Chapter 5
Realization: Intersectionality, Integration, Collaboration, and Cooperation

5.1 Platform Construction and Data Sharing

There are various ways to acquire data in Earth science research. Observation and timely sharing of datasets are indispensable approaches for deepening the quantitative research of the Earth system. Shortcomings need to be identified with respect to existing observation systems for each sphere in order to construct an integrated observation system for sea-land–atmosphere interaction that is interrelated, internally coordinated, connected into a network, and unified and standardized. This will promote the development and application of a new-generation of Earth observation technologies (e.g., internet of things (IoT), sensors, and telemetry observation), and achieve a continuous all-weather multi-sphere and multi-element observation system for the Earth system.

In terms of information sharing, long-term field observations and experimental survey data must be collected to act as the foundation. Data from social statistics, remote sensing and inversion, aerial observations, surface surveys, model simulations, and other data resources should be harvested and integrated to form standardized model-driven datasets, parameter datasets, and verification datasets. Sharing mechanisms must be established to generate a set of continuous, stable, and standardized scientific observation data of the Earth system and relevant economic and social data as well. A sharing platform for scientific and technological data and information systems must be constructed. A thematic information sharing platform for comprehensive scientific research on typical regional field observations, comprehensive surveys, laboratory experiments, process simulations, and scenario and decision analysis should be formed, and a resource sharing platform should be established for scientific data acquisition, comprehensive analysis, knowledge innovation, and science popularization.

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5.2 Interdisciplinary and Collaborative Research

Interdisciplinary integration should be strengthened. The study of deep-Earth processes and a habitable Earth involves two core disciplines, solid and surface Earth sciences. Breakthroughs will only be made by taking the broad perspective of "deep Earth, deep space, deep sea, and the Earth system". The Earth is a vast and complex system. Along with continual differentiation of disciplines, reinforcing interdisciplinary and encouraging collaborative research is the fundamental way to cope with the complexity of the Earth system. Relying on combinations of research methods (e.g., natural rock sample testing and analysis, HPHT experiments, geophysical exploration, and multi-scale computational simulation), the physical, chemical, and biological processes and mechanisms of their interactions in major geological events will be revealed by constructing databases of various records of related geological events from a global perspective. This will provide a scientific basis for understanding the formation and evolution of the Earth's habitability. The disciplines involved in the study of Earth's habitability include not only those related sub-disciplines of Earth sciences, but also other disciplines such as life sciences, technical sciences, and social sciences. The human-Earth system is a coupled system formed by the interaction between human beings and natural systems, which can only be studied using an interdisciplinary approach involving natural sciences, social sciences, humanities, and information technology.

Leveraging the advantages of the Division of Interdiscipline of the National Natural Science Foundation of China, multi-disciplinary and multi-field research teams can be organized to identify new research paradigms and perform comprehensive research on "deep Earth, deep space, deep sea, and the Earth system" from the global perspective of understanding the past, present, and future of the habitable Earth, and to improve the collaborative research capacity in science and technology. Based on this approach, the systems of national funding and relevant project funding should be further developed and improved to offer a strong combination of competitive selection and stable support. New models can be added to existing funding schemes, and increasing the investment of the National Natural Science Foundation of China should place a strong emphasis on basic scientific research. From the aspect of the national talent pool, it is necessary to break the boundaries of disciplines, strengthen support for interdisciplinary research, and cultivate interdisciplinary talents. On the other hand, it is also necessary to actively recruit or cultivate top scientists and technicians in specific fields who possess a global perspective.

5.3 International Collaboration and Exchanges

At present, there is still a large gap between scientific and technological levels in China and those in Europe and the United States. This reality will be changed in

the short term. International scientific and technological collaboration and exchange must be encouraged, particularly between China and the United States.

A key issue to be urgently resolved in the Chinese scientific and technological community is to bring innovation and fresh thinking to international collaboration and exchange. We must put forward the strategic thinking of scientific and technological transformation in a spirit of cooperation and learning, shifting from 'imitation and tracking' to 'exploration and innovation'. This requires that Chinese scientists not only adopt an international perspective, but also understand the strategic needs of the country. At present, the development of science and technology is increasingly dependent on large-scale scientific projects and programs jointly organized and implemented by multiple organizations, departments, and even countries or regions. The inherent properties and characteristics of Earth science make international cooperation essential for the study of major scientific questions. Participation in, and then initiating and organizing major international scientific research projects will promote China to enter the forefront of global science, enhance the research level of Chinese Earth science, and improve the innovation capacities of the Earth science community in China. It will also ensure the contribution of Chinese wisdom to the development of international Earth sciences.

In recent years, international scientific and technological cooperation in Earth sciences, particularly the development of a series of major international initiatives, has achieved significant outcomes in talent exchange and training, hardware and infrastructure sharing, and tackling scientific problems. However, the overall environment for international cooperation in our country still requires further improvement, and cooperation experience and capabilities also urgently needs to be improved. The in-depth development of China's international scientific and technological cooperation is facing a number of serious challenges:

(1) **Administrative management**: The successful implementation of large-scale international scientific projects depends on the overall coordination and cooperation between individuals, institutions, departments and even countries. However, there are often clear regional and departmental boundaries in China, which makes it difficult to achieve cross-departmental joint organization and funding. Organization, management, and service models need to be improved and optimized. There are still significant shortcomings in the participation and integration of Chinese scientists into the international academic community.
(2) **The scientific community**: The consciousness, ability, and level of independent design and organization of international large-scale scientific projects are insufficient, and the ability to formulate rules in international cooperative research and sharing of results is lacking.
(3) **Subsidiary and evaluation system**: Long-term, systematic and comprehensive observation and research are required to solve major scientific questions in the field of Earth sciences. Most of the existing international cooperation projects in China are short-term and cannot provide sustained support. In addition, the evaluation system has yet to be fully aligned with international standards.

By focusing on system and method innovation, and striving to create a good atmosphere of openness and cooperation, these above-mentioned problems can be solved. It will surely promote China's active integration into the global science and technology innovation network, with a range of specific bilateral and multilateral cooperation efforts sponsored and performed systematically in order to lead the way toward constructing a global scientific and technological innovation community of mutual benefit and win–win cooperation.