A 500-meter High-resolution Long-term Winter Wheat aboveground biomass Dataset for China (2009-2023) from Multi-source Data

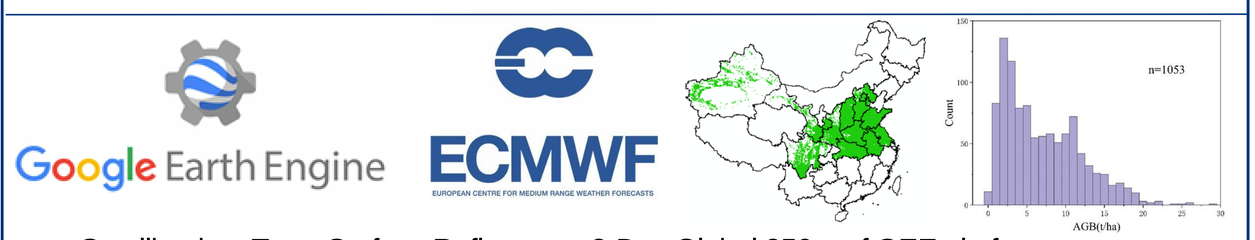
Wang Shijun[1], Stefano Pignatti[2], Giovanni Laneve[3], Raffaele Casa[4],Hao Yang[5], Wenjiang Huang[5],Linyi LiuLi[5], Zhenhai Li[1*]

1:Shandong University of Science and Technology, Qingdao 266590, China;2:Institute of Methodologies for Environmental Analysis (IMAA), National Council of Research (CNR), C. da S. Loja, 85050 Tito Scalo, Italy; 3: School of Aerospace Engineering (SIA), University of Rome "La Sapienza", SIA, via Salaria, 851, 00138 Roma, Italy;4: DAFNE, Università della Tuscia, Via San Camillo de Lellis, 01100 Viterbo, Italy;5: Institute of Crop Sciences, Chinese Academy of Agricultural Sciences/Key Laboratory of Crop Physiology and Ecology, Ministry of Agriculture and Rural Affairs, Beiing 100081, China

BACKGROUND

In today's society with frequent extreme weather events, increasing international tensions and global economic downturn, food security faces unprecedented challenges. Winter wheat is one of the main food crops in China. Above-ground biomass is an important indicator that reflects the growth status of wheat and is also an important factor affecting wheat yield and income. Timely and accurate estimation of above-ground biomass of winter wheat is of great significance for yield prediction, field management decisions and food import and export trade strategies.

Materials



- Satellite data:Terra Surface Reflectance 8-Day Global 250m of GEE platform
- Meteorological data:ERA5 dataset of GEE platform(11132meters)
- Winter wheat land cover data:National Science&Technology Infrastructure
- In-situ measured yield data:Shandong;Beijing;Hebei……(n=1053)

METHODS

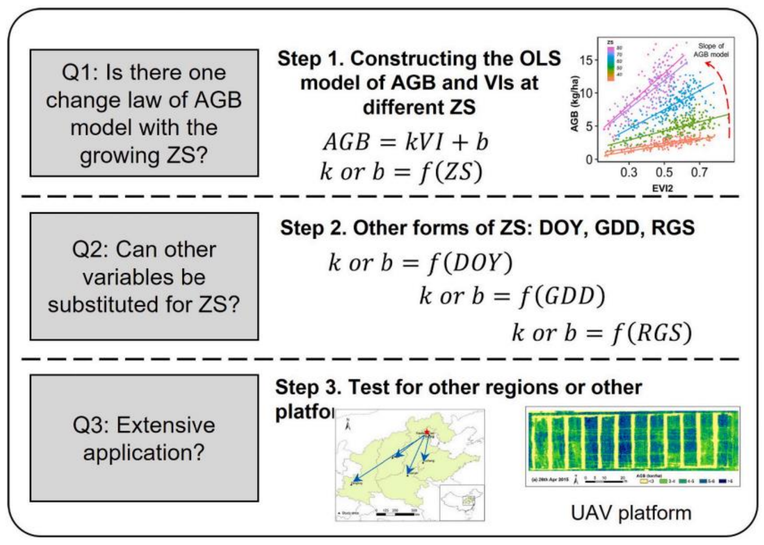


Figure 1: Flowchart of the CBA-Wheat model

CBA-Wheat: Biomass model throughout the growth period: The biomass model coefficients of each growth period have a good evolution pattern with the growth period. The slope has an exponential relationship with the growth period (R^2=0.99), and the intercept has a linear relationship with the growth period (R^2 =0.58), therefore, the biomass prediction model can achieve prediction of the entire growth period.

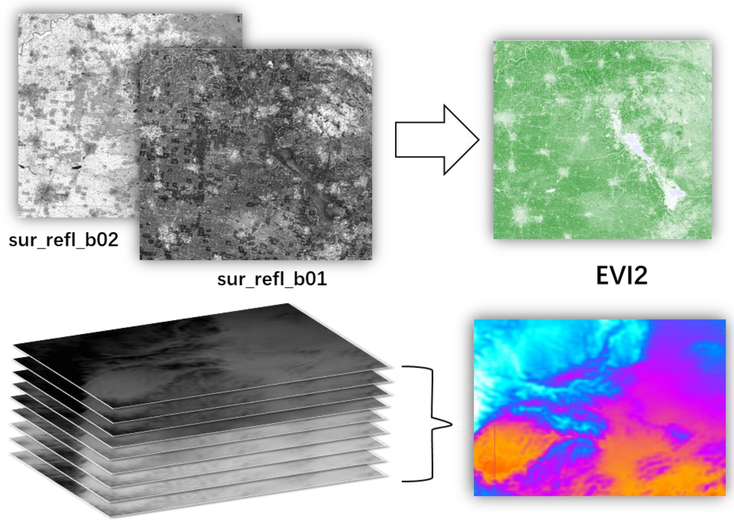


Figure 2: Accumulated temperature and EVI2

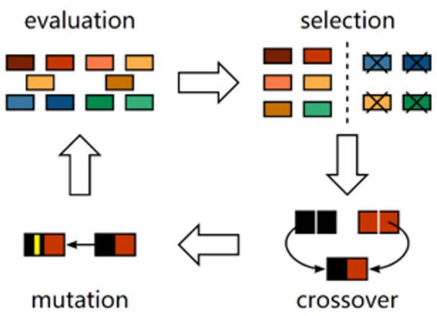


Figure 3: genetic optimization algorithm

The model construction of star images is limited by the number of ground truth points. We try to optimize the CBA-Wheat model parameters through parameter optimization method based on the CBA-Wheat model framework.

Genetic algorithm is an efficient global optimization search algorithm based on natural selection and genetic theory, which combines the survival of the fittest rules in the biological evolution process with the random information exchange mechanism of chromosomes within the population.

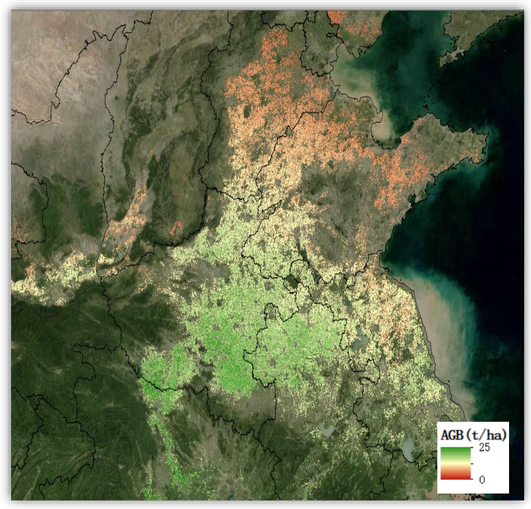


Figure 4: Biomass estimation results

RESULTS

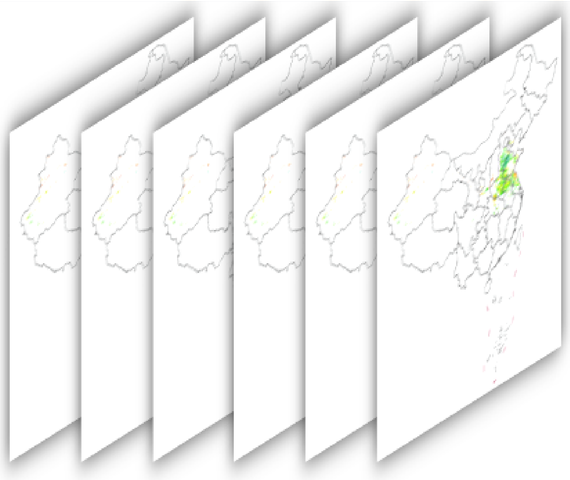


Figure 5: dataset of winter wheat aboveground biomass

The dataset of winter wheat aboveground biomass in China during 2019-2023: By coupling ERA5 and MODIS multi-source remote sensing data, a 500-m resolution winter wheat biomass data set covering the main winter wheat producing areas in China was created. The time coverage is from the beginning of March to the harvest period of each year, and the inversion is performed every eight days. The biomass characteristics of winter wheat are analyzed and discussed from two dimensions: space and time.

The biomass estimation effect of the coupled CBA-Wheat model is better than other traditional models. The modeling data set R^2=0.64, RMSE =2.96t/ha, and the validation set R^2=0.68, RMSE=3.11t/ha. The one-year retention cross-validation accuracy RMSE is 2.49-4.68t/ha. This model shows better resistance to saturation in high biomass situations compared to crop assimilation methods. Secondly, the model performance is comprehensively evaluated through comparison with the machine learning model and cross-validation. The model has high inversion accuracy.

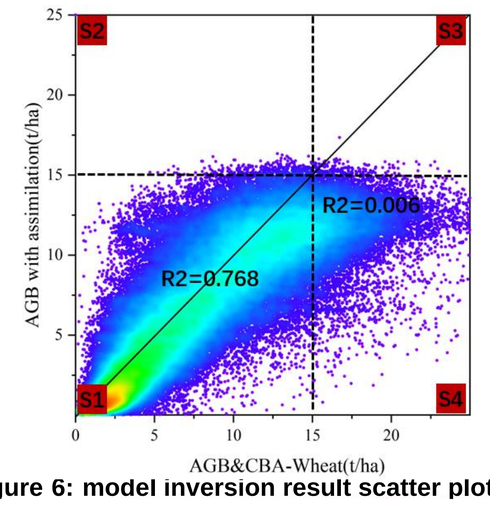


Figure 6: model inversion result scatter plot

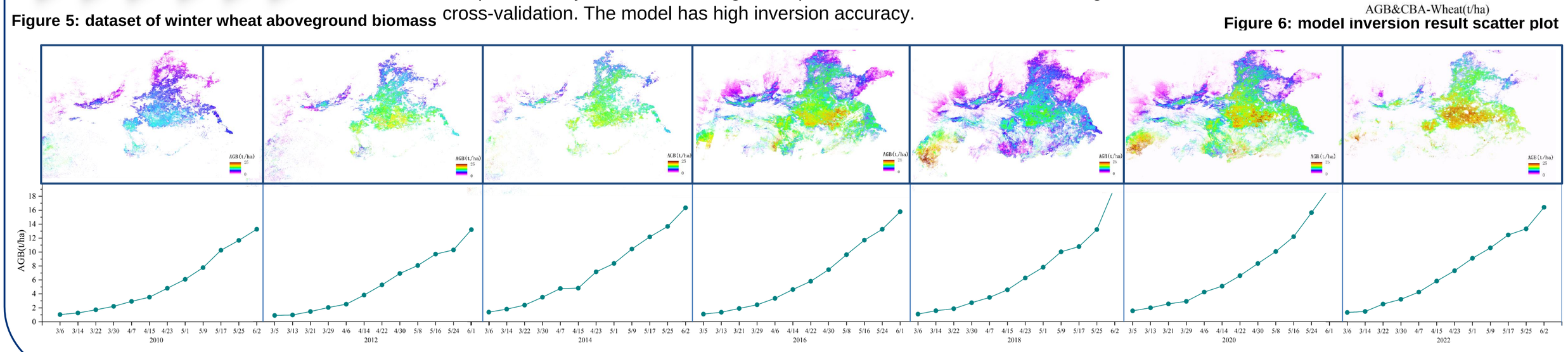


Figure 7: Average AGB in China's main producing areas

CONCLUSION

This study used an optimization algorithm to optimize the parameters of the CBA-Wheat model to obtain a winter wheat biomass estimation model suitable for MODIS data. By coupling ERA5 and MODIS multi-source remote sensing data, a 500-meter resolution covering the main winter wheat producing areas in China was created. Rate winter wheat biomass data set. It has high inversion accuracy and is suitable for inversion throughout the growth period. It has good application potential in regional large-area biomass prediction, and is of great significance to agricultural production management and yield prediction.