

# Identification of thunderstorm occurrence in NWP forecasts using neural networks

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September 8, 2023

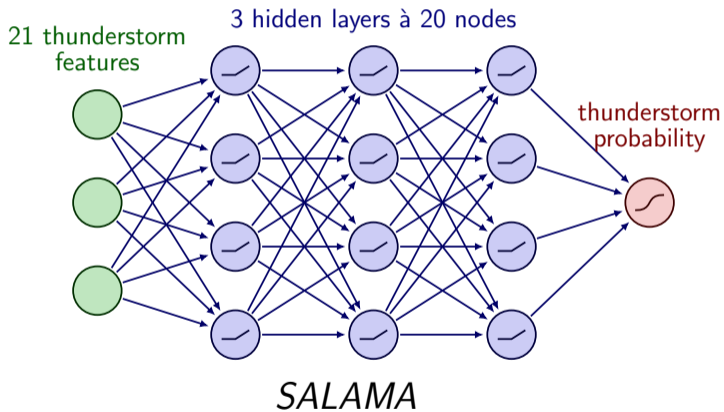
## Introduction

Main assumption: Thunderstorms are visible in NWP forecasts.



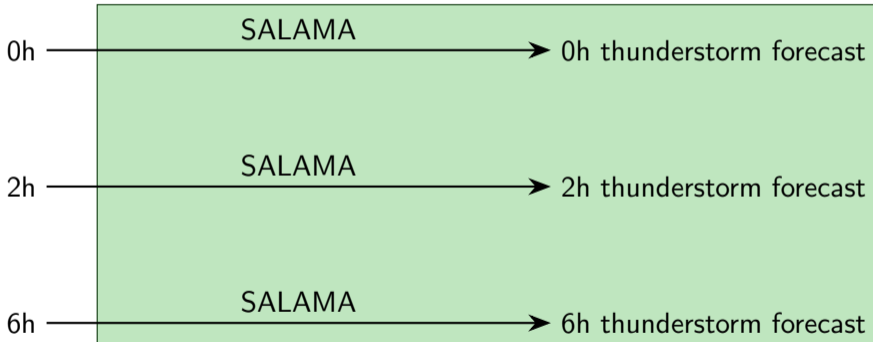
# Introduction

Main assumption: Thunderstorms are visible in NWP forecasts.



# The art of post-processing

NWP forecasts  
of input parameters



lead time

Same identification algorithm for each lead time!

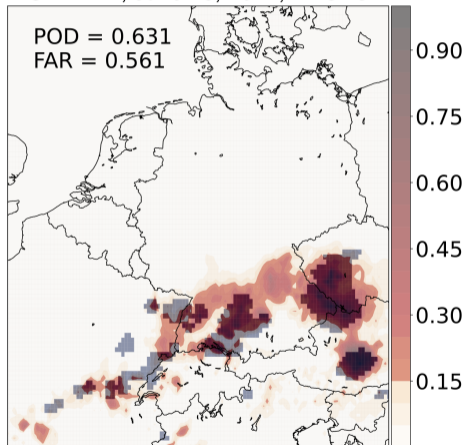
# Model training

*input parameters*  
ICON-D2-EPS  
Jun-Aug 2021  
0-2 h lead times

*labels*  
LINET

Training

SALAMA, June 23, 2021, 21 UTC



## Skill dependence on lead time

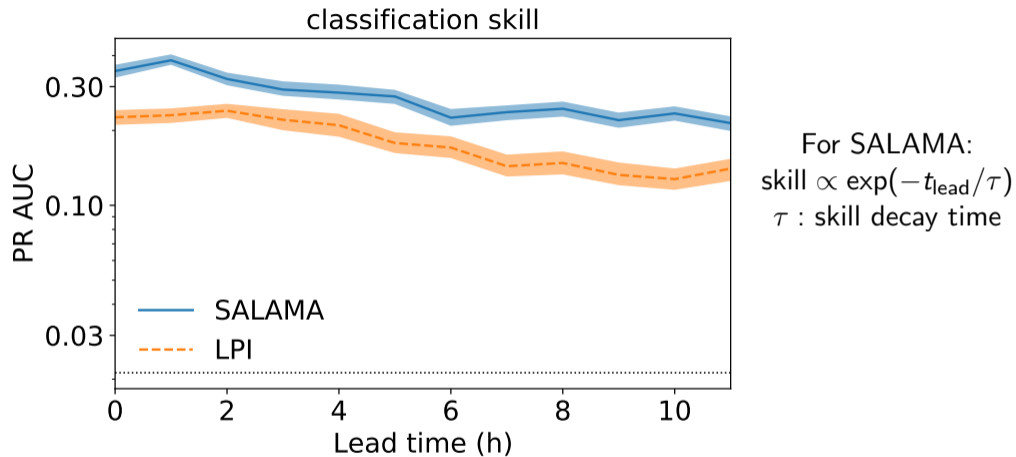


Figure: (a) Classification skill (quantified by the area under the PR curve) as a function of lead time.

## Skill dependence on spatial resolution scale

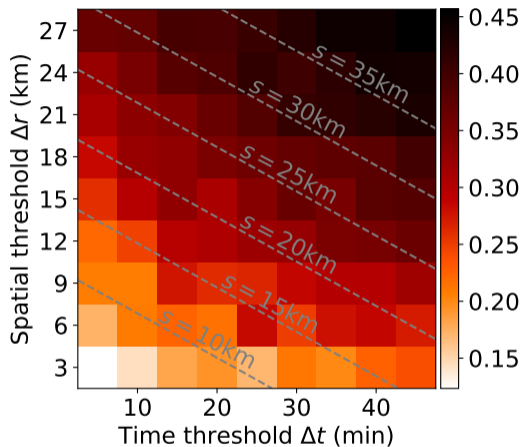
### Definition of thunderstorm target

Thunderstorm occurs at  $(x, t)$  if a lightning flash is detected at any  $(x_l, t_l)$  with

$$\|x - x_l\| < \Delta r \quad \|t - t_l\| < \Delta t$$

So far:  $\Delta r = 15 \text{ km}$ ,  $\Delta t = 30 \text{ min}$

## Skill dependence on spatial resolution scale



spatial resolution scale:

$$s = \Delta r + c\Delta t$$

Fit:  $c = 5.2(3)$  m/s

**Figure:** Classification skill of SALAMA as a function of the label configuration. The slope of the dashed lines is chosen such that classification skill is approximately constant along the lines.



## Decay time of skill vs. lead time

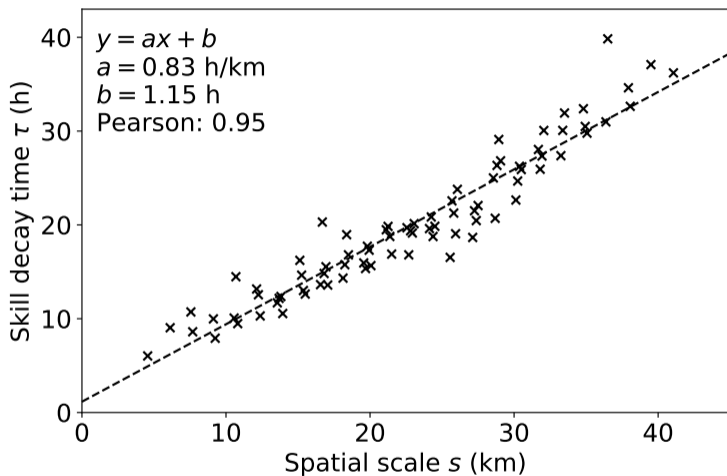


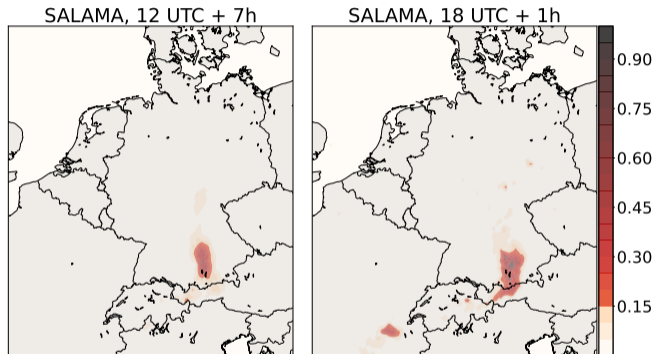
Figure: Decay time of classification skill as a function of the spatial scale.

# Summary

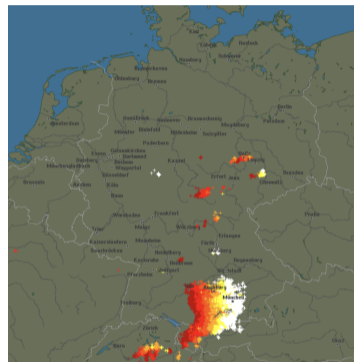
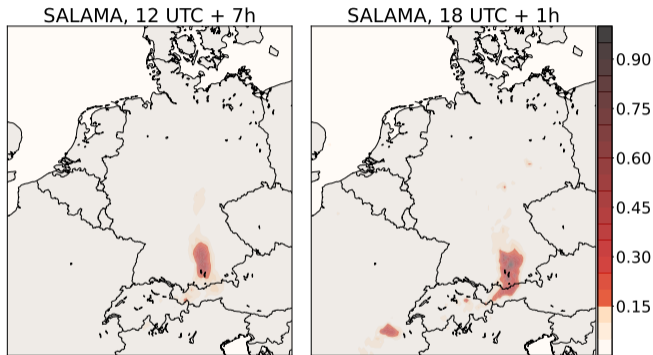
## SALAMA: Inferring the probability of thunderstorm occurrence

- ▶ Training of a neural network, using high-resolution NWP data and lightning data
- ▶ No explicit use of location, time, or forecast range  $\Rightarrow$  universal signature?

# "Operational" use: May 5, 2023, 19 UTC



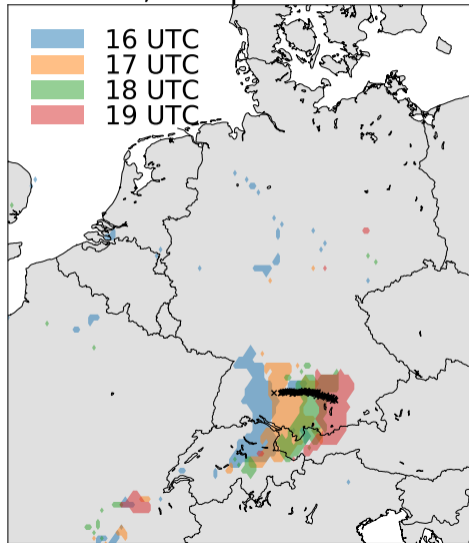
# "Operational" use: May 5, 2023, 19 UTC



19 UTC (lightningmaps.org)

"Operational" use: May 5, 2023, 19 UTC

SALAMA, compared to ESWD



Reports of large hail in ESWD

*Thank you for your attention.*

*More details: arXiv:2303.08736 (submitted to Q. J. R. Meteorol. Soc.)*

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