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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Linking baseflow separation and groundwater storage dynamics in an alpine basin (Dammagletscher, Switzerland)" *by* F. Kobierska et al.

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Revised figures.

Figure 1. The Damma glacier forefield: at sites S1, S3, S5 and S6 (solid circles), stream and groundwater levels are recorded. At site S7 (solid square), stream stage is measured for total discharge. At site S8 (solid triangle), only one piezometer is installed. Color patches indicate zones of high (H1, H2 and H3) and low (L1, L2) electrical conductivity. An automatic weather station (AWS) is located in the middle of the forefield. Lateral moraines are indicated with dashed black lines and terrain

elevation is shown by 10 m contour intervals. (Figure adapted from Magnusson et al., 2014).

Figure 2. Baseflow recession during November 2008. The lower panel shows measured and modelled discharge at S7 on a logarithmic scale. The dotted black line illustrates how the modelled baseflow recession diverges from measured discharge before November 15th. Note that melting periods (non-negative temperature of snow surface) are indicated as grey shaded bars. The upper panel plots successive rain events.

Figure 3. Schematic flow chart summarizing the functioning of the FULL model.

Figure 4. The upper section presents model results for the entire 2009 season. The lower section presents zooms on three specific weeks. For each group of three graphs, the bottom panel displays both measured and modelled discharge (m3/s) at S7. The middle panel presents infiltration and exfiltration (m3/s). Electrical conductivity (μS/cm) and rainfall (mm/h) are plotted in the upper panel. Time periods that were filtered out can be seen as gaps in the EC data (e.g., in zoom 1).

Figure 5. Modelled ratio of groundwater exfiltration to total modelled discharge (in %) as a function of total measured discharge for 2009. Only time steps with less than 10% relative error against measured discharge were plotted.

Figure 6. Recharge of the 'slow' reservoir from snowmelt in spring 2011. Snow melt periods (non-negative snow surface temperature) are indicated as grey shading. Groundwater levels, displayed in blue, represent the depth of water in each piezometer. Total discharge and reservoir depth are plotted in black. Reservoir level is computed using Eq. 10 based on a surface area of 400 by 1000 meters. The corresponding level of the full reservoir is indicated (dotted line).

Figure 7. Conceptual summary of the forefield's hydrogeology. The stream network is drawn, as well as the main groundwater springs where electrical conductivity was

measured and all electrical conductivity zones. A tentative outline of the active reservoir ('slow' + 'fast') is proposed. The discharge station S7 is not displayed as it is slightly outside of the side-cut. The lateral moraines are shown by red dotted lines.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 12187, 2014.

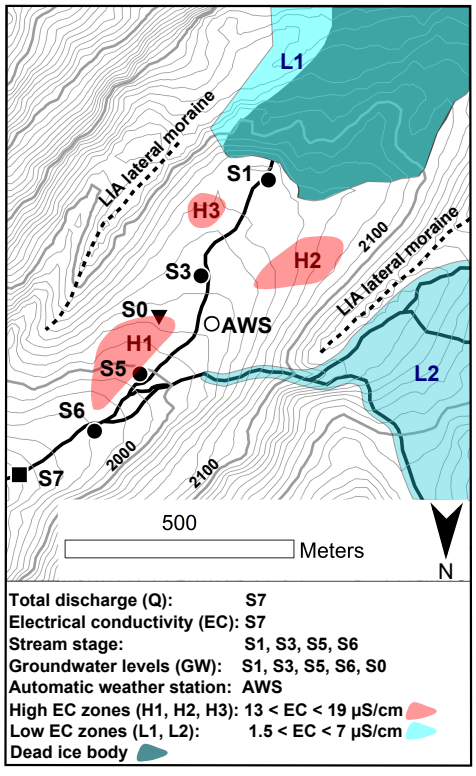

Fig. 1.

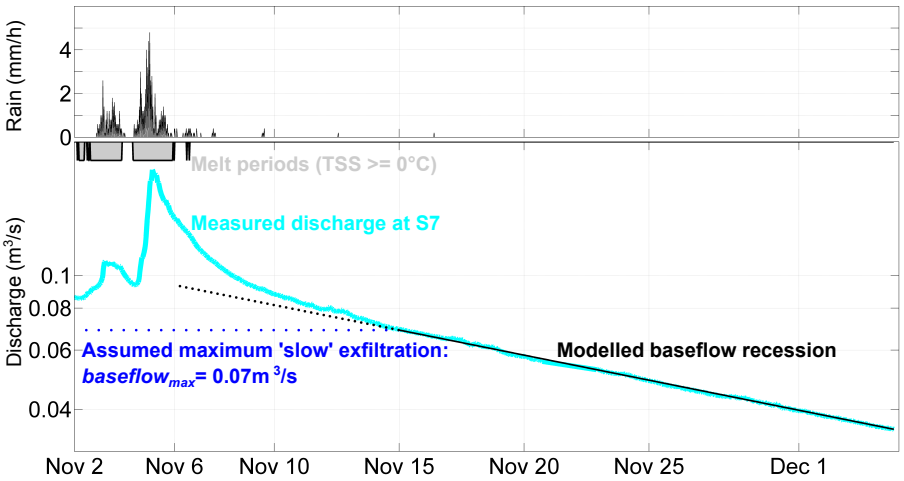
Rain (mm/h)
4
2
0
Melt periods (TSS >= 0°C)
Measured discharge at S7
Discharge (m³/s)
0.1
0.08
0.06
0.04
Assumed maximum 'slow' exfiltration:
baseflow_max= 0.07m ³/s
Modelled baseflow recession
Nov 2
Nov 6
Nov 10
Nov 15
Nov 20
Nov 25
Dec 1

Fig. 2.

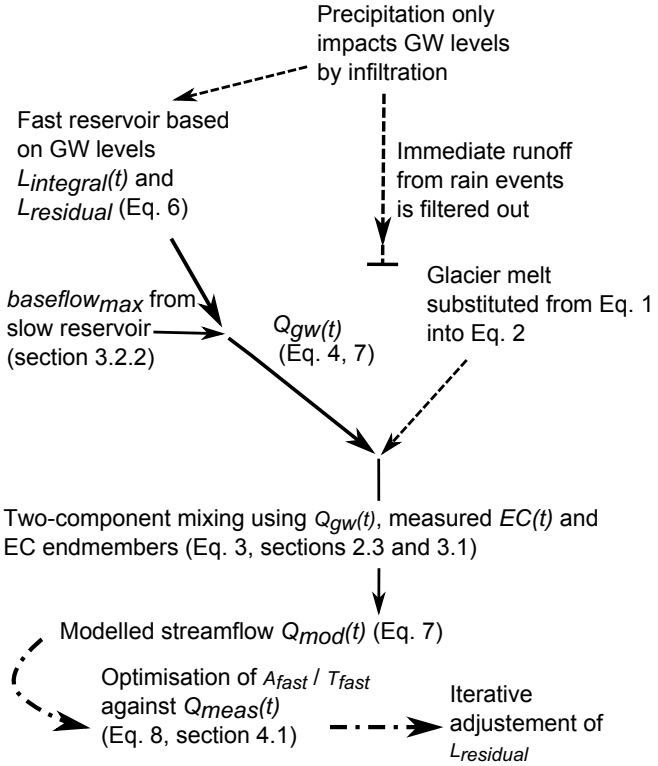
Precipitation only impacts GW levels by infiltration
Fast reservoir based on GW levels $L_{integral}(t)$ and $L_{residual}$ (Eq. 6)
Immediate runoff from rain events is filtered out
Glacier melt substituted from Eq. 1 into Eq. 2
$baseflow_{max}$ from slow reservoir (section 3.2.2)
$Q_{gw}(t)$ (Eq. 4, 7)
Two-component mixing using $Q_{gw}(t)$, measured $EC(t)$ and EC endmembers (Eq. 3, sections 2.3 and 3.1)
Modelled streamflow $Q_{mod}(t)$ (Eq. 7)
Optimisation of A_{fast} / T_{fast} against $Q_{meas}(t)$ (Eq. 8, section 4.1)
Iterative adjustement of $L_{residual}$

Fig. 3.

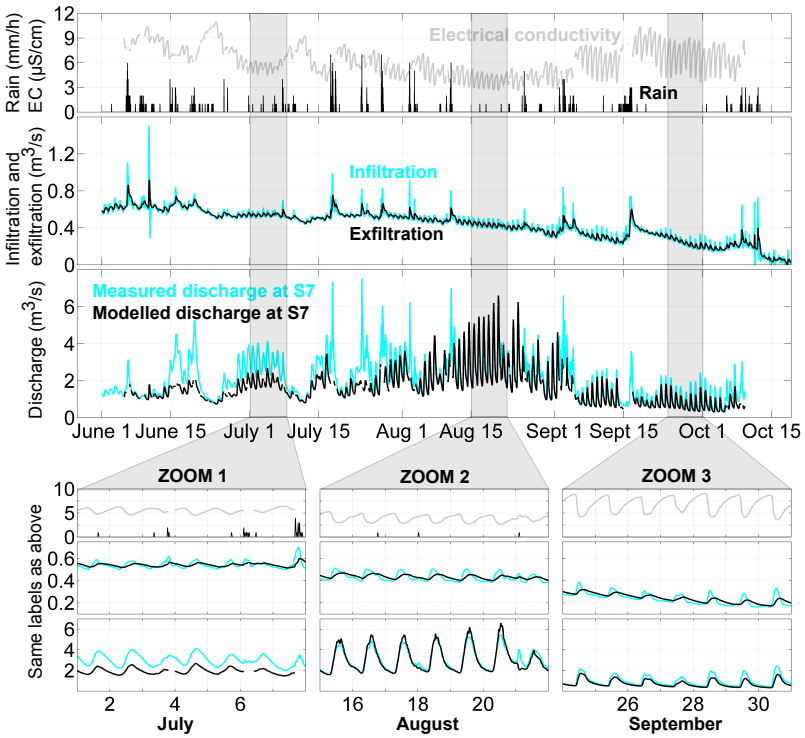
Rain (mm/h)
EC (µS/cm)
Electrical conductivity
Rain
Infiltration and exfiltration (m3/s)
Infiltration
Exfiltration
Discharge (m3/s)
Measured discharge at S7
Modelled discharge at S7
June 1 June 15 July 1 July 15 Aug 1 Aug 15 Sept 1 Sept 15 Oct 1 Oct 15
ZOOM 1
ZOOM 2
ZOOM 3
Same labels as above
July
August
September

Fig. 4.

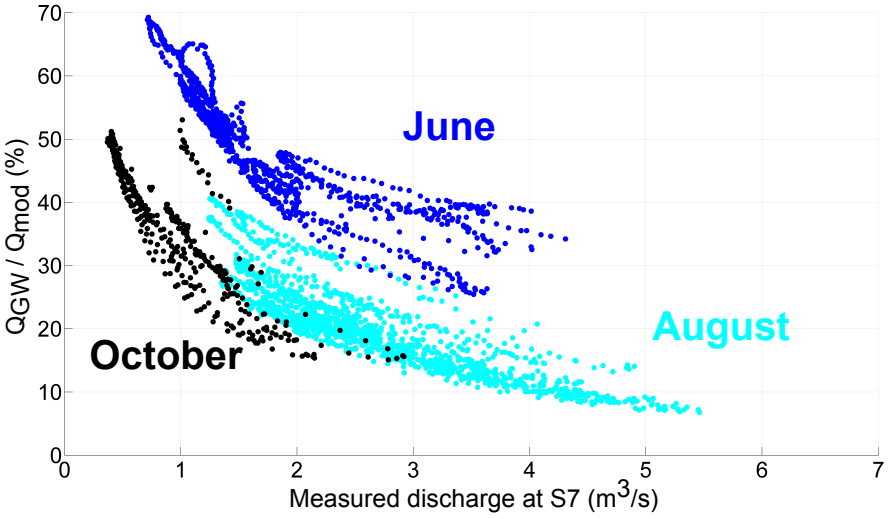
June
August
October
QGW / Qmod (%)
Measured discharge at S7 (m3/s)

Fig. 5.

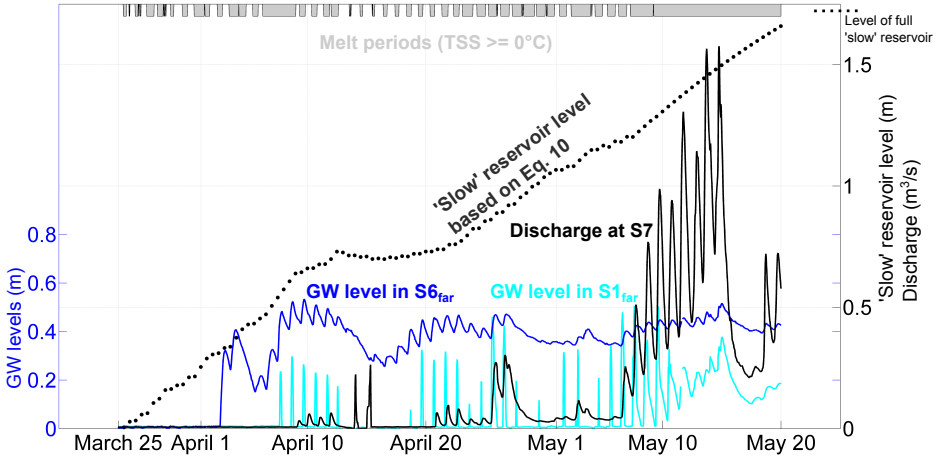
Melt periods (TSS >= 0°C)
Level of full 'slow' reservoir
'Slow' reservoir level based on Eq. 10
Discharge at S7
GW level in S6far
GW level in S1far
GW levels (m)
'Slow' reservoir level (m)
Discharge (m3/s)
0
0.2
0.4
0.6
0.8
0.5
1
1.5
March 25
April 1
April 10
April 20
May 1
May 10
May 20

Fig. 6.

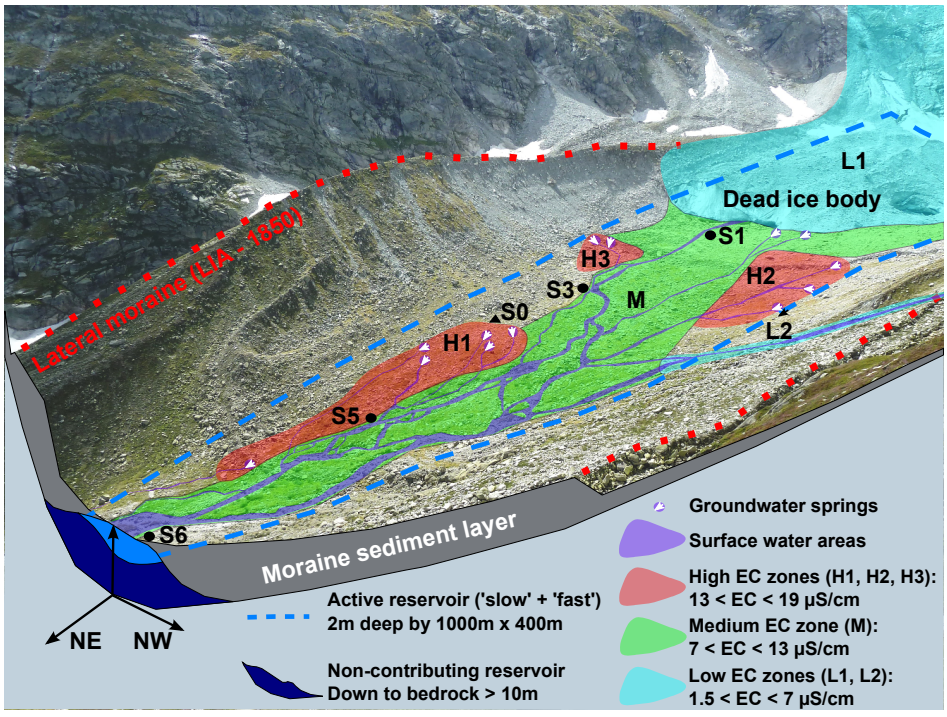
Lateral moraine (LIA, ~1850)
L1
Dead ice body
S1
H3
H2
S3
M
S0
L2
H1
S5
S6
Moraine sediment layer
NE
NW
Groundwater springs
Surface water areas
High EC zones (H1, H2, H3):
13 < EC < 19 µS/cm
Medium EC zone (M):
7 < EC < 13 µS/cm
Low EC zones (L1, L2):
1.5 < EC < 7 µS/cm
Active reservoir ('slow' + 'fast')
2m deep by 1000m x 400m
Non-contributing reservoir
Down to bedrock > 10m

Fig. 7.