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InSAR time series over rewetted bogs highlight spatially heterogeneous surface deformation

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Peatlands represent the largest natural terrestrial carbon store and provide a multitude of ecosystem services. Many peatlands across the world have been intensively used for centuries either for peat extraction, agricultural usage or forestry. Drainage and removal of the peat layer have led to a disruption of respective ecosystem functioning caused by falling water levels, altered microbial activity and the shrinkage or depletion of the peat layer. Lately, some areas have been restored and brought back to a semi-natural state by prohibiting their use and closing drainage ditches to raise the water table. All these activities have resulted in very heterogeneous peatlands composed by severely degraded, less disturbed or successfully rehabilitated patches. The respective state of peatlands affects not only the hydrology and the typical shrinkage and swelling of peat known as mire breathing, it also determines the role of peatlands as carbon sink or source and is thus of high relevance for climate change mitigation.

Through the application of interferometric Synthetic Aperture Radar (InSAR) time series to several rewetted semi-natural pre-alpine bogs south of the city of Munich, Germany, it was possible to monitor the surface deformation of the peat layer caused by mire breathing for the period 2016-2020. An experimental InSAR data set was used where both the Persistent Scatterer Interferometry (Ferretti et al. 2001) as well as the distributed scatterers technique (Ansari et al. 2018) were applied to satellite images from the Sentinel-1A and B platforms. The use of distributed scatterers allows to obtain a good coverage over semi-natural peatlands.

The seasonal height fluctuations peatlands are naturally subject to are clearly visible from the time series. The overall trend for the observation period shows a subsidence for the largest part of the test sites of up to 2 cm. Throughout the year 2018, a stronger negative trend, expectedly related to the extremely dry conditions in 2018 in this part of Europe, was observed, which caused the peat layer to dry out and to shrink. Furthermore, the combination of persistent and distributed scatterers captures spatial differences in the sign and intensity of the surface movement. Such deviations might be related to former uses, the degree of degradation and the implementation of restoration measures which have affected the hydrology, soil chemistry and vegetation cover of the bogs.

The findings show that peatlands respond to dry periods in a spatially heterogeneous manner. In the light of climate change, such InSAR time series can be used to monitor surface changes over long time frames to assess the long-term vulnerability of semi-natural peatlands and to indicate whether and which restoration measures prove successful.

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