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编者按：2024浦江创新论坛——空天海洋论坛以“空天海洋先进科学与技术论坛”为主题，来自国内著名专家学者围绕先进科学与技术发展现状及未来趋势展开深入研讨。本期专报基于空天海洋论坛的嘉宾观点进行梳理，供参考。

Editor's note: At the Aerospace and Marine Advanced Science and Technology Forum under the 2024 Pujiang Innovation Forum, renowned domestic experts and scholars conducted in-depth discussions on the current status and future trends of advanced science and technology development. This special report summarizes the viewpoints of the guests at the Aerospace and Marine Advanced Science and Technology Forum for your reference.

2024 浦江创新论坛专报之十八

Special Report 18 of the 2024 Pujiang Innovation Forum

推进空天海洋领域创新　为全球挑战提供新方案

Promoting innovation in the aerospace and marine fields to provide new solutions to global challenges

气候变化是全人类面临的严峻挑战，需要世界各国携手努力、共同应对。空天海洋领域涵盖空间、大气、海洋研究和先进设备制造等多方面，其协同创新将在应对气候变化、能源短缺等全球性挑战中发挥至关重要的作用。**与会嘉宾一致认为，先进科学与技术是推动空天及海洋科学研究高质量发展的关键，未来应聚焦在应用数据科学和人工智能技术对海量数据进行建模和深度分析，通过多学科交叉的空天地海一体化观测与通信系统，实现更高效的科学研究与技术应用。**

Climate change is a severe challenge faced by humanity, and requires joint efforts from all countries around the world. The aerospace and marine fields cover multiple aspects such as space, atmosphere, marine research, and advanced equipment manufacturing, and collaborative innovation in these fields will play a crucial role in addressing global challenges such as climate change and energy shortage. **The guests present agreed unanimously that advanced science and technology is the key to promoting the high-quality development of aerospace and marine scientific**

research. In the future, the focus should be on applying data science and AI technology to model and deeply analyze massive data, and realize more efficient scientific research and technological applications through a multidisciplinary integrated space-air-ground-sea observation and communication system.

一、应对全球环境气候变化需要能力合作开展技术创新

1. Addressing global climate change requires cooperation in scientific and technological innovation

一是全球环境气候变化推动空天海洋技术创新的需求加剧。上海海洋大学教授、上海河口海洋测绘工程技术研究中心主任韩震指出，全球海岸带作为生态环境脆弱的地区，受到工业化和城市化快速发展的冲击，不仅改变了土地利用类型和产业结构，还导致近海环境的显著变化，迫切需要如卫星遥感技术等新兴技术进行有效监测。**亚太台风研究中心主任汤杰**提出，根据世界气象组织统计，全球气旋有 1/3 来自热带地区，其中一半由台风引发，成为全球公共安全的重大威胁之一，而现有的气象观测技术和监测手段仍存在局限。**印尼国家研究与创新局（BRIN）航空航天研究中心负责人罗伯特斯·赫鲁·特里哈扬托**进一步强调，气候变化对印尼沿海生态系统的破坏日益严重，部分小渔村已消失，粮食产量也因此减少。为应对这一挑战，印尼亟需开发更加精确的遥感技术，更好地监测海平面上升、森林和红树林的变化。

First, the demand for innovation in aerospace and marine technology driven by global climate change is increasing. Han Zhen, professor at Shanghai Ocean University, and Director of the Shanghai Estuary Marine Surveying and Mapping Engineering Technology Research Center, pointed out that as ecologically vulnerable areas, worldwide coastal zones have been affected by the rapid development of industrialization and urbanization, which has not only changed land use types and industry structures, but also led to significant changes in the offshore environment. There is an urgent need for effective monitoring using emerging technologies such as satellite remote sensing technology. **Tang Jie, Director of the Asia-Pacific Typhoon Collaborative Research Center,** pointed out that according to the World Meteorological Organization, one third of worldwide cyclones are from tropical regions, half of which arise from typhoons, becoming one of the major threats to global public safety. However, there are still limitations in existing meteorological observation technologies and means of monitoring. **Robertus Heru Triharjanto, Head of the Aerospace Research Center, National Research and Innovation Agency, Indonesia (BRIN)**, further emphasized that climate change is causing increasingly severe damage to Indonesia's coastal ecosystems, with some small fishing villages disappearing and food output declining. To address this challenge, there is an

urgent need for Indonesia to develop a more accurate remote sensing technology to better monitor sea level rise, and changes in forests and mangroves.

二是技术创新合作已成为应对环境气候变化的共识。葡萄牙系统与计算机工程、技术和科学研究所高级研究员若阿金·若昂·索萨指出，开源性国际创新合作有助于培育下一代地球观测卫星引领者，以应对气候变化、能源短缺、资源有限等全球挑战。**阿联酋大学国家空间科技中心（NSSTC）主任阿里·阿勒谢希**表示，空间技术的全球创新合作带来了诸多新机遇，包括联合卫星飞行任务开发、联合太空飞行科学计划、关键实验室共建以及卫星数据共享等。**中科院微小卫星创新研究院副院长、卫星数字化技术重点实验室主任张永合**指出，星海“一带一路”联合实验室（STARLab）是中国与葡萄牙共建的空间与海洋研究平台，专注于解决宇宙探索、全球气候变化和蓝色经济等重大问题与挑战。

Second, cooperation in scientific and technological innovation has become a consensus in addressing environmental and climate change. Joaquim João Sousa, senior research fellow at INESC TEC in Portugal, pointed out that cooperation in global open source innovation helps train next-generation Earth observation satellite leaders to address global challenges such as climate change, energy shortage, and limited resources. **Ali Al Shehhi, Director of the National Space Science and Technology Center (NSSTC), United Arab Emirates University,** said that global innovation

cooperation in space technology has brought many new opportunities, including joint satellite mission development, joint spaceflight science programs, joint building of key laboratories, and satellite data sharing. **Zhang Yonghe, Vice President of the Innovation Academy for Microsatellites, Chinese Academy of Sciences, and Director of the Key Laboratory of Satellite Digital Technology**, pointed out that STARLab, an aerospace and marine research platform jointly built by China and Portugal, focuses on solving major problems and challenges such as cosmic exploration, global climate change, and the blue economy.

二、空天海洋技术未来发展趋势与有关建议

2. Future development trends of aerospace and marine technology, and relevant suggestions

一是空天海洋技术领域正涌现出多项关键技术方向。中科院声学所深海科学与信息技术研究室主任王姝湘表示，未来海洋信息技术的突破将有望基于北斗导航构建水下导航“星座”，使无人潜水器等水下航行器实现高精度定位，解决深海大规模、长航时、低成本导航定位的问题。**中国海洋大学信息科学与工程学部教授聂婕**表示，海洋气候预报系统涉及超大规模物理运动和微型、快速的动态事件（如海浪、微风等），这些过程相互耦合，需要构建更复杂且强大的预测模型。**上海交通大学海洋学院副教授布莱德利·艾伦·韦莫**指出，卫星图像、激光雷达、无人机、遥控潜水器等现有技术手段难以实现对海岸线环境的精确观测。将遥感与

近地表数据相结合是一个具有潜力的解决方案。**土耳其航天局（TUA）空间技术专家阿赫麦德·汉姆迪·塔坎**提到，月球及深空探索航天任务面临着无数挑战，技术方面包括发射推进技术、着陆动力学和地面机动性、极端条件、自主操作等技术难题。

First, multiple key technological directions are emerging in the field of aerospace and marine technology. Wang Shuxiang, Director of the Deep Sea Science and Information Technology Research Laboratory, Institute of Acoustics, Chinese Academy of Sciences, said that future breakthroughs in marine information technology are expected to create an underwater navigation "constellation" based on Beidou navigation, and realize high-precision positioning for unmanned underwater vehicles (UUVs) and other underwater vehicles, as well as large-scale, long-endurance and low-cost deep-sea navigation and positioning. **Nie Jie, professor at the Department of Information Science and Engineering, Ocean University of China**, said that the marine climate forecast system involves large-scale physical movements, and microscopic, fast dynamic events (sea waves, breezes, etc.), which are coupled with one another, requiring the creation of a more complex and powerful prediction model. **Bradly Allen Weymer, associate professor at the School of Oceanography, Shanghai Jiao Tong University,** pointed out that existing technologies such as satellite imagery, LiDAR, drones, and remotely operated vehicles

can hardly realize the precise observation of the coastline environment. Combining remote sensing with near-surface data is a promising solution. **Ahmet Hamdi Takan, space technology expert at the Turkish Space Agency (TUA)**, mentioned that lunar and deep space exploration missions are facing numerous challenges, including launching and propulsion technologies, landing dynamics and ground maneuverability, extreme conditions, autonomous operation, and other technological problems.

二是学科交叉成为空天海洋技术创新的重要途径。布莱德利·艾伦·韦莫指出，受益于新技术的推动。随着现有地球物理工具的优化和新技术开发，卫星成像、机器学习、人工智能和统计建模的进步推动了地球物理成像与卫星遥感技术的融合。**阿金·若昂·索萨**表示，地球观测卫星搭载合成孔径雷达（SAR）的自动图像分析在地面观测上面临挑战，但基于人工智能的应用正推动技术突破，助力全球气候与环境监测。**中科院微小卫星创新研究院卫星数字化技术重点实验室副主任高法睿**指出，全球首枚3D打印火箭（Terran 1）于2023年3月发射，其85%部件由3D打印完成，3D打印技术将传统火箭推进器设计生产由六个月的时间缩短至五天。实现这一技术需要高强度专用3D打印材料、人工智能驱动的过程控制系统以及高效的传感器与分析系统。

Second, interdisciplinary research has become an important path of innovation in aerospace and marine technology. Bradly Allen Weymer pointed out that this has benefited from new

technology. With the optimization of existing geophysical tools, and the development of new technologies, advances in satellite imaging, machine learning, AI, and statistical modeling have driven the integration of geophysical imaging and satellite remote sensing technology. **Joaquim João Sousa** said that the automatic image analysis of synthetic aperture radars (SARs) on Earth observation satellites faces challenges in ground observation, but AI-based applications are driving technological breakthroughs, and boosting global climate and environmental monitoring. **Farid Gamgami, Deputy Director of the Key Laboratory of Satellite Digitalization Technology, Innovation Academy for Microsatellites, Chinese Academy of Sciences**, pointed out that the world's first 3D printed rocket (Terran 1) was launched in March 2023, with 85 percent of its components made by 3D printing; 3D printing technology has shortened the time of conventional rocket propeller design and production from six months to five days. Realizing this technology requires high-strength special-purpose 3D printing materials, a process control system driven by AI, efficient sensors, and an efficient analysis system.

三是空天海洋技术创新成果将适配多元应用场景。罗伯特斯·赫鲁·特里哈扬托指出，印尼政府机构广泛使用遥感卫星技术，测绘机构利用卫星更新国家地图，农业部评估农业用地和作物产量，公共工程部监控基础设施，渔业和海洋部监察非法捕捞，省

级和地区政府则通过地理信息系统（GIS）分析社会经济状况。**若阿金·若昂·索萨**提到，地球观测卫星在全球气候与环境监测中具有广泛应用，包括水资源、植被、农作物、森林火灾以及地质灾害监测等。**汤杰**表示，太空、天空、海洋和陆地的多模式监测平台收集了大量数据，使我们更深入了解台风对城市环境的影响，台风预测的准确度提高了 5%-20%。

Third, innovative achievements of aerospace and marine technology will match diverse application scenarios. Robertus Heru Triharjanto pointed out that Indonesian government agencies apply remote sensing satellite technology extensively, where mapping agencies update national maps, the Ministry of Agriculture evaluates agricultural land and crop yields, the Ministry of Public Works monitors infrastructure, and the Ministry of Marine Affairs and Fisheries monitors illegal fishing, all through satellites, while provincial and regional governments analyze socioeconomic conditions through the geographic information system (GIS). **Joaquim João Sousa** mentioned that Earth observation satellites are applied extensively to global climate and environmental monitoring, including the monitoring of water resources, vegetation, crops, forest fires, and geological disasters. **Tang Jie** said that the space-air-ground-sea multimodal monitoring platform collects massive data, enabling us to gain a deeper understanding of impacts of typhoons on the urban environment, and improve the accuracy of

typhoon prediction by 5-20 percent.

四是通过人工智能深度应用和跨国研发深度合作推进空天海洋领域创新发展。聂婕建议加强人工智能在海洋大数据分析与气候环境预测模型中的应用力度，特别是通过深度神经网络和数据驱动模型的使用，能够显著提高气候与海洋环境的预测精度，推动海洋科学研究的精细化和智能化。**若阿金·若昂·索萨**建议加强全球合作与开源性创新合作，以推动地球观测技术的进一步发展。他指出，人工智能和机器学习技术在提升图像分辨率、时间分辨率以及数据融合和分析能力方面具有巨大潜力。**阿里·阿勒谢希**指出，跨国合作仍面临诸多挑战，如出口管制、技术转让机制差异以及流程监管的不一致等问题，需要通过国际政策协调加以解决，以进一步为全球应对气候变化和可持续发展提供了新的路径。

Fourth, promote innovation and development in the aerospace and marine fields through the in-depth application of AI and in-depth cross-border R&D cooperation. Nie Jie suggested strengthening the application of AI to marine big data analysis, and climate and environmental prediction models, especially through the use of deep neural networks and data-driven models, which can improve the prediction accuracy of climate and the marine environment significantly, and realize refined and intelligent marine scientific research. **Joaquim João Sousa** suggested strengthening global cooperation and open source

innovation cooperation to promote the further development of Earth observation technology. He pointed out that AI and machine learning technologies have great potential in improving image resolution, temporal resolution, and data aggregation and analysis capabilities. **Ali Al Shehhi** pointed out that cross-border cooperation still faces many challenges, such as export controls, differences in technology transfer mechanisms, and inconsistent process regulation practices, which should be addressed through international policy coordination to provide further new paths for global response to climate change and sustainable development.

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