


**WP 5 Users Application**  
**EC-JRC Agriculture Contribution**

**Test of the JRC Crop Model with  
DEMETER downscaled hindcasts:  
Application to Spain 1987,88,89**

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## DEMETER work plan

 Task 1 : Define climatic variable of interest

 Task 2 : Refine model using ERA15/40  
Downscaling by D.M.I.

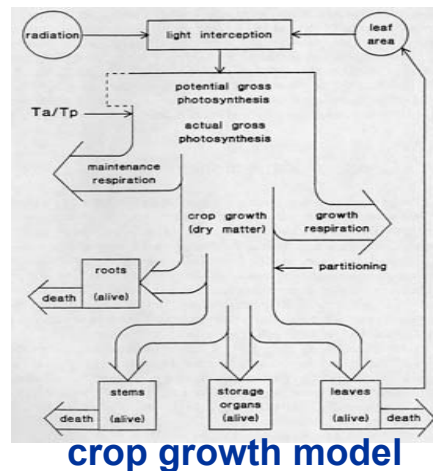
➔ JRC Crop model ready to be run with DEMETER outputs

(Task 3) First assessment of DEMETER hindcasts,  
Yield Simulation for 3 years in Spain

Use of Ensemble as input of the Crop Model

# JRC Crop Yield System

- **Meteo Data**
- **Soil Data**
- **Crop Data**



## Yield Forecast

Regression:

Yield  $\sim f(t, \text{Crop indicators})$

8 years of archive/EUROSTAT

**Crop Indicators**  
simulation of biomass,  
dry matter, storage  
organs... all along the  
growing season

# A statistical regression analysis to predict crop yield

Multiple regression analysis between current season vs historical series

**1. Selection of the best predictor on historic series : 9 years (at time t)**

$$Y_t = f_t (\text{Trend} + \text{Parameter}) + e_t$$

ex:

$$Y_{1t} = T_{1t} (x) + e_{1t}$$

**Trend only**

$$Y_{2t} = T_{2t} (x) + f_t (S_w) + e_{2t}$$

**Storage organ**

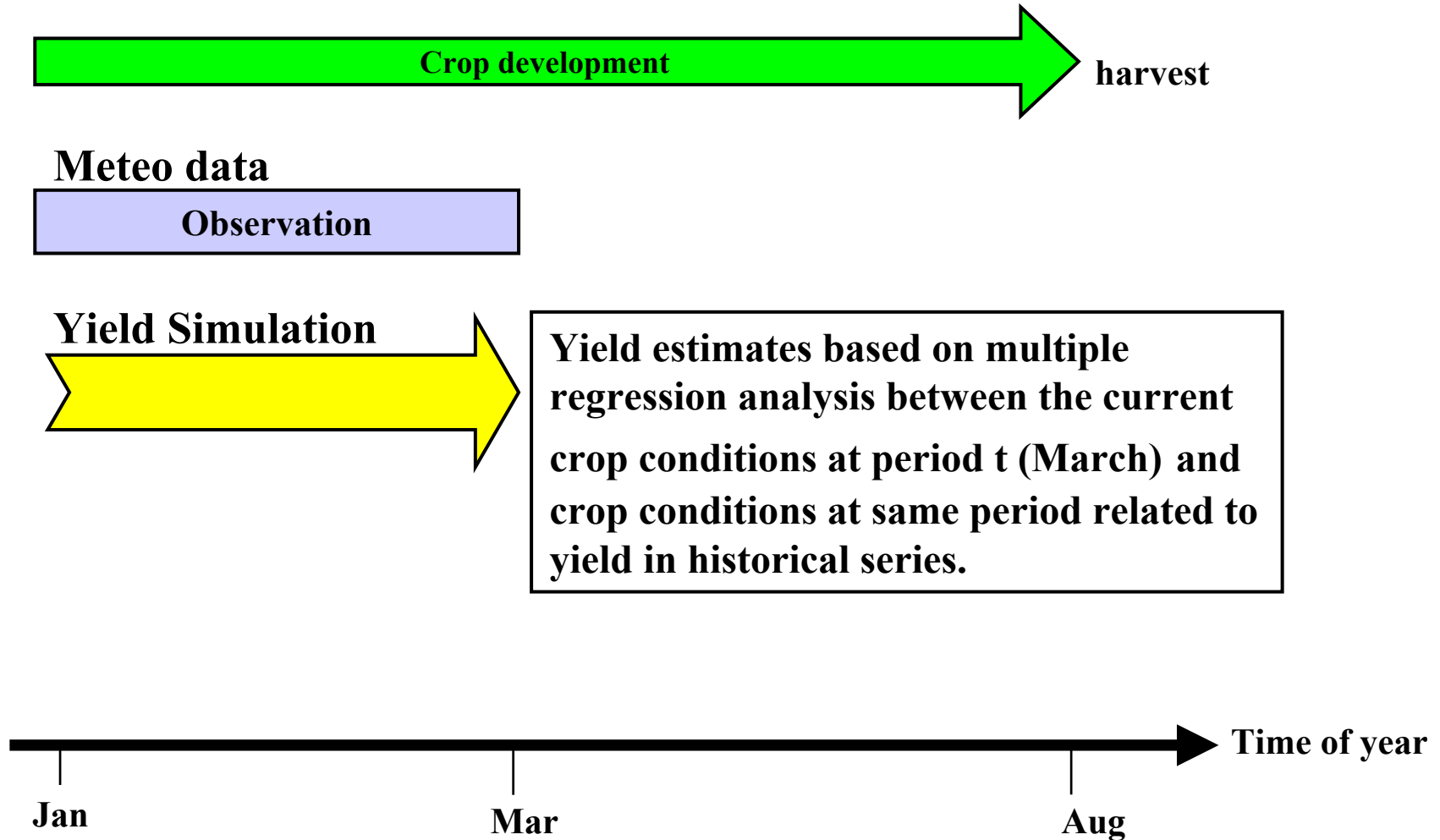
$$Y_{4t} = T_{4t} (x) + f_t (B_w) + e_{3t}$$

**Total biomass**

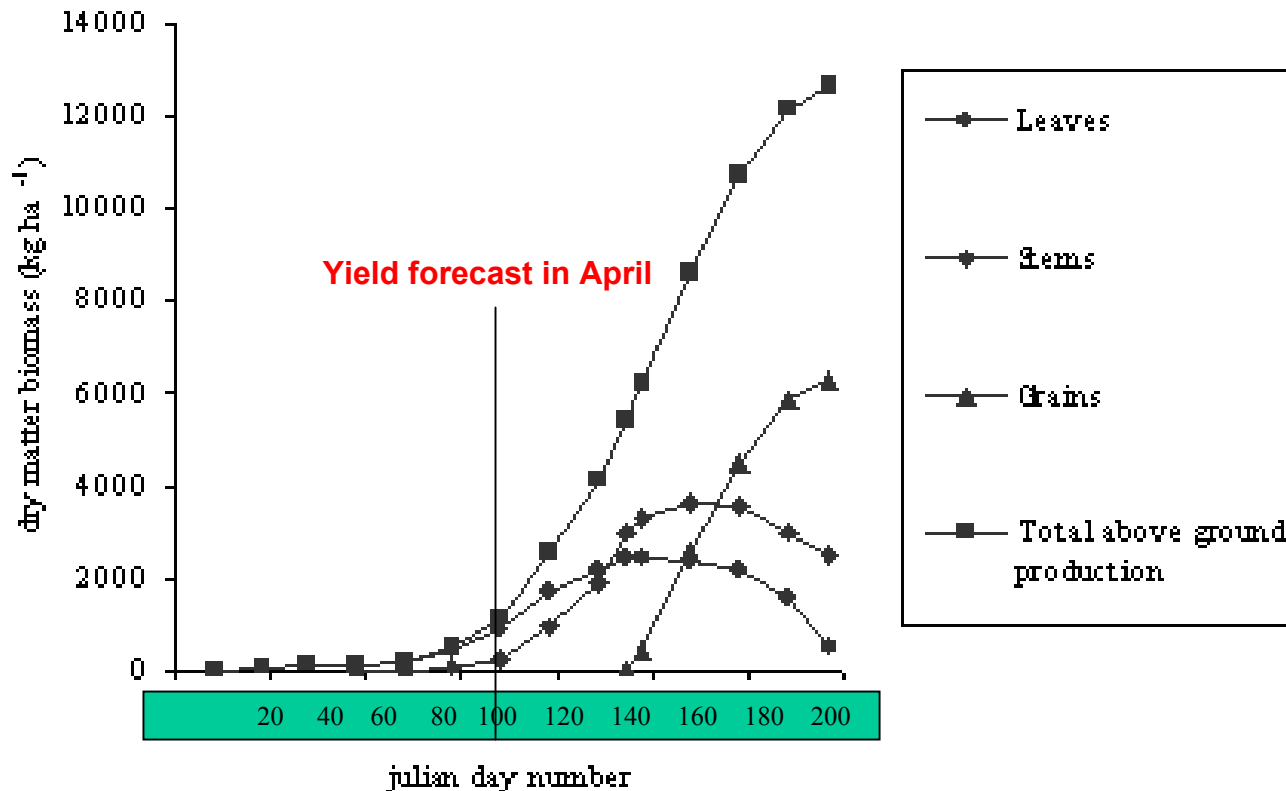
**2. Application of the best predictor to the current year**

$$Y_t = T_t (x) + f_t (S, B) + e_t$$

# JRC crop yield system (actual)

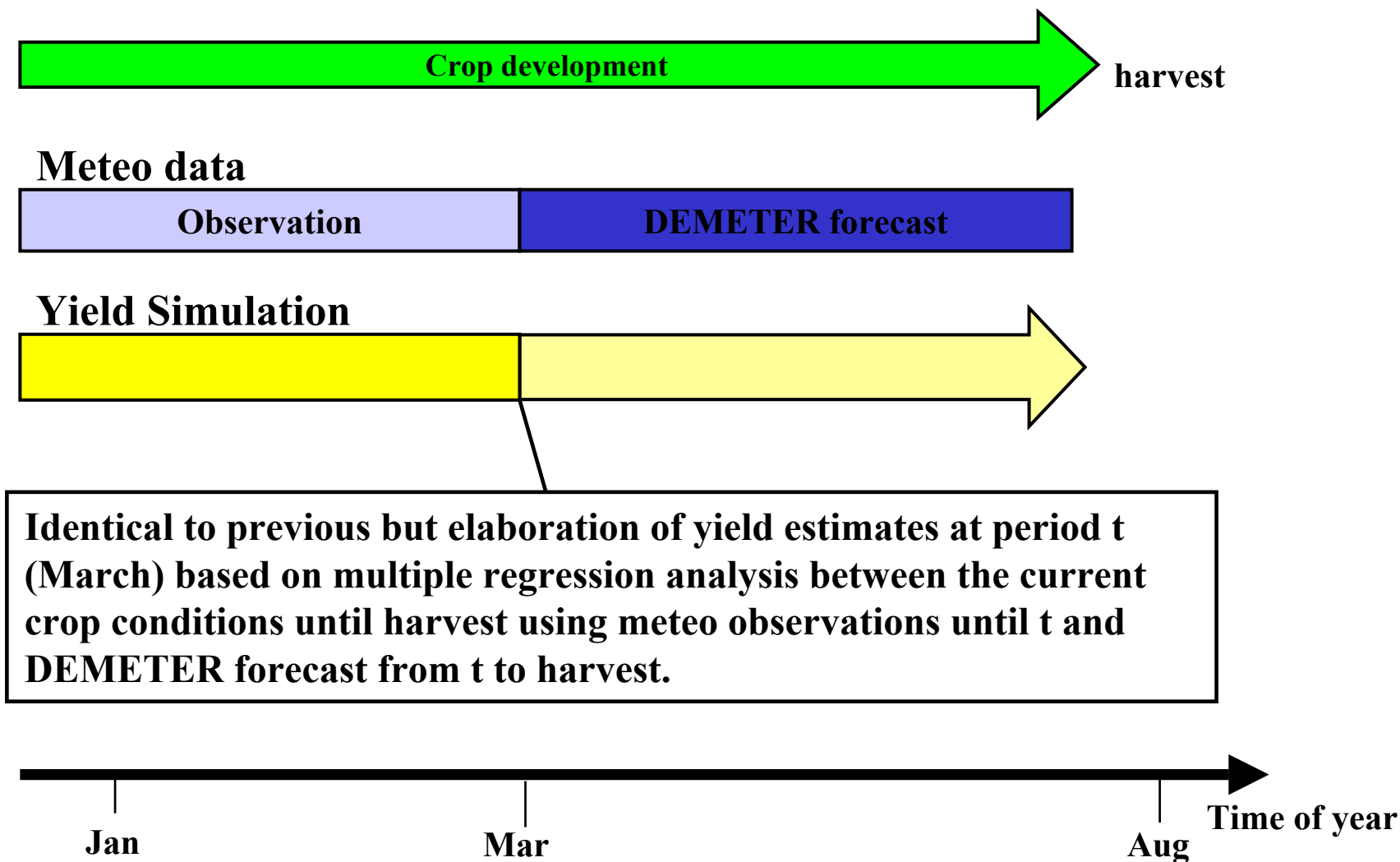


# Problem when using the regression analysis for Yield forecast early in season



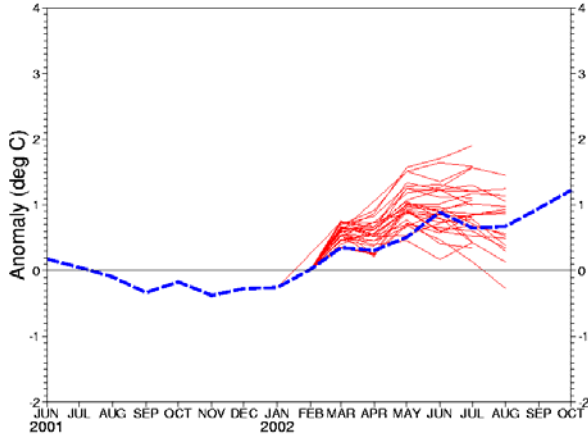
Mainly the time trend is found best predictor at this period, simulated crop indicators (total biomass & grains) are still at an early development stage and therefore their contribution in the regression error calculation is high compared to the trend

# Use of seasonal forecast within the JRC Crop Model



# DEMETER data as input of the Crop Model

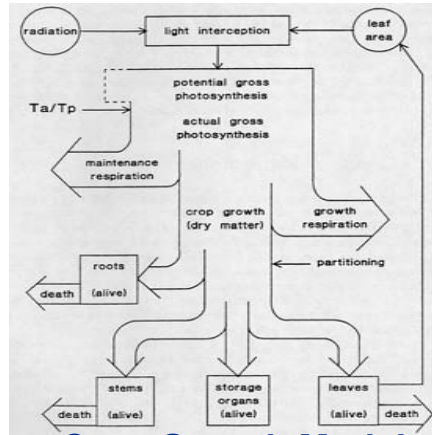
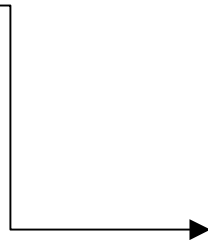
NINO-3 SST anomaly plume  
ECMWF forecasts from dates in Feb 2002



MAGICS 6.6 hades - errors Wed Nov 13 18:16:58 2002



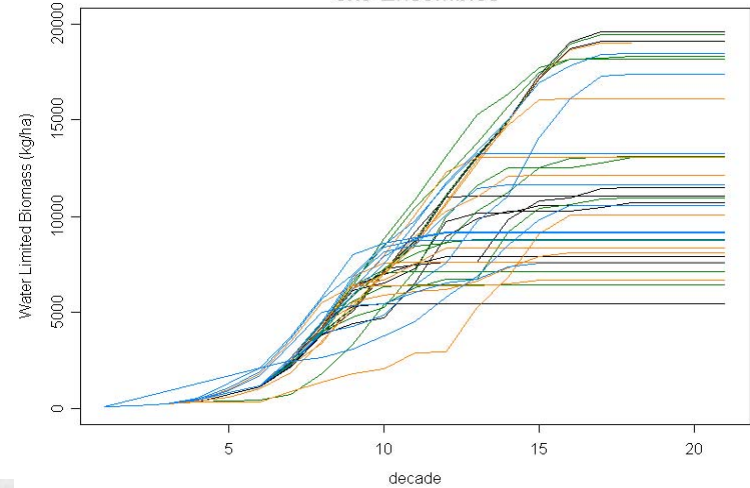
## DEMETER Seasonal Ensemble weather predictions



Crop Growth Model

## Ensemble of Simulated Yields

Simulated Biomass  
9x6 Ensembles



# DEMETER data as input of the Crop Model

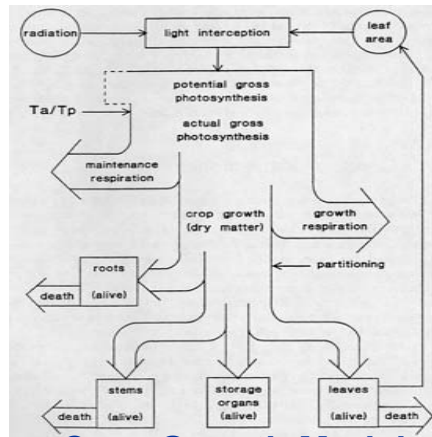
**DEMETER** data

**Downscaled** by *DMI*

*T*<sub>min</sub>, *T*<sub>max</sub>, Rain, *E*<sub>tp</sub>, Radiation

(DEMETER WP 1 & WP2)

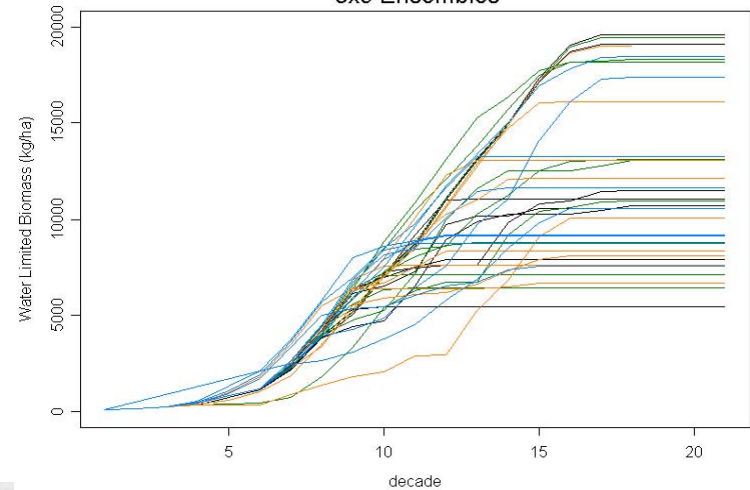
**DEMETER Seasonal Ensemble  
weather predictions**



**Crop Growth Model**

## Ensemble of Simulated Yields

Simulated Biomass  
9x6 Ensembles



# DEMETER data as input of the Crop Model

By the time we made this test, were available only 2 models: ECMWF and UKMO

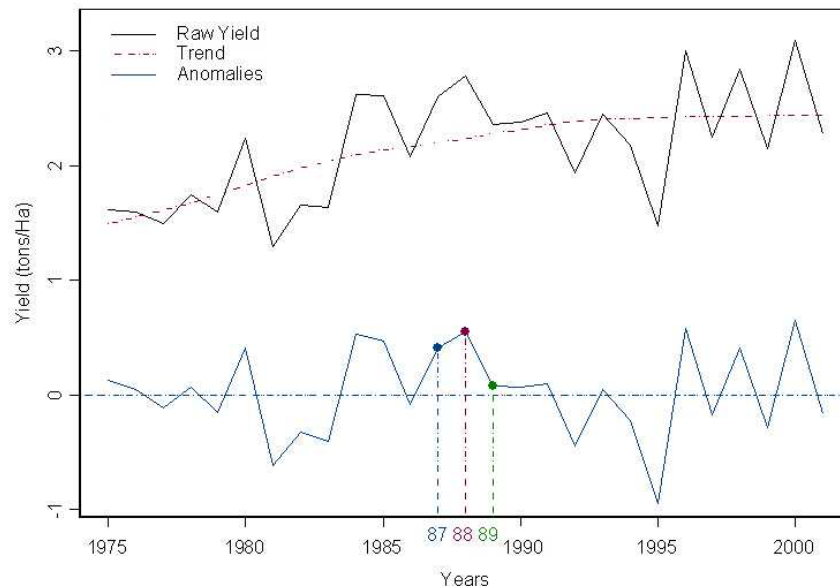
During the **downscaling** phase, each run of the stochastic **weather generator** provide a different daily distribution of the original data.

Thus, to test the simulations with 54 members, we took 3 runs of the weather generator for each combination model/initial condition

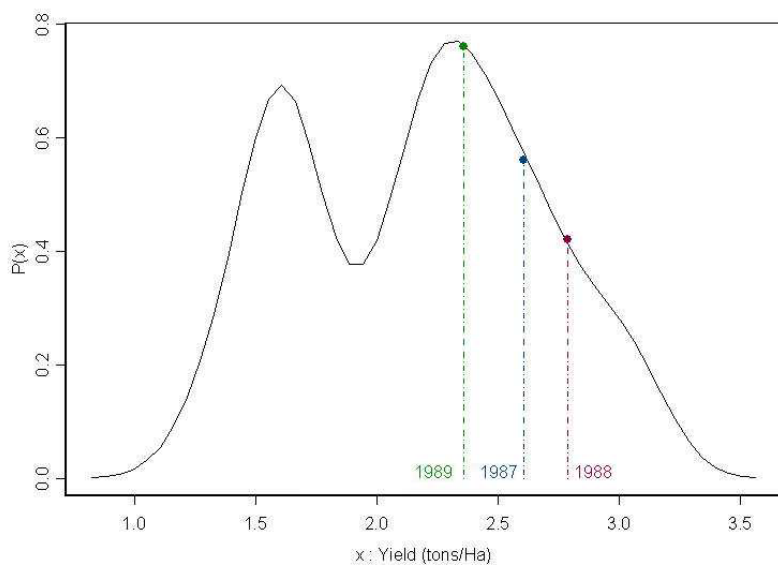
$$(2 \times 9) \times 3 = 54 \text{ members}$$

⇒ Test on an ensemble of 54 members

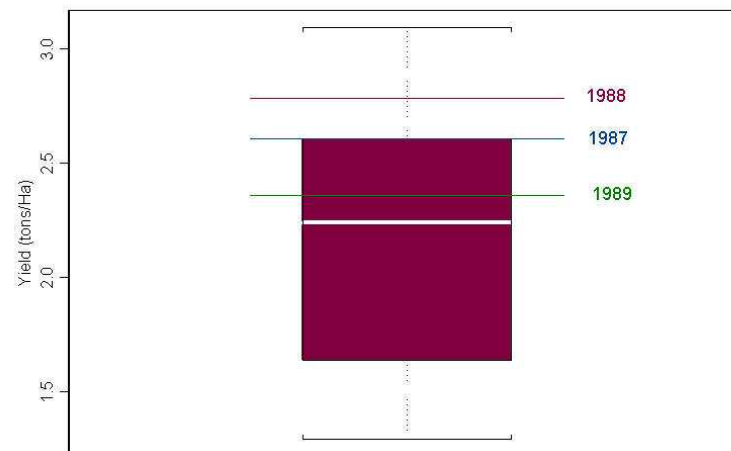
# Wheat Yield in Spain : Time series & studied years



PDF : Wheat Yield in Spain (1975-2001)

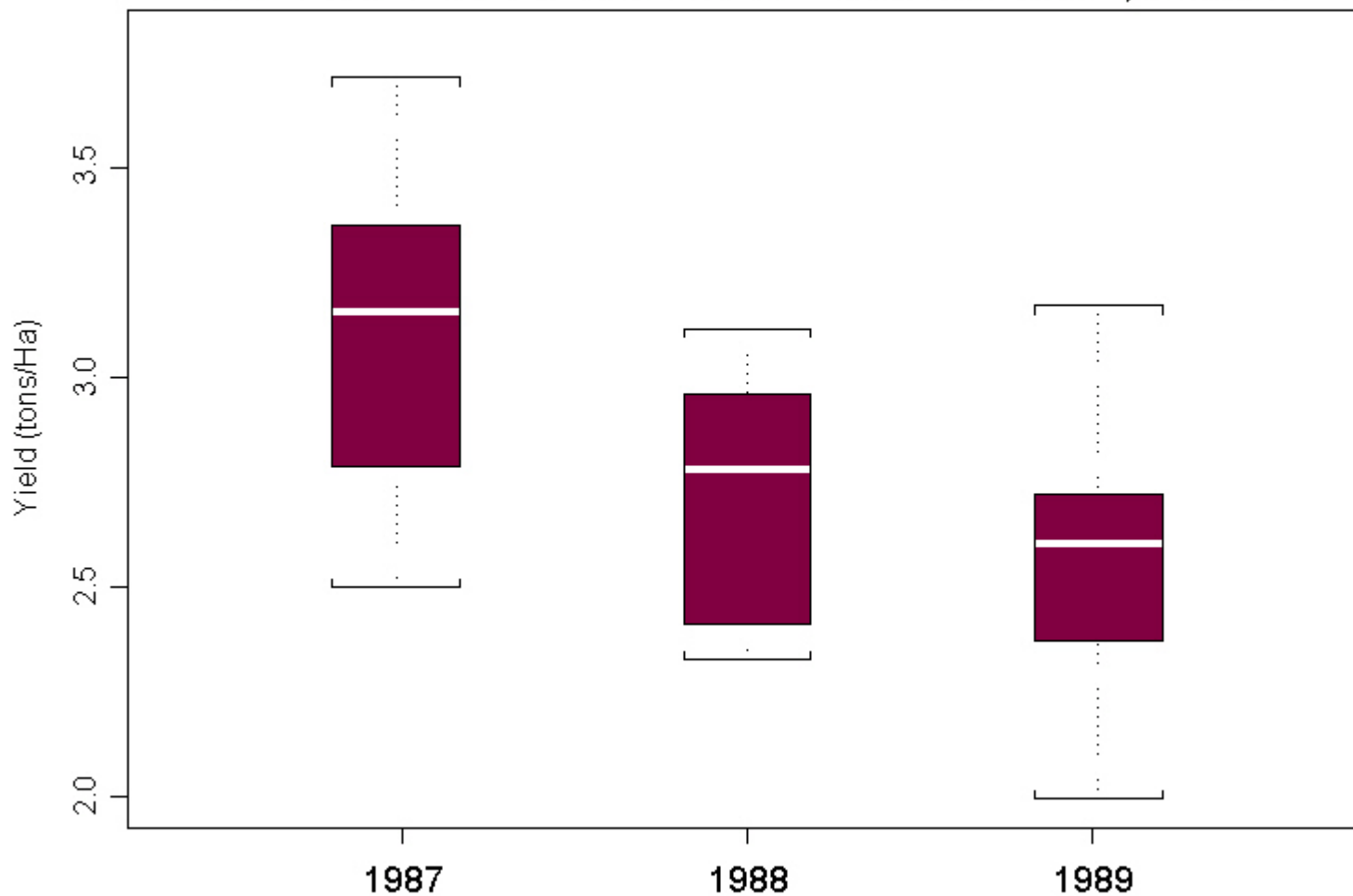


Box-Plot : Wheat Yield in Spain (1975-2001)



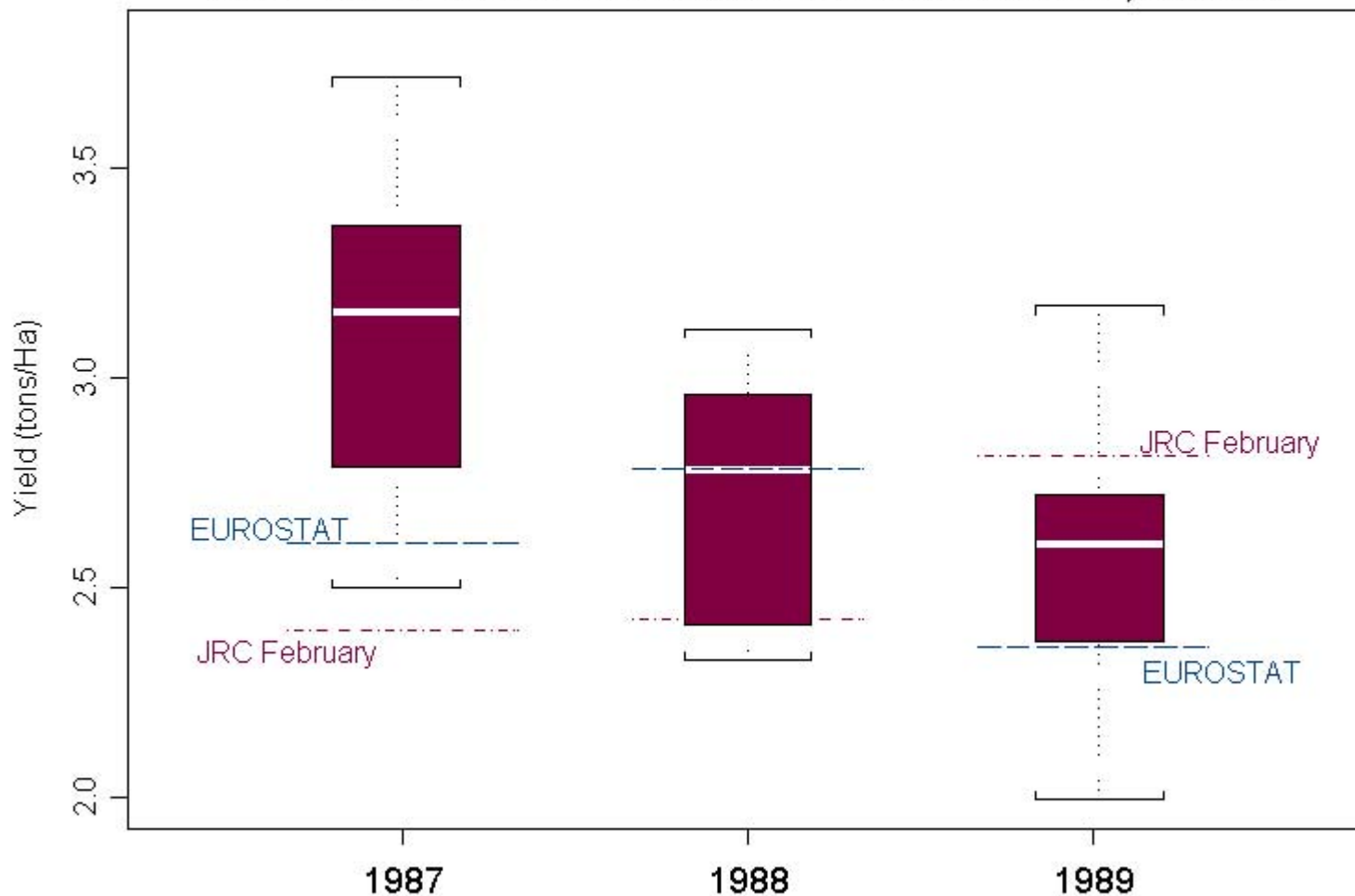
# Forecasted Yield 1987,88,89 - Spain

54 DEMETER membres 3 x 2 models ECMWF, UKMO



# Forecasted Yield 1987,88,89 - Spain

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# Sampling the 54 members to reduce the number of runs

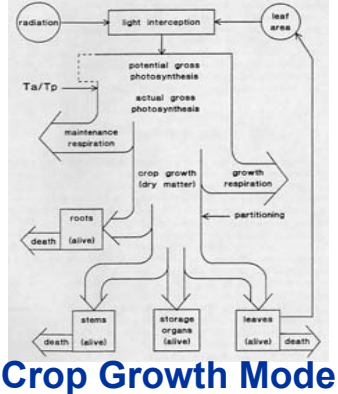
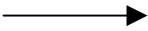
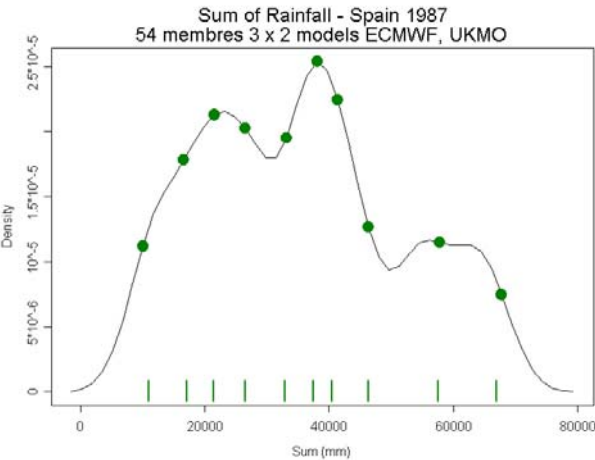
## Characterising the DEMETER ensemble

### Temperatures, Rainfall, Etp, Radiation

- Total Rainfall Amount (March to July)
- Fournier Index : rainfall amount/distribution

$$P_{total} = 5 \sum_{i=march}^{July} \frac{P_i^2}{P_{total}}$$

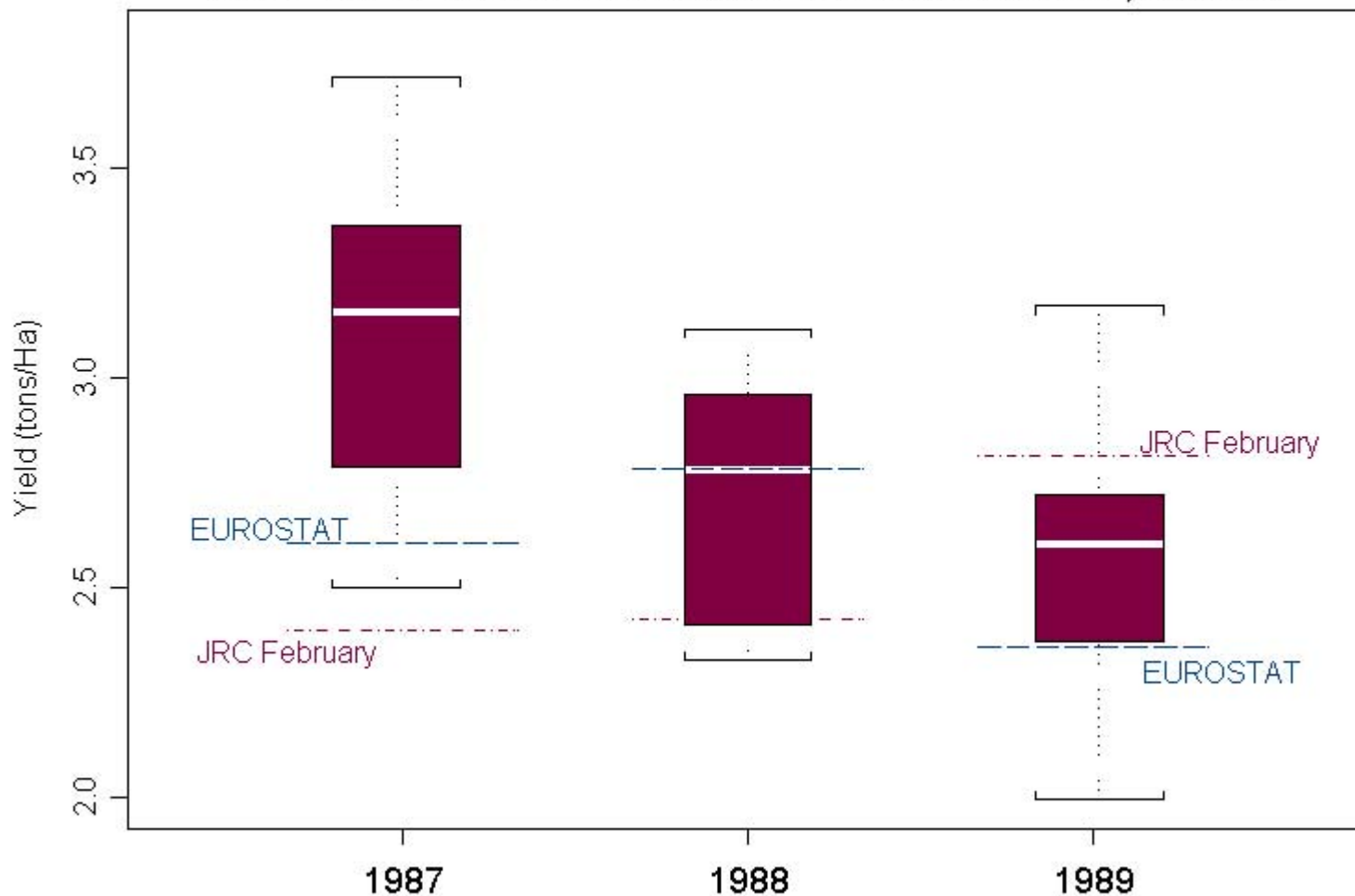
Take the Quantiles/Deciles from pdf



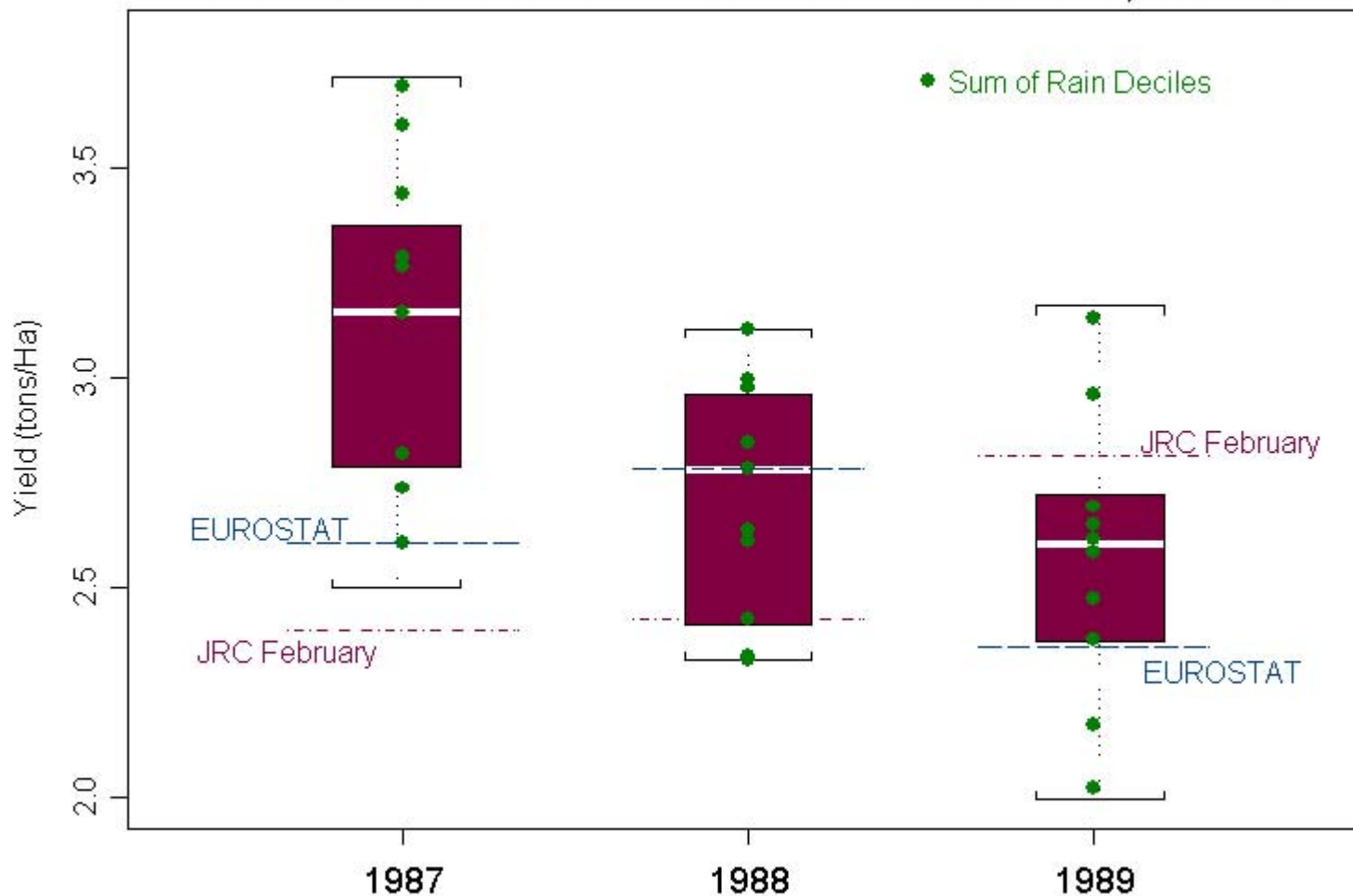
10 runs only

# Forecasted Yield 1987,88,89 - Spain

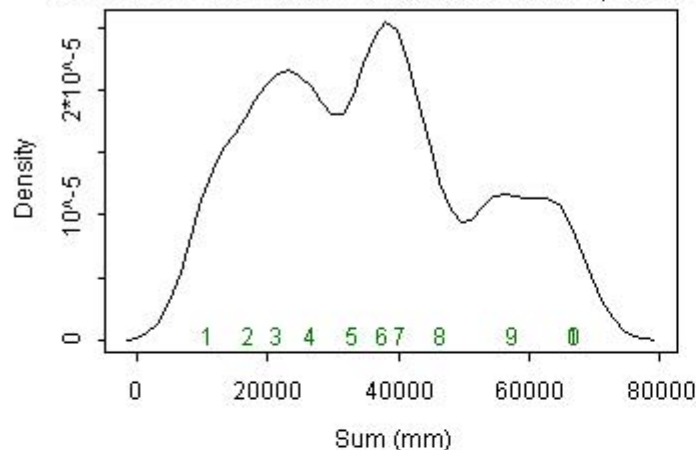
54 DEMETER membres 3 x 2 models ECMWF, UKMO



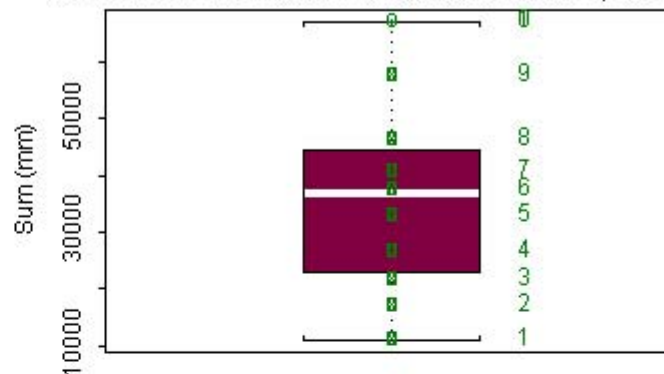
## Forecasted Yield 1987,88,89 - Spain 54 DEMETER membres 3 x 2 models ECMWF, UKMO



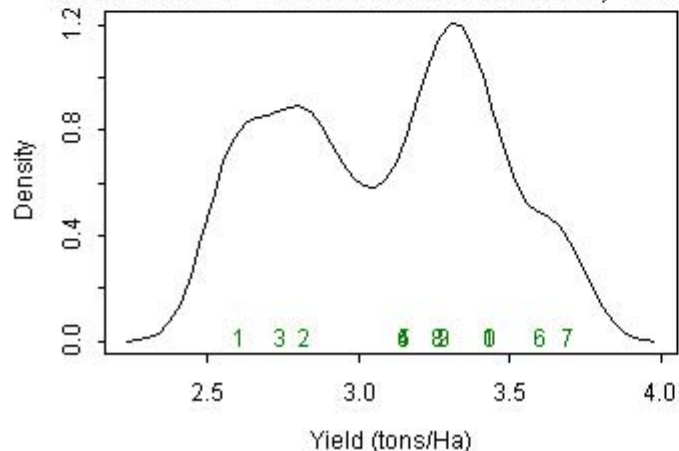
Sum of Rainfall - Spain 1987  
54 membres 3 x 2 models ECMWF, UKMO



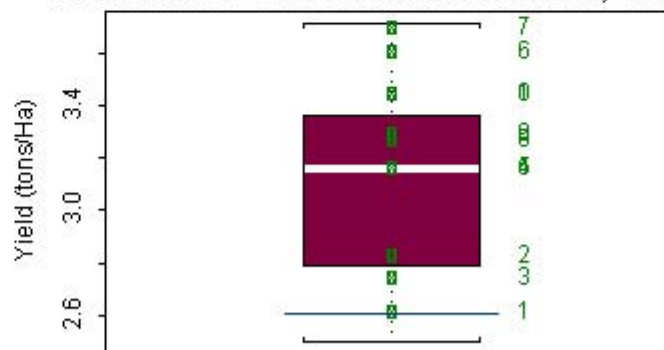
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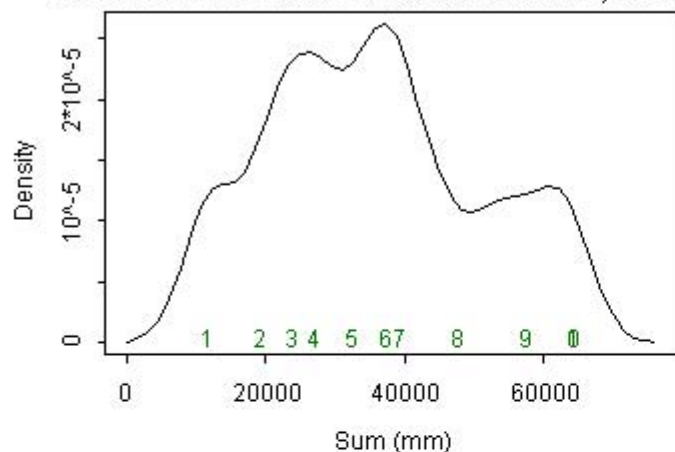
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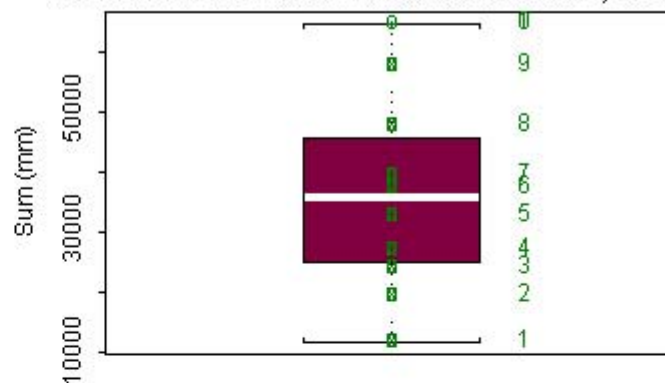
Forecasted Yield - Spain 1987  
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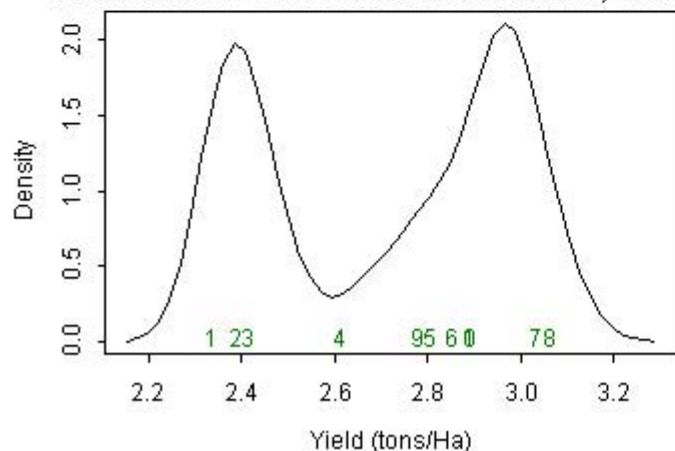
Sum of Rainfall - Spain 1988  
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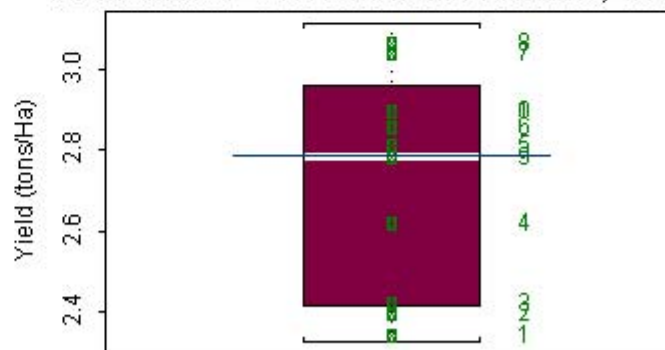
Sum of Rainfall - Spain 1988  
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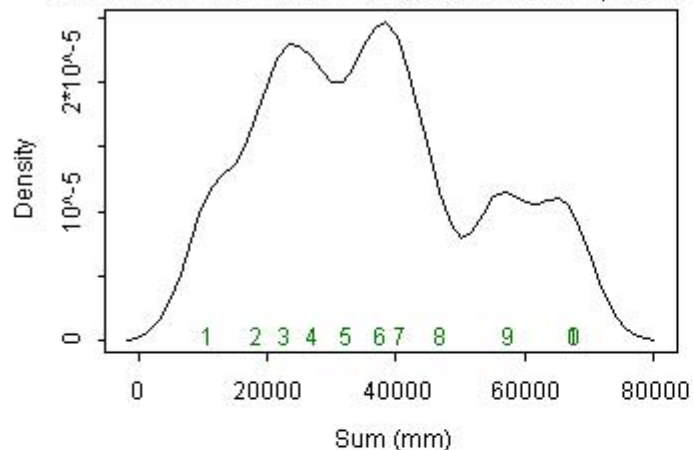
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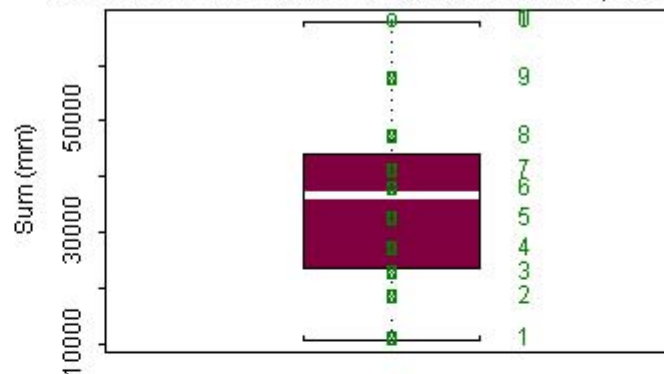
Forecasted Yield - Spain 1988  
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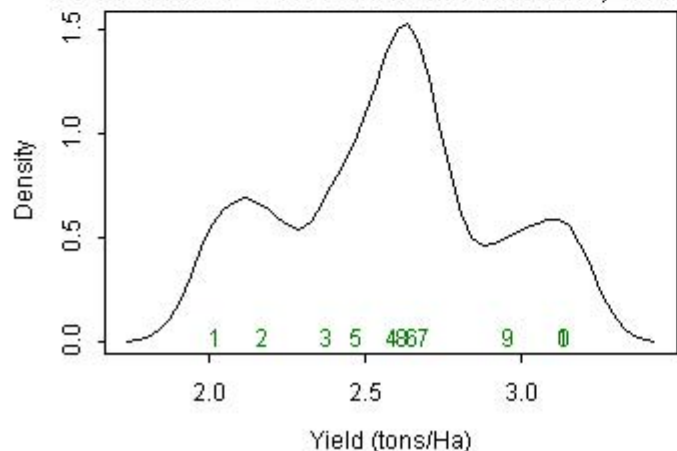
Sum of Rainfall - Spain 1989  
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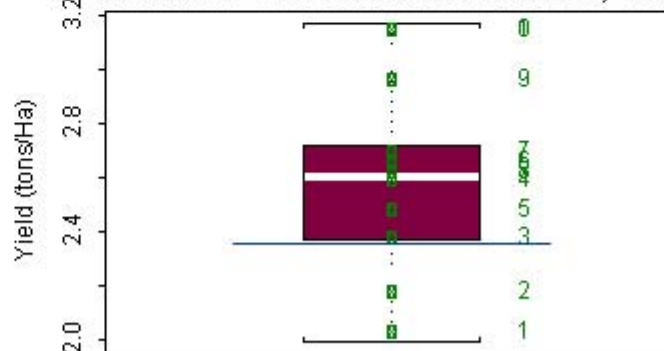
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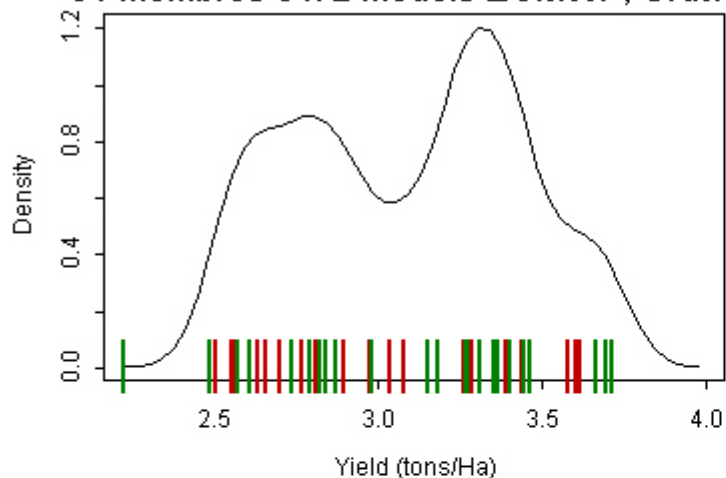
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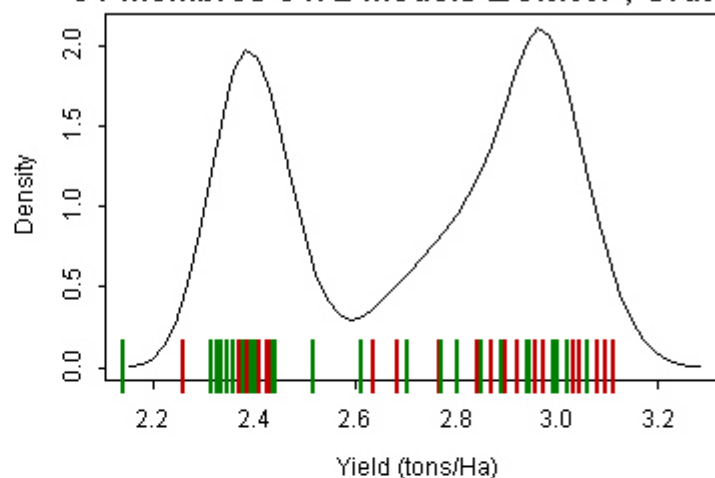
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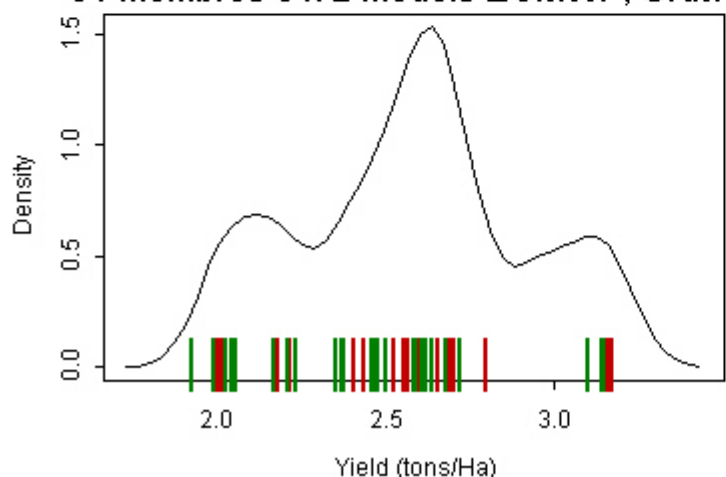
**Forecasted Yield - Spain 1987**  
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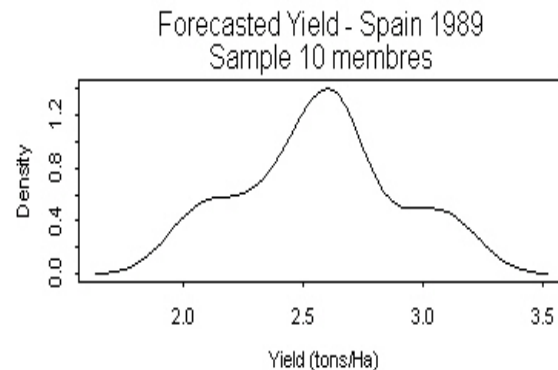
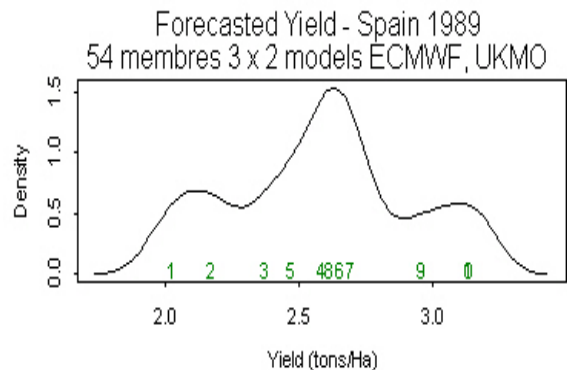
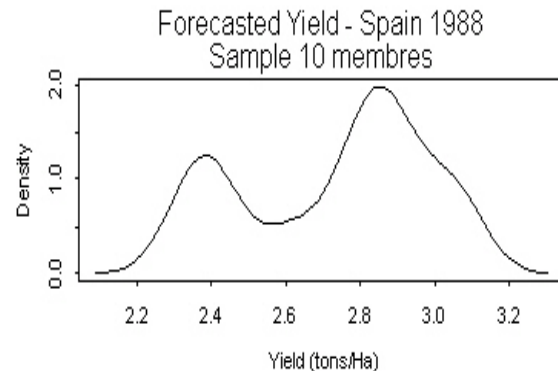
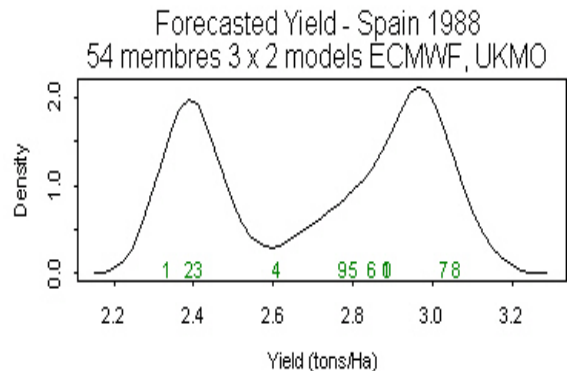
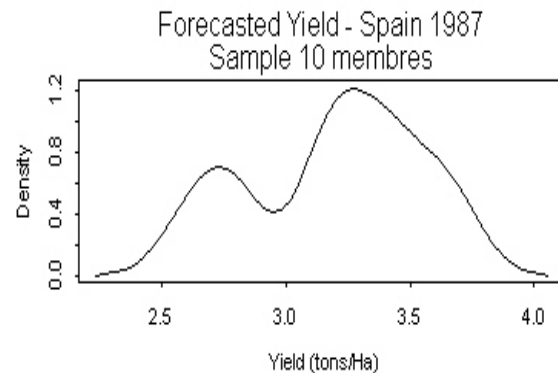
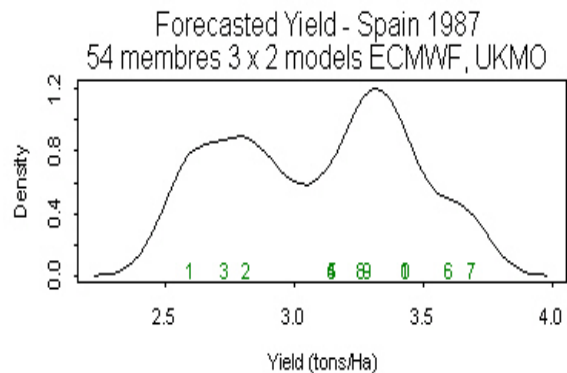


**Forecasted Yield - Spain 1988**  
54 membres 3 x 2 models ECMWF, UKMO

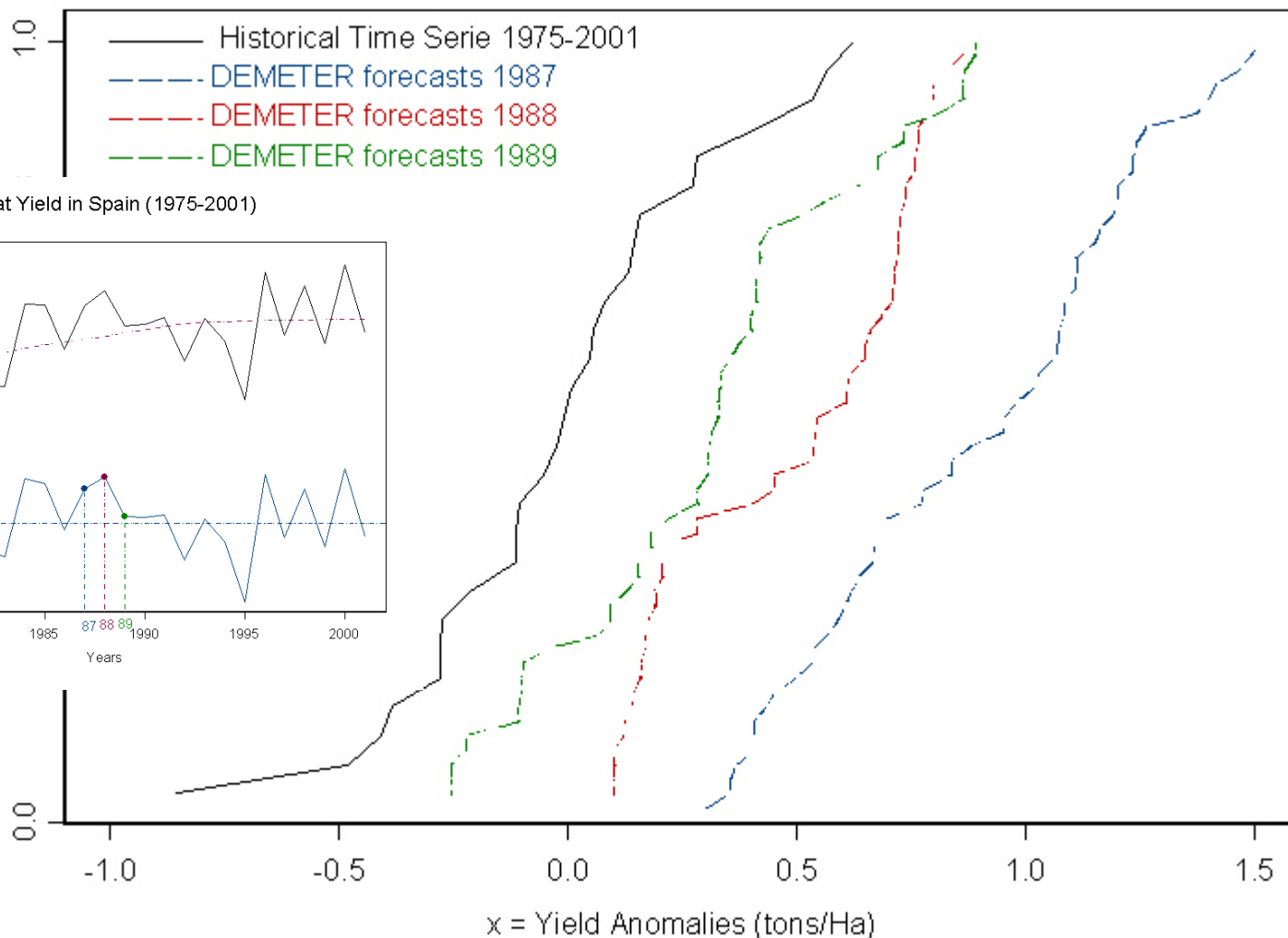


**Forecasted Yield - Spain 1989**  
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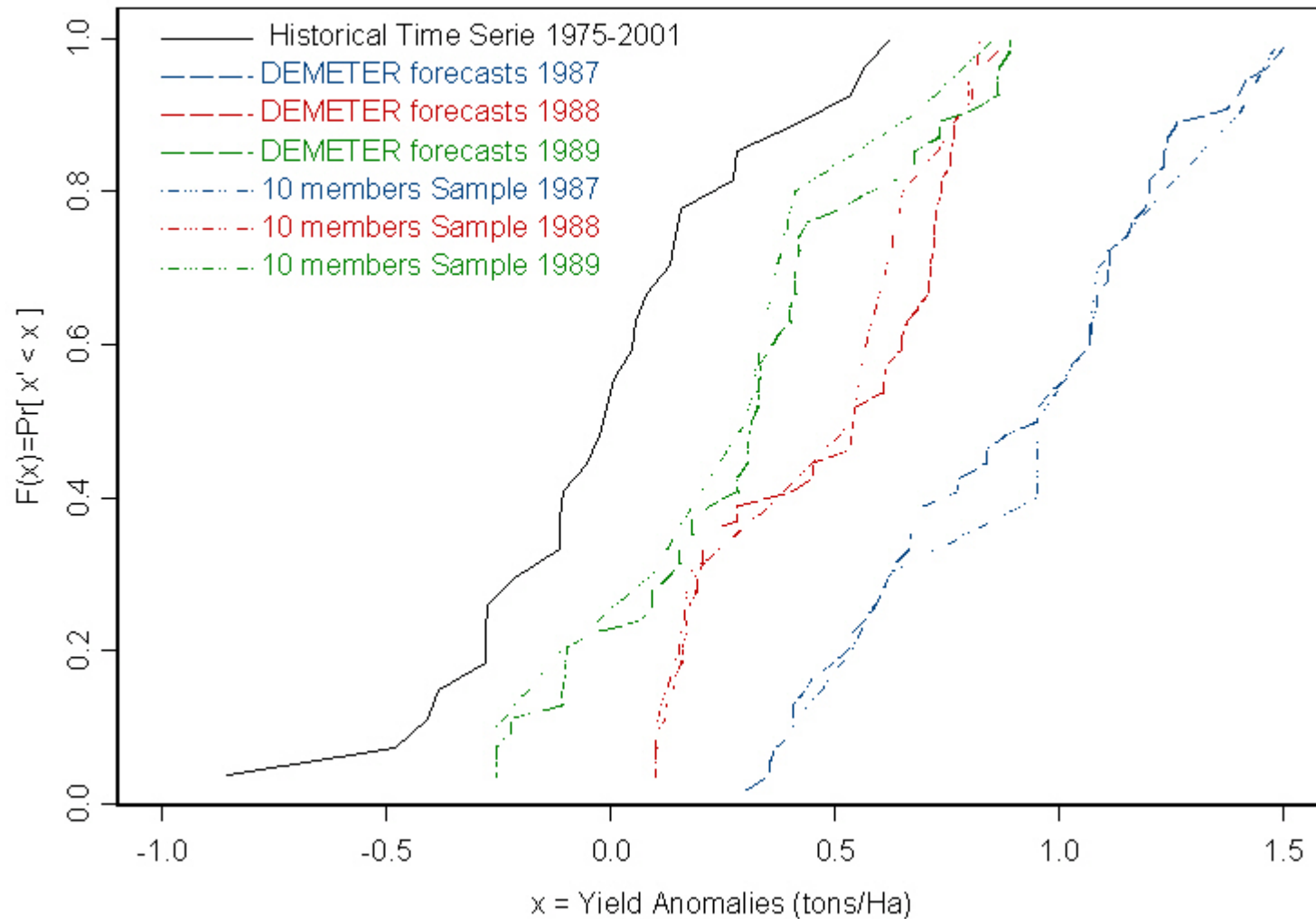




# Probability Density Function Wheat Yield Anomalies (Spain)



## Probability Density Function Wheat Yield Anomalies (Spain)



# Conclusion#1

1. pdf of yield do not present the same pattern each year
2. Deciles: representative sampling of the 54 members
3. Rainfall deciles different from Yield Deciles (rank)
4. No difference between Total Amount and Fournier Index

# Conclusion #2 / Perspectives

- The JRC Crop model was fully run with DEMETER output (downscaled - DMI)
- Probability of Yield Anomalies (Spain - 1987, 88, 89)
- Satisfying results
- Question: Sampling method for the 54 members (deciles only ?)

Next step: **Assessment of DEMETER output on the whole Europe.**

The necessary 8 years archive for the regression phase will be ERA40 (to be downscaled)