We would like to thank the anonymous reviewer for the detailed and helpful comments. Please find our replies below in red.

The manuscript entitled “Monitoring surface water dynamics in the Prairie Pothole region using Dual-Polarized Sentinel-1 SAR time series” by Schlaffer et al. developed a new approach for classifying open water extent dynamic. The manuscript is novel and well organized. Most sections are informative, which can also lead to a long description and thus need to be significantly improved before acceptance. In the revised version, authors need to revise the writing style of this manuscript.

1. In this study, authors used many data sources to achieve their goals and these data are not in the same spatial resolution. For instance, the spatial resolution of Sentinel-1 data, the digital terrain model, and land cover are 20 m, 1m, and 30 m, respectively. To upscale the resolution from lower to higher is fine, while to downscale from lower to higher resolution can introduce uncertainty in data analysis, particularly for this study. In this study, land cover data (CDL) in 2015, which scaled from 30 m to 10 m, are used as reference data. Such a downscale can introduce potential uncertainty and should be discussed in the manuscript.

   In this case, CDL was used to sample pixels in order to characterise backscatter distributions for water and land areas as well as to draw samples of HAND values for fitting equation 7. From the CDL classes only the water class was of interest to us, whereas the rest was combined to a non-water class. In both cases, pixels at the border between water and land areas were masked in order to avoid sampling from mixed pixels. Masking was done in both directions, towards water and land, i.e. a distance of 20 m along the water-land border was avoided. This is already mentioned in line 219 for the characterisation of backscatter distributions but not for the HAND sampling. In order to avoid repetition, we will now describe the masking in section 2.2.3 along with the other pre-processing.

2. In this manuscript, for Eqn. (7), the author only included the regression model. However, for data transparency, authors should list the regression parameter in the supplementary material.

   We will add the used regression parameters $b_0 = 1.9479$, $b_1 = -3.5598$ to the supplement or in the caption of Fig. 5.

3. 3.For section 3.2 surface water dynamic, the authors described their results based on the temporal dynamics, i.e., only describe the results change with time, which helps understand model accuracy. At the same time, the authors compared surface water dynamic with wet or dry conditions. In sum, this section is too long and not well-organized. I suggest authors can describe the temporal dynamics in the first section while discussing how surface dynamics change with hydrological conditions (wet or dry conditions). In this way, the readers can easily get the ideas that you want to express.

   This is a very helpful comment. We propose to reorganise section 3.2 by splitting the section into two subsections: in 3.2.1, we will describe results by explaining the temporal dynamics of number of water bodies, total water area and median water extent as observed using Sentinel-1 data (Figures 8-9). In 3.2.2, we will discuss our observations in the context of hydrometeorological conditions (i.e. discharge,

precipitation) and discuss their impacts on the observed intra-annual surface water extent dynamics. After this, we discuss the observed inter-annual dynamics in the light of dry and wet periods as indicated by PDSI. This structure should be much clearer.

4. Research title is not specific. The current title can mislead readers that authors had mapped surface water dynamics in the whole prairie pothole region. Actually, this is a case study. Please revise your research title.

   We can change the title to "Monitoring Surface Water Dynamics in the Prairie Pothole Region of North Dakota Using Dual-Polarised Sentinel-1 SAR Time Series".

5. The abstract and introduction are informative, but they are too long. For instance, the authors discussed the many key points, I can easily lose while I am reading the paper. I strongly suggest authors shorten the abstract and introduction. In addition, the conclusion section is well-written. Please follow this style to revise your abstract.

   We will try to shorten the abstract and introduction. However, given the substantive amount of work which has been dedicated to the PPR over the last few years in the field of remote sensing we see the necessity to describe the other technologies used for remote sensing of wetlands in the PPR (optical satellite and airborne imagery) and make a point for the value of Sentinel-1 SAR data in addition to optical satellite/airborne and e.g. Radarsat-2 data.

   We propose to shorten the abstract from ca. 480 to 380 words:

   "The North American Prairie Pothole Region (PPR) represents a large system of wetlands with great importance for biodiversity, water storage and flood management. Knowledge of seasonal and inter-annual surface water dynamics in the PPR is important for understanding the functionality of these wetland ecosystems and the changing degree of hydrologic connectivity between them. Optical sensors widely used for retrieving such information are often limited by their temporal resolution and cloud cover, especially in the case of flood events. Synthetic aperture radar (SAR) sensors can potentially overcome such limitations. However, water extent retrieval from SAR data is often impacted by environmental factors, such as wind on water surfaces. Hence, for reliably monitoring water extent over longer time periods robust retrieval methods are required.

   The aim of this study was to develop a robust approach for classifying open water extent in the PPR and to analyse the obtained time series covering the entire available Sentinel-1 observation period from 2015 to 2020 in the hydrometeorological context. Open water in prairie potholes was classified by fusing dual-polarised Sentinel-1 data and high-resolution topographical information using a Bayesian framework. The approach was tested for a study area in North Dakota. The resulting surface water maps were validated using high-resolution airborne optical imagery. For the observation period, the total water area, the number of water bodies and the median area per water body were computed. The validation of the retrieved water maps yielded producer's accuracies between 84 % and 95 % for calm days and between 74 % and 88 % on windy days. User's accuracies were above 98 % in all cases, indicating a very low occurrence of false positives due to the constraints introduced by topographical information.

The observed dynamics of total water area displayed both intra-annual and inter-annual patterns. In addition to differences in seasonality between small (< 1 ha) and large (> 1 ha) water bodies due to the effect of evaporation during summer, these size classes also responded differently to an extremely wet period from 2019 to 2020 in terms of increase in number and total area covered. The results demonstrate the potential of Sentinel-1 data for high-resolution monitoring of prairie wetlands. Limitations exist related to wind inhibiting correct water extent retrieval and due to the rather long acquisition interval of 12 days over the PPR."

6. In figures 8 and 9, the authors only compared the water body with wet or dry seasons. I recommend authors can plot the hydrography on figures 8 and 9. Authors can compare the relationship between flood and drought conditions. In this way, the relationship between hydrology and water bodies can be quantitively assessed. Authors can relate the hydrology data to the surface water body.

   In the text, we discuss the observed surface water dynamics in the context of wet and dry periods which are indicated by PDSI. The PDSI time series is shown in Figure 2 when introducing the study site and hydrological/meteorological events during the study period (section 2.1). It would be possible to show PDSI in figure 8 instead, however, the data are already very useful in section 2.1. We hope that the restructuring of section 3.2 in response to your previous comment will clarify the relationships between surface water extent and hydrometeorological conditions.

7. Line 89, please list the references here.

   Thank you for pointing this out. We will do so.

8. Here are some thoughts for authors' reference. 1) In this study, authors used a high-resolution digital terrain model (1m). For the topography, there are many topographic indices, for instance, topographic wetness index (TWI) and others, which can represent the topographic information in detail. In my thoughts, the appearance of surface water is highly related to topography information. I suggest authors can try to relate water body location with TWI or other indices. This may help authors to validate your results. 2) Authors extracted the water body from Sentinel-1 data. To date, Google Earth has spatial resolution data. In authors' data, authors validated the results using the same data source but for different locations. The validation is good. However, this data is not easy to obtain. Can you try to validate the data through Google Earth. I know this is beyond the scope of this study, but authors can try this in future studies.

   Thank you for these interesting suggestions.

   1) In this case we used Height Above Nearest Drainage (HAND) to represent the topographic information in relation to the drainage network. Of course, TWI may yield additional information and could be used as a predictor variable in Eq. 7 instead or in addition to HAND.

   2) In this case we used imagery from the National Agriculture Imagery Program (NAIP) which we downloaded from USGS Earth Explorer. We are aware that Google Earth Engine (GEE) also contains NAIP imagery. However, we found it simpler to download the data and take the reference samples locally.