Calibration and Validation of Multi-Satellite scatterometer winds

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Topics

- Estimation of homogeneous long time series of surface wind vector over global ocean
  - Processing, combining, analyzing, and validating data from ERS-1, ERS-2, NSCAT, QuikSCAT, and ASCAT

- Assessment of surface wind comparisons between various scatterometer retrievals at various scales
  - Characterisation of the differences
  - Empirical bias correction
Example of Long Time Series from Multiu-Satellite Observations

(Bentamy et al, 2009)

- Time series of statistical parameters of NDBC buoy and blended wind speed differences: a) bias (m/s); b) Std (m/s); c) regression slope coefficient; d) correlation coefficient; e) sampling length
ASCAT / QuikSCAT

Previous Comparison results (Bentamy et al, 2008):

- **Period**: April – November 2007 / ASCAT: Actual winds

Present Study: April 2007 – November 2009

Focus: November 2008 – November 2009

ASCAT

- Data Source: OSI SAF / KNMI
- Products: L1b & L2b 25
- GMF: CMOD5 and CMOD5n
- Wind retrieval: Selected solution
- Data selection:
  - All WVC
  - Wind Speed: 0 – 50 m/s
  - Wind direction: 0° – 360°
  - Quality flags

QuikSCAT

- Data Source: PODAAC / JPL
- Products: L1b & L2b 25
- GMF: QSCAT-1/F13
- Wind retrieval: Selected solution
- Data selection:
  - All WVC
  - Wind Speed: 0 – 50 m/s
  - Wind direction: 0° – 360°
  - Quality flags
Ancillary Data

- **Buoy**
  - NDBC (hourly / Pacific and Atlantic)
  - MFUK (hourly / Atlantic and Mediterranean)
  - TAO (10mn-Hourly / Pacific)
  - PIRATA (10mn-Hourly / Atlantic)
  - RAMA (10mn-Hourly / Indian)

- **Numerical Model**
  - ECMWF Analyses (6-hourly/0.5°)

- **QuikSCAT l2b products**
  - RSS
  - KNMI
Collocation

Matchup Data
• For Each QSCAT swath all ASCAT WVC occurring within 4 hours and 50km of QSCAT data are selected
• Only the closest, in space and time, collocated data are used
• Only valid retrievals are selected with respect to ASCAT and QuikSCAT Quality flags.
• QuikSCAT rain flagging:
  • Only QSCAT WVC wind data such as both IMUDH algorithm and rain detection are valid, are selected
  • Mp_rain-probability values are selected for further investigations.

Sampling length of Collocated data as function of time separation and latitudes
Error Sources

- **Temporal Separation Impact**
  - Statistics of differences between buoy wind speeds $W_{bq} - W_{ba}$
  - $W_{bq}$ and $W_{ba}$ are buoy data collocated with QSCAT and ASCAT, respectively.

No systematic bias is found

Mean differences are lower than 0.30m/s for 95% of buoys
Error Sources

- Using ECMWF analysis
- 6-hourly Estimates are interpolated in time and space over ASCCAT and QuikSCAT Swaths
- Simulated data are spatially and temporally collocated (ASCAT / QSCAT procedure)

Mean Difference (m/s)

Std Difference (m/s)
Local Assessment for ASCAT/QSCAT Collocated Data

- Comparisons with NDBC buoy hourly measurements
Error Analysis

Scatterometer wind speed errors as determined from triplet collocated data: buoy (NDBC and MFUK), ASCAT, and QuikSCAT during the period: April 2007 – November 2009.

\[ U_b = \alpha_b U + \varepsilon_b; U_a = \alpha_a U + \varepsilon_a; U_q = \alpha_q U + \varepsilon_q \] (e.g. Janssen et al, 2007).

Distribution of time difference between collocated NDBC/ASCAT/QuikSCAT

Monthly NDBC buoy, ASCAT, and QuikSCAT wind speed errors
Global Comparisons

Mean Wind Fields from Collocated ASCAT and QuikSCAT data during November 2008 – November 2009 period.

ASCAT

QuikSCAT

Speed

Zonal

Meridional

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Global Comparisons

➢ Wind Direction Comparison
  – Steadyness coefficient:

\[
St = 100 \cdot \sqrt{\frac{\sum_{i=1}^{N} u_i^2 + \sum_{i=1}^{N} v_i^2}{\sum_{i=1}^{N} w_i}}
\]
Global Comparisons

- **Bias** (left) and **STD** (right) of wind speed (top), **U** (middle), and **V** (bottom) differences between QuikSCAT and ASCAT during November 2008 – November 2009.
Global Comparisons

- Spatial distributions of Correlation coefficients
Analysis of ASCAT and QSCAT Differences

- $\sigma^o = B_0 + B_1 \cos \chi + B_2 \cos 2\chi$
- $B_0$ highly related to wind speed
- $B_0 = (\sigma^o_u + \sigma^o_d + 2\sigma^o_c)/4$
- Difference between ASCAT measured and estimated (Cmod5n) $B_0$
Tropical Buoy Comparisons

(a) ASCAT Wind Speed (m/s) vs. Tropical Buoy Wind Speed (m/s)
(b) ASCAT Wind Direction (deg) vs. Tropical Buoy Wind Direction (deg)
(c) QSCAT Wind Speed (m/s) vs. Tropical Buoy Wind Speed (m/s)
(d) QSCAT Wind Direction (deg) vs. Tropical Buoy Wind Direction (deg)
Analysis of ASCAT and QSCAT Differences

➤ Rain Impact

Wind Speed Differences: November 2008 – November 2009

- All QSCAT - ASCAT
- QSCAT Rain free (Quality flag) - ASCAT
- QSCAT Rain free (Quality flag+mrp threshold) - ASCAT
Analysis of ASCAT and QSCAT Differences

- Analysis is performed over Tropical area and as a function of
  - Wind speed ranges
  - Swath locations
  - …
Analysis of ASCAT and QSCAT Differences

QSCAT – ASCAT as a function of MRP values

Wind Speed Distribution as a function of QSCAT MLE

QuikSCAT-ASCAT Wind Speeds (m/s)

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Analysis of ASCAT and QSCAT Differences

Wind Speed Difference as a function of Wind direction relative to ASCAT mid-beam azimuth (AZIM1)

QSCAT – ASCAT

Buoy– ASCAT

Wind Difference as a function of Wind direction relative to ASCAT mid-beam azimuth (AZIM1)

QSCAT – ASCAT

Buoy– ASCAT

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Summary

- 30 months of space and time collocated wind from ASCAT and QuikSCAT have been investigated over global ocean.
- Winds from both scatterometers agree very well with a global bias of 0.20m/s and rms of 1.10m/s.
- The main bias spatial patterns are found in inter-tropical and at high latitude zones.
- The main parameters founded to be associated with such differences are:
  - Rain impact on Ku band measurements
  - Wind distributions along swath for both scatterometers
  - MLE distribution
  - ASCAT Wind distribution with respect to azimuth direction
- For long time series calculation data selection and empirical bias correction determined from above parameters will be applied.