Digital Earth: Sen2Cube – Exercise 9 (Assignment)

Felipe Camacho Hurtado **12214476**

For this exercise, the .XML, descriptions, and screenshots will be provided.

1. Create a new model (or adjust an existing one) for a specific use case and execute it in 3-4 areas within Austria (so called inferences) or you can try also the transfer to the Syrian data cube.

- Export the model as xml, create a document with a short description and screenshots of the results of the inferences and submit it to blackboard.

1. Context and Data

The main idea was to create a model to visualize water, ice, and cloud coverages between November 1 (2020) and June 30 (2021), and to discuss how they interacted in the temporal and spatial frame. For this purpose, three lakes in the Salzburg providence were selected as points of interest: Fuschlsee, Irrsee, and Wolfgangsee. Regarding the Fuschlsee and Wolfgangsee lakes, they were selected as during the winter, they get frozen, while the Irrsee lake, was selected as it's the warmest lake in the region, reaching temperatures up to 25°C.

Once the study lakes were decided using data from the Open Data Austria portal and the "Feature to JSON" tool in ArcGIS Pro, the related lakes were exported as GeoJSON formats with the WGS 84 (4326) spatial reference.

2. Implementation

In the Sen2Cube software, the "Water_and_Snow" model was created. It contains three entities and three results to be exported. The first entity ("clouds") it's related to the pixels labeled as "Thin clouds on water area or Barren land or Built-up areas". The second entity ("snow") it's related to the pixels labeled as "Snow or water ice". Finally, the third entity ("water") includes the pixels labeled as "Deep water or shadow", "Shallow water or shadow", "Turbid water or shadow", and "Salty Shallow Water". For each of the entities, the pixel counts were reduced over space and time. The results names are "Snow_Count", "Water_Count", and "Clouds_Count" respectively. (Figure 1)

After designing the model, and selecting it as the Knowledgebase, each of the GeoJSON files were uploaded (one by one) as the Factbase parameter, then, the temporal subset was filled with the initial date (2020-11-01) and end date (2021-06-30), and as the final step, the inference was started. (Figure 2).

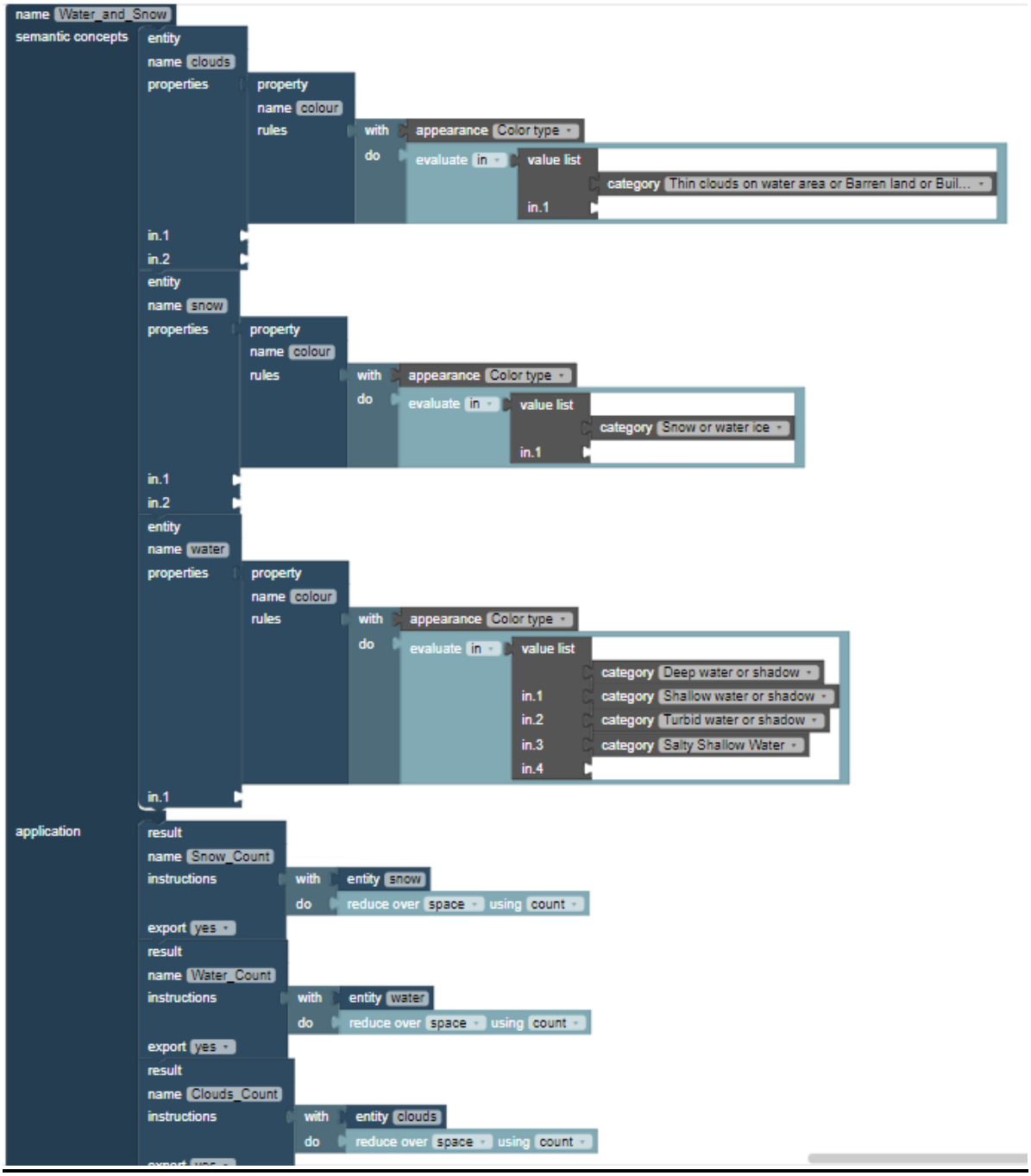

Figure 1. *Sen2Cube - Water and Snow Model.*

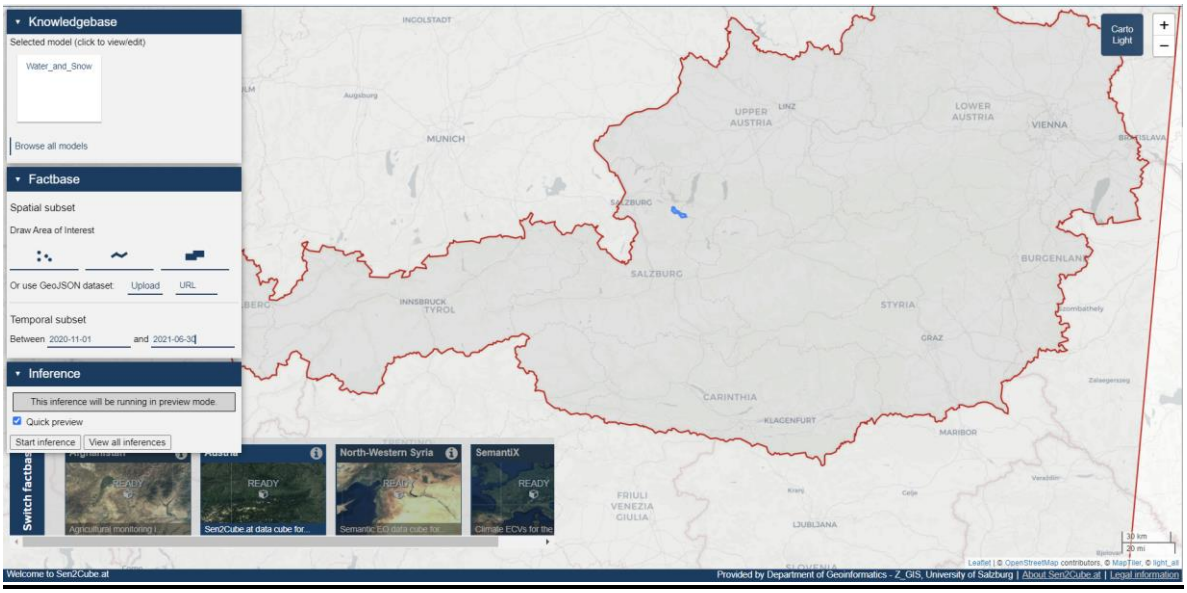

Figure 2. *Sen2Cube – Inference Configuration.*

3. Results

When reducing over space, the count of pixels over the time of the study for the three different entities was generated as “Water_Count”, “Snow_Count”, and “Clouds_Count”. When reduced over time, GeoTiff files were generated and then using ArcGIS Pro, they were presented as cartographic maps. The space and time reductions were performed based on 96 imagery measurements.

Those two approaches (space and time) will be used to discuss for each lake, in which periods each entity was predominantly and how they changed between winter and spring.

3.1 Lake Fuschlsee

For the Fuschlsee lake, with the spatial results, we can evidence three major groups (red boxes) of peaks for the cloud's pixel count. Those peaks are observed during the end of December and the first days of January, the end of February and the first days of March, and the end of April. (Figure 5). For each Cloud pixel-count peak, we should expect to not have the presence of any other type of coverage, that’s the case for the “Water” and “Snow” coverages, which have a pixel count of 0 (or near to 0) in the time periods identified as predominantly covered by clouds.

For the water pixels count (Figure 3), there are four periods of time (blue boxes) in which no pixels were recorded as water coverages. Those periods were the middle-end of December, the middle-end of February, the middle of March middle-end of May. The second-period result can be explained mostly by the prevalence of the Clouds coverages, however, in the remaining periods, we can observe predominantly snow/water ice coverages (Figure 4 - yellow boxes). These relationships between the water and snow/ice coverages could be explained by the fact that due to the low temperature in winter, the lake gets frozen, and the surrounding get covered by snow.

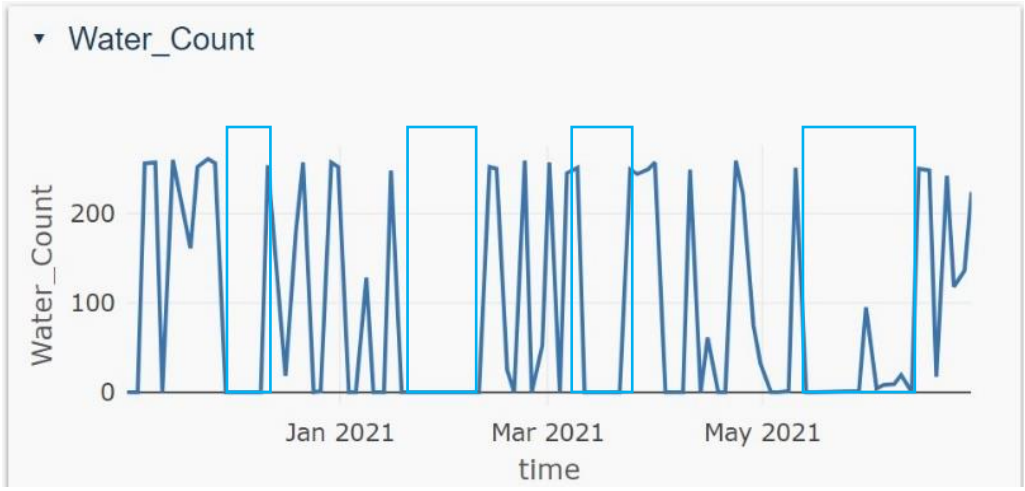

Figure 3. *Fuschlsee – Water Count Result (Space).*

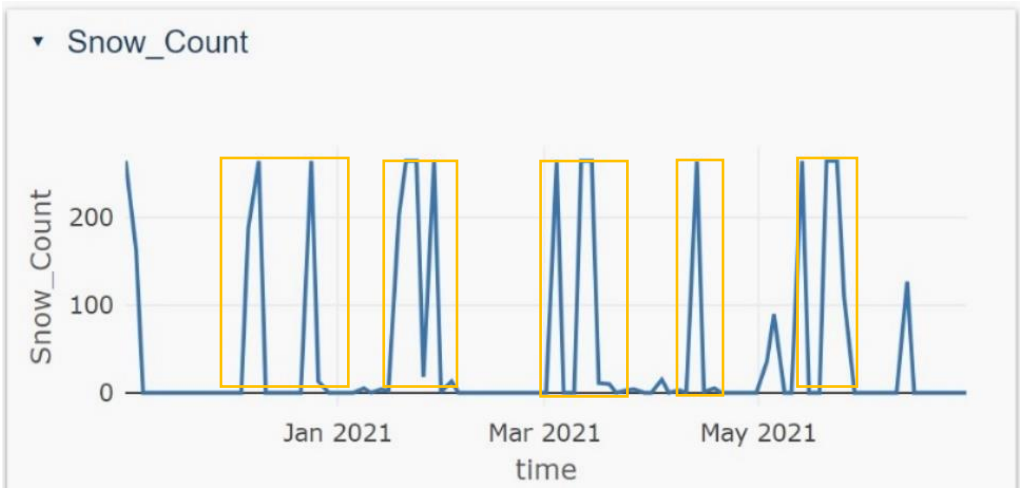

Figure 4. *Fuschlsee – Snow Count Result (Space).*

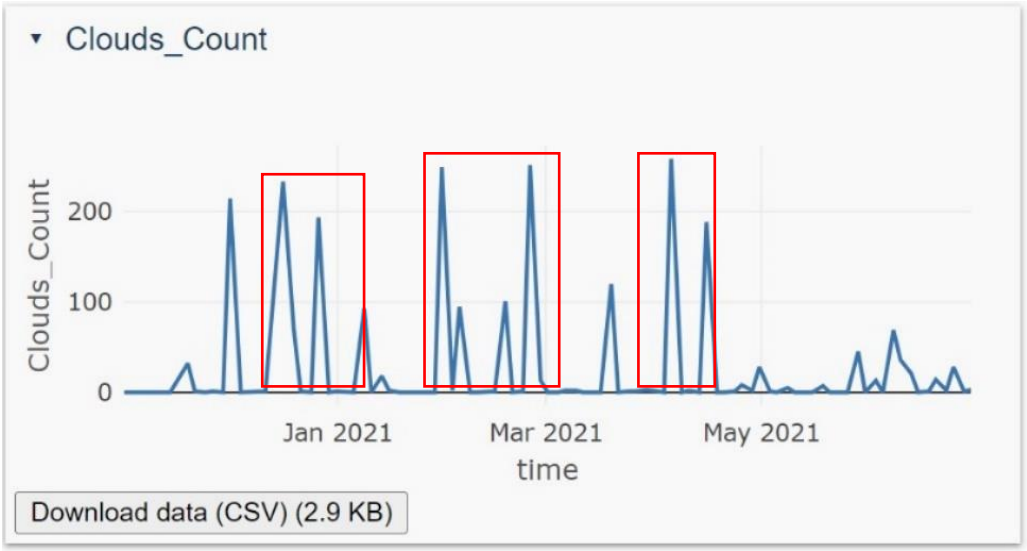

Figure 5. *Fuschlsee – Cloud Count Result (Space).*

Regarding the time reduction, for the “Water” pixel count (Figure 6), it can be observed that along the lake, the water pixels were predominantly, however, mainly in the north-western part, and some small areas in the northern and south-east of the lake, other coverages were predominantly. In this case, comparing the water pixel count with the snow/water ice (Figure 7) and Clouds (Figure 8), in the north and south-east areas, the predominant pixel was the snow/water ice, while in the north-western zone, there was more presence of clouds pixels.

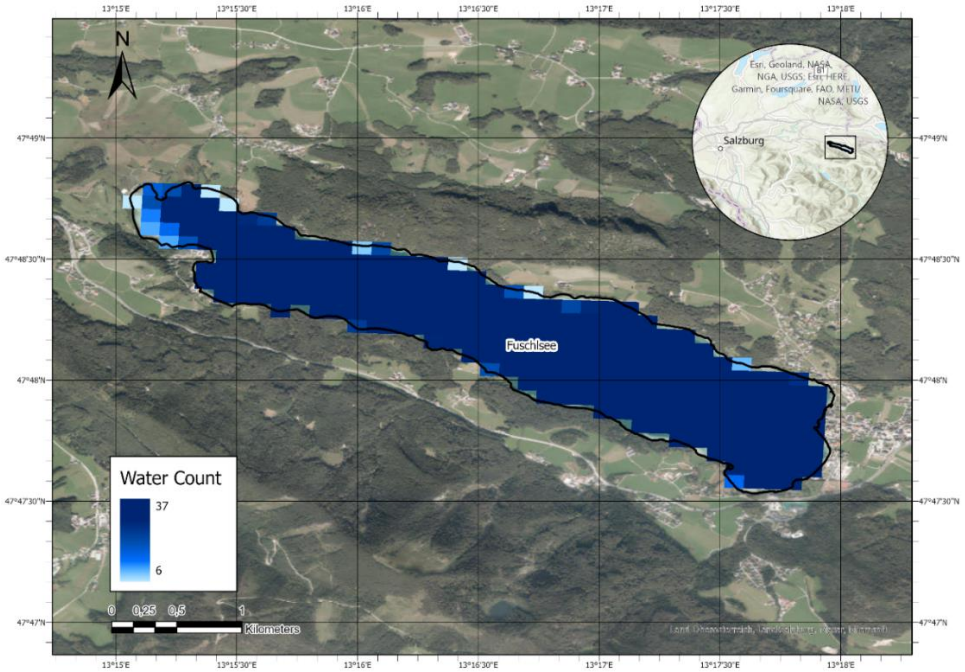

Figure 6. *Fuschlsee – Water Count Result (Time).*

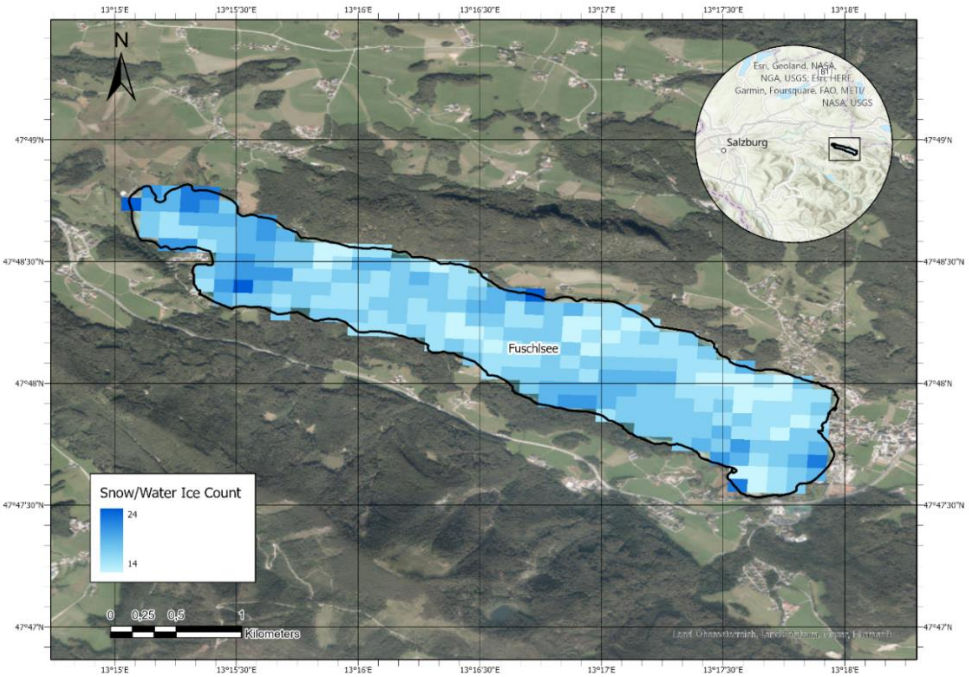

Figure 7. *Fuschlsee – Snow Count Result (Time).*

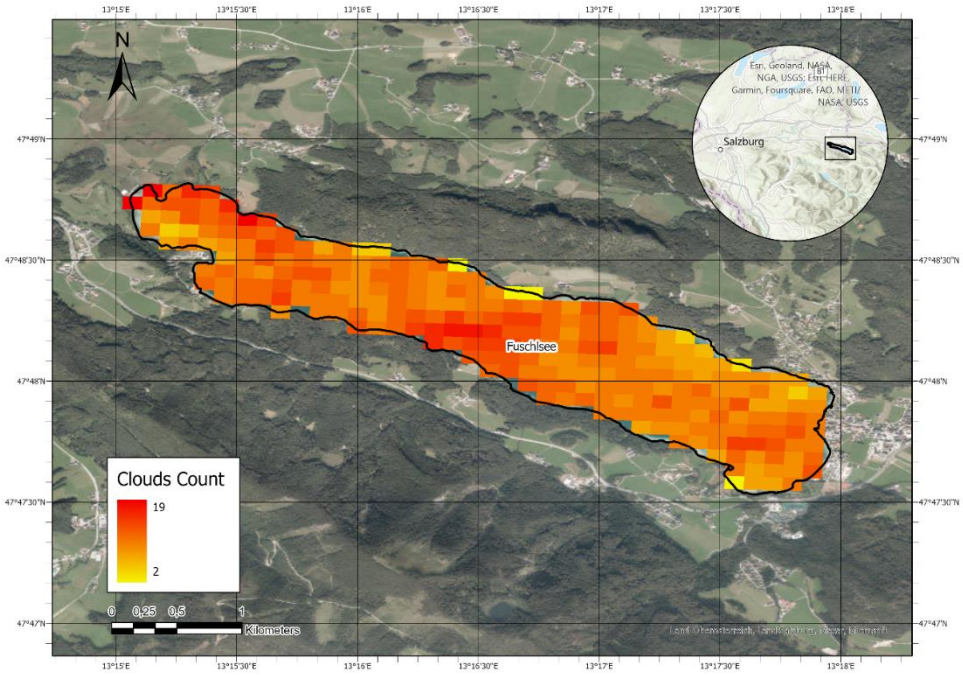

Figure 8. *Fuschlsee – Clouds Count Result (Time).*

3.2 Lake Irrsee

For the Irrsee lake, with the spatial results, we can evidence three major group (red boxes) of peaks for the clouds pixels count. Those peaks are observed during the end of December and first days of January, first days of March, and middle-end of April. (Figure 11). Regarding the water pixels count (Figure 9), there are three periods of time (blue boxes) in which no pixels were recorded as water coverages. Those periods were December, end of January and February, and first days of March.

With the spatial results, we can evidence three major groups (red boxes) of peaks for the cloud's pixel count. Those peaks are observed during the end of December and the first days of January, the first days of March, and the middle-end of April. (Figure 11). Regarding the water pixels count (Figure 9), there are three major periods of time (blue boxes) in which no pixels were recorded as water coverages. Those periods were December, the end of January and February, and the first days of March.

Additionally, as the Irrsee lake it's one of the warmest lakes in Salzburg, the resulting snow/water ice pixels count, should be mostly related to the presence of snow in the surrounding areas and not to the water ice coverage.

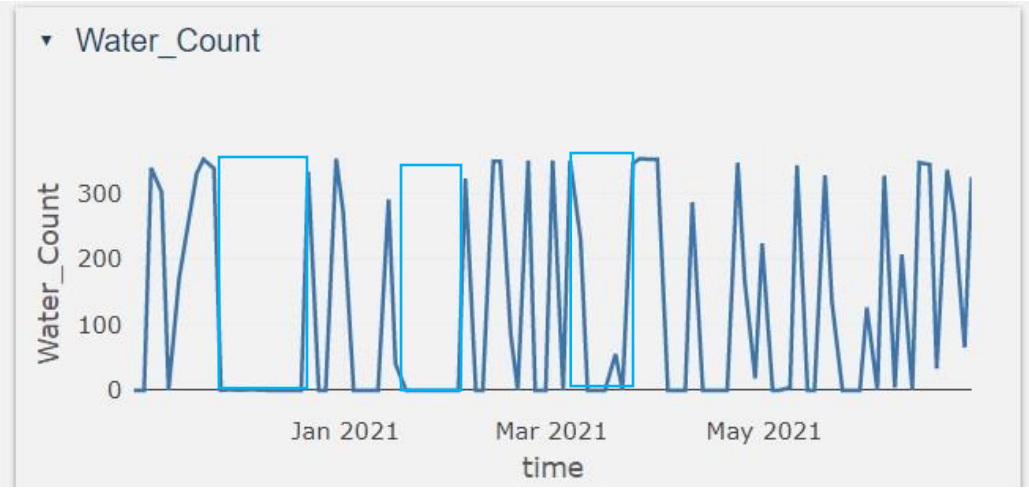

Figure 9. *Irrsee – Water Count Result (Space).*

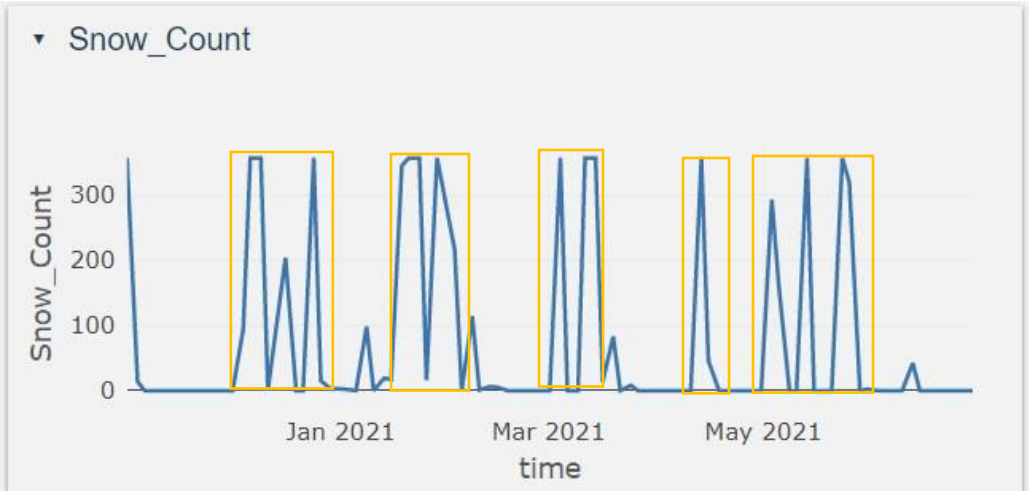

Figure 10. *Irrsee – Snow Count Result (Space).*

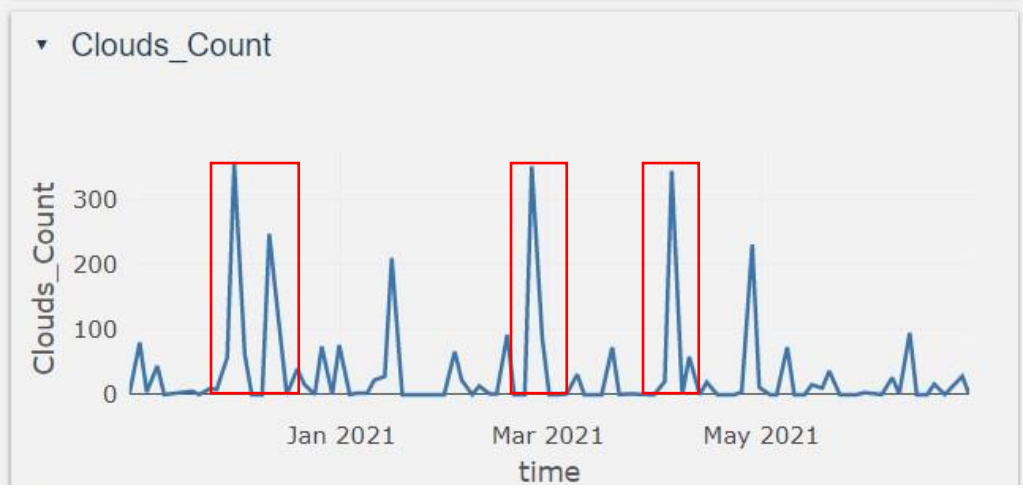

Figure 11. *Irrsee – Clouds Count Result (Space).*

For the time reduction of the “Water” pixel count (Figure 12), it can be observed that along the lake, the water pixels were predominantly, however, along the western border of the lake, some areas were predominantly covered by other pixel types. By comparing the water pixels with the snow/water ice (Figure 13) and Clouds (Figure 14) pixel counts, it could be confirmed that the high presence of snow/water ice pixels was related mainly to the presence of snow in the surrounding land areas, as in the left border, the presence of cloud pixels was not significantly.

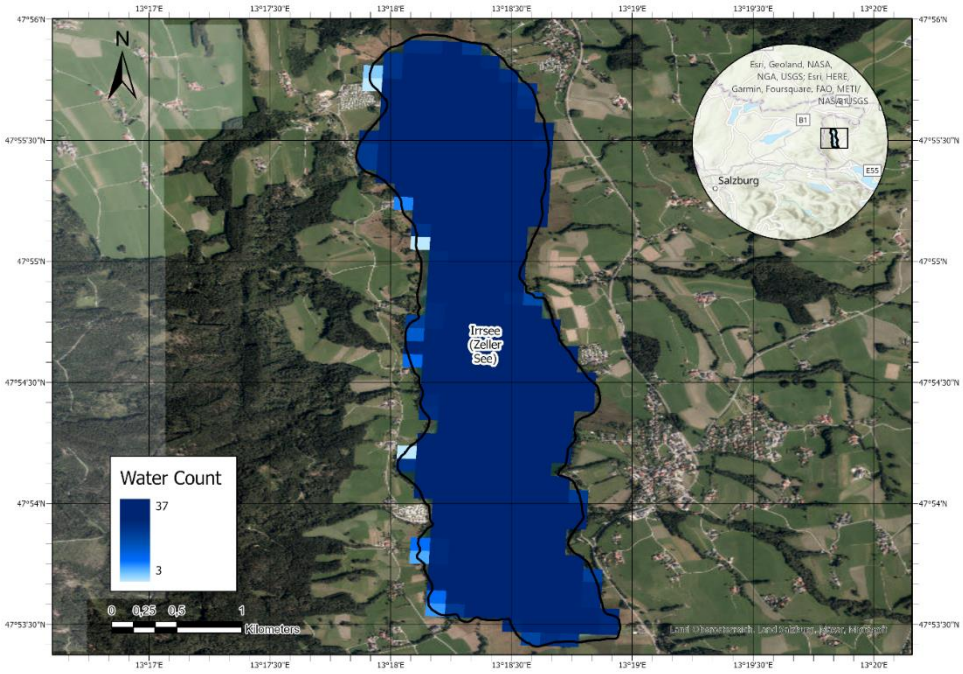

Figure 12. *Irrsee – Water Count Result (Time).*

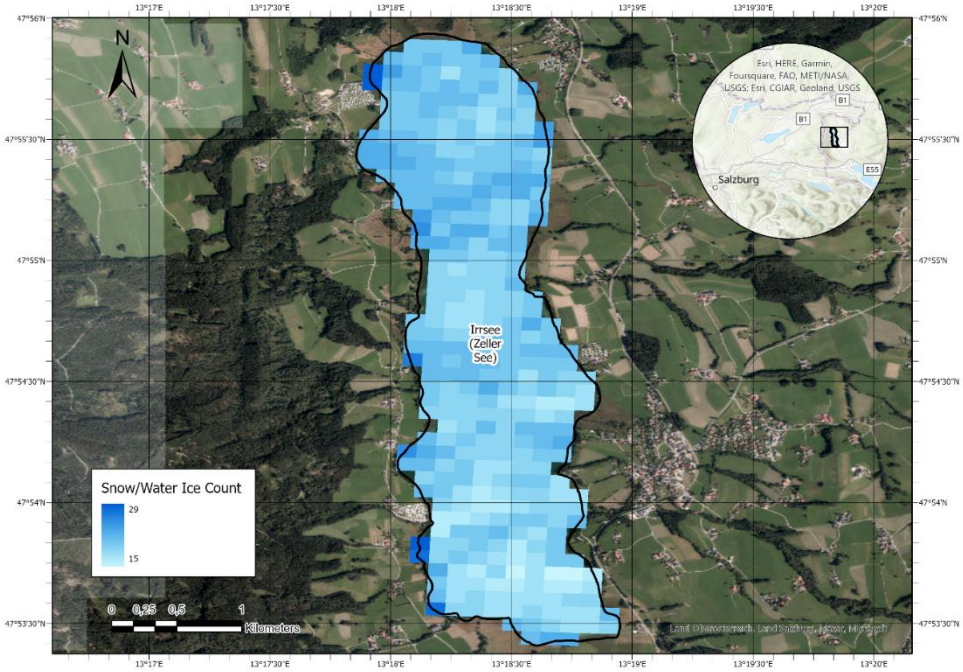

Figure 13. *Irrsee – Snow Count Result (Time).*

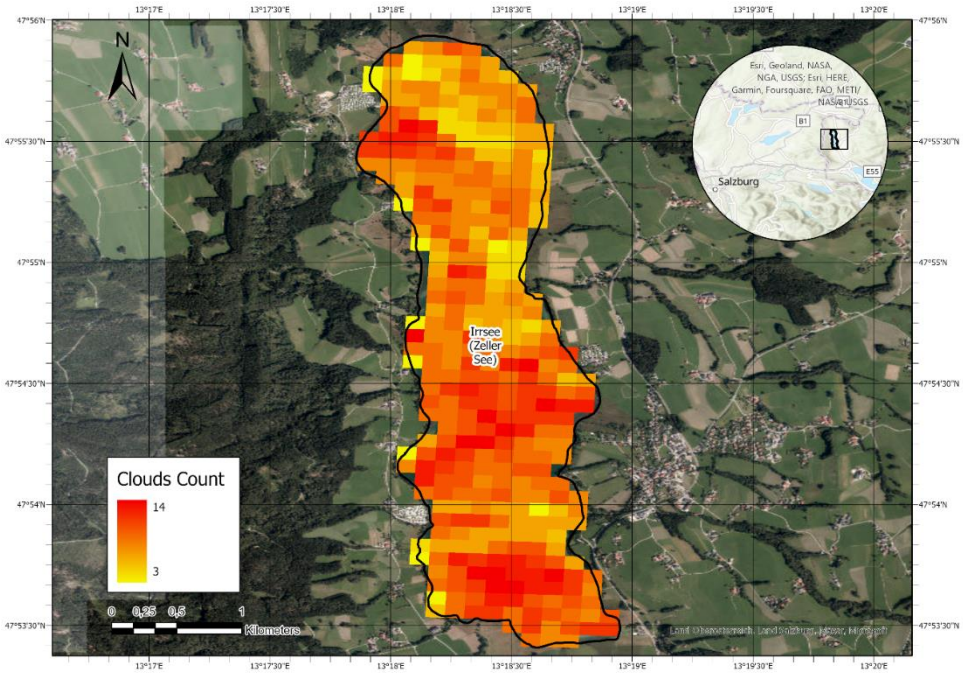

Figure 14. *Irrsee – Clouds Count Result (Time).*

3.3 Lake Wolfgangsee

For the Wolfgansee lake, with the spatial results, we can evidence three major groups (red boxes) of peaks for the cloud's pixel count. Those peaks are observed during December, the last days of April, and the beginning of May. (Figure 17). Regarding the water pixels count (Figure 15), there are five periods of time (blue boxes) in which no pixels were recorded as water types. Those periods were December, the end of January, the end of March, the end of April, and the end of May.

As for the other lakes, the non-presence of water pixels in the first period it's mainly due to the predominance of cloud pixels. However, for each of the other time ranges, the presence of snow pixels (Figure 16 – yellow boxes) is predominant in Lake Wolfgangsee. For the Snow pixel counts, the high-count peaks are located between the end of December and January, February, March, the end of April, and the end of May.

In this case, the Wolfgangsee lake evidenced a similar behavior with respect to the high-snow peaks, and with regards to three of the four low-water pixels counts periods. As it's known that Wolfgangsee lake is colder than Irrsee lake, the similarities in the snow/water ice cycles, can confirmed that this pre-defined class it's referring (regarding Irrsee lake) mostly to the snow amount in the land borders of the lake, and not to water ice coverages.

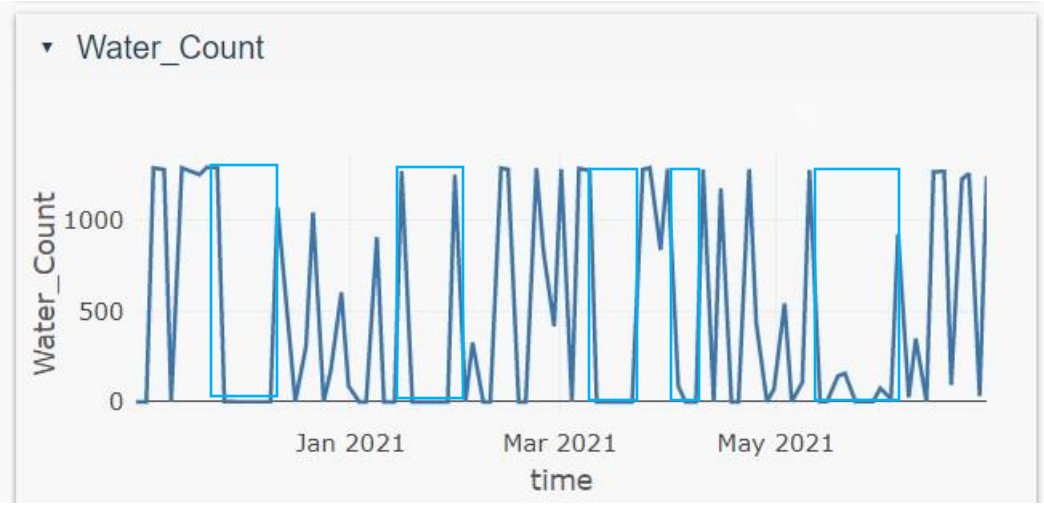

Figure 15. *Wolfgangsee - Water Count Result (Space).*

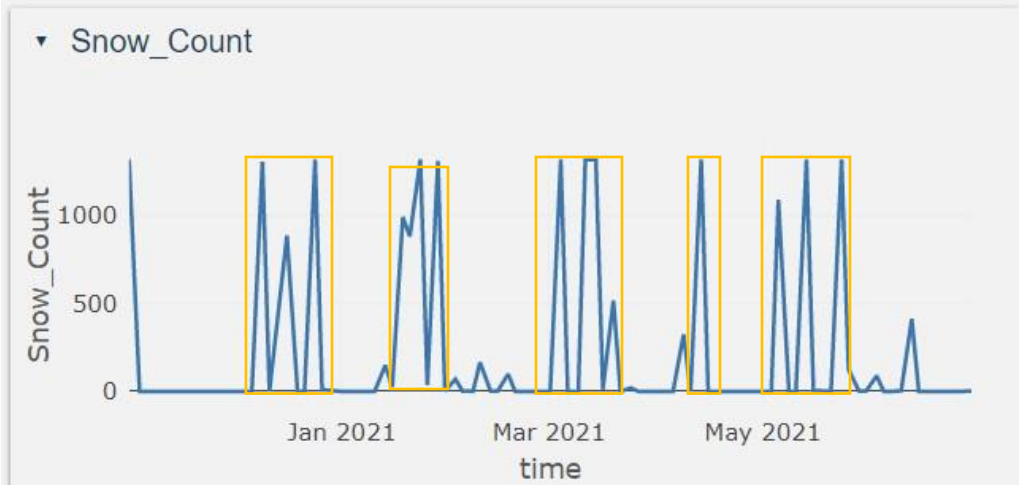

Figure 16. *Wolfgangsee - Snow Count Result (Space).*

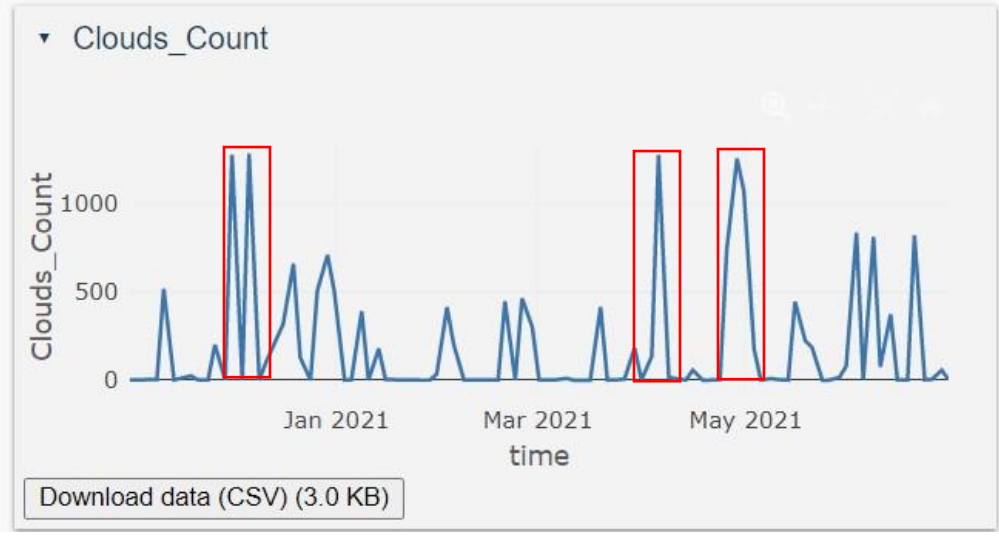

Figure 17. *Wolfgangsee - Clouds Count Result (Space).*

With the time reduction of the “Water” pixel count (Figure 18), it can be observed that along the lake, the water pixels were predominantly, without a high presence of low water count values. In comparison to the other two lakes, in the “Snow/Water ice” count (Figure 19) there is a high presence of these pixels in the center and East of the lake, which can be used to identify the zones of the lake that were frozen during winter. Finally, the cloud count (Figure 20), evidenced a high presence of clouds in up to 34 imagery records along the lake, except for an area near the east borders.

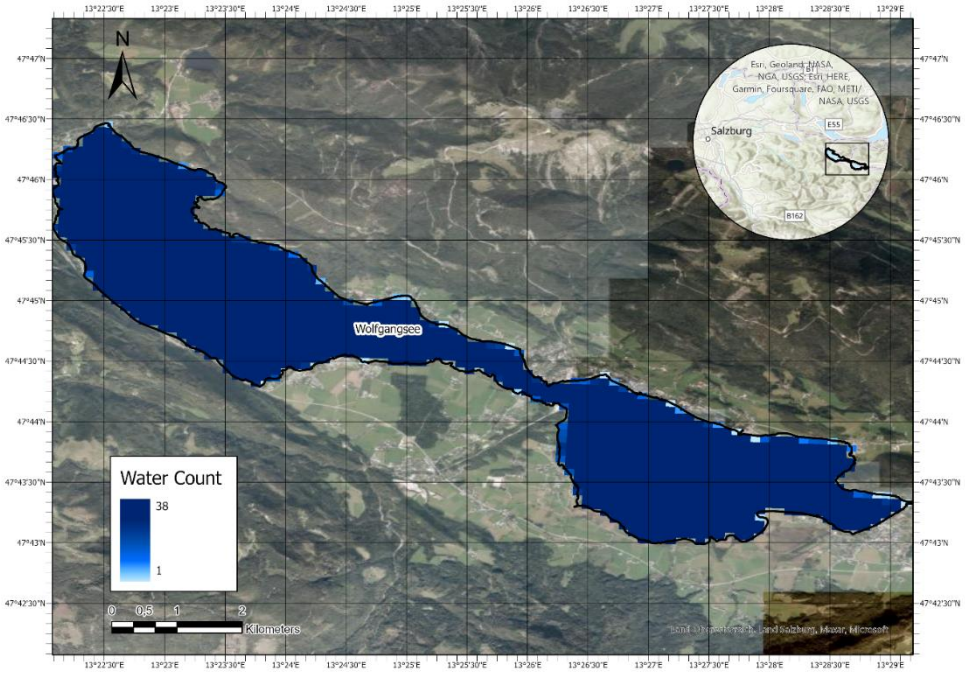

Figure 18. *Wolfgangsee – Water Count Result (Time).*

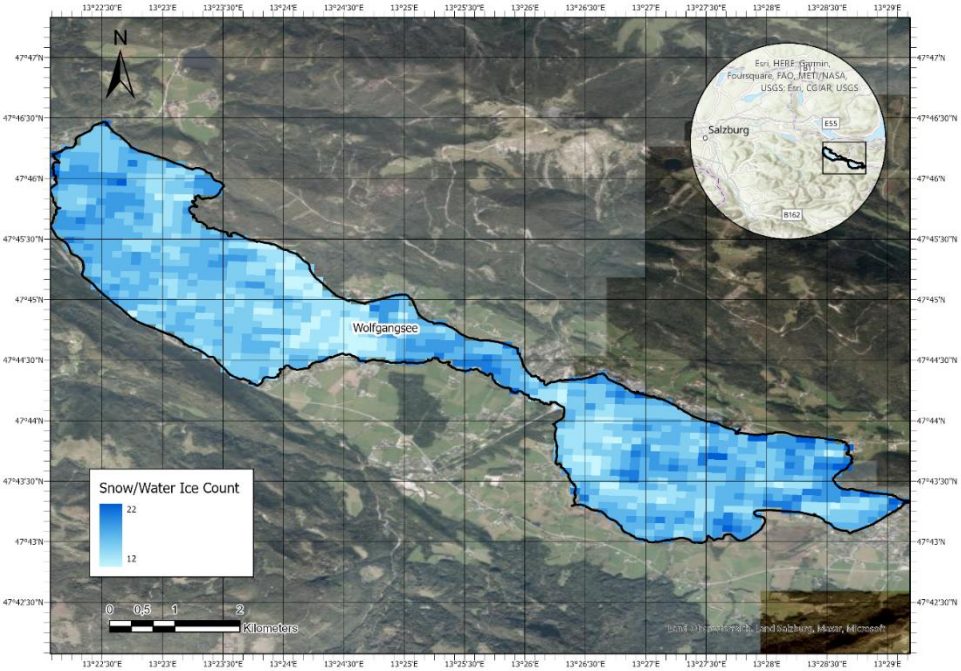

Figure 19. *Wolfgangsee – Snow Count Result (Time).*

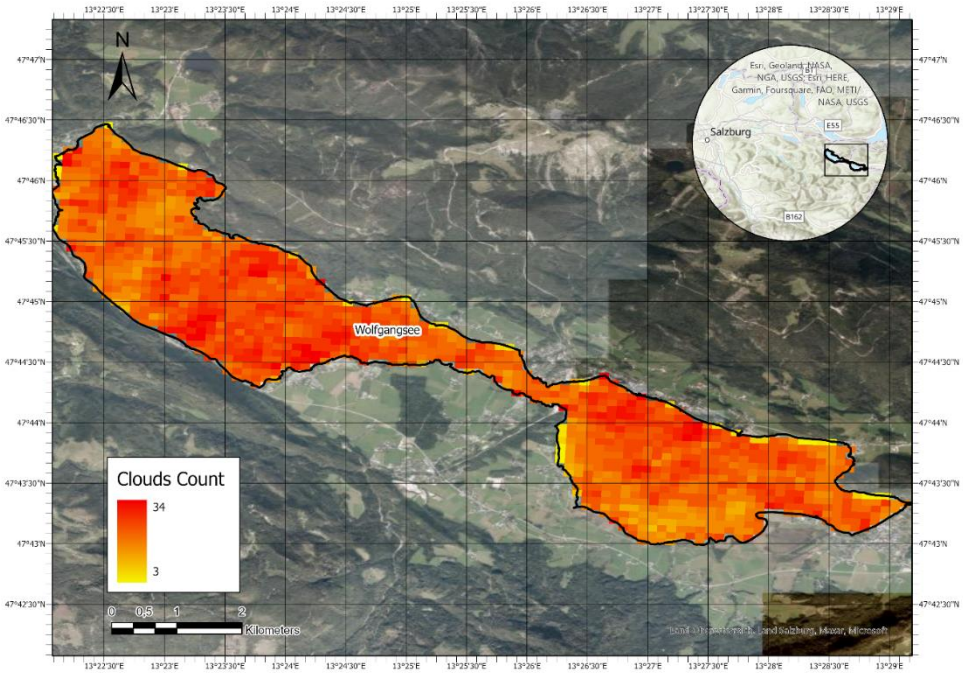

Figure 20. *Wolfgangsee – Cloud Count Result (Time).*

4. Conclusions

With Sen2Cube, we were able to analyze the winter-spring cycles for three different lakes in the providence of Salzburg, with respect to Water, Snow/Water Ice, and Cloud pixel counts. For all the lakes, it was observed that the first high presence of clouds was by the end of December, and the first peak of snow values by December too. An additional behavior that was evidenced, through the reduction of the results over space, was a higher presence of Snow/Water ice pixels count for the Fuschlsee and Wolfgangsee lakes, compared to the Irrsee lakes, which matches the fact that the Irrsee lake is the hottest one.

In conclusion, the Sen2Cube, provided me with user-friendly workflows to analyze the presence of predefined classes in the study area, with a good learning curve as after a couple of sessions, I get used to interacting with the “Model Builder” interface. As a personal comment, I would be really interested to improve my knowledge of how the Sen2Cube works, and getting involved in investigation projects.