Cross-Calibrating OSCAT Land Sigma-0 to Extend the QuikSCAT Land Sigma-0 Climate Record

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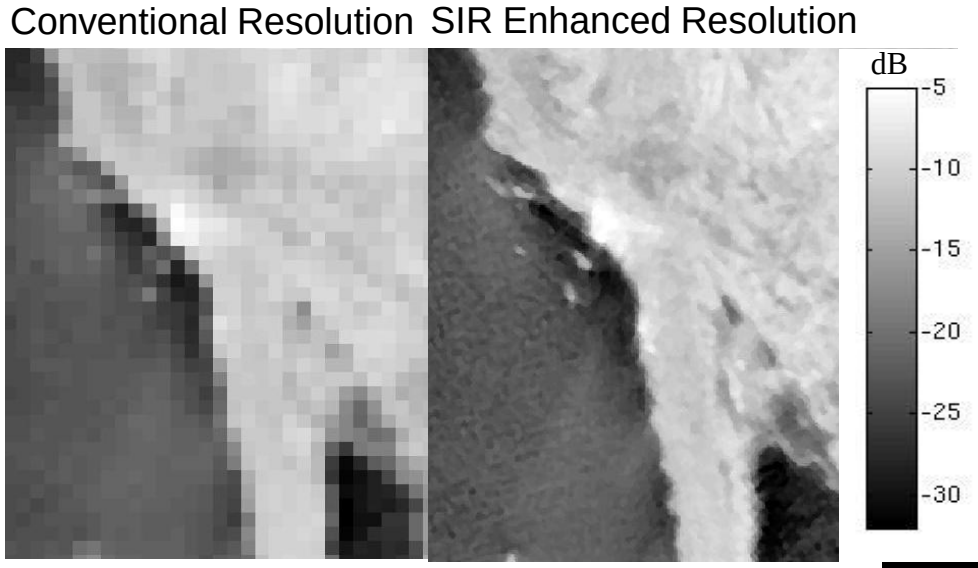
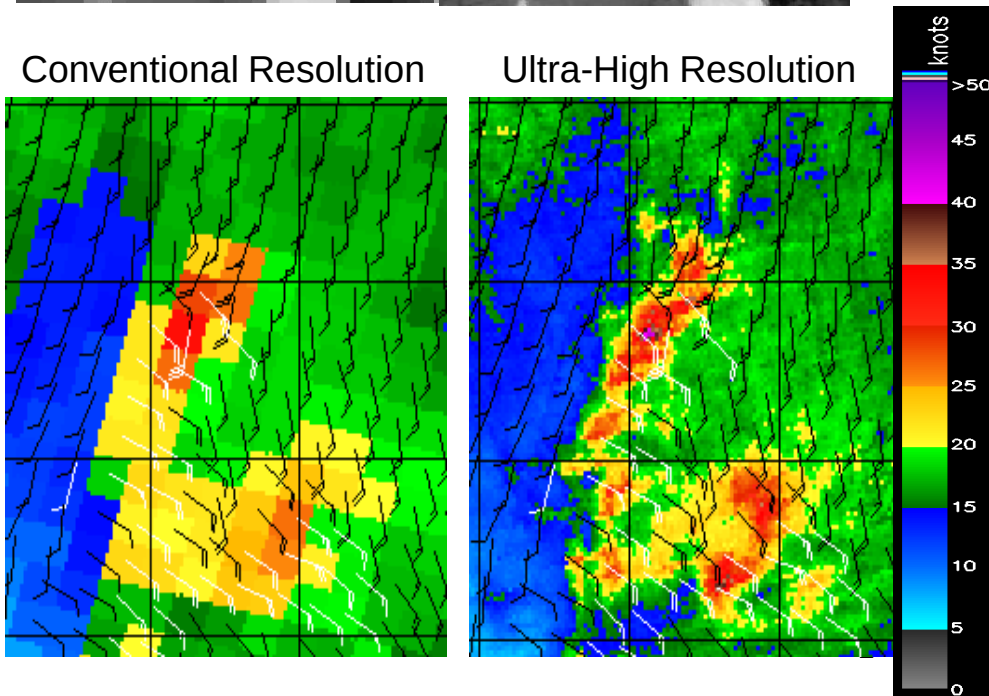
Scatterometer Resolution Enhancement

- **σ^0 imaging**
  - SIR/AVE for OSCAT
  - Beta version of OSCAT enhanced resolution land/ice products now available at the Scatterometer Climate Record Pathfinder (www.scp.byu.edu)



- **Wind from σ^0**
  - Ultra-high resolution (UHR) (1.25 km/pixel) OSCAT ASCAT wind processing now operational
  - OSCAT includes near-land, and sea-ice wind retrieval



DGL May 2013

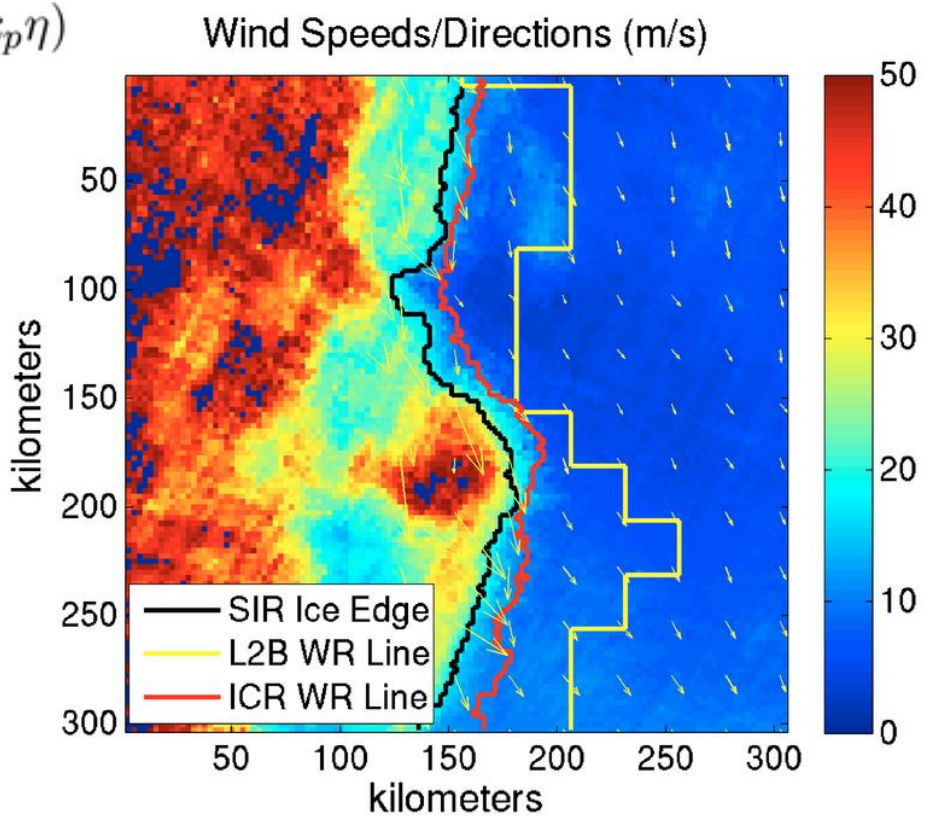
Ice Contamination Mitigation for QuikSCAT and OSCAT

- Model: Ice Contribution Ratio (ICR)

$$\sigma^0_{Obs} = [\sigma^0_{Ice}\mathrm{ICR} + \sigma^0_{Ocean}\,(1-\mathrm{ICR})](1+k_p\eta)$$

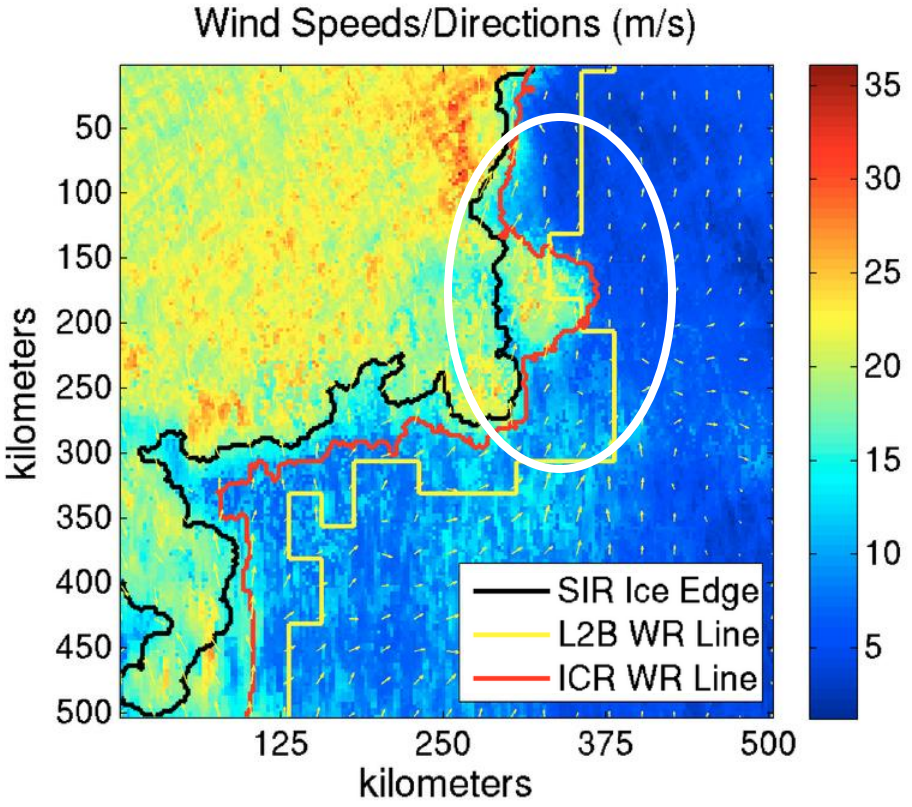
$$\mathrm{ICR} = \frac{\iint\limits_{\text{slice}} P_{x,y}(\text{ice}|\boldsymbol{\sigma^0_m})R_{x,y}dxdy}{\iint\limits_{\text{slice}} R_{x,y}dxdy}$$

- Monte Carlo simulation to set wind error threshold on ICR of each sigma0 measurement
  - Wind speed/direction
  - Ice backscatter intensity
  - Cross-track location
  - Sea ice prior probability map
- Discard high ICR sigma0s prior to retrieval



Ice Contamination Wind Mitigation

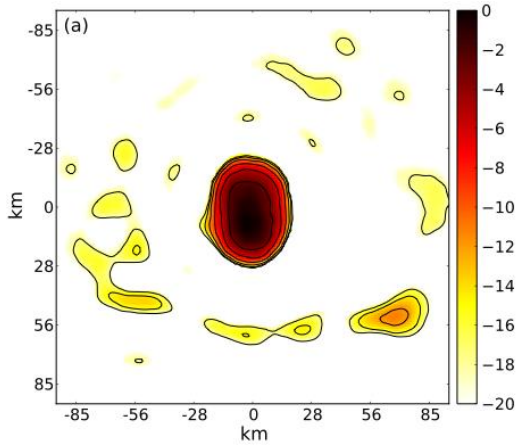
- Eliminates "ice winds" and enables retrieval nearer to sea ice
  - Similar to near-land approach, but using Bayes sea ice maps
  - Both L2B and UHR winds available in BYU product
- Retrieves winds on *average **30 km** closer to sea-ice edge than conventional L2B winds* (which are nominally 50 km from the ice edge)



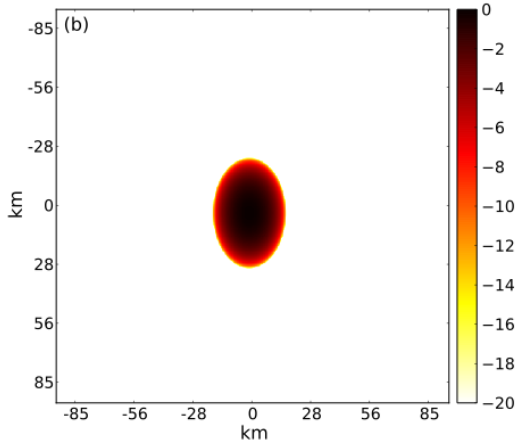
W.J. Hullinger and D.G. Long, "Mitigation of Sea Ice Contamination in QuikSCAT Wind Retrieval," *IEEE Transactions on Geoscience and Remote Sensing*, to appear, 2013.

OSCAT SRF Estimates from Island “targets”

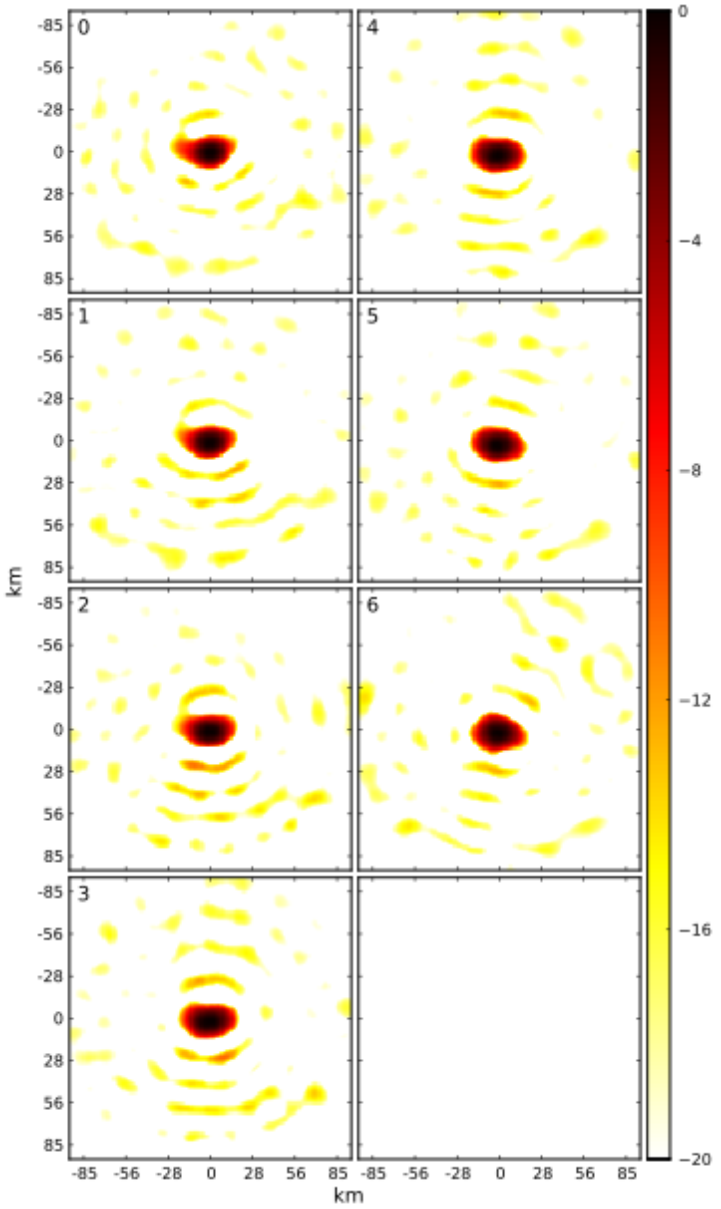
H-pol Egg



V-pol Egg



H-pol Slices

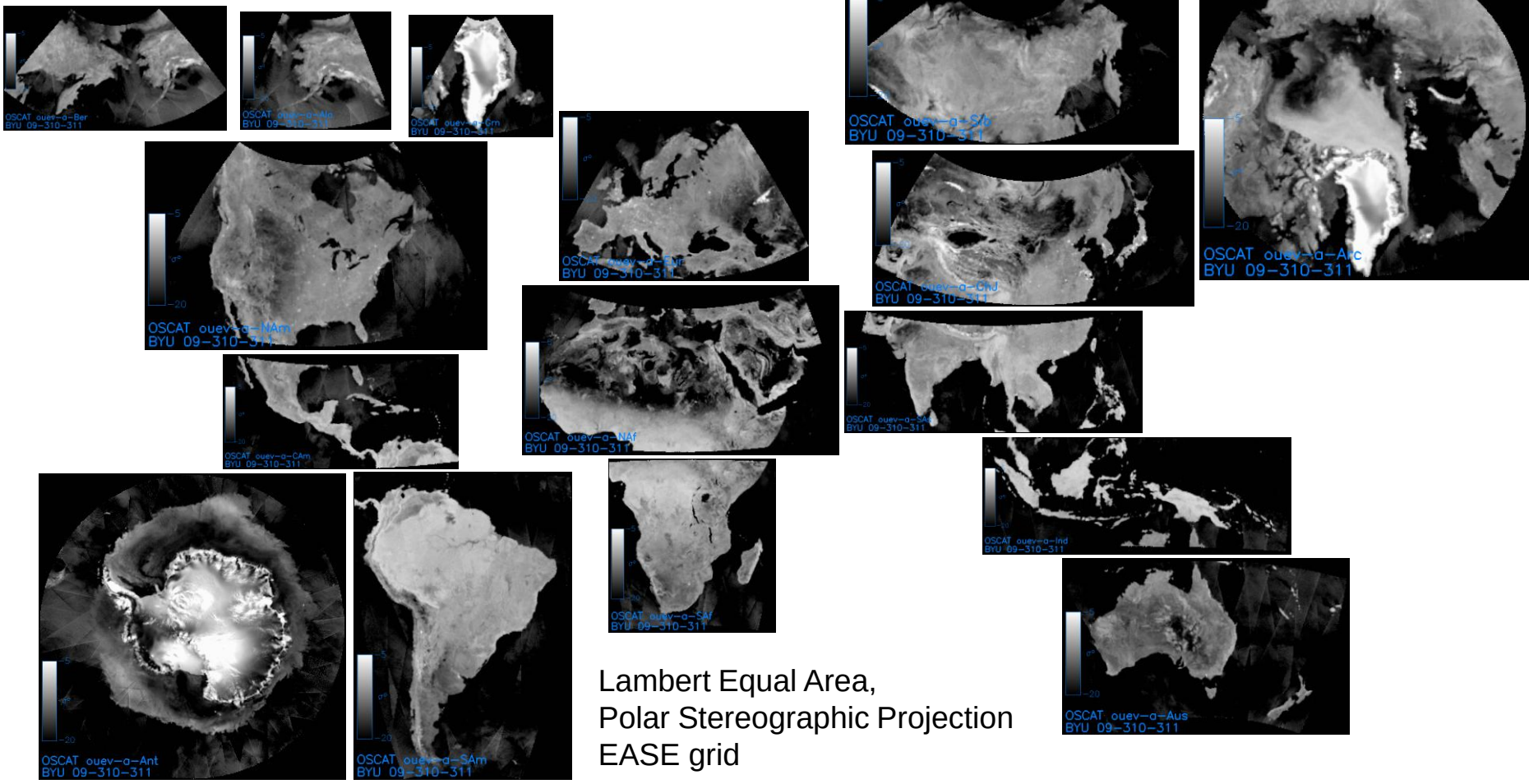


J.P. Bradley and D.G. Long, "Estimation of the OSCAT Spatial Response Function Using Island Targets", *IEEE Transactions on Geoscience and Remote Sensing,* to appear, 2013.

NASA SCP

Scatterometer Climate Record Pathfinder

BYU Center for Remote Sensing , NASA Jet Propulsion Labratory, European Space Agency



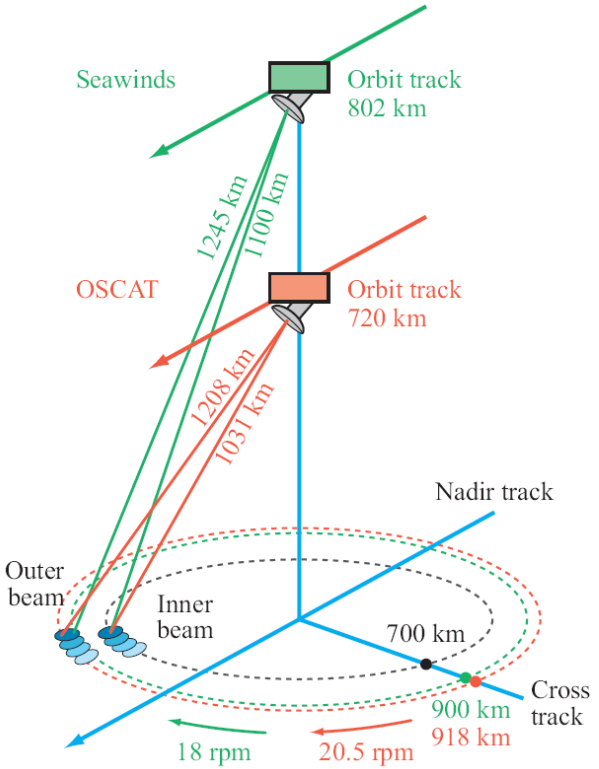
(OSCAT images)

Lambert Equal Area,
Polar Stereographic Projection
EASE grid

Compatible grids for ERS-1/2, NSCAT, SeaWinds/QuikSCAT, OSCAT, ASCAT1/2, SSM/I, AMSRE

OSCAT/QuikSCAT Differences for the Land/Ice Scatterometer Climate Record

- Orbit geometry
  - Orbit revisit time (Q=4 day repeat, O=2 day repeat)
  - Observation azimuth angles differ and vary with time
  - Time of orbit ascending node differ
  - QuikSCAT=6:30 am OSCAT=noon
- Measurement incidence angle
  - H: QuikSCAT=46°, OSCAT=48°
  - V: QuikSCAT=54°, OSCAT=56°
- Instrument azimuth gain variation
- Cross calibration parameters
  - *Incidence angle*
  - *Azimuth angle*
  - *Local time of day*



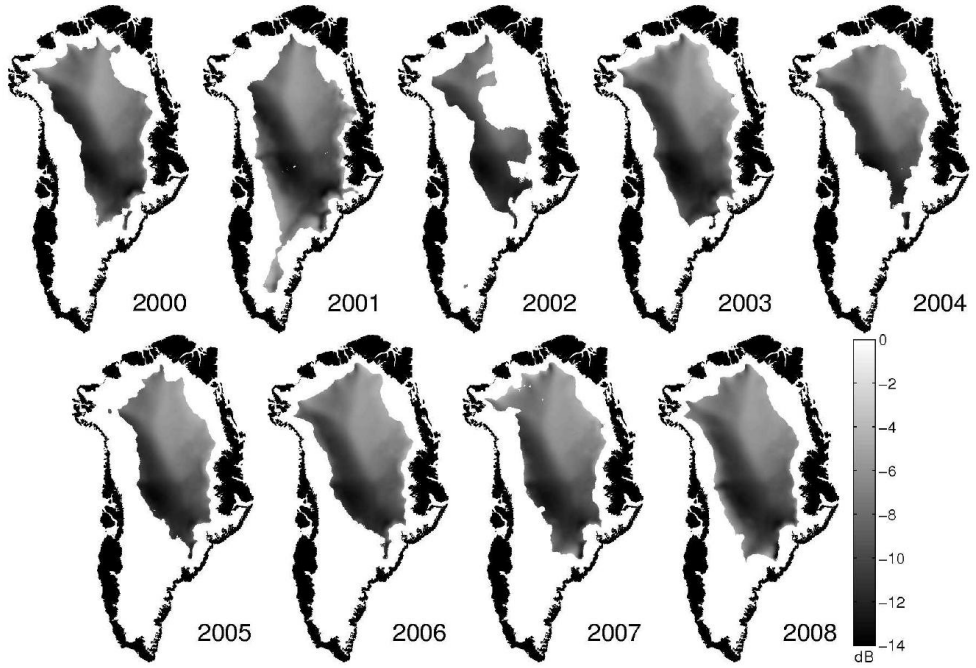
Cross-calibration over Land & Ice

- Goal: Determine a "correction" factor to apply to OSCAT land/ice *images* to enable extension of QuikSCAT time series
  - Correct azimuth prior to image formation
  - Otherwise, use ocean-calibrated OSCAT sigma-0s
- Fixed *calibration offset* + *incidence angle correction* applied post-image formation
- Question: *Is this simple cross-calibration scheme adequate for extending the land/ice scatterometer climate record?*

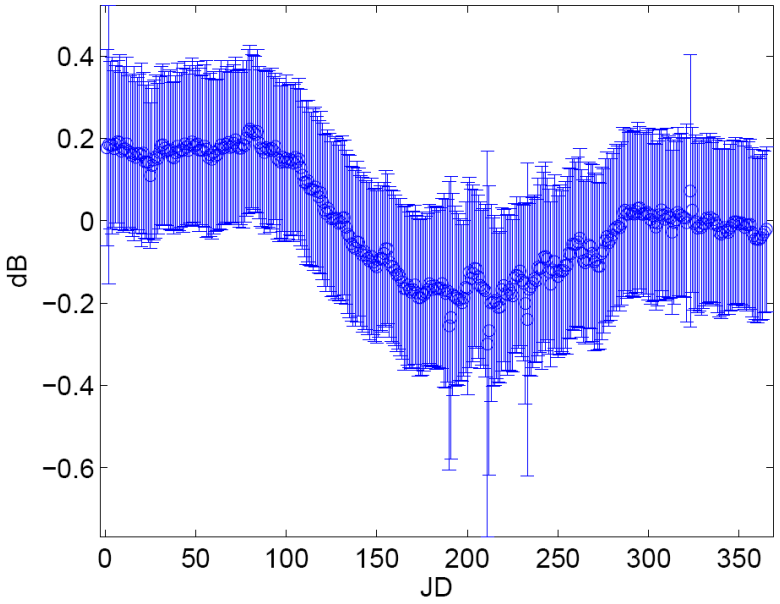
Greenland & Scatterometer Calibration

Evaluate locations within the dry snow zone of Greenland for calibrating scatterometers using the 10-year long QuikSCAT data set.

- K.R. Moon and D.G. Long, "Considerations for Ku-band scatterometer calibration using the dry snow zone of the Greenland ice sheet," *IEEE Geoscience and Remote Sensing Letters*, to appear, 2013.



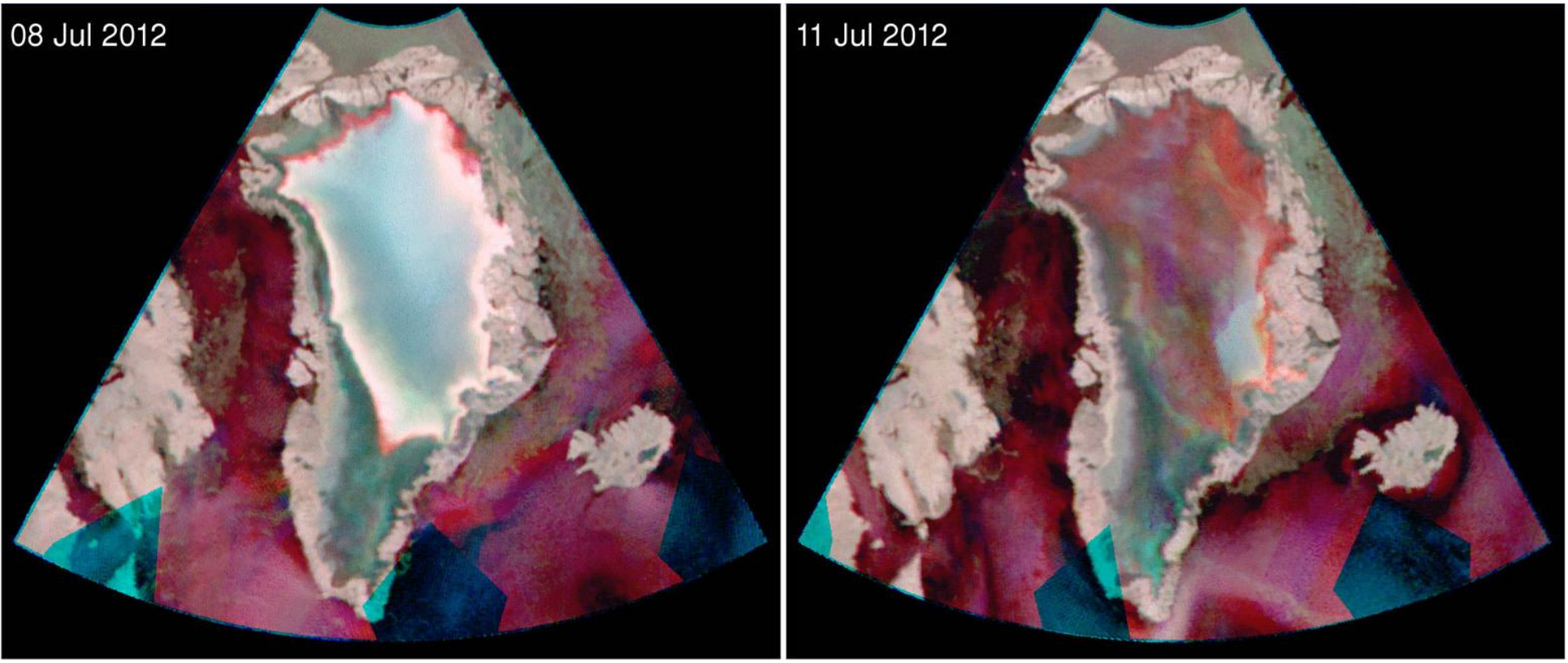
Dry snow zone extent and average sigma-0.
Note significant variability in spatial extent



Seasonal cycle of sigma-0 within dry snow zone

Greenland Summer Melt

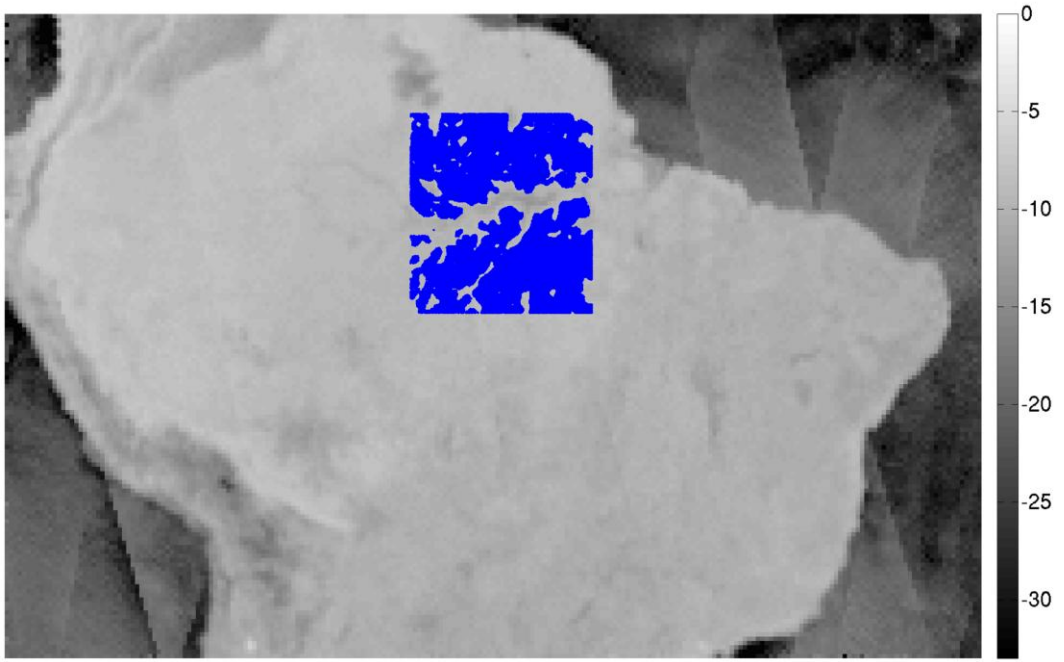
During the Summer of 2012, Greenland endured one of the largest areal melt cycle observed in the satellite record. The melt event was recorded by OSCAT and ASCAT.



False color RGB images from a single day of Ku-band data (Oceansat-2 H=Red, V=Grn) and C-band data (ASCAT=Blu). Land shows up as pink-grey. Deep melt is the green. Surface melt is red. Refrozen melt is bright white. Unmelted firn is dark grey/blue. This event affects future calibration activities in this region.

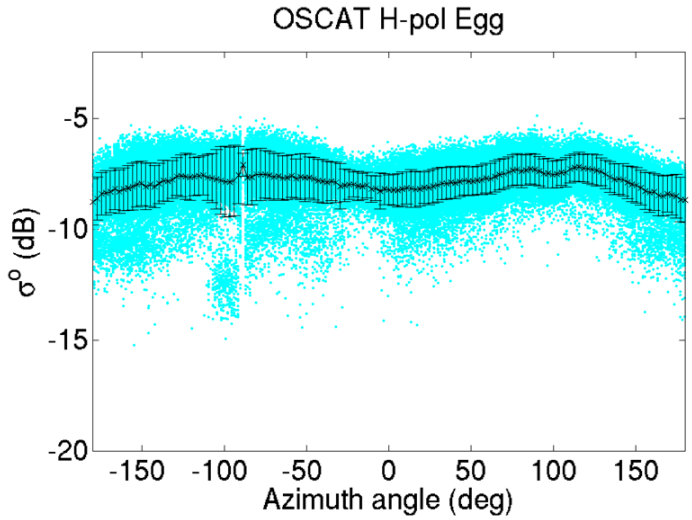
Amazon Study Region

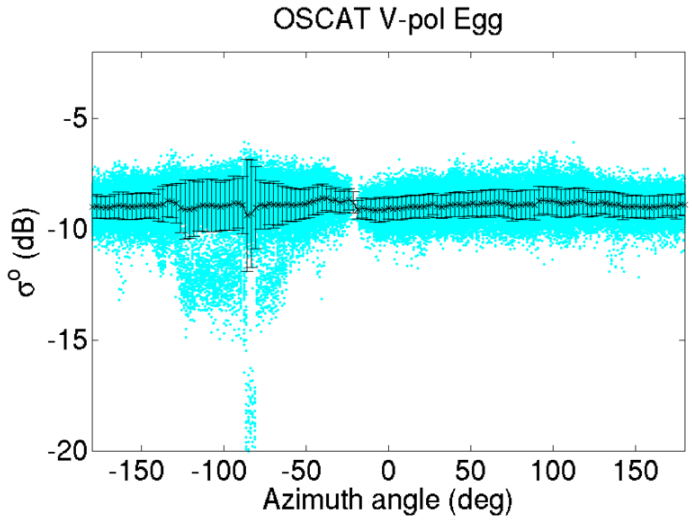
- Rain forest is a good calibration target (anisotropic), but exhibits spatial inhomogeneity
  - Select homogenous region
- Time-of-day variation
  - Sigma-0 varies with time of day as moisture moves up/down in canopy
  - Several tenths of a dB effect
- OSCAT and QuikSCAT observe at different local times
- Different incidence angles

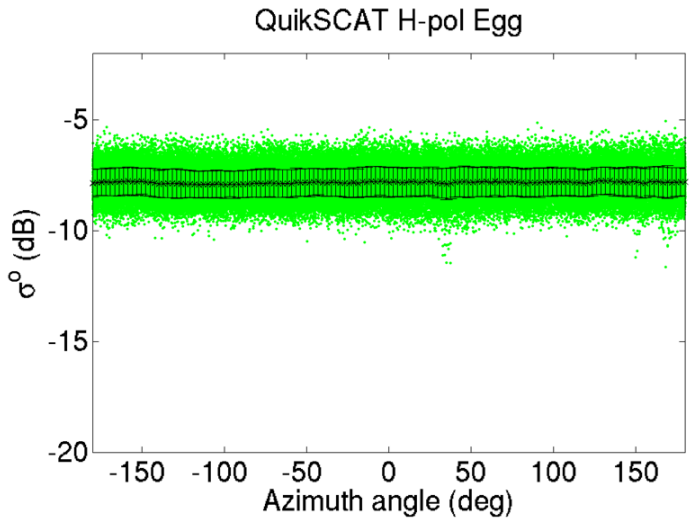


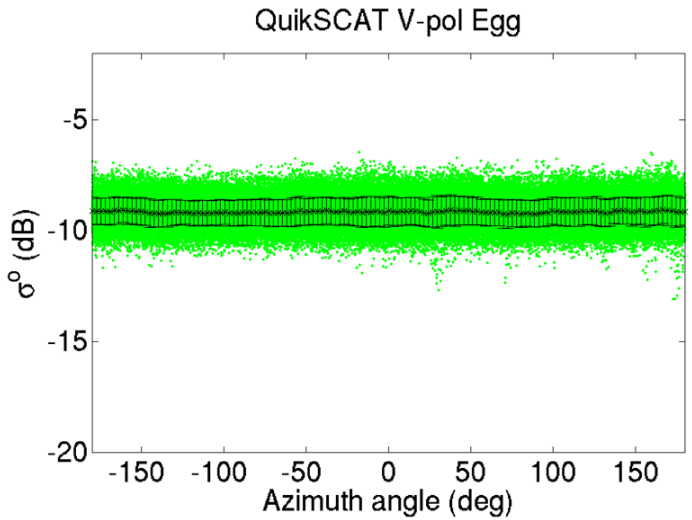
Select region that both QuikSCAT and OSCAT sigma-0 fall within narrow range

Amazon rainforest
Egg Sigma-0 vs Azimuth Angle

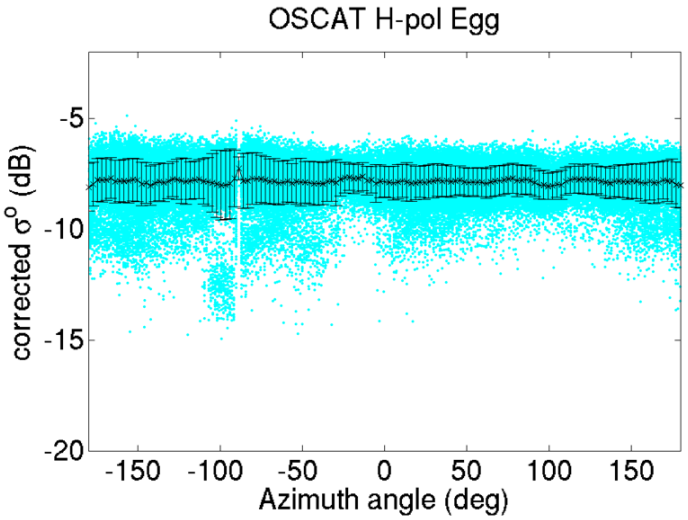


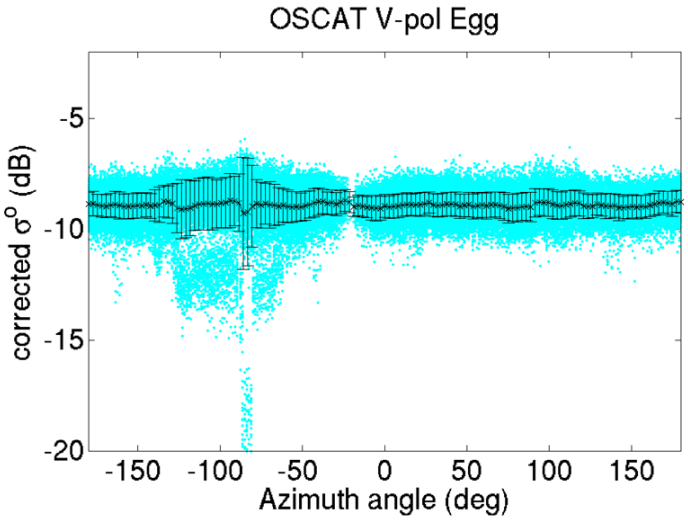


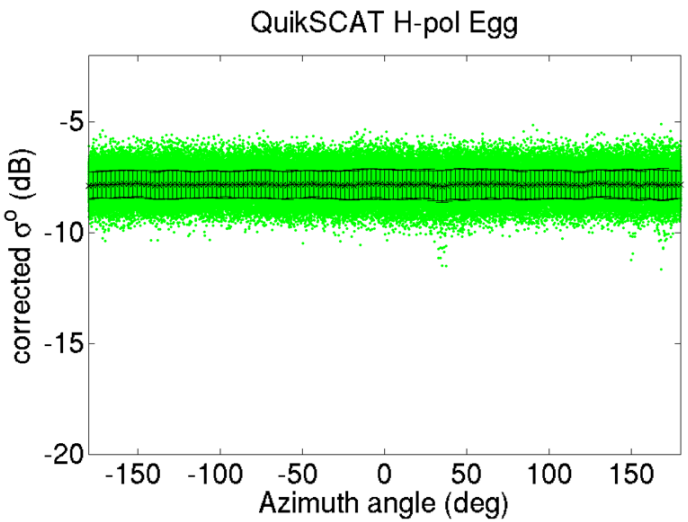


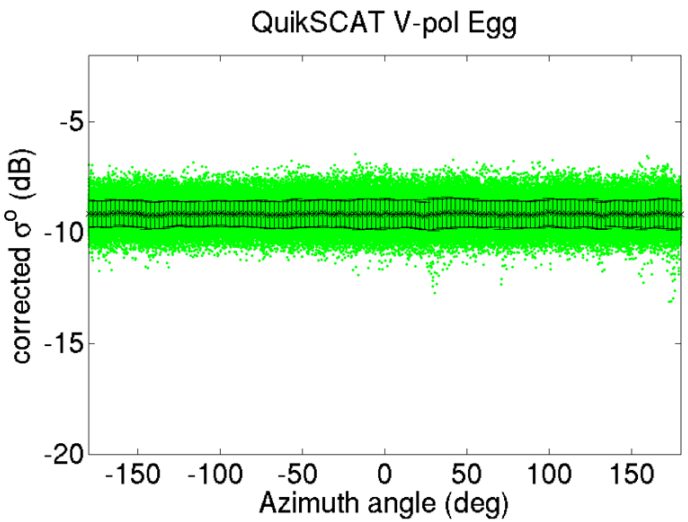


Amazon rainforest
Azimuth-Corrected Egg Sigma-0 vs Azimuth Angle

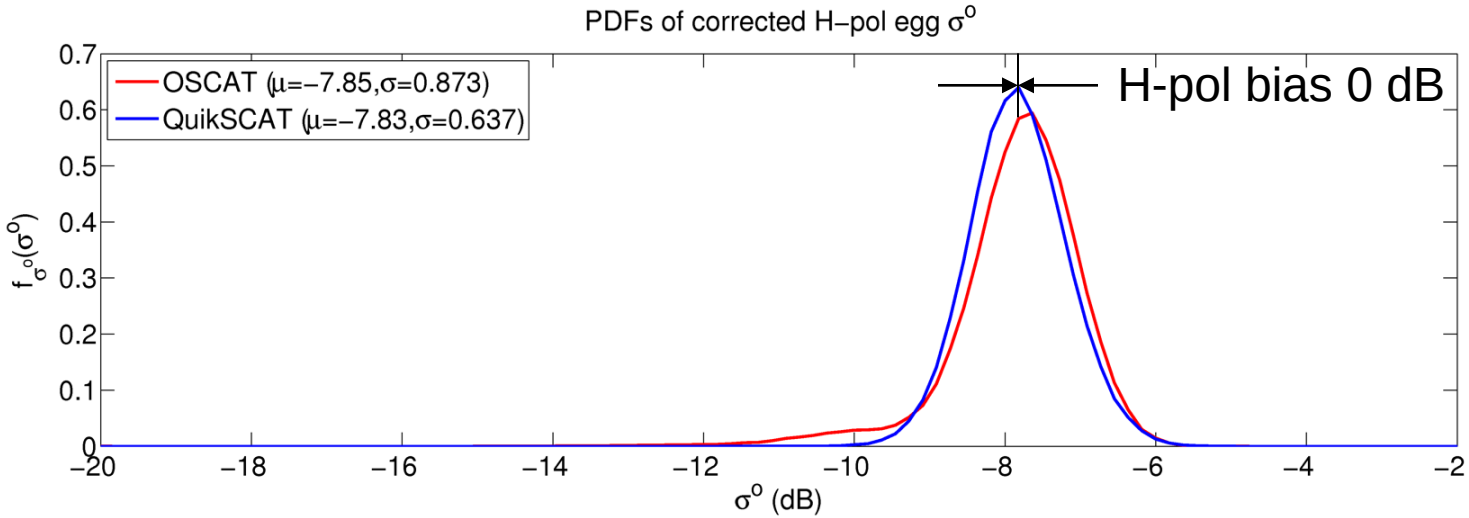


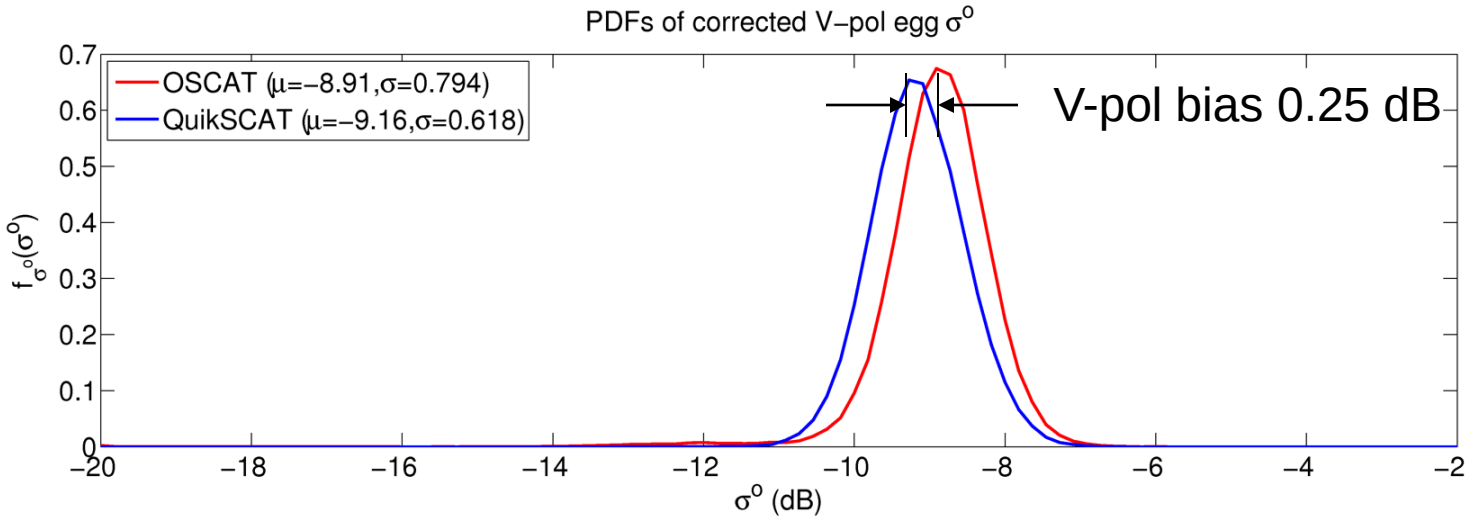




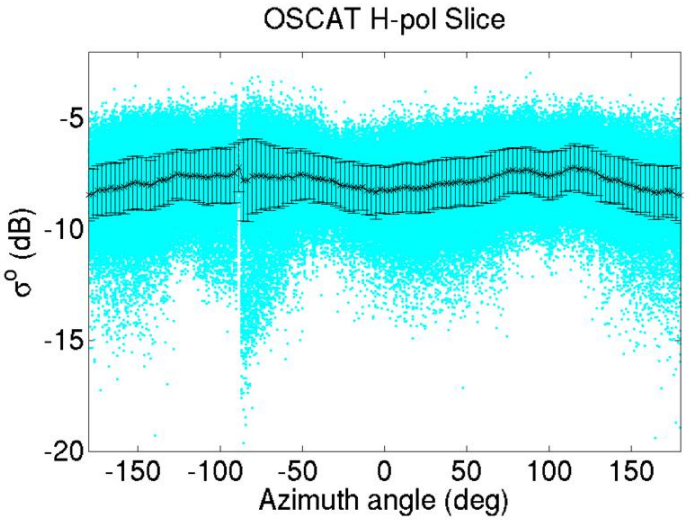


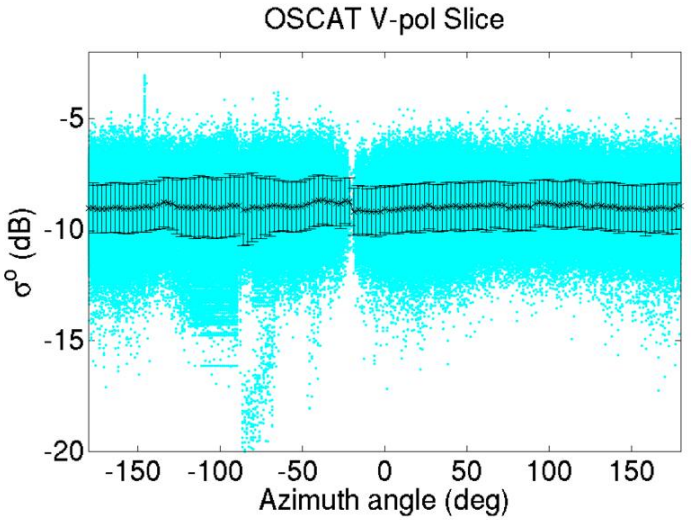
Comparison of Corrected Sigma-0 Distribution in Amazon Study Region

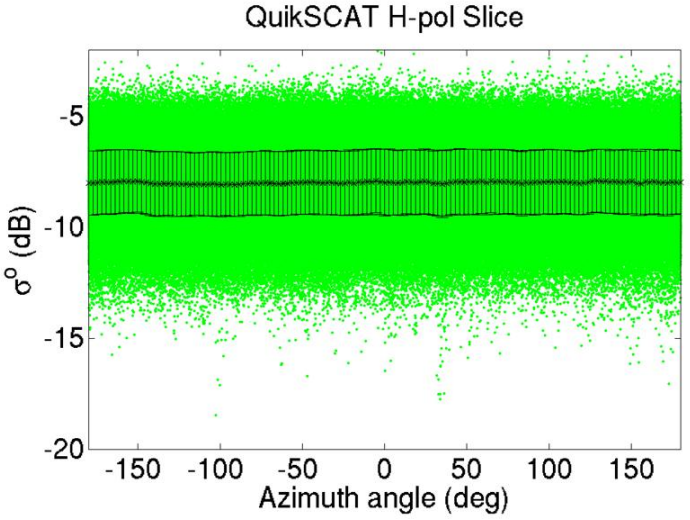


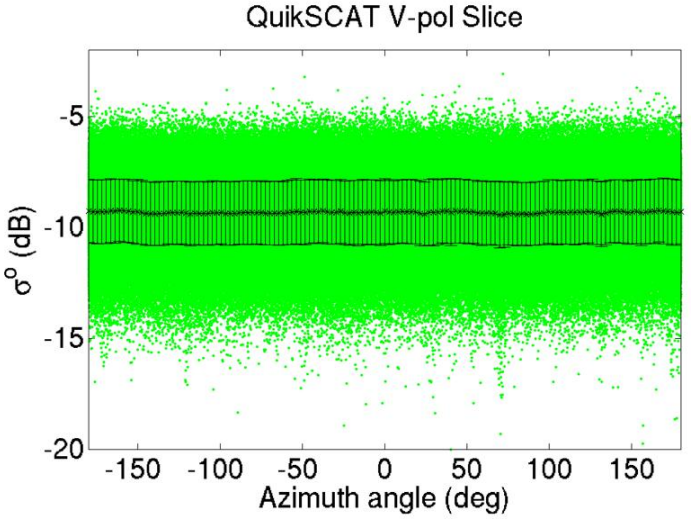


Amazon rainforest
Slice Sigma-0 vs Azimuth Angle

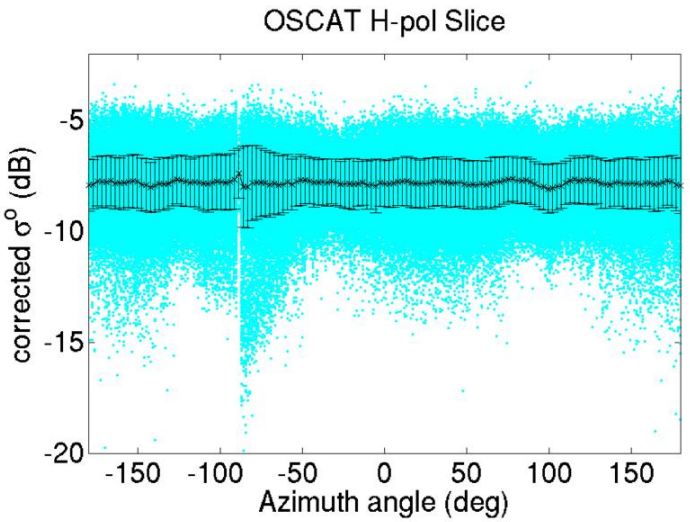


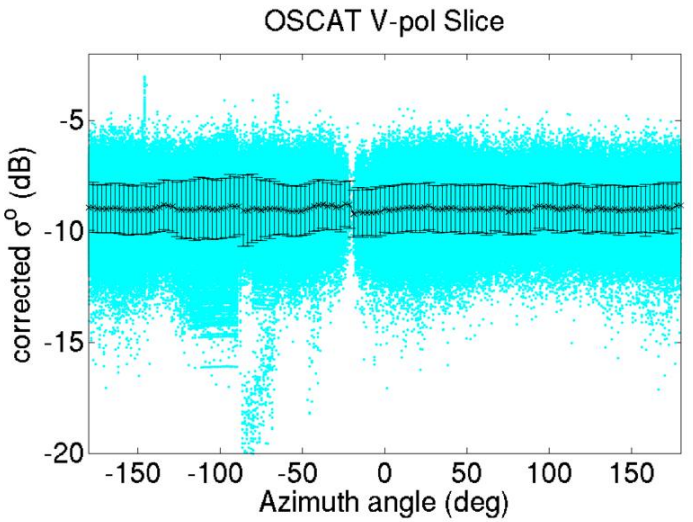


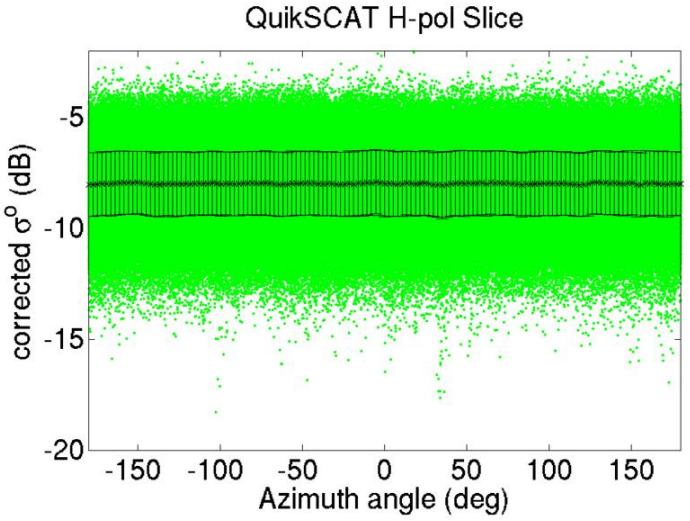


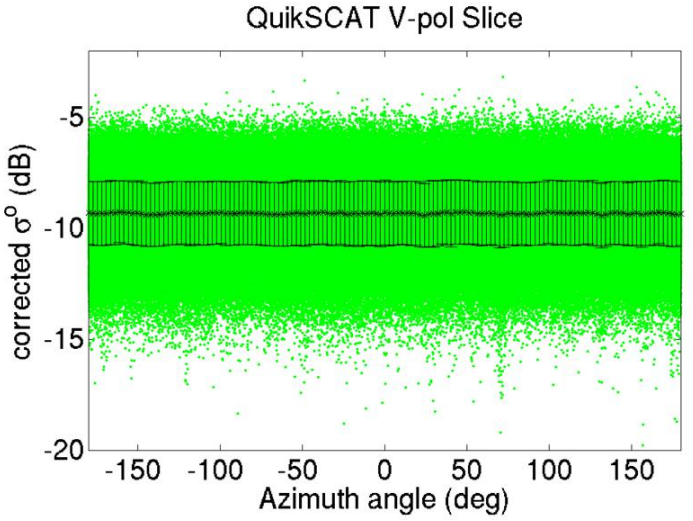


Amazon rainforest
Az-Corrected Slice Sigma-0 vs Azimuth Angle

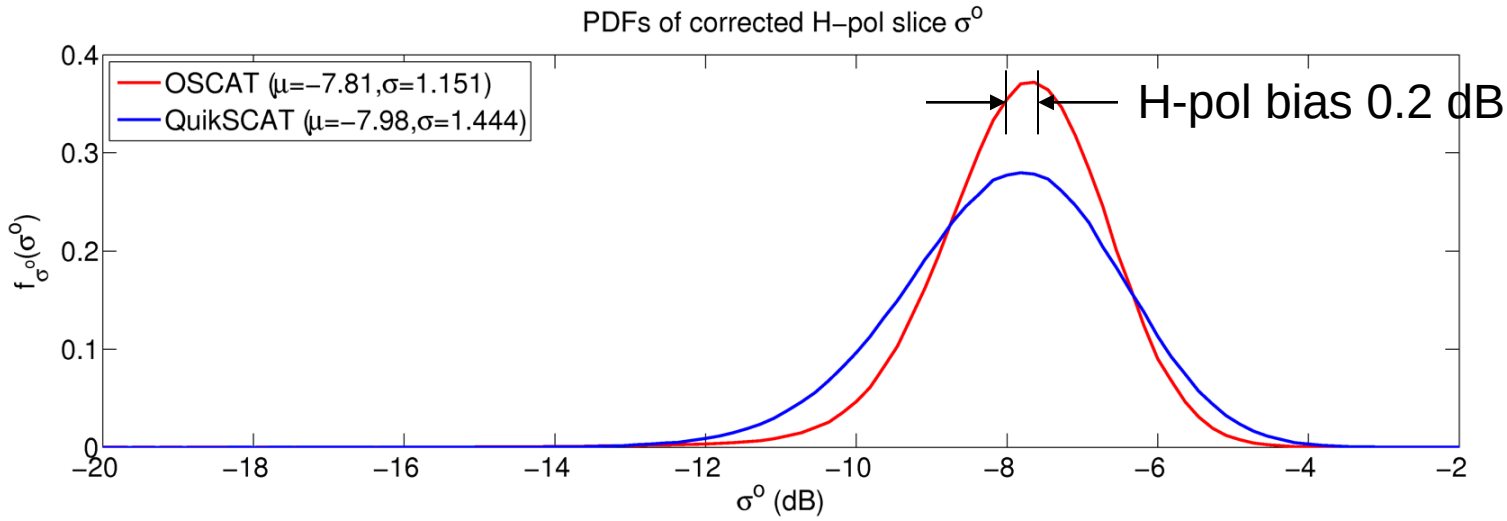


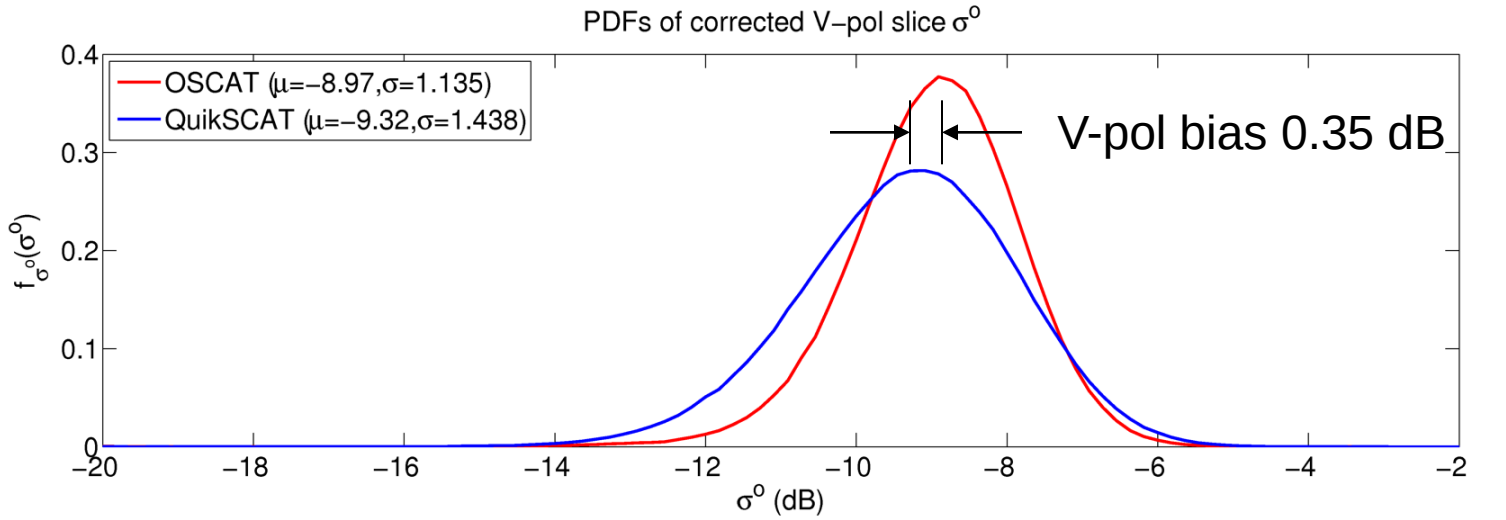




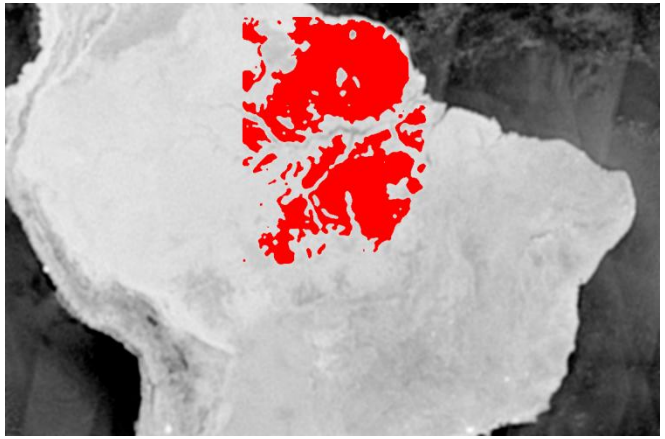


Comparison of Corrected Slice Sigma-0 Distribution in the Amazon Study Region

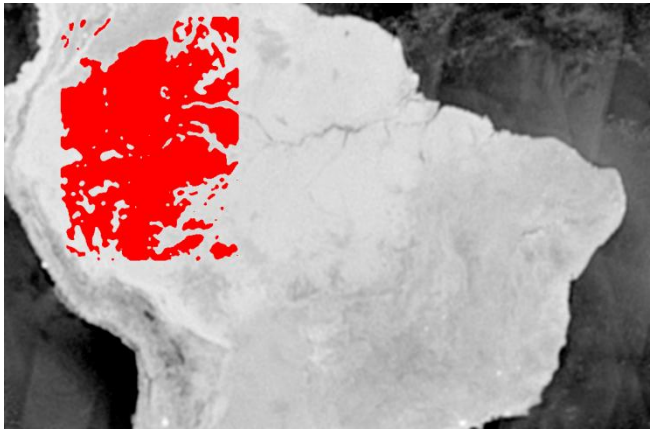




Rainforest study regions



East Amazon

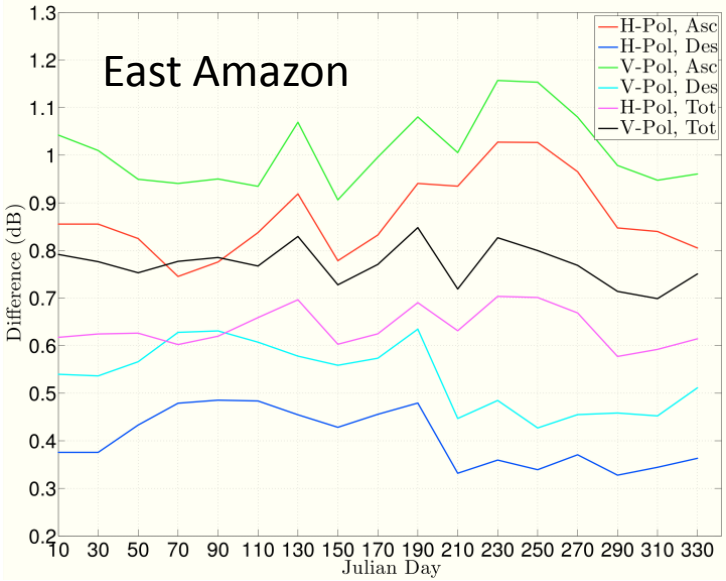


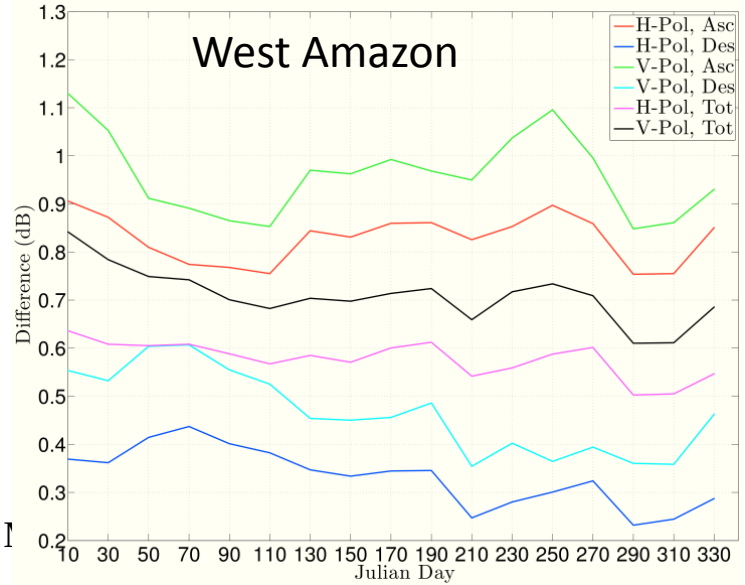
West Amazon

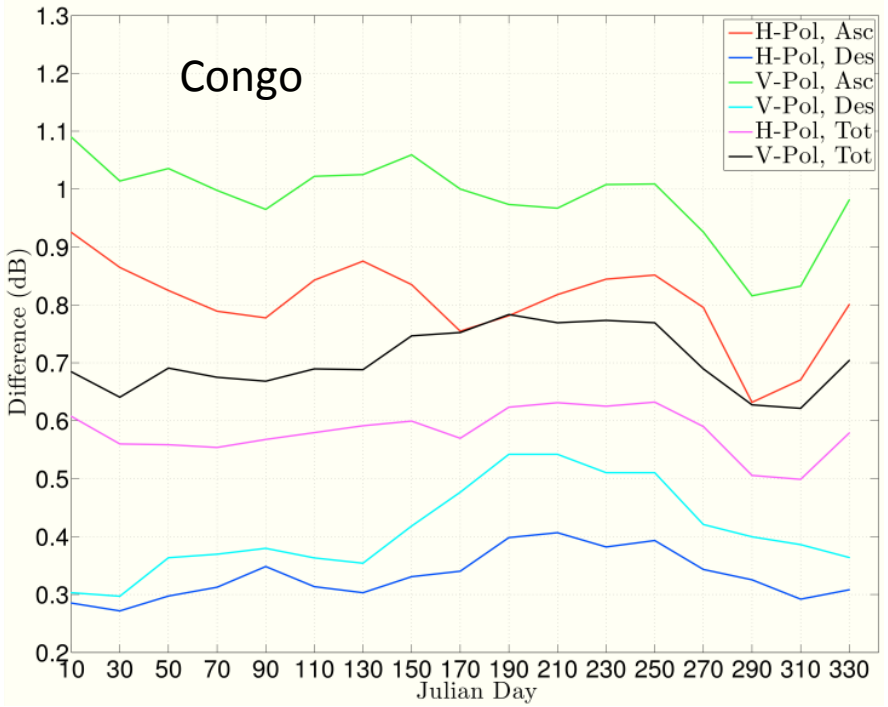
Congo

- Homogenous study regions selected with narrow sigma-0 range, low temporal variation

Time/Location Dependence of Incidence Angle Difference

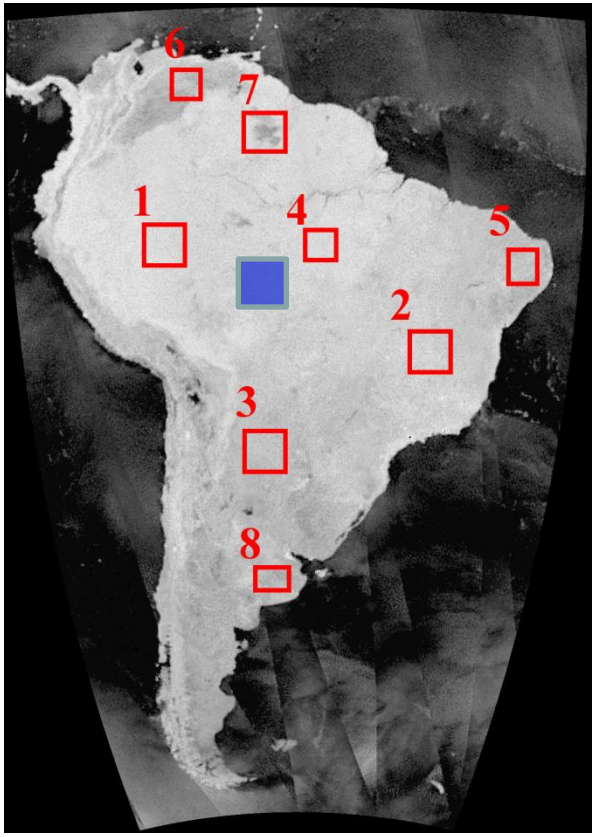


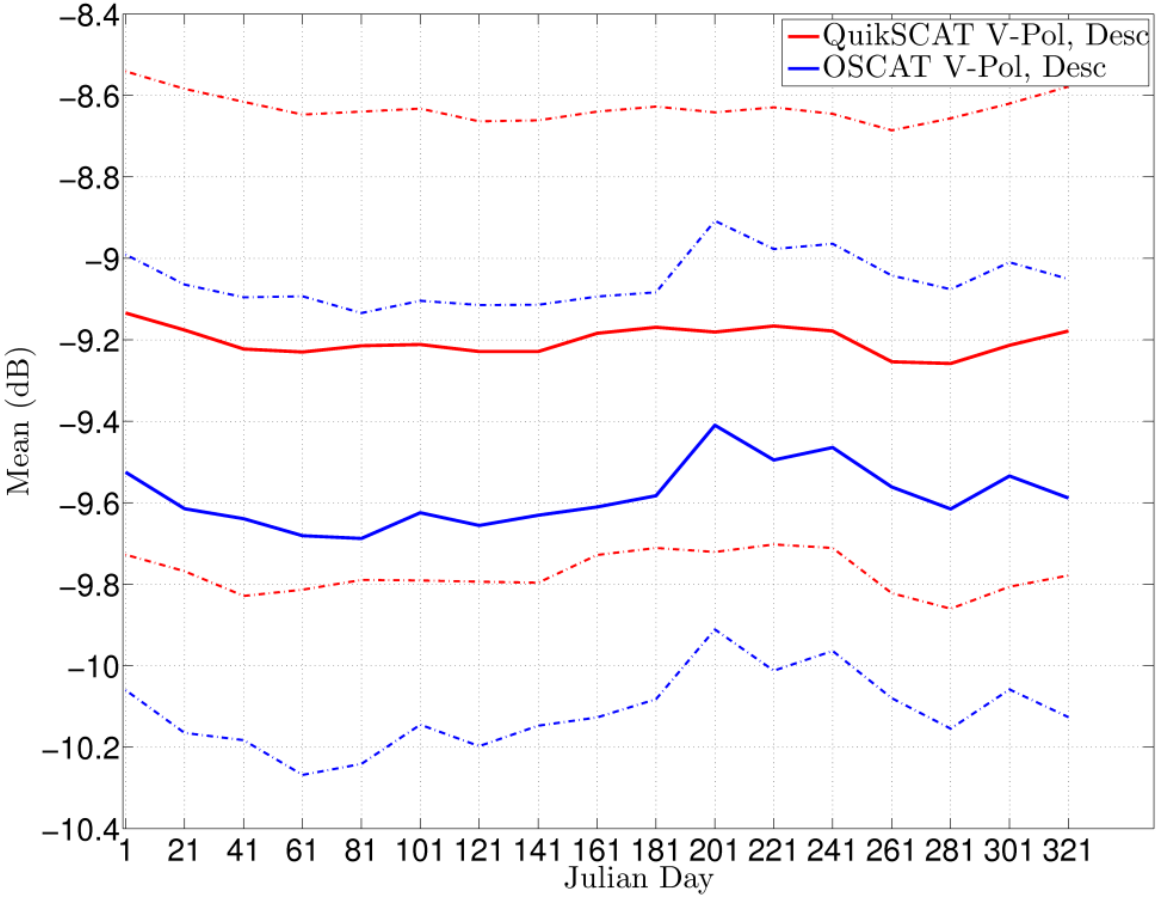




Region Distributions

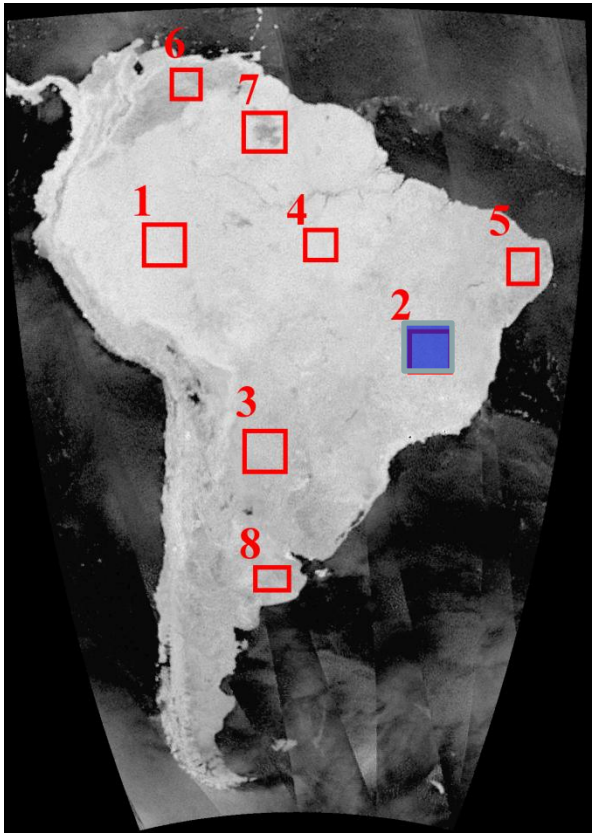
different years

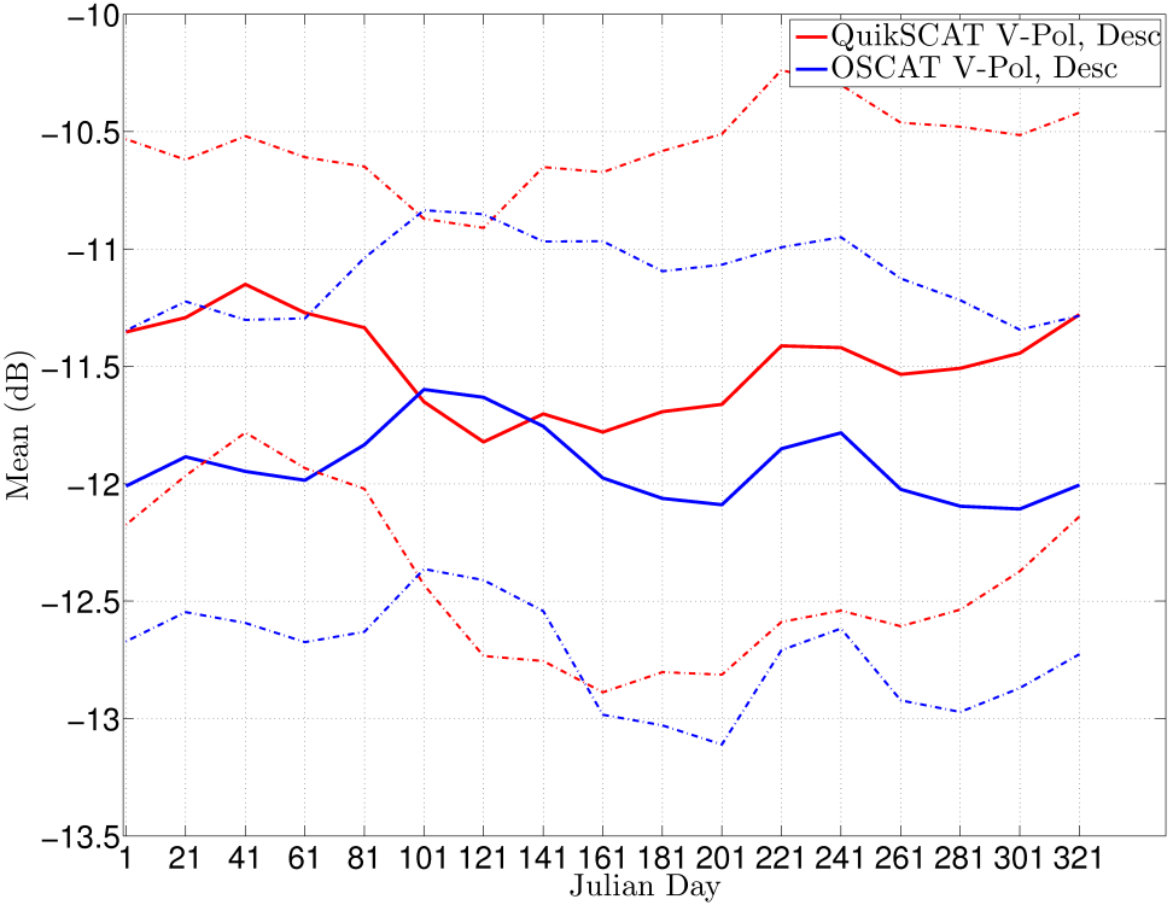




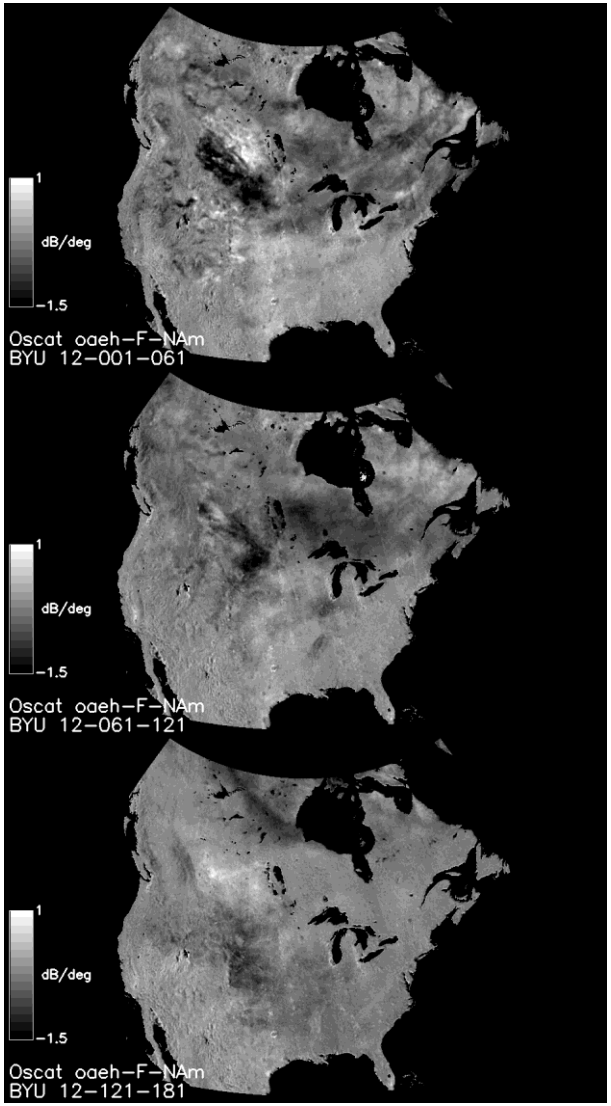
Region Distributions

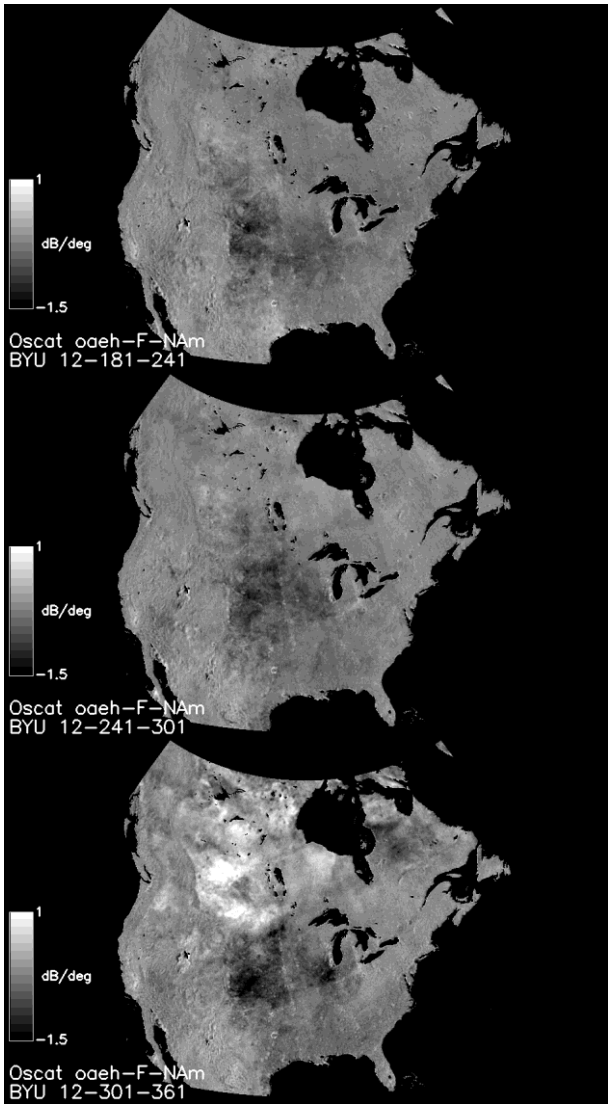
different years



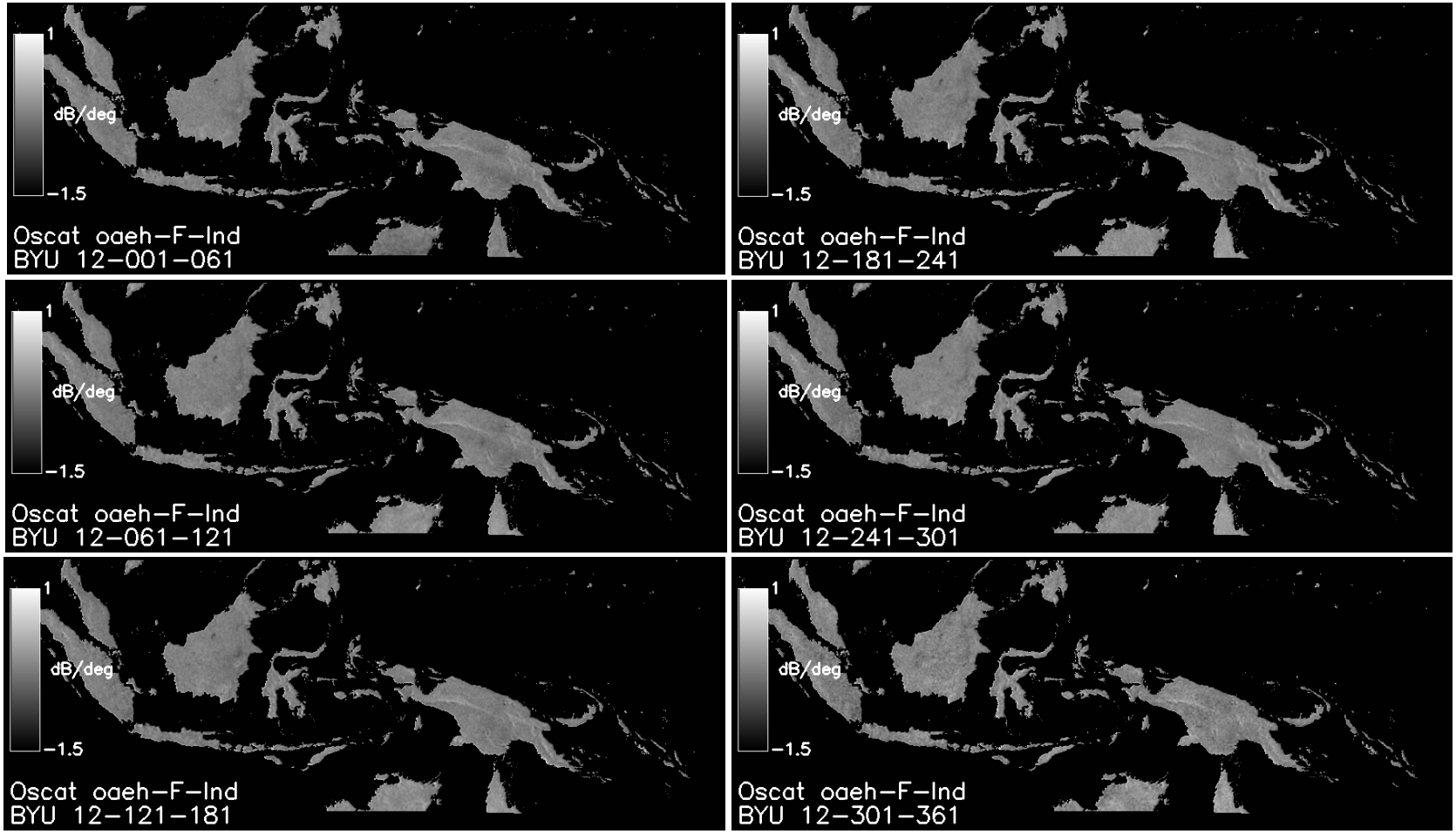


Incidence Angle Bias Maps



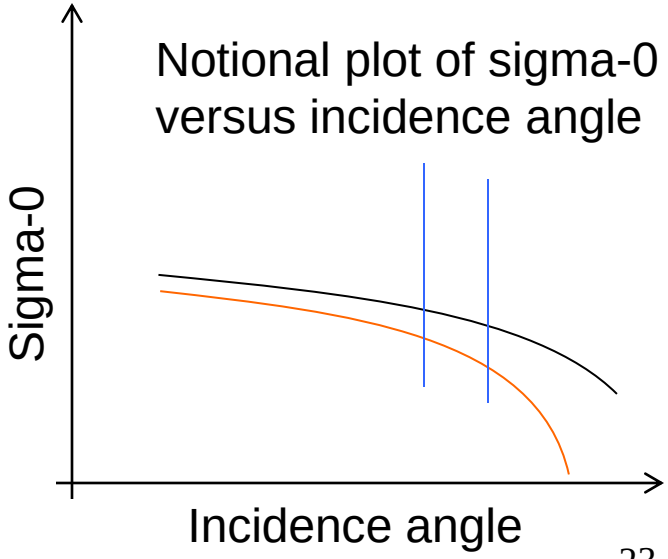


Incidence Angle Bias Maps



Region Distributions

- QuikSCAT and OSCAT trends generally follow each other. Differences are primarily due to weather differences between 2009 and 2012
- Incidence angle response dependent on terrain, vegetation, as well as soil moisture and freeze-thaw
- *(Gamma normalization applies only for perfectly rough surfaces)*



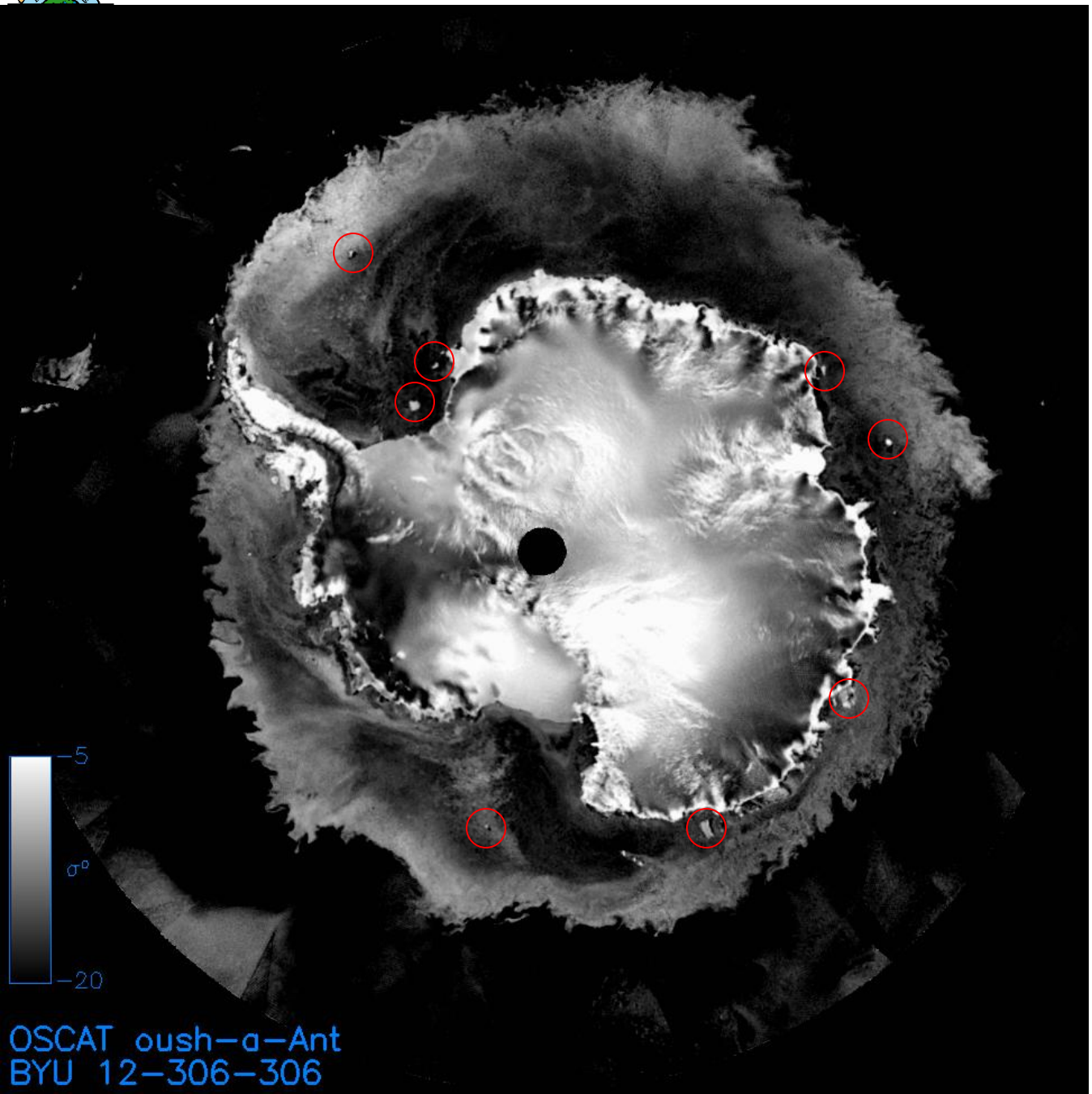
Conclusion

- QuikSCAT and OSCAT produce very similar land/ice sigma-0 distributions
  - Azimuth angle dependent bias must be removed from OSCAT

- Mean sigma-0 offsets
  - Egg: Hpol 0.0 dB and Vpol 0.25 dB
  - Slice: Hpol 0.2 dB and Vpol 0.35 dB

- Incidence angle dependence makes it difficult to develop an incidence angle adjustment
  - Get close

OSCAT Enhanced Resolution Antarctic Image



Enhanced resolution OSCAT image, 2 Nov 2012

Selected major icebergs circled

Daily tracking of icebergs using OSCAT data is continuing

BYU Summary

David Long

- Paper on scatterometer calibration in Greenland accepted, *IEEE Geoscience and Remote Sensing Letters*
- Paper on OSCAT spatial response function estimation accepted, *IEEE Trans. Geoscience and Remote Sensing*
- Beta version OSCAT land, ice, & UHR wind processing running at BYU
  - Have processed entire OSCAT data set available to images: www.scp.byu.edu
  - Regularly extracting and reporting iceberg positions from OSCAT image data in Near Real Time (NRT)
- Enhanced resolution ASCAT1/2 and OSCAT UHR hurricane and NRT polar ice processing
  - BYU code ported to NOAA. Installed and in use.