Meteorological similarities and differences of the great European floods

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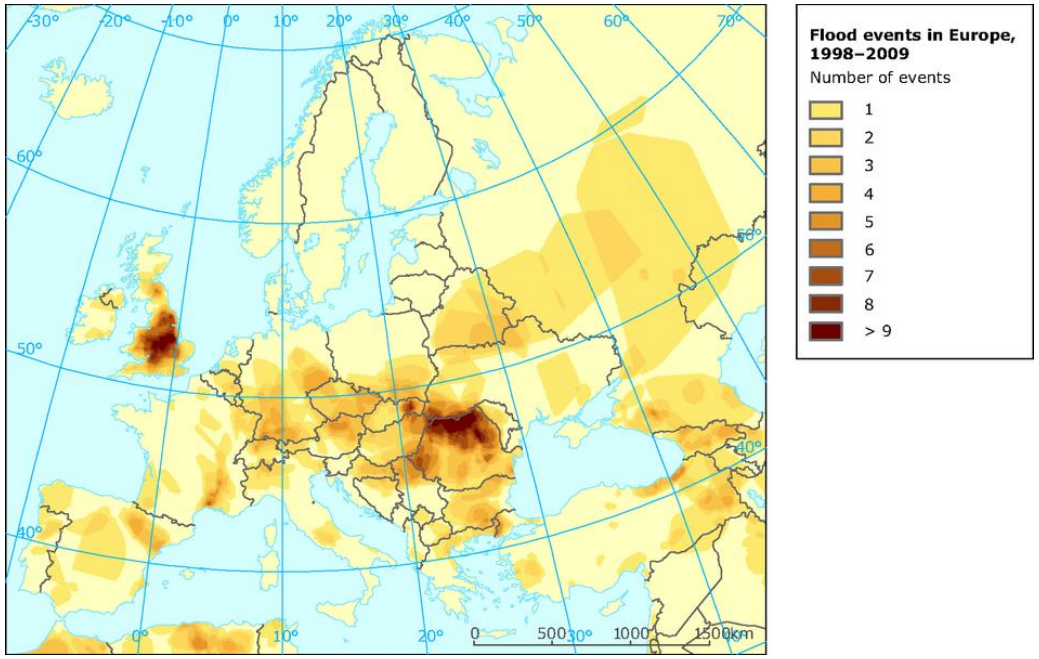
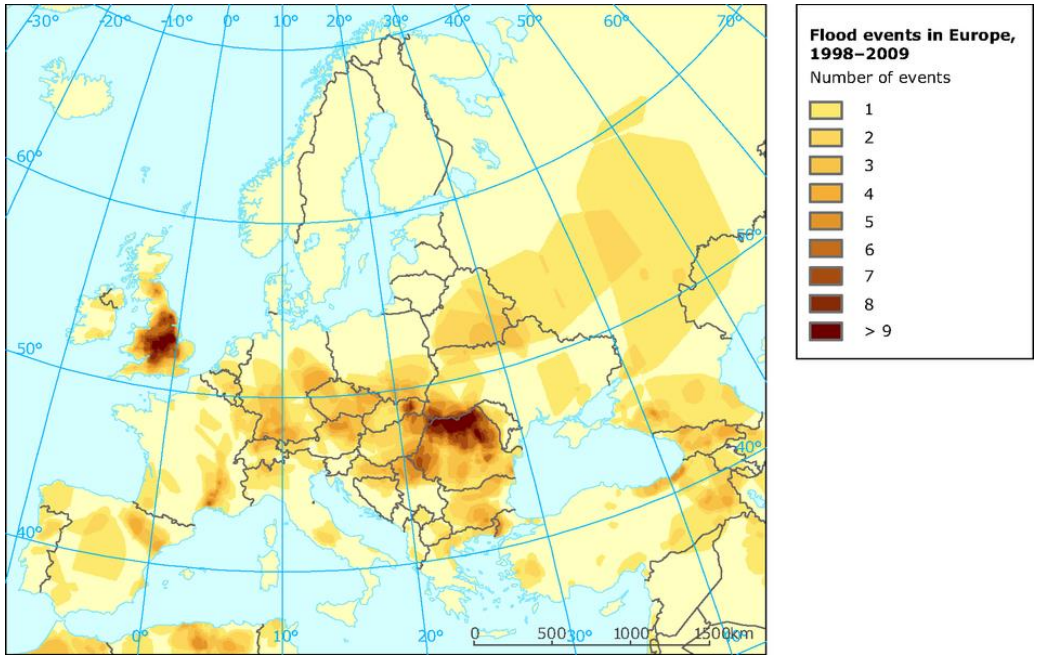
DHMZ – Meteorological and Hydrological Service, Croatia

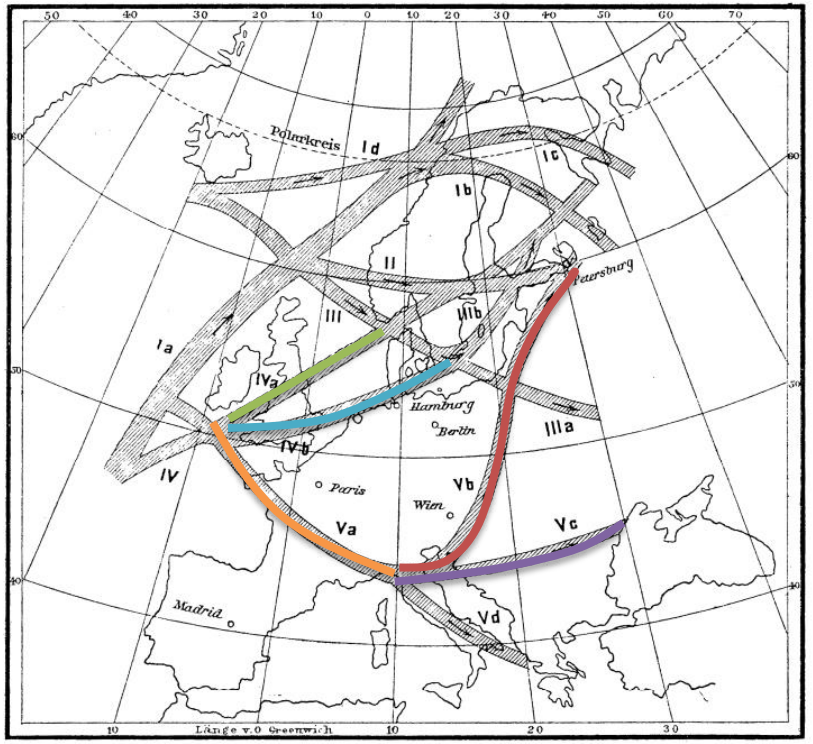
Europe floods 1998-2008



- Areas most frequently affected by catastrophic floods are Great Britain, and Central and Eastern Europe, especially Romania

Europe floods 1998-2008



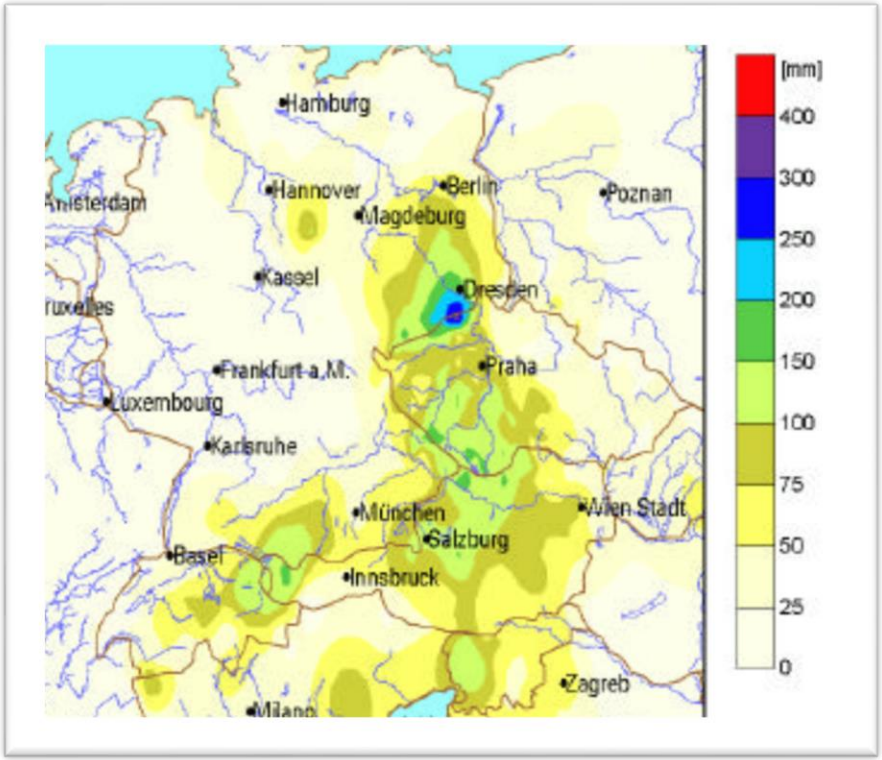


Zugstraßen der Minima in Europa nach W. J. v. Bebber und W. Köppen.

- **Va** cyclones bringing cold and moist air from the Atlantic
  - Intensified in the lee of the Alps in the Genoa bay
  - Moving along **Vb** or **Vc** track bringing heavy rain to either Central or Eastern Europe
- Floods in England usually caused by cyclones moving along **IVa** or **IVb** track

2002 - Floods in Central Europe

- Czech Republic, Austria, Germany, Slovakia, Poland, Hungary, Romania and Croatia affected

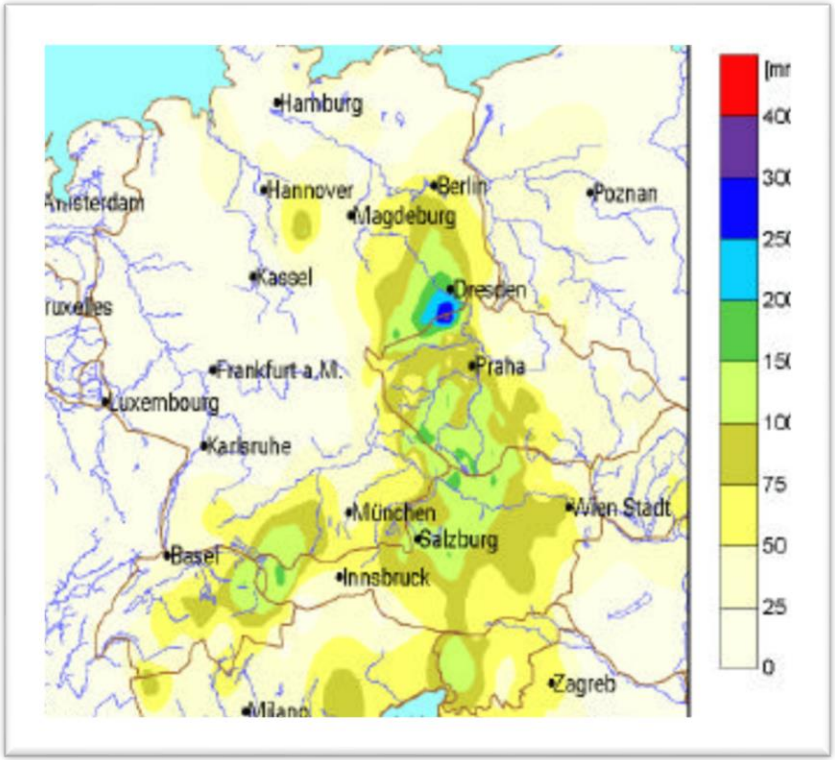


Precipitation observations
from 10 to 13 August 2002

- 100 fatalities
- >15 billion euro damages
- Extreme precipitation, at Zinnwald station in Germany 312 mm in 24 hours – highest amount of daily precipitation ever measured in Germany
- Vltava submerged parts of Prague on 13-15 August
- Elbe flooded Dresden

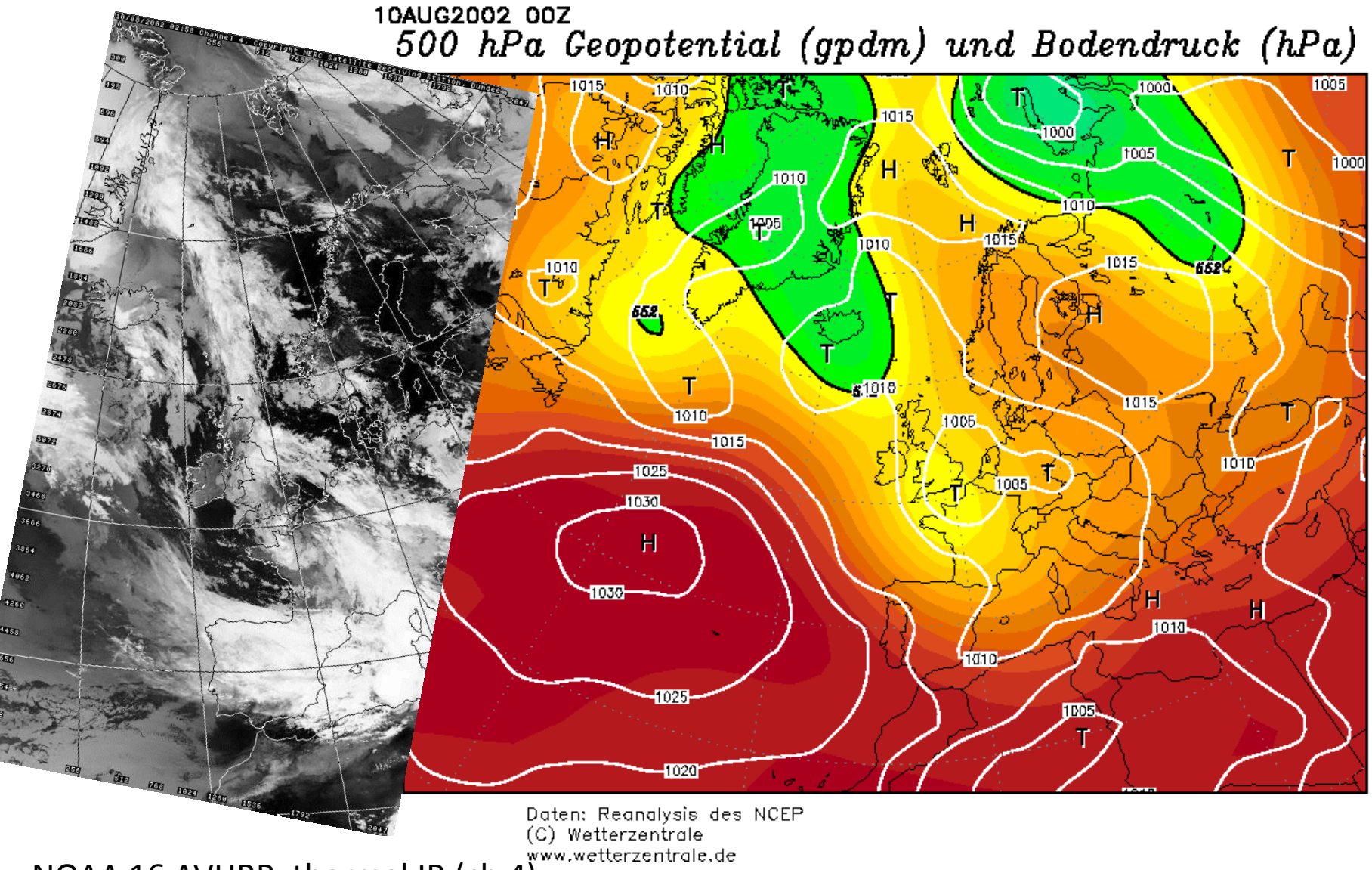
2002 - Floods in Central Europe

- Czech Republic, Austria, Germany, Slovakia, Poland, Hungary, Romania and Croatia affected
- >15 billion euro damages

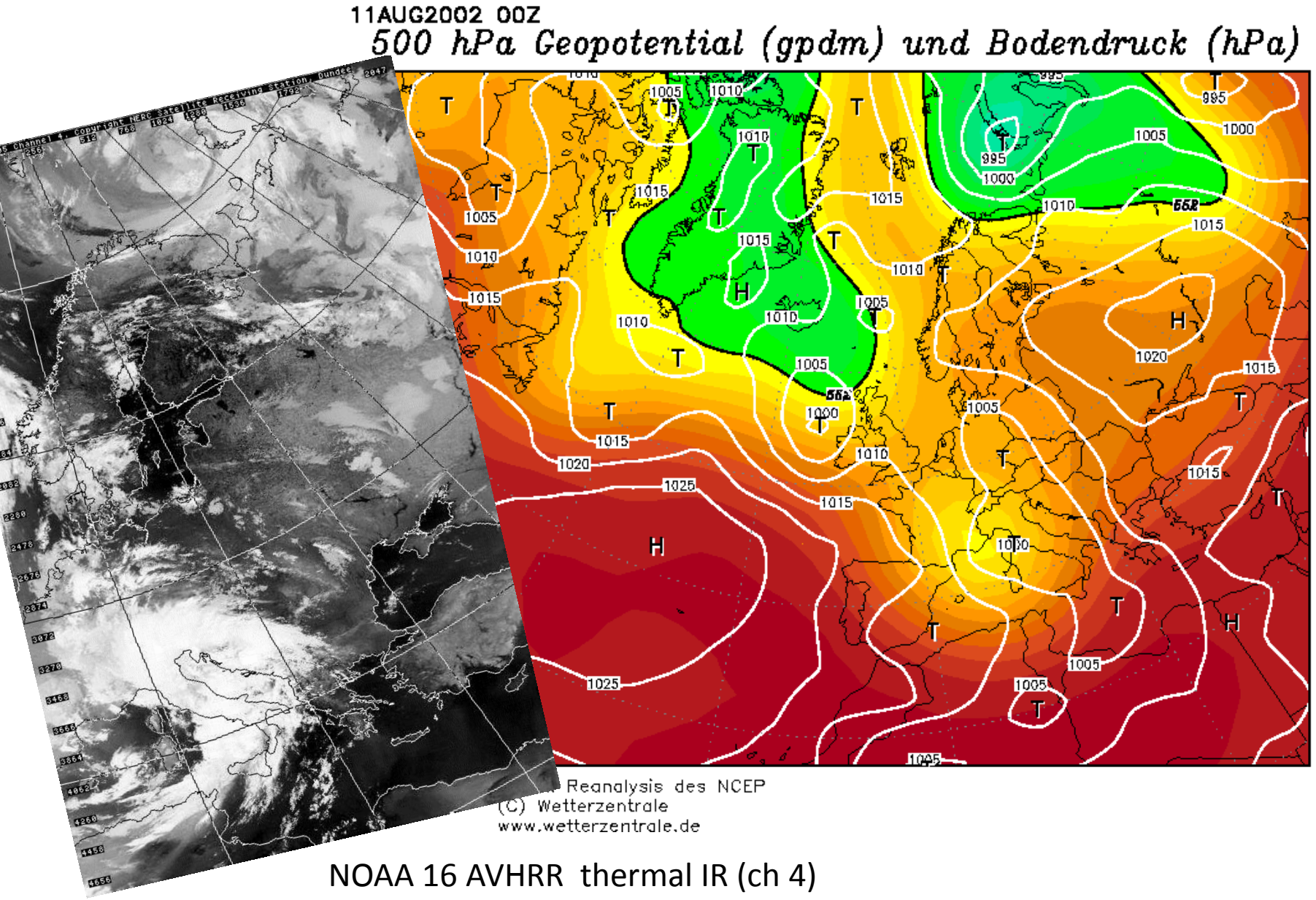


Precipitation observations from 10 to 13 August 2002

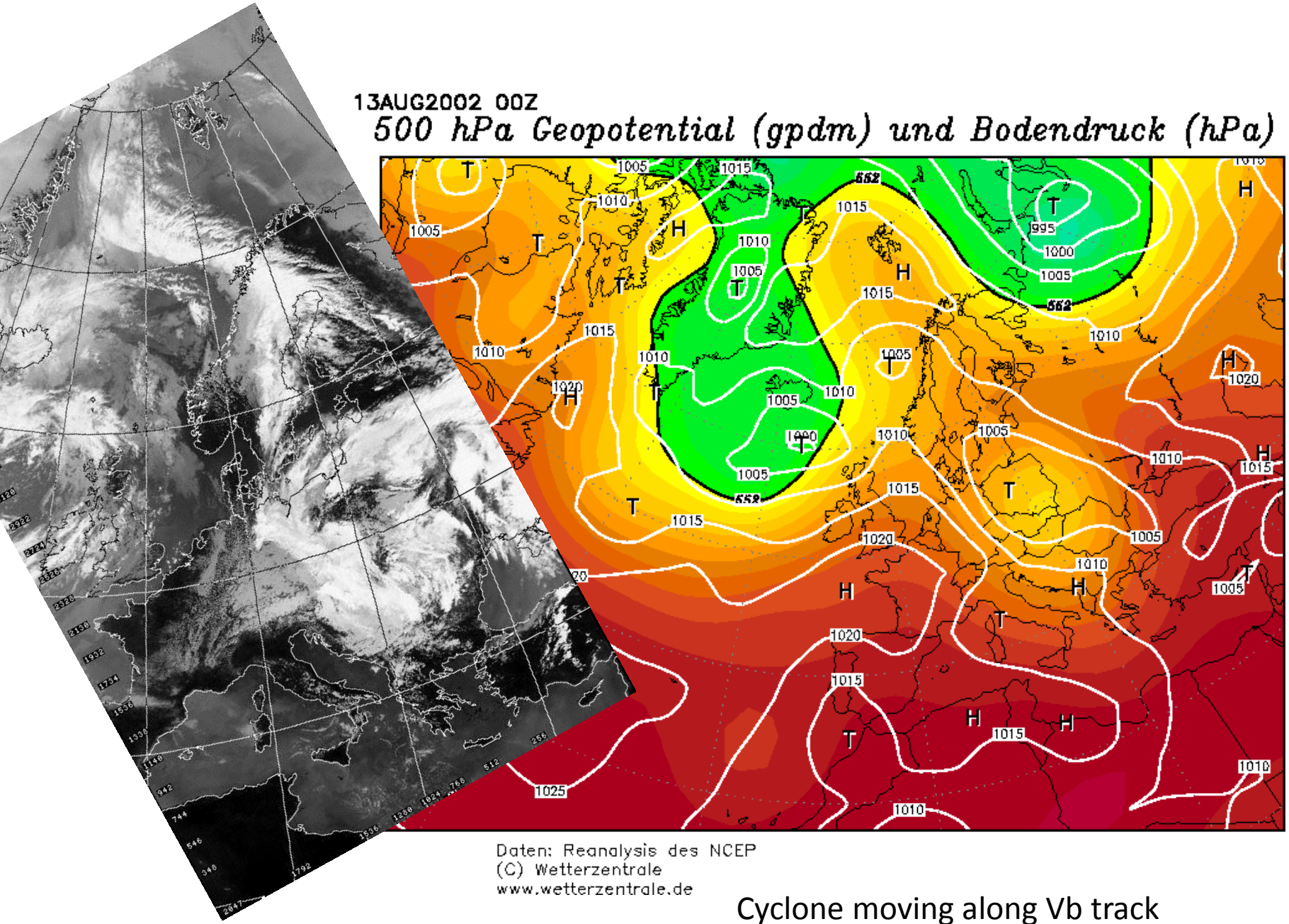
Track of the "Vb-low" with indication of the core pressure (map by M. Neumann, DWD).



NOAA 16 AVHRR thermal IR (ch 4)
10 August 2002, 10:48 UTC

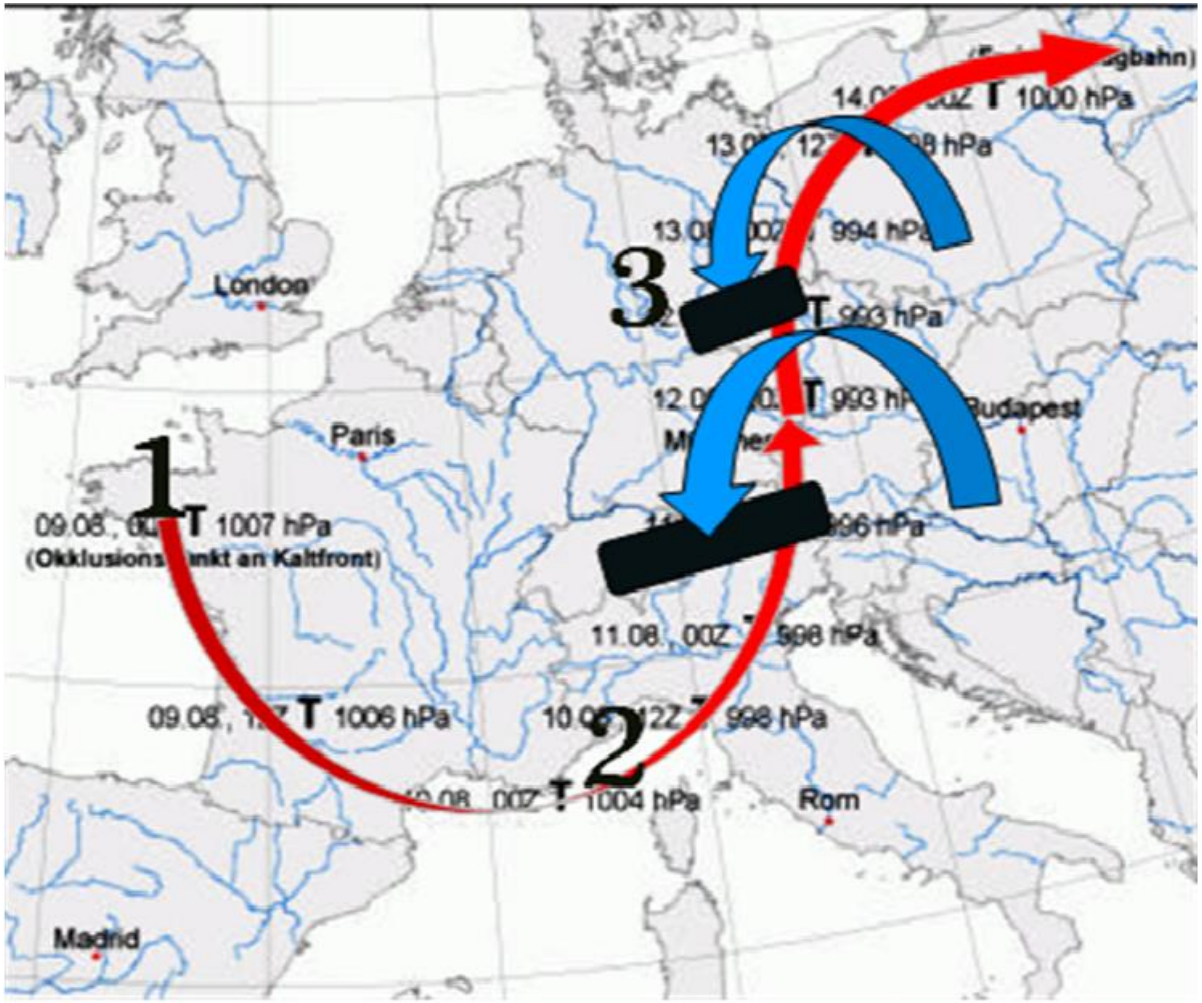


NOAA 16 AVHRR thermal IR (ch 4)
11 August 2002, 01:05 UTC



NOAA 16 AVHRR thermal IR
13 August 2002 12:19 UTC

Cyclone moving along Vb track
Cut-off low at 500 hPa



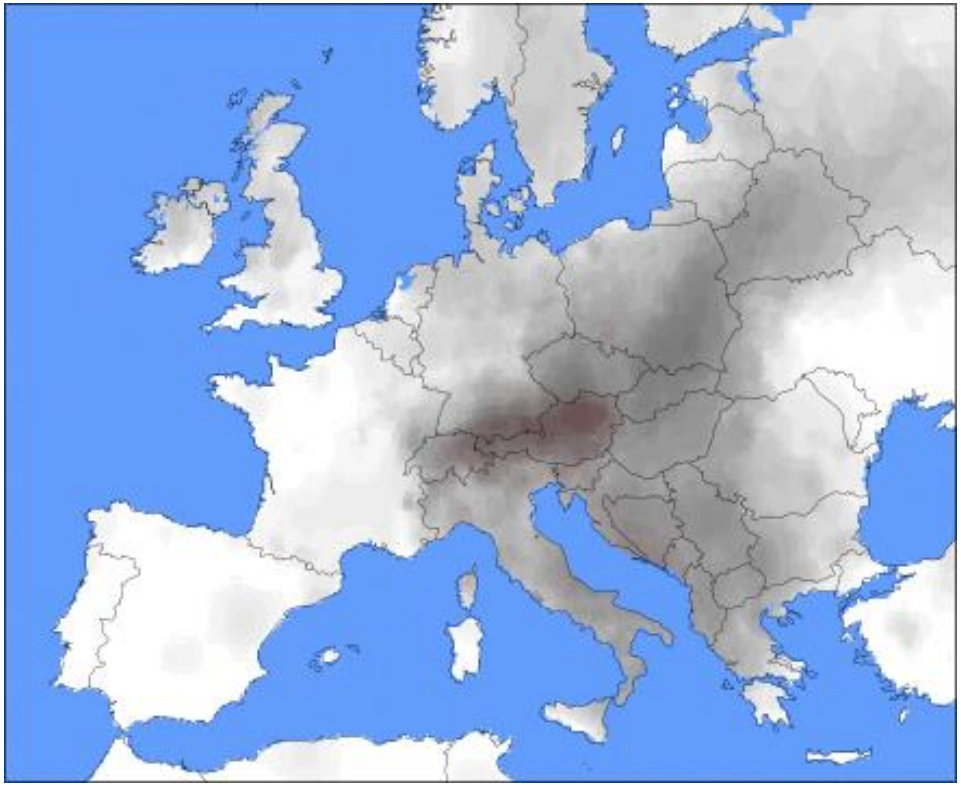
- Cyclone track and the orographic influence – movement of the air-mass towards the orography within the cyclonic rotation

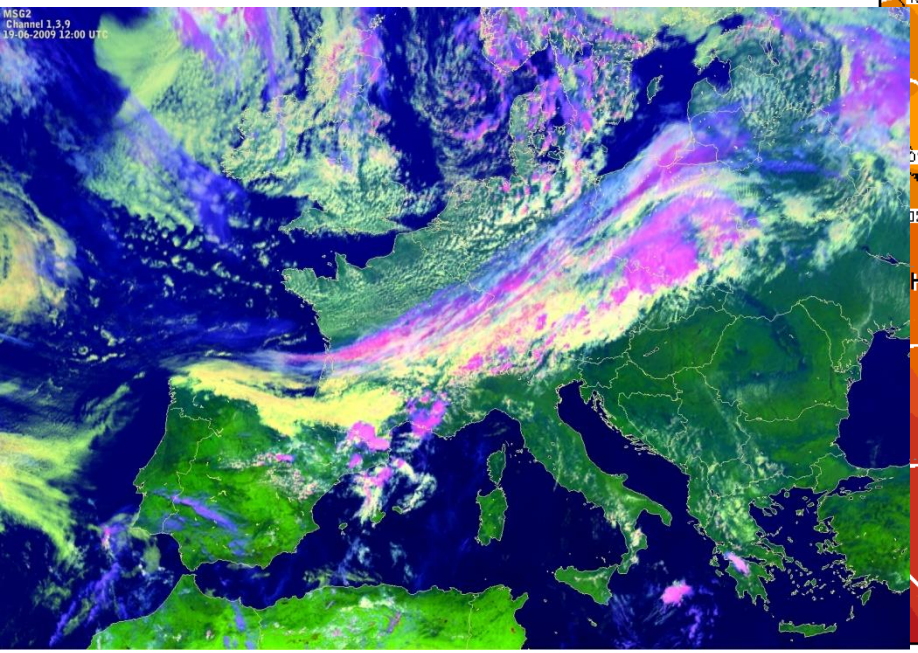
From: Rudolf and Rapp (2003), Hofstätter (2011)

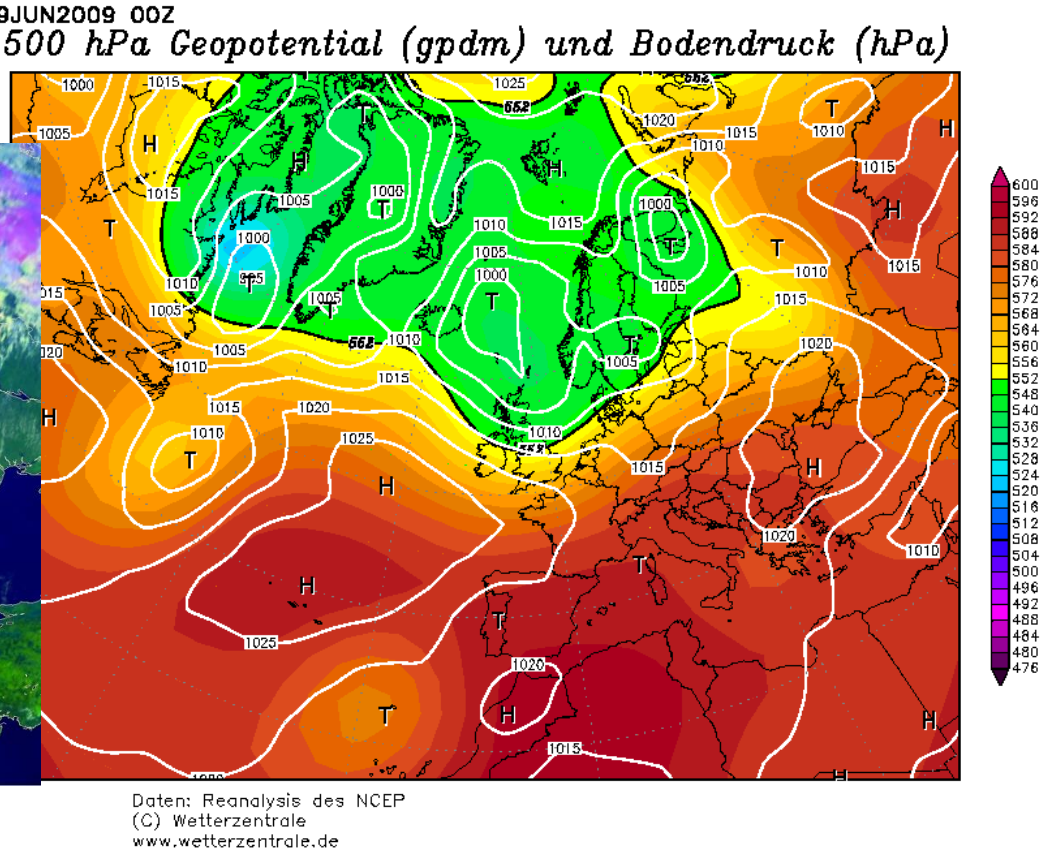
2009 European floods

- Austria, Czech Republic, Hungary, Poland, Romania, Slovakia, Turkey affected
- 33 fatal victims

Precipitation
June 19–24, 2009

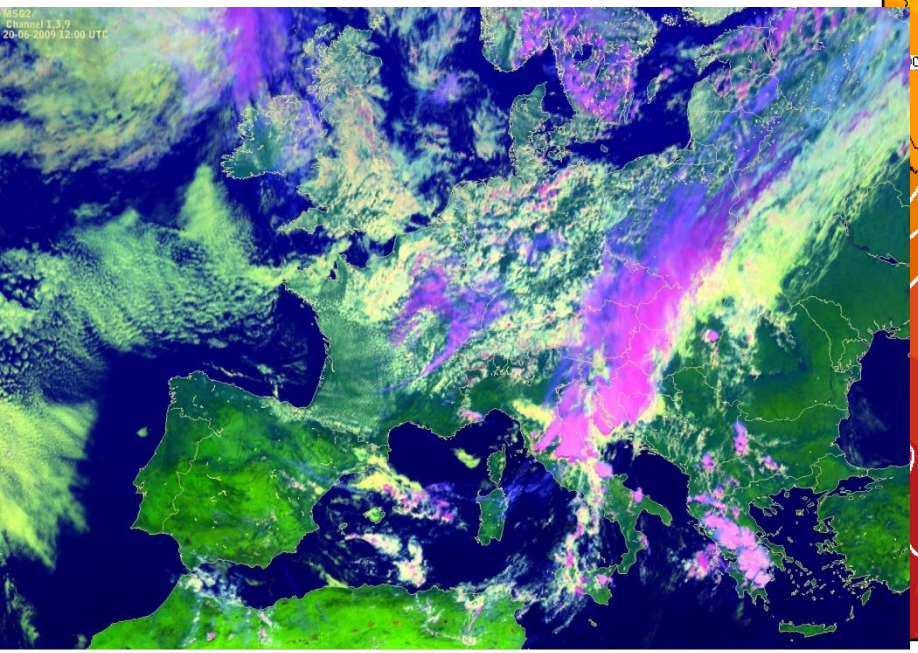


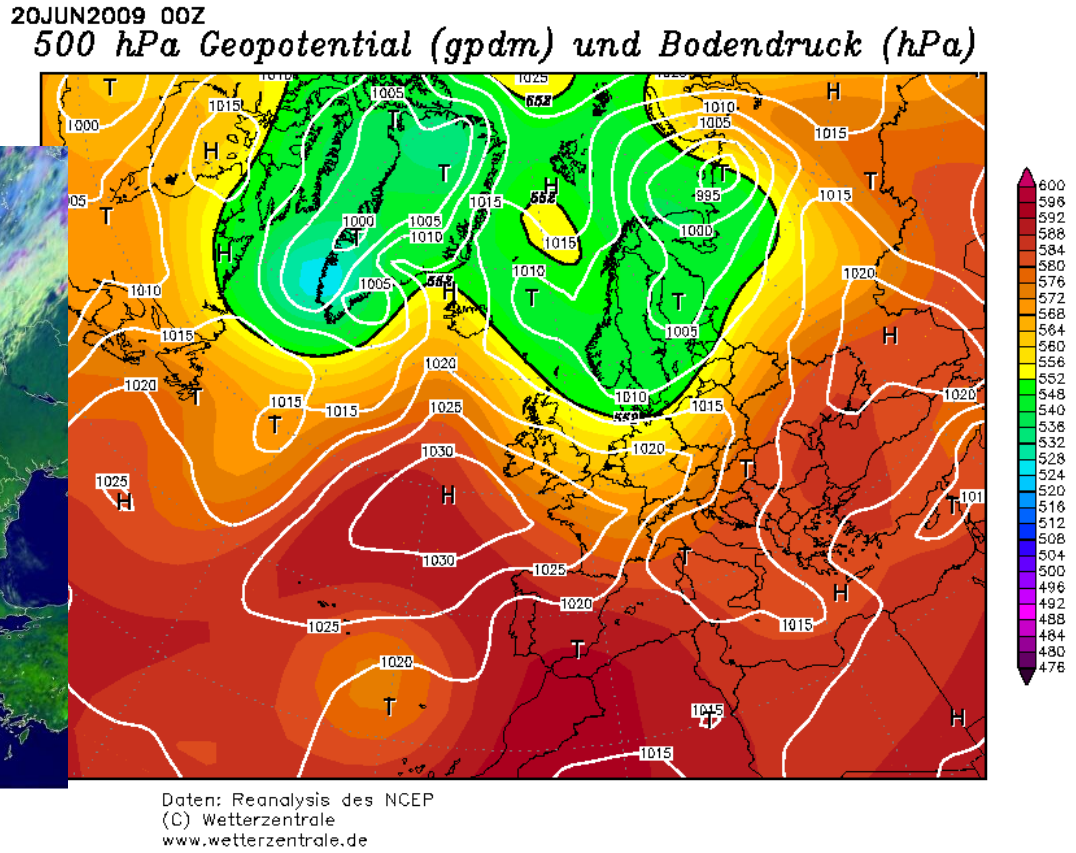




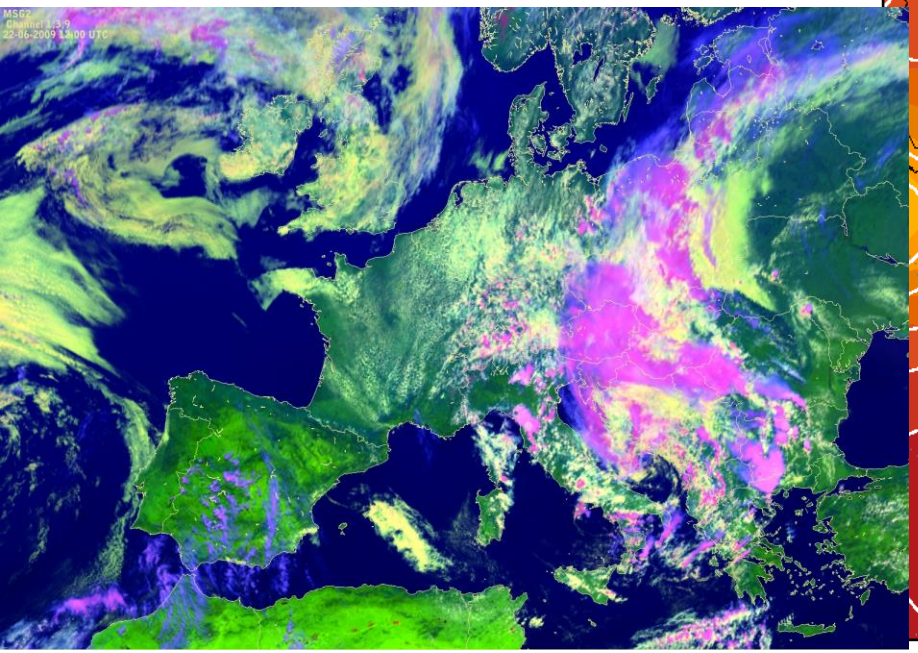
MSG, 0.6, 1.6, 10.8 µm RGB
19 June 2009, 12 UTC

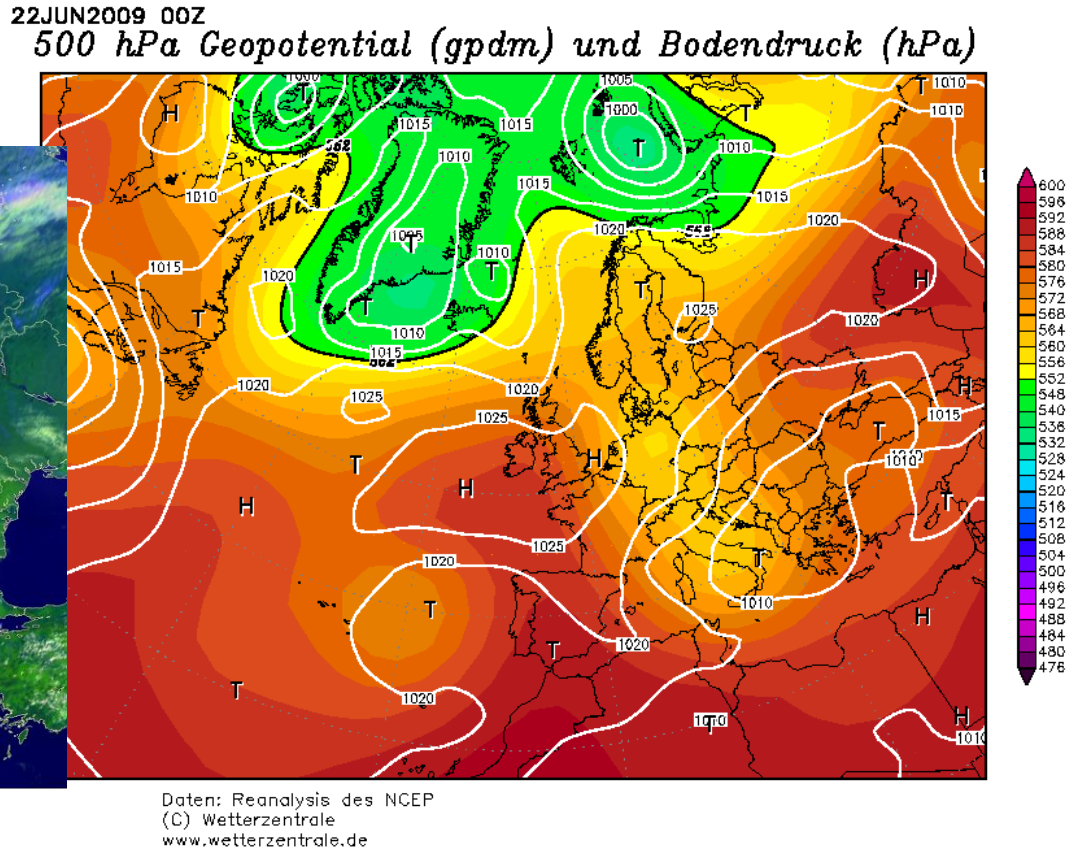
- Cold front moved across west Europe on 19 June
- cold air advancing towards the continent



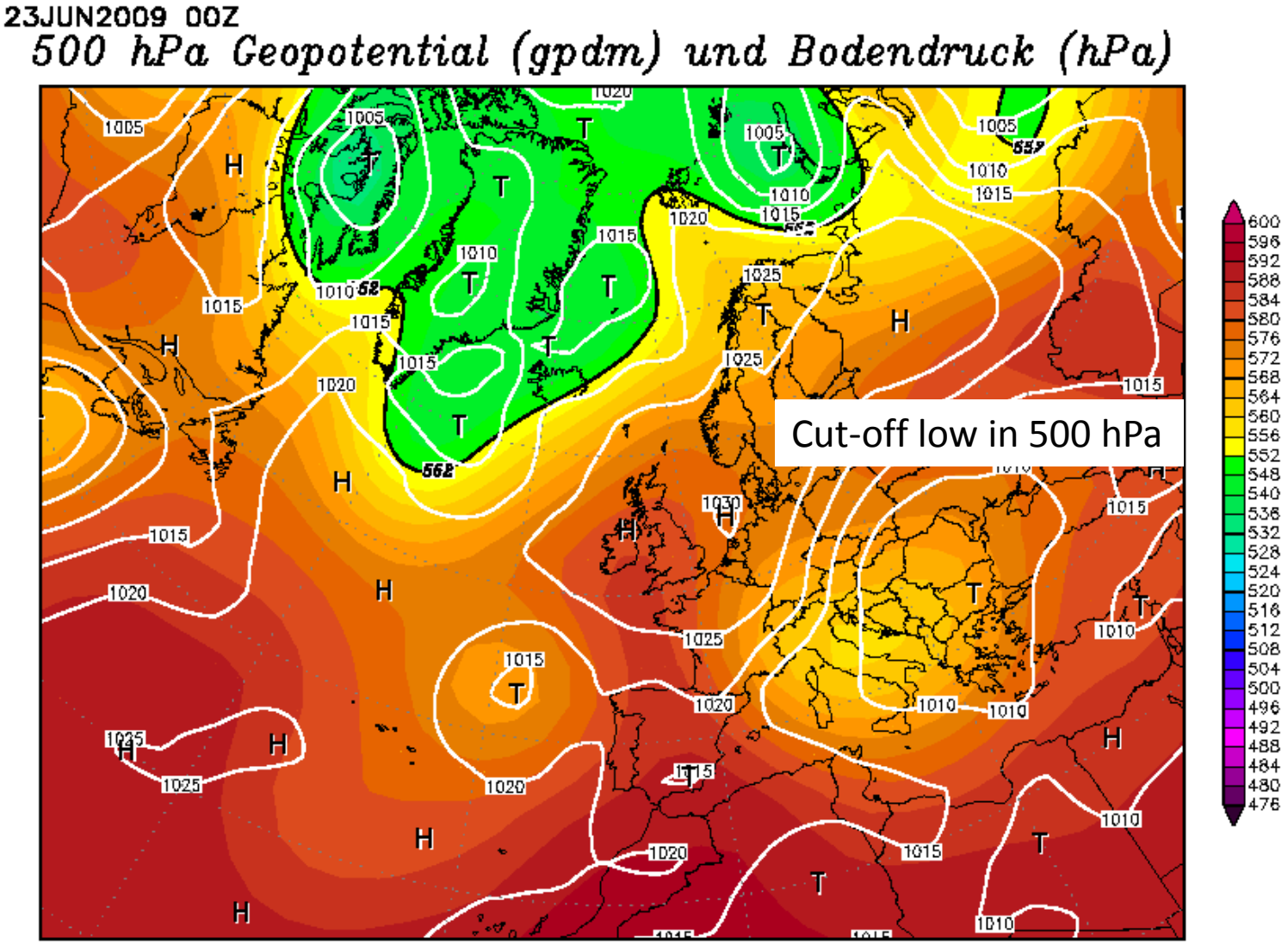


- In 24 hours front has moved over the Alps
- Cyclogenesis starts over Italy

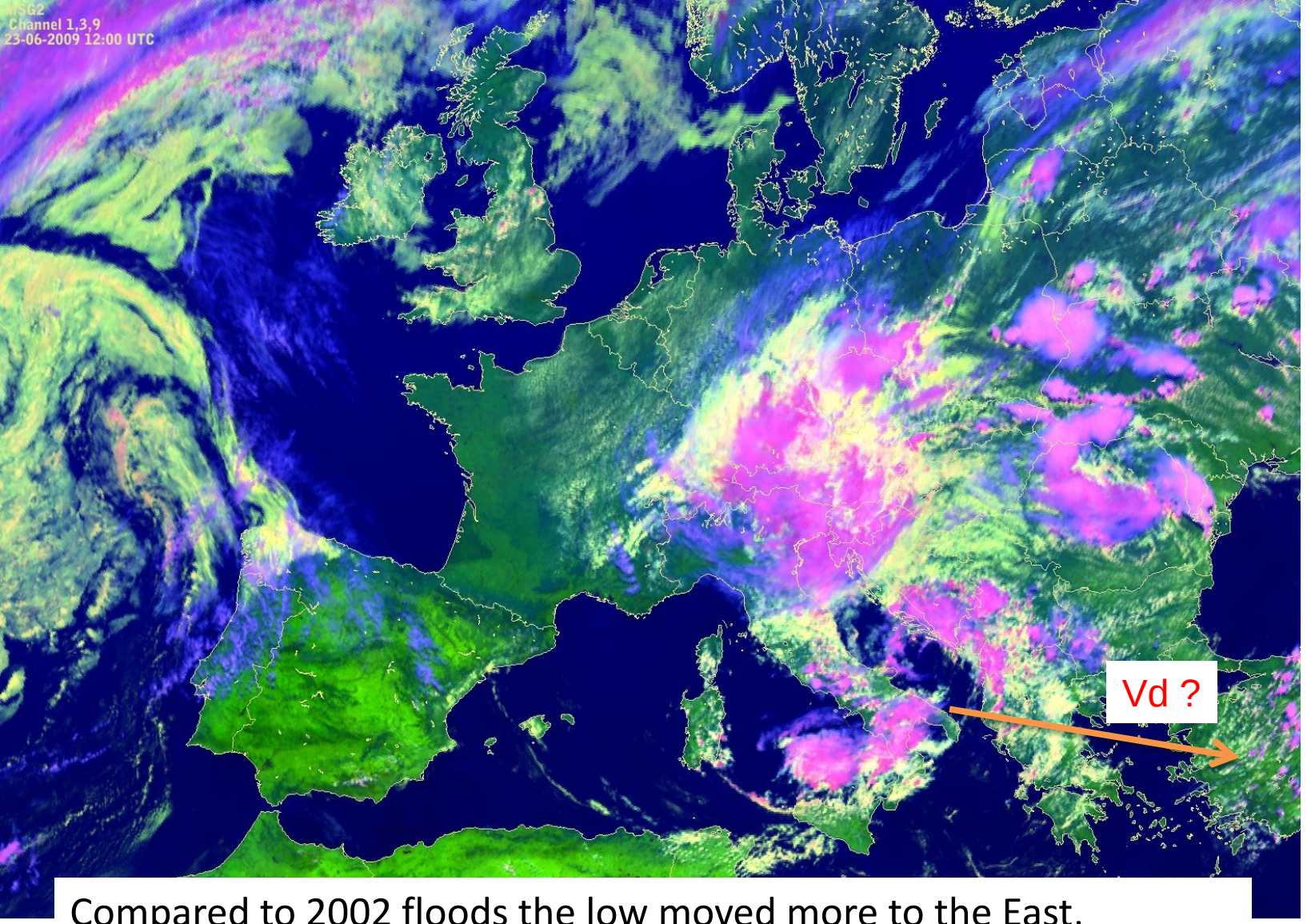




- The low moves to south Adriatic
- Cut off at 500 hPa



- Surface low coincides with 500hPa low

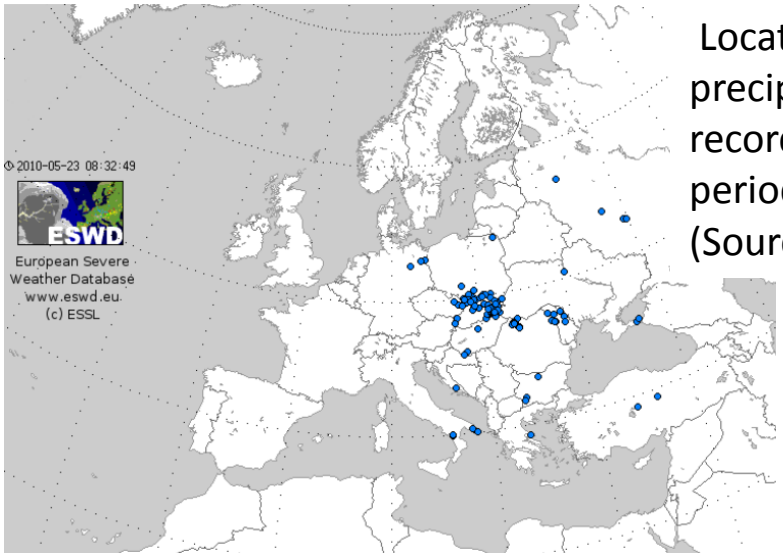


Compared to 2002 floods the low moved more to the East, towards South Adriatic

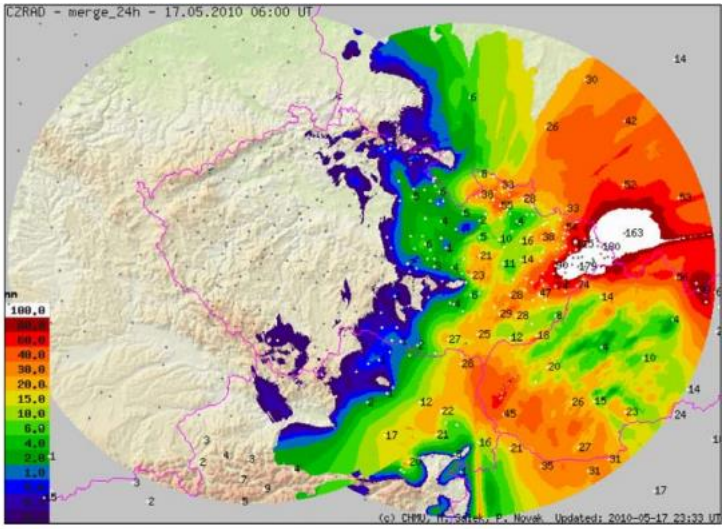
Highest precipitation amounts on the northern slopes of the Alps due to orographic effect

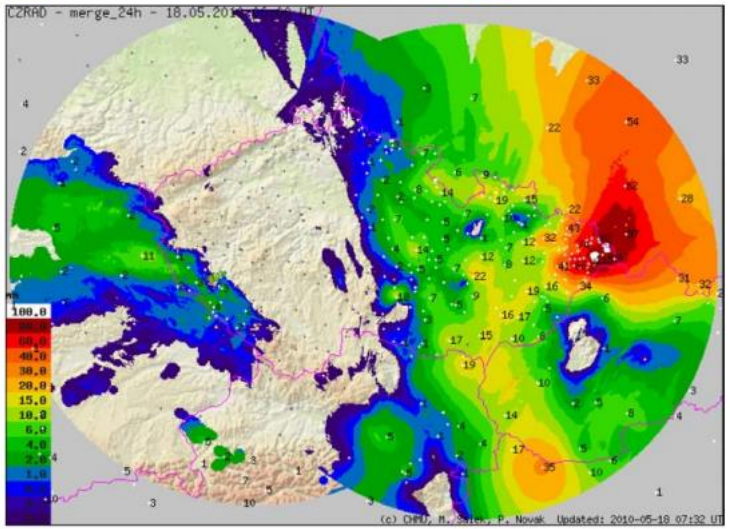
2010 – Floods in Central Europe

- Poland was the worst affected.
- Austria, Czech Republic, Germany, Hungary, Slovakia, Serbia and Ukraine also affected.
- 37 fatalities
- 23.000 people evacuated

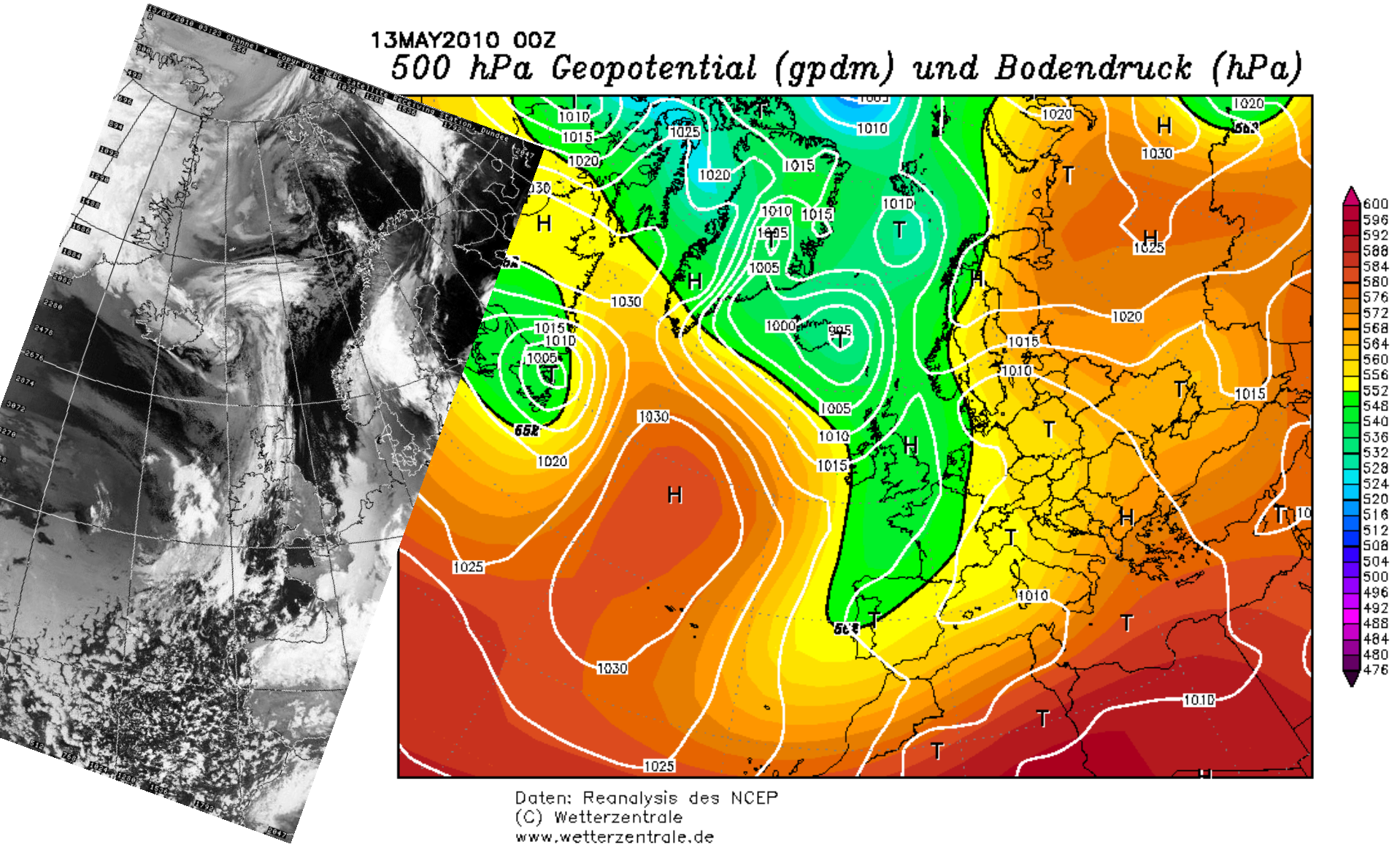


Locations of severe precipitation events recorded during the period 16-23 May 2010 (Source: ESWD)

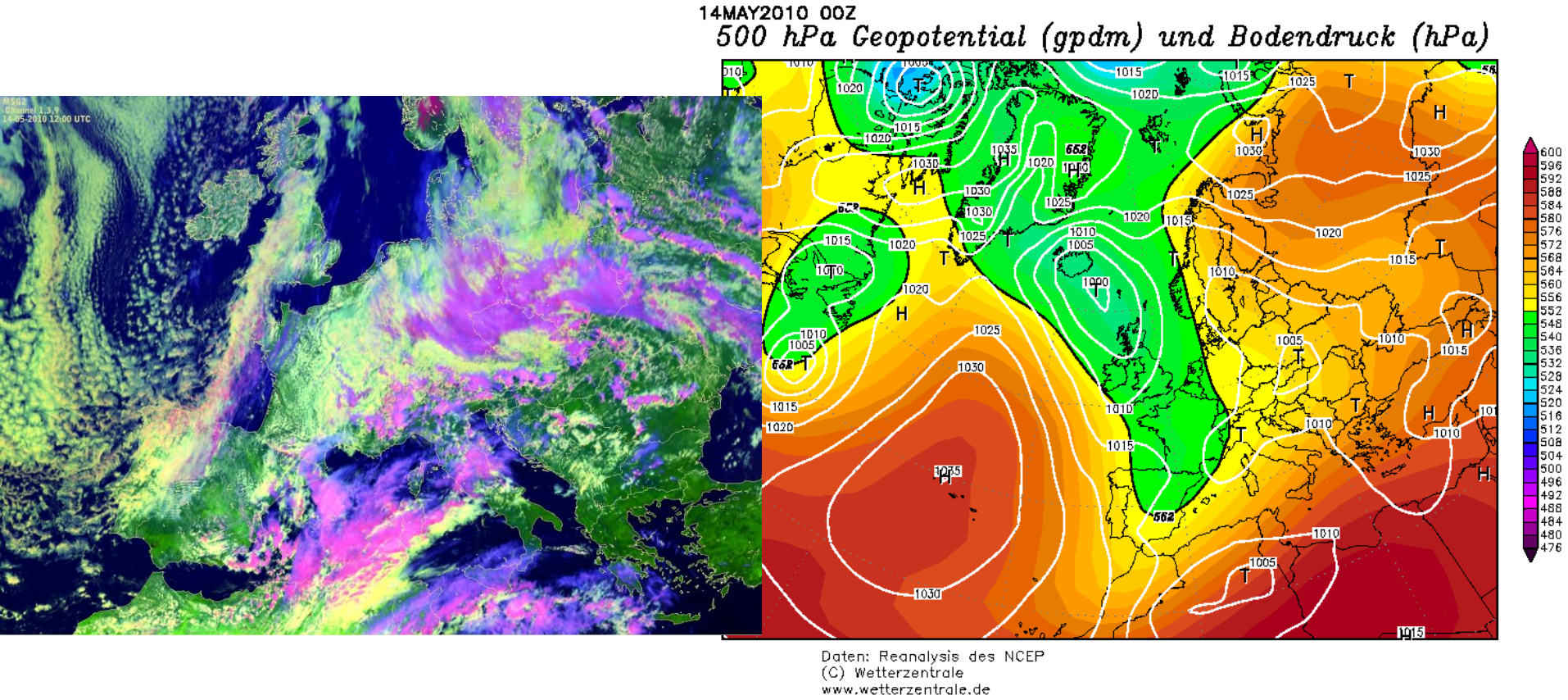




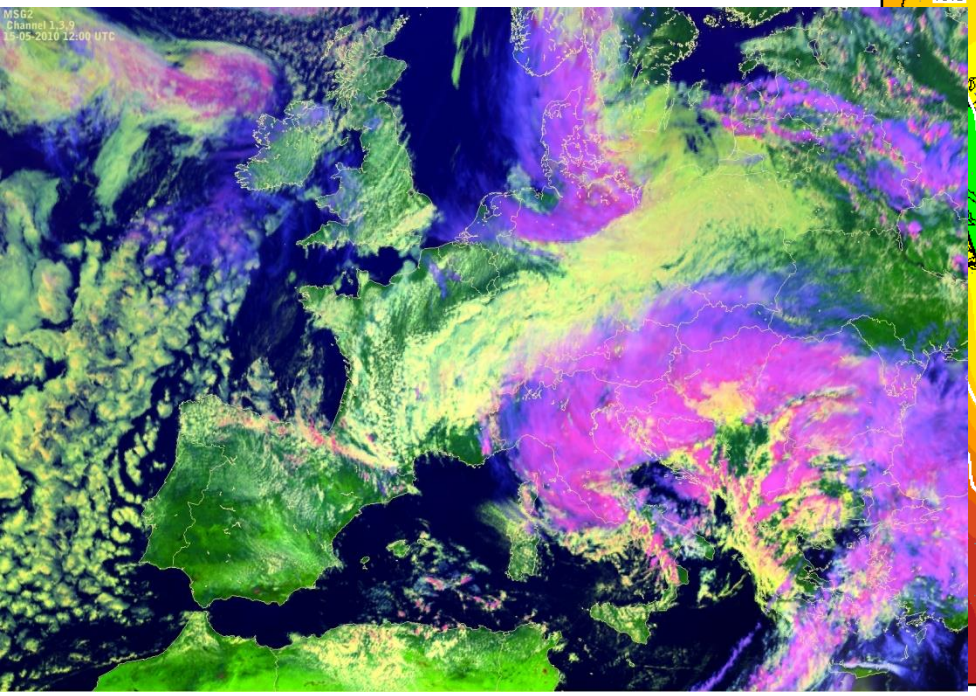
Accumulated Precipitation Amounts over Eastern Czech Republic and Southern Poland for 16-17 May 2010 and 17-18 May 2010 (Source: Czech Hydrometeorological Institute)

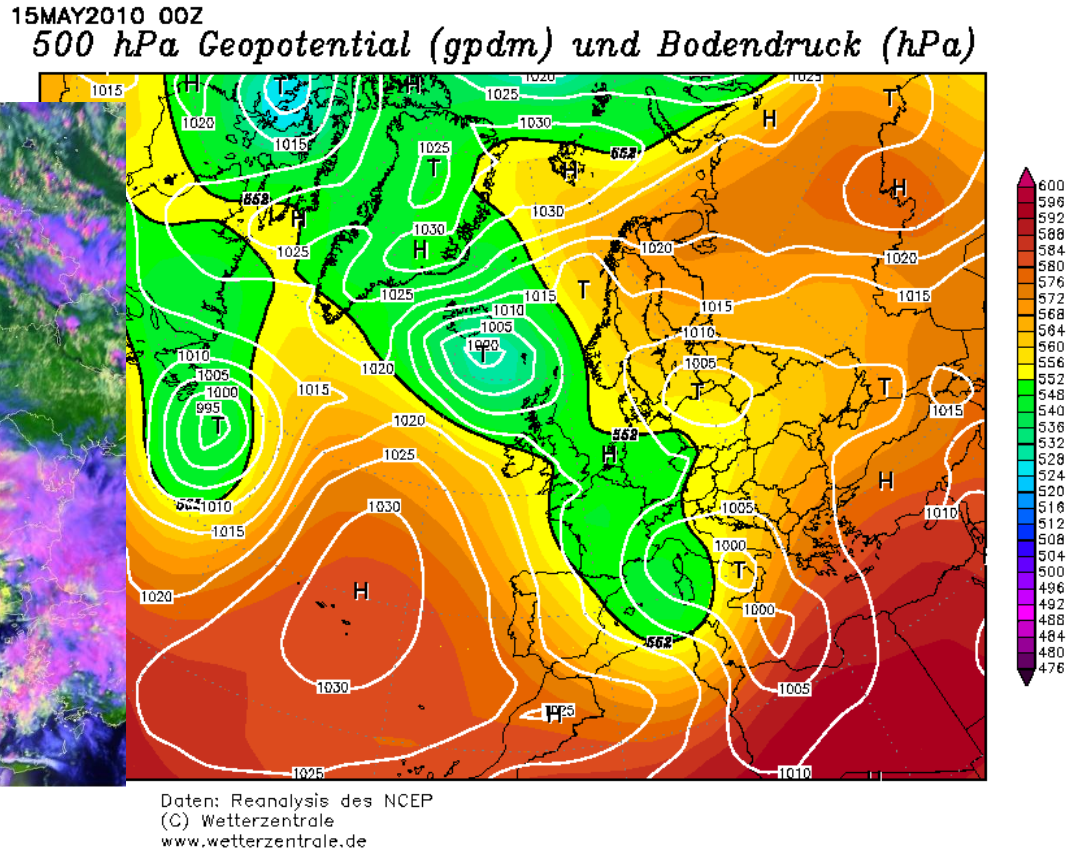


NOAA 19 AVHRR thermal IR
13 May 2010 03:23 UTC

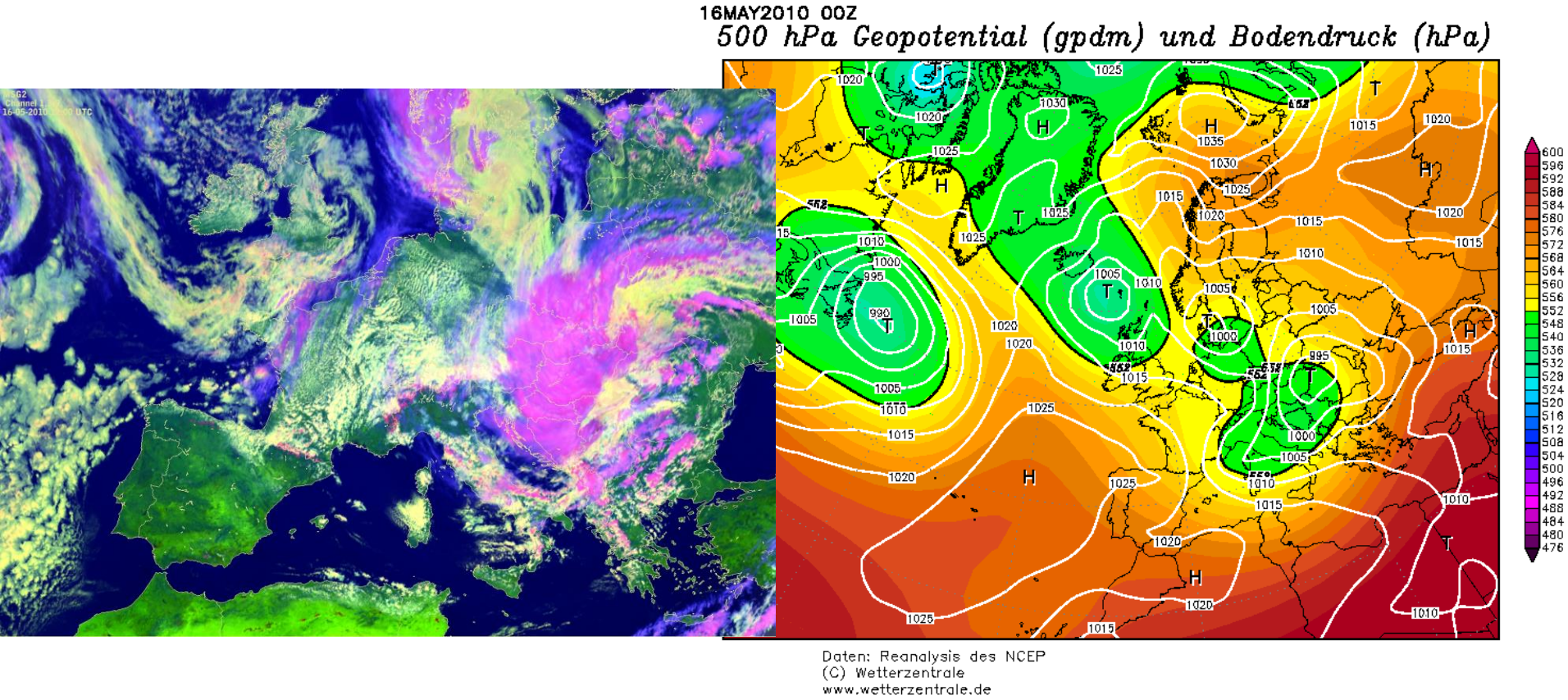


- Upper lever trough stretches towards Iberian peninsula

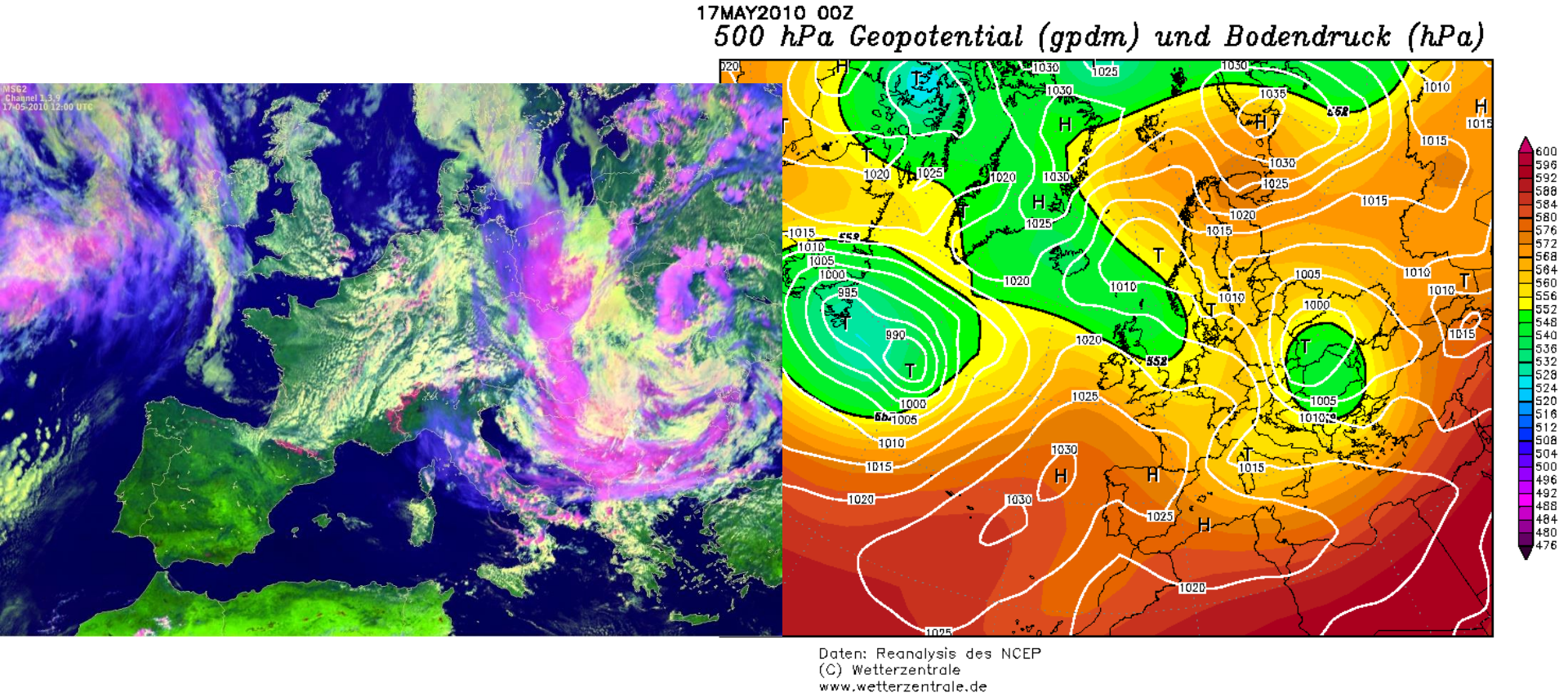




- Surface low forms over Italy
- Cut-off starts at 500 hPa, center of the upper-level low in Genoa Bay



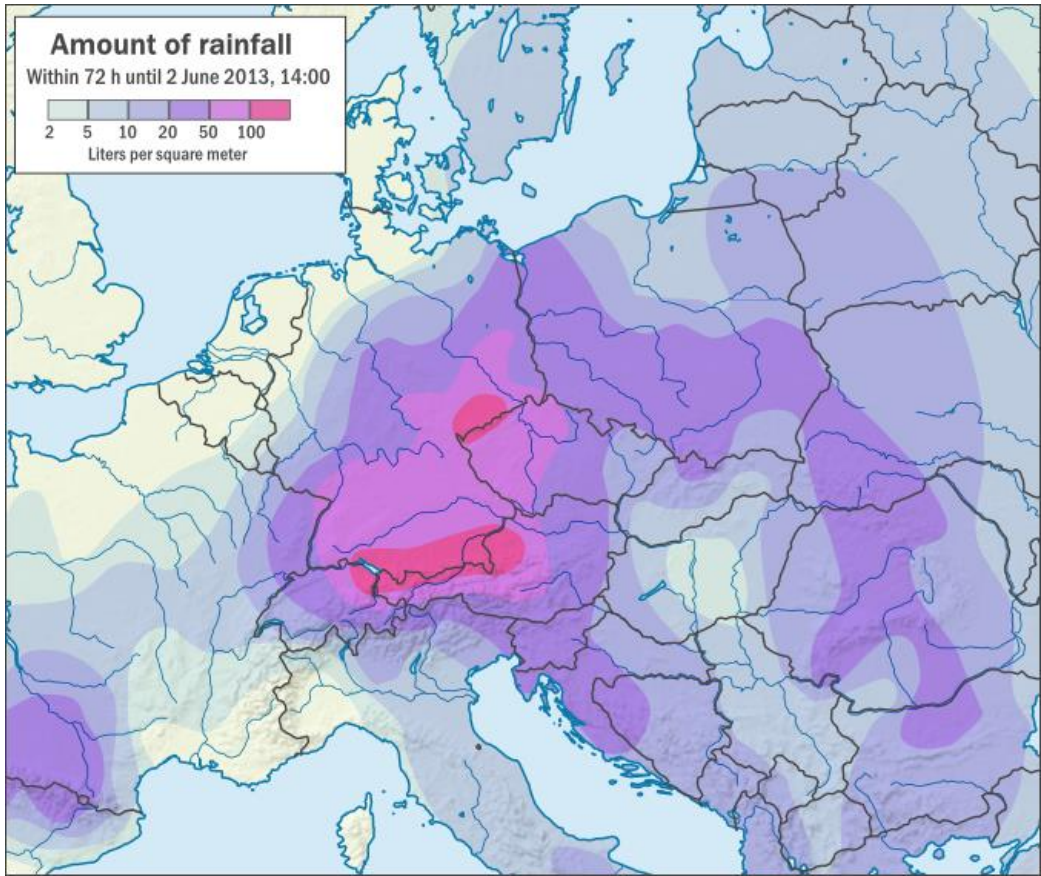
- low moves towards Black Sea (Vc track)

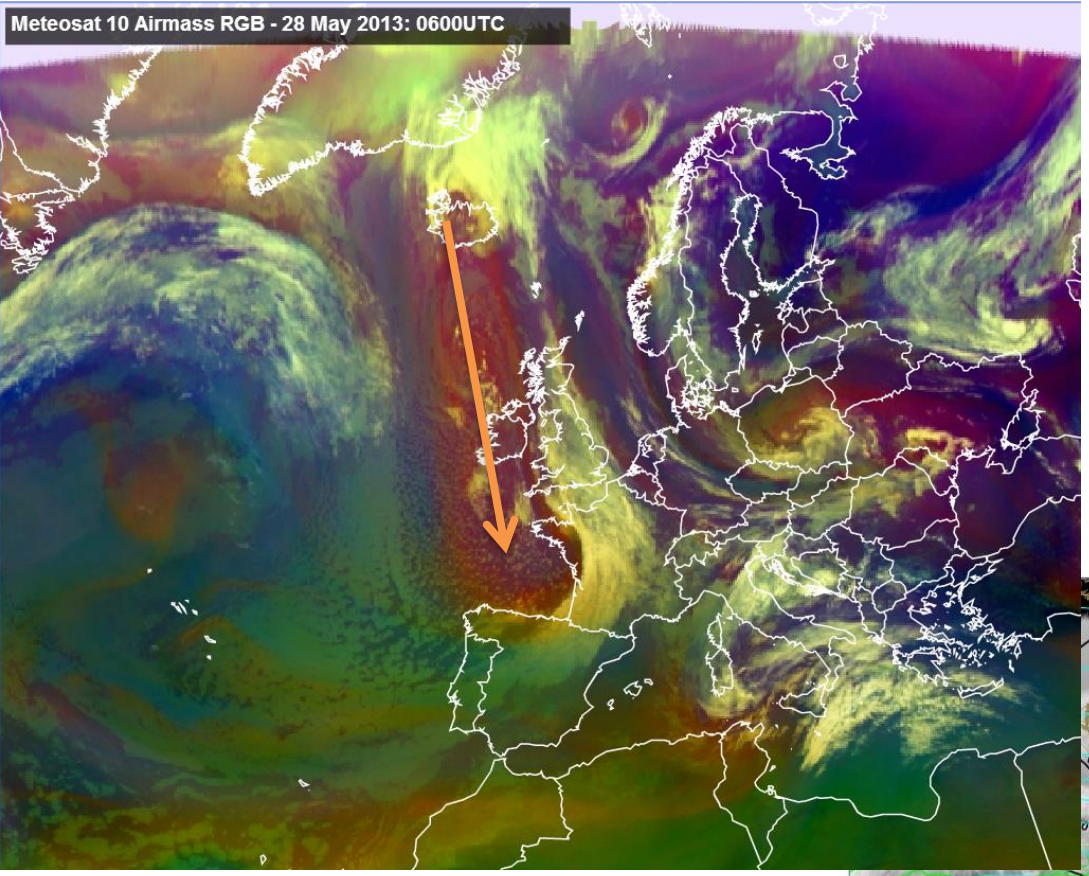


- Surface cyclone moving along Vc track
- Cut-off low in 500 hPa
- In this case the low was even more to the east, bringing the heaviest precipitation to Central and Eastern Europe, especcially southern Poland

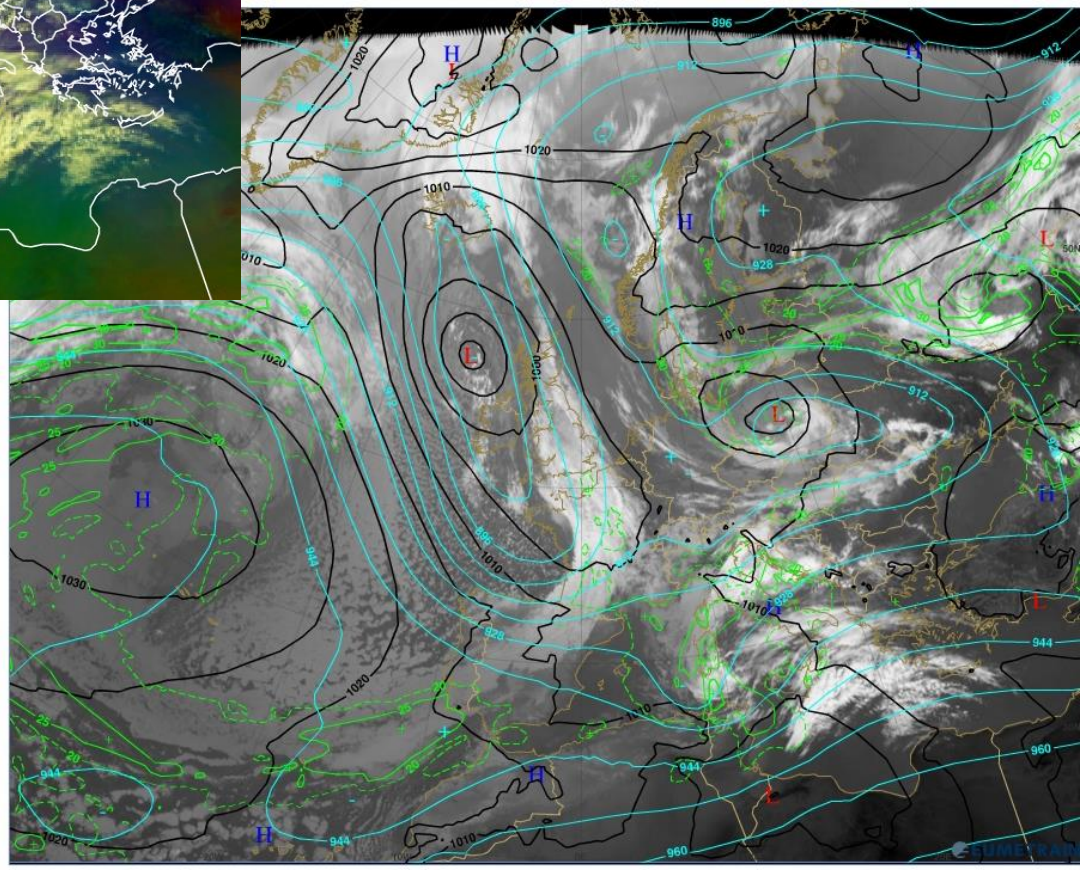
2013 European Floods

- Austria, Czech Republic, Germany, Hungary, Poland, Slovakia and Switzerland affected
- 25 fatalities
- 12 billion euro losses

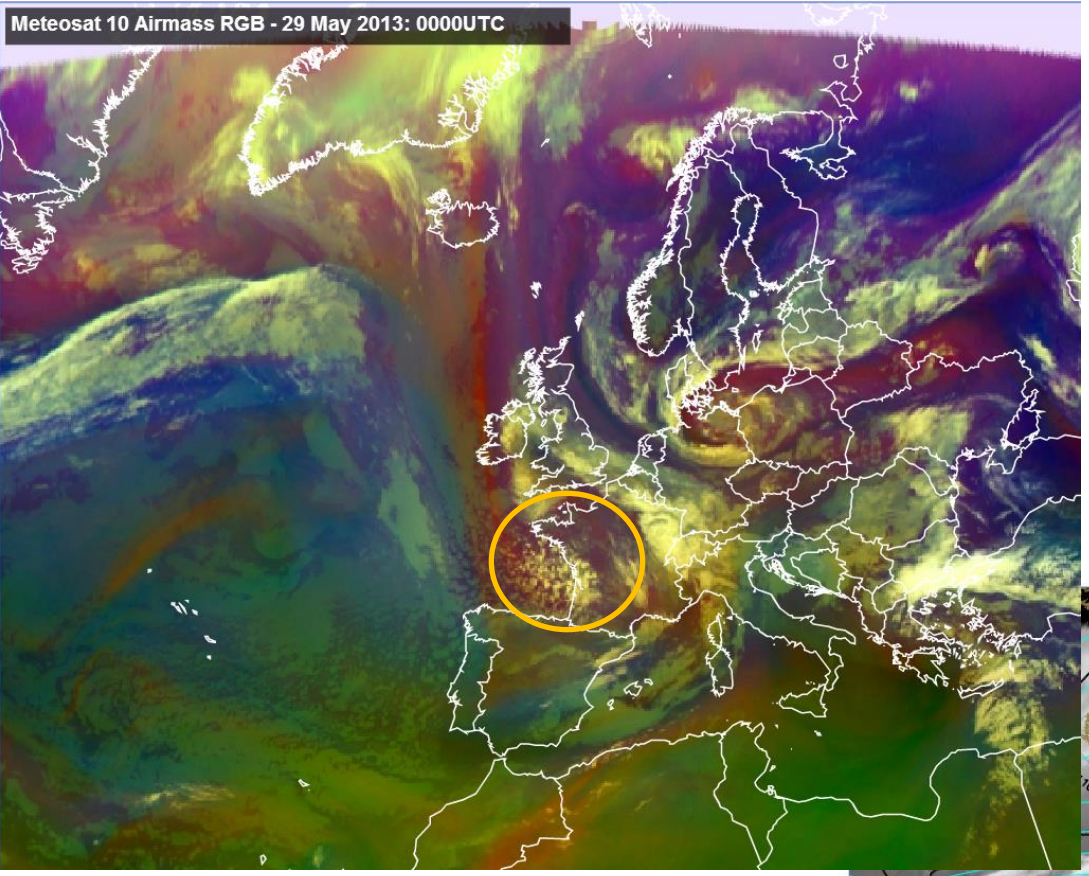




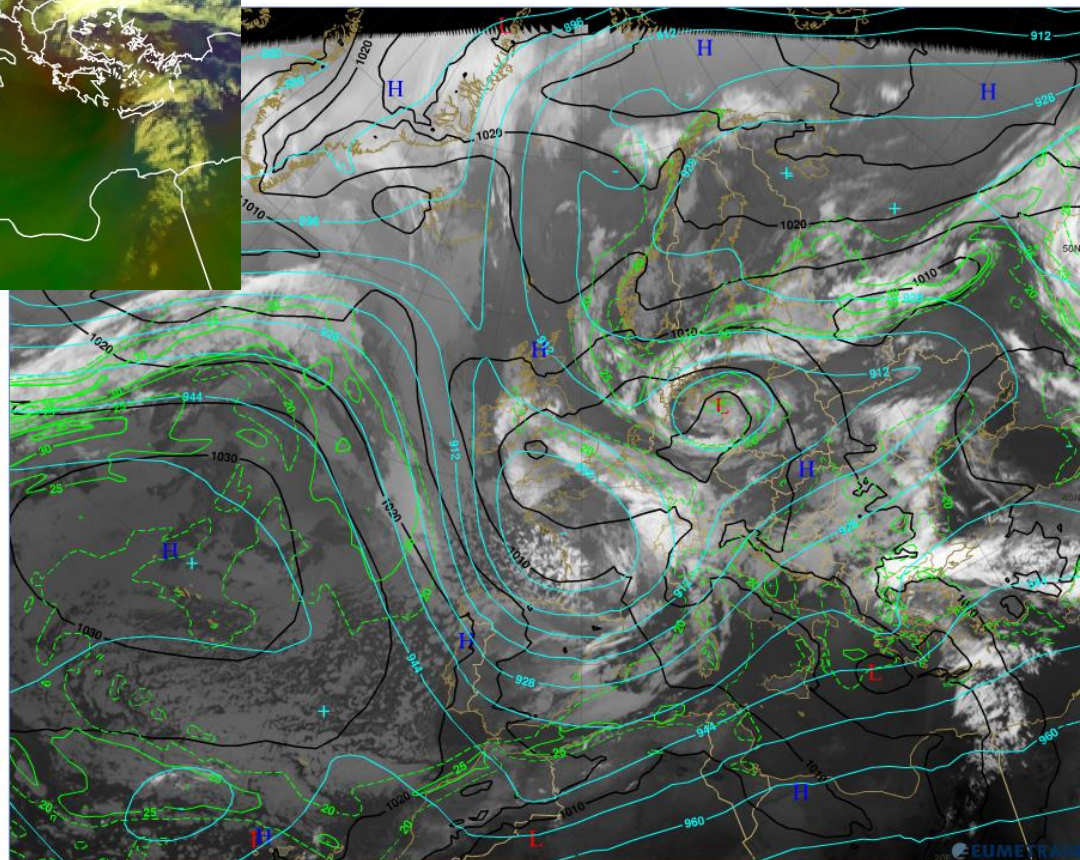
Moisture transport from the Atlantic and the Mediterranean



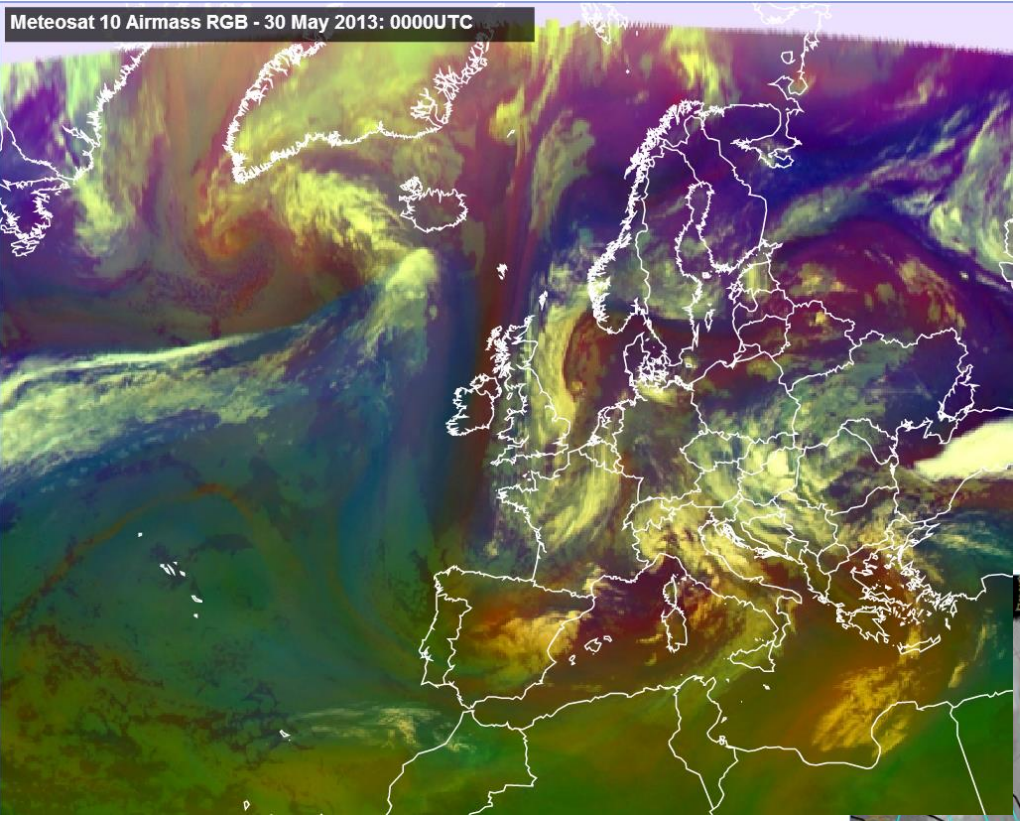
- 28 May 2013, 06 UTC

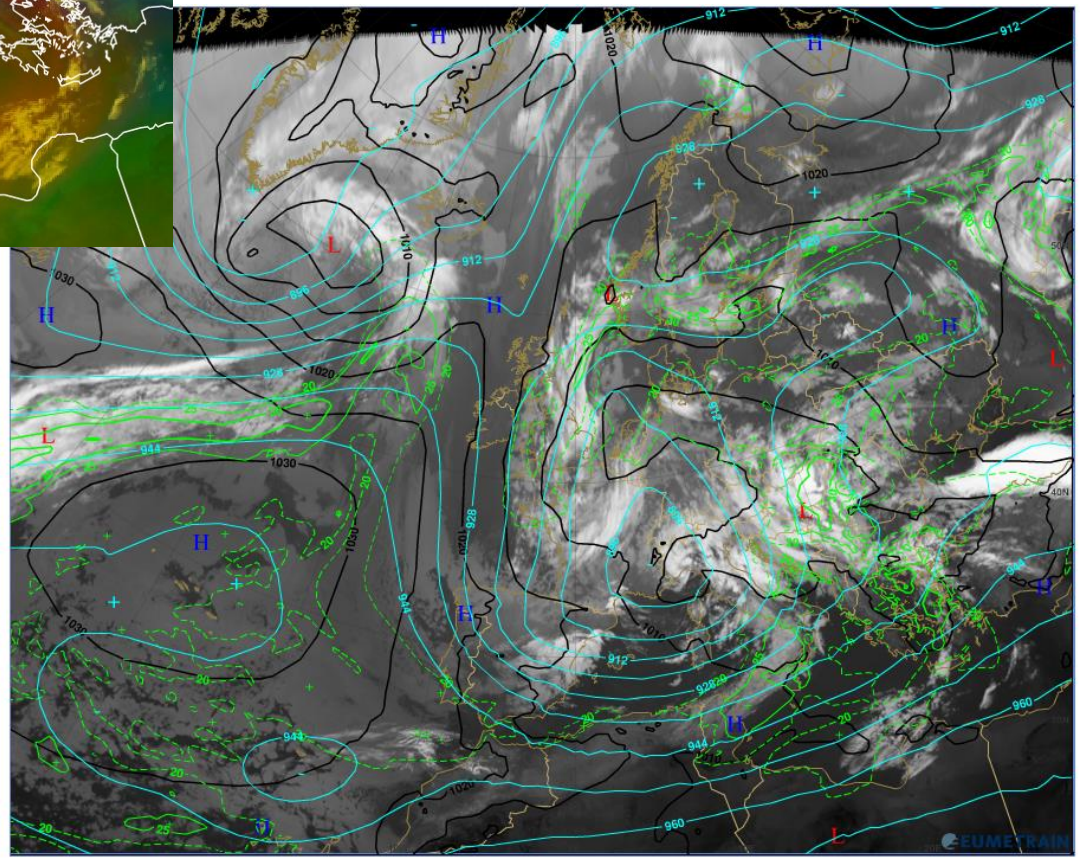


Cut-off low
in the upper levels
formed ower west
France

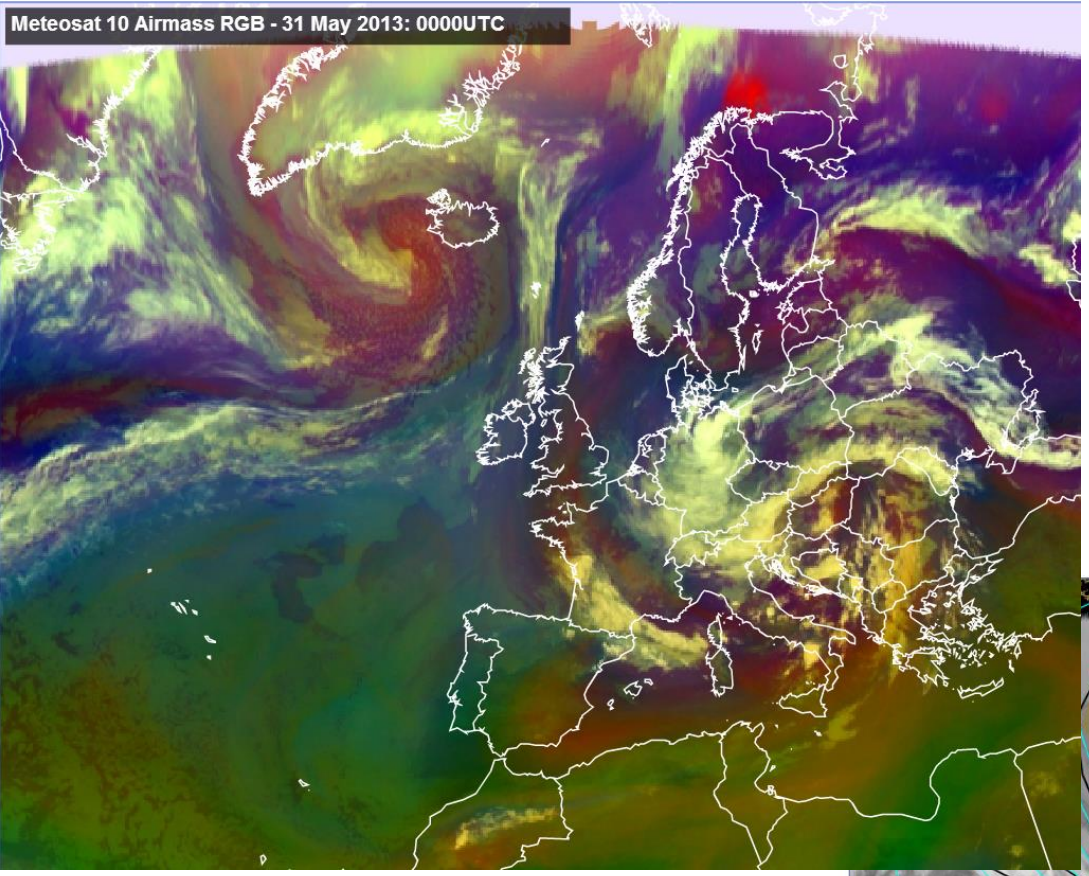


- 29 May 2013, 00 UTC

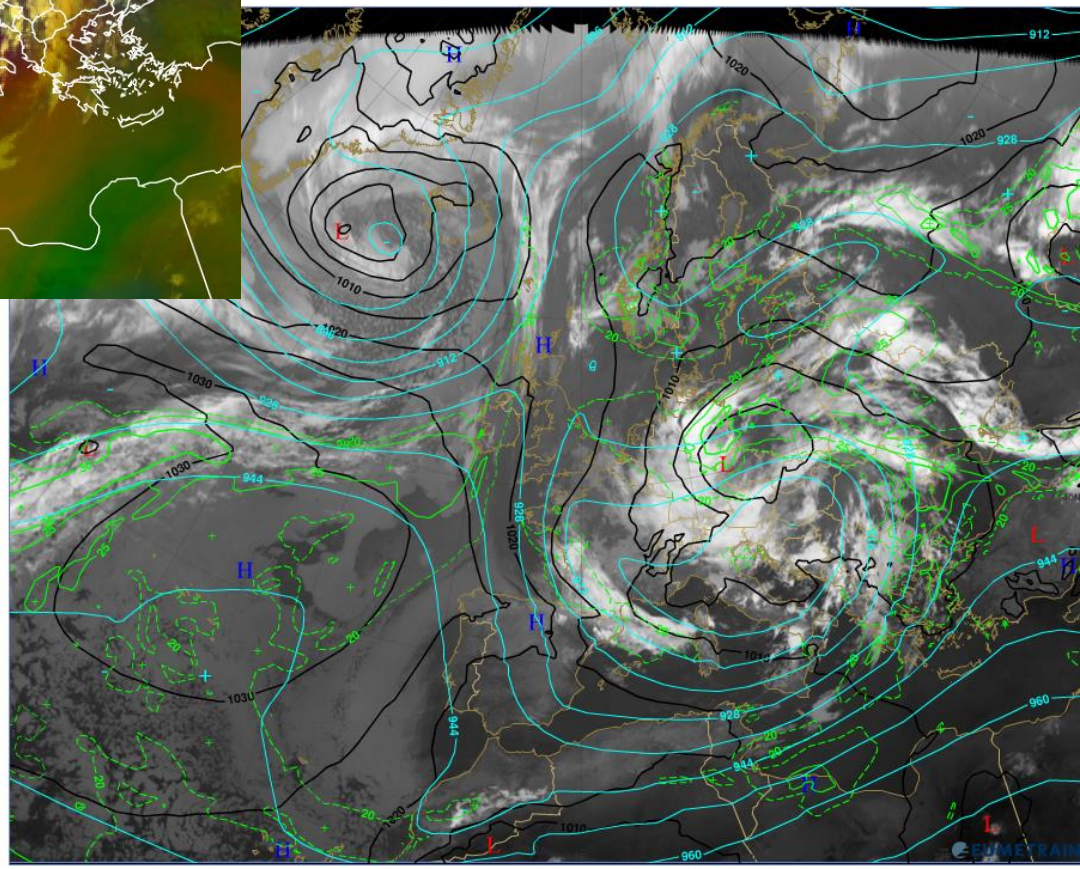




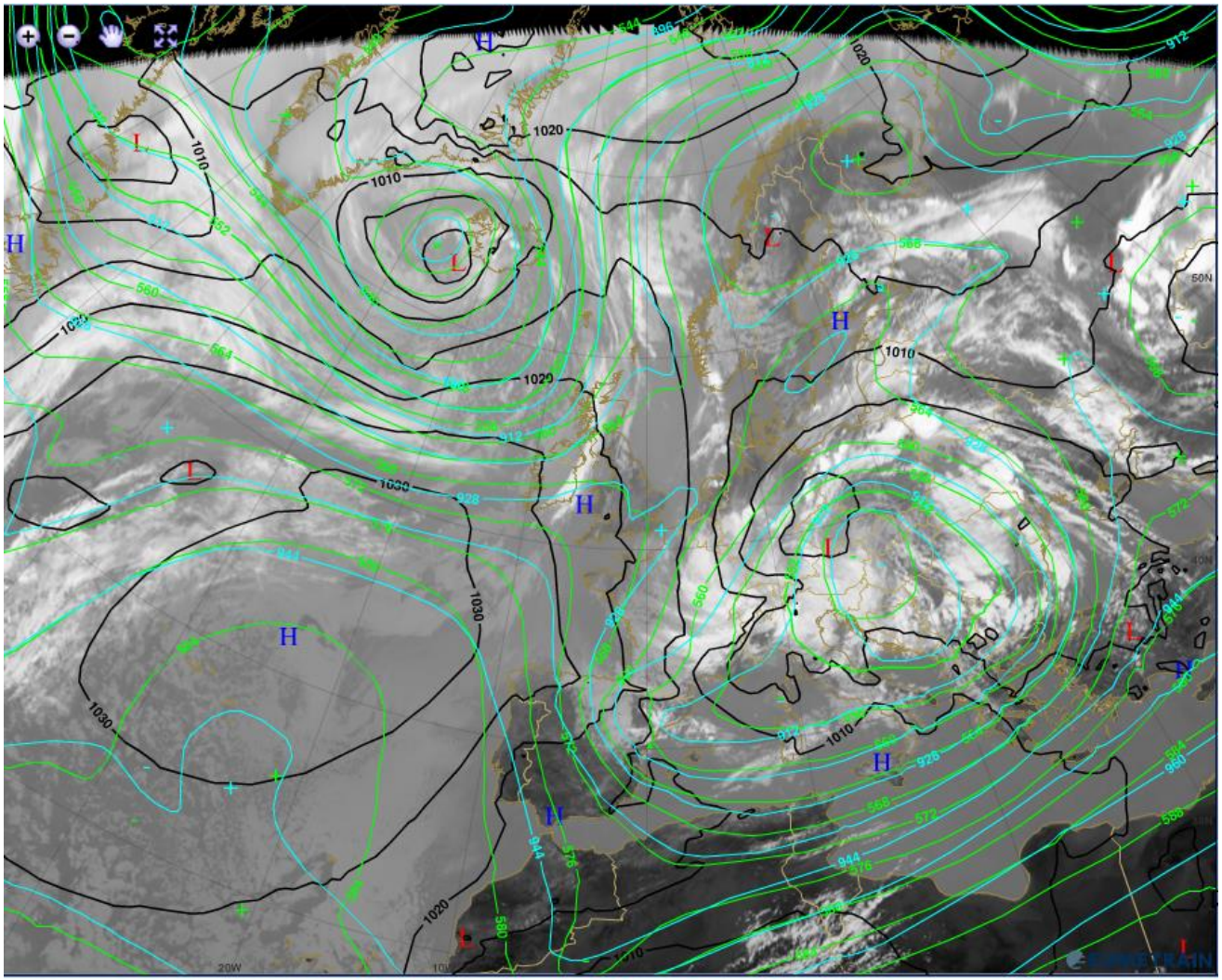
- 30 May 2013, 00 UTC



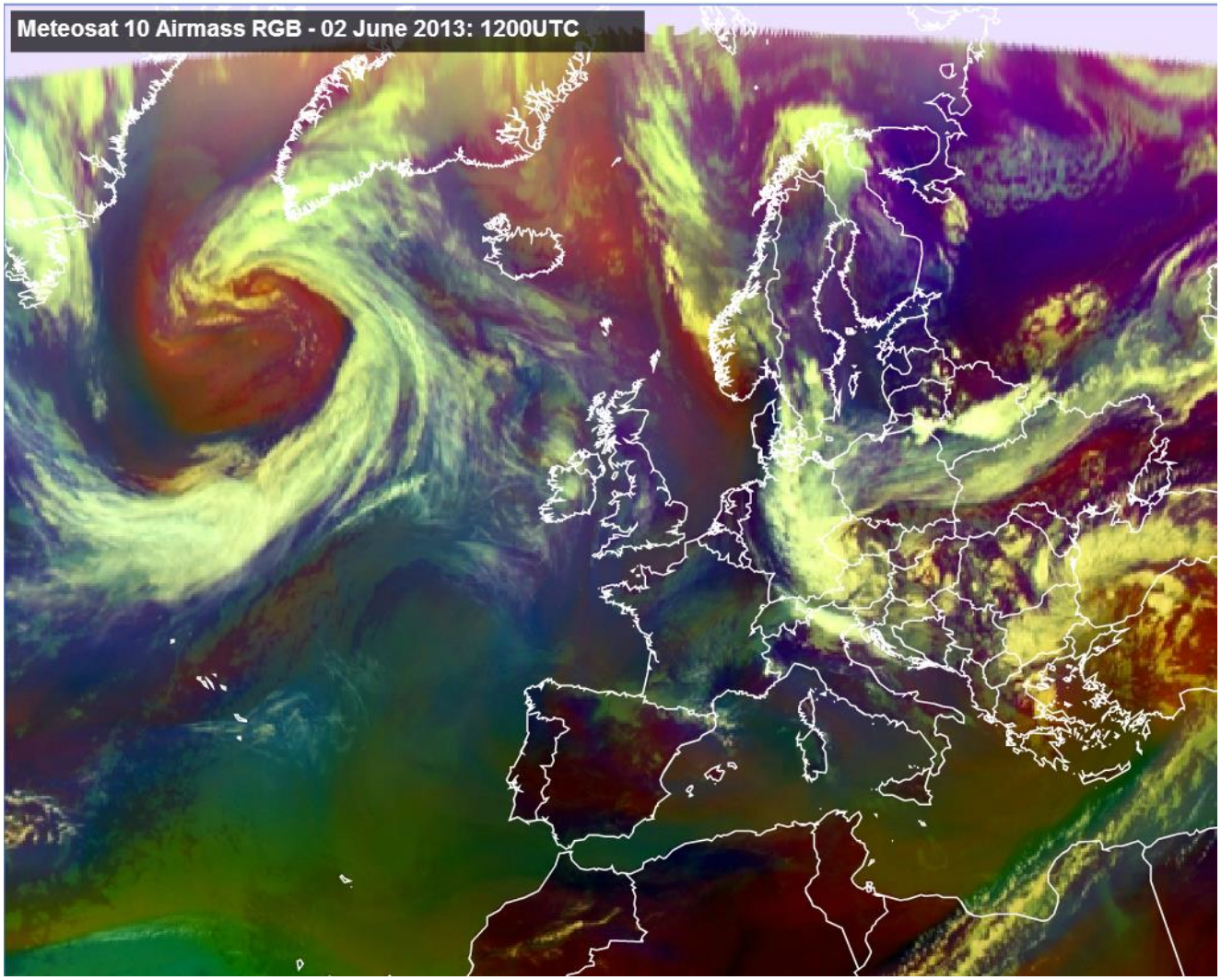
Surface low moving along Vb track



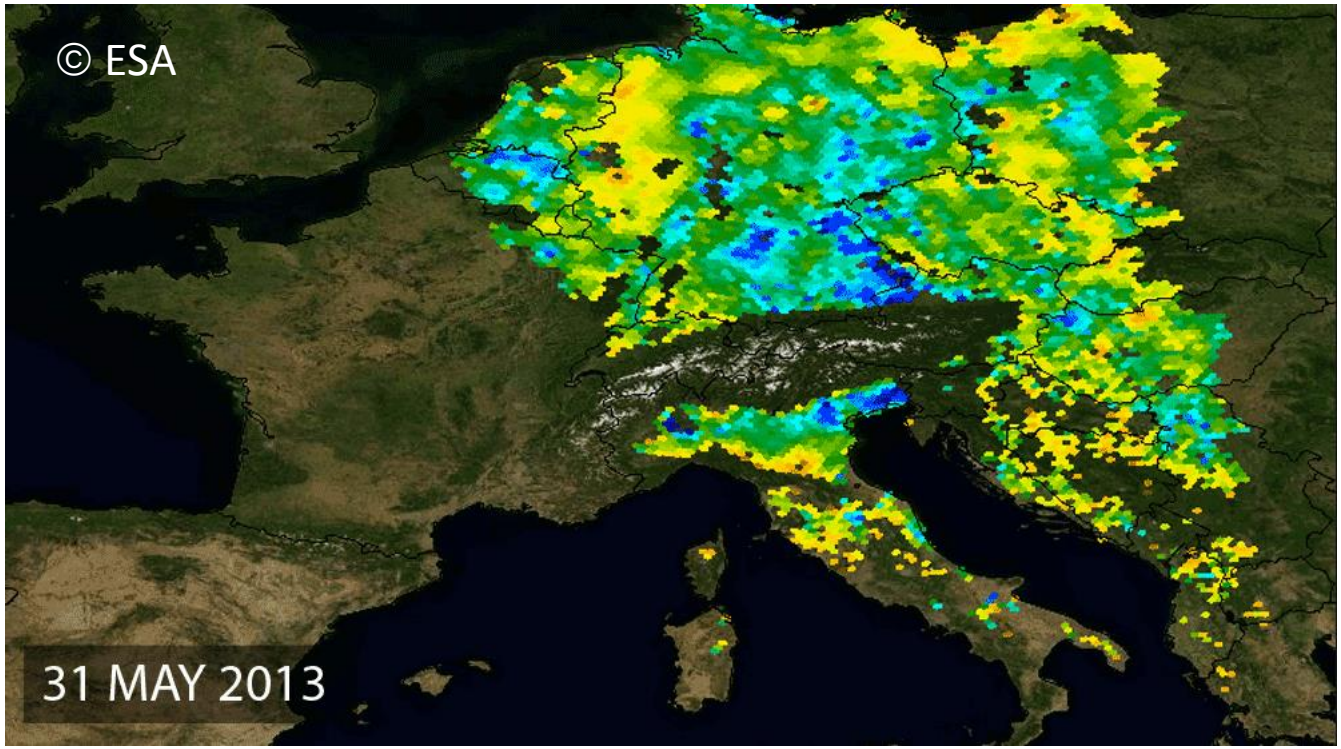
- 31 May 2013, 00 UTC



- 31 May 2013, 12 UTC



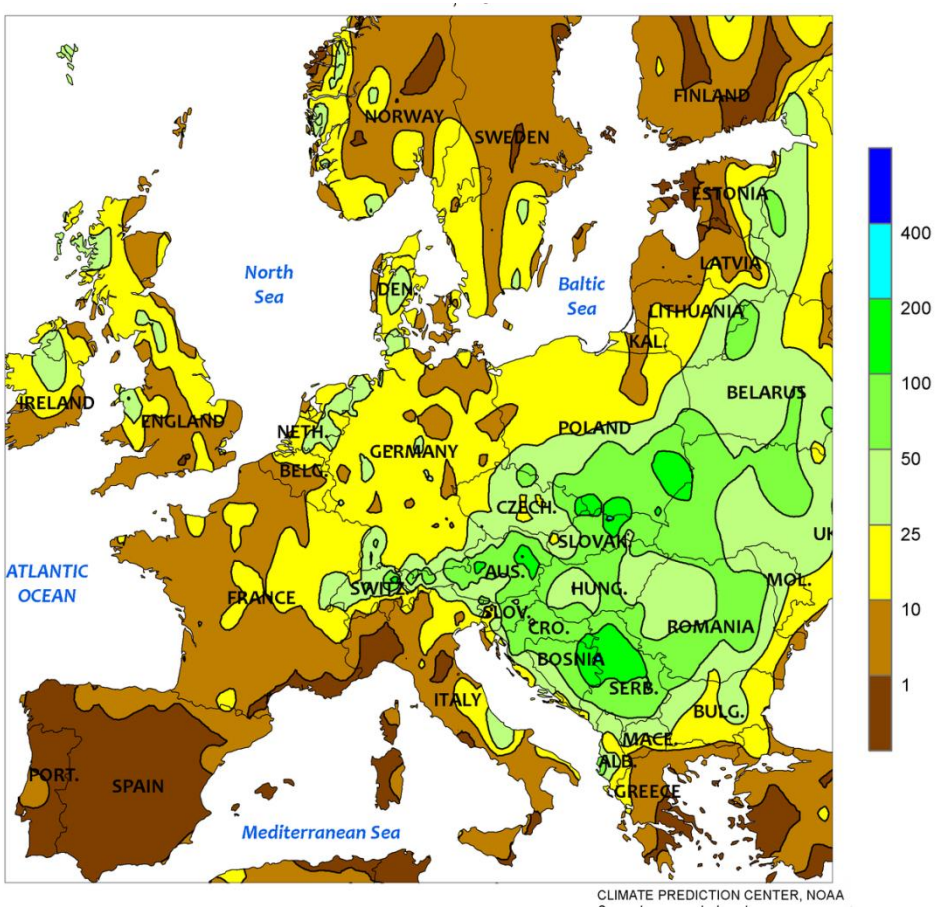
- This situation was similar to the flood in 2002 with the highest precipitation recorded in Germany and the Alpine region
- Cyclone moved to the north from Genoa Bay

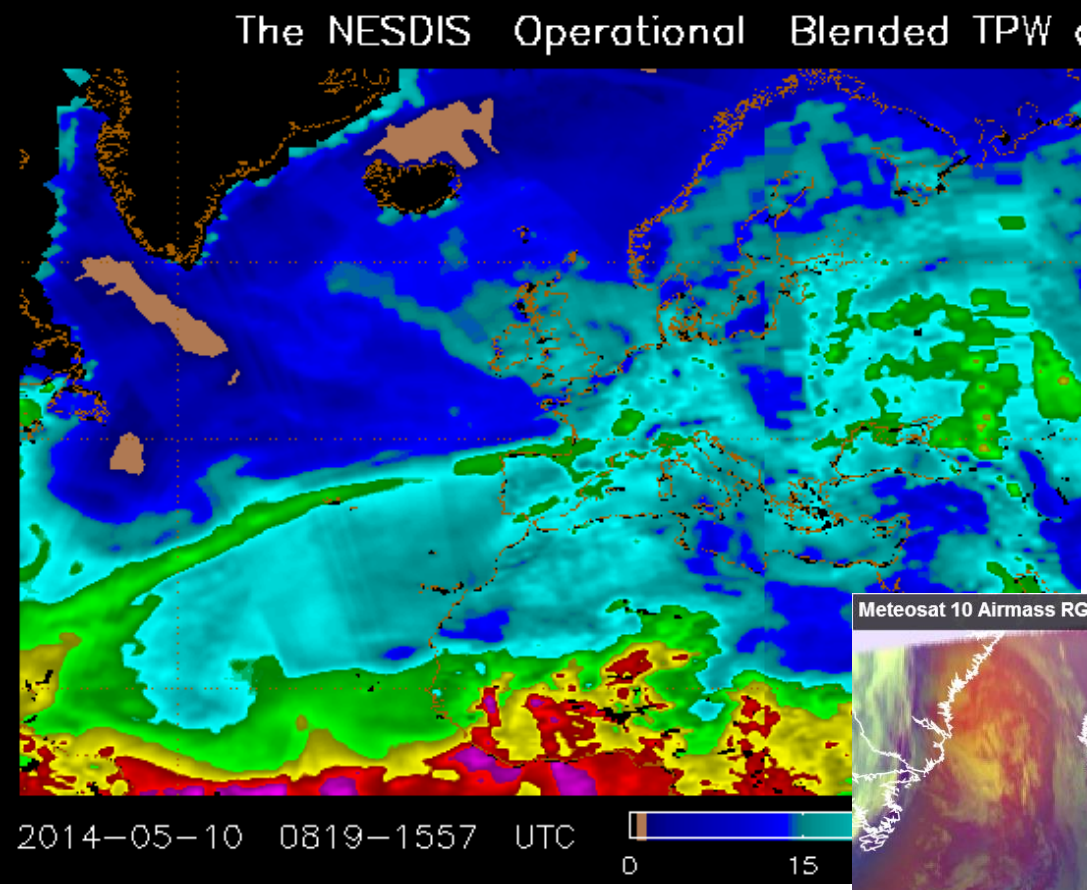


- The map, generated using ESA's SMOS (Soil Moisture Ocean Salinity satellite) data, shows the soil moisture values across central Europe on 31 May 2013. The blues indicate wetter soils and the yellow and orange colours indicate dryer soils. For example, a value of 0.50 means that there is 500 litres of water in one cubic metre of soil. Heavy rainfall has led to disastrous flooding in Germany, Austria, the Czech Republic and Slovakia.

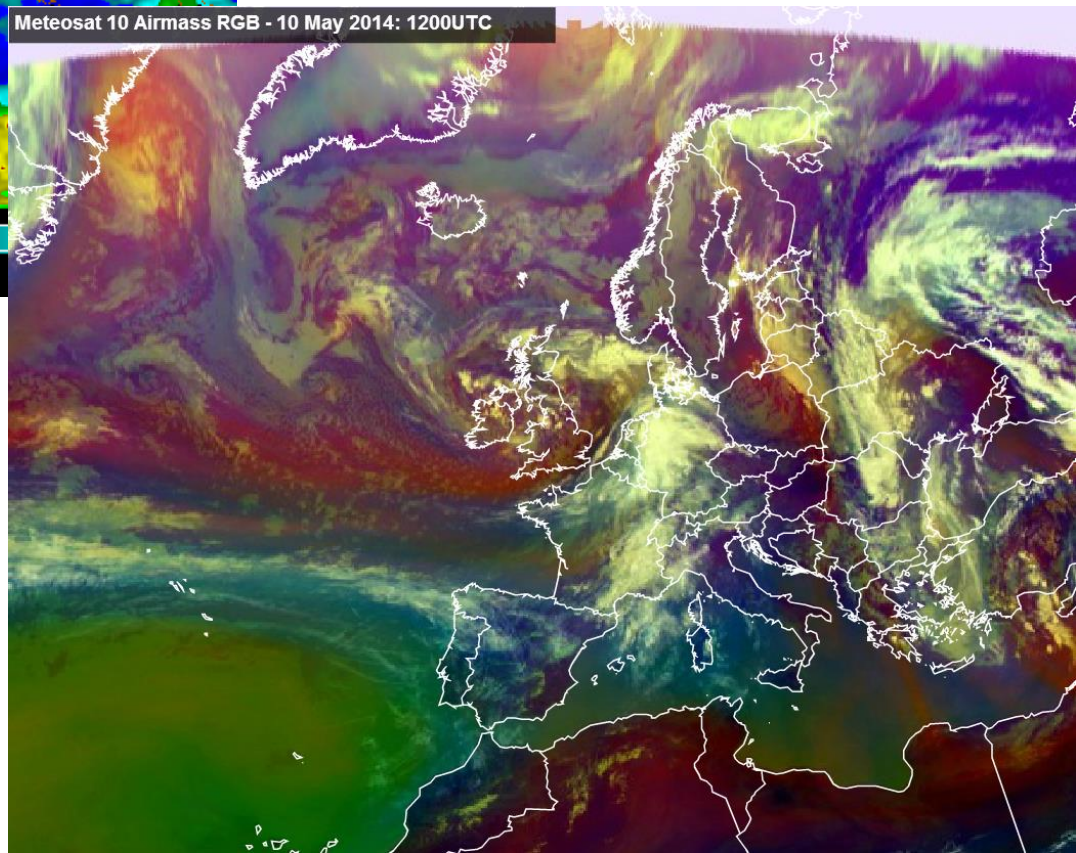
2014 – Floods in SE Europe

- Bosnia and Herzegovina, Croatia, Serbia and Romania mostly affected
- At least 86 fatalities
- more than one billion euro damages

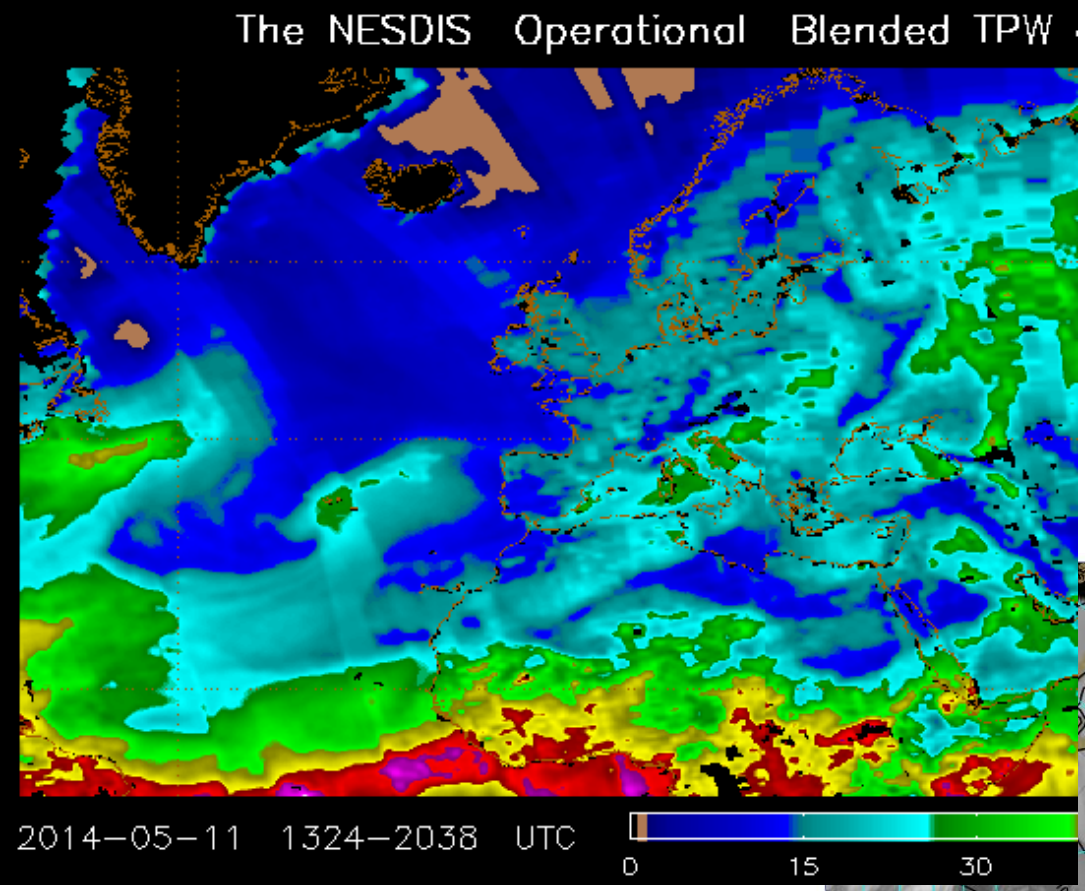


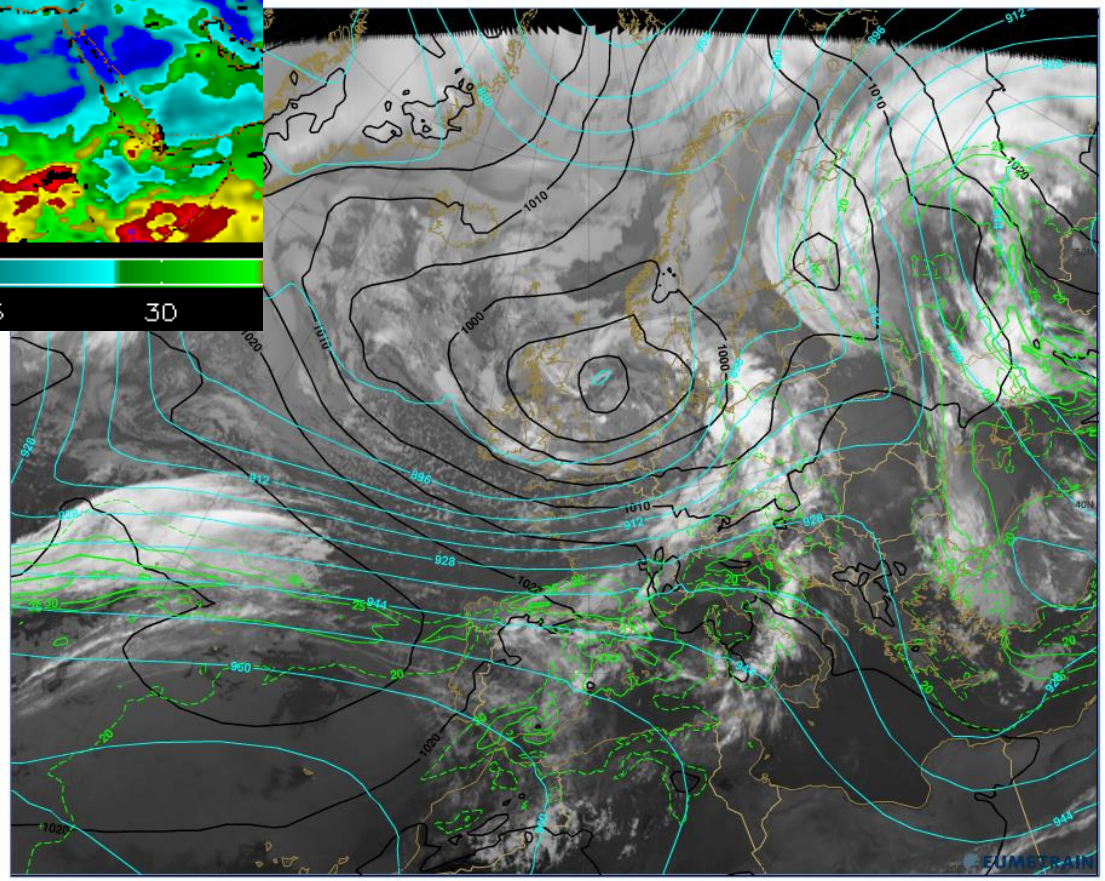


http://www.ospo.noaa.gov/Products/bTPW/Product_Animation.html

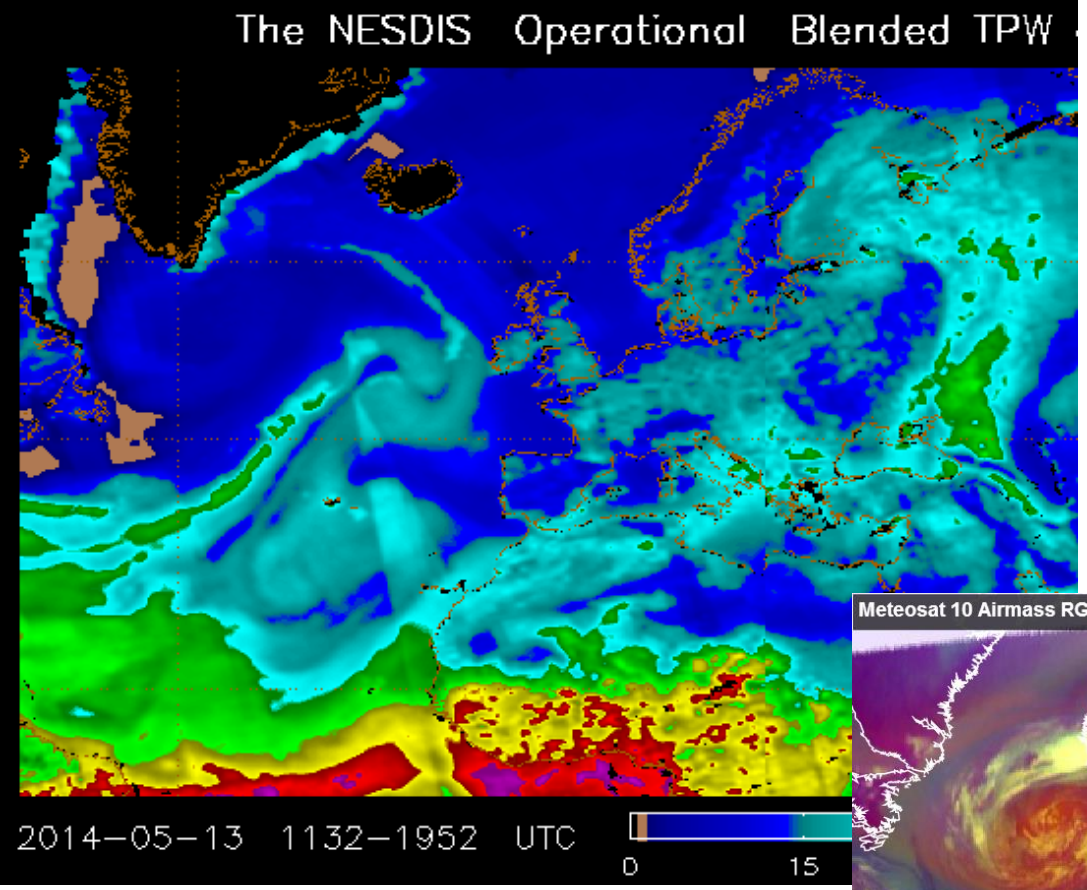


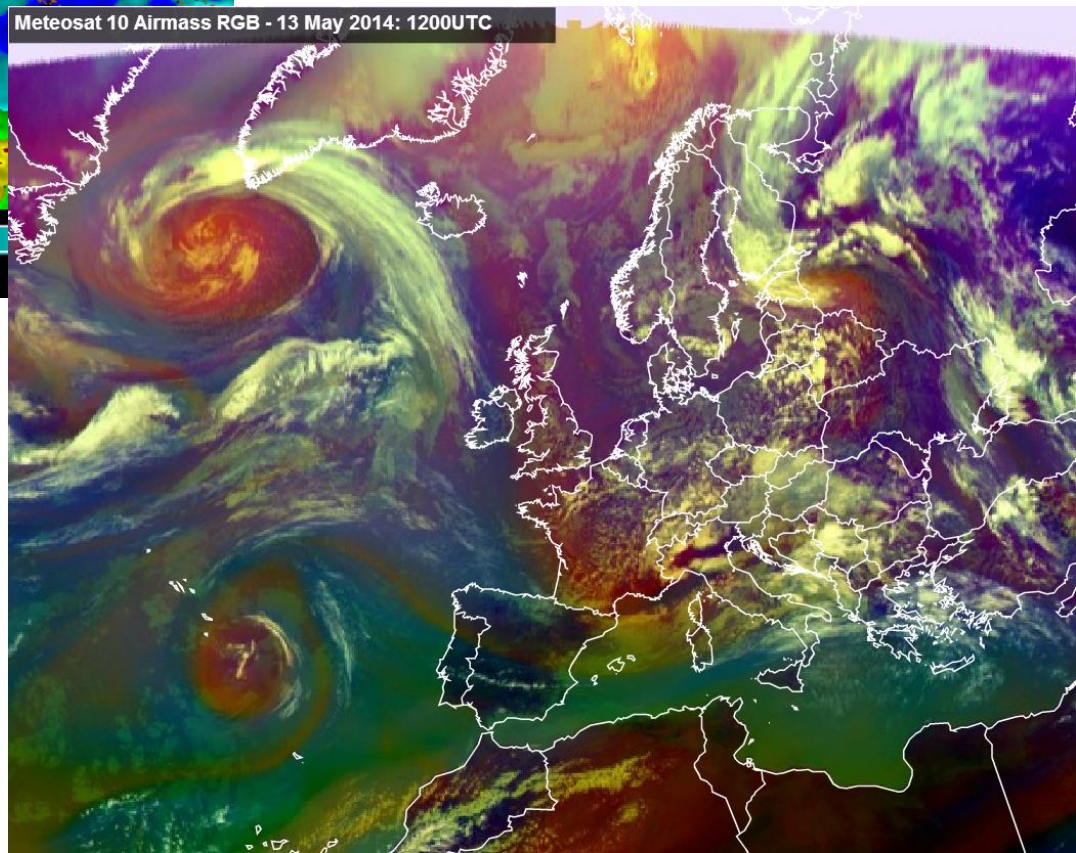
- Moisture transport from the Atlantic



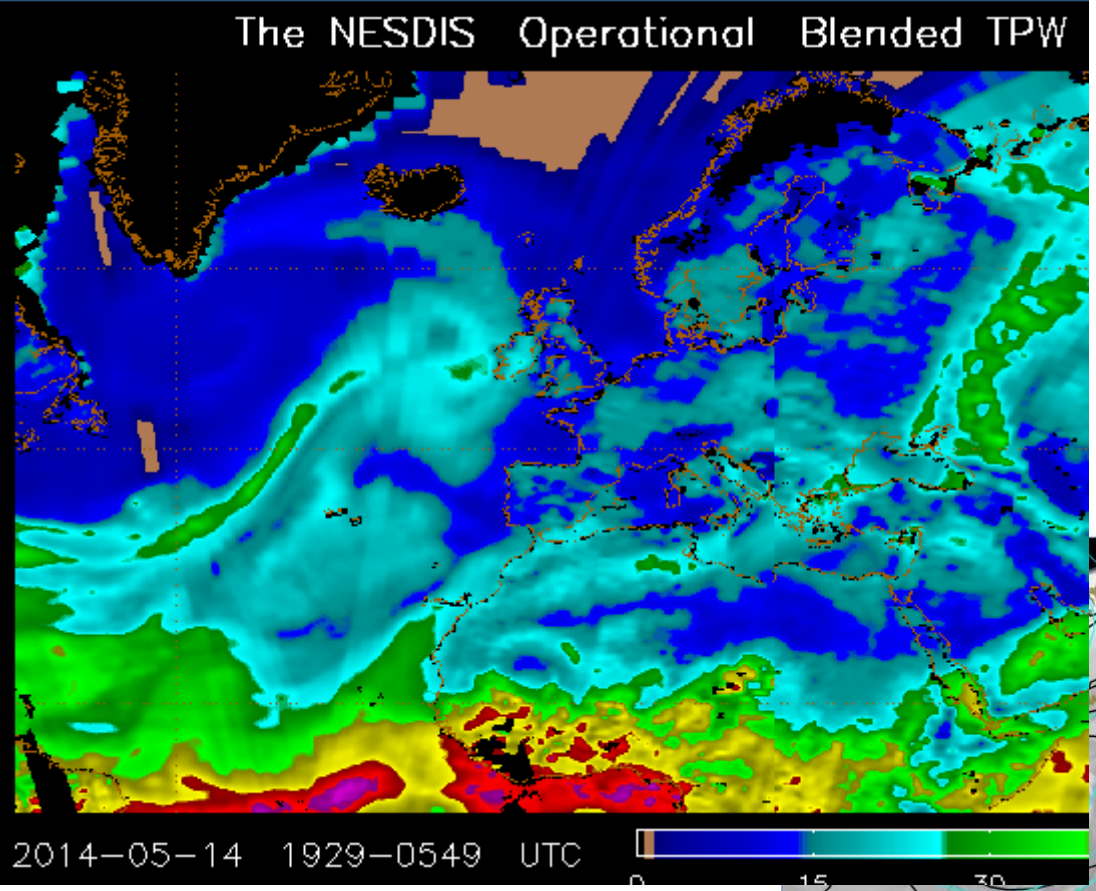


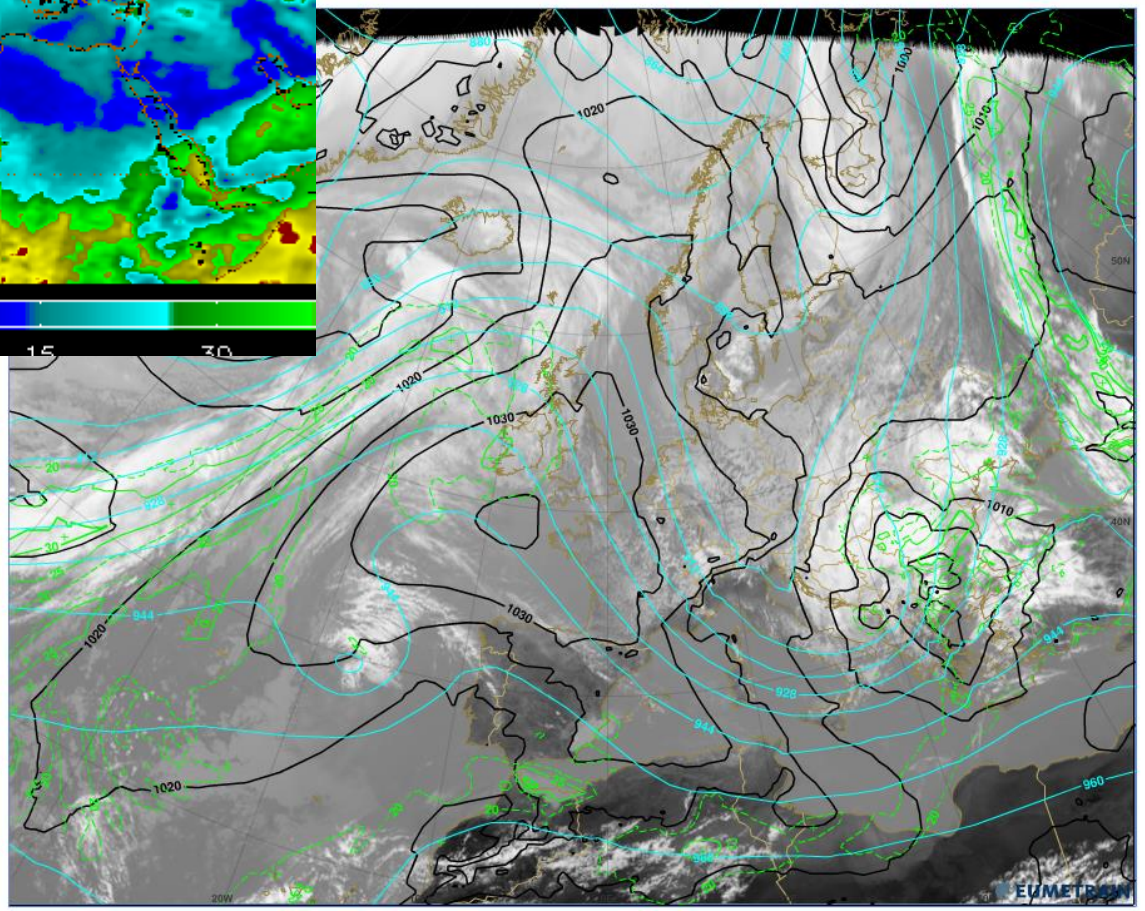
- Front moving across central Europe



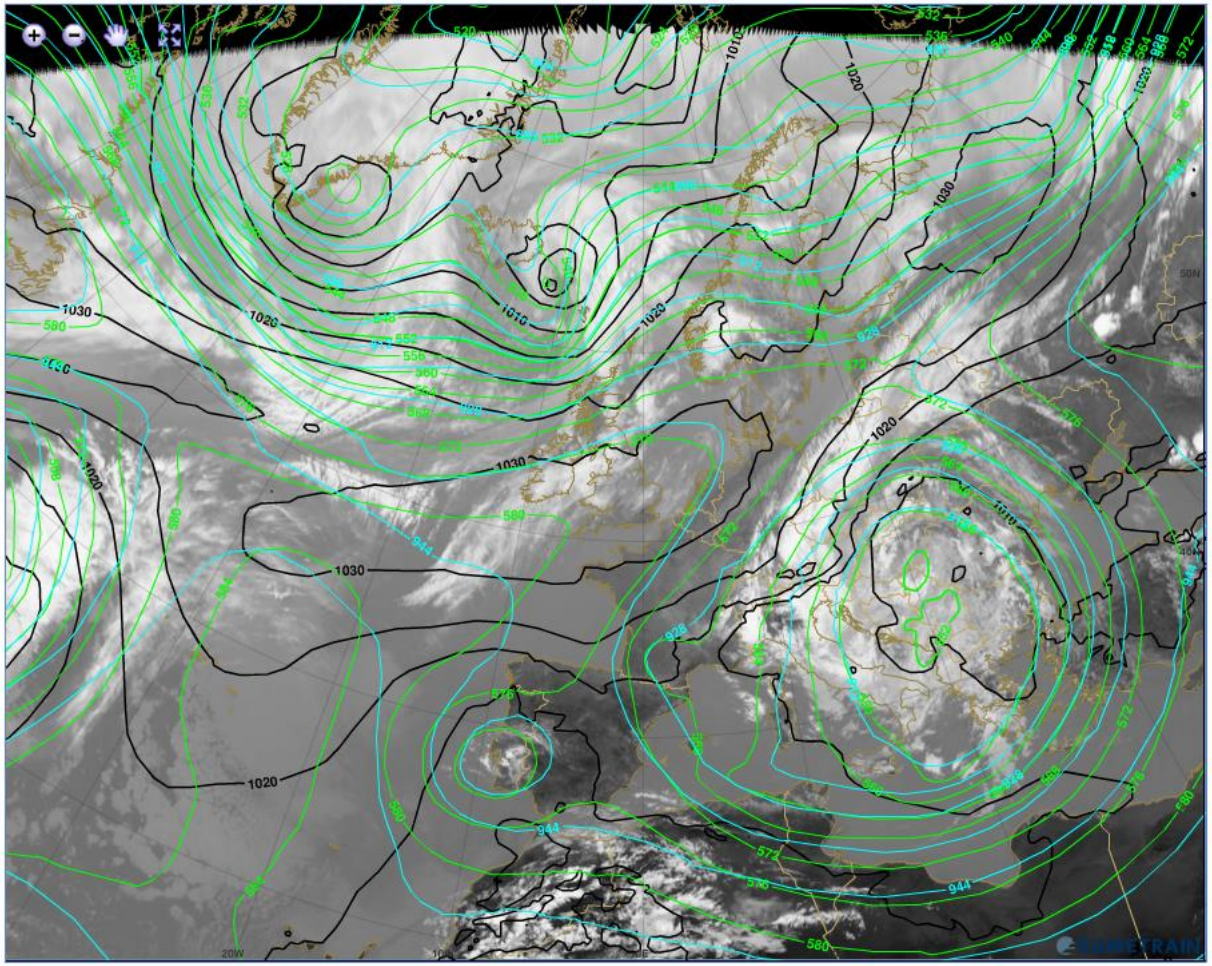


- Moisture transport over the Mediterranean to the Adriatic





- Enhancement of convection and precipitation by orography



Cut-off low in the upper levels

- 16 May 2014, 12 UTC

Common features

- Cold air inflow from far north – cold front passing over west Europe
- Moisture transport from the Atlantic (atmospheric rivers! - TPW from models can help)
- Cyclogenesisin the lee (SE) of the Alps
- Cyclones moving along Vb and Vc (or Vd) tracks
- Cut-off low in all cases
- Enhancement of precipitation due to lift on the orography in cyclonic flow

Thank you!

Questions, comments?