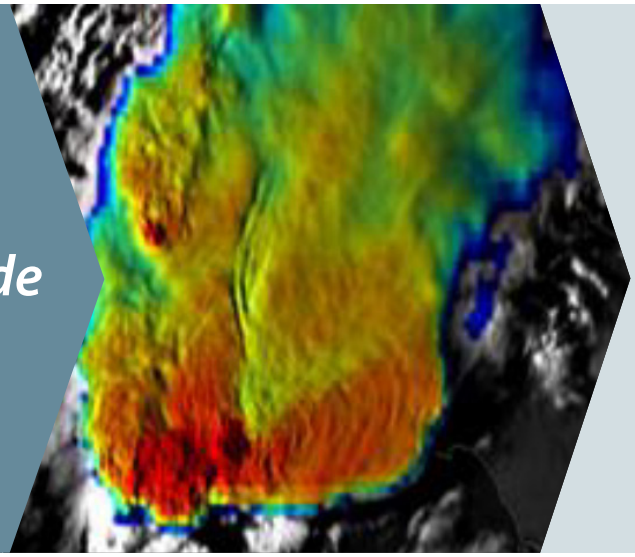
EUMeTrain

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

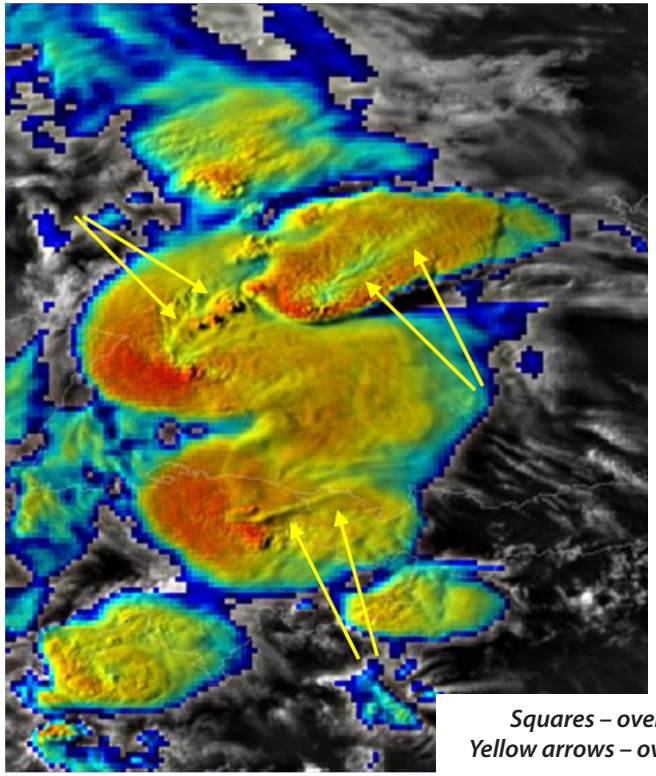
- Available during the day only.
- Close to midday the cloud top features like overshooting tops, ice plumes, gravity waves can be less prominent than at low solar elevation (as the shadows are shorter).
- The temperature range of the infrared colour scale might need a tuning (usuallya shift) depending 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

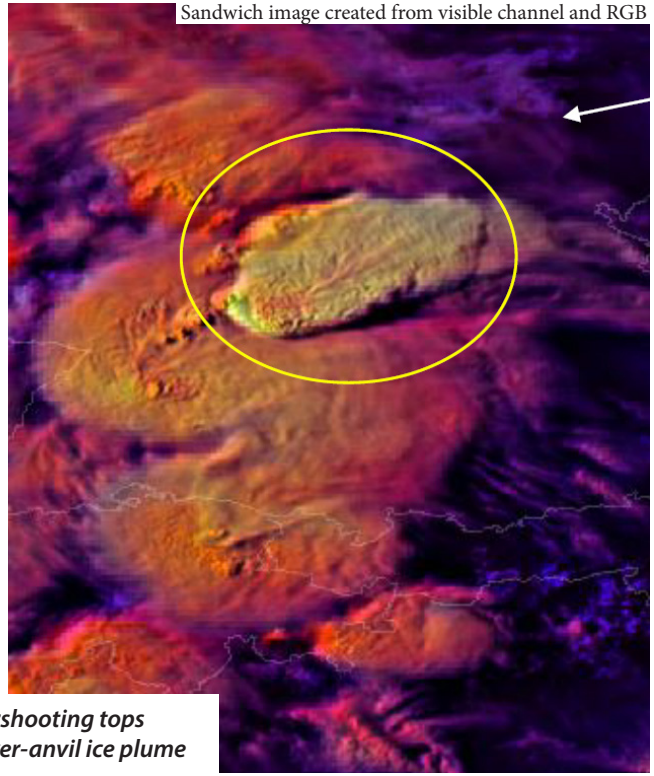
- Not only the convective cloud tops will be colour enhanced, but any clouds that are cold enough, for example thick cold clouds of a front, jet stream cirrus clouds, or orographic wave clouds.
- It is worth using it together with other types of satellite images and/or products, providing information,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

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

Sandwich Products **QG**



Sandwich image created from visible channel and RGB



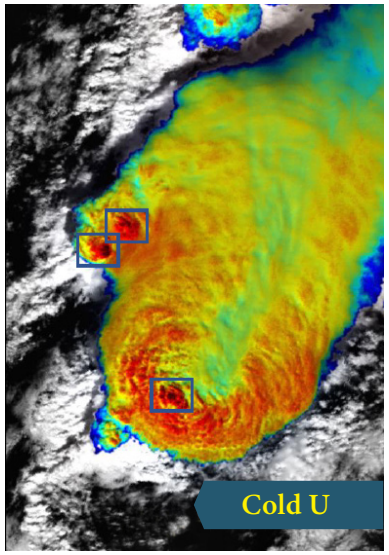
Squares – overshooting tops
Yellow arrows – over-anvil ice plume

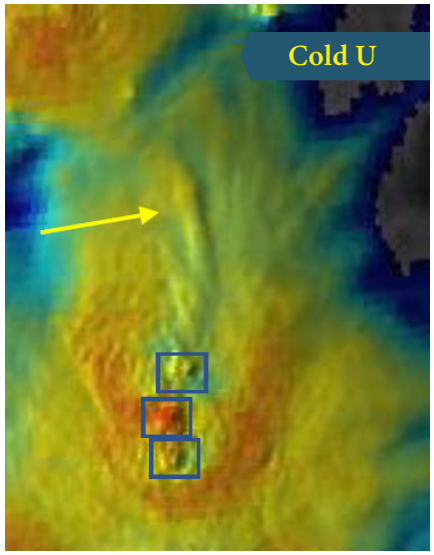
Other type of sandwich product

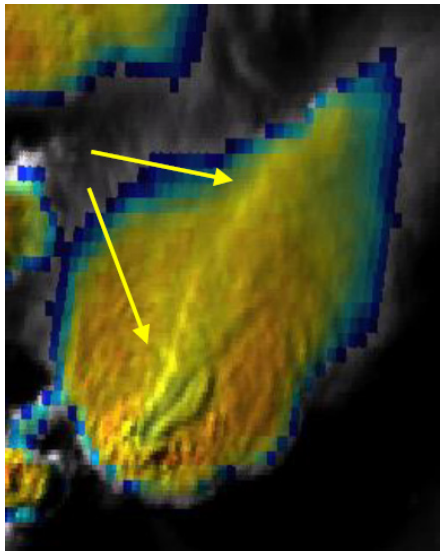
The left sandwich image shows the same scene as the image far left, but it is created from both the SEVIRI **HRV and Severe Storms RGB**. **The encircled cell is likely the most intense one in this scene, because it is more yellow than the other cell**, so its cloud top is composed of very small ice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

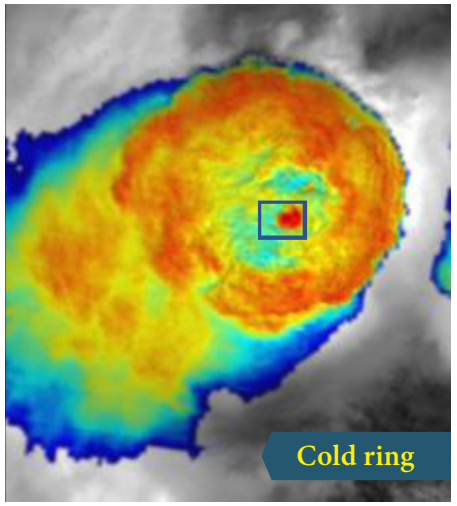
Why is the cloud top particle size interesting? Small ice crystals at (or above) the cloud top of a continental mid-latitude storm can be an indicator of strong updraft (not necessarily always). Strong updraft scan transport small ice particles up to the cloud tops, as the small water droplets which 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

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