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Intermittent Small Baseline Subset (ISBAS) InSAR of rural and vegetated terrain: a new method to monitor land motion applied to peatlands in Wales, UK

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It is renowned that the success of multi-interferometric Synthetic Aperture Radar (SAR) methods such as Persistent Scatterer Interferometry (PSI) and Small BASeline Subset (SBAS) is controlled by not only the availability of data, but also local topography and land cover. Locations with sufficient temporal phase stability and coherence are typically limited to either built-up, urban areas or areas of exposed bedrock. Whilst conventional PSI and SBAS approaches have limited potential to monitor surface motions in areas where few (or zero) scatterers or coherent targets exist, the newly developed Intermittent SBAS (ISBAS) technique (Sowter et al. 2013) can fill the gap by providing a more complete picture of ground movement in rural and vegetated regions. ISBAS is a small baseline, multi-look, coherent target method, which considers the intermittent coherence of rural areas and can work over a wide range of land cover classes including agriculture and grassland. Building upon a nationwide study that the British Geological Survey (BGS) undertook to assess the feasibility of InSAR techniques to monitor the landmass of Great Britain (Cigna et al. 2013), we identified a rural region in North Wales as an appropriate target area to evaluate the efficacy of ISBAS, where conventional SBAS and PSI approaches are unlikely to succeed. According to the UK Land Cover Map 2007 (LCM2007) from the Centre for Ecology & Hydrology (CEH), this area is dominated by improved and acid grassland, heather, bog and coniferous woodland, which are likely to result into extremely low PSI or SBAS point densities and sparse coverage of monitoring results. We employed 53 ERS-1/2 C-band (5.3GHz frequency) SAR data acquired in descending mode between 1993 and 2000, which were made available to BGS via the ESA Category 1 project id.13543. In the framework of the Glastir Monitoring & Evaluation Programme (Emmett et al. 2013), funded by the Welsh Government, we processed these using ISBAS covering a 4,460 km^2 region of interest. By using thresholds for perpendicular and temporal baselines of 200 m and 4 years respectively, a total of 300 small baseline interferograms were generated and good network redundancy was obtained. Average temporal coherence of the processed scenes was rather low, with only $\sim$4% of the processed area showing values exceeding 0.25 (hence suitable for an SBAS analysis), and most of the region revealed very low coherence, especially over areas of peat, grass, forest and heather. Processing with ISBAS allowed us to consider the intermittent behaviour of rural scatterers, dramatically improving the point density and achieving areal coverage results of around 99%. This increased the total number of monitored points by a factor of 25. The greatest improvement in terms of point density was achieved for coniferous woodland, which showed ISBAS/SBAS ratios exceeding 300, and densities increasing up to 150 points/km^2 with ISBAS. Bog, acid grassland and dwarf shrub heath showed densities increasing from 2-10 to 150-160 points/km^2 when using ISBAS with respect to conventional SBAS. It is worth noting that despite intermittence and the fact of relying only on a temporal subset of interferograms, the vast majority of the ISBAS points showed velocity standard deviations lower than 1.0-1.5 mm/yr, hence good quality of the estimated ground motion rates was retained using ISBAS and intermittently coherent targets. Geological interpretation, analysis and further discussion of the results in relation to changes in surface elevation of blanket peat are presented by Rawlins et al. 2014 (cf. BG2.3/SSS6.6).

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