Calibration of the ERS scatterometer wind product with NOC and Cone Metrics

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A reprocessing of all European Remote Sensing satellites ERS1 and ERS2 scatterometer data is planned, based on the reprocessed ESA Advanced Scatterometer Processing System (ASPS) fundamental backscatter record. Also, archived near-real time BUFR data will be used as input. Both datasets are complementary in their time coverage, in some cases data from one dataset fills gaps in the other dataset. Hence, for a seamless integration, it is also important to assess any difference between the backscatter data characteristics of ASPS and BUFR data. The global wind data record will span the period of August 1991 to January 2001.

In the reprocessing ECMWF ERA5 re-analysis 10-m-height stress-equivalent background winds will be collocated with these calibrated scatterometer winds, such that ERA5 errors in local trends can be evaluated.

1. Introduction

The NWP Ocean Calibration (NOC) method directly compares the measured backscatter data with simulated backscatter data from Numerical Weather Prediction (NWP) winds using the geophysical model function (GMF) CMOD7. The averaged NOC residuals over a longer period are used to calculate correction factors that are applied to the measured backscatter values used for wind retrieval. This method has shown to improve the wind retrieval. NOC corrections will be used to verify calibration stability and consistency of scatterometers and ERA5.

A second calibration method is Cone Metrics (CM), where the distribution of measured backscatter triplets from, e.g., one month is compared to a reference distribution from a long period, e.g., one year [Belmonte *et al 2017*]. This method does not involve NWP winds nor a GMF model, thus only the scatterometer measurements and their errors are involved. As such, it is a useful instrument for trend monitoring and anomaly detection, and for the intercalibration of different scatterometers. CM calibration will be used for absolute calibration of the ERS scatterometers.

Hence, in the reprocessing both methods will be combined. CM is combined with the NOC from the reference distribution to give Total Ocean Calibration (TOC) corrections.

2. Results

In the following figures results from the reprocessing are shown. Figure A. shows the remaining ocean calibration residuals after applying the TOC corrections. Figure B. compares the wind statistics for ASPS [*Crapolicchio et al 2004*] and BUFR.

Figure C. shows the wind speed bias for ASPS and BUFR data, and Figure D. the standard deviation (SD) of the wind components *u* and *v* over time. Increasing amounts of assimilated data in the ERA5 NWP model make that the difference SD is gradually decreasing over time.

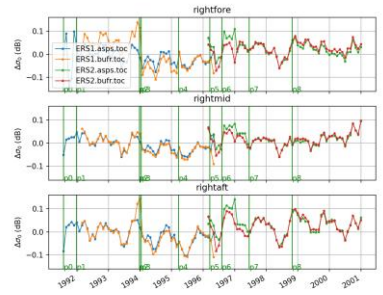

Figure A. *Time series of the TOC residuals for ERS1 and ERS2 from ASPS and BUFR data over their respective life spans for the three antennas. The green vertical lines separate the different instrument calibration periods.*

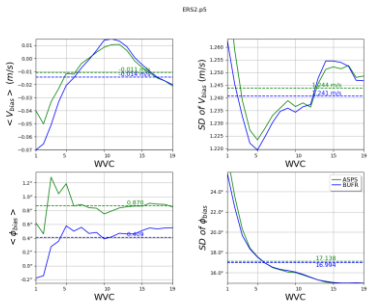

Figure B. *Wind statistics for ERS2 ASPS and BUFR data from period p5. Upper half: Wind speed bias (V_{scat}-V_{nwp}) and Standard Deviation (SD) of wind speed difference; lower half: wind direction bias (Φ_{bias}) and SD of wind direction difference.*

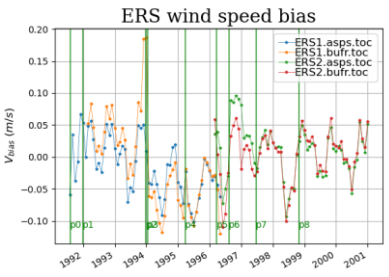

Figure C. *Wind speed bias (V_{scat}-V_{nwp}) for ERS1 and ERS2 from ASPS and BUFR data (TOC calibration).*

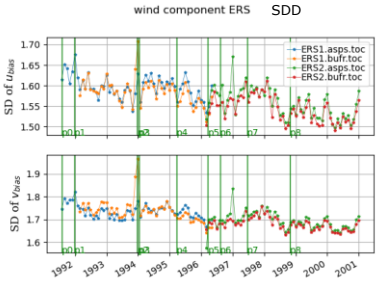

Figure D. *SD of wind vector differences for westerly u and southerly v component for ERS1 and ERS2 from ASPS and BUFR data.*

3. Conclusions

The two datasets for ERS1 and ERS2, namely ASPS and BUFR, have similar quality of the derived wind product after TOC calibration. Thus they can be used both to complement each other in geographical location and in time. Time series show variations in the wind speed bias of ~0.1 m/s.

Also, the datasets reprocessed with NOC and TOC corrections have similar quality. TOC has the advantage that it does not involve dependency on GMF and NWP model and can be used for trend analysis.

References

Crapolicchio et al (2004), The Advanced Scatterometer Processing System for ERS Data: Design.
European Space Agency, (Special Publication) ESA SP. 10.13140/RG.2.1.4852.0567

Belmonte et al (2017), "Cone metrics: an new tool for the inter-calibration of scatterometer records" in JSTARS, vol. 10, no. 5, May 2017, doi:10.1109/JSTARS.2017.2647842