Assumptions

- ADS-B data is used in the model before 18:00 UTC.
- The plane flies at constant speed starting from 18:25 UTC.
- The plane flies with constant speed and heading starting from 19:40.
- The plane is turning between between 18:25 and 18:29 UTC.
- The decomposition of the BFO data is based on Mike Exner's work in which the Inmarsat Burst Frequency Offset (BFO) data is the sum of L-band shift, the C-band shift, and an offset correction.
- L-band Doppler calculation includes the effects of plane and satellite motion.
- Any other frequency offset (e.g., oscillator drift) is lumped in with the offset correction.
- The offset correction algorithm implemented in the SATCOM needs the position, speed, and heading of the plane as inputs.
- Before 18:00 UTC, the SATCOM is attempting to reduce the frequency shift due to Doppler effects by applying a correction opposite of the L-band shift. However, this correction is imperfect, and removes most (but not all) of the L-band shift. The fraction of the L-band shift that is removed is represented by the parameter F_c in the BFO graph. (F_c =1 implies a perfect correction. F_c > 1 is an over correction. Fc<1 is an under correction.)
- After 18:00 UTC, the offset correction is held constant. I hypothesize that this is due to a broken data link between the SATCOM and the Aircraft Information Management System (AIMS), possibly by pulling the Communication processor module from the AIMS. This would require entry into the aviation bay via a hatch.
- The north and south paths were constrained such that the elevation angle to the satellite at 00:11 UTC equals 40.1 deg. This is based on the elevation angle data that was made available today.
- The location of the current search zone did not enter into the analysis. This differs from the analysis dated 4/28/2014.
- For both the north and south paths, the speed, direction, and offset correction were inputs that were allowed to vary and the measured BFO was fit to the calculated BFO by minimizing the square of the error (the variance).

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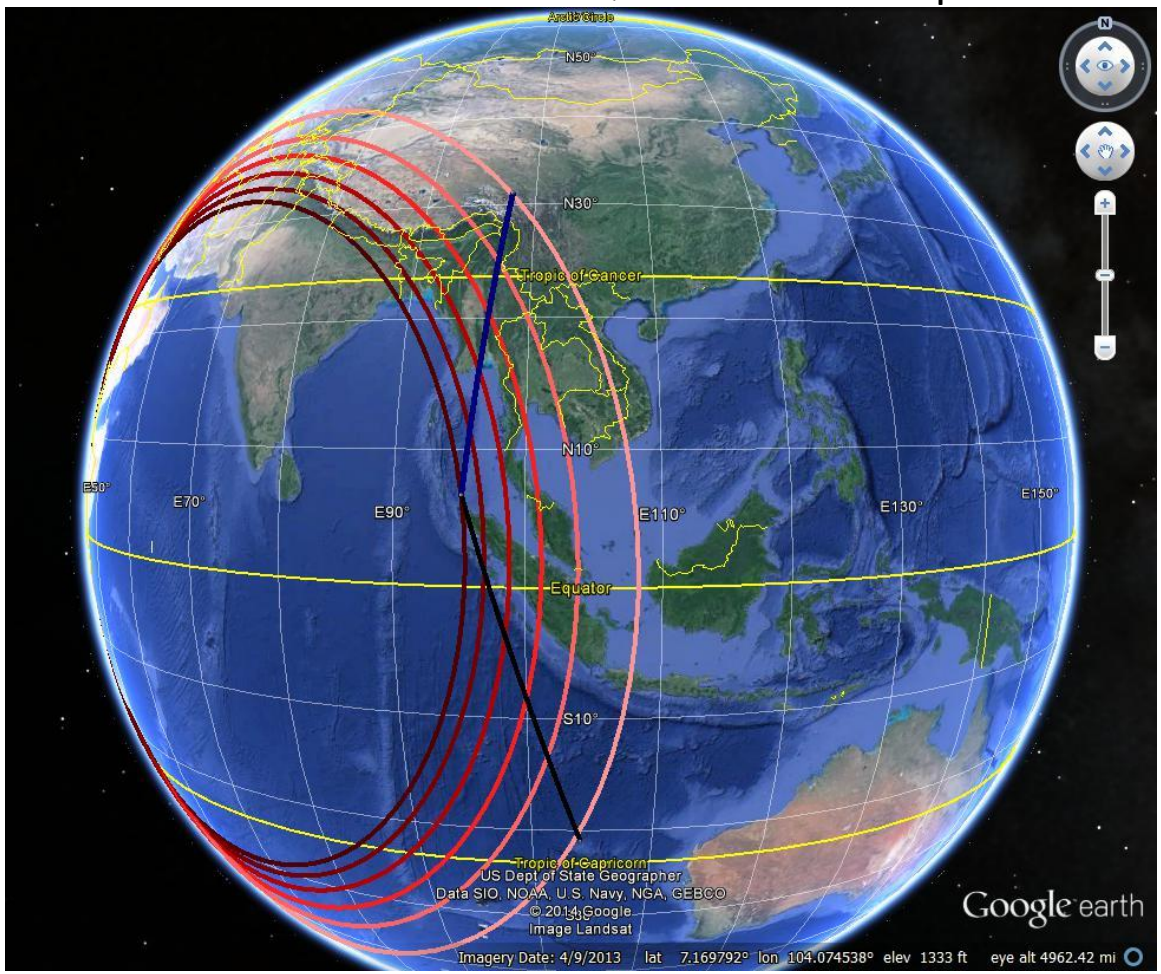
Predicted Paths

- South path: 310.7 knots at 166.2 deg ending at 00:19 UTC at (22.64S, 102.52E).
- North path: 258.0 knots at 3.6 deg, ending at 0:11 UTC in Tibet at (31.14N, 96.85E). This is about 36 nm from the Qamdo Bamda airport.



Representative paths are shown. Do not use to measure coordinates

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Predicted Paths in Tabular Form

North Path

Time (UTC) (UTC)	Lat (deg)	Long (deg)	Speed (kts)	Heading (deg)
16:30:00	2.747	101.713	0.0	140.00
16:43:00	2.813	101.680	201.0	327.00
16:56:00	3.932	102.162	452.0	25.00
17:07:00	5.419	102.864	469.0	25.00
18:25:00	6.441	95.184	258.0	31.86
18:27:00	6.563	95.260	258.0	16.40
18:29:00	6.700	95.300	258.0	11.58
19:40:00	11.772	95.629	258.0	3.60
20:40:00	16.060	95.898	258.0	3.60
21:40:00	20.349	96.168	258.0	3.60
22:40:00	24.637	96.437	258.0	3.60
0:11:00	31.1428	96.846	258.0	3.60

South Path

Time (UTC) (UTC)	Lat (deg)	Long (deg)	Speed (kts)	Heading (deg)
16:30:00	2.747	101.713	0.0	140.00
16:43:00	2.813	101.680	201.0	327.00
16:56:00	3.932	102.162	452.0	25.00
17:07:00	5.419	102.864	469.0	25.00
18:25:00	6.981	95.102	310.7	138.73
18:27:00	6.851	95.216	310.7	151.03
18:29:00	6.700	95.300	310.7	155.09
19:40:00	0.758	96.775	310.7	166.22
20:40:00	-4.267	98.008	310.7	166.22
21:40:00	-9.294	99.241	310.7	166.22
22:40:00	-14.325	100.475	310.7	166.22
0:11:00	-21.968	102.350	310.7	166.22
0:19:00	-22.640	102.515	310.7	166.22

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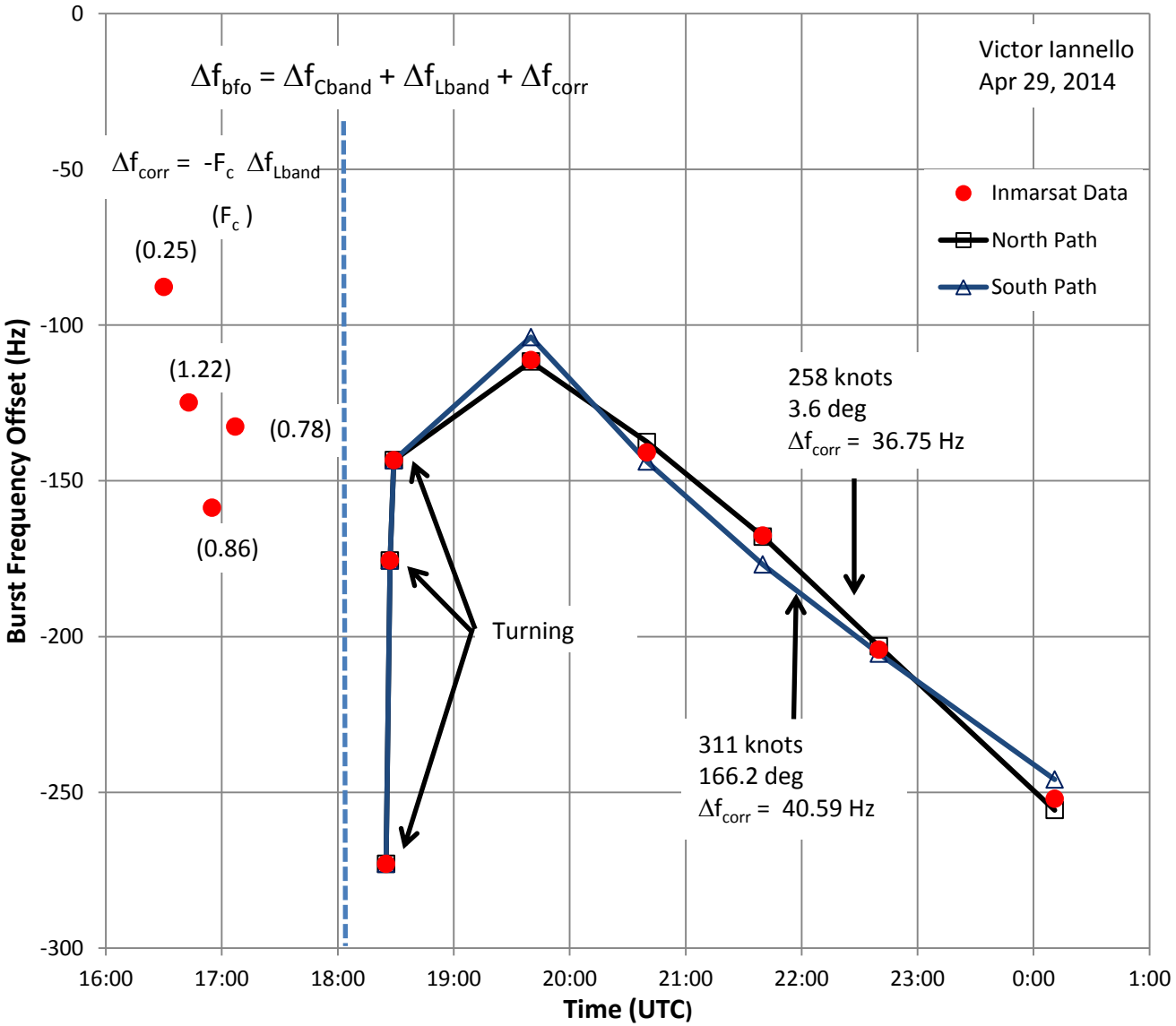
Burst Frequency Offsets



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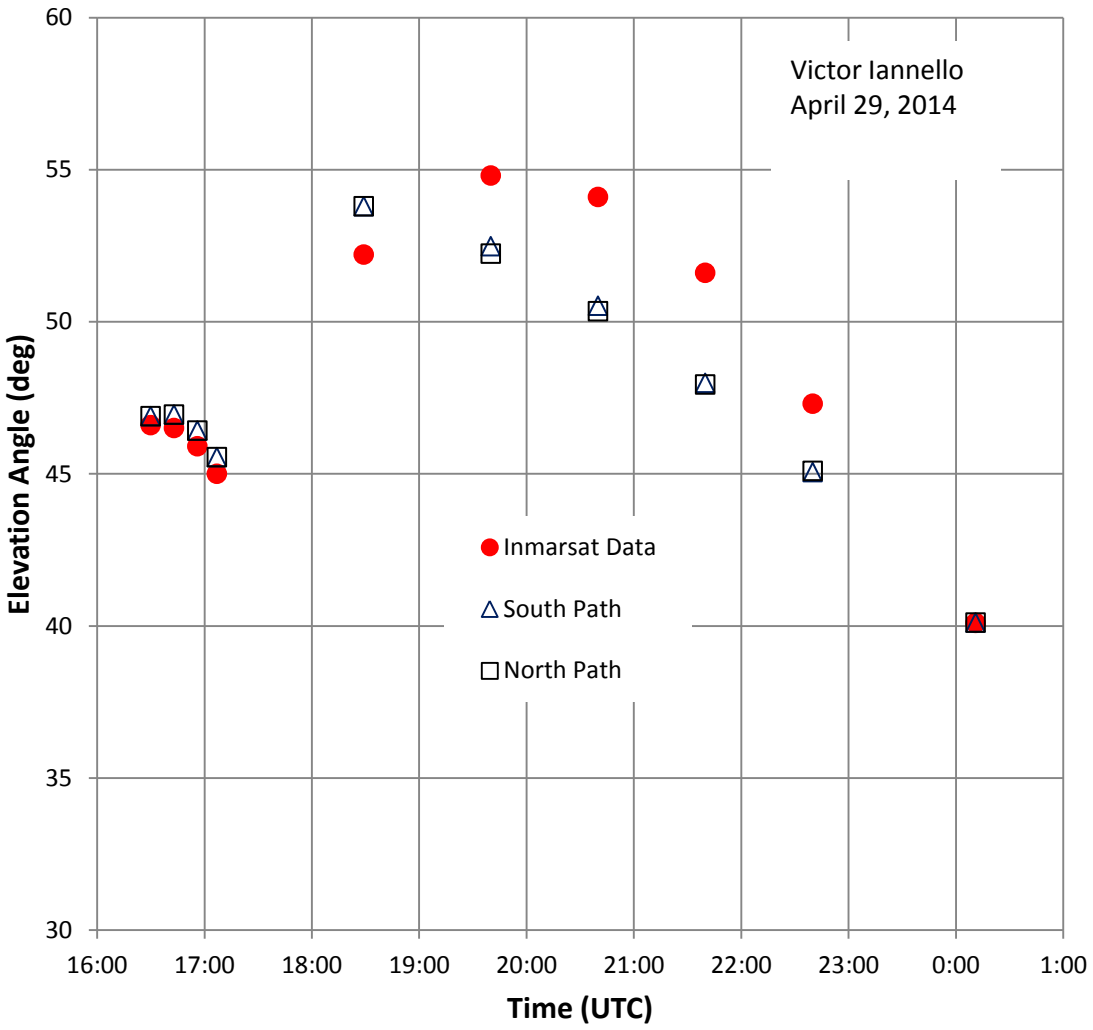
Elevation Angle to Satellite



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Observations

- The BFO decomposition methodology developed by Mike Exner appears to be correct in that it produces physically reasonable and consistent results.
- The BFO data presented by Inmarsat can be reproduced using simulated paths if the frequency shift correction algorithm of the SATCOM changes after 18:00 UTC.
- If the data path between the Aircraft Information Management Systems (AIMS) and the SATCOM were lost, the SATCOM would not be able to properly apply an offset correction.
- There is a Communications processor module in the AIMS that is responsible for all aircraft communication. If this module were removed or damaged in the two redundant AIMS cabinets, the data path to the SATCOM would be lost.
- Using the elevation angle of the satellite at 00:11 UTC and the BFO data, paths can be predicted for both the north and south routes.
- The agreement with the BFO data is good for the south path (σ = 6.2 Hz) and excellent for the north path (σ = 2.3 Hz) when a constant offset correction is applied after 18:00 UTC.
- The elevation angle data agrees with the ADS-B data before 18:00. The agreement for the predicted paths is poor between 18:25 and 22:40.
- The predicted north path ends in Tibet, 36 nm from the Qamdo Bamda Airport.

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