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Assessing variability in surface water-groundwater dynamics using combined hydraulic and tracer methods

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Ground water-surface water interaction in a lowland headwater stream, the Holtum in Denmark, is studied with focus on the spatial and temporal variability which occur at relatively small spatial scales (from 200 m to 5 km). At four selected sites along a 5 km reach of the stream, stream water has been collected during two rainfall events in May and September 2012. During both events the sampling frequency was 3 hours and the total sampling period was 6 days and 10 days respectively. Daily precipitation samples were collected during the September event. Water samples from deep and shallow groundwater wells were sampled prior to the May event at all four locations, which gives the possibility of addressing the uncertainty in end-member composition. All water samples have been analysed for δ18O, D and Electrical Conductivity.

From March 2012 continuous water velocities and water stage were measured at each of the two most downstream stations (2 km distance) to give detailed hydrographs. Velocities were measured with two Acoustic Velocity Meters (AVM) placed in two different heights above the stream bed. A field campaign was carried out in June 2012 where a DTS cable was laid out in the along stream direction between the two AVM stations, measuring temperature changes at the stream bed for 24 hours. At the same time detailed discharge measurements were conducted with an Acoustic Doppler Current Profiler (ADCP), for every 200 m.

The objectives of the study are to investigate changes in end-member fractions between the four selected sites both temporally as the precipitation event progresses, as well as spatially between the four stations. This will be done by carrying out a three-component analysis with the end-member fractions consisting of shallow groundwater, deep groundwater and precipitation, based on a maximum likelihood method which allows for uncertain end-members. In addition, a hydrograph separation will be carried out at the two AVM stations, and this analysis will be compared to the tracer hydrographs and the DTS/ADCP campaign, to investigate whether any temporal and spatial changes in the two types of hydrographs are linked in order to detect and quantify groundwater inputs to surface water.