SOCIETY OF PETROLEUM EVALUATION ENGINEERS

2024 SOFTWARE SYMPOSIUM

www.spee.org

History and Guidelines

2024 was 7th Symposium

2000 — 2004 — 2009 — 2011 — 2015 — 2018 — 2024

Focus on Economic Cashflow Calculations

Focus on Automated Forecasting

- Society has targeted a Software Symposium every 2 years
- Previous events held in 2000, 2004, 2009, 2011, 2015, 2018 and 2020 (cancelled) focused on comparing Economic Cashflow Calculations

2024 Symposium focused on Automated Forecasting

- Datasets are getting bigger and computers are getting faster
- Industry has a need for speed, efficiency and accuracy
- Software companies are creative and competitive

Thank You

Participants

4cast
BLR PetroCurveFit
Blue River Analytics for Energy
ComboCurve
Danomics
Enertel QuantumCast
FDC Dash Energy
inerGeconomics
OGRE
Omnira MOSAIC
PDQ Decide
Quorum Val Nav
S&P Harmony
Upstream Edge
Predico Advanced Flow Analytics

Sponsors

Proved + Probable ($5000)

UPSTREAM EDGE
OMNIRA SOFTWARE
Blue River ANALYTICS
OGRE SYSTEMS
quorum software
predico software

Proved ($2500)

ComboCurve
PHDwin TRC Consultants L.C.

Corporate

OXY

Symposium Committee

Chairman: Lucas Smith, Oxy
Vendor Liaison: Zack Warren, Velocity Insight
Marketing: Christina Hilton, Accelerate Resources
Administration: Andrea Bracho, SPEE

Technical
David Fulford, EIV Capital
John Wright, Wright Consulting
Steven Golko, Sproule
Helene Berthet, Total Energies

Volunteers
Kyle Chandler, IOG Resources
Herbert Lescanne, Total Energies
Yonss Jose, Total Energies
Lindsey Stelmach, Oxy
Ashish Ghotekar, ExxonMobil

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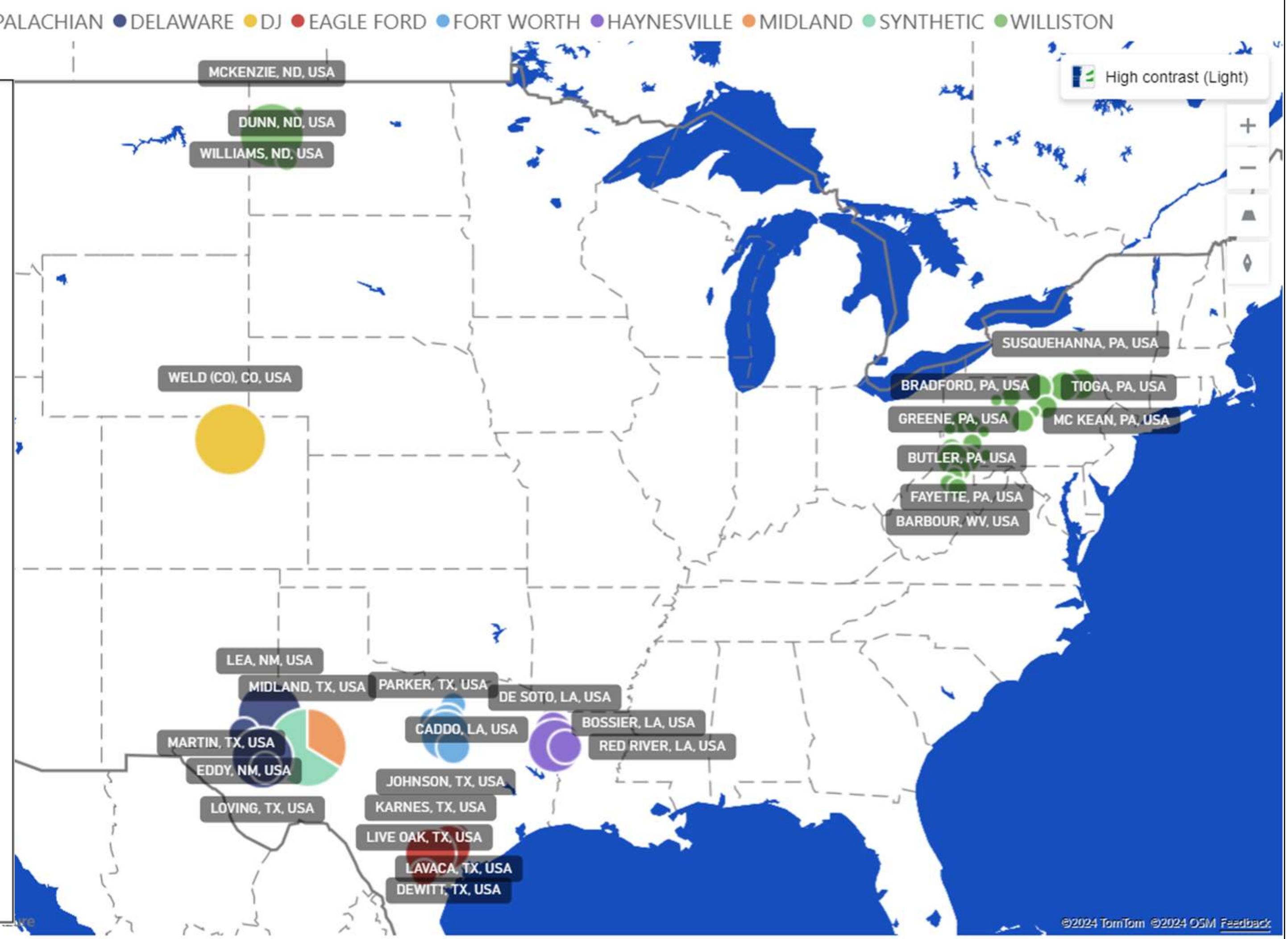
The Bake-Off

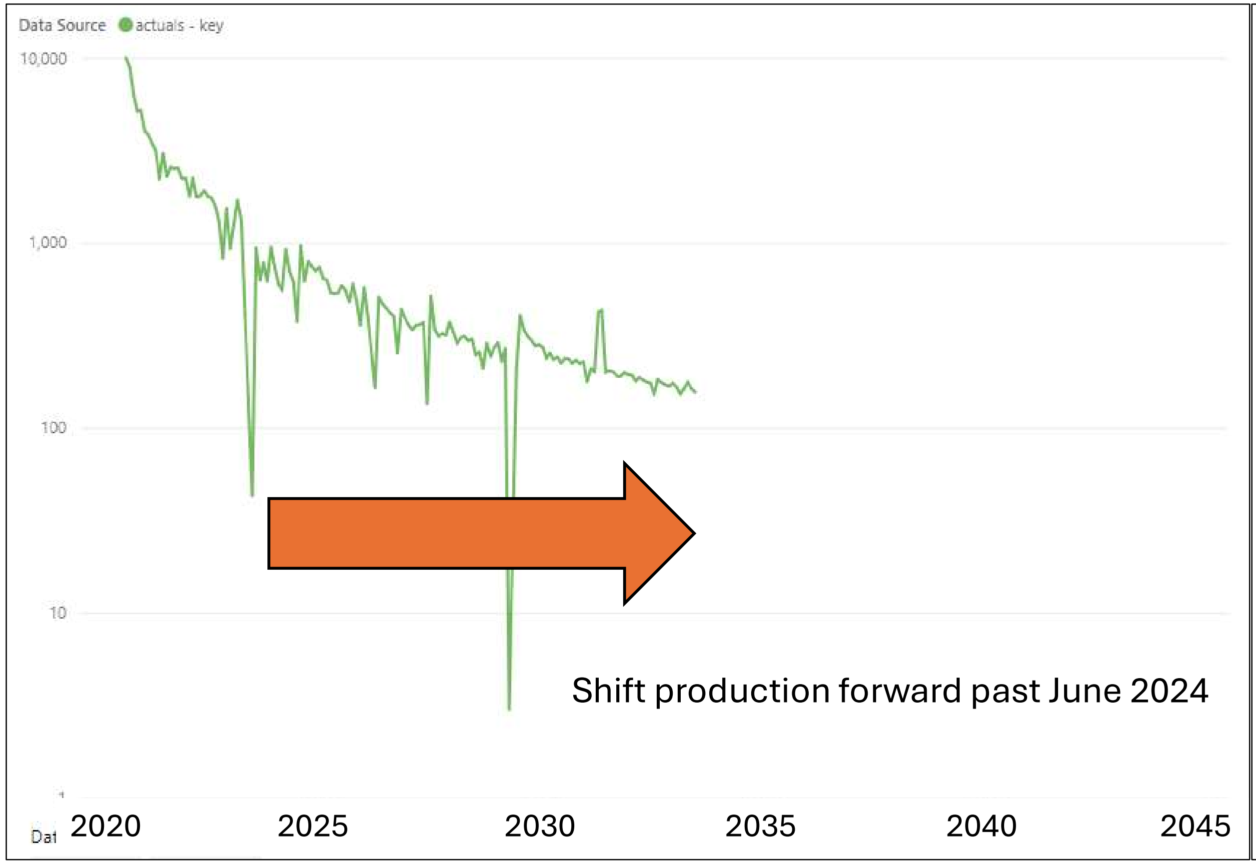
Forecast 1000 Wells in 12 Hours

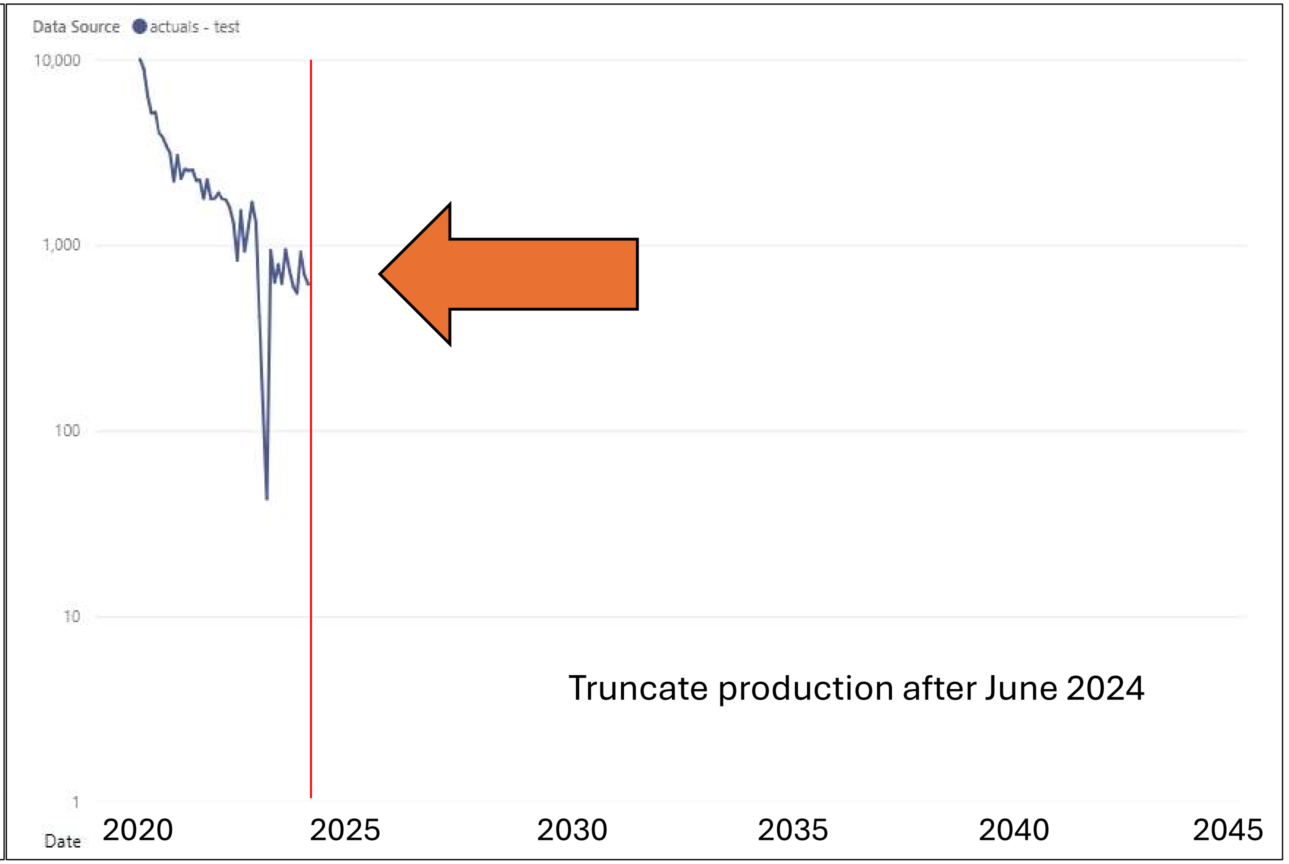
- All onshore U.S. horizontal wells drilled in the last 20 years
- 922 real wells with truncated data across eight basins
  - DJ Basin case study on human hand-forecasting versus machine
- 100 synthetic wells for full forecast life error determination
- Locations slightly anonymized with lat-longs slightly shifted
  - Well header data provided
- Time limit of 12 hours

Basin	Well Count
APPALACHIAN	**100**
MARCELLUS	100
DELAWARE	**200**
AVALON	100
WOLFCAMP A	100
DJ	**122**
CODELL	36
FORT HAYS	1
NIOBRARA	85
EAGLE FORD	**100**
EAGLE FORD	100
FORT WORTH	**100**
BARNETT	100
HAYNESVILLE	**100**
HAYNESVILLE	100
MIDLAND	**100**
LOWER SPRABERRY	100
SYNTHETIC	**100**
WOLFCAMP A	100
WILLISTON	**100**
BAKKEN	53
THREE FORKS	47
Total	**1,022**



Preparing the Data





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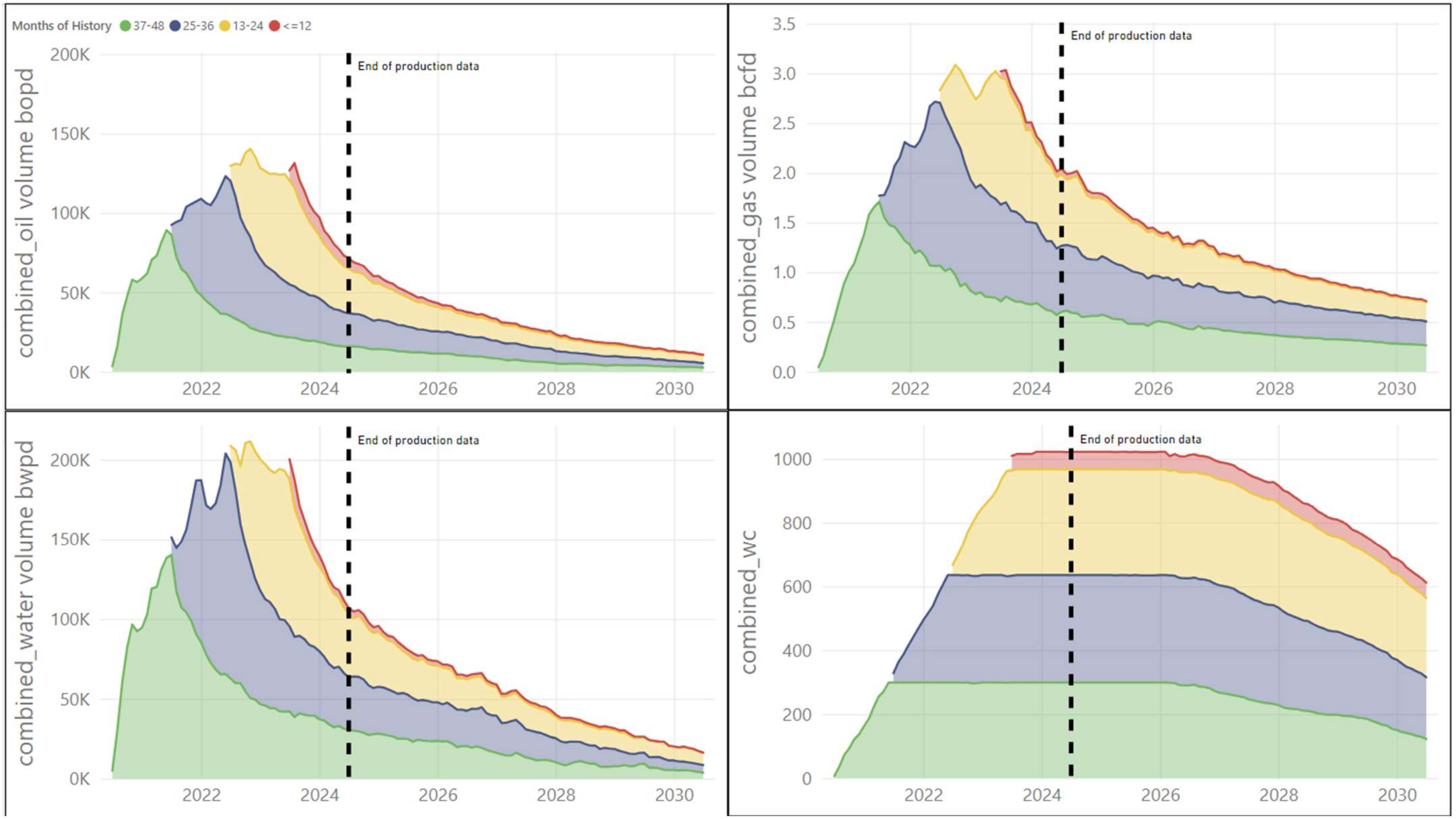
Maximum History of 4 Years

- "Test" data has between 7 and 48 months of history provided
- "Answer key" has 20 to 213 months available for analysis and longer for synthetic wells
- Peaks:
  - 140,000 bopd oil
  - 3.1 BCFD gas
  - 210,000 bwpd water



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Goal of Guiding Developers

Methods

- Get prescriptive on error definitions and calculations
- No emphasis on speed or accuracy for our analysis – participant's choice
- Qualitative survey to record how participants worked
- Committee formed hypotheses before getting any data back

Goals

- Providing guidance to practitioners and vendors on what's working and where improvements are needed
- Committee will not declare winners/losers

Primary Results

4 Major Challenges

- Automated forecasting is steadily getting better, but engineering judgement is still necessary

Secondary Phases	Short Histories	EUR Variability from Operational Upsets	EUR Variability from B Factor Consistency
Primary phase forecasts with larger errors tends to underpredict actual production. Secondary forecasts tend to be too low on oil wells and too high on gas wells	Longer periods of historical production reduces error	But recent operational upsets drive large variance	Some basins and reservoirs are more homogeneous in forecast shape and leads to better agreement in software forecasting

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Error Conclusions

- Median error for all vendor forecasts across all wells is nearly zero…
  - But this not true in all subsets, e.g. by [Vendor] or by [Basin]

- Variance of error varies across all subsets
  - Vendors did not perform equally on all wells despite, on average, having nearly zero error

- Some vendors had symmetrical variance of log errors
  - Vendors were just as likely to be 10% too high as 10% too low

- When vendors had large errors, they tended to under-forecast as opposed to over-forecast

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Basin Rankings

- Vendors performed:
  - Best on gas wells
  - Worst on gas condensate wells
  - Oil wells in between

Overall Scoring (2/3 Absolute Value of Median Log Error + 1/3 StdDev of Log Error):

1. Appalachian – Marcellus
2. Fort Worth – Barnett
3. Synthetic Midland – Wolfcamp A
4. Delaware – Wolfcamp A
5. Western Gulf – Eagle Ford
6. DJ
7. Midland – Lower Spraberry
8. Ark-La-Tex – Haynesville
9. Delaware – Avalon
10. Williston

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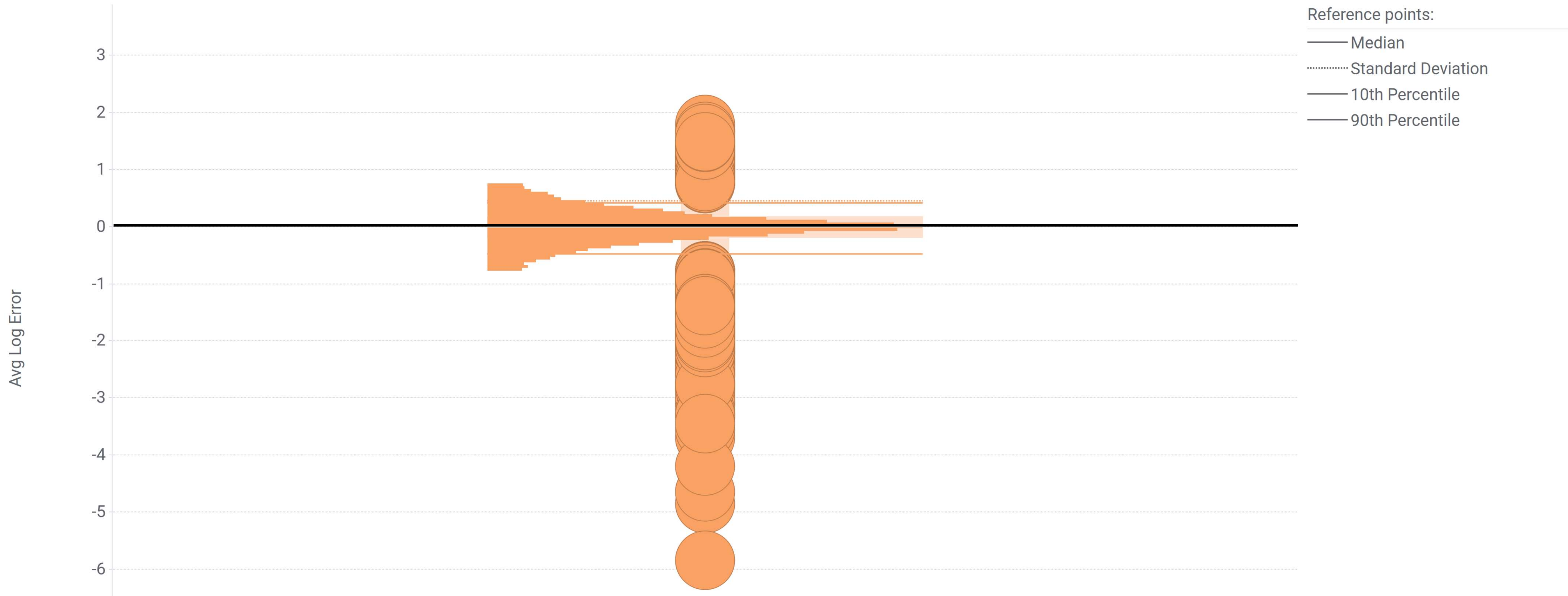
All Wells

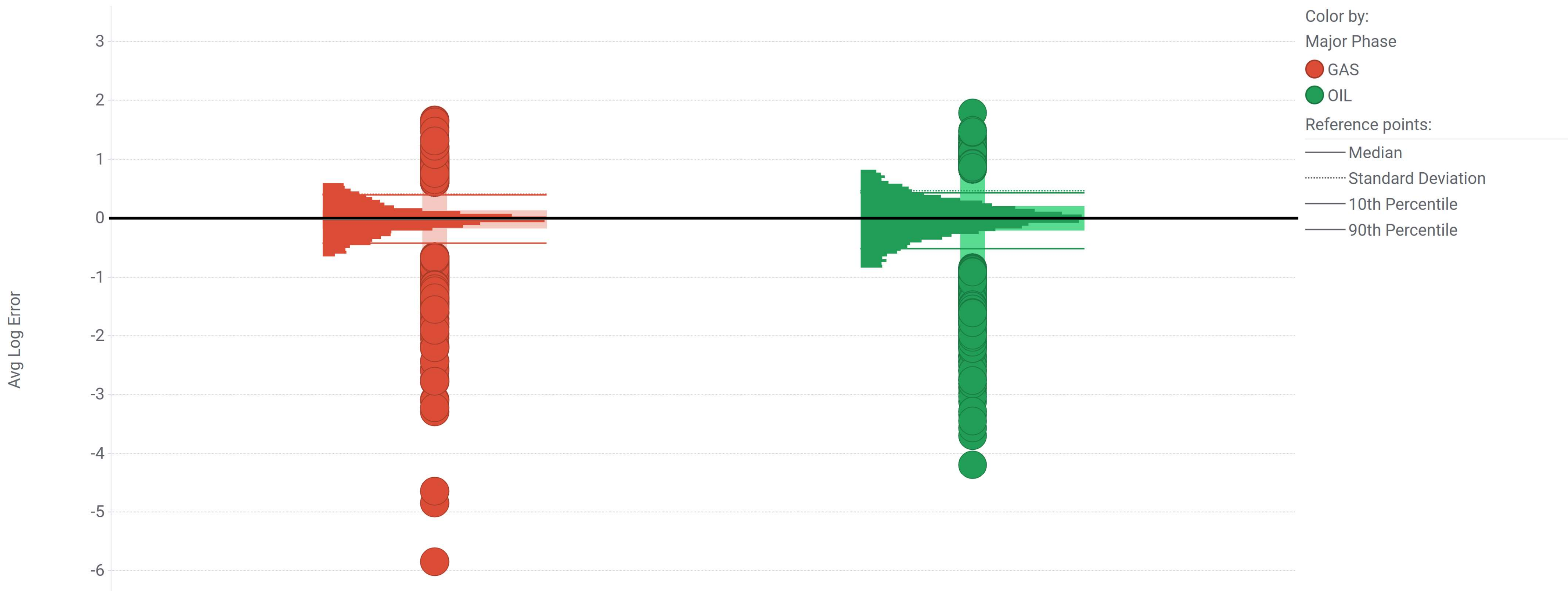


Count	15022
Median	-0.00721765
Outliers	1099
StdDev	0.445188

(None)

Median: -0.7%
StDev: 56%

Major Phase



	GAS	OIL
Count	5184	9838
Median	-0.020078	0.00276286
Outliers	504	665
StdDev	0.410508	0.462434

Major Phase

Median: -2%
StdDev: 51%

Median: 0.3%
StdDev: 59%

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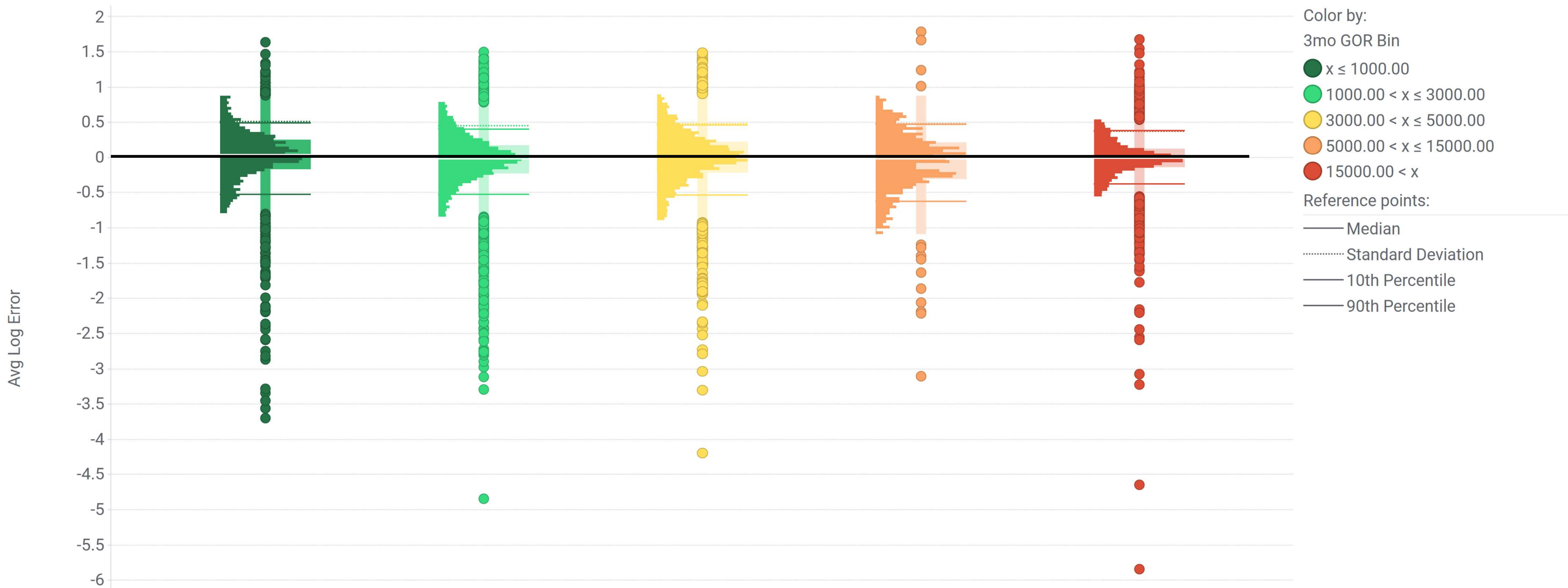
First 3 months GOR



	x ≤ 1000.00	1000.00 < x ≤ 3000.00	3000.00 < x ≤ 5000.00	5000.00 < x ≤ 15000.00	15000.00 < x
Count	1739	6563	2010	510	4200
Median	0.0366214	-0.0198049	0.0137888	-0.0256215	-0.00898475
Outliers	131	455	111	14	449
StdDev	0.515915	0.45309	0.481785	0.48352	0.369726

3mo GOR Bin

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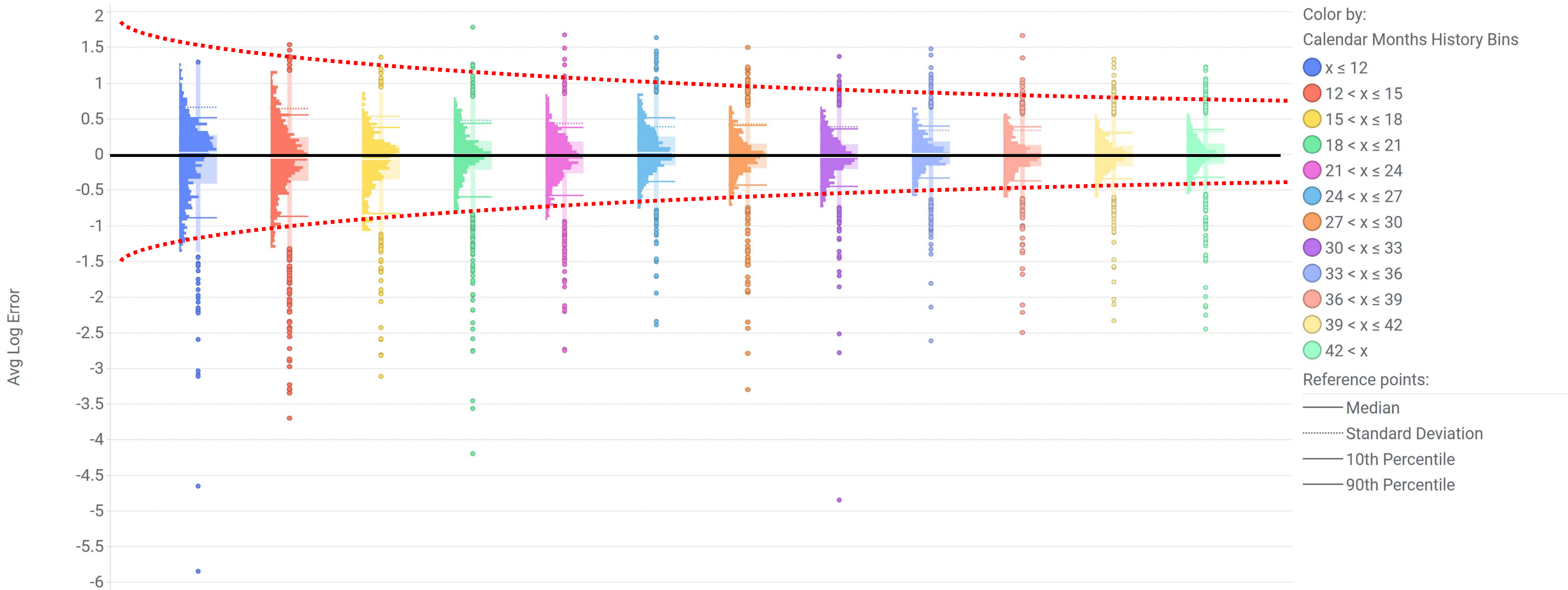
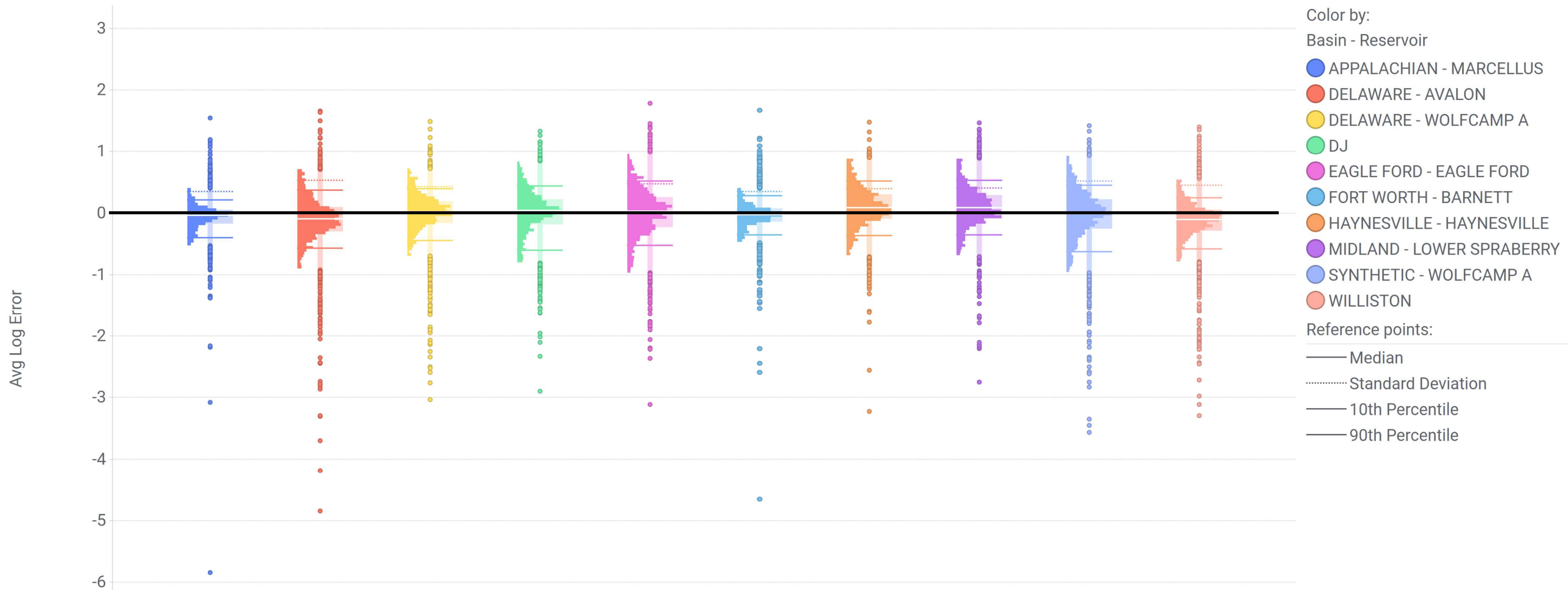
Months of History



	x ≤ 12	12 < x ≤ 15	15 < x ≤ 18	18 < x ≤ 21	21 < x ≤ 24	24 < x ≤ 27	27 < x ≤ 30	30 < x ≤ 33	33 < x ≤ 36	36 < x ≤ 39	39 < x ≤ 42	42 < x
Count	814	1278	751	1460	1399	1430	1024	1156	1320	1128	1245	2017
Median	0.0272366	-0.0433514	-0.0623575	0.00675393	-0.031135	0.0295092	-0.00943157	-0.0341116	0.0115055	-0.0218193	-0.00927279	0.00125513
Outliers	29	67	47	100	70	64	84	62	94	79	90	137
StdDev	0.66251	0.643943	0.53581	0.484685	0.440482	0.393439	0.434941	0.389653	0.341838	0.346641	0.32398	0.320872

Calendar Months History Bins

Basin/Reservoir



	APPALACHIAN - MARCELLUS	DELAWARE - AVAL...	DELAWARE - WOLF...	DJ	EAGLE FORD - EAG...	FORT WORTH - BA...	HAYNESVILLE - HA...	MIDLAND - LOWER ...	SYNTHETIC - WOL...	WILLISTON
Count	1400	1494	1500	1829	1500	1400	1400	1500	1500	1499
Median	-0.0386071	-0.0944442	0.0229386	0.0365628	0.0269843	-0.0316238	0.0831571	0.0824128	-0.00422708	-0.101674
Outliers	157	116	118	138	78	167	77	91	90	141
StdDev	0.351399	0.5261	0.430745	0.43691	0.470285	0.349178	0.389799	0.408794	0.522335	0.453586

Basin - Reservoir

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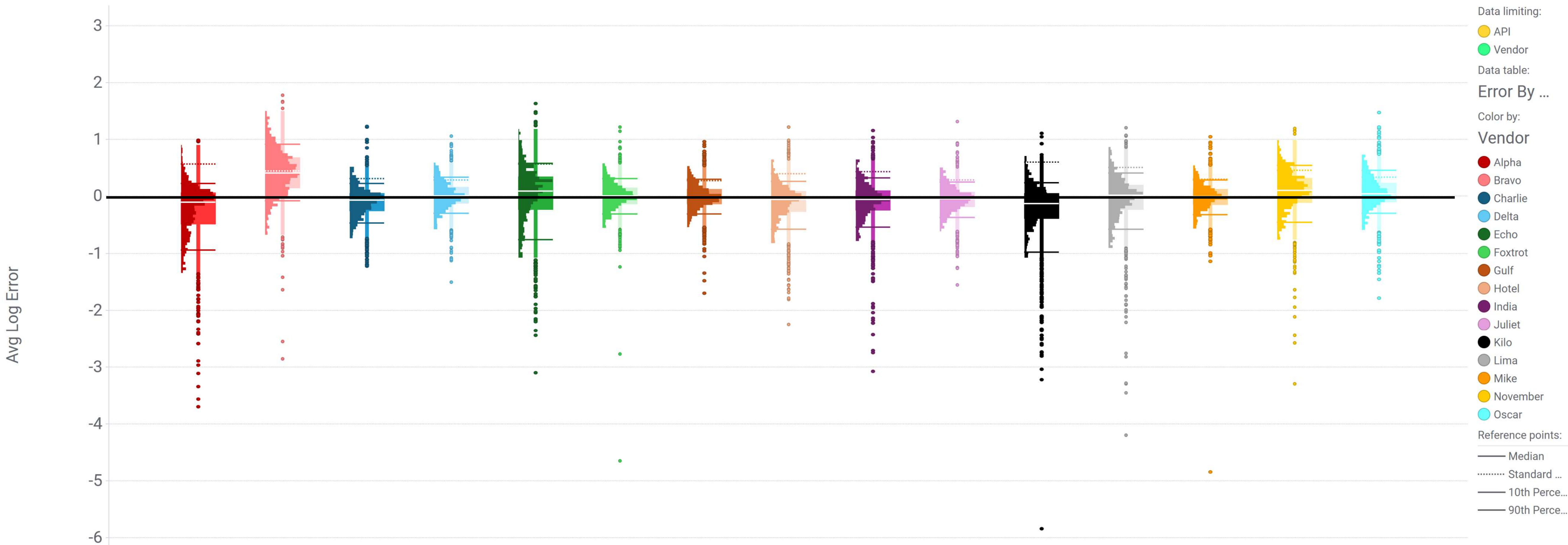
Vendor



	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Gulf	Hotel	India	Juliet	Kilo	Lima	Mike	November	Oscar
Count	1022	1021	1022	1020	1020	1022	1022	1022	1022	1022	1021	1022	1022	721	1021
Median	-0.107745	0.410732	-0.0702604	0.00388335	0.0887235	0.00385549	-0.0178015	-0.0608778	-0.0537391	-0.0481886	-0.133189	0.0139318	-0.0111251	0.1039	0.0445701
Outliers	50	20	49	53	61	47	72	77	71	60	93	59	53	37	55
StdDev	0.568532	0.442548	0.303163	0.28057	0.570087	0.313625	0.274425	0.394134	0.426497	0.280189	0.605238	0.507909	0.300936	0.453683	0.334601

Vendor

Secondary Phases

Algorithms Showed Difficulty

- Primary phases (oil for oil wells, gas for gas wells) are typically the economic and volumetric focus, but secondary phases are also important
  - Gas in oil wells
  - Oil in gas wells
  - Water
- Lots of implied ratio forecasts violate our expectations about the shapes of curves
  - Algorithms consistently **under-forecast** GOR's on oil wells
  - Algorithms consistently **over-forecast** CGR's on gas wells
  - A more Bayesian approach could be helpful

Oil Volume Variance

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to black/volatile oil wells with 1st three month GOR <3,200 cf/bo

Observations:

- Participants generally too optimistic about DJ, Eagle Ford, and Midland
- Too pessimistic about Delaware, Synthetic, and Williston
- Bravo, Echo, November, and Oscar >15% optimistic
- Hotel, Charlie, Alpha, and Kilo >15% pessimistic

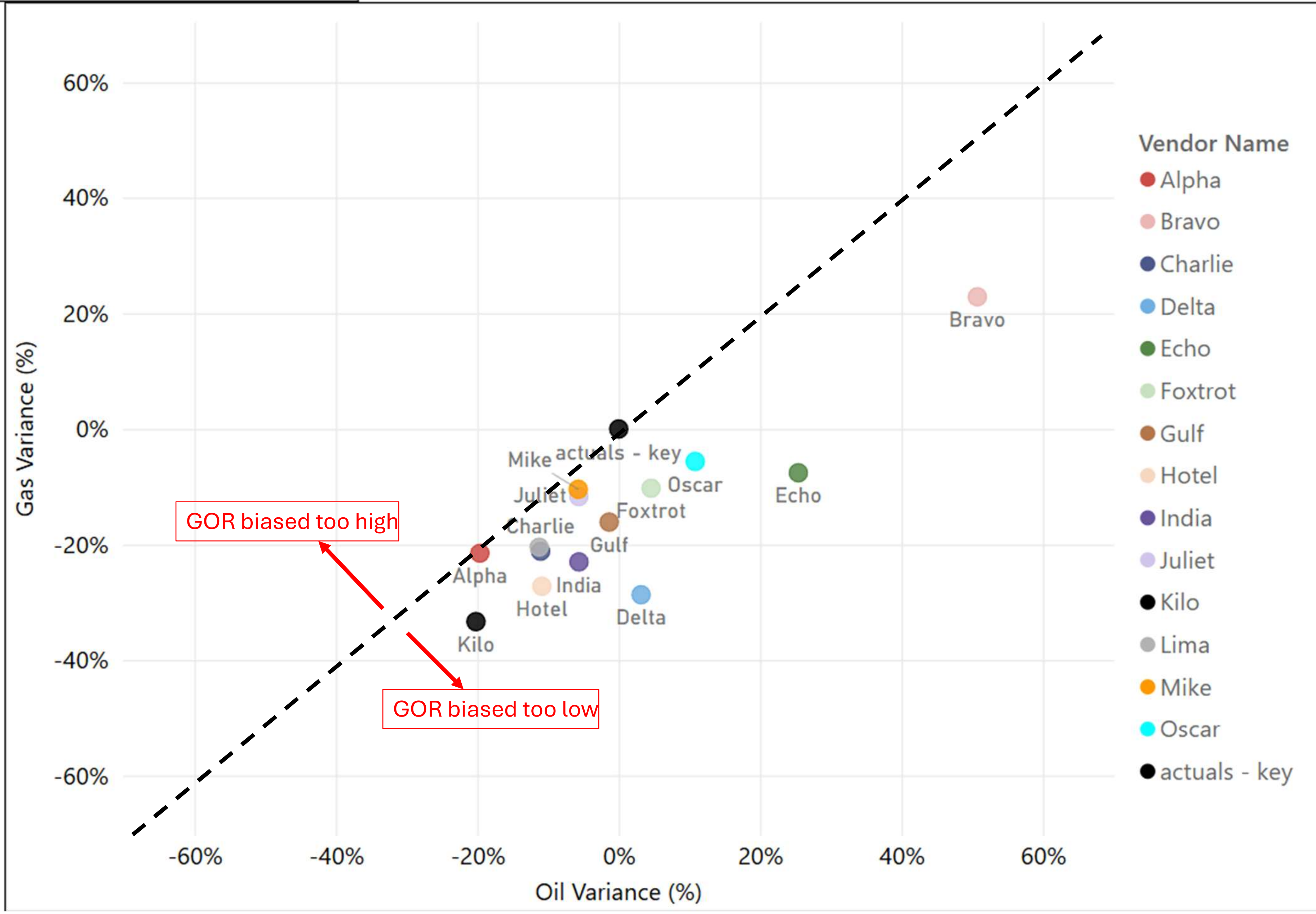
Basin	DELAWARE		DJ		EAGLE FORD		MIDLAND		SYNTHETIC		WILLISTON		**Total**	
Vendor Name	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	**Oil Vol, MMBO**	**Oil Variance, %**
Bravo	21.5	49.9%	13.5	59.7%	4.1	102.3%	19.6	65.2%	47.1	37.2%	17.3	50.0%	**123.2**	**48.8%**
Echo	19.4	36.5%	9.5	25.3%	3.9	99.8%	15.6	31.8%	41.8	42.7%	15.8	41.5%	**106.0**	**39.6%**
November	16.7	18.2%	9.8	19.3%	2.8	39.8%	15.1	27.0%	39.6	22.6%	12.5	9.8%	**96.5**	**20.8%**
Oscar	14.6	2.1%	9.5	16.3%	2.5	24.2%	14.0	17.6%	44.6	30.5%	12.4	7.4%	**97.7**	**19.2%**
Foxtrot	14.0	-2.1%	10.6	25.0%	2.3	12.1%	13.9	16.5%	34.8	3.6%	11.0	-4.8%	**86.5**	**5.6%**
Delta	13.7	-3.7%	9.8	15.7%	2.5	22.2%	13.5	13.3%	31.9	-2.2%	10.7	-7.5%	**82.0**	**1.4%**
actuals - key	14.3	0.0%	8.5	0.0%	2.0	0.0%	11.9	0.0%	36.6	0.0%	11.5	0.0%	**84.9**	**0.0%**
India	13.3	-7.5%	8.0	-1.1%	2.2	8.1%	12.2	3.1%	30.7	-1.9%	9.8	-11.4%	**76.2**	**-3.1%**
Gulf	13.7	-4.4%	9.0	6.4%	2.3	11.4%	12.9	8.3%	29.3	-8.7%	10.4	-9.5%	**77.6**	**-3.7%**
Mike	12.7	-11.6%	9.1	7.7%	2.4	18.0%	11.8	-0.4%	30.5	-8.1%	9.6	-17.1%	**76.0**	**-6.6%**
Juliet	13.2	-7.8%	8.8	4.8%	1.6	-19.2%	12.5	4.8%	27.7	-14.7%	10.4	-9.5%	**74.3**	**-8.3%**
Lima	12.1	-15.9%	8.3	-1.7%	2.2	8.4%	12.9	8.7%	25.0	-23.2%	9.6	-16.8%	**70.1**	**-13.7%**
Hotel	12.5	-12.6%	7.0	-17.0%	2.3	14.8%	11.8	-0.4%	25.7	-21.2%	9.1	-21.3%	**68.6**	**-15.6%**
Charlie	13.5	-5.7%	7.7	-5.0%	1.9	-9.0%	11.8	-1.1%	20.1	-29.6%	9.6	-17.0%	**64.5**	**-16.9%**
Alpha	11.0	-23.5%	5.0	-41.0%	1.9	-8.7%	12.0	1.1%	25.3	-22.5%	8.1	-29.7%	**63.2**	**-21.8%**
Kilo	10.8	-24.7%	8.0	-5.9%	2.3	10.4%	9.5	-19.7%	23.0	-28.8%	8.0	-31.0%	**61.5**	**-23.9%**

Oil Well Volume Cross-plot

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to black/volatile oil wells with 1st three month GOR <3,200 cf/bo

Basin

All

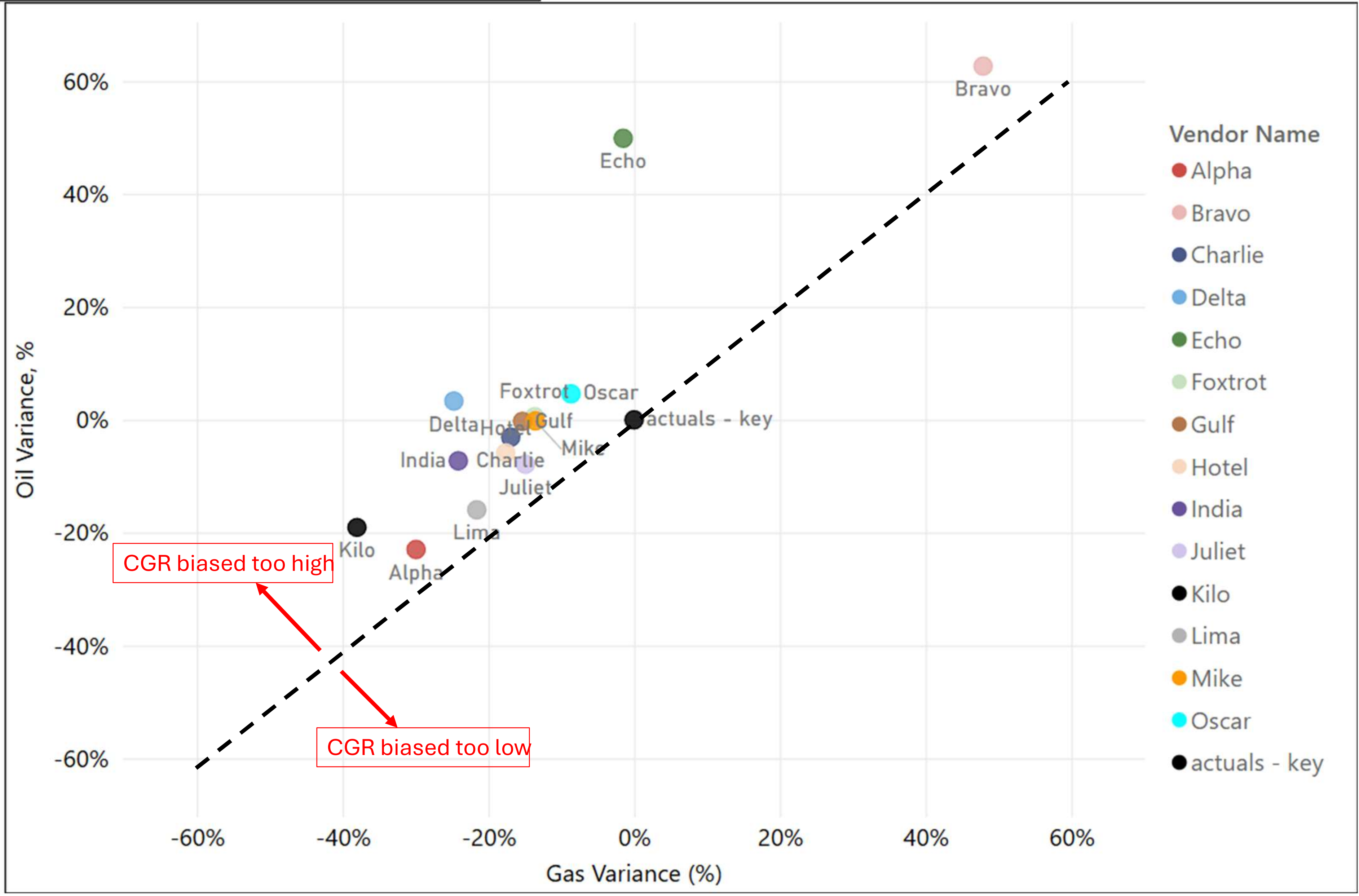


Gas Well Volume Cross-plot

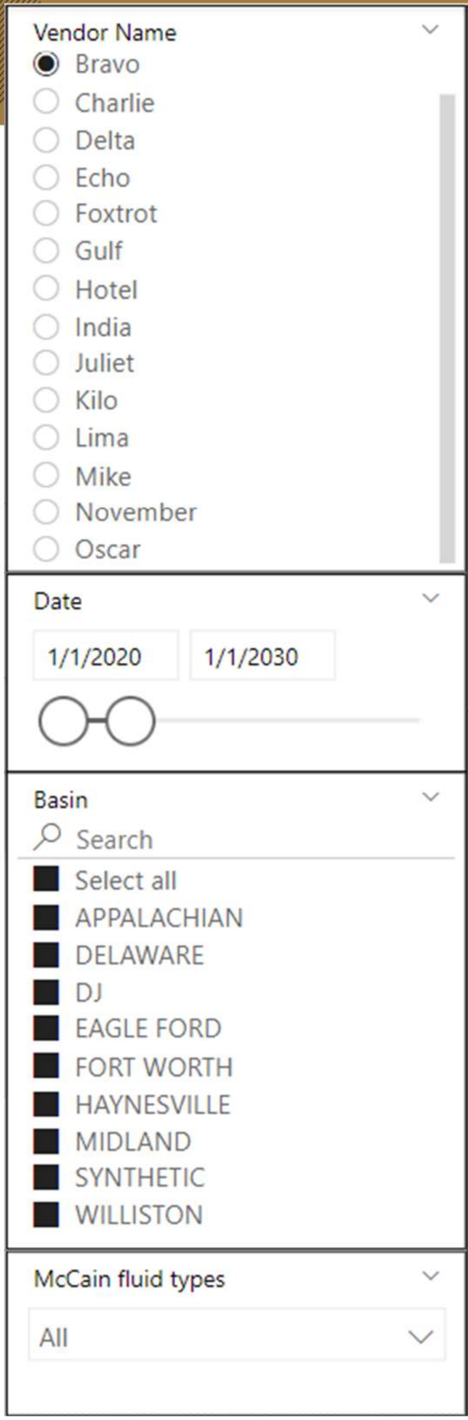
- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to gas condensate / wet gas / dry gas wells with 1st three month GOR >3,200 cf/bo
- Filtered out gas basins due to lack of oil

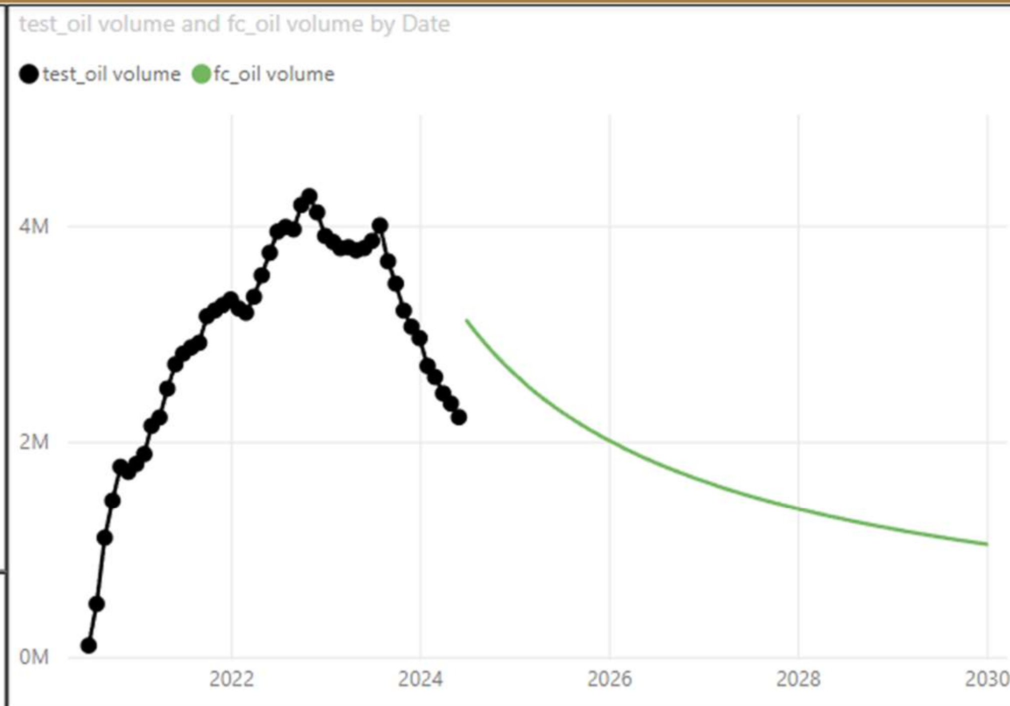
Basin

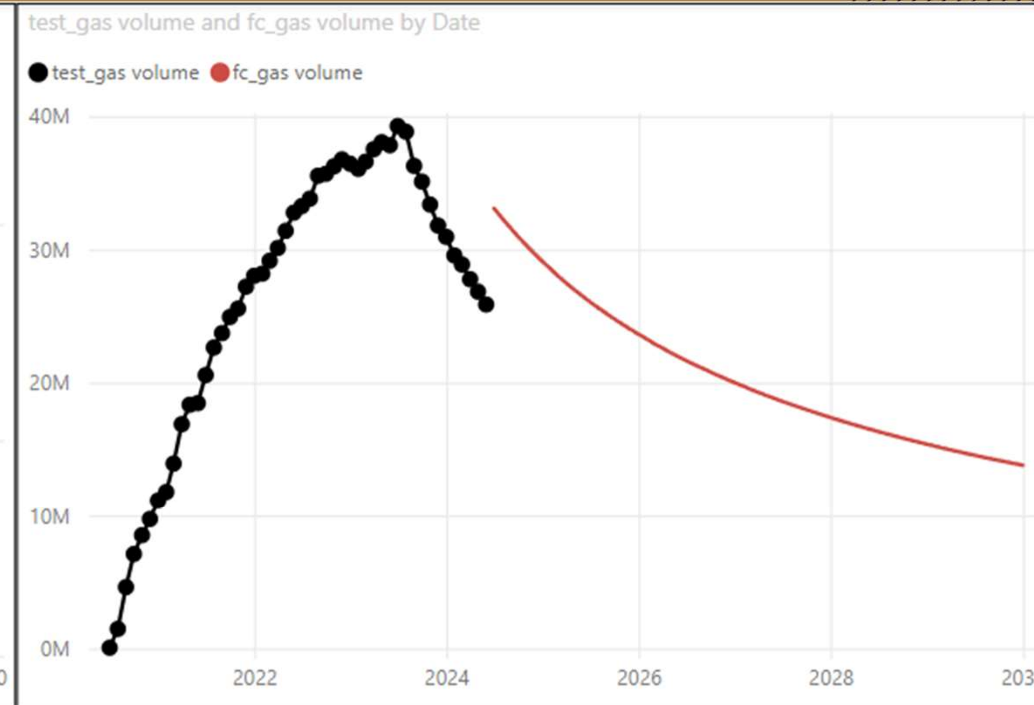
All

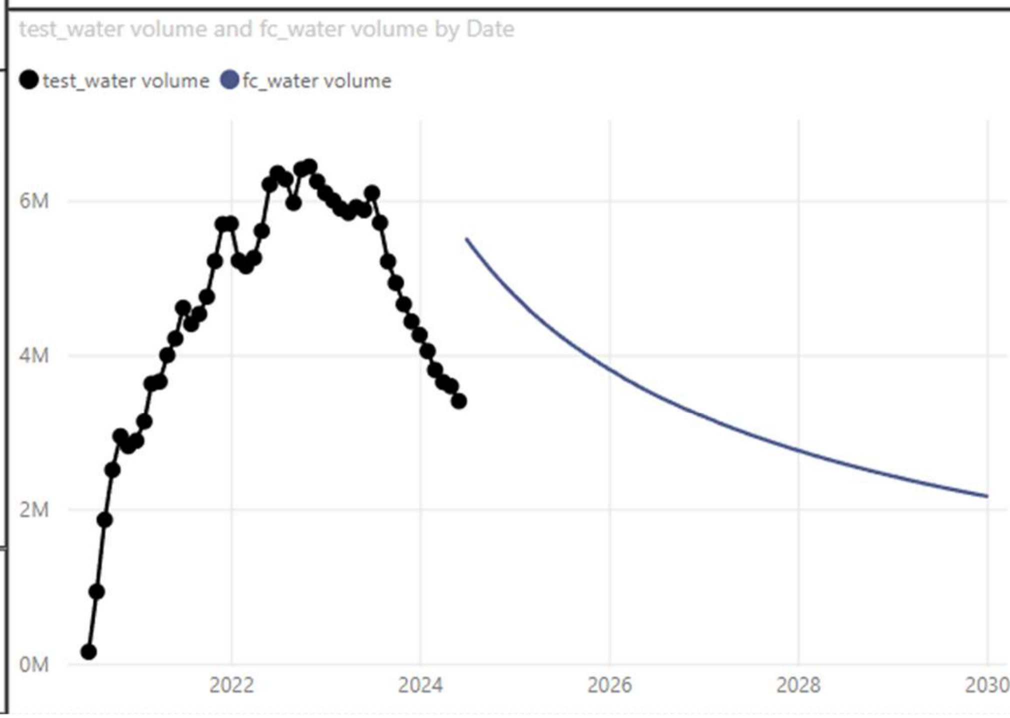


Entrance Rates drive the bus – why Bravo is optimistic



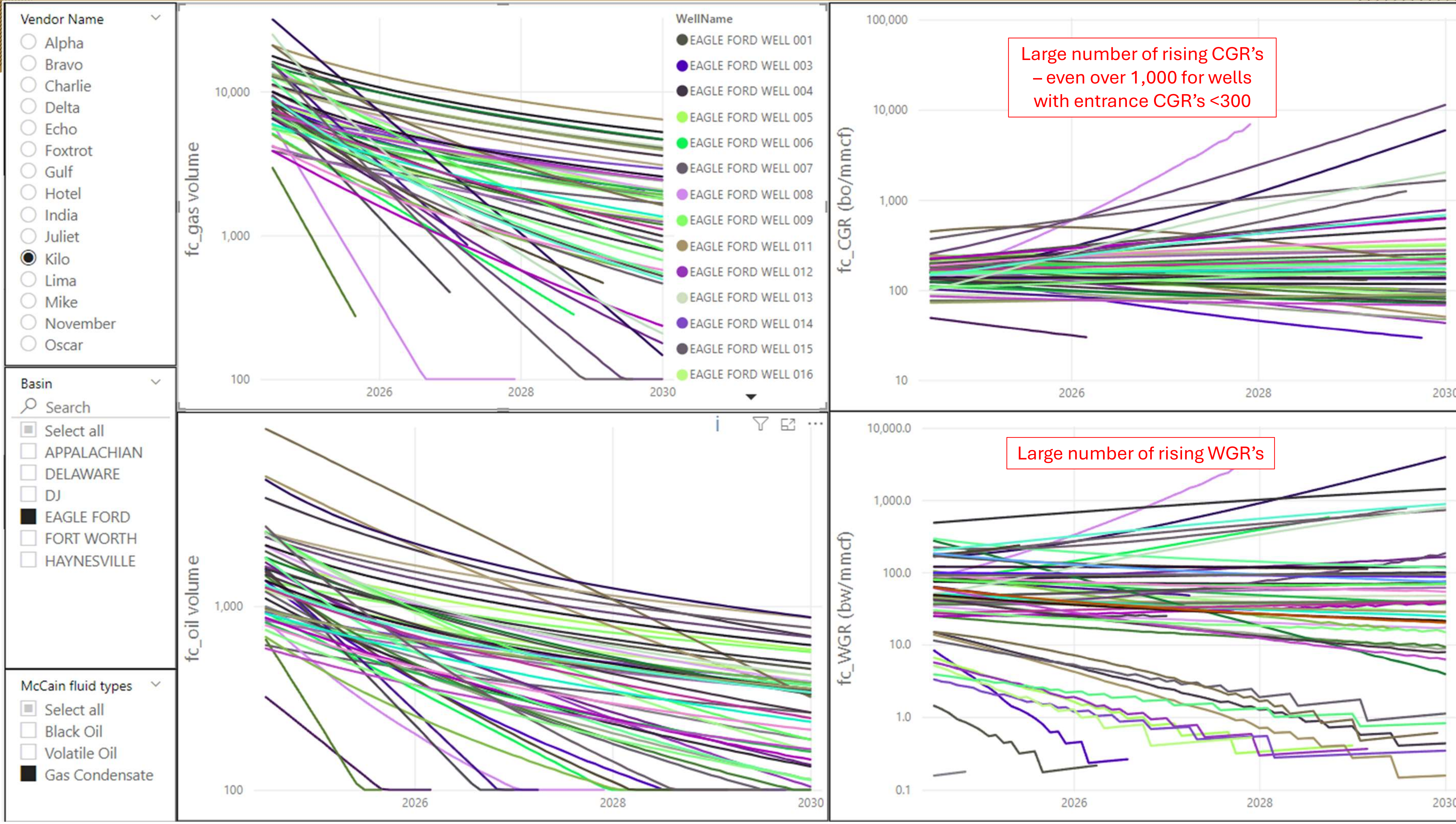






Date	test_oil volume	fc_oil volume	test_gas volume	fc_gas volume	test_water volume	fc_water volume
04/01/24	2,445,882		27,764,506		3,646,254	
05/01/24	2,351,937		26,827,123		3,592,018	
06/01/24	2,225,945		25,867,862		3,399,544	
07/01/24		3,119,863		33,084,524		5,494,465
08/01/24		3,024,070		32,334,161		5,355,486
09/01/24		2,934,581		31,622,011		5,224,782
Total	**7,023,764**	**9,078,514**	**80,459,491**	**97,040,696**	**10,637,816**	**16,074,733**

Gas Wells Example: Kilo Eagle Ford with rising CGR's and WGR's



Oil Wells Example: Oscar DJ Well

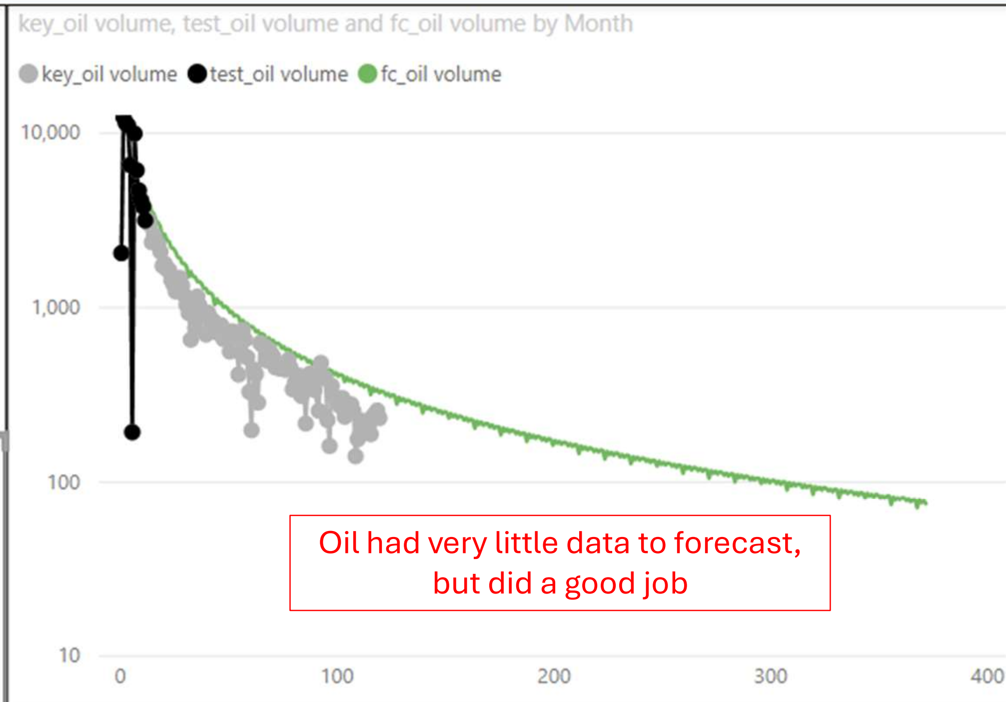
Vendor Name

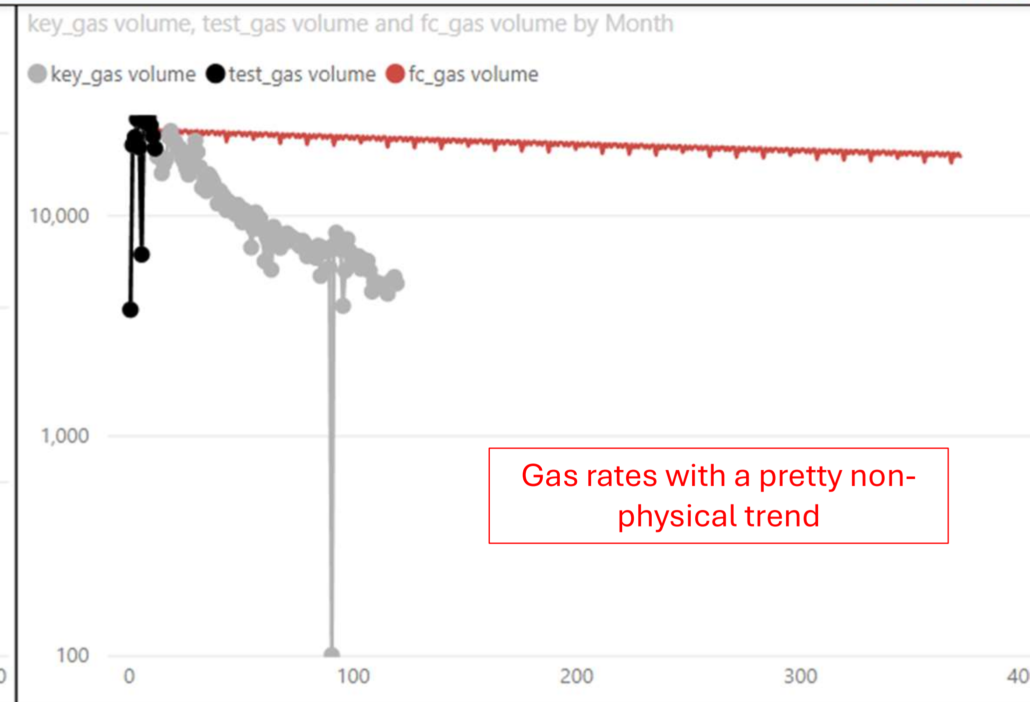
- November
- Oscar
- SPEE_01
- SPEE_02
- SPEE_03
- SPEE_04
- SPEE_05
- SPEE_06
- actuals - key
- actuals - test

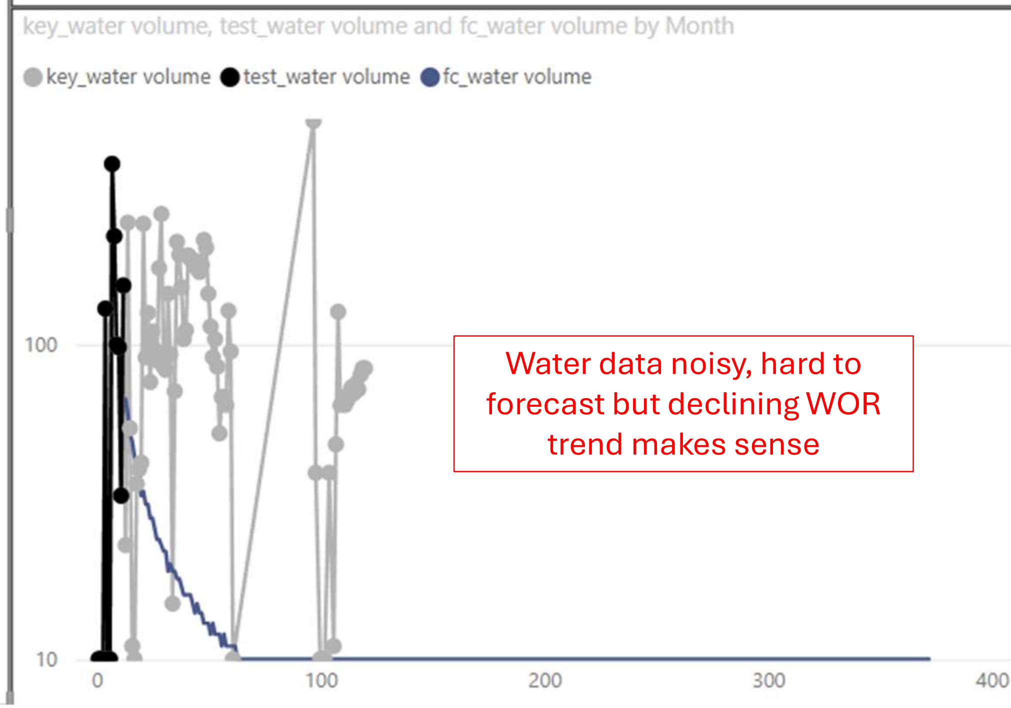
WellName

djwell 052

- DJWell 052





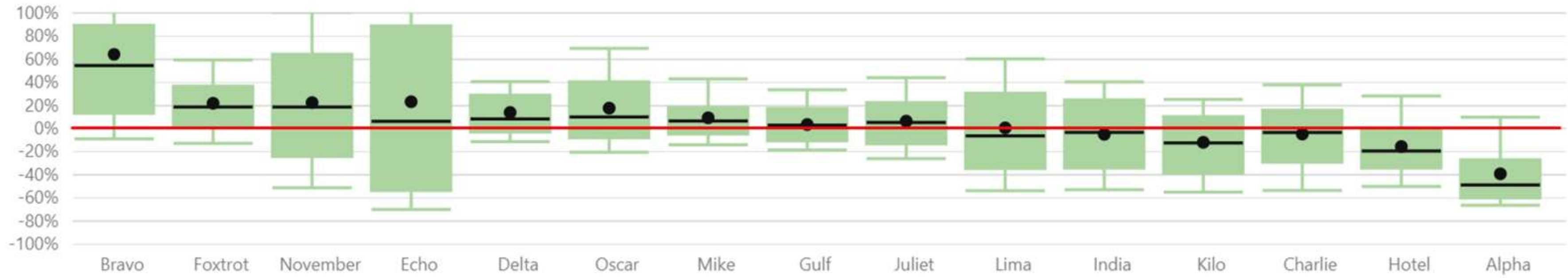


API14	Data Source	Monthly Production Date	Calendar Months Online	Monthly Oil	Monthly Gas	Monthly Water
05123990520000	Oscar	7/1/2024	13	4,143	24,346	67
05123990520000	Oscar	8/1/2024	14	3,864	24,325	60
05123990520000	Oscar	9/1/2024	15	3,503	23,521	52
05123990520000	Oscar	10/1/2024	16	3,402	24,285	49
05123990520000	Oscar	11/1/2024	17	3,102	23,483	44
05123990520000	Oscar	12/1/2024	18	3,029	24,246	42
05123990520000	Oscar	1/1/2025	19	2,865	24,225	39
05123990520000	Oscar	2/1/2025	20	2,460	21,864	33
05123990520000	Oscar	3/1/2025	21	2,594	24,187	34
05123990520000	Oscar	4/1/2025	22	2,391	23,388	31
05123990520000	Oscar	5/1/2025	23	2,358	24,148	31
05123990520000	Oscar	6/1/2025	24	2,180	23,350	28
05123990520000	Oscar	7/1/2025	25	2,156	24,108	28
05123990520000	Oscar	8/1/2025	26	2,065	24,088	26
05123990520000	Oscar	9/1/2025	27	1,918	23,293	24
05123990520000	Oscar	10/1/2025	28	1,905	24,049	24
05123990520000	Oscar	11/1/2025	29	1,773	23,255	23
05123990520000	Oscar	12/1/2025	30	1,764	24,010	22

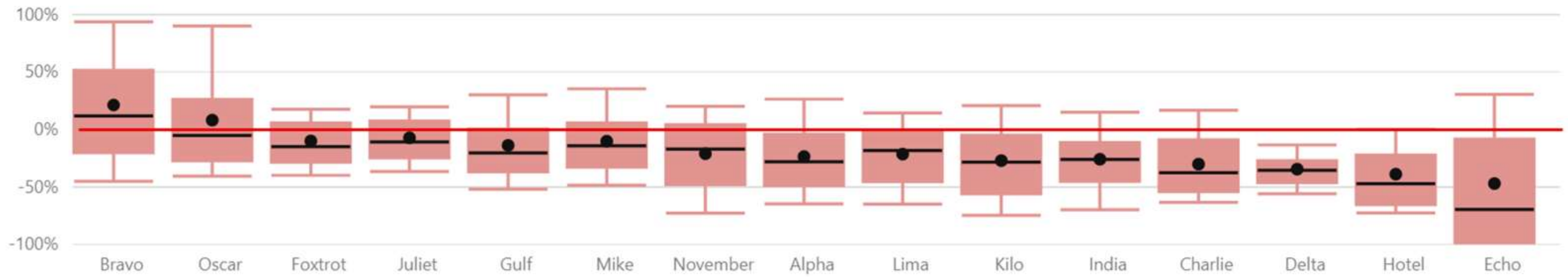
OWG Variance

	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Gulf	Hotel	India	Juliet	Kilo	Lima	Mike	November	Oscar
oil variance, %	-38.9%	60.5%	-9.0%	14.7%	15.4%	23.9%	5.8%	-16.0%	-5.1%	4.5%	-7.0%	-1.1%	7.3%	15.8%	12.6%
gas variance, %	-26.6%	9.5%	-34.6%	-38.2%	-57.4%	-12.1%	-17.1%	-42.5%	-29.8%	-13.3%	-29.7%	-26.8%	-19.4%	-26.4%	3.4%
water variance, %	-45.4%	-35.3%	-17.7%	-18.6%	231.0%	287478.0%	-33.6%	-48.2%	-57.4%	-12.5%	-75.9%	-32.5%	-51.7%	-29.0%	-7.6%

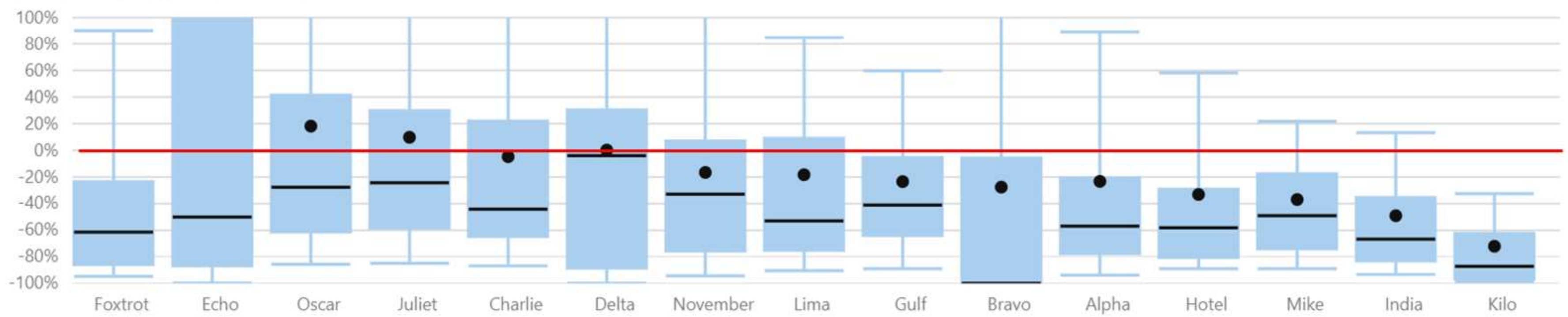
oil variance, % and oil variance, % by Vendor Name and WellName



gas variance, % by Vendor Name and WellName



water variance, % by Vendor Name and WellName



DJ Basin Example

Oil Primary Phase much closer forecast than secondary phases by most vendors

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Short vs Long History

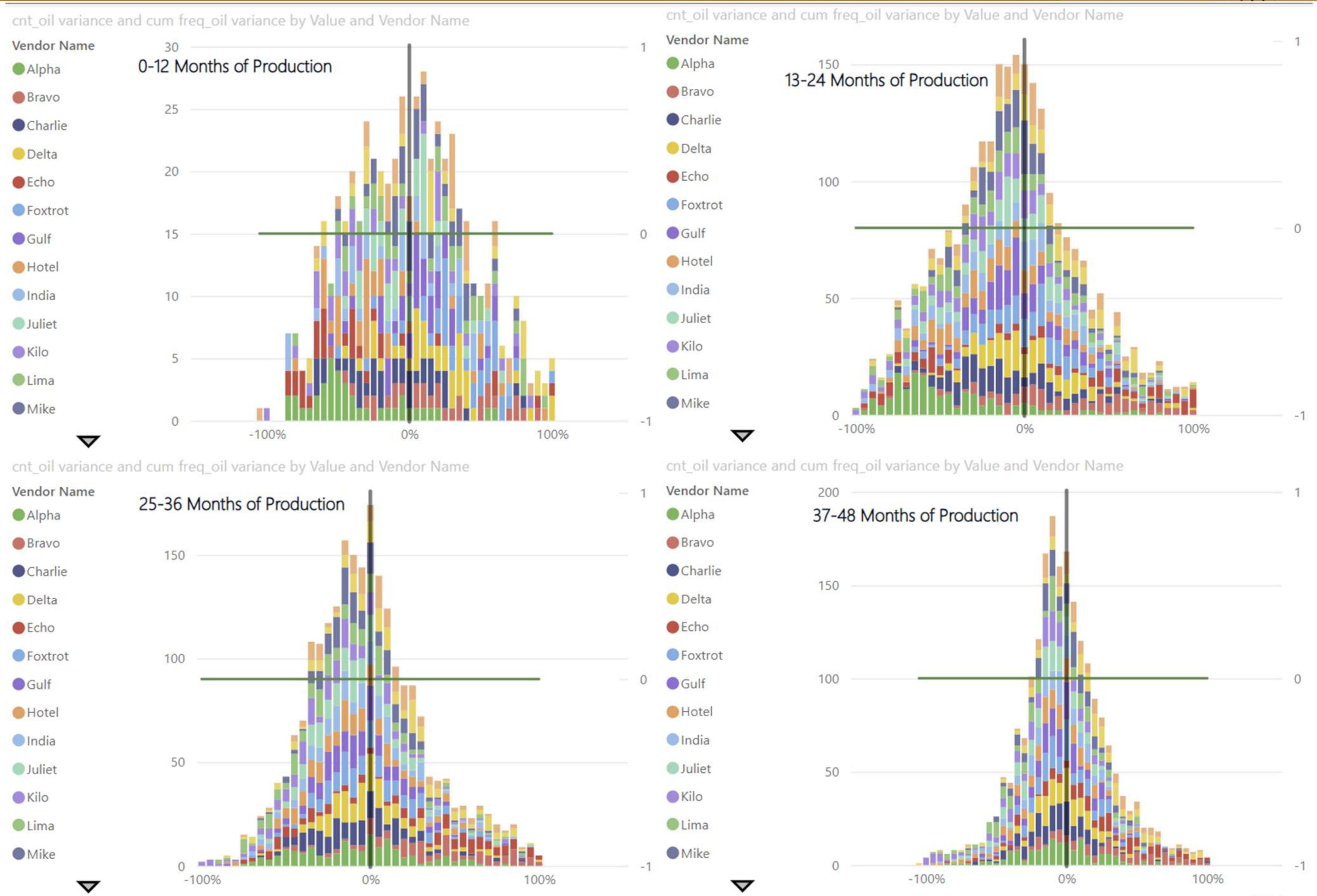
Conclusions are Mixed

- On one hand, results became more reliable with a longer production history
  - Mean variability trending towards 0% when auto-forecasting with three to four years of production history
  - Distribution of results becomes much “cleaner” with more production history, and most results are +/- 10% of the key
- On the other hand, there is still a lot of variability in the results
  - Wide variance from play to play and from vendor to vendor
  - Outlier events **widen** with a longer production history

Oil - Variance Tightens

- Plots show variance of oil with different production histories

- Distribution becomes tighter and more normal when more production history is used for forecasting



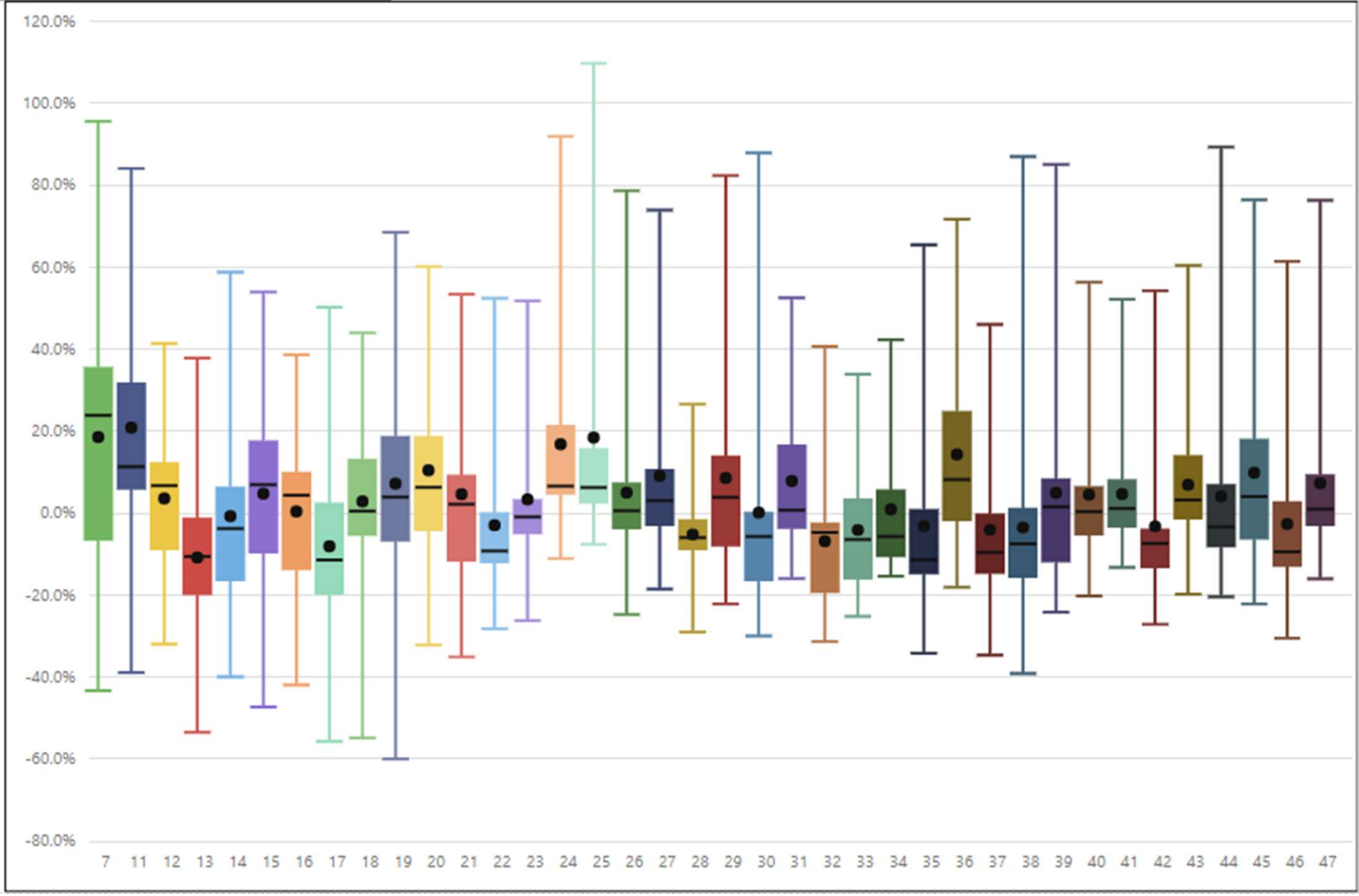
Oil Well Volume Box and Whisker

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to Black Oil and Volatile Oil wells with 1st three month GO <3,200 cf/bo
- Filtered out Synthetic due to all vendors being pessimistic, gas basins due to lack of oil

Basin

Multiple selections

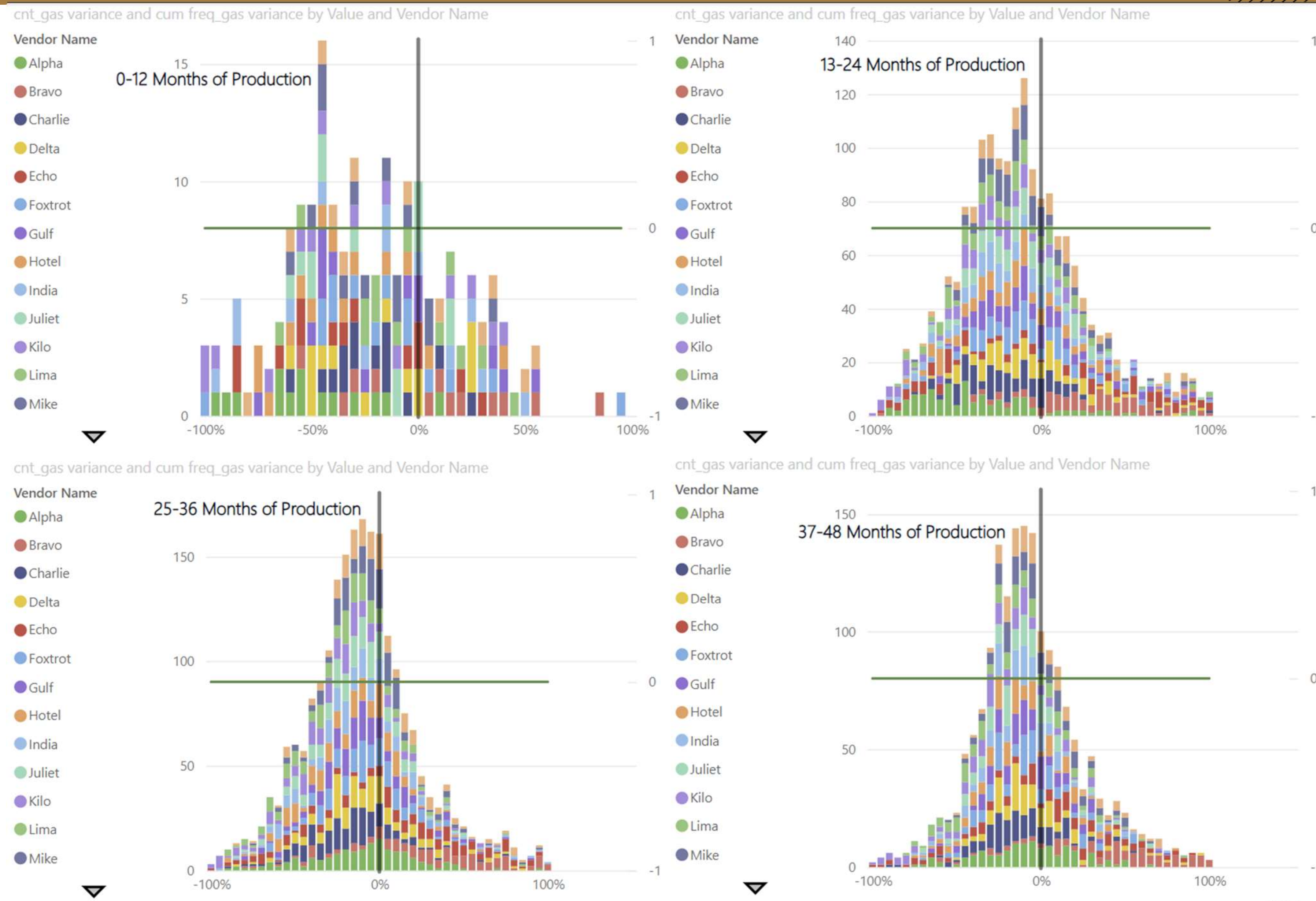
Overall range of variance **stays the same** with more production history, but the results are more concentrated



Gas - Variance Tightens

- Plots show variance of gas with different production histories

- Distribution becomes tighter and more normal when more production history is used for forecasting



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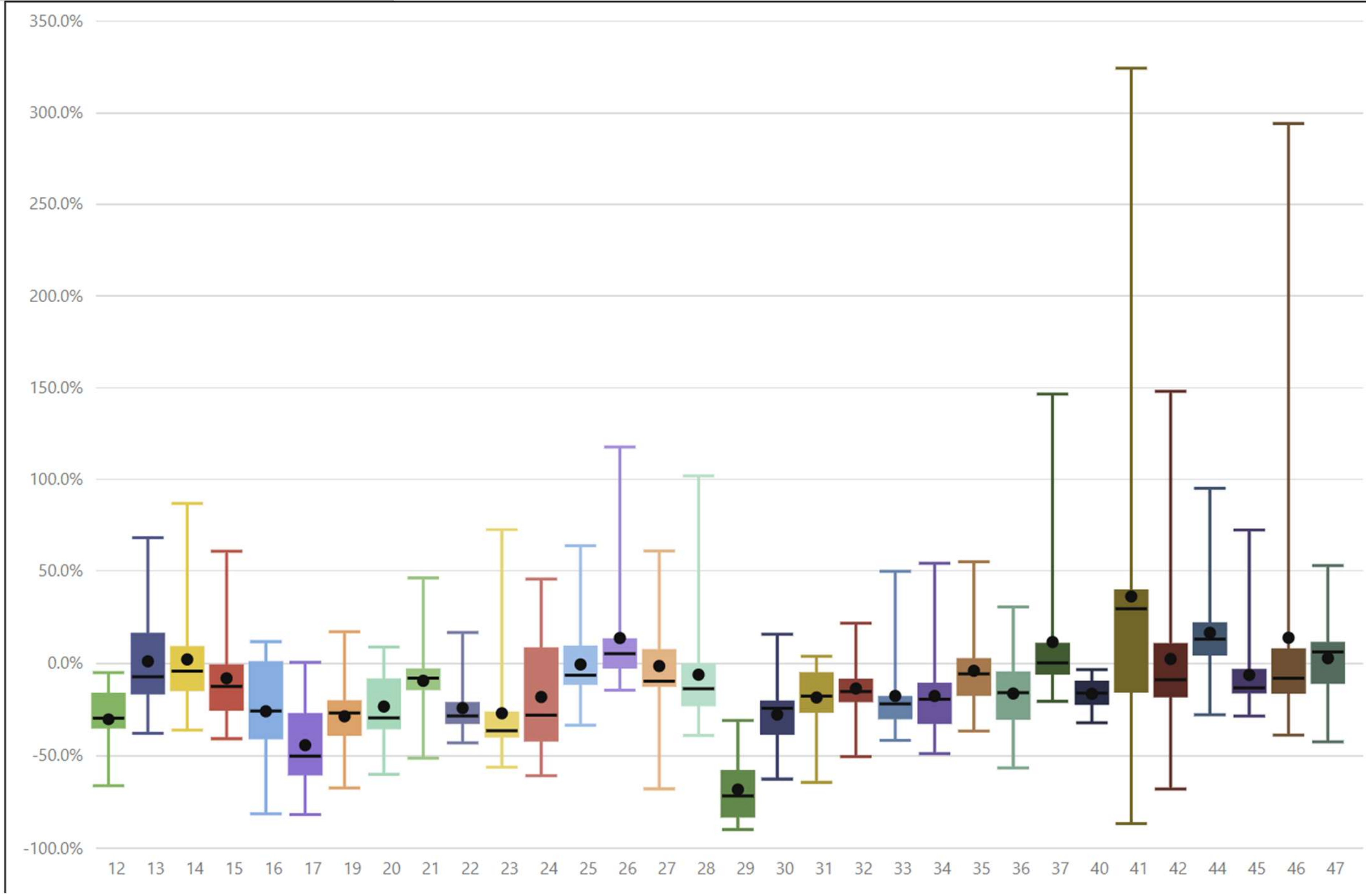
Gas Well Volume Box and Whisker Plot

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to gas condensate / wet gas / dry gas wells with 1st three month GO >3.200 cf/bo
- Filtered out Synthetic due to all vendors being pessimistic, gas basins due to lack of oil

Basin

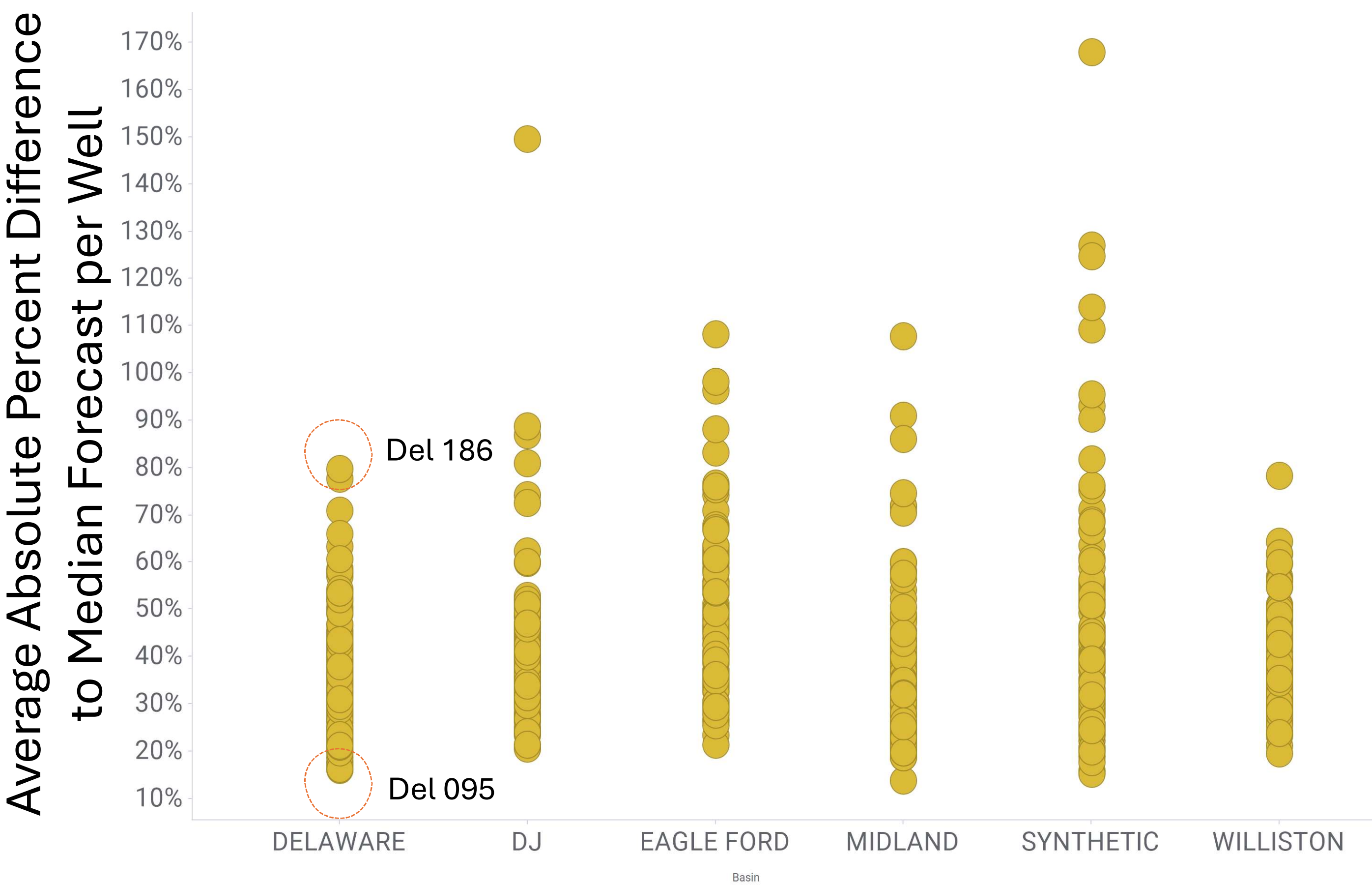
Multiple selections

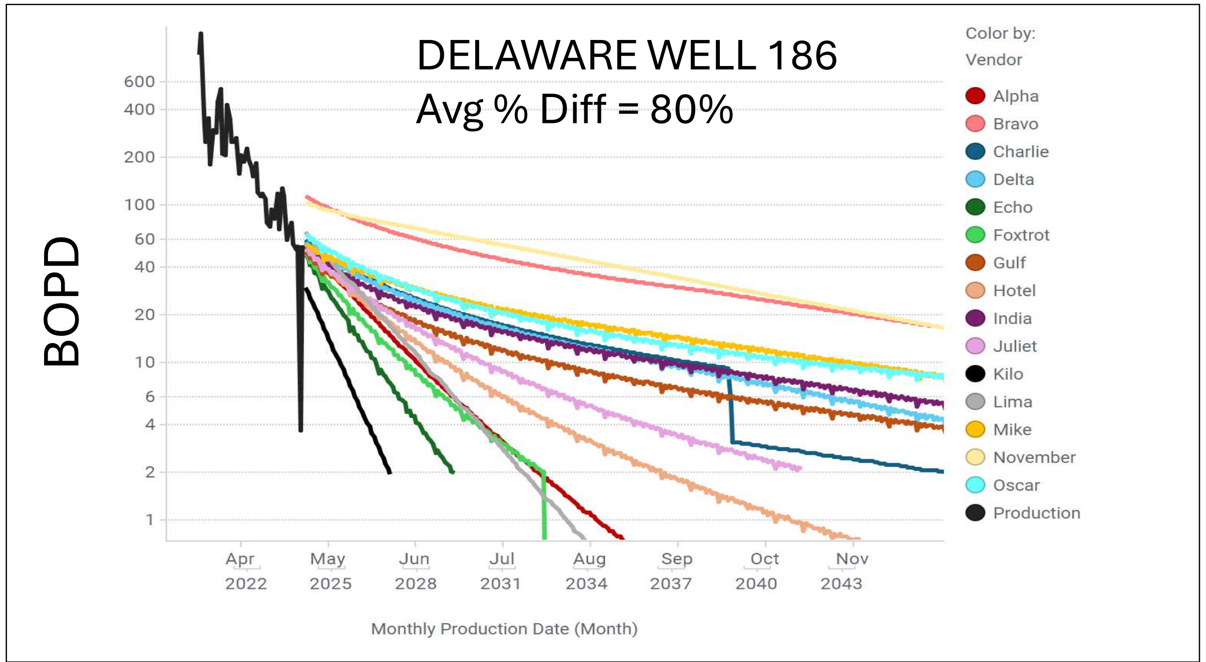
Overall range of variance **gets larger** with more production history, but the results are more concentrated

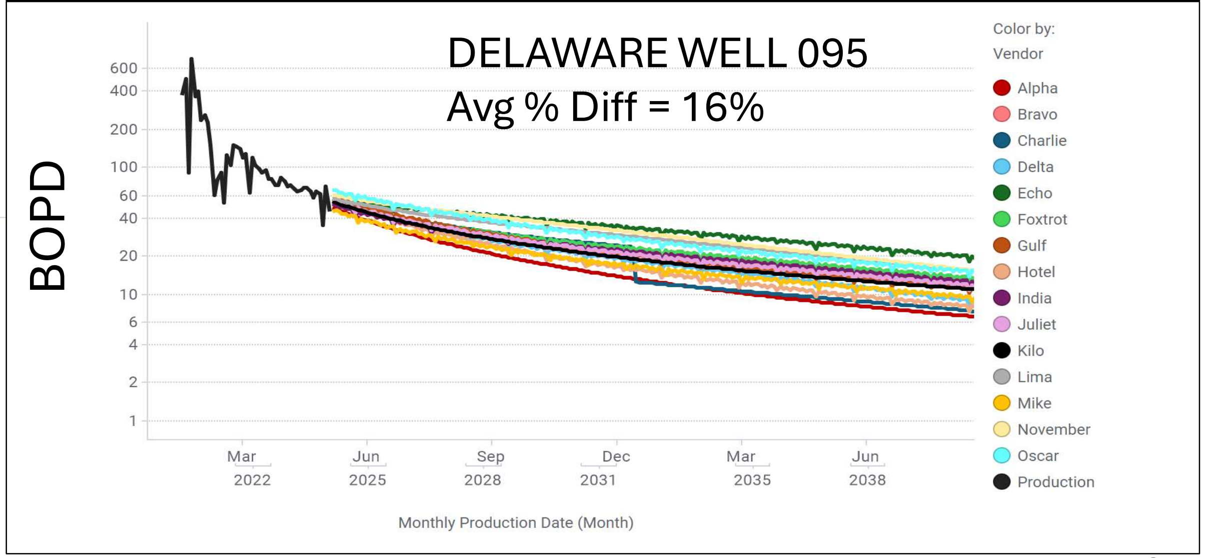


EUR Variability

Variability Examples



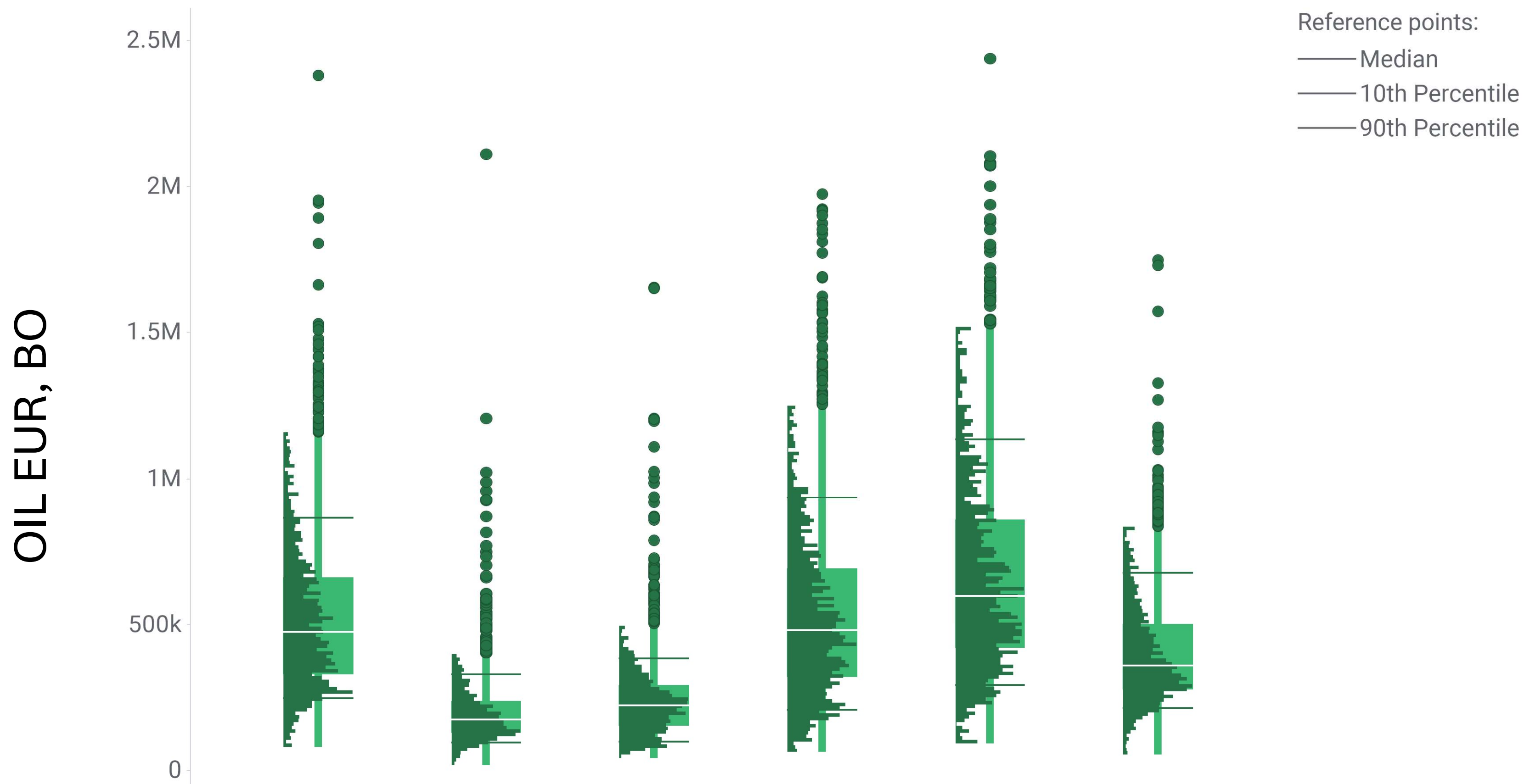




- “Noisiness” of the production data will have the most impact on forecast variation

EUR Variability

Certain basins have more uniform distribution of forecast volumes



	DELAWARE	DJ	EAGLE FORD	MIDLAND	SYNTHETIC	WILLISTON
Count	2130	1799	1380	1500	1500	1499
Median	475836	175053	223115	480139	599040	359867
Outliers	53	80	60	47	37	57
StdDev	262859	119883	146134	308830	362052	196689

Basin

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Consistent Error by Vendor

Avg Perc Err per Basin and Vendor

(Column Names)	Basin	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Gulf	Hotel	India	Juliet	Kilo	Lima	Mike	November	Oscar	Grand total
Avg Perc Err	DELAWARE	-18%	63%	-9%	-6%	72%	4%	-5%	-10%	-2%	-3%	-26%	-7%	2%	38%	18%	7%
	DJ	-47%	77%	-19%	13%	45%	26%	1%	-22%	-9%	12%	-19%	4%	15%	28%	32%	9%
	EAGLE FORD	-22%	100%	-24%	20%	114%	5%	12%	-7%	1%	-29%	-10%	-27%	29%	29%	43%	16%
	MIDLAND	-10%	76%	-14%	8%	37%	15%	-3%	-21%	6%	-2%	-38%	5%	-2%	39%	34%	9%
	SYNTHETIC	-18%	87%	-22%	19%	36%	23%	3%	-17%	0%	0%	-25%	-26%	15%	37%	62%	12%
	WILLISTON	-18%	82%	-16%	1%	96%	12%	1%	-19%	0%	5%	-24%	-12%	-11%	30%	37%	11%
Grand total		-23%	79%	-17%	8%	66%	14%	1%	-16%	-1%	-2%	-24%	-10%	8%	34%	36%	10%

Data table:
ForecastOneline Wi...
Colors:
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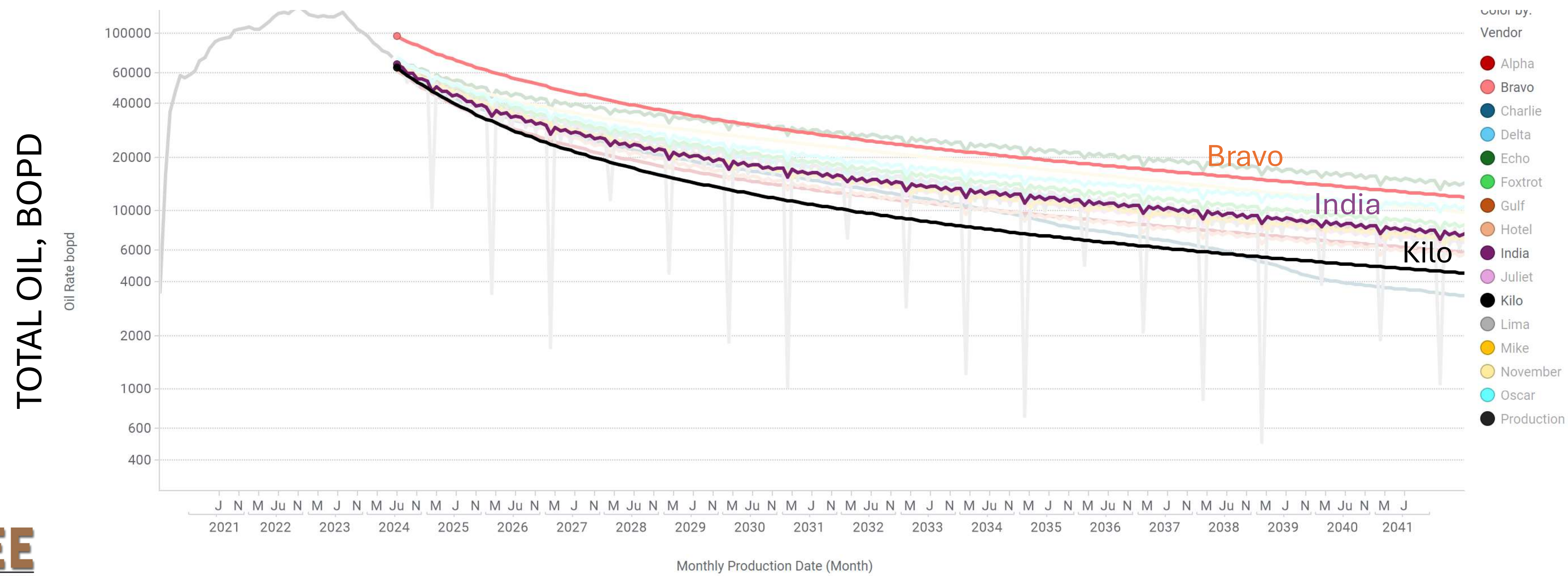
0
-1



Error Reduced with Review

Percent Error from Median By Automation Amount

Basin	All auto	Mostly auto	Half auto	Mostly manual
	Autofcst Amount			
DELAWARE	17%	1%	-4%	-3%
DJ	13%	9%	-4%	12%
EAGLE FORD	28%	9%	11%	-29%
MIDLAND	15%	10%	-12%	-2%
SYNTHETIC	14%	17%	-1%	0%
WILLISTON	22%	7%	-15%	5%

Percent Error from Median By Forecast Review Amount

Basin	None	Some	Half	Most	All
	Review Amount				
DELAWARE	34%	14%	-4%	-9%	-6%
DJ	23%	20%	-4%	-19%	-1%
EAGLE FORD	63%	31%	11%	-24%	-18%
MIDLAND	17%	21%	-12%	-14%	2%
SYNTHETIC	20%	30%	-1%	-22%	-5%
WILLISTON	48%	21%	-15%	-16%	-3%

Colors:
- 1
- 0
- -1

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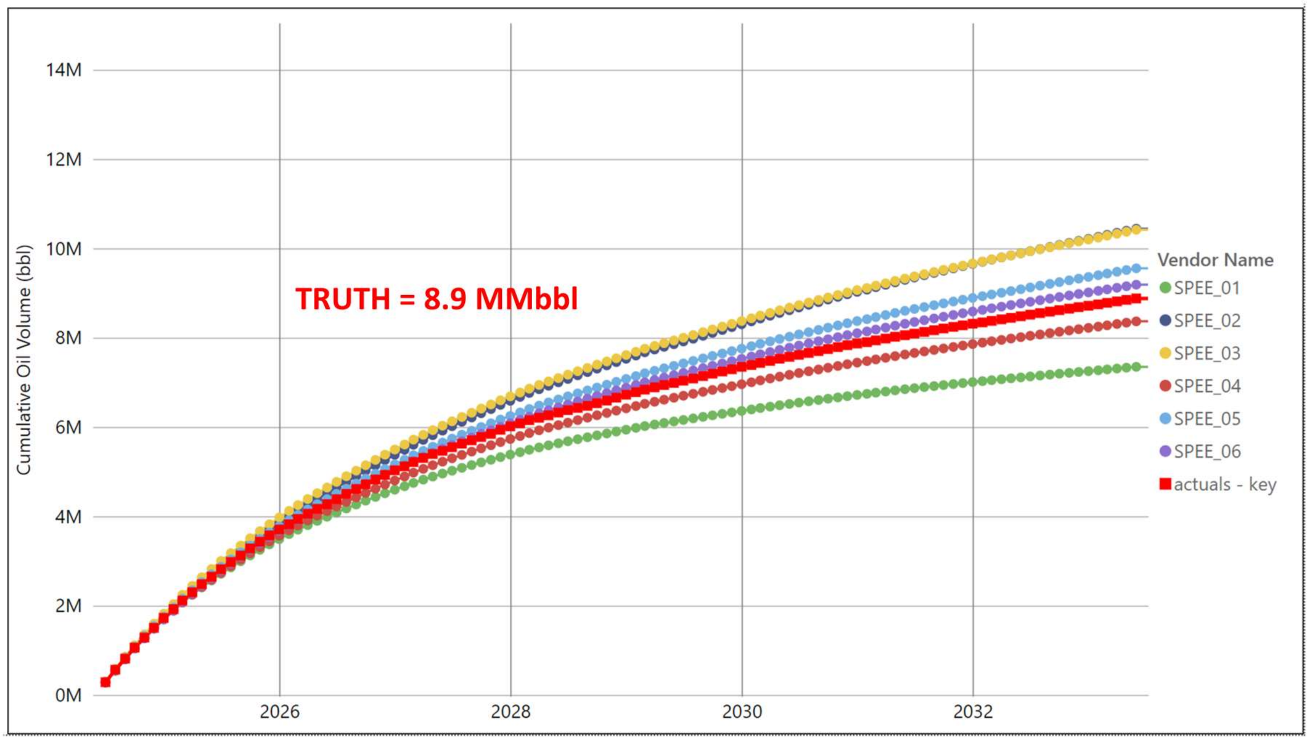
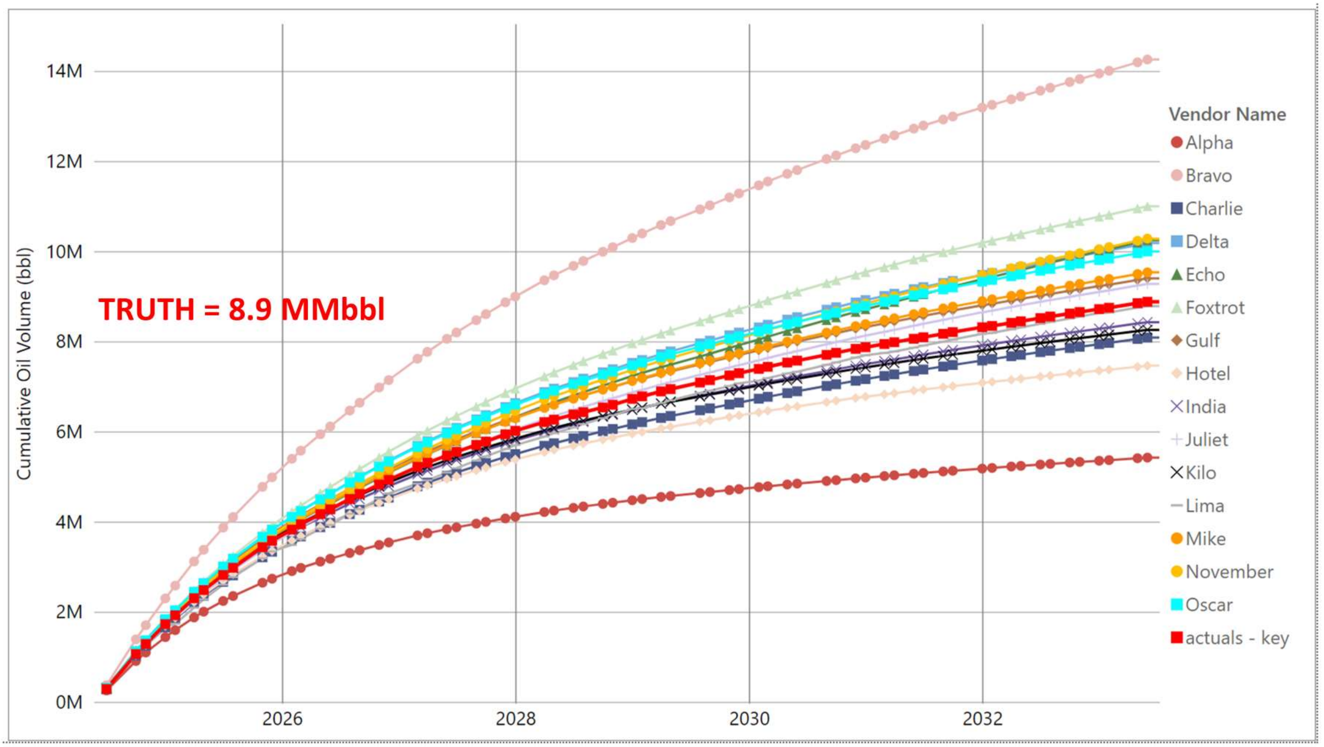
Human vs Machine

DJ Basin Example

Human



Machine



- DJ Basin wells were hand forecasted and compared to machine forecasted
- Best machines were comparable to the best humans
- Worst machines were much worse than the worst humans

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ANALYSIS CONCLUSIONS

Automated forecasting is getting better steadily. Engineering judgement is still required, but software comfort factor is increasing.

Some basins and reservoirs are more homogeneous in forecast shape. Less variability leads to better agreement in software forecasting.

Longer periods of historical production reduce the error in forecasting. However recent operational upsets drive large forecast variations by vendor.

Primary phase forecasts with larger errors tends to underpredict actual production. Secondary forecasts tend to be too low on oil wells and too high on gas wells.

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INDUSTRY CONCLUSIONS

- Sweet spot between speed and accuracy. Current need is heavier focus on accuracy.
- General areas for improvement:
    - Short histories
    - Operational upsets
    - B factor consistency
    - Secondary products

- The software vendors participating in the 2024 Software Symposium have helped create a tremendous dataset worth additional time and resources to study.
- The evaluation continues and look for presentations at future SPEE Chapter road show luncheons and the 2025 SPEE Annual Meeting in Hilton Head, SC.

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Next Steps

- The software vendors participating in the 2024 Software Symposium have helped create a tremendous dataset that warrants additional time and resources to study
- Plan to present a workshop at the 2025 SPEE Conference in Hilton Head, SC June 7-10
- More to come!

Questions

If you want to help in 2026, email symposium@spee.org

Backup Slides

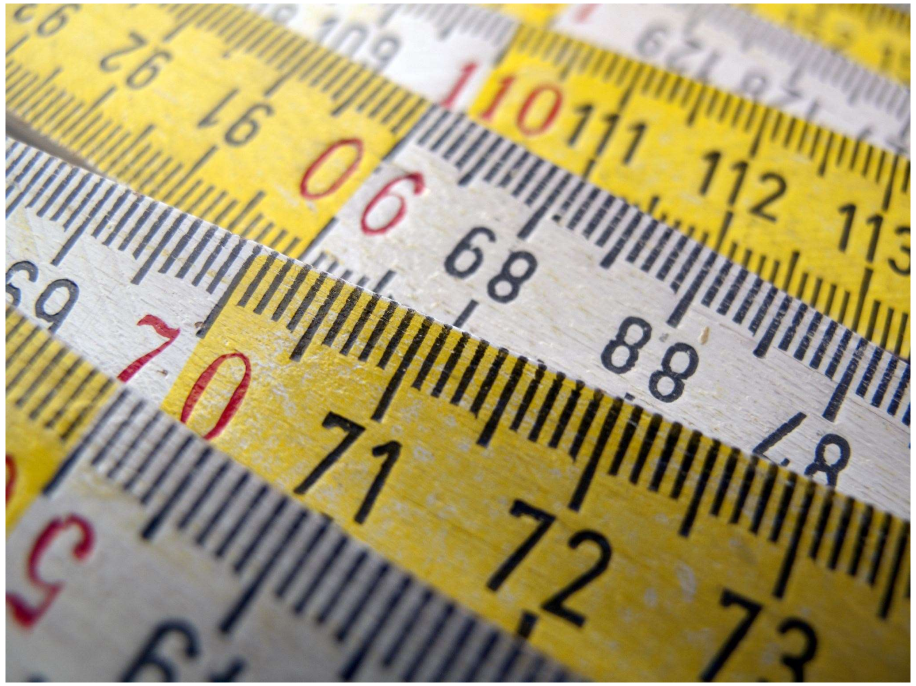
Problem Statement

Set up like the first pass of a data room evaluation

- Forecast 1000 wells
- Production and well header data provided
- Time limit of 12 hours
- Well specifics are unknown ahead of time

Certain parameters defined for consistent analysis

- Sample files of header and production format provided
- Sample file of output format provided
- Common cutoff of 60 bopm or 30 years
- If used, select common minimum decline of 6%



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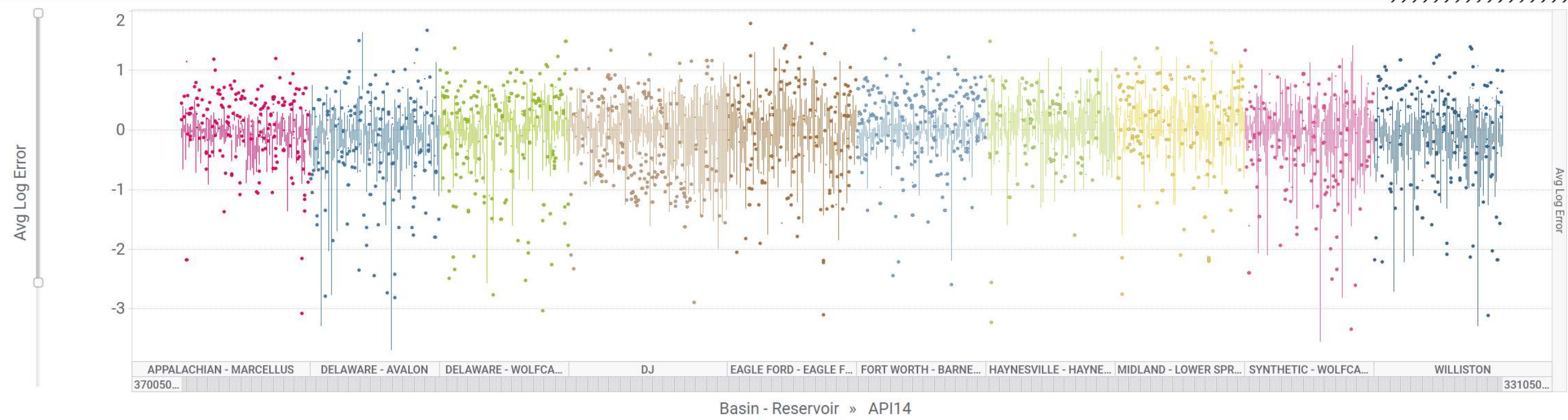
Well



2
1
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-1
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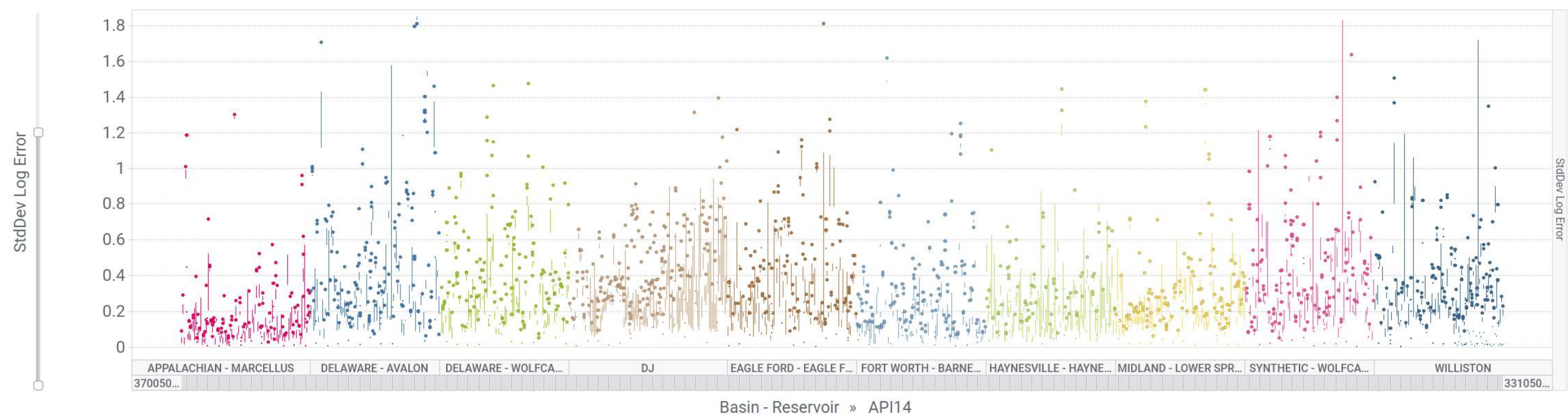
Avg Log Error
APPALACHIAN - MARCELLUS
DELAWARE - AVALON
DELAWARE - WOLFCA...
DJ
EAGLE FORD - EAGLE F...
FORT WORTH - BARNE...
HAYNESVILLE - HAYNE...
MIDLAND - LOWER SPR...
SYNTHETIC - WOLFCA...
WILLISTON
370050...
331050...
Basin - Reservoir » API14



1.8
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StdDev Log Error
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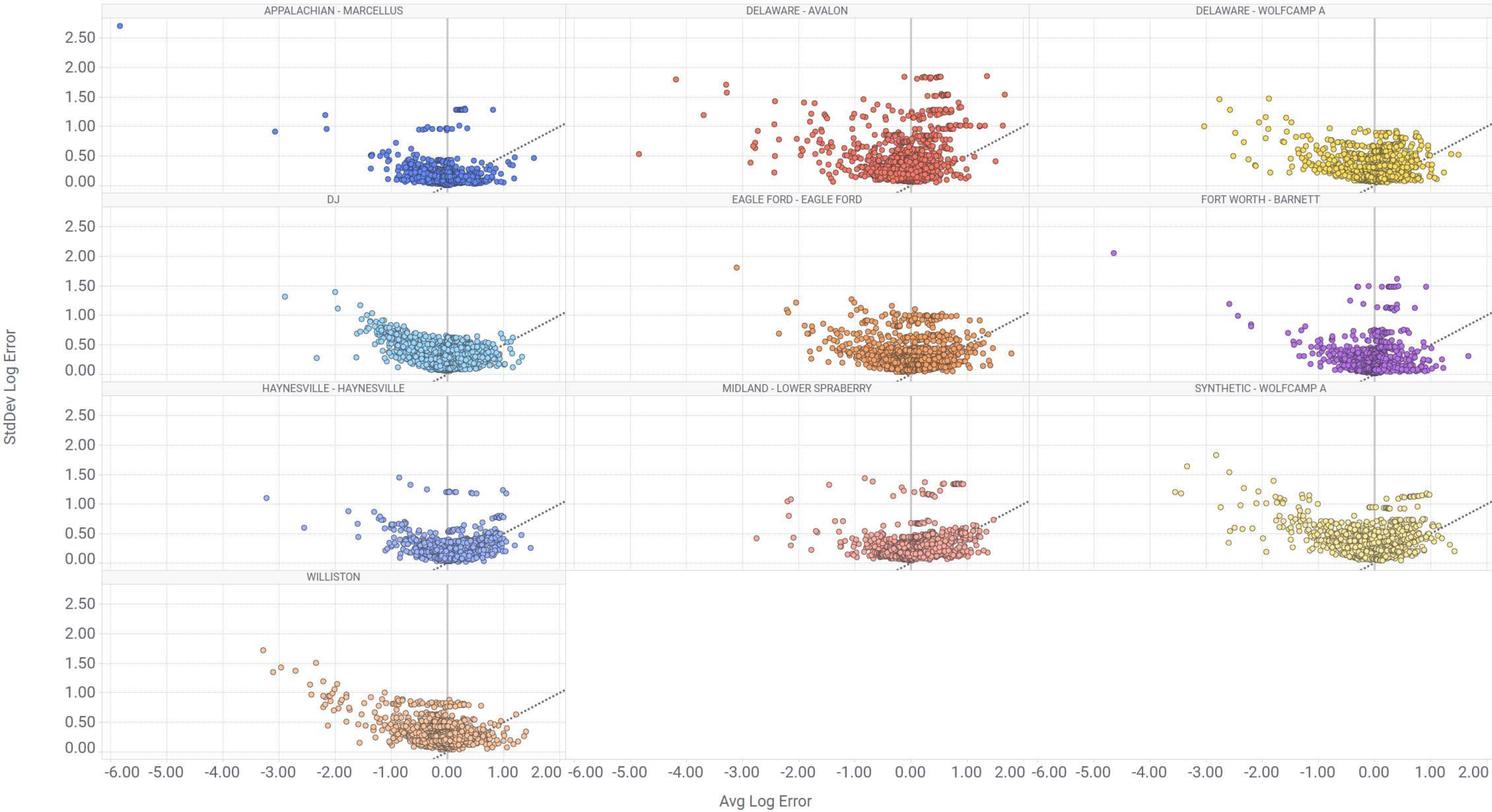
DELAWARE - AVALON
DELAWARE - WOLFCA...
DJ
EAGLE FORD - EAGLE F...
FORT WORTH - BARNE...
HAYNESVILLE - HAYNE...
MIDLAND - LOWER SPR...
SYNTHETIC - WOLFCA...
WILLISTON
370050...
331050...
Basin - Reservoir » API14

Bias vs. Variance



Gas Volume Variance for Oil Wells

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to black/volatile wells with 1st three month GOR <3.200 cf/bo

Observations:

- Participants generally too pessimistic about all basins
- Bravo > 15% optimistic
- Twelve vendors >15% too pessimistic

Basin	DELAWARE		DJ		EAGLE FORD		MIDLAND		SYNTHETIC		WILLISTON		**Total**	
Vendor Name	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	**Gas Vol, BCF**	**Gas Variance, %**
Bravo	144.2	25.3%	106.2	10.8%	16.2	99.3%	42.6	16.4%	155.2	2.5%	63.1	56.8%	**527.6**	**17.1%**
actuals - key	115.0	0.0%	95.9	0.0%	8.1	0.0%	36.6	0.0%	175.3	0.0%	40.3	0.0%	**471.2**	**0.0%**
Echo	114.1	0.3%	40.4	-38.9%	10.9	40.8%	36.4	1.4%	123.9	7.4%	39.6	3.7%	**365.3**	**-4.0%**
Oscar	107.8	-6.3%	100.7	7.8%	8.7	7.1%	31.6	-13.5%	134.0	-9.1%	36.7	-8.8%	**419.5**	**-5.0%**
Foxtrot	104.6	-7.4%	85.1	-11.2%	8.0	-2.0%	34.6	-5.3%	111.8	-22.1%	29.8	-26.1%	**373.9**	**-15.0%**
November	105.5	-7.8%	70.9	-20.5%	10.2	26.5%	26.8	-26.8%	103.4	-18.8%	30.4	-22.5%	**347.3**	**-16.6%**
Mike	103.2	-9.3%	77.7	-18.9%	8.7	7.5%	36.1	-1.2%	105.1	-25.7%	25.7	-36.2%	**356.6**	**-18.7%**
Juliet	109.9	-4.4%	83.6	-12.6%	6.0	-25.6%	32.1	-12.4%	90.3	-32.7%	31.9	-20.9%	**353.7**	**-19.0%**
Gulf	103.7	-9.9%	80.6	-15.9%	8.4	2.9%	28.5	-22.0%	85.2	-33.6%	28.1	-30.1%	**334.5**	**-22.4%**
Lima	102.0	-11.3%	70.6	-26.4%	8.4	3.5%	28.6	-22.0%	102.4	-27.7%	26.2	-35.0%	**338.1**	**-23.1%**
India	94.5	-17.8%	67.6	-24.2%	8.0	-1.0%	27.4	-24.8%	82.3	-32.0%	24.1	-36.1%	**303.9**	**-26.2%**
Charlie	99.0	-13.9%	63.1	-28.9%	6.6	-18.3%	31.6	-13.7%	69.1	-36.4%	26.1	-35.2%	**295.5**	**-27.2%**
Alpha	101.0	-12.2%	70.7	-26.2%	7.0	-13.8%	27.2	-25.6%	82.1	-39.3%	25.6	-36.4%	**313.7**	**-28.3%**
Hotel	97.6	-15.2%	54.6	-43.1%	7.8	-3.4%	26.6	-27.3%	83.6	-38.4%	23.2	-42.5%	**293.4**	**-32.6%**
Delta	81.1	-27.5%	59.5	-38.0%	8.2	0.4%	26.0	-29.0%	79.6	-37.1%	24.2	-40.0%	**278.5**	**-33.9%**
Kilo	78.8	-31.5%	68.5	-28.6%	6.7	-17.6%	23.3	-36.3%	50.0	-57.6%	15.2	-62.3%	**242.5**	**-43.4%**

Gas Volume Variance

- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to gas condensate / wet gas / dry gas wells with 1st three month GOR >3.200 cf/bo
- Excluded November (didn't forecast gas basins)

Observations:

- Participants generally too optimistic about Haynesville
- Too pessimistic about Appalachia, Delaware, DJ (only 9 wells), Eagle Ford, and Fort Worth
- Bravo and Oscar >15% optimistic
- Kilo >15% pessimistic

Basin	APPALACHIAN		DELAWARE		DJ		EAGLE FORD		FORT WORTH		HAYNESVILLE		**Total**	
Vendor Name	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	Gas Vol, BCF	Gas Variance, %	**Gas Vol, BCF**	**Gas Variance, %**
Bravo	331.2	50.0%	89.6	46.9%	4.2	-15.0%	41.6	62.1%	146.5	65.4%	388.2	66.3%	**1001.3**	**57.8%**
Oscar	219.5	-0.6%	52.5	-14.1%	3.5	-26.8%	27.8	8.4%	79.7	-10.0%	364.0	55.9%	**747.0**	**17.7%**
Echo	240.8	9.0%	59.5	-0.5%	2.6	-47.8%	25.9	6.0%	119.5	35.0%	243.4	4.2%	**691.6**	**9.4%**
Delta	212.0	-4.0%	41.1	-32.6%	2.8	-42.8%	24.6	-4.1%	76.1	-14.1%	322.6	38.2%	**679.2**	**7.0%**
Gulf	197.6	-10.5%	50.1	-18.0%	3.0	-39.4%	23.9	-6.8%	74.5	-15.9%	313.4	34.2%	**662.4**	**4.4%**
Foxtrot	226.5	2.6%	52.4	-14.2%	3.5	-29.3%	22.2	-13.0%	81.7	-7.7%	262.7	12.5%	**649.1**	**2.3%**
actuals - key	220.8	0.0%	61.0	0.0%	4.9	0.0%	25.7	0.0%	88.6	0.0%	233.5	0.0%	**634.5**	**0.0%**
India	195.4	-11.5%	44.9	-26.3%	3.2	-34.1%	19.5	-19.4%	76.2	-14.0%	288.6	23.6%	**627.8**	**-0.9%**
Mike	203.7	-7.8%	49.3	-19.2%	3.6	-27.5%	25.7	0.2%	75.6	-14.6%	256.6	9.9%	**614.5**	**-3.1%**
Lima	198.4	-10.2%	49.0	-19.7%	3.2	-34.6%	19.1	-25.4%	73.1	-17.5%	259.7	11.2%	**602.5**	**-5.0%**
Hotel	202.8	-8.2%	50.3	-17.6%	3.4	-31.4%	20.2	-21.5%	71.7	-19.1%	252.3	8.1%	**600.6**	**-5.3%**
Juliet	189.5	-14.2%	55.9	-8.4%	3.9	-21.3%	16.5	-33.9%	79.6	-10.1%	239.7	2.6%	**585.1**	**-7.7%**
Charlie	202.7	-8.2%	52.3	-14.3%	2.8	-40.4%	19.9	-22.0%	72.3	-18.4%	230.4	-1.3%	**580.4**	**-8.5%**
Alpha	196.1	-11.2%	42.8	-29.8%	3.3	-32.5%	16.5	-35.9%	71.4	-19.4%	247.4	5.9%	**577.5**	**-9.0%**
Kilo	174.1	-21.2%	35.8	-41.4%	2.4	-51.6%	17.4	-32.3%	59.9	-32.4%	243.7	4.4%	**533.2**	**-16.0%**

Oil Volume Variance for Gas Wells

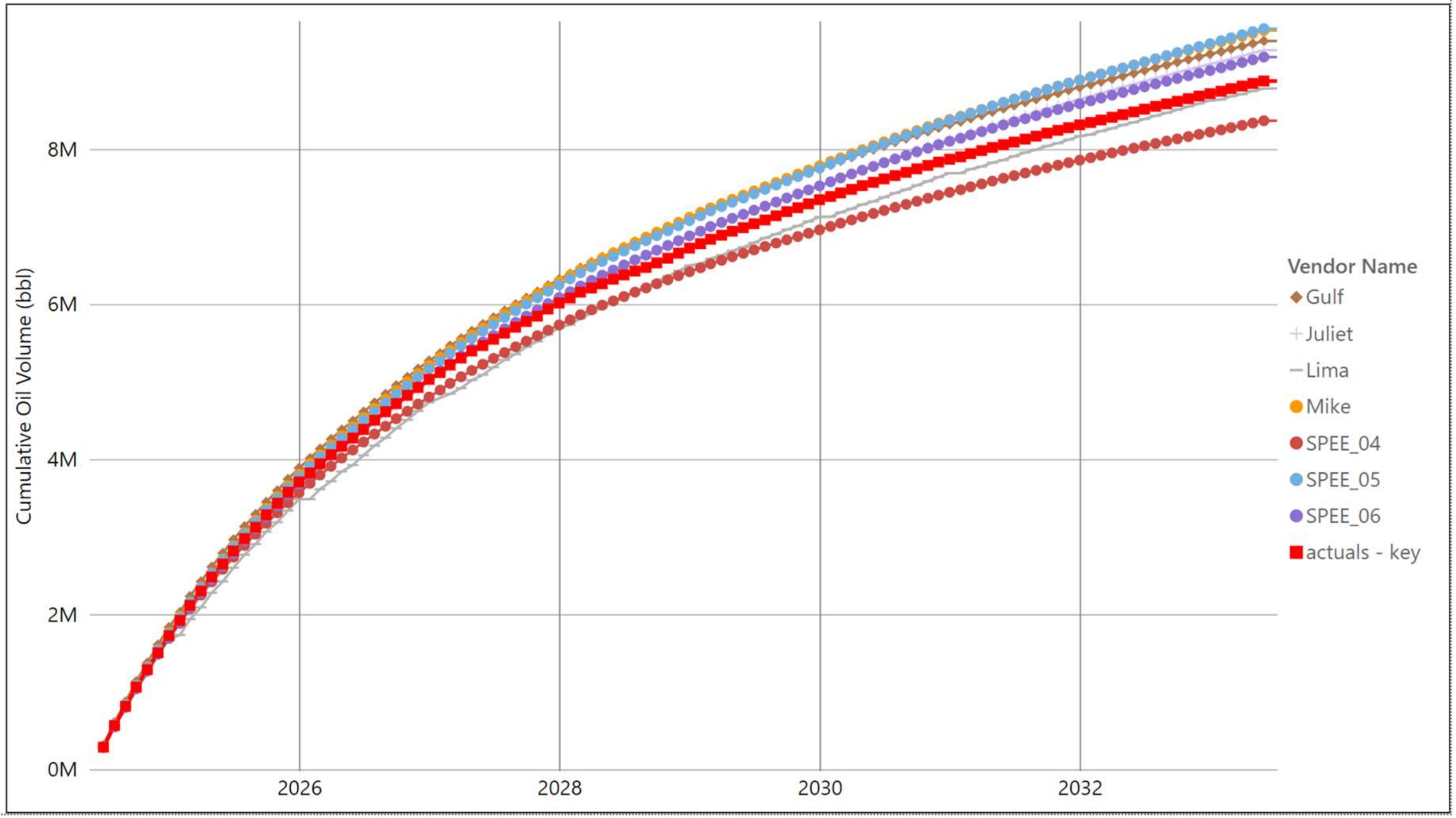
- Filtered to time periods with truncated data
- Values are remaining volumes from start of forecast (7/1/2024)
- Filtered to gas condensate / wet gas / dry gas wells with 1st three month GOR >3.200 cf/bo
- Filtered out Appalachia, Fort Worth, and Haynesville due to lack of oil volumes

Observations:

- Echo and Bravo >15% optimistic
- Lima, Kilo, and Alpha >15% pessimistic

Basin	DELAWARE		DJ		EAGLE FORD		**Total**	
Vendor Name	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	Oil Vol, MMBO	Oil Variance, %	**Oil Vol, MMBO**	**Oil Variance, %**
Bravo	8.4	56.7%	0.8	77.6%	6.1	73.2%	**15.2**	**63.9%**
Echo	8.2	55.5%	0.8	78.8%	5.1	51.5%	**14.1**	**55.1%**
November	6.1	13.4%	0.5	15.9%	3.7	7.8%	**10.2**	**11.4%**
Oscar	5.1	-4.6%	0.4	7.8%	4.2	19.6%	**9.7**	**5.1%**
Delta	5.2	-2.3%	0.4	-5.4%	4.0	13.9%	**9.6**	**3.7%**
actuals - key	5.4	0.0%	0.4	0.0%	3.5	0.0%	**9.3**	**0.0%**
Mike	4.9	-8.4%	0.4	2.3%	3.9	12.4%	**9.3**	**-0.1%**
Foxtrot	5.4	1.8%	0.4	1.7%	3.3	-4.3%	**9.2**	**-0.5%**
Gulf	5.3	-1.5%	0.4	-6.2%	3.5	0.6%	**9.2**	**-0.9%**
Charlie	5.7	5.6%	0.4	-9.2%	2.8	-18.1%	**8.9**	**-4.0%**
India	4.9	-8.3%	0.4	-7.0%	3.2	-5.9%	**8.4**	**-7.3%**
Hotel	5.0	-5.8%	0.4	3.8%	3.0	-12.9%	**8.5**	**-8.1%**
Juliet	5.4	1.1%	0.4	2.4%	2.5	-26.3%	**8.4**	**-9.2%**
Lima	4.7	-12.4%	0.5	11.1%	2.6	-26.9%	**7.7**	**-16.8%**
Kilo	4.2	-22.1%	0.3	-28.9%	2.9	-15.8%	**7.4**	**-20.0%**
Alpha	4.2	-22.3%	0.4	1.4%	2.4	-32.9%	**6.9**	**-25.2%**

3 Best Humans and 4 Best Machines



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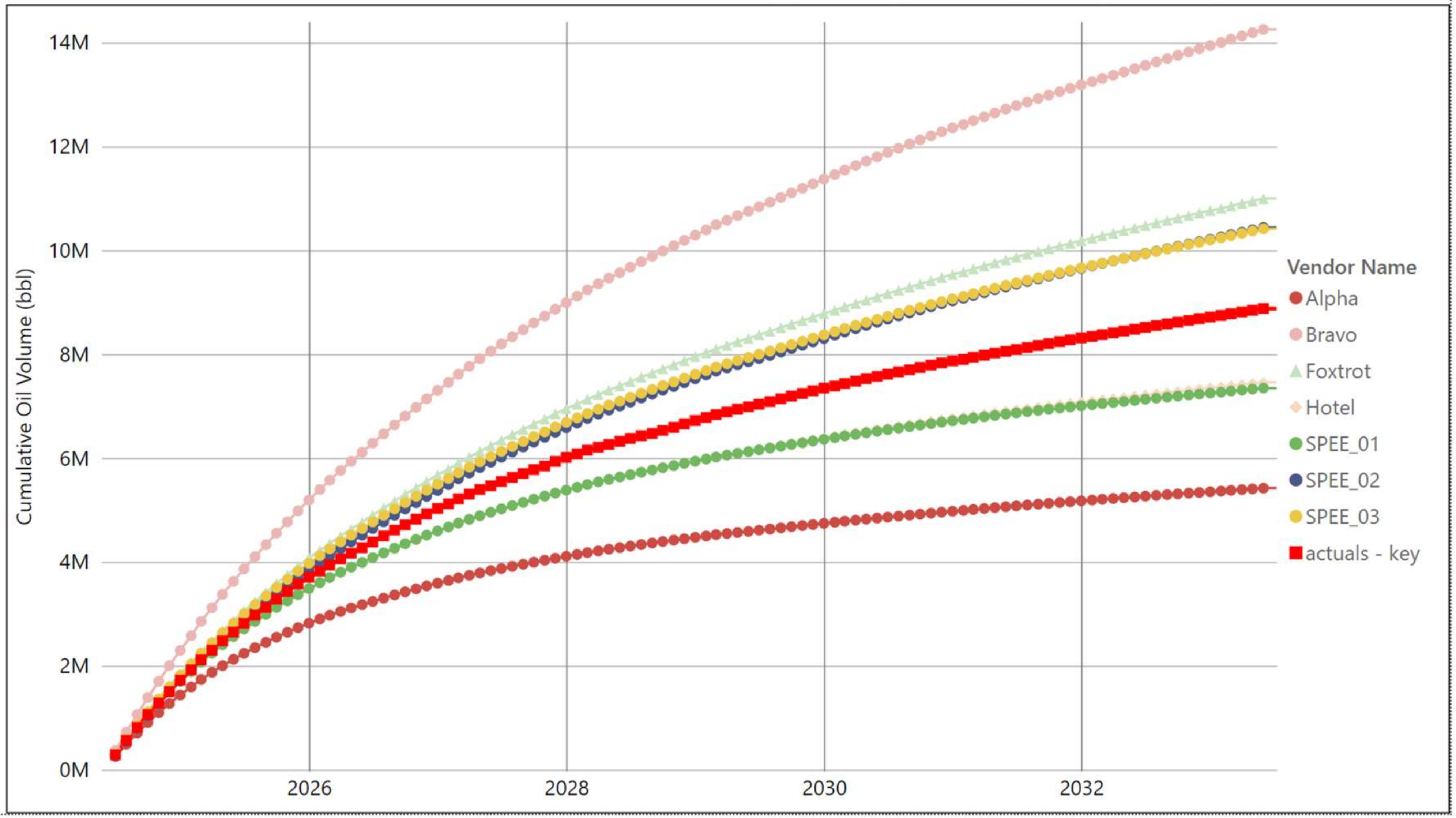
3 Worst Humans and 4 Worst Machines



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