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How useful are stream level observations for model calibration?

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Streamflow estimation in ungauged basins is especially challenging in data-scarce regions and it might be reasonable to take at least a few measurements. Recent studies demonstrated that few streamflow measurements, representing data that could be measured with limited efforts in an ungauged basin, might be needed to constrain runoff models for simulations in ungauged basins. While in these previous studies we assumed that few streamflow measurements were taken during different points in time over one year, obviously it would be reasonable to (also) measure stream levels. Several approaches could be used in practice for such stream level observations: water level loggers have become less expensive and easier to install and can be used to obtain continuous stream level time series; stream levels will in the near future be increasingly available from satellite remote sensing resulting in evenly space time series; community-based approaches (e.g., crowdhydrology.org), finally, can offer level observations at irregular time intervals. Here we present a study where a catchment runoff model (the HBV model) was calibrated for gauged basins in Switzerland assuming that only a subset of the data was available. We pretended that only stream level observations at different time intervals, representing the temporal resolution of the different observation approaches mentioned before, and a small number of streamflow observations were available. The model, which was calibrated based on these data subsets, was then evaluated on the full observed streamflow record. Our results indicate that streamlevel data alone already can provide surprisingly good model simulation results, which can be further improved by the combination with one streamflow observation. The surprisingly good results with only streamlevel time series can be explained by the relatively high precipitation in the studied catchments. Constructing a hypothetical catchment with reduced precipitation resulted in poorer performance when calibrating with only streamlevels and an increased value of the additional streamflow observation.
These results are encouraging for hydrological observations in data scarce regions as level observations are much easier to obtain than streamflow observations. Based on runoff modeling it might be possible to derive streamflow series from level observations using loggers, satellites or community-based approaches. The approach presented here also allows comparing the value of different kind of (level) observations and, thus, to guide the monitoring of (previously) ungauged basins.