The International Society of Precision Agriculture presents the
15th International Conference on Precision Agriculture
26–29 JUNE 2022
Minneapolis Marriott City Center | Minneapolis, Minnesota USA

Cloud correction of Sentinel-2 NDVI using S2cloudless package

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A paper from the Proceedings of the
15th International Conference on Precision Agriculture
June 26-29, 2022
Minneapolis, Minnesota, United States

Abstract.

Optical satellite-derived Normalized Difference Vegetation Index (NDVI) is by far the most commonly used vegetation index value for crop monitoring. However, it is quite sensitive to the cloud, and cloud shadows and significantly decreases its usability, especially in agricultural applications. Therefore, an accurate and reliable cloud correction method is mandatory for its effective application. To address this issue, we have developed an approach to correct the NDVI values of each and every pixel of the image captured by the Sentinel-2A satellite of the European Space Agency's Copernicus Program. The Chhattisgarh region of India was selected to analyze the variation in NDVI value. The NDVI value of each pixel shows a slight decrease in the value because of clouds. Cloud probability was calculated using the S2cloudless package provided by Sentinel Hub. The cloud probability of a pixel implies how densely the cloud is present over that pixel, thus inversely affecting the NDVI values. To understand the relationship between cloud probability and NDVI, we did a pixel to pixel (>25 million pixels) comparison between clouded and non-clouded NDVI Images on two consecutive dates in June 2021. Our analysis shows that an increase in 0.1 Unit of cloud probability corresponds to a decrease in 0.2668 units of NDVI value. We further validated this finding on images captured during the months of August and September 2021. The validation was done on more than 35k square meters of actual farm fields and the results indicate that the proposed method shows more than 60% improvement in the cloud-affected NDVI images.

Keywords.
NDVI, Cloud correction, Sentinel-2, Remote sensing

Introduction

NDVI, or normalized difference vegetation index, is an indicator of a plant's health and is helpful when you want to remotely monitor what's currently happening to your crops. It's calculated by comparing the values of absorption and reflection of red and infrared light. A healthy plant actively absorbs red light and reflects near-infrared light, while the exact opposite happens to a diseased or dying plant. Sentinel 2A data is very popular in agriculture because of its high resolution images which are more accurate to calculate vegetation indices and new images are available in 4 to 5 days. The NDVI derived from Sentinel 2A is commonly used in crop assessments. However, a thick cloud in the sky can completely corrupts the reflectance signal and affect the accuracy of the NDVI maps derived using Sentinel 2A imagery. Thus it is very important to detect anomalies caused due to clouds.

Approach

Sentinel Hub provides the S2cloudless package that calculates cloud probability. We developed a simple cloud correction approach by performing pixel to pixel (>25 million pixels) comparison between clouded and non-clouded NDVI Images to understand the relationship between cloud probability and NDVI.

Results

Based on our analysis, we observed that a 0.1 Unit of cloud probability corresponds to a decrease in 0.2668 units of NDVI value. We further tested this finding on more than 35k square meters of actual farm fields. The proposed method showed more than 60% improvement in the cloud-affected NDVI images as shown in the figure below.

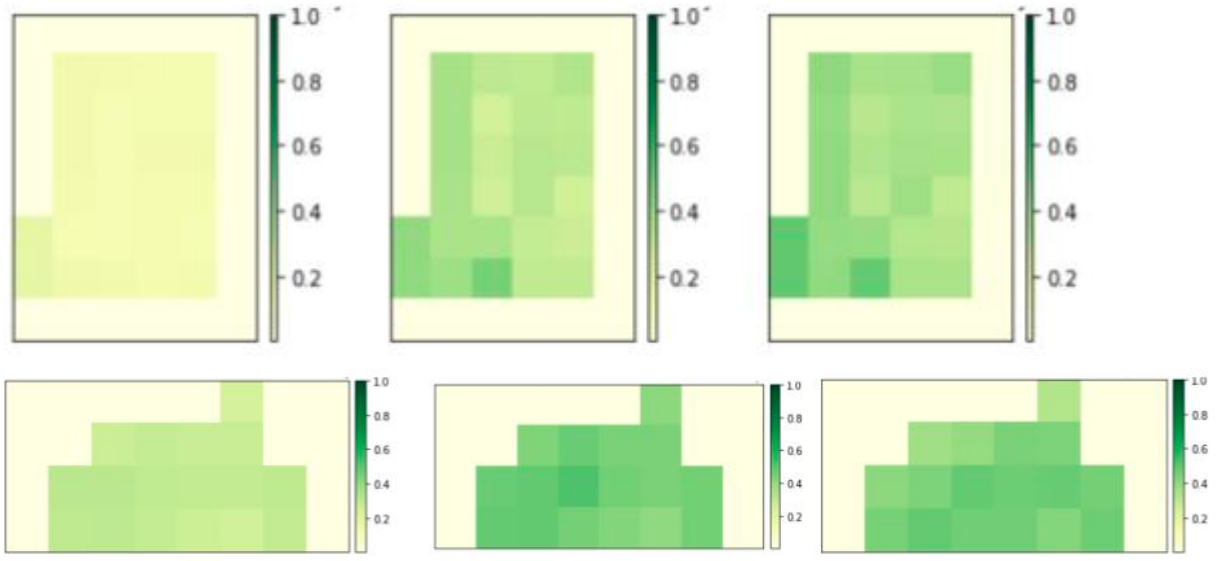

Fig 1. The images on the extreme left shows NDVI map of plots derived from Sentinel 2A imagery captured on 3rd of August 2021 whereas the ones on the extreme right were derived from Sentinel 2A imagery captured on 5th of August 2021. The huge drastic difference observed between the two nearby dates is due to cloud cover. NDVI plot maps in the middle are developed post cloud correction using the approach mentioned above.