Modelling European Agriculture with Climate Change for Food Security

Modelling of carbon cycle in grassland ecosystems of diverse water availability using Biome-BGCMuSo

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Nature, to be commanded,
must be obeyed.

Francis Bacon

- Forest-steppe ecotone in the Kiskunság
- Water as the main limiting factor
- Main characteristics of the Biome-BGCMuSo biogeochemical model
- Uncalibrated runs
- Pre-calibration of selected parameters by aboveground biomass
- Conclusions, outlook and further plans

Forest-steppe ecotone in the Kiskunság

Water as the main limiting factor

- Water supply is highly variable in time and space
- Influence of the relief in fine scale
- Influence of the seasonal and interannual changes in the weather
- Long-term decrease in the level of groundwater
- Differences in habitats and the vegetation
- Differences in land-use
- What factors and how do influence the biomass production in the grassland habitats?

Studied ecosystems

Marshland

Biome-BGCMuSo biogeochemical model

- Modelling of storage and flux of water, carbon, and nitrogen between the ecosystem and the atmosphere (BBGC, Thornton 2000)
- **--> Mu**ltilayer **So**il Module (Hidy et al. 2012, 2016)
- improved representation of soil hydrology
- … and plant phenology (e.g. drought related plant senescence)
- improved parameterization of plant ecophysiology
- developed management modules (mowing, grazing, fertilization, cropland and forest management options)
- daily variable groundwater level

Biome-BGCMuSo biogeochemical model

- **Input**: daily meteorological data
  - Initialization of the target ecosystem – geography, soil properties, phenology, maximum depth of rooting zone
  - Ecophysiological parameters
  - Groundwater
  - CO_2 concentration
  - N-deposition
  - Management

Biome-BGCMuSo biogeochemical model

- **Output**: more than 500 possible output variables
  - Soil states (water, temperature, nutrients)
  - Variables of the water, carbon and nitrogen cycles and pools
  - Vegetation characteristics
  - Daily and annual

Biome-BGCMuSo biogeochemical model

- **Process**: ecosystem by ecosystem
  - Uncalibrated runs
  - Selection of ecophysiological parameters and intervals to calibrate the parameters (by literature, sensitivity analyses)
  - Study of parameter distributions (first on 1000, later on 100 000 runs)
  - Study of parameter interdependences
  - Calibration to standing aboveground biomass data

Calibration of selected parameters by aboveground biomass

annual whole-plant mortality fraction

new fine root C : new leaf C

canopy light extinction coefficient

canopy average specific leaf area

bulk N denitrification proportion (DRY)

symbiotic+asymbiotic fixation of N

critical value of soilstress coefficient

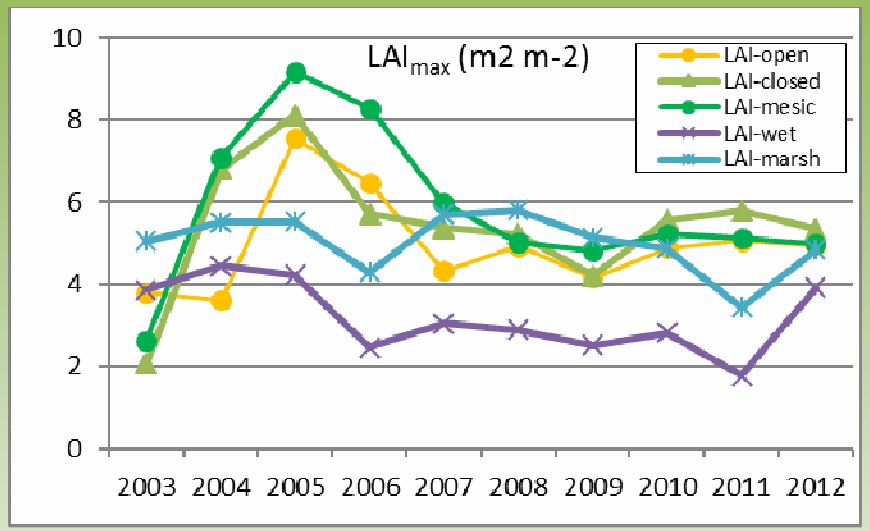
maximum depth of rooting zone

root distribution parameter

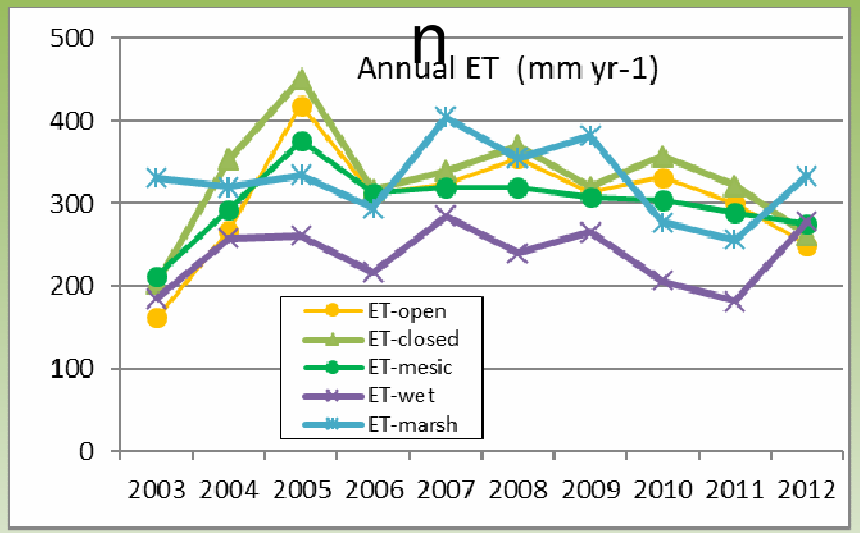
rate constant scalar of recalcitrant SOM (humus) pool

Uncalibrated runs

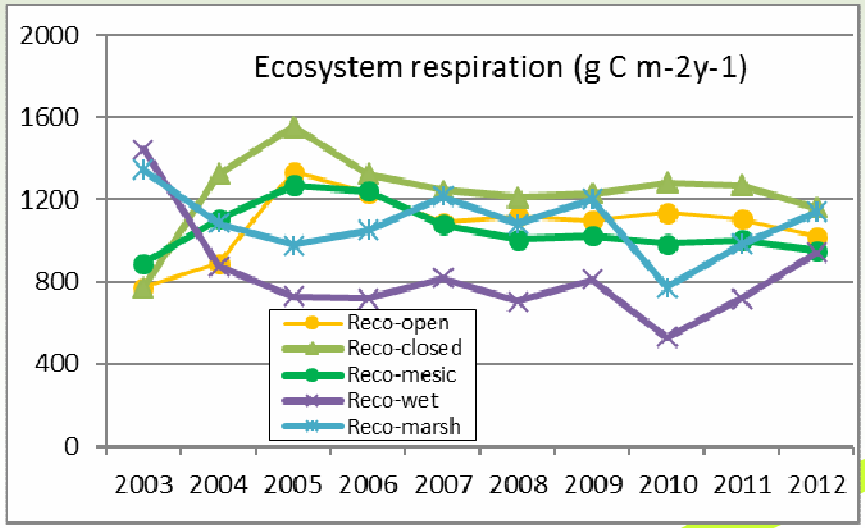
Leaf Area Index



Evapotranspiration

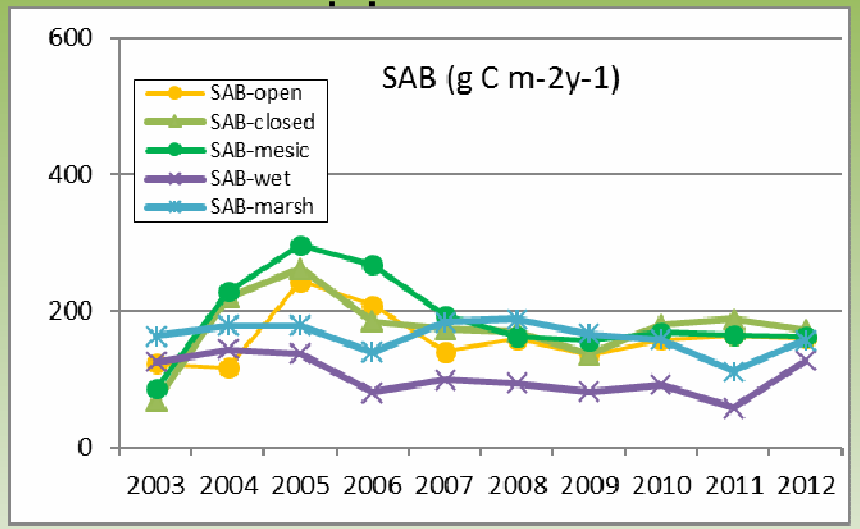


Net ecosystem respiration

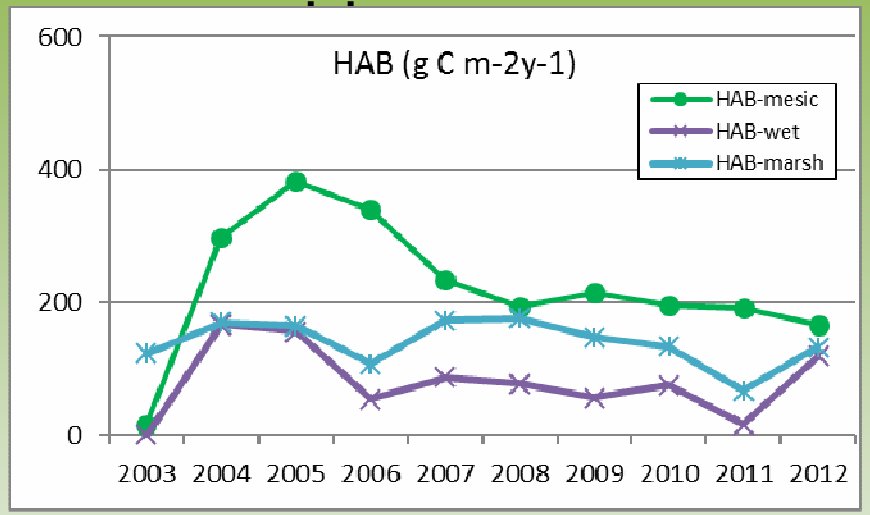


Uncalibrated runs

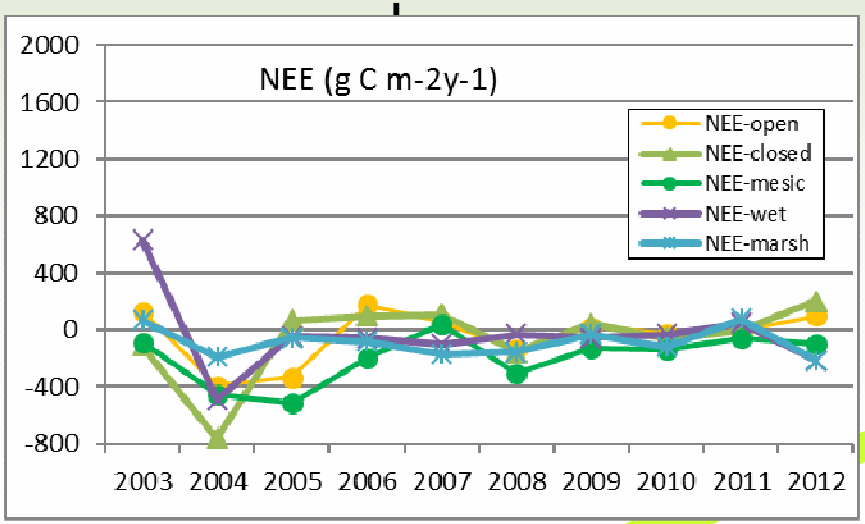
Standing aboveground



Harvested aboveground

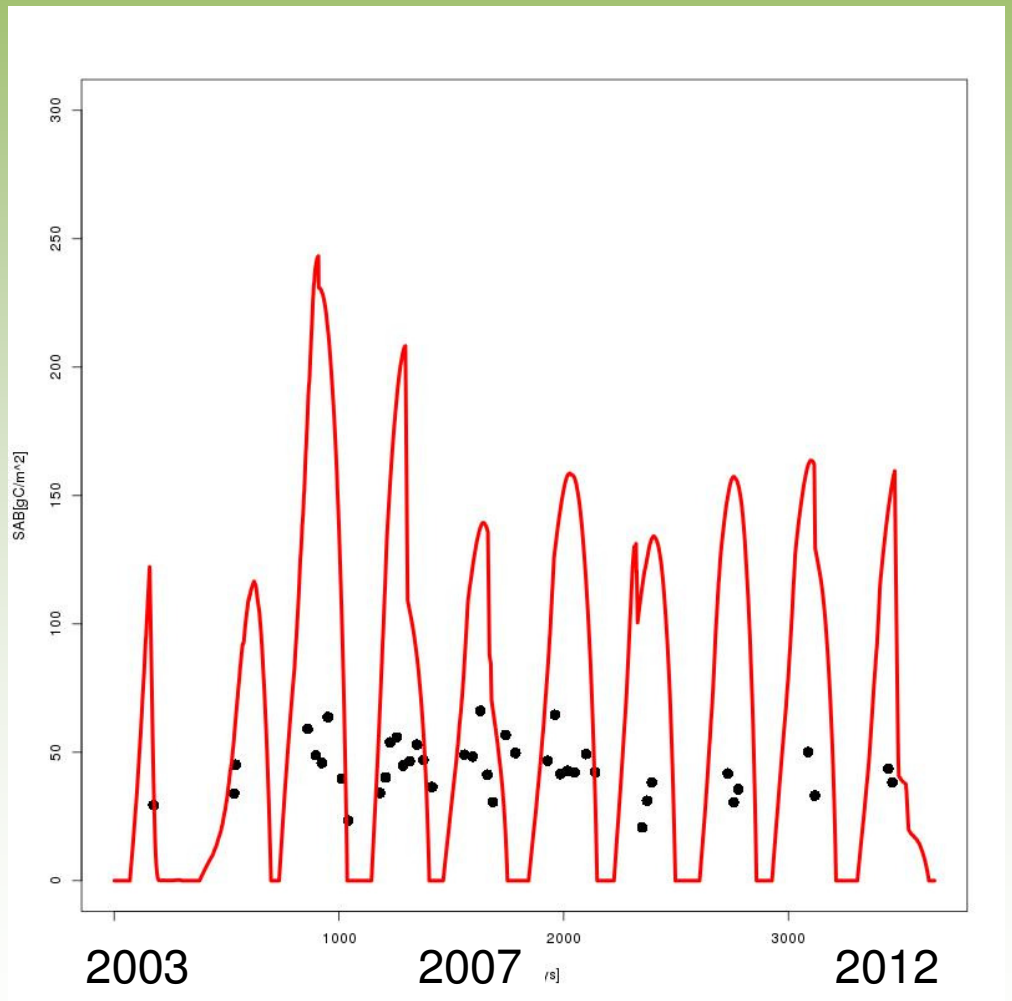


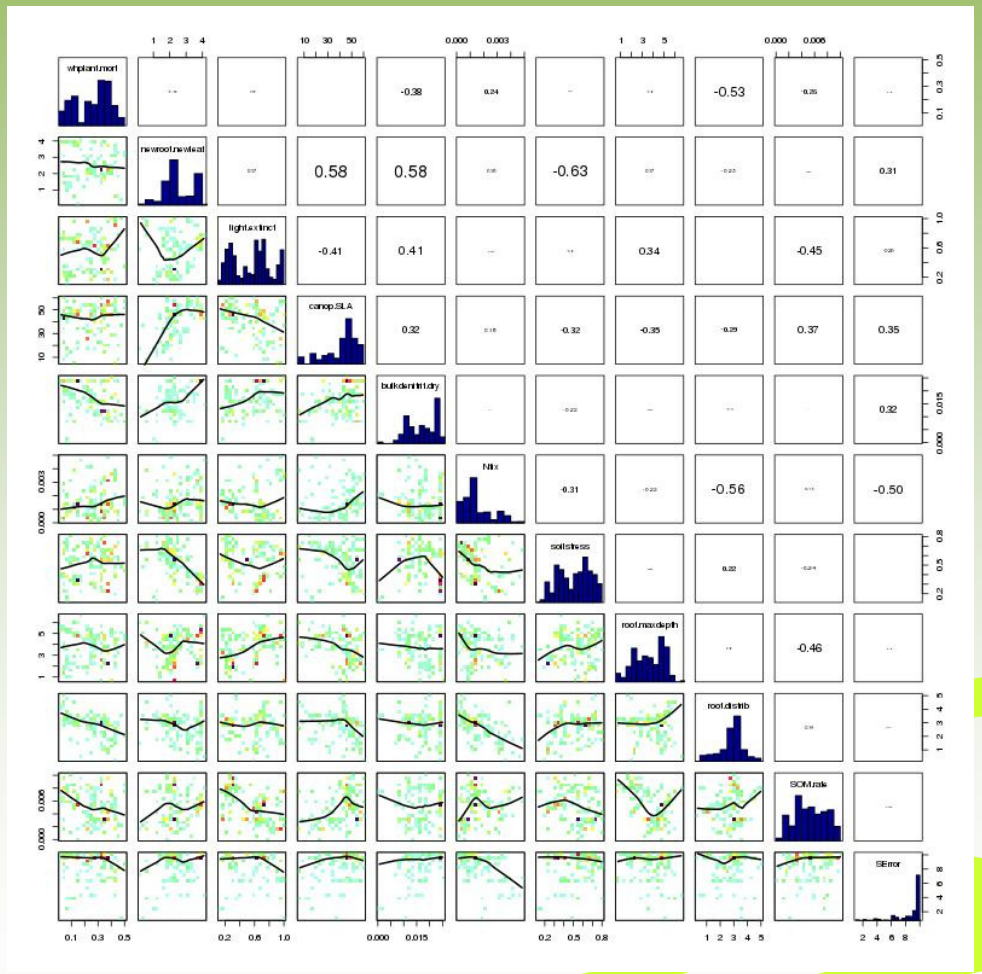
Net ecosystem



Pre-calibration 1

Open sand grassland

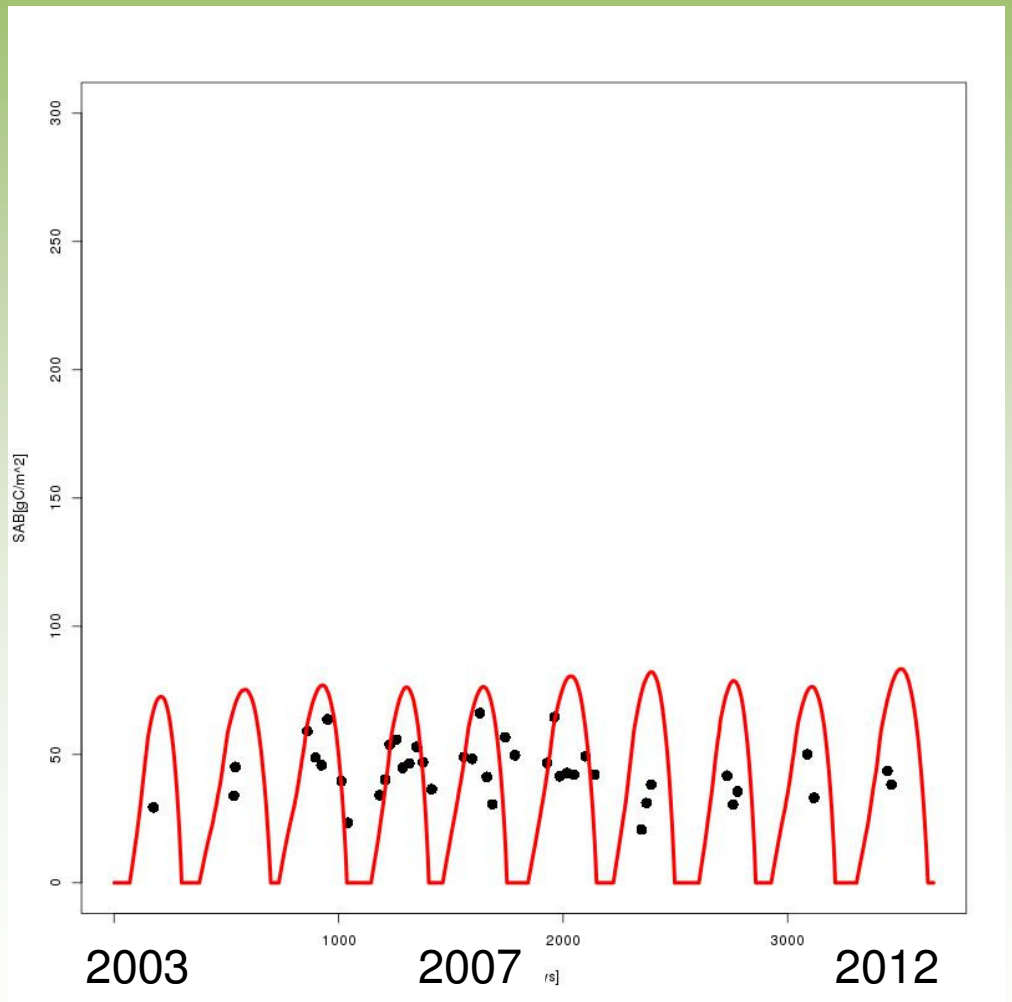


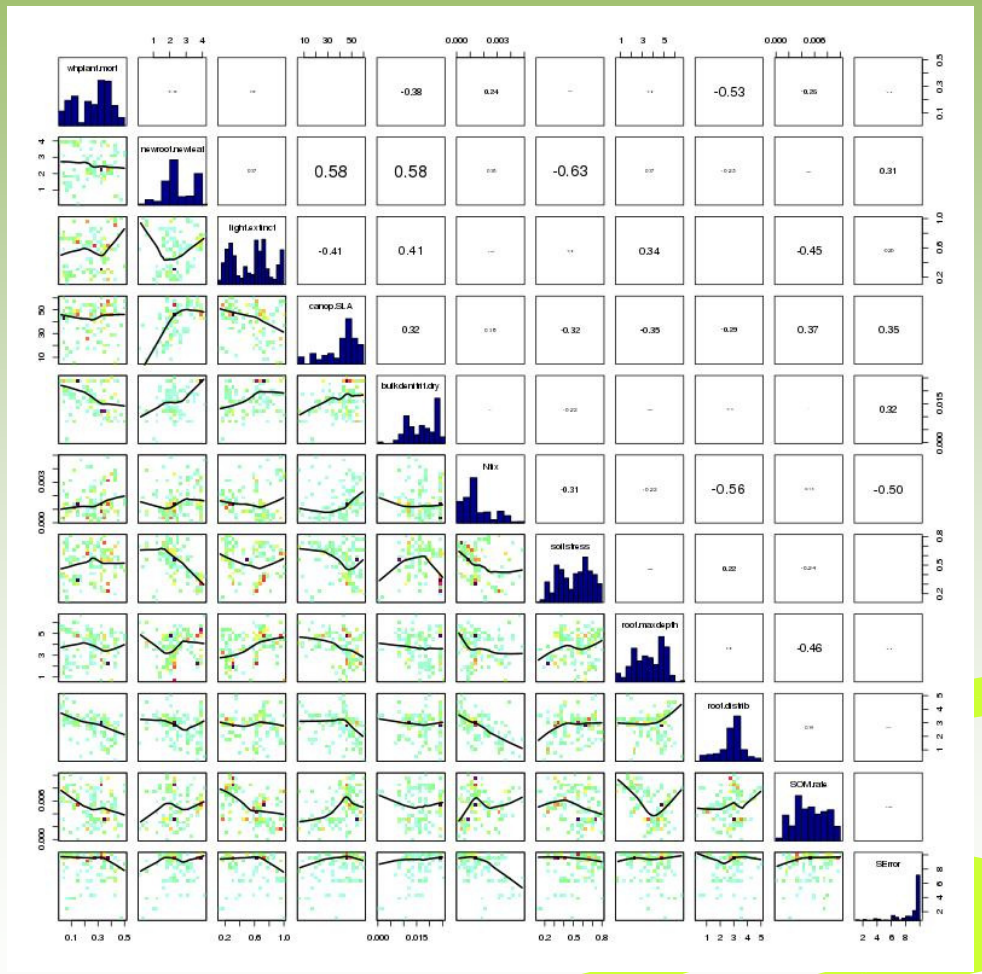


Standing aboveground biomass

Pre-calibration 1

Open sand grassland

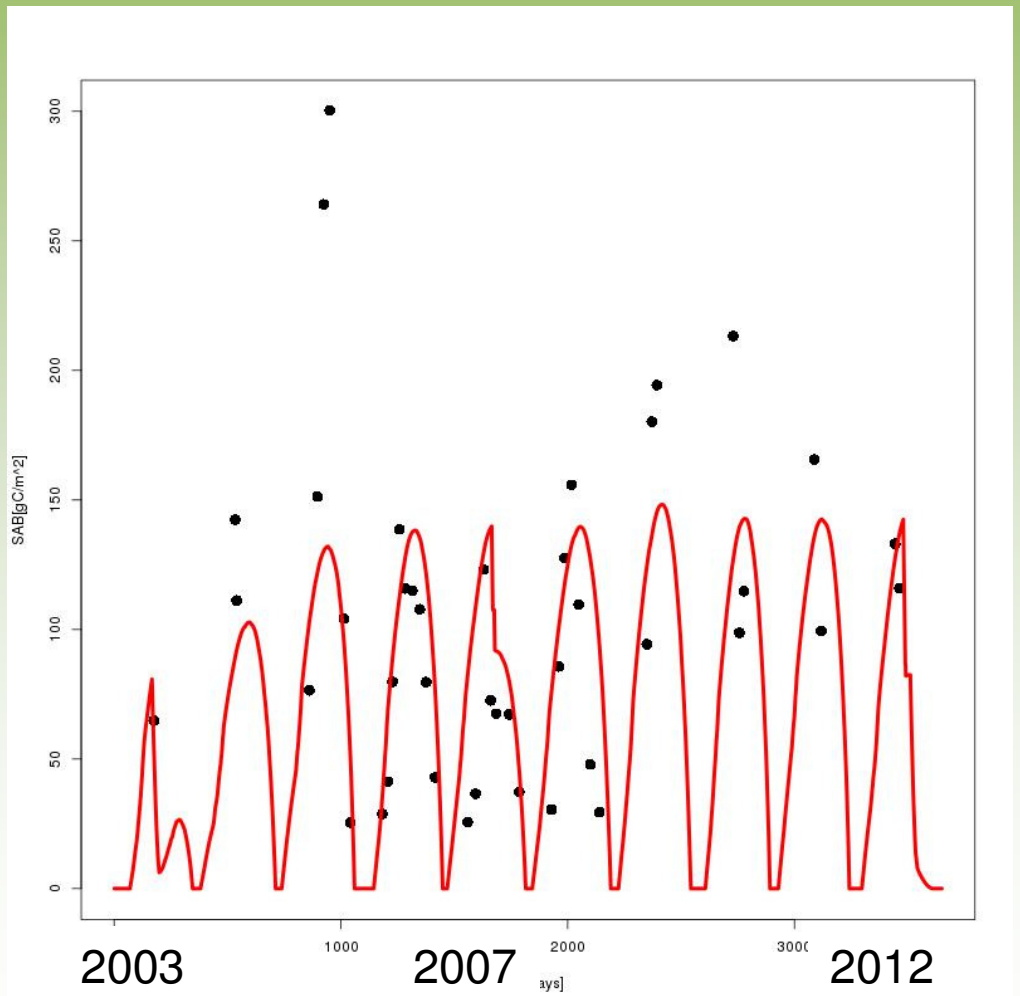


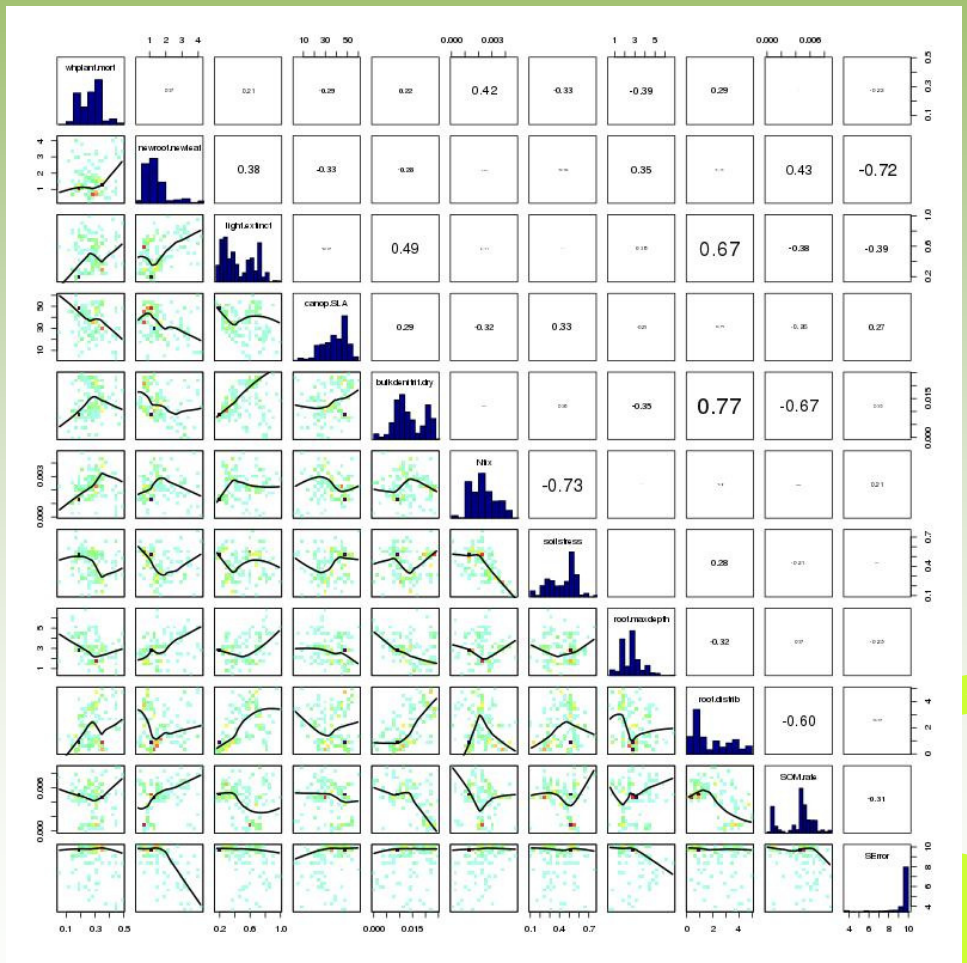


Standing aboveground biomass

Pre-calibration 2

Closed sand grassland

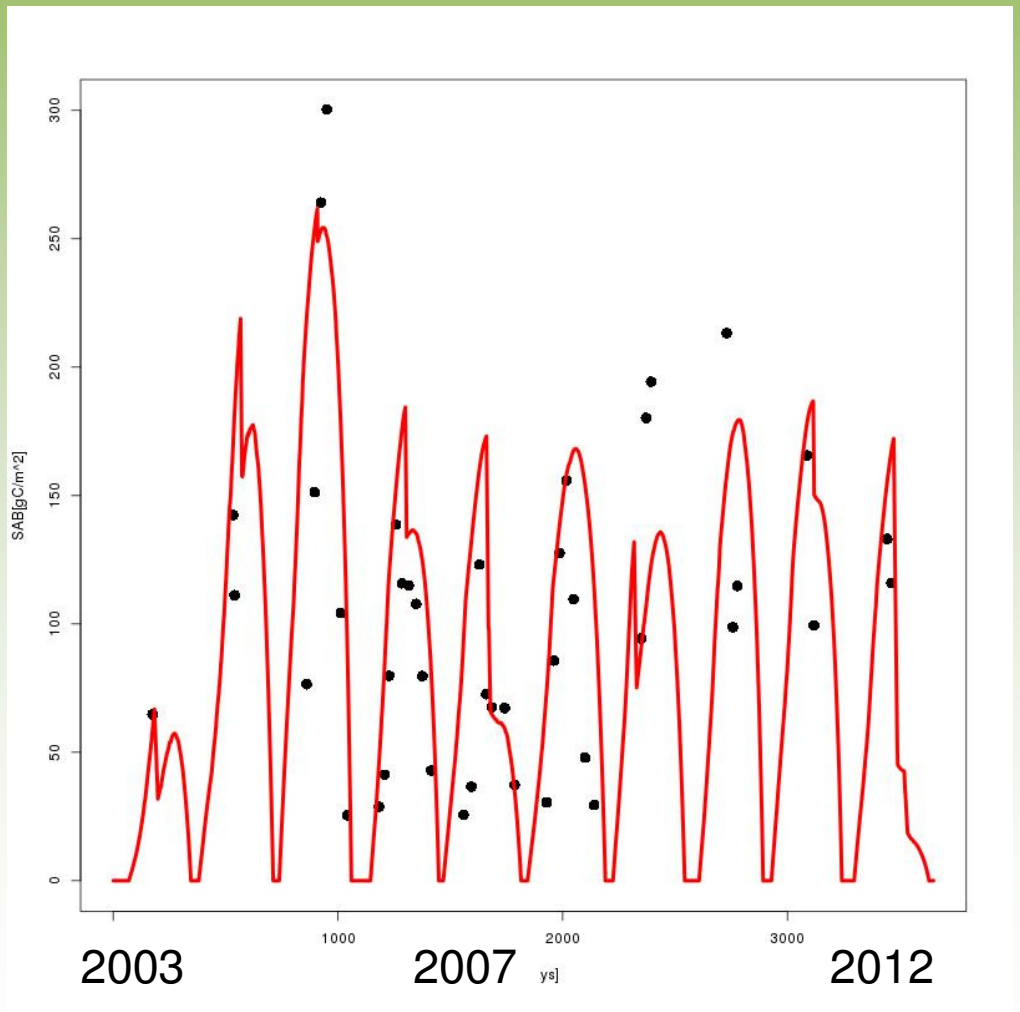


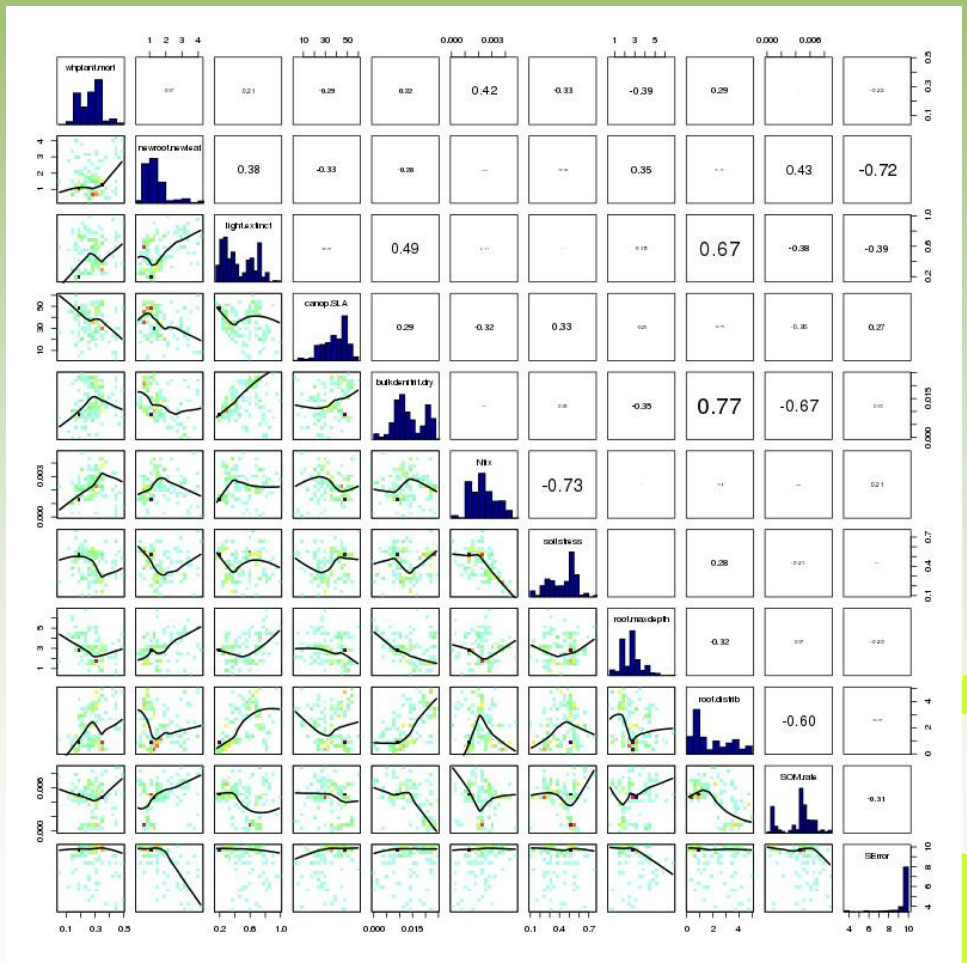


Standing aboveground biomass

Pre-calibration 2

Closed sand grassland

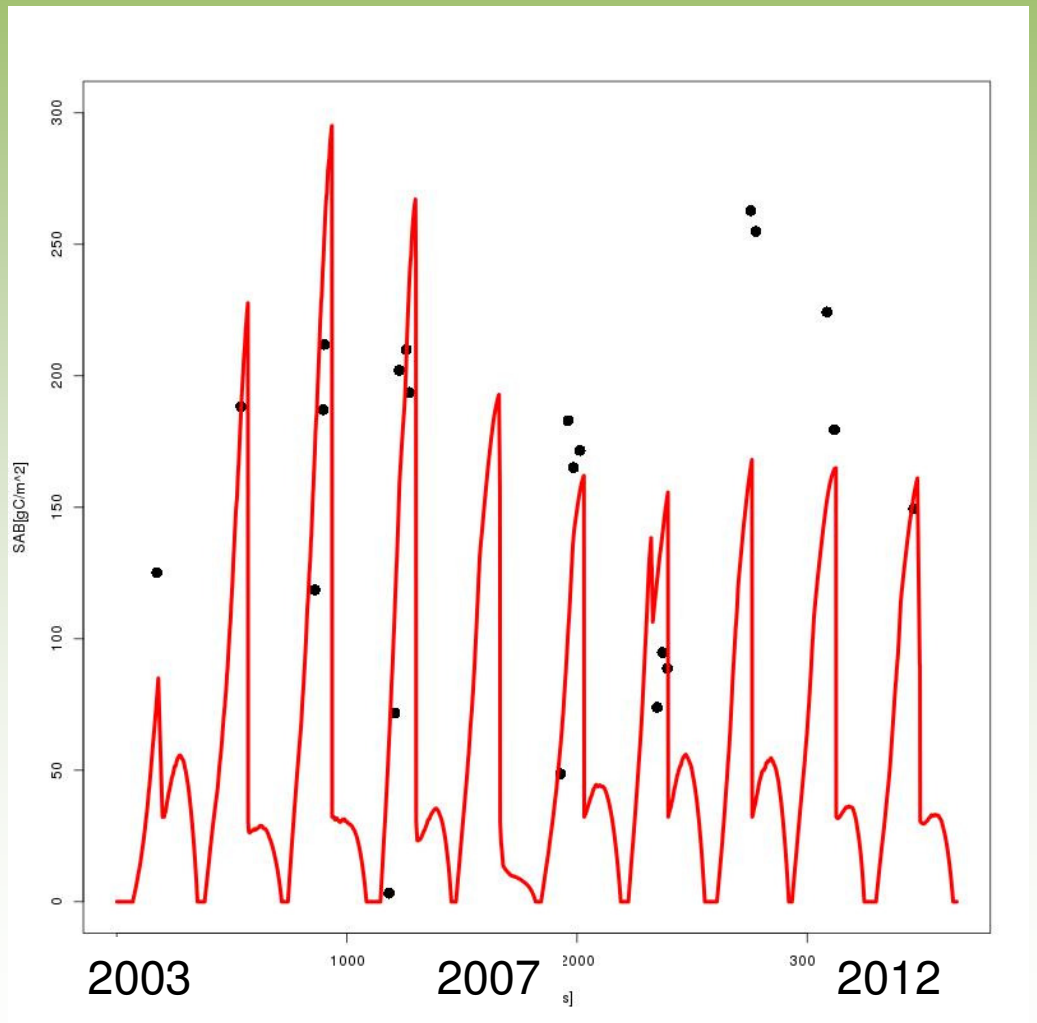


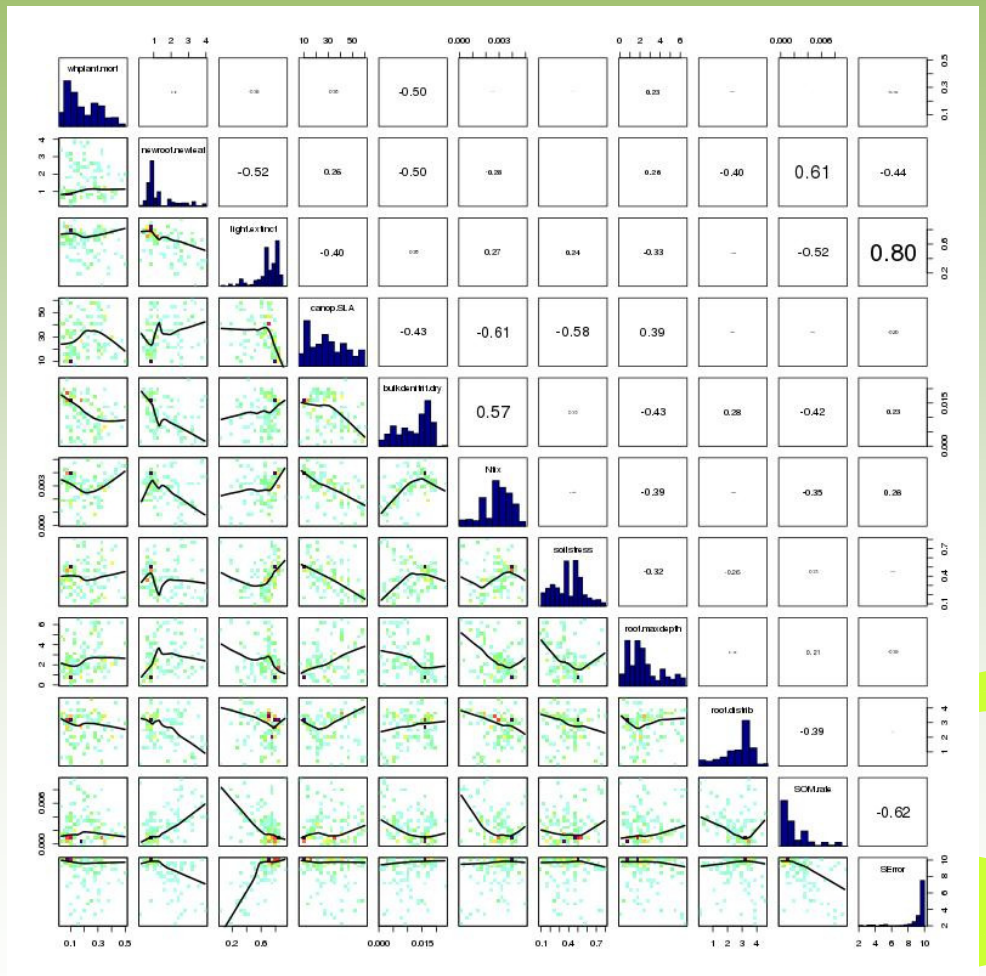


Standing aboveground biomass

Pre-calibration 3

Mesic meadow

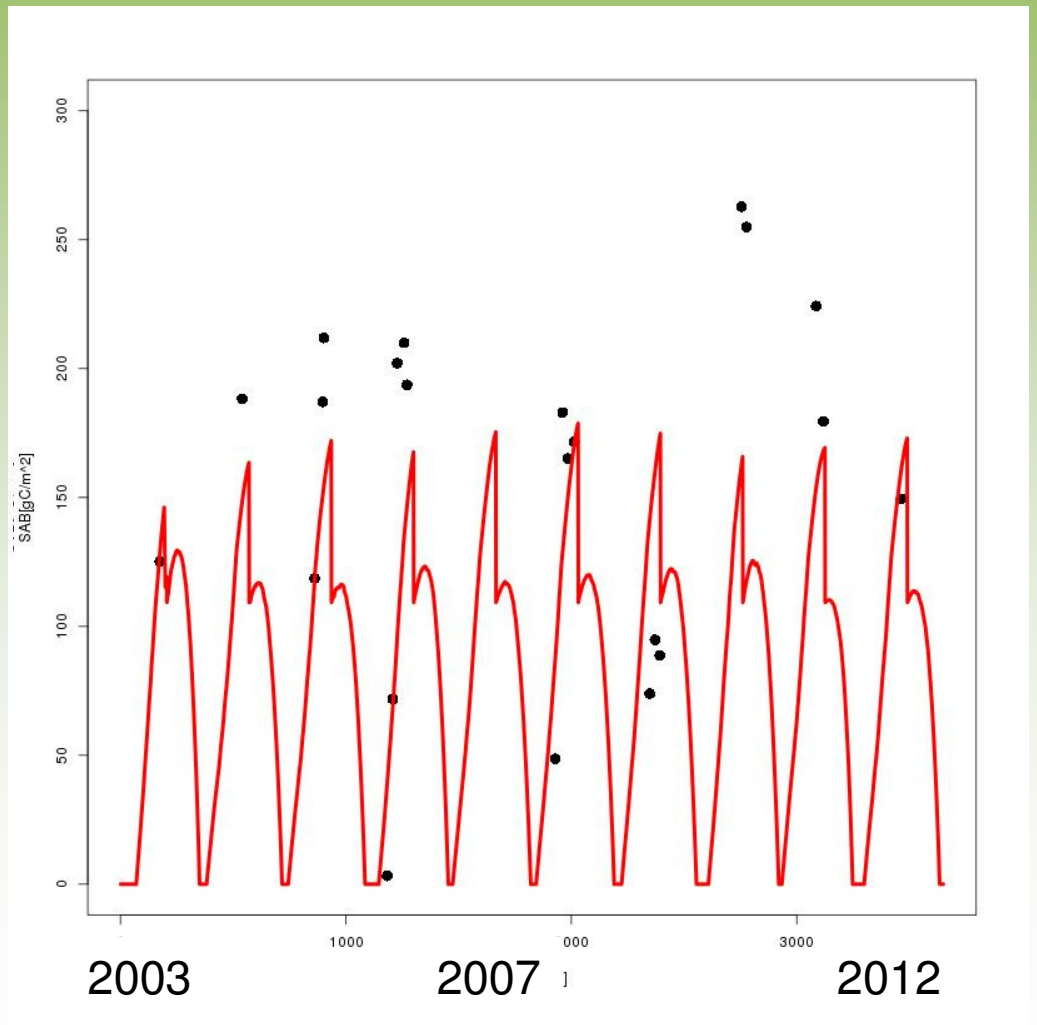


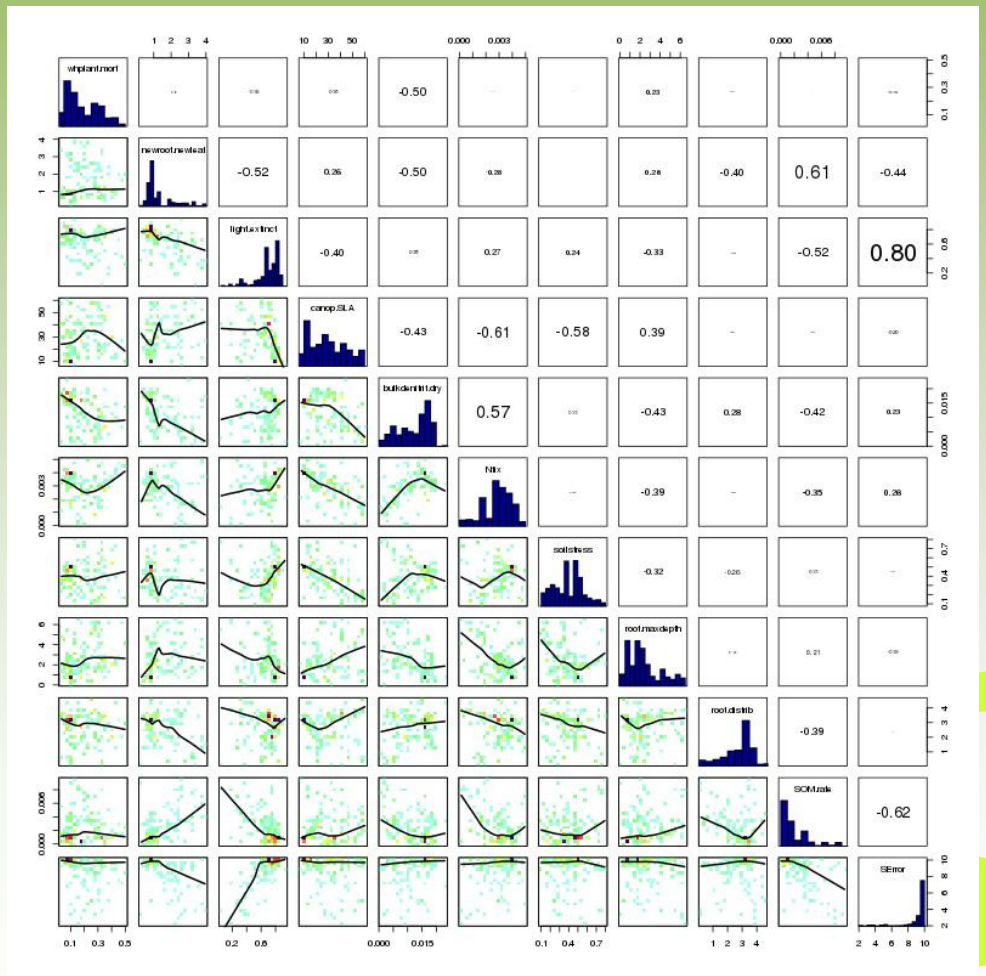


Standing aboveground biomass

Pre-calibration 3

Mesic meadow

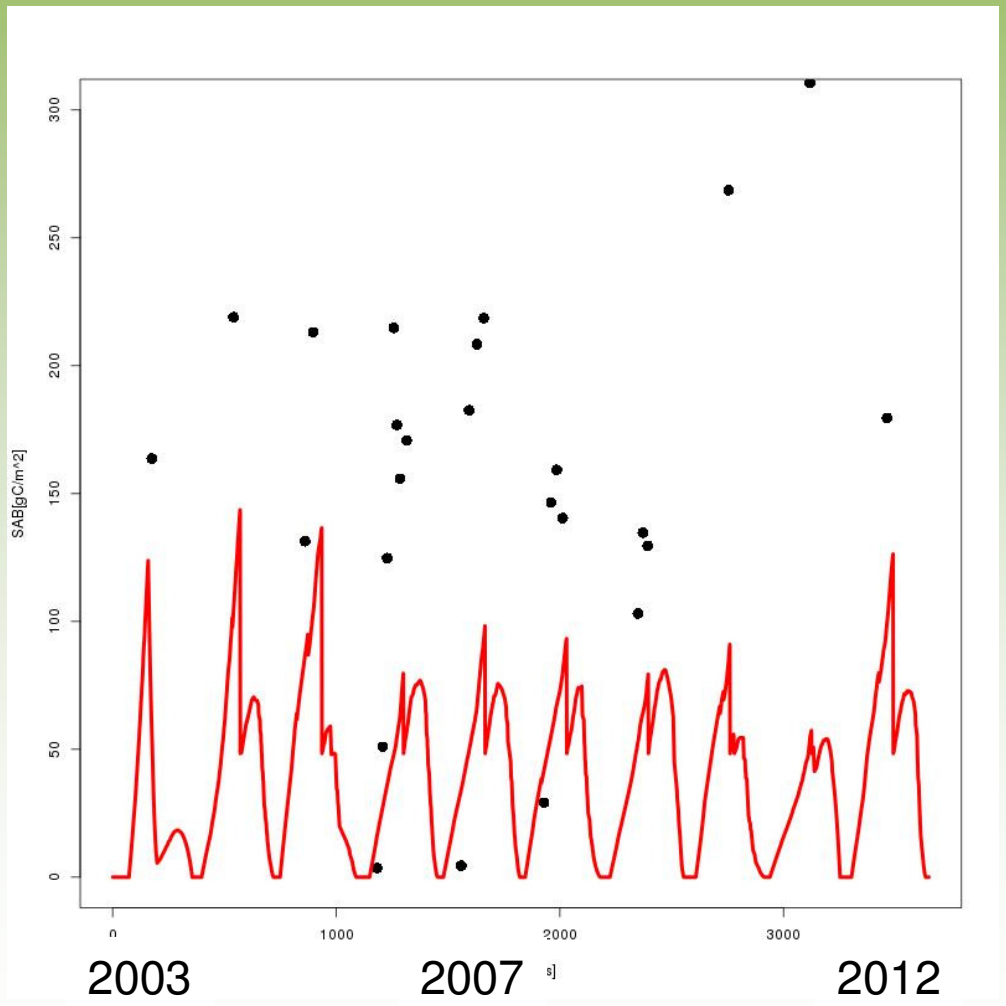


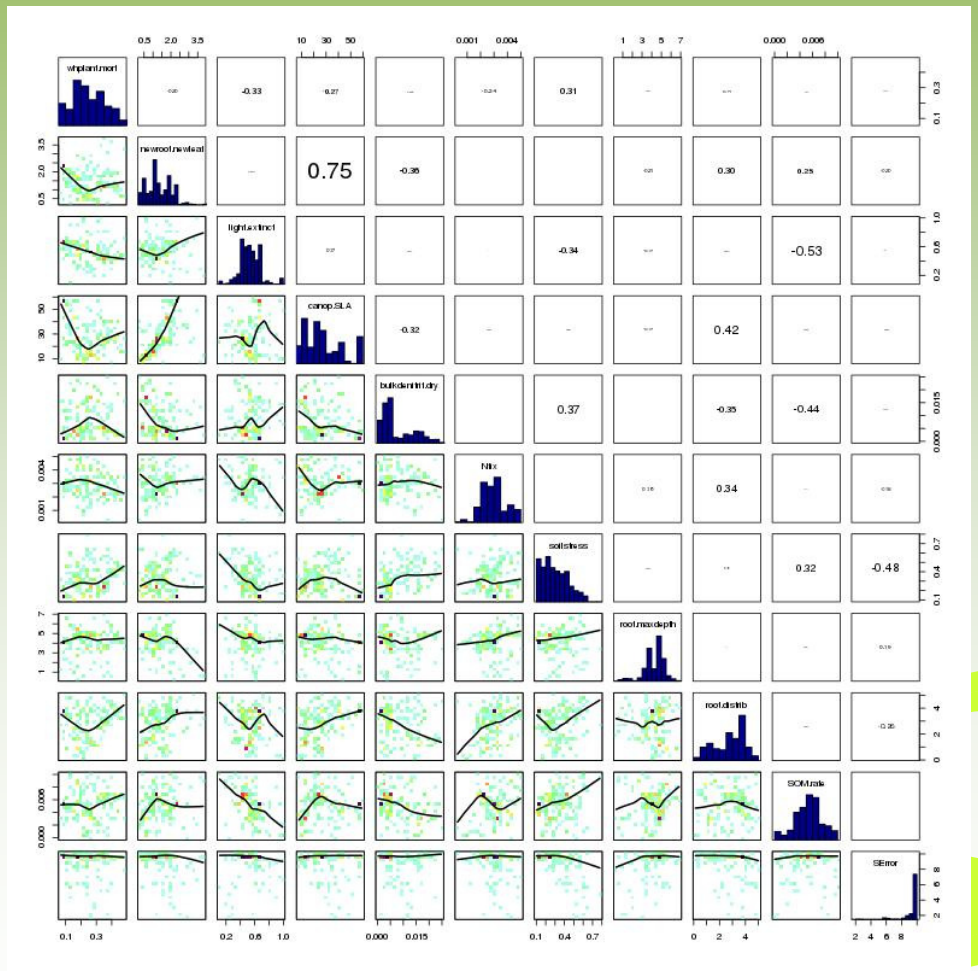


Standing aboveground biomass

Pre-calibration 4

Wet meadow

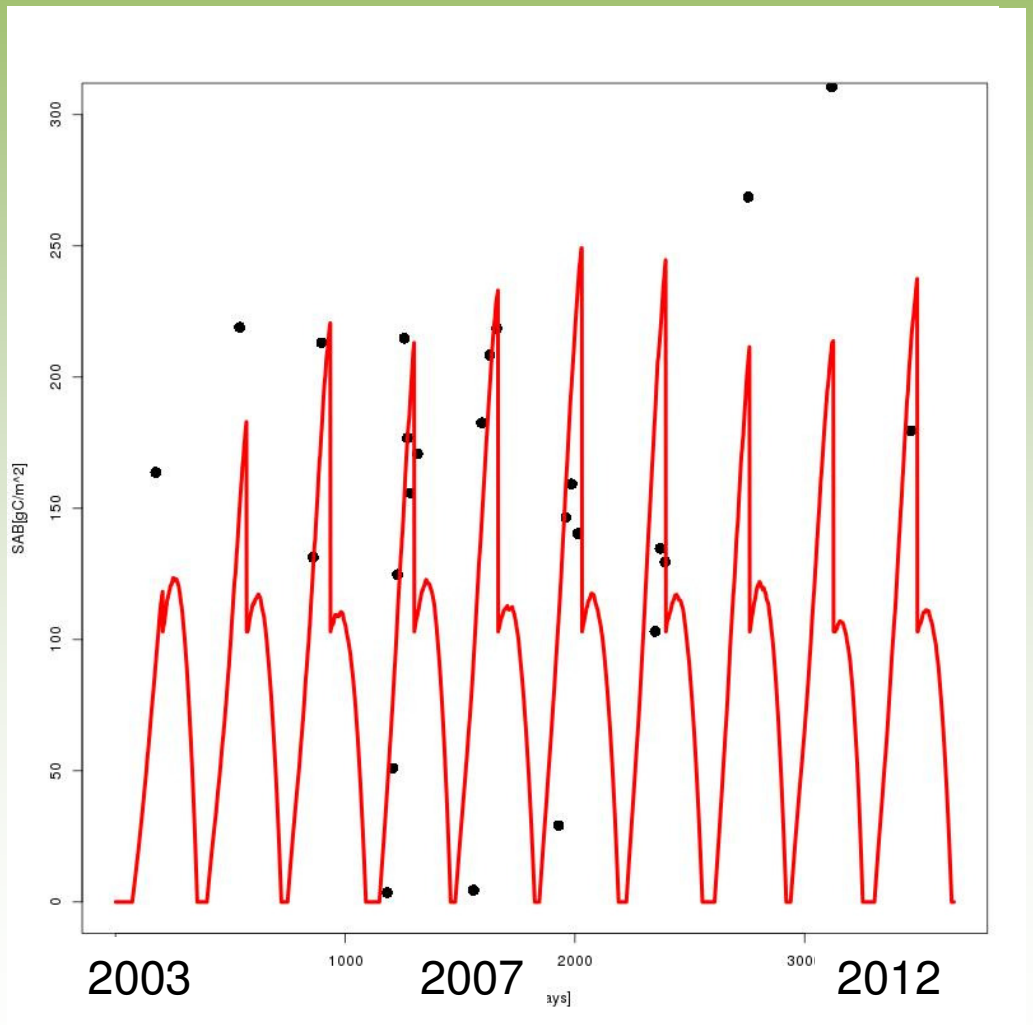


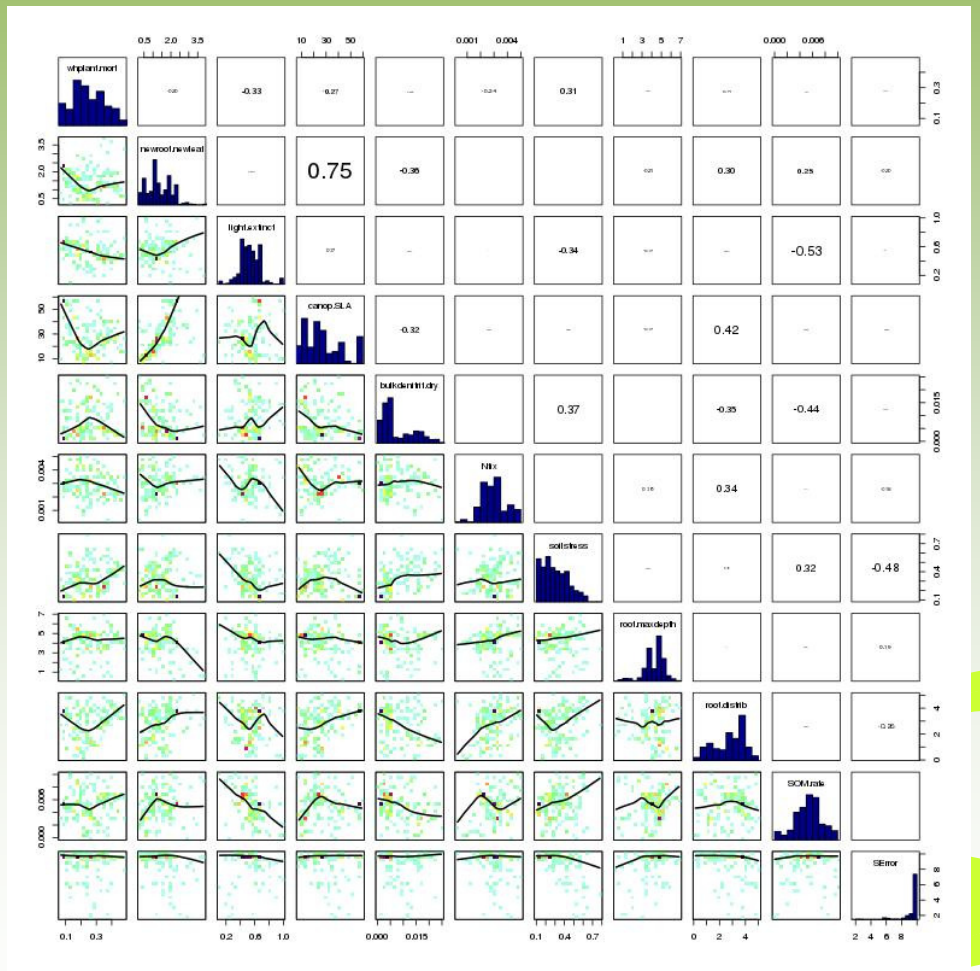


Standing aboveground biomass

Pre-calibration 4

Wet meadow

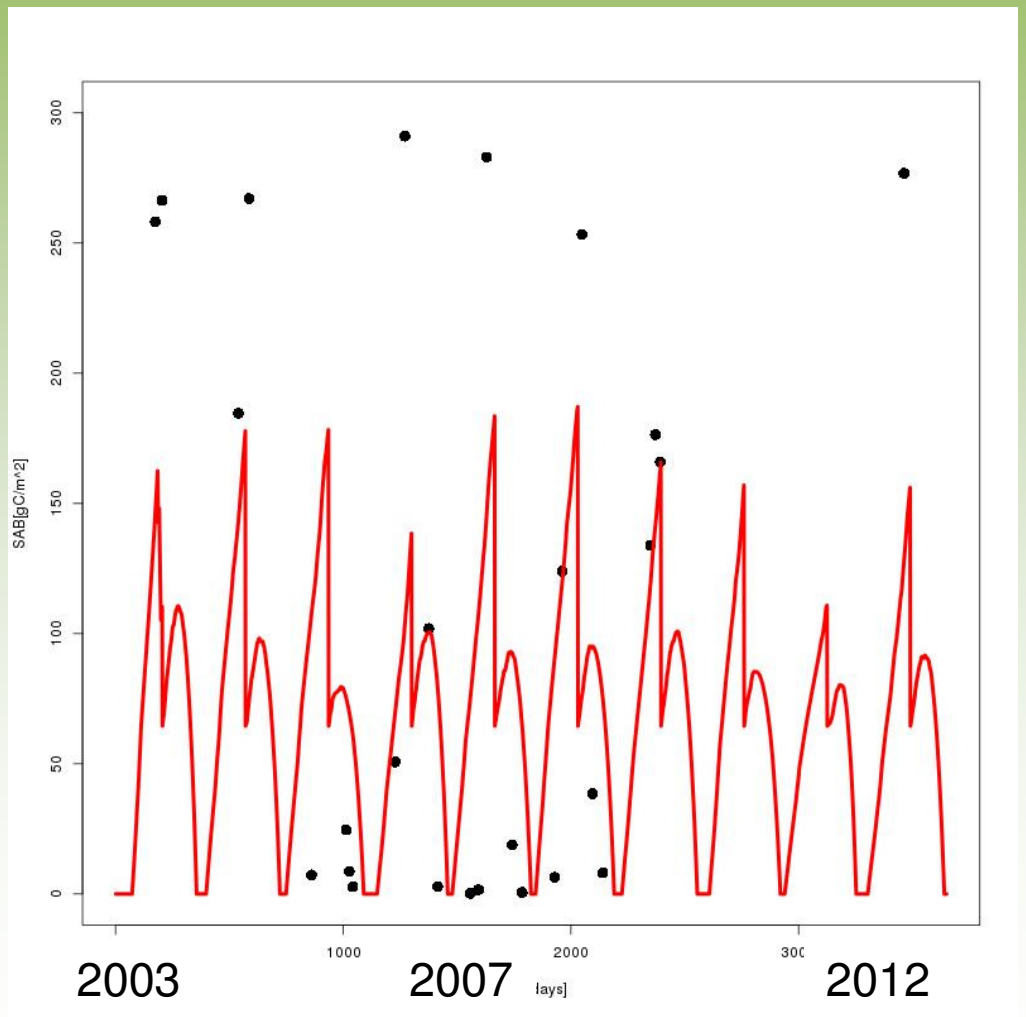


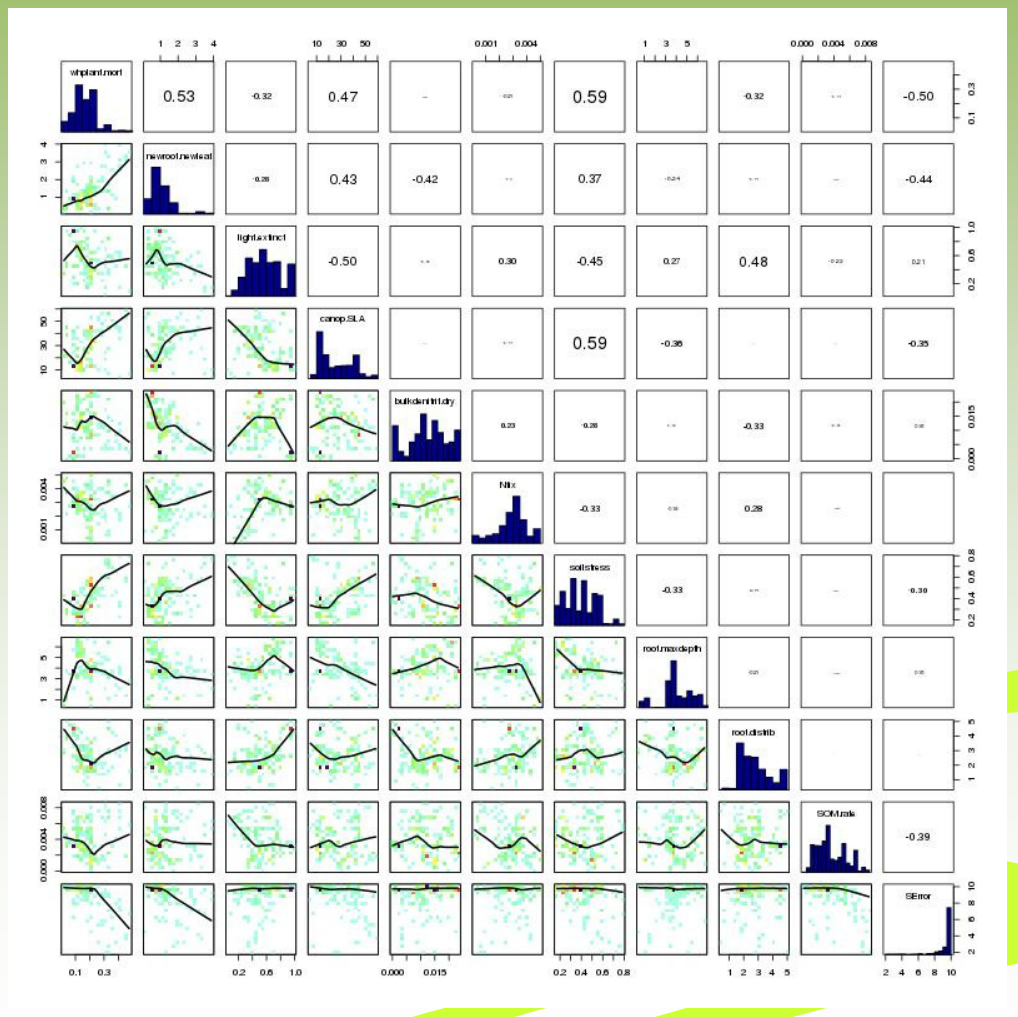


Standing aboveground biomass

Pre-calibration 5

Marshland

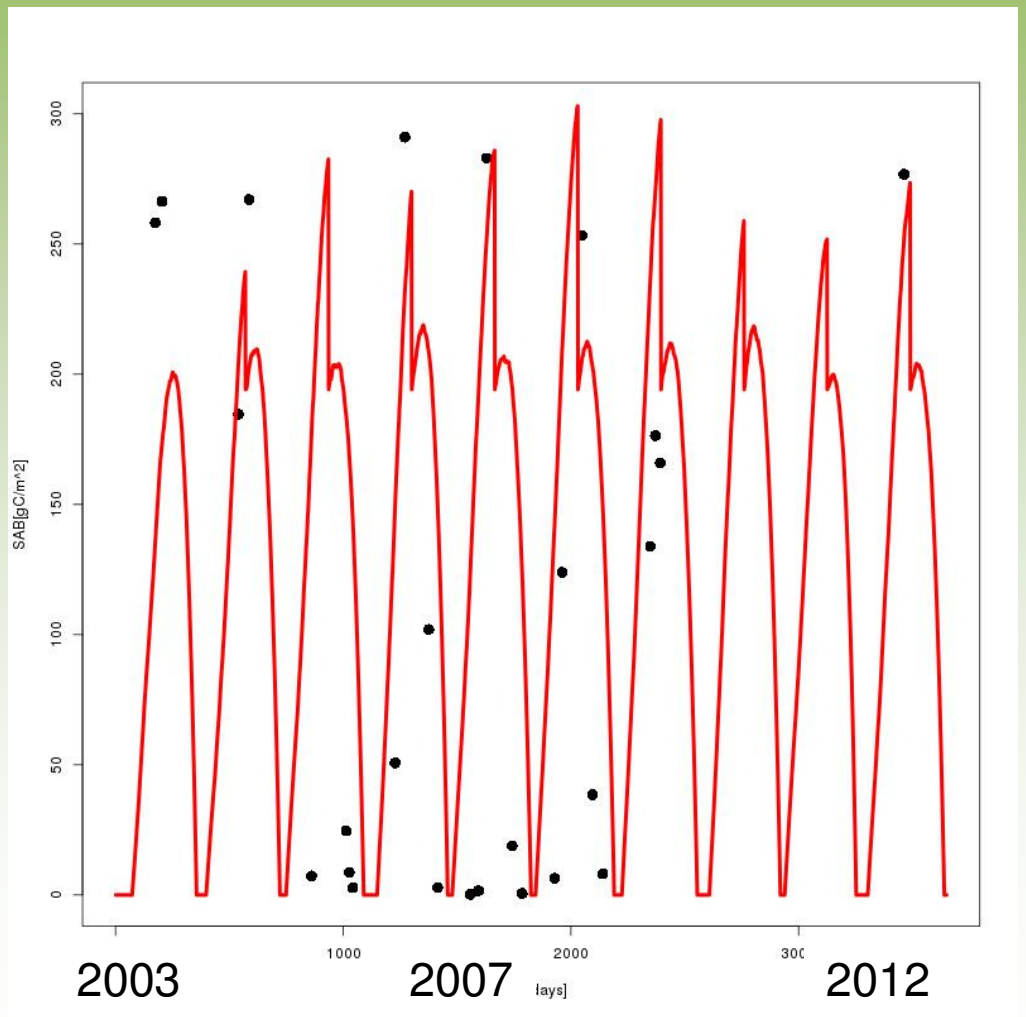


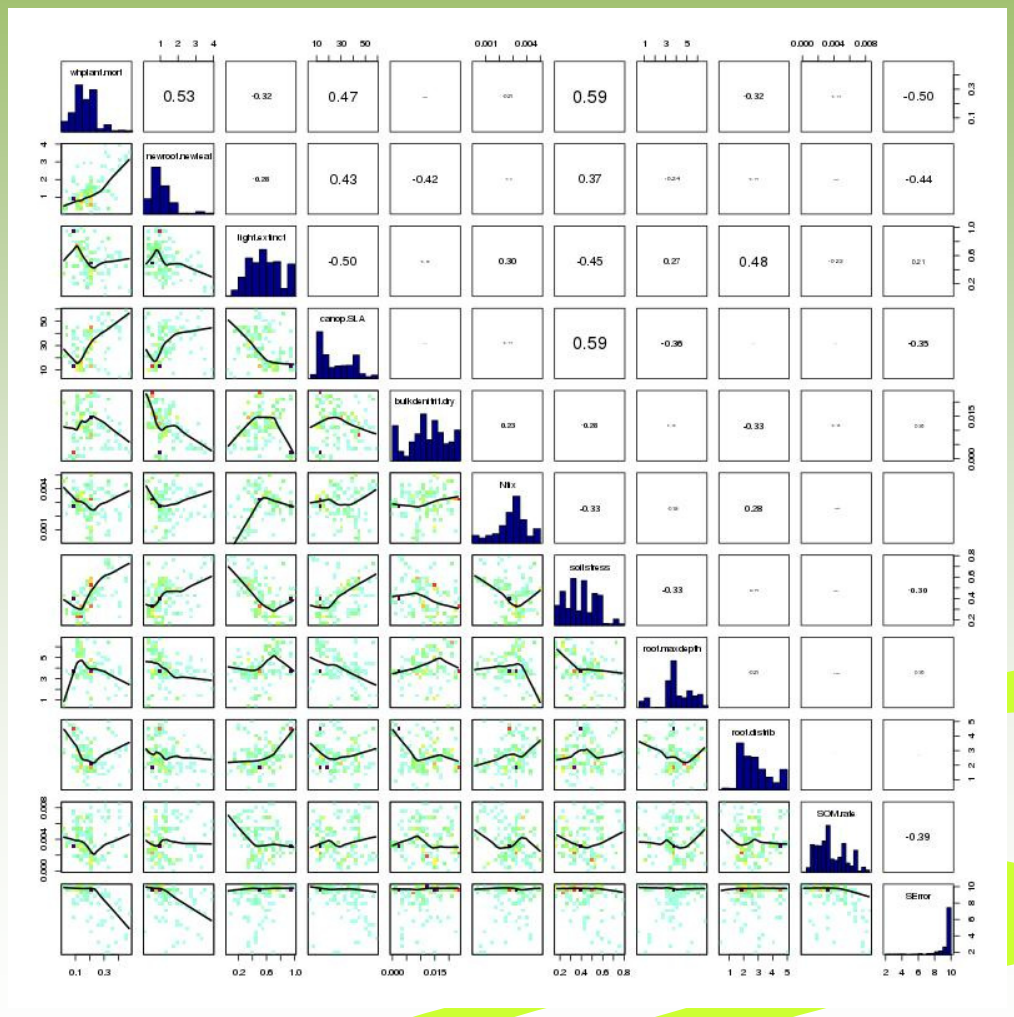


Standing aboveground biomass

Pre-calibration 5

Marshland





Standing aboveground biomass

Conclusions, outlook and further plans

- Aboveground biomass estimation is mostly realistic and may be further improved by calibration
- LAI is systematically overestimated by the model
- Open grassland has overestimated vegetation development
- Wet meadow has underestimated vegetation development
- Continue the calibration…
- Validation on further years of biomass data

Thank You for Your attention!

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