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A NAO based subsampling approach for winter seasonal predictions

MedCOF Workshop on OSF

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Introduction

The idea is to propose a subsampling methodology designed to **improve the quality of the winter forecast** over the Euro-Mediterranean sector, **applicable to real-time operations**:

- ✓ Rely on the ensemble itself (e.g. in decadal framework, Smith et al., 2020)
- ✓ Rely on external sources of information (e.g. observational predictors; Wang et al. 2017, Dobrynin et al., 2018; Dobrynin et al., 2022)

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Which is the subsampling criterion?

Given the known impact of NAO on winter weather conditions over Europe, we aim at identifying the ensemble **members more reliable in the NAO representation,** under the assertion that the improvement in NAO will reflect also in ”observables of interest” (e.g. T2m and precip)

Subsampling approaches

- **Ensemble mean NAO subsampling:** we select the ensemble members with NAO closest in sign and amplitude to the value of the **ens mean NAO at the beginning of the forecast (lead seas 0)**

- **Empirical NAO subsampling:** we select the ensemble members with NAO closest in sign and amplitude to the value of an **independent estimate of NAO for the target season**

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✓ In both cases we retain 1/3 of the full ensemble

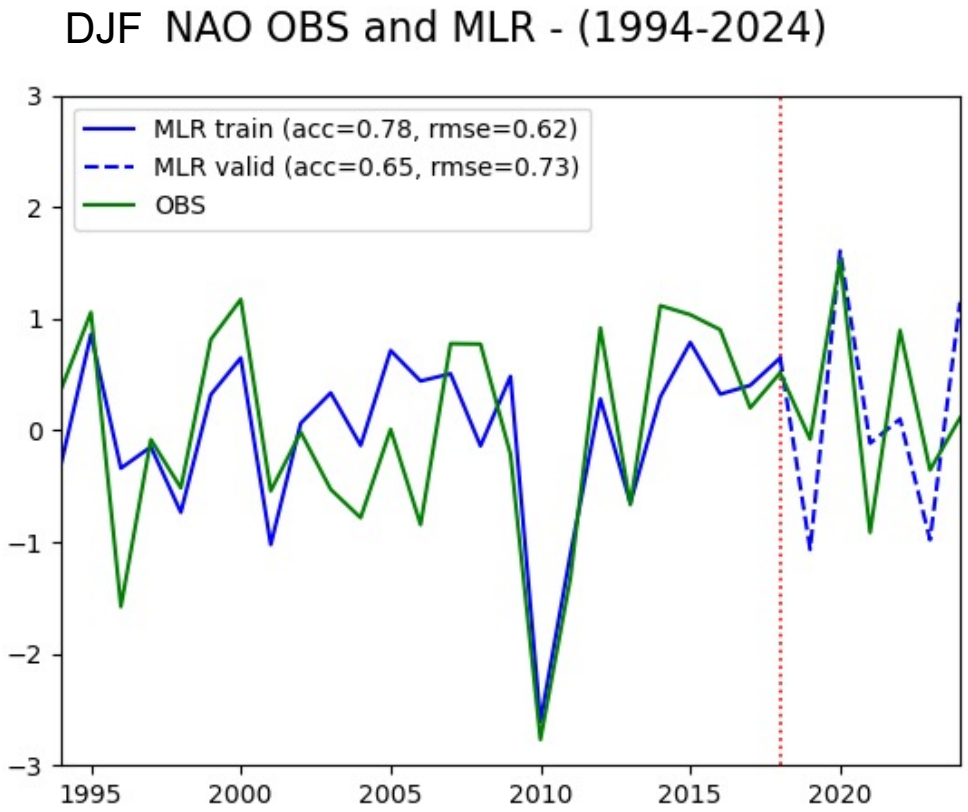
✓ NAO computed following Li and Wang (2003) definition

✓ **November initialization**: target season **DJF**

Both the approaches have been applied in C3S multi-model ensemble and for CMCC-SPS3.5

C3S multi model ensemble	hindcast size	initialization strategy
CMCC-SPS3.5	40	burst
DWD-GCF2.1	30	burst
ECMWF-SEAS5	25	burst
METEO-FRANCE System 8	25	lagged
UK-MetOffice- GloSea6v02	28	lagged
JMA- CP3	10	lagged
NCEP-CFSv2	20	lagged
ECCC-CanAM4	10	burst
ECCC-GEM5-NEMO	10	burst

Empirical NAO definition



Empirical DJF NAO produced following multiple linear regression (MLR) approach as in *Wang et al.* (2017):

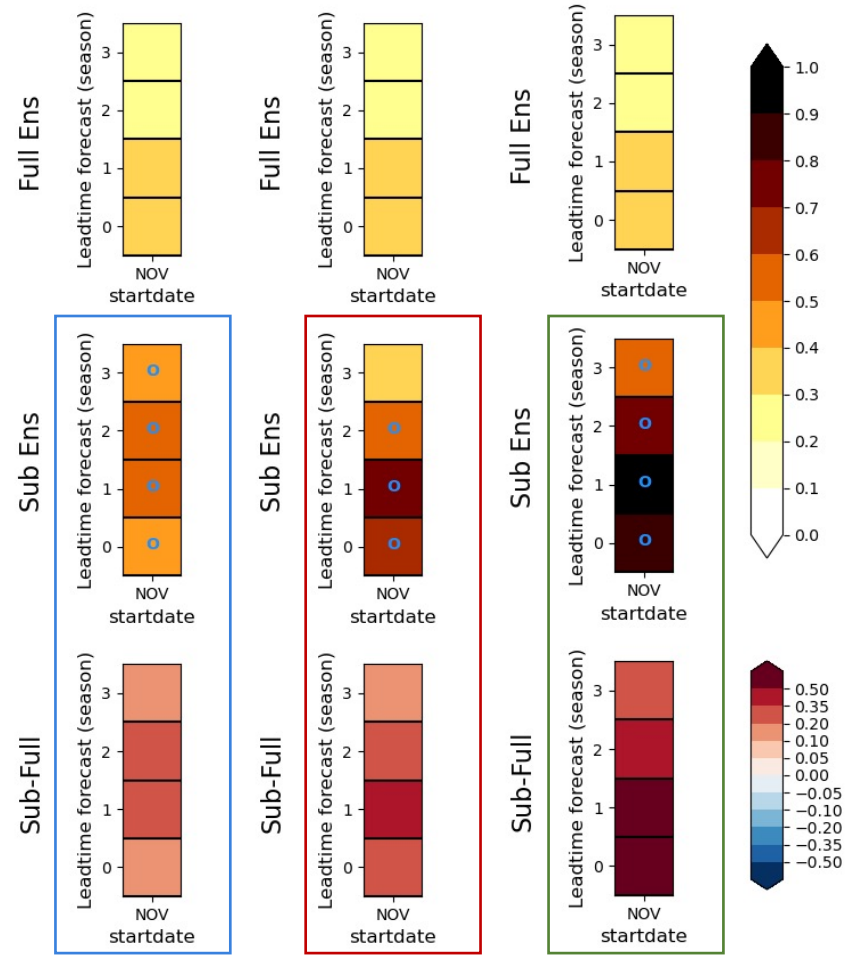
- Predictors: sea-ice cover, sst, 70hPa geopotential height (September and October PCs)
- First three EOFs retained for each predictor and PCs computed over September and October (18 predictors: 3 fields x 3 PCs x 2 month)
- NAO ACC over the training period (winter 1994-2017): 0.78
- NAO ACC over the evaluation period (winter 2018-2024): 0.65

Subsampling on C3S multi-system ensemble

NAO ACC (1994-2017) C3S vs ERA5

198 members

66 members



EMEAN NAO EMP NAO OBS NAO

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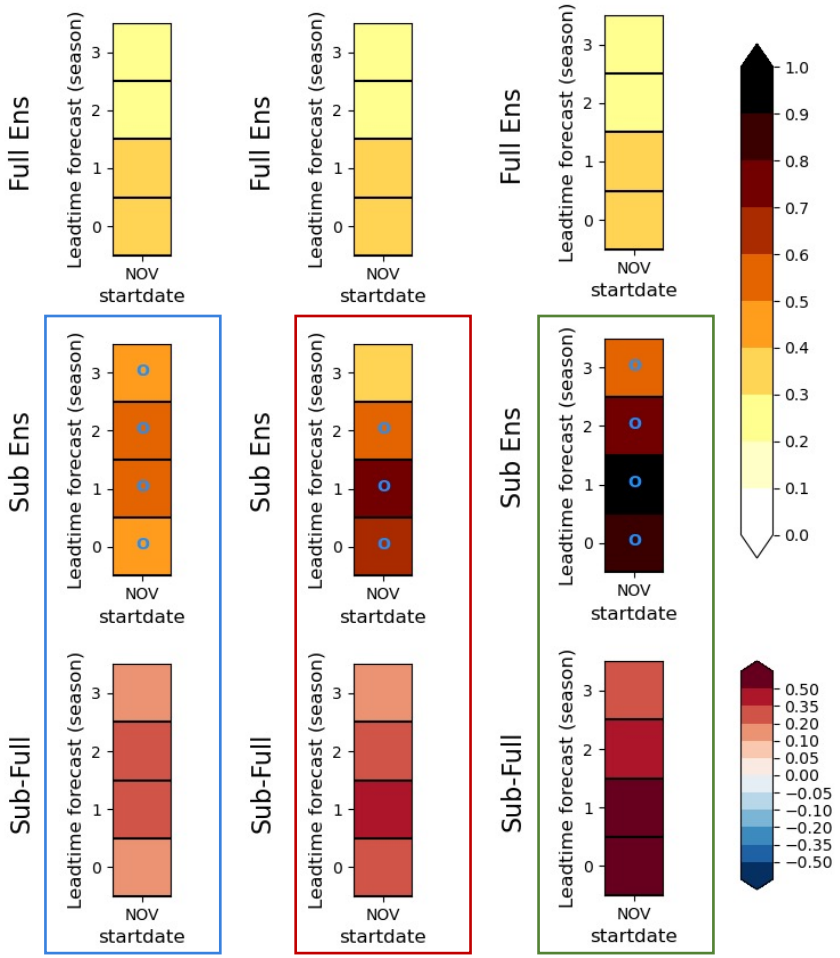

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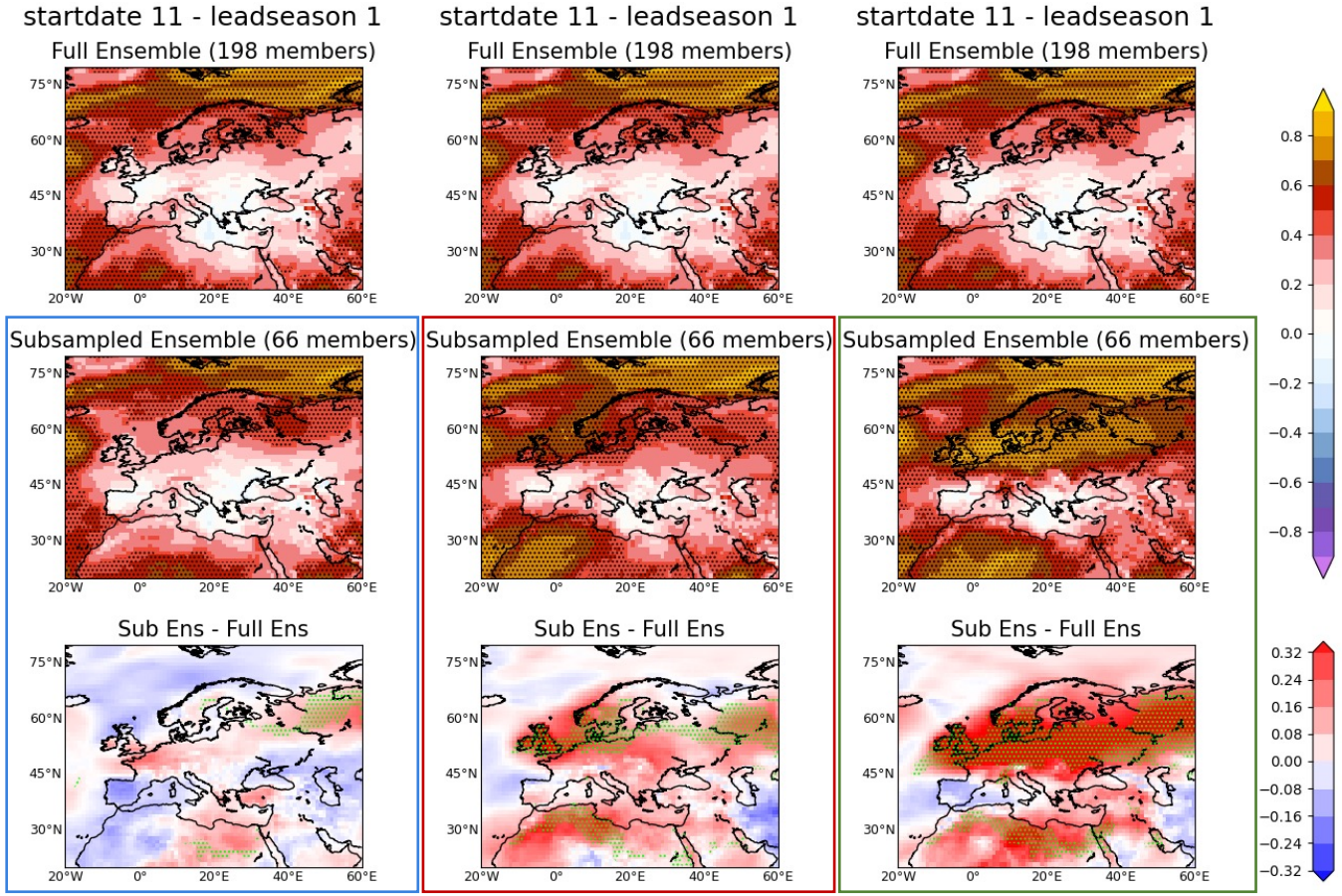
T2m ACC (November 1993-2016) C3S vs ERA5



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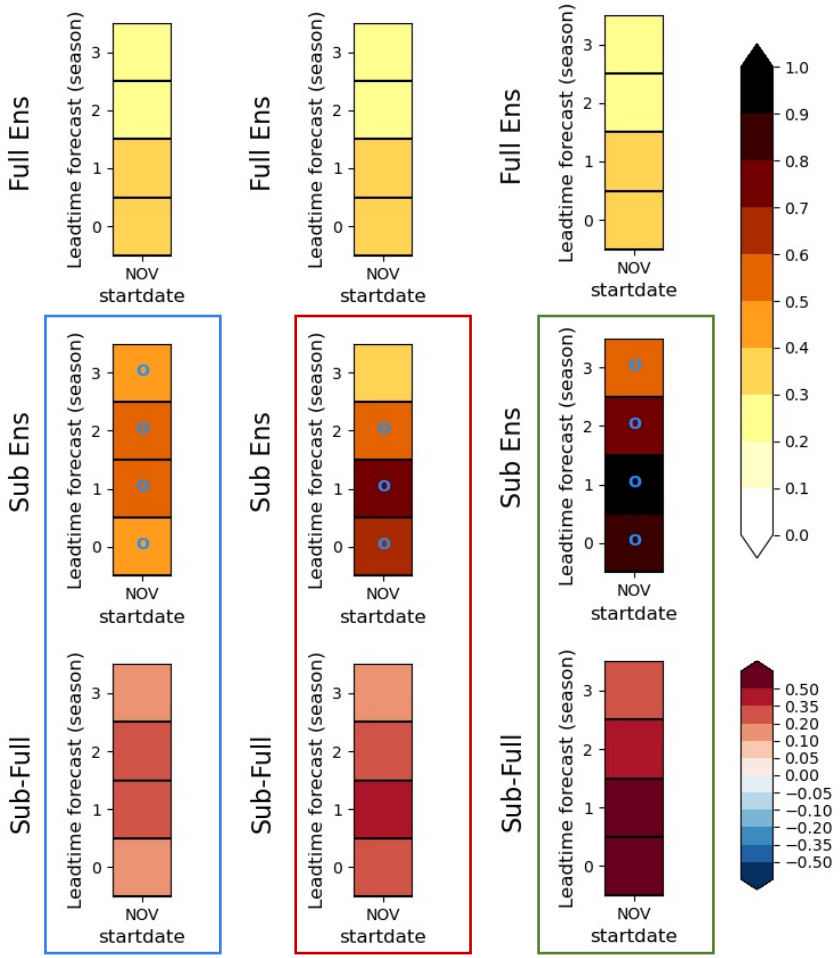

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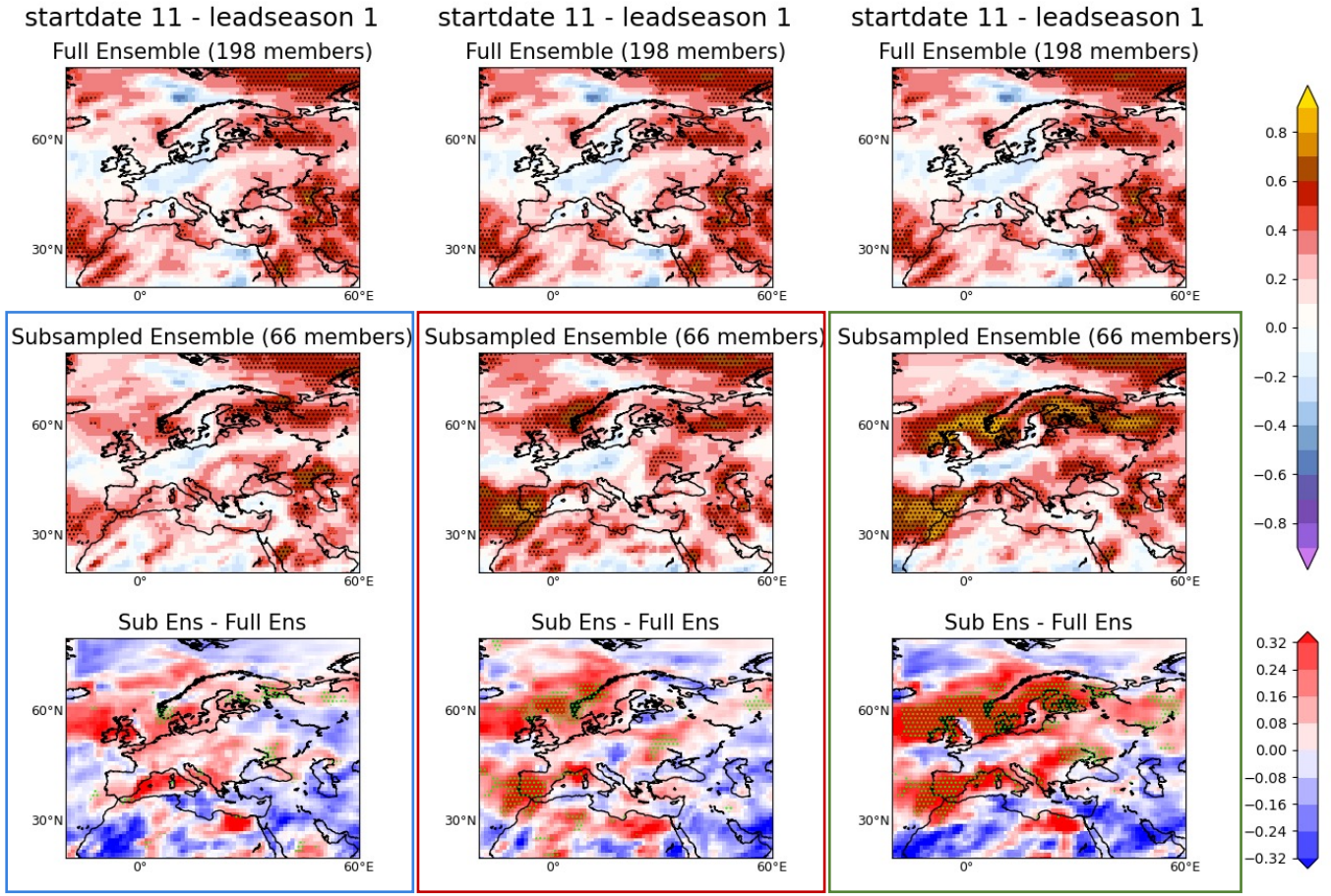
Precip ACC (November 1993-2016) C3S vs GPCP



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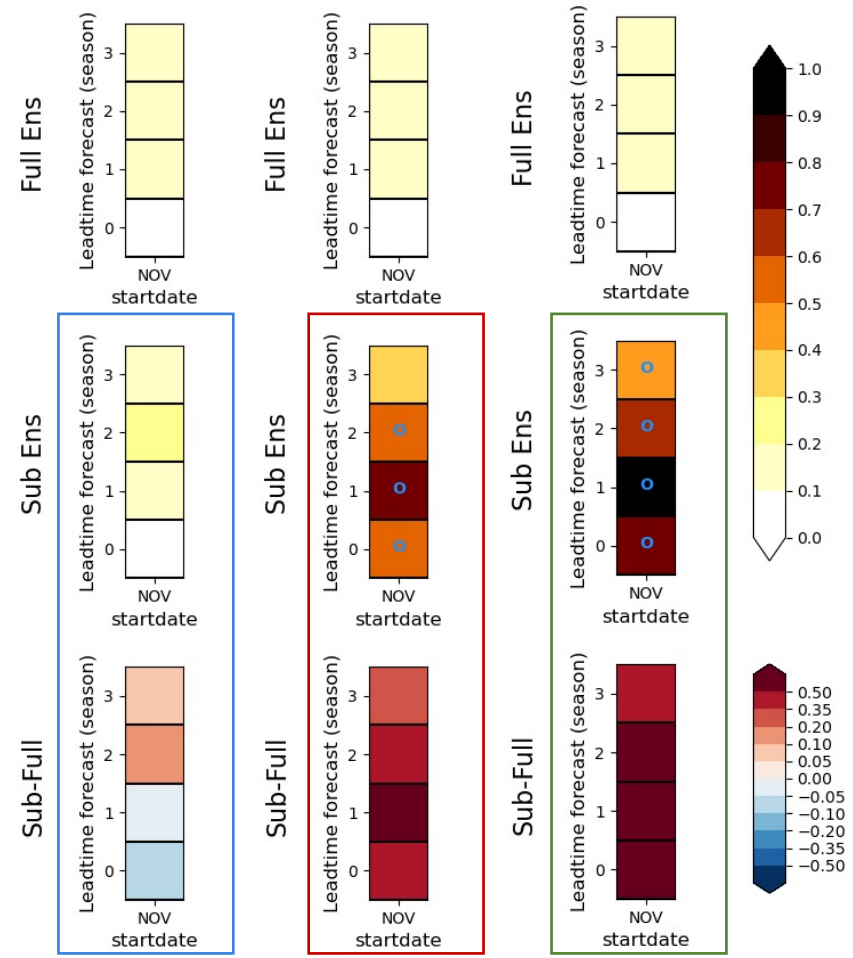
Subsampling on CMCC-SPS3.5

NAO ACC (1994-2017) CMCC vs ERA5

40 members

13 members



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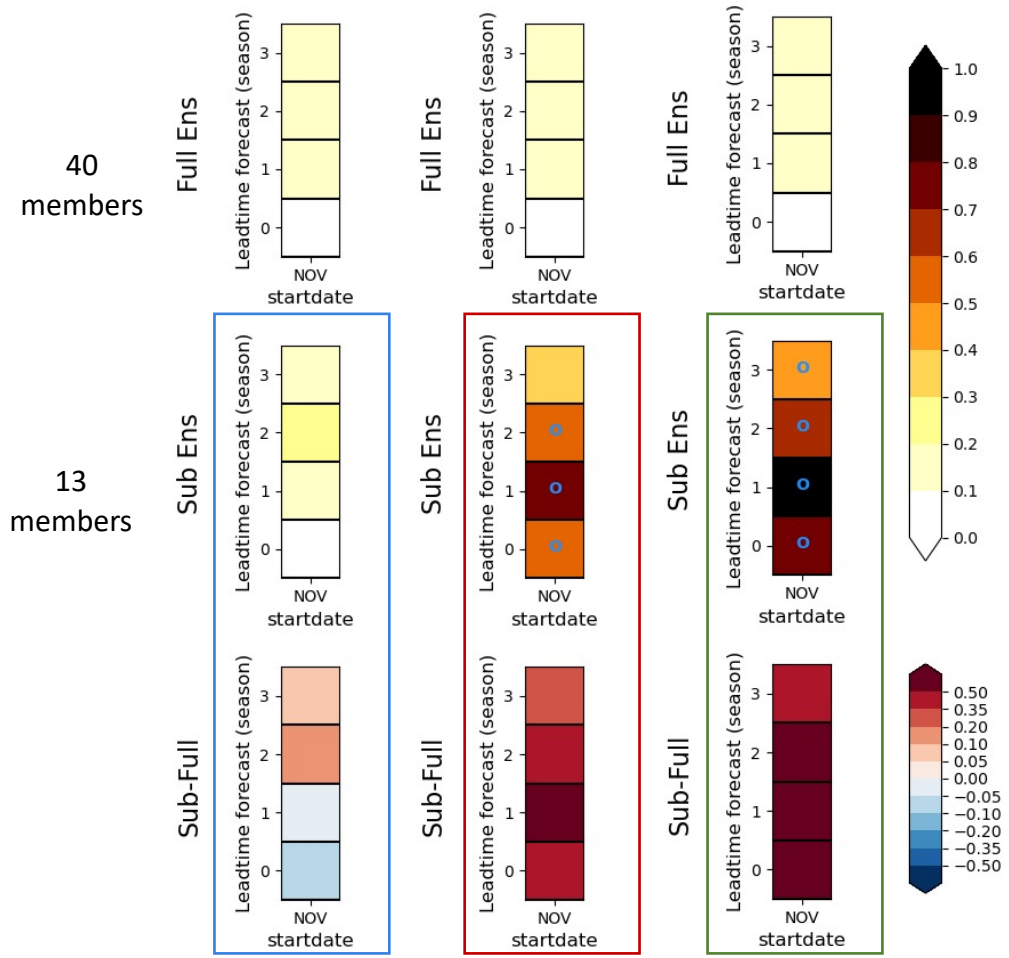

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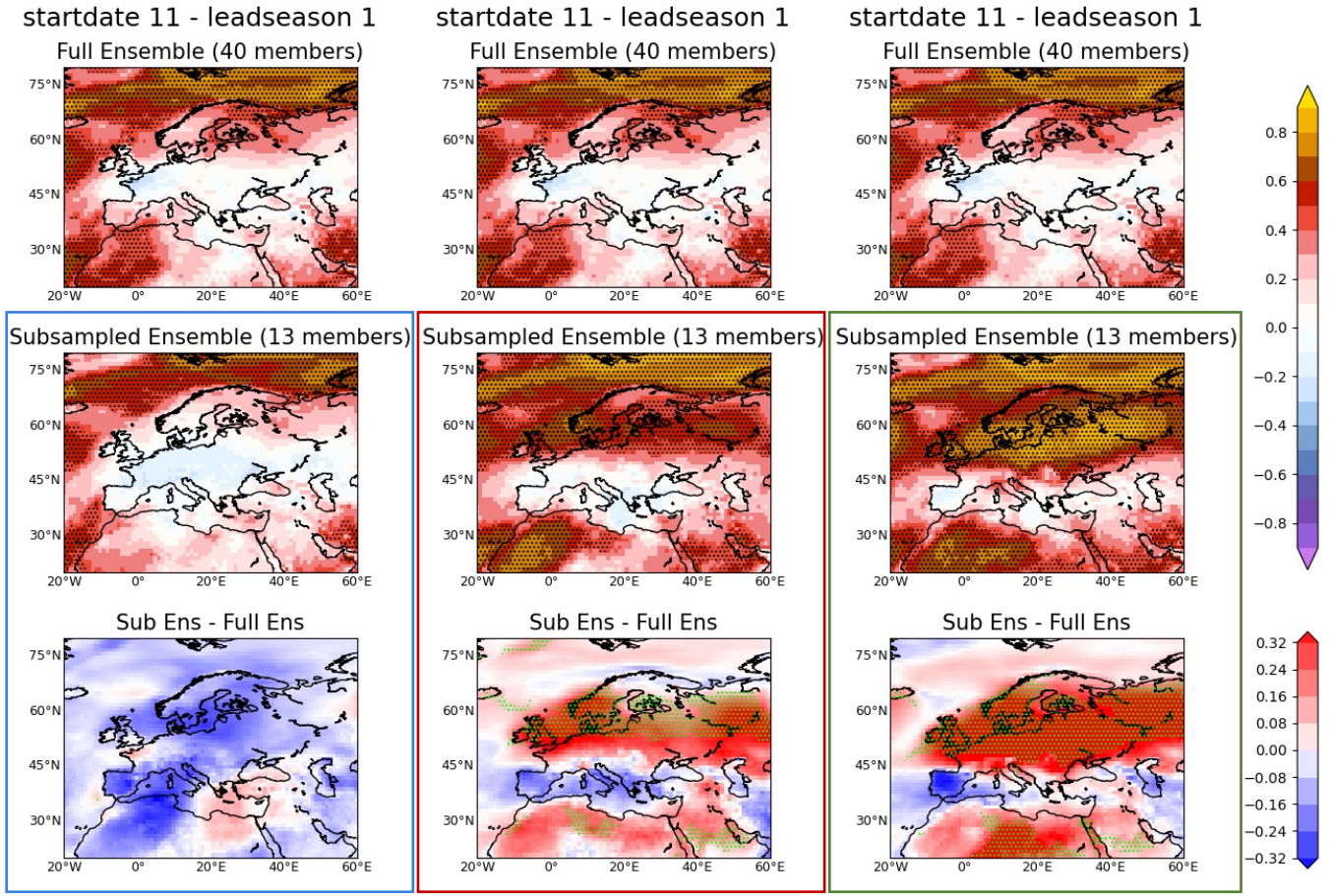

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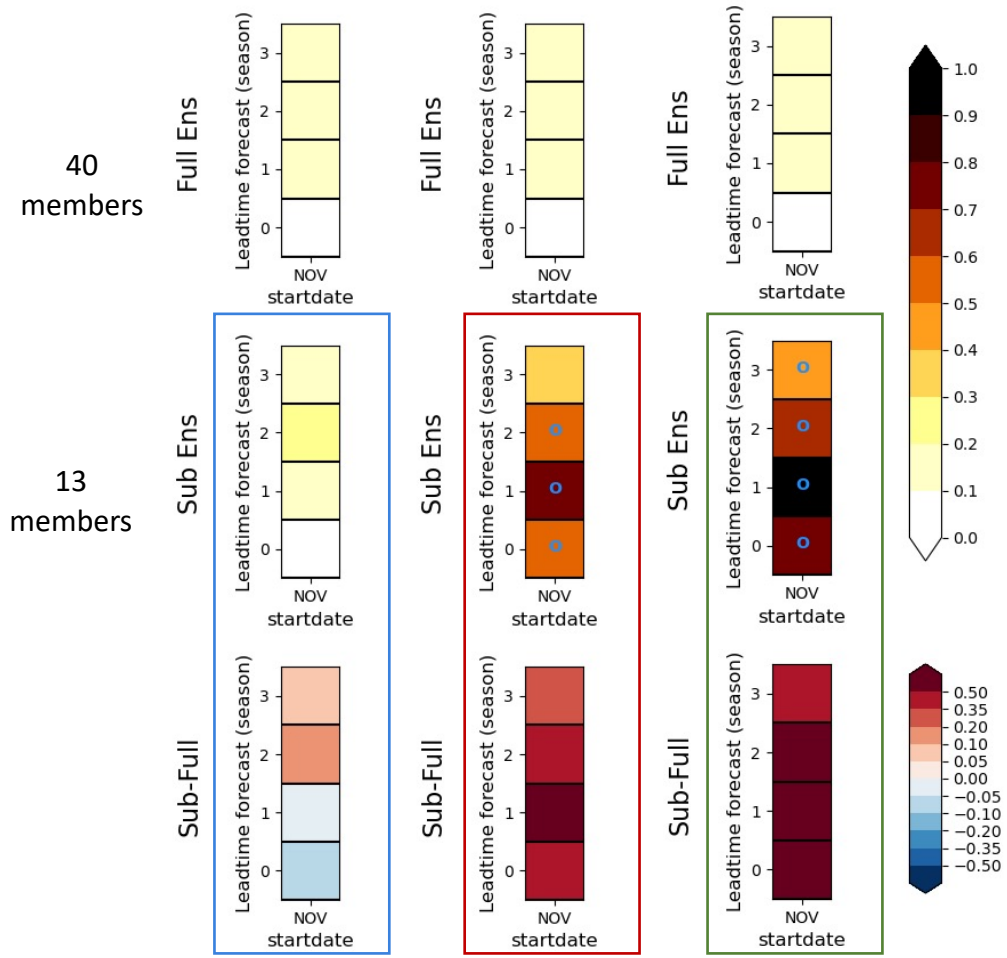

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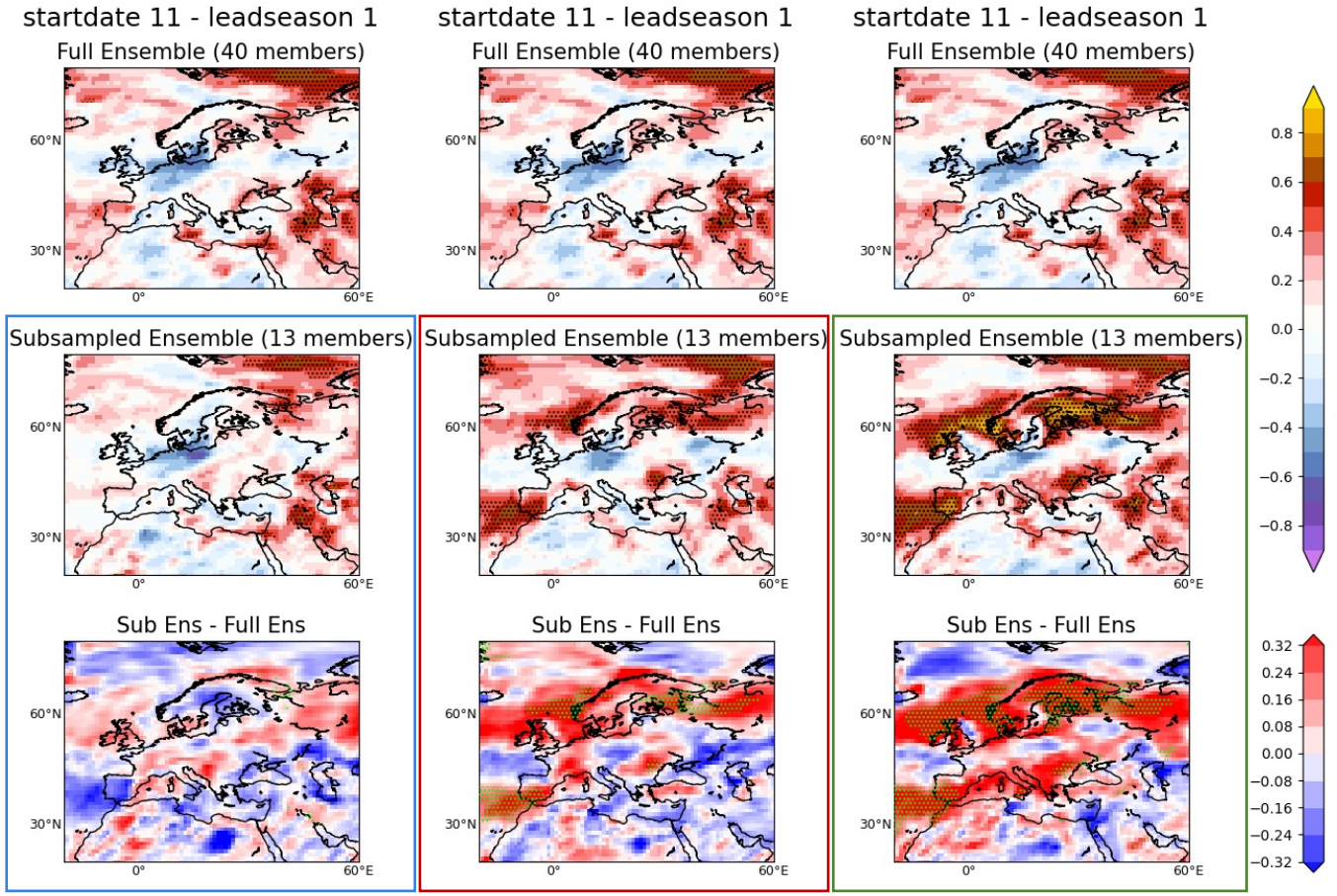

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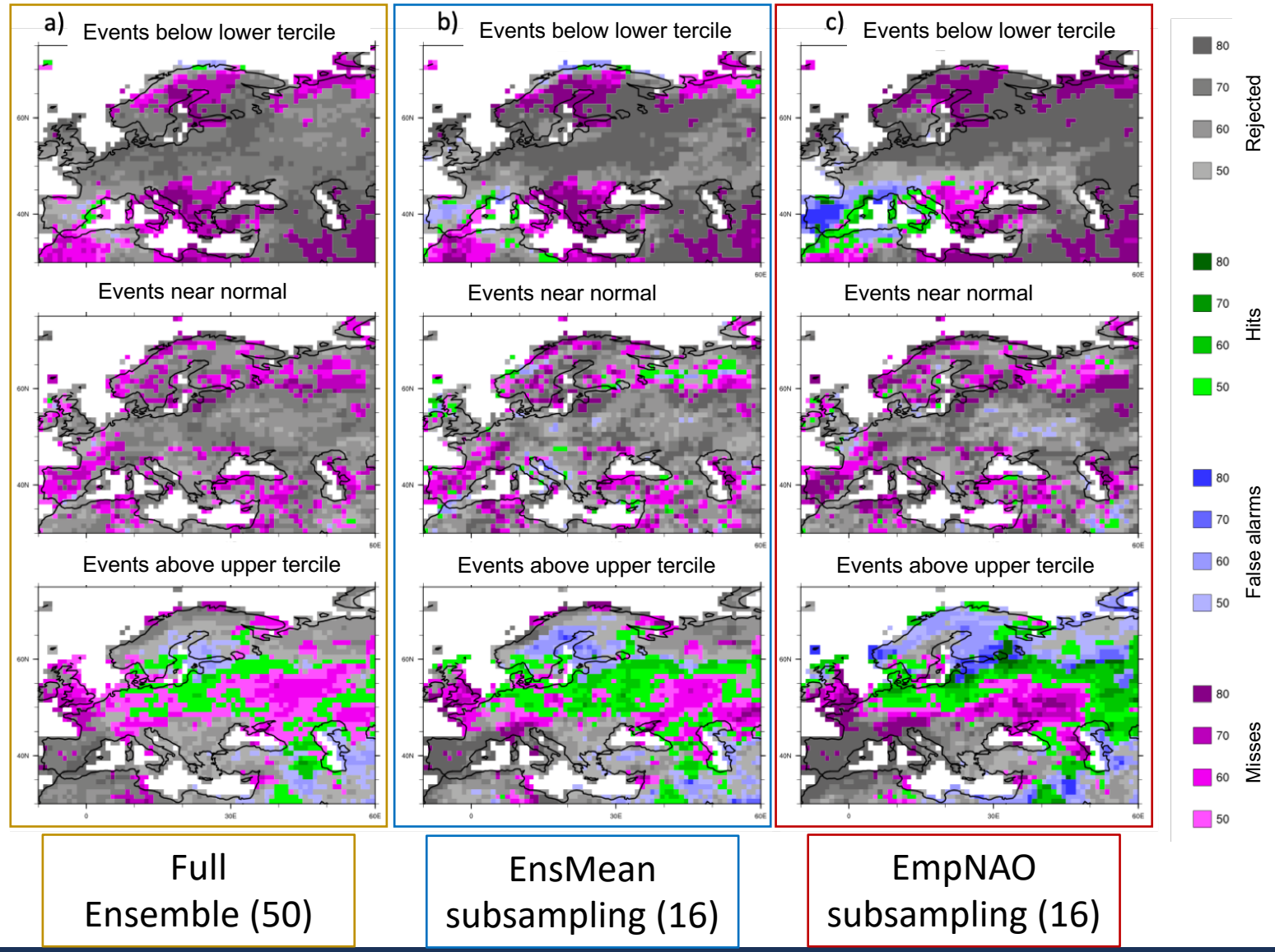
An example of real-time evaluation (DJF 2023/2024)



Full Ensemble (50)

EnsMean subsampling (16)

EmpNAO subsampling (16)

Grid-point contingency table for **precipitation over the Euro-Mediterranean** domain for winter (DJF) 2023/2024

(**forecast initialized in November 2023** evaluated against GPCC data)

Top row shows the percentage of forecast occurrences of events below the lower tercile, mid row shows the percentage of forecast occurrences of events around the average, and the bottom row shows the percentage of forecast occurrences of events above the upper tercile.

Column a) reports results for the **full ensemble** (50 members); column b) reports results for the subsampled ensemble (16 members) using **lead-season 0 ensemble mean NAO criterion**; column c) reports results for the subsampled ensemble (16 members) using **DJF empirical NAO criterion**.

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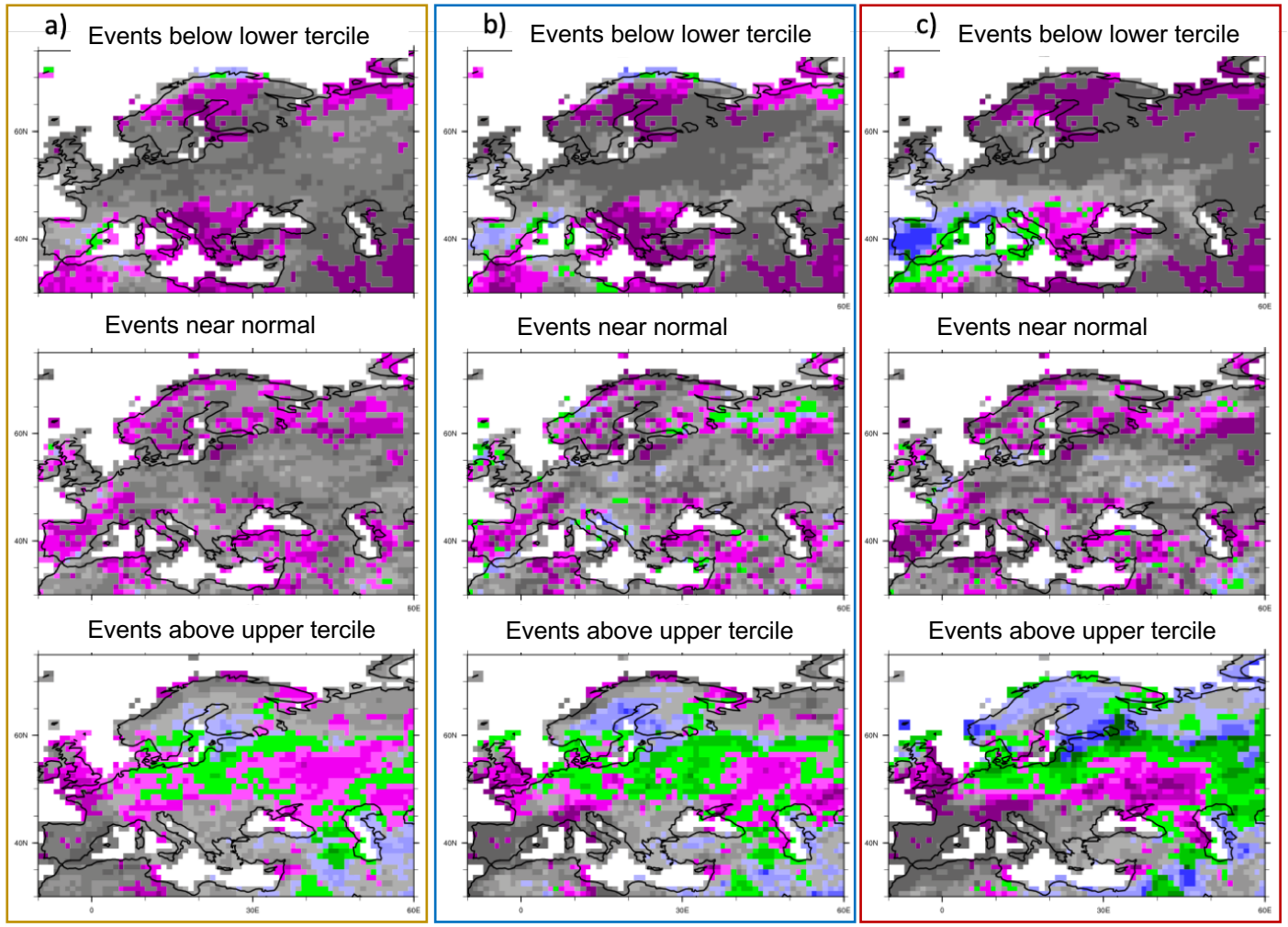

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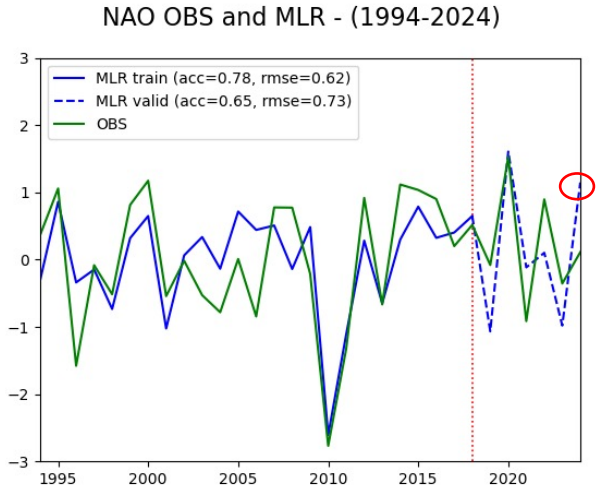

Summary and Conclusions

- Two different subsampling approaches have been tested, both potentially applicable in a real-time operational framework
- In C3S multi-ensemble, both approaches enhances NAO skill and consequently 2m temperature and precipitation ones
- In single model framework, as expected, the improvement depends on the system skill on NAO; the subsampling relying on an independent empirical estimate of NAO has a strong beneficial impact on the system skill
- Some impacts can be seen also in terms of real-time forecast evaluation

What's next?

- On going analysis on the added-value of the selected members: insight on possible sources of predictability for NAO at the seasonal timescale

The results shown for CMCC SPS are based on the current operational system (CMCC-SPS3.5) but we are presently running the new set of hindcasts for the forthcoming CMCC-SPS4 system (operational from Nov 2024)

- Comparison btw the two systems: exploiting the longer hindcast period (1994-2023) keeping 1994-2017 for ACC/skill analysis (as SPS3.5) and using the extra years 2018-2023 for independent evaluation

- Application of subsampling in the real-time operational chain from November 2024

Thanks for the attention

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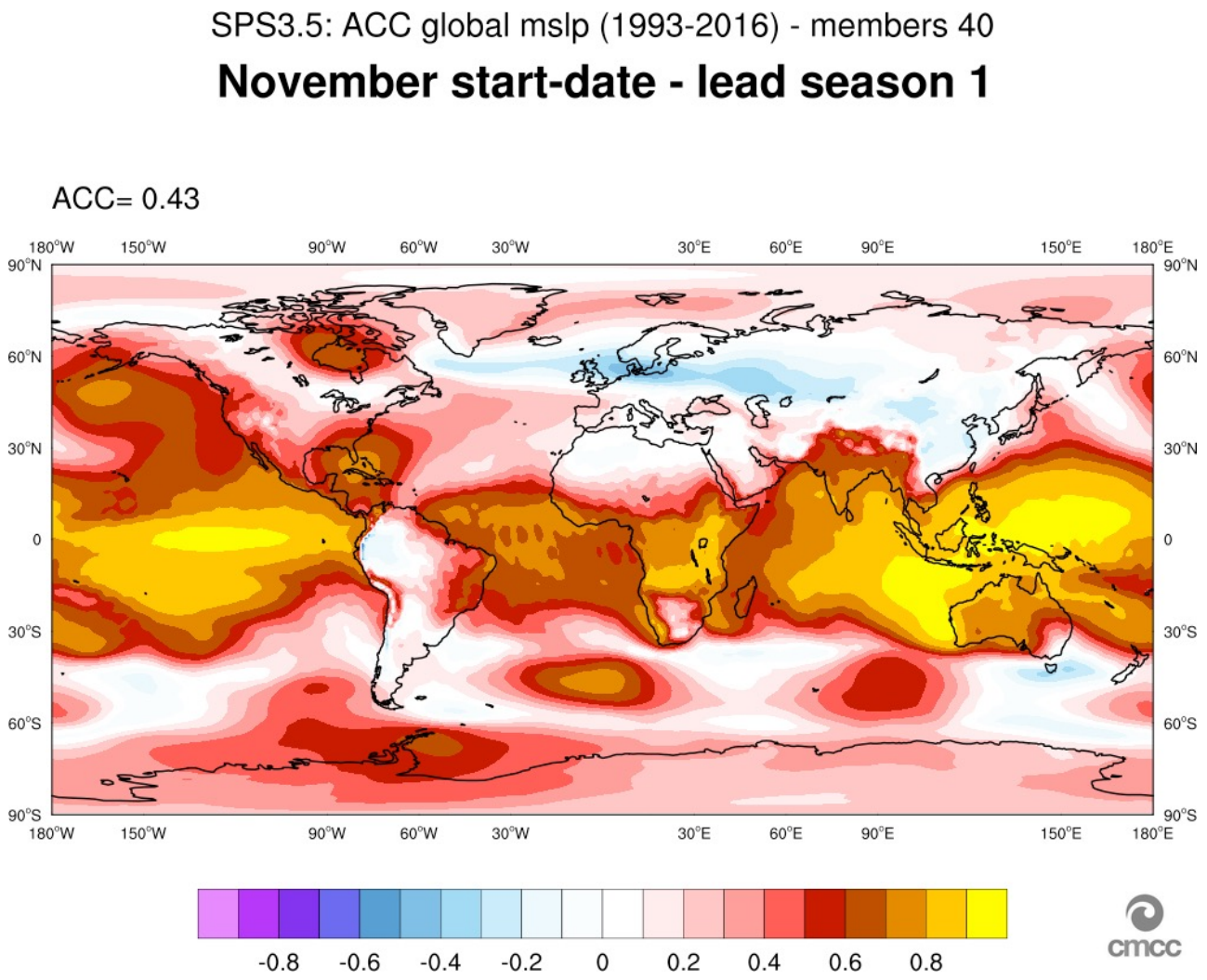
CMCC-SPS3.5 – MSLP ACC



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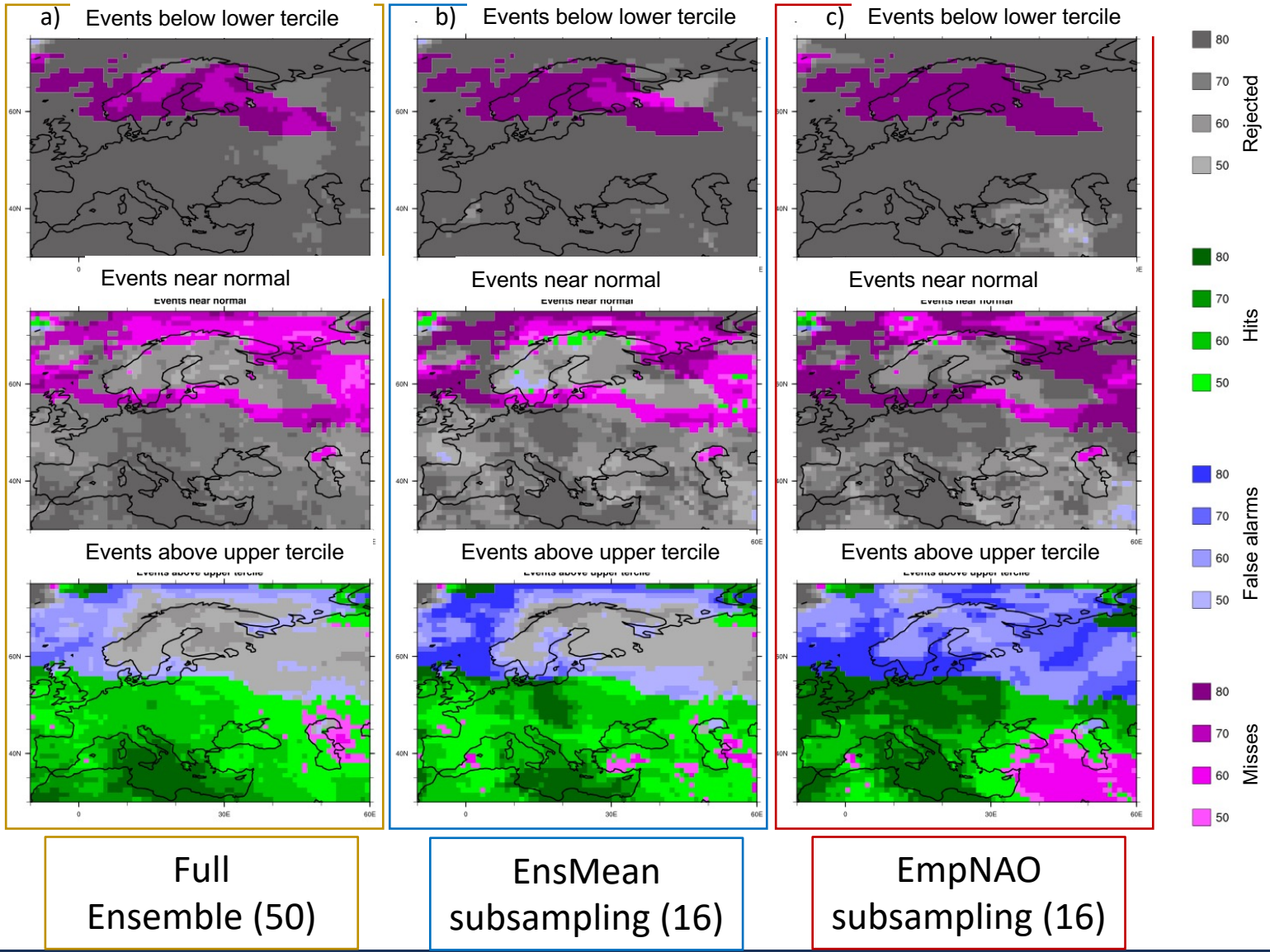

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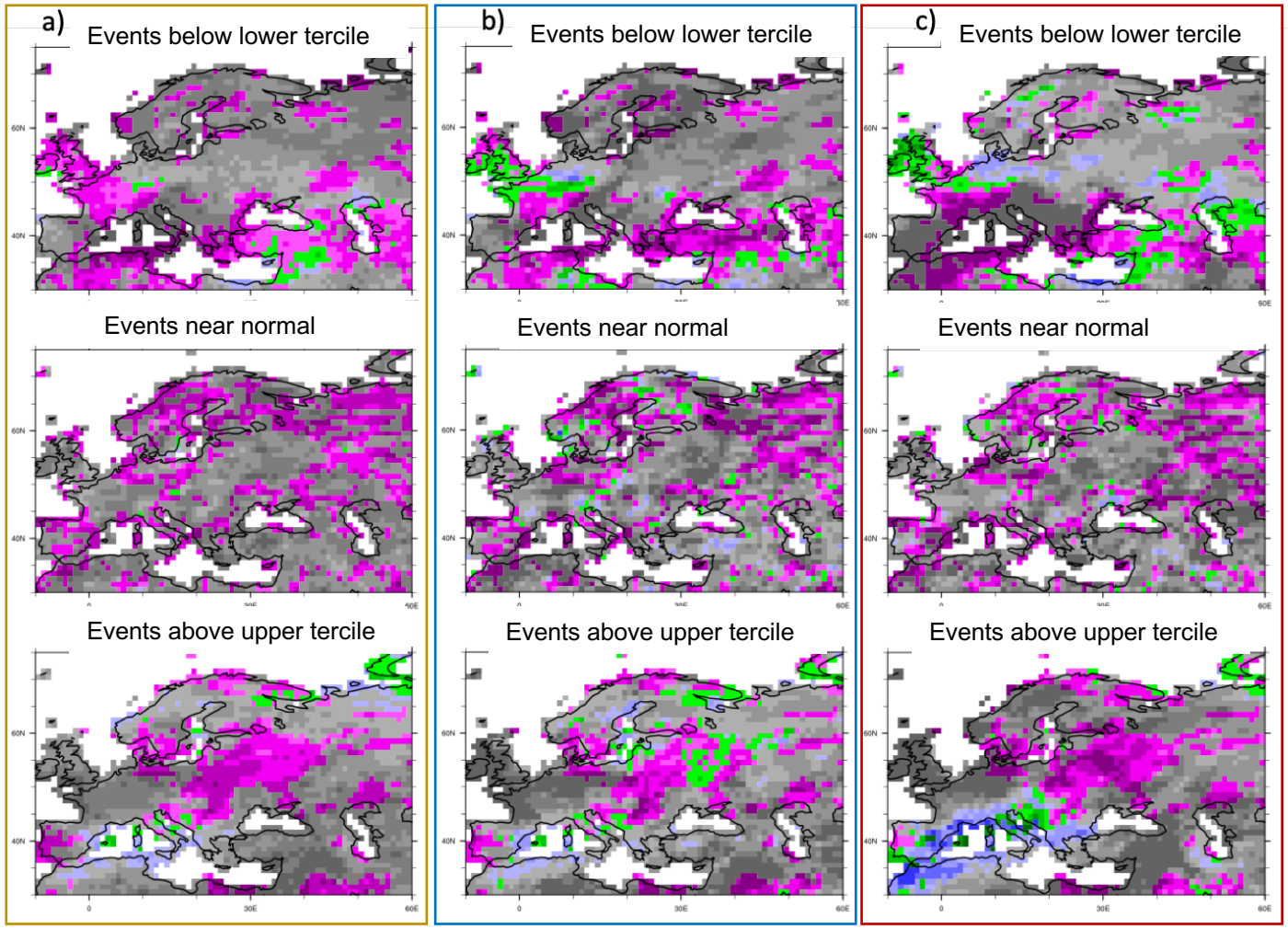

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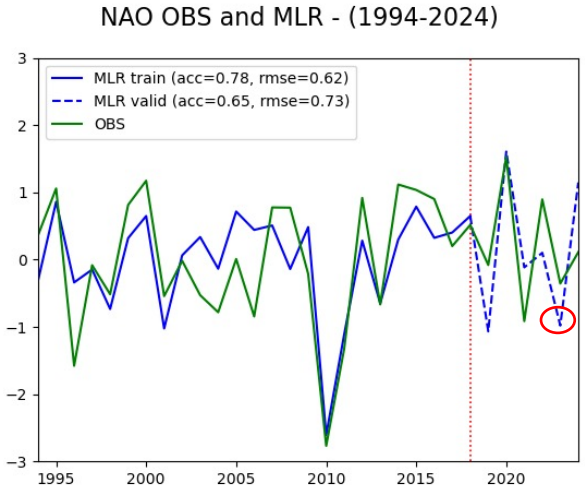
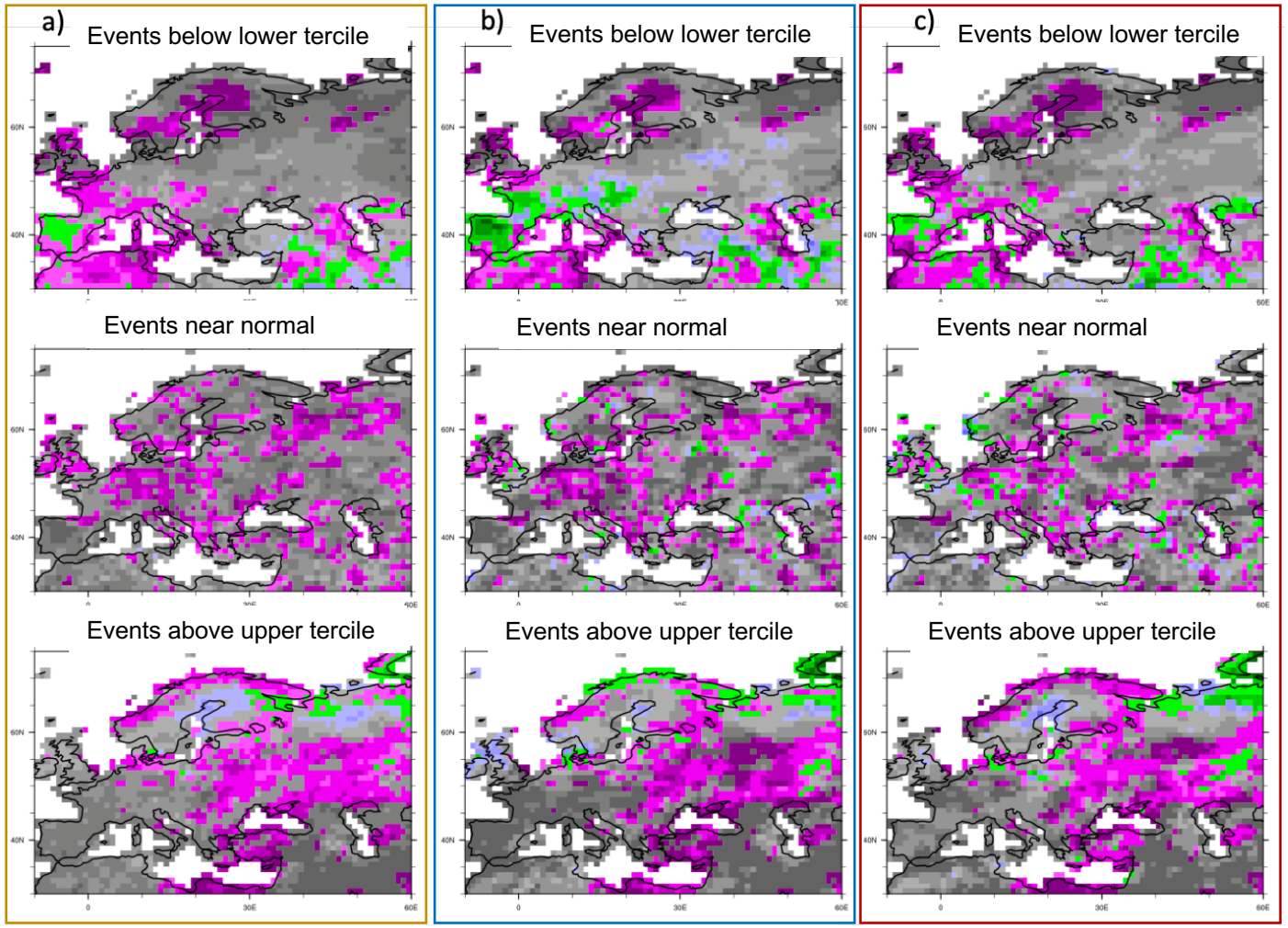


An example of real-time evaluation (DJF 2021/2022)



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Grid-point contingency table for **precipitation over the Euro-Mediterranean** domain for winter (DJF) 2021/2022

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