

**Post processing of ECMWF EPS outputs by using an analog and transference technique to improve the extreme rainfall predictability in Ebro basin (Spain)**  
**[ IMDROFLOOD ]**

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# Introduction

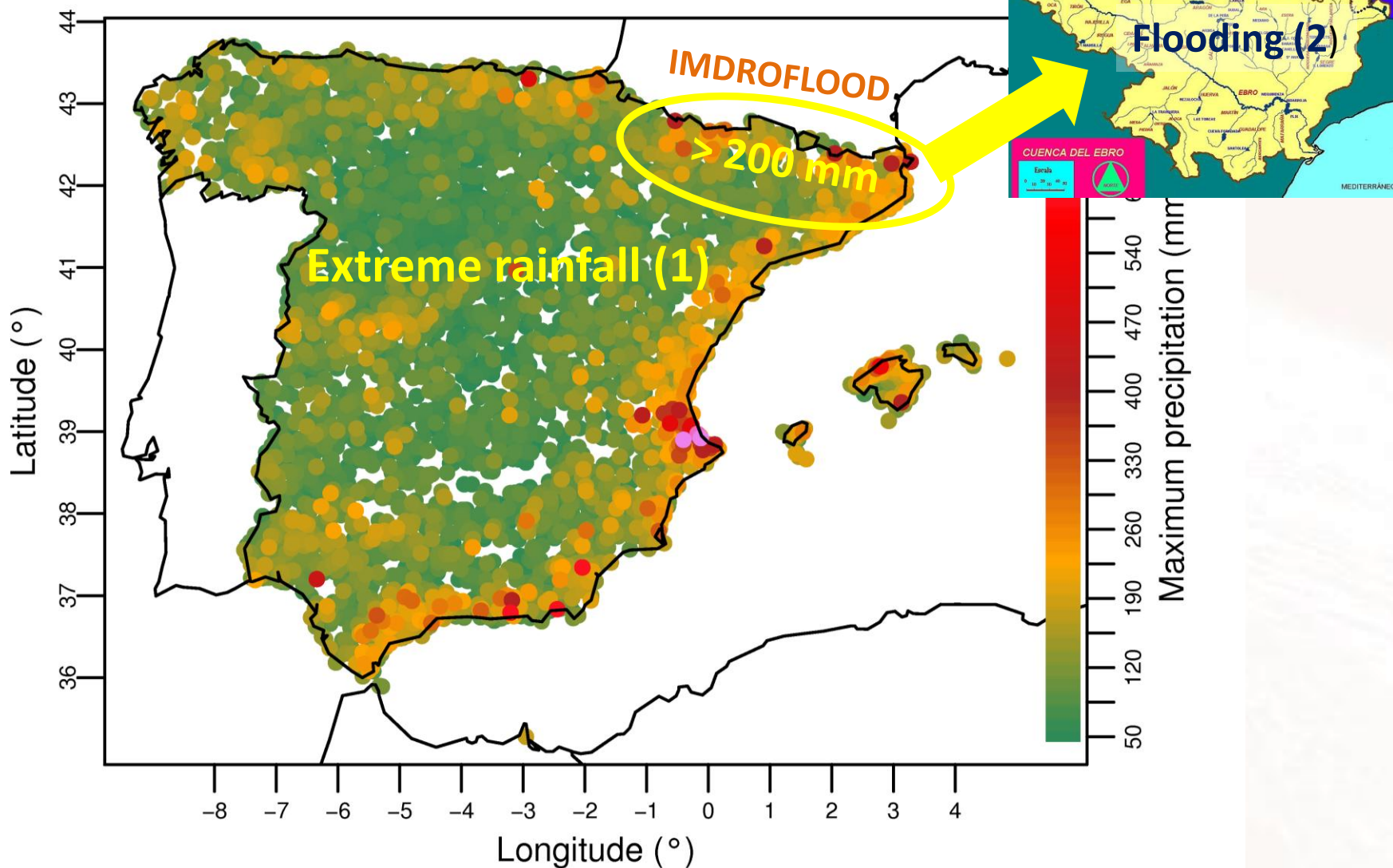
## Introduction

Pilot case and data

Preliminary study in Catalonia

# Introduction

## Historical maximum daily rainfall in Spain

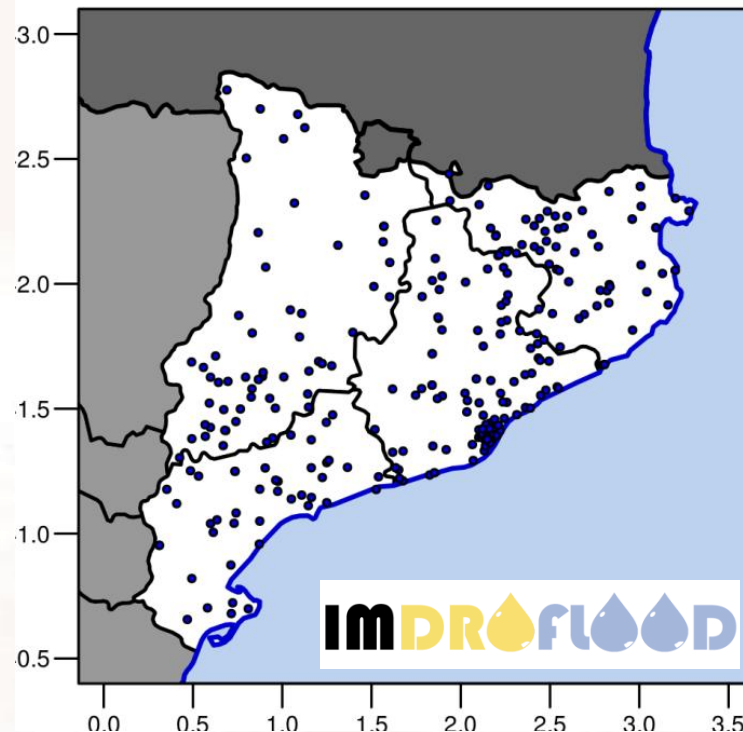


# Pilot case & data

Pilot case

- Ebro watershed  
 Length **930 km**, basin **80,093 km<sup>2</sup>**, discharge **426 m<sup>3</sup>/s**  
 Cantabria, Castile and León, La Rioja, Navarra, Aragon and **Catalonia**.

Catalonia



Used data

- Observations
  - **Daily precipitation** from the Spanish State Agency of Meteorology (AEMet).
  - Time-series with **at least 5 years**: Total of **269 rain gauges** in Catalonia.
- Era-Interim
  - Re-analysis of winds at **500 & 1000 hPa** (resolution of 0.7°)
  - Historical period: 1979-2016.
- ECMWF-EPS
  - **50+1**: The 50 individual outputs + control output (resolution of 0.28°)
  - Short-term forecast (**+24h** horizon): winds at **500 & 1000 hPa**, **precipitation** amounts
  - Hindcast for **2010-2011**

# Methodology

Methodology

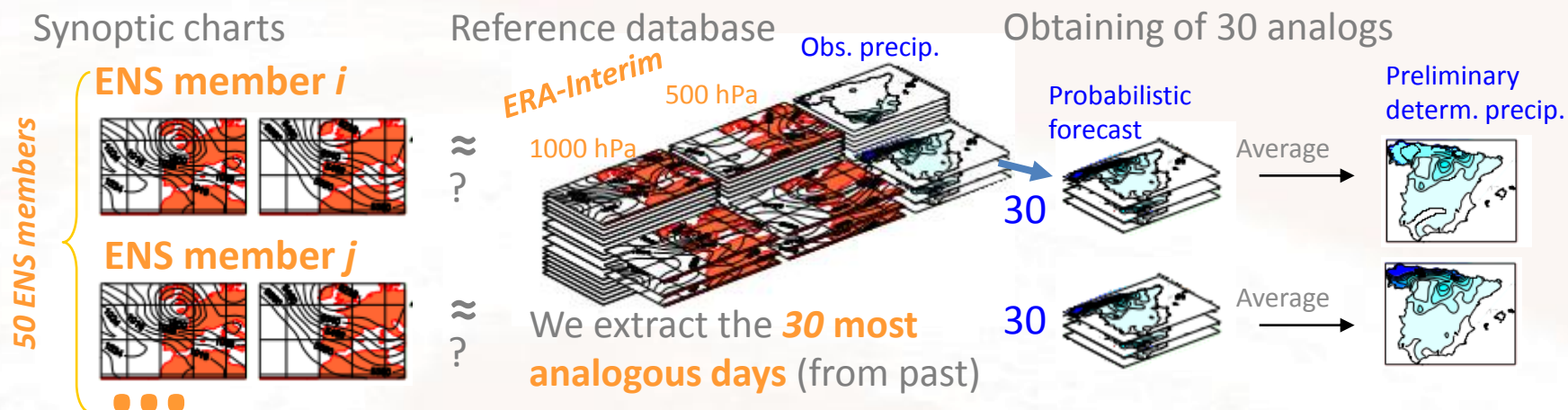


# Methodology

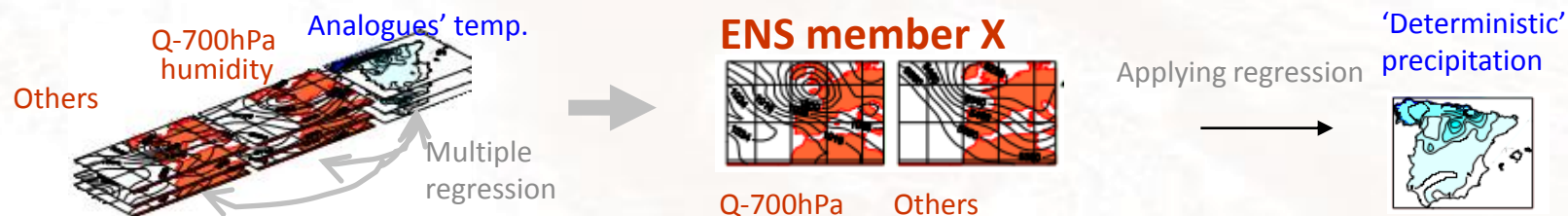
## SHORT-TERM: Daily statistical downscaling

(Ribalaygua *et al.*, 2013).  
Two step analogue/regression

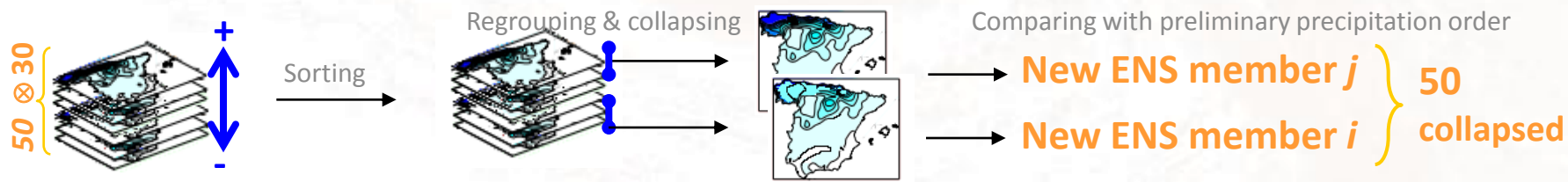
1. Analogs from Euclidean distance for normalised predictor fields: wind at 1000 & 500hPa



2. Rainfall transference from the most analogous days to each ENS member by using humidity



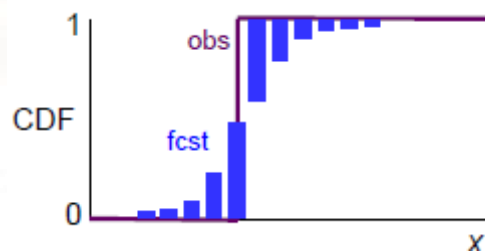
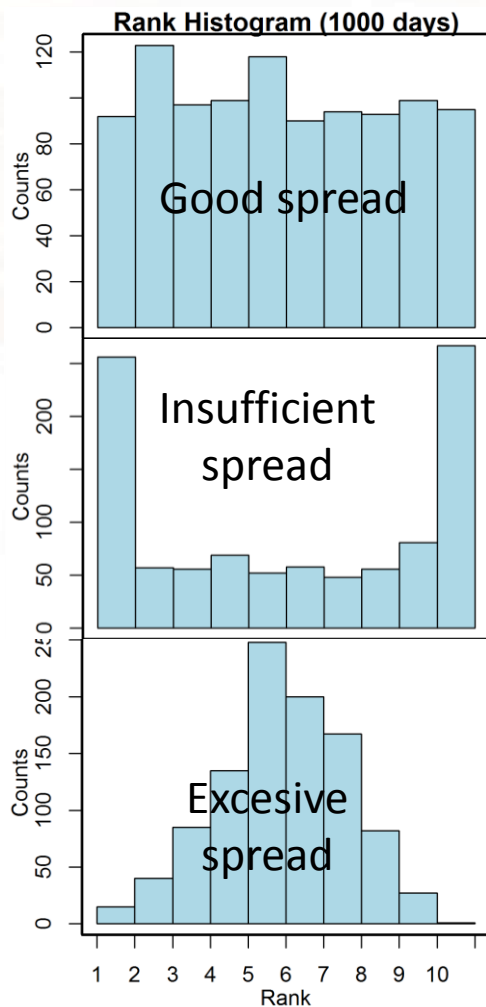
3. Sorting of probability distribution of precipitation (1500 = 30 analogs x 50 ENS members)



# Methodology

## MEDIUM-TERM: Verification statistics

### Typical statistics: Rank Histogram, RPS/RPSS, ROC/AUC



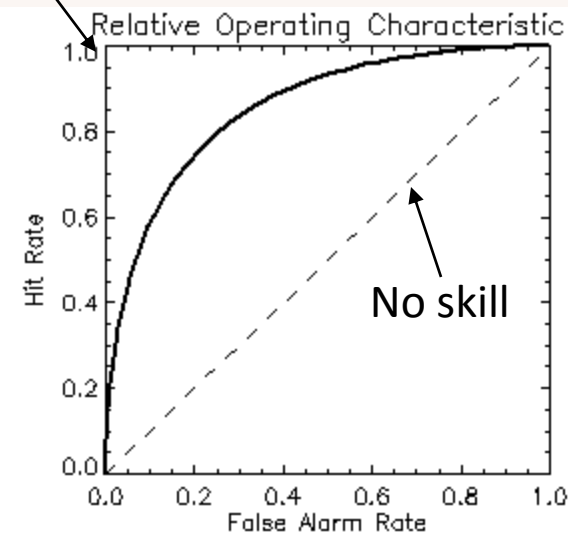
$$RPS = \frac{1}{M-1} \sum_{m=1}^M (CDF_{fcst,m} - CDF_{obs,m})^2$$

$$RPSS = 1 - \frac{RPS_{fcst}}{RPS_{clim}}$$

#### Four classes:

- No rain (0 to 0.1 mm)
- Light rain (0.1 to 5 mm)
- Moderate (5 to 15 mm)
- Heavy rain (> 15 mm)

#### Perfect forecast



$$Hit = \frac{TP}{P} = \frac{TP}{TP + FN}$$

$$FalseAl = \frac{FP}{N} = \frac{FP}{FN + TN}$$

Statistics usually used for the verification of probability and ensemble forecasts

**References:** Laurence J. Wilson (1999), Beth Ebert (2005), ...

# Methodology

## MEDIUM-TERM: Verification statistics

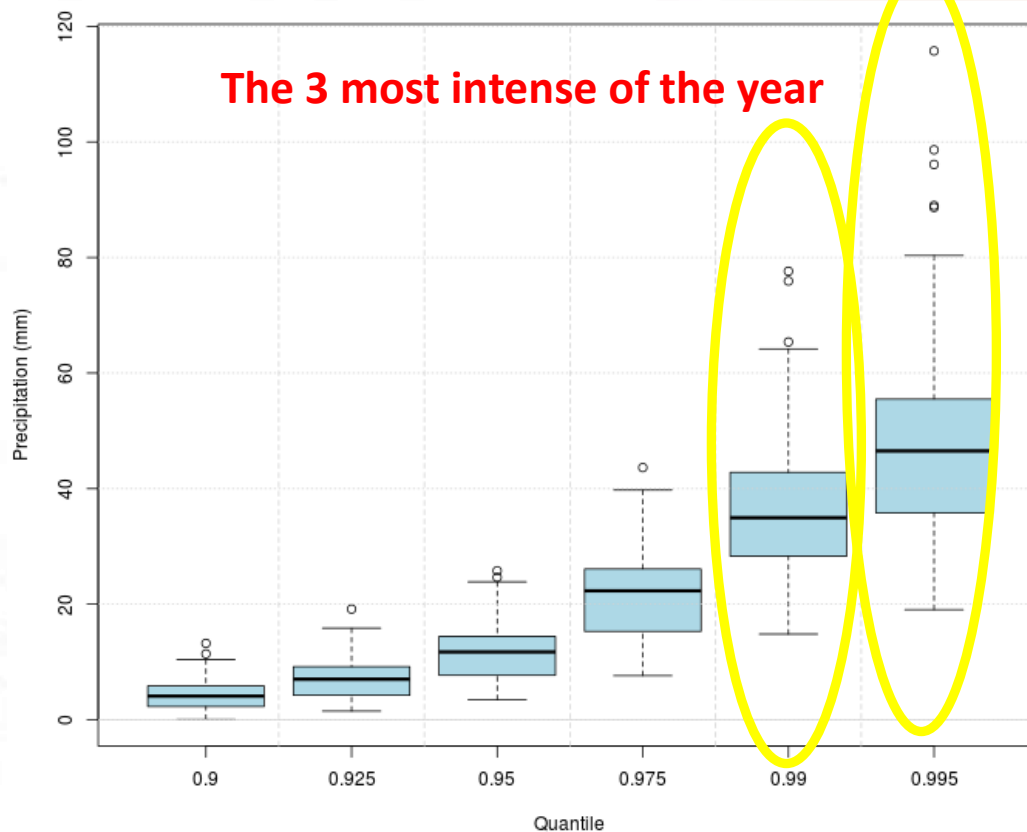
Typical statistics: Rank Histogram, RPS/RPSS, ROC/AUC

ROC for binary forecasts of rare events

P99 ~ 15 to 80 mm

P995 ~ 20 to 120 mm

The maximum per year





# Methodology

## MEDIUM-TERM: Verification statistics

Typical statistics: **Rank Histogram, RPS/RPSS, ROC/AUC**

### R libraries

#### *Verification*

NCAR - Research Applications Laboratory (2015). verification: Weather Forecast Verification Utilities. R package version 1.42. <https://CRAN.R-project.org/package=verification>

#### *SpecsVerification*

Stefan Siegert (2017). SpecsVerification: Forecast Verification Routines for Ensemble Forecasts of Weather and Climate. R package version 0.5-2. <https://CRAN.R-project.org/package=SpecsVerification>

# Results & discussion

Results & discussion

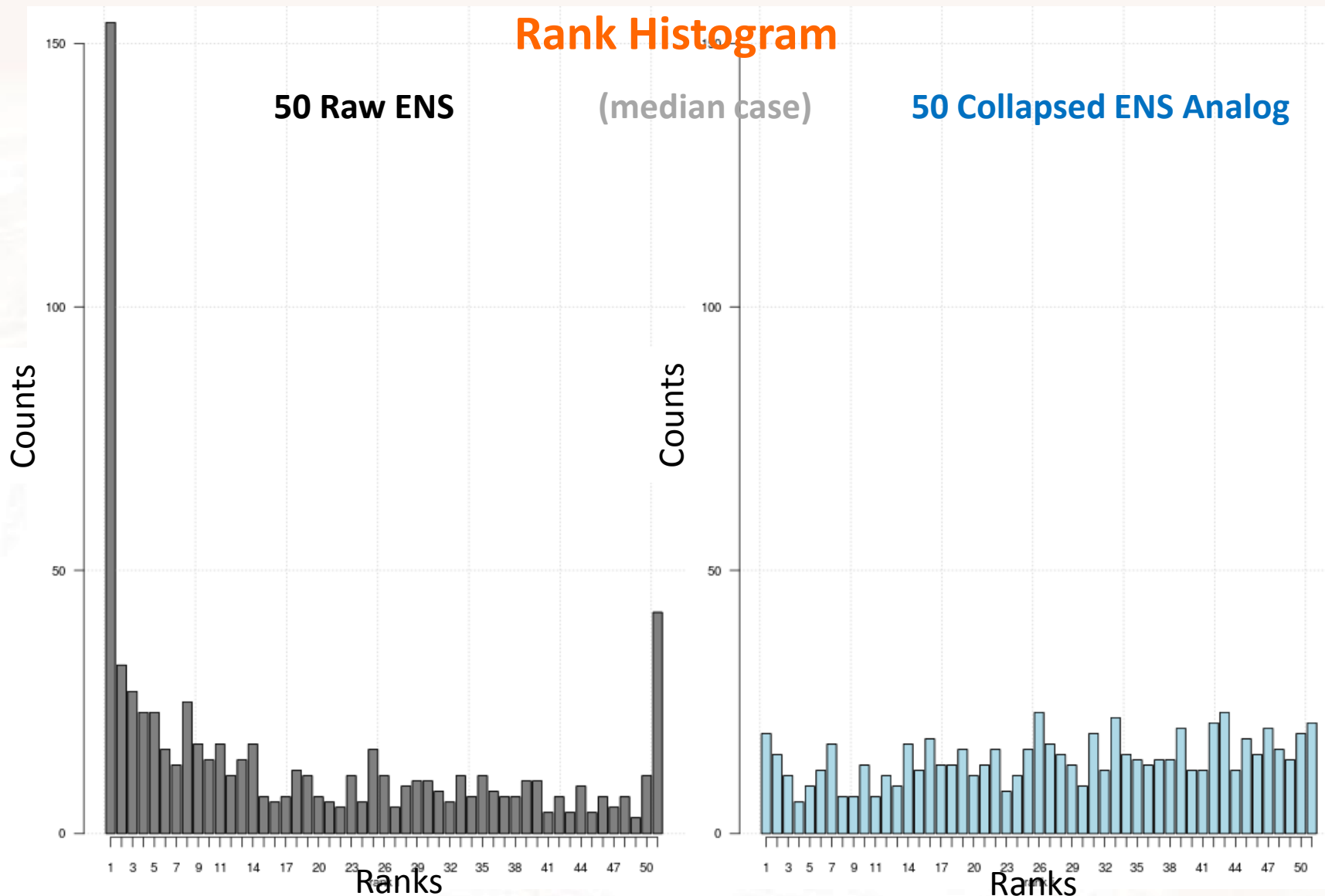
# Results & discussion

## Rank Histogram

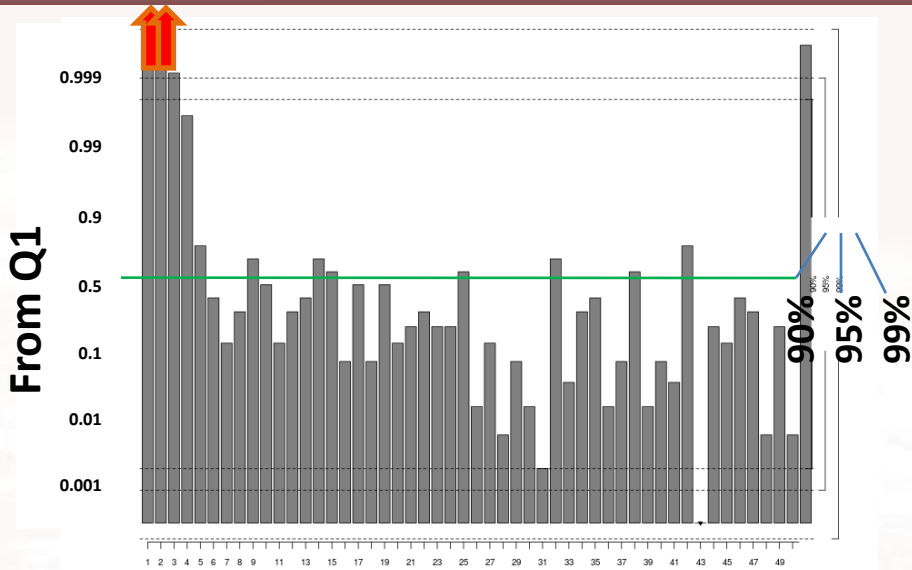
50 Raw ENS

(median case)

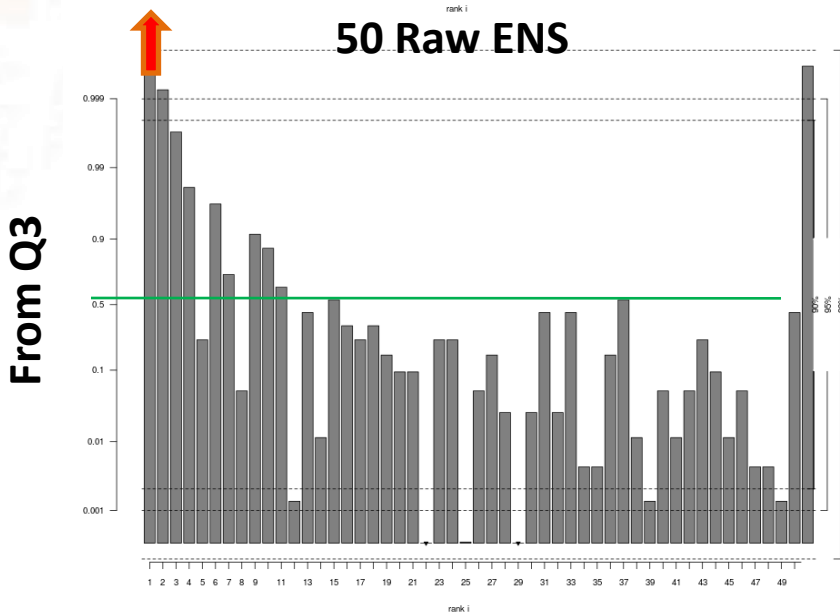
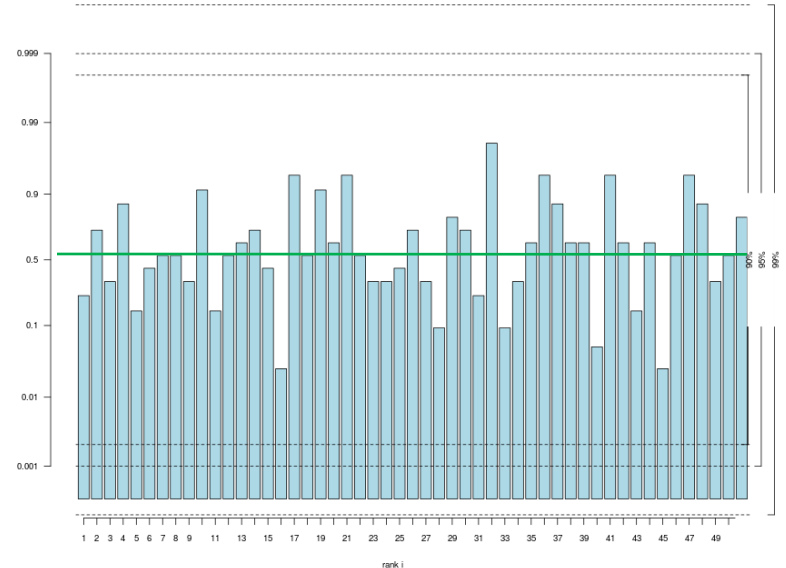
50 Collapsed ENS Analog



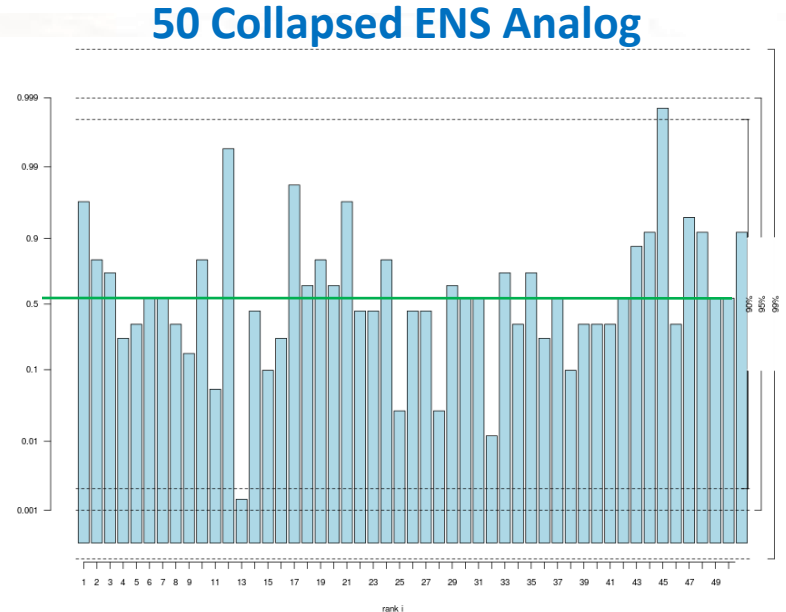
# Results & discussion



**From Q1**

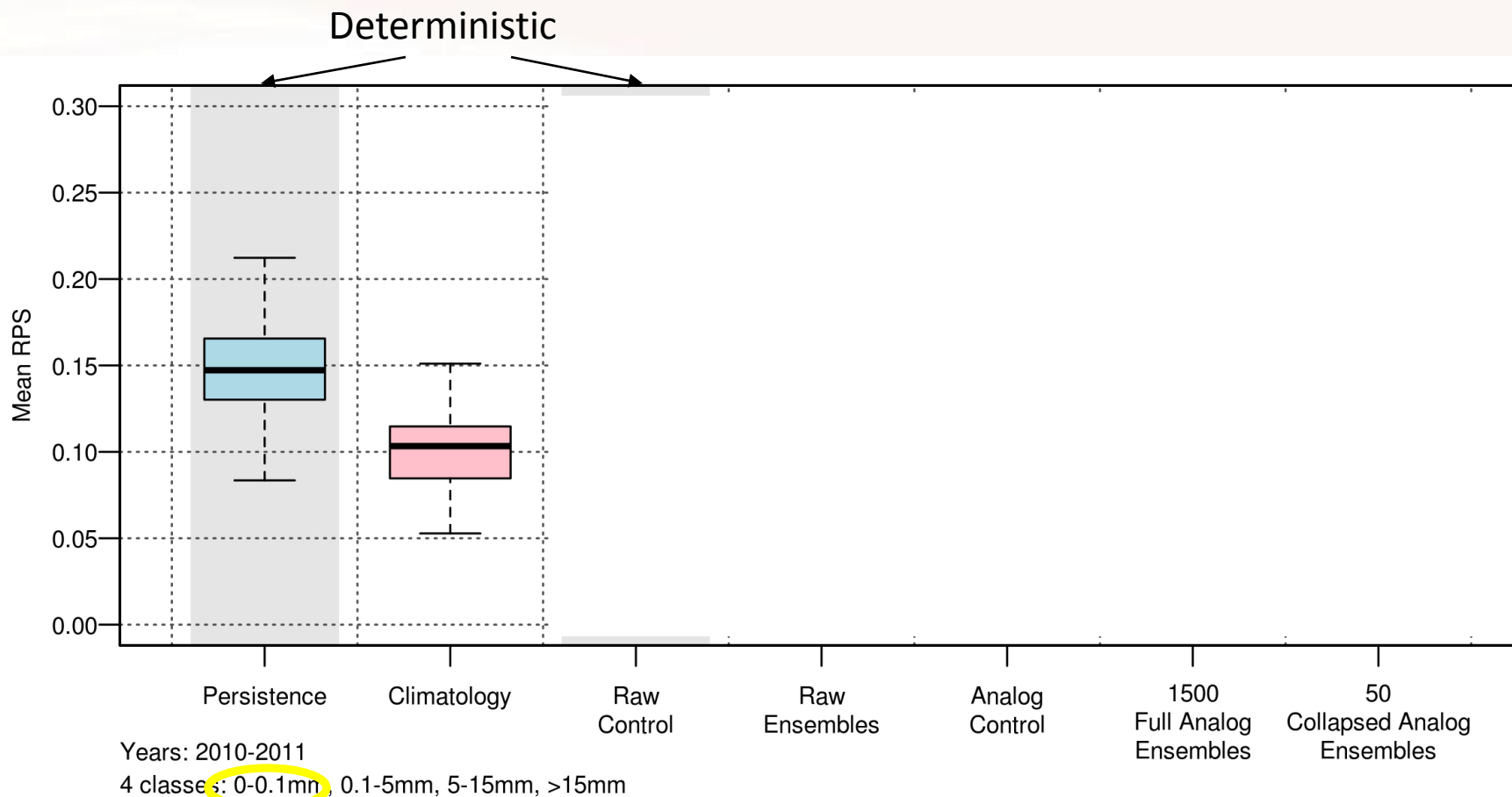


**From Q3**



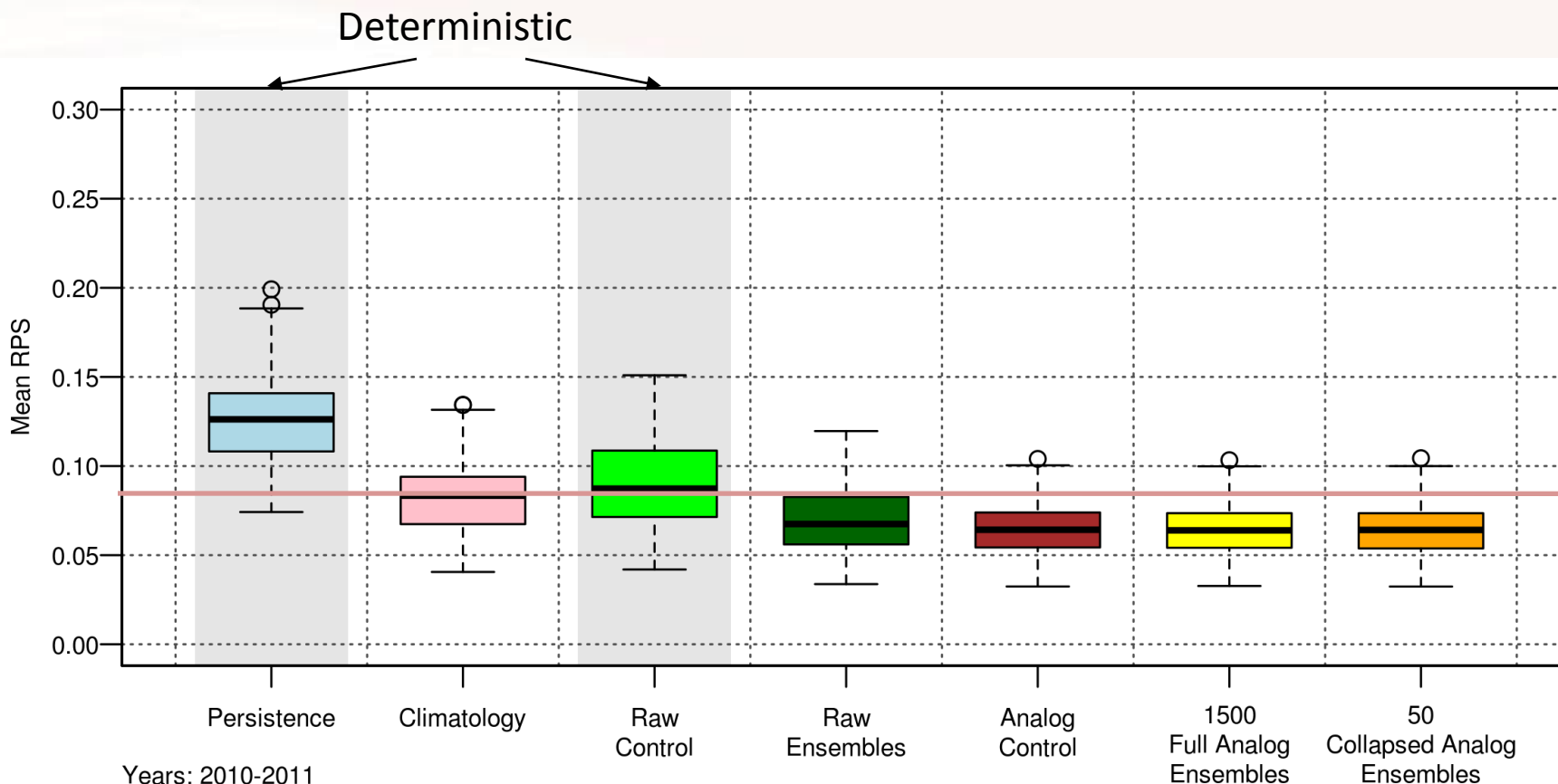
# Results & discussion

## Ranked Probability Score (RPS)



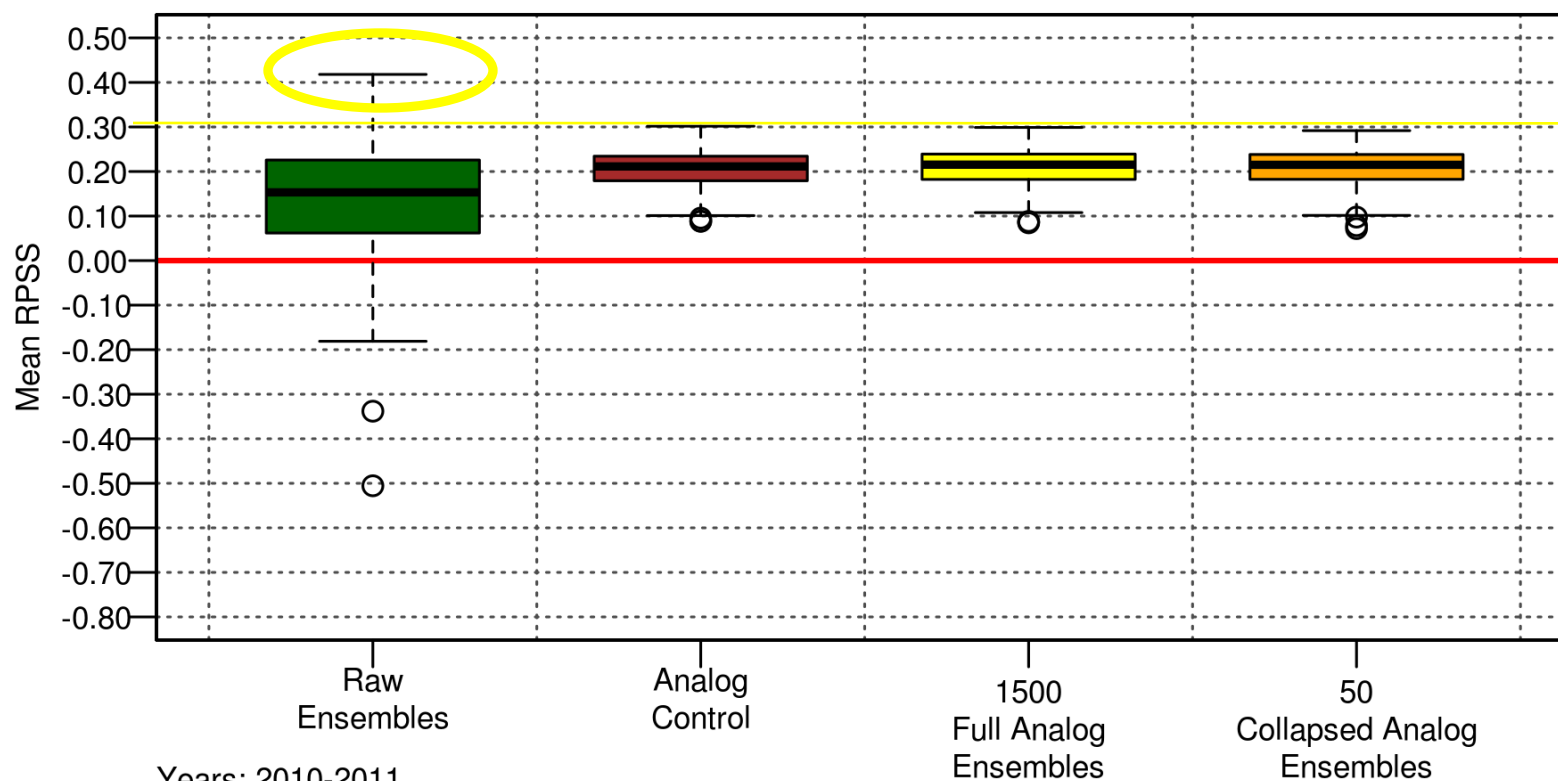
# Results & discussion

## Ranked Probability Score (RPS)



# Results & discussion

## Ranked Probability Skill Score (RPSS)



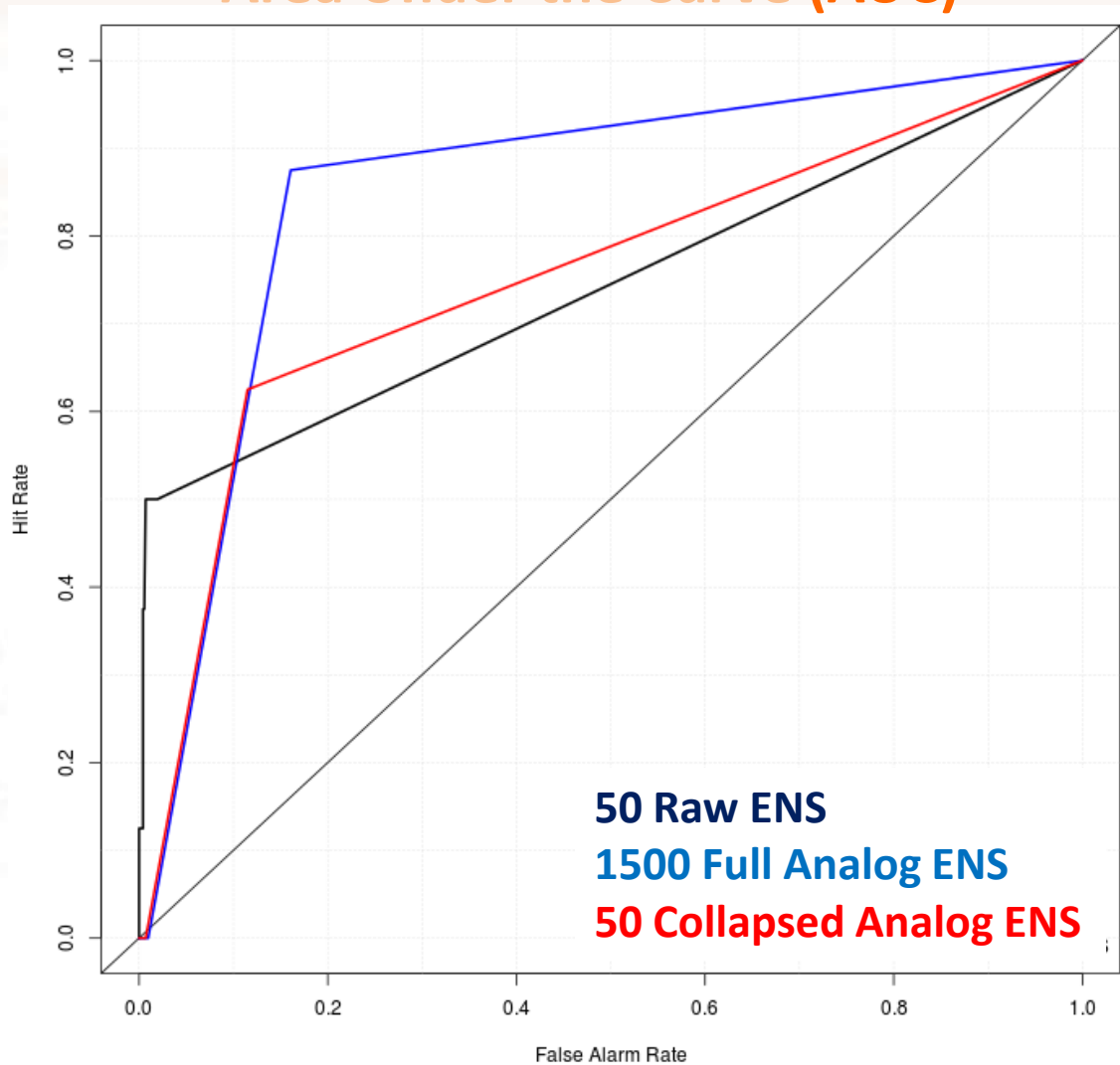
Years: 2010-2011

4 classes: 0-2mm, 2-5mm, 5-15mm, >15mm

# Results & discussion

## Receiver Operating Characteristic (ROC) curve and Area Under the Curve (AUC)

Example for P99

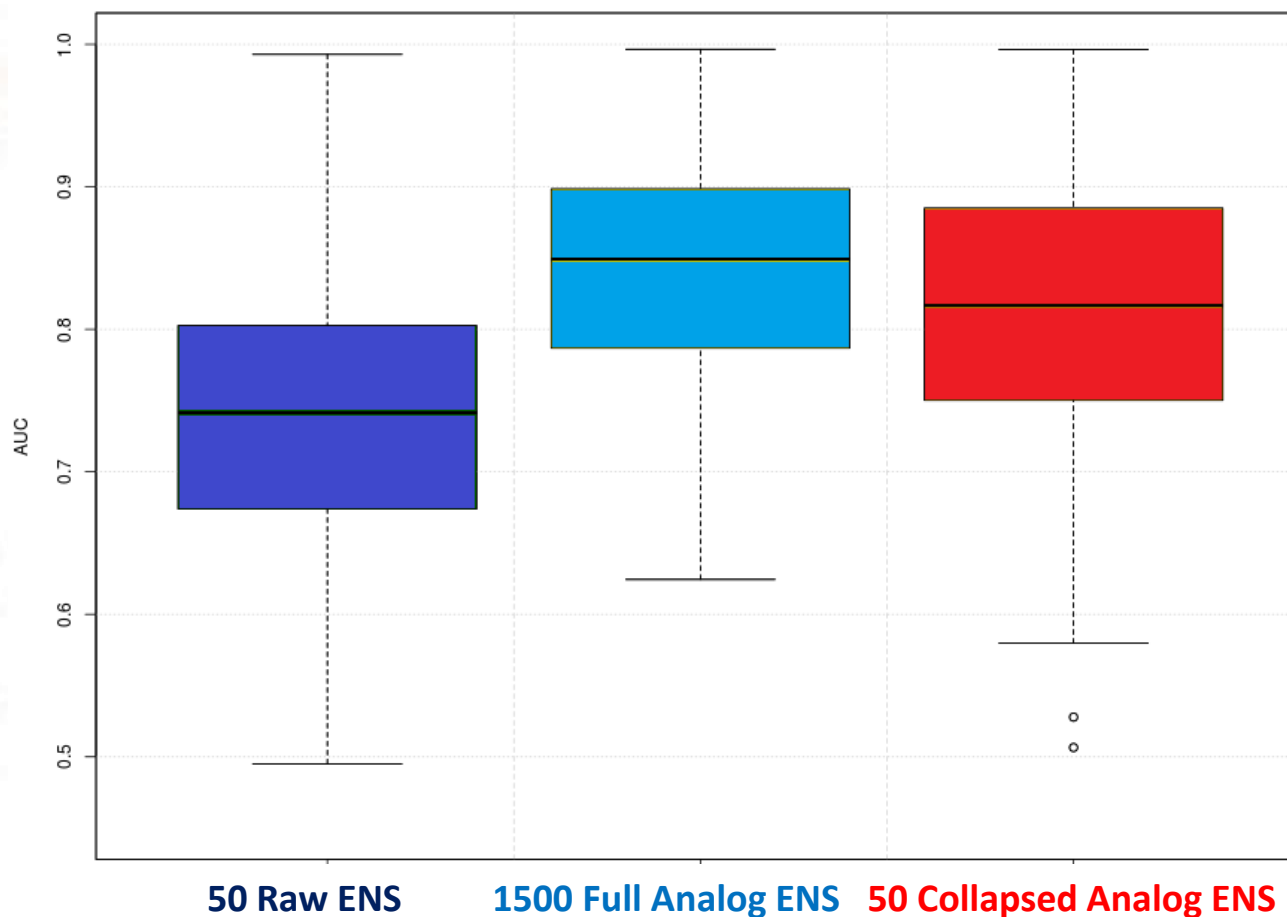




# Results & discussion

## Receiver Operating Characteristic (ROC) curve and Area Under the Curve (AUC)

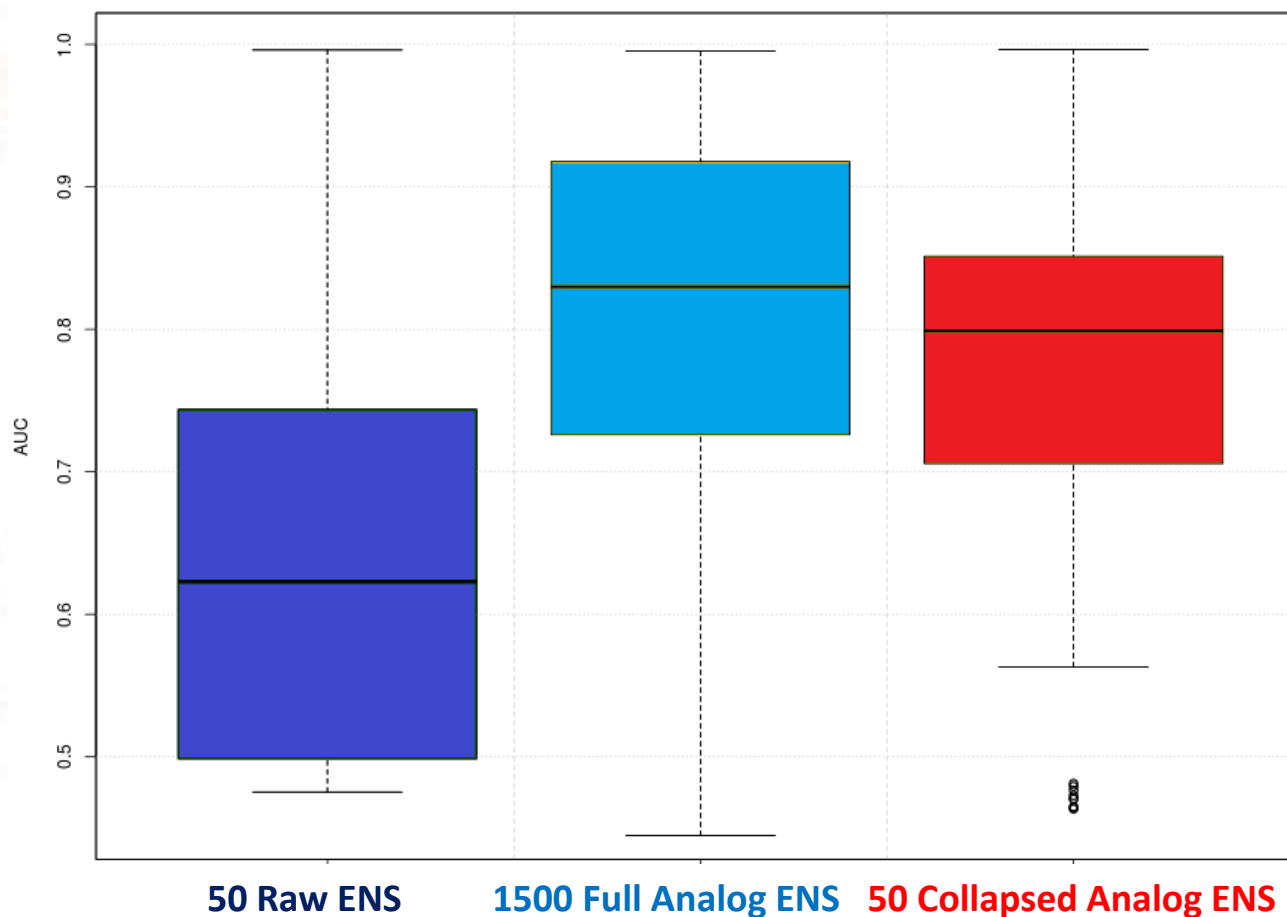
All results for P99



# Results & discussion

## Receiver Operating Characteristic (ROC) curve and Area Under the Curve (AUC)

All results for P995



# Conclusions

Conclusions



# Conclusions

- **EPS underestimates dry days and extreme rainfall at local scale**
- Some **post-process** is required for **downscaling EPS**
- **Analog/transfer statistical downscaling** method improves:
  - \* **Spread** of the probabilistic forecast (Ranking Histogram).
  - \* **General forecast** of four classes (RPS/RPSS).
  - \* **Extreme point rainfall** forecast (ROC/AUC).
- **Limitations:**
  - \* The used method requires **long observed time-series** (>5years)
  - \* All these results are **preliminary**

# Questions?

## Acknowledgment

The authors would like to thank the **EU** and the **Spanish Ministry of Economy and Competitiveness** (MINECO) for funding, in the frame of the collaborative international consortium **IMDROFLOOD**, financed under the ERA-NET Cofund **WaterWorks2014** Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (**Water JPI**)



Thank you very much for your attention!

Questions?