

Reflections on the Global Development of Meteorological Technology in the Digital Era

Xuejun Wei

weixj03@163.com

Wuhai Meteorological Bureau of Inner Mongolia Autonomous Region 01600

Abstract: Meteorological technology adapts to the development of globalization, responds quickly to changes in user needs, and also adapts to market changes in the digital age. In the development process of information globalization characterized by "cloud, object, mobile, large, and intelligent", in accordance with national development strategies, we vigorously develop a digital based global meteorological model. The digitization of meteorological technology digitizes all links related to atmospheric movement in all regions of the world, enabling all meteorological data forms related to weather and climate integration to be timely perceived and accurately quantified. Numerical mode scientific algorithms can accurately predict future weather trends or achieve simulation interactive display, making the meteorological industry invincible in the fierce international competition.

Keywords: Meteorological data; Cloud services; Numerical mode; globalization

1 Introduction

In the global development of meteorological technology in the digital era, China's meteorological services have significantly improved in terms of refinement, data transmission stability, and security capabilities, and the level of service for domestic and international users has further improved. The global weather numerical prediction model is more powerful than the "China Core", and the global spatial resolution is gradually reaching the international advanced level. The new generation weather radar business software with independent intellectual property rights in China has been promoted and operated nationwide. The observation system for the operation of polar orbit and geostationary satellite networks has been further improved. The coverage of communication satellites has expanded from the Asia Pacific region to most parts of Africa, Europe, and the Middle East. Gradually realize the spatialization of meteorological data integration and the globalization of meteorological system services, continuously promote the scientific development of meteorological technology and the innovative application of meteorological digital technology, complete the digital upgrading of the meteorological industry and the construction of meteorological digital ecology, strengthen the intelligent application of meteorological data AI and the construction of meteorological cloud service system.

2 Spatial integration of meteorological data

Meteorological satellites and weather radars, as well as a dense network of ground meteorological stations, form a three-dimensional monitoring network covering the atmosphere from space to the Earth and from the ground to the air. The characteristic data of each layer with a certain spatiotemporal density is obtained from the five major layers, and all meteorological data is collected and integrated into various cloud, surface, and sea surface spatial meteorological spatiotemporal inversion data. After further model calculations, various meteorological data are obtained to scientifically interpret the laws of atmospheric motion, forming a global meteorological digital platform with characteristics such as "experience leading", "data driven", "scientific operation", "open sharing", and "agile and accurate". Meteorological data integration is based on computerization, networking, informatization, and cloud technology, which is different from the traditional manufacturing industry's production form of mechanical processing and assembly. Meteorological data, as a basic condition for business and scientific research work, is processed and processed based on data. Meteorology has the basic characteristics of the digital industry, with three major businesses: detection, forecasting, and service. The global business interoperability and network interconnection of meteorological data mark the entry of meteorological digitization into a highly integrated and intelligent era of meteorological information.

3 Meteorological Systemic Globalization Services

Utilize meteorological data mining and intelligent management technology to promote meteorological digitization and globalization. Using "global meteorological operations, global meteorological management, and global meteorological services" as important means, optimize various business processes, fully tap into the value of meteorological data, break through data silos and data barriers at different levels between links, and ensure that data output is complete and has scientific value. To achieve the strategic vision of becoming a "world-class meteorological service provider", we will comprehensively and systematically strengthen the construction of meteorological digitization, and achieve full process electronic digitization^[1](chen yun 2021). By utilizing the new generation of meteorological information technology, a closed-loop system of global meteorological data collection, transmission, storage, processing, and feedback is completed, forming a secure browser server structure. A global digital meteorological service system is constructed under the protection of data privacy laws, achieving fully connected, scenario, and intelligent meteorological digital services.

4 Scientific development of meteorological technology

A few years ago, multiple countries proposed global digital solutions for meteorology based on internet architecture, gradually forming meteorological services such as meteorological data control technology, cloud mode computing, and big data analysis. Intelligent devices in meteorological systems are interconnected and managed through data analysis to achieve active operation and maintenance. The country has developed a comprehensive monitoring,

forecasting, and service meteorological system through research and development, creating an independent and controllable "smart brain" for global meteorological management. In recent years, with the high-quality development of meteorology, continuous efforts have been made to develop intelligent meteorology, focusing on a global perspective. By integrating subsystems such as intelligent meteorological operation and maintenance systems, intelligent safety meteorological data systems, and intelligent meteorological management systems, digital intelligent meteorology has been created. In the "14th Five Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Long Range Goals for 2035", the fifth article "Accelerating Digital Development and Building a Digital China" proposes to welcome the digital era, activate the potential of global meteorological data elements based on the concept of scientific development, and promote the construction of China's meteorological power.

5 Innovative application of meteorological digital technology

Subsequently, key areas such as high-end meteorological detection chips, business operating systems, key algorithms for artificial intelligence, and sensors continue to be deeply researched; The research and development of basic theories, advanced algorithms, equipment materials, and iterative applications of weather numerical models are constantly breaking through; Continuously developing integrated meteorological big data processors, cloud computing systems, and software core technologies; Quantum computing, quantum communication, neural chips, cloud storage and other cutting-edge technologies are constantly integrated ^[2](Duan Wenguang 2021); The continuous cross innovation between information science, mathematical science, materials science and other basic disciplines; The open source intellectual property rights and legal system of meteorological digital globalization are constantly improving; Cultivate and strengthen emerging digital industries such as meteorological artificial intelligence, big data, full chain, cloud computing, and network security, enhance the level of meteorological communication equipment, core electronic components, key software, and other industries, and provide support for the joint development of open source innovation in meteorological digital globalization technology.

6 Digital upgrading of the meteorological industry

Implement the "Meteorological Cloud Data Intelligence" action to promote the collaborative upgrading of the meteorological data empowerment industry chain. Build an international level meteorological internet platform and digital meteorological service center, deepen the meteorological digital application in research and development design, production and manufacturing, operation management, market service, and other links, cultivate and develop a new model of meteorological personalized customization, fixed-point production, and long-term sequence release of weather and climate globalization. Deepen the digital upgrading of meteorological service industry, attach importance to top-level design and high-end guidance, and accelerate the development of digital upgrading of integrated meteorological services in the Earth system, including heaven, earth, and space. Adapting to the new trend of fully integrating digital technology into society, promoting innovation in meteorological services and system operation, providing intelligent and convenient global meteorological

services, promoting the inclusive application of meteorological digital services, increasing the openness, sharing, and application of meteorological services, and promoting the impact of diverse meteorological analysis data on public decision-making, industrial and agricultural production, natural disasters, emergencies, shopping and consumption, home life, tourism and leisure Digital services for various scenarios such as transportation and travel. Accelerate the accessibility construction of meteorological digital information, help the elderly, disabled, and others share digital weather, and build a globally accessible Chinese meteorological digital life.

7 Meteorological digital ecological construction

Create a digital ecosystem of global meteorological openness, health, and safety. Coordinate data development and utilization, privacy protection, and public security, strengthen basic systems and standards for meteorological data resource property rights, transaction circulation, cross-border transmission, and security protection. Strengthen the protection of national interests, trade secrets, data security, and personal information, and strengthen the full lifecycle security protection of global meteorological data resources. Improve the data classification and classification protection system in the meteorological big data environment. Promote the safe and orderly cross-border flow of global meteorological data. Improve the global digital meteorological statistical monitoring and evaluation system. Enhance meteorological network security protection and maintain political security capabilities. Strengthen risk assessment and review of meteorological network security. Strengthen the construction of network security infrastructure, strengthen cross domain network security information sharing and work collaboration, and enhance the capabilities of network security threat detection, monitoring and warning, emergency command, and attack tracing. Promote international exchange and cooperation in meteorological cyberspace, strengthen publicity and education on meteorological cybersecurity, and cultivate talents. Promote the construction of a global meteorological cyberspace community with a shared future^[3] (Xu Yucong 2021). To build a global comprehensive digital meteorological basic network ecosystem that integrates heaven and earth, integrates cloud and network, is intelligent, agile, green, low-carbon, and safe and controllable.

8 AI Intelligent Application of Meteorological Data

Predict weather phenomena more real-time and accurately through scientific and technological means. With the help of intelligent algorithms and image technology, "Tianlian" can be efficiently recognized. Build an intelligent meteorological observation platform, and launch intelligent algorithms for the meteorological intelligent observation system. Through artificial intelligence, weather phenomena such as frost, dew, ice, snow, and fog can be intelligently identified. The meteorological intelligent observation system can monitor the flow rate and water level in real-time through remote video images and intelligent analysis algorithms^[4] (Wu Tong 2022). If the water level and flow rate reach the set threshold, a real-time alarm will be issued. When the management department arrives, it can help the management department control the on-site situation and carry out drainage scheduling. The meteorological intelligent observation system can also provide industry level and minute level monitoring data for six

conventional meteorological elements: temperature, humidity, air pressure, wind speed, wind direction, and rainfall, improving the accuracy of regional meteorological observations and helping to enhance meteorological disaster warning capabilities. While AI assists in meteorological observation, it also pushes information to the early warning center. In the event of an emergency, the management department can implement efficient emergency measures across multiple departments, levels, and regions through an integrated communication platform; If there is a danger, provide a 3D realistic map to visually restore the geographic and spatial information of the scene. At the same time, connected IoT devices can also achieve complete spatial information mastery. Integrating communication and 3D applications to help implement the "early action" initiative.

9 Construction of Meteorological Cloud Service System

Develop and construct a "meteorological cloud" industry service cloud platform; Utilizing meteorological computing power and professional advantages to jointly promote the construction of a computing power platform for national meteorological departments; Utilizing the advantages of mobile network security technology to enhance the national meteorological network security prevention and control capabilities^[5] (Yu Yu 2018); ; Jointly carry out scientific and technological breakthroughs such as meteorological big data mining and AI technology application. Consolidate the foundation of information networks and build meteorological cloud zones with meteorological characteristics; Utilize the advantages of meteorological disaster prevention and reduction emergency communication to ensure smooth meteorological emergency communication; Implementing innovation in "meteorology+industry" and providing refined and customized meteorological services to society through the "Meteorological Cloud" platform; Actively carry out "Beidou+Meteorological" application services; Unify the release of meteorological warnings, jointly build a "green channel" for the release of meteorological disaster warning information, achieve targeted release and accurate real-time push of meteorological disaster warning information, and jointly build the first line of defense for meteorological disaster prevention and reduction; Fully leverage the advantages of mobile communication and 5G networks, expand the development of interdisciplinary technology, strengthen meteorological technology exchange and talent cooperation in scientific research.

10 Autonomous and controllable meteorological technology

Establish a national level meteorological software engineering enterprise, utilize market mechanisms, integrate and optimize advantageous resources of meteorological software, enhance technological innovation and service supply capabilities of meteorological software, achieve independent and controllable safety of key core technologies of meteorological software, promote specialization, intensification, and sustainable development of meteorological business systems, and better support and ensure high-quality development of meteorology. The restructured meteorological software system research and development talent team has multiple types and broad fields of business qualifications and meteorological information operation service capabilities, forming a meteorological technology industrial park and a large-scale state-owned meteorological technology core enterprise cluster. Build a

professional and more comprehensive team for meteorological software research and operation and maintenance, comprehensively forming a situation where key core technologies of meteorological software systems are safe, controllable, and intensively developed, effectively promoting the rapid evolution of meteorological software towards Earth system software, improving the modernization level of meteorological technology, and promoting the relevant functional components of meteorological system software to integrate and apply in fields such as national defense, transportation, military, ocean, and emergency response, Support the goal of achieving a strong meteorological country.

11 Conclusion

Against the backdrop of the flourishing development of big data and artificial intelligence technology, we aim to digitize, value, and innovate our meteorological core business, supporting real-time online, timely analysis, and intelligent management. Promote independent innovation throughout the development, testing, and service process of China's global meteorological digital products. Boosting the high-quality development of meteorology with the global digitization of meteorology, continuously advancing towards the goal of building world-class meteorology.

Reference:

- [1] Chen Yun, Song Jianyang, Zhang Xiaomei.(2021) Analysis of the current situation and innovative models of integrated professional meteorological services in meteorological departments [J] Science and Technology Bulletin. (12).
- [2] Duan Wenguang, Fan Feiyong, Liu Yan, Zhang Ling, Wang Ji, Shi Yongwei .(2021) Reflection and Exploration on Integrating Smart Meteorological Services into the Spacetime Information Cloud Platform of Smart Cities [J] Progress in Meteorological Science and Technology. (06).
- [3] Xu Yucong. Data.(2021) Cloud expansion and super automation platform stimulates new momentum of enterprise Digital transformation [J] Xu Yucong. Data, 2021 (10).
- [4] Wu Tong .(2022).The China Meteorological Administration deploys and promotes the informationization of meteorological management throughout the year [N] China Meteorological Daily, March 29 .
- [5] Yu Yu; Ju Xiaohui;Fan Shaohua. (2018) Progress and Application of Meteorological Data Digitization [J]Progress in Meteorological Technology, (01).