Seasonal Hydrometeorological Ensemble Prediction System: Forecast of Irrigation Potentials in Denmark

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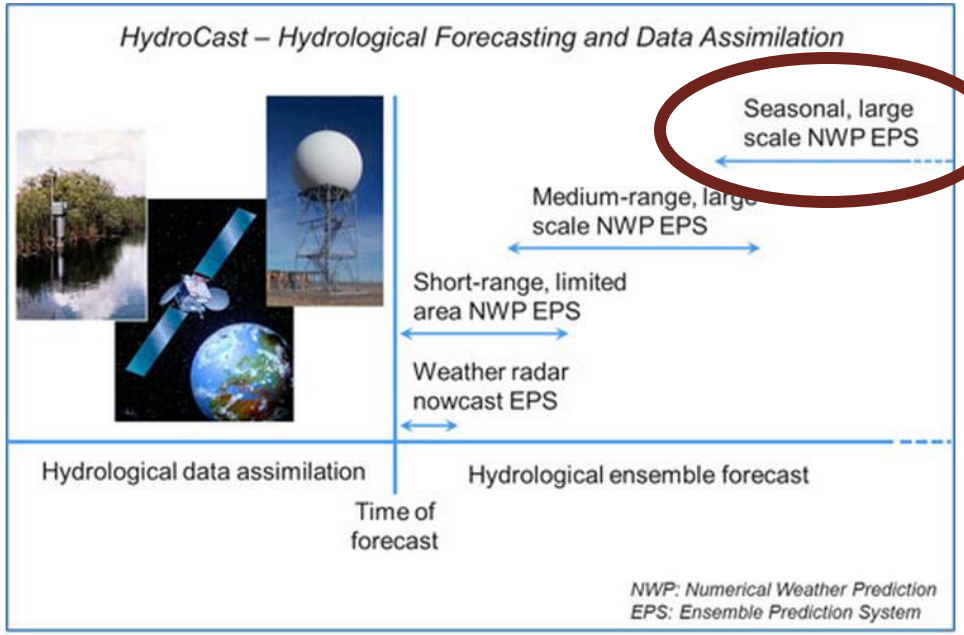
OUTLINE

- ❑ HydroCast Project and Seasonal Forecasting
- ❑ Irrigation permissions in Denmark
- ❑ ECMWF Seasonal meteorological EPS System 4
- ❑ For the near future
- ❑ Summary and Conclusions

❑ HydroCast Project and Seasonal Forecasting



❑ Objective: 'Develop and test new forecasting and DA tools that combine different data sources with **meteorological and hydrological modelling** to provide **probabilistic hydrological forecasts**'

Vejdirektoratet
Miljøministeriet Naturstyrelsen
KNOWLEDGE CENTRE FOR AGRICULTURE
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UNIVERSITY OF COPENHAGEN
AALBORG UNIVERSITY DENMARK
TU Delft
ECMWF

❑ Irrigation permissions in Denmark

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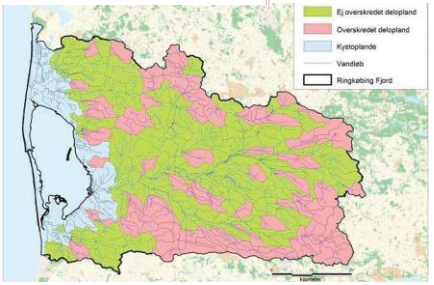
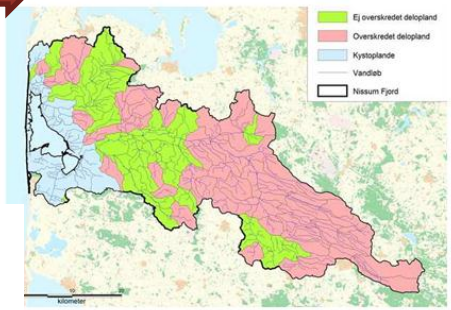
❖ How are the extraction for irrigations permits now defined?

Impact of -10% on median of yearly minimum streamflow

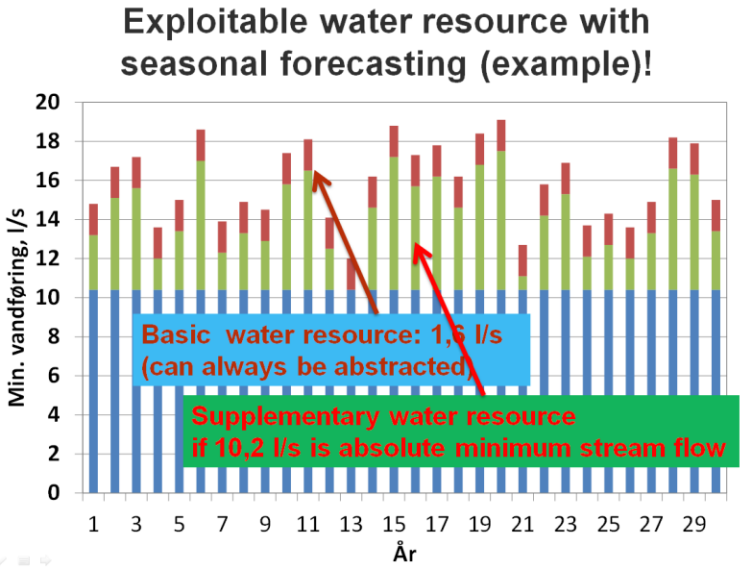
Issued for 15 years

Areas where extraction must be reduced due to exceeded impact on streamflow





❖ How are they expecting to define them?



Seasonal forecasting of irrigation potentials

- March: Preliminary forecast for planning of agricultural crops etc.
- Mid April: Final forecast for annual irrigation permissions
- During growing season: Possible adjustment of forecast according to weather conditions and pattern of ground water extraction

- ECMWF Seasonal meteorological EPS System 4

TIME AVAILABILITY

- 20 years reforecast data, 1990-2013
- Forecast every month (01/MM/YYYY)
- 7 month forecast

FIELDS AVAILABLE

167 – 2 meter temperature, 6h, (deg K).

Solar Radiation

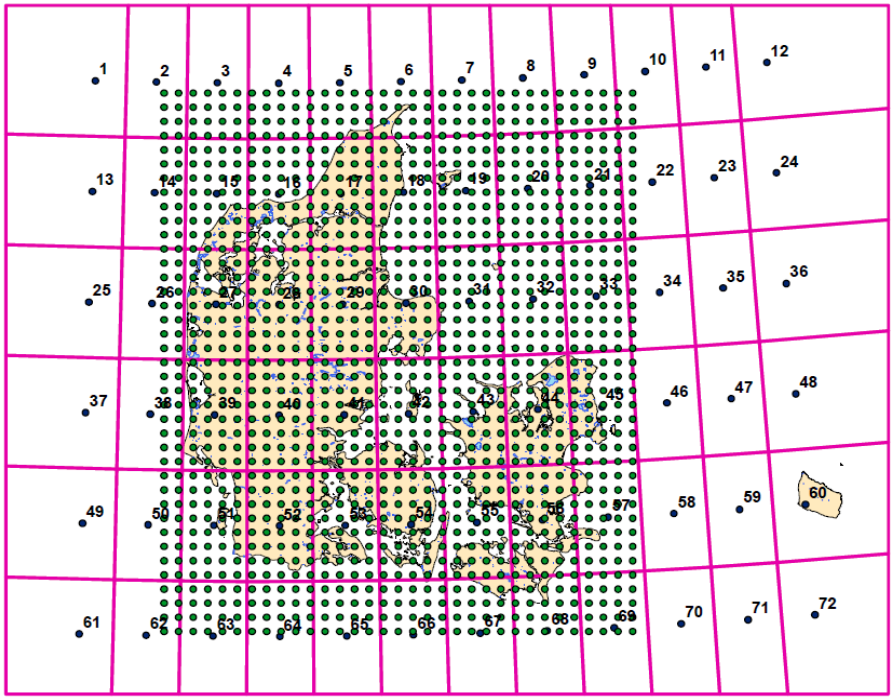
228 – Precipitation, 24 h, accumulated (mm).

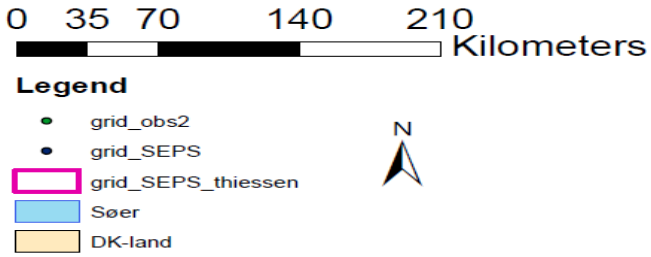
ENSEMBLES AVAILABLE

51 members (02,05,08,11)

15 members (rest)

❑ ECMWF Seasonal meteorological EPS System 4





❖ **EPS**
-0.75 deg,
-80 km northing
(approx)

❖ **Observations 10 km**
- Precipitation rate
(mm/day)
-Temperature
(deg C)
-Reference Evapotranspiration
(mm/day)

❑ ECMWF Seasonal meteorological EPS System 4: Downscaling, bias correction

Linear Scaling of precipitation and temperature (Teutschbein and Seibert, 2012)

-> Corrects biases on the mean
-> Simplest approach, straightforward to implement

$$P^*_{contr}(d) = P_{contr}(d) \cdot \left[\frac{\mu_m(P_{obs}(d))}{\mu_m(P_{contr}(d))}\right] \qquad T^*_{contr}(d) = T_{contr}(d) + \mu_m(T_{obs}(d)) - \mu_m(T_{contr}(d))$$

$\mu_m(P_{obs}(d))$ -> Monthly mean of daily precipitation, observed values
m = 1, 2, ... , 12

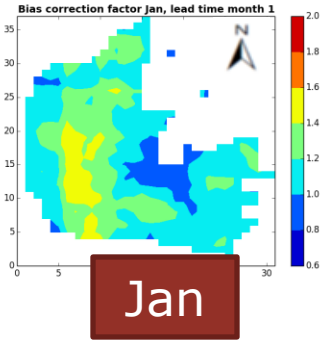
$\mu_m(P_{contr}(d))$ -> Monthly mean of daily precipitation, forecast values

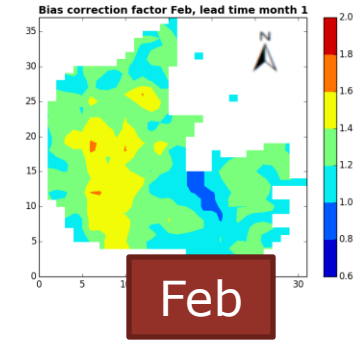
$P_{contr}(d)$ -> Raw forecast of daily precipitation

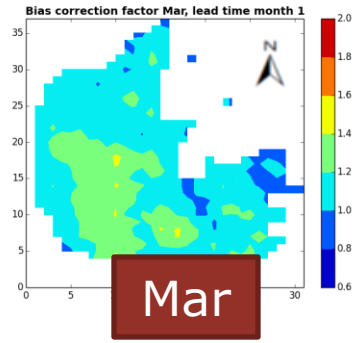
$P^*_{contr}(d)$ -> Corrected forecast of daily precipitation

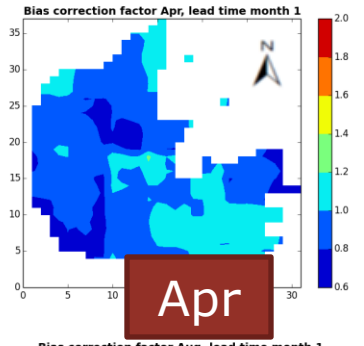
❑ ECMWF Seasonal meteorological EPS System 4: PRECIPITATION

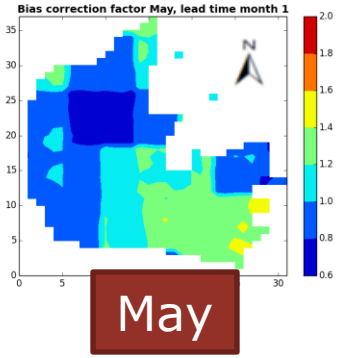
$$\left[\frac{\mu_m(P_{obs}(d))}{\mu_m(P_{contr}(d))}\right]$$

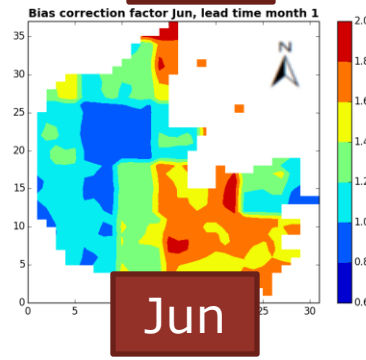


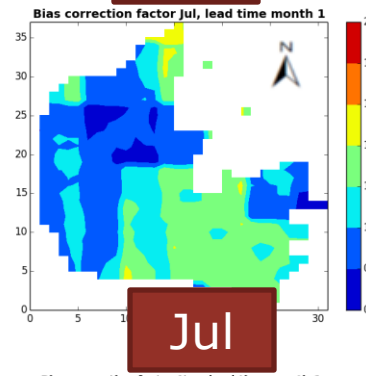


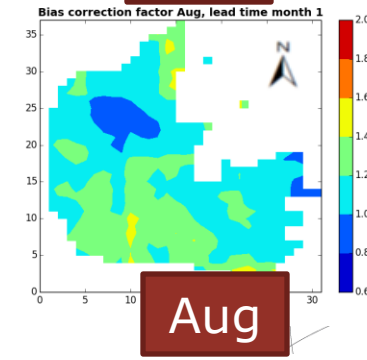


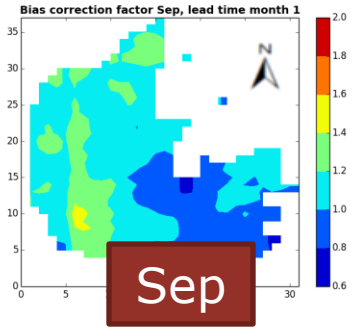


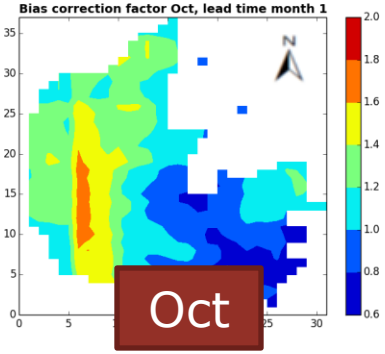


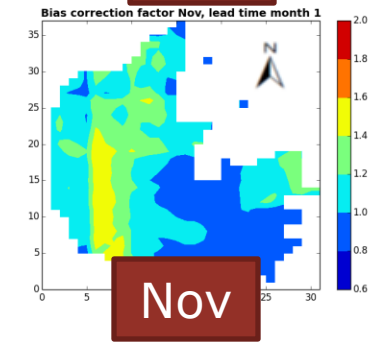


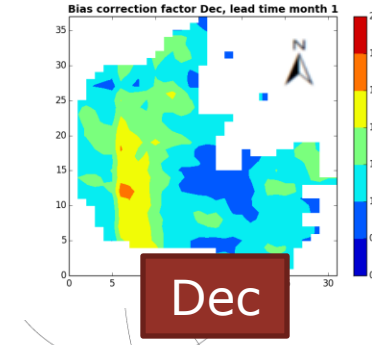






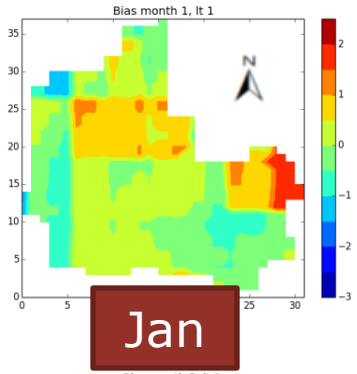


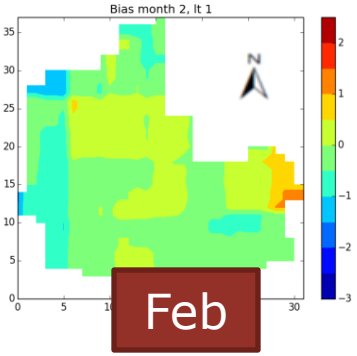


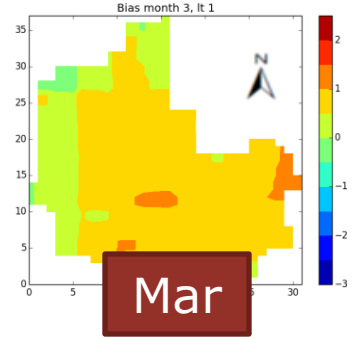


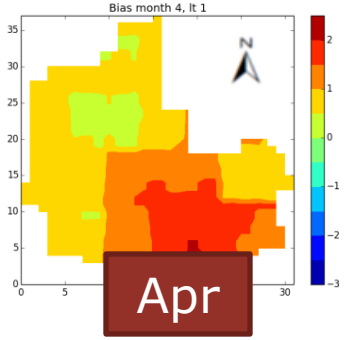
$$T^{*}_{contr}(d) = T_{contr}(d) + \mu_m(T_{obs}(d)) - \mu_m(T_{contr}(d))$$

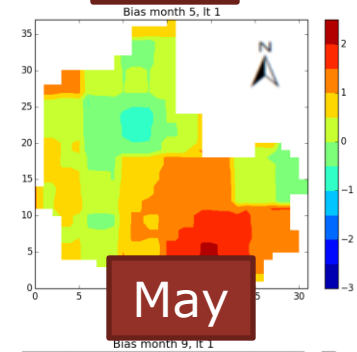
❑ ECMWF Seasonal meteorological EPS System 4: TEMPERATURE

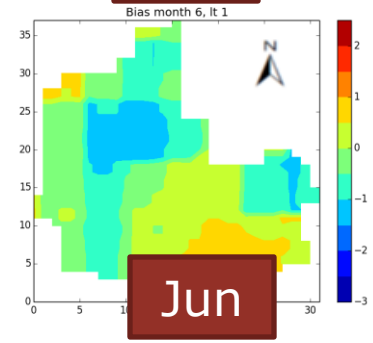


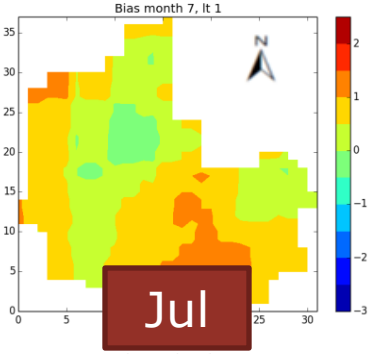


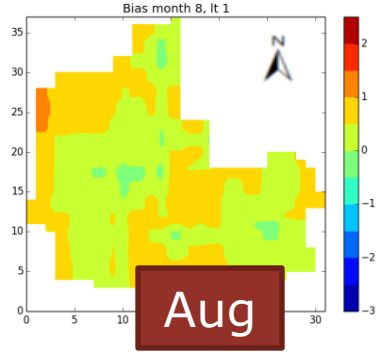


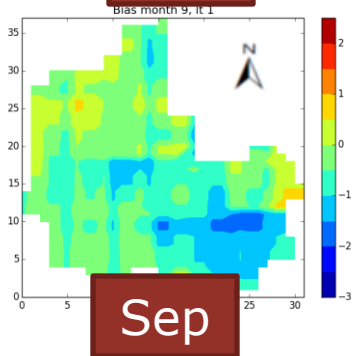


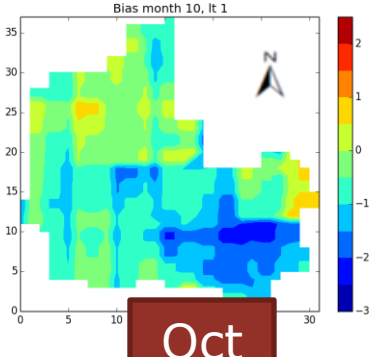


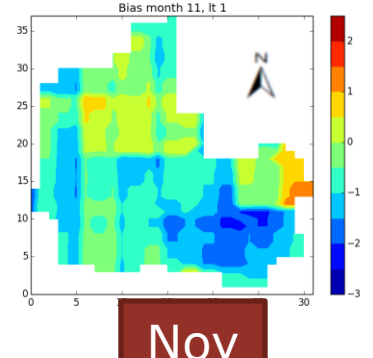


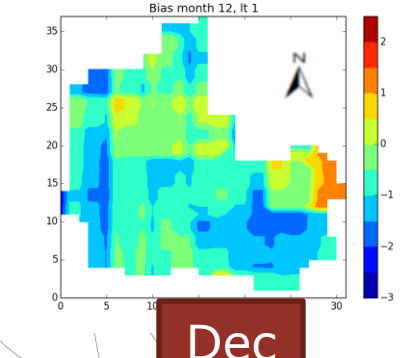






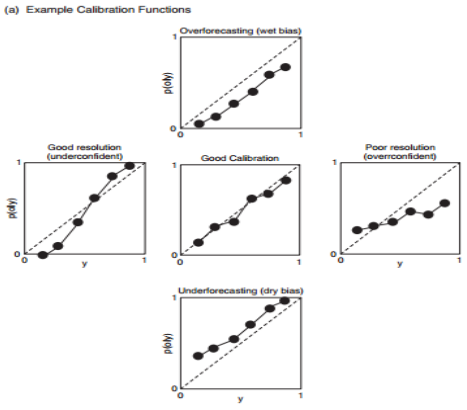






❑ ECMWF Seasonal meteorological EPS System 4: Skill assessment

- ❖ Reliability Diagrams
- ❖ Brier Skill Score -> BSsys4 vs Bsclim
- ❖ Climatology -> 20 year observed data
- ❖ Verification experiments



-Verification A: Raw vs corrected ensembles, different lead times

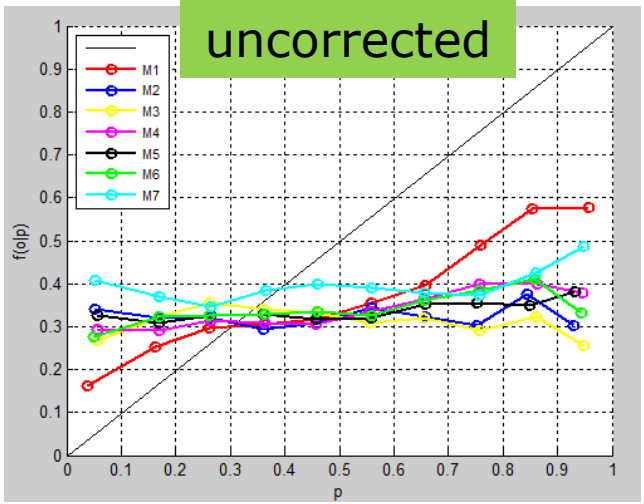
- Verification B: Corrected ensembles, different seasons

Probability thresholds -> a) <= below T (dry, cold) b) >= above T (wet, warm)

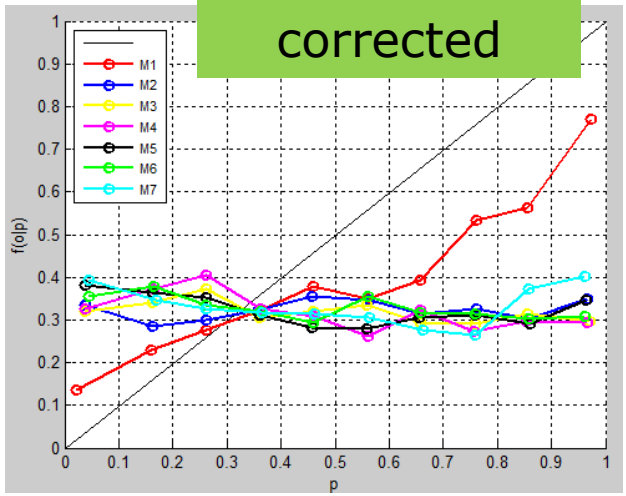
- Verification C: Corrected ensembles, different regions in Denmark (west, east)

❑ ECMWF Seasonal meteorological EPS System 4: Skill assessment

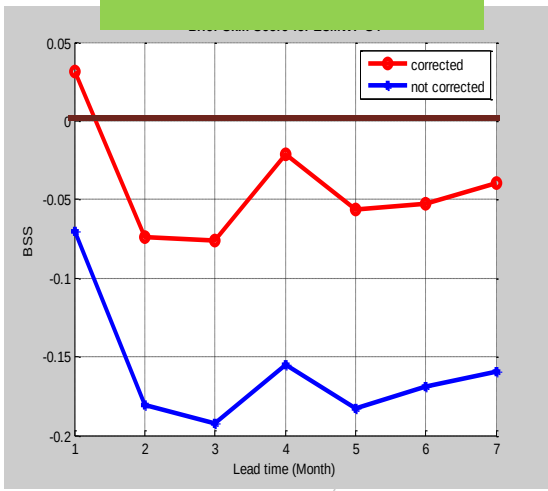
PCP uncorrected



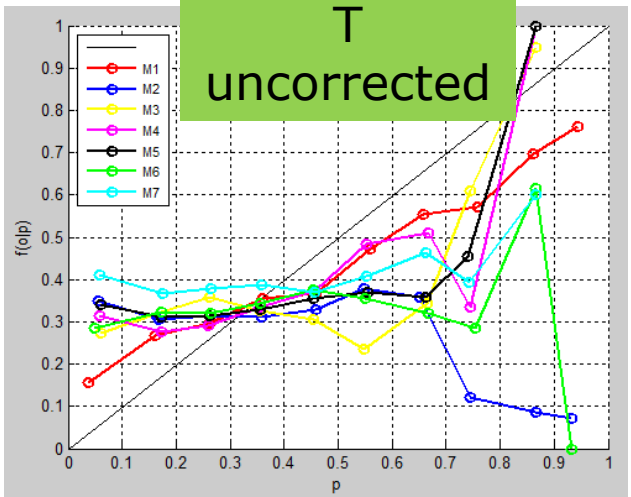
PCP corrected



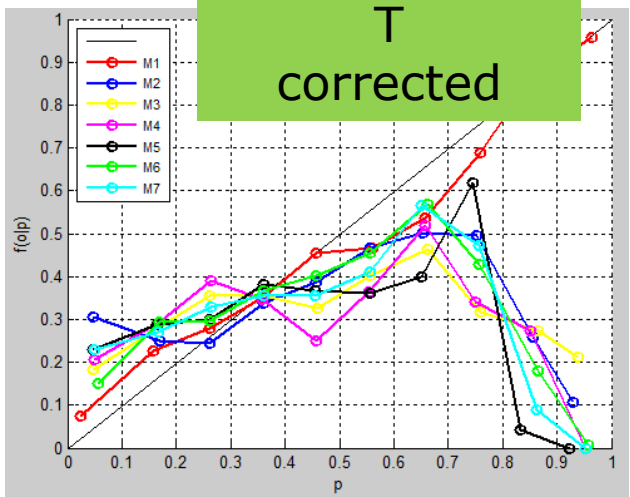
BSS



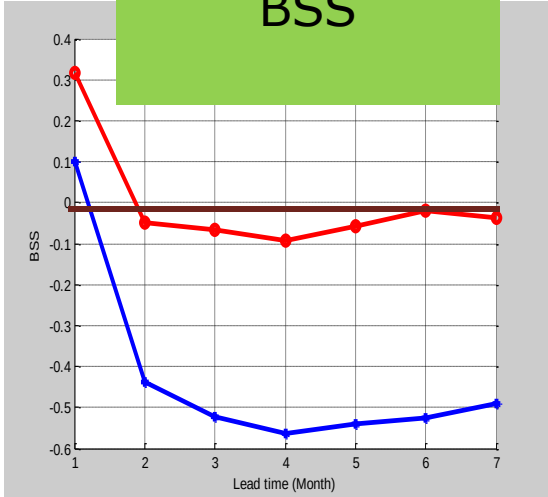
T uncorrected



T corrected

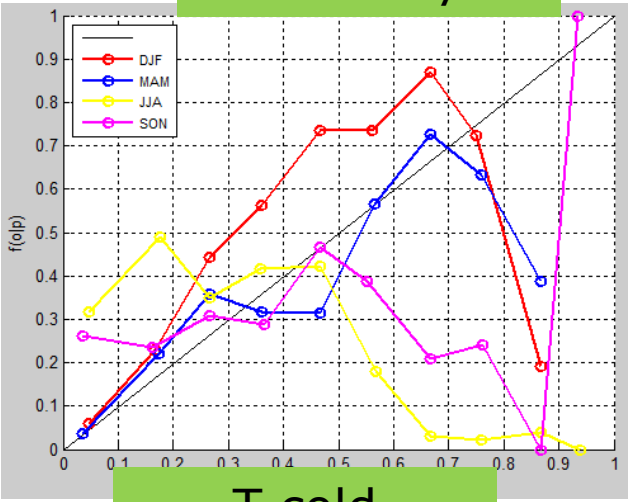


BSS

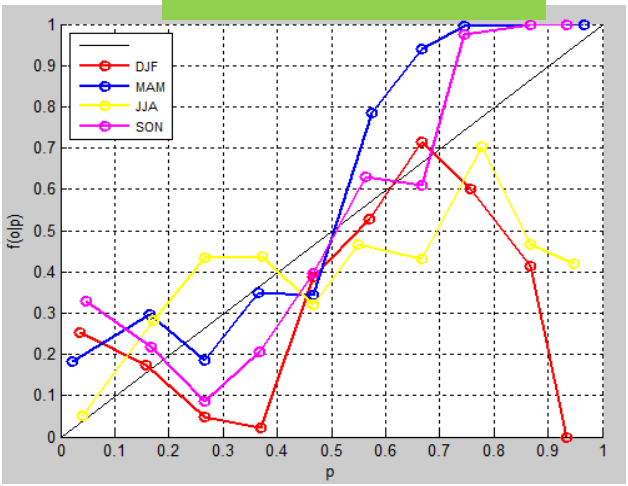


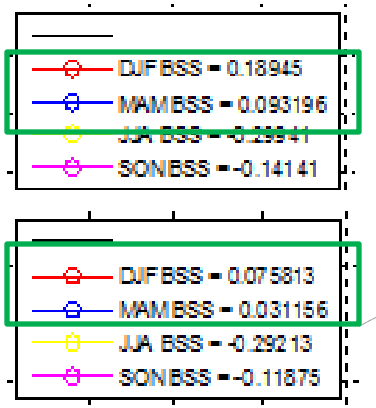
❑ ECMWF Seasonal meteorological EPS System 4: Skill assessment, corrected

PCP dry

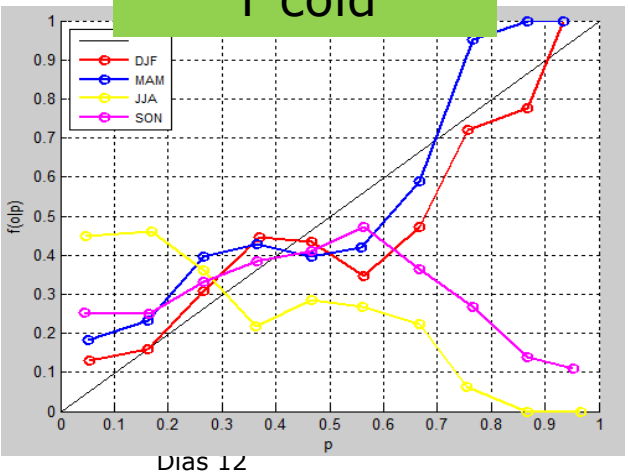


PCP wet

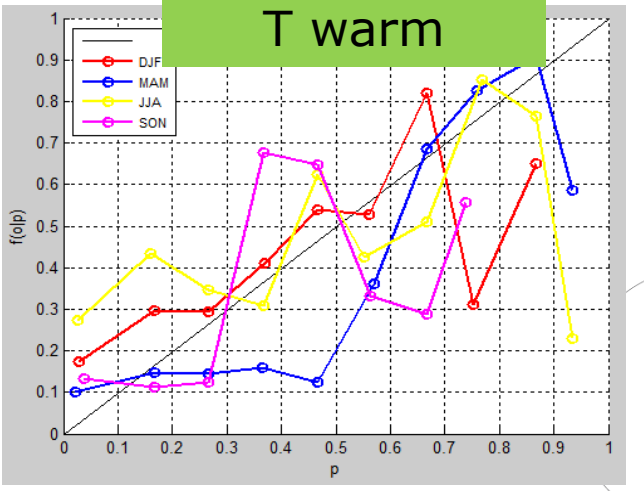


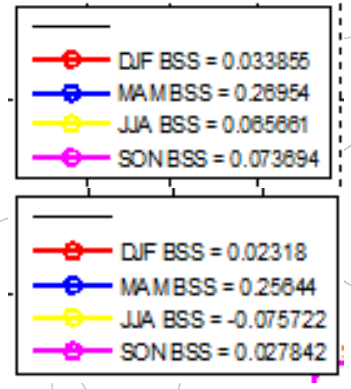


T cold



T warm

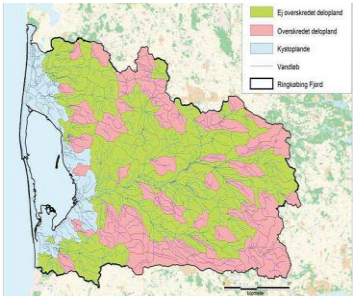




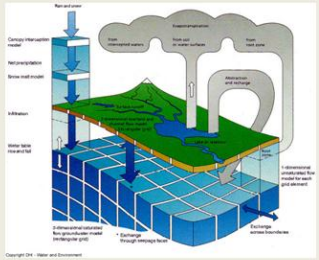
❑ For the near future

Meteo Bias + Skill assessment → Hydro modelling → Risk Analysis → Decision making for irrigation permissions

-Other sophisticated bias correction methods?



MIKE SHE/MIKE 11



❑ Conclusions and Summary

❖ Assessment of meteorological inputs:
- Improvement of bias corrected ensembles
- Good skill for the first month lead time, decreases as time evolves
- Good skill for winter and spring precipitation, not so much for summer and autumn
- Good skill for temperature, except warm temperatures during summer (further investigation)

❖ Combination of skillful meteo inputs + better initial conditions for better forecasting
- Analysis of the influence of both

❖ How do we translate probabilistic information about discharge and groundwater levels into efficient irrigation permit amounts?
- Decision making process
- Meeting and continuous feedback between the researh team and with potential users

Thank you!
QUESTIONS?