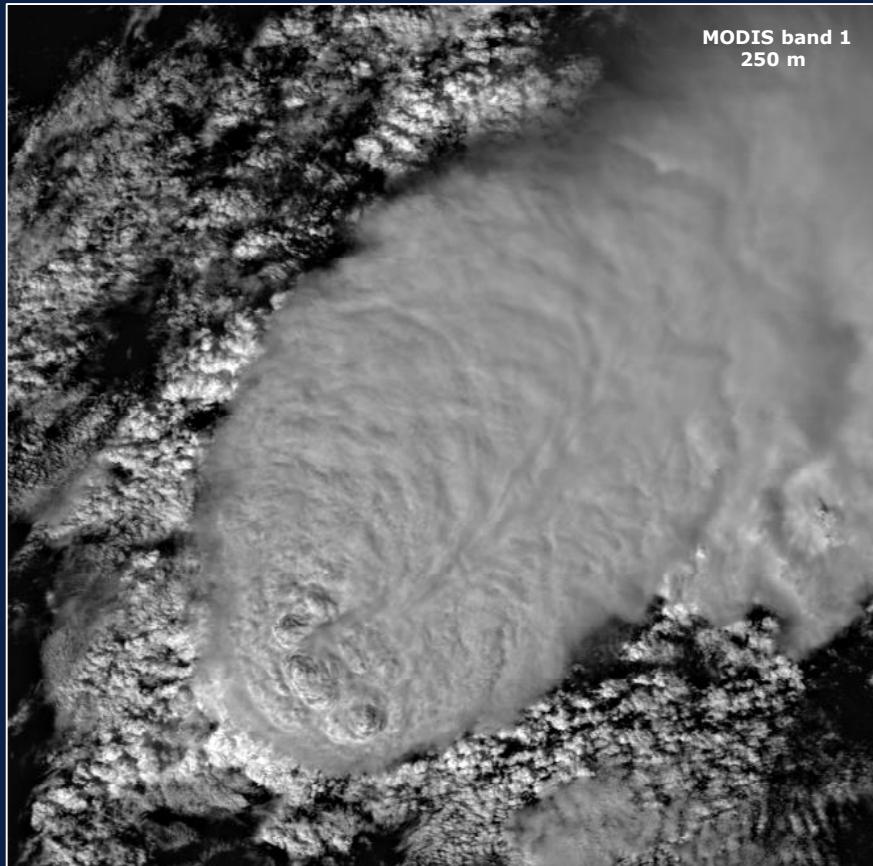


Why the high resolution matters ?

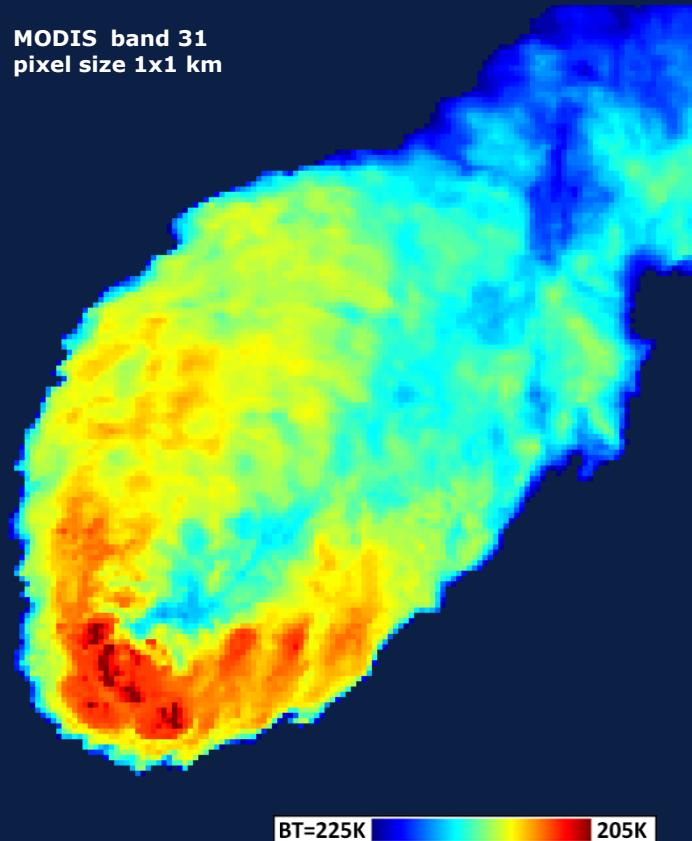


Simulation of 0.5 km, 1 km, 2 km and 3 km nadir resolution (square pixels), based on VIIRS NPP data
(2016-09-16 12:43 UTC, Tyrrhenian Sea)

Why the high resolution matters ?

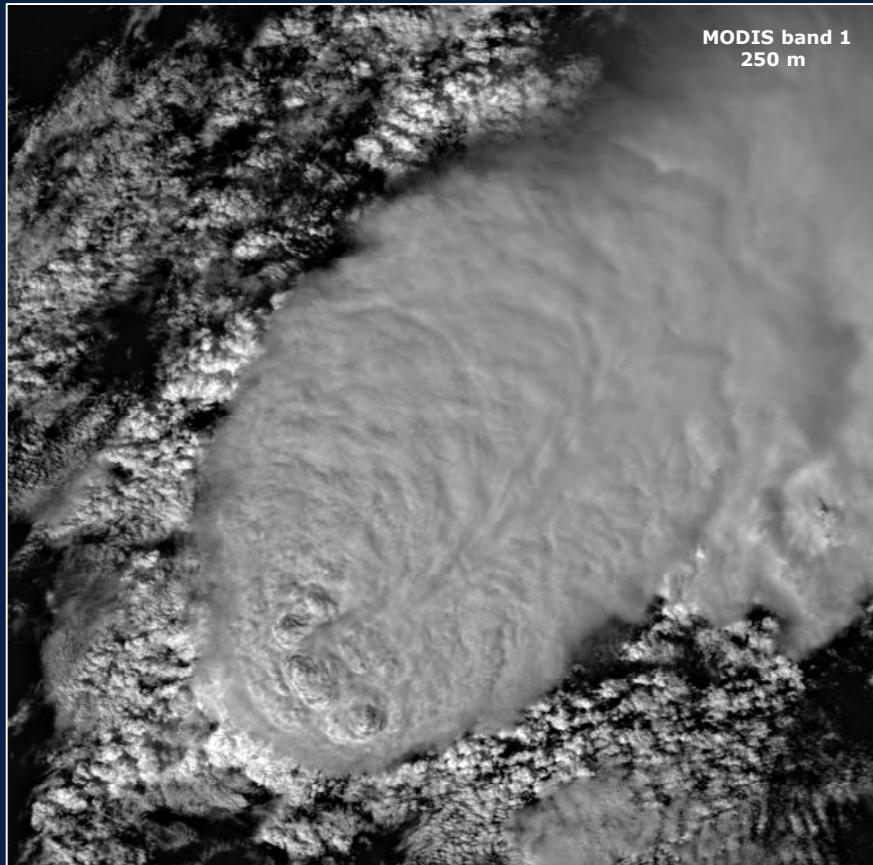


MODIS Aqua, 16 September 2016 12:22 UTC

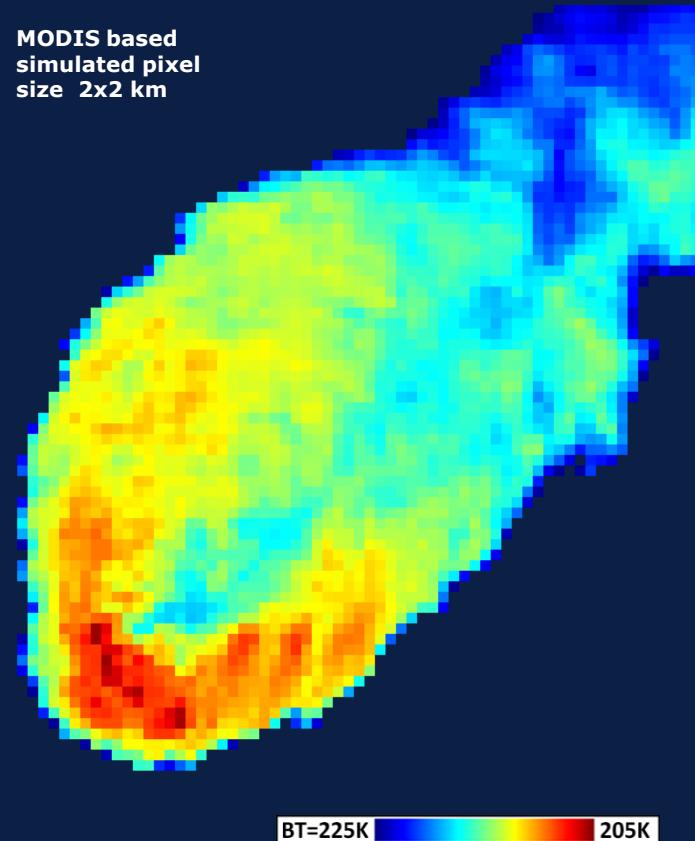


BT=225K 205K

Why the high resolution matters ?

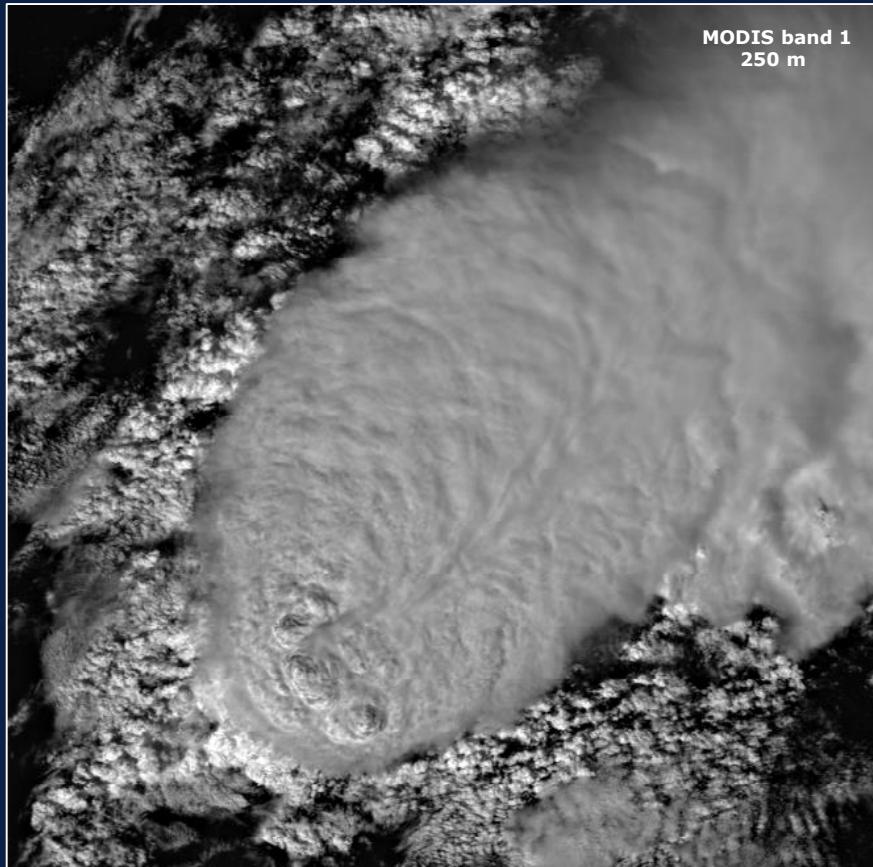


MODIS Aqua, 16 September 2016 12:22 UTC

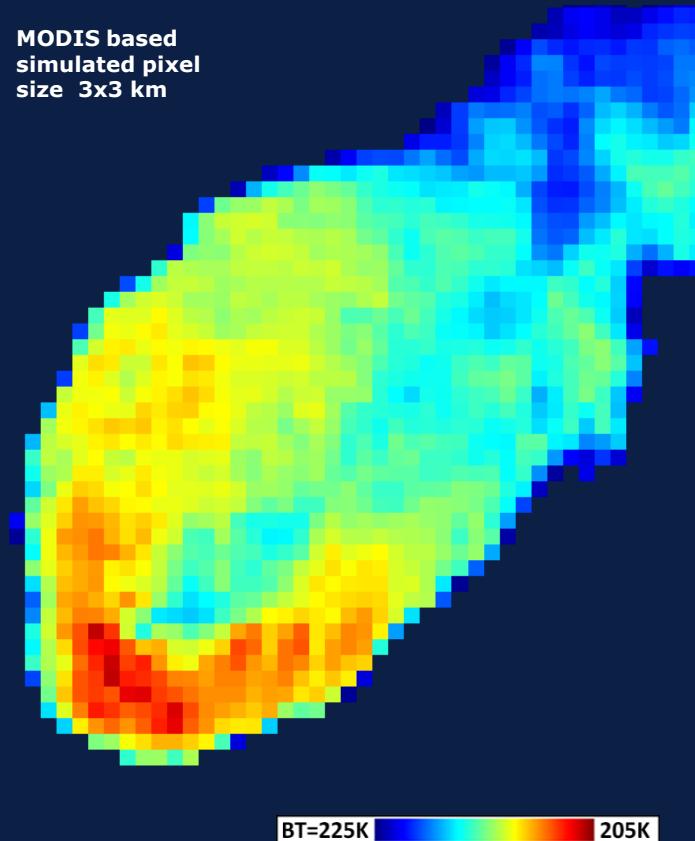


BT=225K 205K

Why the high resolution matters ?



MODIS Aqua, 16 September 2016 12:22 UTC



Impact of spatial and temporal resolution ...

2015-08-09 15:23-17:37 UTC
Ricoh GX100, IR72 filter, interval 10 seconds
From: <http://www.setvak.cz/timelapse>

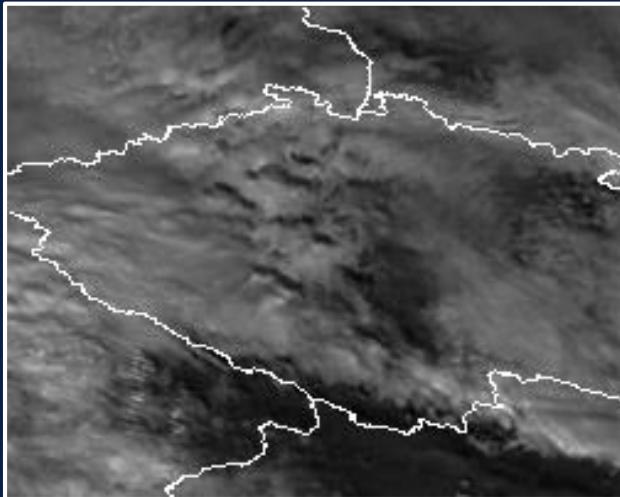
15-54-49 UTC



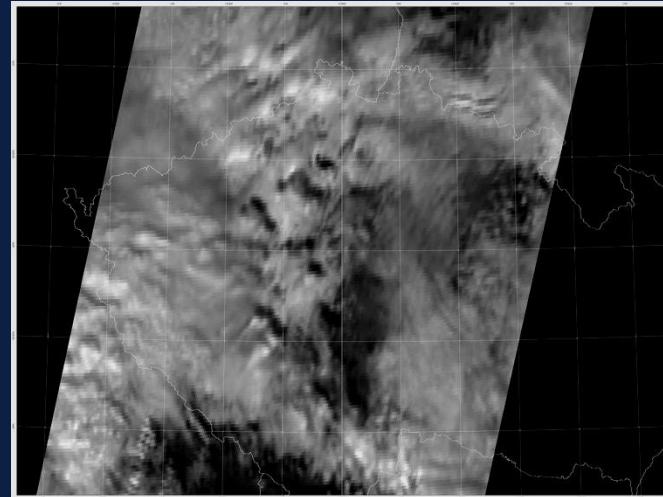
15:25-16:25 UTC	10 sec	1 min	2.5 min	5 min	10 min
50 m	MP4				
0.5 km	MP4				
1.0 km	MP4				

How to simulate MTG FCI pixel size (resolution)

- In reality, most of users care about pixel size at their location (town, country, ...), and not at nadir.
- The pixel size impact is obvious only when displaying the images at their full resolution or enlarged. Zoomed out images (showing larger geographic area) are not affected at all.
- Pixel size and its tilt (skew) depend on location of the satellite (its nominal position above the Equator), and on LAT/LON of the location where the pixel is being mapped to.

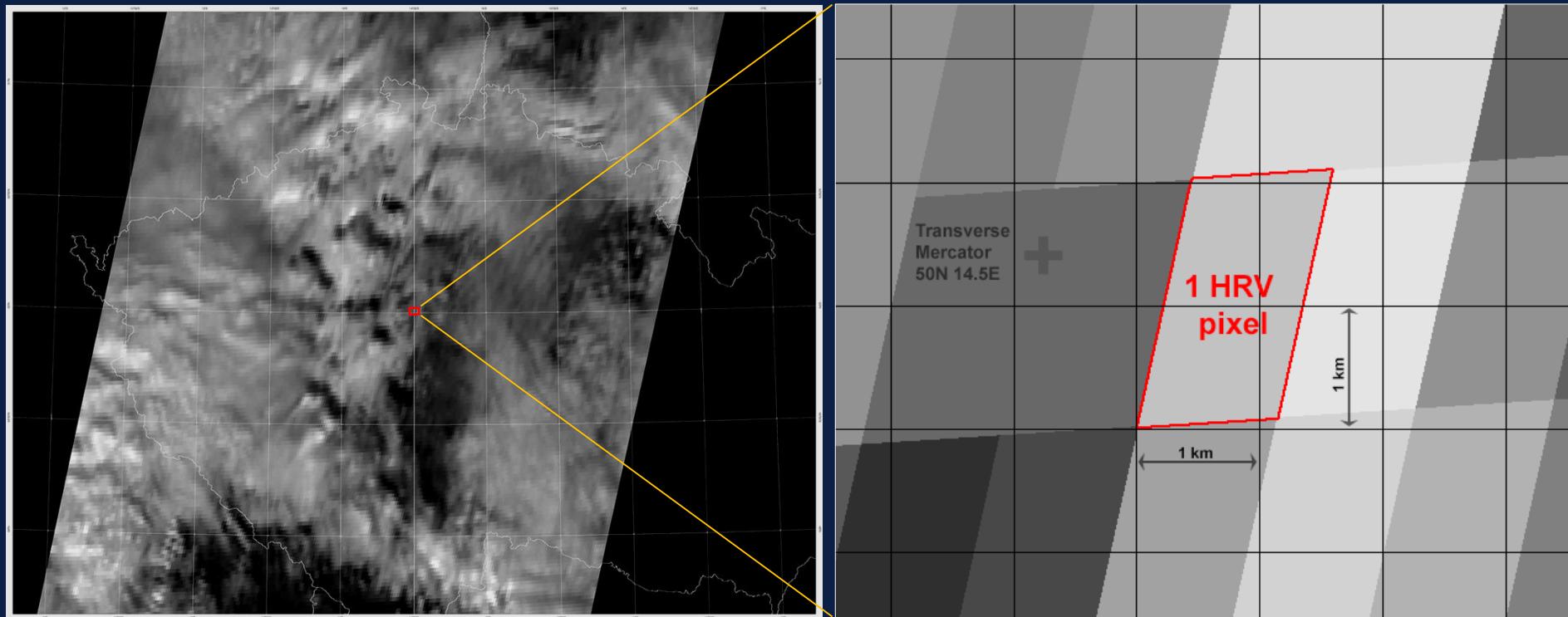


Original GEO projection (0°)



Transverse Mercator (50°N , 14.5°E) projection

How to simulate MTG FCI pixel size (resolution)

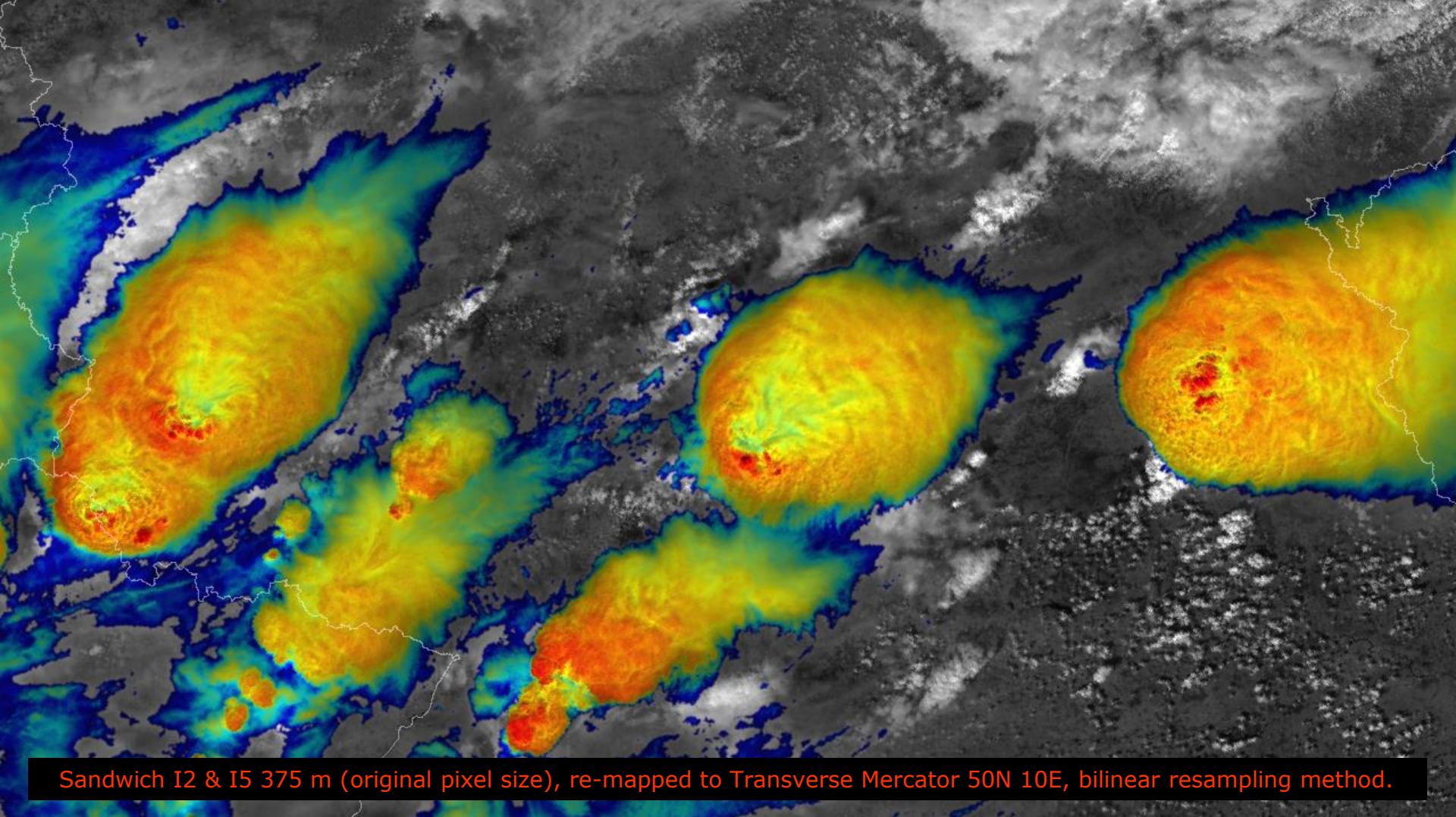


Original 1km HRV pixels re-mapped from original GEO projection (MSG at LON=0°) into Transverse Mercator 50N, 14.5E and 10m image pixel size, using nearest neighbor resampling method. Processed in 2met!, ENVI and Adobe Photoshop.

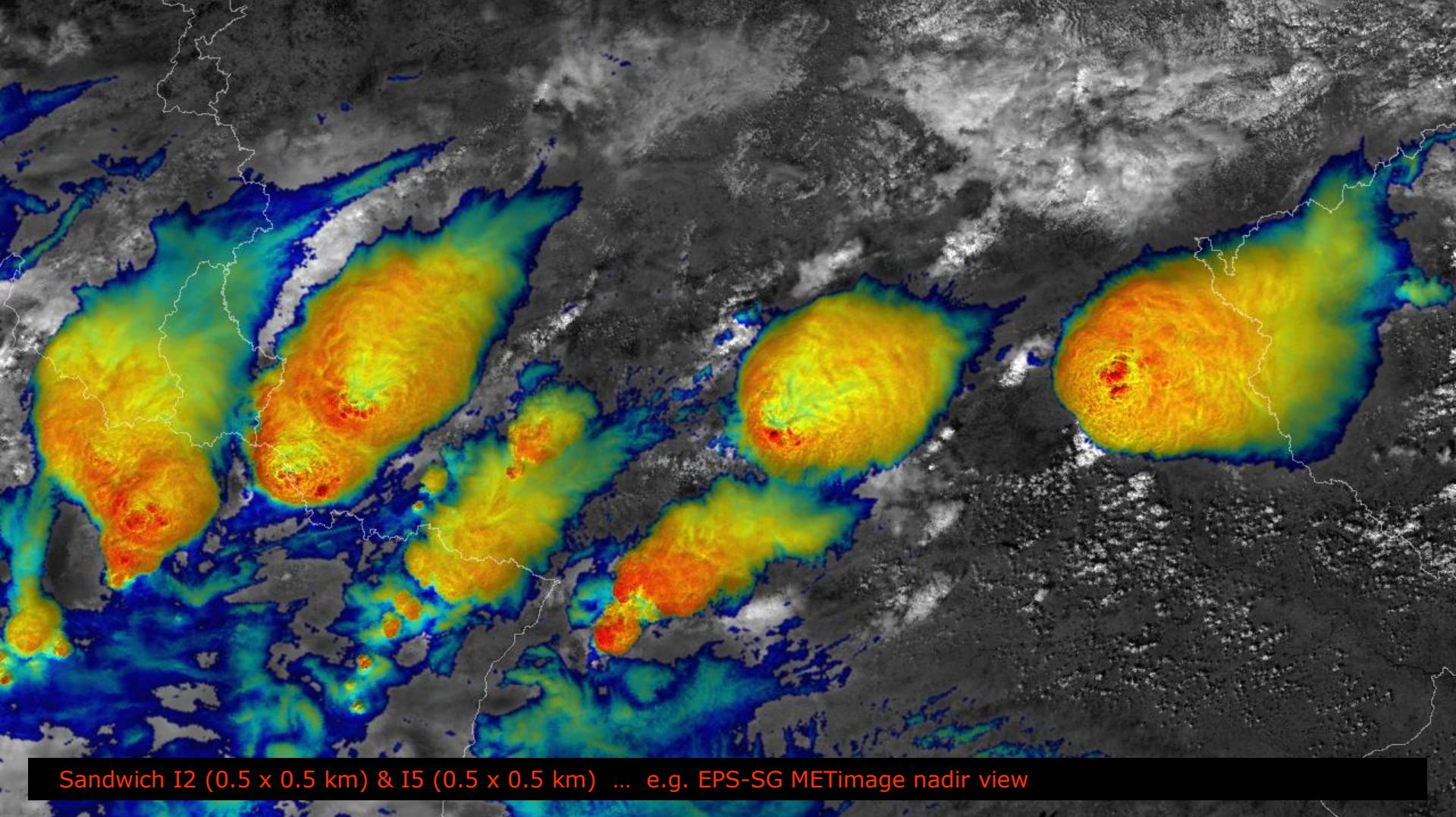
11 June 2018 – CONVECTIVE STORMS

Central Europe

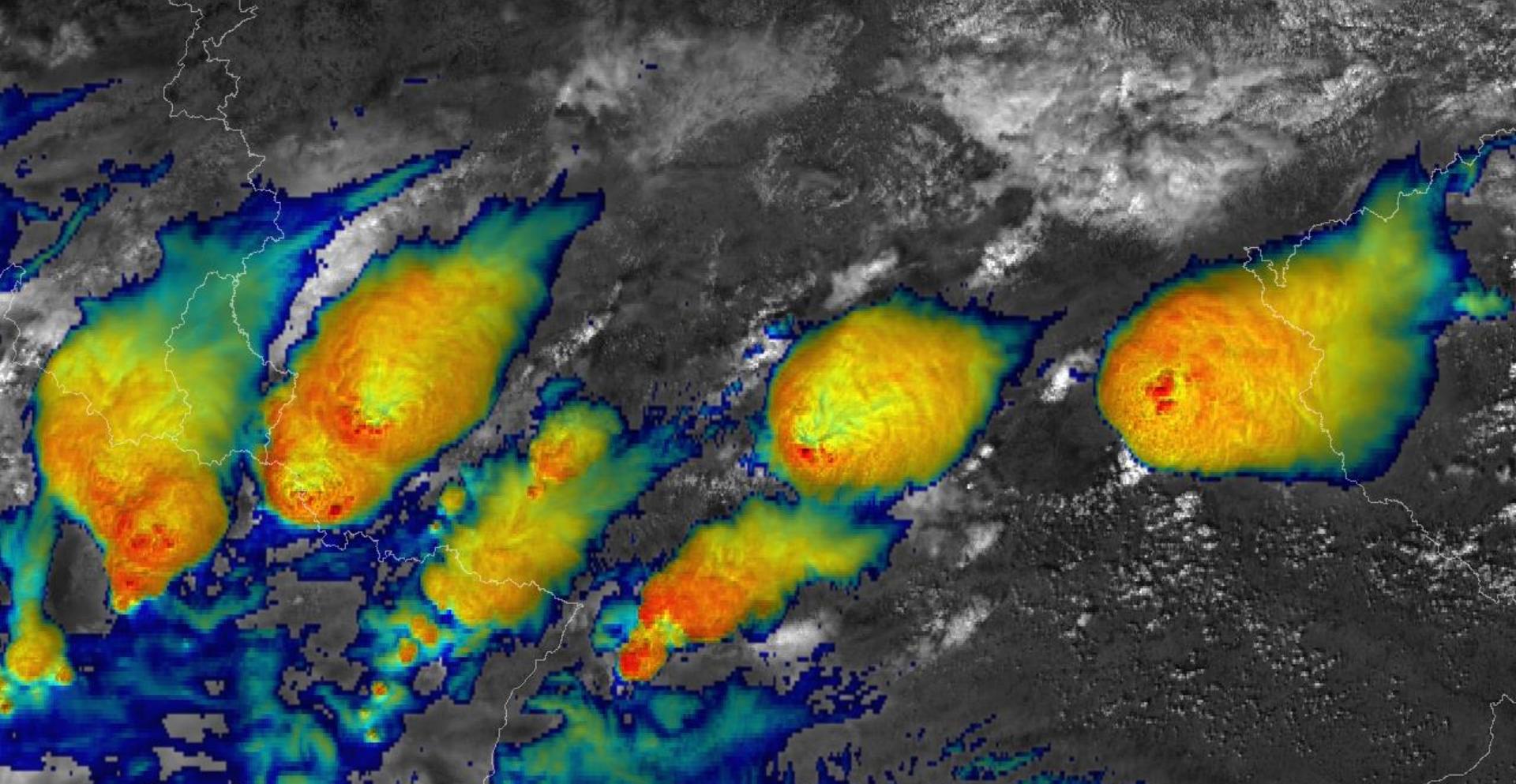
Source data: S-NPP, VIIRS bands I2 0.862 μm and I5 11.45 μm (375m, SDR), 11:37 UTC, processed in ENVI, using its [bilinear interpolation](#) for initial remapping of VIIRS data, and [pixel aggregate](#) and [nearest neighbor](#) resampling methods for simulations of lower pixel resolution,
simulations of MTG FCI VIS 0.6 (0.640 μm) 0.5 km HR / 1 km NR, and IR10.5 (10.50 μm) 1 km HR / 2 km NR bands, assuming position of the satellite at 9.5 E (RSS satellite).



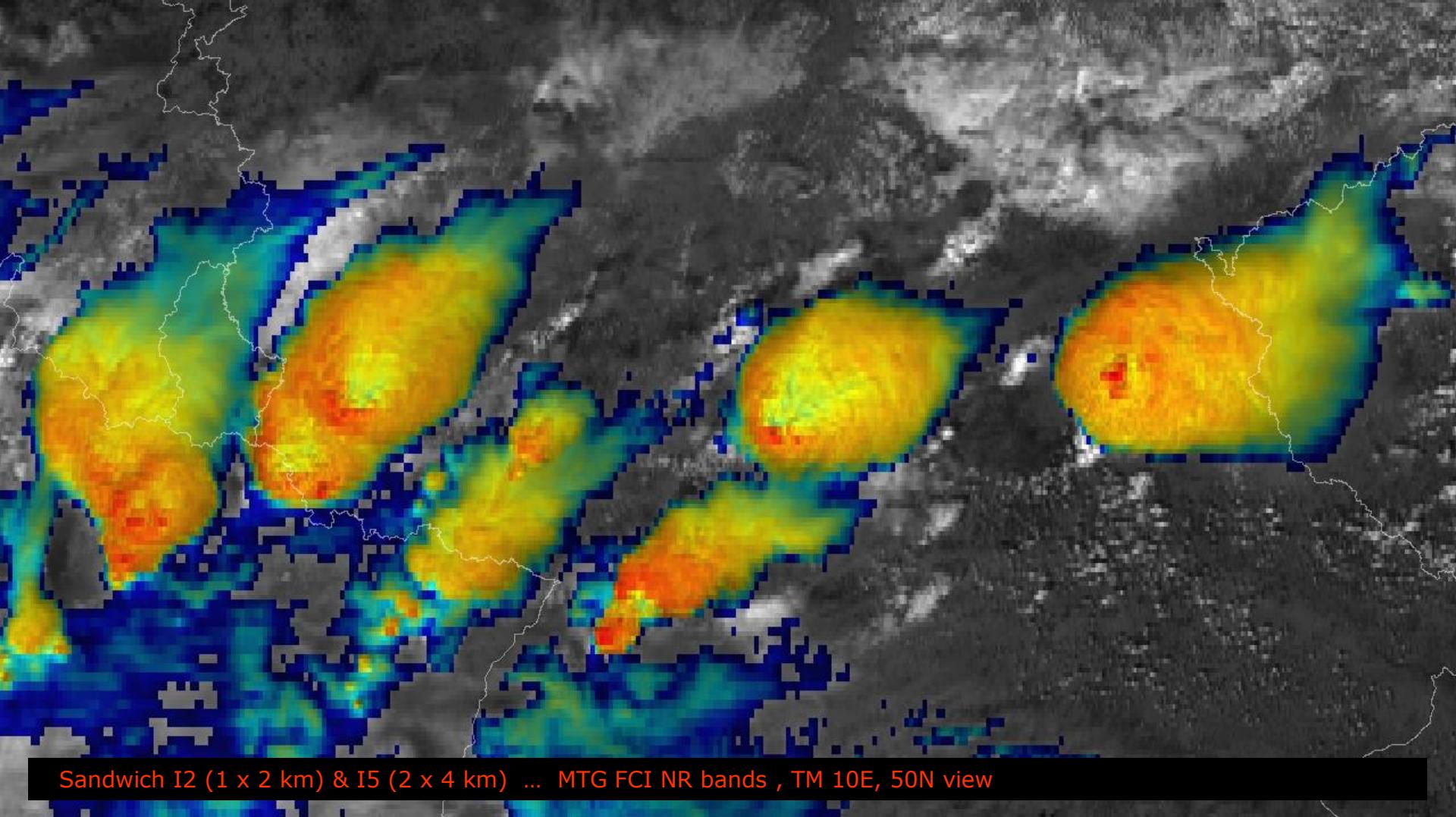
Sandwich I2 & I5 375 m (original pixel size), re-mapped to Transverse Mercator 50N 10E, bilinear resampling method.

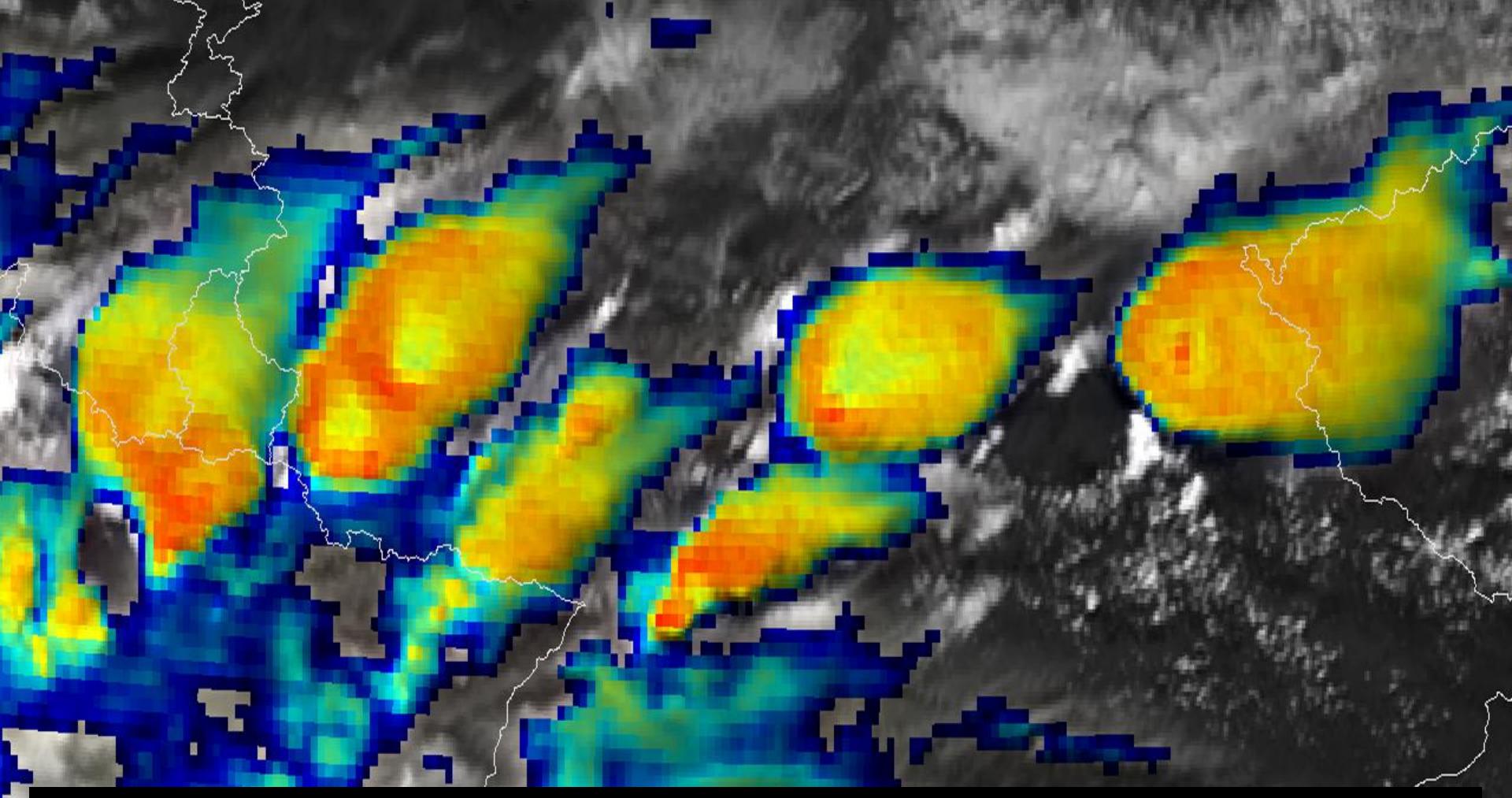


Sandwich I2 (0.5 x 0.5 km) & I5 (0.5 x 0.5 km) ... e.g. EPS-SG METimage nadir view

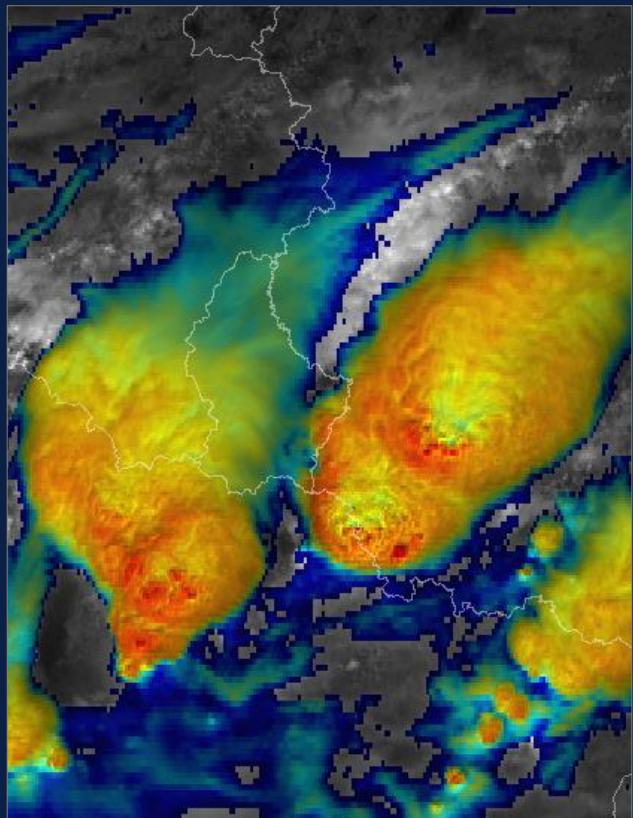


Sandwich I2 (0.5 x 1 km) & I5 (1 x 2 km) ... MTG FCI HR bands, TM 10E, 50N view

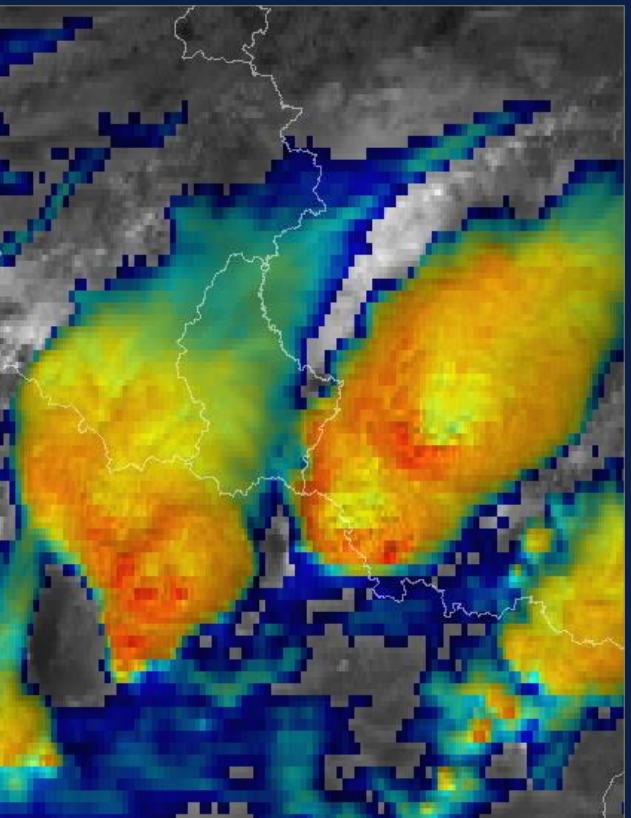




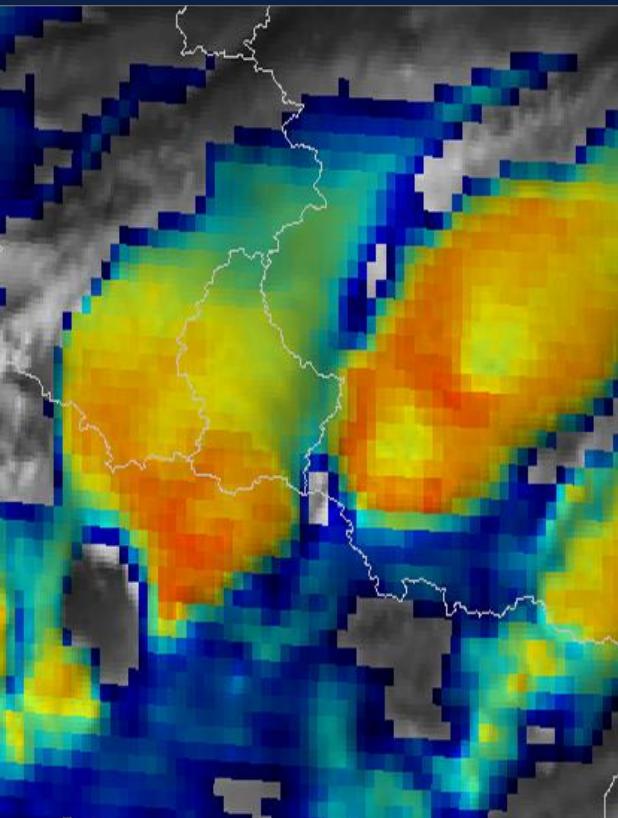
MSG RSS, sandwich HRV & IR10.8, 3 km (E-W) x 6 km (S-N), TM 10E, 50N



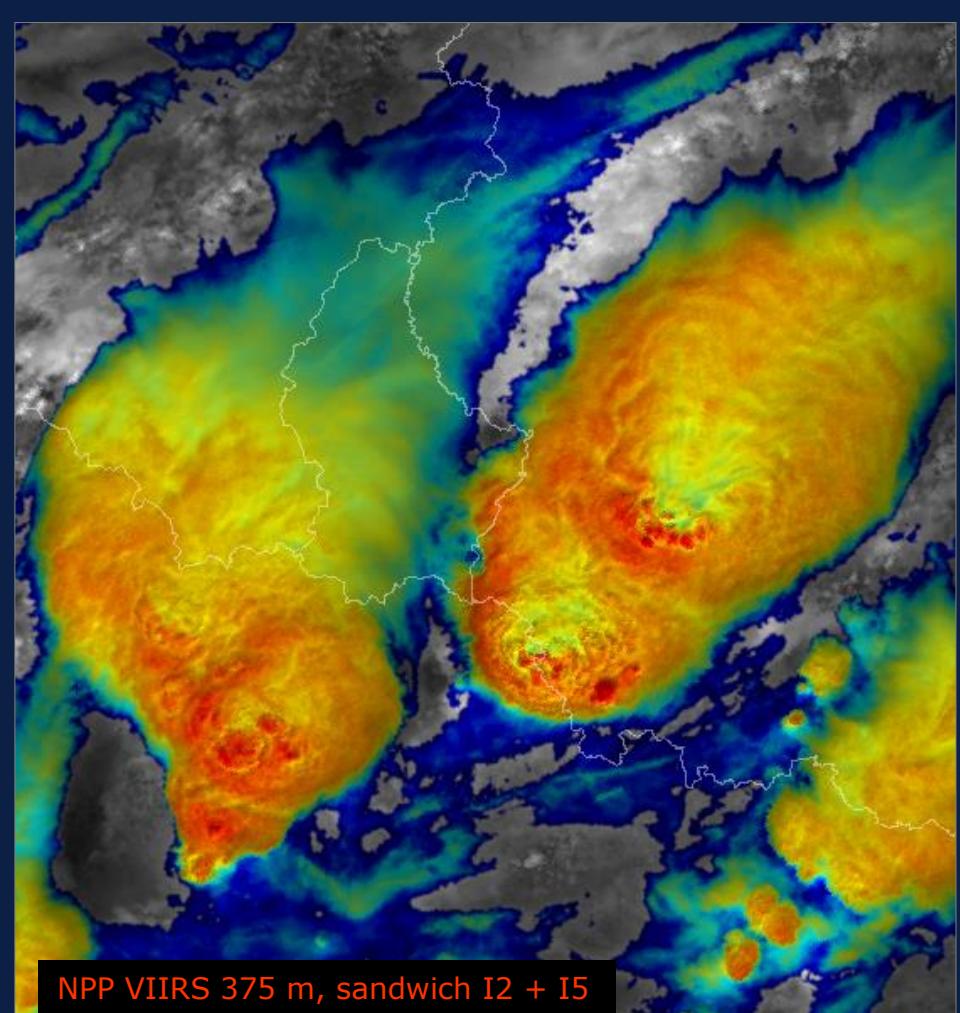
simulated FCI sandwich, 0.5x1 / 1x2 km



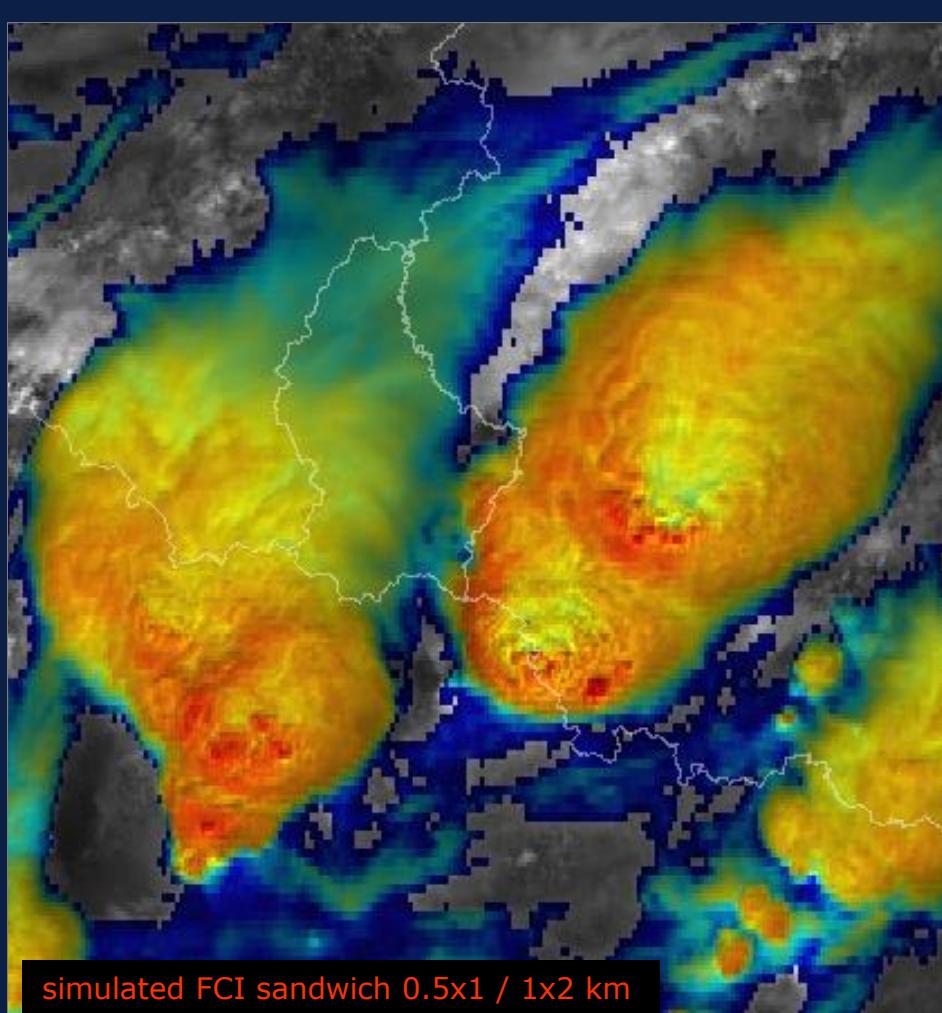
simulated FCI sandwich, 1x2 / 2x4 km



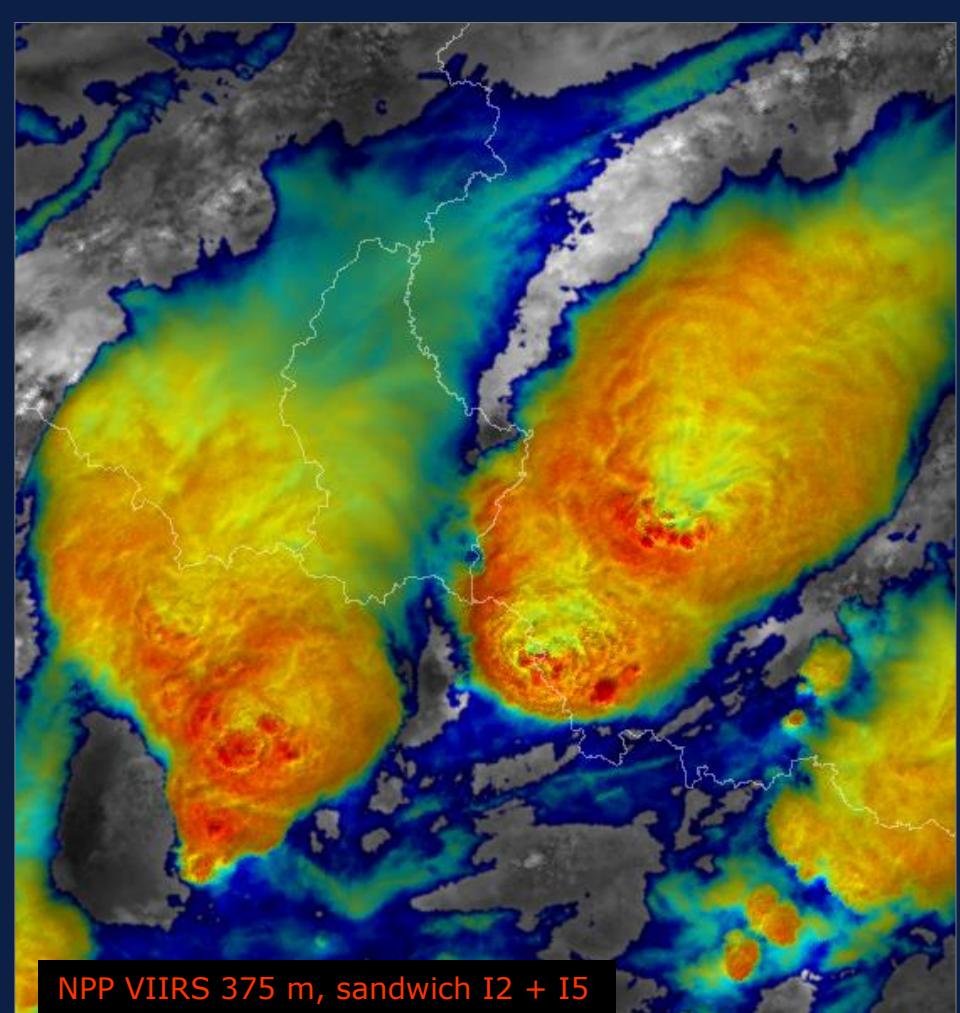
MSG RSS, sandwich HRV & IR10.8



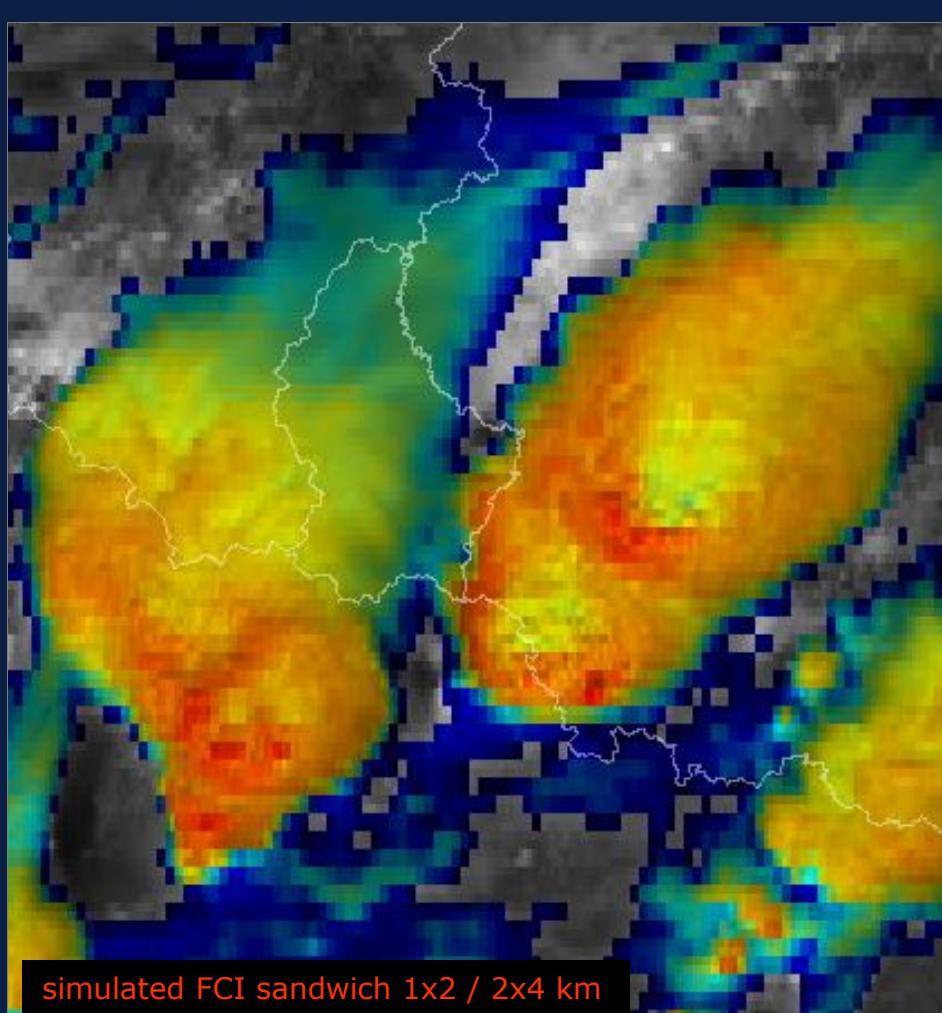
NPP VIIRS 375 m, sandwich I2 + I5



simulated FCI sandwich 0.5x1 / 1x2 km



NPP VIIRS 375 m, sandwich I2 + I5

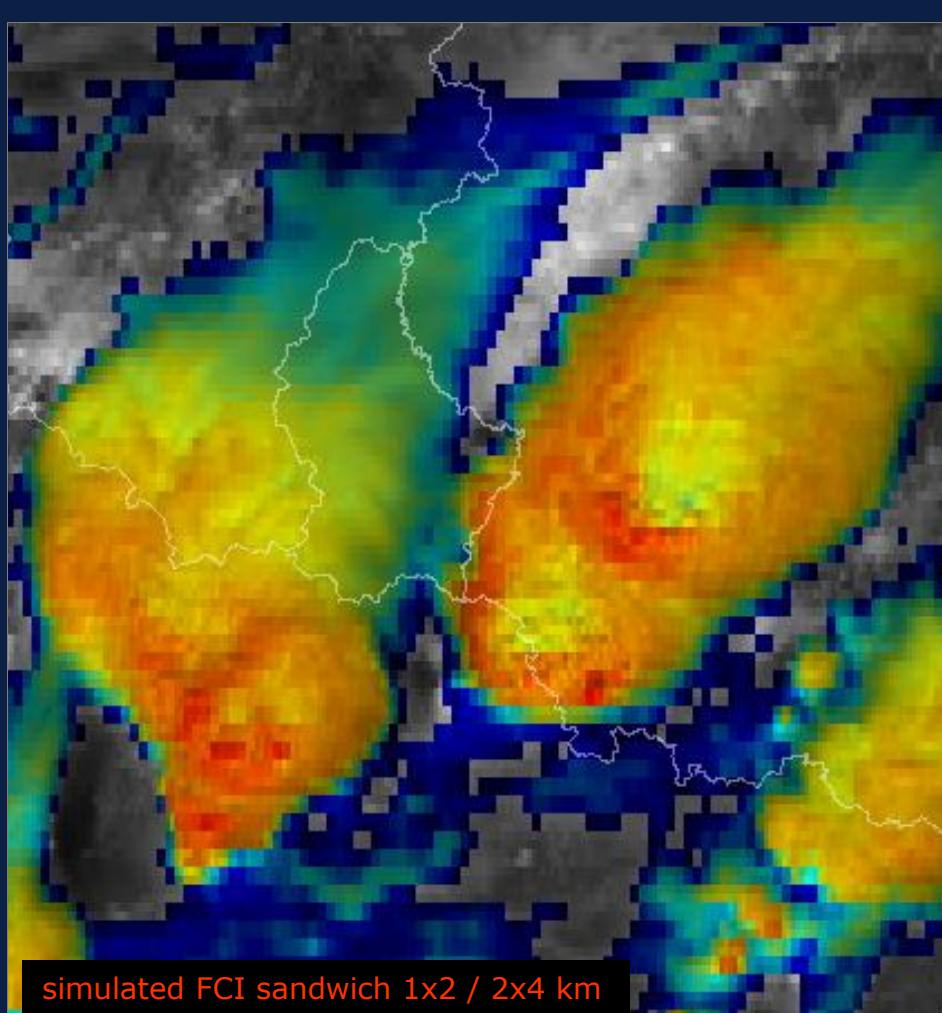
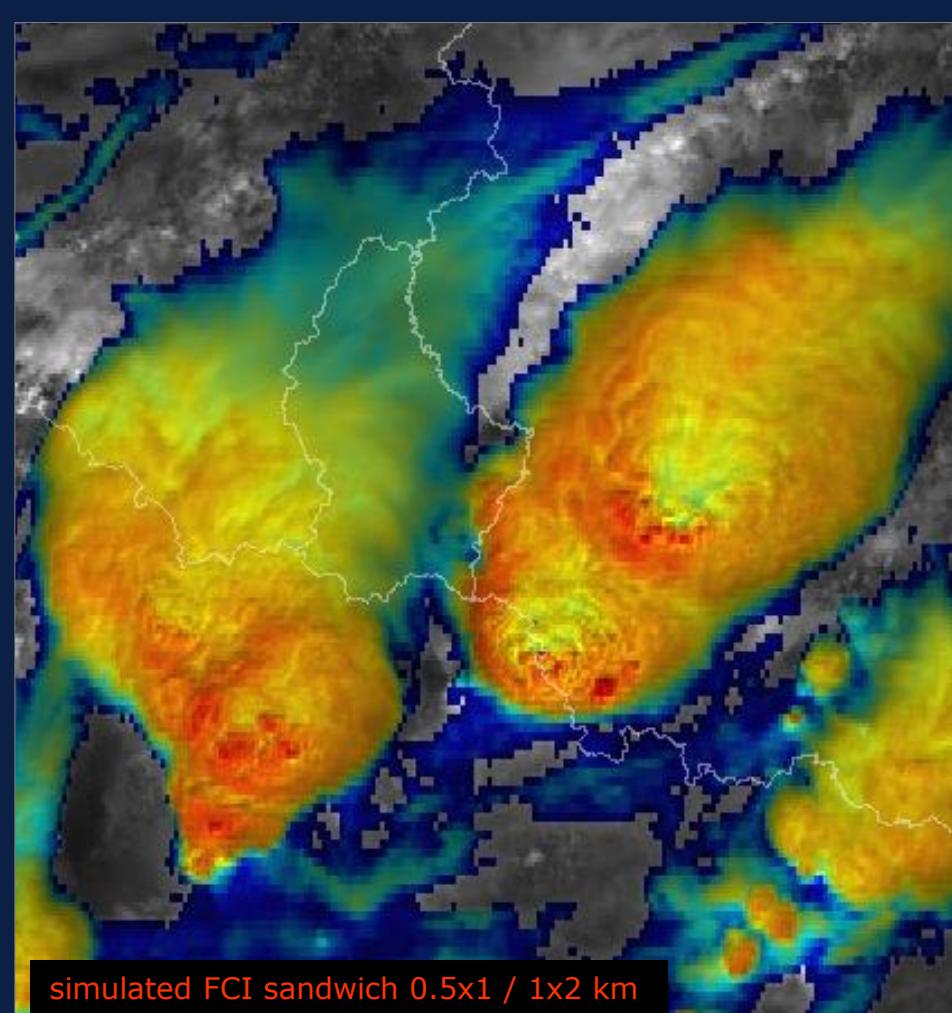


simulated FCI sandwich 1x2 / 2x4 km

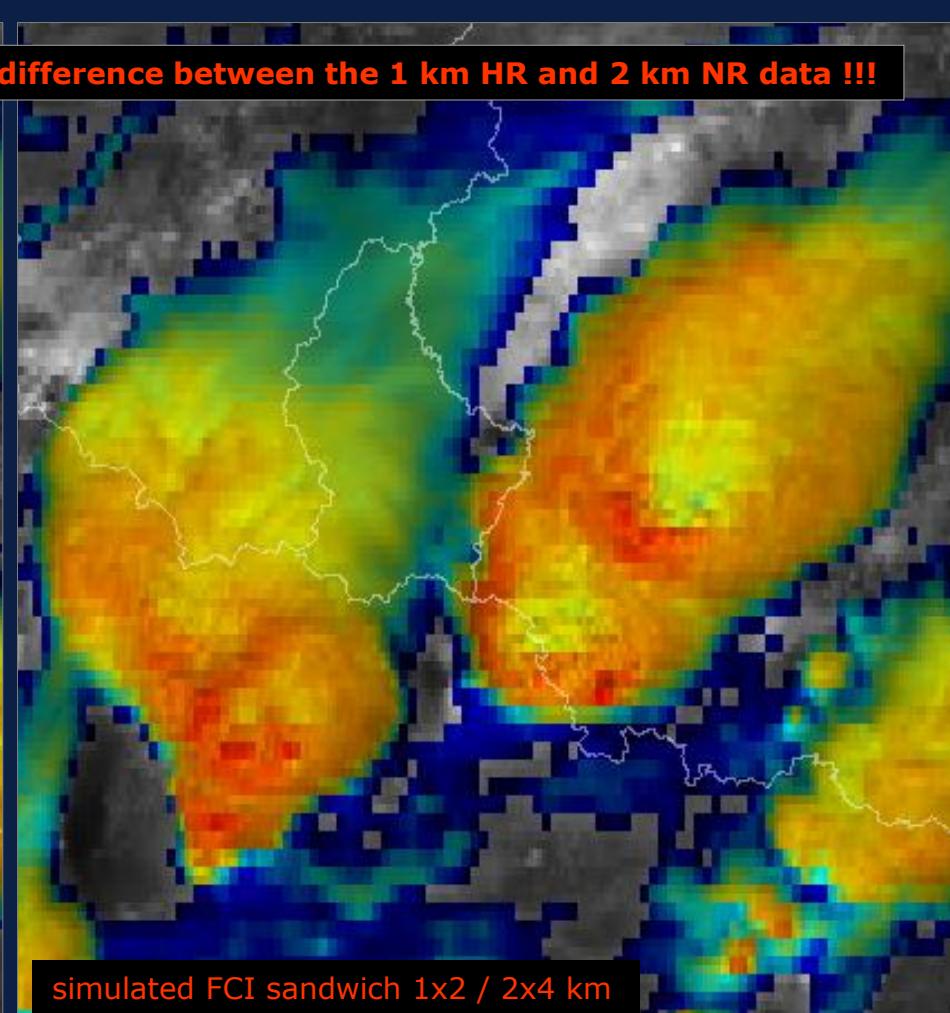
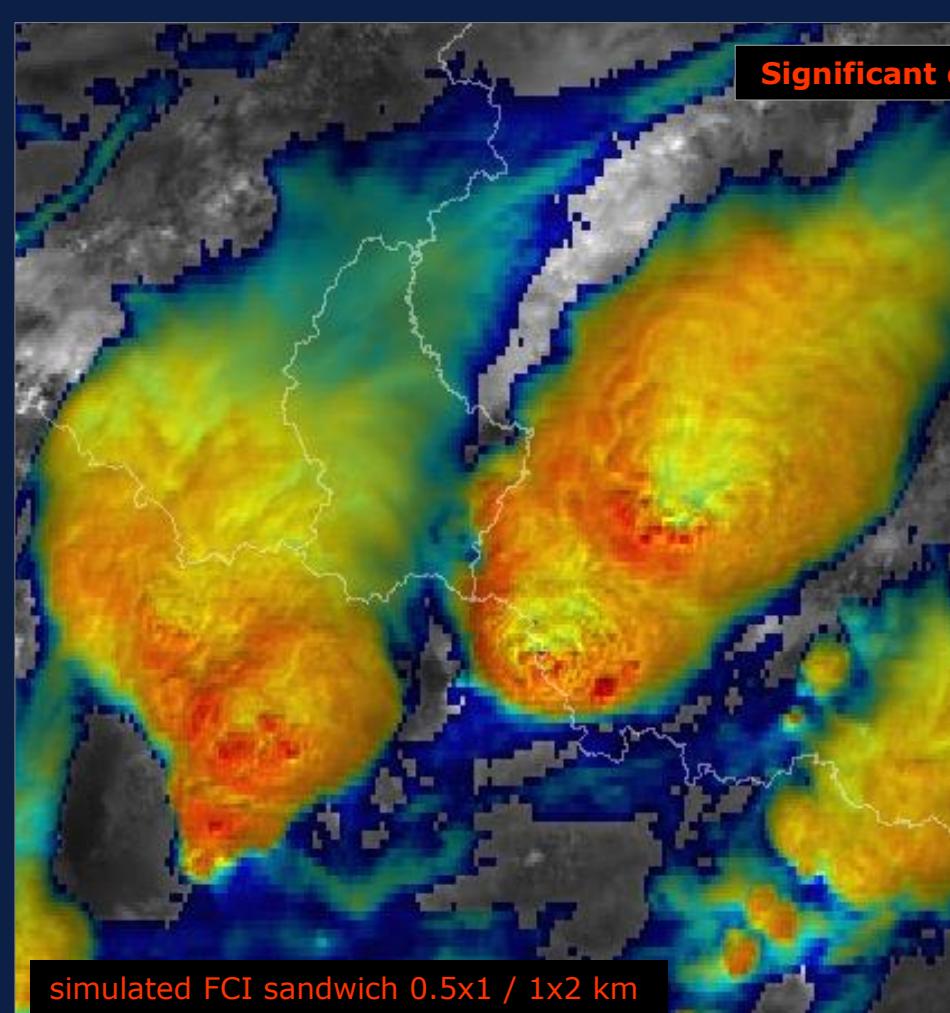
Why do we care about all these details, about their visibility in the images?

- Most of the storm-top features, their appearance or characteristics are related to intensity and persistence of storm updrafts – overshooting tops, above anvil cirrus plumes, radial cirrus, cloud-top gravity waves or ship waves, etc.
- As strong, longer lasting updrafts are typical for severe storms, most of the features above witness (to a certain degree) about possible storm severity. Therefore, the better we can see these features, and the sooner we reveal these, the higher is our chance to classify a storm as **possibly severe** – crucial for nowcasting! The same is true for efficiency of various automatic detection methods (such as detection of overshooting tops or plumes).
- **THUS, HIGH PIXEL RESOLUTION AND HIGH SCANNING FREQUENCY ARE ESSENTIAL FOR NOWCASTING OF CONVECTIVE STORMS !!!**

More about various aspects of satellite observations of tops of convective storms at website of the Convection Working Group (CWG), <https://cwg.eumetsat.int/>



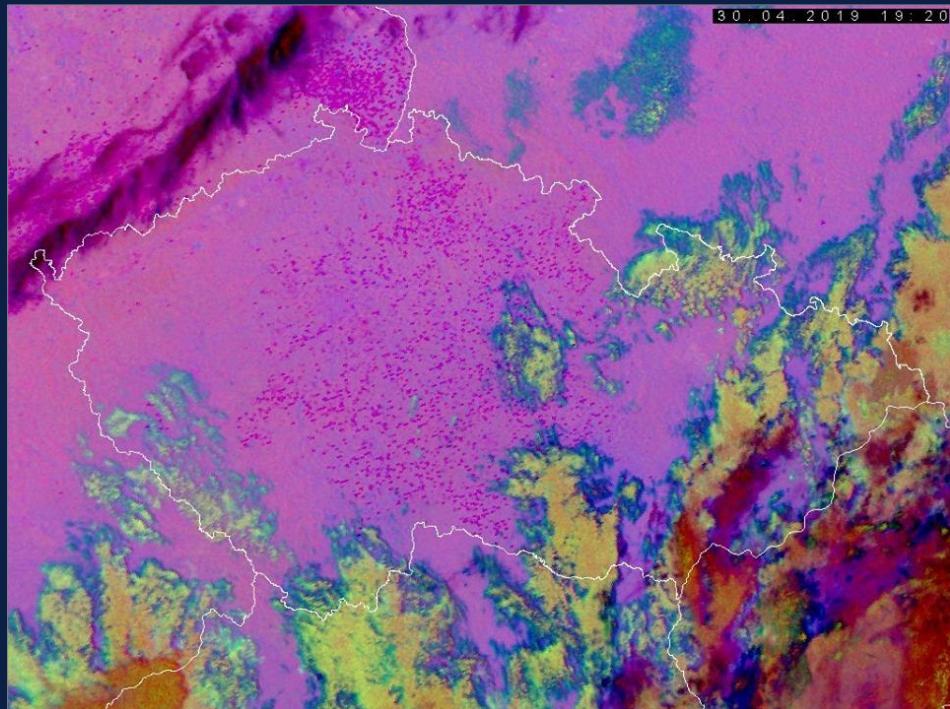
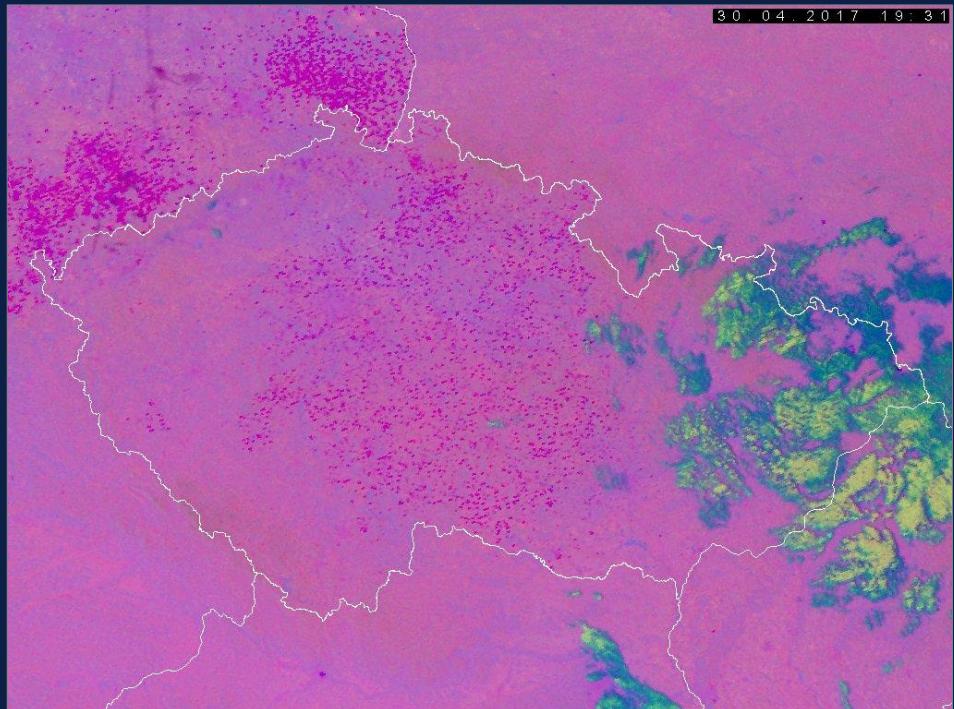
Significant difference between the 1 km HR and 2 km NR data !!!



30 April / 01 May 2019 – FIRE DETECTION

Beltain (Beltane) night, or Walpurgis night

Source data: NOAA-20 (JPSS-1), VIIRS bands I4 3.74 and I5 11.45 μm (375m, SDR), 01:20 UTC
processed in ENVI, using its [bilinear interpolation](#) and [pixel aggregate](#) resampling methods
simulations of MTG FCI IR 3.8 (3.80 μm) and IR10.5 (10.50 μm) 1 km HR / 2 km NR bands

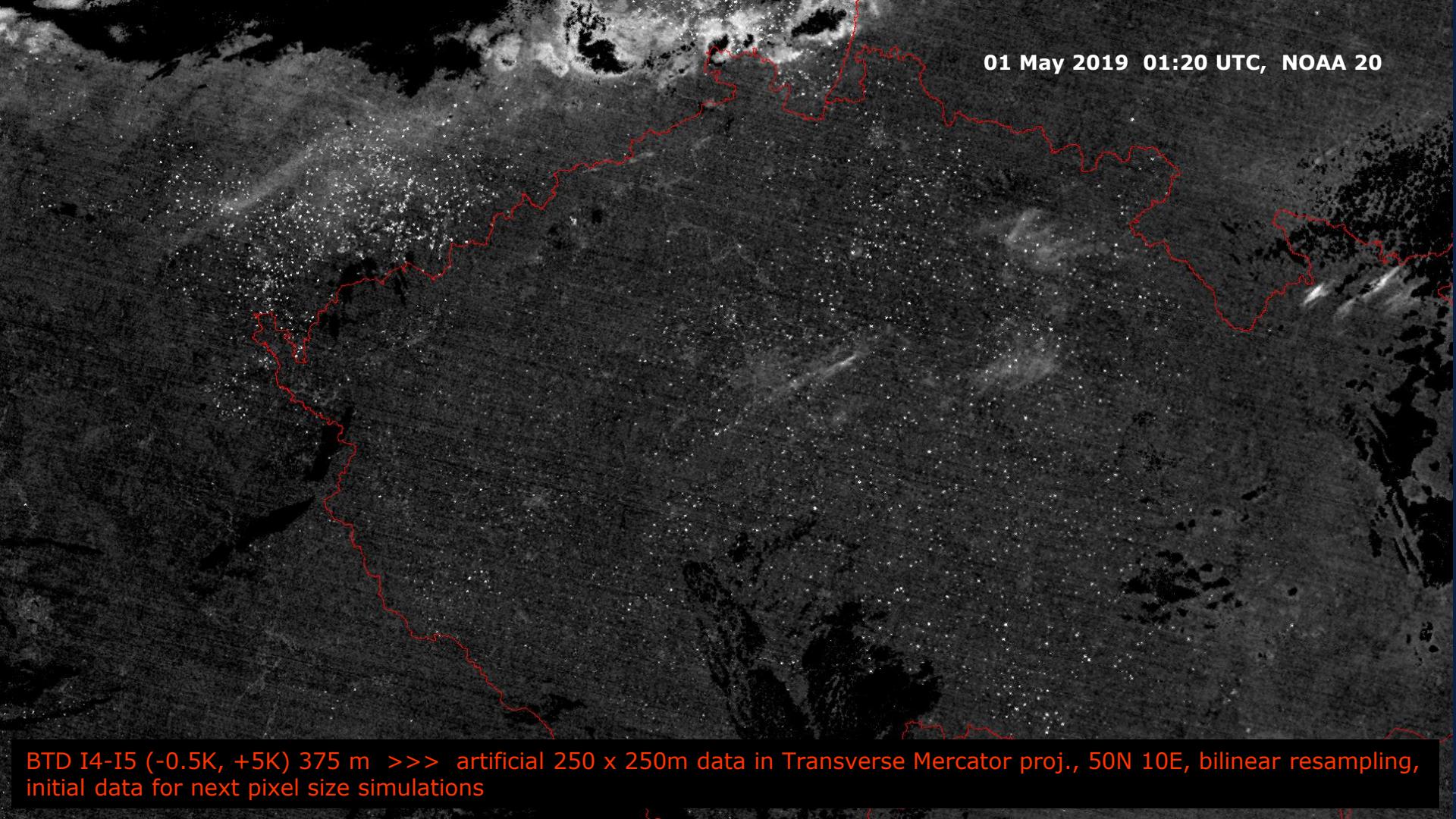


METOP AVHRR, Night Microphysics RGB



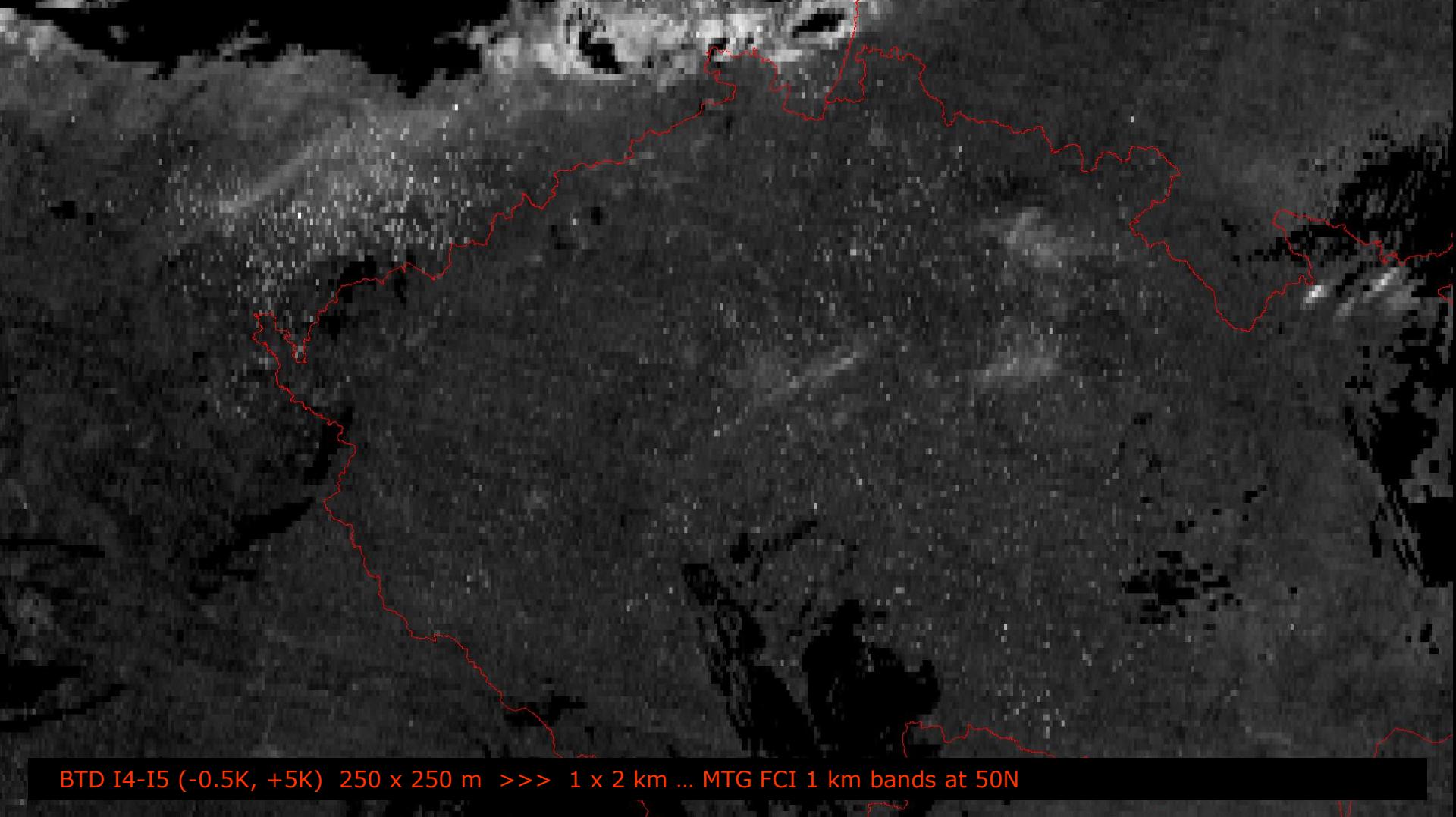
Temperature of bonfire – up to about 1400 K



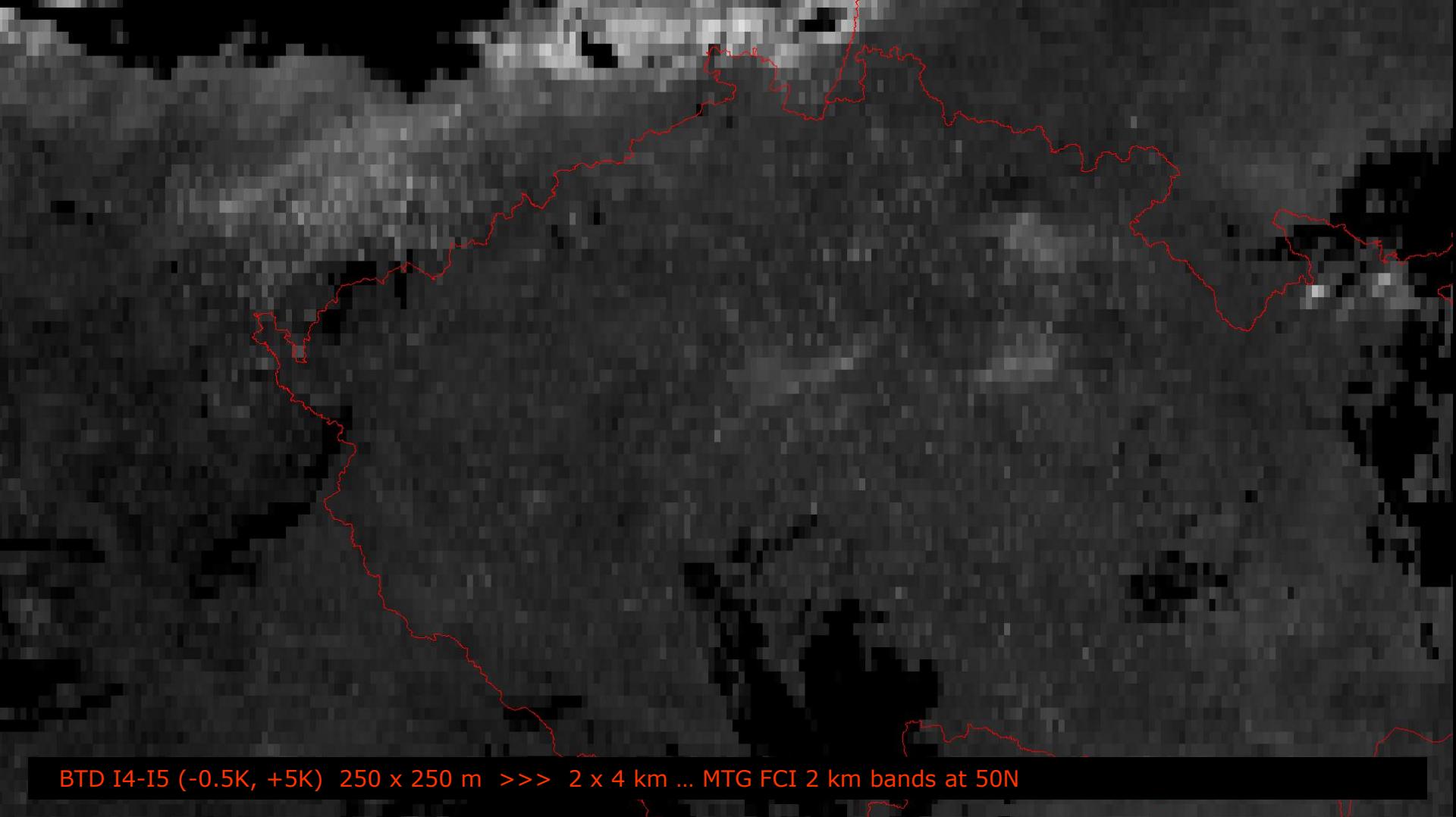


01 May 2019 01:20 UTC, NOAA 20

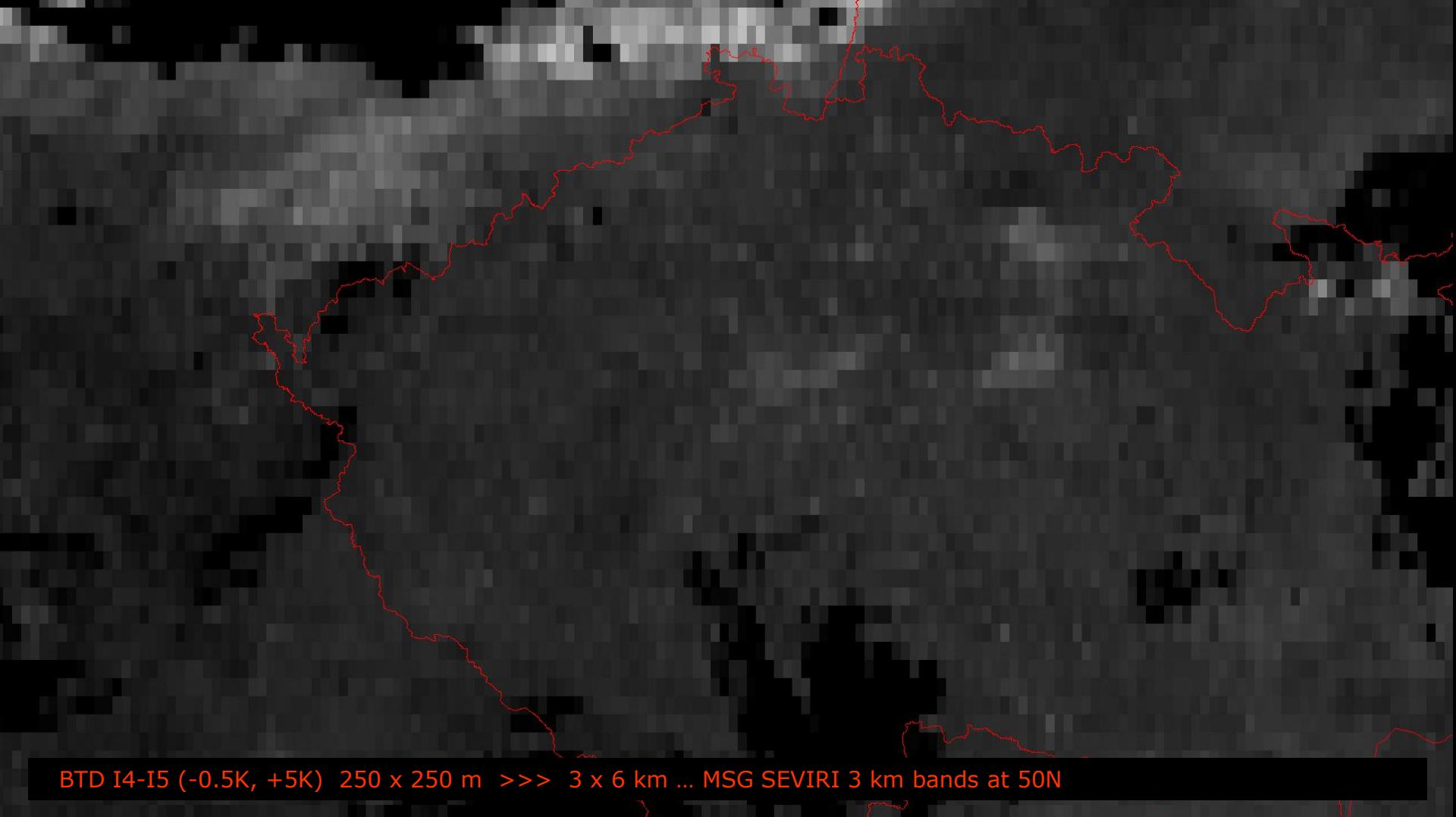
BTD I4-I5 (-0.5K, +5K) 375 m >>> artificial 250 x 250m data in Transverse Mercator proj., 50N 10E, bilinear resampling, initial data for next pixel size simulations



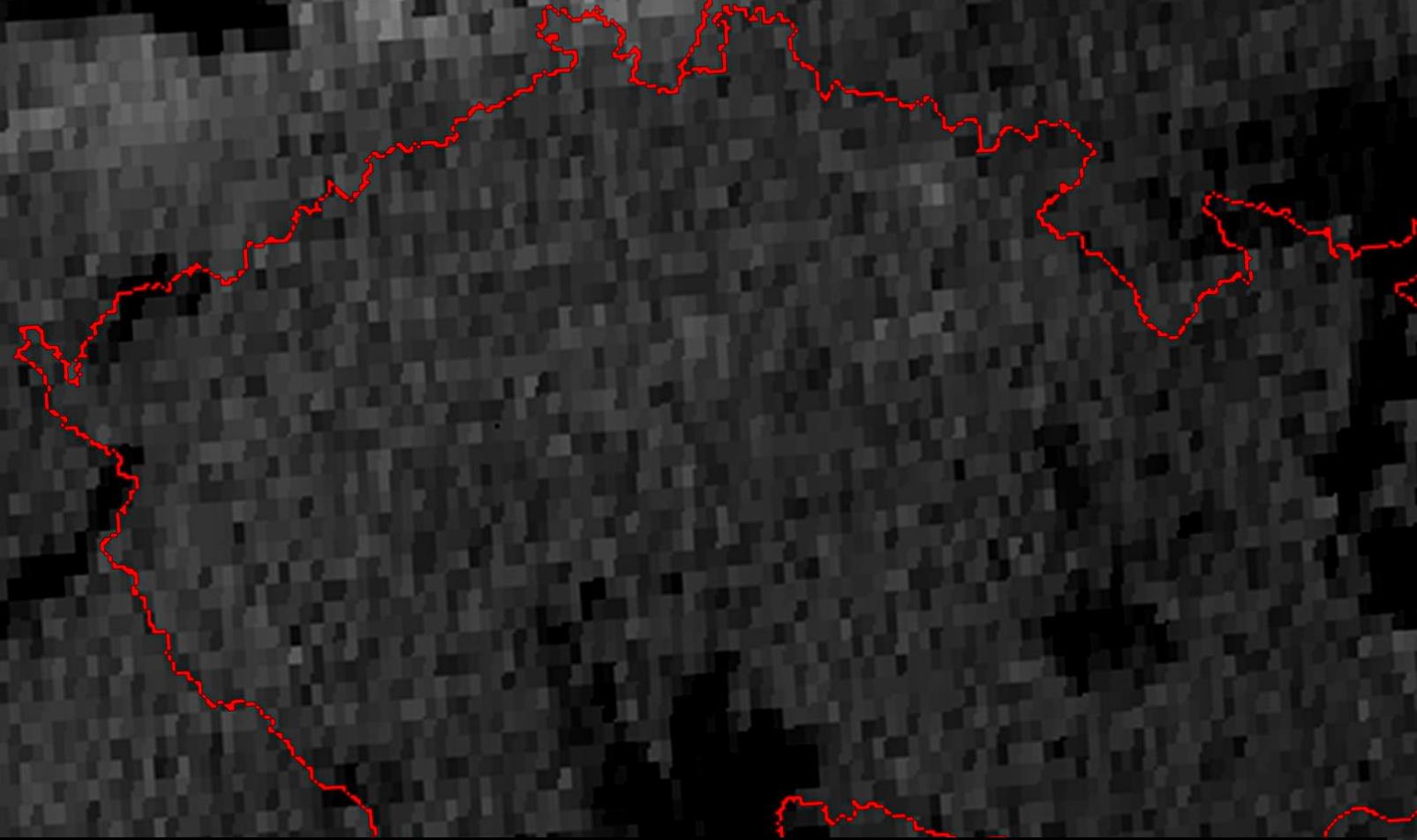
BTD I4-I5 (-0.5K, +5K) 250 x 250 m >>> 1 x 2 km ... MTG FCI 1 km bands at 50N



BTD I4-I5 (-0.5K, +5K) 250 x 250 m >>> 2 x 4 km ... MTG FCI 2 km bands at 50N



BTD I4-I5 (-0.5K, +5K) 250 x 250 m >>> 3 x 6 km ... MSG SEVIRI 3 km bands at 50N



MSG SEVIRI RSS 01:20 UTC, BTD IR3.9 - IR10.8 (~ 3 x 6 km), 50N

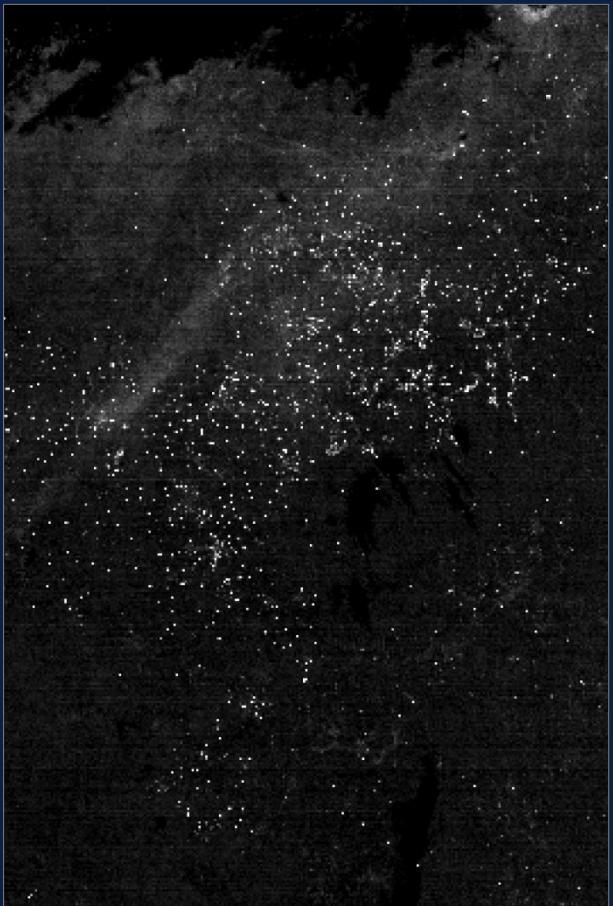
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

V

The same as in previous slides, but without the initial projection into Transverse Mercator, using as source data for simulations the 375 m data in the original satellite (swath) projection – more accurate.

Simulated for nominal meridian (0° or 9.5 E) at nadir view, and at 50 N

Original satellite projection (VIIRS)

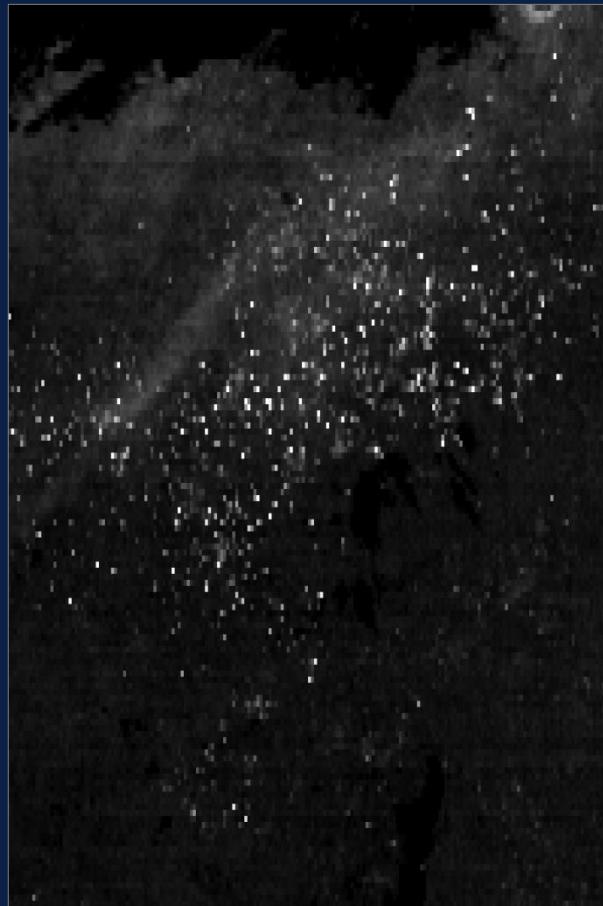


original 375 m data

EPS-SG METimage 0.5 km bands – nadir view



500 x 500 m



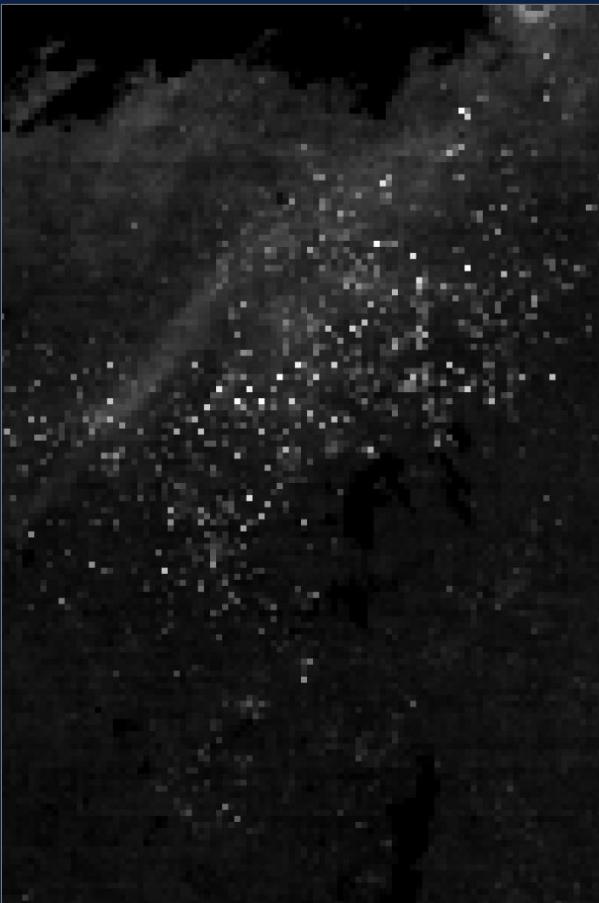
500 x 1000 m

Original satellite projection (VIIRS)



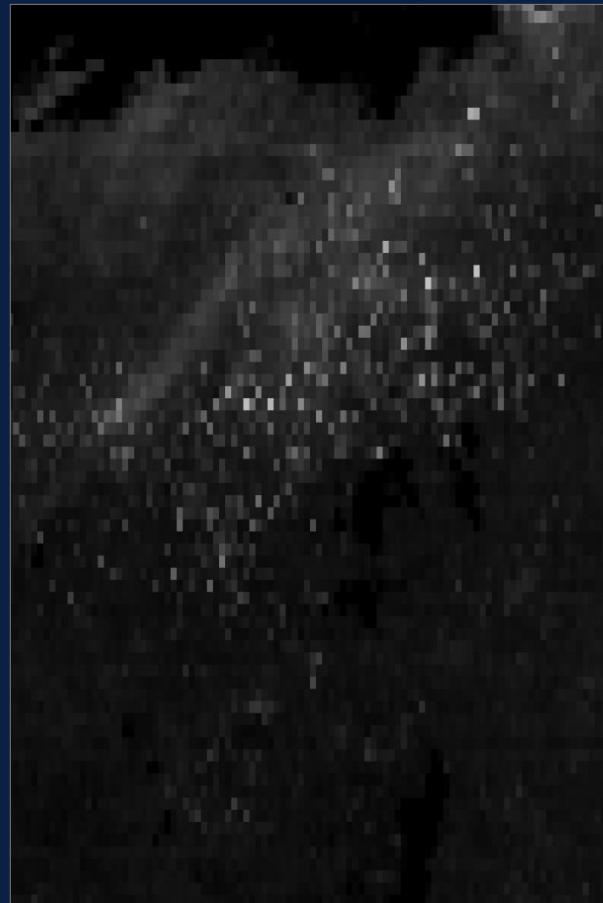
original 375 m data

MTG FCI, 1 km bands – nadir view



1 x 1 km

MTG FCI, 1 km bands – 50°N view



1 x 2 km

Original satellite projection (VIIRS)



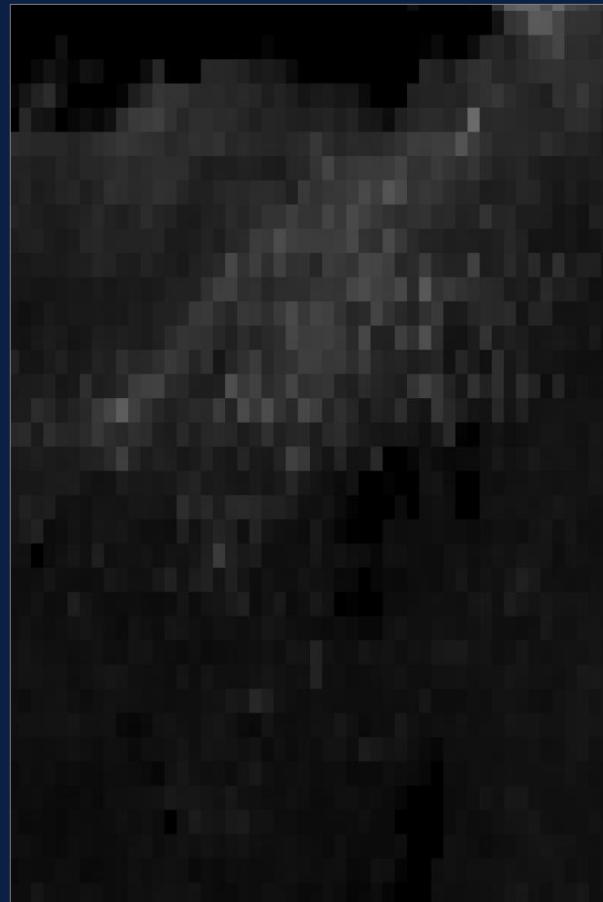
original 375 m data

MTG FCI, 2 km bands – nadir view



2 x 2 km

MTG FCI, 2 km bands – 50°N view



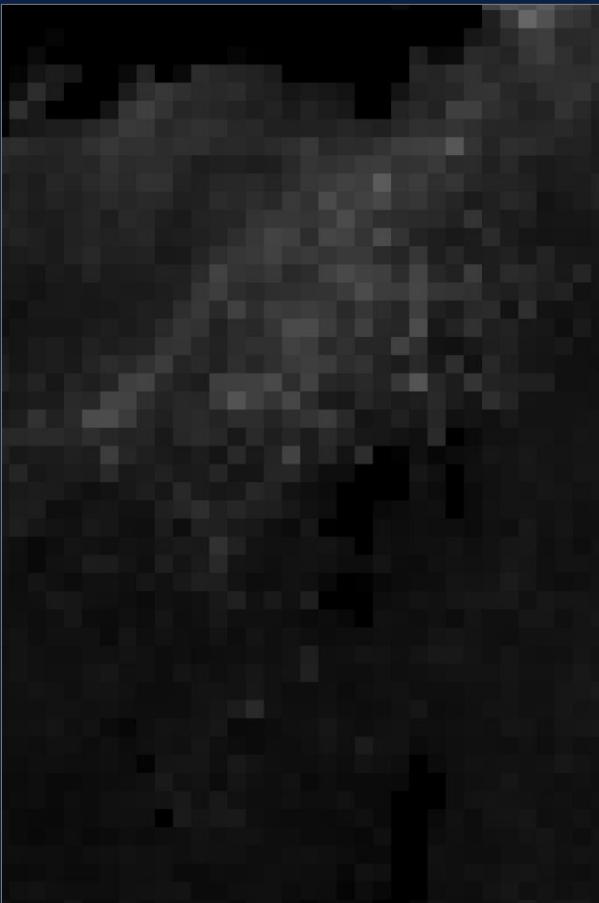
2 x 4 km

Original satellite projection (VIIRS)



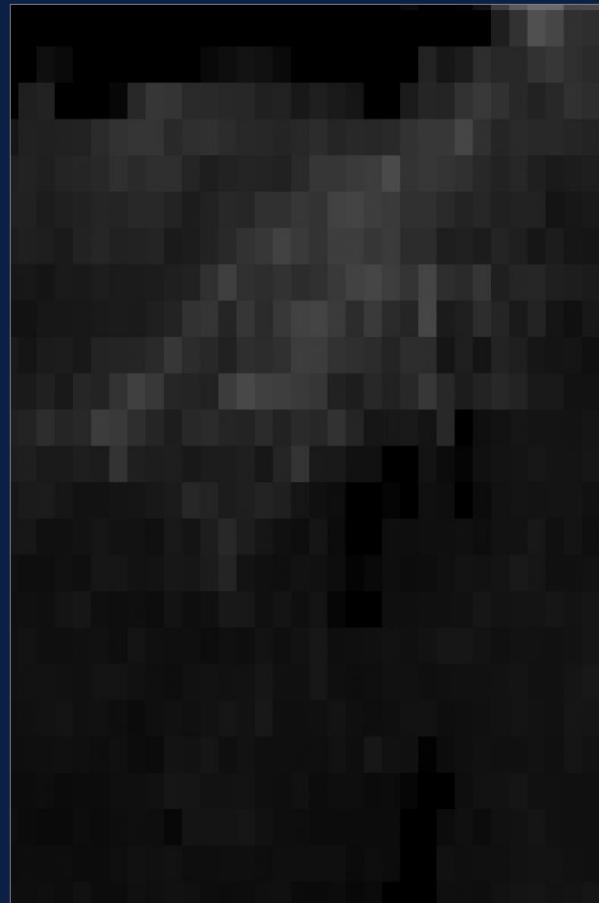
original 375 m data

MTG SEVIRI, 3 km bands – nadir view



3 x 3 km

MSG SEVIRI, 3 km bands – 50°N view



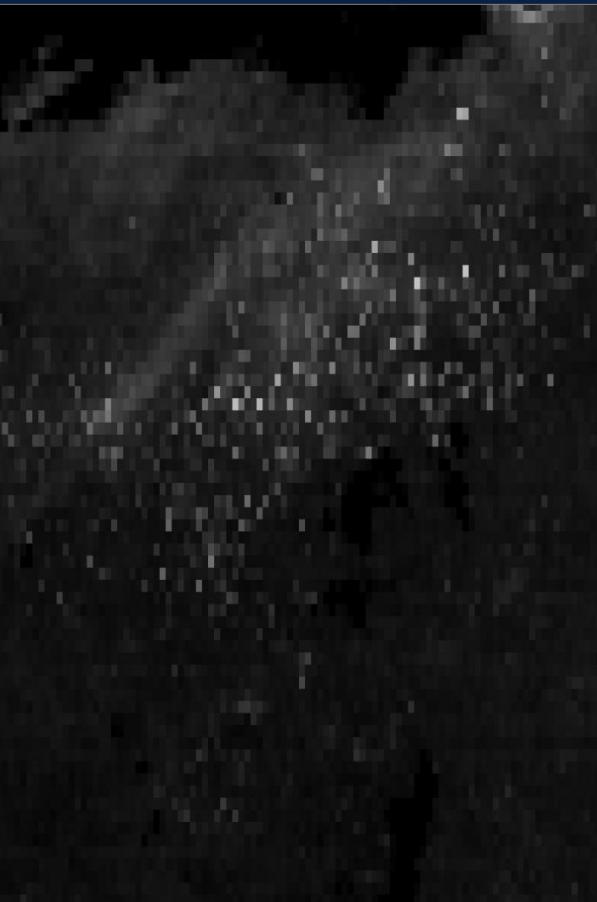
3 x 6 km

Original satellite projection (VIIRS)



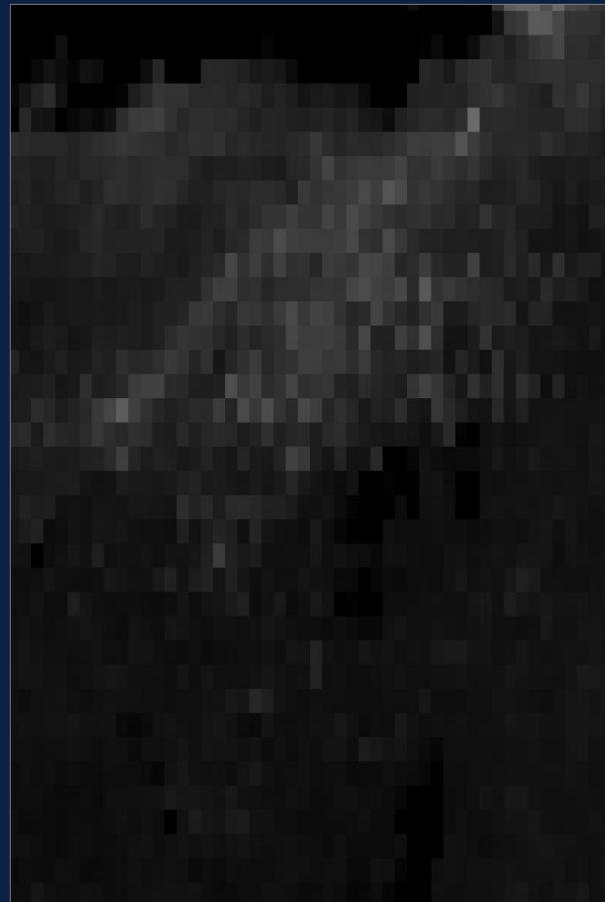
original 375 m data

MTG FCI 1 km HR bands – 50°N view



1 x 2 km

MTG FCI 2 km NR bands – 50°N view



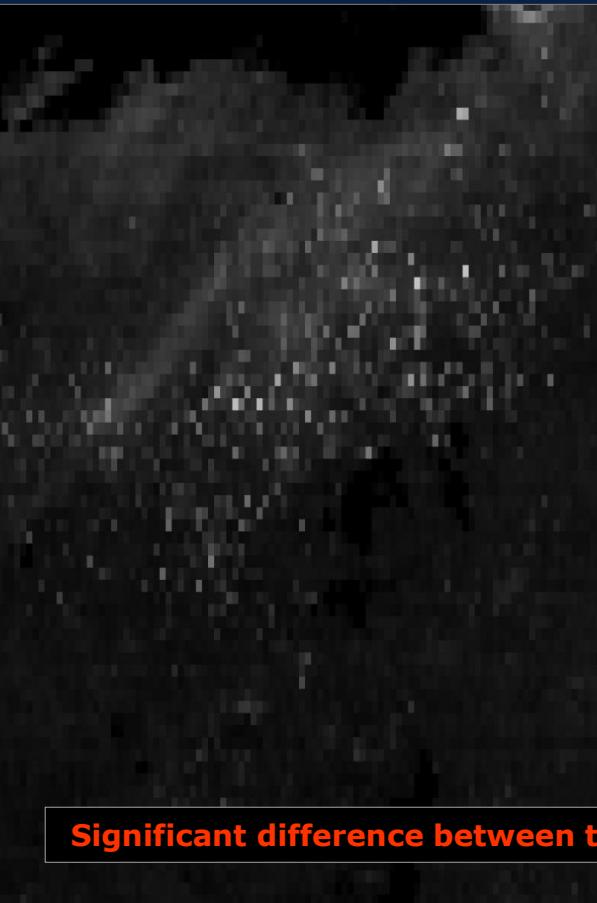
2 x 4 km

Original satellite projection (VIIRS)



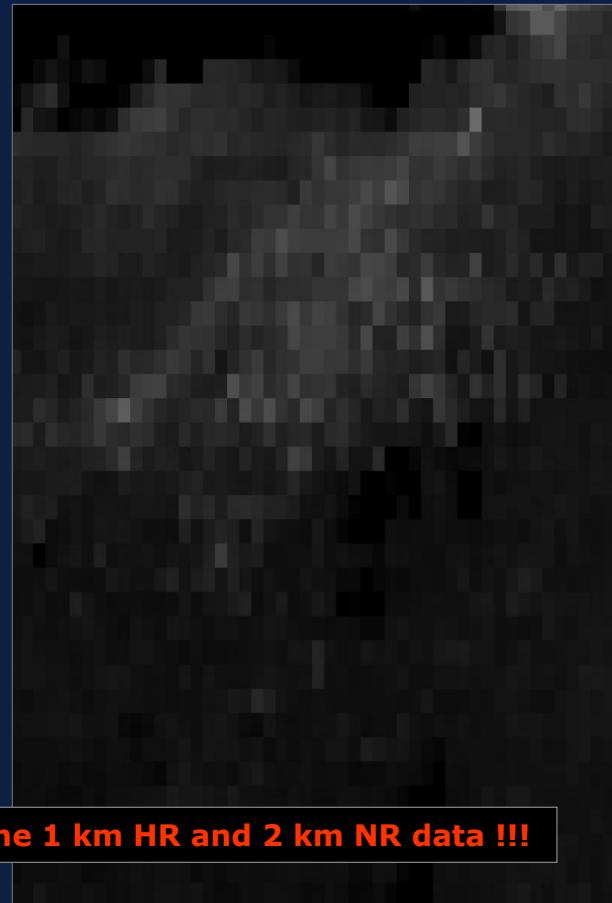
original 375 m data

MTG FCI 1 km HR bands – 50°N view



1 x 2 km

MTG FCI 2 km NR bands – 50°N view



2 x 4 km

Significant difference between the 1 km HR and 2 km NR data !!!

Summary – short and very simple:

The MTG FCI will be a significant step ahead compared to MSG SEVIRI as regards image pixel resolution.

The FCI HR bands will provide significantly better and more useful information than the corresponding FCI NR bands.

