HIGH-RESOLUTION ASCAT SCATTEROMETER WINDS NEAR THE COAST

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ABSTRACT

The Advanced scatterometer, ASCAT, on MetOp-A was launched on 19 October 2006 as the third wind scatterometer currently in space joining up with the ERS-2 and the SeaWinds scatterometers. Scatterometers measure the radar backscatter from wind-generated cm-size gravity-capillary waves and provide high-resolution wind vector fields over the sea with high quality. In this paper we show progress in high resolution processing and its verification and in processing closer to the coast.

Index Terms— high-resolution, wind, scatterometer, ASCAT, coast

1. INTRODUCTION

The all-weather capability of a scatterometer provides unique wind field products of the most intense and often cloud-covered wind phenomena (for example, see figure 1). As such, it has been demonstrated that scatterometer winds are useful in the prediction of tropical cyclones [4], and extra-tropical cyclones [13]. At the moment the European METeorological SATellite organisation (EUMETSAT) ASCAT, European Space Agency (ESA) ERS-2 and the National Aeronautics and Space Agency / National Oceanographic and Atmospheric Administration (NASA/NOAA) SeaWinds scatterometer on QuikScat provide a selection of regional real-time and global near-real time data streams. In addition, in 2008 Indian Space Research Organisation (ISRO) will launch an Indian Ku-band scatterometer (ISCAT). As such, continuity of both services is likely provided to the operational meteorological community for another period of 15 years.

In Europe, scatterometer product development is organized through the EUMETSAT Satellite Application Facilities, SAF, at the Royal Netherlands Meteorological Institute (KNMI). Available scatterometer data products and wind retrieval software are summarized at www.knmi.nl/scatterometer. The SAFs attempt to improve the spatial filtering properties of the wind retrieval by using prior information on the expected meteorological balance, e.g., favoring rotational structures in high-latitude regions. Moreover, we use solutions in all wind directions, but weighted by their inherent probability. The 2-Dimensional Variational Ambiguity Removal (2DVAR) method has the advanced filtering properties for maintaining small-scale meteorological information in SeaWinds, while reducing noise. This is tested by comparing the spatial covariance structures of the KNMI products, with those of the

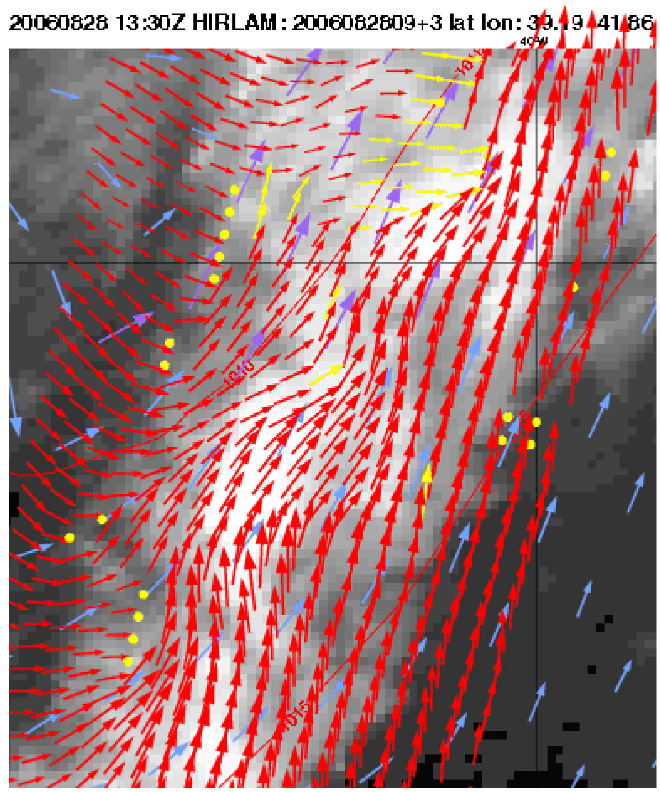

Figure 1. ERS-2 scatterometer winds (red) on 28 August 2006 13:00 Z showing a train of atmospheric waves in the North Atlantic at 25W and 40N. Yellow arrows and dots are quality-flagged ERS-2 scatterometer cells. The blue and purple arrows depict simultaneous background Numerical Weather Prediction, NWP, model winds (KNMI HiRLAM) that generally do not resolve such weather phenomena. The METEOSAT Infra-Red background image is consistent with the scatterometer surface winds. (from www.knmi.nl/scatterometer) © EUMETSAT. The missed Rossby train resulted in a bust NWP forecast the next day in the Netherlands and England.

NASA/NOAA SeaWinds product, and, for reference, those of Numerical Weather Prediction (NWP) models and buoys.

The methodology leads towards a high-resolution scatterometer wind product. Based on these principles KNMI plans in the next phase of the SAFs to develop a 12.5-km ASCAT scatterometer wind product in the coastal zone.

Product enhancement and the preparation of wind production and user services for ASCAT on MetOp-A are the main goals of this investigation (R&D). KNMI currently processes global Ocean and Sea Ice (OSI) SAF QuikScat 100-km and 25-km products, a global pre-operational ASCAT OSI SAF 25-km wind product, and a North Atlantic ERS-2 25-km product in quasi real-time through the EUMETSAT Advanced Retransmission Service (EARS). Moreover, at www.knmi.nl/scatterometer links to the visual presentation of these products are provided, both in vector and flag presentation. Global maps of wind speed are provided over the last 22 hours, segregated in ascending and descending orbit tracks. By mouse clicks on these maps more detailed regional plots become available (as in figure 1). The link also provides documentation, papers, and software products.

2. RESOLUTION VERSUS NOISE

The standard OSI SAF 100-km QuikScat product has been developed for NWP assimilation and it is verified to compare better with independent European Centre for Medium-range Weather Forecasts (ECMWF) NWP winds than the NOAA Direction Interval Retrieval THresholding (DIRTH) product and the OSI SAF 25-km product and is thus indeed suitable for NWP assimilation [8]. At higher resolutions more random wind noise is expected from SeaWinds. Noise reduction is beneficial and further progress is being made by implementing the so-called Multiple Solution Scheme (MSS). The improvement by MSS is brought by using wind vector probability information in combination with the 2DVAR background constraints on rotation and divergence [8]. We further note that the improved verification of MSS is mainly due to the reduction of occasional erratic noise; coherent mesoscale structures remain present and become more visible due to the noise reduction.

Based on this experience a 25-km MSS SeaWinds product has been developed and is now operated operationally at KNMI [5]. Figure 2 shows an example of the product in the tropical region. Scatterometer products thus provide wind variance on scales not well analyzed by NWP models (see e.g. Figure 2). It of interest to verify the scatterometer provided wind variance with buoy data to check the benefit of MSS.

3. BUOY VERIFICATION OF ASCAT WINDS

Buoy verification statistics of the OSI SAF 25-km ASCAT, SeaWinds 25-km and SeaWinds 100-km product are provided in Table 1. Both tropical and extra-tropical moored buoys are used for one month of data. It is interesting to note that the ASCAT 25-km product compares best to ECMWF as it compares best of all products to the buoys as well, providing evidence of the superior quality of the ASCAT scatterometer winds. The ASCAT 25-km winds are effectively at 50 km resolution and it is interesting to note

ASCAT 25		SeaWinds 25		SeaWinds 100	
SD u [m/s]	SD v [m/s]	SD u [m/s]	SD v [m/s]	SD u [m/s]	SD v [m/s]
1.76	1.79	1.84	1.83	2.19	2.00

Table 1. Buoy verification of the Ocean and Sea Ice SAF 25-km ASCAT, SeaWinds 25-km and SeaWinds 100-km product. Both tropical and extratropical moored buoys are used for one month of data.

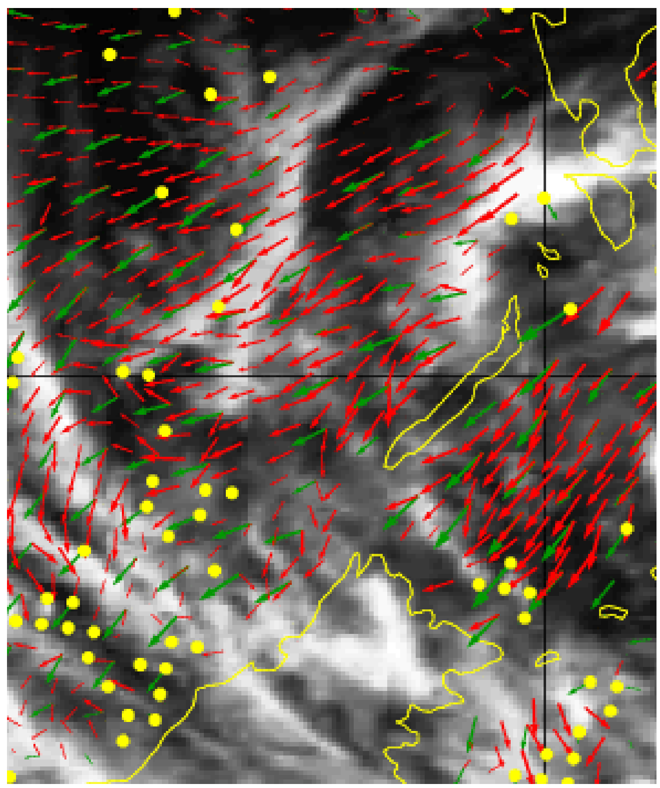

Figure 2. QuikScat 25-km (red) wind product generated at KNMI on top of the background ECMWF winds (green) used in 2D-VAR. GOES IR cloud imagery is provided underneath for reference.

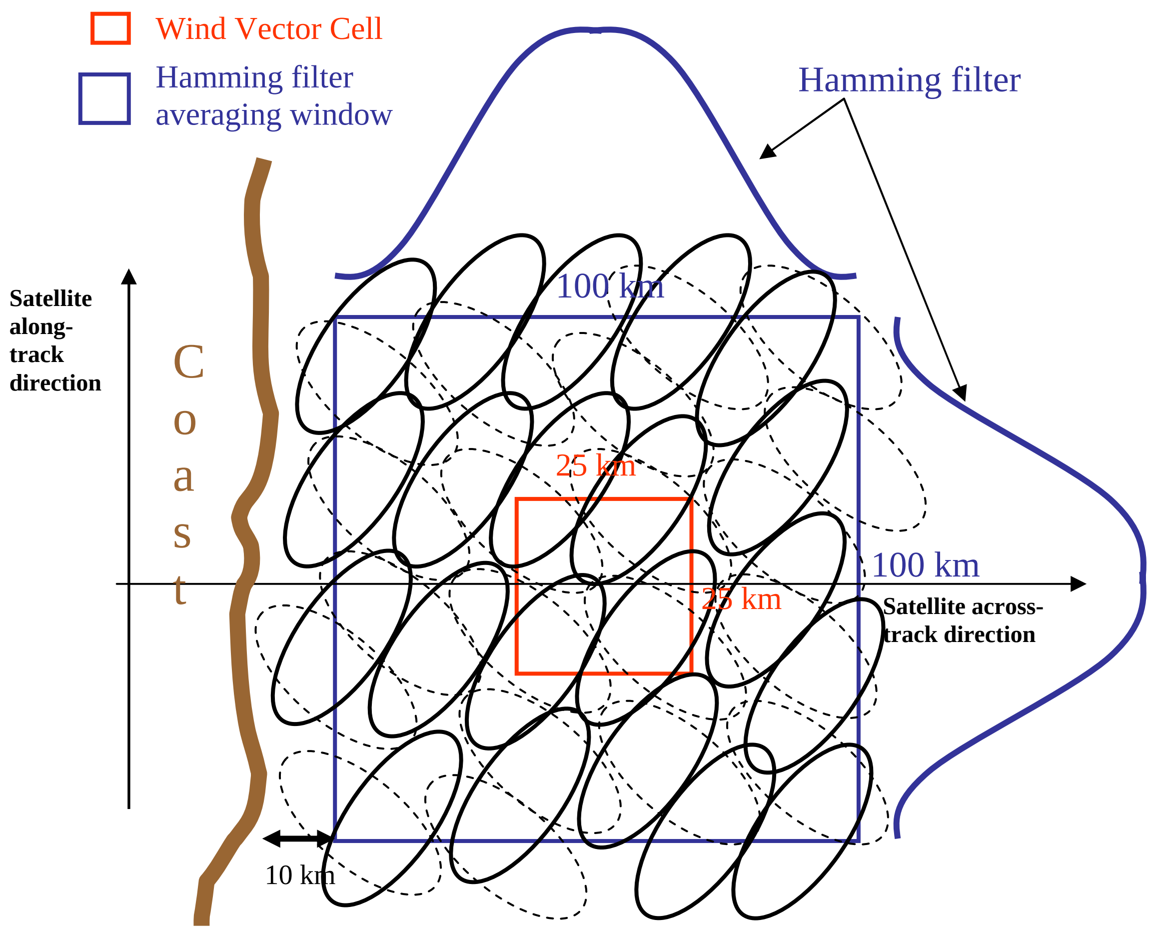

Figure 3. Depiction of the application of a Hamming filter in the ASCAT backscatter processing.

that the SeaWinds 25 km product, while supposedly at higher resolution and containing more mesoscale wind detail, also must contain more wind error than ASCAT in order to provide worse buoy verification. Finally we note that the ECMWF model verification with the buoys is very similar to the SeaWinds 100-km product, as may be expected from the above-presented analysis (not shown here). Scatterometer data thus indeed capture mesoscale detail not resolved by NWP model analyses and forecast fields, but that verifies with buoy measurements.

4. COASTAL SCATTEROMETER PRODUCTS

Another new development for the ASCAT scatterometer will be in the development of a coastal product. Figure 3 depicts the spatial ASCAT processing. The projected scatterometer fan beams of approximate 20 km width are along the long axis cut into pieces of approximate 10 km length. The remaining footprints thus have typical dimensions of 10 by 20 km with a main orientation across the beam, as represented by the elliptical shapes in figure 3. Currently, these backscatter measurements are collected over a hamming window extending over 100 km (50 km spatial resolution). It may be clear that near the coast land contamination will be probable due to the extent of the hamming filter, since land or coastal returns are generally high relative to the ocean returns. In the context of the NWP SAF visiting scientist scheme, KNMI built a prototype ASCAT wind processor based on a box-average spatial averaging scheme. In a box average much closer distances to the coast may be achieved than with the Hamming window. The next step will be in the tuning and verification of the coastal processor with NWP and buoy data.

5. OUTLOOK

Scatterometers provide accurate and spatially consistent near-surface wind information [10]. Hardware permitting, there will be a continuous series of scatterometers with at times ideal coverage of the ocean surface wind for the first two decades of this century. EUMETSAT provides user services in collaboration with KNMI, where these are now being set up and freely available at www.knmi.nl/scatterometer for the ASCAT, QuikScat and ERS-2 scatterometers. Near-real time FTP products or software can be obtained after registration. Moreover, a visiting scientist scheme is funded in order to support the development programme and the use of the KNMI services. The authors will provide more information on request.

The OSI SAF ASCAT product proves to be of unprecedented quality as compared to other scatterometer products. ASCAT winds for the northern hemisphere ascending tracks are being made available within 30 minutes through the EARS programme. KNMI developed a spatial filtering method that fully exploits the information obtained by scatterometer wind retrieval, called MSS [8], and which is meteorologically balanced through the application of a 2DVAR scheme. Given the beneficial working of MSS, an increase in the resolution of the QuikScat wind products is verified against buoy observations.

Improvements in geophysical modeling are being pursued and a change of the SAF product definition to 10-m equivalent neutral winds is being made [6]. Moreover, KNMI participates in the NOAA hurricane hunter air campaign to provide ASCAT underflights with the IWRAP instrument. Prototypes on higher resolution ASCAT winds (12.5 km) and for winds nearer to the coast exist. Moreover, the SAFs provide a wind product independent of the SeaWinds input, such that user applications may be transparent to the forthcoming updated NOAA stream.

KNMI is involved in the GMES MCS MyOcean consortium with the ambition to provide, together with IFREMER, gridded mesoscale wind forcing with an hourly frequency. The ISRO SCAT at 12 LST nicely complements SeaWinds at 6 LST and ASCAT at 9:30 LST, and will be a very useful complement for providing temporally-resolved eddy-scale ocean winds. Global NRT backscatter (L2A) products would be greatly appreciated from ISRO to aid in a timely exploitation of the instrument and its data.

6 ACKNOWLEDGEMENTS

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