Session 5 P21

Addressing Spatial Uncertainty of Convection in Thunderstorm Forecast Verification

Jadran Jurković (jadran.jurkovic@crocontrol.hr) Croatia Control Ltd.
Vinko Šoljan (vinko.soljan@crocontrol.hr) Croatia Control Ltd.

ECSS 2023

1. Introduction

Thunderstorms (TS) and convection

- Reduces air traffic operation at airports (and routes)
- Pronounced diurnal and spatial variation
- Forecasting using ingredients-based methodology (Doswell et al., 1996)
    - Forecasting of convection is challenging
    - Ingredients for deep moist convection are never ideally known, especially **mesoscale lift uncertainty for local initiation** is always present
- The standard reference area for a TS forecast in TAF is a 16 km diameter circle around the airport.
- The commonly used procedure of verifying TS in TAFs is against observed TS stated in standard reports for the airport (METAR reported with PrWx, RE, VC)
- **Question: considering the inherent spatial uncertainty of the convection initiation, is 16km radius enough and fair for forecast verification**?

TAF Terminal Aerodrome Forecast

- standard forecasts for aviation planning purposes (ICAO, 2020)
- used worldwide
- created by forecasters
- states forecasted weather conditions significant for aviation and their changes for the airport in the next 24 hours.
- TAF Verification in Croatia control follows the approach proposed by Mahringer (2008).

TAF example hours with observed and forecastes TS hours
Forecasted hours with TSs : Temporary 1-11UTC, becoming 20-22

Hour (UTC)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FORECAST																								
OBSERVED																								
Event	**d**	**b**	**a**	**a**	**b**	**b**	**b**	**b**	**b**	**b**	**b**	**d**	**d**	**d**	**d**	**d**	**d**	**d**	**d**	**c**	**a**	**a**	**b**	**b**

Posible events: Hit (a), False alarm (b), Miss (c), Correct rejection (d)

2. Method and data

Data

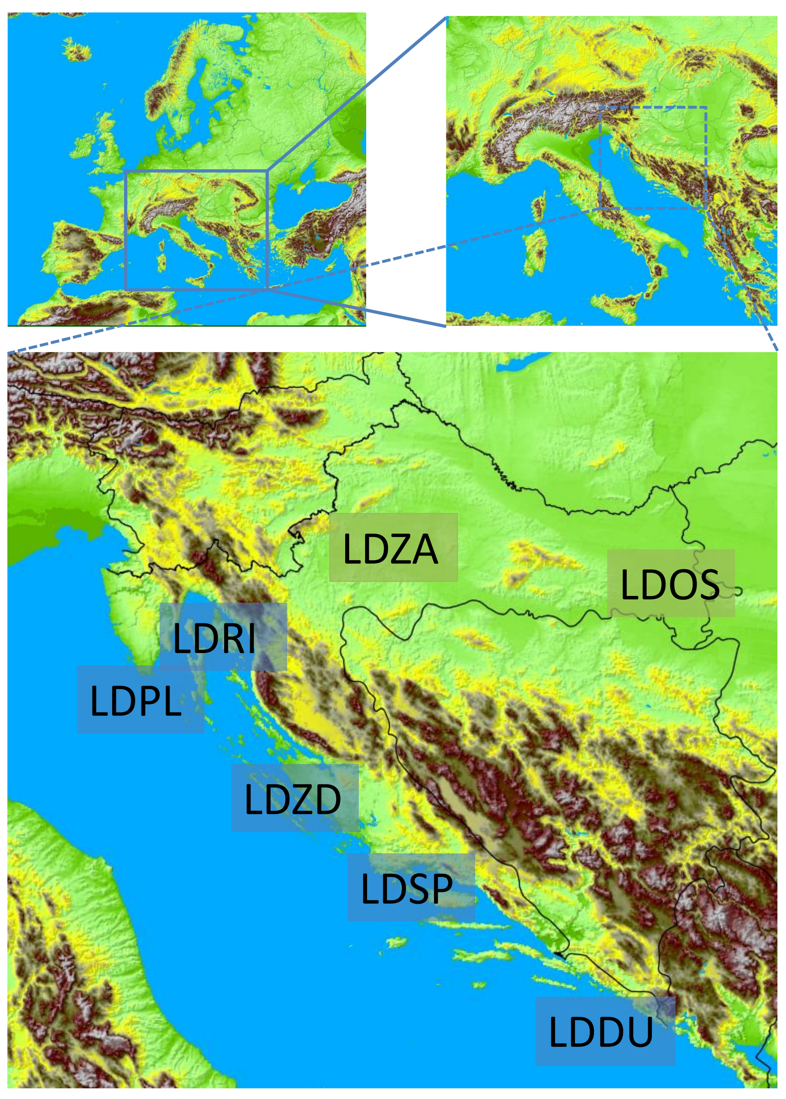
- Croatian airports

Continental climate Zagreb (LDZA), Osijek (LDOS)
Mediterranean climate Rijeka (LDRI), Pula (LDPL), Zadar (LDZD), Split (LDSP), Dubrovnik (LDDU)

- Forecasts: TAF 2020-2023
  3 warm seasons (months 04-09)
  3 cold seasons (months 10-03)

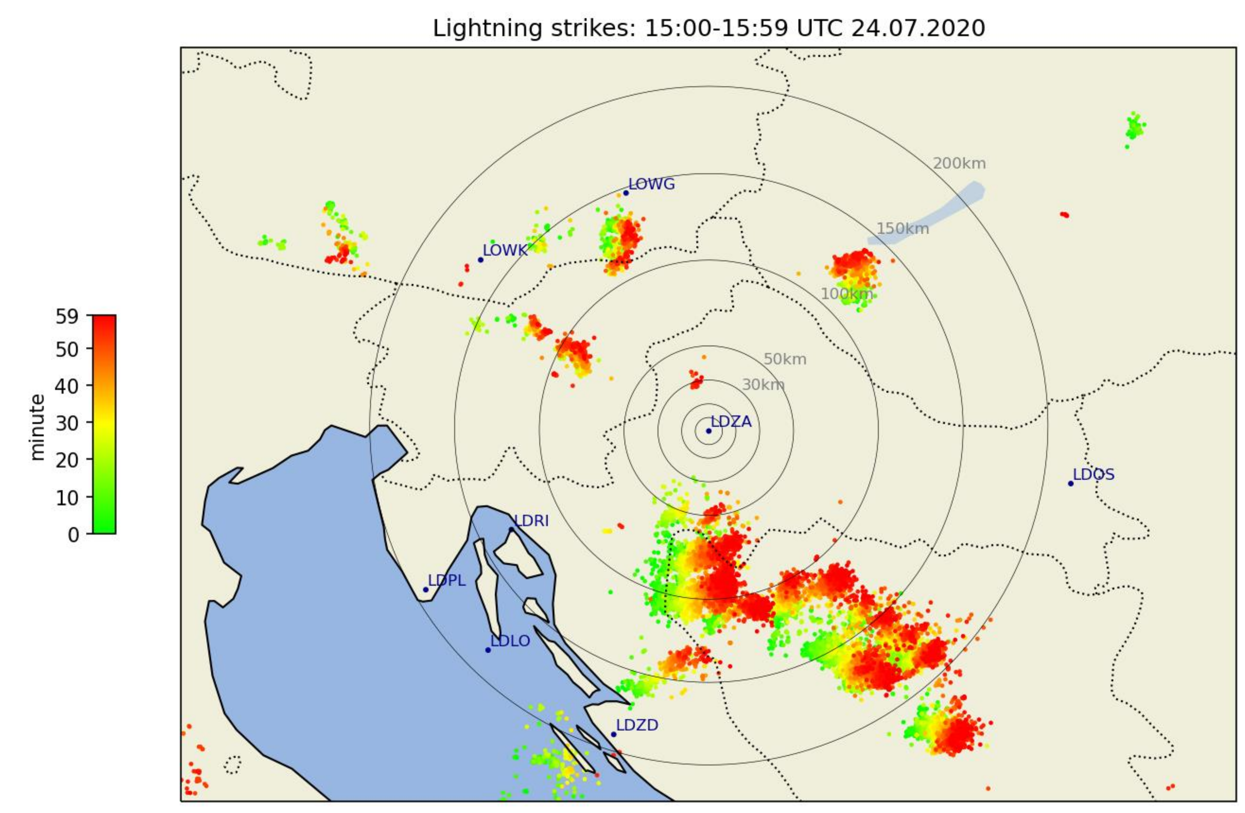
- Observation: Lightning (LINET network)
  Areas with various radiuses R:
  8,16,30,50,100,150,200km

- Verification for each hour
  score KPI=(HSS+PSS)/2
  (threshold p(TS)>0.01)



TAF Example 24.7.2020.

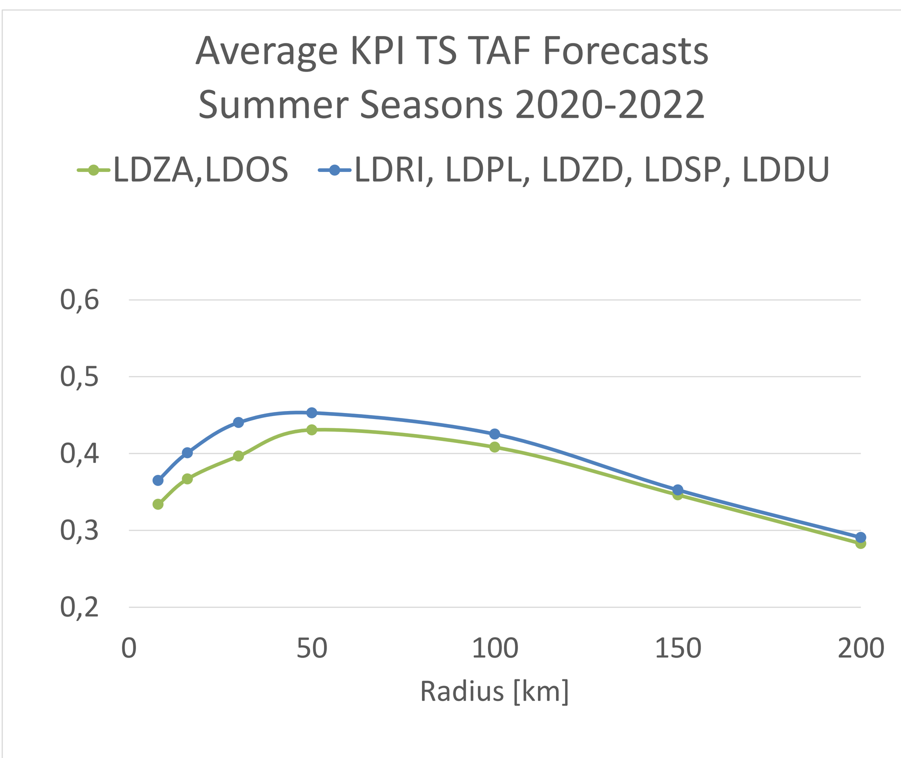
```
TAF LDZA 240525Z 2406/2506 VRB02KT CAVOK TX26/2413Z TN16/2420Z
    PROB30 TEMPO 2413/2416 FEW035CB
           TEMPO 2416/2423 VRB15G25KT 1500 +TSRA SCT035CB BKN045
           TEMPO 2423/2506 3000 RA BKN005
    PROB30 TEMPO 2423/2506 TSRA SCT010 FEW035CB BKN045=
```



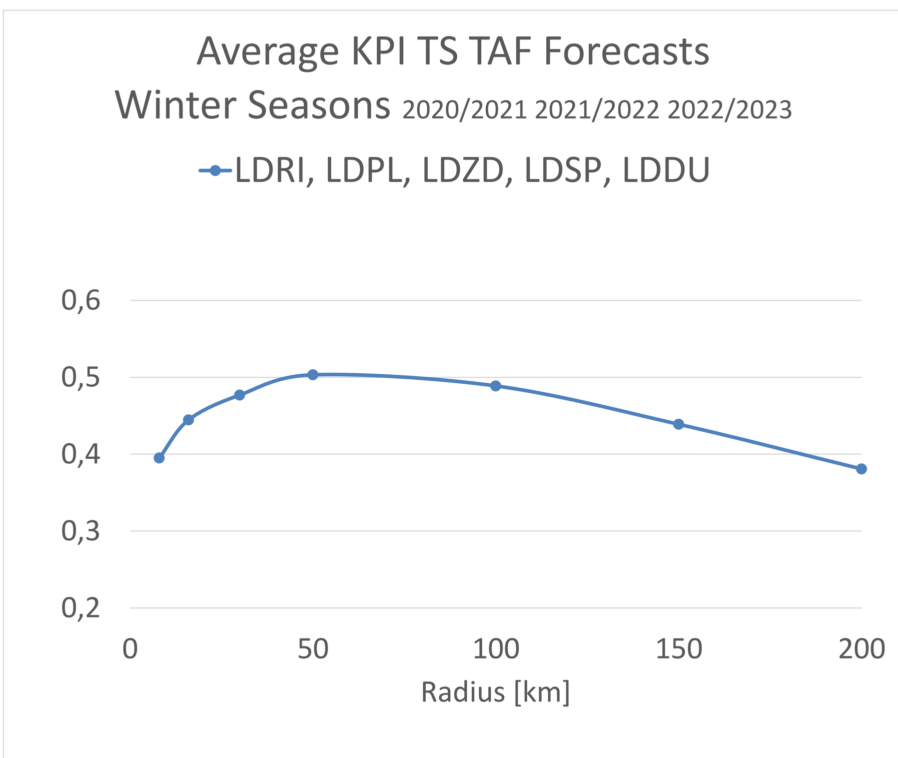
Event for hour 15Z: Correct rejection (R<16), Miss (R≥30)

3. Results

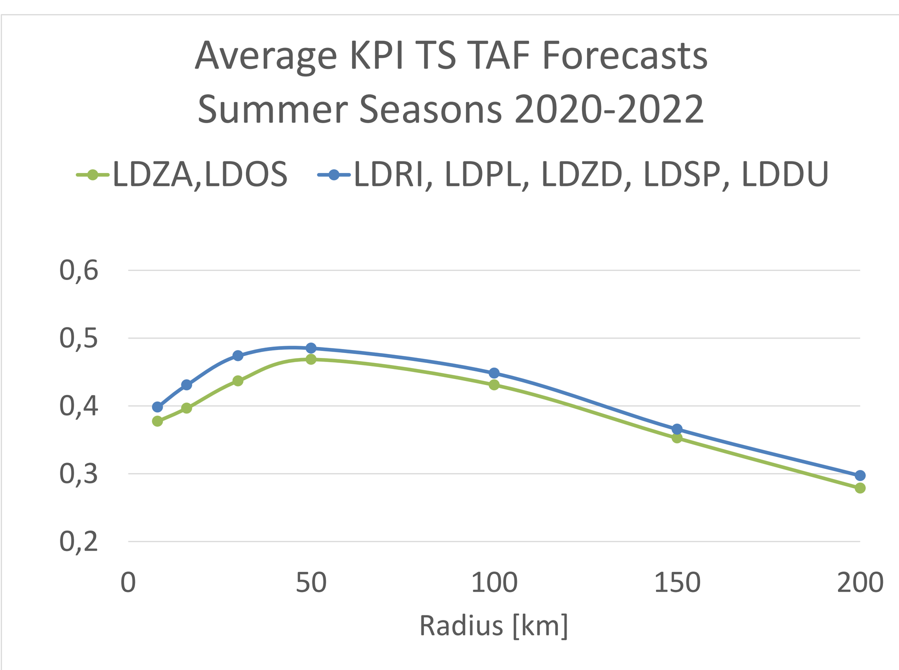
Summer results



Winter results (LDZD, LDSP, LDDU)



Summer results (Lead time 0-2h)



Best KPI for radiuses

	LDZA	LDOS	LDRI	LDPL	LDZD	LDSP	LDDU
2020 summer	50	50	50	50	30	100	30
2020/2021 w.	#N/A	#N/A	100	30	50	100	100
2021 summer	50	100	30	50	50	50	50
2021/2022 w.	#N/A	#N/A	#N/A	#N/A	30	50	50
2022 summer	50	50	50	100	50	50	50
2022/2023 w.	#N/A	#N/A	50	#N/A	50	100	100

4. Conclusion

- **Data set for different climates and seasons**
- **Best verification scores are for radius >16 km : mostly 50 km (varies from 30 to 100 km)**
- **Better scores at the coastal airports**
- **Better scores during winter**
  -easier to distinguish TS hours and days
  -synoptic forcing (convective ingredients)
- **Results for short lead time (0-2) are better (as expected)**
- **All results related to maximum predictability considering TAF product (format and its condensed information) and ingredients uncertainties**

References:
Doswell, C. A., Brooks H. E., and Maddox R. A., 1996: Flash flood forecasting: An ingredients-based methodology. Wea. Forecasting, 11, 560– 581.
International Civil Aviation Organization (ICAO). 2020. Meteorological Services for International Air Navigation. Annex 3 to the Convention on International Civil Aviation, 20th edn. ICAO: Montreal.
Mahringer, G., 2008: Terminal aerodrome forecast verification in Austrocontrol using time windows and ranges of forecast conditions. Meterol. Appl. 15: 113–123.
Wilks, D. S., 2006: *Statistical methods in the atmospheric sciences*. 2nd edn. Academic Press, San Diego, 627 pp.