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A multi-source data fusion approach to assess spatial-temporal variability and delineate homogeneous zones in a vineyard in Greece

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The application of Precision Viticulture requires a quite accurate assessment of very fine-scale spatial and temporal variation in a vineyard. At present advances in proximal sensing technology and spatial-temporal data analysis are available to characterize the local changes of plant vigor over time, which can be advantageously used in Precision Viticulture. The objective of the work was to verify the potential of multivariate geostatistical techniques to fuse data from a multi-band radiometer and a geophysical sensor with different support for delineation of a vineyard into homogeneous zones, to be submitted to differential agricultural management. The study was conducted in a commercial table grape vineyard located in southern Greece during the years 2015, 2016 and 2017. Table grapes were trained to a double cross arm trellis system and spaced by 1.8 x 2.6 m. A regular grid of 36 cells (0.0298-0.0404 ha per cell) was set up to facilitate field sampling in order to assess crop vigour, yield and grape quality covering the total area. Soil electrical conductivity was measured using the EM38 sensor (Geonics Ltd., Ontario, Canada). A Crop Circle canopy sensor (ACS-470, Holland Scientific Inc., Lincoln, NE, USA) with the sensor located at 1.5 m height from the soil surface and 1.2 m horizontally from the vines was used for scanning the side canopy area at different crop stages. The temporal multi-sensor data were analysed with the geostatistical data fusion techniques of block cokriging, to produce thematic maps, and factorial block cokriging to estimate synthetic scale-dependent regionalized factors. From Factorial analysis the first two regionalised factors were retained because associated to eigenvalues greater than 1: the first one related to the plant performance after the start of veraison and the second to the early performance of the vine. The two factors produced two different delineations of the vineyard into zones characterized by different plant vigour that remained stable enough over the time. These maps can be effectively used by the farmer to diversify management through time and space. The results have shown the potential of the proposed approach to delineate areas characterized by different plant and soil attributes, which might affect grape production and quality significantly. However, further research on data fusion of the outcomes from different sensors, by using multivariate geostatistical techniques, is still needed.