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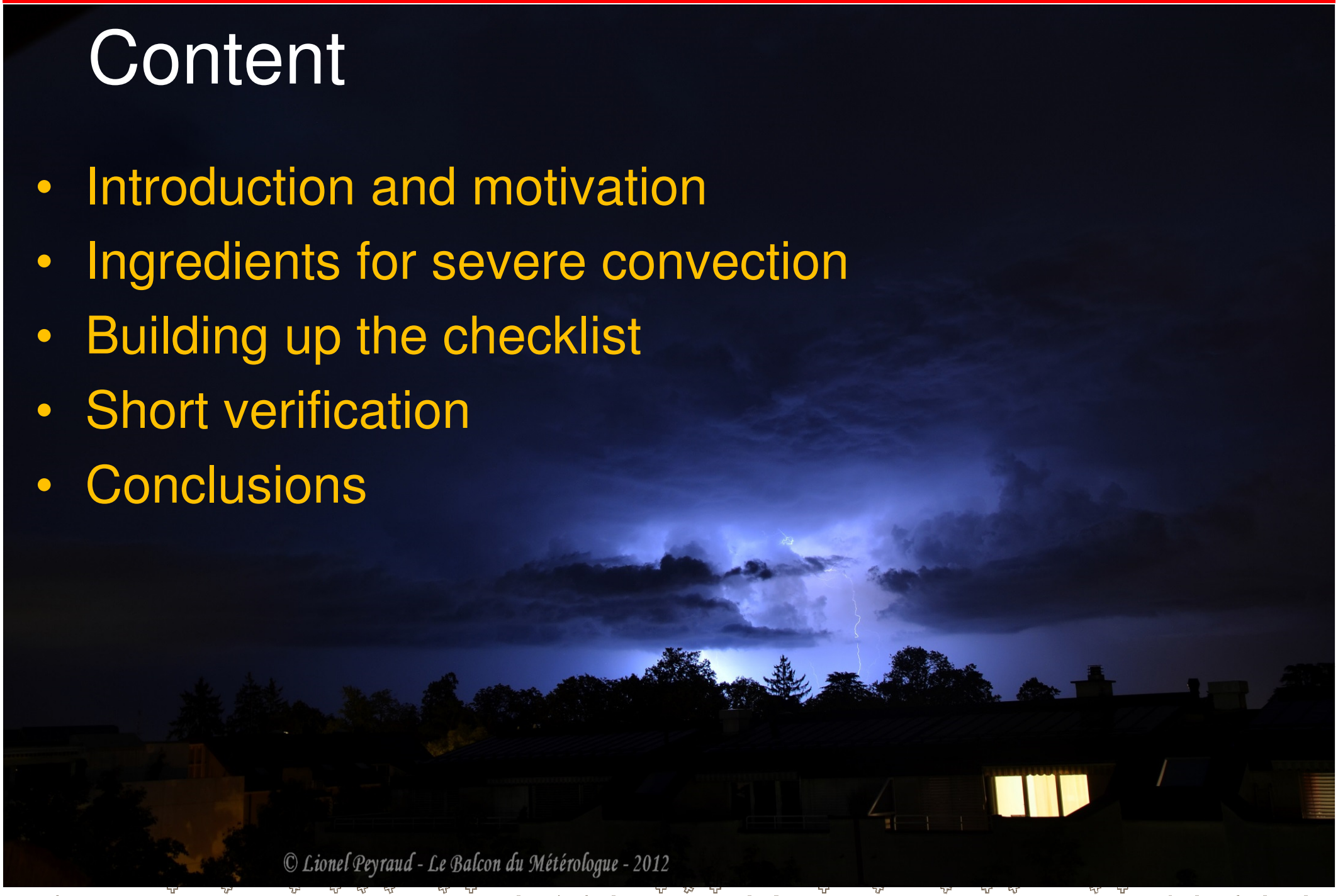
Thunderstorm checklist

Pierre Eckert

Based on work by Lionel Moret and Lionel Peyraud

Content

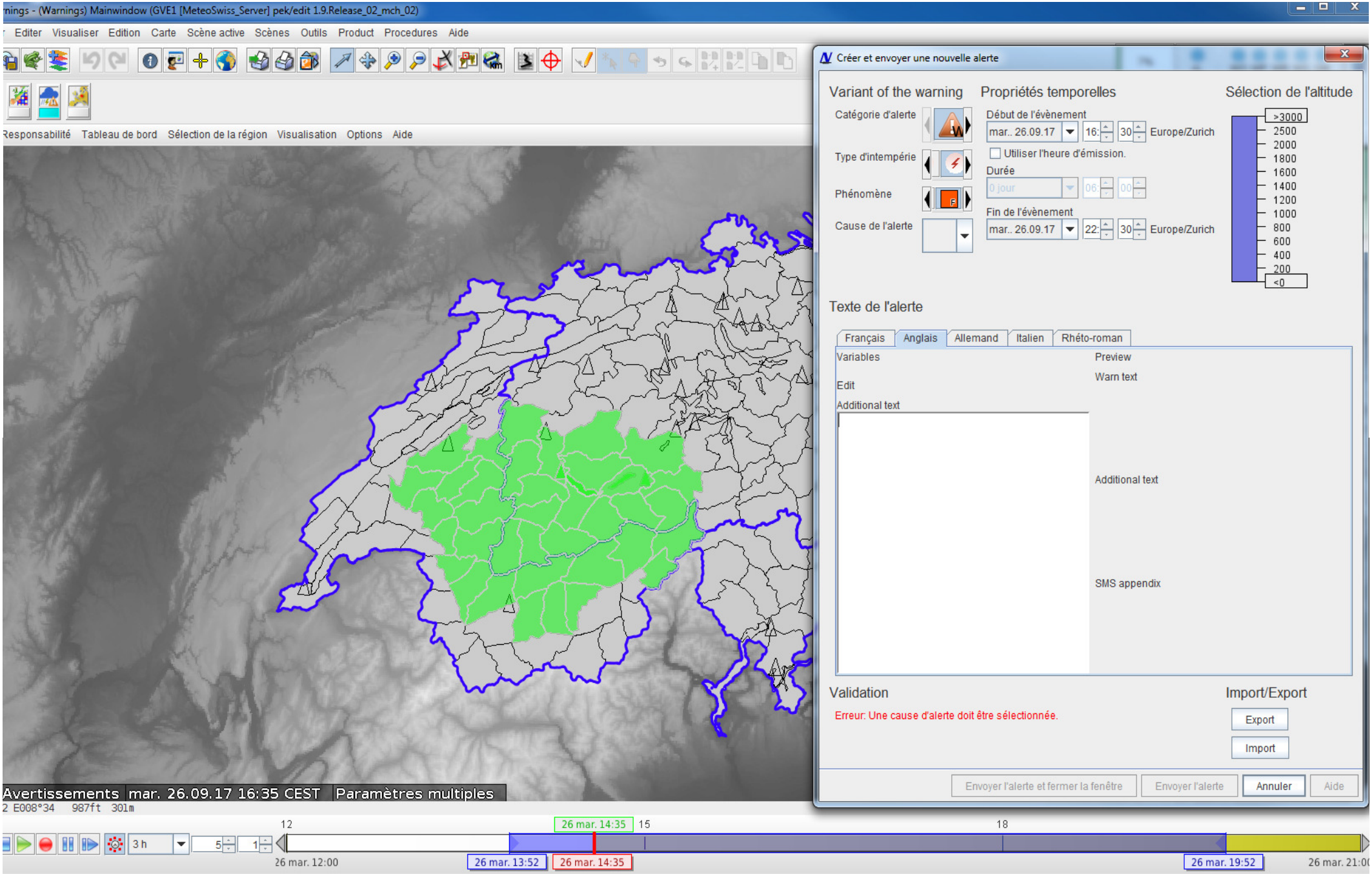
- Introduction and motivation
- Ingredients for severe convection
- Building up the checklist
- Short verification
- Conclusions



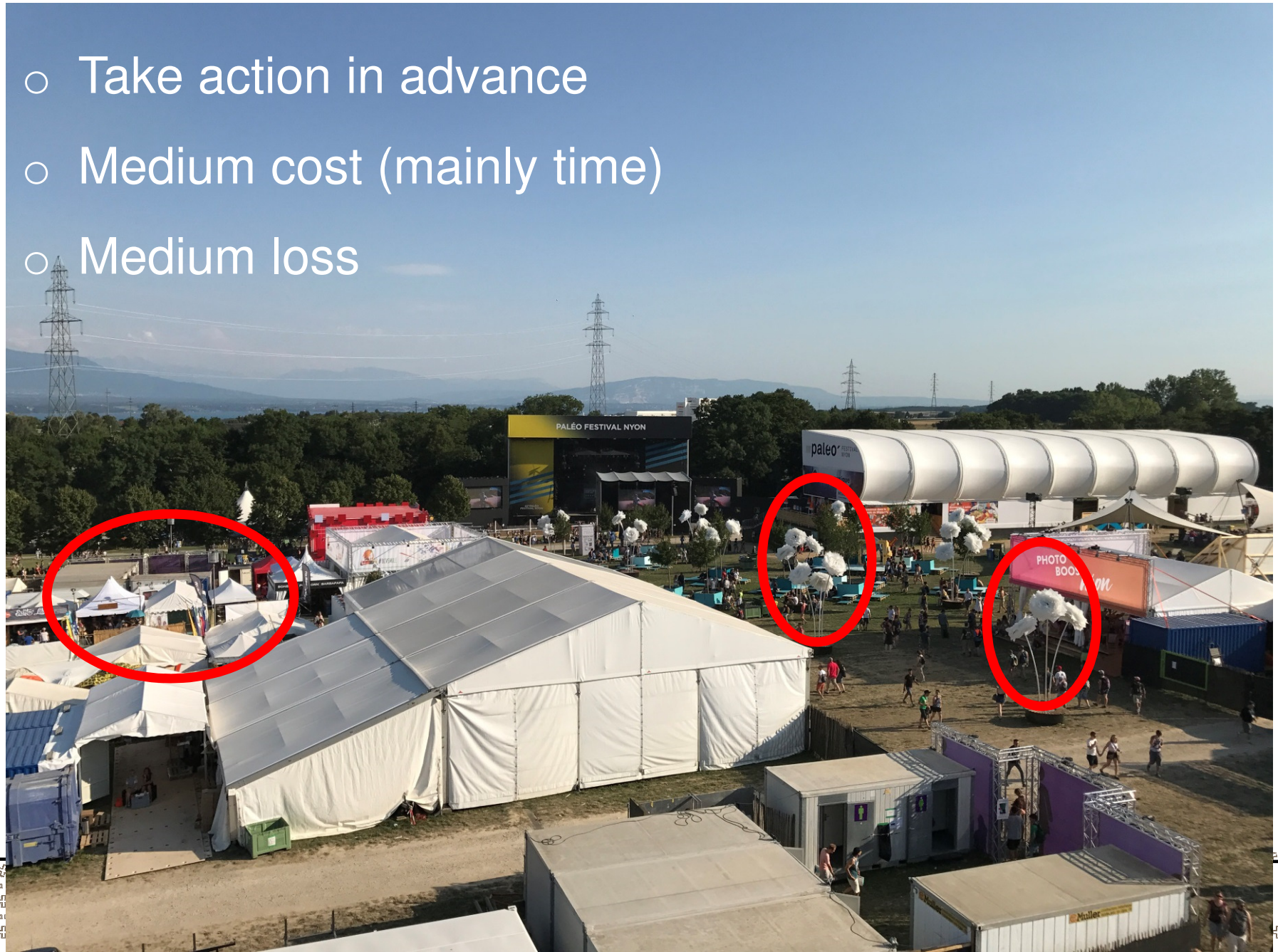
Forecasting of convection

- Forecasting (mainly based on numerical models)
  - Forecast funnel : synoptical scale => mesoscale => microscale
  - Look for conditions for strong convection: «ingredient based approach»
  - Eventually issue «**severe thunderstorm watches**»: mentions a risk, localisation quite broad (mainland west, central Alps,…).
- Nowcasting (after convective initiation)
  - Sat/Rad with various algorithms (TRT, Coalition, etc…)
  - Lightning network, wind measurements,…
  - Eventually issue «**severe thunderstorm warnings**»: few regions touched, on the extrapolated track of the TS cell.
- **Severe** = wind gusts > 90 km/h / hail > 2cm diameter / rainfall rate > 30mm/h

Severe thunderstorm watch



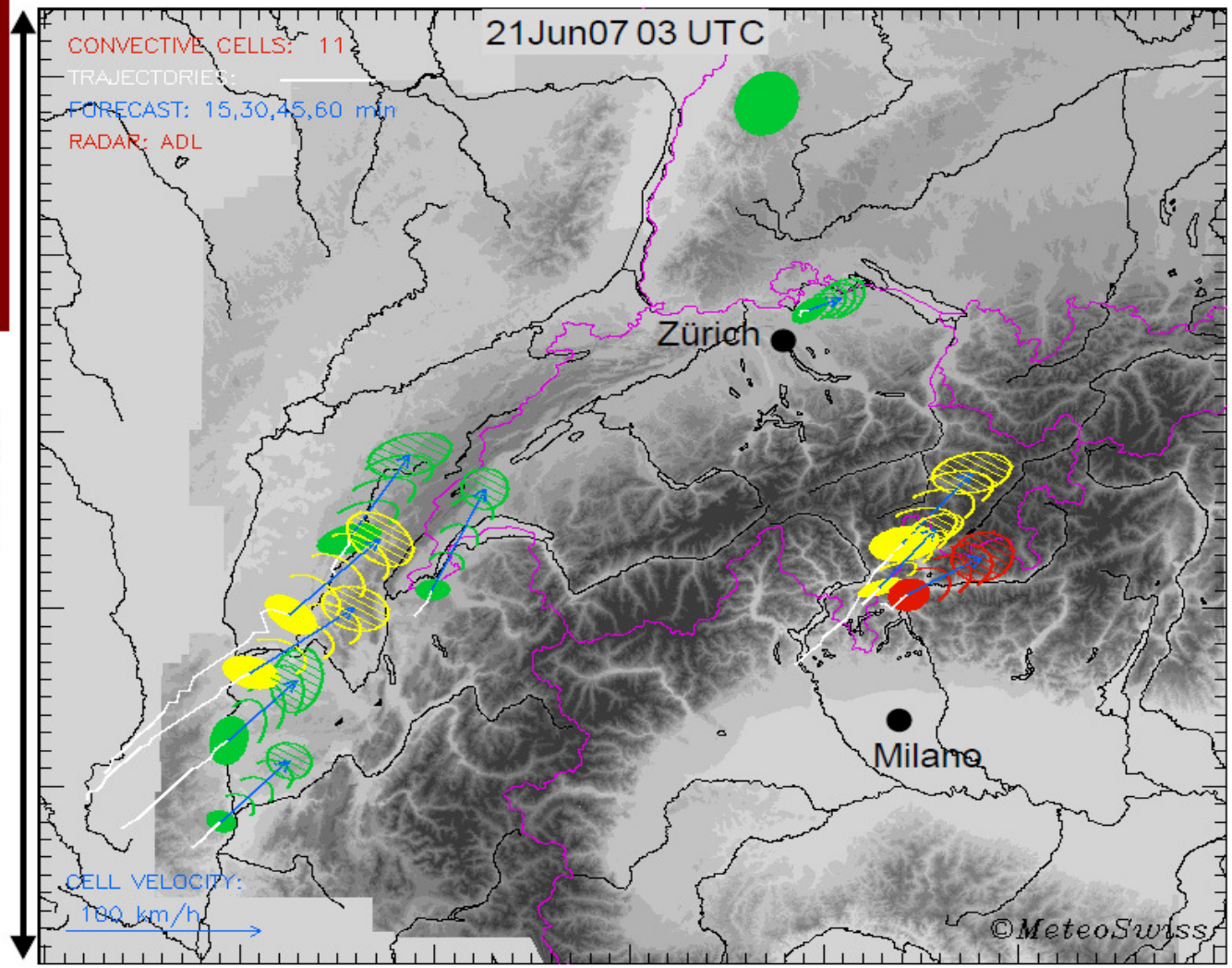
Severe thunderstorm watch



- Take action in advance
- Medium cost (mainly time)
- Medium loss

Nowcasting

Thunderstorm nowcasting



Legend

Solid: present position
Hatched: 1 hour forecast
Blue vector: cell velocity
White line: trajectory

Cell severity ranking:

WEAK

MODERATE

SEVERE

VERY SEVERE

based on vertically integrated liquid water, 45 dBZ echo top, max dBZ and area > 55dBZ

TRT by A Hering

Severe thunderstorm warning

- Take immediate action
- High cost
- High possible loss

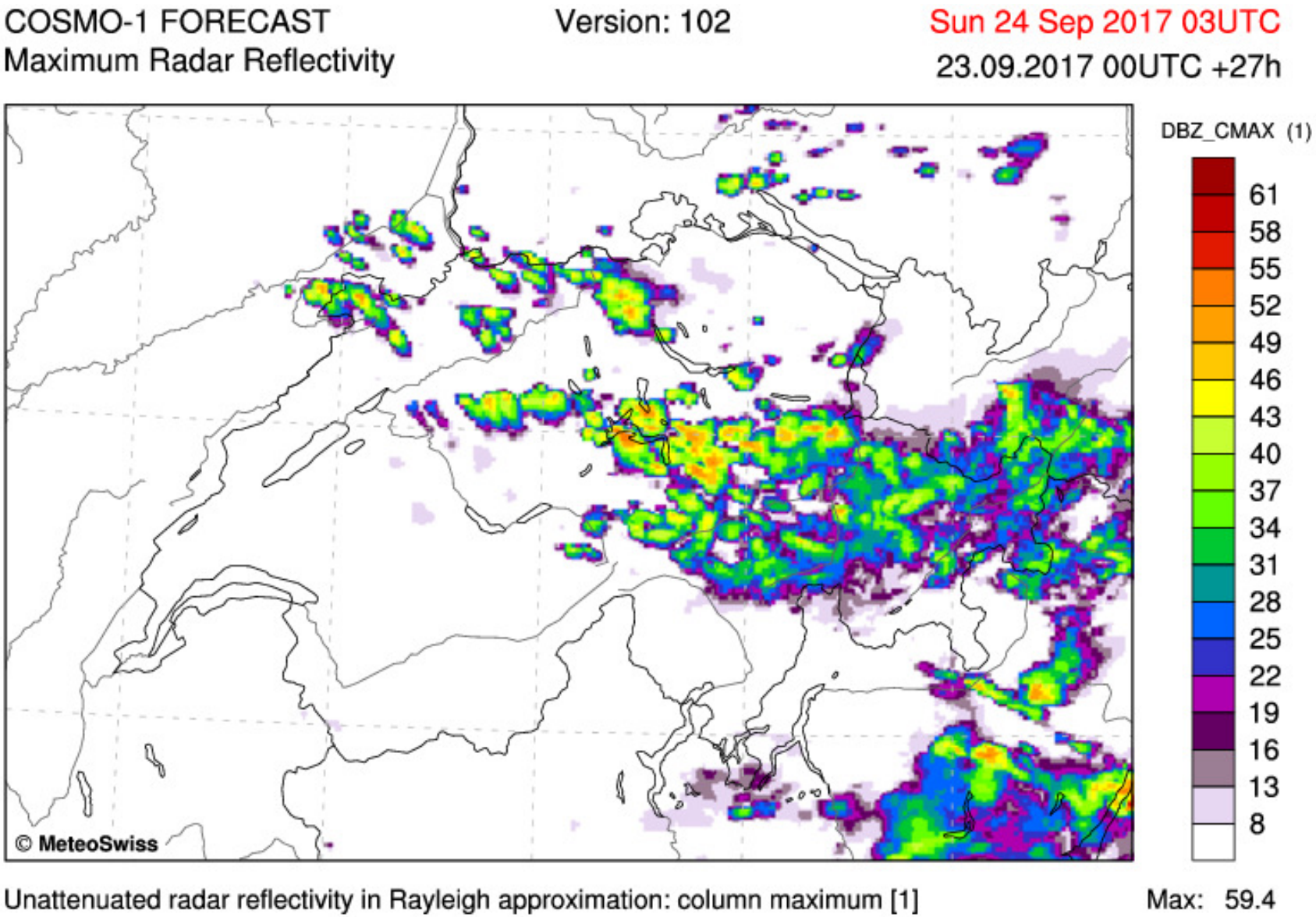
Forecasting of convection

- Forecasting (mainly based on numerical models)
  - Forecast funnel : synoptical scale => mesoscale => microscale
  - Checklist strong convection: «ingredient based approach»
  - Eventually issue «**severe thunderstorm watches**»: mentions a risk, localisation quite broad (mainland west, central Alps,…).
- Nowcasting (after convective initiation)

12 to 24 hours in advance

  - Eventually issue «**severe thunderstorm warnings**»: few regions touched, on the extrapolated track of the TS cell.
- **Severe** = wind gusts > 90 km/h / hail > 2cm diameter / rainfall rate > 30mm/h

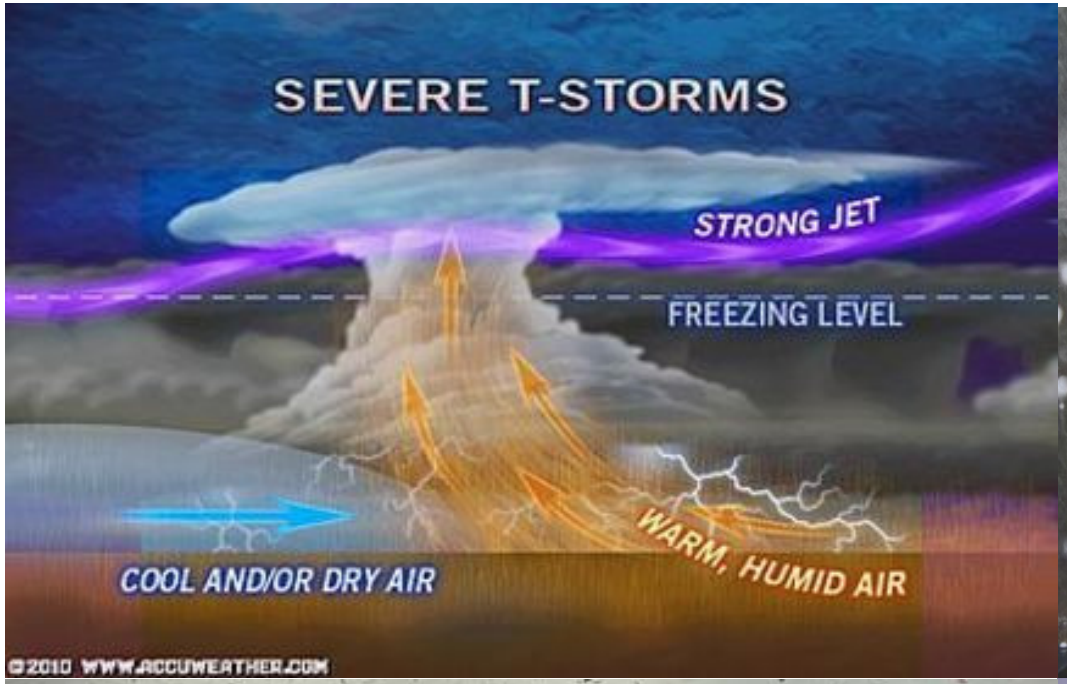
Forecasting of convection (direct model)



Possible drawbacks of direct output

- Precipitation is not the best parameter to look at in convective situations (end of chain)
- Organised convection is (often) not well captured
- The triggering of airmass convection is often missing / exaggerated / not well positioned / …
- The onset of an extreme phenomenon is often a combination of various ingredients, which may be correctly represented in the models, or not.
- The goal is to asses the risk.

Severe TS checklist



Ingredient for strong convection

- **Synoptic lift**
  - Thermal gradient at surface (front)
  - Configuration (cyclonality) of the flux in altitude
  - Configuration of the jet streams (PVA/NVA)
- **Instability**
  - MUCAPE
  - Lifted Index (LI)
  - Delta temperature 500-850 hPa
- **Humidity**
  - Surface dew point
  - 850 hPa Theta-E
  - Precipitable water
- **Vertical wind shear**
  - Deep-Layer Shear 0-6 km
  - Low-Level Shear 0-3 km

Ingredient for high impact convection

Synoptic Lift

Low-Level Lift	500/300 hPa flow	500/300 hPa Jet
Other	Other	Other
Prefrontal with mod. dT	Cyclonic or zonal SW flow	PVA (cold exit or warm entrance)
Prefrontal with strong dT	Shortwave in SW flow	PVA (cold exit and warm entrance)

Instability

MUCAPE	Delta T (850-500hPa)	Lifted Index
MUCAPE < 700 J/kg	Delta T < 27°	LI > -3°
700 J/kg < MUCAPE< 1500 J/kg	27°< Delta T < 30°	-6°< LI < -3°
MUCAPE > 1500 J/kg	Delta T > 30°	LI < -6°

Humidity

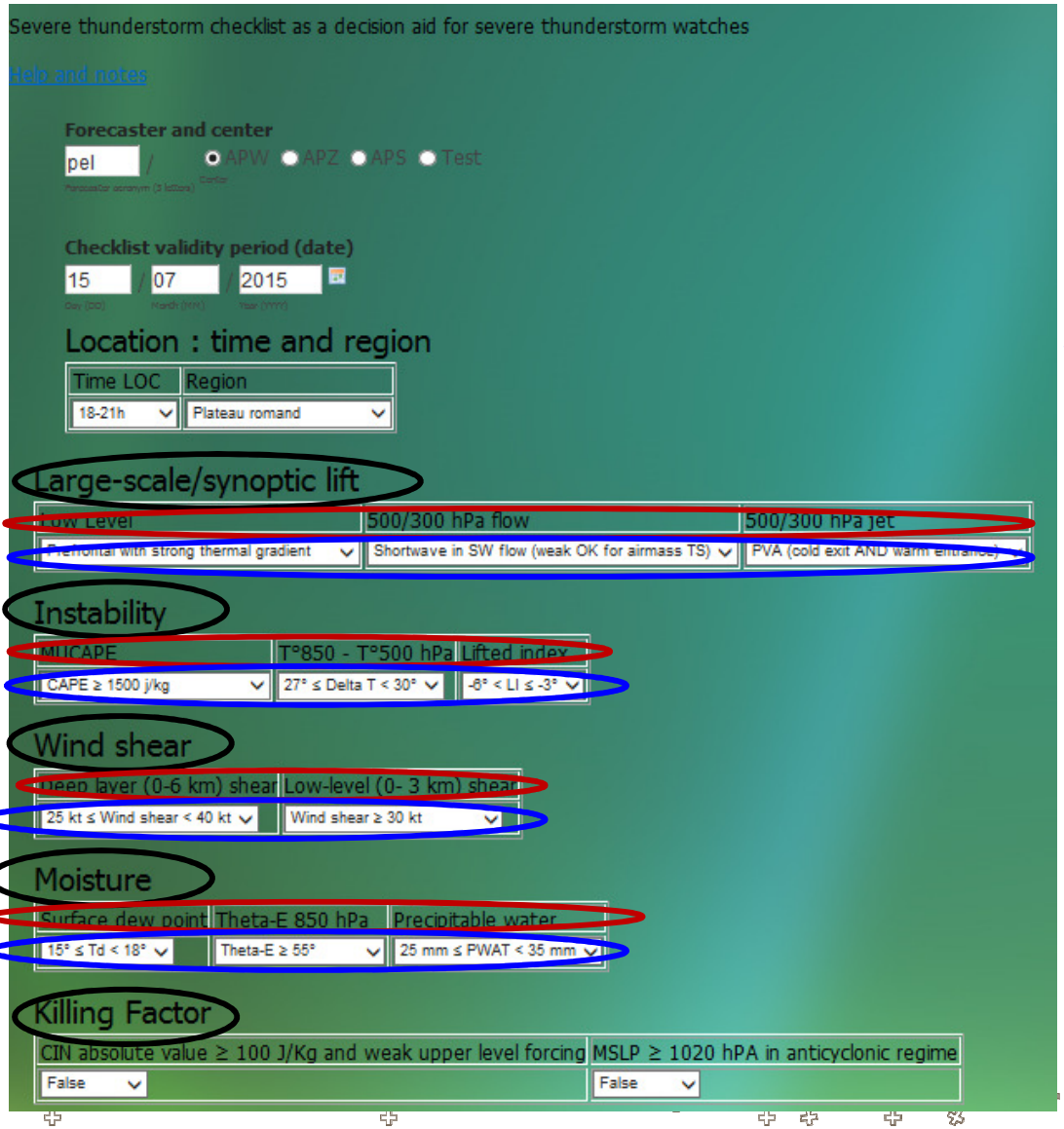
Surface Td	Theta-E 850 hPa	Precipitable Water
Td < 15°	Theta-E < 45°	PW < 25 mm
15°< Td < 18°	45°< Theta-E < 55°	25 mm < PW < 35 mm
Td > 18°	Theta-E > 55°	PW > 35 mm

Wind Shear

Deep Layer Shear	Low-Level Shear	Killing Factors
Wind shear < 25 kts	Wind shear < 15 kts	**CIN > 100 J/kg**
25 kts < wind shear < 40 kts	15 kts < wind shear < 30 kts	**MSLP > 1020 hPa**
Wind shear > 40 kts	Wind shear > 30 kts	

La prévision convective à MétéoSuisse

- A quoi ressemble la checkliste? Quels sont les ingrédients qui la compose?



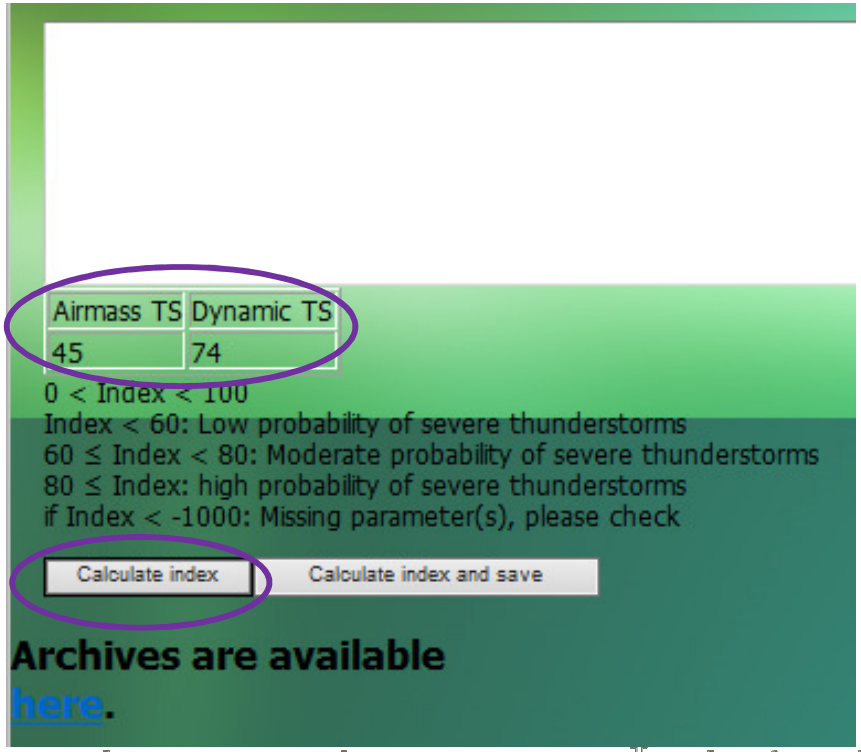
Version actuelle sur APW intranet

Ingrédients

Paramètres

Final result

Classes / Thresholds



Severe Thunderstorm Checklist

Weighting of ingredient value classes :

For **strongly-forced** thunderstorm preconvective environments, weights were maximized for :

- **Strong synoptic forcing**
- High Instability
- **High Shear**
- High Humidity
- => favoring well organized convection (strong squall lines, bow echoes, supercells, well organized MCSs)

For **weakly-forced** thunderstorm preconvective environments, weights were maximized for :

- Curvature in weak upper-level flow (vorticity centers)
- High Instability
- **Weak Shear**
- High Humidity
- => favoring quasi-stationary airmass convection (pulse storms, weakly organized squall lines/multicells/MCSs, local flooding)

- The checklist was tested with past cases in order to tune the parameter thresholds to local climatology (60% and 80% values mainly).

Weighting and normalisation of the values

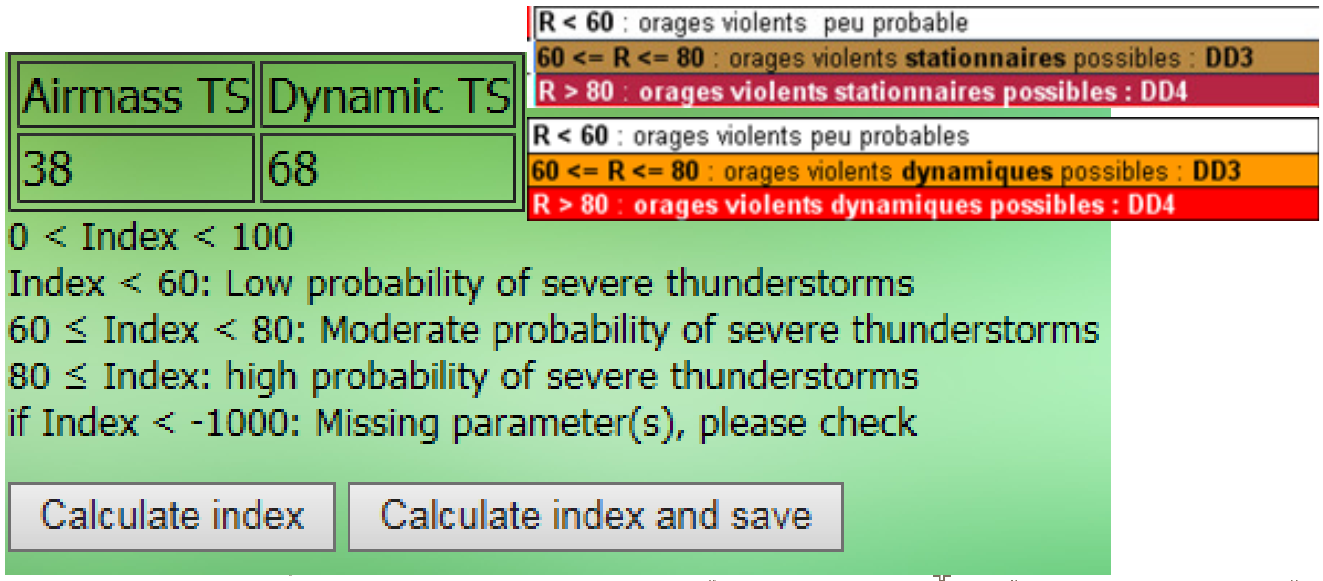
Forcing : weak vs. Strong

(airmass) vs. (Dynamic)

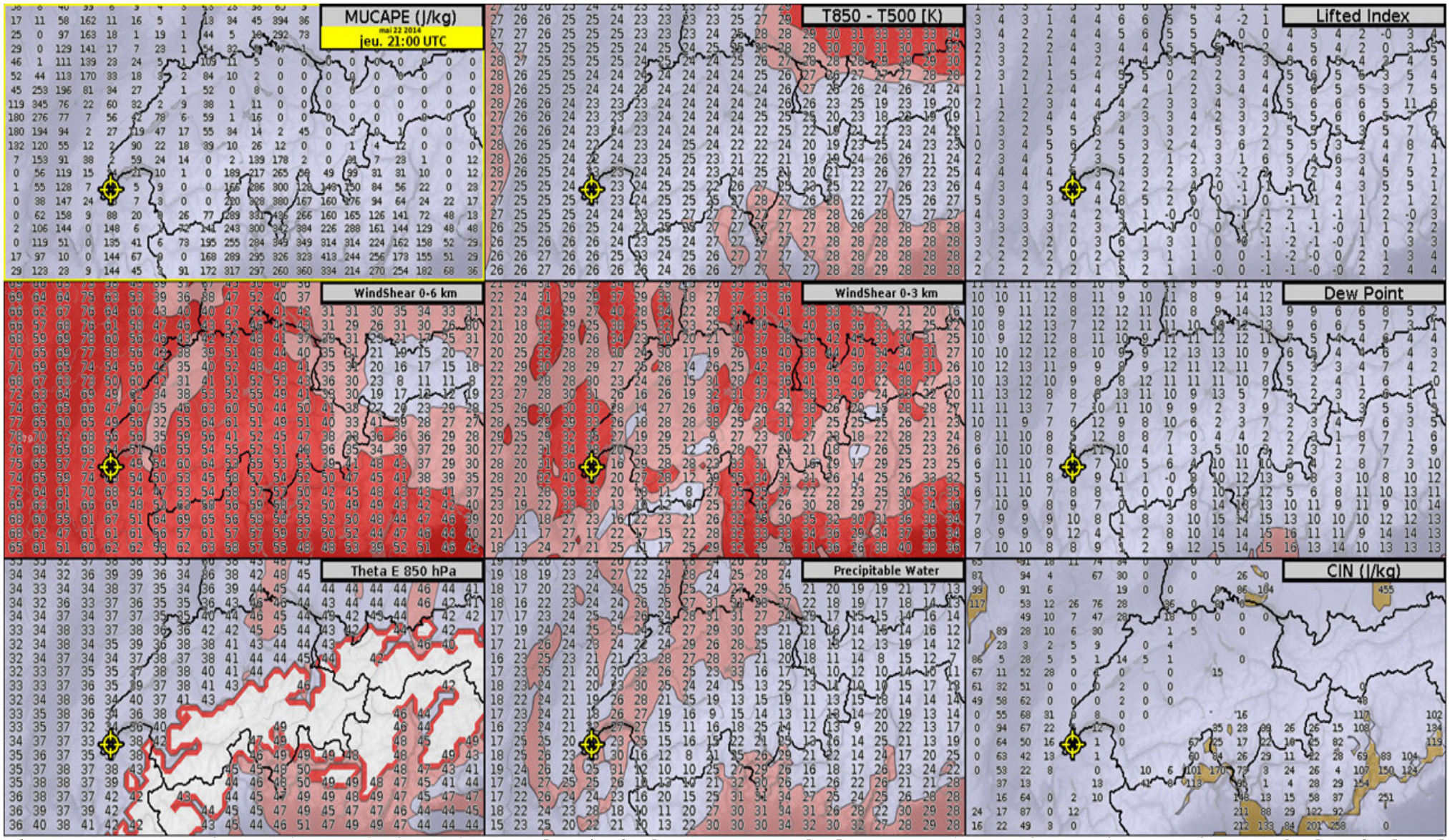
Low-Level Lift	**6**,0,0	1,5,**9**
500/300 Flow	1,2,**6**	1,5,**9**
500/300 Jet	**9**,0,0	1,6,**9**
MUCAPE	0,3,**8**	1,3,**9**
Delta T 850/500	0,3,**6**	1,3,**9**
Lifted Index	0,3,**6**	1,3,**9**
Surface Td	0,2,**9**	1,4,**9**
Theta-E 850	0,3,**9**	1,4,**9**
PW	0,3,**9**	1,4,**9**
DLS	**4**,0,0	1,5,**9**
LLS	**4**,0,0	1,5,**9**

- The method is normalized so that the final severe thunderstorm risk is expressed as a number between 0 and 100, with 100 representing the highest risk

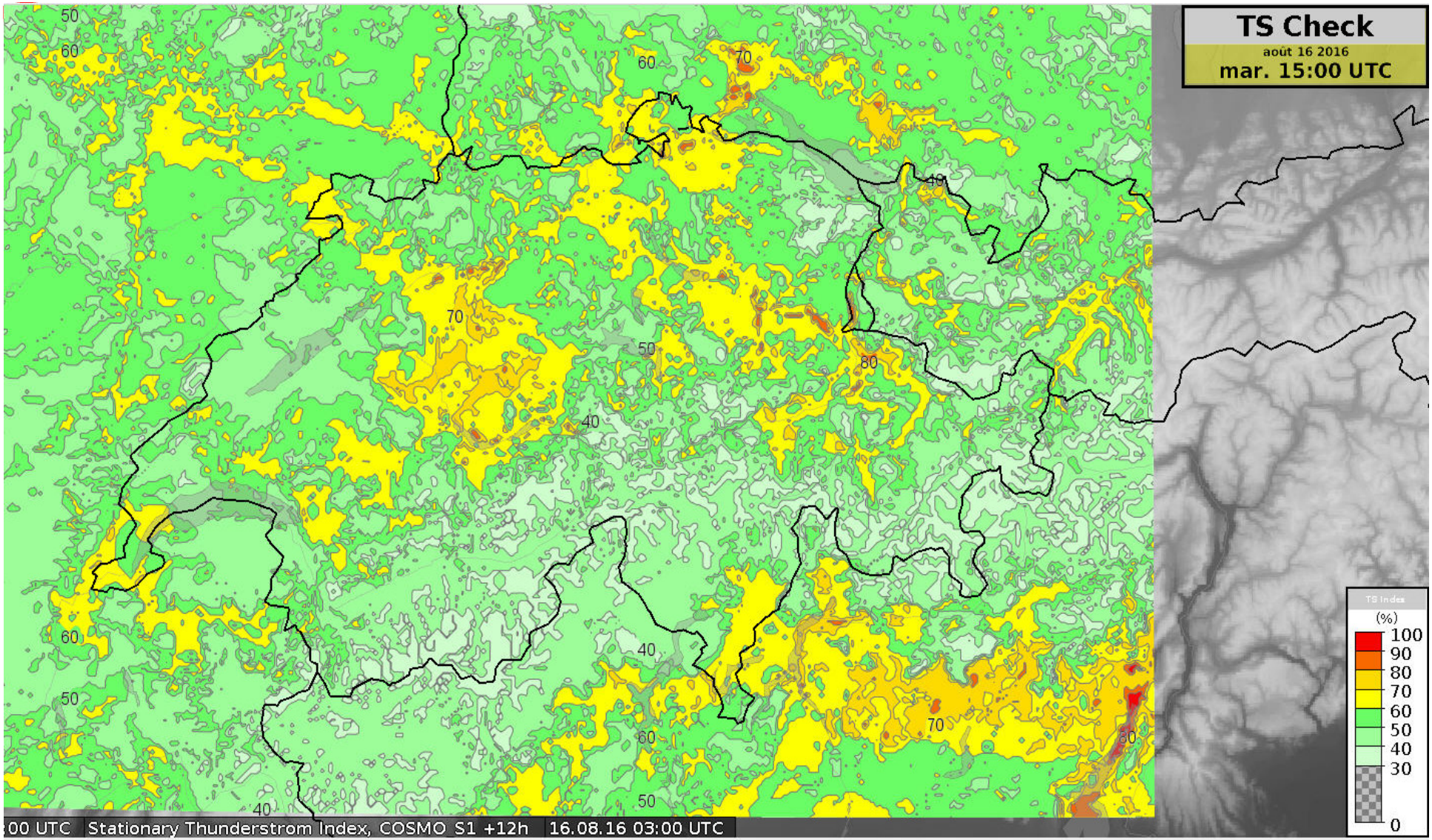
$$N = \frac{\text{Max column}}{\text{Max score}} * 100$$



Display of the parameters in NinJo

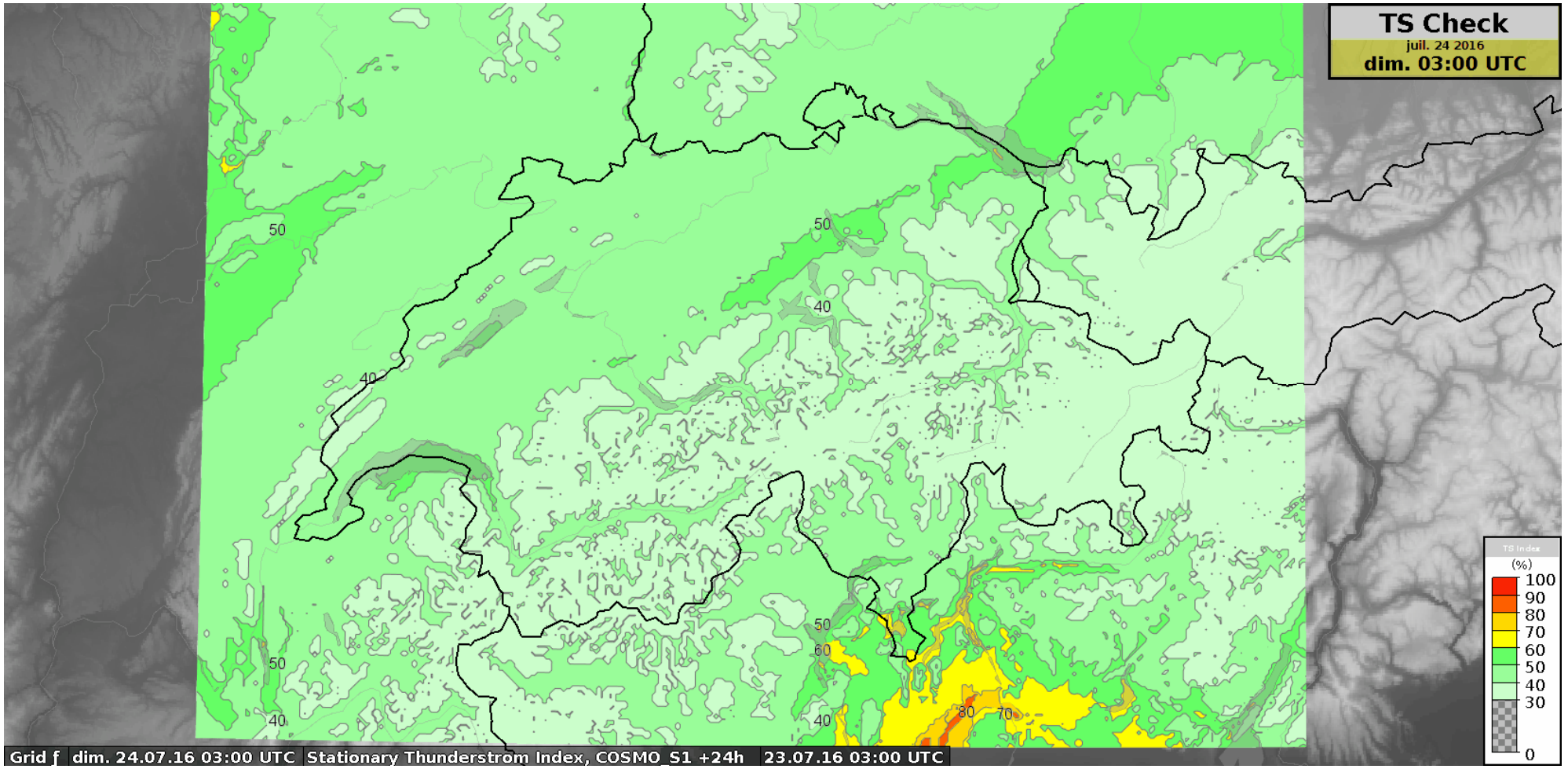


Display of the result in NinJo

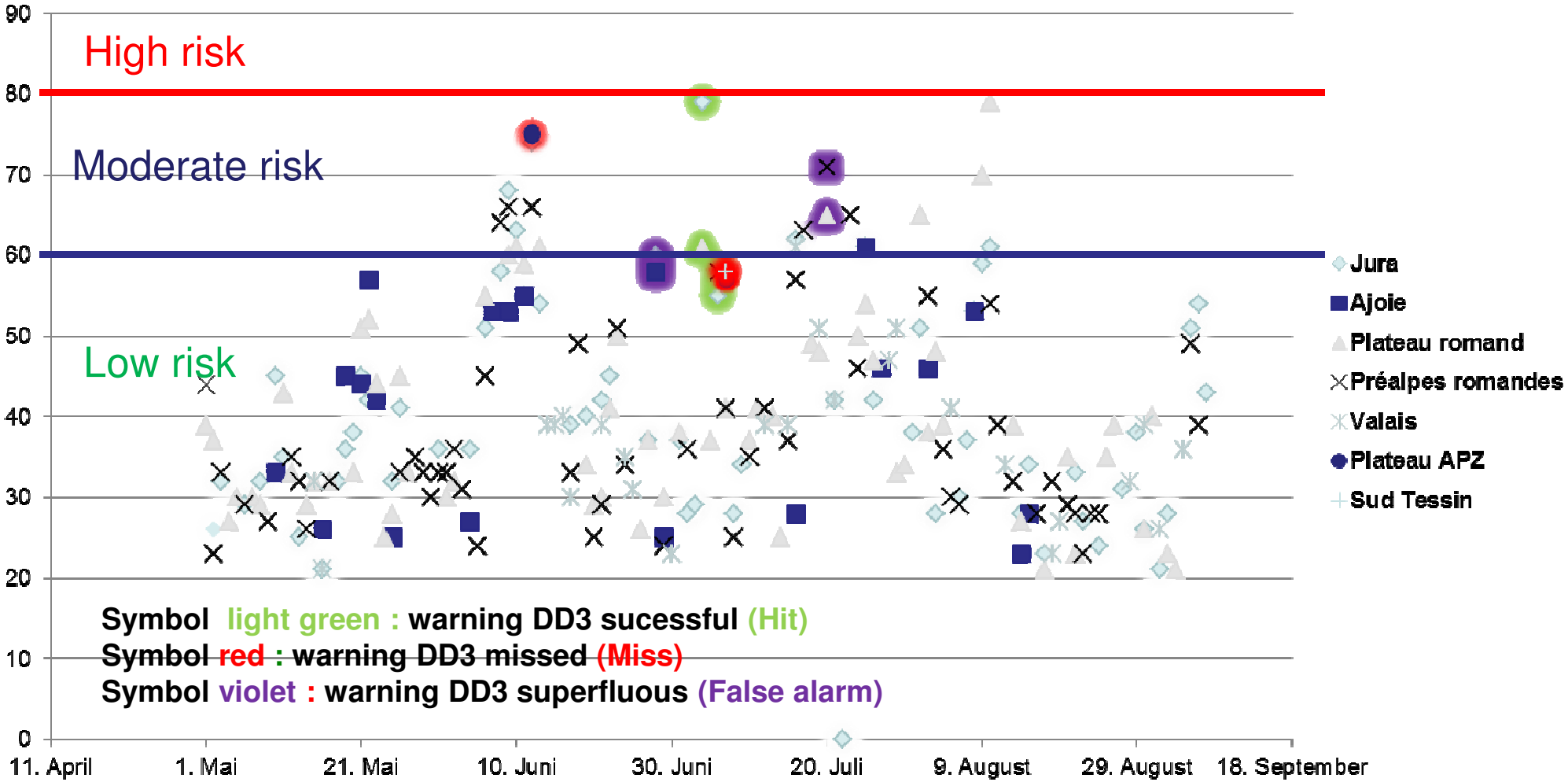


Display of the result in NinJo

- Example of the 24th July 2016 : animation of TS-Index in a weakly forced environment



Verification of summer 2014 (Mai-Sept)



Verification of the severe thunderstorm checklist performance

- Qualitatively, this method has helped introduce a more objective method amongst forecasters for analysing the severe convective potential…
- … and to look systematically at various model parameters
- When the 60% severe t-storm prob. threshold is surpassed in the checklist, the false alerts that occur appear mainly due to high CIN and/or insufficient lifting mechanisms (especially over the plain regions). These false alerts appear to occur in HIGH CAPE / LOW SHEAR environments.
- For widespread severe convection to occur over the plain regions, the checklist final value often needs to surpass 70 or 80% . These widespread cases seems to most often occur in HIGH CAPE / HIGH SHEAR environments.

Some conclusions

- This forecast (and others) is strongly based on (high resolution) NWP.
- The forecasters should be conducted to look more systematically at the parameters relevant to the given phenomenon and to analyse the results critically.
- The forecaster has the last word (and will also have to communicate and explain the forecast / warning).
- Collaboration of modellers, postprocessors and forecasters is gaining in importance.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CALM
AND
PADDLE
ON


Questions /
discussion
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