Satellite Image Interpretation

Introduction to RGBs and channel differences

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Jarno Schipper

Danielle Schipper

Sepp Schipper

Jarno Schipper

Danielle Schipper

Sepp Schipper

Jarno Schipper

Annick Schipper

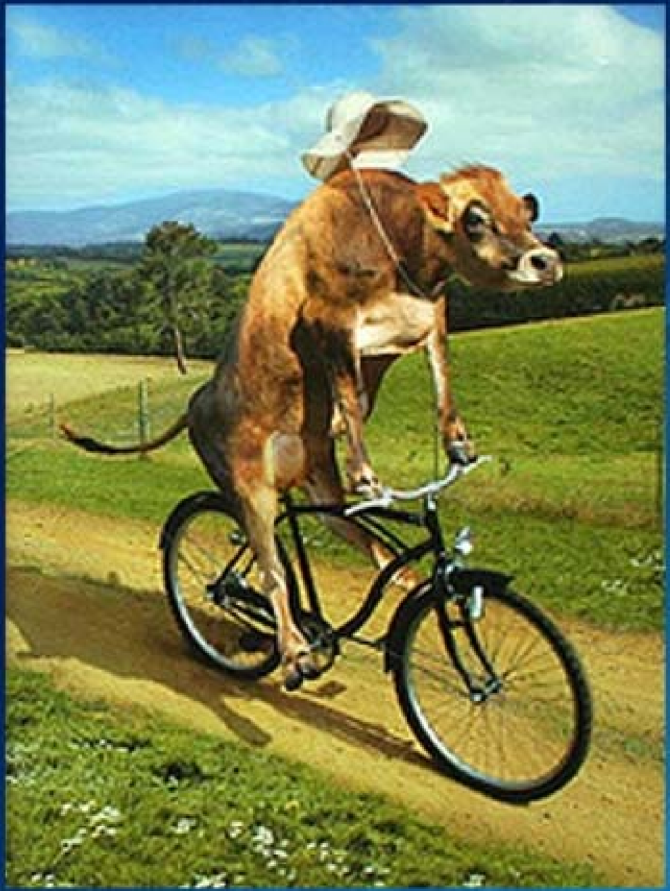
Danielle Schipper


I want to go where there are farm animals


I want to go where there are farm animals
Kai, kai, kai, kai....

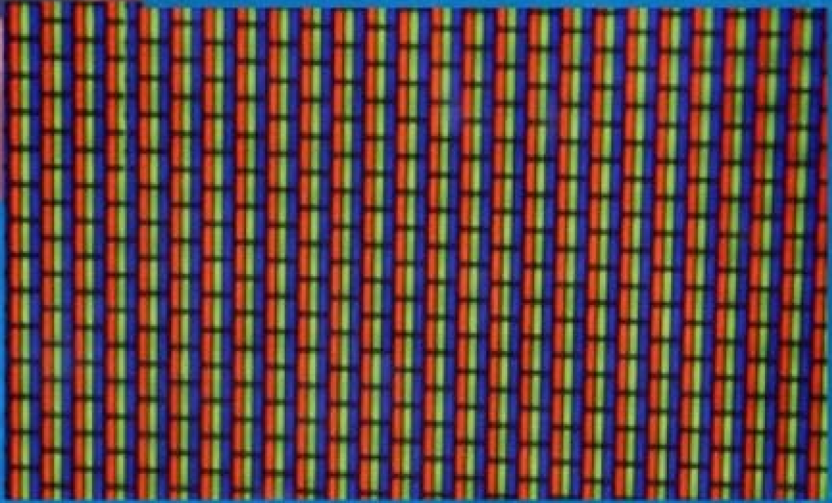

I want to go where there are farm animals
Some hiking in the mountains
Kai, kai, kai, kai....


I want to go where there are farm animals
Cycling!
Some hiking in the mountains
Kai, kai, kai, kai....



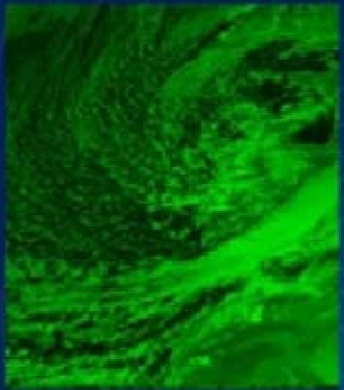

DAYLIGHT
TELEVISION


DAYLIGHT TELEVISION



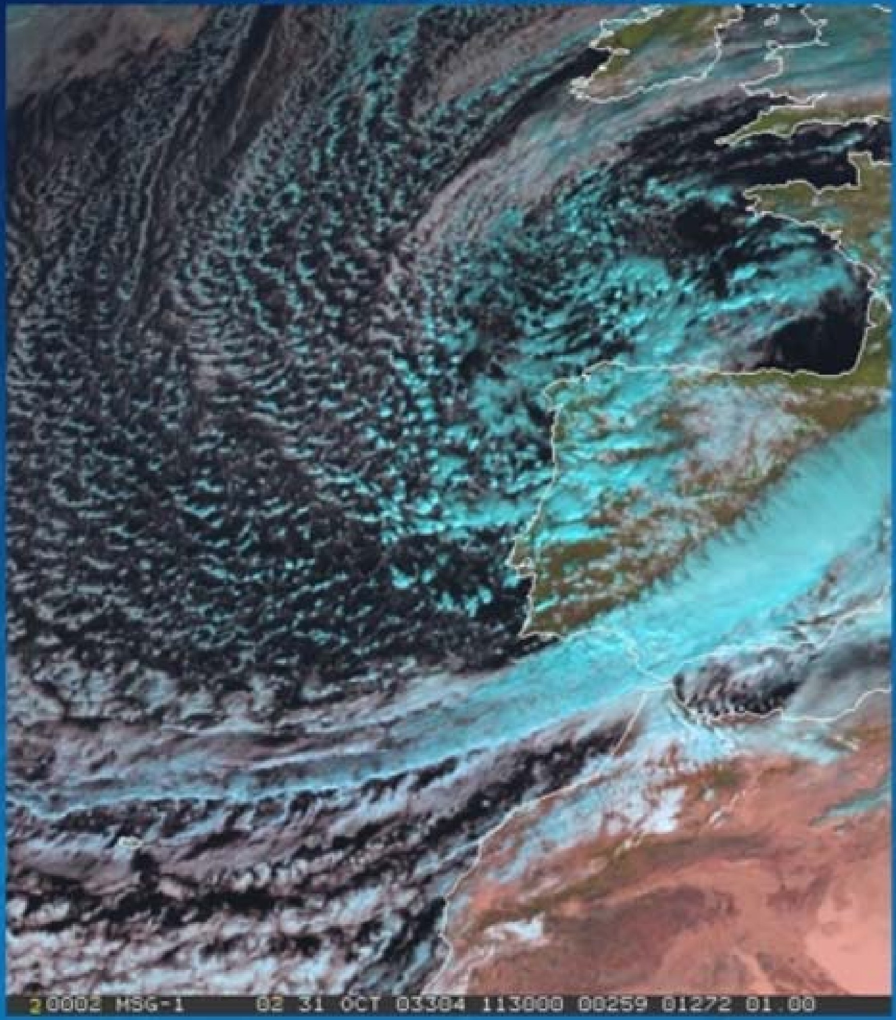
NIR1.6

VIS0.8



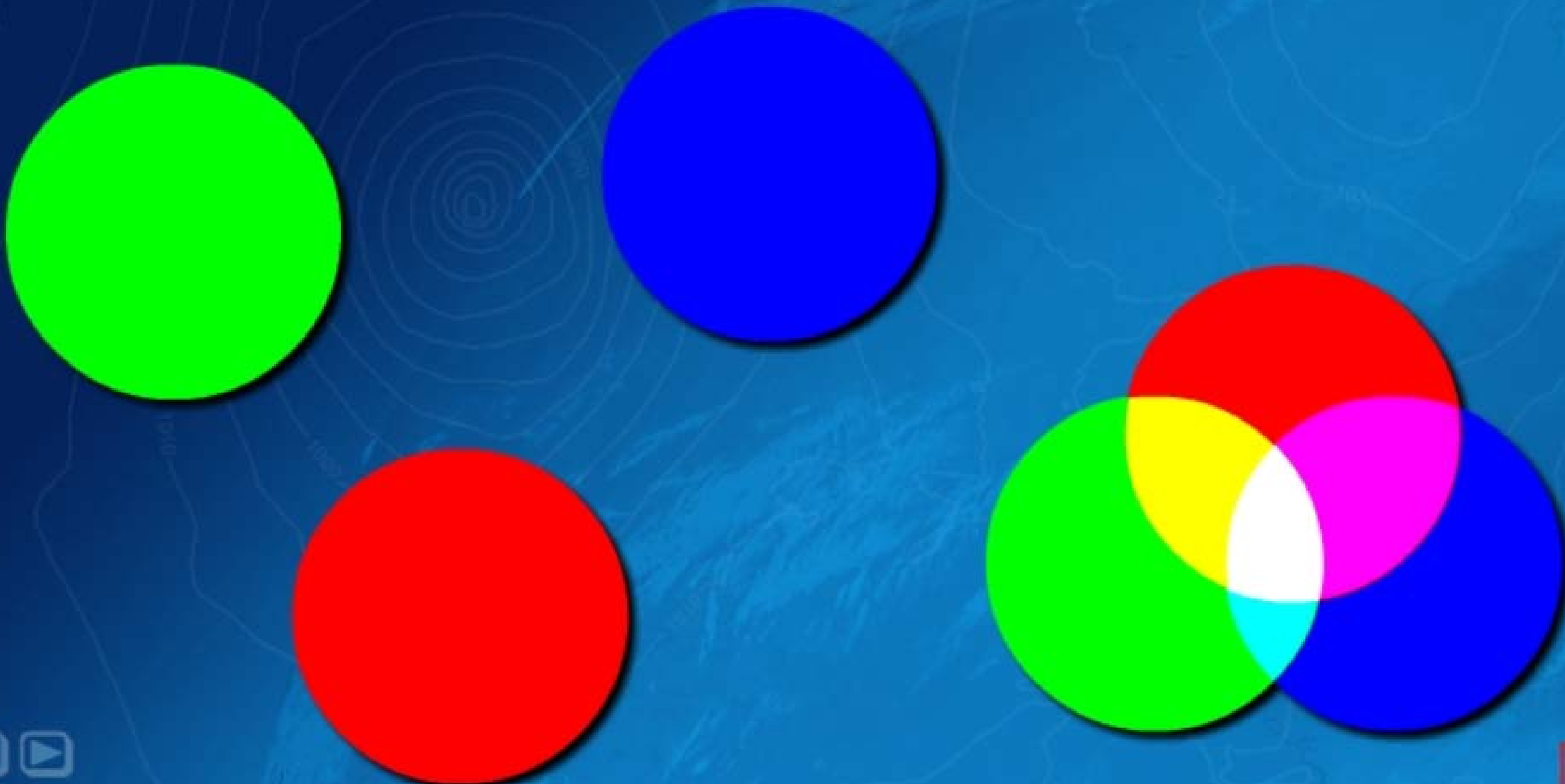
VIS0.6

Natural Colour RGB



RGB Playschool

RGB refers to the primary light colours used to create all the colours seen on a computer screen. By mixing various proportions of these primary colours, any colour in the visible spectrum can be created. When all three colours are present in full intensity the resulting image is white.



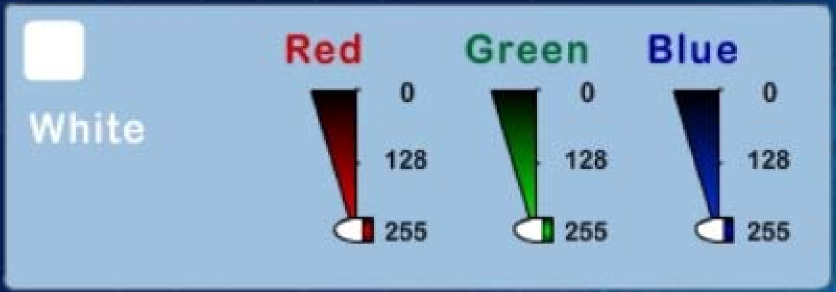
RGB Playschool

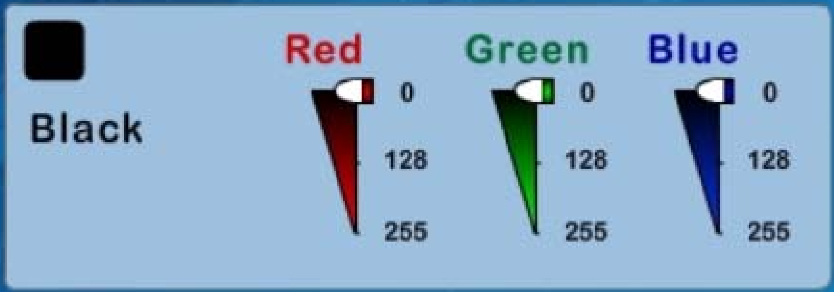
Exercises! Let's mix color

White

RGB Playschool

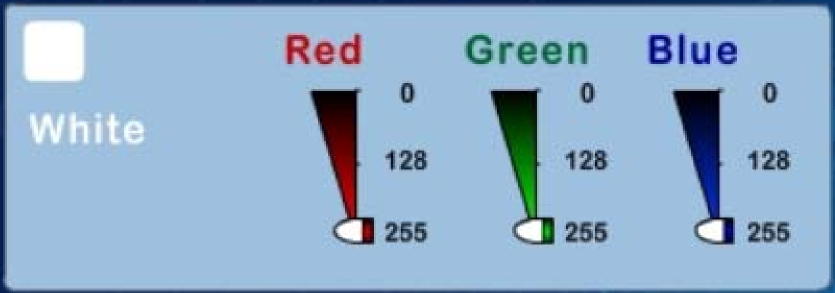
Exercises! Let's mix color

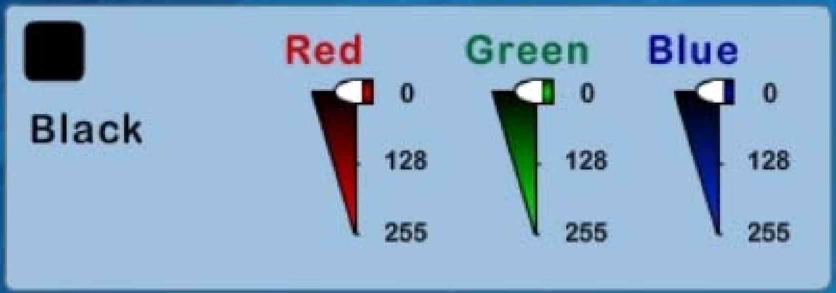


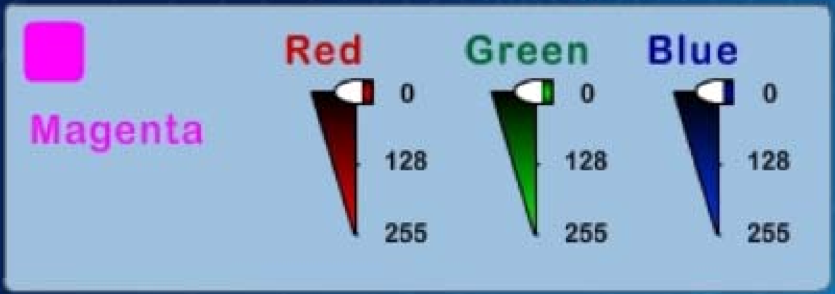


RGB Playschool

Exercises! Let's mix color

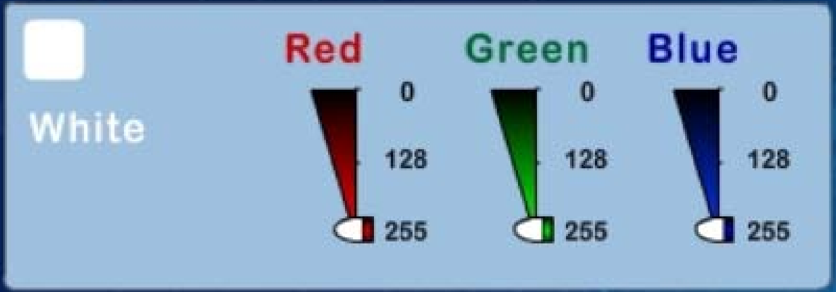


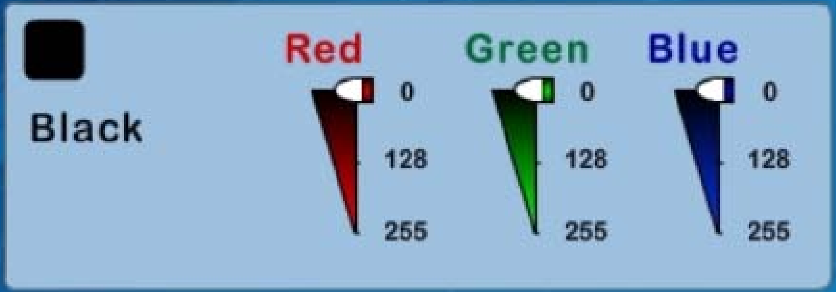


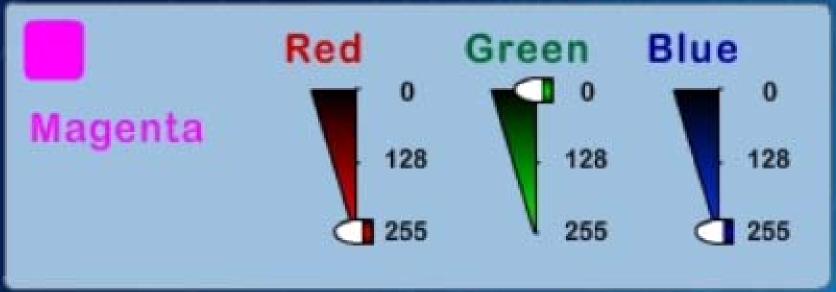


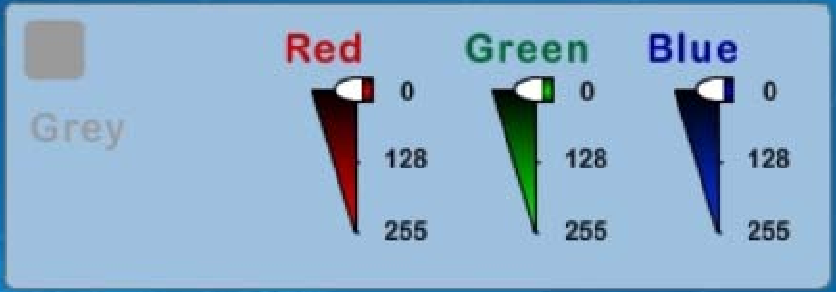
RGB Playschool

Exercises! Let's mix color



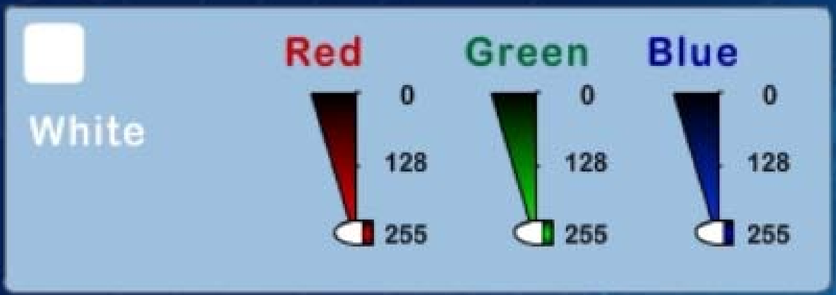


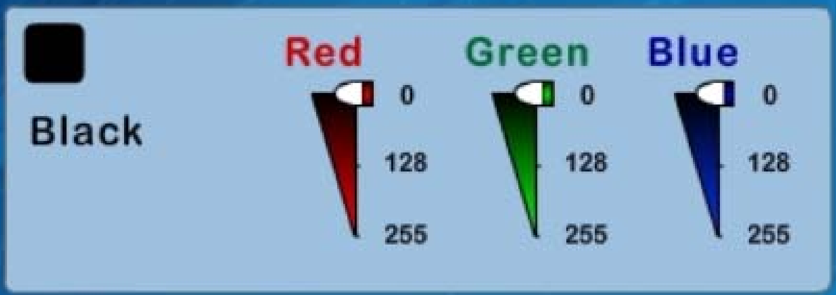


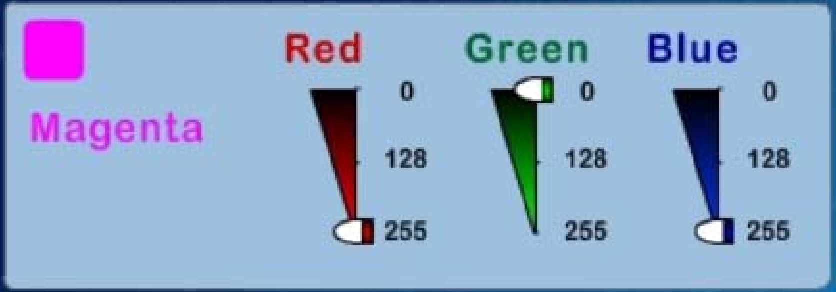


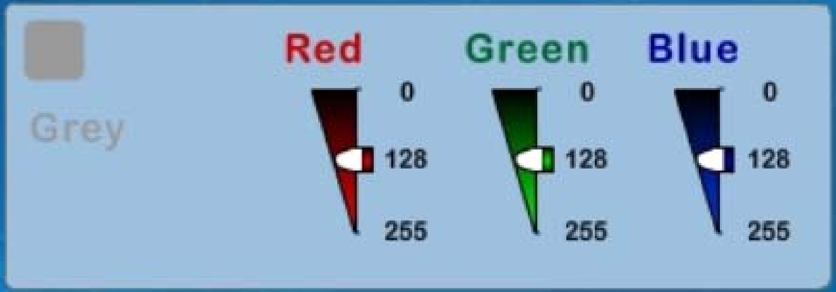
RGB Playschool

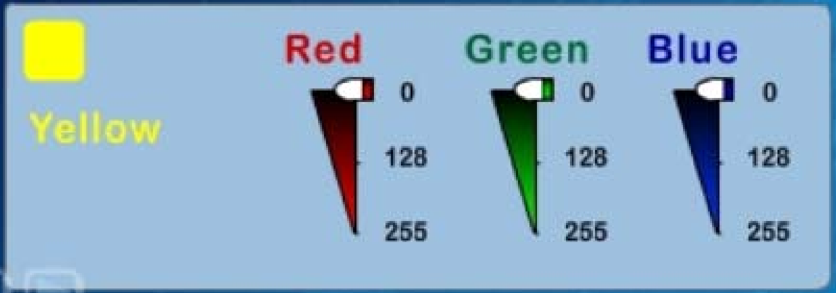
Exercises! Let's mix color









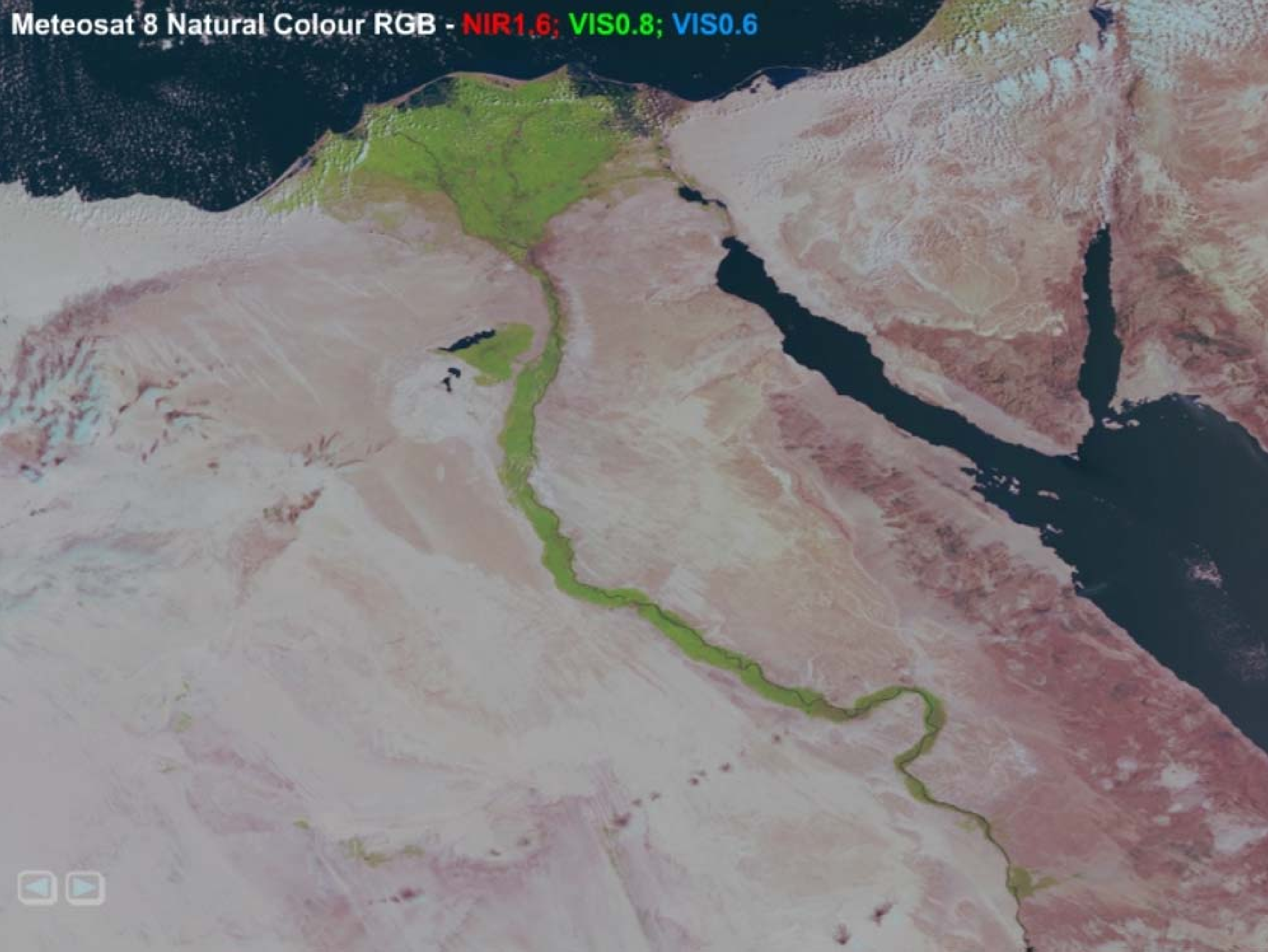


RGB Playschool

Exercises! Let's mix color

RGB Playschool

Exercises! Let's mix color


Meteosat 8 Natural Colour RGB - NIR1.6; VIS0.8; VIS0.6

15	€1.000.000
14	€500.000
13	€250.000
12	€125.000
11	€64.000
10	€32.000
9	€16.000
8	€8.000
7	€4.000
6	€2.000
5	€1.000
4	€500
3	€250
2	€100
1	€50

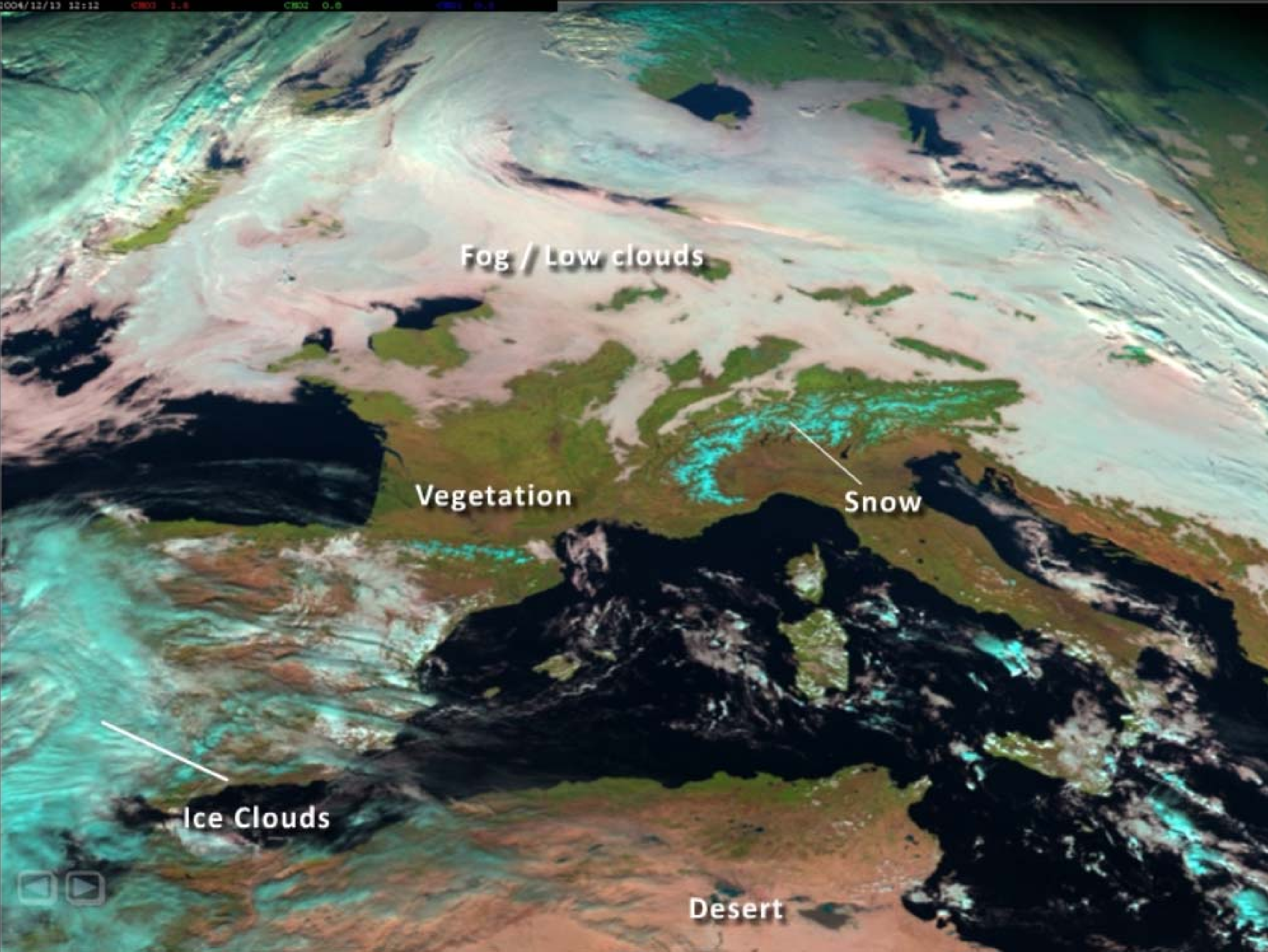
What colour would snow get when observed with the Natural Colour RGB

A: White

B: Black

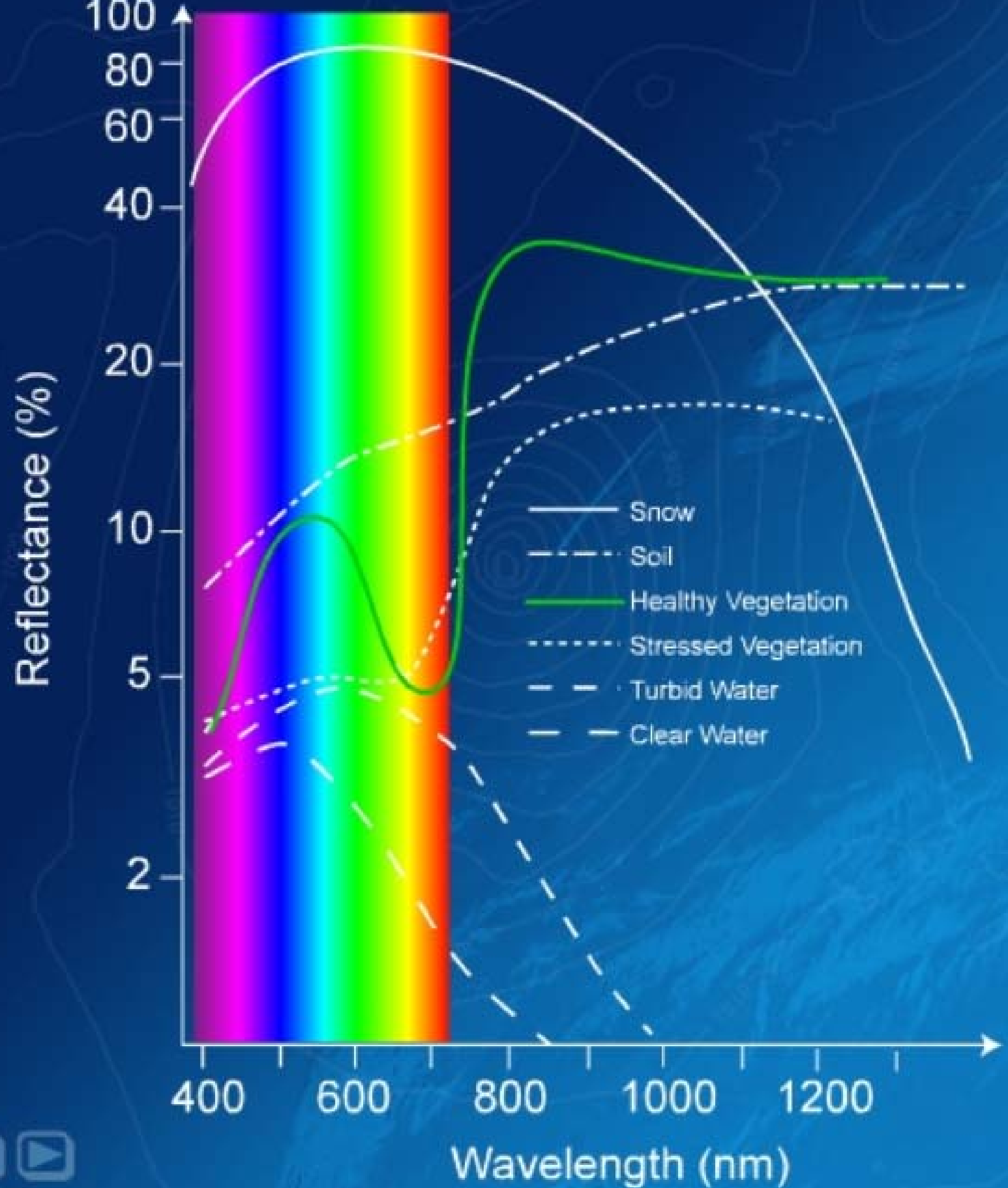
C: Cyan

D: Magenta

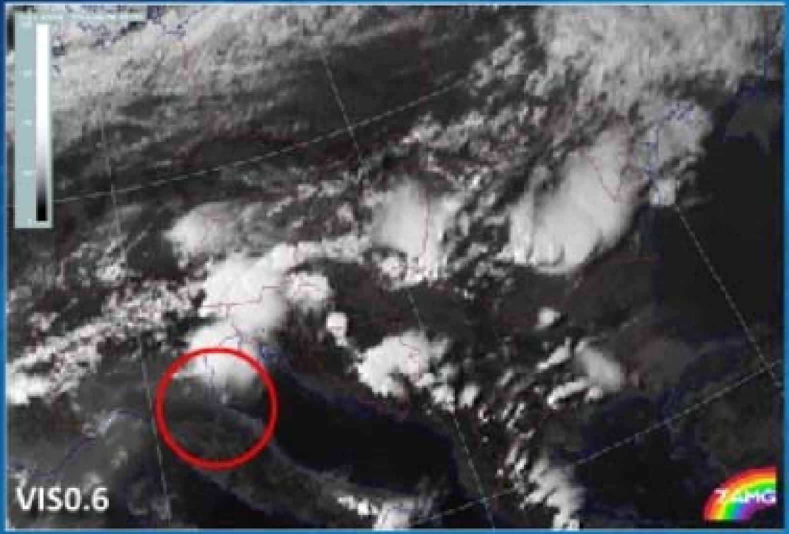


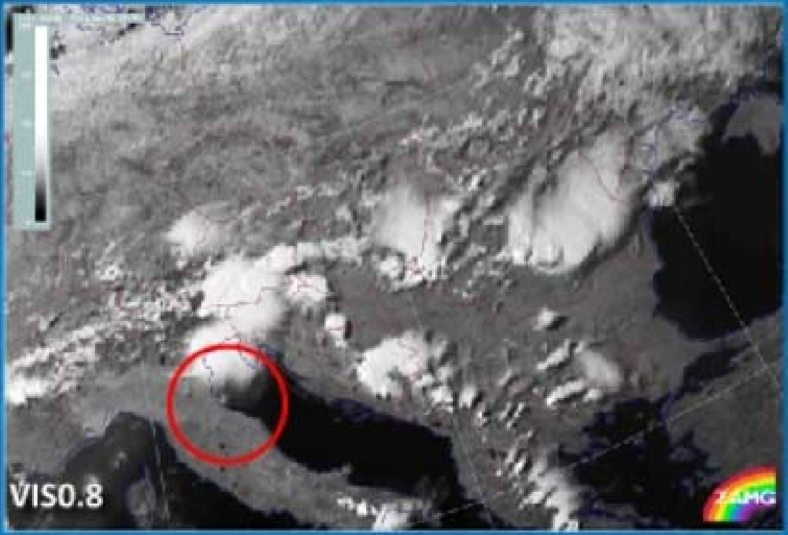
2004/12/13 12:12
Fog / Low clouds
Vegetation
Snow
Ice Clouds
Desert

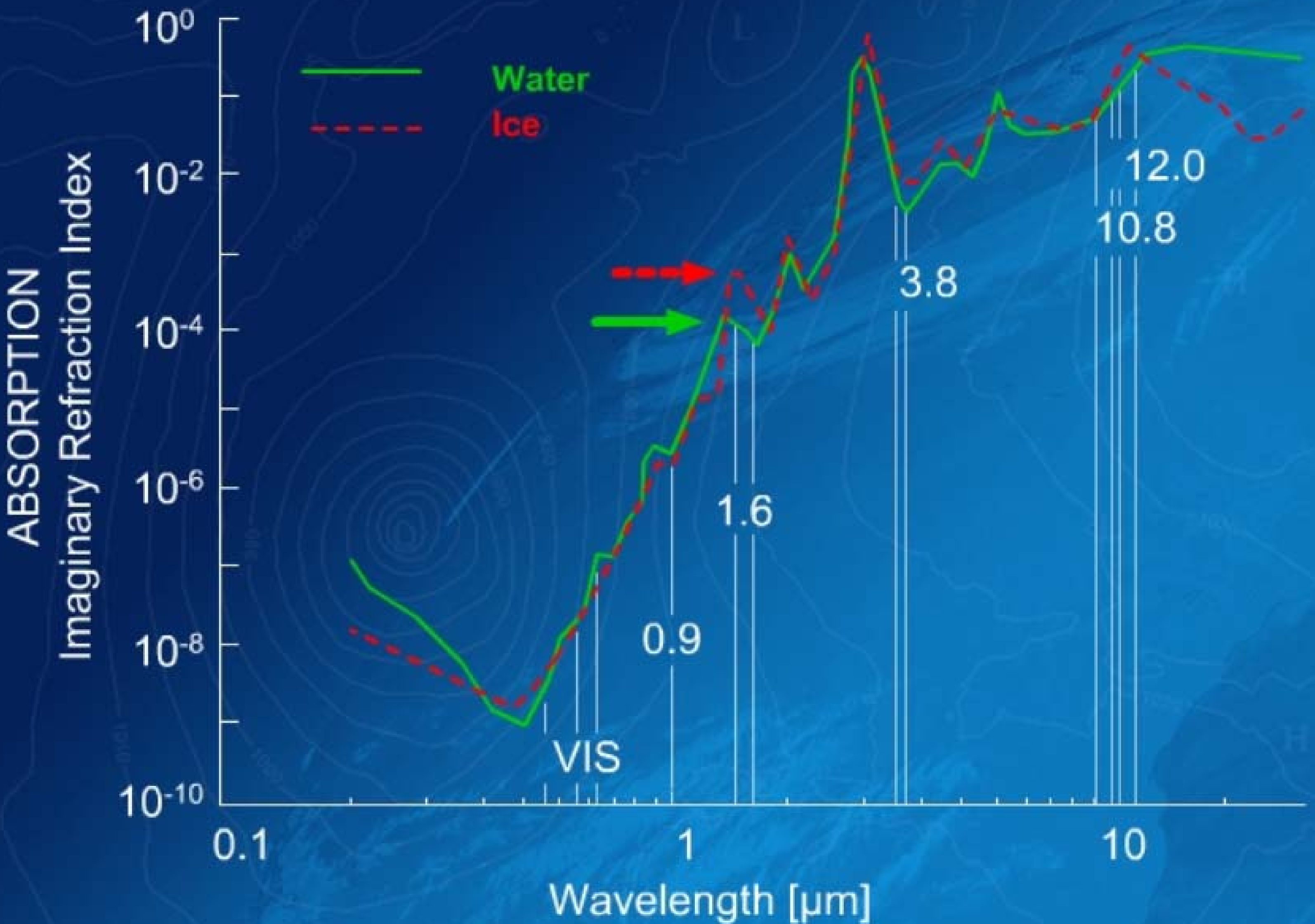
Generalized Reflectance Curves for Land-use Classification Applications



- Both channels: recognition of cloud due to reflected sun radiation
- In VIS0.8 better recognition of surface structures because of higher reflectance of soil and leafs
- Transparent clouds better visible in VIS0.6 due to less reflectivity of surface

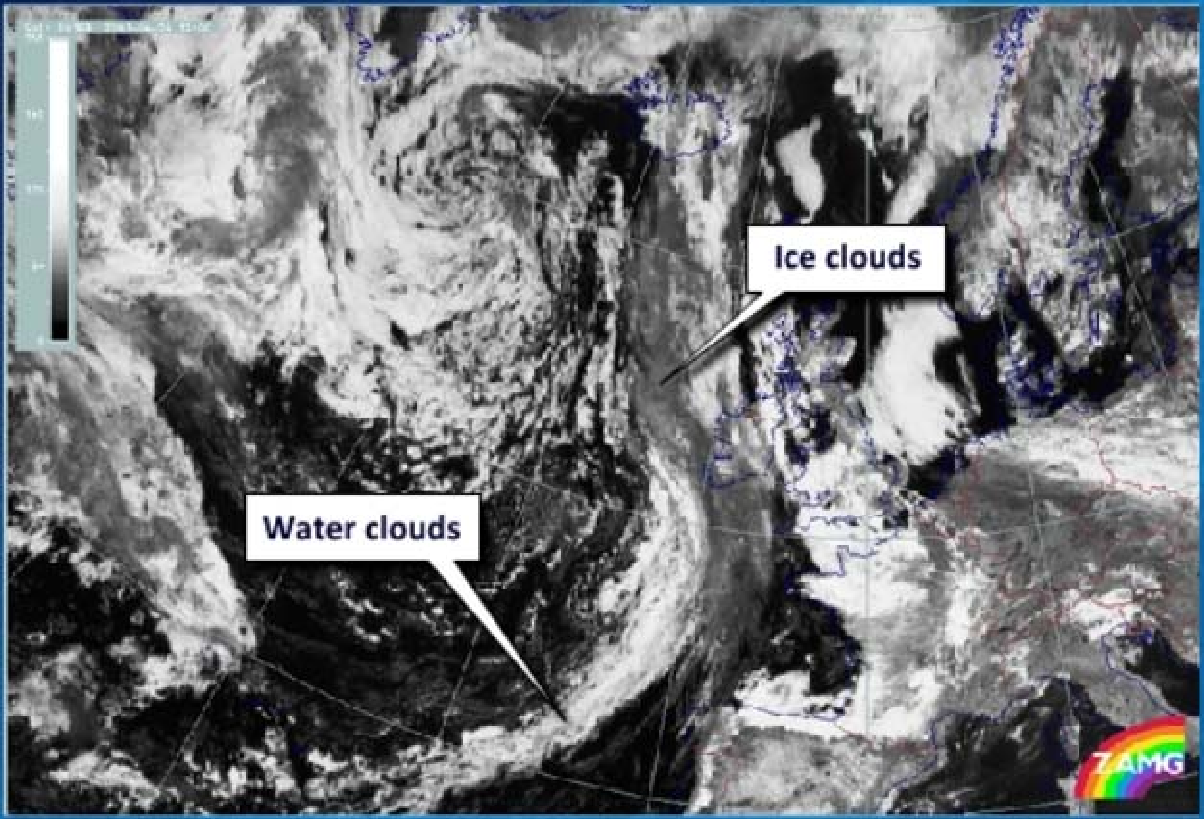




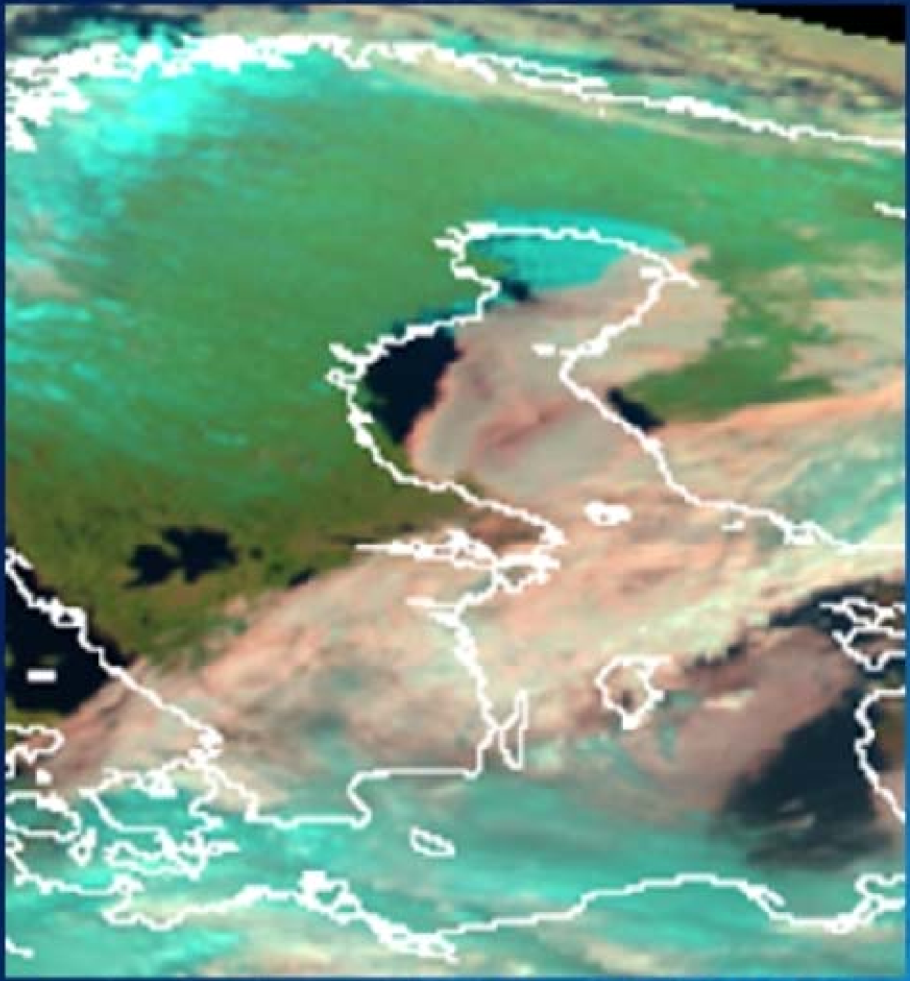


Channel 1.6 µm, absorbs much more solar radiation than the visible. Ice absorbs much more strongly than water at 1.6 µm (Rosenfeld et al., 2004).

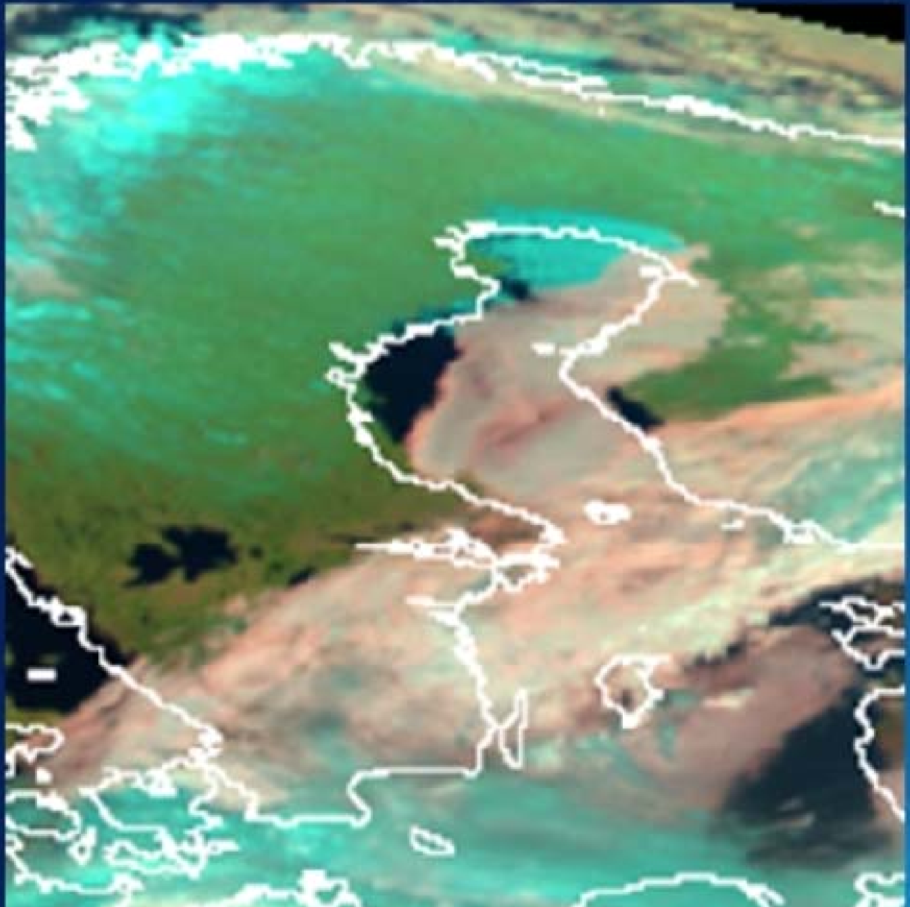
Different appearance of ice - and waterclouds because of stronger absorption in the icephase



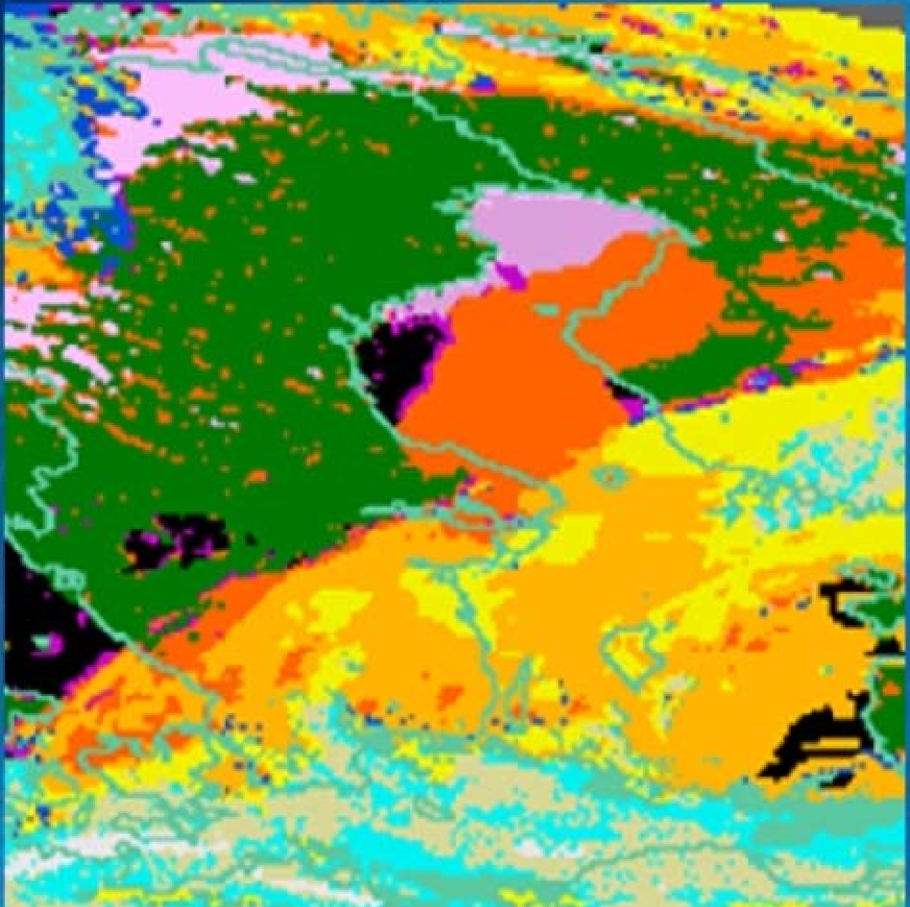
- Waterclouds: white
- Iceclouds: dark grey



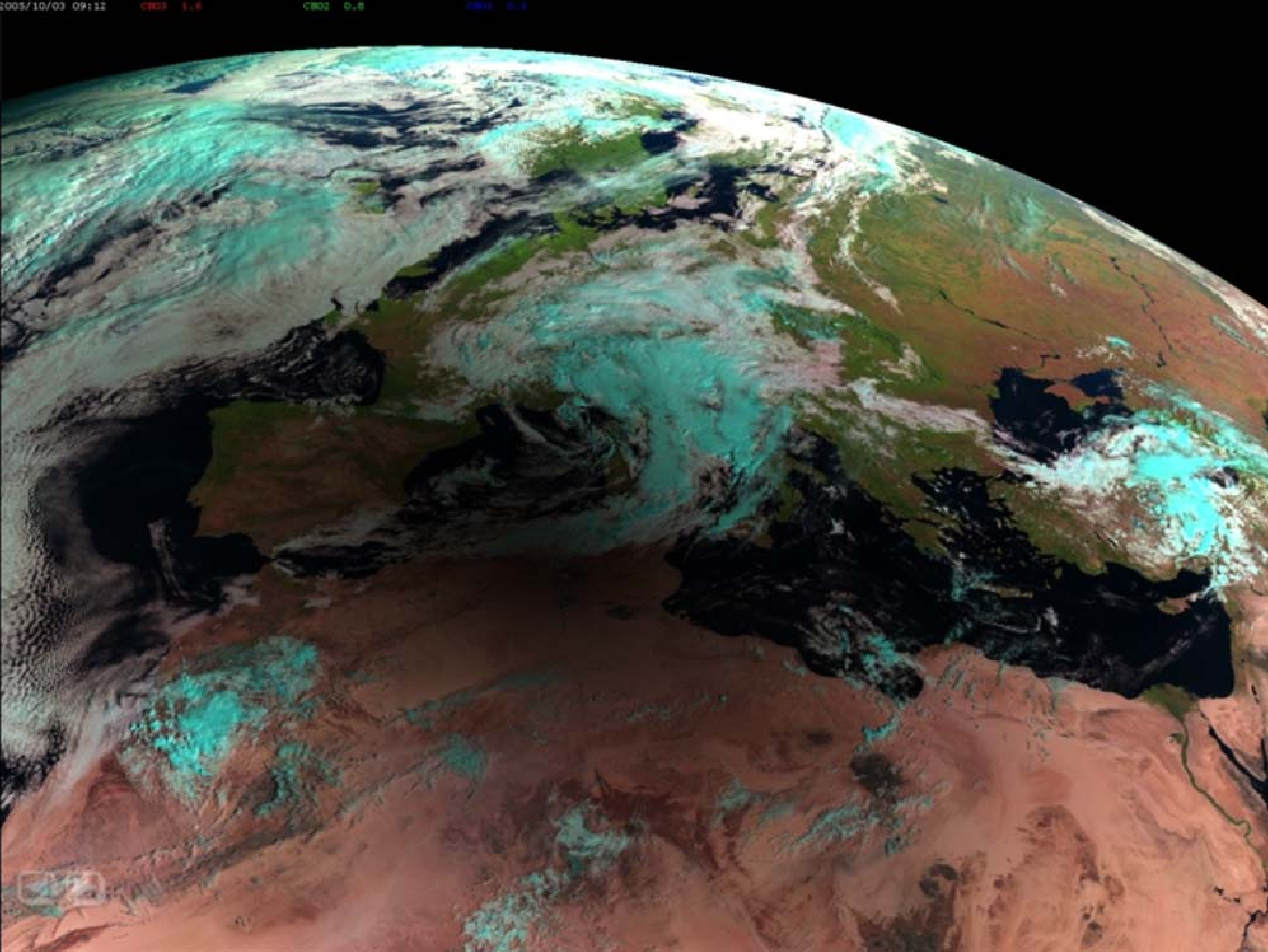
Meteosat 8 Natural Colour RGB - 21 March 2007: 1200 UTC

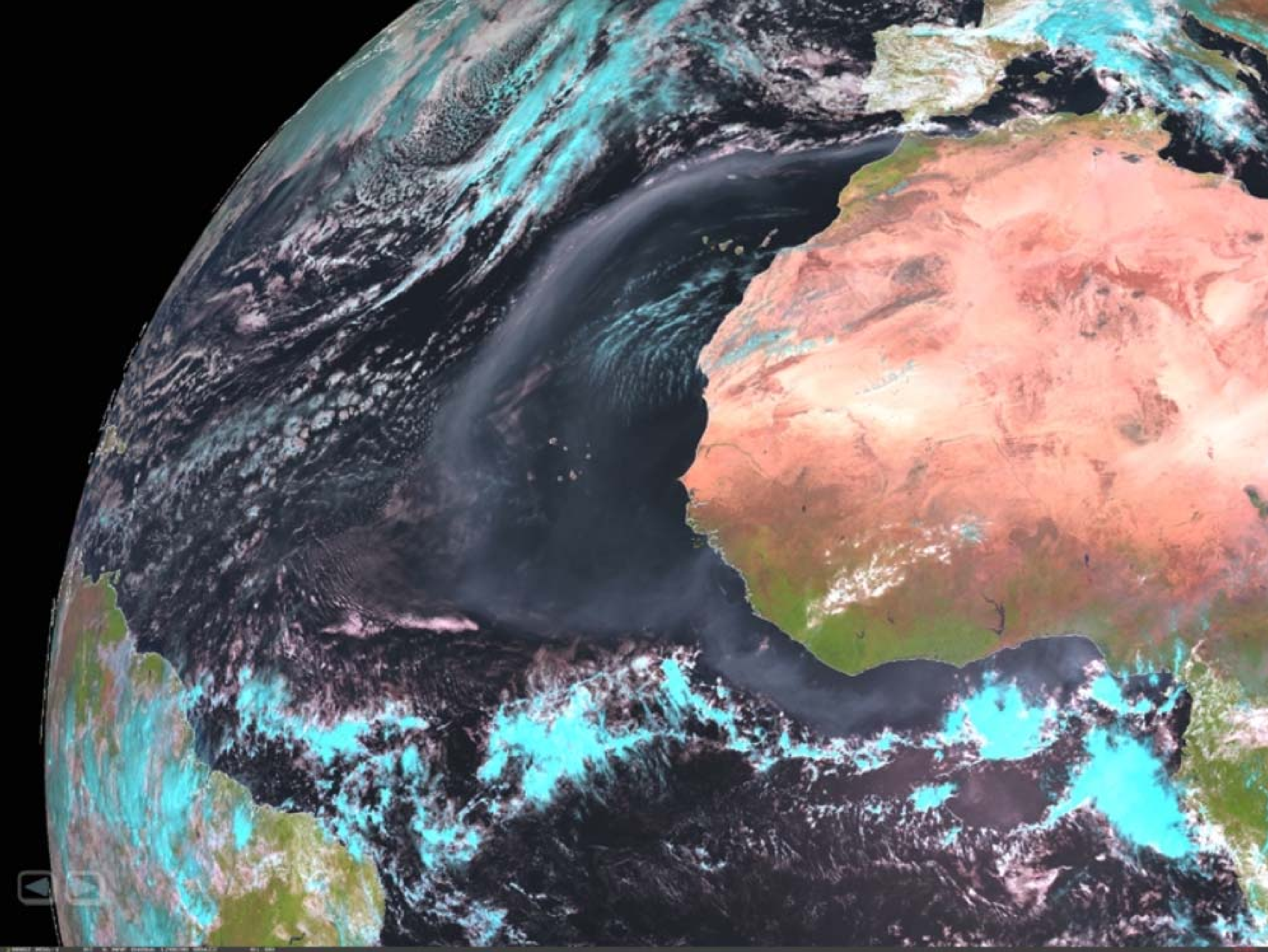


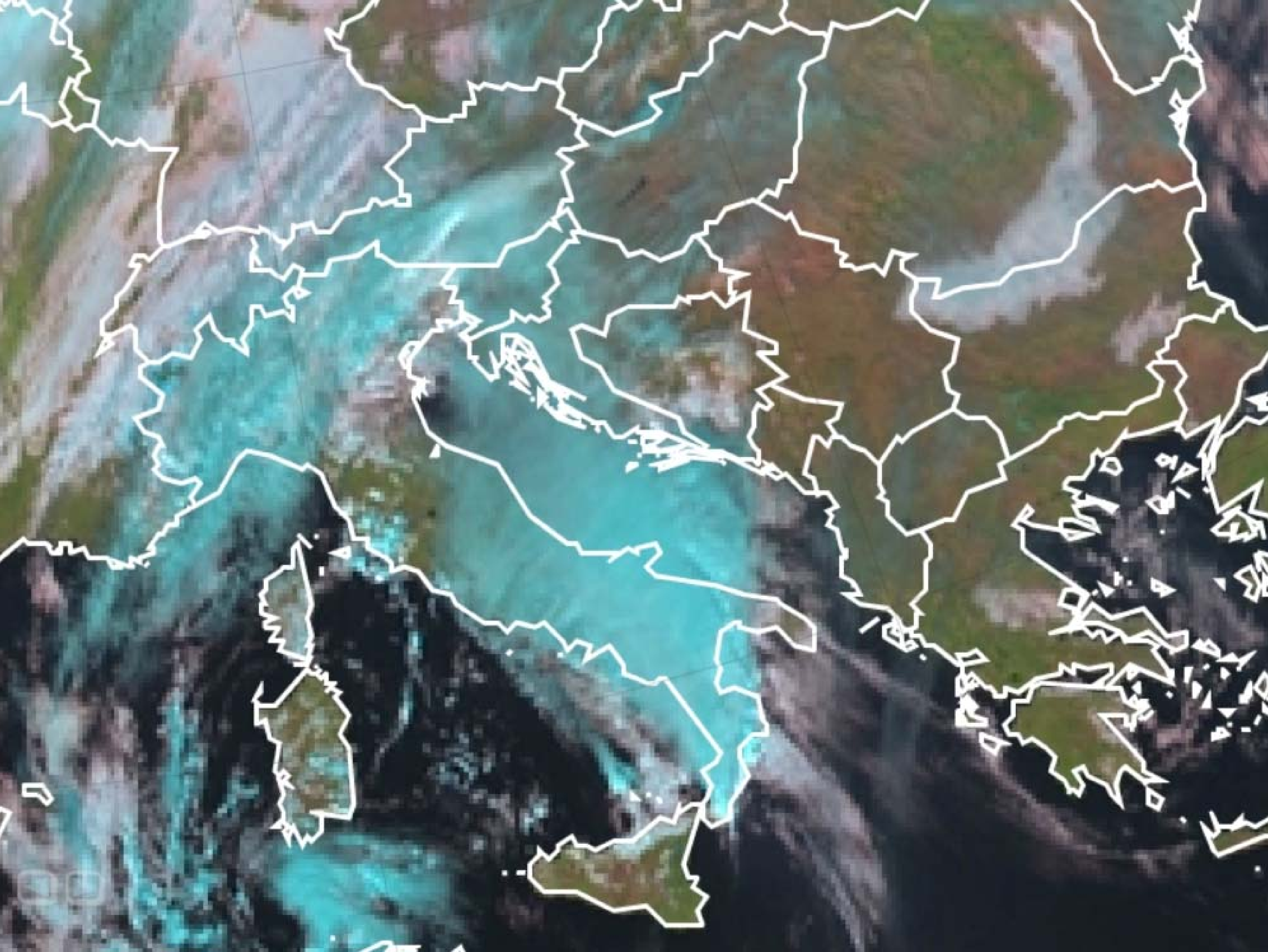
Meteosat 8 Natural Colour RGB - 21 March 2007: 1200 UTC

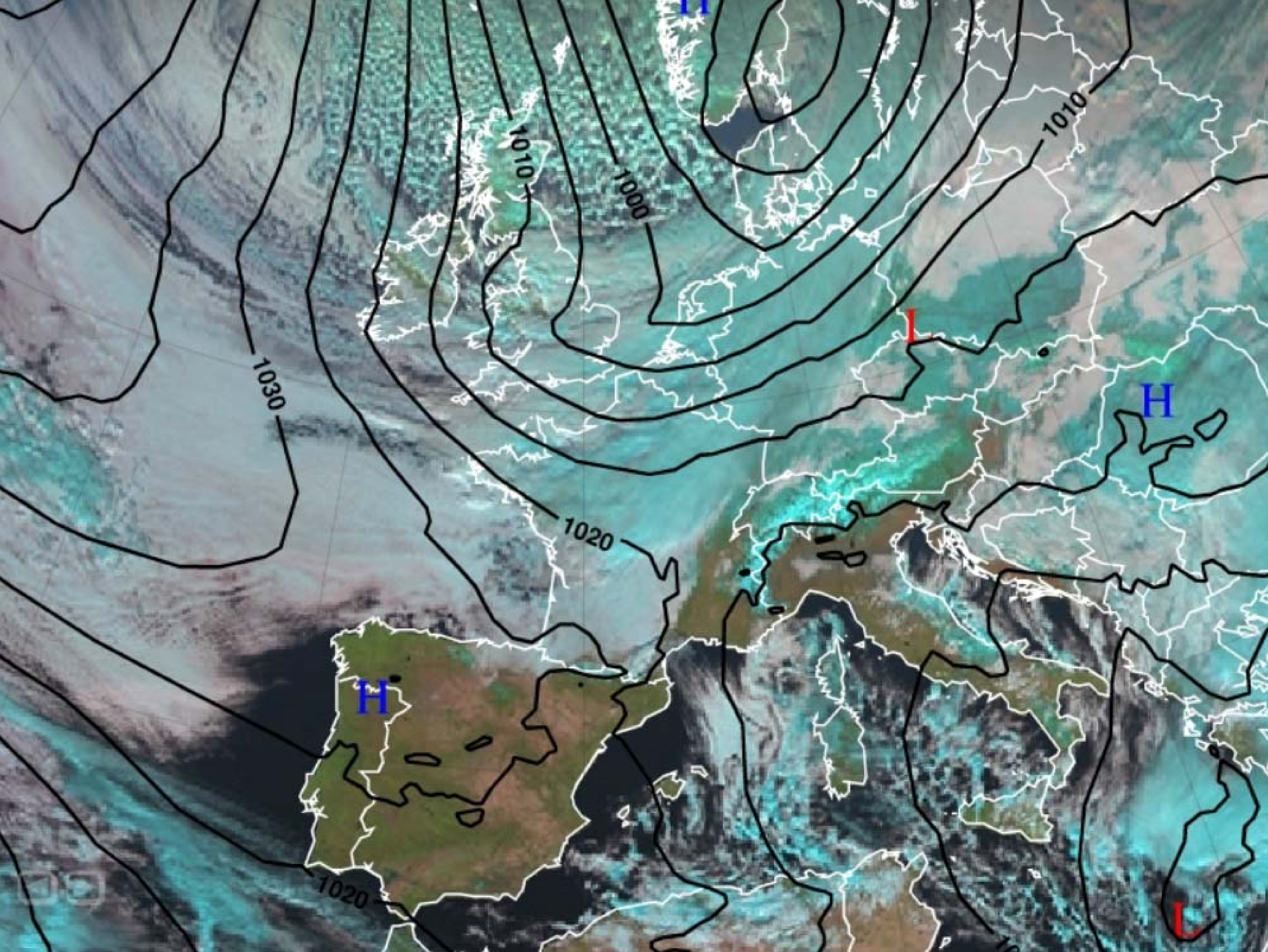


Meteosat 8 Cloud Type (NWC SAF) - 21 March 2007: 1200 UTC

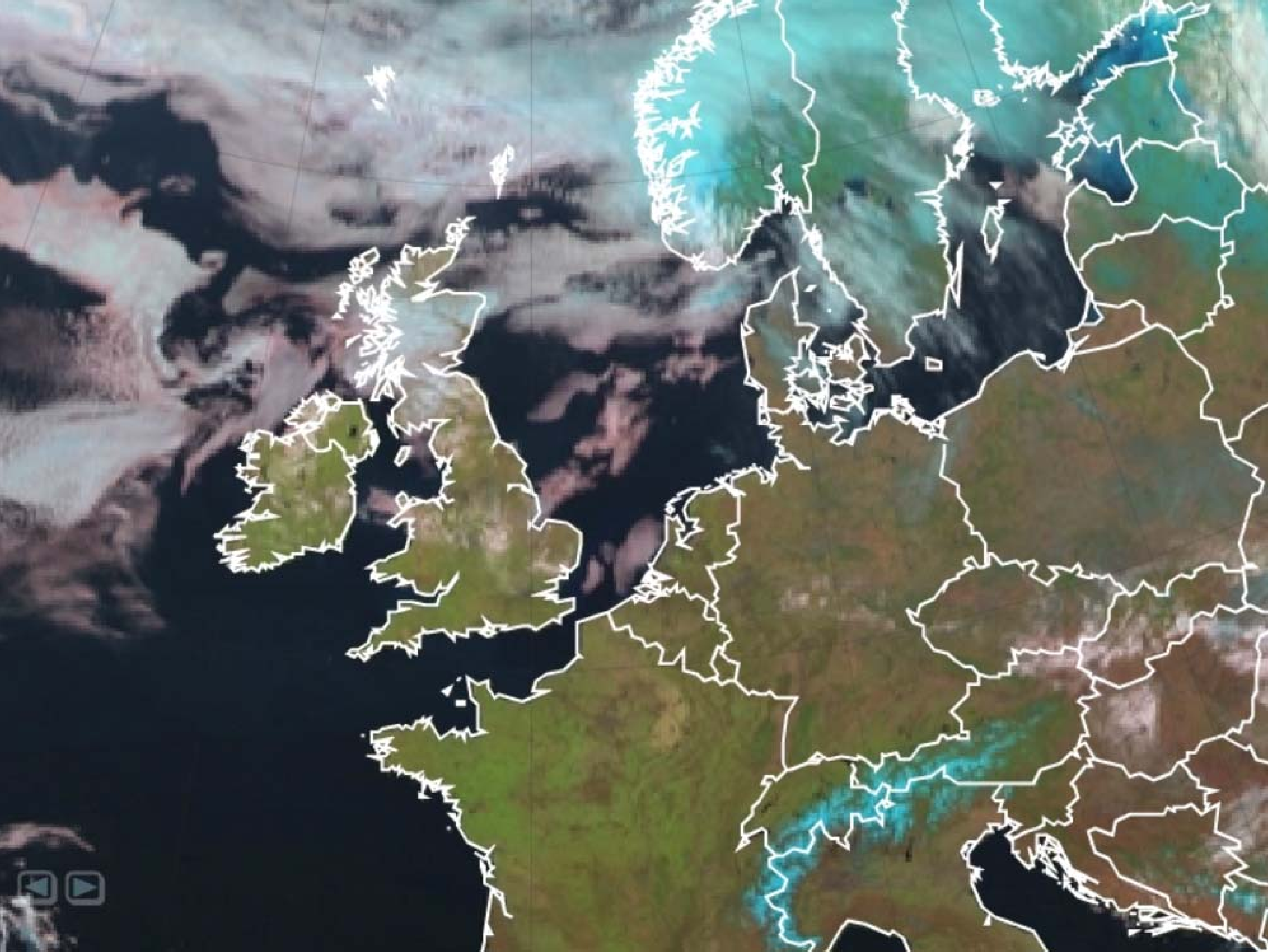

2005/10/03 09:12

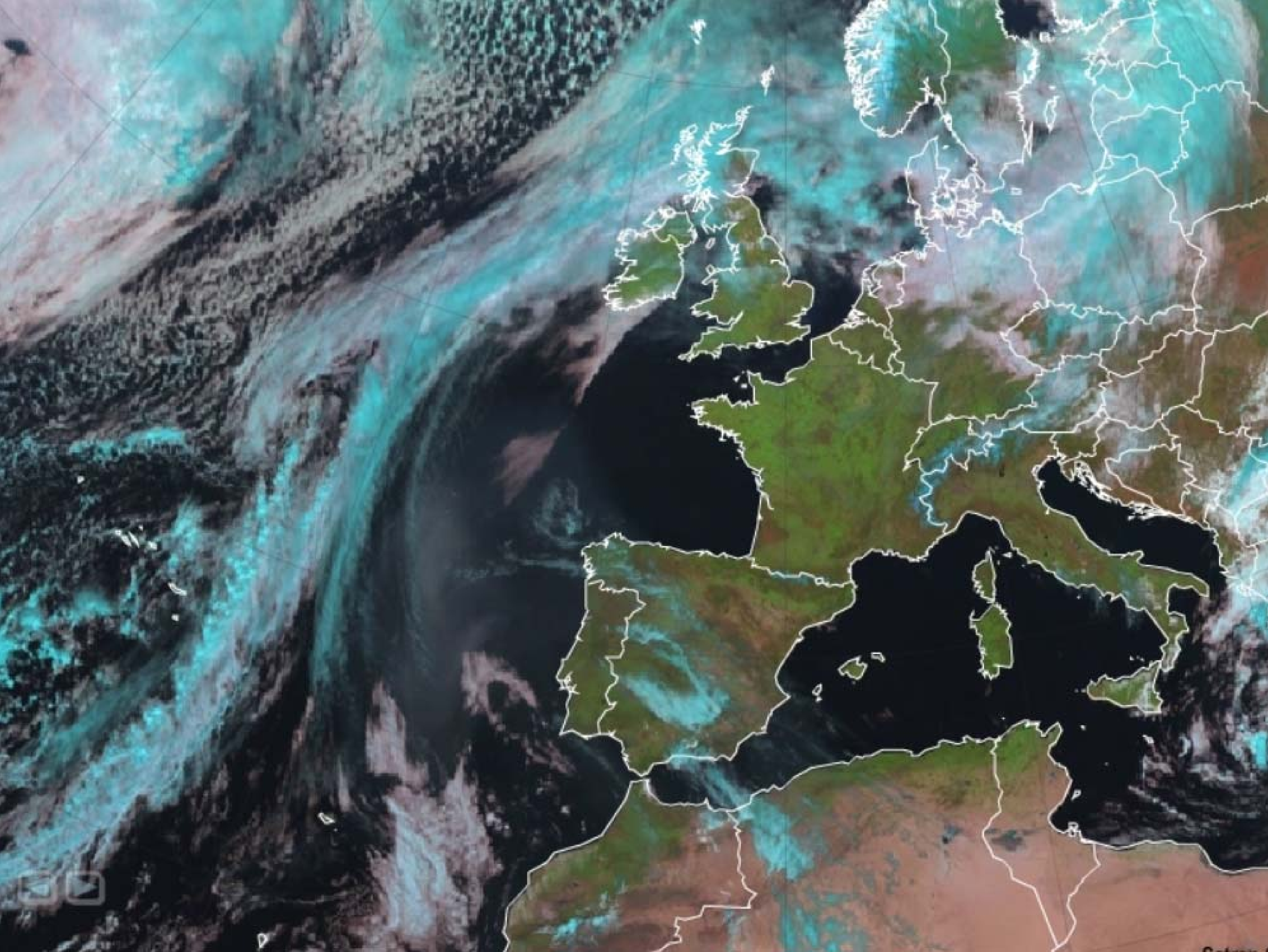


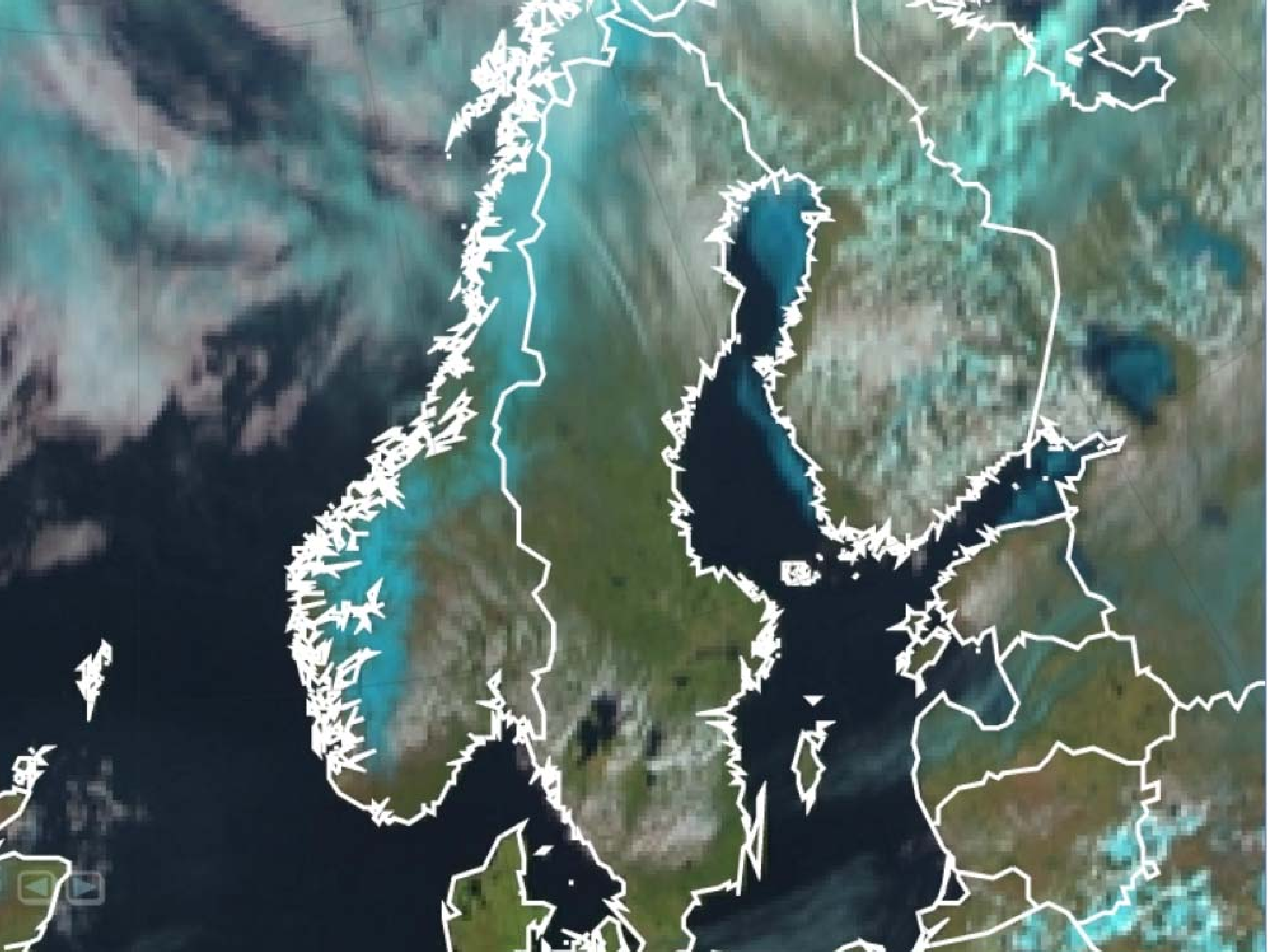


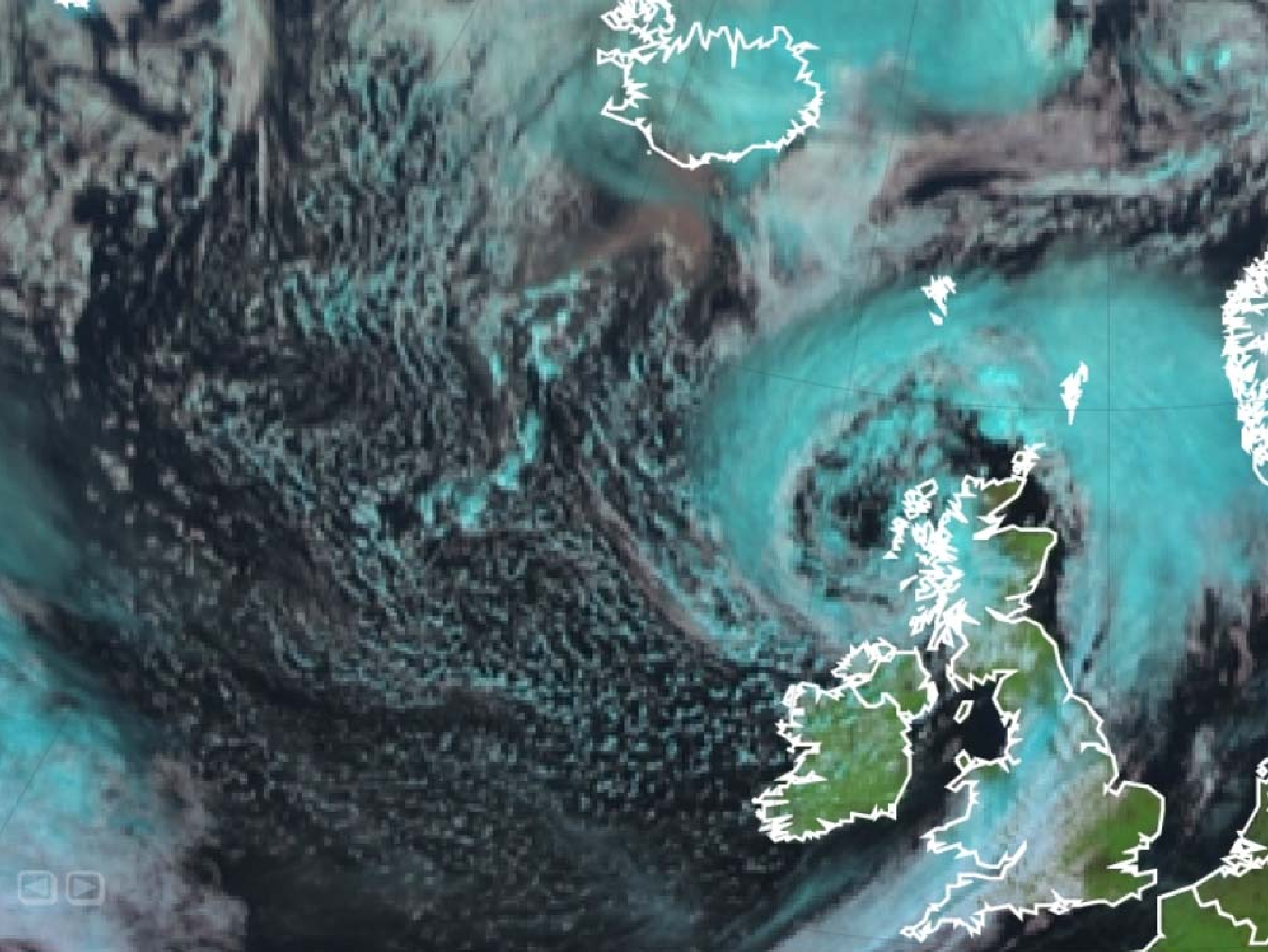


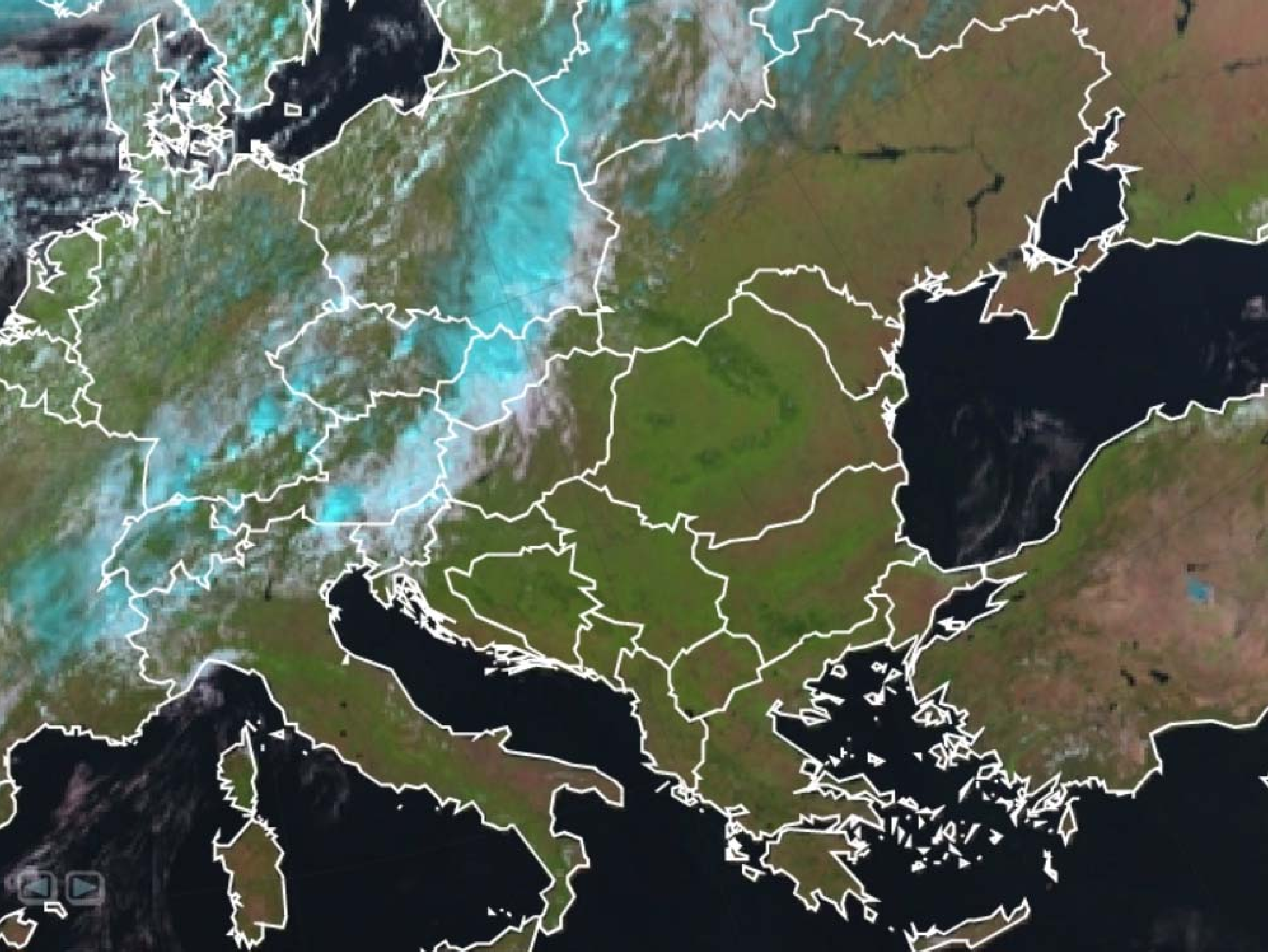
1010
1000
1010
1030
L
H
1020
H
1020
L





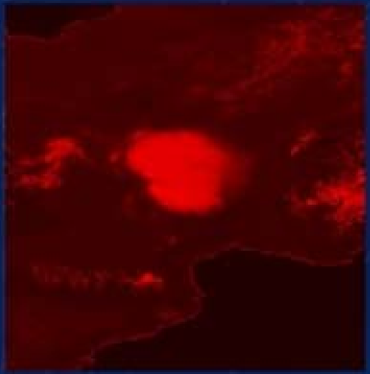




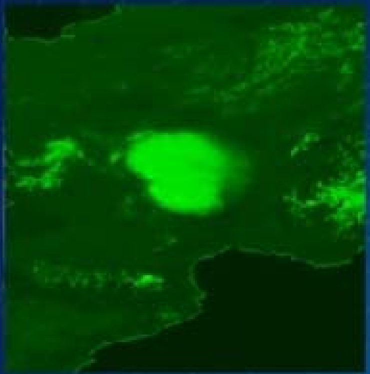


- Easy RGB, especially for media purposes
- Able to distinguish water clouds from ice clouds
- Use in forecasting room questionable. Better RGBs exist that do more and better
- I'd rather see you invest your time in something else than looking at this RGB

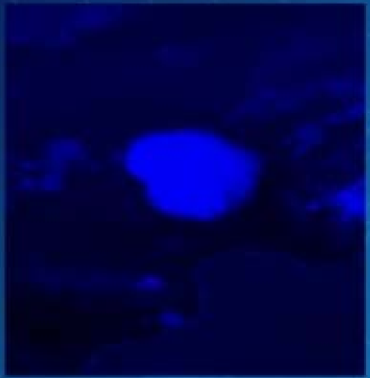
HRVIS



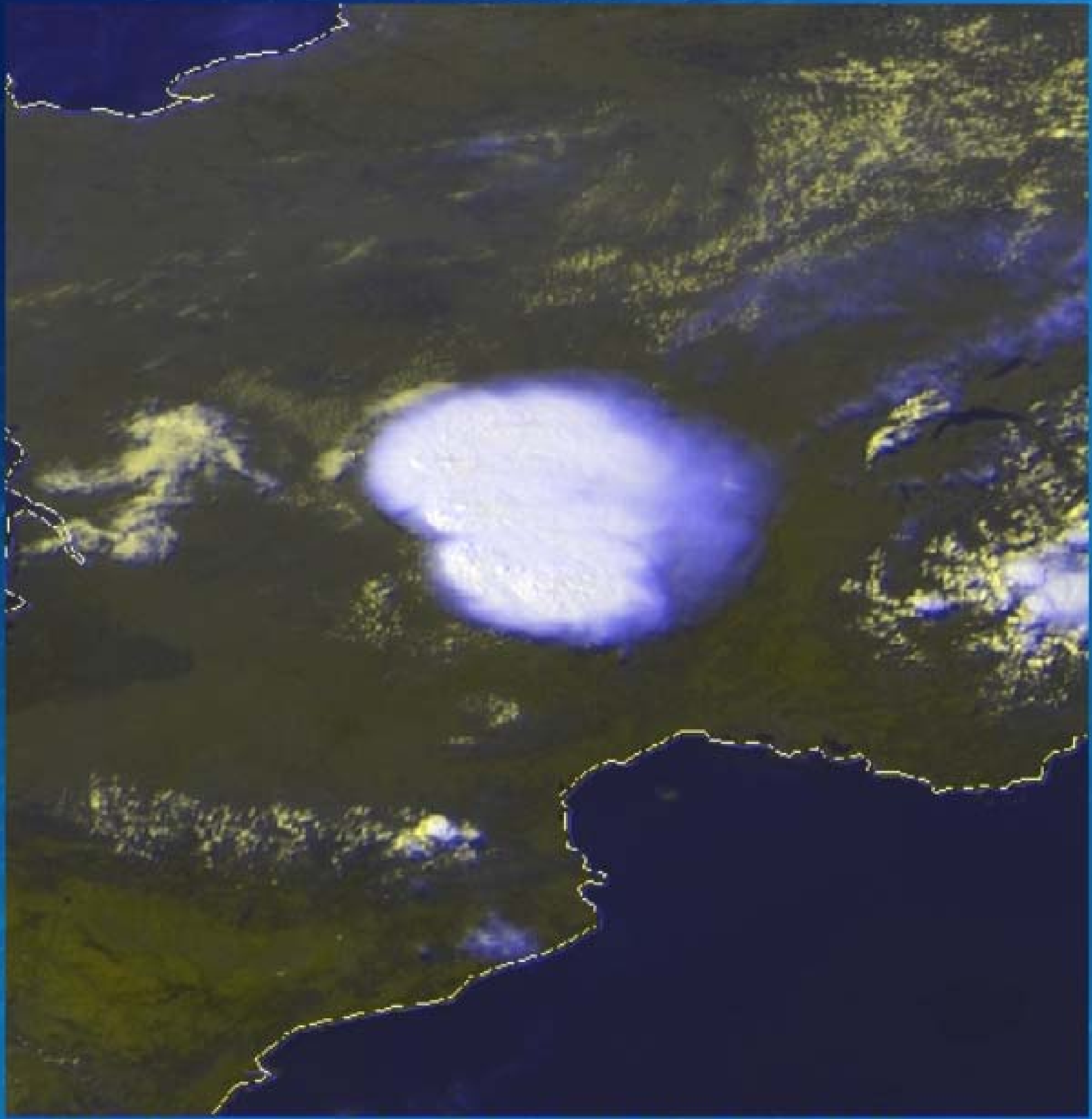
HRVIS

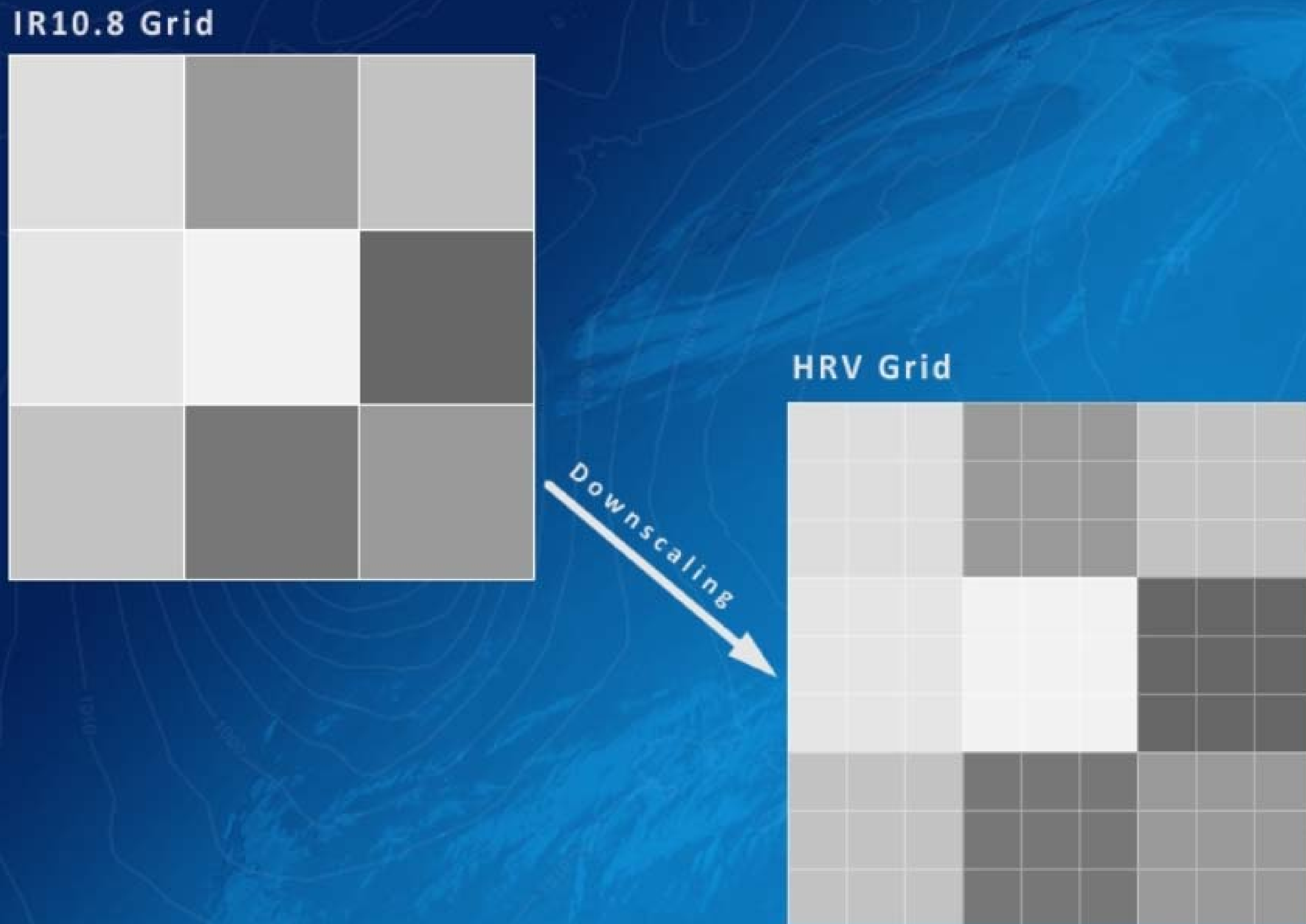


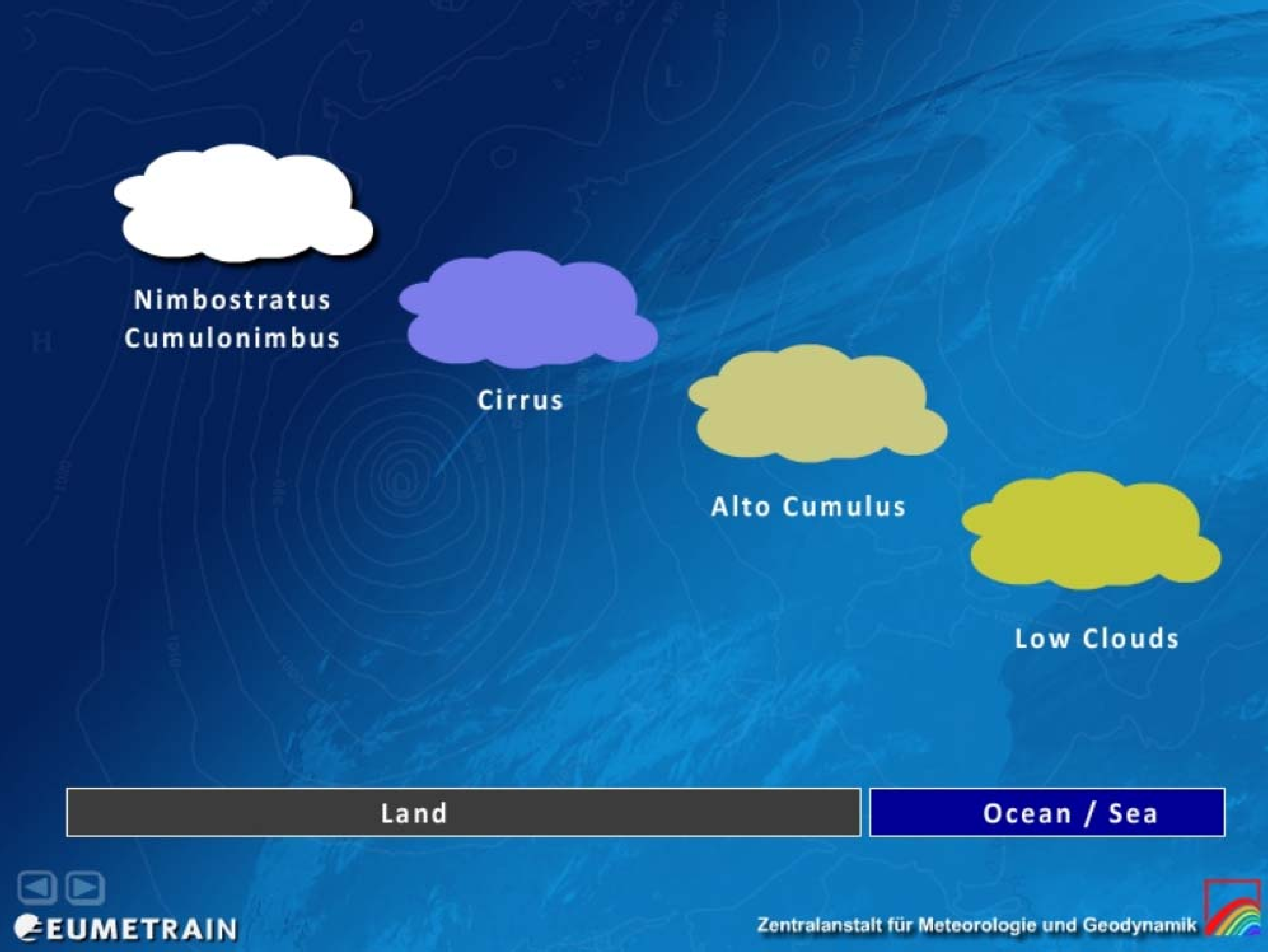
IR10.8

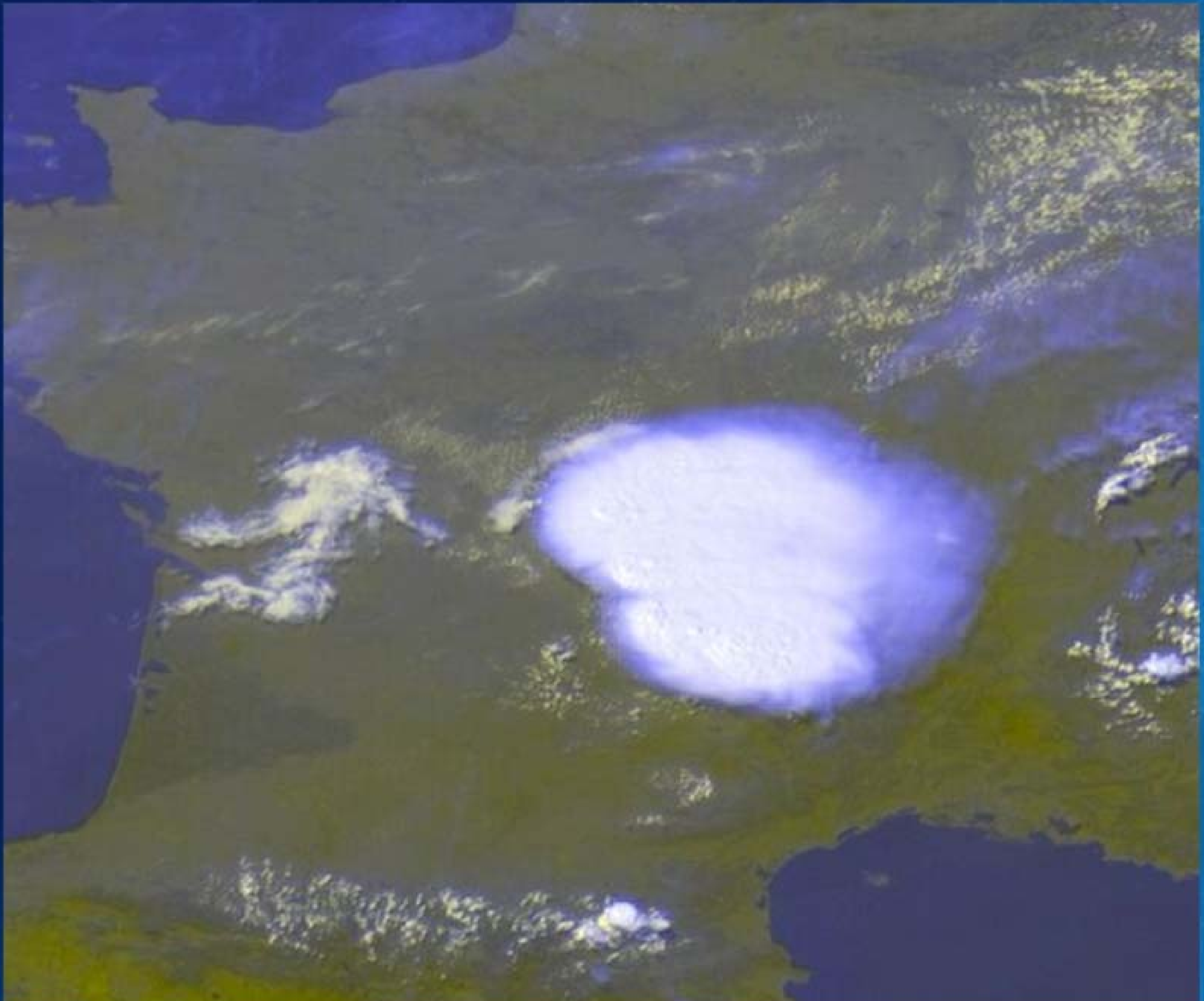


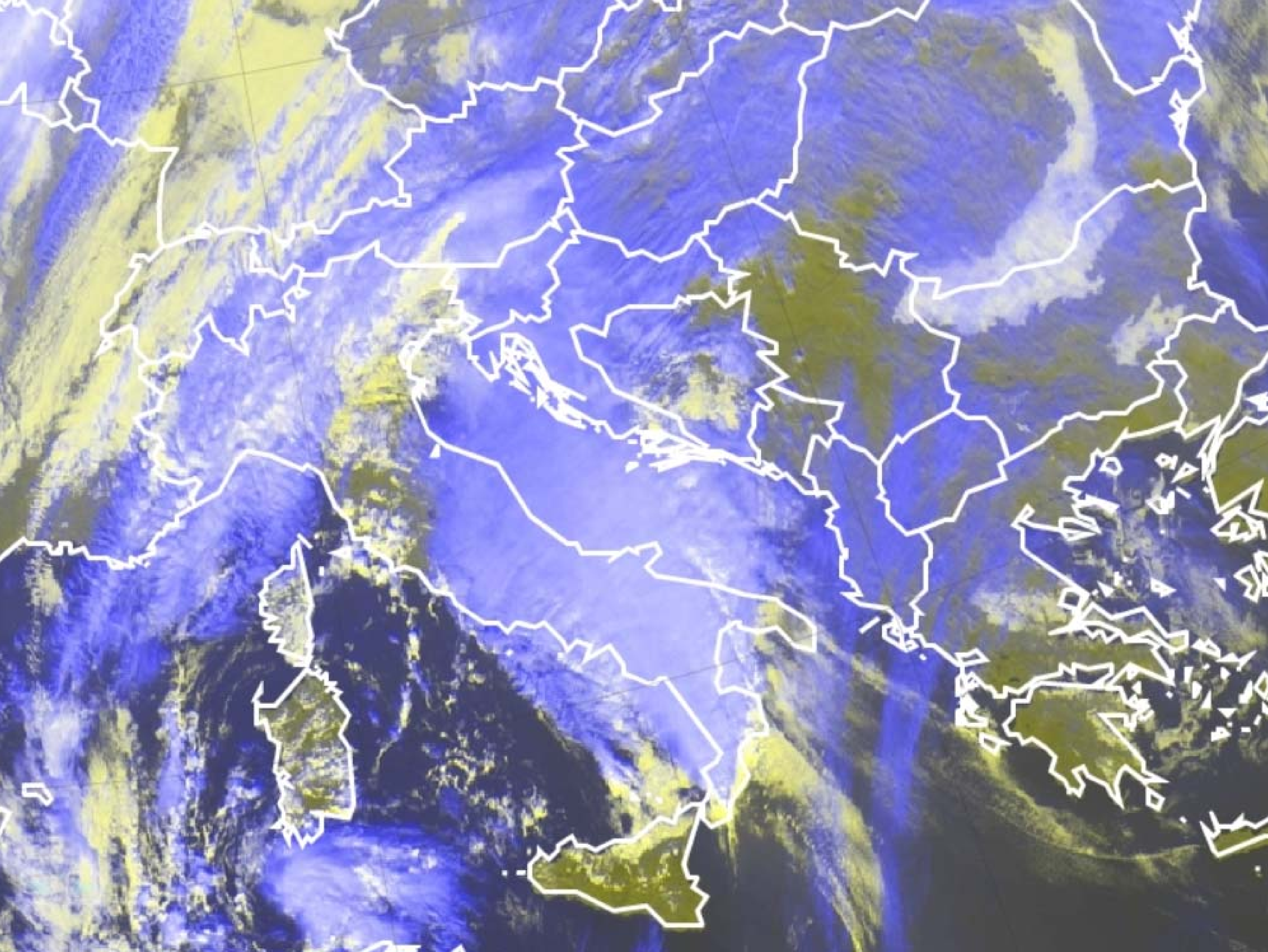
HRV RGB

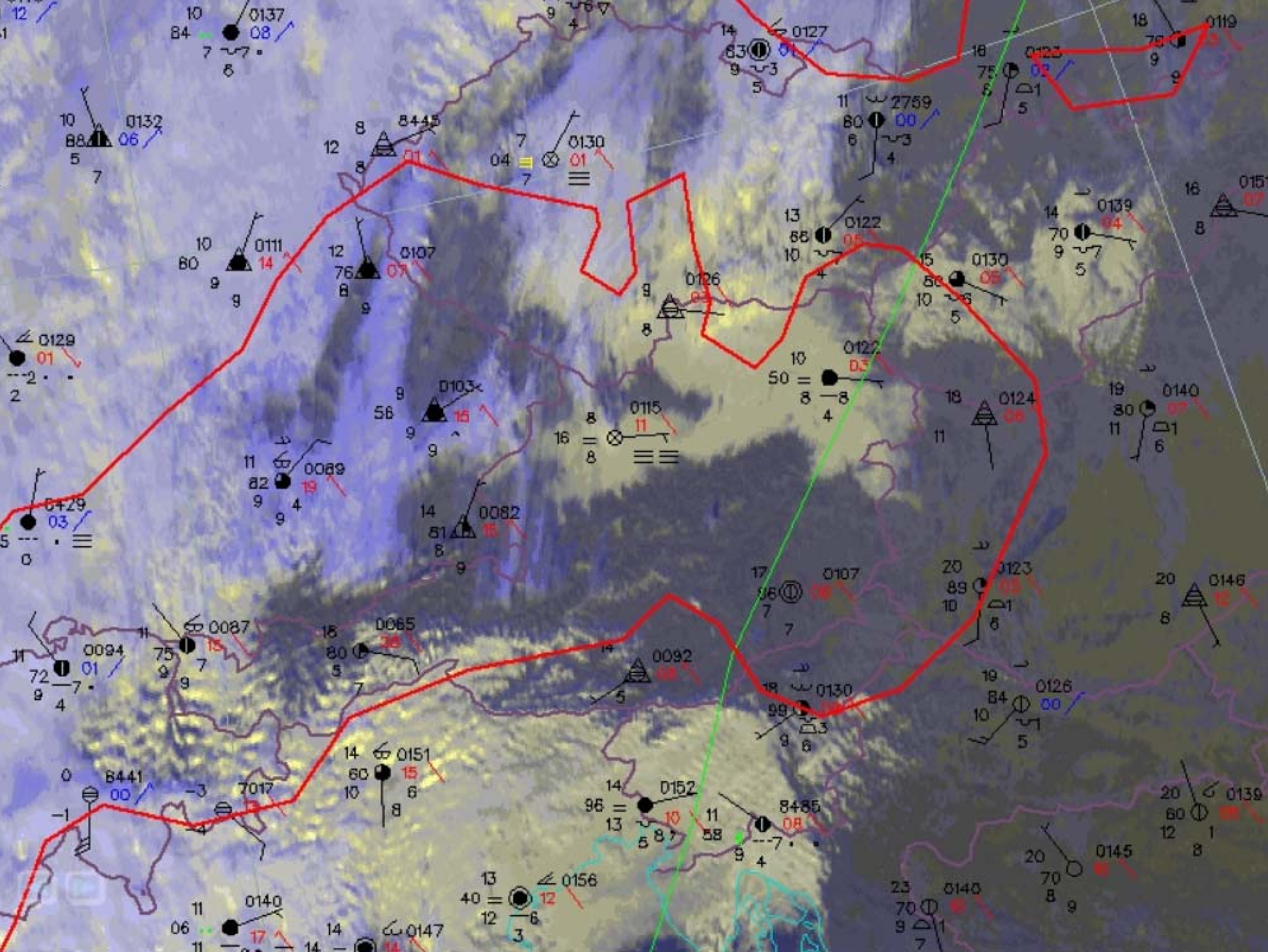


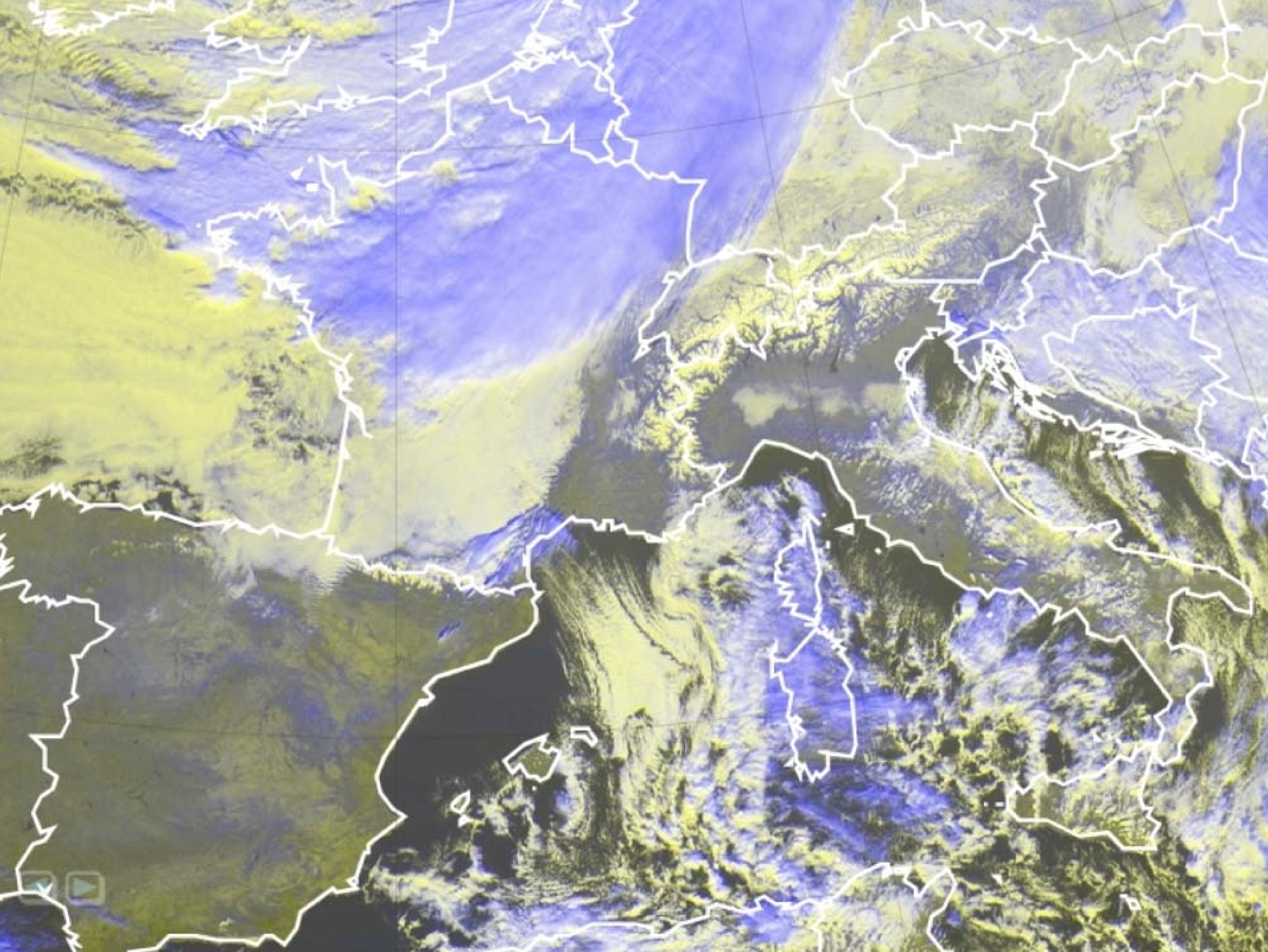

IR10.8 Grid
Downscaling
HRV Grid

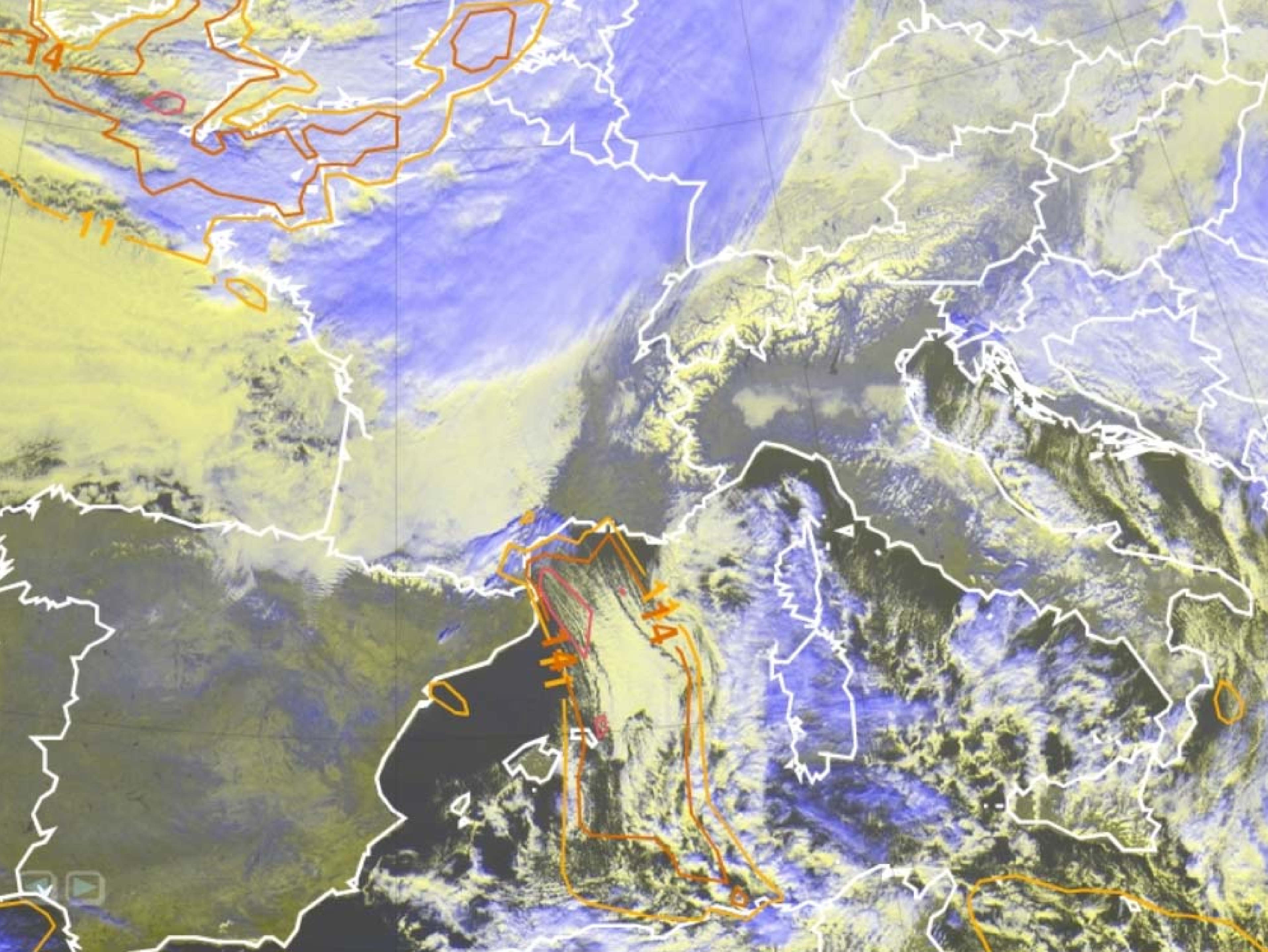

Nimbostratus
Cumulonimbus
Cirrus
Alto Cumulus
Low Clouds
Land
Ocean / Sea
EUMETRAIN
Zentralanstalt für Meteorologie und Geodynamik

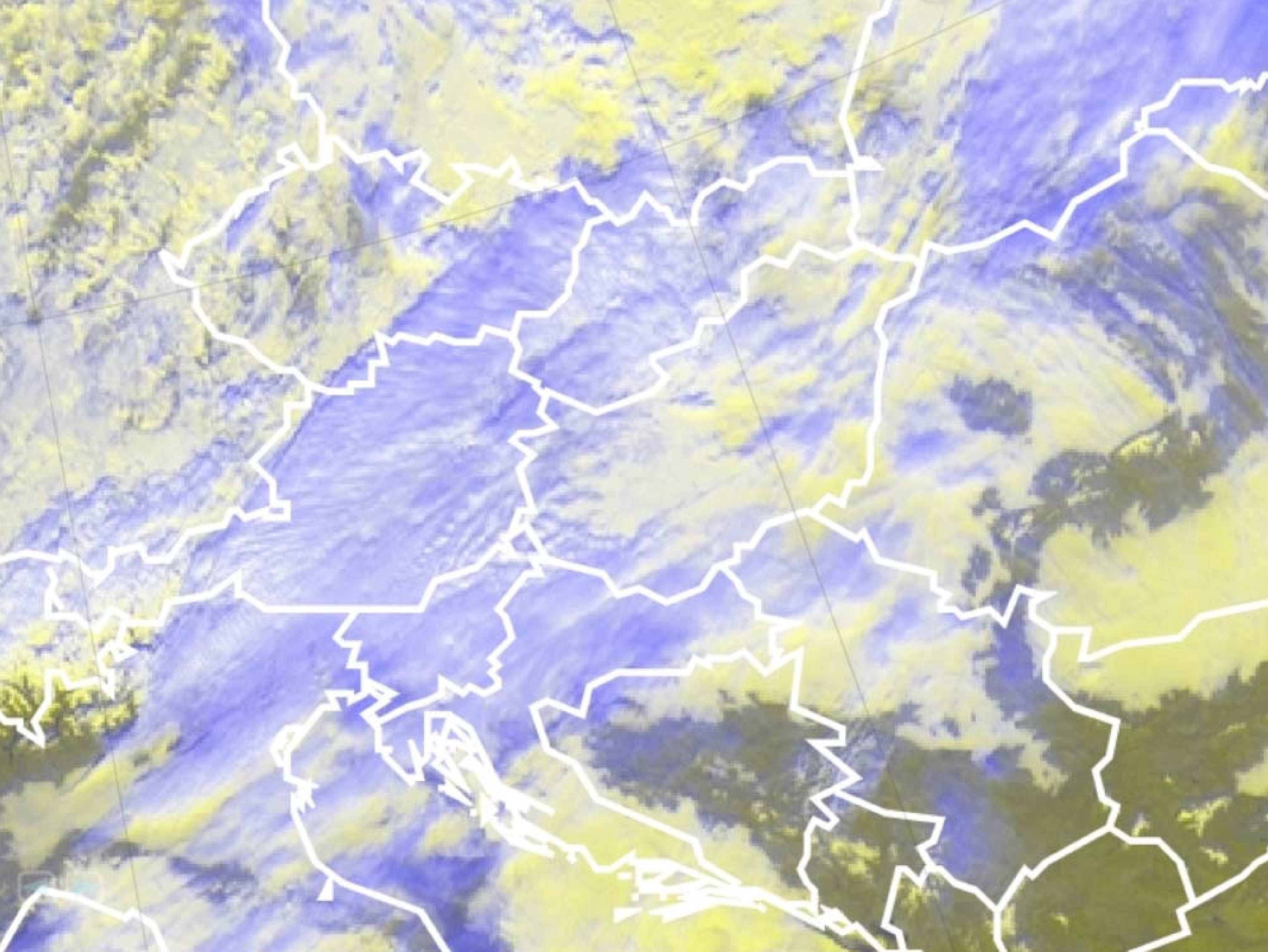


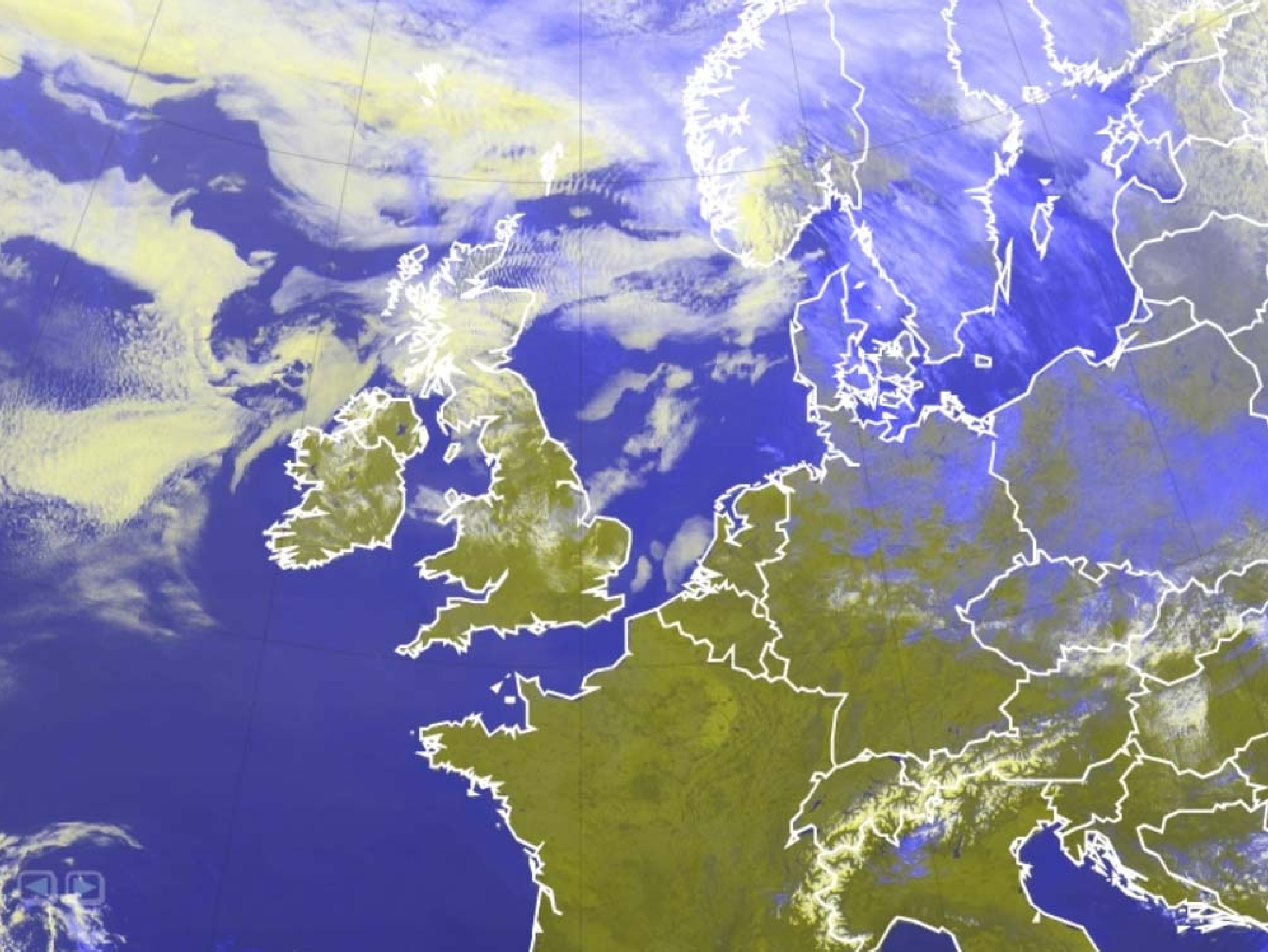


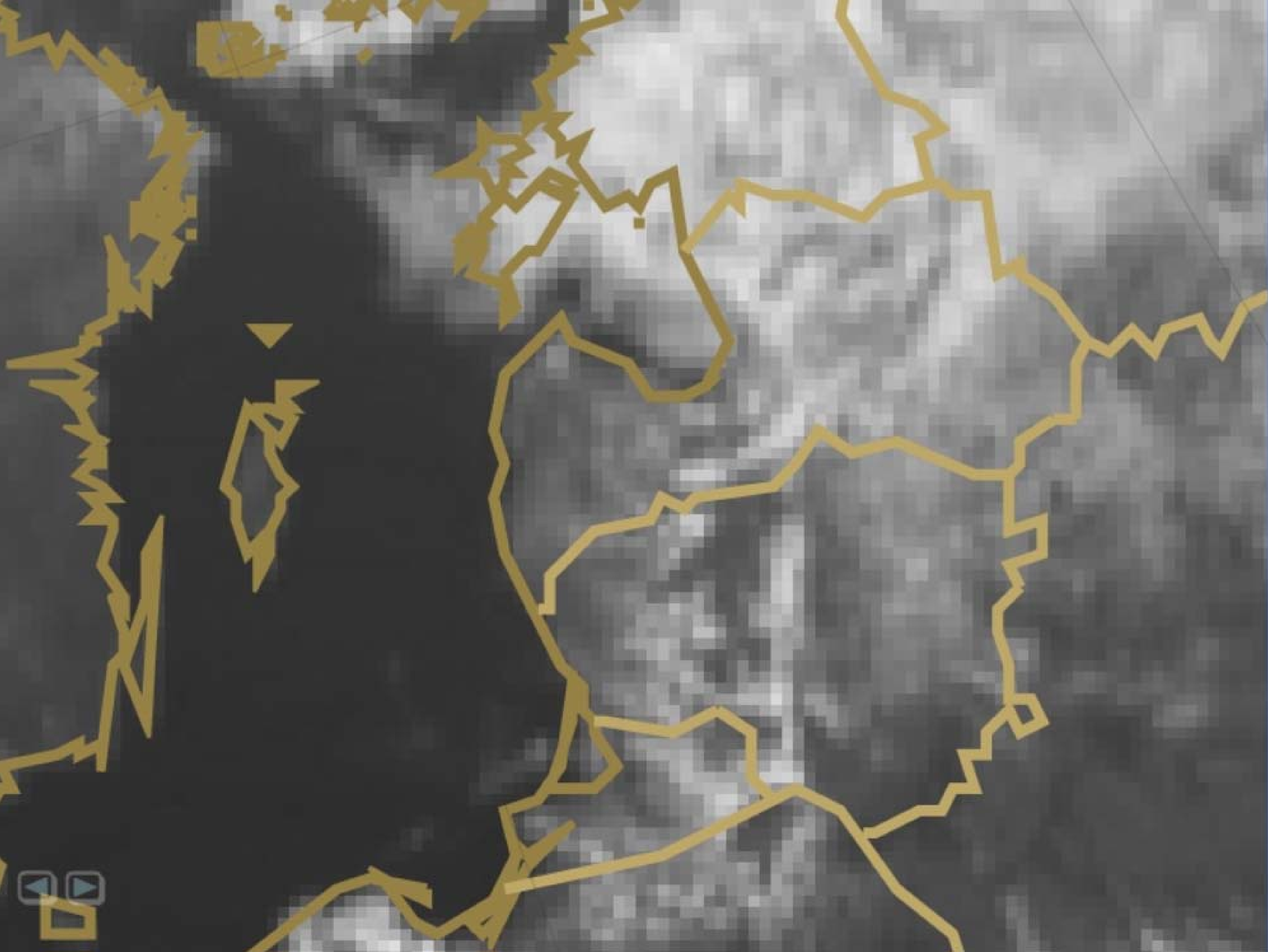


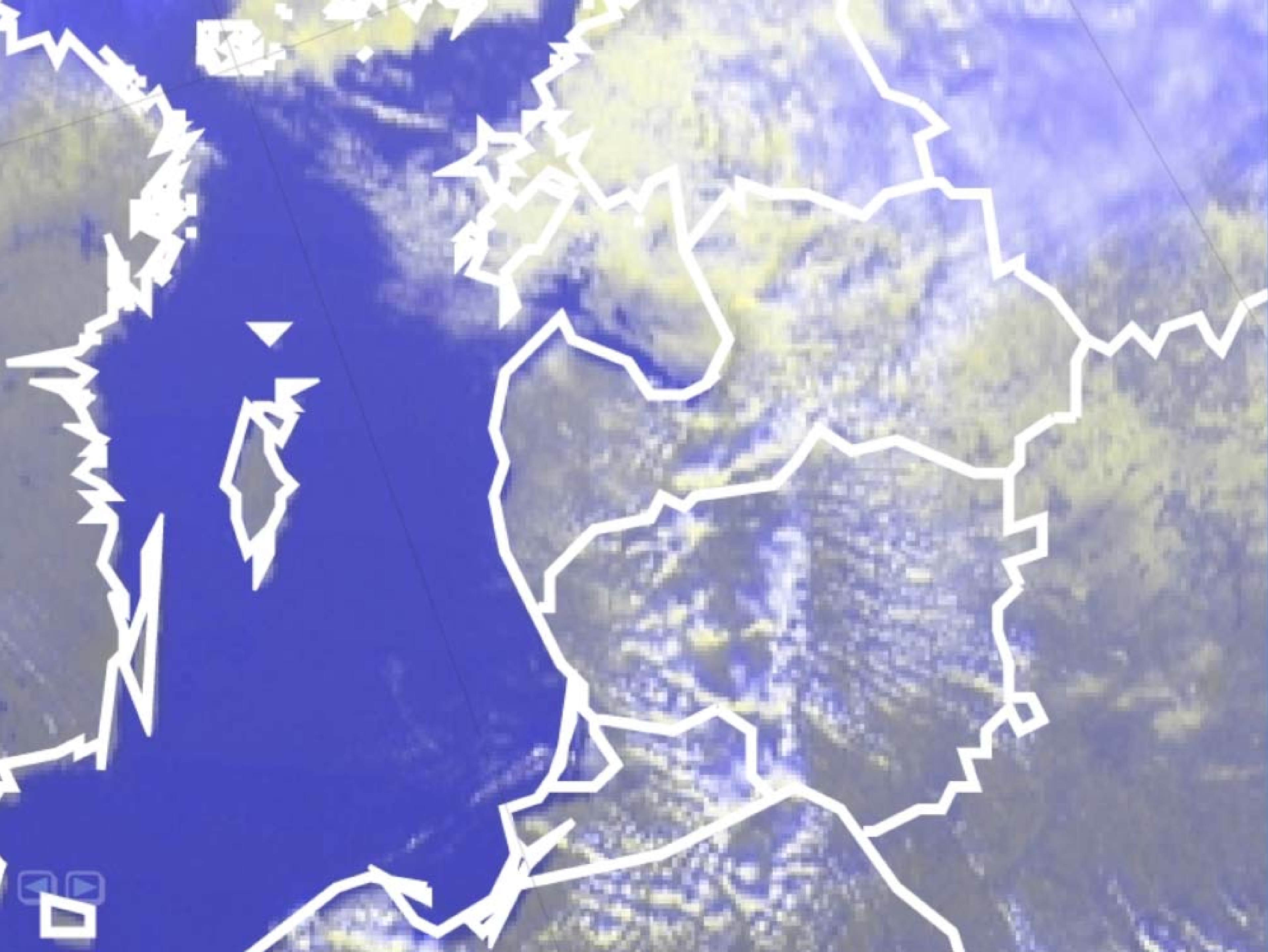


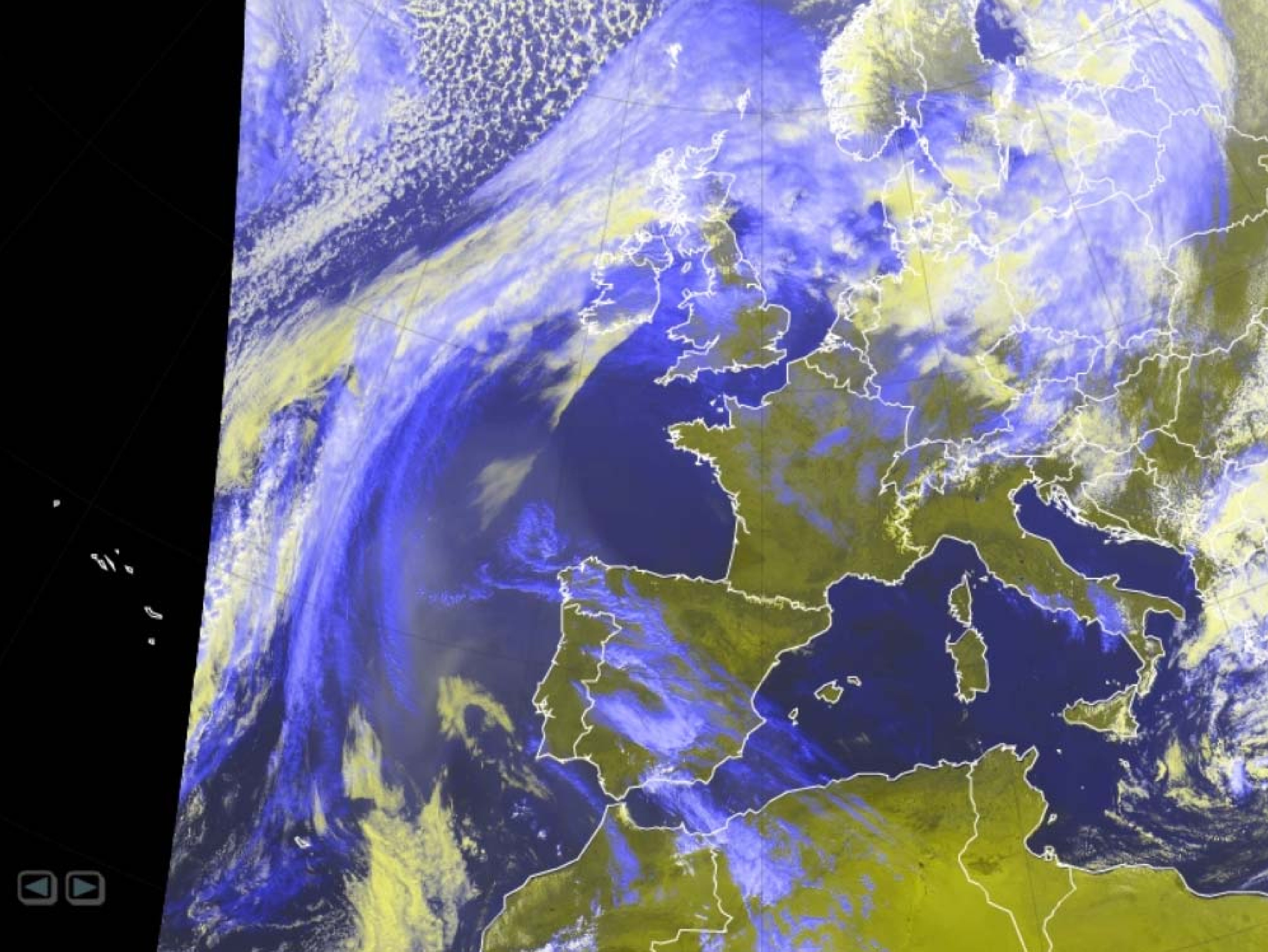

14
11

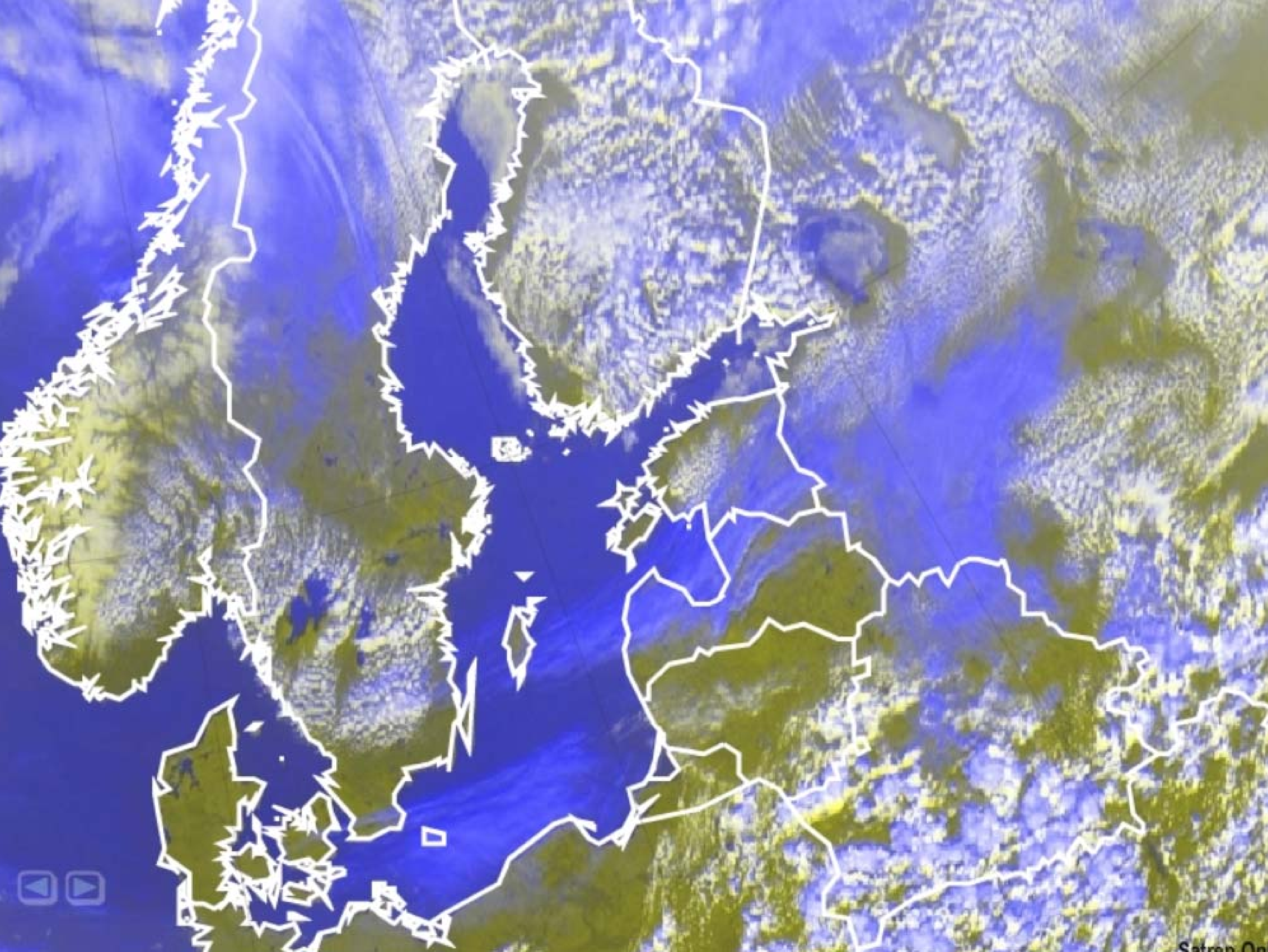


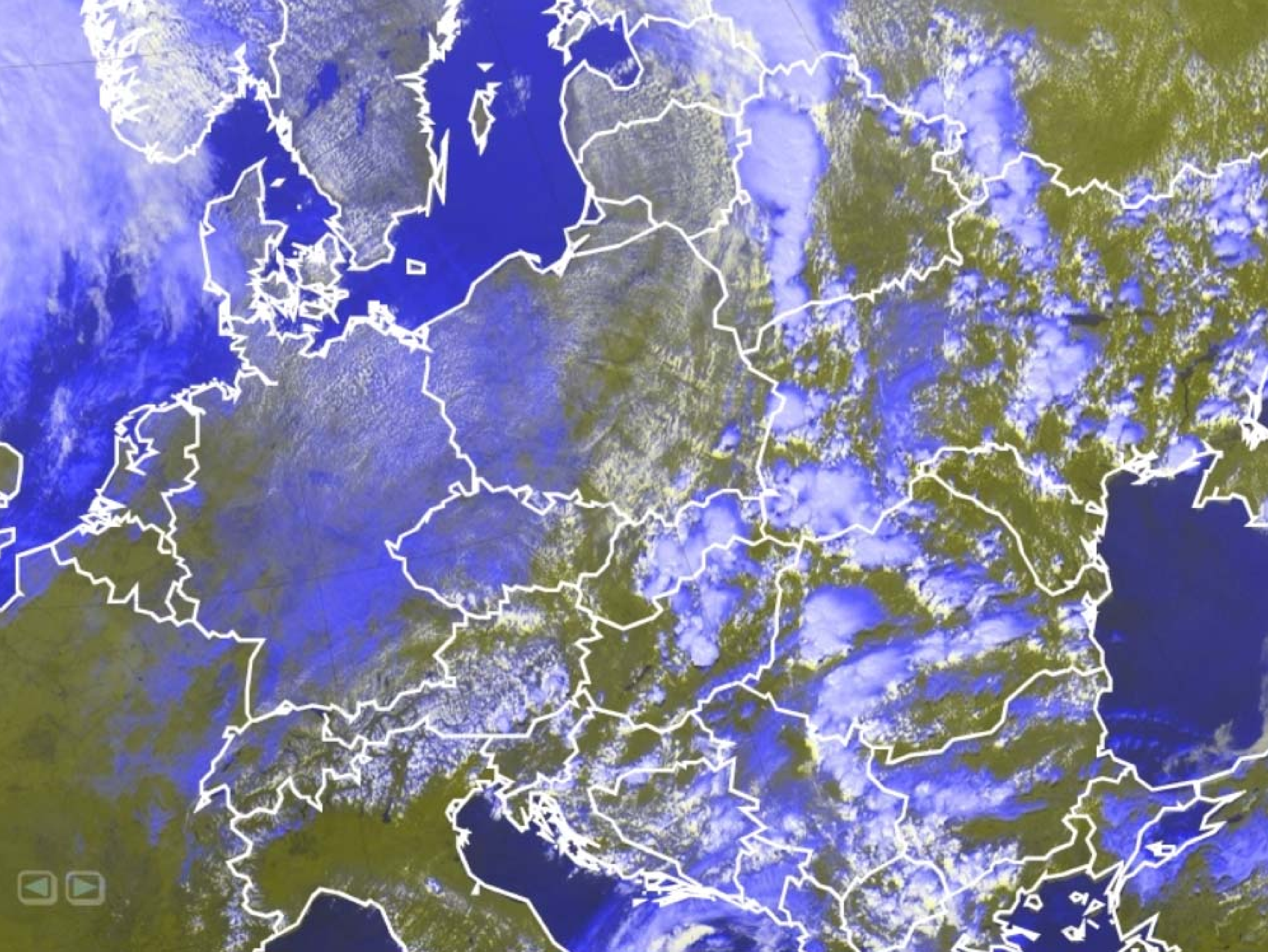












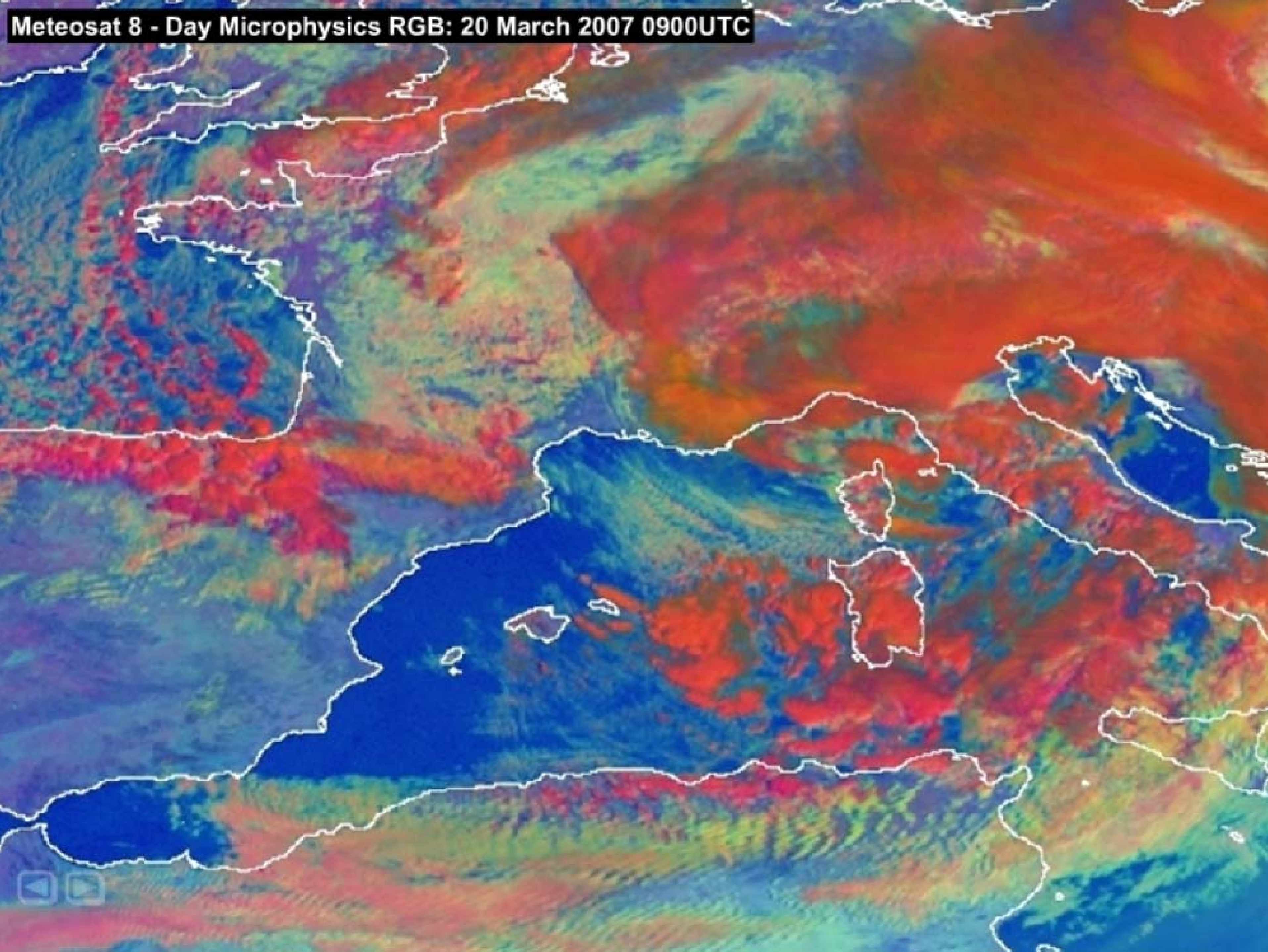
- Usefull RGB, especially in RSS mode
- Able to detect both high cloud (OT) and low cloud features (Fog)
- Also suitable as image to the media when in need to show finer scale features
- The HRV image is not equivalent to a US spionage satellite and thus not enables you monitor the migration of a mockingbird in late autumn

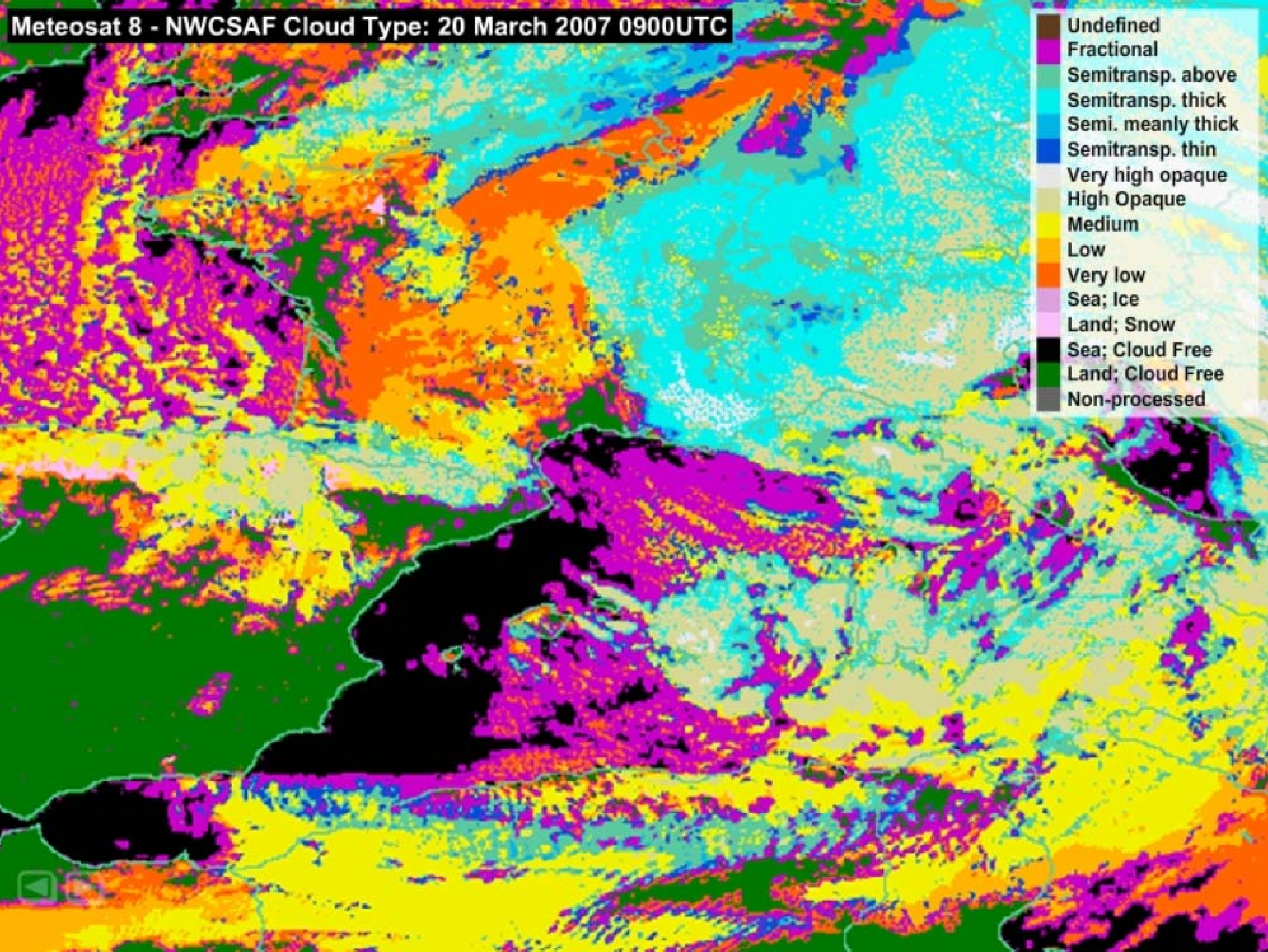
Drawbacks

- Millions of colours compared to discrete classes used in quantitative image products; interpretation more difficult
- Cannot be handled by colour-blind

Advantages

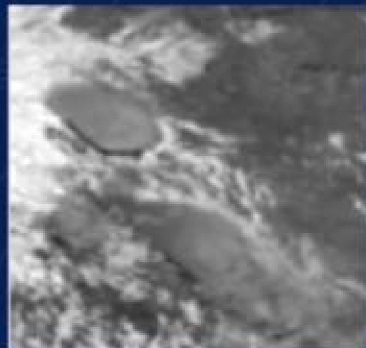
- Millions of colours: high information content
- Easily implemented
- Preserves *natural look* of images by retaining original textures (in particular for clouds)
- Preserves spatial and temporal continuity allowing for smooth animation of RGB image sequences


Meteosat 8 - Day Microphysics RGB: 20 March 2007 0900UTC


Meteosat 8 - NWCSAF Cloud Type: 20 March 2007 0900UTC
Undefined
Fractional
Semitransp. above
Semitransp. thick
Semi. meanly thick
Semitransp. thin
Very high opaque
High Opaque
Medium
Low
Very low
Sea; Ice
Land; Snow
Sea; Cloud Free
Land; Cloud Free
Non-processed

Channel Differences

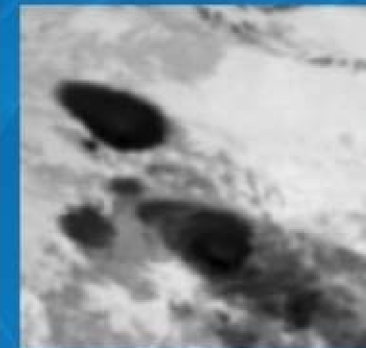
VIS0.8



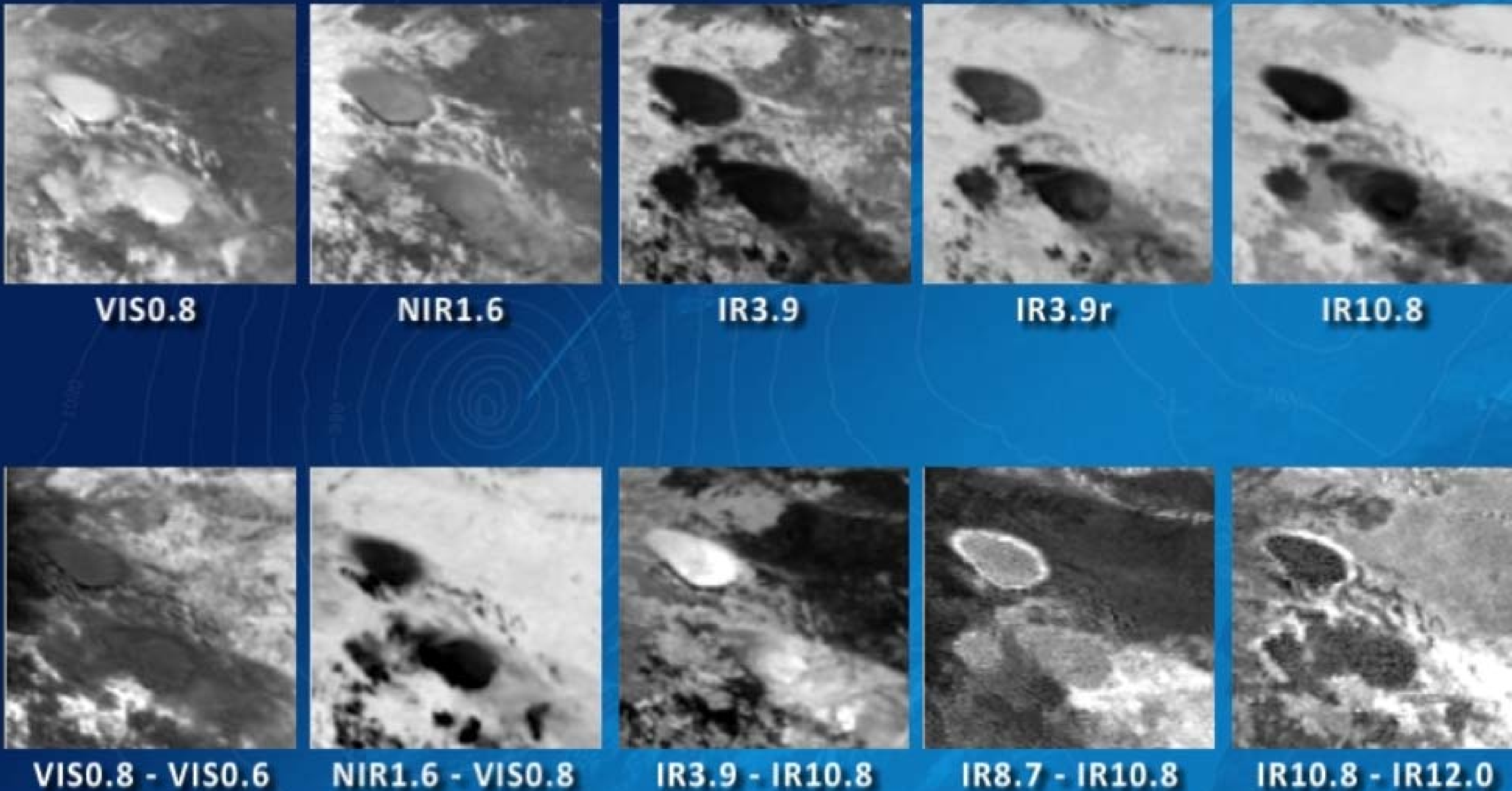
NIR1.6

IR3.9

IR3.9r



IR10.8


VIS0.8
NIR1.6
IR3.9
IR3.9r
IR10.8
VIS0.8 - VIS0.6
NIR1.6 - VIS0.8
IR3.9 - IR10.8
IR8.7 - IR10.8
IR10.8 - IR12.0

Channel difference	Application
IR8.7 - IR10.8	Day and Night: optical thickness, phase
IR10.8 - IR12.0	Day and Night: optical thickness
NIR1.6 - VIS0.6	Day: phase (ice index), particle size
IR3.9 - IR10.8	Day: particle size, top temperature
	Night: particle size (only for warm clouds)
VIS0.8 - VIS0.6	Vegetation (Greeness)

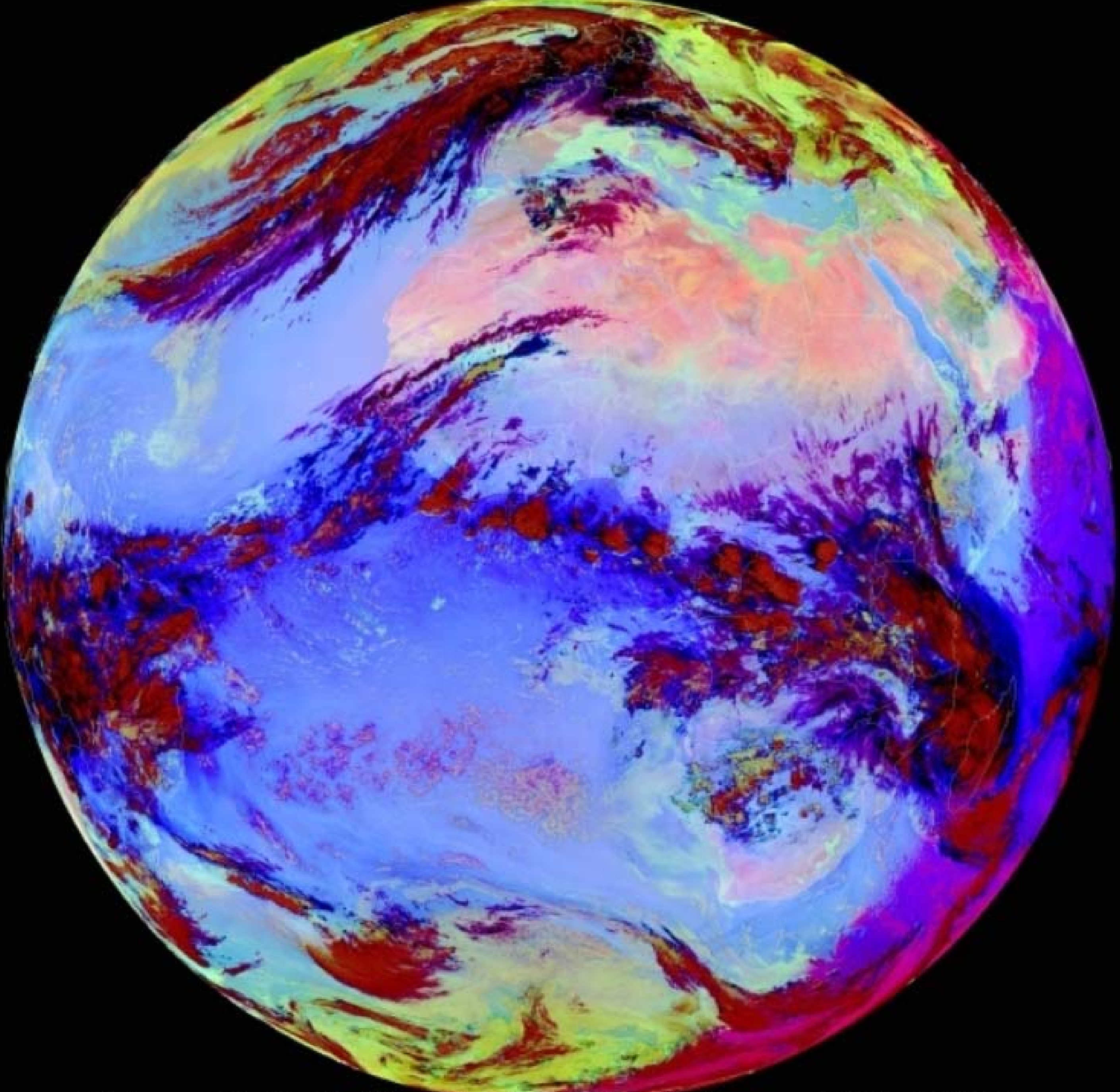
Night Microphysics RGB

Red = IR12.0 - IR10.8

Green = IR10.8 - IR3.9

Blue = IR10.8

Applications:	Fog and Low Clouds, Cloud analysis, Fires, Contrails, Snow
Area:	Full MSG Viewing Area
Time:	Night
Users:	Most European and African NMSs, Middle East



Meteosat 8 - Night Microphysics RGB: 3 February 2004 0300UTC

Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8	-4K to +2K	1.0
Green	IR10.8 - IR3.9	0 to +10K	1.0
Blue	IR10.8	+243K to +293K	1.0

15	€1.000.000
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4	€500
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2	€100
1	€50

Whould there be limitations in the use of this RGB?

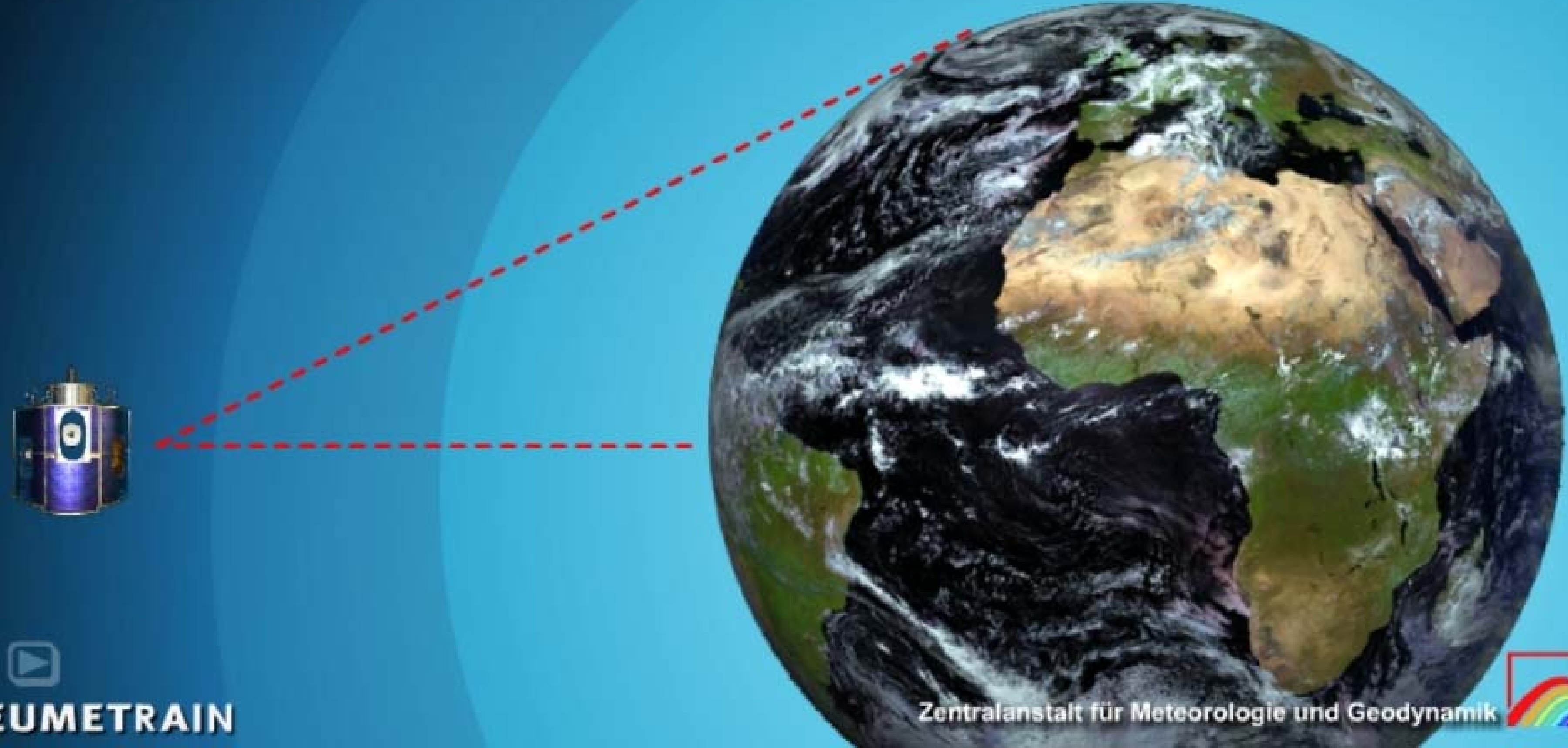
A: No limitations

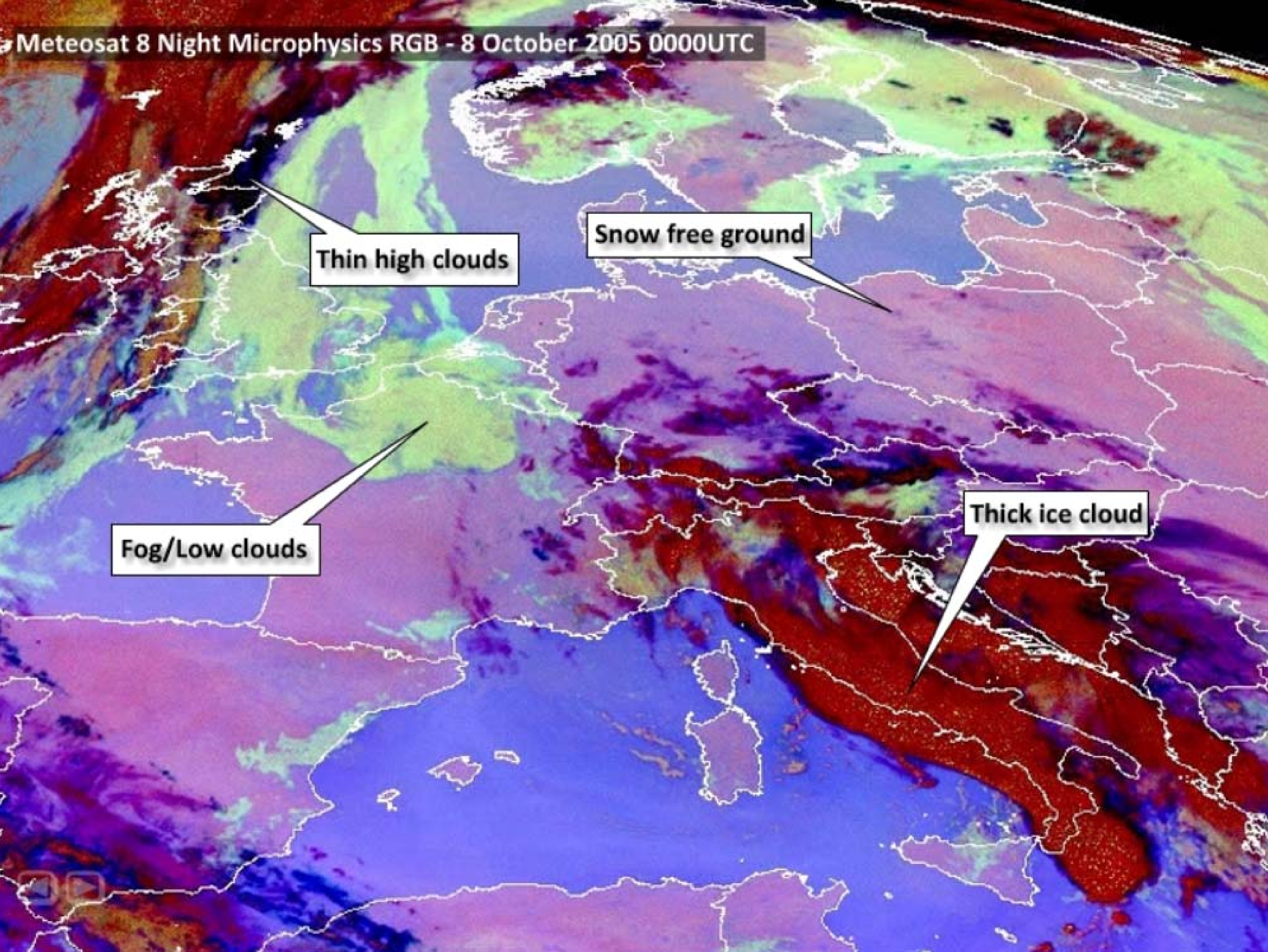
B: Geographical

C: Temporal

D: Both Temporal and Geographical

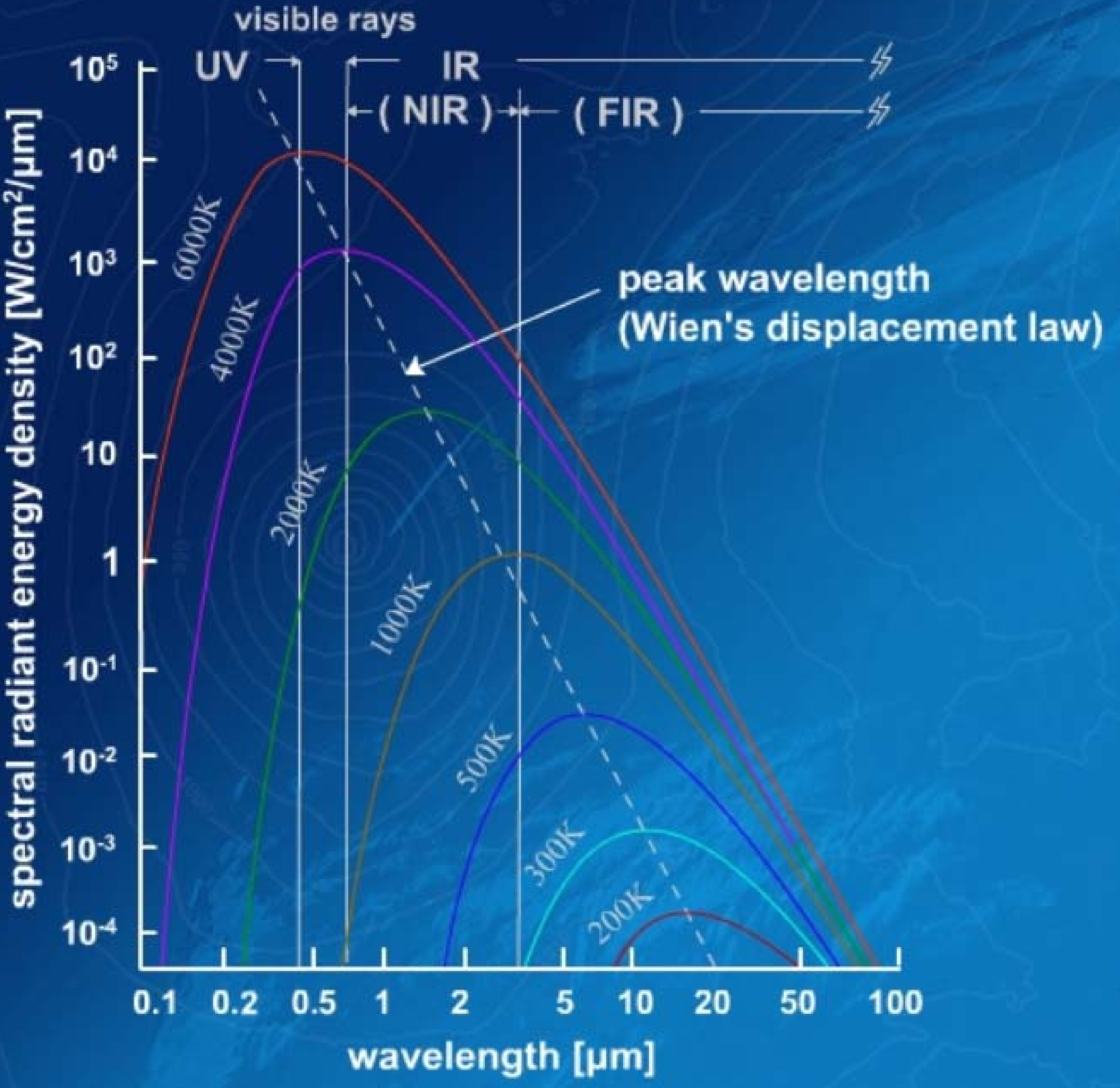
Higher latitudes also mean longer optical path, and therefor larger erroneous measurement of certain trace gasses.



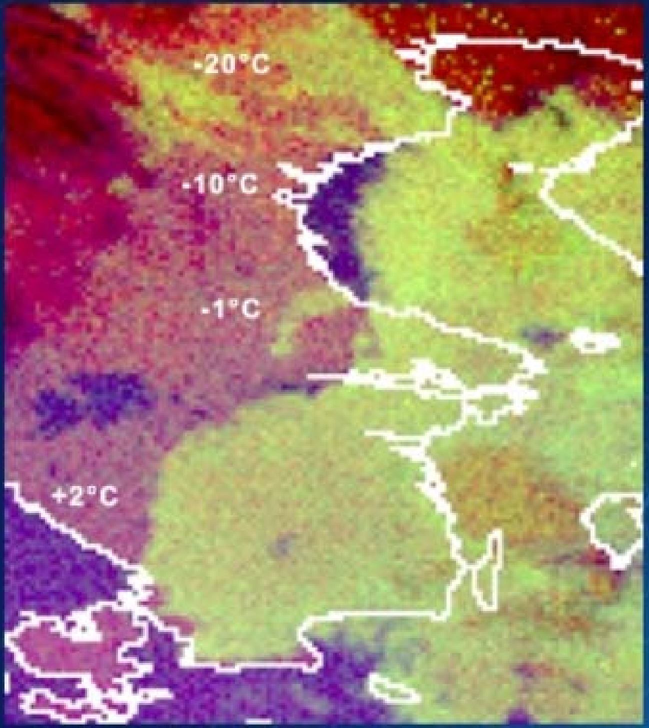

Meteosat 8 Night Microphysics RGB - 8 October 2005 0000UTC
Thin high clouds
Snow free ground
Fog/Low clouds
Thick ice cloud

For Cirrus IR12.0 < IR10.8; IR3.9

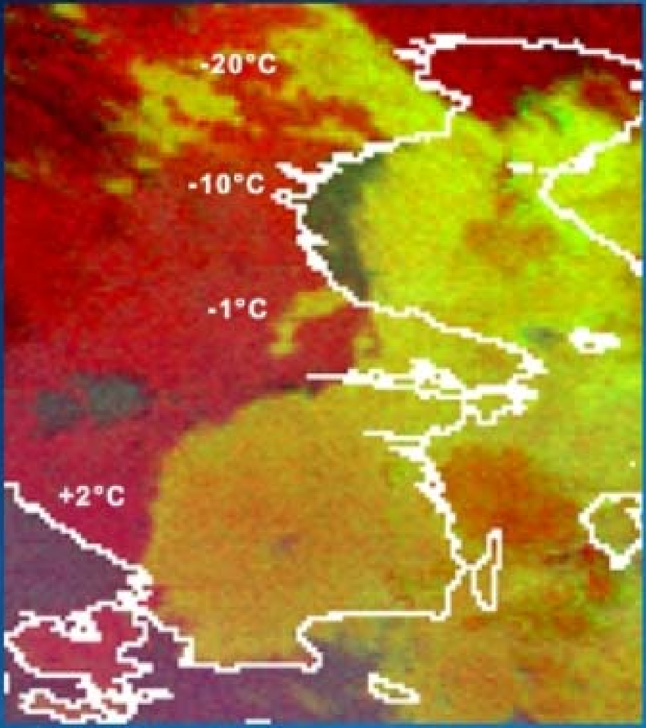
Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8	-4K to +2K	1.0
Green	IR10.8 - IR3.9	0 to +10K	1.0
Blue	IR10.8	+243K to +293K	1.0



visible rays
UV
IR
(NIR)
(FIR)
spectral radiant energy density [W/cm²/µm]
10⁵
10⁴
10³
10²
10
1
10⁻¹
10⁻²
10⁻³
10⁻⁴
6000K
4000K
2000K
1000K
500K
300K
200K
peak wavelength
(Wien's displacement law)
0.1
0.2
0.5
1
2
5
10
20
50
100
wavelength [µm]

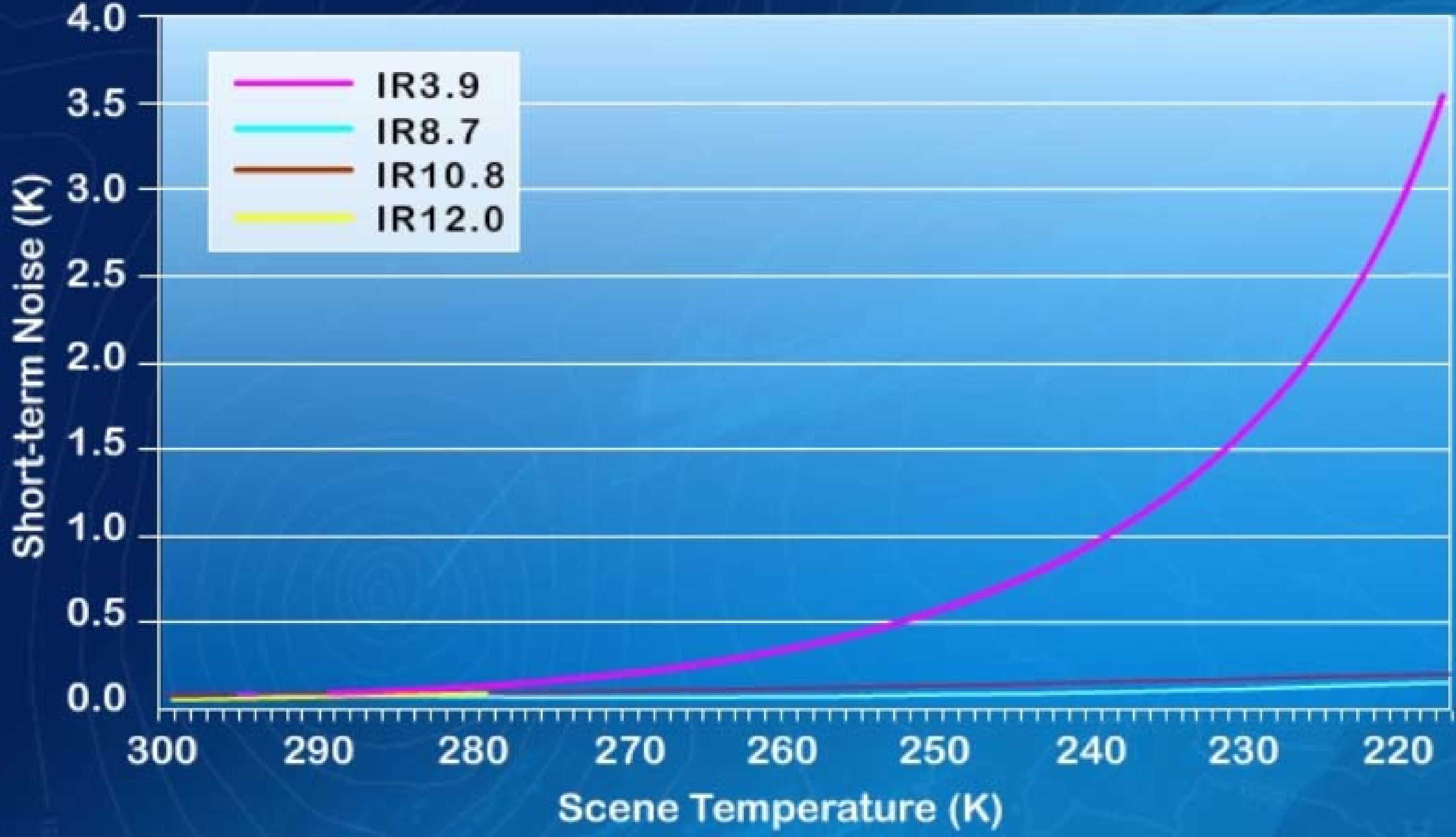


Meteosat 8 Night Microphysics RGB -
1 February 2007 0145UTC

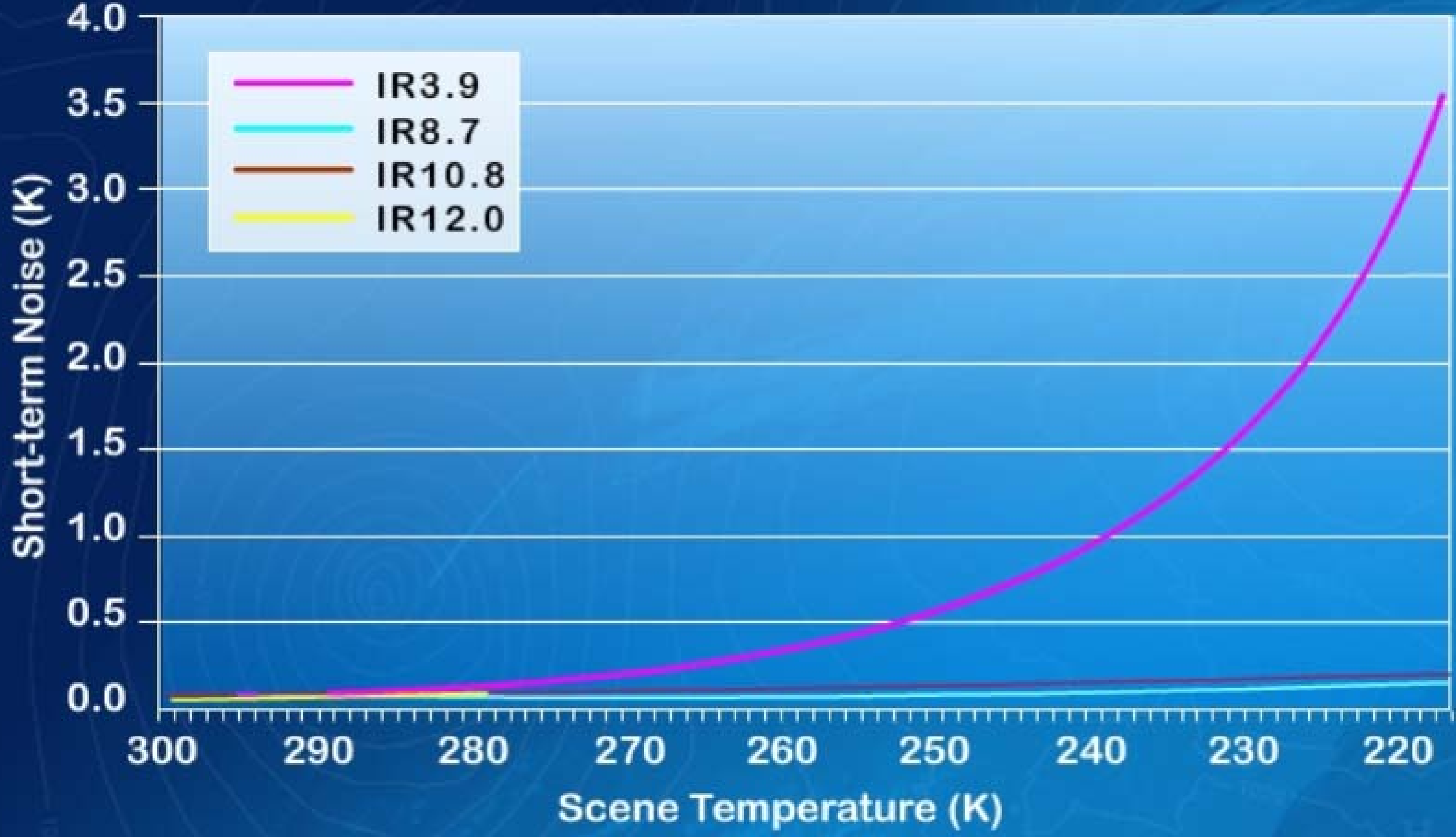


Meteosat 8 24 hr Microphysics RGB -
1 February 2007 0145UTC

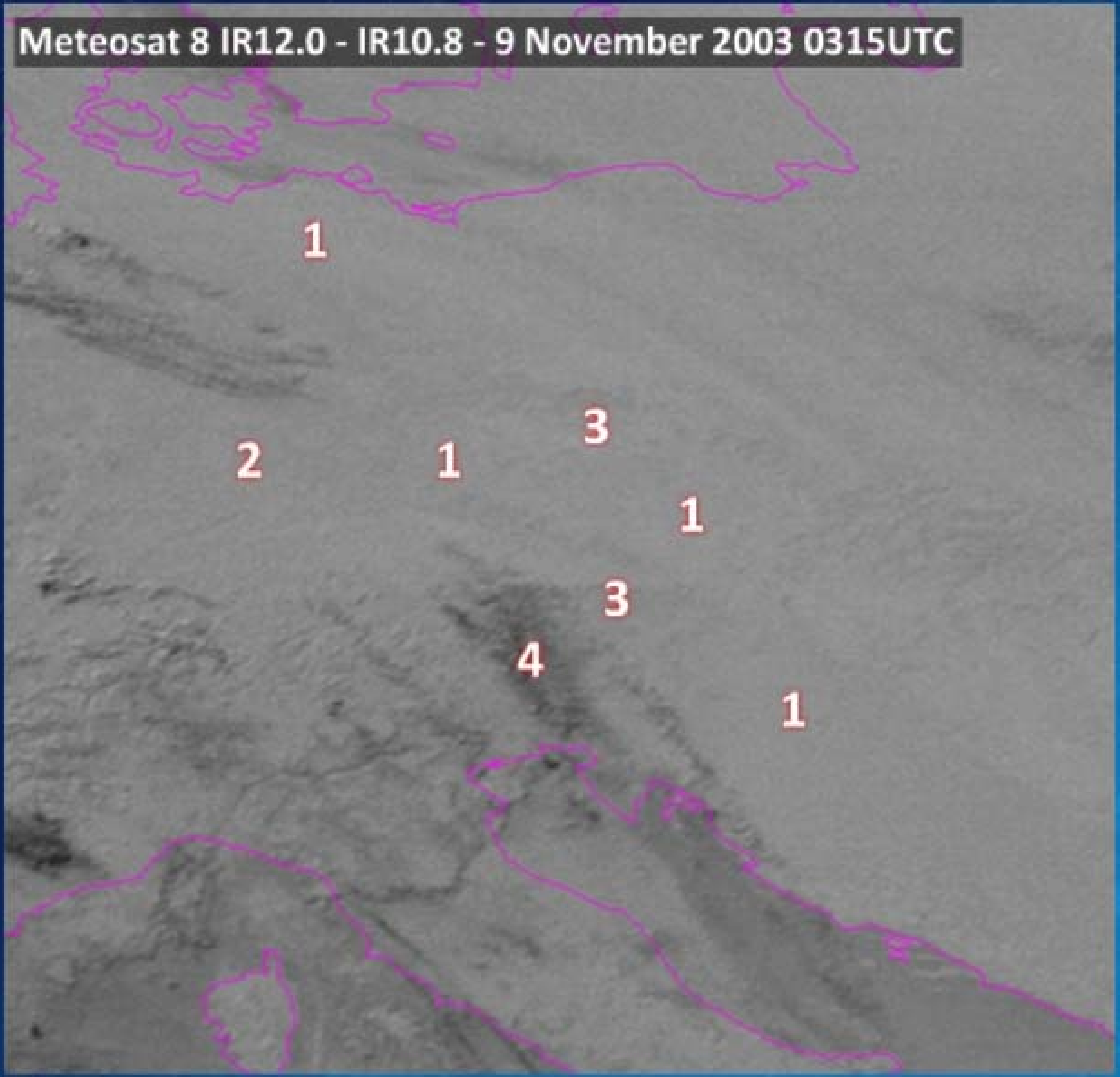
In wintertime the IR3.9 produces noise for extreme cold scenes. This noise can reach values of 1 to 1.5K. Remember that for the recognition of fog and low stratus we need a BTD (IR10.8 – IR3.9) of about 6 – 10K. If the IR3.9 then provides an error of 1 to 1.5K this will have a significant influence on the BTD and the possibility to monitor fog and low stratus.



IR3.9
IR8.7
IR10.8
IR12.0
Short-term Noise (K)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
300
290
280
270
260
250
240
230
220
Scene Temperature (K)



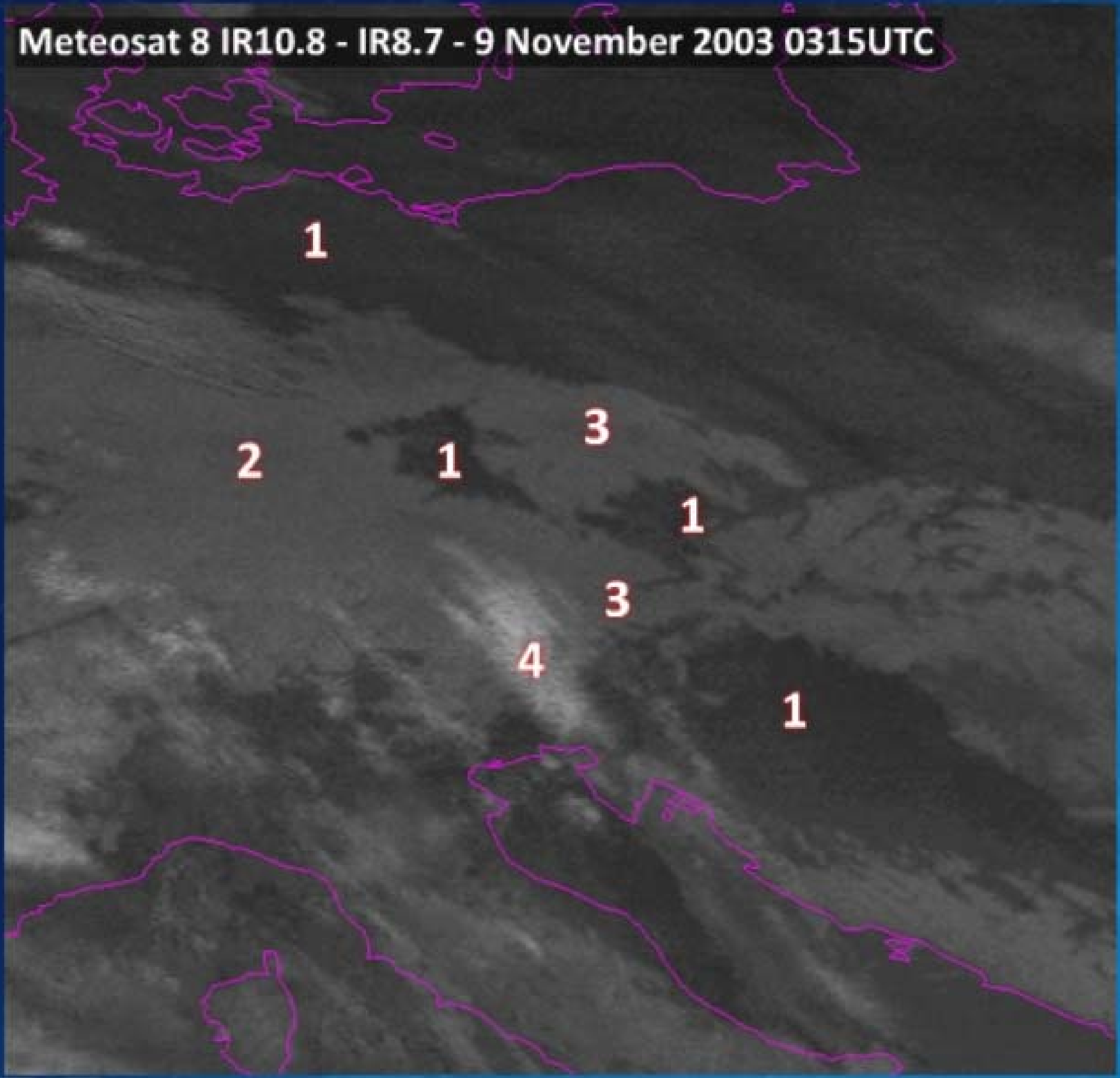
Brightness Temperature Difference	Fog and Low Clouds	Bare Soil
IR10.8 - IR8.7	+4K	-2K to +1K
IR10.8 - IR3.9	+5.5 to +10K	0K



Fog at night NOT VISIBLE in brightness temperature difference of IR12.0 - IR10.8. Cirrus however is observed!

Fog: 0/+1 K (black)
Ground: 0/+1 K (grey)
Ocean: -1K

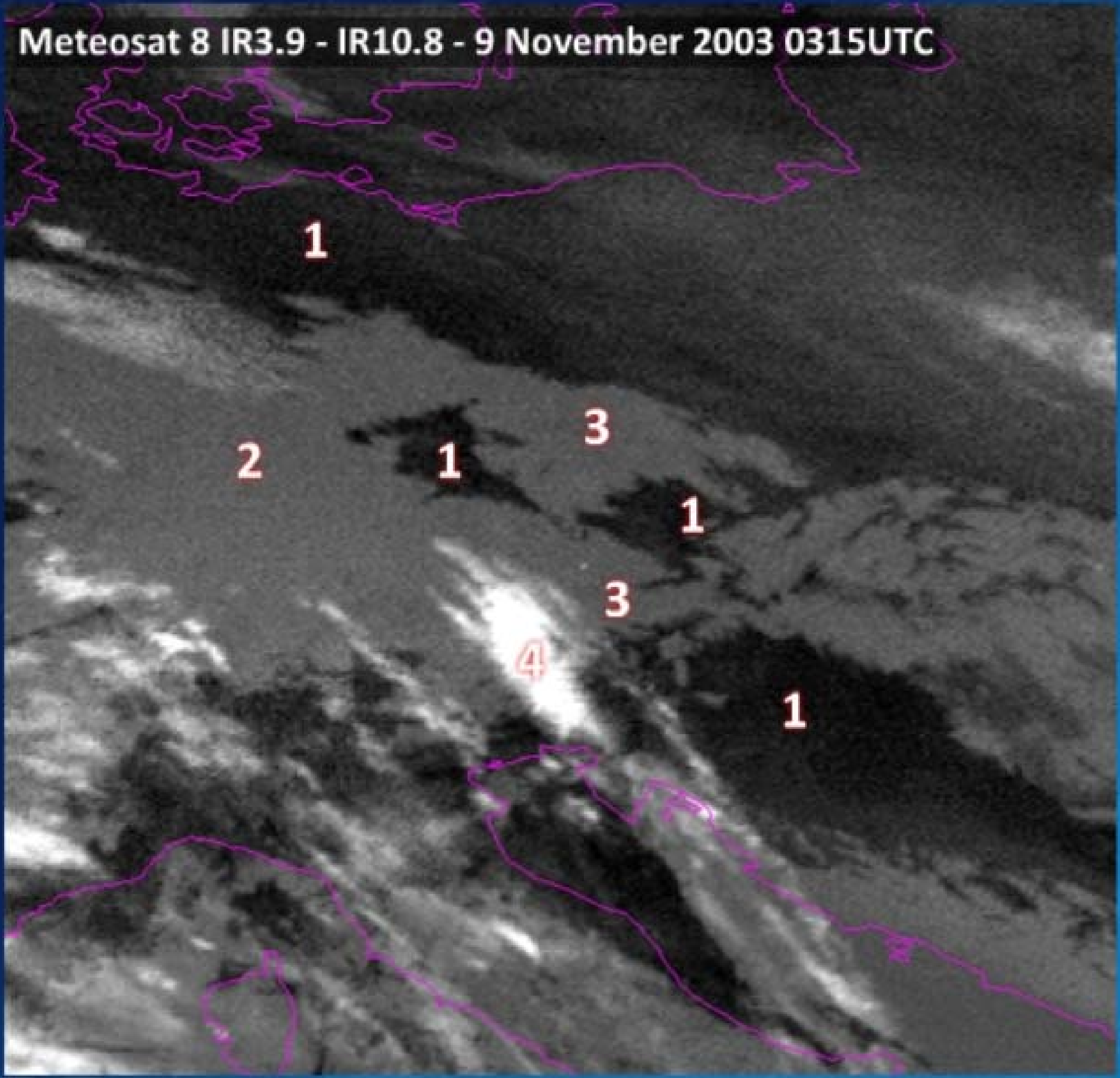
1 = Low-level fog or stratus
2 = cold clear ground
3 = warm clear ground (mountains)
4 = Thin, high-level clouds



Fog at night also visible in brightness temperature difference of IR10.8 - IR8.7

Fog: +4K (black)
Ground: -2/+1K (grey)

1 = Low-level fog or stratus
2 = cold clear ground
3 = warm clear ground (mountains)
4 = Thin, high-level clouds



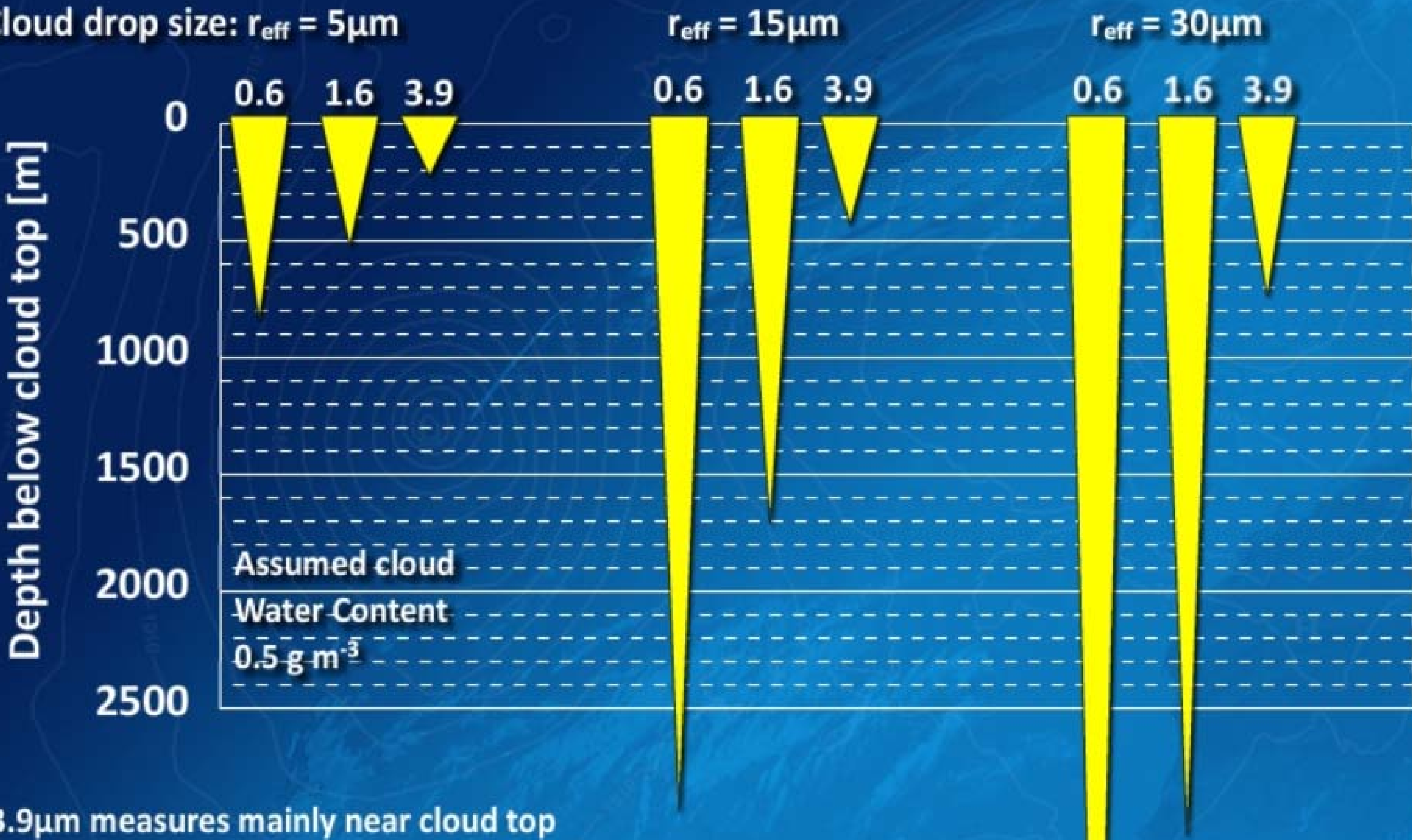
Fog at night very good visible in brightness temperature difference of IR3.9 - IR10.8

Fog: +6/+11K (black)
Ground: 0K (grey)

1 = Low-level fog or stratus
2 = cold clear ground
3 = warm clear ground (mountains)
4 = Thin, high-level clouds

How thick must a layer of fog be so that we can detect it with MSG

How deep can we seen into the clouds?

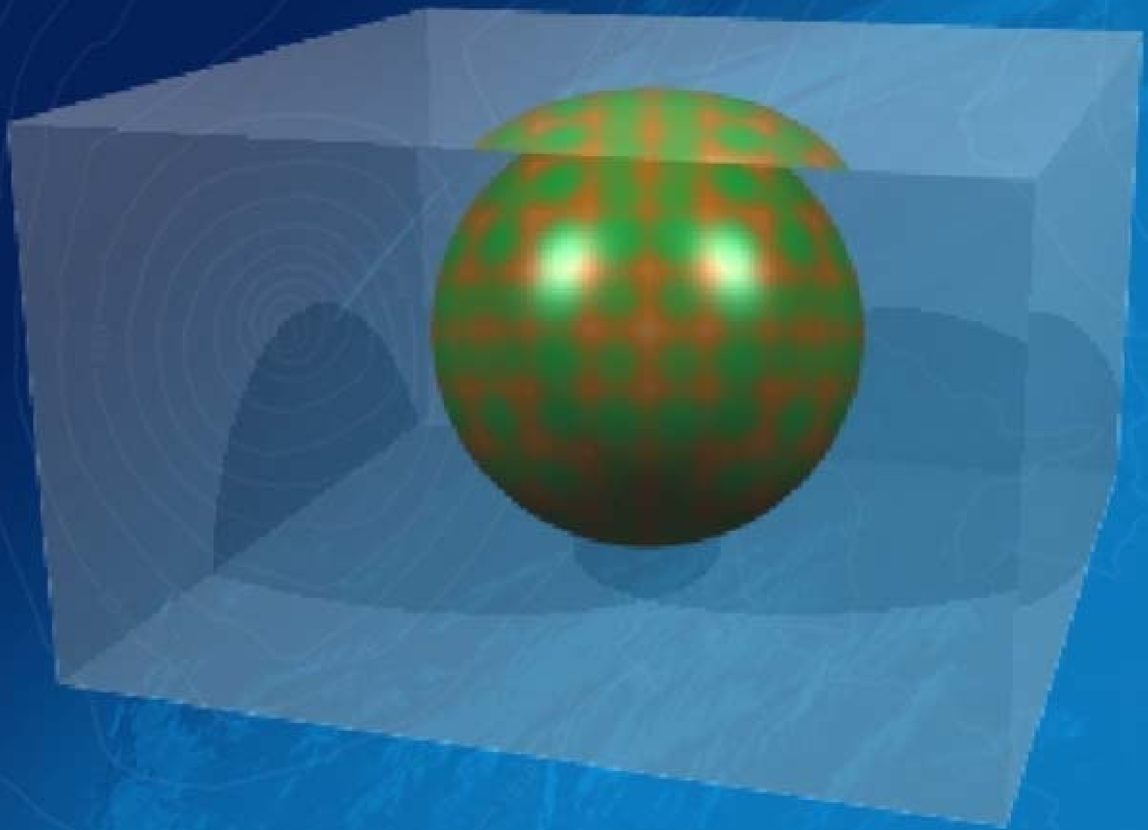


3.9µm measures mainly near cloud top

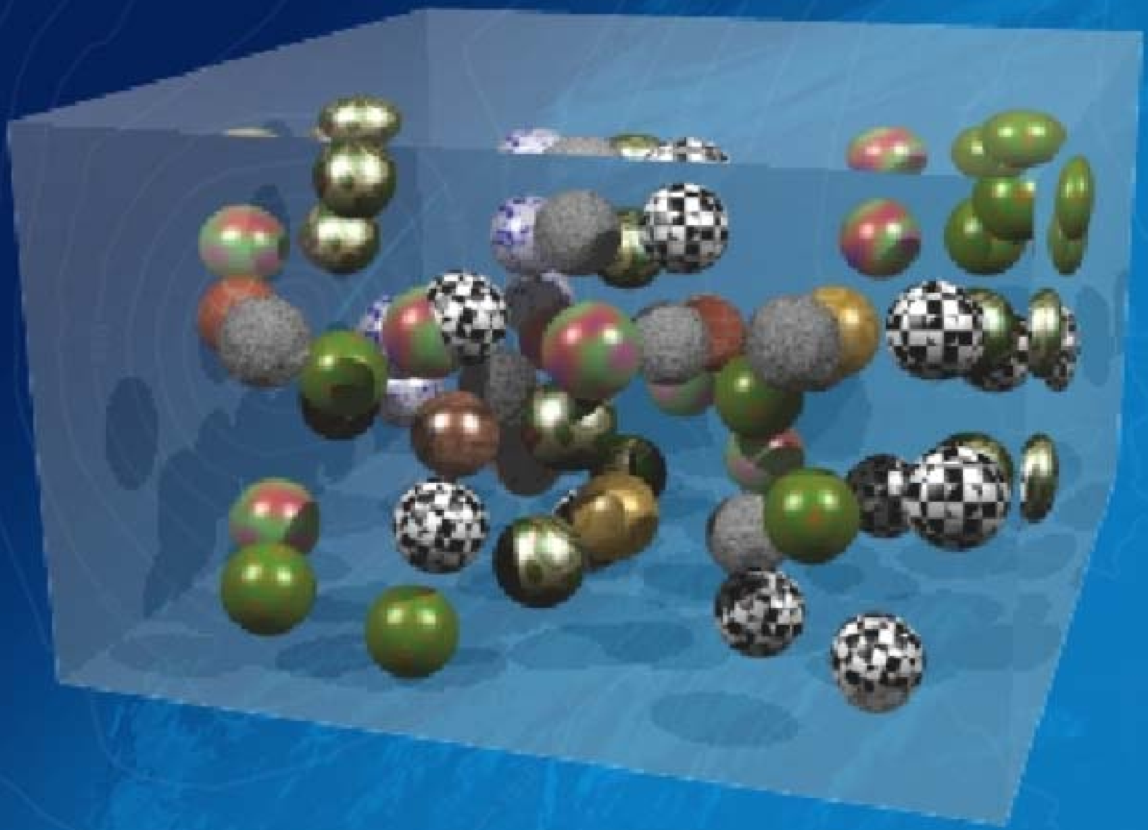
1.6 µm penetrates into larger cloud depth

0.6µm often affected by surface, especially in clouds with large drops of iceparticles

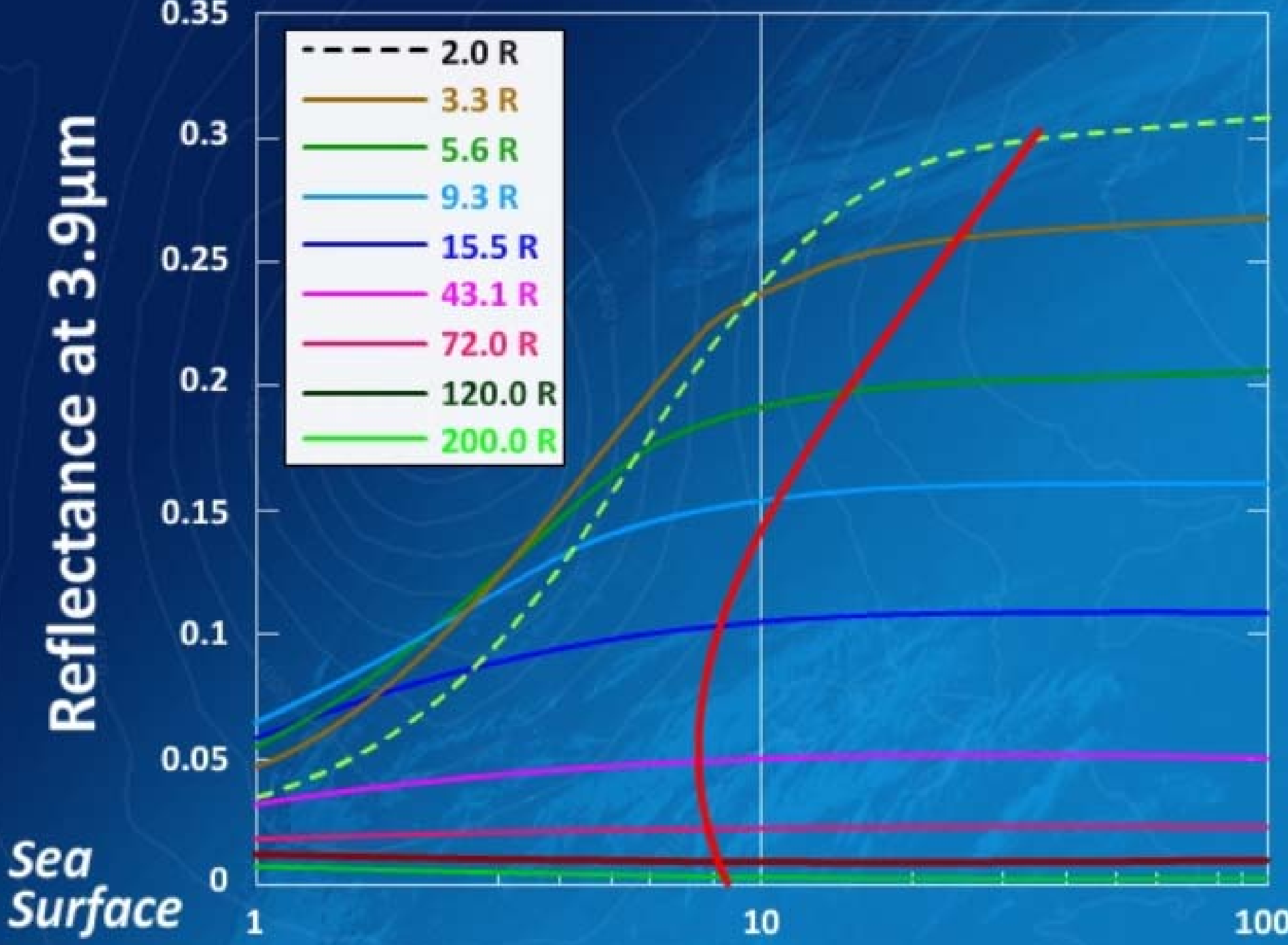
How deep can we seen into the clouds?



How deep can we seen into the clouds?

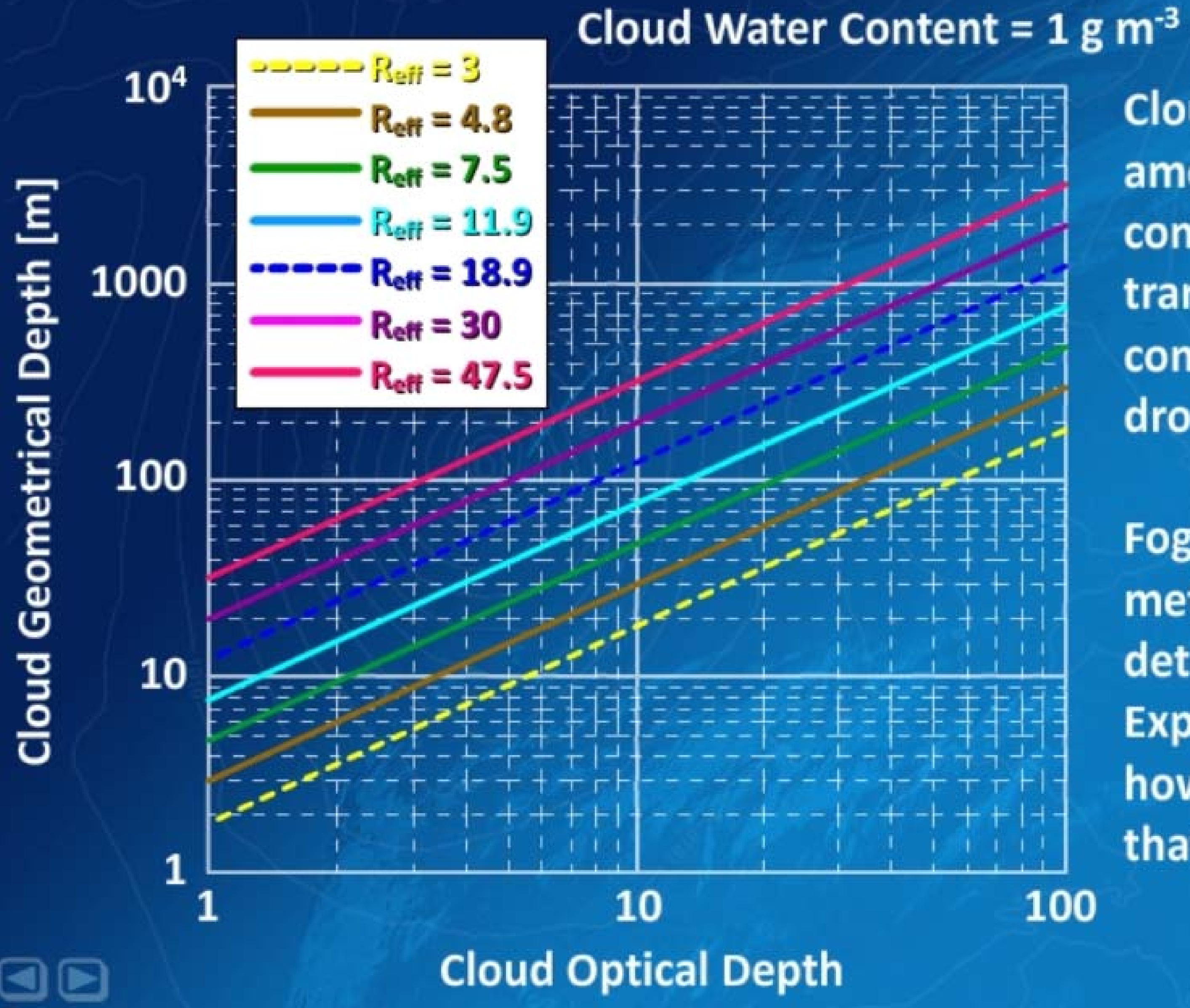


How deep can we seen into the clouds?



3.9µm requires visible optical depth of 10 for neglecting surface reflectance

How deep can we seen into the clouds?



Clouds with a fixed amount of water content become more transparent when composed of larger drops.

Fog needs to be 30 meters thick to be detected by MSG. Experience teaches however to double that figure

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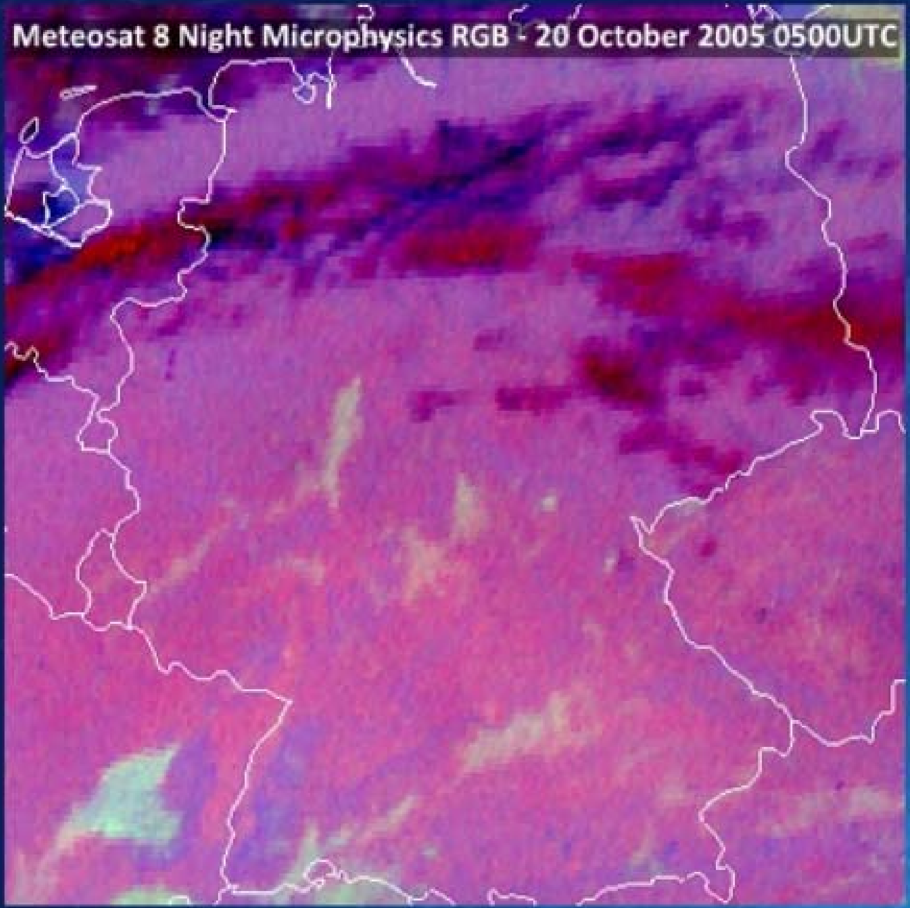
Increasing latitudes will increase the detection of fog

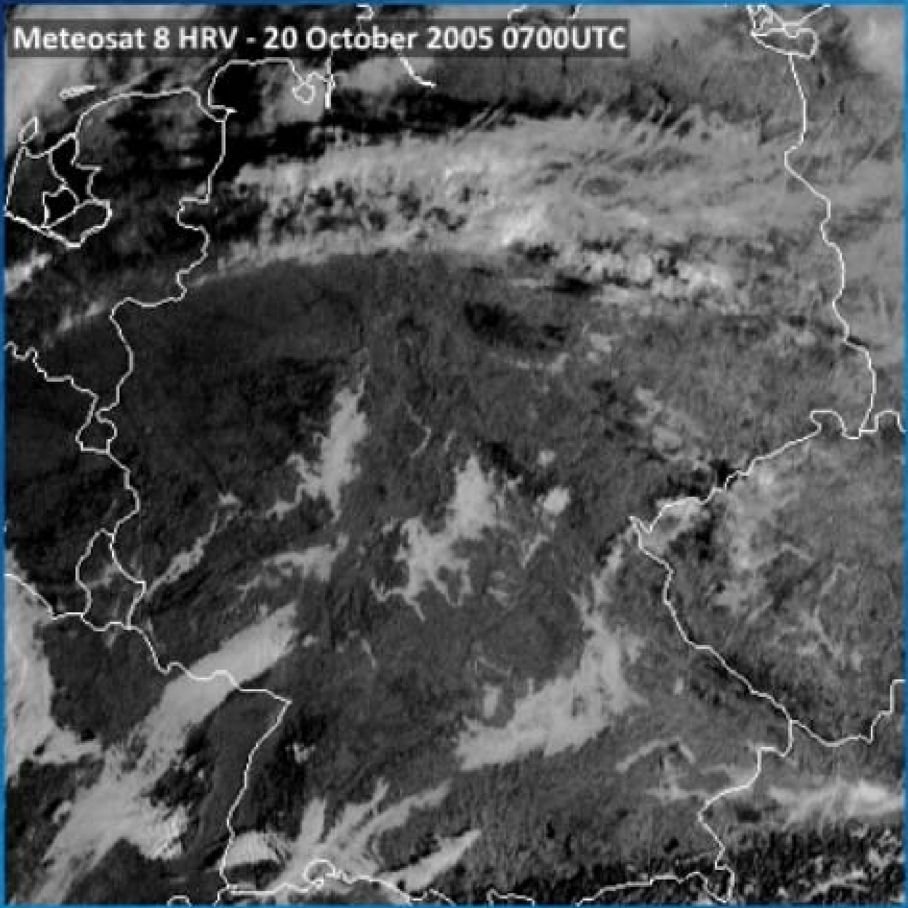
A: True

B: False

C: Depends on thickness of fog

D: Only in winter





Case of fog with a thickness of 100 to 200 meters over Germany. Fog in the IR3.9 appears smaller in size as it is in reality!

15	€1.000.000
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8	€8.000
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6	€2.000
5	€1.000
4	€500
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2	€100
1	€50

x2

Why does Fog appear smaller in the IR3.9

A: Reflection of solar component

B: IR3.9 does not like cold objects

C: There is no difference in fog, but in resolution

D: You are asking too many questions

1 MSG pixel

4 MSG subpixel

4 MSG subpixel

$$B = T^{\alpha/\lambda}$$

4 MSG subpixel

$$B = T^{\alpha/\lambda}$$

$$B = T^{4.8}$$

$$B = T^{13.6}$$

IR10.8

IR3.9

4 MSG subpixel

$$B = T^{\alpha/\lambda}$$

$$B = T^{4.8} \qquad B = T^{13.6}$$

$$B = \frac{B1 + B2 + B3 + B4}{4}$$

IR10.8 IR3.9

4 MSG subpixel

$$B = T^{\alpha/\lambda}$$

$$B = T^{4.8}$$

$$T = B^{1/4.8}$$

IR10.8

$$B = T^{13.6}$$

$$T = B^{1/13.6}$$

IR3.9

4 MSG subpixel

$$B = T^{\alpha/\lambda}$$

IR10.8	IR3.9
$B = T^{4.8}$	$B = T^{13.6}$
$T = B^{1/4.8}$	$T = B^{1/13.6}$
$T = 271K$	$T = 277K$