Winds at sea from satellite radar measurements

Ad Stoffelen, Jeroen Beyens, Jos de Kloe and John de Vries

Introduction
Winds at sea are important for many routing and off-shore activities, moreover, they are essential to drive ocean wave and circulation models. KNMI investigates satellite scatterometer measurements, and is processing the corresponding winds in near real-time. A scatterometer measures radar backscatter from the sea surface from which wind information is inferred.\(^1\)

Objectives
The European Meteorological Satellite Organisation (EUMETSAT) is planning for the launch of the ASCAT wind scatterometer on the Meteorological Operational series of satellite platforms (MetOp).\(^2\) This will most likely prolong by 15 years the continuous series of scatterometer wind missions since 1991, when the first European scatterometer was put into orbit. To prepare for MetOp, EUMETSAT in collaboration with national meteorological services set up so-called Satellite Application Facilities (SAF).\(^3\) Given our experience and background in scatterometer wind processing, KNMI is responsible for:

- The software for wind scatterometer data assimilation in weather forecast models (Numerical Weather Prediction SAF);
- The production, distribution, and archiving of the ASCAT wind product in the EUMETSAT ground segment (Ocean and Sea Ice SAF); and
- The generation of scatterometer climate products (Climate SAF);

This indicates that the KNMI scatterometer group activities span from research to operations. The current focus is on the NASA SeaWinds scatterometer to span the time gap between the successive European scatterometers.

Results
The KNMI scatterometer research has been diverse in the past few years:

- KNMI was the first to propose an effective SeaWinds rain elimination procedure in 2000, shortly after launch;
- A new and generic wind retrieval module was developed and applied in a simulation study on a rotating fan beam scatterometer, but at the same time in the SeaWinds wind processing software at KNMI;
- The method for assimilation of scatterometer winds in weather forecast models was made more generic and made applicable for SeaWinds. Its impact was successfully tested in a two-dimensional variational analysis procedure that is used for wind direction ambiguity removal;
- In an European collaboration, a set of wind direction ambiguity removal algorithms was compared, which lead to some new insights and improvements in ambiguity removal;
- A real-time monitoring flag and report were developed for boosting the user confidence in product reliability.

\(^{1}\) Figure 1. KNMI SeaWinds product overview as available on the web.\(^{4}\)
Besides the progress in SeaWinds interpretation over open water, the KNMI scatterometer group developed an improved C-band sea ice model. This will aid in the discrimination of open water and ice areas in the scatterometer wind (re-)processing, but also in improved ice characterisation in a wider context.

In 2001 KNMI started the production of a near real-time SeaWinds 100-km product, based on some of the above developments. A global overview of the products is displayed on the KNMI web site, from where, by clicking on an area of interest, a full resolution SeaWinds map can be obtained, including satellite imagery for reference. Several national weather services use the product to their benefit, e.g. see.

Outlook
Apart from the wind products, also the SeaWinds processing software is made available to the meteorological community at large, and several national weather services assimilate SeaWinds data based on the KNMI methodology.

Our aim is to increase the resolution of the wind processing without compromising the required wind quality, and to make scatterometer wind retrieval more generic.

3) EUMETSAT SAFs, www.eumetsat.de, “programmes under development”, “SAFs”
4) KNMI scatterometer web site, www.knmi.nl/scatterometer
6) NWP SAF scatterometer plans, www.metoffice.com/research/interproj/nwpsaf/scatterometer/