Introduction

- Nete catchment area: 1540 km²

Existing MODFLOW groundwater model

- 9644 active cells
- 400 x 400 m
- 16 layers

Challenging geometry:
- thickness 0 to 200 m
- wedging out layers
Coupling to improve the groundwater recharge

- Current model: uniform recharge 280 mm y\(^{-1}\)
  - calculated with HYDRUS-1D for a typical soil profile, grass cover
- Goal of HYDRUS-MODFLOW coupling is to improve the estimation of the recharge (spatial and temporal)

**HYDRUS-MODFLOW**

- Zone definition for a Hydus simulation:
  - number of zones is a compromise:
    - averaging gw levels & fluxes
    - CPU
  - 3 criteria were chosen:
    - gw depth from calibrated steady-state model
    - soil type
    - land use
  - preliminary results: 1 soil type (typical podzol) & 1 land cover assumed on whole catchment (grass)

Issues during practical implementation (1)

- Warming-up: example with 6 zones
  - GW level not yet stabilized after 1 yr
  - => need to warm up model several years

- Warming-up: example with 10 zones
Issues during practical implementation (2)

- Oscillatory behaviour, possibly leading to chaotic behaviour and non-convergence
  - solved by forcing MODFLOW time steps ≤ 1 day (= HYDRUS time step)
  - but oscillations remain (here with 3 time steps per day until 60 d after)

Issues during practical implementation (3)

- Seepage:
  - due to averaging effect and shallow groundwater, MODFLOW heads sometimes exceeds ground level

Results with 20 zones

(no calibration; only based on gw depth; 1 soil, 1 land use)

- 10 years warm-up, then 10 years simulation

Results with 20 zones

(no calibration; only based on gw depth; 1 soil, 1 land use)

- Nete catchment: average simulated recharge = 274 mm y⁻¹
  - average seepage = 32 mm y⁻¹ (mainly in zone 1)
  - Net simulated recharge = 242 mm y⁻¹
Results with 20 zones
(no calibration; only based on gw depth; 1 soil, 1 land use)

Comparison with piezometer observations

Summary

Current model:

- **20 zones**
  (1 soil, 1 land cover)

Future challenges

- Different soil types & land covers (i.e. more zones)
- Optimize CPU:
  - sensitivity to # zones
  - automation of zone def. (e.g. using std. dev. of gw depths)
- Calibration vs. piezometer data
- Seepage
- Closely examine coupling (heads and fluxes)

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