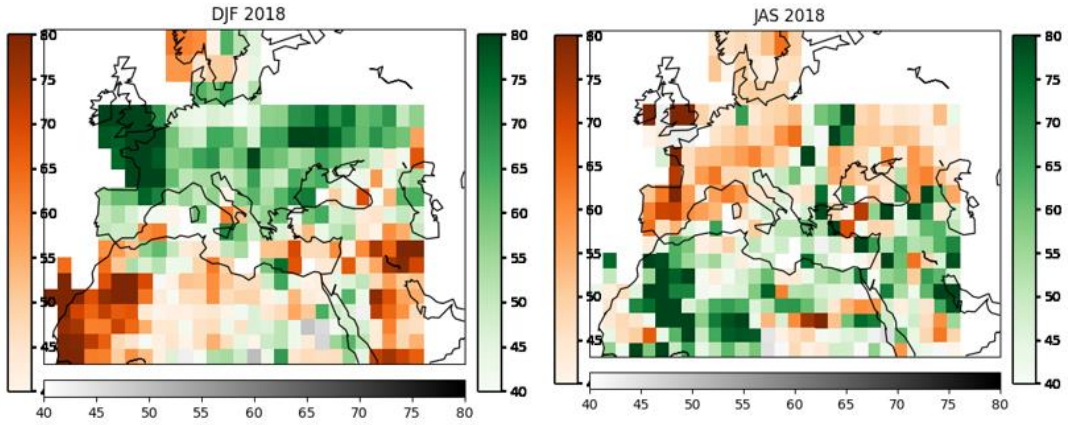
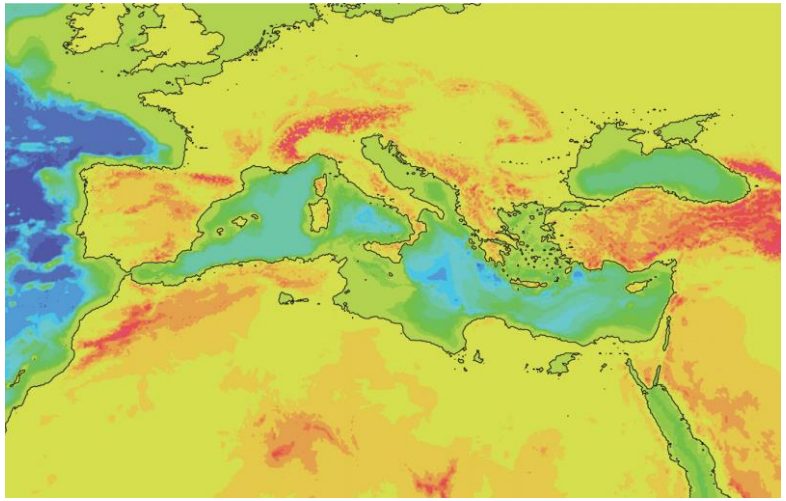
Medscope's Task 2.4 Development of empirical forecast systems

Development of an Empirical Forecast System for the Mediterranean

Rodriguez-Guisado, E; Serrano de la Torre, A.; Sanchez-Garcia, E.; Navascués, B.; Domínguez-Alonso, M.; Rodríguez-Camino, E.

AEMET





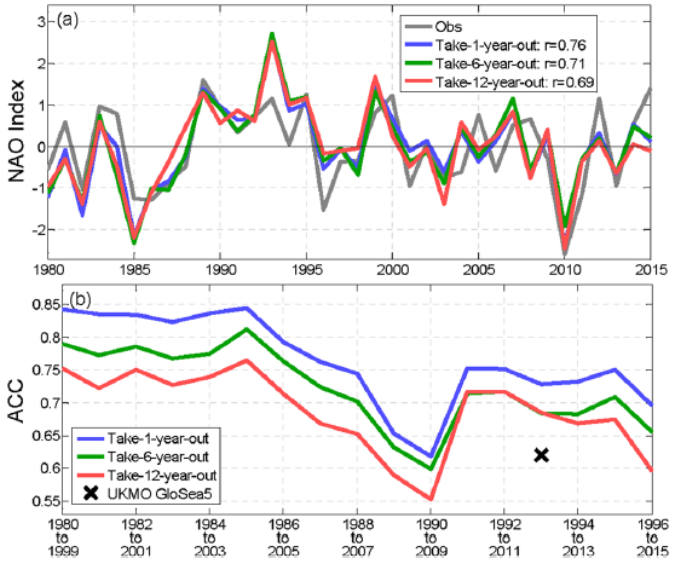
Outline

- Introduction/motivation
- Requirement of MEDSCOPE Task 2.4
- Base line version of Empirical Seasonal Forecasting System
- Verification/ Comparison against Dynamical Systems
- Final remarks
- Future work

Task 2.4 Development of empirical forecast systems

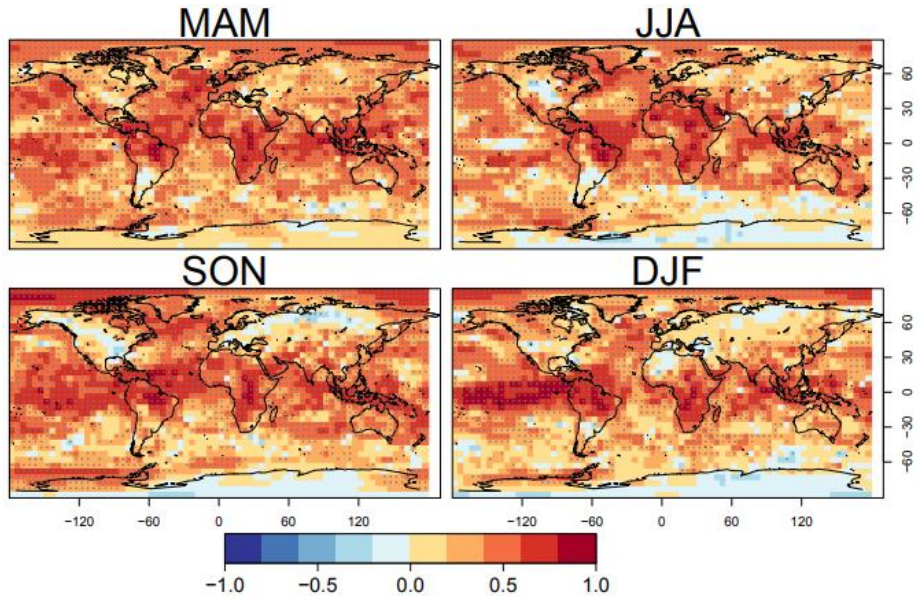
- Dynamical seasonal forecasts still show low skill over Europe/Mediterranean regions
- Computationally-cheap
- Possibility of different ways to combine results with dynamical forecasts
- Good results when predictors are carefully selected (Wang et al, 2017) (tasks 2.1, 2.2, 2.3)

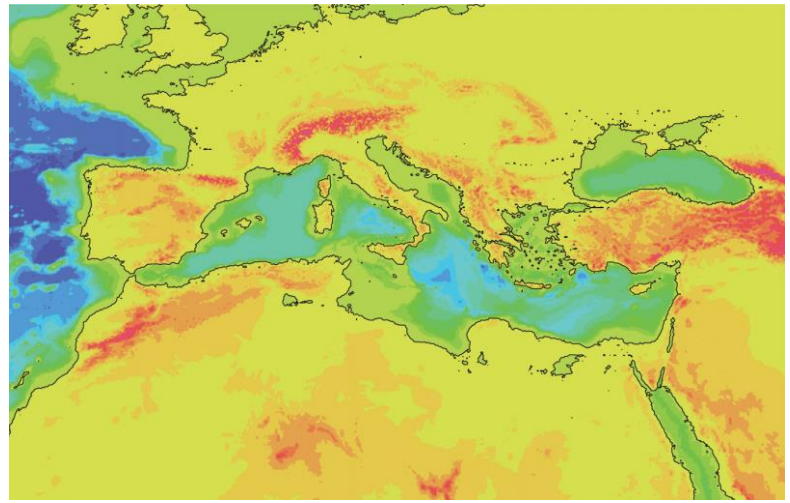
- Development of a preliminar version of the model



- First version of empirical model
  - Based on global climate indices
  - Flexible: new predictors should be added easily
  - “Continuous” look: avoid too much noise.

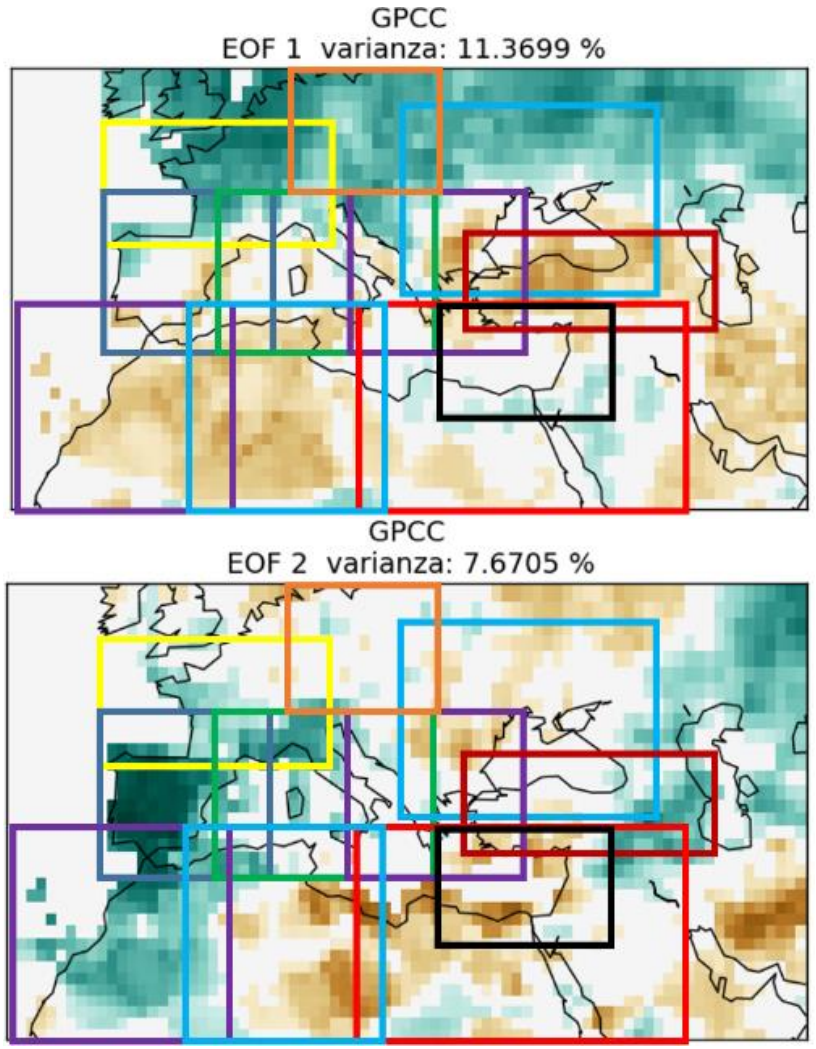
- Multiple linear regression (MLR) selected (similar to Eden et al, 2015), or Ibimet model (Pasqui et al, 2007) Possible problems:
  - Predictors show signal at different areas and times, and can introduce noise at regions where there is no signal from them.
  - Mediterranean area: influenced by many factors, including orographic complexity.
  - Divide in regions to select best predictors for each area
  - MLR results can be noisy (other alternatives are not discarted for final version)





Proposal: divide the area in different regions.

- Selecting areas on a compromise based on patterns of variability and country borders
- Overlap among areas to produce “soft” transitions (weighted interpolations)
- Search of predictors for every area and season
- Partial coincidence in predictors from neighbour areas and consecutive seasons for continuity
- Use of low resolution predictands (GPCC for precipitation and ERA interim for t2m, both 2.5 degrees)



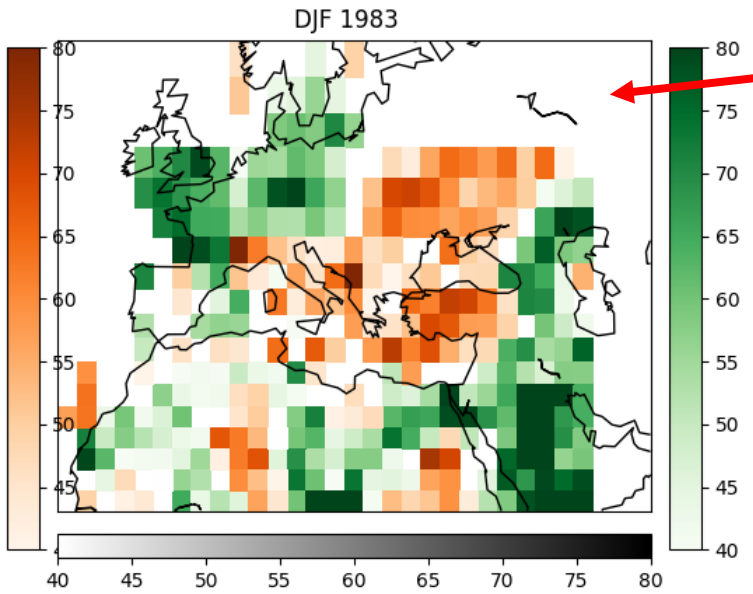
- Testing and selecting predictors:
  - 1979-2017 period
  - Around 30 predictors tested SST-based, global patterns, ice and snowcover based
  - Absolute value and month to month increment tested
  - Up to 12 months lead
  - 2-6 months moving average.
- 4-8 predictors selected for each area and season.
- Around half of them should coincide among neighbour areas and between consecutive seasons
- Avoid collinearity

GPCC		EFM									FMA									MAM									
		-2	-3	-4	-5	-6	-7	-8	-9	-10	-2	-3	-4	-5	-6	-7	-8	-9	-10	-2	-3	-4	-5	-6	-7	-8	-9	-10
EA	1M	9	55	18	12	0	9	3	0	18	15	0	15	6	12	21	0	0	3	0	3	0	9	6	3	52	15	6
	2M	0	45	9	39	9	0	12	3	9	0	15	15	9	0	15	6	12	9	0	0	3	0	0	9	18	6	12
	3M	0	0	15	6	21	6	0	9	0	0	0	21	18	3	6	9	6	18	0	0	3	0	6	15	0	0	0
	4M	0	0	0	6	0	30	3	6	6	0	0	0	18	12	3	9	9	6	0	0	0	0	6	0	0	0	0
	5M	0	0	0	0	3	6	15	0	0	0	0	0	0	15	6	12	6	6	0	0	0	0	6	9	0	0	0
	6M	0	0	0	0	0	9	9	9	6	0	0	0	0	0	18	12	12	9	0	0	0	0	0	6	0	0	0
incr_EA	1M	9	48	6	15	12	6	3	6	3	12	6	15	18	15	15	0	3	9	3	3	3	12	12	30	42	12	3
	2M	0	24	58	6	15	3	0	9	0	0	0	6	6	12	6	6	0	12	0	0	0	0	6	30	12	24	0
	3M	0	0	45	36	6	21	3	15	6	0	0	21	12	27	0	6	18	24	0	0	9	6	9	36	18	0	21
	4M	0	0	0	6	30	21	15	3	15	0	0	0	18	0	6	9	12	3	0	0	0	0	0	15	0	3	0
	5M	0	0	0	0	0	9	18	9	12	0	0	0	0	27	12	3	6	6	0	0	0	0	0	33	12	9	6
	6M	0	0	0	0	0	0	6	48	3	12	0	0	0	0	0	9	6	3	0	0	0	0	0	12	12	6	3
EA/WR	1M	6	6	0	6	0	6	9	39	3	3	6	3	6	15	6	9	3	6	0	0	3	3	45	21	3	0	6
	2M	0	6	3	9	0	3	0	21	15	0	9	6	0	6	15	12	18	9	0	0	3	0	18	24	0	0	3
	3M	0	0	6	3	3	0	0	15	21	0	0	6	0	0	9	6	15	12	0	0	3	0	12	6	9	6	0
	4M	0	0	0	6	3	3	0	0	15	0	0	0	0	3	3	3	6	3	0	0	0	0	9	9	6	12	12
	5M	0	0	0	0	6	3	0	0	0	0	0	0	0	3	6	0	0	3	0	0	0	0	0	6	6	3	9
	6M	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	6	3
incr_EA/WR	1M	3	6	0	0	3	0	3	6	15	0	15	6	9	3	9	3	6	6	3	0	9	24	36	21	3	0	0
	2M	0	3	0	0	3	9	21	9	0	0	9	3	3	12	15	12	21	9	0	6	6	9	21	12	9	9	6
	3M	0	0	12	3	0	18	12	0	15	0	0	3	3	0	18	12	21	0	0	0	0	9	6	6	9	6	0
	4M	0	0	0	6	3	6	27	6	36	0	0	0	9	9	3	6	24	3	0	0	0	27	21	0	9	12	24
	5M	0	0	0	0	18	3	27	3	3	0	0	0	0	6	9	9	0	6	0	0	0	0	18	0	0	0	0
	6M	0	0	0	0	0	9	3	3	27	0	0	0	0	0	9	12	15	15	0	0	0	0	0	6	0	0	6
SCAND	1M	3	0	12	0	6	18	52	0	33	15	0	3	27	9	0	3	15	18	3	3	18	0	3	15	0	3	3
	2M	0	0	3	0	0	9	30	9	12	0	12	3	12	24	0	0	9	6	0	6	12	3	6	9	3	0	0
	3M	0	0	0	0	15	9	0	15	0	0	0	9	6	15	27	0	0	6	0	0	15	9	6	6	6	0	0
	4M	0	0	0	0	12	15	0	3	0	0	0	0	0	9	15	6	3	6	0	0	0	18	6	9	6	0	0
	5M	0	0	0	0	0	9	0	3	0	0	0	0	0	0	9	6	3	6	0	0	0	0	18	9	9	0	0
	6M	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	6	0	0	0	0	0	15	9	6	0

PCP	Marruecos	Iberia	Francia	Cent-Eur	Italia	Argelia-Tunez	Libia
EFM	I_AAO_S EA_ON TNA_Julio I_Bo_Ns_SO DMI_SON	_AAO_JJAS EA_JJAS EA_ON DMI_SON SOI_JJ	EA_SON _AAO_JJAS EA_JJAS SOI_JJ _Bo_EuA_Jun	AAO_Ag SOI_JJ _AAO_S EA_ON _BoNs_O _SOI_O	EA_ON _Bo_Ns_O SOI_JJ _Bo_EuA_O DMI_ASO _AAO_S	NAO-N Bo_NA_O _Bo_Ns_SO SOI_JJ _Niño4_N	NAO_JA _Bo_Ns_SO TNA_ON I_Niño4_N
FMA	I_AAO_S NAO-OND I_Niño4_N EA_OND TNA_Julio TNA_D _Bo_Ns_SO DMI_SON	_AAO-JJAS NAO-OND EA_OND TNA_D DMI_SON SOI_JJ _Niño4_N	_AAO_JJAS NAO-OND _Niño4_N TNA_D SOI_JJ _Bo_EuA_Jun	SOI_JJ _AAO_S _BoNs_O _SOI_O	_Niño4_N _Bo_Ns_O SOI_JJ EA_ON DMI_ASO _AAO_SON	NAO-ND Bo_NA_O _Bo_Ns_SO SOI_JJ _Niño4_ND TNA_ND	NAO_JA _Bo_Ns_SO TNA_ON _SOI_O _Niño4_N EA/WR_O
MAM	NAO-ONDE I_Niño4_N TNA_Julio TNA_DE I_Bo_Ns_SO DMI_SON	NAO-ONDE _Niño4_N TNA_Julio TNA_DE _TNA_ND DMI_SON SOI_JJ	NAO-ONDE _Niño4_N TNA_Julio TNA_DE SOI_JJ	SOI_JJ _AAO_SON _BoNs_O TNA_DE _SOI_O	_Niño4_N TNA_Julio TNA_DE SOI_JJ EA_ON DMI_ASO _AAO_SON	NAO-ND Bo_NA_O _Bo_Ns_SO SOI_JJ _Niño4_ND TNA_ND	NAO_JA _Bo_Ns_SO TNA_ON _SOI_O DMI_E EA/WR_O
AMJ	NAO-ONDE I_Niño4_N TNA_Julio TNA_DE DMI_SON I_NAO_EF	NAO-ONDE TNA_Julio TNA_DE DMI_SON _TNA_ND _NAO_EF SOI_JJ	NAO-ONDE _Niño4_N TNA_Julio TNA_DE TSA_F _NAO_EF SOI_JJ _Bo_EuA_EF	SOI_JJ TNA_DE TNA_AS NAO_EF _AAO_NDE	_Niño4_N TNA_Julio TNA_DE EA_ON	NAO-ND Bo_NA_O _NAO_EF _SOI_F SOI_JJ _Niño4_ND TNA_ND	_Niño3_NDE _Bo_Ns_SO TNA_ON _SOI_O DMI_E EA/WR_O
MJJ	TNA_Julio TNA_DE I_NAO_EF TSA_FM	TNA_Julio NAO-NDE _EA/WR_FM TNA_DE _TNA_NDE _NAO_EF _EA_O	TNA_Julio TSA_FM _NAO_EF _Bo_EuA_EF	TNA_E TNA_AS NAO_EF _AAO_NDE SAM_O	TNA_Julio EA_ON _AAO_NDE EA/WR_E SAM_O	Bo_NA_O _NAO_EF _SOI_F TNA_DEF TSA_FM	_Niño3_NDE _SOI_O DMI_E EA/WR_O PDO_N

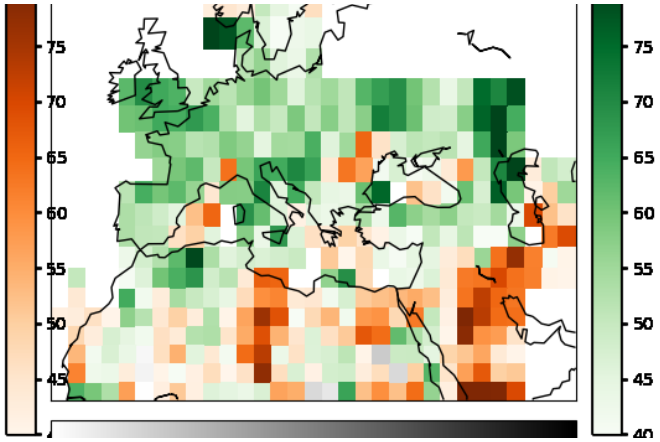
Task 2.4 Development of empirical forecast systems

- Forecast for 1983-2014 period, using Leave One Out (LOO) with two year interval

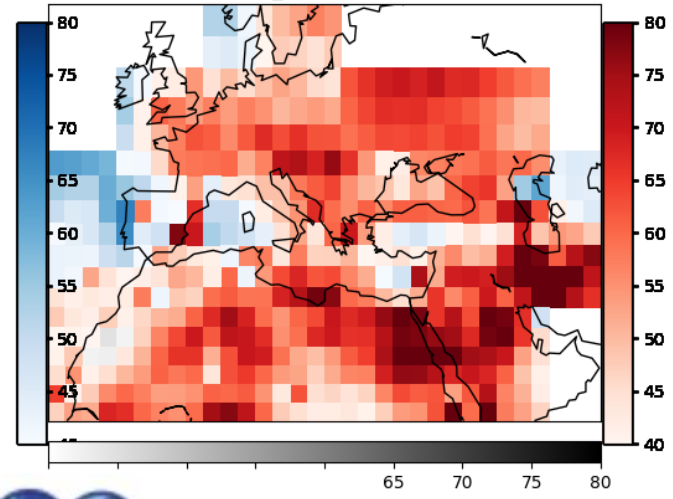


	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1983																																
1984																																
1985																																
1986																																
1987																																
1988																																
1989																																
1990																																
1991																																
1992																																
1993																																
1994																																
1995																																
1996																																
1997																																
1998																																
1999																																

- Example results:
  - Precipitation



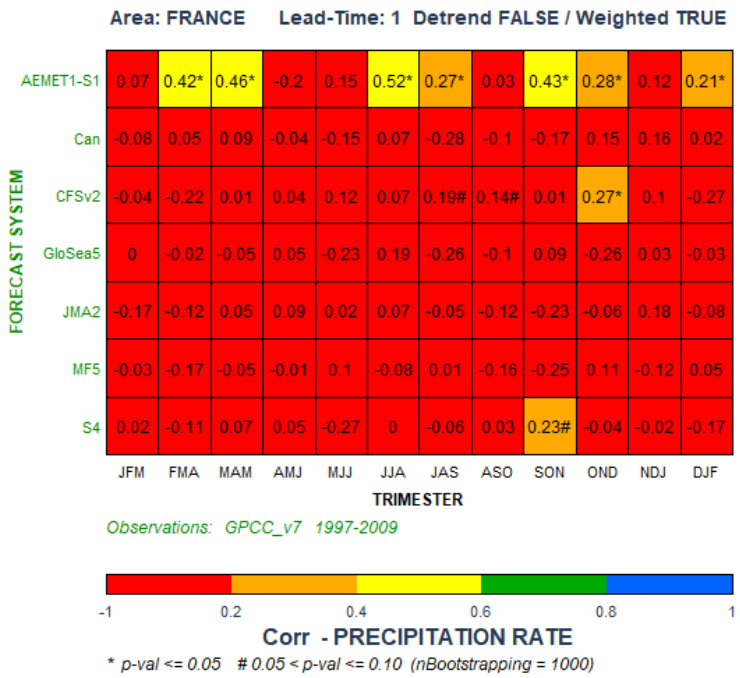
  - Temperature

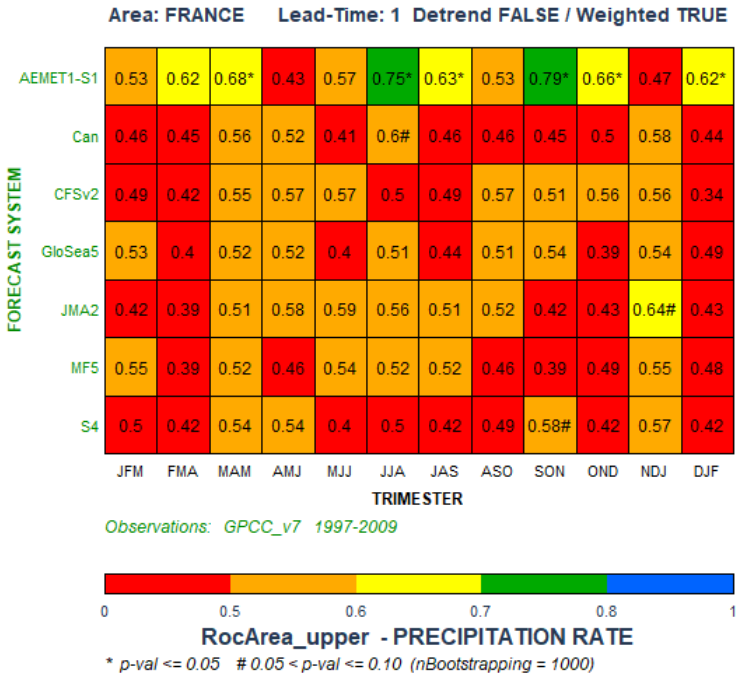


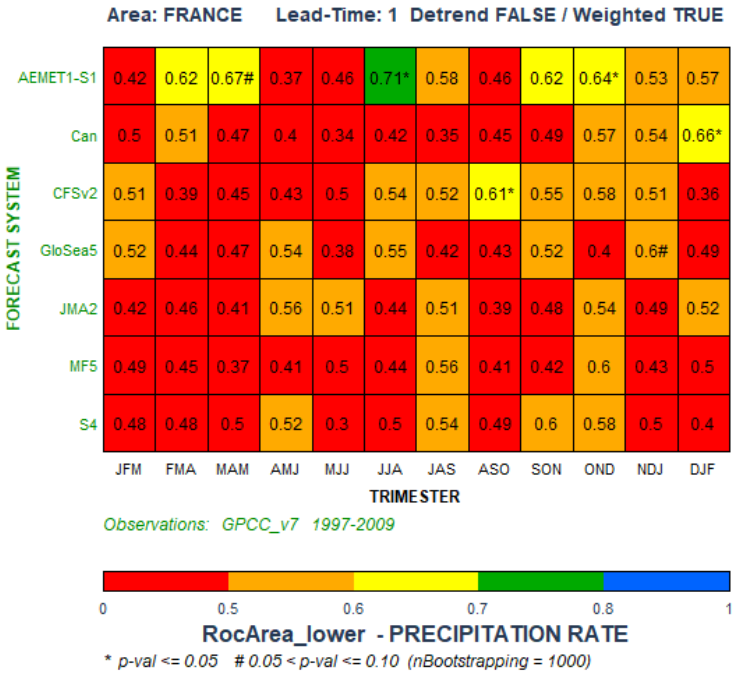
- Sinoptic structures observed.
- Not too much noise
- Borders can still be seen some times
- Currently predictors table constructed manually.
- Currently selection of predictors made for precipitation. Use of the same predictors for temperature

- Verification of empirical system (v1) compared with main seasonal forecast dynamical models :
- Correlation and ROC area for France

Precipitation

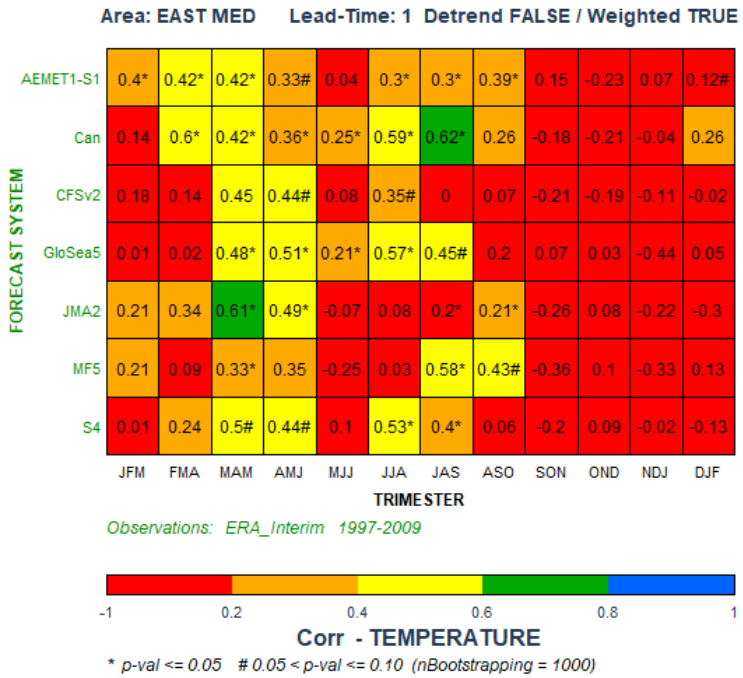


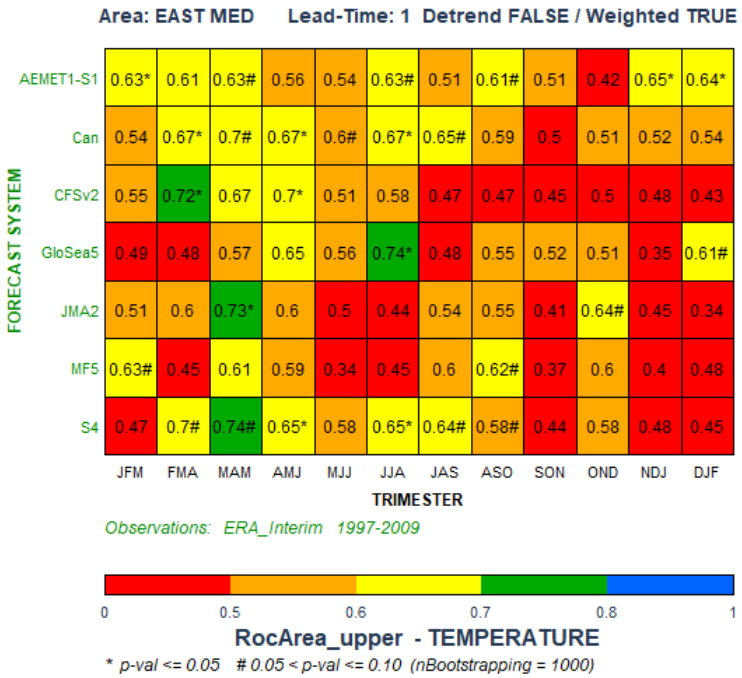


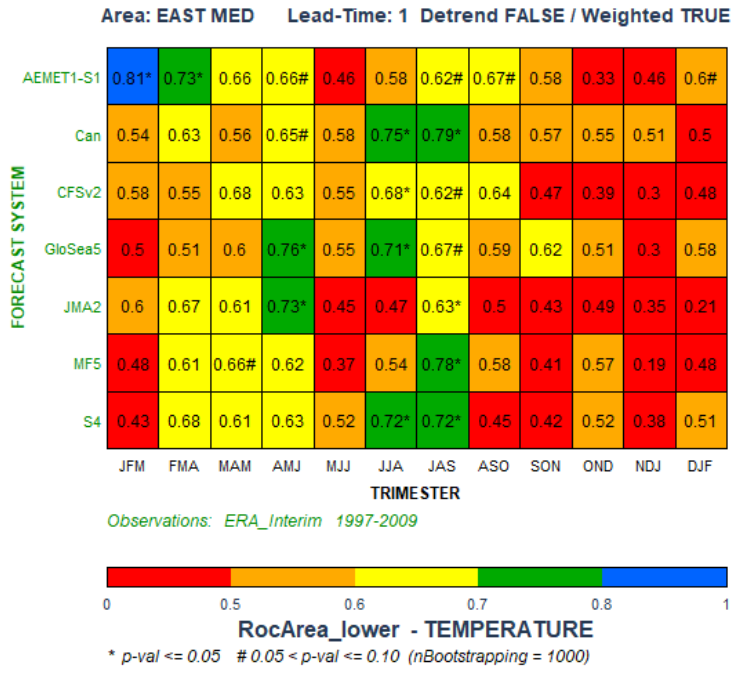


- Verification of zones against main seasonal forecast dynamical models :
- Correlation and ROC area for Eastern Mediterranean:

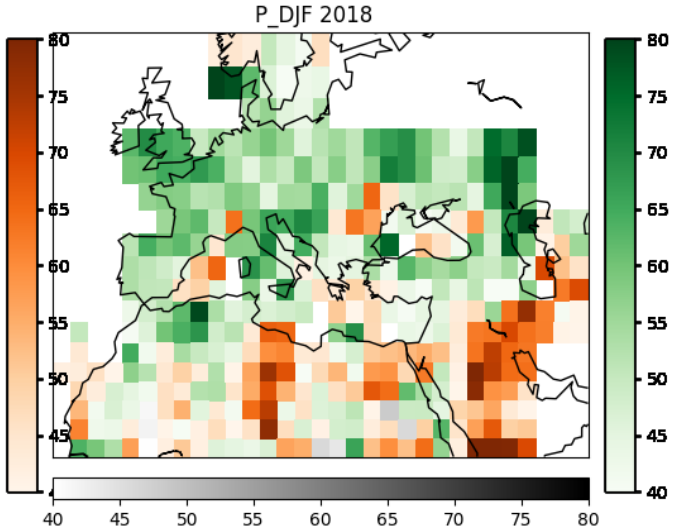
Temperature

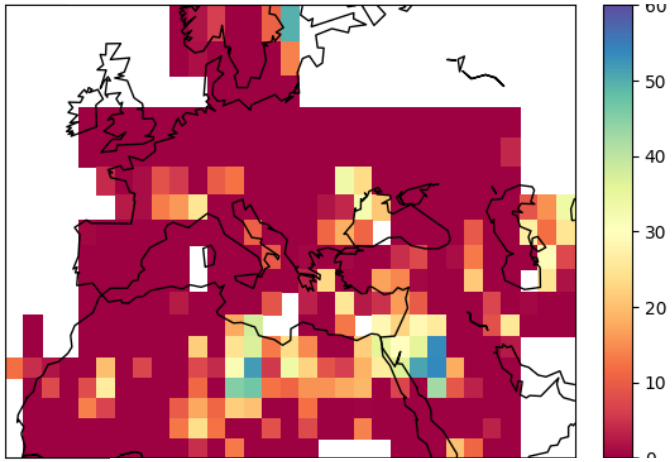




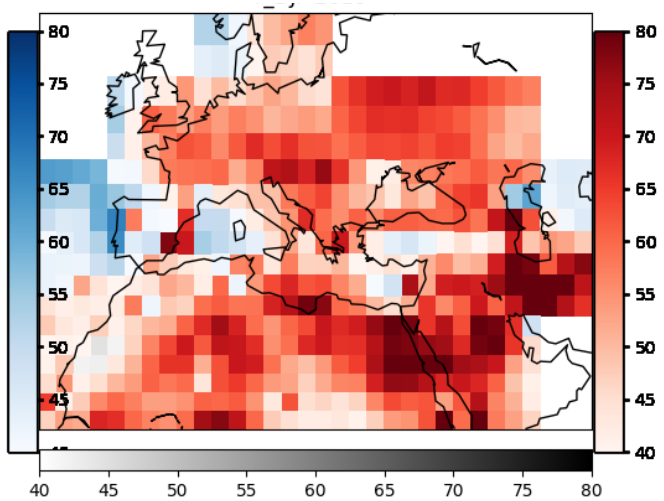


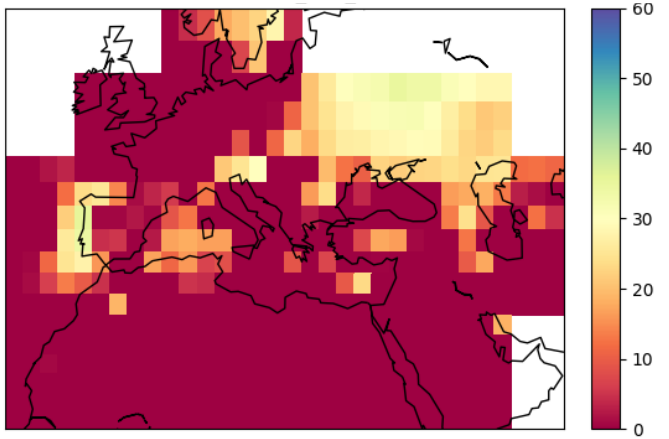
- Example results:
- Precipitation





- Temperature





Conclusions:

- Preliminar version of empirical model showed ability to produce synoptic anomaly patterns
- Good results (considering that this is only the first version) for some regions show potential of this type of model.
- Still work to do on selection of predictors for every area.

Next Steps:

- Automatic procedure for selection of predictors
- Exploration of specific predictors for temperature
- Incorporation of snow cover (and other) indices with no available data during the hole period (SAI/SNV not used)
- Incorporation of results from other tasks

REFERENCES

Dee, D. P., Uppala, S. M., Simmons, A. J., Berrisford, P., Poli, P. Kobayashi, S., Andrae, U., Balmaseda, M. A., Balsamo, G., Bauer, P., Bechtold, P., Beljaars, A. C., Van De Berg, L., Bidlot, J., Bormann, N., Delsol, C., Dragani, R., Fuentes, M., Geer, A. J., Haimberger, L., Healy, S. B., Hersbach, H., Hólm, E. V., Isaksen, L., Kållberg, P., Köhler, M., Matricardi, M., Mcnally, A. P., Monge-Sanz, B. M., Morcrette, J., Park, B., Peubey, C., De Rosnay, P., Tavolato, C., Thépaut, J. And Vitart, F. (2011) The ERA-Interim reanalysis: configuration and performance of the data assimilation system Q.J.R. Meteorol. Soc., 137: 553-597. doi:http://dx.doi.org/10.1002/qj.828

Eden, J. M., van Oldenborgh, G. J., Hawkins, E., and Suckling, E. B.: A global empirical system for probabilistic seasonal climate prediction, Geosci. Model Dev., 8, 3947-3973, https://doi.org/10.5194/gmd-8-3947-2015, 2015.

Godfrey, G., 1978. Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables.

Pasqui, M., Genesio L., Crisci., Primicerio, J., Benedetti, R., Maracchi, G.(2007). An adaptive multi-regressive method for summer seasonal forecst in the Mediterranean área. 87th AMS, 13-16January 2007.

Sánchez García, E., Voces Aboy, J., Rodríguez Camino, E. (2018). Verification of six operational seasonal forecast systems over Europe and Northern Africa. Nota Técnica, AEMET. Puede consultarse en http://medcof.aemet.es/index.php/models-skill-over-mediterranean.

Schneider, U., Ziese, M., Meyer-Christoffer, A., Finger, P., Rustemeier, E., and Becker, A. (2017) The new portfolio of global precipitation data products of the Global Precipitation Climatology Centre suitable to assess and quantify the global water cycle and resources, Proc. IAHS, 374, 29-34, https://doi.org/10.5194/piahs-374-29-2016, 2016.

Wang,L.,Ting,M.,Kushner,P.J., (2017) A robust empirical seasonal prediction of winter NAO and surface climate, Nature. https://doi.org/10.1038/s41598-017-00353-y.

Wilks, D. (2006). Statistical Methods in the Atmospheric Sciences. Department of Earth and Atmospheric Sciences. Cornell University.