Outline of RGB Composite Imagery

Data Processing Division, Data Processing Department
Meteorological Satellite Center (MSC)
JMA
Akihiro SHIMIZU

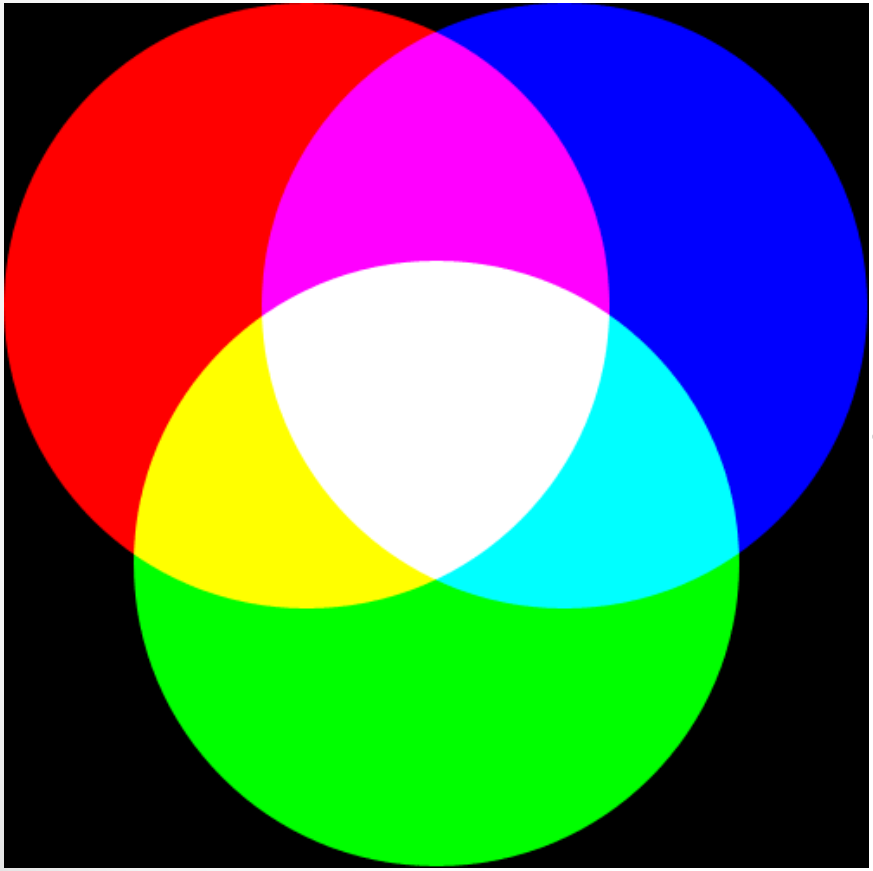
29 September, 2014
Updated 6 July, 2015

Contents

- What's RGB composite imagery?
- How to create RGB composite imagery
- RGB composite imagery presented by EUMETSAT
  - ✓ RGB composite imagery which are possible to create by traditional images of MTSAT satellites
  - ✓ RGB composite imagery which are possible to create by Himawari-8 and -9 imagery
- RGB composite imagery by Himawari-8 and -9
- Practical training to create RGB composite imagery by SATAID

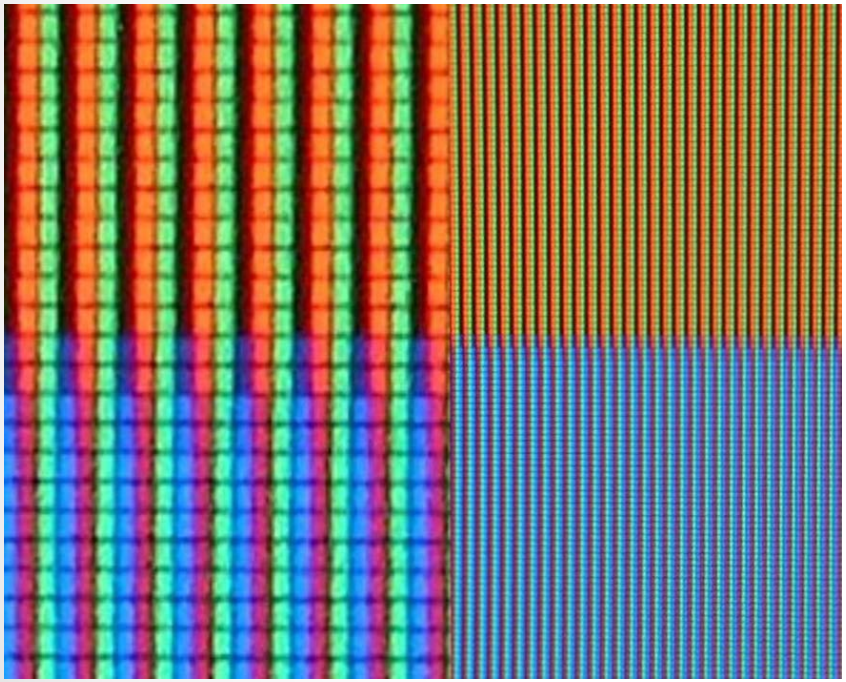
What's RGB composite imagery?

What's RGB composite imagery?

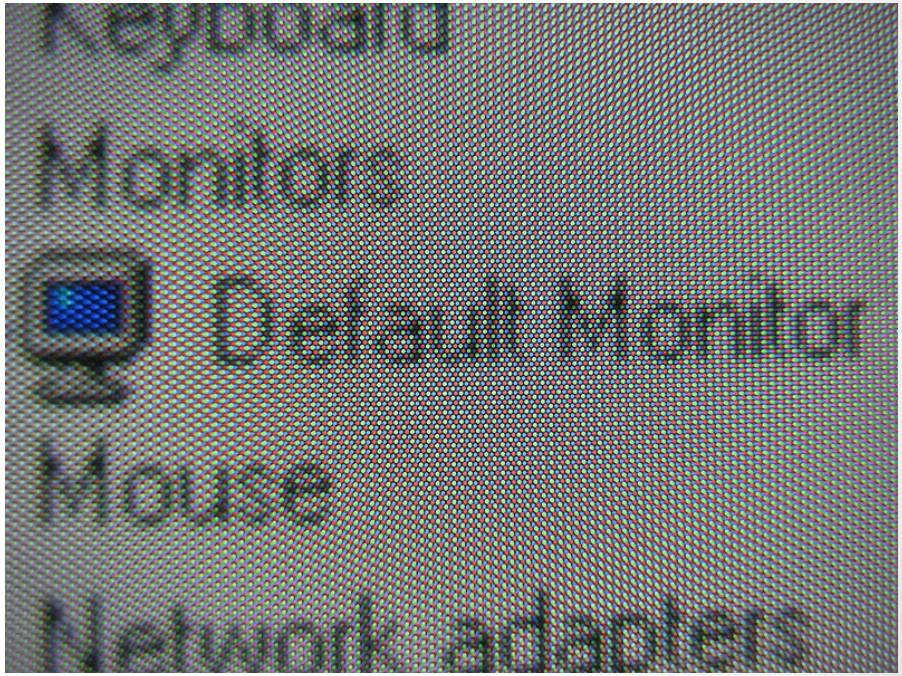


- Red (R), green (G) and blue (B) which are the three primary colors of light constitute color space expressing additive color composite
- The RGB composite imagery is a technique to display a color using this property of the three primary colors of light

What's RGB composite imagery?



RGB sub-pixels in an LCD TV



RGB phosphor dots in a CRT monitor

Ref: Wikipedia RGB color model: http://en.wikipedia.org/wiki/RGB_color_model

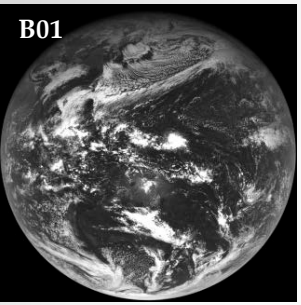
What's RGB composite imagery?
List of satellites/imagers specifications

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties	
1	0.46 µm			vegetation, aerosol **B**	Visible
2	0.51 µm			vegetation, aerosol **G**	
3	0.64 µm	0.68 µm	0.635 µm	low cloud, fog **R**	
4	0.86 µm		0.81 µm	vegetation, aerosol	Near Infrared
5	1.6 µm		1.64 µm	cloud phase	
6	2.3 µm			particle size	
7	3.9 µm	3.7 µm	3.92 µm	low cloud, fog, forest fire	Infrared
8	6.2 µm	6.8 µm	6.25 µm	mid- and upper level moisture	
9	6.9 µm			mid- level moisture	
10	7.3 µm		7.35 µm	mid- and lower level moisture	
11	8.6 µm		8.70 µm	cloud phase, SO2	
12	9.6 µm		9.66 µm	ozone content	
13	10.4 µm	10.8 µm	10.8 µm	cloud imagery, information of cloud top	
14	11.2 µm			cloud imagery, sea surface temperature	
15	12.4 µm	12.0 µm	12.0 µm	cloud imagery, sea surface temperature	
16	13.3 µm		13.4 µm	cloud top height	

There are different properties in each channel, as shown in the left figure.

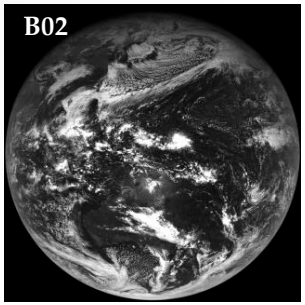
What's RGB composite imagery?

16 bands Images by Himawari-8/AHI



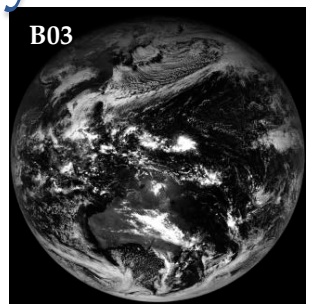
B01:
0.46 μm
Visible

Vegetation, aerosol



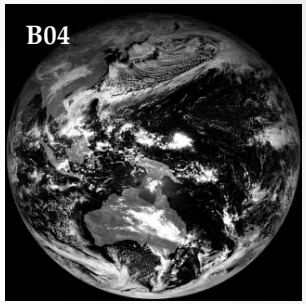
B02:
0.51 μm
Visible

Vegetation, aerosol



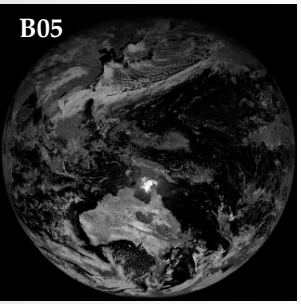
B03:
0.64 μm
Visible

Low cloud, fog



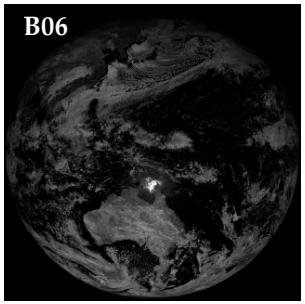
B04:
0.86 μm
Near infrared

Vegetation, aerosol



B05:
1.6 μm
Near infrared

Cloud phase

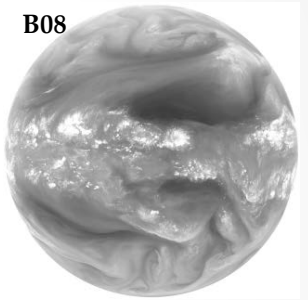


B06:
2.3 μm
Near infrared

Particle size

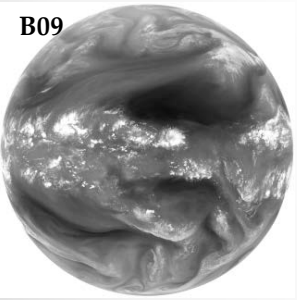
B07:
3.9 μm
Infrared

Low cloud, fog, forest fire



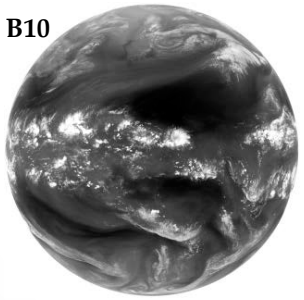
B08:
6.2 μm
Infrared

Mid- and upper level moisture



B09:
6.9 μm
Infrared

Mid level moisture



B10:
7.3 μm
Infrared

Mid- and lower level moisture

B11:
8.6 μm
Infrared

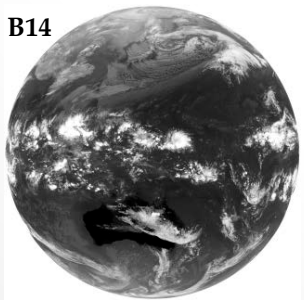
Cloud phase, SO2

B12:
9.6 μm
Infrared

Ozone content

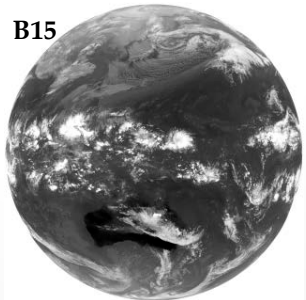
B13:
10.4 μm
Infrared

Cloud imagery, information of cloud top



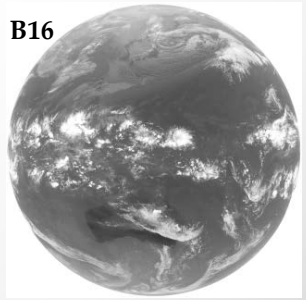
B14:
11.2 μm
Infrared

cloud imagery, sea surface temperature



B15:
12.4 μm
Infrared

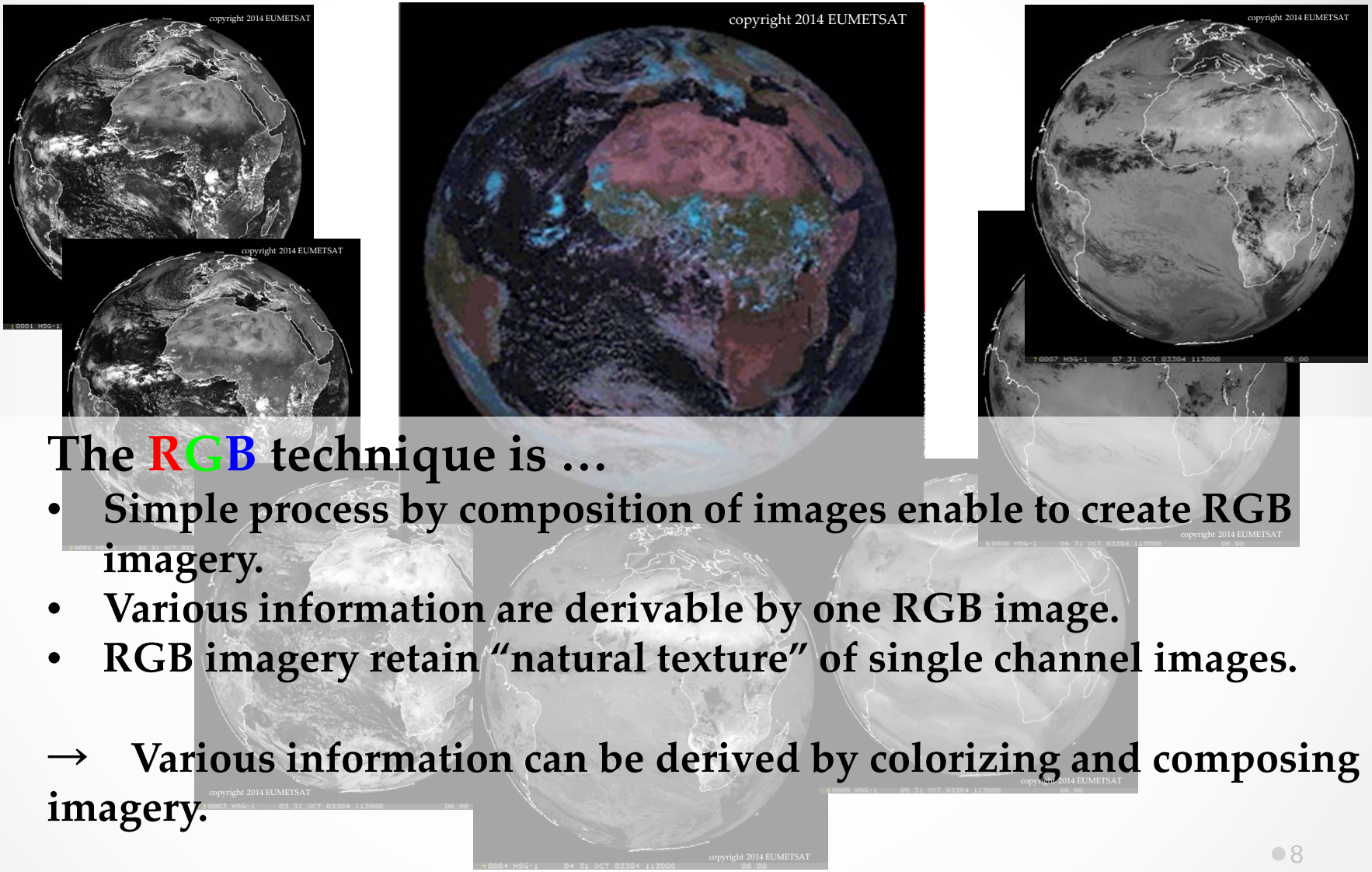
Cloud imagery, sea surface temperature



B16:
13.3 μm
Infrared

Cloud top height

There are too many channels!



The RGB technique is …

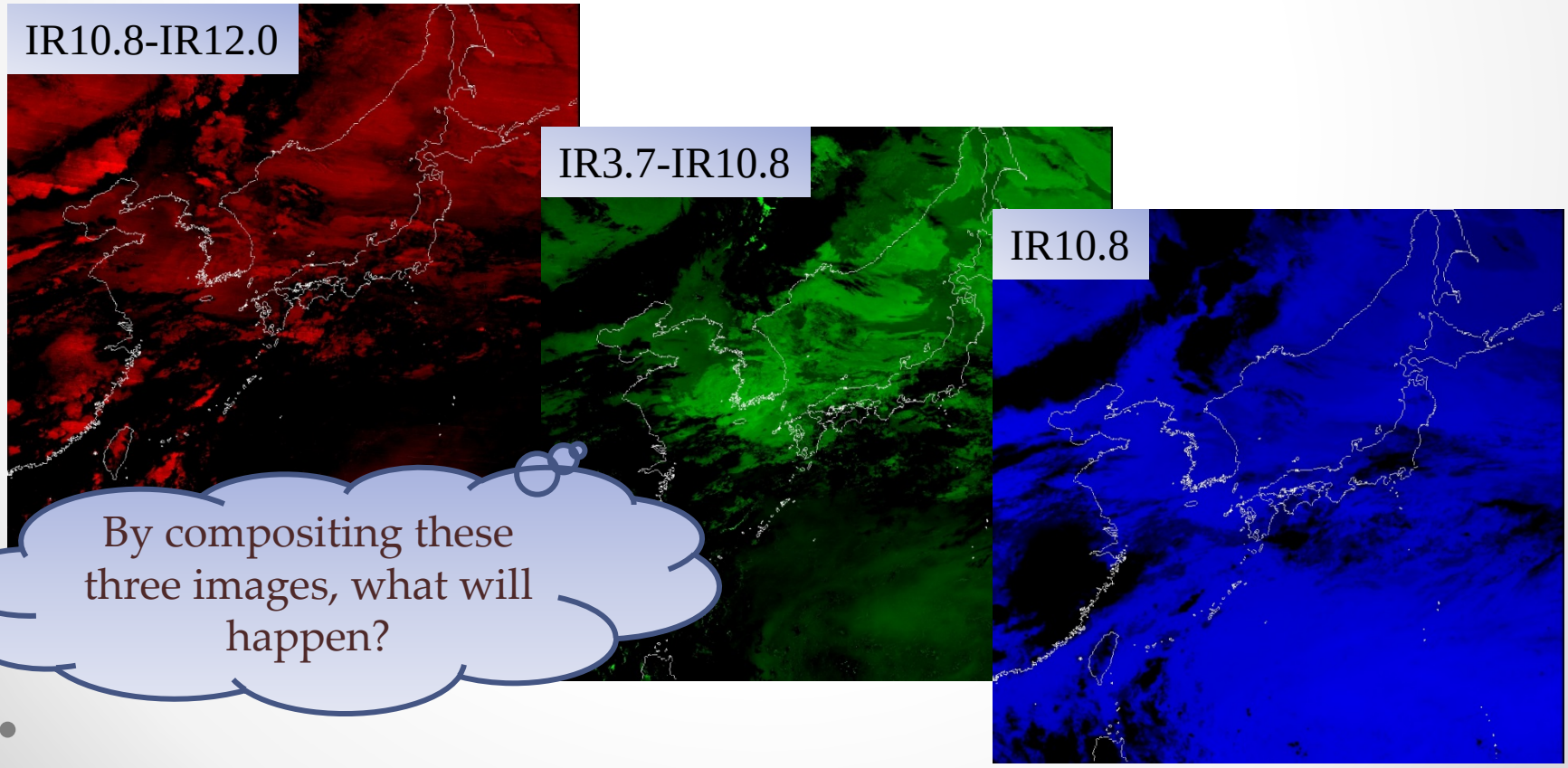
- **Simple process by composition of images enable to create RGB imagery.**
- **Various information are derivable by one RGB image.**
- **RGB imagery retain "natural texture" of single channel images.**

→ Various information can be derived by colorizing and composing imagery.

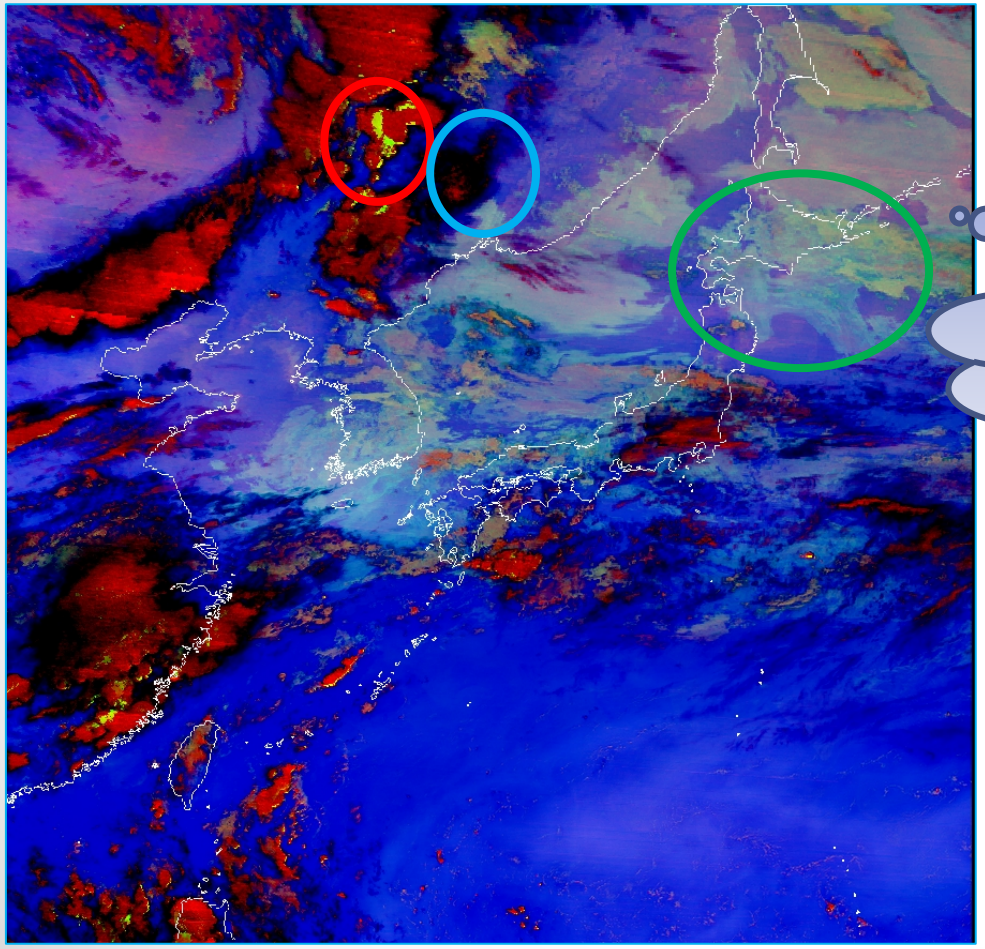
How to create RGB composite imagery

How to create RGB composite imagery

- RGB composite imagery can be displayed by three individual colorized (red, blue or green) images of 2 or 3 channels (or channel differences) and by composing them.



How to create RGB composite imagery



- Hereby a RGB image is created.

Information can be derived from coloration by overlapping plural images.

In this example,

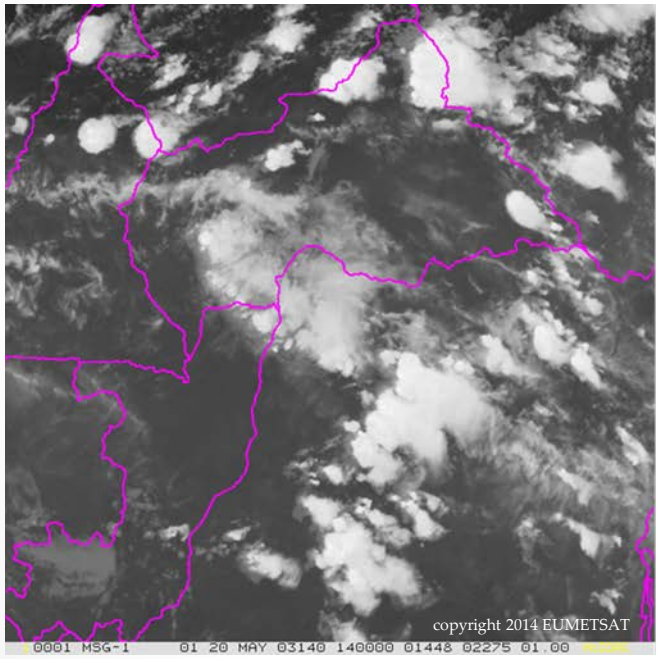
low cloud or fog, thin high cloud and thick Cb cloud etc.

How to create RGB composite imagery

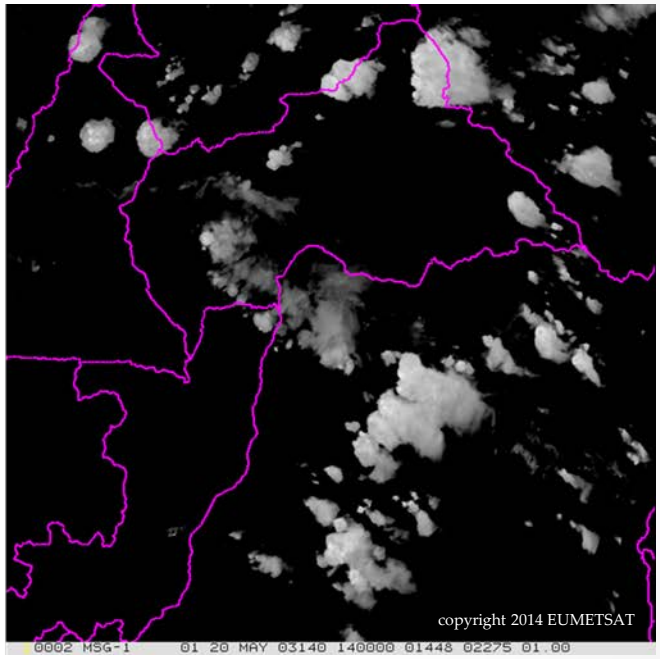
- Adjustment of gradation
  - For extracting and enhancing specific phenomenon
  - Requirement to adjust visual aspects when compositing images
  - The visual aspects of RGB composite imagery are manipulated by adjusting “gradation (gray-scale) range” and “gamma correction”

How to create RGB composite imagery

- Example of gradation (gray-scale) adjustment (emphasis on "Cb")



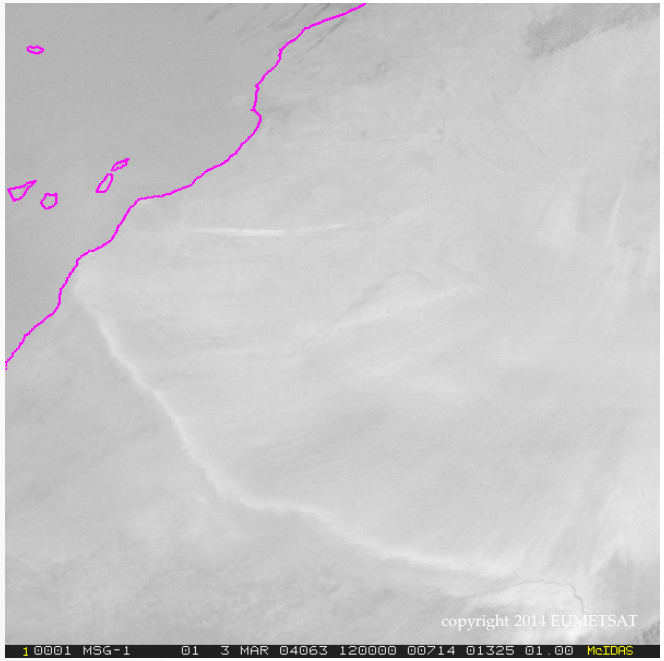
IR10.8
Range : 180～340K
Gamma: 1



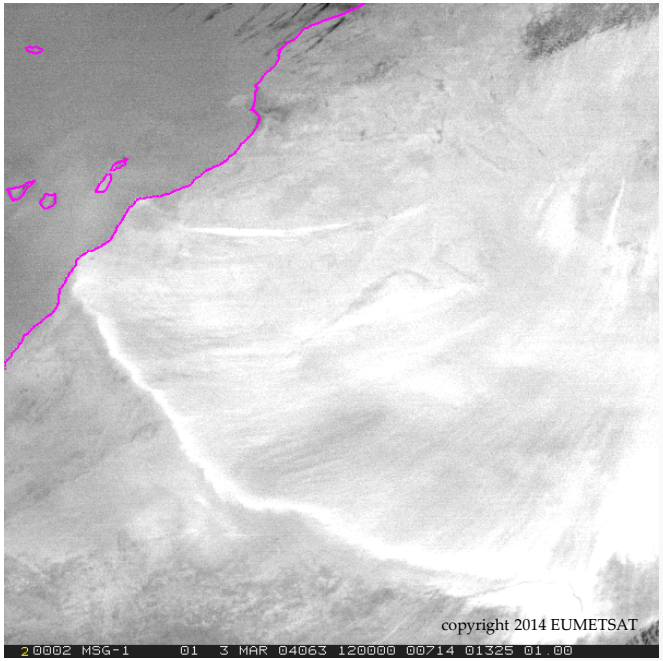
IR10.8
Range : 180～233K
Gamma : 1

How to create RGB composite imagery

- Example of gradation (gray-scale) adjustment (emphasis on "dust")



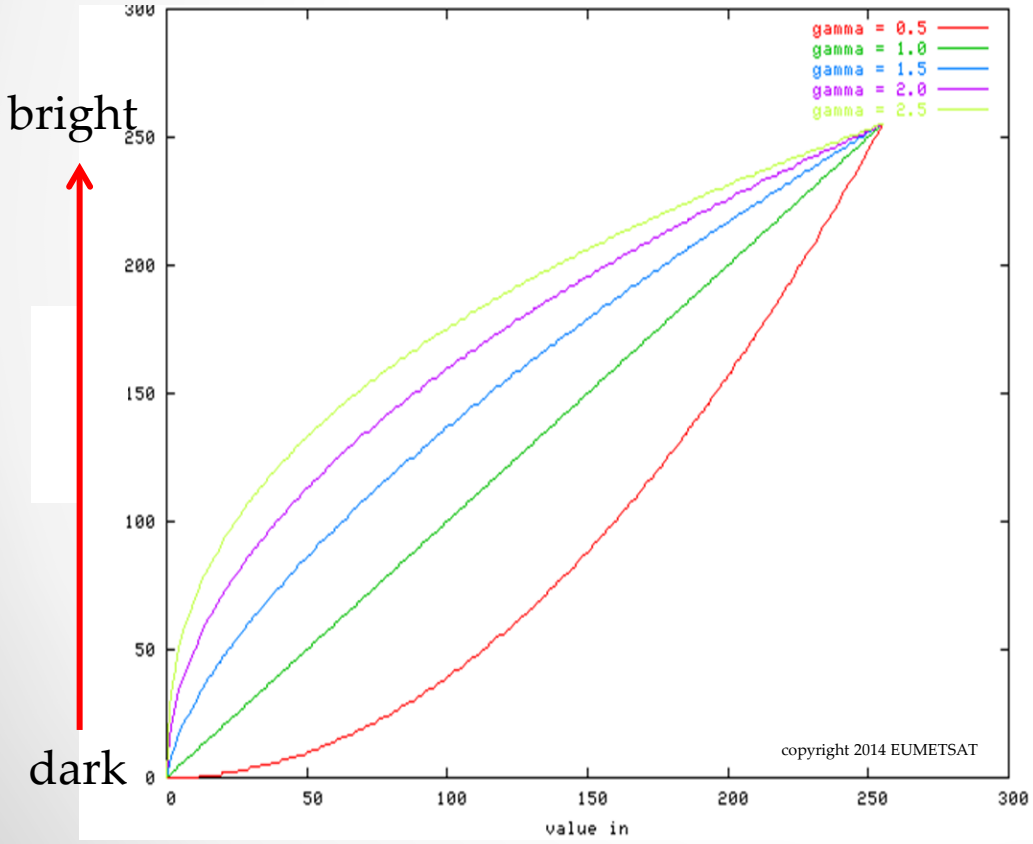
IR12.0-IR10.8
Range : -15～5K
Gamma : 1



IR12.0-IR10.8
Range : -4～2K
Gamma : 1

How to create RGB composite imagery

- Gradation (gray-scale) vs gamma value



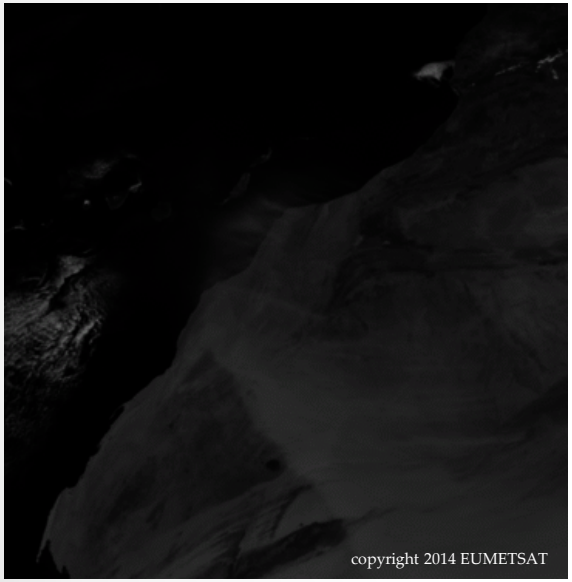
Mapping function for different gamma corrections with calibration of 0 – 255 (8 bit)

It's not easy to imagine this concept.

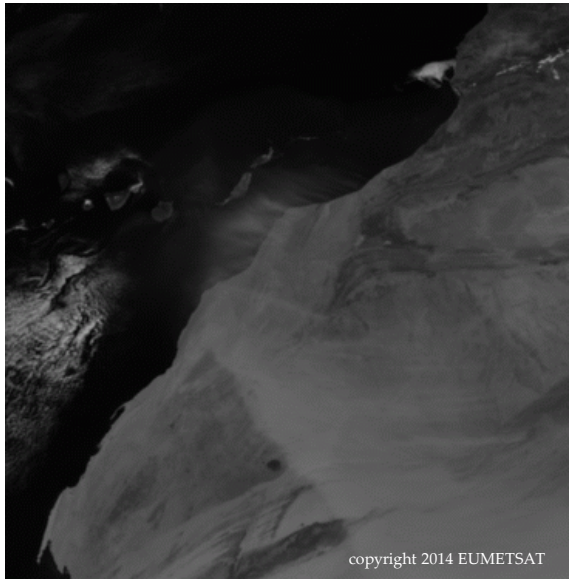
Let's move on to the next slide!

How to create RGB composite imagery

- Examples of gradation (gray-scale) adjustment (emphasis on “land”)



VIS0.6
Range : 0～100%
Gamma : 0.5



VIS0.6
Range : 0～100%
Gamma : 1.0

VIS0.6
Range : 0～100%
Gamma : 2.0

RGB composite imagery presented by EUMETSAT …

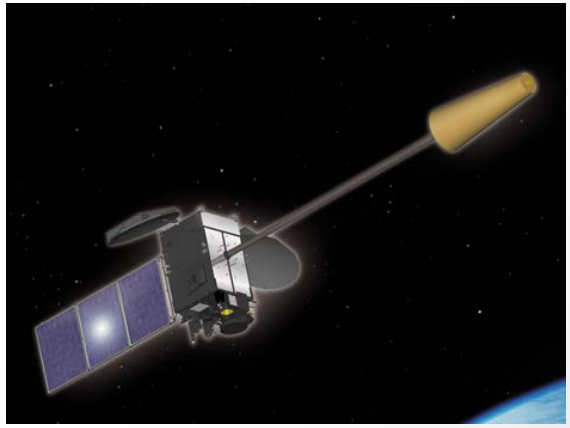
RGB composite imagery presented by EUMETSAT

- RGB composite imagery which are possible to create by traditional images of MTSAT satellites
  - Limited combinations by VIS • IR10.8 • IR12.0 • IR6.8 • IR3.7

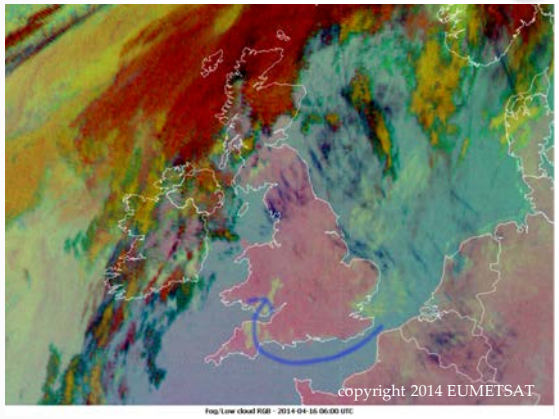
- RGB composite imagery which will be possible to create by Himawari-8 and -9 imagery
  - Various combinations are covered almost all RGB composite imagery schemes presented by EUMETSAT

→ Let's see some examples on the following slide!

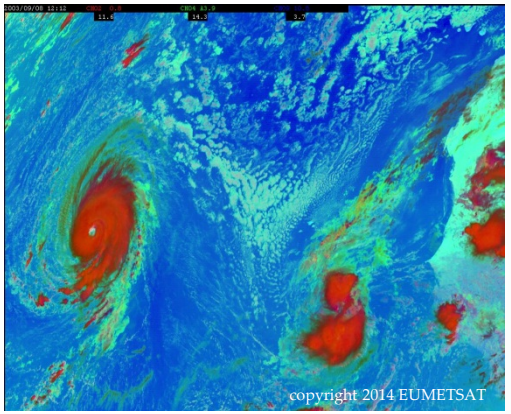
RGB composite imagery
which are possible to create by
traditional images of MTSAT satellites



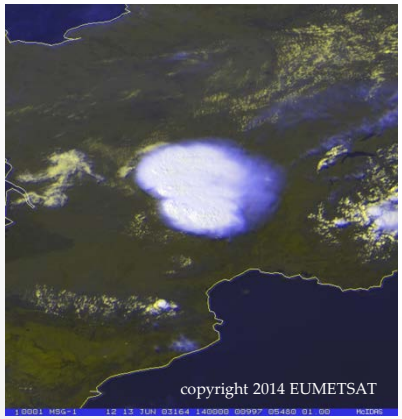
RGB composite imagery which are possible to create by traditional images of MTSAT satellites



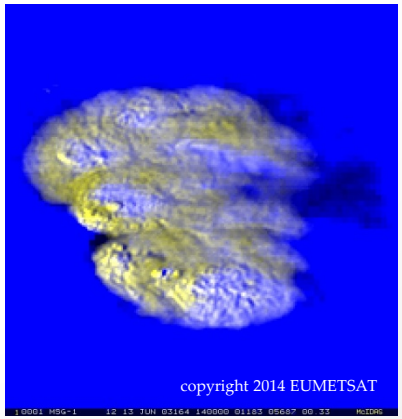
Night Microphysics



Day Microphysics



Clouds Convection



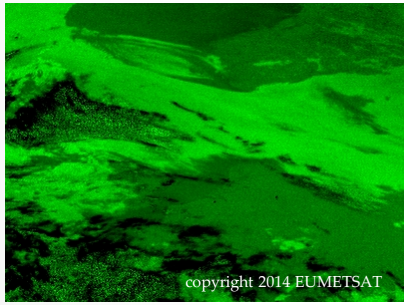
Severe Storms

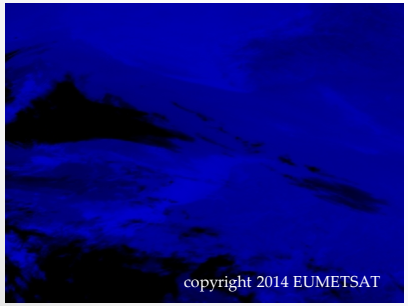
Night Microphysics (for night-time cloud analysis)

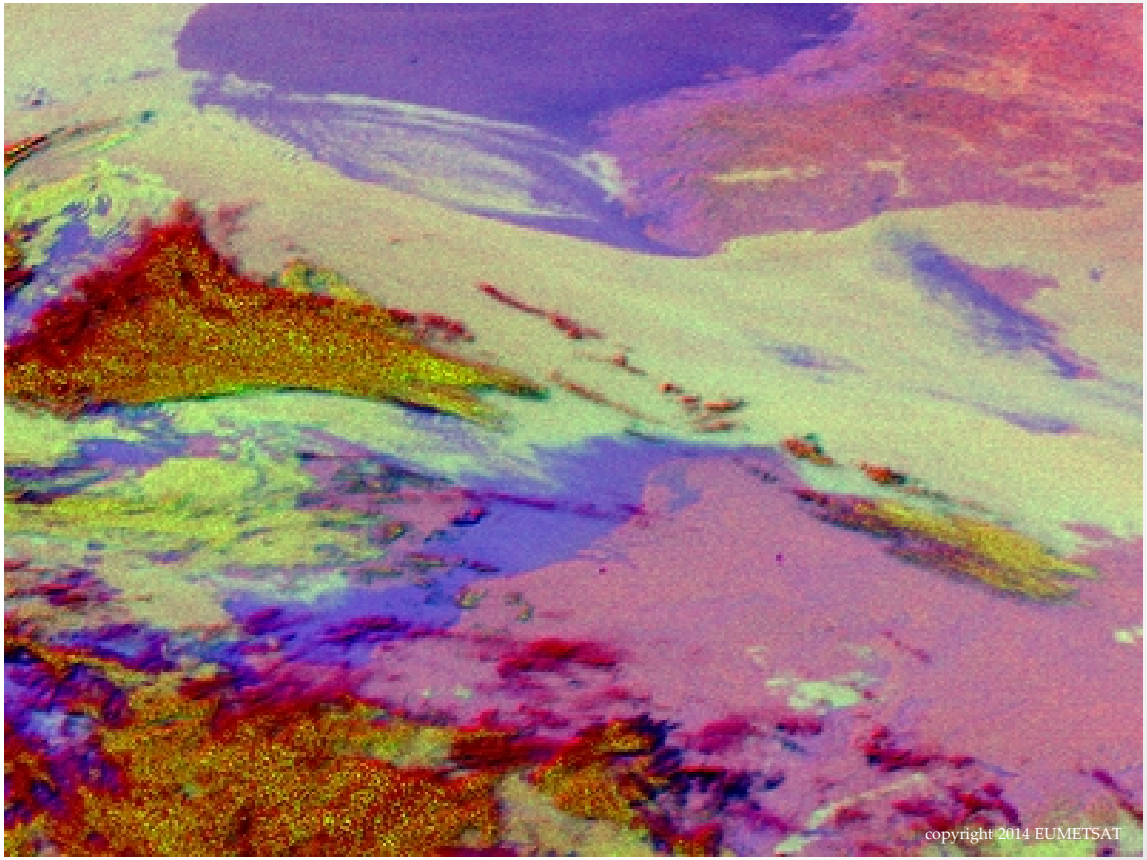
- R : IR12.0 – IR10.8
  Range : -4～2 [K]　Gamma : 1.0
- G : IR10.8 – IR3.9
  Range : 0～10[K]　Gamma : 1.0
- B : IR10.8
  Range : 243～293[K]　Gamma : 1.0

- Applications
  - night-time cloud analysis
  - Fog/low cloud distinction for night-time

Night Microphysics

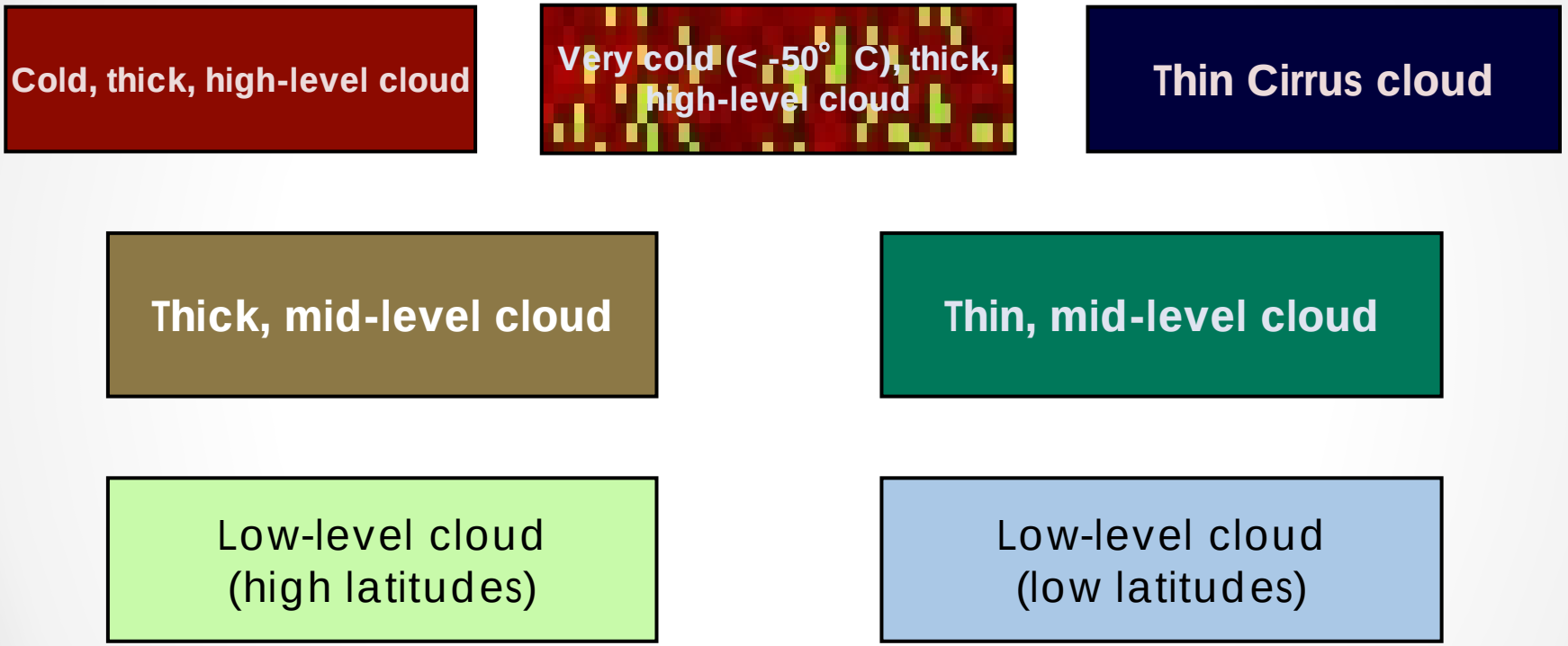




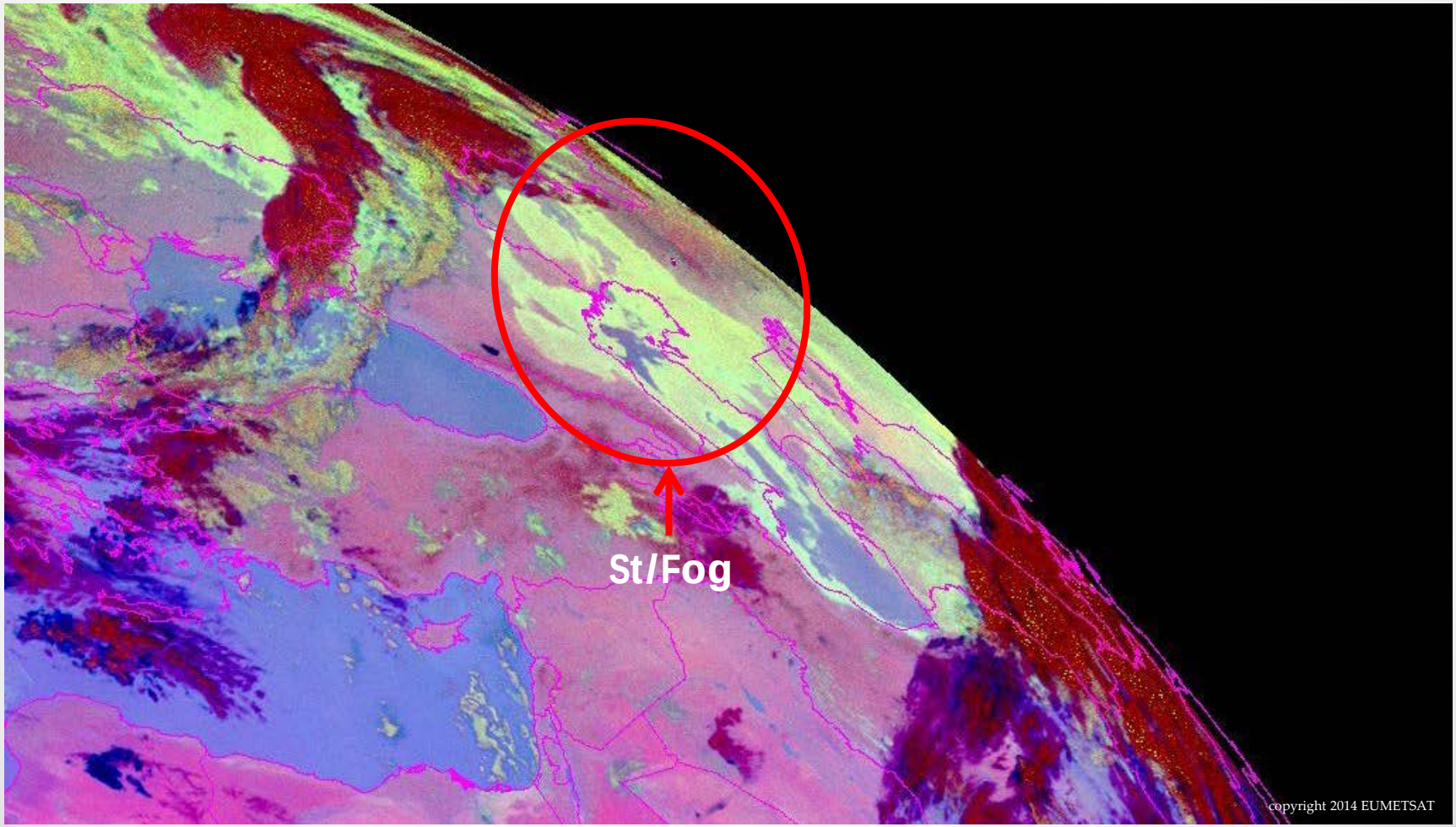


MSG 2003/11/9 02:45UTC

Interpretation of Colors for "Night Microphysics"

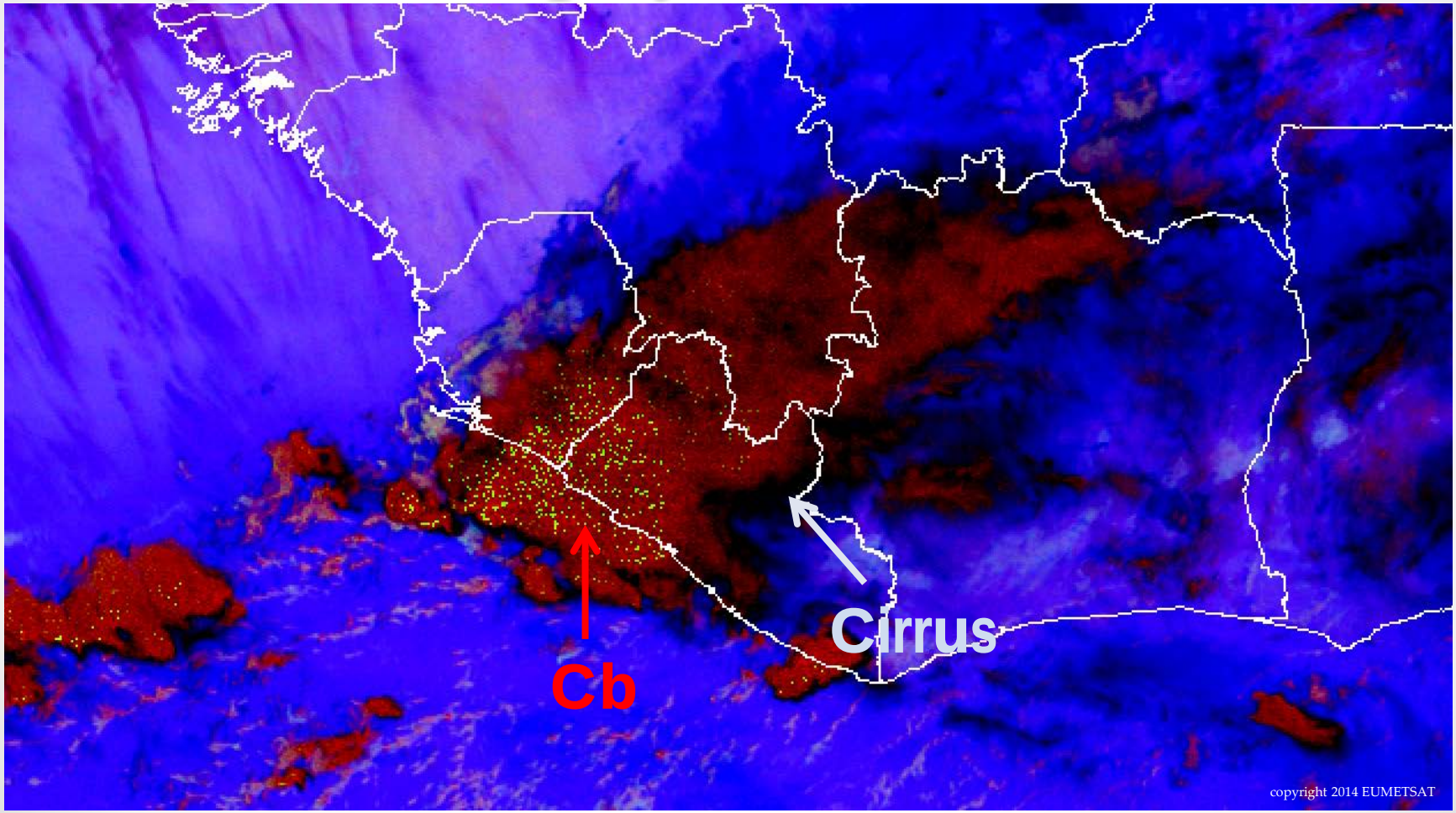


Night Microphysics（St/Fog）



MSG 2005/3/14 00:00UTC

Night Microphysics（Cb/Cirrus）



MSG 2005/4/19 03:15UTC

Night Microphysics (summary)

This RGB scheme is …

- effective for low cloud distinction in night time (especially St/Fog)
- effective for thick Cb cloud distinction in night time
- viewable by SATAID (the details will follow later)
- available on MSC website for the Southeast Asia and the South Pacific Islands in real time

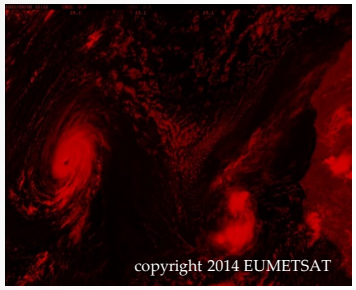
  → the web site is here!

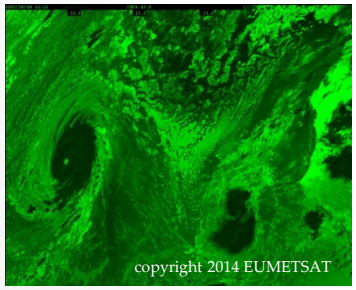
Day Microphysics (for day-time cloud analysis)

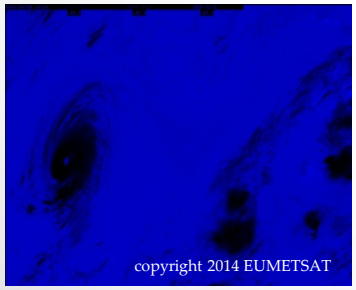
- R : VIS0.8
  Range : 0～100 [%]　Gamma : 1.0
- G : IR3.9 Solar reflectance component
  Range : 0～60[%]　Gamma : 2.5　(summer)
  Range : 0～25[%]　Gamma : 1.5　(winter)
- B : IR10.8
  Range : 203～323[K]　Gamma : 1.0

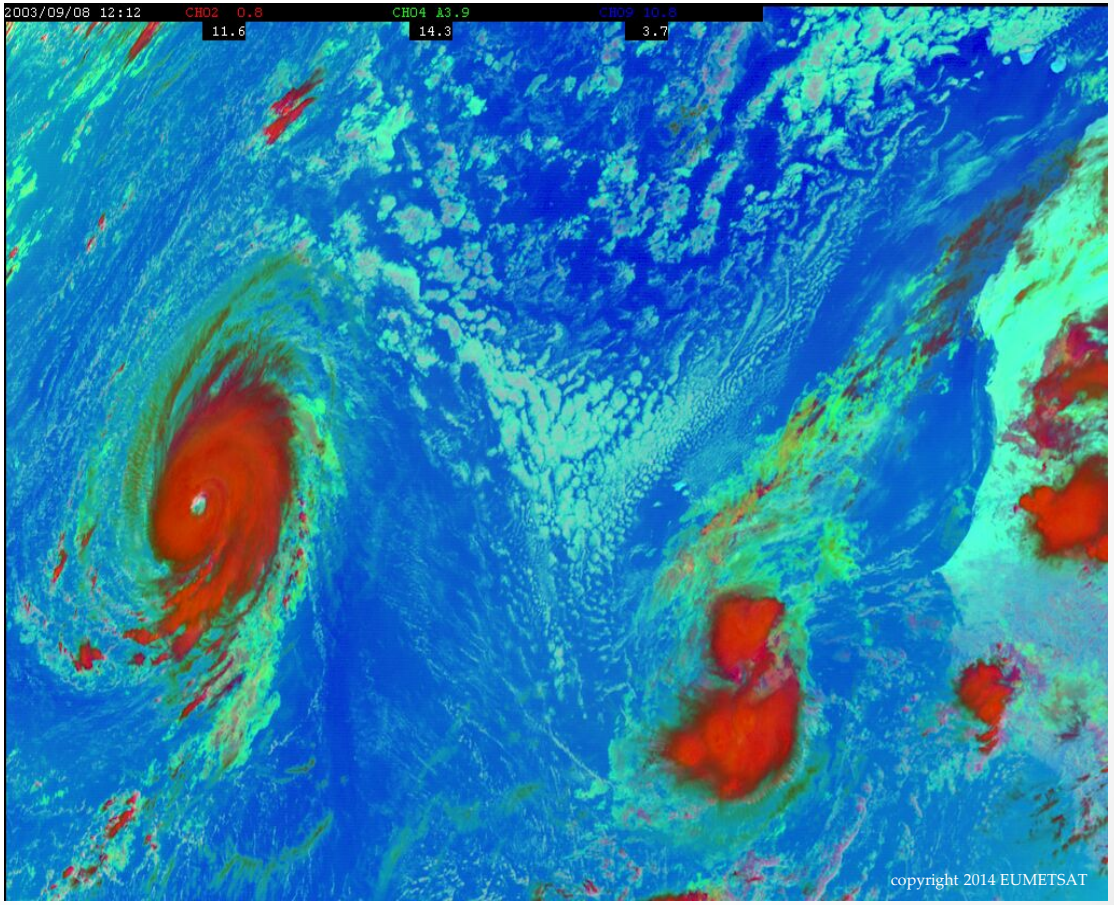
- Applications
  - Day-time cloud analysis
  - Convective cloud with strong updrafts
  - Vegetation
  - Fire (hot spot)

Day Microphysics
(for day-time cloud analysis)









MSG 2003/9/8 12:00UTC

Interpretation of Colors for "Day Microphysics"

Deep precipitating cloud (precip. not necessarily reaching the ground) - Bright, thick - Large ice particles - Cold cloud	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - Bright, thick - Small ice particles - Cold cloud *or thick, high-level lee cloudiness with small ice particles	Thin Cirrus cloud (Large ice particles)	Thin Cirrus cloud (Small ice particles)

Ocean	Vegetation	Fires(Hot Spot) /Desert	Snow

Interpretation of Colors for "Day Microphysics"

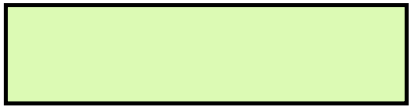
Supercooled, thick water cloud
- Bright, thick
- Large droplets

Supercooled, thick water cloud
- Bright, thick
- Small droplets

Supercooled thin water cloud
- Large droplets

Supercooled, thin water cloud
- Small droplets

Thick water cloud (warm rain cloud)
- Bright, thick
- Large droplets

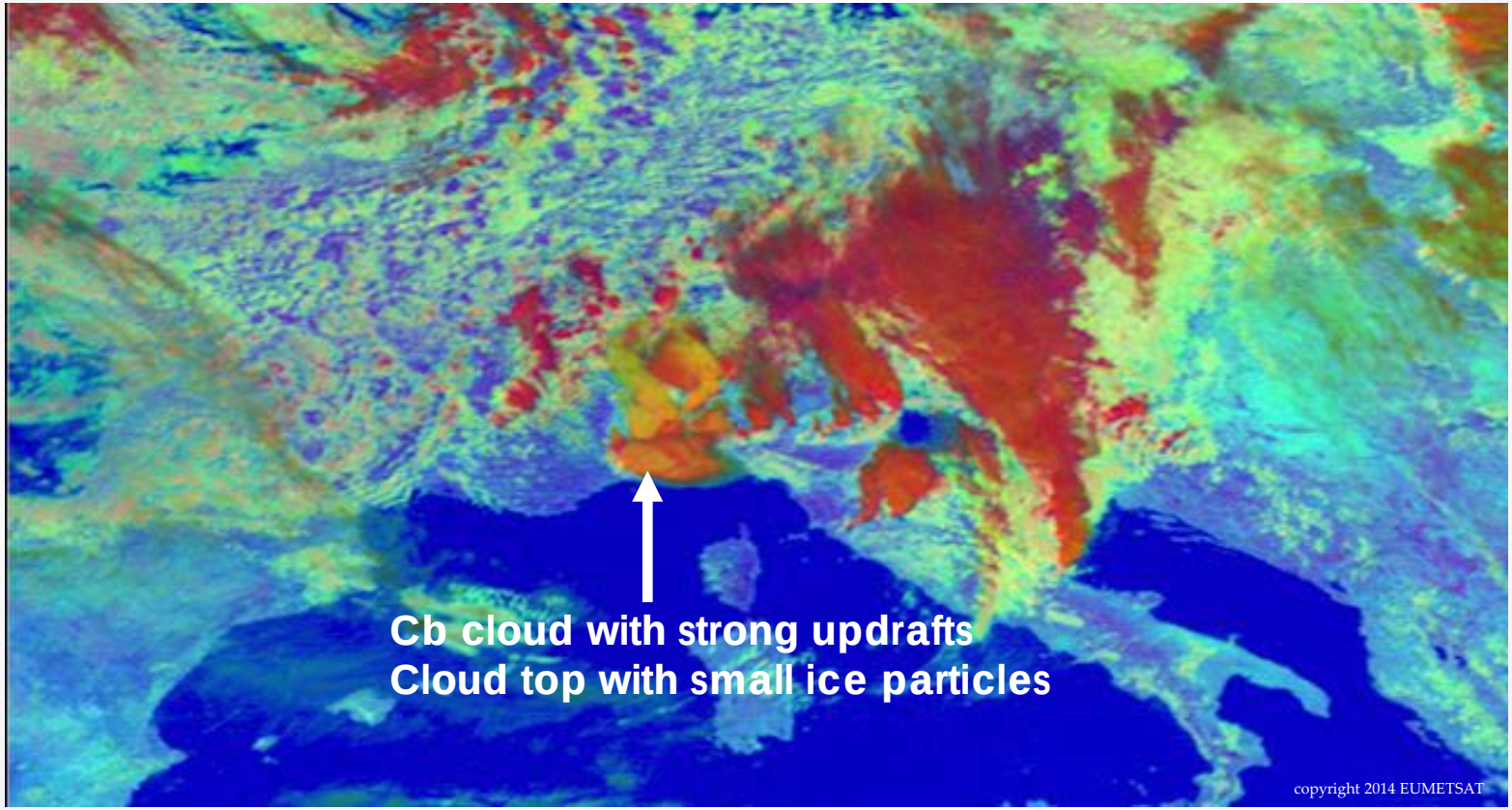


Thick water cloud (no precipitation)
- Bright, thick
- Small droplets

Thin water cloud
- Large droplets

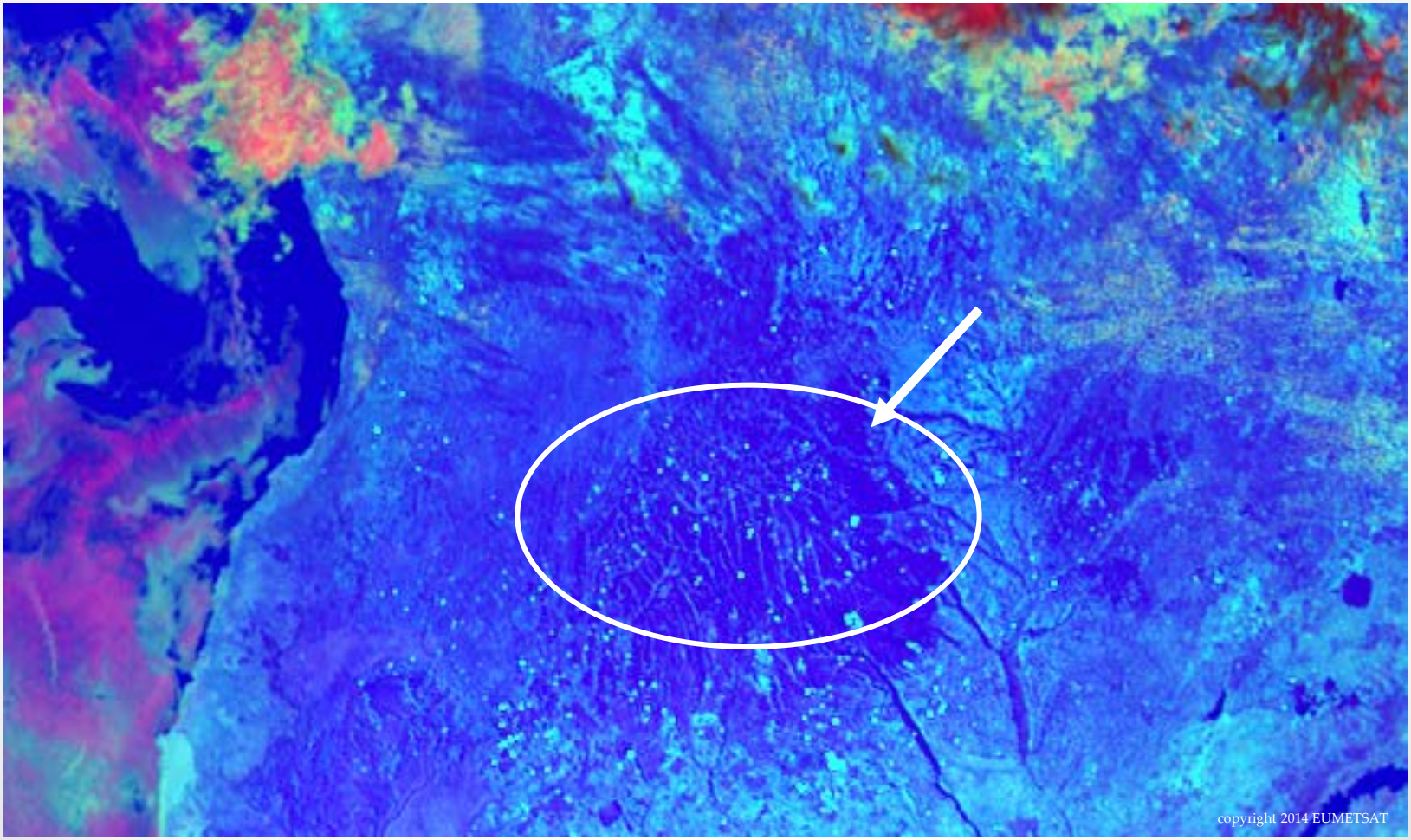
Thin water cloud
- Small droplets

Day Microphysics (Severe Convection)



MSG 2003/5/20 13:30UTC

Day Microphysics（Fires）



MSG 2003/9/7 11:45UTC

Day Microphysics (summary)

This RGB scheme is …

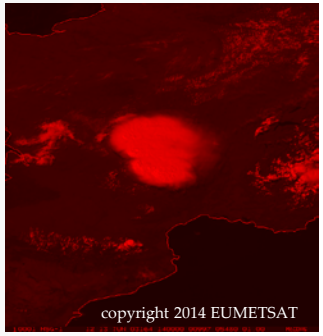
- effective for convective cloud distinction in day time (especially particle size distinction in rough)
- effective to distinguish the distribution of fires
- so far, unavailable for SATAID, because this includes the solar reflectance component

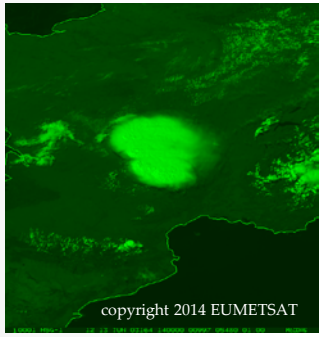
Clouds Convection

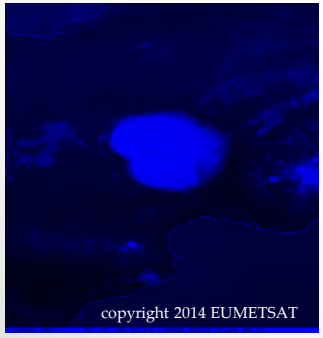
- R : VIS0.8
  Range : 0～100 [%]　Gamma : 1.0
- G : VIS0.8
  Range : 0～100 [%]　Gamma : 1.0
- B : IR10.8
  Range : 323～203 [K]　Gamma : 1.0

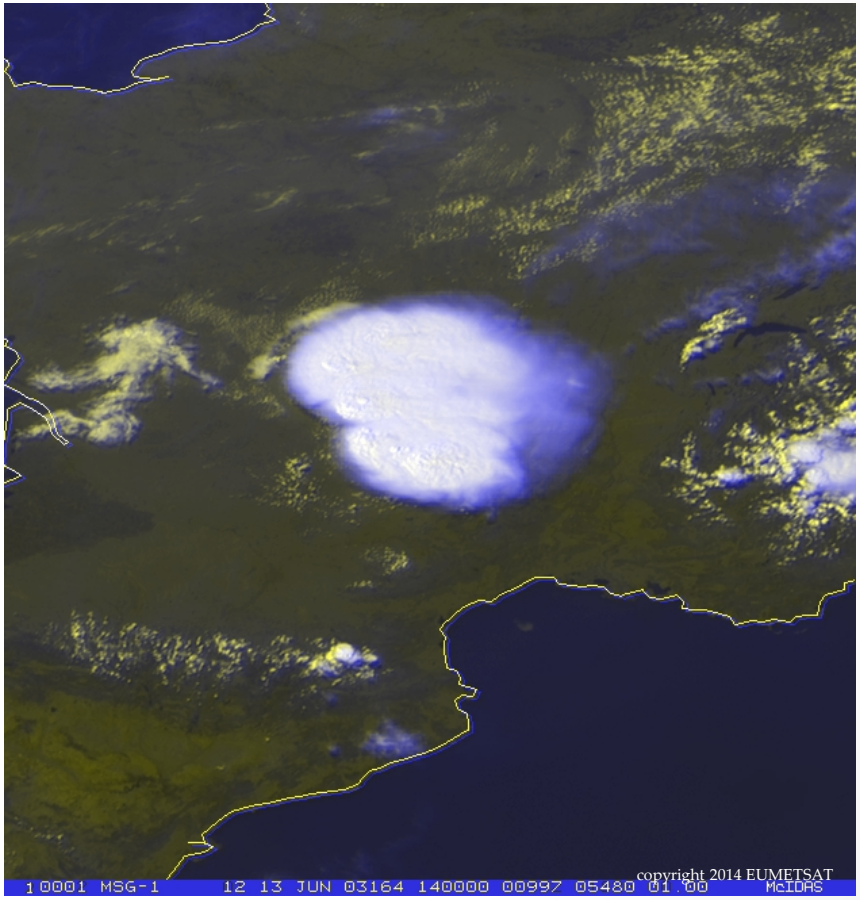
- Applications
  - Day-time cloud analysis
  - Convective cloud distinction

Clouds Convection



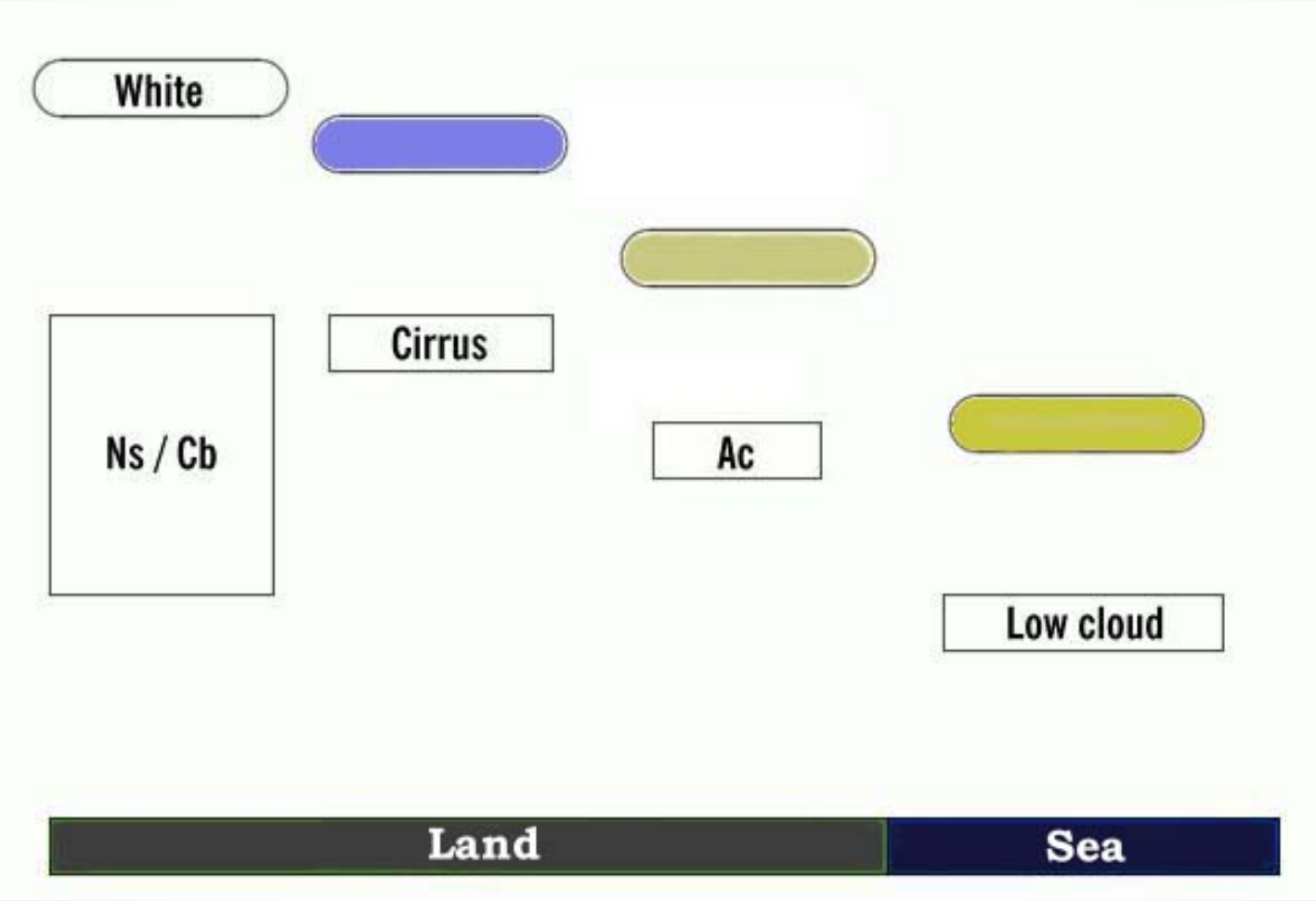




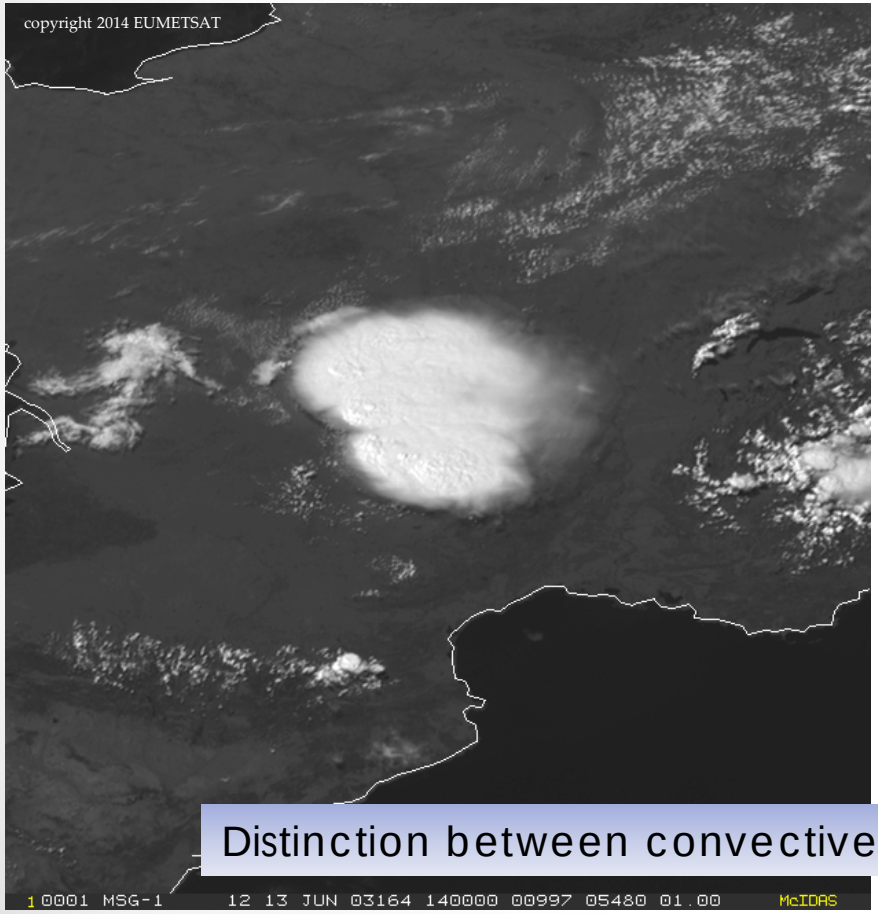


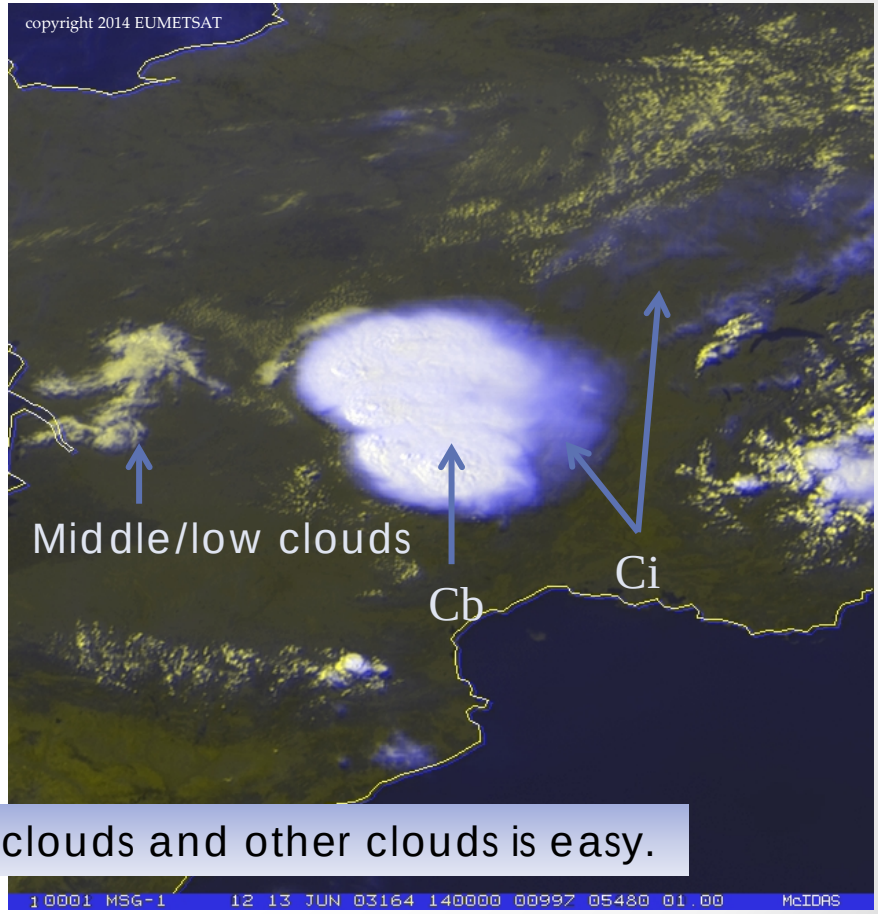
MSG 2003/6/12 14:00UTC

Interpretation of Colors for "Clouds Convection"



Clouds Convection vs. VIS





Distinction between convective clouds and other clouds is easy.

VIS

RGB

Clouds Convection (summary)

This RGB scheme …

- makes easy to distinguish clouds even in case that the distinction is difficult by switching individual IR and VIS imagery
- is viewable by SATAID (the details will follow later)
- is being used by relevant aviation office

Severe Storms

- R : VIS0.8

  Range : 0～100 [%]　Gamma : 1.0

- G : VIS0.8

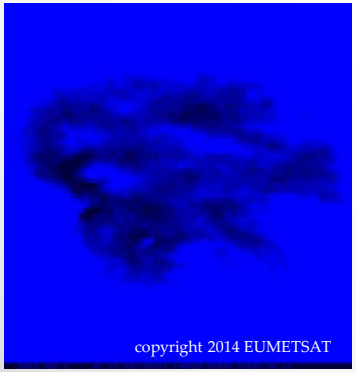
  Range : 0～100 [%]　Gamma : 1.0

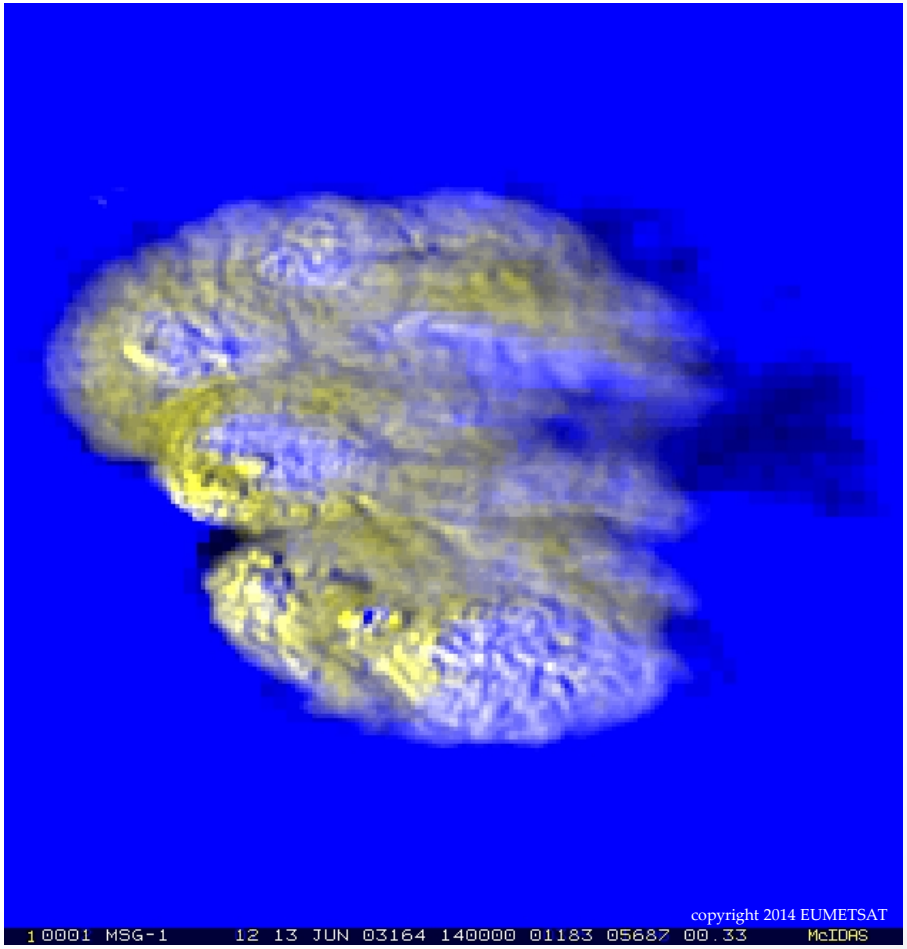
- B : IR10.8-IR3.9

  Range : -60～-40 [K]　Gamma : 2.0

- Applications
  - distinction for severe convection

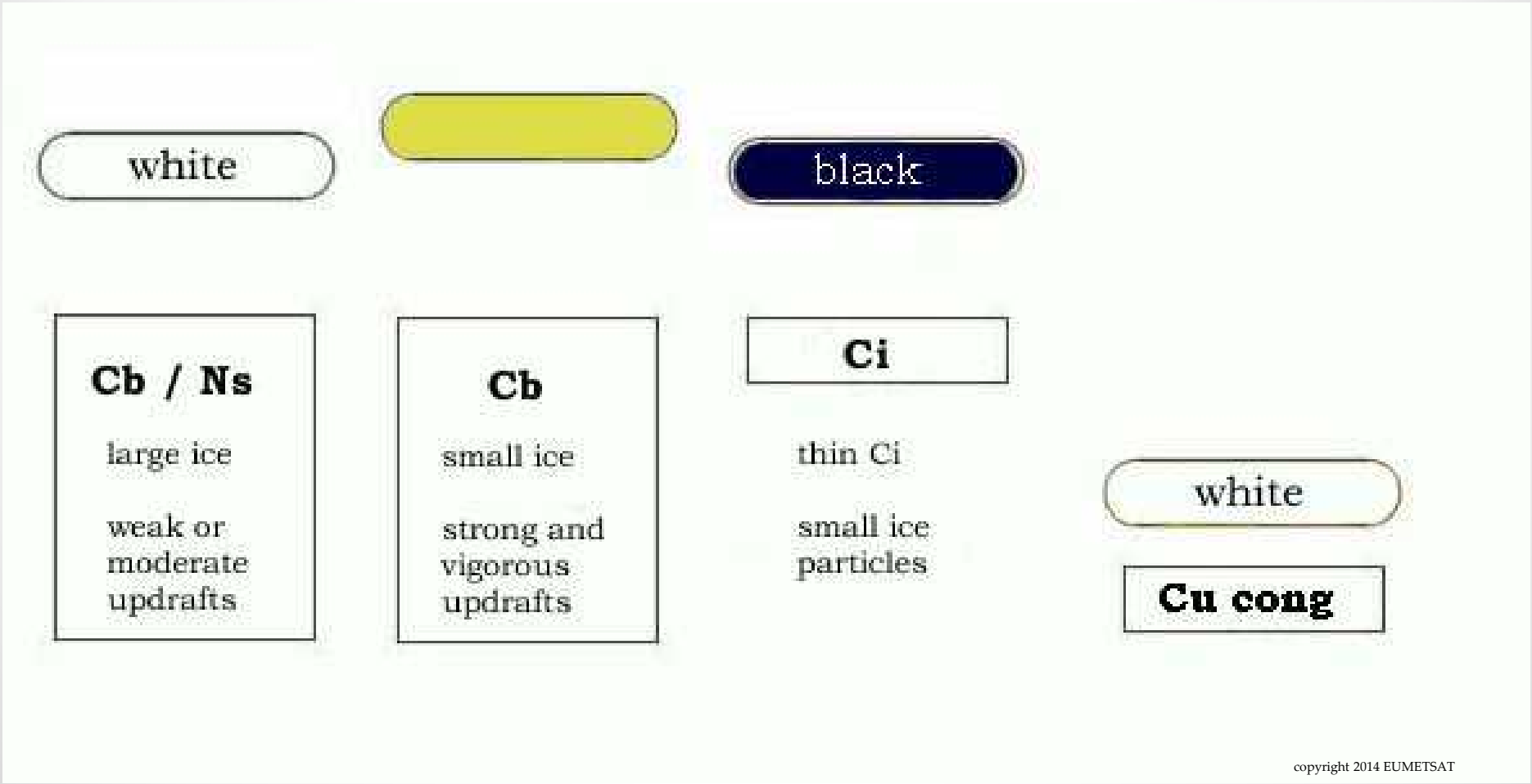
Severe Storms



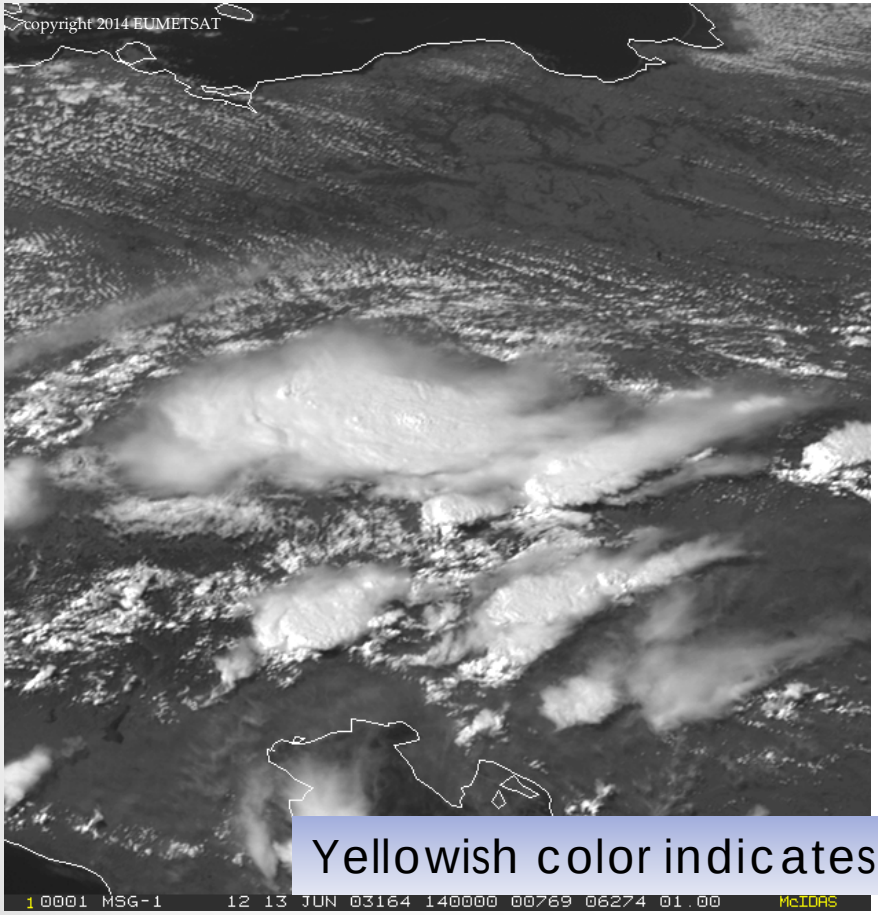


MSG 2003/6/12 14:00UTC

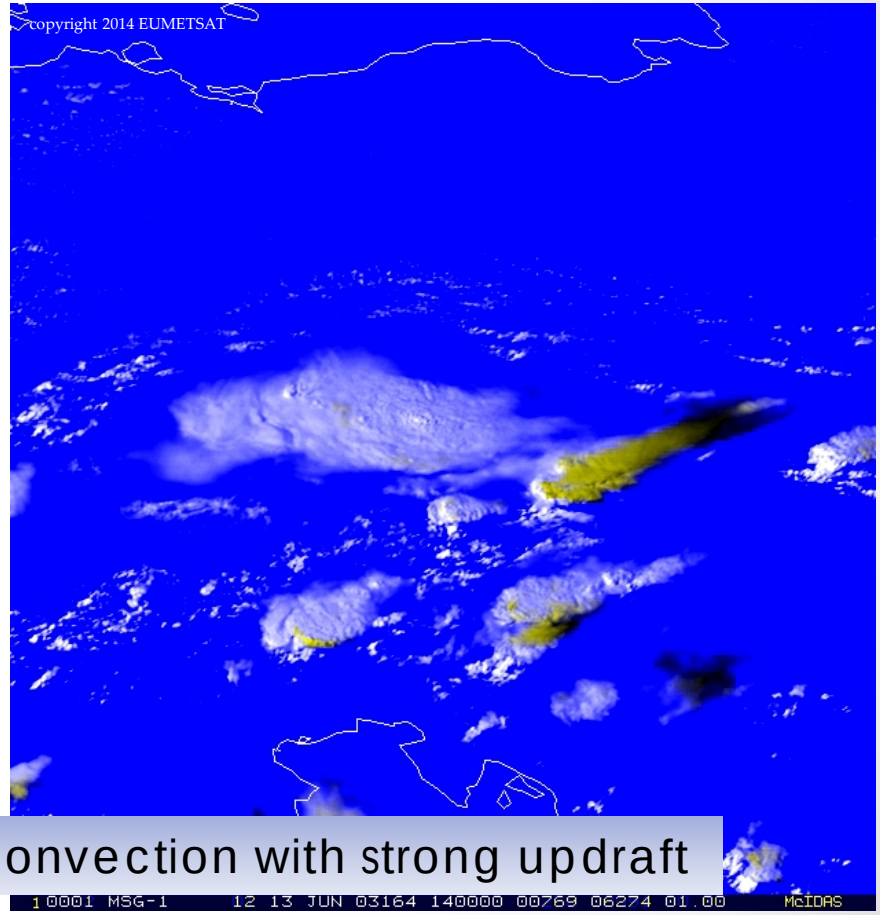
Interpretation of Colors for "Severe Storms"



Severe Storms vs. VIS



VIS



RGB

Yellowish color indicates convection with strong updraft

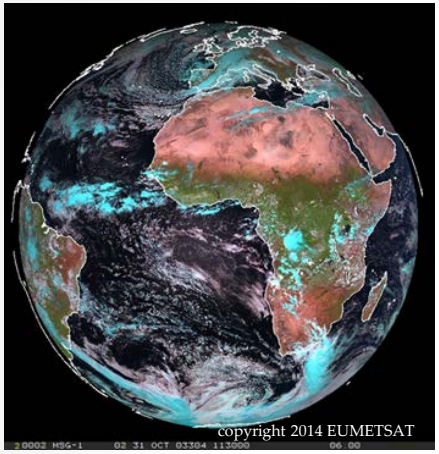
Severe Storms (summary)

This RGB scheme is…

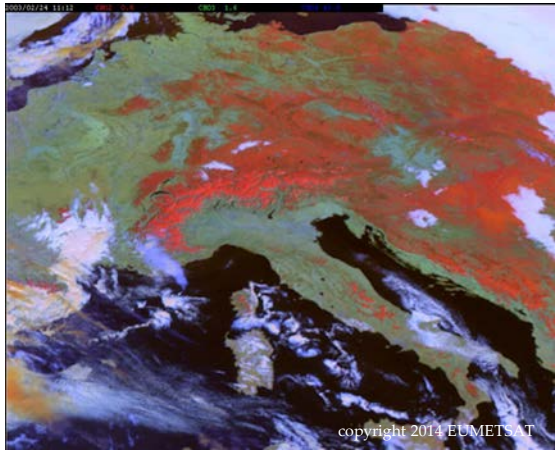
- available to distinguish strong updraft location from convective clouds
- but in day-time only
- viewable by SATAID

RGB composite imagery
which will be possible to create by
Himawari-8 and -9 imagery

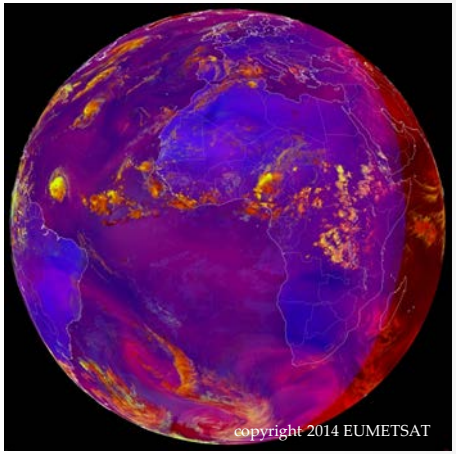
RGB composite imagery which will be possible to create by Himawari-8 and -9 imagery



Natural Colors

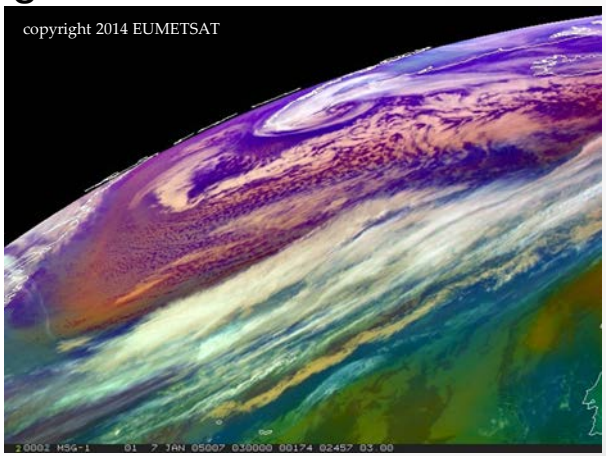


Day Snow-Fog



Day Convective Storms

Dust



Airmass

Natural Colors

- R : NIR1.6

  Range : 0～100 [%]　Gamma : 1.0

- G : VIS0.8

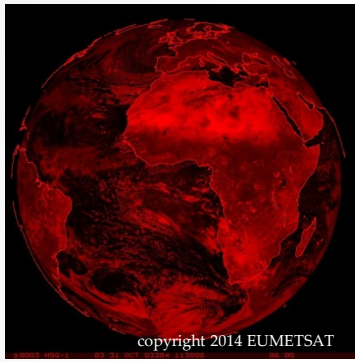
  Range : 0～100 [%]　Gamma : 1.0

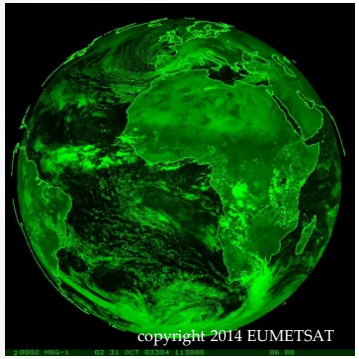
- B : VIS0.6

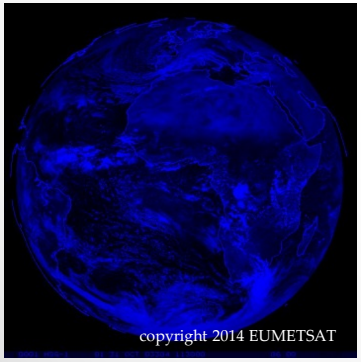
  Range : 0～100 [%]　Gamma : 1.0

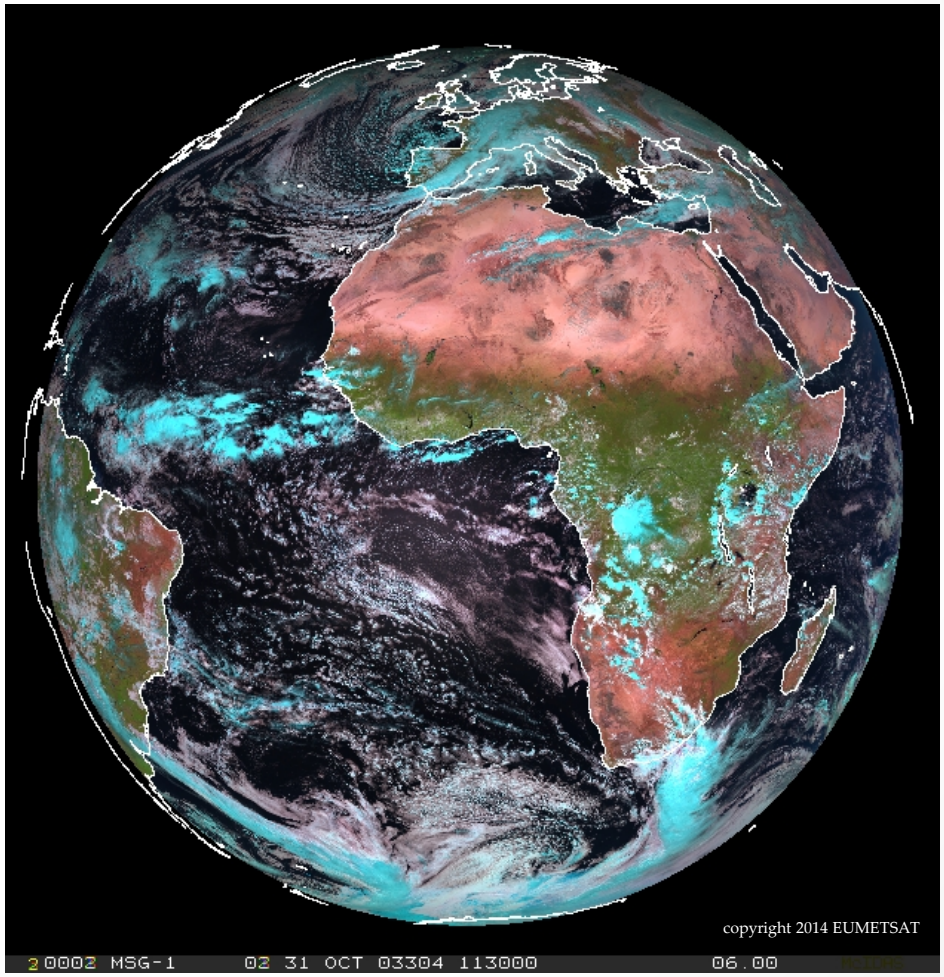
- Applications
  - Day-time cloud analysis
  - Distinction for snow and ice
  - Vegetation

Natural Colors



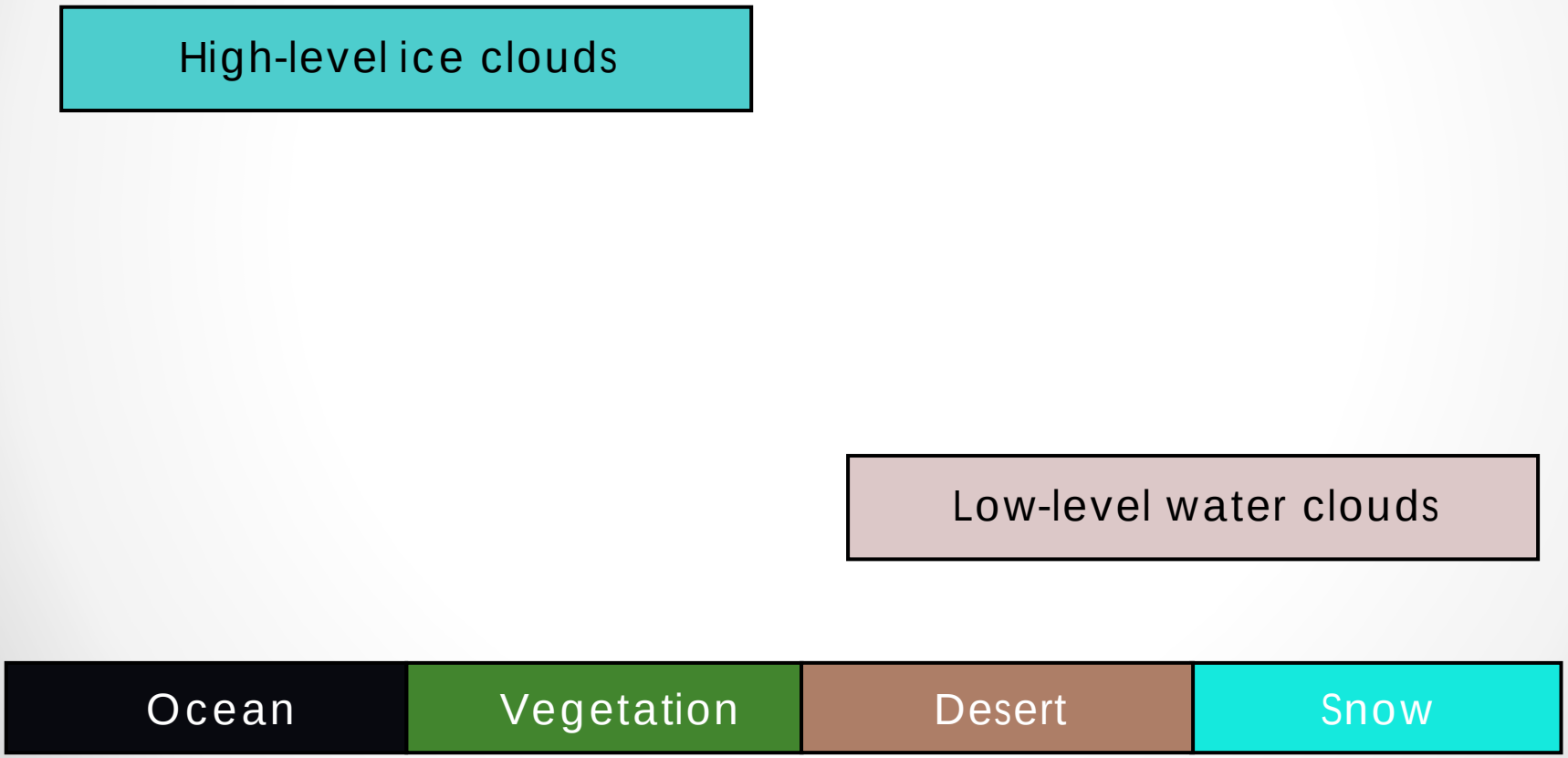




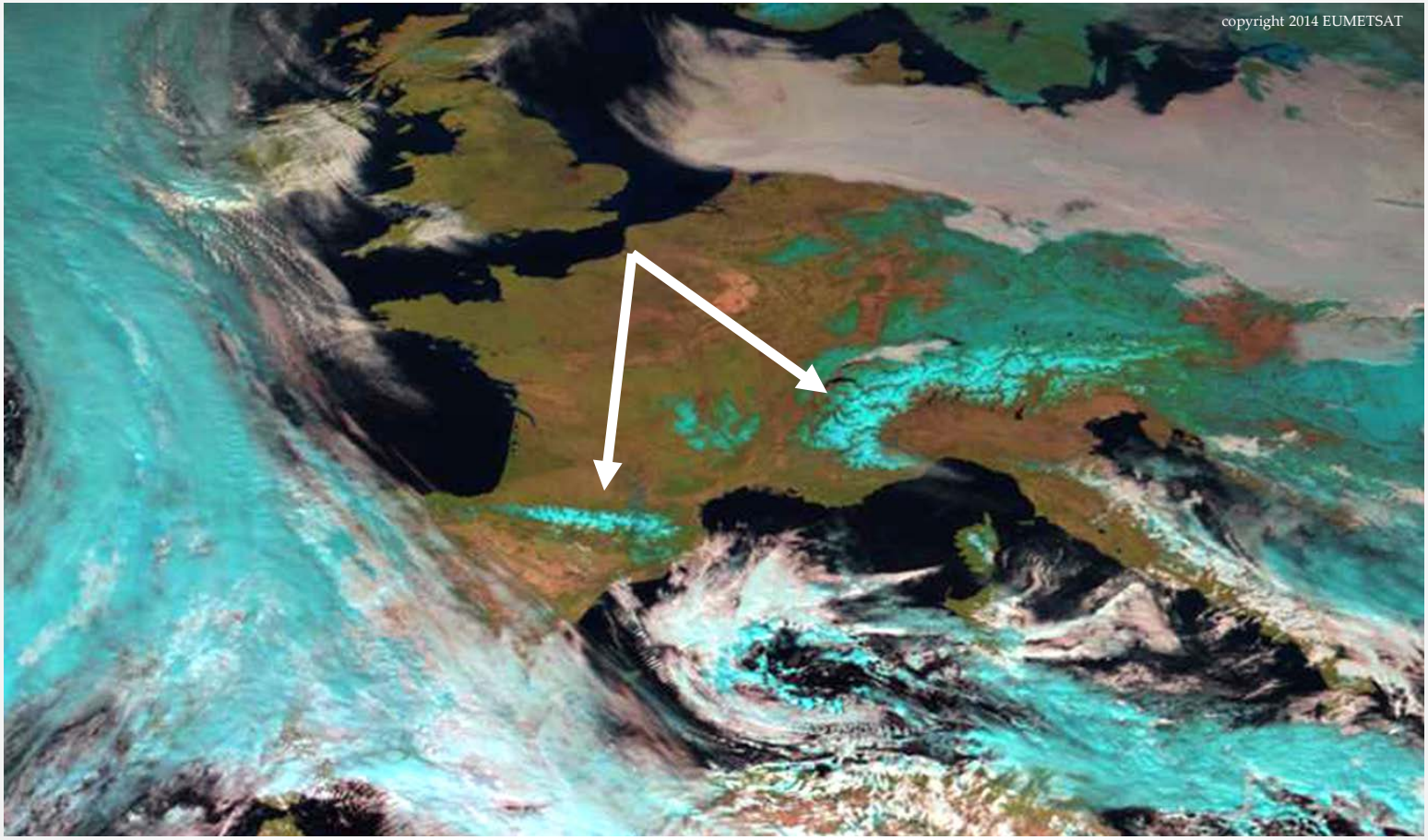


MSG 2003/10/31 11:30UTC

Interpretation of Colors for "Natural Colors"

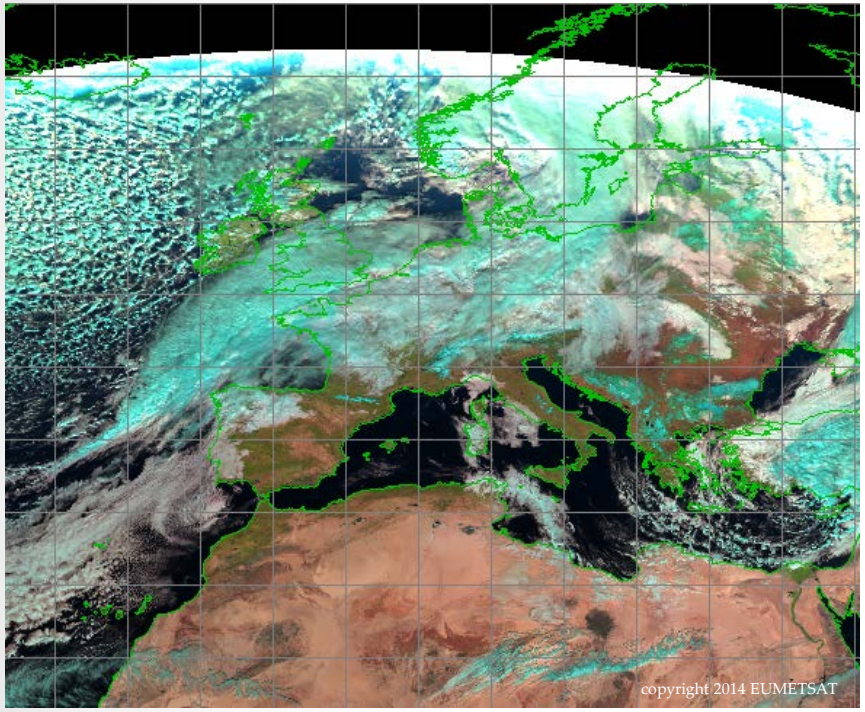


Natural Colors (snow)

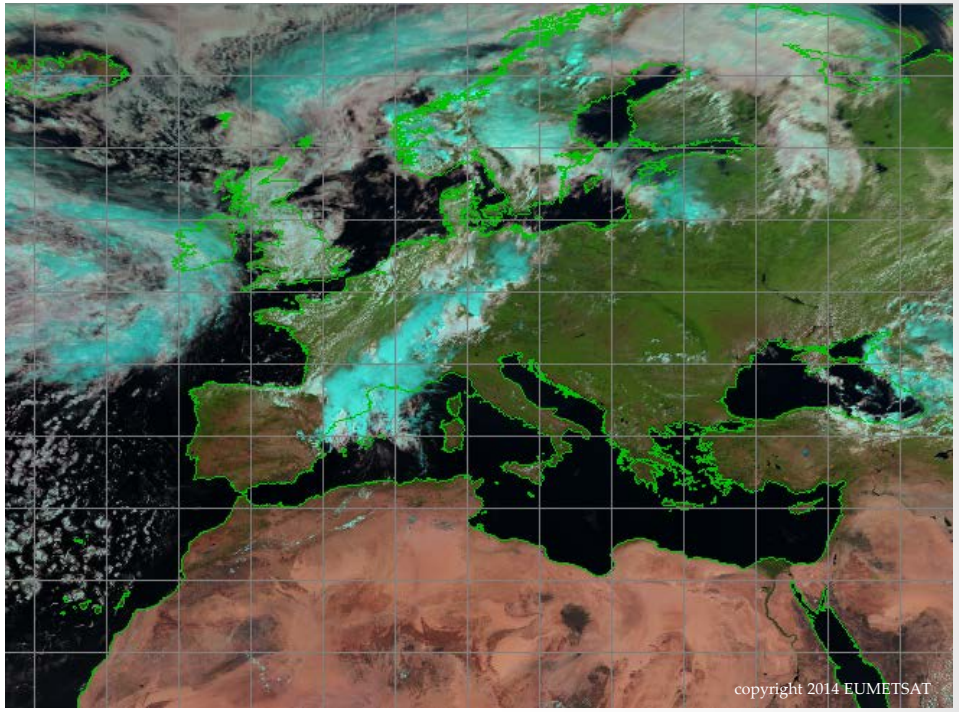


MSG 2003/2/18 13:00UTC

Natural Colors (vegetation)



MSG 2012/1/1 11:57UTC



MSG 2012/7/1 11:57UTC

By comparison, seasonal changes are obvious.

Natural Colors (summary)

This RGB scheme will…

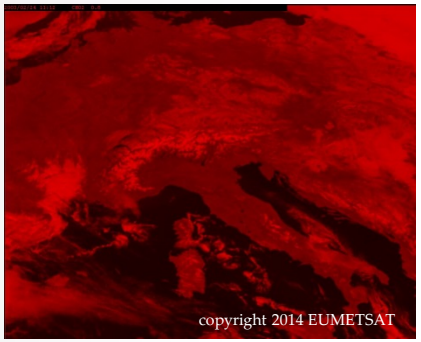
- make easy to distinguish between high-level ice clouds and low-level water clouds
- be available to distinguish vegetation, desert and snow/ice
- but in day-time only

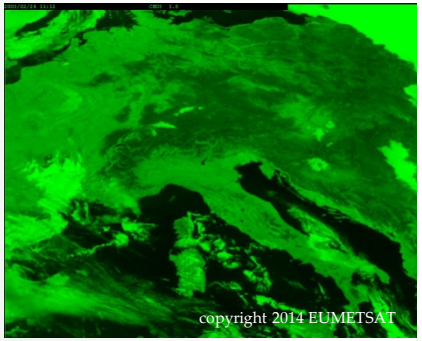
Day Snow-Fog

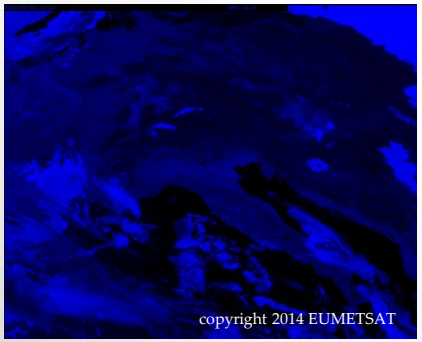
- R : VIS0.8
  Range : 0～100 [%]　Gamma : 1.7
- G : NIR1.6
  Range : 0～70 [%]　Gamma : 1.7
- B : IR3.9 Solar reflectance component
  Range : 0～30 [%]　Gamma : 1.7

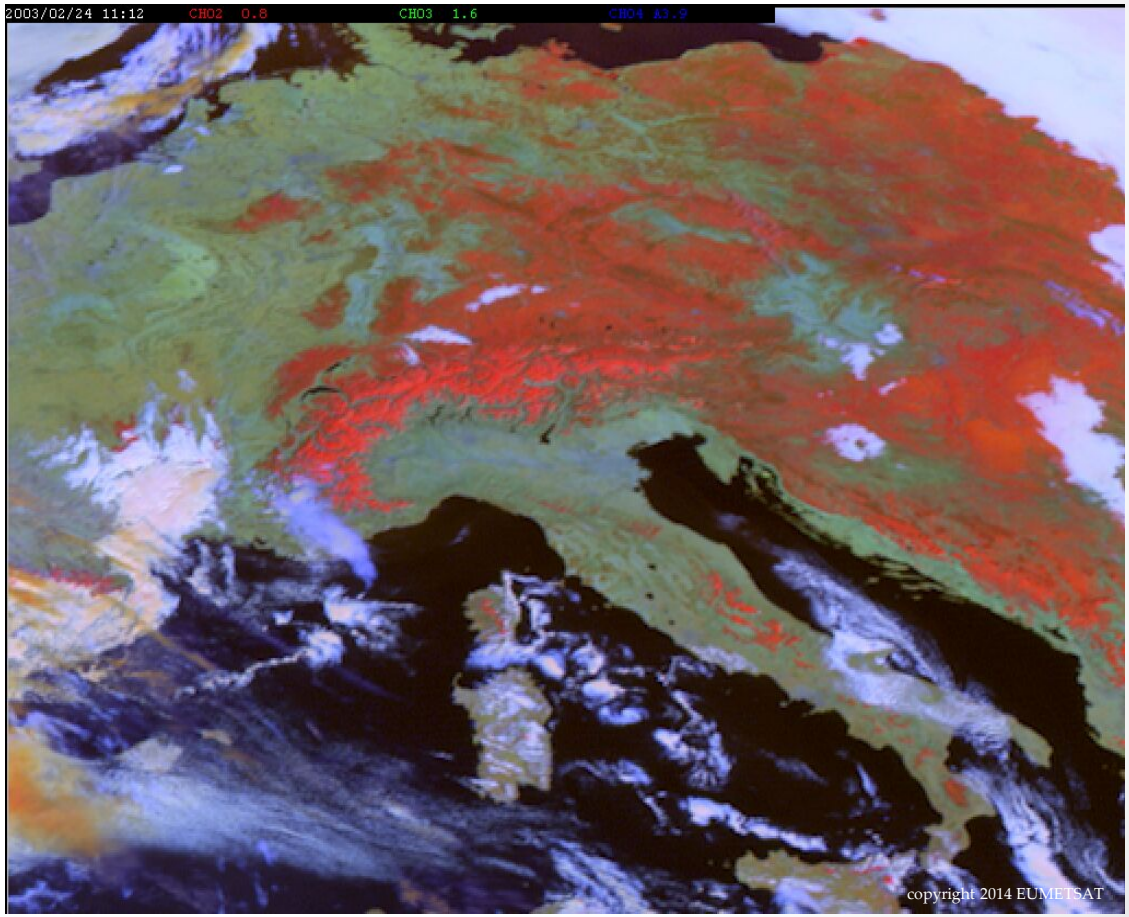
- Applications
  - distinction between low clouds and snow/ice

Day Solar









MSG 2004/2/24 11:00UTC

Interpretation of Colors for "Day Snow-Fog"

Deep precipitating cloud (precip. not necessarily reaching the ground)

- Bright, thick
- Large ice particles

Deep precipitating cloud*

- Bright, thick
- Small ice particles

*or thick, high-level lee cloudiness with small ice particles

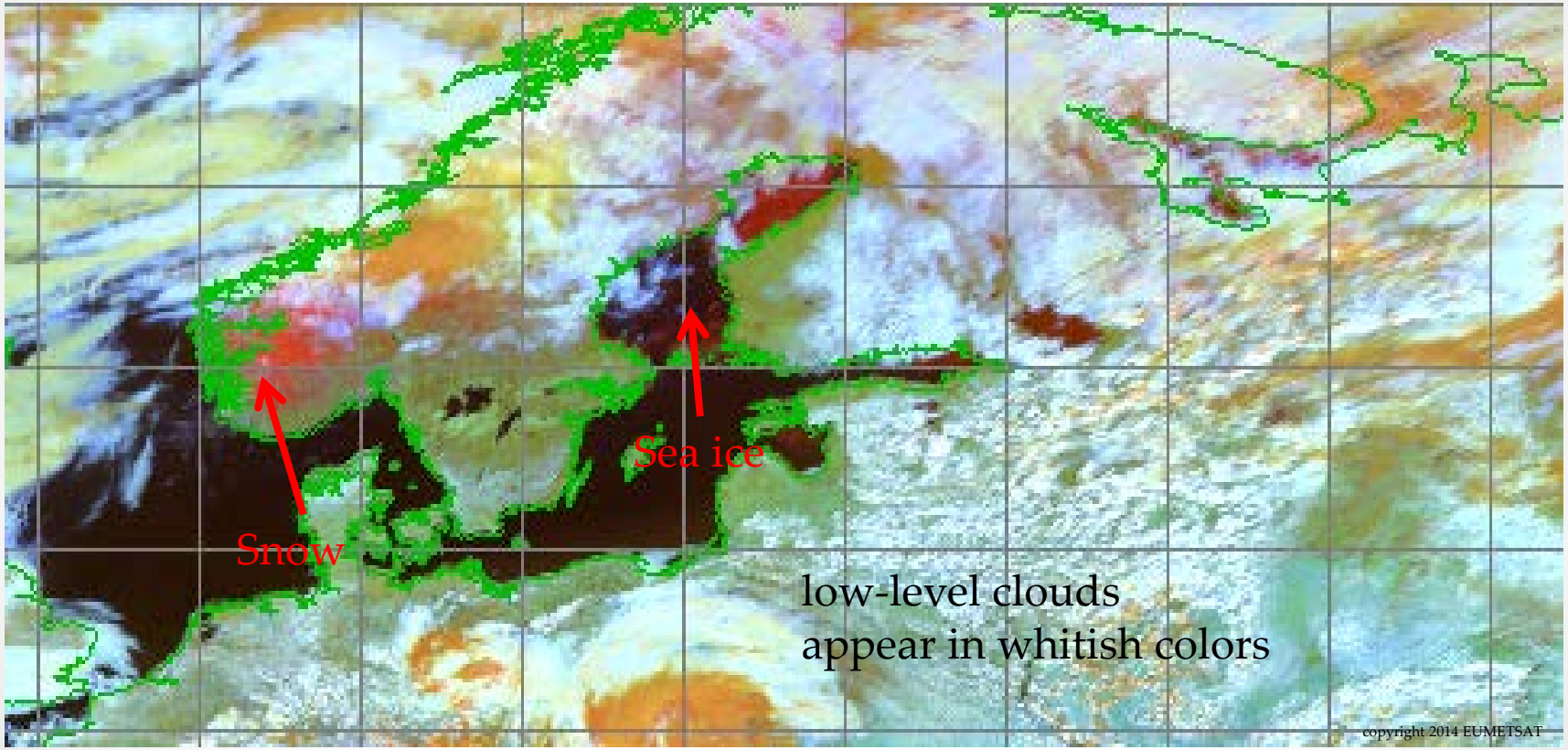
Thick water cloud

- Large droplets

Thick water cloud

- Small droplets

Day Snow-Fog (low clouds and ice)



MSG 2010/4/14 11:57UTC

Day Snow-Fog (summary)

This RGB scheme will…

- make easy to distinguish between low clouds and snow/ice rather than only VIS
- but in day-time only

Day Convective Storms

- R : WV6.2-WV7.3

  Range : -35～5 [K]　Gamma : 1.0

- G : IR3.9-IR10.8

  Range : -5～60 [K]　Gamma : 0.5

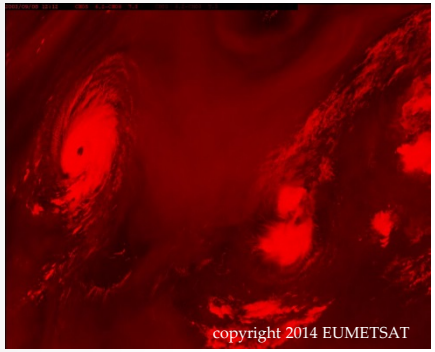
- B : NIR1.6-VIS0.6

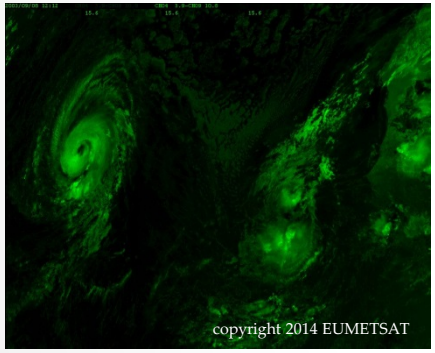
  Range : -75～25 [%]　Gamma : 1.0

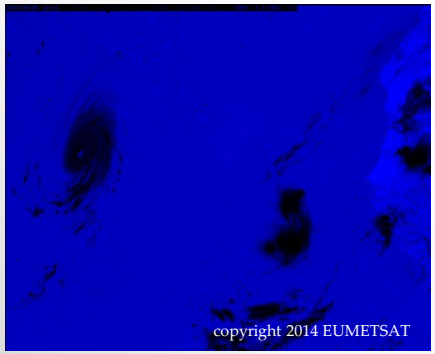
- Applications

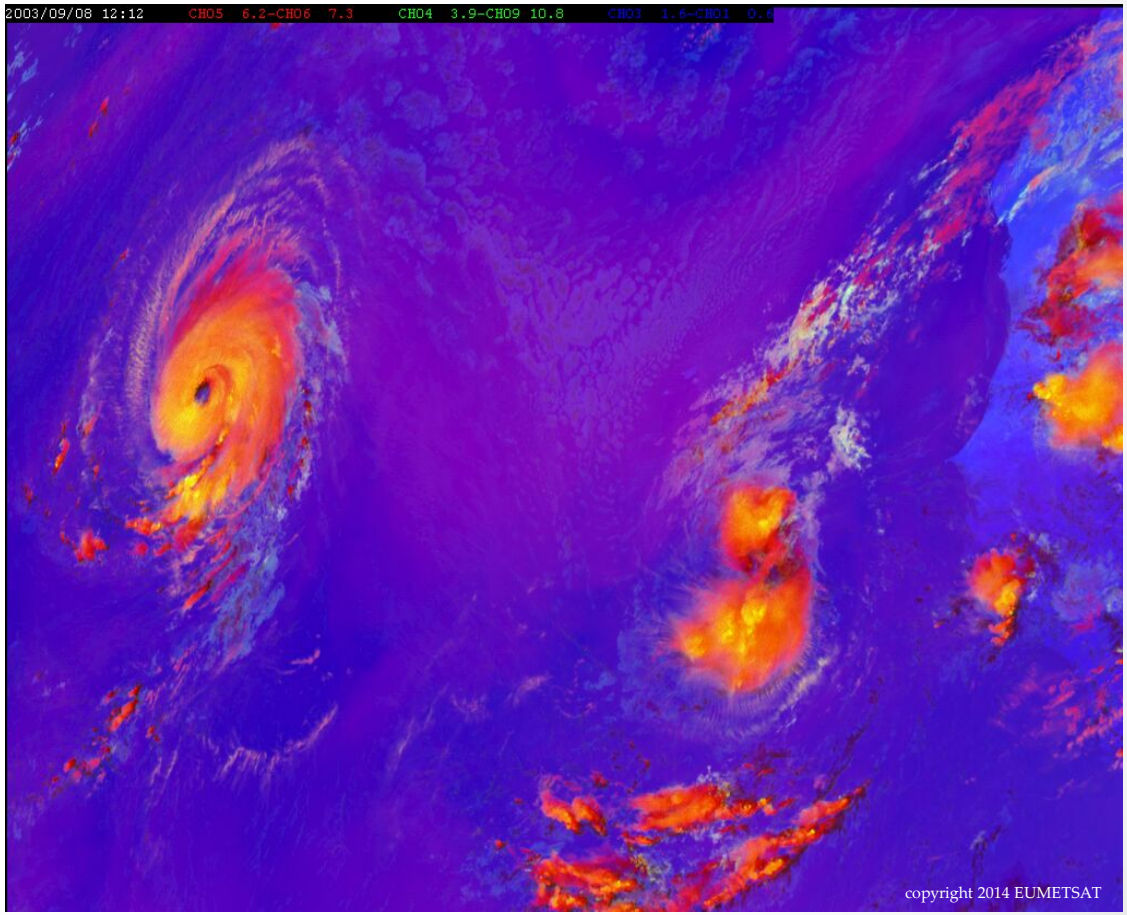
  • distinction of convective clouds with severe phenomenon such as gust and tornado etc.

Day Convective Storms







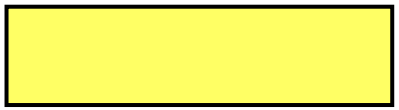


MSG 2003/9/8 12:00UTC

Interpretation of Colors for "Day Convective Storms"

Deep precipitating cloud
(precip. not necessarily reaching the ground)

- High level Cloud
- Large ice particles



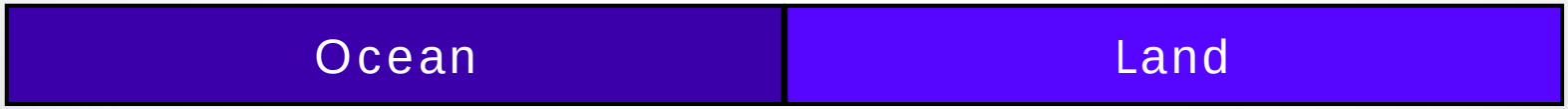
Deep precipitating cloud
(Cb cloud with strong updrafts and severe weather)*

- High level Cloud
- Small ice particles

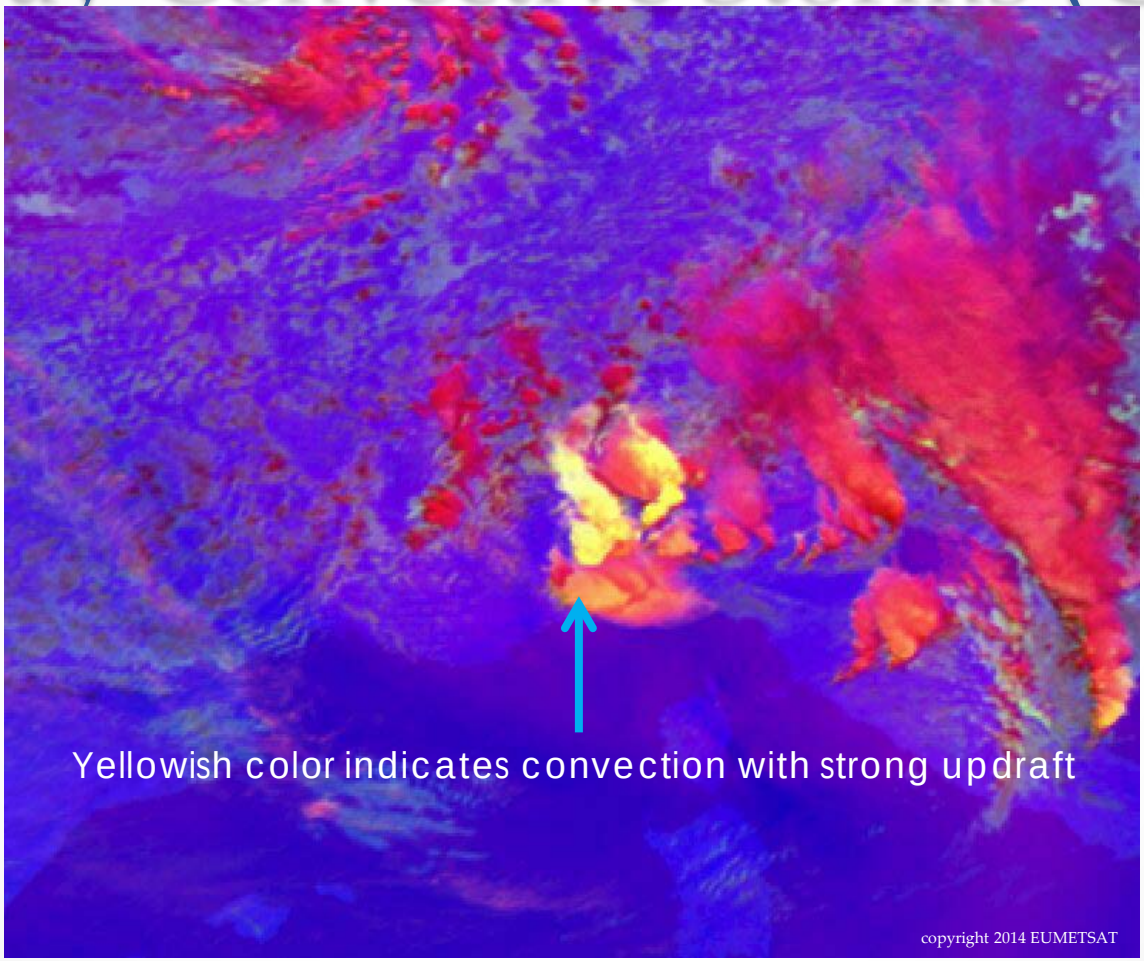
*or thick, high-level lee cloudiness with small ice particles

Thin Cirrus cloud
- Large ice particles

Thin Cirrus cloud
- Small ice particles

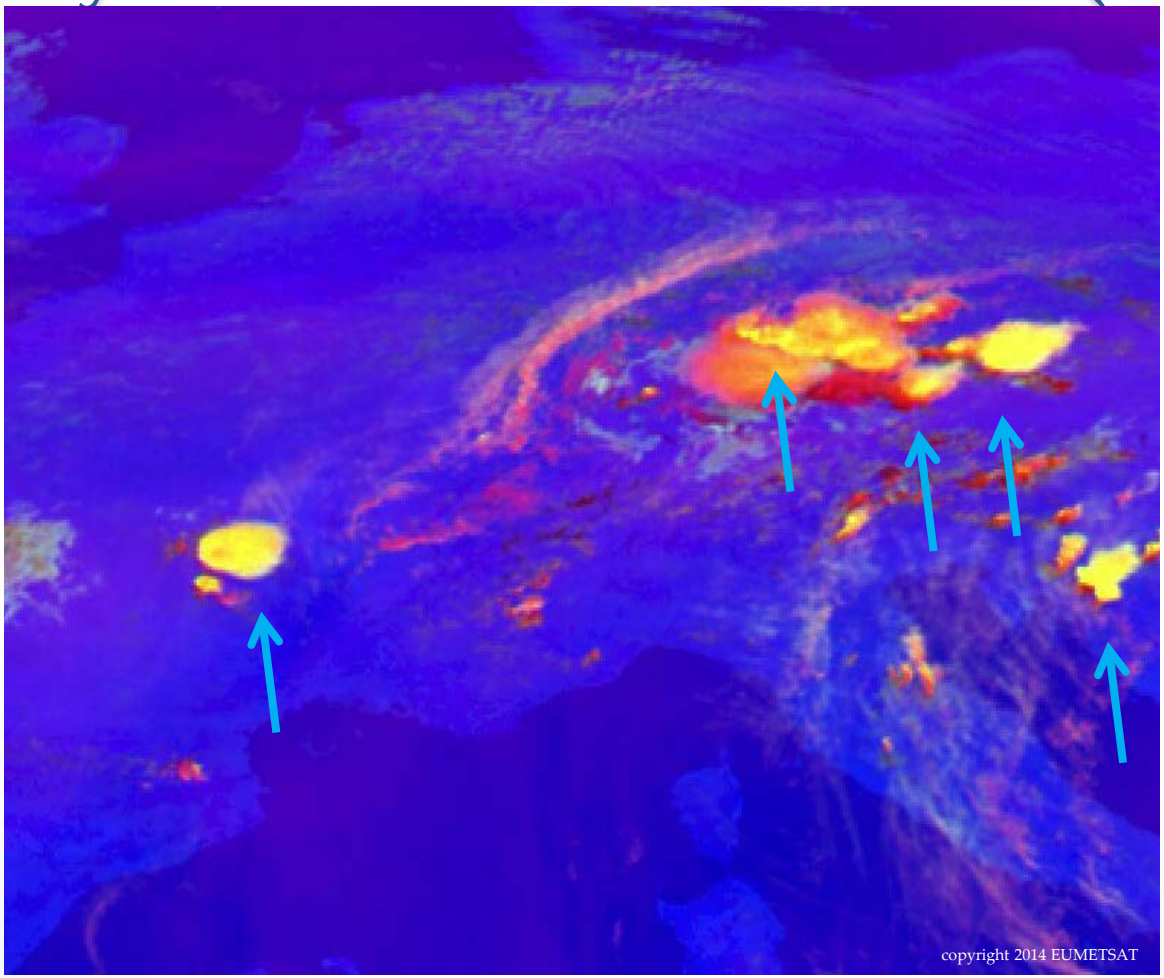


Day Convective Storms (Cb)



MSG 2003/5/20 13:30UTC

Day Convective Storms (Cb)



MSG 2003/6/13 12:00UTC

Day Convective Storms (summary)

This RGB scheme will…

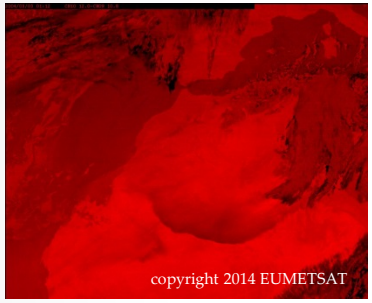
- be available to distinguish convective clouds with severe phenomenon (gust, tornado etc.)
- but in day-time only

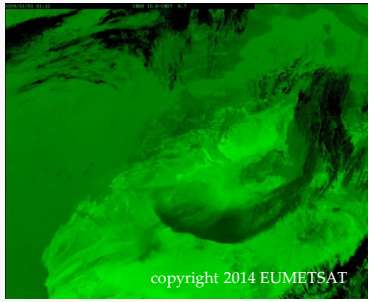
Dust

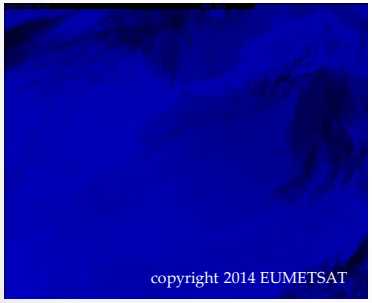
- R : IR12.0-IR10.8
  Range : -4～2 [K] Gamma : 1.0
- G : IR10.8-IR8.7
  Range : 0～15 [K] Gamma : 2.5
- B : IR10.8
  Range : 261～289 [K] Gamma : 1.0

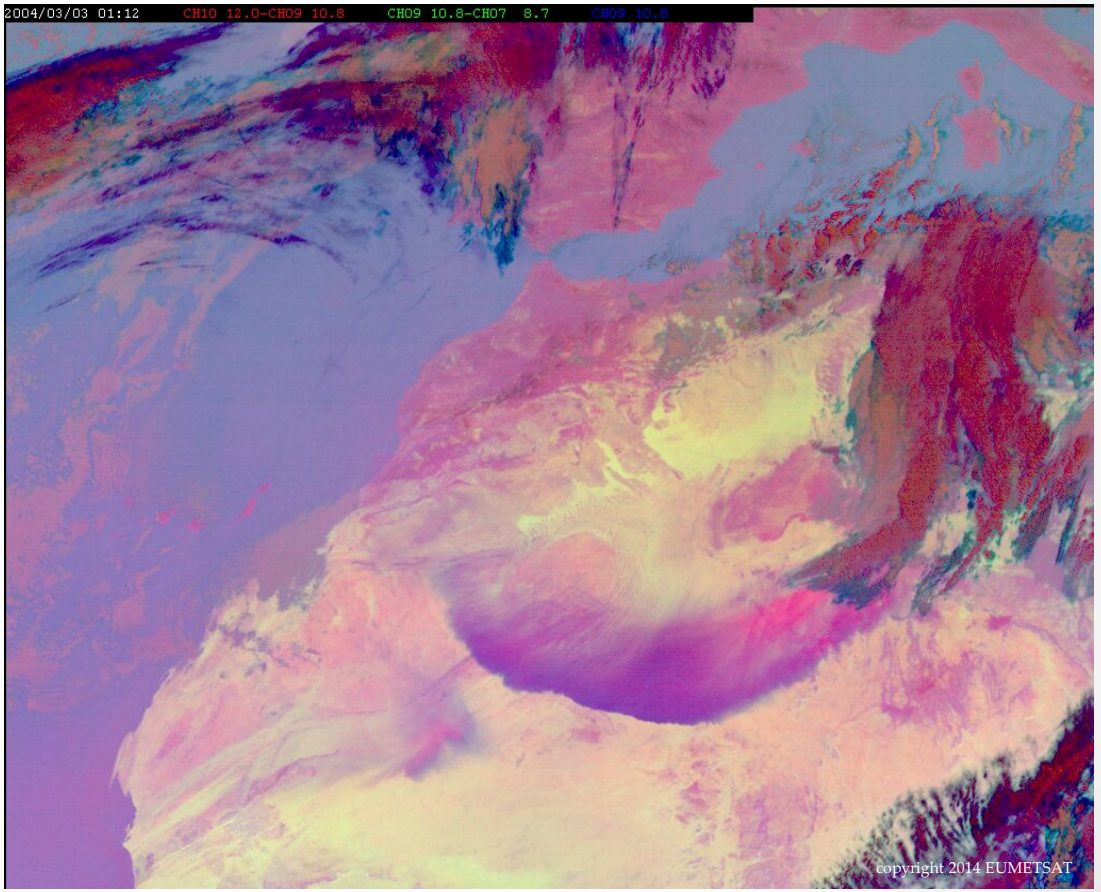
- Applications
  - Dust/ Yellow sand
  - Volcanic ash
  - Cloud analysis

Dust



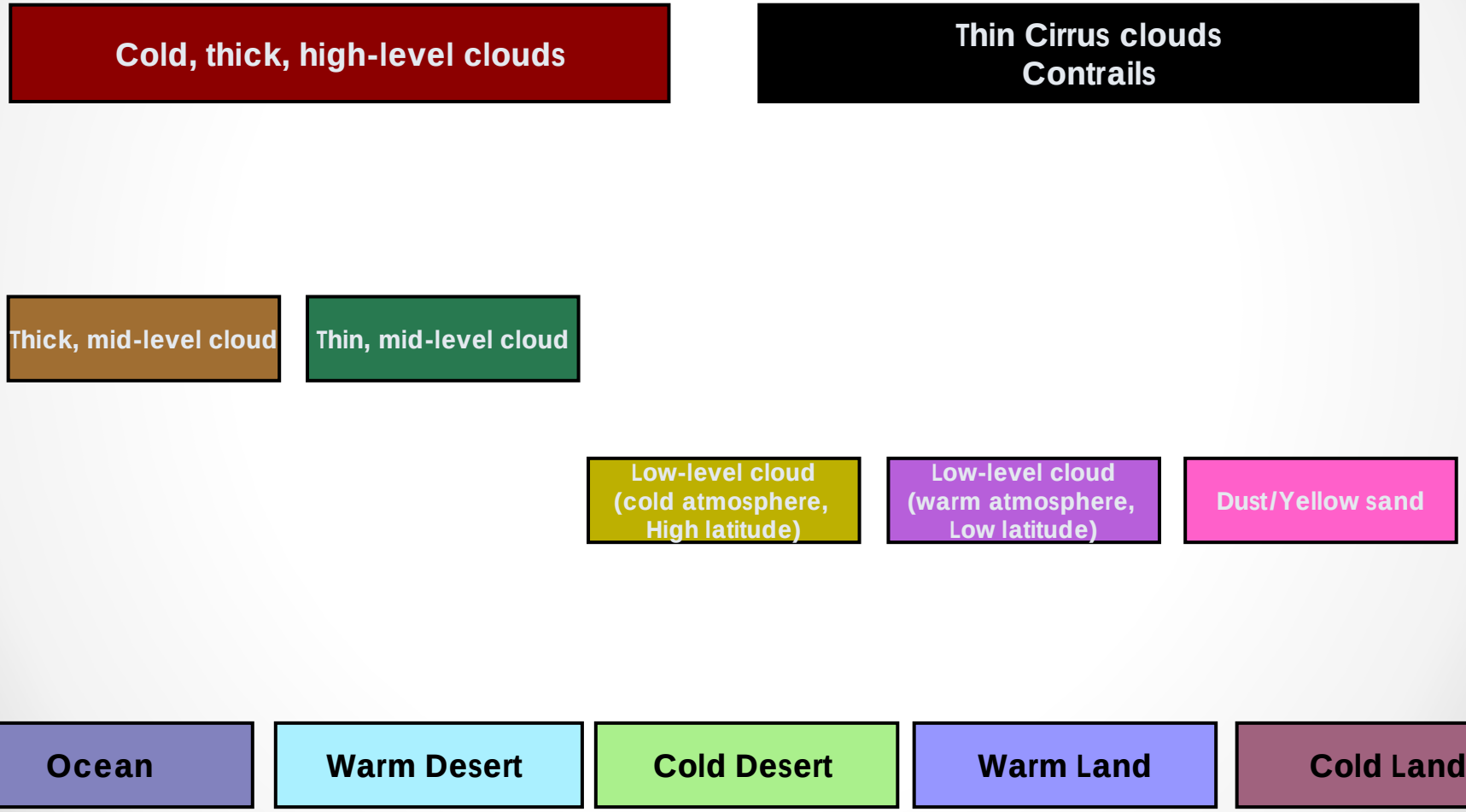




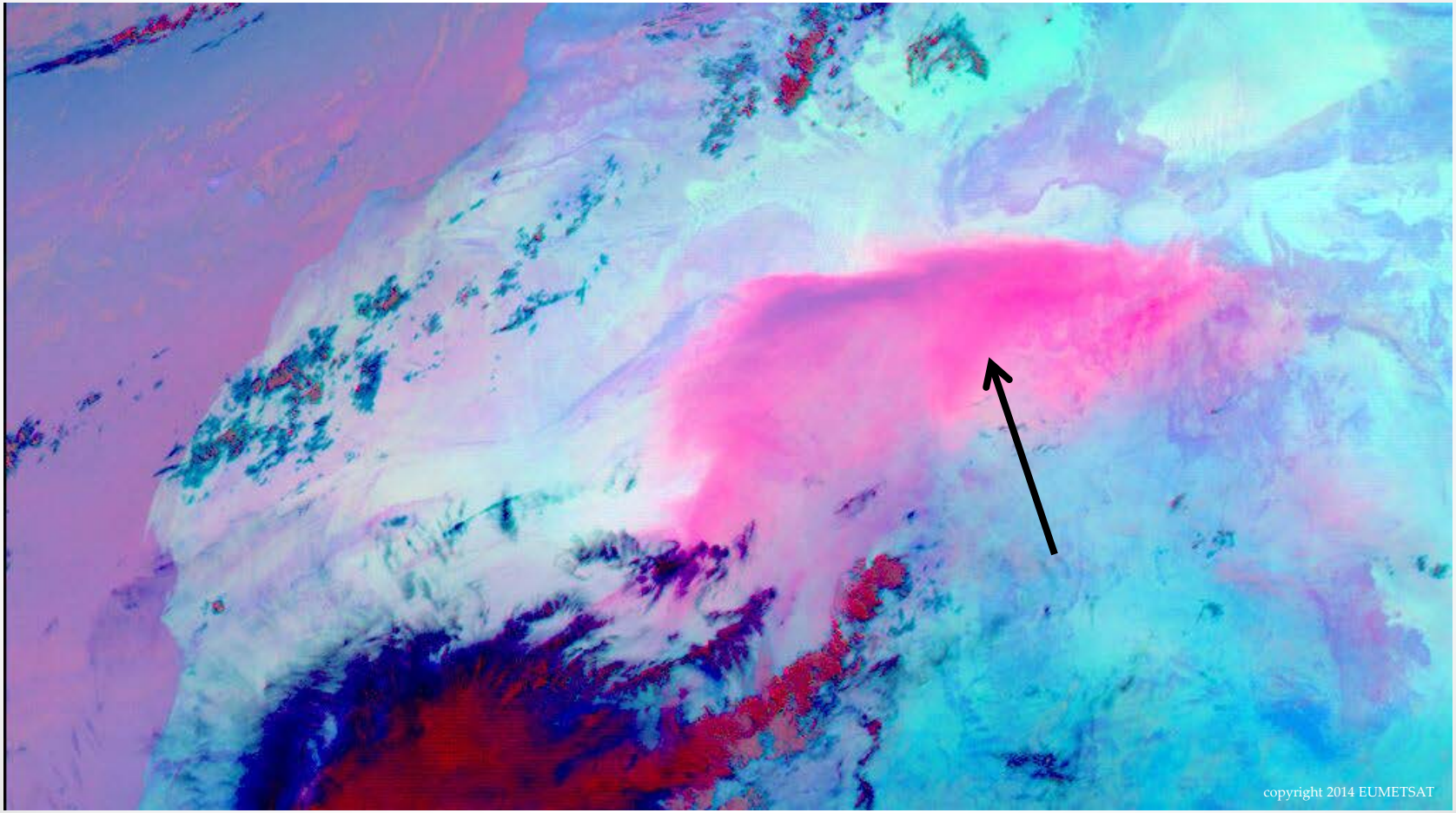


MSG 2004/3/3 01:00UTC

Interpretation of Colors for "Dust"

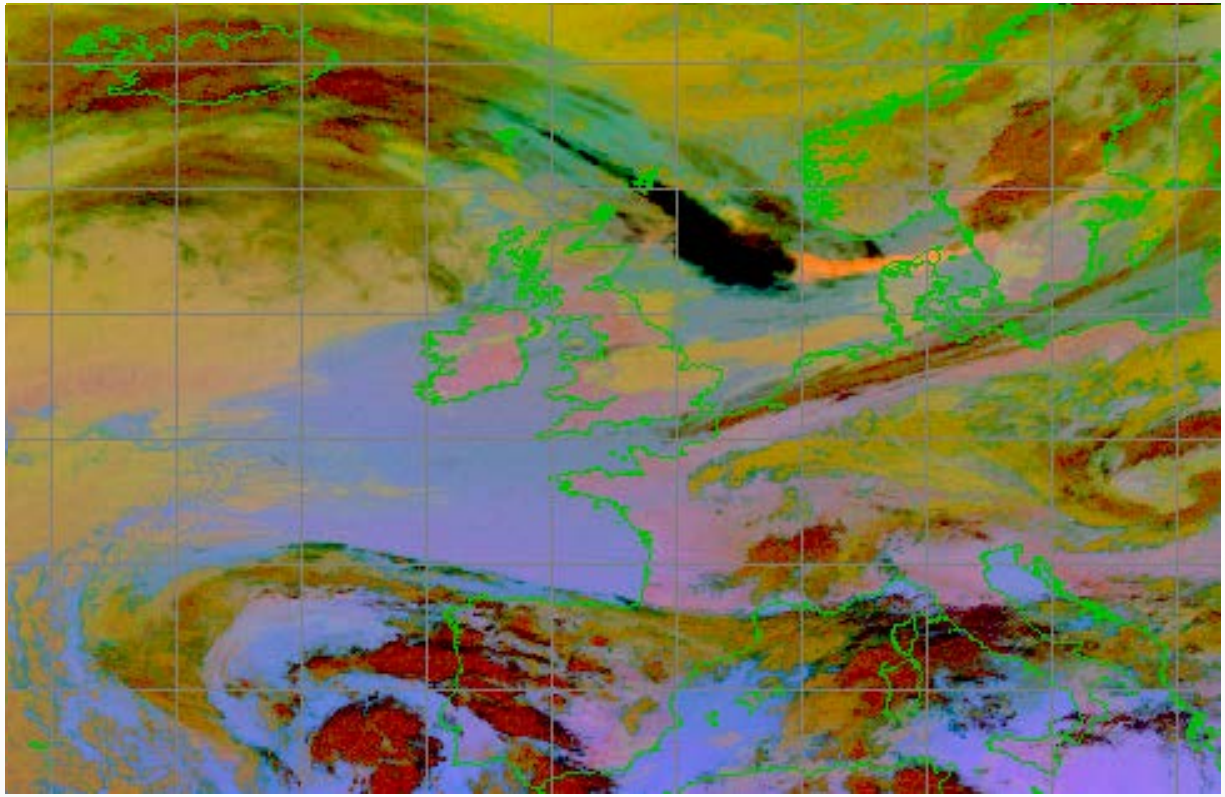


Dust



MSG 2004/3/3 10:00UTC

Dust (volcanic ash)



MSG 2010/4/15

The 2010 eruptions of Eyjafjallajökull (Iceland)

This eruptions caused enormous disruption to air travel across western and northern Europe.

Dust (summary)

This RGB scheme will be…

- available to distinguish dust storm or yellow sand
- available for cloud analysis for day and night
- also available to distinguish volcanic ash

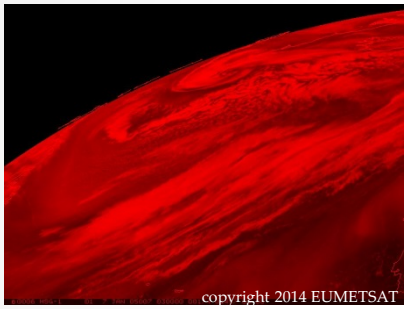
→ The same RGB combination named "Ash" which is adjusted gradation for focusing on volcanic ash had been contrived.

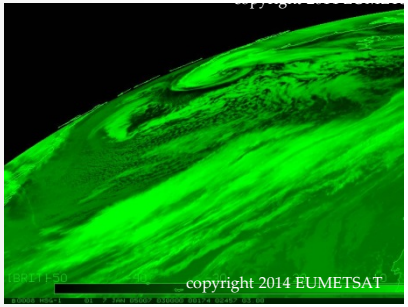
Airmass

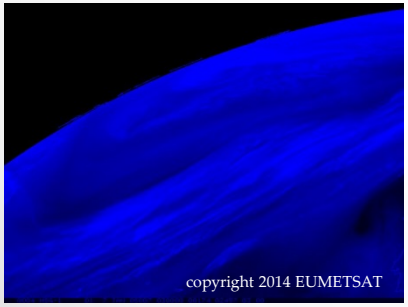
- R : WV6.2-WV7.3
  Range : -25～0 [K]　Gamma : 1.0
- G : IR9.7-IR10.8
  Range : -40～5 [K]　Gamma : 1.0
- B : WV6.2
  Range : 243～208 [K]　Gamma : 1.0

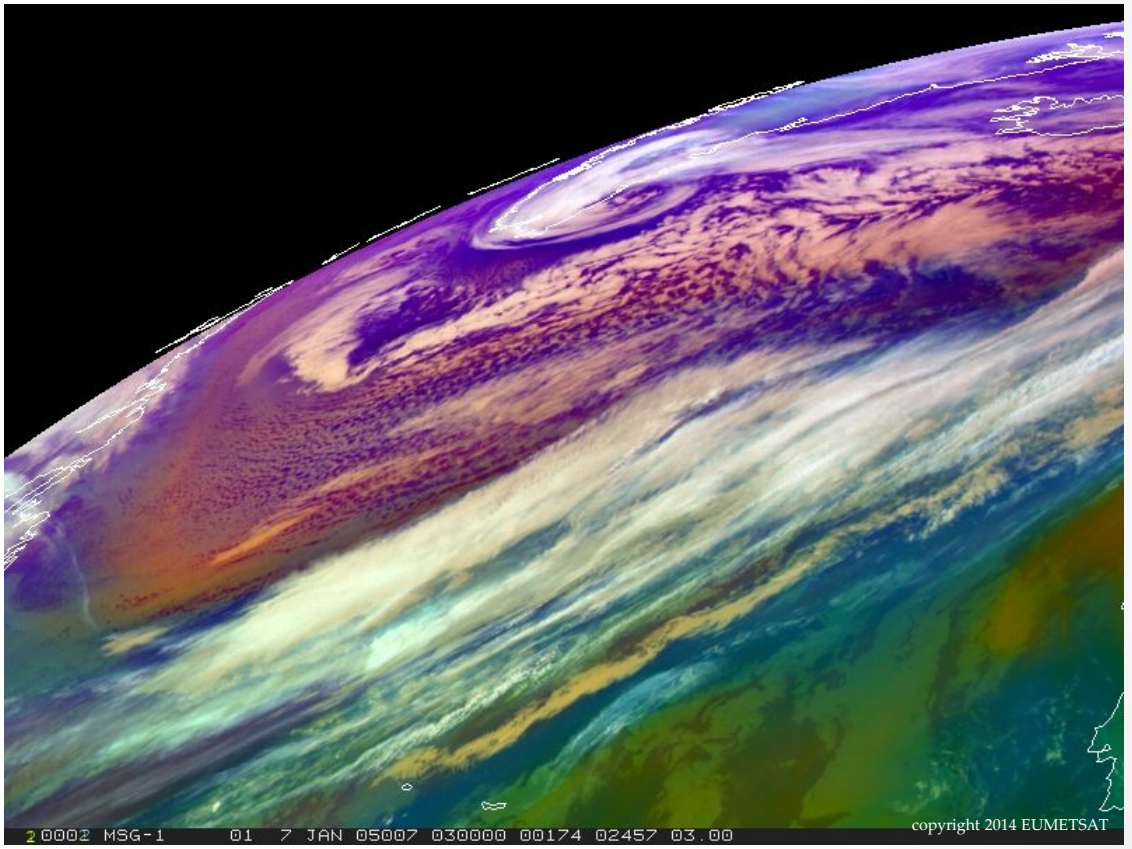
- Applications
  - Air mass(cold/warm) analysis
  - Jet stream analysis
  - Analysis of troughs and upper vortices

Airmass



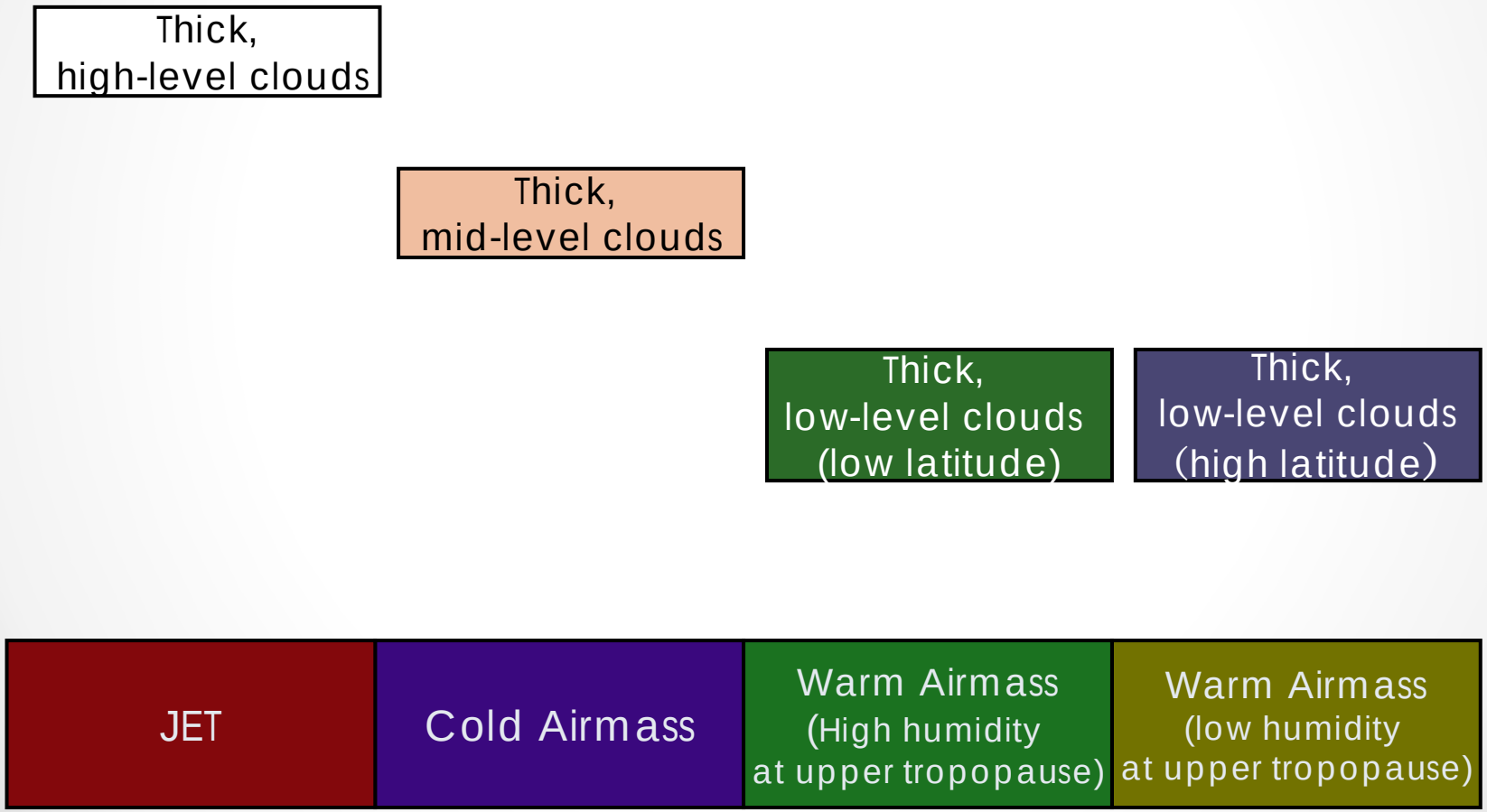




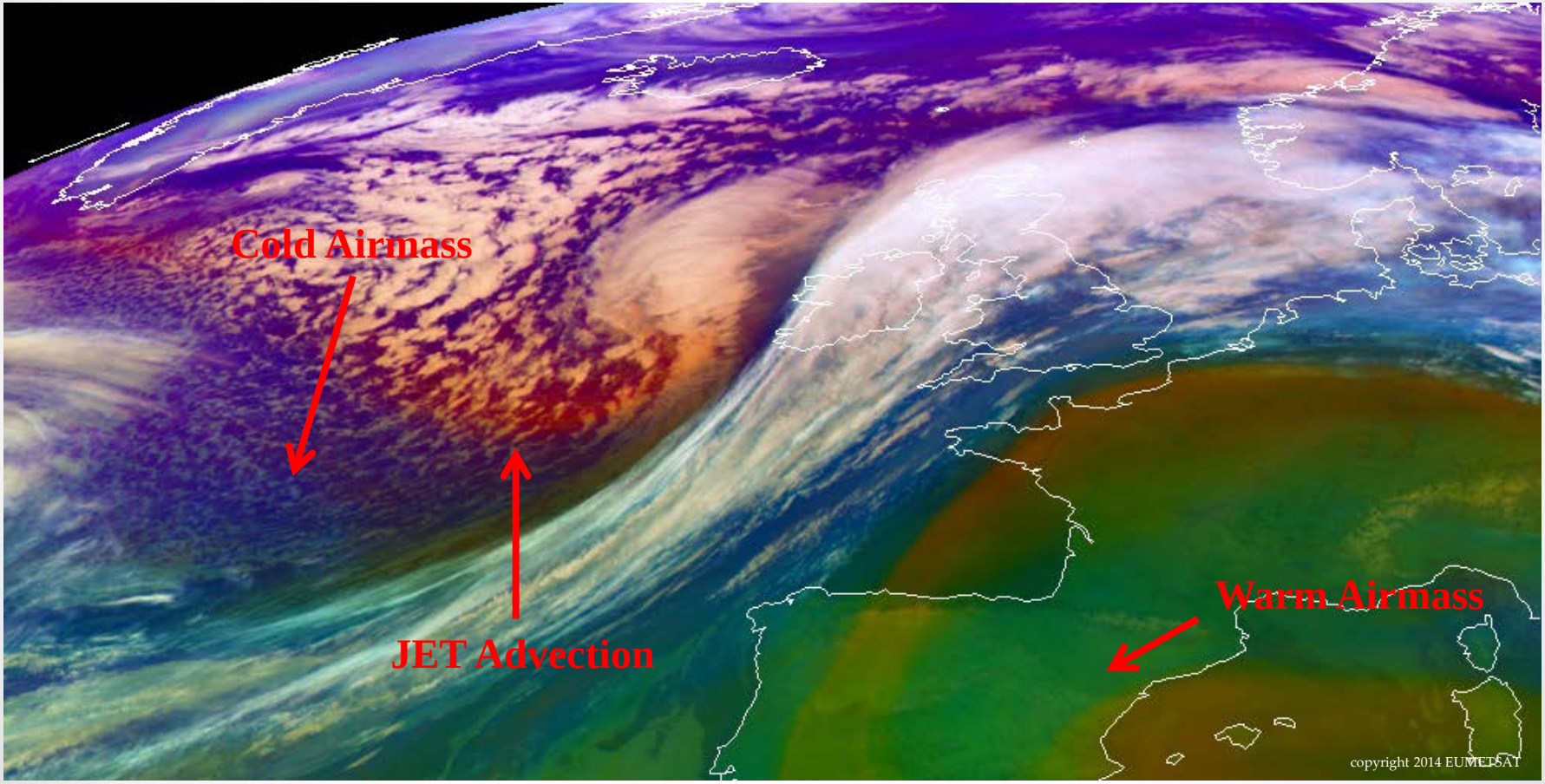


MSG 2005/1/7 03:00UTC

Interpretation of Colors for "Airmass"



Airmass

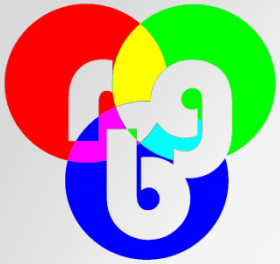


MSG 2005/1/7 22:00UTC

Airmass (summary)

This RGB scheme will be…

- available for air mass analysis
- available for jet stream analysis
- available day and night



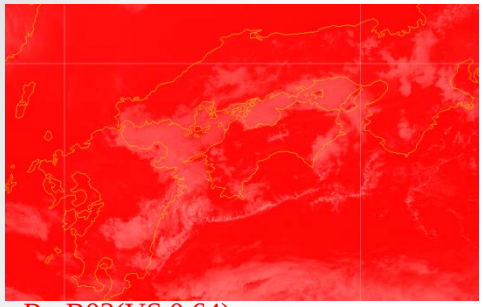
RGB composite imagery
by Himawari-8 and -9

True Color

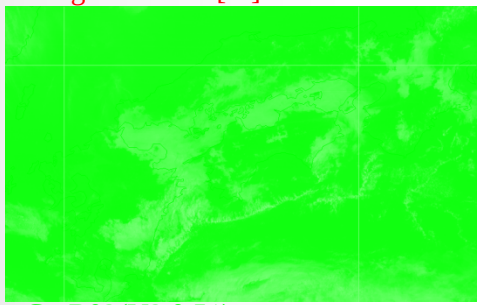
- R : VIS0.6
  Range : 0～100 [%]　Gamma : 1.0
- G : VIS0.5
  Range : 0～100 [%]　Gamma : 1.0
- B : VIS0.4
  Range : 0～100 [%]　Gamma : 1.0

- Applications
  - Day-time cloud analysis
  - Distinction for snow and ice
  - Vegetation

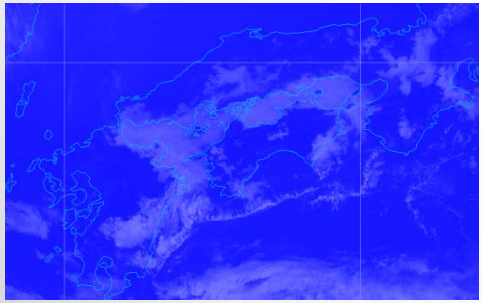
True Color RGB



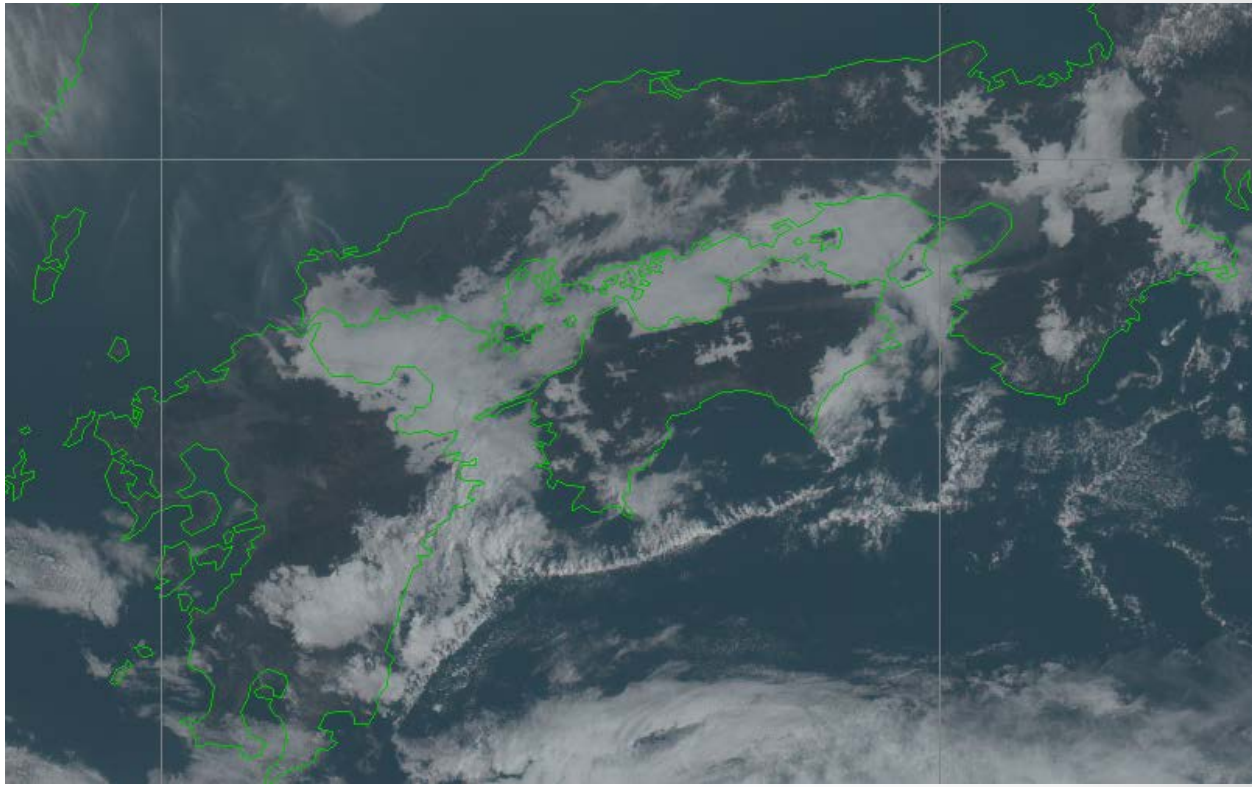
R : B03(VS 0.64)
Range : 0～100 [%]　Gamma : 1.0



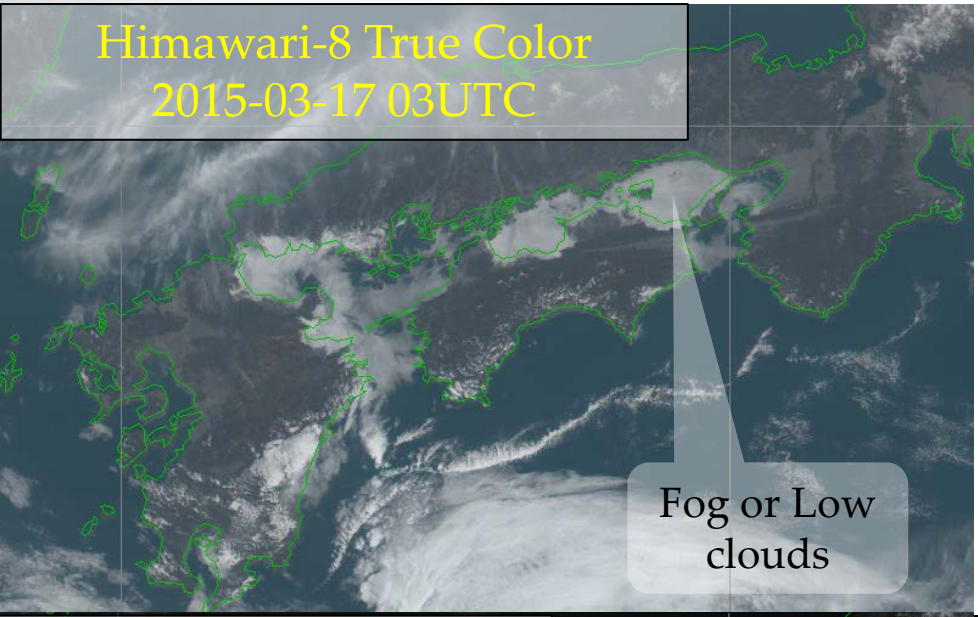
G : B02(V2 0.51)
Range : 0～100 [%]　Gamma : 1.0



B : B01(V1 0.46)
Range : 0～100 [%]　Gamma : 1.0

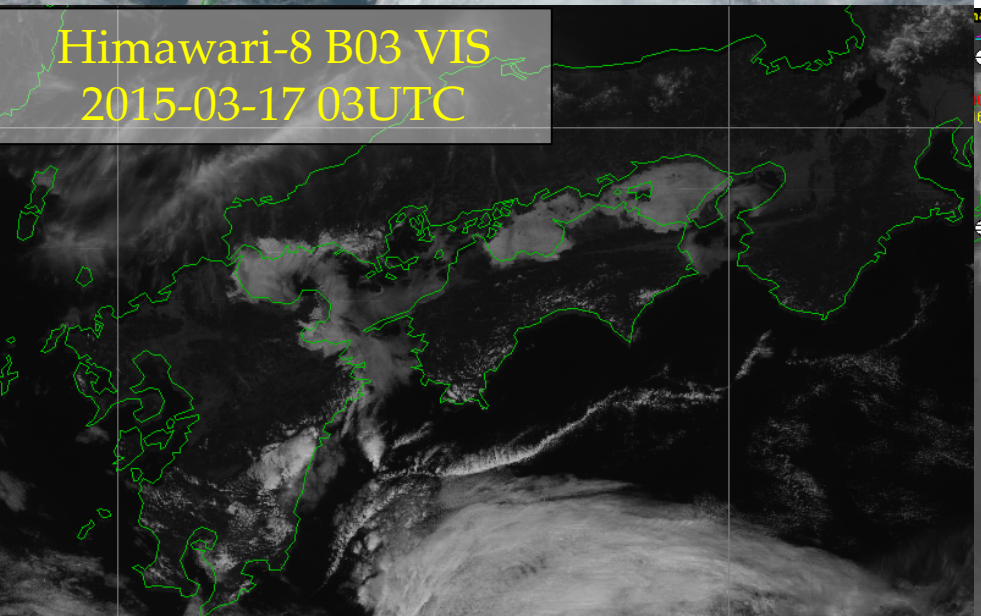


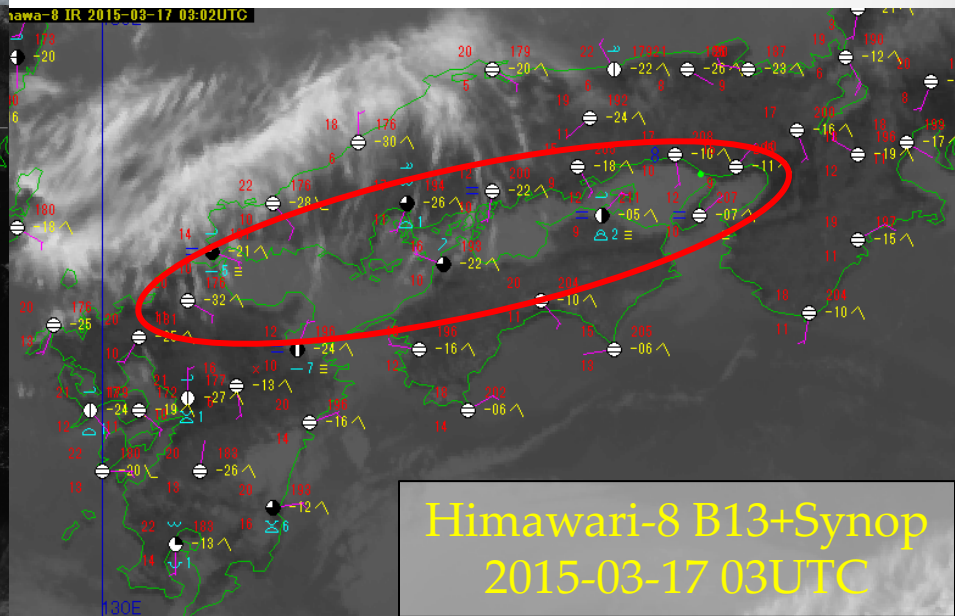
True Color Fog/Low Clouds of "Setonai-kai (Inland Sea of Japan)"



(Lower right) Fog/ low-clouds were observed at some stations (around red oval). However, fog/ low-clouds are not clear in the IR image.

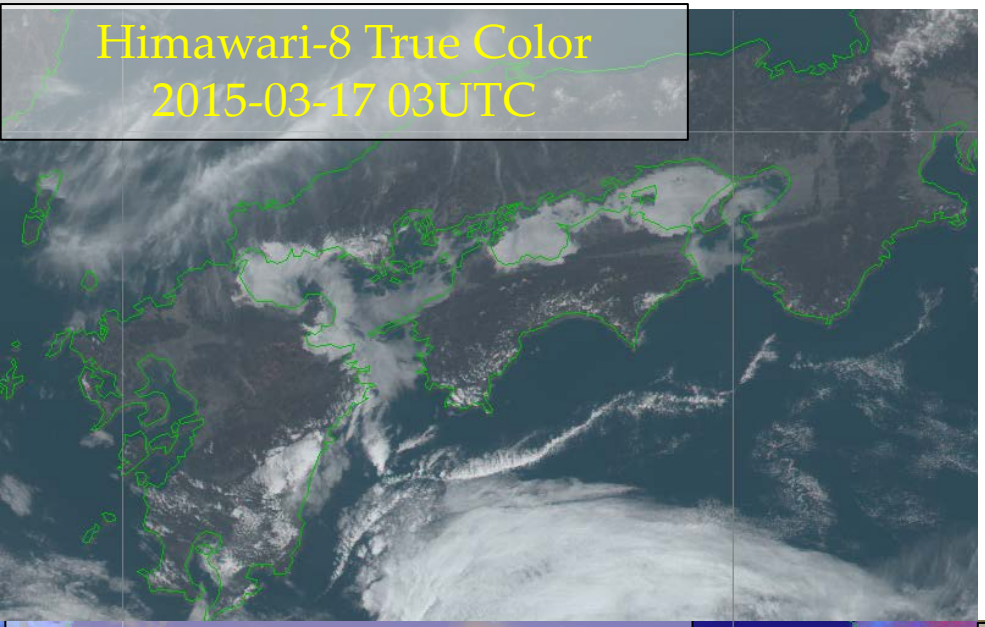
(Upper and lower left) Smooth, whitish areas correspond to fog/ low-clouds in true color RGB and B03 visible image.





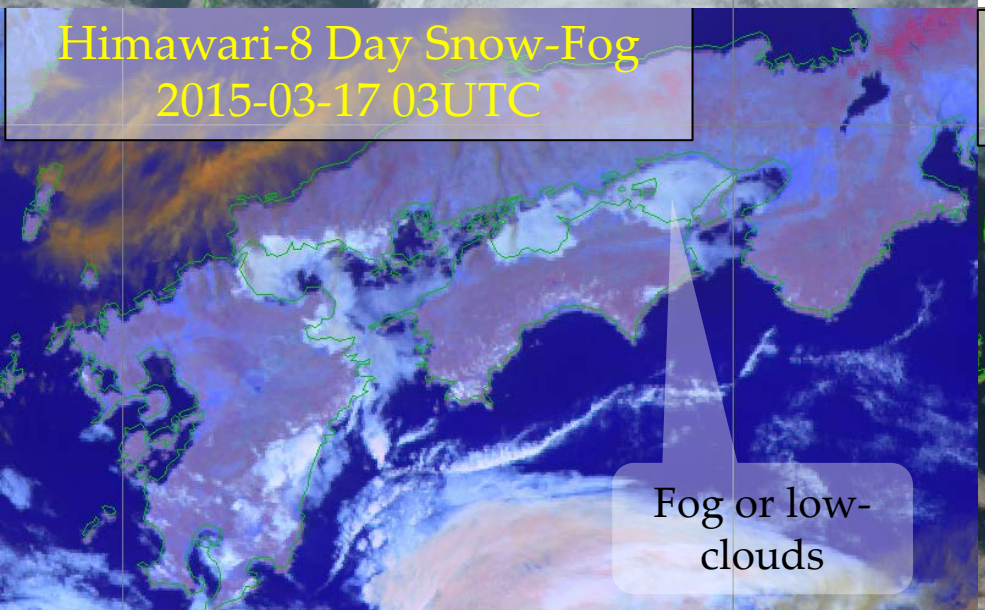
True Color Fog/Low Clouds of "Setonai-kai (Inland Sea of Japan)"

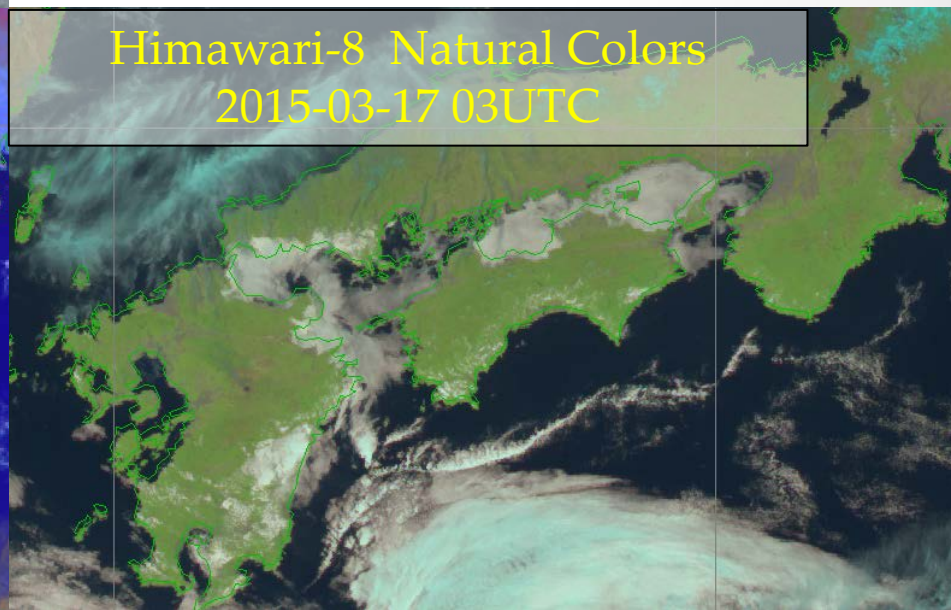
Comparison with standard RGB schemes



The distinction between fog/low-clouds and other layer clouds is easier in Day Snow-Fog RGB and Natural color RGB imagery.
In True color RGB, all clouds including fog/ low-clouds appear in whitish.

It is required to discriminate them based on texture and movement of clouds.
However, the True color RGB will be easy to use for traditional "single band" imagery user and RGB beginner.





True Color RGB (summary)

This RGB scheme will be…

- available to display "true colored" image that is nearly visible with the naked eye, by composition of "three visible images" corresponding to red, green and blue colors with human's naked eye
- easy to use for traditional “single band” imagery user and RGB beginner
- available day time only
- second-best compared with other specific RGB scheme in the specific case such as nephanalysis and volcanic ash

Practical training to create RGB composite imagery by SATAID

Practical training to create RGB composite imagery by SATAID

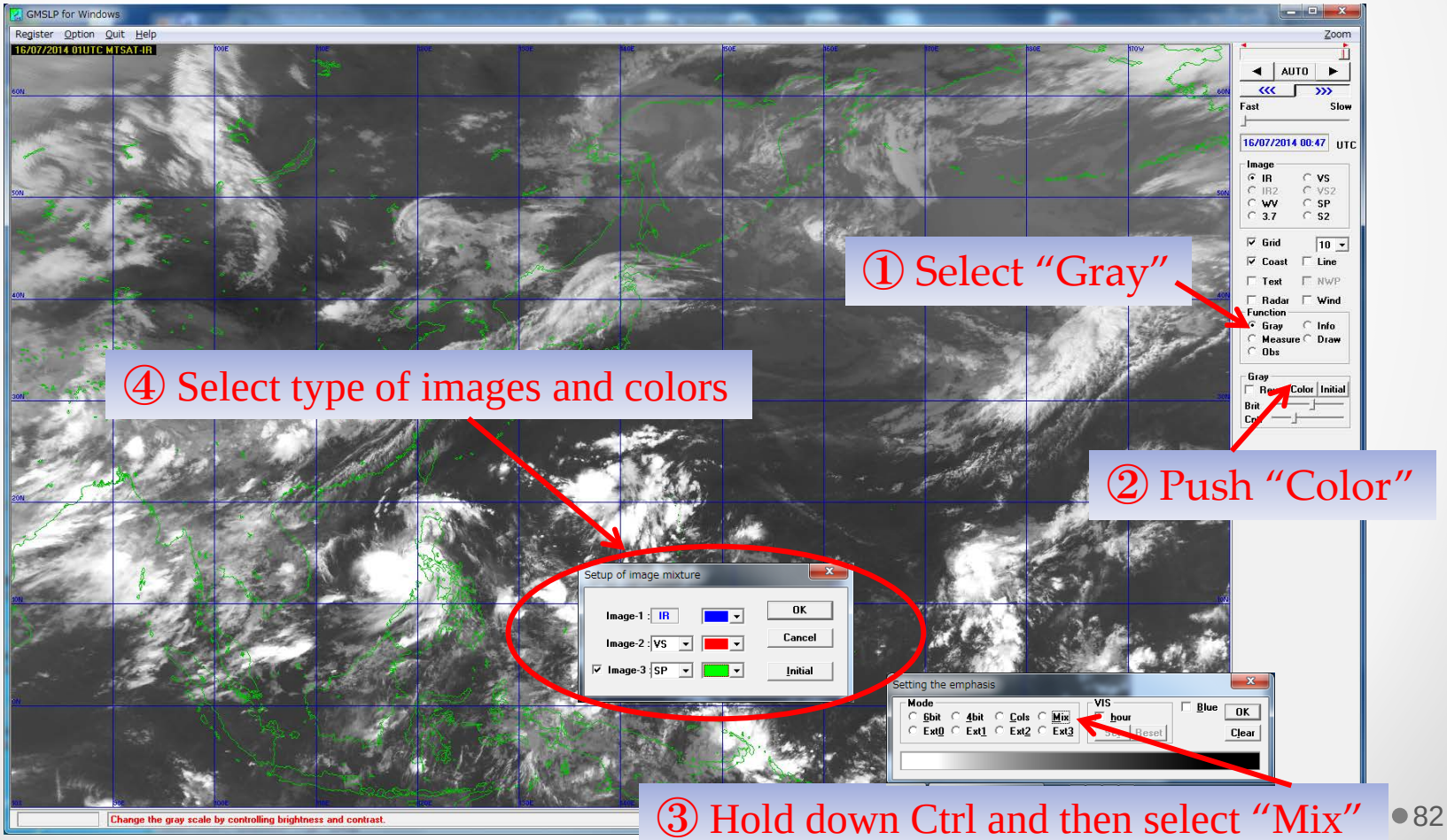
- SATAID has a function of coloring and compositing the plural imagery.
- SATAID, however, doesn't have configurations of gamma value.

→ Some simple compositions are available even by SATAID.

Let's move on to the next slide!

Practical training to create RGB composite imagery by SATAID

- Procedure for coloring and compositing imagery by SATAID



Practical training to create RGB composite imagery by SATAID

- Let's try to make following two RGB composite imagery by SATAID!

- Clouds Convection
  - R : VIS0.8
  - G : VIS0.8
  - B : IR10.8
- Night Microphysics
  - R : IR12.0 – IR10.8 ← indicated as "SP" on SATAID
  - G : IR10.8 – IR3.9 ← indicated as "S2" on SATAID
  - B : IR10.8 (Reverse)

Summary of RGB composite imagery

Pros & cons

- Drawbacks
  - A phenomenon does not always correspond to the allocated color.

  Distinction by movement and shift on imagery is required according to the situation. → The skill for analysis is required.
  - The examples introduced to you this time are the schemes adjusted for EUMETSAT's MSG to see easily.
  - The gradation adjustment and gamma correction will be required for imagery of the next “Himawari” satellites.

- Advantages
  - Simple process by composition of images enable to create RGB imagery.
  - Various information are derivable by one RGB image.
  - RGB imagery retain natural texture of single channel images.

References

EUMETSAT, 2005 : METEOSAT SECOND GENERATION SATELLITES Innovation for a reliable service,EUMETSAT,Darmstadt, 2-9.

Kerkmann, J., 2004 : APPLICATIONS OF METEOSAT SECOND GENERATION (MSG) RGB IMAGES: PART 02 INTRODUCTION TO RGB COLOURS (PowerPoint, Personal donation).

Kerkmann, J., D. Rosenfeld and M. König, 2005 : APPLICATIONS OF METEOSAT SECOND GENERATION (MSG) RGB IMAGES: PART 03 CHANNEL SELECTION AND ENHANCEMENTS (PowerPoint, Personal donation).

Kerkmann, J., D. Rosenfeld and G. Bridge, 2005 : APPLICATIONS OF METEOSAT SECOND GENERATION (MSG) RGB IMAGES: PART 04 RGB COMPOSITES WITH CHANNELS 01-11 AND THEIR INTERPRETATION (PowerPoint,Personal donation).

Kerkmann, J., 2005 : APPLICATIONS OF METEOSAT SECOND GENERATION (MSG) RGB IMAGES: PART 05 RGB COMPOSITES WITH CHANNEL 12 AND THEIR INTERPRETATION (PowerPoint, Personal donation).

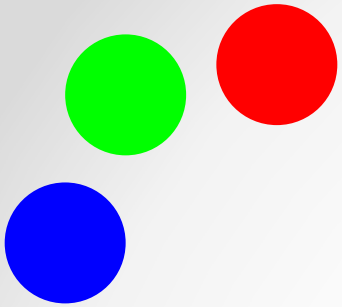
Kidder, S. Q. and T. H. V. Harr, 1995: Satellite Meteorology: An Introduction, Academic Press, 146-181.

Lensky, I., 2005 : User Guide for MSG_RGB Version 1.1 A Windows®-based interactive software for research of cloud microphysics and cloud aerosol interaction with MSG SEVIRI data, Hebrew University of Jerusalem, Jerusalem, 1-17.

Roesli, H., J. Kerkmann, D. Rosenfeld and M. König, 2004 : Introduction to RGB image composites (PowerPoint, Personal donation).

Rosenfeld, D. and I. M. Lensky, 1998: Satellite-based insights into precipitation formation processes in continental and maritime convective clouds, The Bulletin of American Meteorological Society 79, 2457–2476.

EUMETSAT website (The reference date: October 1, 2013)
http://www.eumetsat.int/



Thank you!

The End