Space Missions

RADARSAT-2 Image Quality and Mode Maintenance and Enhancement

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Topics

- Phases of Image Quality work in the RADARSAT-2 Mission

- Establishing, monitoring and maintaining Image Quality

- Achieving enhanced performance goals

- Adding and upgrading modes

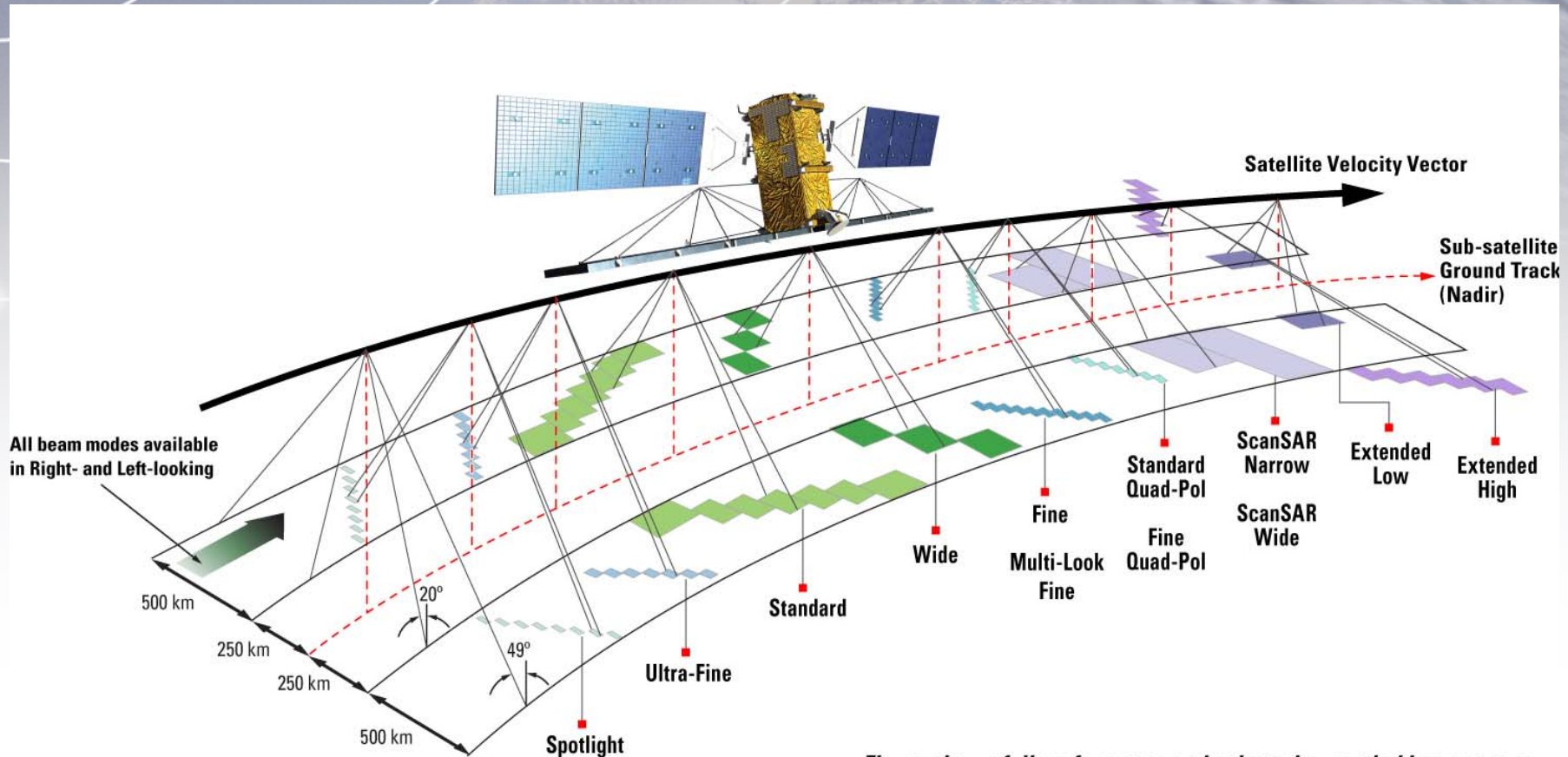- Future plans

RADARSAT-2 Imaging Modes

Figure shows full performance and selected expanded beam ranges

AI-8760-91CR12

RADARSAT-2 Mission Phases

Phases in RSAT-2 Image Quality Work

- **Meet specifications and achieve initial calibration**
- **Implement monitoring/calibration update plan**
- **Identify areas of potential improvement relative to specification, and any visual defects/limitations that can be improved.**
- **Undertake program of enhancement, adjustment and tuning**
- **Add new capabilities**

Establishing, monitoring and maintaining Image Quality

Commissioning, Initial Calibration, Early Operations

Commissioning:

- Achieve specification performance.
- Planned as 90 days from launch; actually ~120 days.

Initial Calibration:

- Provide data files for processing that ensure that products for all modes achieve the radiometric, polarimetric, geolocation accuracy specifications.
- Planned to last up to 150 days; completed in 90 days.

Early Operations:

- Start of Monitoring/Maintenance phase

Monitoring Operations

The schedule of data collections includes:

- Radiometric and Polarimetric Calibration monitoring with Amazon.
- Polarimetric and Geolocation monitoring with trihedrals and other point targets.
- Noise level monitoring with Receive Only modes
- Antenna monitoring with Non-Imaging Calibration data sets.
- Monitoring of system variations through a database of processing and analysis report data.

Calibration files with applicability dates have been updated for

- Polarimetric parameter adjustments
- Elevation pattern refinement
- Timing and delay data for geolocation
- Relative phase between Dual-Receive channels

Enhanced Performance Goals

Specifications and Goals

Commissioning tasks were targeted towards meeting the specification performance before the Operational Phase started.

By end of Commissioning, some requirements were met comfortably, and it was clear that other requirements could be exceeded if periodic updates to calibration data were made to track variations in the instrument.

It was also apparent that for a system dealing with such large dynamic range it was desirable to try to enhance certain aspects of performance well beyond the specification level. This was particularly true for ambiguity and artifact levels.

Upgrade Work since Commissioning

Geolocation

Initial specifications were loose, and an upgrade to on-board software in July 2008 brought accuracy down to ~10m.

Ambiguities and artifacts

Initial requirements on ambiguities were set at around -20dB. The aim now is to reduce some effects to -35dB or lower.

Polarimetric fidelity

Initial goals were set at relative channel amplitude and phase of <0.5dB and 10°, with cross-pol leakage below -30dB.

Current update strategy is aimed at <0.3dB, 3° and <-40dB.

Absolute radiometric reference

Requirements are in terms of radiometric stability. Initial absolute levels were set on the basis of Amazon Gamma of -6.5dB.

This Amazon model has been refined using additional data.

Revised Amazon Backscatter Model

The backscatter model was revised in January 2009 using data from the first year of RADARSAT-2 operation, together with data from the full RADARSAT-1 mission. This applies to the mean dawn/dusk and seasonal levels for the Primary RADARSAT Amazon site.
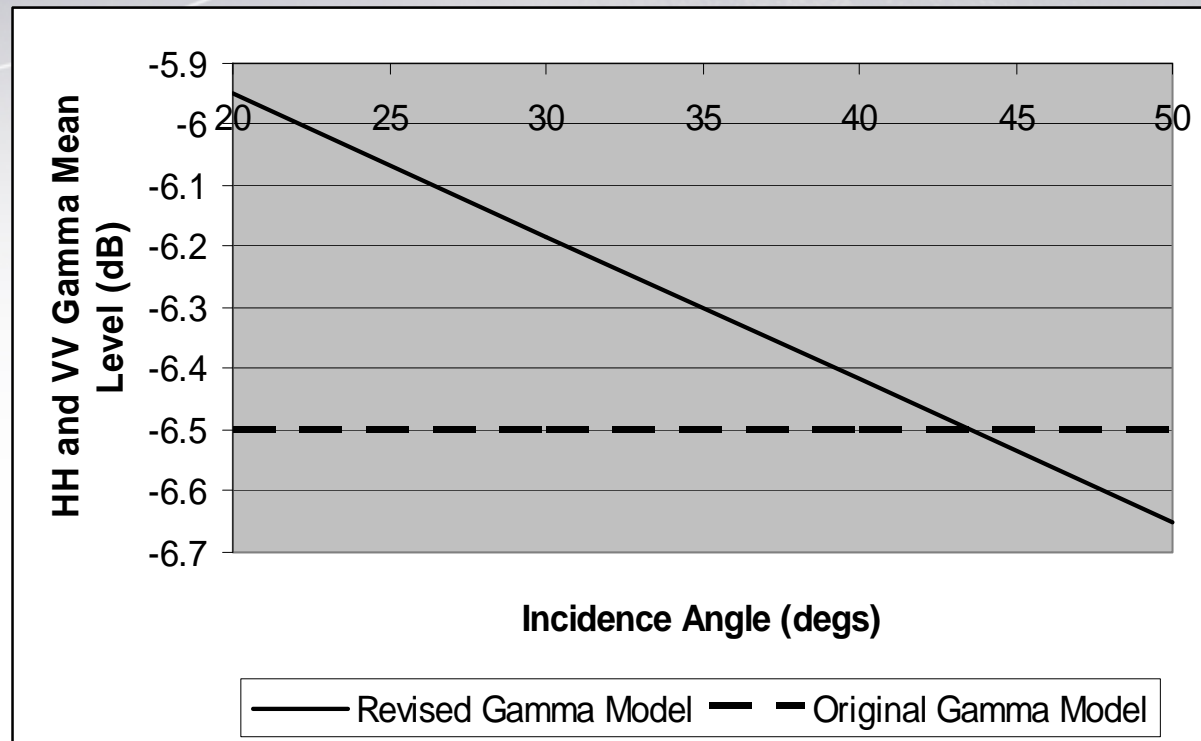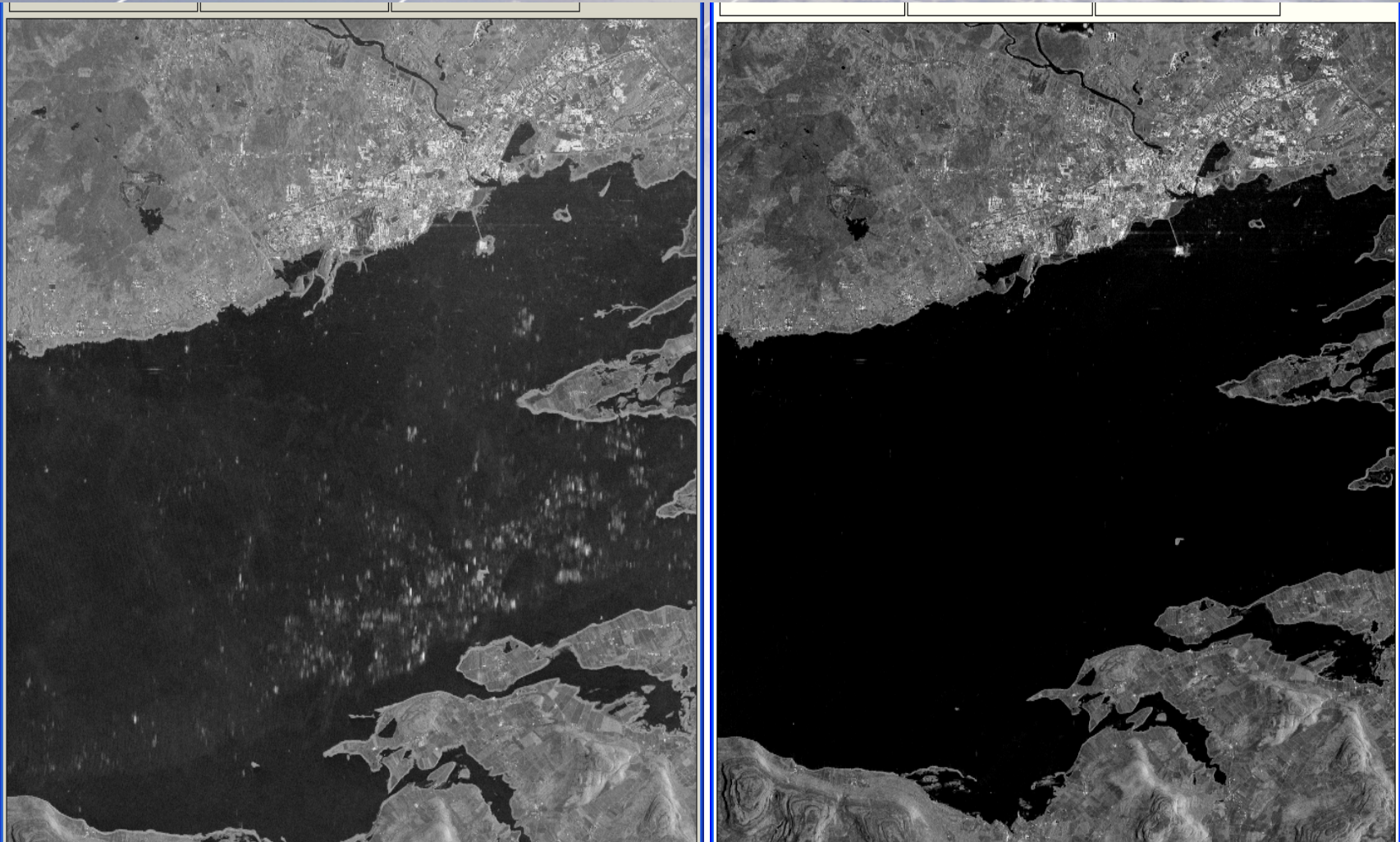
Cross-Pol Levels from Amazon Covariance data
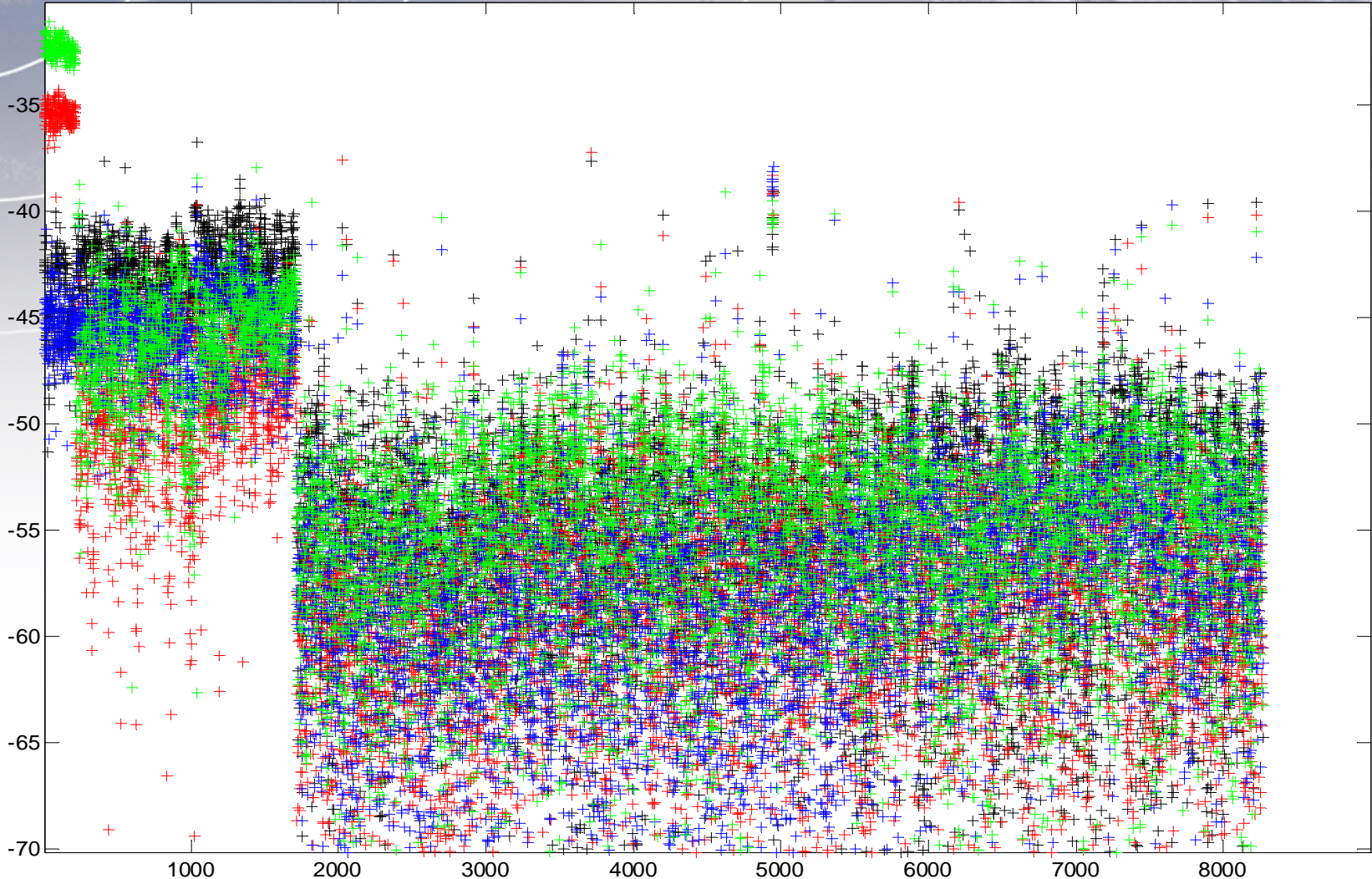
Removal of Quad-Pol Range Ambiguities
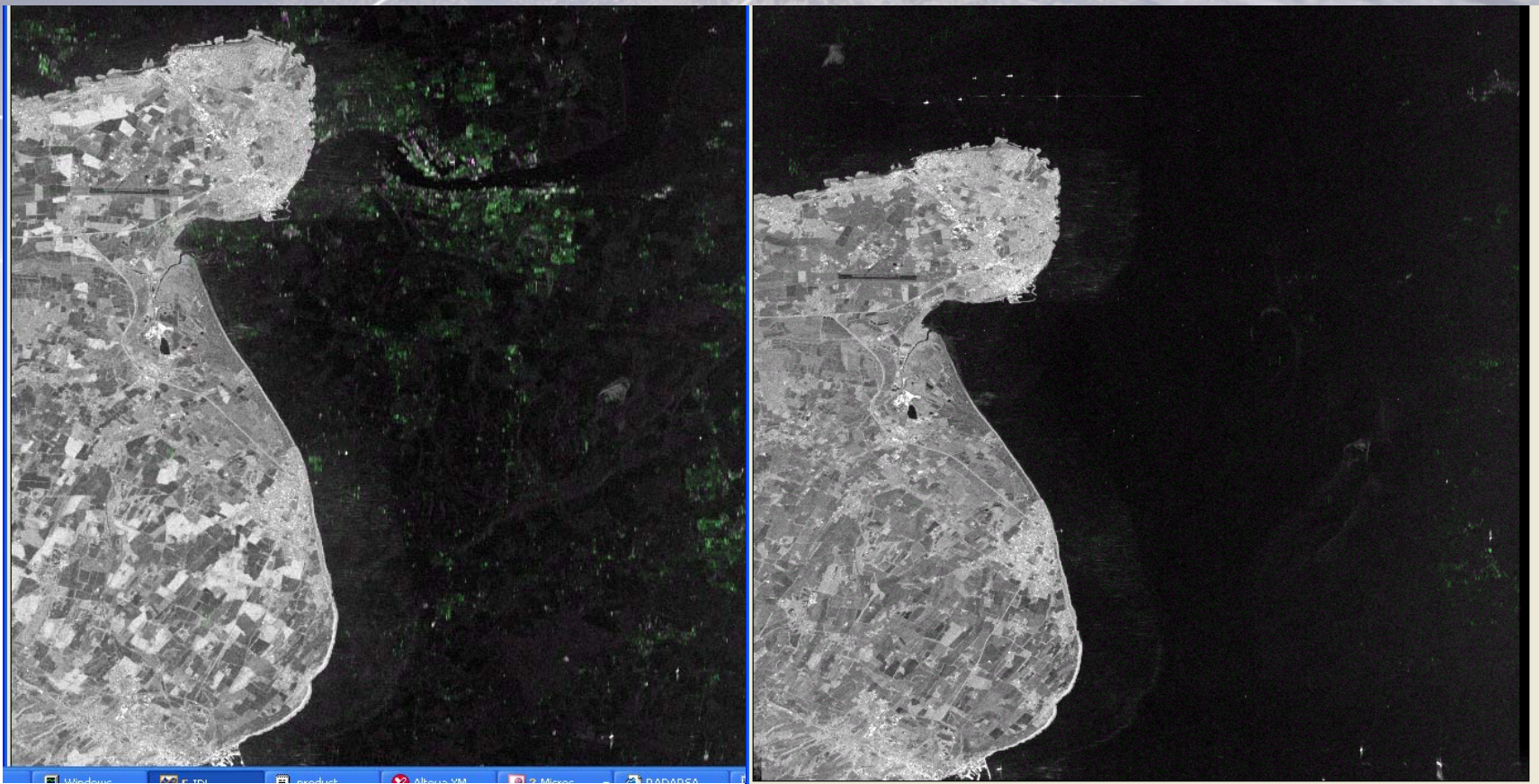
Azimuth Ambiguity Reduction in Dual-Receive Modes

Suppression of Stitched Pulse Artifacts

The RSAT-2 100MHz pulse was implemented as a "stitched" combination of two 50MHz pulses.

In high contrast scenes, some artifacts were visible from imperfections in the hardware implementation:

- Signals leaking around the transmit pulse
- Imperfect filtering of signals from the "other band"
- Intermodulation products with various mixing frequencies

Levels were -30dB or below, but could produce misleading false features.

Changes made to suppress these effects:

- Implementation of "inverse filter" in processing
- Changes to electronics timing
- Replacement of pulse forms with non-linear up/down chirps to decorrelate the two halves and any intermodulation products

Example of Stitched Pulse Artifact Suppression

Additional Modes

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Additional Imaging Modes

Additional capabilities that are either available or are planned for future release include:

- Finer resolution with Spotlight A (0.8m x 1.8-3m) and Spotlight B (0.5m x 1.8-3m)

- Increased incidence angle ranges for Quad-Pol (18⁰-49⁰), UltraFine and Spotlight (20⁰-60⁰)

- Increased swath width options for UltraFine (50km), Quad-Pol (50km) and ScanSAR (800km)

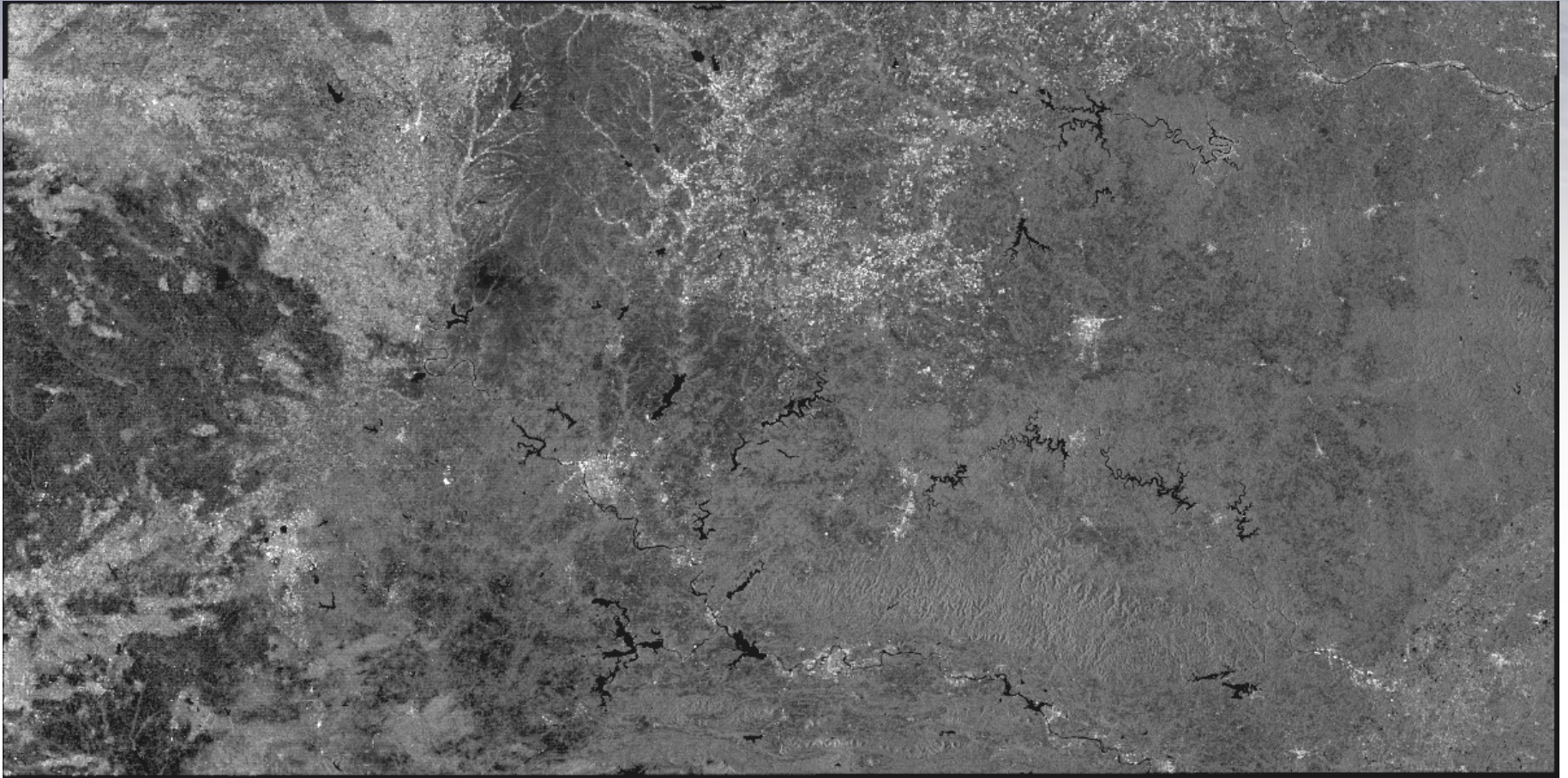- New ScanSAR combinations covering different angles and swath widths

50km UltraFine Image

50km Fine Quad-Pol Image
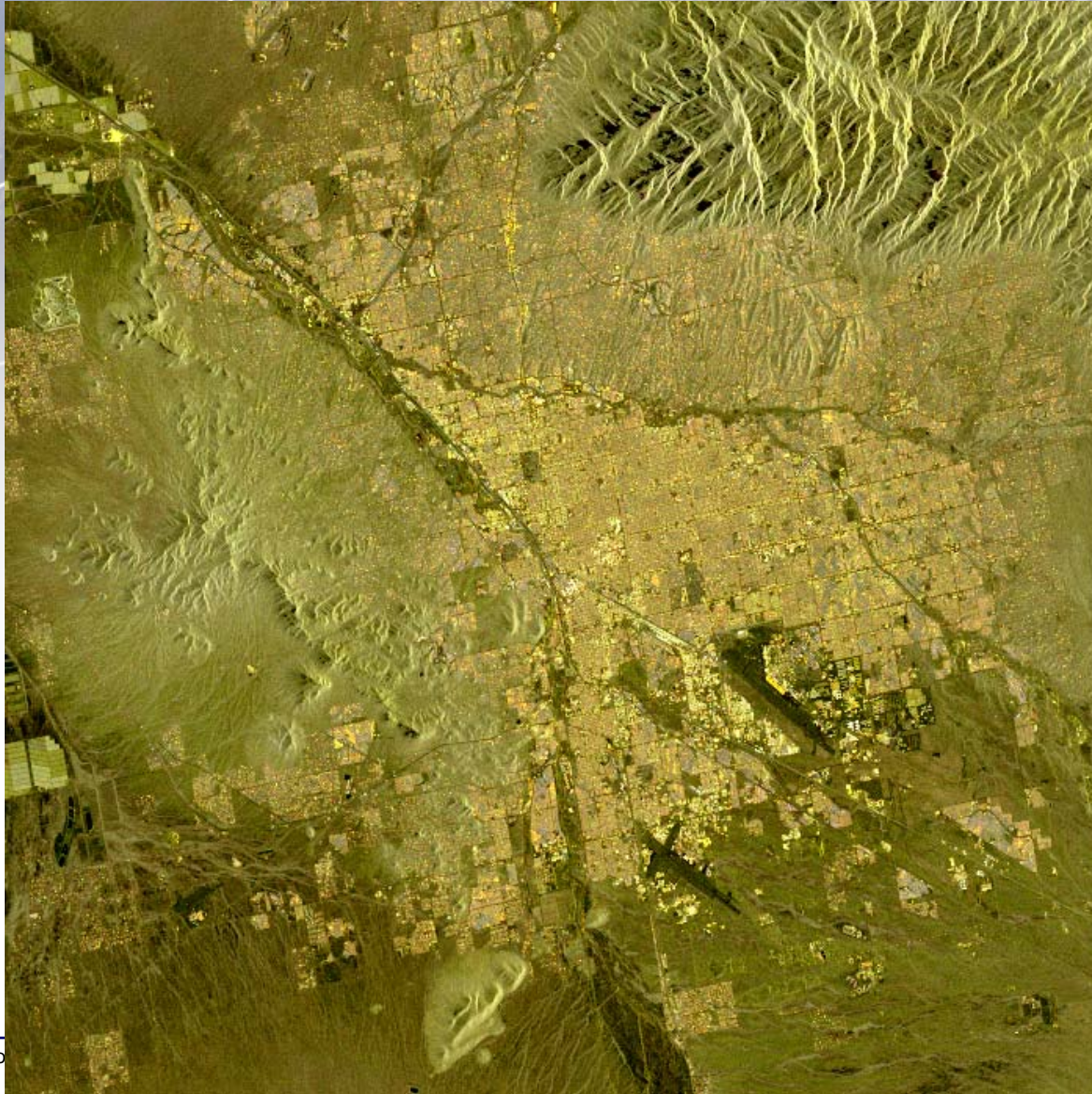
800km ScanSAR

Future Upgrades and Additions

Work will continue to upgrade image quality and extend the range of modes where possible: e.g.

- Release of extended and expanded sets of UltraFine, Quad-Pol and ScanSAR modes after Operating Licence permission has been obtained.

- Ongoing work to refine the processor "inverse filter" for highest resolution modes.

- Continue development of finer resolution Quad-Pol modes and other new modes.