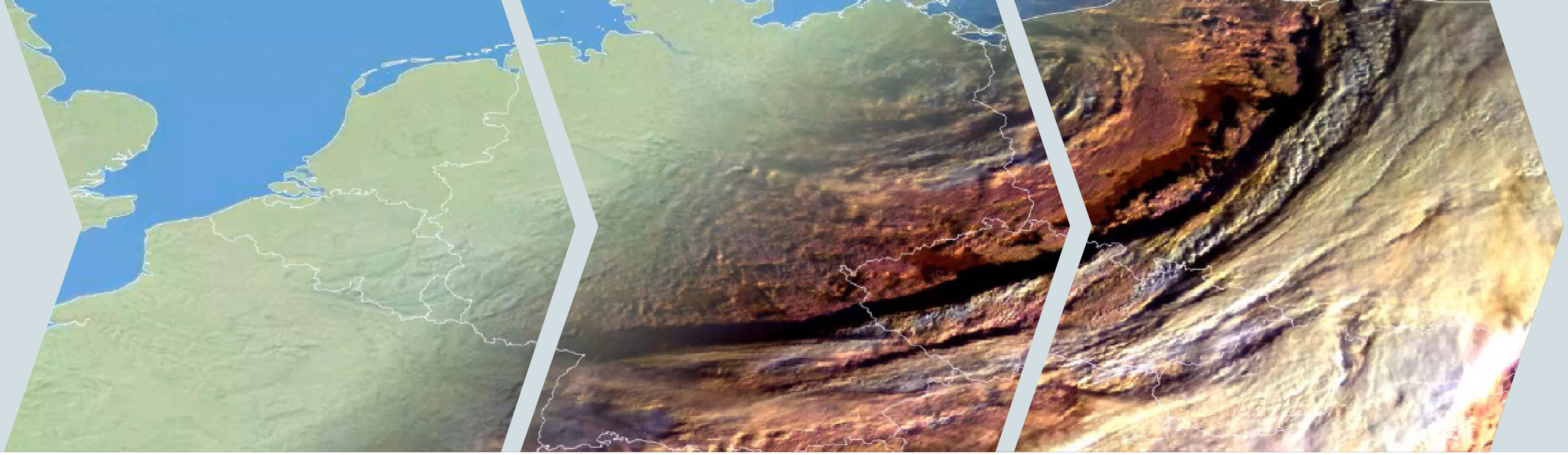

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# Quick Guides on SEVIRI composite images

- Sandwich Products QG
- Snow QG
- Natural Colour QG
- Airmass QG
- Dust QG
- Day Microphysics QG
- 24-hour Microphysics QG
- Severe Storms QG
- Night Microphysics QG
- HRV fog QG
- HRV Cloud QG
- Ash QG

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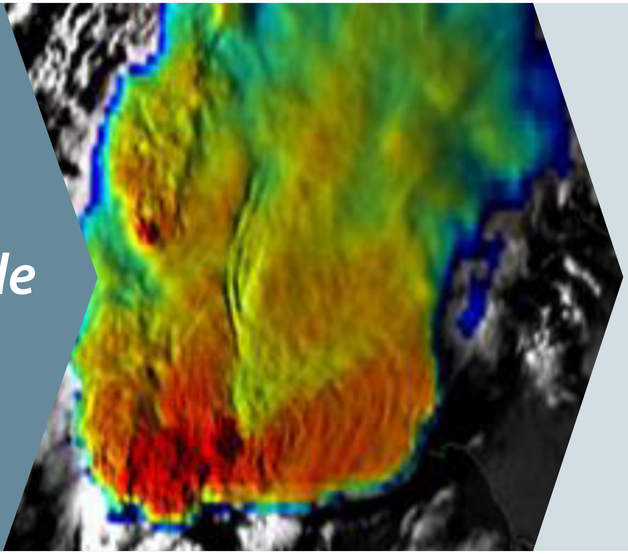
# Sandwich Products

## Quick Guide



**Aim:** Monitoring deep convection.

**Time period and area of its main application:**
All regions prone to convective storms, daytime in convection season.

**Applications and guidelines:**
With this product(s) it is possible to monitor those cloud top features of mature convective storms which are possibly related to severity. It combines two different image types, a high resolution visible band, and (most often) a colour-enhanced infrared window image.Such combination provides information on both cloud top 'morphology' and cloud top temperature. Mature thunderstorm cloud top features, such as overshooting tops, gravity waves, and above-anvil ice plumes are seen in solar channels due to the shadows these cast. The IR channel adds the cloud top temperature distribution info, e.g. overshooting top, cold U or cold ring shapes*. Intense (and/or long lived) overshooting tops, long-lived cold U/V or cold rings are indicators of strong updraft, thus possibly the severity of a storm. Another possible combination of the sandwich product is the Severe Storms RGB with a solar channel. In this way cloud top microphysics information (particle phase and size) is combined with the cloud top morphology. This sandwich product complements the first one, as small iceparticlesat (or above) the cloud top can be an indicator of possible storm severity. Sandwich products are most useful when monitoring or studying convective storms in a rapid scan animations and close up.

**Cold ring, cold U/V shaped storm: the storm top temperature distribution resembles ring, U or V shape with warmer temperatures inside.*

## Background

It combines two images in a different way to RGB images. While in the case of the RGB three channels or channel combinations are visualised in the three primary colours (red, green and blue), this method works with a background image (visible band) overlaid with another one (e.g. the colour-enhanced IR image or Severe Storms RGB), then blended together, using various mathematical functions. In that way both the visible and the upperlayer image can be observed simultaneously, in one single image.The table below is an example of the Meteosat SEVIRI channel pair often used to create the sandwich product.In principle, it is possible to use any other colour image product as the upper image, but one has to consider the added value of such combinations.

| Layers | Channel (µm) | Physically relates to |
|---|---|---|
| **Upper** | **Colour enhanced IR10.8** | Cloud top temperature of opaque clouds |
| **Background** | **HRV*** | Cloud top morphology |

**HRV: High Resolution Visible channel, IR: infrared, number: central wavelength of the channel in µm.*

EUMETSAT recommends using a standard colour scale (see below) to enhance the coldest regions of the IR10.8 image. Note that the temperature range of the colour scale might need tuning (shift or stretch) depending on the actual tropopause height and temperature.


## Benefits

- It merges two types of characteristics (e.g. visible and infrared) in one single product, making it possible to monitor these characteristics **simultaneously in animations.**
- The **sandwich product animation** is a proper tool to monitor severity related cloud top features of mature thunderstorms, such as intense (and/or long lived) overshooting tops, long-lived (more than ~40 minutes) cold U/V, cold rings, above-anvil ice plumes and gravity waves, which are typical indicators of strong updrafts, and, thus, possibly the severity of the storm.
- Good tool for both research and operational purposes.

## Limitations

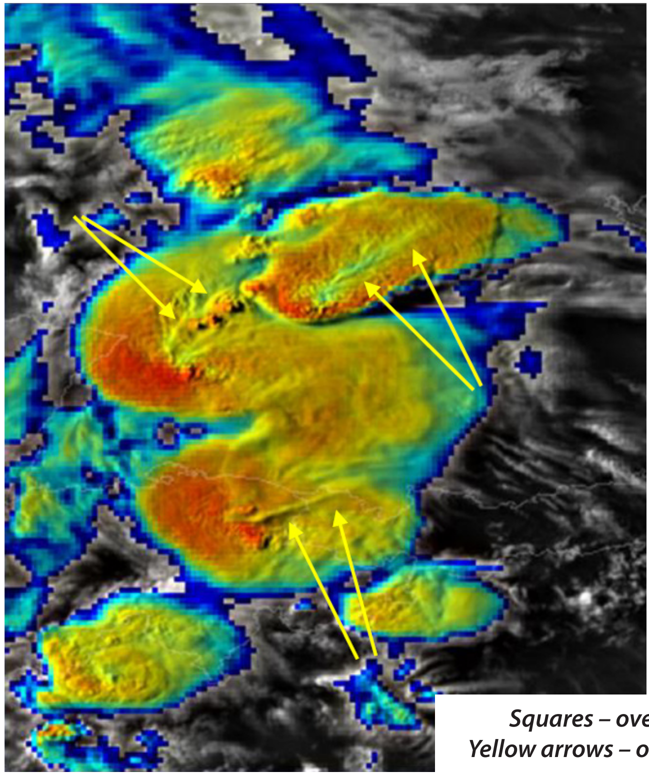
- Available during the day only.
- Close to midday the cloud top features like overshooting tops, ice plumes, gravity waves can be less prominent than at low solar elevation (as the shadows are shorter).
- The temperature range of the infrared colour scale might need a tuning (usuallya shift) depending on the geographical region (latitude) and/or actual tropopause height/temperature to obtain optimal result. One can find an optimal range for a geographical region, but even in that case the actual „best" range can change from case to case. However, an operational processing usually works with a fixed temperature range.

## Remarks

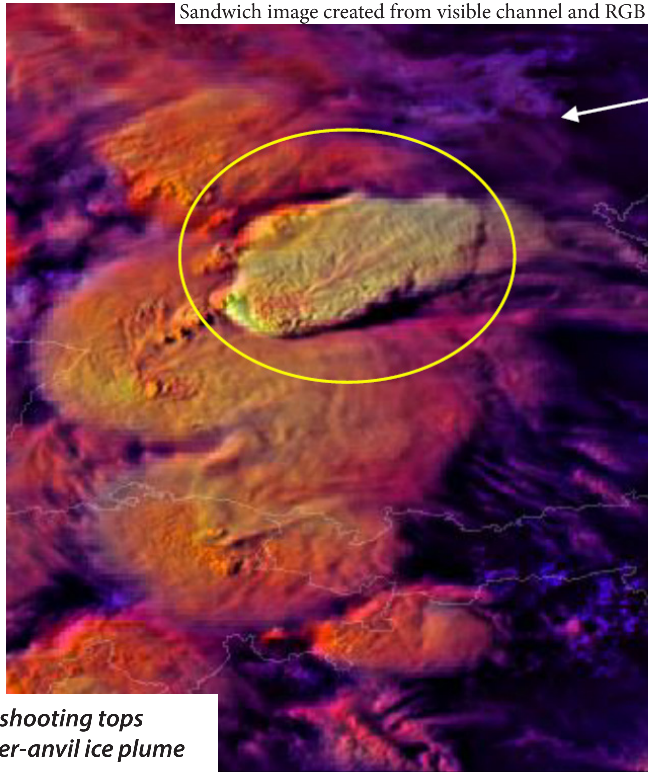
- Not only the convective cloud tops will be colour enhanced, but any clouds that are cold enough, for example thick cold clouds of a front, jet stream cirrus clouds, or orographic wave clouds.
- It is worth using it together with other types of satellite images and/or products, providing information, for example, on low-level features or the environment.

# Cloud top features in sandwich images created from visible and IR window channels






Sandwich image created from visible channel and RGB



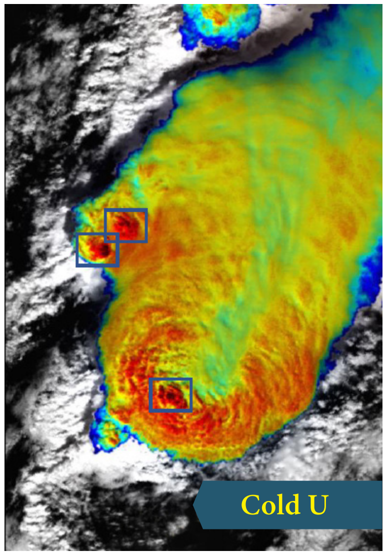
*Squares – overshooting tops*
*Yellow arrows – over-anvil ice plume*

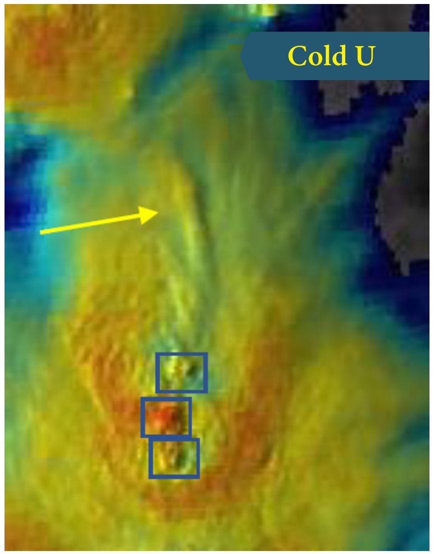
## Other type of sandwich product

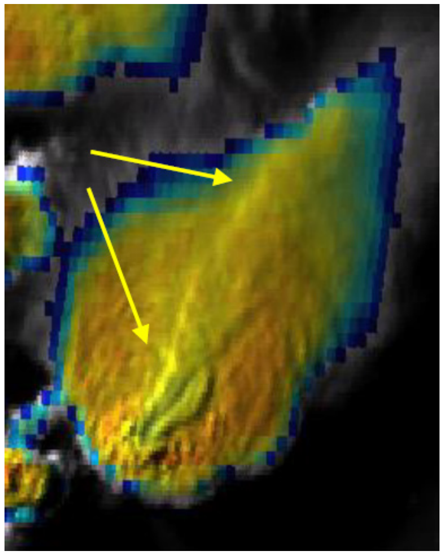
The left sandwich image shows the same scene as the image far left, but it is created from both the SEVIRI HRV and Severe Storms RGB. **The encircled cell is likely the most intense one in this scene, because it is more yellow than the other cell**, so its cloud top is composed of very small ice particles.

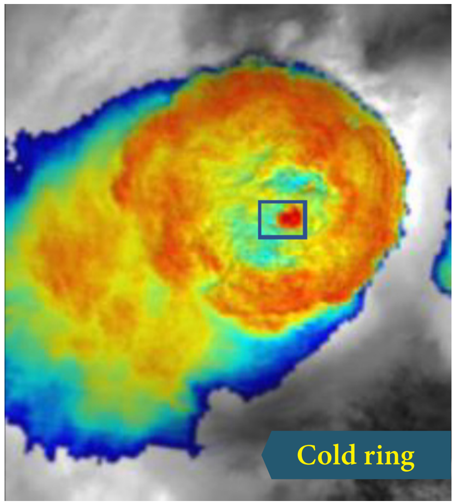
***Why is the cloud top particle size interesting?*** Small ice crystals at (or above) the cloud top of a continental mid-latitude storm can be an indicator of strong updraft (not necessarily always). Strong updraft scan transport small ice particles up to the cloud tops, as the small water droplets which formed at the cloud base, or within mid-levels of the updraft, do not have sufficient time to grow larger before freezing. In other cases, the small crystals may form above the anvil cloud top, in a drier air, e.g. Pileus clouds, or the above-anvil ice plumes (which typically are also indicators of strong updrafts).

***What does the yellow colour indicate?*** Yellowish pixels indicate small ice crystals in most of the cases, however, the colour shade also depends on the cloud top temperature. The encircled cell is likely the most intense one in this scene, as it is the most yellow in the image, although its temperature does not differ much from the temperature of the other big cells in the area, see the image bellow.






*Images created by Martin Setvak (CHMI) and Maria Putsay (Hungarian Meteorological Service)*

More about sandwich products on [www.eumetrain.org](www.eumetrain.org)

Contact: info@eumetrain.org

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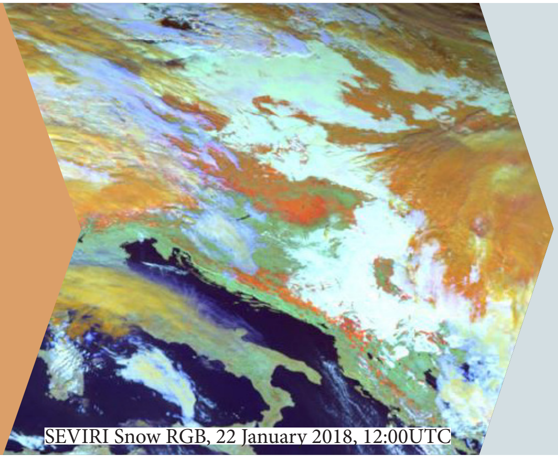
# SEVIRI Snow RGB

## Quick Guide



SEVIRI Snow RGB, 22 January 2018, 12:00UTC

**Primary aim**

To detect cloud-free snow with very good colour contrast against water clouds and clear ground not coveredbysnow.

**Secondary aim**

Distinguishing ice from water clouds and ice clouds from snow on ground.

**Time period and area of its main application:**

Daytime, throughout the year. Restrictions during winter for higher latitudes.

**Guidelines**

The Snow RGB provides **the best colour contrast** between snow-covered land and water clouds/fog. In most of the cases it discriminates water and ice clouds, and ice clouds from snow on the ground. Water clouds with **large** droplets are similar to mixed phase cloud tops or water clouds with thin cirrus on top. Particle size in cloud tops plays a role regarding the colour shade of the clouds in the Snow RGB (see theback side of the guide).

## *Background*

The table below lists the channels used in the **Snow RGB**. The red colour beam (**VIS0.8**) reflects cloud optical thickness. Optically thick clouds (e.g. stratus and fog) show a high contribution to the red colour beam while thin ice clouds (e.g. cirrus) are barely visible. The **NIR1.6** channel used for the green colour beam is primarily sensitive to the ice and water phase. At 1.6 µm, snow and ice crystals usually have a **low** reflectivity (~30%), while **water clouds** strongly reflect (~60-70%) the incoming radiation. Therefore, snow and ice are usually darker than water clouds in the **NIR1.6** image. Additionally, there is a less pronounced dependency upon cloud particle size at 1.6 µm.

Ice clouds with very small ice crystals may be as bright as water clouds, and water clouds with very large droplets may be as dark as ice clouds. During the day, IR3.9 radiation includes reflected solar and emitted thermal radiation. The blue channel (**IR3.9refl**) uses only the reflected part of the solar radiation at 3.9 µm. The solar component strongly depends on **cloud phase** on one hand and on **particle size** on the other. Water droplets reflect more solar radiation at this wave length than ice crystals. This property is overlaid by the particle size effect: large water drops or ice crystals reflect less solar radiation than small water droplets or ice crystals.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **VIS0.8** | Cloud optical thickness<br>Snow and ice | Thin clouds | Thick clouds<br>Snow-covered land/sea ice |
| **Green** | **NIR1.6** | Cloud top microphysics<br>Snow and ice | Ice clouds with large ice crystals on the cloud top<br>Snow-covered land/sea ice | Thick water clouds with small droplets |
| **Blue** | **IR3.9refl** | Cloud top microphysics<br>Snow and ice | Ice clouds with large ice crystals on the cloud top<br>Snow-covered land/sea ice | Thick water clouds with small droplets |

Notation: NIR: near-infrared, VIS: visible; channel number: central wavelength of the channel in micrometer.
IR3.9refl: 3.9 µm reflectivity computed from the solar component of the measured IR3.9 radiation.

## *Benefits*

- It provides **the best colour contrast** between snow/ice covered groundand water clouds.
- Provides a good discrimination between cloud-free land/sea and clouds.
- In most of the cases it provides information on cloud phase.
- It provides acceptable colour contrast between snow-covered ground and ice clouds.

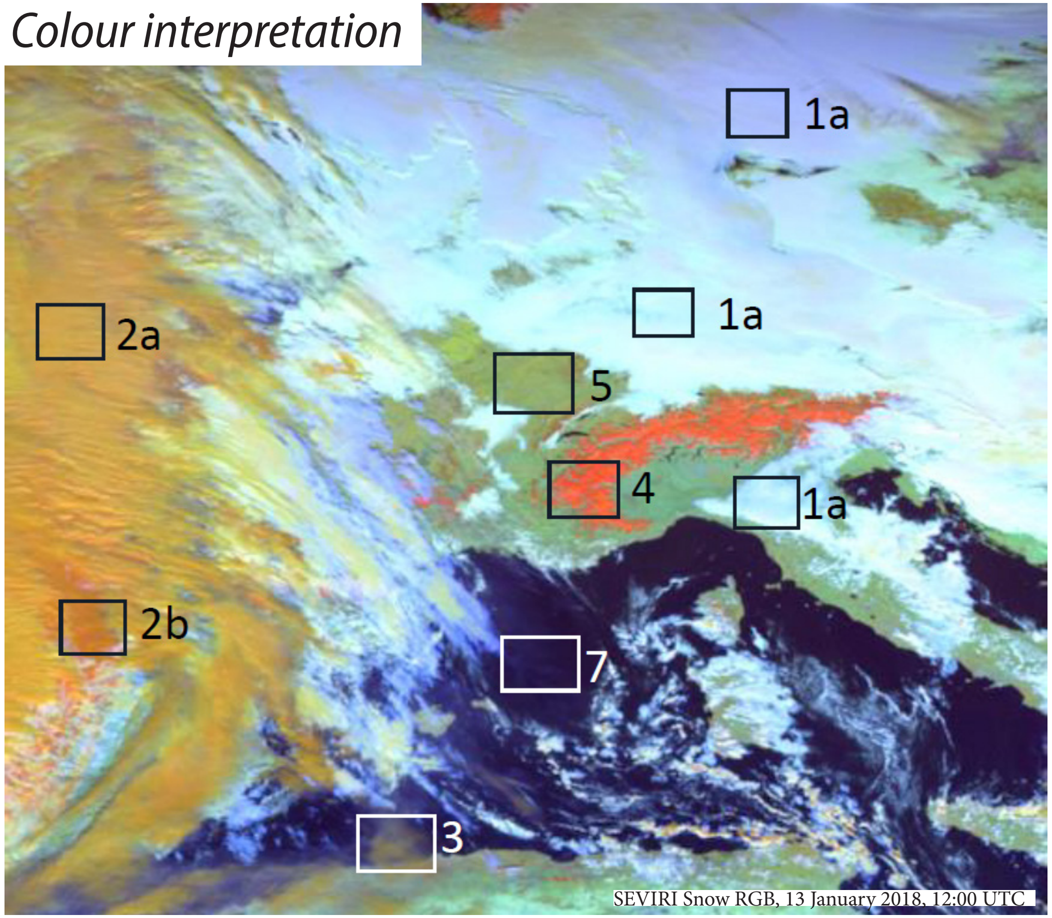
## *Limitations*

- Available during the day only.
- Pixel colour fades during dawn/dusk when the Sun's angle is low.
- Not applicable for higher latitudes during winter season.
- Water clouds with large droplets are similar to mixed phase cloud tops or water clouds with thin cirrus over them.
- Not usable over sandy deserts.

## *Good to remember*

- Limited use to discriminate soil surface characteristics.
- Limited ability to detect thin cirrus clouds.Thin ice clouds (e.g. cirrus) are barely visible.

# Colour interpretation



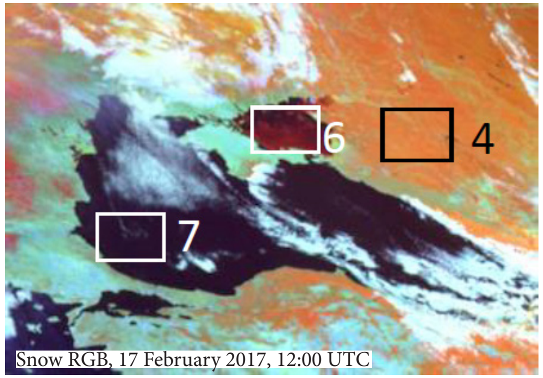
SEVIRI Snow RGB, 13 January 2018, 12:00 UTC

# SEVIRI **Snow** RGB

**QG**

| | |
|---|---|
| **1a** | Thick water cloud with **small** drop-lets (shades close to white, maybe slightly greenish or bluish) |
| **1b** | Thick water clouds with **large** drops or mixed phase clouds |
| **2a** | Thick ice clouds with **small** ice crys-tals on the cloud top |
| **2b** | Thick ice clouds with **large** ice crys-tals on the cloud top |
| **3** | Thin ice cloud over sea * |
| **4** | Snow on the ground |
| **5** | Cloud-free land (winter conditions) |
| **6** | Sea ice not covered by snow |
| **7** | Oceans, seas and lakes |

The colour shades depend on the position of the Sun and the viewing angle of the satellite.
***Semi-transparent clouds** can appear in different shades: very thin ice clouds are not seen, others add some orange/greyish shade to the colour of the underlaying surface.
**Snow-covered land and sea ice** (items 4 and 6) can vary in colour shade depending on how compact both the sea ice and snow cover on the ground are. Extended snow fields on mountain tops will show brighter red-orange tones than snow cover in urban areas or forests.

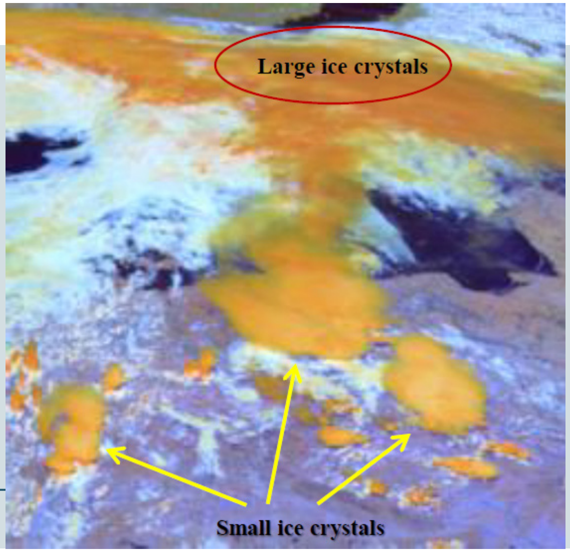


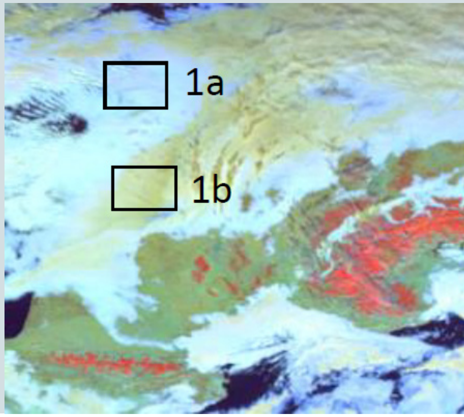
Snow RGB, 17 February 2017, 12:00 UTC

## *Drop size effects*

In the case of small ice crys-tals, both channels, NIR1.6 and IR3.9refl show higher reflectivity of solar radiation. Hence, the green and blue colour beam contribute more than in case of large ice crys-tals, turning the prevailing colour from a darker orange to a brighter orange hue.

Snow RGB, 30 May 2017, 12:00 UTC




Snow RGB
25 December 2017, 12:00 UTC

In the case of small water drops, the **Snow RGB** appears **whitish**, while larger drops are **light yellowish green**. This effect is due to the particle size sensitivity of both the NIR1.6 and the IR3.9 channel.

*More on RGBs on [www.eumetrain.org](www.eumetrain.org)*

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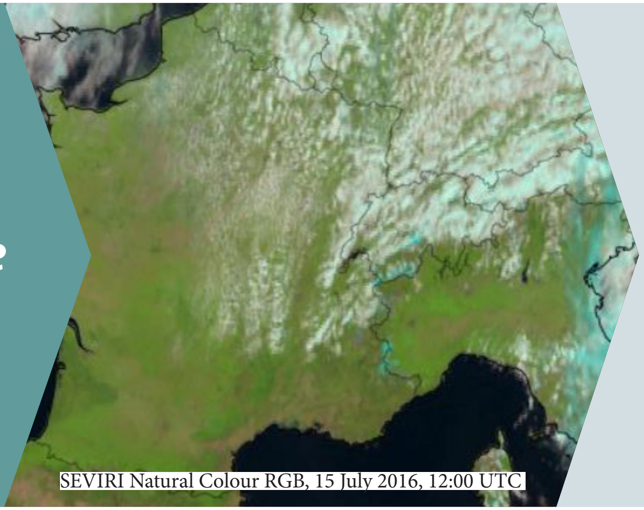
# SEVIRI **Natural Colour** RGB

## *Quick Guide*



SEVIRI Natural Colour RGB, 15 July 2016, 12:00 UTC

### Primary aim

Display **surface characteristics** (e.g. snow/vegetation/bare soil). Similar to a True Colour image except for ice, ice clouds and snow.

### Secondary aim

Distinguishing **ice from water phase** (water clouds from ice clouds or from cloud-free snow).

### Time period and area of its main application:

Daytime, throughout the year. Restrictions during winter for higher latitudes.

### Guidelines

The Natural Colour RGB is tuned to provide a satellite image which provides **surface vegetation information** and which resembles a colour photograph of the Earth. The three daylight channels provide similar colours to a True Colour image of the Earth, except for ice crystals (ice clouds, snow and ice) which are depicted in cyan. This RGB is sensitive to photosynthetically active vegetation while deserts, bare soils and dry vegetation show in a different colour. Snow on the ground can be distinguished from ice clouds, not so much by its hue than by its structure.

## *Background*

The table below lists the channels used in the Natural Colour RGB. The SEVIRI channel (**VIS0.6**) scans the Earth in the orange visible spectrum. As this channel is the one nearest to the blue spectrum it is used for the blue colour beam of the Natural Colour RGB. The green colour beam (**VIS0.8**) is already in the IR spectrum and, therefore, not visible to the human eye. However, plants strongly reflect solar radiation at this wavelength when they are photosynthetically active (see example above). The **NIR1.6** channel used for the red colour beam is primarily sensitive to the ice and water phase of clouds. At 1.6 µm, **ice clouds** usually have a low reflectivity (~30%), while **water clouds** strongly reflect (~60-70%) the incoming radiation. Therefore, ice clouds are usually darker than water clouds in the **NIR1.6** image. Additionally, there is a less pronounced dependency upon cloud particle size at 1.6 µm. Ice clouds with very small ice crystals may be as bright as water clouds, and water clouds with very large droplets may be as dark as ice clouds.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **NIR1.6** | Cloud phase<br>Snow cover | Ice clouds<br>Snow covered land/sea ice | Water clouds |
| **Green** | **VIS0.8** | Cloud optical thickness<br>Green vegetation | Thin clouds | Thick clouds<br>Snow covered land / Vegetation |
| **Blue** | **VIS0.6** | Cloud optical thickness<br>Green vegetation | Thin clouds<br>Vegetation | Thick clouds<br>Snow covered land / Sea ice |

Notation: NIR: near-infrared, VIS: visible; channel number: central wavelength of the channel in micrometer.

## *Benefits*

- Easy to interpret because most of the colours of the image are very similar to a True Colour image of the Earth.
- Reflects surface characteristics like vegetation, rocky soils and deserts.
- Ice clouds can be distinguished from water clouds.
- Snow on the ground, as well as frozen sea ice, can be detected.
- There is a high colour contrast between snow and fog/water clouds.

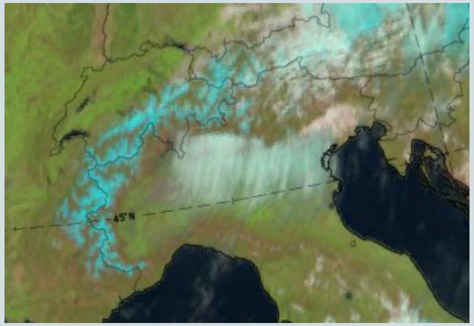
## *Limitations*

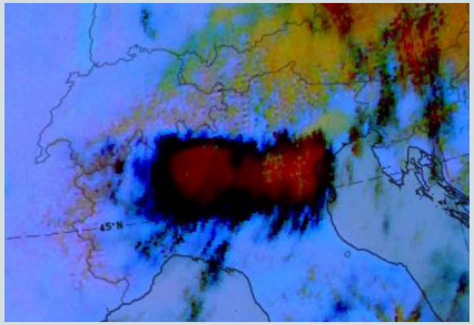
- Available during the day only.
- Pixel colour fades during dawn/dusk when the sun angle is low.
- Not applicable for higher latitudes during winter season.
- Snow-covered land might have similar colour as high clouds with large ice crystals.
- Very small ice crystals in cirrus clouds appear whitish instead of cyan.
- The cyan colour as indication for ice phase clouds can be misleading in the case of large water droplets. The latter absorb shortwave solar radiation at 1.6 µm the same way small ice crystals do.
- Thin cirrus clouds are not seen in the Natural Colour RGB.

# SEVIRI **Natural Colour** RGB **QG**

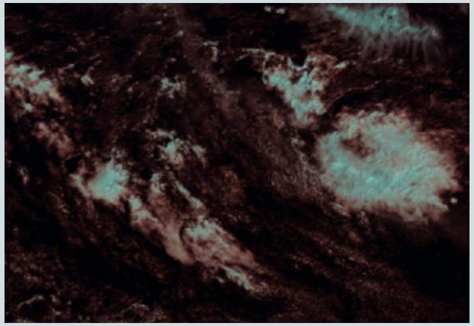
| | | | |
|---|---|---|---|
| 1 | Water clouds (fog or stratus) | 5 | Ground covered by photosynthetically active vegetation |
| 2 | Mixed phase clouds or clouds with a cirrus veil on top | 6 | Sandy deserts, bare soils or arid vegetation |
| 3 | Thick ice clouds with large ice crystals in higher levels | 7 | Sea ice not covered by snow |
| 4 | Snow and ice on the ground | 8 | Oceans and lakes. |

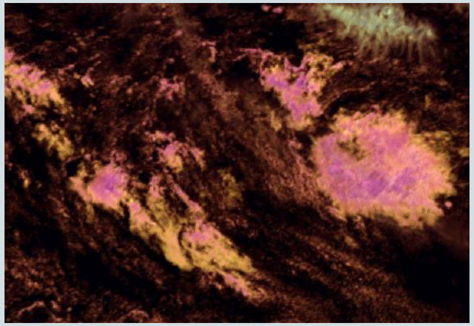
## *Limitations*





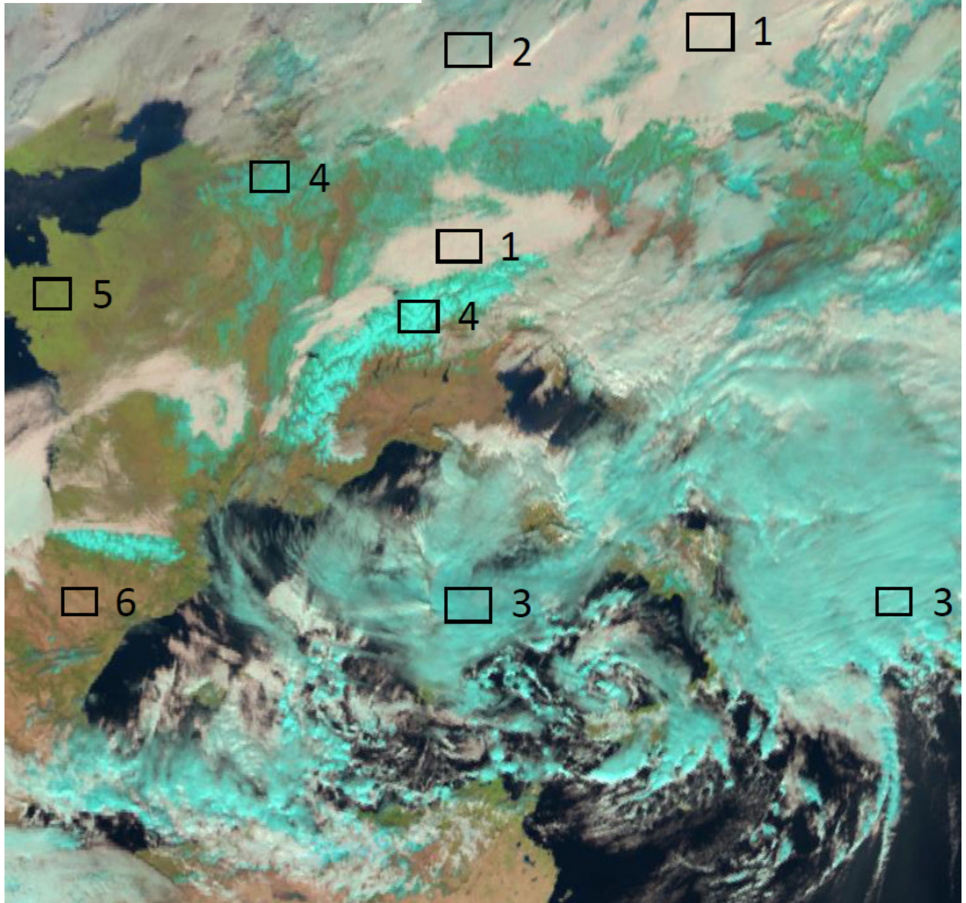
In the case of **very small ice particles** (e.g. orographic clouds) as shown in the left image over northern Italy on 7 April 2017 at 12:00 UTC, the colour of the ice cloud becomes whitish. The **Dust RGB** (right image) of the same date shows a compact ice cloud.



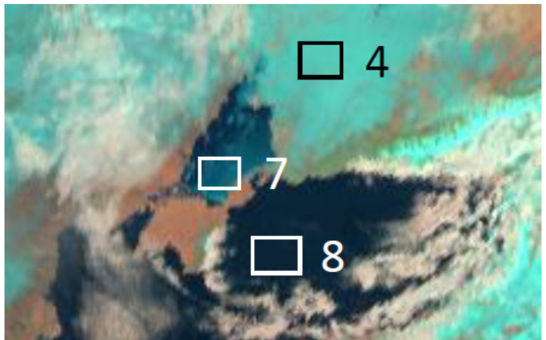


If water droplets reach bigger sizes, the Natural Colour RGB will depict them in cyan hues as shown in this example over the Tropical Sea (left image). A comparison to the **Cloud Phase RGB** (right image) shows that most clouds are water clouds (magenta to yellow), and only the cloud in the upper right image corner is an ice cloud.

## *Colour interpretation*




SEVIRI Natural Colour RGB, 18 January 2017, 12:00 UTC




Natural Colour RGB, 17 February 2017, 12:00 UTC

**Sea ice and snow covered land** (item 4 and 7) can vary in the colour shade depending on the compactness of sea ice and of the snow cover on the ground. Extended snow fields on mountain tops will show brighter cyan colour than snow cover in urban areas or forests.

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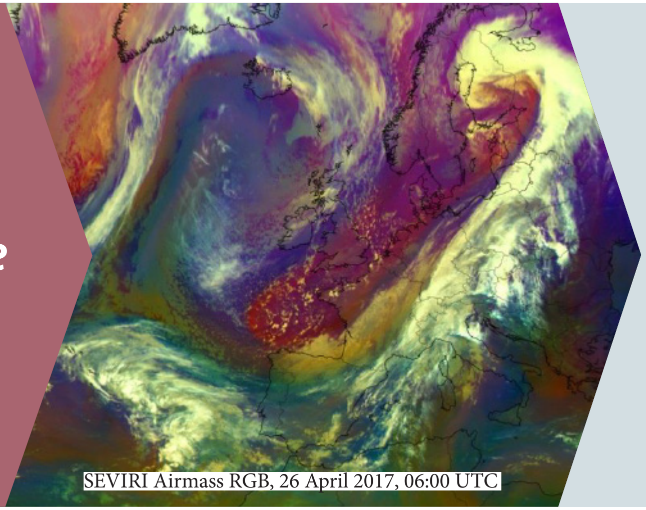
# SEVIRI **Airmass** RGB

## *Quick Guide*



SEVIRI Airmass RGB, 26 April 2017, 06:00 UTC

### Primary aim

Distinguishing **air masses** and high reaching **multi-layered clouds**; helps to analyse dynamic processes in the atmosphere.

### Time period and area of its main application:

This RGB can be used day and night through out the year, its colours do not change with seasons. Difficulties might arise at larger satellite viewing angles with increasing ozone absorption (limb cooling effect). Close to the limb, tropical air masses can not be analysed.

### Secondary aims

Detection of ongoing **cyclogenesis**, identification of areas with **subsidence**. Distinguishing high from mid-level clouds.

### Guidelines

The **Airmass RGB** is mainly used for distinguishing **polar** from **tropical** airmasses. Ongoing cyclogenesis, the position of jets and deformation zones can been seen at a glance, as well as frontal cloud systems and descending dry stratospheric air behind them.

## *Background*

The **Airmass RGB** uses the two water vapour and the ozone absorption channels. The **WV6.2–WV7.3** difference (**red** colour beam) reflects the vertical humidity distribution. It distinguishes mid-level from high-level humidity and mid-level from high-level clouds. The **IR9.7–IR10.8** difference (**green** colour beam) is sensitive to the ozone content of the atmosphere. It distinguishes ozone rich polar air from ozone poor tropical air masses. All clouds are seen in this channel difference. **WV6.2** (**blue** colour beam) separates dry from moist air. Only the high clouds and upper level humidity are seen. The Airmass RGB does not provide microphysical information about clouds.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **WV6.2–WV7.3** | Vertical water vapour distribution / Mid-and high-level clouds | Mid-level humidity Mid-level clouds | Dry upper levels High-level clouds |
| **Green** | **IR9.7–IR10.8** | Height of tropopause Clouds at all levels | Polar air mass (Ozone rich) | Tropical air mass (Ozone poor) |
| **Blue** | **WV6.2** | Water vapourcontent in upper layer – High clouds | Dry upper levels | Moist upper levels |

Notation : WV: water vapour, IR: infrared, channel number: central wavelength of the channel in micrometer [μm].

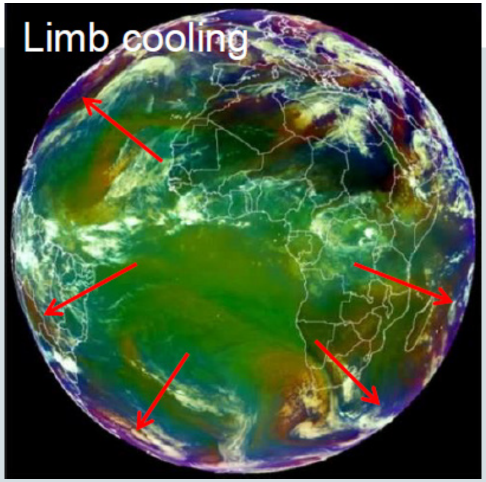
## *Benefits*

- It indicates the position of jet streams and deformation zones.
- It indicates descending dry stratospheric air (e.g. behind cold fronts and in the centre of cyclones/upper level lows).
- The Air mass RGB distinguishes between cold and warm air masses (polar/tropical) through the assessment of the ozone content in channel IR9.7.
- It helps detect potential vorticity anomalies and related cyclogenesis.
- It discriminates mid- from high-level clouds.
- It evaluates the amount of upper tropospheric humidity (bright, strong green colour stands for more upper tropospheric humidity).
- Under certain conditions (e.g.over desert surfaces) the Air mass RGB is even better for volcanic $SO_2$ detection than the Ash RGB.

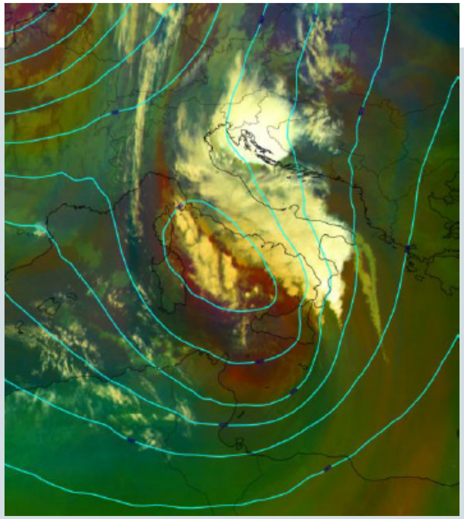
## *Limitations*

- Close to the limb a tropical air mass appears bluish instead of greenish.
- If the surface temperature is very low in cloud-free areas, the contribution of the green beam is very large. This results into an olive green colour within a **polar** air mass instead of a bluish colour.
- While high- and mid-level clouds are easy to monitor, low-level clouds are hard to identify. Low-level clouds appear as patchy structure in the colour of the corresponding air mass.
- Reddish tones might also appear over areas without subsidence. This is caused by very hot and dry air (e.g. deserts).
- Very low clouds can not be distinguished satisfactorily.

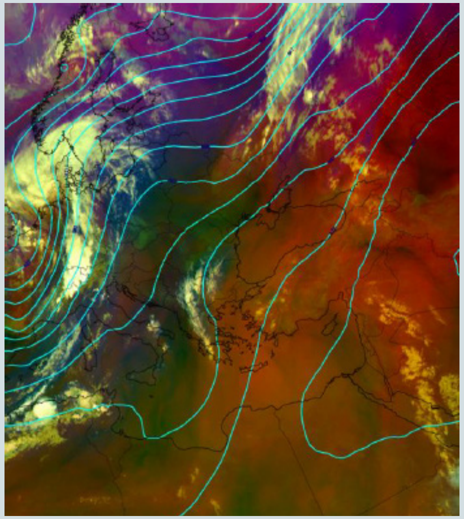
# SEVIRI *Airmass* RGB — QG

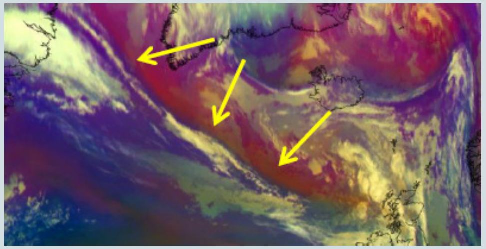



**Limb cooling effect:** Ozone absorption increases with increasing satellite viewing angles. This results in high ozone absorption even in tropical areas and to a misleading blue colourfor the affected regions.



The Airmass RGB from 11 Sept. 2017, 06:00 UTC shows **reddish** colour tones over the Mediterranean Sea south west of Italy in the centreof an upper level trough (geopotential height at 500 hPa). This is an indication of ongoing **cyclogenesis** within a tropical air mass.

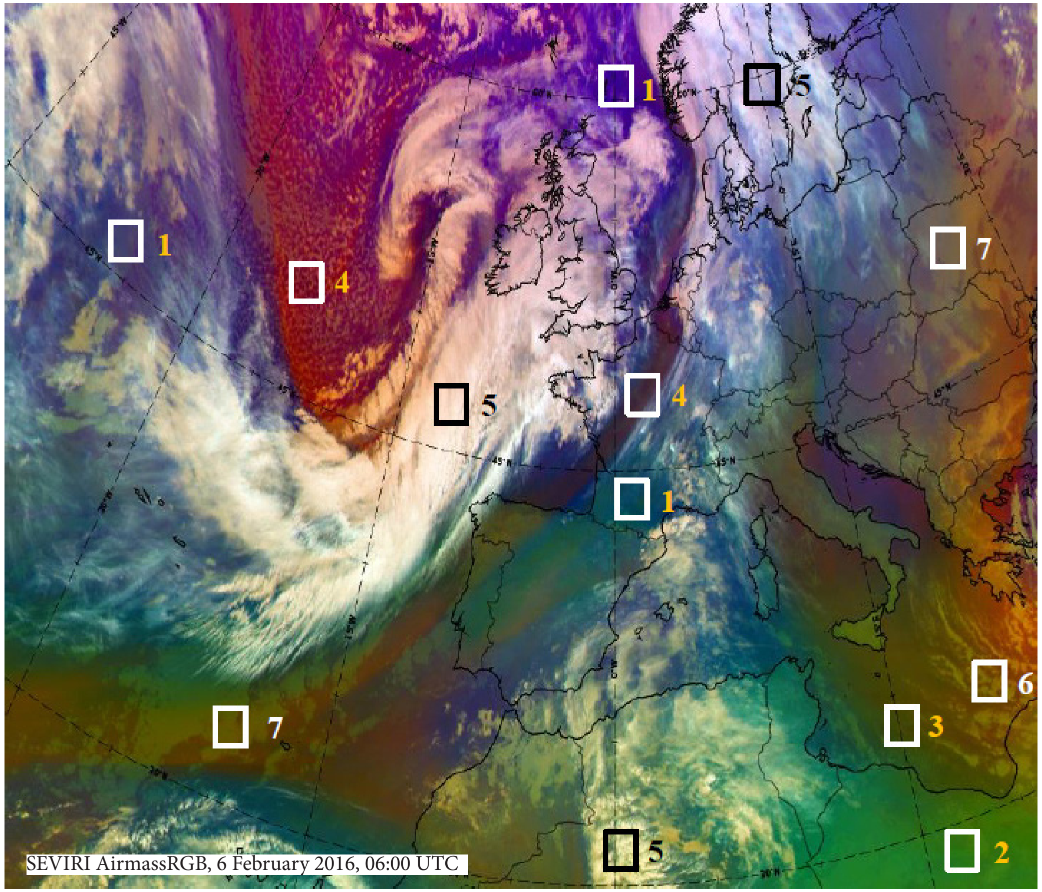




The above image from 7 Sept. 2017, 06:00 UTC shows the position of the **jet axis** along the transition from blue to red colours (yellow arrows).

Very **hot and dry air masses** also appear as **reddish** colour tones in the Airmass RGB as can be seen in the above image over south-eastern Europe on 8 August 2017 at 18:00 UTC. This is not an indication of ongoing cyclogenesis or subsidence.

## *Colour interpretation*




| | Air masses: | | Clouds: |
|---|---|---|---|
| 1 | Cold, ozone richpolar air mass | 5 | High-level thick clouds |
| 2 | Warm, ozone poor tropical air masses (high upper tropospheric humidity) | 6 | Mid-level ice and water clouds |
| 3 | Warm air masses with low upper tropospheric humidity | 7 | Low-level clouds: no specific colour, just the structure is visible,appears bluish in polar and greenish in tropical air masses. |
| 4 | Dry air masses (indicating e.g. subsiding air, PV anomalies and the position of jet streams) | | |

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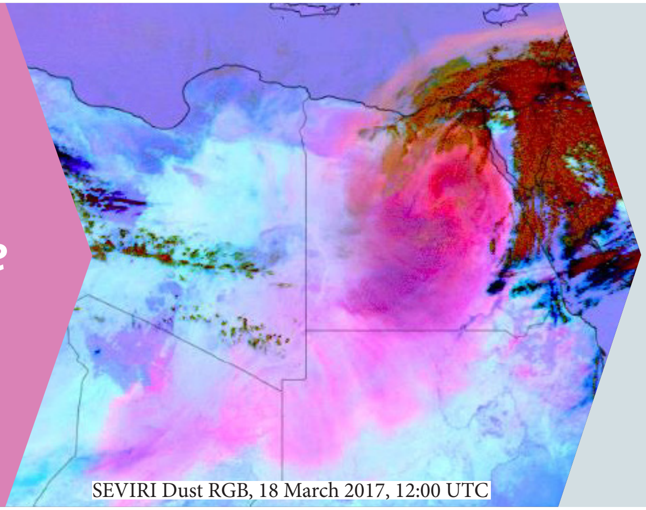
# SEVIRI **Dust** RGB

## *Quick Guide*



SEVIRI Dust RGB, 18 March 2017, 12:00 UTC

**Primary aim**

Detection of **dust** in the atmosphere.

**Time period and area of its main application:**

Day and night throughout the year.

**Secondary aims**

Identification of **high level cirrus clouds** and low level **moisture boundaries**, distinguishing water clouds from ice clouds. Further on it also allows the detection of volcanic ash and $SO_2$ plumes.

**Guidelines**

The **Dust RGB** is identical to the 24-hour Microphysics and to the Ash RGB as far as the involved channels are concerned, except that the temperature ranges have been tuned for the detection of **dust clouds**. Although the Dust RGB does not provide information on height and concentration, it provides excellent temporal resolution and colour contrast, day and night. Because it works over deserts, we can follow its movement back to the dust source. It also detects **water vapor boundaries** in lower atmospheric levels. It depicts **thin and thick ice clouds** (e.g. cirrus clouds versus cumulonimbus clouds), and thin and thick **mid-level water clouds**. The colours of the cloud-free areas in the Dust RGB vary strongly with surface temperature, thus from night to day, and from winter to summer.

## *Background*

The **Dust RGB** makes use of the three **window channels** of MSG. This RGB has been primarily tuned for dust detection, but it is able to detect other cloud types as well. The **IR12.0–IR10.8** difference (red colour beam) helps to distinguish dust from ice and water clouds. The red signal is high for dust, low for thin cirrus clouds and medium for all other cloud types. Additionally, this difference helps to identify thin (mid- and high-level) clouds and provides visual information on low-level moisture boundaries in cloud-free areas. The **IR10.8–IR8.7** difference (green colour beam) helps distinguish dust clouds from the cloud-free desert surface. It also distinguishes ice from water clouds. The blue signal (IR10.8) depends on the thickness and temperature of the dust cloud (and on the temperature of the underlying surface). The magenta colour of dust clouds over warm land results from a high blue contribution. The blue signal also distinguishes thick water from ice clouds according to their top temperature.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **IR12.0–IR10.8** | Cloud optical thickness<br>Thin dust | Thin ice clouds | Dust |
| **Green** | **IR10.8–IR8.7** | Cloud phase | Thin ice clouds<br>Dust | Water clouds<br>Deserts |
| **Blue** | **IR10.8** | Temperature | Cold clouds | Warm surface<br>Warm clouds |

Notation: IR: infrared; channel number: central wavelength of the channel in micrometer.
Remark : The channel combination is the same as for the Ash and the 24-hour Microphysics RGBs, but the tunings are different (not shown here).

## *Benefits*

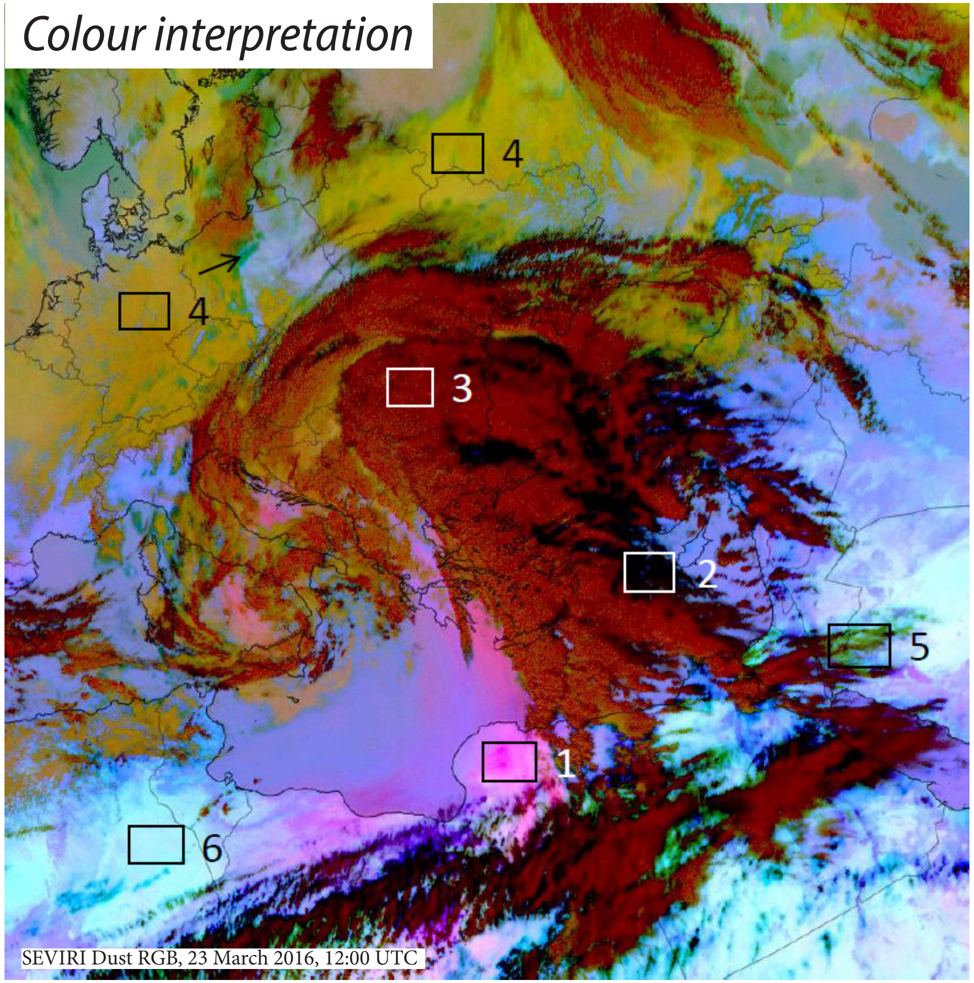
- The Dust RGB is available day and night.
- Allows for monitoring of the displacement of a dust clouds at high temporal resolution.
- The Dust RGB is best suited for thin cirrus cloud detection.
- Allows water clouds to be distinguished from ice clouds.
- Allows for detection of water vapour boundaries in the lower troposphere.
- Good colour contrast between thin and thick midlevel clouds and between thin and thick ice clouds.

## *Limitations*

- It is not possible to determine the height nor the concentration of the dust cloud in the atmosphere from the Dust RGB alone.
- It isn't possible to deduce the visibility on the ground.
- The typical magenta colour of dust in the atmosphere is not visible when clouds obscure the scene.
- Thin or low level dust clouds over the sea are difficult to detect. Solar imagery should be used in this case (e.g. Natural Colour RGB).
- Very thin (low concentration) dust clouds are not detected by the Dust RGB.
- Low clouds are not well seen in the Dust RGB.

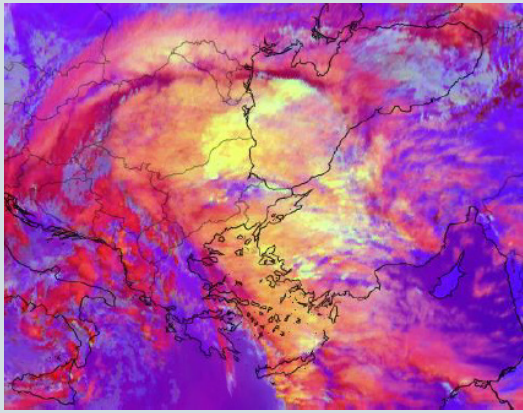
## Colour interpretation

# SEVIRI **Dust** RGB | QG



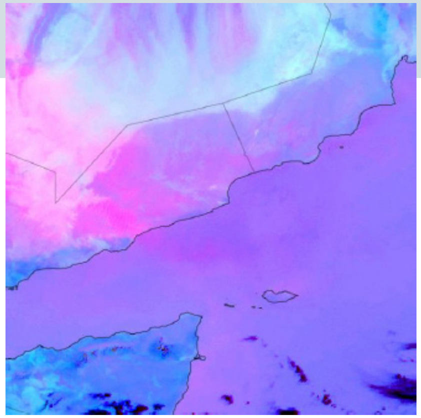
SEVIRI Dust RGB, 23 March 2016, 12:00 UTC

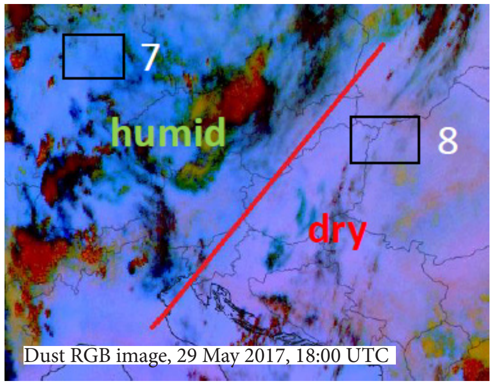
## Comparison to other RGBs



**Dust** in cloud-free regions is depicted in magenta by the Dust RGB. Inside clouds, the presence of dust particles acts as cloud condensation nuclei and generates small ice crystals which can be seen in the Severe Storms RGB (bright yellow colour). **Sev. Storms RGB, same date as upper right image.**

The comparison of the Dust RGB with the Natural ColourRGB shows that the latter better resolves low dust clouds over the sea due to higher reflectivity of dust particles compared to the sea (high contrast). Over land, the situation is reversed. Because of the high reflectivity of sand for shortwave solar radiation, the contrast between dust cloud and land is poor in the Natural ColourRGB. **Natural ColourRGB (left) and Dust RGB (right) from 1 June 2017, 12:00 UTC.**





Dust RGB image, 29 May 2017, 18:00 UTC

| | | | |
|---|---|---|---|
| 1 | Dust or ash clouds. The colour of dust clouds varies from pink to violet, ash clouds are more reddish. | 5 | Thin cirrus clouds over deserts appear green. |
| 2 | Cirrus clouds with no clouds below are black or dark blue. | 6 | Hot sandy deserts, dry air mass.* |
| 3 | Thick, high and cold ice clouds | 7 | Humid air in lower levels.* (~ 700 hPa) |
| 4 | Thick mid-level clouds. Thin mid-level clouds appear green (black arrow). | 8 | Dry air in lower levels.* |

** Colours can vary considerably depending on surface temperature.*

Upper image: Low level humidity gradients can be observed in the Dust RGB in form of a colour gradient from **darker blue** (humid air mass) to a more **pinkish blue** (dry air mass).

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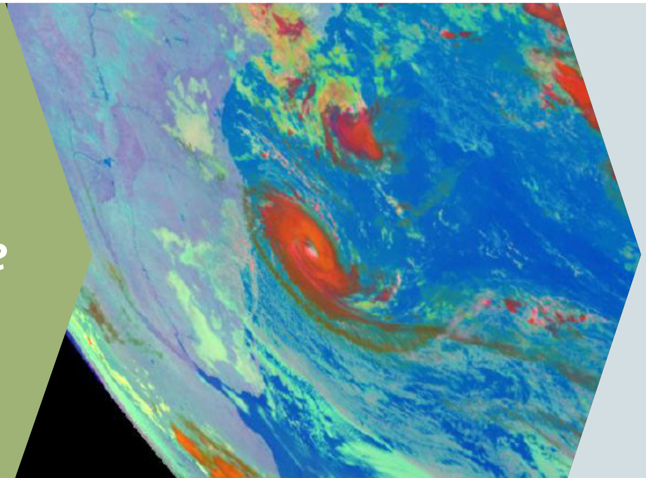
# SEVIRI *Day Microphysics* RGB

*Quick Guide*



SEVIRI Day Micro RGB, 27 March 2004, 12:00UTC

### Primary aim

To provide a complex cloud analysis, to distinguish **ice from water phase**, and to provide information on **cloud top particle size, temperature** and cloud **optical thickness**.

### Secondary aims

Monitor the development of **convection**, fog and low clouds.

### Time period and area of its main application:

Daytime, throughout the year. Restrictions during winter for higher latitudes.

### Guidelines

The Day Microphysics RGB is a **cloud-oriented** RGB. It provides a complex cloud analysis, merging cloud thickness with cloud top temperature and microphysical (phase and particle size) information. This RGB is tuned to highlight cloud top microphysical characteristics: **cloud top phase** and **cloud particle size.** On Day Microphysics RGB animations one can monitor the **phases/ processes of developing convection** (i.e. the starting of glaciation at the cloud tops, the evolution of particle size and the dissipation process with mainly large ice crystals).

## *Background*

The table below lists the channels used in the Day Microphysics RGB. The red colour beam (**VIS0.8**) reflects cloud optical thickness. Optically thick clouds show a high contribution to the red colour beam. The green channel (**IR3.9refl**) uses only the reflected part of the solar radiation at 3.9 µm. During theday the IR3.9 data includes reflected solar and emitted thermal radiation. The Day Microphysics RGB uses the reflectivity computed from the solar component. The solar component is depending on **cloud phase** on one hand and on **particle size** on the other. Water droplets reflect more solar radiation at this wavelength than ice crystals. This property is overlaid by the particle size effect: large water drops or ice crystals reflect less solar radiation than small water droplets or ice crystals. The blue channel (**IR10.8**) reflects surface and cloud top temperatures, where warm temperatures result in a high blue contribution and cold temperatures in a low blue contribution (inversed IR image).

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **VIS0.8** | Cloud optical thickness | Thin clouds | Thick clouds |
| **Green** | **IR3.9refl** | Cloud microphysical properties | Ice clouds<br>Large particles | Water clouds<br>Small particles |
| **Blue** | **IR10.8** | Temperature | Cold thick clouds | Warm land/sea<br>WarmClouds |

Notation: IR: infrared, VIS: visible; channel number: central wavelength of the channel in micrometer.
IR3.9refl: 3.9 µm reflectivity computed from the solar component of the measured IR3.9 radiation.

## *Benefits*

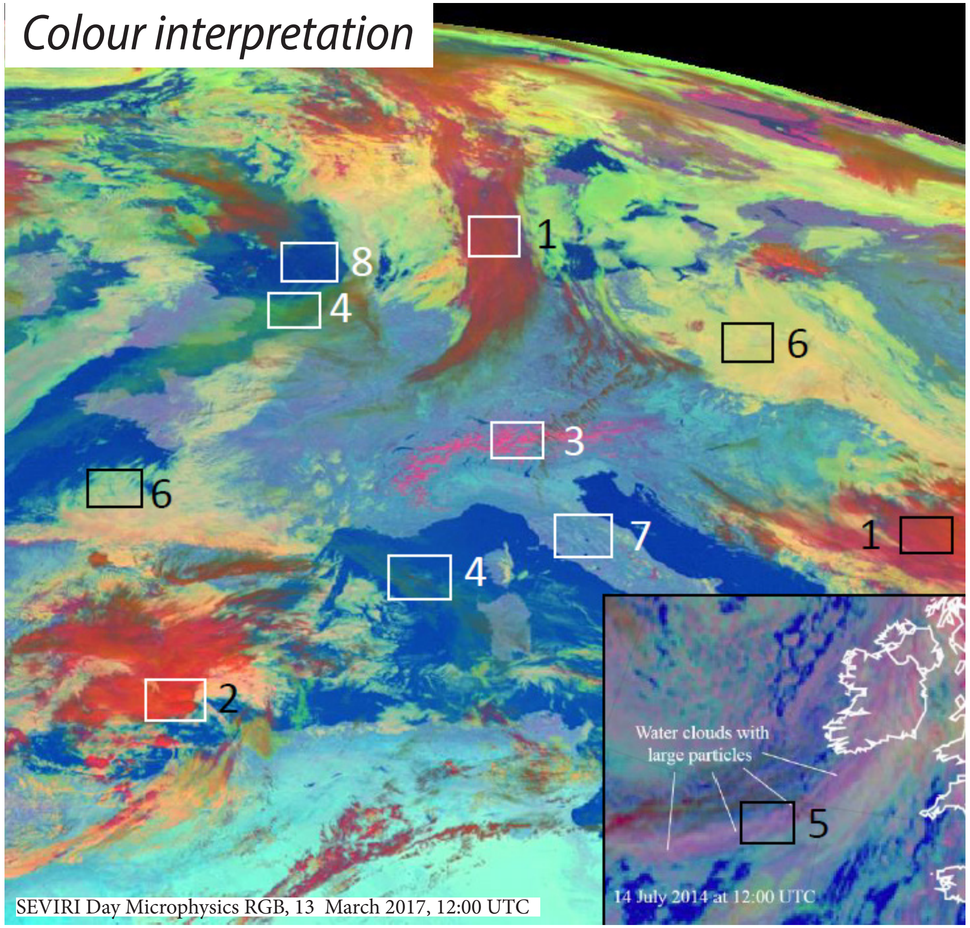
- Good colour contrast between ice and water clouds, especially for water clouds with small droplets.
- Provides information on cloud particle size. Orange colour indicates the presence of small ice crystals on top of cumulus clouds.
- Good colourcontrast between water clouds with small droplets and snow on ground.
- Provides information on cloud optical thickness.
- Provides information on cloud top temperature.
- It detects wildfires.
- Detection of super-cooled water clouds.

## *Limitations*

- Available during the day only.
- Pixel colour fades during dawn/ dusk when the sun's angle is low.
- The proper interpretation of all colour shades needs practice.
- Not applicable for higher latitudes during winter season.

# SEVIRI *Day Microphysics* RGB — QG

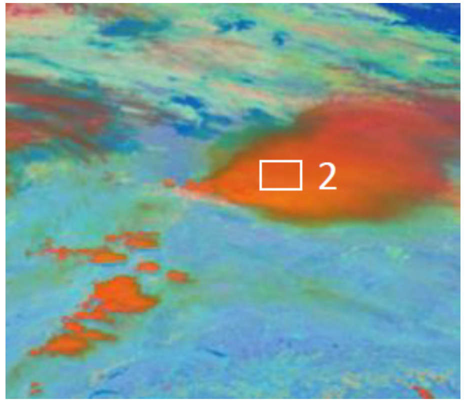
## *Colour interpretation*




SEVIRI Day Microphysics RGB, 13 March 2017, 12:00 UTC

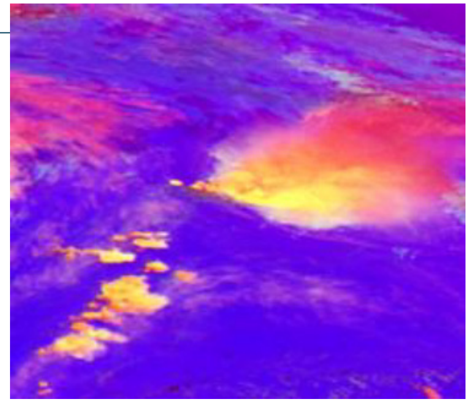
| | |
|---|---|
| 1 | Thick ice clouds with large ice particles. |
| 2 | Thick ice clouds with small ice crystals on top. |
| 3 | Snow and ice on the ground. |
| 4 | Semi-transparent ice clouds.* |
| 5 | **Thick**, low-level water clouds with large particles. |
| 6 | Low to mid-level **thick** water clouds with smaller particles. |
| 7 | Cloud-free land. |
| 8 | Oceans and lakes. |

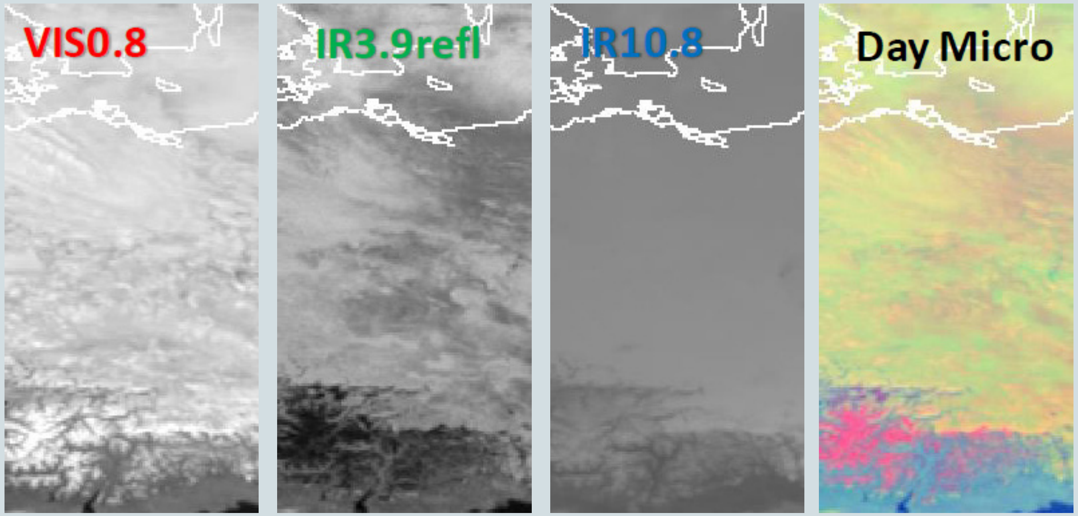
* The colour shade of **thin clouds** depends also on the type of the underlaying surface.




*Images:* In case of **highly active** thunderstorms, the **Day Microphysics RGB** (image above) turns from dark red into a bright orange. This colour change is owed to the sensitivity of the **IR3.9** channel to **ice particle size**. The same effect of channel IR3.9 can be observed in the **Severe Storms RGB** (image below) which offers more distinct information about the storm's activity centers.

Day Microphysics RGB, 22 June 2017, 12:00 UTC






## *Drop size effect*

**18 February 2017, 12:00 UTC**

The VIS0.8 image shows optically thick cloudiness over central Europe with a more patchy cloud structure over Poland and the Czech Republic. The IR3.9refl image shows **larger** water droplets over Poland and East Germany reflecting less sunlight at 3.9 µm than the **smaller** drops over central Germany. The IR10.8 image indicates uniformly warm cloud top temperatures. In the **Day Microphysics** image, this cloud physical property is reflected with **magenta** tones for larger cloud droplets and with **pinkish-green** hues for small cloud droplets.

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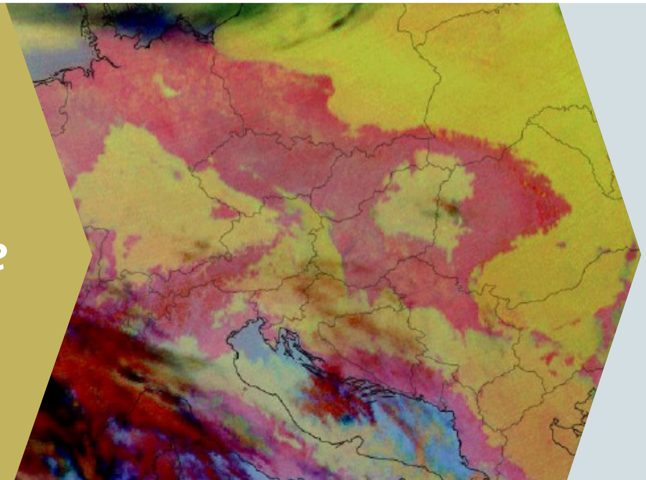
# SEVIRI 24-hour Microphysics RGB

## Quick Guide



SEVIRI, 24-hour Microphysics RGB, 13 February 2017, 00:00 UTC

### Primary aim

**24-hour cloud analysis** – distinguishing ice from water clouds and detection of high level cirrus clouds.

### Time period and area of its main application:

This RGB can be used day and night throughout the year. Its use over deserts is not recommended.

### Secondary aims

Identification of low level **moisture boundaries** and low level **water clouds**, detection of **dust and volcanic ash** in the atmosphere (not as good as in the Dust RGB).

### Guidelines

The **24-hour Microphysics RGB** is identical to the Dust and to the Ash RGB as far as the involved channels are concerned, except that the temperature ranges (and the gamma correction) have been tuned for the detection of **low-level water clouds**. It better depicts low-level water clouds under cold winter conditions, at high latitudes, and at dusk and dawn, than the Night Microphysics RGB, but otherwise is less suitable for this purpose. Among all RGBs, it better discriminates **thin and thick ice clouds** (e.g. cirrus clouds from Cb clouds), and thin from thick **mid-level water clouds**. The colour of the cloud-free land strongly varies with surface temperature (and low-level moisture) from night to day, and from winter to summer.

## Background

The 24-hour Microphysics RGB makes use of the three **window channels** of MSG which reduces the dependency from the viewing angle. The IR12.0– IR10.8 difference (**red** colour beam) distinguishes optically thin from optically thick clouds in mid and high levels and helps to identify low-level moisture boundaries. The IR10.8– IR8.7 difference (**green** colour beam) is large for water clouds, low for ice clouds and medium for cloudfree surfaces, except for sandy deserts. For sandy deserts, this difference is high. IR10.8 (**blue** colour beam) helps to separate optically thick clouds according their top temperature. On cloud-free areas the blue contribution depends on the surface temperature, warmer surfaces appear more bluish, while cold surfaces appear more reddish.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **IR12.0 – IR10.8** | Cloud optical thickness<br>low-level moisture | Thin clouds<br>Moist atmosphere | Thick clouds<br>Dry atmosphere |
| **Green** | **IR10.8 – IR8.7** | Cloud phase | Ice clouds | Water clouds |
| **Blue** | **IR10.8** | Temperature | Cold thick clouds<br>Cold surfaces | Warm thick clouds<br>Warm surfaces |

Notation: IR: infrared; channel number: central wavelength of the channel in micrometer [μm].
Remark: The channel combination is the same as for the Ash and the Dust RGBs, but the tunings are different (not shown here).

## Benefits

- The 24-hour Microphysics RGB is applicable day and night.
- It allows monitoring of the formation and dissipation of fog and low stratus at high temporal resolution day and night.
- It has a better performance for low cloud detection during winter at high latitudes than the Night Microphysics RGB.
- It is best suited to thin cirrus cloud detection.
- It shows a good colour contrast between thin and thick midlevel clouds and between thin and thick ice clouds.
- It provides information on low-level moisture boundaries in cloud-free areas.
- It is able to detect dust clouds.

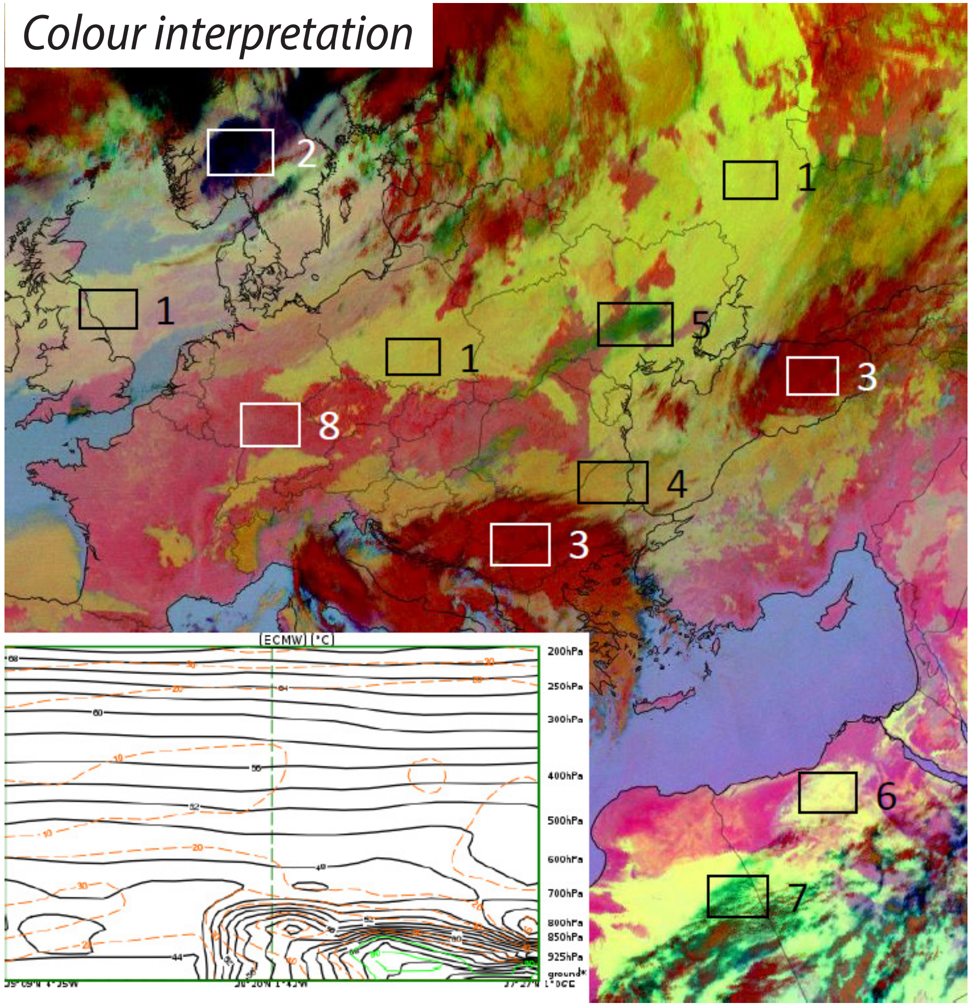
## Limitations

- Very cold cloud-free land and high reaching ice clouds have a similar red colour.
- Fog and low stratus detection over low emissivity surfaces (e.g. deserts) is not possible.
- No good colour contrast between bare soils/deserts and low water clouds.
- Cloud-free land in the 24-hour Microphysics RGB strongly changes its colour with seasons and between day and night due to the RGBs strong dependency on temperature (blue channel).

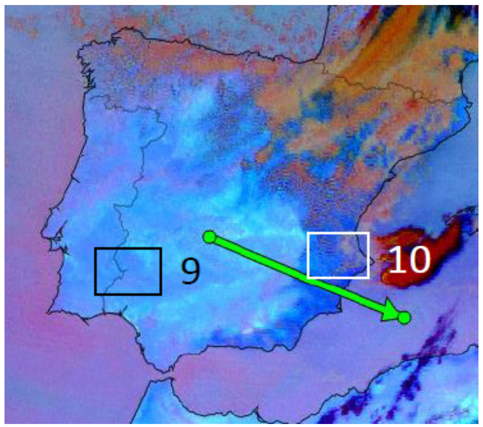
# Colour interpretation

# SEVIRI **24-hour Microphysics** RGB — QG

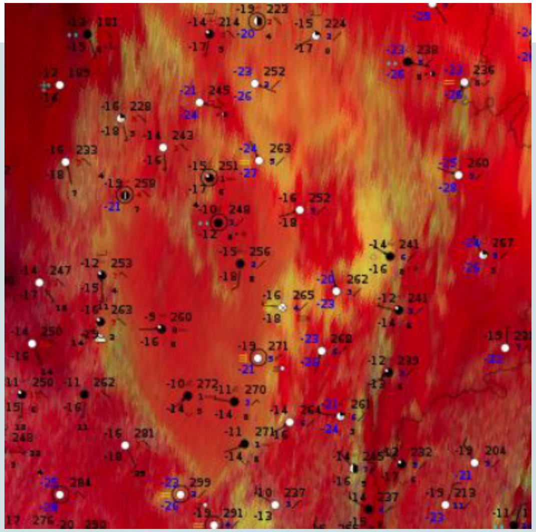
| | | | |
|---|---|---|---|
| 1 | Low level water clouds (fog or stratus), pinkish for larger drops | 6 | Cold sandy deserts |
| 2 | Cirrus clouds with no clouds below, dark blue for the thinner parts | 7 | Cirrus clouds over deserts (same colour as item 5) |
| 3 | Thick, high and cold ice clouds | 8 | Cold land |
| 4 | Thick mid-level water or mixed phase clouds | 9 | Hot land, dry boundary layer |
| 5 | Semi-transparent mid-level clouds | 10 | Hot land, moist boundary layer |

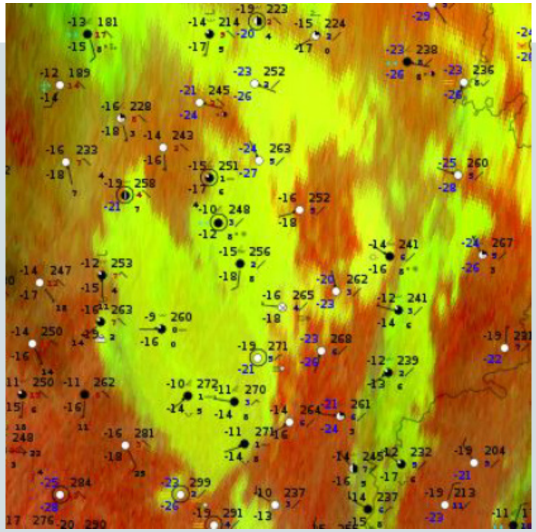



*SEVIRI 24-hour Microphysics RGB, 19 January 2017, 00:00 UTC*




*Left hand image:* The 24-hour Microphysics RGB from **9 July 2017, 12:00 UTC** shows the strong influence of surface temperature and low-level moisture. Blue colours stand for warm land (light blue for a dry boundary layer and dark blue for a humid boundary layer).
*Top image (small):* The vertical cross section through the moisture boundary (green arrow) shows high humidity values (green isolines) up to 800 hPa near the Spanish coast. Humidity values below 80% are depicted in brown isolines, potential temperature in black.





## *Comparison between 24-hour Microphysics and Night Microphysics RGB*

**Low stratus and fog** is better depicted in the **24-hour Microphysics RGB** under **cold winter conditions at high viewing angles** (e.g. Scandinavia or Russia). The Night Microphysics RGB uses channel IR3.9 instead of channel IR8.7 which can be noisy at very low temperatures. Moreover, IR3.9 is increasingly affected by $CO_2$ absorption with increasing viewing angle (the so-called limb cooling effect). Both effects, $CO_2$ absorption and the noisiness of channel IR3.9 at very low temperatures reduce the ability to detect fog at high latitudes in winter.

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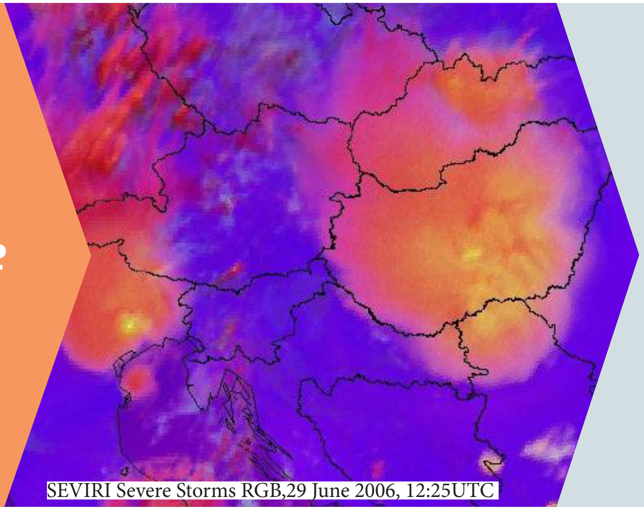
# SEVIRI Severe Storms RGB

## Quick Guide


SEVIRI Severe Storms RGB,29 June 2006, 12:25UTC

**Primary aim**
Monitoring of convection

**Secondary aims**
Monitoring (the cloud top microphysics) of high clouds

**Time period and area of its main application:**
Daytime, in convection season at low- and mid-latitudes, although different tunings/versions should be used for low- and mid-latitudes.

**Guidelines**
Ice clouds usually have large ice crystals at the top. For the mid-latitude continental storms the presence of small ice crystals on (or above) the cloud top and/or very cold cloud top temperatures are possible indicators of severity. This RGB was tuned to highlight such high clouds, and it does this with excellent colour contrast. However, one has to be careful when using this RGB, to interpret it well. Non-convective clouds can also consist of small ice crystals. Small ice crystals can be present in a convective cloud top without a strong updraft.

## Background

The table shows which channel differences are used in this RGB type, and lists some of the land and cloud features which typically make a low or high contribution to the colour beams in this RGB. **WV6.2–WV7.3** is used to highlight high-level clouds. **NIR1.6–VIS0.6** is used to separate ice from water clouds. **IR3.9–IR10.8** is used to highlight those cloud tops which are covered by small ice crystals and/or which are very cold.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| Red | WV6.2–WV7.3 | Cloud top height | No mid or high clouds | High-level clouds |
| Green | IR3.9–IR10.8 | Cloud top particle size and temperature | Opaque ice cloud with large cloud top particles and/or not very cold cloud top temperature | Opaque ice cloud with small crystals and/or very cold cloud top temperature |
| Blue | NIR1.6–VIS0.6 | Cloud top phase | Thick ice clouds | Water clouds / Land, sea surface |

Notation: IR: infrared, NIR: near-infrared, VIS: visible; number: central wavelength of the channel in micrometer.

## Benefits

- It highlights with excellent colour contrast those high clouds whose cloud tops are very cold and/or covered by small ice crystals.
- It helps to identify intense updrafts in mid-latitude, continental convective clouds.

## Limitations

- It works only during the day.
- Pixel colour fades during dawn/dusk when the sun angle is low.
- The yellow colour is a common effect of small ice crystals and cold cloud top temperature.
- It was not designed to provide full cloud analysis. This high clouds-oriented RGB contains very little information about lower level clouds and the surface.
- Snow-covered land might have a similar colour as high clouds with large crystals.
- One has to be careful when using this RGB, to interpret it well. Yellow colour not necessarily means strong updraft or severe storm, see "Good to remember".

## Good to remember

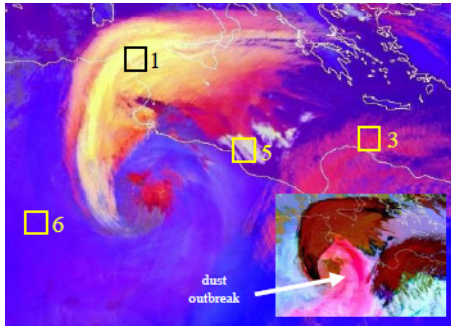
- Small particles at the top of a convective cloud do not necessarily indicate a strong updraft.
  + A continental convective cloud with a cold cloud base usually has small ice crystals at the top –without a strong updraft
  + Highly polluted convective cloud (like pyro Cb) usually has small ice crystals at the top – without a strong updraft
- There are some (non-convective) ice cloud types which consist of small ice crystals, like high-level lee clouds or highly polluted cirrus clouds (e.g. dust carried aloft can lead to long-lived small ice particles).

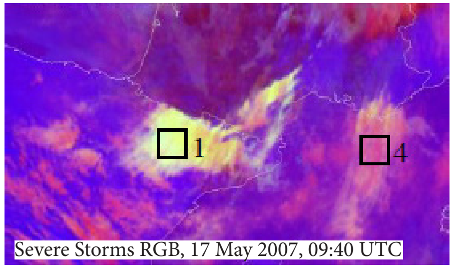
# SEVIRI **Severe Storms** RGB QG

| | |
|---|---|
| **1** | Thick ice cloud with small ice crystals on the top and/or very cold cloud top (Shades of yellow) |
| **2** | Thick ice cloud with large ice crystals on the top and/or not very cold cloud top (Shades of red) |
| **3** | Thin ice cloud with large ice crystals (Shades of pink/violet depending on the transparency) |
| **4** | Thin ice cloud with small ice crystals (Shades of mauve depending on particle size and cloud transparency) |
| **5** | Super-cooled water cloud (Greyish with some green-yellow shades if very cold) |
| **6** | No mid or high cloud (Shades of blue or magenta) |

Surface is not seen, low clouds are not or hardly seen. Colours depend on solar and satellite viewing angles, fading with low solar elevation.

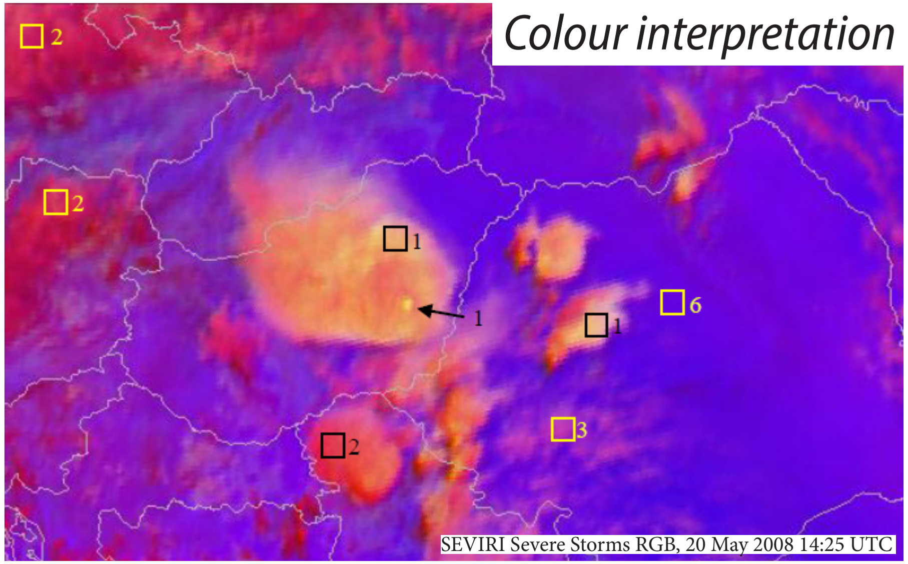
Image 1 - below: Severe Storms RGB and Dust RGB (in the corner), 22 February 2007,12:00 UTC



Severe Storms RGB, 17 May 2007, 09:40 UTC

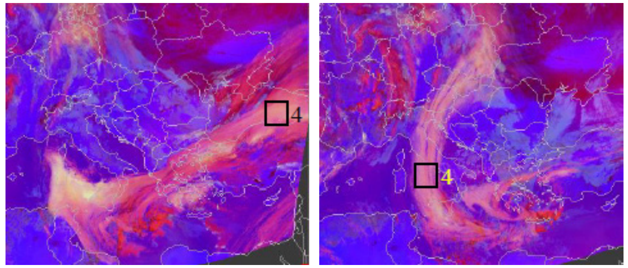
## *Colour interpretation*

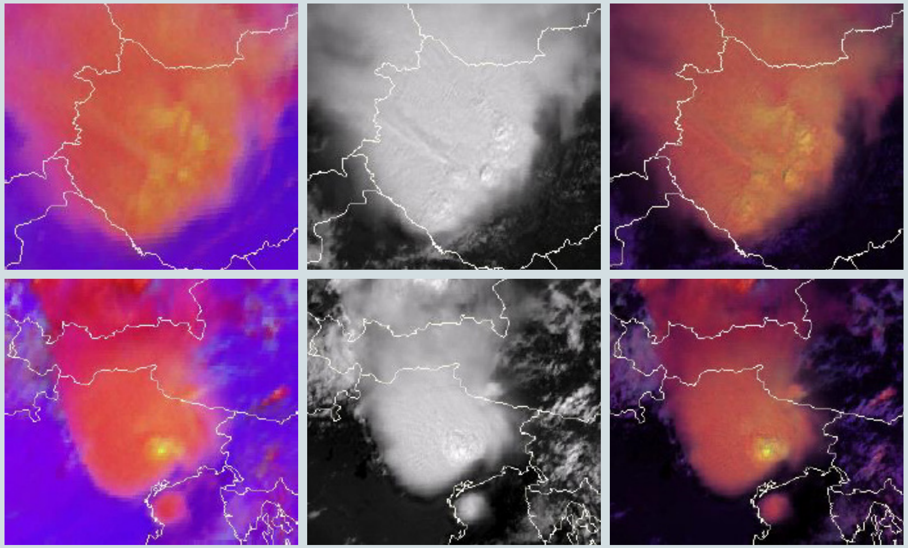


SEVIRI Severe Storms RGB, 20 May 2008 14:25 UTC

Left: High level lee clouds consist of very small ice crystals.

Right: Severe Storms RGB images, 23 (left) and 24 (right) February 2007, 10:55UTC





Severe Storms RGB (left), HRV (middle), HRV/Severe Storms RGB blended (right) images, 29 June 2006, 10:10 (up) and 12:25 (bottom) UTC

## *Comparison to other products*

The images on the left show Severe Storms RGB and HRV images separately and together: the third column shows blended images composed by the two.

In the HRV image one can see cloud top features, like overshooting tops and an ice plume. In the blended image one can clearly see which cloud top features are yellow(ish). In the bottom row the yellow overshooting top indicates a strong updraft. In the upper row the overshooting tops are yellow, the ice plume is slightly yellowish, and other parts of the anvil are also yellowish. Strong updrafts often bring small ice particles up to the cloud top. The water particles formed at the cloud base do not have much time to become larger by coagulation before freezing. Small particles coming up from the updraft spread along the anvil. Small ice crystals may belong to an above anvil cirrus cloud as well, like Pileus or ice plume. They are also indicators of a strong updraft.

Highly polluted clouds consist of small particles, because of the many condensation nuclei. Image 1 shows a cyclone polluted by dust (see the Dust RGB in its corner, pink colour indicating a dust cloud). The two upper images were taken on the next two days showing remains of the cyclone cloudiness – thin cirrus clouds with very small ice crystals (in mauve shades).

The Severe Storms RGB is created following the EUMETSAT recommended recipe. Using different ranges and/or gamma corrections will modify the colours.

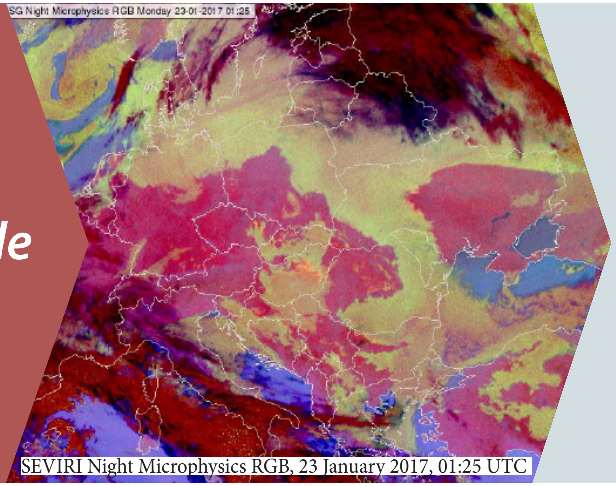
EUMeTrain

*More on RGBs on www.eumetrain.org*
*Contact: info@eumetrain.org;*

EUMeTrain

# SEVIRI **Night Microphysics** RGB

*Quick Guide*




SEVIRI Night Microphysics RGB, 23 January 2017, 01:25 UTC

**Primary aim**

**Detection of fog/low clouds** at night.

**Secondary aims**

**Full cloud analyses** at night and fire monitoring.

**Time period and area of its main application:**

Low- and mid- and high-latitudes, at night. In cold winter situations, the 24-hour Microphysics RGB is more useful.

**Guidelines**

It provides the **best colour contrast** between fog/low cloud and cloud-free area at night. However, in the case of solar radiation (during the day, twilight, solar equinox around midnight) this RGB is not usable. Over cloud-free areas moisture boundaries might be seen.

## *Background*

The table shows which channels (or channel differences) are used in this RGB type, and lists some of the land and cloud features which typically make a low or high contribution to the colour beams in this RGB. **IR10.8–IR3.9** is the key channel difference for fog/low cloud detection. The **IR12.0–IR10.8** channel difference helps to separate thin from thick clouds. **IR10.8** channel helps to separate thick clouds according their cloud top temperature. The colour of the cloud-free surface depends not only on the surface temperature, but also on the atmospheric low-level moisture content.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **IR12.0–IR10.8** | Cloud optical thickness | Thin clouds | Thick clouds |
| **Green** | **IR10.8–IR3.9** | Cloud phase | Thin ice clouds | Thick fog/water clouds |
| **Blue** | **IR10.8** | Cloud top temperature Land sea temperature | Cold clouds | Warm surface<br>Warm clouds |

Notation: IR: infrared, number: central wavelength of the channel in micrometer.

## *Benefits*

- At low and mid-latitudes the Night Microphysics RGB provides the best colour contrast between water clouds and cloud-free surface at night.
- It provides full cloud analysis at night.
- In some special conditions it provides nighttime snow detection – only if the temperature is very low and the snow is deep enough to completely cover the vegetation.
- It detects dust clouds.
- It detects fires, even if they are much smaller than the pixel size.

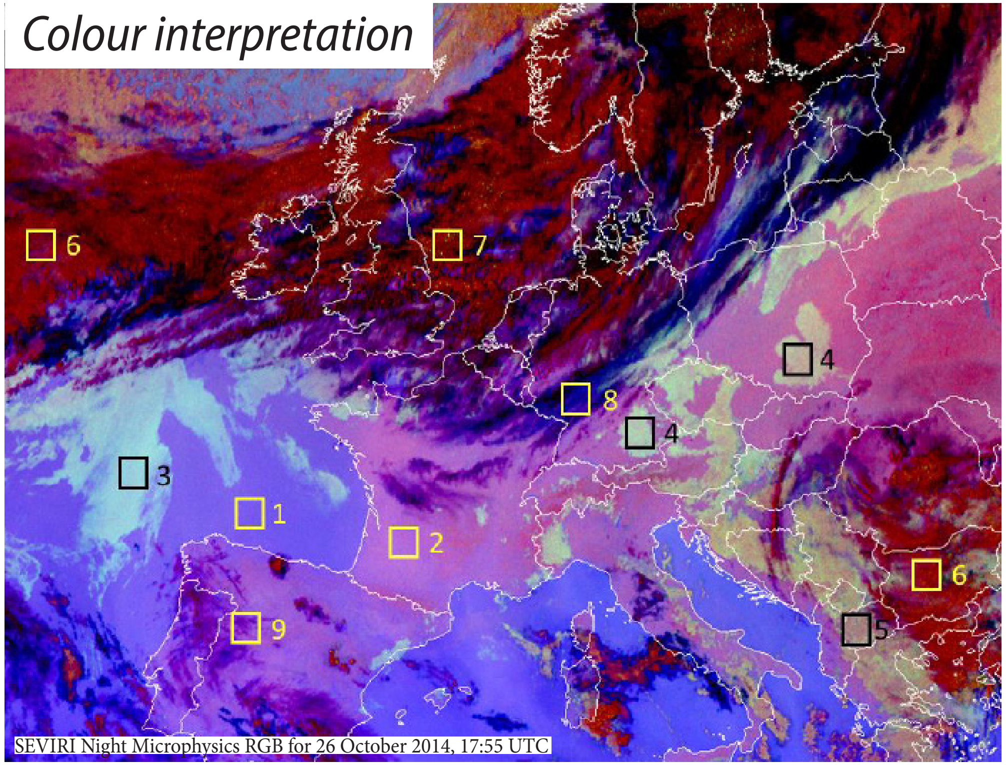
## *Limitations*

- It is not designed to be used during the day. During the day the HRV Fog, the Day Microphysics or the 24-hour Microphysics RGBs are recommended for fog or low cloud detection.
- The colours change in cases where solar radiation is present: all clouds appear magenta, except the fog/low clouds which may even 'disappear' during twilight. Around the solar equinox the IR3.9 channel may contain some solar radiation around midnight, spoiling this RGB at some areas.
- Fog and low clouds cannot be separated from each other based only on their colours.
- Fog/low cloud can be covered by higher level clouds. If there are thin cirrus clouds above fog/low clouds, the Night Microphysics RGB might not detect the fog/low clouds.
- The thinner the low clouds/fog the more the colour looks like the colour of the ground (pinkish). The detection of very thin fog/low cloud is problematic.
- The IR3.9 brightness temperature values of the high, very cold clouds are often noisy resulting in green dots in the reddish-brownish ice clouds. Therefore, this RGB is not recommended for night-time convection analysis. The IR10.8 single channel is more appropriate for this purpose.
- There is no snow detection at night – except some special cases (see benefits).

# SEVIRI **Night Microphysics** RGB

**QG**

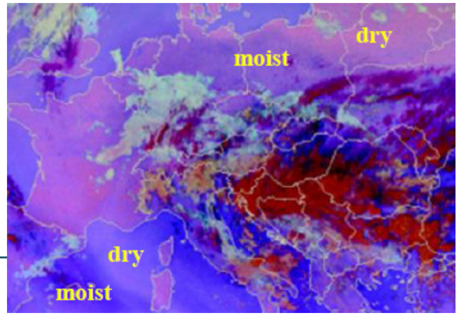
## Colour interpretation

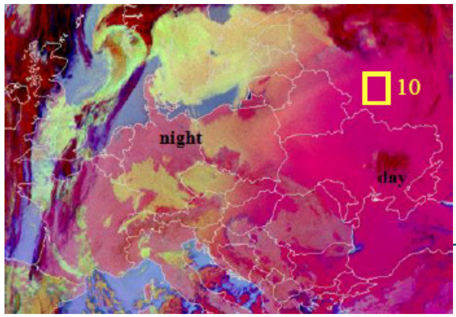


SEVIRI Night Microphysics RGB for 26 October 2014, 17:55 UTC

| | | | |
|---|---|---|---|
| 1, 2 | Cloud free sea and land *(Shades of blue or pink depending on temperature and water vapour content)* | 6 | Thick ice cloud *(Reddish brown)* |
| | | 7 | Very cold thick ice cloud *(Reddish brownwith green dots)* |
| 3 | Warm, thick fog/low cloud, with small droplets *(Shades of aqua)* | 8 | Thin cirrus *(Shades of dark blue)* |
| 4 | Cold, thick fog/low cloud *(Greenish in case of small droplets; pinkish grey in case of large droplets or thin cloud)* | 9 | Very thin cirrus *(Shades of magenta depending on the transparency and the type of underlying surface)* |
| 5 | Thick mid-level cloud *(Shades of tan)* | 10 | Clouds during daytime *(Shades of magenta, red or blue)* |

**3 September 2014, 20:40 UTC**
Over cloud-free areas moisture boundaries might be seen. The colour of the cloud-free area depends on the surface temperature and (low-level) moisture: moist areas have less red (look more bluish) and dry areas have more red (look more pinkish).

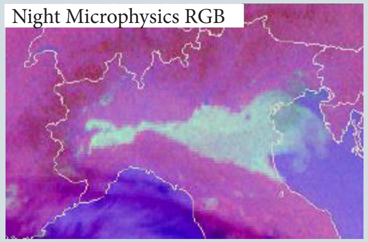


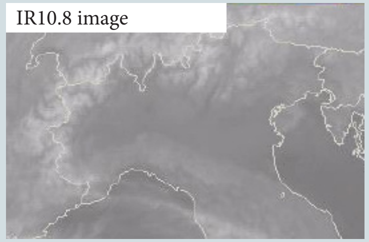



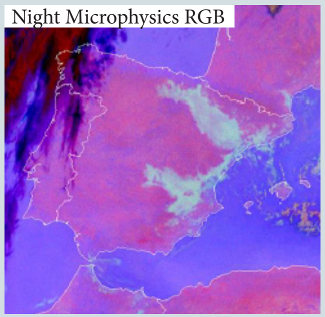

**15 January 2006, 08:55 UTC**
The Night Microphysics RGB is created following the EUMETSAT recommended recipe. Using different ranges and/or gamma corrections will modify the colours.

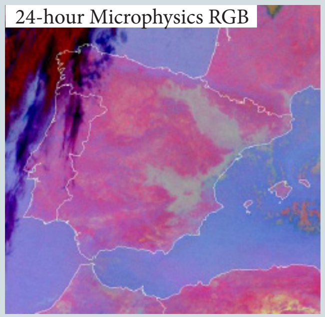
## Comparison to other products

**20 March 2014, 03:55 UTC**
In the Night Microphysics RGB one can clearly see the fog in the Po Valley, much better than on the IR10.8 image. Fog/low cloud is usually not, or hardly, recognisable in the IR10.8 image, as its top temperature is close to the temperature of the surrounding cloud-free area. Although the example shows a so-called "black fog" with warm top, it is not as eye-catching in the IR10.8 image.



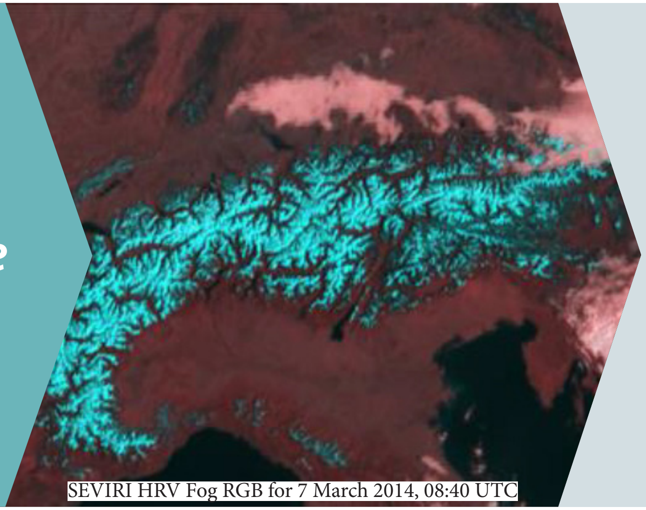

**31 October 2014, 06:10 UTC**
At low and mid-latitudes the Night Microphysics RGB provides better colour contrast between fog/water clouds and the surface than the 24-hour Microphysics RGB does.

EUMeTrain

*More on RGBs on www.eumetrain.org*

# SEVIRI **HRV fog** RGB

## *Quick Guide*


SEVIRI HRV Fog RGB for 7 March 2014, 08:40 UTC

### Aim

Distinguishing of fog/low clouds from snow-covered land in high resolution.

### Time period and area of its main application:

Mid-latitude region, day time during winter.

### Application and guidelines

The identification of foggy and low cloud-covered areas is important for traffic and aviation security. Winter fog/stratus frequently forms over snowy cloud-free surfaces in high pressure conditions. Fog/water clouds have good colour contrast against snow and snow-free land.

This is a daytime RGB as it uses short wave channels.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **NIR1.6** | Cloud phase<br>Snow reflectivity | Ice cloud<br>Snow covered land | Water clouds |
| **Green** | **HRV** | Cloud optical thickness<br>Snow reflectivity | Thin clouds | Thick clouds<br>Snow covered land |
| **Blue** | **HRV** | Cloud optical thickness<br>Snow reflectivity | Thin clouds | Thick clouds<br>Snow covered land |

Notation: HRV: High Resolution Visible channel, NIR: near-infrared, number: central wavelength of the channel in micrometer. HRV is used in two colour beams so the high resolution is not lost.

## *Benefits*

- Detection of the cloud phase: ice and water clouds appear in different colours (in most cases – see limitations).
- Detection of snow: snow-covered land and snow-free land have different colours.
- Fog and water cloud have good colour contrast both against snow-covered and snow-free land.
- Highresolution:
  - + Smaller patches of snow, fog or low clouds are recognisable.
  - + The structure of the land and cloud features are better seen.
- This RGB is easy to understand, it has nice colours. It is relatively good for the public.

## *Background*

The table shows which channels are used in the HRV Fog RGB and lists some of the land and cloud features which typically make a low or high contribution to the colour beams in this RGB. Snow's reflectivity is much higher in the HRV than in the NIR1.6. As water clouds reflect much of the radiation in both channels they can be used in combination to distinguish snow and water clouds.

## *Limitations*

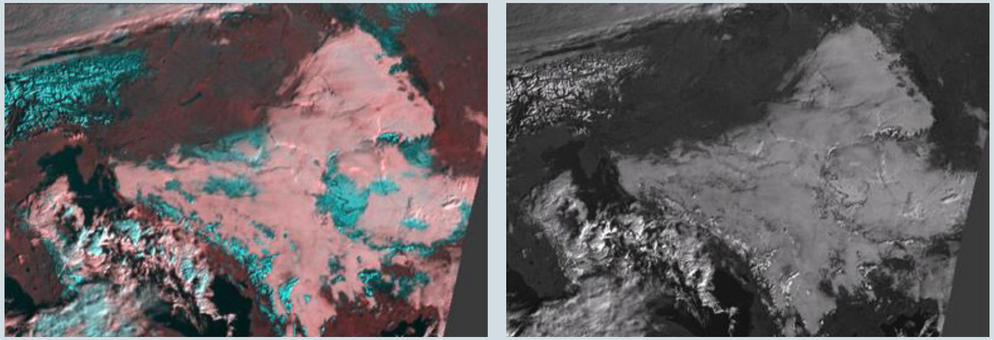
- It works only during the day. At night the Night Microphysics RGB can be used.
- In twilight conditions the colour contrast may get lower.
- Snow/fog/low cloud is not seen under higher level thick clouds.
- Fog and low clouds cannot be distinguished based on their colours. Studying the form, structure and movement may help.
- The colours of snow and ice clouds are similar (ice cloud may have some more grey shades). It is not easy to distinguish them. Studying their form, structure and movement may help.
- This RGB type only combines two channels, thus two types of information. It does not contain, for example, temperature information.
- The separation between ice and water clouds is not perfect. Water clouds with large droplets can have similar colours as ice clouds; ice clouds with small ice crystals can have similar colours as water clouds.

# SEVIRI **HRV fog** RGB

**QG**

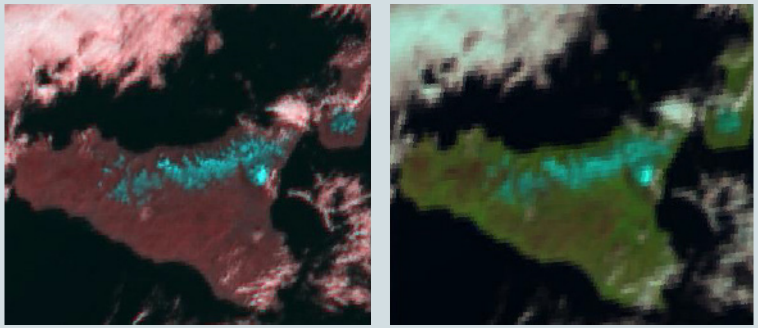
| | | | |
|---|---|---|---|
| **1** | Snow-covered high mountains (*Shades of bright cyan*) | **5** | Thin ice cloud (*Shades of cyan depending on the transparency and the type of the underlying surface; in case of small ice crystals it may have pinkish tones*) |
| **2** | Snow-covered lowland (*Shades of greyish cyan with patches, lines*) | **6** | Snow-free land (*Shades of reddish brown*) |
| **3** | Fog or water cloud (*Shades of pink, in case of very large droplets, it may have some cyan tones*) | **7** | Ice-free sea (*Shades of black*) |
| **4** | Thick ice cloud (*Shades of greyish cyan, in case of small ice crystals, it may have some pinkish-greyish tones*) | | |

## *Comparison to other products*



*HRV Fog RGB (up) and HRV (bottom) for 28 November 2013,07:40 UTC*

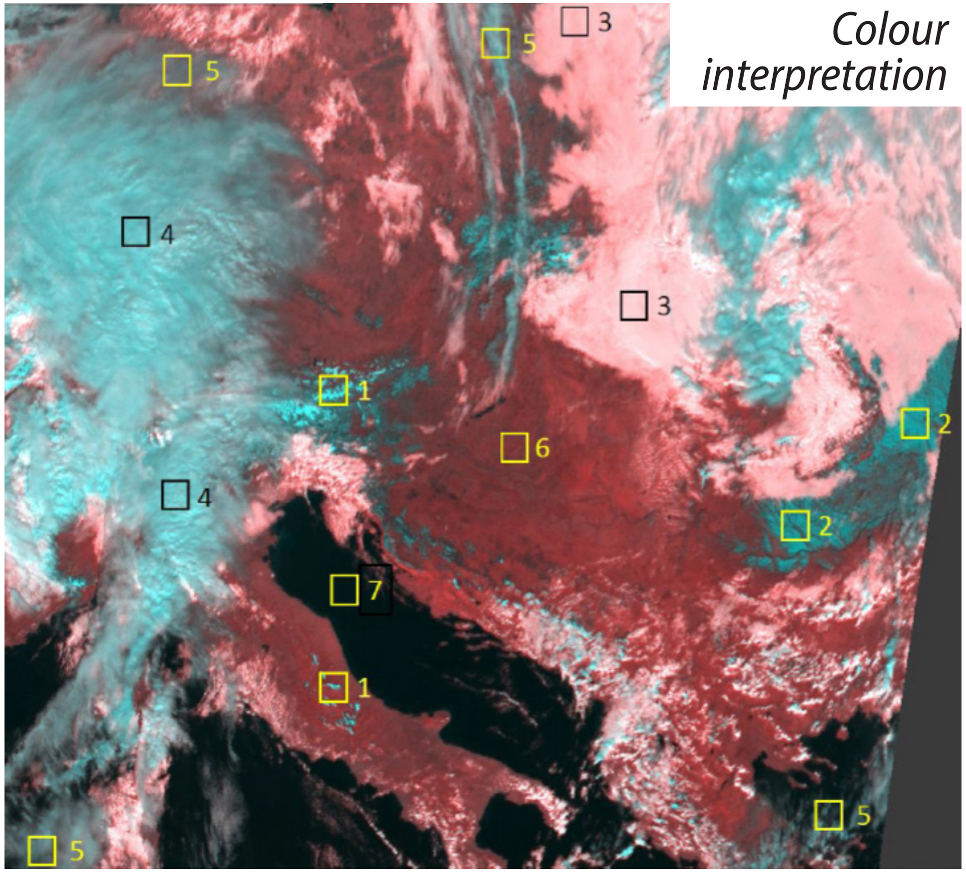
In the HRV Fog RGB image (left) one can distinguish snow from fog or water clouds much easier than in HRV image (right).



Natural Colour RGB (right) also detects snow and fog/water clouds in different colours and it provides vegetation information as well, but it has lower spatial resolution.

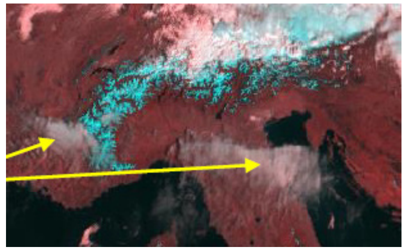
*HRV Fog RGB (left) and Natural Colour RGB (right), 12 January 2017,09:40 UTC*

## *Colour interpretation*




*13 February 2014, 11:40 UTC*

Colours depend on the solar and satellite viewing angles, on the quality of the snow, and whether the area is totally covered by snow. Snow on high mountains usually has a brighter colour than on hills or low lands, as the snow cover is less disrupted by vegetation. The colour of a cloud also depends on the size of the cloud top particles. Water clouds with large droplets may appear slightly cyan. Ice clouds with extreme small crystals may appear pinkish-whitish, like the high-level lee clouds in the image on the right (indicated by arrows).



*16 March 2014, 10:25 UTC*

The HRV Fog RGB is created following the EUMETSAT recommended recipe. Using different ranges and/or gamma corrections will modify the colours.

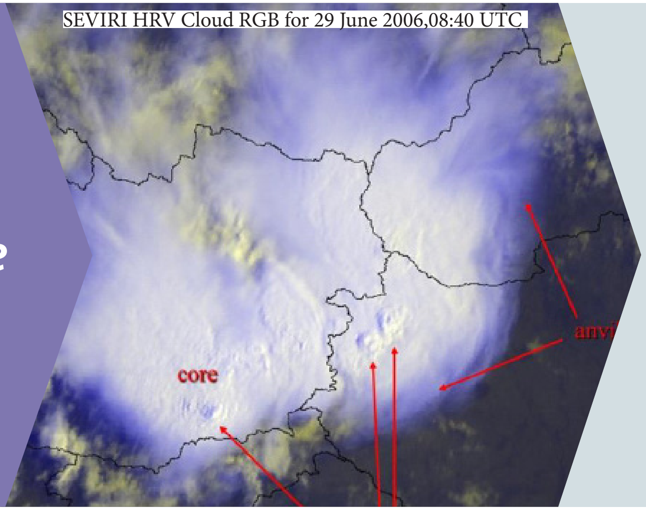
EUMeTrain

More on RGBs on www.eumetrain.org

EUMeTrain

# SEVIRI **HRV Cloud** RGB

## *Quick Guide*




### Aim

Monitoring of convection in high resolution. It is useful for any other high-level cloud system monitoring (like fronts, cirrus) if high resolution is needed.

### Time period and area of its main application:

Low- and mid-latitude region, daytimes in convection season.

### Applications and guidelines

This RGB type concentrates on **high cloud monitoring**. Thin and thick high clouds have good colour contrast from each other, from lower level clouds and cloud free region (including snow/ice). For convection monitoring **high temporal and spatial resolution** is needed: animations of **5-minute HRV Cloud RGB images** are useful in combination with other products showing information on cloud top microphysics and/ or cloud top temperature distribution (possible presence of cold U, cold ring features). Mature thunderstorm cloud top features like overshooting tops, gravity waves, ice plumes are well seen in this RGB due to the shadows and the high resolution. Intense (and/or long lived) overshooting tops, gravity waves, long lived cold U/V, cold rings are indicators of strong updraft thus possibly severity.

## *Background*

The table shows which channels are used in the HRV Cloud RGB and lists some of the land and cloud features which have typically low or high contribution to the colour beams in this RGB. This is the most ‘traditional RGB’, as it is based on channels which were available already from Meteosat first generation satellites. HRV is used in two colour beams not too lose the high resolution.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **HRV** | Cloud optical thickness / Snow reflectivity | Thin clouds | Thick clouds |
| **Green** | **HRV** | Cloud optical thickness / Snow reflectivity | Thin clouds | Thick clouds |
| **Blue** | **IR10.8 inverted** | Cloud top temperature / Land/sea temperature | Warm cloud / Warm land / sea | Cold clouds |

Notation: HRV: High Resolution Visible channel, IR: infrared, number: central wavelength of the channel in μm. ‘IR10.8 inverted’means that higher signals are assigned to cold brightness temperatures, while lower signals to warm brightness temperatures, like it is visualisedas a single channel image.

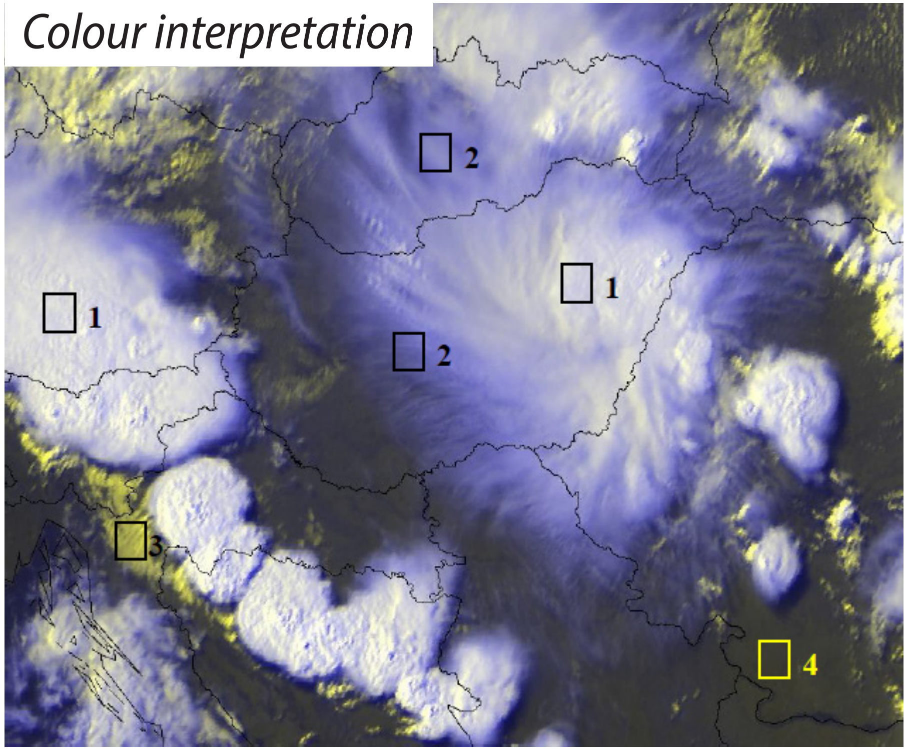
## *Benefits*

- Thin and thick high clouds have goodcolour contrast from each other. The semi-transparent part of the anvil and the thick storm core are well separated.
- High level clouds have good colour contrast against lower level clouds, and cloud free region (including snow/ice).
- Small size, developing (towering) cumulus clouds are earlier recognizable due to higher spatial resolution.
- Due to the higher spatial resolution one can better see the cloud top structurethan in the 3 km resolution images.
  - + Mature thunderstormcloud topfeatures likeovershootingtops, gravitywaves, iceplumesarebetterseeninthisRGBduetothe higherresolution.
  - + The cloud top structure might provide useful information even in case of non-convective clouds. For example, low-level wave clouds, cloud streets are also better seen in higher spatial resolution. They give hint of the wind.
- This RGB is nice and easy tounderstand. It is very good for public.

## *Limitations*

- It works only during daytime as it uses shortwave channel.
- Close to midday the cloud top features like overshooting tops, ice plumes, gravity waves are less seen than at low solar elevation.
- This RGB type concentrates on high cloud monitoring. It does not provide complexc loud analyses. The snow covered land, fog, low-and mid-level clouds appear insimilar colours. It is not eay to distinguish them. Studying their form, structure, movement may help. Even better to use this RGB together with other types of images, for example, with Day Microphysics RGB.
- This RGB type combines only two channels, thus two types of information. It does not contain e.g. microphysical (phase, size) information.

## Colour interpretation



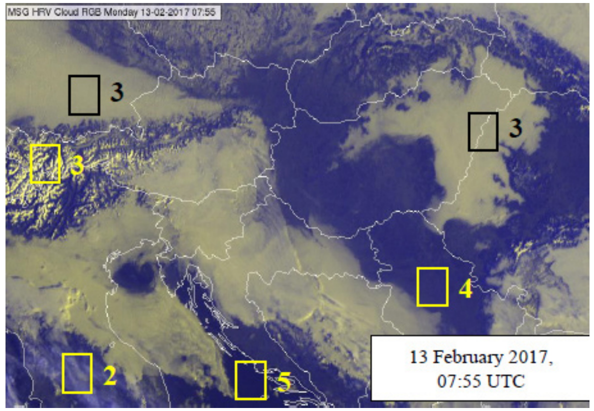

# SEVIRI **HRV Cloud** RGB

**QG**

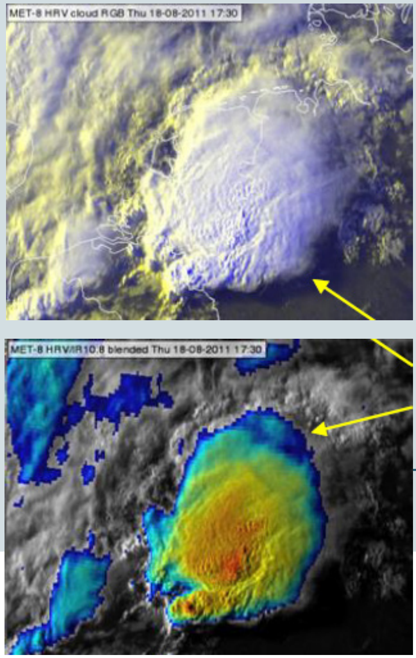
| | |
|---|---|
| **1** | Thick high clouds (*Bright greyish, whitish shades with shadows*) |
| **2** | Thin high level clouds (*Bluish shades depending on the transparency and the type of the underlying surface*) |
| **3** | Fog, low-and mid-level clouds or snow covered land (*Shades of yellow depending on the cloud top temperature, cloud thickness; temperature and state of the snow*) |
| **4** | Snow-free land (*Shades of grey with some bluish or yellowish tones depending on the temperature and surface reflectivity*) |
| **5** | Ice-free sea (*Shades of dark blue*) |

Colours depend also on the solar and satellite viewing angles.

The HRV Cloud RGB is created following the EUMETSAT recommended recipe. Using different ranges and/or gamma corrections will modify the colours.



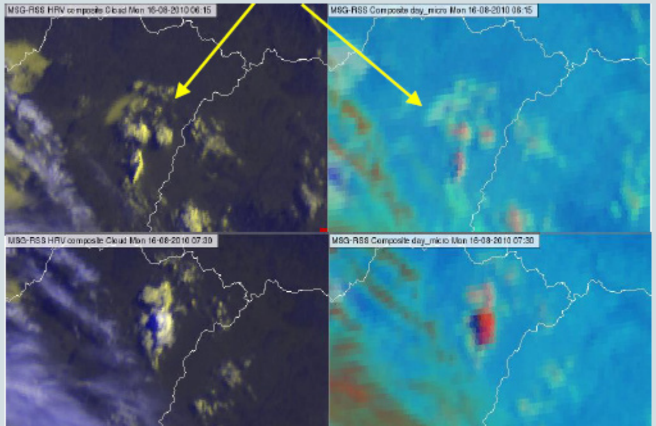

13 February 2017, 07:55 UTC




## Comparison to other products

Both the HRV cloud RGB and the HRV/IR10.8 blended ('sandwich') image combine HRV with the IR10.8 channel data, but in different ways. The blended image is designed to study the cloud top temperature distribution and its collocation with other cloud top features of mature thunderstorms: collocation of cold U/V, cold ring with overshooting tops, ice plumes, gravity waves, etc. The sandwich product is better for thunderstorm top analyses, while the HRV Cloud RGB sees and identifies thin Cirrus better.

HRV Cloud RGB (up) and HRV/IR10.8 blended image (bottom), 18 August 2011, 17:30 UTC

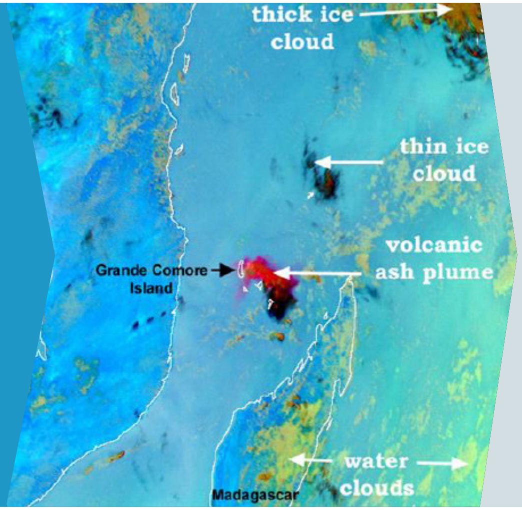


HRV Cloud RGB (left) and Day Microphysics RGB (right), 16 August 2010, 06:15 and 07:30 UTC

The HRV Cloud and the Day-Microphysics RGB rapid scan image sequences together is a good combination to monitor the convective initiation and development. As the cumulus clouds become colder their yellow colour turns to white in the HRV Cloud RGB images. In Day Microphysics RGB one can follow the glaciation of the cloud top as the cumulus clouds turn to red.

# SEVIRI **Ash** RGB

## *Quick Guide*




Volcanic ash ejected by Karthalavolcano, Comoros SEVIRI Ash RGB, 25 November 2005,08:00 UTC

**Aim**

Detection of volcanic ash and $SO_2$ gas.

**Guidelines**

Optically **thin ash cloud** can be well detected and clearly distinguished from ice and water clouds in the Ash RGB images. Optically **thick ash clouds** look like thick ice clouds. However, the volcanic ash becomes rapidly optically thin. **Pure SO2 gas plumes** can be better detected at low satellite viewing angles closer to the sub-satellite point than, for example, London or Copenhagen. In the case of **very low concentrations**, ash and $SO_2$ gas might be not seen from geostationary satellites, only by the sounding instruments of polar orbiting satellites. The Ash RGB does not provide information on height and concentration, but does provide high temporal resolution. Volcanoes also inject **water vapour**, which becomes cirrus cloud when reaching a height. Note that higher level $SO_2$ plumes are detected by the Airmass RGB as well.

**Time period and area of its main application:**

**In case of volcanic eruption.**

## *Background*

The table shows which channels (or channel differences) are used in the Ash RGB and lists some of the landand cloud features which make typically low or high contribution to the colour beams in this RGB. Thin volcanic ash is separated from water and ice clouds by the IR12.0–IR10.8 channel difference. $SO_2$ gas is detectable due to its absorption band at 8.7µm.

| Colour | Channel (mm) | Physically relates to | Smaller contribution to the signal of | Larger contribution to the signal of |
|---|---|---|---|---|
| **Red** | **IR12.0–IR10.8** | Cloud optical thickness | Thin ice clouds | Thin volcanic ash |
| **Green** | **IR10.8–IR8.7** | Cloud phase | Ice clouds<br>Thin volcanic ash | SO2 gas plume<br>Water clouds |
| **Blue** | **IR10.8** | Temperature | Cold clouds | Warm surface<br>Warm clouds |

Notation: IR: infrared, number: central wavelength of the channel in micrometer. Remark: The channel combination is the same as for Dust and 24-hour Microphysics RGBs, the tunings are different (not shown here).

## *Benefits*

- It works during the day and at night (this allows for the creation of long animations).
- Different colours for thin volcanic ash, $SO_2$ gas plume and cirrus clouds (and for the mixture of ash and $SO_2$ gas).
- Thin volcanic ash has good colour contrast against water and ice clouds and surface features.
- $SO_2$ gas plume has good colour contrast against ice clouds and surface features, but close to the limb water clouds might have similar colour as pure $SO_2$ plume – see limitations.
- The colours of the water and ice clouds and the surface are similar (paler) to their colours in the Dust/24-hour Microphysics RGBs.

## *Limitations*

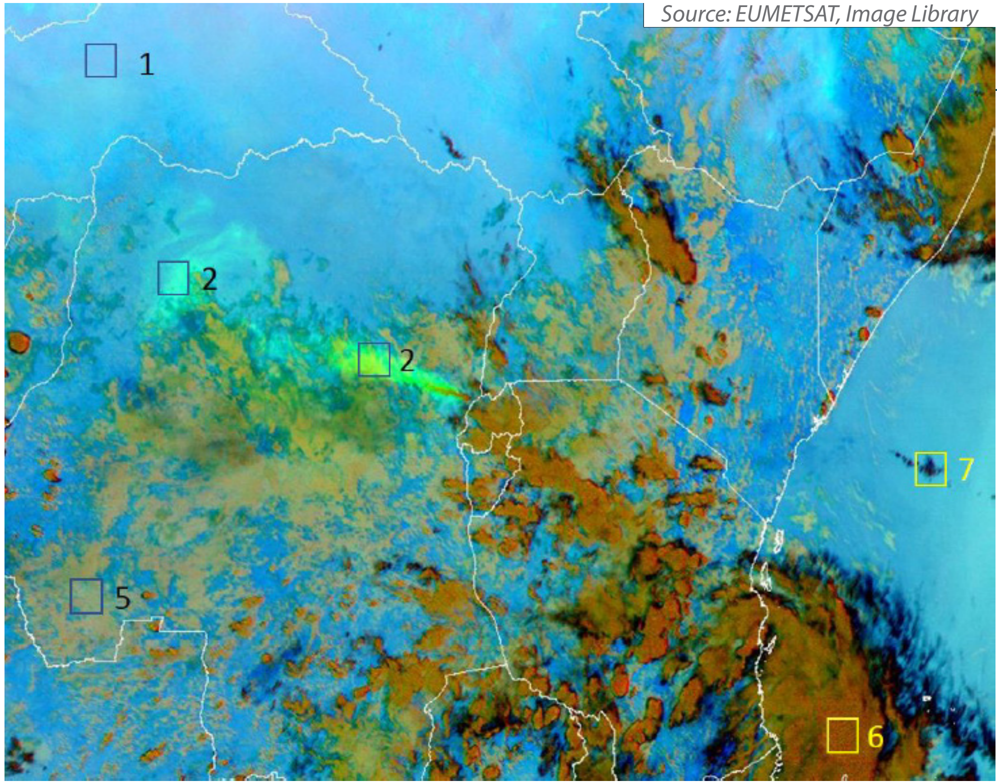
- Lower-level volcanic ash and $SO_2$ gas plume can be covered by higher-level clouds.
- Very thick ash clouds cannot be discriminated from ice clouds.
- If volcanic ash and/or a $SO_2$ gas plume is mixed with cirrus cloud identification might be problematic.
- The colours greatly depend on the satellite viewing angle. The colour of the water clouds changes to green towards the limb. Thus, **pure $SO_2$ gas plumes** can only be easily separated from water clouds at low satellite viewing angles closer to the subsatellite point (zero latitude and longitude) than, for example, London or Copenhagen. In the case of high satellite viewing angles the Dust RGB is more appropriate for $SO_2$ detection.

# SEVIRI **Ash** RGB

**QG**

## *Interpretation*

*Source: EUMETSAT, Image Library*




***$SO_2$ plume ejected by the Nyamuragira volcano, Congo SEVIRI Ash RGB, 29 November 2006,11:10 UTC***

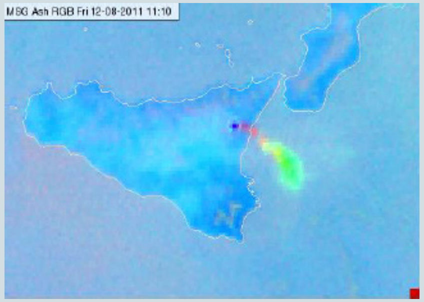
| | | | |
|---|---|---|---|
| 1 | Cloud free land (*Shades of blue or pink depending on the temperature and water vapour content*) | 5 | Water cloud (*Shades of greyish tan*) |
| 2 | $SO_2$ gas plume (*Shades of bright green depending on the concentration*) | 6 | Thick ice cloud or Thick volcanic ash cloud (*Shades of brown*) |
| 3 | Thin volcanic ash (*Shades of red depending on the concentration*) | 7 | Thin ice cloud (*Shades of dark blue depending on the transparency*) |
| 4 | Mixed ash and $SO_2$ gas (*Shades of yellow depending on the concentrations*) | | |

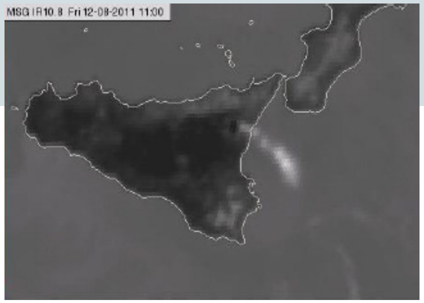
Colours may depend on viewing angle, concentration, cloud transparency, temperature, surface emissivity and water vapour content.

The Ash RGB is created following theEUMETSAT recommended recipe. Using different ranges and/or gamma corrections will modify the colours.

## *Comparison to other products*

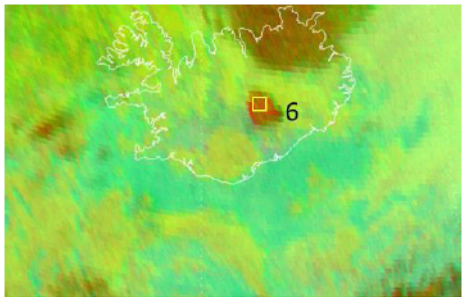
In the Ash RGB one can see both the ash (red/magenta) and the $SO_2$ gas plume (green). In the IR10.8 image one cannot see the$SO_2$ gas plume at all. In the IR10.8 image one can see the volcanic ash plume, but one cannot distinguish it from water or ice clouds.



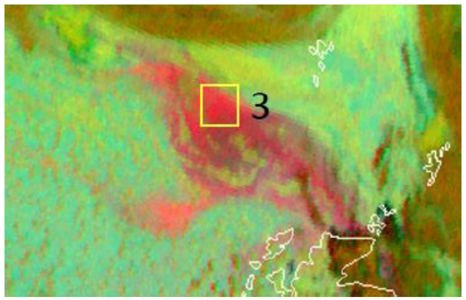




***Volcanic eruption of Mount Etna in Sicily. Ash RGB (left) and IR10.8 (right) images,12 August 2011,11:10 UTC***

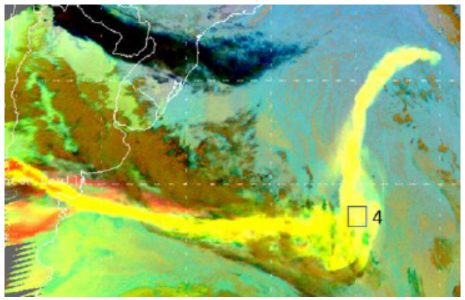
***Thin ash cloud originated from Iceland 24 May 2011,03:10 UTC***




***Thin ash cloud originated from Iceland 24 May 2011,03:10 UTC***

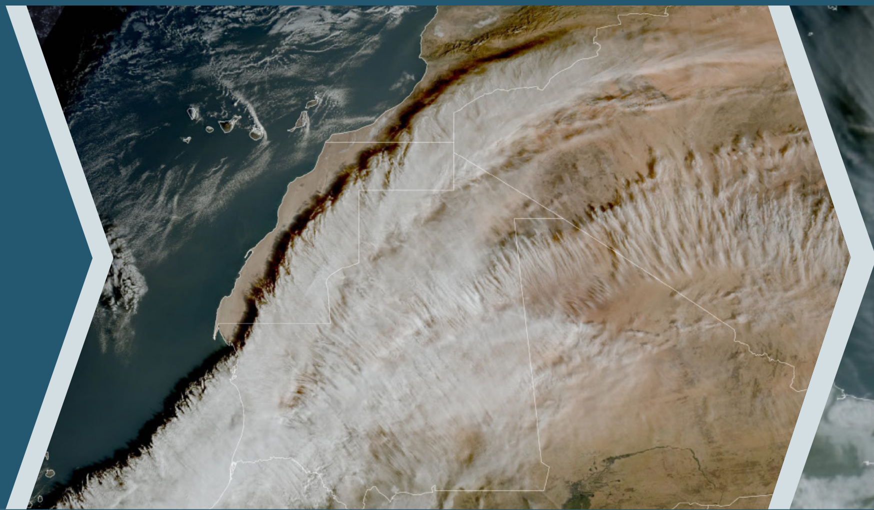



***Mixed ash and $SO_2$ originated from Chile 06 June 2011,12:00 UTC***

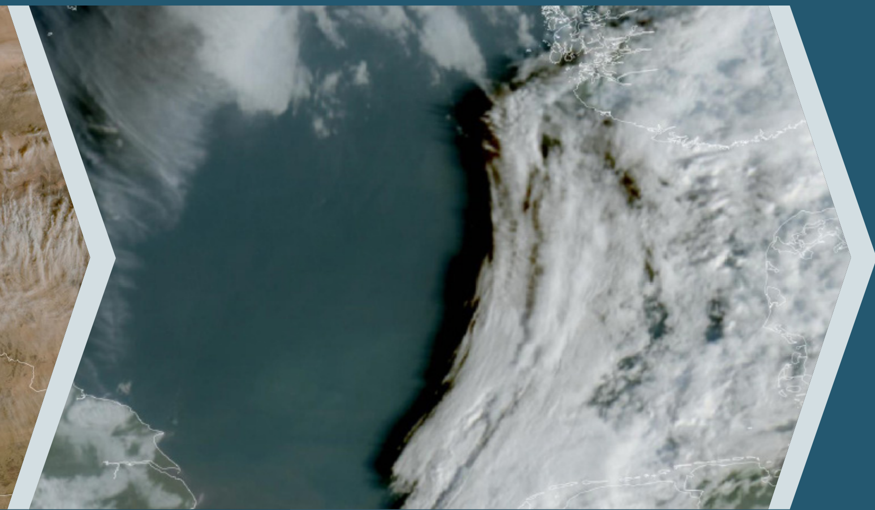



EUMeTrain

More on RGBs on www.eumetrain.org



*Two cyclones / Atlantic Europe*



*Front shadow / North Sea*