Integration and Command and Control of Maritime and Space Network Environmental Support

1.0. Key Findings

- The People's Republic of China's (PRC) integration of ocean environmental science and national space resources is a nationally driven strategic effort to exploit the ocean environment as an advantage against potential adversaries and to enable its own maritime operations.
- Core to this effort is the role of the civilian scientific and engineering community, research institutions, and public and private companies that can develop, construct, and maintain a networked ocean monitoring system. The leading role civilians play makes this subject highly amenable to open-source research.
- Since major reforms in 2016, the People's Liberation Army (PLA) has placed greater emphasis on incorporating ocean battlefield environmental intelligence to support joint operations and has dedicated groups to support commanders in Joint Operations Command Centers at the Central Military Commission and theater command levels.
- There are many military and civilian institutions working on a wide variety of programs and projects related to the integration of the marine and space domains, including specific efforts at increasing coverage, data collection, and threat detection. While incomplete, efforts are underway to improve military and civilian resource sharing, joint development, and dual-use capabilities. Many national-level programs have significant military involvement, with the intent of having many systems built by the civilian side with the military as a key user.

2.0 Introduction

Deeply rooted in the PRC's military-civilian fusion national strategy, the PLA has striven to build a system of networked meteorological and oceanic sensors, data collection platforms, and satellite constellations to improve its battlespace awareness and command and control. As several experts from the Naval Research Institute Ocean Environment Research Institute (海军研究院海洋环境研究所) explained in 2018:

> "From the requirements of our navy's various operations, products related to ocean geography, hydroacoustics, hydrometeorology, gravity, magnetism, and the electromagnetic environment are urgently needed to provide effective support for the ocean battlefield. Using marine environmental satellite resources to provide and supplement ocean battlefield environmental information support will be an effective means to improve marine environmental information monitoring capabilities as well as serving as an effective implementation of the major strategic ideas proposed by General Secretary

> Xi on strategically managing the ocean, protecting maritime rights, and building a world-class navy …"

These authors provide an authoritative statement on the importance of the nexus between ocean environmental science and national space resources in supporting PLA maritime operations. An important principle, they note, is how critical civilian and commercial entities are to the creation and operation of this system, or as they phrase it, "persisting the principles of military-civilian fusion and having the civilian [sector] build it and the military utilize it" (坚持军民融合，民建军用的原则). This short brief will highlight some key efforts and entities in this national effort to exploit the marine environment through the integration of sea and space capabilities.

3.0. Strategic and Campaign Integration of Meteorological and Oceanographic Information into PLA Operations

The creation of the Central Military Commission's Joint Operations Command Center (CMC JOCC) in 2016 was designed to provide a more robust joint strategic command organ complementary to the campaign-level JOCCs established in each of the five reformed Theater Commands (TC JOCC). Within these two command levels are components that provide meteorological and oceanographic support to operational decision making, military forecasting, and enemy target detection. Referred to as METOC in the U.S. military, meteorological and oceanographic support (气象海洋保障) is an important element of battlefield environmental intelligence in the PLA and is essential to the decision making, battlefield awareness, and command and control within the JOCCs. Since the last round of reforms in mid-2010s, the PLA has increased its efforts at enhancing meteorological and oceanographic support to joint operation commands.

The PLA's concept of "battlefield environmental support" (战场环境保障) includes a variety of intelligence subjects covering terrain, meteorology, hydrology, and other natural geophysical characteristics. The CMC Joint Staff Department contains the Battlefield Environment Support Bureau (战场环境保障局), which is a key integrator of marine and space environmental data and works closely with various government and commercial entities, such as regional satellite network data centers.

3.1. CMC JOCC Meteorological and Oceanographic Group (中央军委联合作战指挥中心气象海洋大队)

It was confirmed in 2016 that the CMC JOCC contained a subordinate Meteorology and Oceanography Group, revealed by the inclusion of a senior engineer from the unit as deputy head of the expert advisory group of the "Ocean Environment Security Support" program. This group, being directly plugged into the strategic-level command and control organ, can likely draw on the integrated resources provided by the Joint Staff Department's Battlefield Environment Support Bureau to support larger trans-theater or distant area operations.

3.2. TC JOCC Meteorology and Oceanography Group (战区联合作战指挥中心气象海洋大队)

Each Theater Command's Joint Operations Command Center (JOCC) contains a subordinate "Meteorology and Oceanography Group" to incorporate various data and provide operational support to the command and operational units. These units also consult with the "meteorology and oceanography departments" (气象海洋部门) of the TC's service components. Since the formation of TCs, the role of the Meteorology and Oceanography Groups shifted from land-centric support under the army-dominated military regions to maritime-focused environmental support. The groups contain an "Ocean Support Office" (海洋保障室) with personnel focused on space observation and ocean measurement in support of joint operations. Personnel interact with various units, including air force pilots and naval ship captains, to better ascertain specific support requirements.

3.3. Integration of Various Data to Support Command

With the growing demand for comprehensive sea and space information for deployed forces, PLA Equipment Academy experts wrote in 2017 on the need to construct an improved "sea and space integrated battlefield common operational picture" (海天一体战场通用态势图) that can better support operations in the far-seas. They note that the PLAN has built its command and control system into an "integrated naval command information system" (综合海军指挥信息系统) comprising command, intelligence, and communication sub-systems. According to the authors, it currently contains information on the sea, air, space, electromagnetic, and network domains, directives and orders from upper echelons, decision-making information from the user's echelon, friendly force status, battlefield situations, operational progress reports, and other information. This, the authors state, satisfies the navy's requirements for combined arms and joint operations in the near-seas, but lacks sufficient support for combat and non-war operations in the far-seas. They break down the additional layers of data resources needed at the strategic-level (CMC JOCC), campaign-level (TC), and tactical-level (combatant units) operational pictures that integrate more diverse data relevant for commanders at each level.

For subsea sources, they propose the use of undersea listening stations in areas around the First Island Chain, to be used in concert with other ASW forces in countering adversary submarines. For space-based resources, they propose the navy utilize reconnaissance capabilities of the then Strategic Support Force and national satellite resources, in addition to the navy's own maritime monitoring satellites.

While it stated that more is needed to better integrate sea and space systems into support systems for naval and joint command organs, the authors do report that the navy has made progress in applying military satellite resources toward its operations.

4.0. Other Institutes Supporting Battlefield Environment Support

Several PLA academies and research institutes provide essential research and development, applications, testing, and various other services that directly contribute to enabling the technological integration of the sea and space domains. Specific to the marine environment, PLA personnel specialized in meteorology and oceanography largely come out of military academies such as the National University of Defense Technology's (NUDT) Meteorological and Oceanographic College (国防科技大学气象海洋学院), PLAN Engineering University (海军工程大学), and the Dalian Naval Academy (大连舰艇学院). From the civilian side, Nanjing Information Engineering University (南京信息工程大学), China Ocean University (中国海洋大学), and others generate a number of specialists entering the PLA.

Some PLA experts find there is excellent quality in the officers that are educated at the civilian institutions. However, they note that there is a shortage of professional meteorology and oceanography personnel in the PLA, requiring local institutions to bolster numbers.

4.1. National University of Defense Technology's College of Meteorology and Oceanography

The College of Meteorology and Oceanography at NUDT is an important institution supporting many PLA development efforts in sea-space integration. NUDT's College of Meteorology and Oceanography (国防科技大学气象海洋学院) trains newly arriving personnel in providing meteorological and oceanographic command support in accordance with the new model and system of joint operational oceanographic support within the theater commands.

According to a 2021 article on the NUDT's website, the numerical weather forecast team (数值天气预报团队) has shifted their work from the skies to the ocean environment. They are involved in numerical forecasting of the ocean environment through key technology breakthroughs in ocean data assimilation and ocean numerical forecasting cloud computing. They have reportedly improved forecasting of ocean temperature, salinity, currents, waves, and other ocean environmental conditions, thereby improving ocean environment support capabilities. In particular, the "deep sea team" (深海团队) of the college has worked for decades on increasing ocean awareness, with current projects focusing on "theater command requirements" and the creation of various types of hydrophones that can be part of the larger underwater monitoring system. Another part of the university, the College of Aerospace Sciences (空天科学学院) Advanced Aircraft Systems and Intelligent Swarm Technology Group (先进飞行器系统与智能集群技术团) developed the TX-0501 long-endurance UAV designed to serve as a shipborne launched platform for ISR and information relay. The UAV helps fill in gaps in ocean situation reconnaissance by collecting buoy data and relaying it forward, thereby solving gaps in range limitations for ship and shore-based collection points as well as coverage gaps in satellite passes, helping to contribute to underwater threat detection.

5.0. Military – Civilian Fusion in Meteorology, Oceanography, and Hydrology (MOH)

PRC sources within and outside the military make it abundantly clear that the military's ability to exploit the underwater environment, particularly the deep-sea domain, is predicated on the extent of the PRC's scientific understanding of the ocean environment. Such extensive scientific understanding often resides in civilian institutions. Overall military-civilian fusion in the development of MOH capabilities is formed via top-level design involving the CMC's Joint Staff Department and Equipment Development Department and their directly subordinate entities, in concert with the China Meteorology Administration, State Oceanic Administration, and other national ministries and commissions. According to an article on civil-military fusion in MOH equipment published in 2019, several authors from the Baicheng Arms Testing Center (Unit 63850, Baicheng City, Jilin Province) explained the general arrangement between the PLA and the civilian government in building this broader system of environmental monitoring.

> "At present, the Battlefield Environment Support Bureau of the Joint Staff Department of the Chinese People's Liberation Army and the China Meteorological Administration (中国气象局) have carried out military-civilian integration projects cooperating on building capabilities in meteorological disaster early warning, earthquake disaster emergency rescue, and microwave video transmission fusion systems. In accordance with the overall idea of co-construction in peacetime, mutual support in wartime, resource sharing, mutual promotion, and win-win, we will focus on promoting the integrated development of key areas such as combat readiness, new military talent, network informatization, system-of-systems equipment construction, and realistic military training."

This effort at integration spans infrastructure use, maintenance and repair of equipment, joint development of new technologies, and most critically, data sharing. For example, "National Project 602" (602专项工程), which has been referred to as "Military and Civilian Dual-Use Marine Environment Support System Construction" (军民兼用海洋环境保障体系建设) in online contract bidding notices, is an effort at joint construction and resource sharing between the military and national informatization construction. There are likely many other national projects entailing joint development and data sharing arrangements.

Another source focuses on the deep-sea domain and explores the requirements for battlefield environment support. Its authors repeatedly highlight the need for extensive surveying, mapping, and monitoring of the ocean environment and seabed. They propose the construction of a seabed geodetic control network based on the PRC's "National Space Reference Military and Civilian Fusion Project" (国家空间基准军民融合工程). This would entail the deployment of reference stations on the seafloor to form a seabed position reference system. The stations, the authors discuss, should carry payloads such as sonar equipment, pressure sensors, geomagnetic diurnal stations, and gravimeters to monitor the environment. It would provide navigation and positioning services for various types of surface and underwater equipment, comprehensively supporting deep-sea military operations.

5.1. "Ocean Environment Security Support" Special Project (海洋环境安全保障重点专项)

Military-civilian fusion in marine environmental science is being developed at the national level and features several supported projects with varying degrees of military applications. In 2016, the PRC launched the "Ocean Environment Security Support" Program as a key special project (重点专项) under the National Key Research & Development Plan (国家重点研发计划). The implementation plan was jointly written by the Ministry of Science and Technology, the State Oceanic Administration, the Ministry of Transportation, the Ministry of Education, and the Chinese Academy of Science and was to be carried out from 2016 to 2020. Focused on enhancing the nation's marine environmental security support capabilities, the plan's goals were the following:

- Focus on the development of high-tech marine monitoring equipment and achieve its industrialization, cultivate a number of marine high-tech industrial innovation bases, and increase China's self-sufficiency in instruments and equipment to more than 50%.

- Focus on the development of a 10-kilometer resolution (4-kilometer resolution in Maritime Silk Road areas) marine environmental forecasting model globally and provide multi-user forecast products and realize its business operations.

- Focus on building a national system of marine environmental security platform technologies, achieve the business trial operations of platforms, and support the response to major marine disasters and sudden environmental events such as storm surges, Enteromorpha, and oil spills.

The first batch of supported R&D projects in 2016 covered a range of subjects, including three-dimensional observation/monitoring of the marine environment and the indigenous production of core equipment, focusing research on the subjects in Figure 1:

Figure 1: 2016 Selected Projects from the Ocean Environment Security Support Program

Research on new technologies for three-dimensional observation/monitoring of the marine environment and the indigenous production of core equipment	• The marine hydroacoustic environment and underwater acoustic detection technologies • Observation equipment on the polar environment • Sensors on the marine dynamic environment and ecological elements • Marine remote sensing detection mechanisms and models • Standardized testing technology for marine instruments and equipment

Technologies for forecasting changes in the marine environment	• A global marine environment numerical forecast system • Big data analysis technology for dynamic marine environments
Technologies in early warning and response for marine environmental disasters	• Marine dynamic disasters, Enteromorpha, microplastics, marine oil spills, hazardous chemical leaks, and radioactive incidents, etc.
Supporting technologies for a national marine environmental security platform	• Deployment of the "Two Ocean and One Sea" Ocean Dynamic Environment Three-Dimensional Observation Demonstration System ("两洋一海" 海洋动力环境立体观测示范系统)

Management, planning, and guidance of the program during its launch had a significant PLA Navy presence. When the Ocean Environment Security Support Program was launched in 2016, it was overseen by an expert group of 15 members from across various scientific and technological research institutes, and also included personnel from the CMC JOCC's Meteorology and Oceanography Group, the PLAN's Oceanography, Hydrology, and Meteorology Center (海军海洋水文气象中心), PLAN research unit 92537, and the Naval Research Institute.

6.0. Conclusion

Numerous sources, both in the PLA and across the PRC's science and technology sectors, hail the critical importance of future integration of the ocean and space domains. Major, large-scale development projects are supported by national strategic programs and are a key component of China's military-civilian fusion strategy. How these domains are developed and operationalized for military use is still unclear and merits further research into the specific technologies and methods put into practice. This short brief presents an overview of some identified entities and programs in the PRC that comprise this system in development. With the abundance of literature available on this wide topic due to the leading role civilian entities have in building it, significant additional research could identify the key organizations and programs and unearth critical technical details in its applications.

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