The Benefit of Using Water Vapor-Imagery in Diagnosing Fronts and Cyclogenesis

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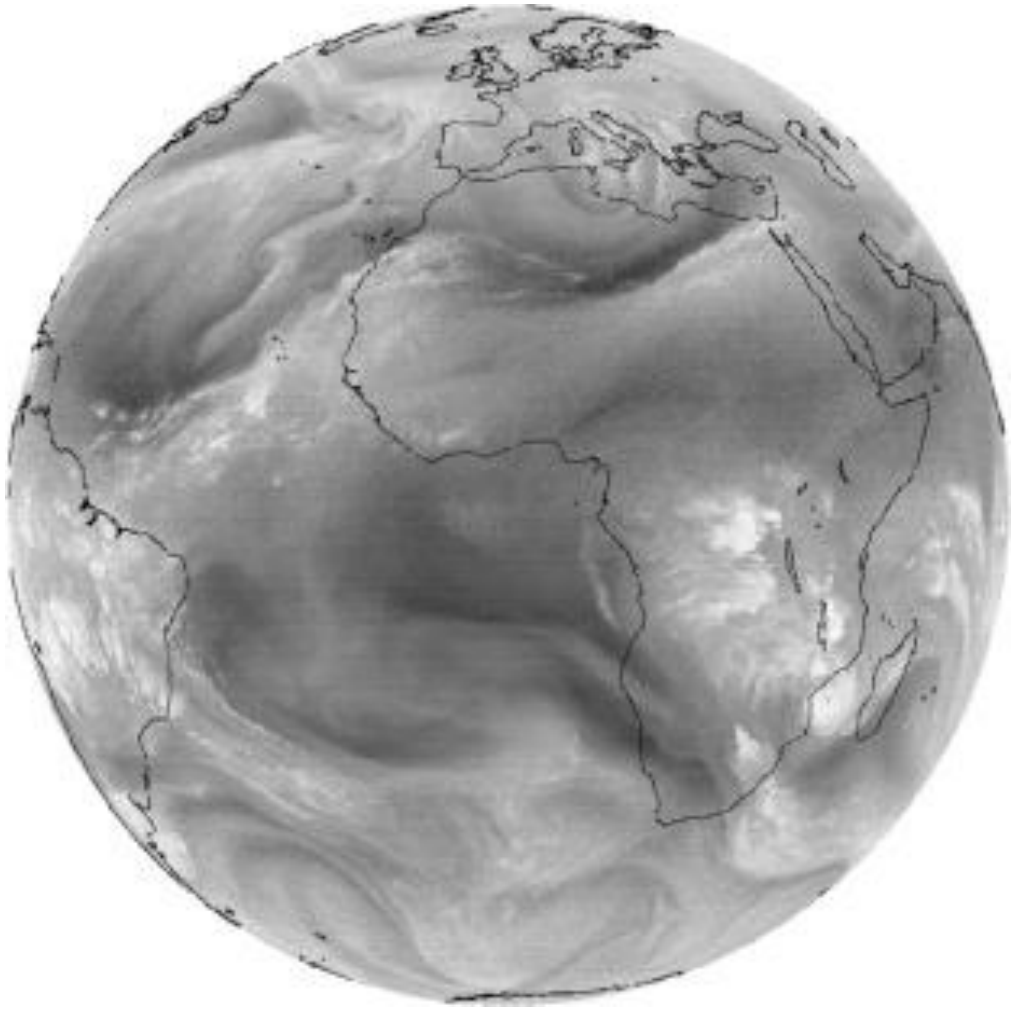
Outline

- What is so special with Water Vapor channels?
- What are they good for?
- The Airmass RGB and conveyor belts
- WV and fronts
- WV and cyclogenesis



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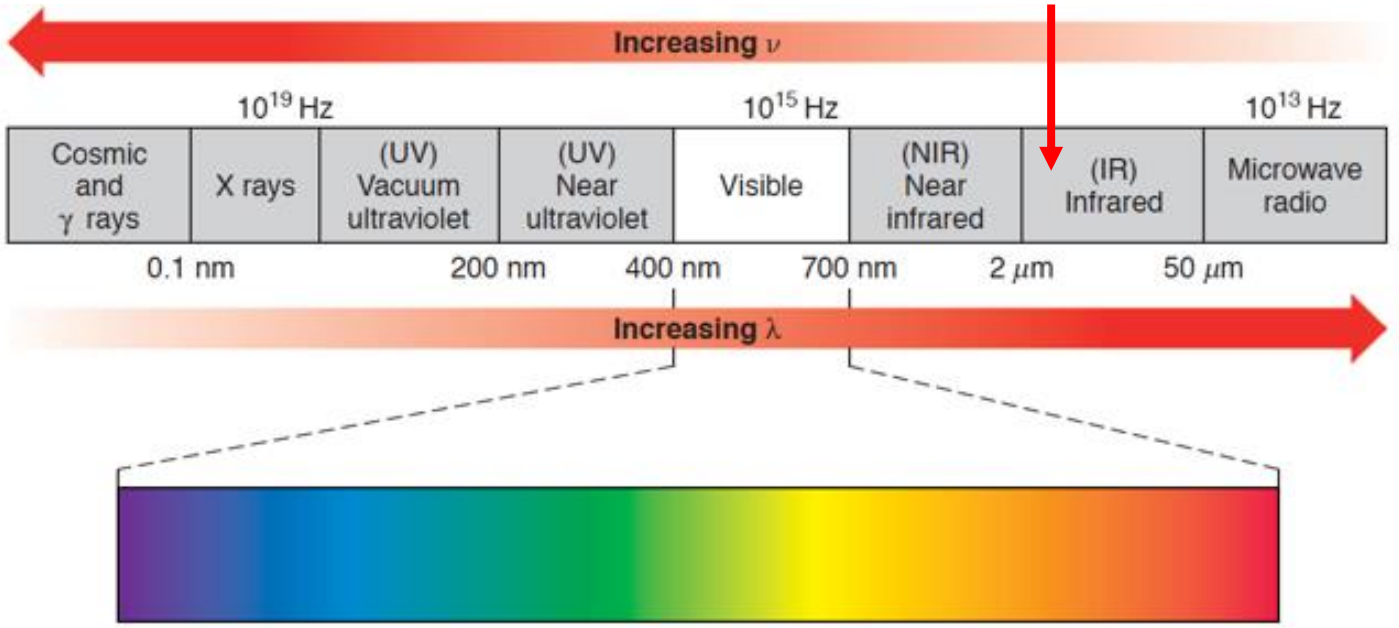
What is so special with Water Vapor (WV) channels?

First of all: WV channels are **IR channels**.

→ That means, the satellite sensor senses radiation in the IR-range that is emitted from the Earth.



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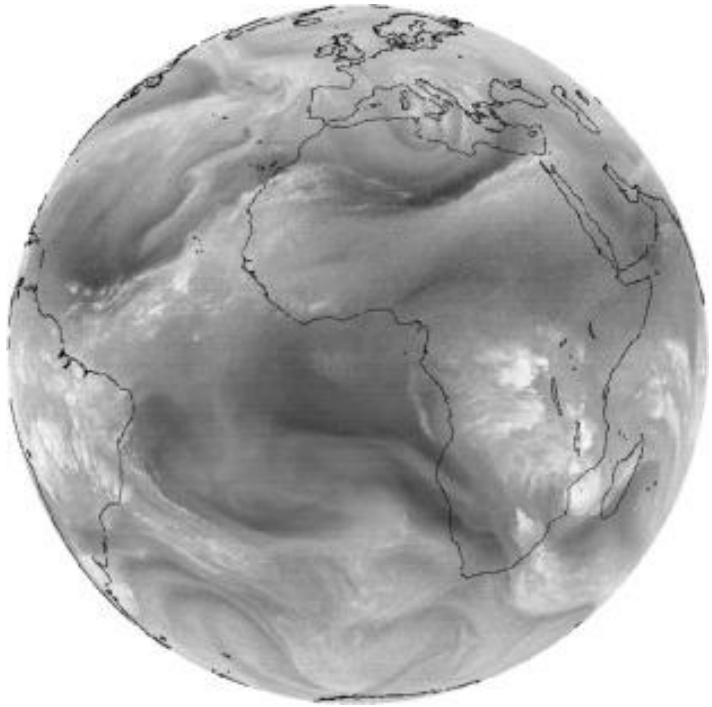
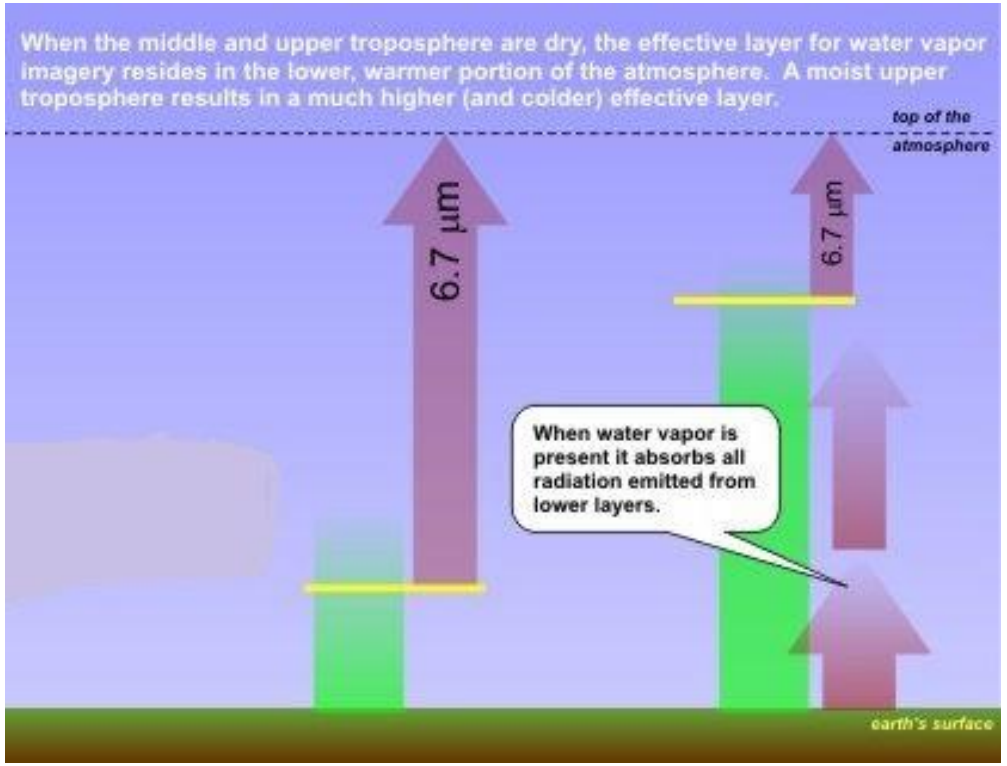
What is so special with Water Vapor (WV) channels?

First of all: WV channels are **IR channels**.

→ That means, the satellite sensor senses radiation in the IR-range that is emitted from the Earth.

→ But, absorption by water vapor is so strong, that we can see only the atmosphere.





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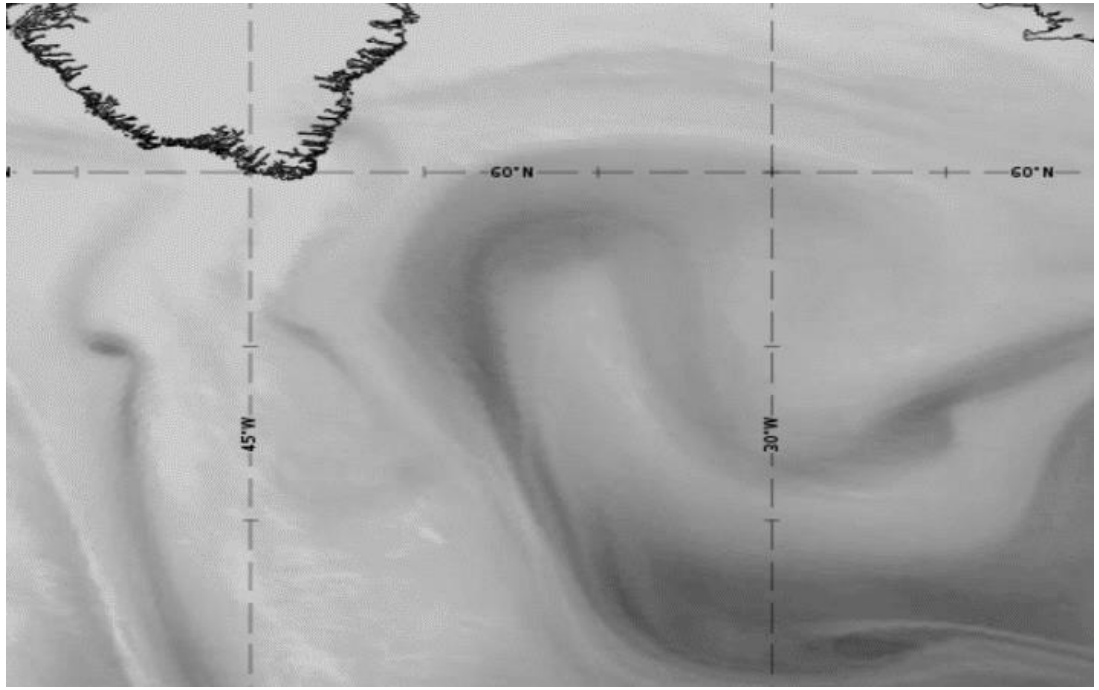
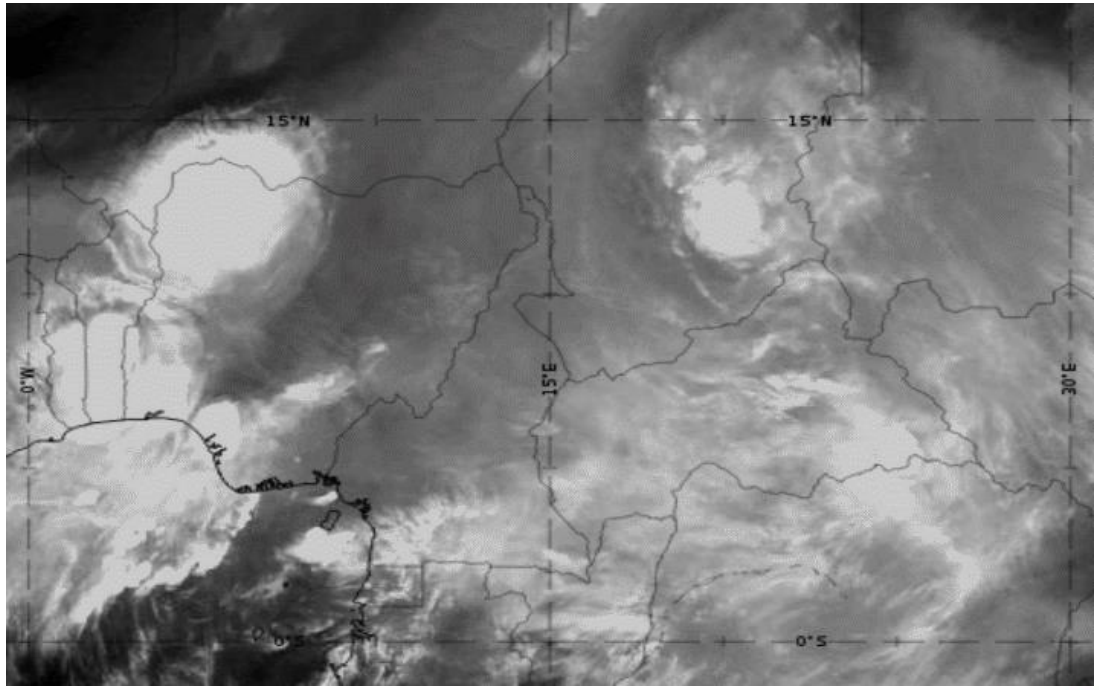
What are WV-channels good for?

As all water/humidity comes from the Earths surface, WV imagery helps us detecting:

1) Belts and dry slots; i.e., **the horizontal transport** (synoptic scale)
2) Sources and drains; i.e., **the vertical transport** (meso- and synoptic scale)





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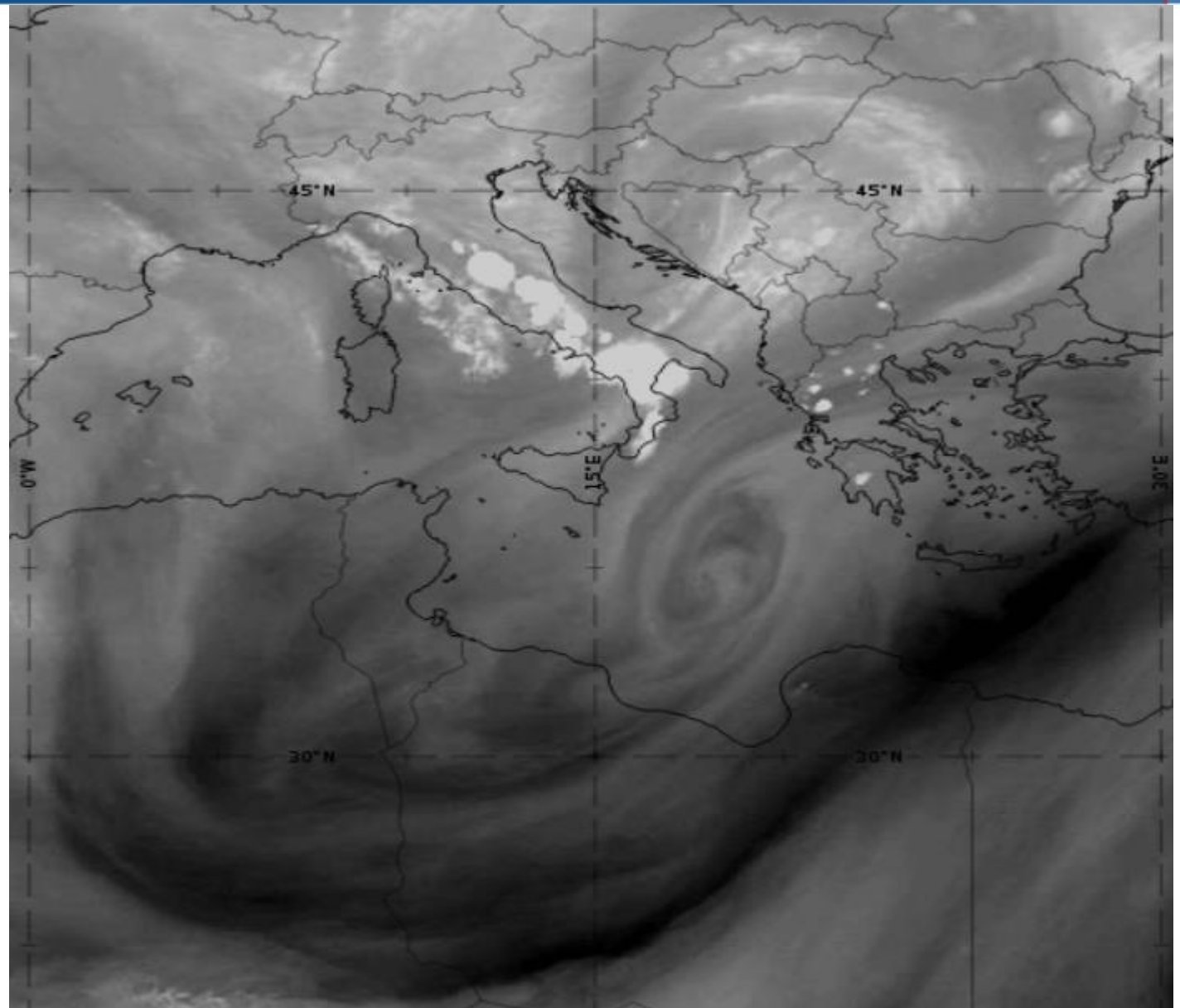
What are WV-channels good for?

Mark areas where you identify **vertical** transport.



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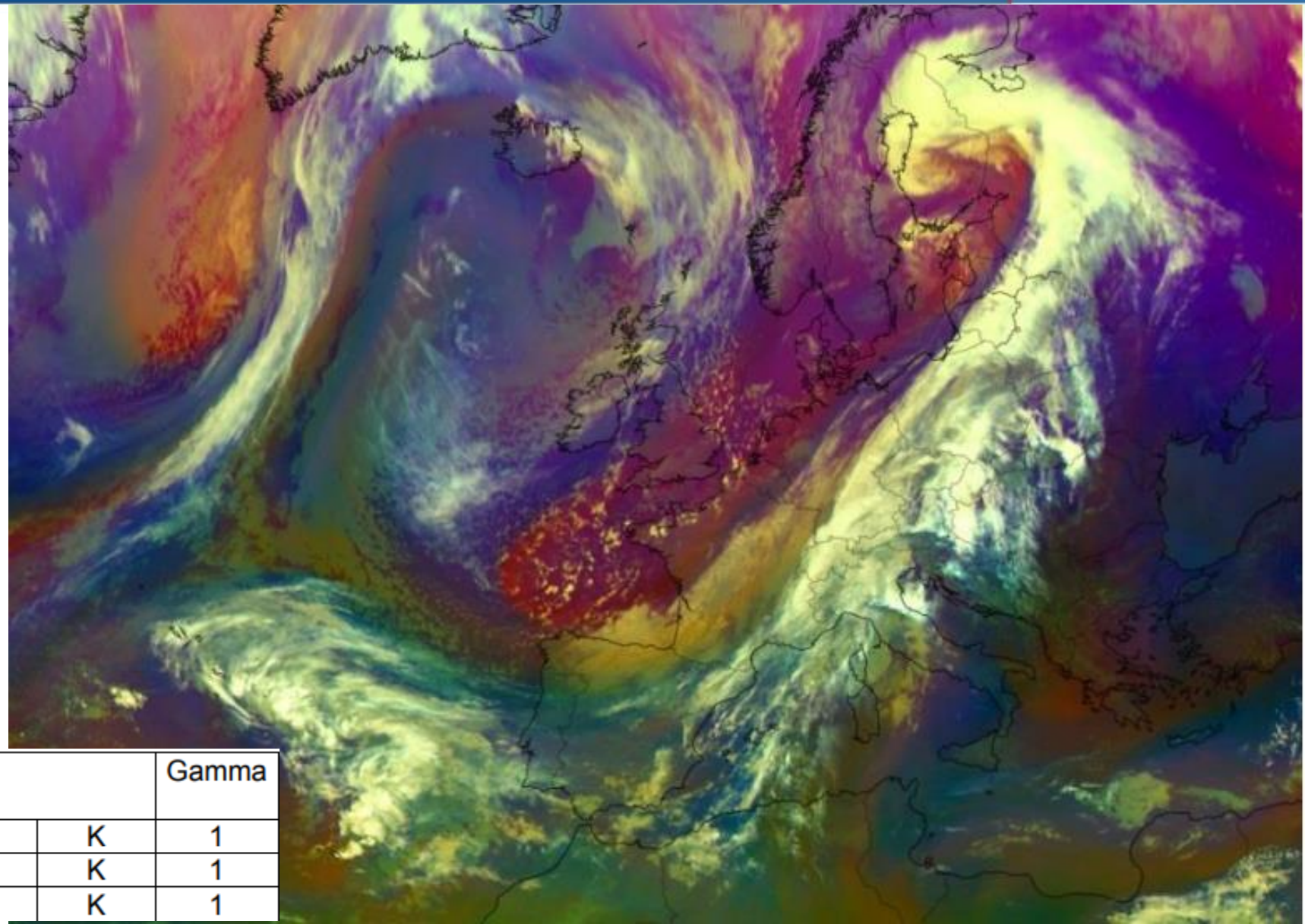
The Airmass RGB

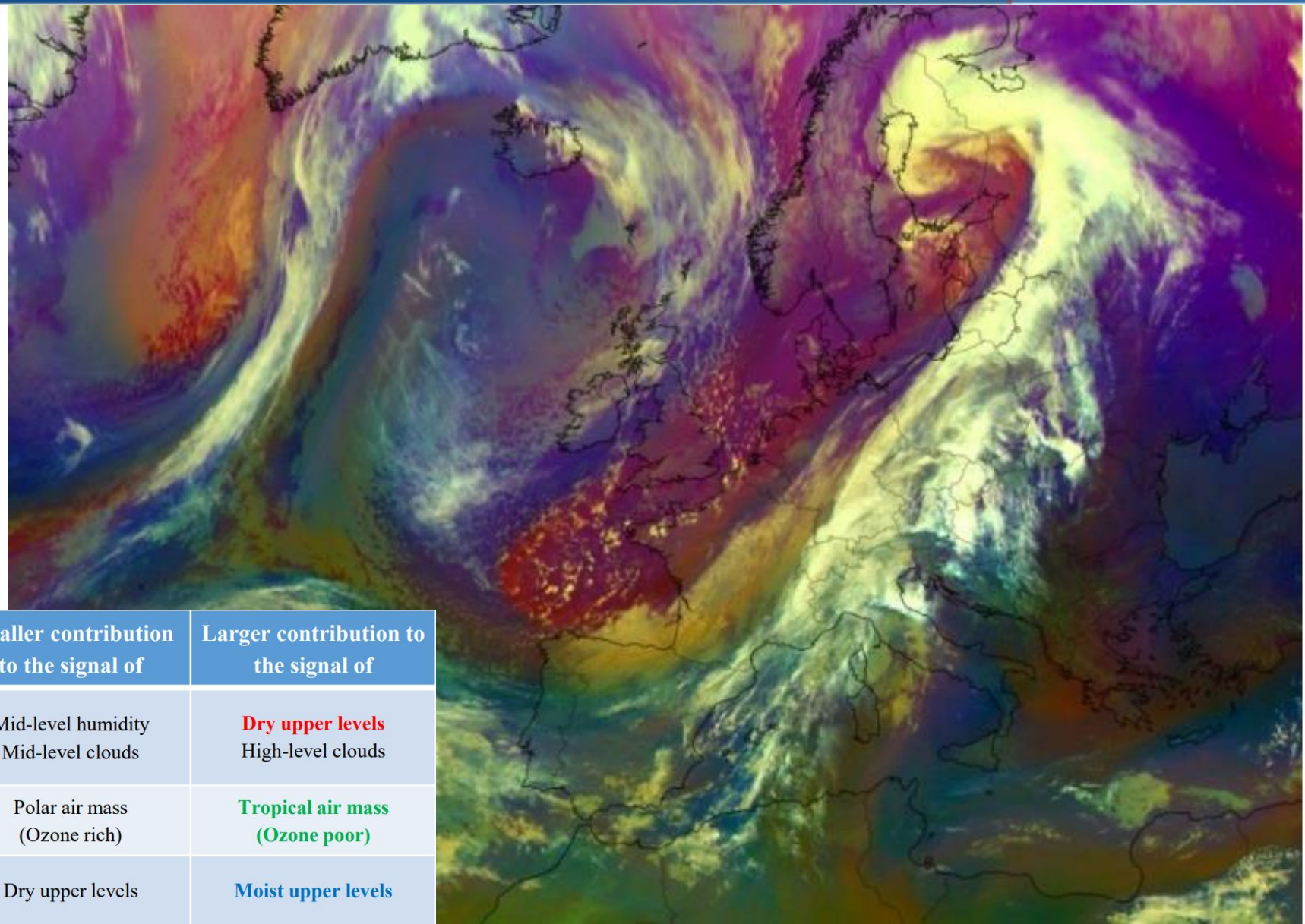
Where do you see a strong contribution from the red signal?



Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25	0	K	1
Green	IR9.7 – IR10.8	-40	+5	K	1
Blue	WV6.2 inverted	243	208	K	1

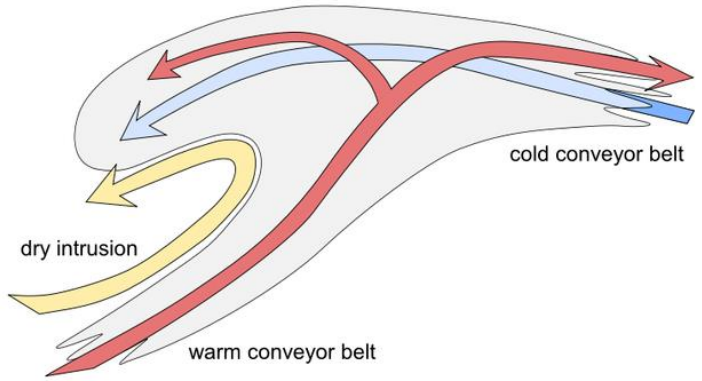
The Airmass RGB

- The Airmass RGB uses both WV channels.
- The Airmass RGB helps displaying the vertical transport.

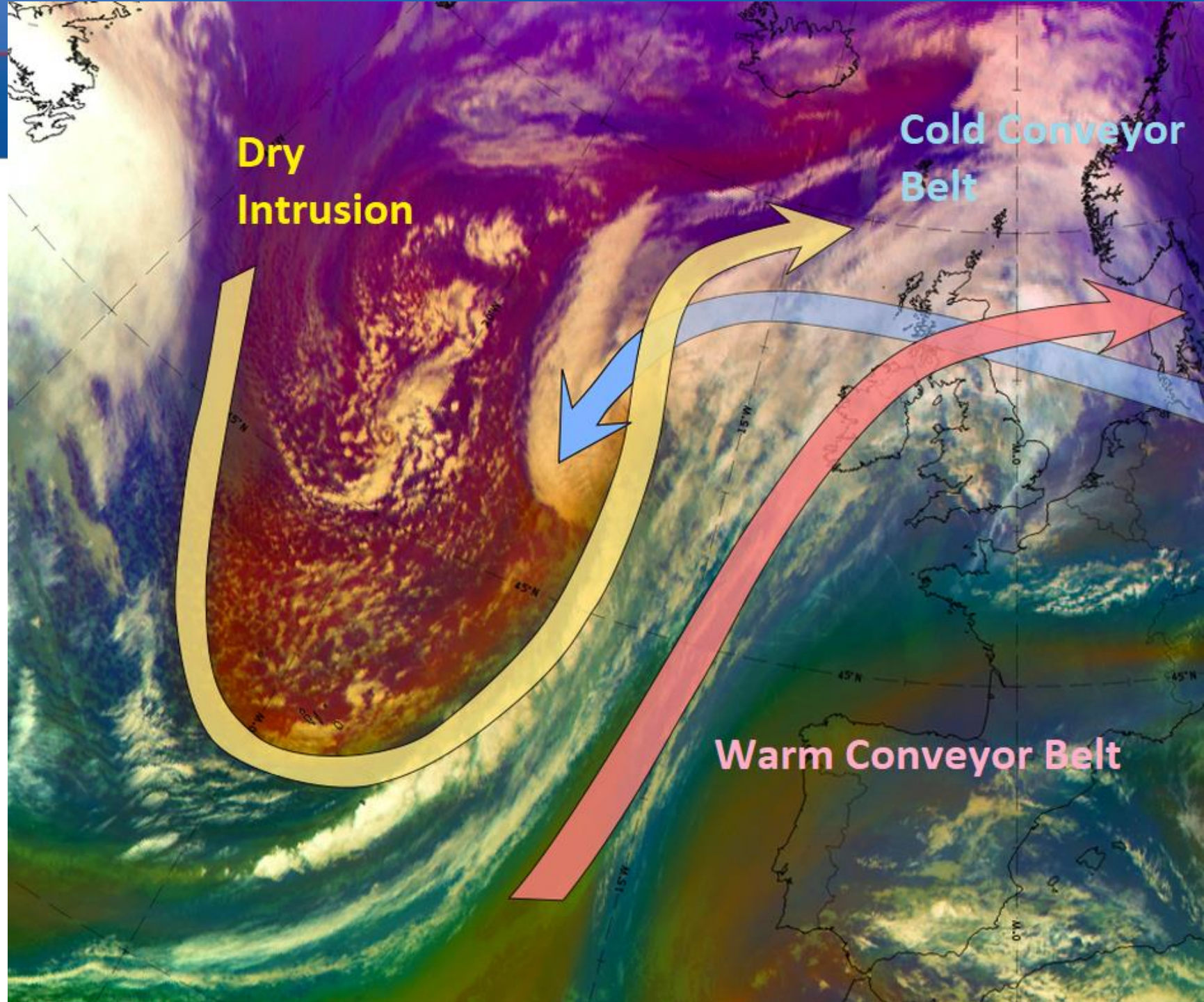


Colour	Channel [µm]	Physically relates to	Smaller contribution to the signal of	Larger contribution to the signal of
Red	WV6.2–WV7.3	Vertical water vapour distribution Mid- and high-level clouds	Mid-level humidity Mid-level clouds	Dry upper levels High-level clouds
Green	IR9.7–IR10.8	Height of tropopause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

… and conveyor belts

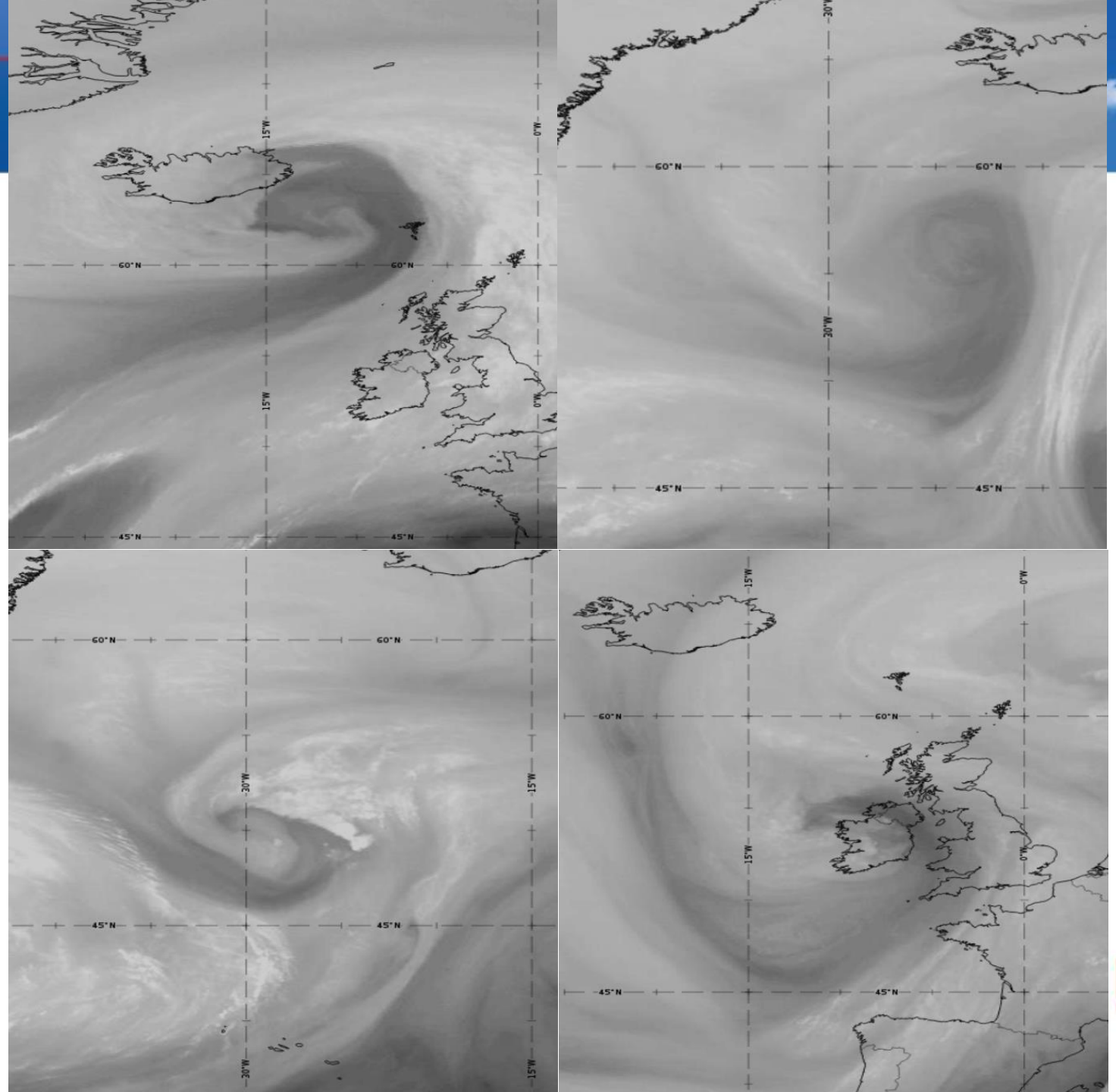


The exact configuration of the conveyor belts depends on the stage of the cyclogenesis.



Cold fronts …

Where is the dry intrusion conveyor belt?



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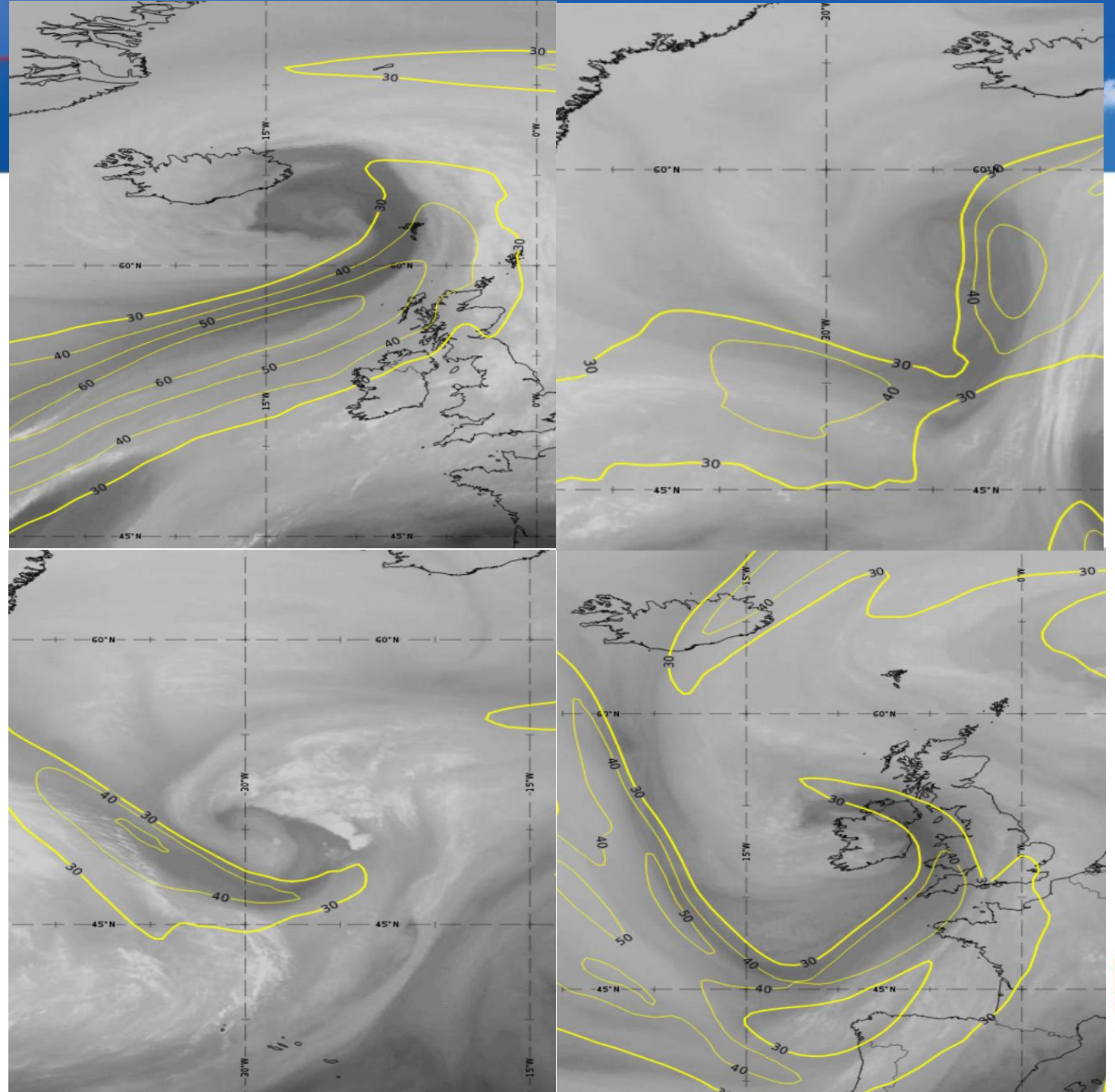
Cold fronts …

And now you also have the position of the jet.

The dry intrusion and the jet are not the same!



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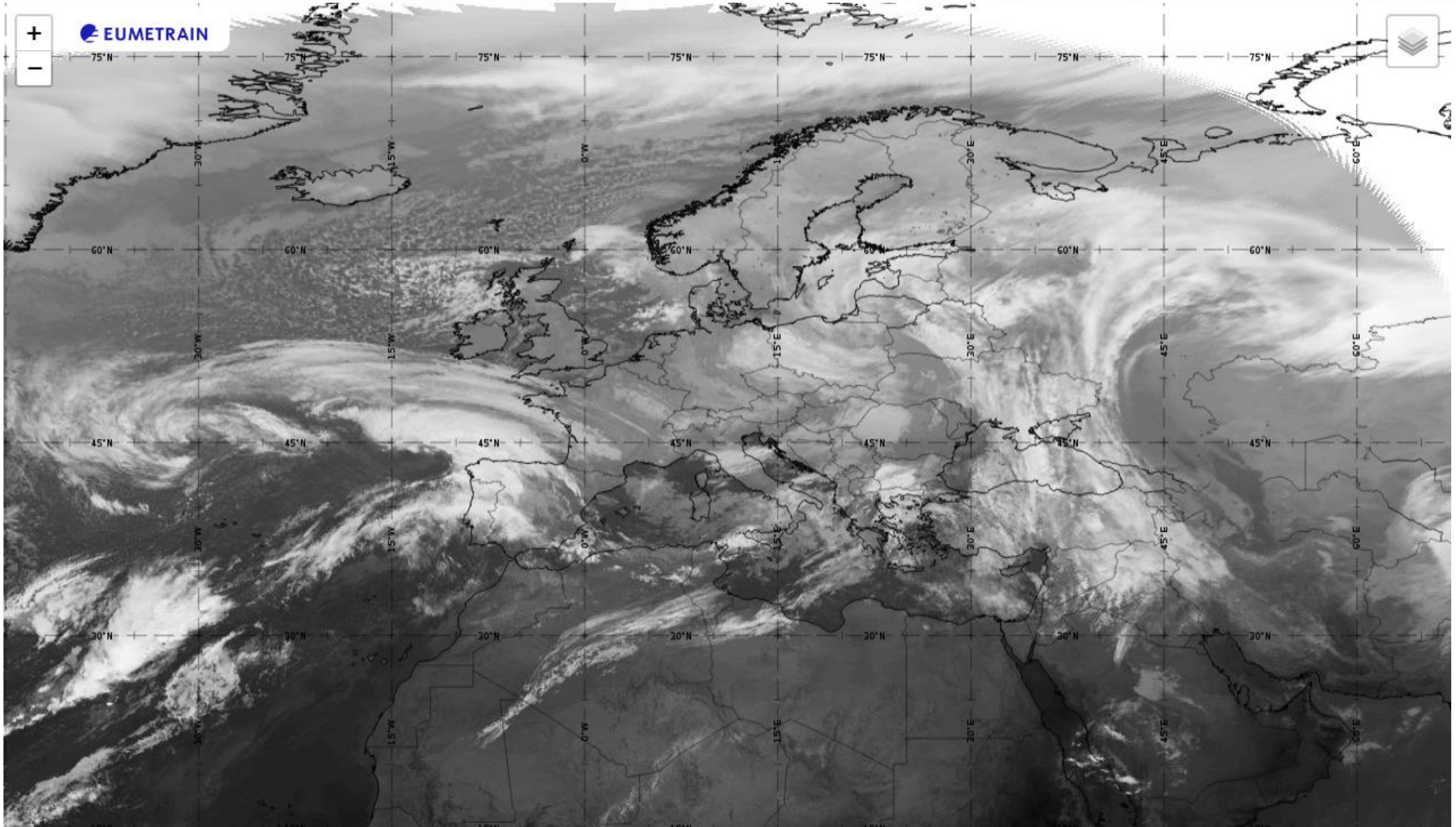
WV imagery helps finding Fronts (12.12.2022 – 06:00 UTC)



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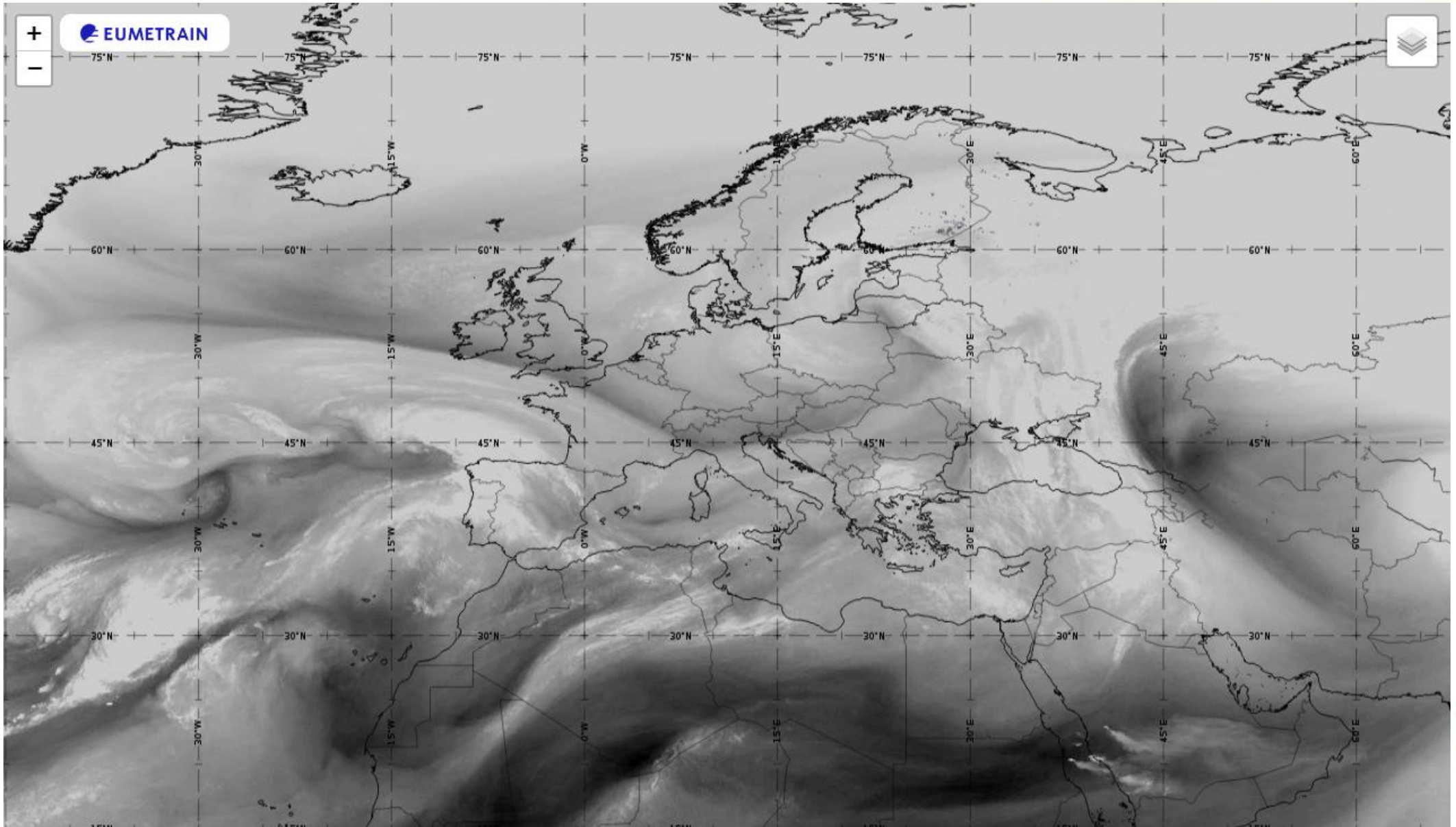

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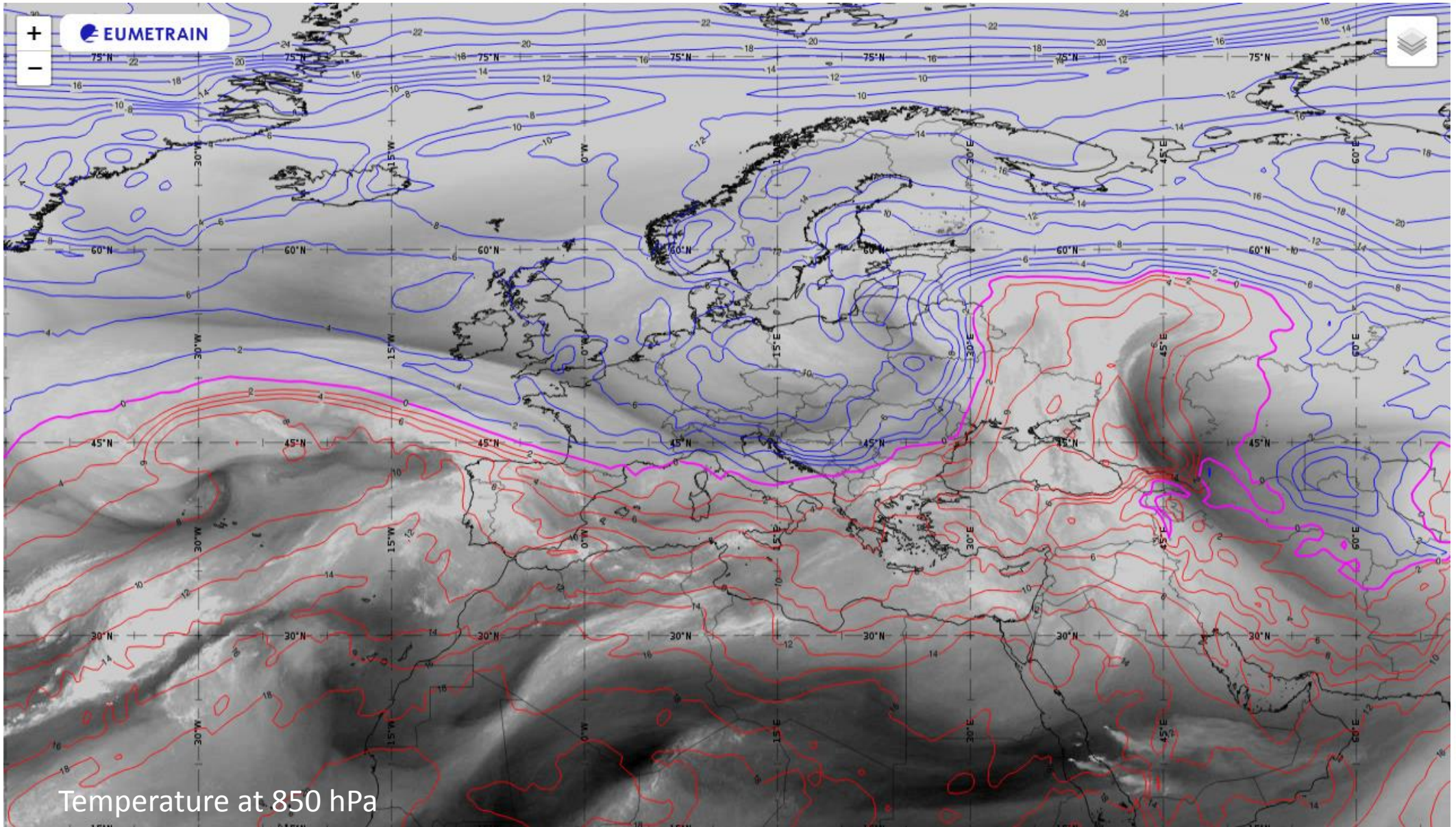

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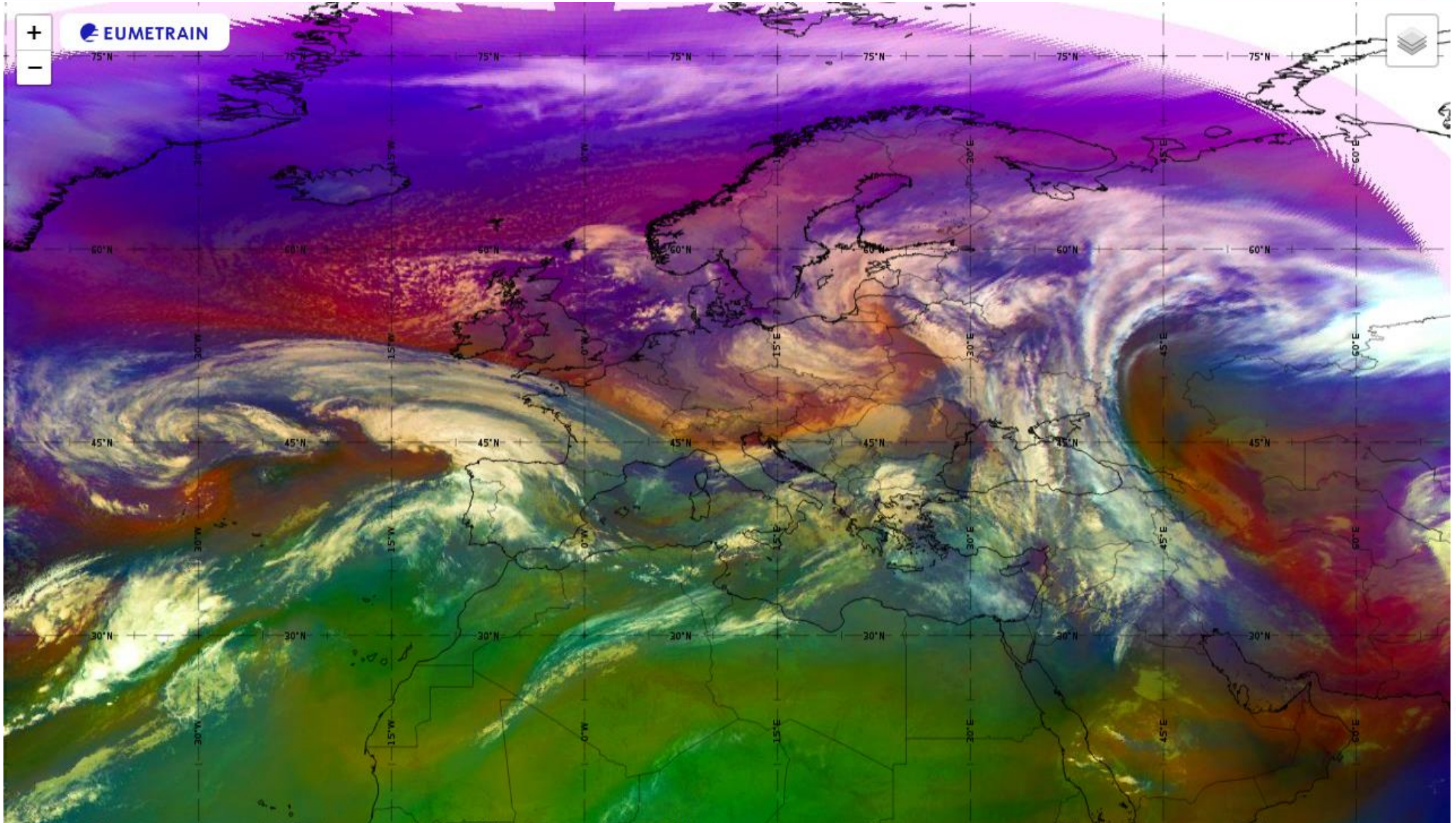

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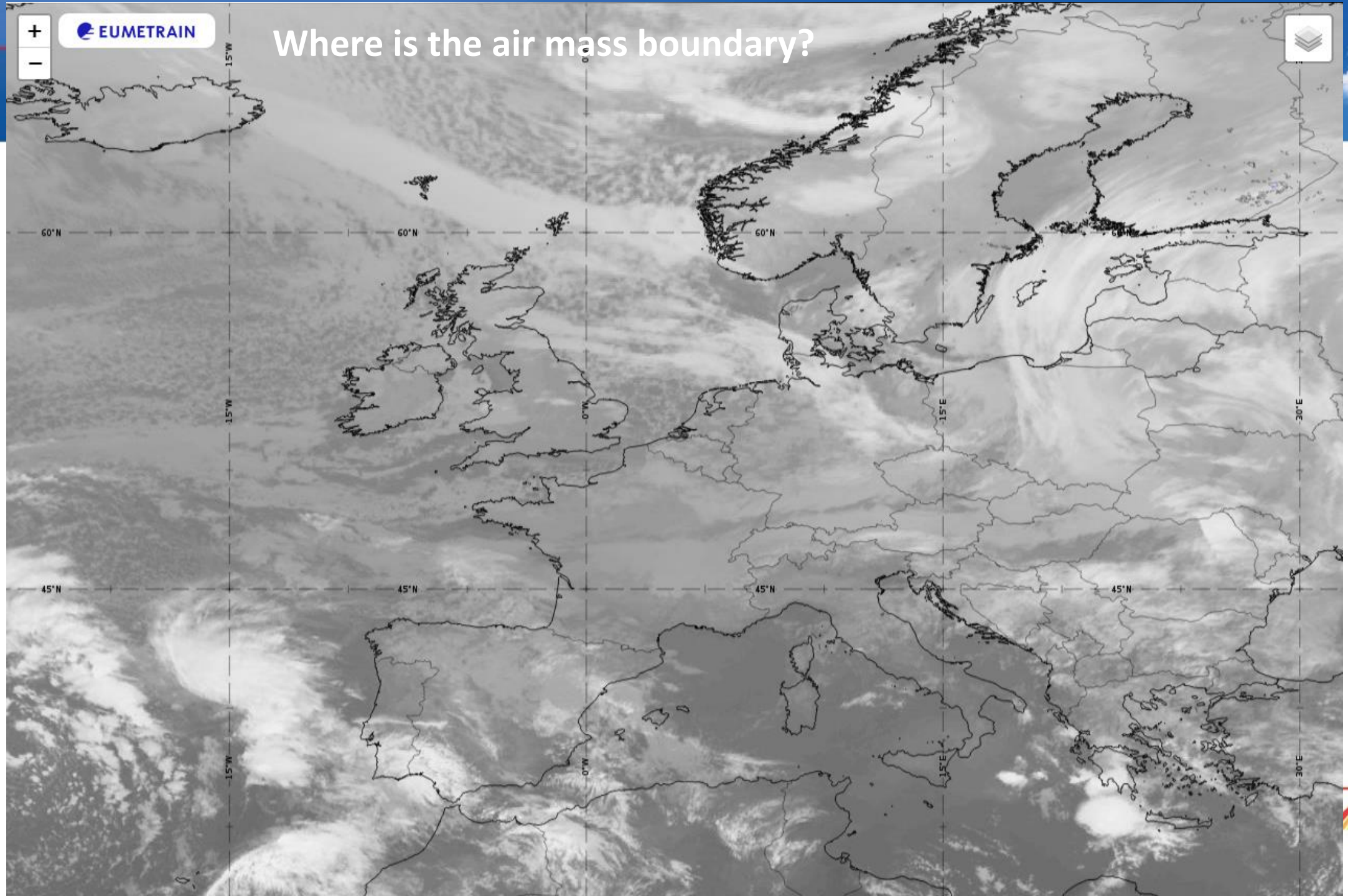
Where is the air mass boundary?



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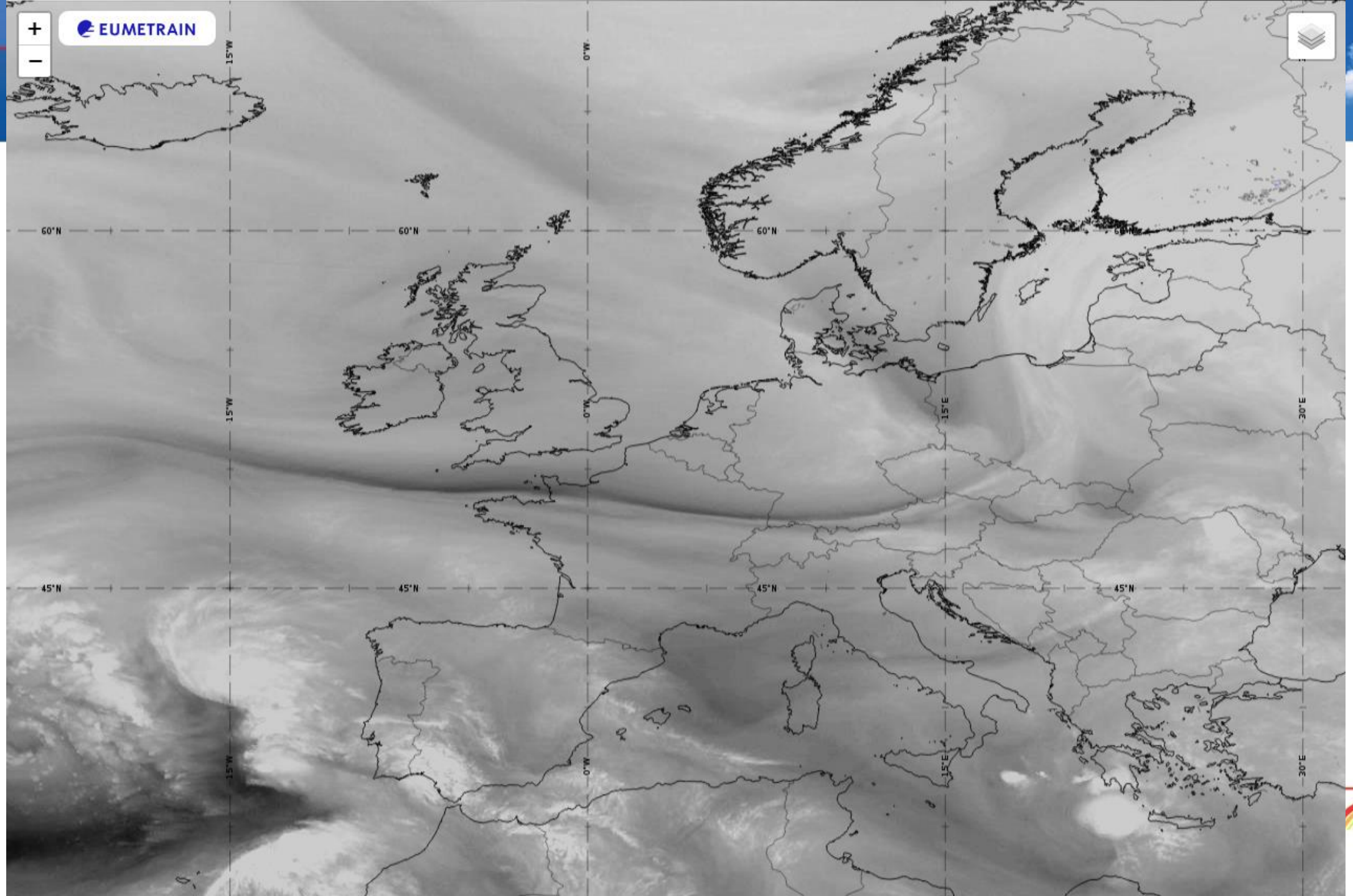

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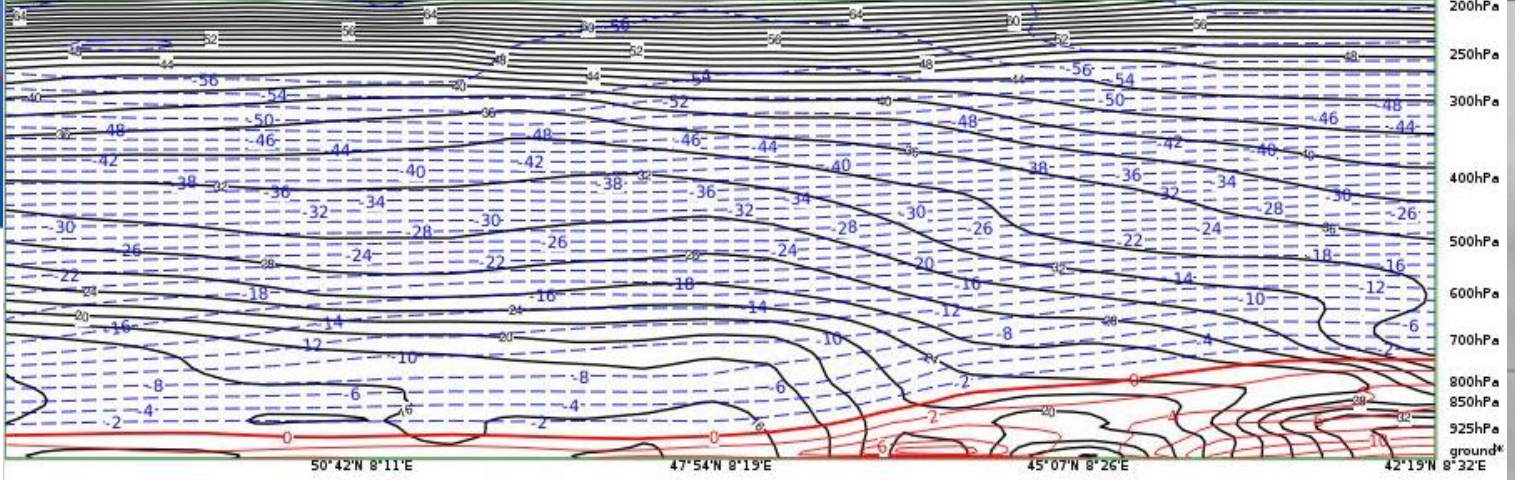
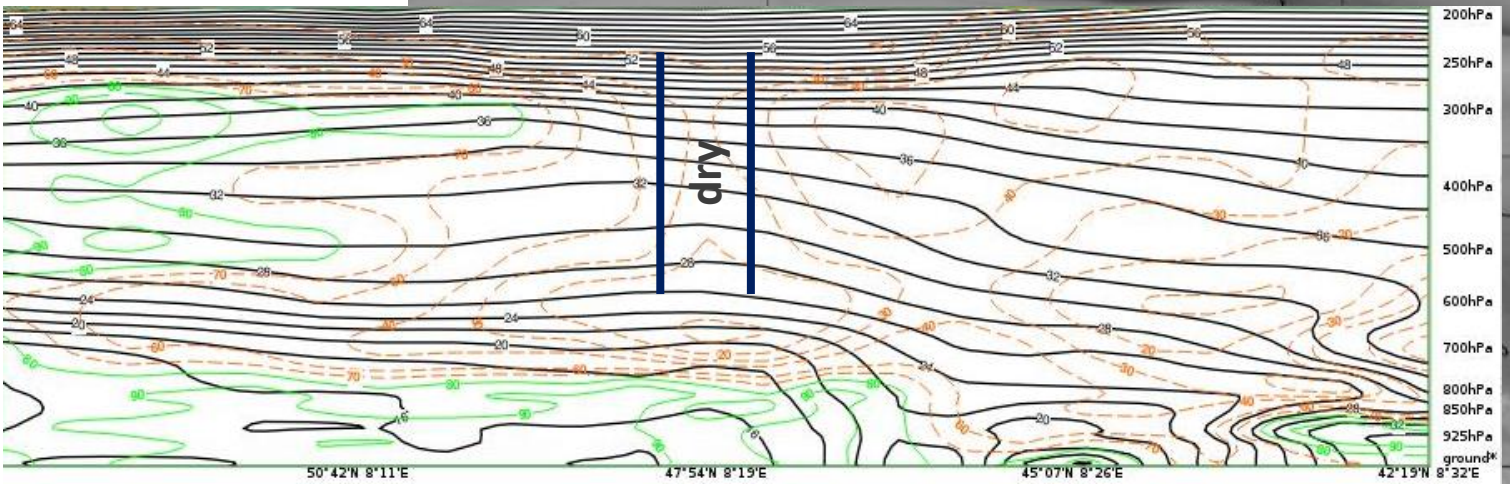
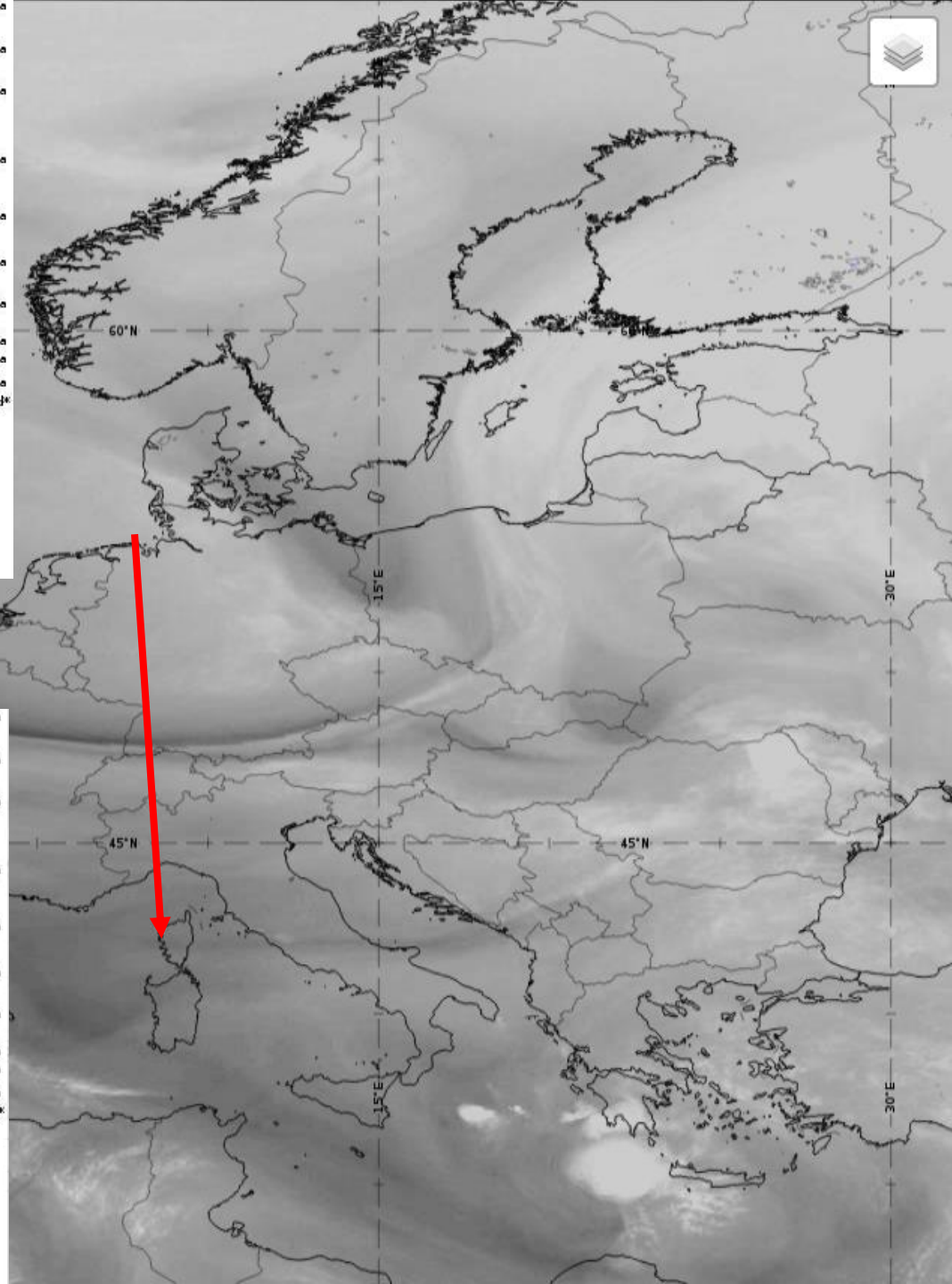
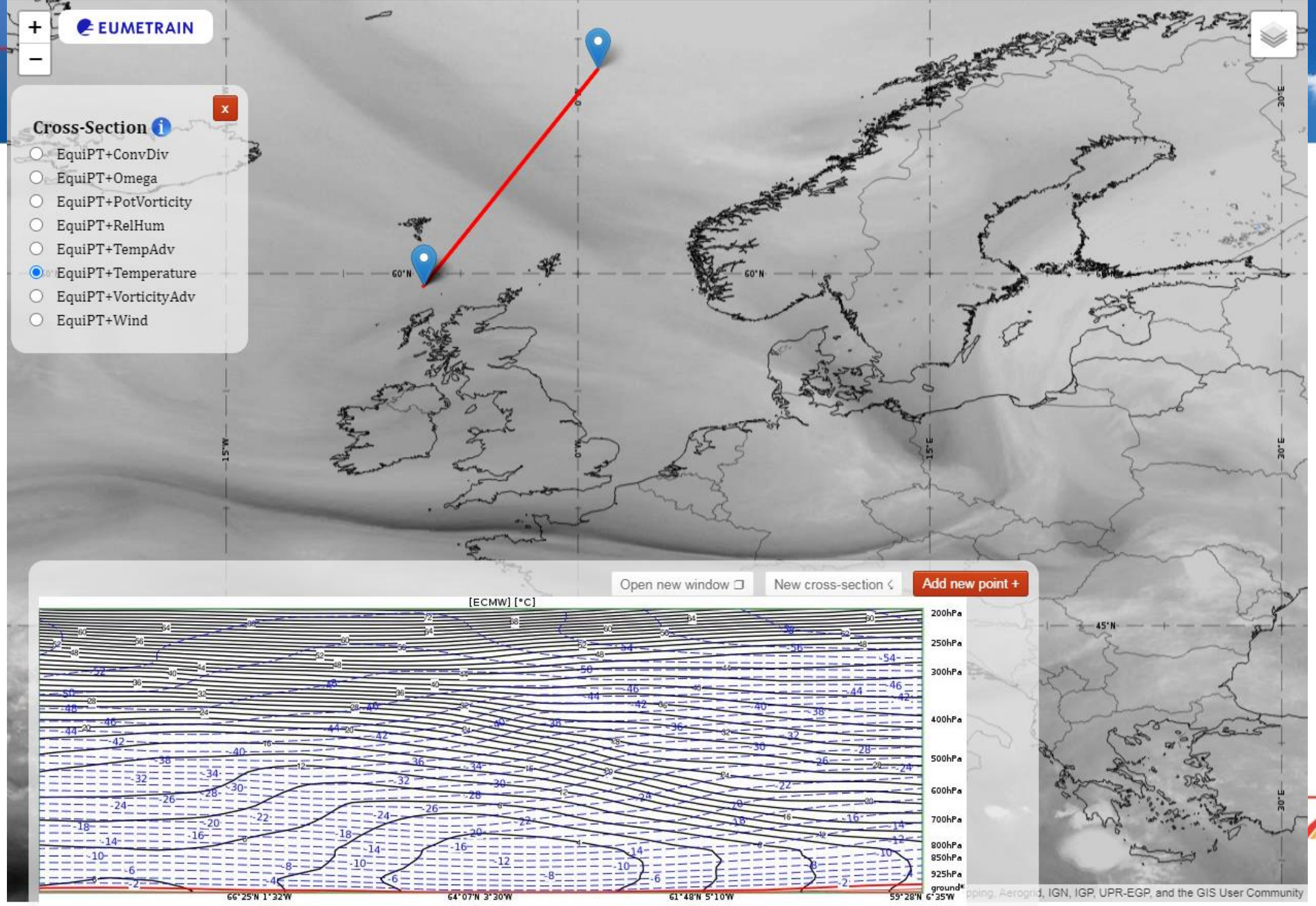


Cross-Section from map **Equivalent Potential Temperature** and **Temperature**
for 53°29'N 8°02'E - 42°19'N 8°32'E, valid 07.12.2022 09:00



Cross-Section from map **Equivalent Potential Temperature** and **Relative Humidity**
for 53°29'N 8°02'E - 42°19'N 8°32'E, valid 07.12.2022 09:00





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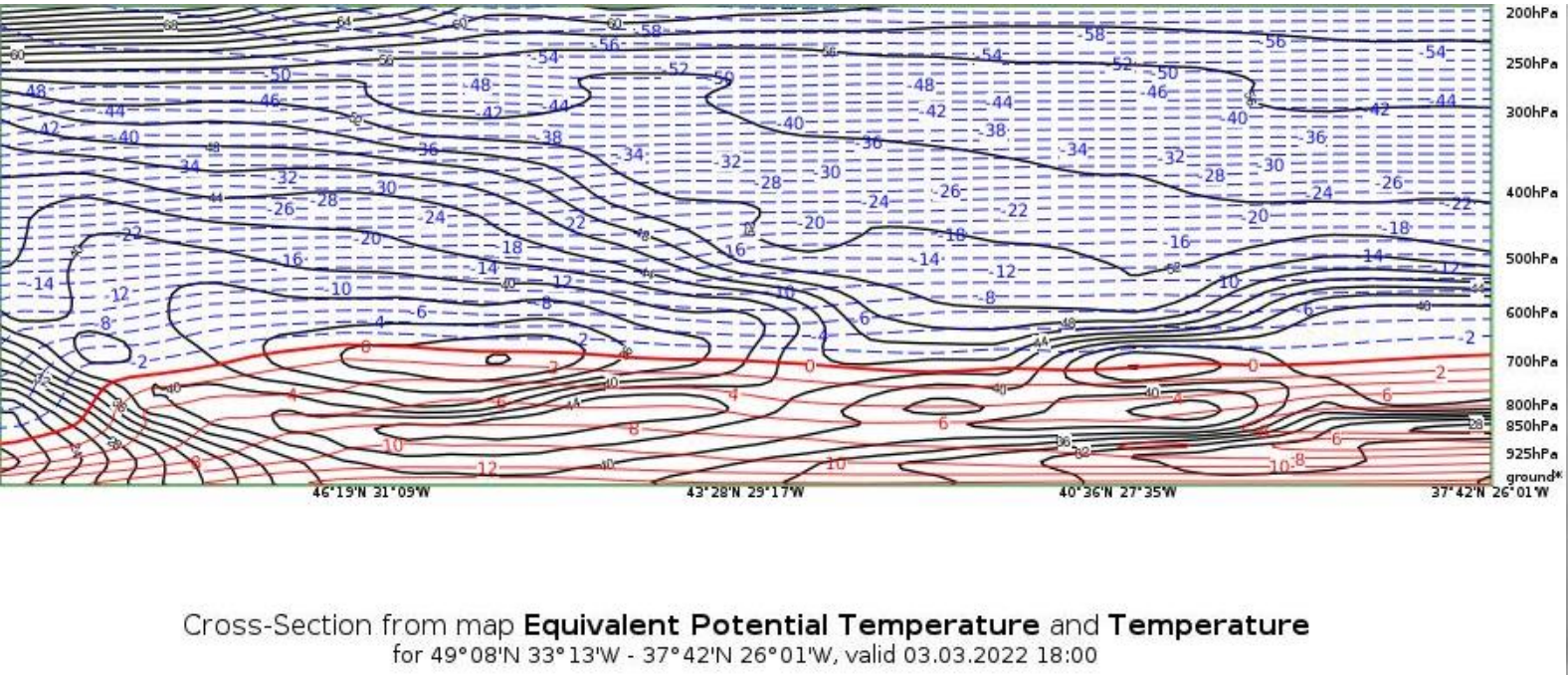
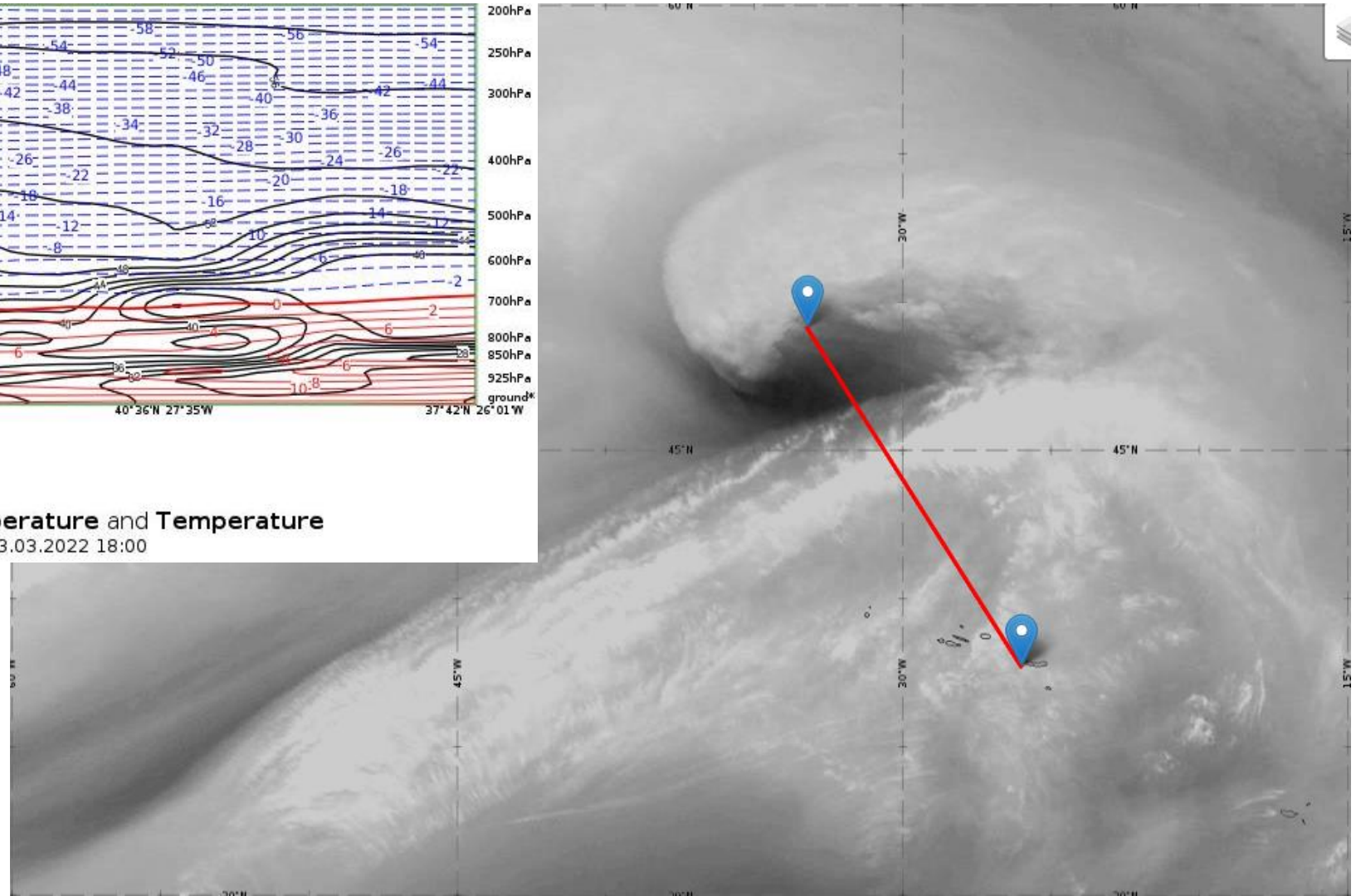
… and upper-level cold fronts

You cannot determine the vertical structure of a front from WV imagery alone.

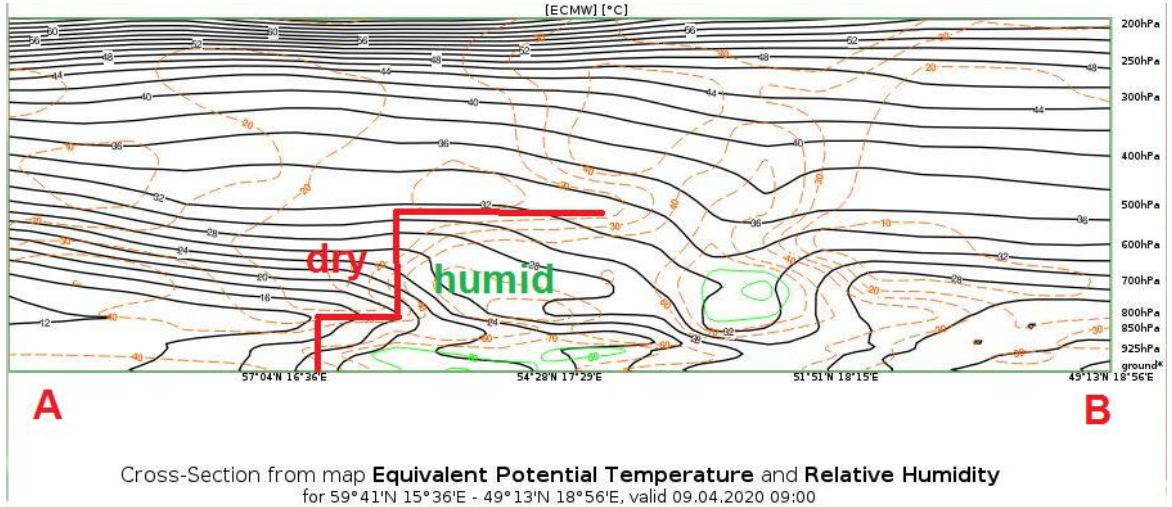


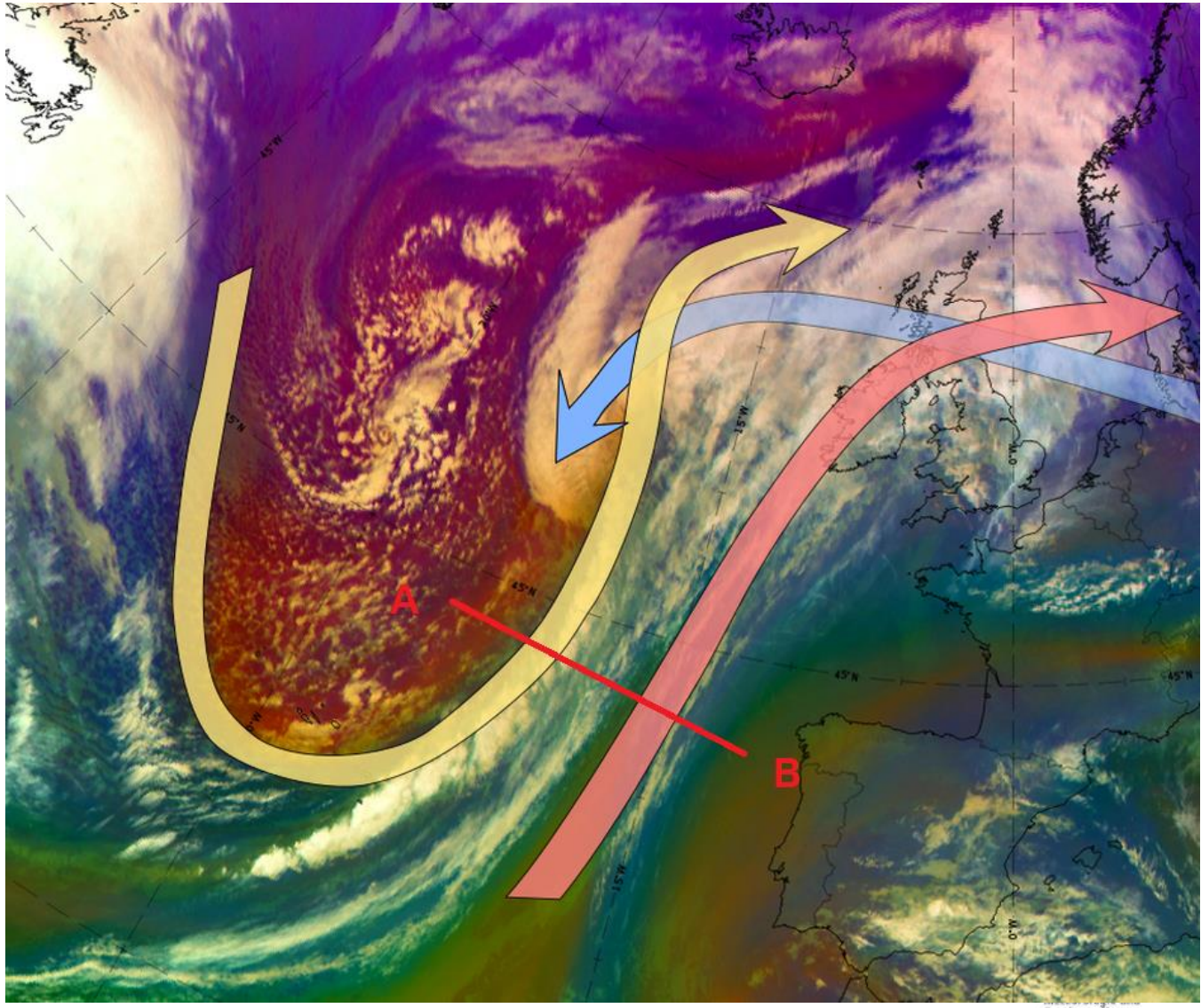
Cross-Section from map **Equivalent Potential Temperature** and **Temperature**
for 49°08'N 33°13'W - 37°42'N 26°01'W, valid 03.03.2022 18:00



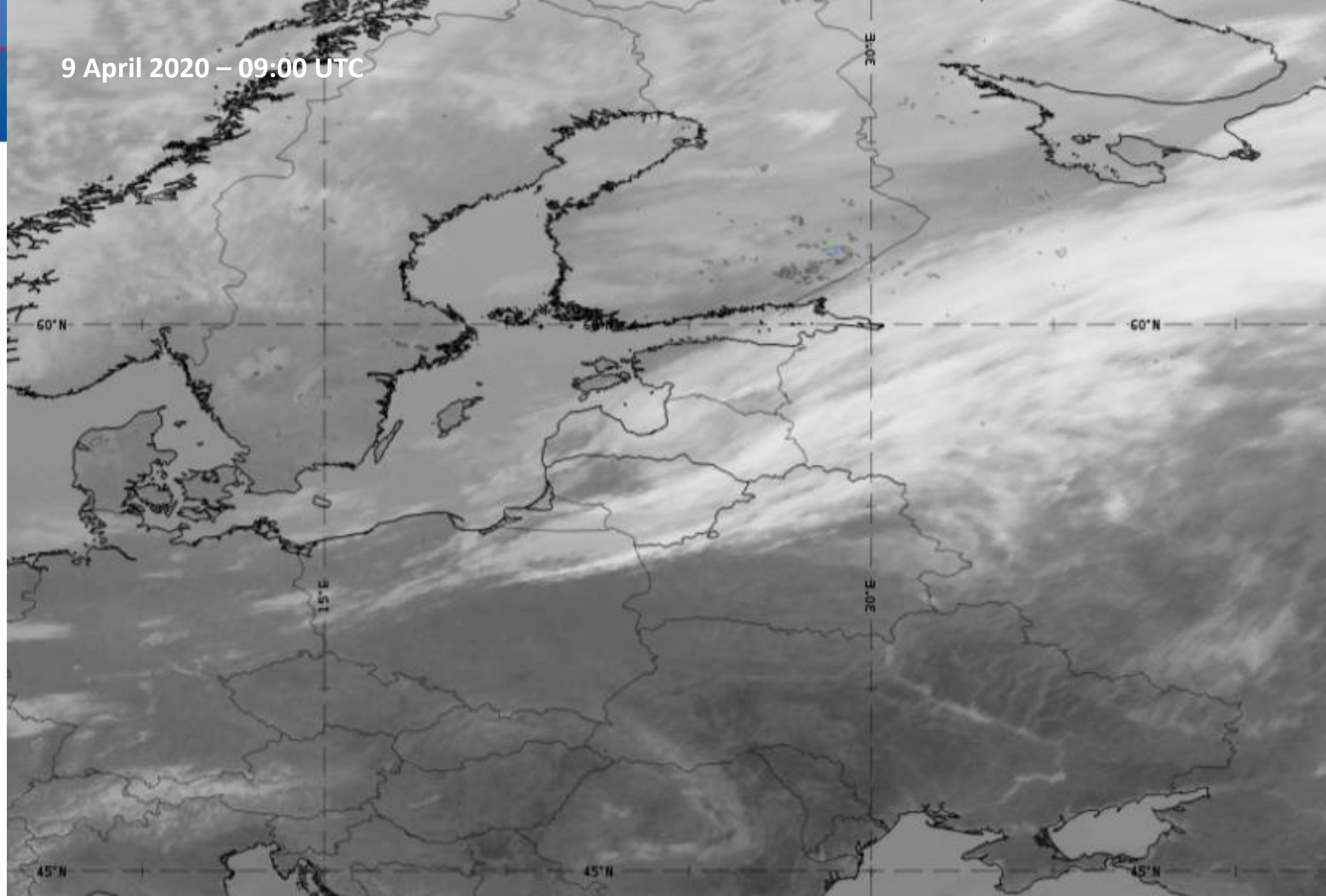
Split Fronts

Split fronts are cold fronts that are overrun by the dry intrusion (Kata-fronts).

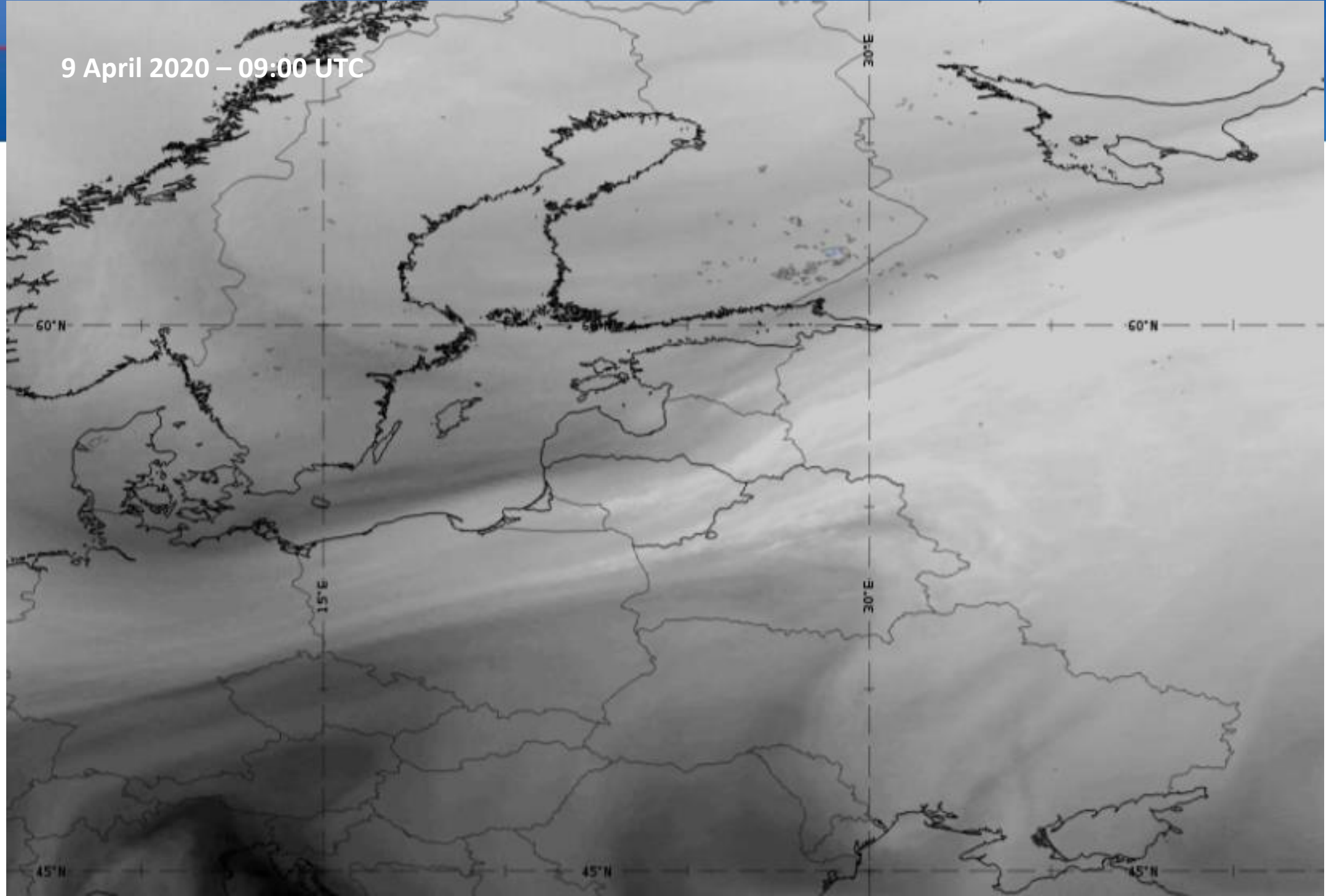




Split Fronts



Split Fronts



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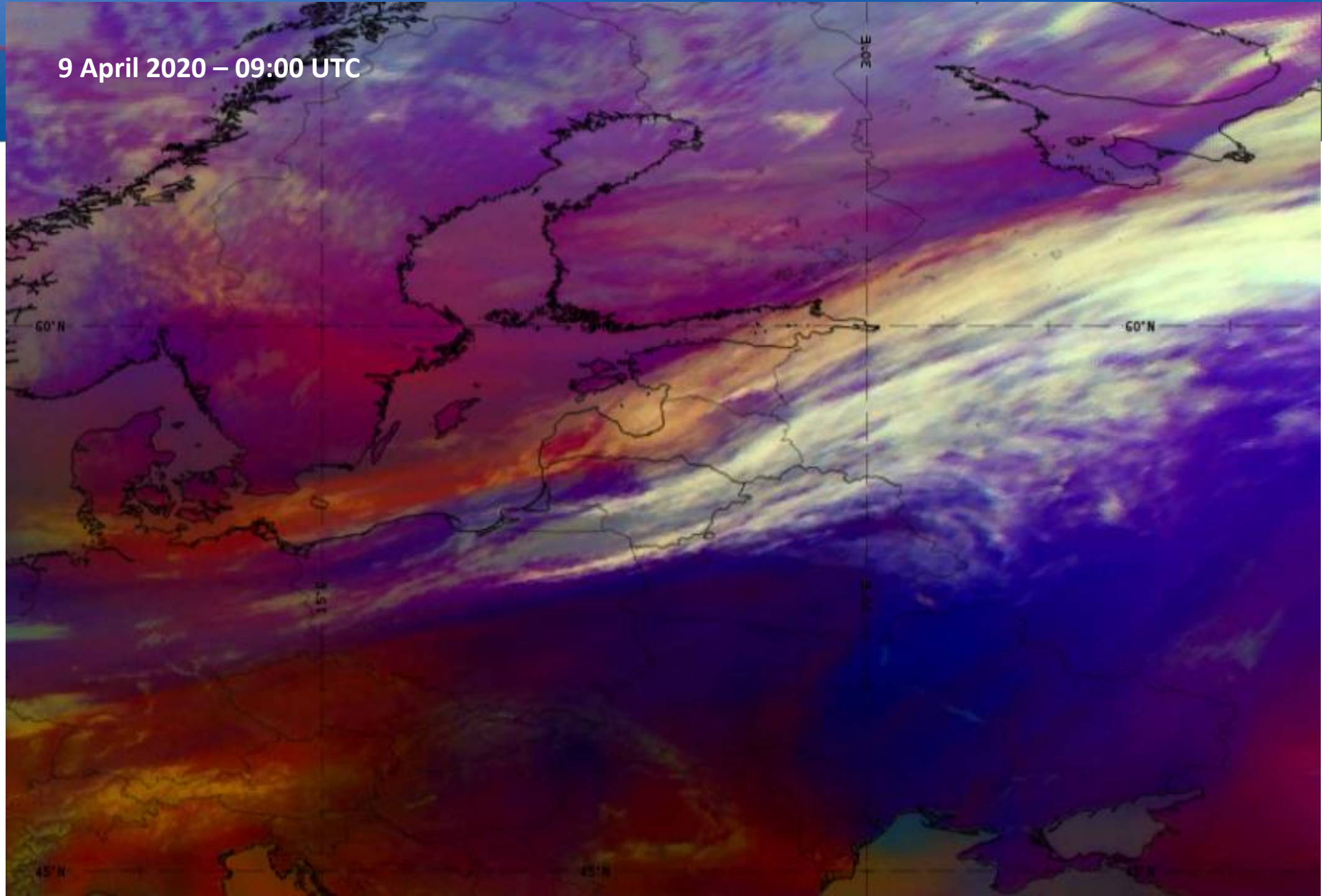
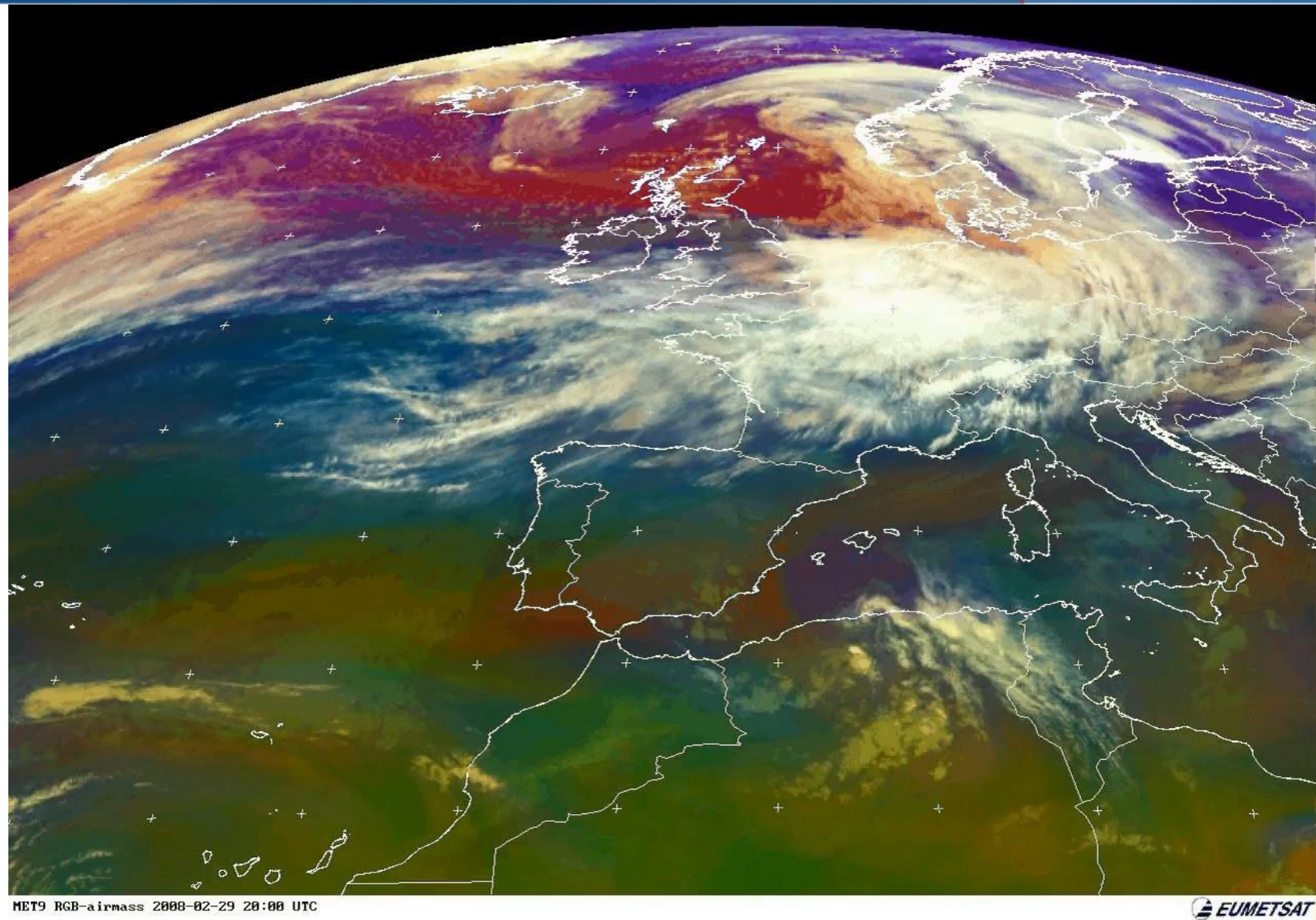


Split Fronts

Winter storm (Cyclone) Emma was an extratropical cyclone that passed through several European countries on 1 March 1, 2008



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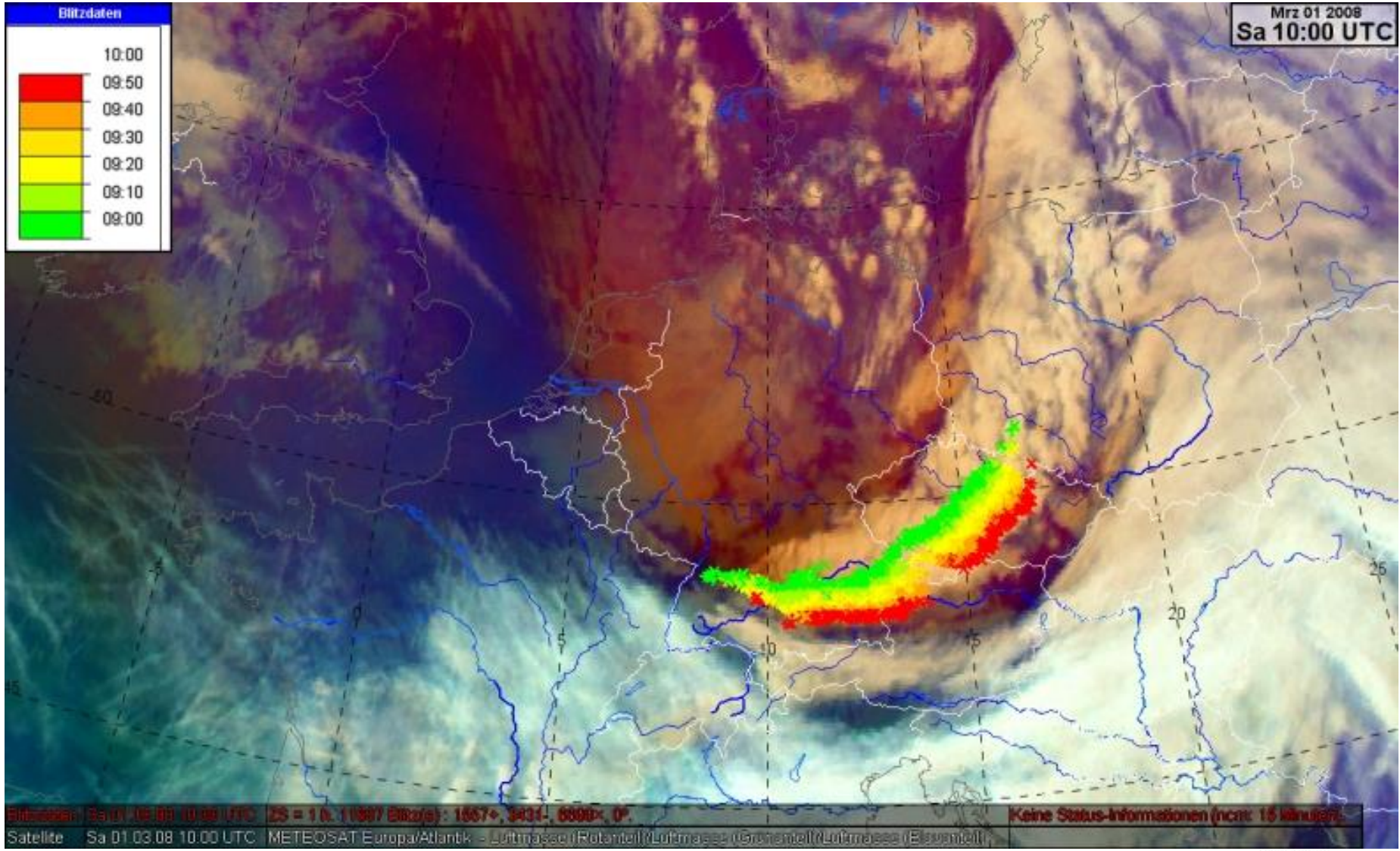
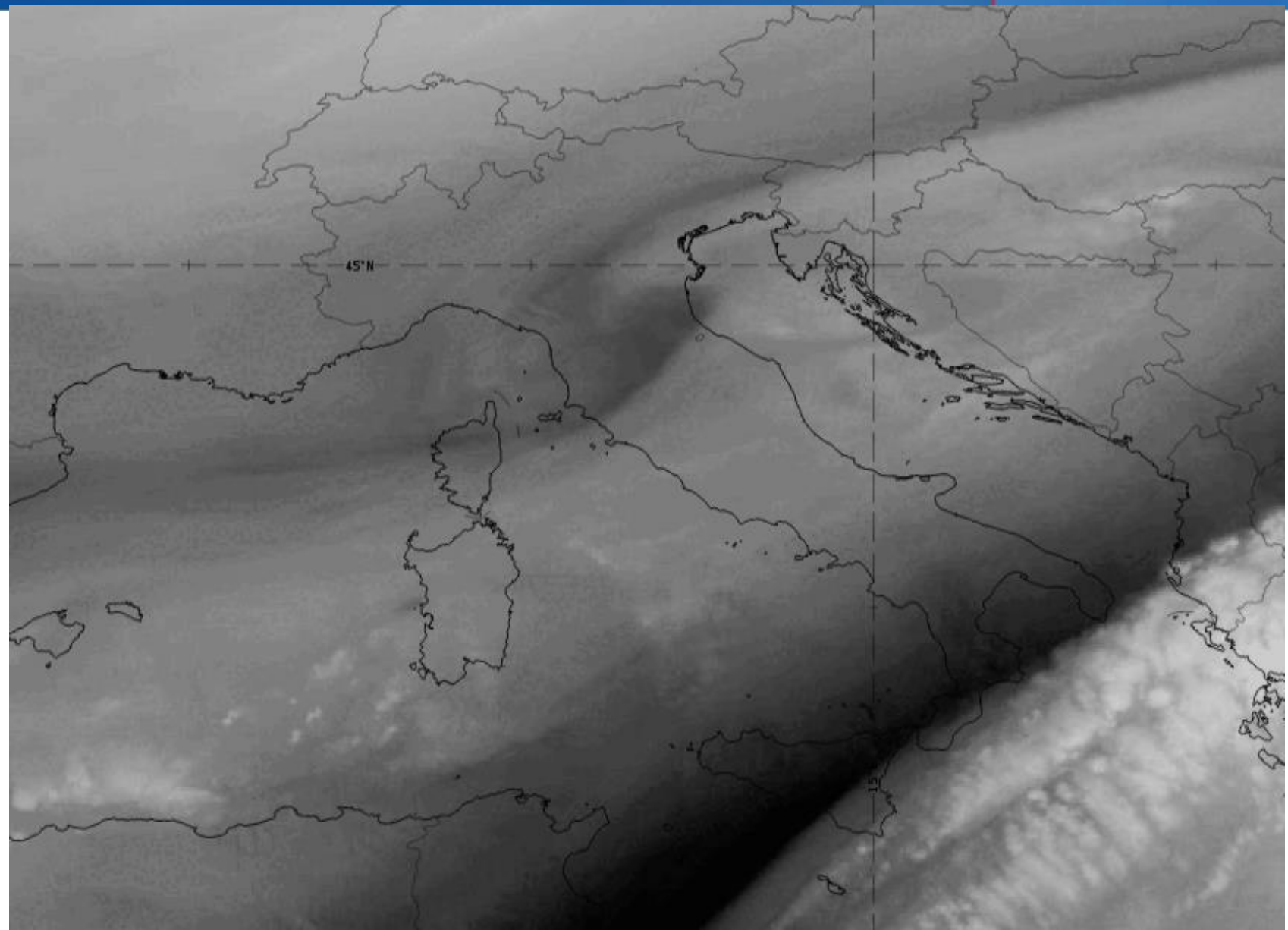


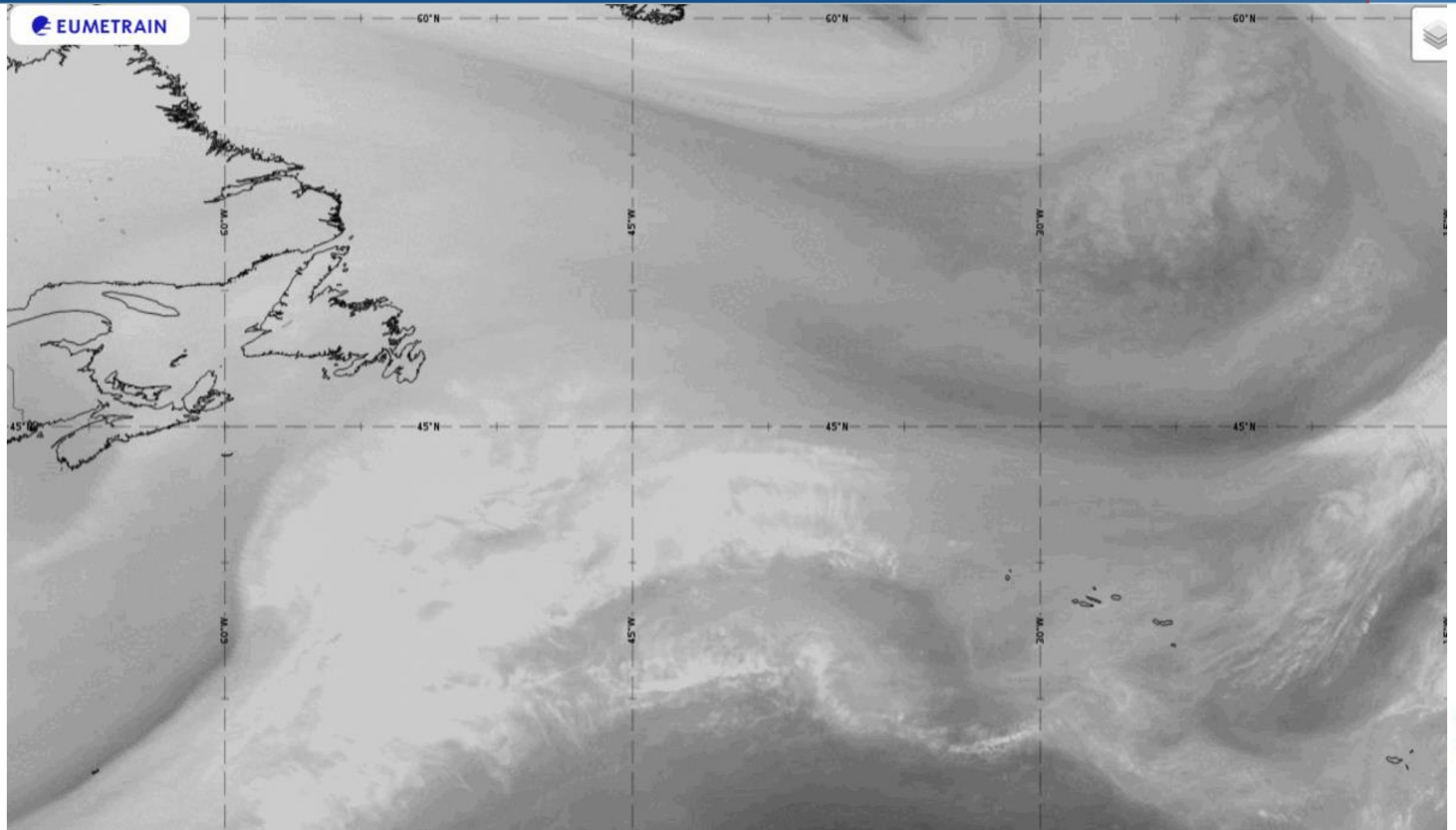
Cyclogenesis (ULL)

Most Upper-Level-Lows develop in a trough (early stage), before they either disintegrate or become a cut-off low.

Some ULLs never become visible in IR/VIS imagery.



Rapid Cyclogenesis



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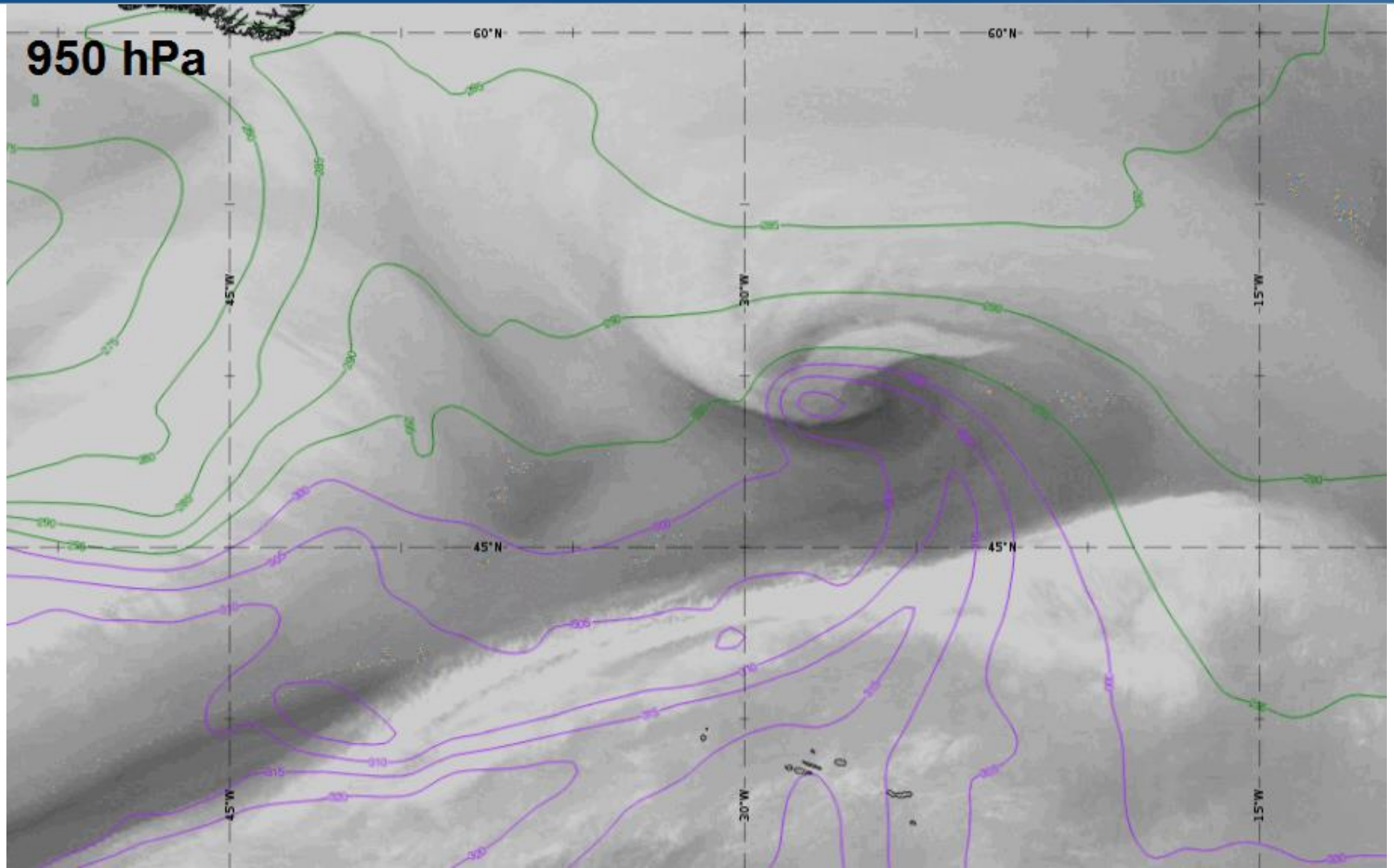

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Thank you for your attention

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