PERSISTENCY AS A REFERENCE IN VERIFICATION OF FORECAST WITH CATEGORICAL PREDICTANDS

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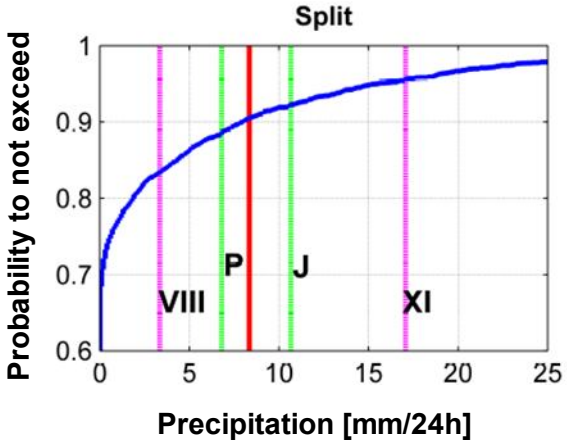
INTRODUCTION

- „Good forecast" – what does it mean?
  - Quality, consistency and value
- Finley affair
- Verification of the precipitation forecast (24h accumulation):
  - ALADIN regional model (2008.-2011.)
    8 km horizontal resolution, 37 vertical levels,
    boundary conditions from ARPEGE global model
  - ECMWF global model (2007.-2011.)
    0.25° horizontal resolution, 62 vertical levels
  - Locations: Rijeka, Split, Zagreb, Osijek

METHODS

- Precipitation- categorical predictand
- 3 categories
- Thresholds: 0.2 mm and 66. percentile
- Contingency tables



		OBSERVATIONS			
		DRY	LIGHT	HEAVY	∑
FORECAST	DRY	A	B	C	D
	LIGHT	E	F	G	H
	HEAVY	I	J	K	L
	∑	M	N	O	P

VERIFICATION MEASURES:

- Climatological probability: $P_d = \frac{M}{P}; \quad P_l = \frac{N}{P}; \quad P_h = \frac{O}{P}$
  - Based only on observations
- Accuracy (Percent Correct): $ACC = \frac{A + F + K}{P} * 100\%$
  - Influence of P
- Frequency bias:
  - < or > 1? $FBIAS_d = \frac{D}{M}; \quad FBIAS_l = \frac{H}{N}; \quad FBIAS_h = \frac{L}{O}$

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Verification Measures

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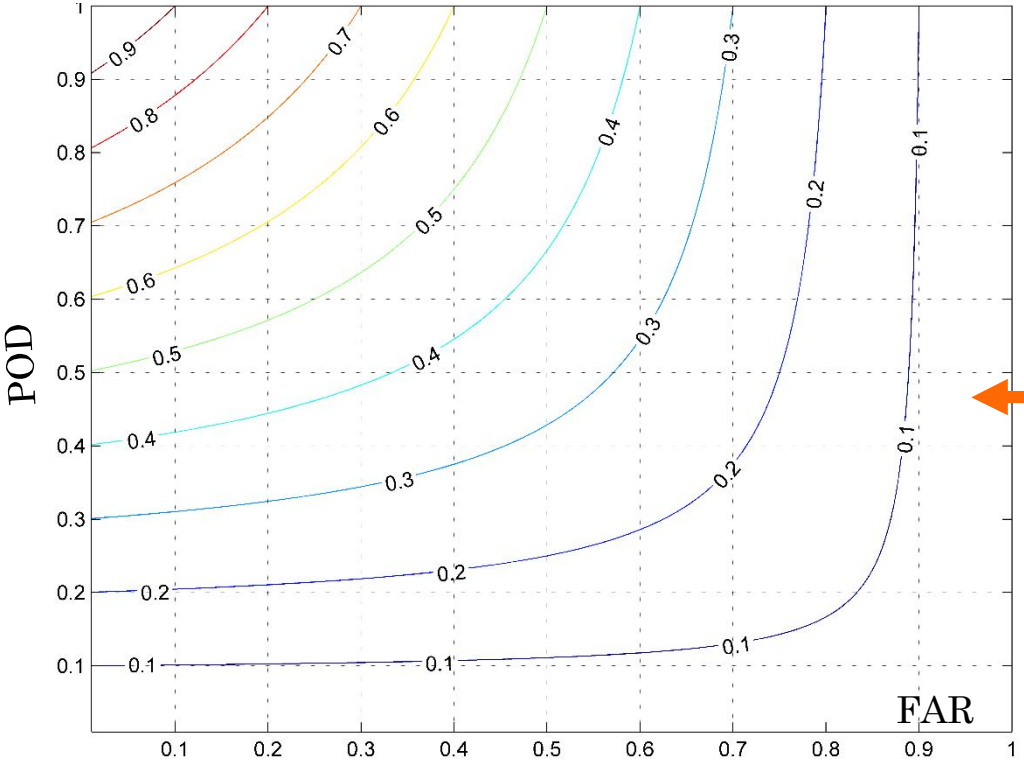
- Critical Success Index:

$$CSI_{\mathrm{d}} = \frac{A}{D + M - A}; \quad CSI_{\mathrm{l}} = \frac{F}{H + N - F}; \quad CSI_{\mathrm{h}} = \frac{K}{O + L - K}$$

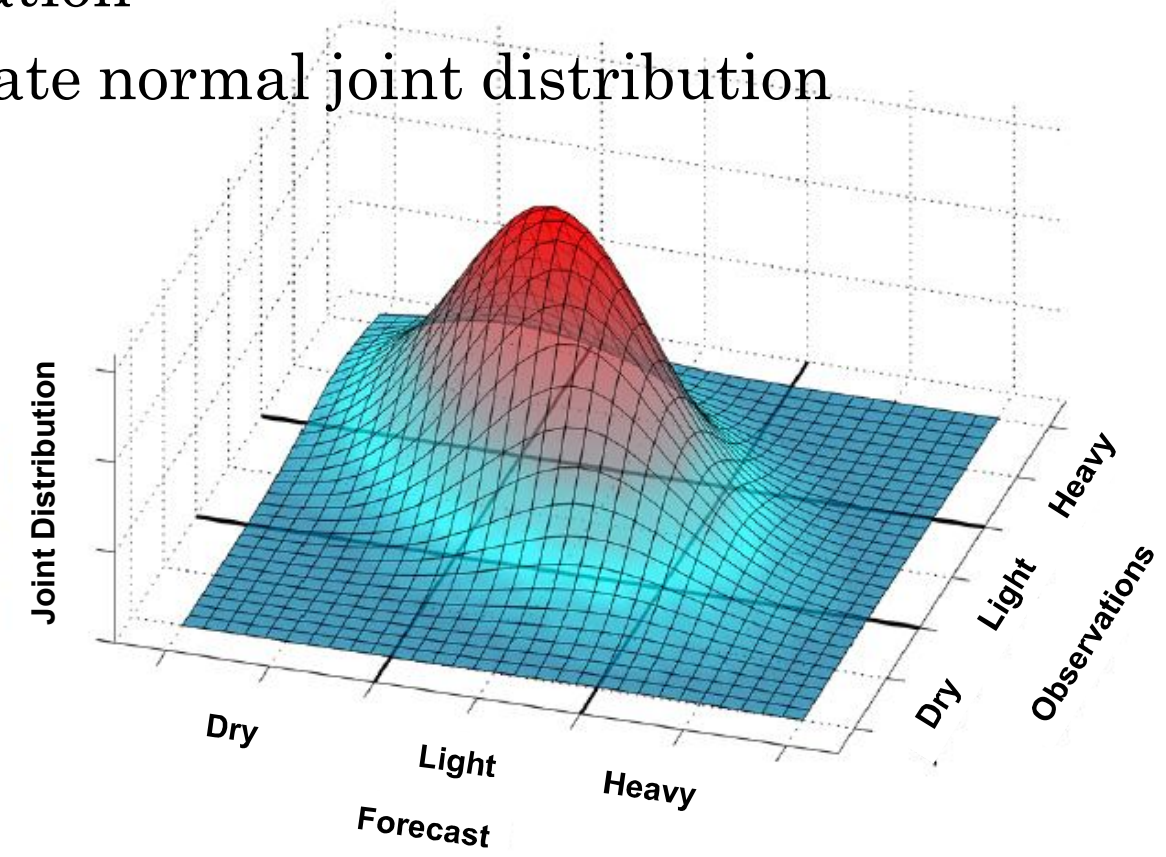


- Measure of relative accuracy:

$$CSI = \frac{1}{\frac{1}{(1 - FAR)} + \frac{1}{POD} - 1}$$

Verification Measures:

- Polychoric Correlation Coefficient – measure of association
- Bivariate normal joint distribution



SKILL SCORES:

		OBSERVATIONS			
		DRY	LIGHT	HEAVY	$\sum$
FORECAST	DRY	A	B	C	D
	LIGHT	E	F	G	H
	HEAVY	I	J	K	L
	$\sum$	M	N	O	P

- General: $$SS = \frac{S_{prog} - S_{ref}}{S_{ideal} - S_{ref}}$$
- Random forecast as a reference:
  - Heidke Skill Score: $$HSS = \frac{A + F + K - \frac{MD + NH + OL}{P}}{P - \frac{MD + NH + OL}{P}}$$
  - Pierce Skill Score: $$PSS = \frac{A + F + K - \frac{MD + NH + OL}{P}}{P - \frac{M^2 + N^2 + O^2}{P}}$$

SKILL SCORES:

SEEPS:

- Error measured in 'probability space'
- Equitable (1-SEEPS)
- Scoring matrix
- Refinement

$$SM = \frac{1}{2}\begin{bmatrix} 0 & \frac{P}{P-M} & \frac{P}{O} + \frac{P}{P-M} \\ \frac{P}{M} & 0 & \frac{P}{O} \\ \frac{P}{M} + \frac{P}{P-O} & \frac{P}{P-O} & 0 \end{bmatrix}$$

$$SM = \begin{bmatrix} 0 & 0.752 & 1.315 \\ 1.494 & 0 & 0.546 \\ 5.922 & 4.429 & 0 \end{bmatrix}$$

		OBSERVATIONS			
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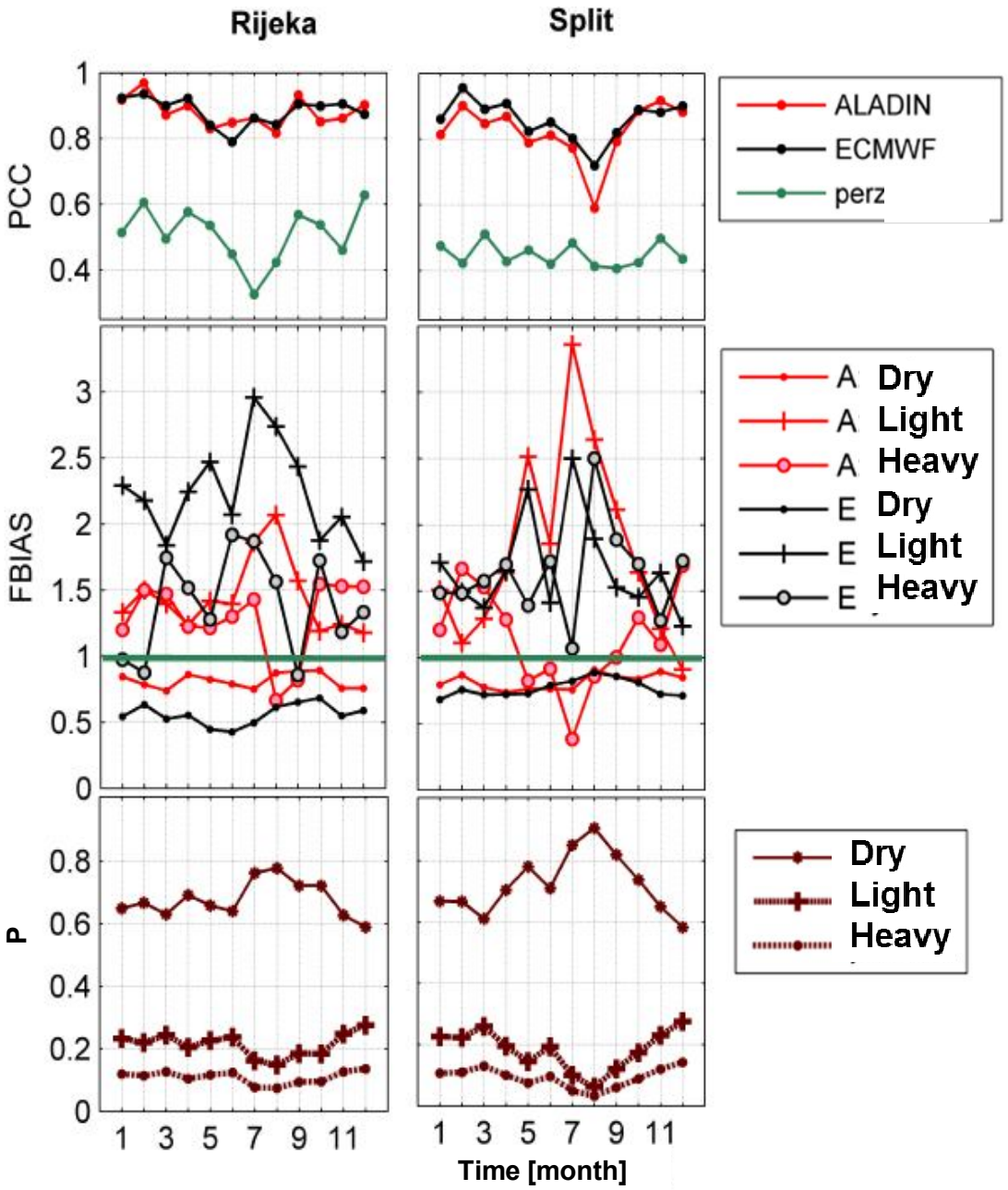
VERIFICATION



- 'Dry' – most probable
- Under-forecasting 'Dry'
- Over-forecasting 'Light' & 'Heavy'
- Drier – less associated

SKILL SCORES:

- Persistency as a reference:

$$pCSI_k = \frac{CSI_{model,k} - CSI_{perz,k}}{1 - CSI_{perz,k}}$$

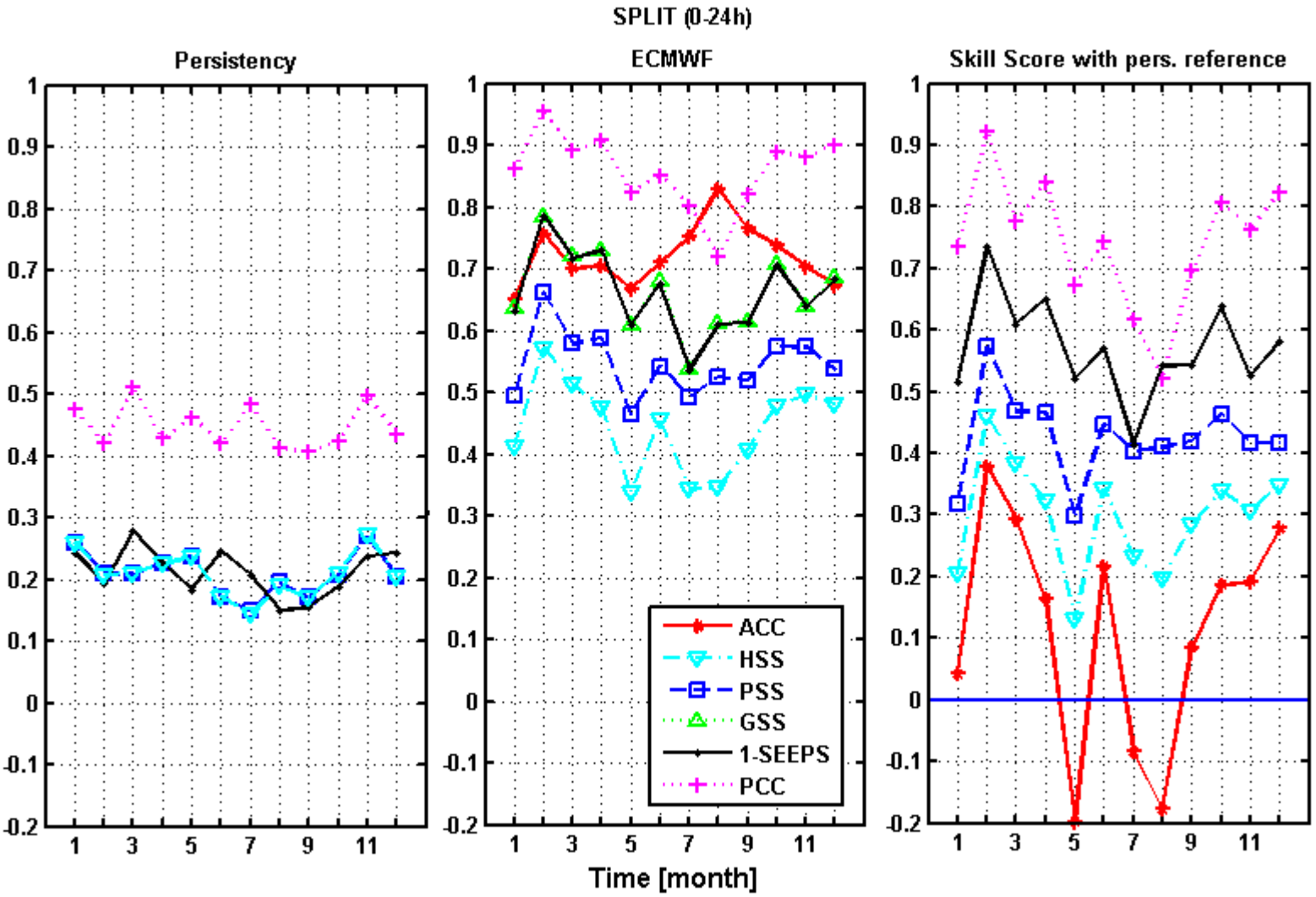
$$pPCC = \frac{PCC_{model} - PCC_{perz}}{1 - PCC_{perz}}$$

$$pHSS = \frac{HSS_{model} - HSS_{perz}}{1 - HSS_{perz}} \qquad pPSS = \frac{PSS_{model} - PSS_{perz}}{1 - PSS_{perz}}$$

Same for (1-SEEPS), GSS and any other….

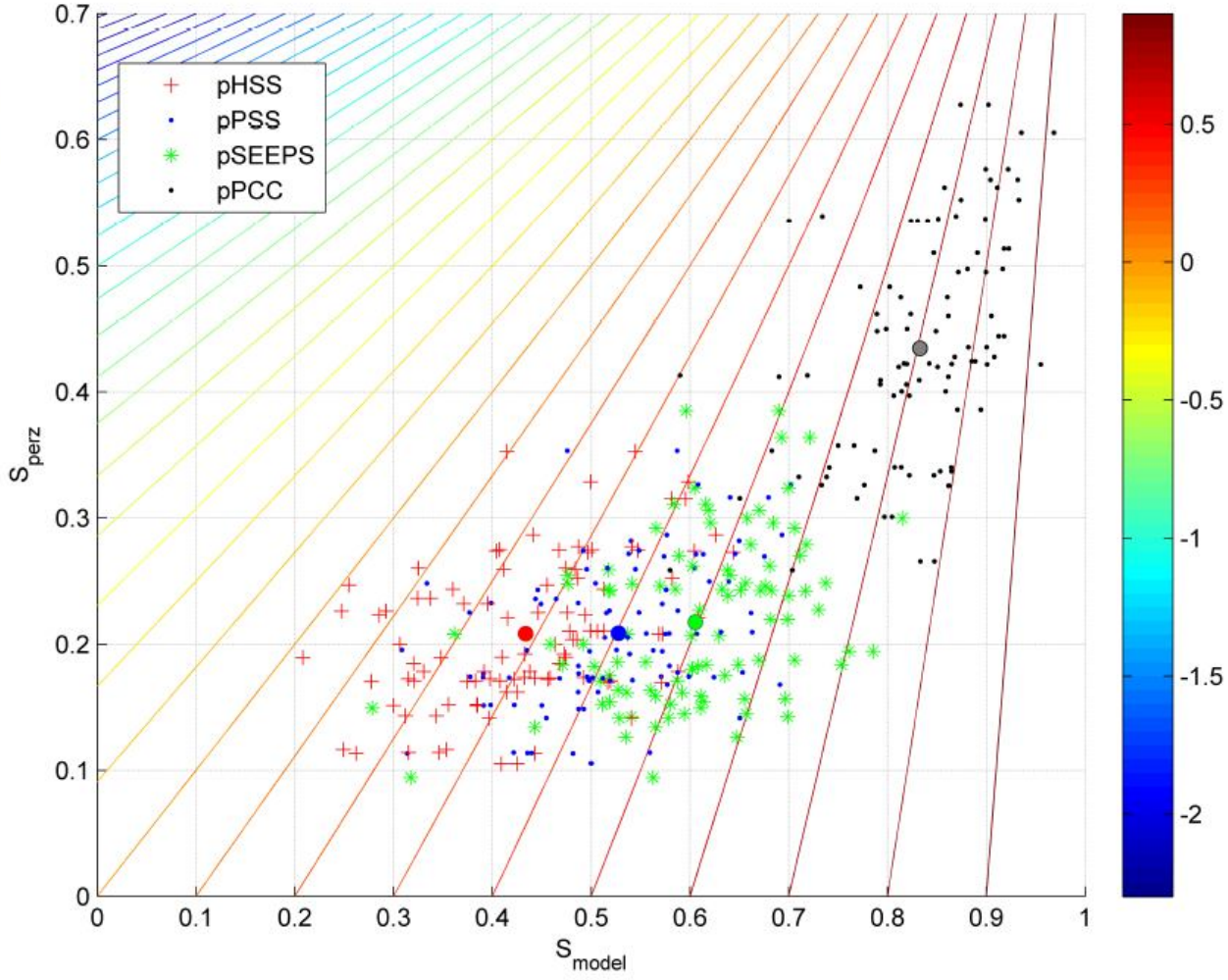
SKILL SCORES - PERSISTENCY AS A REFERENCE

- SS generally differ in size → pSS as well



Persistency as a reference:

$$SS = \frac{S_{prog} - S_{ref}}{S_{ideal} - S_{ref}}$$



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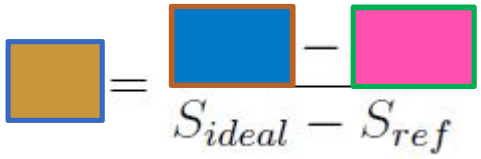
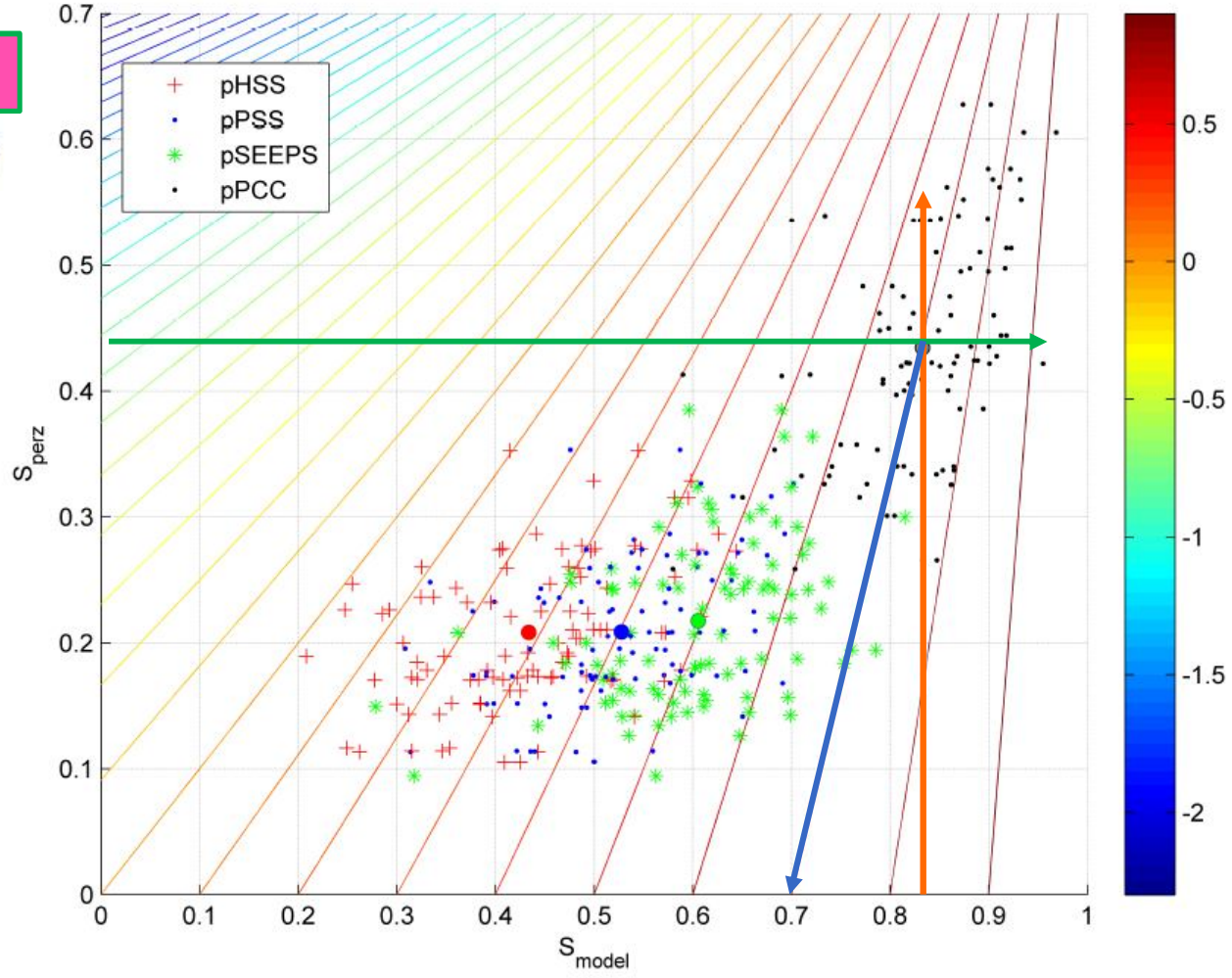
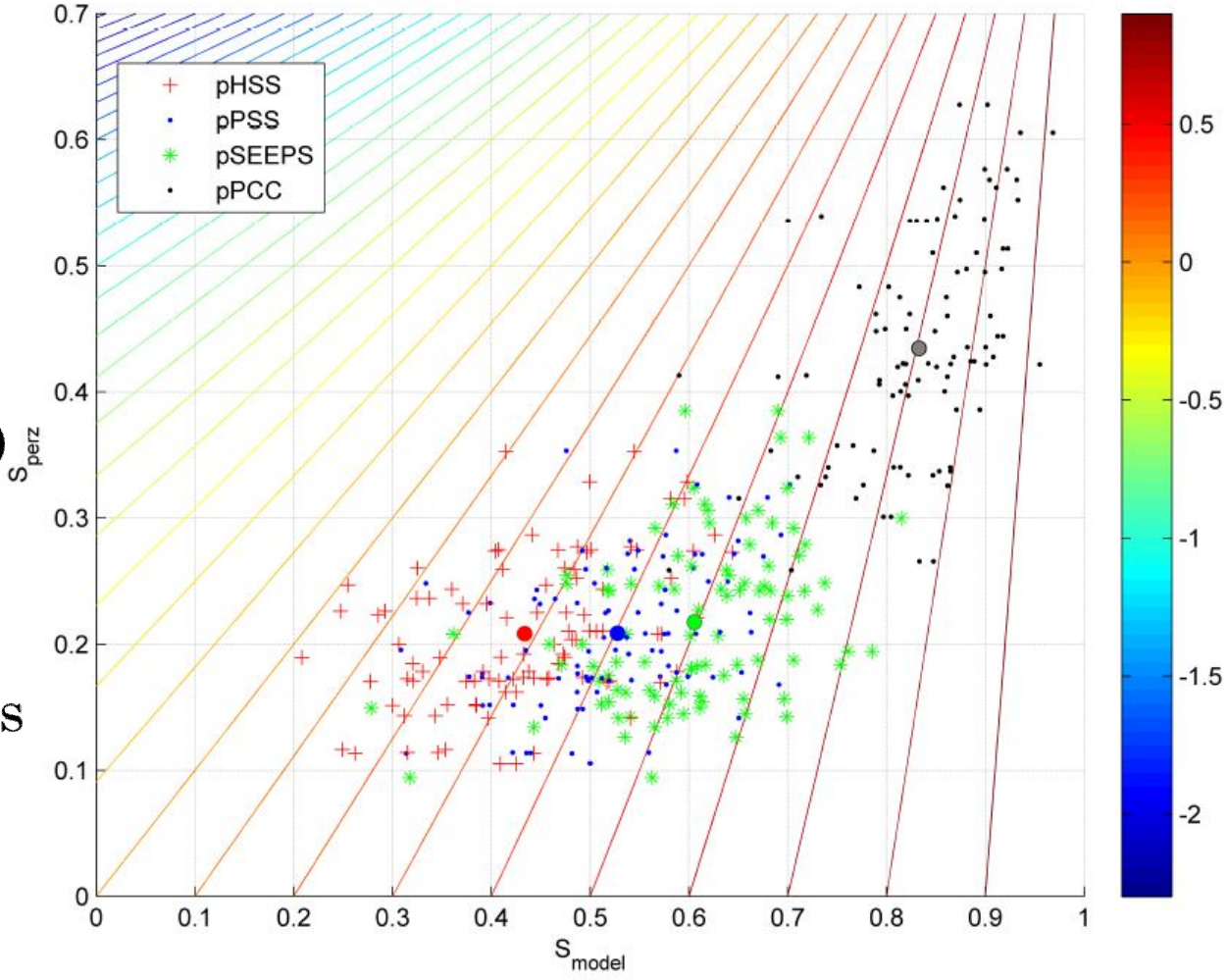




PERSISTENCY AS A REFERENCE:

$$SS = \frac{S_{prog} - S_{ref}}{S_{ideal} - S_{ref}}$$

- $\overline{HSS}$: low values biggest difference (0.14)
- $PSS, SEEPS$: less sensitive
- PCC: high values for persistency (0.12)



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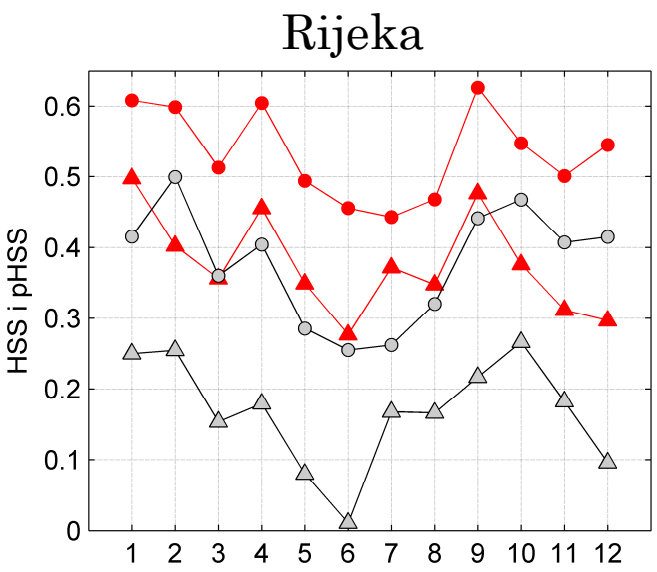
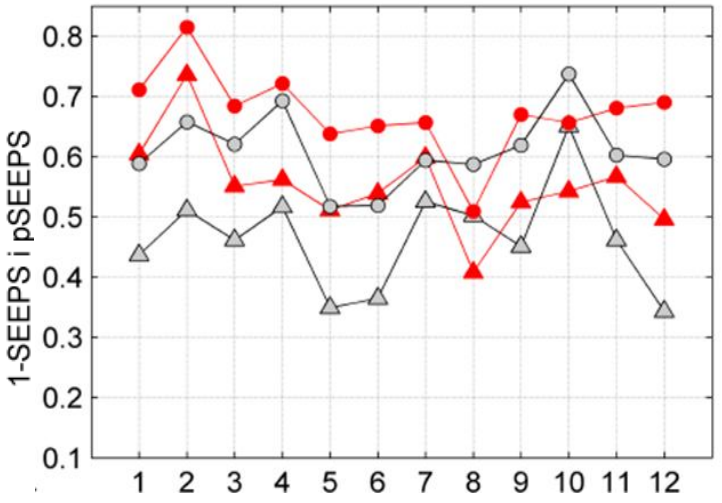
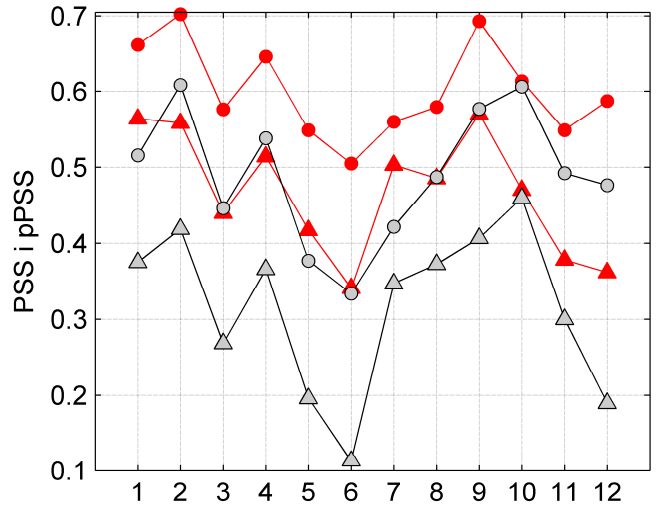
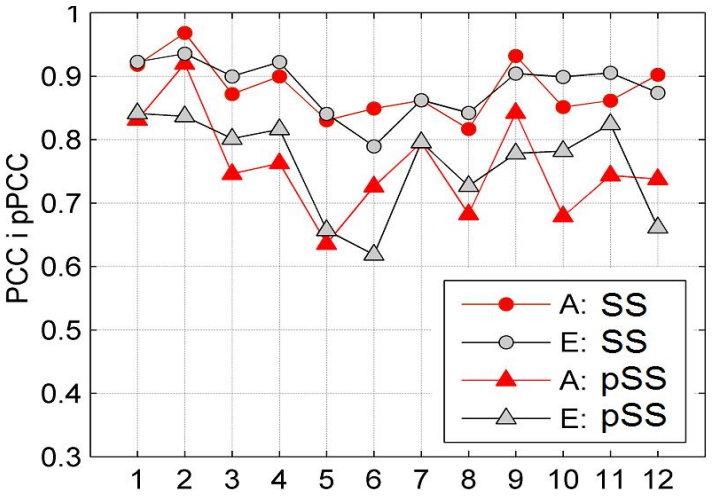






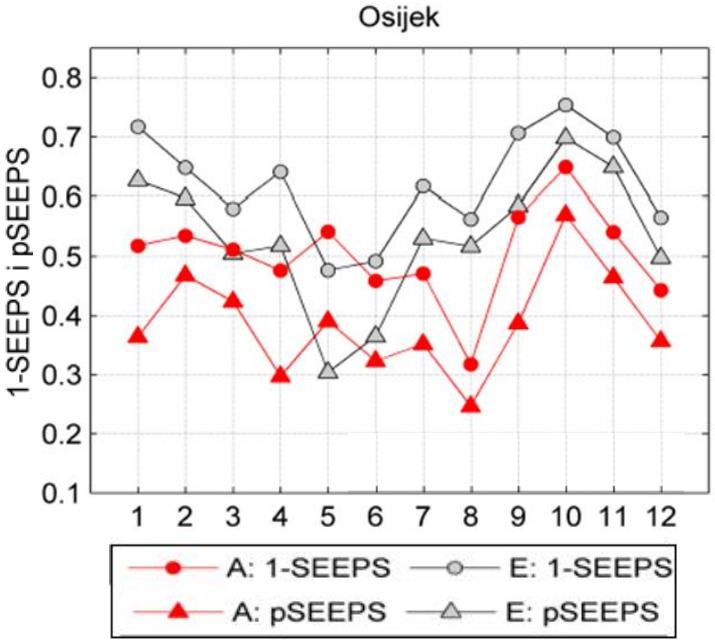


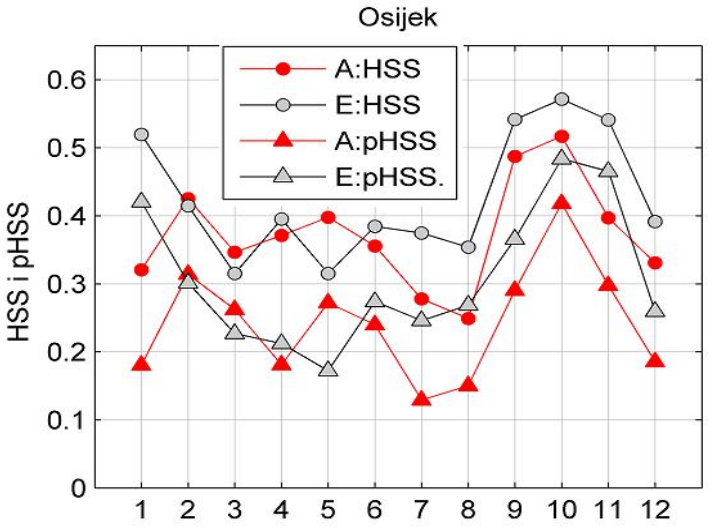
- Inheritance of original verification measure properties: pSS has similar shape, but smaller values, except for driest months (Jul, Aug)

- HSS_{perz} i PSS_{perz} larger ~ 0.06 for Aug than Jul → larger difference
- $HSS_{ALADIN} > HSS_{ECMWF}$ u Jan → larger difference SS and pSS

PERSISTENCY AS A REFERENCE:

- Inheritance of original verification measure properties

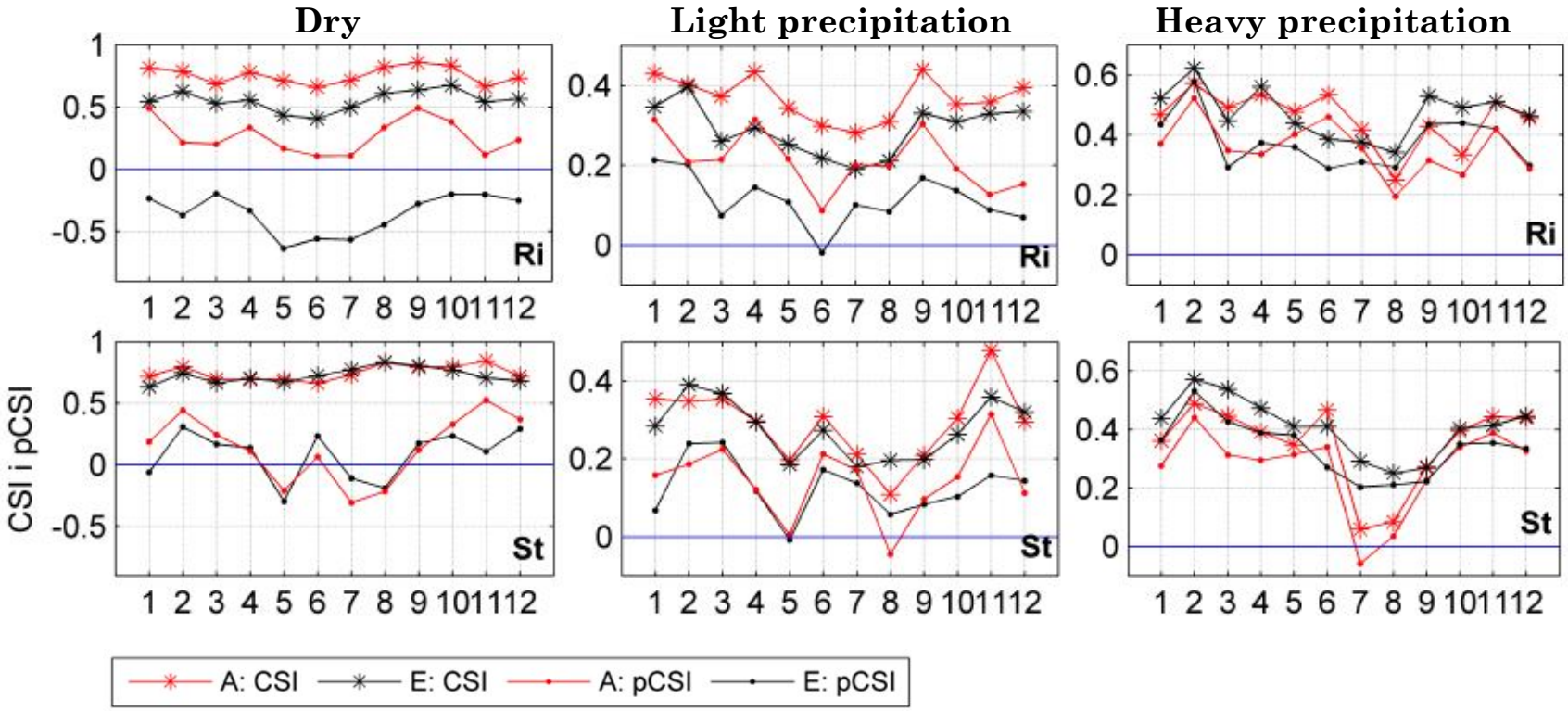




- Os (I.):
  PCC & CSI (E) > PCC & CSI (A)
  (for ∀categ.)
  → larger $(1 - SEEPS)$ & HSS

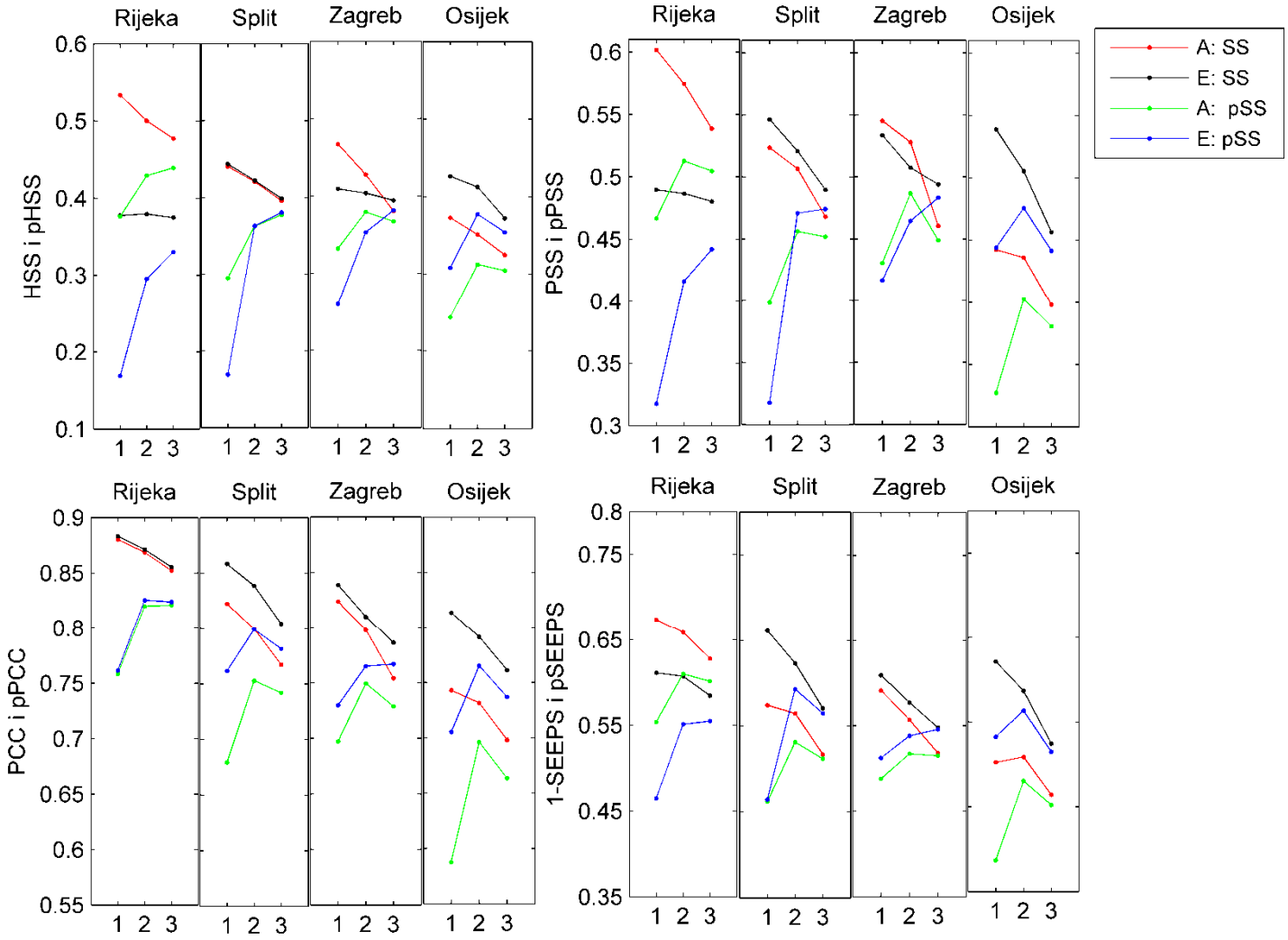
- Os (III.): ≈ PCC i $CSI_{umj.}$
  CSI_{dry}: ALADIN > ECMWF (0.13)
  CSI_{heavy}: ECMWF > ALADIN (0.06)
  → larger $(1 - SEEPS)$ for ECMWF
  → smaller HSS

PERSISTENCY AS A REFERENCE:



- Biggest difference between SS and pSS for climatologically most probable category ('Dry')
- For climatologically least probable category ('Heavy prec.') SS and pSS are almost the same

DEPENDENCE ON LEAD TIME



- Reference: random forecast → SS monotonically decreases
  persistency → pSS has a maximum!!!

Conclusion

- Rare or extreme events → persistency as a reference makes more sense
- Comparison with persistency – pSS differs more for SS with smaller values (HSS)
- Mostly affects the most probable category (not rare events or extremes)
- Usually maintains the similar shape as measure it is derived from
- It inherits properties of original measure
- Has a specific dependency on lead time that has to be taken into consideration

Questions or suggestions?

Thank You!!!

POPIS LITERATURE

- **ALADIN Numerical Weather Prediction Project**, (2008.): http://www.cnrm.meteo.fr aladin-old
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