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Hydrology and Earth System Sciences
Discussions



# *Interactive comment on* "Applicability of Landsat 8 Thermal Infrared Sensor to Identify Submarine Groundwater Discharge Springs in the Mediterranean Sea Basin" *by* Sònia Jou-Claus et al.

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Dear Prof. Marnik Vanclooster,

Thank you very much for your letter with the Editor's and Reviewers' thorough comments on our manuscript. We sincerely appreciate the effort devoted by the two Reviewers on revising the manuscript and we are pleased to see that our work might be considered worthy for publication. We have now prepared a revised version of the manuscript and a letter with a detailed point-by-point response to the comments of re-



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viewers. Please find enclosed our responses and actions undertaken in response to each comment. We have also added the modified text that would appear in the revised version of the manuscript.

Sincerely,

Sònia Jou-Claus et al.

Reviewer #2

The manuscript presents an interesting approach to use satellite TIR images to identify SGD springs at different spatial and temporal scales. The manuscript gives a good overview of existing literature and addresses a the need for this method. In addition, the study defines a conceptual framework, identifying and discussing the principal limitations of the approach, which is useful for further applications.

Answer: Thanks for the positive comment.

Generally, the manuscript is well written. However, sections 3.2.1 and 3.2.2 need a check on language. In my opinion the figures can be much improved to show better the data and results of the study.

Answer: Thanks for this comment.

Action: Following the reviewer comment the language in sections 3.2.1 and 3.2.2 will be reviewed and we will improve the figures in the reviewed version of the manuscript as we specify below in the technical correction and following the comments of the reviewer 1.

Technical corrections:

Pg2; L42-44 you describe three different occurrences of SGD springs. This needs more explanation, instead of only references, because it is important to understand later better what we can distinguish with the presented method.

Answer: Thanks for the comment. We agree with the suggestion.

Action: We will include a more detailed explanation about the three different occurrences of SGD springs in a reviewed manuscript. Now the text reads (L42-L47):

Depending on its geological origin, SGD occurs in three different forms: coastal onshore springs, which discharge on the coastline throughout surface sinkholes (Garcia-Solsona et al., 2010; MejiÌĄas et al., 2012), submarine springs, which the discharge occur throughout deep sinkholes (Bakalowicz, 2015; Fleury et al., 2007) and diffuse discharge, which discharge is not focused and occur throughout sediments (Rodellas et al., 2012).

Pg4; L94 Replace "For those satellite suitable" with "For those sensors suitable" or "For those images suitable"

Action: The replacement will be done according to the reviewer suggestion.

L97 needs a full stop at the end of the sentence.

Action: The change will be done according to the reviewer suggestion.

L148: Here it is referred to Supplementary material 1 as the springs, but it contains the table with the used Landsat scenes

Answer: Thank you for the comment, there is an error and the supplementary material with the hydrogeologic information available of each spring is missing.

Action: A Table showing the 54 springs and all of the hydrogeologic information available of each spring will be added in the Supplementary material.

Pg5 L164: replace "a thermal imager two" with "a thermal imager with"

Action: The replacement will be done according to the reviewer suggestion.

In section 2.2 the reference to Supplementary material 1 is missing

Action: The reference will be added according to the reviewer suggestion.

L187: correct m-2 unit typography

Action: The unit typography correction has been done according to the reviewer suggestion.

Pg6; L205: "The applied water emissivity in band 10 was 0.9904". Is this representative for sea water with mixing of SGDs? Is this depending on temperature, turbidity and/or minerals?

Answer: The emissivity water value is representative for water in general. In this study we use the same approach as reported in the literature (Wilson & Rocha, 2012 ; Mallast et al., 2014; Vanhellemont, 2020b). The emissivity of water in the Landsat 8 TIR bands ranges from 0.98 (band 11) to 0.99 (band 10) and in this study, we assume a constant emissivity of 0.99. On the other hand, turbidity could modify the emissivity of water. Wen-Yao (1987) measured in the laboratory, the thermal infrared emissivity of water as the suspended sediment concentration was varied from zero to extremely high values. The result indicated that increasing turbidity decreases the spectral emissivity. If the emissivity is taken to be 1.0 when it is actually 0.965 the water surface can easily be more than one degree C cooler than the brightness temperature would indicate, an effect which will have consequences for the interpretation of thermal infrared images. This is tested in laboratory and none of the consulted literature in this study use different emissivity water values to atmospherically correct images at sensor spectral radiance (Wilson & Rocha, 2012; Mallast et al., 2014 among others).

Action: We will modify the text in the review version in order to include the reviewer comment. The text now reads:

The emissivity of water in the Landsat 8 TIR bands ranges from 0.98 (band 11) to 0.99 (band 10) and in this study, we assume a constant emissivity of 0.99 (Wen-Yao et al., 1987). Fig 1 presents the 54 SGD springs. The springs have different properties as mentioned in the text. It would be helpful for the reader to vary shape, color and/or symbol of the wells in the figure to have different attributes visualized in a clear way.

The info in lines 153-160 can then be presented in the figure.

Answer: We agree with the reviewer comment, but the problem is that we do not have the hydrogeological information of all springs. However, we consider that summarize the information could help the reader to visualize the information in a clear way.

Action: In the revised version of the manuscript a table with all the hydrogeologic information available of each spring in supplementary material 1 will be added.

Fig 2 shows the SST images. Negative values represent clouds. Wouldn't it be better to have masked the clouds and use similar temperature ranges for all images for a better comparison?

Answer: We appreciate the suggestion.

Action: following the reviewer comment we will modify the figure masking the clouds and using similar temperature ranges for all images in the new version of the manuscript.

The legends in Figure 6 are lacking units.

Action: The units will be added to the Figure 6 legend according to the reviewer comment.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-569, 2020.

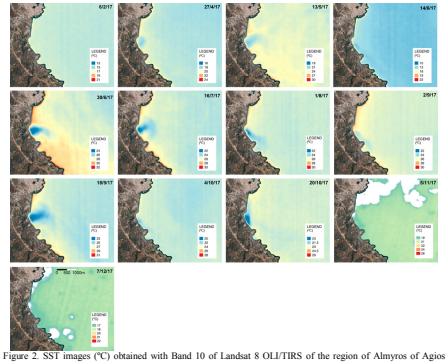

Figure 2. SST images (°C) obtained with Band 10 of Landsat 8 OLI/TIRS of the region of Almyros of Agios Nikolaos (Greece) along 2017. Of the 23 images analyzed, the presence of a SGD spring was clearly visible in 9 images that represents a 37.5% of success. In January, March and November 2017, it was not possible to obtain a SST image due to the presence of clouds. © Google Earth 2020.

**Fig. 1.**



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