GEOBENE

# Simulation of climate scenarios and sensitivity analysis with the bio-physical process model EPIC

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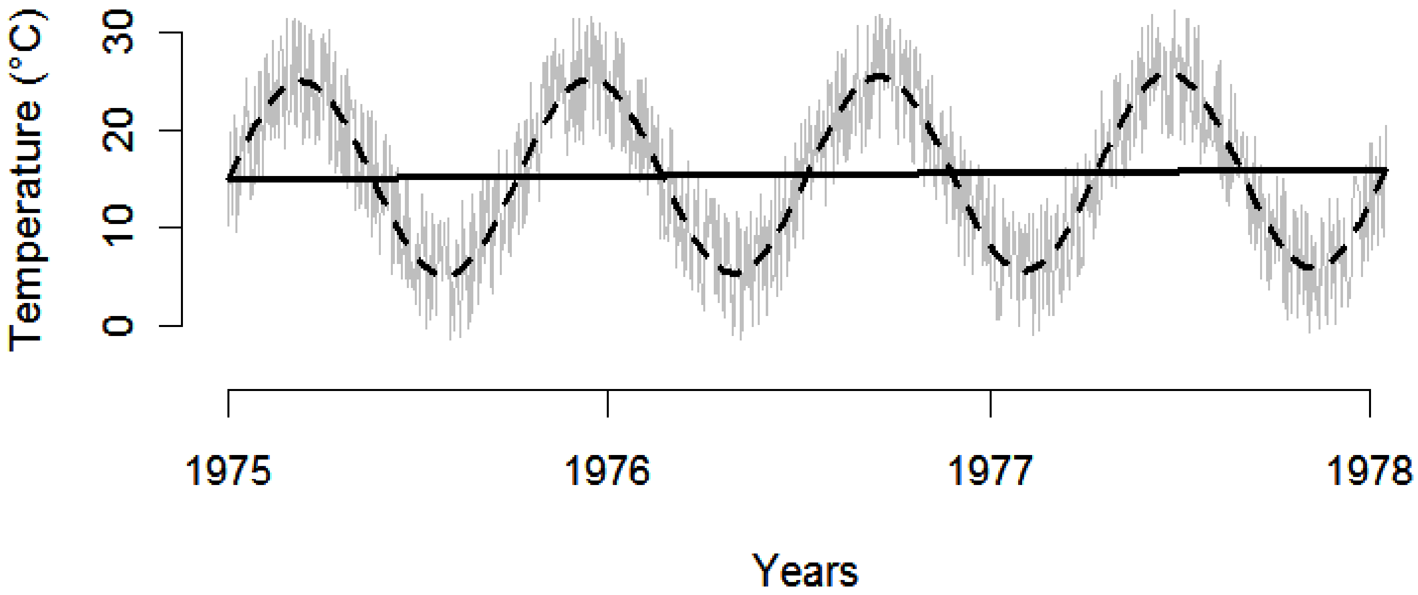
# Climate scenarios for the future

- General circulation models (GCMs)
  - Strong assumptions on initial conditions
    - Economic growth, global demographics, implementation of new technologies
    - A wide range of climate scenarios for the next 100 years -> TYNDALL data (TYN SC 2.0: A1FI, B1)
    - But: only small differences between scenarios in the next 20 to 30 years
- Statistical climate models (SCMs)
  - Linear regression models
    - Projection of stochastic climate trends for the next 20 to 30 years based on historical in situ weather observations
  - Local variations better captured than in regional climate models

# Overview about SCMs

- Linear and seasonal dependencies



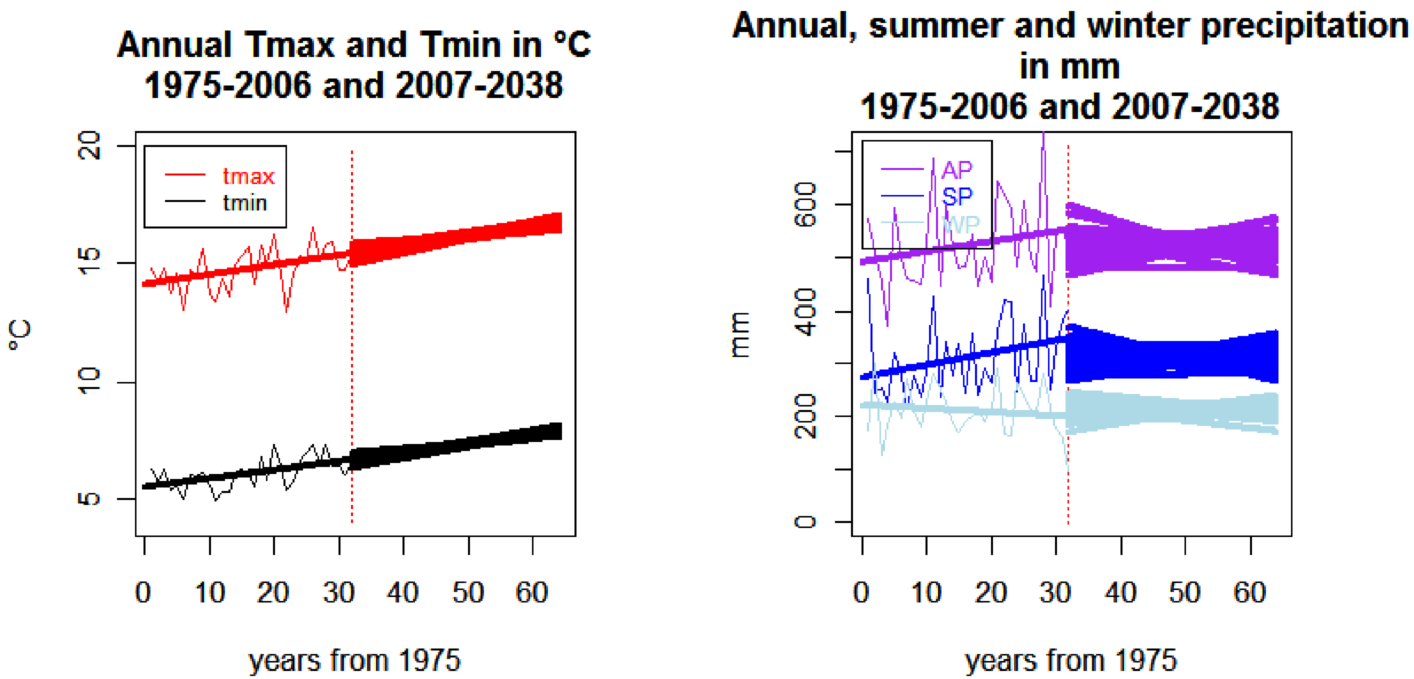
# Overview about SCMs

- Performance of two SCMs
  - Model A
    - Regression for temperature and re-allocation of data from the other weather parameters: solar radiation, precipitation, relative humidity and wind
  - Model B
    - Regression for temperature as well as for the other weather parameters
  - Comparison between models
    - In-sample error: Akaike Information Criterion (AIC)
    - Ranking of our SCMs according to their AIC, with the lowest value of AIC corresponding to the best model

# Akaike Information Criterion (AIC)

| | AIC with model A | AIC with model B |
|---|---|---|
| Tmax | 68430.70 | 68430.70 |
| Tmin | 64093.53 | 64093.53 |
| Radiation | 82099.34 | 68233.23 |
| Rain | 895.1963 | 834.0782 |
| Rel. Humidity | 31238.39 | 28518.11 |
| Wind | 47763.13 | 47496.27 |

# Stochastic feature of our models




- Pick a random year in the past to allocate residuals (respectively observations in model A) for a given month

# Comparison SCMs/TYNDALL

| | model A | model B | A1FI | B1 |
|---|---|---|---|---|
| Tmax | 1.31 | 1.31 | 0.34 | 0.41 |
| Tmin | 1.19 | 1.19 | 0.78 | 0.85 |
| Rad | -0.0006 | 0.0713 | -0.6300 | -0.6600 |
| Rain | 1.9 | 2.4 | 33.9 | 36.11 |

- Rate of change between weather observations from 1975-2006 and the different weather scenarios from 2007-2038 (mean values)

The differences in weather inputs are influencing the simulations with EPIC model

| | Corn (t/ha) | | Winter Wheat (t/ha) | |
|---|---|---|---|---|
| | mean | stdev | mean | stdev |
| model A | 10.92 | 0.63 | 6.71 | 0.44 |
| model B | 10.78 | 0.60 | 6.71 | 0.46 |
| A1FI | 10.86 | 0.35 | 6.19 | 0.44 |
| B1 | 10.81 | 0.37 | 6.25 | 0.44 |
| | Sunflower (t/ha) | | Spring Barley (t/ha) | |
| | mean | stdev | mean | stdev |
| model A | 4.19 | 0.20 | 4.77 | 0.54 |
| model B | 4.20 | 0.21 | 4.73 | 0.53 |
| A1FI | 3.81 | 0.10 | 4.88 | 0.30 |
| B1 | 3.81 | 0.11 | 4.87 | 0.31 |

| | Soil organic carbon (t/ha) | | Nitrate leaching (kg/ha) | |
|---|---|---|---|---|
| | mean | stdev | mean | stdev |
| model A | 118.40 | 3.15 | 13.17 | 14.84 |
| model B | 118.25 | 3.38 | 13.82 | 15.18 |
| A1FI | 118.96 | 3.16 | 13.94 | 13.52 |
| B1 | 118.90 | 3.24 | 14.14 | 13.23 |

# Conclusions

- Comparison SCMs/TYNDALL
  - Temperature is increasing stronger and precipitation is lower in our SCMs
- Differences in weather input do slightly influence EPIC outputs
  - Higher spring barley yields simulated with TYNDALL, but lower yields for winter wheat and sunflower. Corn yields simulated with TYNDALL are between values of model A and B
  - Soil organic carbon almost the same
  - Biggest model-to-model differences for nitrate leaching, but differences are not significant because of large standard deviations
- Comparisons are useful for assessing uncertainties of different approaches in developing climate change scenarios and their bio-physical impacts

# Outlook

- Improvement of precipitation scenarios by changing the appropriate precipitation statistics
  - Provide options to model weather extremes, which are highly relevant in bio-physical impact assessments of climate change

- Improvement of statistical sensitivity and uncertainty analysis
  - Ideas are welcome!

# Distribution of residuals

| | January | | July | |
|---|---|---|---|---|
| | mean | res | mean | res |
| Tmax [°C] | 2.64 | 5.28 | 26.32 | 4.14 |
| Tmin [°C] | -2.93 | 5.17 | 14.73 | 2.72 |
| Radiation [MJ/m²] | 3.87 | 1.75 | 20.74 | 6.37 |
| Rain [mm] | 15.15 | 12.93 | 58.26 | 35.68 |
| Rel. humidity [%] | 80 | 13 | 62 | 13 |
| Wind [m/s] | 3.36 | 2.42 | 3.11 | 1.50 |

- Residuals change only marginally between our SCMs
- Residuals are distributed Gaussian-like, except for precipitation which shows substantial and erratic variations