

Convection in the Alps

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To begin with...



„The hills are alive with the sound of music“ thunder

ALPINE PUMPING

Definition: differential heating between mountain ridges and the adjacent foreland – a circulation pattern transporting mass, heat and moisture



Requirements:

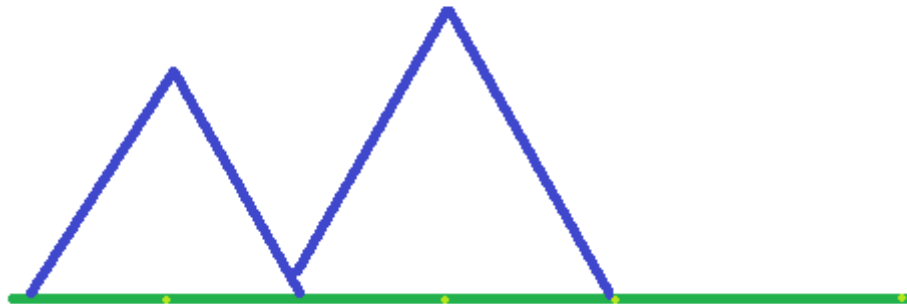
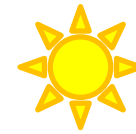
- high solar radiation
- weak synoptic pressure gradient

„Alpine Pumping“

Effects leading to Alpine Pumping:

Radiative energy is the driving force!

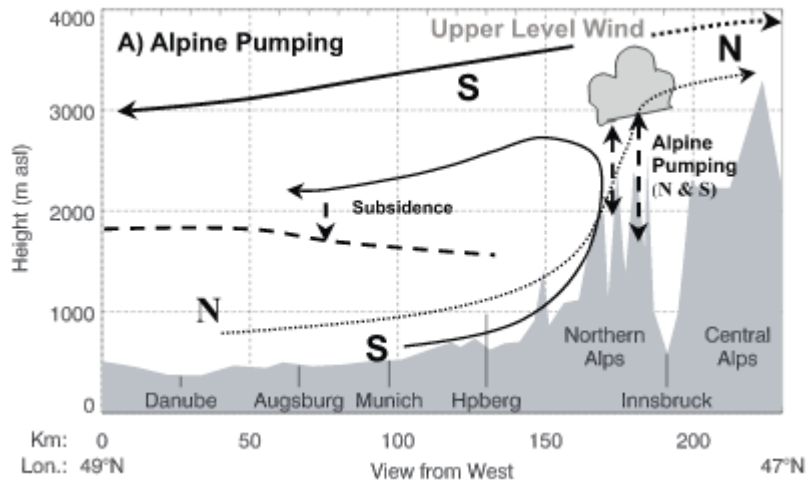
- air column has a lower volume over valley locations
=> faster warming
- increased heating surface
- lower pressure in higher regions – smaller air mass has to be heated
- faster cooling during the night



„Alpine Pumping“

Influences affecting the formation of Alpine Pumping:

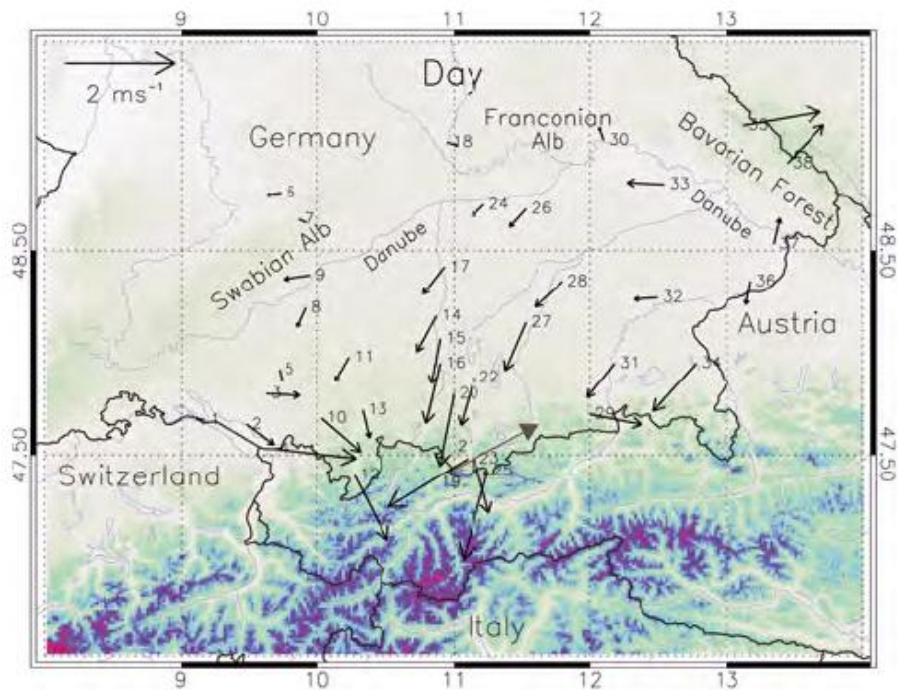
- weather conditions
=> northerly/southerly airflow,...
- atmospheric stability
- snow cover in higher regions
- synoptic pressure gradient



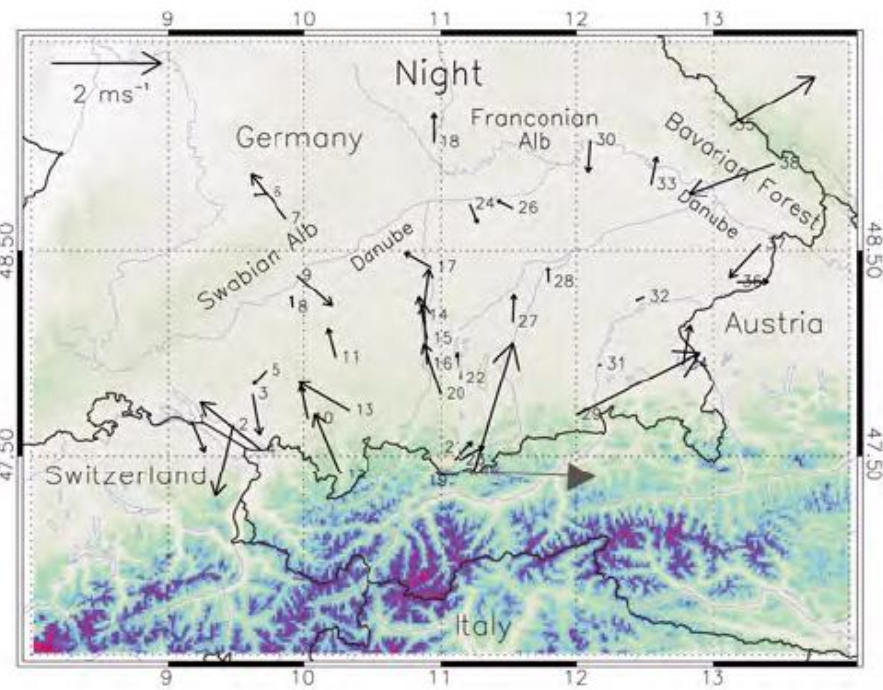
from Lugauer et al. (2005)

„Alpine Pumping“

Diurnal cycle – mean surface wind (1996 – 2000, daily global radiation > 20 MJ/m²)



8-20 CET



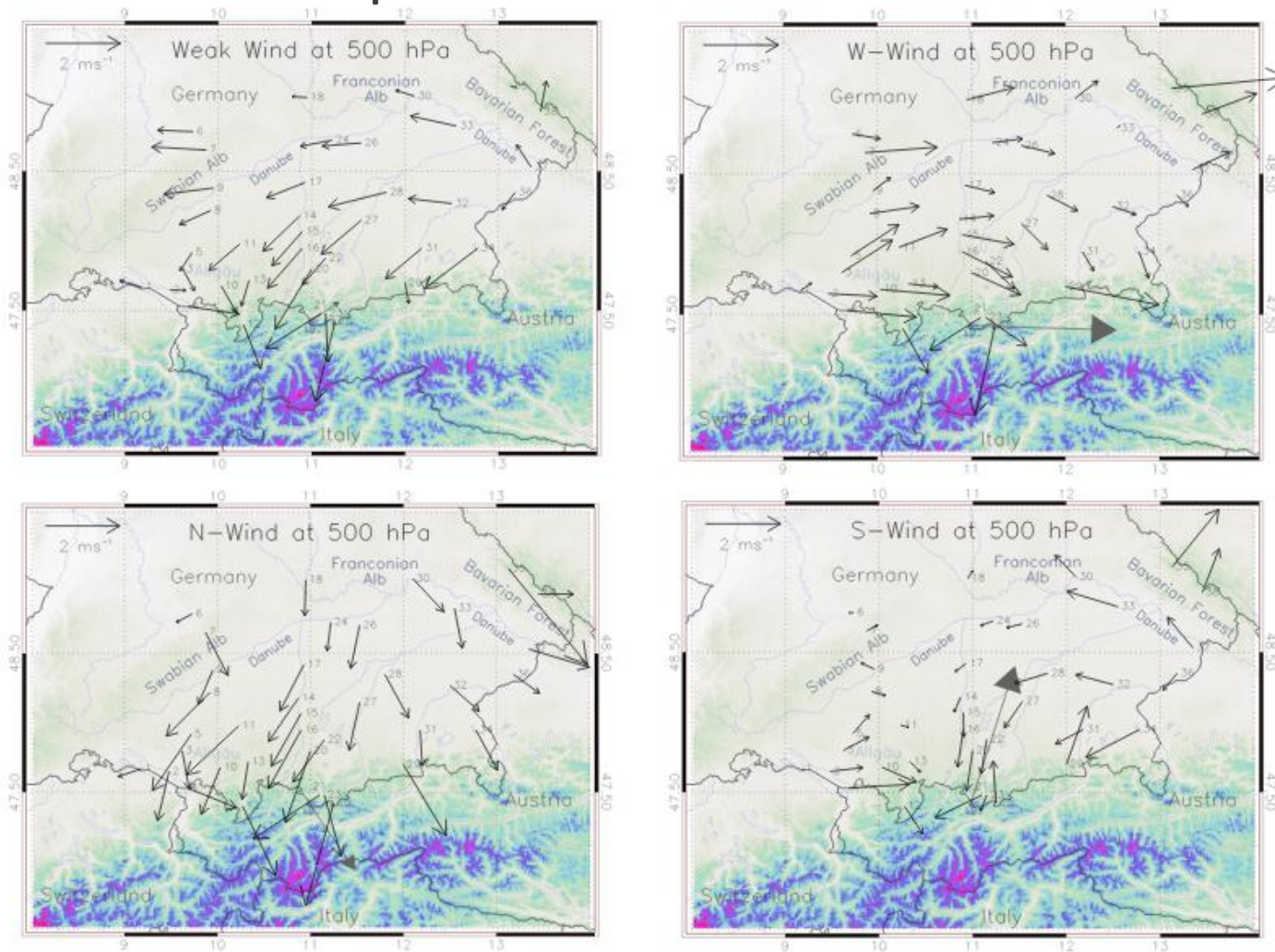
20-8 CET

from Lugauer et al. (2005)

„Alpine Pumping“



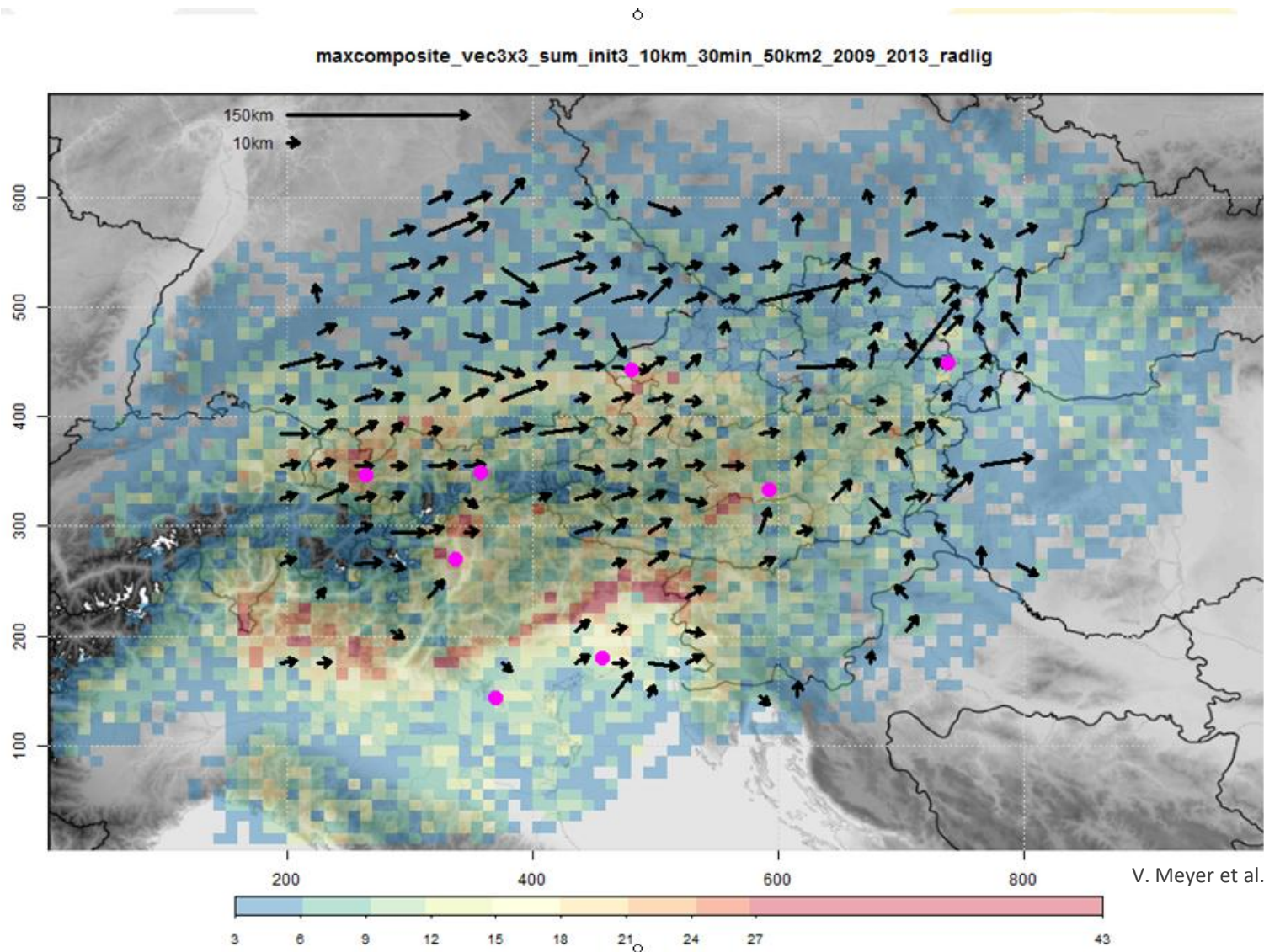
Different weather patterns – mean surface wind



8-20 CET

from Lugauer et al. (2005)

„Thunderstorm climatology“



Ingredients for thunderstorms... (3+1)



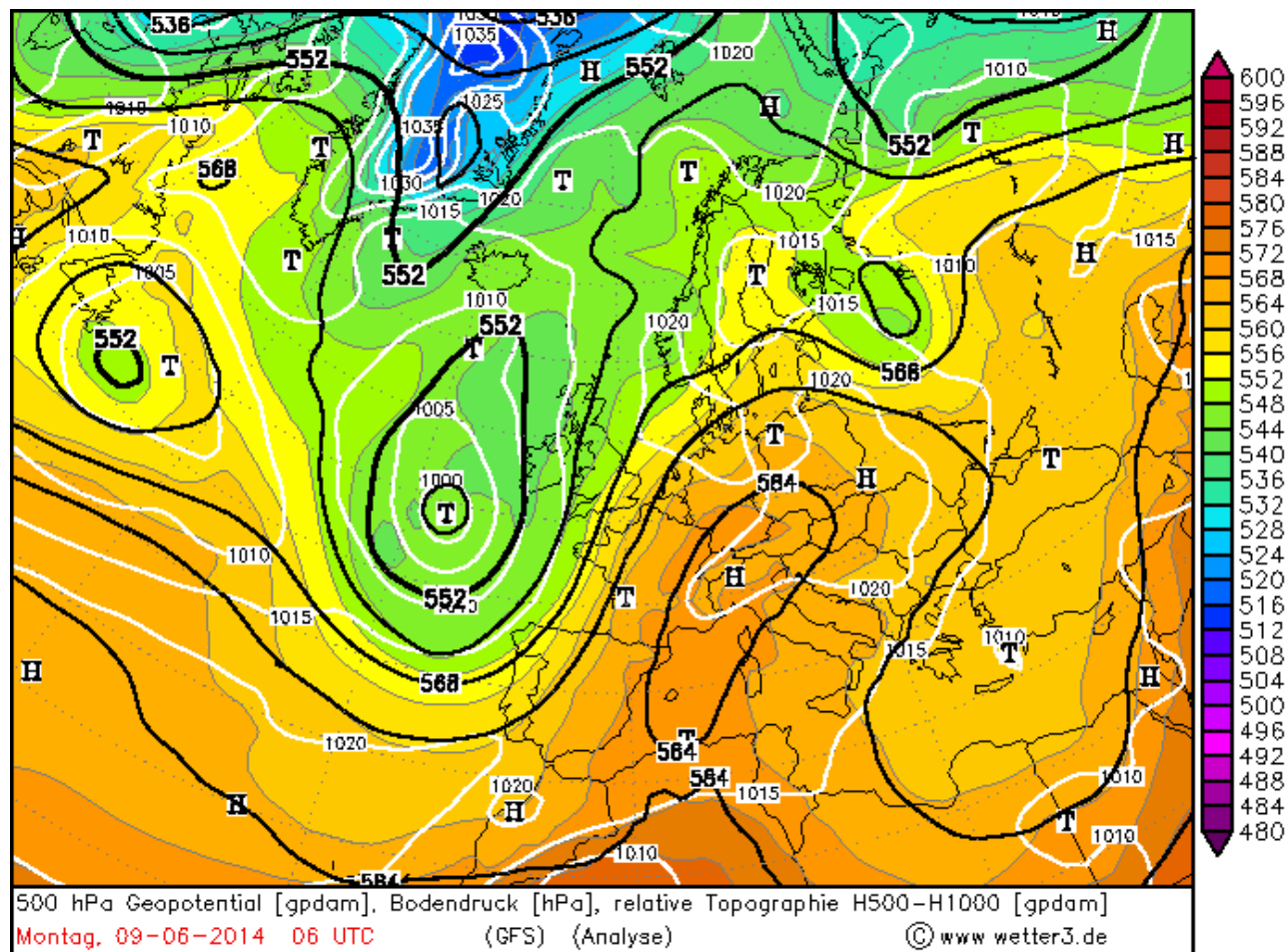
radar MSG **lifting** radio-sounding derecho dynamics
rain sunshine hodograph **tornado** moisture downburst
forecasters HR-VIS
instability **halo**
orography EUMeTrain
mountains **cumulonimbus**
overshooting tops CAPE
isotachs convection
lightning
storm chaser clouds wind shear tropopause hail
vorticity rainbow bow echo **flash flood** equivalent thickness
satellite images sleet snow NWCSAF weather



© Daniel Loretto

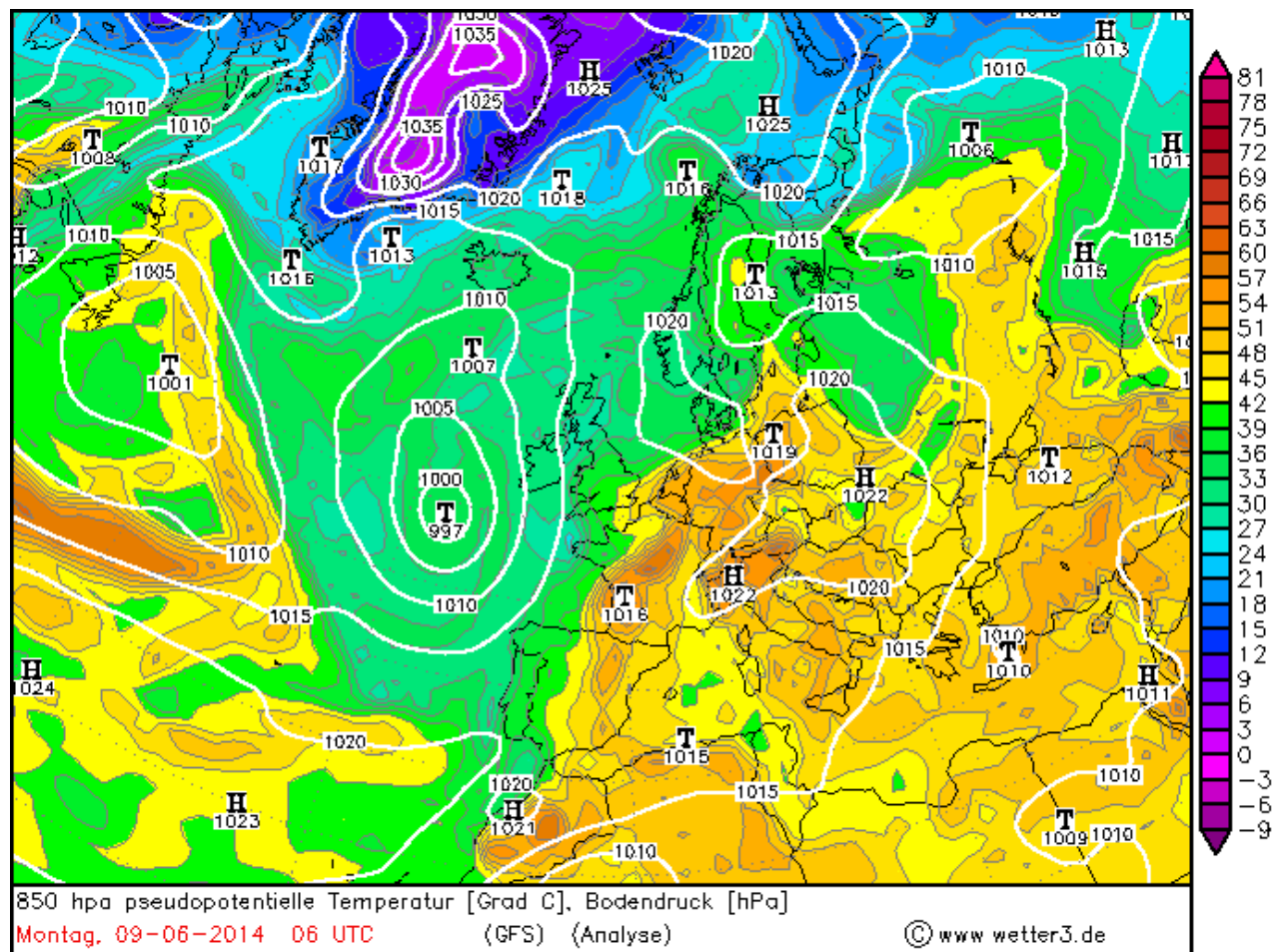
Case study - 9 June 2014

Geopotential 500 hPa / MSLP / Equivalent thickness (500-1000)



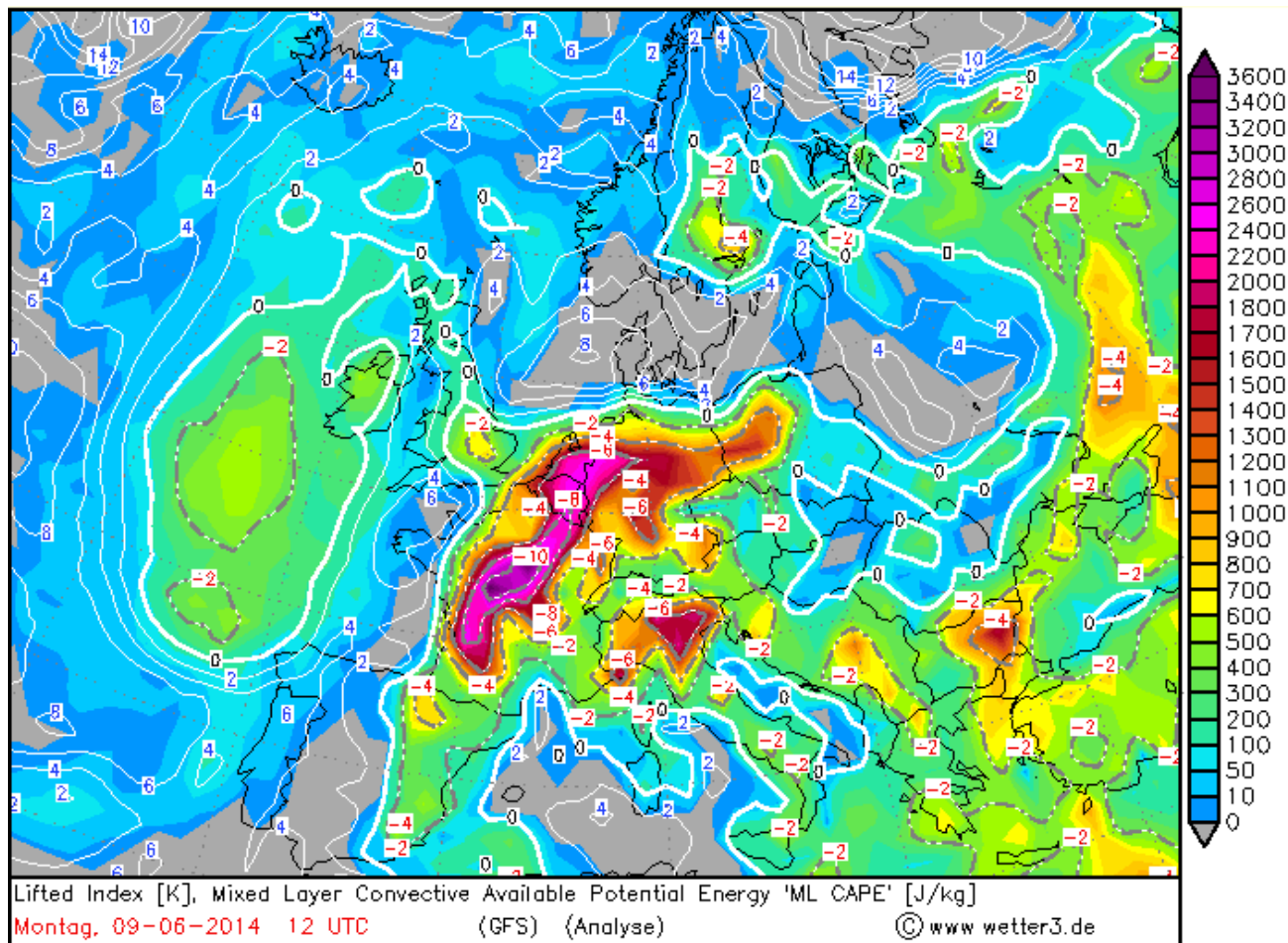
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Θ_e 850 hPa



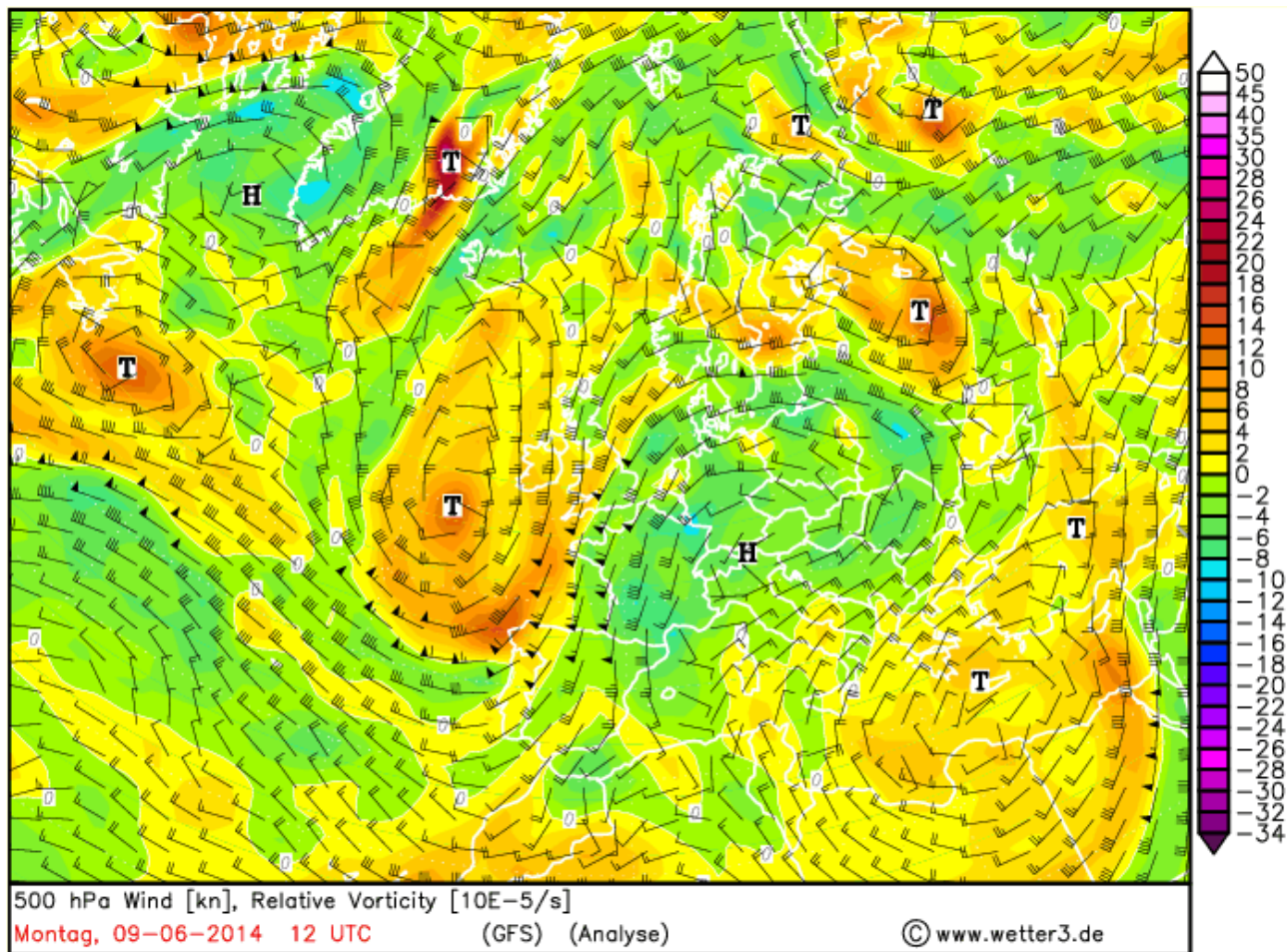
Case study - 9 June 2014

Lifted Index / CAPE



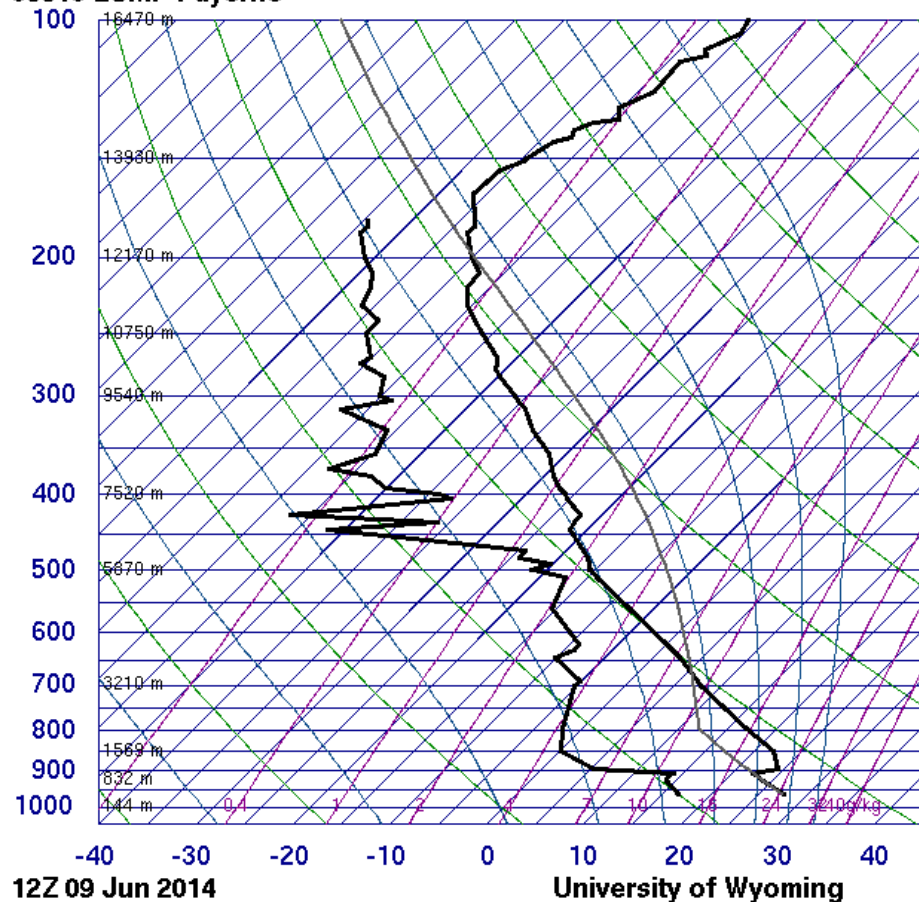
Lifted Index: $LI = T(500) - T(\text{parcel})$

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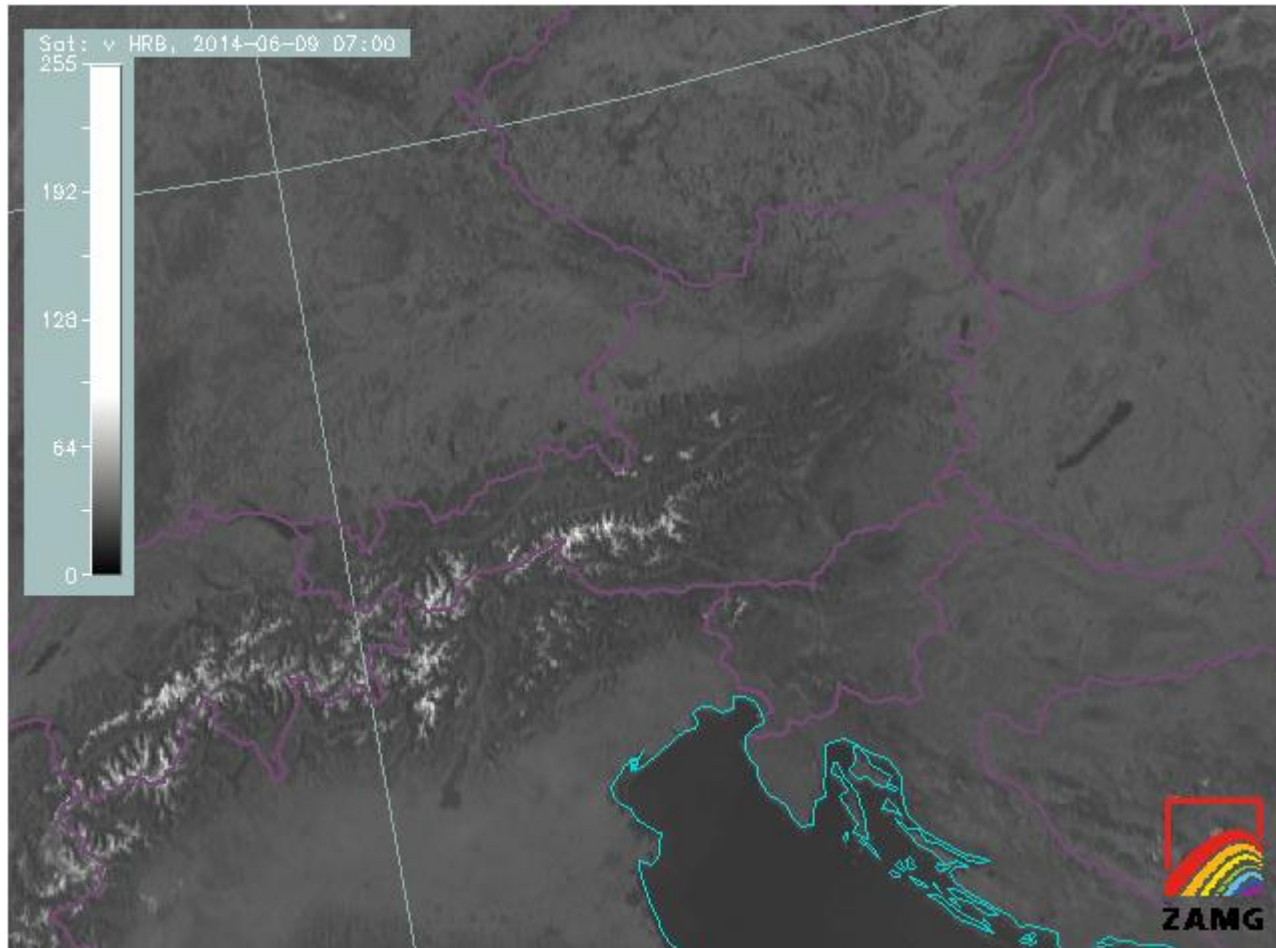
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06610 LSMP Payerne

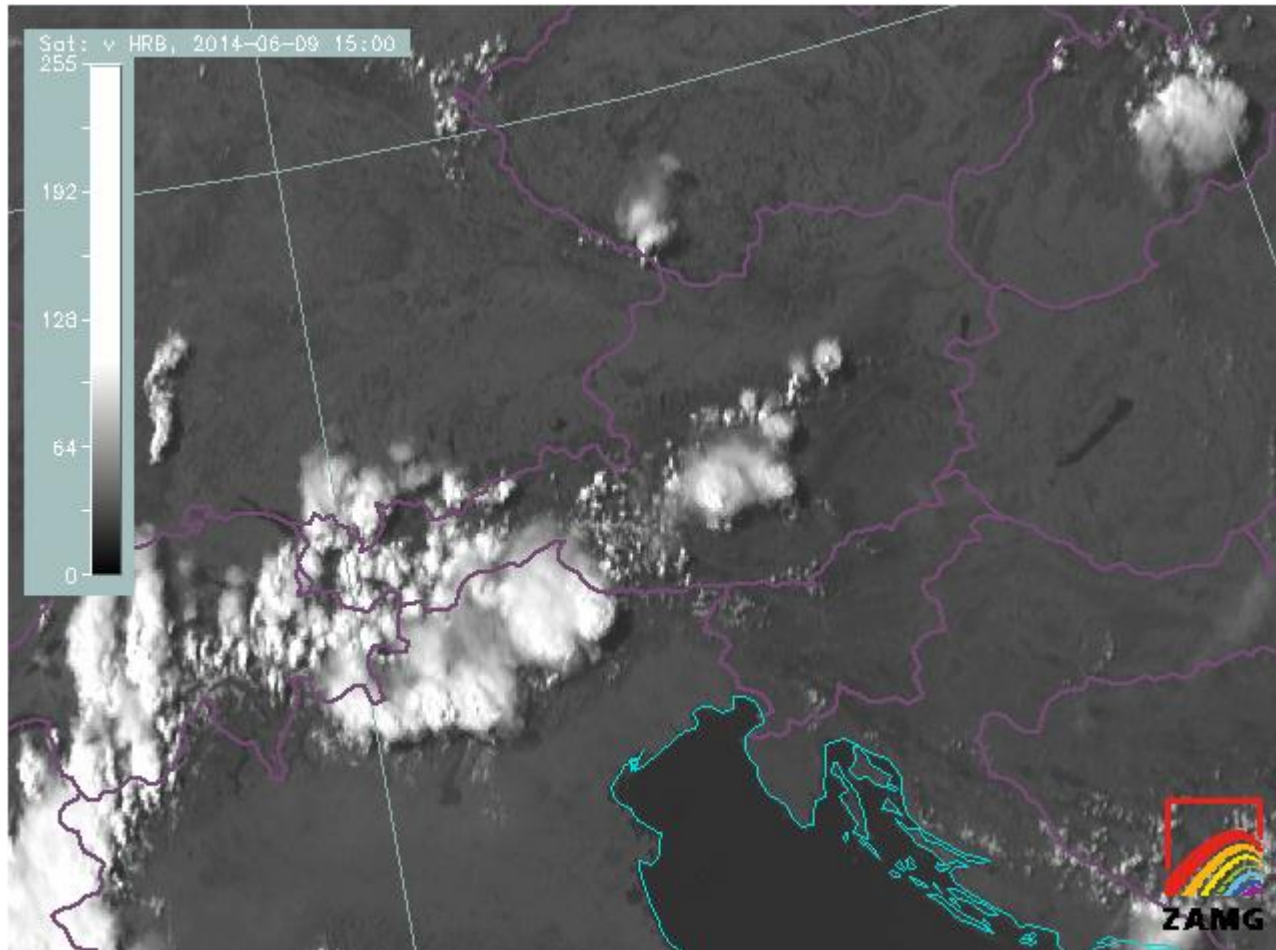


SLAT 46.81
SLON 6.95
SELV 491.0
SHOW -1.16
LIFT -7.93
LFTV -8.41
SWET 123.4
KINX 24.90
CTOT 15.70
VTOT 37.70
TOTL 53.40
CAPE 1880.
CAPV 1985.
CINS -279.
CINV -197.
EQLV 196.0
EQTV 195.9
LFCT 675.8
LFCV 702.9
BRCH 89.46
BRCV 94.46
LCLT 285.6
LCLP 805.0
MLTH 303.9
MLMR 11.48
THCK 5726.
PWAT 22.52

Case study - 9 June 2014



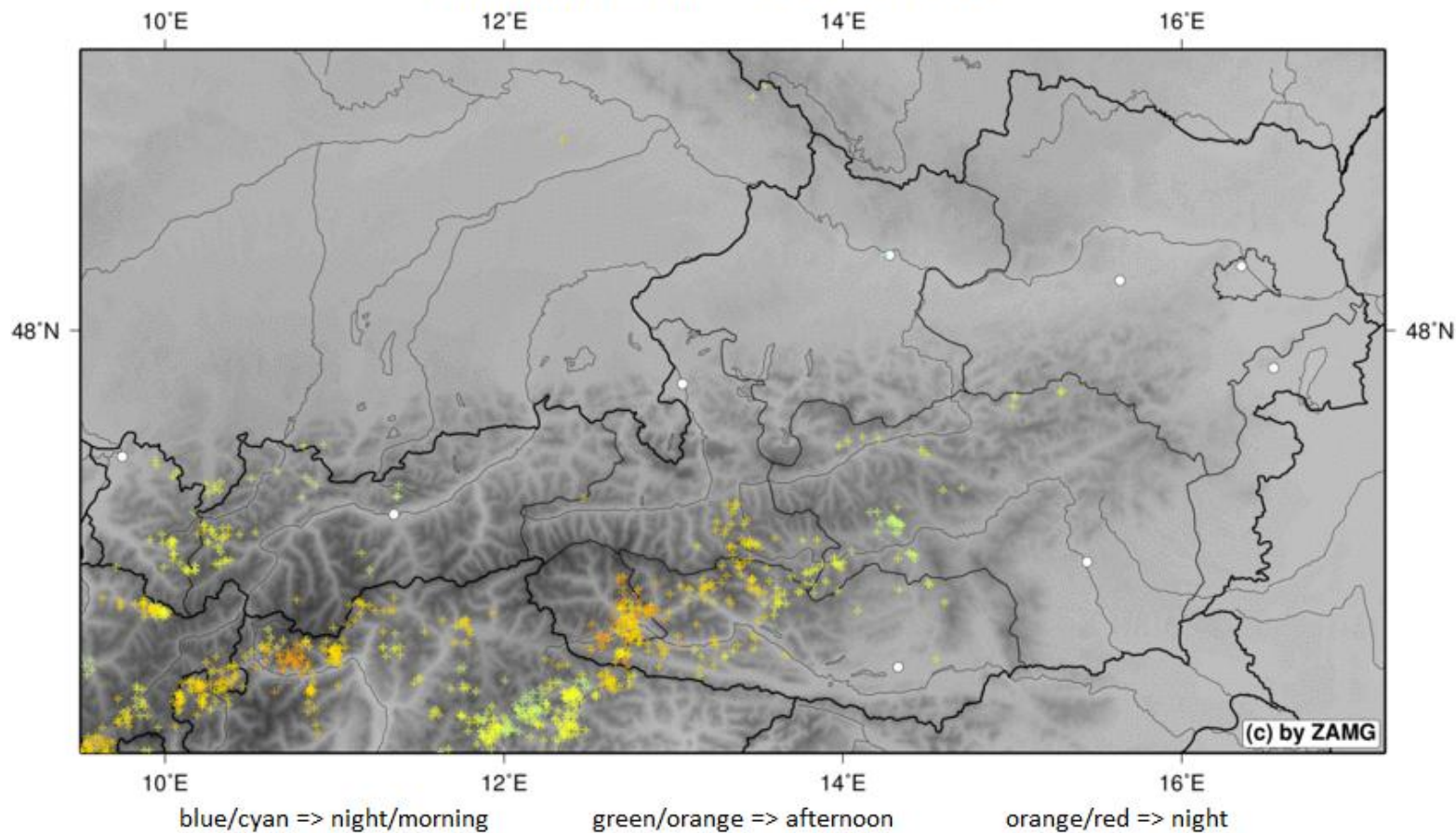
Case study - 9 June 2014



Case study - 9 June 2014

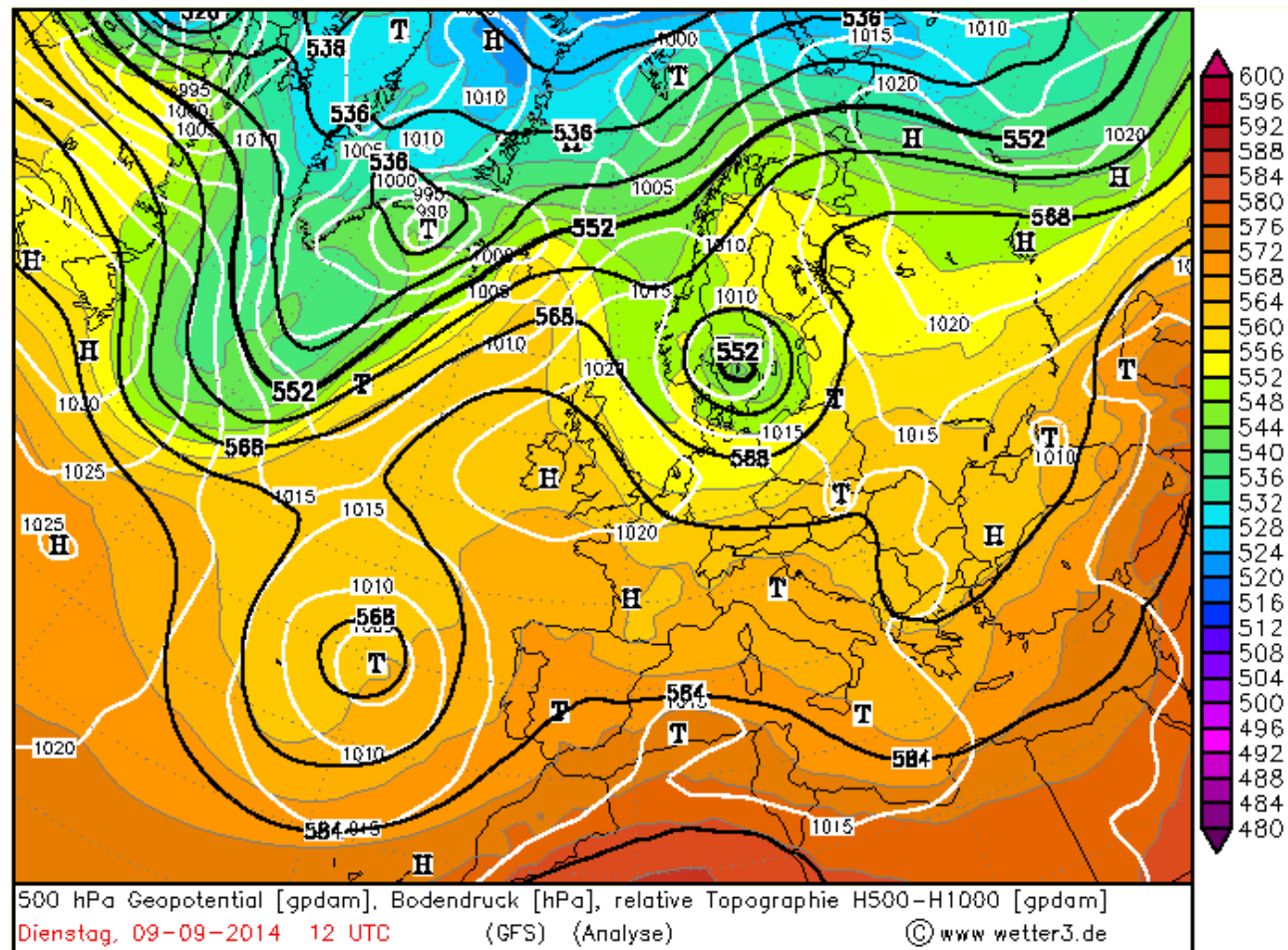


Lightning - 9.6.2014 00 to 24 UTC



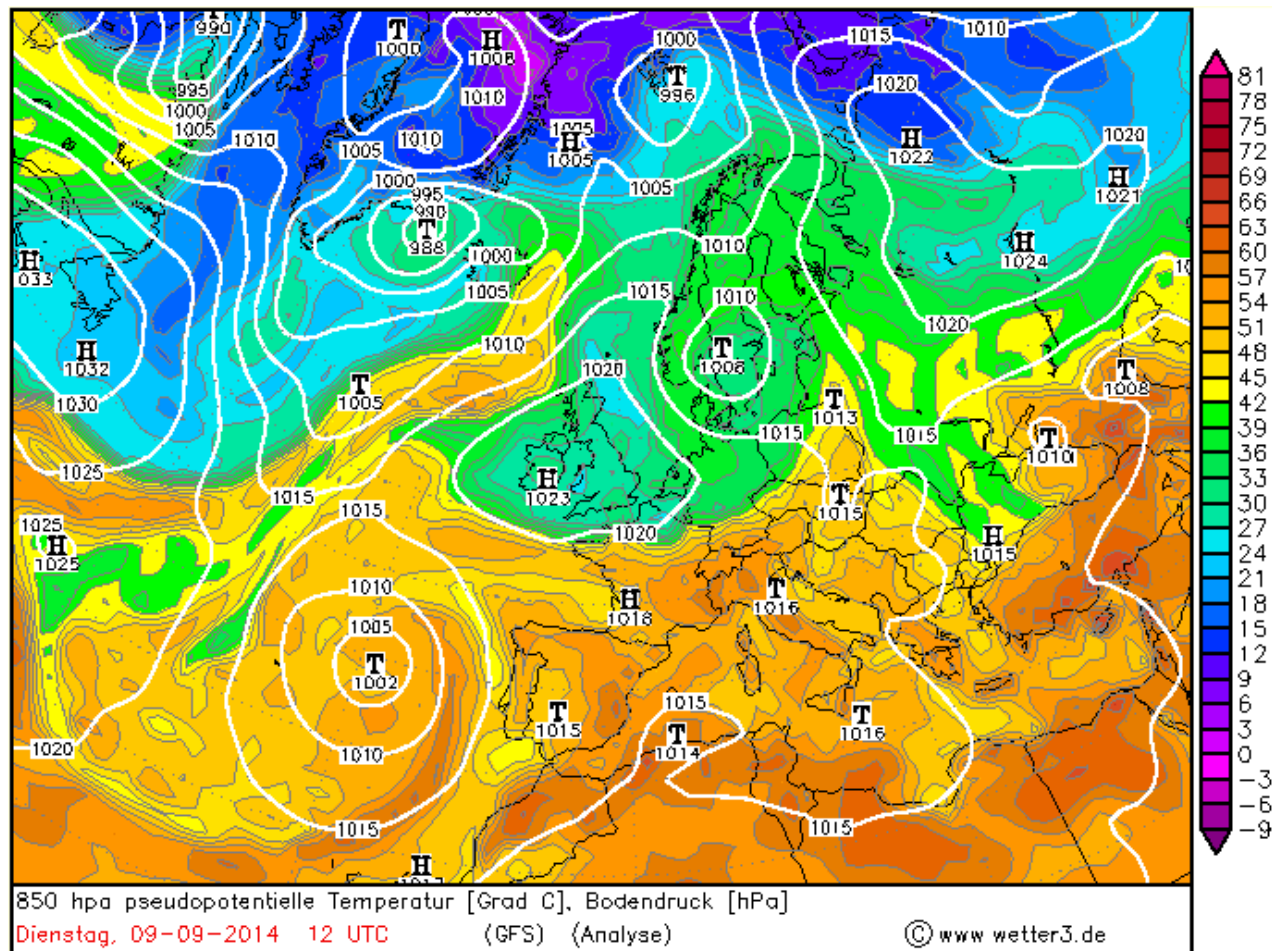
Case study - 9 September 2014

Geopotential 500 hPa / MSLP / Equivalent thickness (500-1000) c



Case study - 9 September 2014

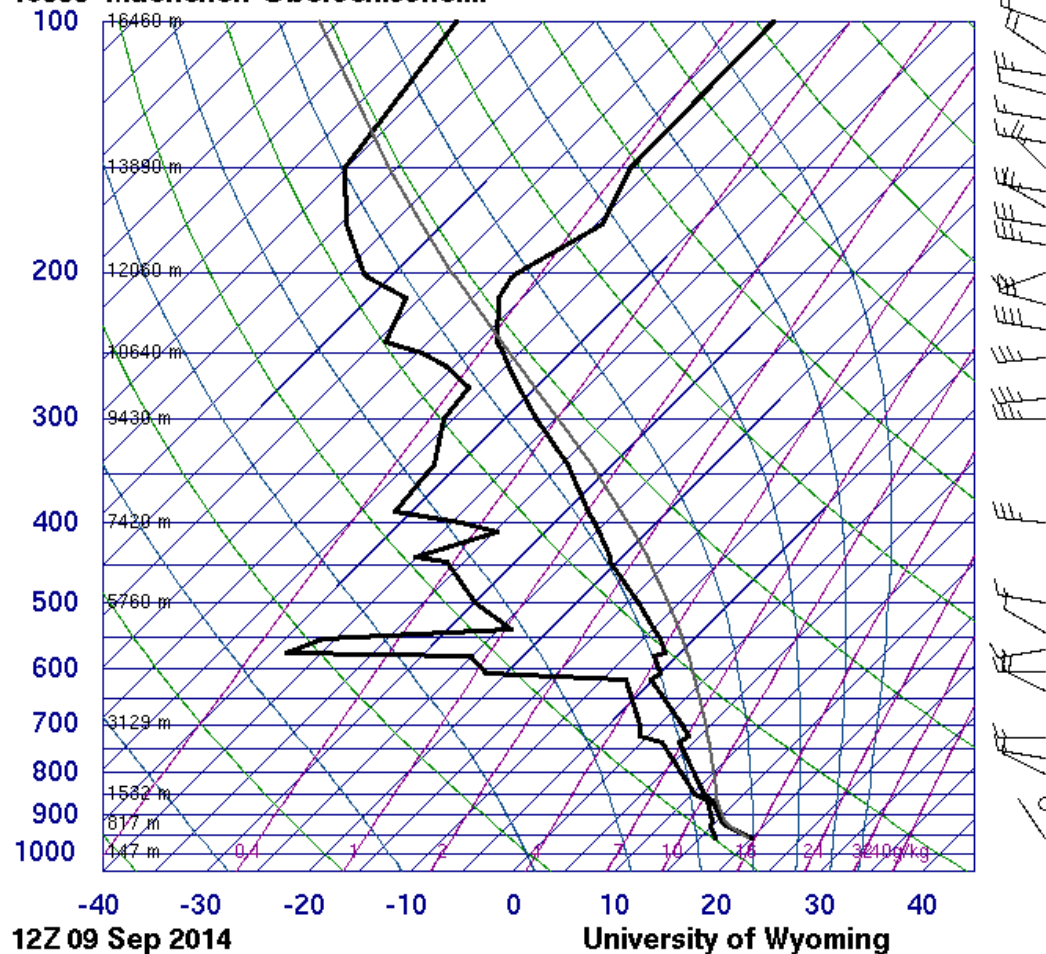
Θ_e 850 hPa



Lifted Index [K], Mixed Layer Convective Available Potential Energy 'ML CAPE' [J/kg]
 Dienstag, 09-09-2014 12 UTC (GFS) (Analyse) © www.wetter3.de

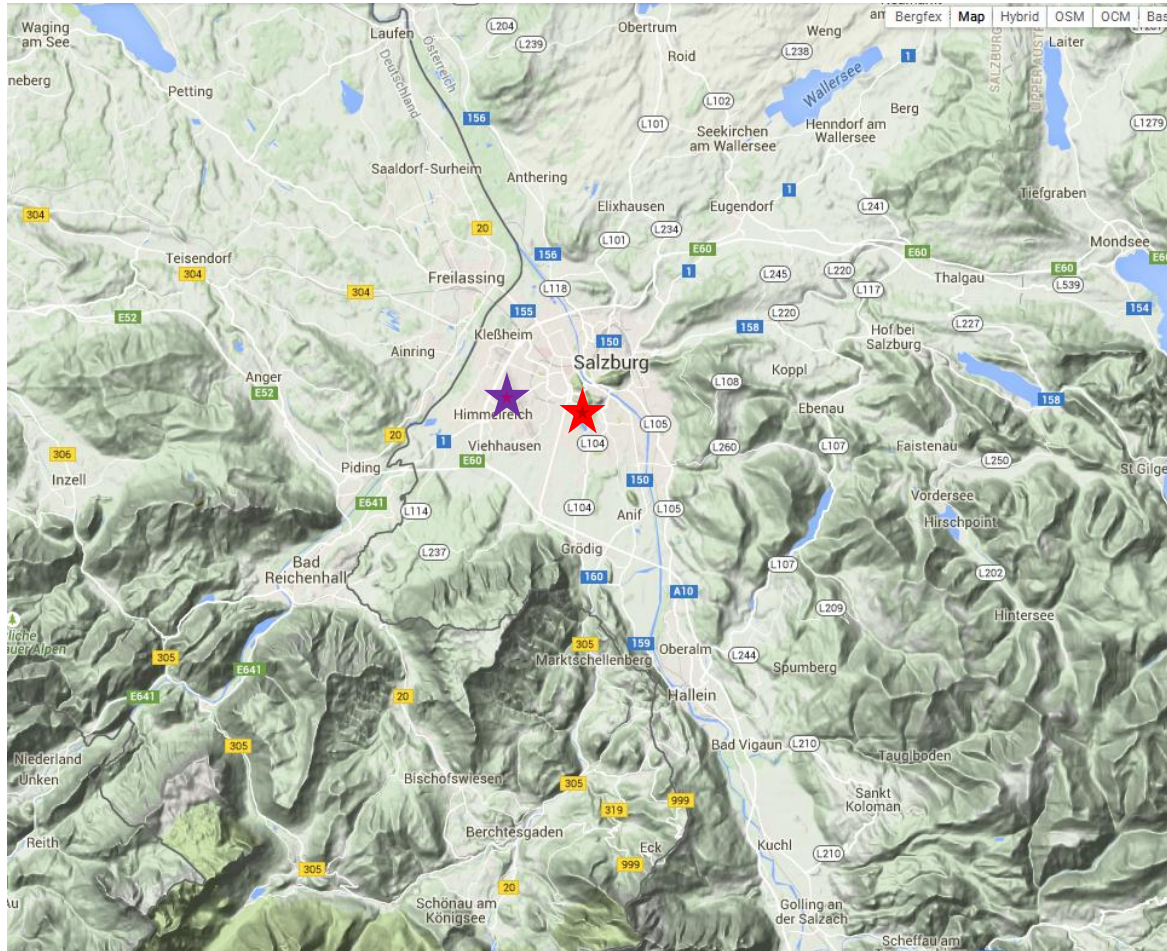
Case study - 9 September 2014

10868 Muenchen-Oberschlsheim

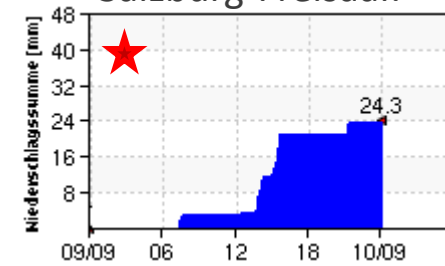


SLAT 48.25
 SLON 11.55
 SELV 489.0
 SHOW -0.24
 LIFT -2.93
 LFTV -3.36
 SWET 150.9
 KINX 31.30
 CTOT 24.20
 VTOT 25.10
 TOTL 49.30
 CAPE 919.3
 CAPV 1022.
 CINS -0.15
 CINV 0.00
 EQLV 239.4
 EQTV 239.3
 LFCT 896.8
 LFCV 903.2
 BRCH 59.34
 BRCV 66.02
 LCLT 288.0
 LCLP 905.5
 MLTH 296.3
 MLMR 11.89
 THCK 5613.
 PWAT 28.62

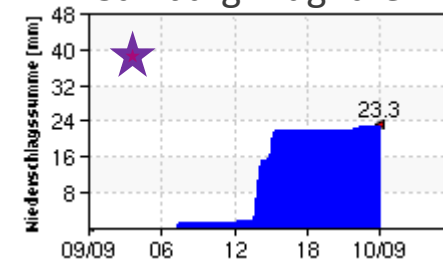
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Salzburg-Freisaal:

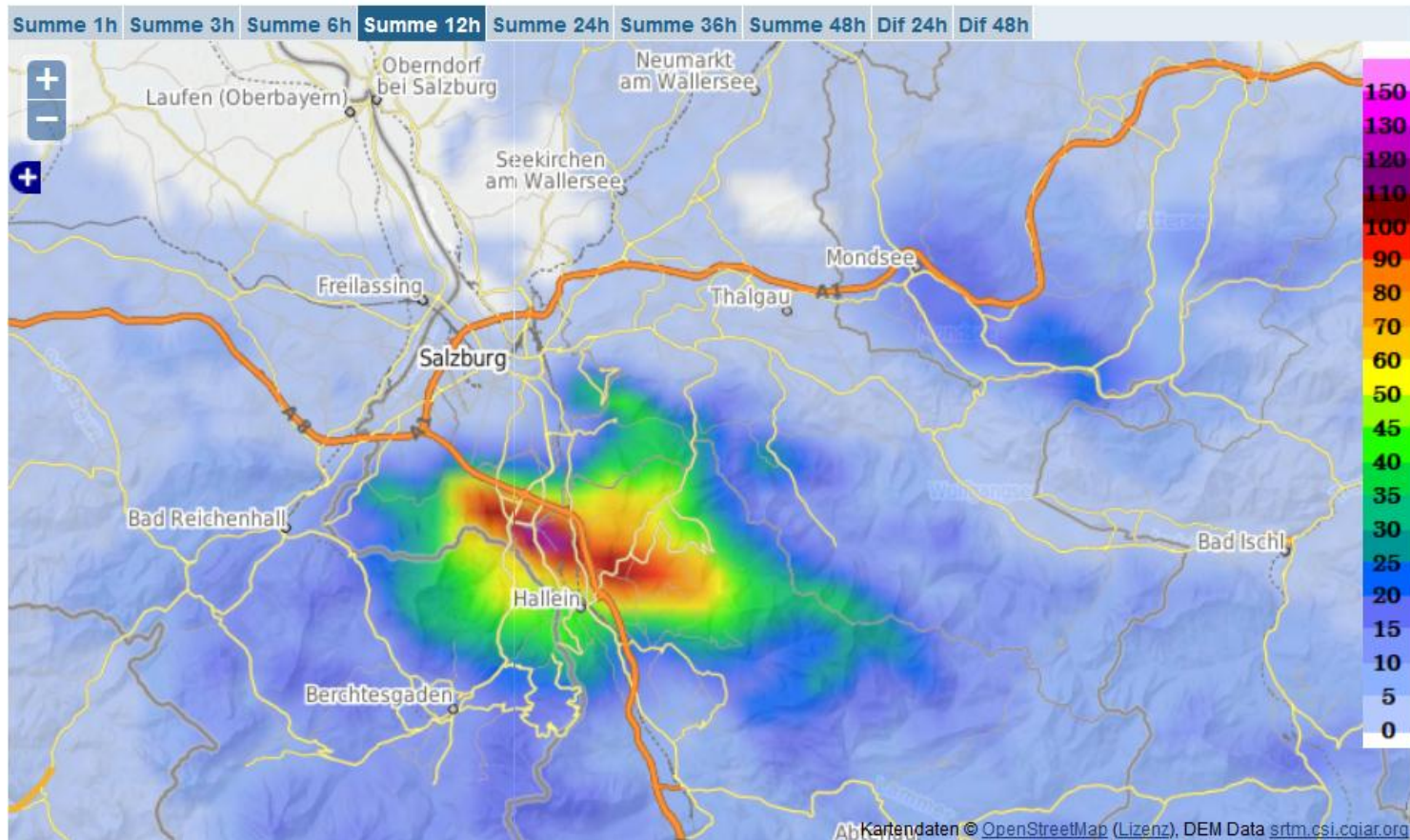


Salzburg-Flughafen:

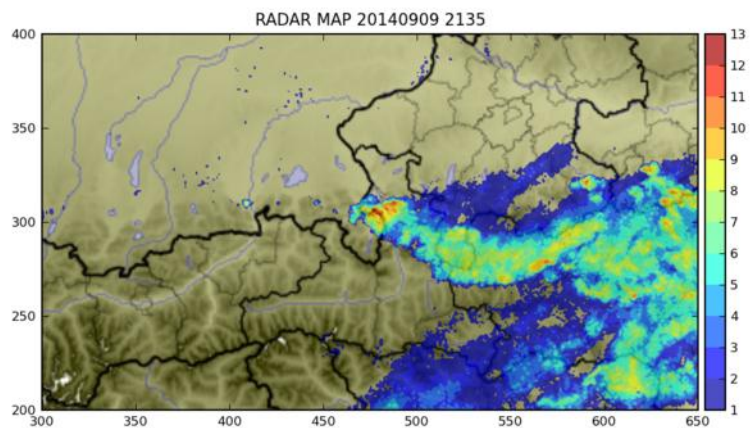
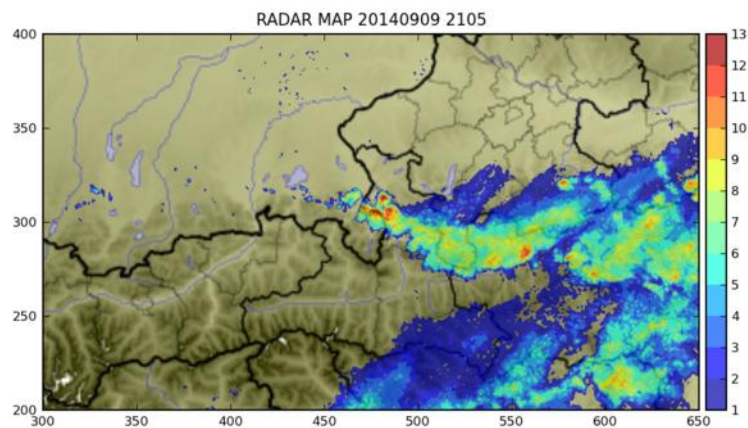
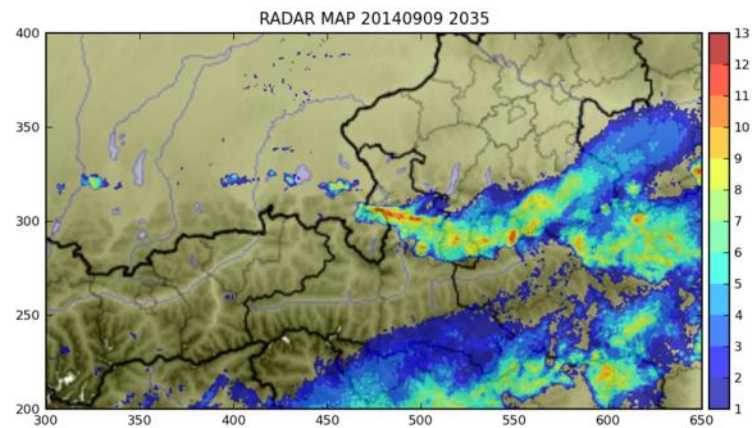
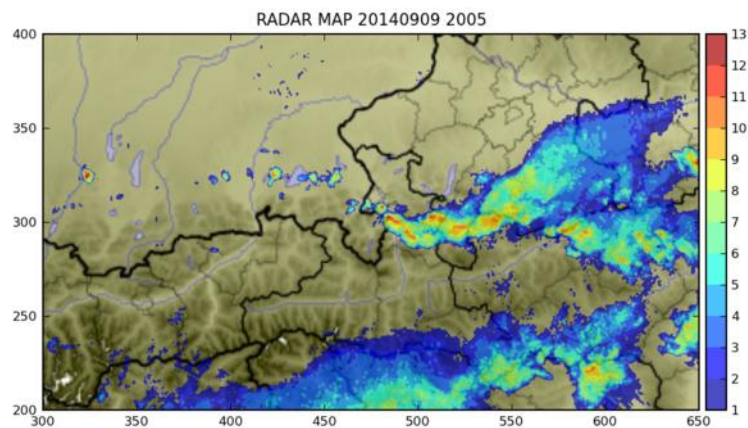


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Niederschlagssumme 12std: Analyse von Mittwoch 09:00 Lokalzeit



Case study – 9 September 2014



Case study – 9 September 2014

(Possible) causes:

- very unstable stratification – (nearly) no CIN/capping inversion
- orography
- local wind convergences

=> constant new and re-developements of convective cells

=> small scale-floodings...





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QUESTIONS?