Error Model Maintenance Committee Update

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Speaker Bio

- Andy McGregor
- Technical Director, H&P UK.
- Inverness, Scotland
- 25 years in navigation and positioning
- 15 years in wellbore survey
- Previously with Tech21, Weatherford, AJC
- Specialised in survey management, algorithms, error modeling,

Meeting Monday 12th April - Agenda

- Rev5 Update
- Documentation Updates
- Working Group Report - Handling Uncertainty in Side-tracks
- Breaking Tool-code Set Into Discrete Blocks

Revision 5 – Status

- Last meeting status changed from beta to full release.
- Changes in rev 5 were:
  - Addition course length dependant terms (XCL)
  - Changes to misalignments and sag
  - Breakout of geo-mag terms for relative uncertainty between wells
  - Defined handling of tie-on to surface

Check on Random Misalignments

- XYM3/4 misalignments are now random
- Generally significant in top hole / low inclination
- Added a check function to stop their contribution disappearing at short survey intervals.
- Recently observed that this causes problems with extremely short intervals
  - e.g. surveys ~1mm apart.
  - Landmark have removed the check function from Compass
- Needs further evaluation.

Rev5 Website Documentation Update

- Documented on ISCWSA website:
  - https://www.iscwsa.net/error-model-documentation/
- Added spreadsheets defining ISCWSA Set of Generic Tool-codes
  - i.e. 'OWSG Models'
  - Set A and Set B
  - Numbered Rev5-1
  - "MWD" now "MWD+SRGM"
- Document defining the categories of geomagnetic model
  - LRGM, SRGM, HRGM
  - Update frequency, harmonic degrees of the model
- No diagnostics files yet

Standard Models – Set E

These were Experimental Models, proposed for inclusion:

MWD+HRGM+MS – to be included

A number of Dual Inclination models - not suitable for generic set.

- should be service provider models

Un-surveyed Assumed Vertical Models – not suitable for generic set

- very field/drilling equipment dependant.

- blind drilling should be default generic model

- any local assumed vertical model best validated against surveyed wells in that field.

Documentation- Archive Technical Documents

OWSG Rev2 Model definitions and diagnostics

A series of technical notes written by Steve Grindrod:

- Notes on implementation of test profiles
- Notes on toolface independent terms and models.
- Notes on depth model changes
- Additional MWD models (pre-OWSG, MWD+IFR etc.)

Presentations from Stefan Maus deriving the LRGM and HRGM magnitudes.

Derivation of the Singular X-axis Accel terms from Chad Hanak.

https://www.iscwsa.net/error-model-additional-documentation/

Open Source Error Model Implementation

- Welleng Python Library by Jonny Corcutt
- https://pypi.org/project/welleng/

- Calculate well bore uncertainty data (utilizing either the ISCWSA MWD Rev4 or Rev5 models) –"the coded error models are within 0.001% accuracy of the ISCWSA test data."
- Calculate well bore clearance and Separation Factors (SF)
  - standard ISCWSA method within 0.5% accuracy of the ISCWSA test data.
  - new mesh based method using the Flexible Collision Library.

- May be of interest, but not checked or endorsed by the committee

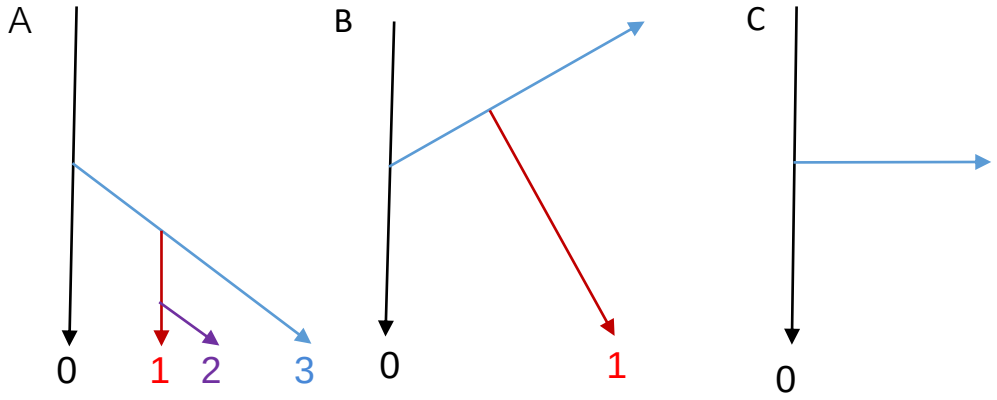
Handling of Errors in Side-tracks

- Collision avoidance test set includes a side-track well.
- Inconsistency in handling errors for that well.
- Setup a working group to recommend best practice.
- Has met three times since last ISCWSA.

- Work on-going
- Will produced recommendation document & test-cases

Conceptual Test Cases

Differing geometries
Permutations of reference and offset
Varying survey program
MWD + gyros



Scan	1	2	3	4	5	6	7	8	9	10
Reference	A1	A2	A2	A3	A3	A3	B1	B2	B2	C1
Offset	A0	A0	A1	A0	A1	A2	B0	B0	B1	C0

Calculation of Relative Uncertainty

- Existing method of calculating relative uncertainty will apply.
- Correct method is described in SPE 67616 and the Error Model Definitions document
  - Add covariance matrices
  - Subtract product of error vectors of the globally propagating sources.
- Simple RSSing of pedal curve radii does not manage global terms correctly

Calculation of Relative Uncertainty

- Erik Nyrnes and Jon Bang presented the Matrix method
  - an alternative to the error summation formulation in SPE 67616
- Both implementations handle Global terms correctly, and give the same results
- Will be documented and added to definition document as alternative.
- It was agreed that there is nothing specific to side-tracks that will not be handled properly by the current mathematics

MD terms: Propagation

ISCWSA rev 5 terms:

Error Source		Propagation Mode	Units	Fixed	Floating
Depth: Depth Reference – Random	DREF	R	m		2.2
Depth: Depth Reference – Systematic	DREF	S	m	0.35	1
Depth: Depth Scale Factor – Systematic	DSF	S	-	0.00056	0.00056
Depth: Depth Stretch – Global	DST	G	1/m	2.5E-07	2.5E-07

- Re-considered propagation modes for depth terms.
- Applying to both drill-pipe & wireline
- For relative uncertainty – main consideration is which have global propagation

Propagation: Term by Term Evaluation

- Reference - DREF(S) and DREF(R)
  - Fit for purpose.

- Scale Factor – DSF(S)
  - Systematic might not be correct in all scenarios
  - Is conservative, hence best option.
  - Applies to both drill-pipe and wireline and also drill-pipe // wireline comparisons.

Propagation: Term by Term Evaluation

Stretch – DST

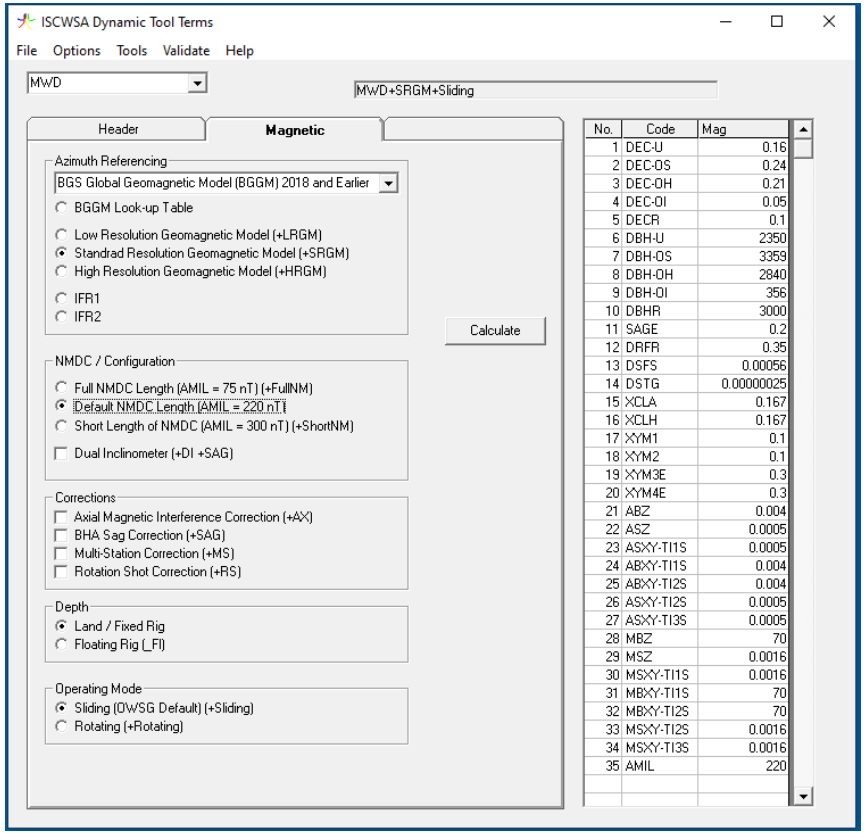
Drill-pipe: global propagation justified.

Wireline:

- Inappropriate for wireline tools to use current DST term.
- Errors not correlated with drillpipe stretch
- Recommend new wireline DST term
- With systematic propagation – DSTW-S

Breaking Models Down into Component Parts

- > 100 models in generic set.
- Many are permutations of magnetic tool options
  - MWD/EMS, Geomagnetic reference, axial/multi-station corrections, sag ….etc.
- Would be easier to manage if published as ‘building blocks’
- Greater flexibility and would allow more options-
  - E.g. drillstring interference models



No.	Code	Mag
1	DEC-U	0.16
2	DEC-OS	0.24
3	DEC-OH	0.21
4	DEC-OI	0.05
5	DECR	0.1
6	DBH-U	2350
7	DBH-OS	3359
8	DBH-OH	2840
9	DBH-OI	356
10	DBHR	3000
11	SAGE	0.2
12	DRFR	0.35
13	DSFS	0.00056
14	DSTG	0.00000025
15	XCLA	0.167
16	XCLH	0.167
17	XYM1	0.1
18	XYM2	0.1
19	XYM3E	0.3
20	XYM4E	0.3
21	ABZ	0.004
22	ASZ	0.0005
23	ASXY-TI1S	0.0005
24	ABXY-TI1S	0.004
25	ABXY-TI2S	0.004
26	ASXY-TI2S	0.0005
27	ASXY-TI3S	0.0005
28	MBZ	70
29	MSZ	0.0016
30	MSXY-TI1S	0.0016
31	MBXY-TI1S	70
32	MBXY-TI2S	70
33	MSXY-TI2S	0.0016
34	MSXY-TI3S	0.0016
35	AMIL	220

Breaking Models Down into Component Parts

- Website publishing or software generating models on the fly
- Need clear information for users – what to do all the acronyms mean.
- Put axial interference magnitude in short name
- How best to exchange models
- Use of reference number
- Application to gyro models
- Handling dynamically varying magnitudes (geomag / axial)
- Formed a working group

Questions

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