Passive Interferometric Ocean Currents Observation Synthetic Aperture Radar (PICOSAR)

Thomas Börner[(1)], Paco López Dekker[(1)], Gerhard Krieger[(1)], Markus Bachmann[(1)], Hartmut Müller[(2)]

[(1)] DLR, Microwaves and Radar Institute
Münchner Str. 20, 82234 Weßling, Germany
[(2)] DLR, Institute of Space Systems
Robert-Hooke-Str. 7, 28359 Bremen, Germany
e-mail: thomas.boerner@dlr.de

Abstract This paper describes PICOSAR (Passive Interferometric ocean Currents Observation Synthetic Aperture Radar), a concept consisting of two small, low-cost and low power spacecraft carrying a passive, receive-only SAR payload. PICOSAR enhances the functionality of a full SAR system such as Sentinel-1 or TerraSAR-X by adding a unique along-track interferometer dedicated to ocean surface current measurements. The passive nature of this system and the focus on a single application and single operation mode allows the implementation of PICOSAR using a very cost effective payload design and the use of a compact and low-cost micro-satellite bus. Besides the clear scientific value of PICOSAR, it would also foster the development of several key technologies: micro-satellite architectures, autonomous formation flying, and multi-static SAR constellations.

The primary scientific application is measuring ocean surface currents, which are continuous streams of ocean water induced by global wind fields. Surface currents have a major impact on regional climates. They also have a significant direct economic impact due to their effect on shipping costs. Measuring and monitoring changes in surface current patterns is of high importance to understand the global sea-atmosphere interaction and the global climate and climate change.

Ocean currents are traditionally measured using drifters and, in coastal regions, using land based HF radars. Single-channel SAR systems have also been used for years to retrieve surface current information from the estimation of the Doppler Centroid. However, the addition of a second channel, in an along-track interferometric (ATI) configuration, is what can turn a SAR system into a highly accurate, high-resolution surface current mapping system. At C-band, the optimum along-track baseline of approx. 100 m can only be achieved in a close formation flying configuration.

This paper will present the whole PICOSAR mission concept consisting of a strong science case, a detailed satellite and payload design (developed in collaboration with DLR's Concurrent Engineering Facility, CEF), and an elaborate performance analysis, where the latter strongly supports the PICOSAR system concept. As a reference, the surface current estimation error predicted for the wave mode of Sentinel-1 is in the order of 0.30 m/s after averaging over a 20x20 km^2 area. The predicted performance of PICOSAR is 5 to 6 orders of magnitude better compared with a single-channel SAR system. PICOSAR's preliminary payload concept is based on a very simple receiver system employing a reflector antenna on a small satellite in the 100-200 kg class. The current baseline is a bi-static C-band system with two satellites designed to operate in conjunction with Sentinel-1.