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Application of Sentinel-2A data for dairy pasture growth modelling and monitoring

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Predictions of near-real-time pasture growth and quality are key to sustainable dairy farming. Traditionally, farmers have been relying on labour and cost intensive manual survey techniques. A potentially more efficient solution to this management problem involves employing remote sensing based technologies. The Innovate UK funded PASQUAL project is researching and developing products for dairy farmers that combine satellite data with weather driven daily time-step pasture growth and quality models for regular monitoring and near future (∼10days) pasture growth prediction. Tools like these would reduce manual efforts involved in weekly pasture surveys.

The advent of the Sentinel satellites provides a step change in the ability to provide frequent information about pastures. We combined optical remote sensing data (proximal hyperspectral and Sentinel 2A 4-band 10 m resolution) with a radiative transfer (RT) model (PROSAIL) to estimate pasture cover (leaf area index, LAI, and biomass), in a dairy farming context. Three sites in Southern England were used: two pasture farms that differed in pasture type and management, and small agronomy trial plots with different mixtures of grasses, legumes and herbs, as well as pure perennial ryegrass. Proximal and satellite spectral data were used to retrieve LAI data via RT model inversion, which were compared against field observations of LAI. The potential of four bands of Sentinel 2A, that correspond with 10m pixel size, was studied by convolving narrow spectral bands (from in situ sensor) into Sentinel 2A bands. Retrieved LAI, using resampled in situ spectral data, compared well with measured LAI, for all sites, even for those with mixed species. This proved the suitability of 10m Sentinel 2A spectral bands for capturing LAI dynamics for different types of pastures. Sentinel 2A image based retrieval also yielded good agreement with LAI measurements obtained for a typical perennial ryegrass based pasture farm.

Furthermore, a grass growth model was developed to simulate daily pasture growth driven by weather data and management decisions (cutting and grazing). LAI retrieved using remote sensing was used to calibrate sensitive model parameters (light use efficiency and biomass partitioning coefficients) and ultimately generate daily biomass maps. The biomass simulations satisfactorily captured daily changes in biomass in a grazing cycle and model-Sentinel 2A derived biomass maps represented within-paddock variability in the biomass sufficiently well. However, there is still scope for improvement in the model performance in terms of accuracy of biomass estimates. This can potentially be achieved by improving model parameterization with respect to the effects of soil nutrients, effect of animal age and lactation cycle, as well as pasture quality on the pasture intake.