Hydrol. Earth Syst. Sci. Discuss., 3, S785–S790, 2006
www.hydrol-earth-syst-sci-discuss.net/3/S785/2006/

Hydrology and
Earth System
Sciences
Discussions

Interactive comment on “Technical Note: Real-time updating procedure for flood forecasting with conceptual HBV-type models” *by* Th. Wöhling et al.

Th. Wöhling et al.

Received and published: 26 August 2006

With the technical note we aim to present a simple updating procedure for flood forecasting with the PREVAH model. Although it is a tailor made solution for this model, it is applicable for other HBV-type models as well. It might even be easier to implement the proposed procedure in those models when the handling of the temporal resolution is straighter forward. The reason why we have to use a work-around in PREVAH is historical. The original model (e.g. in Gurtz et al. 1997) was developed by coupling different modules at daily time step. For better representation of the hydrological response from mountainous basins the computation of snow cover dynamics and runoff generation was then extended to the hourly time step (e.g. Gurtz et al. 2003 and Zappa et al. 2003). Evapotranspiration is still based on algorithms requiring daily meteorological input and is computed prior to the runoff generation in order to update the soil moisture storage (Gurtz et al. 1999). Thus, all hourly data has to be aggregated to the daily time step before running the runoff module. This requires reading all input data for one day at the beginning of a new day (and saves by the way some in/out activity). Therefore PREVAH has a time loop structure, which seems to be confusing. And therefore we use a vector with 24 updating factors for a simulation day rather than just using one factor calculated at the end of each hourly time step. In a later version of PREVAH it is anticipated to reverse the two inner loops of the loop structure and thus calculate the flow components from the HRUs at hourly time steps. Since this requires substantial recoding of a comprehensively grown program code, and thus a substantial amount of time and money, we are not able to do that in the near future. However, we like to show that it is possible to improve flood forecasting also for real time applications - with relatively simple means. Many conceptual models for flood forecasting have been developed in the past as have updating procedures for these models. To discuss and compare but a number of these models and procedures would certainly go beyond the scope of this contribution which is therefore submitted as technical note and not as full paper.

Specific remarks:

Volume Balance: Improvement on the prediction of emerging flood events is the main aim of the proposed updating procedure. It is not feasible to include conservation of mass in the updating since the systems response would be much to slow. However we have calculated the mass balance error when continuously updating the events in the Verzasca catchment to be in the range of 5..10%. Naturally this would be too much for water balance calculations. But water balance calculations with the calibrated model in both the Linth and the Verzasca catchments match well with the observations.

Size of the basins: Yes, we agree, scale is something very subjective. We consider that PREVAH is well able to describe the behavior of basins with areas from 50 to 2000 km2, whereby the reaction times should be bigger than 1-2 hours. The procedure itself should work also for other dimensions and shorter corrivation times. In such case other models are required.

To understand the **meaning of SUZ** in PREVAH, we cite from Gurtz et al. 2003, with reference on Figure 2.: "*In PREVAH the soil water reservoir and to the runoff storages are calculated in spatially distributed manner as a function of the plant-available soil moisture storage (SSM) content and of the soil characteristics of the HRUs. The submodels for runoff generation are derived from the HBV-model (Bergström, 1976), but they were adapted to the HRU structure. The changes on the HBV structure allow the dynamic parameterization of every HRU according to its land surface and soil characteristics. The capacity of plant-available soil moisture storage (SSM) is limited by the average plant-available field capacity, and is related to the average soil depth or the average root depth within the grid elements summarized by specific HRU. The land surface runoff (RS), the interflow (RI), and the percolation to the groundwater storage (SG1 and SG2) are generated in the upper runoff storage (SUZ). Baseflow (RG) is produced by the combination of two linear groundwater reservoirs with a fast and a delayed component (Fig. 2). The computation of all the previously described water fluxes is computed separately for each HRU. The storage coefficients for runoff generation are catchment specific parameters which have to be estimated by calibration.*"

HBV-Version: No original HBV code is included in PREVAH. The model was programmed following the equations published by the HBV developers and others. We refer again to Gurtz et al. (2003) and to Zappa and Gurtz (2003) for a more detailed discussion on the HBV-like runoff generation of PREVAH.

HBV Acronym: The definition of HBV is rarely given in technical literature. It can be found on the developers site: The HBV-model is named after the abbreviation of Hydrologiska Byråns Vattenbalansavdelning (Hydrological Bureau Water balance-section).

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Data basis interpolation: Since 1999 we adopt the standard defined by Gurtz et al. (1999) for all PREVAH applications in Swiss basins. In this study the model forcing was obtained from automatic meteorological stations of MeteoSwiss on a hourly time basis. Additional information on precipitation was obtained from a dense network of daily rain gauges. The spatial interpolation relies on interpolation schemes similar to that of Garen and Marks (2001) and Klok et al. (2001). The interpolation algorithms adopted here is an elevation de-trended inverse distance weighting. For the Verzasca basin we adopted 4 automatic hourly stations and six rain gauges. For the Linth we used 5 automatic stations and 23 rain gauges. The choice of the stations considered the need for stations at high elevations in order to better represent the temperature gradients. For operational application of the Linth only the automatic stations were available.

Model runs: The model runs on a continuous basis. The model conditions can be stored at the end of any day. The model run can be continued from this date at any later point in time. This allows making scenarios for certain events or periods. We used this option to make event based runs for the presented floods. Prior to the operational running mode with updating, the model is calibrated on the average hydrograph of the calibration period to obtain a better fit of the shape of the flood events.

Channel routing: In case of headwater basins like the two presented watersheds, channel routing is done implicitly by means of the calibrated storage coefficients; no routing is done from upstream and downstream HRU within a specific basin. This is one of the conceptual ideas of PREVAH.

Eq. (1): It should read a minus sign between the brackets in the denominator of Eq. (1). The index j is the count of iterations as described in the original text.

VOL: Yes positive and negative deviation can compensate. Thus, the VOL value gives only insight if the simulated discharge volume is close to the observation. No discrimination is made if this deviation occurs due to large compensation of positive and negative deviations. The NSE score accounts already for that implicitly.

NSE Logarithmic: Eg: Hock (1999): The NSE score quantifies the relative improvement of the model compared with the mean of the observations. Any positive value corresponds to an improvement. NSE tends towards unity when S_i tends towards O_i.

$$NSE = 1 - \frac{\sum_{i=1}^{n} \left|O_i - S_i\right|^2}{\sum_{i=1}^{n} \left|O_i - \left[\frac{1}{n}\sum_{i=1}^{n} O_i\right]\right|^2} \tag{1}$$

The logarithmic formulation of NSE (Hock 1999) gives valuable indications on the model performance in the case of discharge simulations during the low-flow periods in winter.

$$NSE^{log} = 1 - \frac{\sum_{i=1}^{n} \left|ln\left(O_i\right) - ln\left(S_i\right)\right|^2}{\sum_{i=1}^{n} \left|ln\left(O_i\right) - \left[\frac{1}{n}\sum_{i=1}^{n} ln\left(O_i\right)\right]\right|^2} \tag{2}$$

References

Garen, D., and Marks, D.: Spatial fields of meteorological input data including forest canopy corrections for an energy budget snow simulation model. In: Dolman, A.J., Hall, A.J., Kavvas, M.L., Oki, T. and Pomeroy, J.W. (Eds.). Soil-Vegetation-Atmosphere Transfer Schemes and Large Scale Hydrological Models, IAHS Publication No. 270, 349-353, 2001.

Gurtz, J., Baltensweiler, A., Lang, H., Menzel, L., Schulla, J.: Auswirkungen von klimatischen Variationen von Wasserhaushalt und Abfluss im Flussgebiet des Rheins. vdf Hochschulverlag an der ETH Zürich: Schlussbericht NFP 31: "Klimaänderungen und Naturkatastrophen";1-147, 1997.

Gurtz, J., Baltensweiler, A., Lang, H.: Spatially distributed hydrotope-based modelling of evapotranspiration and runoff in mountainous basins. Hydrological Processes 13: 2751-2768, 1999.

Gurtz, J., Zappa, M., Jasper, K., Lang, H., Verbunt, M., Badoux, A., Vitvar, T.: A comparative study in modelling runoff and its components in two mountainous catchments. Hydrological Processes 17: 297-311, 2003.

Hock, R.: A distributed temperature-index ice- and snowmelt model including potential direct solar radiation. Journal of Glaciology 45: 101-111, 1999.

Klok, E.J., Jasper, K., Roelofsma, K.P., Gurtz, J., Badoux, A.: Distributed hydrological modelling of a heavily glaciated Alpine river basin. Hydrological Sciences Journal-Journal Des Sciences Hydrologiques 46: 553-570, 2001.

Zappa, M., Gurtz, J.: Simulation of soil moisture and evapotranspiration in a soil profile during the 1999 MAP-Riviera Campaign. Hydrology and Earth System Sciences 7: 903-919, 2003.

Zappa, M., Pos, F., Strasser, U., Warmerdam, P., Gurtz, J.: Seasonal water balance of an Alpine catchment as evaluated by different methods for spatially distributed snowmelt modelling. Nordic Hydrology 34: 179-202, 2003.