Ocean and Sea Ice SAF

Technical Note

SAF/OSI/CDOP/KNMI/TEC/RP/147

Validation of ASCAT 12.5-km winds

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Version 1.0	Jan 2009		First version.
Version 1.1	Jan 2009	Minor	DRI comments included
Version 1.2	Feb 2009	Minor	Some editorial changes
Version 1.3	May 2013	Minor	Added comment on Bayesian ice screening method.

Contents

1 Introduction

The Ocean and Sea Ice Satellite Application Facility (OSI SAF) delivers an operational level 2 wind product in near-real time, based on the ASCAT level 1 product with 25-km Wind Vector Cell (WVC) spacing from EUMETSAT. However, since backscatter measurements (σ_0) of up to 70 km away from each WVC centre are used in the spatial averaging, the spatial resolution of the product is only approximately 50 km [1].

EUMETSAT also produces a level 1 product with 12.5-km WVC spacing that has a resolution of approximately 25 km. Since the backscatter values of the 12.5-km product are averaged over fewer full resolution σ_0 measurements, it can be expected that it contains more noise. On the other hand, the higher resolution is profitable since small-scale meteorological phenomena can be resolved that are not visible in the 25-km product.

The 25-km wind product has been subject to much validation work already in the OSI SAF project. In [2], the calibration and validation of ASCAT σ_0 and wind data using an ocean calibration method is described. This report is an extension to the existing work and it describes the validation of the 12.5-km wind product. The 12.5-km and 25-km products are compared with in situ wind data from moored buoys and also a comparison of the two products is made. It appears that the 12.5-km product compares even slightly better to the buoy winds than the 25-km product does. The 25-km and 12.5-km winds compare very well with each other.

In 2012, a Bayesian sea ice screening algorithm was introduced in the operational ASCAT wind processing. This algorithm replaces the ice screening based on the Sea Surface Temperature (SST) field from the ECMWF global NWP model. It was extensively tested that the new algorithm is better capable to distinguish between open water and sea ice, especially during melting and freezing. The ice screening algorithm is extensively described in [9]. The ice screening method does not change the results in this report, since it only influences the regions where winds will be available or not, near the ice edges; it does not influence the wind retrieval itself.

1.1 References

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1.2 Abbreviations and acronyms

ASCAT	Advanced SCATterometer
AWDP	ASCAT Wind Data Processor
BUFR	Binary Universal Form for the Representation of meteorological data
ECMWF	European Centre for Medium-Range Weather Forecasts
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
ERS	European Remote Sensing satellite
GTS	Global Telecommunication System
KNMI	Royal Netherlands Meteorological Institute
MSS	Multiple Solution Scheme
NWP	Numerical Weather Prediction
OSI	Ocean and Sea Ice
SAF	Satellite Application Facility
WVC	Wind Vector Cell

1.3 Acknowledgement

We are grateful to Jean Bidlot of ECMWF for helping us with the buoy data retrieval and quality control.

2 Buoy validation method

In this report, scatterometer wind data are compared with in situ buoy wind measurements. The buoy winds are distributed through the Global Telecommunication System (GTS) and have been retrieved from the ECMWF MARS archive. The data are used of approximately 150 moored buoys spread over the oceans (most of them in the tropical oceans and near Europe and North America). See Figure 1 for the locations of the buoys considered in the comparisons (before any screening). A scatterometer wind and a buoy wind measurement are considered to be collocated if the distance between the WVC centre and the buoy location is less than the WVC spacing divided by √2 and if the acquisition time difference is less than 30 minutes.

The buoy winds are measured hourly by averaging the wind speed and direction over 10 minutes. The real winds at a given anemometer height have been converted to 10-m neutral winds using the LKB model [4,5] in order to enable a good comparison with the 10-m scatterometer winds.

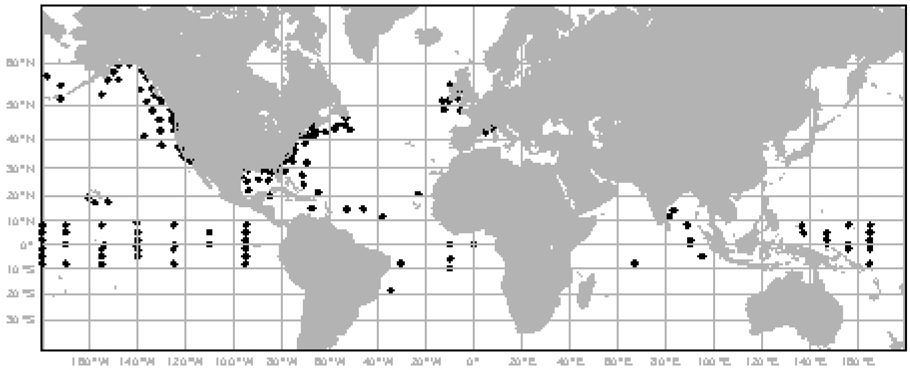

Figure 1: Locations of the moored buoys used in the intercomparisons.

Monthly buoy validations are already available on the product viewer web pages of the OSI SAF ASCAT 25-km and SeaWinds 25-km and 100-km wind products (see the links on http://www.knmi.nl/scatterometer/osisaf/).

3 Results

The plots in this section show contoured histograms of the buoy winds versus the scatterometer winds (speed, direction, *u* and *v* components). The wind directions are compared only for buoy wind speeds of 4 m/s and higher. The contour colours and lines are in logarithmic scale: each colour change corresponds to a factor of 2, each contour line to a factor of 4. The histogram bin sizes are 1 m/s for wind speed and 10° for wind direction.

Figure 2 and Figure 3 show the results for the 25-km operational wind product and the 12.5-km wind product, respectively. The results of both wind products are over the same period of October 2008. Moreover, the two data sets have been compared and only those WVCs have been used for which a collocation is present in both the 25-km and 12.5-km results. Hence the two figures show results for the same set of buoy measurements.

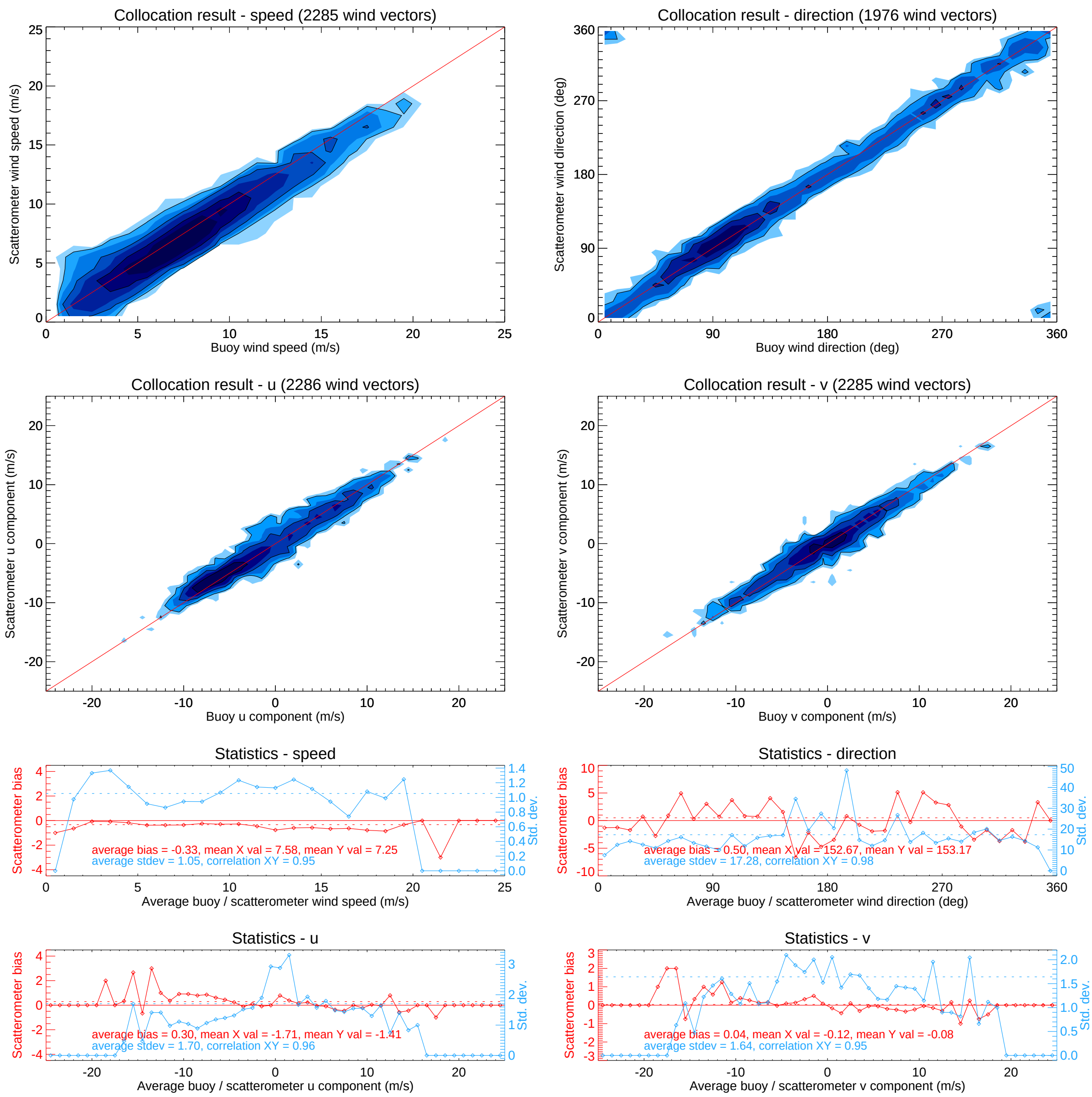

Figure 2: Two-dimensional histograms of wind speed, direction (w.r.t. wind coming from the North), *u* and *v* components of ASCAT 25-km winds from October 2008 (top). The biases (red) and standard deviations (blue) as a function of the average buoy and scatterometer results are shown in the bottom.

In the bias plots at the bottom of the figures we use the average buoy/scatterometer wind speed or direction along the X-axes, since we assume that differences may be due to either of both products and the average is the best representation of the true wind at the scatterometer measurement (WVC) scale. Note that using a mixed X-axis in the bias plots is similar to computing the mean deviation perpendicular to the diagonal in the top histograms, whereas using the scatterometer wind along the Y-axis in the bias plots would be similar to computing the mean in horizontal rows in these histograms. In the event of spread, the row (Y) and column (X) means in a histogram never overlap and so an appropriate mixed reference needs to be chosen for a proper regression to obtain the bias. Stoffelen (Chapter IV in [6]) discusses these effects of error attribution in more detail.

Note that the 12.5-km ASCAT winds are neutral winds, whereas the 25-km winds are real winds. Although since 20 November 2008 the 25-km ASCAT product also contains neutral winds, in October this was not the case. The only difference between neutral and real ASCAT winds is a bias of +0.2 m/s for the neutral winds as compared to the real winds [7].

The wind speed bias of the 25-km product is -0.33 m/s (see Figure 2) and this would mean that for neutral winds the bias is -0.13 m/s, very close to the value of -0.19 m/s that we get for the 12.5-km product (see Figure 3). The speed biases are quite constant over the entire speed range with a tendency of underestimation at wind speeds above 12 m/s.

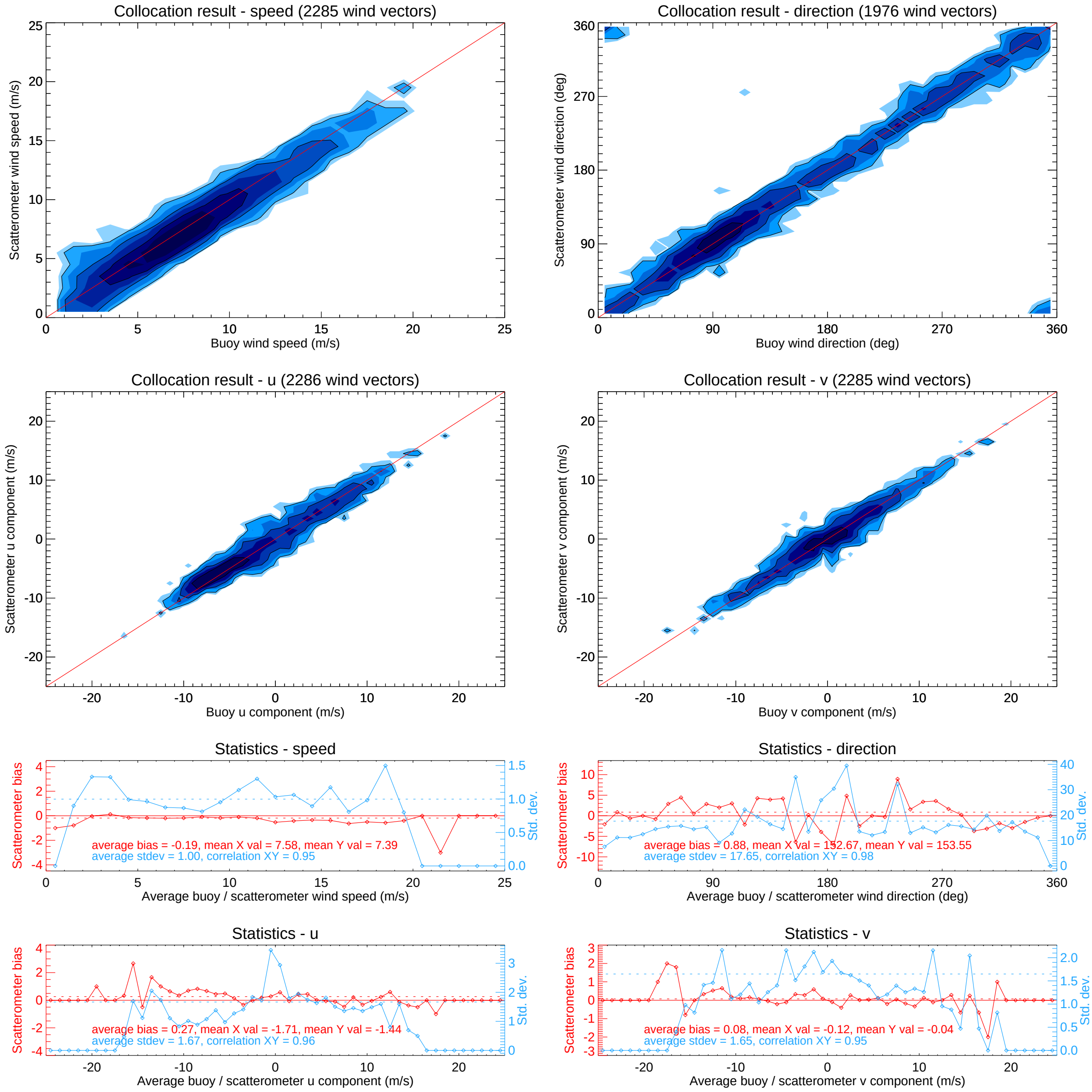

Figure 3: Same as Figure 2, but now for the ASCAT 12.5-km winds.

When we look at the *u* and *v* wind component standard deviations, it is clear that the 12.5-km product performs equally well or slightly better than the 25-km product: 1.67 versus 1.70 m/s for *u* and 1.65 versus 1.64 m/s for *v*, respectively. The 12.5-km product apparently contains more small-scale phenomena that are also present in the buoy measurements. This is confirmed when we look at some examples of the wind fields at 12.5-km and 25-km, see Figure 5. There are some clear phenomena in the 12.5-km wind field, indicated with green, that nicely follow the cloud patterns in the background infrared image but that are hardly resolved in the 25-km product.

The wind direction standard deviation appears slightly worse at 12.5-km, which merits further detailed investigation on the longer term. We anticipate that processing with the Multiple Solution Scheme (MSS) will be needed for more accurate wind direction determination, and this will be elaborated according to OSI SAF plans. Associated with this, ambiguity removal becomes more challenging for the 12.5 km processing [8].

Finally, in Figure 4 the 12.5-km and 25-km products are compared with each other. Except for the bias in wind speed that is connected to the difference between neutral and real winds, the products are to a large extent equivalent.

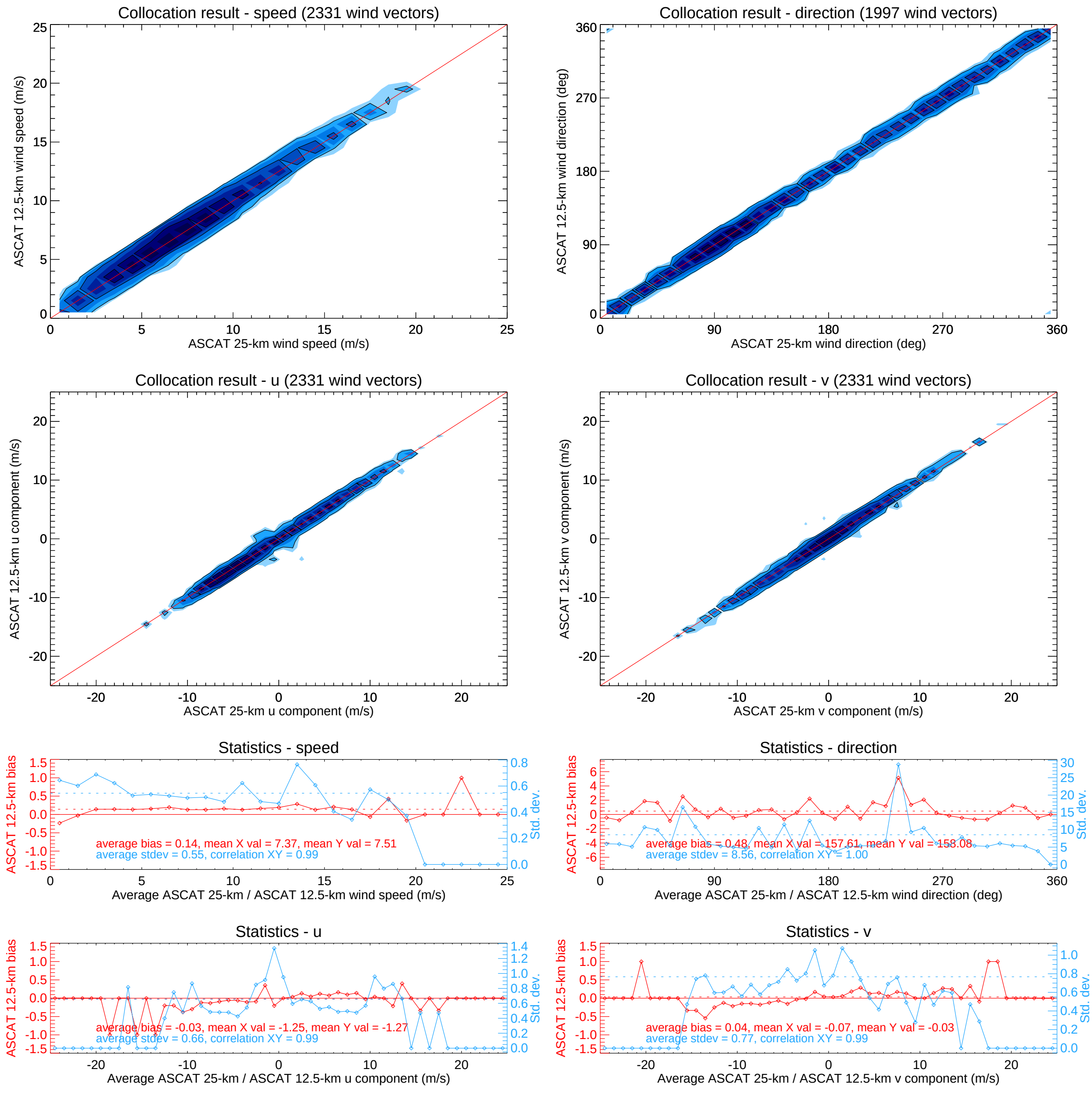

Figure 4: Same as Figure 2, but now the ASCAT 12.5-km winds are compared with the ASCAT 25-km winds.

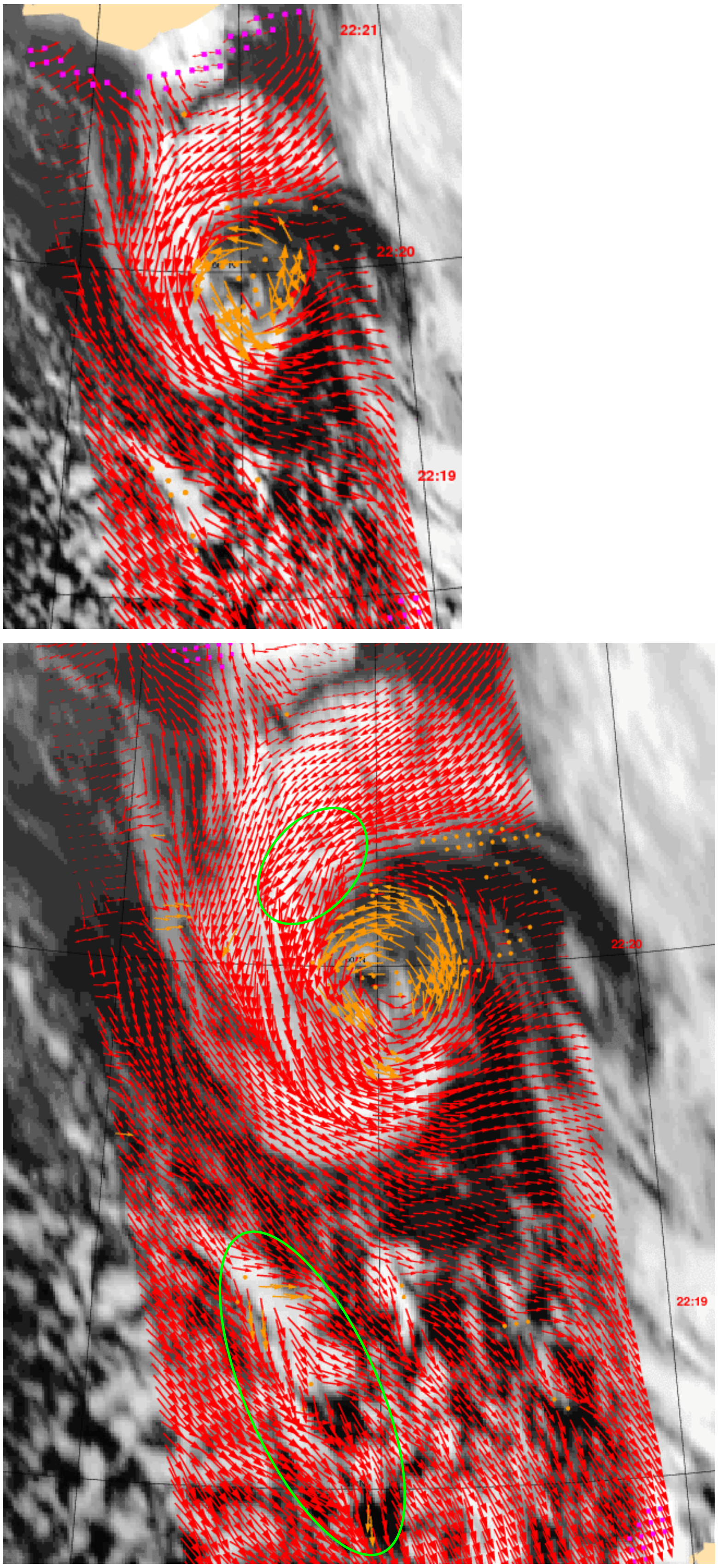

Figure 5: ASCAT 25-km (top) and 12.5-km (bottom) wind products of 13 December 2008 around 22:20 UTC over the Atlantic Ocean (55° to 65° North, ~15° West, South of Iceland). Also shown is an infrared cloud image of the METEOSAT 9 geostationary satellite.

4 Conclusions

The ASCAT 12.5-km winds compare to buoy measurements very well, slightly better than the 25-km winds. The high-resolution product contains small-scale phenomena that are less pronounced in the 25-km wind fields. The wind quality indicators (wind speed bias, wind component standard deviations) are well within the requested OSI SAF accuracies. We therefore recommend to make the 12.5-km winds available to the OSI SAF users.

Although the first results are very encouraging, further improvements in the 12.5-km product are expected. The wind direction retrieval in particular can be much improved in noisy conditions, as has been shown for SeaWinds [8]. According to the OSI SAF plan for the Continued Development and Operational Phase, these aspects are being further elaborated.