# Using ASCAT Overlaps to Develop Rain flagging and Corrections for ScatSAT Winds

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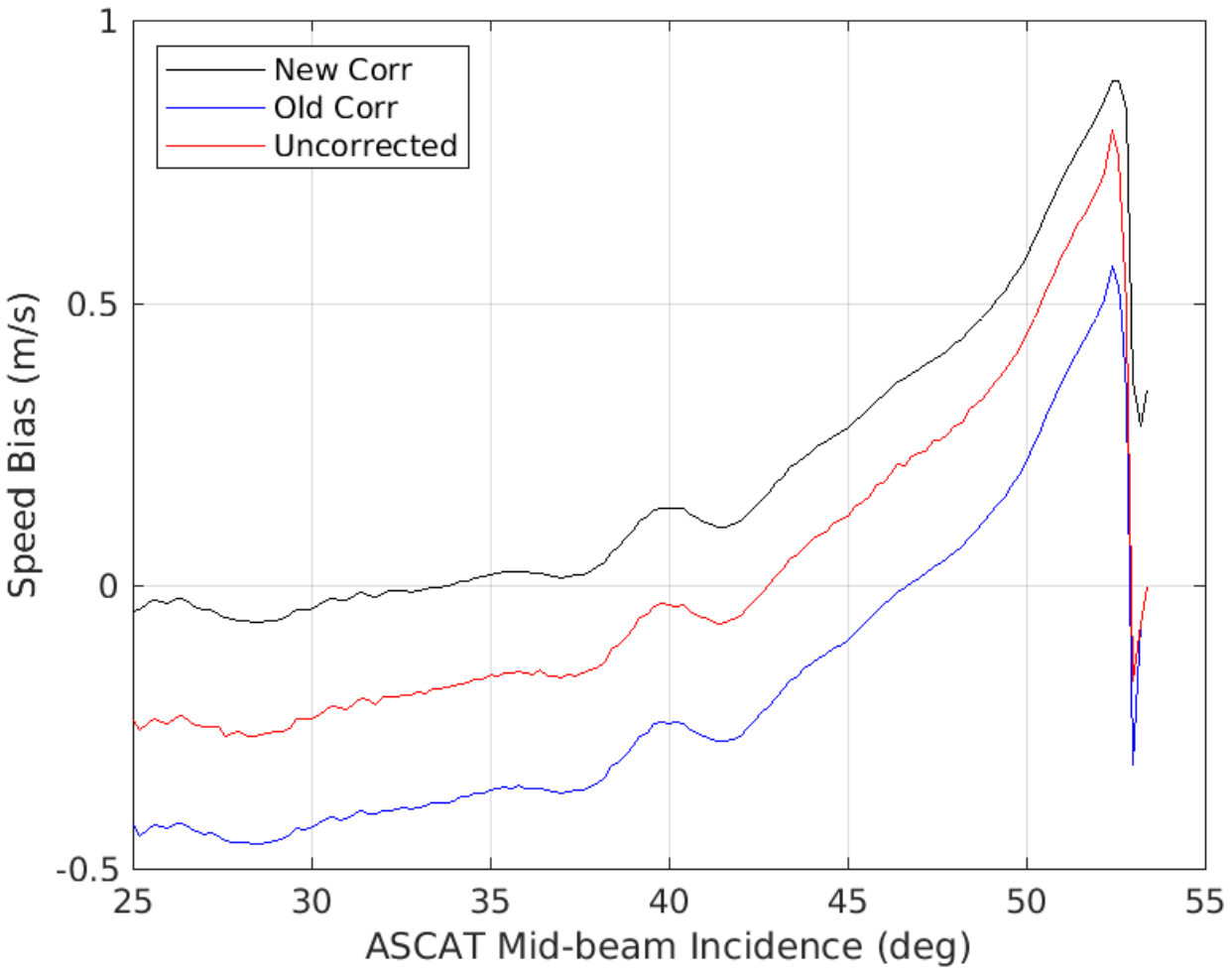
# Overview

- Description of Method
- Preliminary ScatSAT Speed, U, and V, Correction Validation
- Preliminary ASCAT Flagging Statistics
- Future Work
- Task Plan Milestones

# Description of Method

- Trained multi-layer neural networks to match ASCAT-B speed, zonal wind, and meridional winds from input vector of ScatSAT retrieved wind, 4 look sigma-0s, brightness temperature, and cross track distance.
  - Needed to include a mid-beam ASCAT incidence angle input, suggesting we at JPL do not have the full ASCAT-B calibration numbers with incidence. (See next slide)
  - Using https://archive.eumetsat.int, ASCAT GDS Level 1 Sigma0 at Full Sensor Resolution; Not using any additional corrections; No C-band atmospheric attenuation correction, etc.
- Excluded data:
  - above 60 N and below 60 S,
  - with temporal matchup separated by more than 30 minutes, (except for map plots which use all data within 90 minutes)
  - with mid beam incidence angle greater than 40 degrees,
  - with any missing C-band or Ku-band looks.
  - with ASCAT sigma-0 greater than unity (0 dB).
- Validation results for >3000 orbits of ScatSAT data.
  - Training data set < 1/100 the size of the overlapping validation data set.

# ScatSAT-ASCAT speed bias as a function of ASCAT incidence angle




Bias varies significantly with incidence angle for incidence angle values above 40 degrees.

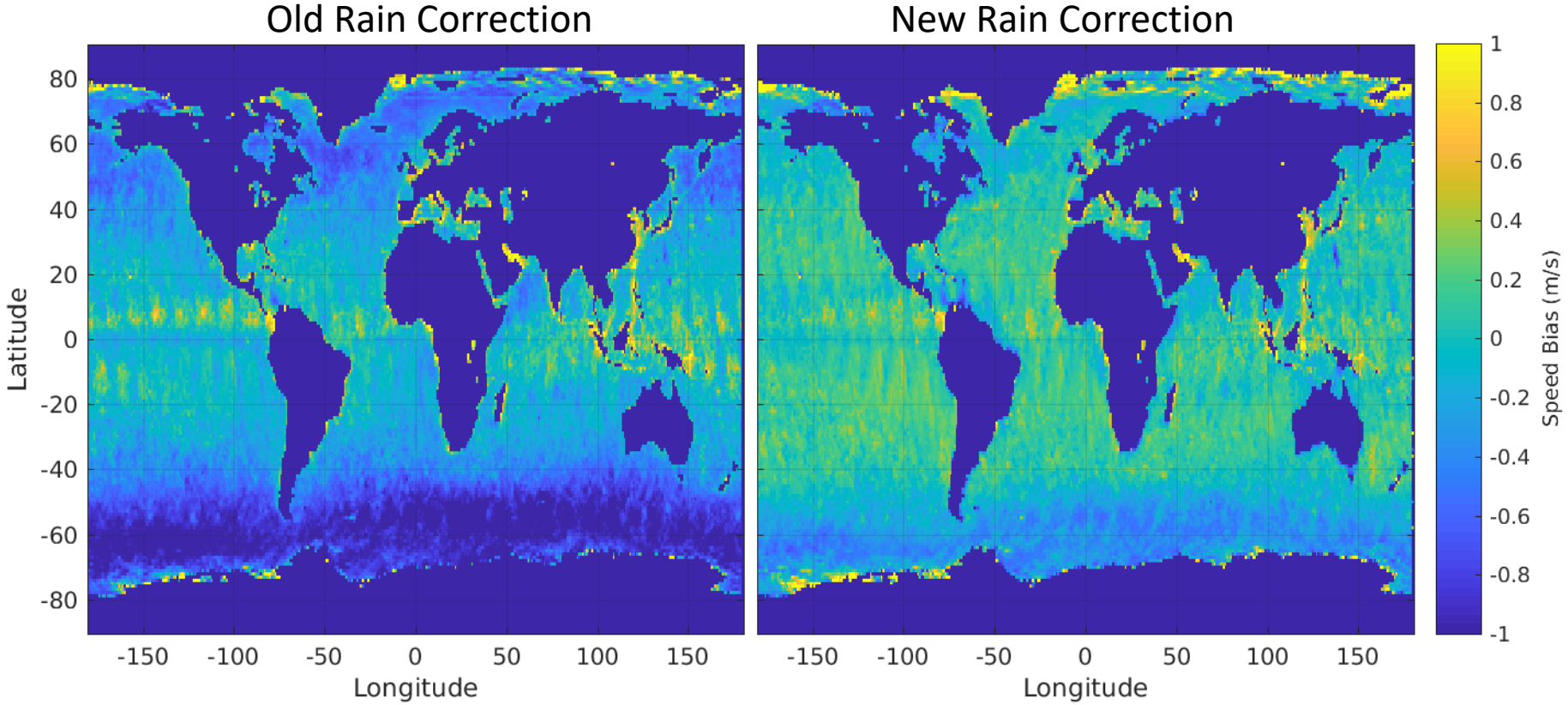
For now we use a ScatSAT correction tuned for 35 degree ASCAT mid-beam incidence.

We exclude ASCAT data with mid-beam incidence above 40 degrees from validation results.

# ScatSAT- ASCAT Speed Bias

## (90 minute time co-location)

Green is zero bias.




Using a neural network to tune Ku-band speeds to match C-band:

1. Reduces biases due to rain (see following slides).
2. Eliminates latitudinal biases due primarily to SST determined from brightness temperature.
   (Latitude is not an input to the neural network)

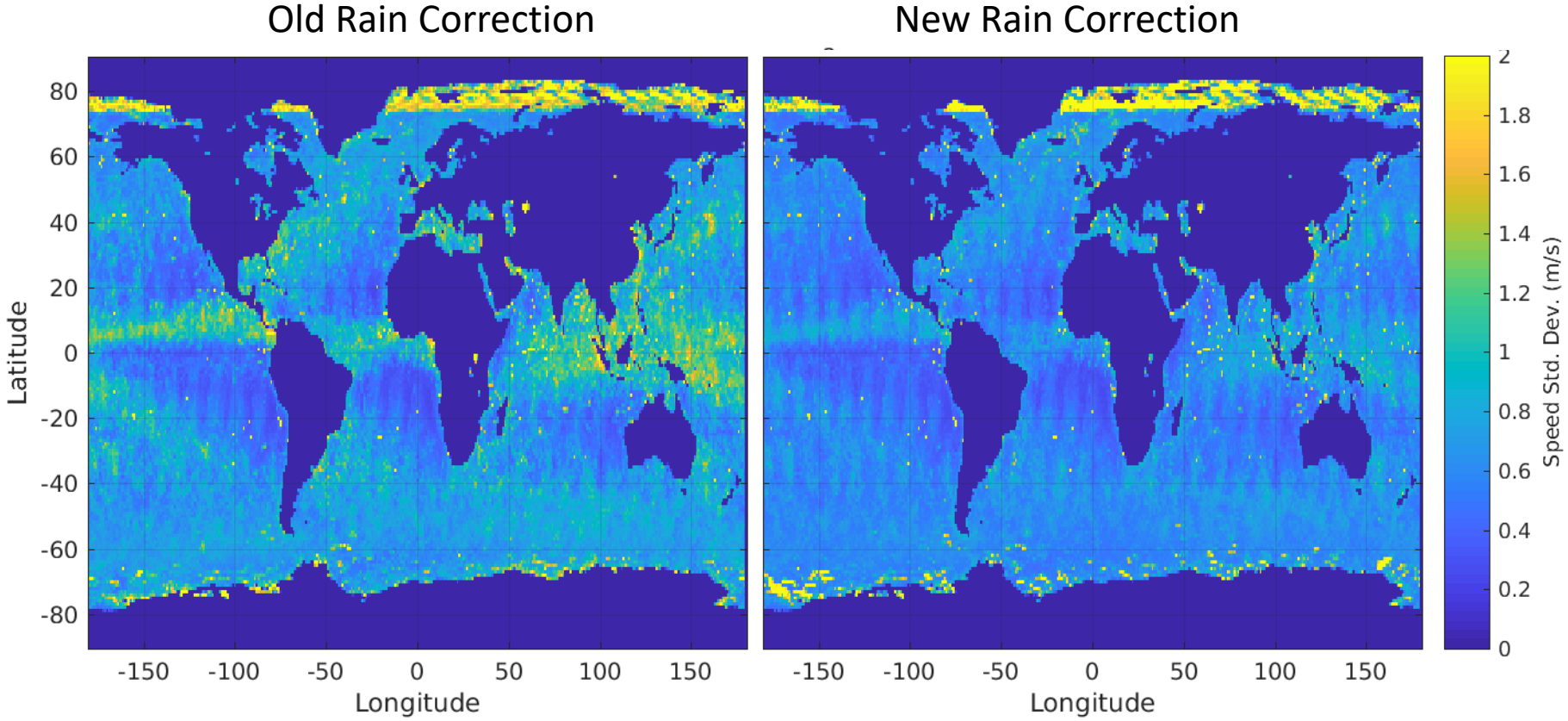
Need to apply SST-dependent RapidSCAT GMF to ScatSAT and repeat.

Also need to compare KNMI ASCAT retrievals and/or correct incidence angle errors in JPL retrievals.

# ScatSAT- ASCAT Speed Std. Dev.

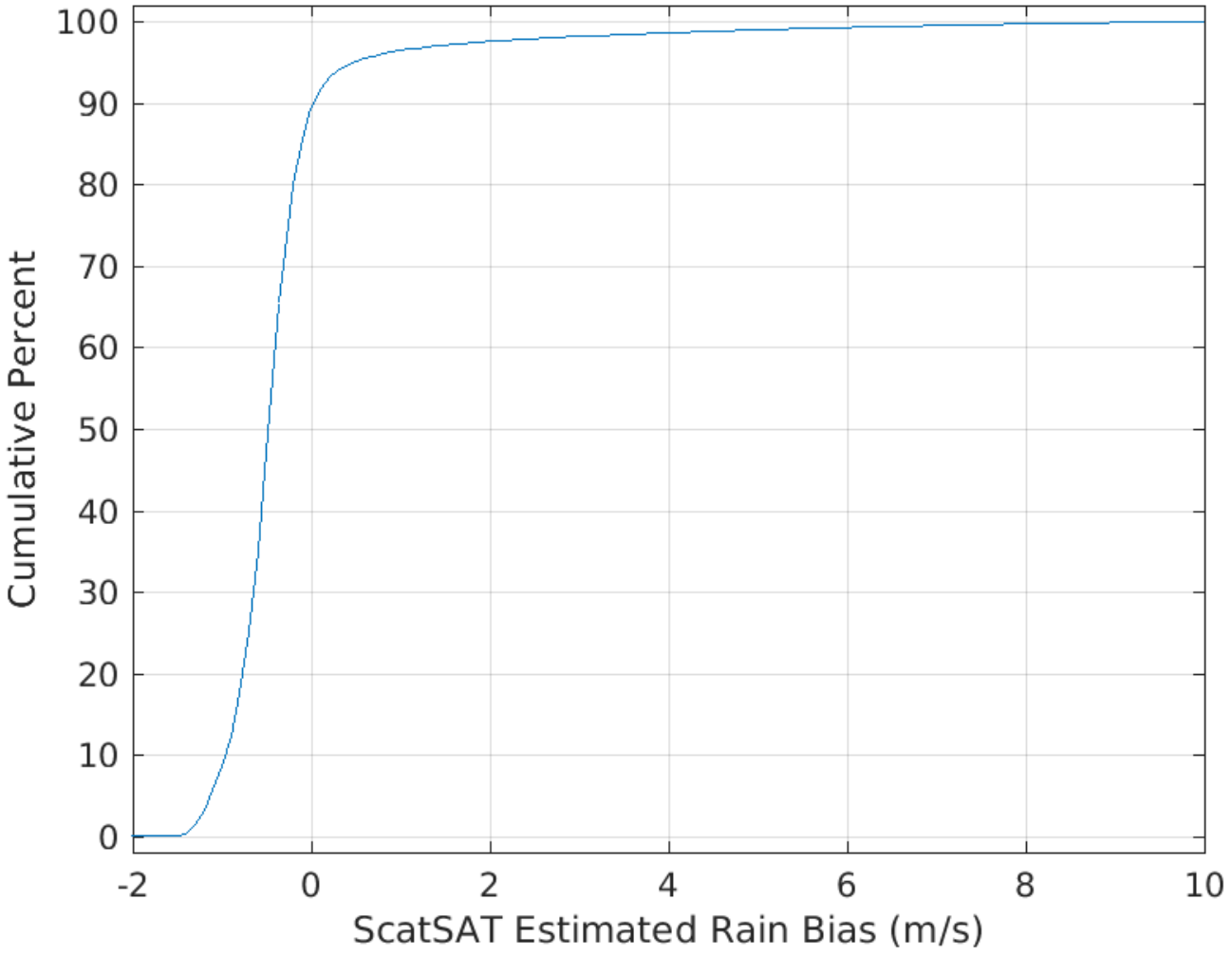
(90 minute time co-location)

Dark blue is zero  std. dev. or land




1. Standard deviation between sensors is reduced in rainy areas.
2. One reason for the pronounced decrease is that speeds are always corrected not just in the rainiest 2% of data.
3. Ice flagging in high latitudes needs improvement at least for ScatSAT, possibly ASCAT JPL retrievals as well.

# ScatSAT-ASCAT percentile vs. flag quantity

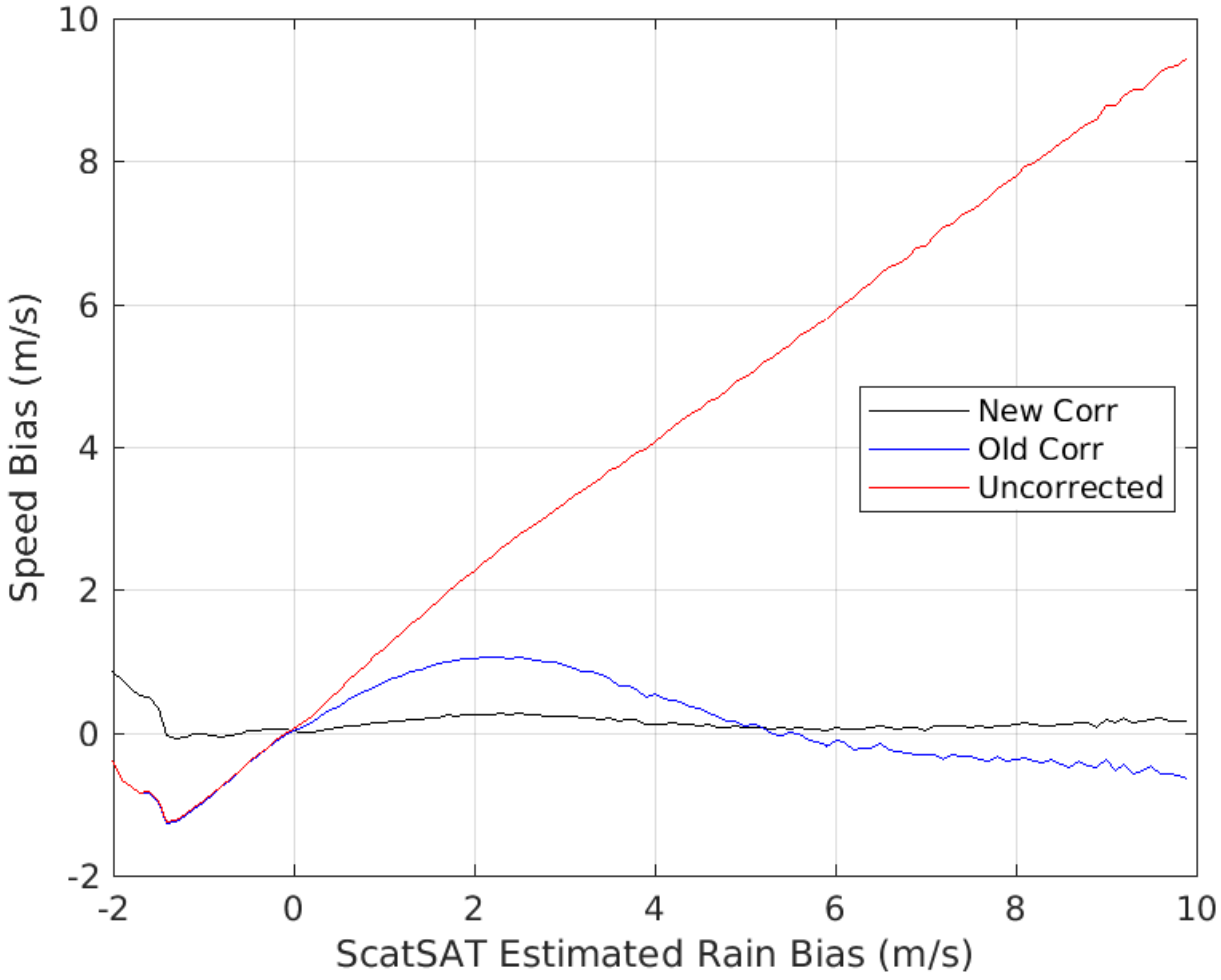



In the new Ku-band flagging technique, the flag quantity is *the estimated speed bias*, that is -1 times the new neural network speed correction.

Y=percent of data for which the estimated speed bias > X.

When Y=50%, X=-0.3 m/s the median bias for ASCAT incidence angles less than 40 degrees. Roughly 3% of the data have rain induced speed biases > 2 m/s.

# ScatSAT-ASCAT speed bias vs. flag quantity



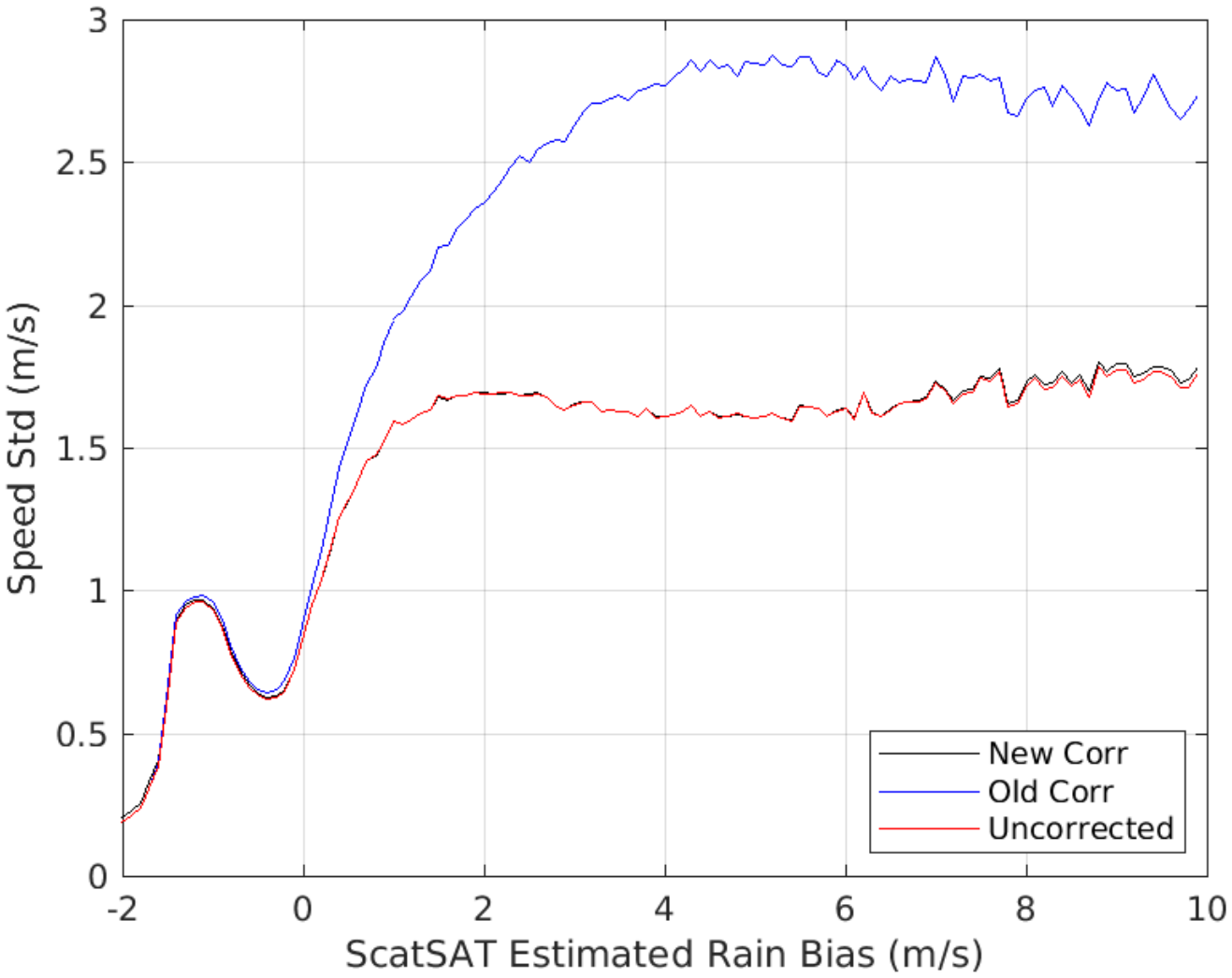

Y= the actual speed bias
X= the neural network estimate

The uncorrected data has an actual bias very similar to the estimate,

The new correction which subtracts that estimate is mostly unbiased except for the very rare cases in which the estimated bias is less than -1.3 m/s.

The old correction overcorrects for high rain, because it was trained using NWP winds, and undercorrects light rain because only 2% of the data is corrected.

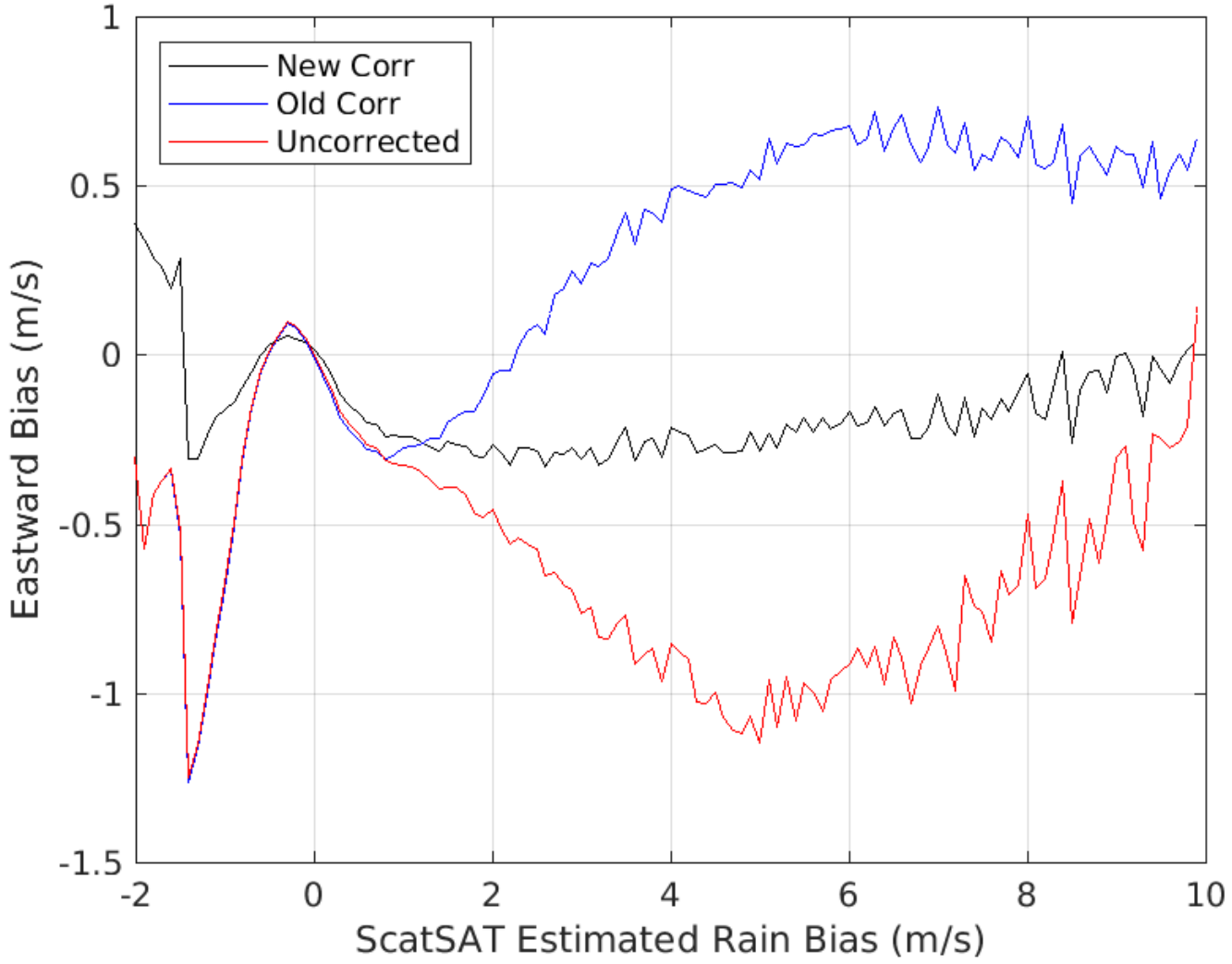
# ScatSAT-ASCAT speed std. dev. vs. flag quantity




The standard deviation for the new correction is similar to that of the uncorrected data.

The standard deviation for the old correction was substantially worse, possibility because of the binary choice used to apply or not apply a correction.

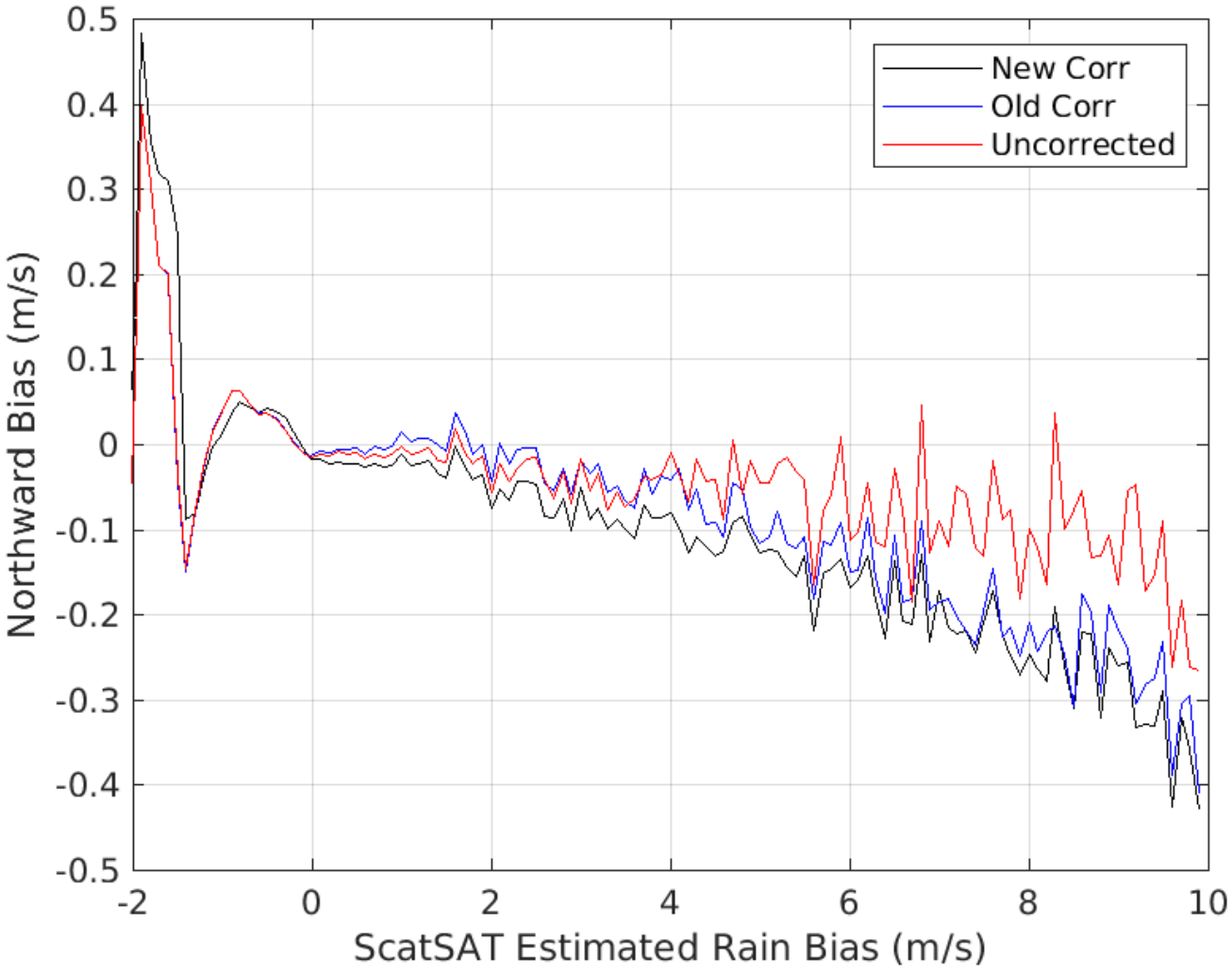
# ScatSAT-ASCAT eastward bias vs. flag quantity




The eastward zonal bias in the winds is greatly reduced in the new correction as opposed to the uncorrected case and the older correction that is currently used in the JPL ScatSAT retrievals.

It is unclear where the improvement is due to the new cross track and along track component correction or just the better speed correction.

# ScatSAT-ASCAT northward bias vs. flag quantity




The biases in the northward wind component is small to start out with and is not improved by either rain correction method.

The correction slightly worsens the bias especially for high rain conditions.

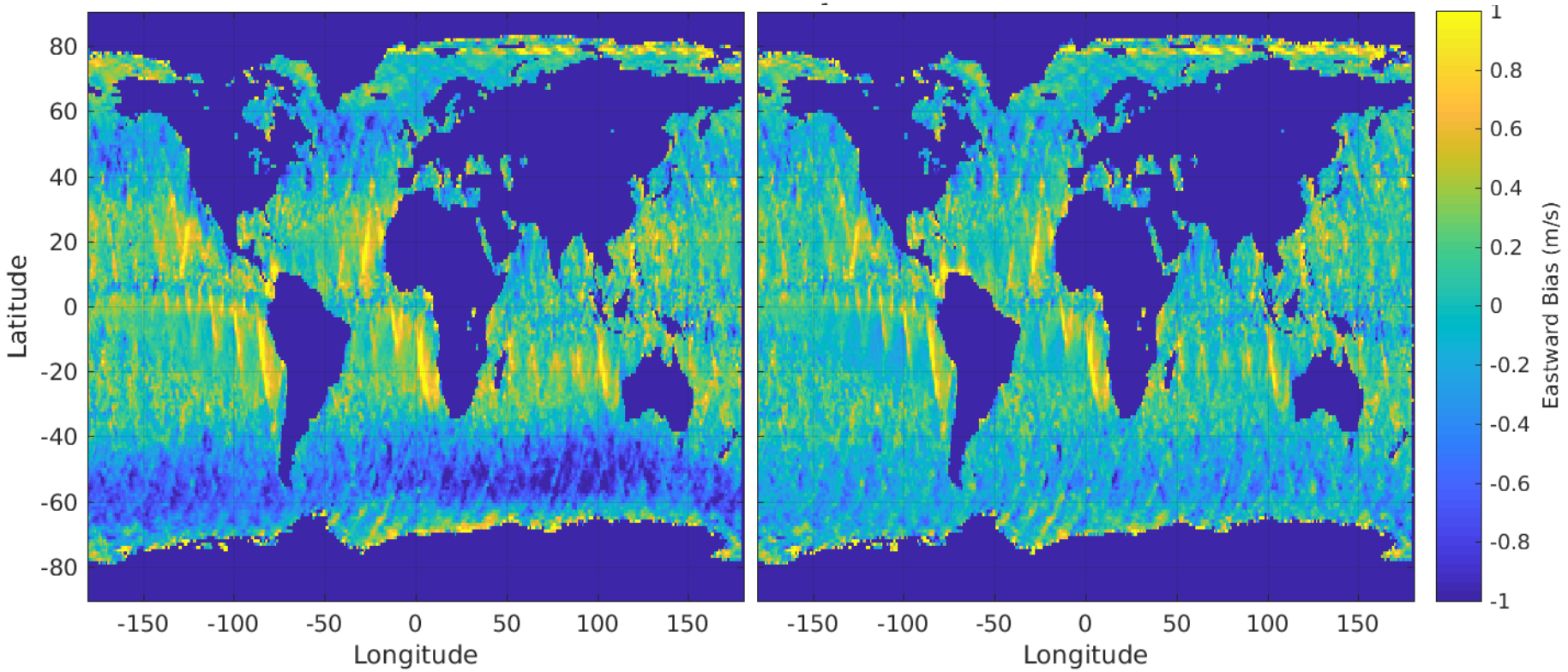
# ScatSAT- ASCAT Eastward Bias

## (90 minute time co-location)

Green is zero bias.

Old Rain Correction

New Rain Correction



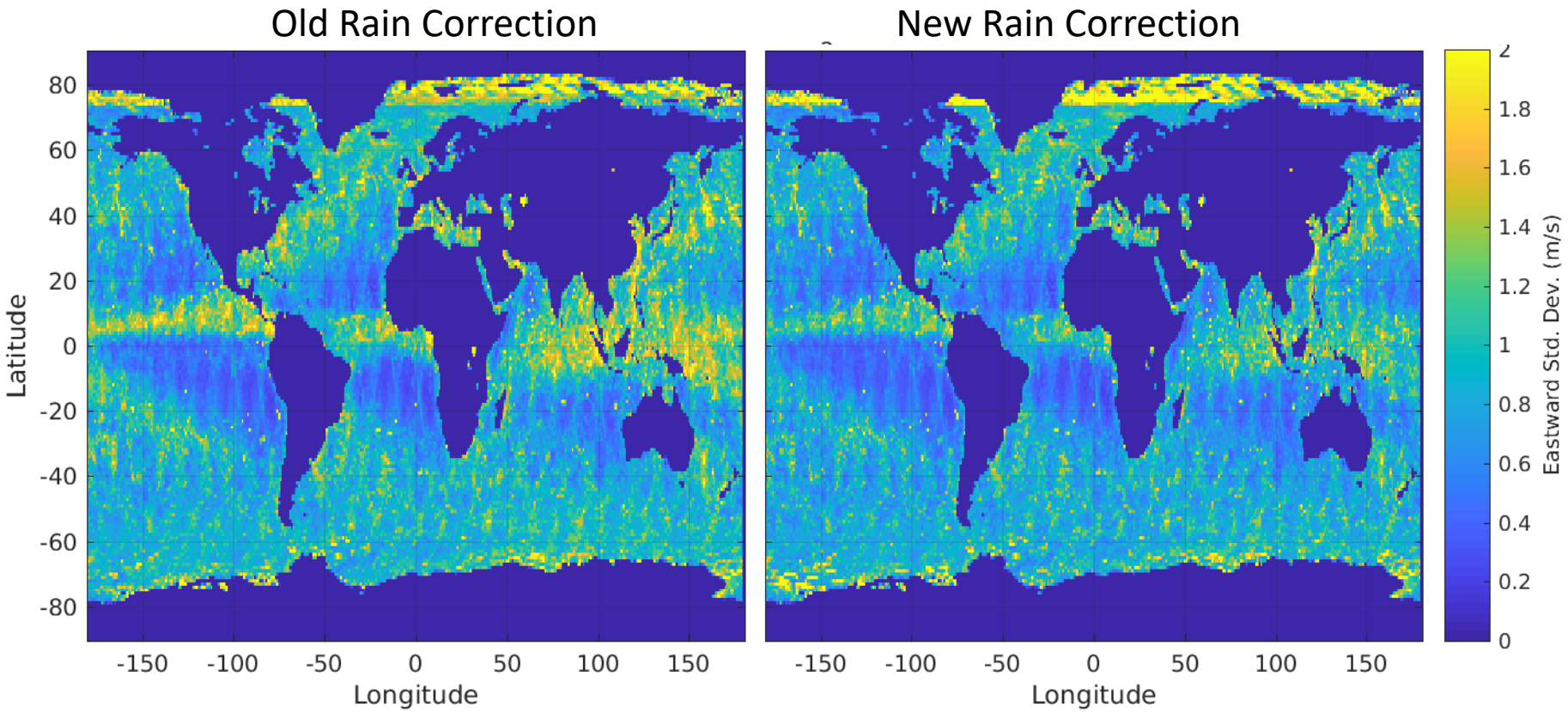

The new correction reduces zonal biases globally and improves but does not entirely fix the biases we see that appear to be associated with particular tracks.

Two candidates for the source of the track dependent biases, are:

1. Circular features in individual swaths due to a ScatSAT geolocation bug.
2. Issues with retrieval near edges of dual beam swath or in center of swath.

# ScatSAT- ASCAT Eastward Std. Dev.

## (90 minute time co-location)

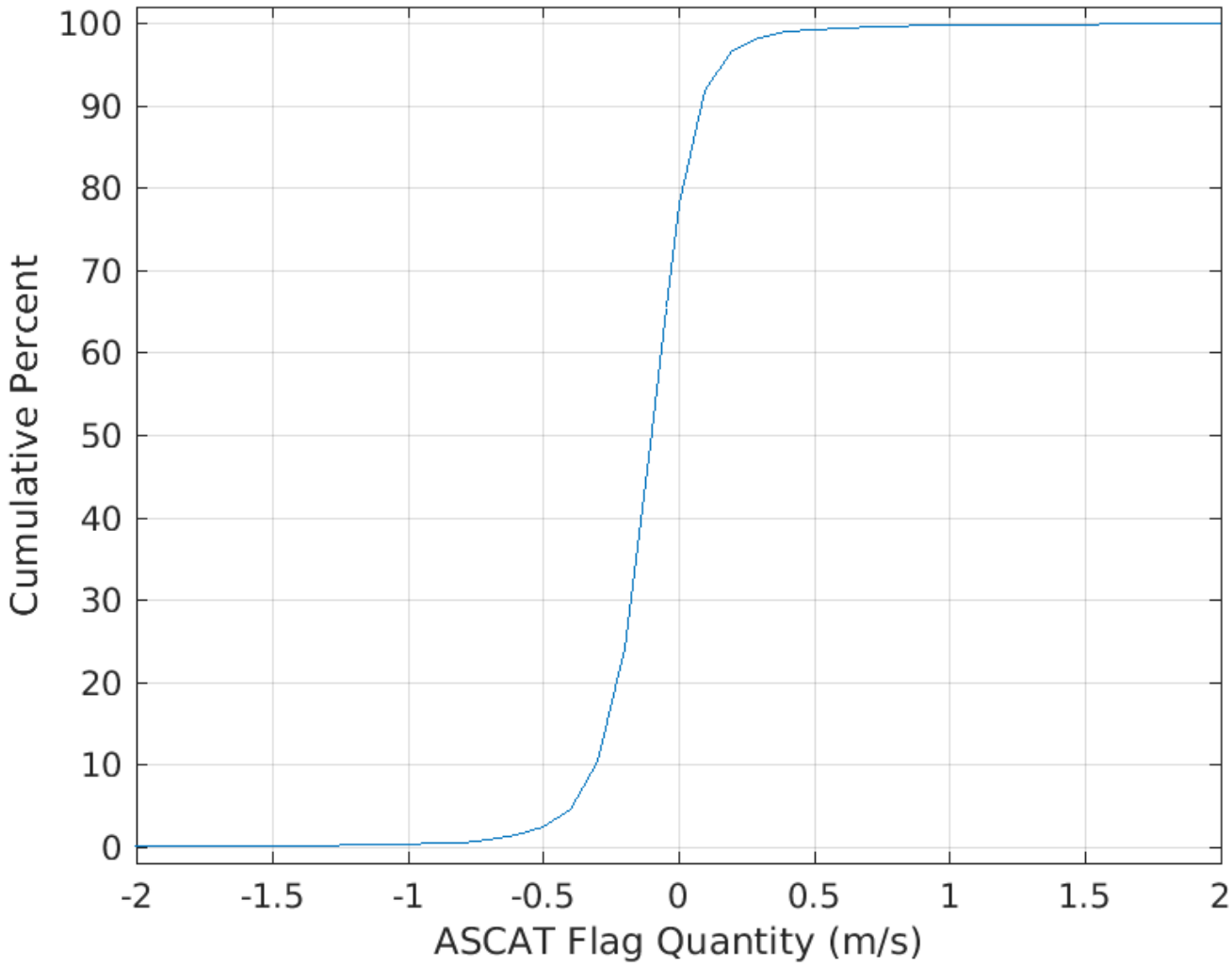



Zonal standard deviation is reduced in rainy areas by new correction.

Not much change anywhere else.

Ice flagging needs work.

# Percentile vs. ASCAT flag quantity



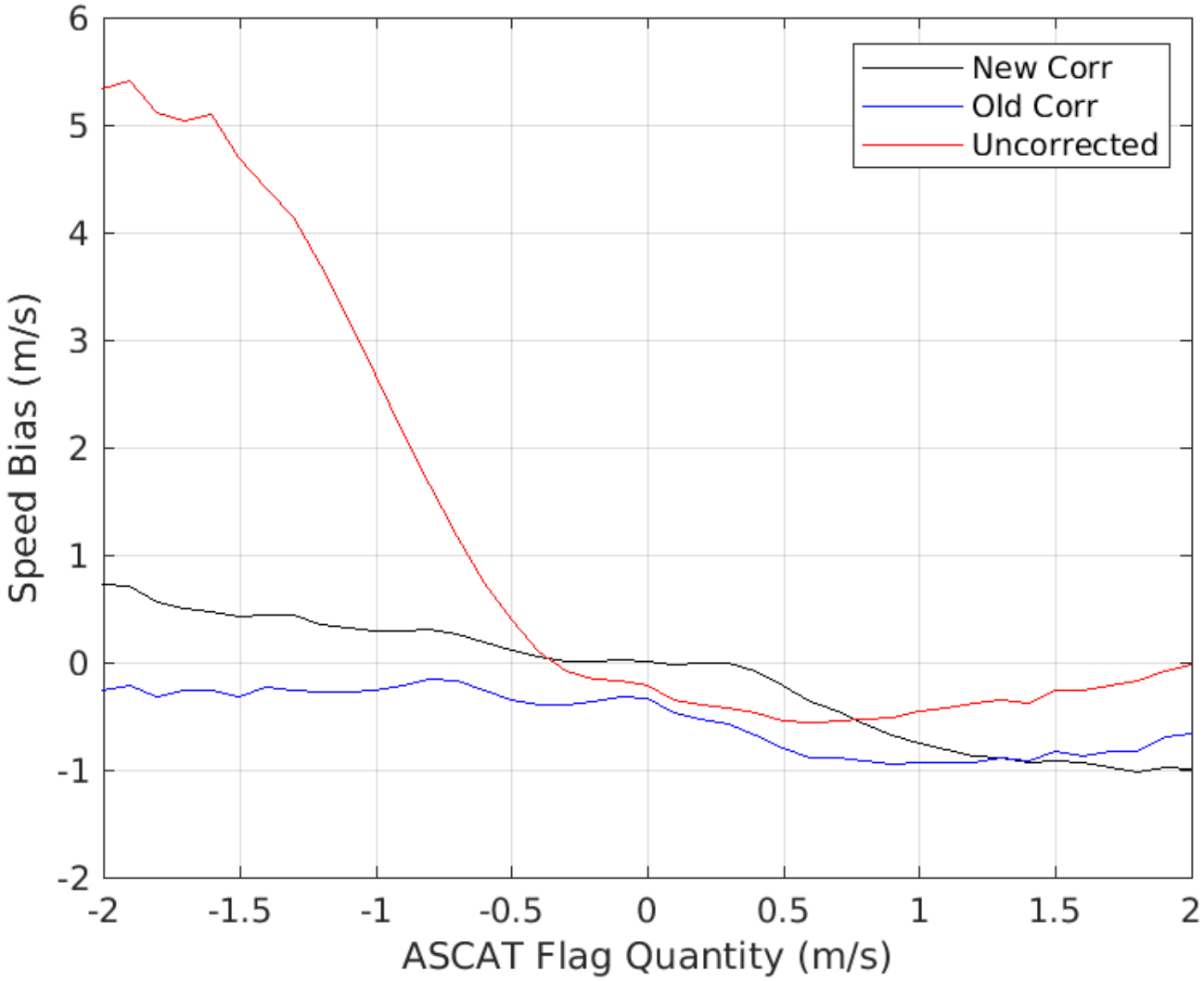

ASCAT flag quantity is S-M where:

M= the mean over all three looks of the expected wind speed given the measured sigma-0 and the retrieved direction.

S= the retrieved speed.

Y= Percentage of data such that the M-S is greater than X.

# ScatSAT-ASCAT Speed Bias vs. ASCAT flag quantity




Low values of S-M correspond to rainy data where the SCATSAT (uncorrected) retrieved wind speed is much larger than the ASCAT retrieved speed.

This metric is similar to the inside/outside of the cone metric used by KNMI.

# Future Work and Discussion:

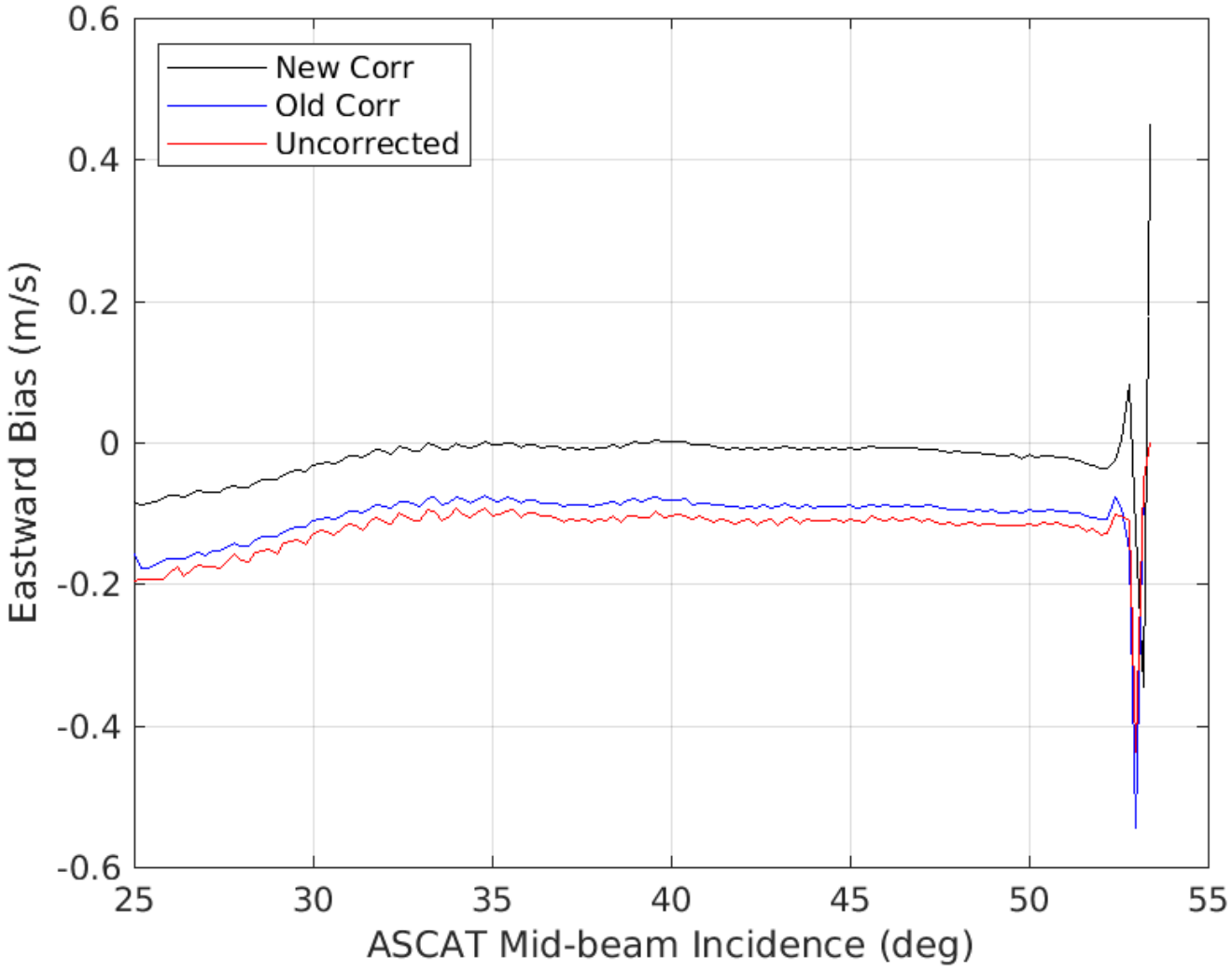
- Retrieve ScatSAT data using SST dependent GMF, then retrain correction
- Modify ASCAT GMF to better match rain-free ScatSAT data; Incorporate ASCAT incidence angle dependent calibration
- Compute and remove ASCAT biases in rain as a function of ASCAT flag quantity.
- Train rain correction using nearest ambiguity to ASCAT;  Do ambiguity removal and DIRTH after correction is applied.

# Consistent Rain Flag: Task Plan Milestones

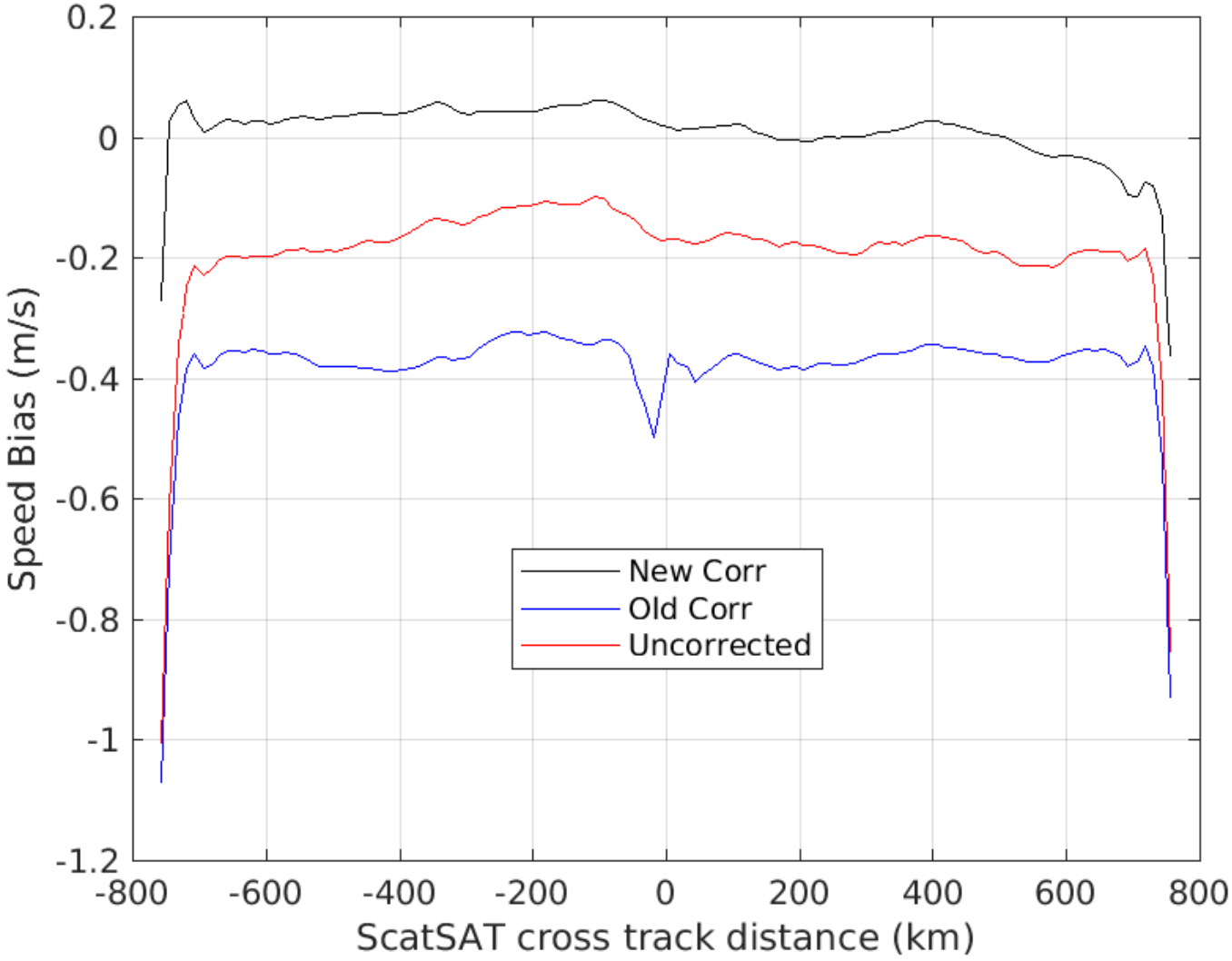
- April 1, 2020.  Deliver two-years of ScatSAT and ASCAT rain flags and ScatSAT corrected speed data to OVWST team members.
- Dec 1, 2020. Publish peer-reviewed journal article on rain flagging and correction method for ScatSAT
- April 1, 2021  Deliver full (1999-2009) QuikSCAT flagged and speed corrected data set to public via PO.DAAC.
- Nov 1, 2021 Deliver ASCAT rain flag and ScatSAT corrected speeds and rain flag data set for all data acquired by those sensors before Dec 31, 2020 to public via PO.DAAC.
- Dec 1, 2021. Publish peer-reviewed journal article on consistent rain flagging method for QuikSCAT and ASCAT.
- Apr. 1, 2022 Deliver volume of latest ASCAT rain flagged and ScatSAT speed corrected and rain flagged data to the public via PO.DAAC.

# Backup Slides

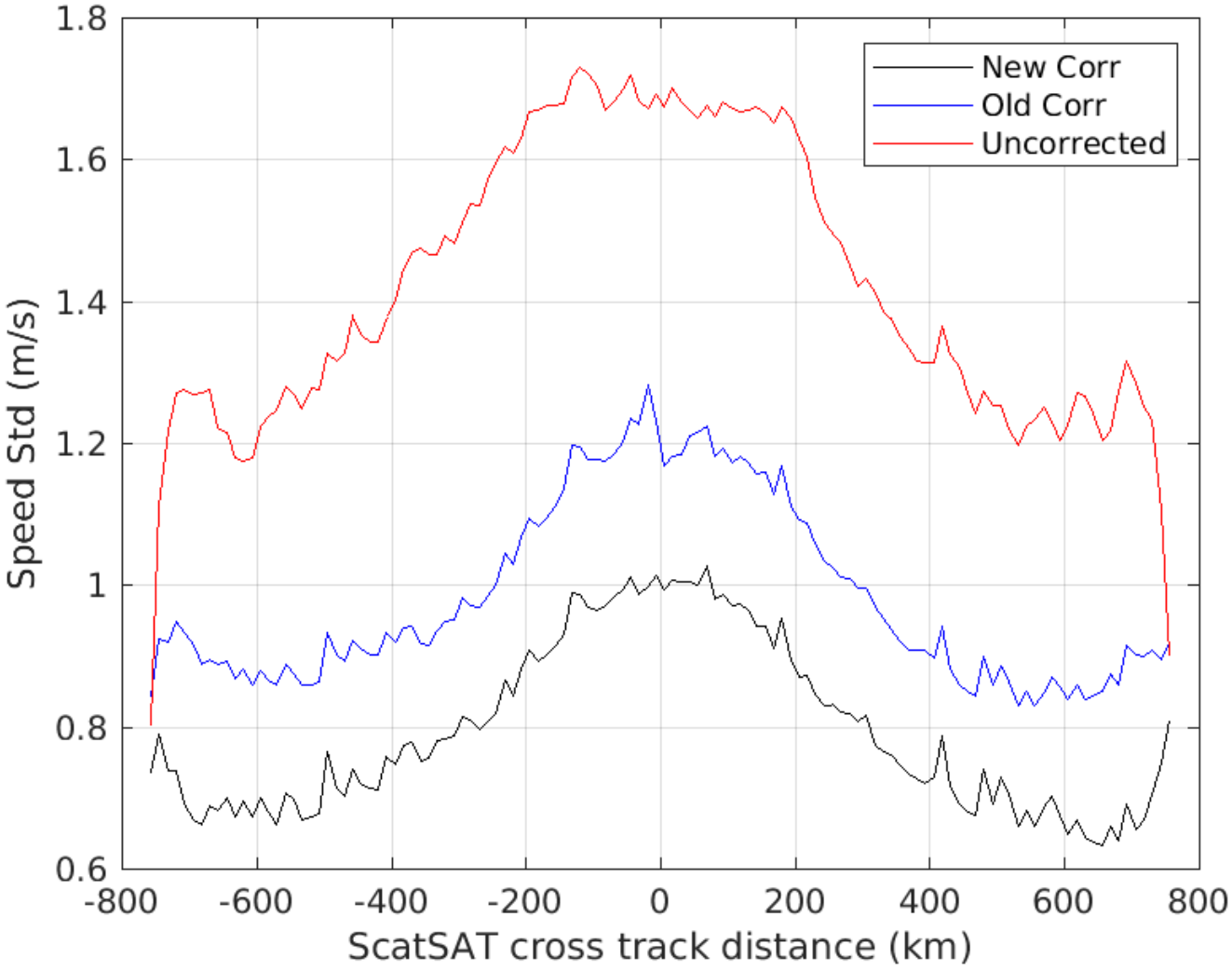
# ScatSAT-ASCAT Eastward bias vs. ASCAT incidence



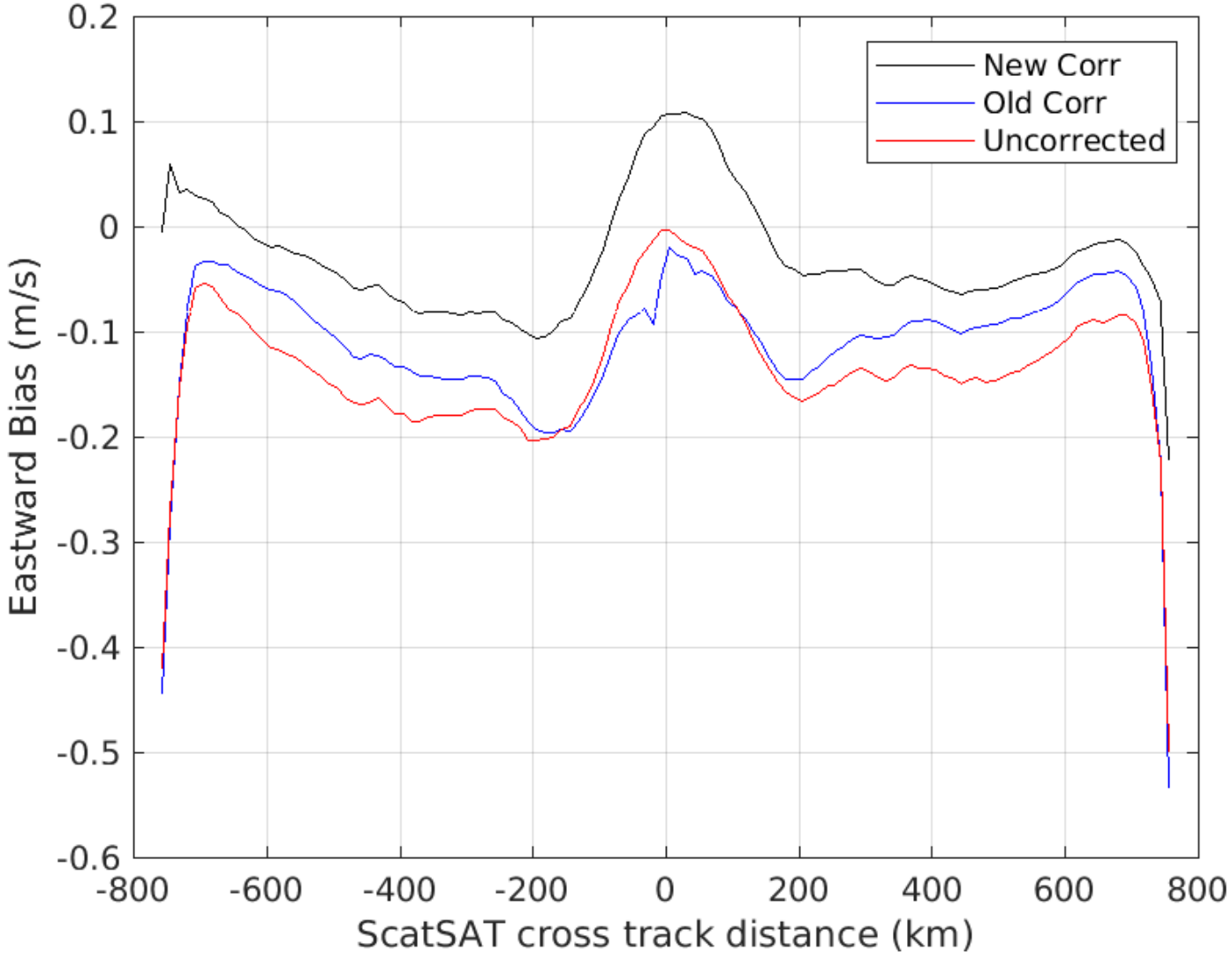
# ScatSAT-ASCAT speed bias vs. CTD



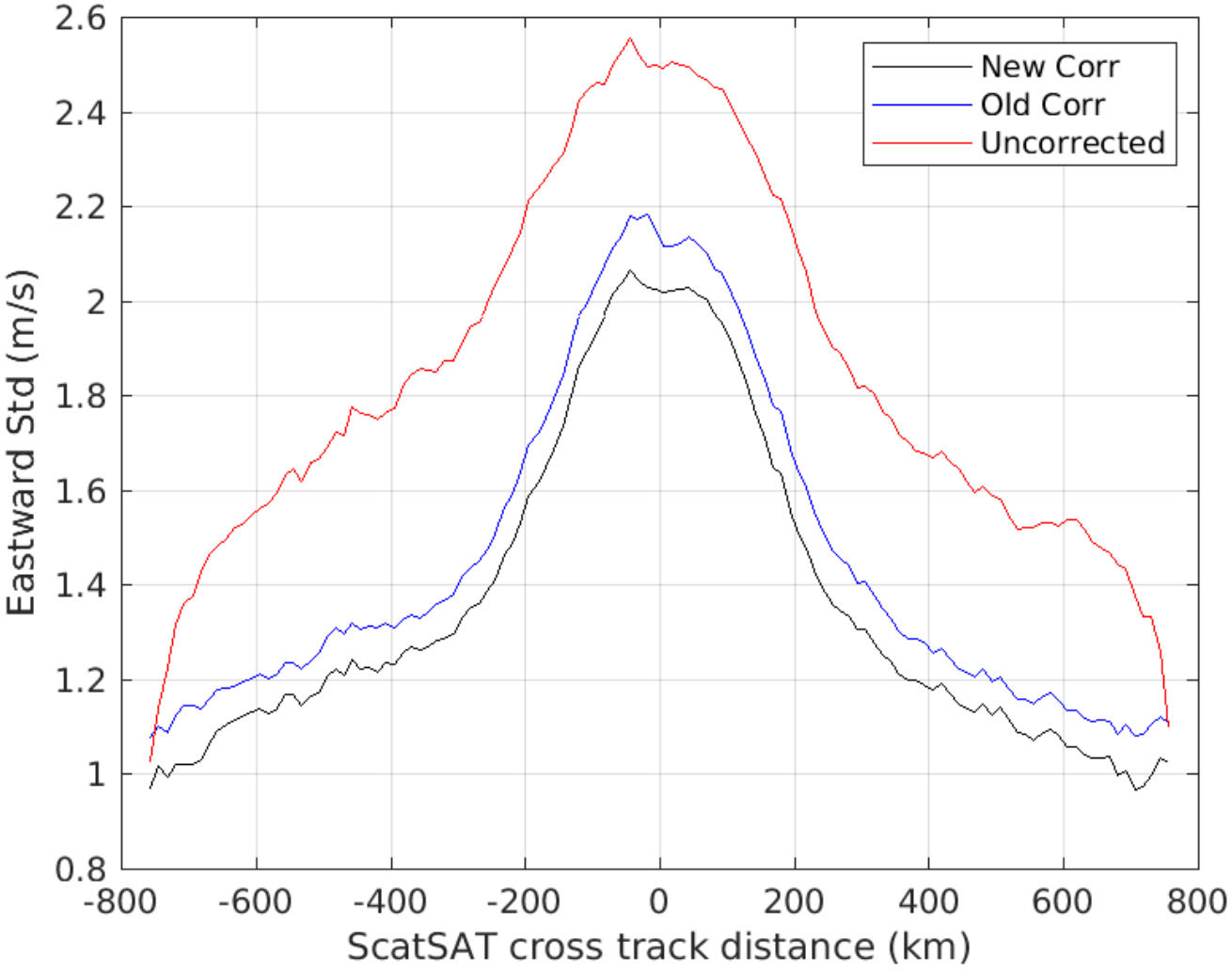
# ScatSAT-ASCAT speed std. dev. vs. CTD



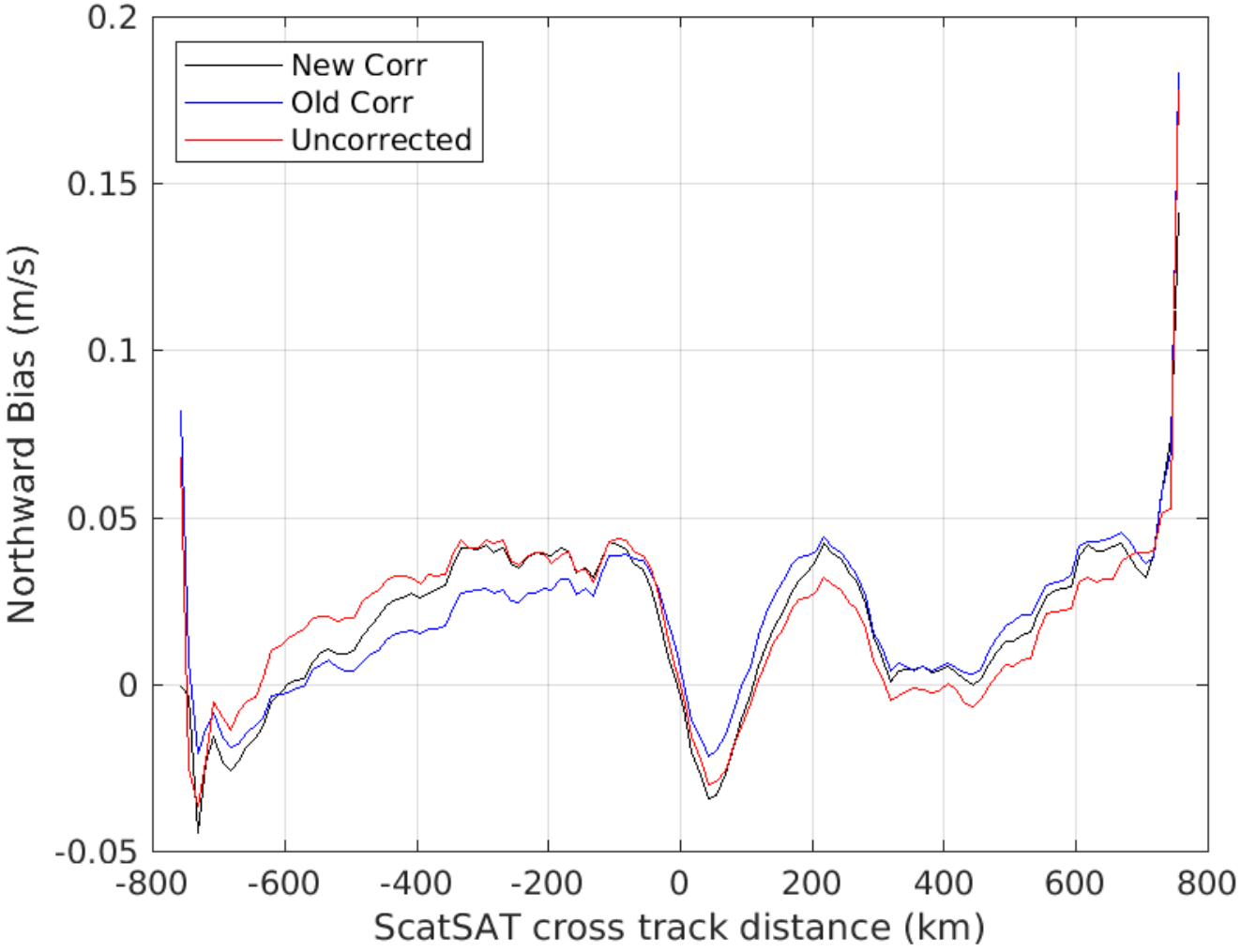
# ScatSAT-ASCAT Eastward bias vs. CTD



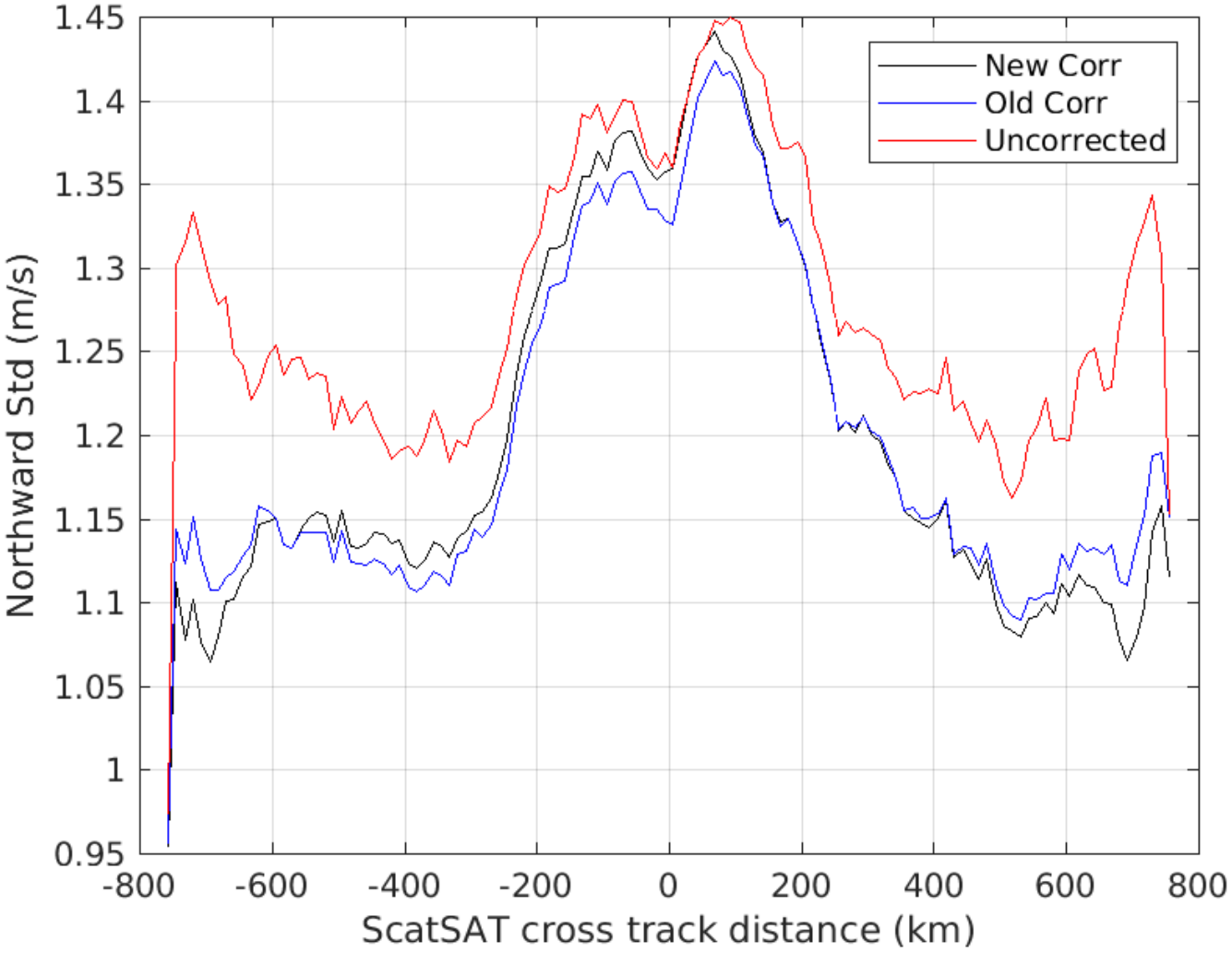
# ScatSAT-ASCAT Eastward Std. Dev. vs. CTD



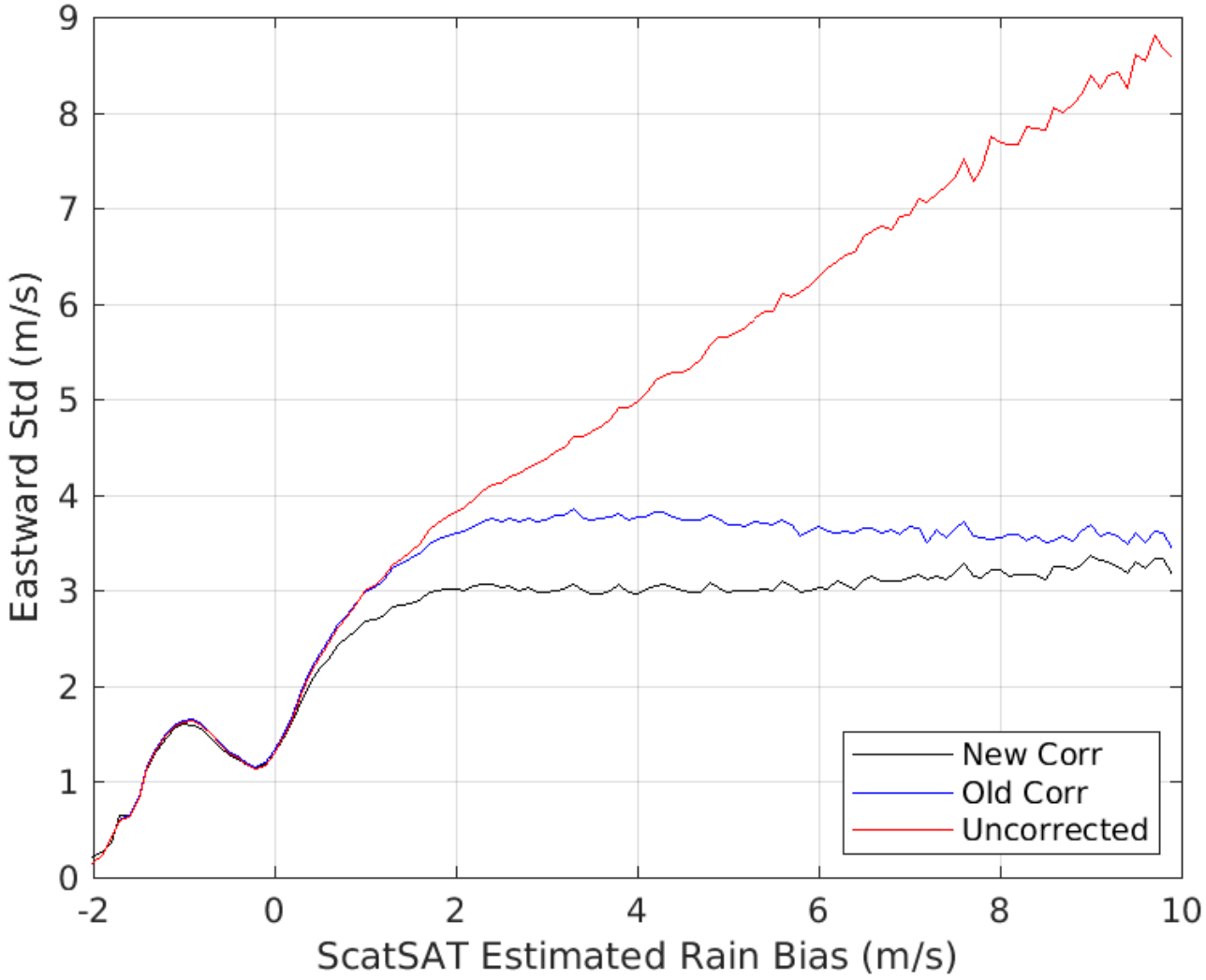
# ScatSAT-ASCAT Northward Bias vs. CTD



# ScatSAT-ASCAT Northward Std. Dev. vs. CTD



# ScatSAT-ASCAT eastward std. dev. vs. flag quantity



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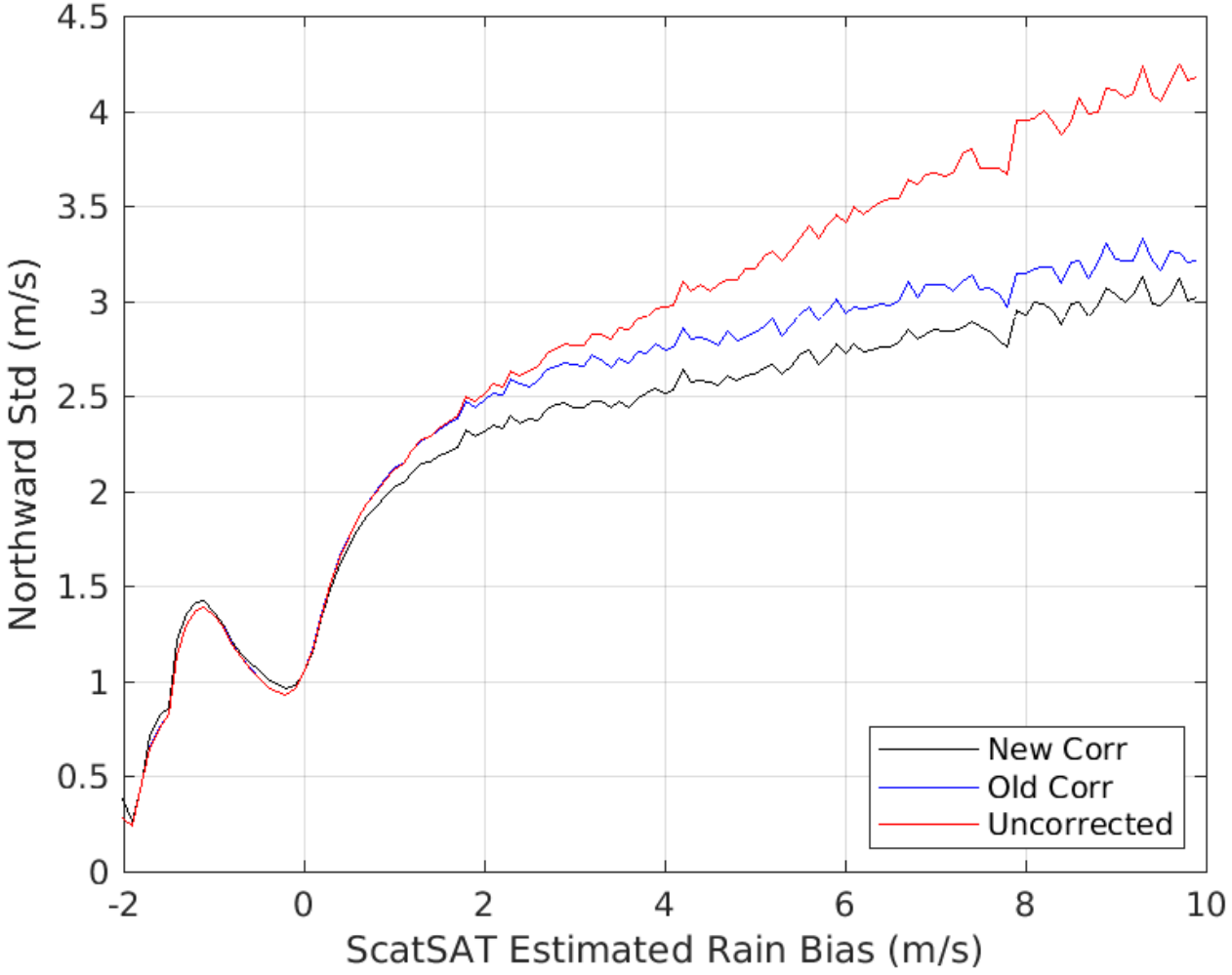
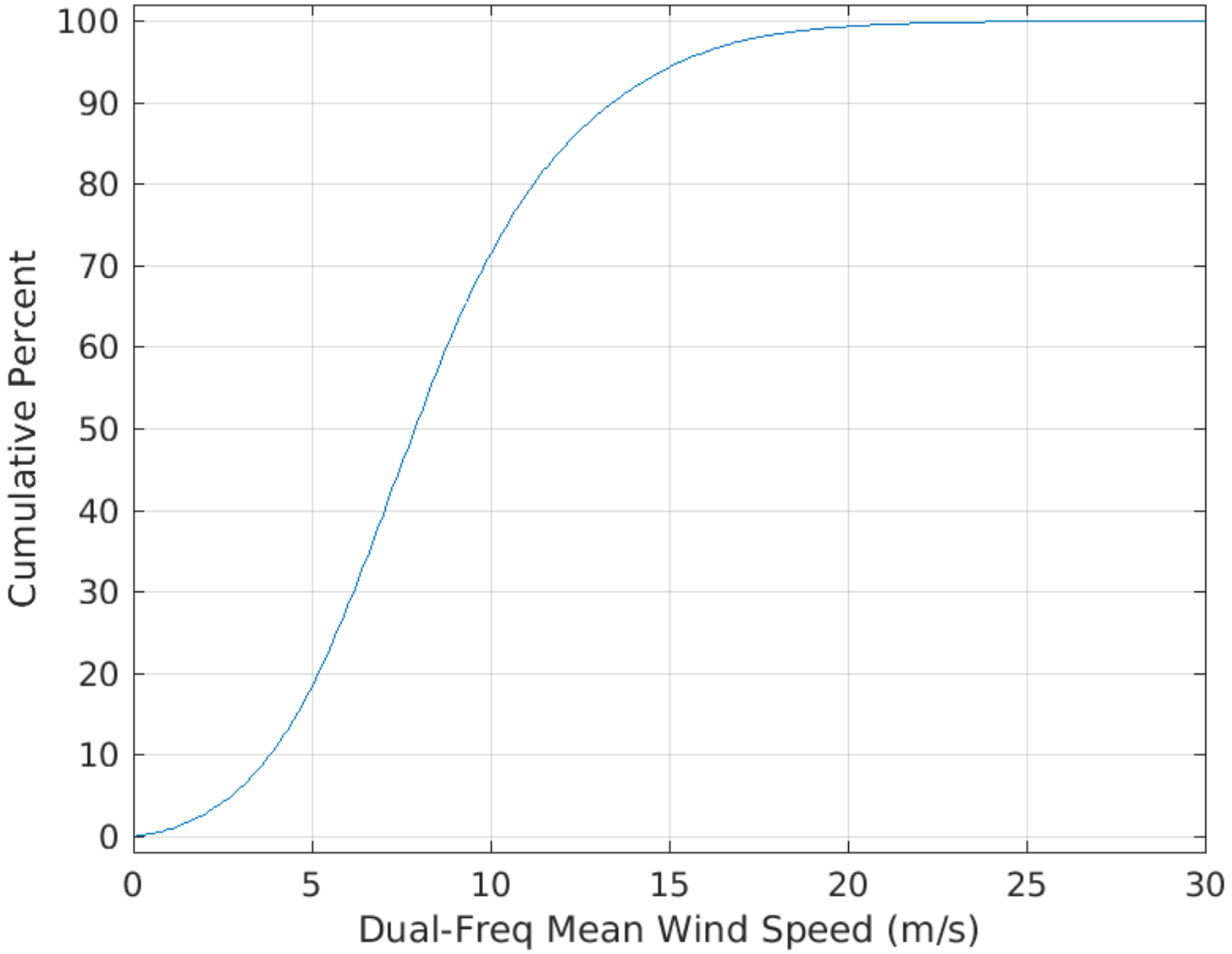
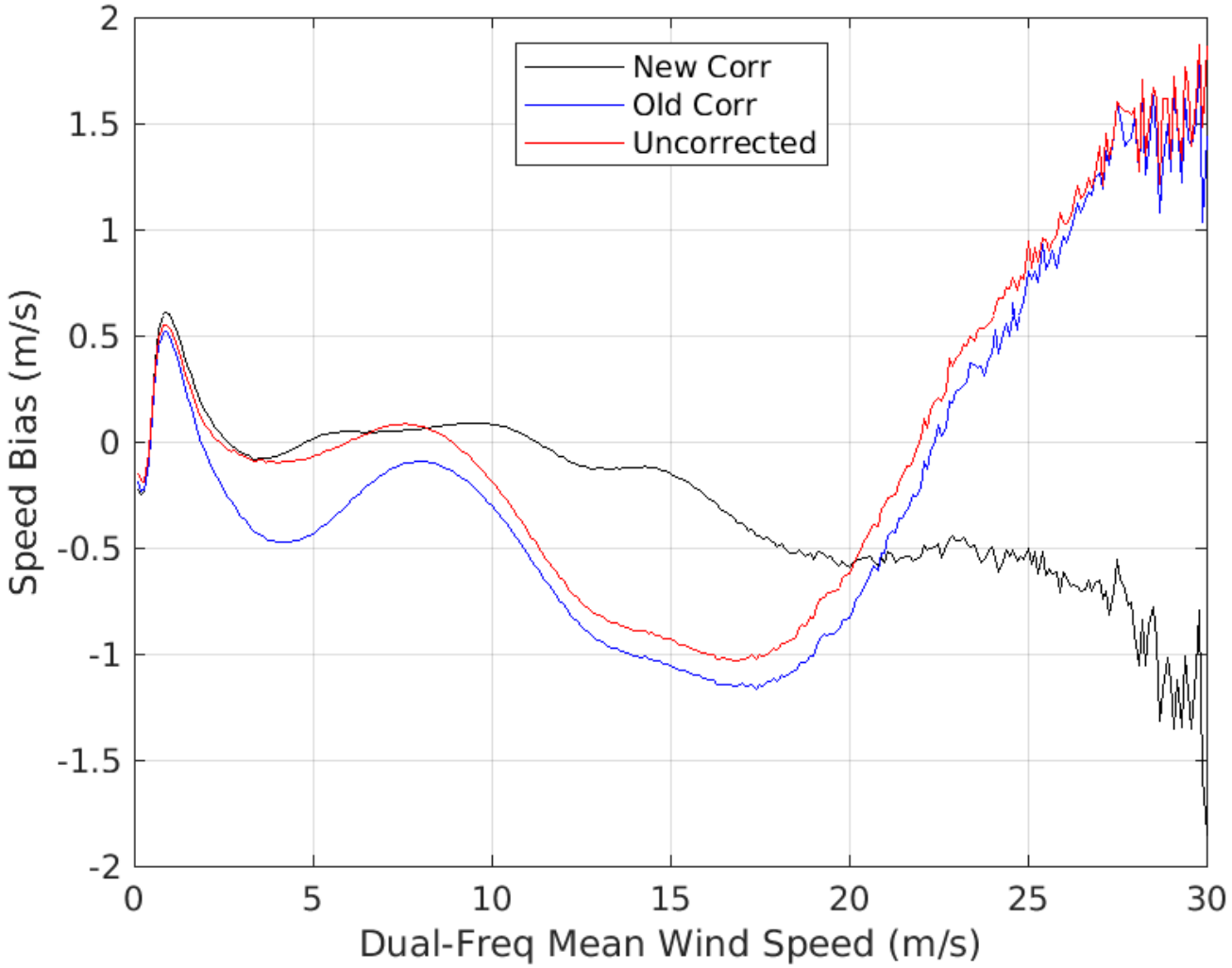


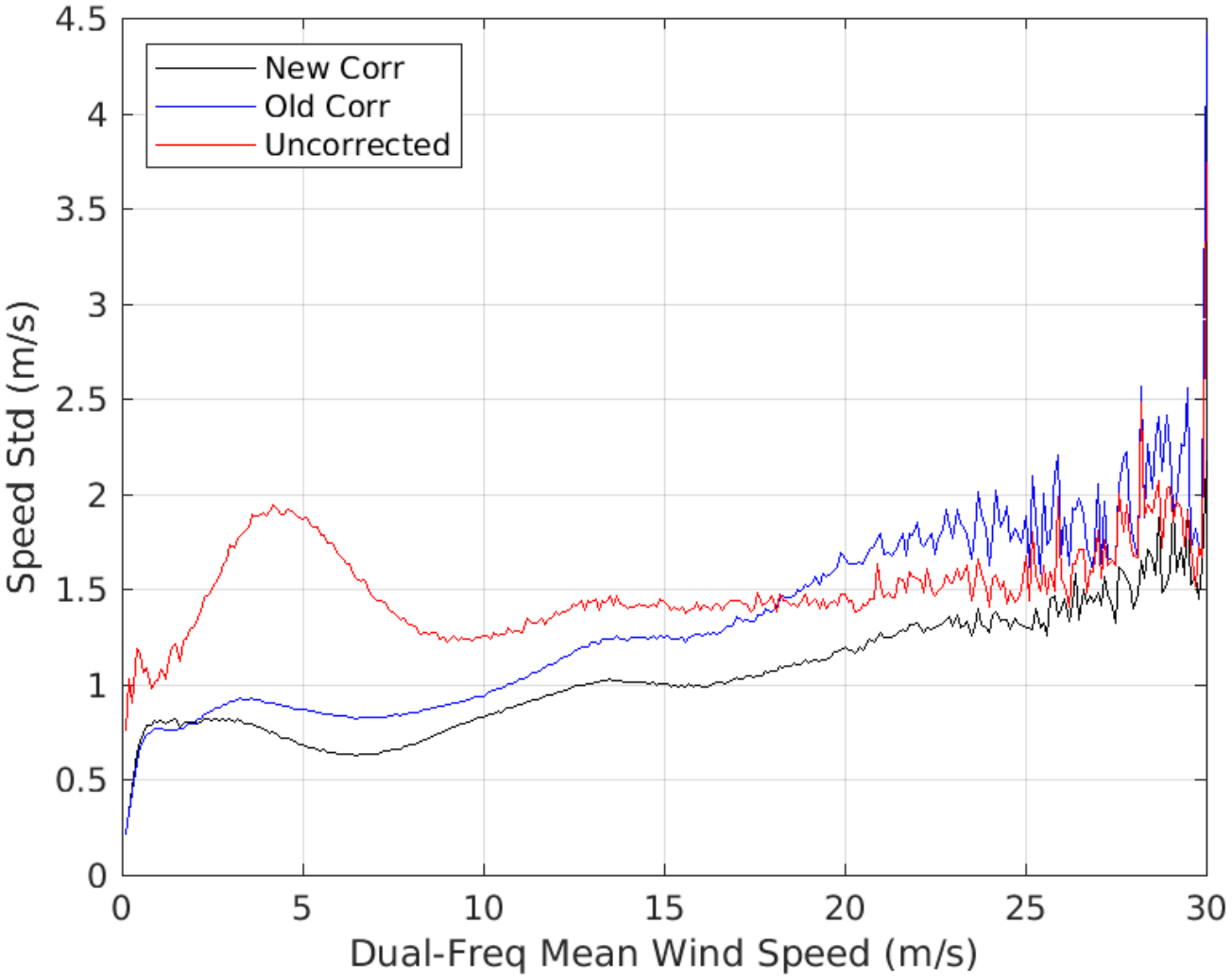
# Percentile vs. mean dual frequency speed



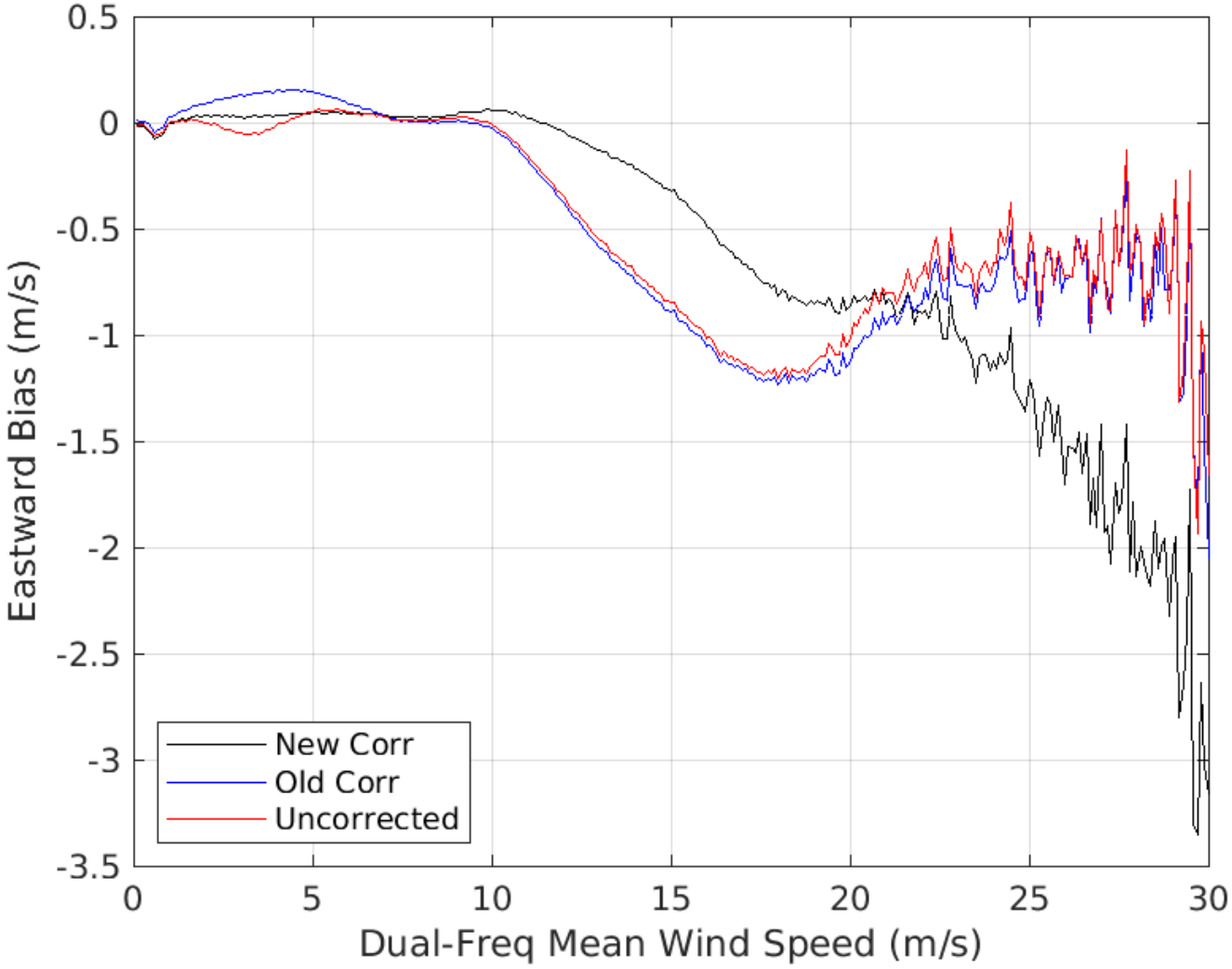
# ScatSAT-ASCAT Speed Bias vs. mean dual frequency speed



# ScatSAT-ASCAT Speed Std. Dev. vs. mean dual frequency speed



# ScatSAT-ASCAT Eastward Bias vs. mean dual frequency speed



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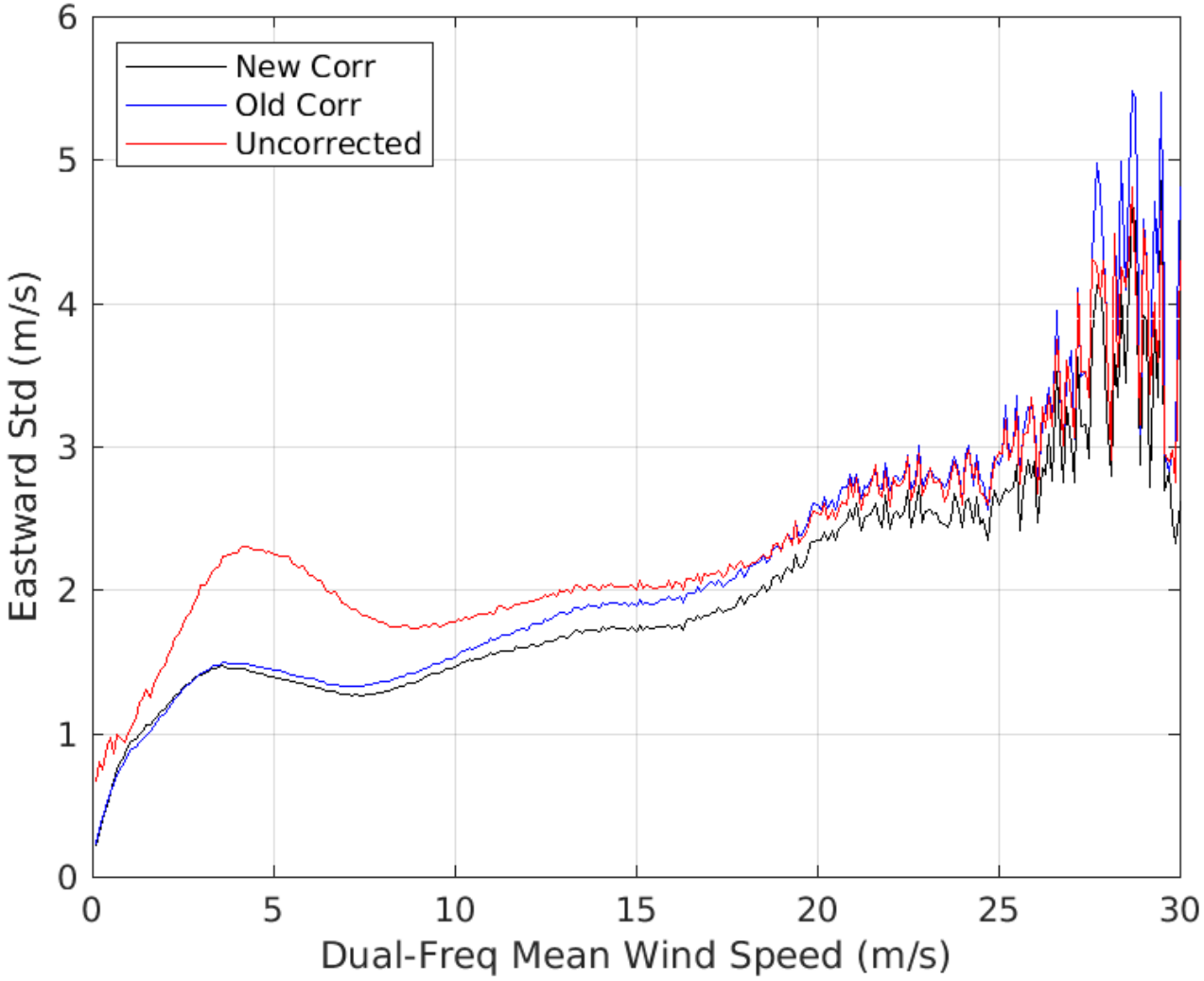

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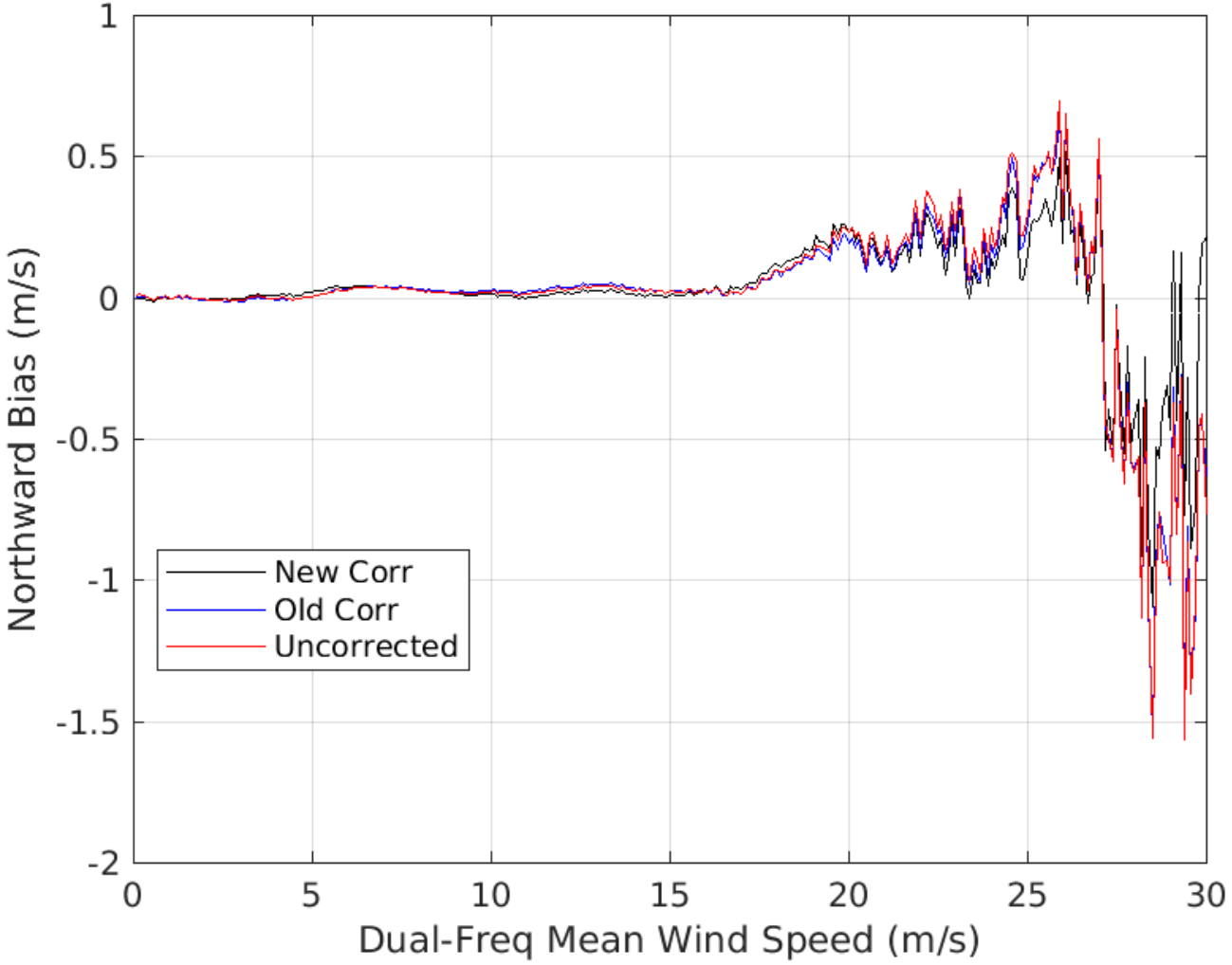

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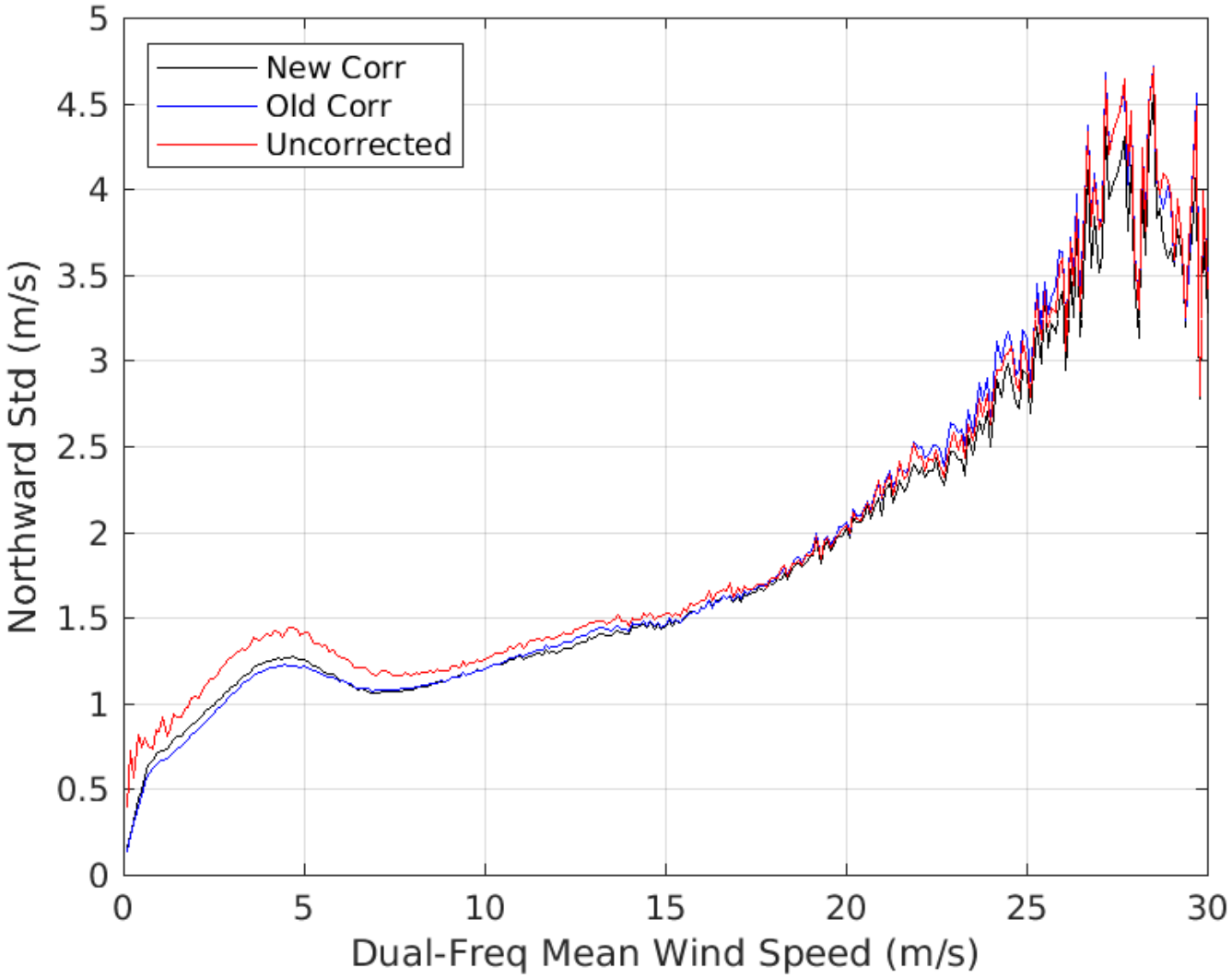
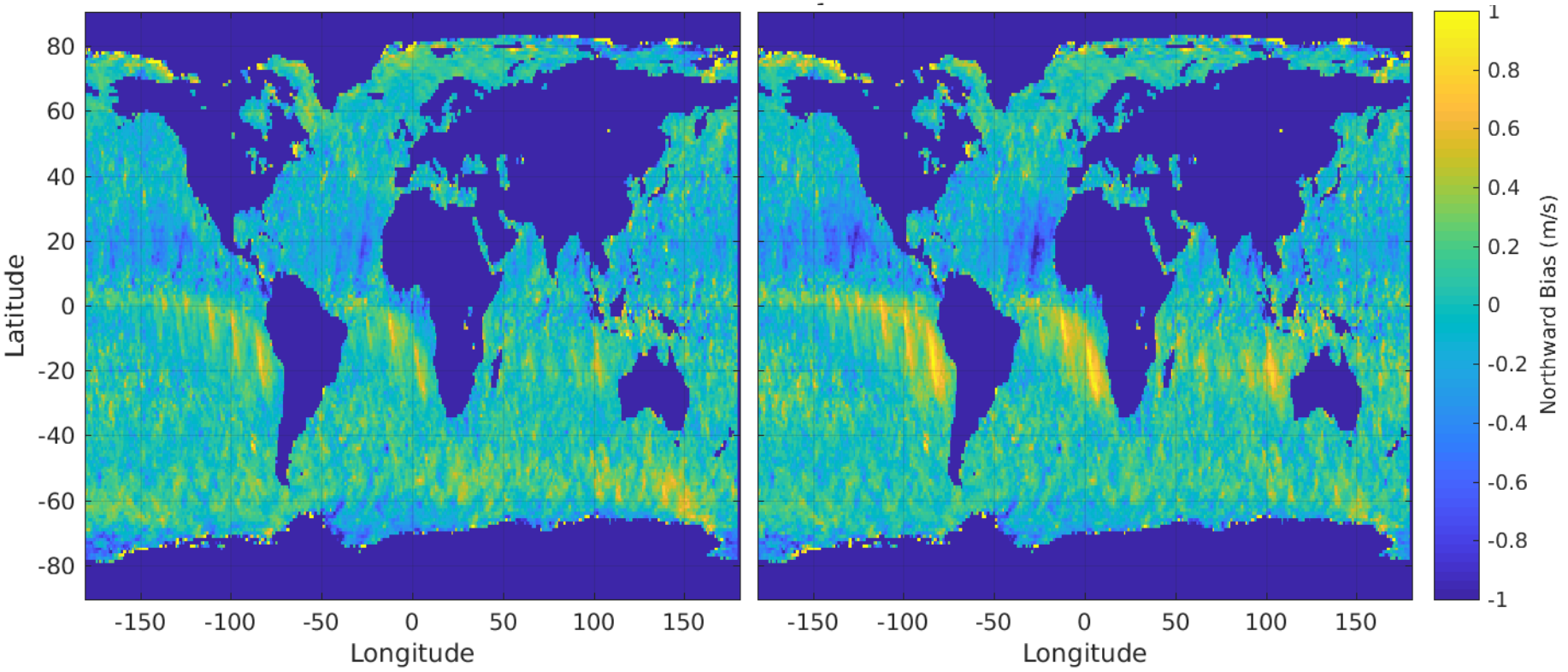


# ScatSAT- ASCAT Northward Bias

## (90 minute time co-location)



# ScatSAT- ASCAT Northward Std. Dev.

## (90 minute time co-location)