

## ***Interactive comment on “Quantification of the Beauce’s Groundwater contribution to the Loire River discharge using satellite infrared imagery” by E. Lalot et al.***

### **Anonymous Referee #1**

Received and published: 24 March 2015

“Quantification of the Beauce’s Groundwater Contribution to the Loire River Discharge Using Satellite Infrared Imagery” uses Landsat TIR images to determine groundwater contributions to the Loire River using a simple energy budget approach and compares this to a groundwater budget approach. A method for determining groundwater contributions to rivers over space and time is presented, however there were many different assumptions and acknowledged errors in data utilized, calculations completed, or comparisons made that undermine the potential impact of the study. These included:

1.) Number of pixels spanning the channel that were included within the analysis. In general, there were 3 pixels spanning the channel, but at times these were mixed

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pixels (water and land). The mixed pixels were still included within the analysis (2053 line 3-7).

2.) No atmospheric corrections of the satellite TIR (2053 line 11) and shade influences from clouds were removed (2053 line 1-2). There was no explanation of how cloud influences were removed.

3.) Tributaries and power plant influences were considered negligible even though their influence was difficult to separate (2051 line 24-25) and can be close to 1°C in the winter (2051 line 10-16).

4.) Weir influences along the river (2050 line 25-27) were not accounted for.

5.) Surface area estimates within the heat budget calculations were based on the pixels selected for the analysis. These did not cover the entire channel surface area (2054 line 18-22). The potential 20% error in surface area translates into increased error in heat budget calculations because this value scales all surface flux estimates (S in eqn. 3).

6.) Groundwater temperatures were assigned for summer and winter based on a data base (2054 line 16). No information was provided regarding the data or variability in these values.

7.) Inaccurate estimates of river temperature from TIR when compared to river temperatures. At times differences were > 3 °C different (Figure 2) and on average they were +0.3 °C in winter and -1 °C in summer (2056 line 5). Some of the “sharp” changes in temperature used to estimate groundwater influences were 0.5 °C (2057 line 19), which is a small or possibly insignificant change relative to the errors observed.

8.) Longitudinal temperature profiles varied less than 2 °C when the variability was at its highest (Figure 3).

The overarching concern with these combined assumptions and errors are the influences on the findings within the paper. It is unclear if there is enough variability in the

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longitudinal temperatures to confidently back out groundwater influences and needs to be further investigated. There are many questions and concerns regarding the influence of the assumptions or treatment of data. What are the errors in the satellite based TIR data and what is the influence of not correcting for atmospheric conditions that will vary throughout the study reach and over different times of year? Torgersen et al. 2001 states that 10 pixels are required to avoid the influences of banks emission and to get accurate river temperatures. It does not seem that 3 pixels are adequate, particularly when they are mixed pixels. Given these issues and additional uncertainty in other foundational data used in the heat balance approach (e.g., assumed groundwater temperature and incorrect surface area estimates), the confidence in groundwater estimates are likely low. The current comparison with the groundwater budget that has long averaging times, similar uncertainties, and is vaguely described does not provide the type of validation needed to illustrate the potential of this approach.

In order for this paper to have an impact within the remote sensing and groundwater communities, more information regarding a quantitative understanding of the accuracy of the proposed methodologies is necessary. Some additional information that validate the findings is also needed.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 2047, 2015.

**HESSD**

12, C670–C672, 2015

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