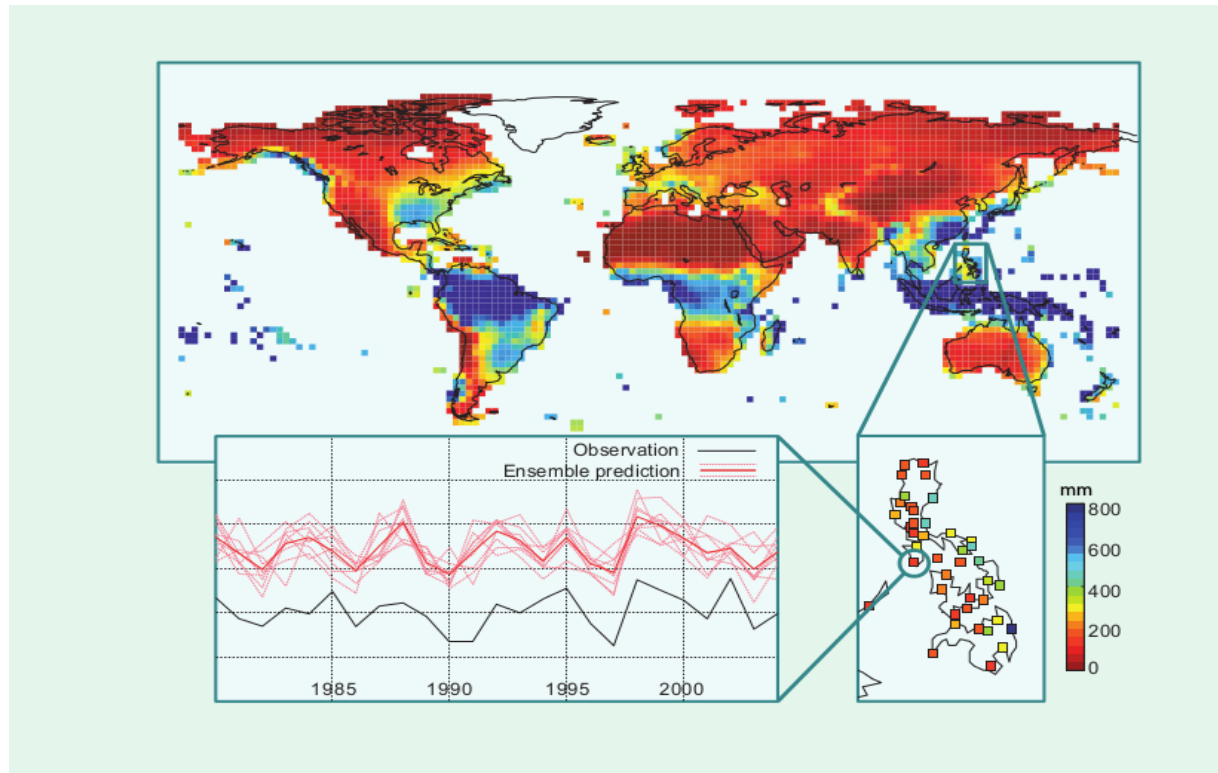# Advantages and limitations of different statistical downscaling approaches for seasonal forecasting

R. Manzanas, J.M. Gutiérrez, A. Weisheimer
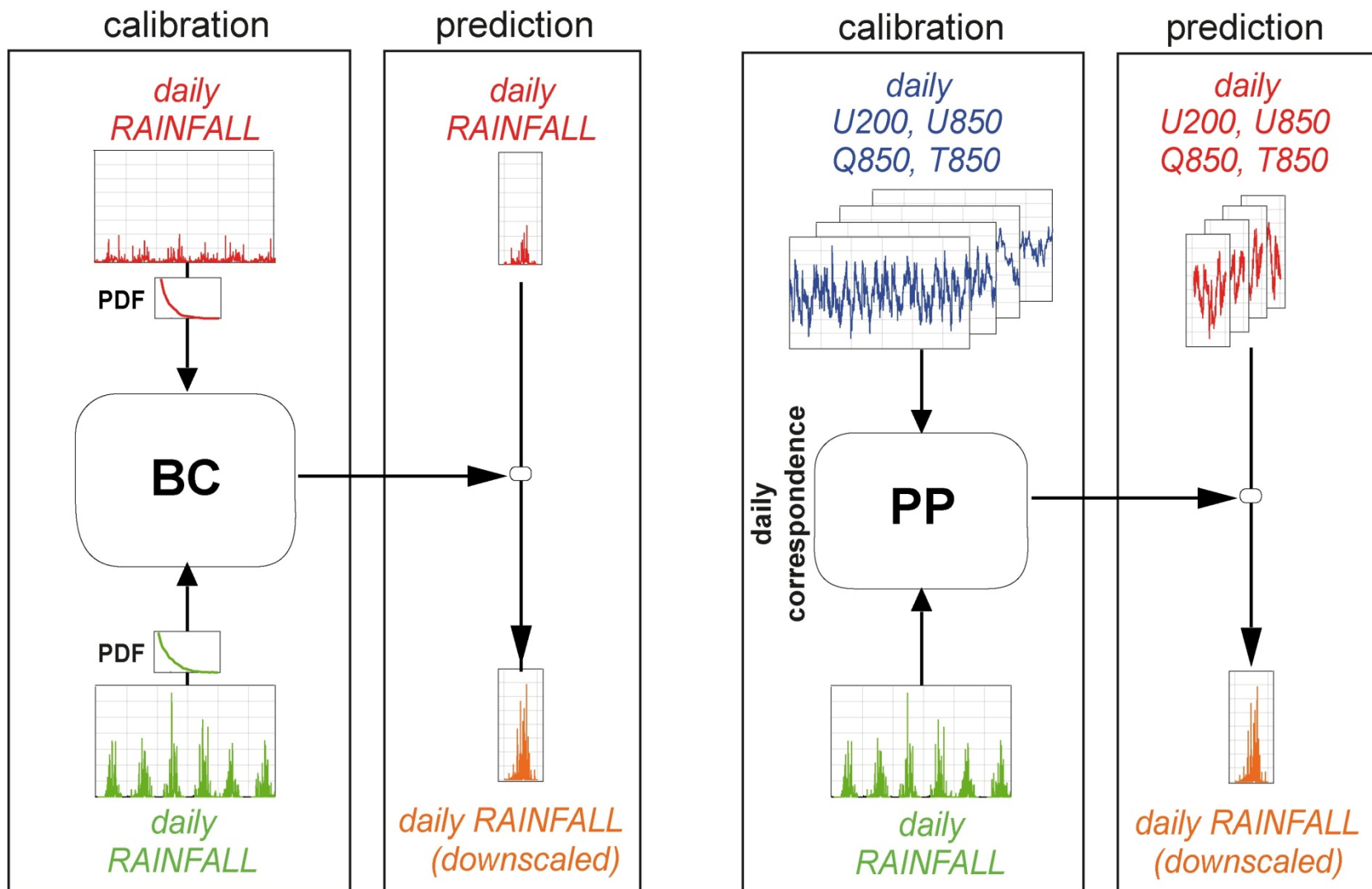
Santander Meteorology Group (CSIC - University of Cantabria)
PREDICTIA Intelligent Data Solutions

Exeter, 6 October 2016

Motivation

Statistical downscaling (SD): Statistical methods linking the local observations (**predictand** *Y*) with the global simulations given by the GCMs (**predictors** *X*):

$$Y = f(X; \theta)$$

Motivation

1) Can SD improve raw model global precipitation forecasts (beyond reducing the systematic biases)?

2) Which are the advantages and limitations of the BC vs. the PP approach?

BC
- Parametric Q-Q
- Empirical Q-Q

PP
- GLM
- Nearest analog

The ENSEMBLES dataset (*Weisheimer et al. 2009*):

Centre	Atmospheric model and resolution	Ocean model and resolution
ECMWF	IFS CY31R1 (T159/L62)	HOPE ($0.3° − 1.4°$/L29)
IFM-GEOMAR	ECHAM5 (T63/L31)	MPI-OM1 (1.5°/L40)
CMCC-INGV	ECHAM5 (T63/L19)	OPA8.2 (2.0°/L31)
MF	ARPEGE4.6 (T63)	OPA8.2 (2.0°/L31)

- One-month lead predictions for 1981-2005
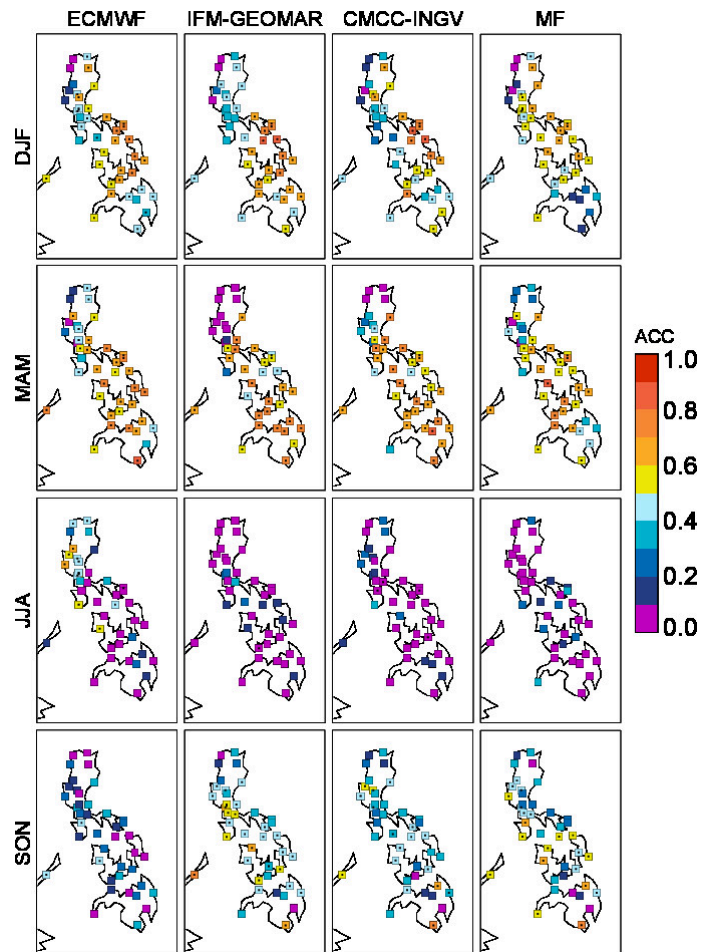- The Philippines

The regional case study: The Philippines
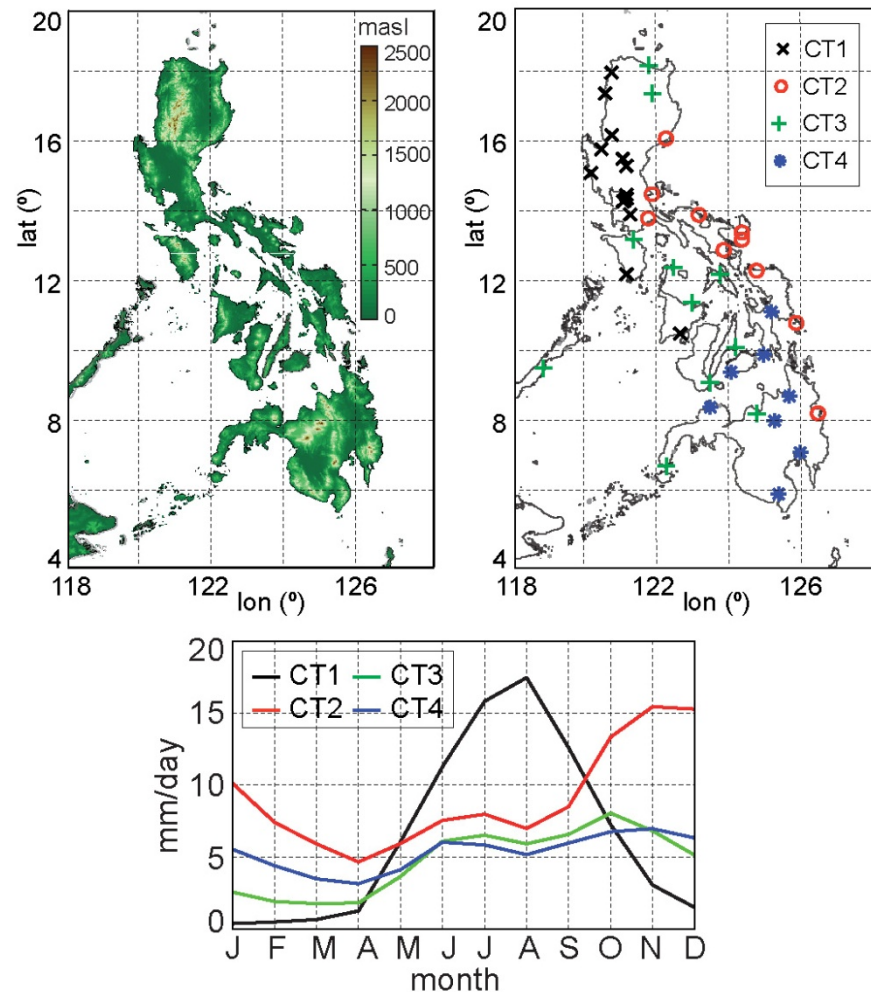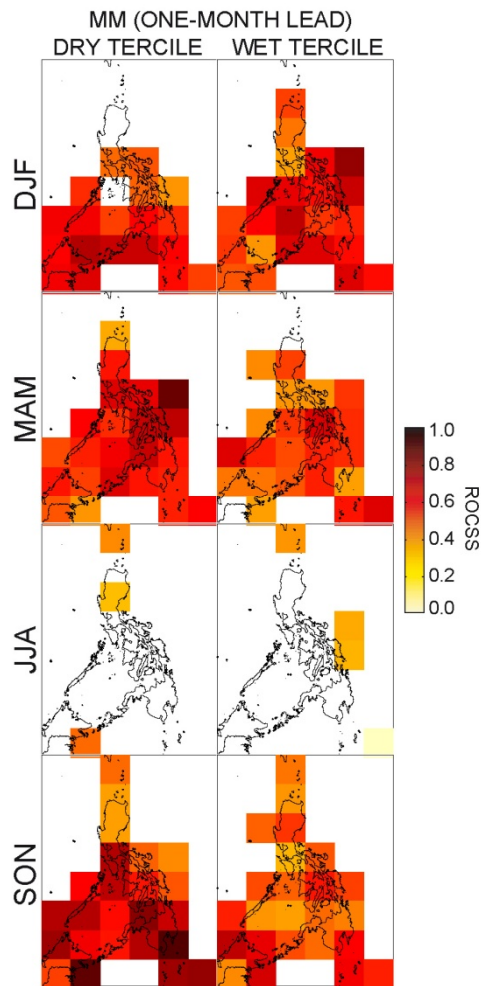
□ Relatively skillful region located in the tropics, strongly affected by ENSO
□ More than 7000 islands (land/sea contrasts) with complex orography: Ideal test-bed for SD studies (*Moron et al. 2009*)
□ High quality obs. (42 PAGASA stations,1981-2005): 4 CTs (*Coronas, 1920*)
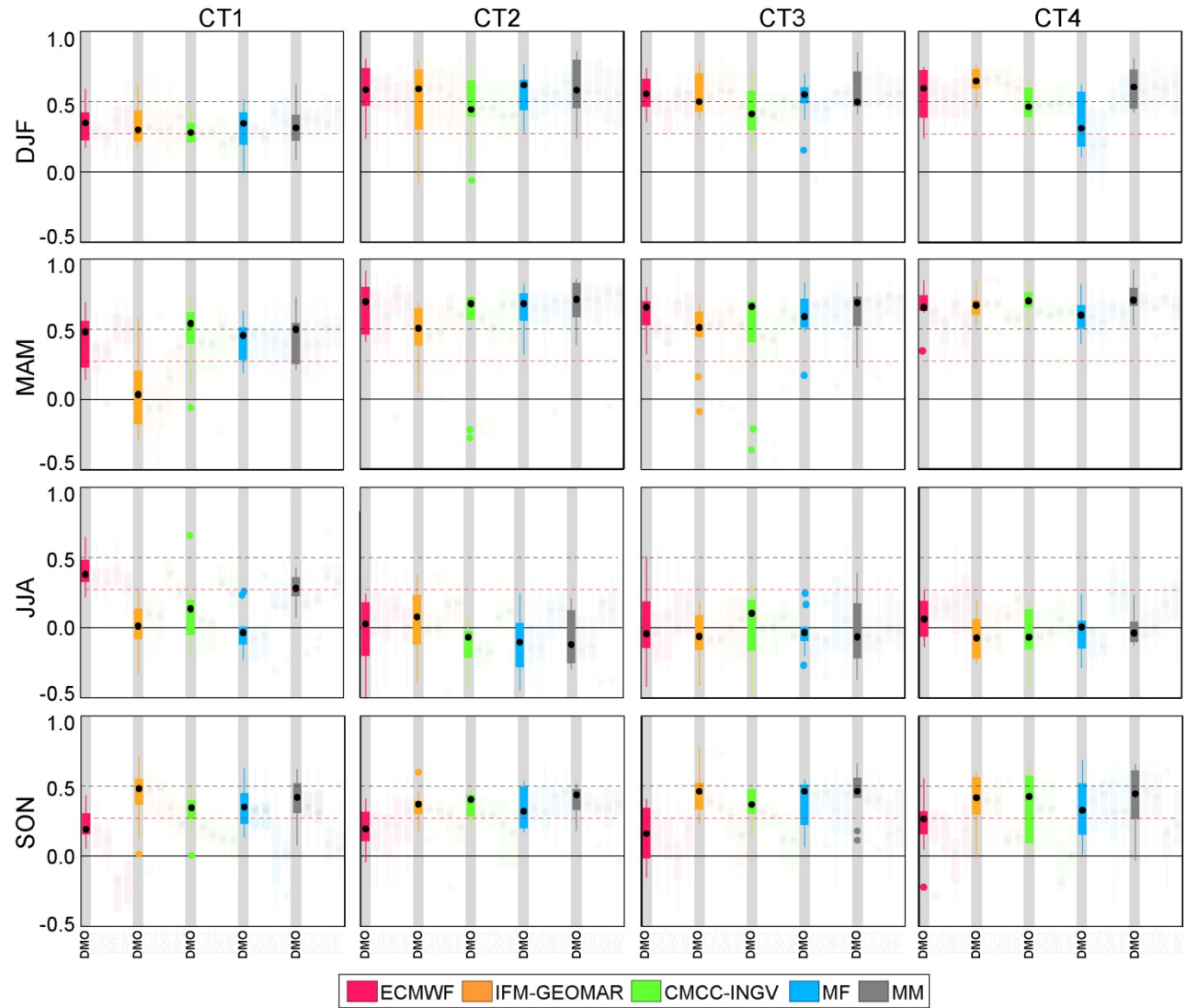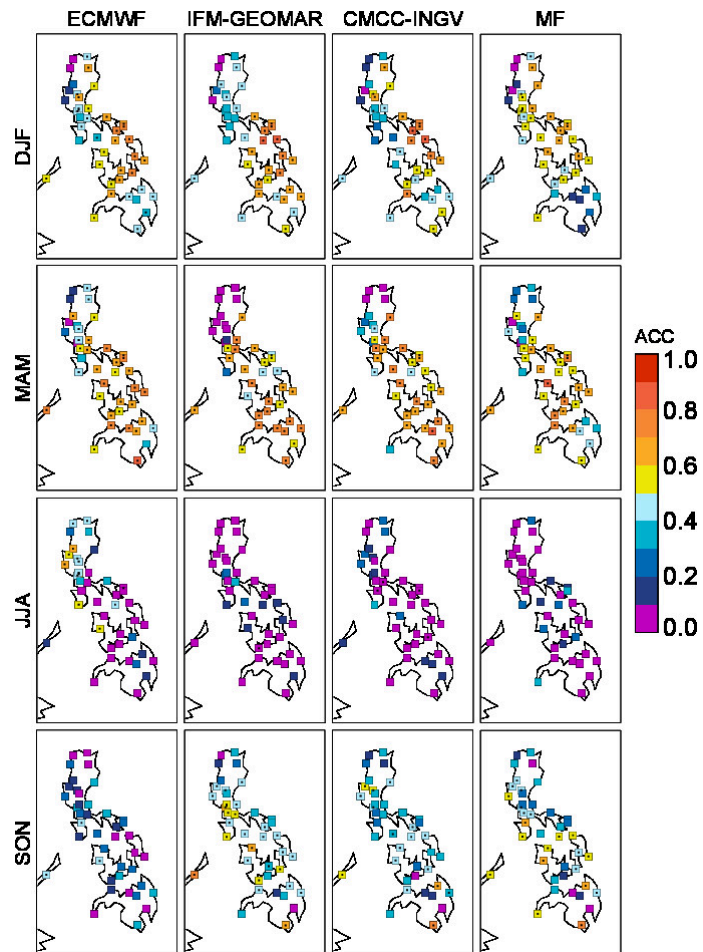
ACC: Summary for each season and CT

▪ DMO

□ All models show the highest (lowest) accuracy in DJF and MAM (JJA)

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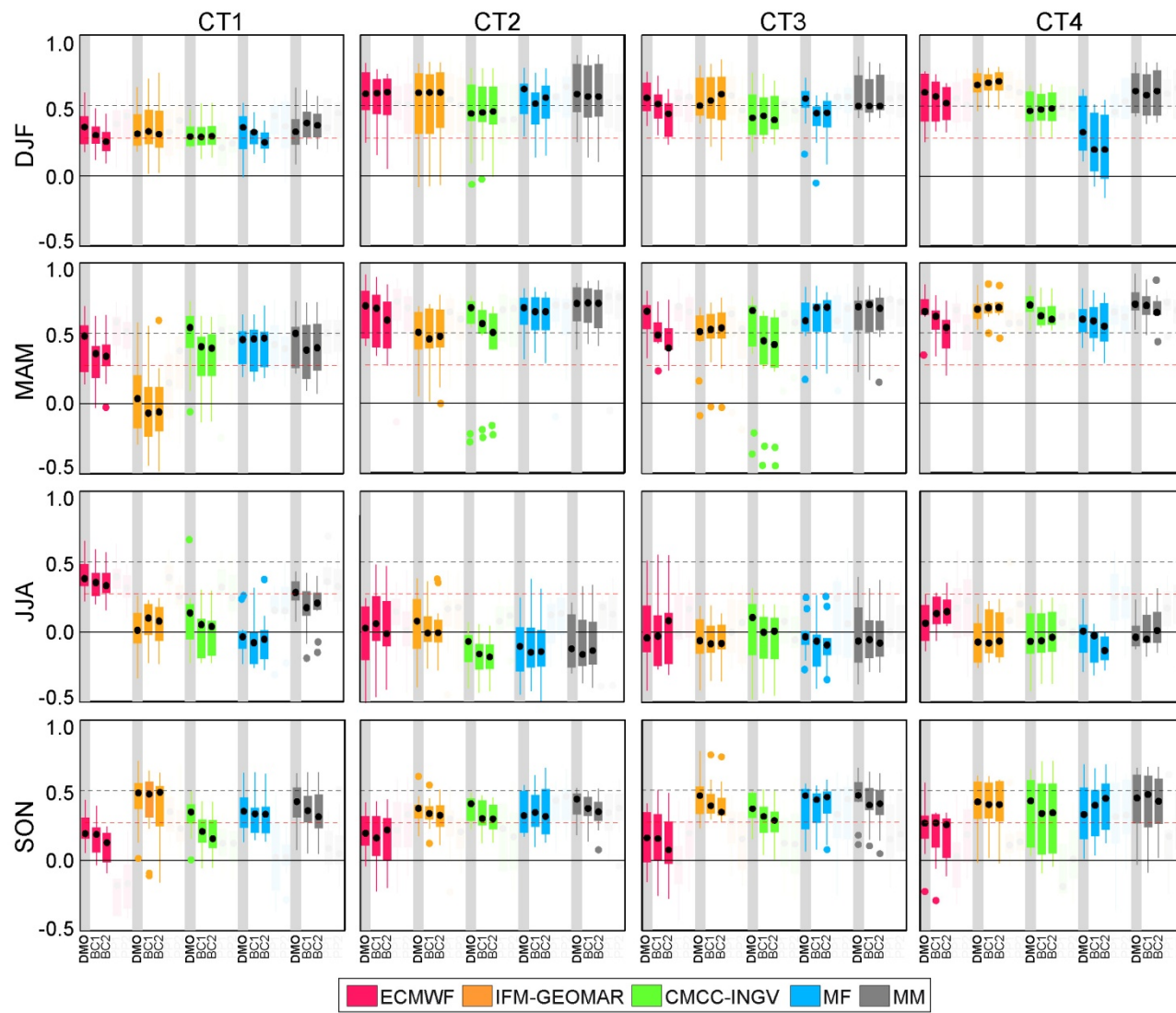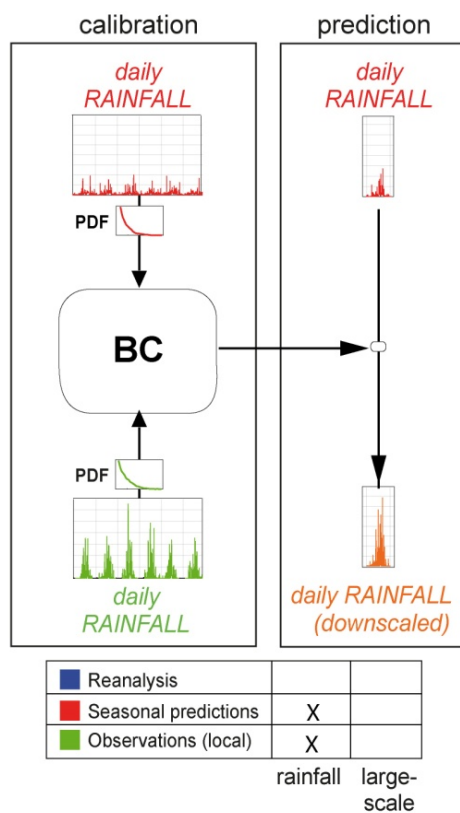
- DMO

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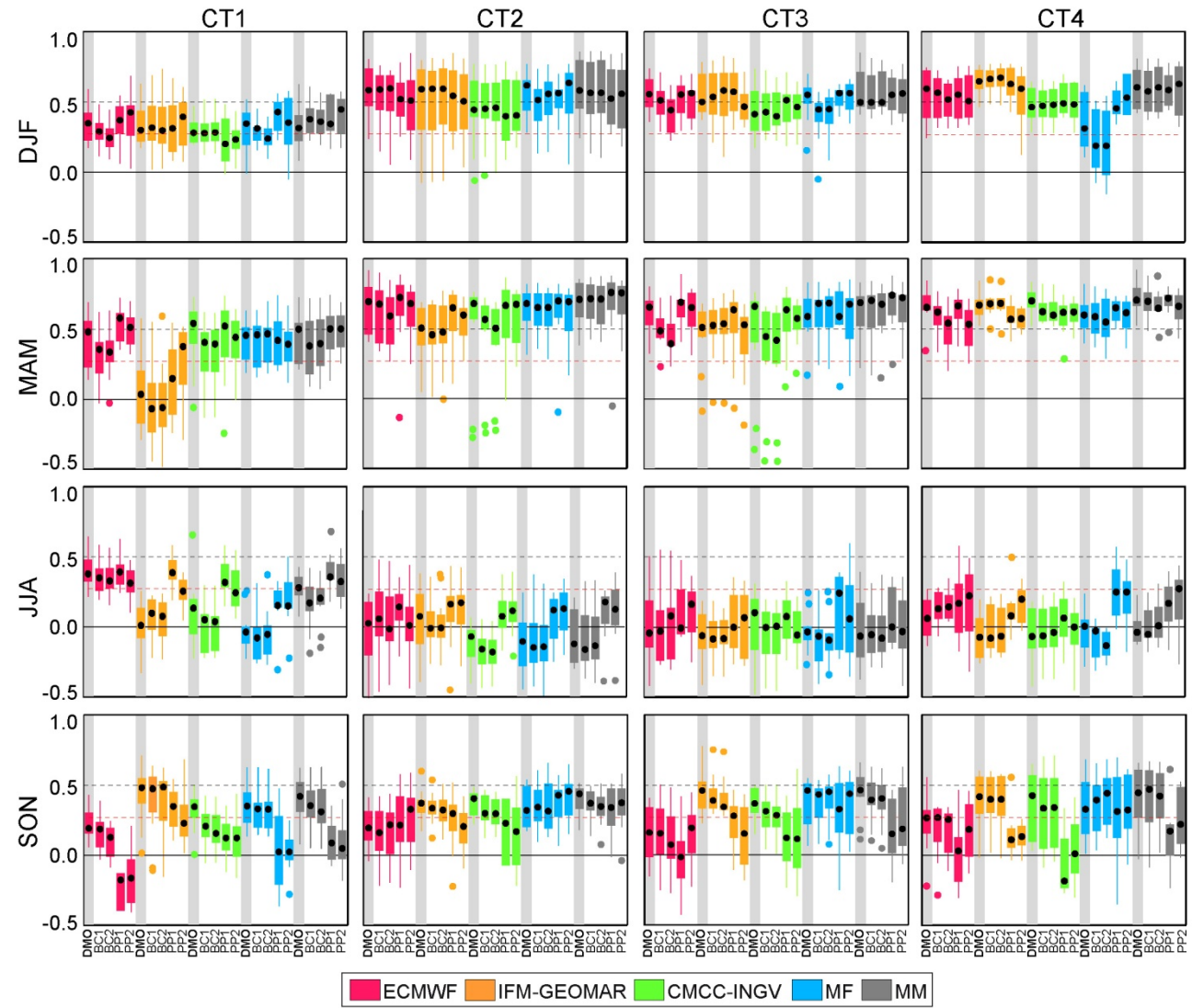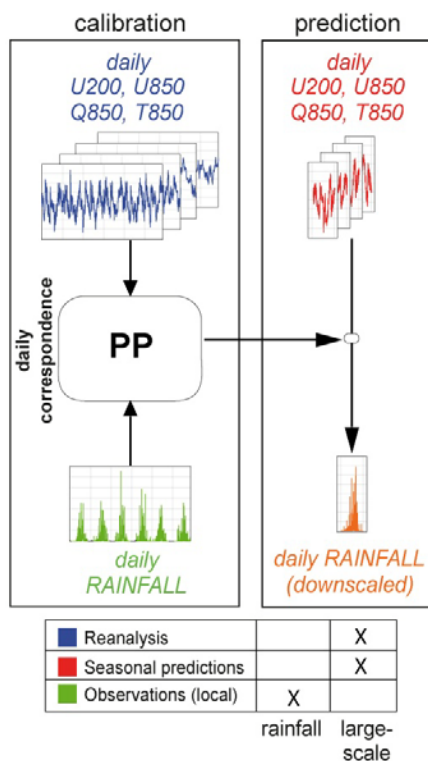
- BC1: Parametric Q-Q
- PP2: Empirical Q-Q

- 5-fold cross-validation (1981-2005)

ACC: Summary for each season and CT

- PP1: GLM
- PP2: Nearest analog
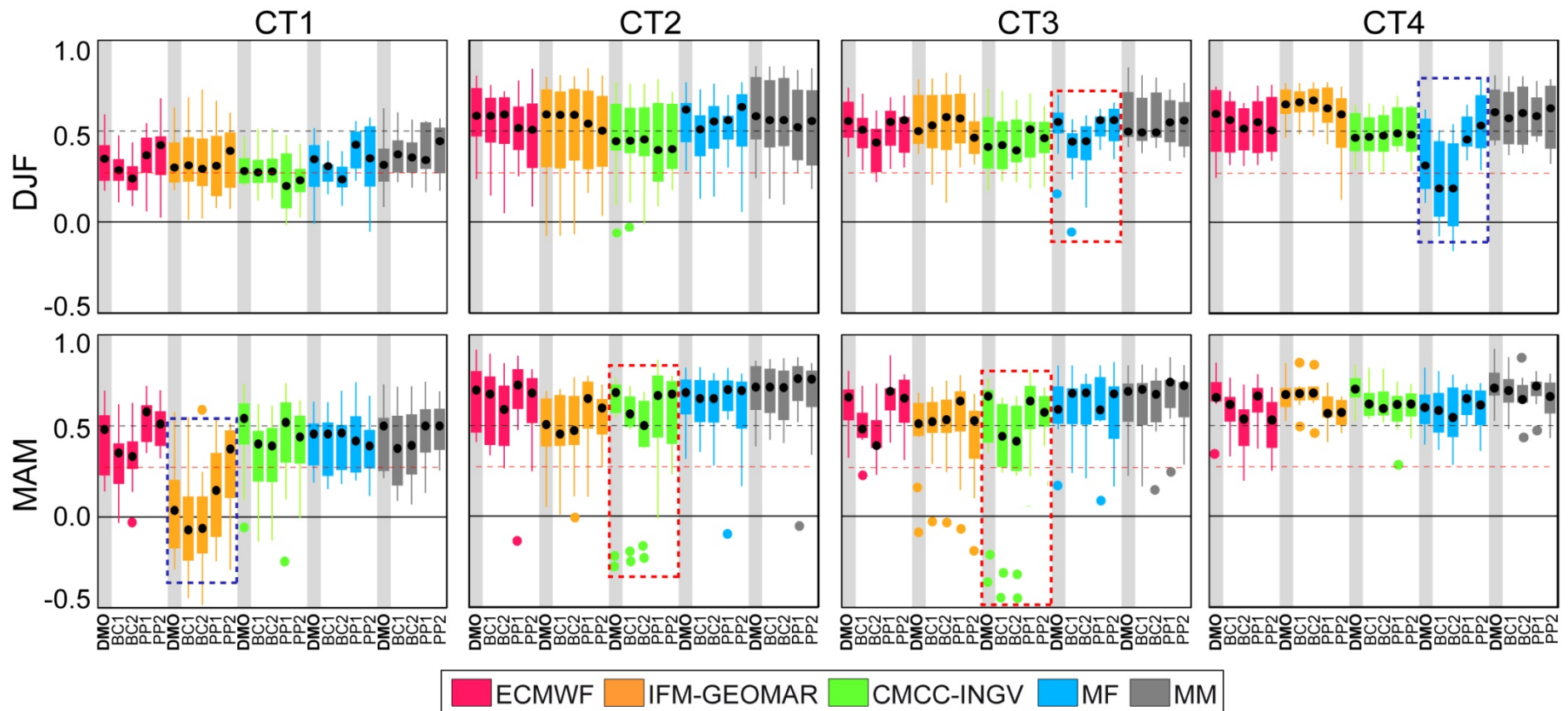
- 5-fold cross-validation (1981-2005)
- ERA-Interim predictors (*Manzanas et al. 2015*, doi: 10.1175/JCLI-D-14-00331.1)

□ Results are more sentitive to the approach (BC or PP) than to the different methods considered within each approach

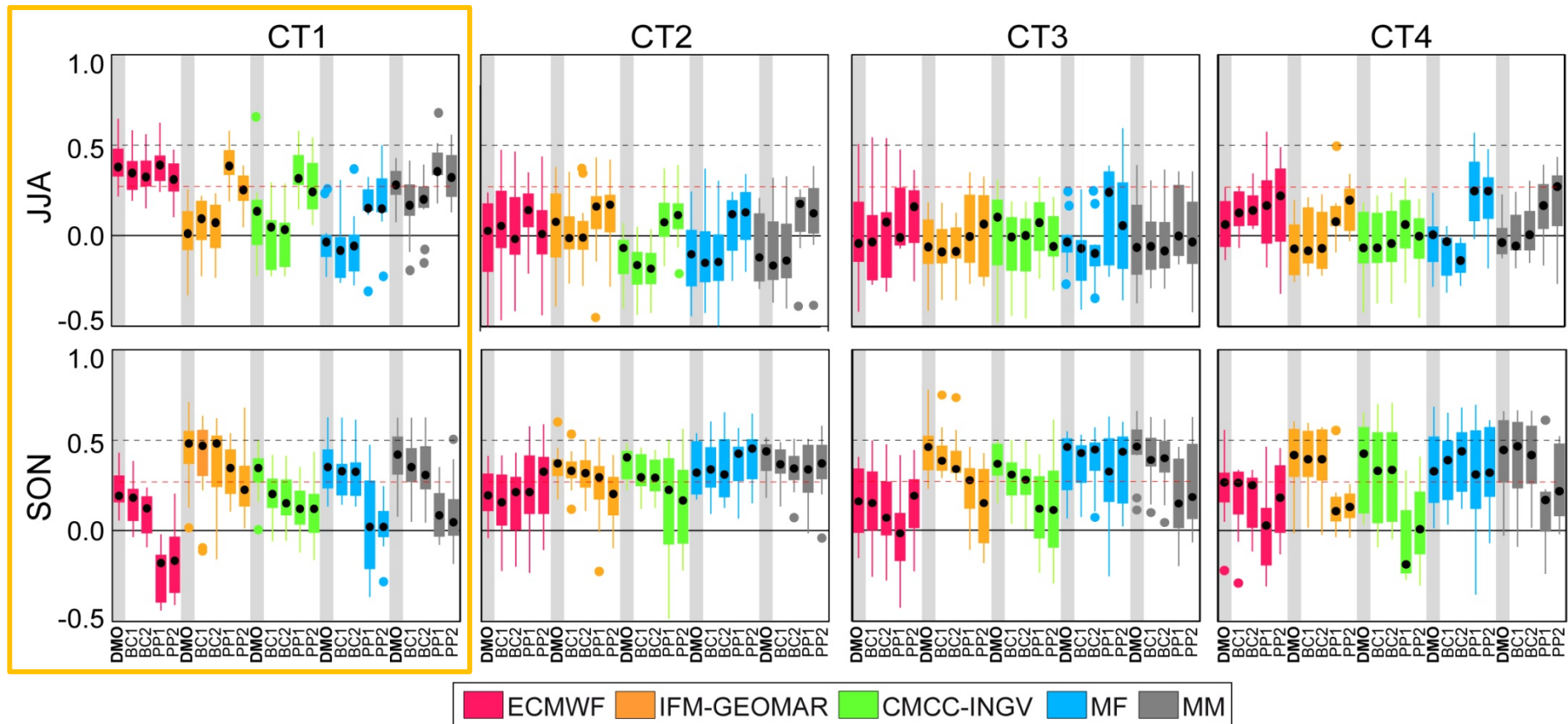## ACC: Summary for each season and CT

DJF and MAM:

- ❑ BC methods do not improve (or even worse) the DMO
- ❑ However, PP methods show important improvements for some cases:
  - Bad performing (as compared to other) models
  - Particular "outlier" stations

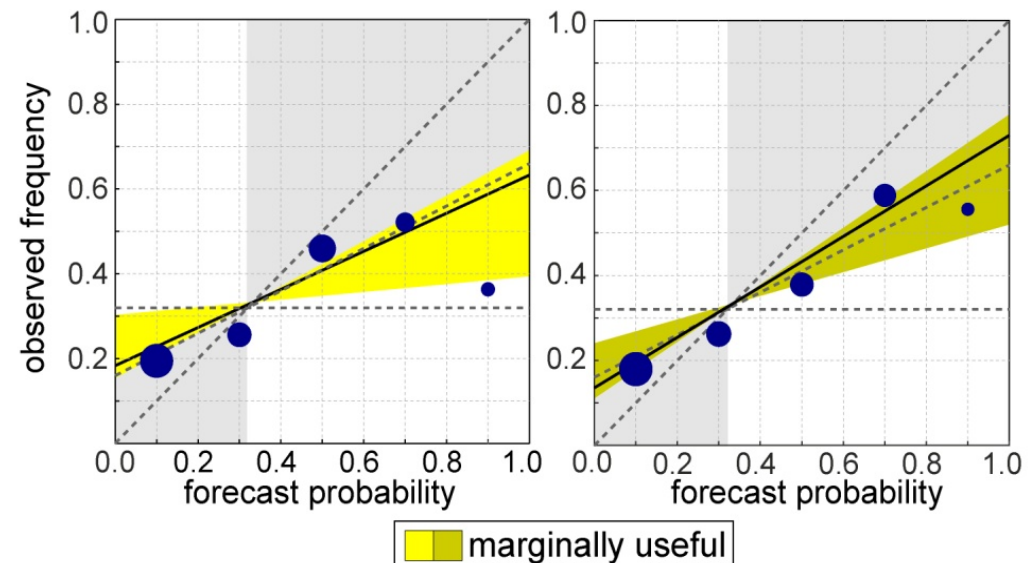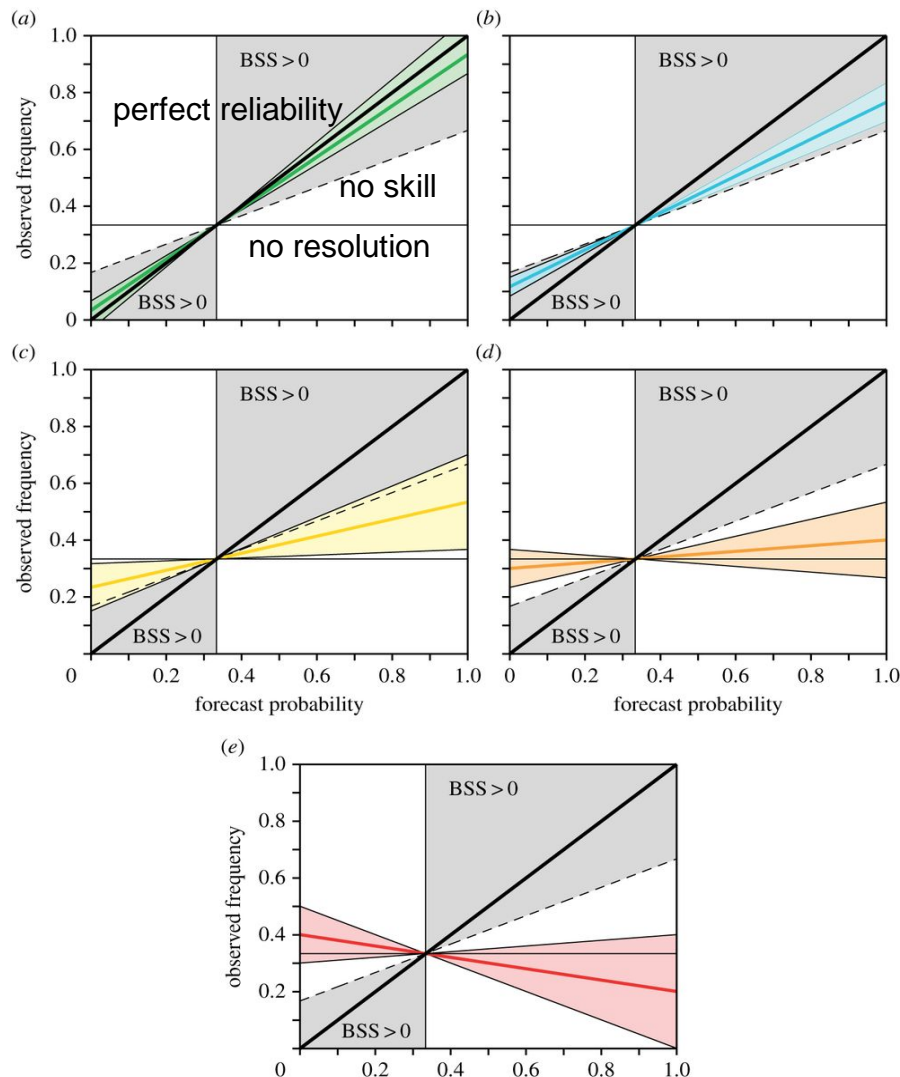## ACC: Summary for each season and CT

JJA and SON:

- BC methods do not improve (or even worse) the DMO
- However, PP methods provide in general better (worse) accuracy than the DMO in JJA (SON), especially for the CT1 region

Reliability categories: Weisheimer and Palmer 2014

- 5 categories (intuitive for users), based on the reliability diagram (terciles)

□ Better categories discrimination

perfect | still useful | marginally useful | not useful | dangerous

Source: http://rsif.royalsocietypublishing.org/content/11/96/20131162

Reliability categories: Summary for each season and CT
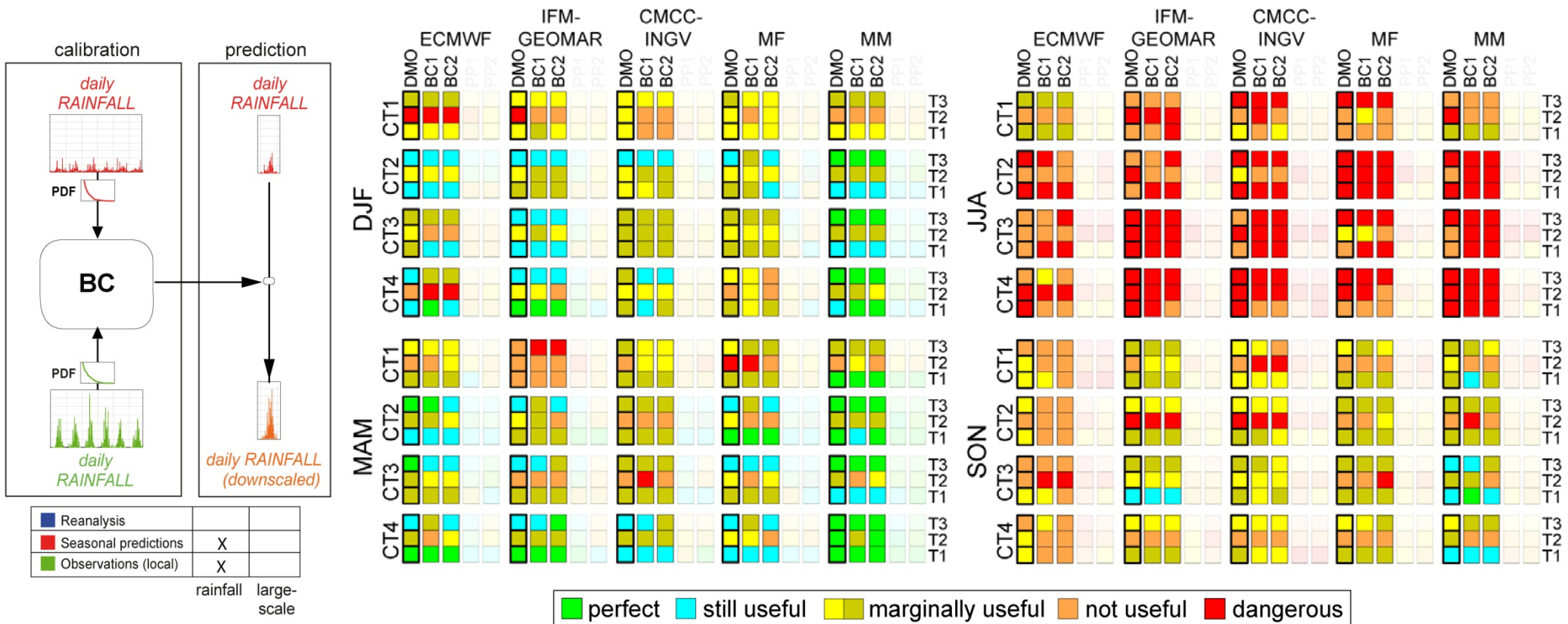
- Tercile-based probabilistic seasonal forecasts
- For each CT, all stations are jointly considered
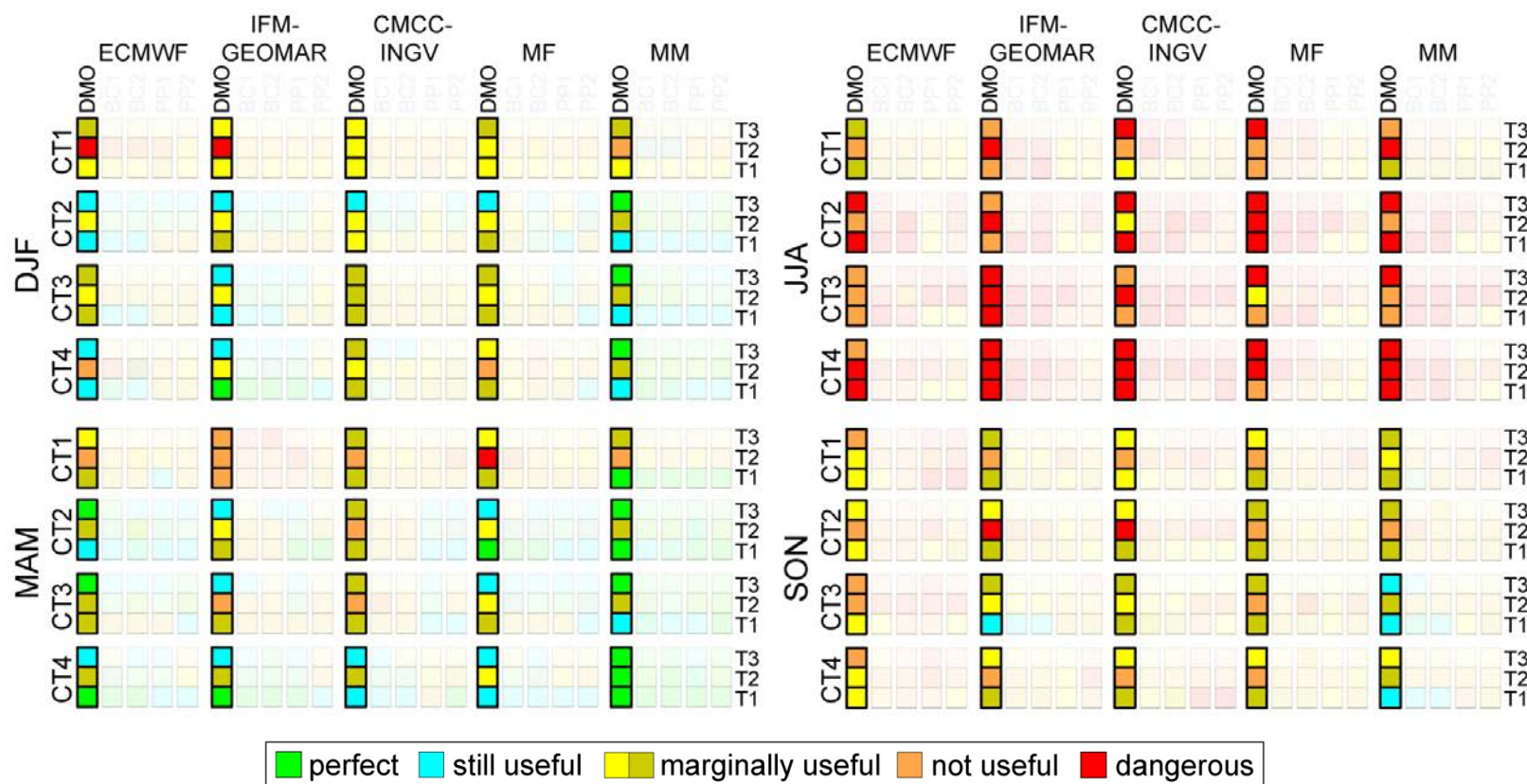
- DMO

Reliability categories: Summary for each season and CT
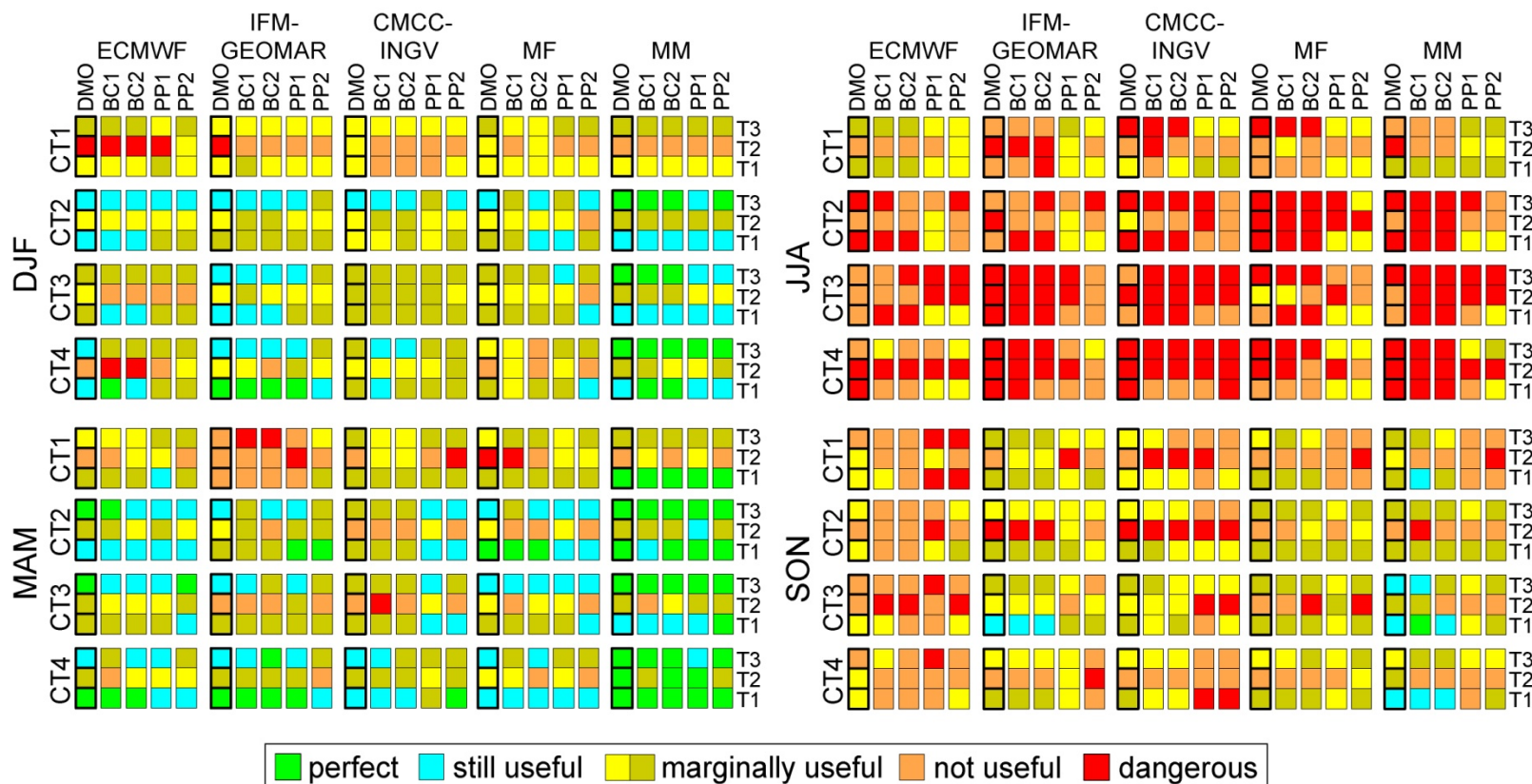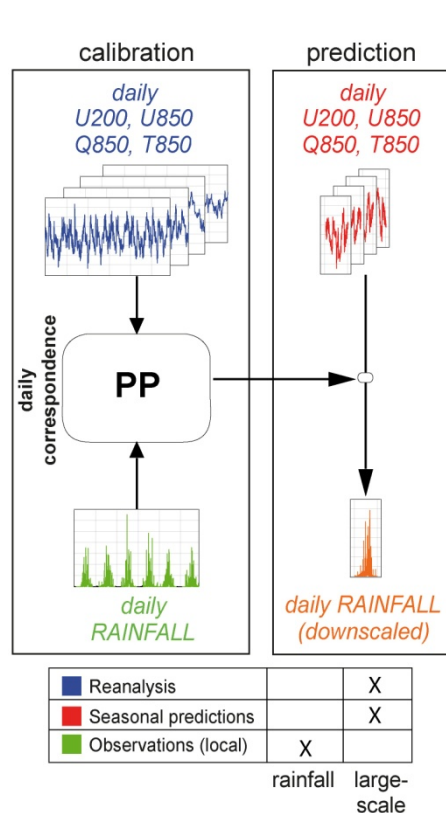
- Tercile-based probabilistic seasonal forecasts
- For each CT, all stations are jointly considered

- BC1: Parametric Q-Q
- BC2: Empirical Q-Q

## Reliability categories: Summary for each season and CT

- Tercile-based probabilistic seasonal forecasts
- For each CT, all stations are jointly considered

- PP1: GLM
- PP2: Nearest analog

Reliability categories: Summary for each season and CT

- Within each approach, the two methods are jointly considered
- For clarity, T2 and MM are excluded

(a) DJF (b) MAM (c) JJA (d) SON

perfect | still useful | marginally useful | not useful | dangerous
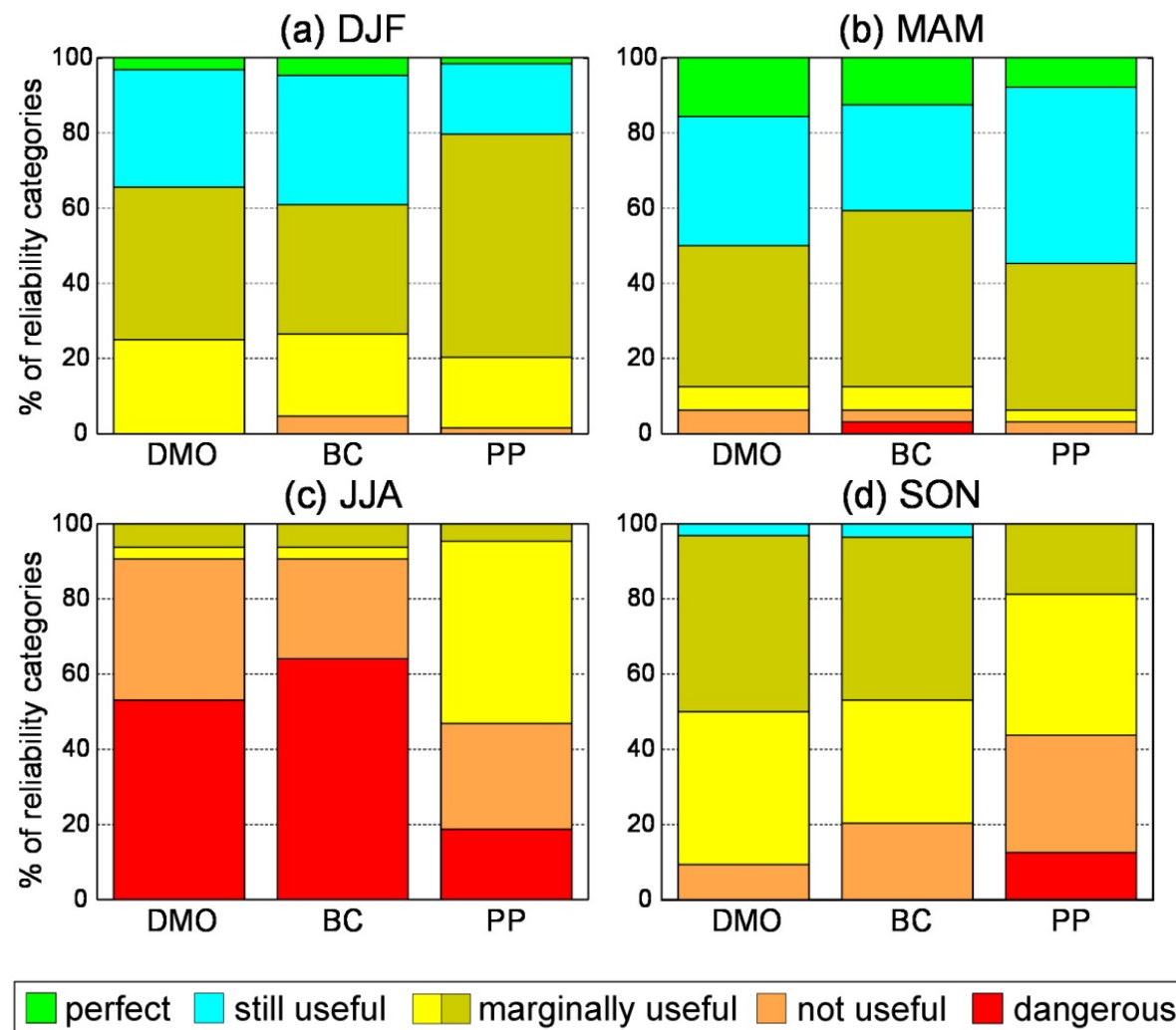
- BC methods do not provide clear added value (or even worsen the DMO)

- However, PP methods improve (deteriorate) the reliability of the DMO in JJA (SON)

- There is a good alignment between these results and those obtained for ACC, which points out the **suitability of the methodology** for regional studies

An explanation for the added value of PP methods

Interannual ACC between JJA observed precipitation in CT1 and the corresponding ERA-Interim and ENSEMBLES outputs
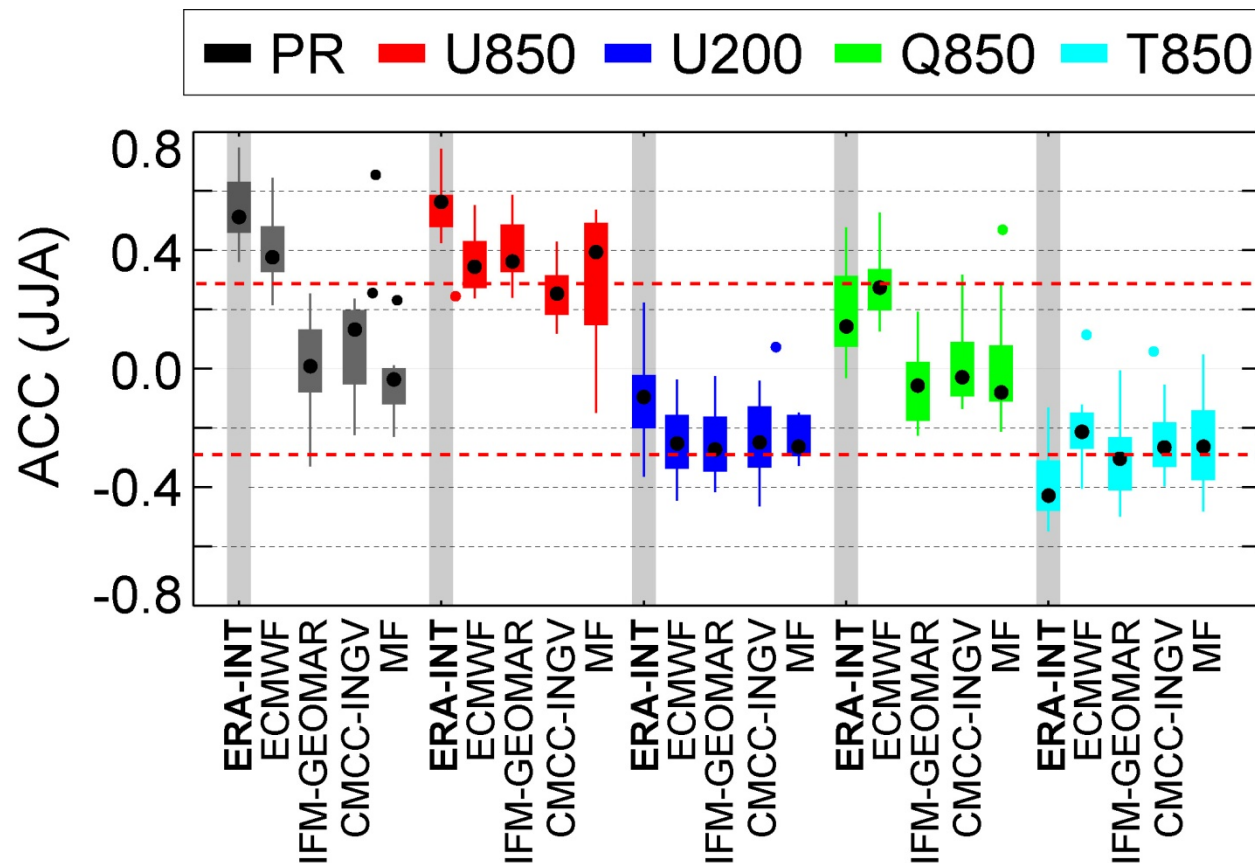
JJA (gain of skill)
- **Bad** model performance for **precipitation**

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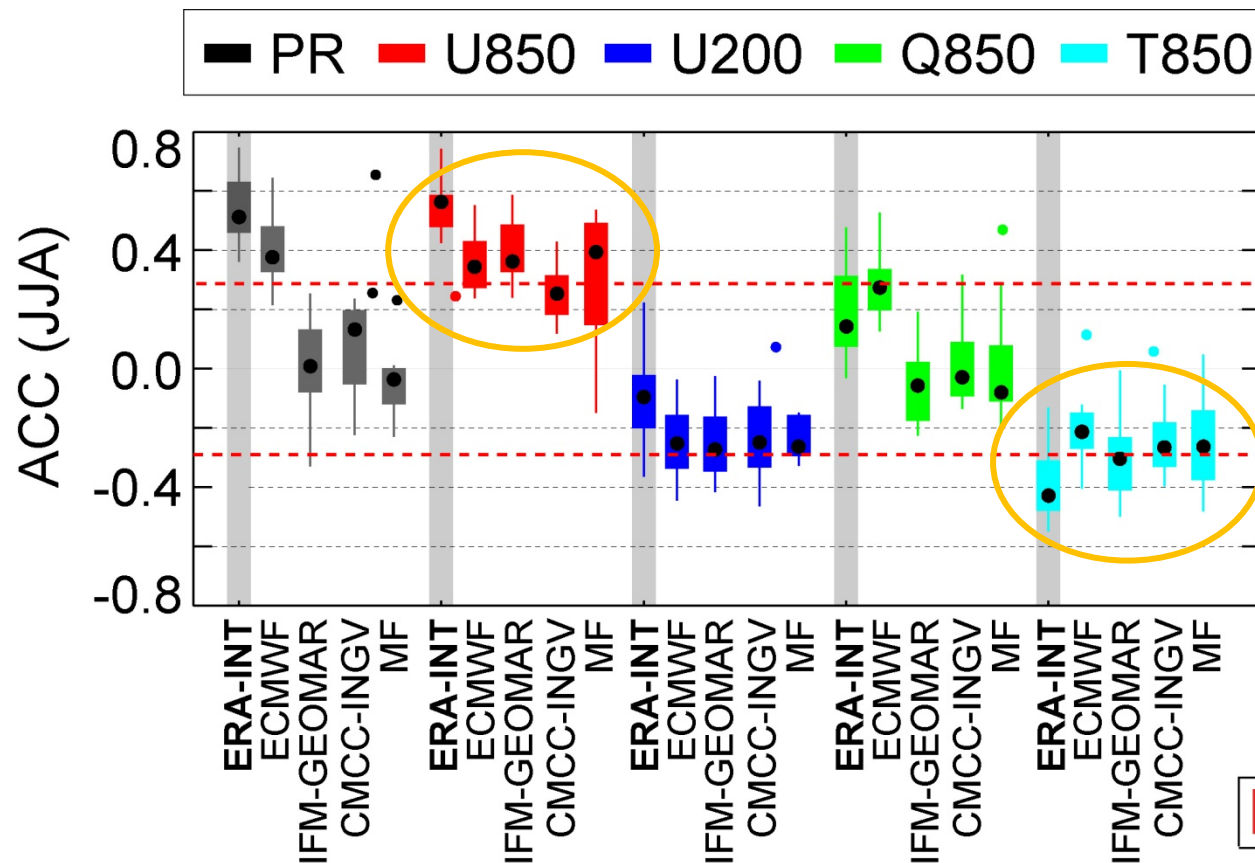

JJA (gain of skill)
- **Bad** model performance for **precipitation**
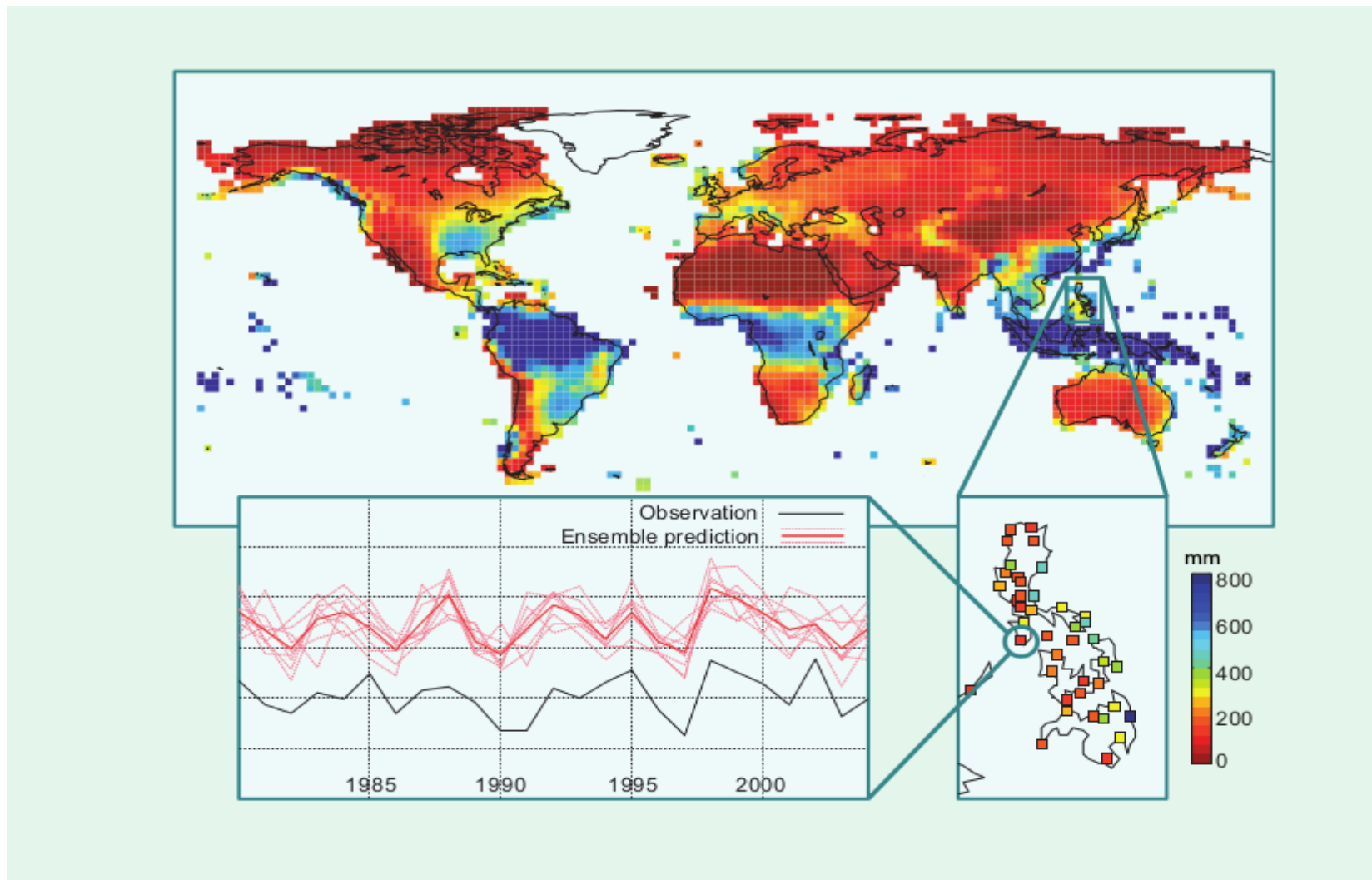- However, **good** model performance for **large-scale** predictor variables

	rainfall	large-scale
Seasonal predictions	✖	✔
Rainfall (downscaled)		✔

Key conclusions

- In general, **no robust signal** of added value is found for the **BC** methods

- However, **PP** methods can yield **important improvements/worsenings** (w.r.t. the DMO) in certain situations. In particular, they may add large local value in those cases where raw model precipitation is not realistic but large-scale predictors are well simulated

R. Manzanas, J.M. Gutiérrez, A. Lucero and A. Weisheimer, 2016: "Can statistical downscaling and bias correction methods improve the accuracy and reliability of raw seasonal forecasts?". Submitted to *Climate Dynamics*

Thank you very much for your attention

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