Comparison of Stationary Versus Non-Stationary MWD Surveys to Justify A Pragmatic Use of Non-Stationary MWD Surveys

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Introduction

Introduction

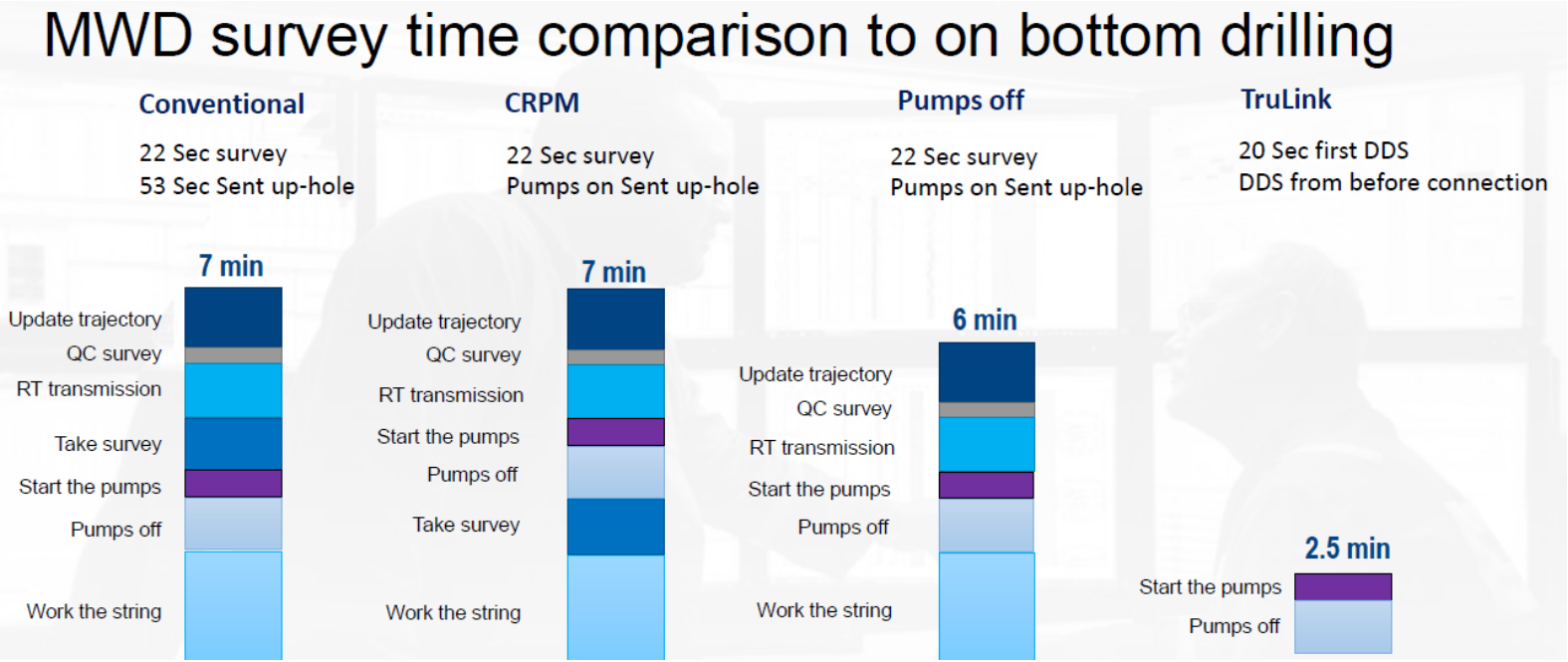
- TotalEnergies looking:
  a) For accuracy similar to standard MWD (long term better)
  b) for better hole geometry description & earlier confirmation of BHA tendency
  c) to reduce time spent on surveying, plus re-surveying due to pipe-movement (deep water) resulting in out of spec survey.
  d) to reduce the risk of stuck pipe

- TotalEnergies anti-collision policy, requires using ISCWA tool error models.

Introduction

1. TotalEnergies is exploring the potential use and advantages of SLB's latest MWD TruLink tool, which aims to replace the TeleScope MWD
2. The TruLink tool offers the capability to independently perform both Dynamic Drilling Surveys and traditional Static MWD surveys
3. PathControl performed a detailed analysis of TruLink DDS data based on large scale of data provided by SLB
4. Data consists in sets of standard stationary surveys and continuous DDS surveys

Introduction



Comparison of MWD survey time between diverse acquisition methods (Courtesy of SLB)

Presentation Agenda

1. Introduction
2. TotalEnergies Offshore Wells DDS surveys analysis
3. Introduction to Large-Scale SLB Data Analysis
4. Depth-based SLB Data Overview
5. Time-based SLB Data Overview
6. Conclusions & Road Map

TotalEnergies Offshore Wells DDS surveys analysis

TotalEnergies Wells' TruLink DDS analysis

- TotalEnergies have recently acquired TruLink DDS surveys on 4 offshore deep water wells
- The DDS data was compared to static MWD measurements considering the Standard MWD Error Model

Well	Run	Inclination		Azimuth		Static survey count (#)
		Min (°)	Max (°)	Min (°)	Max (°)	
Well #1	17-1/2"	5.93	44.15	143.90	198.30	40
	12-1/4"	45.70	78.16	194.24	227.81	80
Well #2	12-1/4"	15.49	71.30	117.00	158.35	19
	9-1/2"	75.61	89.97	161.11	163.76	14
Well #3	12-1/4"	37.41	90.17	307.73	20.31	121
Well #4	12-1/4"	77.12	78.17	7.71	21.26	41
	12-1/4" vs GWD	77.14	78.79	10.30	20.58	34

TotalEnergies Wells' TruLink DDS analysis

1. The comparison between DDS and static surveys demonstrated high level of agreement
2. The DD raw data show consistent overlap with static data
3. DDS surveys were within standard MWD Error Model budget
4. We also performed a Chi-squared test and Survey Overlap comparison in a satisfactory manner, but due to brevity we will not show here.

Run	MD in (m)	MD out (m)	Run length (m)	Surveys within thresholds Inclination difference (%)			Surveys within thresholds Azimuth difference (%)		
				0.3 deg	0.5 deg	1 deg	1 deg	1.5 deg	3 deg
Well #1 (12-1/4in)	2343	3890	1547	100 %	100 %	100 %	100 %	100 %	100 %
Well #1 (17-1/2in)	1839	2334	495	100 %	100 %	100 %	100 %	100 %	100 %
Well #2 (12-1/4in) (Without DDS outliers)	2358	2983	625	94.4 %	100 %	100 %	72.2 %	94.4 %	100 %
Well #2 (9-1/2in)	3000	3337	337	92.9 %	100 %	100 %	100 %	100 %	100 %
Well #3 (12-1/4in)	1766	3190	1424	93.3 %	100 %	100 %	98.3 %	100 %	100 %
Well #4 (12-1/4in – MWD)	2808	4055	1247	97.6 %	100 %	100 %	92.7 %	97.6 %	100 %
Well #4 (12-1/4in – GWD)	2804	4054	1250	100 %	100 %	100 %	100 %	100 %	100 %

Introduction to Large-Scale SLB Data Analysis

Introduction to Large-Scale SLB Data Analysis

1. We have performed a large-scale analysis using all SLB-provided data
2. SLB have provided us with a total of 87 runs for comparison, including 17 depth-based and 70 time-based surveys
3. Both static and DDS data were available for each run
4. The analysis was conducted separately for depth-based and time-based data

	Low Inclination 0-30°		Mid Inclination 30-60°		High Inclination 60-90°	
	East/West	North/South	East/West	North/South	East/West	North/South
Low latitude 0-30°	174 *(4%)*	185 *(5%)*	406 *(10%)*	173 *(4%)*	351 *(9%)*	395 *(10%)*
Mid latitude 30-60°	238 *(6%)*	153 *(4%)*	227 *(6%)*	705 *(18%)*	370 *(9%)*	600 *(15%)*

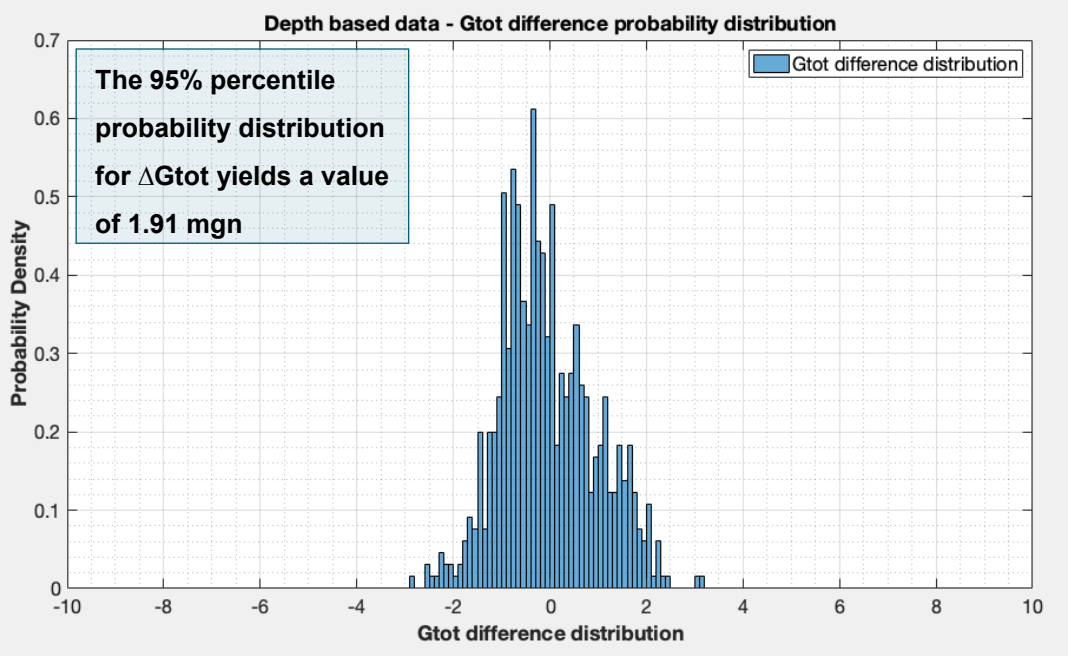
Large Scale SLB Data Depth-based Overview

SLB Data Depth-Based Overview

Methodology

1. SLB provided us with 17 depth-based runs of DDS & Static data
2. The current methodology involves performing a global analysis of the concatenated depth-based runs, focusing on the differences between Gtot, Btot and Dip angle and then analysis of the inclination and azimuth characteristics
3. Comparison will be conducted between a substantial number of DDS surveys and a total of 654 static surveys.
4. In addition, thanks to the large amount of data, the probability distribution of all these key parameters was also analyzed
5. The conclusions drawn from the analysis, along with the pertinent data, are summarized in a report table

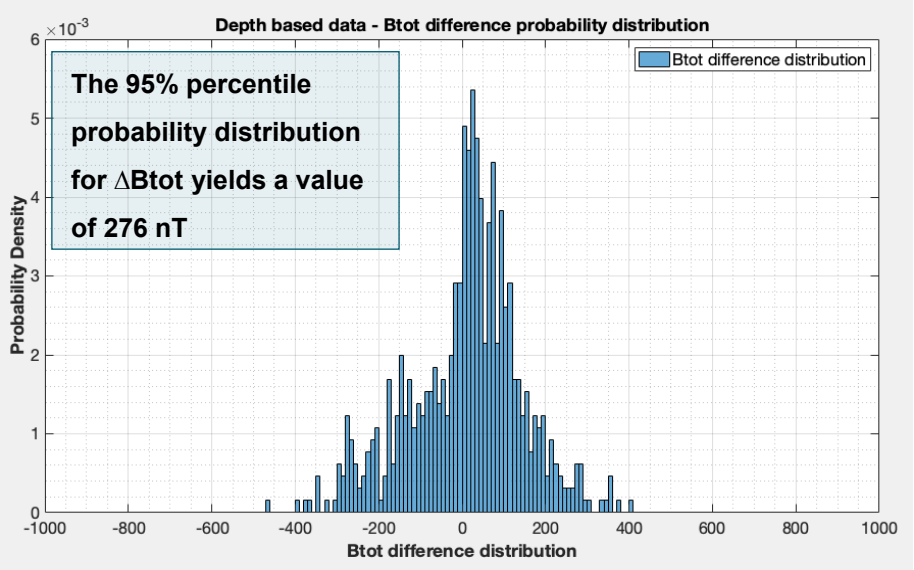
SLB Data Depth-Based Overview - ΔGtot

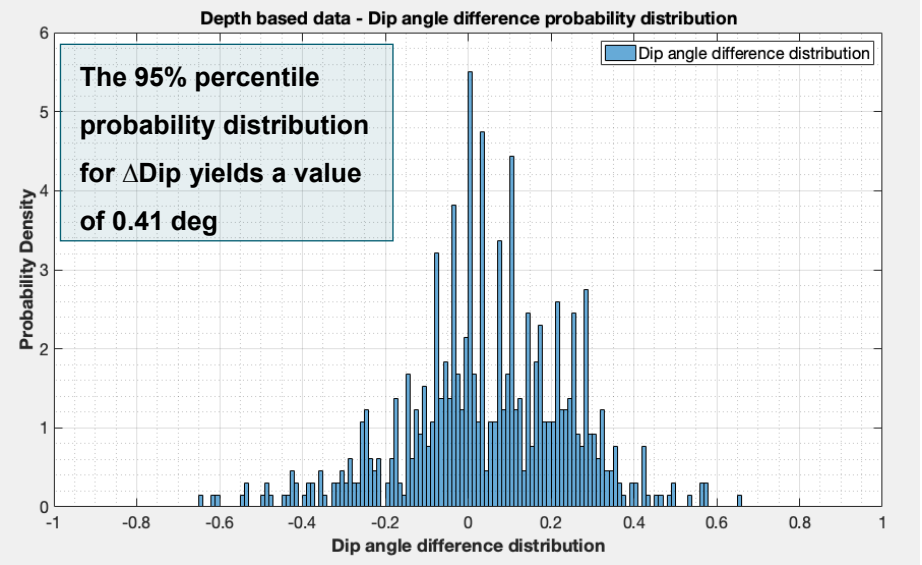


Difference thresholds (mgn)	Surveys within thresholds (%)
2	95.87
3	99.69

SLB Data Depth based

SLB Data Depth-Based Overview - ΔBtot, ΔDip

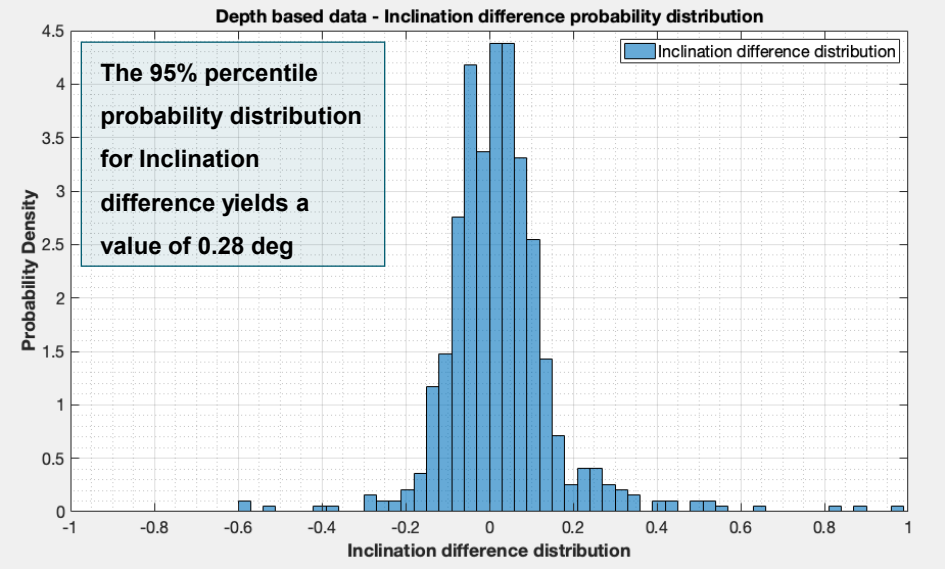


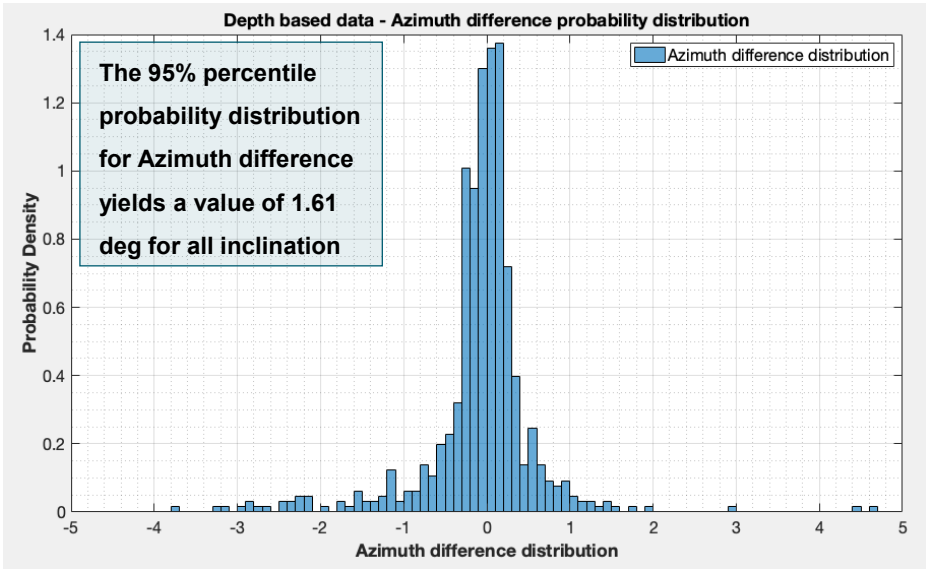


Difference Thresholds (nT)	Surveys within thresholds (%)
300	97.40
450	99.85

Difference thresholds (deg)	Surveys within thresholds (%)
0.45	96.79
0.65	99.85

SLB Data Depth-Based Overview - Inclination difference, Azimuth difference





Difference thresholds (deg)	Surveys within thresholds (%)
0.3	95.87
0.5	98.01
1	99.69

Difference thresholds (deg)	Surveys within thresholds (%)
1	90.21
1.5	94.19
3	98.32

SLB Data Depth-based

SLB Data Depth-Based Overview

1. The majority of data are within the Field Acceptance Criteria (FAC)
2. Similarly, the inclination and azimuth of DDS and static surveys are very consistent
3. Only a few surveys deviate from the FAC, but these deviations are minimal and have negligible impact
4. Overall, the data demonstrates a high level of conformity to the FAC, indicating a reliable and accurate representation of these measurements

		Surveys within thresholds (%)														
		Raw data						Inclination difference (deg)			Azimuth difference (deg)					
	Static survey stations	ΔBtot (nT)		ΔDip (deg)		ΔGtot (mgn)					Azimuth			Azimuth (for Incl >10°)		
		300	400	0.45	0.65	2	3	0.3	0.5	1	1	1.5	3	1	1.5	3
Depth-based	654	97.50	99.85	96.79	99.85	95.87	99.69	95.87	98.01	99.69	90.21	94.19	98.32	93.86	96.85	99.34

Large Scale SLB Data Time-based Overview

SLB Data Time-Based Overview

1. SLB provide us with 70 time-based runs of DDS & Static data
2. The runs represent a wide range of drilling scenarios:
   a) Both low and mid latitudes
   b) North/South and East/West directions
   c) Range from low to mid to high inclinations
3. The current methodology involves performing a global analysis of the concatenated time-based runs, focusing on the differences between Gtot, Btot and Dip angle and then analysis of the inclination and azimuth characteristics
4. The conclusions drawn from the analysis, along with the pertinent data, are summarized in a report table

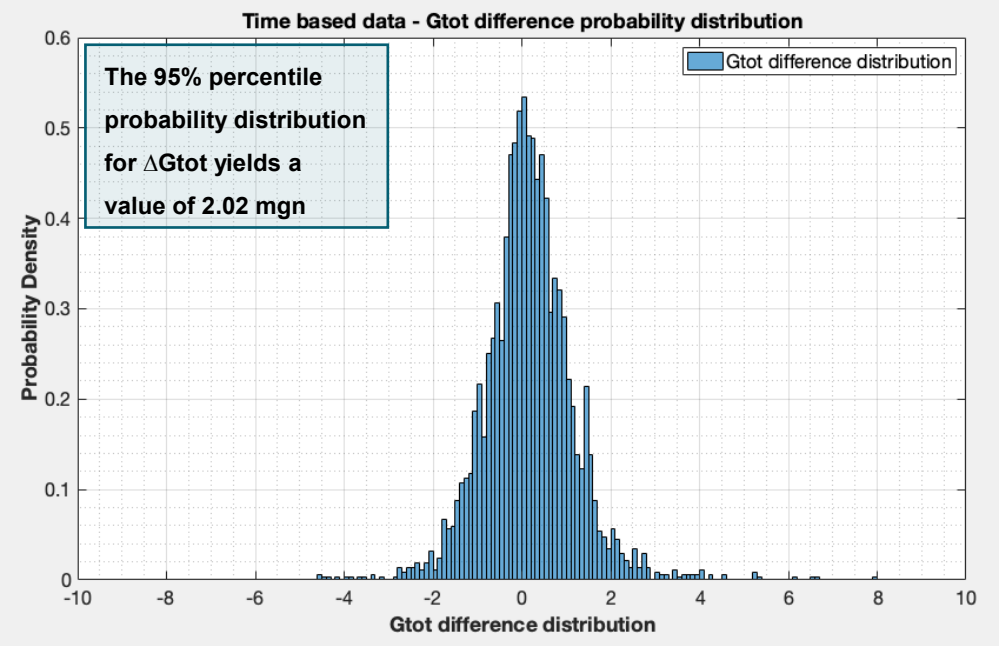
Filtered SLB Data Time-Based Overview

Several comparison methods were used to assess the quality of DDS surveys (use of all raw DDS surveys, **use of Filtered DDS surveys**, use of interpolated static surveys)

The analysis of the time-based data was performed in four different steps:

1. Removing outliers: only 3,756 static surveys were used out of 3,880 (~97 % of usable data)
2. Removing potential static data from the DDS listings (to improve the decorrelation between both survey sets)
3. Back-calculating Inclination & Azimuth using raw data
4. Comparing static surveys with DDS surveys averaged over a 3-minute interval

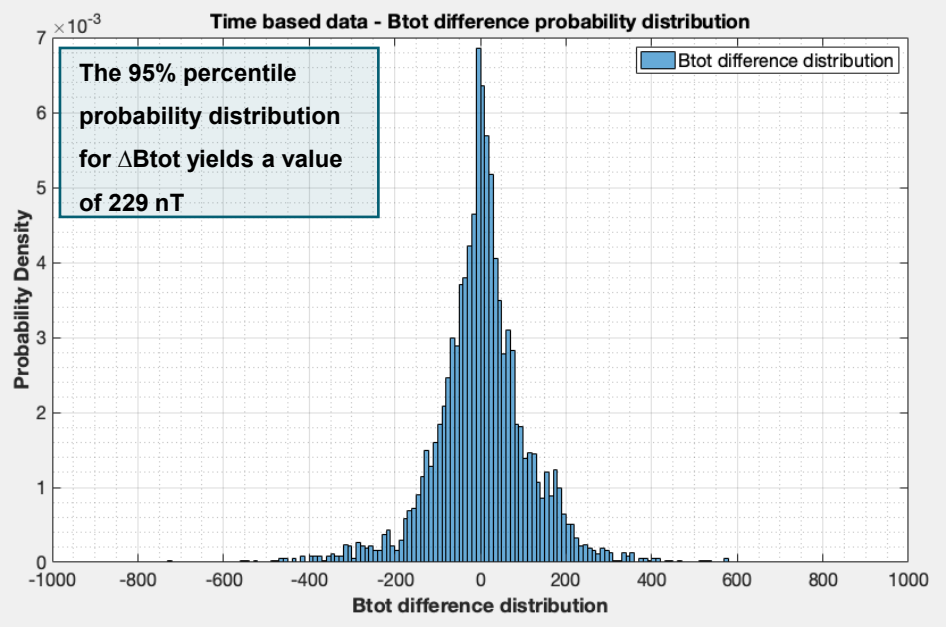
Filtered SLB Data Time-Based Overview - ΔGtot

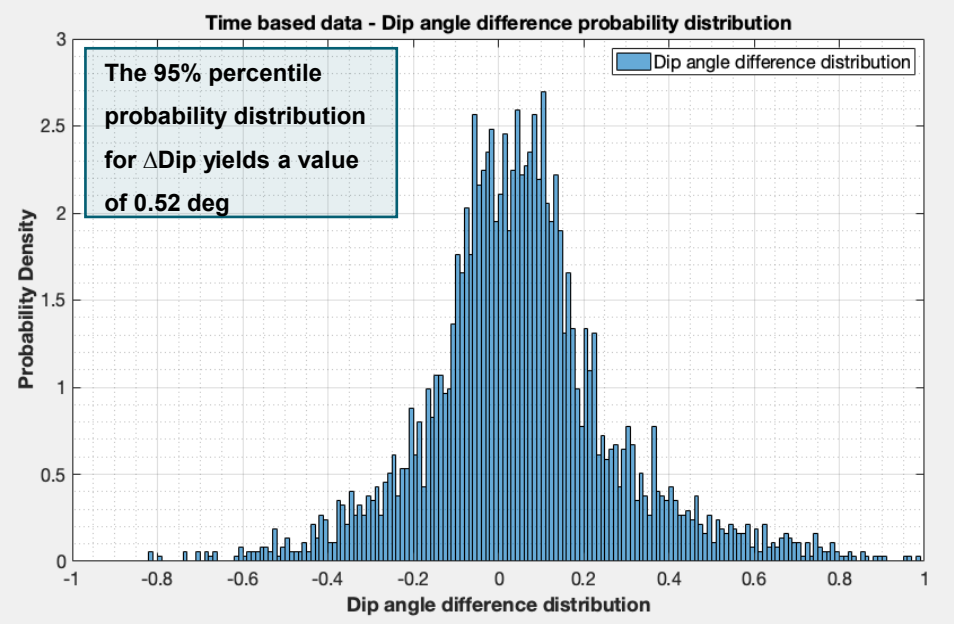


Difference thresholds (mgn)	Surveys within thresholds (%)
2	94.85
3	98.72

SLB Data Time-based

Filtered SLB Data Time-Based Overview - ΔBtot, ΔDip



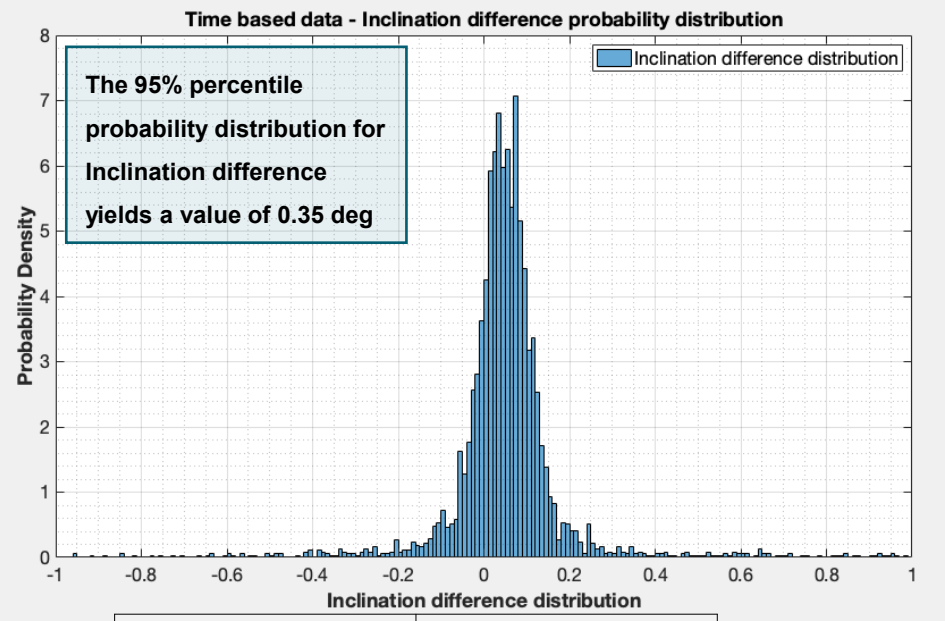


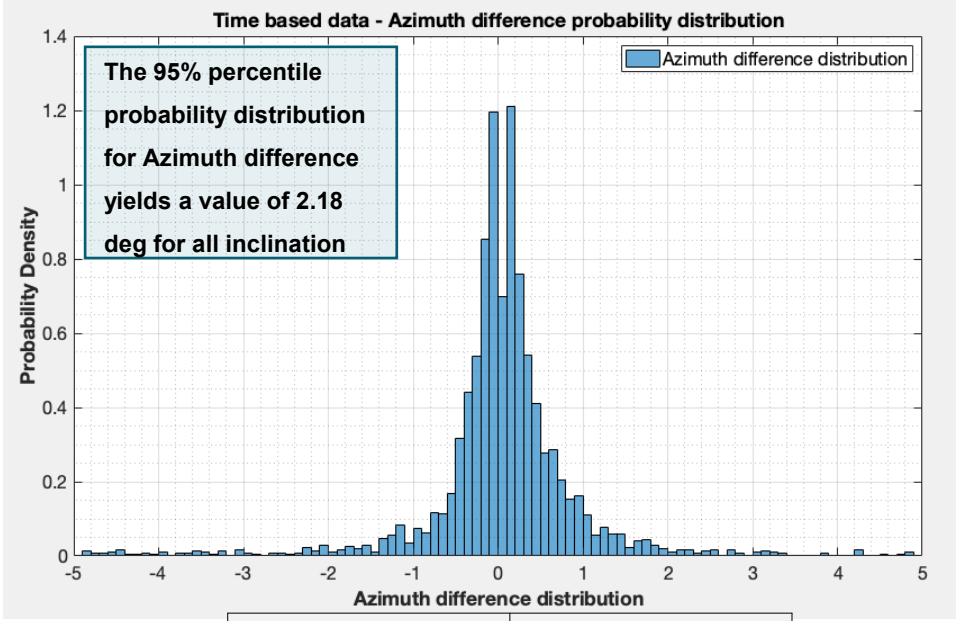
Difference thresholds (nT)	Surveys within thresholds (%)
300	97.54
450	99.57

SLB Data Time-based

Difference thresholds (deg)	Surveys within thresholds (%)
0.45	92.87
0.65	97.68

Filtered SLB Data Time-Based Overview Inclination, Azimuth differences





Difference thresholds (deg)	Surveys within thresholds (%)
0.3	94.26
0.5	96.40
1	98.53

SLB Data Time-based

Difference thresholds (deg)	Surveys within thresholds (%)
1	85.87
1.5	91.80
3	96.53

Conclusions of Data Analysis

1. The analysis of time-based surveys demonstrate a high level of quality
2. The majority of ΔGtot, ΔBtot, and ΔDip measurements in the time-based surveys fall within the Field Acceptance Criteria
3. The azimuth and inclination characteristics of the time-based surveys also exhibit a significant consistency compared to static surveys
4. The presence of a few surveys outside the FAC criteria is considered negligible

		Surveys within thresholds (%)														
		Raw data						Inclination difference (deg)			Azimuth difference (deg)					
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Time-based Filtered	3756	97.54	99.57	92.87	97.68	94.85	98.72	94.26	96.40	98.53	85.87	91.80	96.53	86.70	92.47	96.95

TotalEnergies Road Map

1. Participate in ISCWSA Error-model-subcommittee to encourage development of tool error model for non-static-MWD surveys
2. Check with other DD vendors for development stage of alternative tools.
3. Build user-group together experience and lessons learnt
4. Define circumstances under which DDS surveys can replace MWD:
   a) Planning stage screening that Clearance Factor > 5 (warning trigger).
   b) For sections where planned DLS≤ 2.0°/30m, replace every 2nd survey with DDS.
   c) For sections where DLS> 2.0°/30m take static survey every stand.
   d) Written TotalEnergies DDS protocol. E.g. DDS not more frequent than every 3m in final survey and more likely every 10m.
   e) Currently use excel to calculate DDS DLS taking survey some 30m back to compare with standard DLS calculations , look to build in to MWD software.
   f) Gather data – and data-handling experiences.