

# Verifikacija rezultata ALADIN modela

**Iris Odak Plenković, Mario Hrastinski, Kristian Horvath, Martina Tudor,  
Stjepan Ivatek-Šahdan, Antonio Stanešić, Alica Bajić, Tomislav Kovačić**

**Državni hidrometeorološki zavod  
Služba za meteorološka istraživanja i razvoj operativnih prognostičkih modela**

1. Uvod
2. Operativna verifikacija
- 3. Razvojna verifikacija**
  - a. Kontinuiranog prediktanda
  - b. Kategoričkog prediktanda
  - c. Probabilističkog prediktanda
4. Zaključak

## VERIFIKACIJA

- Operativna – prati rad numeričkog modela ALADIN
- **Razvojna** – analiza i poboljšanje rada ALADIN-a

MOTIVACIJA – Praćenje, analiza i razvoj numeričkog modela ALADIN

CILJ – pokazati na primjerima postupak verifikacije kakav se koristi na DHMZ-u

## PODACI

- **ALADIN 8 km:** 37 nivoa; 240 x 216 točaka mreže; 72-satna prognoza, 3-satni izlaz; hidrostatski
- **ALADIN 2 km:** 37 nivoa; 450 x 450 točaka mreže; 24-satna prognoza; 1-satni izlaz; nehidrostatski
- **DADA 2 km:** 15 levels; 450 x 450 grid points; 72-satna prognoza; 3-satni izlaz; hidrostatski

# OPERATIVNA VERIFIKACIJA

## - Prati rad numeričkog modela ALADIN



[oborina 06 UTC 20140520 - 06 UTC 20140521](#)

[oborina 06 UTC 20140519 - 06 UTC 20140520](#)

[oborina 06 UTC 20140518 - 06 UTC 20140519](#)

[oborina 06 UTC 20140517 - 06 UTC 20140518](#)

[oborina 06 UTC 20140516 - 06 UTC 20140517](#)

[oborina 06 UTC 20140515 - 06 UTC 20140516](#)

[oborina 06 UTC 20140514 - 06 UTC 20140515](#)

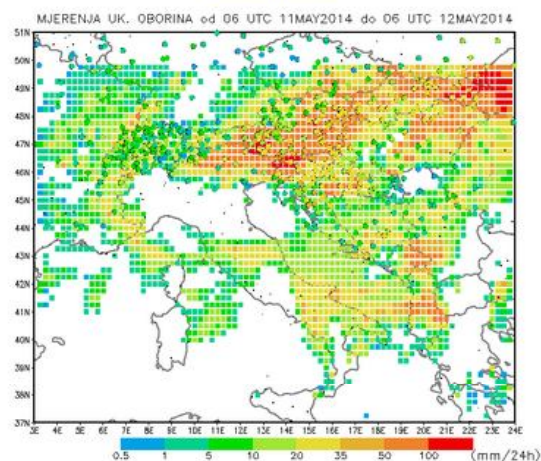
[oborina 06 UTC 20140513 - 06 UTC 20140514](#)

[oborina 06 UTC 20140512 - 06 UTC 20140513](#)

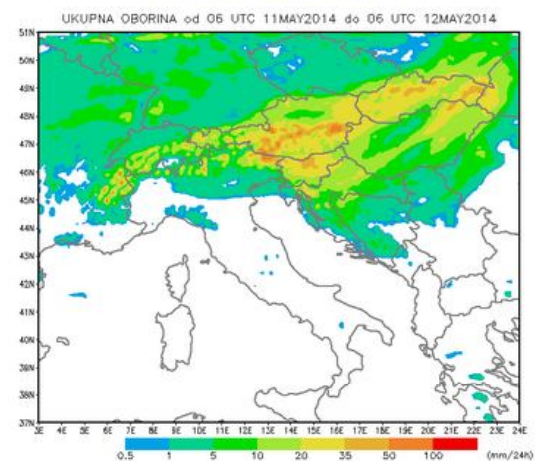
VIHOR Usporedba 24 satnih polja oborine sa mjerenjima  
06 UTC 20140511 - 06 UTC 20140512



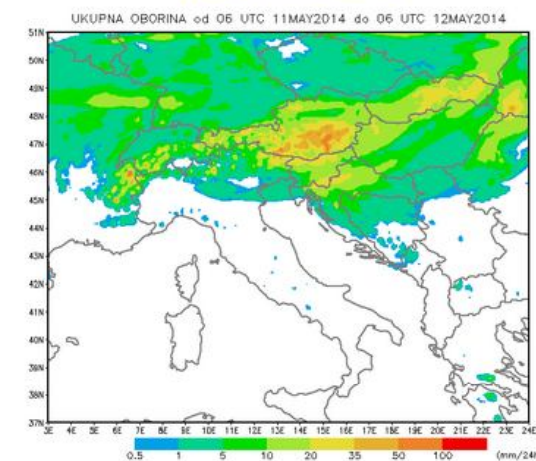
sirova mjerenja



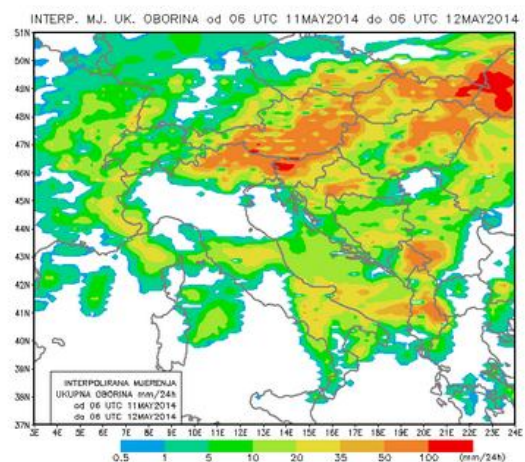
20140511 00 UTC +06-+30



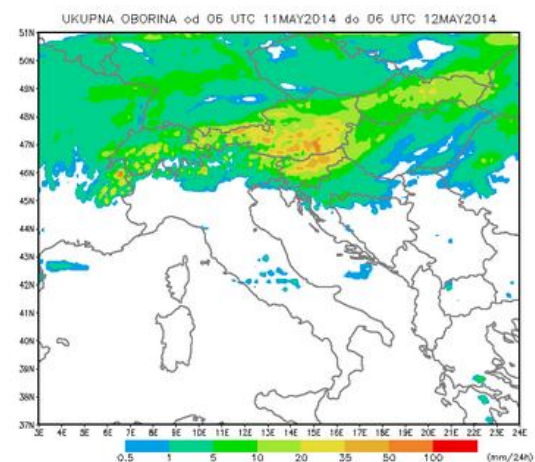
20140510 12 UTC +18-+42



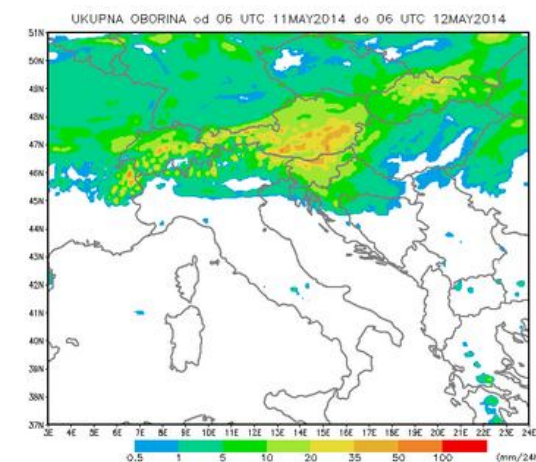
interpolirana mjerenja



20140510 00 UTC +30-+54



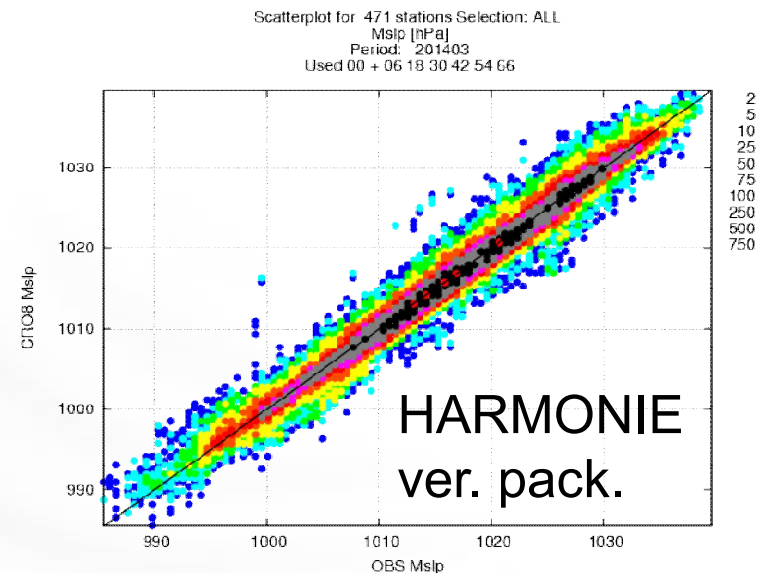
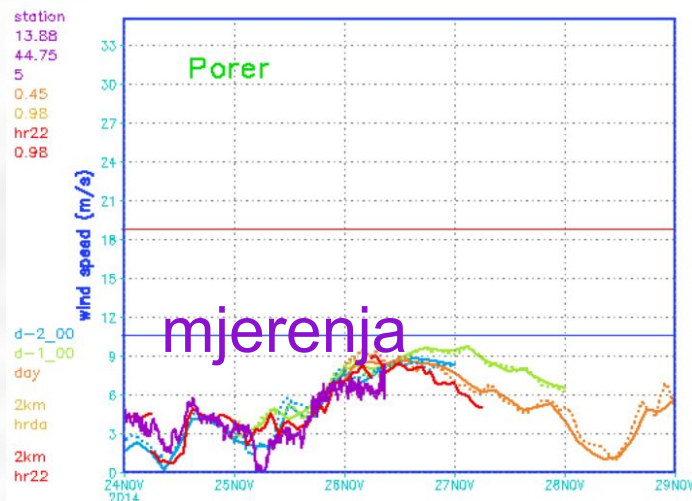
20140509 12 UTC +42-+66



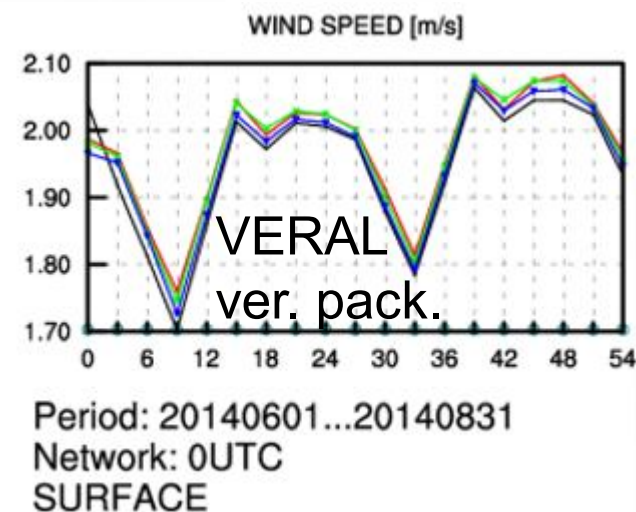
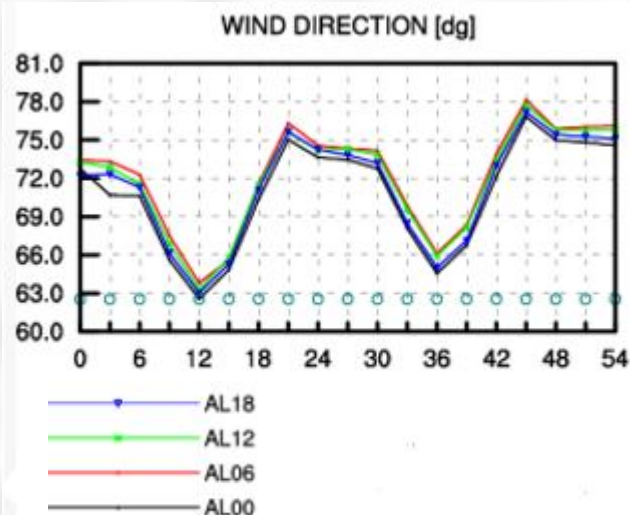


# OPERATIVNA VERIFIKACIJA

- Prati rad numeričkog modela ALADIN



RMSE  
BIAS  
STD

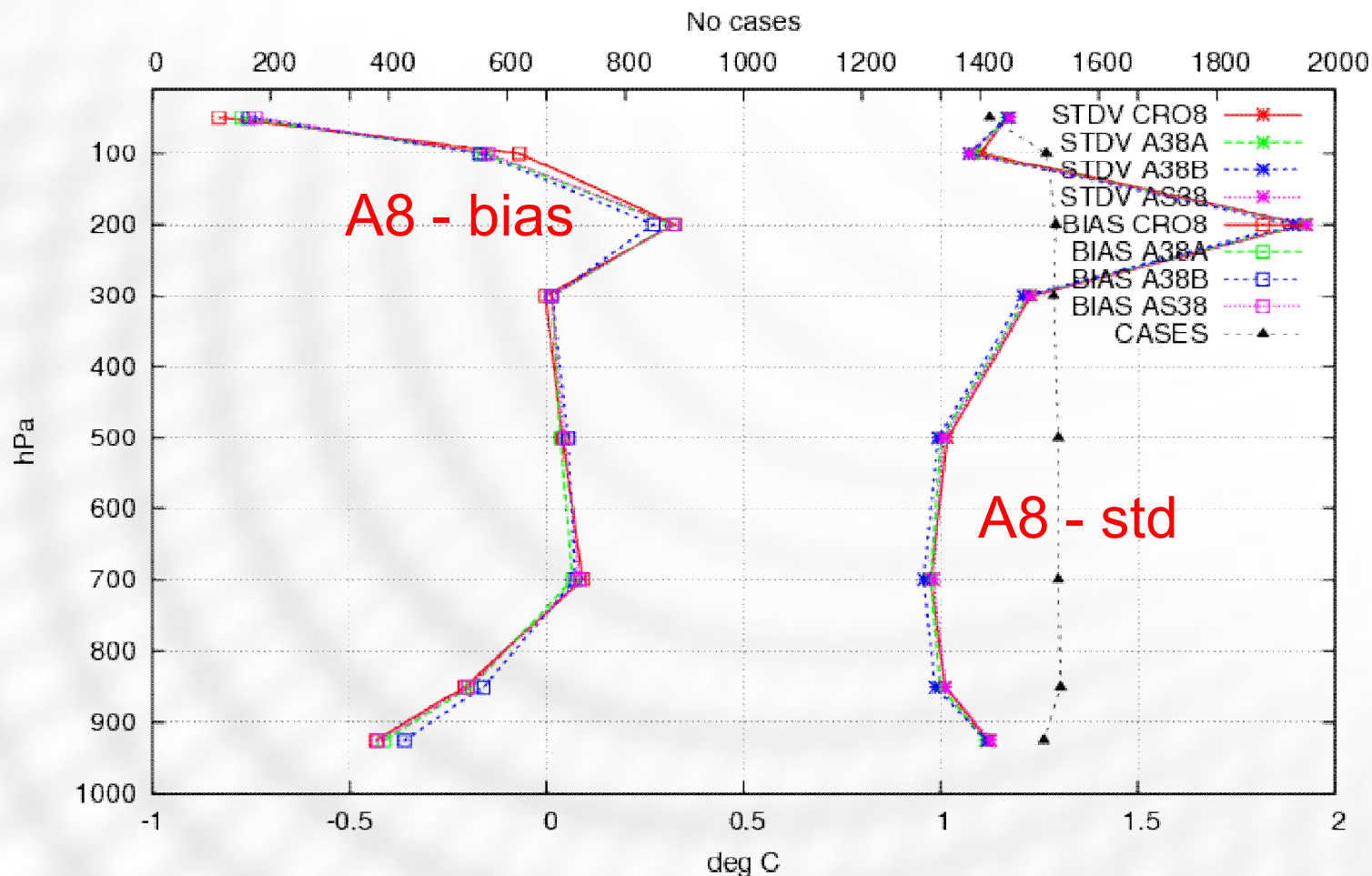


# OPERATIVNA VERIFIKACIJA

## - Prati rad numeričkog modela ALADIN

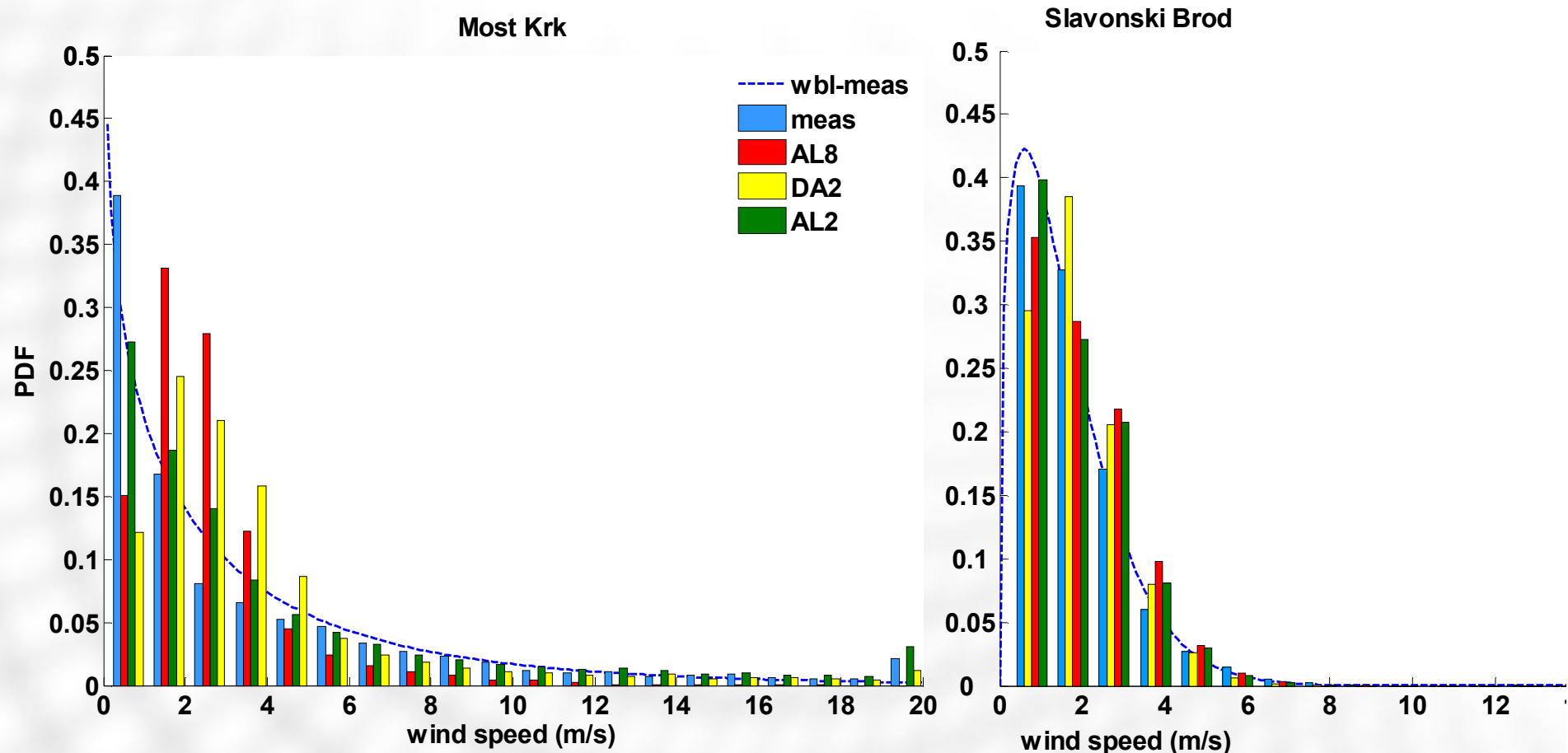


27 stations Selection: ALL  
Temperature Period: 201403  
Statistics at 00 UTC Used 00 + 00 24 48 72



Kvalitativno:

- Dijagram raspršenja, vremenski niz, razdiobe
- Razdiobe mjerene i modelirane brzine vjetra



# RAZVOJNA VERIFIKACIJA

## VERIFIKACIJA KONTINUIRANOG PREDIKTANDA



- Kvantativno

RMSE: Generalna ocjena uspješnosti prognoze

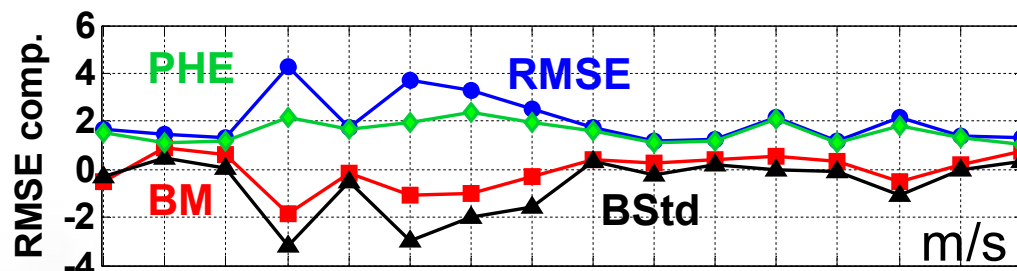
Usporedba rezultata prognoze brzine vjetrova:

3 verzije modela za 16 različitih stanica usrednjeno za sva nastupna vremena

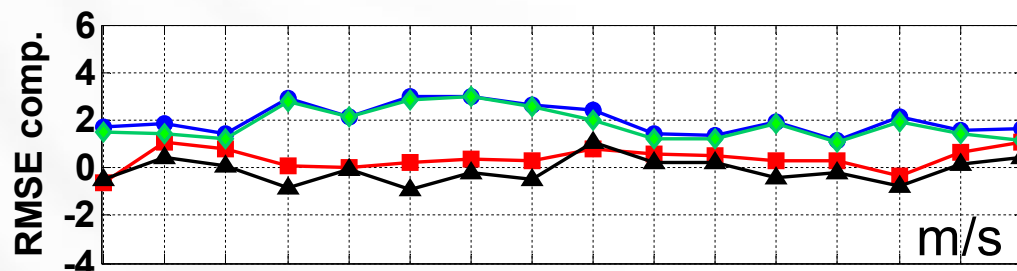
Dekompozicija:

$$\overline{(f - o)^2} = \underbrace{(\bar{f} - \bar{o})^2}_{\text{RMSE}^2} + \underbrace{(\sigma_f - \sigma_o)^2}_{\text{BStd}^2} + \underbrace{2\sigma_f\sigma_o(1 - r_{fo})}_{\text{PHE}^2}$$

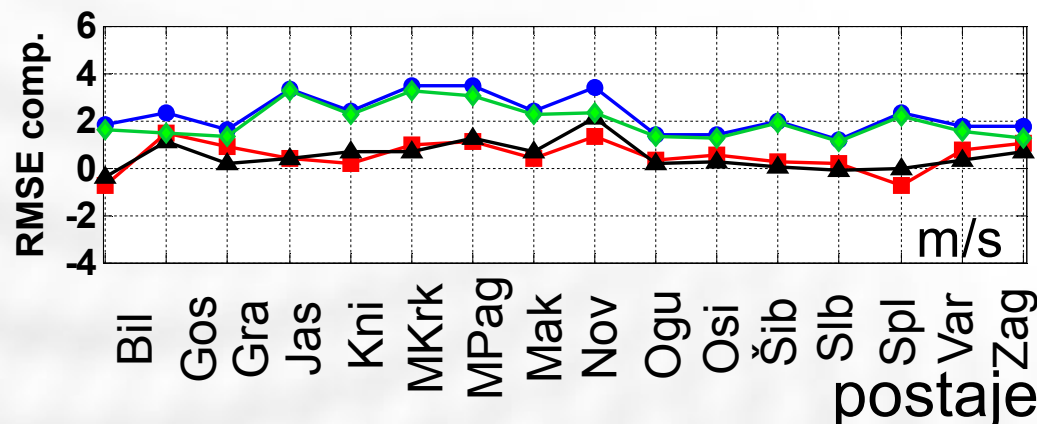
ALADIN 8 km forecast - 2010-2012.



DADA 2 km forecast - 2010-2012.



ALADIN 2 km forecast - 2010-2012.





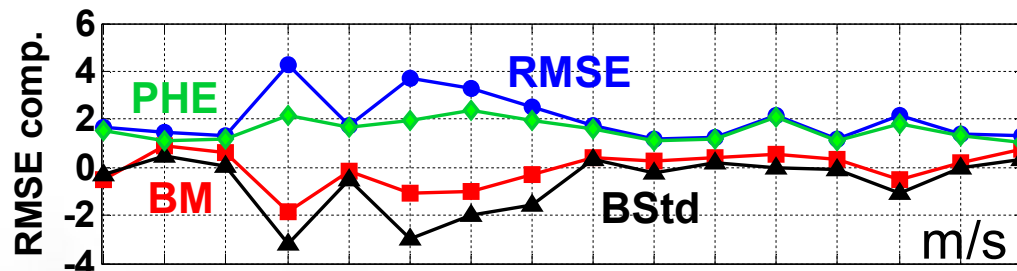
Dekompozicija:

Poboljšanje rezultata u obalnom području

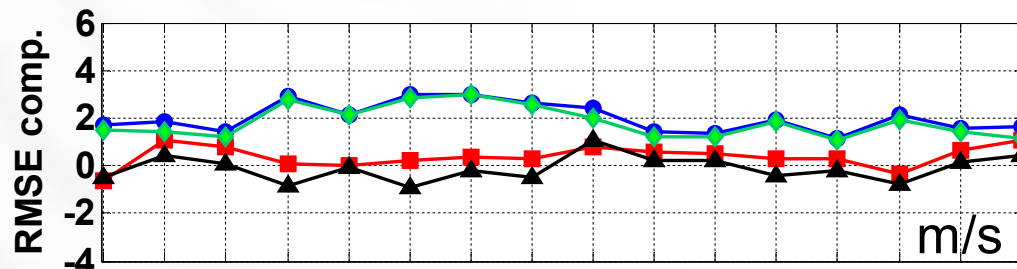
1. Prostorne sistematske pogreške se značajno smanjuju s 8 km (A8) na 2 km rezoluciji (D2, A2)

2. Fazna pogreška je dominantni izvor RMSE-a na 2 km

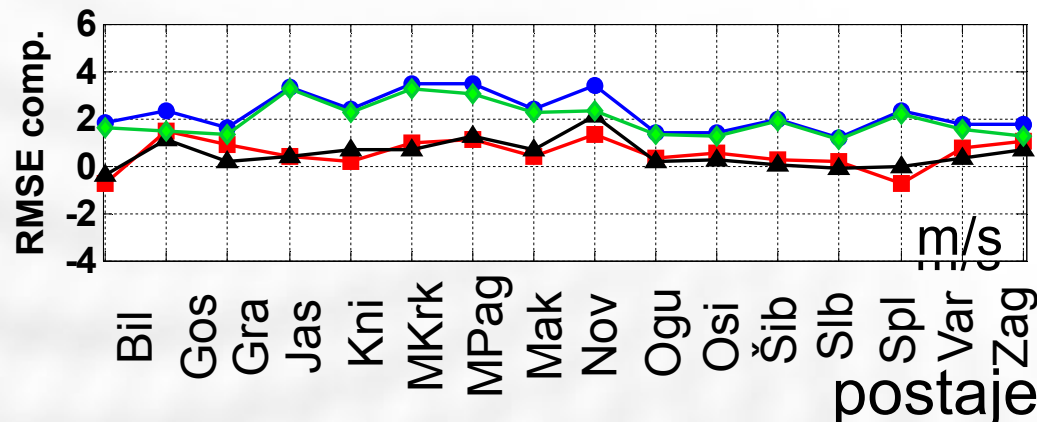
ALADIN 8 km forecast - 2010-2012.



DADA 2 km forecast - 2010-2012.



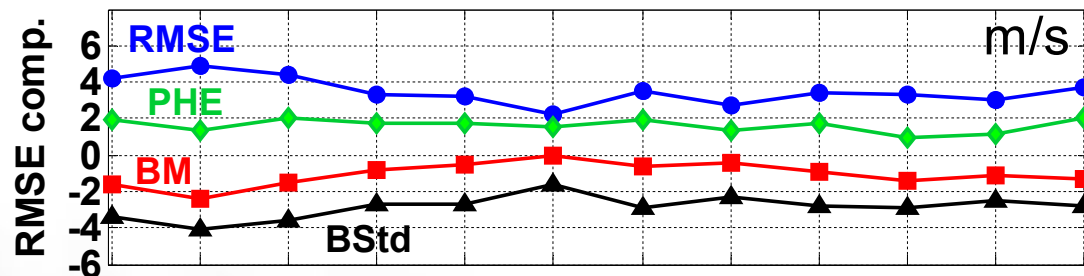
ALADIN 2 km forecast - 2010-2012.



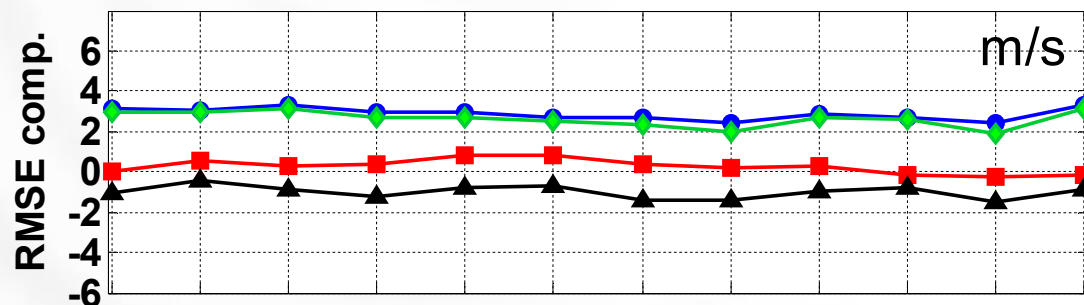
Dekompozicija za postaju u obalnom području po mjesecima:

Poboljšanje rezultata u zimskom razdoblju

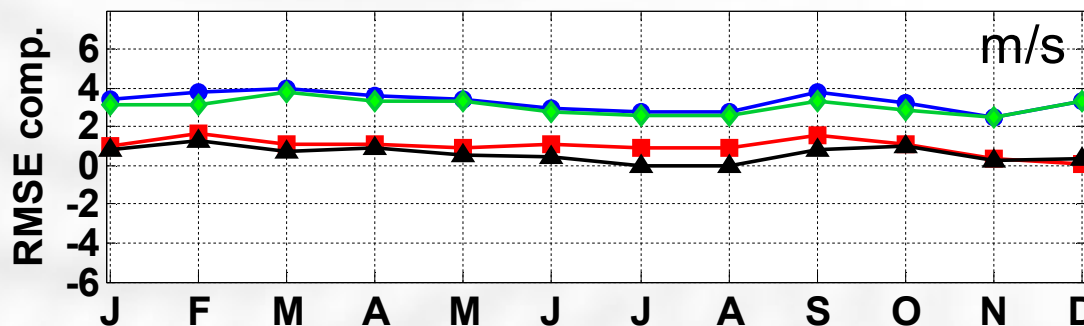
### ALADIN 8 km forecast - Most Krk



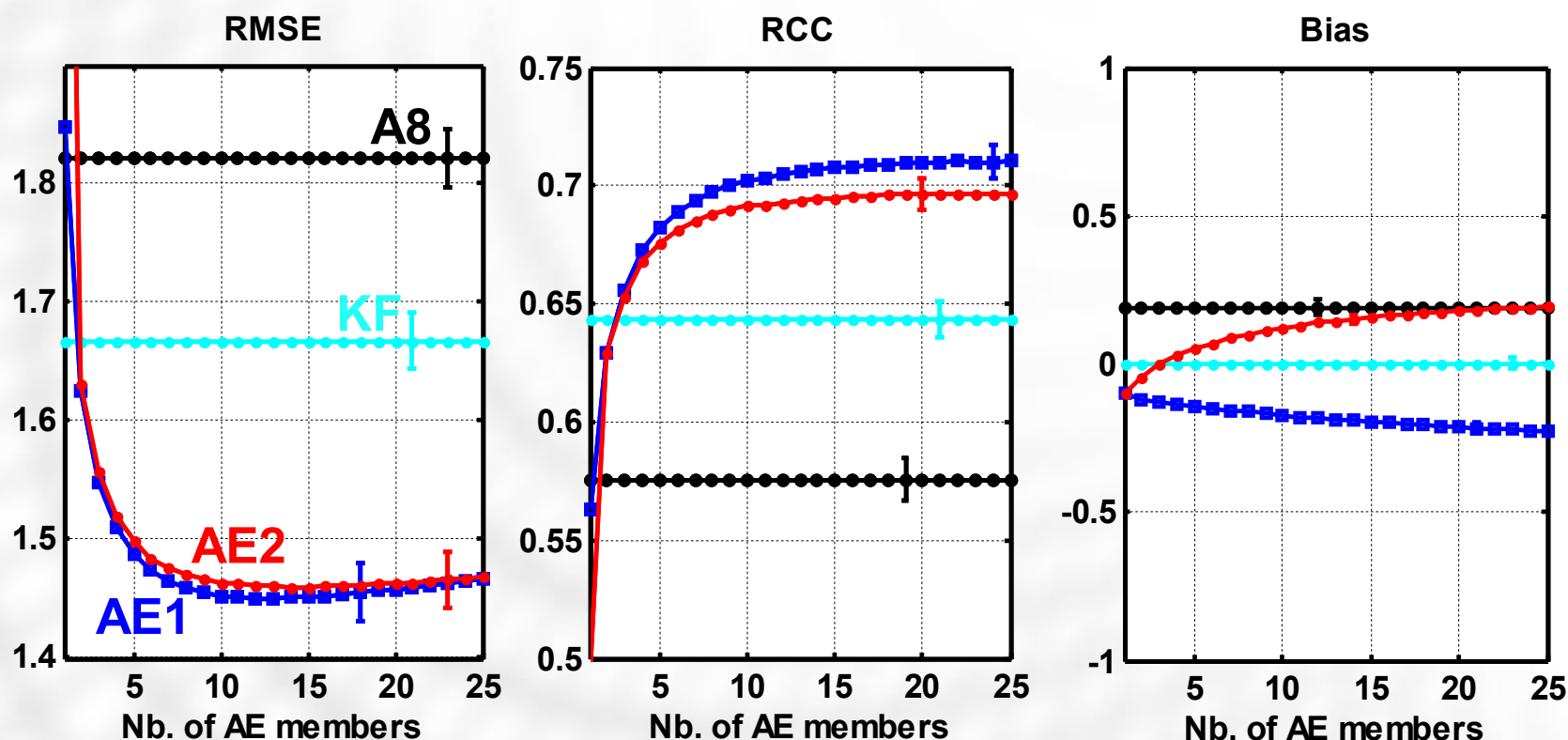
### DADA 2 km forecast - Most Krk



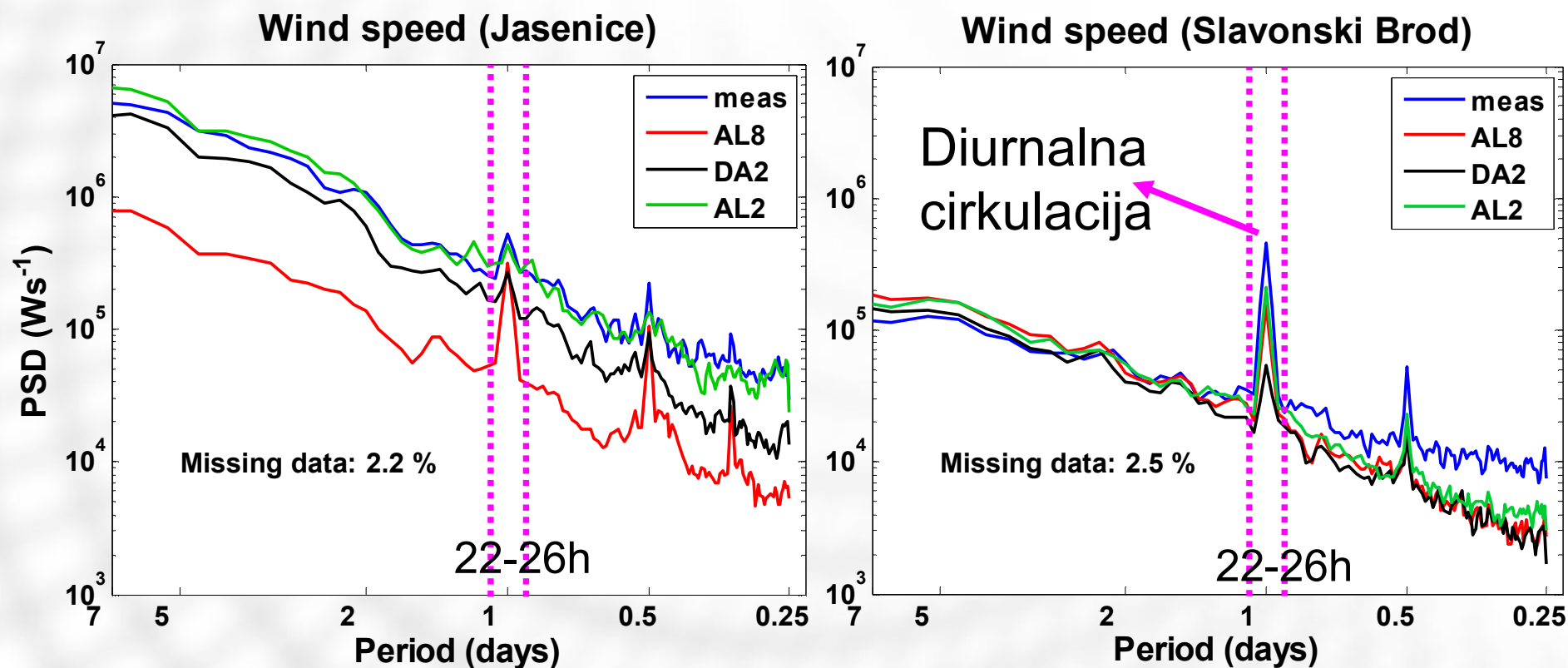
### ALADIN 2 km forecast - Most Krk



- upotreba u razvoju AE post-processing statističke metode za prognozu brzine vjetra (14 postaja, sva nastupna vremena): određivanje optimalnih parametara



Spektralna analiza – kvalitativno:  
Usporedba po dijelovima spektra na raznim skalama





### Spektralna analiza: Kvantifikacija spektralne verifikacije (Jasenice)

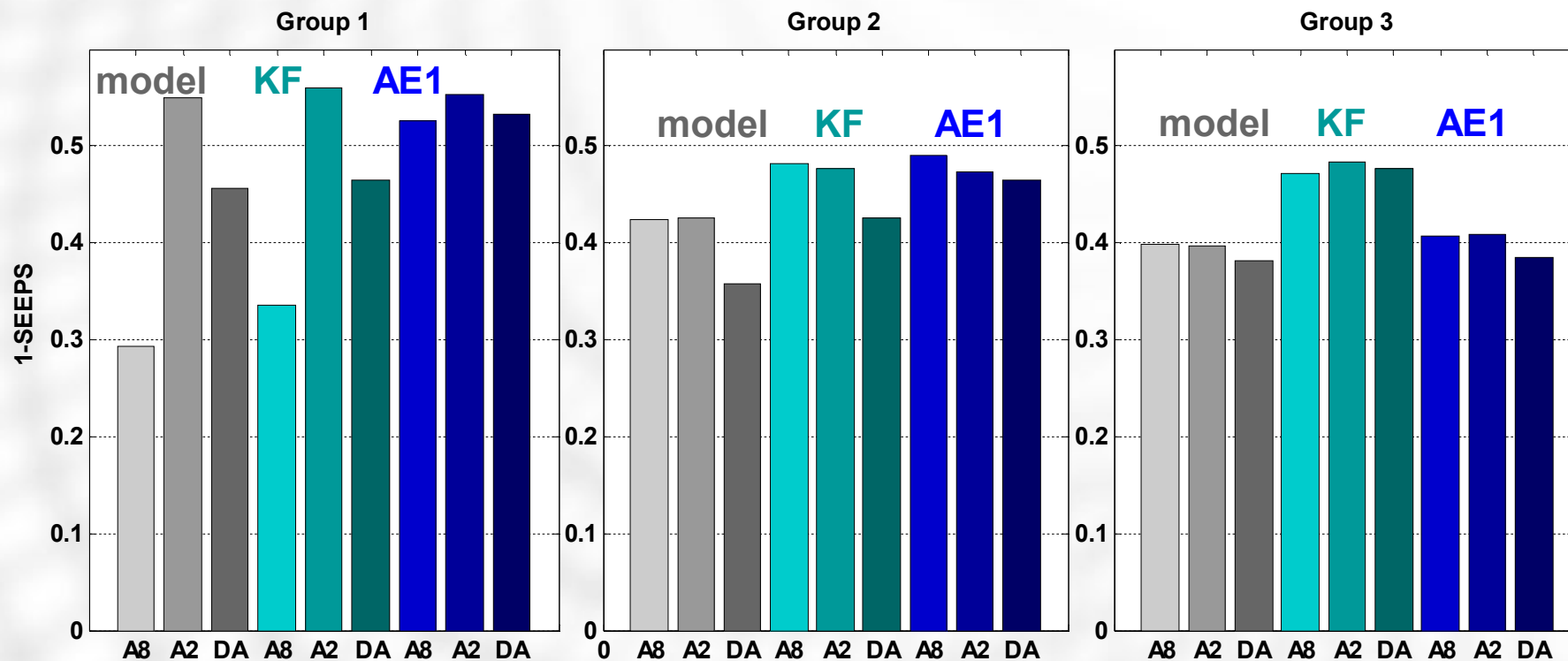
	$P_{LTD}/P_{TOT}$	$P_{DIU}/P_{TOT}$	$P_{SUB}/P_{TOT}$	$P_{TOT}/P_{TOT(mj)}$
<b>Mjerenja</b>	0.778	0.045	0.177	1.000
<b>ALADIN 8 km</b>	0.709	0.098	0.193	0.158
<b>DADA 2 km</b>	0.847	0.036	0.117	0.654
<b>ALADIN 2 km</b>	0.815	0.039	0.146	1.105

Brzina vjetra podijeljena je u **3 kategorije** koje su određene 50. i 90. percentilom

### 1-SEEPS

- Mjeri pogrešku prognoze (idealno 1)
- Od modela najuspješniji A2 model

Razmatraju se 3 grupe postaja: obalne, na većoj nadmorskoj visini i kontinentalne



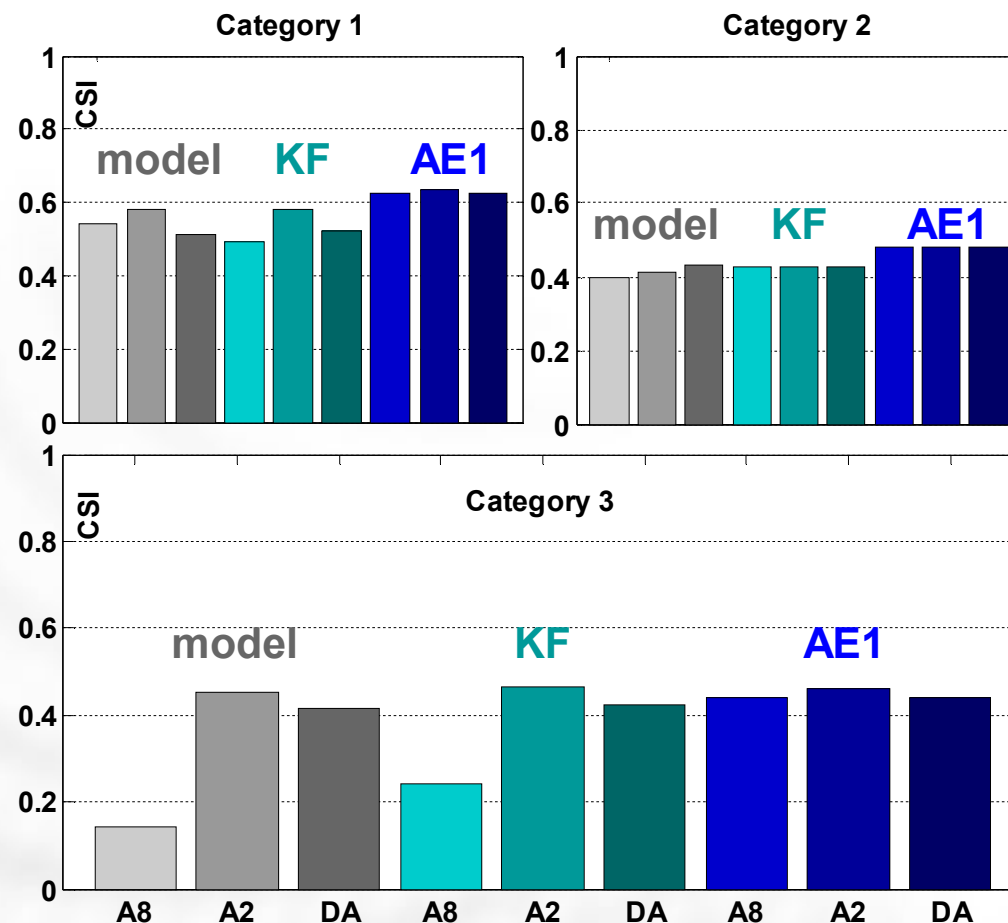
Indeks uspješnosti

(CSI; eng. Critical Success Index)

- mjera relativne točnosti za svaku kategoriju
- Idealno 1

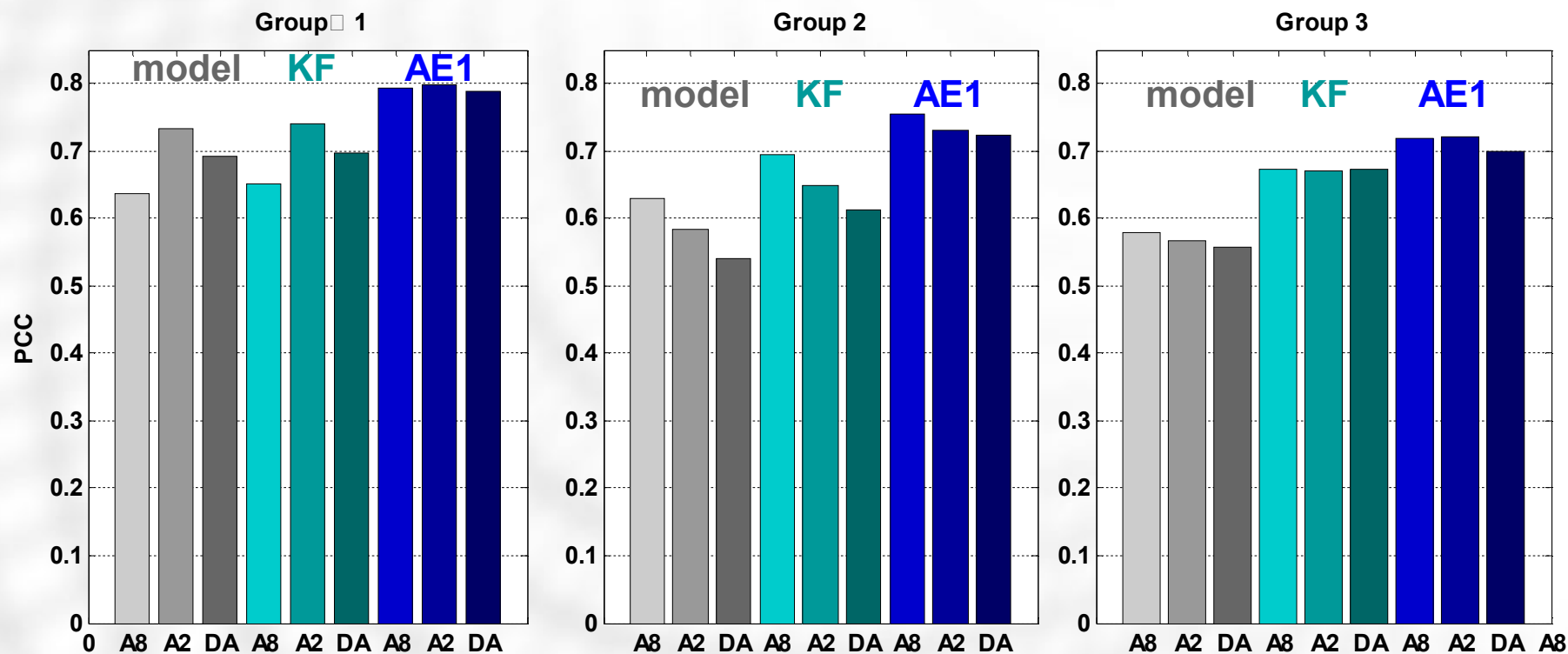
Obalne postaje:

- Velike brzine vjetra – najteže za prognozirati
- Najbolji ukupni rezultat za A2
- Poboljšanje statističkim prognoziranjem



Polihorički koeficijent korelacije (PCC)

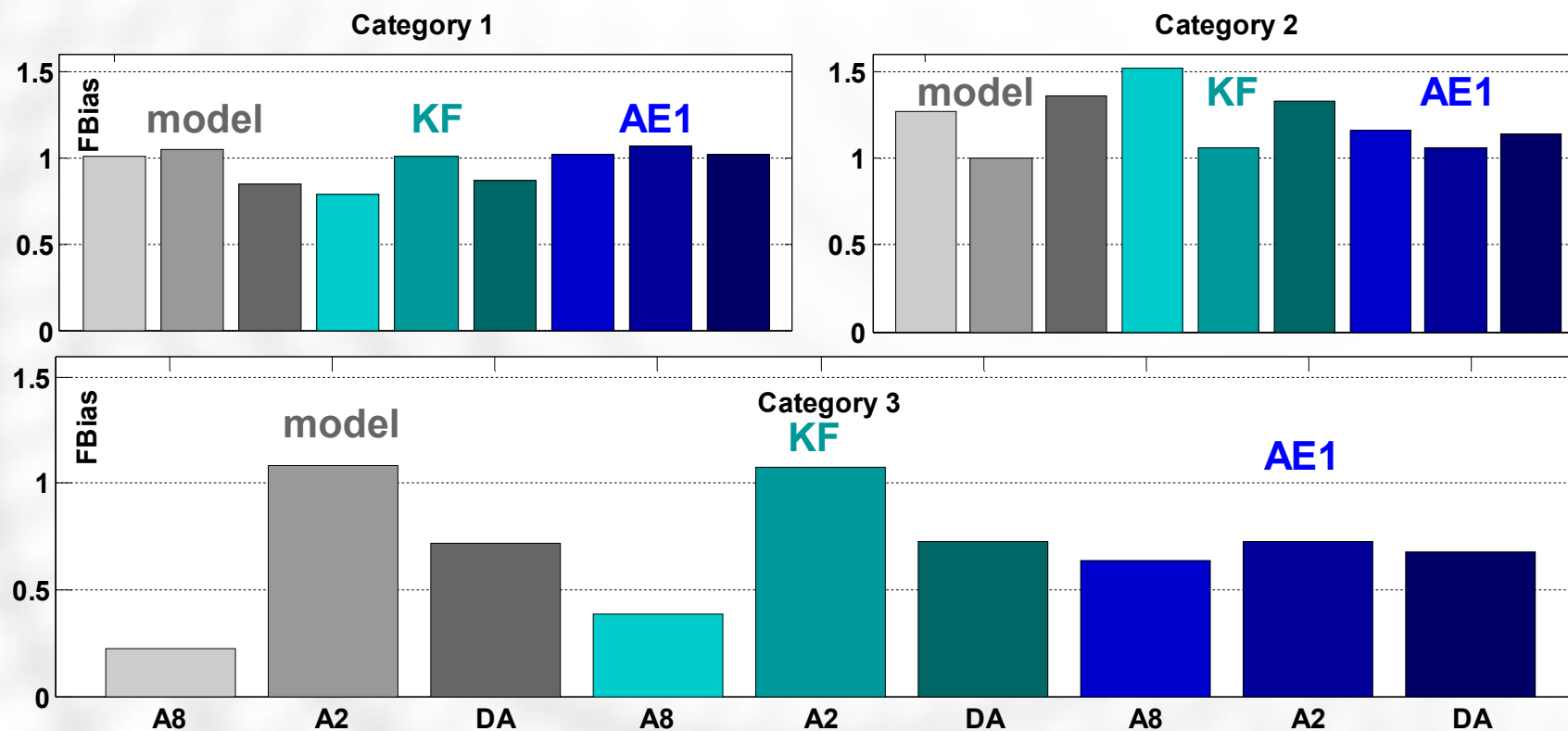
- Mjeri asocijaciju u tablici kontingencije (idealno 1)
- AE1 statističko prognoziranje – poboljšava rezultat u sve tri grupe postaja





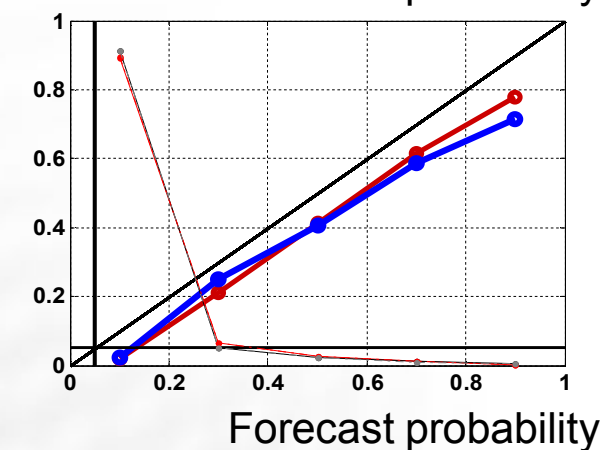
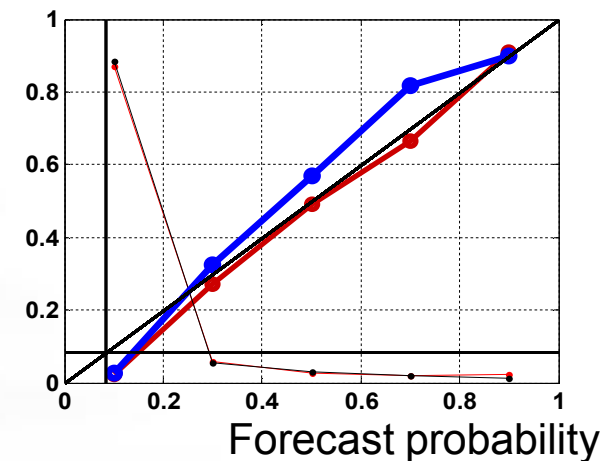
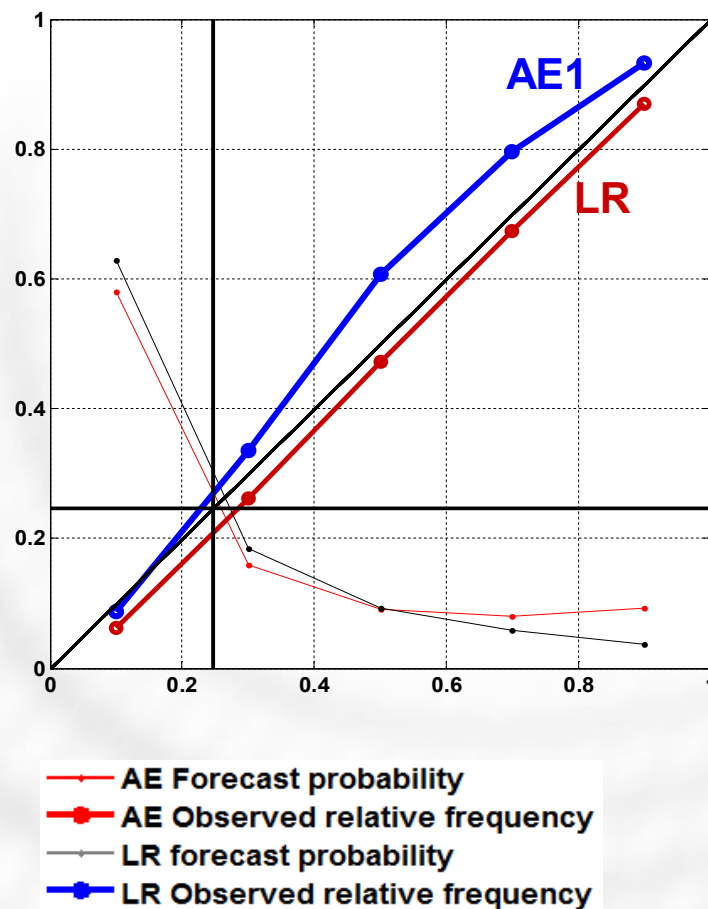
Učestalost pristranosti po kategorijama (Fbias; eng. Frequency Bias)

- idealno 1 – najbliži A2 model u sve 3 kategorije



Dijagram atributa:

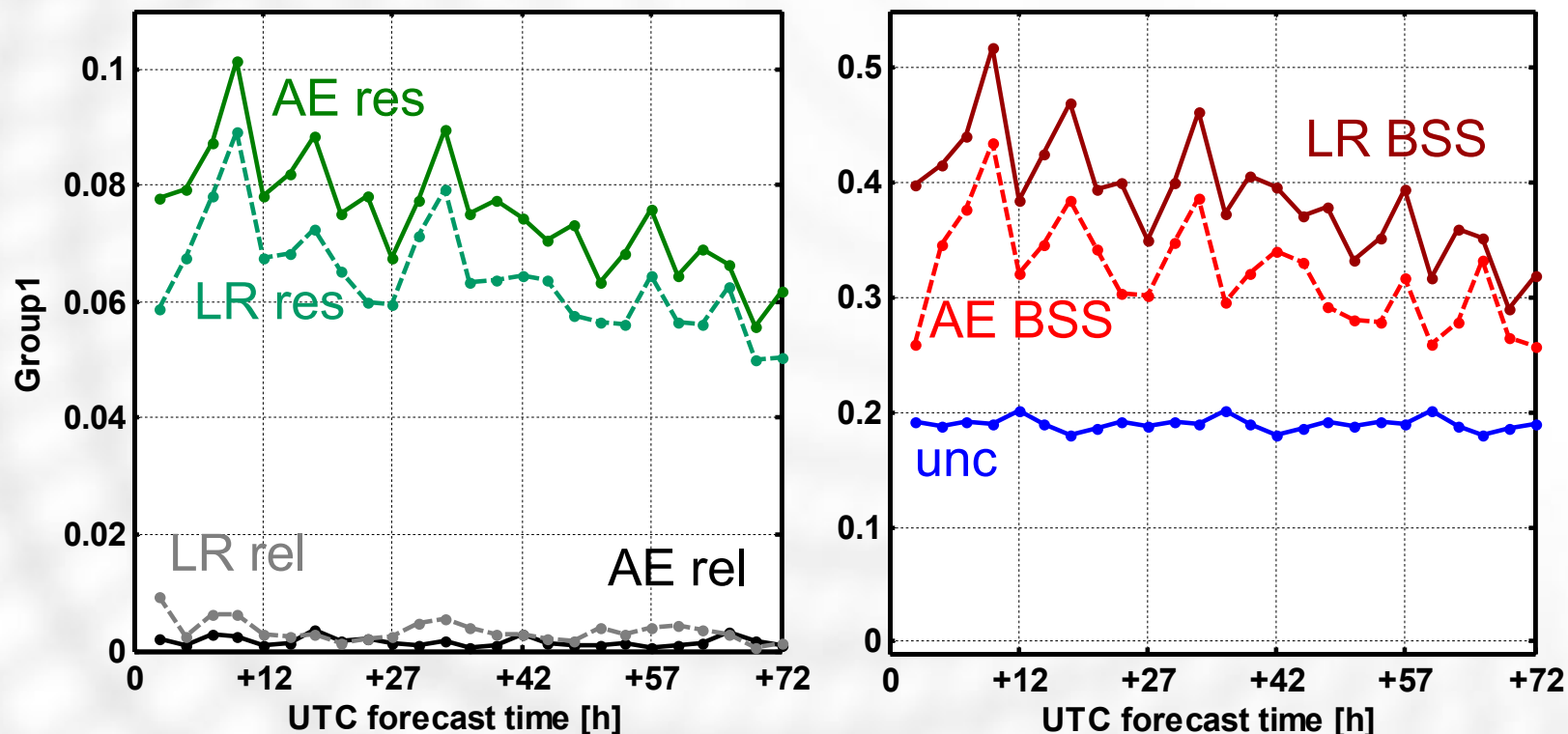
- Kvalitativna mjera pouzdanosti (idealno na dijagonali)
- LR i AE1 su pouzdane probabilističke prognoze za sve 3 grupe postaja



Kvantitativna ocjena: Brierova mjera uspješnosti (BSS)

- Dekompozicija na više aspekata:  
pouzdanost (rel), rezoluciju (res) i neizvjesnost (unc)

Wind speed >5 m/s; 1.1.2012.-31.12.2012.



# RAZVOJNA VERIFIKACIJA

## VERIFIKACIJA PROBABILISTIČKOG PREDIKTANDA



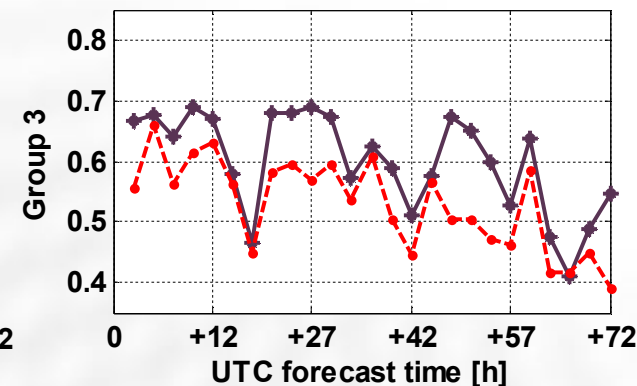
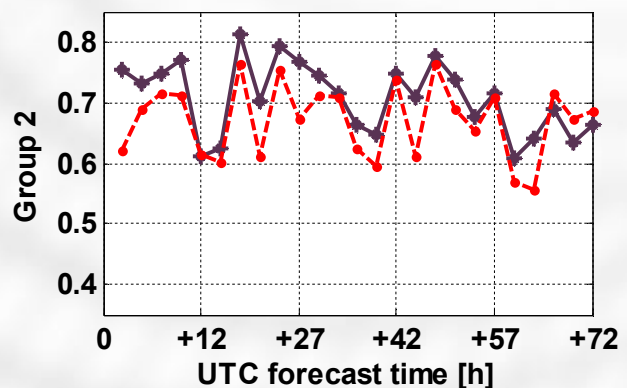
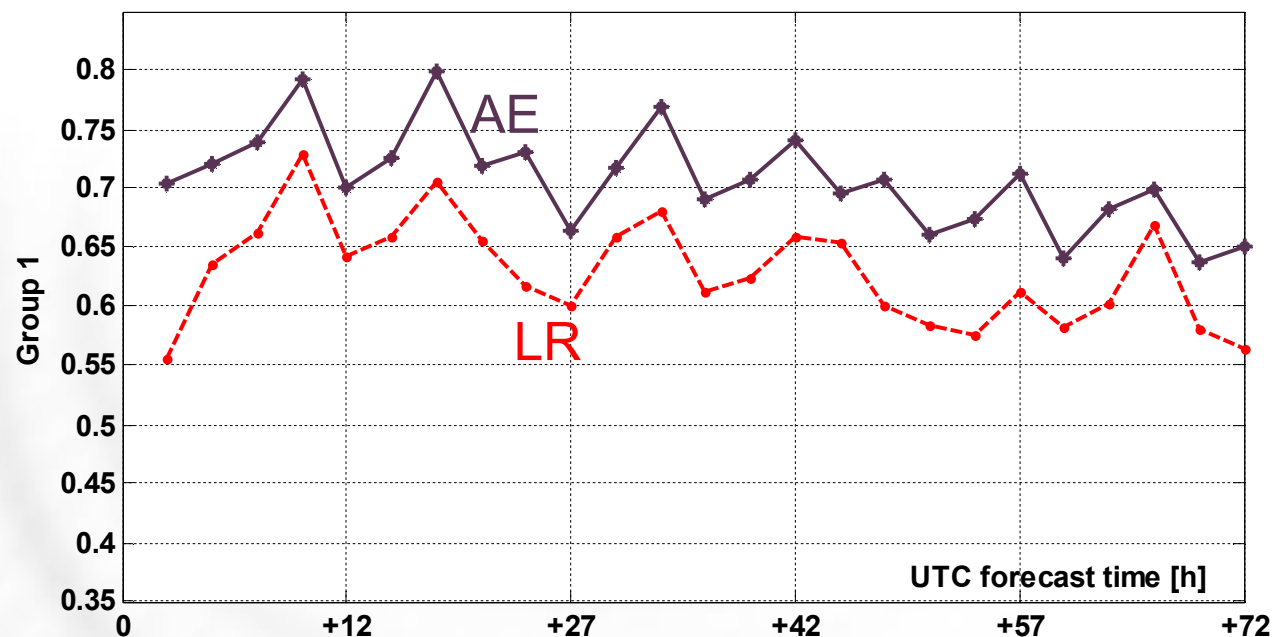
ROCSS

Mjera uspješnosti

temeljena na

osjetljivosti

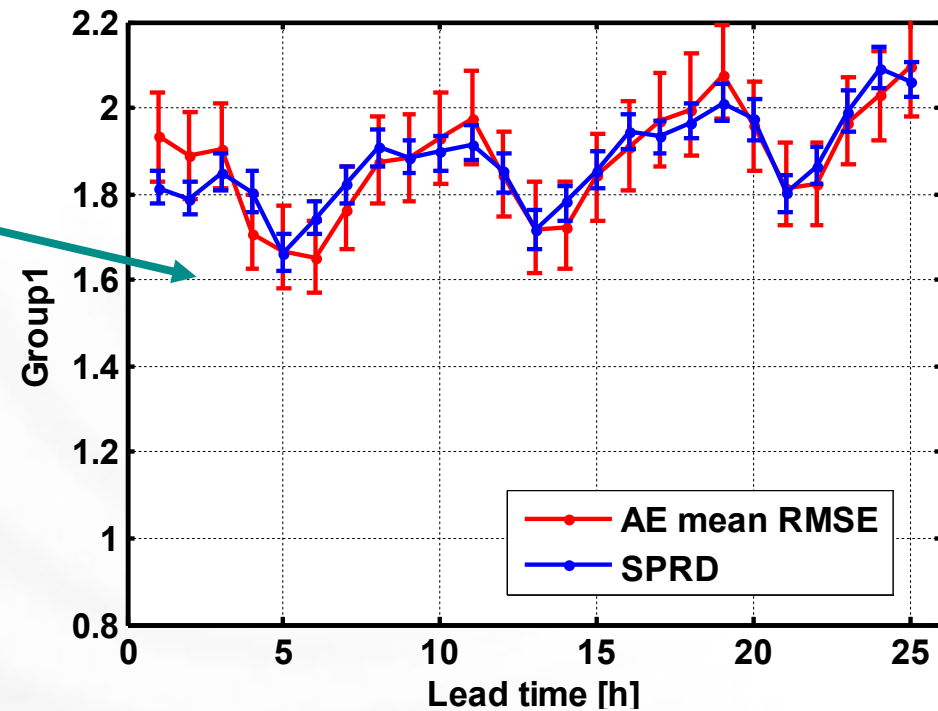
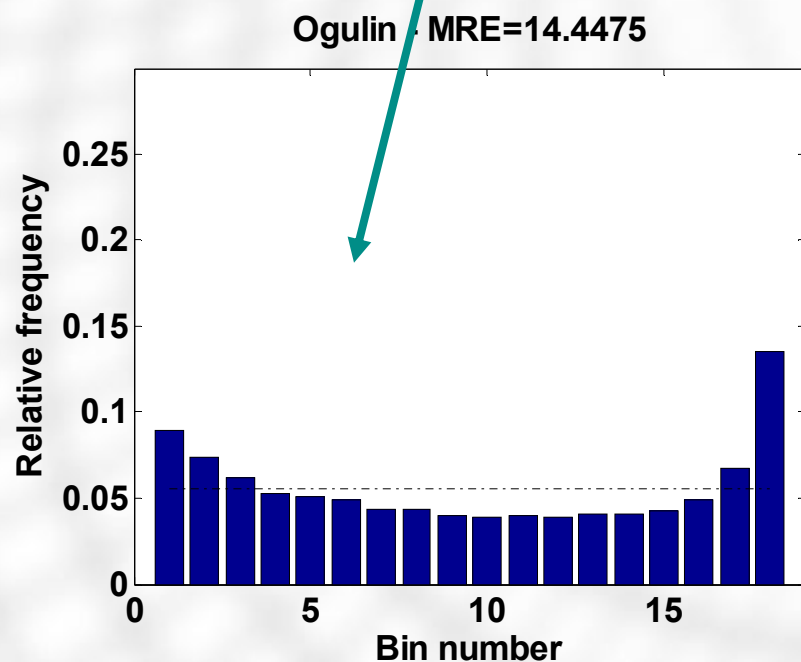
2012 (366 days verification period)





Mjere disperzije ansambla:

- Dijagram disperzije
- Dijagram ranga



- Verifikacija je složen i sveobuhvatan postupak
- Nužno je provoditi rutinski, ali i u razvojne svrhe
- Na mnogo različitih načina govori nam o numeričkom modelu koji se razmatra, pružajući korisne informacije kako razvojnom timu, tako i korisnicima
- Istaknute su prednosti ALADIN modela 2 km horizontalne rezolucije, te statističkog prognoziranje

HVALA NA PAŽNJI!



# DISKRIMINACIJSKI DIJAGRAM & ROC krivulja

- Faktorizacija vjerodostojnost – klim. distribucija (eng. *likelihood – base rate factorization*):  
 $p(f_i, o_j) = \underbrace{p\{f_i|o_j\}}_{\text{ROCA}} p\{o_j\} \longrightarrow$  ROC krivulja (eng. *relative operating characteristic*);

$$H = p(f_1|o_1)$$

$$F = p(f_1|o_2)$$

	$p(o_1)=0.297$	$p(o_2)=0.703$
$f_i$	$p(f_i o_1)$	$p(f_i o_2)$
0.0	0.152	0.363
0.1	0.108	0.182
0.2	0.084	0.107
...	...	...
1.0	0.044	0.010

H
0.848
0.741
...
0.044

F
0.637
0.455
...
0.010

