Multi-Station for MWD: Update and Validation

Brett vanSteenwyk

Algorithms and Analytical Thinking

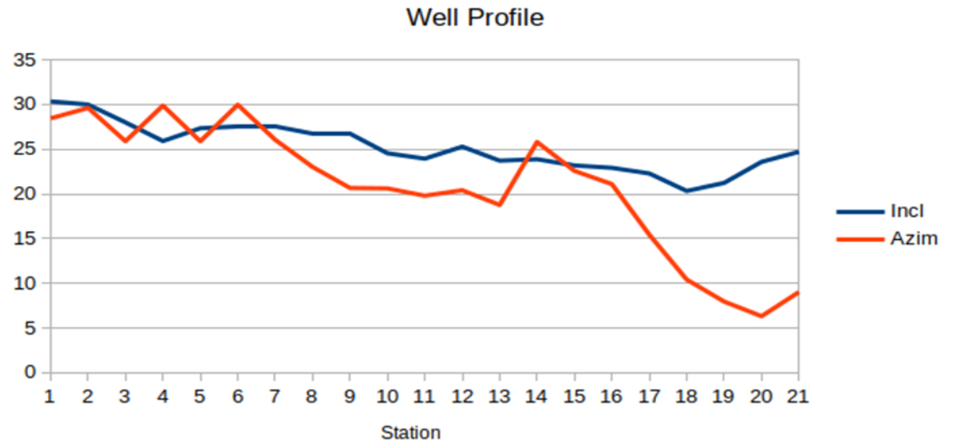
"**Unstart**": Heuristic, then Simplex Optimizer 2

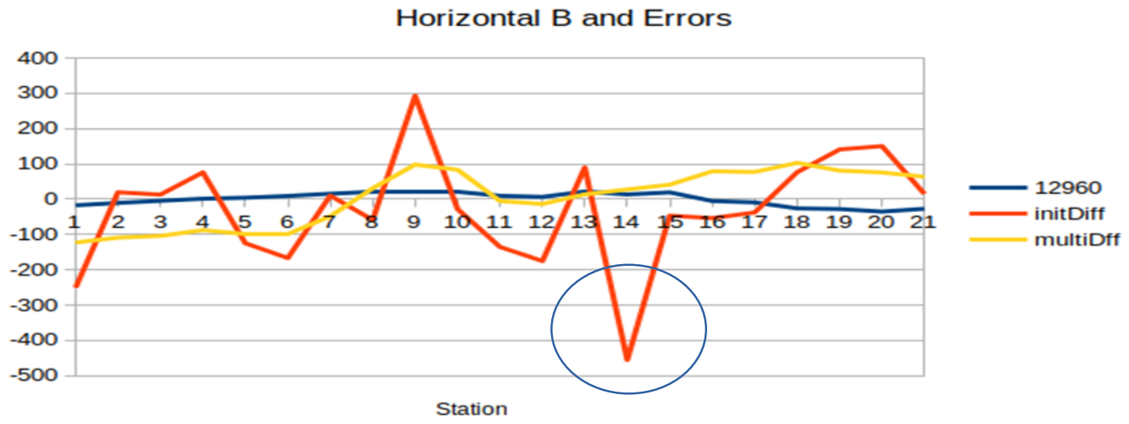
Stage

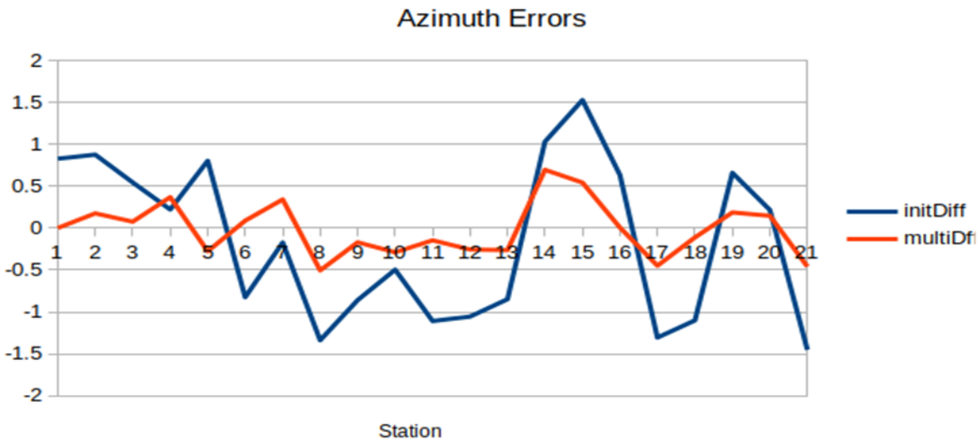
Outliers:

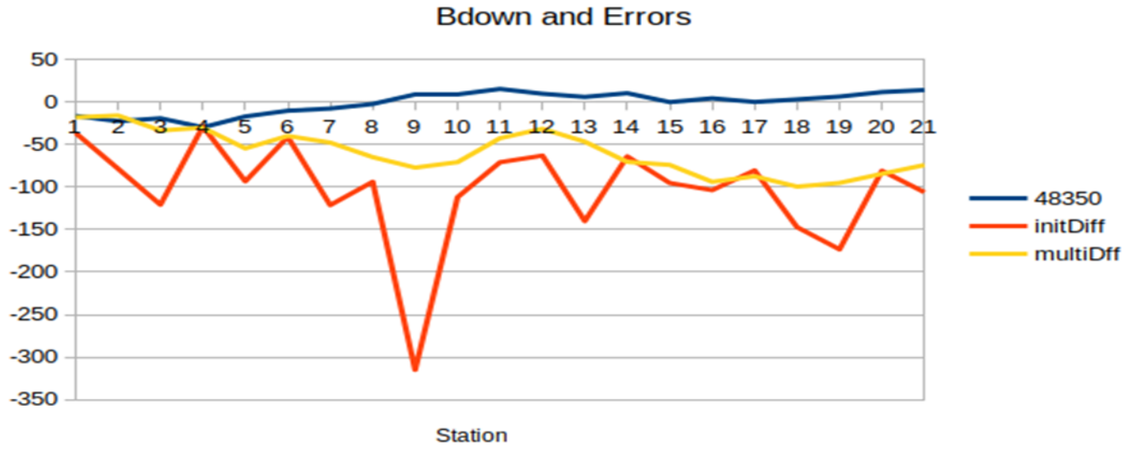
X reading at 14 station affects mostly B_{horiz}

RMS Azim Error: 0.91º to 0.33º



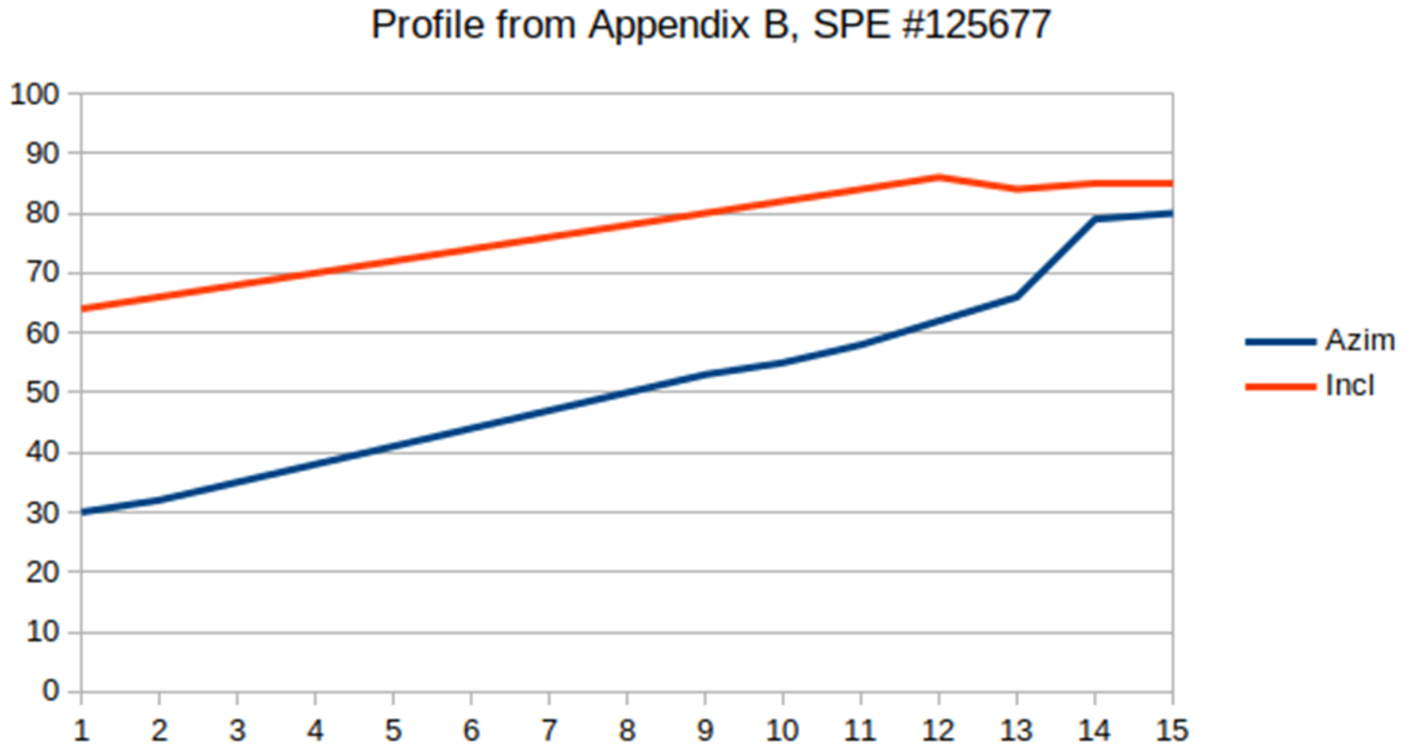






Unfinished Business…

Profile data is synthetic



All accelerometer bias offsets < 0.1mg All magnetometer offsets < 1nT

We still need to show enough performance to make running this worthwhile.

Error Model Basis for setting parameters in multi-station

Parameters also used to
- Generate synthetic data
- For testing

Accelerometer Bias	0.5mg
Accelerometer Scale	0.0004
Accelerometer Misalignment	0.2º
Gravity Reference	0.3mg
Accelerometer Reading Unc	0.2mg
Magnetometer Bias X-hole	80nT
Magnetometer Bias Down	450nT
Magnetometer Scale	0.0016
Magnetometer Misalignment	0.2º
Earth Field Reference	65nT
Dip Reference	0.12º
Magnetometer Reading Unc	40nT

Additional parameters for performance and reliability testing

Nominal Total Field	50000nT
Nominal Dip	75º
# Trials	2000
# stations	18
Outlier Confidence Value	98.5%
Intended X-Hole Abias Improvement	
Intended D-Hole Abias Improvement	
Intended X-Hole Mbias Improvement	
Intended D-Hole Mbias Improvement	
Highside Toolface	random
Initial Azimuth	random

Process	Azim	Incl	HTF	Gtotal (mg)	Bhoriz (nT)	Bdown (nT)	Pos X	Pos Y	Pos Z
Unbiased	1.20º	0.033º	0.053º	0.67	264.7	314.6	24.4’	13.6’	0.51’
SS	0.71º	0.033º	0.053º	0.59	93.2	73.0	11.1’	4.7’	0.51’
MS	0.50º	0.030º	0.038º	0.35	70.6	64.8	10.6’	4.2’	0.47’

Outliers: Accelerometer: 5 instances of single outlier in run
Magnetometer: 97 instances of single outlier in run
3 instances of pair of outliers in run

	# Worse	Avg of Worse
Azimuth	352/2000	0.84º
Inclination	735/2000	0.032º
Highside TF	377/2000	0.027º

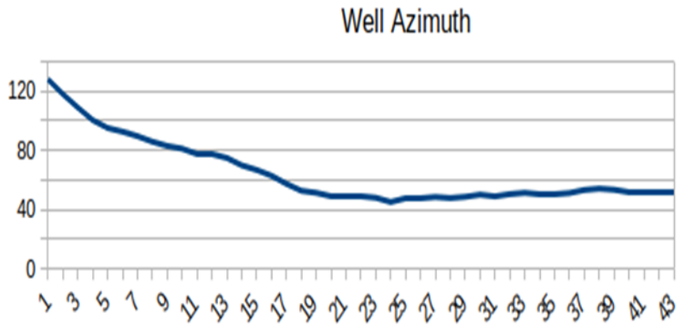
A worse inclination appears to remain
well-behaved: details in the chart to the left

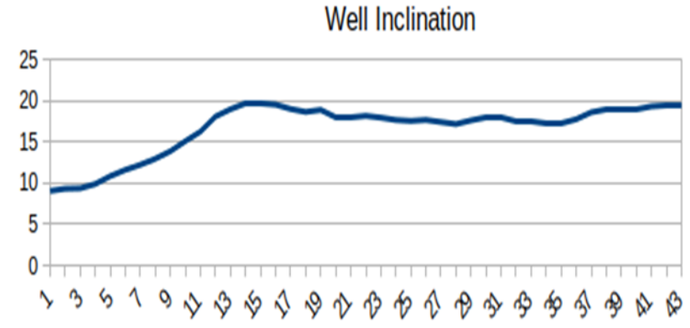
Count	% Increase	Net Incl RMS
493	0-50	0.032º
127	50-100	0.031º
56	100-150	0.035º
20	150-200	0.031º
12	200-250	0.034º
14	250-300	0.035º
13	300+	0.033º

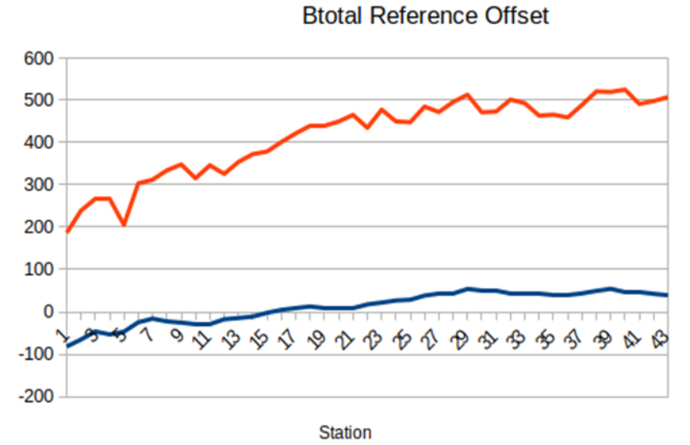
Azimuth distribution has
a long tail

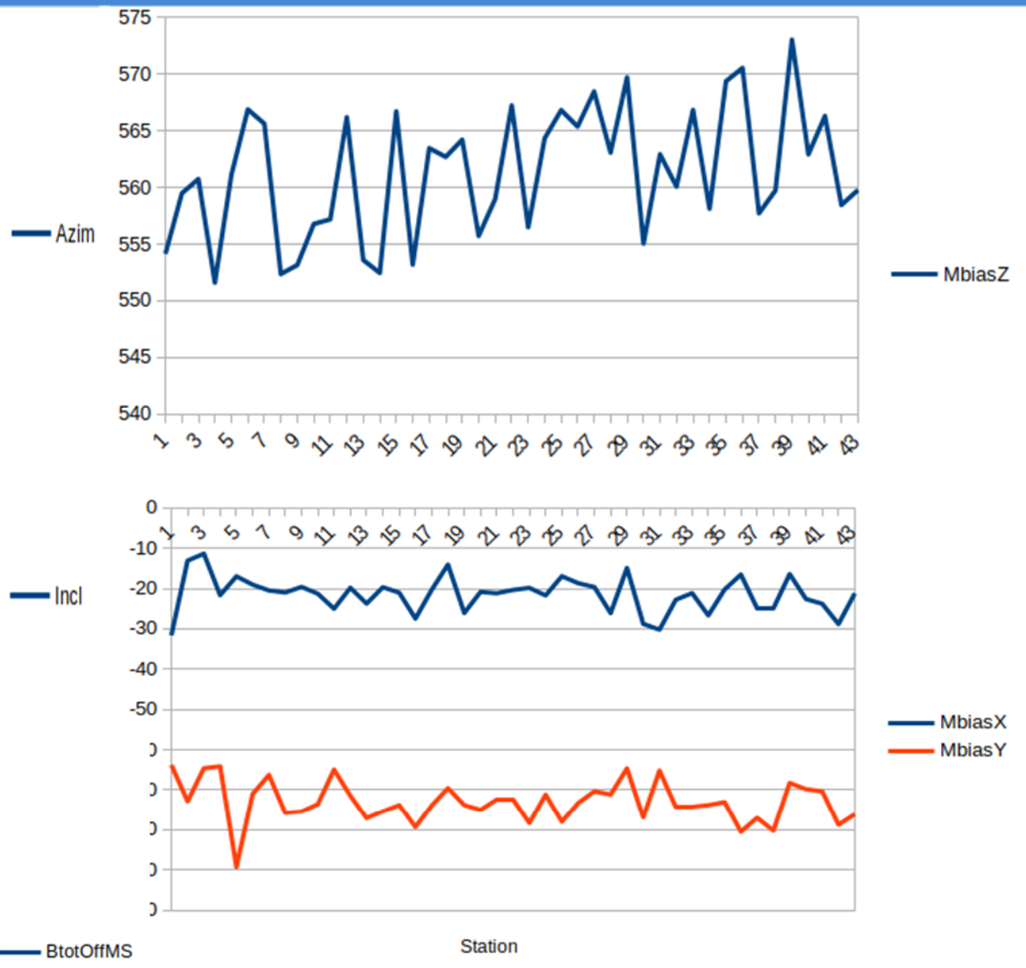
Count	% increase	Azimuth RMS
228	50	0.52
78	100	0.81
45	150	0.72
16	200	0.99
15	250	1.32
6	300	1.21
36	350+	1.36

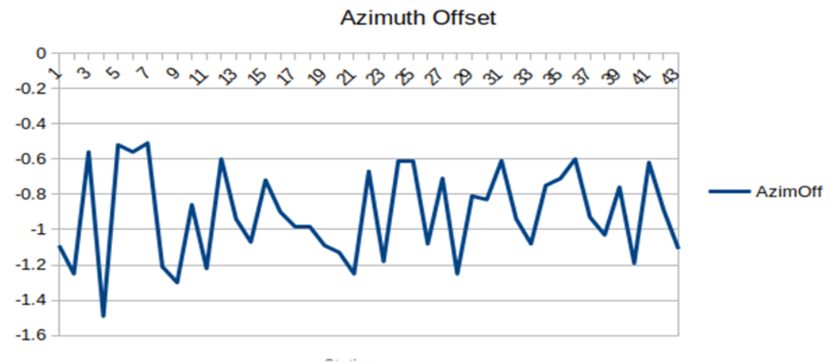
Wellbore Positioning Technical Section

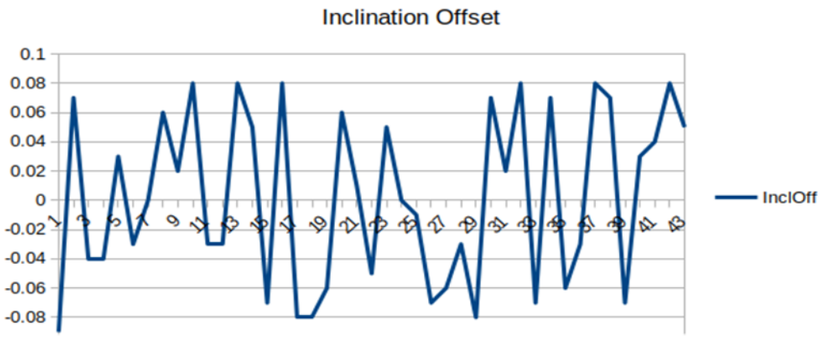


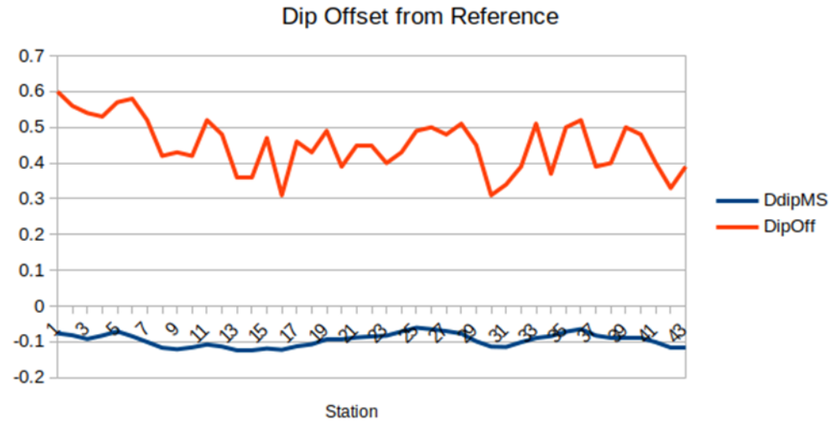












Y accel bias: 1.5mG

Anonymous Real MWD Run

Coming soon: Merging Multistation and Passive Ranging:

"Multistation with a Pole Dance"

1. Is there a pole out there (confidence level)?
2. Is there more than one pole out there?