

USE OF QUICKSCAT WIND OBSERVATIONS AND OSI SAF SOFTWARE IN THE ASSIMILATION AND FORCECASTING SYSTEM OF THE DWD

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ABSTRACT

Space-borne scatterometer data provide accurate near surface wind observations (both wind speed and direction) over the global oceans with a high temporal and spatial resolution under most weather conditions. With an intensification of usage of satellite data at the German Weather Service (DWD), especially for global modeling, the implementation of wind observations from the Seawinds scatterometer aboard the QuikSCAT satellite is being worked on. The Seawinds scatterometer consists of two rotating beams operating at KU-band frequency with incidence angles of 46° respectively 56° . Each beam provides a fore and an aft measurement. They cover a swath of 1.800 km in diameter, although only the inner 1400 km is illuminated by both beams. The horizontal resolution is 25 km and in one day, approximately 90% of the earth surface is covered by the instrument. Unfortunately, the Ku-band scatterometer is very sensitive to rain contamination, which makes a careful elimination of poor quality data necessary.

The first setup focuses on using the scatterometer data within the currently operational OI assimilation scheme of the DWD for its global model GME, while also a 3Dvar system is being developed which will allow a better use of the data in the near future. Also usage for an enlarged regional model is being considered.

I. Quality control

The QuikSCAT observations and wind vector retrievals provided by JPL at a resolution of 25 km are thinned to a resolution of 50 km, roughly in match with the operational model resolution of 40 km. Duplicated and incomplete records are filtered out of the observation handling process. As the OI can only handle one wind solution, we currently select the most likely wind vector solution from the up to four ambiguities and insert it as a "Pseudobuoy" into the assimilation scheme. Additionally, the land/sea and ice flag, which is part of the QuikSCAT observation Bufr-file (Leidner, et al., 2000), is set to exclude such data from the data processing.

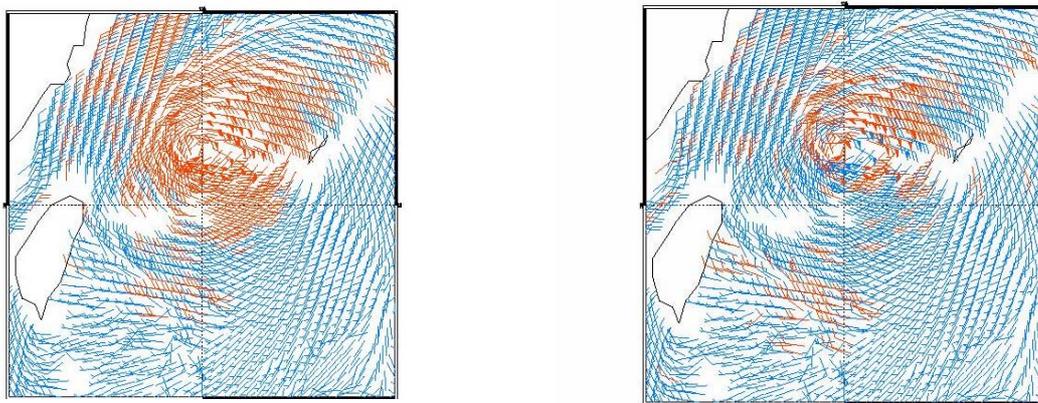


Figure 1. QuikSCAT wind observations (25 x 25 km) for a tropical cyclone (11 Aug. 2004) off the coast of Taiwan. Red barbs are based on the JPL rain-flagging method (left panel) and the KNMI rain-flagging scheme (right panel).

As, unfortunately, the Ku-band scatterometer is very sensitive to rain contamination, a careful elimination of poor quality rain contaminated data is necessary. For this purpose, the performance of the rain-flagging algorithm developed at KNMI in the framework of OSI-SAF has been compared with the JPL rain flag provided with the data. The JPL rain flag is based on a multidimensional histogram (MUDH) method, incorporating various quantities, such as `mp_rain_probability` or `nof_rain_index` that may be used for the detection of rain (Huddleston and Styles, 2000). In contrast to this, the rain-flagging algorithm developed at KNMI (Portabella et al., 2002) is based on the computation of a normalized Maximum Likelihood Estimator (MLE). The MLE indicates how well the backscatter measurements used in the retrieval of a particular wind vector fit the Geophysical Model Function (GMF). A large MLE indicates conditions other than those modeled by the GMF, like rain, confused sea state or ice, and gives therefore a good indication for the quality of the retrieved winds. Data monitoring results suggest, that the KNMI rain flag is mostly able to flag poor quality scatterometer data, whereas the JPL rain flag eliminates too many winds in rainy areas which seem of acceptable quality. This is especially obvious in regions of extreme weather conditions, like e.g. tropical cyclones (Figure 1). However, data monitoring for long time periods indicates, that in the Tropics some bad quality data may still pass the quality control. In the outer 200 km at both sides of the swath, there are no inner-beam measurements. Therefore, due to a lack of sufficient independent observations, the quality of the wind product is poor. Besides, there is no rain flag information available for these cells. Therefore, these outer swaths are excluded from assimilation, leaving a swath width of 1400 km.

For assimilation, a bias correction of wind speeds is applied, since data monitoring shows dependencies of biases both on wind speed and on rain probability. First of all, the wind speeds are reduced by 4%. Additional monitoring results showed that the residual bias between QuikSCAT winds and DWD first guess winds depends on the value of `mp_rain_probability`. The reason for that is, for higher amounts of precipitation, a larger part of the total backscatter is induced by rain, leaving a smaller part for the wind signal. The beneficial impact of rain-flagging, elimination of land/ice contaminated data and bias correction on the data quality is illustrated in Figure 2. Obviously, the correlation between QuikSCAT wind speed and collocated GME first guess wind speeds increases from 0.62 to 0.88 and the Bias and RMS values decreases considerably, by rejecting rain and land/ice contaminated data and using the bias correction described above.

II. First results

The assimilation of QuikSCAT data has a positive impact on the analyses performance of the assimilation system of the DWD. As an example, Figure 3 shows the QuikSCAT observations, first guess and analysis wind fields of a typhoon off the coast of Taiwan. The analysis has improved, surface winds are enhanced and the typhoon is moved towards its observed direction, but a lot of winds around the center of the typhoon are rain-flagged and the OI system is not able to use the winds near the center of the typhoon correctly, so the analysis improvement of the position and strength of the typhoon is not very large. So far, a forecast improvement by using the QuikSCAT observations could not be proved in this case.

Future work will be focused on improving the quality control scheme by including an azimuth diversity check for the observed wind direction of the QuikSCAT scatterometer and on running an impact study for a one month period.

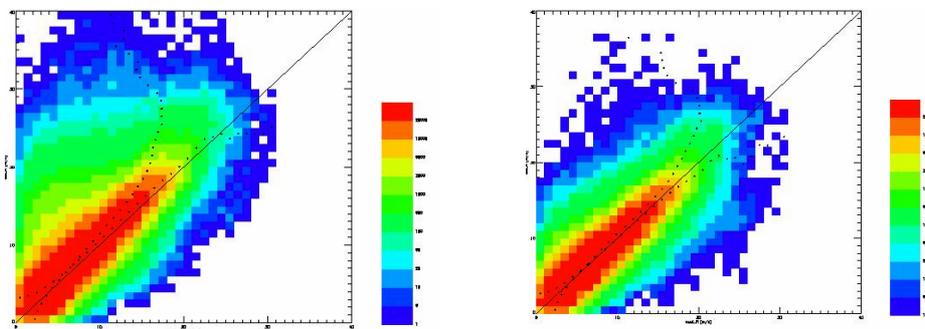


Figure 2. Scatter plot between QuikSCAT wind speeds and collocated GME first guess wind speeds, for all data (left panel), and for data the were not rejected due to rain land/ice contamination and bias corrected (right panel).

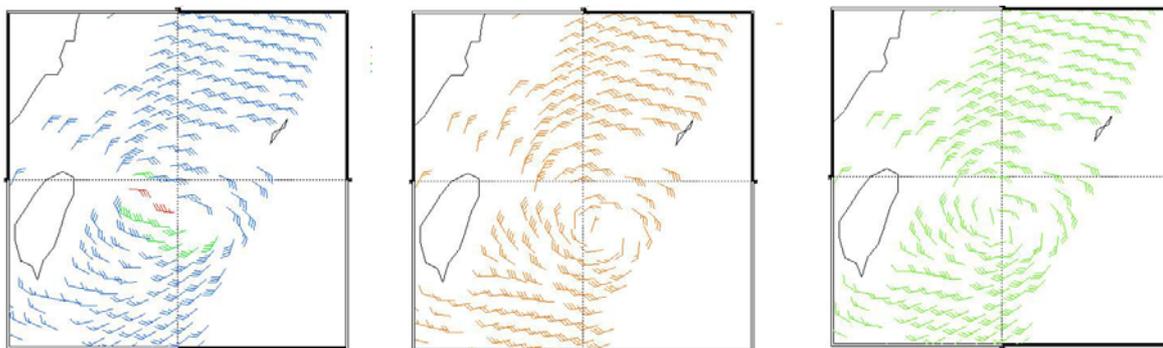


Figure 3. Assimilation of a typhoon off the coast of Taiwan for 20040811 09 UTC. First-guess (middle panel), analysis (right panel) winds and assimilated QuickSCAT wind observations (left panel). Only blue vectors were active. Red vectors are rejected by the analyses scheme due to the first-guess check and green vectors are rejected due to a consistency check (OI) in the assimilation scheme of the model.

III. References

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