Cross calibration between QuikSCAT and Oceansat-2

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Overview

- History
- Calibration procedure
  - Histogram matching method
- Calibration results
- Accuracy of calibration

History

- In September 2011, we perform the first calibration between Oceansat-2 and QuikSCAT. It is determined that calibration numbers of 0.3362 dB for H-pol, 0.2205 dB for V-pol should be added to Oceansat-2 data in dB scale.
- Now, the total record of Oceansat-2 data are reprocessed using these calibration numbers. This includes current near-real-time Oceansat-2 data.
- We continue to monitor the stability of OSCAT backscatter because we believe that the cal loop back is not in used. Therefore, OSCAT backscatter is subjected to change/drift due to change in conditions of instruments

In this investigation, we recalculate the calibration numbers because

- Previous calibration are based on small set of data available at that time for both Oceansat-2 and repointed QuikSCAT. We used just about 2 months worth of Oceansat-2 data.
- We use ocean backscatter data to perform calibration and because they are subjected to seasonal variation, we improve the calibration procedure to include ‘histogram matching’ method in order to minimize the seasonal variation
- Inconsistency in applying atmospheric attenuation (error in the code) was found.

In addition, we analyze the accuracy of the calibration

Calibration procedure

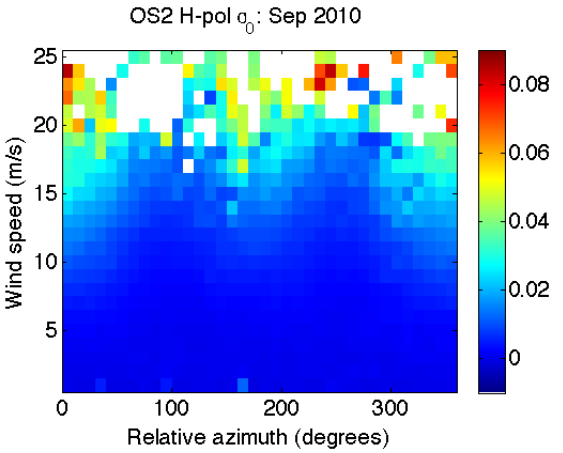
- For both repointed QuikSCAT and OSCAT data
  - Pick only ocean data, abs(latitude) < 50 degree
- For OSCAT data
  - Pick only scan position 100 for H-pol, 101 for V-pol
  - Use high gain slices (slice #4 for Hpol #6 for Vpol)
- Method
  - Bin data versus footprint matched ECMWF speed and relative azimuth
  - Apply histogram matching method to the average backscatter falling into speed-relative azimuth bin
  - Calculate average backscatter as a function of time
  - Determine appropriate calibration numbers

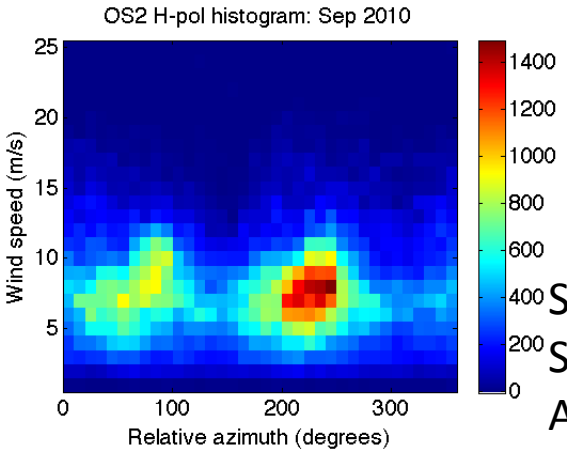
Histogram matching method

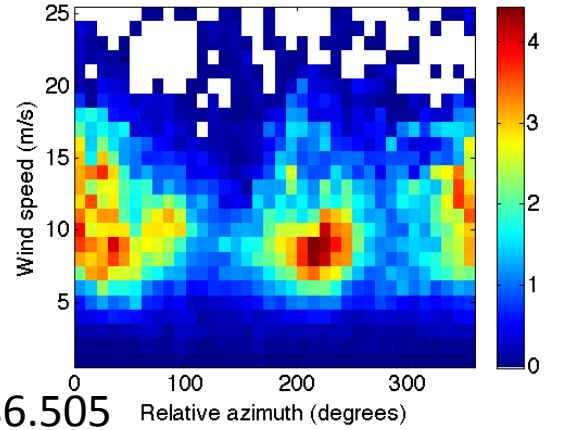
- Use collection of speed/relative azimuth histogram of repointed QuikSCAT as reference histogram
- For both Oceansat-2 and QuikSCAT data, the speed/relative azimuth histogram is calculated for each month along with the corresponding backscatter average in speed/relative azimuth bins.
- The average backscatters binned by speed and relative azimuth are then weighted by the fraction of the total measurements observed in each bin using the reference histogram
- Thus, the monthly average backscatter average for each month is the average backscatter based on similar wind speed/relative azimuth distribution (according to ECMWF).

Monthly backscatter average calculation comparison

average S0 = sum(binned average S0 x Sep 2010 histogram)/sum(Sep 2010 histogram)





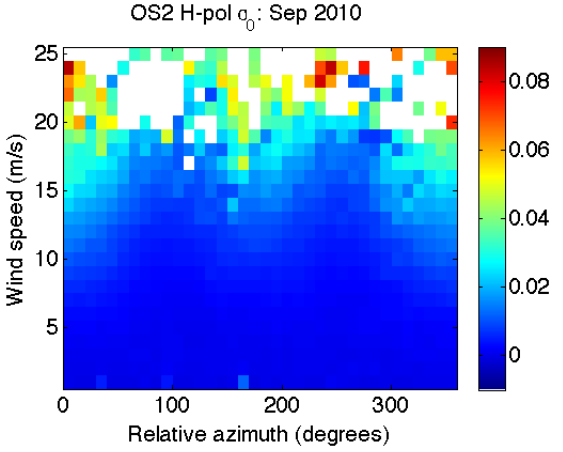


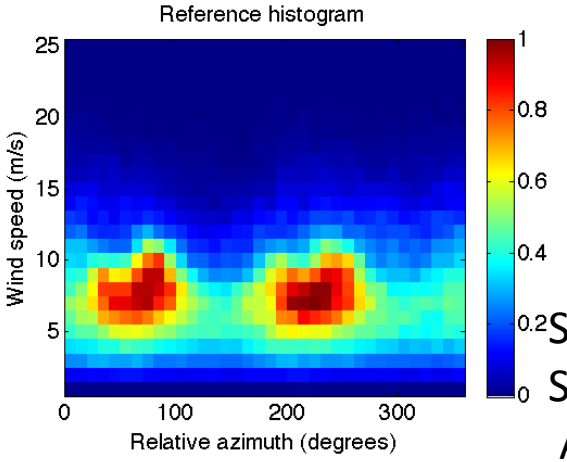
Sum = 786.505

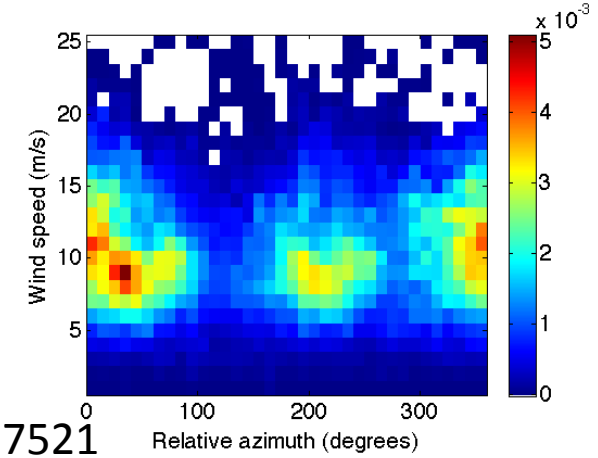
Sum Sep 2010 histogram = 183891

Average S0 = 4.17913e-3 (-23.6886 dB)

Histogram match average S0 = sum(binned average S0 x reference histogram)/sum(reference histogram)





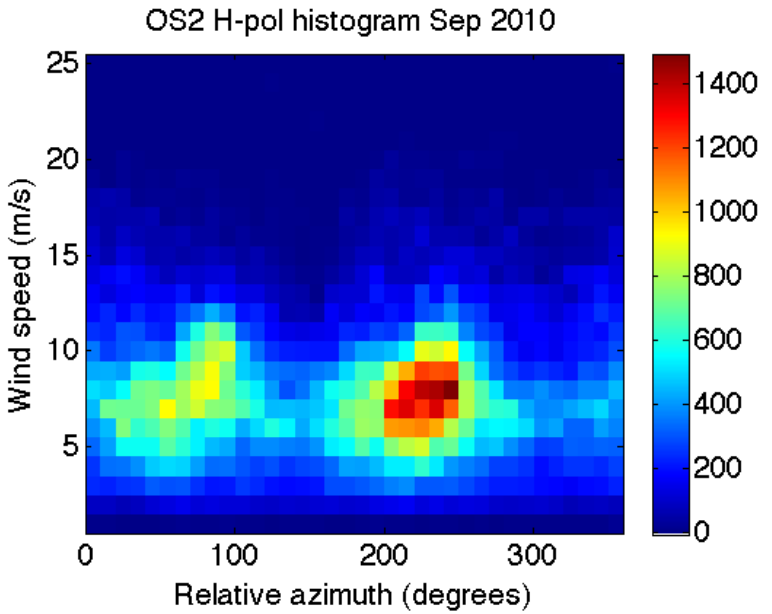


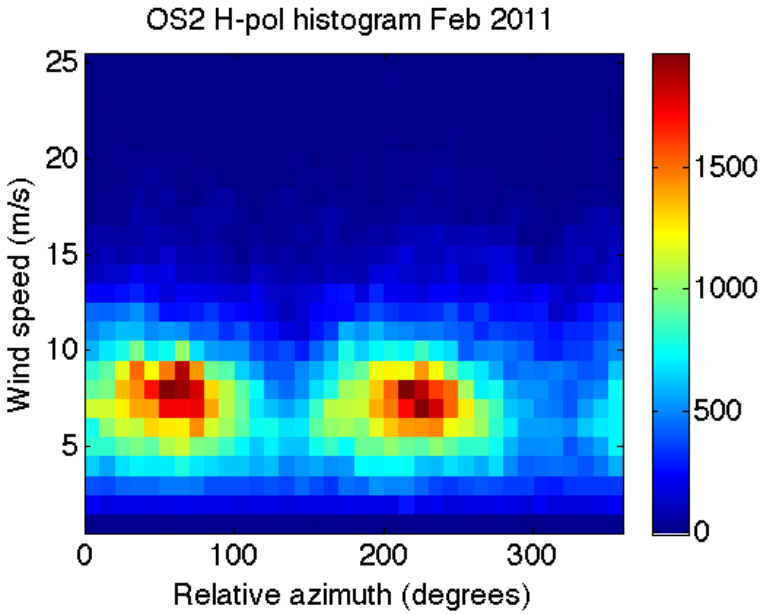
Sum = 0.7521

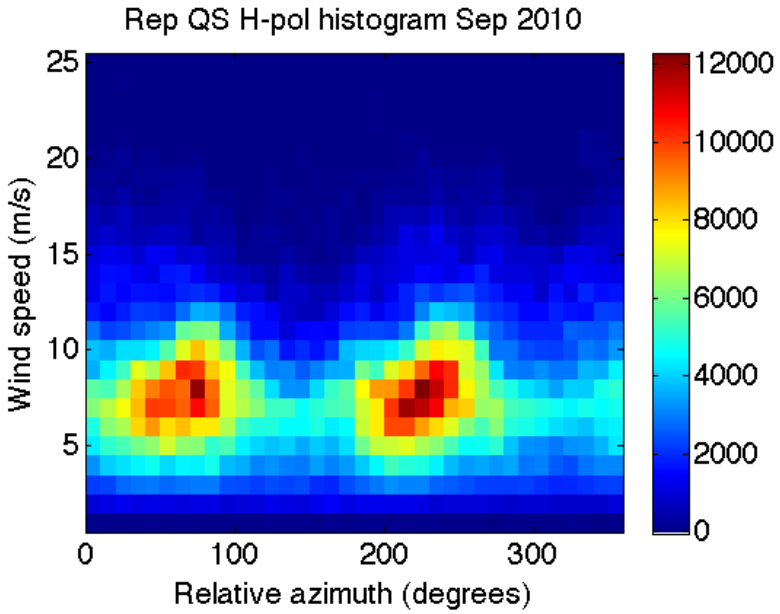
Sum reference histogram = 176.7797

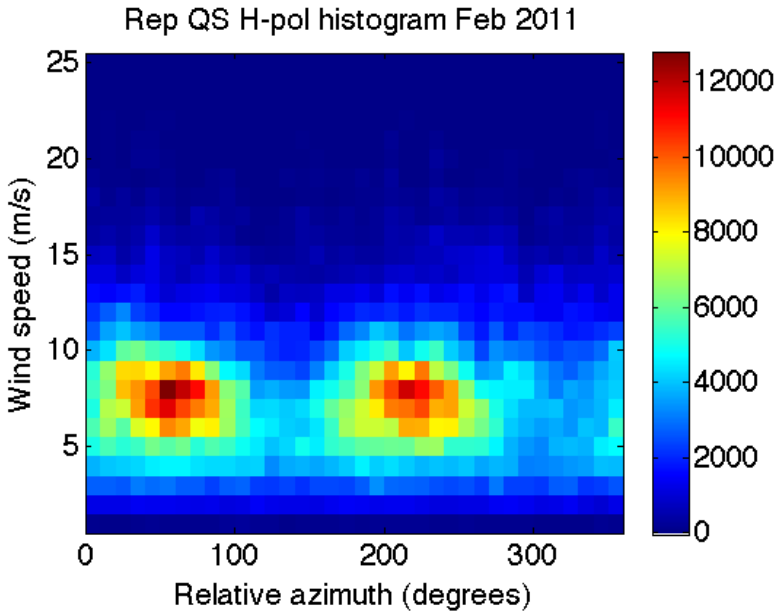
Average S0 = 4.25444e-3 (-23.7113 dB)

Examples of histogram variation

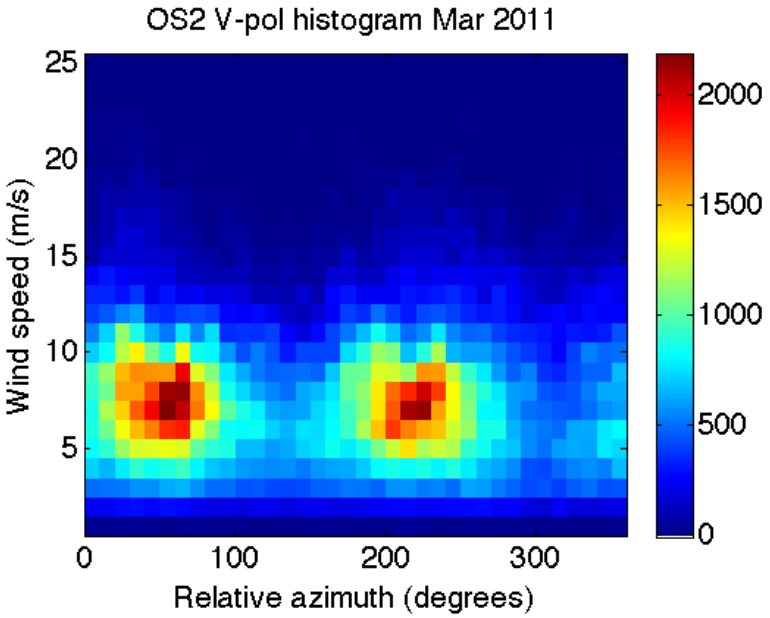


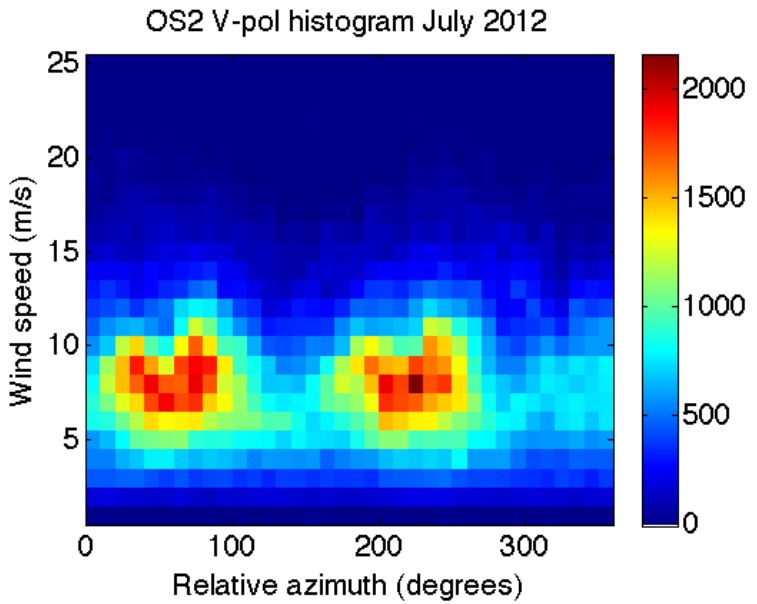


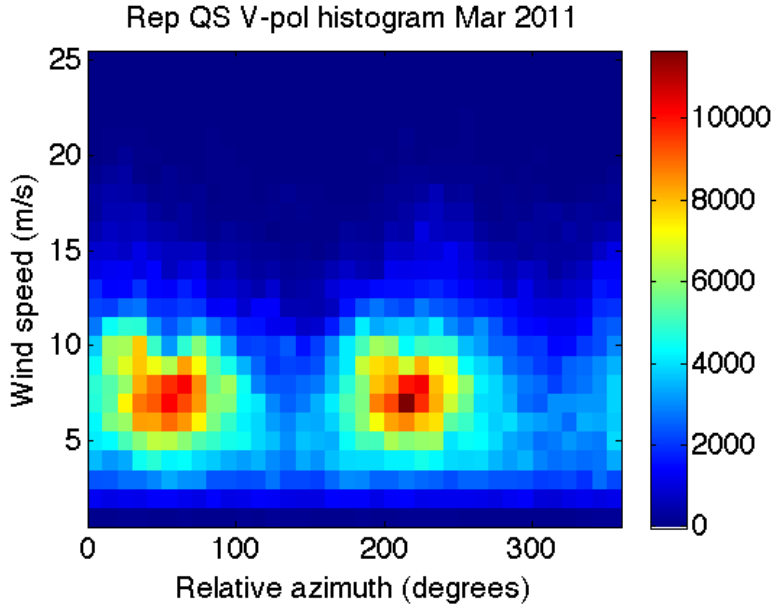


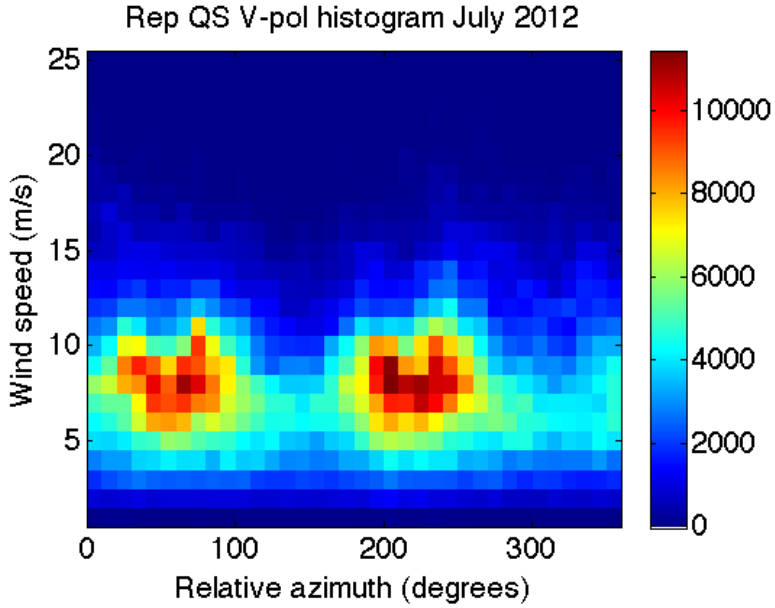


Examples of histogram variation









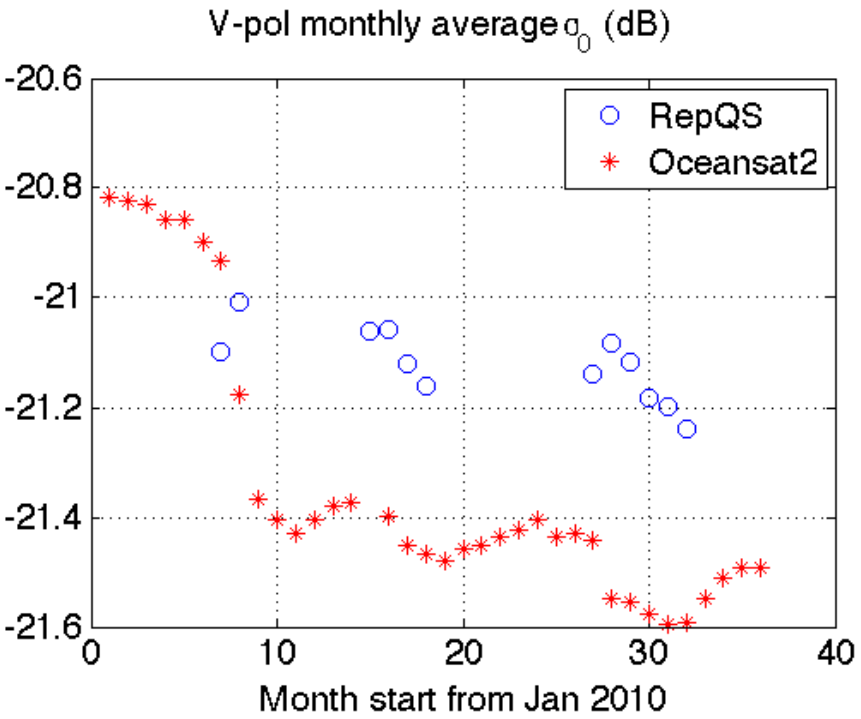
Possible remaining issues of Histogram match method

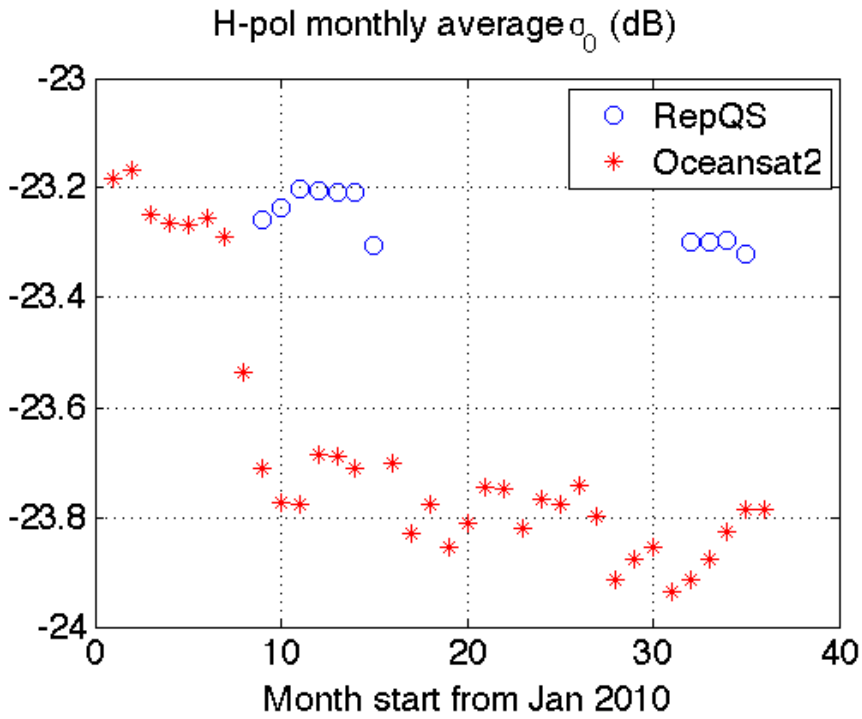
- Rain contamination. Because the effect of rain is not accounted for, if the effect of the rain is more pronounced for one sensor than the other, the backscatter can be biased.
- Bias from ECMWF wind speed and direction. Since we are using data from sensors that was obtained 6 hours apart, we rely on ECMWF 6 hour wind differences being accurate in a globally averaged sense. Local or short term errors in ECMWF will not effect our calibration. Neither will an absolute error or long term geographic biases in wind speed.

Backscatter vs time results

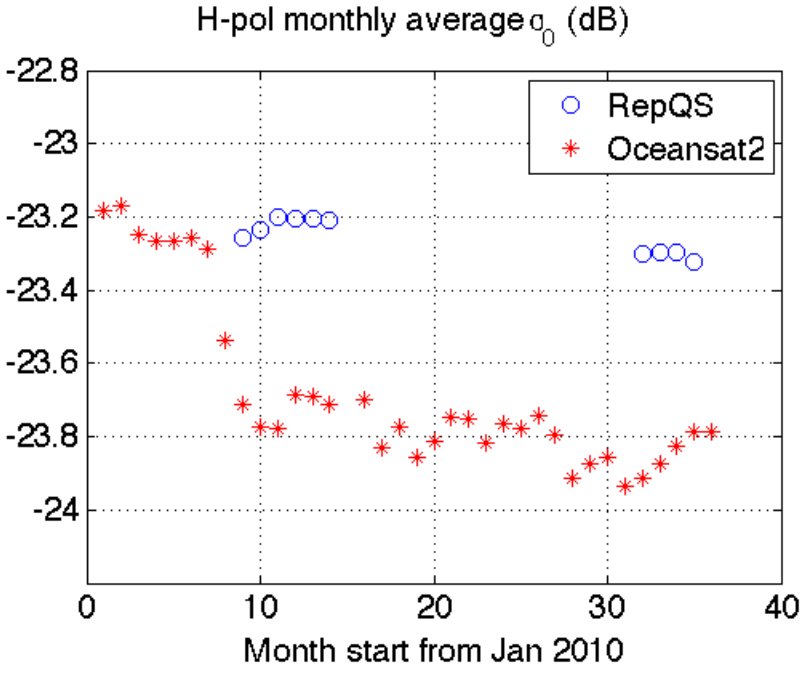
- Drop of ~ 0.5 dB of Oceansat-2
- It is determined to be between rev 04796_04797 and 04798_04799 (August 20, 2010)
- Calibration numbers are calculated for before and after this drop

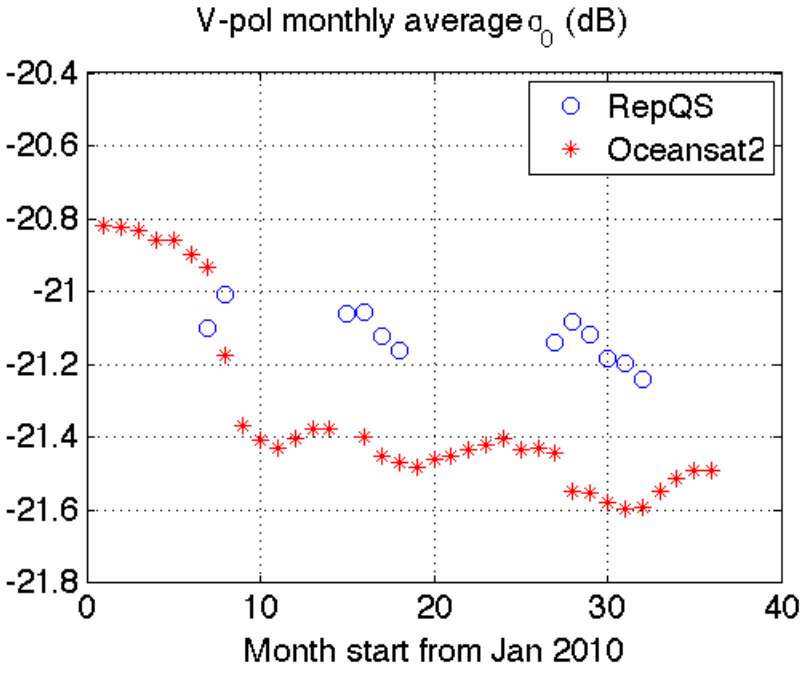
	Before rev 04796_04797	After rev 04798_04799
V-pol	-0.2023 dB	+0.3036 dB
H-pol	+0.0235 dB	+0.5296 dB



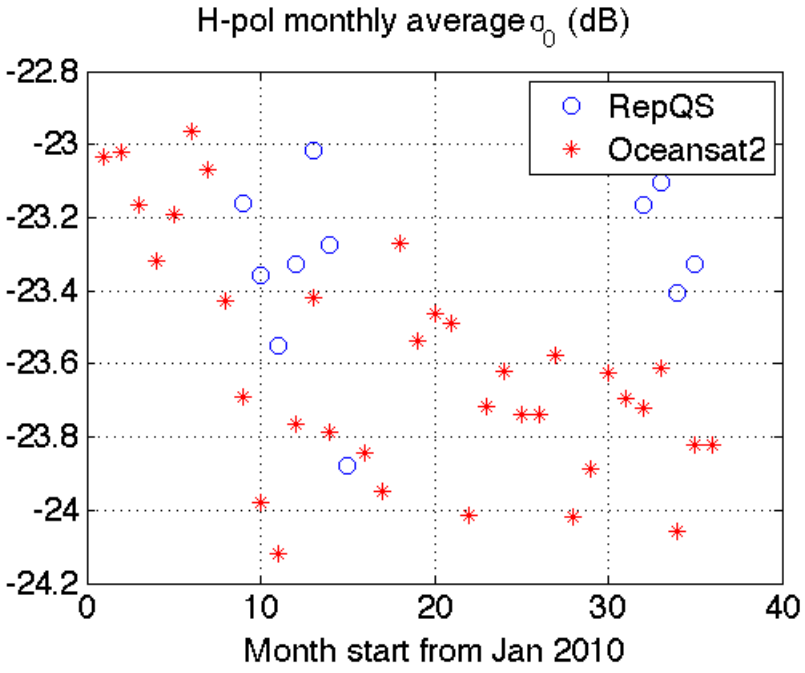


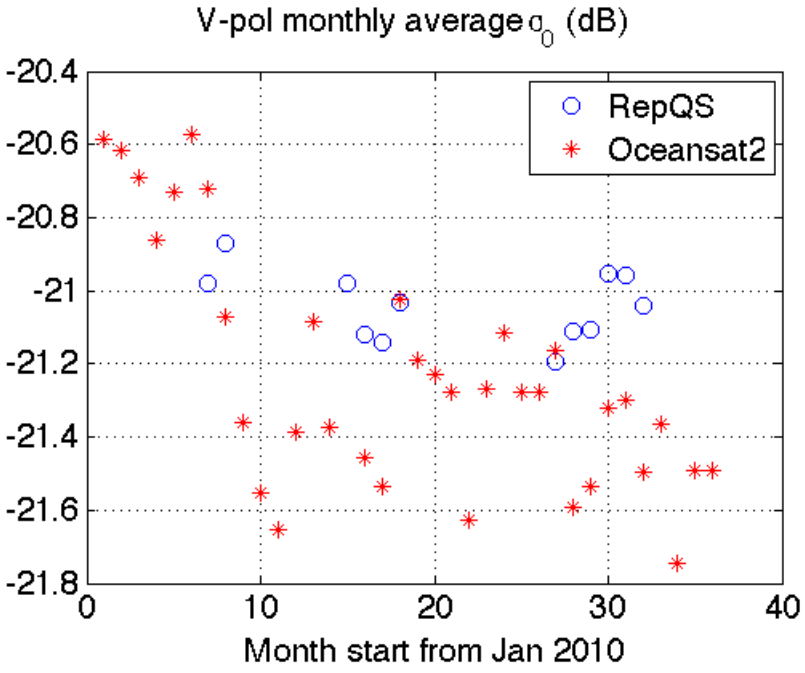
with histogram match





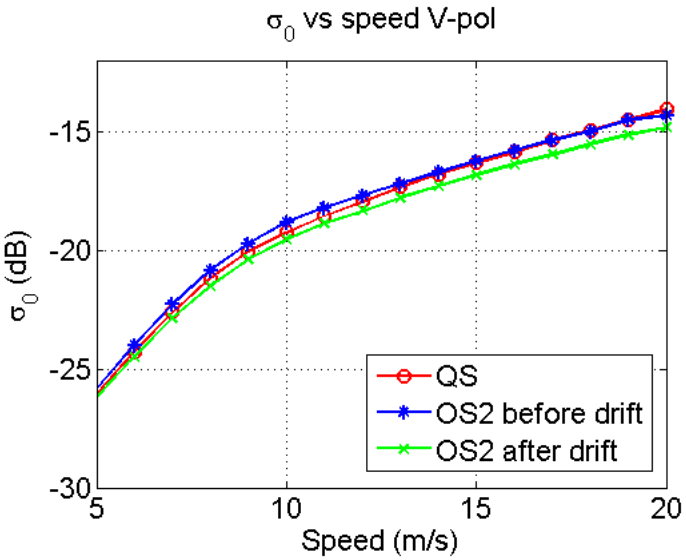
without histogram match

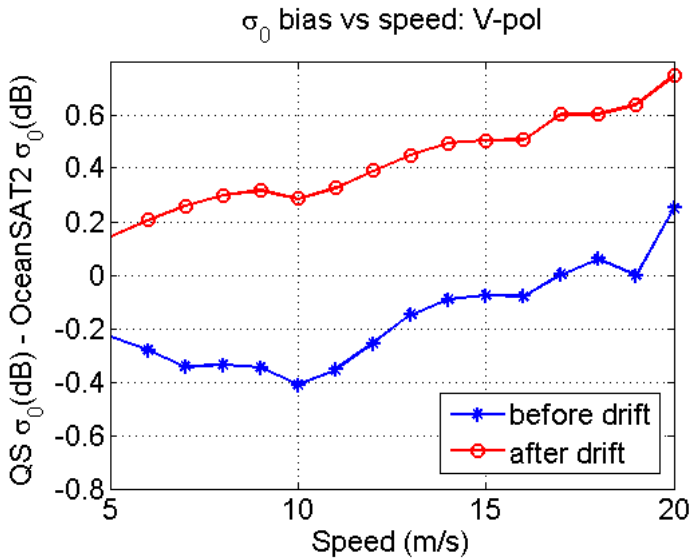


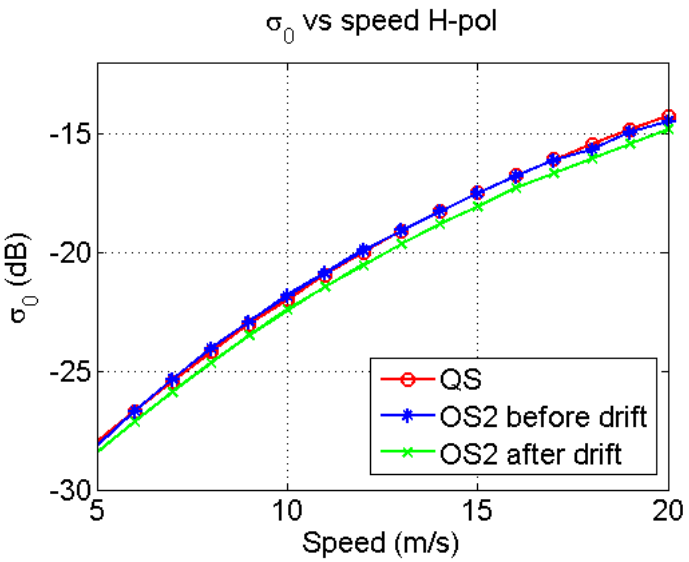


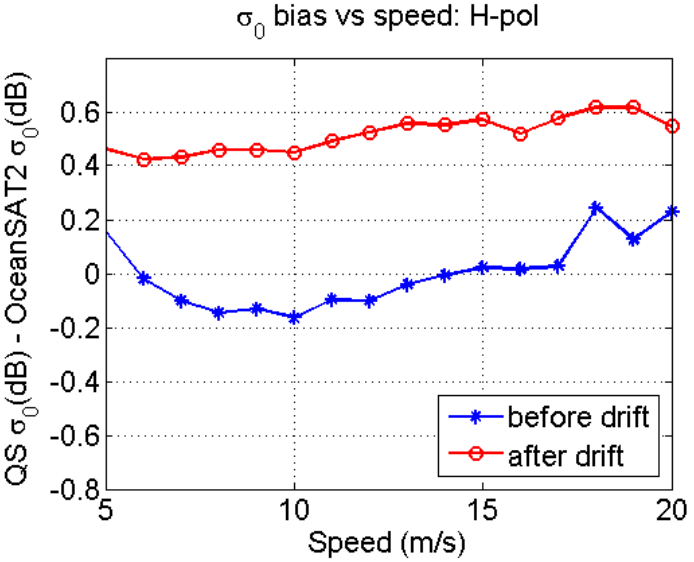
Behaviors of bias versus speed

QuikSCAT(dB) – Oceansat-2(dB)



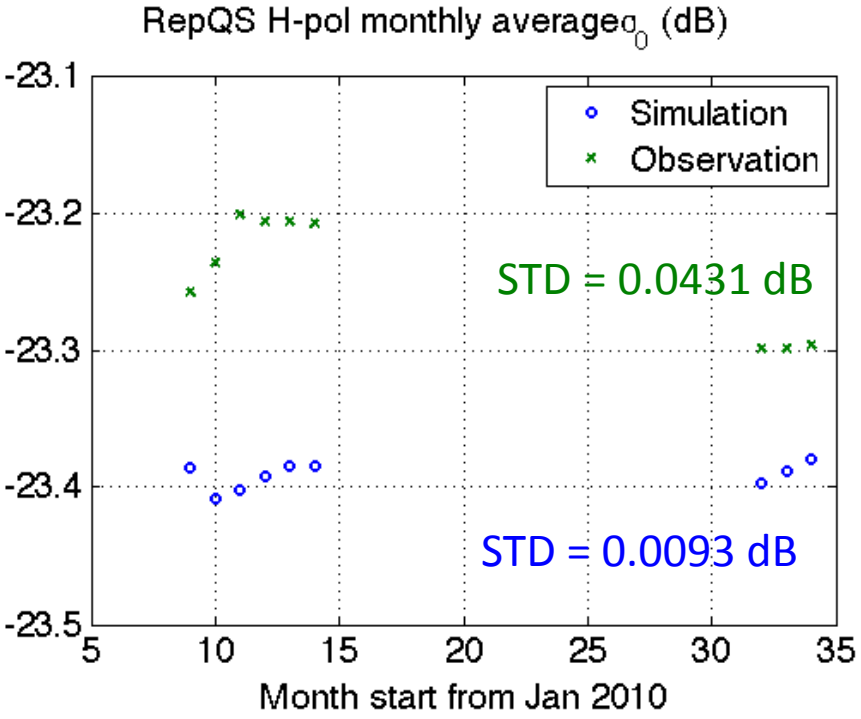


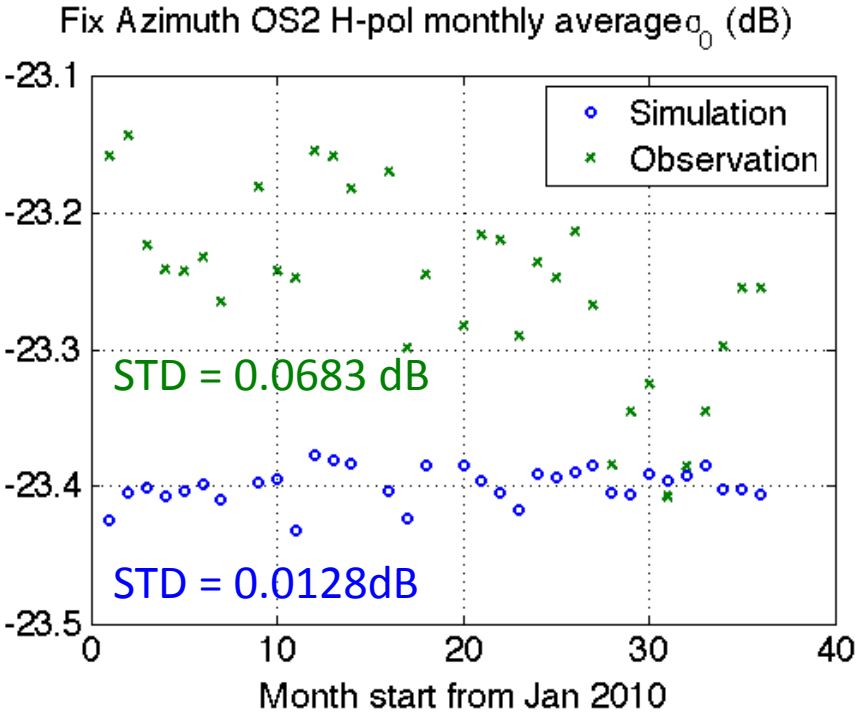


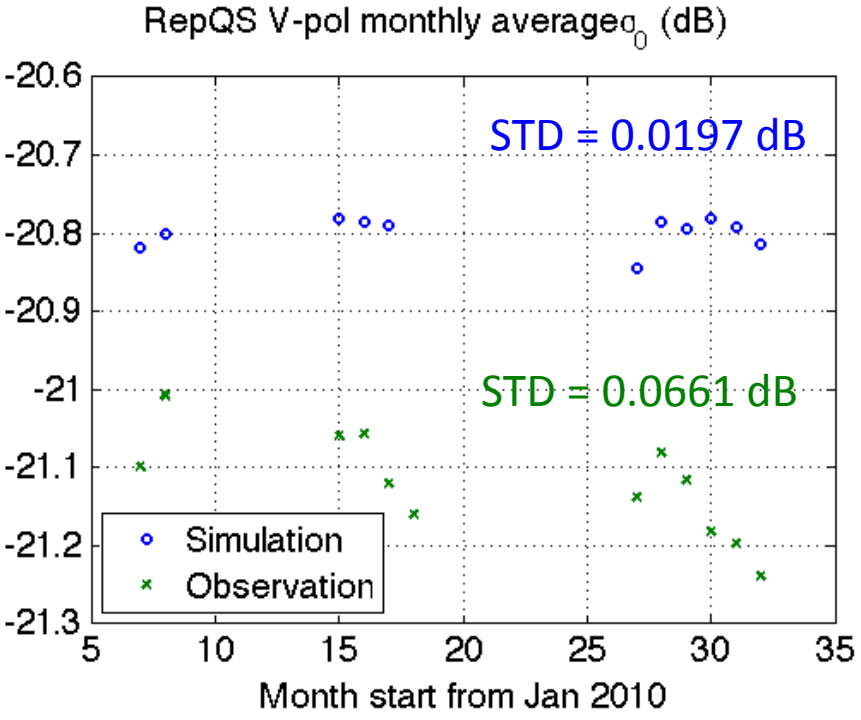


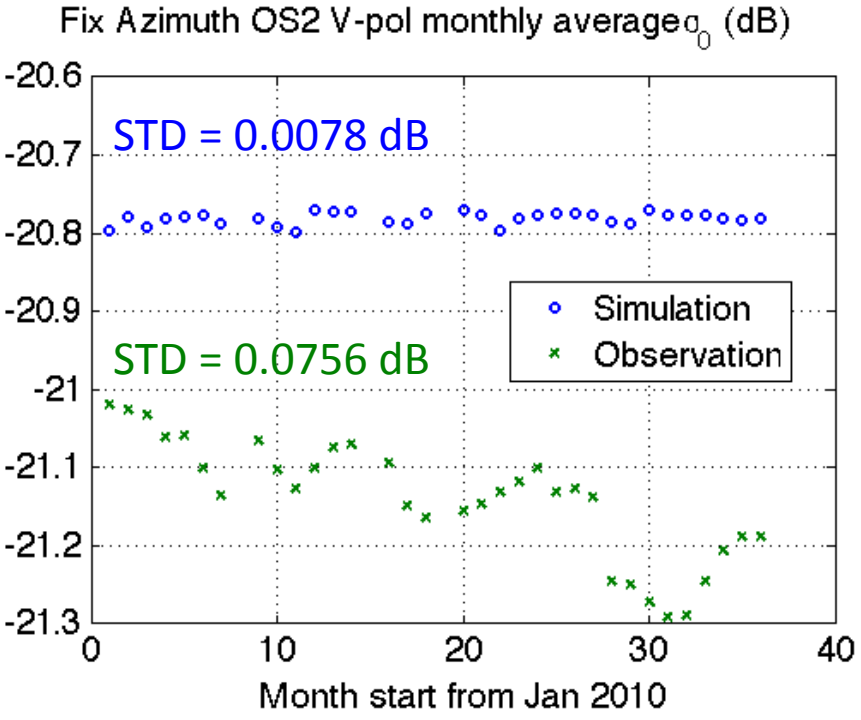
Evaluation of accuracy of calibration

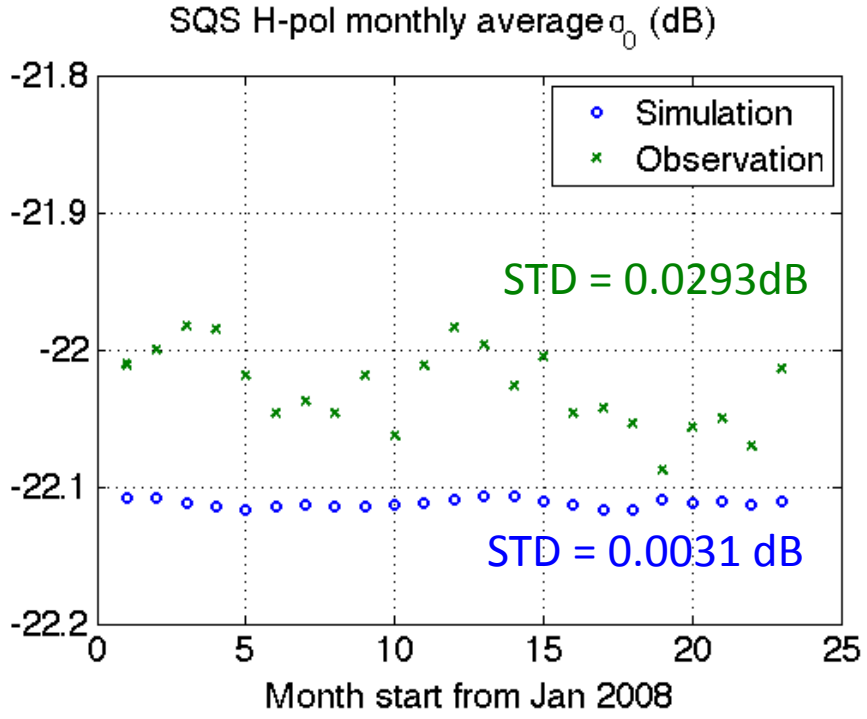
- Use geometry from data (Oceansat-2, Repointed QuikSCAT, Spinning QuikSCAT)
- Obtain ECMWF matched speed and relative azimuth
- Simulation of backscatter using GMF
- Apply appropriate noise for each sensor
- Calculate variation as a function of time

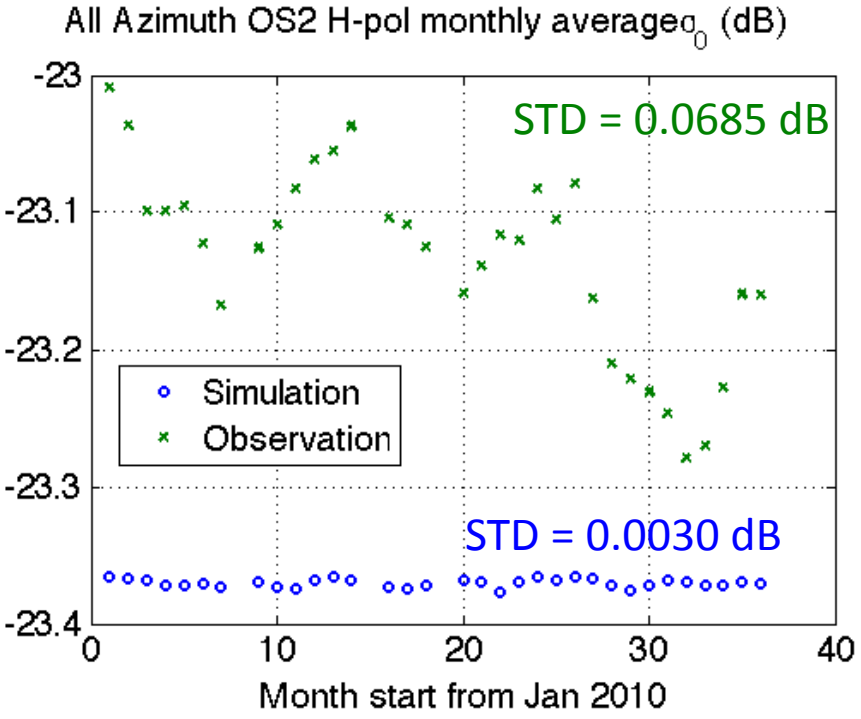

RepQS H-pol monthly average σ0 (dB)
Simulation
Observation
STD = 0.0431 dB
STD = 0.0093 dB
Month start from Jan 2010

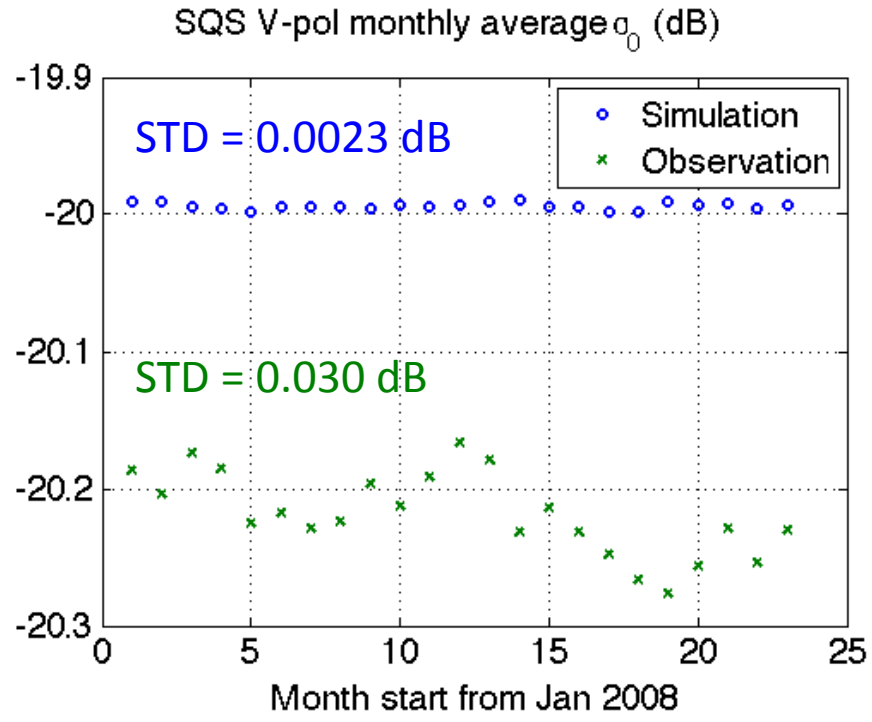

Fix Azimuth OS2 H-pol monthly average σ0 (dB)
Simulation
Observation
STD = 0.0683 dB
STD = 0.0128dB
Month start from Jan 2010

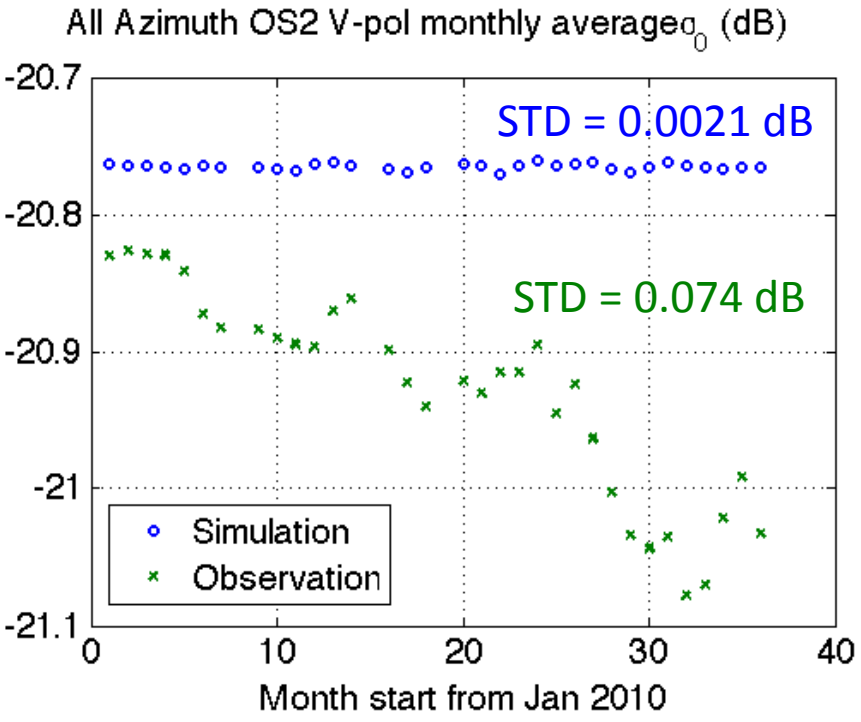

RepQS V-pol monthly average σ0 (dB)
STD = 0.0197 dB
STD = 0.0661 dB
Simulation
Observation
Month start from Jan 2010


Fix Azimuth OS2 V-pol monthly average σ0 (dB)
STD = 0.0078 dB
STD = 0.0756 dB
Simulation
Observation
Month start from Jan 2010


SQS H-pol monthly average σ0 (dB)
Simulation
Observation
STD = 0.0293dB
STD = 0.0031 dB
-21.8
-21.9
-22
-22.1
-22.2
0
5
10
15
20
25
Month start from Jan 2008


All Azimuth OS2 H-pol monthly average σ0 (dB)
STD = 0.0685 dB
Simulation
Observation
STD = 0.0030 dB
-23
-23.1
-23.2
-23.3
-23.4
0
10
20
30
40
Month start from Jan 2010


SQS V-pol monthly average σ0 (dB)
STD = 0.0023 dB
Simulation
Observation
STD = 0.030 dB
-19.9
-20
-20.1
-20.2
-20.3
0
5
10
15
20
25
Month start from Jan 2008


All Azimuth OS2 V-pol monthly average σ0 (dB)
STD = 0.0021 dB
STD = 0.074 dB
Simulation
Observation
-20.7
-20.8
-20.9
-21
-21.1
0
10
20
30
40
Month start from Jan 2010

Conclusions

- Calibration between QuikSCAT and Oceansat-2 has been performed on ocean data using histogram matching method.
- New calibration numbers are calculated for H-pol and V-pol before and after rev 04796_04797 and 04798_04799 (August 20, 2010)
- Calibration accuracy is also evaluated.

BACKUP

Repointed QuikSCAT data

QuikSCAT Orbit	Periods	Mode
57676 – 58317	16 July 2010 – 30 Aug 2010	Oceansat-2 outer beam point
58347 – 60967	1 Sep 2010 – 4 Mar 2011	Oceansat-2 inner beam point
60969 – 62351	4 Mar 2011 – 9 June 2011	Oceansat-2 outer beam point
66446 – 68443	22 Mar 2012 – 9 Aug 2012	Oceansat-2 outer beam point
68446 – 69881	9 Aug 2012 – 18 Nov 2012	Oceansat-2 inner beam point