Microwave Remote Sensing of China Seas and Coastal Zones and Application in Ocean Renewable Resource Evaluation

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Scientific issues:

Over the past decade, the tools to observe, understand and model the marine coastal environment have gradually improved, both in development of in-situ and remote sensing observational technology and in advances in numerical simulation and high performance computing, including new methods for data assimilation. However, there are still deficiencies in our ability to understand and describe the variability within the coastal and shelf seas and their influence on the marine environment and ecosystems. These deficiencies arise from lack of regular and routine observations, limitations in quantitative interpretations of satellite observations as well as from gaps in our understanding of the many processes involved. Closely allied to these is the need to fully integrate an adequate hierarchical set of properly validated models capable of assimilating heterogenic data and simulating the state and evolution of this marine system.

Objectives:

(1) To investigate winds, waves, currents and other mesoscale processes (internal waves, fronts, eddies, etc) in China Seas with multiple satellite sensors (SAR, Altimetry and Scatterometry) from China, ESA and TPM. To some extent the project builds on the achievements from Dragon as well as recently innovative findings with the combined use of Doppler observations from ASAR, empirical modelling and the DopRIM simulation. In particular the investigation shall focus on internal wave observations. The Chinese continental shelf and open seas are excellent natural laboratories for studies of internal waves. Their signals are regularly detected in specific areas and reveal both determination of the generation site, the propagating phase speed, and their interaction with shallow water bathymetry and the location of dissipation.

(2) To develop ocean wave energy resource evaluation method with remote sensing data. To get ocean wave energy resource distribution map of China Seas. Ocean wave parameters are retrieved from SAR imagery by using cross spectra method, and at coastal regions, the effects of islands, ships and oil spill should be considered. The results are also compared with in situ data to correct SAR retrieval results. The study area is segmented by 15kmx15km, and the quality control of ocean waves is conducted before the monthly statistical results of ocean wave parameters, such as wave height, period, and average wave direction are given. Because the coverage of remote sensing data is temporally and spatially uneven, ocean wave models will also be used to calculate ocean wave parameters. Then the power density of ocean waves is estimated based on remote sensing data and numerical models.

(3) To analyse coastlines changes in the China coastal zones especially Yangzi River Estuary due to reclamation. Coastline monitoring is an important step in many coastal engineering projects such as harbour construction and for coastal protection. Furthermore, coastline change detection is an important environmental parameter, i.e. in connection with erosion from storm impact or human disturbance. Using the synthetic

aperture radar (SAR) technique it is possible to monitor the coastline change. This has been demonstrated with the single polarization SAR technique and multipolarization SAR technique. There are two key techniques to monitor coastline changes. The first one is sea/land discrimination by using SAR images (different approaches will be applied for different mode), and the other is the extraction of the coastline from waterlines and other models such as digital elevation model (DEM) and the tidal model (based on tidal correction, and DEM in the intertidal zone and the tidal model). Coastline detected results from multi sensor satellite data over coastal regions will be compared. The impact of human activities on the coastline change will be analyzed.

(4) To prepare CFOSAT by using SAR and Scatterometry data. A wave-scatterometer spectrometer (SWIM: Surface Waves Investigation and Monitoring) and a scatterometer (SCAT) are on board CFOSAT. It is scheduled to begin orbital operations in 2015. The algorithm and methodology are prepared by using existing SAR and Scatterometer data.

中国海和海岸带微波遥感以及海洋可再生能源评价

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科学问题：

在过去的十年中，无论是现场观测和遥感技术，还是包括新的数据同化方法在内的数值模拟和高性能计算等用来观察、了解和模拟海洋及沿岸环境的工具都得到了逐步改善。但是，在理解和描述沿海和大陆架的海洋变异以及对海洋环境和生态系统的影响等方面仍然有不足之处。这些不足之处来源于定期和常规观测的缺乏，对卫星资料定量解释的局限，以及对所涉及的许多过程的认识方面的差距。与此密切相关的是，要充分整合足够的经过验证的模型，这些模型能够同化不同类型数据和模拟海洋系统的状态和演化。

目标：

（1）利用中国、欧空局和第三方的多源卫星传感器（合成孔径雷达、高度计和散射计）研究中国海的风、浪、流和其它中尺度过程（内波，锋面，涡旋等）。在一定程度上，利用了"龙计划"项目的最新进展以及综合使用ASAR多普勒观测、经验建模和DopRIM模拟的最新成果，并将侧重于内波观测研究。中国大陆架和公海，是从事内波研究的优良的天然实验室，在特定海域能定期检测到内波信号，并揭示发生源和传播速度，以及与浅海水下地形的相互作用和耗散的位置。

（2）开发基于遥感数据的海洋波浪能评估方法，获取中国海海洋波浪能的分布图。首先，利用交叉谱方法从合成孔径雷达图像中提取海浪参数，并通过与现场数据的比对检验对结果进行修正；然后，在对所有数据进行质量控制后，按15kmx15km的小区域进行海浪波高、周期、平均波向的统计。由于遥感数据时空分布的不均性，利用海浪数值模式的结果作为重要的补充。最后，基于遥感统计和数值模拟的结果进行海浪能能流密度的计算，得到波浪能的分布图。

（3）分析由于开垦造成的中国海岸带，尤其是长江口的海岸线变化。海岸线监测是海岸带工程项目（如港口建设）和海岸带保护中重要的步骤。此外，海岸线变化检测是重要的环境参数，它与风暴潮影响或人类破坏的侵蚀有关。使用合成孔径雷达技术能监测海岸线的变化。这在单极化和多极化合成孔径雷达技术上都得到了证明。使用合成孔径雷达技术监测海岸线变化的关键技术有两项。第一项是使用合成孔径雷达图像进行海陆分割，第二项是根据水边线和其它辅助模型，如地面高程模型和潮汐模型等，提取海岸线。最后，将多传感器卫星数据获得的海岸线检测结果进行比较，并分析人类活动对海岸线变化产生的影响。

（4）利用合成孔径雷达和散射计数据为中法CFOSAT卫星做准备。计划2015年发射的CFOSAT卫星上装载有一个波谱仪（SWIM）和散射计（SCAT）。通过使用现有的合成孔径雷达和散射计数据为今后处理中法CFOSAT卫星数据提供算法和方法准备。