Geophysical Research Abstracts
Vol. 18, EGU2016-11073, 2016
EGU General Assembly 2016

Estimation of chlorophyll contents in leaves and canopy of steppe vegetation using hyperspectral measurements

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As an important part of the Eurasian Steppe, the temperate typical steppe in Inner Mongolia is highly representative of the Eurasian vegetation. Compared to multispectral remote sensing, hyperspectral remote sensing is more sensitive in monitoring some characteristics of vegetation. However, the research on the typical temperate steppe in Inner Mongolia is still not perfect, so we selected three sampling zones with different dominant species on the typical steppe in Xilinhot of Inner Mongolia. We collected spectrum of leaves and canopy separately to estimate content of chlorophyll of steppe vegetation. In addition, we compared and analyzed the advantage and feasibility of different estimation methods in estimating chlorophyll contents of meadows which have different dominant species through cross validation. The conclusions drawn in this research are as follows:
Due to significant discontinuity, maximum first derivative method and Lagrange interpolation method are not suitable for estimation of chlorophyll of typical steppe. Compared with other methods, the red edge position calculated with four points linear interpolation obviously migrates to long wave direction. Inverted Gaussian model and four points linear interpolation both show low sensitivity for Stipa grandis steppe zone (with Stipa grandis as dominant species) where chlorophyll concentration is low and there is saturation phenomenon and weak stability (obvious variation of R2) for Leymus chinensis steppe (with Leymus chinensis as dominant species) where chlorophyll concentration is high, so they are also not the best choice. Linear extrapolation and polynomial fitting show certain saturation for high concentration of chlorophyll and also high correlation coefficient for both leaves and canopy, so they are suitable for estimation of chlorophyll concentration of leaves and canopy on the steppe. The different methods of extracting red edge are better at estimating chlorophyll of leaves than canopy and the determination coefficients of all methods are high for sampling zones with large quantity of samples.
Vegetation indices and the absorption and reflection characteristic on narrow bands are also good choices for estimation of chlorophyll content of leaves. It is obviously wiser to use vegetation indices to estimate chlorophyll of leaves than canopy. The bands obtained by screening with the chlorophyll content of leaves which is estimated with vegetation indices on narrow bands are mainly on green light and red light bands, while the optimal bands for canopy are mainly red light and near infrared bands.
The chlorophyll content of leaves and canopy can be well estimated with multiple regression method, especially partial least squares regression, both of which get high determination coefficient and small root-mean-square error. The bands obtained by screening with the leave chlorophyll content which is estimated by multiple stepwise linear regression are mainly on the position of 700nm, 760nm, etc., while the bands for canopy are mainly on the position of 450nm, 700nm, 1000nm and 1200nm, which accord with the absorption and reflection characteristic of chlorophyll. The estimation result and stability of the two methods with multivariate, namely partial least squares regression and multiple stepwise linear regression are better than the methods with univariate.