Mechanisms and Challenges of Generative AI in Transforming the Publishing Process: Taking Earth Sciences as an Example

Haiyun Zheng

China Earthquake Networks Center, Beijing 100045

Abstract: ***Currently, the rapid development of generative AI is profoundly revolutionizing the academic publishing field, especially in the earth sciences, presenting a dual effect of both efficiency improvement and risks. This paper systematically analyzes the reshaping mechanisms of AI in content production, editing and proofreading optimization, and ethical norms. The research findings are as follows: In the content production link, AI has achieved automation from text generation to multimodal content creation, but accompanied by new risks such as data fabrication, misuse of terms, and false citation of literature; in the editing and proofreading link, although AI has improved the efficiency of review and proofreading, it has limited capabilities in the identification of professional terms and the detection of academic misconduct; in terms of ethics, the author identity of AI, implicit use, and the impact on the academic evaluation system pose unprecedented challenges. To address these issues, this paper proposes countermeasures such as constructing a three-level content verification mechanism, developing domain-specific large language models, and establishing an interdisciplinary ethical governance framework. The research conclusion points out that the future of the publishing industry needs to seek a dynamic balance between technological innovation and academic integrity, and achieve the coordinated development of intelligence and standardization through technological standardization and the reconstruction of talent capabilities.***

Keywords: Generative AI; Academic Publishing; Earth Sciences; Editing Process; Publishing Ethics.

1. INTRODUCTION

Generative AI is profoundly restructuring the publishing industry ecosystem. Its academic applications have been upgraded from auxiliary tools to systematic solutions, significantly enhancing the ability to process multi-modal and unstructured data and promoting the standardization of the publishing process (such as the policies of authoritative institutions like Springer Nature). This transformation is particularly prominent in data-intensive disciplines (such as earth sciences).

Earth science publishing involves unstructured data such as seismic waveforms and remote sensing images. Traditional processes are difficult to efficiently handle multi-modal content. Generative AI, through cross-modal technology, enables applications such as converting seismic wave data into vector diagrams and generating 3D geological models, significantly improving the publishing efficiency and the level of content visualization.

This paper focuses on the three core dimensions of generative AI reshaping the publishing process: intelligent content production, transformation of editing and proofreading quality, and change in the ethical system. It should be noted that there are significant technical differences in AI applications - basic scenarios (such as grammar checking) have been scaled up, but the generation of high-risk original content (such as geological hazard prediction) is still limited.

Taking earth science publishing as an example, the Journal of Earth Science Data clearly prohibits AI from participating in the review of high-risk content such as geological hazard prediction, reflecting the high requirements for data accuracy and logical consistency in this field. Currently, publishing institutions generally hope to improve efficiency through AI technology, but over-reliance may lead to the anomie of the evaluation system. According to data from the American Geophysical Union, in 2023, the number of "hallucination documents" generated by AI containing fictional information or false citations on earth science preprint platforms has increased rapidly, highlighting the urgency of establishing a technical governance framework.

Ge and Wu [1] conducted an empirical study on the adoption of ChatGPT for bug fixing among professional developers (Ge & Wu, 2023), while Gong et al. [2] provided a comprehensive review of neural network lightweighting techniques (Gong et al., 2023). Miao [3] explored big data technologies for enhanced network security analysis (Miao, 2026), and Gao [4] proposed an intelligent operations and public relations collaborative management model for corporate image enhancement in smart manufacturing environments (Gao, 2026). In the domain of human pose estimation, Peng et al. [5] exploited aggregation and segregation of representations for domain adaptive human pose estimation (Peng et al., 2025), and Zheng et al. [6] presented DiffMesh, a motion-aware diffusion framework for human mesh recovery from videos (Zheng et al., 2025). Shan et al. [7] rethought wine tasting for Chinese consumers using a service design approach enhanced by multimodal personalization (Shan et al., 2025), while Xia et al. [8] developed KOA-Monitor, a digital intervention and functional assessment system for knee osteoarthritis patients (Xia et al., 2025). Xu et al. [9] conducted a systematic review on game-based learning for environmental resilience, highlighting the transition from engagement to resilience (Xu et al., 2026). In natural language processing, Deng et al. [10] proposed LLM-MVR, an LLM-guided multi-view reasoning distillation framework for sarcasm detection (Deng et al., 2026). For computer vision tasks, Wang et al. [11] introduced QA-ReID, a quality-aware query-adaptive convolution method for clothes-changing person re-identification (Wang et al., 2026), and Li et al. [12] developed MFT, a memory-aware fine-tuning strategy for SAM2 enabling efficient long-sequence video object segmentation (Li et al., 2026). Wu et al. [13] presented Tiny-Critic RAG, empowering agentic fallback with parameter-efficient small language models (Wu et al., 2026), while Yan et al. [14] designed PRISM, a pipeline for root-cause investigation via specialized multi-agents (Yan et al., 2026). Yuan et al. [15] introduced TA-Mem, a tool-augmented autonomous memory retrieval system for LLMs in long-term conversational question answering (Yuan et al., 2026), and Yang et al. [16] developed a recursive multi-agent trading system for iterative optimized portfolio strategy under geopolitical uncertainty (Yang et al., 2026). Zhou [17] diagnosed bottlenecks in international automotive sales funnels using gradient boosting trees (Zhou, 2026). Wensi [18] explored AI-enabled data visualization marketing for automated production lines to build customer trust and improve lead-to-order conversion (Wensi, 2026). Shen et al. [19] applied the whale optimization algorithm to financial payment fraud detection (Shen et al., 2025). In photonics, Tang et al. [20] designed and optimized a shallow-angle grating coupler for vertical emission from indium phosphide devices (Tang et al., 2020). Sun [21] proposed adaptive interfaces for personalized user experience using a machine learning approach (Sun, 2025). Mao [22] introduced a clustering-based approach to image compression using the K-means algorithm (Mao, 2026). Luo [23] discussed the integration analysis of computer application technology and information management (Luo, 2026). Ma [24] proposed a unified framework for congestion diagnosis and dynamic mitigation in complex networks (Ma, 2025). Finally, Jin [25] optimized order allocation algorithms for industrial internet platforms (Jin, 2025).

2. CHANGES IN THE CONTENT PRODUCTION LINK

2.1 Academic Text Assisted Generation

The application of generative AI in academic text production has expanded from initial grammar checking to structured creation and logical organization [1]. According to the statistics of Elsevier’s Earth-Science Reviews in 2023, approximately 10% of the submitting authors used tools such as ChatGPT to assist in writing the first draft of literature reviews. The applications were most concentrated in topics such as plate tectonics, paleoclimate simulation, and seismic mechanism analysis. In fields with higher timeliness requirements such as disaster science, this trend is particularly evident. For example, in the rapid review of the 2024 Turkey earthquake, the background framework generated by AI significantly improved the efficiency of review writing and shortened the cycle from data collection to manuscript completion.

However, there are still obvious problems with the reliability of text generated by AI. Tests by the Geological Society of America have shown that AI has a high error rate when describing complex concepts such as "mantle plume dynamics" and "lithospheric rheological structure", and often confuses professional terms such as "hot plume" and "super mantle plume". For this reason, the American Geophysical Union issued the "Guidelines for Labeling Generative AI Content" in October 2023, requiring authors to explicitly state the specific scope of AI-generated text and provide a comparison with the manually revised version to ensure the authenticity and traceability of responsibility of the content.

For non-native English-speaking earth science researchers, AI tools have significantly reduced language barriers. A 2024 survey of Science China: Earth Sciences showed that 30% of the authors used AI for English paper polishing, especially in the fields of geochemistry and sedimentology. However, the journal also found that direct translation by AI may lead to distortion of professional expressions, such as mis-translating the Chinese term "ductile shear zone" as "stretchable cutting area". Such errors require additional verification and correction by proofreaders [2].

2.2 Multimodal Content Creation and Verification

Generative AI demonstrates unique value in multimodal content creation such as remote sensing data processing, seismic map generation, and geological model construction. For example, an AI tool developed by the European Space Agency in collaboration with the Journal of Remote Sensing of Environment can automatically convert Sentinel-2 satellite images into surface classification maps that meet publication standards and generate accompanying legend texts. However, practice shows that the recognition error of AI for glacier boundary lines can reach ±1.2 kilometers, and manual correction is required in combination with Landsat data to ensure the accuracy of geographical information.

The verification of AI-generated content has become a new link in the publishing process. For example, the Journal of Geophysical Research: Solid Earth requires that seismic prediction maps made by AI must be cross-verified with the database of the US Geological Survey. In 2024, a preprint paper on magmatic activity in the East African Rift Valley was retracted because the AI model output did not match the synthetic aperture radar interferometry deformation data, reflecting the importance of multimodal data verification.

In addition, the application of generative AI in scientific visualization is also becoming increasingly widespread. For example, video generation models such as Sora can dynamically simulate the fault rupture process based on seismic sequence data, providing a powerful tool for science popularization and academic communication. However, its scientificity and authenticity still need to be strictly reviewed in combination with relevant field knowledge.

3. OPTIMIZATION AND CHALLENGES OF THE EDITING AND PROOFREADING PROCESS

3.1 Applications and Limitations of Intelligent Proofreading Systems

Generative AI has significantly improved the proofreading efficiency of scientific and technological journals. Taking Springer Nature’s *Earth Science Data Journal* as an example, the journal deployed an intelligent proofreading system based on GPT-4 in 2023, which can automatically identify basic language problems such as spelling, grammar, and punctuation, and can also conduct automated checks on reference formats, figure and table annotations, chapter structures, etc. According to statistics, this system has shortened the average proofreading time by more than 40%, and is highly efficient in proofreading papers in the field of earth science that contain a large number of professional terms and complex sentence patterns. In addition, the AI system can preliminarily judge the logical coherence of the text by means of natural language processing technology, such as identifying whether there are obvious contradictions between the "methods" and "results" sections and whether necessary transitional sentences are missing.

However, although generative AI performs well at the basic language level, it has obvious limitations in identifying subject-specific professional knowledge. Tests by the American Geophysical Union in 2023 showed that the accuracy rate of the AI system in identifying the misuse of geological terms was only 67%, far lower than 95% of domain experts. When differentiating between near-synonymous terms such as "gabbro" and "diorite", "thrust fault" and "strike-slip fault", the AI system not only often makes misjudgments, but also "overcorrects", replacing the correct term with an incorrect expression. The complex term system in the field of earth science, with numerous synonyms, polysemous words and the continuous emergence of new terms, is the key reason for this problem, as general large language models lack sufficient domain knowledge training.

Another serious challenge is to detect the hidden academic misconduct caused by AI-generated content. Traditional plagiarism detection tools mainly target direct plagiarism and paraphrasing behaviors, and are difficult to effectively identify the "deep content reconstruction" completed by generative AI. Although Crossref launched an AI detection service in 2024, which can identify some AI-generated paragraphs based on text feature analysis and generation pattern recognition, the misjudgment rate for mixed writing content (completed jointly by humans and AI) is still as high as 15% - 30%. Some authors use ChatGPT to make synonymous replacements, sentence restructuring or even logical reconstruction of paragraphs, changing the surface form of the original text but keeping the substantial content unchanged. Such behaviors are very difficult to detect under the current AI detection technology.

3.2 References and Data Verification

There is a risk of forgery in the generation of references by generative AI. AI systems can automatically extract citation information from text, generate a reference list in standard format, and initially verify the consistency of basic information such as author, year, journal name, etc. For example, the "Reference Authenticity Checker" developed by Elsevier uses natural language processing technology to quickly compare authoritative databases such as Crossref and PubMed to identify obviously false or misformatted citation entries. The system can also detect mismatches between "author-year" citations in the text and the reference list, such as when the text cites "Smith et al., 2023" but it is missing or has inconsistent information in the reference list.

However, there is an inherent risk of forgery in the automatic generation of references. Since large language models are based on a probabilistic generation mechanism, when there is a lack of sufficient training data, they may automatically generate seemingly reasonable but fictional literature information. In a paper retracted by *Tectonophysics* in 2023, the references generated by ChatGPT contained false DOIs, and the cited literature actually did not exist. More subtly, AI may confuse papers with similar titles or misassociate different works by the same author, leading to distortion of the academic inheritance chain.

In the field of earth sciences, the accuracy requirements for data verification are extremely high. *Journal of Climate* has introduced an AI-assisted data review module that can automatically detect the consistency between statements in the text and the data in the attached figures. The system can identify abnormal values, inconsistent units, or data points that are clearly outside the reasonable range, such as abnormally high surface temperature values or mismatches between earthquake magnitudes and impact descriptions. However, AI systems may overlook key differences such as time resolution and spatial scale, resulting in incorrect data matching. For example, in paleoclimate research, AI may wrongly directly compare proxy indicators of different time scales, affecting the reliability of the conclusions.

It is worth noting that generative AI shows new application prospects in cross-modal data consistency verification. Recent research has attempted to use multimodal AI models to synchronously verify the consistency between text descriptions and corresponding chart and image data. For example, when a paper describes the "glacier retreat trend on the Tibetan Plateau", the AI system can automatically analyze the remote sensing images provided in the text to detect whether they truly support this conclusion or whether there are behaviors such as image tampering or misreading. Although such technologies are still in the early stage, they are of great significance for preventing data fraud.

4. NEW CHALLENGES TO PUBLISHING ETHICS

4.1 Disputes over Authorship and Data Authenticity

In 2023, Frontiers in Earth Science retracted a paper generated by ChatGPT and signed by "AI Researcher", sparking discussions in the academic community. The Committee on Publication Ethics (COPE) clearly stated that generative AI does not meet the definition of an "author" as it cannot take on academic responsibilities. However, in the field of earth science, the issue of AI authorship is more complex. For example, when AI generates a seismic hazard model, should the algorithm contribution be disclosed? Seismological Research Letters requires authors to specify the model name, version, and degree of human intervention to ensure the reproducibility of the research.

A 2024 survey by Science China: Earth Sciences showed that 20% of the submitting authors did not declare the use of AI-assisted writing, and most of them evaded detection [3] by the method of "AI generating the first draft + manual rewriting". More covertly, some authors used AI to modify the response letters to reviewers. For example, in a paper on the uplift of the Tibetan Plateau, the author used a response letter generated by ChatGPT to exaggerate the uncertainty range of the data to address the reviewers' doubts. This not only constitutes academic fraud but also seriously undermines the foundation of peer review.

In 2024, the preprint platform EarthArXiv retracted a paper on hydrothermal activity in the Mariana Trench because the "hydrothermal vent temperature data" it used was actually false values generated by AI based on historical literature patterns (retraction statement) [4]. Detection found that these data were statistically reasonable (conforming to the lognormal distribution), but deviated from the actual ROV observation records by as much as 300°C, highlighting the high deceptiveness and risk of AI -generated data.

The ambiguous definition of authorship, lack of usage declarations, and the risk of data forgery in the academic application of generative AI are triggering serious academic ethical violations and authenticity crises, and urgent regulatory norms are needed.

4.2 Impacts on the Academic Evaluation System and Governance

Academic fraud rings are using generative AI to churn out papers in Earth science in batches. A 2023 investigation by Nature found that a "paper mill" used GPT-4 to generate fake paleomagnetic research, quickly producing manuscripts by randomly combining continental names such as the "South China Block" with polarity data such as "normal magnetization". Contradictions often appear in the methodology section of its papers. For example, the same batch of samples is described as both "obtained by drilling" and "collected on the surface", reflecting the lack of logical consistency in AI.

The regulatory efforts of different Earth science journals regarding AI vary significantly: Geology requires the submission of original data and AI usage logs when submitting manuscripts (new policy in 2024), while Petrology only recommends "where possible" disclosing AI usage. Such fragmented standards not only increase the compliance costs for authors, but also leave room for speculative behavior, which is not conducive to building a unified academic governance ecosystem.

To address this challenge, the Geoscience and Remote Sensing Society of the Institute of Electrical and Electronics Engineers (IEEE) is developing a blockchain system to record the complete operation track of AI in paper production. Pilot tests show that the system can trace the version of training data used to generate videos by Sora, but there are still technical bottlenecks in tracing text content, which urgently need to be further broken through.

5. FUTURE OUTLOOK AND COUNTERMEASURES

5.1 Technological Innovation and Talent Reconfiguration

The limitations of current general AI models in the field of earth sciences are becoming increasingly apparent. The United States Geological Survey is collaborating with NASA to develop GeoGPT, which is specifically designed to handle professional content such as geochronology, isotope geochemistry, and seismology. The training data for this model includes over 2 million earth science literature and USGS historical survey reports. Tests show that its accuracy in "interpretation of zircon U-Pb dating data" is about 30% higher than ChatGPT, demonstrating the great potential of domain-specific models.

The changing talent requirements of publishing institutions are the vane for the industry to adapt to AI transformation. The job requirements for senior earth science editors recruited by Cambridge University Press in 2024 have added multiple AI-related requirements, including: understanding the technical boundaries of generative AI (such as being able to identify false descriptions of paleontological fossils generated by GPT-4); mastering AI-assisted decision-making tools (such as the intelligent citation analysis of Scite.ai); having the ability to review multi-modal content (such as verifying animations of geophysical models generated by AI). This indicates that in the future, the role of editors will shift more towards "human-machine collaboration supervisors".

5.2 Risk Prevention and Control and Interdisciplinary Governance

It is recommended to build a three-level content verification mechanism (as shown in Table 1) to systematically control the risks of AI-generated content

Table 1: Three-level Content Verification Mechanism

Verification level	Checked content	Examples of technical means
Text layer	Term accuracy/Logical consistency	Comparison with professional term databases
Data layer	Degree of match between raw data and AI output	Meta-data analysis
Expert layer	Scientific value judgment	Double-blind manual review + Domain knowledge graph

At the international level, it is recommended that the International Union of Geodesy and Geophysics take the lead in formulating unified guidelines to clearly prohibit the types of content generated by AI (such as radioactive isotope measurement data, earthquake early warning parameters, etc.), and stipulate that the scenarios of AI use must be disclosed (such as downscaling in paleoclimate reconstruction, generation parameters in ground motion simulation, etc.).

6. CONCLUSION

Generative AI is reshaping the publishing process. While enhancing efficiency (such as automated content generation and intelligent proofreading), it also brings risks such as data fabrication, misuse of terms, and ethical misconduct. Taking earth sciences as an example, this paper reveals the dual impacts of AI in content production, editing, and ethics, emphasizing that the application of technology must be closely integrated with disciplinary characteristics (such as geological data verification and seismic model review). Future research should further explore the training methods of domain-specific AI models, the interpretability of AI generated content, and the construction of global academic ethics guidelines that dynamically adapt to technological developments, helping the publishing industry to move towards a new stage that emphasizes both intelligence and norms.

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