

A flood forecasting system for the river Inn – case studies of successful and failure applications



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Background & Scope

Flood forecasting in alpine catchments is challenging due to the spatial variability of topography which in consequence causes high spatial variability of meteorological processes, e.g. precipitation, temperature or solar radiation. The snow cover plays a key role for runoff generation and the storage or release of water. Although headwater areas often are remote and sparsely populated, downstream areas with higher population density and infrastructure are affected by runoff processes in alpine catchments. In addition, hydropower production in alpine catchments influences (and is influenced by) runoff processes. Hence, accurate flood

forecasting with as little predictive uncertainty as possible is required in water management of catchments with multiple users. This study presents the flood forecasting system “HoPI” (*Hochwasser-Prognosesystem Inn*) which was developed for the Tyrolean part of the river Inn catchment in Austria. The HoPI system is currently run in a test mode and is under further development. This work will present the model structure and show examples discharge / flood forecast simulations with the HoPI system and discuss the reasons for successful or failure applications.

The HoPI system

Study area

- The HoPI model system is run for the Tyrolean part of the river Inn catchment.
- Catchment area: 6740 km²
- Non-glacierized area: 6290 km² (modelled with Hqsim)
- Glacierized area: 460 km² (modelled with SES)
- Forecast horizon: 48 h

Fig. 1: Tyrolean part of Inn catchment (coloured)

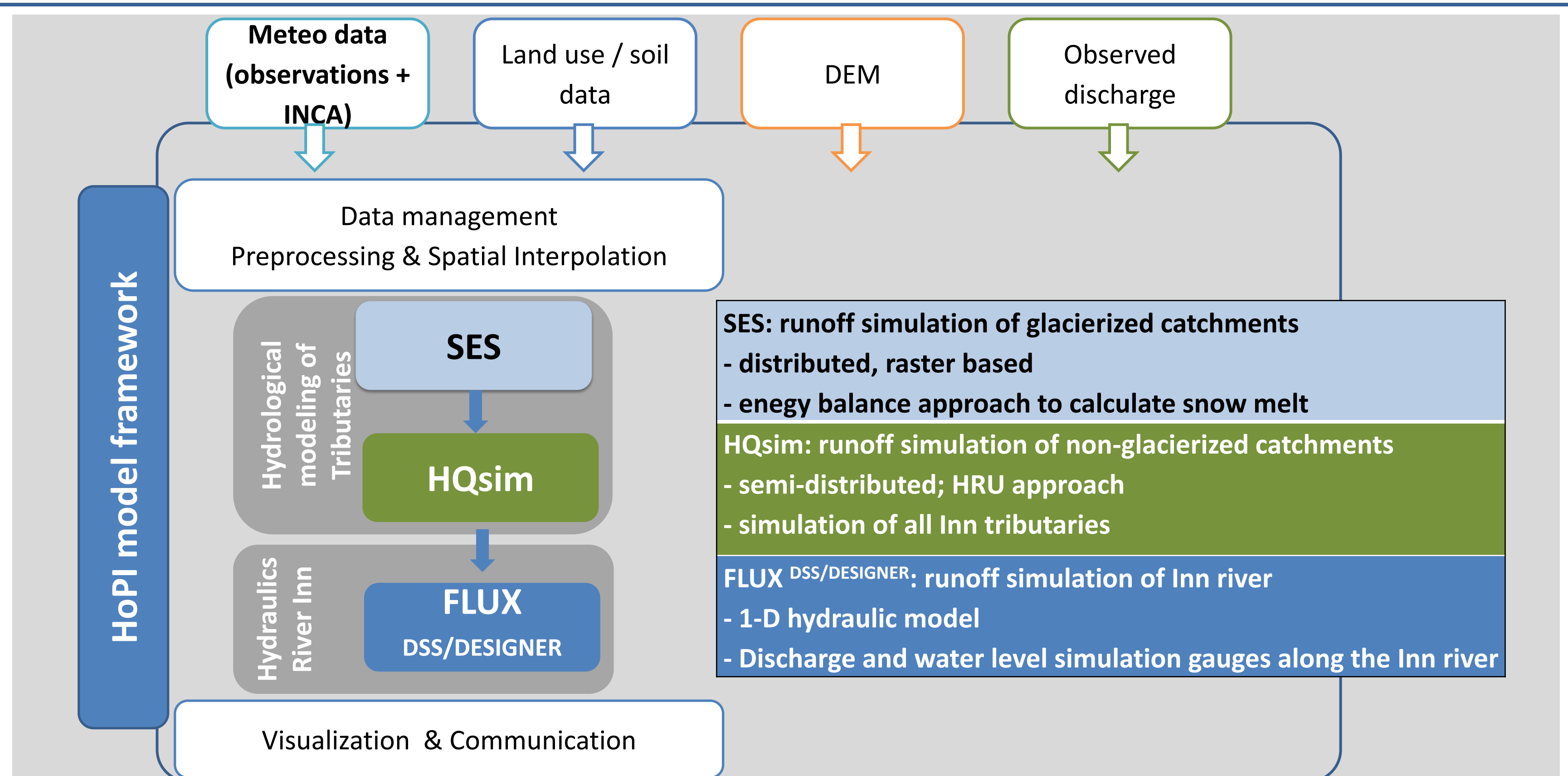
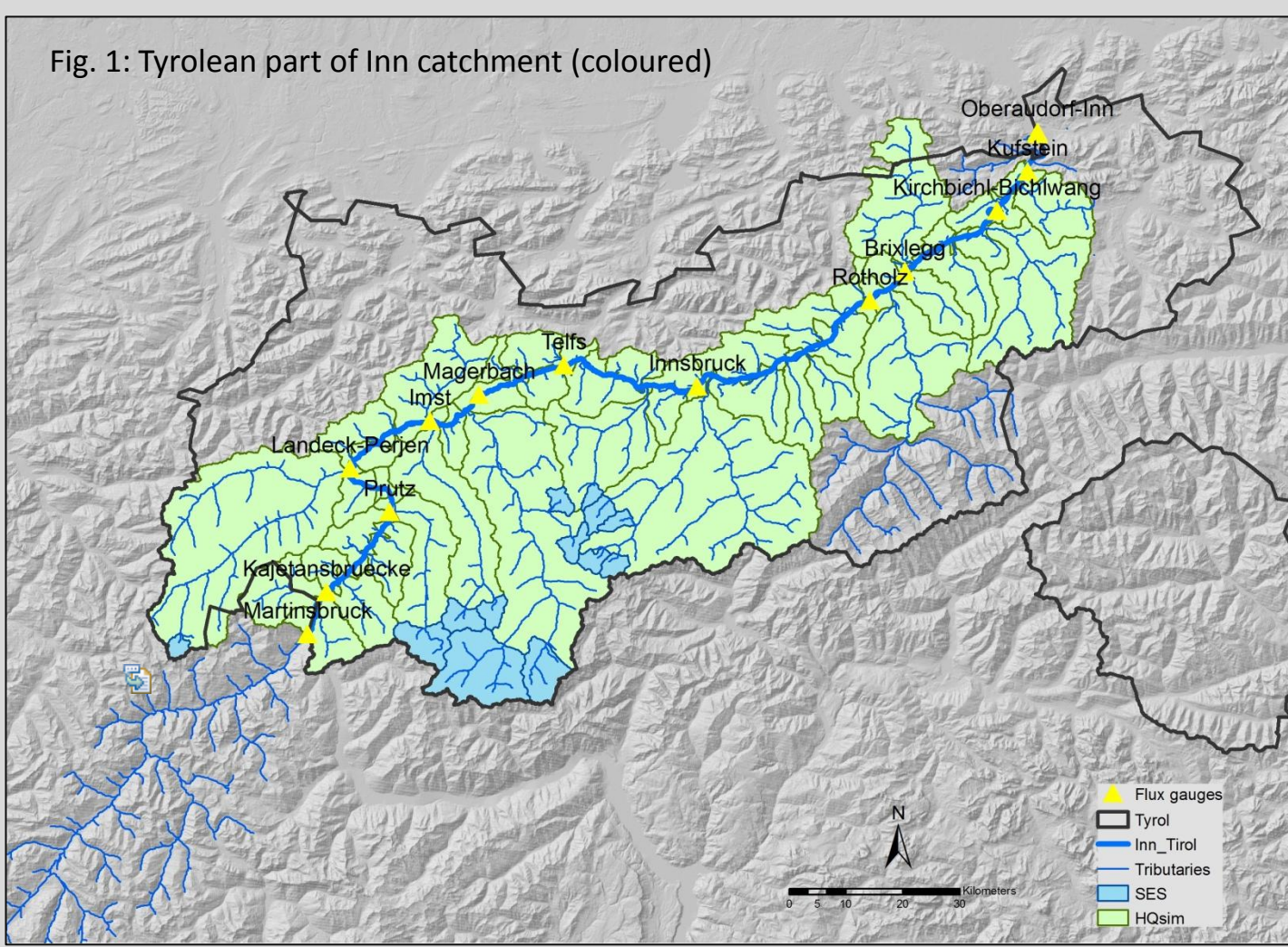


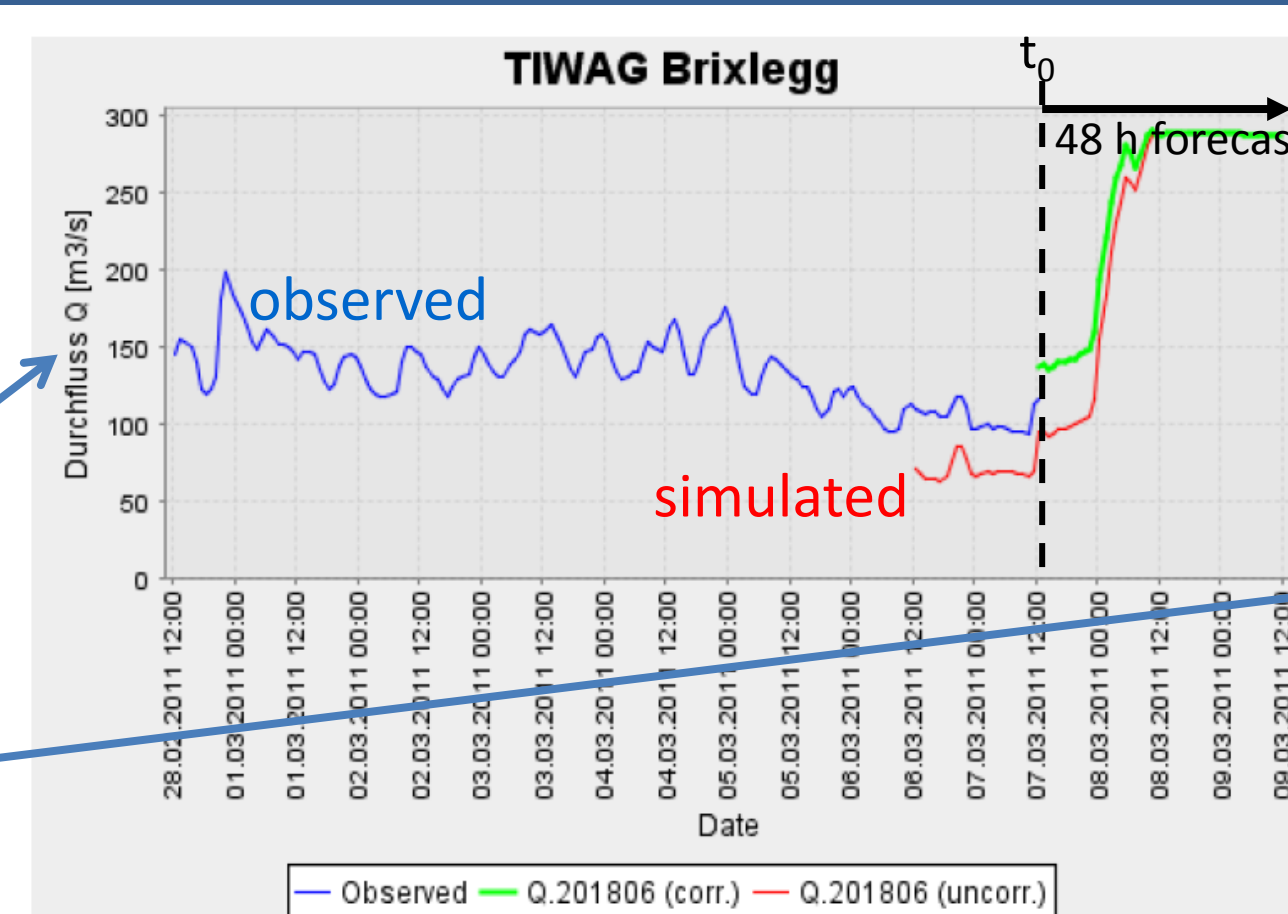
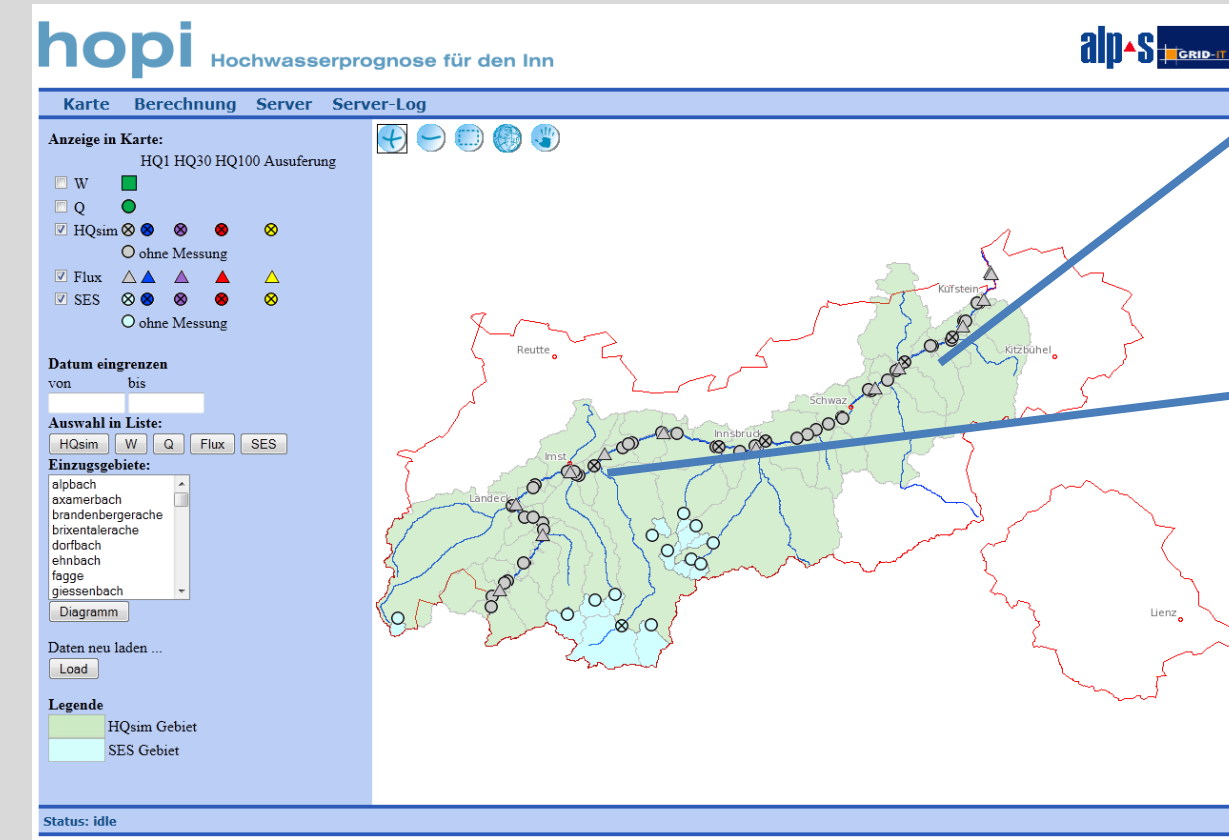
Fig. 2: HoPI model components

The system is run with a 48 h forecast horizon. Driving force to the models during the forecast period is the meteorological forecast model INCA (Integrated Nowcasting through Comprehensive Analysis). The data set consists of all required input parameters. The meteorological forecast data is already provided as spatially distributed data set on a 1 km grid. The forecast period of +48 h consists of a nowcasting part (first 6 hours) and a numerical weather modeling part.

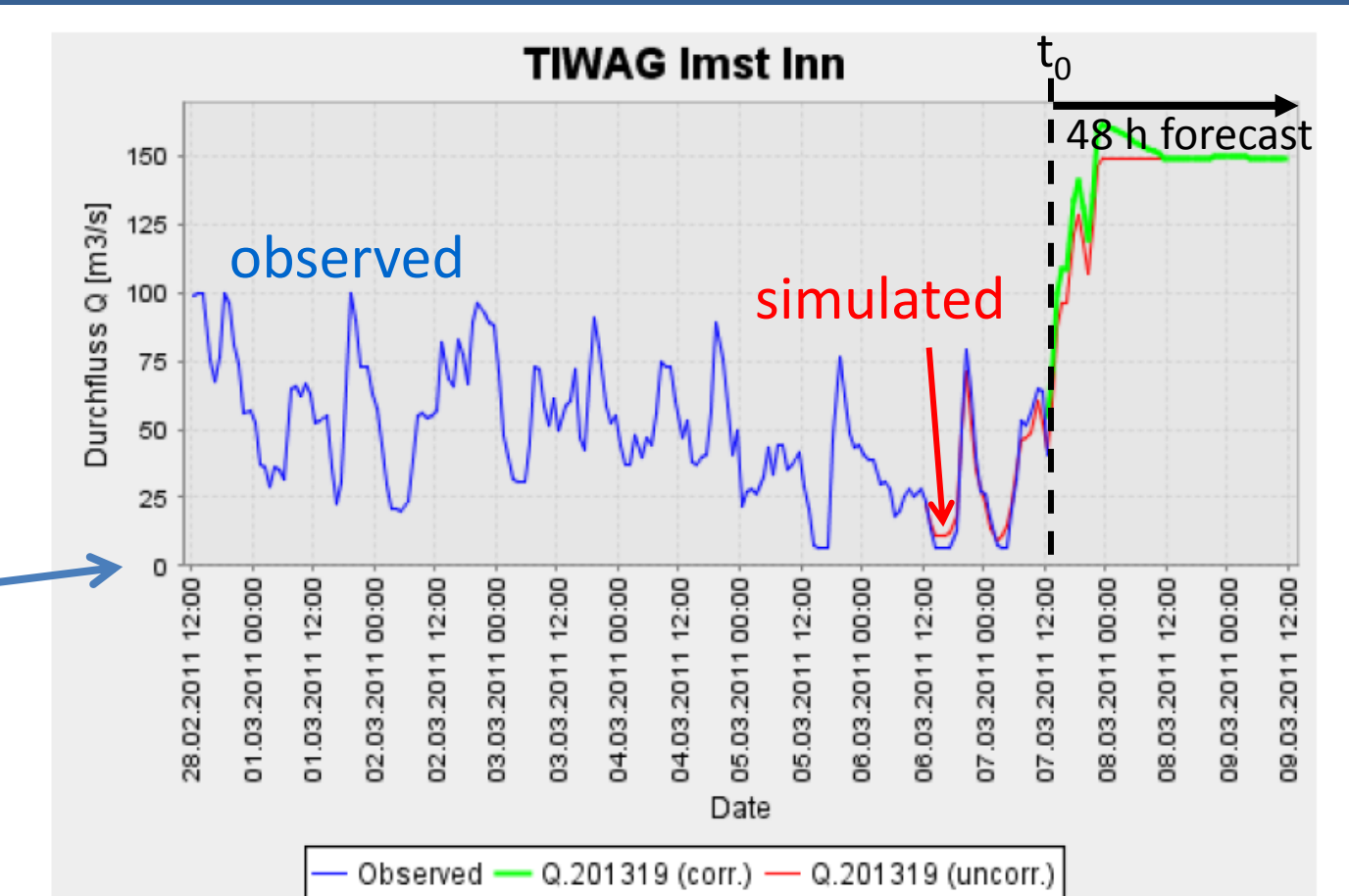
Examples

HoPI web interface

The results of the hydrologic and hydraulic simulations of the SES, Hqsim, and Flux model can be visually assessed through a web interface (non-public). Coloured symbols indicate whether the discharge simulation exceeds certain warning levels (e.g. HQ 1, HQ 30, HQ 100).



- Bias between observed and simulated discharge until t_0 due to information lack in partly ungauged catchment
- Increase in discharge simulation during 48 h forecast: discharge from hydropower plant is assumed to be at maximum (usually not realistic)



- Good agreement between observed and simulated discharge until t_0
- Increase in discharge simulation during 48 h forecast: discharge from hydropower plant is assumed to be at maximum

Summary & further challenges

Despite the complex hydrological processes in an alpine catchments like the Inn river and the uncertainties related to input data (e.g. precipitation distribution due to complex topography), the HoPI flood forecasting system provides a valuable tool for water management applications. The hydrologic/hydraulic simulation using observed data in general provides satisfying results. The parameterization of sub-catchments with biased results is currently being improved, as is the simulation of snow-hydrologic processes. In order to improve the 48 h hydraulic forecast for the Inn river, the management schemes of the hydro-power plants need to be implemented in a more realistic way in the HoPI system.

Current developments

- Uncertainty analysis with respect to model structure (Hqsim) and meteorological input data
 - Implementation of management schemes of hydro-power plants
 - Improvement of representation of snow-hydrological processes (e.g. snow cover distribution, snow accumulation, snow water equivalent)
- References:
- EGU2011-10169, Schöber et al.: The potential of airborne laser scanning driven snow depth observations for modelling snow cover, snow water equivalent and runoff in high alpine catchments (HS 2.13)
 - EGU2011-2156, Helfricht et al.: Modelling of snow- and icemelt contribution to Alpine streamflow at different scales in the Ötztal Alps (Tirol, Austria): the alpS MUSICALS project (HS 2.13)