Assumptions

- ADS-B and radar data are used in the model before 18:00 UTC as extracted by Mike Exner.
- The plane is at 6.7N, 95.3E at 18:29 UTC based on radar data and the work of Duncan Steel.
- The plane flies at constant cruising speed starting from 18:25 UTC until 00:01 UTC and then slows to 240 knots and remains at 240 knots until the last ping at 00:11 UTC.
- The plane is allowed to make corrections to its heading every 15 minutes starting at 18:29 UTC.
- 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.
- Satellite positions and velocities were supplied by Duncan Steel.
- Any other frequency offset (e.g., oscillator drift) is lumped in with the offset correction.
- L-band Doppler calculation includes the effects of plane and satellite motion.
- 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, no offset correction is applied. I hypothesize that this is due to a broken data link between the SATCOM and the Aircraft Information Management System (AIMS), possibly by a missing or damaged Communication processor module from the AIMS or some other hardware anomaly.
- The path was found by successive iterations in which the cruising speed and headings were varied and the sum of the squares of the error of elevation angle and BFO were minimized.

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Predicted North Path

- Cruising speed along path is 290 knots and slows to 240 knots for last 10 minutes
- At 00:11 UTC, the plane is 14 nm from Qamdo Bamda Airport

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Predicted Data at Ping Times

Time	Lat	Long	Speed	Heading
(UTC)	(deg)	(deg)	(kts)	(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	6.391	95.216	290.3	21.67
18:27:00	6.541	95.275	290.3	8.93
18:29:00	6.700	95.300	290.3	4.77
19:40:00	11.046	93.252	290.3	357.34
20:40:00	15.751	92.317	290.3	355.42
21:40:00	20.572	92.184	290.3	352.36
22:40:00	24.648	93.978	290.3	352.60
0:11:00	30.426	97.341	240.0	1.32

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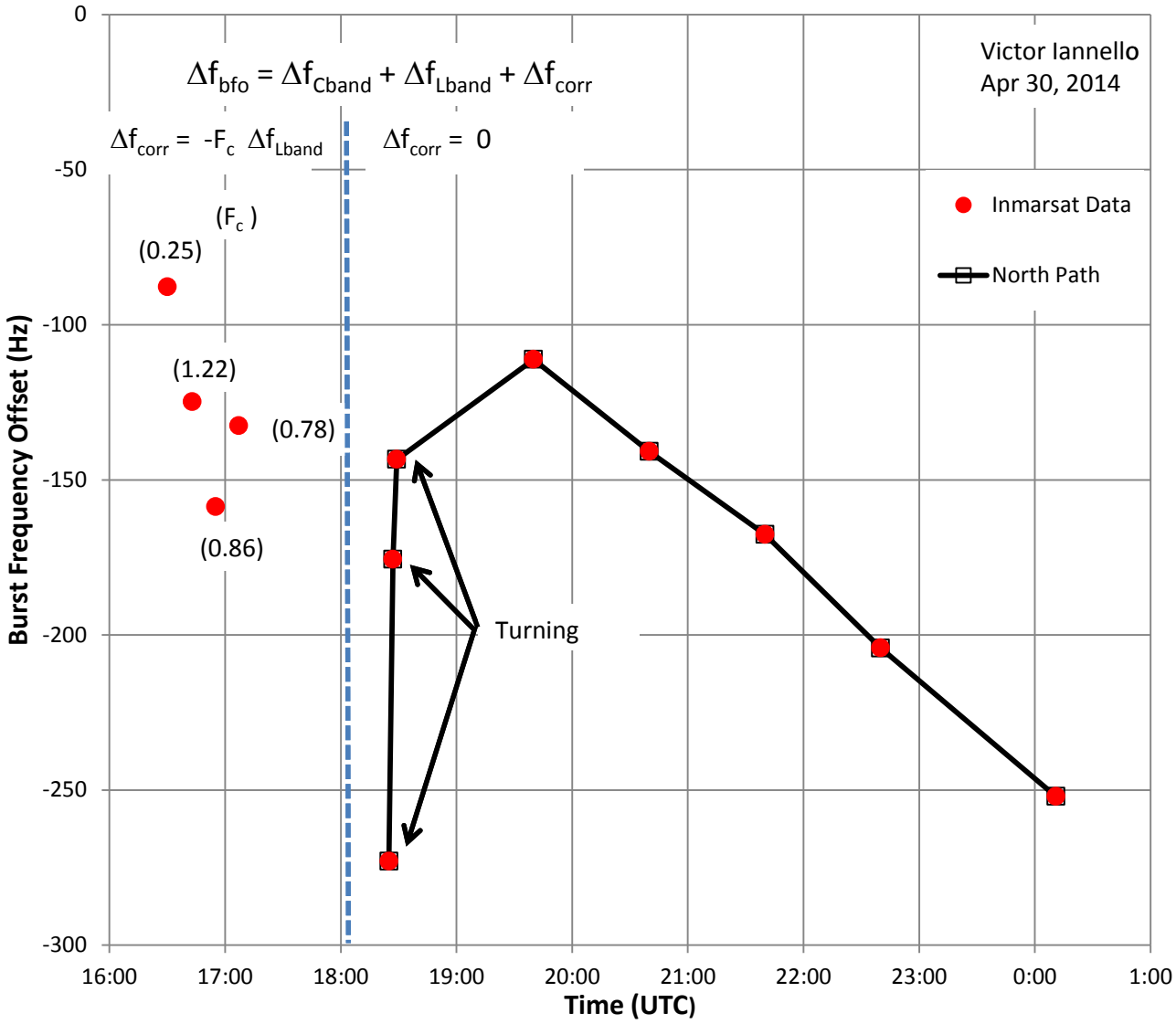
Burst Frequency Offset



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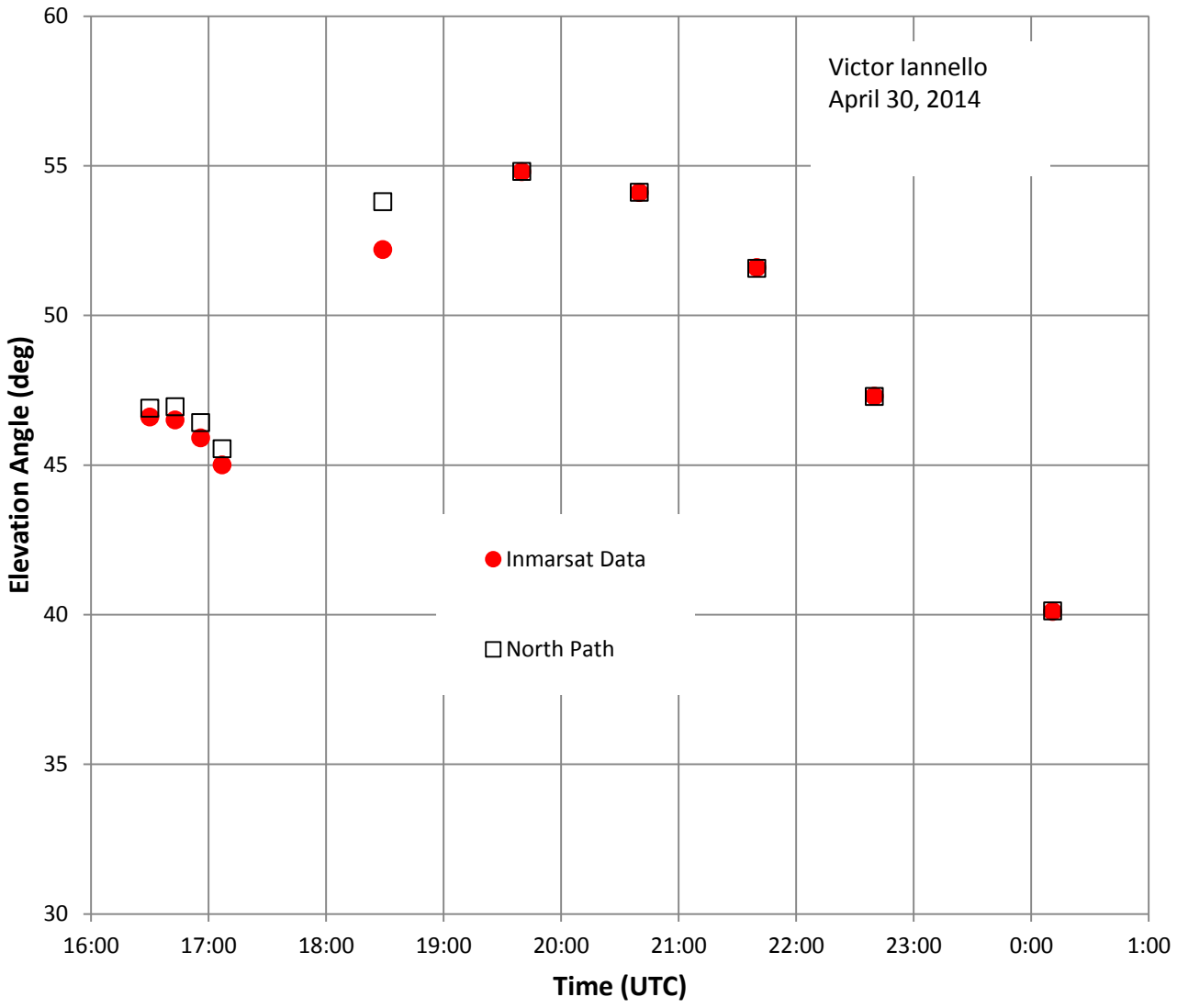
Elevation Angle to Satellite



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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 by a north path if the frequency shift correction algorithm of the SATCOM applies no correction 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.
- The predicted path passes over the Andaman and Nicobar Islands and then turns north to the western Myanmar border, passing into Bangladesh, India, Arunachal Pradesh, and into Tibet.
- The assumed position of 6.7N, 95.3E at 18:29 UTC is likely not correct, leading to an error in elevation angle at this time.
- The predicted position of the plane at 00:11 UTC (the time of the last full ping) is very close (14 nm) to the Qamdo Bamda Airport and the plane could have landed before the final, partial ping at 00:19 UTC.
- Although this predicted path matches the data well, there might be other paths that match equally well. I am evaluating this.

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