Using citizen science for the prediction of climate extremes

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BAMS Article

Adopting Citizen Observations in Operational Weather Prediction

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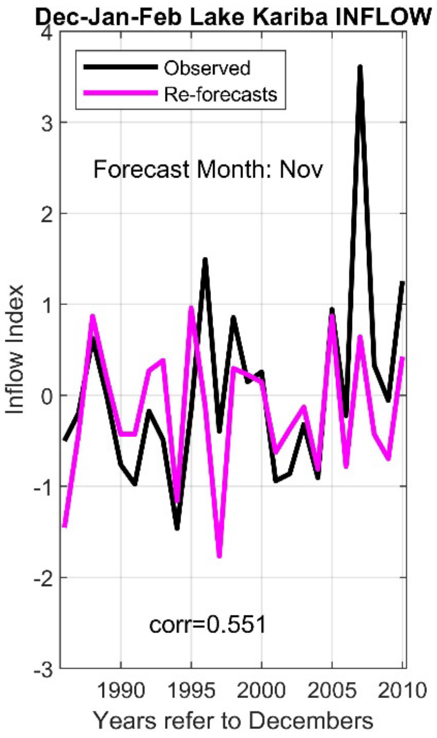
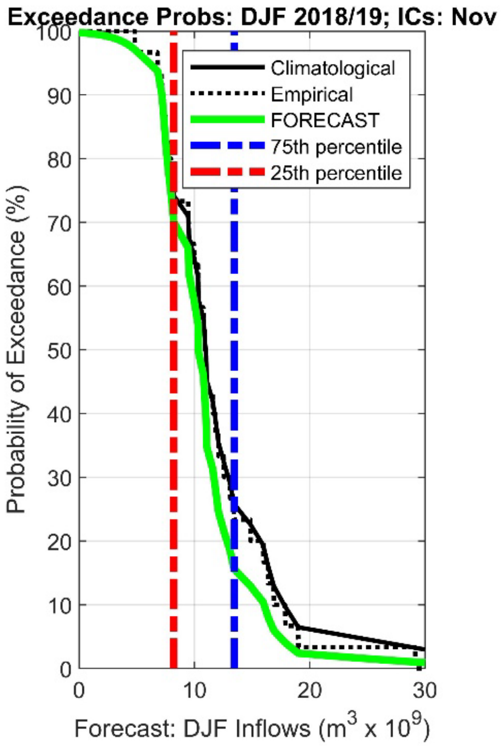
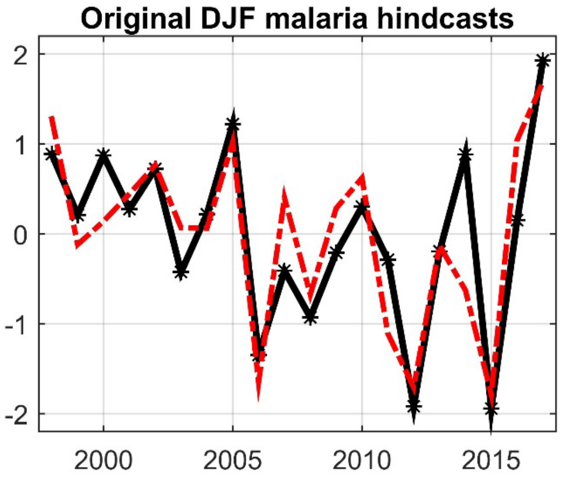
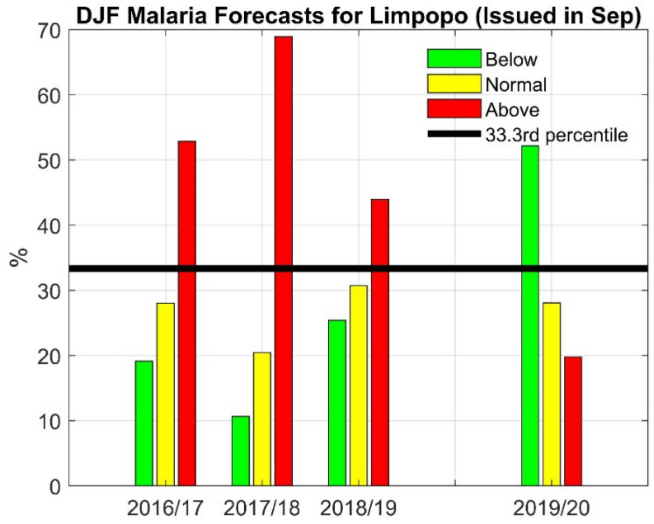
What we used to do vs. CO-PRODUCTION

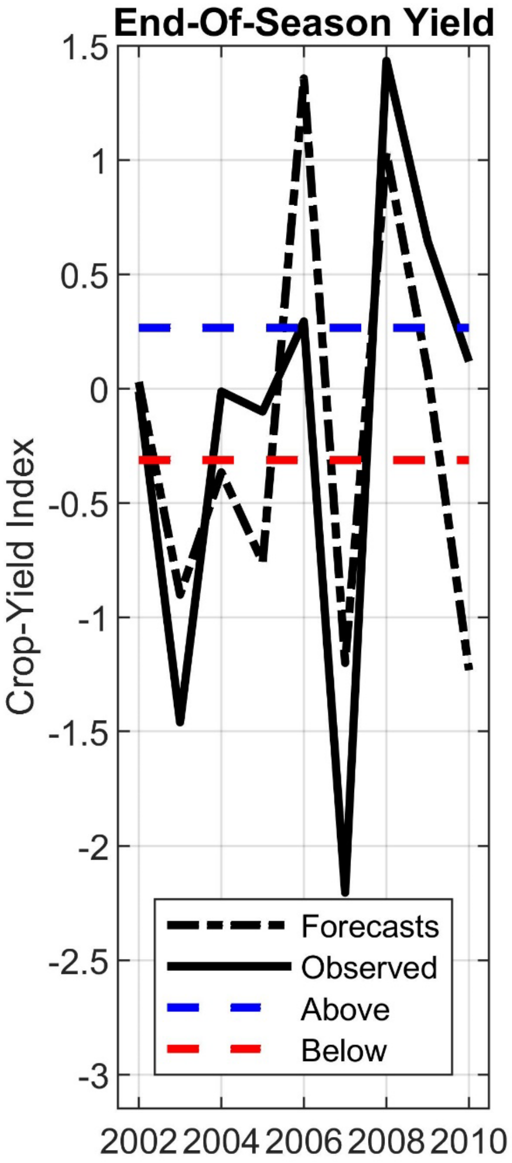




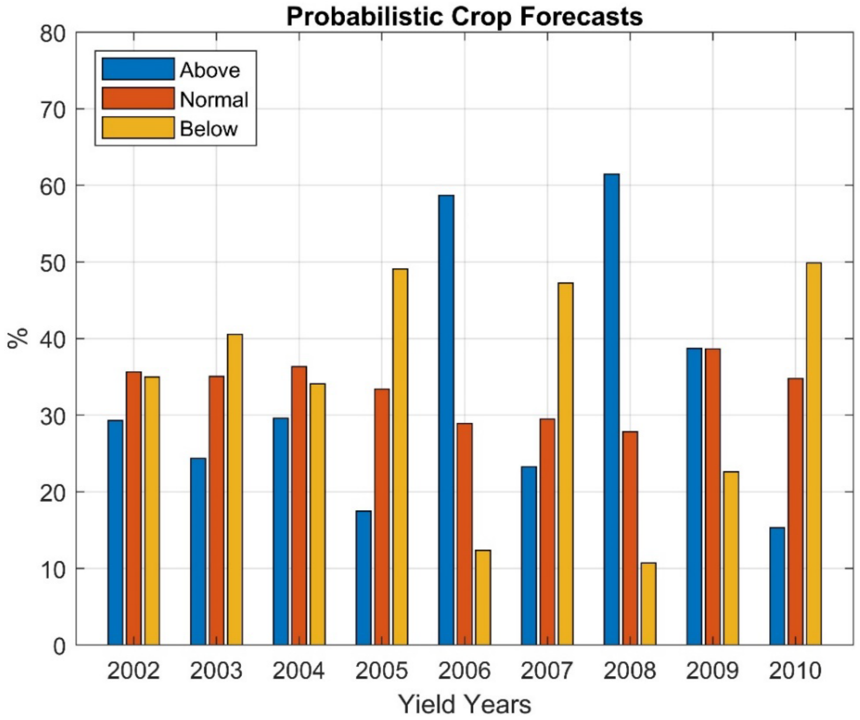


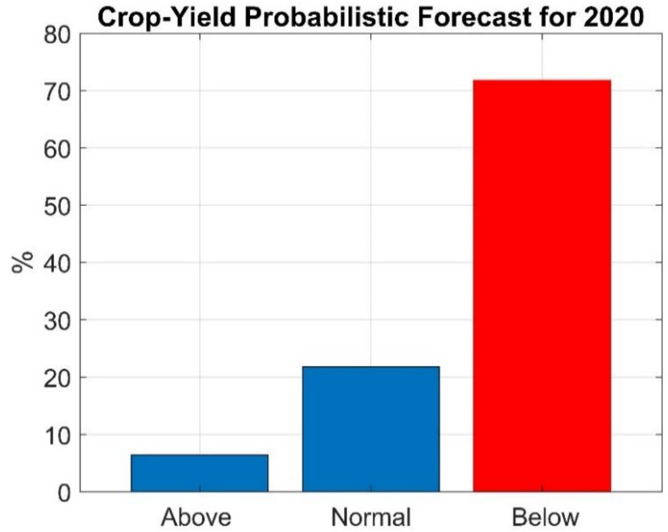


Are you a farmer who wants to make use of science-based seasonal predictions for your farm? If you are interested to be part of an initiative at the University of Pretoria that involves the development of seasonal forecast systems for farms, specifically tailored to farmers' needs, please send an email to WALandman1981@gmail.com



Have a look at this example of end-of-season crop yield forecasts for a farm near Bapsfontein. The farmer provided several decades of crop-yield data and these data were subsequently used to create a crop forecast model specific to the farm





Above is the crop-yield forecast for the coming season. The forecast is for enhanced probabilities of below-normal (low) crop yield for the farm. The farmer may be able with support to use this forecast information to plan for the coming season

On the left are time series of forecast and observed crop yields at the time of harvest for the years indicated. Next to the time series are probabilistic forecasts over the same 9-years for below- (low yields), near- (about average) and above-normal (high yields). For example, in 2008 the forecast and observed index values are high and positive (figure on the left), and the highest predicted probability is for above-normal yield (figure in the middle).

Share your data and become part of this initiative

Haelskade 75% 1994/95 Was goeie mielies!
1995/96 te veel reën

Plaasdata vir simposium

Oom Gawie 1992/93 – 2006/07 (15) daagliks reënval oesdata

Bapsfontein: gebruik SAVAW resultate

Smithfield 1997 (Jan) – 2019 (Nov) reënval

Ermelo: 1983 – 2010 oes

Lichtenburg: 1983 – 2011 oes

Witfontein: 2001 – 2016 reën

Burgersfort: 1986 – 2015 daaglikse reën

Bitterfontein Kamiesberg (winter): 1966 – 2017

Wonderboom-Suid 1985 – 2019

Namibië Rus-en-Vrede 2001 – 2019

Bushbrunnen 1955 – 2019

Dabis (Gobabis) 1956 – 2018

Ossa 1929 – 2014 Windhoek

Aranos 1973 – 2004

Poolmanskloof 1966 – 2015

Frauenstein 1980 – 2020

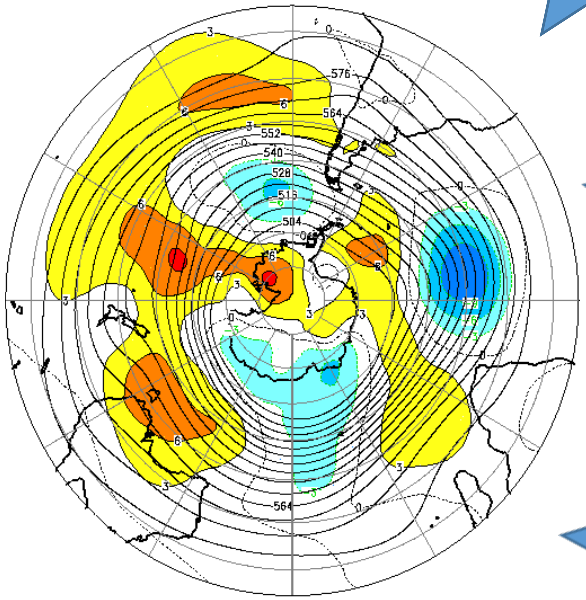
Alfredshöhe 1988 – 2014 + oesdata

Einbaum 1991 – 2014 + oesdata

The prediction scheme

1. Phenomena to be predicted should contain a climate signal (e.g. ENSO) in the data; 2. Observed and model time series must be over sufficiently long enough periods so that robust statistical relationship can be developed; 3. and some form of quality control of the observed data had taken place.

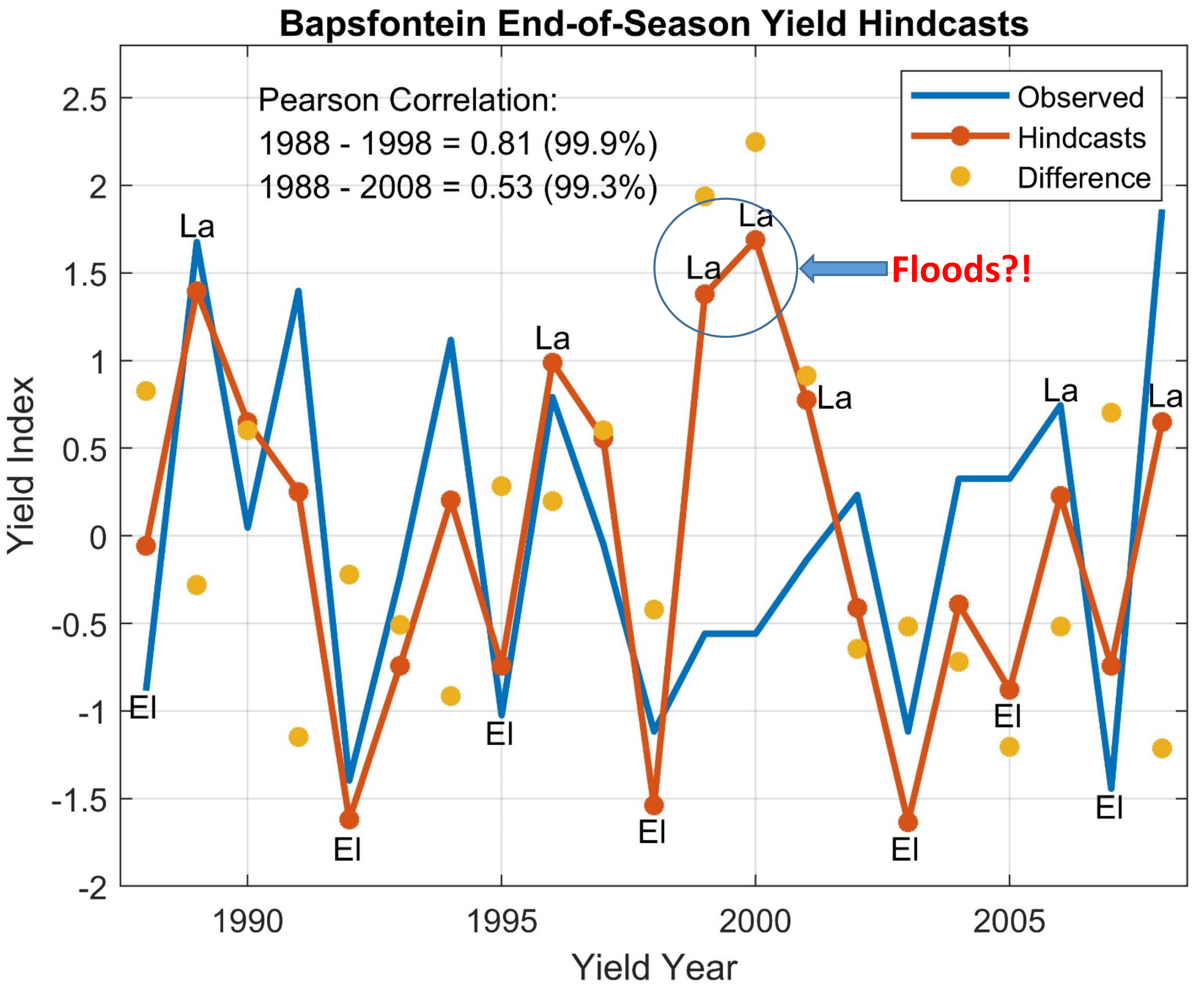
Climate model(s)



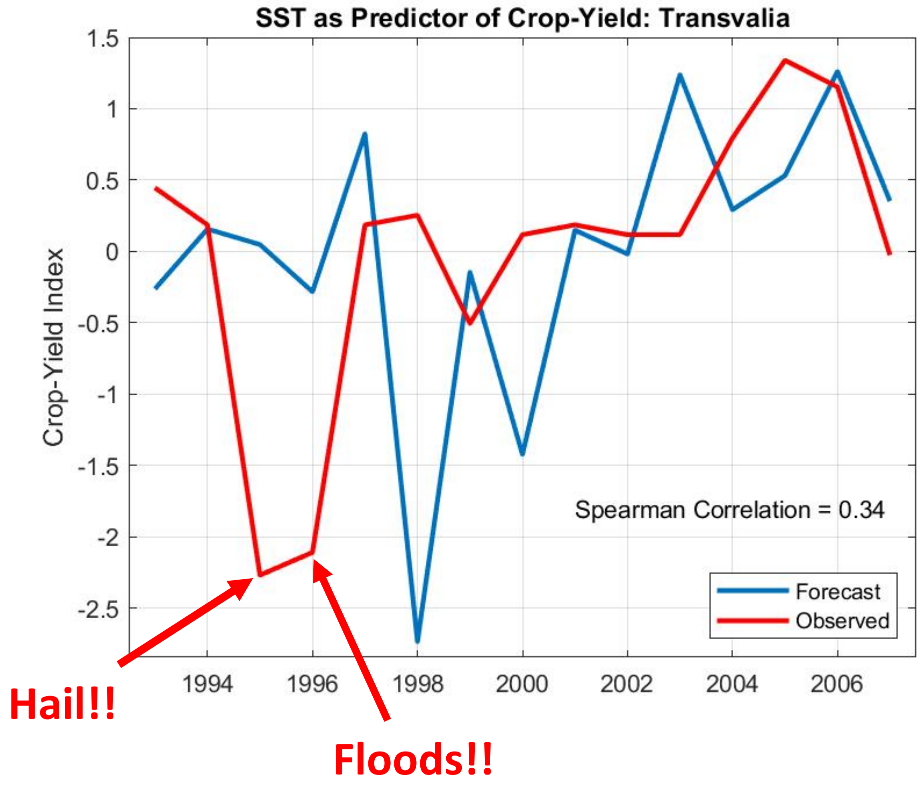
Geopotential heights / Model rainfall

Rainfall

Dry-land crop yield

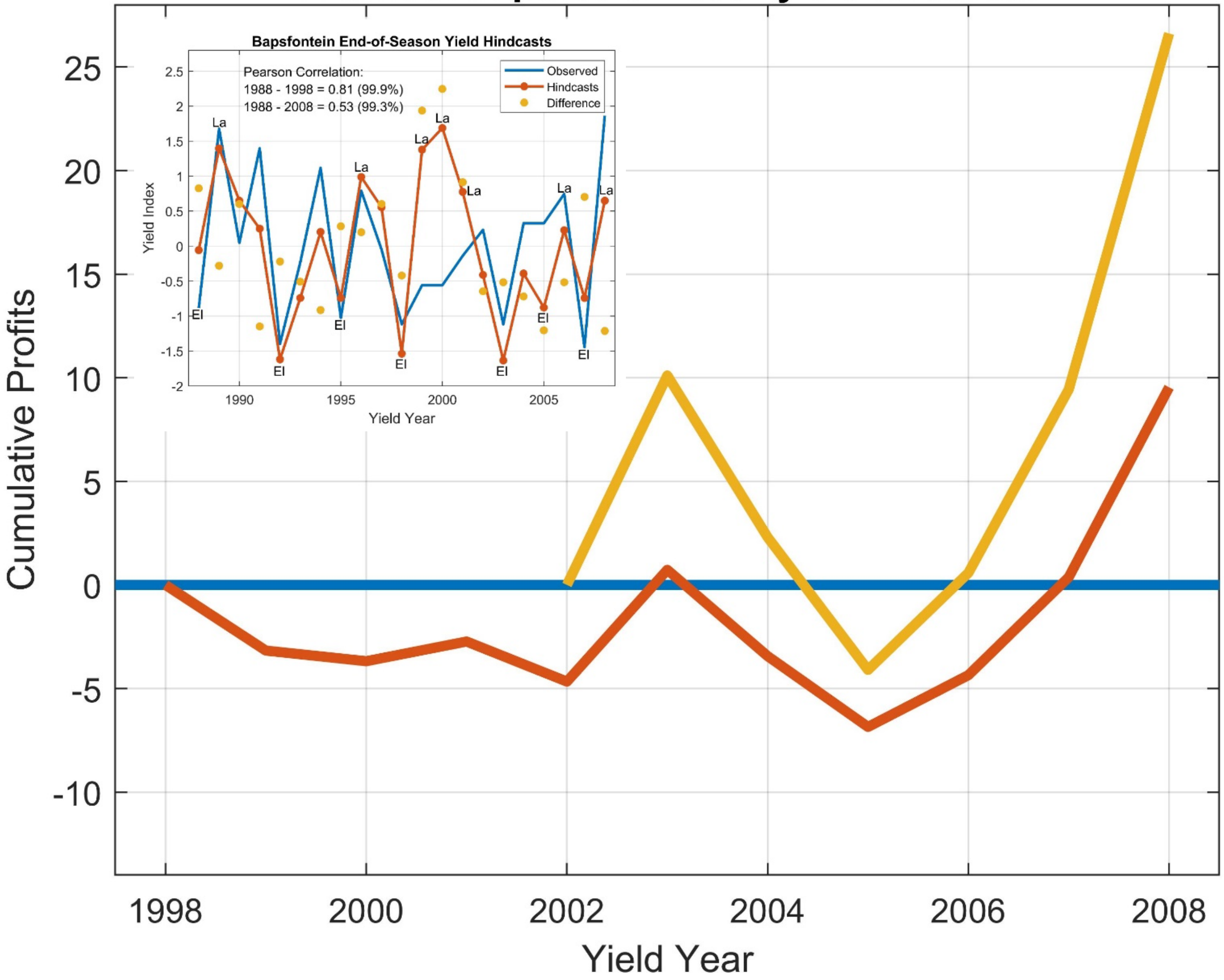


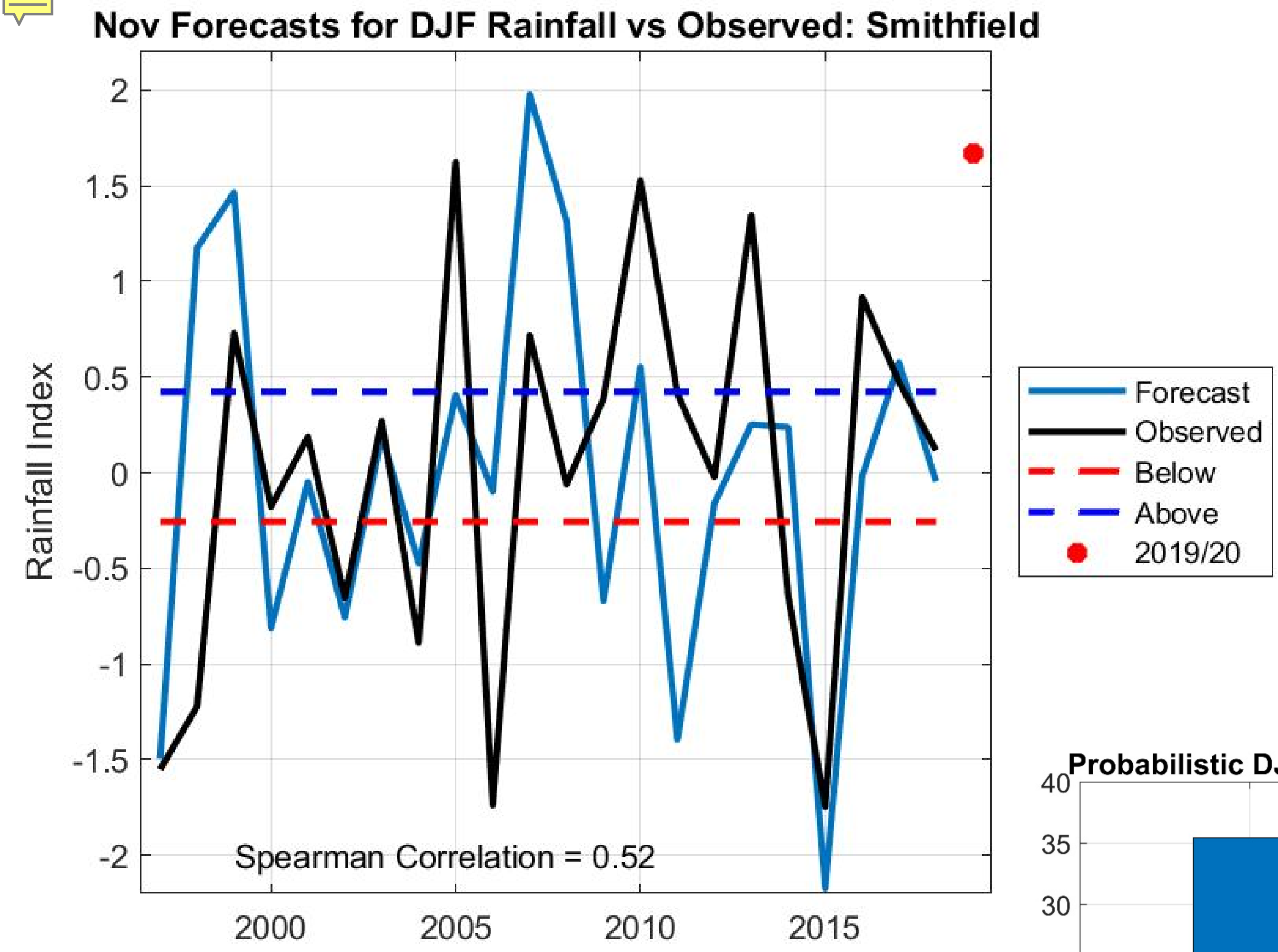
Bapsfontein End-of-Season Yield Hindcasts
Pearson Correlation:
1988 - 1998 = 0.81 (99.9%)
1988 - 2008 = 0.53 (99.3%)
Observed
Hindcasts
Difference
Floods?!
La
El
Yield Index
Yield Year

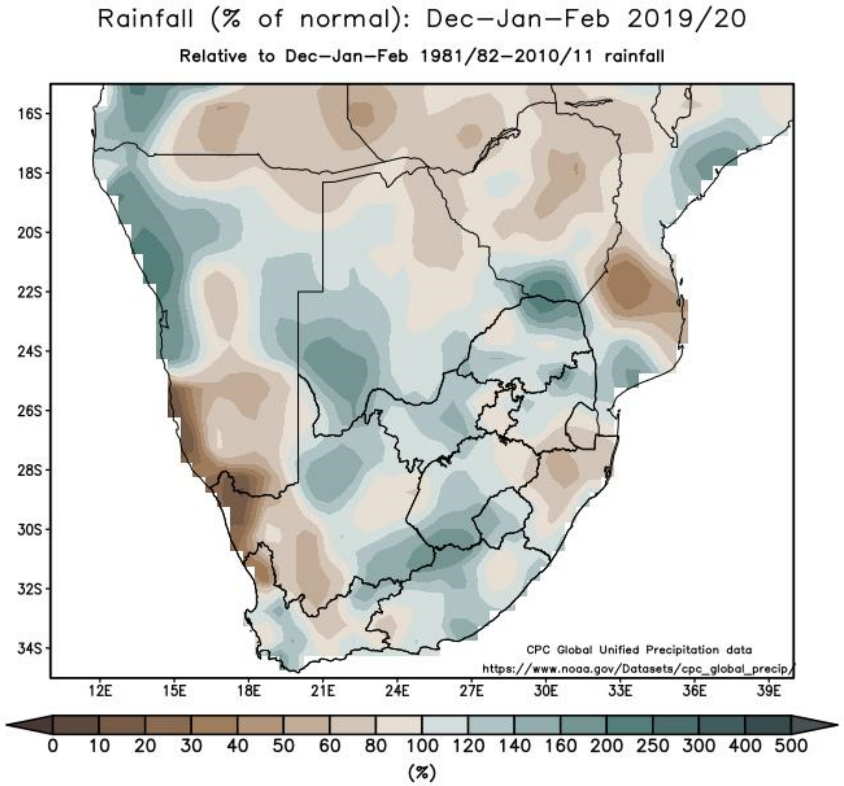


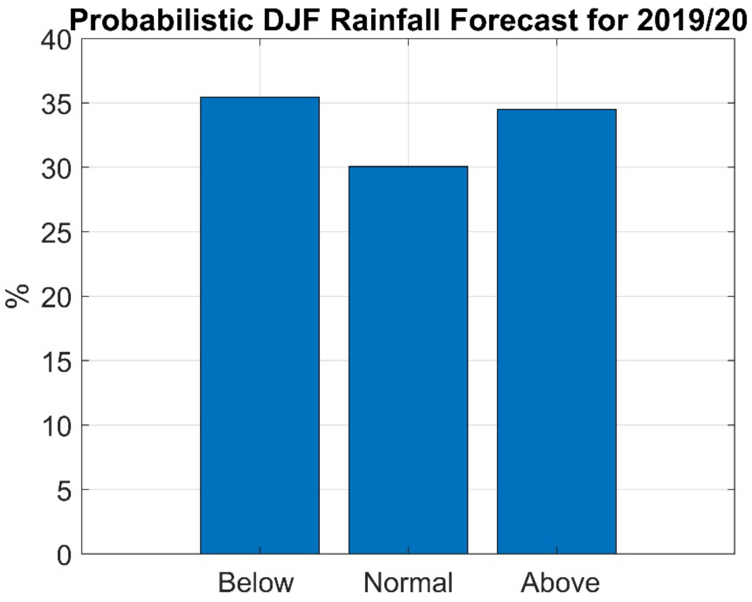
SST as Predictor of Crop-Yield: Transvalia
Crop-Yield Index
Spearman Correlation = 0.34
Forecast
Observed
Hail!!
Floods!!

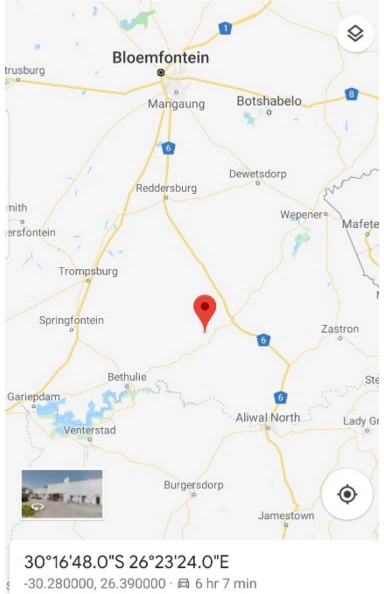
Financial impacts of "bad" yield forecasts



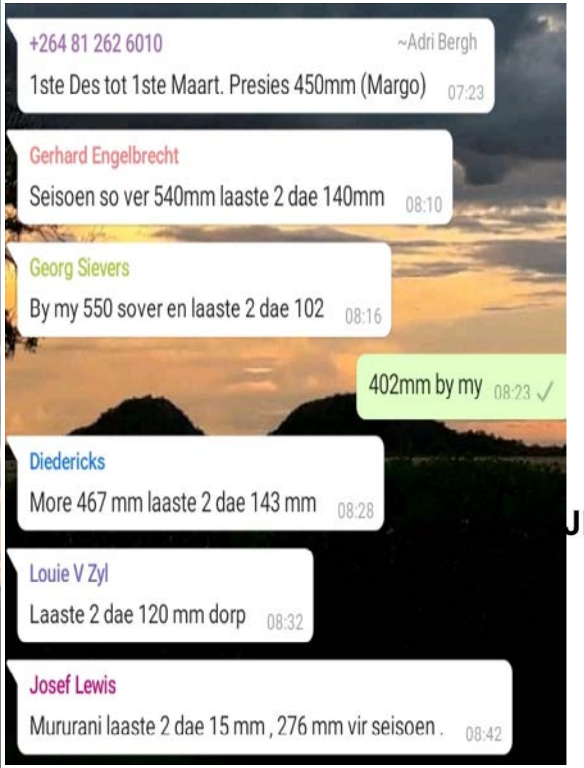

Nov Forecasts for DJF Rainfall vs Observed: Smithfield
Rainfall Index
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
2000
2005
2010
2015
Spearman Correlation = 0.52
Forecast
Observed
Below
Above
2019/20

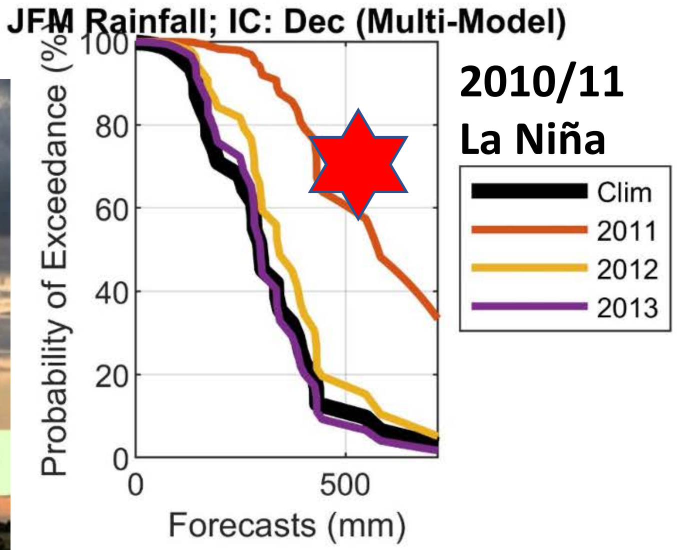

Rainfall (% of normal): Dec–Jan–Feb 2019/20
Relative to Dec–Jan–Feb 1981/82–2010/11 rainfall
16S
18S
20S
22S
24S
26S
28S
30S
32S
34S
12E
15E
18E
21E
24E
27E
30E
33E
36E
39E
CPC Global Unified Precipitation data
https://www.noaa.gov/Datasets/cpc_global_precip/
0 10 20 30 40 50 60 80 100 120 140 160 200 250 300 400 500
(%)

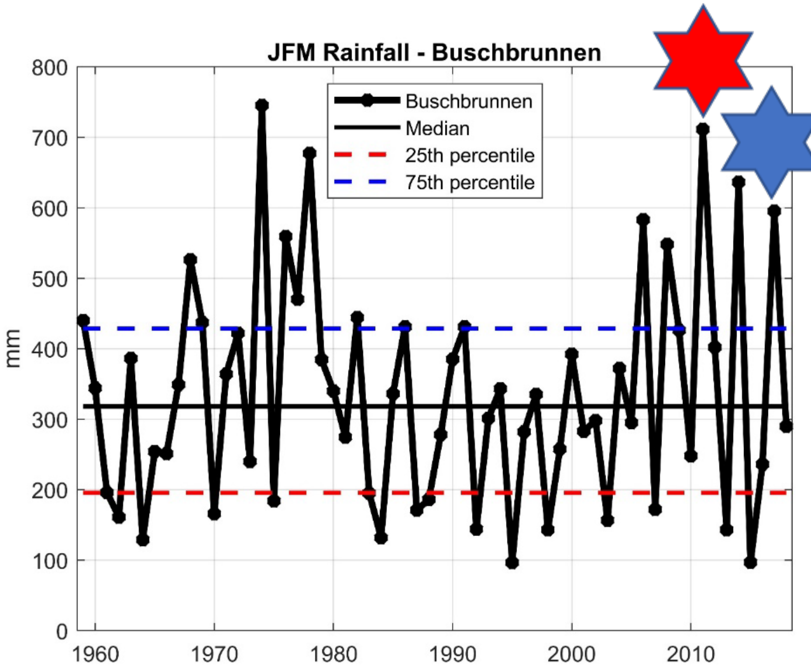

Probabilistic DJF Rainfall Forecast for 2019/20
%
40
35
30
25
20
15
10
5
0
Below
Normal
Above

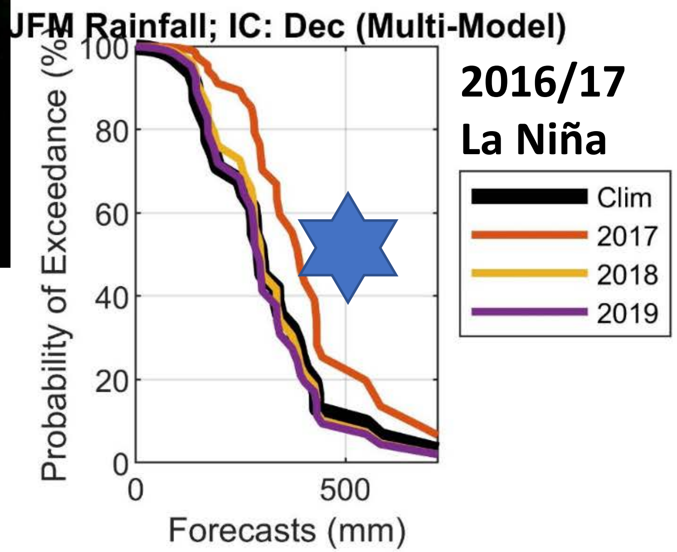

Bloemfontein
Mangaung
Botshabelo
Dewetsdorp
Reddersburg
Wepener
Trompsburg
Springfontein
Zastron
Bethulie
Gariepdam
Venterstad
Aliwal North
Burgersdorp
Jamestown
30°16'48.0"S 26°23'24.0"E
-30.280000, 26.390000 · 6 hr 7 min

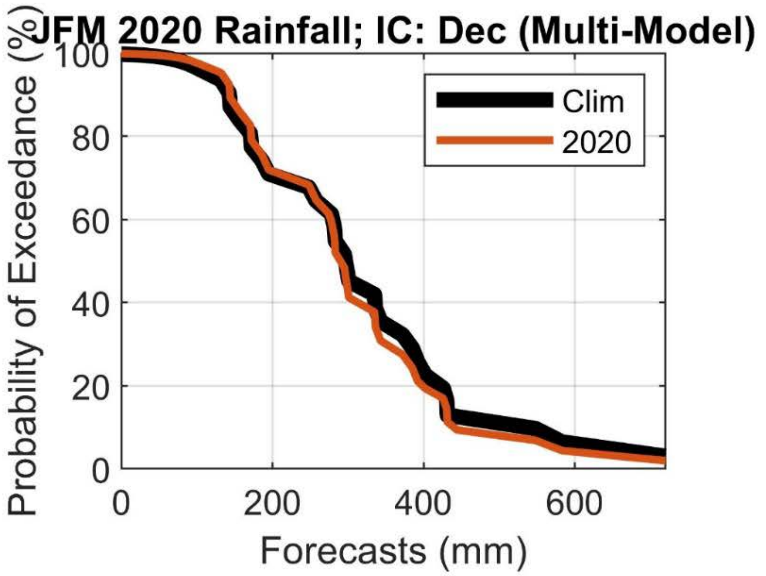
Data and forecasts for the farm Buschbrunnen near Grootfontein, Namibia

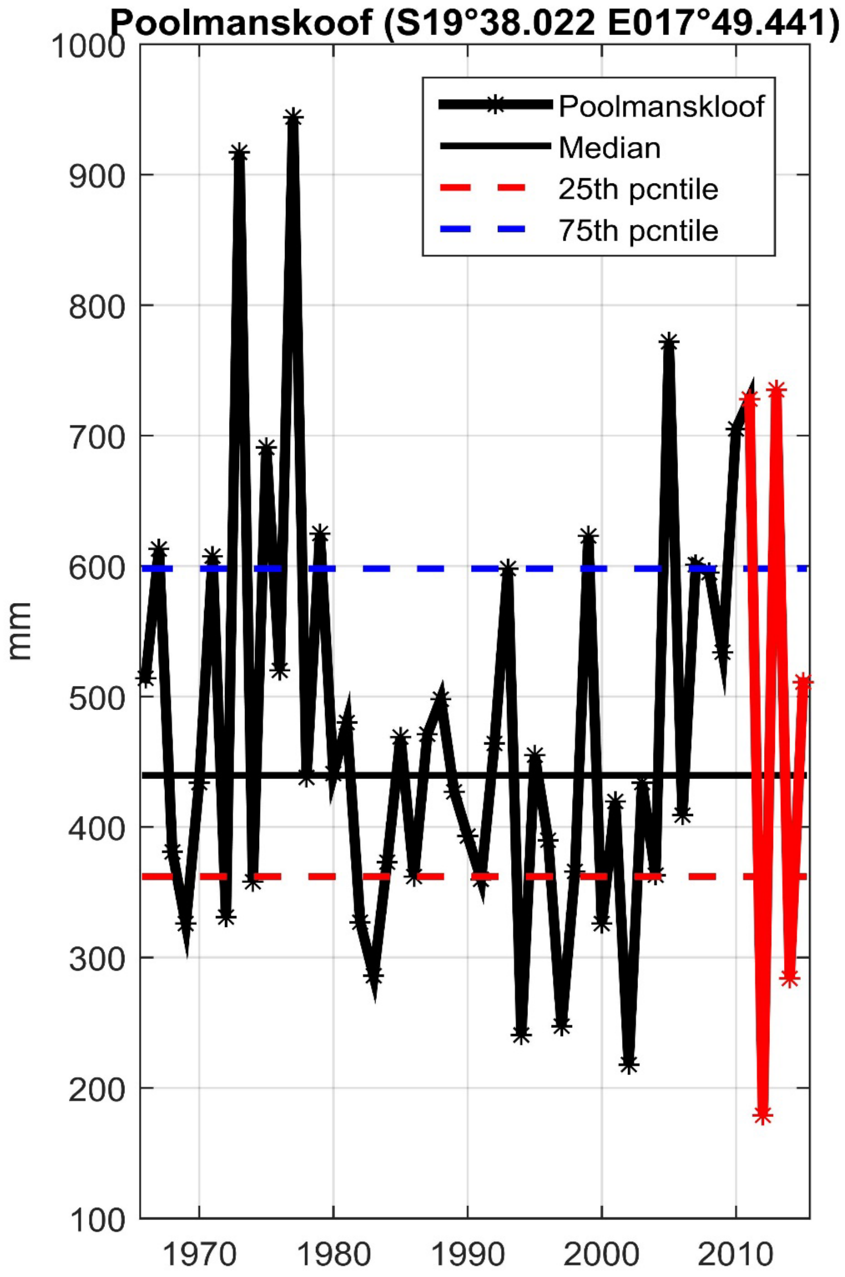








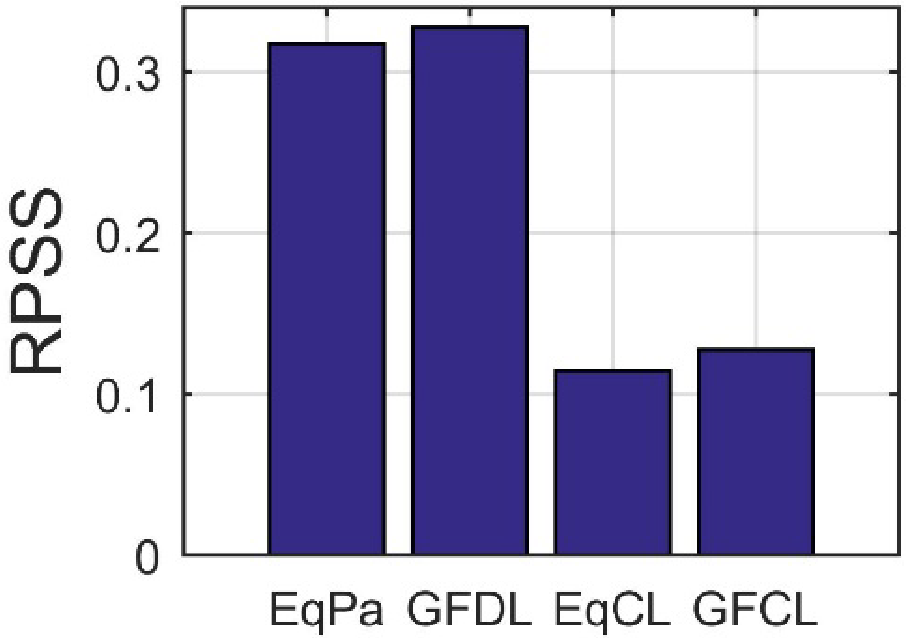




$$RPS = \sum_{m=1}^{J}\left[\left(\sum_{j=1}^{m} y_j\right) - \left(\sum_{j=1}^{m} o_j\right)\right]^2$$

$$SS_{RPS} = \frac{\overline{RPS} - \overline{RPS}_{\text{clim}}}{0 - \overline{RPS}_{\text{clim}}} = 1 - \frac{\overline{RPS}}{\overline{RPS}_{\text{clim}}}$$

…**and** against a "Home made model"



Concluding remarks

- In order to address the notion of low seasonal forecast uptake, we here propose that getting farmer's involved through the notion of "citizen science" can help alleviate the uptake problem
- There has been a positive response thus far from nearly 20 farmers
- Predictability of the farmers' data is demonstrated here, but there are caveats to consider:
  - Poor forecasts, especially poor ones in succession, may lead to serious financial implications for the farmer
  - Forecasts will have to be accompanied by an extensive discussion on forecast quality
  - No ENSO, no forecast
- But using physically-based forecast systems have the potential to be the best tools for tailoring forecasts in agriculture
- From the responses in terms of providing data and exchanges in social media (WhatsApp groups) it seems farmers are keen to engage in a process of co-production to create optimized tailored forecasts for their farms