Land-climate interactions and soil moisture memory

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Simple Model

- Model solves water balance equation:
  \[ w_{n+\Delta t} = w_n + (P_n - E_n - Q_n) \Delta t \]
  with \( \Delta t = 1 \) day. It is further assumed that:
  \[ \frac{Q_n}{P_n} = \left( \frac{w_n}{c_s} \right)^\alpha \text{ with } \alpha \geq 1 \]
  \[ \frac{\lambda \rho_w E_n}{R_n} = \beta_0 \left( \frac{w_n}{c_s} \right)^\gamma \text{ with } \gamma > 0 \text{ and } \beta_0 \leq 1 \]
  - the parameter set \((c_s, \alpha, \beta, \gamma)\) is fitted to maximize the correlation between modeled and observed streamflow \(Q_n\)
Fitted functions, SM-histogram and coupling strength

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\]
Modeled vs. observed soil moisture time series
Soil Moisture Memory

- Soil moisture storage results from solving the water balance, which is affected by anomalies of meteorological forcing
  - For example: Higher temperature, more evaporation, less soil moisture
- Hence, soil moisture anomalies are represented longer in the soil
  → soil moisture memory
- Can be used for forecasting!
Soil Moisture Memory

![Soil Moisture Memory Graph](image)

- **Default lag (Days):** 10, 20, 30, 40
- **Correlation:** 0.0 to 1.0
Getting started

1. Install R
2. Install RStudio via: https://www.rstudio.com/products/rstudio/download/#download
3. Download the zipfile with everything you need to run the model from the course website (Modellierung mit einem Landoberflächen-Modell):
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     ▶ pay_meteo_1998-2012.txt
     ▶ PAY_SM_2008-12.txt
     ▶ simplemodel.R
     ▶ SoilMoisture_SimpleModel_Payerne_1998-2012
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4. Then copy the resulting line into the following command and replace ”Documents” by ”Desktop”, like this: `setwd("C:/Profiles/Jasper/Desktop")`. Type this statement in the console window
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2. Load the model code by typing `source('Ex3_simplemodel/simplemodel.R')` in the console window
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2. Load the model code by typing `source('Ex3_simplemodel/simplemodel.R')` in the console window.

3. Run the model for site Payerne (Switzerland) by typing `simplemodel(exp_runoff=6.4,exp_et=0.06,beta=0.66)` in the console window (when you copy this statement make sure that you’ve got the underscore `_`).