POLARISATION AND MODE COMBINATIONS FOR SHIP DETECTION USING RADARSAT-2

Tonje Nanette Hannevik

E-mail: tonje-nanette.hannevik@ffi.no

Norwegian Defence Research Establishment (FFI), P.O. Box 25, N-2027 Kjeller, Norway

Norway has been using SAR satellite images for ship detection since 1998. One important aspect in successful ship detection is to get good contrast between ship radar cross section and the ocean surface backscatter. The SAR operating mode, the characteristics of the SAR instrument on the satellite, the settings of the SAR processor, the output data products, as well as the imaging geometry and wind and wave conditions [2].

Extensive research has been done at the Norwegian Defence Research Establishment (FFI) on satellites such as ERS and RADARSAT-1. Earlier advice has been to use large incidence angels and HH-polarisation to detect ships. The ocean backscatter is decreasing with increasing incidence angels for co-polarisation, thus making it easier to detect ships at lager incidence angles. HH-polarisation gives lower ocean backscatter than VV-polarisation. The ENVISAT Alternating Polarisation mode opened up the possibility to do research on cross-polarised data [1]. It has been shown that cross-polarised data can be used for ship detection at low incidence angels. New research also indicates that it is easier to estimate more accurate ship length in cross-polarised data. RADARSAT-2 was launched in December 2007 which introduced significant improvements, compared to earlier radar satellites, including better resolution, flexible look direction and multiple polarisation options. RADARSAT-2 has the opportunity to acquire full-polarisation data.

The paper presents an evaluation of some of the modes and polarisation options that RADARSAT-2 offers. Two test sites have been used: 1) Malangen and Tromsøflaket and 2) The Norne Field outside the Norwegian coast.

Malangen is a fjord in the region of Troms in northern Norway. There are many ships in the area, including ferries that can be imaged multiple times making Malangen a good test site. Tromsøflaket is a maritime zone in the south western Barents Sea and is used as a fishing ground. Around 40 RADARSAT-2 ScanSAR Narrow and ScanSAR Wide images have been acquired over the Malangen and Tromsøflaket areas. A series of images with HH-/HV-polarisation will be compared with a series of images with VV-/VH-polarisation.

The Norne Field is a large oil and gas field on the Norwegian continental shelf. The oil from the field is loaded onto a tanker and transported to the market. The production and cargo ship Norne is used constantly on the field and is moored to a template on the ocean floor. Due to the Norne ship that is moored to the ocean floor, it is possible to image the same ship in multiple images in addition to the other ships and oil platforms that are in the area. The reflection of the Norne ship from different viewing angles and polarisation channels can be analyzed together with different wind and wave conditions. Results from analysis of around 20 RADARSAT-2 ScanSAR images and 20 RADARSAT-2 standard quad-pol images will be presented in the paper. Using all four polarisation channels to image a ship, also gives the possibility to combine the information from the different polarisation channels in an analysis. Single Look Complex (SLC) data have been used in the analysis. Results indicate that applying the Pauli decomposition to an image, the double bounce |HH-VV| suppresses the ocean while the ships are visible. Even better results are obtained when combining the double bounce and the volume scattering |HV|. The Circular Basis Decomposition also gives promising results, using the |RL| image, increasing the ratio of signal peak of the ship to the signal from the ocean clutter.

Information from external sources will be used to verify the identity of the ships. Information about the oil platform and other ships in the Norne Field will be obtained to be sure which oil platform is in the imaging area and also get data about other ships inside the imaging area. Results from the analysis of the Norne oil production ship compared with earlier analysis using the ENVISAT Alternating Polarisation mode will be presented.

Information about the ships in test sites can be obtained using coastal AIS, coastal radar and AIS from airplane. The ships position, identification and length can be obtained, and the data from satellite SAR can be compared with the AIS data [3].

[1] Arnesen, T. og R. Olsen (2004). *Vurdering av ENVISAT ASAR for skipsdeteksjon. FFI-rapport 2004/02121.* Norwegian Defence Research Establishment.

[2] Olsen, R.B. et al. (2009). *MARISS Extension Phase 2. European Maritime Security Services. Analysis of Options for MARISS Services Extension.* MARISS-FFI-TN2-TN-015.

[3] Weydahl, D. et al. (2007). *Ship traffic monitoring using satellite SAR images in combination with AIS reports.* Proceedings of SPIE 2007, Firence, Italy, vol. 6749, 7 pages.