Duanyang Liu

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EDUCATION

2017.9-2021.1 (M.A degree)	**Cartography and geography information system**	Faculty of Geographical Science, Beijing Normal University, China
2013.9-2017.6 (B.S degree)	**Remote Sensing Science and Technology**	Faculty of Geosciences and Environmental Engineering, Southwest Jiaotong University, China

RESEARCH INTERESTS AND CAREER PLANS

I am interested in remote sensing methodology development and its application to large-scale terrestrial mapping. More specifically, the following areas will be my research areas of focus:

- Vegetation growth tracking
- Vegetation biophysical and biochemical parameter retrieval
- Land surface parameter mapping
- Remote sensing data processing and analysis with AI
- Ecomodeling
- Integration of optical, radar and passive microwave for large scale/global terrestrial mapping

HONORS AND AWARDS

- First-class outstanding student scholarship, Beijing Normal University, 2019 to 2020
- Outstanding Undergraduate Student Award, Southwest Jiaotong University, 2017
- National encouragement scholarship, Southwest Jiaotong University, 2016 to 2017
- National encouragement scholarship, Southwest Jiaotong University, 2015 to 2016
- One software copyright titled Remote Sensing Image Processing System, which conducts geometric correction, radiometric calibration, and image classification of sensing image data.

PUBLICATIONS

a. D. Liu, K. Jia, M. Xia, X. Wei, Y. Yao, X. Zhang, G. Tao, "Fractional Vegetation Cover Estimation Algorithm based on Recurrent Neural Network for MODIS 250 m reflectance data", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 14 (2021): 6532-6543 (*Published*).

Key message from the paper: *In this study, a Recurrent Neural Network with the Long*

Short-Term Memory unit (RNN-LSTM) was adopted to develop the novel FVC estimation method over sequence training sample form MODIS 250 m reflectance and GLASS FVC data. The results indicated that the RNN-LSTM derived FVC had reliable spatial-temporal continuity and good consistency with the GLASS FVC product. Additionally, the proposed method was capable of capturing the temporal characteristics of vegetation growth and reducing the uncertainties from the atmosphere and radiation. Finally, an independent validation indicated that the RNN-LSTM FVC achieved reliable accuracy.

1. ***Liu, D.**; Jia, K.; Jiang, H.; Xia, M.; Tao, G.; Wang, B.; Chen, Z.; Yuan, B.; Li, J. Fractional Vegetation Cover Estimation Algorithm for FY-3B Reflectance Data Based on Random Forest Regression Method. Remote Sens. 2021, 13, 2165. https://doi.org/10.3390/rs13112165. (Published)*

   Key message of this paper: This study proposed a novel FVC estimation algorithm based on random forest method for FY-3B reflectance data, which aims to investigate the capability of FY-3 reflectance data on global FVC estimation. The spatial–temporal validation over the regional area indicated that the FVC estimations generated by the proposed algorithm had reliable continuities. Furthermore, a satisfactory accuracy performance (R^2 = 0.7336, RMSE = 0.1288) was achieved for the proposed algorithm based on the Earth Observation LABoratory (EOLAB) reference FVC data. All these results indicated that the FY-3 reflectance data were capable of generating a FVC estimation with reliable spatial–temporal continuities and accuracy.

2. Wang, Bing, Kun Jia, Xiangqin Wei, Mu Xia, Yunjun Yao, Xiaotong Zhang, **Duanyang Liu**, and Guofeng Tao. "Generating Spatiotemporally Consistent Fractional Vegetation Cover at Different Scales Using Spatiotemporal Fusion and Multiresolution Tree Methods." ISPRS Journal of Photogrammetry and Remote Sensing 167 (2020/09/01/ 2020): 214-29. (Published)

   Contributions: *I conducted data simulation of Landsat-7 ETM+ and corresponding FVC values using the PROSAIL mode. I also contrived to the manuscript review and editing.*

3. **Liu, Duanyang**, Kun Jia, Xiangqin Wei, Mu Xia, Xiwang Zhang, Yunjun Yao, Xiaotong Zhang, and Bing Wang (2019). "Spatiotemporal Comparison and Validation of Three Global-Scale Fractional Vegetation Cover Products." Remote Sensing, 11 (21): 2524. (Published)

   Key message of this paper: *This study investigated the performances of three popular global FVC products, including GEOV2 FVC (2001-2016), GEOV3 FVC (2014-2016), and GLASS FVC (2001-2016), in term of spatiotemporal continuities and accuracy. The results show that the GLASS FVC product achieved complete continuities over space and time. Using ground FVC measurement data collected and processed by the EOLAB as reference data, the GLASS FVC (R^2=0.7878, RMSE=0.1212) product also achieved the highest accuracy compared with GEOV2 (R^2=0.5798, RMSE=0.1921) and GEOV3(R^2=0.7744, RMSE=0.2224). This research*

verifies the performance and differences among these three popular global FVC products, which is curial for their usage and improvement in land surface models.

4. Jia, Kun, Shunlin Liang, Xiangqin Wei, Yunjun Yao, Linqing Yang, Xiaotong Zhang, and **Duanyang Liu**. "Validation of Global Land Surface Satellite (Glass) Fractional Vegetation Cover Product from MODIS Data in an Agricultural Region." Remote Sensing Letters 9, no. 9 (2019): 847-56. (Published)

   Contributions: *In this research, I evaluated the accuracy of GLASS FVC generated from MODIS Collection 6 data in Heihe study area and contrived to the manuscript review and editing.*

5. **Liu, Duanyang**, Linqing Yang, Kun Jia, Shunlin Liang, Zhiqiang Xiao, Xiangqin Wei, Yunjun Yao, Mu Xia, and Yuwei Li (2018). "Global Fractional Vegetation Cover Estimation Algorithm for VIIRS Reflectance Data Based on Machine Learning Methods." Remote Sensing 10 (10): 1648. (Published)

   Key message from the paper: *As an essential global land surface vegetation product, GLASS FVC generated from MODIS data has achieved reliable performances and has been widely used. However, MODIS has already exceeded its design lifespan, and its successor, the VIIRS sensor, was launched in 2011. To maintain the continuity of GLASS FVC product, a novel algorithm, which adopted machine learning method for global FVC estimation for VIIRS data, was proposed. Four machine learning methods (BPNN, GRNN, MARS, and GPR) were used for global FVC retrieval. The training samples were extracted from VIIRS reflectance data (Red and NIR bands) and GLASS FVC product (2013) according to BELMANIP network. The validation result indicates that GPR method achieves the best accuracy (R^2=0.9019, RMSE=0.0887) and MARS method has the highest computational efficiency. Furthermore, FVC data estimated by the proposed algorithm also show complete spatiotemporal continuities and consistency with corresponding vegetation types.*

6. Jia, Kun, Linqing Yang, Shunlin Liang, Zhiqiang Xiao, Xiang Zhao, Yunjun Yao, Xiaotong Zhang, Bo Jiang, and **Duanyang Liu**. "Long-Term Global Land Surface Satellite (Glass) Fractional Vegetation Cover Product Derived from MODIS and AVHRR Data." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 12, no. 2 (2018): 508-18. (Published)

   Contribution: *I generated the GLASS AVHRR FVC product (2016-2018) using MARS method and contrived to the manuscript review and editing.*

7. Yang, Linqing, Kun Jia, Shunlin Liang, Meng Liu, Xiangqin Wei, Yunjun Yao, Xiaotong Zhang, and **Duanyang Liu** (2018). "Spatio-Temporal Analysis and Uncertainty of Fractional Vegetation Cover Change over Northern China During 2001–2012 Based on Multiple Vegetation Data Sets." Remote Sensing 10 (4): 549. (Published)

   Contribution: *I evaluated the consistency and accuracy of GLASS FVC and GEOV1 FVC products and contrived to the manuscript review and editing.*

RESEARCH EXPERIENCE

Production of the Global Climate Data Records and Applications to Climate Change Studies

09/2017 – present Advisor: Dr. Kun Jia

- Developed a global fractional vegetation cover estimation algorithm for VIIRS reflectance data using machining learning methods.
- Validated the performance of FVC data generated using the proposed algorithm.
- Developed a time-series fractional vegetation cover estimation algorithm based on recurrent neural networks.

Research of 5m Multispectral Satellite System in Environmental Protection

07/2017 – 12/2019 Advisor: Dr. Kun Jia

- Preprocessed the GF-2 data and extracted information about human activities over three state reserves.
- Contributed to project report writing.

Development of global change key data based on domestic satellite data

07/2018 – present Advisor: Dr. Kun Jia

- Developed a fractional vegetation cover estimation algorithm for FY-3B reflectance data based on machine learning method.
- Validated and evaluated the performance of FY-3B reflectance data for fractional vegetation cover estimation.

Orbit test for 2m/8m optical satellite image application over housing and urban construction industry

07/2018 – present Advisor: Dr. Kun Jia

- Conducted supervision and inspection in urban and rural planning using GF images.
- Evaluated the plausibility of the application for optical satellite data over housing and urban construction industry.
- Completed the assessment report.

TECHNICAL SKILLS AND EXPERIENCE

Computer Programming Language: Proficient in Matlab, Python, and C++

Remote Sensing and GIS Software: Proficient in ArcGIS, ENVI, and ERDAS IMAGINE

Advanced Image Process Techniques: Competent in the application of machine learning and deep learning methods

Fieldwork Experience: Competent in operating field spectrometer for in situ data collection and lab analysis.

Modeling-related Skill: Advance beginner in PROSPECT-5B and 4SAIL.

Data Used: MODIS reflectance data (MOD09A1, MOD09Q1), AVHRR, FY-3B, GF-1.