Aquarius Scatterometer Calibration and Bias Drift Correction

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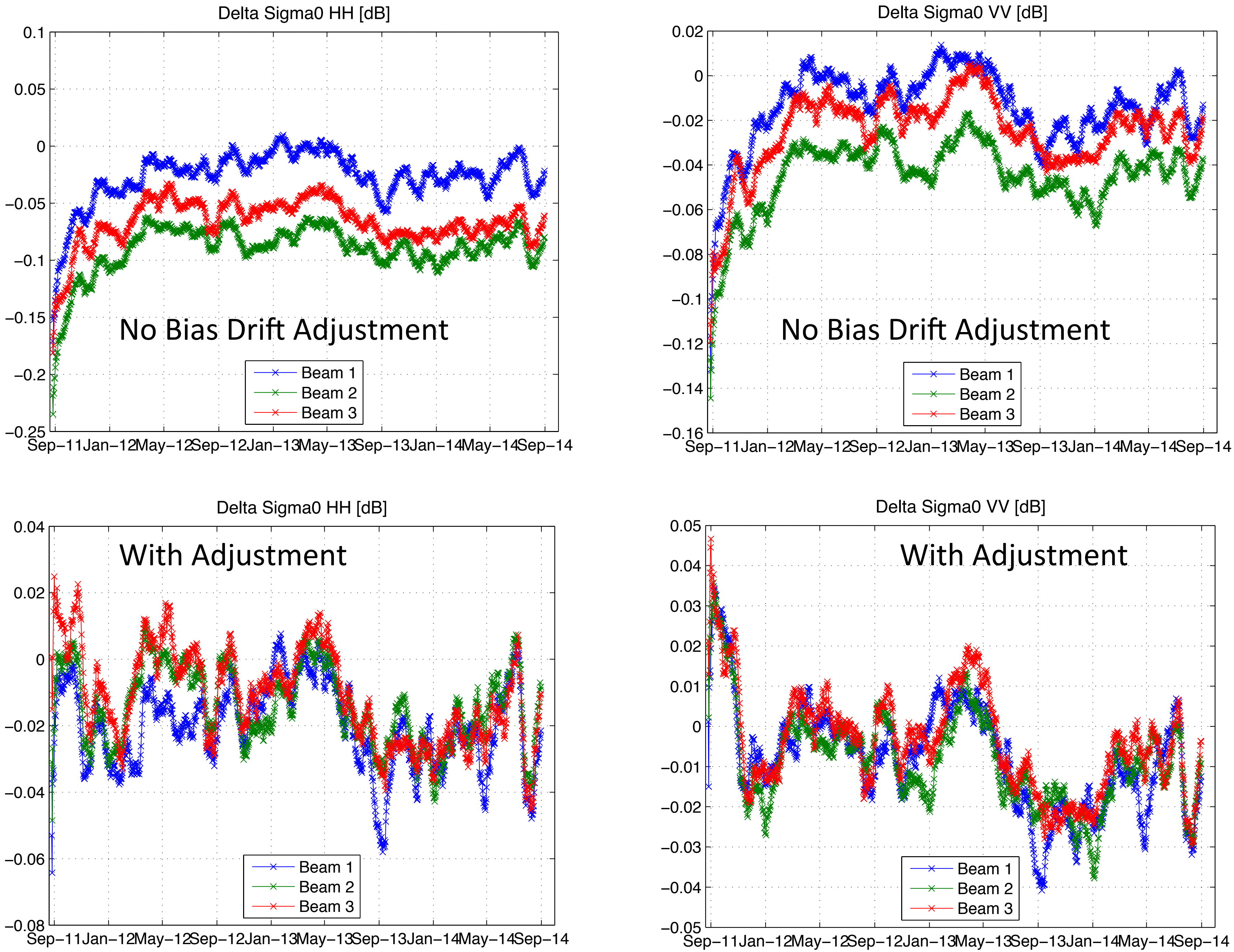
Drift in Scatterometer Calibration

- A very small drift in the scatterometer calibration can be observed over the first few months.
  - Magnitude of drift is order 0.1 dB
  - Time scale is about 1.5 months
- We fit an empirical exponential to these observed sigma0 minus expected sigma0.
- Similar trend observed in all beams/channels indicating trend in common part of scatterometer hardware.
  - Recall Aquarius has one scatterometer, shared between antenna feed-horns for three beams.


Delta Sigma0 HH [dB]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
−0.25
Sep−11 Jan−12 May−12 Sep−12 Jan−13 May−13 Sep−13 Jan−14 May−14 Sep−14
Delta Sigma0 VV [dB]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
0.02
0
−0.02
−0.04
−0.06
−0.08
−0.1
−0.12
−0.14
−0.16
Sep−11 Jan−12 May−12 Sep−12 Jan−13 May−13 Sep−13 Jan−14 May−14 Sep−14
Delta Sigma0 HH [dB]
With Adjustment
Beam 1
Beam 2
Beam 3
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
Sep−11 Jan−12 May−12 Sep−12 Jan−13 May−13 Sep−13 Jan−14 May−14 Sep−14
Delta Sigma0 VV [dB]
With Adjustment
Beam 1
Beam 2
Beam 3
0.05
0.04
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.04
−0.05
Sep−11 Jan−12 May−12 Sep−12 Jan−13 May−13 Sep−13 Jan−14 May−14 Sep−14

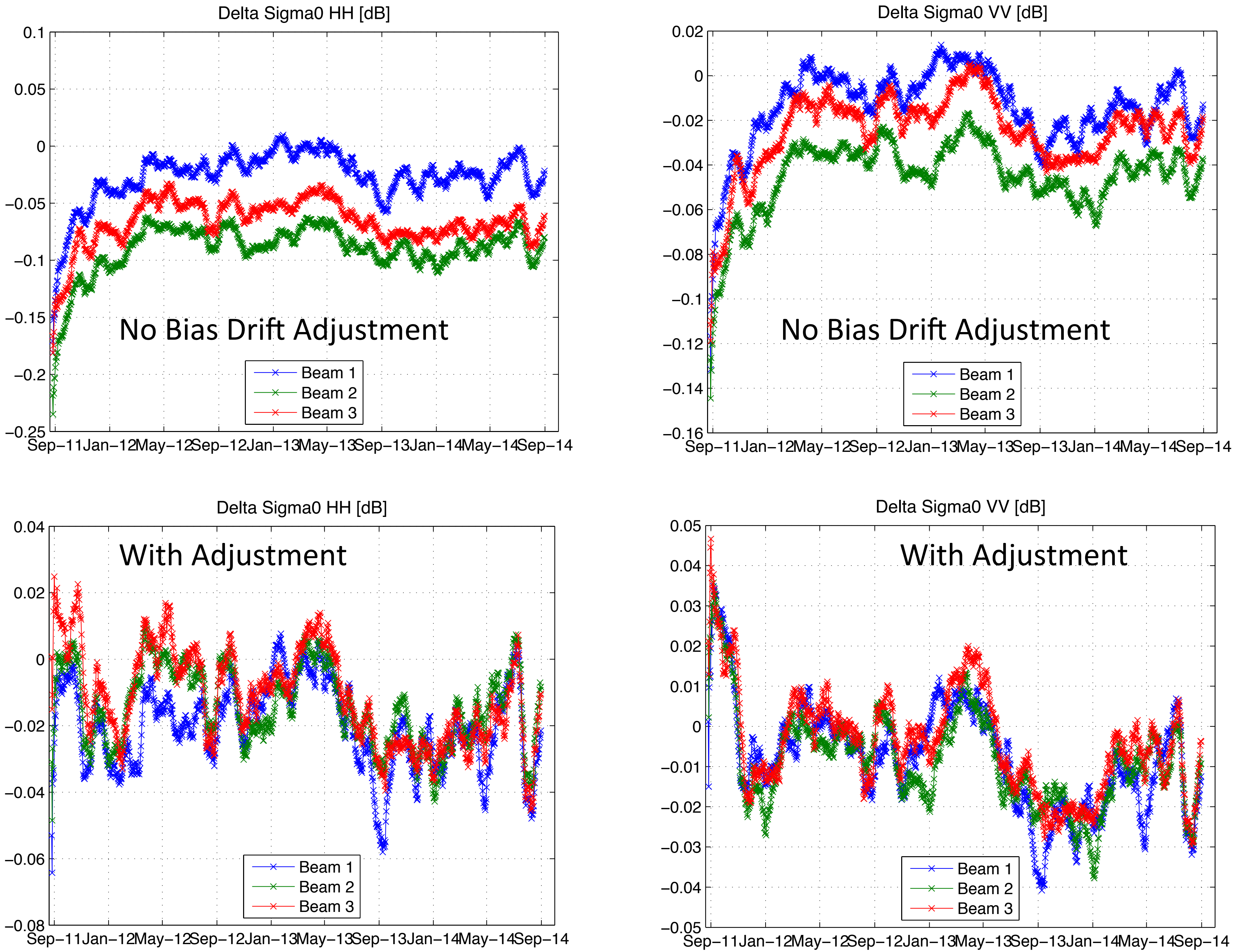
Sigma0 Bias Correction Model

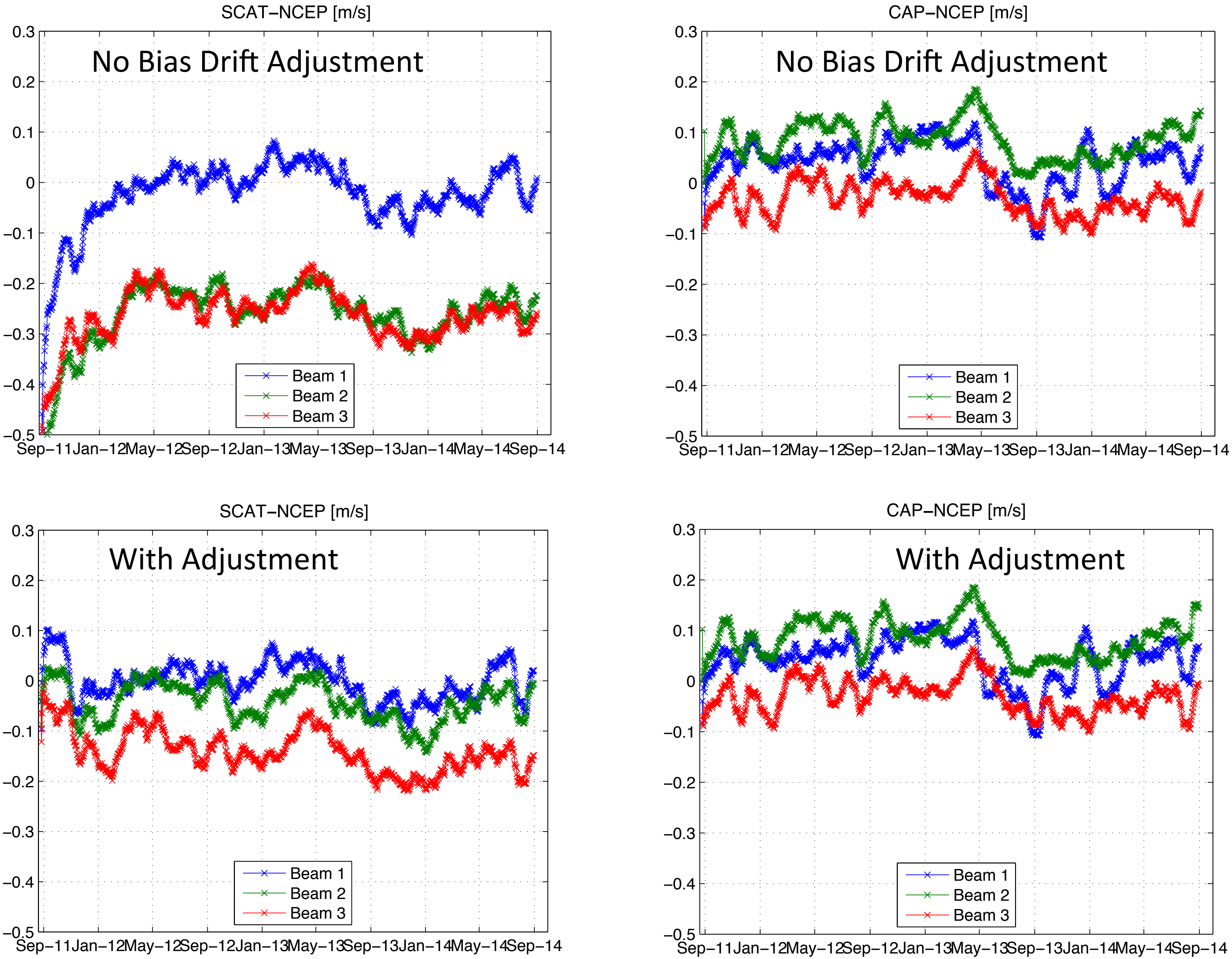
$$\sigma_0^{bias}(t) = Ae^{-\frac{(t-t_0)}{\tau}} + C$$

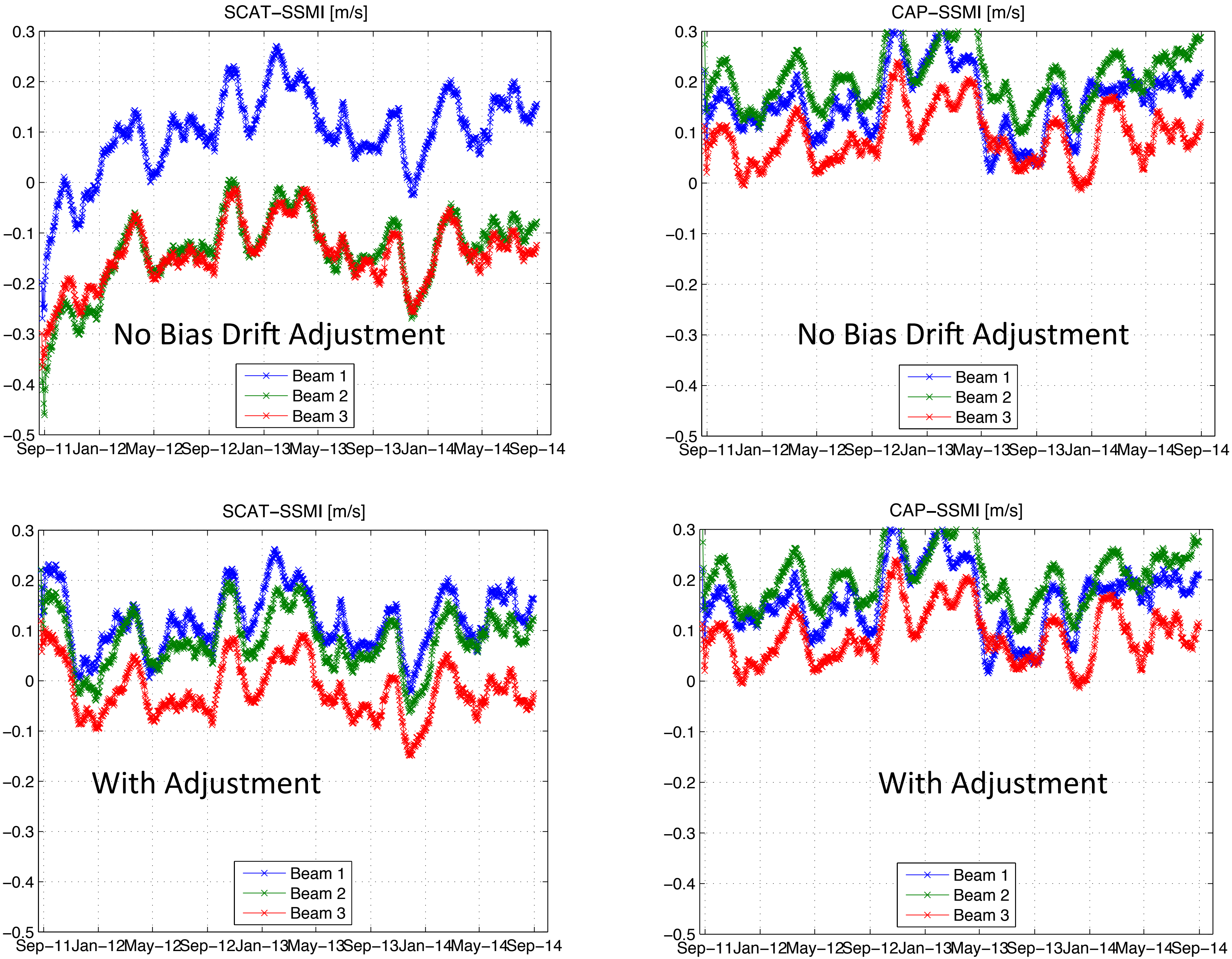
t_0 = August 25[th] 2011

Motivated by the hardware design, we use the same magnitude and decay constant for the exponential adjustment, with different offsets for the various channels.

	A [dB]	Tau [days]	C [dB]
Beam 1 HH	-0.12	45	0
Beam 1 VV	-0.12	45	0
Beam 2 HH	-0.12	45	-0.07
Beam 2 VV	-0.12	45	-0.03
Beam 3 HH	-0.12	45	-0.05
Beam 3 VV	-0.12	45	-0.015


Delta Sigma0 HH [dB]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
−0.25
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14
Delta Sigma0 VV [dB]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
0.02
0
−0.02
−0.04
−0.06
−0.08
−0.1
−0.12
−0.14
−0.16
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14
Delta Sigma0 HH [dB]
With Adjustment
Beam 1
Beam 2
Beam 3
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14
Delta Sigma0 VV [dB]
With Adjustment
Beam 1
Beam 2
Beam 3
0.05
0.04
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.04
−0.05
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14


SCAT−NCEP [m/s]
No Bias Drift Adjustment
CAP−NCEP [m/s]
No Bias Drift Adjustment
SCAT−NCEP [m/s]
With Adjustment
CAP−NCEP [m/s]
With Adjustment
Beam 1
Beam 2
Beam 3
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14

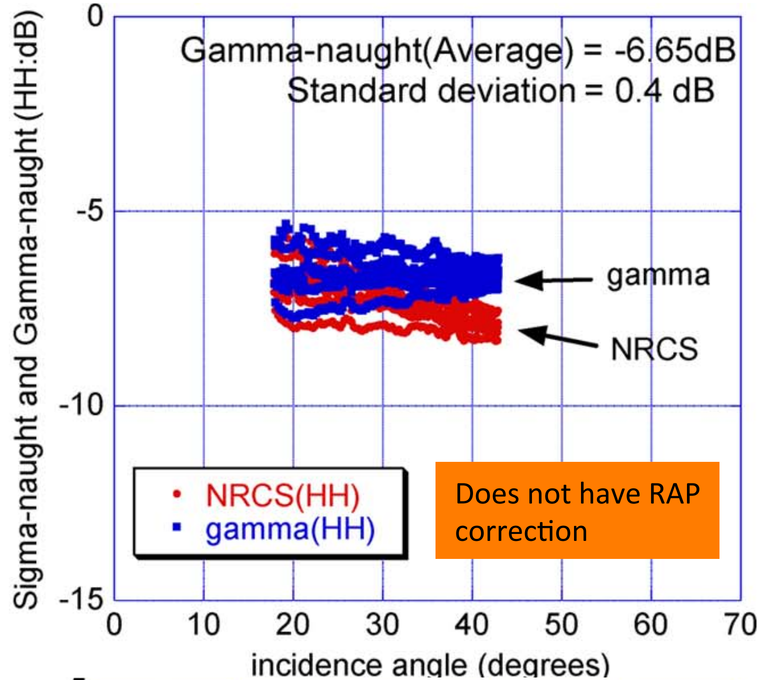


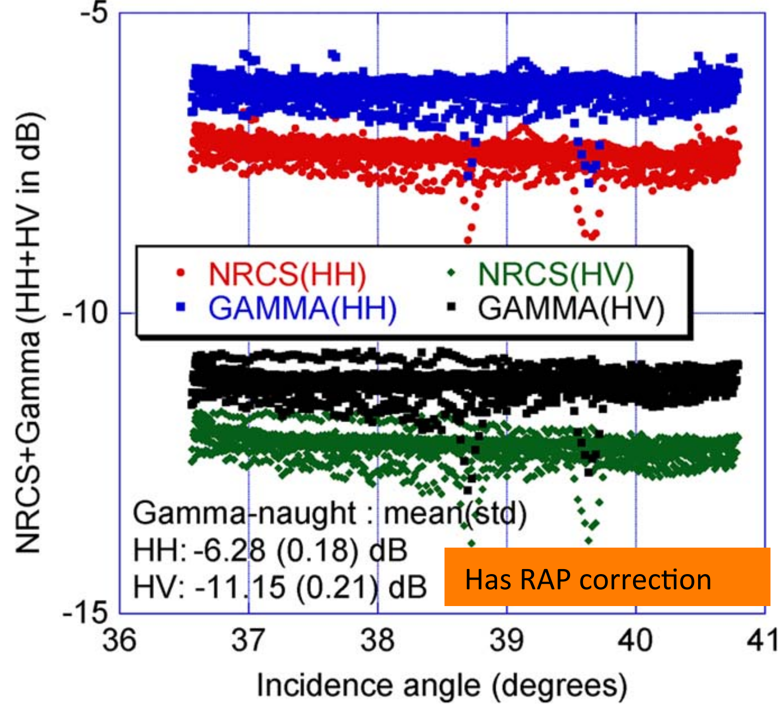
SCAT−SSMI [m/s]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
CAP−SSMI [m/s]
No Bias Drift Adjustment
Beam 1
Beam 2
Beam 3
SCAT−SSMI [m/s]
With Adjustment
Beam 1
Beam 2
Beam 3
CAP−SSMI [m/s]
With Adjustment
Beam 1
Beam 2
Beam 3
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
Sep−11
Jan−12
May−12
Sep−12
Jan−13
May−13
Sep−13
Jan−14
May−14
Sep−14

Amazon γ_0

$$\gamma_0 = \sigma_0 / \cos(\theta_{inc})$$

- PALSAR found γ_0 values in the Amazon stable across 20-45 degrees in incidence angle*
  - Wet-dry seasonal difference of ~ 0.27 dB**
  - Wet season is approx. Nov-April.
- Best estimates are:
  - HH ~ -6.28 dB (std 0.18)
  - HV ~ -11.15 dB (std 0.21)
  - Not clear which season this is from!



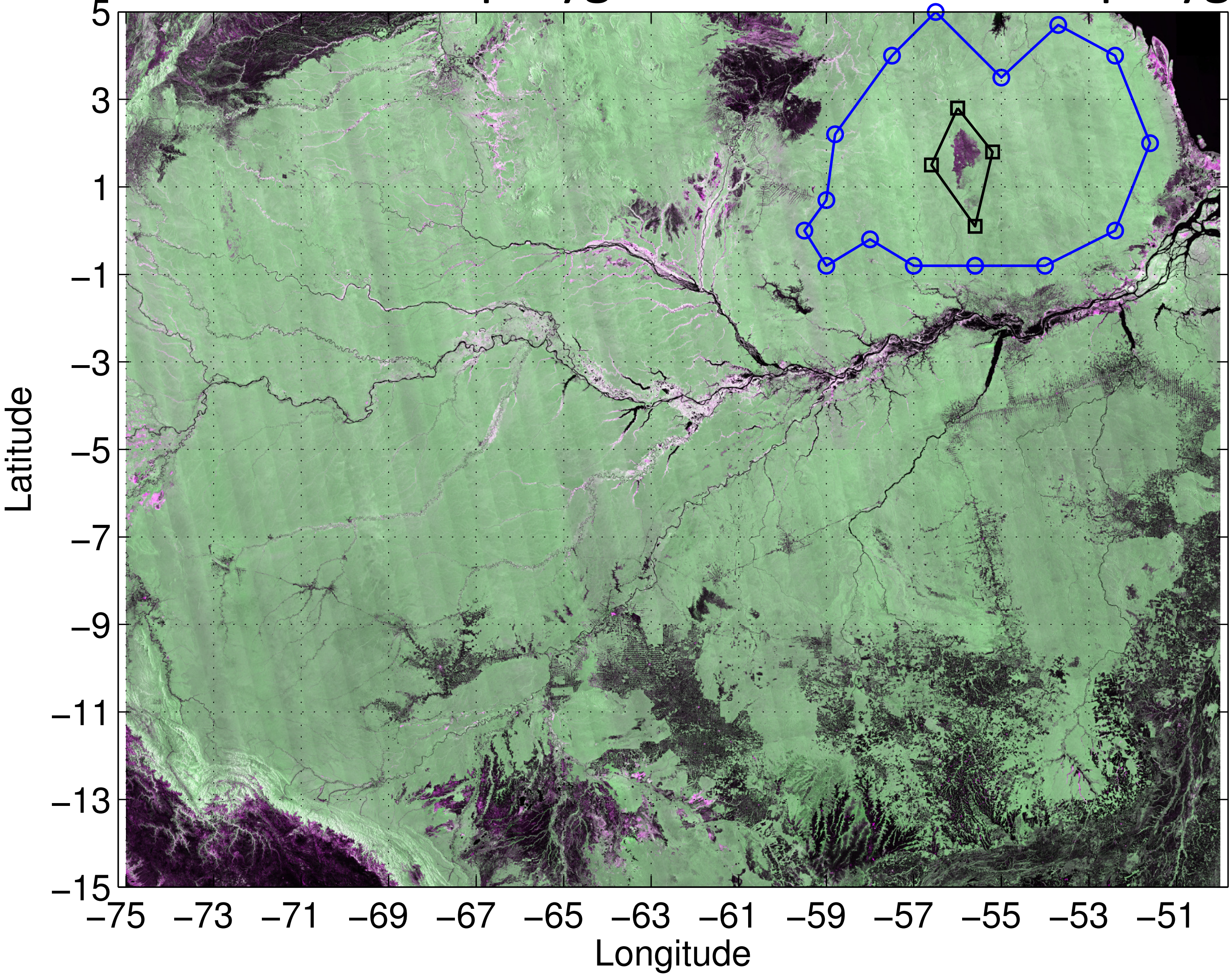


*M. Shimada, O. Isoguchi, T. Tadono, and K. Isono. Palsar radiometric and geometric calibration. Geoscience and Remote Sensing, IEEE Transactions on, 47(12):3915 – 3932, dec. 2009 (Images from this source)

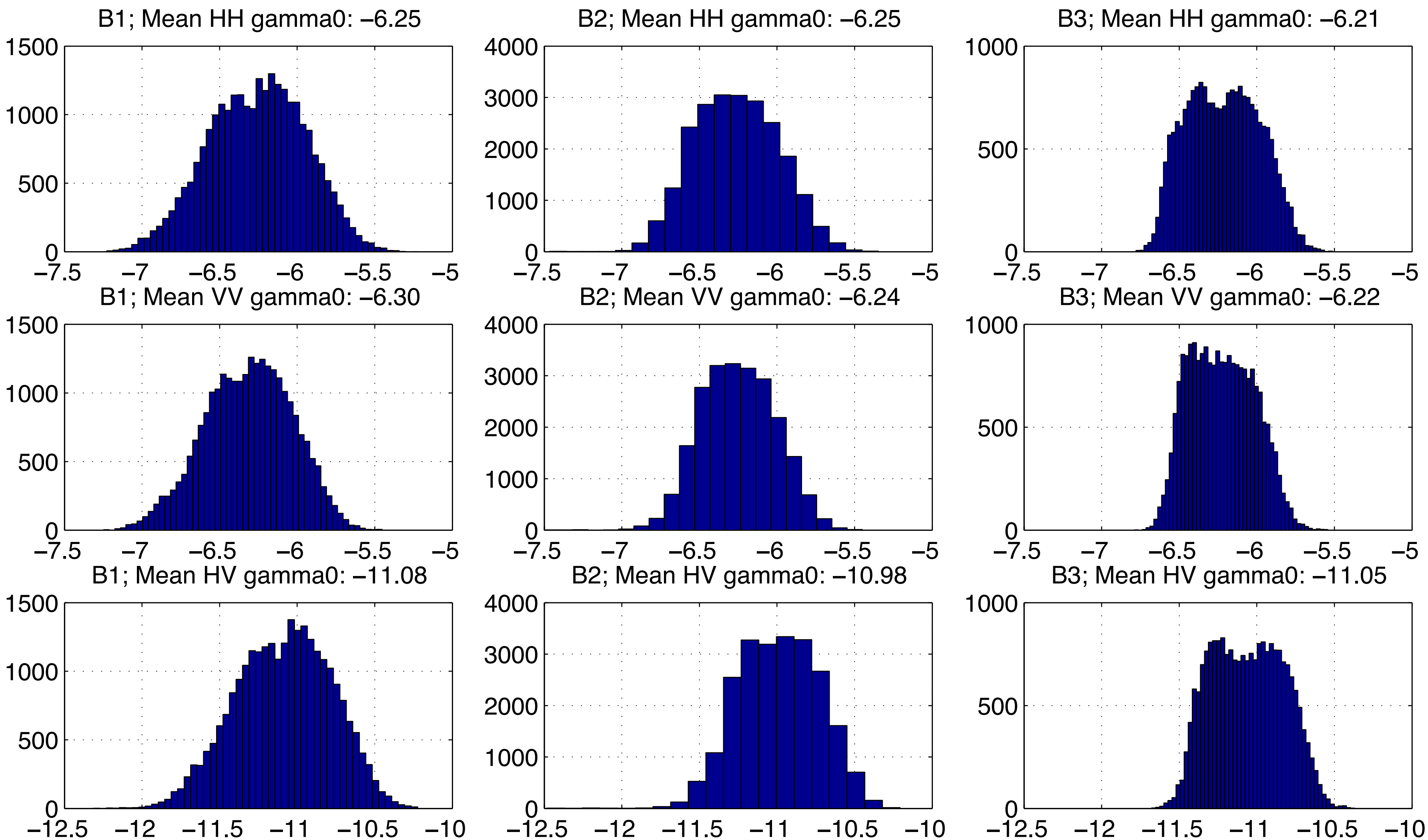
**M. Shimada. Long-term stability of l-band normalized radar cross section of amazon rainforest using the jers-1 sar. Canadian Journal of Remote Sensing, 31(1): 132–137, 2005.

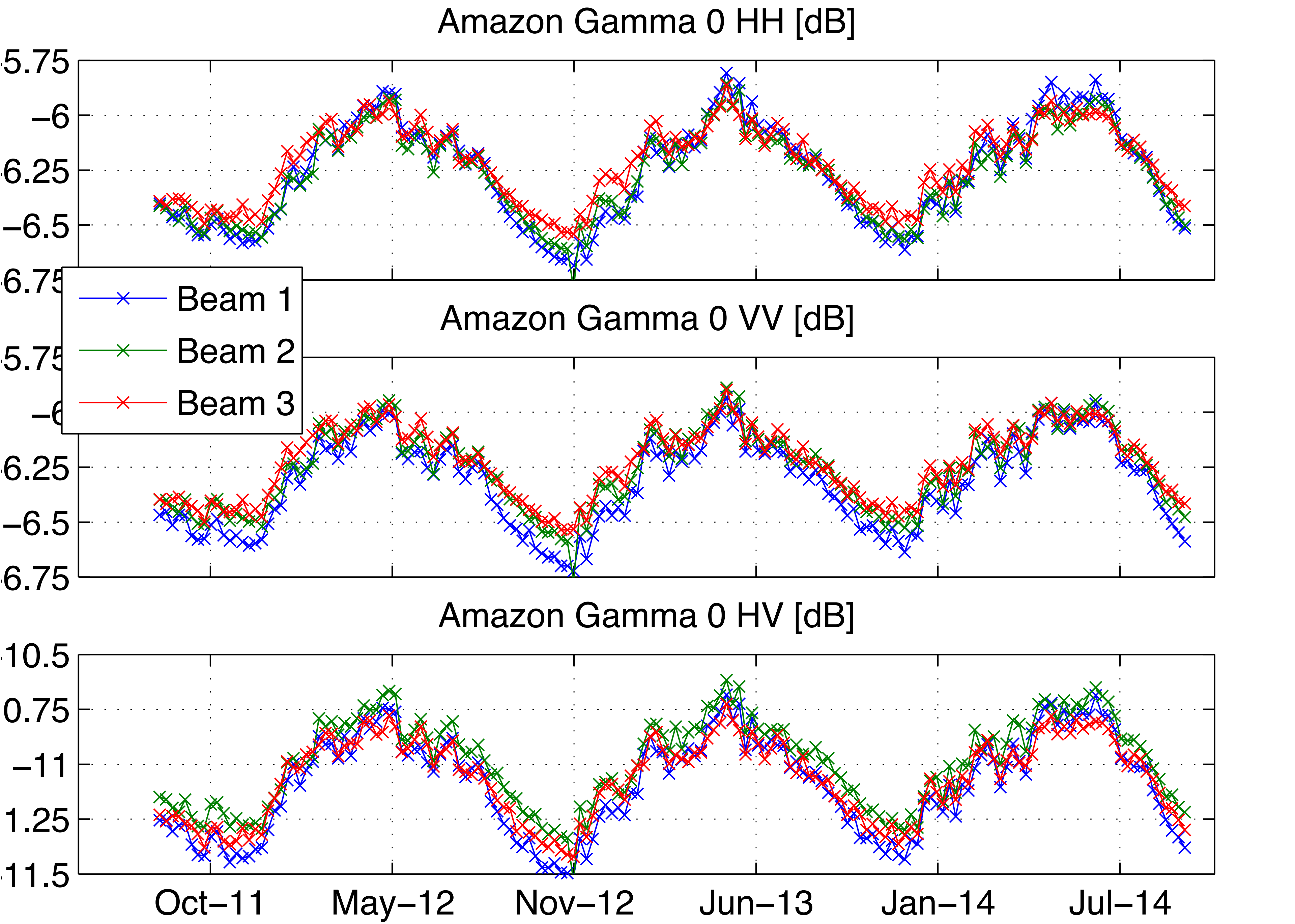
RAP correction is range antenna pattern correction

Regions used in γ_0 Analysis
Include data in blue polygon that not in black polygon



PALSAR Found γ_0^{HH} = -6.28 dB and γ_0^{HV} = -11.15 dB
Histograms of Aquarius γ_0 For the Three Beams





Amazon Gamma 0 HH [dB]
5.75
−6
6.25
−6.5
6.75
Beam 1
Beam 2
Beam 3
Amazon Gamma 0 VV [dB]
5.75
−6
6.25
−6.5
6.75
Amazon Gamma 0 HV [dB]
10.5
0.75
−11
1.25
11.5
Oct−11
May−12
Nov−12
Jun−13
Jan−14
Jul−14

Bias compared to PALSAR

PALSAR values: HH: -6.28 dB; HV: -11.15 dB

Asc / Dec	Beam 1	Beam 2	Beam 3
All HH	0.03	0.03	0.07
Ascending HH	0.06	0.01	0.01
Descending HH	0.01	0.04	0.15
All VV	-0.02	0.04	0.07
Ascending VV	0.00	0.02	0.05
Descending VV	-0.05	0.07	0.08
All HV	0.07	0.17	0.10
Ascending HV	0.09	0.15	0.06
Descending HV	0.05	0.19	0.16

No significant ascending / descending difference

Summary

- The exponential drift correction appears to be effective to remove the calibration drift in the first few months after instrument turn on
  - The drift of scat and CAP wind speed retrieval bias has also been reduced.
- Some fine tuning will still be needed to remove the residual calibration bias.
- **Once tuning is complete, the calibration algorithm and exponential correction table will be applied to the v4 processing.**
- An interesting lesson: Amazon is not an absolute "stable" target, with about 0.5 dB seasonal variation – repeatable over two years.
  - The radar sigma0 reaches peak level around May, near the end of rain season.

Filtering for Calibration Tracking Plots

- Latitude within [-50, 50]
- NCEP speed> 3 , NCEP speed< 15
- SSMI/S speed > 0, SSMI/S speed < 30
- No rain indicated by SSMI/S
- No pointing flags set or anomaly flag set.
  - radiometer_flags, bits 12 and 16.
- Plot 28 day moving window average.