Leibniz Centre for
Agricultural Landscape Research
(ZALF)

Data Analysis
& Simulation

Drought Early Warning System

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Motivation and Challenges

- 1-6% primary energy consumed by agriculture
- 20%+ of GDP by agriculture in 34 countries
- 40% of food production on irrigated land (world wide)
- 70% of freshwater consumed by agriculture
- Optimization:
  - Resource management
  - Economic and ecologic efficiency
  - Food security

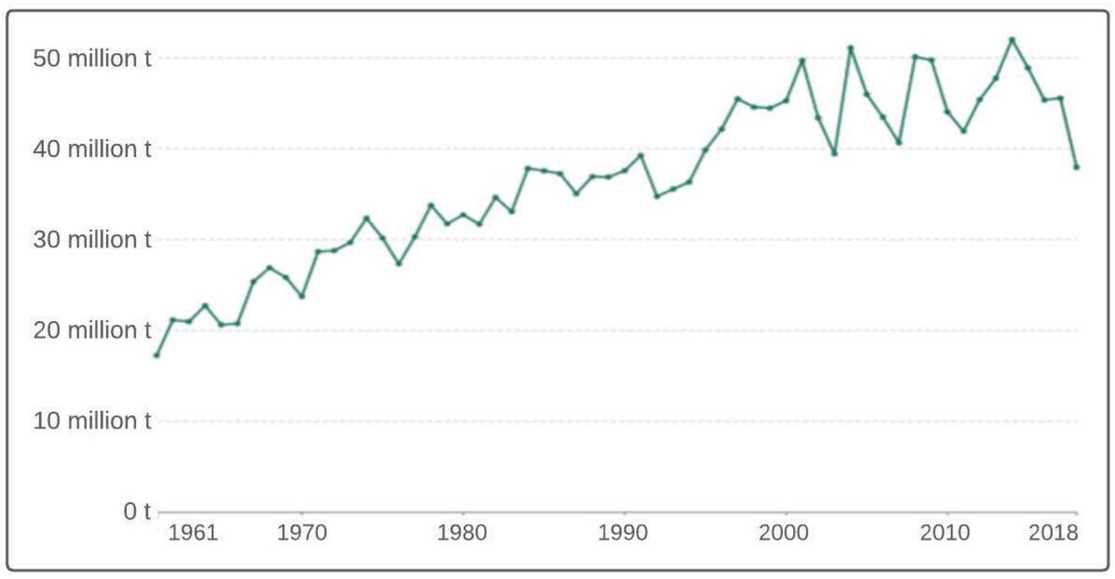

Figure 1: Cereal production between 1961 and 2018 in Germany (FAO and OurWorldinData.org).

Methods

Data assimilation to optimize the model state variables considering model uncertainties, observation uncertainties and forcing uncertainty.

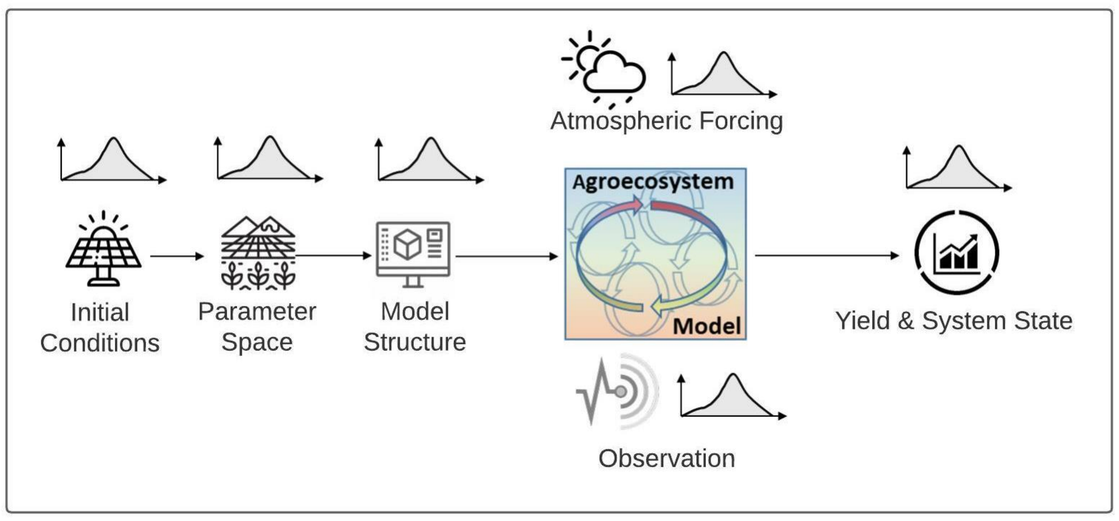

Figure 2: Uncertainties gauged into calculating the updated model state variables at the time of observation.

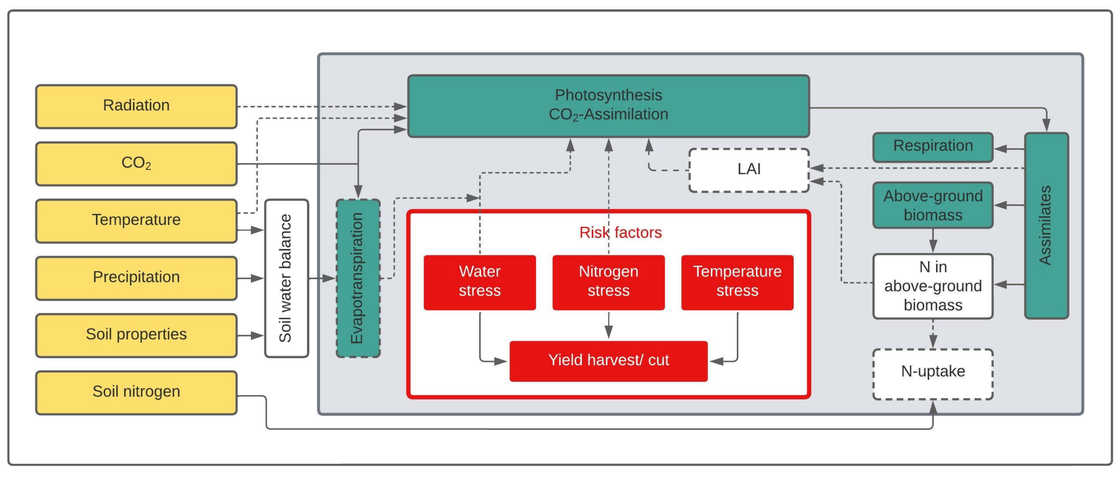

Figure 3: Plant module of the agro-ecosystem model MONICA, into which data is assimilated.

Web application

- Python Django back-end with user-controlled and user-specific MONICA simulations at field scale
- Front-end with leaflet maps projecting MONICA simulation results both Germany-wide and at field-scale
- User-related data, daily drought index and leaf area index are stored in a PostgreSQL database
- Large-scale maps are processed by a geoserver
- Weather data include interpolated observations, 7-day forecast, 6-month forecast stored in a separate database, receiving daily updates
- Daily generation of large-scale drought forecasts on the High Performance Computing (HPC) cluster

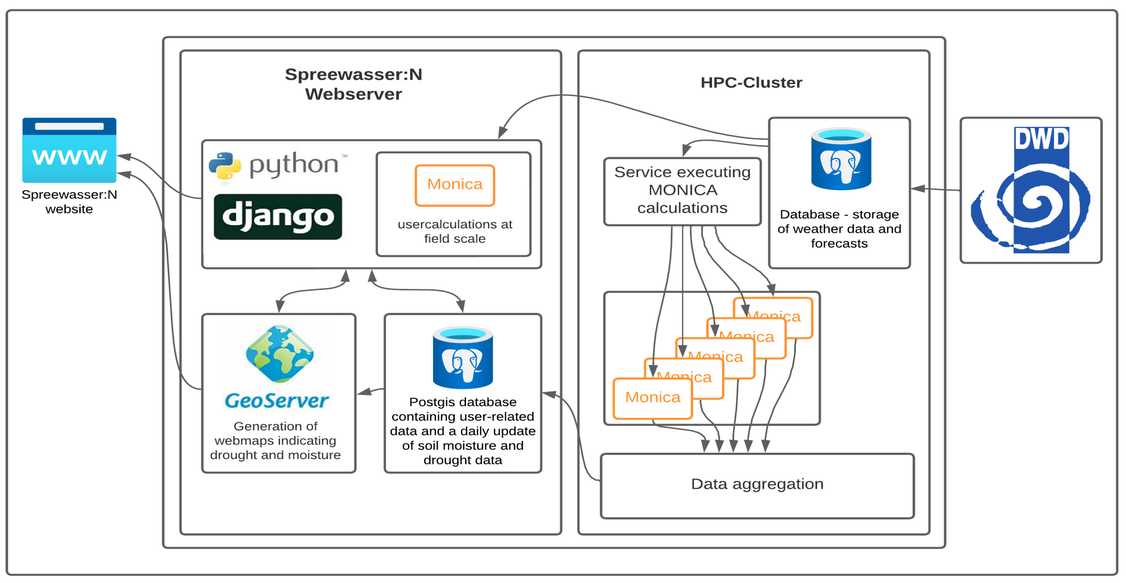

Figure 4: Software architecture of the SpreeWasser:N web application.

Results

Drought forecasting is calculated for the following variables:

- Precipitation drought index
- Agricultural drought index
- Crop-specific drought risk
- Soil moisture development and crop water availability
- Irrigation management options
- End-of-season yield prediction

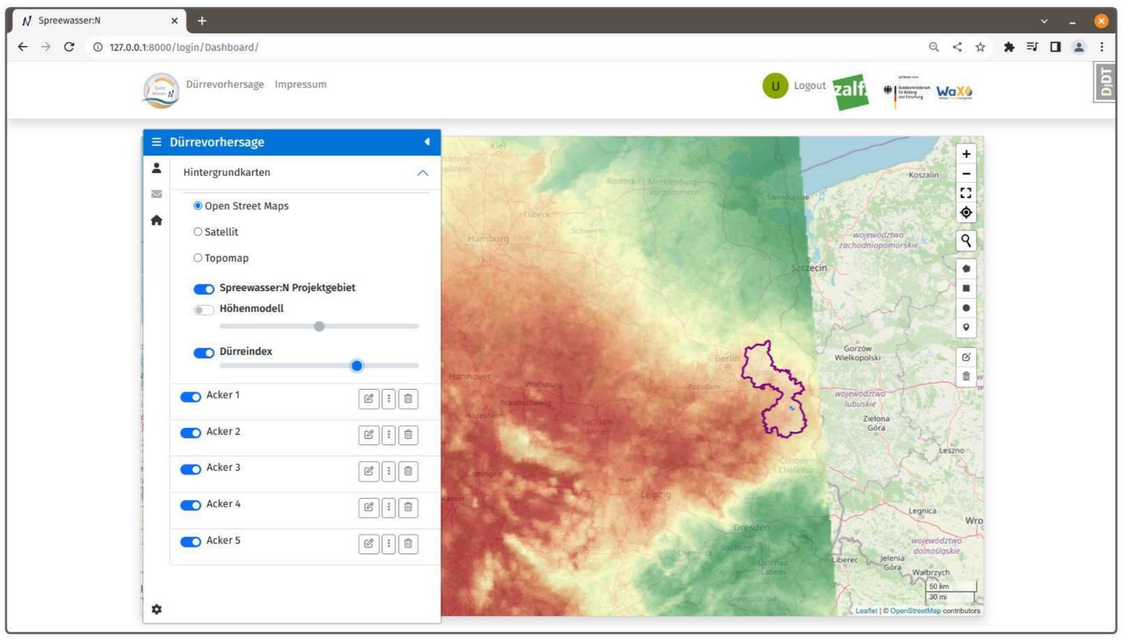

Figure 5: Online drought forecasting system with large-scale precipitation drought index map of Germany based on MONICA simulations generated on the HPC-Cluster using data of the German Weather Service DWD. User-specific simulations at field scale include irrigation data and can be accessed in the left-hand side user panel.

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