MICROWAVE SATELLITE MEASUREMENTS FOR COASTAL AREA AND EXTREME WEATHER MONITOR

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List of Principal Investigators (PIs)

Topic Nr.	PIs	Title
32235_1	*Dr. Ferdinando Nunziata,* *Prof. Xiaofeng Li*	***SARCO - SAR-based Coast Observation***
32235_2	*Dr. Armando Marino,* *Dr. Weizeng Shao*	***Ship and Coastal Water Pollution Observation with Polarimetric SAR Architectures (SCoPeSAR)***
32235_3	*Dr. Marcos Portabella,* *Prof. Xiaofeng Yang*	***SHENLONG: Sea-surface High-wind ExperimeNts with Long-range (satellite) Observations using Numerical Geophysical methods***

EXECUTIVE SUMMARY

The proposed project aims at exploiting microwave satellite measurements to generate innovative added-value products to observe coastal areas also under extreme weather conditions. The project rationale lies on a deep co-operation between Chinese and European (including Italy, UK, Spain, France and Netherlands) partners that are characterized by a complementary expertise. Moreover, young faculty, master and PhD students will actively take part in the modeling and the development of phenomena under study, i.e. coastal water pollution, coast erosion, ship and metallic target detection, typhoon/cyclone monitoring. The project aims also at stimulating the use of complementary microwave instruments, e.g. Synthetic Aperture Radar (SAR), scatterometer and radiometer operational and planned missions, operated by ESA, ESA TPM and Chinese EO.Since the main objective of the proposed project is demonstrating the benefit of microwave products for coastal area monitoring the Ocean & coastal zone Dragon-4 thematic area is covered. This application is of paramount importance for both the scientific and the end-user communities. This means that this research project provides important outcomes that can be summarized as follows: a) Promoting an "intelligent", i.e. physically-based, use of remotely sensed microwave measurement for generating added-values products: coastal water pollution, coast erosion, ship and metallic target detection, typhoon monitoring; b) Developing new models/methods to deal with multi-polarization SAR measurements for costal area observation; c) Promoting the co-operation between Chinese and European partners by taking full advantage of their respective expertise.The above-mentioned added-value products will be generated using an intelligent processing that consists of transforming microwave measurements into end-user friendly products through a tailored modeling of the phenomenon under study. Coastal water pollution, coastal erosion, metallic target observation and sea surface scattering under extreme conditions will be mainly addressed using SAR measurements. Both single-, dual-, full- and compact-polarimetric SAR architectures will be exploited. Hence, single-polarization and polarimetric models will be analyzed and/or developed to generate added-value products that consist of risk/vulnerability maps, targets at sea maps and pollutants maps, cyclone/typhoon monitoring. Cyclone/Typhoon monitoring will be addressed using a multi-sensor approach based on the exploitation of SAR, scatterometer and radiometer measurements together with data assimilation models and ancillary buoys/model information. Hence, models to deal with extreme wind conditions will be analyzed/developed. Project's outcomes will be disseminated submitting periodic progress reports or publications in the Dragon 4 annual Symposia describing the status of their project and papers will be prepared for publication in English at the mid-term stage (i.e. June 2018) and at the end of the Dragon 4 applicable period (i.e. June 2020). Main achievements will be also presented at specialized workshops or symposia organized by ESA and NRSCC at Dragon-4 symposia and at international symposia and will be published in peer-reviewed journals and refereed conferences. The success of the project strongly relies on the co-operation between European and Chinese partners. This co-operation has been already successfully experienced during the Dragon-3 project no. 10689. The proposed project is financially backed on European and Chinese funds, e.g. WISCH project 4 - T2STAR - C.U.P. B88C14000290007, National Natural Science Foundation of China under Grant 41306184, Zhejiang Provincial Natural Science Foundation, NSFC project Grant No. 41371355; EUMETSAT projects Reference OSI_AVS_15_02 Reference NWP_AS16_P02.

ABSTRACT 32235_1: "SARCO - SAR-based Coast Observation"

European Principal Investigator	***Chinese Principal Investigator***
Dr. Ferdinando Nunziata (Dipartimento di Ingegneria, Università di Napoli Parthenope,Italy)	Prof. Xiaofeng Li (International Center for Marine Studies, Shanghai Ocean University,CHINA)

The proposed activities aim at generating added value products that, based on a proper processing of remotely sensed microwave Synthetic Aperture Radar (SAR) polarimetric measurements and ancillary optical data, allow effectively managing coastal areas and related hazards. The following sub-topics will be addressed: coastal classification and coastline analysis. The main objectives can be summarized as follows: a) demonstrating the added-value and the uniqueness of information obtained via remotely sensed data for operational coastal area management; b) developing models and methods to transform remotely sensed data into added-value products; c) promoting technological/scientific transfer between European and Chinese scientists and training young students. The expected scientific outcomes are as follows:

1) Map of inland cover that aims at providing physical-based classification outputs with high accuracy. This kind of added-value product will allows inferring useful information about challenging environments characterized by a large variety of land use, i. e., urban and industrial areas, tideland and sandy beaches, forest, etc. This product will benefit of multi-polarization and multi-frequency SAR measurements jointly combined with ancillary optical data and in situ observations.

2) Map of inland changes/deformations that aims at providing physical-based outputs related to the surface deformation analysis with high accuracy. This kind of added-value product will allow inferring useful information about challenging environments characterized by a large variety of surface deformation phenomena (e.g. subsidence) related to natural and/or anthropogenic factors (e.g. earthquakes, landslides, pumping and extraction of hydrogeological and energetic resources, presence of gas & oil reservoirs, etc.). This product will benefit of multi-temporal and multi-frequency SAR measurements jointly combined with ancillary optical data and in situ observations.

3) Map of the coastline and its changes (due to land deformation, erosion and relative sea level change) for the selected test sites. This product will be generated using time series of multi-polarization SAR data and in situ observations. In addition, geophysical, GPS, tide gauge and modeling data will be used together with SAR products in order to evaluate intermediate parameters (i. e., land deformation and coastal relative sea level rise) that are needed for the retrieval of coastline changes as added-value products;

All the products relevant to the coastline and the inland coastal analysis will be properly merged within a processing chain in order to provide coastal risk and vulnerability maps of selected test sites. The latter will be generated forcing oceanographic models with wave and wind information and using ancillary information on the land area obtained via SAR, optical, GPS, geophysical, geological observations, available aerial photogrammetric data and in situ measurements.

The activities to be undertaken are financially supported by Italian and Chinese funds: WISCH project 4 "Studi e ricerche per la definizione di una superficie aerodinamica multistrato ceramica-metallo con sensori integrati per applicazioni avioniche" - T2STAR - C.U.P. B88C14000290007 and the National Natural Science Foundation of China under Grant 41306184.

ABSTRACT 32235_2: "Ship and Coastal Water Pollution Observation with Polarimetric SAR Architectures (SCoPeSAR)"

European Principal Investigator	***Chinese Principal Investigator***
Dr. Armando Marino	Dr. Weizeng Shao
(The Open University,UK)	(Zhejiang Ocean University,CHINA)

The proposed activities aim at generating added value products based on a proper processing of remotely sensed multi-polarization Synthetic Aperture Radar (SAR) measurements and ancillary optical data. The final goal is to allow managing effectively coastal areas and related hazards, with special focus on detecting targets of interests in SAR images. In particular, we will focus on ship detection and coastal water pollution observation.
From a more general perspective, the objectives of this project can be summarized as follows:
a) demonstrating the added-value and the uniqueness of information obtained via remotely sensed data for operational coastal area management;
b) developing models and methods to transform remotely sensed data into added-value products;
c) promoting technological/scientific transfer between European and Chinese scientists and training young students.
More specifically, the expected scientific outcomes could be separated in two parts considering the two detection tasks we are investigating:
a) Regarding ship detection, we expect to develop the capability to generate accurate maps of maritime traffic exploiting multi-polarization SAR data and Automatic Identification System (AIS). Monitoring the presence of ships near coastal regions will allow a better management and protection of maritime resources (as for Ecological Reserves) and help fighting imperative issues as illegal fishing.
b) With respect to water quality, we aim at enhancing the capability to produce maps of water pollution. This aims at highlighting anomalies, mainly related to stormwater runoff from heavily urbanized watersheds, wastewater discharge from publicly owned treatment works, shoreline industries, rivers and oil spills. This product will benefit of multi-polarization SAR measurements and ancillary optical and in situ observations.

The methodologies investigated in this project are listed as follows:
a) For ship detection, the state-of-art of polarimetric algorithms will be compared to innovative single polarization methodologies as the one exploiting the spectrum of complex SAR images. In the project, we will also try to pioneer innovative ways to combine spectral analysis with polarimetric modelling. Finally, we will investigate novel methodologies to reduce the influence of azimuth ambiguities that often affect SAR images of coastal areas.
b) Regarding water quality, the polarimetric sea surface backscattering with and without surface slicks will be read in physical terms exploiting multi-polarization features. The aim is to detect the surfactant with respect to the surrounding sea and map the damping properties of the surfactant in order to classify them according to their damping properties.
A large variety of satellite data will be processed with special interest for Sentinel-1 dual-polarization data. To test quad polarimetric methodologies, Radarsat-2 and ALOS-1/2 data will be employed, focusing on coastal areas where the presence of cities poses a risk of pollution. AIS data will be collected, compared and fused with the detection masks obtained by SAR data. Finally, ancillary optical data will be analysed for comparison and fusion with SAR data for obtaining water pollution maps.
The activities to be undertaken are financially supported by UK and Chinese funds. The European PI, Dr. Marino is a permanent member of the staff at the Open University and he has access to departmental research funds. As for the Chinese PI, Dr. Shao is an associate professor working at Zhejiang Ocean University and has accessed scientific grants from the university since 2015. Besides, several funds will partly support the research as well, i.e. Zhejiang Provincial Natural Science Foundation and Natural Science Foundation of China. Moreover, Dr. Shao now has a scientific project about oil spill detection on the East China Sea supported by the Department of Science and Technology of Zhejiang province.

ABSTRACT 32235_3: "SHENLONG: Sea-surface High-wind ExperimeNts with Long-range (satellite) Observations using Numerical Geophysical methods"

European Principal Investigator	***Chinese Principal Investigator***
Dr. Marcos Portabella (Institute of Marine Sciences (ICM, CSIC),Spain)	Prof. Xiaofeng Yang (Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences,CHINA)

The proposed activities aim at generating added value products that, based on a proper processing of remotely sensed microwave Synthetic Aperture Radar (SAR) multi-polarization measurements and ancillary optical data, allow effectively managing coastal areas and related hazards.
The main objectives can be summarized as follows: a) Developing models to simulate the multi-frequency and multi-polarization sea surface backscattering under high wind and moist convection conditions; b) developing methods to monitor tropical cyclones from multiple active microwave remote sensed observations; c) promoting technological/scientific transfer between European and Chinese scientists and training young students. The expected outcome of this project can be summarized as:
1) Improve both the physical and the empirical simulation accuracy of polarized sea surface backscattering. The new models will give better results under high winds (including foamed sea surfaces) and moist convection.
2) State-of-the-art wind verification and objective validation tools (including spectral and spatial variance analysis, triple collocation) as well as auxiliary sources (e.g. SFMR and scatterometer winds), to thoroughly assess the SAR wind retrieval quality under such conditions.
3) Map of location, surface winds, center pressure, rain bands, and other parameters of tropical cyclones from multi-sensors, including multi-polarization SARs, single and multi-band Scatterometers, and other EO data.
The activities to be undertaken are financially supported by the following Chinese and European projects: NSFC project "Directional offshore wind energy estimation from space-borne radar" – Grant No. 41371355; EUMETSAT projects "Moist convection by two ASCATs and MSG rain" (Reference OSI_AVS_15_02) and "Optimization of ASCAT data assimilation in global NWP" (Reference NWP_AS16_P02); DLR AO project "Assessment of the dependence of the X-band TerraSAR-X co-polarized and cross-polarized normalized radar cross sections and related parameters on the sea surface wind vector and on the acquisition geometry" (Reference OCE2822); ASI AO project "Assessment of the dependence of the co-polarized and cross-polarized X-band COSMO-SkyMed Normalized Radar Cross Section (NRCS) and their related parameters on the wind vector in low to moderate and extreme wind regimes over sea surfaces" (Reference ID 199); and Spanish MINECO project "Innovative products and services from microwave sensors, SMOS and Earth Sentinels" (pending approval).