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Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology MeteoSwiss

# First results on Verification of lightning probabilities

## Verification applications (spatial) to HIW - LPI in mountain regions (Task 3.2)

Daniel Cattani, André-Charles Letestu, Mathieu Schaer

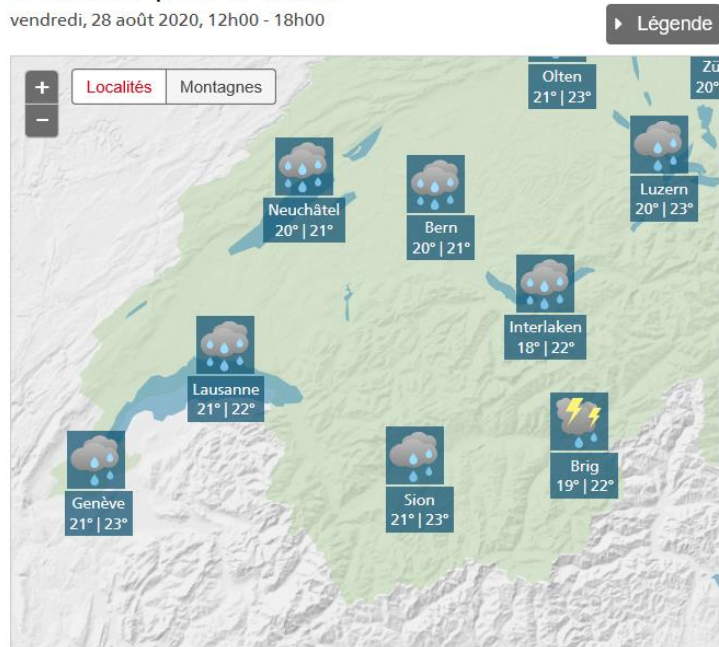
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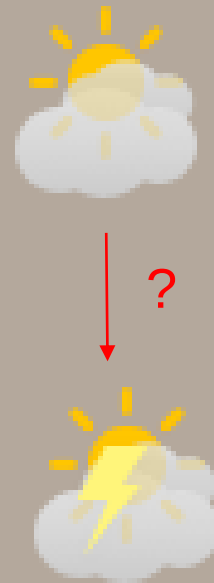
# Motivation

## Prévisions pour la Suisse

vendredi, 28 août 2020, 12h00 - 18h00



Dernière mise à jour des prévisions: 26.08.2020, 10:21

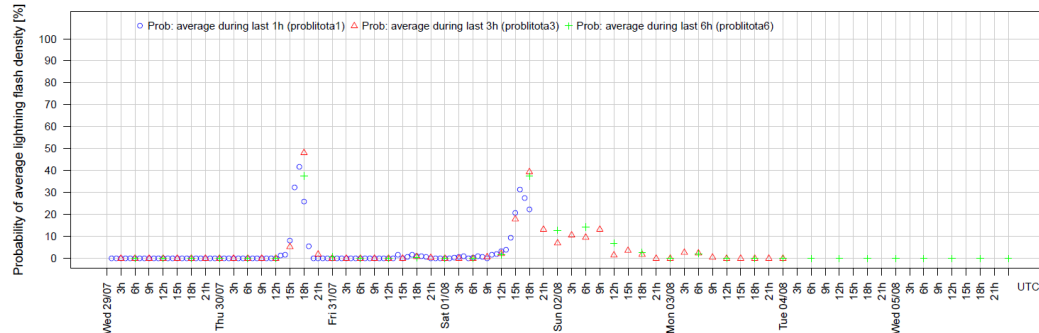




# Direct model outputs

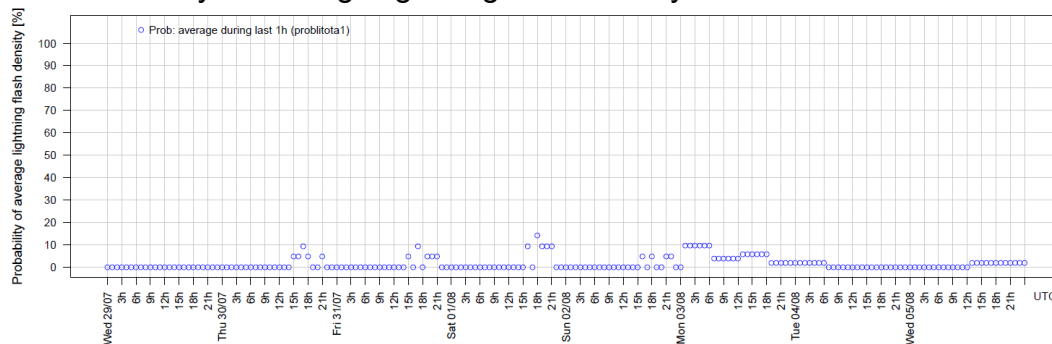
Probability of average lightning flash density  $\geq 1/100 \text{ km}^2/\text{h}$

ECMWF ENS



Probability of average lightning flash density  $\geq 1/100 \text{ km}^2/\text{h}$

COSMO E  
+ ECMWF ENS



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We deal with two issues,

- seamless forecasts
- Methods to enhance the signal

→ Verify the quality and explore how aggregations could help our purpose



# content

- Sources available
  - ECMWF ENS – COSMO-E LPI
- Verification of IFS ENS prob flash density
- Comparison with LPI on COSMO-E



# Indices available

IFS ENS

Average lightning flash density

$$f_T = \alpha Q_R \sqrt{CAPE} [\min(z_{base}, 1.8)]^2$$
$$Q_R = \int_{z(0^\circ C)}^{z(-25^\circ C)} q_{graup} (q_{cond} + q_{snow}) \rho(z) dz$$

- Microphysics by hydrometeor amounts
- Convection by CAPE, height cloud base

COSMO ens

LPI, lightning potential index, converted in lightning flash density

$$LPI = f_1 f_2 \frac{1}{H_{-20^\circ C} - H_{0^\circ C}} \int_{H_{0^\circ C}}^{H_{-20^\circ C}} \epsilon w^2 g(w) dz$$

$$\epsilon = 2(Q_i Q_l)^{0.5} / (Q_i + Q_l), \quad Q_i = q_g \left[ \left( (q_s q_g)^{0.5} / (q_s + q_g) \right) + \left( (q_i q_g)^{0.5} / (q_i + q_g) \right) \right]$$

- Microphysics by hydrometeor amounts
- Convection by vertical velocity  $w$

Ecmwf Newsletter 155

**MeteoSwiss**

Jonas Jucker (Master Thesis MeteoSwiss 2019)

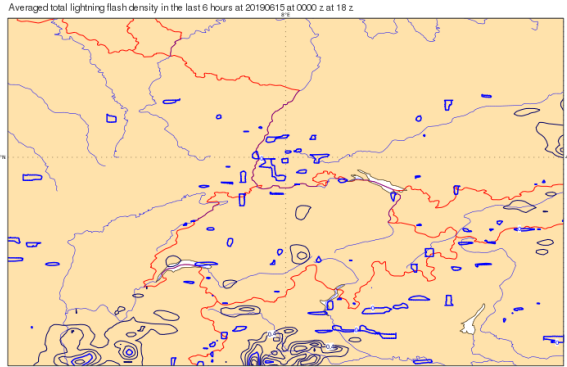
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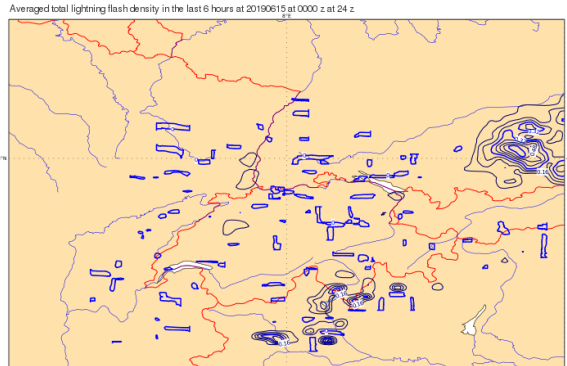
# IFS – average lightning density /6h

## Hres Forecasts

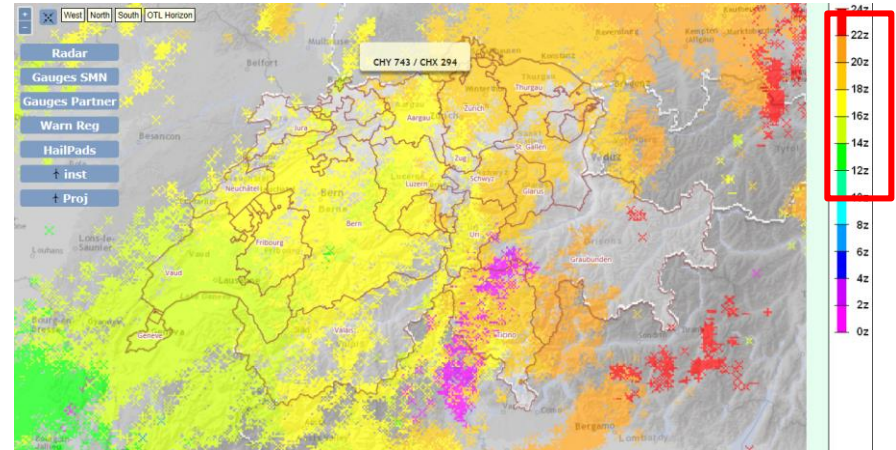
12-18z



18-24z



## Observation

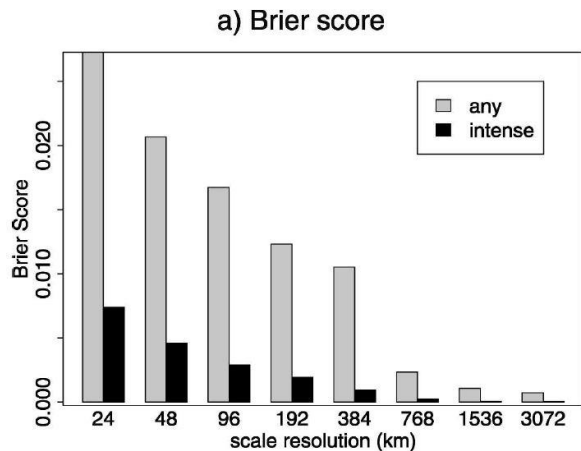


### Case of June 15<sup>th</sup> 2019

- Signal of occurrences present
- Localisation not perfect
- Necessary to work with ENS



# Exploring study on IFS ENS



B. CASATI AND L. J. WILSON, 2006: A New Spatial-Scale Decomposition of the Brier Score: Application to the Verification of Lightning Probability Forecasts  
Mon.Wea.Rev. 135, pp 3052-2069

## Potential improvement with

- Use of threshold
- Scale resolution
- Time aggregation

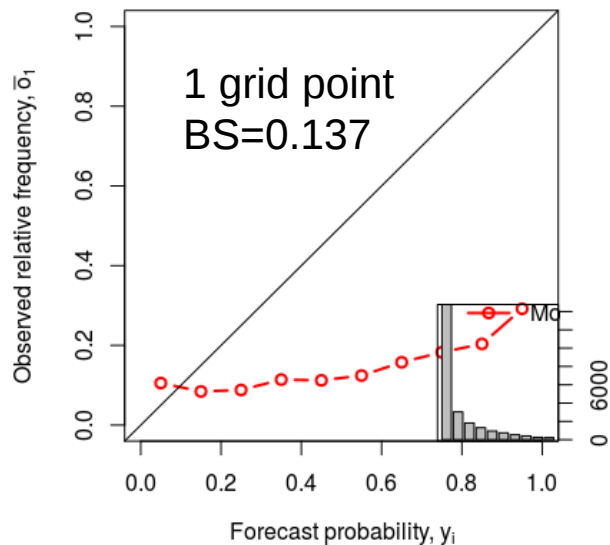
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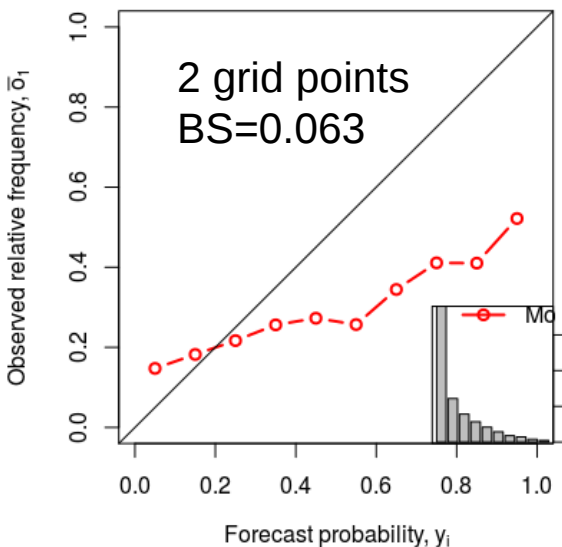


# Scale resolution

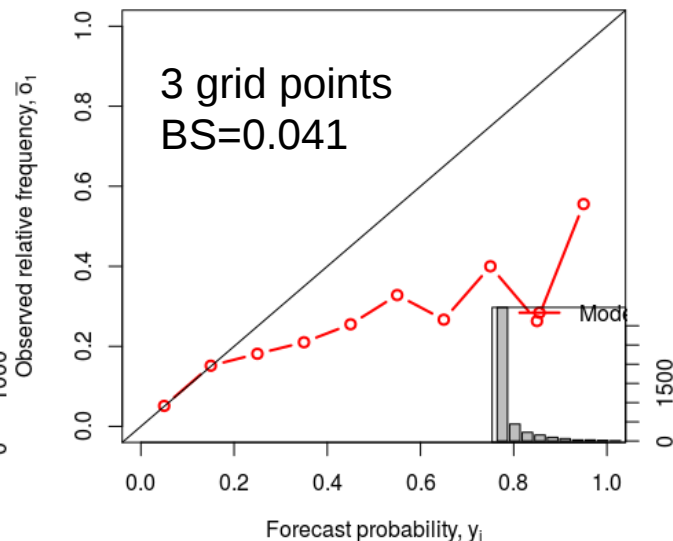
3h,1grid,GC + IC



3h,2grid,GC + IC



3h, 3grid, GC\_IC

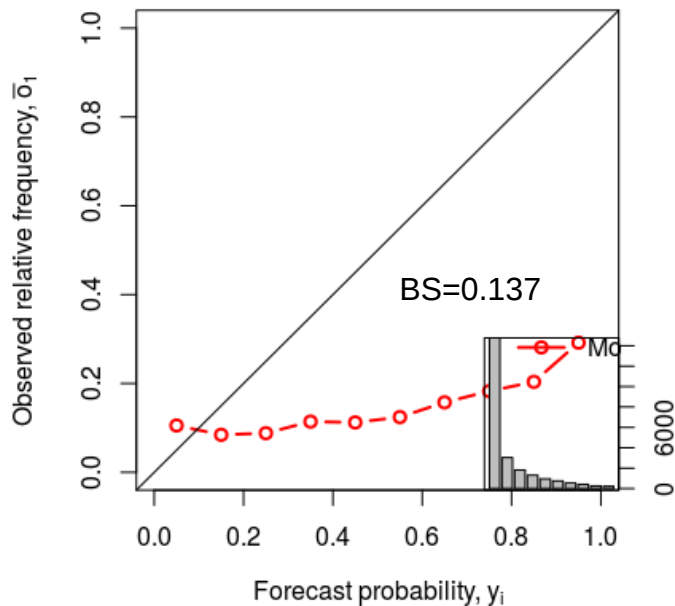


Threshold used very low  $\rightarrow$  density  $\geq 1$  flash/100km<sup>2</sup>

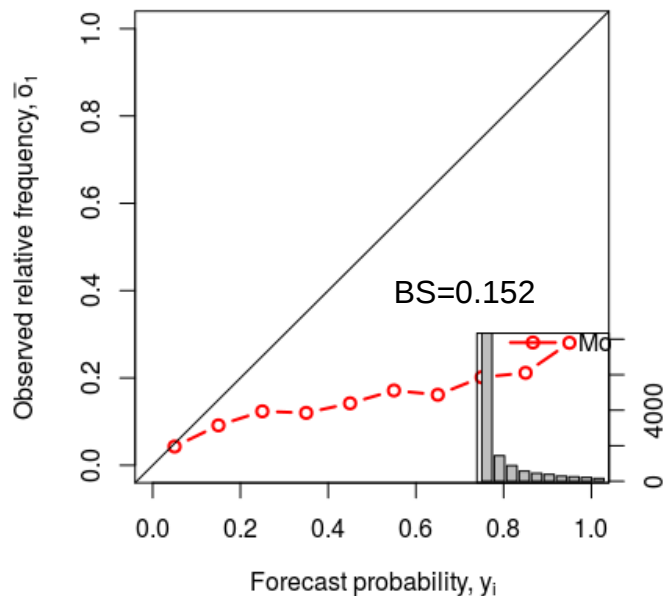


# Time aggregation

3h,1grid,GC + IC



6h, 1grid, IC+GC





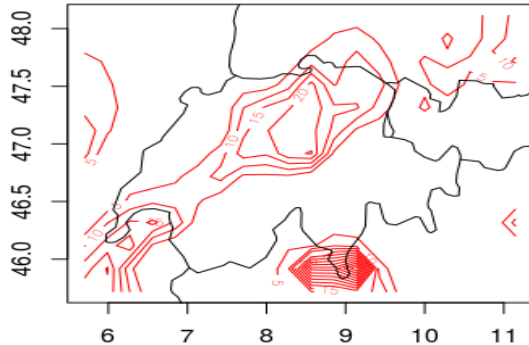
# Case study; 15<sup>th</sup> june 2019

Forecasts

15.6.2019 12-15z prob

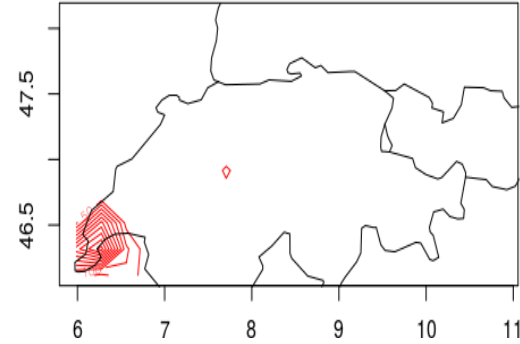


15.6.2019 15-18z prob

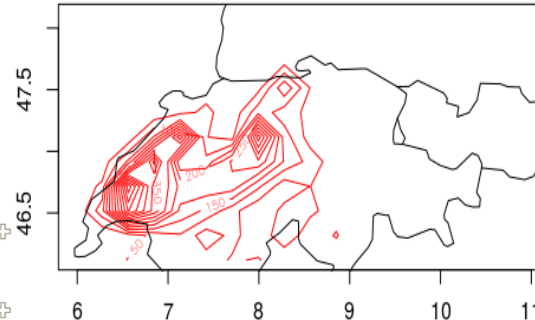


Observations

15.6.2019 12-15z IC-GC



15.6.2019 15-18z IC-GC



2020

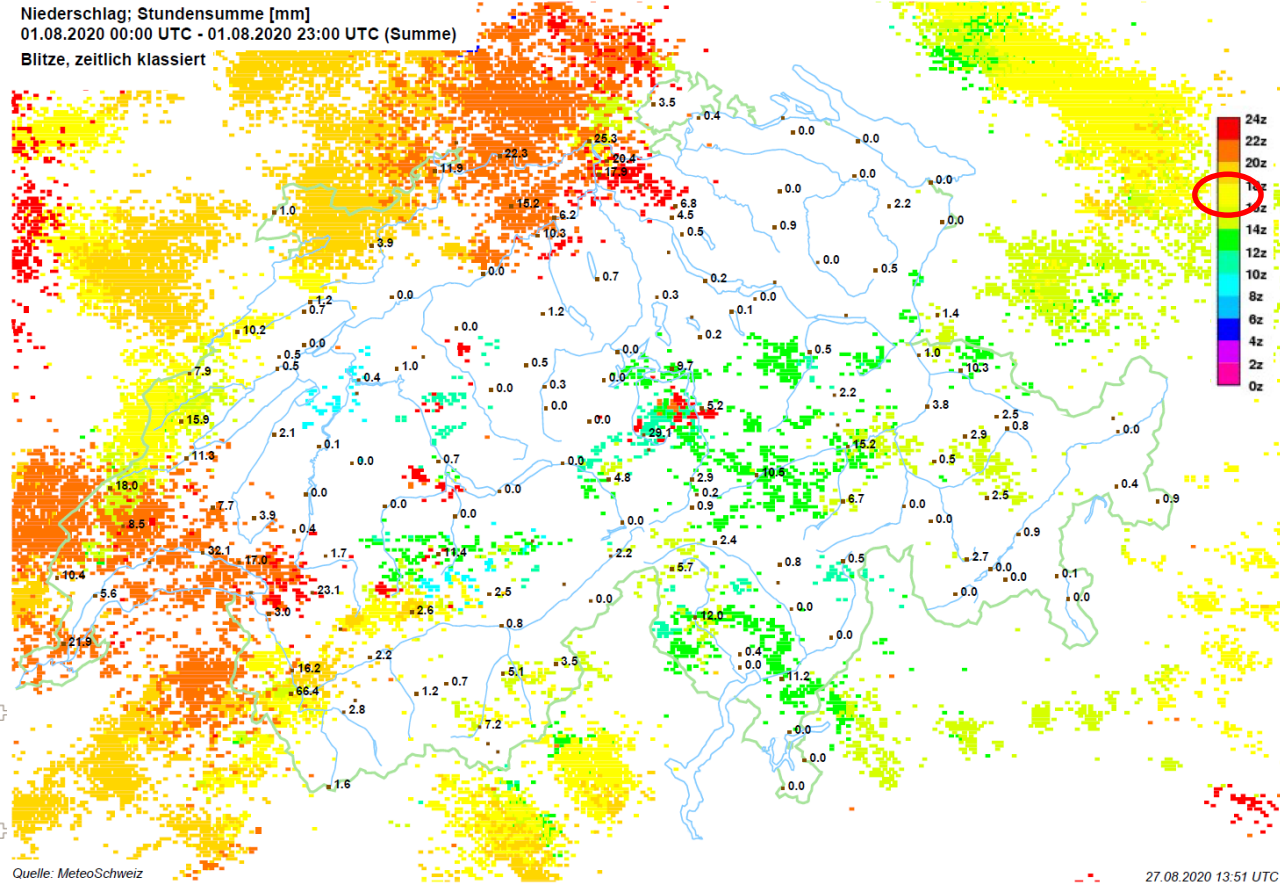
10

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# 1<sup>st</sup> August 2020

Niederschlag; Stundensumme [mm]  
01.08.2020 00:00 UTC - 01.08.2020 23:00 UTC (Summe)  
Blitze, zeitlich klassiert



Quelle: MeteoSchweiz

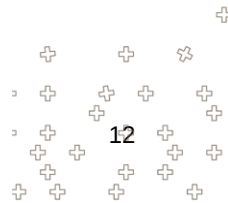
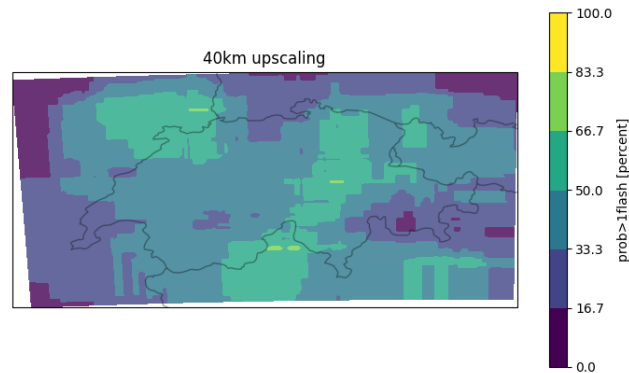
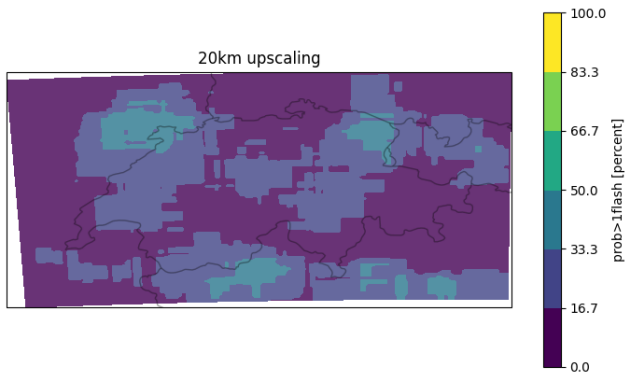
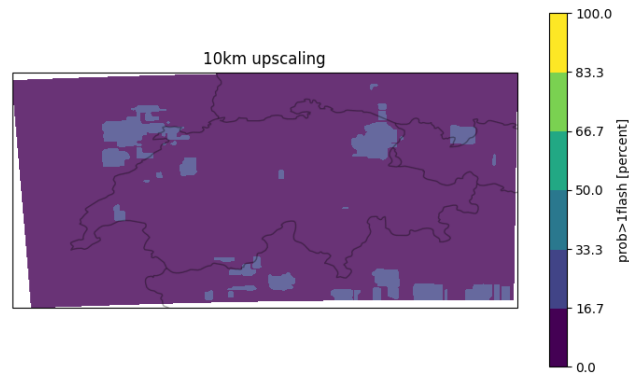
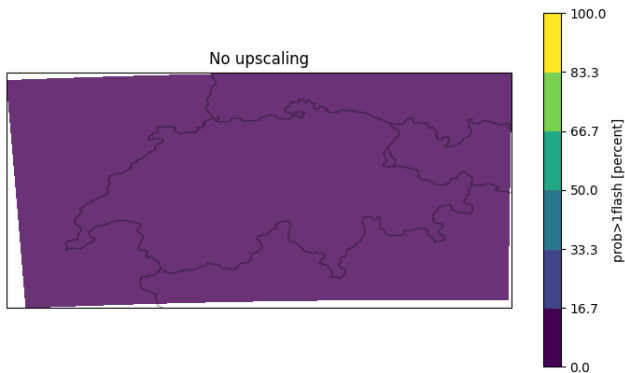
27.08.2020 13:51 UTC

sept 2020  
oswiss.ch



# 1<sup>st</sup> August COSMO 2E

COSMO 2E run 00UTC, val 17UTC, prob of flash density  $\geq 1$  flash / km<sup>2</sup> / h

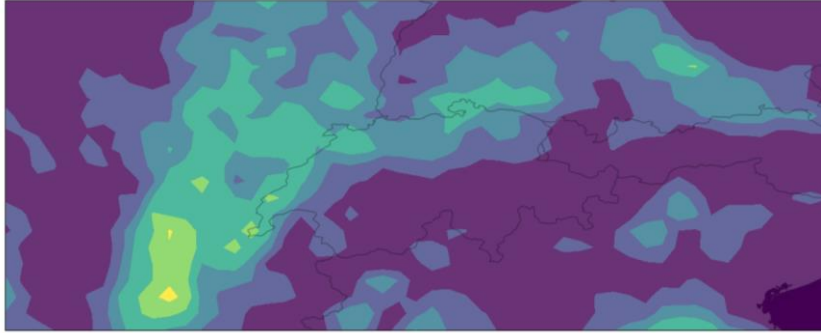




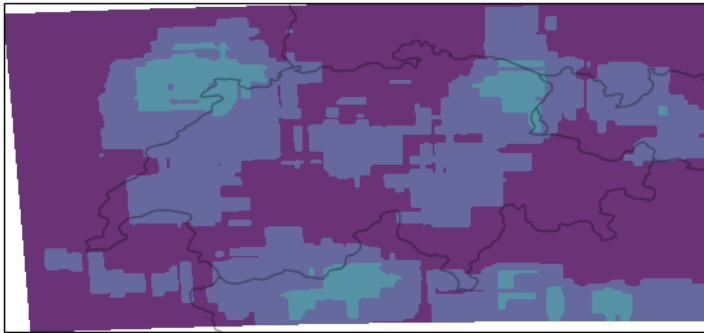
# 1<sup>st</sup> August 2020 IFS ENS – COSMO 2E

run 00UTC, val 17UTC, prob of flash density

Prob > 1 flash / 200km<sup>2</sup> / hr, 01.08.2020 17 UTC, IFS run of 00:00 UTC

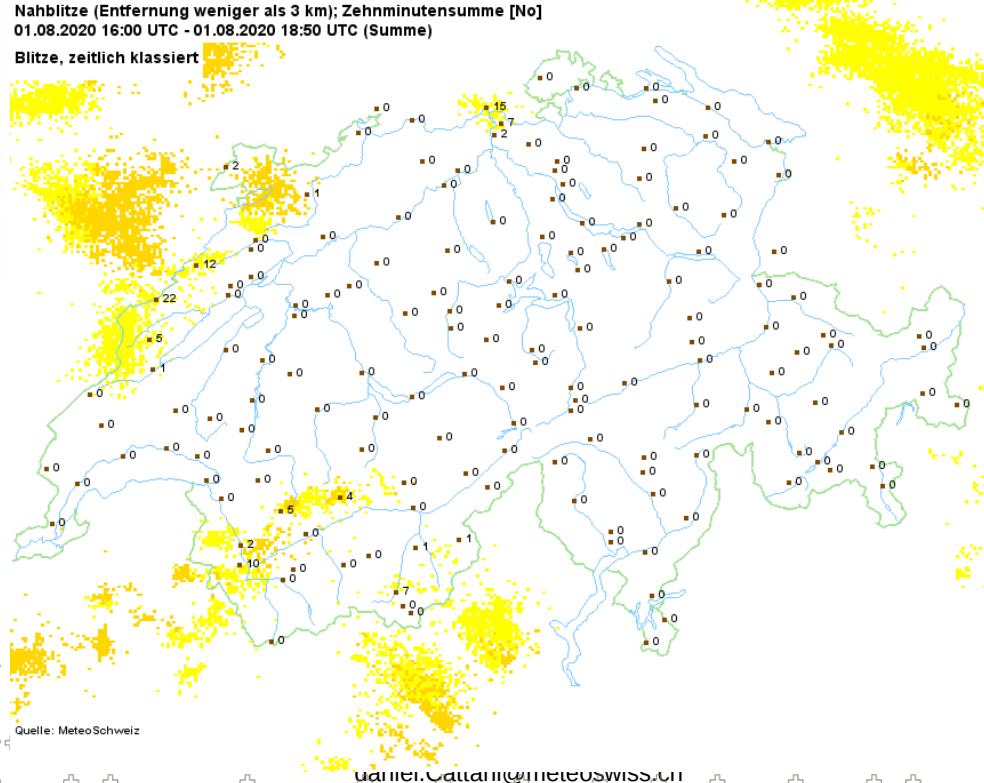


20km upscaling



Nahblitze (Entfernung weniger als 3 km); Zehnminutensumme [No]  
01.08.2020 16:00 UTC - 01.08.2020 18:50 UTC (Summe)

Blitze, zeitlich klassiert



Quelle: MeteoSchweiz

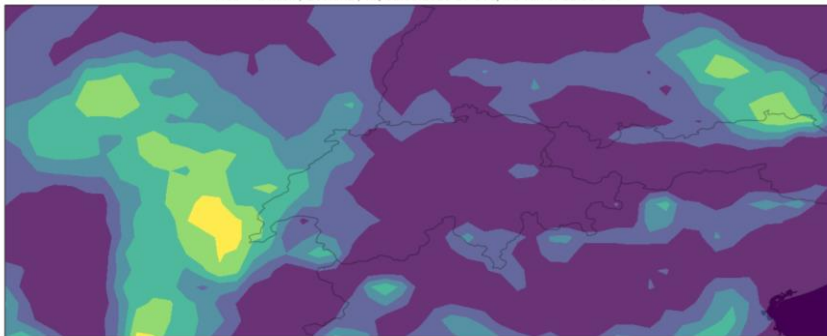
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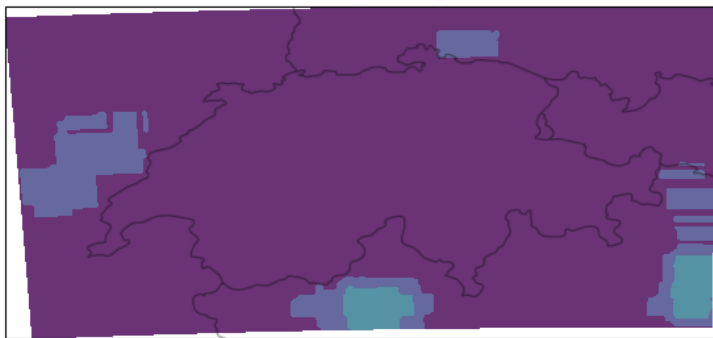
# 1<sup>st</sup> August 2020 IFS ENS – COSMO 2E

run 12UTC, val 17UTC, prob of flash density

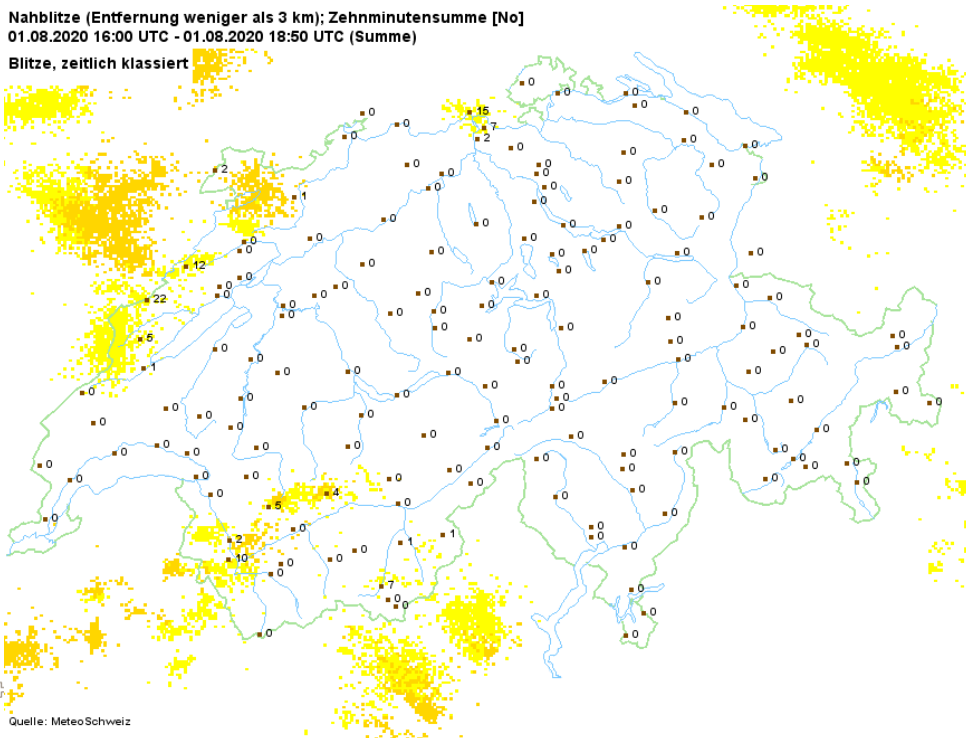
Prob > 1 flash / 200km<sup>2</sup> / hr, 01.08.2020 17 UTC, IFS run of 12:00 UTC



20km upscaling



Nahblitze (Entfernung weniger als 3 km); Zehnminutensumme [No]  
01.08.2020 16:00 UTC - 01.08.2020 18:50 UTC (Summe)  
Blitze, zeitlich klassiert



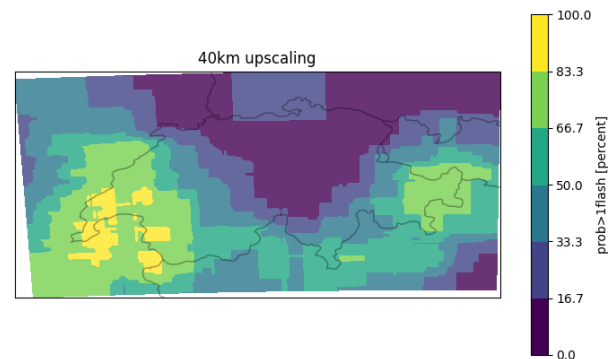
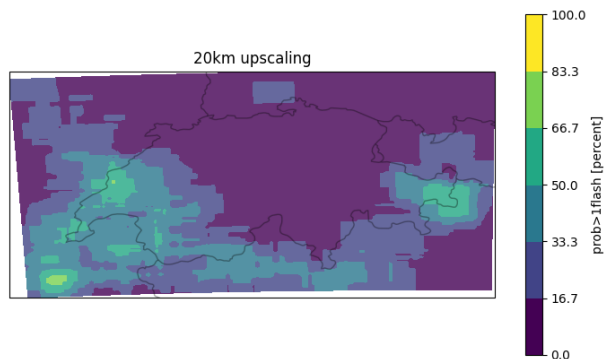
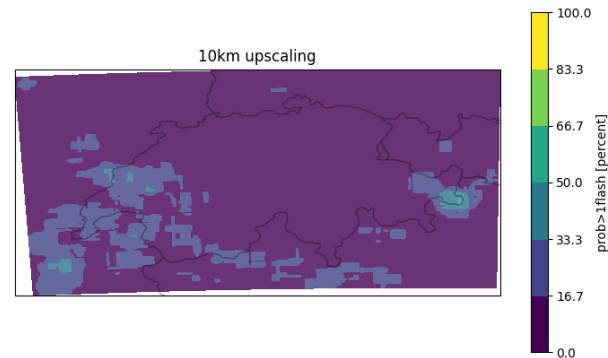
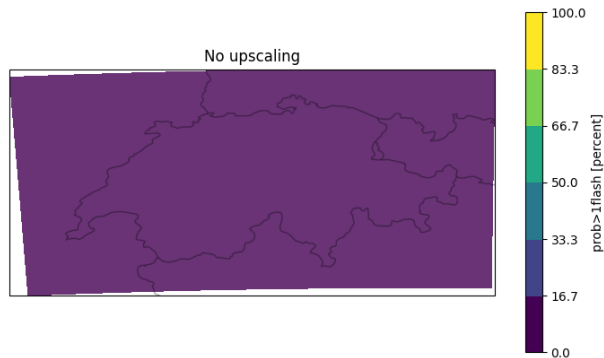
Quelle: MeteoSchweiz

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# 13<sup>th</sup> August 2020 COSMO

COSMO 2E run 00UTC, val 16UTC, prob of flash density  $\geq 1$  flash / km<sup>2</sup> / h

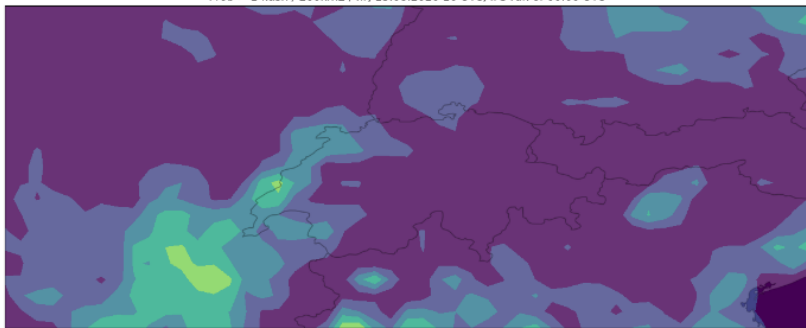




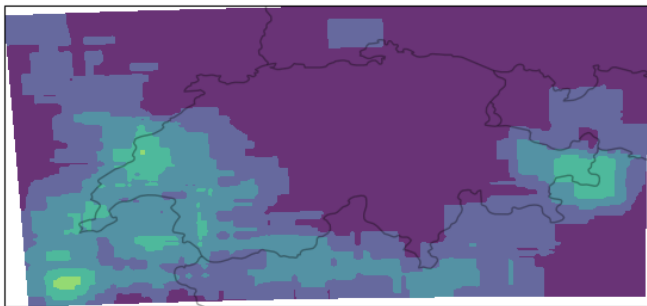
# 13<sup>th</sup> August 2020 IFS ENS – COSMO 2E

run 00UTC, val 16 UTC, prob of flash density

Prob > 1 flash / 200km<sup>2</sup> / hr, 13.08.2020 16 UTC, IFS run of 00:00 UTC



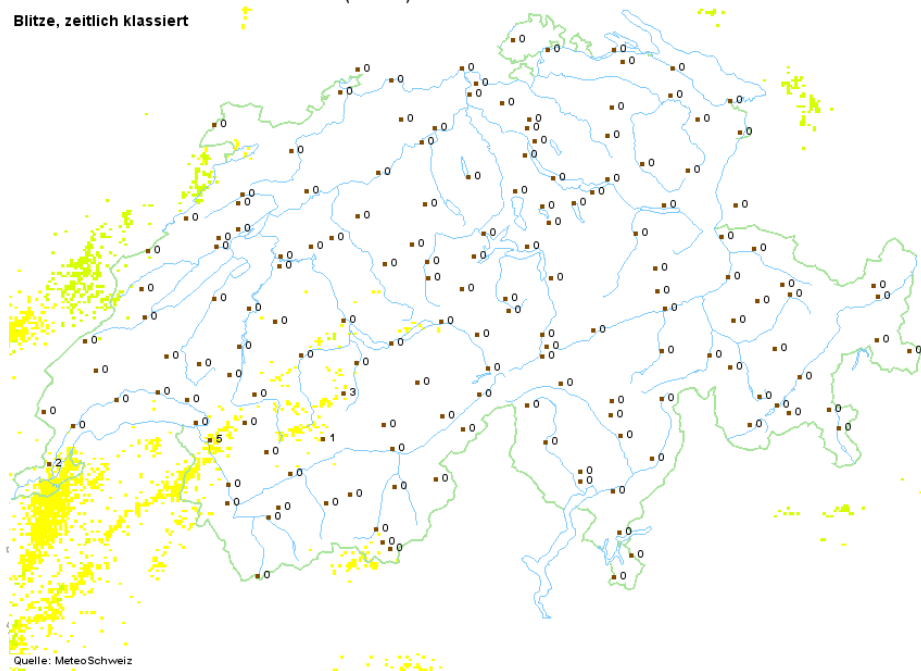
20km upscaling



Nahblitze (Entfernung weniger als 3 km); Zehnminutensumme [No]

13.08.2020 15:00 UTC - 13.08.2020 17:50 UTC (Summe)

Blitze, zeitlich klassiert





# Next steps

- Complete the analysis on IFS ENS (summer 2020)
  - Tests on thresholds
  - Scale resolution
  - Leadtime
- Verification of LPI COSMO-2E (2020)
  - Upscaling method
  - (Ev. Evaluation of the conversion (LPI – lightning))
- And ... production of seamless probability of lightning combining COSMO-1E, 2E and IFS ENS



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