

## MWD TOOLFACE INDEPENDENT MODEL TESTING

This document compares the results of the ISCWSA MWD Rev.2 model with those from toolface independent models for both sliding and rotating modes. The three ISCWSA test profiles from SPE 67616 have been used.

The Table below shows the largest differences in major axis dimensions between the MWD Rev.2 and the toolface independent models in rotating and sliding modes:

Well Profile	Model	Rotating	Sliding
ISCWSA#1	Std MWD	0.97 m	-0.05 m
ISCWSA#1	MWD + Axial Corr.	16.91 m	-5.08 m
ISCWSA#2	Std MWD	2.31 ft	-1.00 ft
ISCWSA#2	MWD + Axial Corr.	4.55 ft	-1.55 ft
ISCWSA#3	Std MWD	0.54 m	-0.85 m
ISCWSA#3	MWD + Axial Corr.	0.64 m	-0.98 m

Note: A negative number means the toolface independent model is larger than the original MWD Rev.2

The results show that in general there is reasonable agreement with the toolface independent models and the toolface dependent model with the exception of well profile ISCWSA#1 and MWD with Axial Correction.

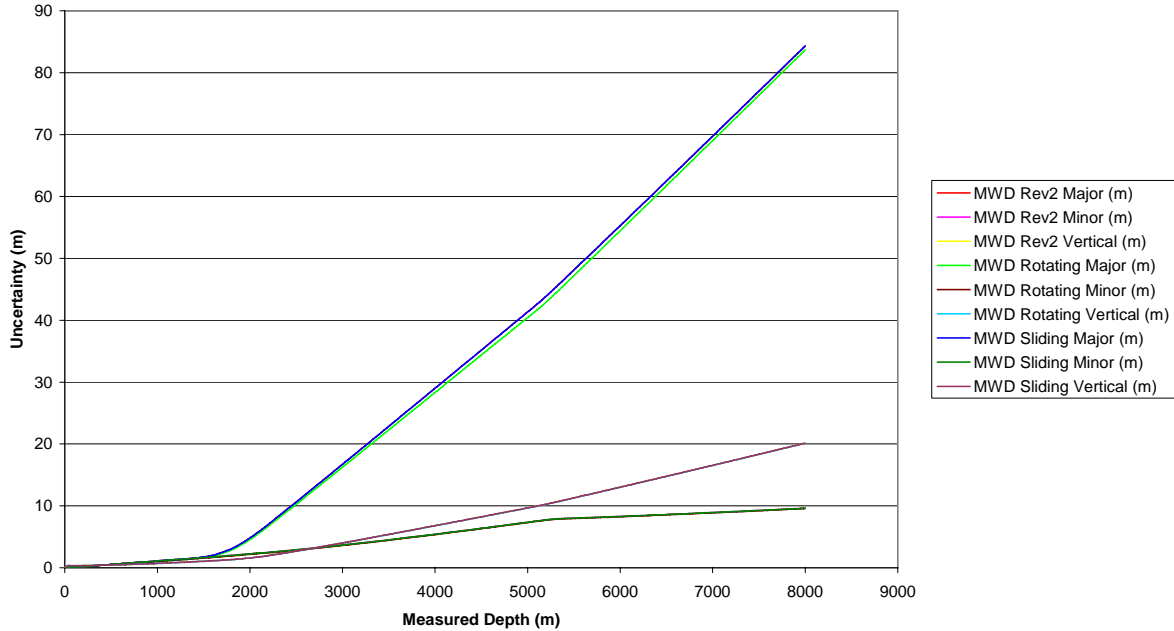
There are some further small anomalies which are being investigated.

### ***ISCWSA#1 Well Profile for 'Standard' MWD***

For ISCWSA#1 the differences in the position uncertainty are less than 0.97 m for the major axis. The sliding mode is almost the same as the original Rev.2 MWD.

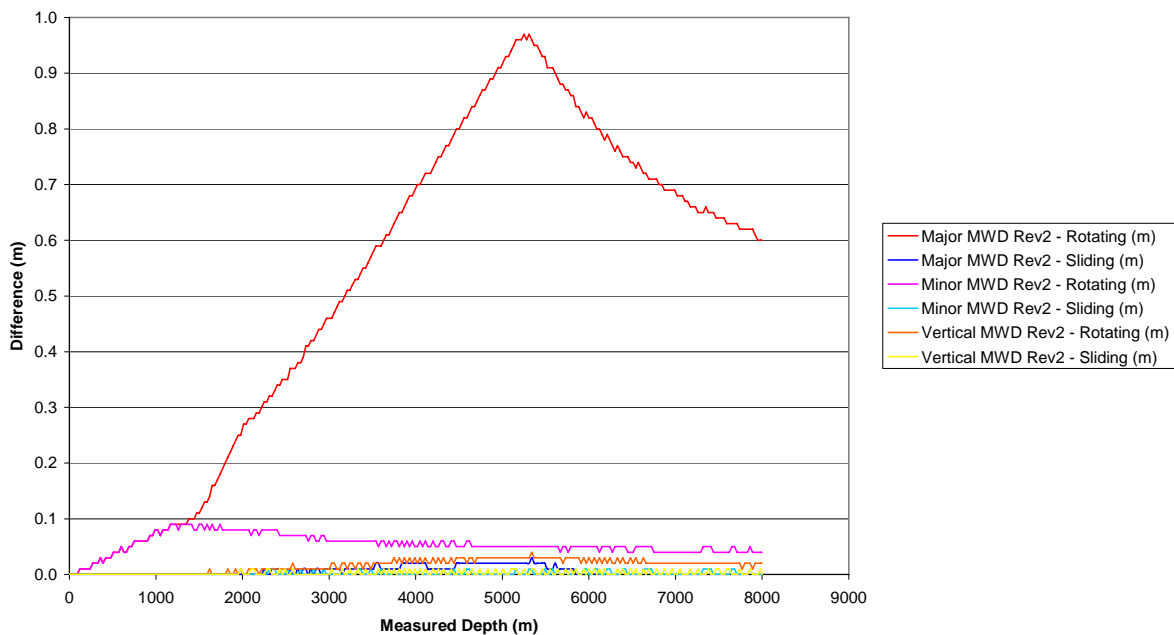
Section: T31 MWD Toolface Independent Model Testing

ISCWSA#1 Well Profile - Comparison of MWD Rev.2 with Toolface Independent Models



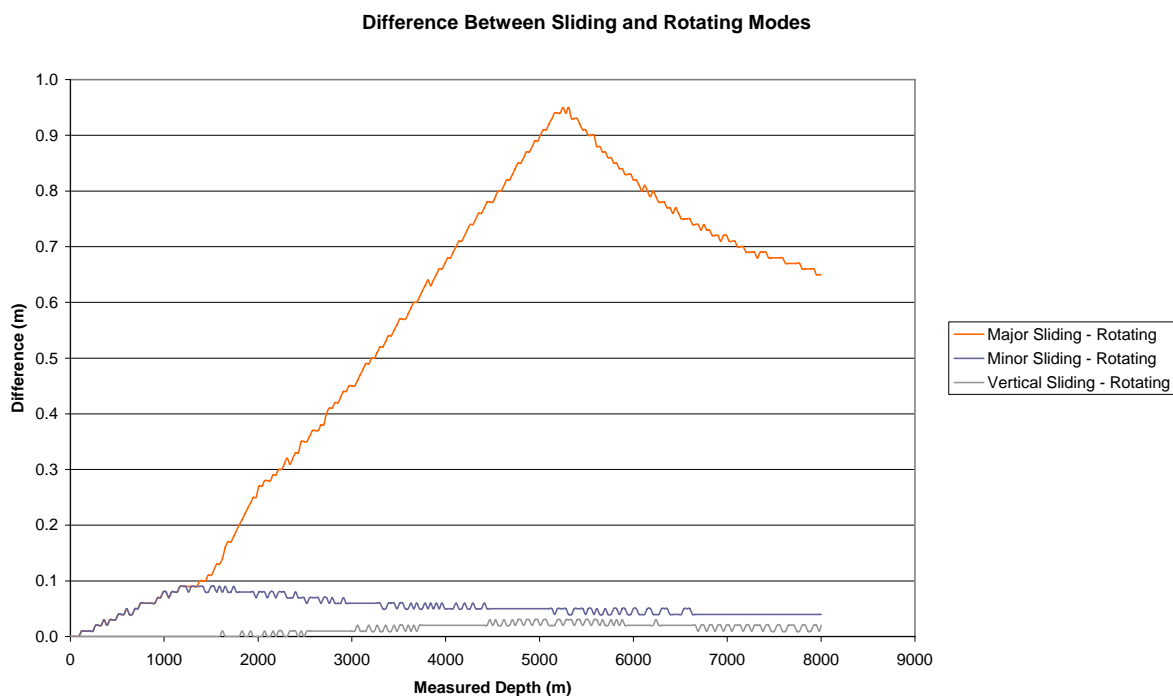
The difference plot below shows the differences between the current MWD Rev.2 and the rotating model and the current MWD Rev.2 and the sliding model.

ISCWSA#1 Well Profile - Uncertainty Difference Plot



The difference between the rotating and sliding models is 0.97 m with the rotating mode giving the smaller uncertainty.

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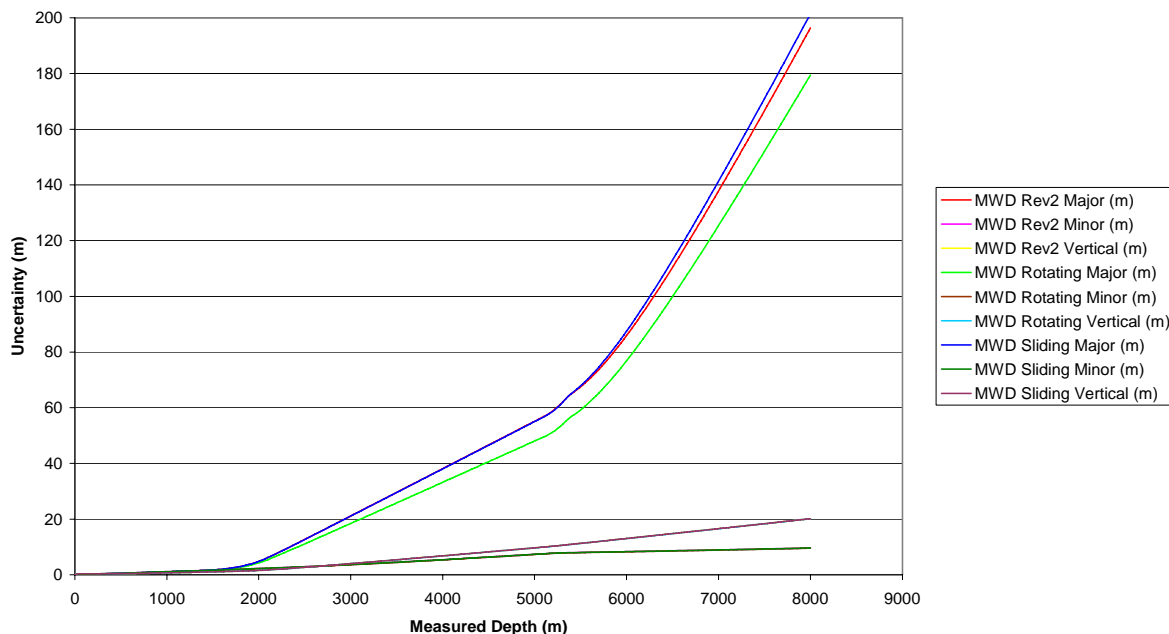


**ISCWSA#1 Well Profile for MWD with Axial Correction**

In this case the maximum difference between the sliding and rotating models is about 22 m. The sliding mode has a major axis radius about 5 m larger than the standard MWD. The rotating mode is about 16.9 m smaller than the standard MWD.

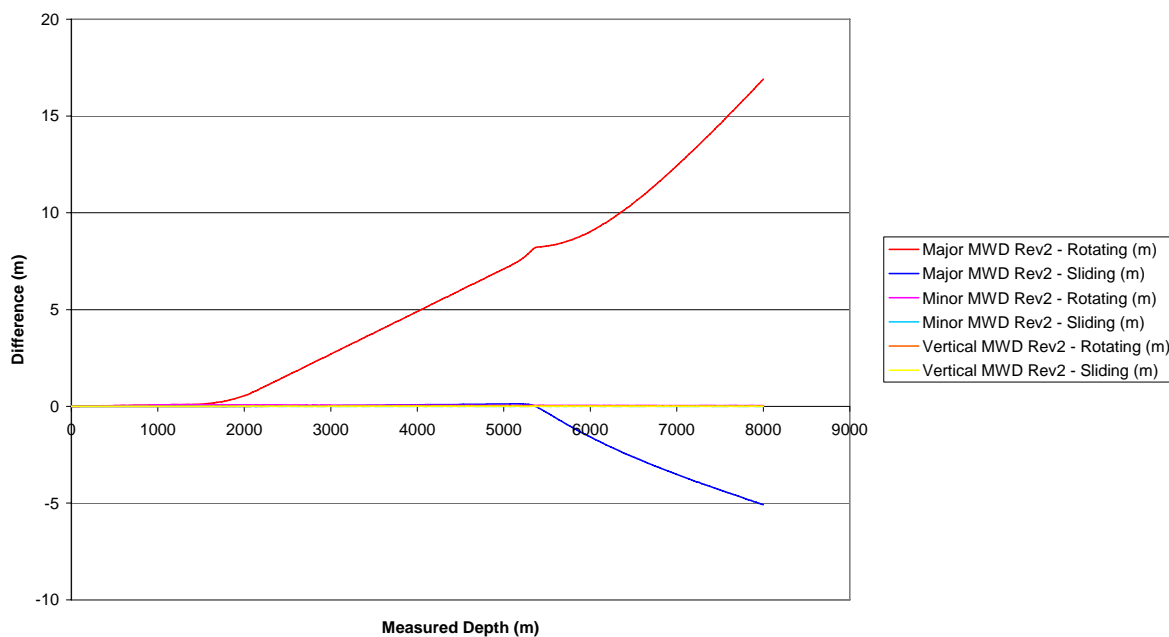
Section: T31 MWD Toolface Independent Model Testing

ISCWSA#1 Well Profile - Comparison of MWD + Axial Corr. Rev.2 with Toolface Independent Models

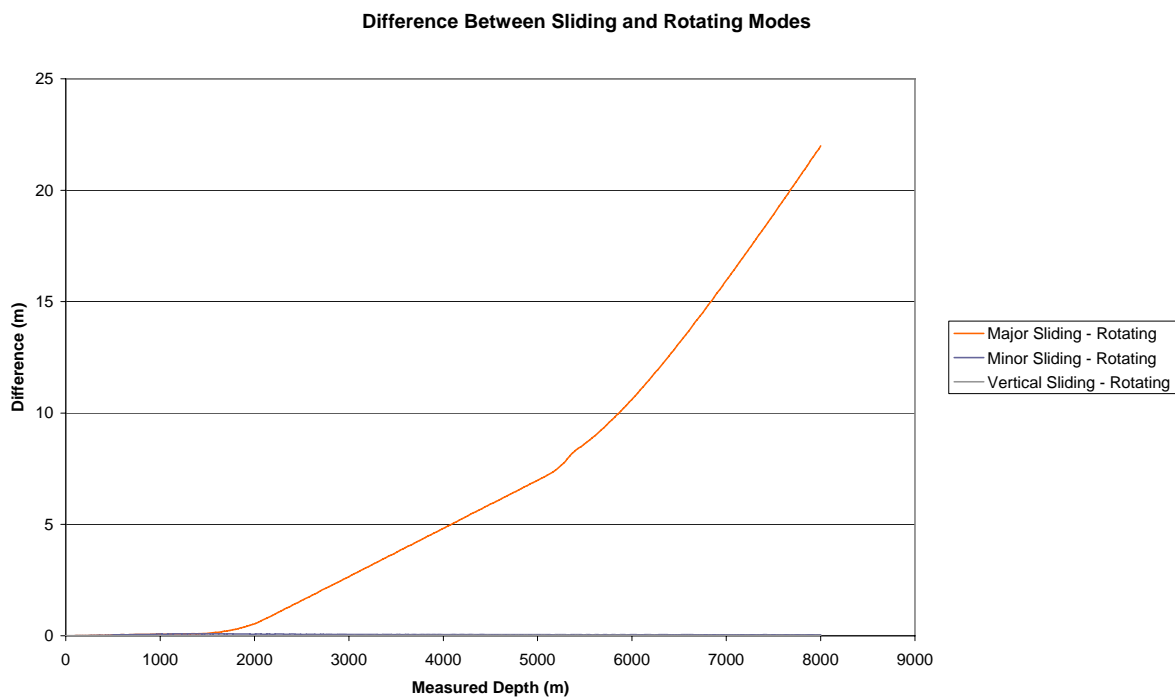


There is a 16.9 metre reduction in the major axis uncertainty as seen in the difference plot below.

ISCWSA#1 Well Profile - Uncertainty Difference



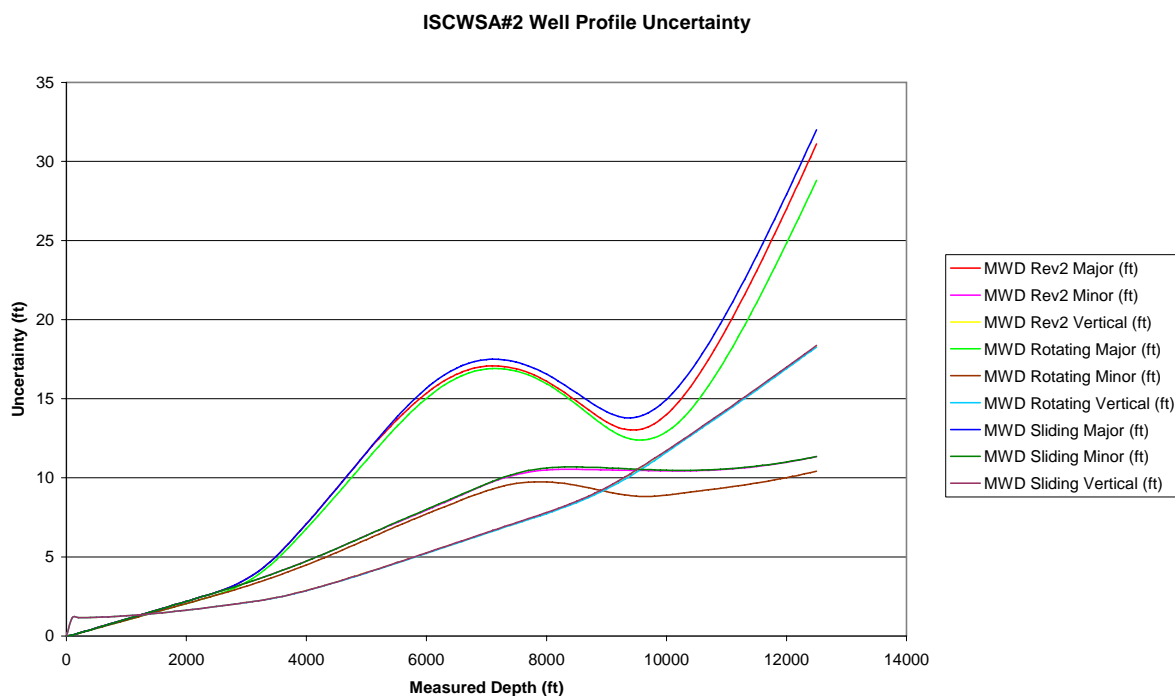
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**ISCWSA#2 Well Profile for 'Standard' MWD**

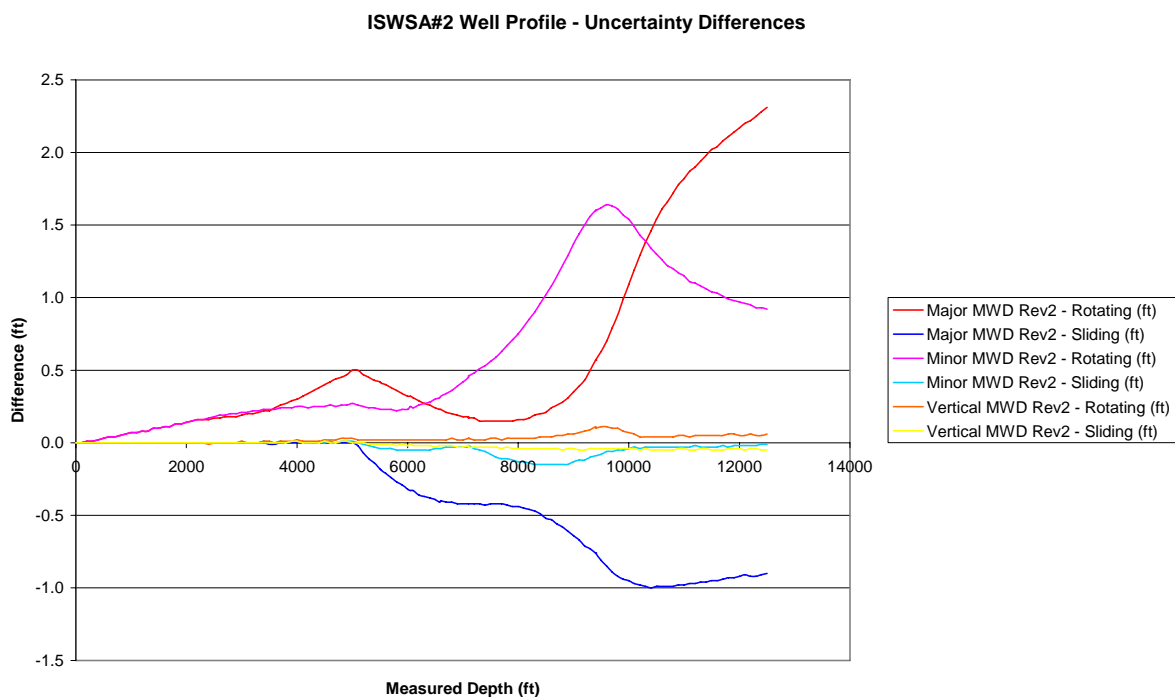
The rotating mode is about a 2.3 ft smaller in the major axis dimensions compared to the original MWD Rev.2. The sliding mode is about 1 ft larger than the original MWD Rev.2.

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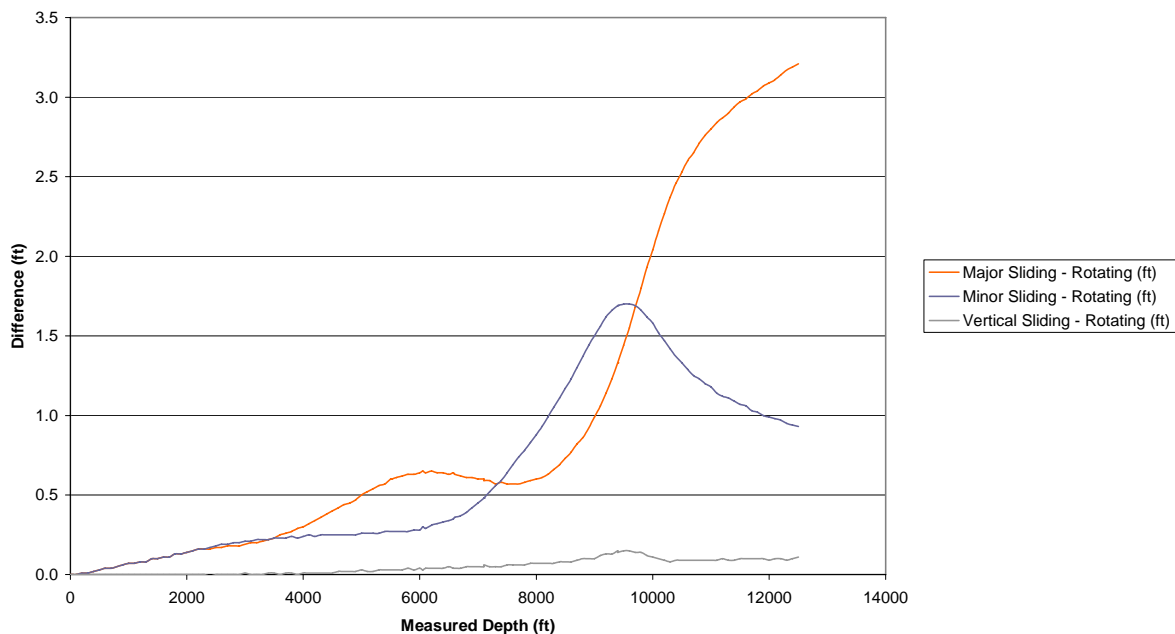
The difference plot shows more variation than in ISCWSA#1.

There is a maximum difference of 3.2 ft between the sliding and rotating models.



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ISCWSA#2 Well Profile - Difference Between Sliding and Rotating Model



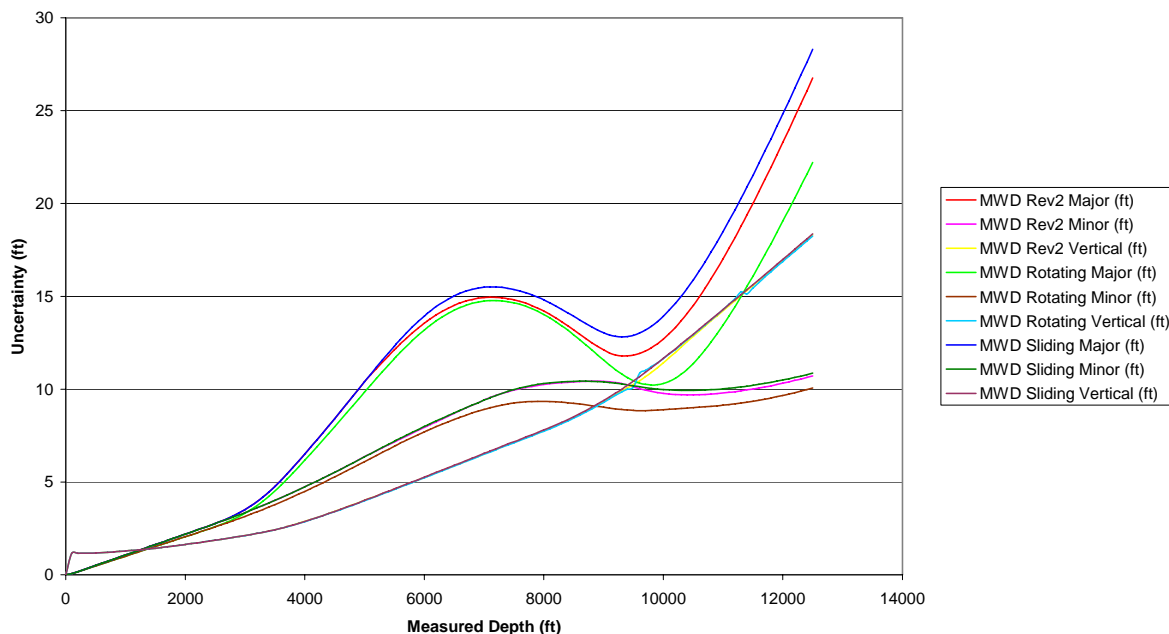
**ISCWSA#2 Well Profile for MWD with Axial Correction**

The rotating mode is about 4.5 ft smaller in the major axis dimensions compared to the original MWD Rev.2. The sliding mode is about 1.5 ft larger than the original MWD Rev.2.

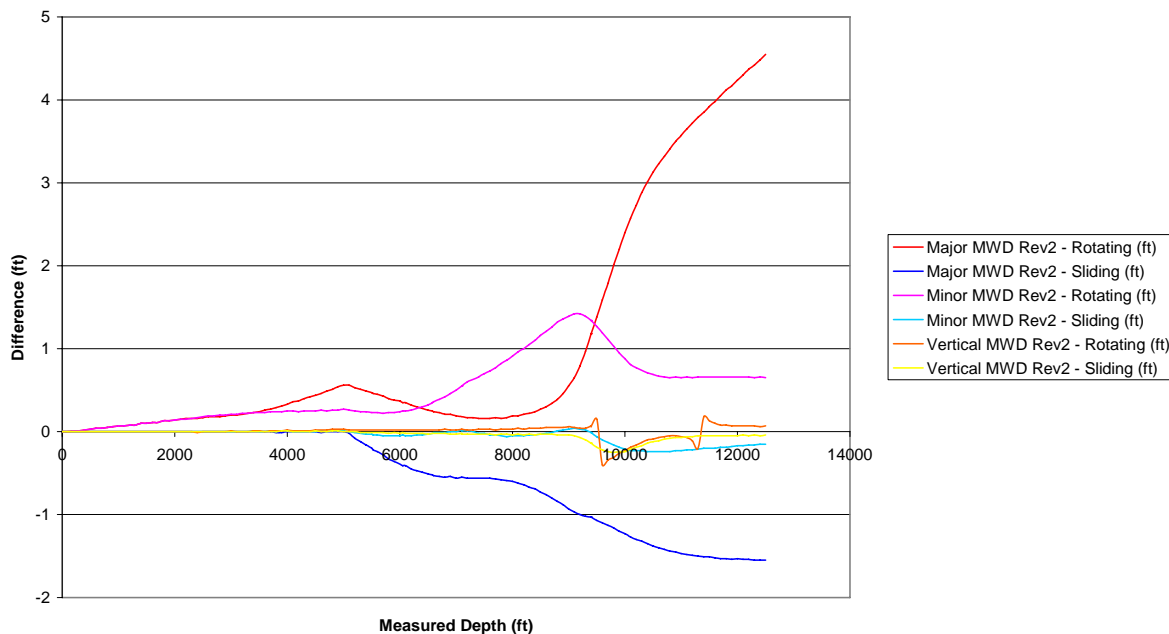
This plot shows some strange jumps in the vertical uncertainty for the rotating and sliding models.

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ISCWSA#2 Well Profile - Comparision of MWD with Axial Corr. with Toolface Independent Models



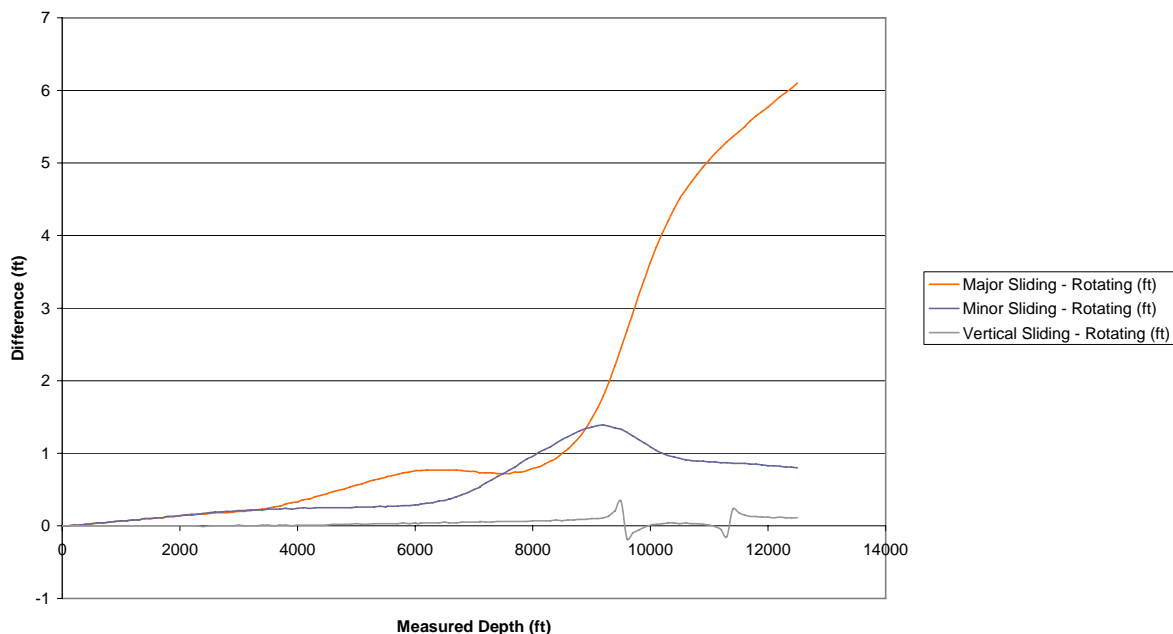
ISCWSA#2 Well Profile - MWD with Axial Corr Differences



The difference between the sliding and rotating models shows the spikes on the vertical axis.

Section: T31 MWD Toolface Independent Model Testing

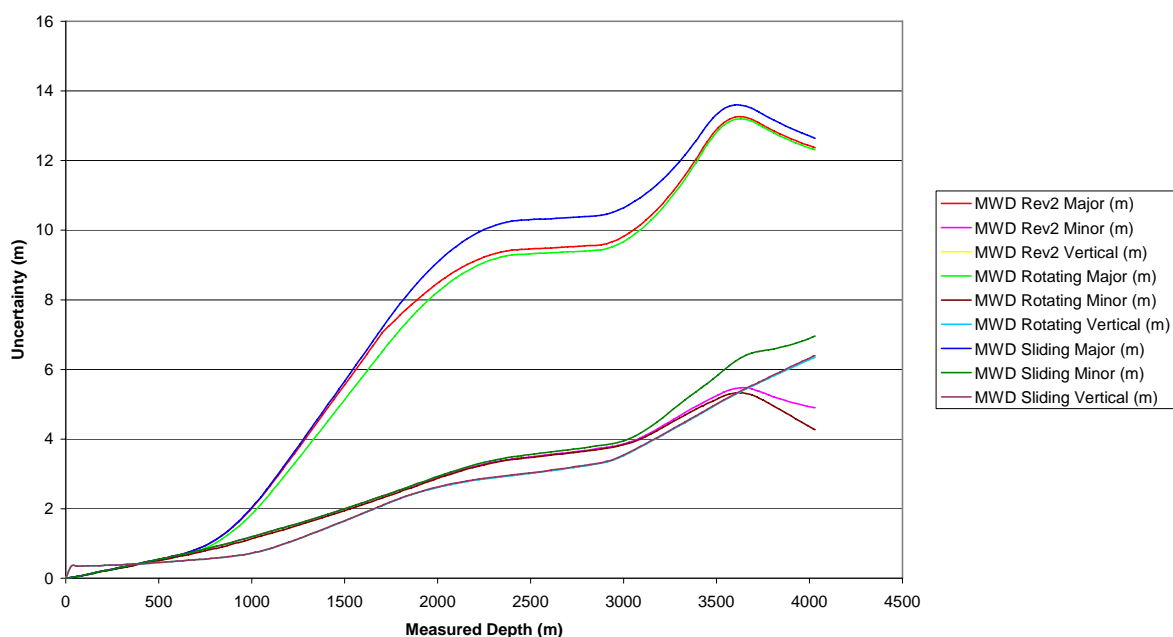
ISCWSA#2 Difference Between Sliding and Rotating Model



**ISCWSA#3 Well Profile for 'Standard' MWD**

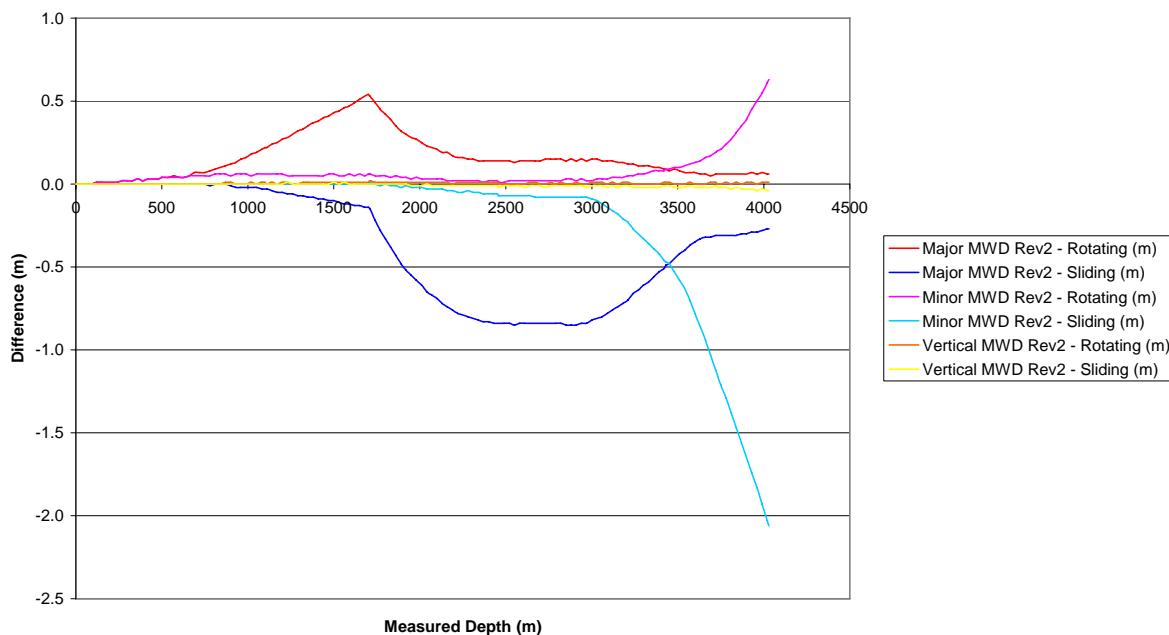
At TD of 4030 m MD the rotating mode is about 0.06 m smaller in the major axis dimensions compared to the original MWD Rev.2. The sliding mode is about 0.27 m larger than the original MWD Rev.2. Note that the largest differences do not occur at TD.

ISCWSA#3 Well Profile - Comparison of MWD Rev.2 with Toolface Independent Models

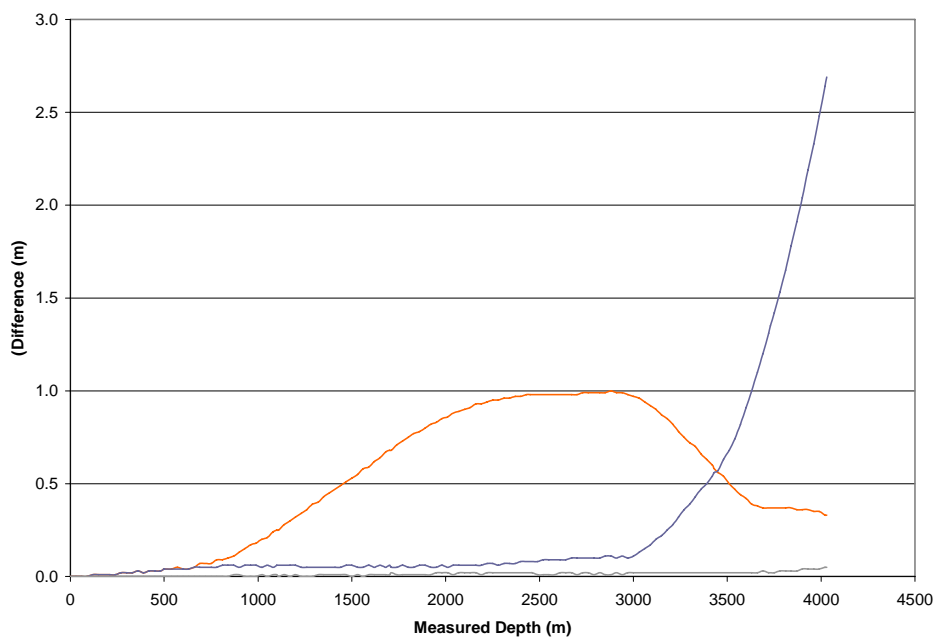


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ISCWSA#3 Well Profile - Uncertainty Difference



ISCWSA#3 Well Profile - Sliding and Rotating Differences

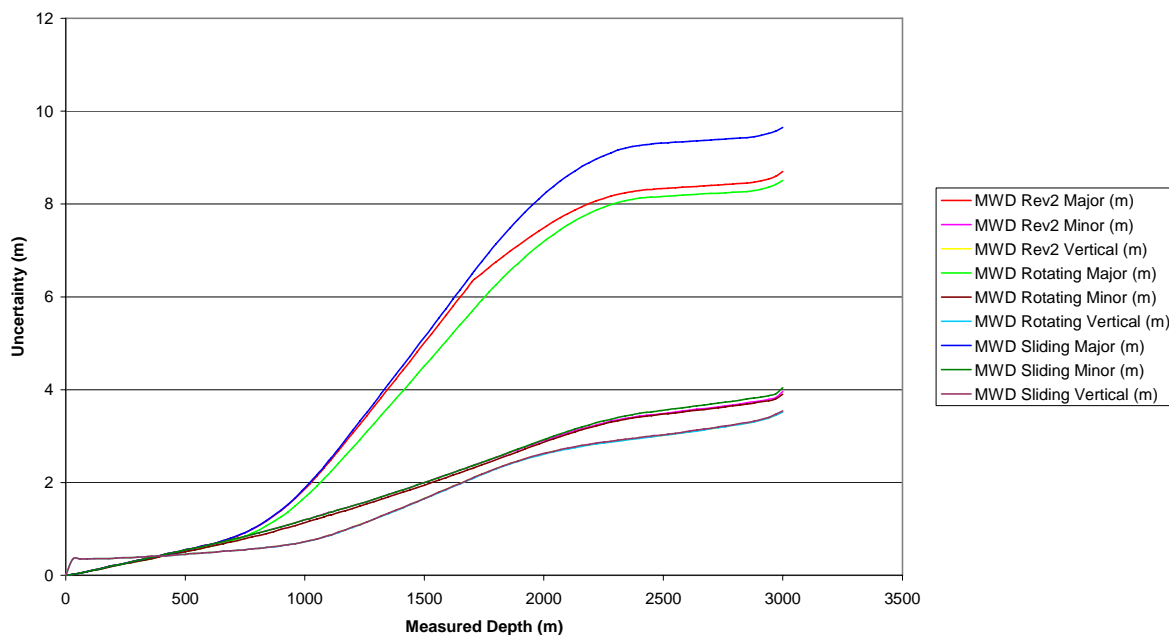


### ISCWSA#3 Well Profile for MWD with Axial Correction

This comparison only goes to 3000 m MD where the axial correction fails.

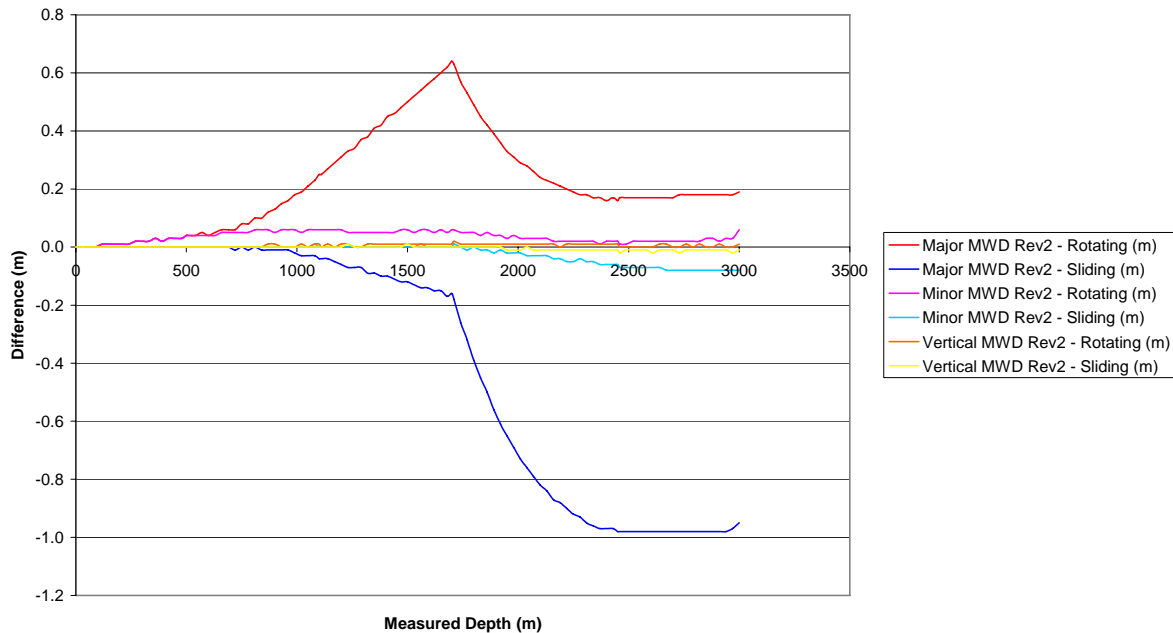
The rotating mode is about 0.19 m smaller in the major axis dimensions compared to the original MWD Rev.2. The sliding mode is about 0.95 m larger than the original MWD Rev.2. Note that the largest differences do not occur at TD.

ISCWSA#3 Well Profile - Comparison of MWD + Axial Corr Rev.2 with Toolface Independent Models



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ISCWSA#3 Well Profile - Uncertainty Differences



ISCWSA#3 Well Profile - MWD + Axial Corr Sliding and Rotating Differences

