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Surface water dynamics in the North American Prairie Pothole Region from Sentinel-1 dual-pol SAR time series spanning 2015 to 2018

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The Prairie Pothole Region represents an important factor of water storage and retention in the North American Great Plains. Prairie potholes typically are topographically isolated from each other but may become ephemerally connected by merging of surface water extent or when precipitation or snow melt cause them to fill and spill into neighbouring potholes. Connectivity relationships between wetlands greatly impact their storage and retention functions during flood events. Precise knowledge of surface water extent, therefore, plays a crucial role in determining temporally variable areas contributing to river runoff. Data from remote sensing systems can be used to regularly derive surface water maps over large areas at a relatively small effort, provided that image analysis is fully automatic. Synthetic aperture radars (SAR) have a high sensitivity to the occurrence of open water bodies and partly inundated vegetation. Moreover, they have the ability to collect imagery independent of weather conditions and time of day. Since 2015, the Copernicus Sentinel-1 mission has been acquiring data at a high spatial resolution and at a temporal interval of ca. 7 days over the study area located in North Dakota, USA. A fully automatic water extent retrieval processing chain taking advantage of the dual-pol capabilities of the sensor was developed for monitoring the strong inter- and intra-annual dynamics of surface water extent and partly inundated vegetation. The processing chain applies a Bayesian approach to merge SAR-based water extents with information on topography derived from a high-resolution digital terrain model in order to minimise overestimation due to bare areas and wet snow. The derived extents were validated against reference data based on multi-spectral high-resolution aerial imagery and satellite data from the PlanetScope constellation. Connectivity between pothole catchments was analysed with the help of topographical analysis. Obtained surface water dynamics and connectivity relationships between pothole catchments are interpreted in the context of discharge and precipitation data. Results show that, on average throughout the observation period 2015-2018, open water extent varied between ca. 164 km^2 in May and 140 km^2 in October.