THE RESEARCH OF NEW OCEAN REMOTE SENSING DATA FOR OPERATIONAL APPLICATION

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List of Principal Investigators (PIs)

Topic Nr.	PIs	Title
32292_1	*Dr. Wolfgang Dierking,* *Dr. Xi Zhang*	***Techniques for Sea Ice Parameter Extraction and Sea Ice Monitoring Using New Satellite Data***
32292_2	*Mr. Bernat Martinez,* *Dr. Jungang Yang*	***Data validation and oceanic application of new satellite altimeters and SWIM***
32292_3	*Prof. Jacqueline Boutin,* *Dr. Xiaobin Yin*	***Sea surface salinity algorithm based on combined active/passive microwave imagers***

EXECUTIVE SUMMARY

The ocean, which covers 71% of the earth's surface, is the important regulator of global climate system. Ocean monitoring is of great significance to the development and utilization of the ocean, the understanding and coping with the global climate change. Remote sensing is an important means for continuous ocean monitoring in large area. European ENVISAT, SMOS, Cryosat-2, Sentinel series satellites and Chinese HY series satellite, CFOSAT satellite provide a lot of remote sensing data for ocean monitoring. The cooperation between China and the Europe in the ocean remote sensing technique is helpful to the comprehensive application of two-side satellite data in ocean monitoring.Ocean dynamic environmental factors (such as ocean wave, ocean current, mesoscale eddy, sea surface salinity) and sea ice is an important part of ocean monitoring, and it is also an important parameter in the study of climate change. As a continuation and expansion Dragon 3 projects (No. 10501 and No. 10466), the project will integrate European and Chinese satellite remote sensing data to study the ocean dynamic environment and sea ice and other monitoring. The project belongs to two themes (Ocean & coastal zones; hydrology & cryosphere) of Dragon 4.The main goals are to extend technologies to further improve sea ice monitoring capabilities on regional and global scale, to validate, improve new satellite altimeters and SWIM data and exploit them to the study of the ocean current and mesoscale eddy, and to develop the sea surface salinity algorithm based on combined active/passive microwave remote sensing.There are three research topics in the project: Techniques for Sea Ice Parameter Extraction and Sea Ice Monitoring Using New Satellite Data (T1), Data validation and oceanic application of new satellite altimeters and SWIM (T2) and Sea surface salinity algorithm based on combined active/passive microwave imagers (T3). T1: 1) Improvement of sea ice remote sensing backscatter and emission modelling. 2) Development of sea ice classification methods with multi-sensor data by comparing different classification algorithms. 3) Sea ice thickness and ice concentration retrieval methods. 4) Development of sea ice drift extraction methods.T2: 1) To validate the new satellite altimeters and to improve the retrieval of SSH. 2) To retrieve ocean wave spectra from SWIM, SAR and HFSWR data. 3) To study geostrophic current calculation and to exploit geostrophic current data to Kuroshio observation. 4) To analyze the spatial-temporal variation characteristics of mesoscale eddies. T3: 1) To derive new improved models for roughness correction. 2) To improve the roughness model at high winds. 3) Correction for atmospheric and roughness impact due to rain by estimating rain radiation and by introducing a rain spectrum model. 4) Multi-parameters retrieval based on the roughness and forward model and validation of retrieval algorithm using remote sensing and in-situ data. The project will promote new satellite data application and deliverables are include 1) Improved sea ice, ocean wave, ocean current, mesoscale eddy and sea surface salinity retrieval model and algorithm. 2) Well-trained European and Chinese young experts for ocean remote sensing. 3) Promotion of the development and long-term cooperation of the European and Chinese ocean satellite remote sensing technology. Funding sources of the project include Funding from National Natural Science Foundation of China (No.41306193, No.41576176 & No.61501130), Ocean Public-welfare Scientific Projects of China (No.201305025), and the Ocean Salinity Satellite Mission of China and Oceanic application with high resolution satellites of China. The European partners are on permanent positions in their institutes which support their work in this project. Additional support may come from ESA or EC Horizon 2020 projects, like H2020 SPICES.

ABSTRACT 32292_1: "Techniques for Sea Ice Parameter Extraction and Sea Ice Monitoring Using New Satellite Data"	
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Sea ice is one of the most sensitive factors reflecting global climate change, and has itself an important impact on the global climate and environment through interaction with the atmosphere and oceans. At the same time, sea ice can cause great harm to offshore production activities, and can block ports and fairways, overturn offshore oil platforms, and destroy aquaculture facilities in the gulf regions (such as the Bohai Sea) and along the coast. Sea ice is an important environmental factor to be considered in marine operations, and in offshore engineering and ship design. Therefore, the realization of timely and accurate monitoring of sea ice is urgently required, for both climate change research and safety assurance of marine traffic and offshore operations.

Under the supporting of Dragon-2 (5290) and -3 (10501) projects, our team focused to a large extent on sea ice monitoring in the Bohai Sea, supplemented by complemetary studies for the Baltic Sea and the Arctic. We developed sea ice classification methods with ENVISAT ASAR and PolSAR, sea ice thickness retrieval methods with PolSAR and optical data, and sea ice drift tracking methods with sequential remote sensing data, adapted to the conditions in the Bohai Sea. The efficient and productive technologies have helped to improve the capability of sea ice monitoring in the Bohai Sea. However, with the emergence of new satellites (e.g. Chinese GaoFen series and European Sentinel series), we will be able to extend technologies to further improve sea ice monitoring capabilities on regional and global scale. Compared with the former work (Dragon-2, and 3 programs), the changes listed below will be included in this proposed project.

1. Team composition is extended. In former projects, only three organizations (Alfred Wegener Institute for Polar and Marine Research, Germany; Finnish Meteorological Institute, Finland; and the first Institute of Oceanography, China) took part in. In this project, another six organizations are added, including universities, research institutes, and operational departments, and realize the industry-university-research cooperation mode.
2. Research area is extended. In the Dragon-2 and 3 projects, our research area mainly focused on the Bohai Sea with only few complementary studies for the Arctic and Baltic Sea. In this proposal, we extend the research to Arctic and Antarctic regions which will not only make it easier to collaborate more closely within the Sino-European team, but also provide sea ice information from local to global scale which is needed for operational sea ice services for marine transportation and climate research.
3. New remote sensing data and new research contents. Nowadays, many new satellites have launched or are planned to be launched, e.g. Sentinel series and GF series. Based on these new remote sensing data, we should develop new techniques for sea ice parameters extraction and promote the capability of operational sea ice monitoring with remote sensing data, e. g. by considering SAR polarimetry, SAR compact polarimetry, and merging multisensory data: SAR, optical, thermal and passive microwave data. The primary research contents include sea ice classification methods for specific regional ice conditions, sea ice thickness retrieval methods combining altimetry, passive microwave, SAR data, and thermal data, and the testing and merging of sea ice drift tracking methods. One important point is to find methods for judging the achievable accuracy. Based on the sea ice parameters extracted by multi-sensor remote sensing data, we will assess the hazard level and the navigation capabilities in economically relevant regions such as the Bohai Sea and the Arctic.

This research is supported by National Natural Science Foundation of China (41306193) projects, Ocean Public-welfare Scientific Projects (201305025), and Oceanic application with high resolution satellites. The European partners are on permanent positions in their institutes which support their work in this project. Additional support may come from ESA or EC Horizon 2020 projects, like H2020 SPICES

ABSTRACT 32292_2: "Data validation and oceanic application of new satellite altimeters and SWIM"	
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Satellite altimeter is one of important global ocean remote sensing monitoring technique. The European satellite Sentinel-3 will be launched in 2016, and the Chinese satellite HY-2A is on orbit and its successor HY-2B has planned to be launched during the Dragon 4 period. The CFOSAT will be launched in 2018. As the continuance of Dragon 3 project(ID.10466), the objectives of this research topic are to validate the sea surface height(SSH) and significant wave height(SWH) data of new satellite altimeters (Sentinel-3 and HY-2 series) by all available data such as buoy, tide gage, High Frequency Surface Wave Radar(HFSWR) and SWIM, to improve the retrieval of SSH and fuse along-track multi-altimeters SSH data such as Sentinel-3, HY-2 series, Cryosat-2 and Jason-3 into regular spatial-temporal resolution grid data, to retrieve ocean wave parameters from SWIM and fuse altimeters SWH data and SWIM data into grid data, to exploit altimeters' along-track and grid data to geostrophic current calculation and the spatial-temporal variation characteristics analysis of mesoscale eddies in the eastern Indian Ocean, western Pacific Ocean and the Chinese seas.
The funding to run the project is the National Natural Science Foundation of China(No.41576176 & No.61501130).

ABSTRACT 32292_3: “Sea surface salinity algorithm based on combined active/passive microwave imagers”

European Principal Investigator	***Chinese Principal Investigator***
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Ocean salinity is a key parameter for oceanic and climate studies. Together with the ocean temperature, the salinity influences the density of sea water and plays a key role in the formation and circulation of water masses. In situ sea surface salinity (SSS), acquired by drifters and oceanographic or commercial ships, remain sparse and irregular and in most cases do not sample the first meter of the sea surface [1].

The SMOS (Soil Moisture and Ocean Salinity) mission is an European Space Agency’s (ESA) Earth Explorer Opportunity mission within its Living Planet Programme and it carries the Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) instrument [2]. The objective of the mission is to address the need for measuring high-quality global observations of soil moisture and sea surface salinity (SSS) from space [3]. It is the first interferometric radiometer operating at L band (1.4GHz) [4], [5] and it’s the merely SSS sensors still in orbit right now.

Aquarius/SAC-D mission, a partnership between USA National Aeronautics and Space Administration (NASA) and Argentine Comisión Nacional de Actividades Espaciales (CONAE), is the first satellite mission specifically designed to provide monthly global measurements of sea surface salinity using the synergy of active and passive L band microwave instruments [6]. It has been launched on 10th June, 2011 and was ended in June 2015 (http://www.nasa.gov/mission_pages/aquarius/main/index.html). Remote Sensing Systems (RSS) has released Version V1.0 (BETA) SMAP ocean surface salinities (http://www.remss.com/missions/smap).

A candidate payload, called the microwave imager combined active/passive (MICAP), for the Ocean Salinity Satellite Mission of State Oceanic Administration of China has been proposed to retrieve SSS simultaneously with SST and wind. The MICAP has the capability of L/C/K multi-band passive and L-band active measurement. The new mission objective is to produce SSS with an accuracy of 1 pss at a single glance and 0.1 pss for a monthly average, to be launched around 2020.

This study will focus on sea surface salinity (SSS) retrieval algorithm base on multi-band radiometer brightness temperature (1.4GHz, 6.9GHz and 18.7GHz etc.) and L band scatterometer backscatter, especially in severe weather under rain and high wind. The idea is to set up an algorithm to inverse SSS from a multi-band combined active/passive microwave data. To achieve that goal, this study includes two scientific activities:

- Theoretical roughness and forward model investigation under rain high wind conditions
- Development and validation of the salinity retrieval algorithm

With the new algorithm, SSS together with sea surface temperature, sea surface wind, atmospheric vapor and cloud liquid will be retrieved, and less auxiliary data from forecast models will be relied on. This study will estimate to which extent information on SSS could be derived in severe weather under rain and high wind, which is not available for present algorithms. Funding from the Ocean Salinity Satellite Mission of China and from the National Natural Science Foundation of China is available to support this project.

Reference

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