Yield prediction of durum wheat: the added value of MED-GOLD climate services products

R. Dainelli, S. Calmanti, M. Pasqui, E. Di Giuseppe, C. Monotti, C. Ronchi, M. Silvestri, C. Chou, N. Gonzalez, R. Marcos, P. Toscano

Aim & scope

Early within-season weather conditions forecast and yield prediction can provide useful information to improve farmers' management decisions.

increase yield and reduce potential risk

The skills of the **ECMWF-System5 seasonal time-scale forecasting** provided through the *Copernicus Data Store* (CDS) were evaluated as a driver to the crop modelling system **DELPHI**

Case study:
durum wheat yield prediction

Three hot spot areas in **Italy**

The DELPHI model

The DELPHI integrated forecast system is a *mechanistic model*

INPUT DATA

- Durum wheat phenology
- Soil hydrology
- Soil and crop N content
- Roots growth

The model has been **calibrated and tuned for durum wheat and Italian conditions** since 1995


Europ. J. Agronomy 43 (2012) 108–118

Contents lists available at SciVerse ScienceDirect

European Journal of Agronomy

journal homepage: www.elsevier.com/locate/eja

Durum wheat modeling: The Delphi system, 11 years of observations in Italy

P. Toscano[a,b,*], R. Ranieri[c,1], A. Matese[a], F.P. Vaccari[a], B. Gioli[a], A. Zaldei[a], M. Silvestri[c], C. Ronchi[c], P. La Cava[c], J.R. Porter[e], F. Miglietta[a,d]

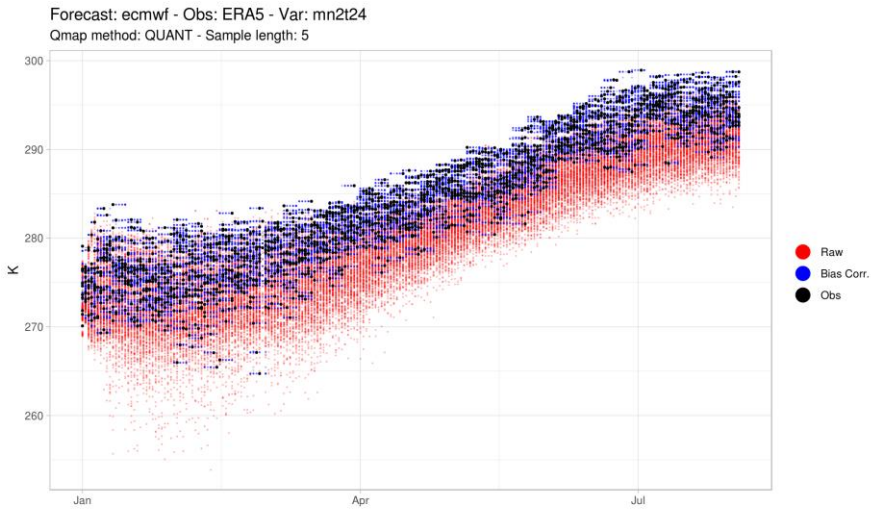
The DELPHI model includes also the climatic reconstruction based on long-term observations in order to create **three synthetic weather scenarios**

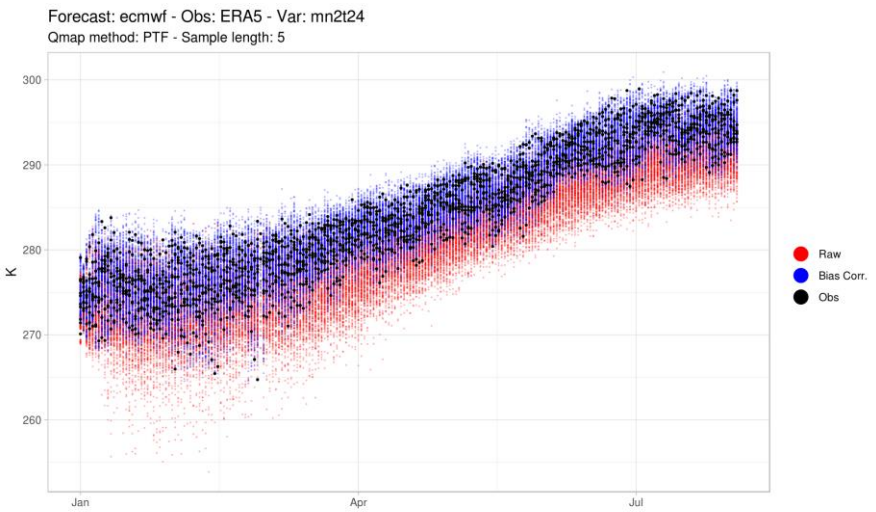
"DRY" **"AVERAGE"** **"WET"**

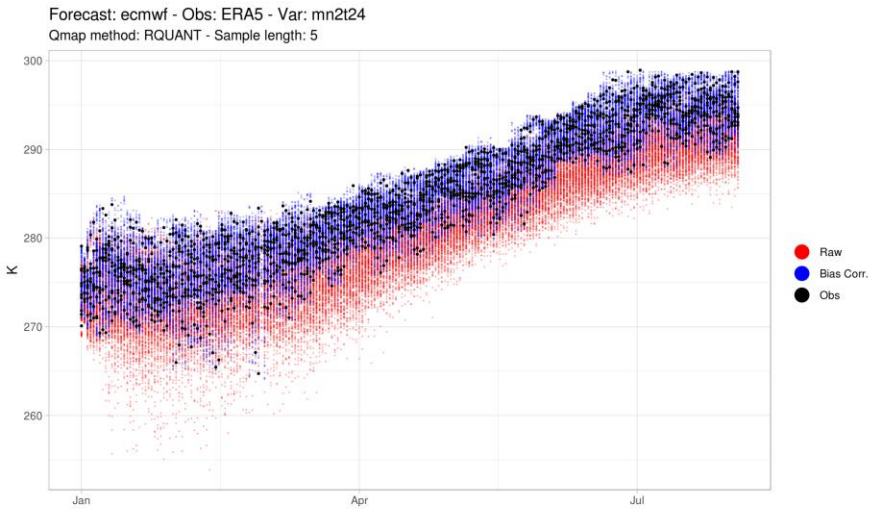
Correction of biased dataset

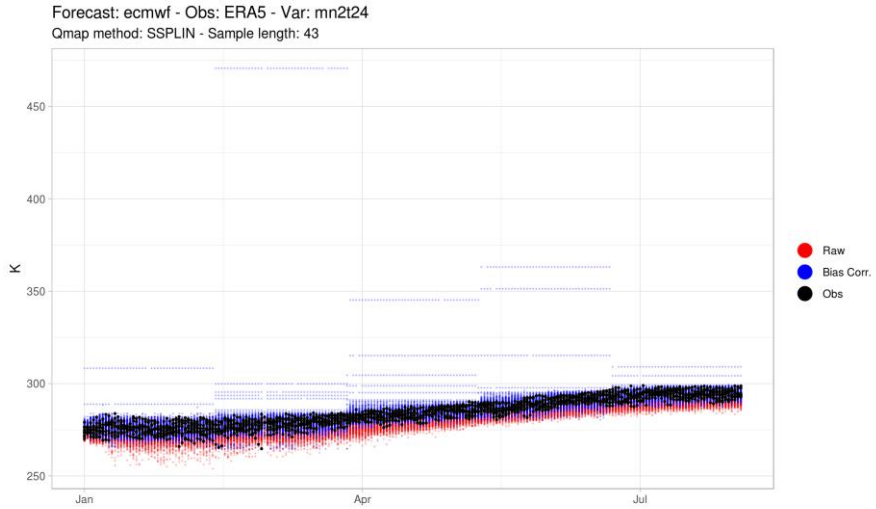
Biases in model simulation are commonly detected by *validation*.

As correction technique, we have performed a **quantile mapping methods**.









Bias correction of temperature forecasts. Each dot represents a daily value from raw seasonal forecast ensemble members (red), the reanalysis ERA5 (black) and the bias corrected daily values (blue).

Crop season simulation benchmark ICT dataset

For both **unbiased and biased** weather forecast dataset, high and low performance crop year in terms of yield have been chosen:

- **BAD year** (below average yield): 2010 for Ravenna; 2007 for Foggia and Ancona
- **GOOD year** (above average yield): 2012 for Ravenna; 2016 for Foggia and Ancona

The DELPHI model was run with observed daily weather data from sowing to harvest → **REFERENCE YIELD**

Yield **hindcasts** were calculated at a *monthly time step*, starting from February 1st and April 1st, by feeding the DELPHI model with:

New tool

vs

Current mode

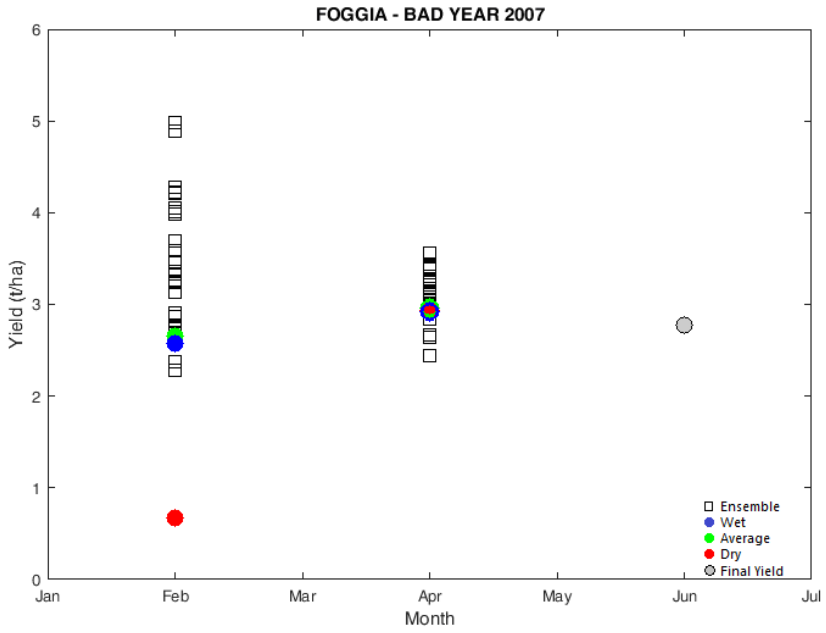
1. weather seasonal forecast (**25 ensemble** for 6 months of forecast) until the end of the growing season
2. synthetic weather scenarios based on historical observations (dry, average, wet)

Hindcast results

Yield prediction on the 1st June on the basis of three historical scenarios (red-green-blue circle) and on the basis of seasonal forecast (black square) are reported.

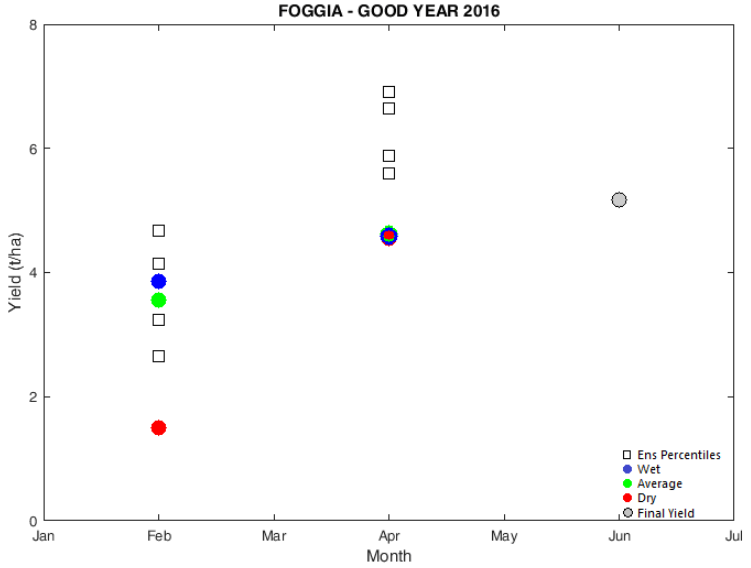
For each year the reference yield is also reported (grey circle).

Biased dataset

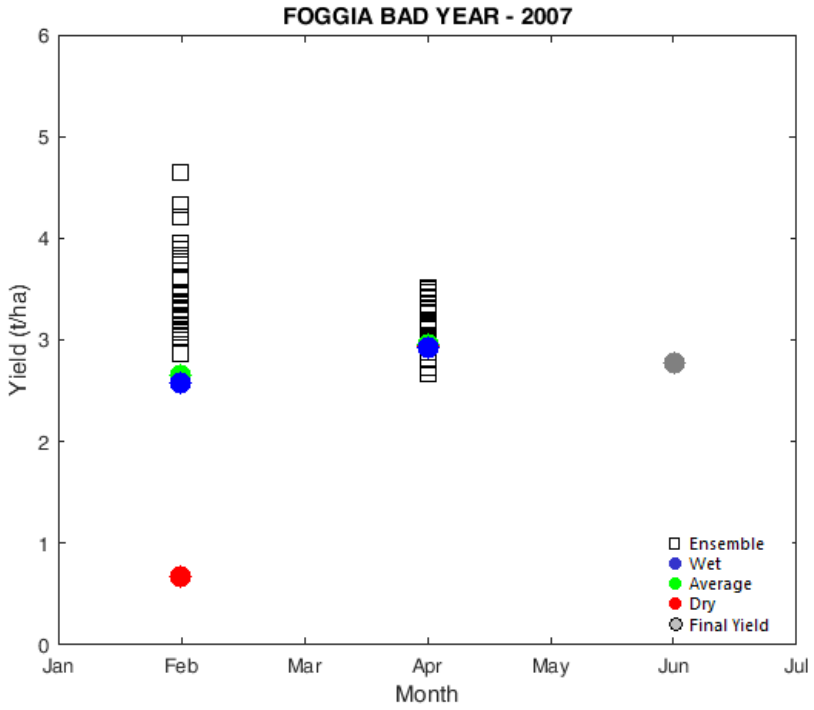


Seasonal forecast scenario range is narrower than that provided by the Dry-Average-Wet scenario on February 1st, wider on April 1st.

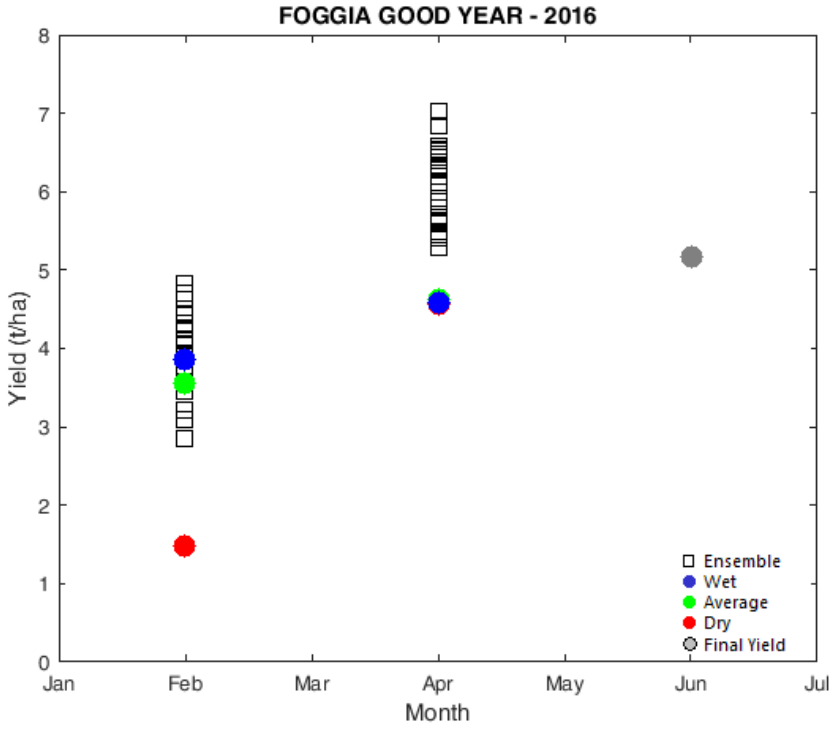
Seasonal forecast scenario range is narrower than that provided by the Dry-Average-Wet scenario on February 1st, wider on April 1st with a tendency to overestimate yield value.



Unbiased dataset

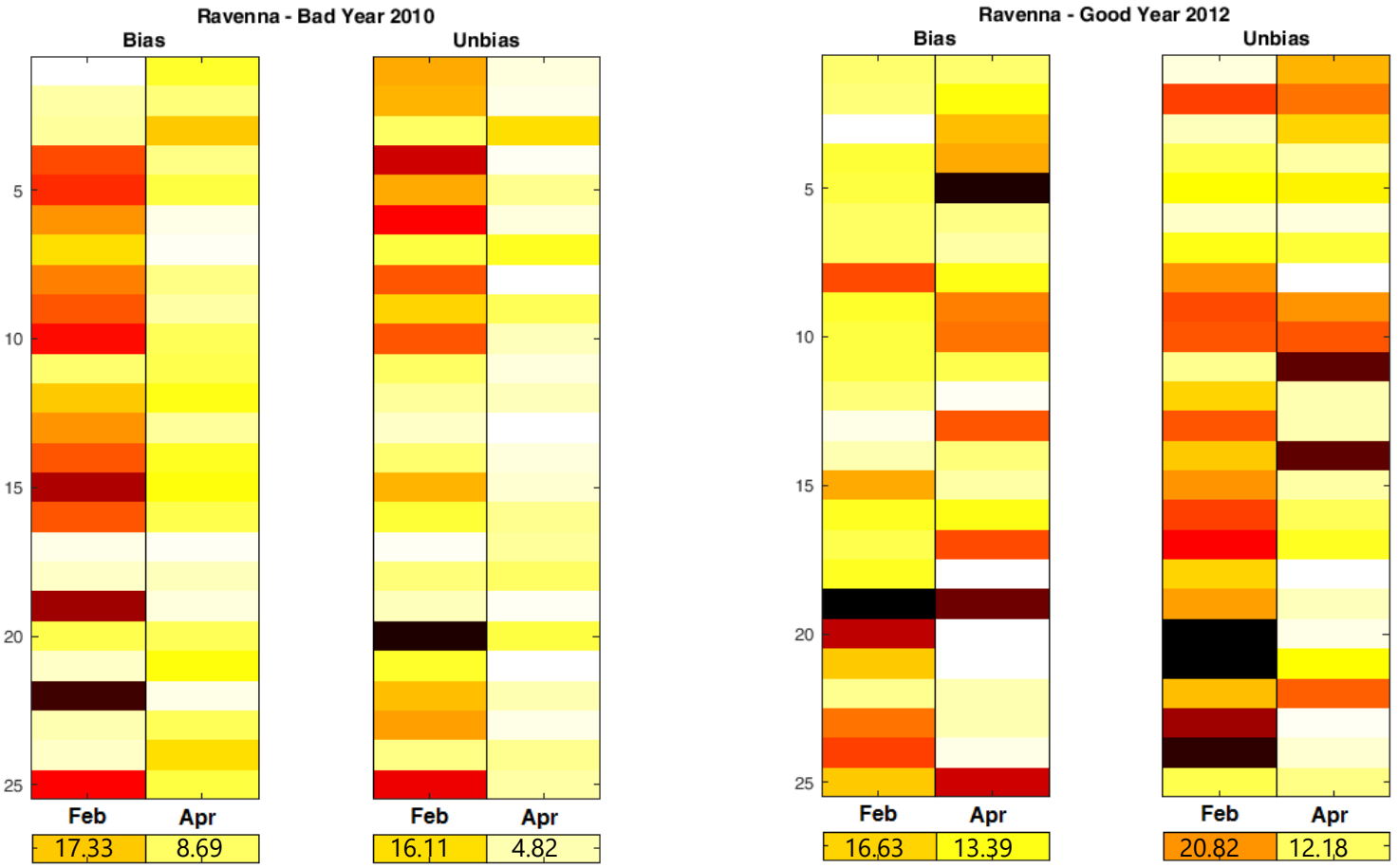


Seasonal forecast scenario range is wider in both dates than that provided by the Dry-Average-Wet scenario on February 1st, with a tendency to overestimate yield value.



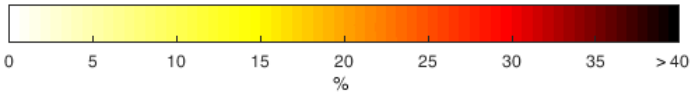
Seasonal forecast scenario range is narrower than that provided by the Dry-Average-Wet scenario on February 1st, wider on April 1st with a tendency to overestimate yield value.

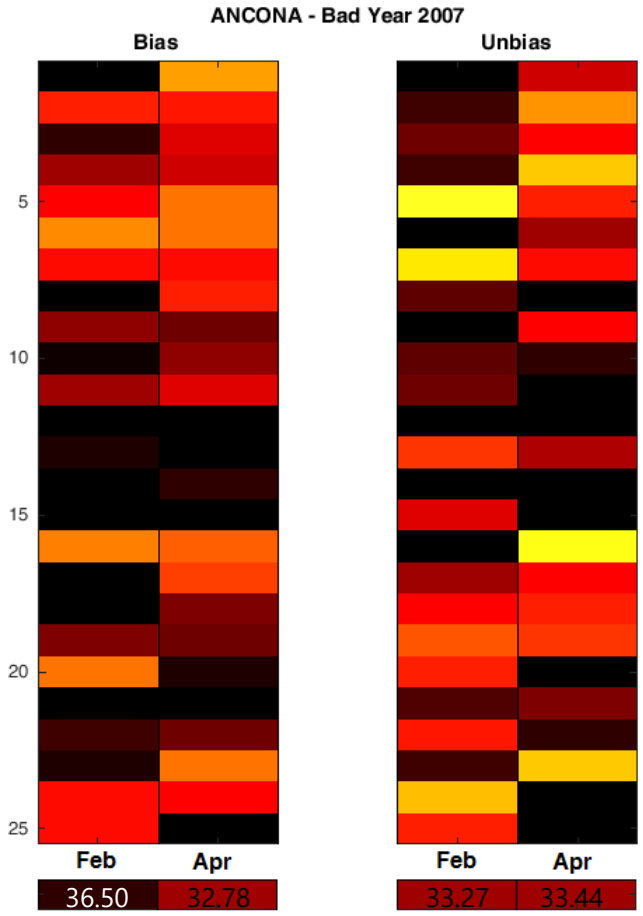
Yield percentage variation between DELPHI ***new tool*** and ***current mode*** vs. **reference value**

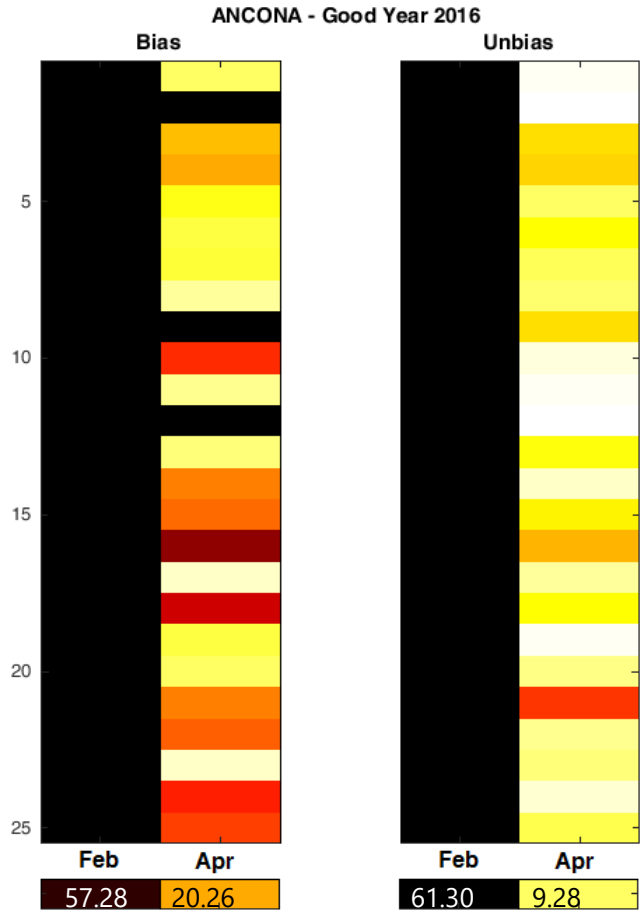


	DRY	AVG	WET
Feb	1.10	9.50	3.24
Apr	7.75	18.93	25.44

DRY	AVG	WET
60.08	32.52	26.03
28.95	9.73	3.89

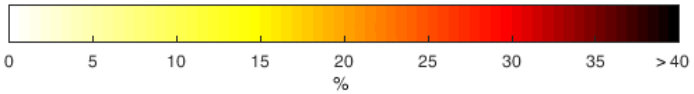


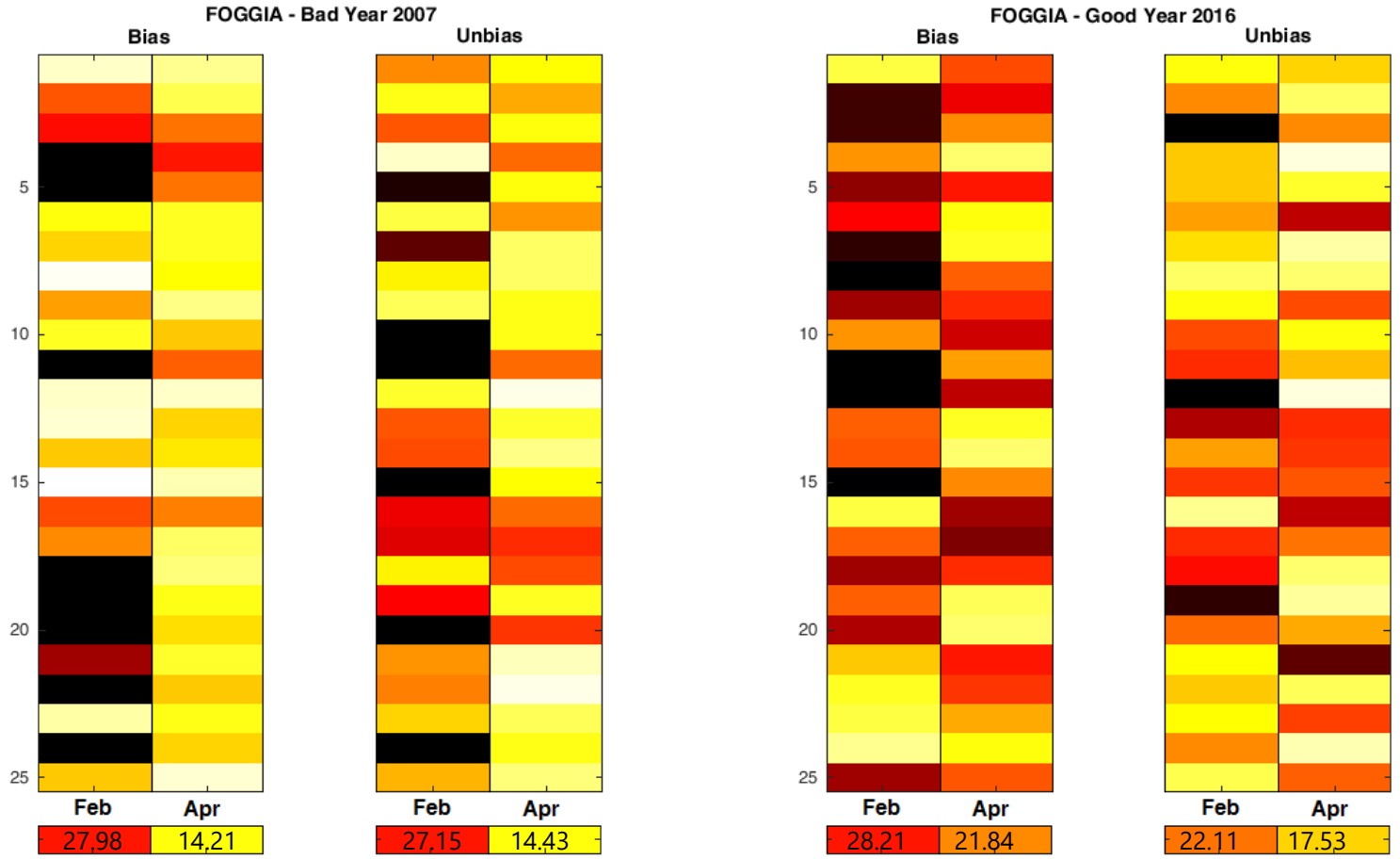




	DRY	AVG	WET
Feb	98.28	6.70	13.51
Apr	21.75	16.33	21.18

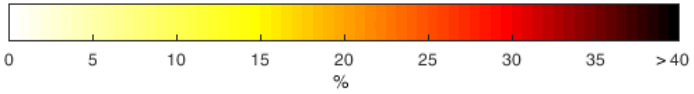
	DRY	AVG	WET
	87.75	70.51	67.01
	41.15	22.71	12.13





	DRY	AVG	WET
Feb	75.96	4.36	7.15
Apr	6.10	6.90	5.53

DRY	AVG	WET
71.16	31.25	25.30
11.83	10.69	11.32



Final remarks and future challenges

- In general, the availability of unbiased data slightly improved the yield forecast, with the best result achieved for the high yielding crop year in Ancona, where 2 months before harvest the nRMSE dropped from 20.3% (*biased*) to 9.3% (*unbiased*).

- Based on these first promising results this benchmarking framework will be extended over a wider study area (the Italian Geographical Domain)

- A state-of-the-art skill model analysis will be performed to better highlight findings and remarks