



Evaluation of AROME NWP model in forecasting extreme weather events in Morocco

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Context

Phénomène météorologique du 22 octobre : Violentes tempêtes causent des dégâts multiples

marrakech 7 23 octobre 2023 13:00



AFRIQUE MONDE ECONOMIE TÜRKIYE POLITIQUE SPORT INFOGRAPHIE VIDÉO PHOTO

Maroc : Le feu qui a ravagé 790 hectares de forêts totalement maîtrisé

- Le départ de feu a été signalé vendredi dans la forêt de Maghraoua dans la province de T... a duré 6 jours sans faire de victime, selon un responsable gouvernemental

Khalid Mejdoup, Iyad Nabolsi | 17.08.2023 - Mise à Jour : 17.08.2023

Le Site info

Accueil Maroc Politique Economie Sport Monde Videos

Le Maroc frappé par une vague de froid record ? Un expert répond

Rédaction N - 27 décembre 2023 - 14:36

TELQUEL

Vague de chaleur, fortes rafales de vent et averses localement orageuses lundi et mardi

Instant T - LE 07 AOÛT 2023

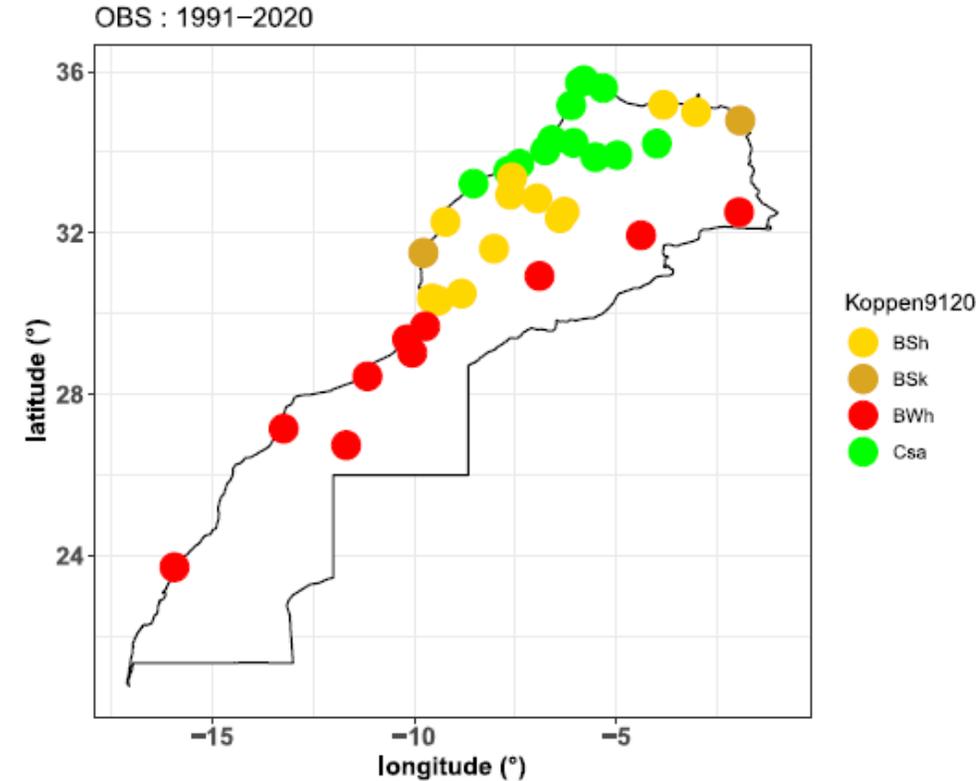
Une vague de chaleur, de fortes rafales de vent et de fortes averses localement orageuses sont attendues lundi et mardi dans plusieurs provinces du Royaume avec des températures pouvant atteindre les 49 °C, a averti lundi la Direction générale de la météorologie (DGM).

Par La Rédaction

- Heatwave: Fires Burned Over 1,200 Hectares of Moroccan Forest in July 2021
- Extreme climate events cost Morocco over \$575 million per year (World Bank)
- Extreme Weather Events are more frequent and intense

Dataset & Study Domain

- Archive of Observations from SYNOP from 2016-2024
- Archive of Hourly Forecasts of AROME Cycle 43 2.5 km from 2016-2024
- Max Lead-time 72h
- 44 Weather Station
- Surface Weather Parameters (T2m, RH, MSLP, WS, RR, FFX)
- Diversity of Micro-Climates



Csa = Hot-summer Mediterranean climate

BSh = Hot semi-arid climates

BWh = Hot desert climates

BSk = Cold semi-arid climates

Definition of Extreme Events

- RR -> Total RR from 18h (J) to 18h (J+1)
- TM -> Min T2m from 6h(J) to 6h (J+1)
- TX -> Max (T2m) from 18h (J) to 18h (J+1)
- FFX -> Max (WS10m) for 24h
- Probability that the Variable > Q95, Q96, Q97, Q98

Verification Scores

Continuous Verification

$$\text{Bias} = \frac{1}{N} \sum_{i=1}^N (F_i - O_i)$$

$$\text{RMSE} = \sqrt{\frac{1}{N} \sum_{i=1}^N (F_i - O_i)^2}$$

$$\text{EHI} = \frac{(T_i + T_{i-1} + T_{i-2})}{3} - \frac{(T_{i-3} + \dots + T_{i-32})}{30}$$

Probabilistic Verification

	Observed Event	No Event
Forecasted Event	Hits (H)	False Alarms (F)
No Forecasted Event	Misses (M)	Correct Negatives (C)

$$\text{FAR} = \frac{F}{H + F}$$

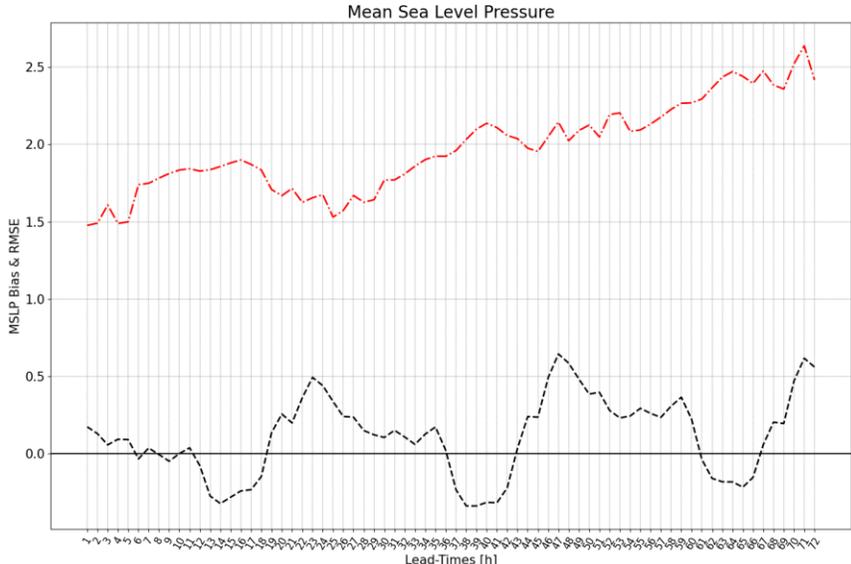
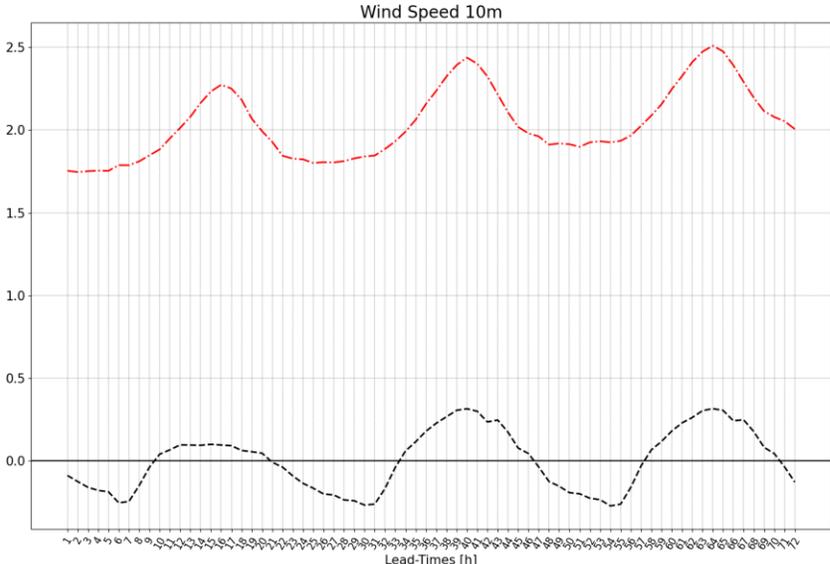
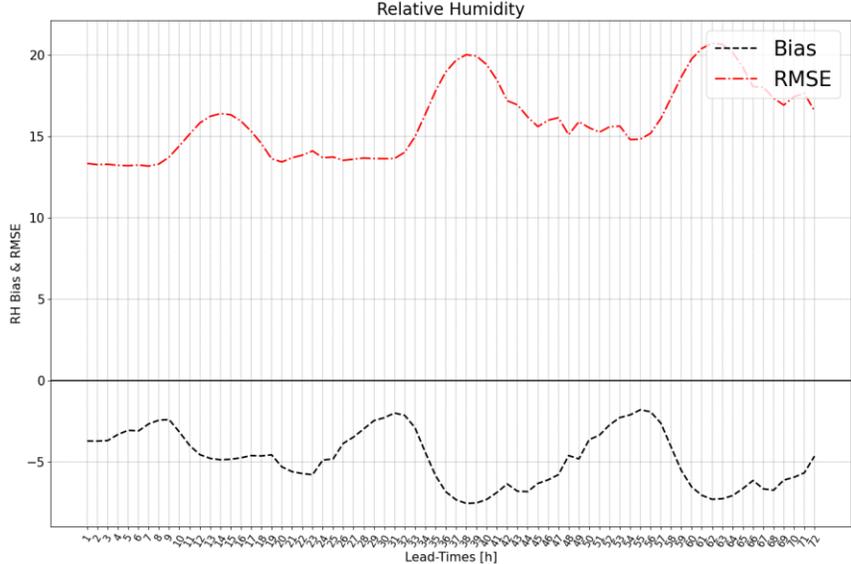
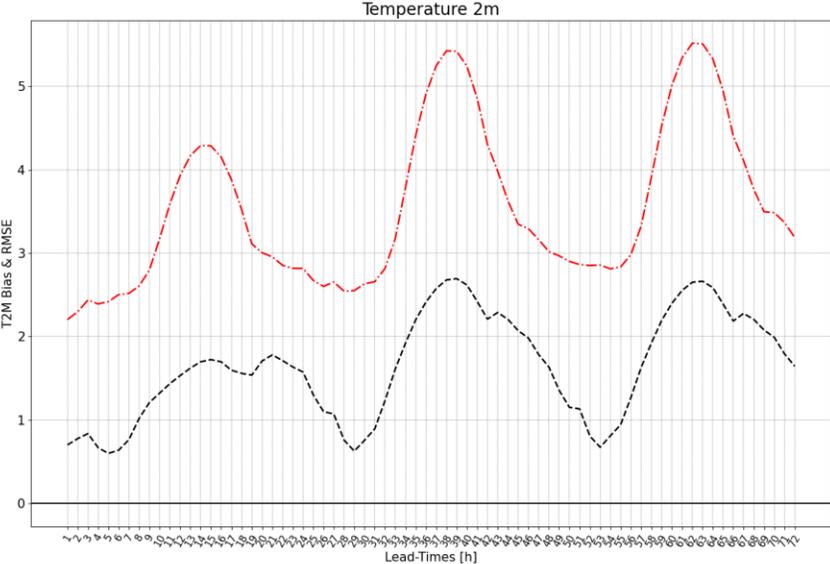
$$\text{POD} = \frac{H}{H + M}$$

$$\text{EDI} = \frac{\log(H) - \log(M)}{\log(H) + \log(M)}$$

$$\text{SEDI} = \frac{\log(\text{FAR}) - \log(\text{POD}) + \log(1 - \text{POD}) - \log(1 - \text{FAR})}{\log(\text{FAR}) + \log(\text{POD}) + \log(1 - \text{POD}) + \log(1 - \text{FAR})}$$

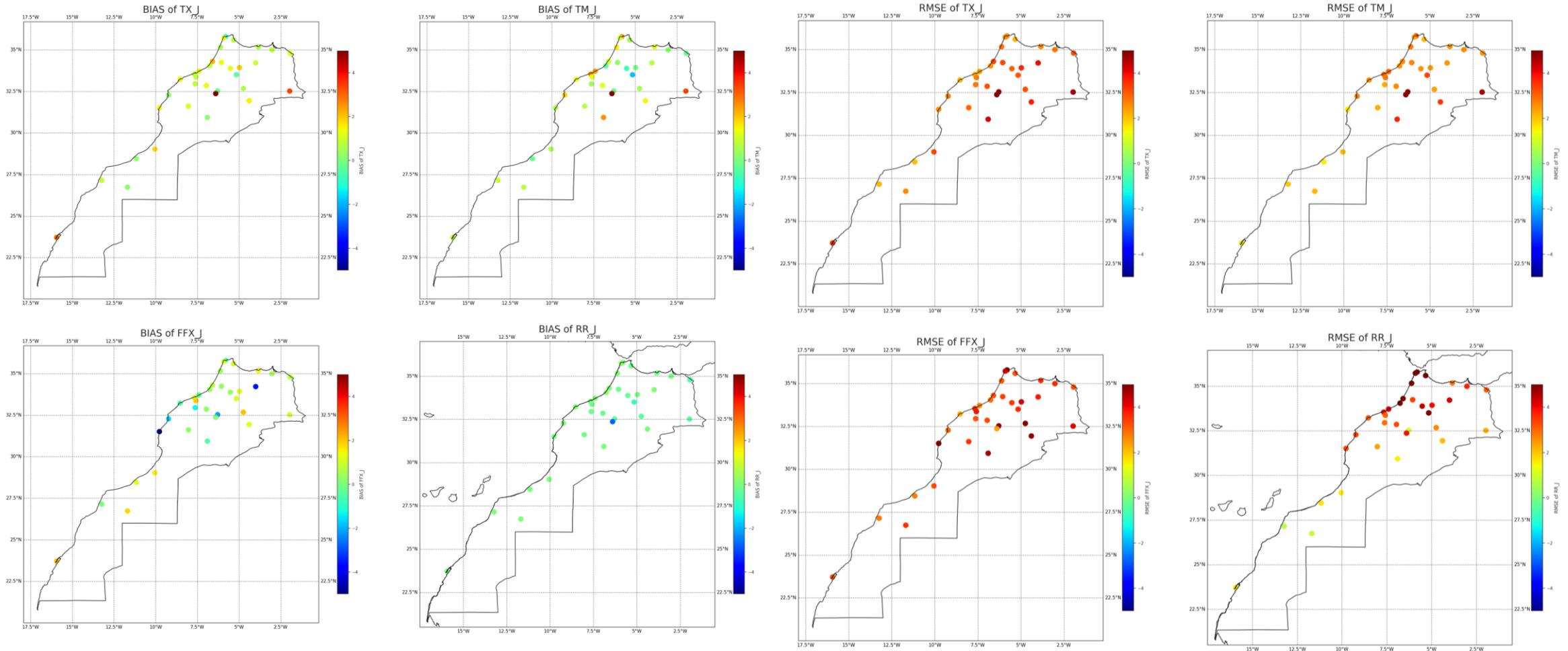
$$\text{ETS} = \frac{H - H_r}{H + M + F - H_r} \quad H_r = (H + M)(H + F) / N$$

Hourly Bias and RMSE



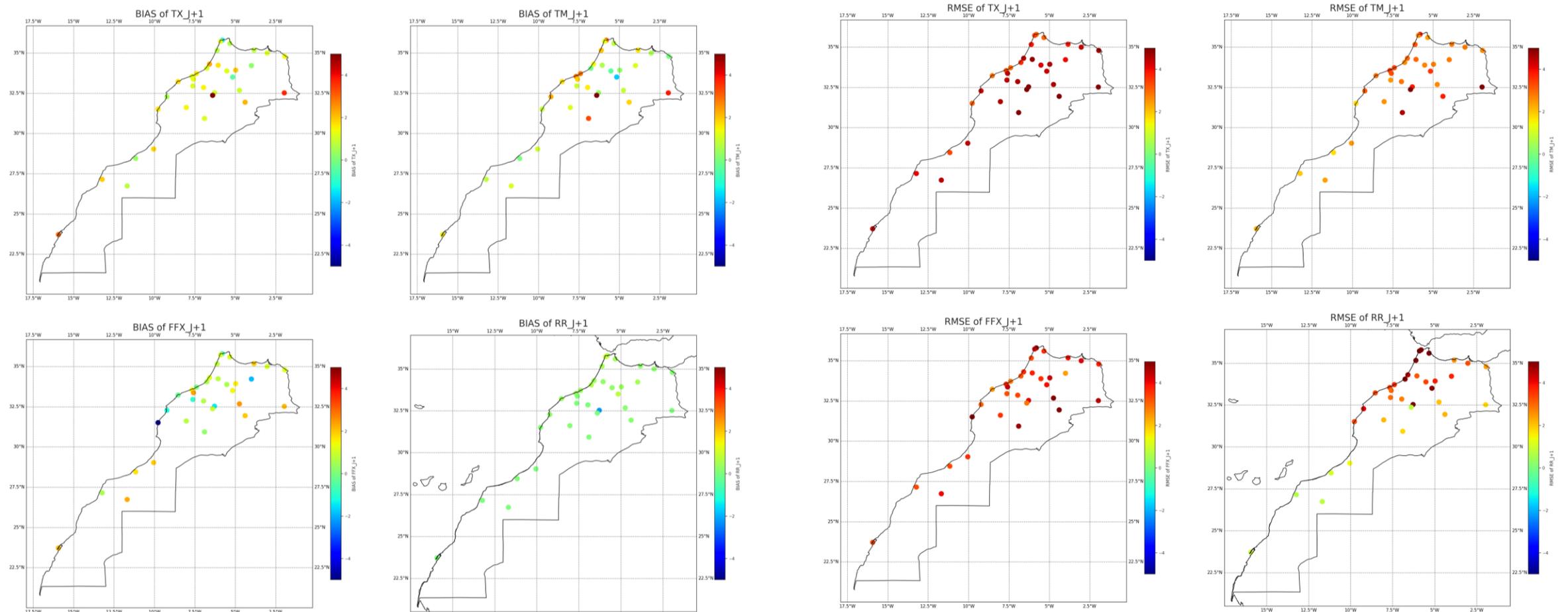
- Max Bias of T2m ~ 2 °C and RMSE ~ 5 °C
- RH Bias ~ -5 % and RMSE ~ 15 %
- WS10m Bias ~ 0 m/s and RMSE ~ 2 m/s
- MSLP Bias ~ 0 hPa and RMSE ~ 1.5 hPa
- Scores getting bad with greater leadtimes -> Predictability

Bias and RMSE at J Extreme



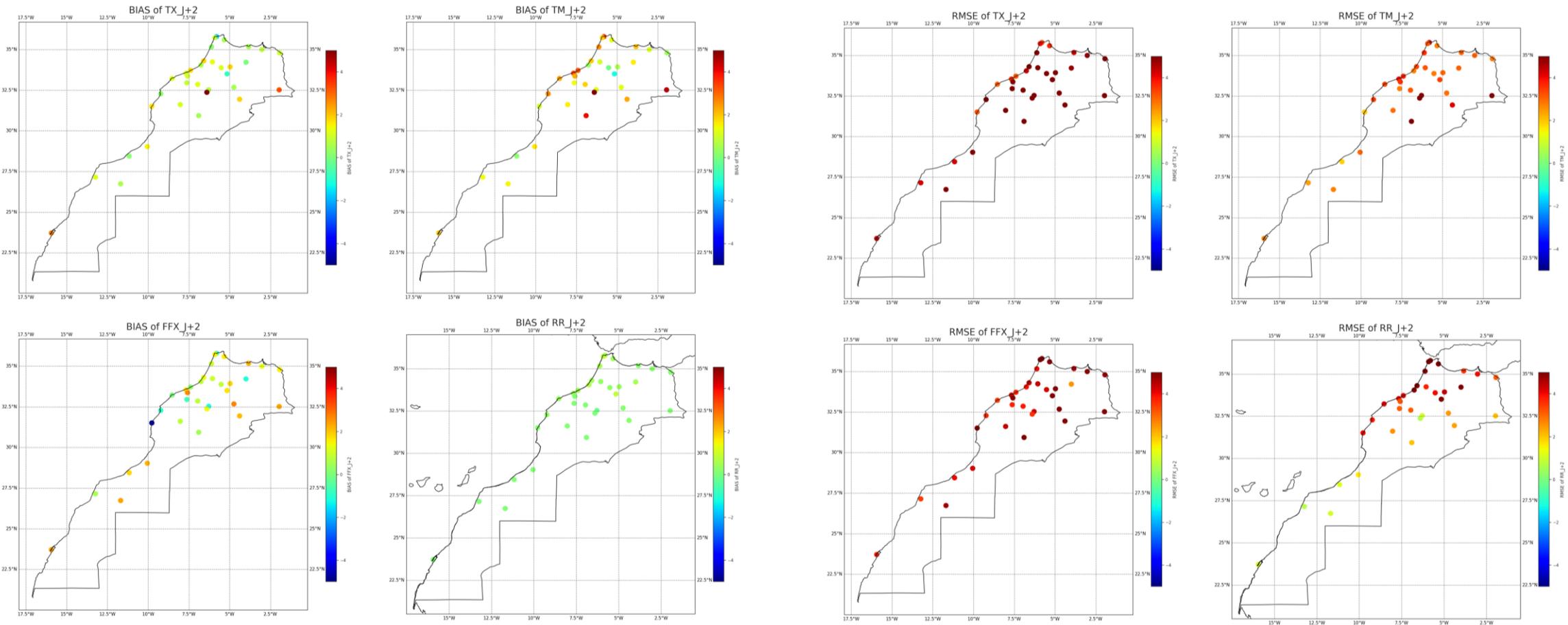
- Weak Bias for All the parameters except for some locations (TX and TM $< 2^{\circ}\text{C}$, FFX > 1.5 m/s, RR ~ 0 mm)
- RMSE superior to 2 in magnitude for all the parameters (except for some locations (desert for RR))

Bias and RMSE at J+1 Extreme



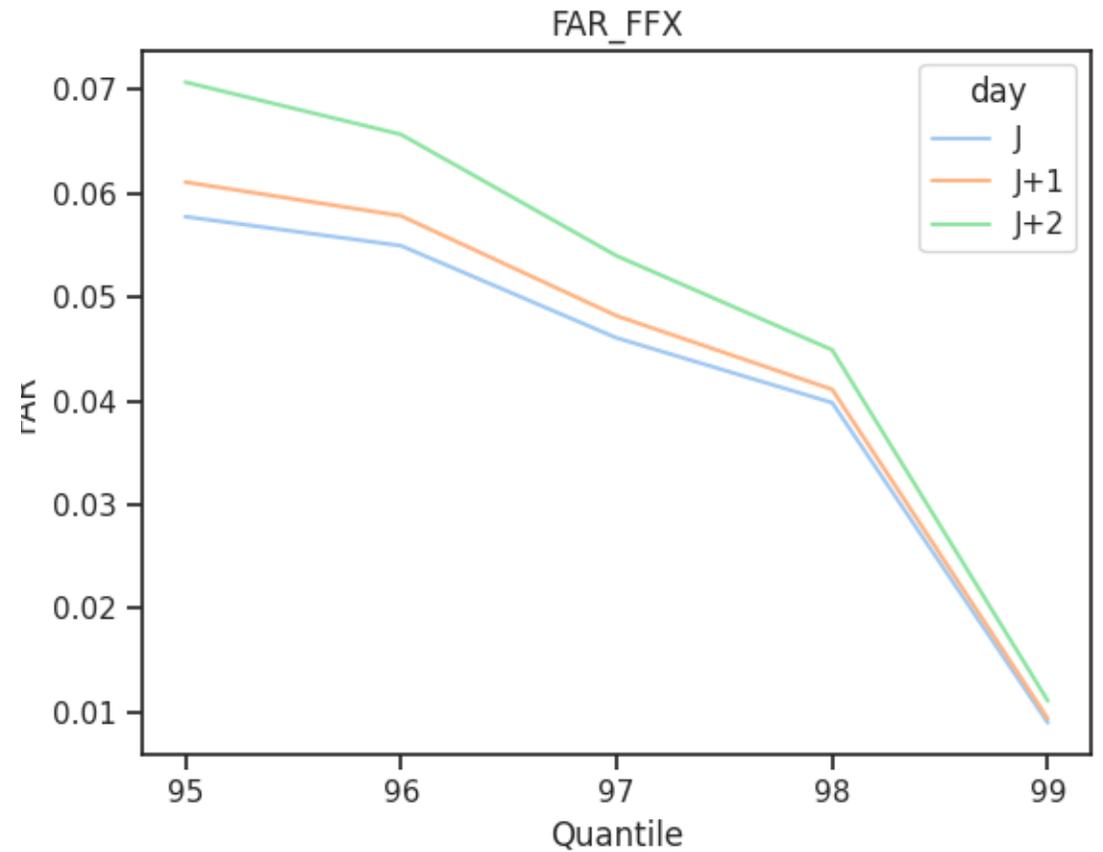
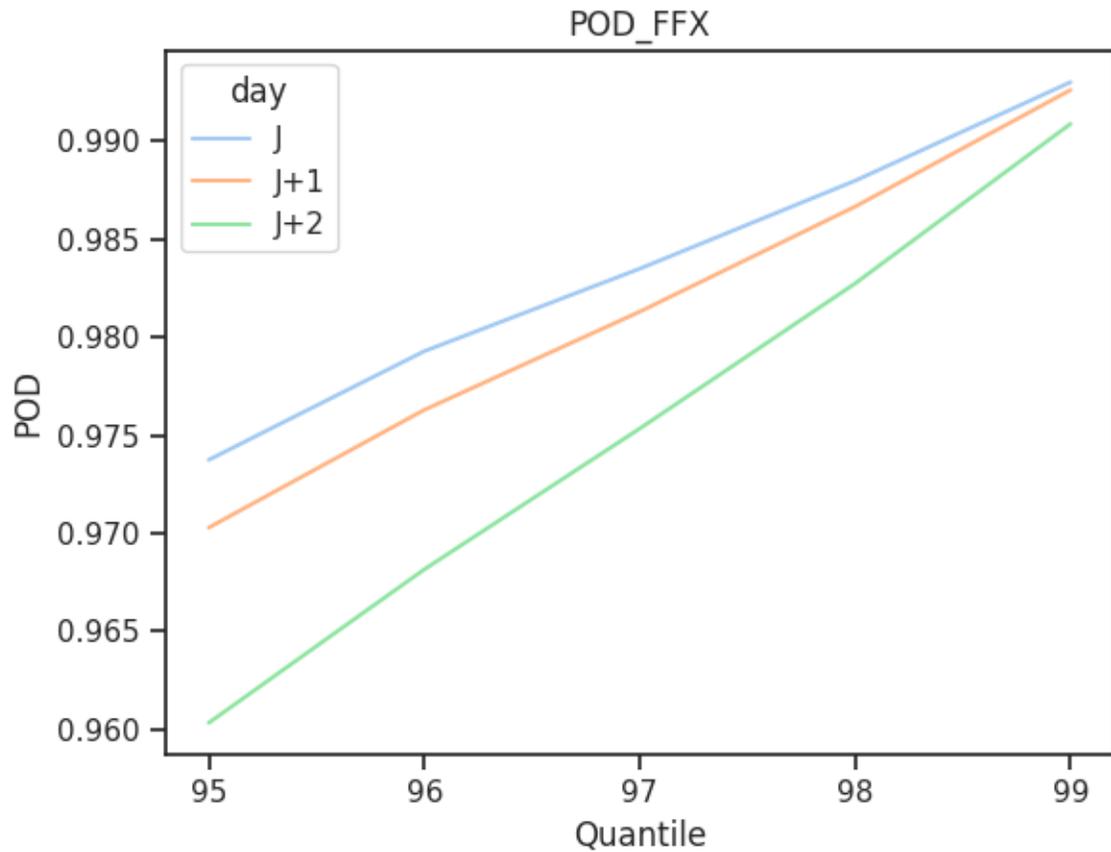
- Weak Bias for All the parameters except for some locations (TX and TM $<3^{\circ}\text{C}$, FFX > 2 m/s, RR ~ 0 mm)
- RMSE superior to 3 in magnitude for all the parameters (except for some locations (desert for RR))
- Bias and RMSE in J+1 is larger than in J

Bias and RMSE Extreme J+2



- Weak Bias for All the parameters except for some locations (TX and TM $<3^{\circ}\text{C}$, FFX > 2 m/s , RR ~ 0 mm)
- RMSE superior to 4 in magnitude for all the parameters (except for some locations (desert for RR))
- Bias and RMSE in J+2 is larger than in J and J+1 (Predictability)

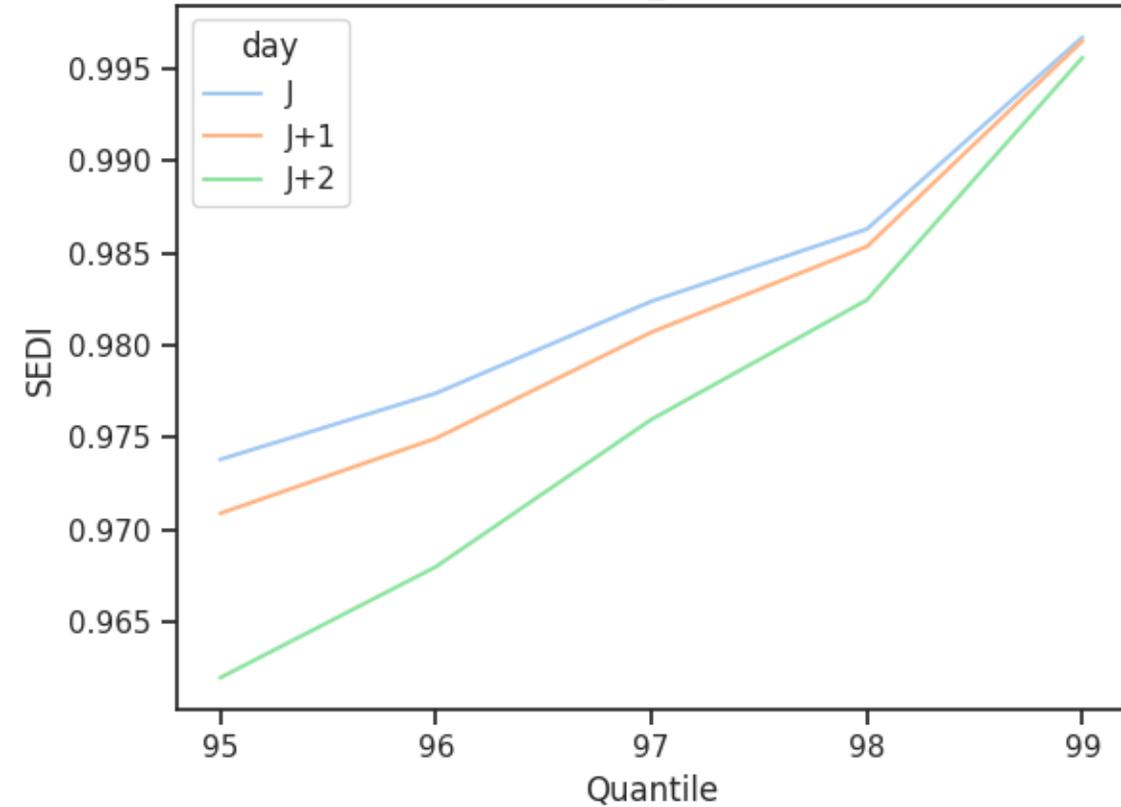
Wind Gust (FFX)



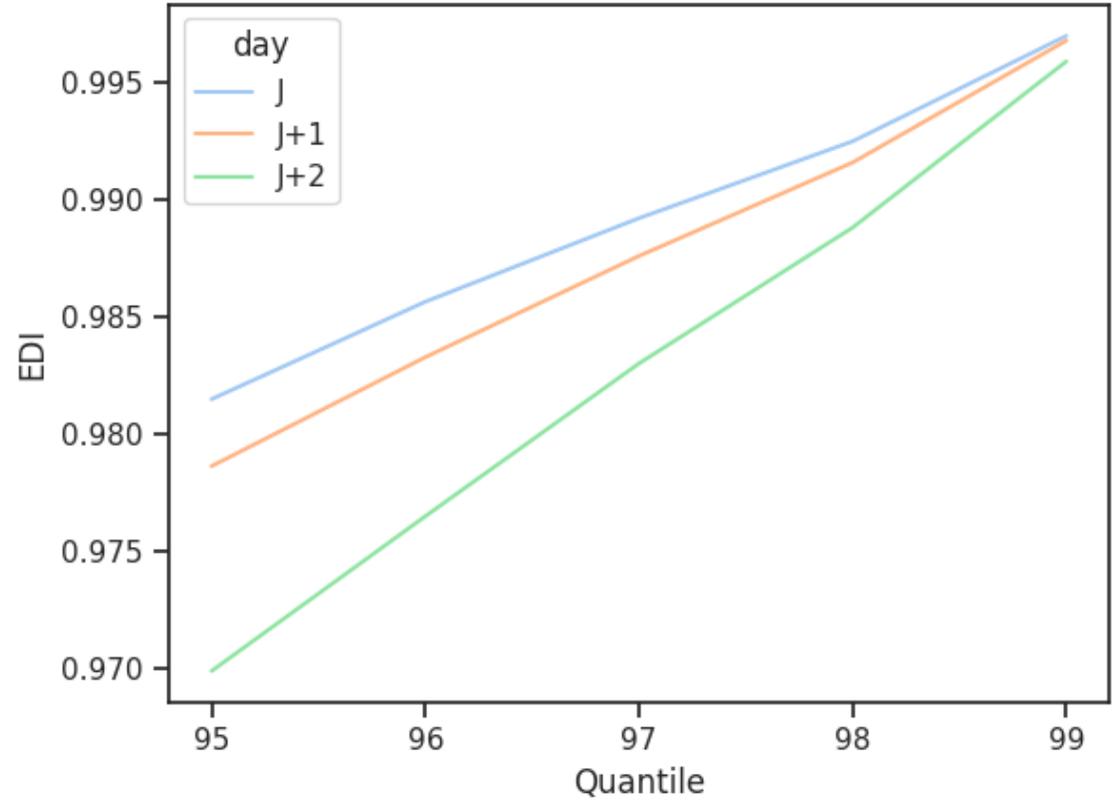
- $POD > 0,96$ for all quantiles
- $FAR < 0,07$ for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Wind Gust (FFX)

SEDI_FFX

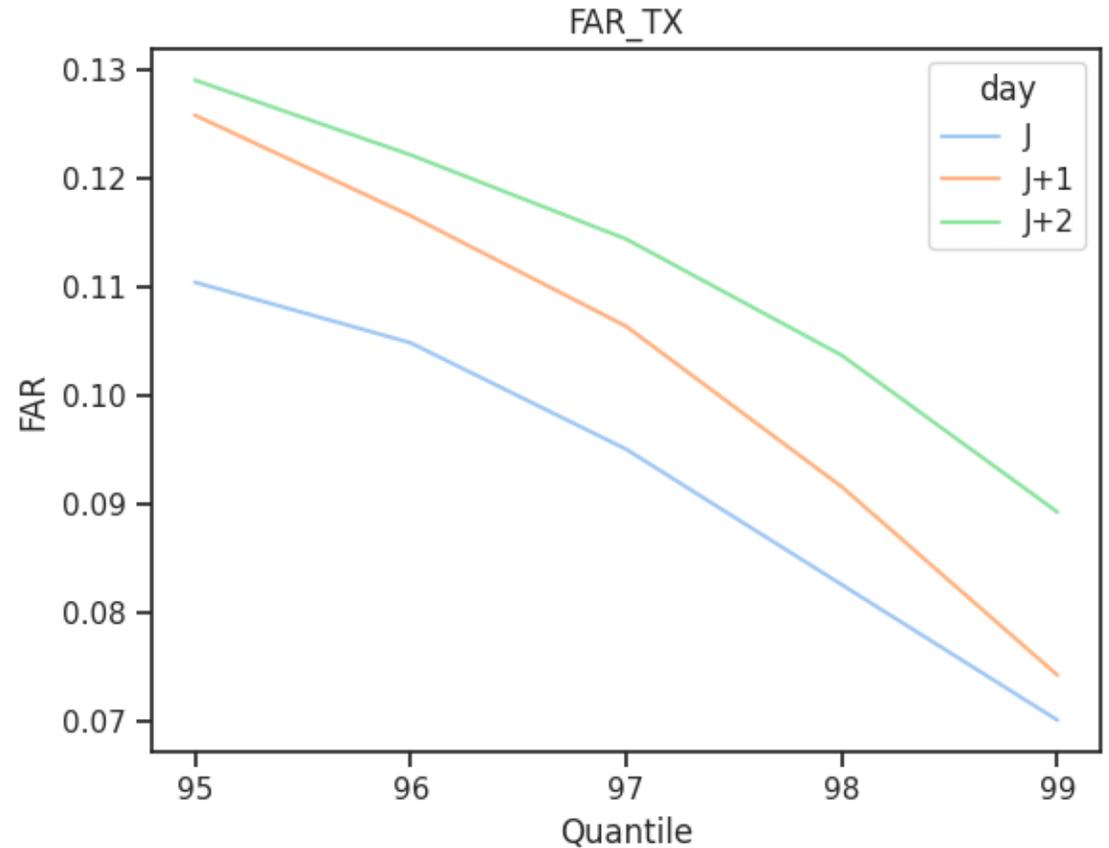
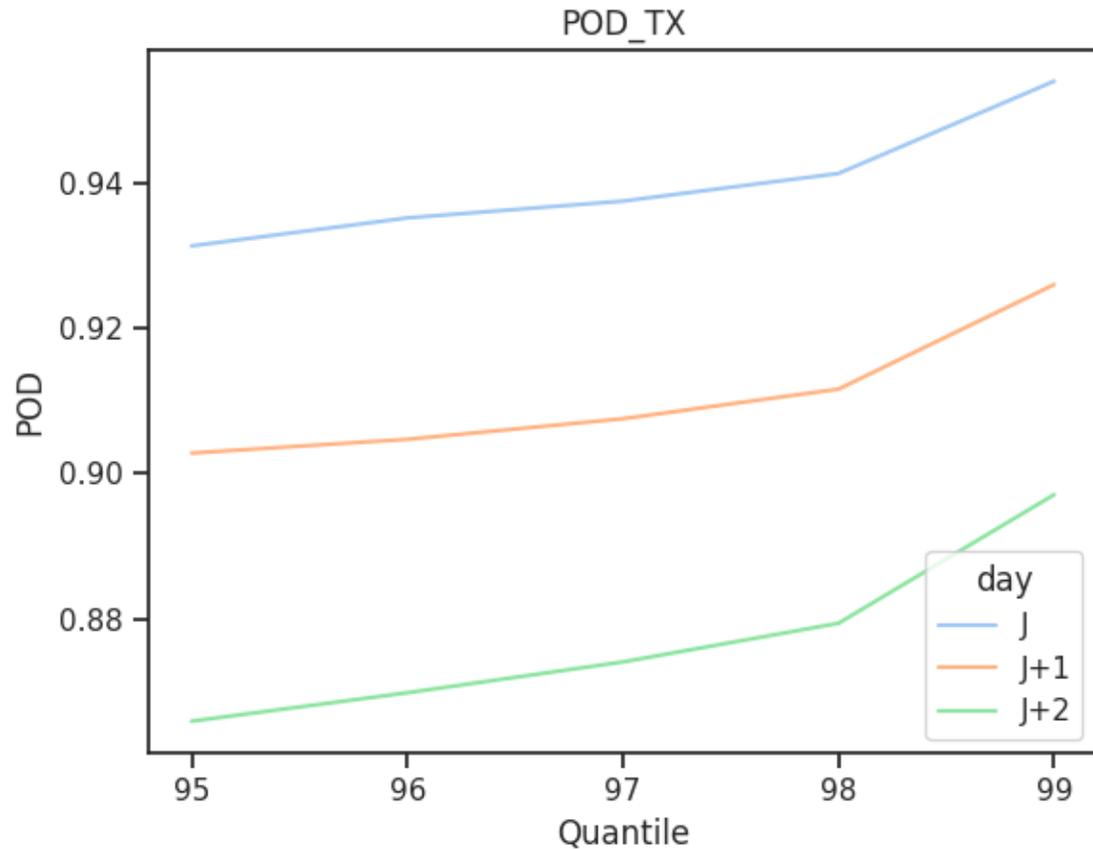


EDI_FFX



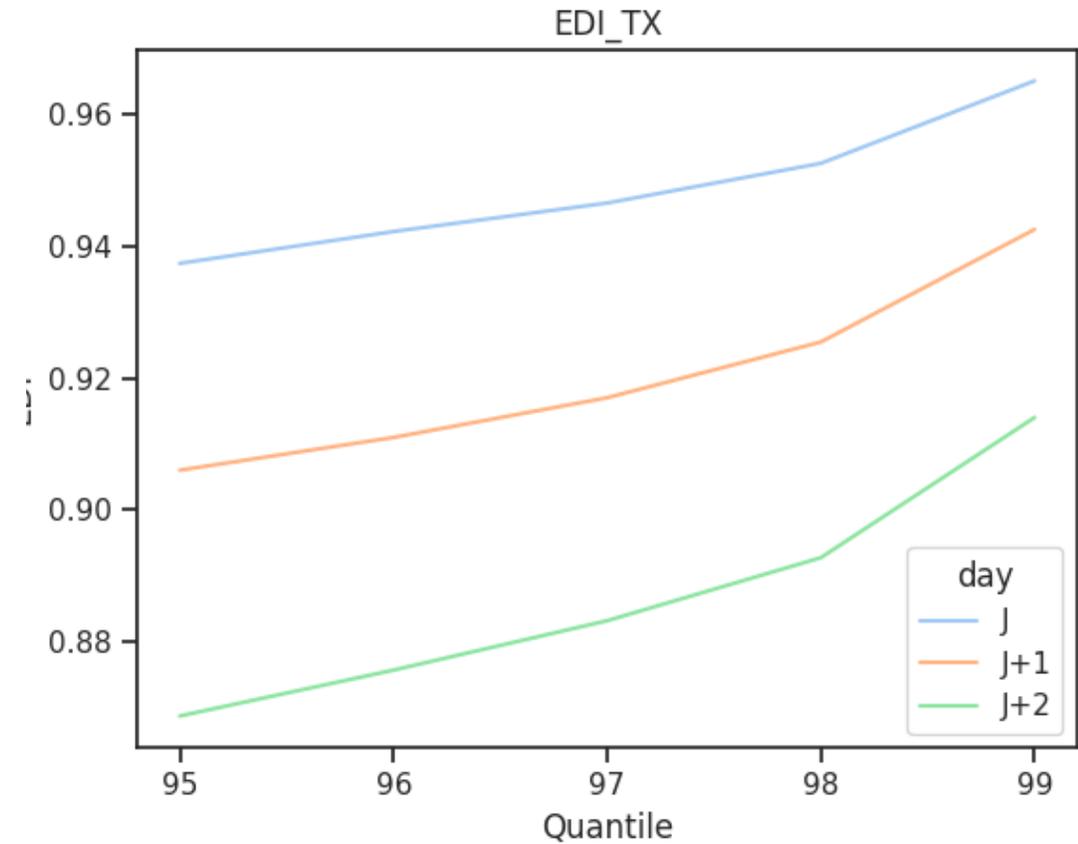
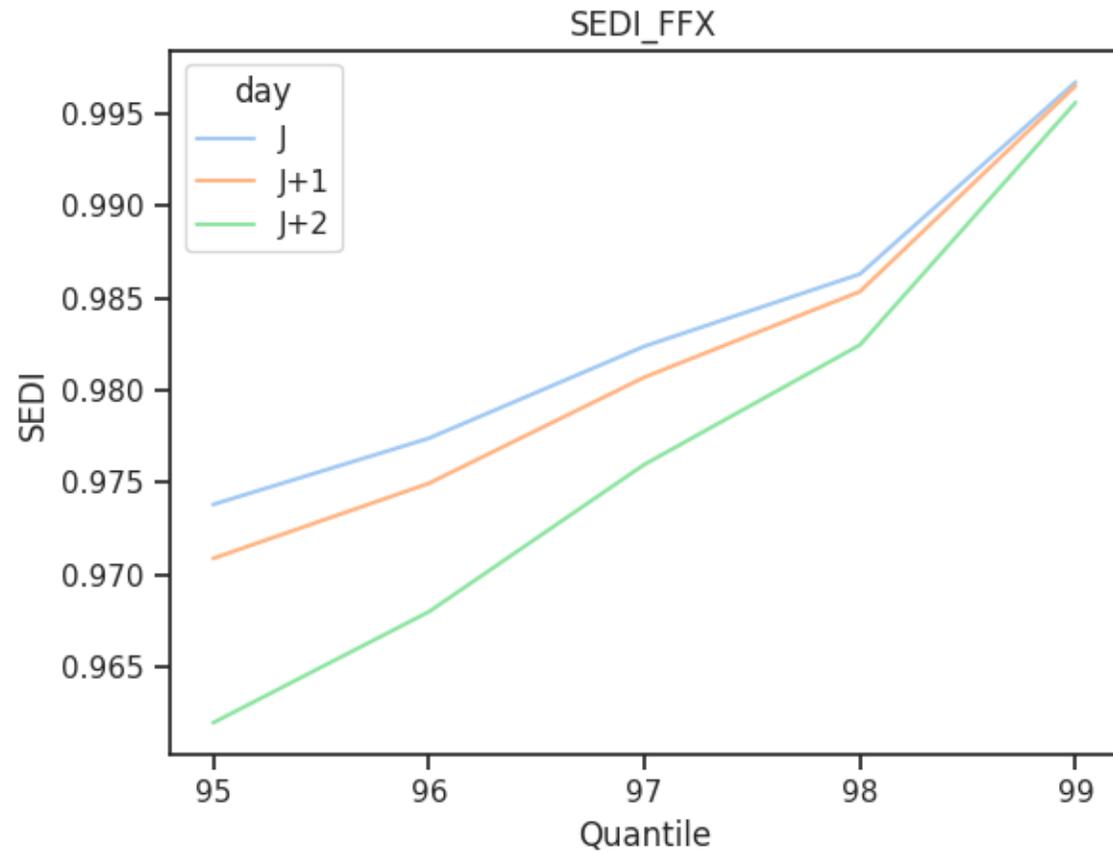
- SEDI > 0,96 for all quantiles
- EDI > 0,97 for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Max Temperature (TX)



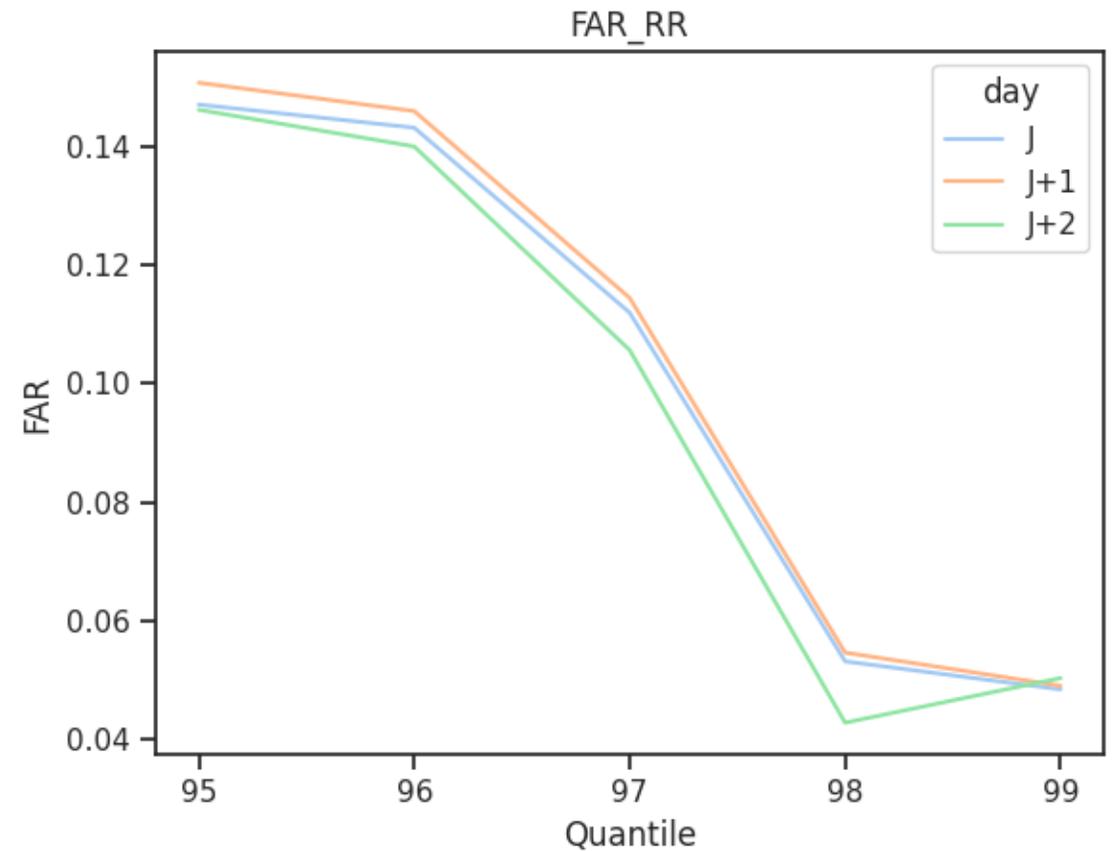
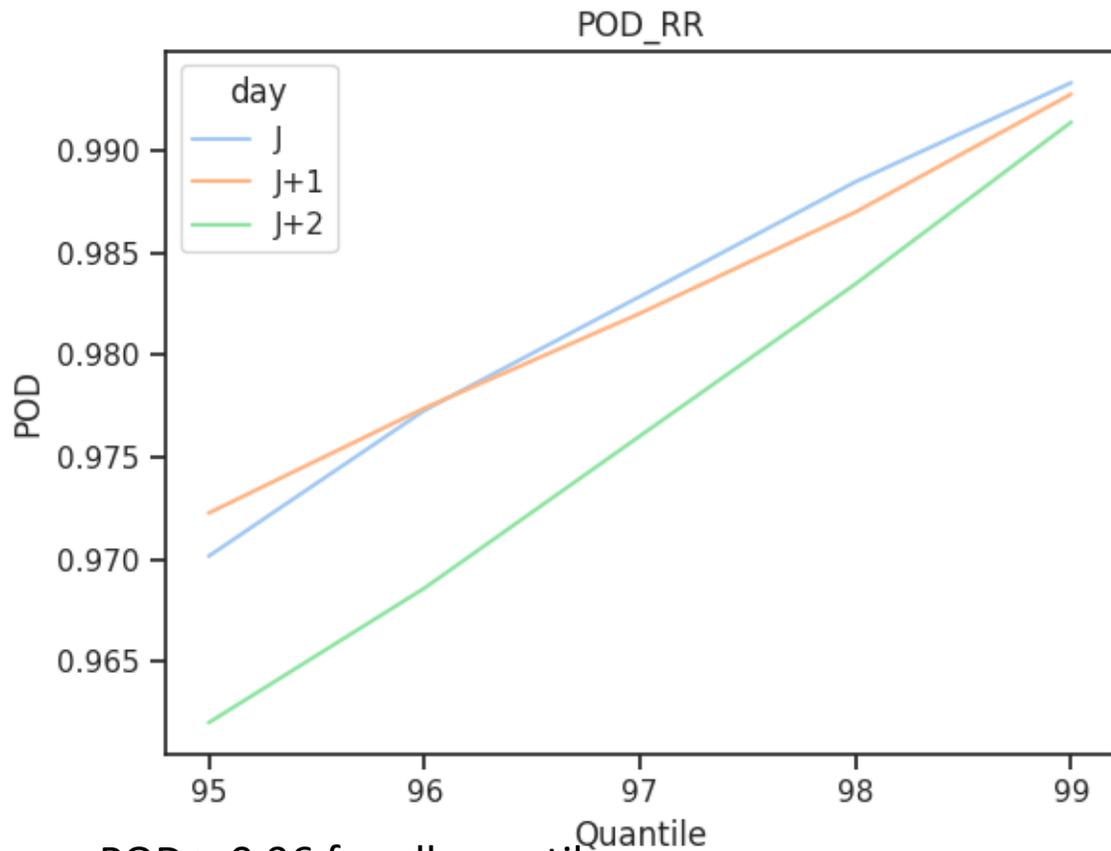
- $POD > 0,86$ for all quantiles
- $FAR < 0,13$ for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Max Temperature (TX)



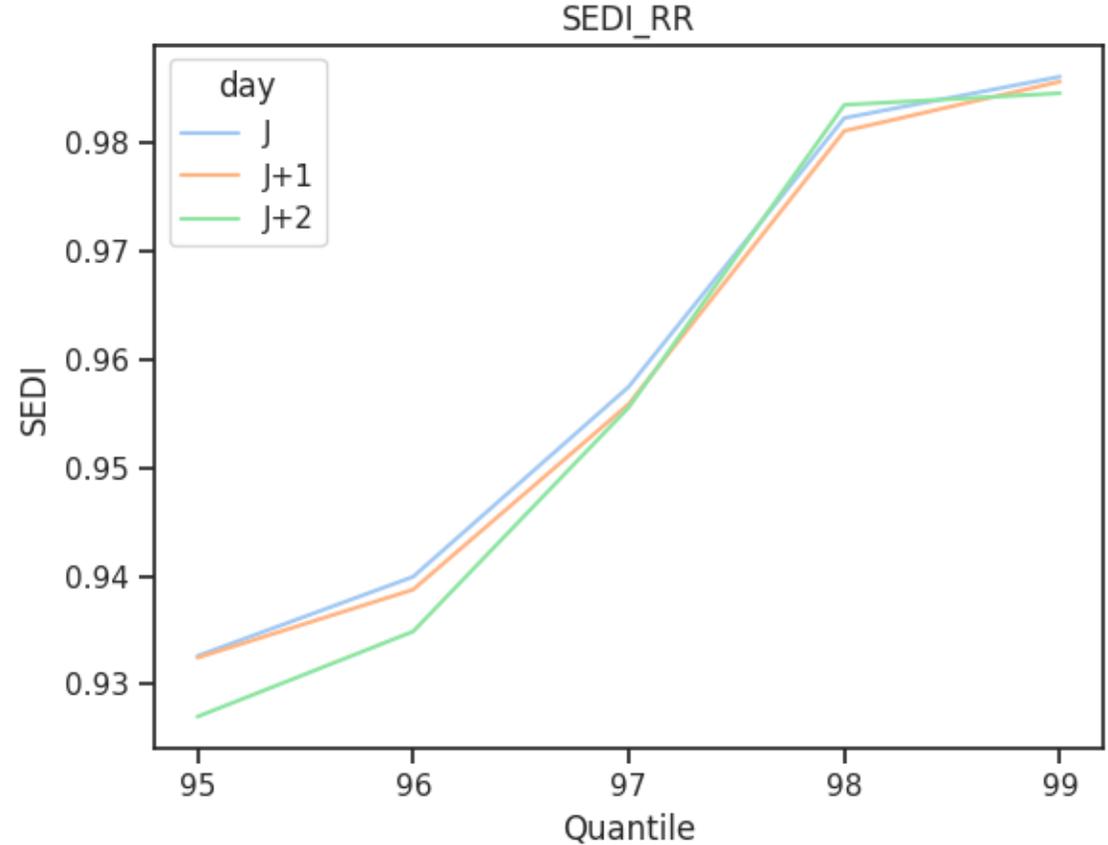
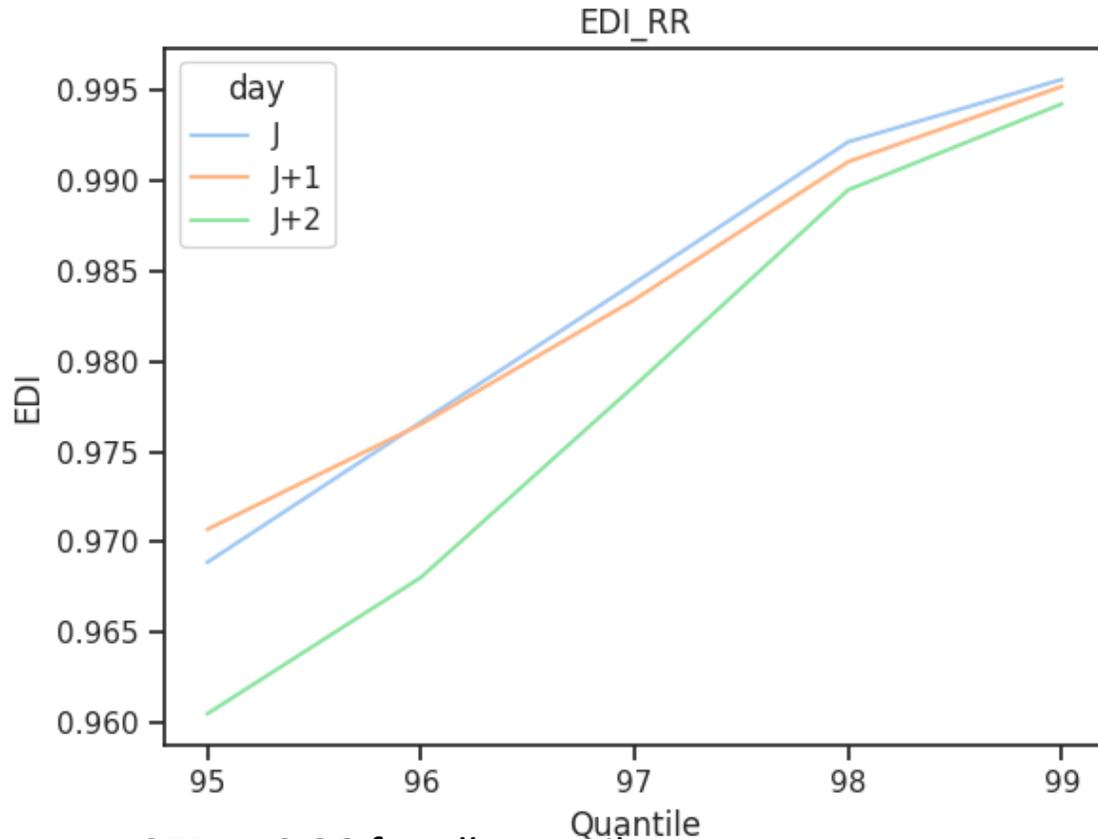
- SEDI > 0,96 for all quantiles
- EDI > 0,86 for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Precipitations (RR)



- $POD > 0,96$ for all quantiles
- $FAR < 0,14$ for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Precipitations (RR)



- SEDI > 0,96 for all quantiles
- EDI > 0,93 for all quantiles
- Better scores for high quantiles
- Better scores for most recent days

Conclusion

- AROME shows weak bias and RMSE for continuous verification for most parameters (except RH)
- Regarding probabilistic verification AROME shows high scores > 96%
- Scores depends on locations
- Degradation of scores with high predictability

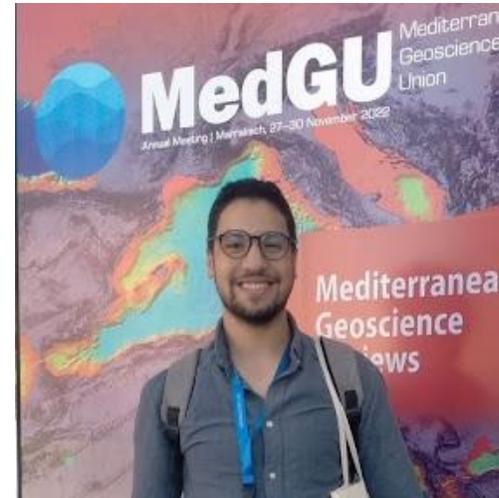
Perspectives

- Verification of AROME relatively to seasons and climate types
- Probabilistic verification of AROME-EPS
- Investigating Calibration methods using AI algorithms



Thank you!

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