National Aeronautics and Space Administration

Soil Moisture Active Passive Mission

SMAP

IGARSS 2016

July 10-15, 2016

Beijing, China

SMAP Radar Processing and Results from Calibration and Validation

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JPL/CalTech

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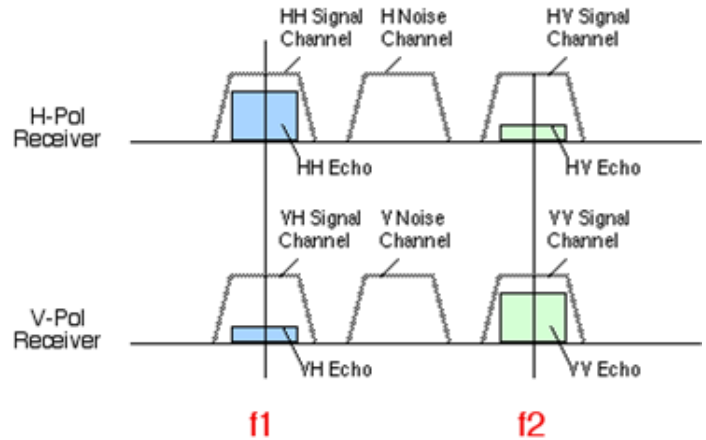
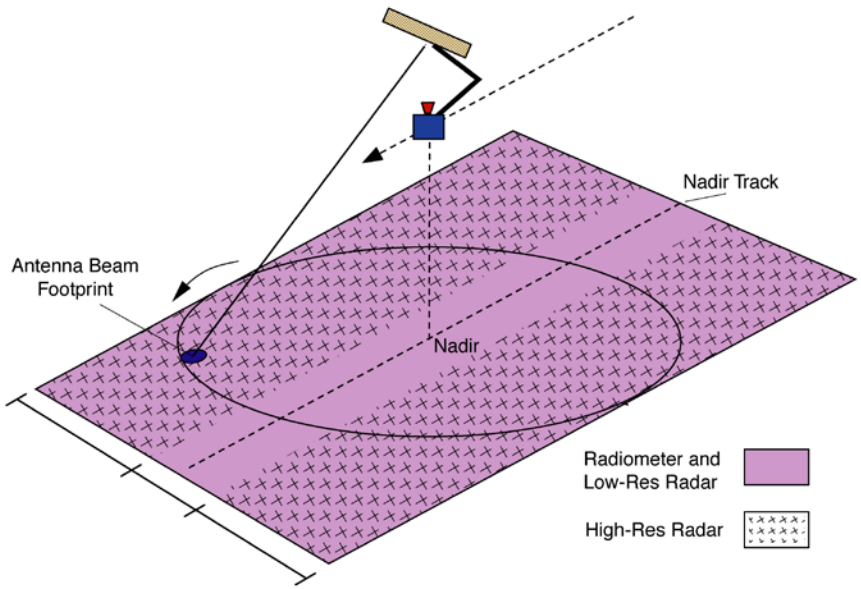
Outline

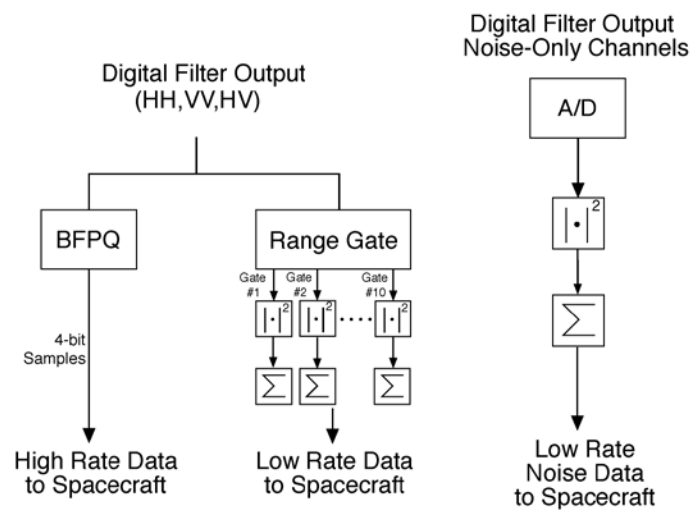
- Radar Operation
- Radar Data Coverage, Example Images
- Geo-location Validation
- Pointing Calibration
- Radiometric Calibration
- Faraday Rotation Correction
- Relative Bias removal
- RFI removal
- Summary

SMAP Radar General Operation

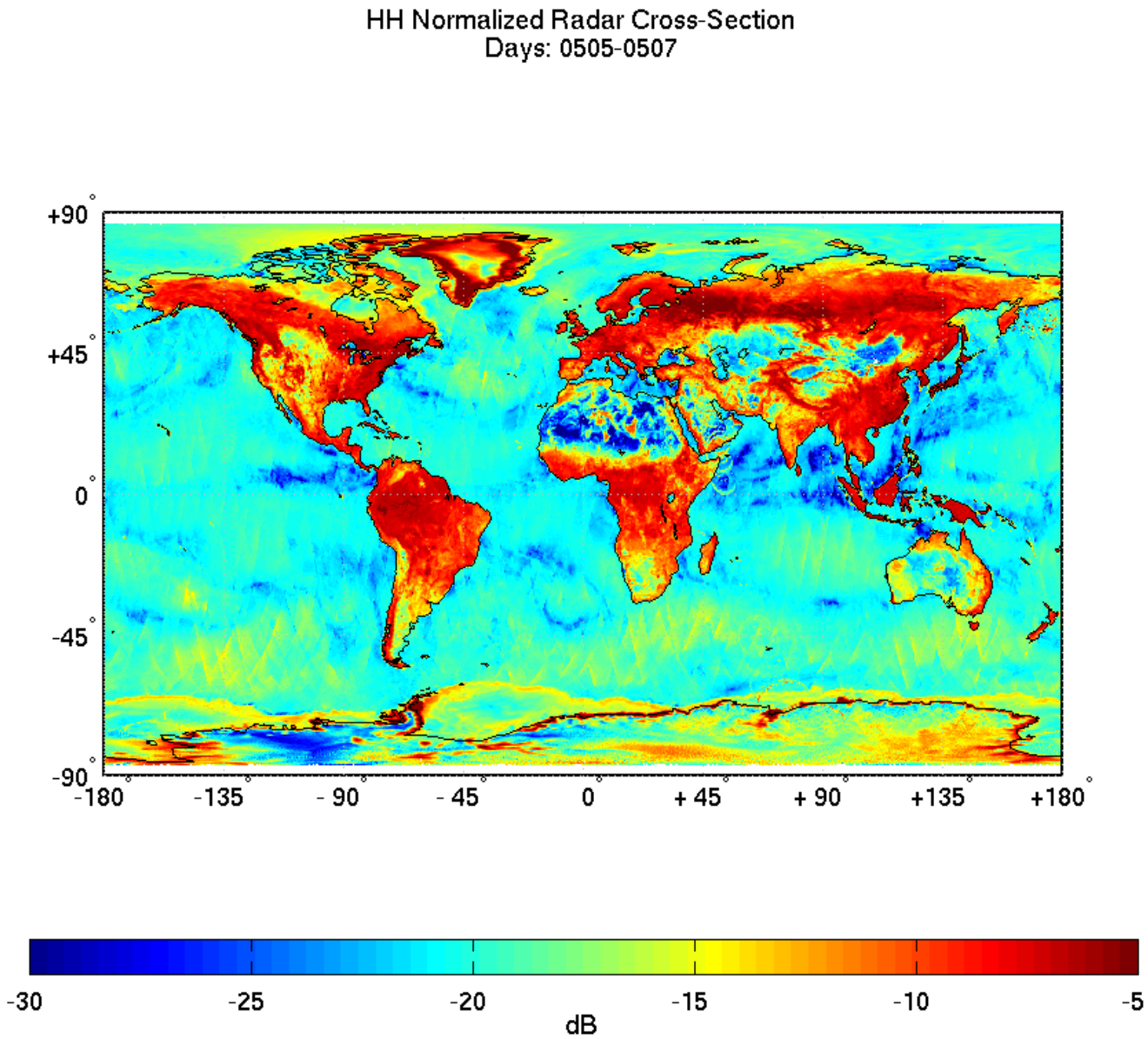
- SMAP uses conical scan to cover a wide 1000 km swath with a pencil beam at L-band
- Radar transmits V-pol and H-pol pulses with echoes received interleaved between transmissions.
- V-pol and H-pol use different frequencies, onboard filtering separates these and provides dual-pol data.
- Noise channel at 3rd frequency provides noise only measurements.
- Loopback path provides tracking of transmit power and receive gain variation



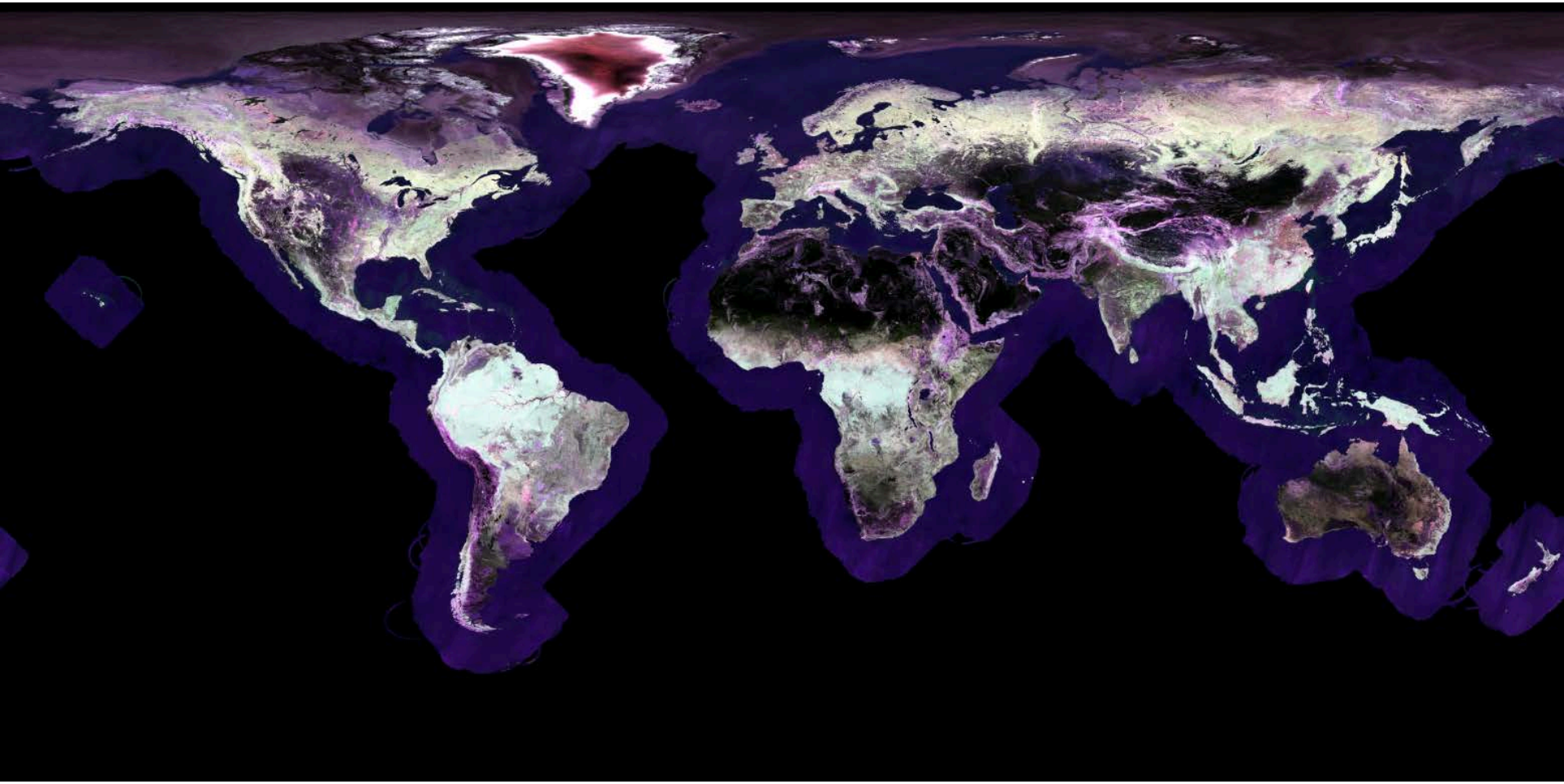




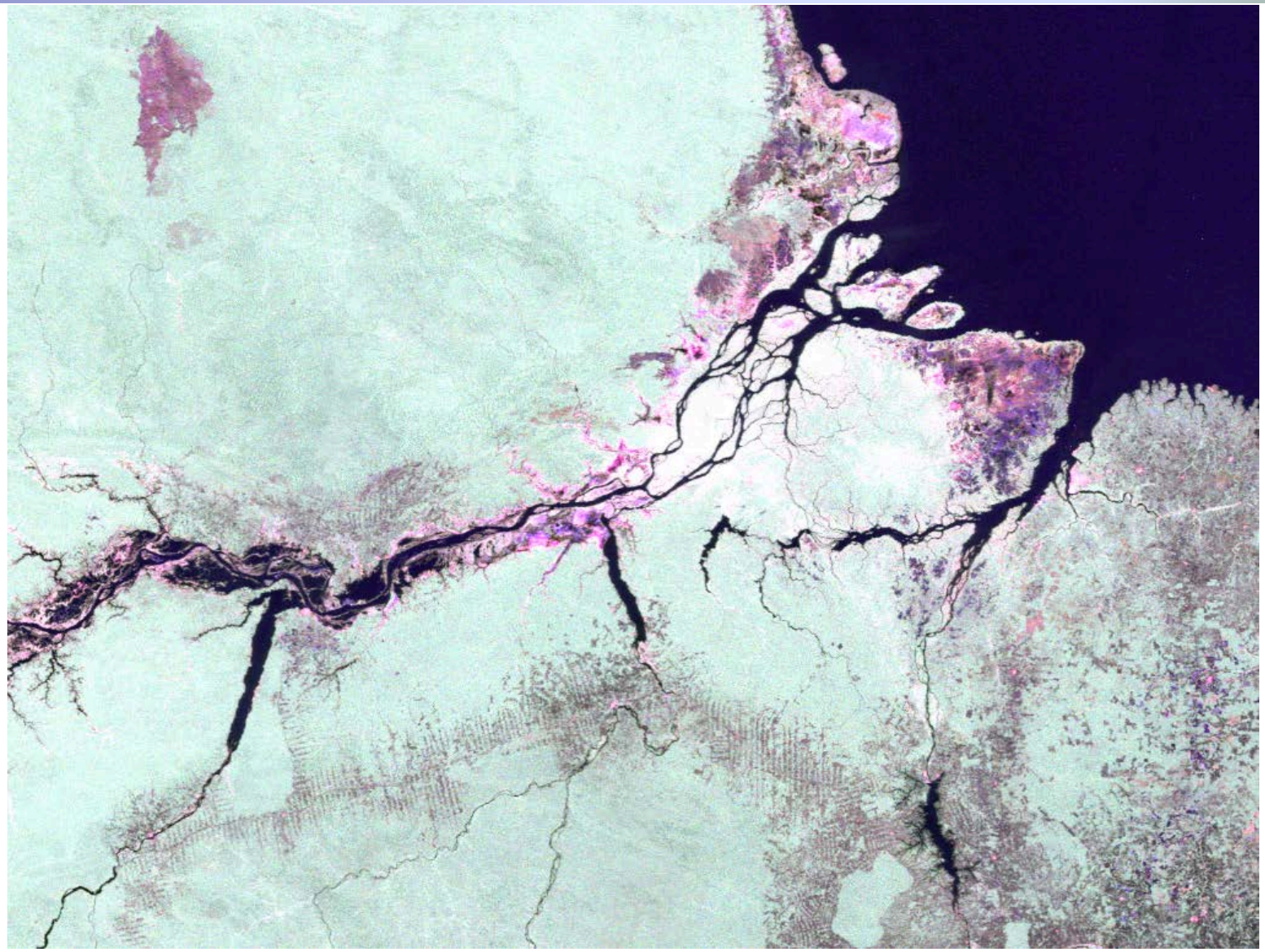
Global Composite of 3-days of L1B radar data



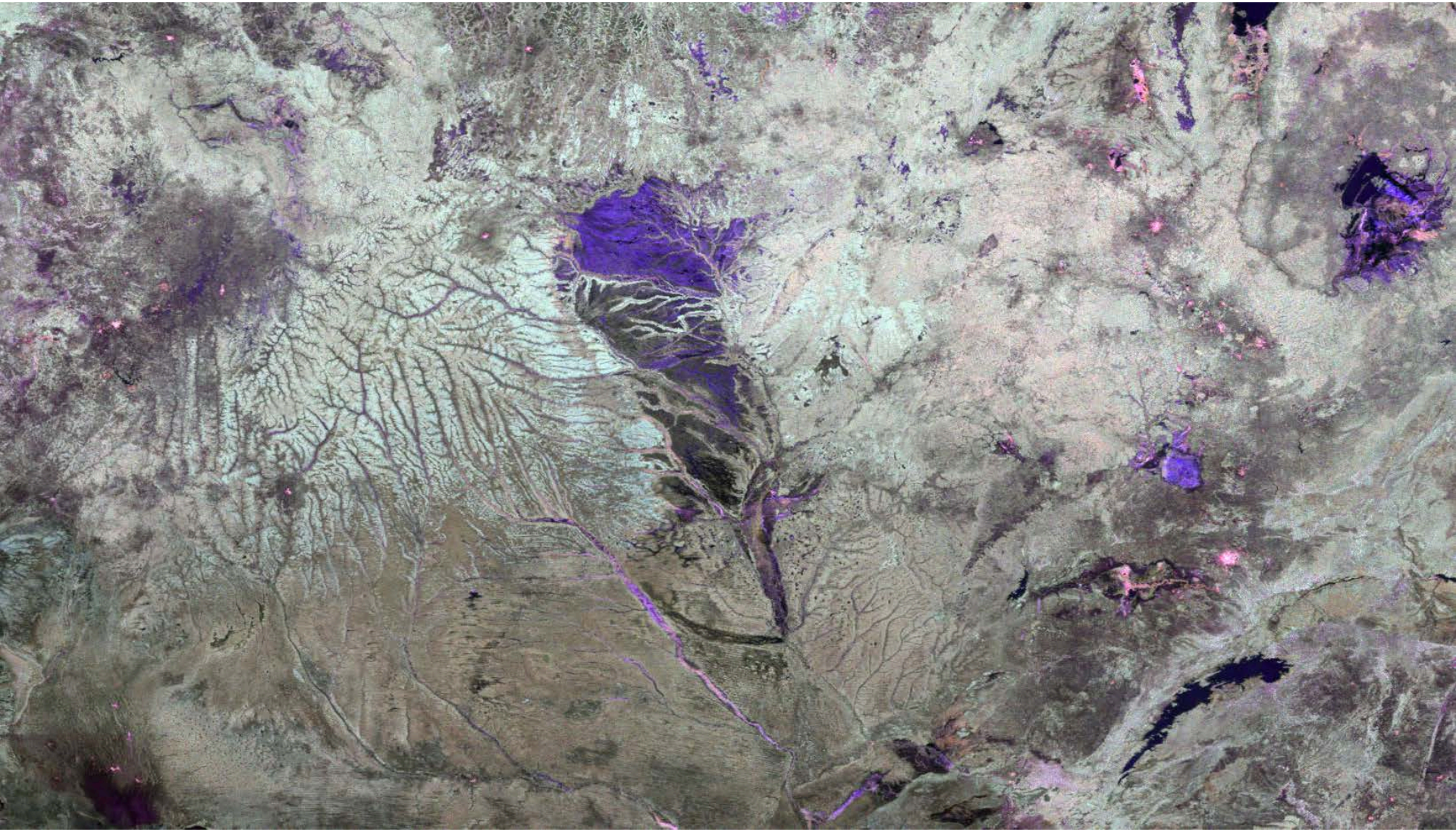
Global composite of 8-days of L1C radar data



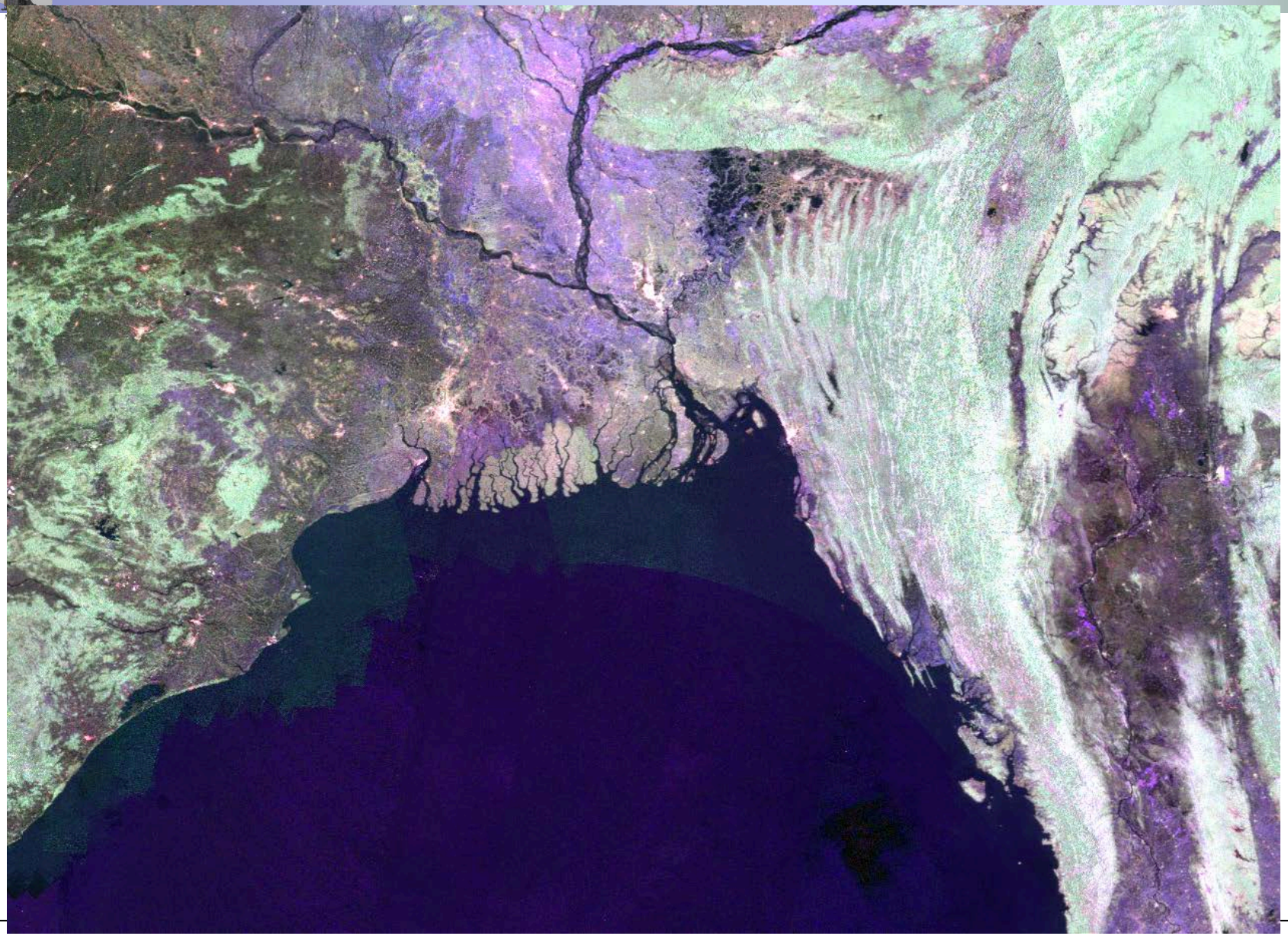
Composite Excerpts – Amazon Basin



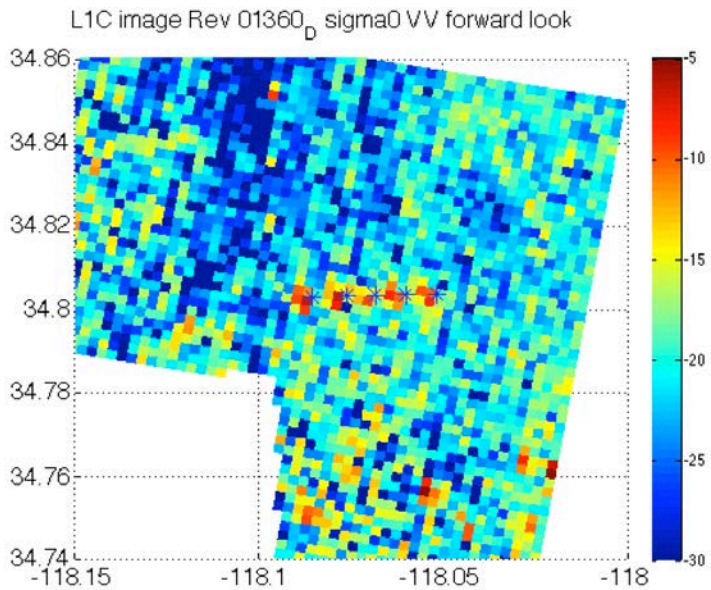
Composite Excerpts – Northern Botswana

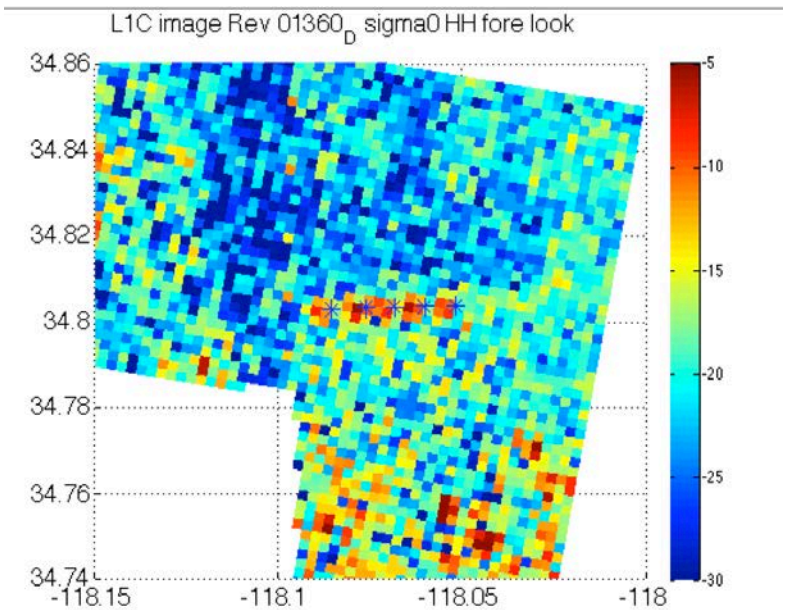


Composite Excerpts - Bangladesh

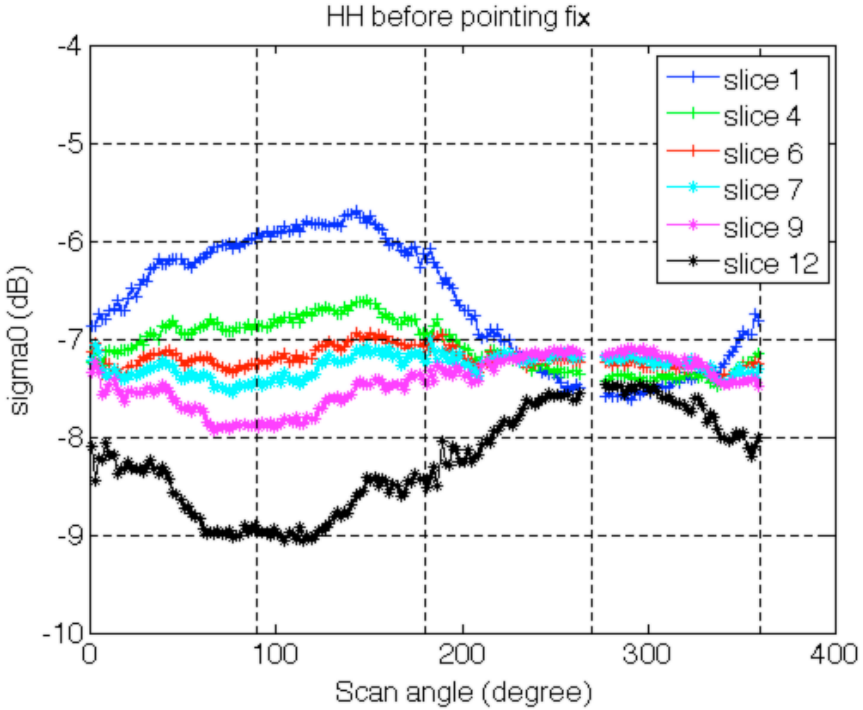


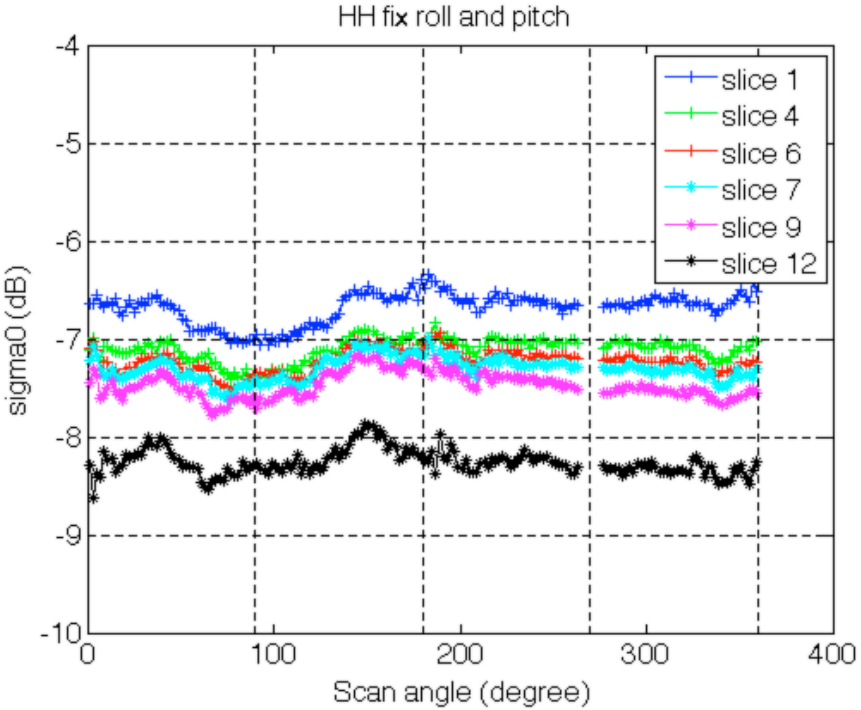
Geo-location Validation



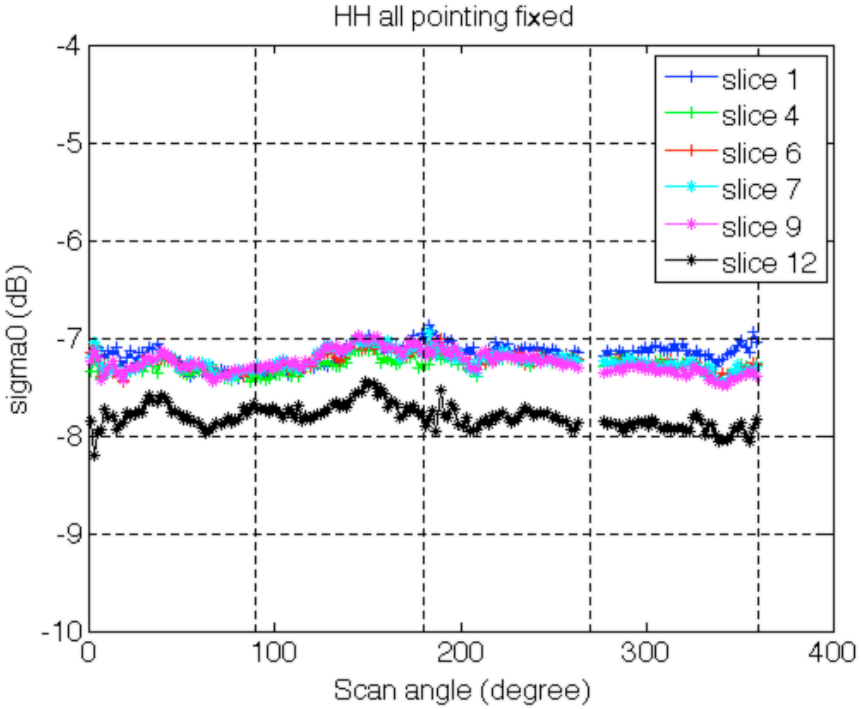


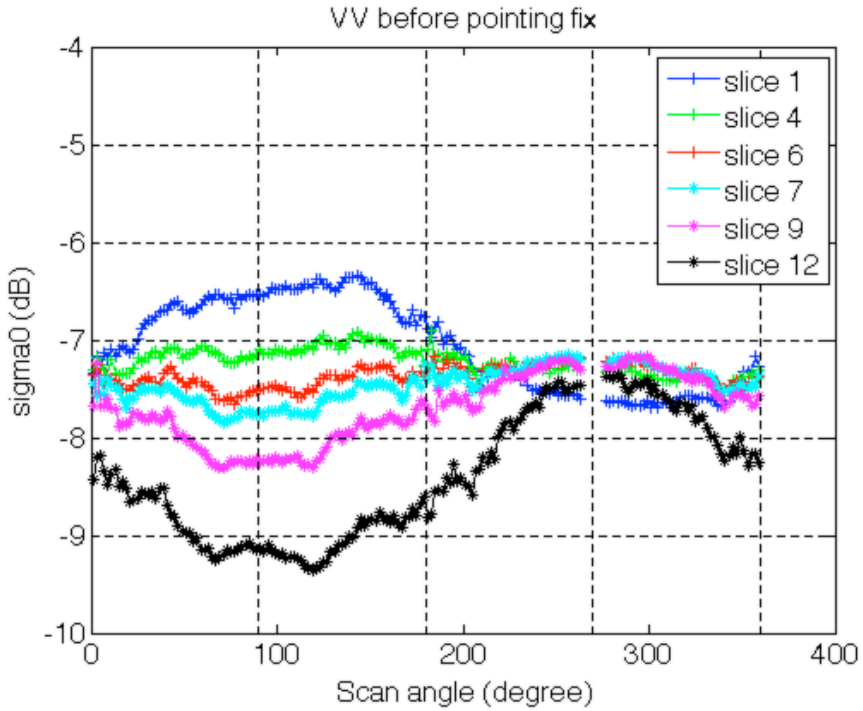
- Corner reflector positions off by about 1.5 pixels
- 250 m pixels -> 350 m position error
- Requirement level: 1 km

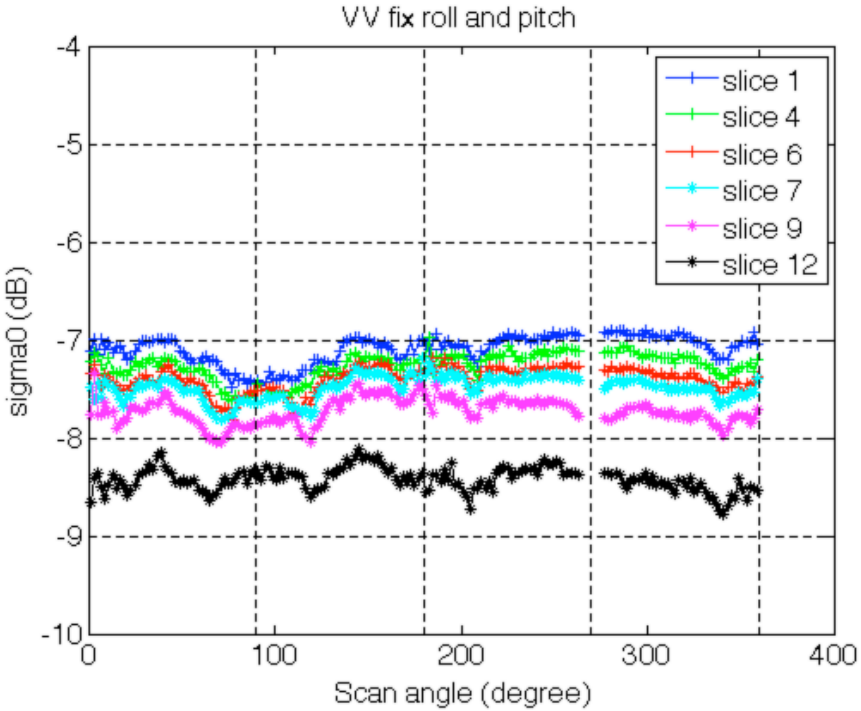




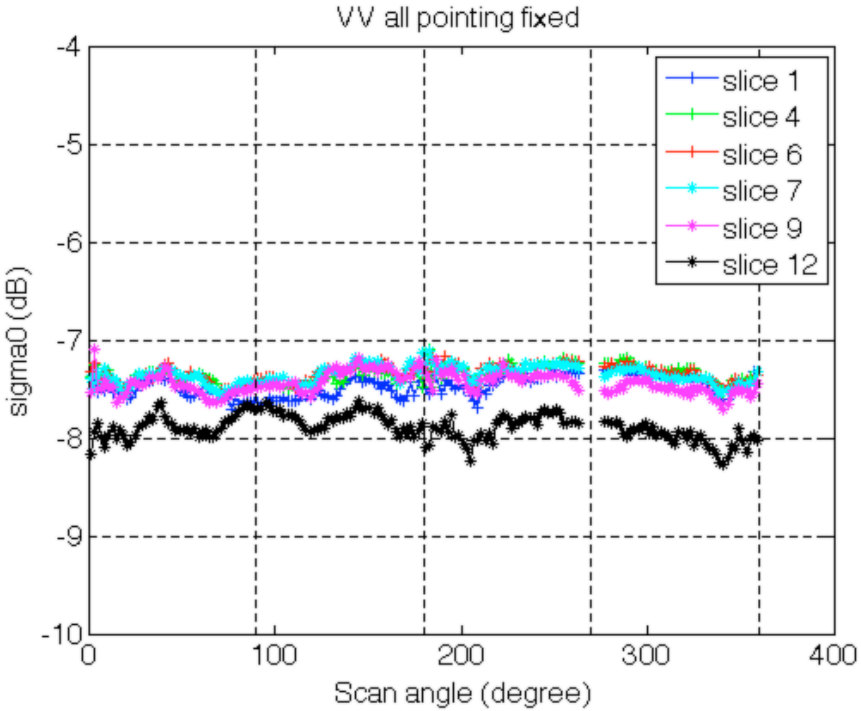
- Roll and pitch biases (0.072 and 0.021 deg) cause azimuthal modulation of sigma0 due to systematic varying errors in the beam elevation angle
- Look angle bias (-0.04 deg) causes slice imbalances due to a fixed error in the beam elevation angle



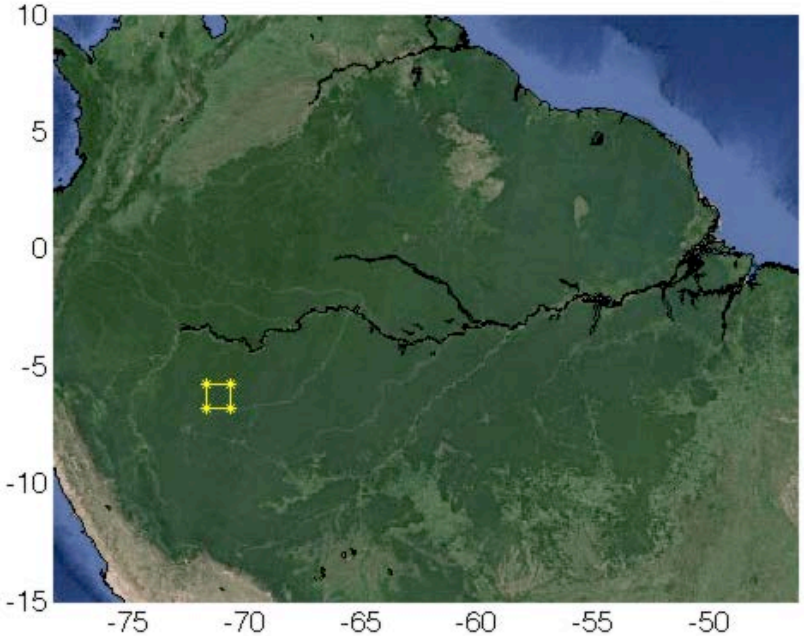




- Applying roll and pitch biases flattens out the azimuthal modulation showing that processing results are consistent with separately derived bias values
- Look angle of 35.46 selected to minimize elevation spread in L1C data (shown next). L1B results are good, but slice 12 needs further investigation.



Absolute Calibration - Amazon



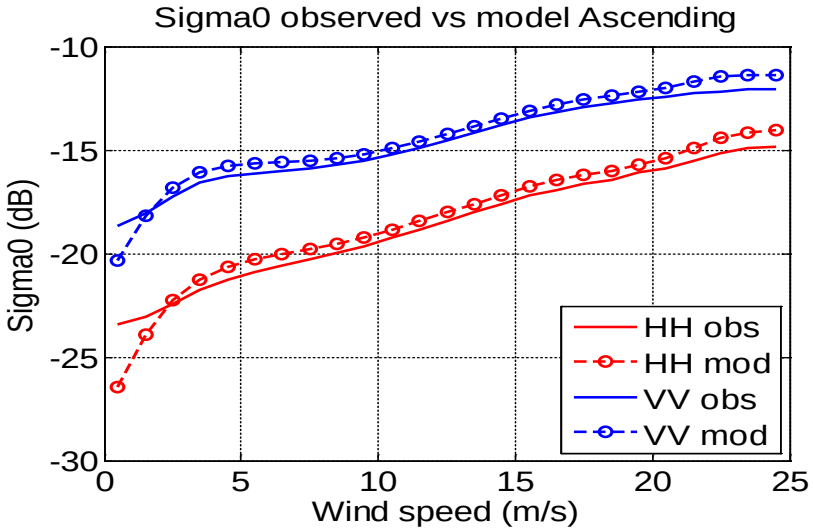
1 degree box center at lat = -6.275 lon = -71.4

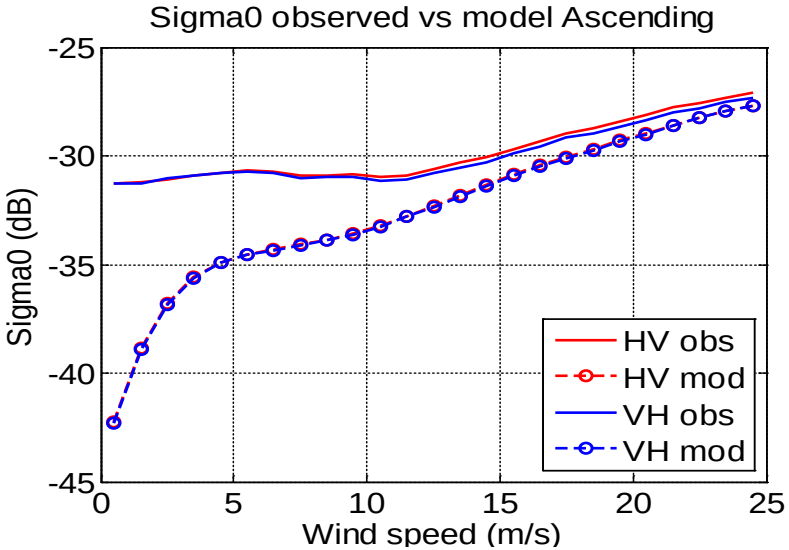
- Co-pol and Cross-pol results are within 1/4 dB over Amazon relative to Aquarius
- L1B and L1C cross-calibration is very good using ad-hoc correction table (< 0.2 dB)
- All based on a-priori calibration

	HH asc	HH des	VV asc	VV des	HV asc	HV des	VH asc	VH des
AQ	-7.28	-7.26	-7.37	-7.31	-12.29	-12.15	-12.29	-12.15
L1B	-7.22	-7.03	-7.36	-7.20	-12.19	-11.94	-12.35	-12.07
L1C	-7.30	-7.06	-7.52	-7.22	-12.13	-11.96	n/a	n/a

Absolute Calibration – Ocean (L1B)

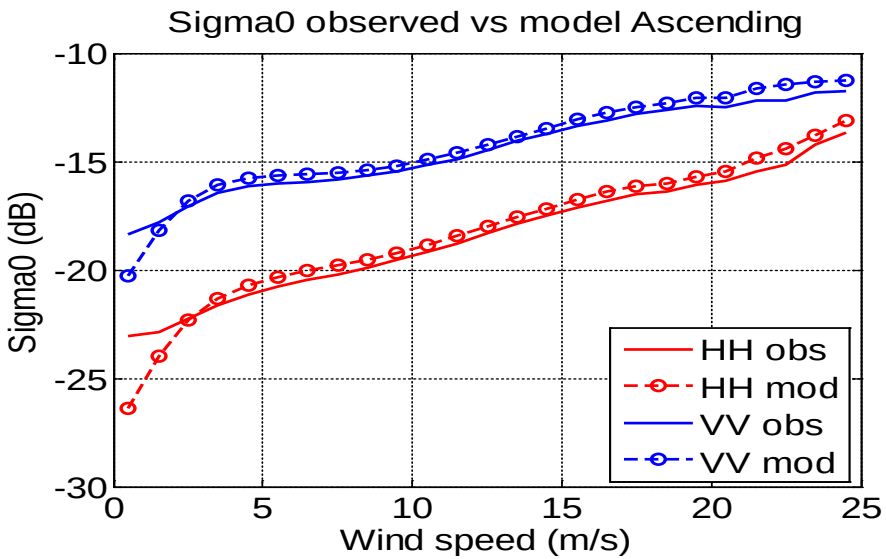
- Co-pol results are about ½ dB low over ocean relative to Aquarius model function using NCEP winds
  - Ocean and Amazon appear to differ by ¾ dB
- Cross-pol deviates at lower wind speeds (lower backscatter)
  - Noise channel cross-talk
  - Faraday rotation

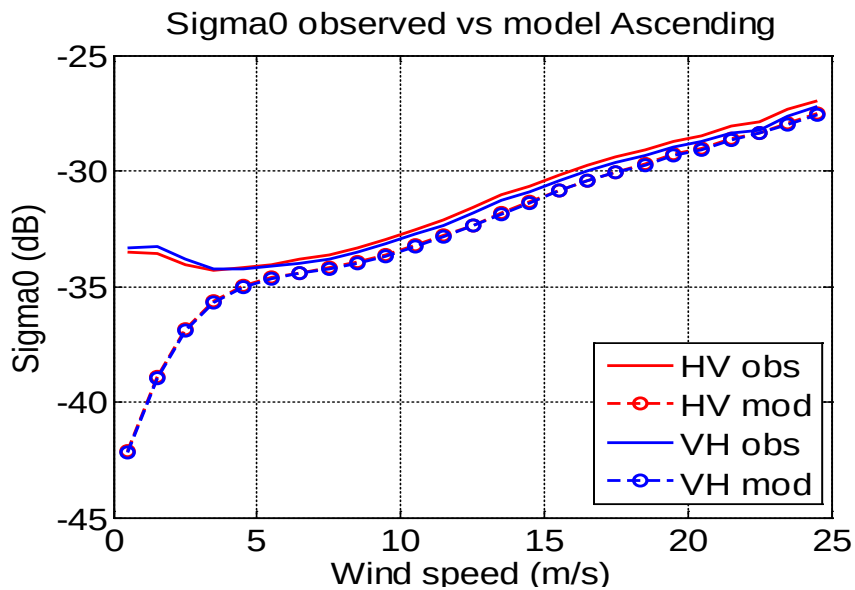




L1B Ocean Comparison

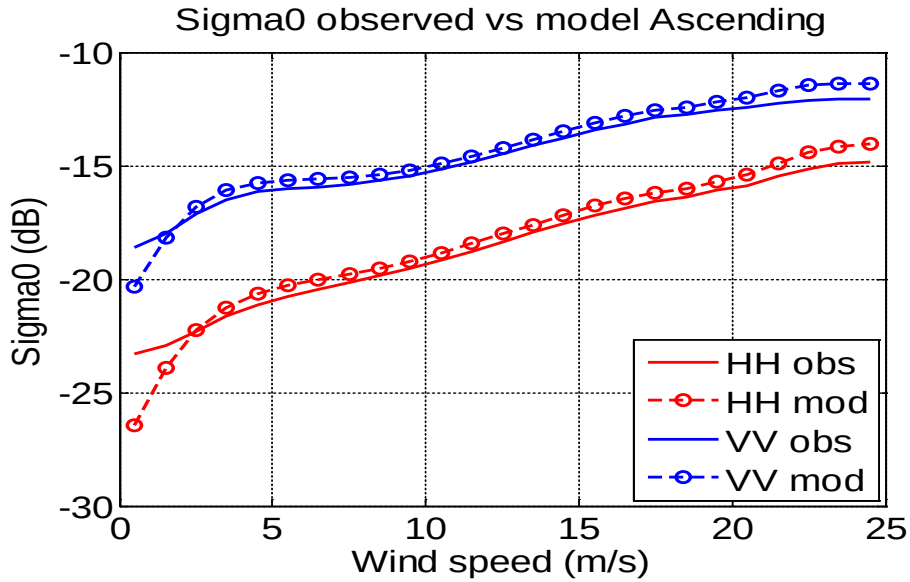
- Data filtered for low Faraday Rotation angles (< 1 deg)
- Faraday Rotation causes the low wind speed bias in cross-pol

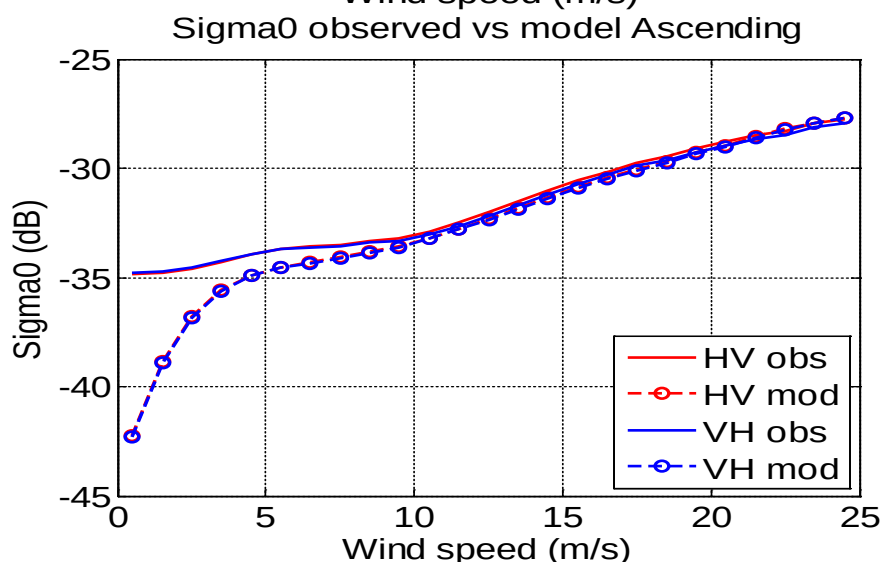




L1B Ocean Comparison

- All Faraday rotation angles included
- Correction based on GPS measured total electron content (TEC) reduces the bias in low wind speed cross-pol measurements

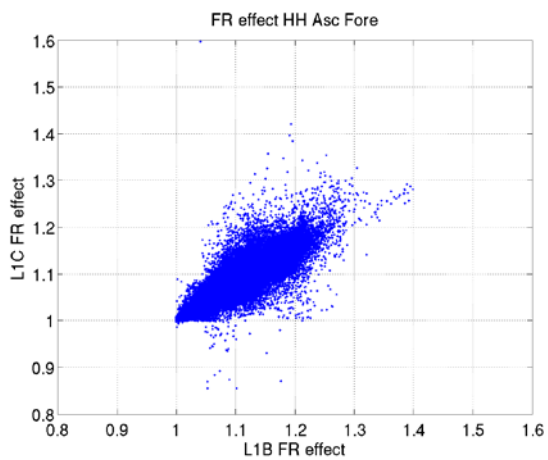




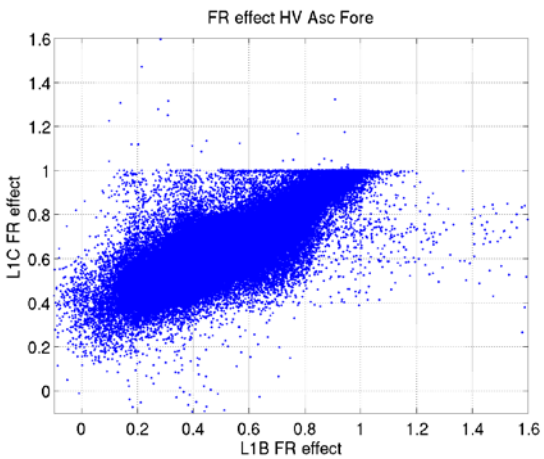
L1C FR Correction

- L1C using L1B FR correction algorithm
- L1C produces same average results as L1B.
  - Some bias evident for very low sigma0

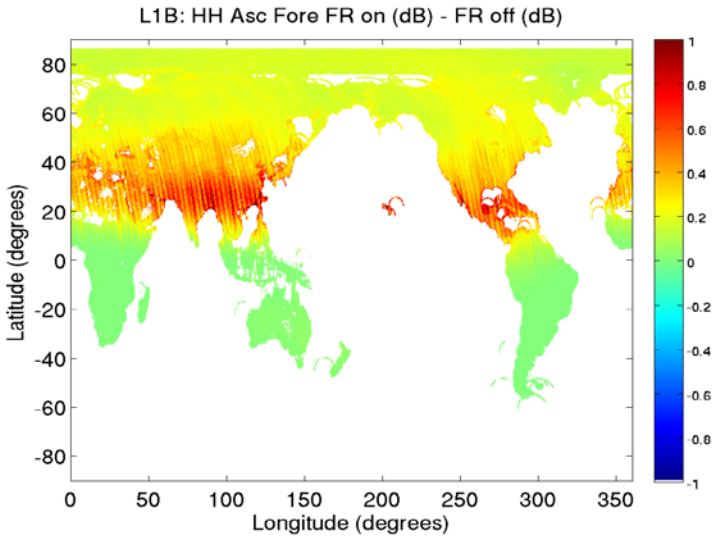
Co-pol

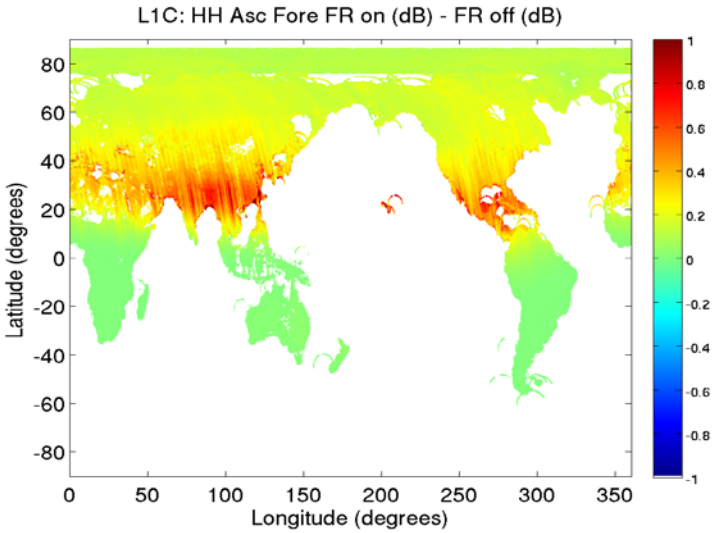


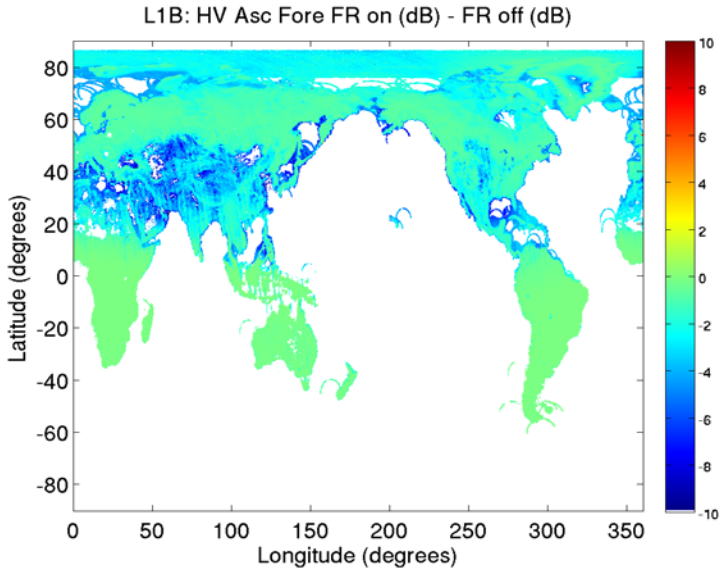
Cross-pol

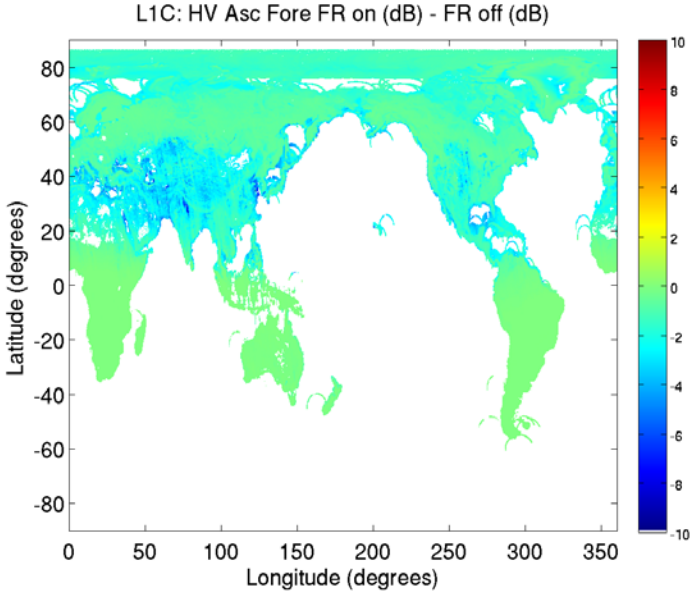


Faraday Rotation Corrections

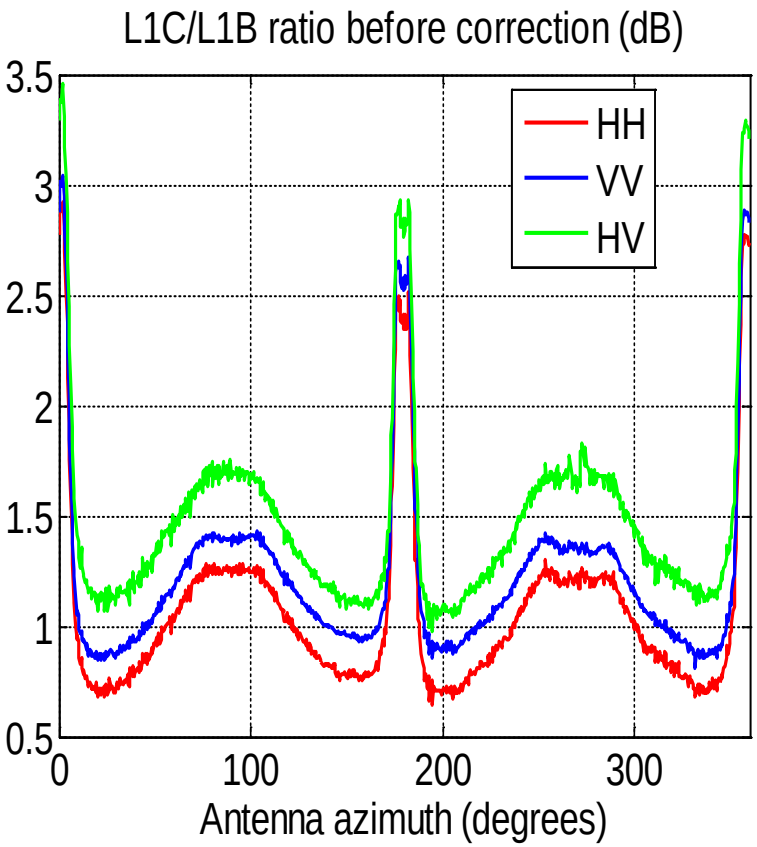


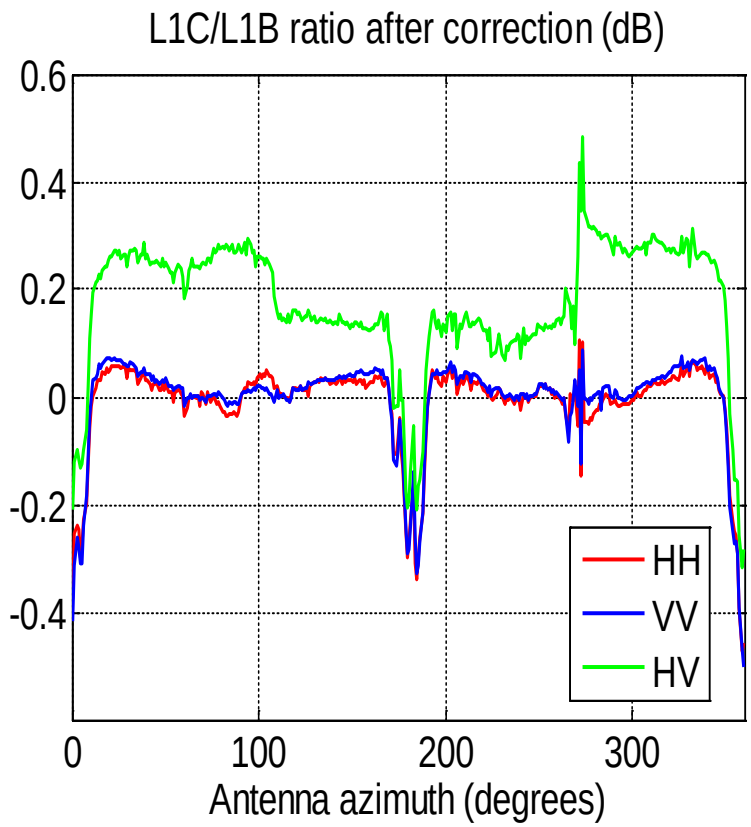




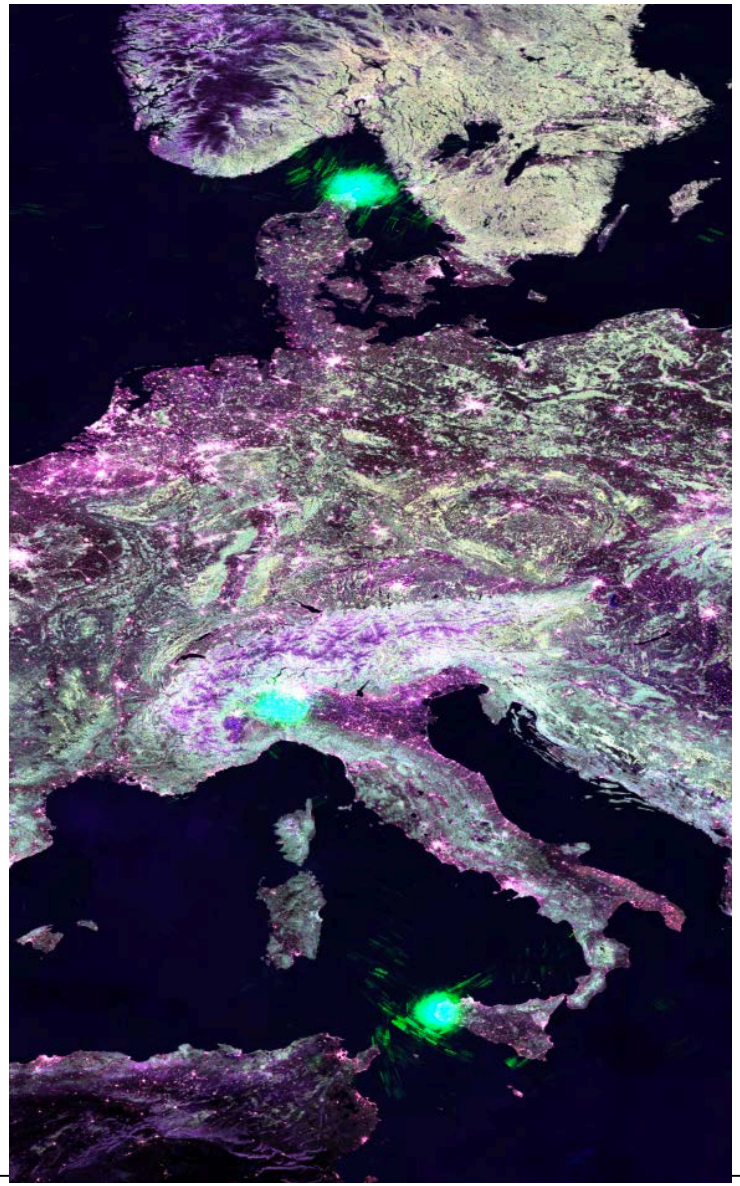


AdHoc Bias Corrections

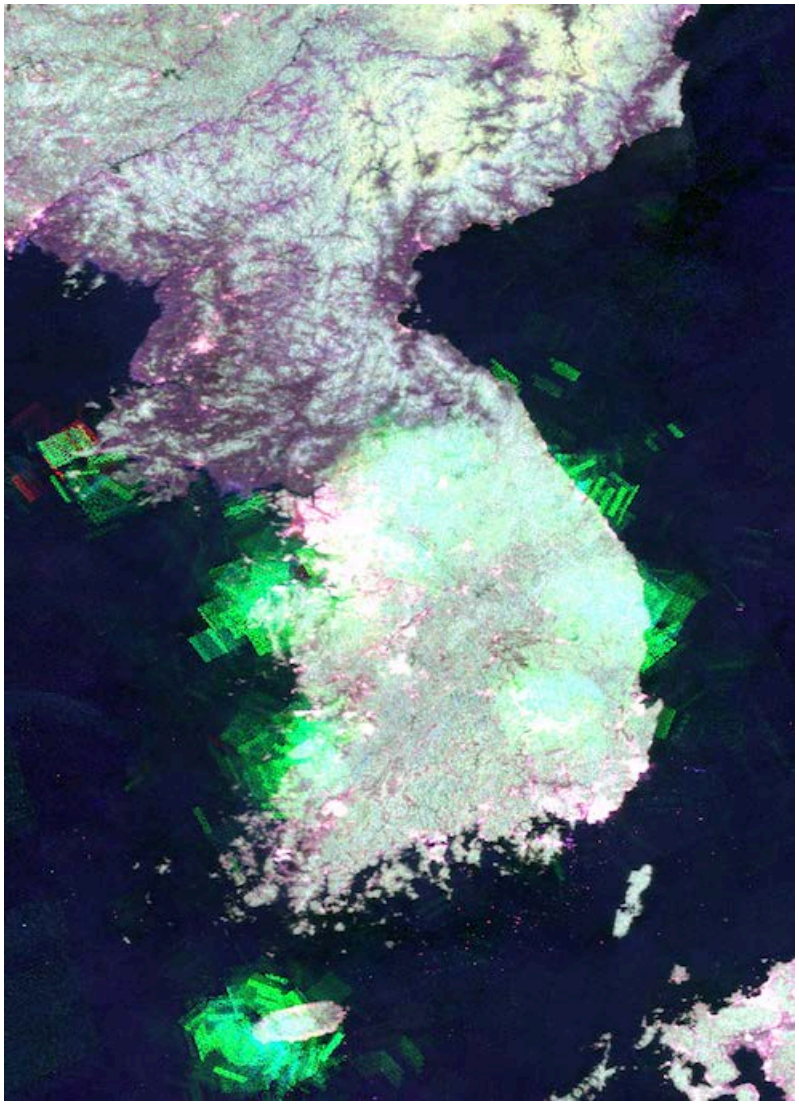




RFI Removal Examples

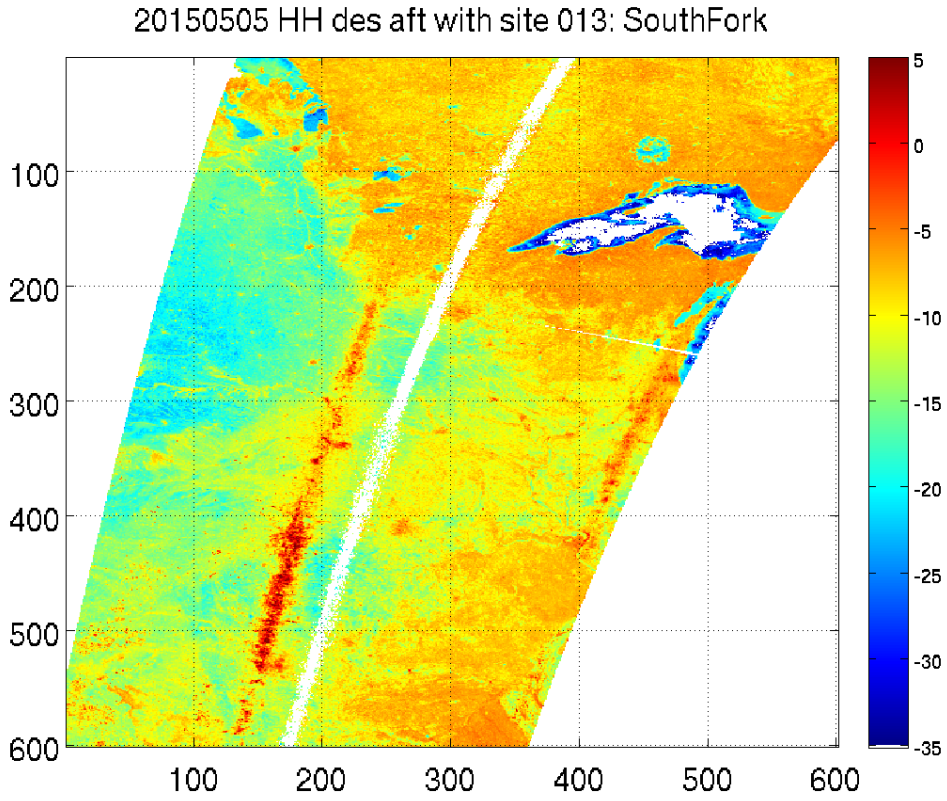


RFI Removal Examples



Possible RFI

- Contamination in both co-pol channels and the noise only channel
- Contamination not present in cross-pol channel
- Shows up consistently at the same azimuth directions and the same locations.



Summary

- SMAP L1 Radar data meets basic accuracy requirements
  - 1 dB overall relative error at 3 km resolution
- Geo-location good to about 350 m
- Pointing biases corrected to better than 0.1 deg
- Cross-calibration with Aquarius good to ¼ dB using a-priori calibration constants
- Faraday Rotation effect is small, well corrected according to the Aquarius ocean wind model.
- RFI mostly removed by slow time threshold algorithm
  - Possible exception shows up in data over North America

- Backup

L1 Radar Product Organization

- L0B – Raw Telemetry Files
  - Up to around 6 GB per half-orbit granule
  - Complicated binary structure
- L1A – Repackaged telemetry in engineering units
  - Up to around 6 GB per half-orbit granule
  - HDF5 files with separate groups of data
- L1B – Low Resolution (real aperture) radar backscatter
  - Up to 350 MB per half-orbit granule
  - Time ordered vectors of radar backscatter measurements in HDF5 files
  - HH,VV,HV,VH
  - Associated geometry and intermediate calibration values
  - Ancillary wind data over the oceans
- L1C – High Resolution(synthetic aperture) radar backscatter
  - Up to 2.3 GB per half-orbit granule, usually around 1 GB
  - Swath grid arranged 2-D arrays of radar backscatter measurements in HDF5 file
  - HH,VV,XY