

HS2.2.1: SIMULATING HYDROLOGICAL PROCESSES WITH A FULLY COUPLED SURFACE-SUBSURFACE MODEL FOR ESTIMATING CATCHMENT TRAVEL TIMES

Adnan Moussa¹

Julian Klaus¹

Mauro Sulis¹

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 adnan.moussa@list.lu

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¹
LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY

LIST 

OBJECTIVE

- The objective of our study is to setup a robust hydrological model for the forested Weierbach catchment in Luxembourg using the coupled Parflow-CLM model
- **Parflow**: a physically based hydrological model that can be coupled with land surface model (ex. **CLM** : community land model)
- We use **Parflow-CLM** to simulate water and energy fluxes for Weierbach catchment
- Model performance is evaluated using discharge, soil moisture, groundwater level and sapfluxes data

STUDY AREA

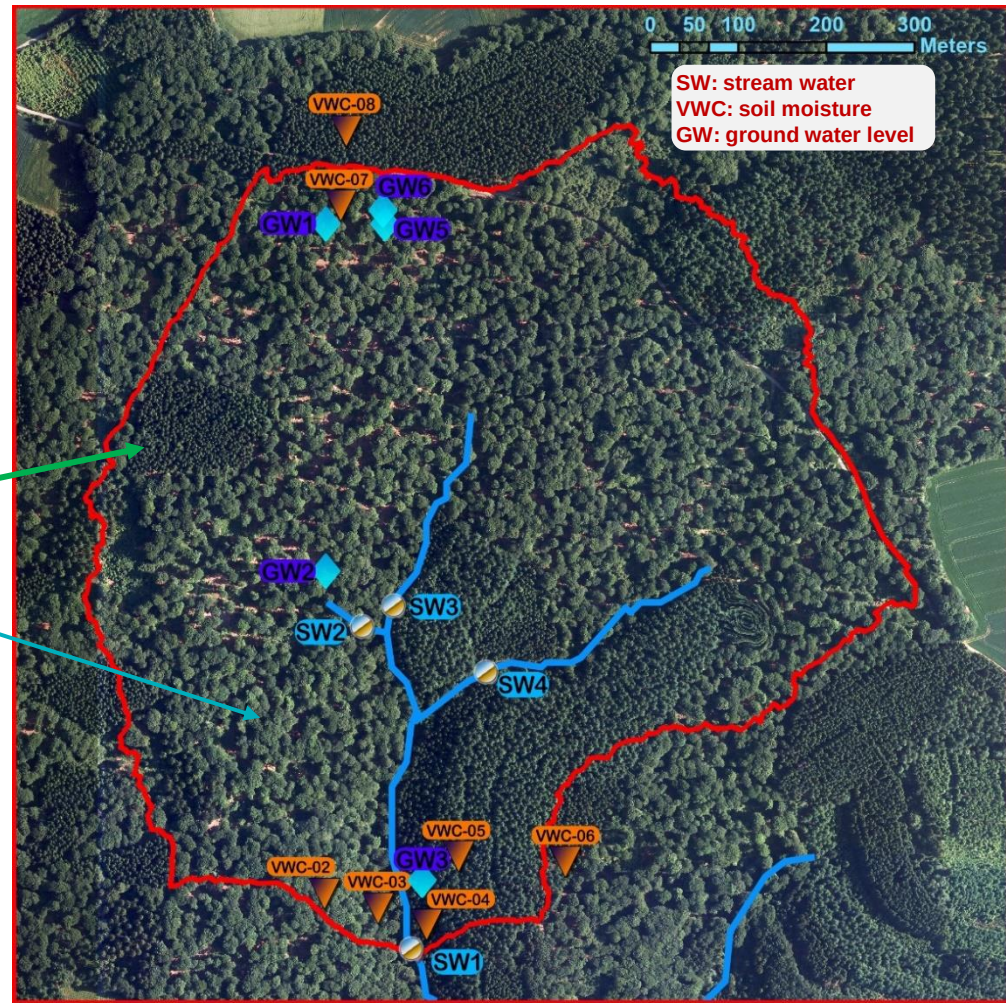
WEIERBACH CATCHMENT*, LUXEMBOURG

- **Area:** 0.42 km²
- **Avg. Precipitation:** 900 mm/yr
- **Avg. discharge:** 500 mm/yr
- **Vegetation:**

1-Evergreen needleleaf forests
(**Spruce and Douglas fir trees**)

2-Deciduous broadleaf forests (**Beech
& Oak trees**)

- **Geology:** Devonian slate/schist +
Phyllite
- **Elevation:** 450-500 m a.s.l.



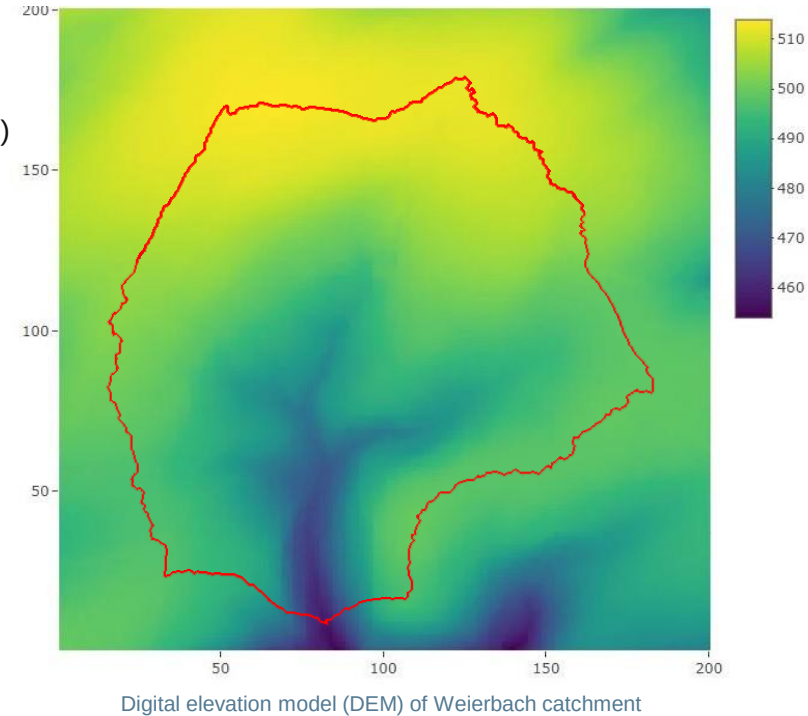
For more information:

* <https://blogs.egu.eu/divisions/hs/2020/07/29/weierbach-catchment/>

MODEL INPUTS

PARFLOW-CLM

- Terrain following grid (GW follows the topography) ⁽¹⁾
- **DEM** processed using “PriorityFlow” ⁽²⁾
- **Resolution:** 5x5 m with 200 grid cells in x and y
- Ten grid cells along z direction (total depth=5m)
- **Meteorological forcing** (long/short wave radiation, precipitation, air temperature, atmospheric pressure ,wind speed,specific humidity)
- Two **Land cover** types (mentioned in the study area)
- **Initial boundary condition:** water pressure file extracted from spin-up simulation
- No flow boundary condition along the sides of the domain as well in the bottom of the domain



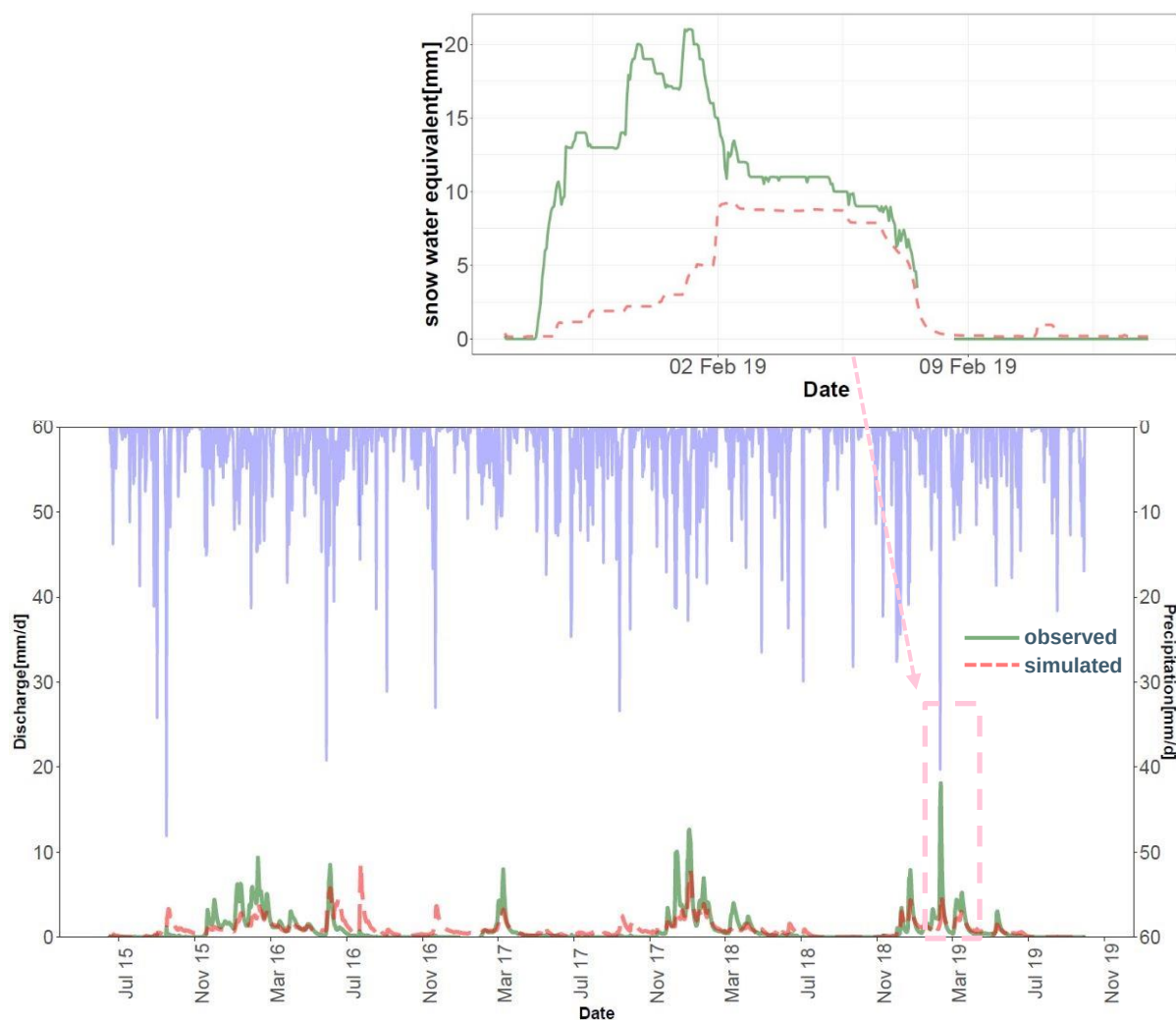
Ref:

(1) Maxwell (2013) <https://doi.org/10.1016/j.advwatres.2012.10.001>

(2) Condon, LE and RM Maxwell (2019) <https://doi.org/10.1016/j.cageo.2019.01.020>

MODEL VALIDATION DISCHARGE + SNOW MELT

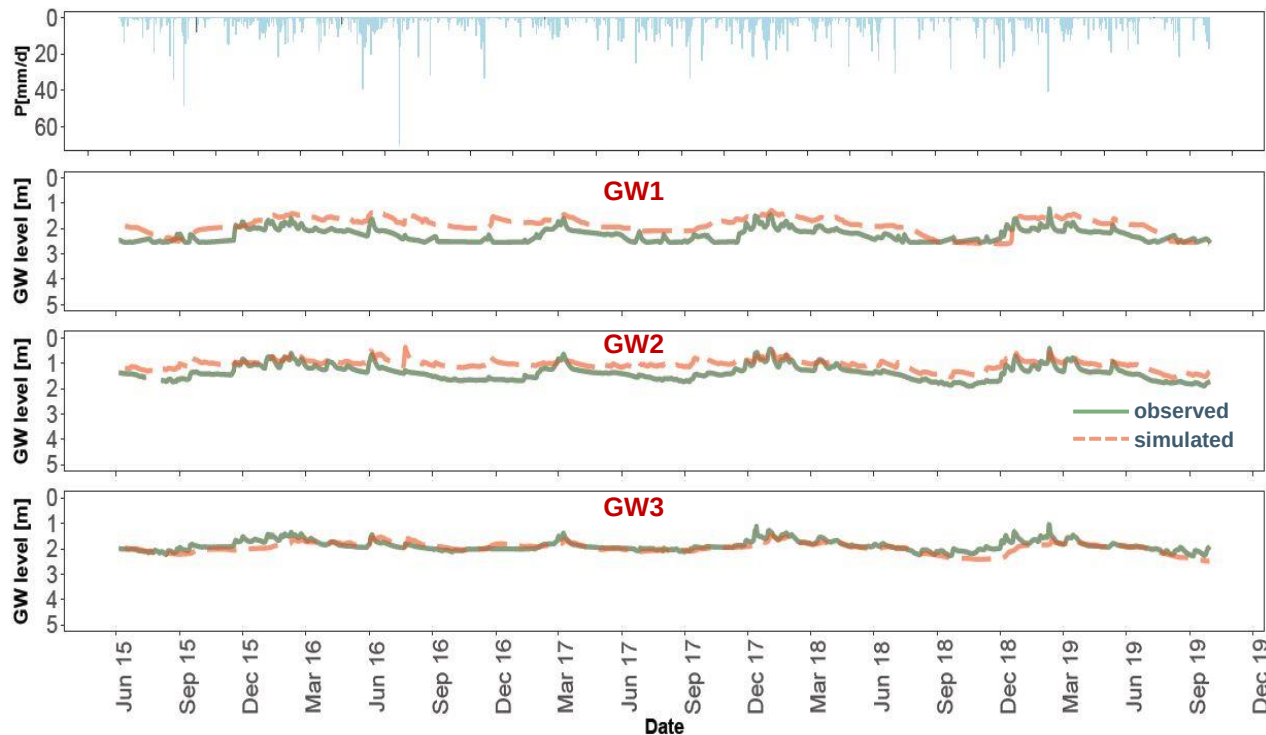
- The observed discharge at (SW1) was fairly predicted for the 4 years simulation along with the seasonal variation
- The value of Nash-Sutcliffe coefficient and Kling-Gupta is 0.51 (4 years)
- During the 2nd month of 2019 the model underestimated the snow melt as shown in the figure above



MODEL VALIDATION GROUND WATER DEPTH

- The dynamic of the observed groundwater level for the three different locations was well reproduced

GW	KGE	Pearson coeff
GW1	0.516	0.614
GW2	0.535	0.792
GW3	0.705	0.71

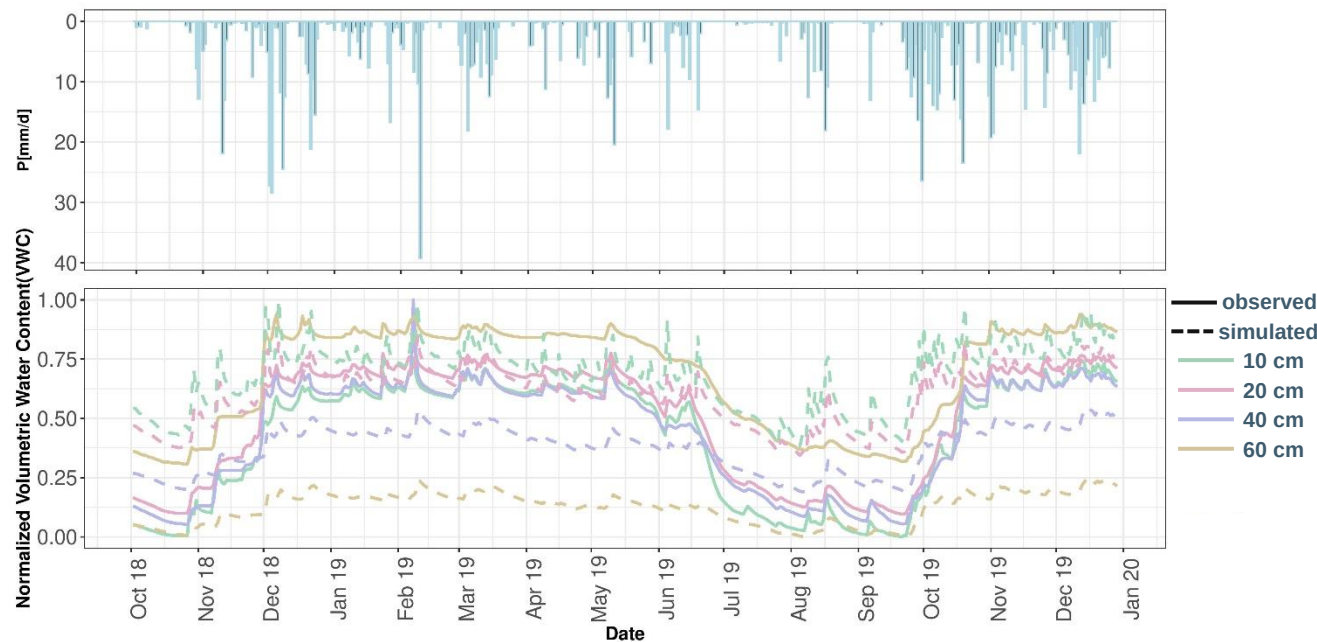


Groundwater level observed and simulated at 3 locations

MODEL VALIDATION

VOLUMETRIC WATER CONTENT

- The Soil moisture at VWC-07 shows a high correlation with the simulated one
- Pearson coeff. > 0.85 for all depths

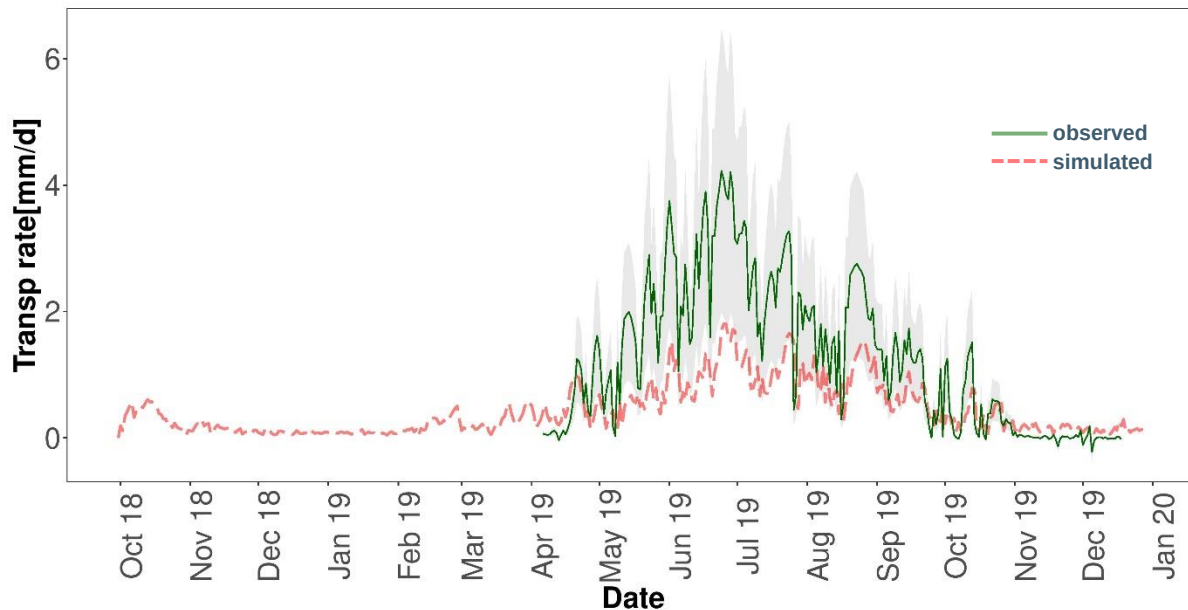


Soil moisture observed and simulated at VWC-07 for 4 different depths for the year 2018-2019

MODEL VALIDATION

TRANSPIRATION

- Observed transpiration was averaged from the sapfluxes (more details can be founded Schoppach et al. 2021 [here](#))
- Transpiration rate was underestimated while the dynamic of the 2019 growing season was well reproduced with pearson coeff. = 0.83



Transpiration rate observed (mean & standard deviation) and simulated for growing season 2019

FUTURE WORK

- Further work needed for validating the transpiration rate
- We will use the particle tracking model **EcoSLIM** to estimate the travel time and water ages of discharge and evapotranspiration to further understand the catchment processes