ENHANCING NMME PRECIPITATION FORECAST ACCURACY USING SM2RAIN-CLIMATE

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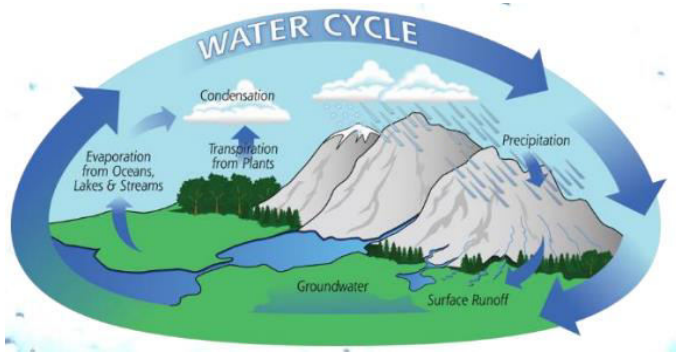
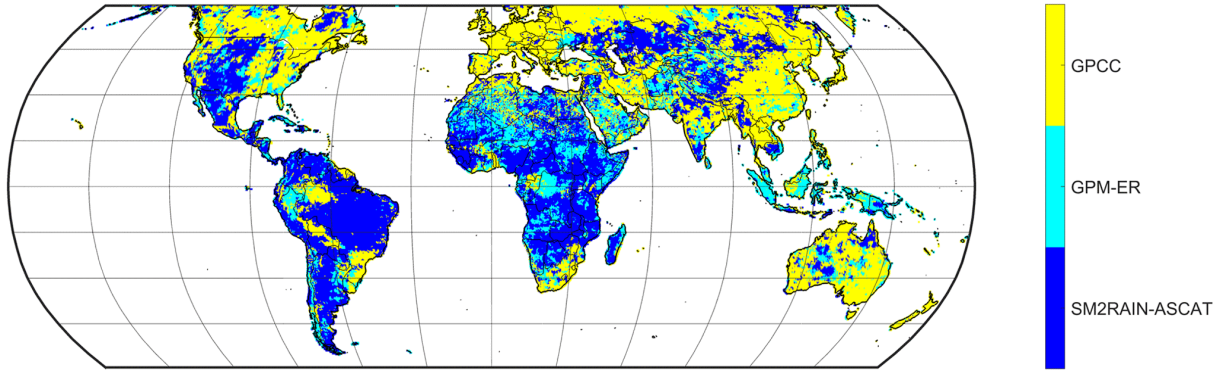
Precipitation

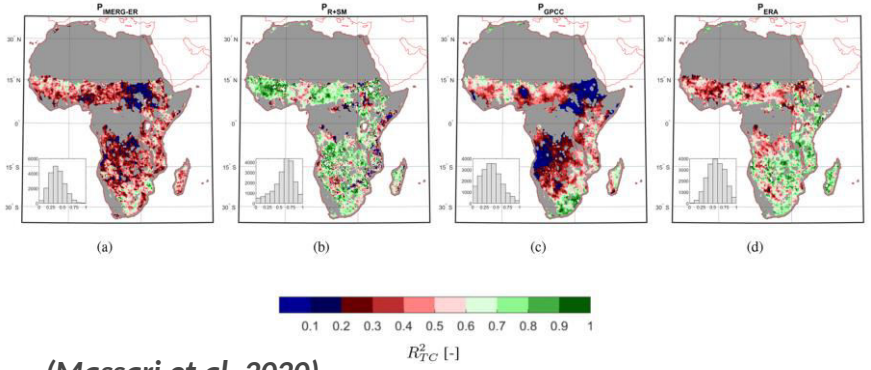


Precipitation is an integral part of the Earth's hydrologic cycle, playing the foremost role in its water and energy balance. Accurate, uninterrupted, and uniform observation of precipitation represents an important input for hydrologic research and operational applications such as drought monitoring, flood forecasting, water resource management.

Precipitation datasets:



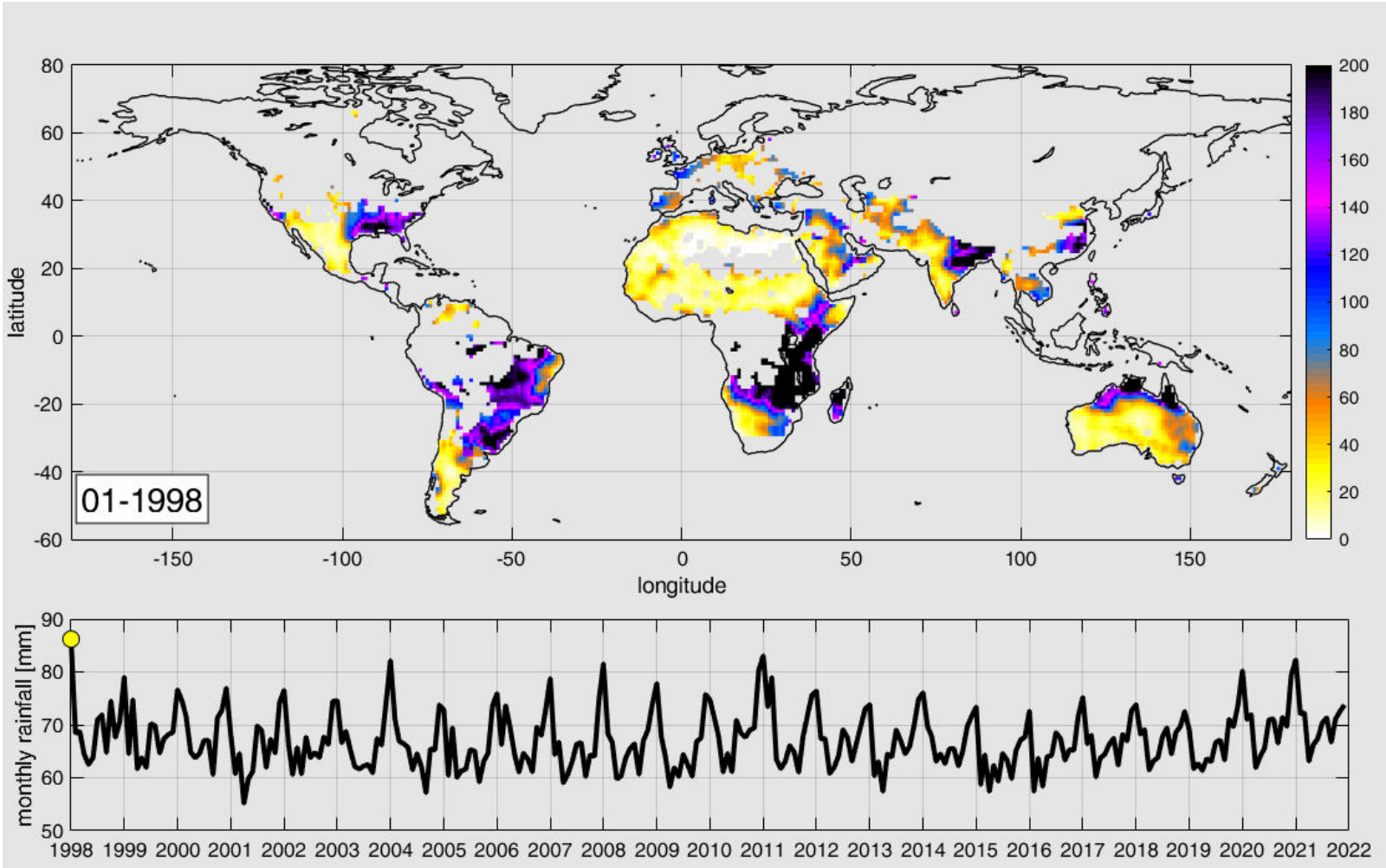
(Brocca et al. 2019)



(Massari et al. 2020)

SM2RAIN-Climate

Temporal coverage: 1998-2021
Spatio-temporal resolution: 1 degree\1-monthly



Mosaffa et al. (submitted to Scientific Data)
https://doi.org/10.5281/zenodo.7276470

Method

CanCM4i
COLA-RSMAS-CCSM4
NCEP-CFSv2
GFDL-CM2p1-aer04
GFDL-CM2p5-FLOR-A06
GFDL-CM2p5-FLOR-B01
NASA-GEOSS2S

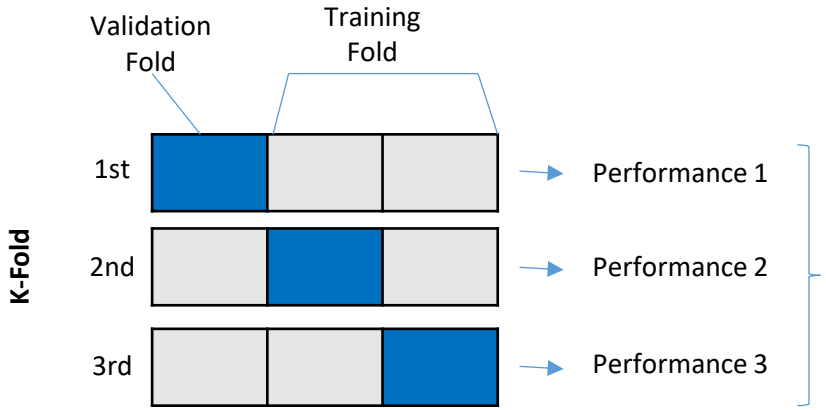
→ 1 degree/monthly
0.5,1.5,2.5,3.5 lead times
Over Europe and Africa
1998-2020

→ NMME

→ Random Forest algorithm

Train model for each lead time, month, and two quantiles

→ Cross validation



- **Correlation Coefficient**
- **RMSE**
- **BIAS (positive mean overestimation)**

Result

3-Fold Cross Validation over Europe

Correlation Coefficient (-)

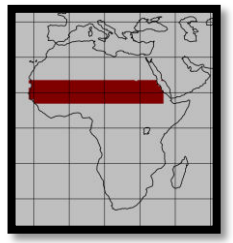
Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	0.598	0.812	0.596	0.813	0.592	0.813	0.594	0.812
2nd	0.701	0.871	0.696	0.869	0.699	0.865	0.703	0.869
3rd	0.710	0.870	0.686	0.866	0.686	0.866	0.689	0.865
Average	**0.670**	**0.851**	**0.659**	**0.849**	**0.659**	**0.848**	**0.662**	**0.849**

RMSE(mm)

Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	34.38	24.65	34.30	24.59	34.29	24.33	34.33	24.64
2nd	28.49	19.40	28.68	19.57	28.50	19.86	28.55	19.52
3rd	27.00	18.64	27.66	18.80	27.93	18.77	27.53	18.85
Average	**29.96**	**20.90**	**30.21**	**20.98**	**30.24**	**20.99**	**30.14**	**21.00**

BIAS(mm)

Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	-2.31	-0.78	-2.07	-0.60	-2.00	-0.63	-1.43	-0.63
2nd	-1.76	-0.33	-2.42	-0.55	-2.32	-0.58	-1.83	-0.62
3rd	1.20	0.95	1.11	1.03	1.64	1.11	2.14	1.11
Average	**-0.96**	**-0.05**	**-1.13**	**-0.04**	**-0.89**	**-0.03**	**-0.37**	**-0.04**



3-Fold Cross Validation over Africa

Correlation Coefficient (-)

Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	0.79	0.88	0.79	0.88	0.79	0.88	0.79	0.88
2nd	0.90	0.94	0.89	0.94	0.90	0.94	0.90	0.94
3rd	0.91	0.94	0.91	0.94	0.91	0.94	0.91	0.94
Average	**0.870**	**0.925**	**0.866**	**0.927**	**0.869**	**0.927**	**0.869**	**0.927**

RMSE(mm)

Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	45.26	33.30	44.77	32.84	44.31	32.80	44.78	32.69
2nd	30.13	20.36	28.03	20.12	27.74	20.19	27.34	20.09
3rd	28.22	20.06	25.92	19.87	25.70	19.78	25.73	19.73
Average	**34.54**	**24.57**	**32.92**	**24.28**	**32.58**	**24.26**	**32.61**	**24.17**

BIAS(mm)

Lead time	0.5 month		1.5 month		2.5 month		3.5 month	
Fold Iteration	Before	After	Before	After	Before	After	Before	After
1st	-6.81	-8.07	-11.07	-7.60	-10.67	-7.47	-10.27	-7.43
2nd	4.52	2.33	-0.54	1.98	-0.40	2.01	-0.01	1.93
3rd	5.86	3.92	1.55	3.93	1.11	3.64	1.70	3.70
Average	**1.19**	**-0.60**	**-3.35**	**-0.56**	**-3.32**	**-0.60**	**-2.86**	**-0.59**

Result

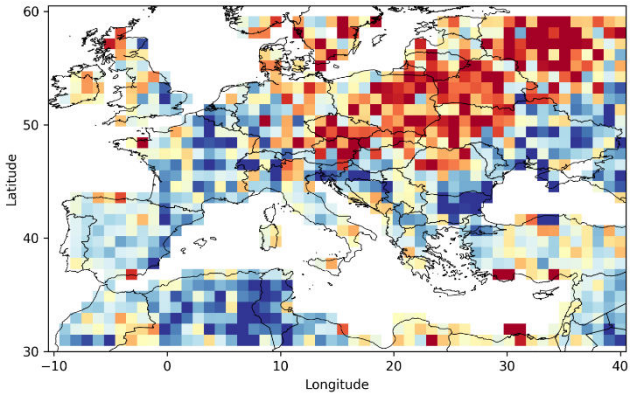
Assessment of bias corrected NMME using GPCC as baseline

Correlation Coefficient		
	Test	
Lead time	Before	After
0.5 month	0.664	0.703
1.5 month	0.628	0.689
2.5 month	0.628	0.690
3.5 month	0.629	0.687

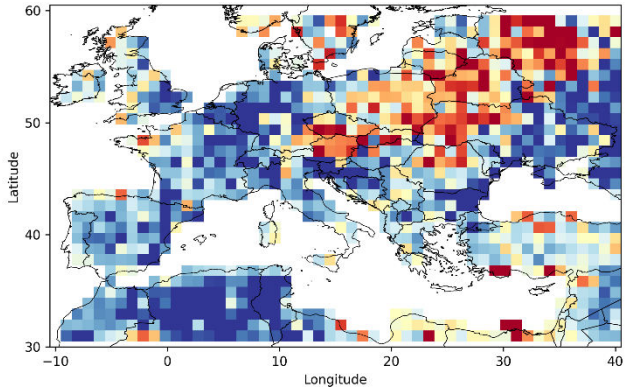
RMSE		
	Test	
Lead time	Before	After
0.5 month	35.161	33.574
1.5 month	36.509	34.234
2.5 month	36.576	34.198
3.5 month	36.677	34.482

Bias		
	Test	
Lead time	Before	After
0.5 month	0.570	1.617
1.5 month	0.455	1.729
2.5 month	0.721	1.692
3.5 month	1.289	1.780

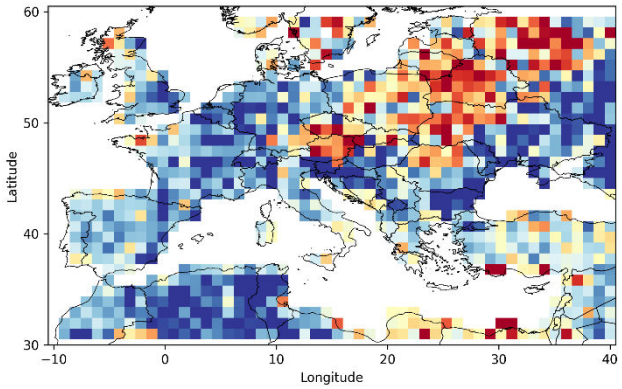
Test-lead 0.5



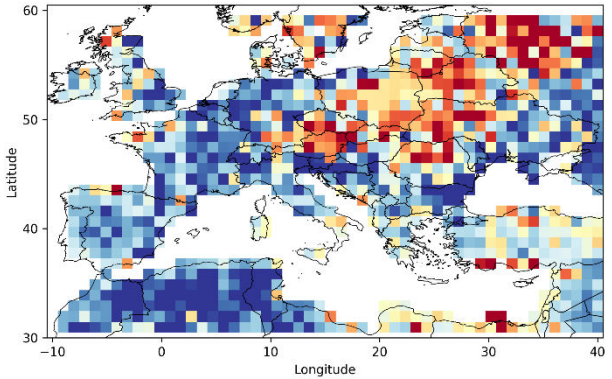
Test-lead 2.5



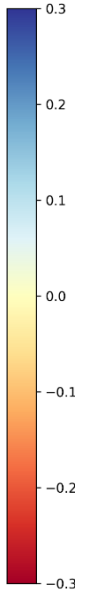
Test-lead 1.5



Test-lead 3.5



Difference (After-bias-correction vs Before-bias-correction) -test period



Result

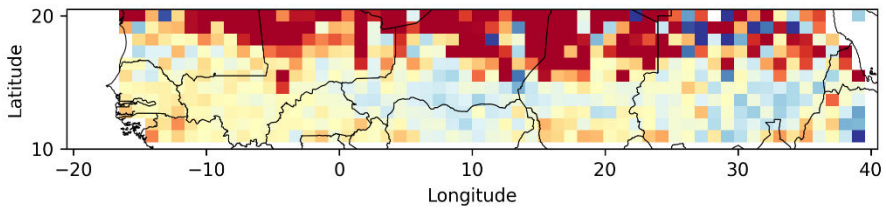
Assessment of bias corrected NMME using GPCC as baseline

Correlation Coefficient		
	Test	
Lead time	Before	After
0.5 month	0.865	0.869
1.5 month	0.857	0.868
2.5 month	0.863	0.867
3.5 month	0.859	0.867

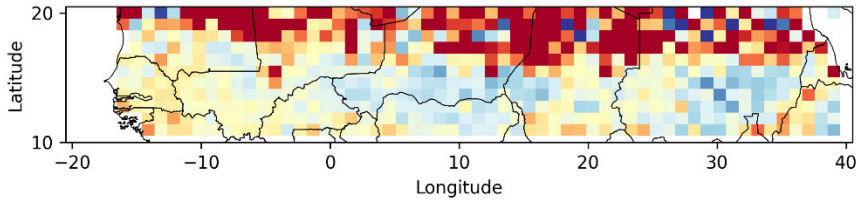
RMSE		
	Test	
Lead time	Before	After
0.5 month	38.69	38.04
1.5 month	38.87	38.17
2.5 month	38.24	38.18
3.5 month	38.66	38.27

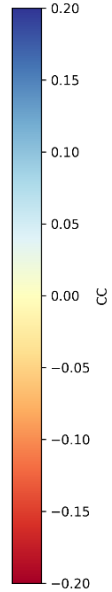
Bias		
	Test	
Lead time	Before	After
0.5 month	7.58	6.63
1.5 month	2.78	6.54
2.5 month	2.87	6.48
3.5 month	3.36	6.47

Test-lead 0.5

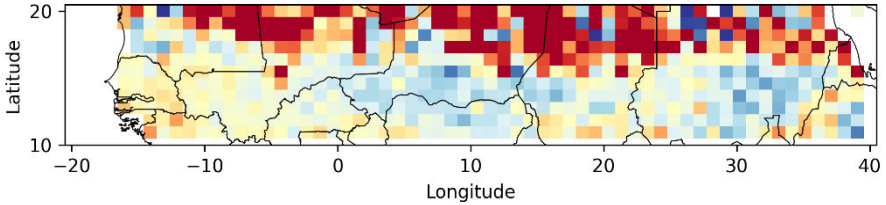


Test-lead 2.5

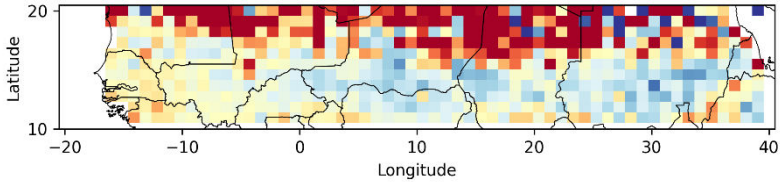




Test-lead 1.5

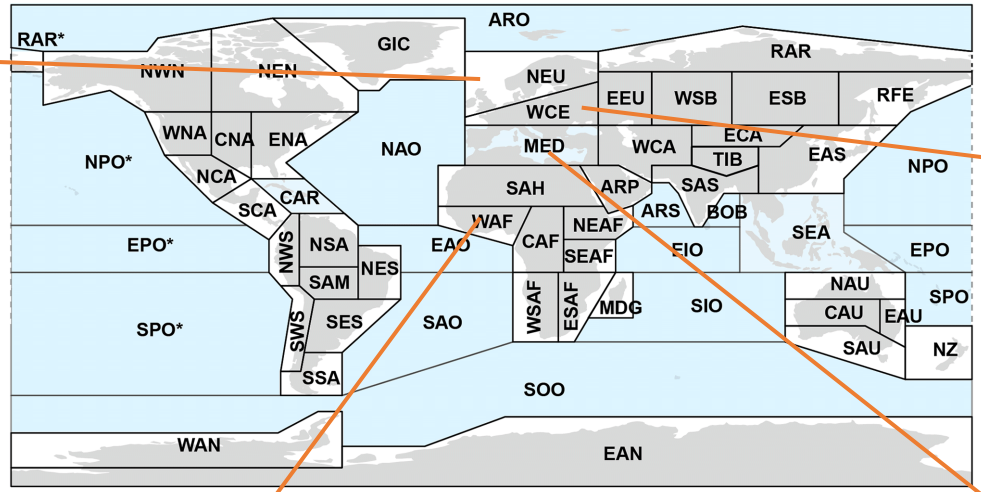


Test-lead 3.5



Result

IPCC climate reference regions *(Iturbide et al. 2020)*



N.Europe (NEU)

CC	• 0.59 (before) • 0.60 (after)
RMSE	• 42.50 (before) • 41.75 (after)
BIAS	• -1.36 (before) • -0.04(after)

Western & Central Europe (WCE)

CC	• 0.53 (before) • 0.54 (after)
RMSE	• 36.17 (before) • 36.16 (after)
BIAS	• 4.12 (before) • 1.01 (after)

Westren Africa (WAF)

CC	• 0.88 (before) • 0.89 (after)
RMSE	• 43.43 (before) • 41.46 (after)
BIAS	• 10.18(before) • 7.44(after)

Mediterranean (MED)

CC	• 0.71 (before) • 0.77 (after)
RMSE	• 34.05 (before) • 30.59 (after)
BIAS	• -3.19 (before) • 2.25 (after)

Conclusion

The major findings are summarized as follows:

- The NMME predictions are more skillful in North Africa and Mediterranean area.
- Bias correction of NMME using the RF algorithm, coupled with the SM2RAIN-Climate product, yields a noticeable enhancement in forecast skill, as demonstrated through cross-validation.
- RF successful in improving the accuracy of the NMME, particularly over Mediterranean area.
- Notably, the areas where SM2RAIN demonstrates superior skill coincide with more pronounced improvements in NMME predictions.

Thank You

For Your Attention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