DIRECTIONAL WAVE SPECTRUM ESTIMATION BY SWIM INSTRUMENT ON CFOSAT

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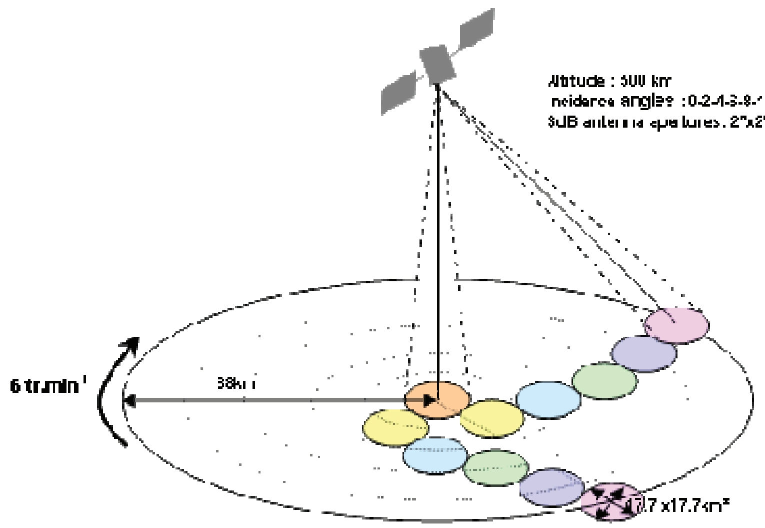
Oceanography greatly benefits from remote sensing satellites for global monitoring and forecast of the sea surface. The CFOSAT (China France Oceanography SATellite) mission, whose launch is planned for 2013, should embark two radar payloads to monitor wind and waves over the ocean. One of this two radar instruments is called SWIM (Surface Waves Investigation and Monitoring). It is a Ku-band scatterometer designed to measure ocean waves. Actually, this SWIM concept is based on the Jackson et al. proposals [1,2,3], which describe the design and processing of a scatterometer dedicated to the wave field estimation.
SWIM is currently in Phase B (concept and design phase). In [6,7], the preliminary design and associated performance analysis have been published taking into account the end of Phase A design. This paper is focused on the performance assessment of the SWIM instrument based on the new developments which occur during Phase B. We aim here at up-dating the first results by taking into account the last developments of the instrument. In addition, major reviews have been carried out on the performance analysis.

First, the SWIM concept is briefly described in order to give the key concepts which are useful to readers' understanding.
SWIM, a follow-on concept of VagSAT and SWIMSAT payloads [4,5], aims at measuring directional ocean wave spectra on a 180 km wide swath. SWIM is a real aperture radar in Ku-band pointing sequentially at six different incidences (from 0° to 10°) with a constant azimuth scanning (see Figure below). The last three incidence angles are used to estimate the directional wave spectrum, at a scale of about 70 x 70 km. This ocean wave spectrum provides information on the distribution of wave energy (or wave height) with respect to wavelength and wave propagation direction. These features are of main interests for ocean wave monitoring and forecast. SWIM permits also naturally to obtain a continuous measurement of the radar cross sections (from 0° to 10° of incidence angles) and to measure the significant wave height and wind speed thanks to nadir beam acquisitions. The selected sun synchronous orbit (characterized by an altitude of 514 km and a 13 day cycle) ensures a nearly full coverage of the oceans. A side paper [9] has been submitted to this same conference to detail the phase B design of SWIM.



Second, the performance analysis is carried out based on both simulation and theory approaches. In each field, improvements have been made to better model and understand the physics of the instrument measurement.
In a first subsection, the theoretical analysis of the wave estimation accuracy is proposed. A review of the estimator accuracy has been stated and is discussed in the paper. Wave spectrum accuracy is quantified through the calculation of an integrated criterion (relying on differences of energy) and a wavelength by wavelength criterion (error computed for each wavelength). These criteria are discussed in the paper.
In a second subsection, the simulation approach is described. This simulation tool is an end-to-end simulator (i.e. from the surface model to the wave spectrum estimate). Therefore, it enables to simulate the sensor parameters and geometry of observation, the signal acquisition, the on-board and on-ground processing. The qualification of the performance is made with the help of previously mentioned criteria defined on the estimated wave spectra. This aims at fulfilling the scientific requirements.

Analyses (theory and simulations) have been performed on seven distinct scenarios of observation, each characterized by a local sea state, standing for wind sea and swell conditions. These scenarios have been defined in order to be representative of the large variety of sea conditions and check whether SWIM is able to measure local sea state characteristics. Such analyses have helped coming out with SWIM limits of detection when local sea energy gets below physical noise. Further results are detailed in the paper.

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