ECSS 2013

Helsinki, 3-7 June 2013

August 1st 2012 convective event over eastern France and Switzerland

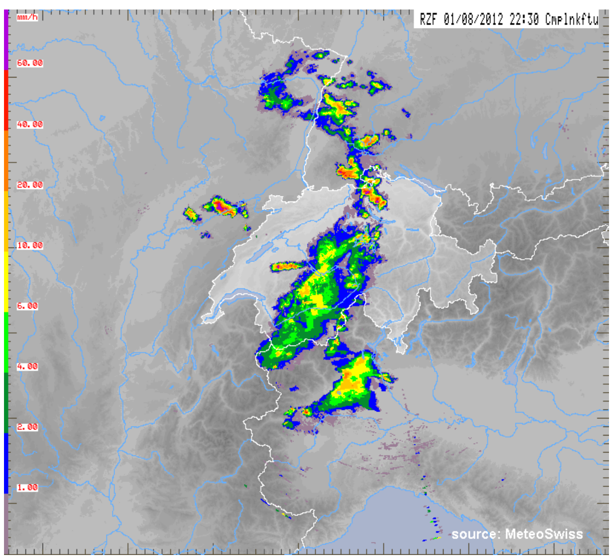
Observations, forecasts and model deficiencies

MeteoSwiss – Federal Office of Meteorology and Climatology

Lionel Peyraud

Convective mode of this MCS affecting eastern France and Switzerland…

This moderately intense convective event was qualified as an asymmetric MCS with a leading line/trailing stratiform squall line structure…



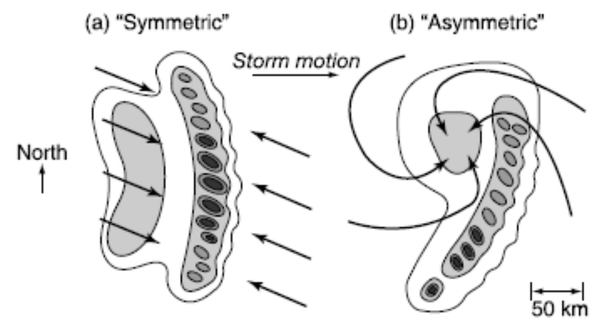
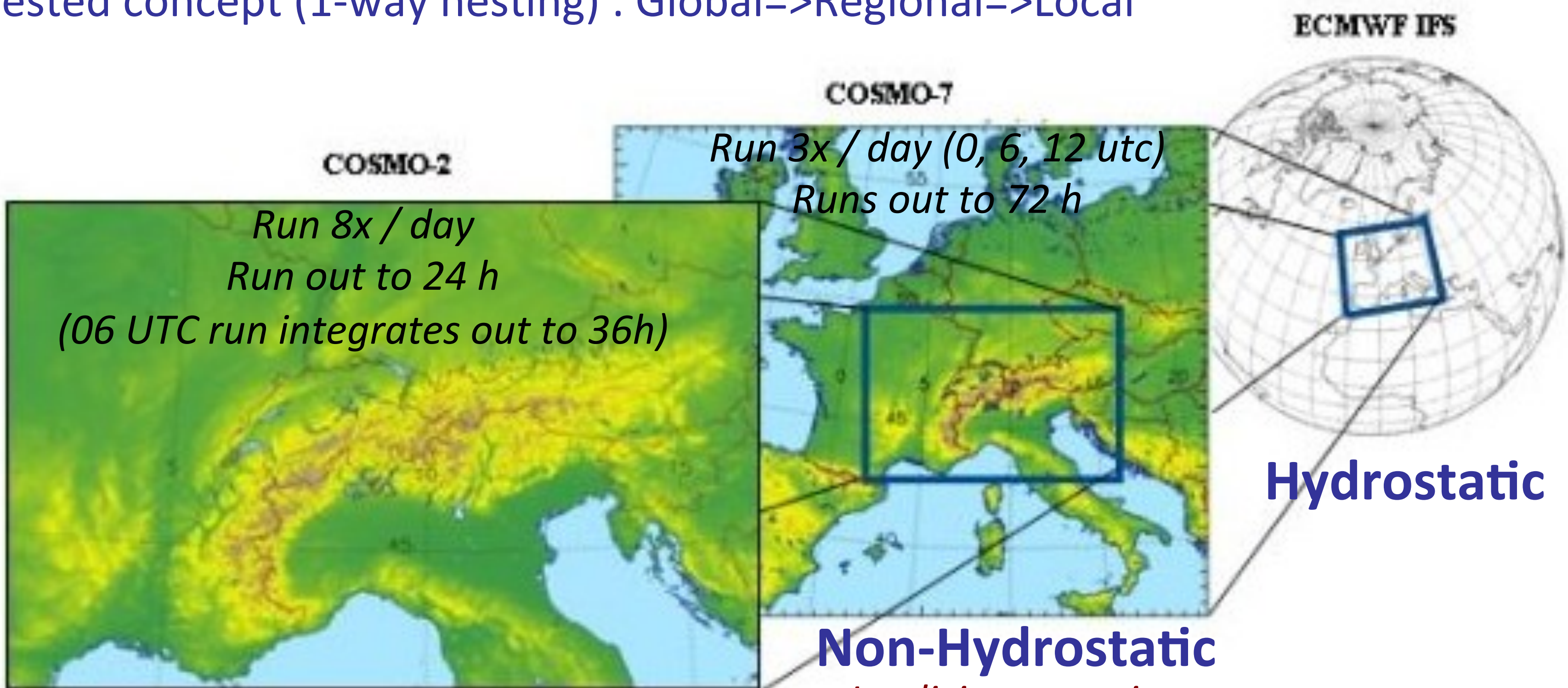


Figure 23. (a) Symmetric and (b) asymmetric paradigms of leading-line/trailing-stratiform squall line MCS structure in the Northern Hemisphere. Contour thresholds indicate radar reflectivity of increasing intensity. Convective regions have cores of maximum reflectivity (dark shading). Stratiform regions are centered on the areas of medium intensity echo (light shading) with no maximum reflectivity cores. Streamlines indicate low level wind direction. Adapted from *Houze et al.* [1989, 1990].

- **mesoscale convective system**—(Abbreviated MCS.) A cloud system that occurs in connection with an ensemble of thunderstorms and produces a contiguous precipitation area on the order of 100 km or more in horizontal scale in at least one direction.
  An MCS exhibits deep, moist convective overturning contiguous with or embedded within a mesoscale vertical circulation that is at least partially driven by the convective overturning.

A few specifics concerning the COSMO-CH model

Nested concept (1-way nesting) : Global=>Regional=>Local



Non-Hydrostatic

Explicit convection
(except for shallow convection : reduced Tiedke scheme)

Large-scale synoptic flow

@ 300-500 hPa :

- Broad SW flow with subtle shortwave features
- Primary upper-level forcing further west

@ 700 hPa :

- Convergence zone humidity signal

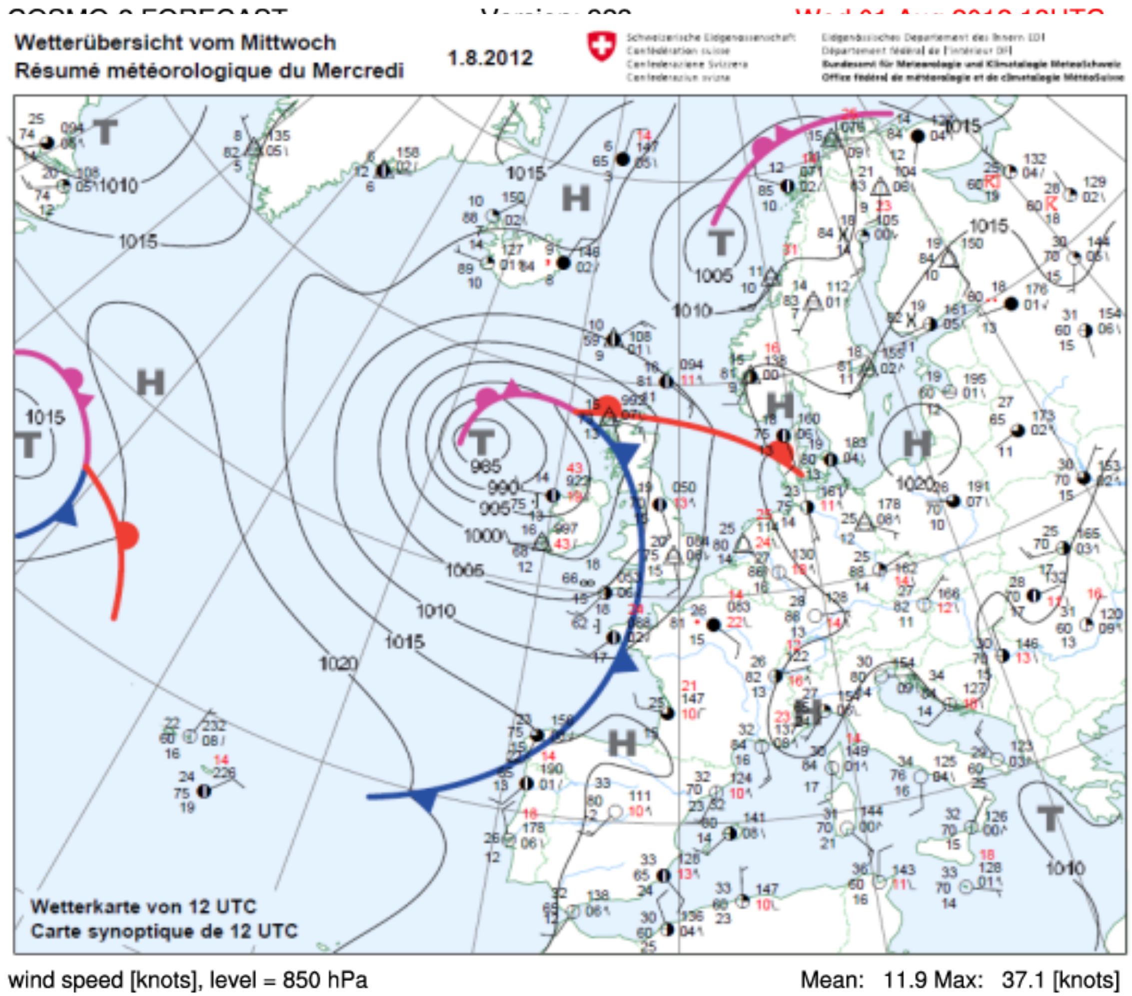
@850 hPa

- Broad warm sector
- Low-level jet up Rhône Valley

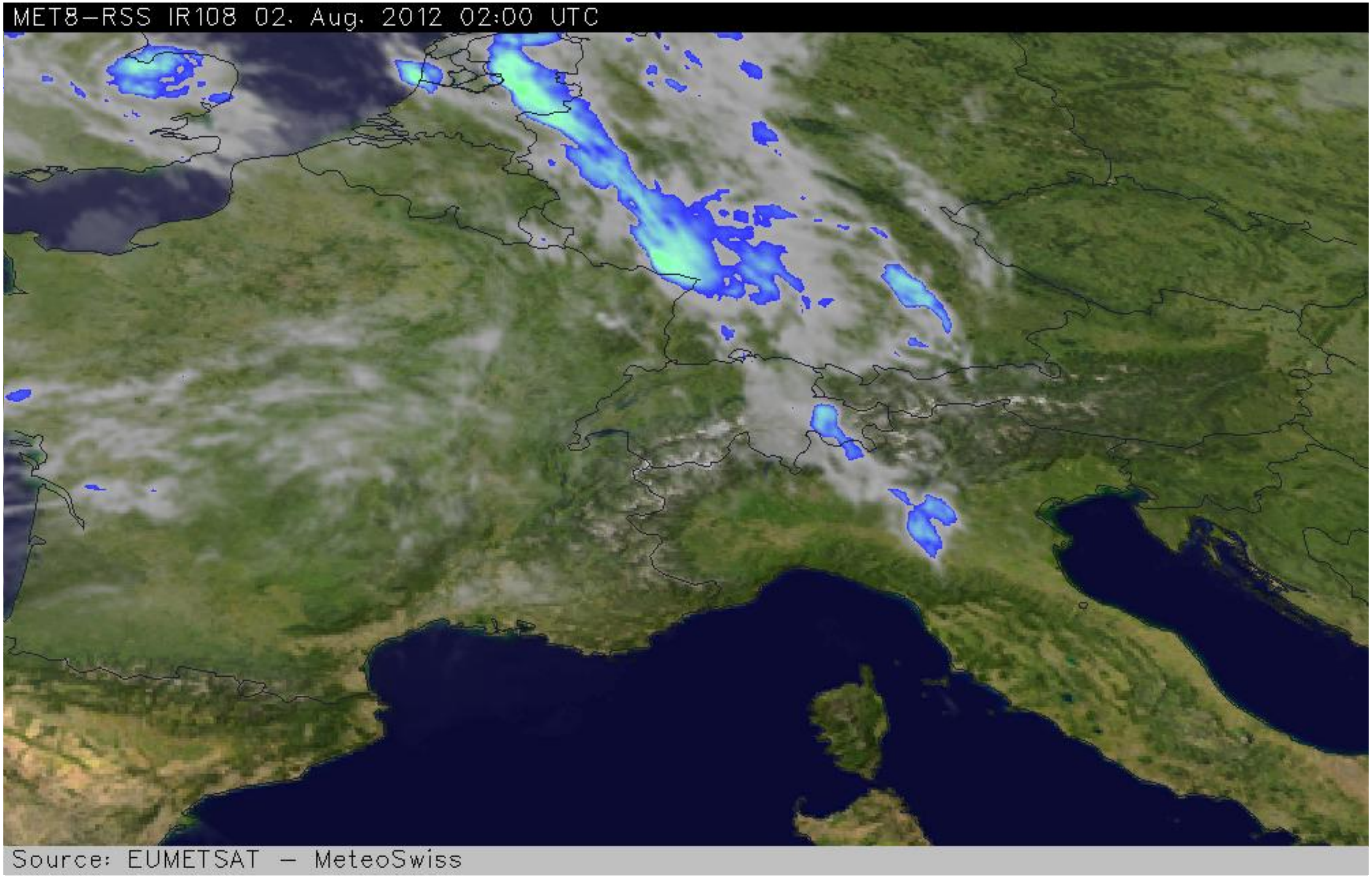
@ Surface :

Warm sector ahead of cold front with prefrontal convergence zone

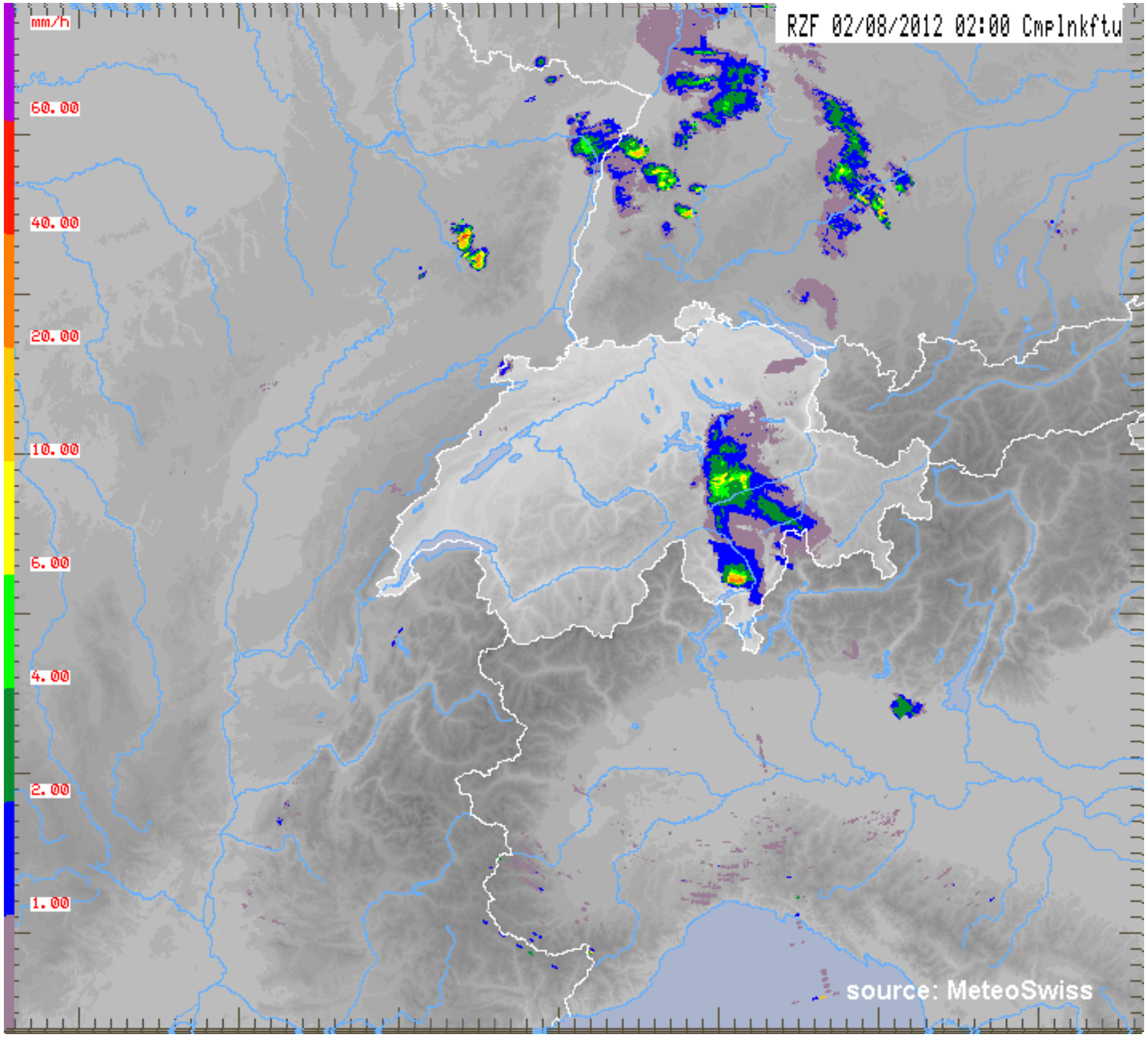
06 UTC COSMO-7 run : H +06h



Observations : animated GIFs of MSG images



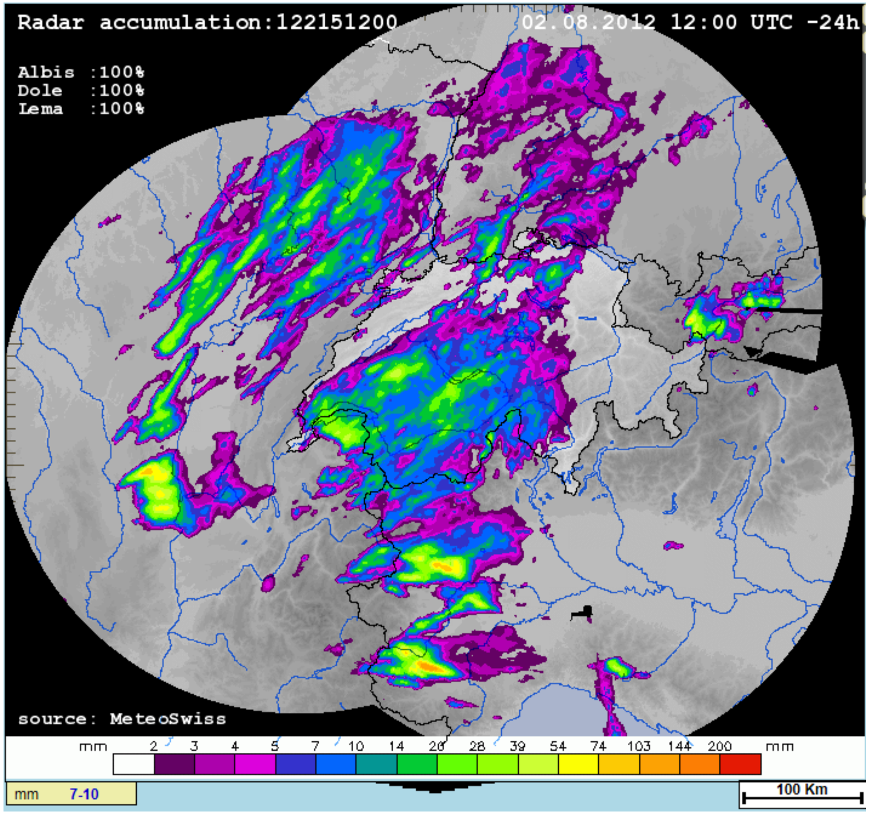
Observations : animated GIFs of radar images



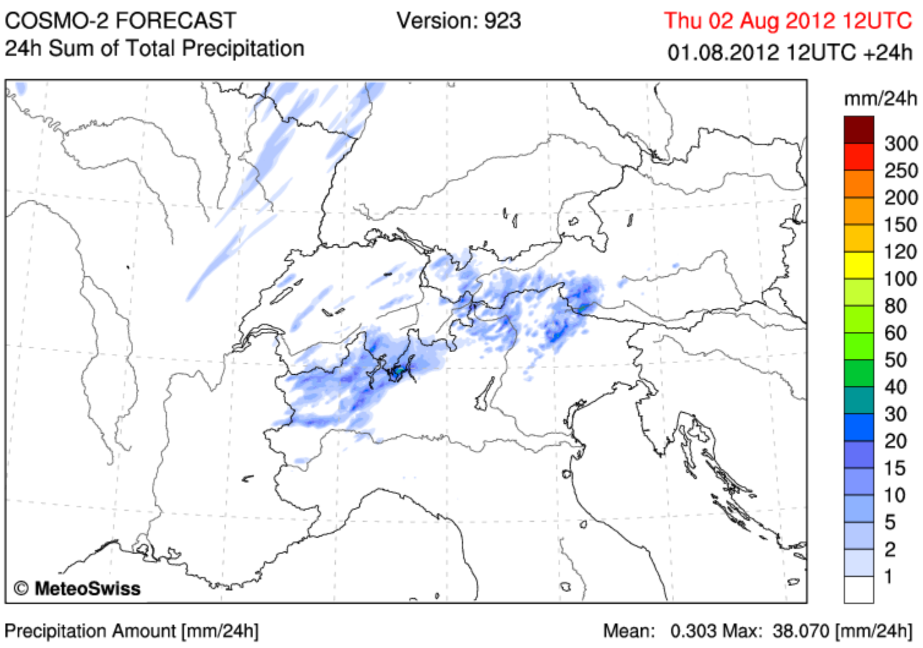
Model deficiencies: precipitation

Comparison

Swiss radar network QPE

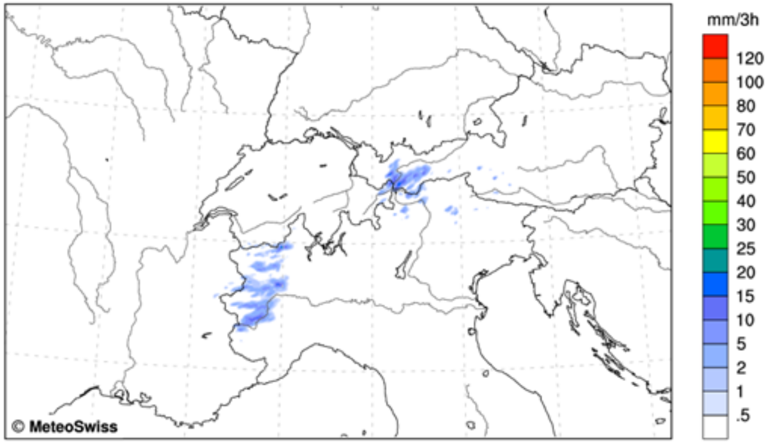


COSMO-2 model QPF



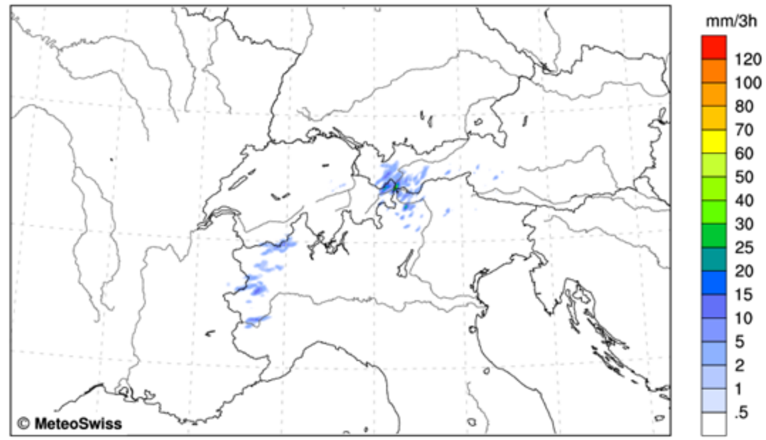
COSMO-2 (6, 9, 12, 15 UTC runs) : 3hr precip sums (15-18 UTC)

COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 18UTC
3h Sum of Total Precipitation 01.08.2012 06UTC +12h



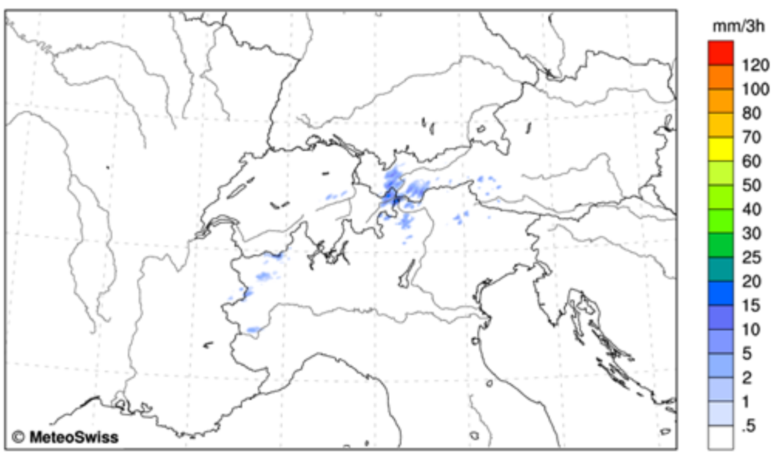
Precipitation Amount [mm/3h] Mean: 0.048 Max: 24.528 [mm/3h]

COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 18UTC
3h Sum of Total Precipitation 01.08.2012 09UTC +09h



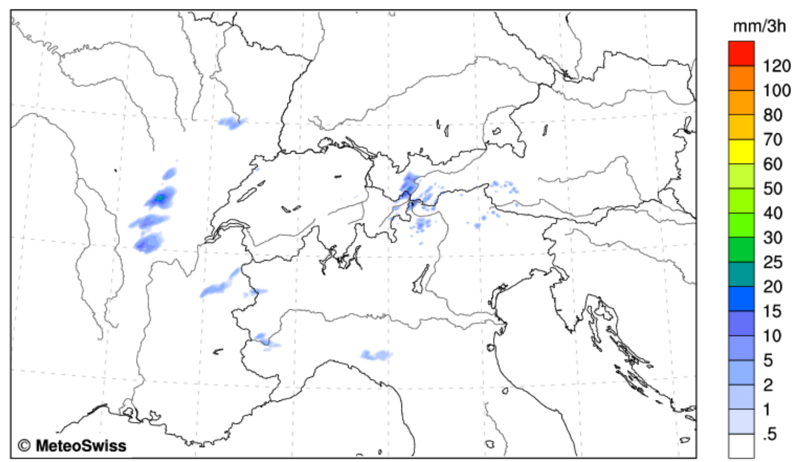
Precipitation Amount [mm/3h] Mean: 0.036 Max: 32.581 [mm/3h]

COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 18UTC
3h Sum of Total Precipitation 01.08.2012 12UTC +06h



Precipitation Amount [mm/3h] Mean: 0.024 Max: 21.367 [mm/3h]

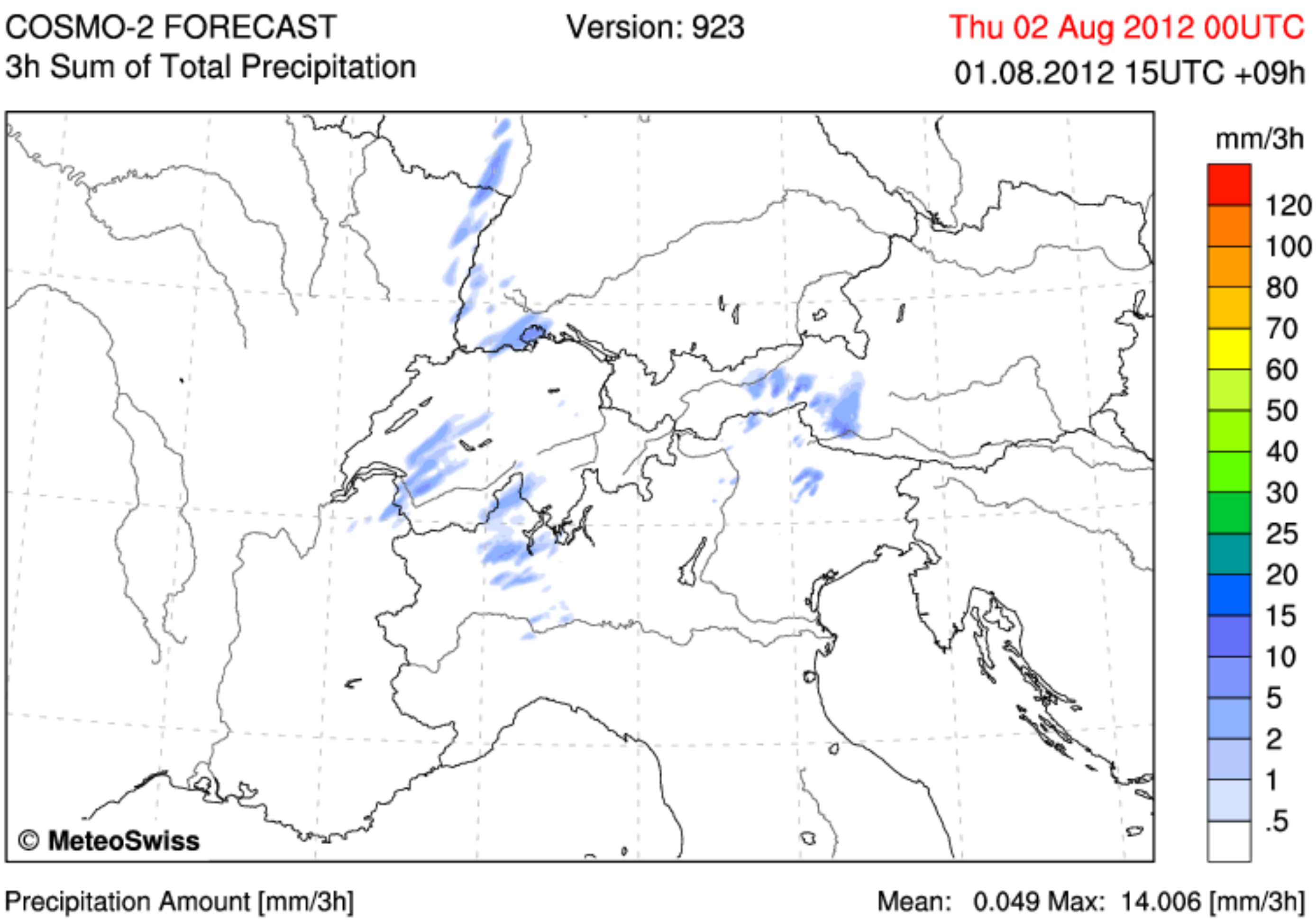
COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 18UTC
3h Sum of Total Precipitation 01.08.2012 15UTC +03h



Precipitation Amount [mm/3h] Mean: 0.045 Max: 25.458 [mm/3h]

COSMO-2 (15 UTC run) : 3hr precip sums (15-24 UTC)

Latent-Heat Nudging (LHN) effect : convective signal doesn't maintain itself

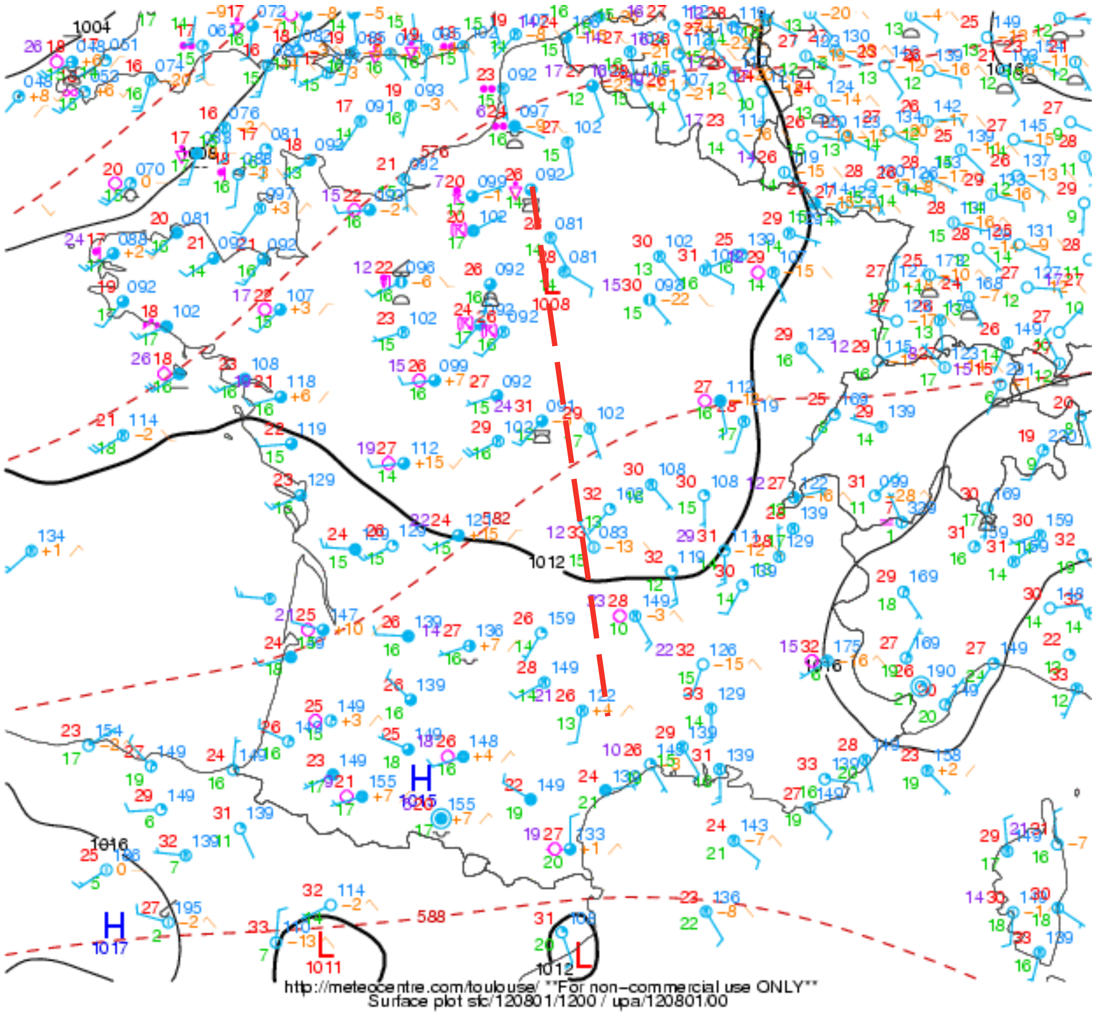


Model deficiencies

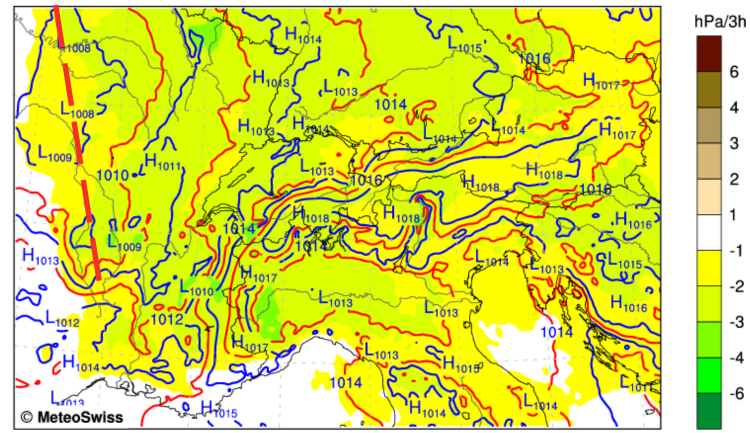
Convective initiation

PBL wind/moisture convergence and
lifting parcels to their LFC

Observations vs model – pre-convective environment

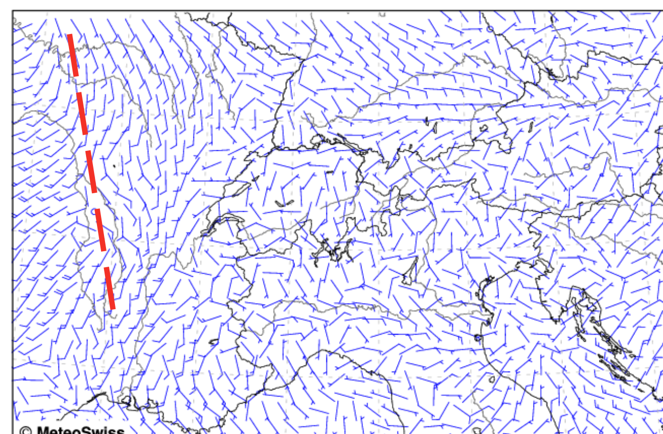


COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 12UTC
Sea Surface Pressure and Tendency 01.08.2012 06UTC +06h



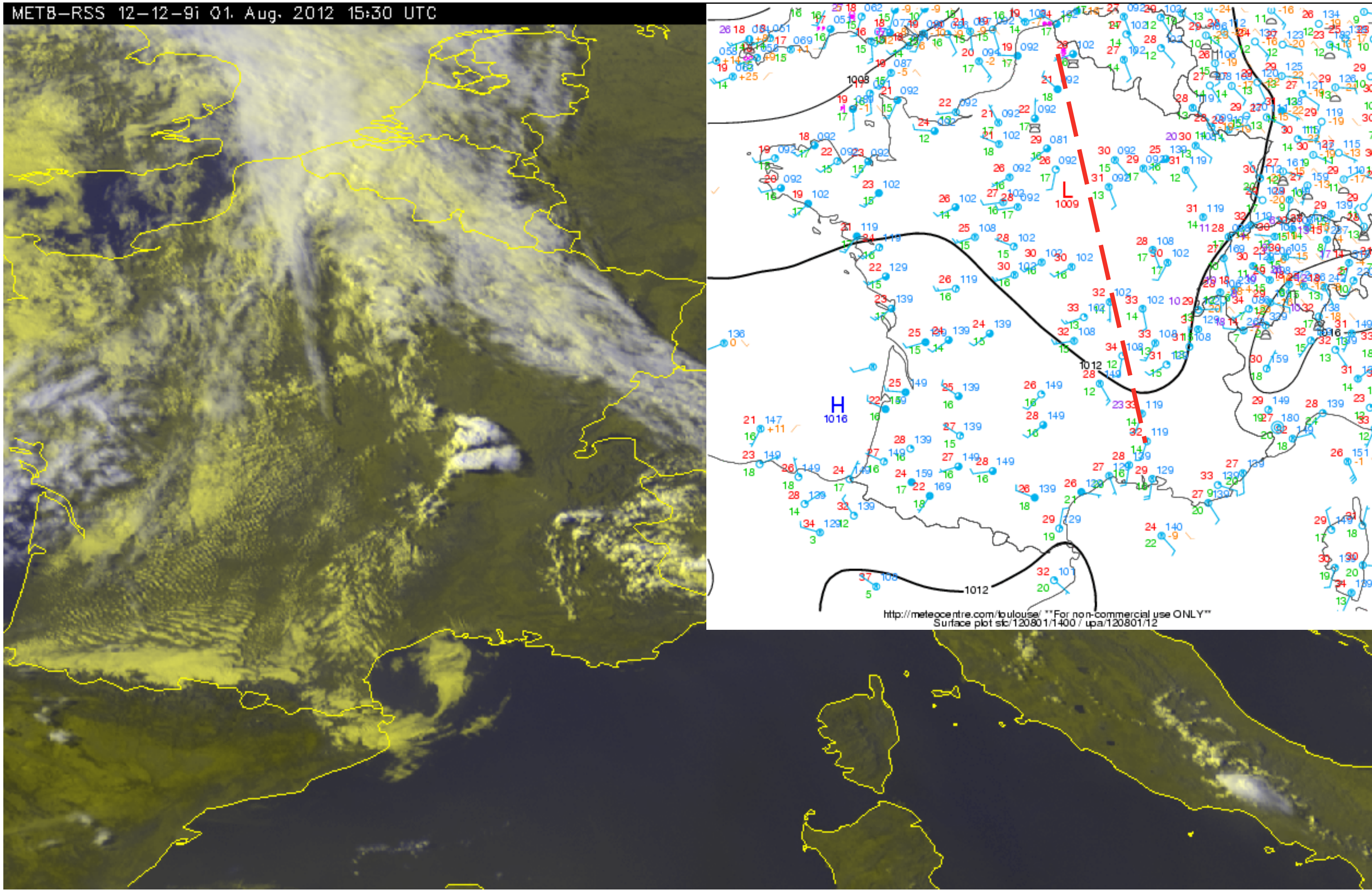
Air Pressure at Sea Level [hPa] Mean: 1013.7 hPa
3h Sea Surface Pressure Tendency [hPa] Mean: -1.9 hPa

COSMO-2 FORECAST Version: 923 Wed 01 Aug 2012 12UTC
10m WMO Wind Flags 01.08.2012 06UTC +06h



wind barbs

Observations – convective initiation (between 13:30-14:00 UTC)

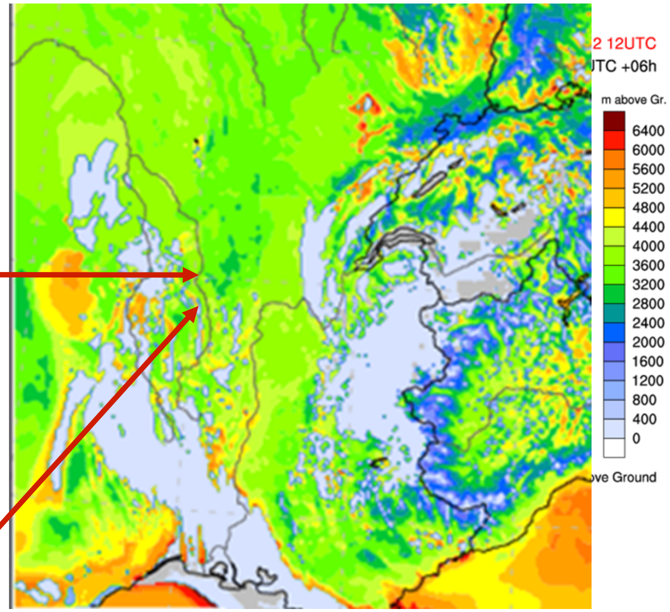


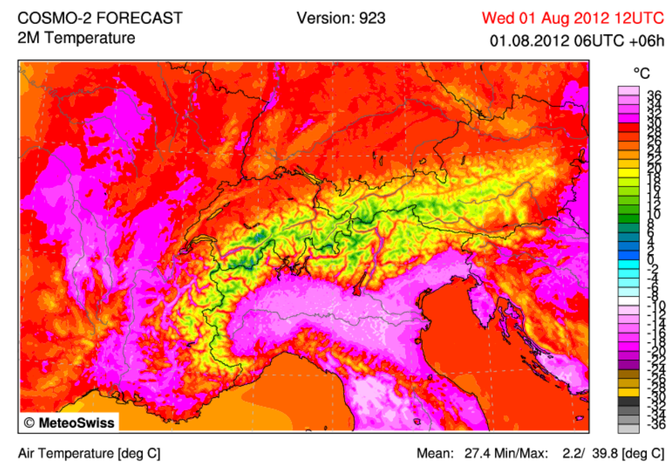
Model deficiencies : convective initiation

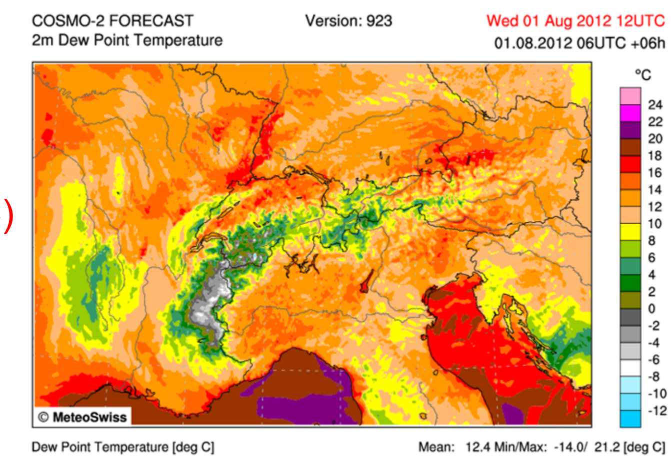
COSMO-2 (06 UTC run, H + 6hr) : Level of Free Convection

Roanne
Alt : 300 m amsl
LFC forecast COSMO-2 : 2800-4000 m ag
LFC forecast COSMO-2 : ~ 3100-4300 m amsl

Monts du Forez
Alt : 800-1600 m amsl
LFC forecast COSMO-2 : 2800-4000 m ag
LFC forecast COSMO-2 : ~ 3800-5000 amsl







<u>Roanne COSMO2 @ 12 UTC</u>

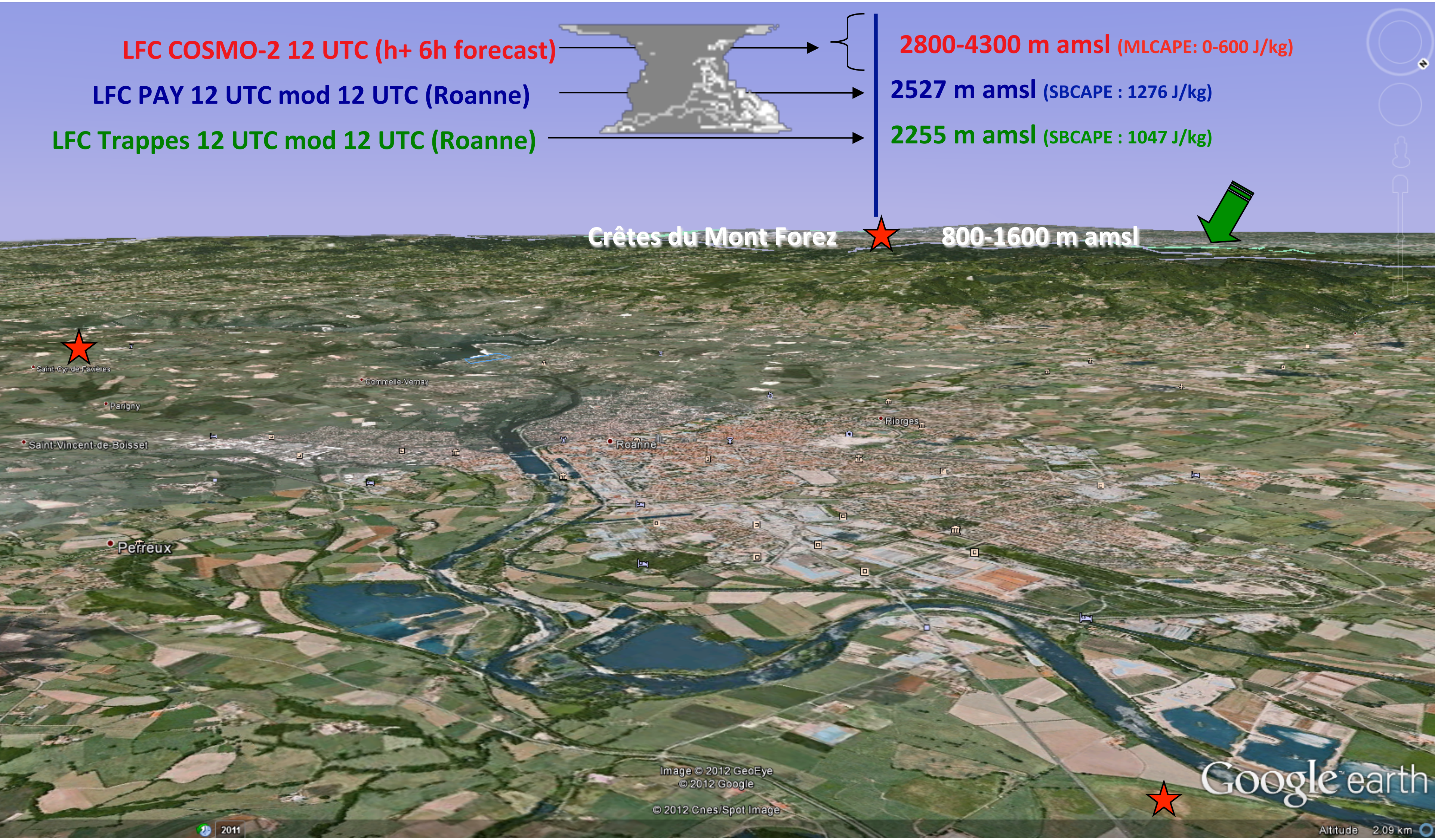
T2m: 32-34°; 36° at Mont Forez (Obs : 30°C)

Td2m : 8-10°C south of town; 10-14°C north of town (Obs : 16°C)

COSMO much too warm/dry (too warm because too dry or parameterization problem with surface moisture flux, foehn effect..?)

Surface Layer	• A Surface layer scheme (based on turbulent kinetic energy) including a laminar-turbulent roughness layer. • Option for a stability-dependent drag-law formulation of momentum, heat and moisture fluxes according to similarity theory (Louis, 1979).
Soil Processes	• Multi-layer version of the former two-layer soil model after Jacobsen and Heise (1982) based on the direct numerical solution of the heat conduction equation. Snow and interception storage are included. • Option for the (old) two-layer soil model employing the extended force-restore method still included.

Model deficiencies : LFC height and CAPE values

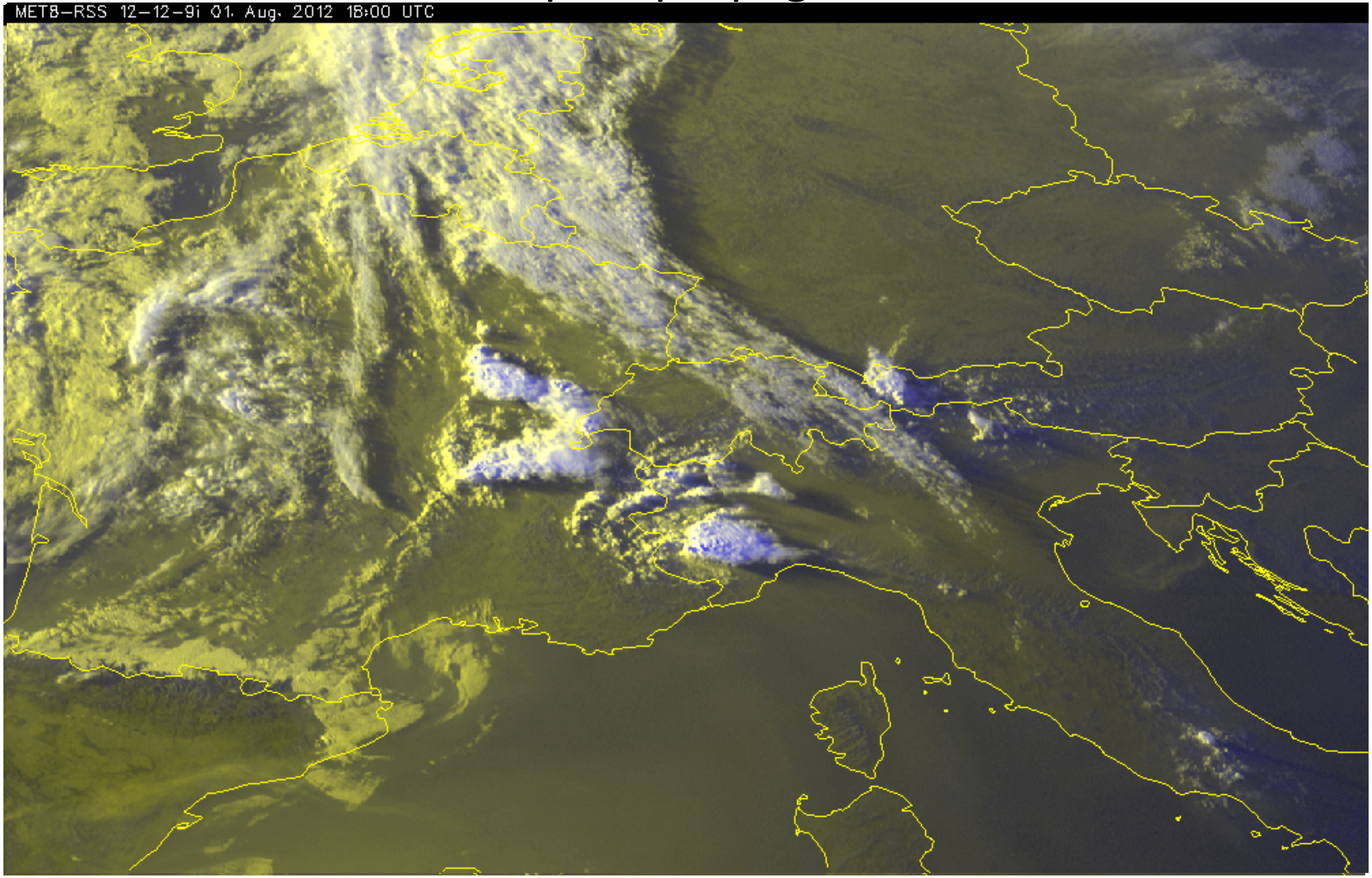


Model deficiencies

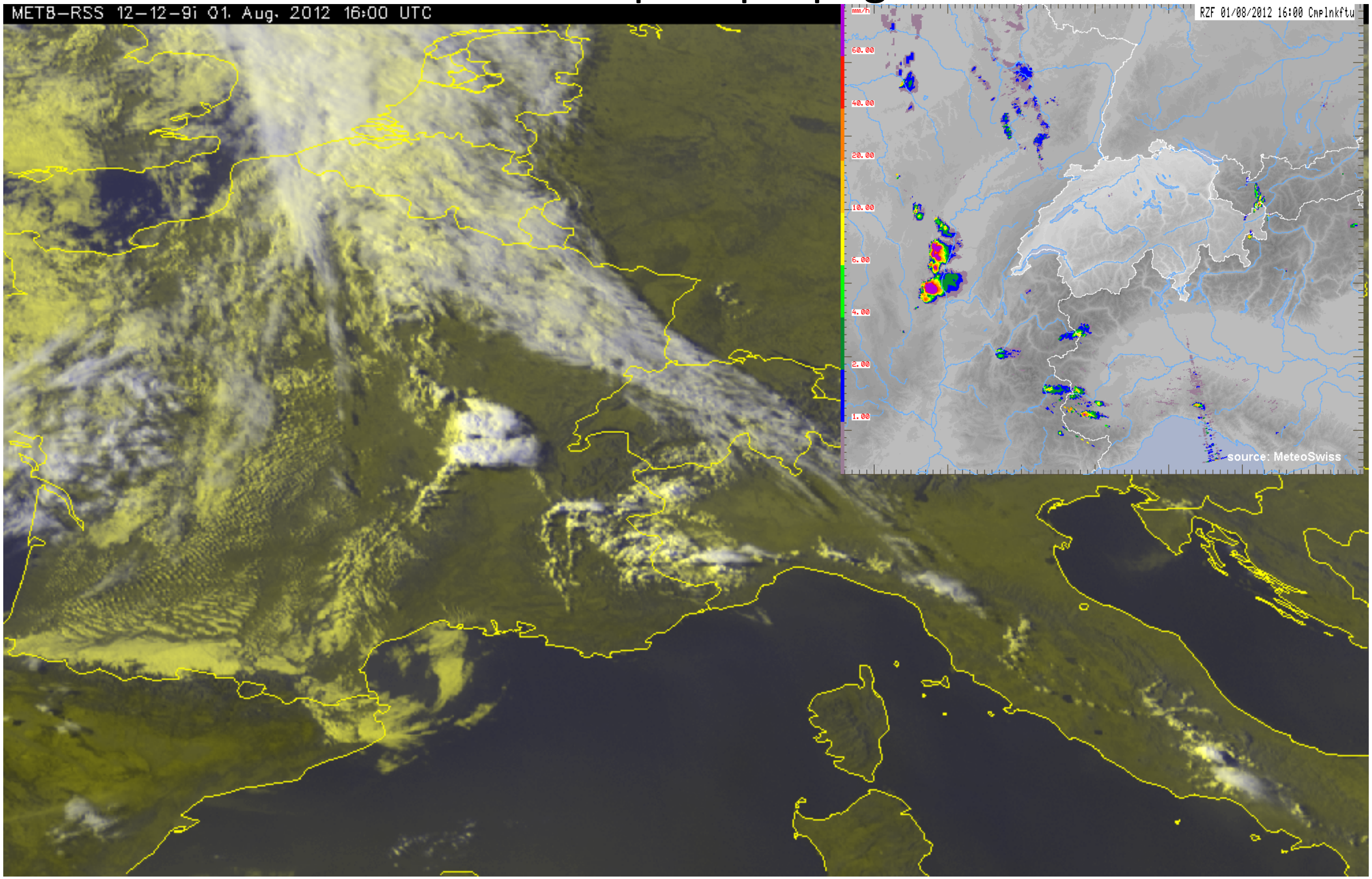
MCS propagation/upscale growth

Cold pool effects

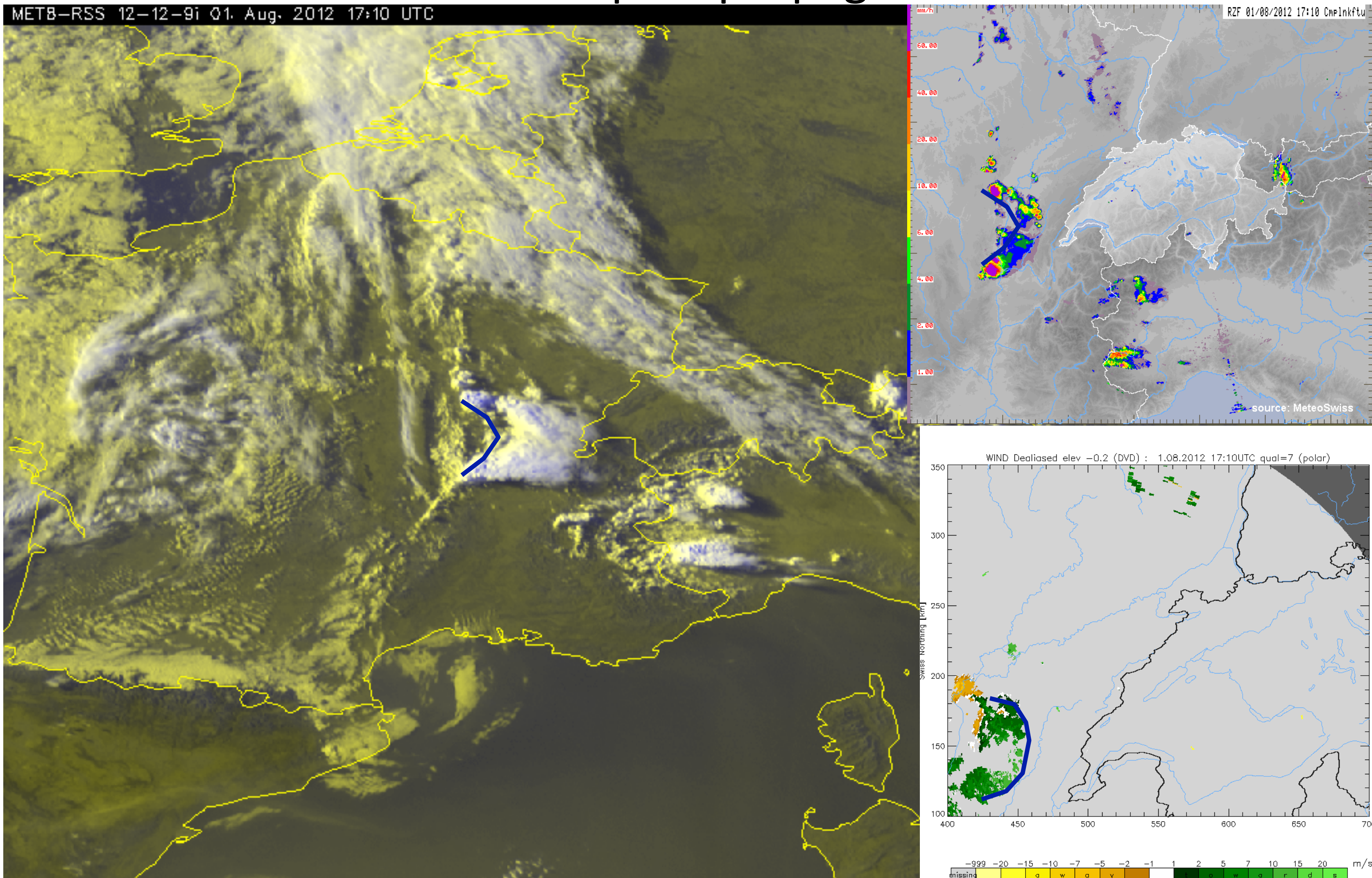
Cold pool propagation



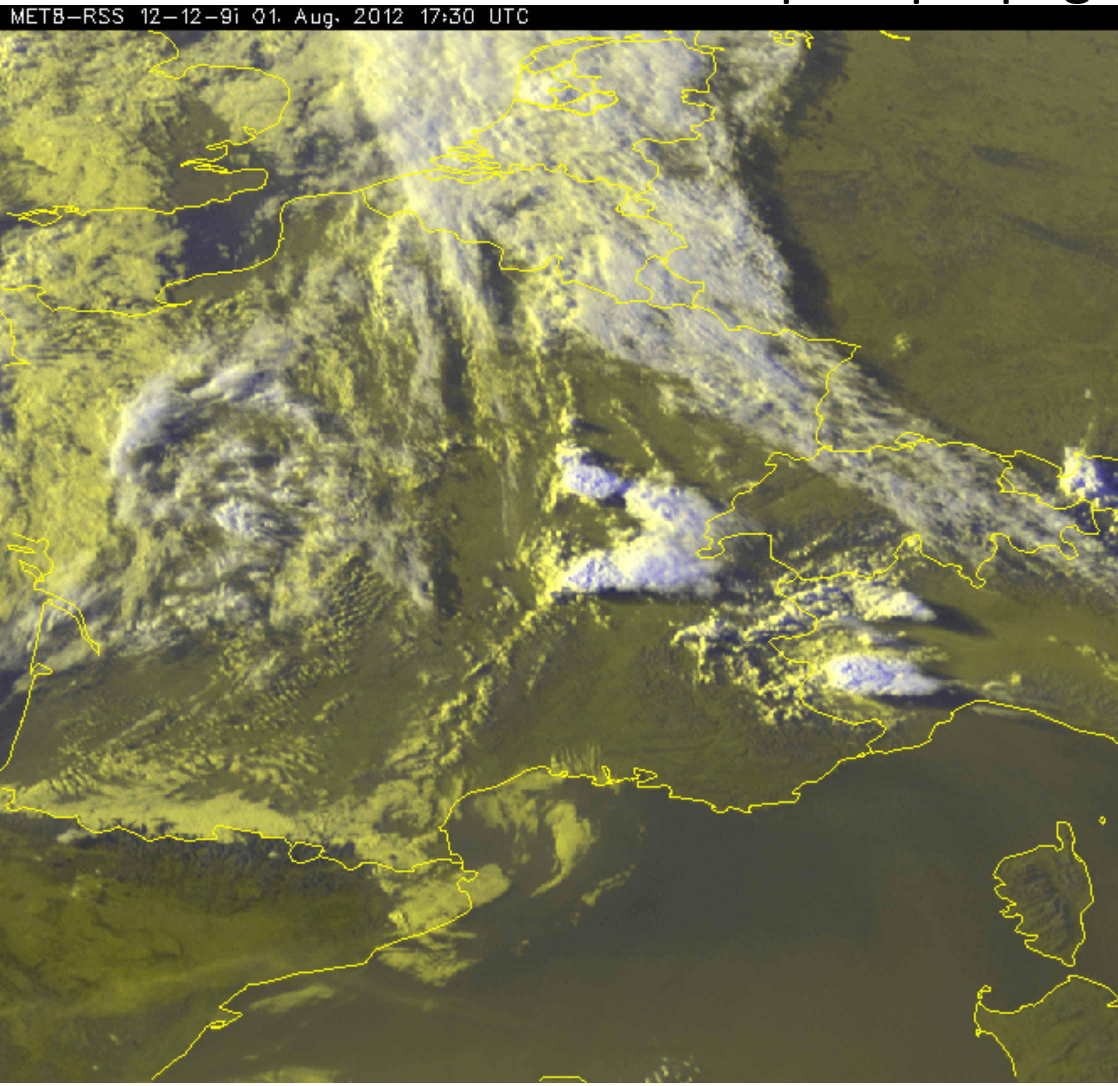
Cold pool propagation

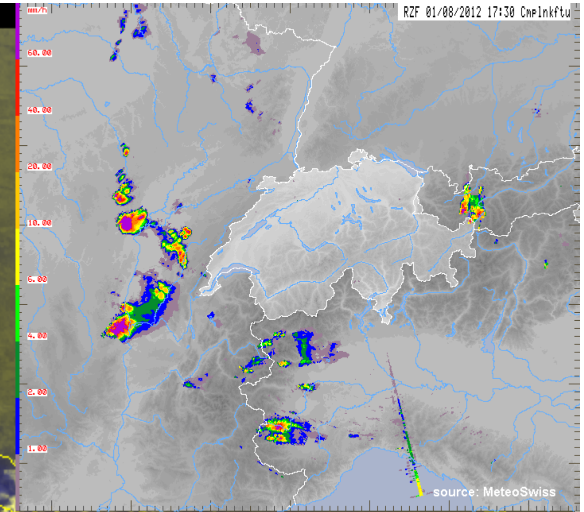


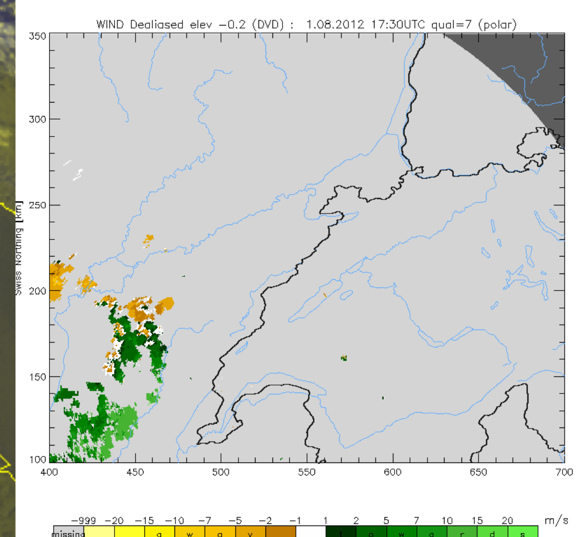
Cold pool propagation



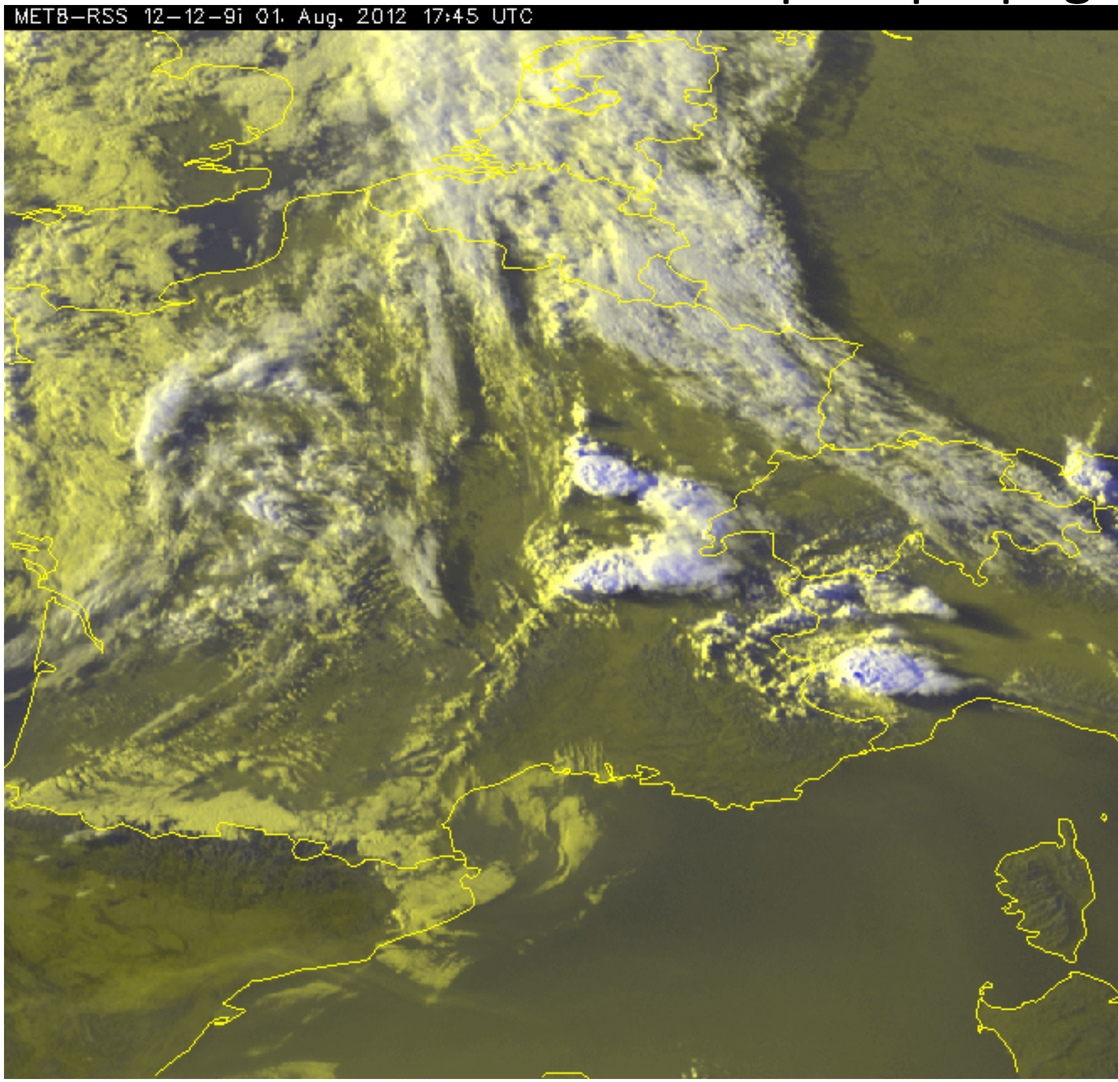
Cold pool propagation

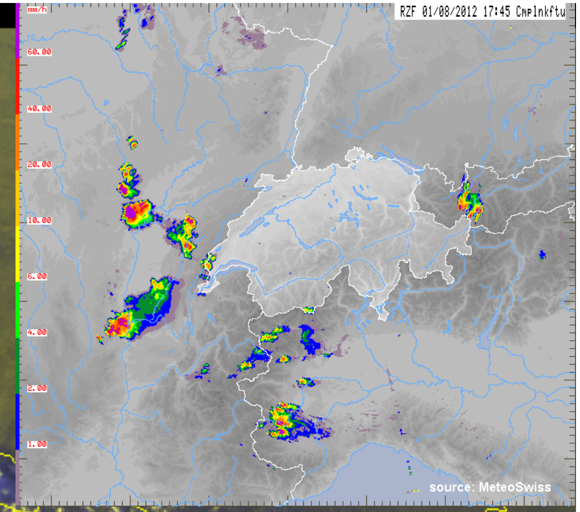


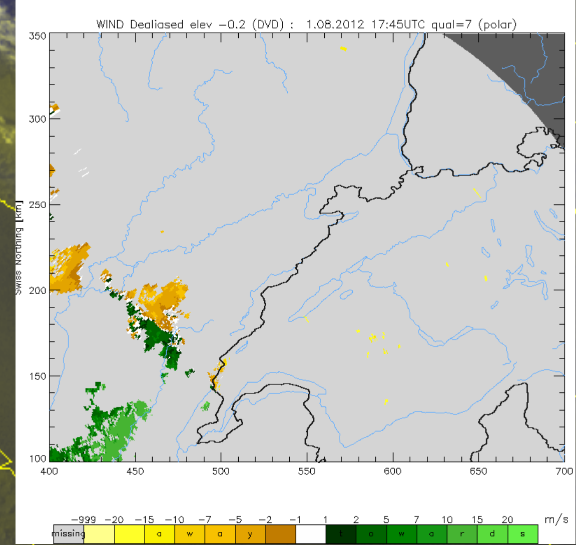




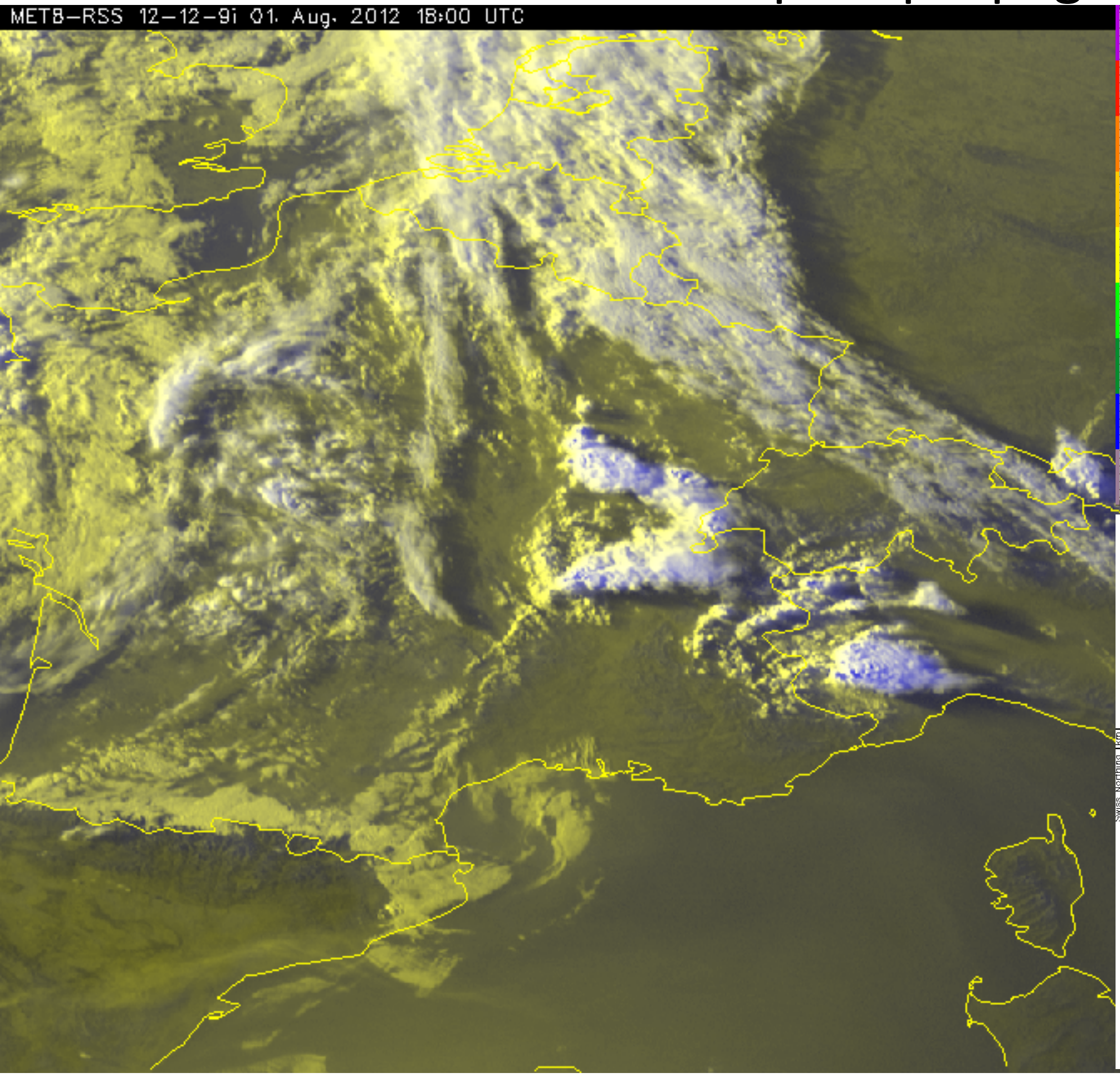
Cold pool propagation

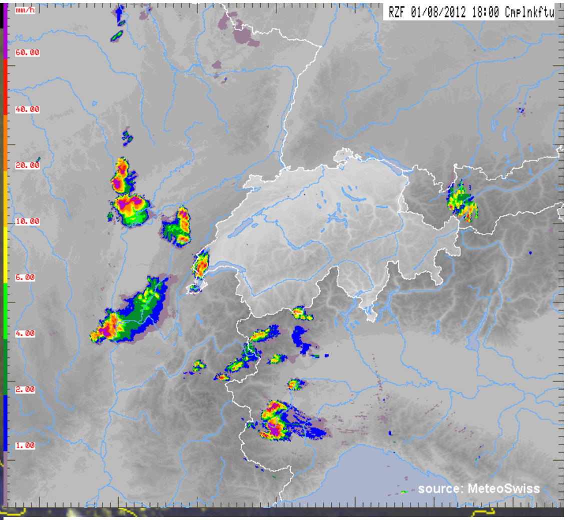






Cold pool propagation





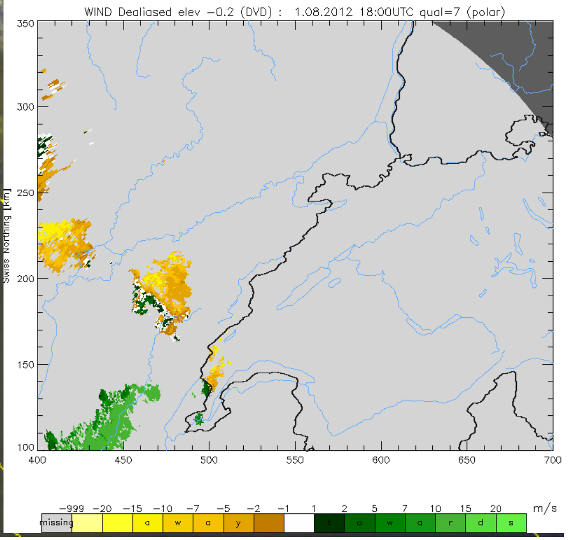
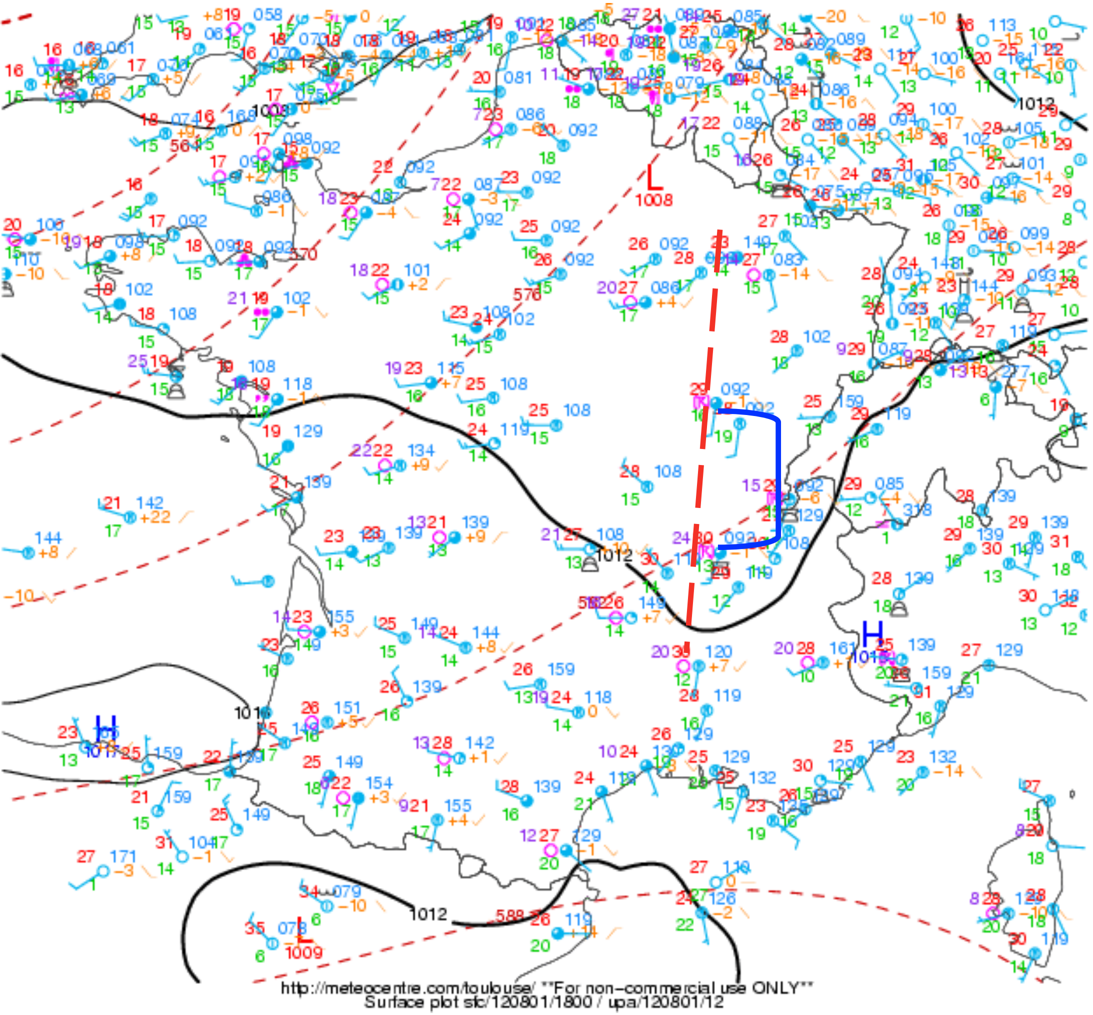
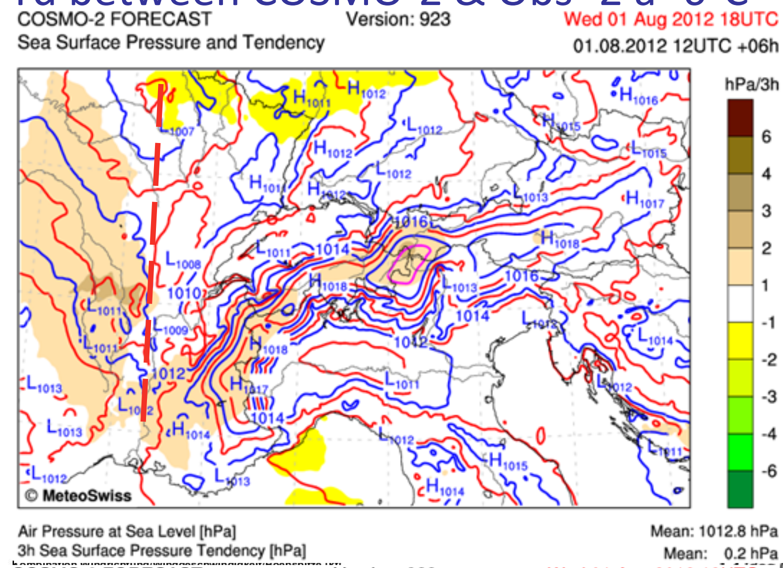


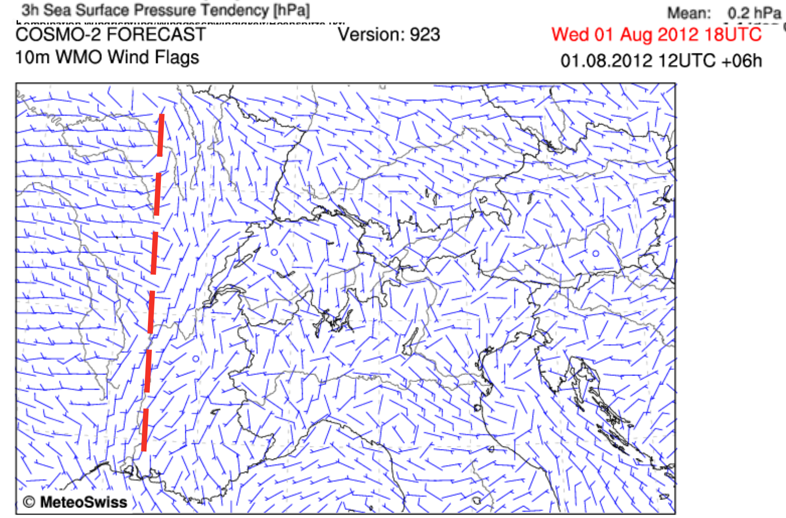
Photo Xavier Delorme : convection approaching Dijon around 8pm

Observations – convective environment @ 18 UTC

No notable Delta T_{2m} between COSMO2 & Obs ; Delta Td between COSMO-2 & Obs -2 à -6°C







wind barbs

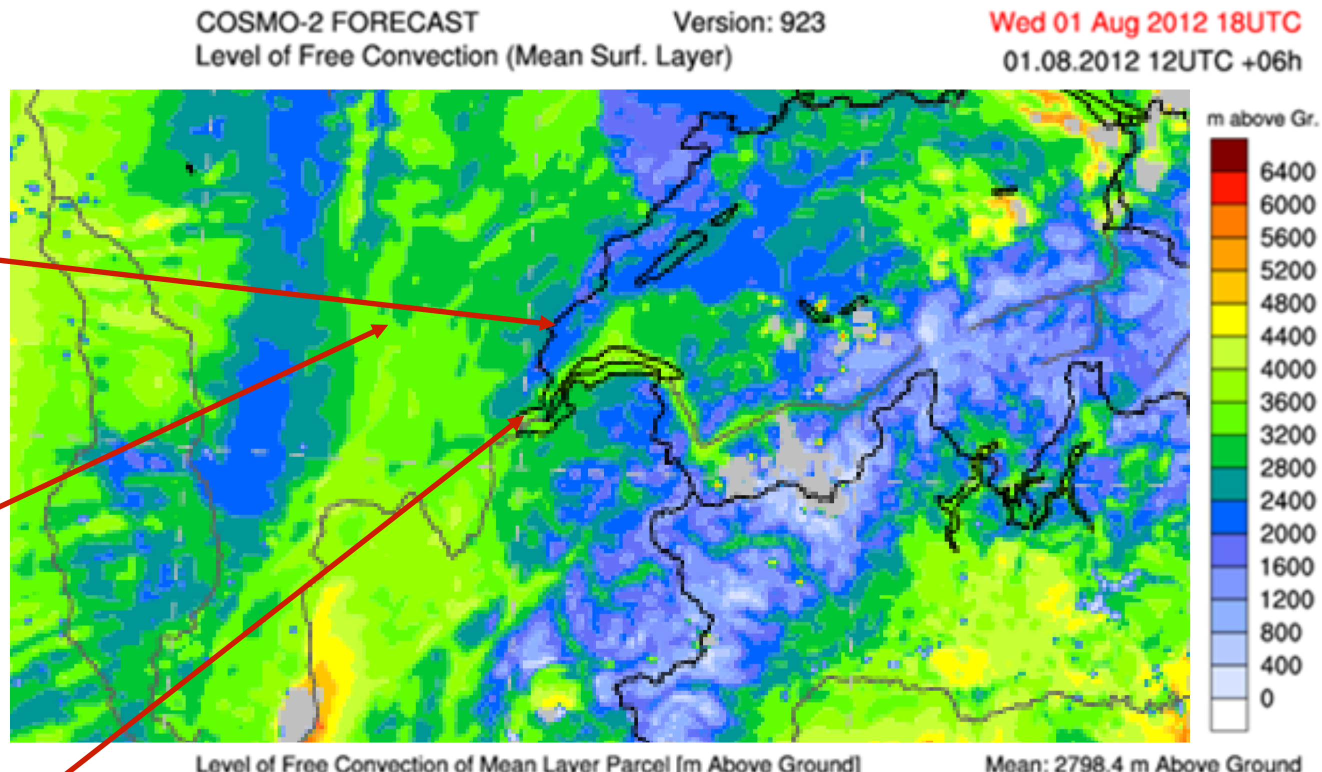
Model deficiencies : convective initiation

COSMO-2 (12 UTC run, H + 6hr) : Level of Free Convection

Jura peaks
Alt : 1500- 1720 m amsl
LFC forecast COSMO-2 :
1600-2400 m ag
LFC forecast COSMO-2 :
~ 3300-4000 amsl

Besançon region
Alt : 235-620 m amsl
LFC forecast COSMO-2 :
2800-3600 m ag
LFC forecast COSMO-2 :
~ 3400-3800 amsl

Geneva region
Alt : 402 m amsl
LFC forecast COSMO-2 :
3200-3600 m ag
LFC forecast COSMO-2 :
~ 3600-4000 amsl



<u>Genève COSMO-2 @ 18 UTC</u>
T2m: 29°C (Obs : 29°C)
Td2m : 13°C (Obs : 15°C)

<u>Besançon COSMO-2 @ 18 UTC</u>
T2m: 28°C (Obs : 28°C)
Td2m : 12-18°C (Obs : 19°C)

COSMO too dry (parameterization problem with surface moisture, foehn effect..?)

Model deficiencies : LFC height and CAPE values

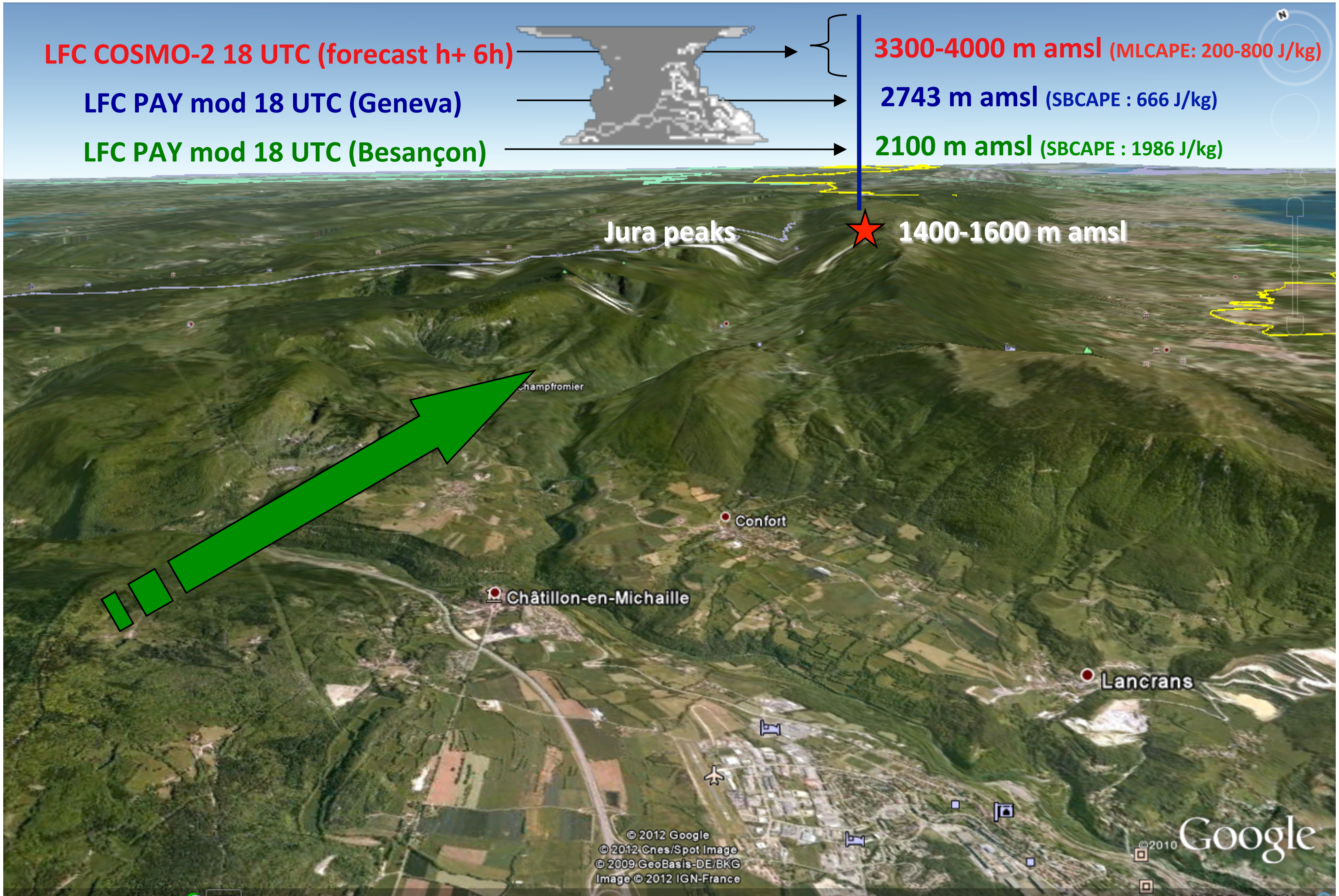
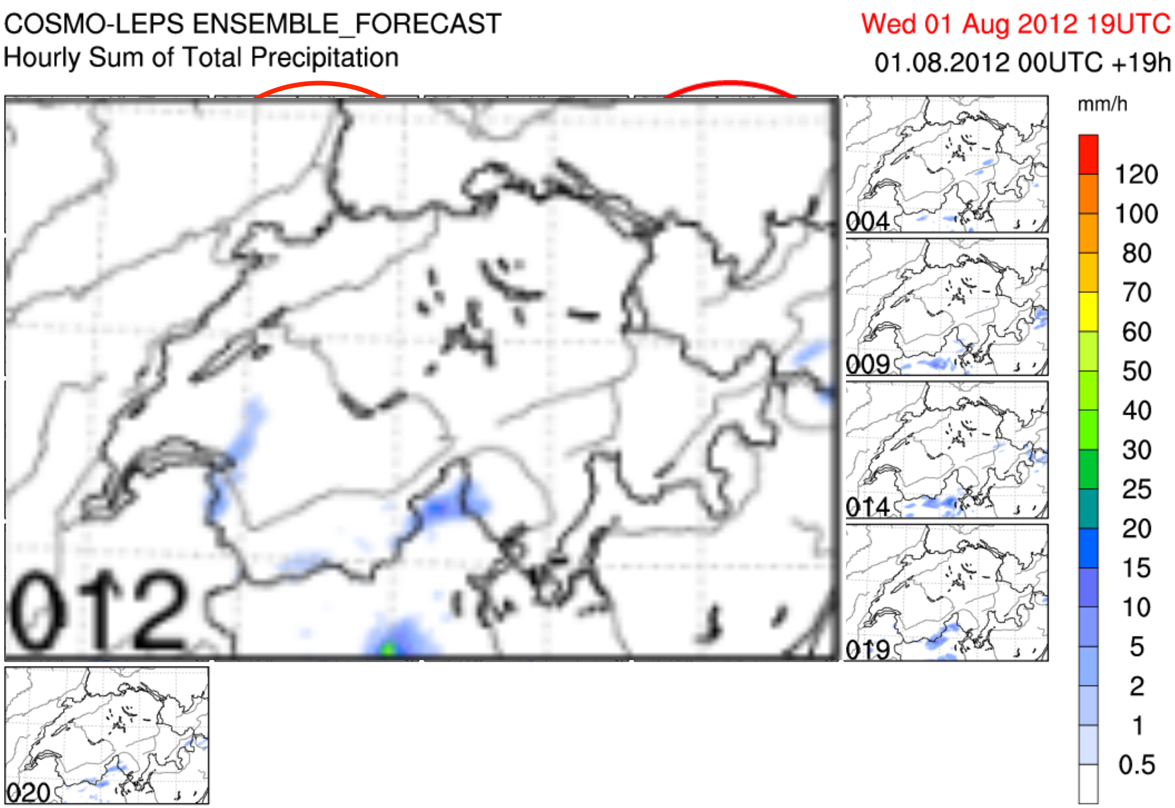


Photo Dean Gill : Geneva convection seen from Lavaux (VD) around 10pm

Post-analysis : probabilistic study of this convective event

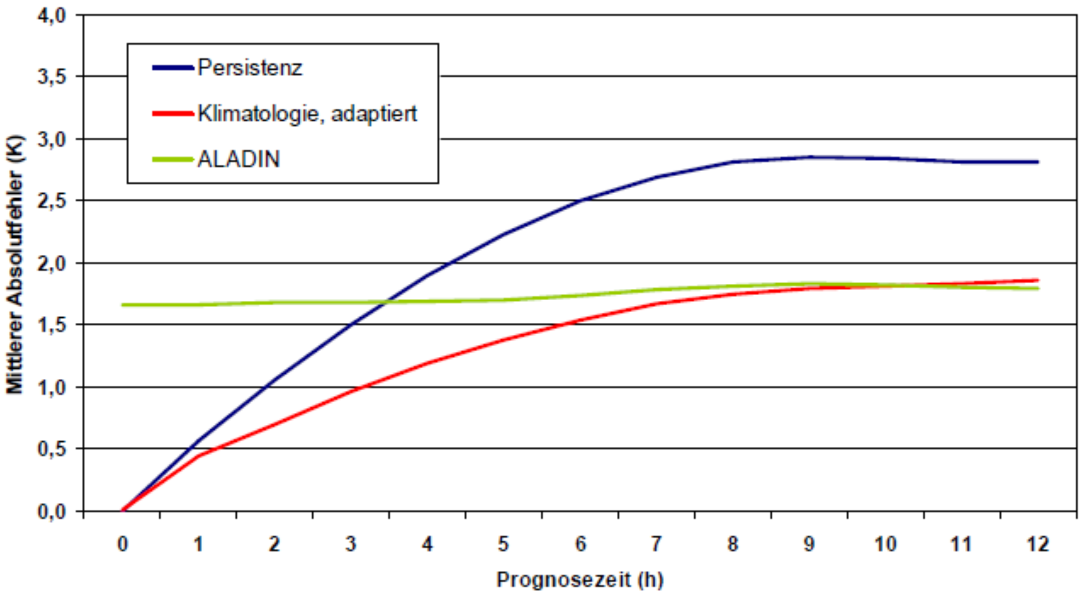


-Daniel Leuenberger (MeteoSwiss colleague Zürich) along with a Master's student investigated the **poor performance of the COSMO model** during this convective event **via a probabilistic approach (ensembles)**

-This recently finished work (March 2013), allowed to check **whether one or several members of the COSMO-LEPS were able to recreate this MCS** and translate it more realistically through the COSMO-2 model domain than the operational deterministic runs on that day…

These model deficiencies clearly show the need to more systematically exploit/develop **obs-based nowcasting systems («data blending» techniques merging observations and model data)** on fine spatial and temporal time scales… at least **every hour!** This is paramount for a better estimation of the convective potential (and improvement of POD/FAR statistics for severe thunderstorm watches)

Currently preferred solutions: usage of obs-based nowcasting methods



Certain obs-based nowcasting systems or **« data blending »** methods (model + obs) are already being tested by MeteoSwiss forecasters…

- **VERA** (Vienna Enhanced Resolution Analysis)

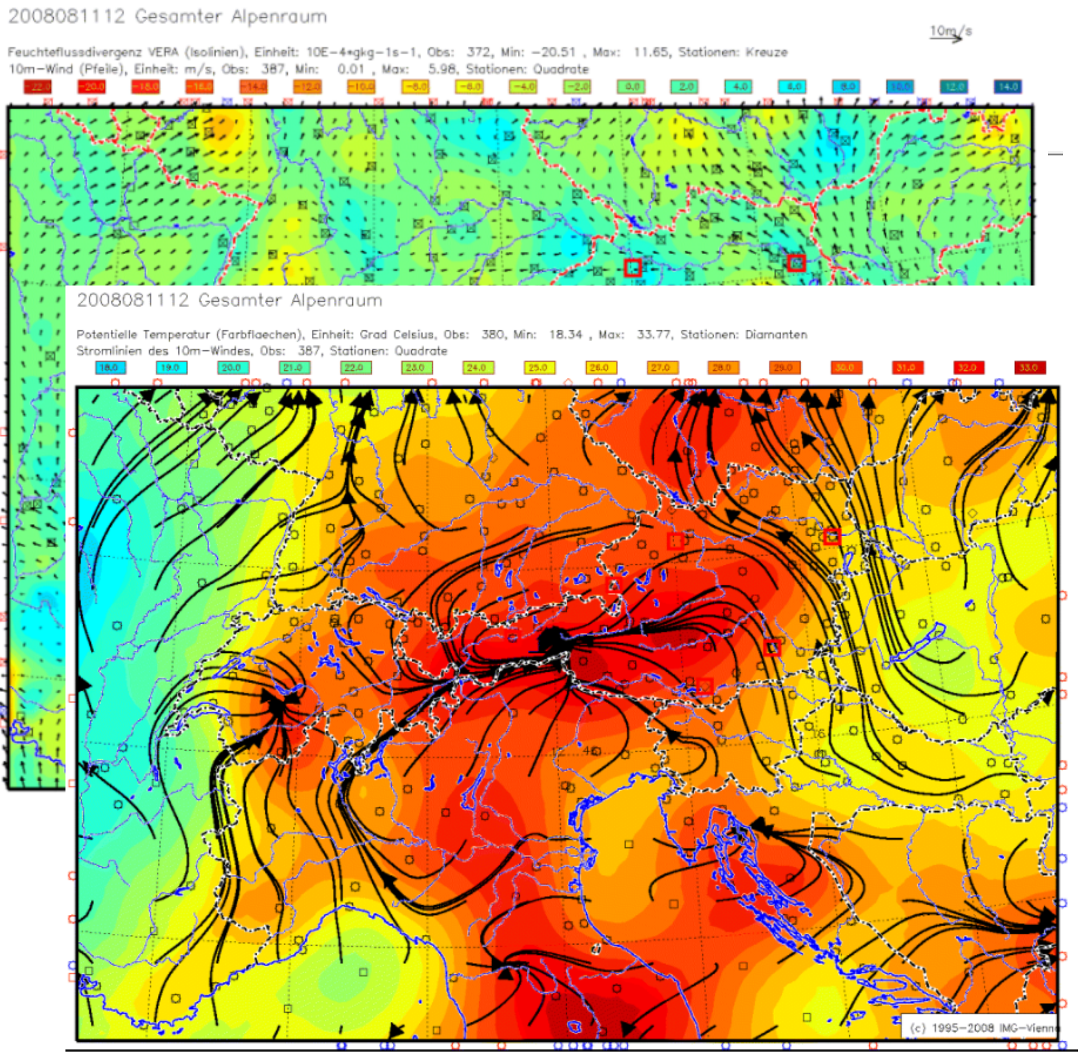
-**INCA** (Integrated Nowcasting through Comprehensive Analysis)

Nice example from the US:

-**SPC** rapid update mesoscale analysis

These obs-based nowcasting systems are being progressively introduced into forecast operations…. **INCA** is present on our NinJo visualization platform but until recently had not yet optimized for efficient operational usage…

Medium-term solutions: development of nowcasting methods



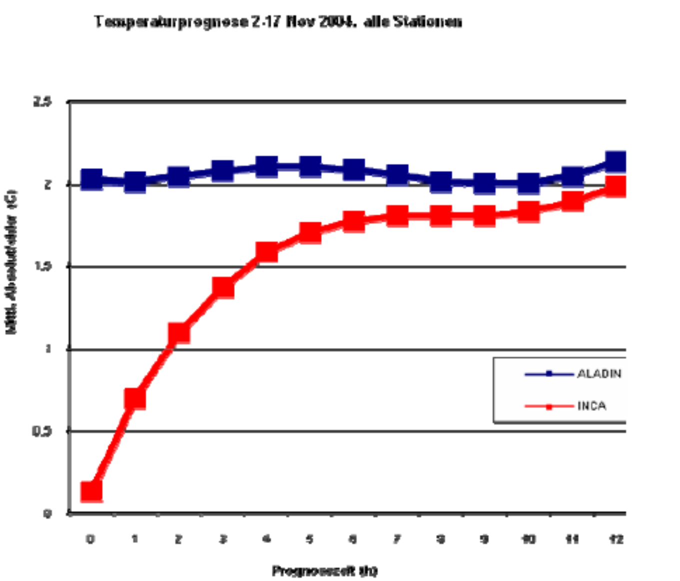
VERA

- -Exploits the obs. (ex : T, Td) at high temporal resolution
- -Uses climatological data «fingerprint method» to interpolate between the observations (ex: T, Td)
- -Calculates derived fields (ex: moisture convergence, ThetaE) based on these improved analyses

http://www.univie.ac.at/img-wien/vera/en/

Medium-term solutions: development of nowcasting methods

INCA



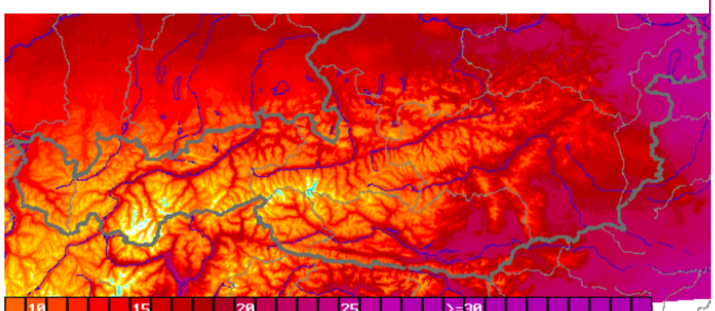


Figure 5.1.5: Example of an INCA 15-min precipitation analysis (top) and its effect on the temperature analysis (bottom). In northern and southeastern Austria the cooling due to convective cells can be seen in the spatial pattern of the temperature analysis.

INCA (Integrated Nowcasting through Comprehensive Analysis)

- Exploits the obs. (ex : T, Td) at high temporal resolution
- Uses model data to interpolate between the observations (ex: T, Td)
- Calculates derived fields (ex: CAPE, CIN) based on these improved analyses
- Extrapolates/advects the radar echoes through time taking into account these improved analyses (CAPE, CIN fields)

Result : improved estimation of CAPE, CIN, LCL, LFC
(cell longevity/intensity better simulated betw. h+0 and h+3)

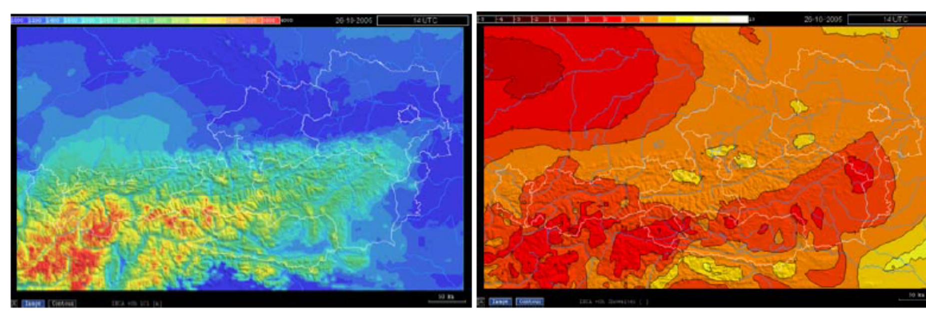
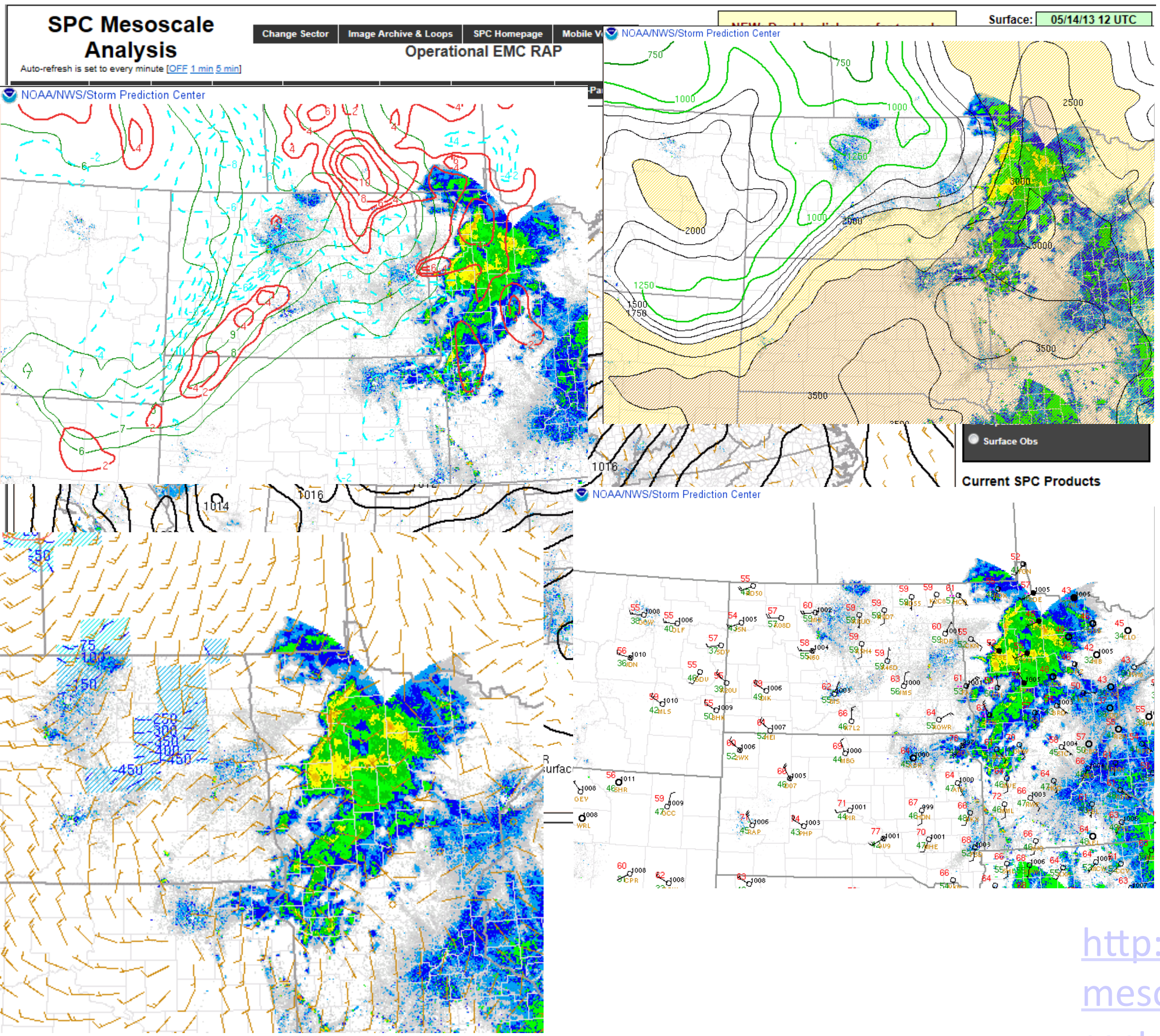


Figure 7.1: Example of INCA convective parameter analyses: LCL (left) and Showalter Index (right).

Medium-term solutions: development of nowcasting methods

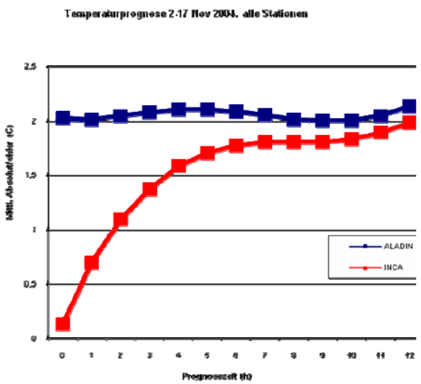


Storm Predicition Center (SPC) mesoscale analysis

- Exploits the hourly obs. (ex : T, Td, ddff) in combination with RAP model
- Uses first guess of preceding RAP forecast h+1 for obj. analysis of sfc. obs.
- most of data above ground comes from RAP model itself
- Calculates derived fields (ex: moisture convergence, ThetaE, CAPE) based on these improved analyses (data blending)
- For ex : calculated CAPE depends on both a mix of sfc obs and RAP model profiles aloft.

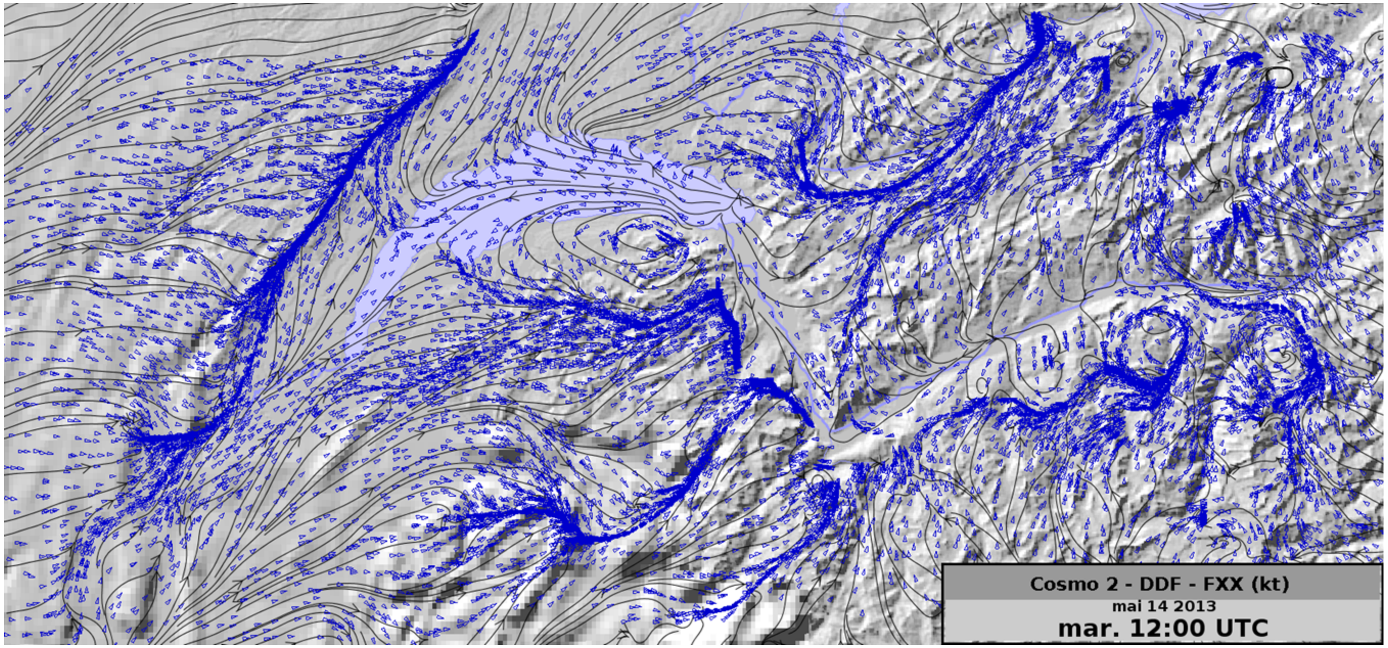
http://www.spc.noaa.gov/exper/mesoanalysis/new/viewsector.php?sector=19#

Medium-term solutions: development of nowcasting methods



NinJo v1.7 : streamlines and convergence lines

<u>With regards to the Sydney FDP:</u>
"Predictive skill above pure translation occurs when boundary layer convergence lines can be identified and used to nowcast cell evolution. 2) For nowcasts beyond 60 min, boundary characteristics are more important for storm initiation than early detection of cumulus clouds." (Wilson et al., 2004)




Thank you !
© www.deanostorm.ch
Photo : © Deanostorm