PERSISTENCY AS A REFERENCE IN DETERMINING RARE EVENT FORECASTING SKILL

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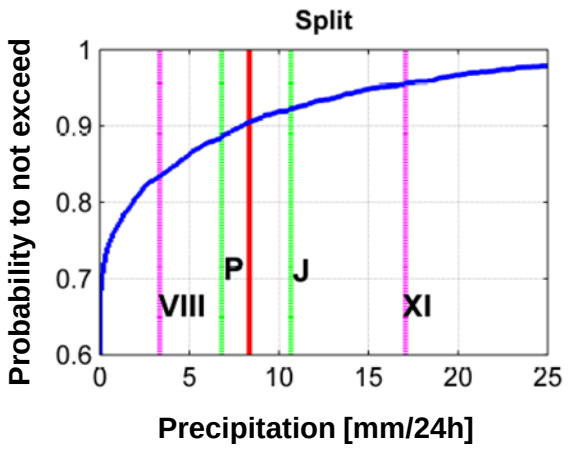
INTRODUCTION

- Verification: skill score
- Referent forecast:
  - Random chance, climatological mean, persistence
- Verification of the precipitation forecast (24h accumulation):
  - ALADIN regional model (2008.-2011.)
    8 km horizontal resolution, 37 vertical levels,
  - ECMWF global model (2007.-2011.)
    0.25° horizontal resolution, 62 vertical levels
  - Locations: Rijeka, Split, Zagreb, Osijek
- Categories:
  - Dry (< 0.2 mm / 24 h)
  - Light precipitation
  - Heavy precipitation



METHODS

- 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:
    $\mathbf{P_{dry} = M/P}$
  - Accuracy (Percent Correct):
    ACC = 100% * (A+F+K)/P
    perfect forecast: **(100%)**
  - Frequency Bias:
    $\mathbf{Fbias_{dry} = D/M}$ **(1)**
  - Critical Success Indeks (Threat Score):
    $\mathbf{CSI_{dry} = A/(D+M-A)}$ **(1)**
  - Polychoric Correlation Coefficient:
    PCC – measure of association **(1)**

METHODS

- Skill Score – random chance as referent forecast:
  - Heidke Skill Score: $\mathbf{HSS}=\frac{A+F+K-(MD+NH+OL)/P}{P-(MD+NH+OL)/P}$ **(1)**
  - Pierce Skill Score (True Skill Score, True Skill Statistic, Kuipers Skill Score): $\mathbf{PSS}=\frac{A+F+K-(MD+NH+OL)/P}{P-(M^2+N^2+O^2)/P}$ **(1)**
  - Stable Equitable Error in Probability Space: **(1-SEEPS)** **(1)**
- Skill score – persistence as referent forecast:

$$\mathbf{pSS}=\frac{SS_{model}-SS_{pers.}}{SS_{ideal}-SS_{pers.}}$$

  - **pCSI,**
  - **pPCC,**
  - **pHSS,**
  - **pPSS,**
  - **pSEEPS**

		OBSERVATIONS			
		DRY	LIGHT	HEAVY	∑
FORECAST	DRY	A	B	C	D
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	HEAVY	I	J	K	L
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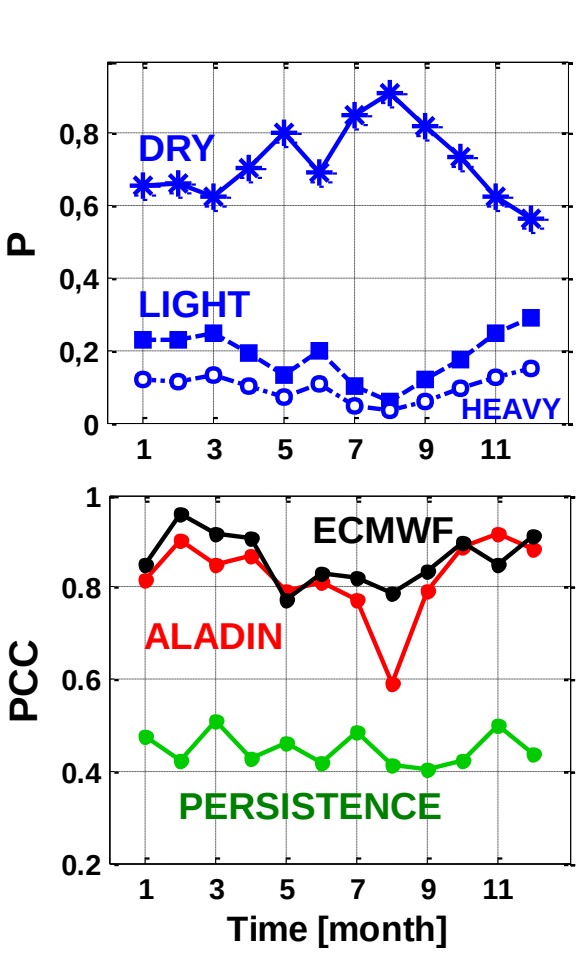
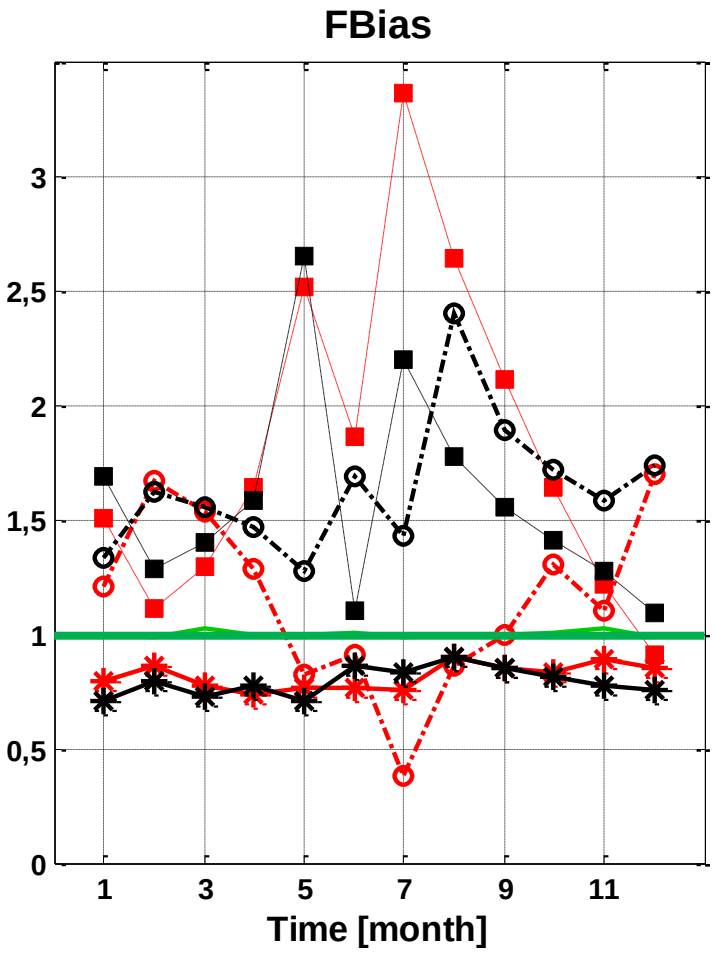
VERIFICATION: SPLIT

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

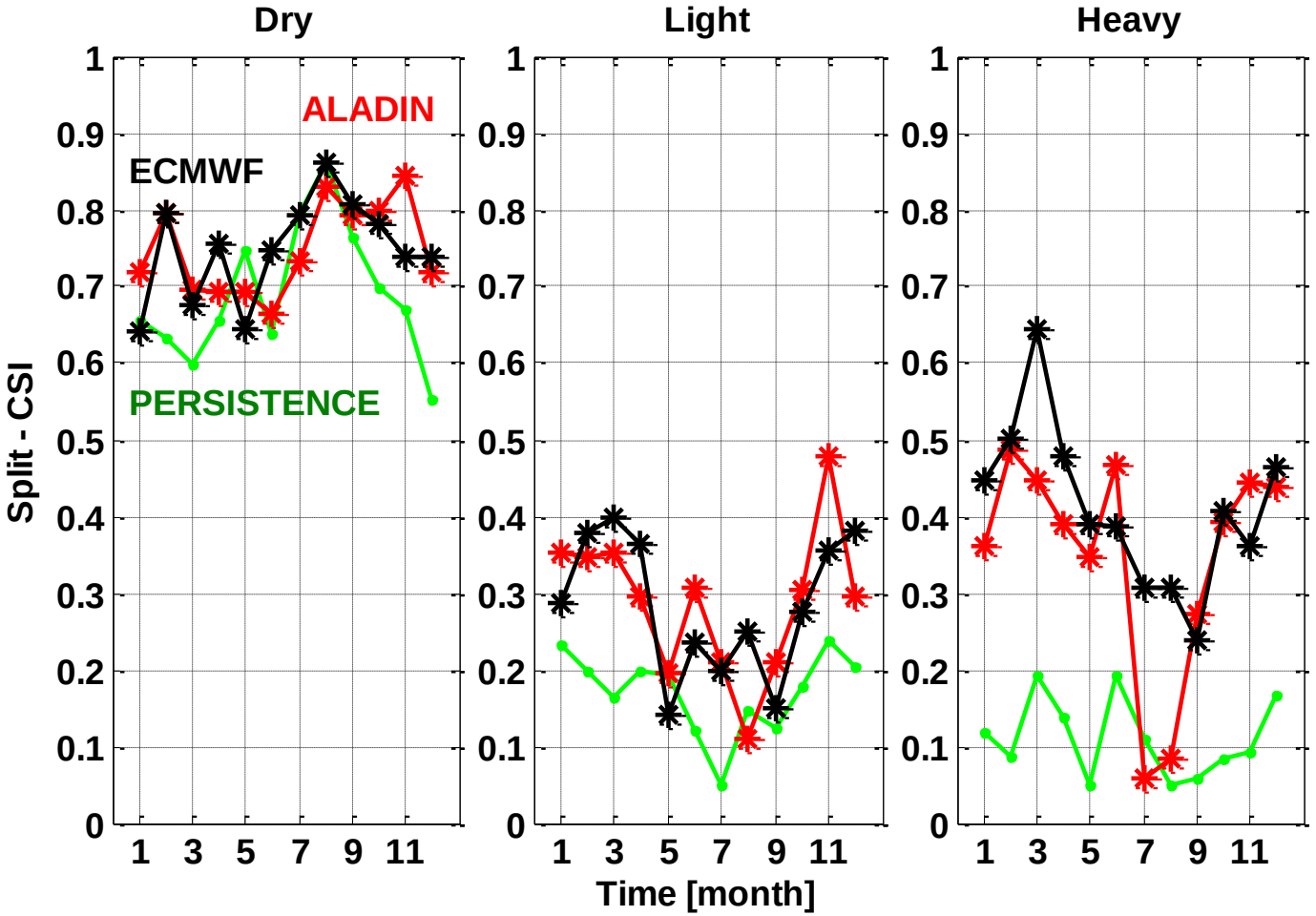




** Dry
■■ Light
○○ Heavy

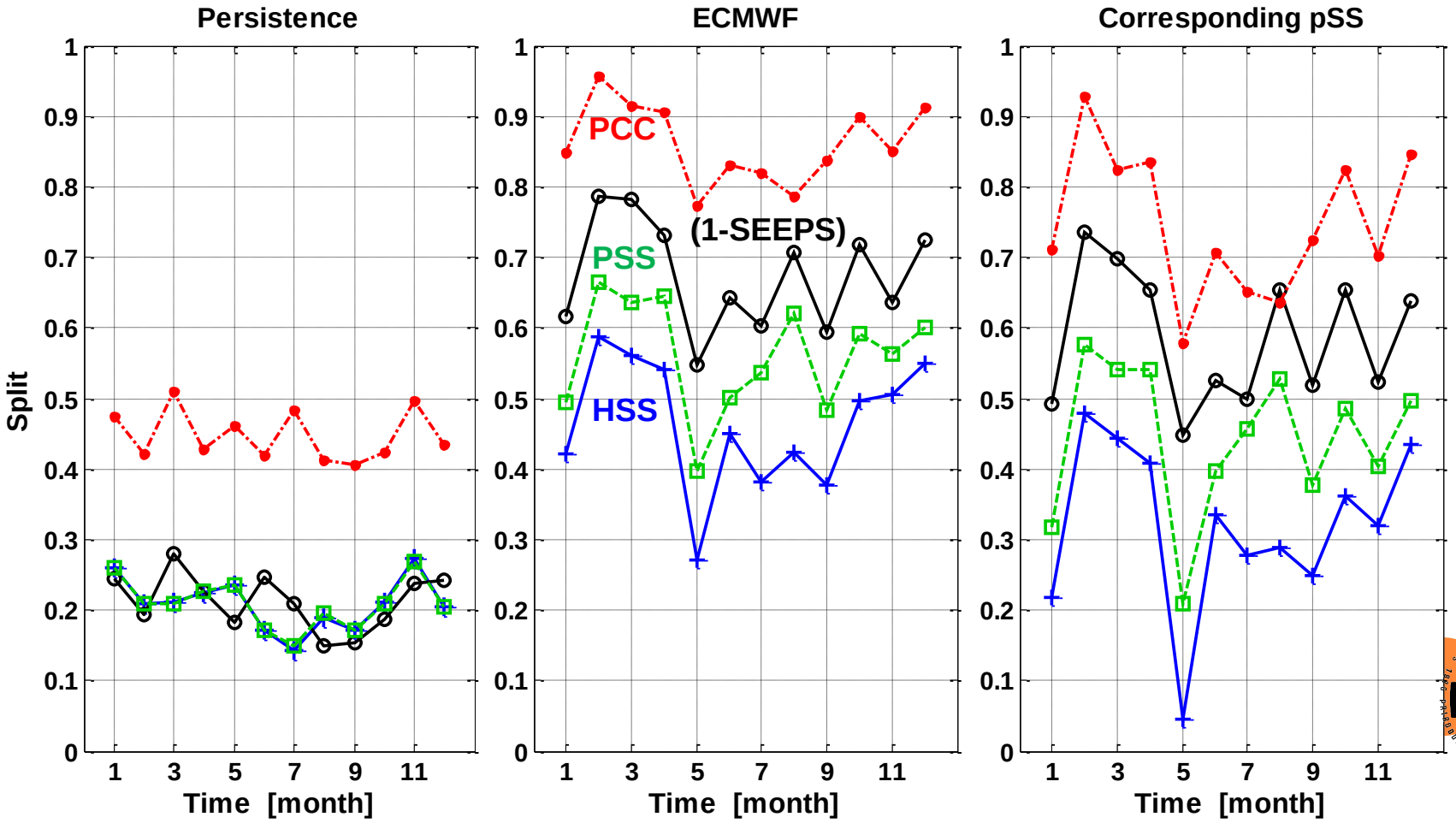
VERIFICATION: SPLIT

- CSI:
  - Highest for dominant category
  - Lowest for „Light precipitation” category



Skill Scores - Persistency as a reference

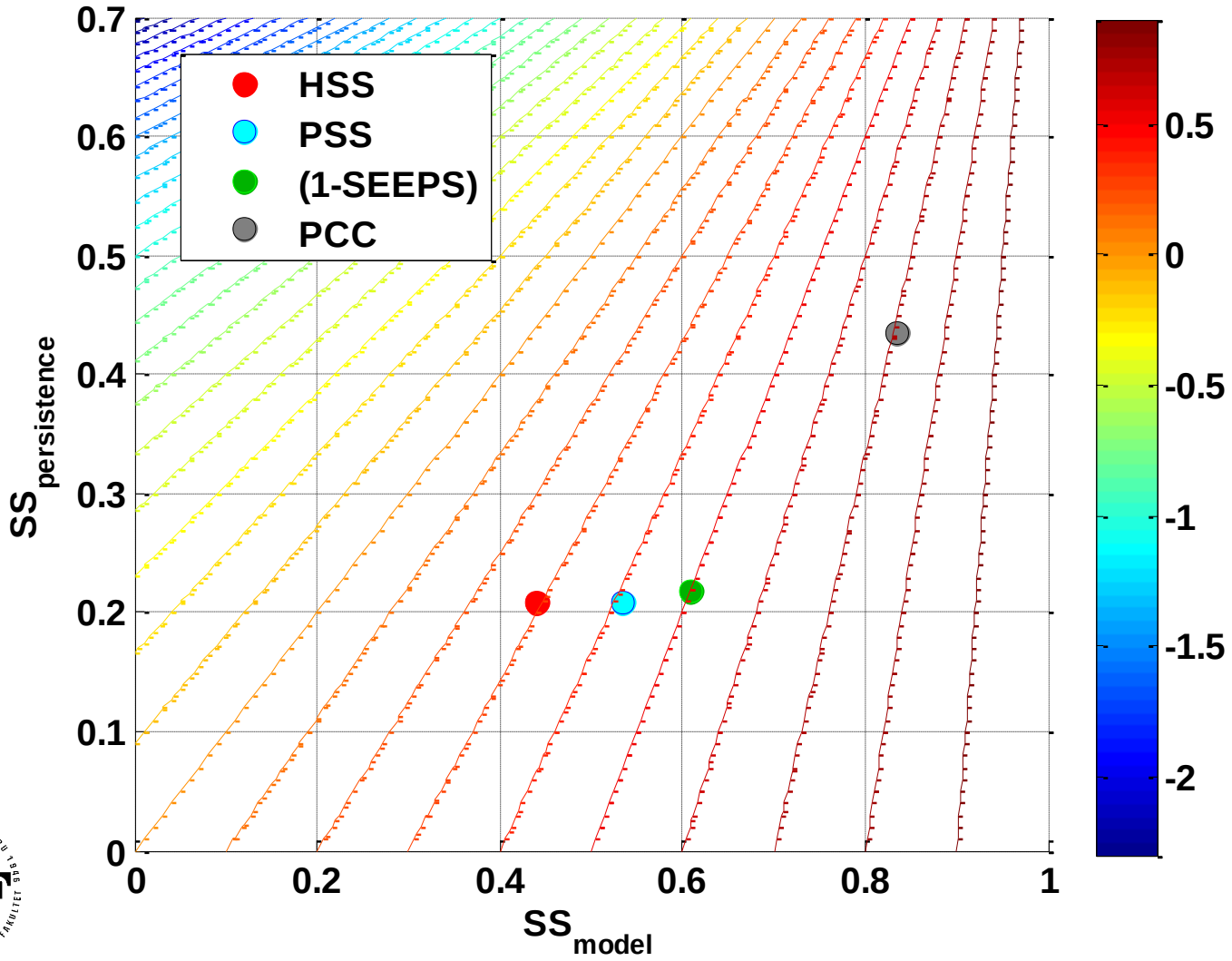
- SS generally differ in size → pSS as well
- Shape remains similar



PERSISTENCY AS A REFERENCE:

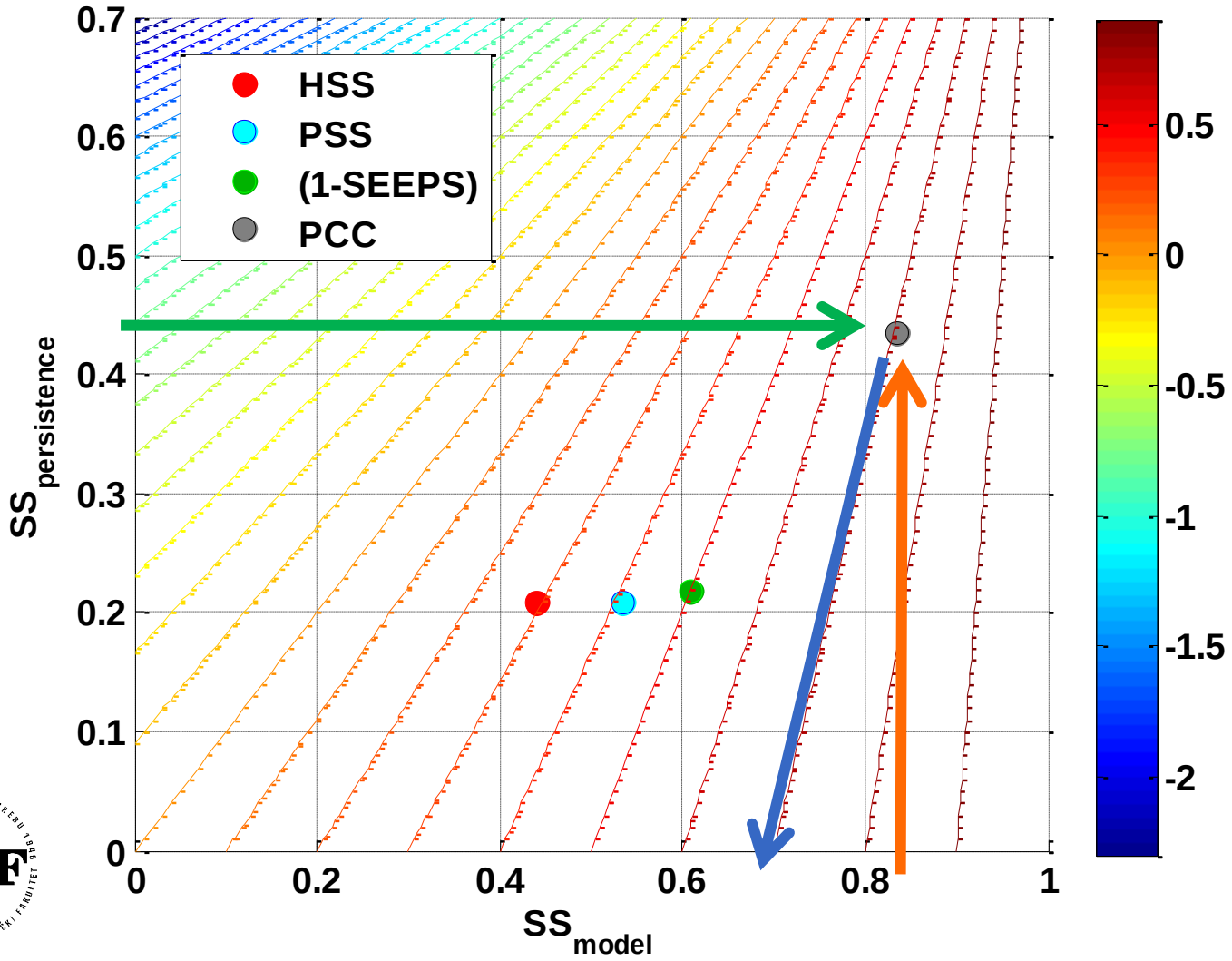
- Nomogram: contour lines for pSS

$$pSS=\frac{SS_{model}-SS_{pers.}}{SS_{ideal}-SS_{pers.}}$$

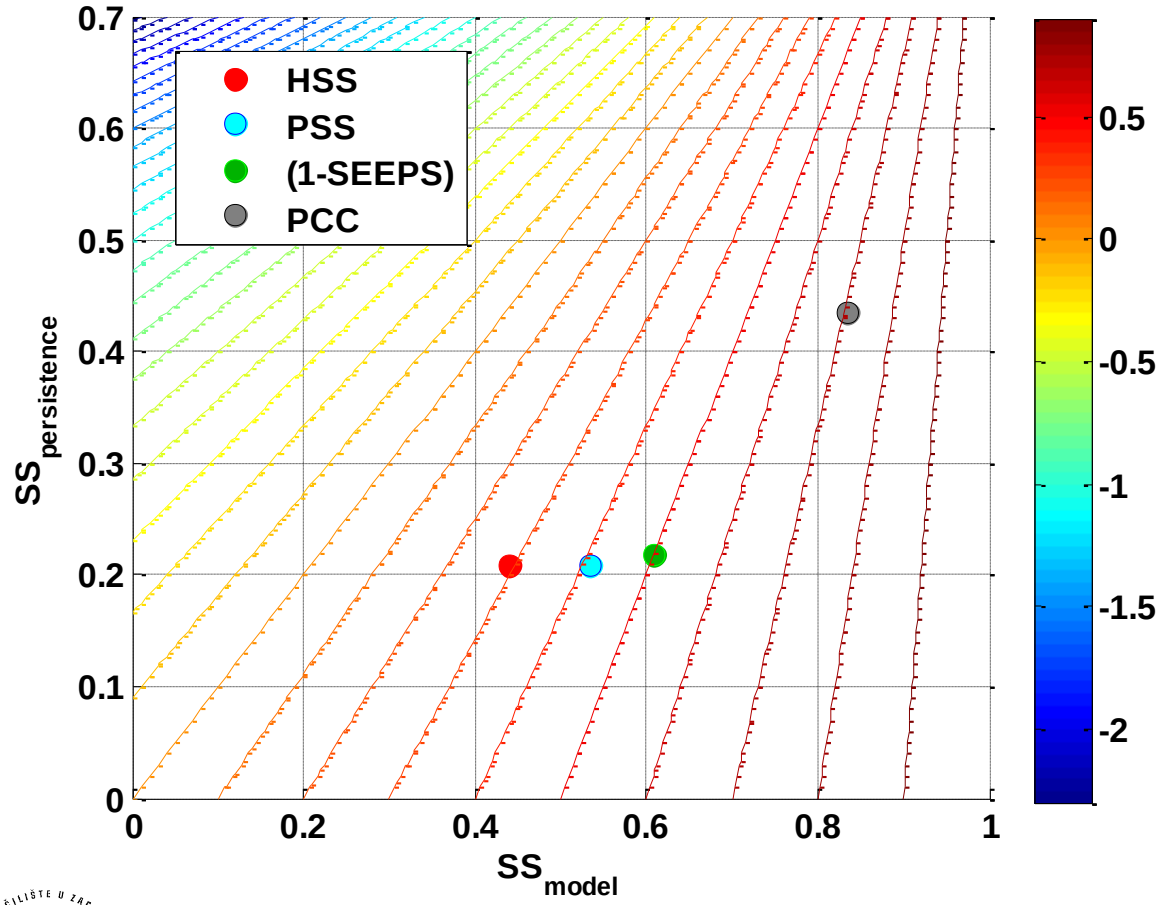


PERSISTENCY AS A REFERENCE:

$$pSS = \frac{SS_{model} - SS_{pers.}}{SS_{ideal} - SS_{pers.}}$$

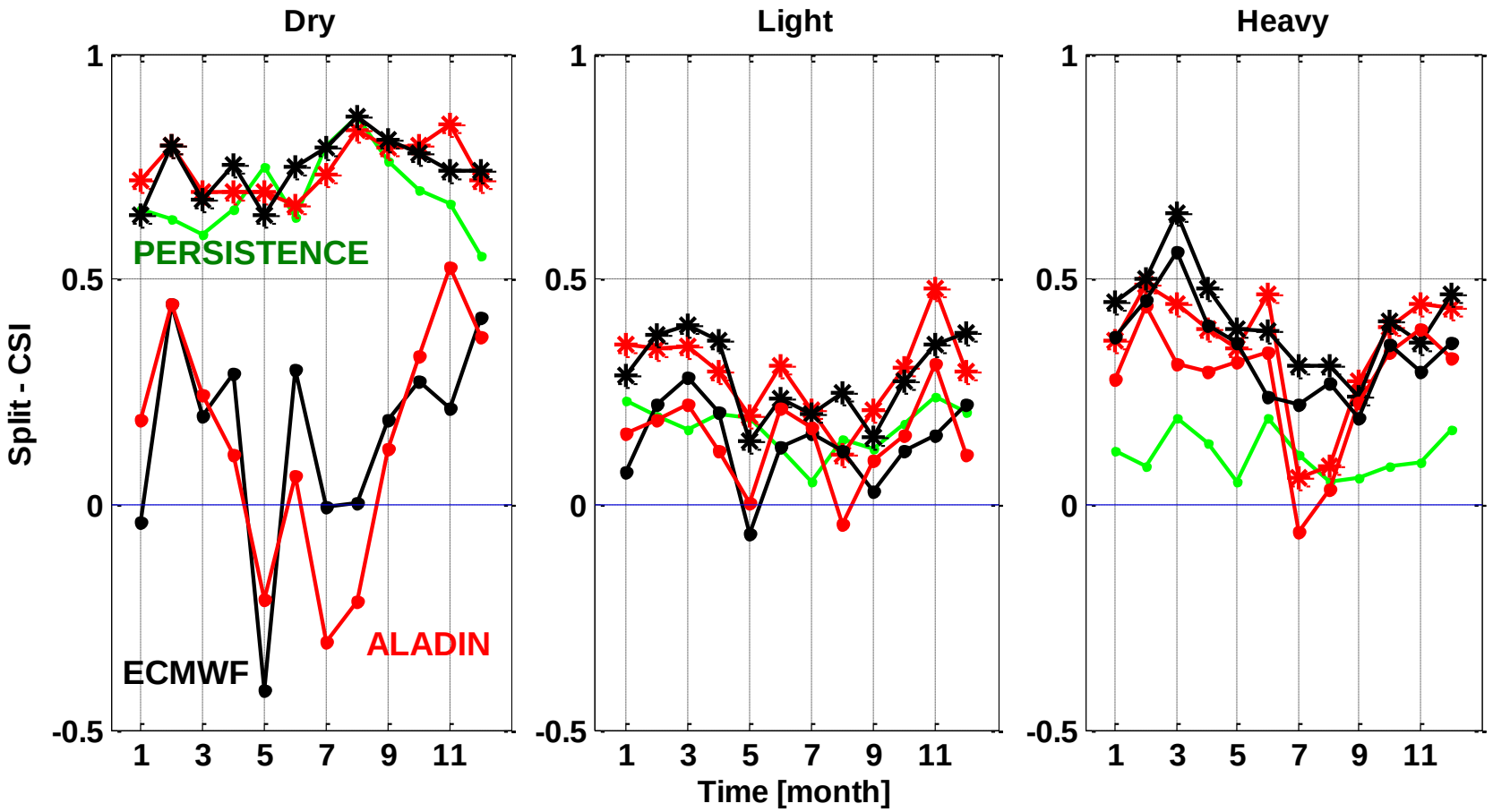


PERSISTENCY AS A REFERENCE:



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

PERSISTENCY AS A REFERENCE:



- Persistence CSI_{dry} larger in May than April → large difference
- CSI_{heavy}: in March ECMWF > ALADIN → larger difference SS and pSS
- Difference between *CSI* and *pCSI* :
  - largest in „Dry" category
  - Small in „Heavy" category

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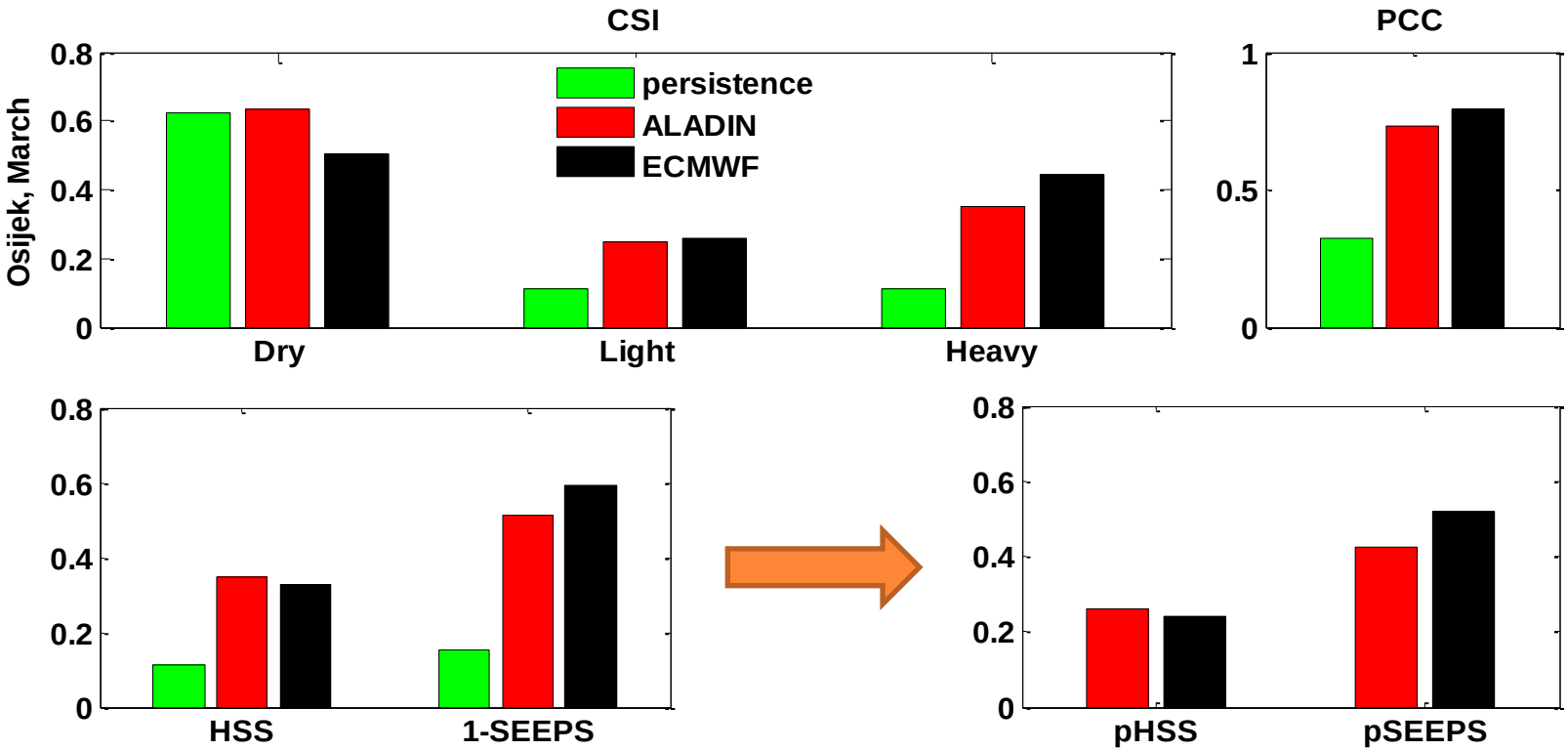
PERSISTENCY AS A REFERENCE:

- Inheritance of original verification measure properties



- Osijek (March):

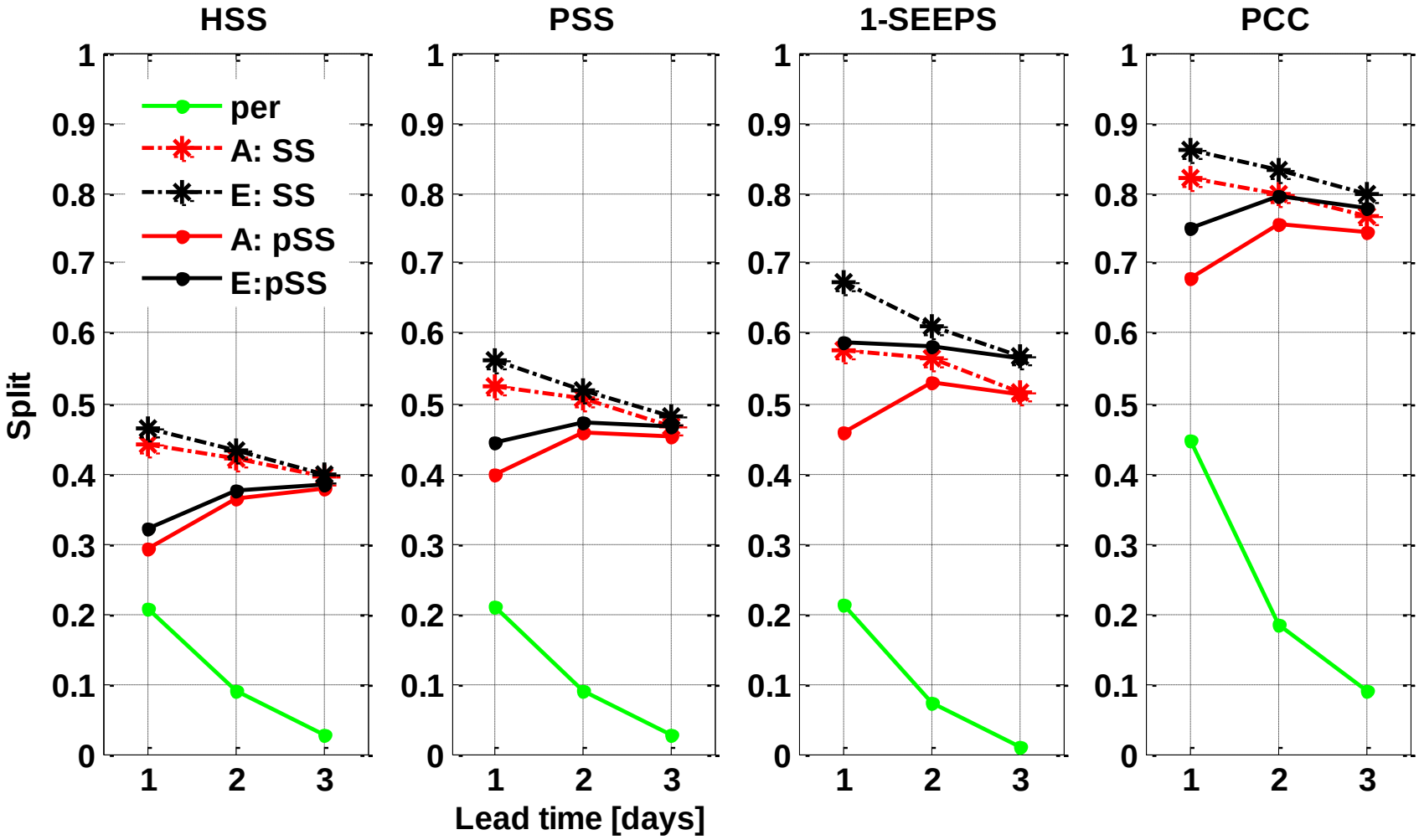
  CSI_{dry}: ALADIN > ECMWF

  CSI_{heavy}, PCC : ECMWF > ALADIN

→ smaller HSS for ECMWF → smaller pHSS

→ larger $(1 - SEEPS)$ → larger pSEEPS

DEPENDENCE ON LEAD TIME



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

Conclusion

- pSS mostly affects the most probable category - less sensitive to climatology
- It usually maintains the similar shape as measure it is derived from and inherits properties of original measure
- Affects more measures that have smaller values in general than larger one
- Has a specific dependency on lead time that has to be taken into consideration
- Rare or extreme events → persistency as a reference makes more sense

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Questions?

Thank You!!!

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? $FBIAS_d = \frac{D}{M}; \quad FBIAS_l = \frac{H}{N}; \quad FBIAS_h = \frac{L}{O}$

		OBSERVATIONS			
		DRY	LIGHT	HEAVY	∑
FORECAST	DRY	A	B	C	D
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Verification Measures

		OBSERVATIONS			
		DRY	LIGHT	HEAVY	∑
FORECAST	DRY	A	B	C	D
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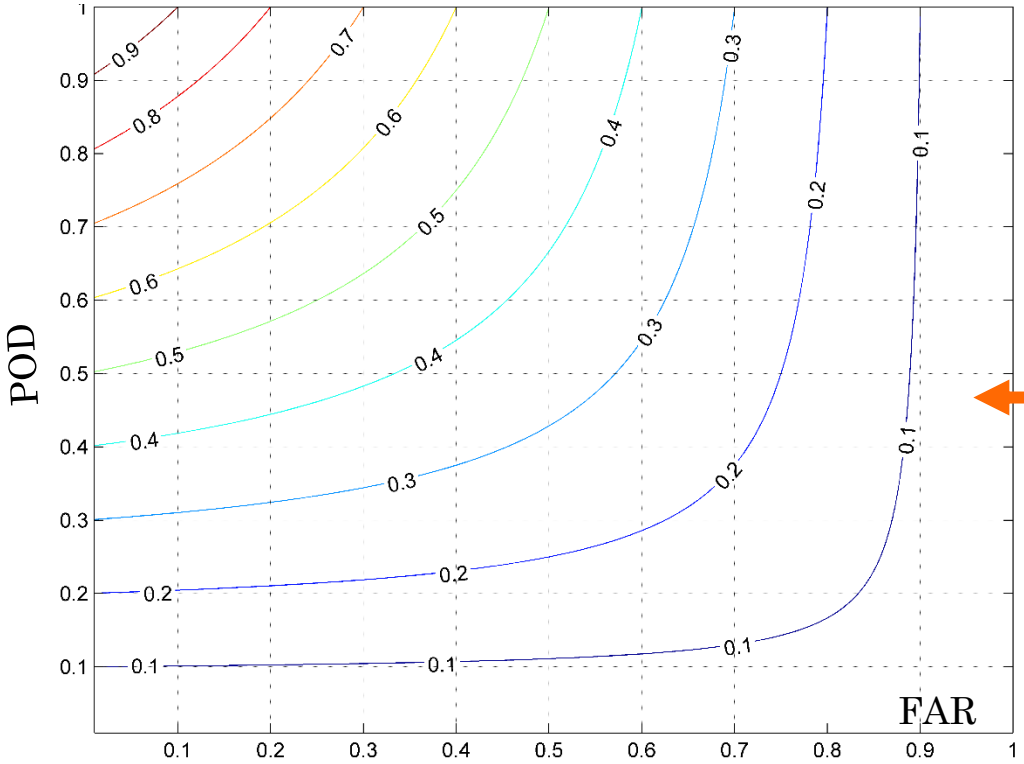
- Critical Success Index:

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

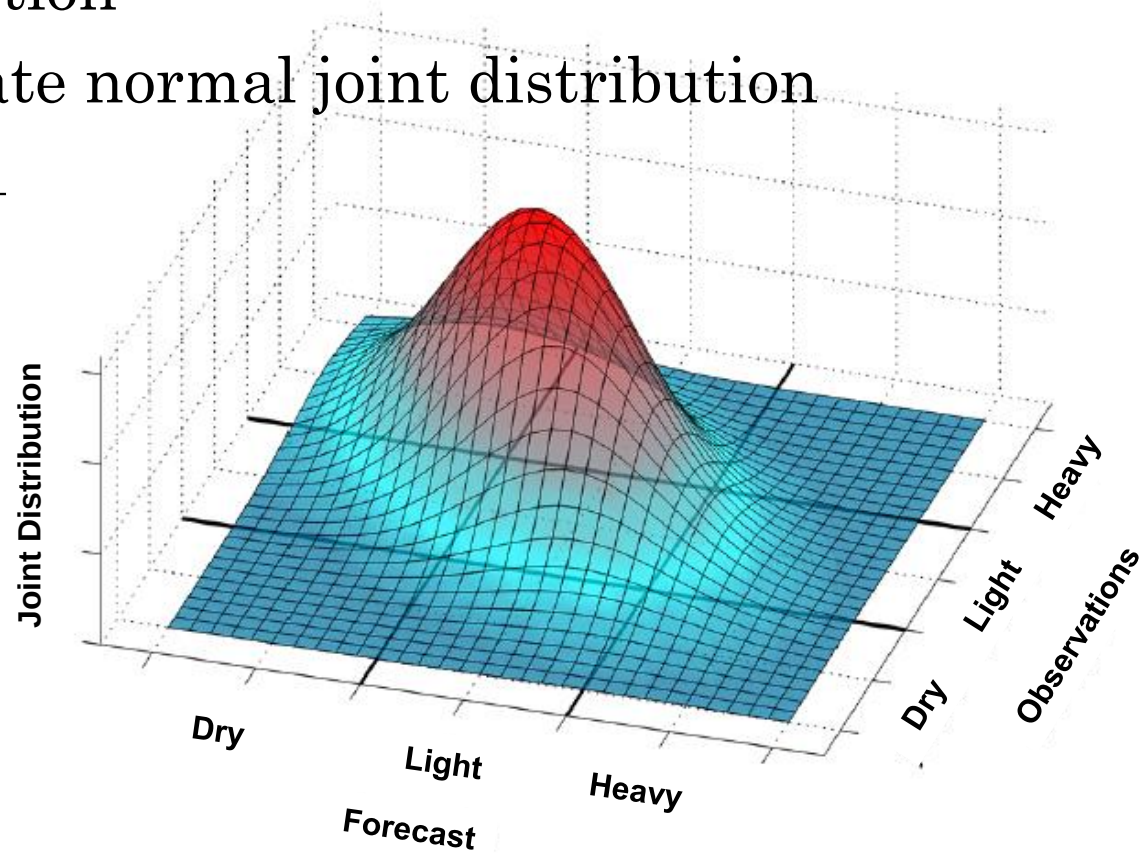


- Measure of relative accuracy:

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

Verification Measures:

- Polychoric Correlation Coefficient – measure of association
- Bivariate normal joint distribution
- Ideal: 1



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:

- 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….