



PRECIOUS

Impact of alternative bias correction methods on
climate projections and pesticide leaching

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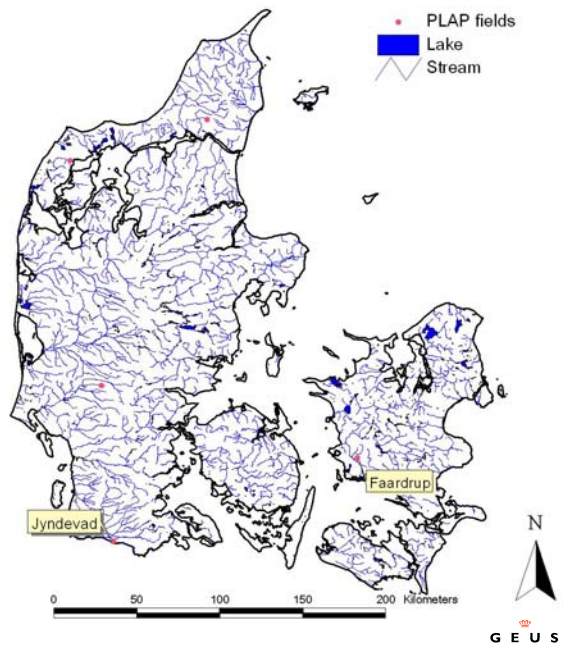
Objectives

- To predict the impact of climate change on leaching of pesticides from the root zone
- Correct climate model results for use in pesticide transport modeling
- To compare different approaches for bias correction



Field sites

- PLAP (Pesticide Leaching Assessment Programme)



Field sites - data

- Observations from the period 1961-2006 on
 - Precipitation
 - Temperature
 - Reference evapotranspiration (Makkink)

Climate model results

- Results from the EU project ENSEMBLE
- Climate model results from multiple climate models (GCM-RCM combinations) using the A1B emission scenario
- The Dutch regional climate model, RACMO, was chosen (forced by ECHAM5)
- Run for the period 1951-2100
- Resolution of 25 km

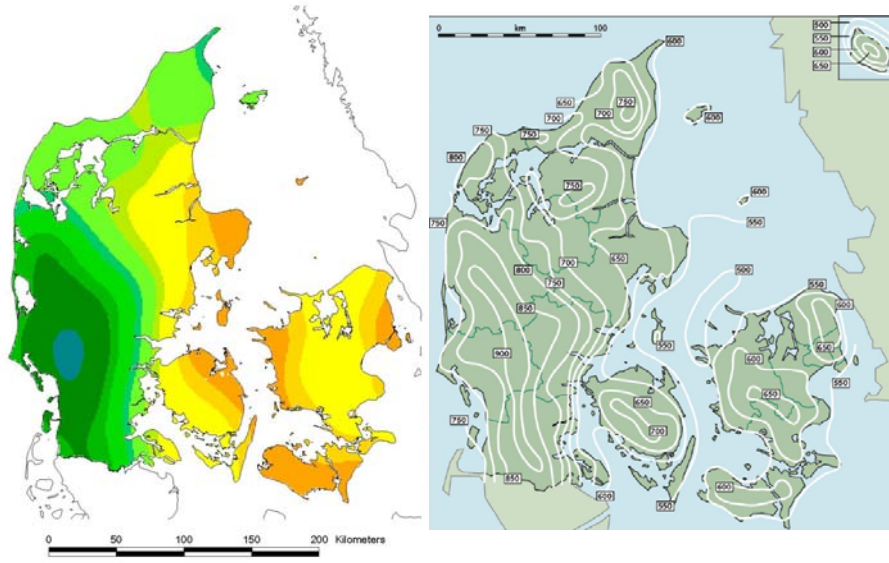


Grid points



Precipitation (1961-1990)

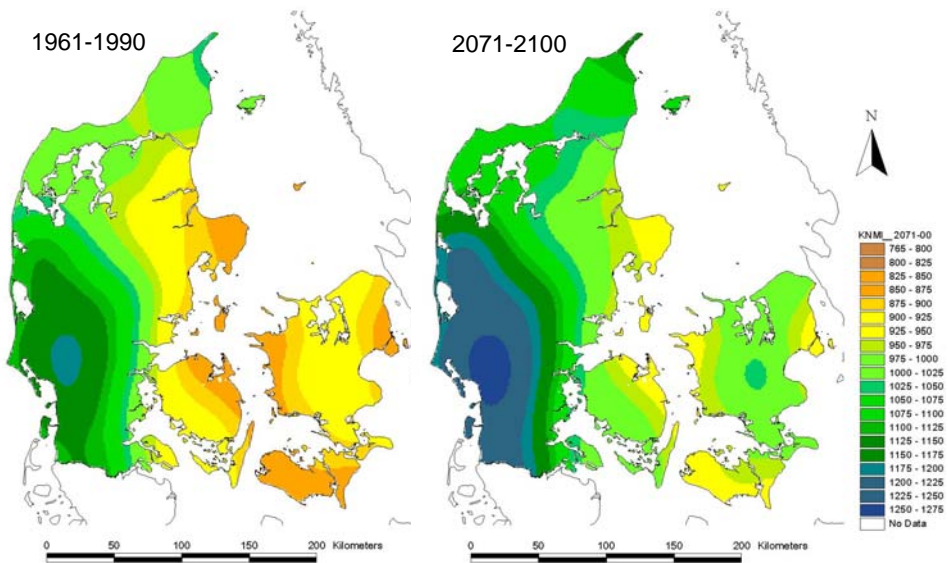
Observed



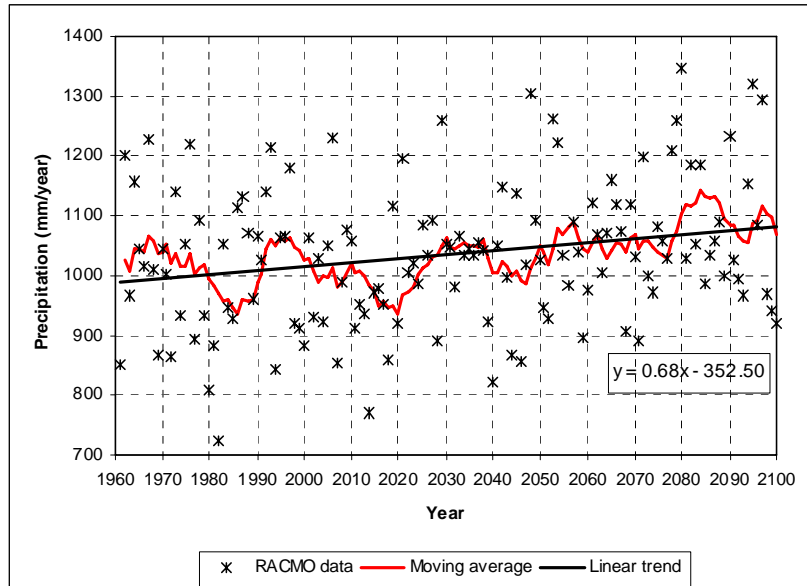
Development in precipitation

1961-1990

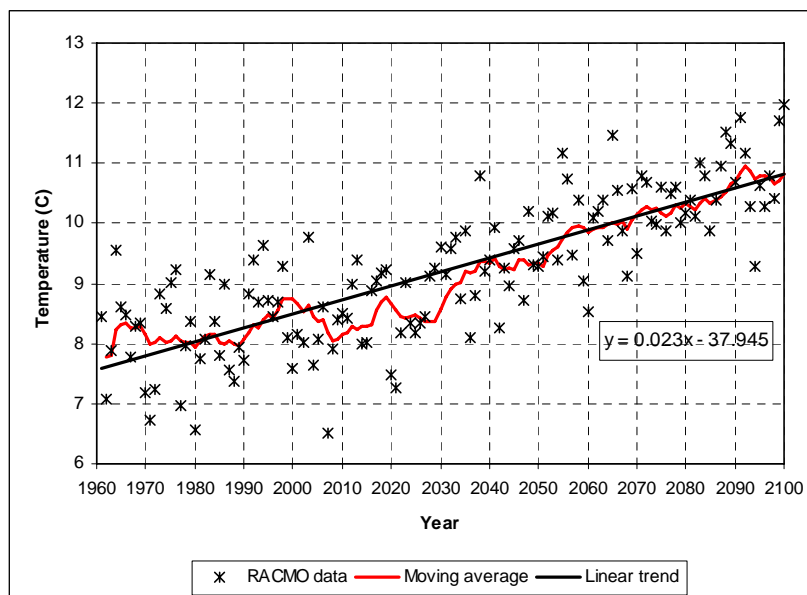
2071-2100



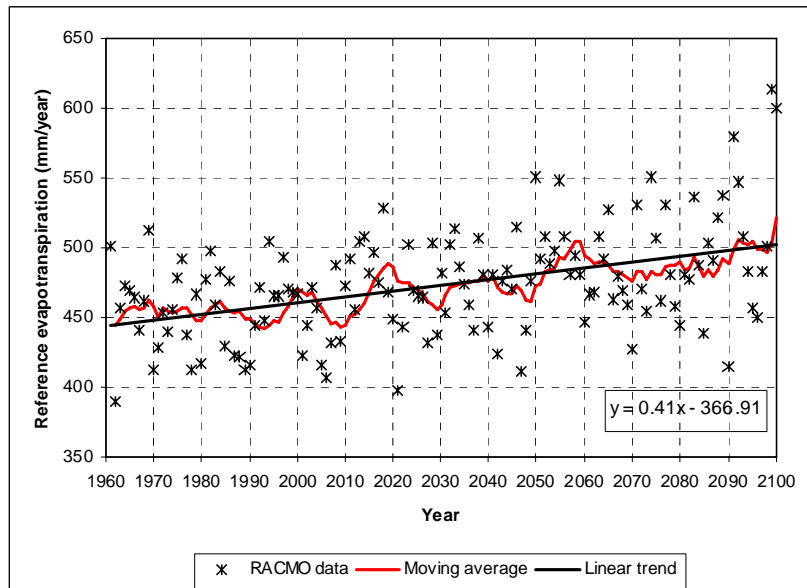
Precipitation (not significant)



Temperature (significant)



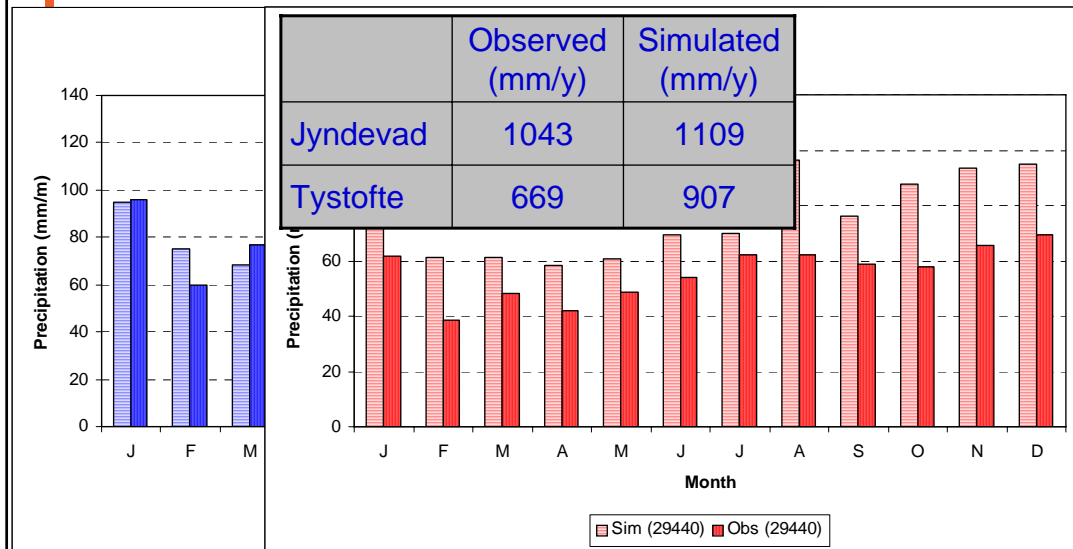
Reference evapotranspiration (significant)



PLAP locations

- A. Compare uncorrected climate model data to observed data – 1961-1990
- B. Compare bias-corrected climate model data to statistics of observed data from 1991-2006
- C. Compare trends of bias-corrected climate model data to trends in uncorrected data

A. Comparison with observations: Precipitation 1961-90



Bias correction

Four different methods; Two types of correction:

1. Based on daily observations (1961-1990)

- Factor is multiplied with observed value
- Historical dynamic preserved
- Carried out for periods (e.g. 2031-2060), assuming stationarity in future climate

2. Based on daily model data (2071-2100)

- Factor is multiplied with model data
- Future dynamic is preserved
- Can be used continuously (e.g., 2010-2100)

Bias correction

1. Delta change
2. Statistical transformation
3. Delta RCM
4. Frequency function



1. Delta change

$$P_{\Delta}(i, j) = \Delta_P(j)P_{obs}(i, j) \quad ; \quad i = 1, 2, \dots, 31; j = 1, 2, \dots, 12$$

$$\Delta_P(j) = \frac{\overline{P}_{fut}(j)}{\overline{P}_{cont}(j)} \quad ; \quad j = 1, 2, \dots, 12$$

Used in several studies, e.g. Roosmalen et al. (2007, 2009)



2. Statistical transformation

- Transformation of scenario distribution to observed data:

$$Y_t = \mu_{sce} + \left[\sigma_{sce} \frac{\log(P_{obs}) - \mu_{obs}}{\sigma_{obs}} \right]$$

- Correction for errors in RCM data:

$$\log(P_{cor}) = \mu_{obs} + \left[\sigma_{obs} \frac{Y_t - \mu_{cont}}{\sigma_{cont}} \right]$$

Based on Mileham et al. (2009)



3. Delta RCM

$$P_{cor}(i, j) = \Delta_{PS}(j) \times P_{sim}^{scen}(i, j) \quad ; \quad i = 1, 2, \dots, 31; j = 1, 2, \dots, 12$$

$$\Delta_{PS}(j) = \frac{\overline{P_{obs}^{cont}}(j)}{P_{sim}^{cont}(j)} \quad ; \quad j = 1, 2, \dots, 12$$



4. Frequency function

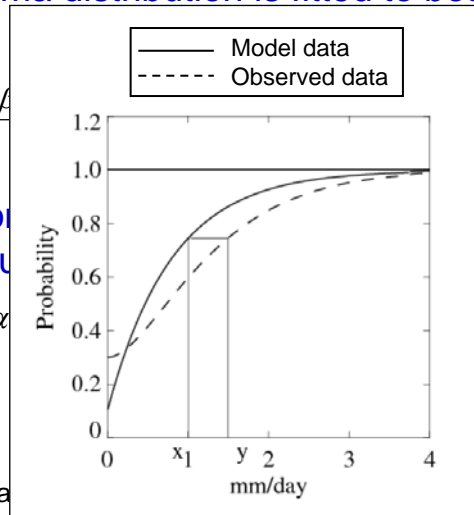
The gamma distribution is fitted to both observed data and

$$f(P) = \frac{(P/\lambda)^\alpha}{\Gamma(\alpha)} e^{-P/\lambda}$$

Correction
gamma fu

$$P_{cor} = f^{-1}(\alpha)$$

Based on Pia



B. Match to observations (1991-2006)

- Annual mean precipitation (mm/yr)

No	1991-2006	Error
Jyndevad		
Observeret	1060	-
Klimamodel	1133	77
1	1008	-52
2	1013	-47
3	1066	6
4	1085	25



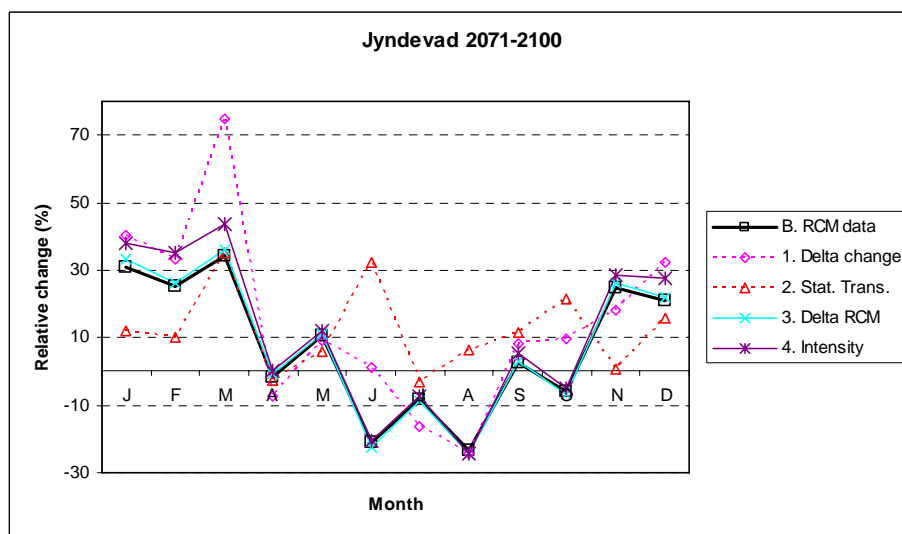
B. Match to observations (1991-2006)

- Annual maximum precipitation (mm/day)

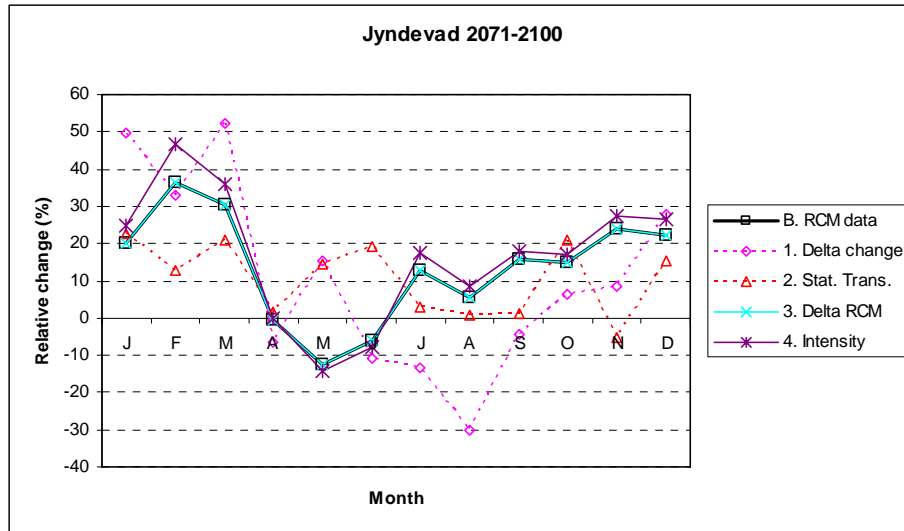
No	1991-2006	Error
Jynde vad		
Observeret	37.6	-
Klimamodel	29.2	-8.4
1	39.7	2.1
2	38.9	1.3
3	28.6	-9.0
4	38.9	1.3



C. Future precipitation: Monthly mean



C. Future precipitation: Monthly maksimum



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Leaching of pesticides

- Three different (model) pesticides

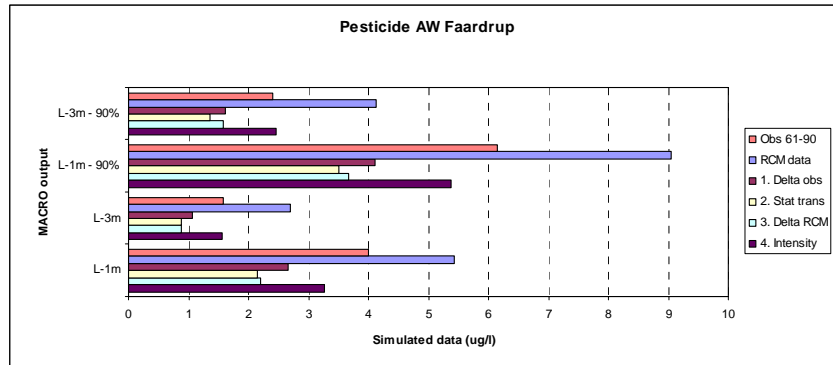
Pesticide	DT50 (d)	K_{oc} (ml/g)
A	49	99.5
B	6.1	30
C	80	400

- Dose of 1 kg/ha (winter)
- Simulated using the MACRO model

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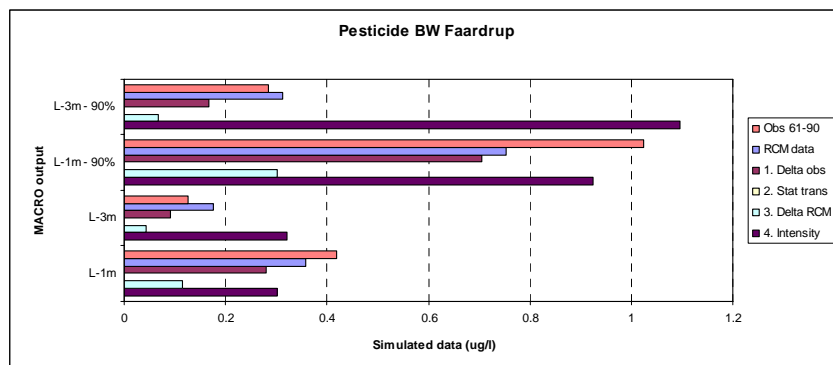
Leaching of pesticides (Faardrup)

- Pesticide A



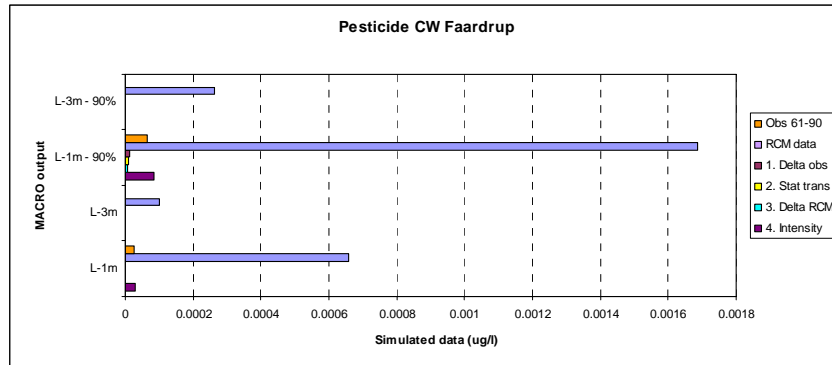
Leaching of pesticides (Faardrup)

- Pesticide B



Leaching of pesticides (Faardrup)

- Pesticide C



Conclusions

- Choise of bias correction method important
 - Different future climate estimates
 - Especially extreme values are affected
 - Additional uncertainty is introduced
- Impact on pesticide leaching
 - Not important at Jyndevad
 - Significant impact at Faardrup