

Investigating the predictability of severe convective outbreaks in central Europe

Monika Feldmann¹, Daniela I. V. Domeisen², Olivia Martius¹

¹ Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

² Université de Lausanne, Lausanne, Switzerland; ETH Zurich, Zurich, Switzerland

1. Introduction

- Severe convection is a considerable weather hazard to society
- Early predictability has high relevance, current predictability explored up to 7 days [1]
- Most severe outbreaks occur during **characteristic weather situations**
- Convective outbreaks in Europe are associated with high CAPE-shear values [2]
- In USA: link found between MJO and tornado-outbreaks at lead time 3-4 weeks [3]

2. Convective variables

- Convective available potential energy (CAPE) - measure for instability in the atmosphere
- **Bulk shear** – wind difference (speed and direction) between surface level and 6 km, higher shear enables convective organization
- **wmax-shear**: $\sqrt{2 \text{CAPE}} \cdot \text{shear}$ – identification of severe convective environments [2]

3. Case evaluations in Switzerland

- **June 21-28, 2021, Northern Switzerland**
- Characteristic **synoptic flow from the SW** for convection [4]
- Most extreme period of severe storms in Swiss radar observations

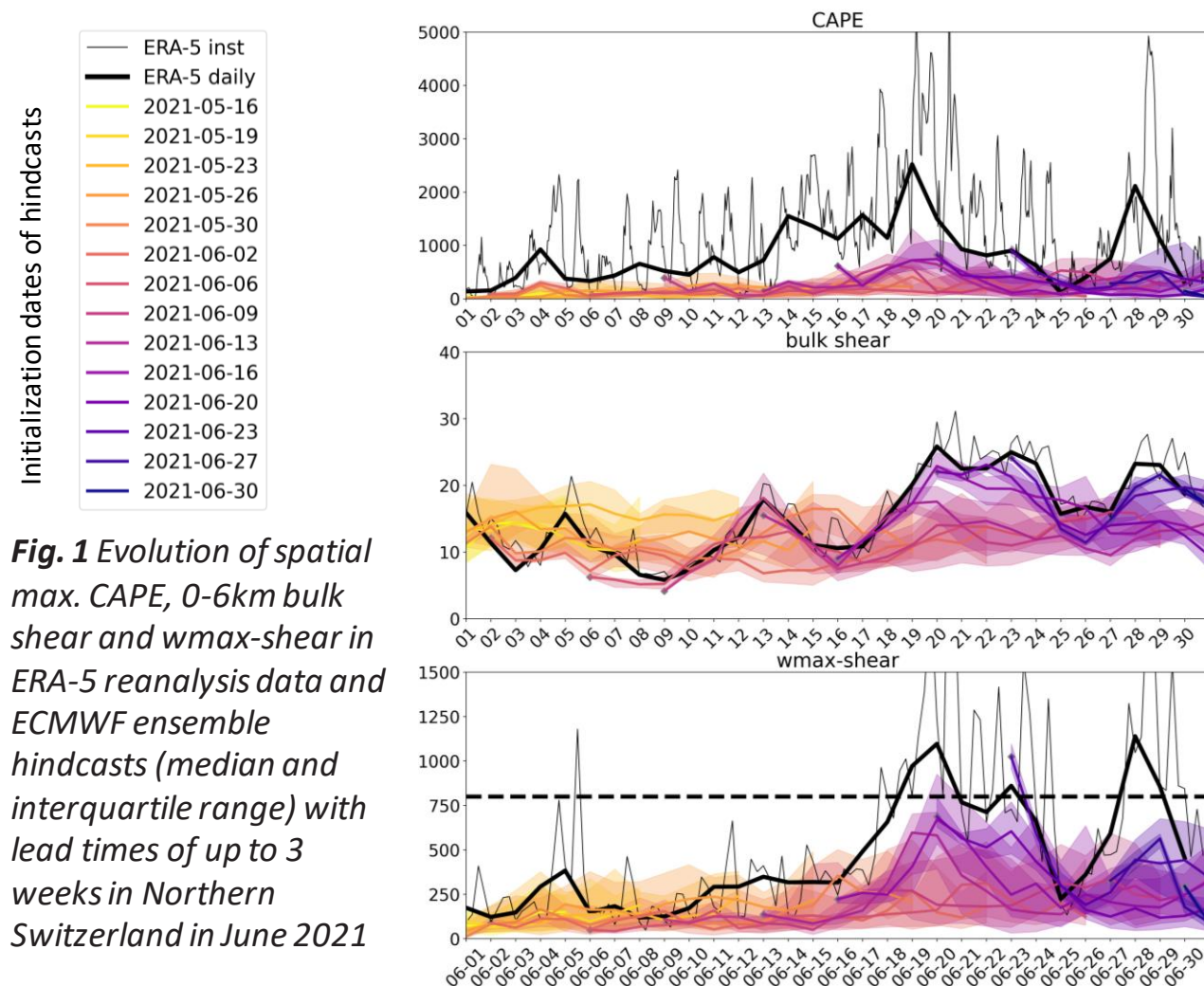


Fig. 1 Evolution of spatial max. CAPE, 0-6km bulk shear and wmax-shear in ERA-5 reanalysis data and ECMWF ensemble hindcasts (median and interquartile range) with lead times of up to 3 weeks in Northern Switzerland in June 2021

- **June 19-28, 2022, Southern Prealps**
- Severe, long-lasting convection in S Prealps
- Recurring severe storms, record wind gusts

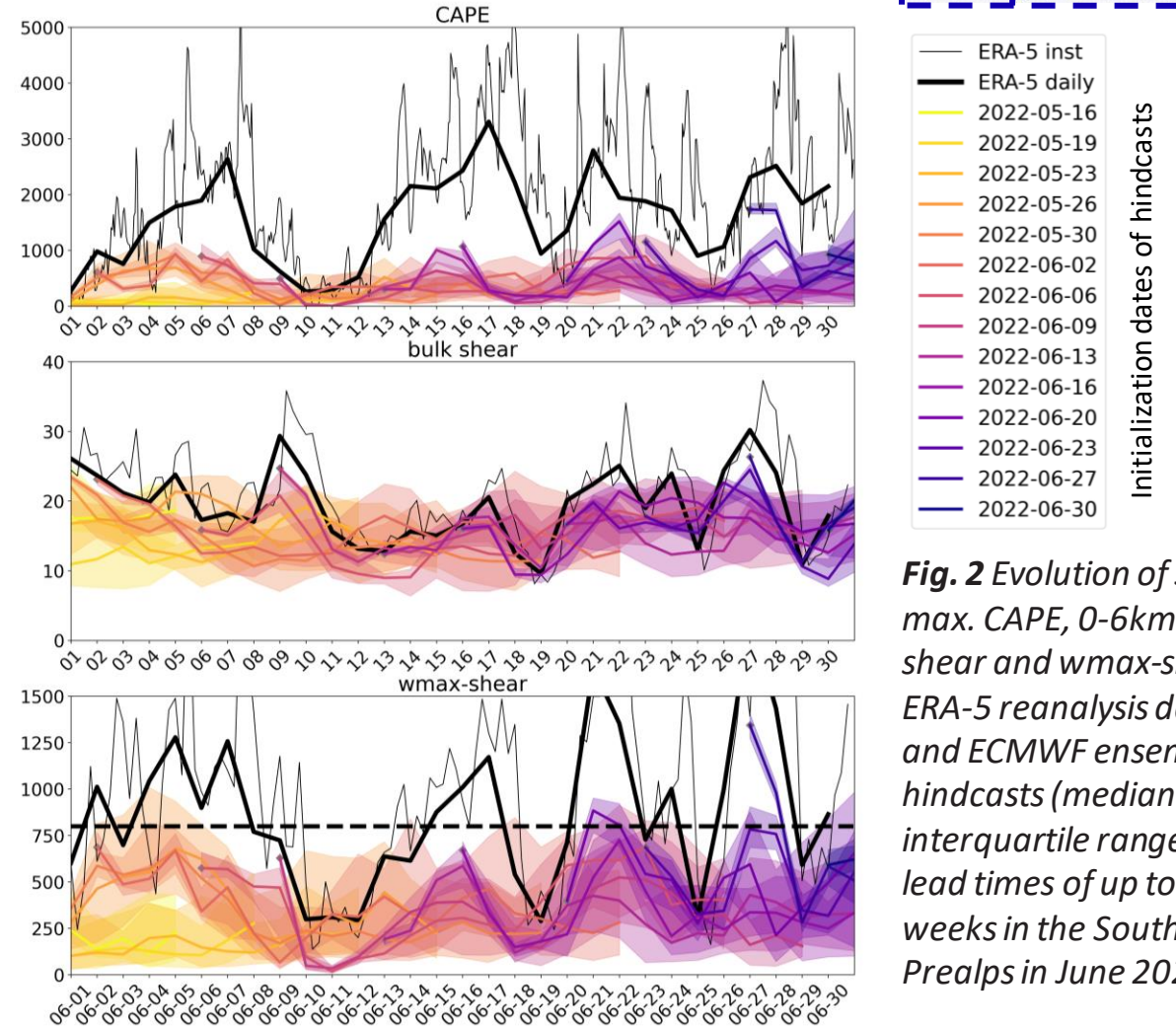


Fig. 2 Evolution of spatial max. CAPE, 0-6km bulk shear and wmax-shear in ERA-5 reanalysis data and ECMWF ensemble hindcasts (median and interquartile range) with lead times of up to 3 weeks in the Southern Prealps in June 2022

First assessment:

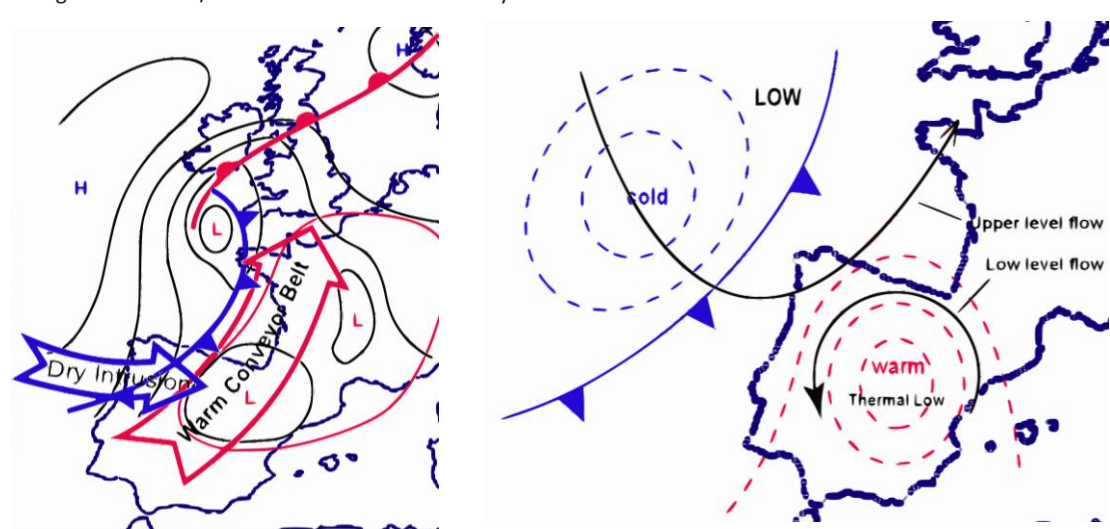
- S2S model **underestimates absolute CAPE** → requires bias correction or quantile regression
- **Time evolution** of the CAPE values is **promising**
- Nonlinear compound parameter (wmax-shear) influenced by errors both in CAPE and shear

4. Typical situation for convective outbreaks [4]

Spanish plume – characteristic for W Europe [5]

- Advection of dry air from the Iberian peninsula
- Approaching low from the Bay of Biscay
- High CAPE due to advection of moist air from Mediterranean and dry cap from Iberian peninsula
- High shear due to synoptic flow in low and upper levels
- Convection in prefrontal zone

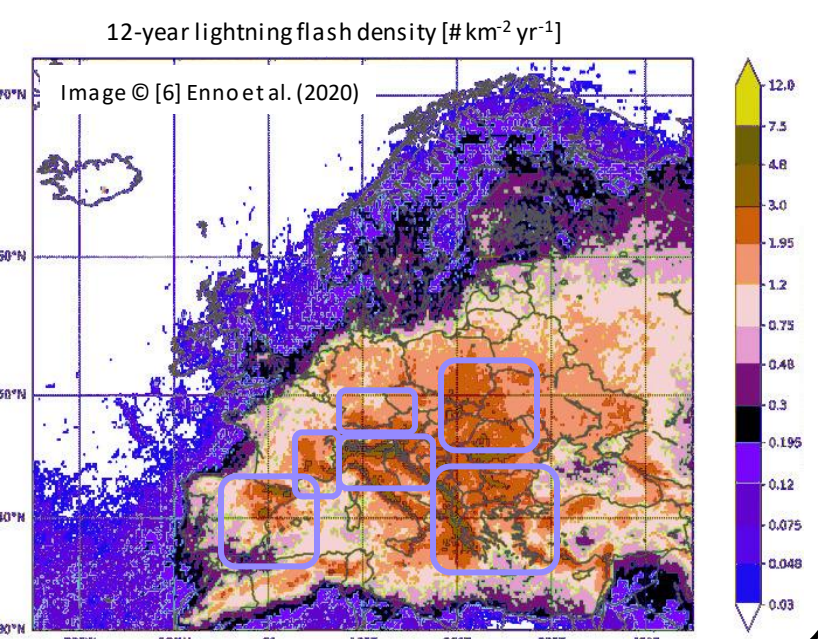
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5. Outlook

We aim to determine the skill of ECMWF S2S forecasts in identifying severe convective outbreaks in European regions at a multi-week lead time.

- Investigating the performance of the **ensemble hindcast**
- **Percentile-based** event definition
 - Determine the percentile of extreme events in ERA-5
 - Apply the same percentile threshold to hindcasts
- **Regions of interest**
 - N Switzerland & S Germany, S Switzerland & N Italy, SE France, Iberian peninsula, SE Europe, CE Europe
 - Determine large-scale situations for extrema, identify likely relevant predictors



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