Sijie Zhao

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EDUCATION

Nanjing University (B.S in Geographic Information Science) *September 2019 – June 2023*

· Core Courses: Earth System Science, Remote Sensing Digital Image Processing, Introduction to Atmospheric Science

· Honors & Awards: National Endeavor Scholarship; Special Award in the 10th National College GIS Application Skills Competition

Nanjing University (M.S in Cartography and Geographic Information System) *September 2023 – June 2026*

· Core Courses: Introduction to Climate Change Science, Remote Sensing of Global Change, Remote Sensing Physics

· Honors & Awards: 2024 National Scholarship

RESEARCH EXPERIENCE

Summary: 3 first-author SCI Q1 publications, 1 submitted SCI Q1 paper, 1 submitted CCF-A conference paper, 3 ongoing projects, 190+ citations, 520+ GitHub stars.

1. Multi-View Remote Sensing Change Detection in Special Scenarios *(Published)* *November 2021 – February 2023*

· Proposed new strategies and a novel backbone for remote sensing change detection tailored to special scenarios, addressing the feature fusion interference problem in intra-class variation scenes and the pseudo-change problem in multi-view imaging scenarios inherent in existing architectures, achieving state of the art results on 6 downstream task datasets across 3 scenarios.

· First-author paper published in the top remote sensing journal *IEEE TGRS (IF: 8.3)* [1], with the project's open-source code garnering 90+ GitHub stars and 50+ citations.

2. Diffusion Model-based Geospatial Vegetation Forecasting *(Published)* *October 2023 – May 2024*

· Proposed using probabilistic methods to model the uncertainty in land surface vegetation change processes, designed a generative approach based on diffusion models to simulate the impact of dynamic meteorological variables and static environmental variables on land surface vegetation, enabling clear and accurate prediction of future vegetation states and overcoming the issue of blurry and inaccurate results from existing deterministic methods unable to effectively model uncertainty.

· First-author paper published in *IEEE TGRS (IF: 8.3)* [2].

3. Omnidirectional State Space Model for Large Remote Sensing Images *(Published)* *February 2024 – June 2024*

· Proposed a state space model-based visual backbone network for remote sensing, performing multi-directional scanning specifically designed for remote sensing images with omnidirectional features, alleviating the computational complexity and memory footprint issues of existing Transformer models when processing large remote sensing images, and achieving SOTA results on 4 downstream dense prediction task datasets.

· First-author paper published in *IEEE TGRS (IF: 8.3)* [3], with the project's code receiving 280+ GitHub stars and 130+ citations.

4. Efficient Latent Space Representation of Weather Data *(Under Review)* *November 2024 – March 2025*

· Proposed a strategy to transform meteorological data from pixel space to latent space for efficient representation, addressing issues in pixel space such as smoothed model outputs, low model generalizability, and high data usage costs; achieved preservation of high-value model results, unified data formats, and significantly reduced data usage costs within the latent space.

· First-author paper submitted to the top AI conference *NeurIPS* [4].

5. Unified Temporal-Spatial-Spectral Model for Remote Sensing *(Under Review)* *January 2025 – May 2025*

· Proposed a unified three-dimensional architecture for remote sensing dense prediction models, applicable to remote sensing image inputs and outputs of arbitrary temporal lengths, spectral counts, and spatial sizes, capable of performing predictions for any number of classes, and unifying semantic segmentation, semantic change detection, and binary change detection tasks.

· First-author paper submitted to *IEEE TGRS (IF: 8.3)* [5].

6. High-Resolution Spatiotemporal Weather Forecasting *(In Progress)* *June 2024 – Present*

· Developing strategies involving the fusion of global low-resolution and regional high-resolution data, decoupling weather reconstruction and prediction, and implementing a compress-then-predict approach for full maps; expected achieving prediction of surface meteorological variables at 1km resolution for mainland China and 3km for the continental US, surpassing numerical weather prediction models HRES and CMA in 24-hour forecast performance. Manuscript currently in preparation.

7. Dimension-Decoupled Compression Representation for Weather Data *(In Progress)* *March 2025 – Present*

· Designing a dimension-decoupling strategy based on commonality and specificity, leveraging similarities in meteorological data across temporal and channel dimensions to achieve efficient compressed representation of meteorological time-series data and flexibility in accessing arbitrary temporal and channel dimensions, addressing limitations of existing compression methods that neglect the temporal dimension and multi-dimensional coupling.

8. Explainability and Scientific Discovery in Large Weather Models *(In Progress)* *April 2025 – Present*

· Developing a mechanistic interpretability method based on Sparse Autoencoders for large-scale meteorological (FengWu) and oceanographic prediction (ORCA-DL) models. Investigating the physical structures embedded within the internal features of these large models by employing a scientific workflow of hypothesis generation, experimental design, and validation, thereby enhancing model trustworthiness at the physical level.

INTERNSHIP EXPERIENCE

AGIBOT *(Algorithm Intern of Large Vision Models)* *June 2023 – September 2023*

· Conducted literature reviews on robotic visual control and large model algorithms.

· Reproduced algorithmic models and optimized/trained their structures based on available hardware and data.

Shanghai Artificial Intelligence Laboratory *(Internship in AI for Science)* *September 2023 – Present*

· Extensively explored cutting-edge technologies and directions in the AI for Earth domain, leveraging advanced techniques such as diffusion models, autoencoders, and mechanistic interpretability to conduct systematic and promising research in areas including high-resolution weather forecasting, efficient representation of Earth data, and scientific discovery in large weather models.

· Completed 4 projects (Projects 2-5 under 'Research Experience'); currently conducting 3 projects (Projects 6-8 under 'Research Experience'), with a manuscript (Project 6) in preparation and preliminary results (Projects 7 and 8) expected by September 2025.

RESEARCH INTERESTS

Efficient Representation of Earth Science Data

· Developing a method to transform Earth science data from its original space to a latent space, addressing issues such as temporal, spatial, and channel redundancy, excessive storage requirements, and diverse data formats inherent in raw data, thereby establishing an efficient representation of Earth science data that reduces storage and computational costs, enhances model task performance, and improves model generalizability, ultimately promoting Earth science research based on efficient data representation.

Universal Earth Foundation Model Development

· Developing universal Earth foundational models applicable across data, scenarios, and tasks, leveraging large-scale, efficiently represented data and visual in-context learning methods to endow the models with both form generality and out-of-domain generalization capabilities, thereby achieving a balanced combination of universality and performance.

Scientific Discovery with Earth Foundational Models

· Designed mechanistic interpretability methods for Earth foundation models, employing Sparse Autoencoders and Circuit Analysis to conduct internal feature interpretation and track analysis within the model, thereby ensuring both model reliability and results credibility. Leveraged model interpretability to extract scientific knowledge that the model has distilled from large-scale datasets, enabling the automated generation of high-quality scientific hypotheses and facilitating scientific discovery from black-box models.

SELF ASSESSMENT

Interdisciplinary background in AI and Earth Science

· Developed a strong foundation in Earth System Science during undergraduate studies, fostering a keen interest in the intersection of AI and Earth Science. Conducted multiple interdisciplinary research projects during Master's studies applying AI to Meteorology and Remote Sensing. Possess an in-depth understanding of both rapidly evolving AI technologies and widely recognized key challenges in the Meteorology and Remote Sensing fields.

Self-motivated to learn new technologies and research directions

· Regularly review weekly arXiv papers in Computer Vision, follow impactful research within the community, and stay abreast of cutting-edge AI technologies and directions. Actively evaluate their potential value when combined with Earth Science, conduct extensive research on the novelty and feasibility of new ideas, and perform preliminary experiments for validation.

Dedicated to pioneering and problem-driven research

· The current research efforts are all aimed at proposing novel and intuitive effective strategies or architectures that address problems in the field of Earth Sciences, providing simple and user-friendly open-source codes, thereby enabling subsequent research to conduct in-depth and expanded studies under these strategies or architectures, eventually forming a systematic research framework.