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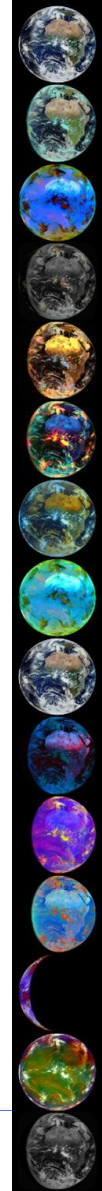
Detecting snow and supercooled water clouds
Two winter challenges

Roxane Désiré

EUMeTrain MTG Event Week
24/06/2025



Outline

Snow
- Which products?
- Keepers and mediocre ones
- The Cloud Type RGB case
- The Cloud Phase RGB case

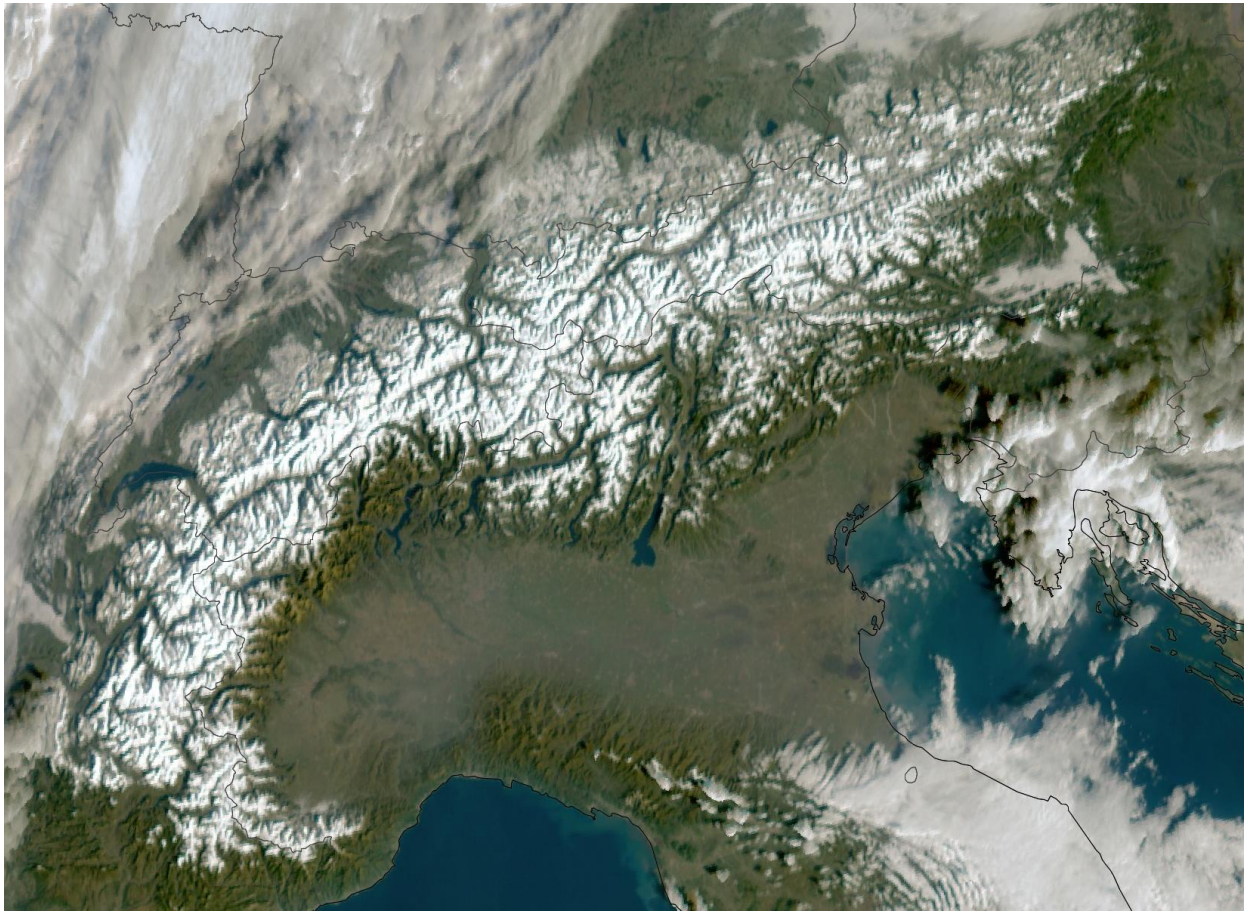
Supercooled water clouds
- Which products?
- Color nuances and additional information
- Further confirmation

Snow on the ground detection

Which products?

True Color RGB

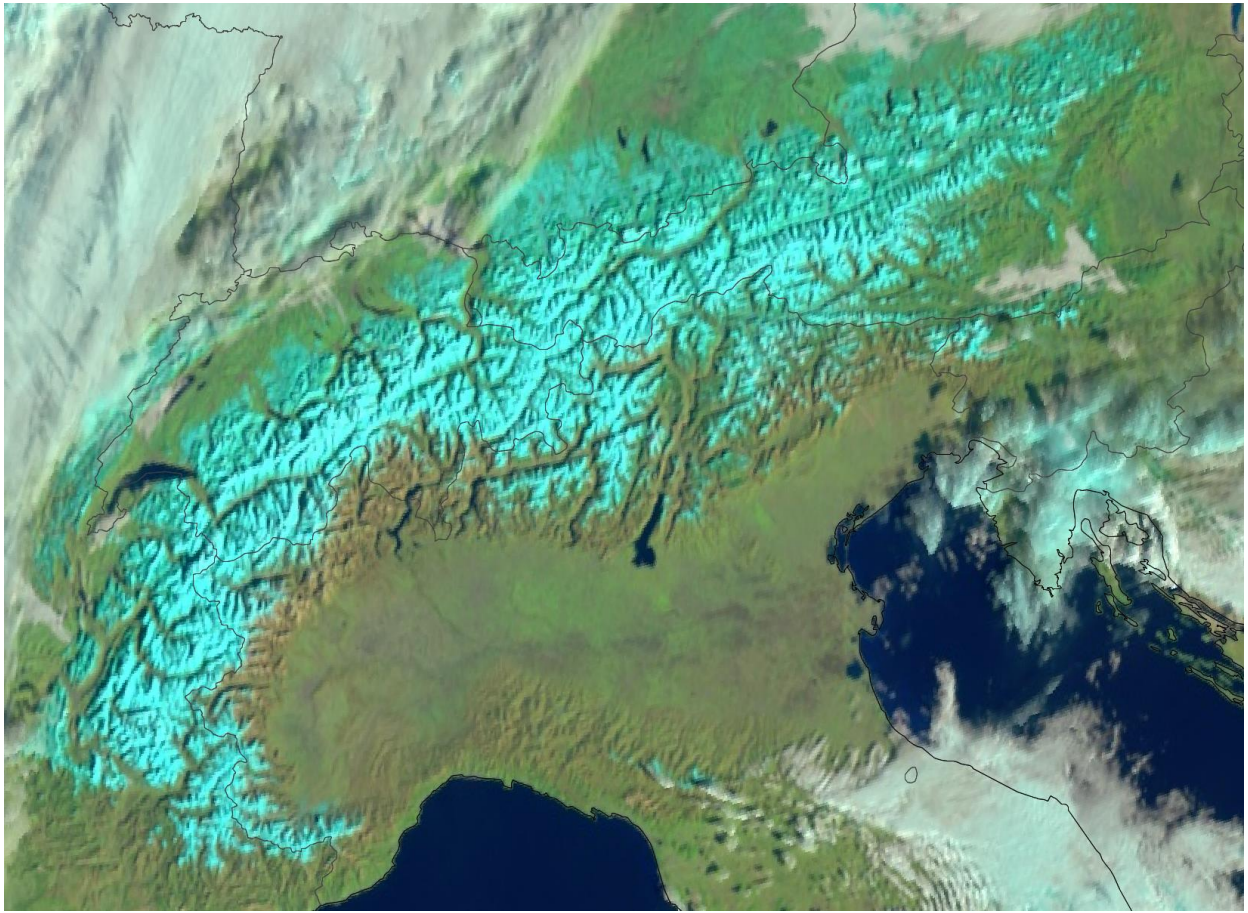
Snow appears in a more or less bright white, like clouds. It could therefore be difficult to differentiate them.



Which products?

Natural Color RGB

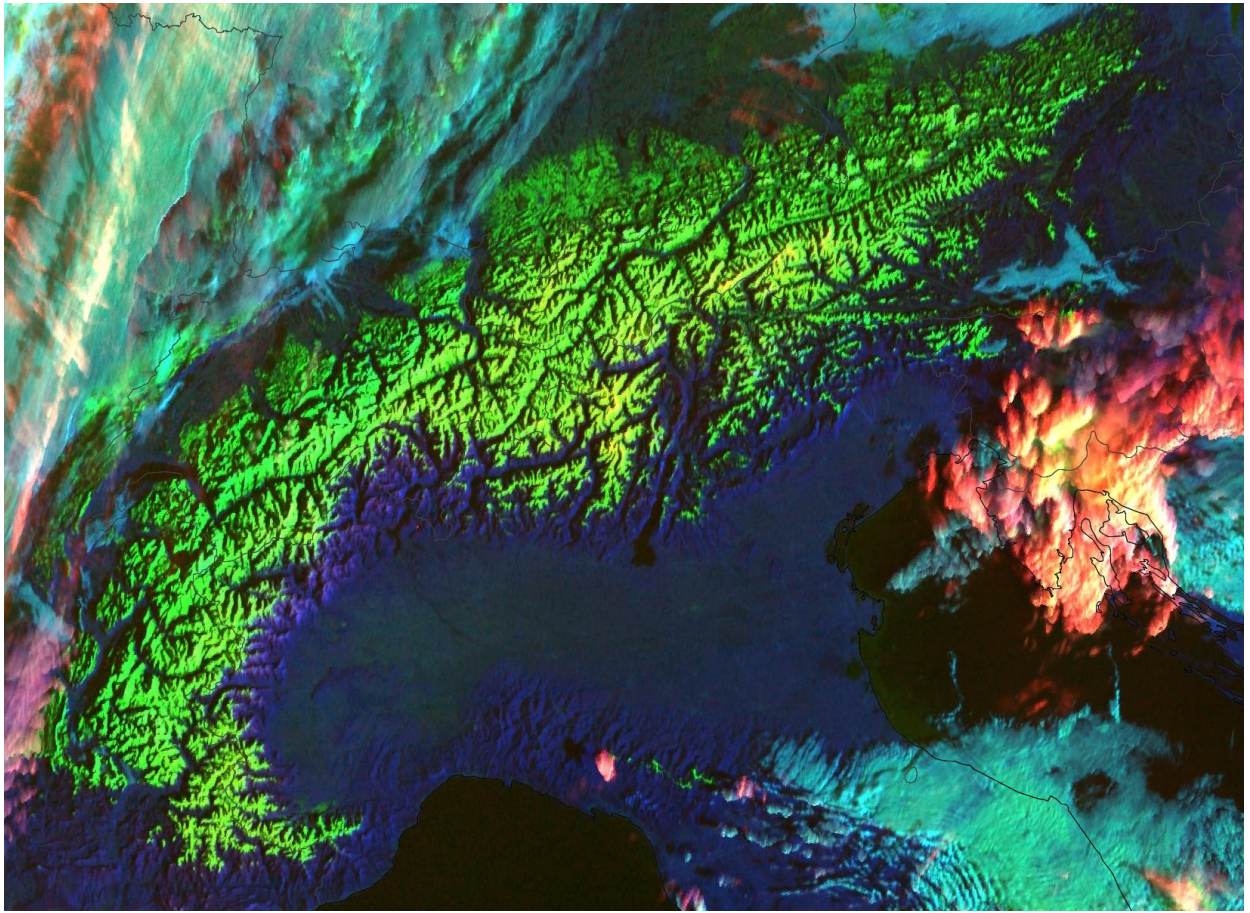
The snow appears cyan blue, a shade that also seems to be found in the thicker clouds over Croatia/Slovenia.



Which products?

Cloud Type RGB

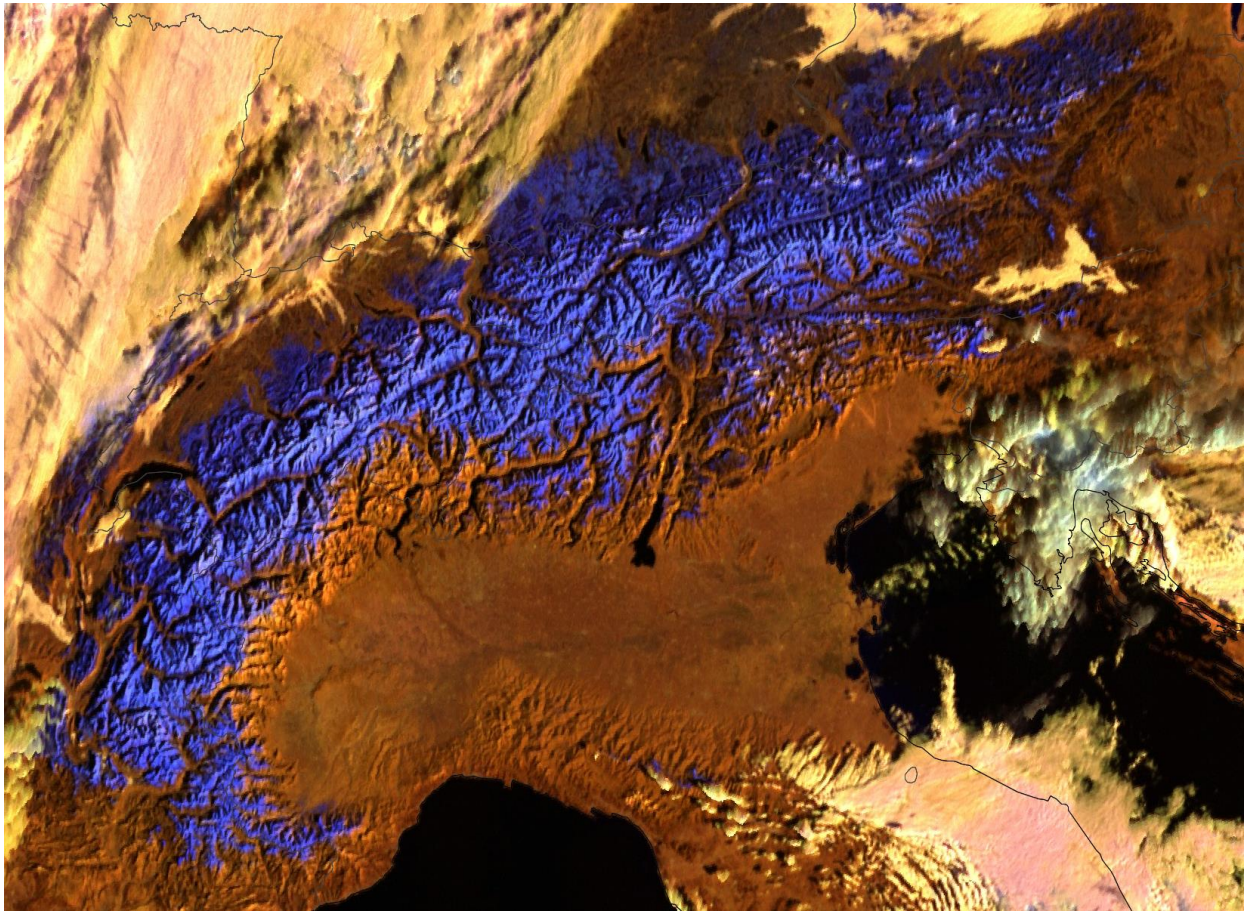
The snow is green, almost yellow in places. There are also similar shades of green in some clouds (southwest Germany).



Which products?

Cloud Phase RGB

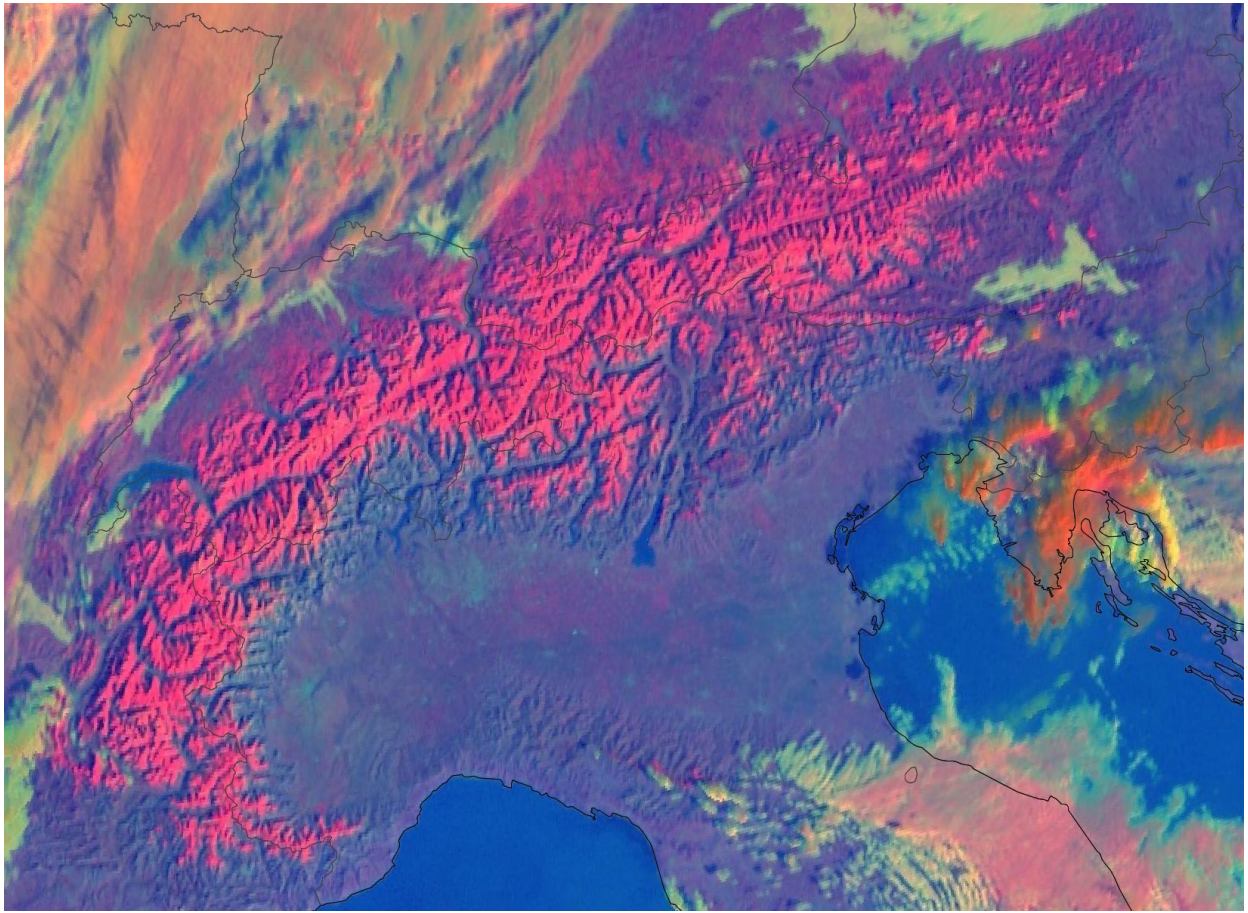
The snow is clearly distinguishable with shades of dark blue/purple. We also note lighter tones on what appear to be the highest peaks.



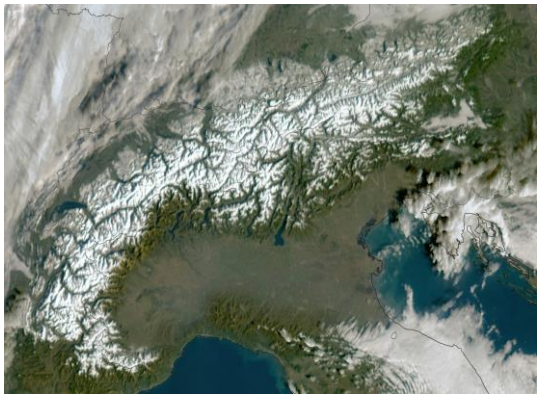
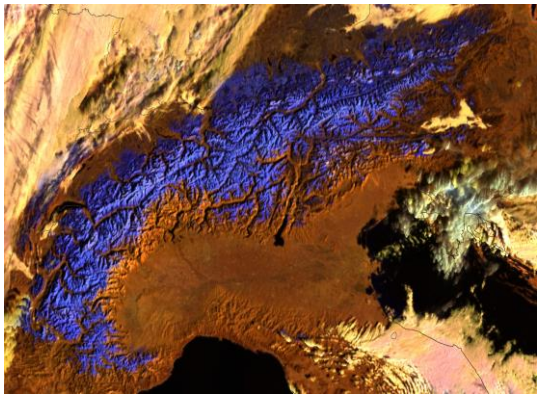
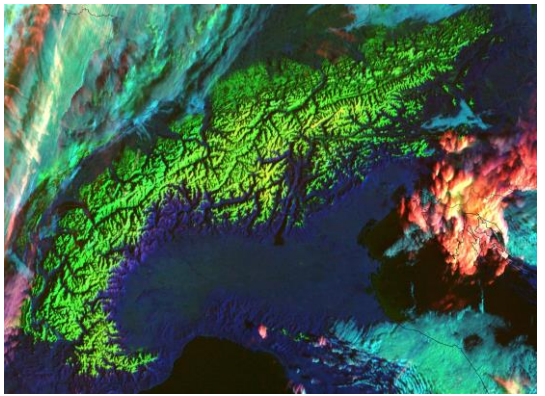
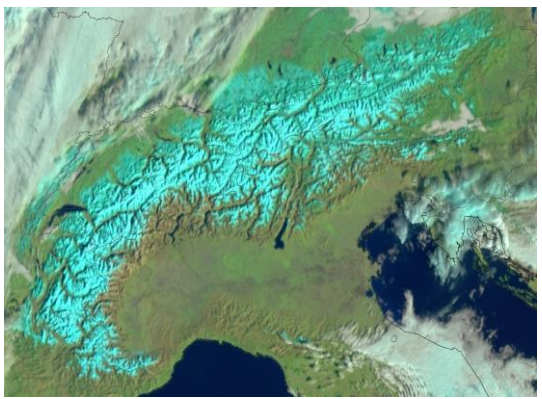
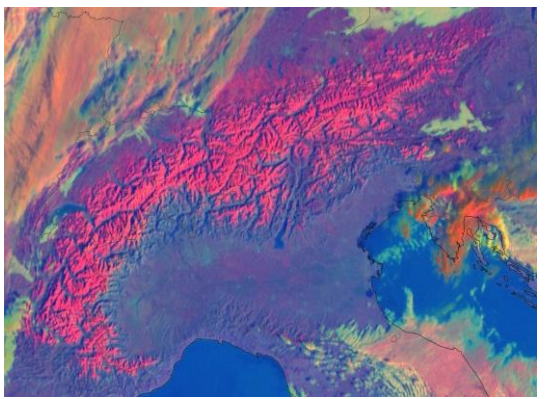
Which products?

Day Microphysics RGB

The snow is pink. There are also similar shades of pink in some clouds (southwest Germany). Differentiation from the ground is not always obvious.



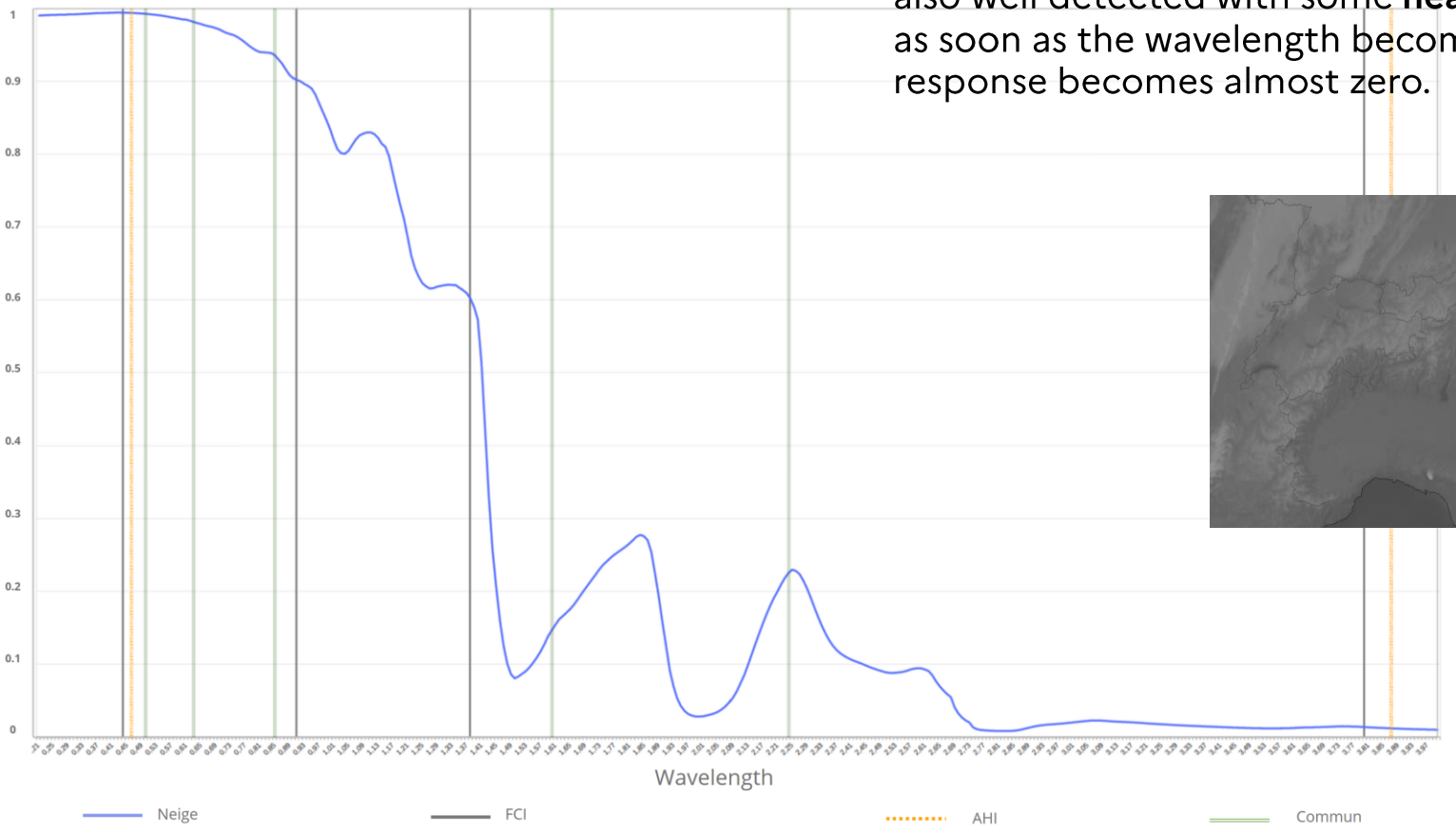
What do all these products have in common?

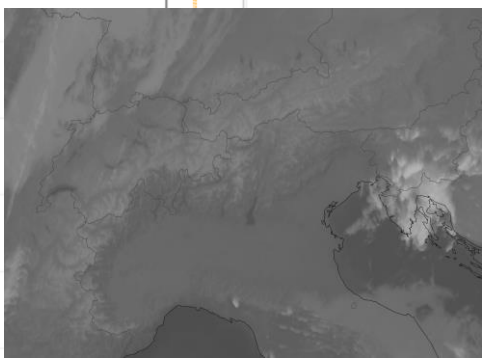






→ They are made from visible and near-infrared channels

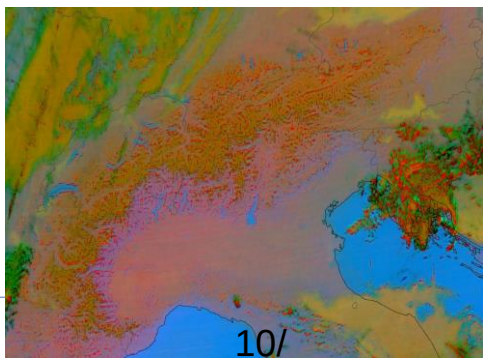
Reflectivity of snow

Snow is very well detected by the **visible channels**. It is also well detected with some **near-infrared channels**. But as soon as the wavelength becomes too long, the spectral response becomes almost zero.



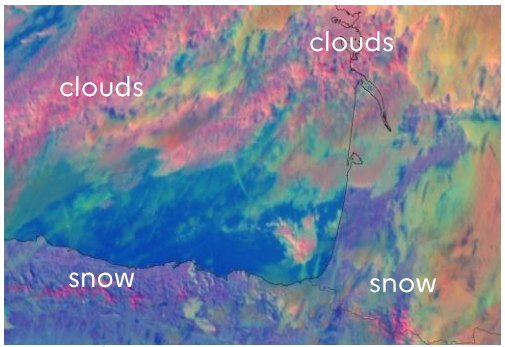


IR 10.5



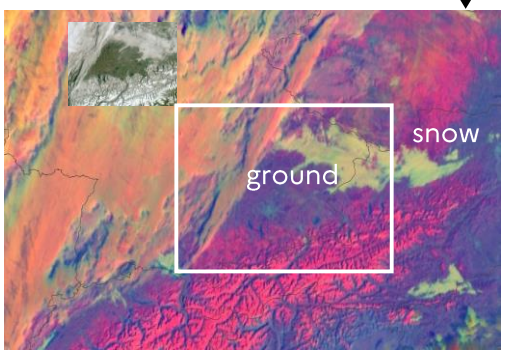
Dust RGB

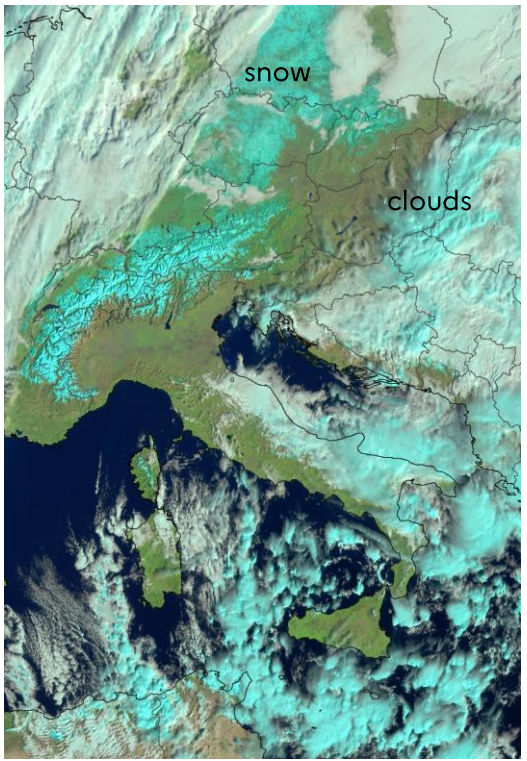
Mediocre ones : detection possible but not ideal



Mid-level clouds have a color very similar to snow, making them hard to separate.

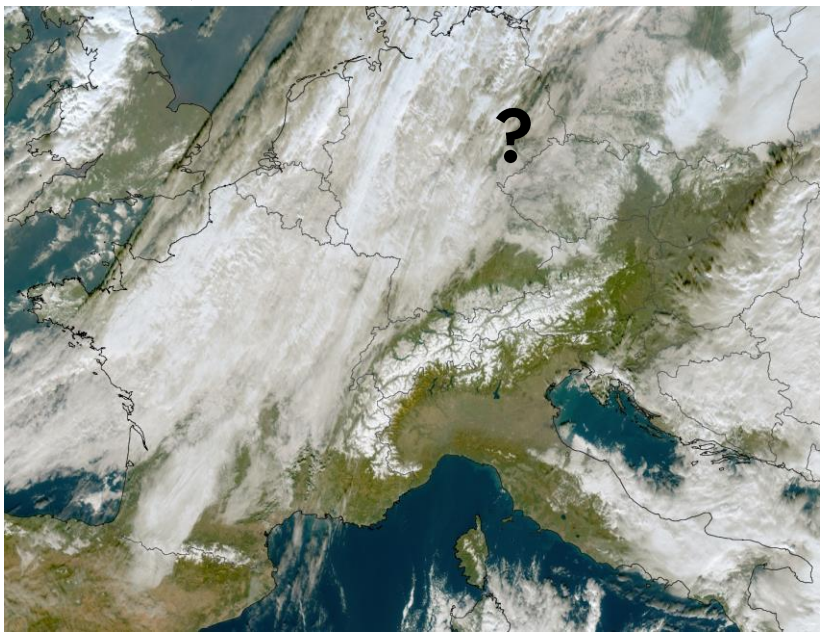
The land can sometimes show a comparable color as well.





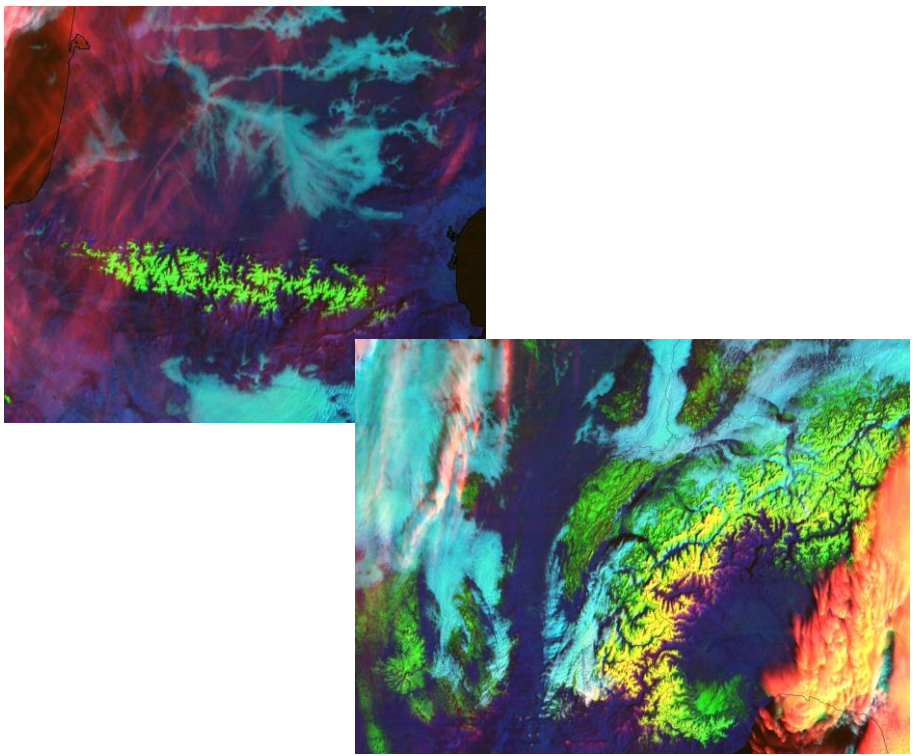
Snow and ice clouds have very similar shades, making them hard to separate.

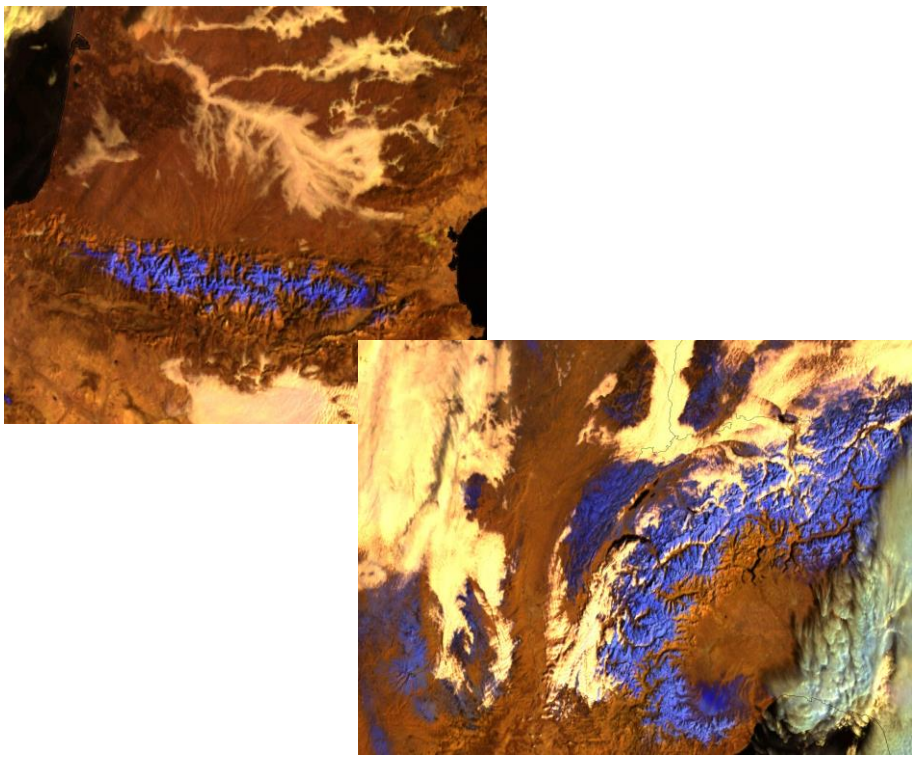
It is very hard to distinguish snow on the ground from clouds.



Keepers : priority images

With Cloud Type RGB and Cloud Phase RGB, snow is clearly identified from land, low-level clouds and high-level clouds thanks to a good color contrast.

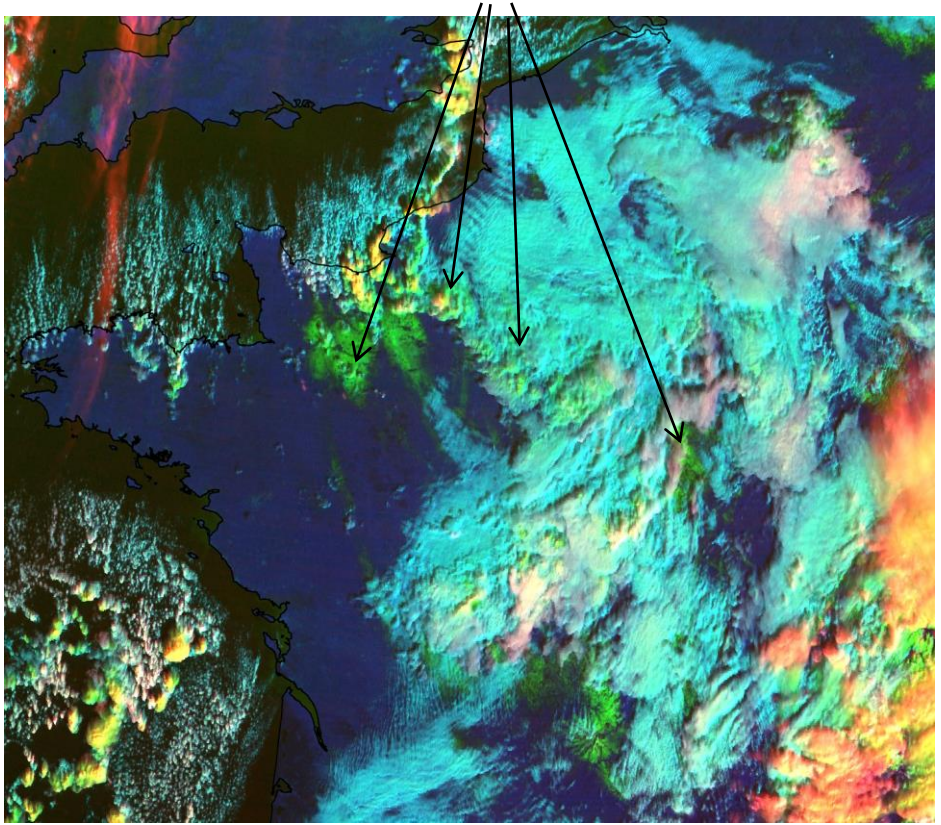




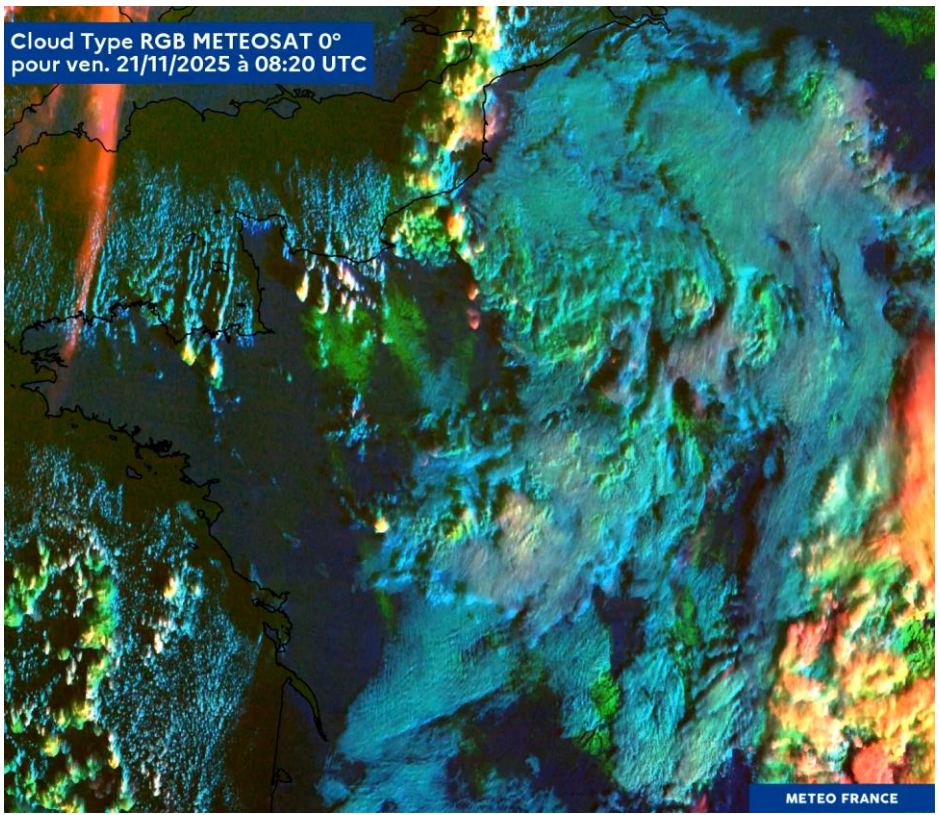
The Cloud Type RGB case

Similar shades of green can be found in mid-level/mix phase clouds.

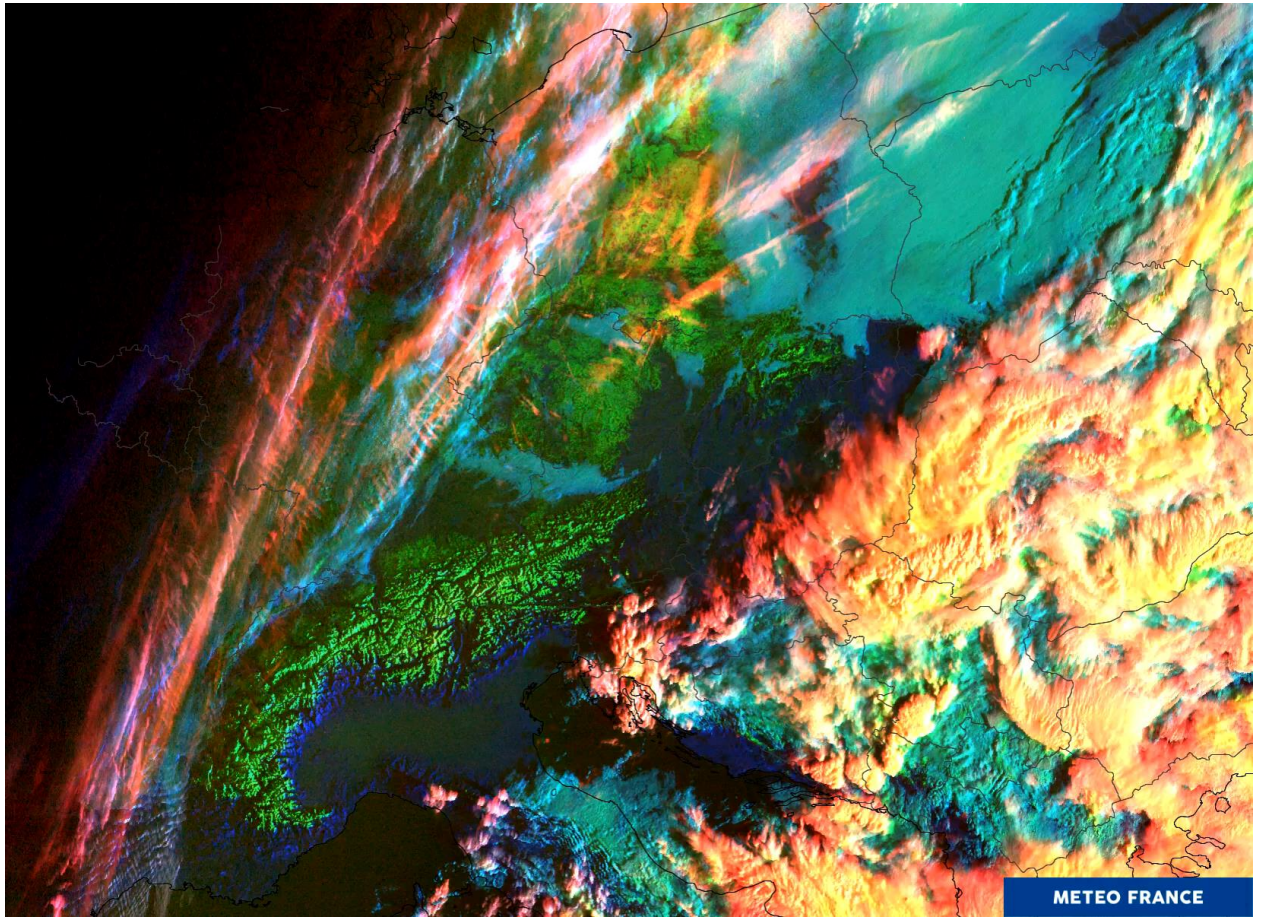
Snow ? Clouds ?



The answer is in a loop !



The Cloud Type RGB case



Why does the snow sometimes turn yellow ?

The Cloud Type RGB case

- Cirrus, thin high clouds
- Thick high-level ice clouds
- Land surface
- Low-level water clouds
- Mid-level clouds, mixed phase on top
- Thin supercooled water clouds
- Thick supercooled water clouds
- Snow on the ground

Highly sensitive channel to thin cirrus clouds.
Detection of any surface in the absence of atmospheric water vapor above.
→ **A red contribution is added as long as the atmosphere is dry.**
→ **This is regularly the case in mountainous regions/at high elevations.**

Snow is usually green

Color	Channel	Physically related to	Low signal contribution	High signal contribution
Red	NIR 1.38	Cloud top height and atmospheric optical thickness	Low clouds	High clouds
Green	VIS 0.64	Cloud optical thickness	Thin clouds	Thick clouds Snow on the ground Sea ice
Blue	NIR 1.61	Cloud top particle phase (and size)	Thick ice clouds Snow on the ground	Thick liquid water clouds

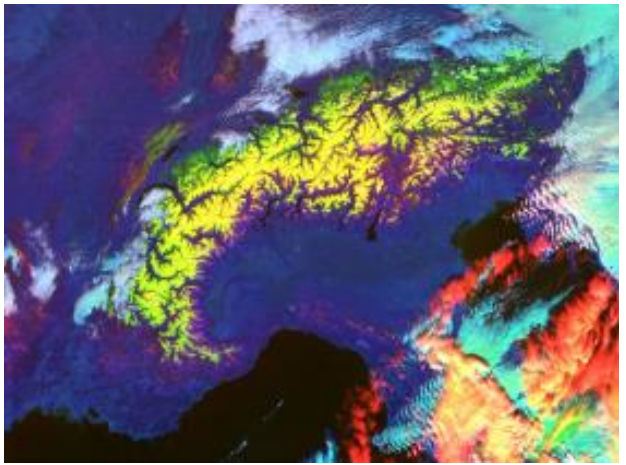
A red component is also added when **semi-transparent cirrus clouds are detected above** the snow-covered surface.

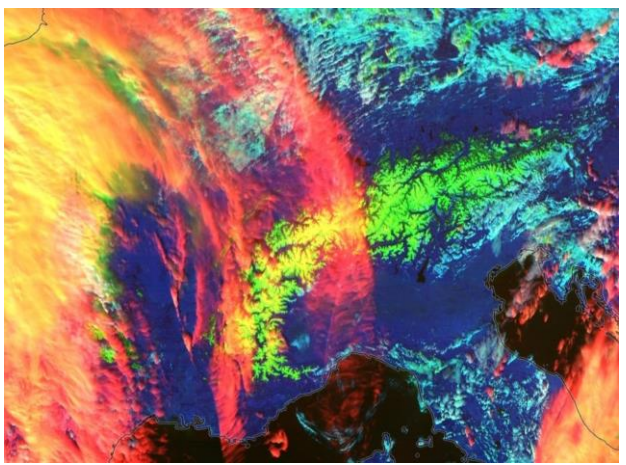
The Cloud Type RGB case

The snow is green, very similar to mid-level/mixed-phase clouds.

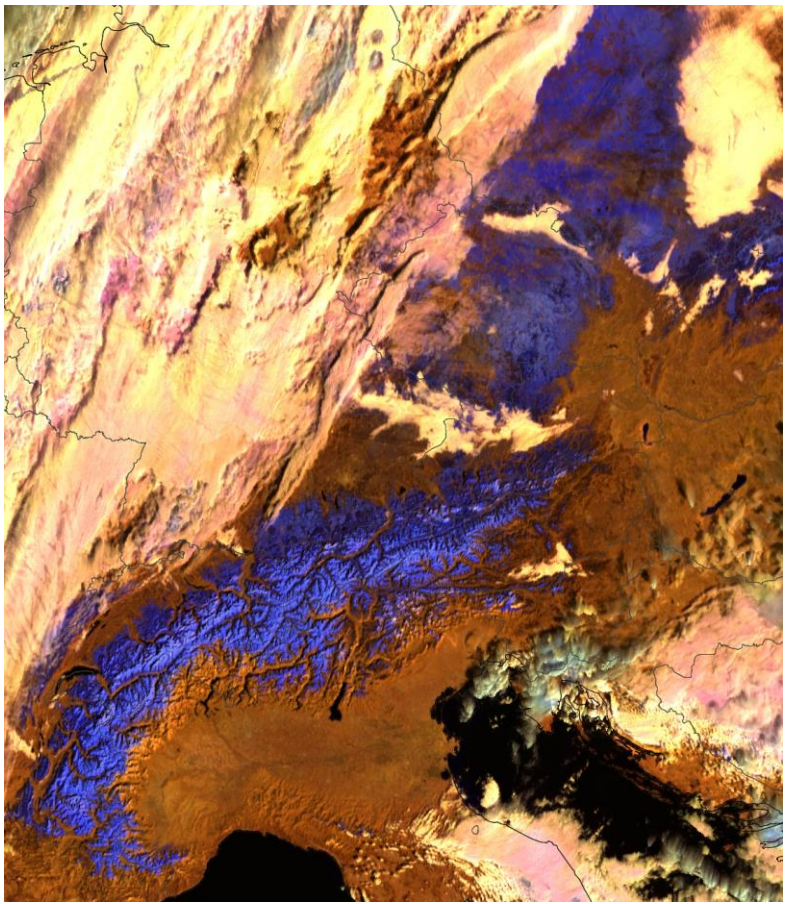
It turns yellow if the atmosphere is very dry or if cirrus clouds are above it.
High contribution of NIR1.38 channel in the red band in both cases.

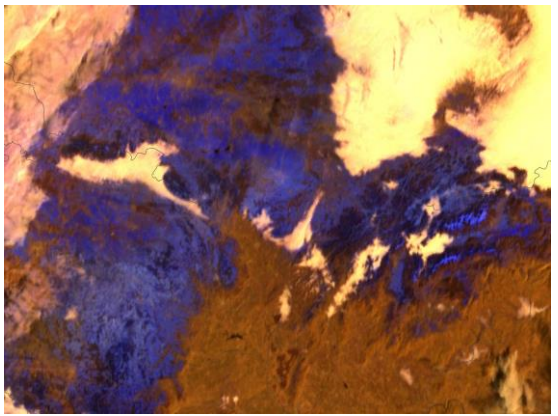
→ A red contribution is added for every features, cloud or ground.
→ Colors are modified.

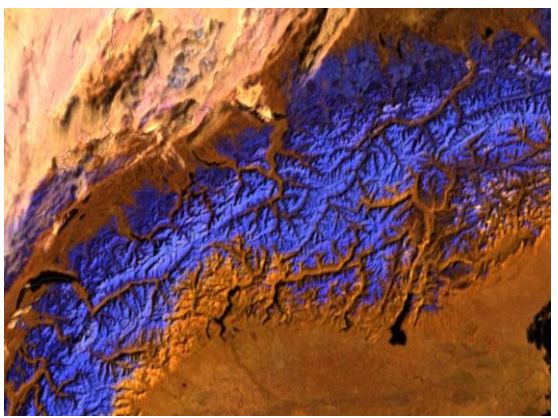




The Cloud Phase RGB case

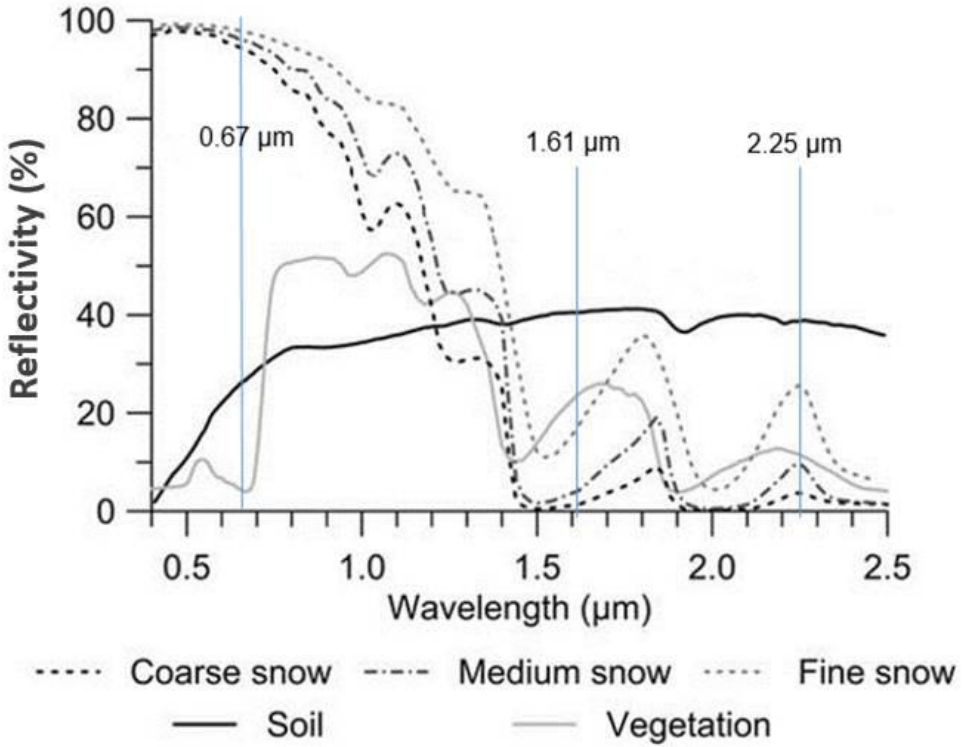






Why are there several shades of blue ?

The Cloud Phase RGB case



In addition to VIS0.6, the Cloud Phase RGB product uses the 1.61 µm and 2.25 µm channels.
The spectral response in these two channels depends on the snow grain size.

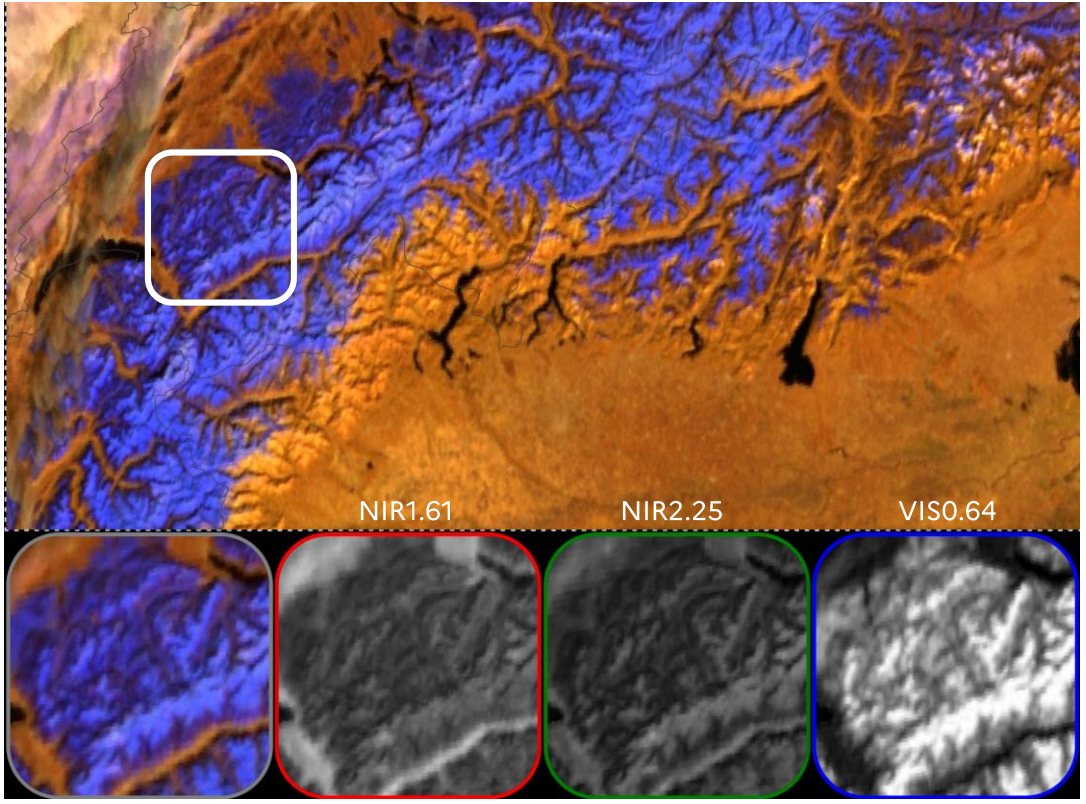
For smaller snow grain size, the reflectivity is higher, both at 1.61 µm and at 2.25 µm.

In VIS0.67 imagery, all kind of snow are much brighter than snow-free land.

The Cloud Phase RGB case

On the highest peaks, where temperatures are very low, the snow cover is generally fine-grained, especially in the case of recent snowfall.

This is consistent with the lighter blue color observed there, corresponding to a stronger reflectivity/spectral response.



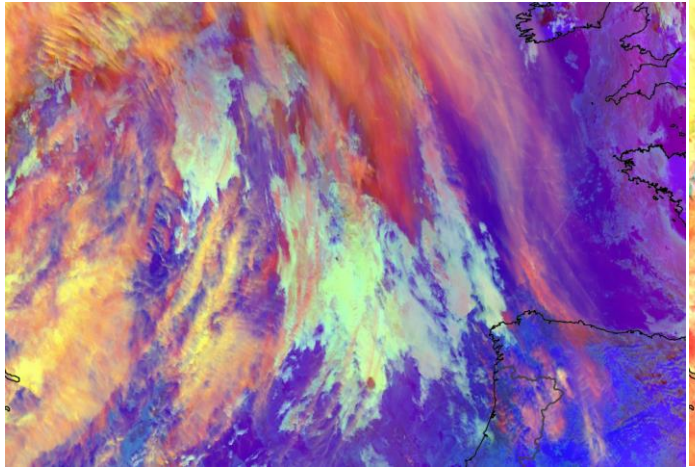
More information: case study on the EUMeTrain webpage

Supercooled water clouds detection

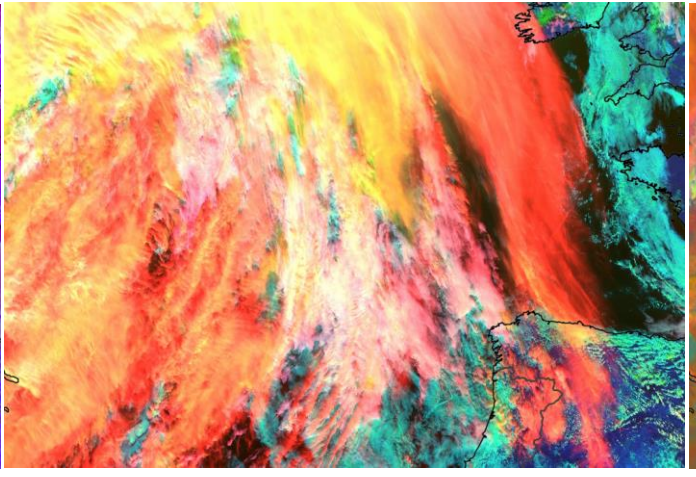
Why is it important?

Supercooled water clouds are a major hazard for **aeronautical meteorology**, and their detection is a crucial information. **Freezing rain** sometimes resulting from this kind of clouds also represents another significant challenge for forecasters.

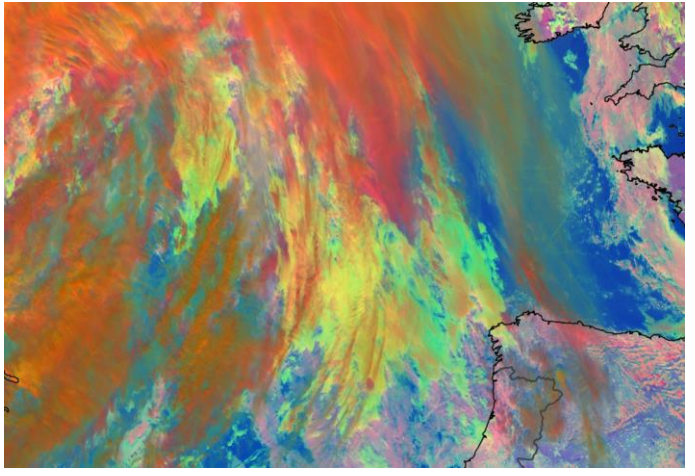
3 RGB products for detecting them :



Convection RGB

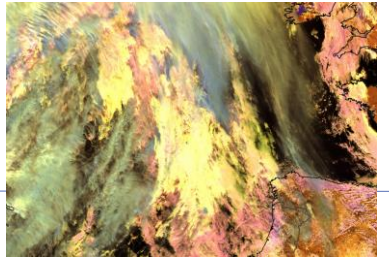


Cloud Type RGB



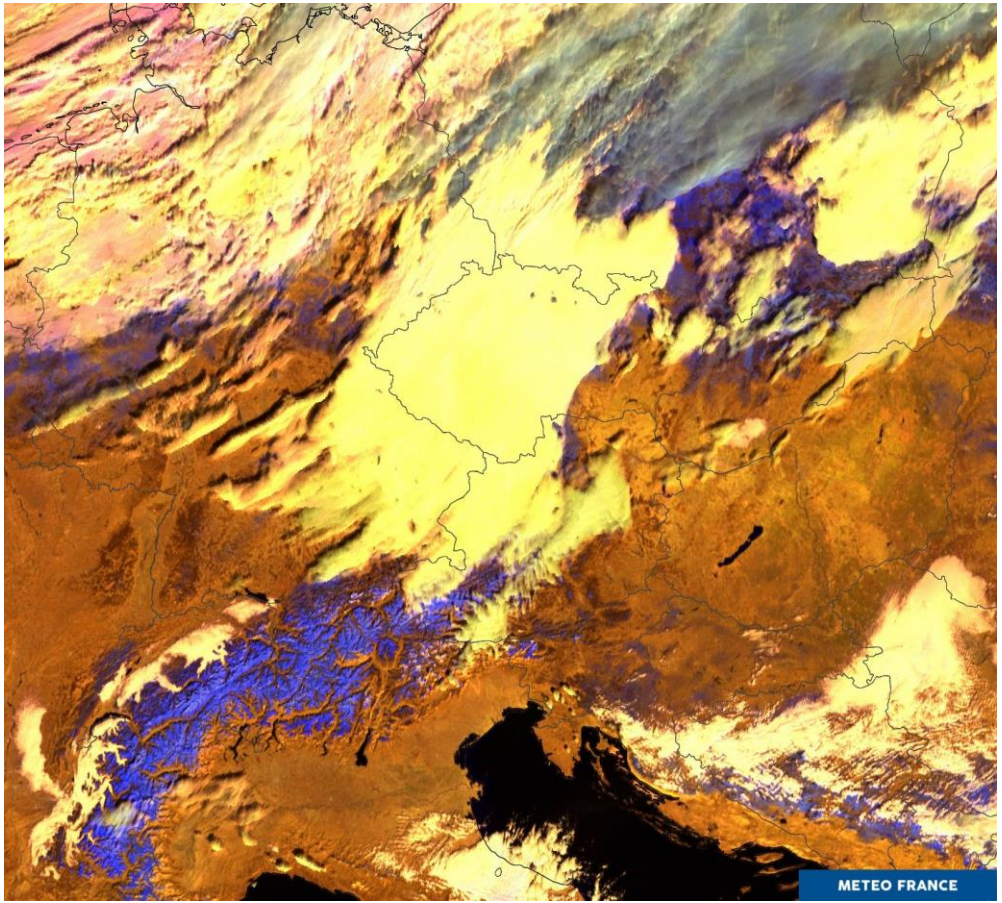
Day Microphysics RGB

And one to confirm the liquid phase of water



Cloud Phase RGB

Which products?

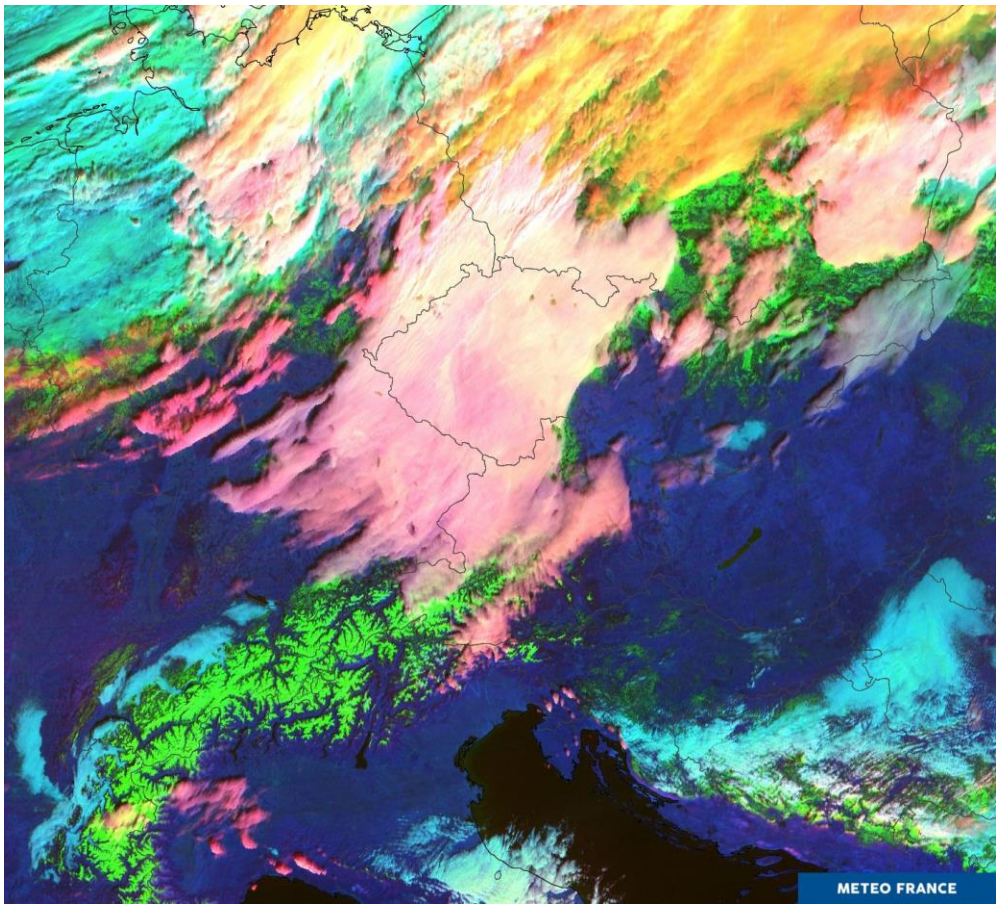


Supercooled water cloud, Czech Republic, 2025/01/14

Cloud Phase RGB – as the name suggests – provides information on the cloud-top particle phase and size, but not directly on the presence of supercooled water.

The yellow/beige shade corresponds to a liquid water cloud composed of small droplets, which is often the case for supercooled water.

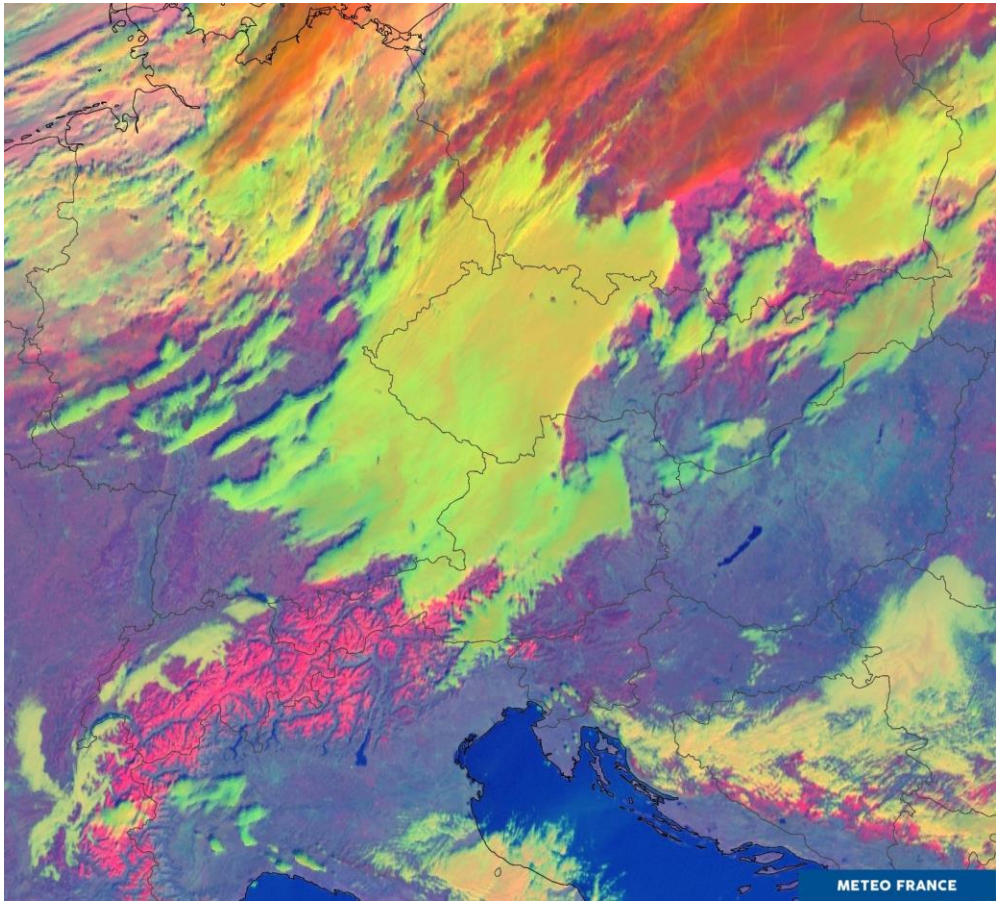
Which products?



With the Cloud Type RGB product, supercooled water droplets will appear pink for a thin cloud or white for a thicker cloud.

Point of attention: when the atmosphere is very dry all the way down to the lower layers, low-level water clouds (not supercooled) can have a similar colour.

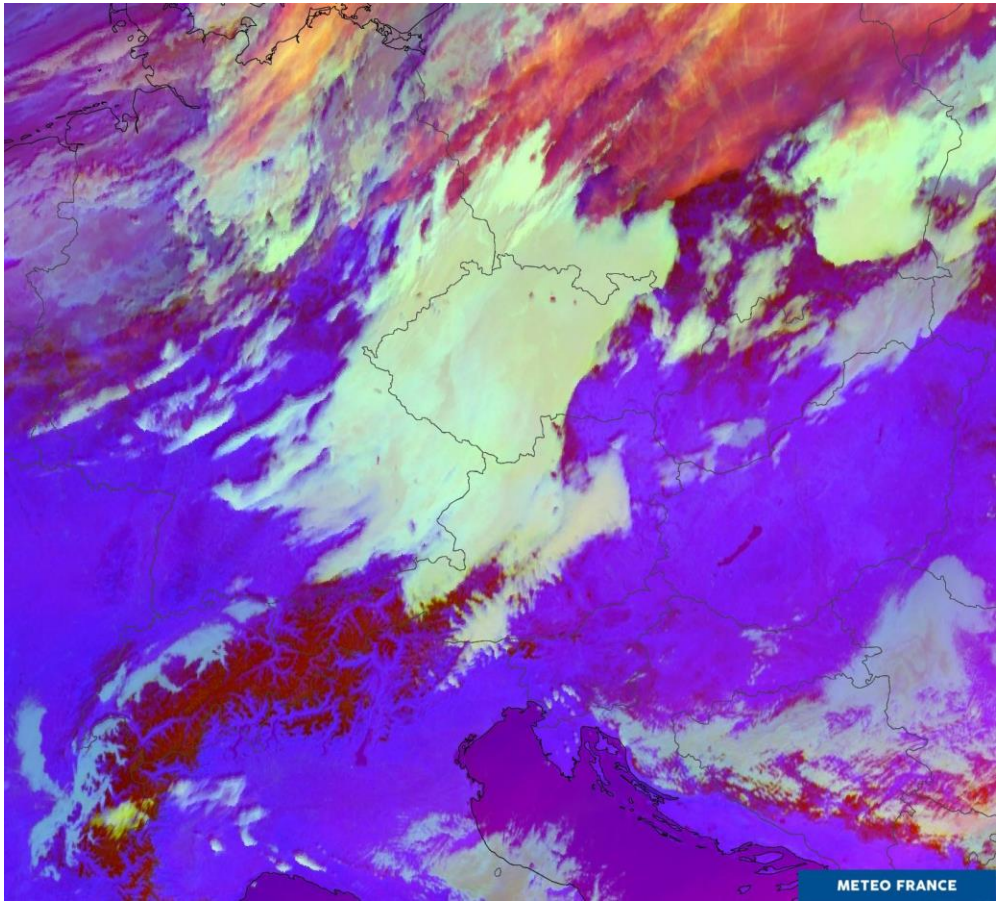
Which products?



Interpreting Day Microphysics RGB is complex due to the wide range of colors it presents. Supercooled water can appear in various colors, depending on particle size and cloud thickness.

Thin clouds generally appear in shades of green, which can be darker or lighter depending on the droplet size. Thick clouds, on the other hand, appear yellow to orange.

Which products?

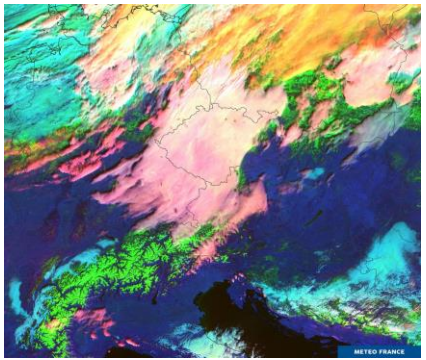


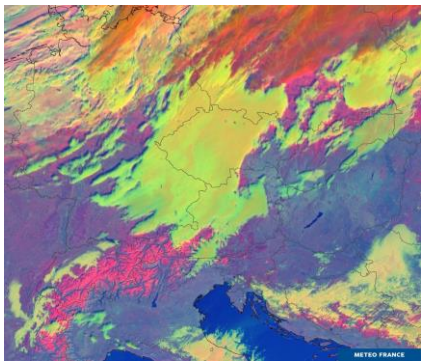
Finally, another product can be used to detect supercooled water clouds: Convection RGB.

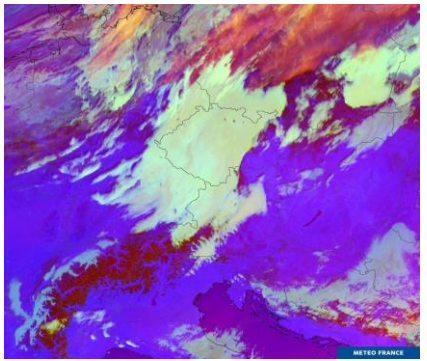
They will appear in a rather bright grey colour (as opposed to low- to mid-level clouds, which will show up as a duller, bluish grey).
When the cloud top is very cold, and/or when the particles are very small, shades of green appear.

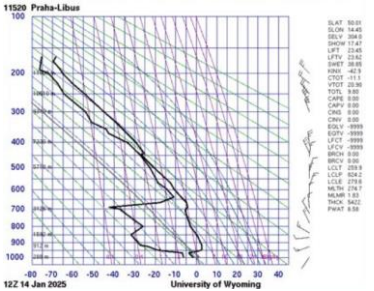
Color nuances and additional information

The 3 products are complementary and provide different information.









To confirm the presence of supercooled water, it is recommended to compare these different images and even to consult a nearby radiosonde measurement.
The one above, from Prague (right in the middle of the cloud), confirms the supercooled nature with a temperature of –27 °C.

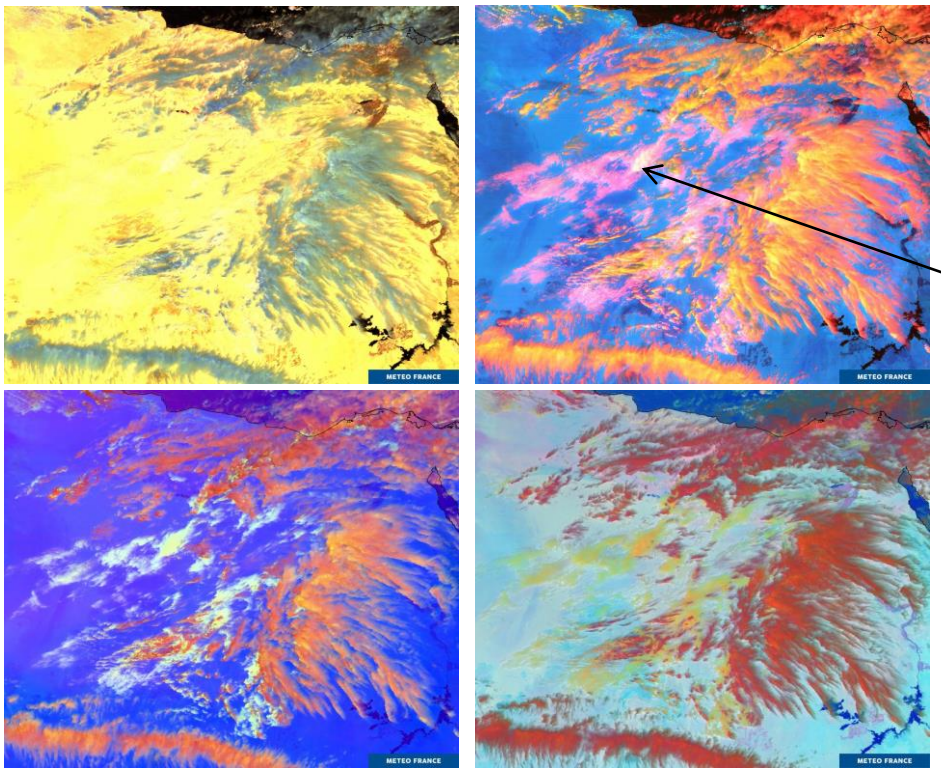
Qualitative thickness information is provided by Cloud Type RGB (white/pink) and Day Microphysics RGB (orange/green)
→ Helps forecasters anticipate potential precipitating clouds.

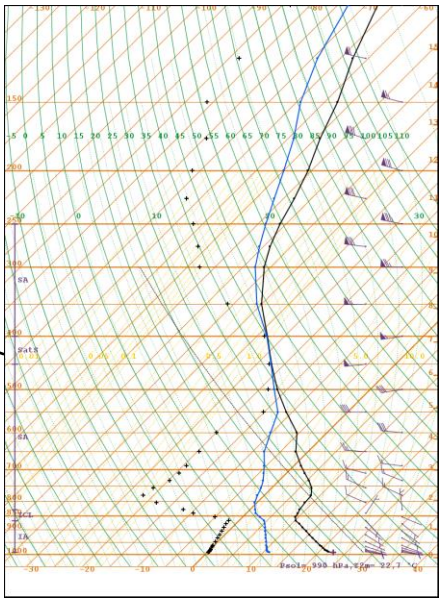
Day Microphysics RGB	Supercooled, thin water cloud, large droplets
	Supercooled, thin water cloud, small droplets
	Supercooled, thick water cloud, small droplets
	Supercooled, thick water cloud, large droplets
Cloud Type RGB	Supercooled, thick water cloud
	Supercooled, thin water cloud
Convection RGB	Supercooled water cloud (green shades when very cold and/or with small particles on top)

Color nuances and additional information

Applicable everywhere and to all types of clouds.

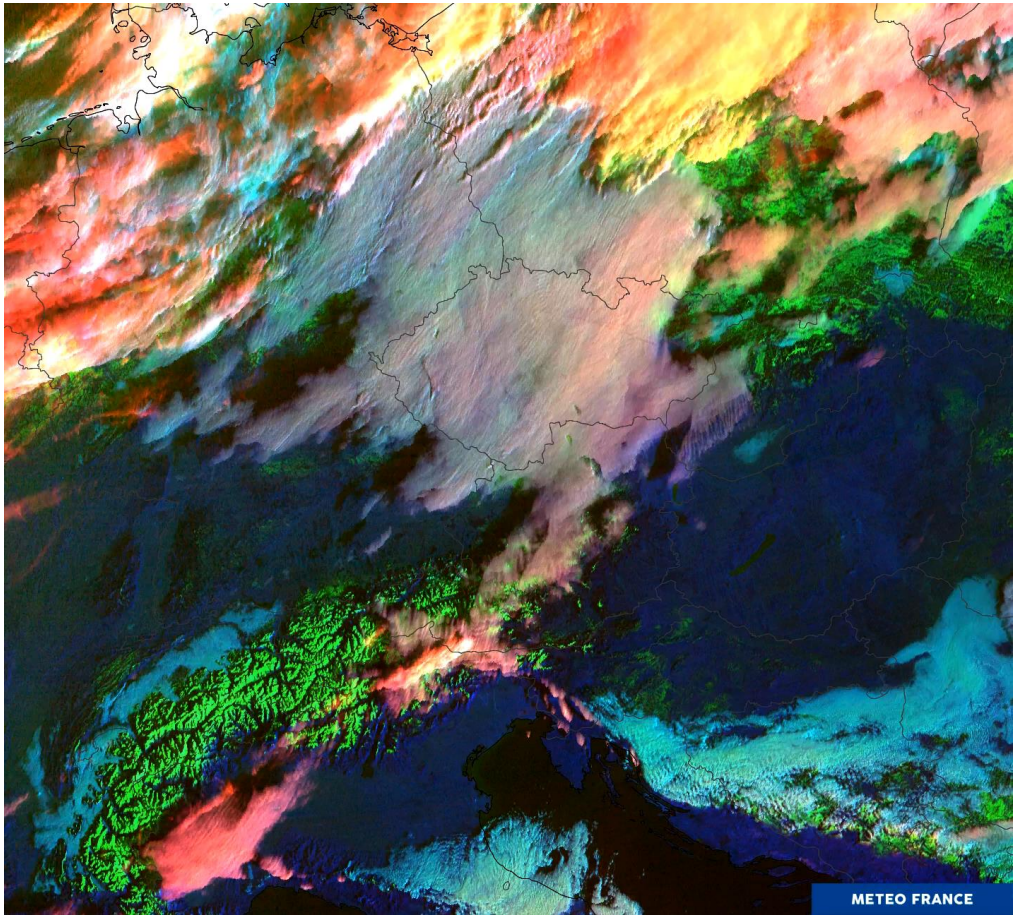
Northeast Africa



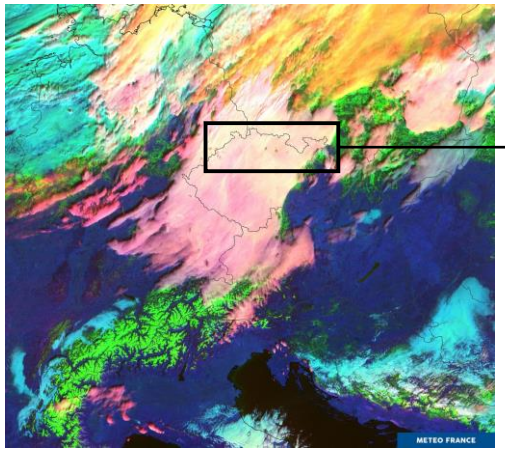


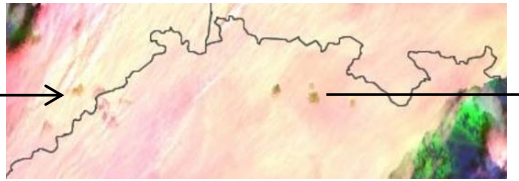
Vertical profile showing a cloud-top temperature of –25 °C.

An other sign of the presence of supercooled water cloud



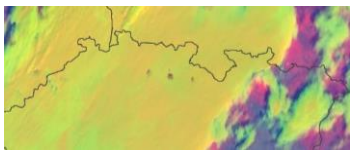
An other sign of the presence of supercooled water cloud



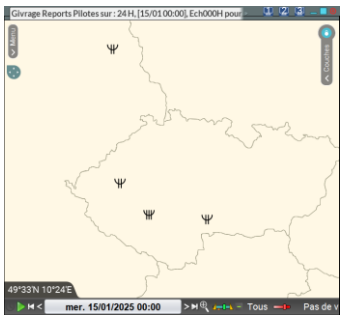


"Holes" appear within the cloud.

Cavum : cloudy feature formed by an aircraft in the presence of supercooled water
→ **A definitive indicator**



These cavum can also be seen on the other products.



Icing pilot reports the same day

Thank you !

Questions ?