A comparison of predictability of historical heavy precipitation events

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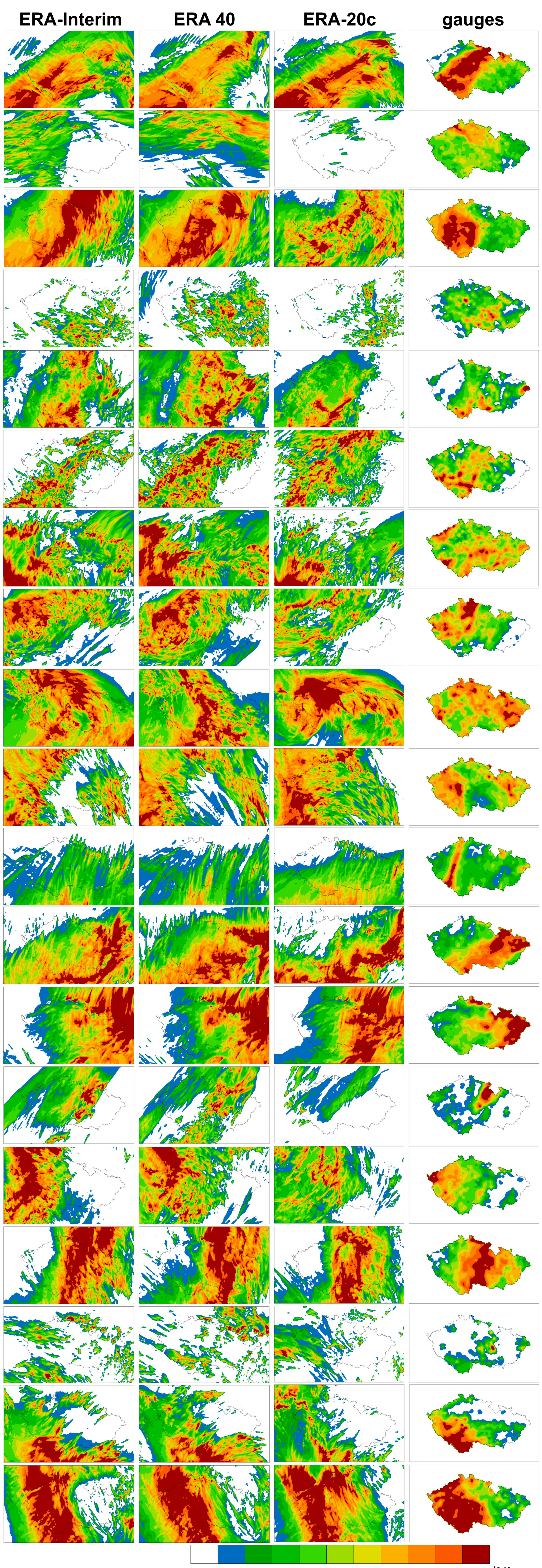
Motivation/Introduction

This paper aims to evaluate a historical precipitation events forecasts based on three European reanalysis. Unlike archived weather analyses from operational forecasting systems, a reanalysis is produced with a single version of a data assimilation system, including the forecast model used, and it is therefore not affected by changes in method.

(I) Heavy precipitation events



Maximum, average mean errors

17.06.1979 – MIXED

mm/24h	E.int	E.40	E.20c	gauges
max	136.6	314.2	167.2	175.8
maxCZ	136.6	314.2	149.6	175.8
mean	20.0	18.2	23.5	28.5
meanCZ	24.3	19.5	29.2	28.5
ME	-4.3	-9.0	0.6	
MAE	17.9	15.7	22.7	

29.07.1979 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	89.4	73.9	34.7	98.3
maxCZ	61.7	73.9	34.0	98.3
mean	3.9	7.3	0.3	11.9
meanCZ	3.2	5.1	0.4	11.9
ME	-8.7	-6.9	-11.5	
MAE	9.8	9.2	11.5	

02.08.1983 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	240.9	162.8	246.0	87.8
maxCZ	169.6	162.8	246.0	87.8
mean	31.2	30.8	20.2	25.0
meanCZ	37.1	36.9	22.8	25.0
ME	12.1	11.9	-2.2	
MAE	24.8	21.8	21.6	

19.06.1986 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	150.9	169.8	184.7	95.8
maxCZ	123.9	169.8	184.7	95.8
mean	3.9	6.3	2.1	7.5
meanCZ	4.1	8.4	1.7	7.5
ME	-3.4	0.9	-5.8	
MAE	8.5	9.9	7.7	

18.07.1986 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	262.1	280.8	166.1	169.3
maxCZ	262.1	280.8	155.2	169.3
mean	11.4	18.2	7.8	7.8
meanCZ	13.4	23.8	10.3	7.8
ME	5.6	16.0	2.5	
MAE	10.6	19.3	9.9	

01.07.1987 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	189.9	231.6	157.0	109.7
maxCZ	189.9	202.9	150.8	109.7
mean	8.3	16.5	14.5	14.3
meanCZ	9.4	20.3	14.4	14.3
ME	-4.9	6.0	0.1	
MAE	12.1	16.9	13.7	

01.08.1991 – MIXED

mm/24h	E.int	E.40	E.20c	gauges
max	260.3	288.2	209.1	174.6
maxCZ	180.4	220.6	209.1	174.6
mean	14.4	17.9	10.0	20.1
meanCZ	12.0	15.6	8.4	20.1
ME	-8.1	-4.5	-11.7	
MAE	17.1	17.4	16.4	

23.06.1992 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	139.3	184.1	140.4	137.8
maxCZ	139.3	184.1	140.4	137.8
mean	12.3	16.7	7.3	17.0
meanCZ	12.4	18.5	7.5	17.0
ME	-4.6	1.5	-9.5	
MAE	13.4	15.2	14.0	

25.08.1994 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	248.0	236.4	319.5	96.3
maxCZ	248.0	236.4	243.0	96.3
mean	26.9	20.7	30.7	26.0
meanCZ	30.8	25.1	35.8	26.0
ME	4.8	-0.9	9.8	
MAE	19.1	21.8	24.1	

01.06.1995 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	143.3	138.6	194.6	94.7
maxCZ	142.8	90.9	152.1	94.7
mean	13.5	12.8	19.8	19.0
meanCZ	12.6	9.2	17.4	19.0
ME	-6.5	-9.8	-1.6	
MAE	15.2	13.6	13.8	

25.06.1995 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	55.6	59.4	88.5	128.8
maxCZ	55.6	59.4	75.2	128.8
mean	3.3	3.0	6.1	8.4
meanCZ	3.4	3.7	5.7	8.4
ME	-5.0	-4.7	-2.7	
MAE	7.4	8.3	8.2	

05.07.1997 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	184.1	192.3	264.2	128.0
maxCZ	165.9	173.7	224.2	128.0
mean	21.9	24.3	18.8	22.9
meanCZ	21.5	26.1	19.8	22.9
ME	-1.4	3.2	-3.2	
MAE	12.9	13.2	17.9	

06.07.1997 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	255.1	248.4	333.6	234.0
maxCZ	255.1	248.4	333.6	234.0
mean	24.2	22.6	26.0	25.0
meanCZ	18.7	17.4	24.6	25.0
ME	-6.3	-7.6	-0.3	
MAE	14.1	14.8	16.2	

22.07.1998 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	156.2	138.4	45.8	204.0
maxCZ	156.2	138.4	45.8	204.0
mean	6.0	5.9	0.9	5.5
meanCZ	7.9	7.2	0.9	5.5
ME	2.4	1.8	-4.6	
MAE	8.3	8.0	5.3	

07.07.2001 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	208.0	209.1	115.1	106.0
maxCZ	164.3	175.0	115.1	106.0
mean	17.4	16.8	8.3	11.6
meanCZ	14.7	16.5	11.4	11.6
ME	3.1	4.9	-0.2	
MAE	9.7	10.6	10.9	

20.07.2001 – MIXED

mm/24h	E.int	E.40	E.20c	gauges
max	201.5	276.8	296.3	141.0
maxCZ	163.6	276.8	131.9	141.0
mean	25.5	24.4	18.4	27.2
meanCZ	27.4	26.5	21.0	27.2
ME	0.3	-0.7	-6.2	
MAE	12.6	20.4	14.1	

15.07.2002 – CONVECTIVE

mm/24h	E.int	E.40	E.20c	gauges
max	183.6	156.4	87.9	172.0
maxCZ	140.8	138.5	76.8	172.0
mean	3.3	3.9	1.4	1.5
meanCZ	2.5	3.5	1.6	1.5
ME	1.0	2.0	0.1	
MAE	3.6	4.4	2.7	

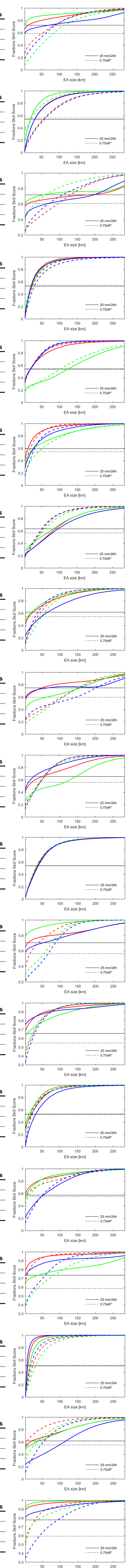
07.08.2002 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	212.6	173.7	129.0	181.1
maxCZ	212.6	153.0	108.5	181.1
mean	11.2	11.0	4.6	15.1
meanCZ	8.5	9.3	3.4	15.1
ME	-6.6	-5.8	-11.7	
MAE	10.9	11.6	12.8	

12.08.2002 – STRATIFORM

mm/24h	E.int	E.40	E.20c	gauges
max	266.1	284.1	251.6	221.0
maxCZ	196.7	224.7	241.7	221.0
mean	31.3	32.4	34.5	37.4
meanCZ	35.4	40.1	42.3	37.4
ME	-2.0	2.7	4.9	
MAE	18.4	16.0	24.5	

Fractions Skill Score

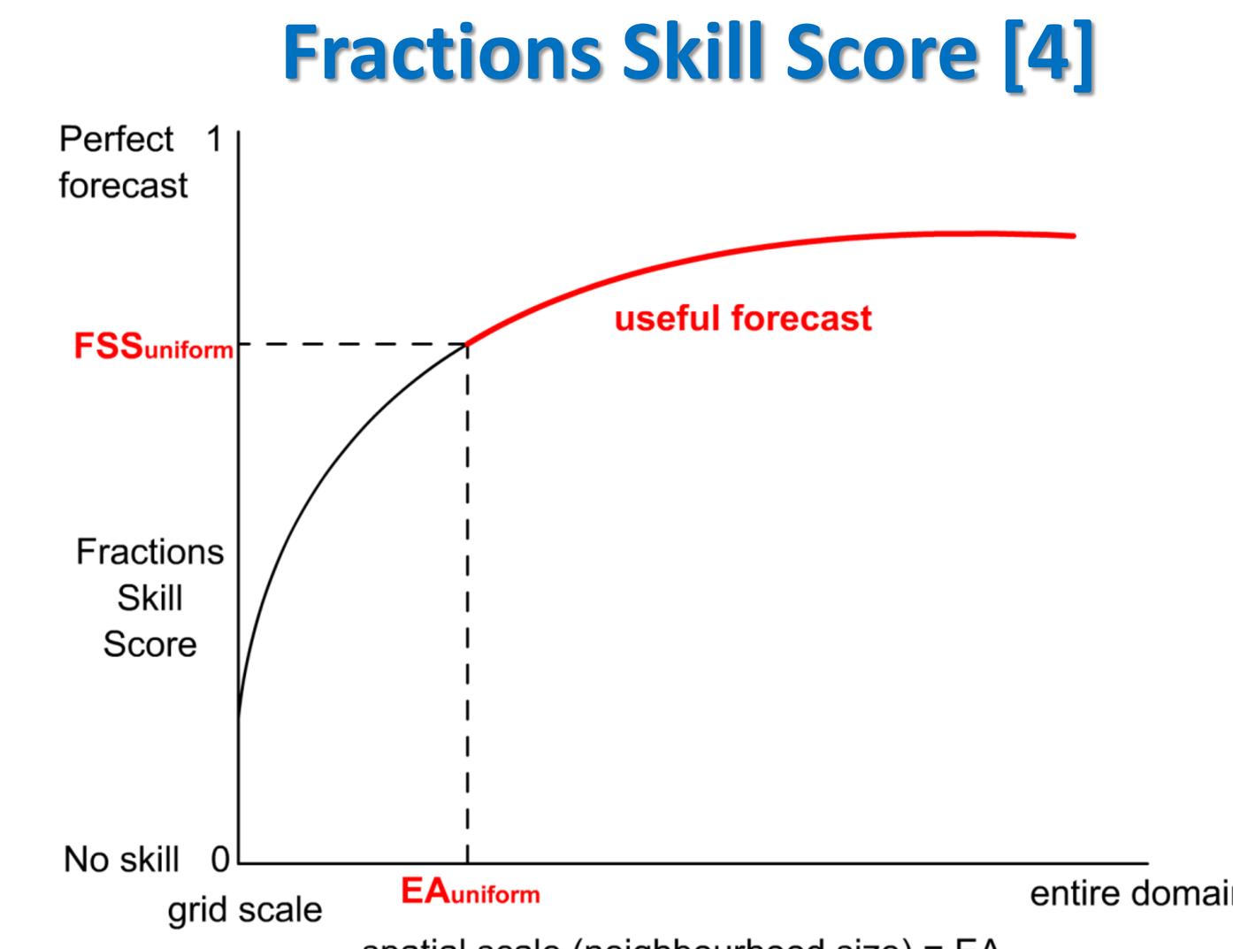


(II) Re-forecast of precipitation by COSMO model

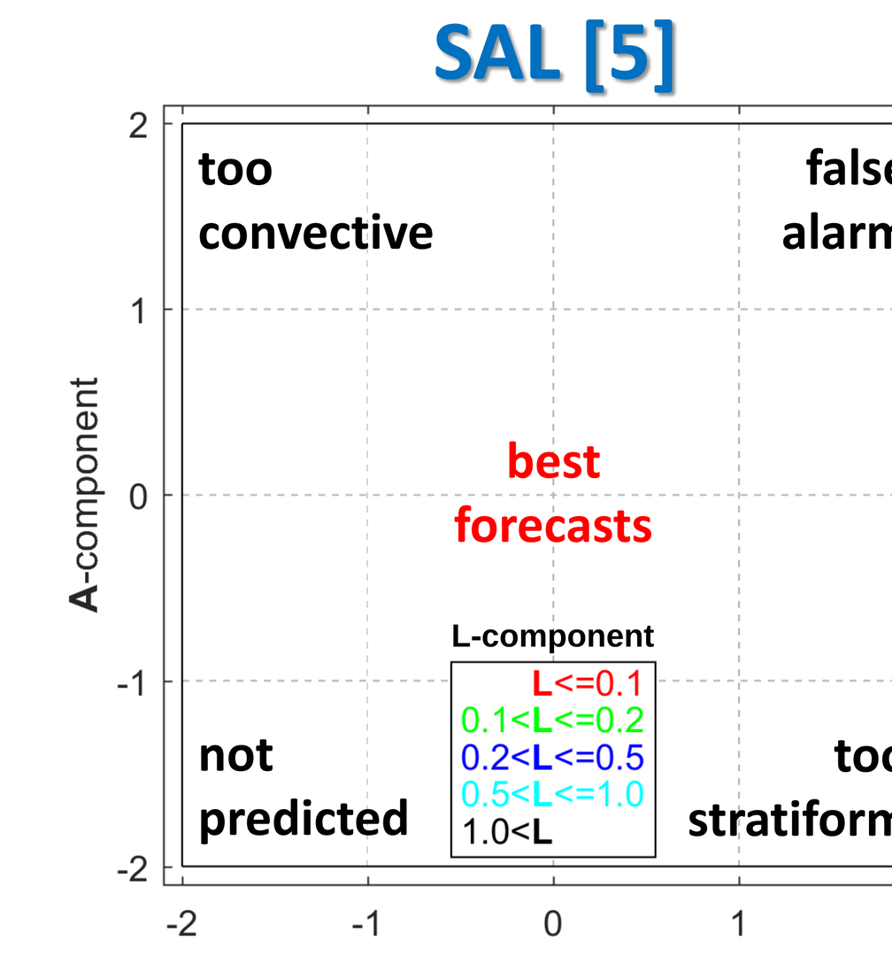
- IC+LBC
  - **ERA-Interim** [1]
  - **ERA 40** [2]
  - **ERA-20c** [3]
- Hor. resolution 2.8 km
- Time step 20 s
- Param. of deep convection
  - switched off

(III) Verification methods

Fractions Skill Score [4]



SAL [5]



Standard Errors [6]

- **M**ean **E**rror (forecast-measurement)
- **M**ean **A**bsolute **E**rror

Contingency table [6]

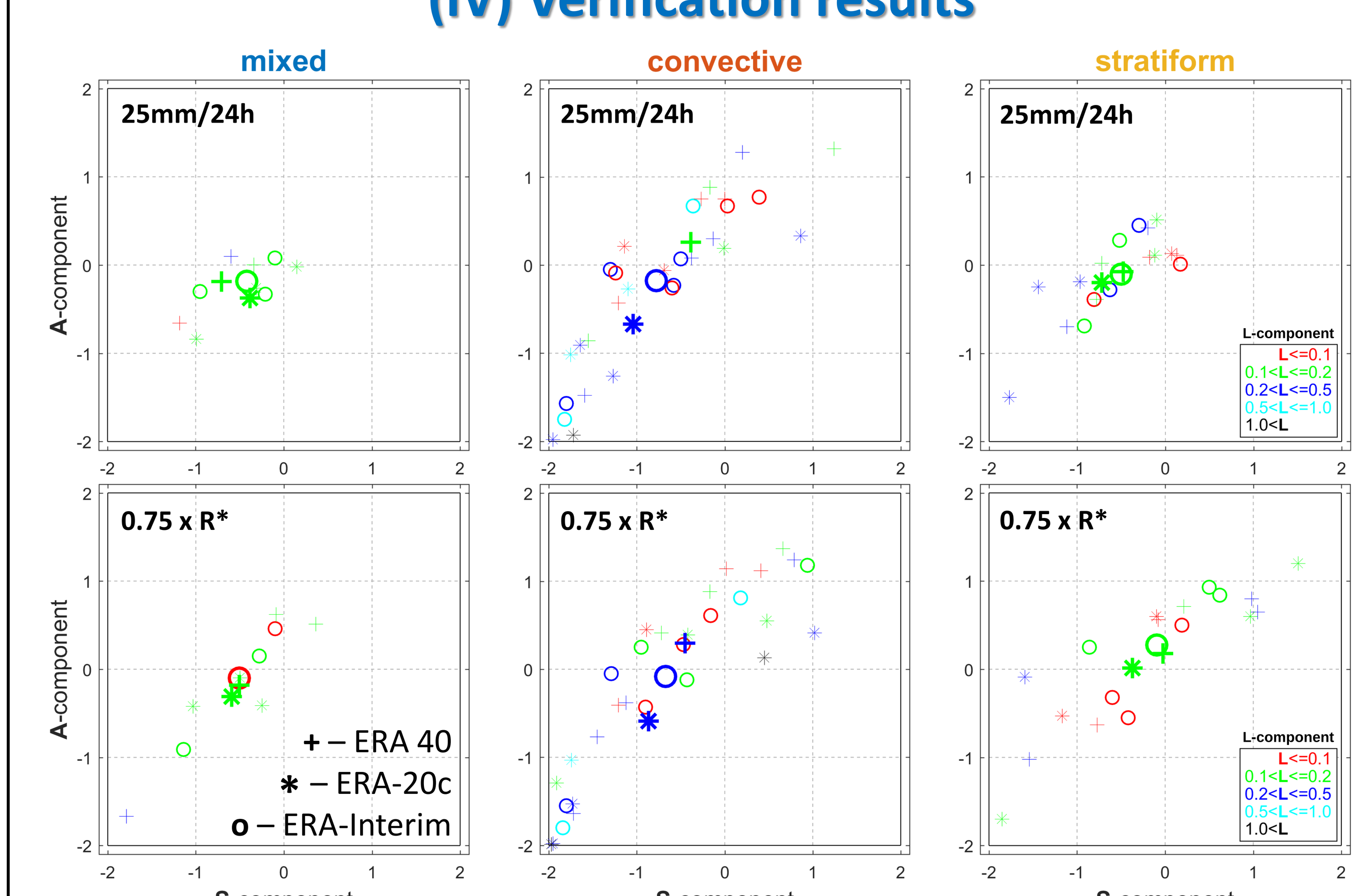
Skill Scores

- **P**robability **O**f **D**etection
- **F**alse **A**larm **R**ate

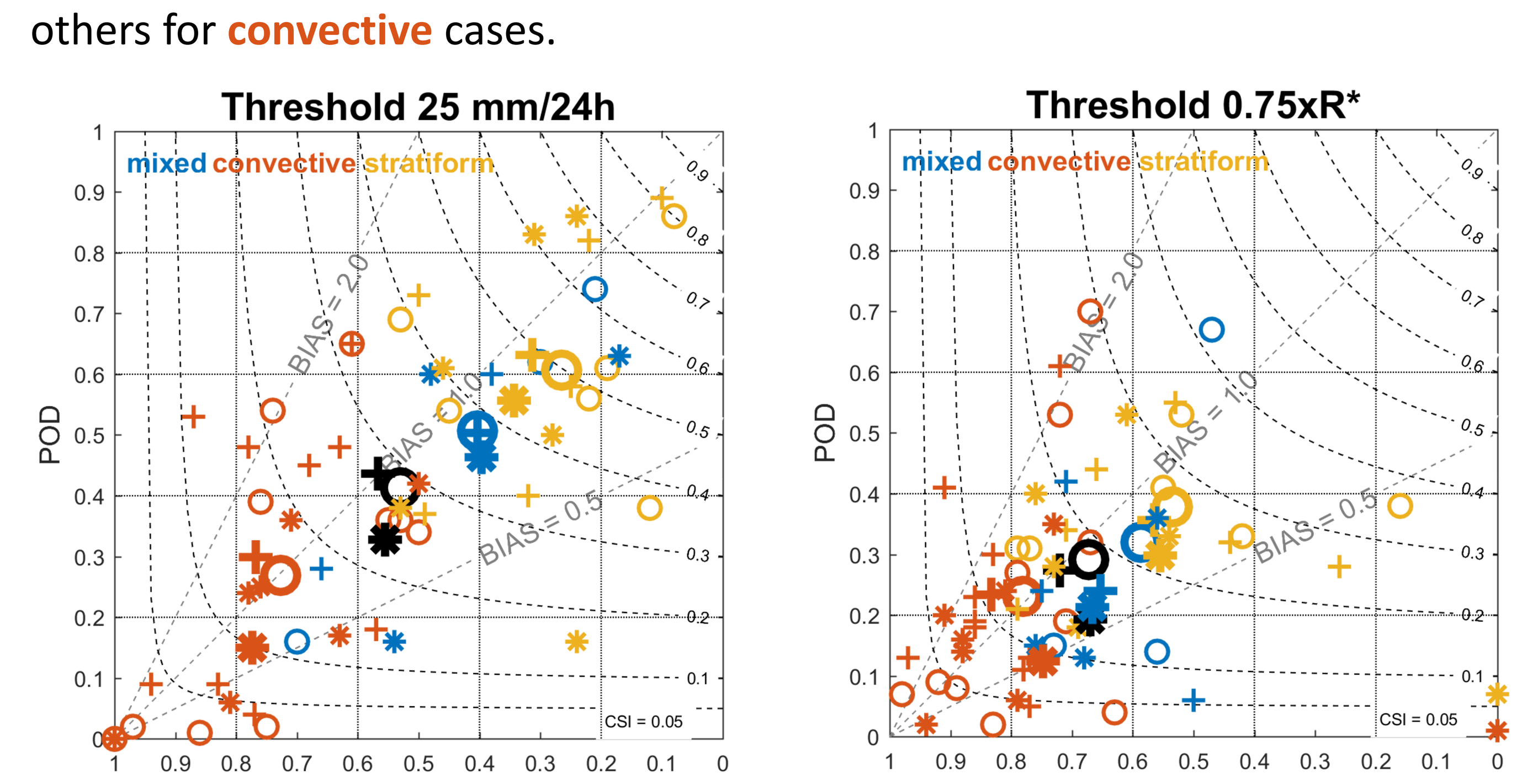
Verification Thresholds

- Fixed – **25mm/24h** and varying – **0,75 x R***
- R* - 95th percentile of each grid with measured precipitation

(IV) Verification results



SAL – big bold markers are averages over each reanalysis. Stratiform and mixed cases are better than convective cases, ERA-Interim (**o**) is better than others for convective cases.



SS from Cont. Table – big bold markers are averages over each reanalysis, big black marker is an average over all forecast of each reanalysis. Stratiform and mixed cases are better than convective cases, almost zero differences among runs with different driving reanalysis.

(V) Results

Average precipitation (Mean Error) – forecasts based on ERA-20c „have a big spread" – often closest to gauges and often farthest than other forecasts.

Mean Absolute Error – forecasts based on ERA-Interim better than others.

SS from Cont. Table – stratiform and mixed cases are better than convective.

FSS – forecasts based on ERA-20c worse than others especially for stratiform.

SAL – stratiform and mixed cases are better than convective cases, ERA-Interim better than others for convective cases.

Forecasts based on ERA-Interim are better than forecasts based on ERA 40 and ERA-20c mainly in localization (L-component and FSS)and also for convective cases. ERA-20c „have a big spread" – often closest and often farthest to gauges than other forecasts.

References

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