Summary of intra- and inter- sensor surface altimetry error analysis

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OIB surface altimetry data collections include a good sampling of data useful for intra- and inter-sensor performance analysis. This is especially true for the 2009 data collection.

The overlapping inter-sensor data was used in the sensor performance and error analysis. Some highlights are included in the next few charts.
Tracks used for analysis

LVIS Intra-sensor

LVIS 2009/04/14 & LVIS3 2009/04/15 crossover analysis. Sample dist = 300 m. Search radius = 10 m.

Crossover \( \sigma \) Gaussian smoothed (window \( \sigma = 2 \) km)

ATM Intra-sensor

ATM1 / ATM2 crossover analysis for 2009/04/20. Sample dist = 300 m. Search radius = 1 m.

Crossover \( \sigma \) Gaussian smoothed (window \( \sigma = 2 \) km)

ATM1/LVIS Inter-sensor

ATM1 2009/04/20 & LVIS 2009/04/14 crossover analysis. Sample dist = 300 m. Search radius = 1 m.

Crossover \( \sigma \) Gaussian smoothed (window \( \sigma = 2 \) km)

ATM2/LVIS Inter-sensor

ATM2 2009/04/20 & LVIS 2009/04/14 crossover analysis. Sample dist = 300 m. Search radius = 1 m.

Crossover \( \sigma \) Gaussian smoothed (window \( \sigma = 2 \) km)

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LVIS/LVIS crossover analysis
(Box width = 300m, Radius = 10m)

Estimating pointing error parameters does not significantly change LVIS xover variance:

The difference between red and black in the plots to the right is negligible. Top plot is for along-track pointing error, bottom is for cross-track.

Analysis suggests LVIS precision better than 5 cm.
ATM1/ATM2 crossover analysis: Different epochs (Box width = 300m, Radius = 1m)

Estimating pointing error parameters does significantly change ATM xover variance:

The difference between red and black in the plots to the right is significant. Top plot is for along-track pointing error, bottom is for cross-track.

Analysis suggests ATM precision better than 6.5 cm after removal of significant cross-track pointing error (red).
ATM1/ATM2 crossover analysis: Different epochs (Box width = 300m, Radius = 1m)

Observed pointing-like error shows high coherence in the cross-track direction. Top plot is the estimated magnitude of the error and the bottom plot is the estimated direction. The error is systematic.

Next we look at LVIS/ATM xovers to see if the error is observed in both or one of the ATM tracks.
ATM/LVIS crossover analysis
(Box width = 300m, Radius = 1m)

Inter-sensor analysis shows ATM systematic pointing error is mostly only observed in one of the tracks studied. Therefore the problem does not exist in all of the data. Could this just be an anomaly?
After removal of systematic pointing errors, the remaining mean inter-sensor crossover discrepancies are used as a proxy for combined inter-sensor trajectory errors after filtering.

These trajectory errors are of particular concern due to their magnitude and long spatial wave-length.

We need to model these errors, validate our models with observation and minimize.
Supporting Details Follow.....
LVIS/LVIS crossover analysis
(Box width = 300m, Radius = 10m)

LVIS 2009/04/14 & LVIS3 2009/04/15 crossover analysis. Sample dist = 300 m. Search radius = 10 m.

Crossover analysis

Longitude (deg)
Latitude (deg)
Distance (km)

Standard deviation of crossovers before and after removal of x-direction slope (cm)

Mean of crossovers (cm)

Standard deviation of crossovers before and after removal of y-direction slope (cm)

Standard deviation of crossovers before and after removal of a fit (cm)
ATM1/ATM2 crossover analysis: Different epochs
(Box width = 300m, Radius = 1m)
ATM1/ATM2 crossover analysis: Different epochs
(Box width = 300m, Radius = 1m)

ATM1 / ATM2 crossover analysis for 2009/04/20. Sample dist = 300 m. Search radius = 1 m.

**Δ slope magnitude**
- Total slope magnitude
- Total smoothed (win = 2 km)

**Δ slope direction**
- Slope direction
- Direction smoothed (win = 2 km)
ATM2/LVIS crossover analysis
(Box width = 300m, Radius = 1m)

ATM2 2009/04/20 & LVIS 2009/04/14 crossover analysis. Sample dist = 300 m. Search radius = 1 m.

Crossover µ Gaussian smoothed (window α = 2 km)

Crossover µ after removal of x-dir Δ slope Gaussian smoothed (win = 2 km)

Crossover µ after removal of y-dir Δ slope Gaussian smoothed (win = 2 km)

Standard deviation of crossovers before and after removal of x-direction Δ slope (cm)

Standard deviation of crossovers before and after removal of y-direction Δ slope (cm)

Mean of crossovers (cm)

Standard deviation of crossovers before and after removal of Δ fit (cm)
ATM1/LVIS crossover analysis
(Box width = 300m, Radius = 1m)

ATM1 2009/04/20 & LVIS 2009/04/14 crossover analysis. Sample dist = 300 m. Search radius = 1 m.
ATM1/LVIS crossover analysis
(Box width = 300m, Radius = 1m)

ATM1 2009/04/20 & LVIS 2009/04/14 crossover analysis. Sample dist = 300 m. Search radius = 1 m.

Δ slope magnitude

Δ slope direction