Modelling streamflow to get insights about catchment characteristics

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Data analysis
Streamflow vs Meteorological variables
Precipitation and streamflow data show a strong variability between the catchments and a good correlation (figure 1). There is no visible correlation between streamflow and potential evapotranspiration.

Lumped and distributed models
We compared the performance of 4 model structures (generated with SUPERFLEX, Fenicia et al., 2011). All the models have a snow reservoir that is not shown in the schemes. The models were first applied with spatially uniform parameters ( lumped and distributed states). The best performing model (M 4) was then applied with spatially distributed parameters.

Residual error model
In order to describe uncertainties, we use the expression $\text{RMS}_f = \sqrt{\text{E}^2 + \text{B}^2}$ where $\text{E}$ is the Bias Coefficient transformation, with $\text{E} = -0.5$ and $\text{B}$ is the transposition, and the error is assumed to be normally distributed with zero mean and constant calibrated variance.

Inference scheme
The model parameters are calibrated to observed data using a Bayesian inference approach

$P(D|M) \propto P(M|D)P(D)$

Depending on the simulation, the model is calibrated at the single gauging station or in all the stations together. A calibration-validation in time scheme has been used. All the plots displayed in the poster are analogous.

Uniform parameters
Nash - Sutcliffe efficiency

$\text{NSE} = 1 - \frac{\text{ SSR }_{\text{obs}}}{\text{ SSR }_{\text{mod}}}$

where $\text{ SSR }_{\text{obs}}$ and $\text{ SSR }_{\text{mod}}$ are the observed and simulated sum of squared residuals, respectively.

Model configuration
Model name | Model configuration | Calibration | BAFU | SNF | Eff.
--- | --- | --- | --- | --- | ---
M 1 | Lumped, Topo | Uniform | | | Excellent
M 2 | Lumped, Topo | Distributed | | | Excellent
M 3 | Lumped, Geo | Distributed | | | Excellent
M 4 | Distributed, Topo | Distributed | BAFU | SNF | Excellent

Conclusion
Best performance of the different configurations

Distributing the states ensures an excellent representation of the water balance but only distributing the parameters gives a good correlation of the signatures. There is an underestimation of the flashiness index probably due to limitations in the likelihood.

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References

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Research objectives
What causes streamflow variability? How much is it caused by climatic conditions and variability? How much is it caused by catchment properties (e.g. geology vs topography)?

Data analysis
• What is more effective distributing the states or the proper-
• Is more effective distributing the states or the proper-

Study area
The Thur is an alpine and peri-alpine catchment in the north-east of Switzerland and it is characterized by a large spatial variability in terms of climatic conditions and physical characteristics.

Model
Distributed vs uniform parameters
Simulated vs measured streamflow

Elevation + Geology:

Streamflow vs Meteorological variables
Precipitation and streamflow data shows a strong variability between the catchments and a good correlation (figure 1). There is no visible correlation between streamflow and potential evapotranspiration.

What we have learnt
• Using other catchment properties to define the HRUs (soil, groundwater resources, land cover, etc.).
• Improve the snow representation.
• Analyse the simulated hydrograph in detail to spot model weaknesses.

What’s next?
• Improve the snow representation.
• Analyse the simulated hydrograph in detail to spot model weaknesses.

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