RapidScat Reprocessing and Data Status

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Outline

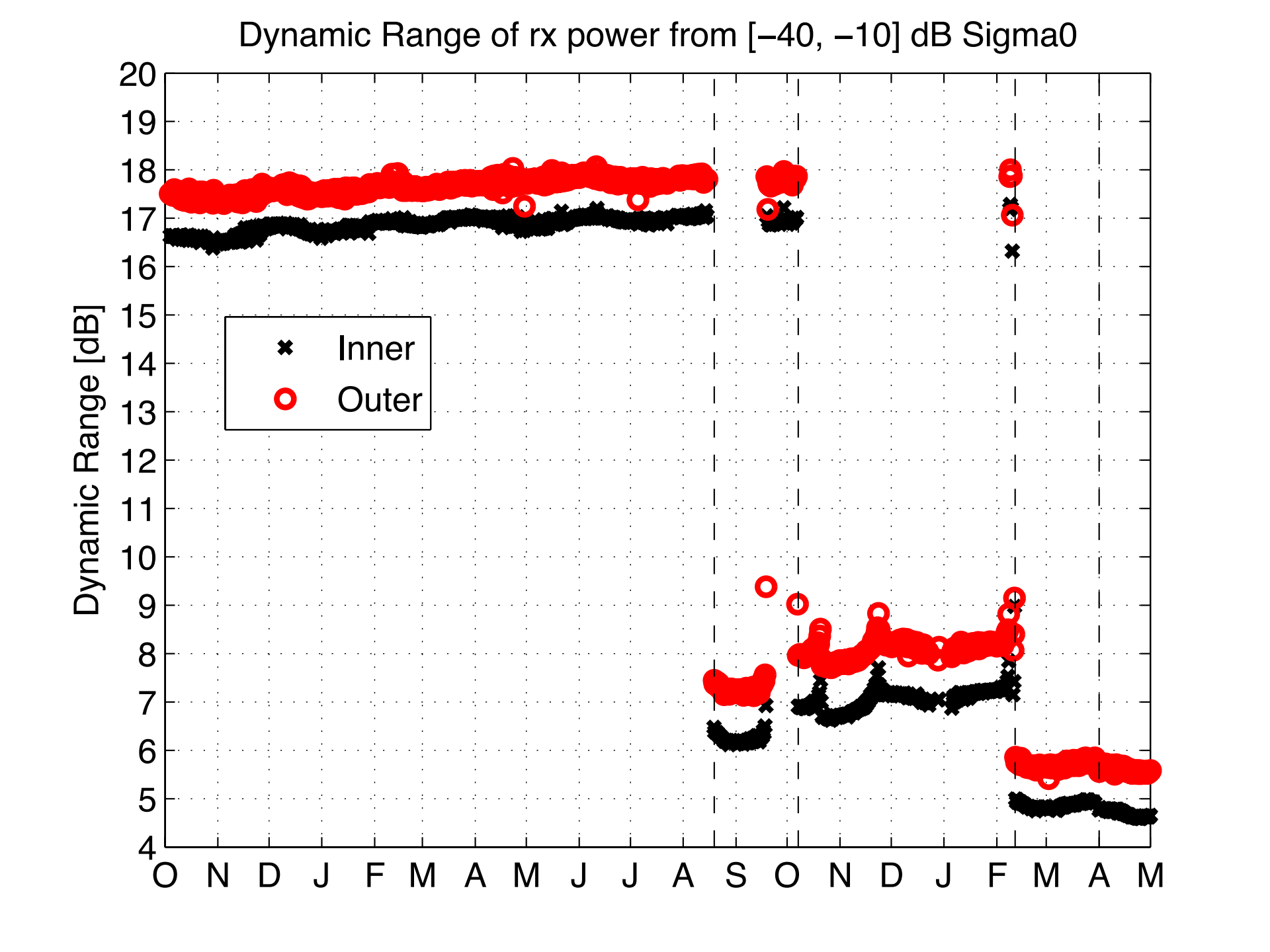
- Status overview of RapidScat.
- Discussion of RapidScat SNR anomalies.
- Recommendations of RapidScat data products to use for various user requirements.
  - Discussion of merits / faults of each.
  - Roadmap for future reprocessing.
- Validation of new RapidScat data products.

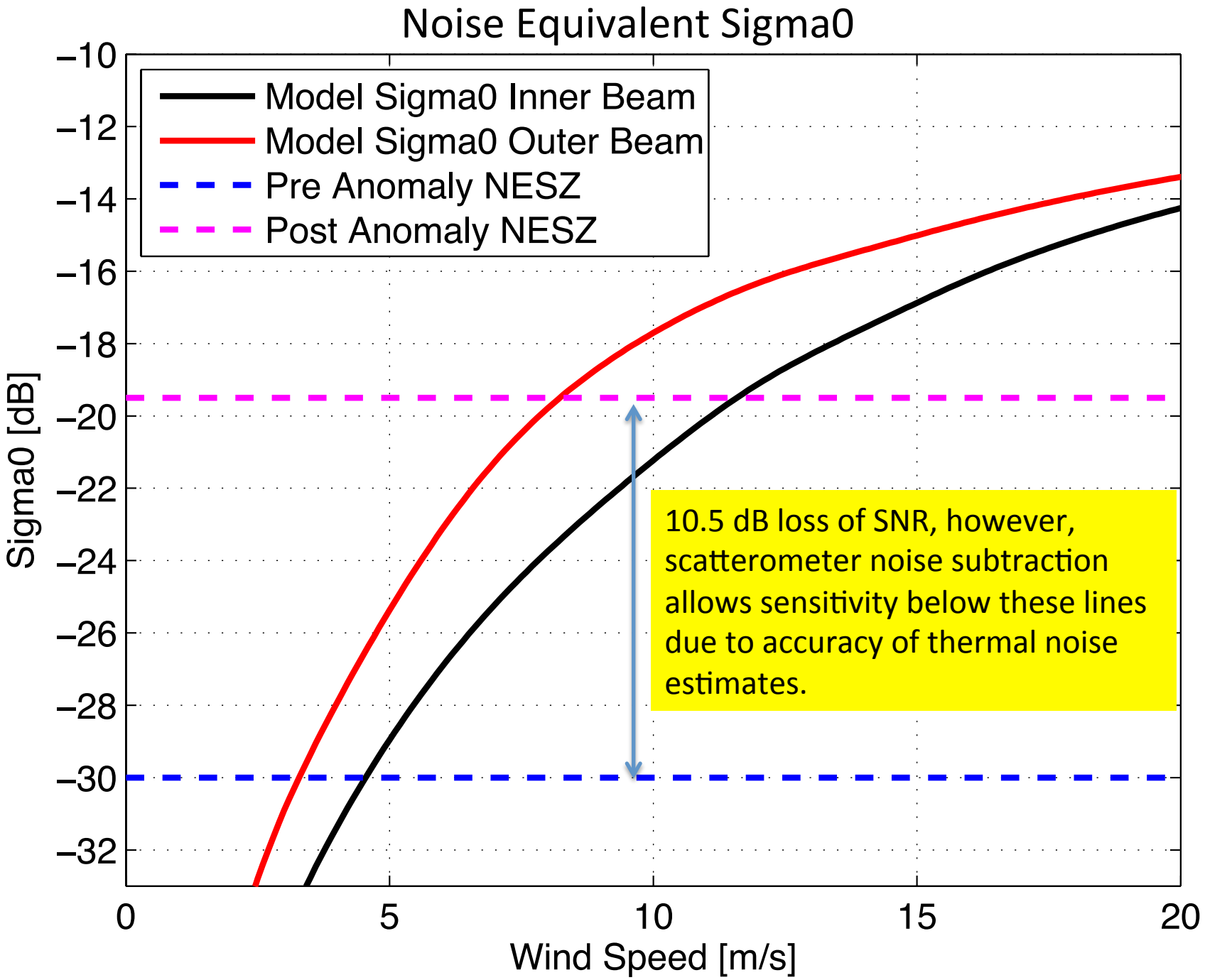
RapidScat Status

- RapidScat has provided 18 months of Ocean Vector Winds so far.
  - 10 months of high SNR data.
  - 8 more months of low SNR data since 1st SNR anomaly.
- QuikSCAT is used to re-calibrate RapidScat.
- All SNR periods are inter-calibrated to the 0.1 dB level, except for low SNR 1 (0.2 dB level).
- Low SNR performance is very similar to high SNR performance above 6 m/s surface wind speed.
- RapidScat continues to meet the QuikSCAT requirements and extends the Ku-band OVW data record.

SNR Anomaly(ies)

- In August 2015 RapidScat suffered a drop in receiver gain causing an approx. 10 dB loss in SNR.
  - Since then it has returned to the high SNR state only for brief periods.
  - Multiple epochs of Low SNR data have occurred since, and we expect more in the future.
- We are on the 4^{th} low SNR epoch.
- Each low SNR epoch requires its own independent assessment of stability and calibration.

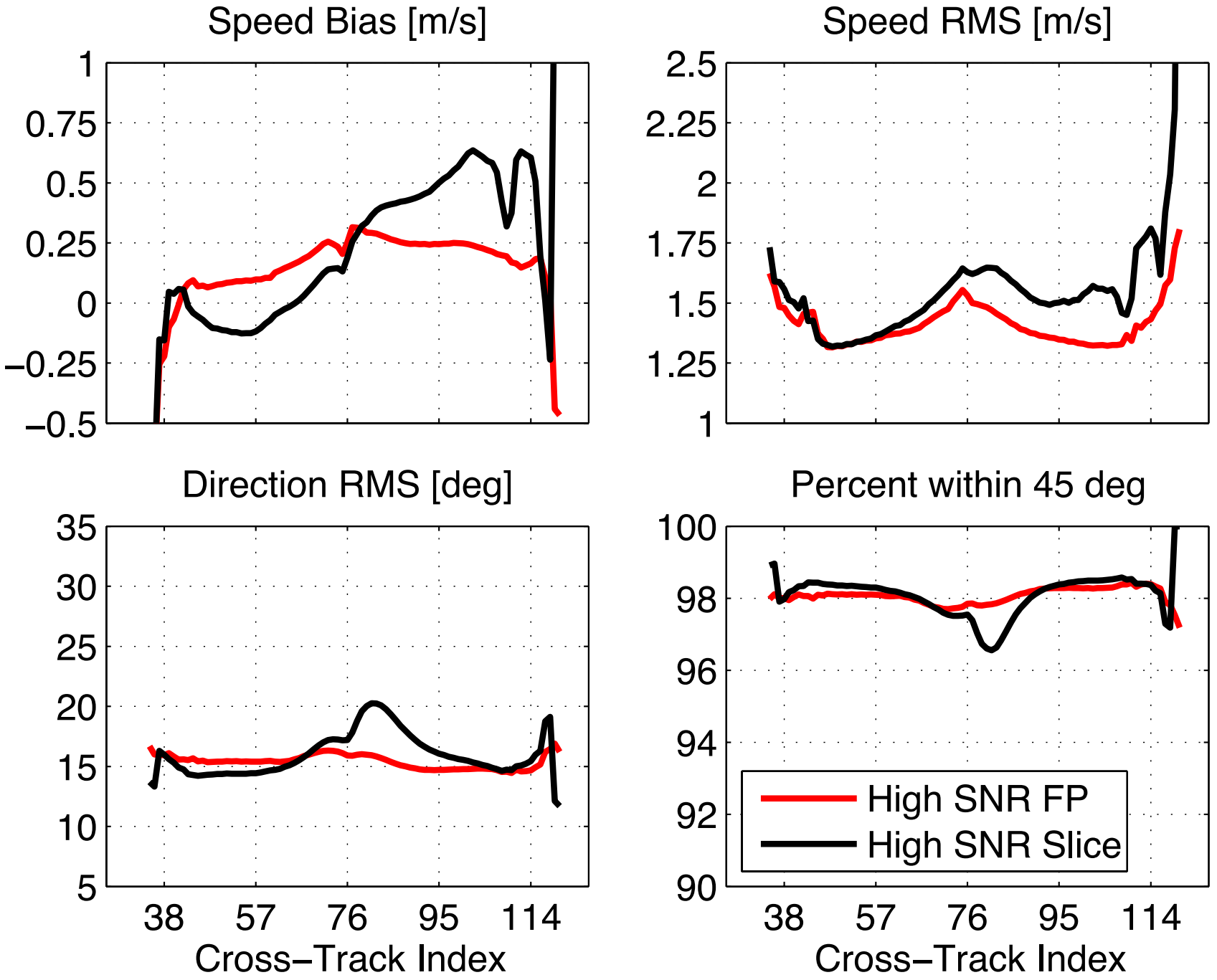

Dynamic Range of rx power from [−40, −10] dB Sigma0
Dynamic Range [dB]
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Inner
Outer
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M

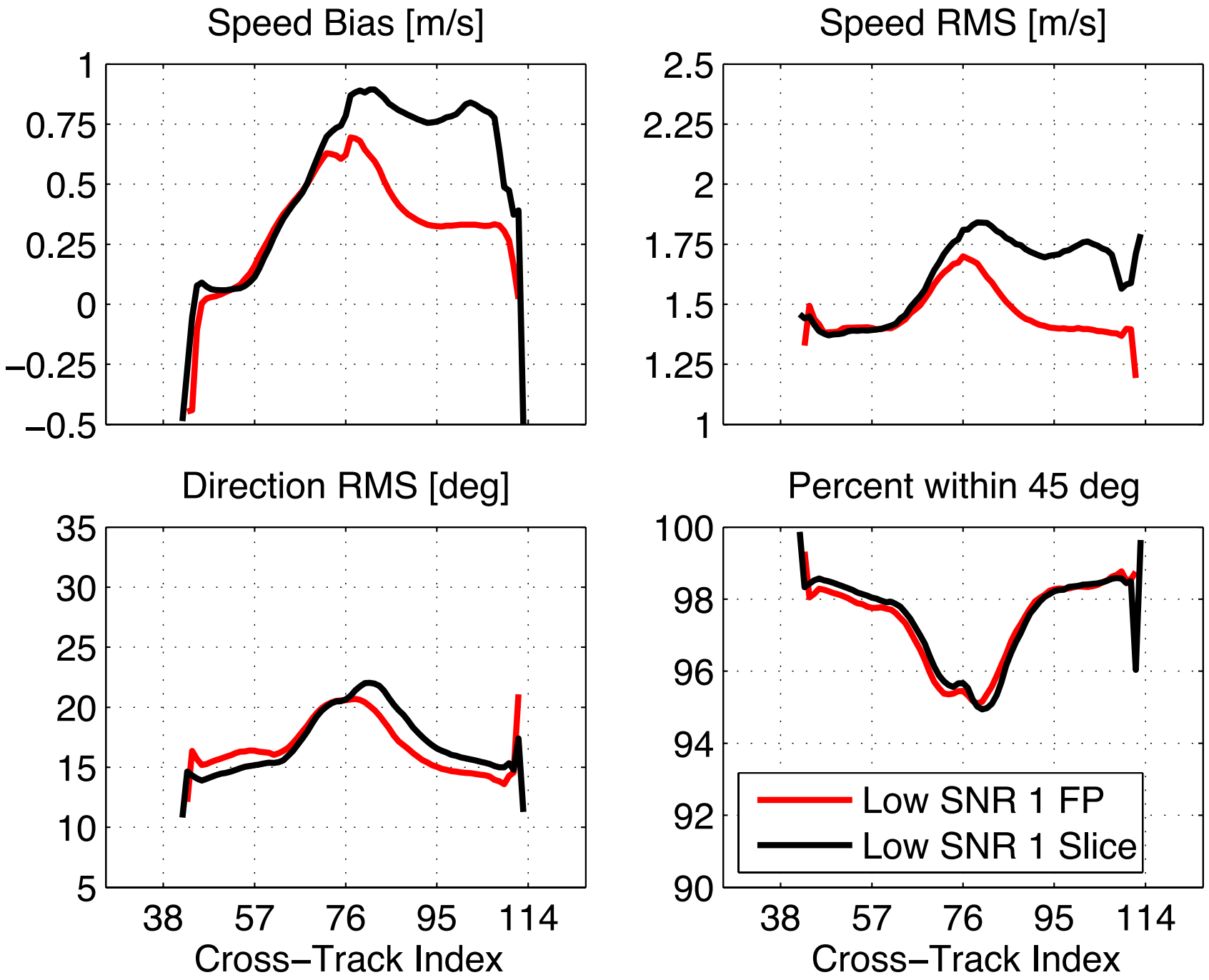

Noise Equivalent Sigma0
Model Sigma0 Inner Beam
Model Sigma0 Outer Beam
Pre Anomaly NESZ
Post Anomaly NESZ
10.5 dB loss of SNR, however, scatterometer noise subtraction allows sensitivity below these lines due to accuracy of thermal noise estimates.
Sigma0 [dB]
−10
−12
−14
−16
−18
−20
−22
−24
−26
−28
−30
−32
0
5
10
15
20
Wind Speed [m/s]

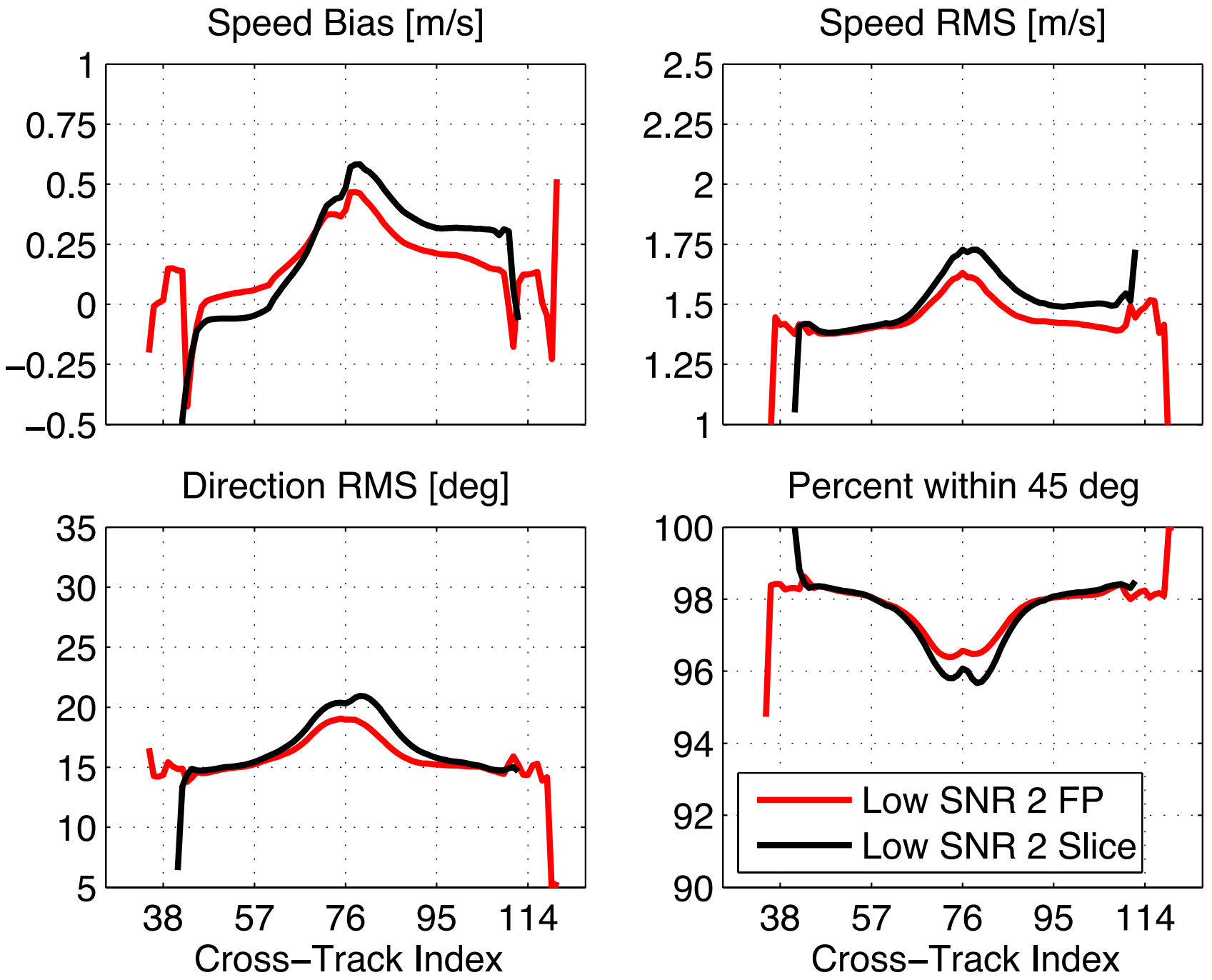
RapidScat Current/Future Data

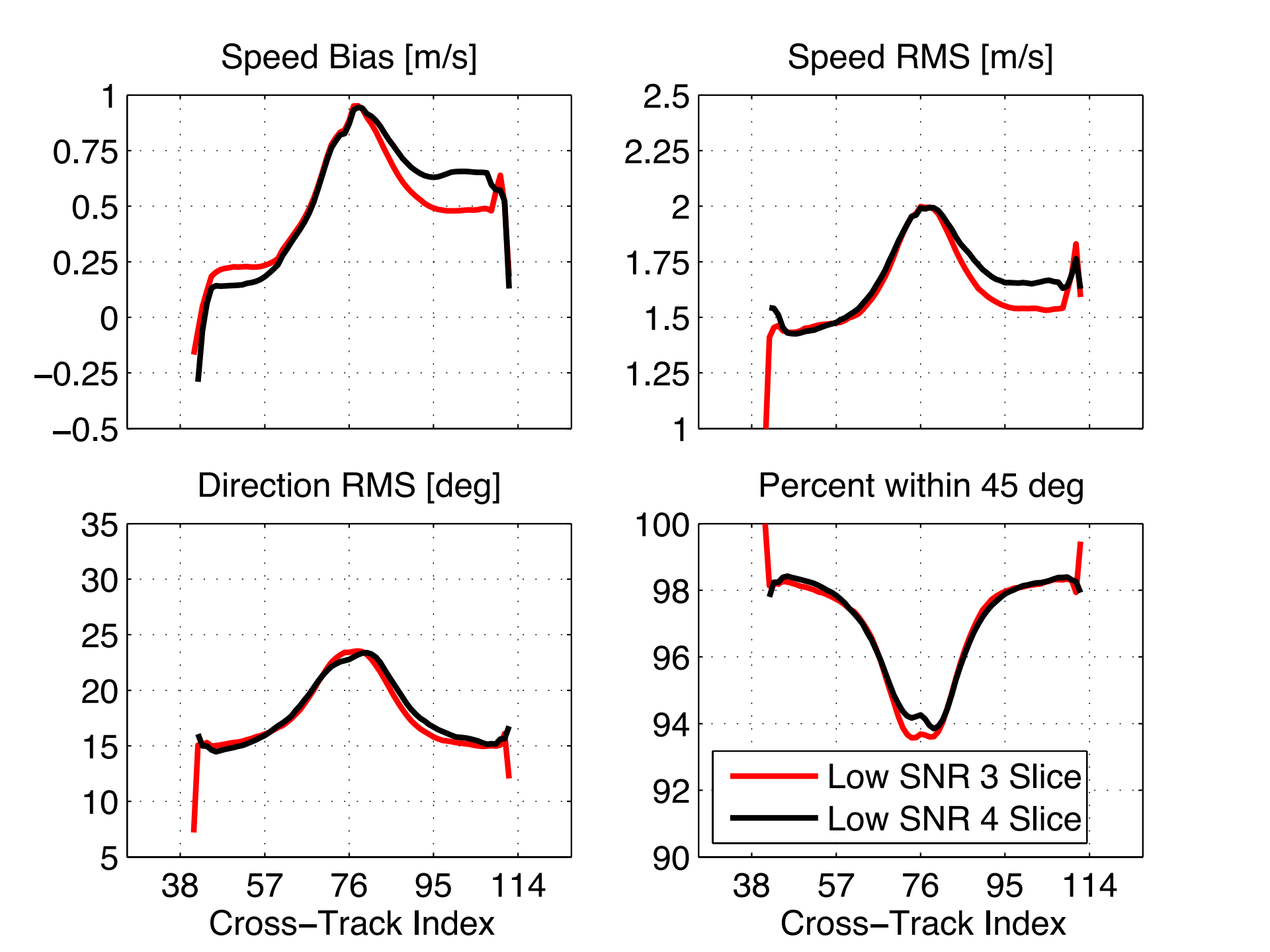
- V1.0_climate (full aperture NRCS; only L2B)
  - High SNR through Low SNR 2 (revs 161-7871; mission start through Feb 11th 2016)
  - 0.25 dB bias adjustment applied.
  - Lags real time by up to a few months pending finalized calibration for low SNR epochs.
  - Use if you want best possible data.
- V1.1 (full suite of L1B, L2A, slice-based L2B)
  - Only use V1.1 for High SNR data!
  - Calibration of high SNR data was determined to be correct and not adjusted or reprocessed.
- V1.2 (full suite of L1B, L2A, slice-based L2B)
  - Use for all Low SNR data.
  - Has final calibration for High SNR through Low SNR 2.
  - Has a preliminary calibration of Low SNR 3 and 4 (about 0.2 dB too high).
  - Use if want data more quickly and don't care about < 0.5 m/s biases with time (pitch variations) or cross-track.
- Update strategy going forward:
  - After final calibration of Low SNR 3/4 we will generate the V1.0_climate data and reprocess other levels as the V1.3 data.
  - Then V1.2 will only be valid for Low SNR 1/2 and V1.3 will be the correct data to use for Low SNR 3/4.
  - We expect the instrument to continue to display changing behavior and future low SNR epochs will all need their own calibration and be dealt with in a similar way.
- **A valid strategy to ensure using best V1.X data is to always use the highest version number for a given rev.**

All data (including re-pointed QuikSCAT used to calibrate) available at:
http://podaac.jpl.nasa.gov

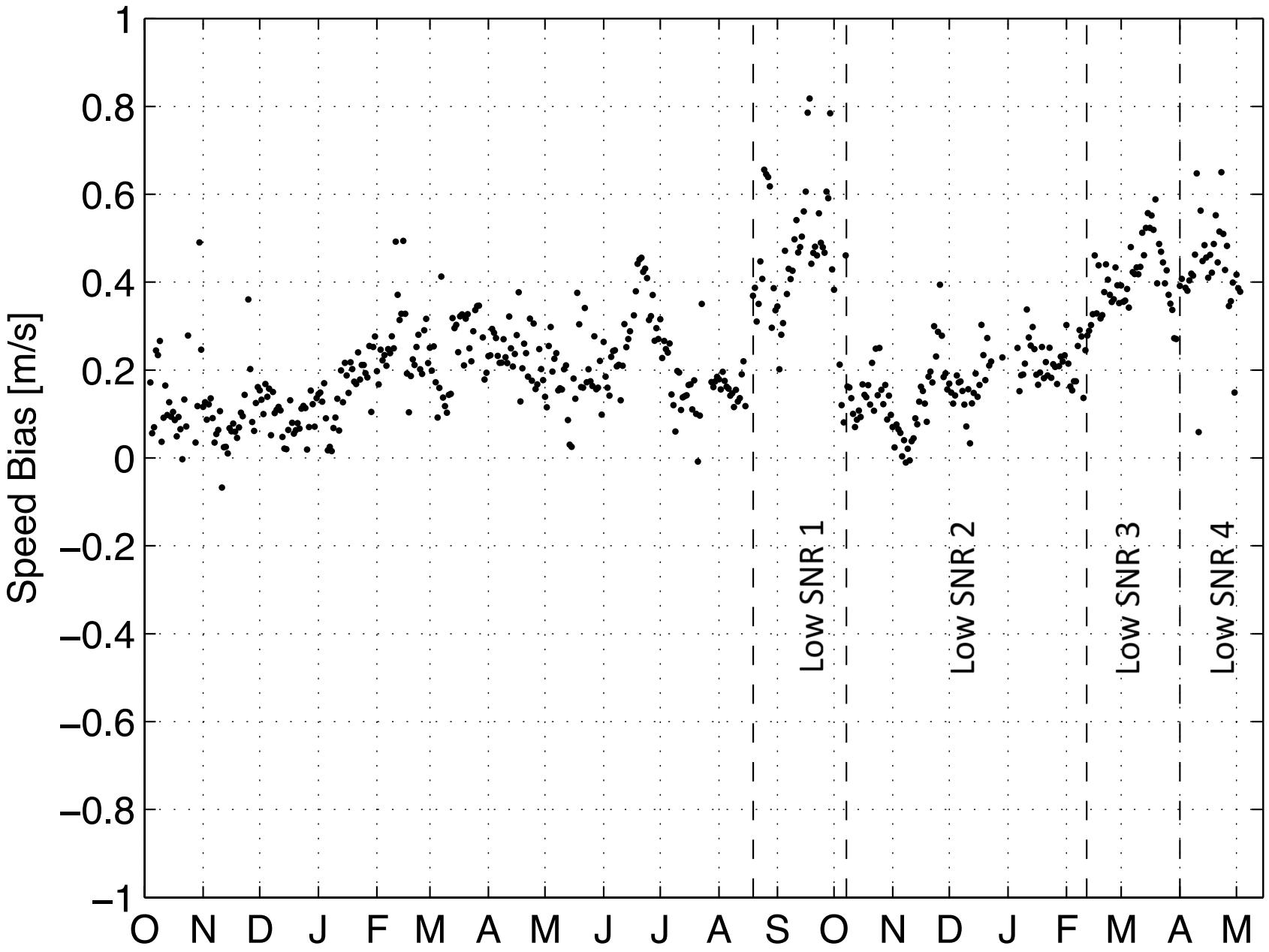

Speed Bias [m/s]
1
0.75
0.5
0.25
0
−0.25
−0.5
Speed RMS [m/s]
2.5
2.25
2
1.75
1.5
1.25
1
Direction RMS [deg]
35
30
25
20
15
10
5
38
57
76
95
114
Cross−Track Index
Percent within 45 deg
100
98
96
94
92
90
38
57
76
95
114
Cross−Track Index
High SNR FP
High SNR Slice


Speed Bias [m/s]
1
0.75
0.5
0.25
0
−0.25
−0.5
Speed RMS [m/s]
2.5
2.25
2
1.75
1.5
1.25
1
Direction RMS [deg]
35
30
25
20
15
10
5
38
57
76
95
114
Cross−Track Index
Percent within 45 deg
100
98
96
94
92
90
Low SNR 1 FP
Low SNR 1 Slice
38
57
76
95
114
Cross−Track Index

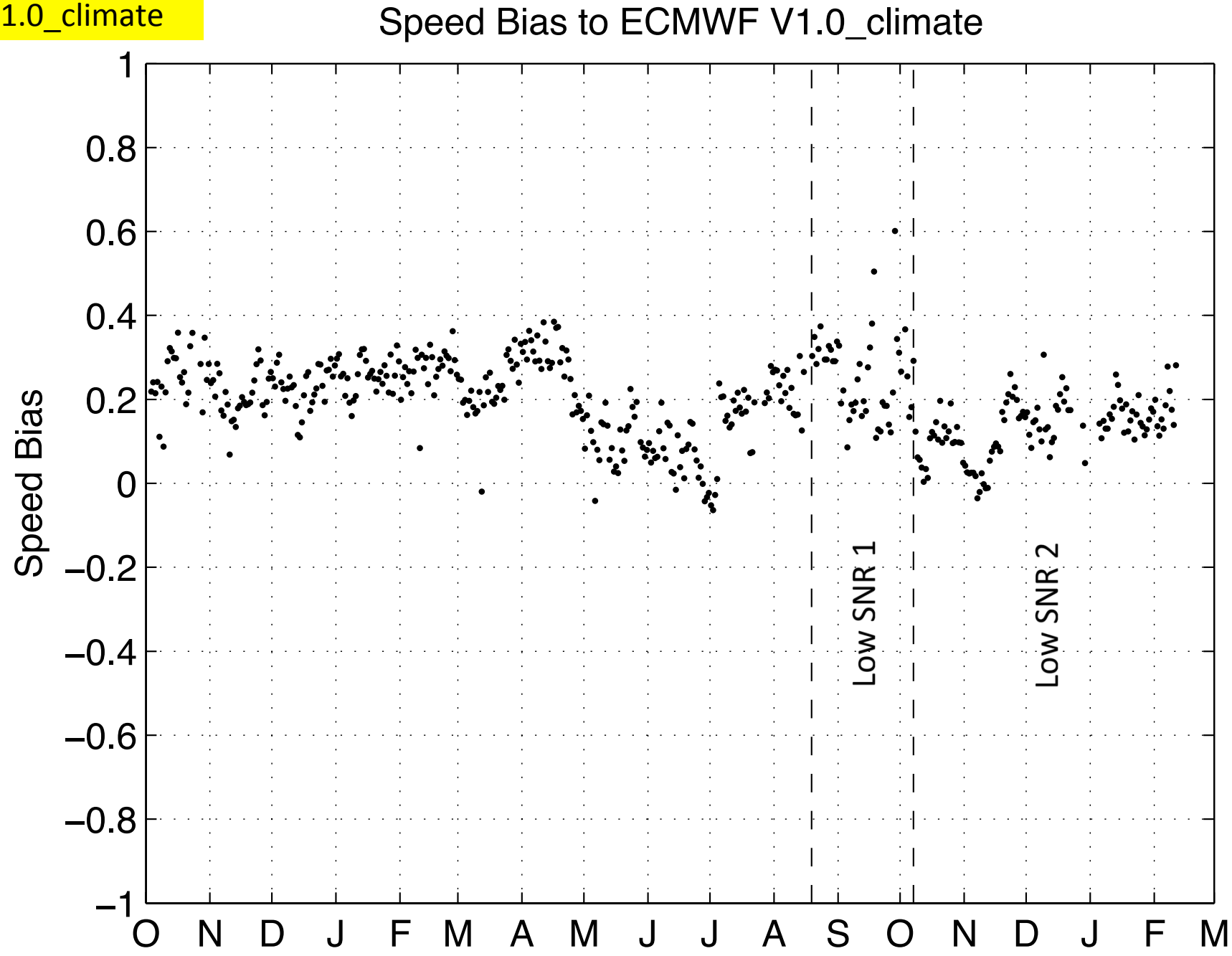

Speed Bias [m/s]
1
0.75
0.5
0.25
0
−0.25
−0.5
Speed RMS [m/s]
2.5
2.25
2
1.75
1.5
1.25
1
Direction RMS [deg]
35
30
25
20
15
10
5
38
57
76
95
114
Cross−Track Index
Percent within 45 deg
100
98
96
94
92
90
Low SNR 2 FP
Low SNR 2 Slice
38
57
76
95
114
Cross−Track Index


Speed Bias [m/s]
1
0.75
0.5
0.25
0
−0.25
−0.5
Speed RMS [m/s]
2.5
2.25
2
1.75
1.5
1.25
1
Direction RMS [deg]
35
30
25
20
15
10
5
38
57
76
95
114
Cross−Track Index
Percent within 45 deg
100
98
96
94
92
90
Low SNR 3 Slice
Low SNR 4 Slice
38
57
76
95
114
Cross−Track Index

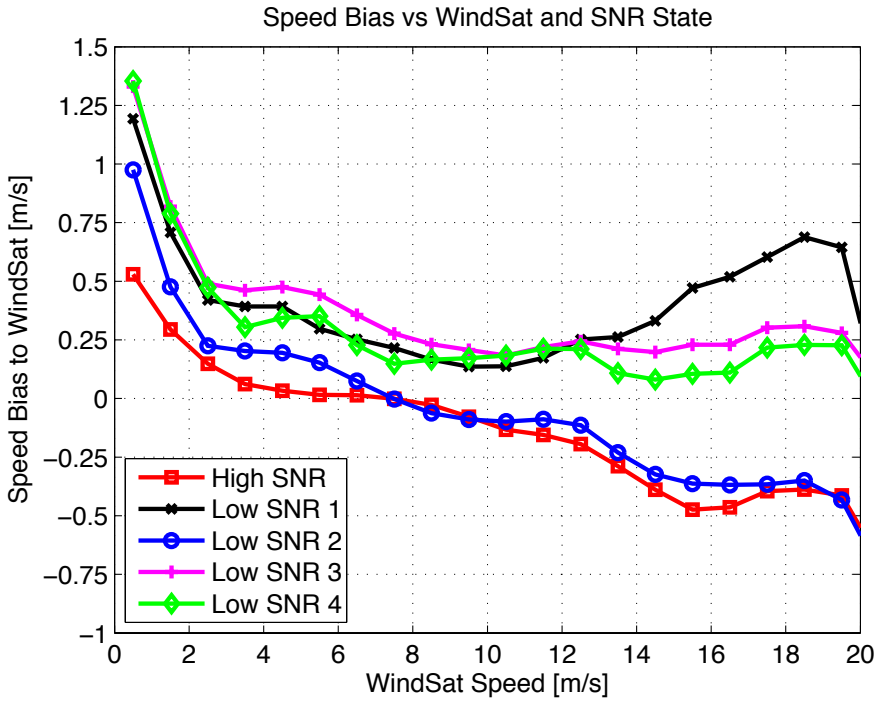
V1.1/V1.2

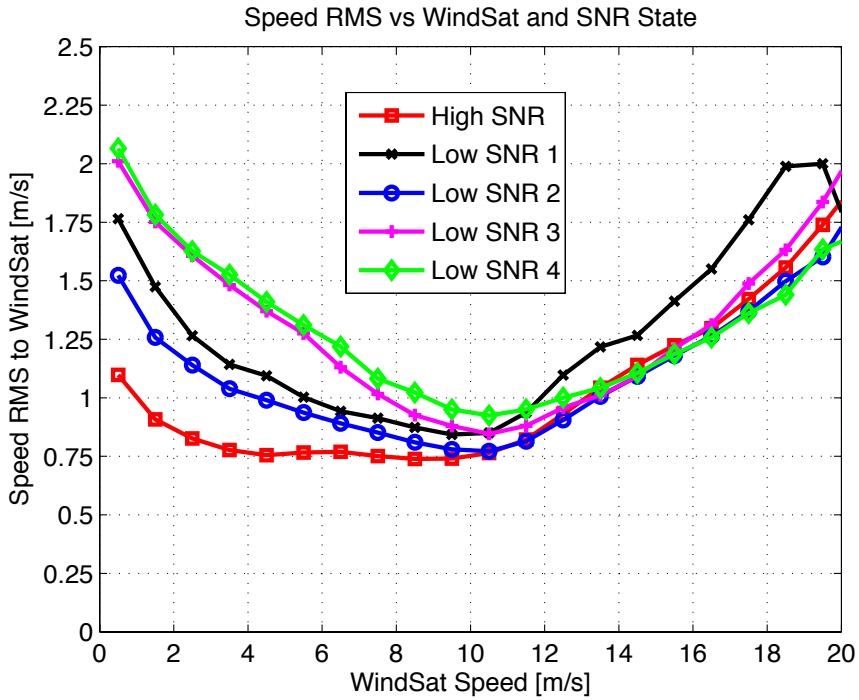

Speed Bias versus ECMWF V1.1 / V1.2
Speed Bias [m/s]
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
O N D J F M A M J J A S O N D J F M A M
Low SNR 1
Low SNR 2
Low SNR 3
Low SNR 4

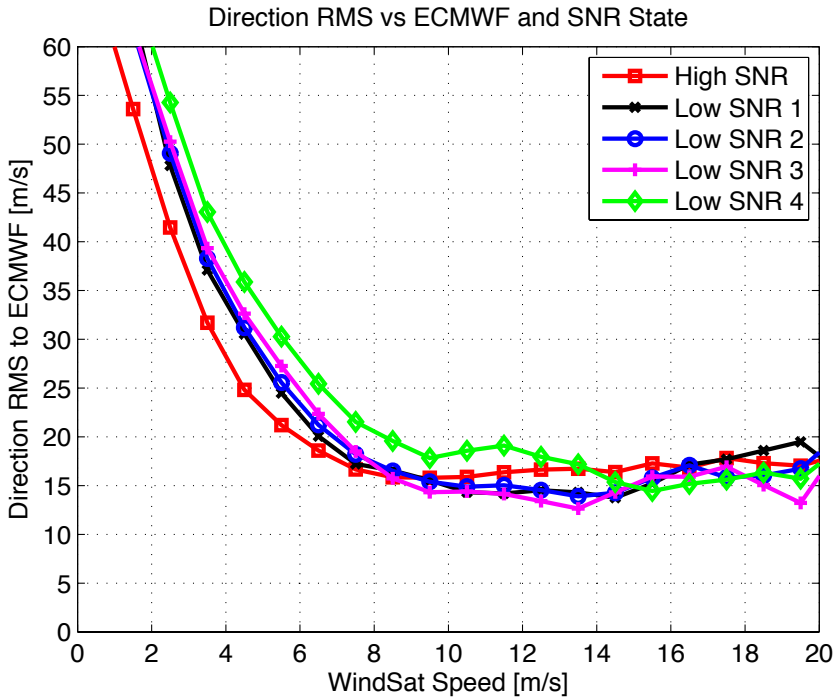
V1.0_climate


Speed Bias to ECMWF V1.0_climate
Speed Bias
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
Low SNR 1
Low SNR 2

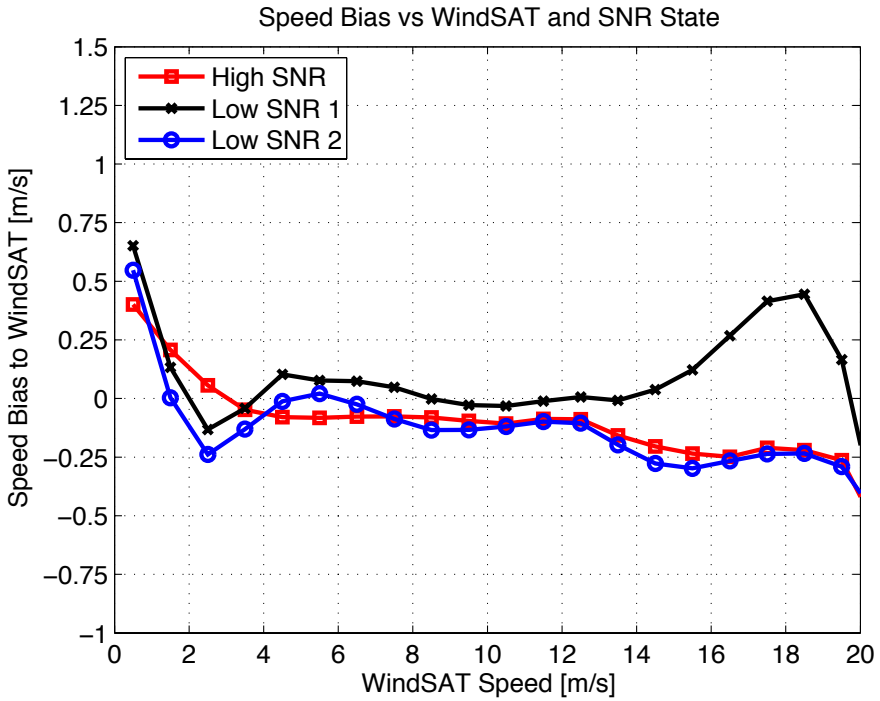
V1.1/V1.2

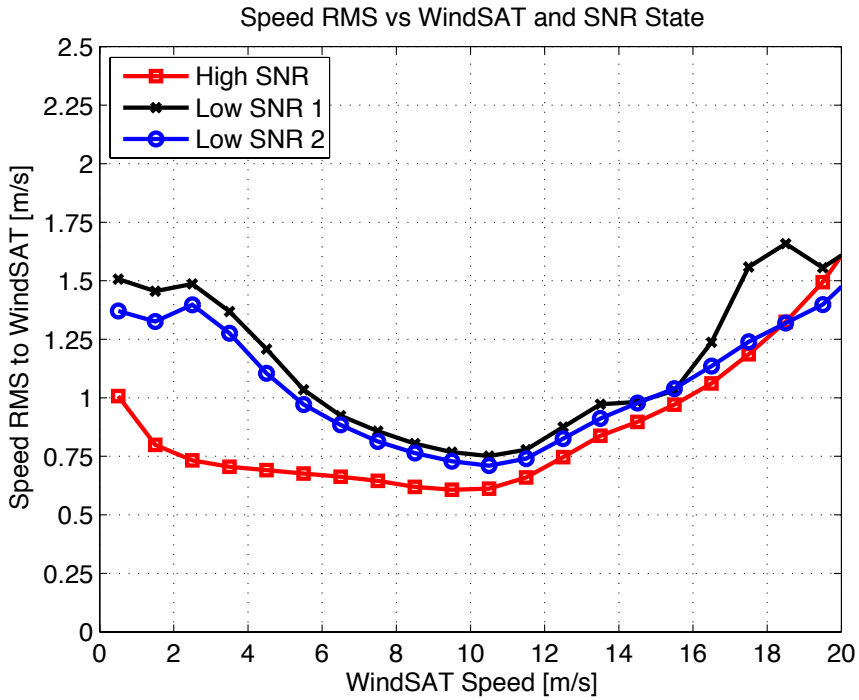

Speed Bias vs WindSat and SNR State
Speed Bias to WindSat [m/s]
WindSat Speed [m/s]
High SNR
Low SNR 1
Low SNR 2
Low SNR 3
Low SNR 4

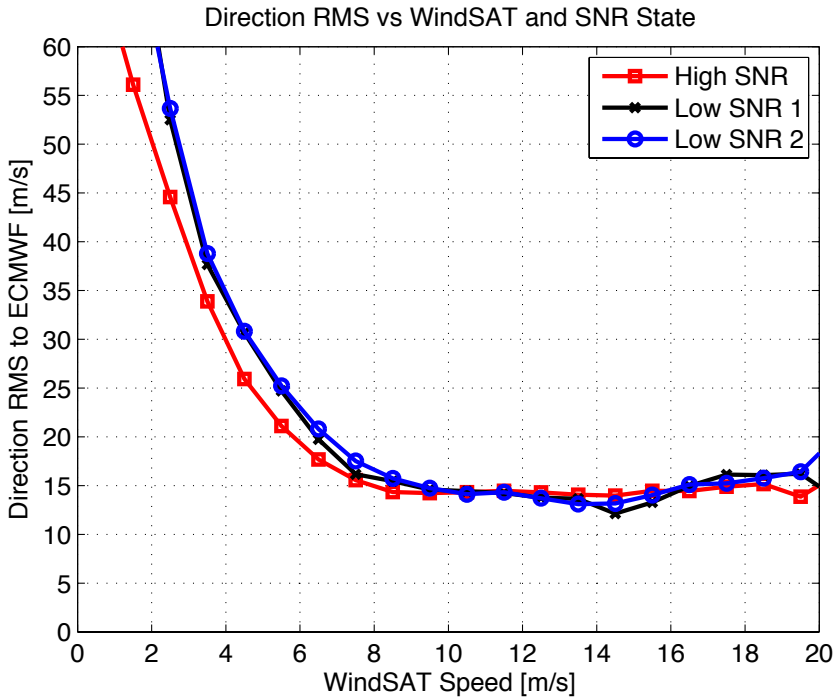

Speed RMS vs WindSat and SNR State
Speed RMS to WindSat [m/s]
WindSat Speed [m/s]
High SNR
Low SNR 1
Low SNR 2
Low SNR 3
Low SNR 4


Direction RMS vs ECMWF and SNR State
Direction RMS to ECMWF [m/s]
WindSat Speed [m/s]
High SNR
Low SNR 1
Low SNR 2
Low SNR 3
Low SNR 4

V1.0_climate


Speed Bias vs WindSAT and SNR State
High SNR
Low SNR 1
Low SNR 2
Speed Bias to WindSAT [m/s]
WindSAT Speed [m/s]


Speed RMS vs WindSAT and SNR State
High SNR
Low SNR 1
Low SNR 2
Speed RMS to WindSAT [m/s]
WindSAT Speed [m/s]

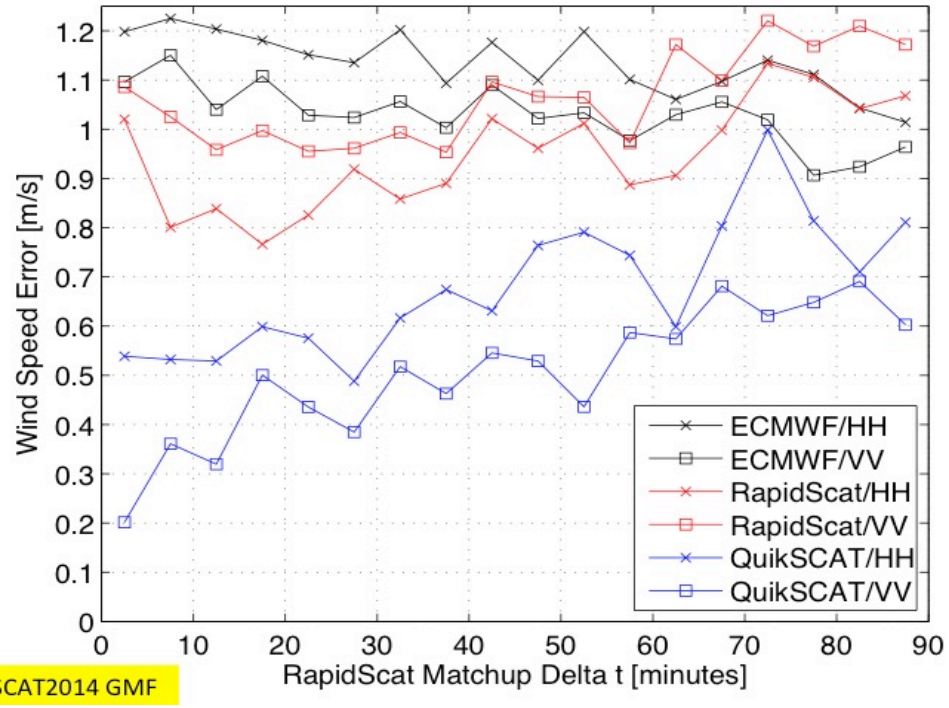

Direction RMS vs WindSAT and SNR State
High SNR
Low SNR 1
Low SNR 2
Direction RMS to ECMWF [m/s]
WindSAT Speed [m/s]

Summary

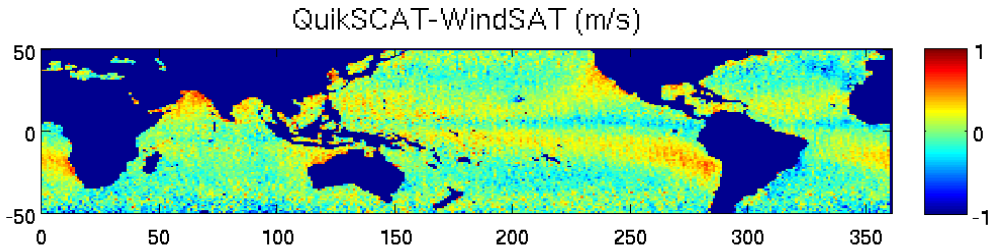
- RapidScat provided 10 months of calibrated data spanning the diurnal cycle about 4 times before the SNR anomaly.
  - Calibration remains stable over time to at least the 0.1 dB level in high SNR.
  - Calibration for Low SNR is also at 0.1 dB, except for low SNR 1.
- RapidScat suffered an anomaly August 15th where SNR dropped by 10.5 dB.
  - Post anomaly, the calibration is stable for each low SNR state.
  - We have adjusted processing algorithms for SNR change.
  - Wind vector performance still meets QuikSCAT requirements above 6 m/s or so.
- The V1.0_climate data is recommended for everyone unless:
  - Need data as quick as possible (use NRT data).
  - Want highest-resolution data (use V1.1/V1.2 data).
  - Insensitive to ~ 0.5 m/s biases with cross-track or pitch (footprints are far easier to calibrate).
- We will continue to monitor and adjust RapidScat calibration with each new low SNR epoch.
  - QuikSCAT plays an essential role in our calibration strategy for RapidScat.
  - Footprint climate data will lag slice composite data for each low SNR epoch.

QuikSCAT 2010-2015 (nonspinning) wind speed and backscatter data (Available at podaac.jpl.nasa.gov)

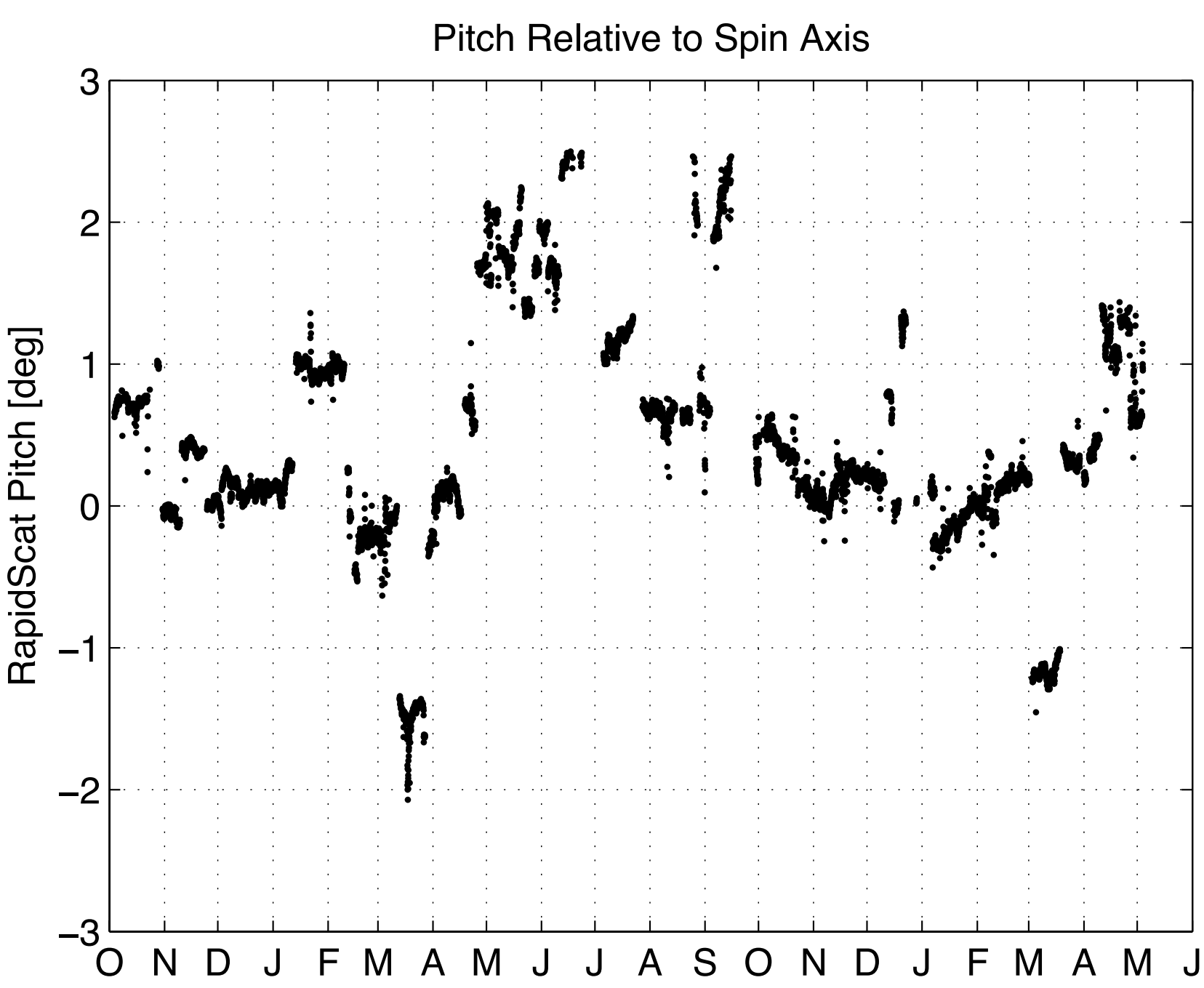
Triple Colocation random error for ECMWF, RapidScat, and QuikSCAT nonspinning data



NSCAT2014 GMF

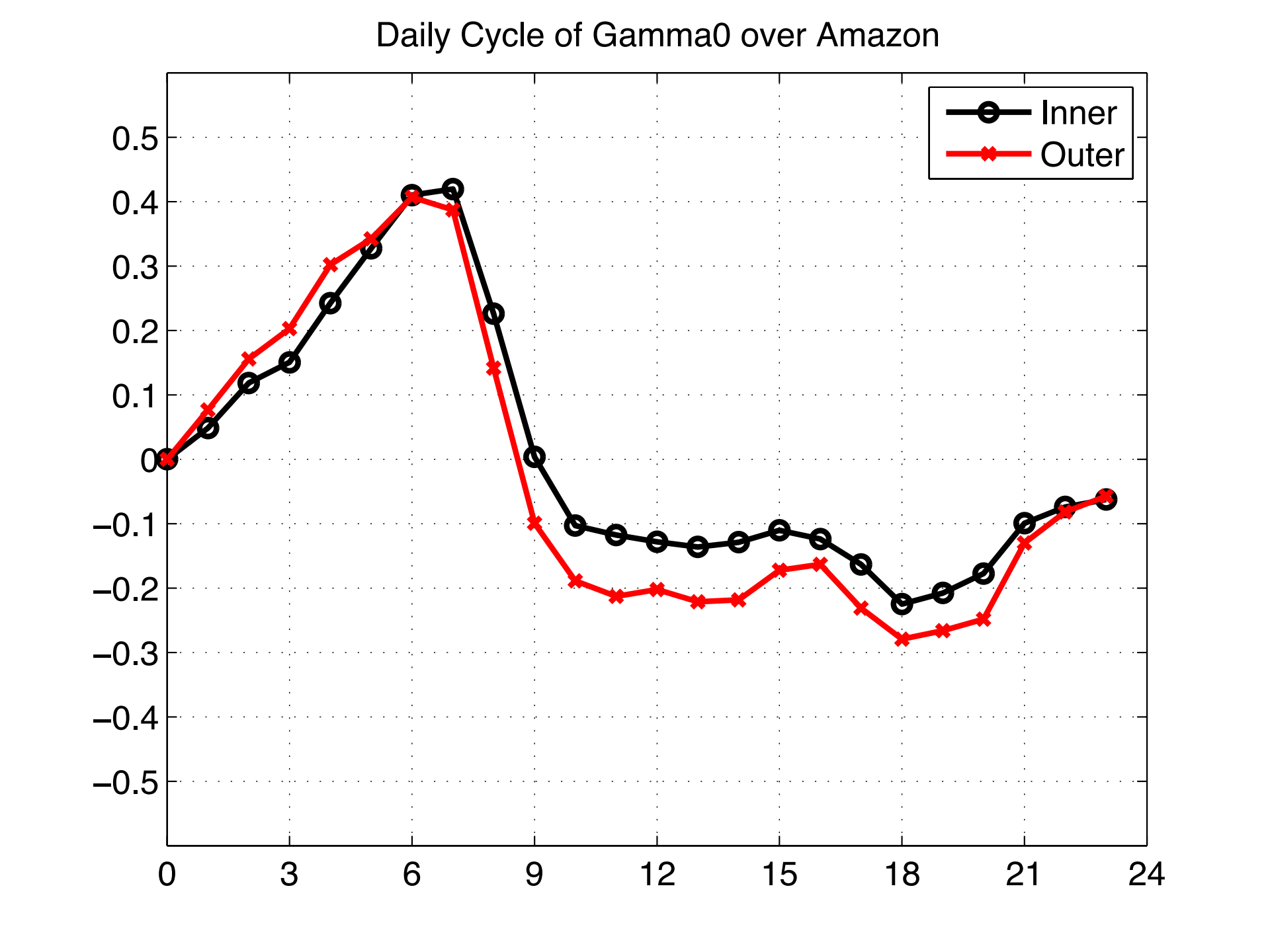


- Most precise spaceborne Ku-backscatter and wind speed measurements available
- Individual 25-km measurement precision is 0.1 m/s as evidenced by comparison between consecutive independent measurements.
- Wind speed accuracy is upper bounded by 0.5 m/s by comparison with ECMWF and RapidScat in triple colocation studies.
- Despite use of ECMWF wind direction to determine wind speeds, QuikSCAT nonspinning wind speeds agree much better with WindSAT than ECMWF.
- Backscatter measurements also available; used to calibrate RapidSCAT data
- Their precision makes QuikSCAT nonspinning measurements suitable for examining mesoscale spectra of wind speed fields and sensitivity of backscatter to er effects such as SST, currents, and other phenomena difficult to observe in wind fields with 1.0 m/s random error.


Pitch Relative to Spin Axis
RapidScat Pitch [deg]
3
2
1
0
−1
−2
−3
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J

Amazon Calibration Methodology

- Generate all QuikSCAT intervals (one week per beam).
  - Pick RS data from same beam.
  - Perform a local time of day correction to QS and RS to 0 UTC.
  - Average each over that week to generate one estimate of RS-QS calibration bias.
- Repeat for all QuikSCAT intervals.
- Average over each SNR epoch.


Daily Cycle of Gamma0 over Amazon
Inner
Outer
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
0
3
6
9
12
15
18
21
24