EGU22-10535
https://doi.org/10.5194/egusphere-egu22-10535
EGU General Assembly 2022

New insights on links between InSAR data products and ecohydrological parameters of raised peatlands.

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Links proposed recently between tropical peatland Greenhouse Gas (GHG) emissions and peat-surface displacements as estimated remotely by Interferometry of Synthetic Aperture Radar (InSAR) could provide a basis for low-cost estimation of peatlands GHG emissions on a global scale. However, links between InSAR estimates and peat ecohydrological parameters remain uncertain. We compared InSAR products (interferograms, coherence maps and temporal evolutions of displacements) from Sentinel-1 data for two well-studied Irish raised bogs with in-situ ecohydrological measurements: Clara bog (Co. Offaly) and Ballynafagh bog (Co. Kildare). On the individual raised bog of Clara, we demonstrate heterogeneity of peat-surface displacements in both space and time: the western part of Clara is in subsidence (up to 15 $mm.yr^{-1}$) while the eastern part shows uplift of some millimetres per year. In addition, these long-term evolutions are affected by annual oscillations of displacements due to the variations of water-table levels and to the meteorological conditions (rainfall and temperature). All of this, therefore, makes it difficult to use an InSAR-GHG proxy on temperate peatlands. Ballynafagh bog shows similar displacement behaviour to Clara bog. Furthermore, we show that the InSAR coherence is not affected by changes to vegetation wrought by a wildfire. This can be interpreted as evidence that the satellite-derived C-band radar waves penetrate through the 10-20 cm thick mossy vegetation layer and into the upper few 10's cm of the underlying peat. Moreover, in-situ data show that the coherence is directly related to the soil moisture within the peat. Implications of this observation are (1) that InSAR displacements could be modified by soil moisture, resulting in biased InSAR-derived displacements during the annual oscillations and (2) that coherence mapping may provide a new method to estimate soil moisture on peatlands. Finally, future work should focus on directly validating InSAR displacements from in-situ data.