

Lei Liu(刘磊)    



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📍 <sup>1</sup>Satellite Navigation & Sensing Laboratory (SeNSe Lab), University of Colorado Boulder <sup>2</sup>Space Weather Technology, Research and Education Center (SWx TREC), University of Colorado Boulder

## EDUCATION

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### Wuhan University, China

2017.09-2020.06

Ph.D. in Geodesy and Geomatics

Advisor: Dr. Yibin Yao

- Topics: Ionosphere Responses to Magnetic Storms; Machine Learning in Space weather
- Thesis: Ground- and Space-based GNSS Ionosphere Inversion Technique and Its Application in Space Weather

### Wuhan University, China

2014.09-2017.06

M.S. in Geodesy and Geomatics

Advisor: Dr. Yibin Yao

- Core Courses: GPS Theory, Algorithms and Applications; Optimal Estimation; Theory and Method of Satellite Orbit
- Thesis: Study on Ionosphere Modeling using Multi-source Data and Ionosphere Responses to Magnetic Storms

### Central South University of Forestry and Technology, China

2010.09-2014.06

B.S. in Surveying and Mapping

Advisor: Dr. Jiangping Long

- Core Courses: GPS Surveying and Data Processing; Foundation of Geodesy; Error Theory and Foundation of Surveying Adjustment; Advanced Mathematics
- Thesis: The program Design for The Traverse Network Adjustment

## EXPERIENCE

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### University of Colorado Boulder, US

2020.08-Present

Post-Doc Research Associate at Aerospace Engineering Sciences Department

Advisor: Dr. Jade Morton

- Machine Learning Prediction of Ionospheric TEC and Irregularities/Scintillation
- GNSS Ionosphere Monitoring and Modeling
- Ionospheric Space Weather Impacts on GNSS operations

### University of Michigan Ann Arbor, US

2018.11-2020.08

Visiting Ph.D. Student at Department of Climate and Space Sciences and Engineering Advisor: Dr. Shasha Zou

- Forecasting of GNSS TEC Using Deep Learning Approaches
- Ionospheric Responses During Geomagnetic Storms

## RESEARCH INTERESTS

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- GNSS Ionosphere Monitoring and Modeling
- Space Weather Impacts on GNSS operations
- Machine Learning Applications in Space Weather
- Equatorial and Mid-latitude Ionospheric Irregularities/Scintillation
- Estimation of Topside Ionosphere TEC and DCB Using LEO Satellites Observations
- Ionosphere Responses to Severe Weather Events (e.g., Ionosphere Storms, Earthquakes)

## PUBLICATIONS (\* 通讯作者; 导师 1 本人 2)

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- [1] **L. Liu**, Y. J. Morton, and Y. Liu, “Machine Learning Prediction of Storm-time High-latitude Ionospheric Irregularities from GNSS-derived ROTI Maps”, *Geophysical Research Letters*, e2021GL095561, 2021.
- [2] **L. Liu**, Y. J. Morton, and Y. Liu, “Machine Learning Prediction of Daily Global Ionospheric TEC Maps”, *In Preparation*, 2021.
- [3] **L. Liu**, Y. J. Morton, and Y. Wang, “Arctic TEC Mapping Using Integrated LEO-based GNSS-R and Ground-based GNSS Observations: A Simulation Study”, *submitted to IEEE Transactions on Geoscience and Remote Sensing*, 2021.
- [4] Z. Wang, S. Zou, **L. Liu**, J. Ren, and E. Aa, “Hemispheric Asymmetries in the Mid-latitude Ionosphere During the September 7–8, 2017 Storm: Multi-instrument Observations”, *Journal of Geophysical Research: Space Physics*, vol. 126, no. 4, e2020JA028829, 2021.
- [5] E. Aa, S.-R. Zhang, P. J. Erickson, L. P. Goncharenko, A. J. Coster, O. F. Jonah, J. Lei, F. Huang, T. Dang, and **L. Liu**, “Coordinated Ground-Based and Space-Borne Observations of Ionospheric Response to the Annular Solar Eclipse on 26 December 2019”, *Journal of Geophysical Research: Space Physics*, vol. 125, no. 11, e2020JA028296, 2020.
- [6] M. Chen, **L. Liu\***, C. Xu, and Y. Wang, “Improved IRI-2016 model based on BeiDou GEO TEC ingestion across China”, *GPS Solutions*, vol. 24, no. 1, pp. 1–11, 2020.
- [7] **L. Liu**, Y. Yao, and E. Aa, “Multi-Instrumental Observations of Early Morning Equatorial Plasma Depletions During the 2017 Memorial Weekend Storm”, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 13, pp. 5351–5357, 2020.
- [8] **L. Liu**, S. Zou, Y. Yao, and E. Aa, “Multi-scale ionosphere responses to the May 2017 magnetic storm over the Asian sector”, *GPS Solutions*, vol. 24, no. 1, pp. 1–15, 2020.
- [9] **L. Liu**, S. Zou, Y. Yao, and Z. Wang, “Forecasting global ionospheric TEC using deep learning approach”, *Space Weather*, vol. 18, no. 11, e2020SW002501, 2020.

- [10] **L. Liu**, Y. Yao, S. Zou, J. Kong, L. Shan, C. Zhai, C. Zhao, and Y. Wang, “Ingestion of GIM-derived TEC data for updating IRI-2016 driven by effective IG indices over the European region”, *Journal of Geodesy*, vol. 93, no. 10, pp. 1911–1930, 2019.
- [11] **刘磊**, 杨梅, 姚宜斌, and 王友昆, “第 24 太阳活动周武汉电离层 VTEC 变化特性分析”, 全球定位系统, vol. 44, no. 1, pp. 23–31, 2019.
- [12] 姚宜斌, 冯鑫滢, 彭文杰, and **刘磊**, “基于 CORS 的区域大气增强产品对实时 PPP 的影响”, 武汉大学学报 信息科学版, vol. 44, no. 12, pp. 1739–1748, 2019.
- [13] J. Kong, Y. Yao, C. Zhou, Y. Liu, C. Zhai, Z. Wang, and **L. Liu**, “Tridimensional reconstruction of the Co-Seismic Ionospheric Disturbance around the time of 2015 Nepal earthquake”, *Journal of Geodesy*, vol. 92, no. 11, pp. 1255–1266, 2018.
- [14] **L. Liu**, Y. Yao, J. Kong, and L. Shan, “Plasmaspheric electron content inferred from residuals between GNSS-derived and TOPEX/JASON vertical TEC data”, *Remote Sensing*, vol. 10, no. 4, p. 621, 2018.
- [15] Y. Yao, **L. Liu\***, J. Kong, and C. Zhai, “Global ionospheric modeling based on multi-GNSS, satellite altimetry, and Formosat-3/COSMIC data”, *GPS Solutions*, vol. 22, no. 4, pp. 1–12, 2018.
- [16] J. Kong, Y. Yao, Y. Xu, C. Kuo, L. Zhang, **L. Liu**, and C. Zhai, “A clear link connecting the troposphere and ionosphere: Ionospheric responses to the 2015 Typhoon Dujuan”, *Journal of Geodesy*, vol. 91, no. 9, pp. 1087–1097, 2017.
- [17] Y. Yao, C. Zhai, J. Kong, and **L. Liu**, “Contribution of solar radiation and geomagnetic activity to global structure of 27-day variation of ionosphere”, *Journal of Geodesy*, vol. 91, no. 11, pp. 1299–1311, 2017.
- [18] **刘磊**, 姚宜斌, 孔建, 翟长治, *et al.*, “附加 GIM 约束的全球电离层建模”, 大地测量与地球动力学, vol. 37, no. 1, pp. 67–71, 2017.
- [19] 姚宜斌, **刘磊**, 孔建, and 冯鑫滢, “GIM 和不同约束条件相结合的 BDS 差分码偏差估计”, 测绘学报, vol. 46, no. 2, p. 135, 2017.
- [20] J. Kong, Y. Yao, **L. Liu**, C. Zhai, and Z. Wang, “A new computerized ionosphere tomography model using the mapping function and an application to the study of seismic-ionosphere disturbance”, *Journal of Geodesy*, vol. 90, no. 8, pp. 741–755, 2016.
- [21] Y. Yao, **L. Liu**, J. Kong, and C. Zhai, “Analysis of the global ionospheric disturbances of the March 2015 great storm”, *Journal of Geophysical Research: Space Physics*, vol. 121, no. 12, pp. 12–157, 2016.
- [22] 姚宜斌, 翟长治, 孔建, and **刘磊**, “2015 年尼泊尔地震的震前电离层异常探测”, 测绘学报, vol. 45, no. 4, pp. 385–395, 2016.

## CONFERENCE PAPERS AND PRESENTATIONS

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1. **L. Liu**, Y. J. Morton, and Y. Wang “Arctic TEC Mapping Using Integrated GNSS-R and ground-based GNSS Observations.” *In AGU Fall Meeting 2021. AGU, 2021.*

2. **L. Liu**, Y. J. Morton, and Y. Liu “Machine learning for Ionospheric TEC and ROTI Forecasting.” *In AGU Fall Meeting 2021. AGU, 2021.*
3. Y. J. Morton, Y. Wang and **L. Liu**, “High latitude ionospheric TEC and disturbance observations from Spire Global CubeSat GNSS reflection signal carrier phase measurements.” *In AGU Fall Meeting 2021. AGU, 2021.*
4. **L. Liu**, Y. J. Morton, and Y. Liu, “Machine Learning Prediction of High-latitude Ionospheric Irregularities from GNSS-derived ROTI Maps.” *In Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021), pp. 3870-3877. 2021.*
5. **L. Liu**, S. Zou, Y. Yao, and Z Wang, “Forecast of Ionosphere GNSS TEC using CNN and LSTM neural network.” *In AGU Fall Meeting Abstracts, vol. 2019, pp. NG31A-0856. 2019.*
6. CEDAR workshop, *Santa Fe, US, In December, 2019*
7. International GNSS Service (IGS) workshop, *Wuhan, Hubei, In October, 2018*
8. 第四届全球华人空间天气科学大会, 北京, 2017 年 8 月
9. International Reference Ionosphere (IRI) workshop, *Taoyuan, Taiwan, In November, 2017*
10. CPGPS 暑期学校, 江苏徐州, 2015 年 8 月

## PROJECTS

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- 基于多源空间数据的电离层层析算法及在暴时极区电离层异常中的应用 青年科学基金项目 (**参与**) 2017.01-2019.12
- 多源数据融合的全球电离层建模 中央高校基本科研业务费专项资金 (**参与**) 2016.01-2017.12
- 一种新的电离层层析模型及在磁暴电离层异常中的应用 中央高校基本科研业务费专项资金 (**参与**) 2016.01-2017.12
- 软件著作权 (**导师 1 本人 2**)
  - 卫星和接收机差分码偏差估计软件 姚宜斌, **刘磊**, 孔建, 张良 2016
  - 地基 GNSS 电离层监测系统 姚宜斌, **刘磊**, 孔建, 翟长治, 张良 2016
- 基于 CORS 的空间环境监测系统开发 (重庆市基础地理信息中心 **参与**) 2015.05
  - 主要负责建立电离层监测系统: 估计卫星和接收机端差分码偏差, 发布实时二维/三维电离层产品, 为测量、导航以及气象等用户提供可靠性服务

## SCHOLARSHIPS AND AWARDS

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- GNSS 近地空间环境监测的理论方法及应用推广 (教育部高等学校科学研究优秀成果奖 一等奖) 2021
- 武汉大学测绘学院优秀毕业生 2020
- 武汉大学学术创新奖 二等奖 2020
- 武汉大学博士研究生国家奖学金 2017, 2018
- 武汉大学测绘学院乐群学术之星 2017
- 武汉大学社会活动积极分子 2017
- 武汉大学中海达奖学金 2016
- 武汉大学优秀研究生 2015
- 中南林业科技大学国家奖学金 2014
- 湖南省优秀毕业生 2014

## SKILLS

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- **Program Languages:** C/C++/C#, Python, Matlab, LaTeX
- **Software:** RTKLIB, GAMIT/GLOBK, GLAB, System Tool Kit(STK)
- **Machine Learning:** Pytorch, Keras, Python SciKit Learn

## REVIEWER FOR JOURNALS

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- GPS Solutions
- Space Weather
- Annales Geophysicae
- IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing