ACCURACY OF SENTINEL-1 GEOPHYSICAL INFORMATION PRODUCTS

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1. INTRODUCTION

Sentinel-1 is an imaging radar mission at C-band consisting of a constellation of two satellites aimed at providing continuity of all-weather day-and-night supply of imagery for user services. Special emphasis is placed on services identified in ESA's GMES service elements program and on projects funded by the European Union Framework Programmes. Three priorities (fast-track services) for the mission have been identified by user consultation working groups of the European Union: Marine Core Services, Land Monitoring and Emergency Services. These cover applications such as:

- Monitoring sea ice zones and the arctic environment
- Surveillance of marine environment
- Monitoring land surface motion risks
- Mapping of land surfaces: forest, water and soil, agriculture
- Mapping in support of humanitarian aid in crisis situations.

Data products from current and previous ESA missions including ERS-1, ERS-2 and Envisat missions form the basis for many of the pilot GMES services. Consequently Sentinel-1 data products need to maintain data quality levels of the Agency's previous SAR missions in terms of spatial resolution, sensitivity, accuracy, polarization and wavelength. In addition, in response to user needs, Sentinel-1 will bring substantial improvements of data provision in terms of revisit frequency, coverage, timeliness and reliability of service.

A key element in the design of the Sentinel-1 mission is the relation between the technical implementation of the mission and the accuracy of the geophysical information products the mission is required to generate and support in the applications community. Such analysis is not only necessary to verify the technical choices of the mission and system vis-à-vis user requirements, but also provides quantitative estimates of the accuracy of key geophysical products helping users prepare for the new data source as well as feedback regarding the choice of operational instrument modes during the post-launch exploitation phase. On a more general level, the analysis and methodology provide a quantitative framework for assessing trade-off between technical implementation and geophysical performance and are thus useful in assessing user requirements evolving with time and assessing the international context including the potential of SAR constellations that integrate national and other non-ESA SAR missions.

2. BACKGROUND

Data products involving information about geophysical variables (Level-2 products) such as ocean surface wind speed, ocean waves and currents, surface pollution, ice type, soil moisture and land cover can be derived from image data products (Level-1 products) using suitable retrieval models. Consequently the accuracy of Level-2 products are affected by measurement uncertainties associated with Level-1 products as well as by uncertainties associated with the retrieval models. Unlike soil moisture and wind speed estimation from the Sentinel-1 images whereby the absolute accuracy of the image intensity is essential many other Sentinel-1 data products rely on image intensity classification and detection of targets. For these types of products sufficient intensity contrast between different surfaces of between a target and its background is more important than the absolute accuracy. Products in this category include land cover classification, forest mapping, ice type classification, ship detection and oil spill detection at the ocean surface.

In terms of the Level-1 data quality, Sentinel-1 radiometric and phase performance are defined by the magnitude of a number of error sources influencing the amplitude and the phase of its complex image products as well as the intensity of its detected image products. They include:

- Instrument gain and phase characteristics
- Thermal Noise
- Effective number of looks
- Non-linearity's including quantisation
- Errors introduced in the processing and data distribution chain

To assess the accuracy of the geophysical products of Sentinel-1, the Level-1 uncertainties above need to be translated into uncertainties in the final geophysical product through simulations based on actual or simplified retrieval algorithms. This forms the core of the accuracy assessment work carried out.

3. THE PRESENTATION

The presentation will provide an overview of the expected accuracy of the Sentinel-1 geophysical products studied. These included ship detection, sea surface wind speed and currents, flood mapping, interferometric subsidence measurements and land cover classification including both general classification and forest/non-forest mapping. The presentation will outline the methodology used and highlight areas of improved performance with respect to existing radar missions.