Shallow Clouds and Related Weather Phenomena

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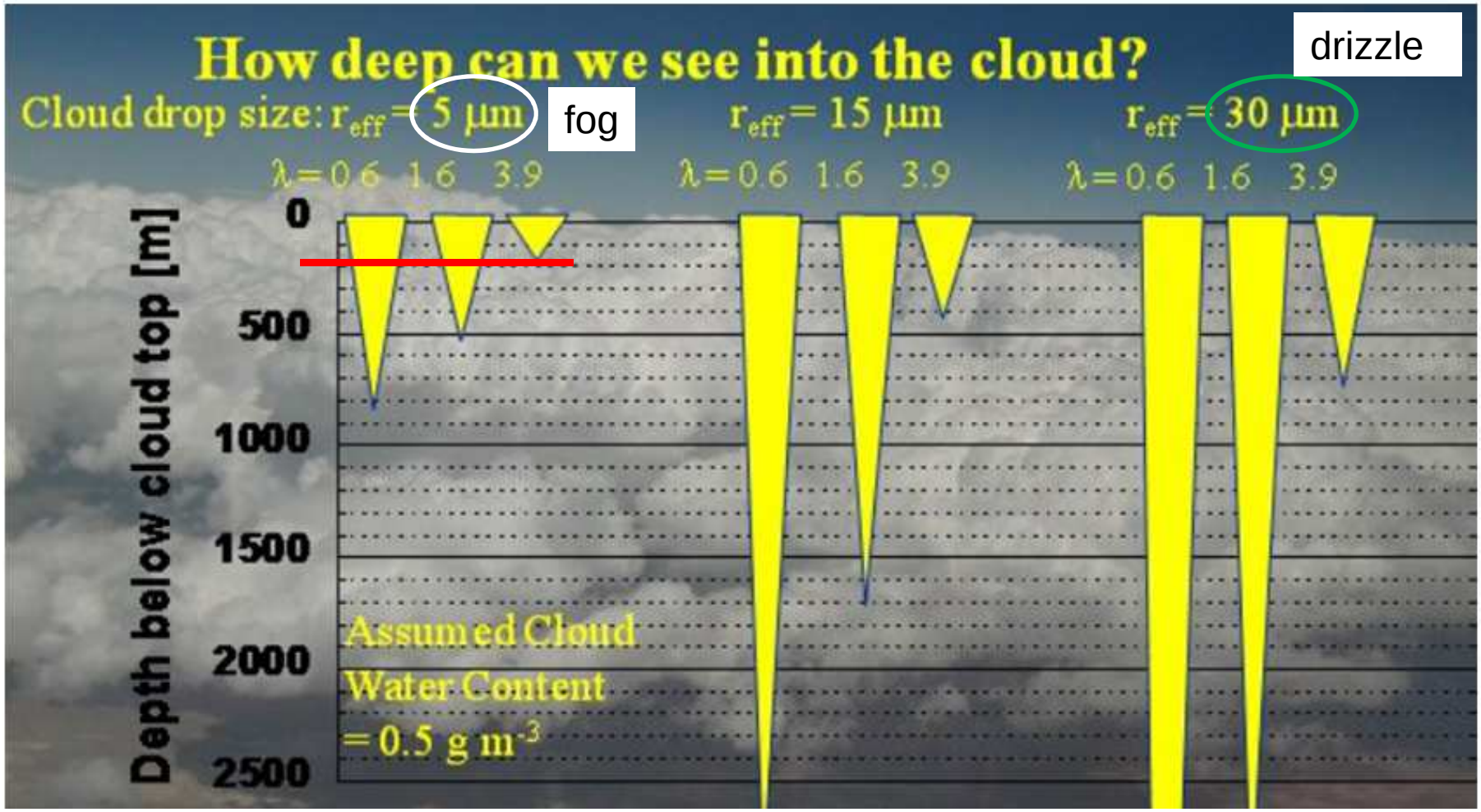
1. Physical background
2. Fog and low stratus
   - Channels and products
   - Interpretation and examples
3. Precipitation and icing
   - Channels and products
   - Interpretation and examples
4. Summary
5. Homework

Fog – low stratus

Basic rules for some solar channels

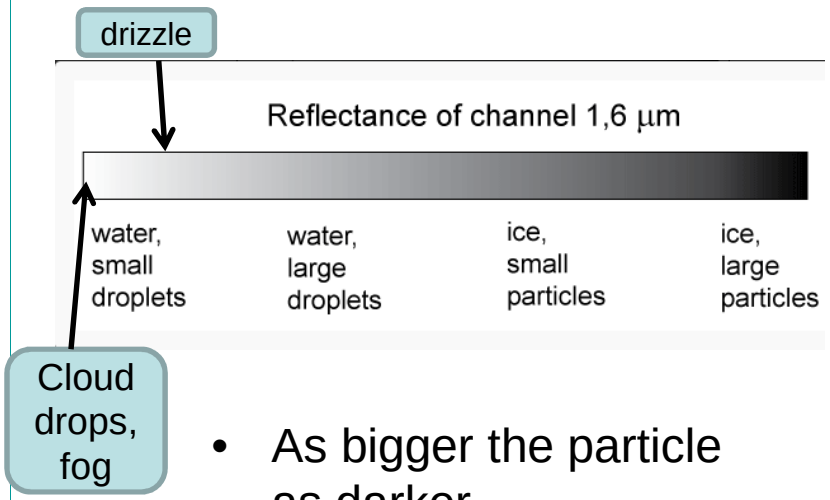
- Netto reflectance
  - 0.6 (and 0.8) µm higher with increasing thickness (more water, more icing (T<0° C))
  - 3.9ref µm (solar part)
    - Scattering (occurs at the drop surface) proportional to r^2
    - Absorption (occurs inside the drop) proportional to r^3
    - Netto reflectance: ($r^2/r^3 = 1/r$) proportional to 1/r
      - r = effective droplet radius



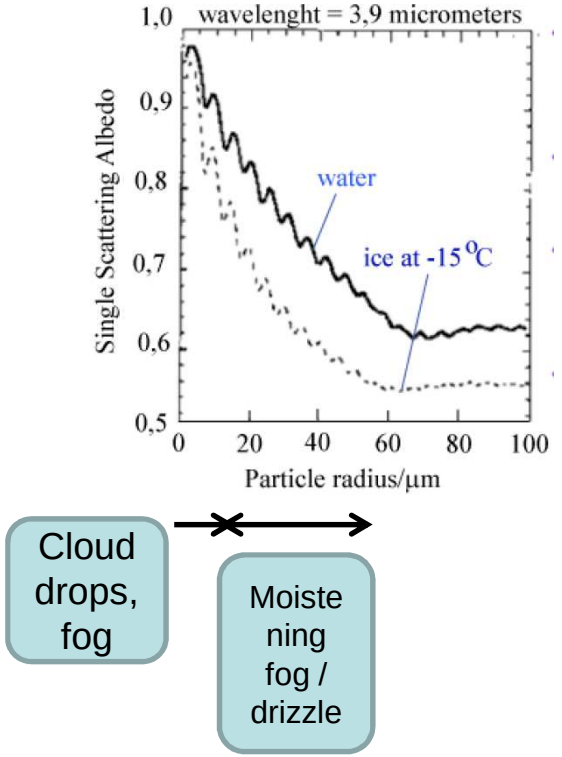
- 3.9 µm: Mainly near the cloud top or in the upper cloud‘s part
- 1.6 µm: Pennetrates deeper into the cloud
- 0.6 µm: Only for small droplets in the upper parts of the cloud. However, with increasing droplet size more and more to the ground, increasing influence by the soil.
- With decreasing drop size better identification, however, in any case cloud layer of less than 200 meters difficult (e.g., thin fog layers, especially radiation fog).

Reflectance of different solar channels

Source: EUMeTrain-CAL-Module: http://www.eumetrain.org/data/2/253/index.htm

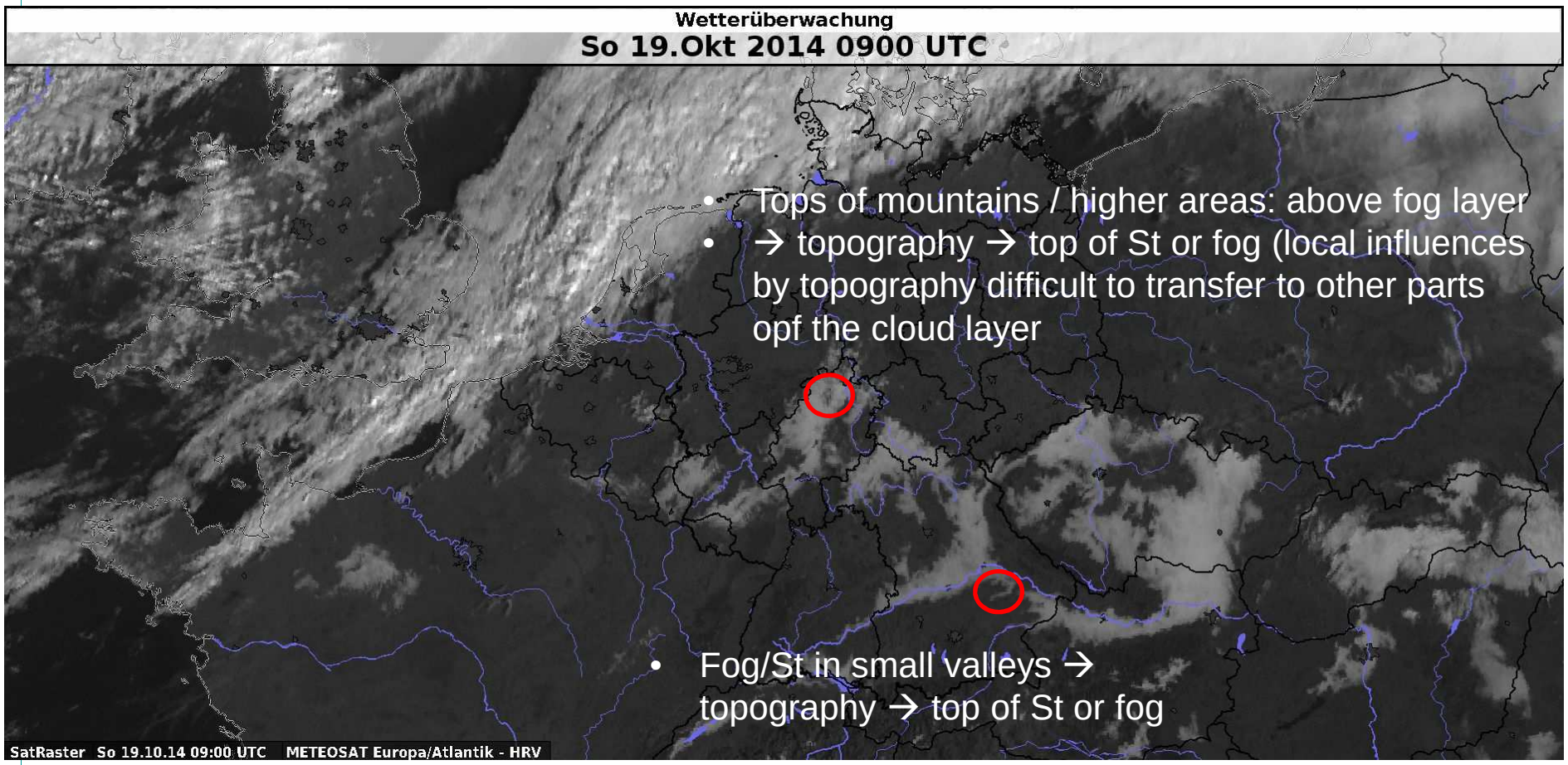


- As bigger the particle as darker
- Ice particles darker than water particles



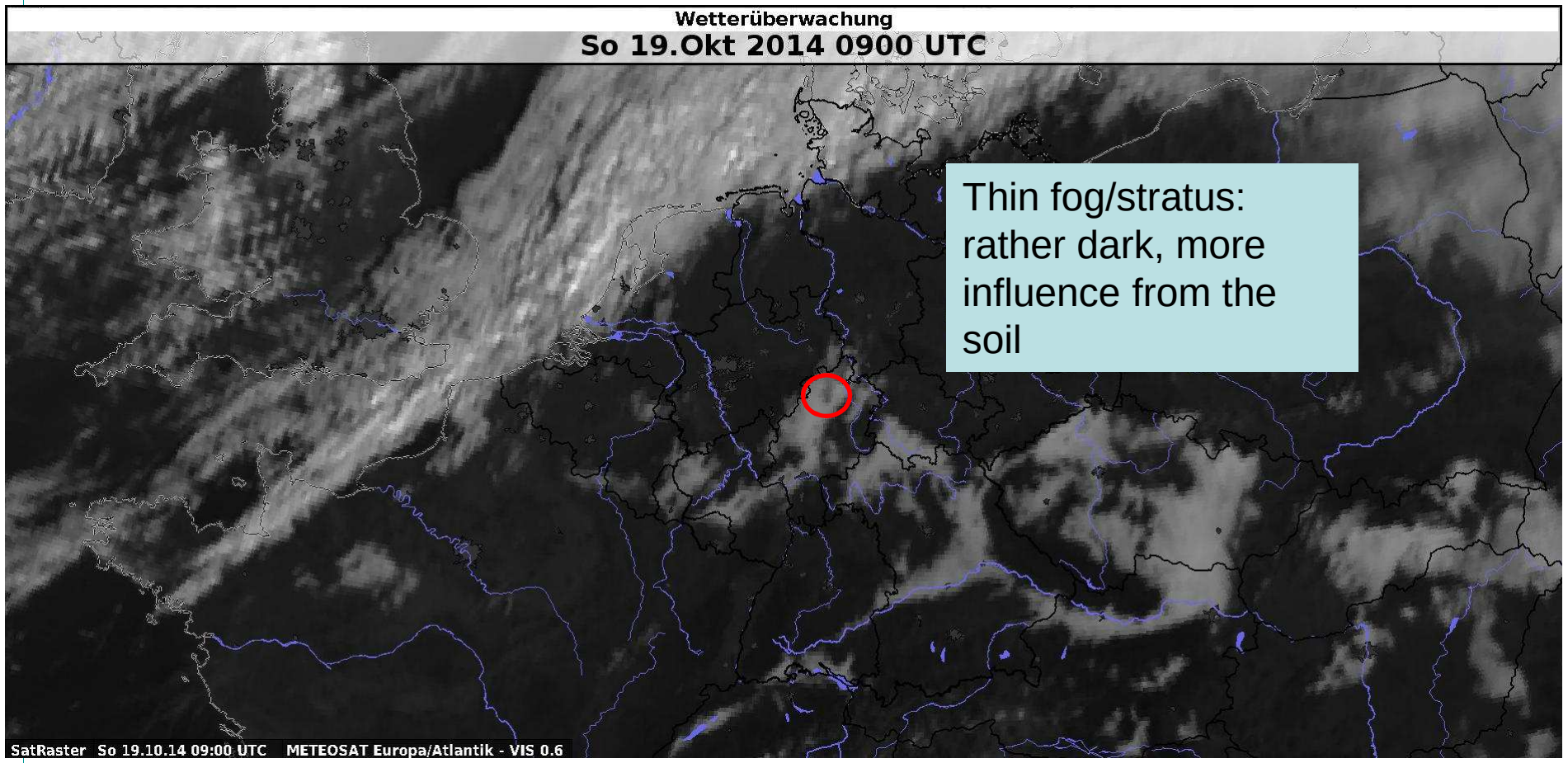
Water clouds brighter than ice clouds. Darker with increasing effective radius

Fog/low stratus: HRV – 19/10/2014, 09 UTC (Most powerful for detailed considerations)



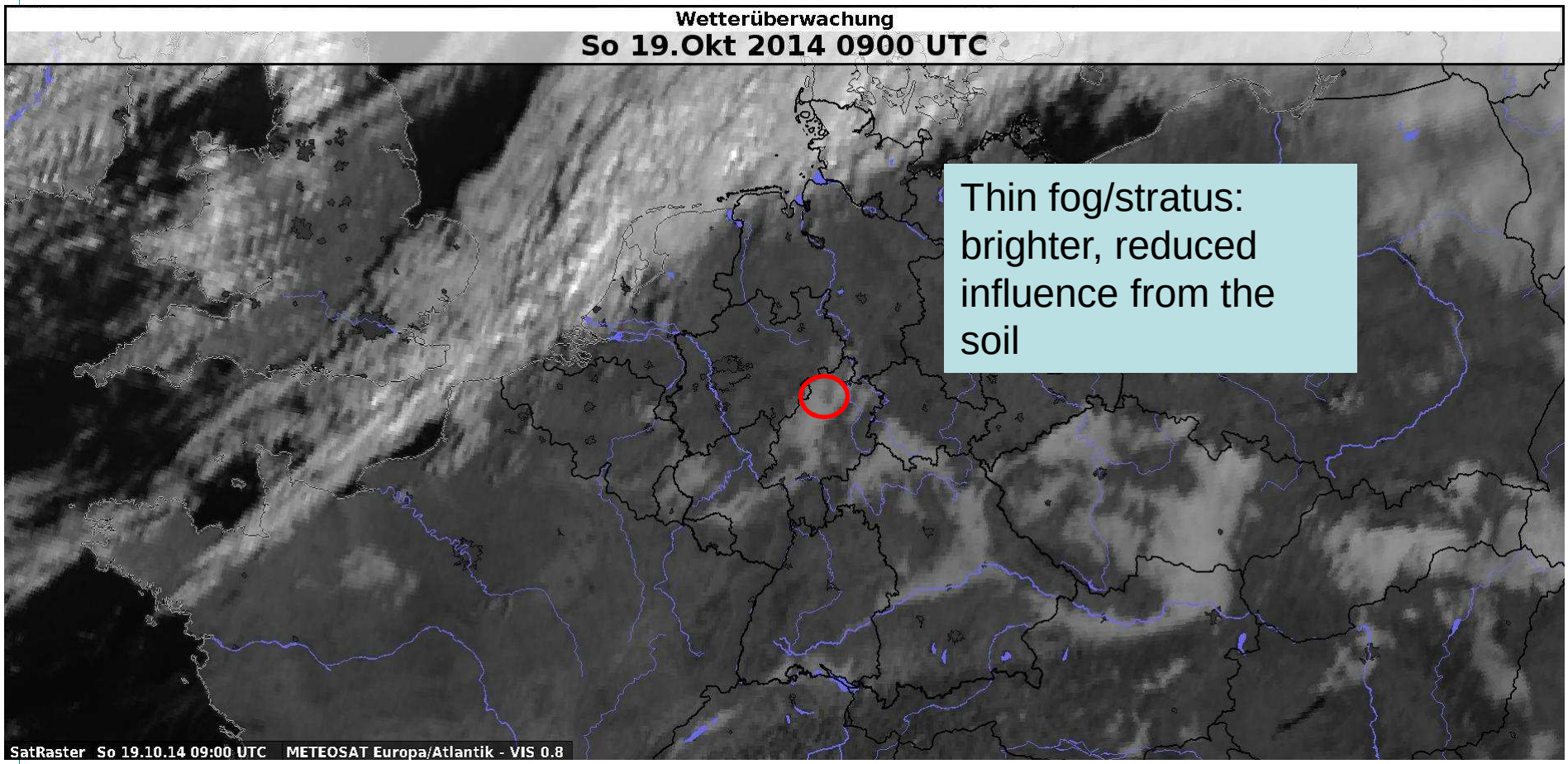
Fog/low stratus: 0.6µm – 19/10/2014, 09 UTC

(higher contrast, however, thinner fog/St-layers difficult to indentify)



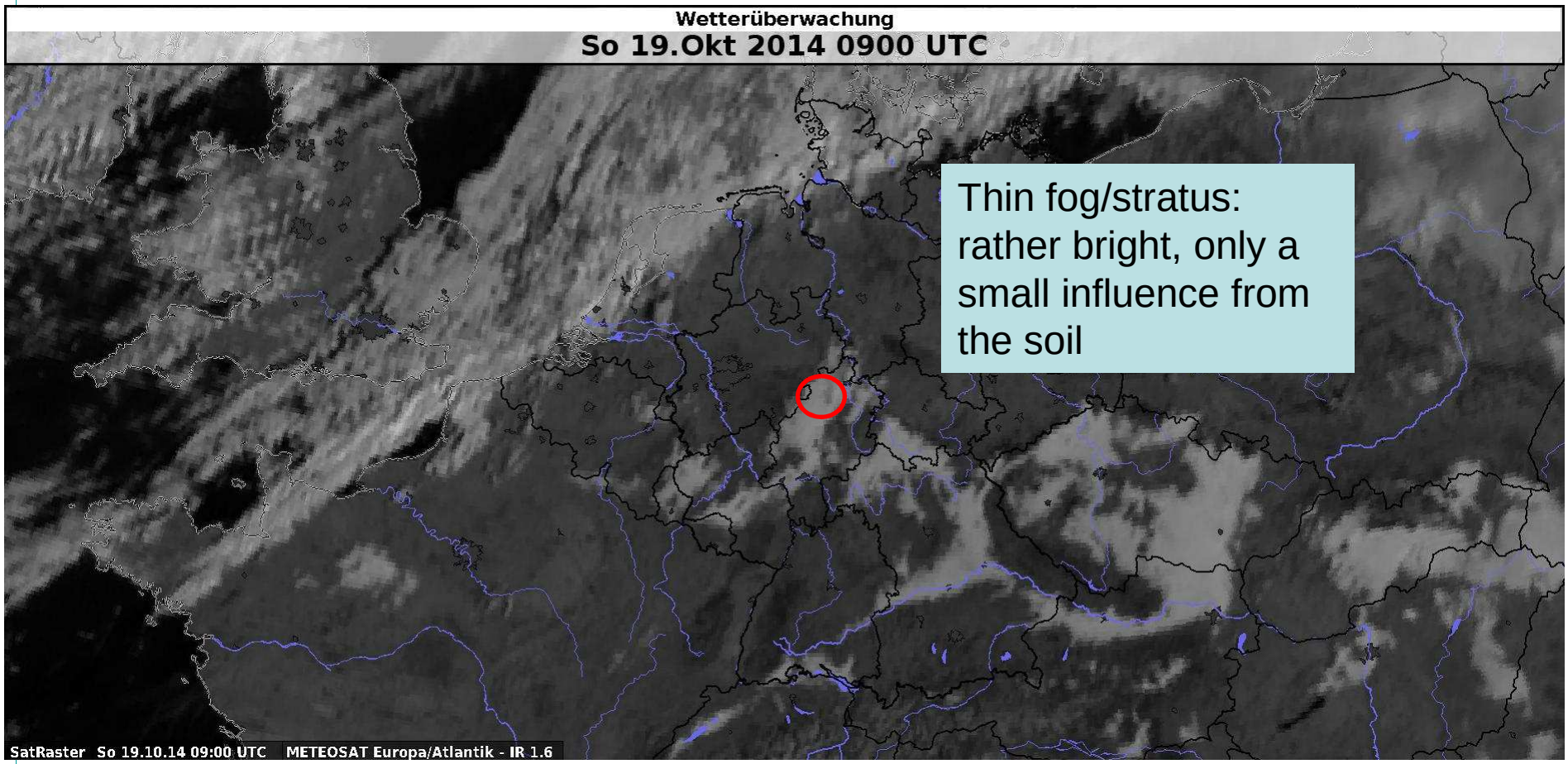
Fog/low stratus: 0.8µm – 19/10/2014, 09 UTC

(less contrast, however, thinner fog/St-layers easier to identify)



Fog/low stratus: 1.6µm – 19/10/2014, 09 UTC

(St, fog brighter, thinner fog/St-layers easier to identify than with 0.8µm)



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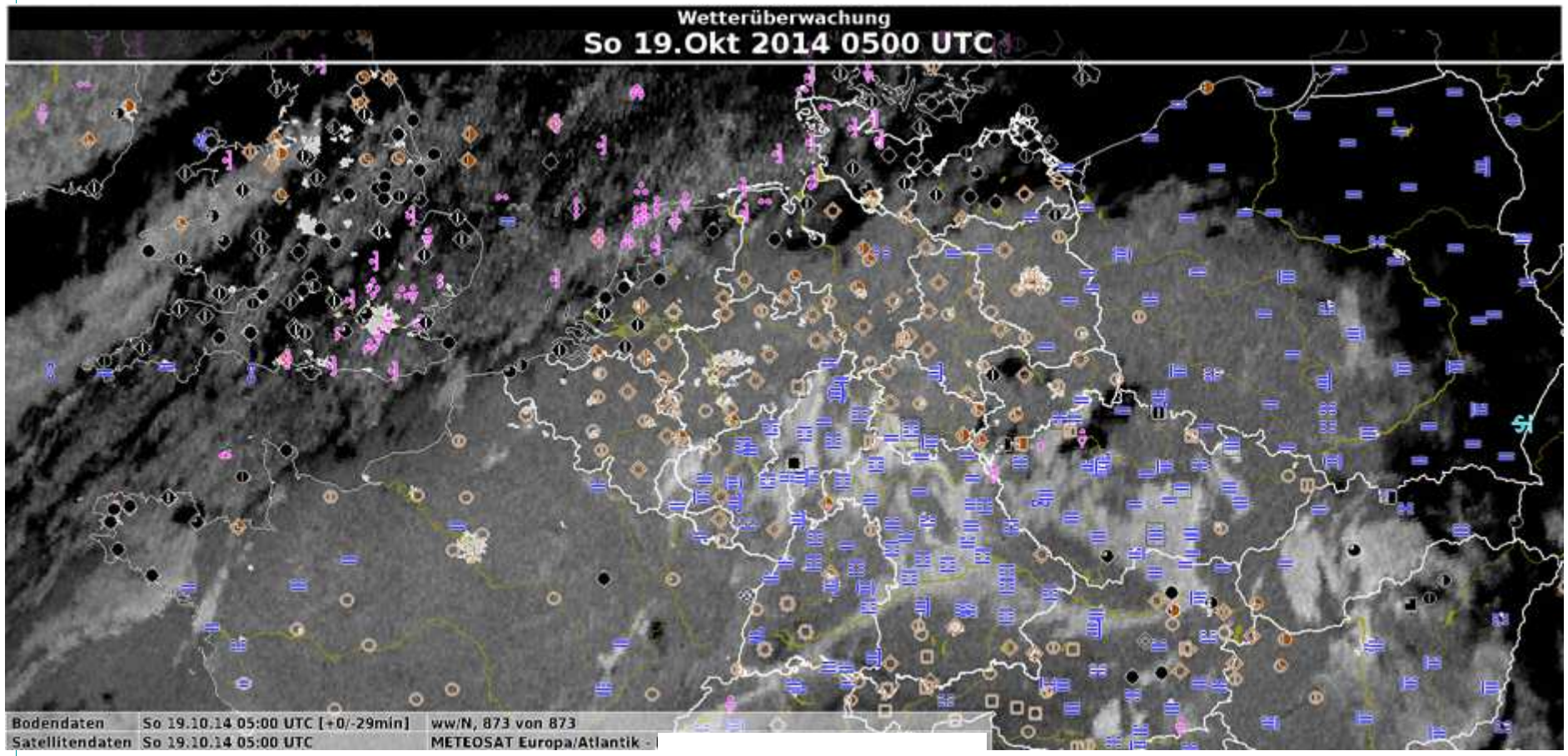
FOG/low stratus: (10.8 – 3.9) µm

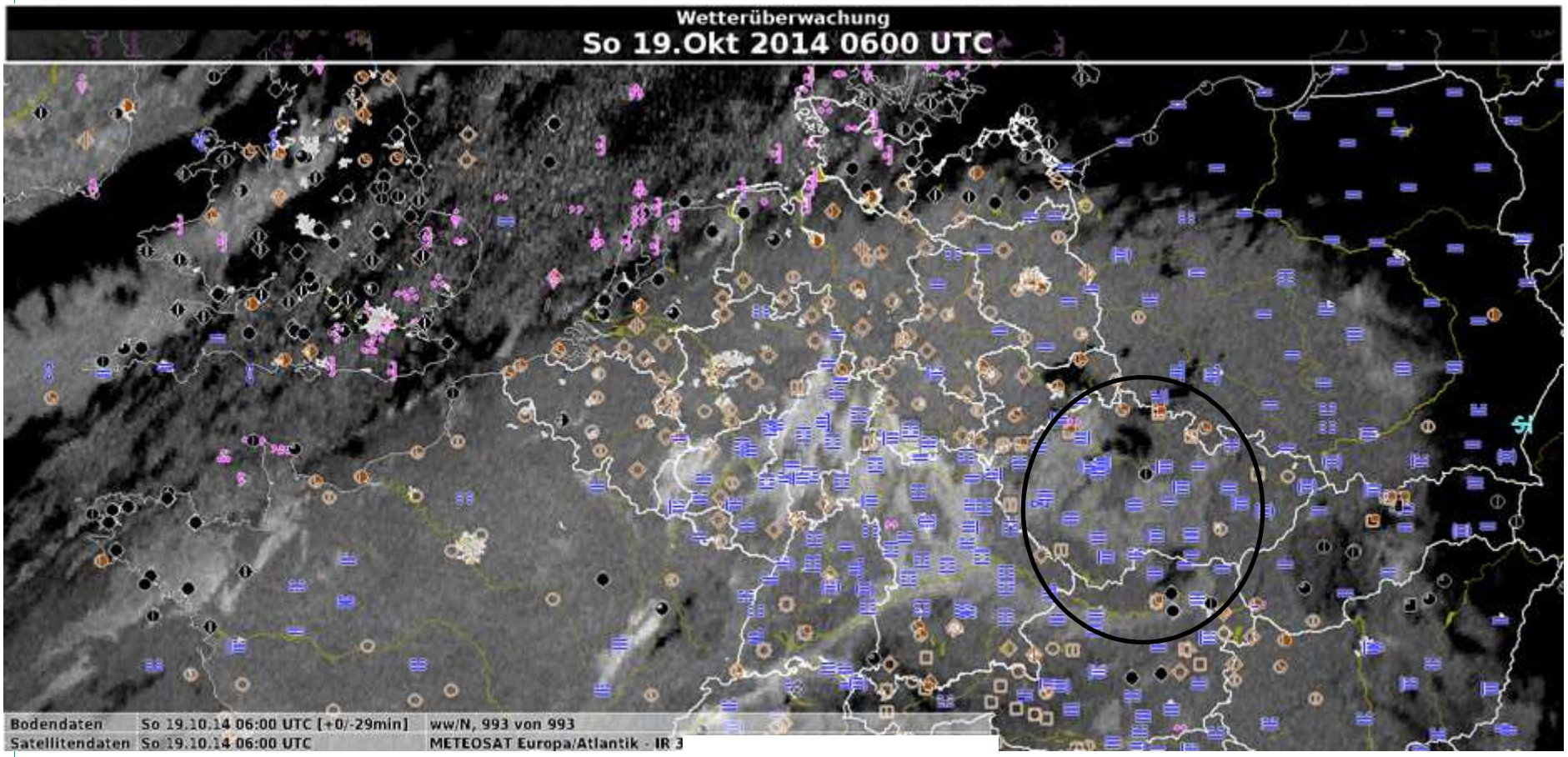
- Small water droplets (fog, low stratus) exhibit a lower emissivity in the 3.9 µm channel than in the 10.8 µm channel.
- Night: Differences (10.8 – 3.9) µm show positive values (normally up to plus 10 K)
- This will be used for the detection of fog and low stratus during night time.
- Recommended for fog/low St-detection during the night

- Hint for practical work: During the night cloud top temperature about -10 degrees and no clouds above → drizzle possible, may be freezing

(10.8 – 3.9) µm 0 to 10 K, 19/10/2014, 05 UTC
(low level water clouds (St, fog): relatively bright (night time))



(10.8-3.9) µm (0 to 10 K) 19/10/2014, 06 UTC
(low level water clouds (St, fog)
bright (night time) / around sunrise (difficult to identify)



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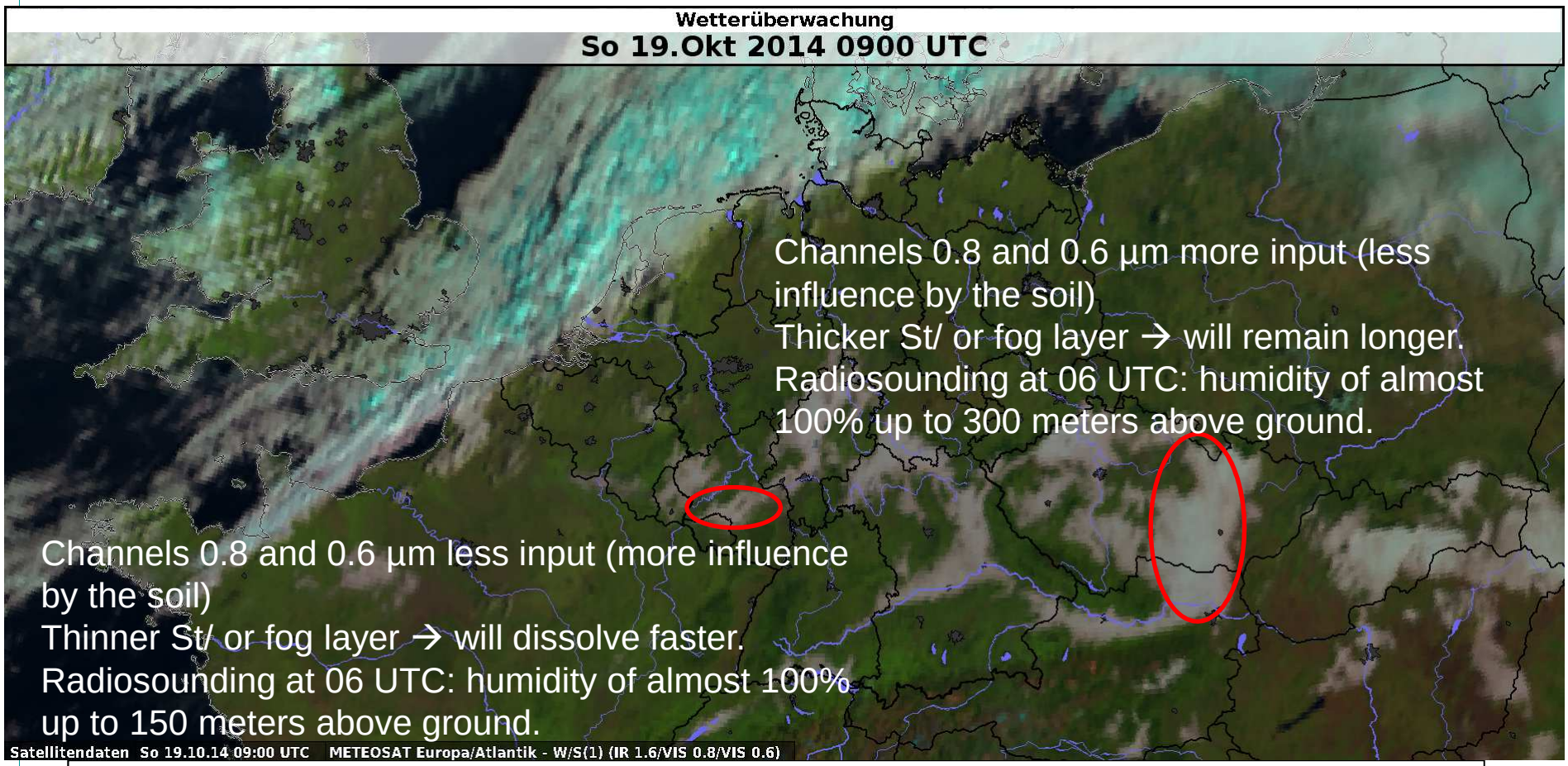
FOG / St: RGBs (during the day)

RGB (Day Natural Colours)

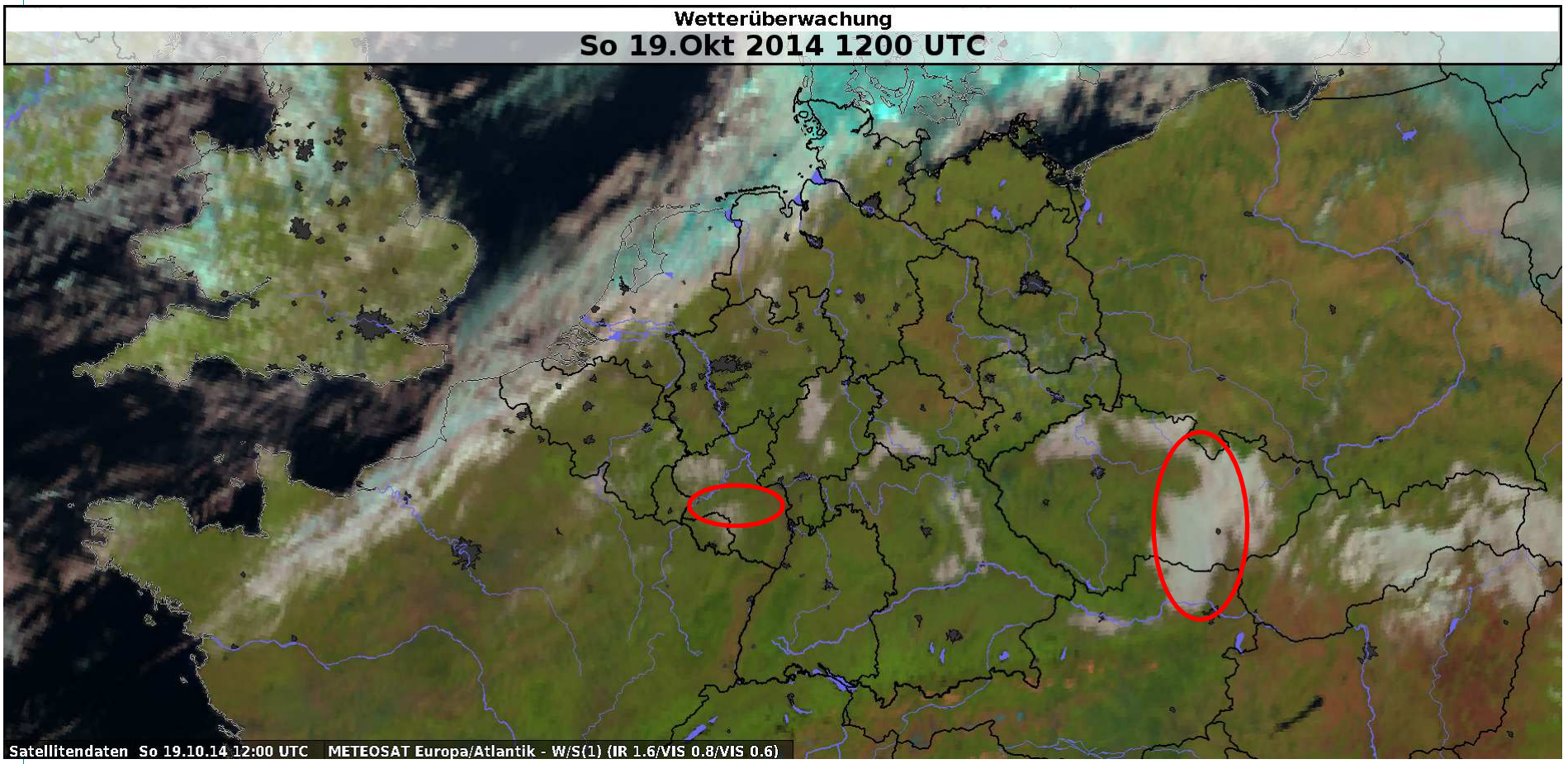
R = NIR1.6
G = VIS0.8
B = VIS0.6

RGB (Day Natural Colours, 1.6/0.8/0.6) – 19.10.2014, 09 UTC (low level water clouds (St, fog)



Low St / fog (thinner layer) appear in pinkish-whitish
Low St / fog (thicker layer) appear in whitish-greenish

RGB (Day Natural Colours, 1.6/0.8/0.6), 19.10.2014, 12 UTC (low level water clouds (St, fog)



Which fog/St-areas will probably not dissolve? (Please the chat box)

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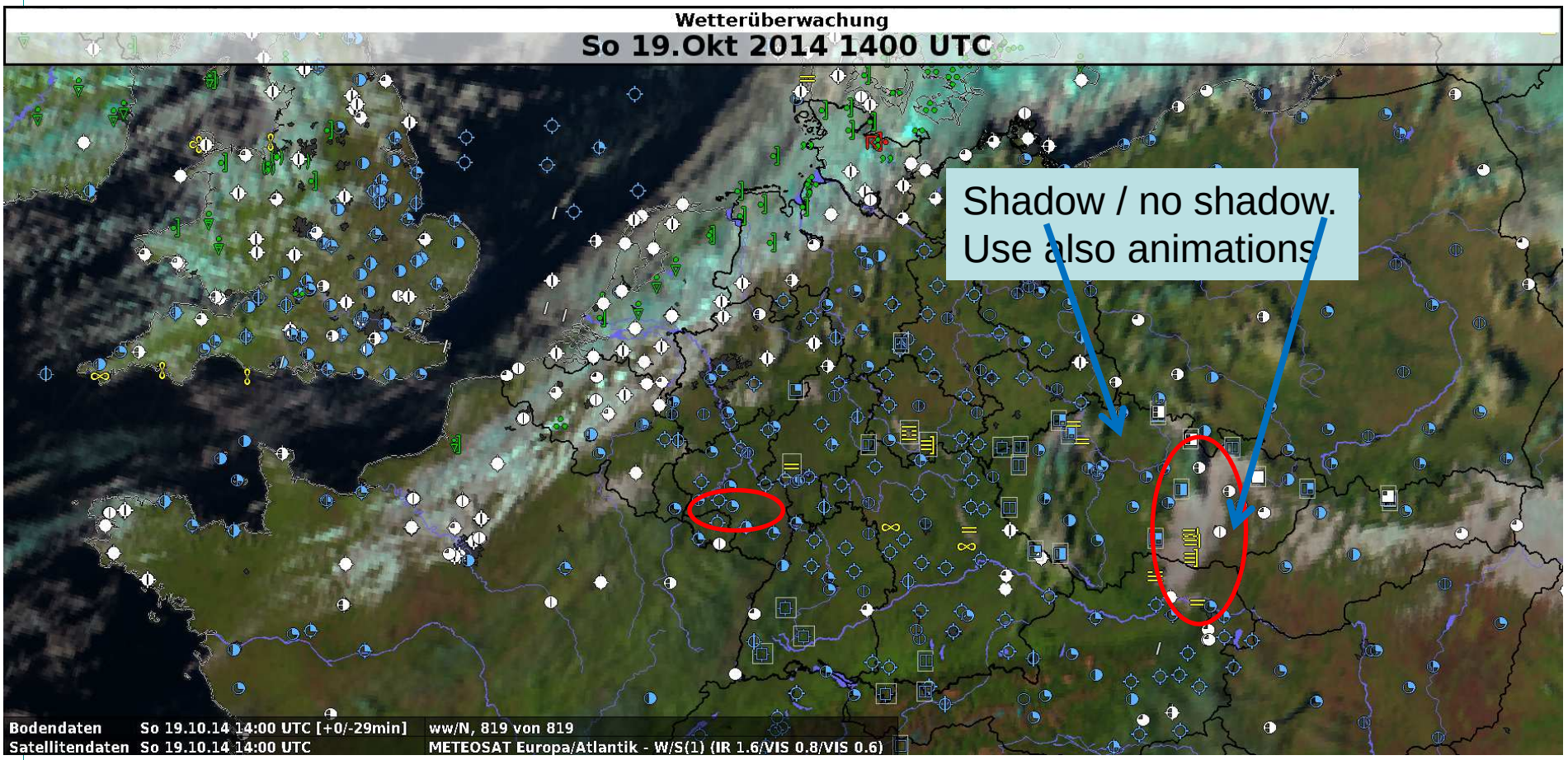
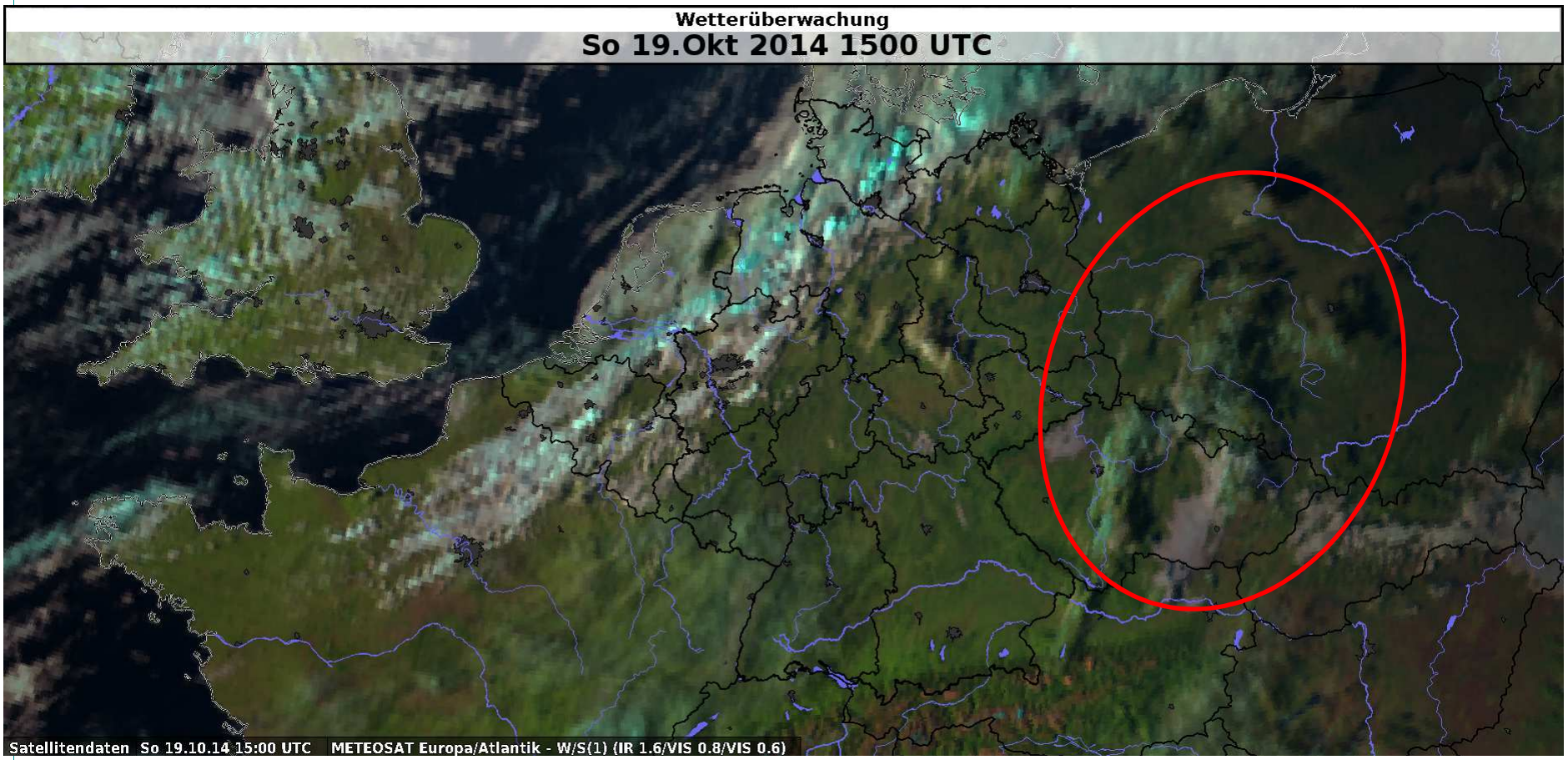
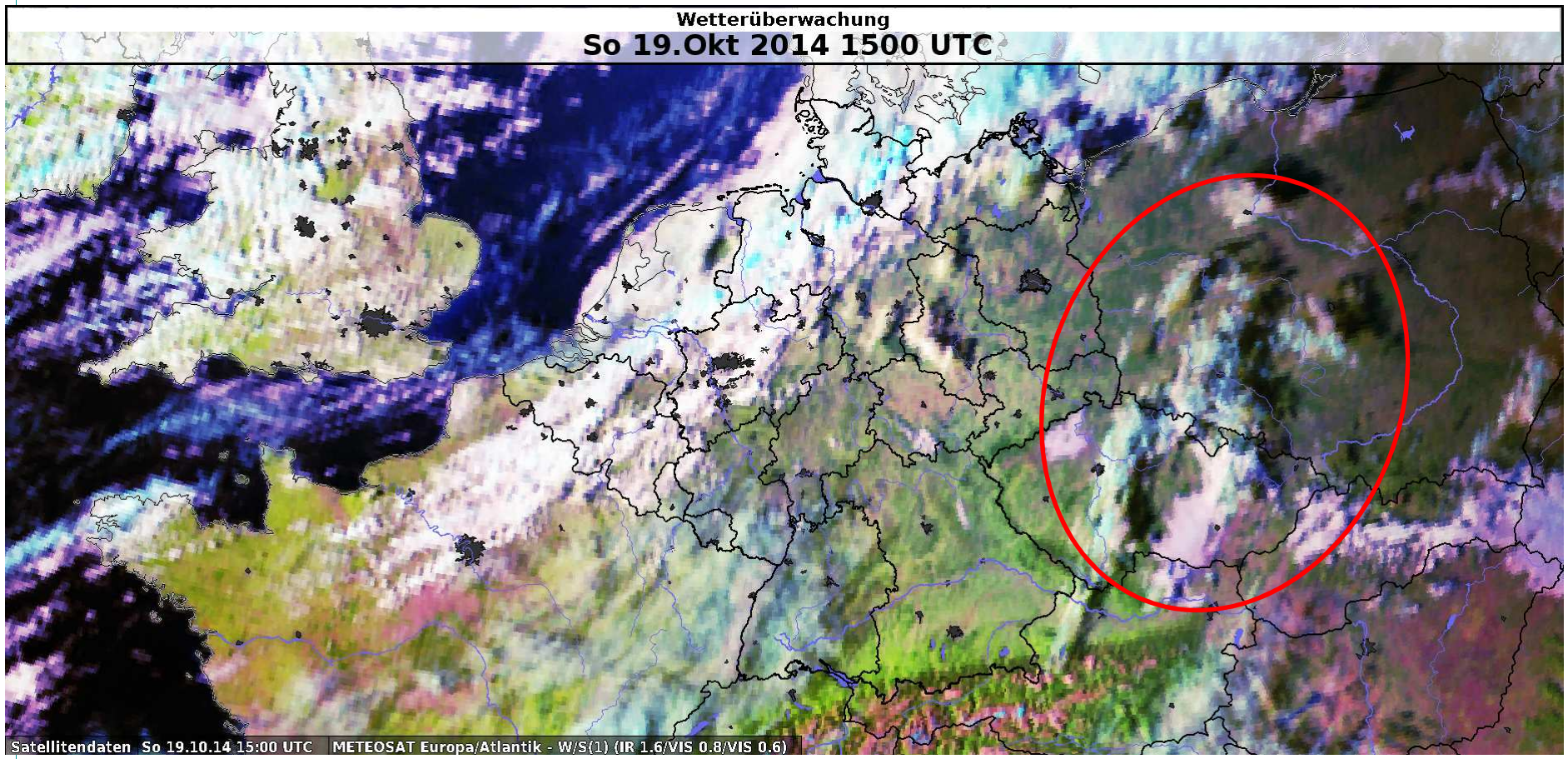
RGB (Day Natural Colours, 1.6/0.8/0.6), 19.10.2014, 14 UTC (low level water clouds (St, fog)



RGB (Day Natural Colours, 1.6/0.8/0.6), 19.10.2014, 15 UTC (low level water clouds (St, fog) – Shadow / no shadow



RGB (Day Natural Colours, 1.6/0.8/0.6) - enhanced, 19.10.2014, 15 UTC (low level water clouds (St, fog) – Shadow / no shadow



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RGB (Night-Composite, during night)

R = 3.9

G = 10.8

B = 12.0

RGB (night, 3.9/10.8/12.0), 19.10.2014, 05 UTC
St, fog: redish to pinkish

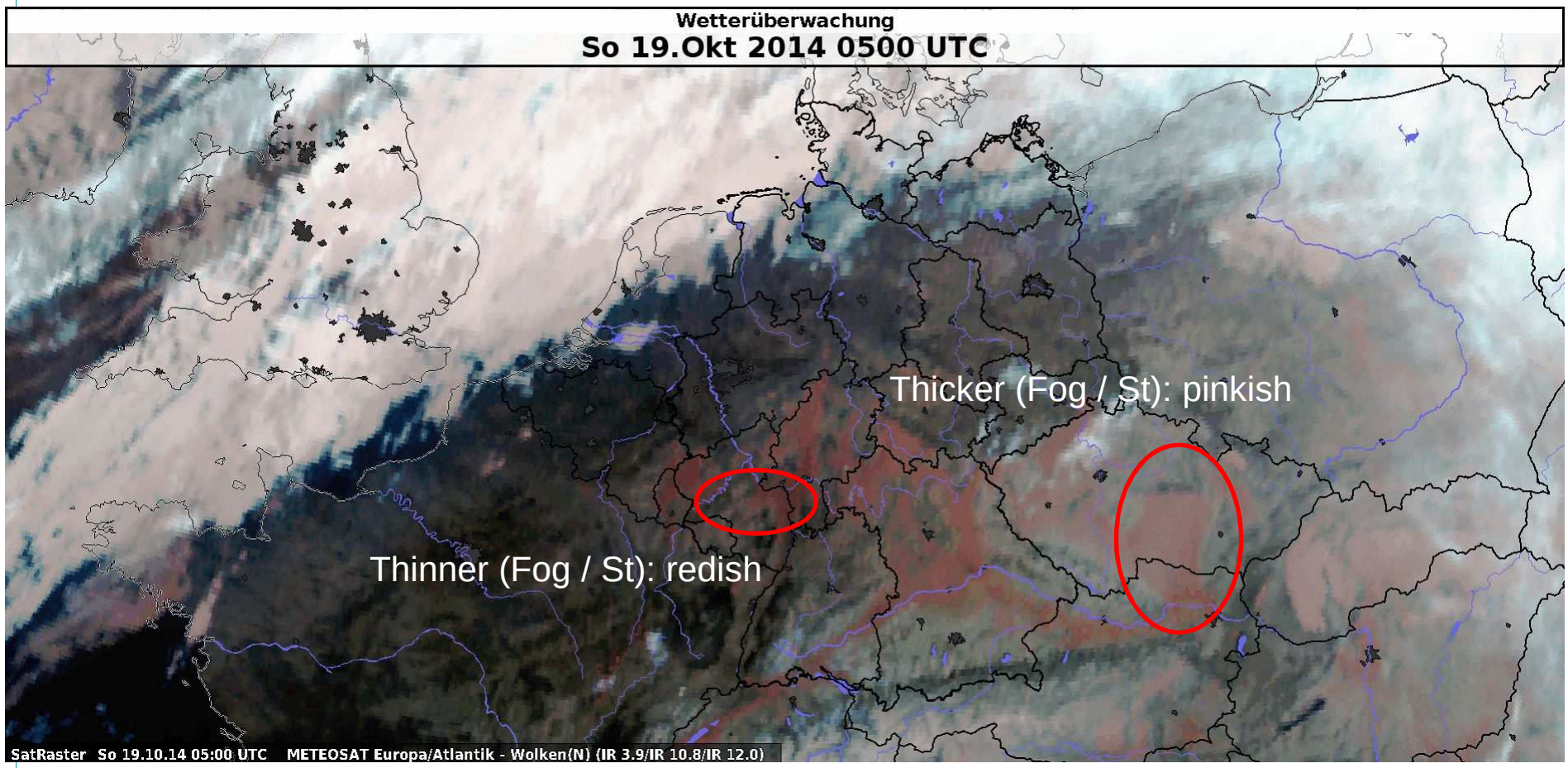
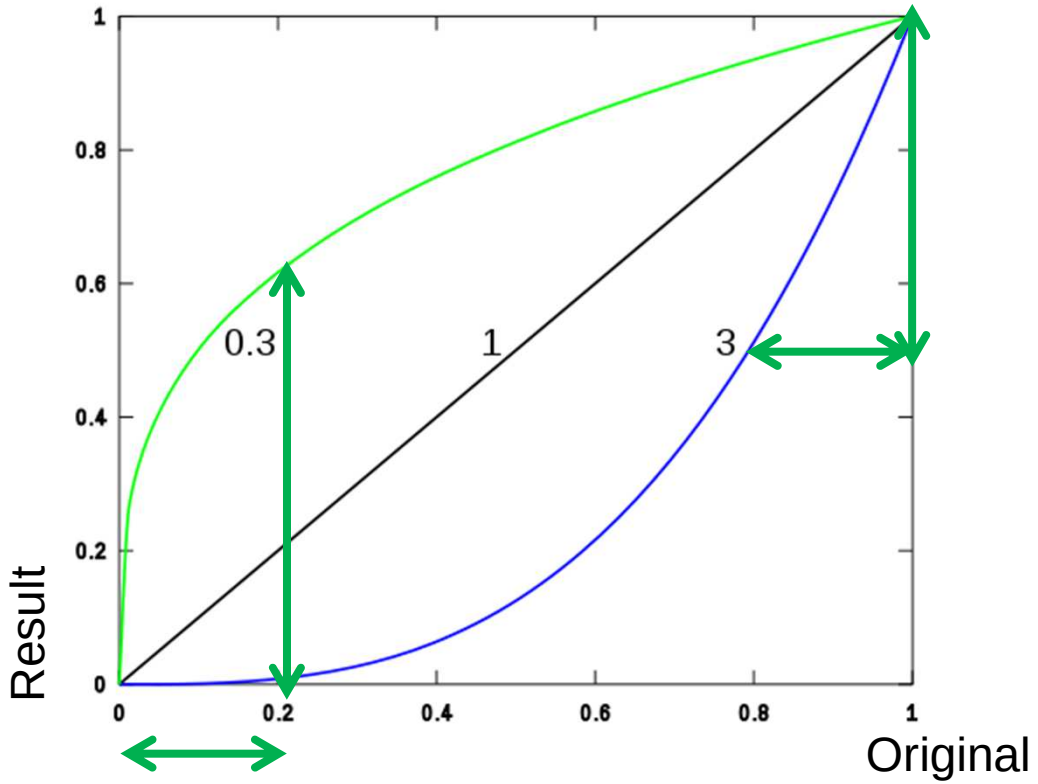


Image processing: Gamma – Principle

- Purpose: Increase amount of information from images
- Processing of brightnesses of pixel
  - Gamma>1: relative high input values expanded, low compressed
  - Gamma<1: Vice-versa

Source: Wikipedia (from 14th November 2016) http://de.wikipedia.org/wiki/Gammakorrektur



RGB (Microphysics-day)

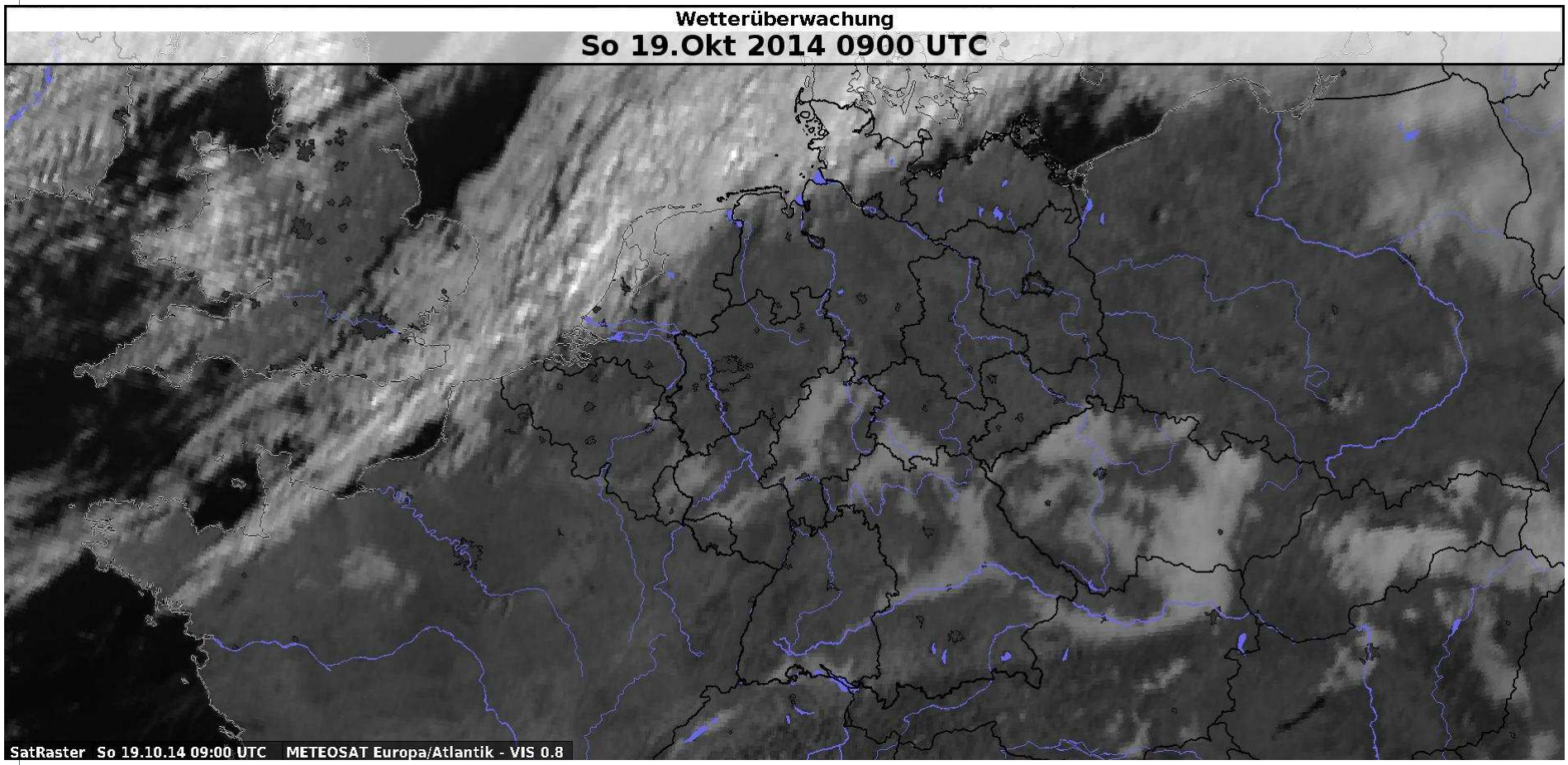
R = VIS 0.8

G = 3.9 ref (0 to 60%) Gamma = 2.5

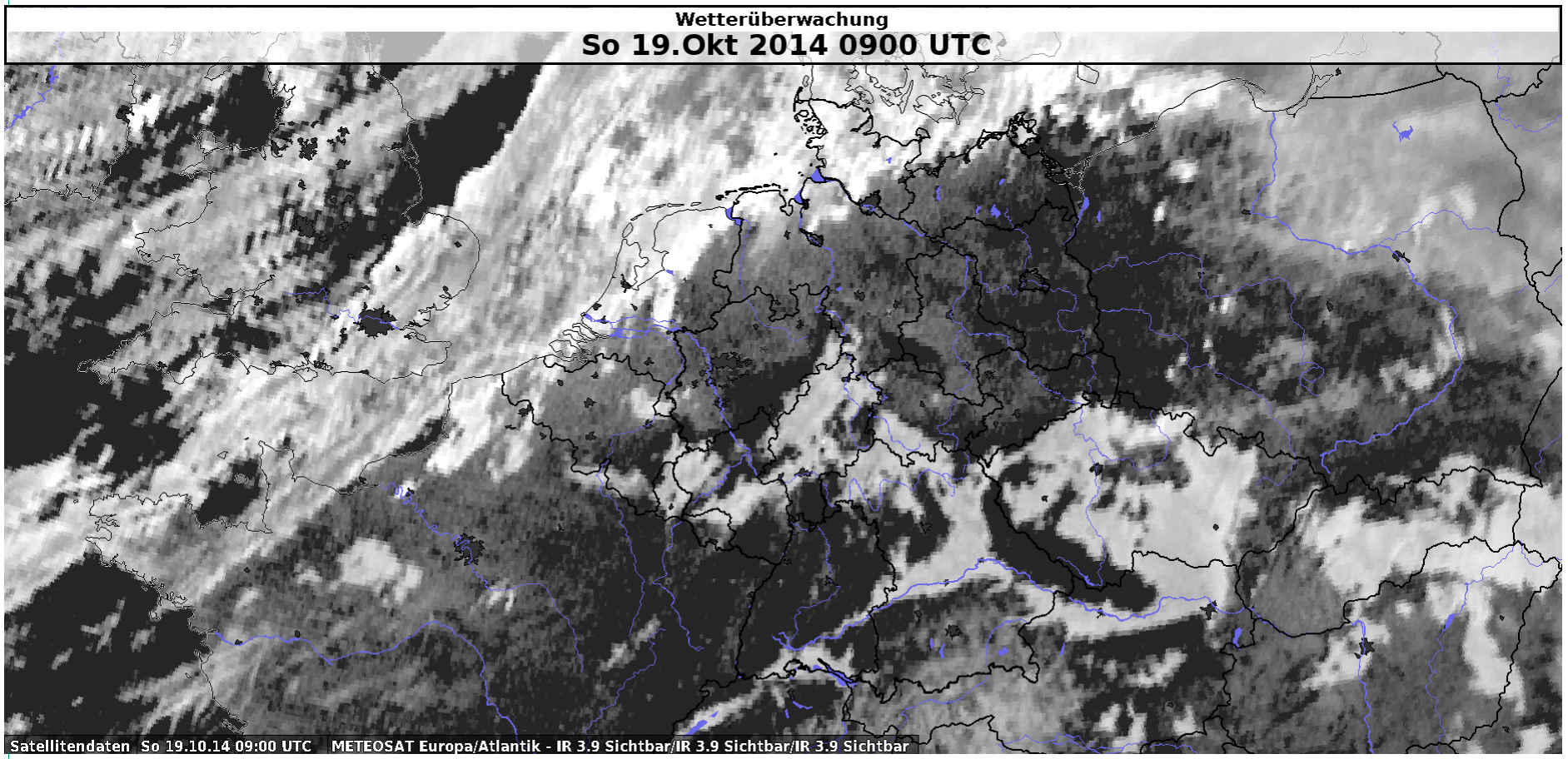
B = 10.8 (203 to 323 K) – fog / St: almost no contribution

Fog/low stratus: 0.8µm – 19/10/2014, 09 UTC

thinner St/fog layers more difficult to identify than with 3.9 ref



3.9 µm-ref (0 to 60%, Gamma = 2.5), 19.10.2014, 09 UTC
St, fog: light-grey to whitish, thinner fog layers (>100m) detectable



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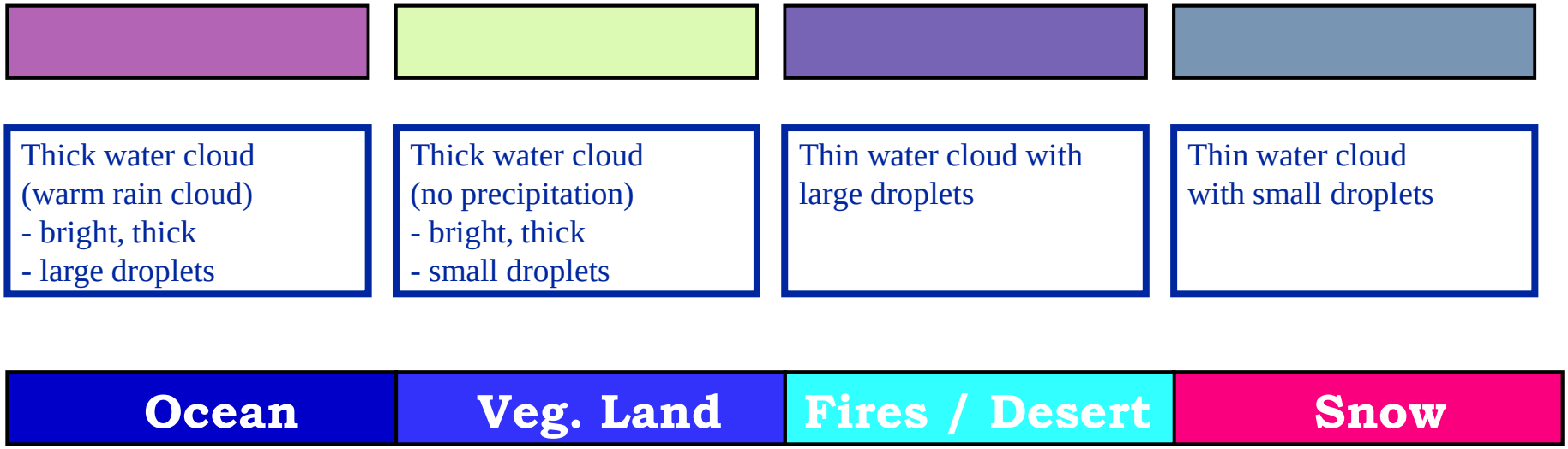
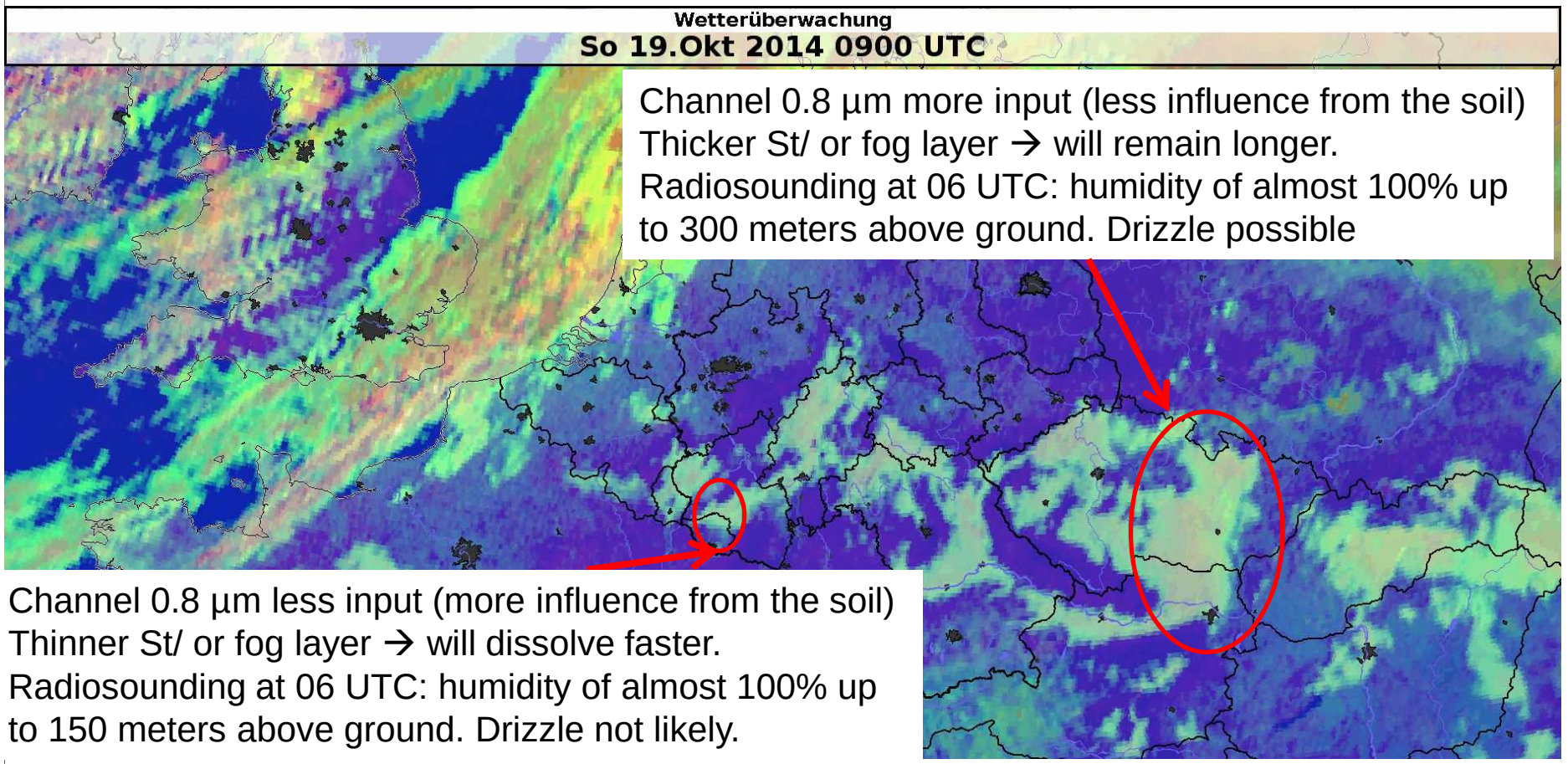
RGB Day Microphysics: Interpretation of Colours for Low-level Clouds

(J. Kerkmann, EUMETSAT)



RGB (Day Microphysics (0.8/3.9ref/10.8), 19.10.2014, 09 UTC
St, fog: thinner layer: bright greenish / thicker layer: pinkish

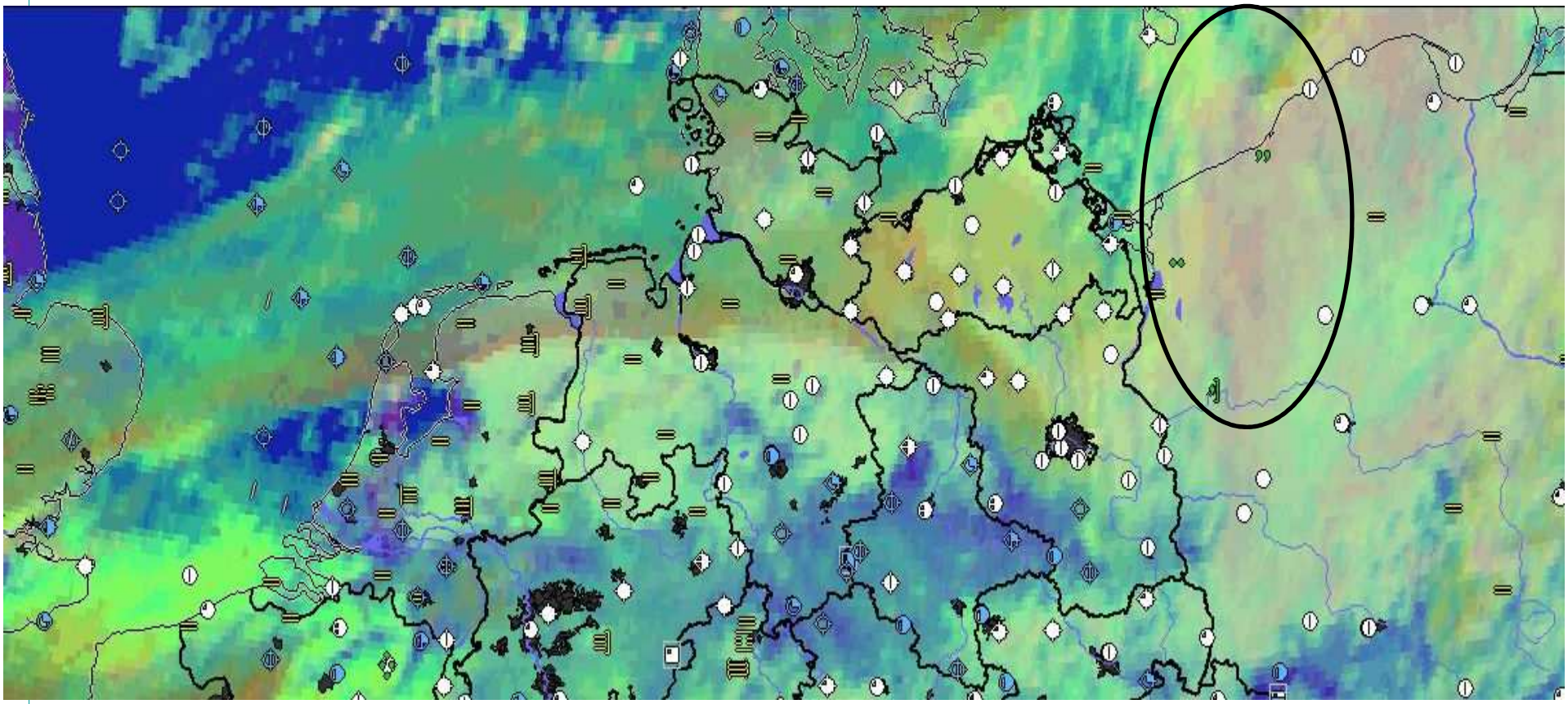


Channel 0.8 µm more input (less influence from the soil)
Thicker St/ or fog layer → will remain longer.
Radiosounding at 06 UTC: humidity of almost 100% up to 300 meters above ground. Drizzle possible

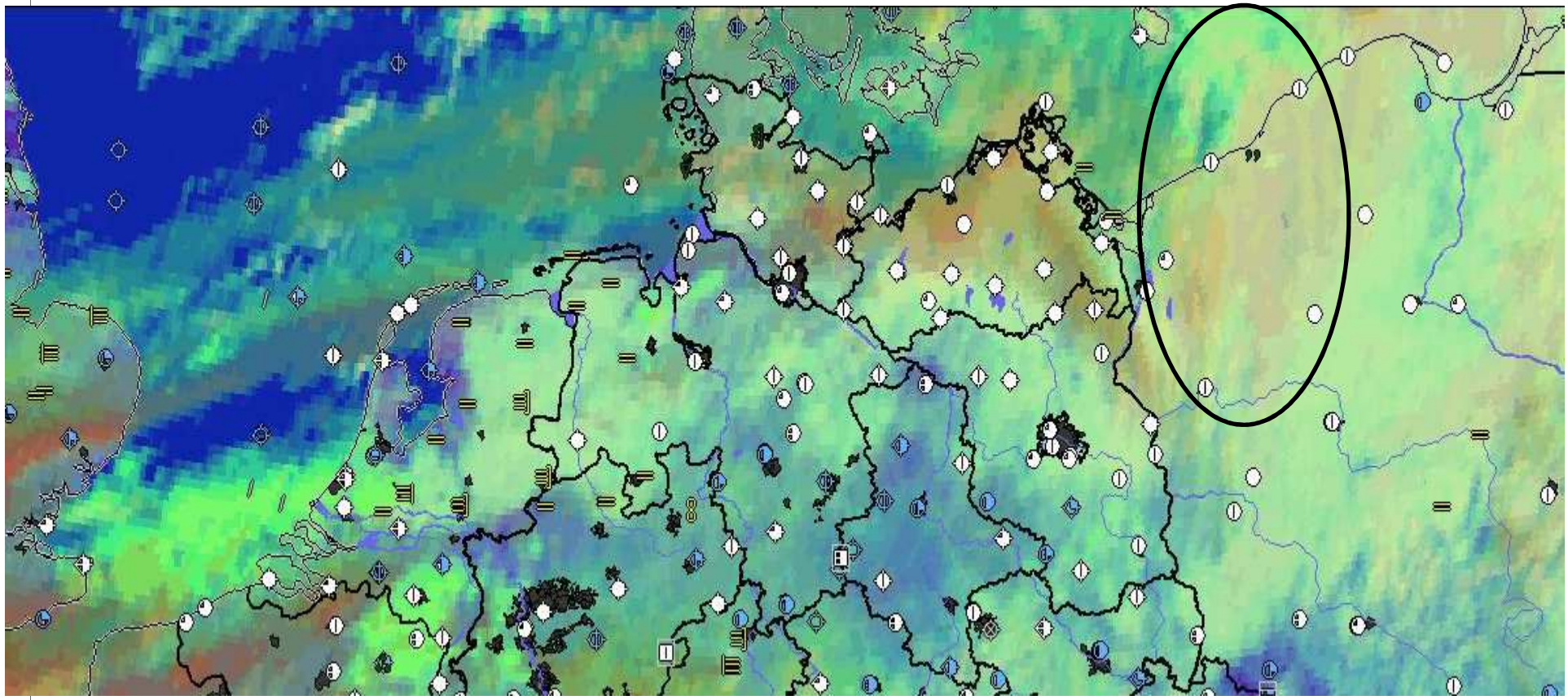
Channel 0.8 µm less input (more influence from the soil)
Thinner St/ or fog layer → will dissolve faster.
Radiosounding at 06 UTC: humidity of almost 100% up to 150 meters above ground. Drizzle not likely.

Small differences are possible due to different image processing or different hardware.

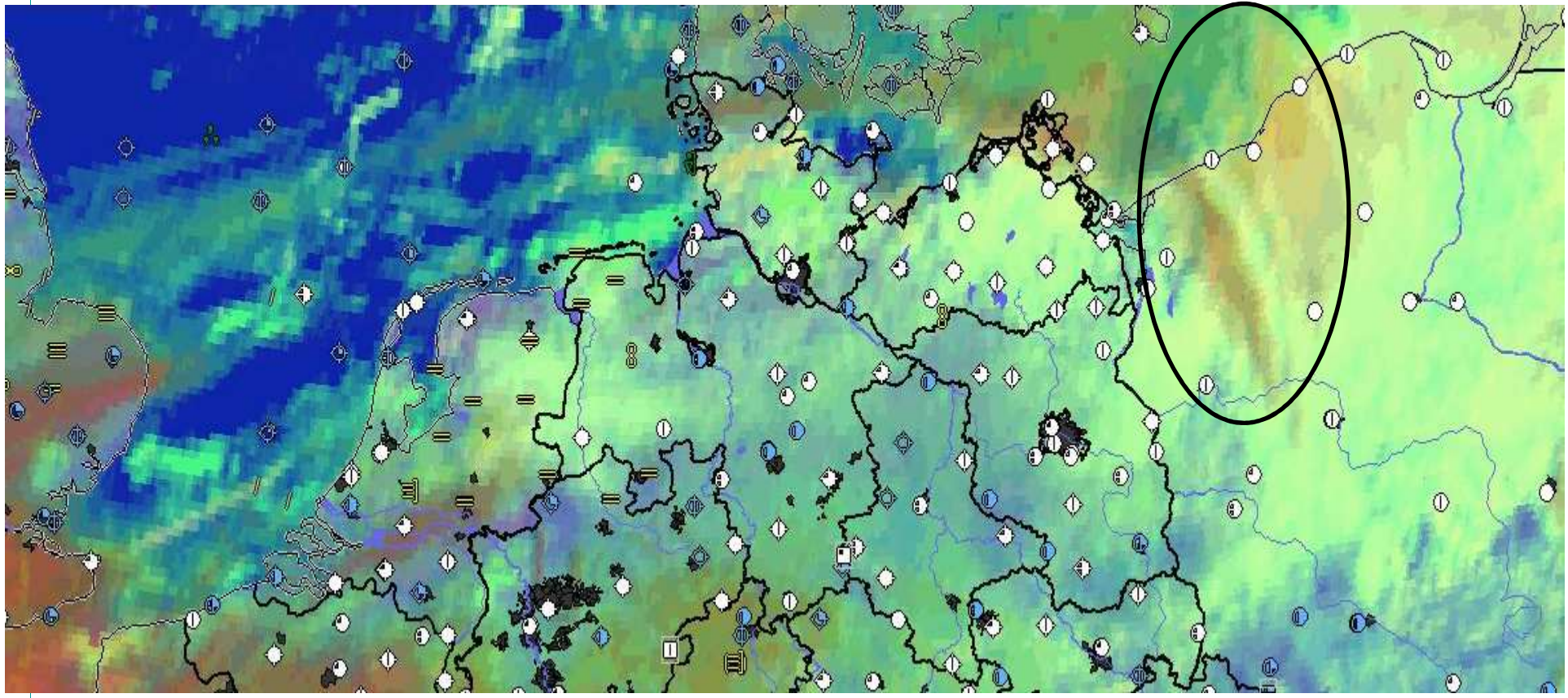
RGB (Day Microphysics (0.8/3.9ref/10.8), 12.10.2014, 09 UTC thicker layer: pinkish (some drizzle/light rain), will remain



RGB (Day Microphysics (0.8/3.9ref/10.8), 12.10.2014, 10 UTC thicker layer: pinkish (some drizzle/light rain), will remain



RGB (Day Microphysics (0.8/3.9ref/10.8), 12.10.2014, 11 UTC thicker layer: superimposed by higher clouds (moved faster)



Shallow clouds and precipitation

Components Day Microphysics (0.8 / 3.9ref / 10.8)

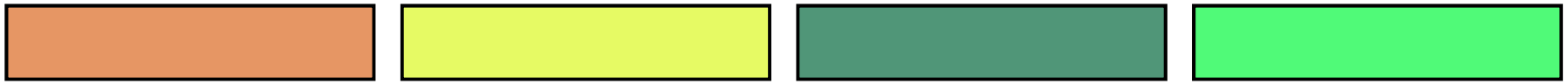
1. R = VIS 0.8: Visible brightness, reflecting more solar radiation for thicker clouds with more water and ice

2. G = 3.9 ref:
   - Cloud particle size and phase (water or ice), having larger drops for clouds with greater depth. Drops appear larger when freezing at temperatures that can range between 0 and -38ºC. → darker
   - brighter with smaller particles

3. B = 10.8: Temperature, lower for higher tops (image not inverted! → darker with decreasing top temperature)

RGB Day Microphysics: Interpretation of Colours for Mid-level Clouds

(J. Kerkmann)

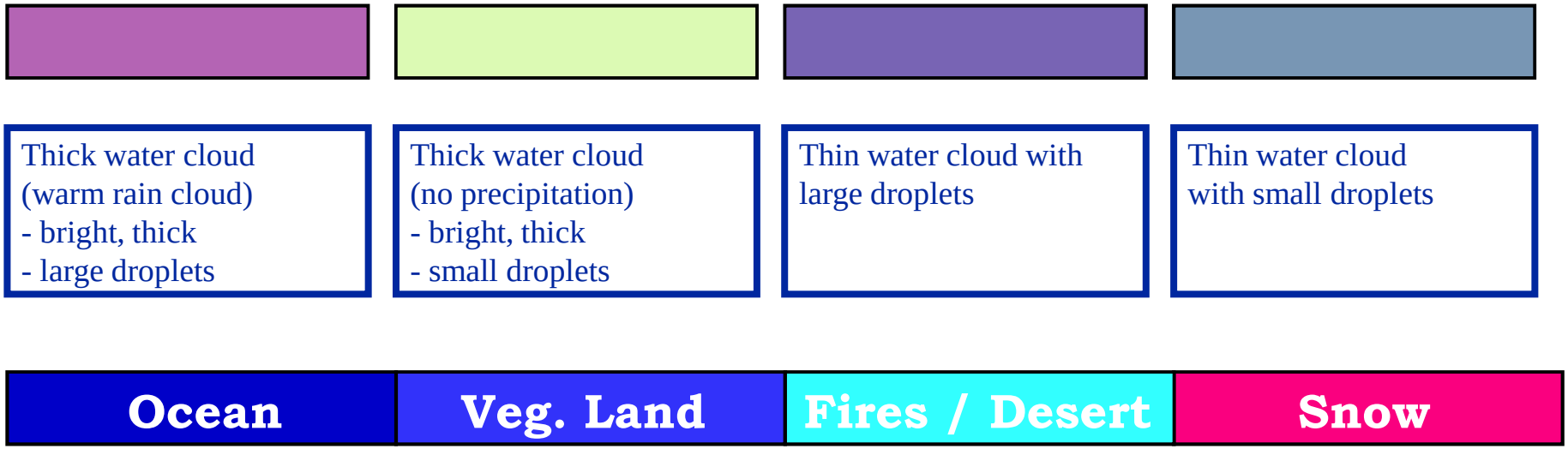


Supercooled, thick water cloud - bright, thick - large droplets	Supercooled, thick water cloud - bright, thick - small droplets	Supercooled thin water cloud with large droplets	Supercooled, thin water cloud with small droplets * * or, in rare occasions, thin Ci cloud with small ice particles

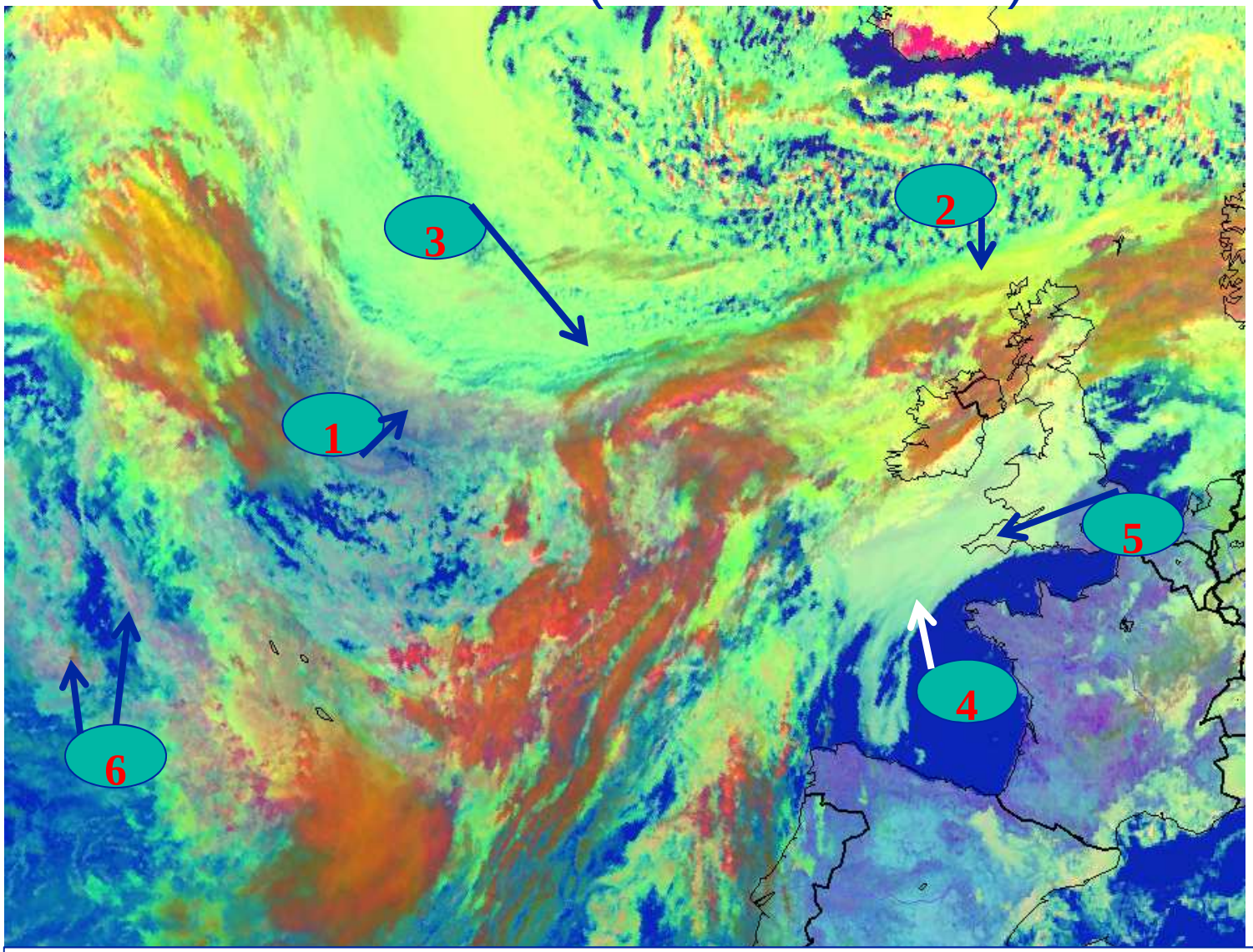
Ocean	Veg. Land	Fires / Desert	Snow

RGB Day Microphysics: Interpretation of Colours for Low-level Clouds

(J. Kerkmann)



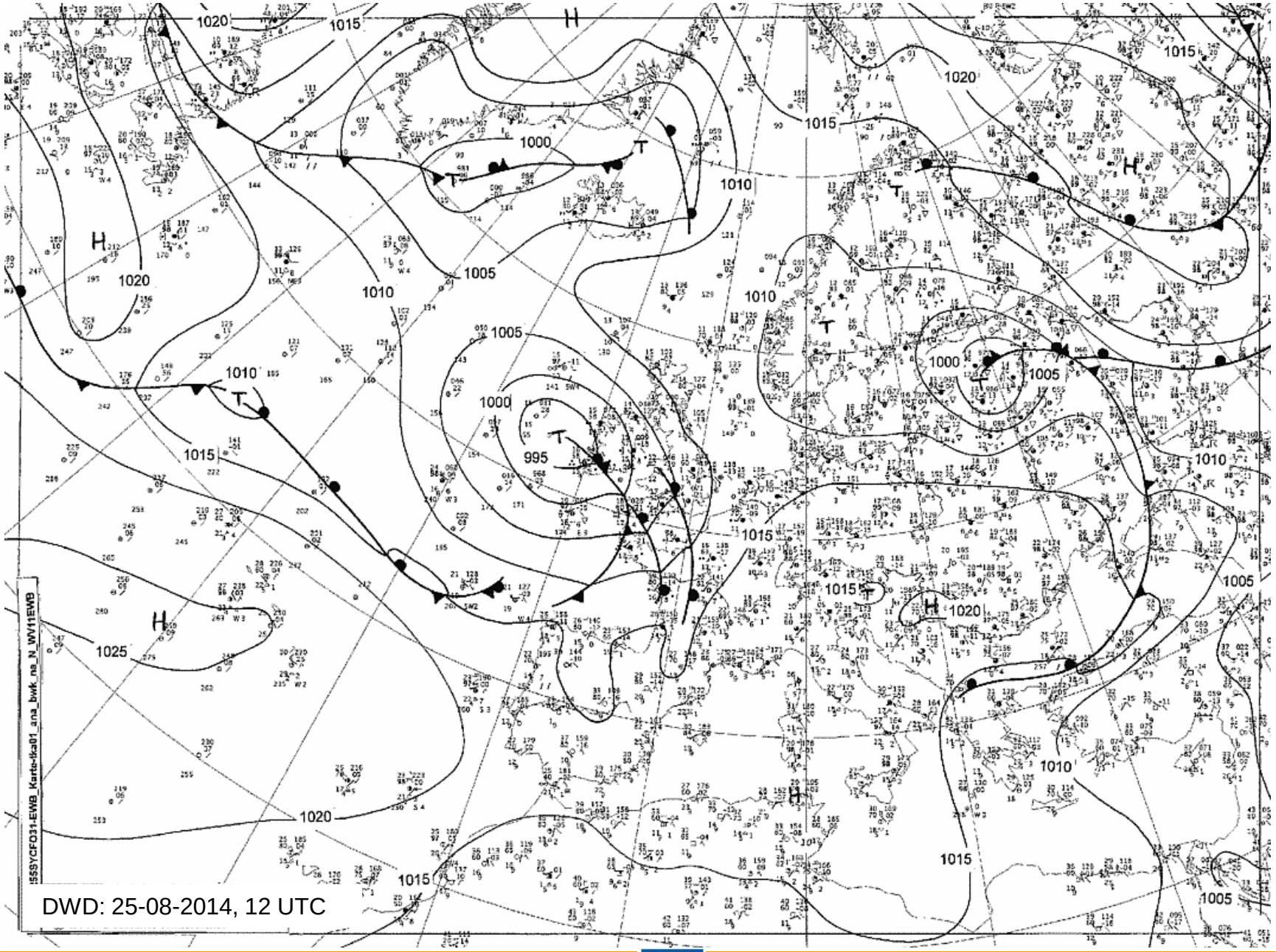
Example: 27-10-2014, 12 UTC (RGB “Day Microphysics” (0.8 / 3.9ref / 10.8)



1. +8 degree Mixture (thin water clouds with small and large droplets, precipitation possible)
2. -20 degree: Supercooled thick water water cloud, small droplets → moderate icing
3. About -5 degree: Supercooled thin/thick water cloud with small and large droplets → precipitation possible and icing!
4. +10 degree: Water cloud, small droplets
5. +8 degree: Thick water cloud, small droplets fog/St-layer about 700 meters.. Near the English South coast light drizzle.
6. About +12 degree: Mixture (think/thick water clouds (warm rain cloud), large droplets). Partly precipitation.

Example 25./26.08.2014, 12 UTC

RGB „Day Microphysics“ - precipitation



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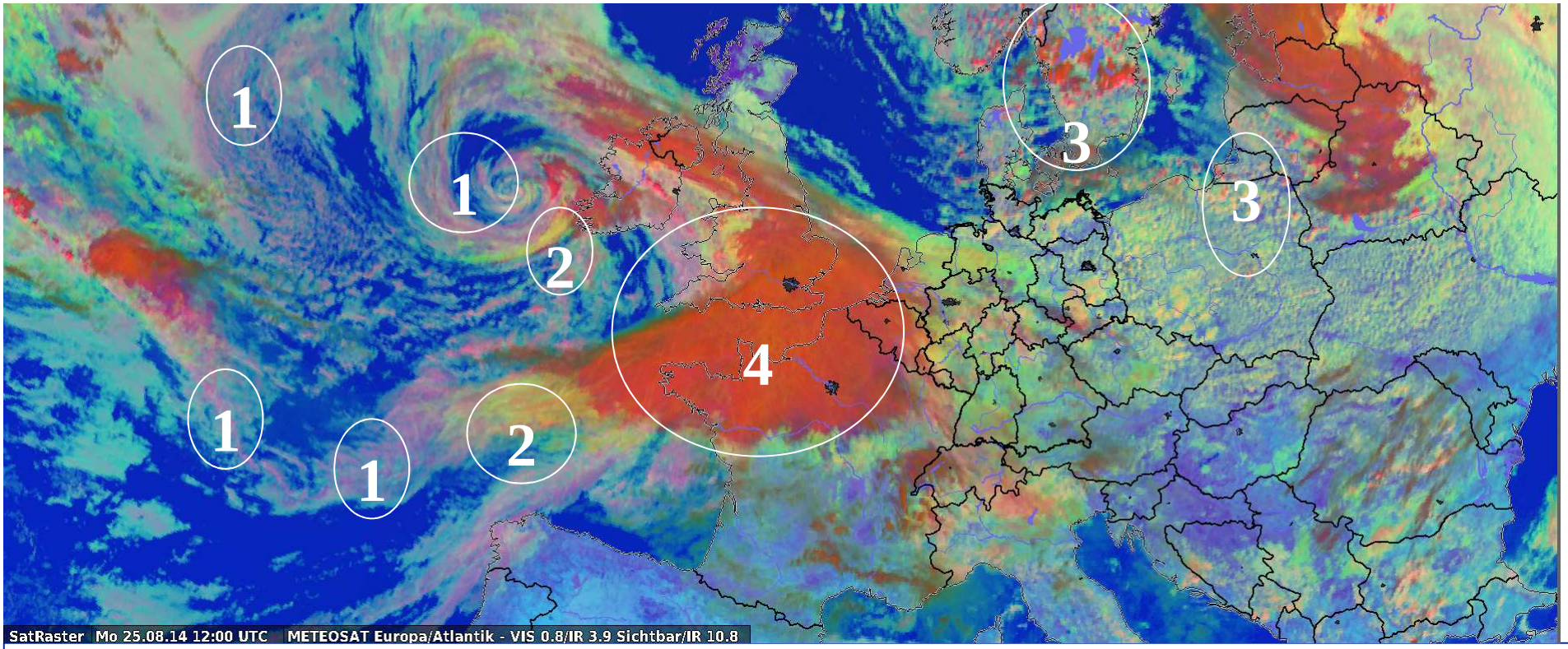
Overview: RGB “Day Microphysics”: 25-08-14, 12 UTC

1. Thick low water cloud, big drops – precipitation likely, Temp between 0 and +10 degree
2. Supercooled water (-10 to -20 degree): Icing
3. High extending ice cloud, compact: Shower
4. High extending ice clouds (WCB): Partly heavy rain (No 65, over UK)



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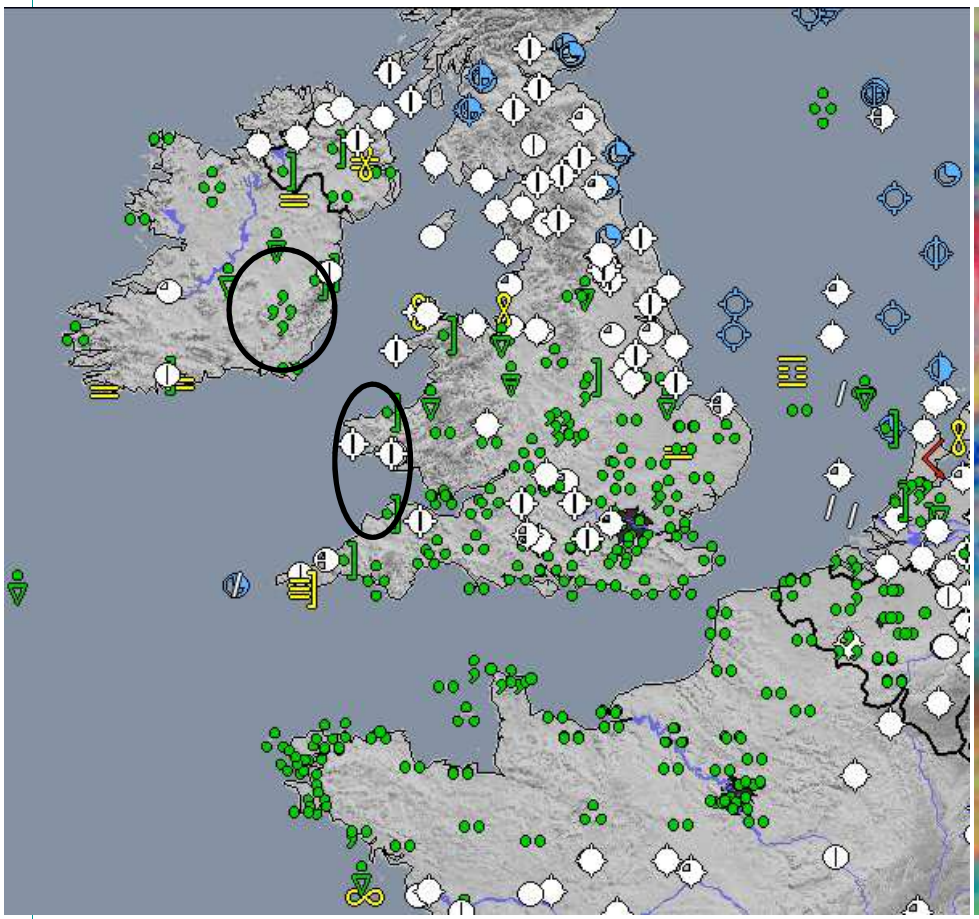
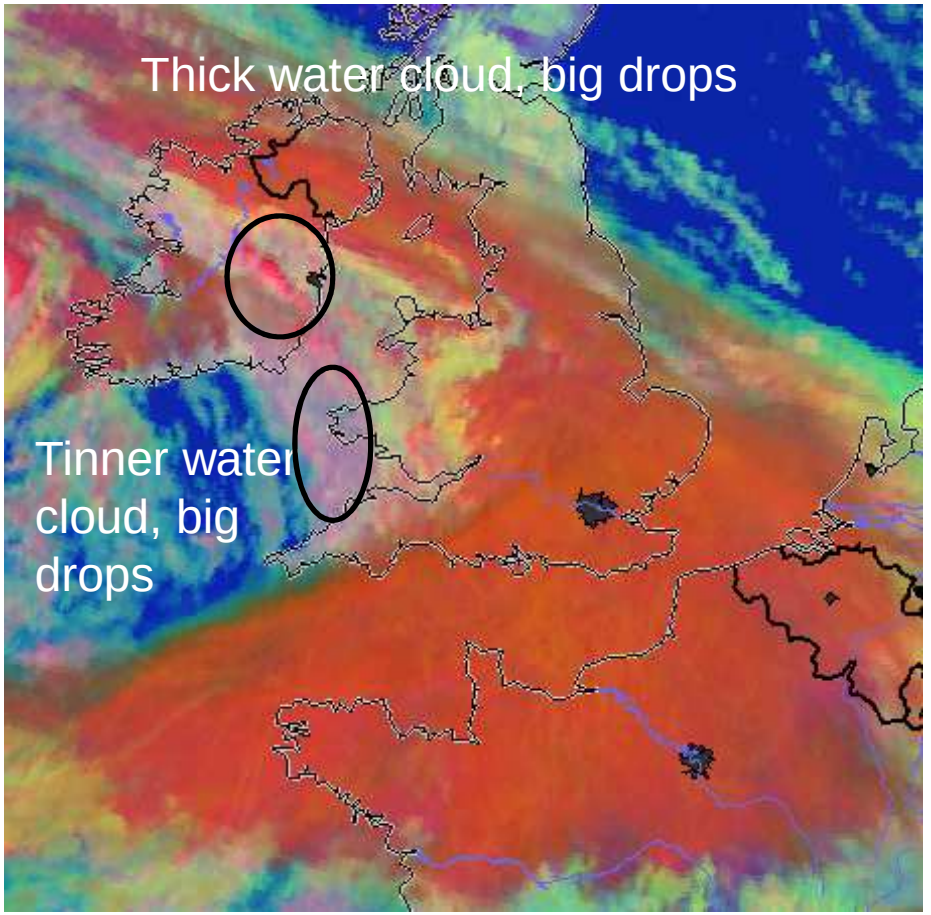
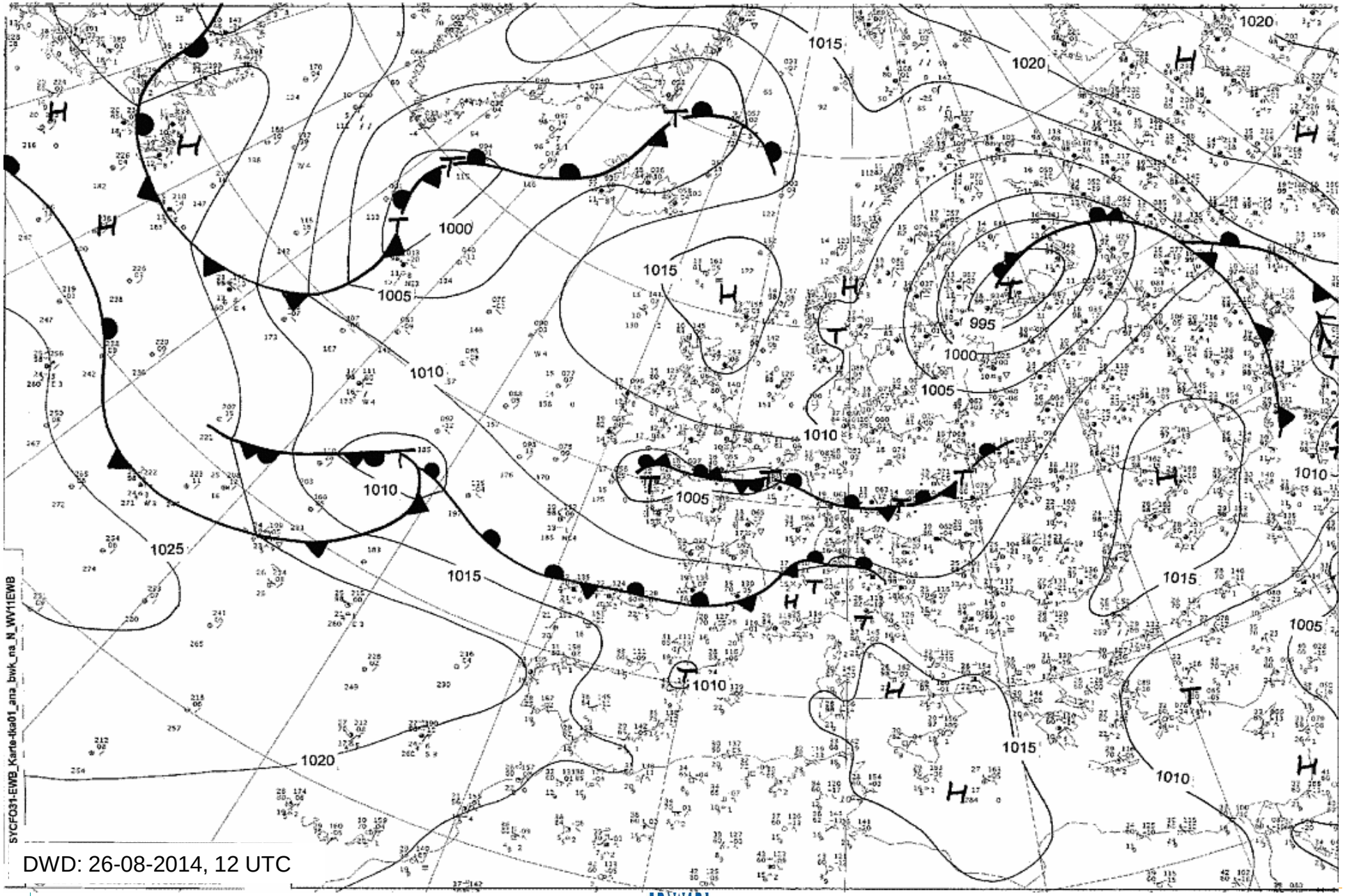
25-08-2014, 12 UTC: ww / Day Microphysics







DWD: 26-08-2014, 12 UTC

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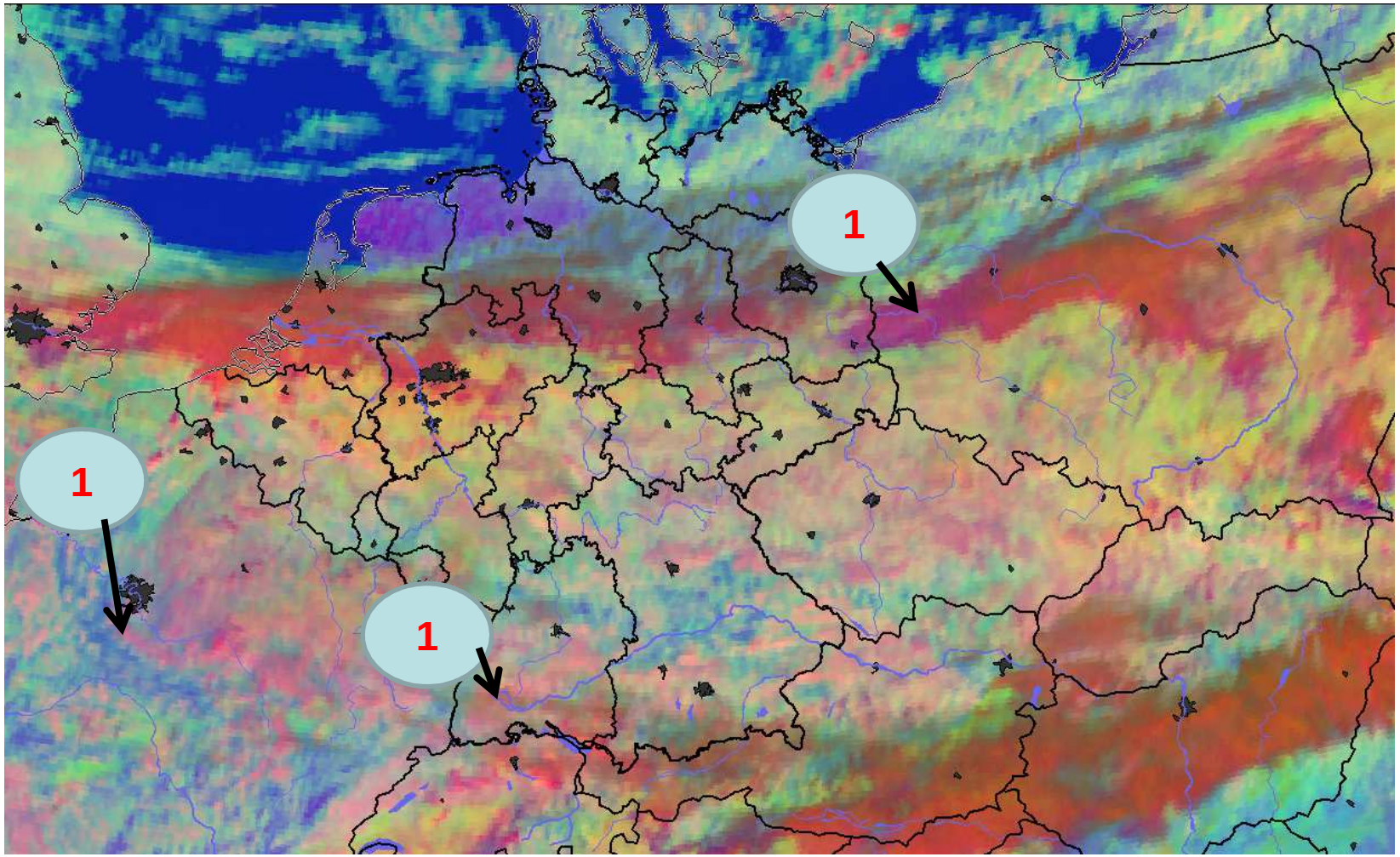
26-08-2014, 12 UTC: Day-Microphysics

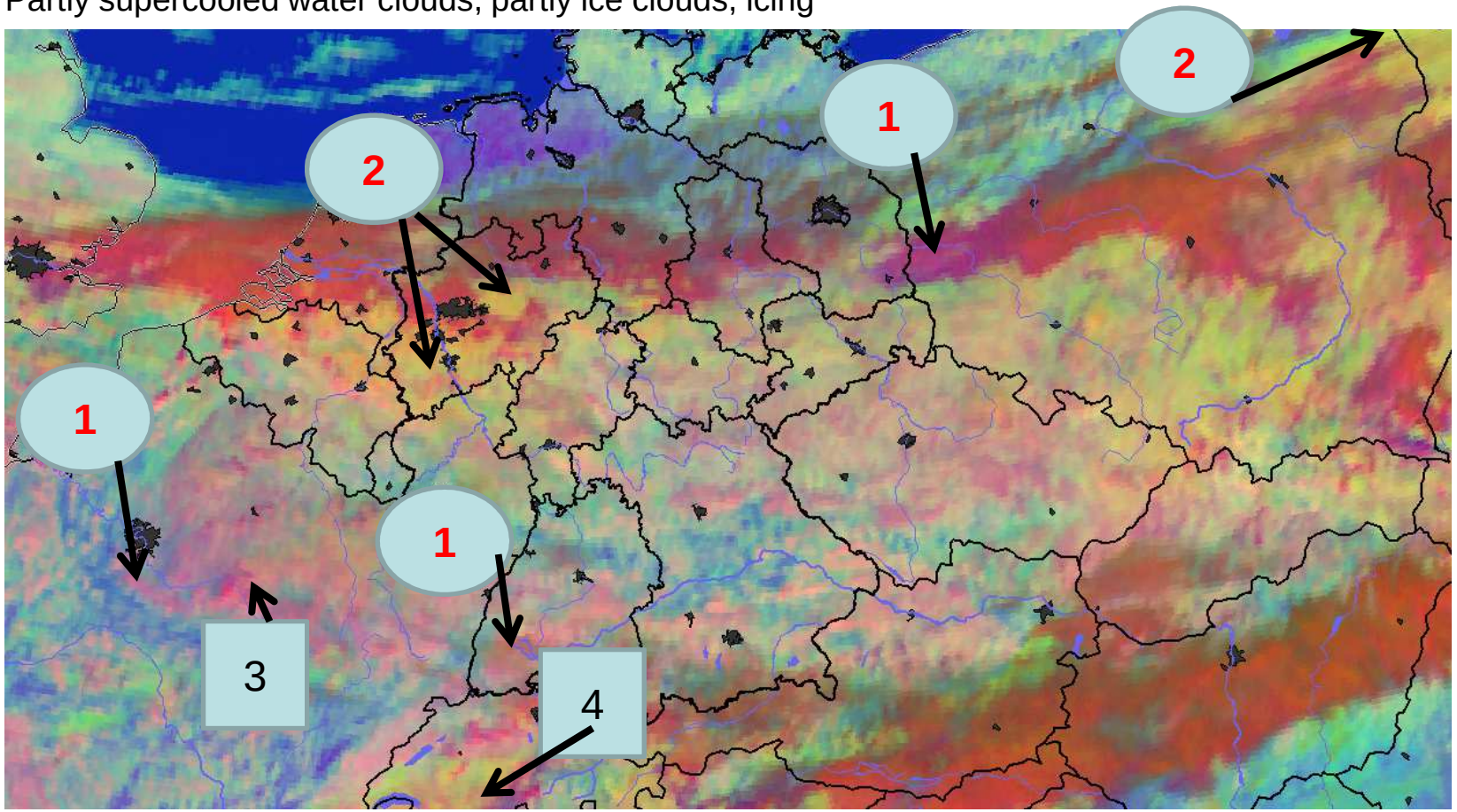
Please use the Chat and tell us which cloud type and weather you expect for cloud category 1. Please use the chat.



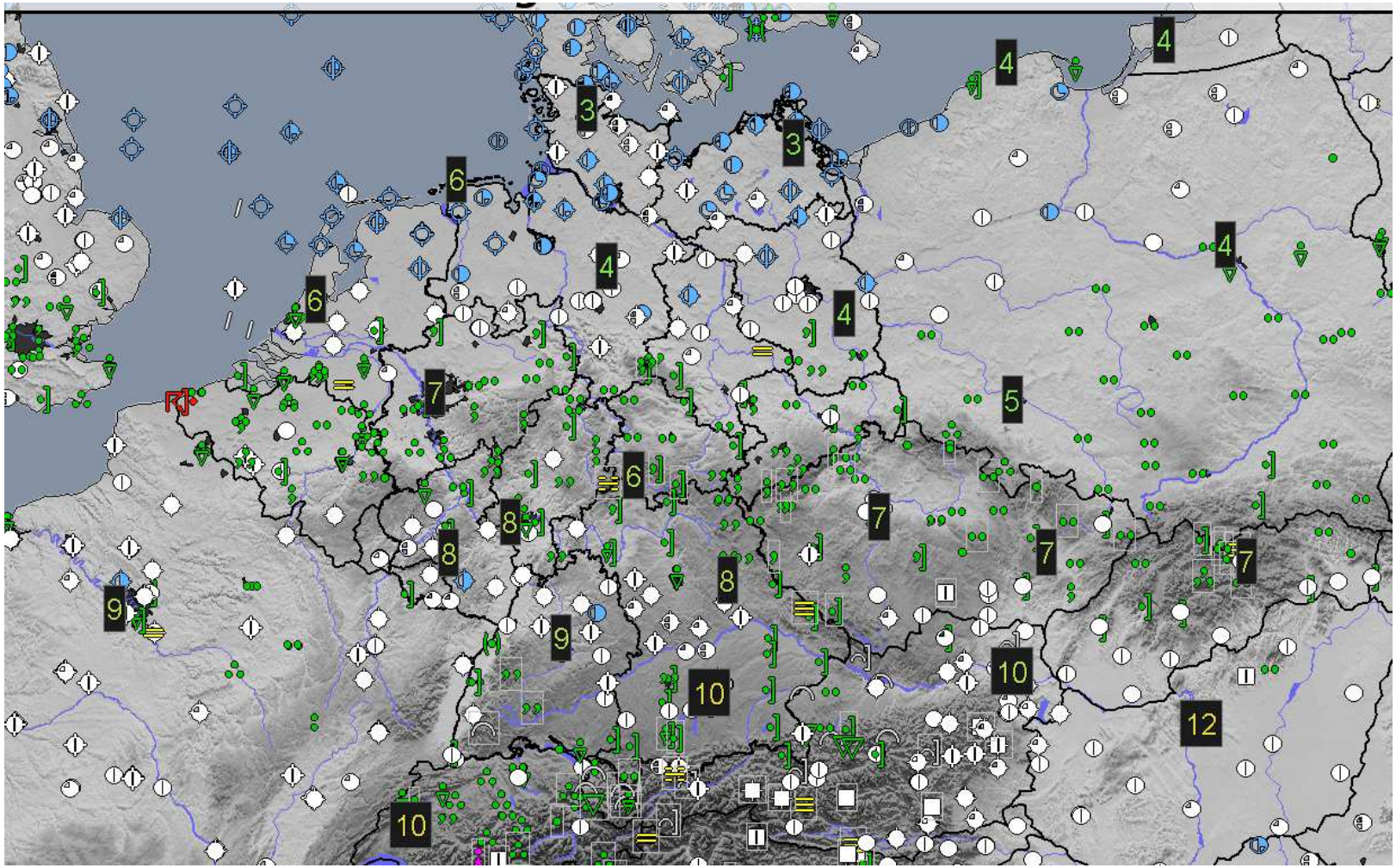
26-08-2014, 12 UTC: Day-Microphysics

1. Low water cloud, thick, precipitation (drizzle, partly light rain, about 0 degree)
2. Supercooled water cloud (-10 to -20 degree, some rain, icing!)

3. Thick water clouds, however, also partly ice clouds, icing
4. Partly supercooled water clouds, partly ice clouds, icing



26-08-2014, 12 UTC: ww + T in 850 hPa (front over Germany)



Summary

Recommended Schemes for RGB Image Composites (Interpretation: Corresponding colour schemes)

RGB	Applications	Time
1.6/0.8/0.6 (Day Natural Colour)	Vegetation, snow, fog (thickness) *whitish-pinkish: thicker fog/Stratus* *whitish: thinner fog/Stratus*	Day
1.6/HRV/HRV	Snow, fog (better spatial resolution) *similar to "Day Natural Colour"*	Day
0.8/3.9ref/10.8 (Day Microphysics)	Cloud diagnosis (ice, water clouds), thickness of clouds, icing, precipitation *yellow: thick cloud super cooled water (icing)* *green (bright/dark): thin cloud, super cooled water (icing)* *violet: warm water cloud (drizzle)* *whitish-greenish: thinner fog, St / pinkish-whitish: thicker fog/Stratus*	Day
0.8/1.6/3.9ref (day solar)	Snow, fog *whitish: thicker fog, St / whitish-bluish: thinner fog, Stratus*	Day

Explanations to (homework / quizzes), next steps

1. One set of multiple choice questions (about basics)
2. Two images for interpretation – like we did here
3. Please consider to deliver your homework (about 15 minutes working time) by 23rd November

4. Certificates (online students) will be distributed by mid of December, at latest
   - Email attachment
   - If you need the original please tell me
     - In that case: Please add your address

Langen, 24-01-2013, after freezing rain, followed by snow (T = -10 degree)

The trainers hope that you enjoyed the seminar so far.

Good travel to Langen for the „full students“

Thank you!

See you

Keep healthy!