GLASS Global LAnd Surface Satellite

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Fractional vegetation cover estimation and evaluation of alpine grassland in Qinghai-Tibet Plateau based on UAV and MODIS data

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INTRODUCTION

Ground-based observations are the main data source for the validation of remote sensing fractional vegetation cover (FVC) products. However, due to the lack of field measurement data in many regions, there is still some uncertainty in the evaluation of FVC retrieval accuracy and validation, especially in the remote and harsh natural environment of the Qinghai-Tibet Plateau (QTP) region.

This study focuses on the evaluation of FVC retrieval accuracy and validation of QTP using MODIS satellite remote sensing images and a large amount of measured data that can be matched with satellite remote sensing images pixels, and aimed to:

(I) assess the accuracy and performance of different machine learning methods (Back Propagation Neural Networks [BPNNs] Support Vector Machine [SVM] Random Forest [RF]);

(II) compare and evaluate the accuracy of the retrieval FVC in this study, GLASS FVC product, and GEOV3 FVC product from 2015 to 2018;

(III) analyze the spatial distribution and change in FVC over the peak growth in the QTP region between 2000 and 2021.

METHODS

- **FVC Retrieval Using Machine Learning**
  BPNNs, SVM, RF
- **Comparison and Validation of FVC products**
  At the temporal scale, the two FVC products (GLASS, GEOV3) in June, July, and August were synthesized into annual-scale images using the maximum value composites (MVC) approach during 2015 to 2018. At the spatial scale, pixel aggregation was used to resample the 250m FVC data to 500 m and 300 m to keep the spatial resolution consistent with the GLASS FVC product and GEOV3 FVC product respectively.
- **FVC product accuracy evaluation**
  The basic idea of FVC product validation is to reduce the uncertainty caused by the underlying surface heterogeneity by removing the sample sites at the NDVI difference threshold so that the “true” FVC can be used to validate the FVC products directly.
- **Accuracy evaluation**
  The fitness of the models is measured by the coefficient of determination (R^2), and the prediction accuracy evaluation index uses the root mean square error (RMSE).
- **Trend analysis**
  The trend of FVC in the QTP region from 2000 to 2021 was analyzed by the Slope algorithm, and the significance of the trend was analyzed by the F-test method on an image-by-image basis.

RESULTS

- **Performance of retrieval methods**

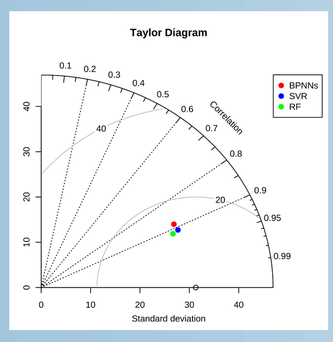

Figure 1 2015 Taylor diagram used to evaluate the performance of three models BPNNs, SVR, and RF

- **Comparison and Validation of FVC products**

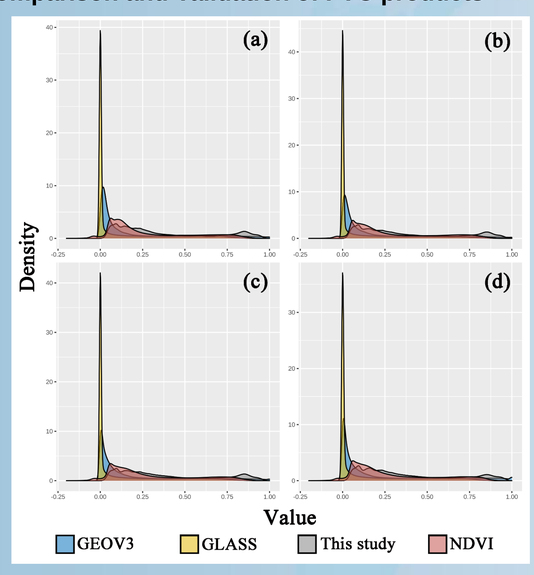

Fig. 2 (a) 2015, (b) 2016, (c) 2017 and (d) 2018 pixel density profiles of different products

RESULTS

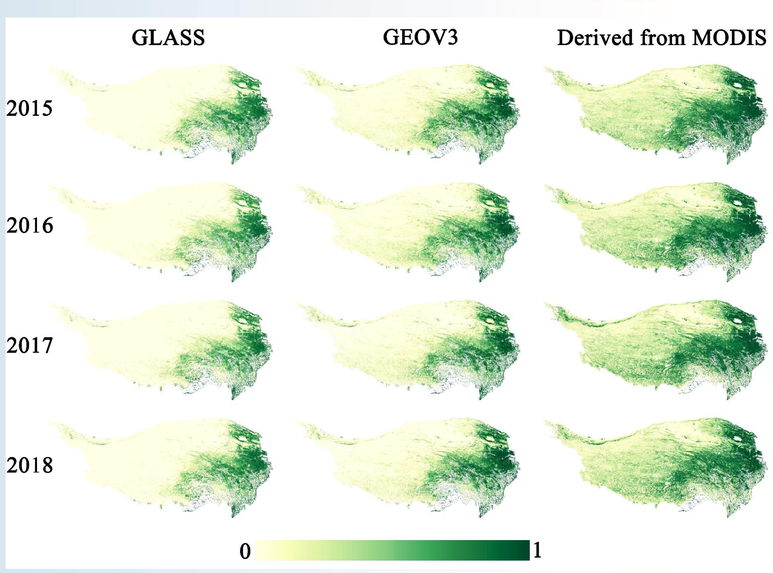

Figure 3 FVC maps for GEOV3 FVC product, GLASS FVC product, and 250m FVC product vegetation growth period from 2015-2018

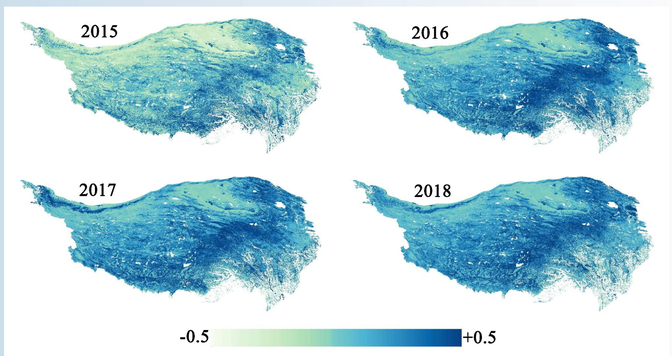

Fig. 4 Spatial distribution of the difference between 250m FVC product and GLASS product

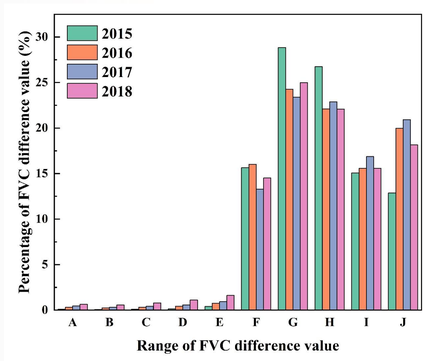

Figure 5 Percentage of 250m FVC product and GLASS FVC product differences in different difference intervals

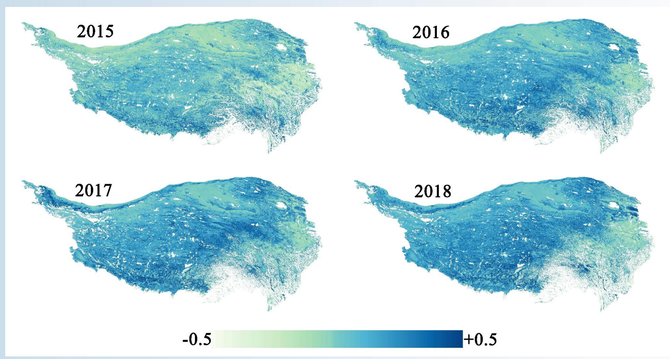

Fig. 6 Spatial distribution of the difference between 250m FVC product and GEOV3 product

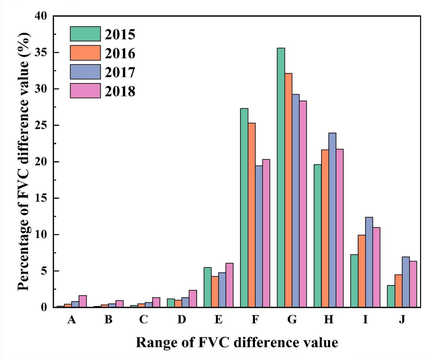

Figure 7 Percentage of 250m FVC product and GEOV3 FVC product differences in different difference intervals

（A: -0.5~-0.4, B: -0.4~-0.3, C: -0.3~-0.2, D: -0.2~-0.1, E: -0.1~0, F: 0~0.1, G: 0.1~0.2, H: 0.2~0.3, I: 0.3~0.4, J: 0.4~0.5）

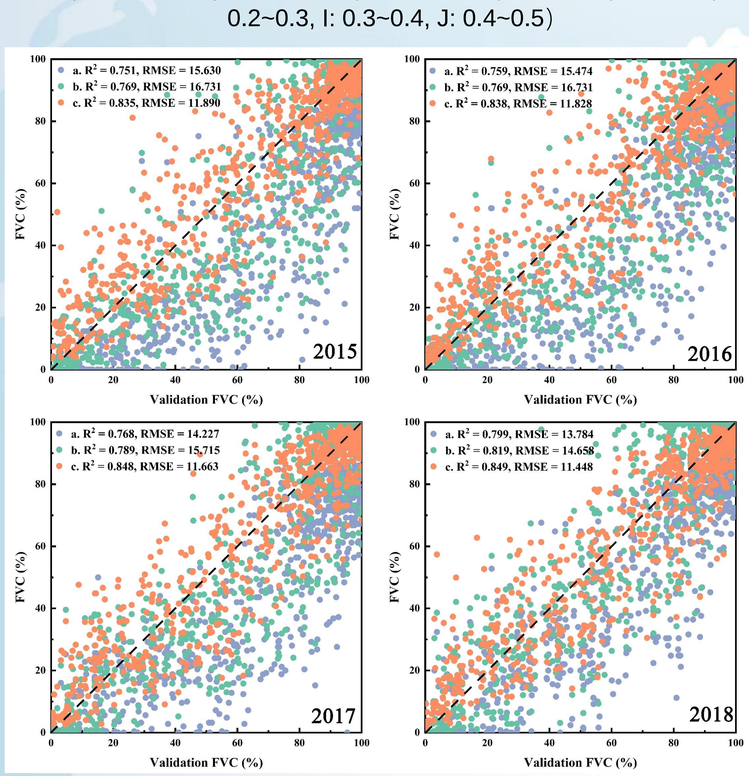

Figure 8 Accuracy evaluation of a. GLASS FVC product, b. GEOV3 FVC product and c. 250m FVC product

RESULTS

- **Spatial distribution of FVC based on the RF**

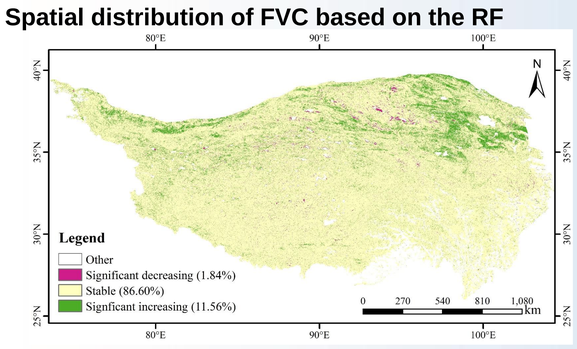

Figure 9 Change trend of FVC in the QTP from 2000 to 2021

DISCUSSION

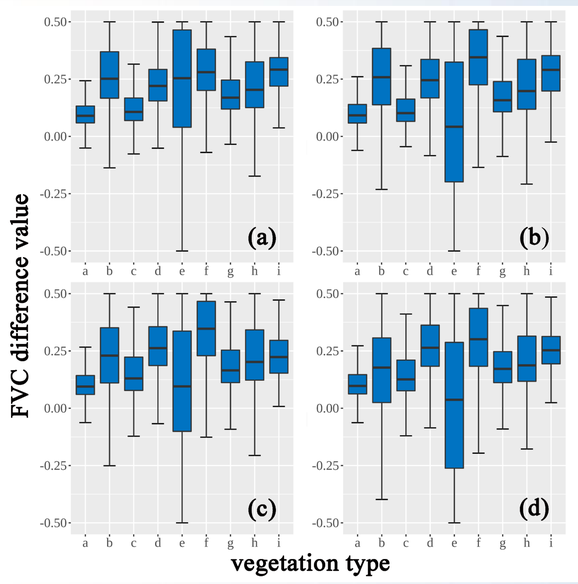

Figure 10 Boxplot of FVC difference value (between 250m FVC product and GLASS FVC product) for different vegetation types in (a)2015, (b)2016, (c)2017, (d)2018

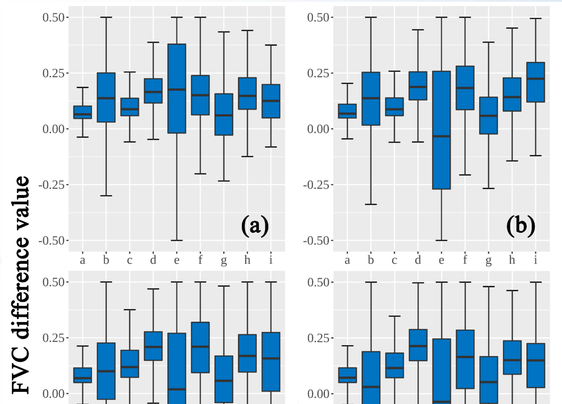

Figure 11 Boxplot of FVC difference value (between 250m FVC product and GEOV3 FVC product) for different vegetation types in (a)2015, (b)2016, (c)2017, (d)2018

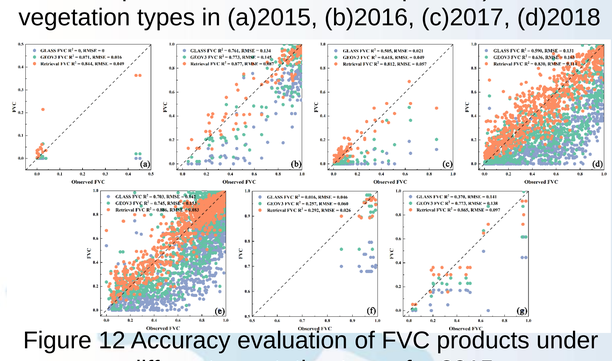

Figure 12 Accuracy evaluation of FVC products under different vegetation types for 2015
(a. other b. scrub c. desert d. grassland e. grass f. meadow g. bog h. alpine vegetation i. cultivated vegetation)

CONCLUSION

The FVC retrieval results of this study are closer to the ground truth, and the accuracy of the constructed FVC retrieval mechanism in the QTP area is higher (the lowest accuracy is R^2=0.835, RMSE=11.890) than the GLASS FVC product (R^2=0.751, RMSE=15.630) and GEOV3 FVC product (R^2= 0.769, RMSE=16.731). 2000-2021 FVC generally shows a trend of increasing from west to east and from south to north. The increase is greater than the decrease in the last 22 years.