

Calibration and Combination of NMME precipitation forecast over South America using Ensemble Regression

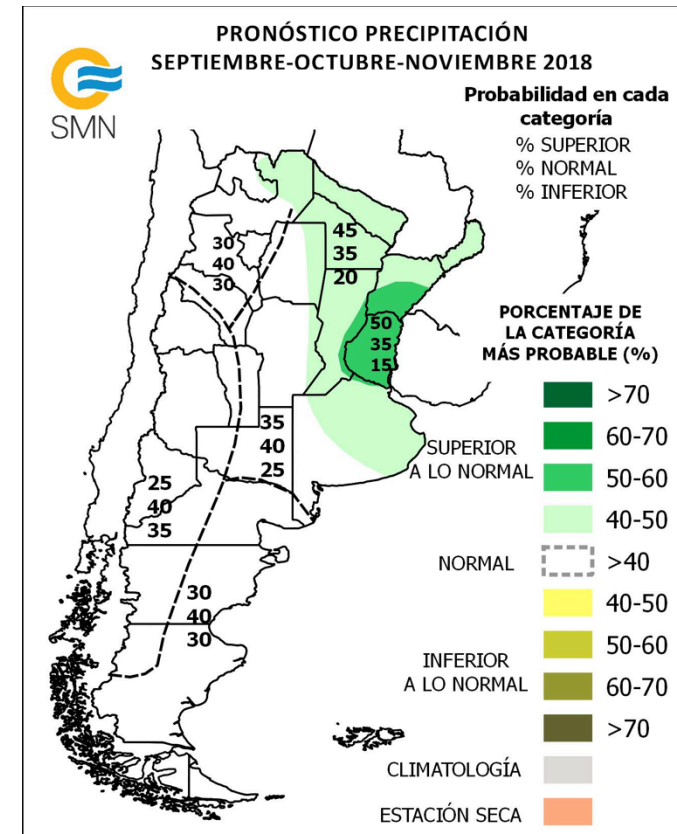
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Motivation

- Current seasonal outlook at the Argentina Met Service (SMN) is based on a **subjective consolidation** of seasonal forecast made in other centers.
- The SMN, as part of the Regional Climate Center for Southern South America, wants an **objective consolidated** forecast tailored for the continent.
- We explore the performance of a calibrated and consolidated forecast based on the outputs from the **NMME project**.



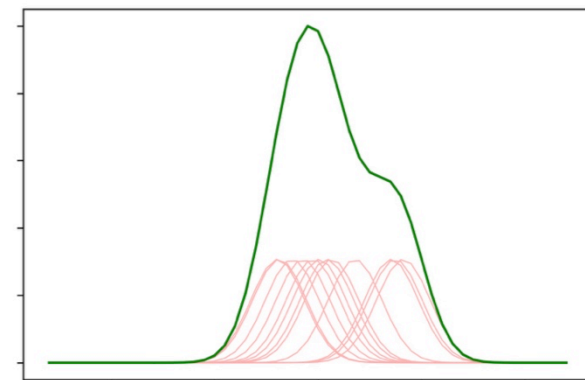
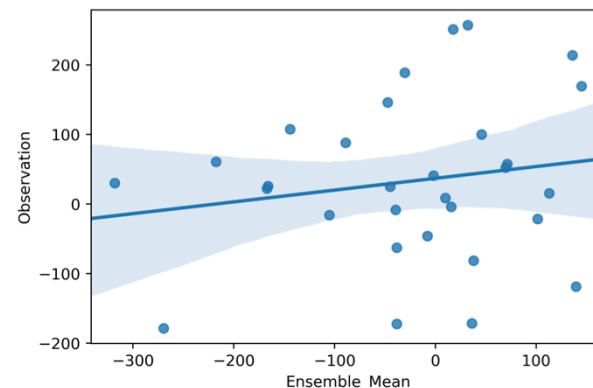
Calibration approach: Ensemble Regression

- Develop a linear model linking the ensemble mean with the observation.
- Evaluate the regression equation on each member of the ensemble (F')

$$Y' = a_0 + a_1 * F' + \varepsilon$$

- Each member is characterized by a PDF which distribution is $N(Y', \varepsilon)$

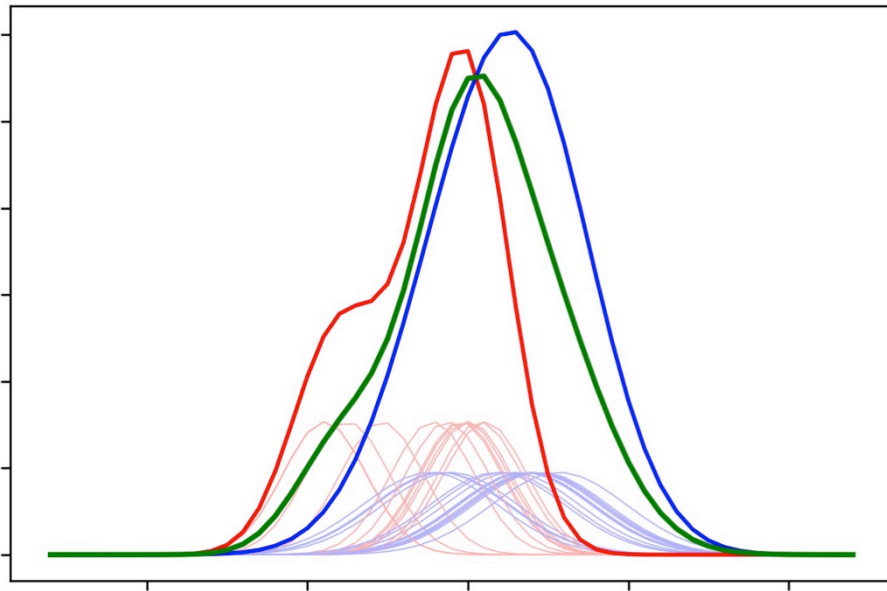
The final PDF is the normalized sum of each PDF obtained after applying Ensemble Regression to each member of the ensemble



Combination approach

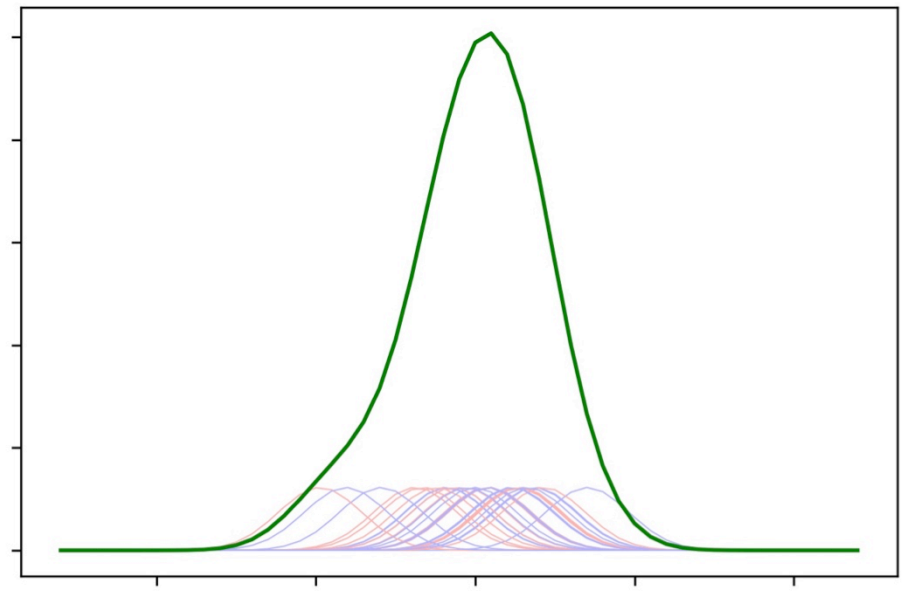
Weighted calibrated PDF (WPDF)

Weighted sum of the calibrated PDF of each model obtained through ensemble regression



Weighted super-ensemble regression (WSEREG)

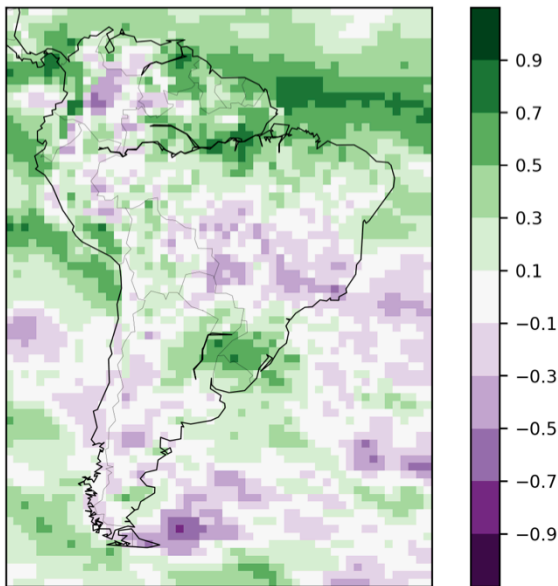
Ensemble regression applied to the weighted super-ensemble



How do we weight models? - 3 options

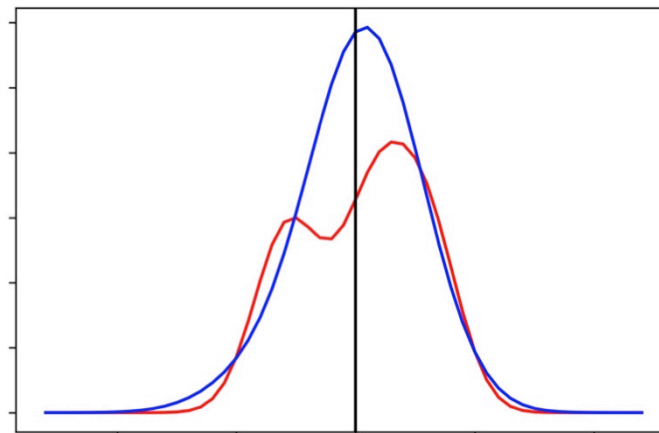
MEAN CORRELATION

Weight proportional to the correlation between the EM of the model and the Obs



PDF_INT

Weight = # of yrs the PDF intensity of a model was **max at the observation value** / total yrs



SAME weight to all models

Data

- **DJF Precipitation Forecast**
- **Initial conditions: November (lead 1 month)**
- **Hindcast years: 1982-2010**

Institution	Model	# Ens Members
CMC	CanCM3	10
CMC	CanCM4	10
COLA	CCSM4	10
COLA	CCSM3	6
GFDL	CM2p1a	10
GFDL	FLOR-A05	12
GFDL	FLOR-B01	12
NASA	GEOS5	4
NCEP	CFSv2	24

Which calibration technique is better?

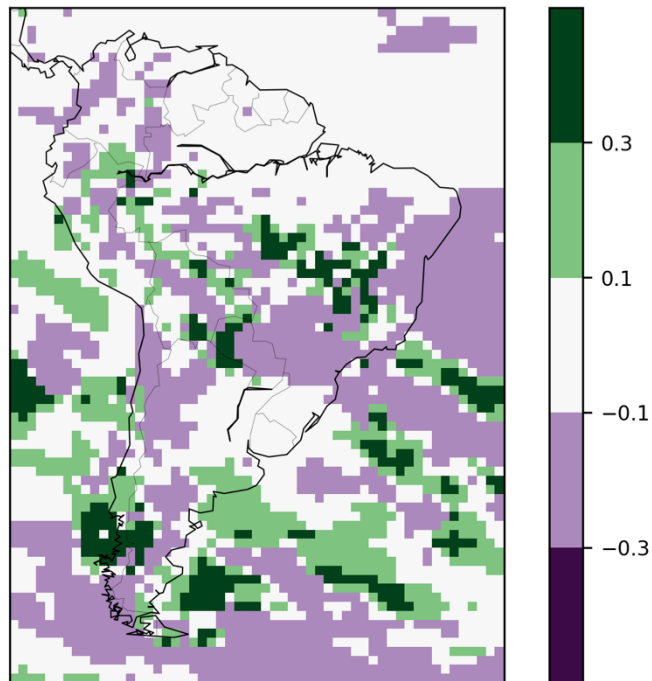
Does weighting models make a difference?

7 examples analyzed

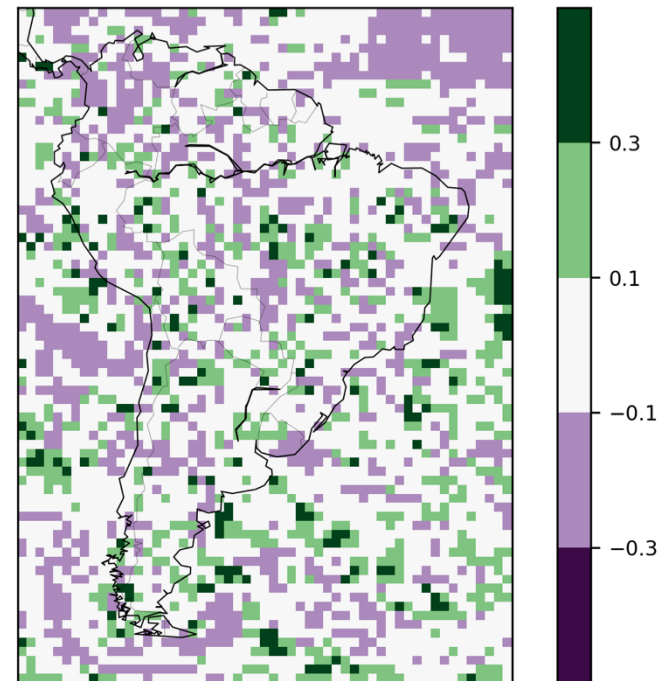
- WPDF + Weighting according to the correlation of each model
- WPDF + Weighting according to intensity of the PDF of each model
- WPDF + Same weight to all models
- WSEREG + Weighting according to the correlation of each model
- WSEREG + Weighting according to intensity of the PDF of each model
- WSEREG + Same weight to all models
- Uncalibrated Ensemble

Model weights

Weight related to the
Correlation



Weight related to the
Intensity of the PDF



Green: Model weights **more** than mean weight
Violet: Model weights **less** than mean weight

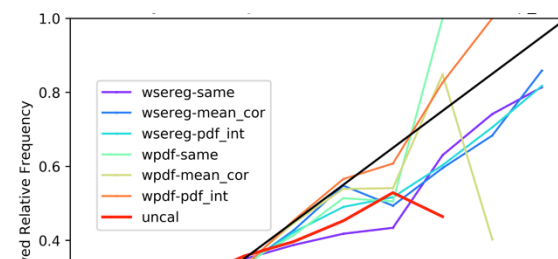
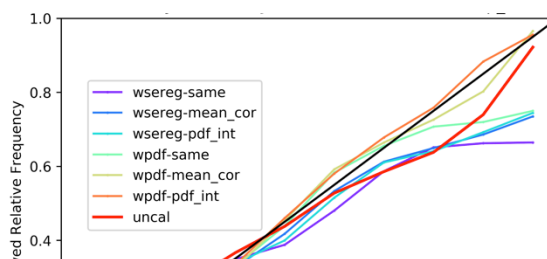
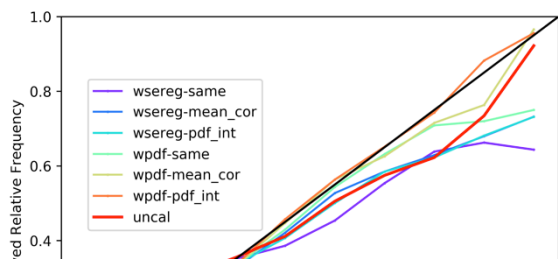
Verification: Reliability - DJF Forecast IC Nov

Entire domain

Tropical S America

Extratrop. S America

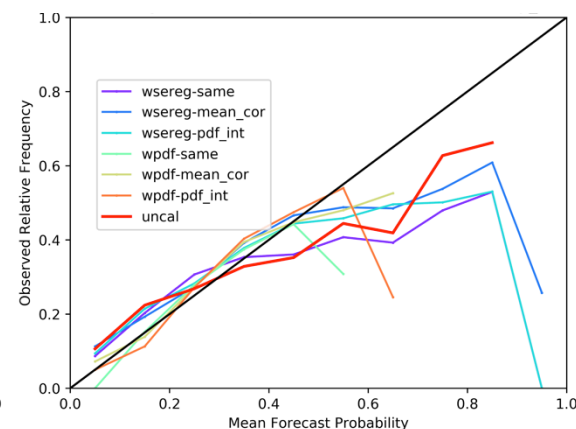
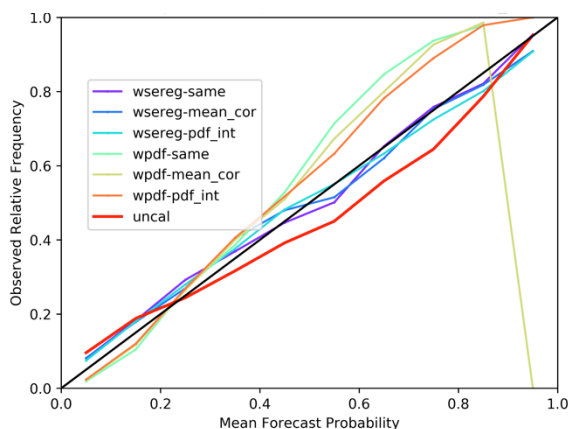
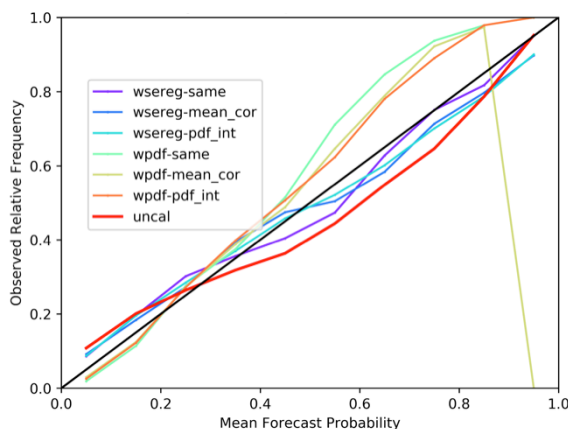
Above
normal
category



The WPDF technique improves the reliability in the above normal category

The WSEREG technique improves the reliability in the below normal category

Below
normal
category



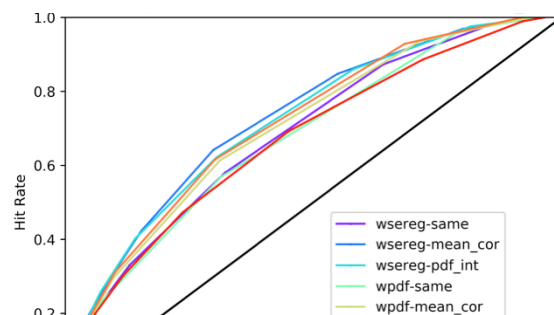
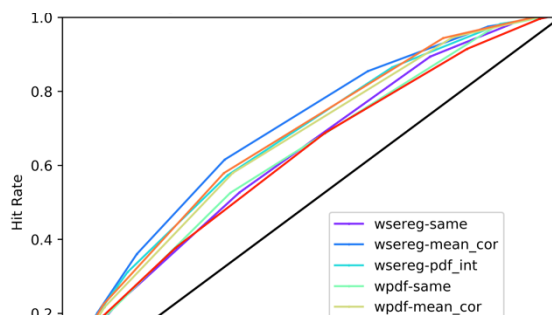
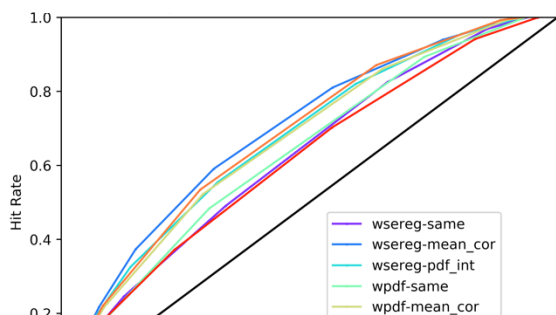
Verification: ROC - DJF Forecast IC Nov

Entire domain

Tropical S America

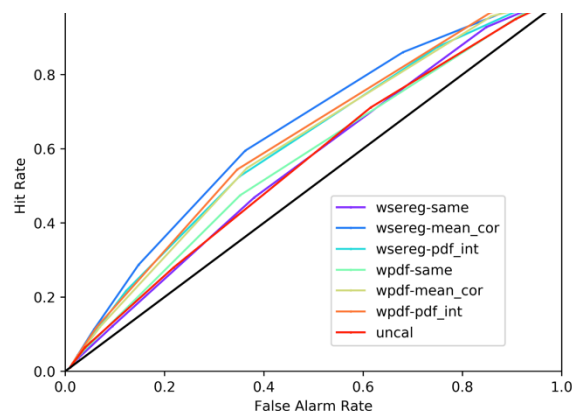
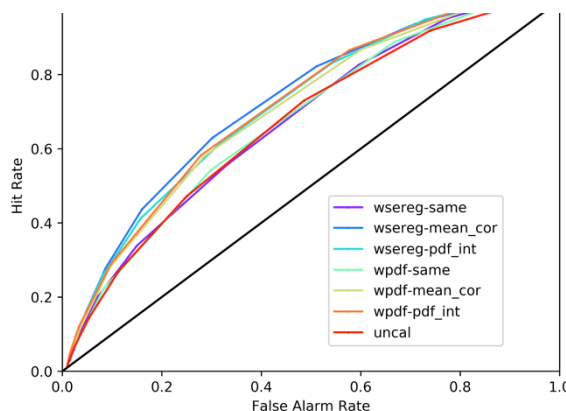
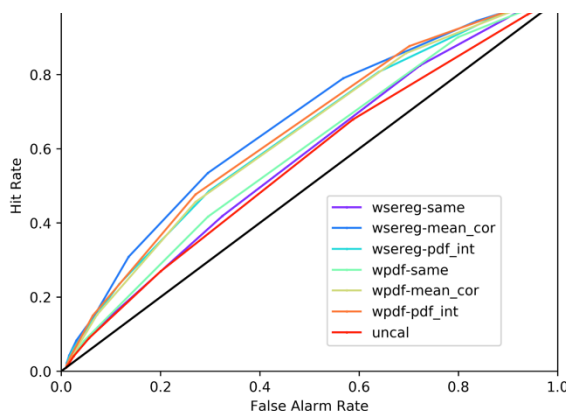
Extratrop. S America

Above
normal
category



All the combination techniques improve the discrimination
Using the same weight for all models doesn't improve the discrimination

Below
normal
category

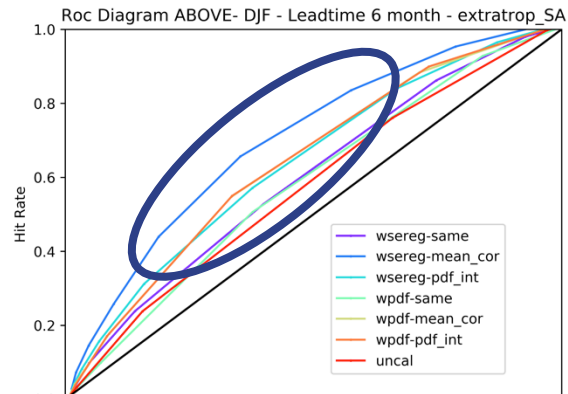
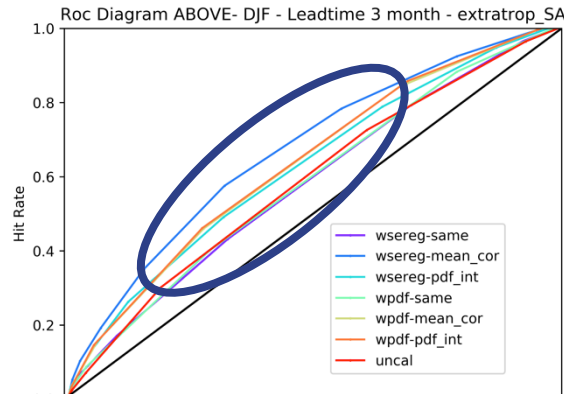
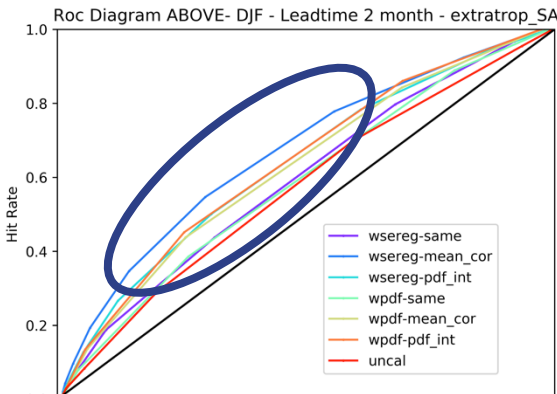
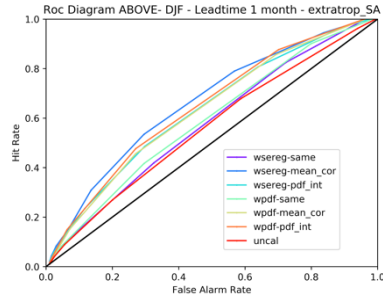


Verification: Impact in lead time

IC Oct

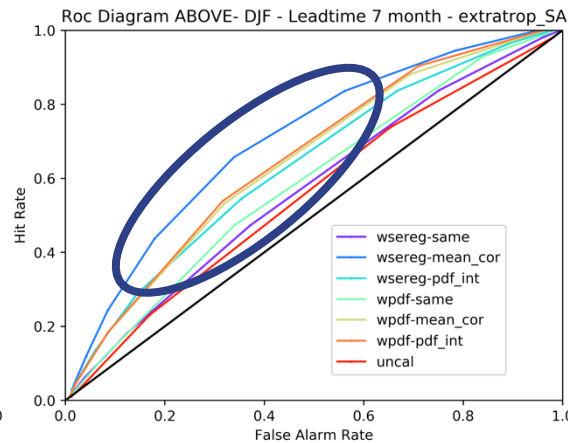
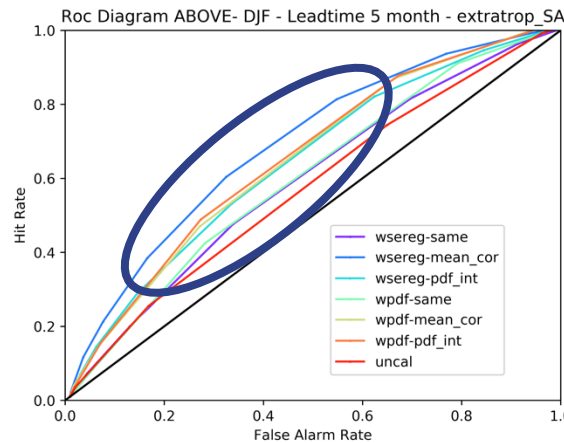
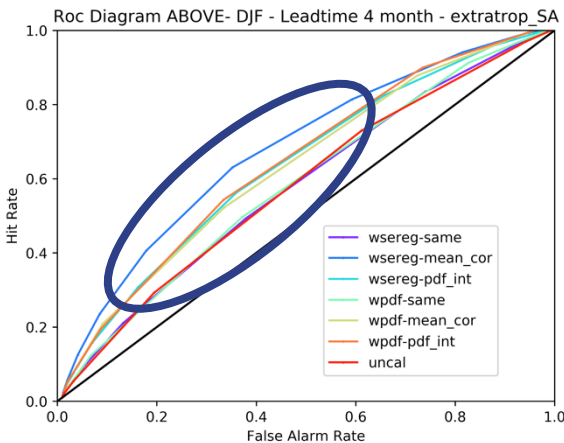
IC Sep

IC Aug



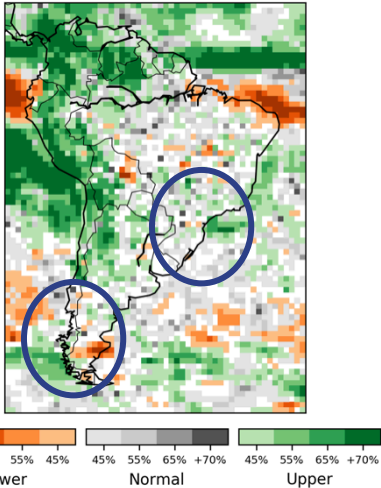
WSEREG + Weighting according to the mean correlation
Shows good discrimination throughout lead times

Extratrop. SA

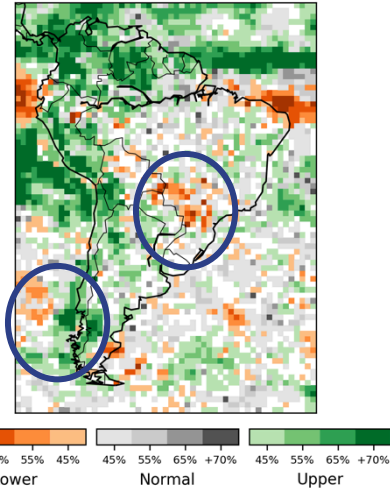


Impact of objective combination in forecast: DJF 83-84

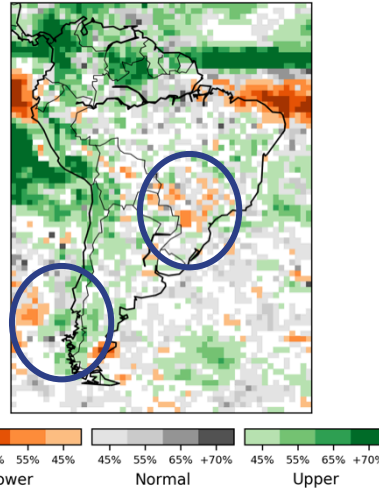
WSEREG Weighted w/
Mean Correlation



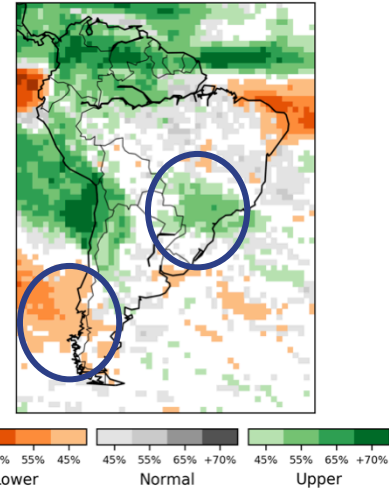
WSEREG Weighted w/
PDF Intensity



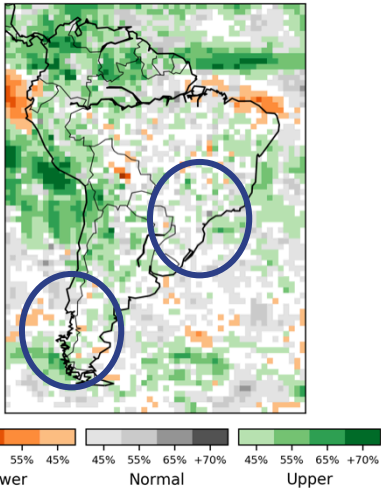
WSEREG Weighted w/
same weight



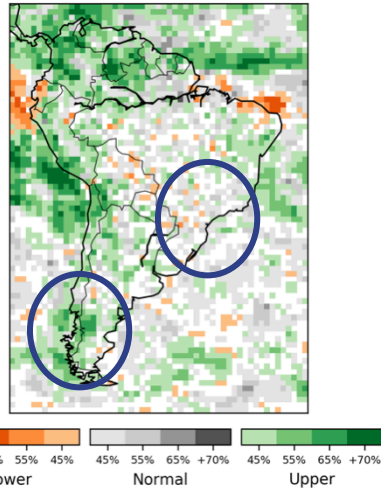
Uncalibrated
ensemble



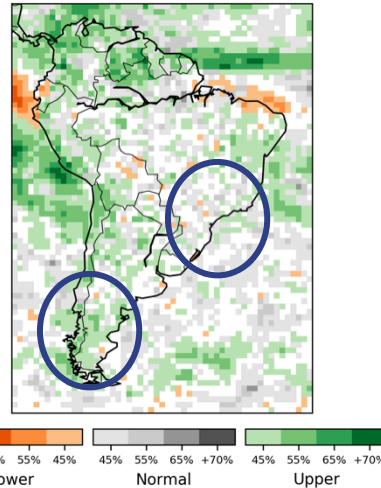
WPDF Weighted w/
Mean Correlation



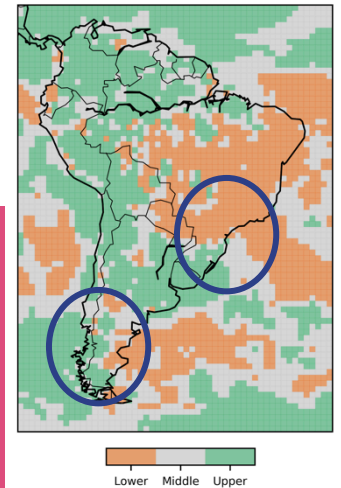
WPDF Weighted w/
PDF Intensity



WPDF Weighted w/
same weight

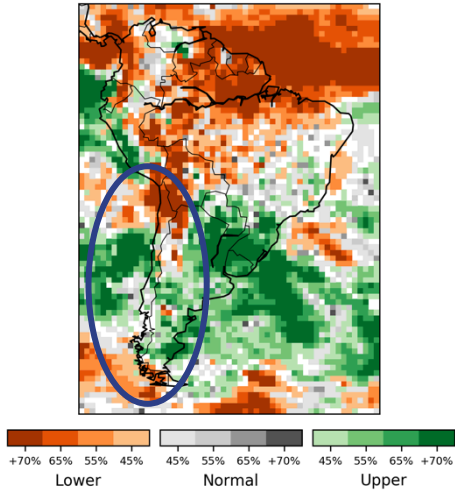


Observed category

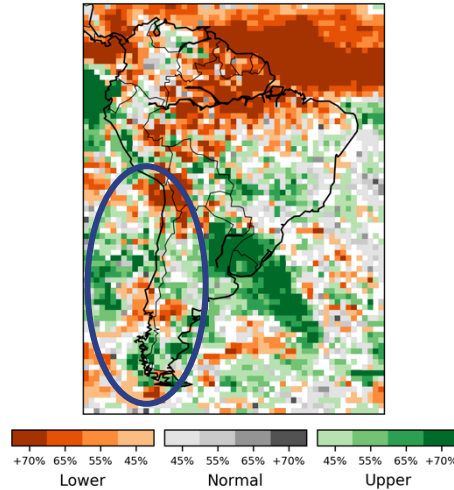


Impact of objective combination in forecast: DJF 97-98

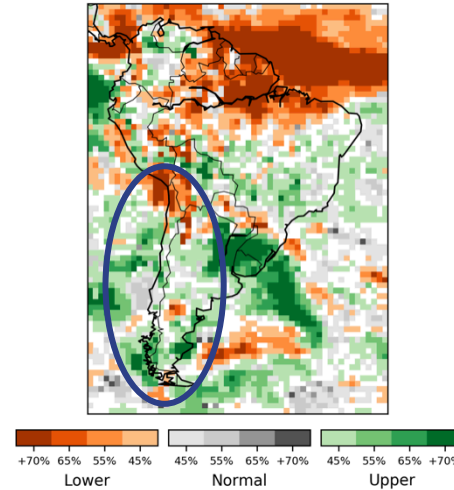
WSEREG Weighted w/
Mean Correlation



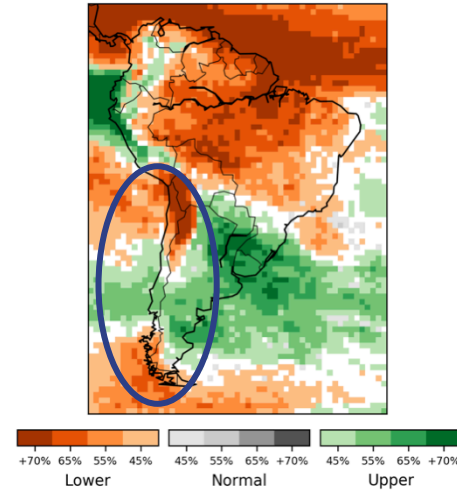
WSEREG Weighted w/
PDF Intensity



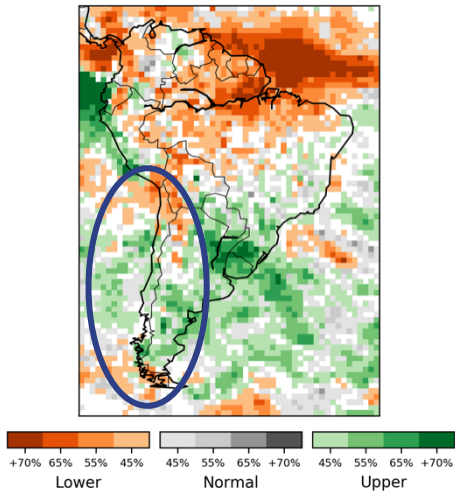
WSEREG Weighted w/
same weight



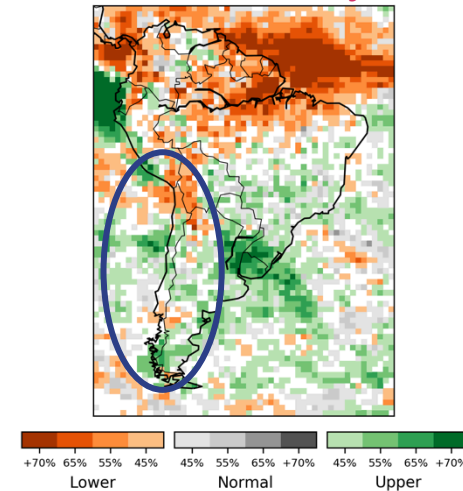
Uncalibrated
ensemble



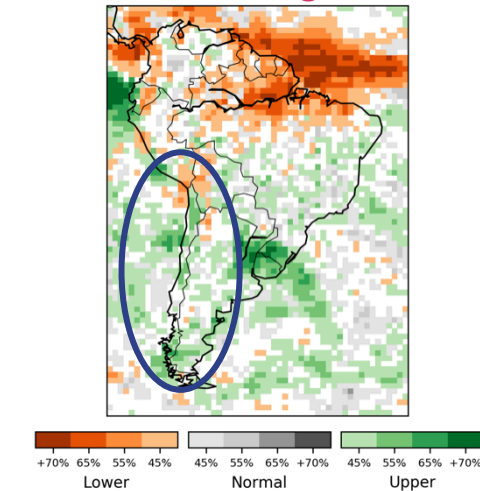
WPDF Weighted w/
Mean Correlation



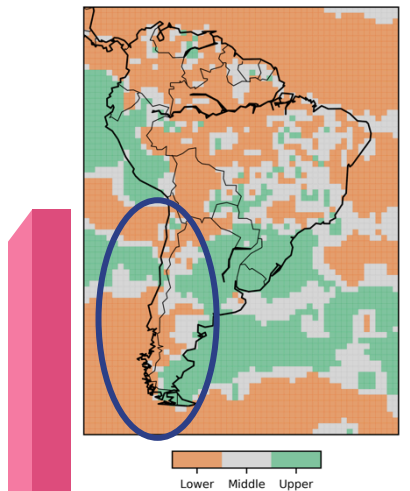
WPDF Weighted w/
PDF Intensity



WPDF Weighted w/
same weight



Observed category



Conclusions

- Calibrating and combining models improved the performance, especially in terms of **discrimination**.
- **Weighting matters!** Even calibrated models need to be weighted before combining them to overcome the performance of the uncalibrated ensemble
- Weighting according to the mean correlation makes weight maps **more regular** than weighting according to the intensity of the PDF
- The combination of models with **WSEREG** with weights according to the **mean correlation** shows a good performance for lead times **longer than 1 month**. Limitation: computational time higher than the rest of the methods
- Forecast maps look **irregular** in regions with **lower seasonal signal** ---> Downgrade the spatial resolution? Apply a spatial smoothing?

Thank you

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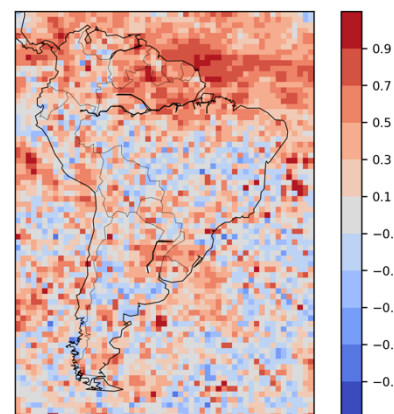
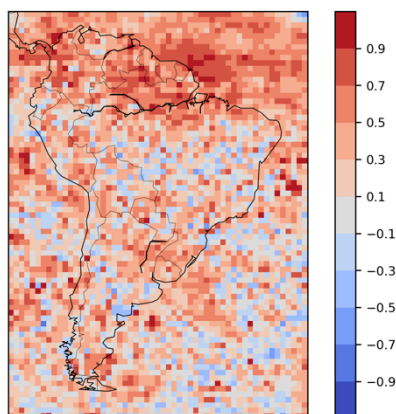
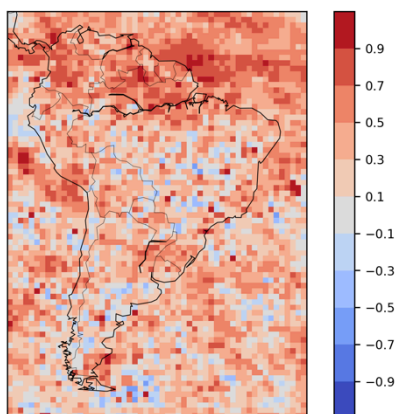


Verification: AUROC - Above normal event

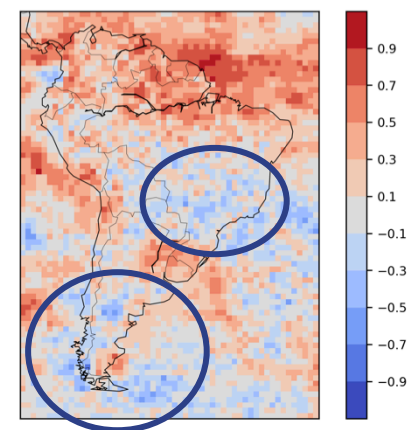
Weighted
according to
correlation

Weighted
according to the
intensity of PDF

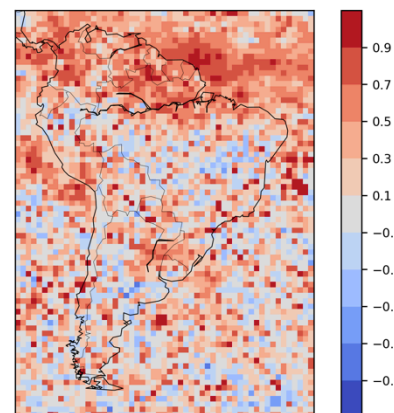
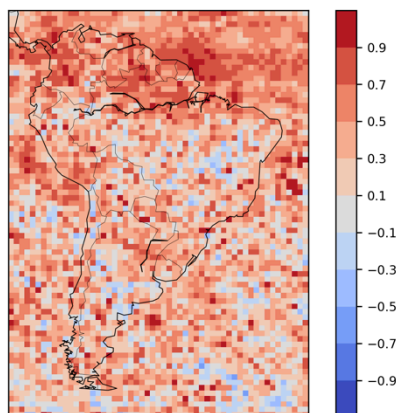
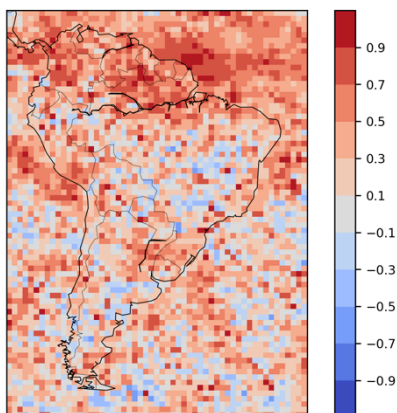
Same
weight



Models with
no calibration



Models
combined
with
WSEREG



Models
combined
with
WPDF