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Mapping UK snow accumulation using satellite passive microwave and visible-infrared remote sensing observations: two case studies from 2009 and 2010

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In February 2009, an unusually significant snow storm deposited considerable amounts of snow in the UK for the first time in several years. A more persistent event deposited larger amounts of snow between December 2009 and January 2010; during this time snow cover duration exceeded a month in some locations and on 7 January, England Scotland and Wales were almost completely covered in snow as observed by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS). Such widespread snow cover has not been observed since 1963 and 1979. Information about snow quantity and distribution in the UK is sparse and while some official observations are made, most observations are made through community-based observers or via more esoteric online social networks. Furthermore, daily snow accumulation maps are not easily obtainable for the UK.

Coupled with unusually cold temperatures which began in mid December, these case studies provide an excellent opportunity to re-evaluate the role of satellite passive microwave observations for estimating snow water equivalent in the UK. Satellite remote sensing observations were obtained for the two snow event periods. MODIS observations are used to determine the location of the snow when cloud does not obscure the field of view. Passive microwave observations from the Advanced Microwave Scanning Radiometer – EOS (AMSR-E) are used to estimate SWE. In the first instance, AMSR-E estimates from the standard NASA algorithm are tested. On account of the documented radio frequency interference at 10 GHz the estimates are deemed unsuitable. A re-configured algorithm is developed at the native sampling resolution (10 km in along and across track) projected to a UTM grid. The re-configured approach to estimate SWE uses 18, 23 36 and 89GHz channels (vertical and horizontal polarization) and uses a frequency ratio approach, rather than difference, to minimize the physical temperature effect on brightness temperatures at 18, 36 and 89 GHz. It also takes advantage of newer ancillary data sets for forest cover and water. The approach is calibrated to estimate 20 mm intervals of SWE using an expert classification system and is validated with a snow analysis modeling approach from the Canadian Meteorological Centre and using the sporadic and irregular ground observations available. The combination of MODIS and a re-configured AMSR-E SWE algorithm demonstrate improved snow observational capability for the UK from this combined approach.