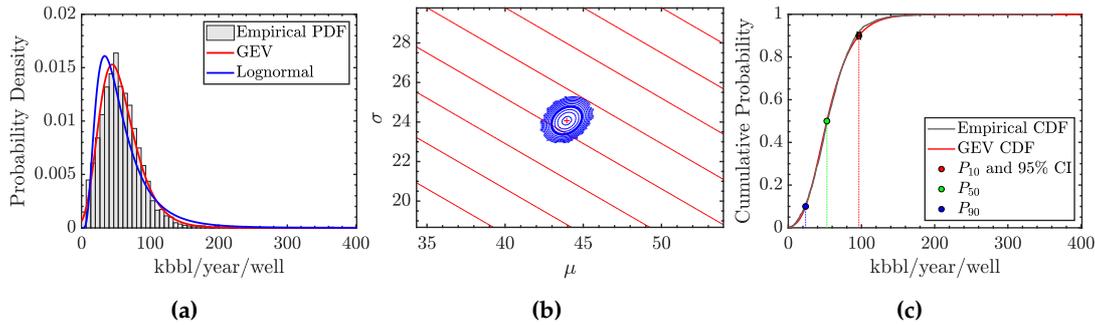


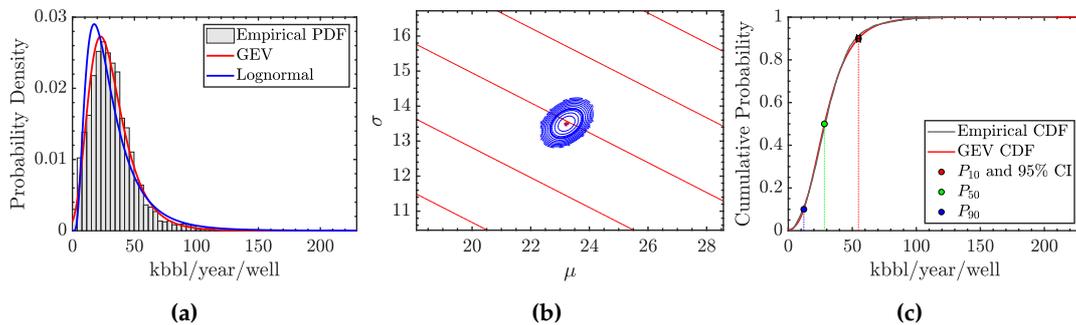
# Supplementary Materials: Generalized Extreme Value Statistics, Physical Scaling and Forecasts of Oil Production in the Bakken Shale

Wardana Saputra , Wissem Kirati and Tadeusz Patzek \* 

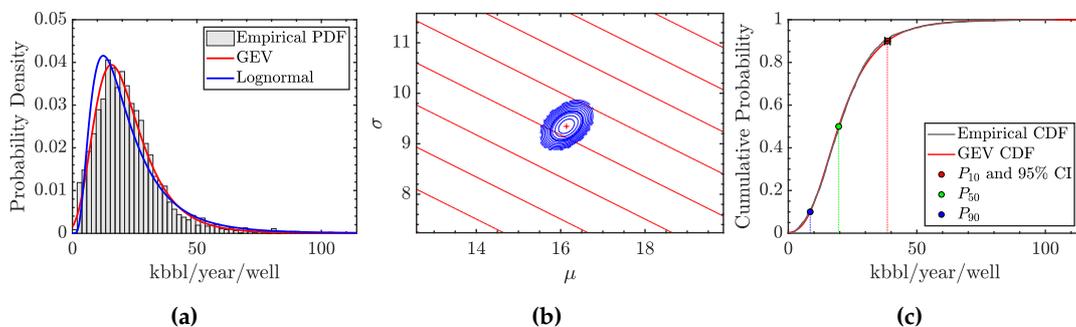
## 1 Supporting Online Materials-1: GEV Fits



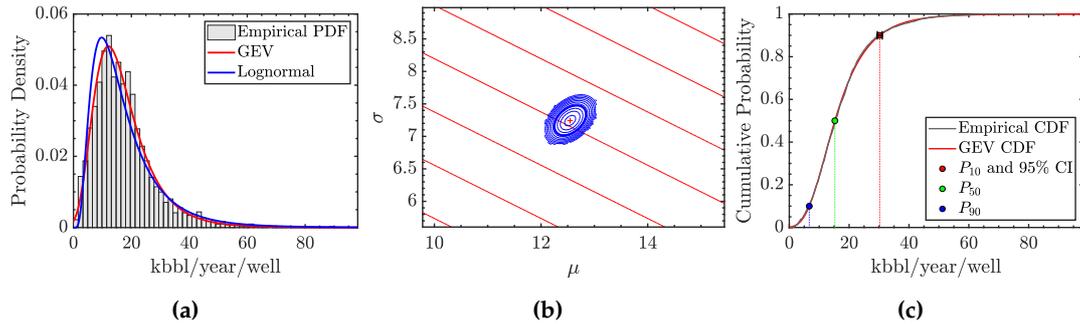
**Figure S1.** Distribution of oil production rates for 2540 horizontal wells with one year on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0274$ ,  $\mu = 43.9421$ ,  $\sigma = 24.0635$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



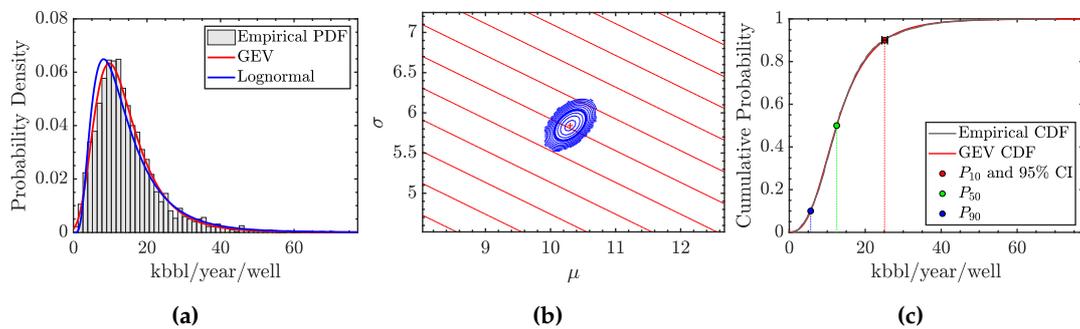
**Figure S2.** Distribution of oil production rates for 2534 horizontal wells with two years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0350$ ,  $\mu = 23.2199$ ,  $\sigma = 13.4957$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



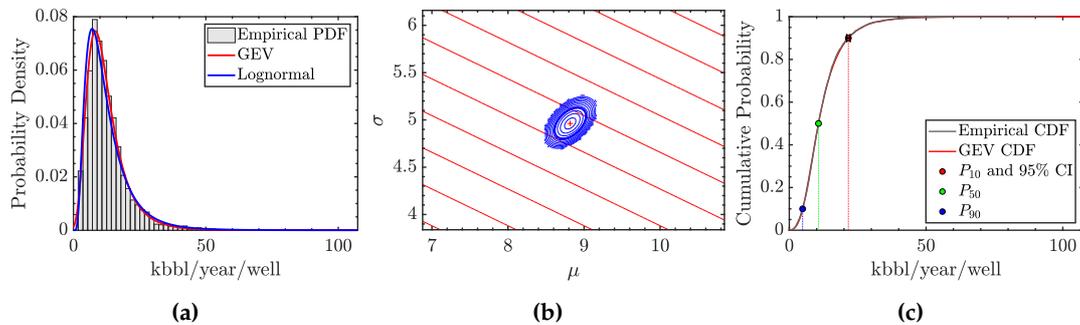
**Figure S3.** Distribution of oil production rates for 2525 horizontal wells with three years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0558$ ,  $\mu = 16.1383$ ,  $\sigma = 9.3447$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



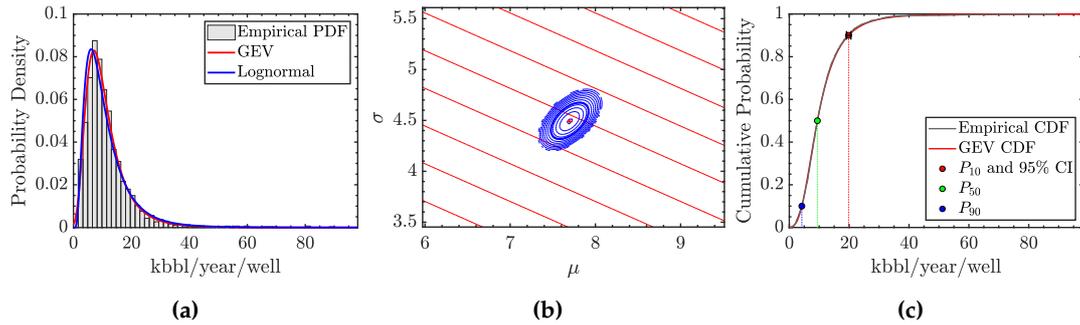
**Figure S4.** Distribution of oil production rates for 2515 horizontal wells with four years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0711$ ,  $\mu = 12.5448$ ,  $\sigma = 7.2414$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



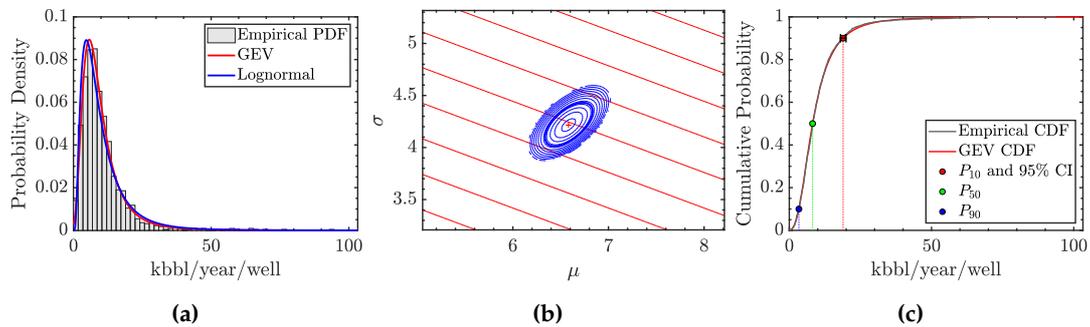
**Figure S5.** Distribution of oil production rates for 2501 horizontal wells with five years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.1028$ ,  $\mu = 10.3013$ ,  $\sigma = 5.8415$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



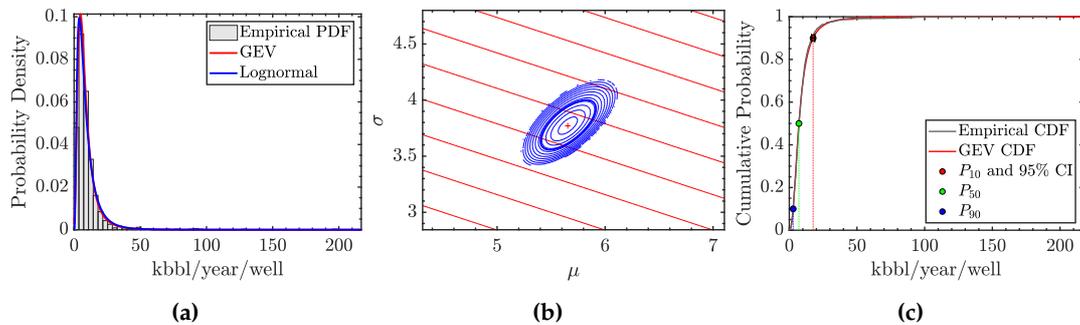
**Figure S6.** Distribution of oil production rates for 2470 horizontal wells with six years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.1177$ ,  $\mu = 8.8175$ ,  $\sigma = 4.9622$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



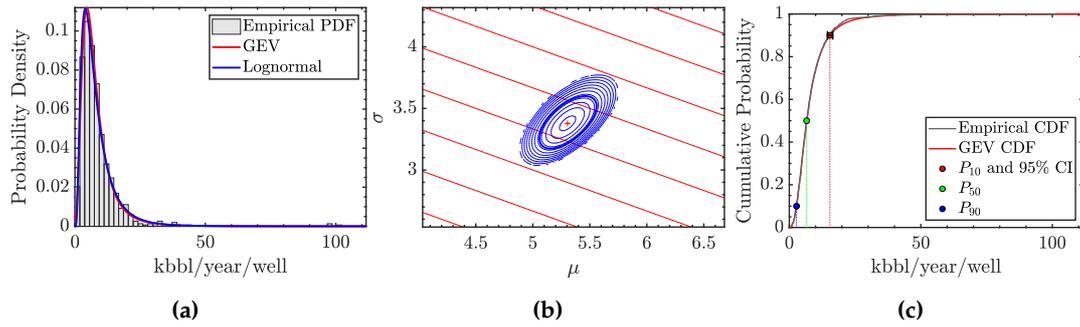
**Figure S7.** Distribution of oil production rates for 1839 horizontal wells with seven years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.1573$ ,  $\mu = 7.6970$ ,  $\sigma = 4.4909$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



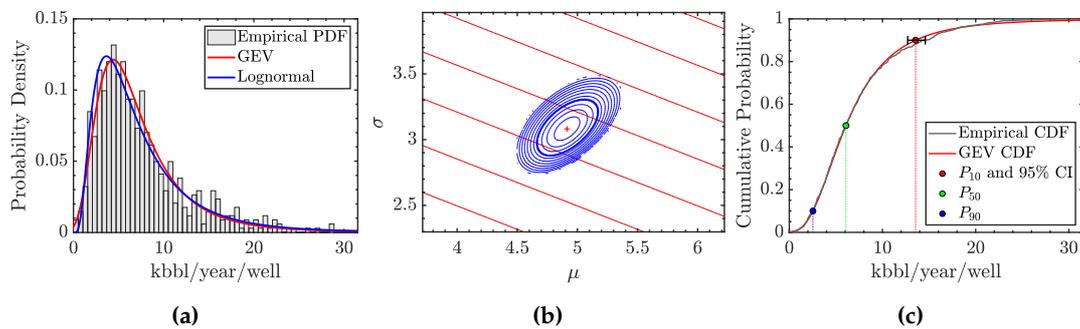
**Figure S8.** Distribution of oil production rates for 1285 horizontal wells with eight years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2238$ ,  $\mu = 6.5823$ ,  $\sigma = 4.2151$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



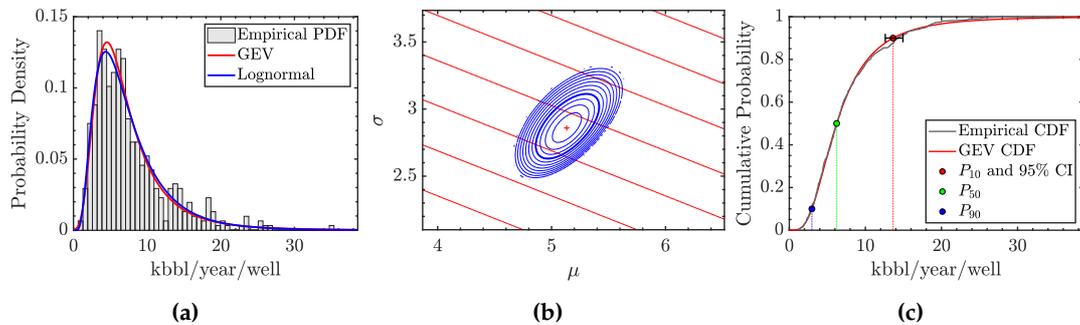
**Figure S9.** Distribution of oil production rates for 979 horizontal wells with nine years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2883$ ,  $\mu = 5.6542$ ,  $\sigma = 3.7709$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



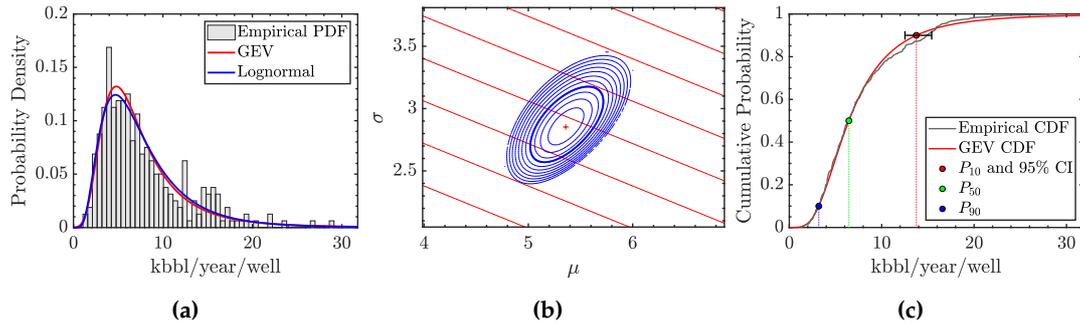
**Figure S10.** Distribution of oil production rates for 825 horizontal wells with ten years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2443$ ,  $\mu = 5.3047$ ,  $\sigma = 3.3781$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



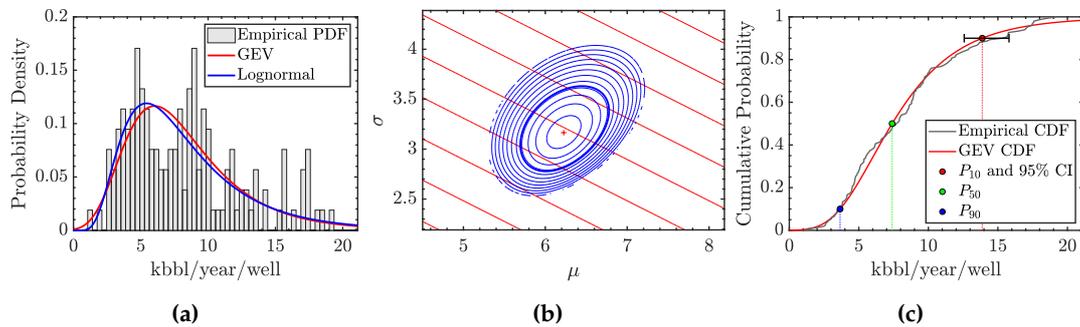
**Figure S11.** Distribution of oil production rates for 651 horizontal wells with eleven years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.1890$ ,  $\mu = 4.9132$ ,  $\sigma = 3.0817$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



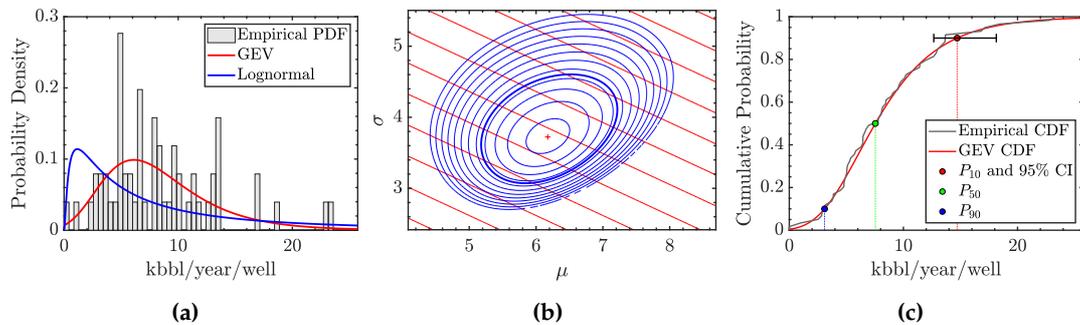
**Figure S12.** Distribution of oil production rates for 477 horizontal wells with twelve years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2376$ ,  $\mu = 5.1329$ ,  $\sigma = 2.8589$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



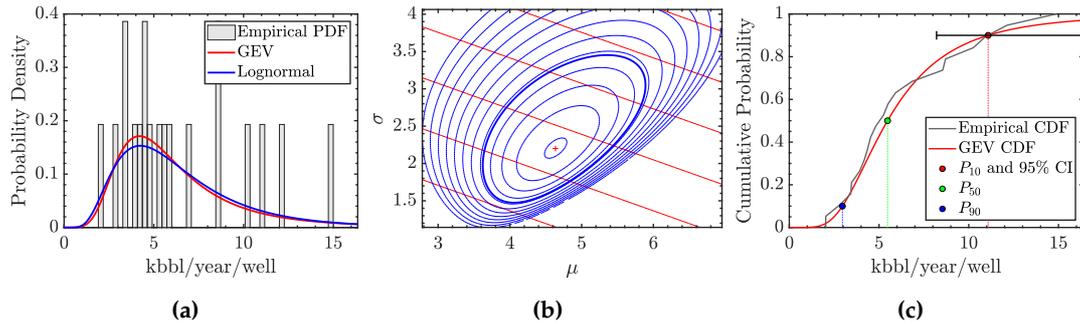
**Figure S13.** Distribution of oil production rates for 302 horizontal wells with thirteen years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2284$ ,  $\mu = 5.3582$ ,  $\sigma = 2.8523$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



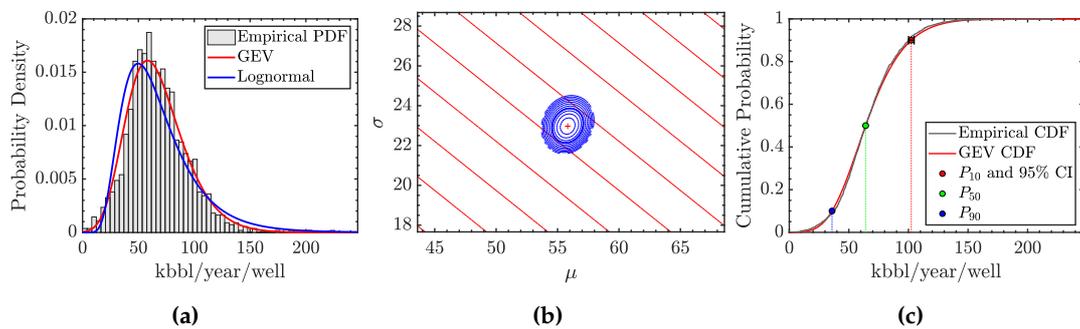
**Figure S14.** Distribution of oil production rates for 150 horizontal wells with fourteen years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0627$ ,  $\mu = 6.2251$ ,  $\sigma = 3.1648$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



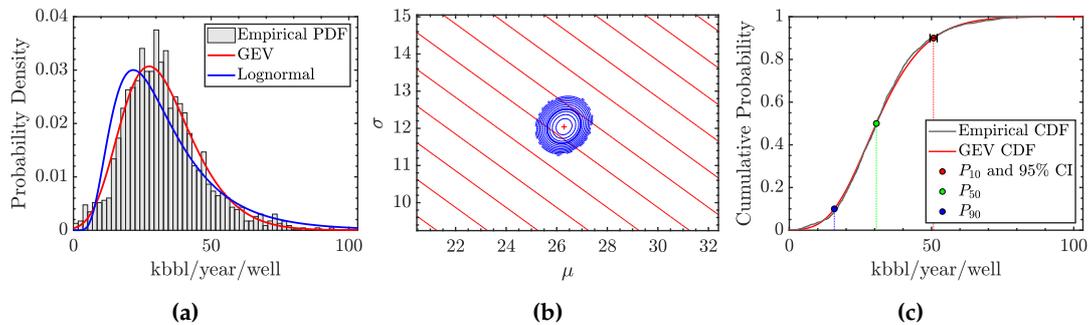
**Figure S15.** Distribution of oil production rates for 59 horizontal wells with fifteen years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0164$ ,  $\mu = 6.1751$ ,  $\sigma = 3.7225$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



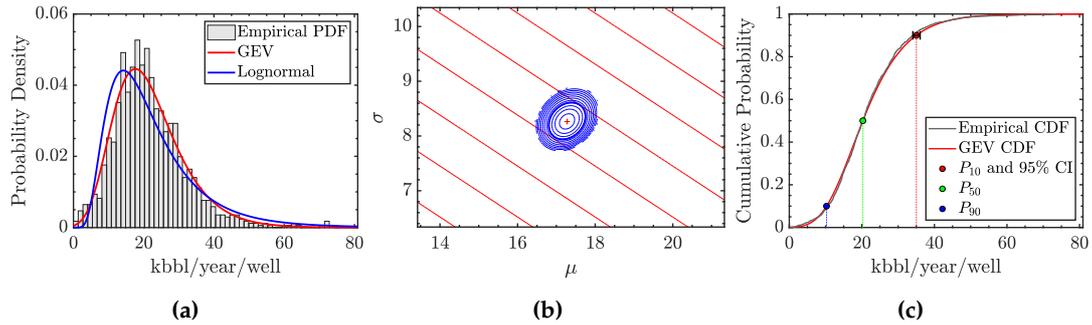
**Figure S16.** Distribution of oil production rates for 19 horizontal wells with sixteen years on production, completed between the year 2000 and 2012 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.2247$ ,  $\mu = 4.6353$ ,  $\sigma = 2.2005$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



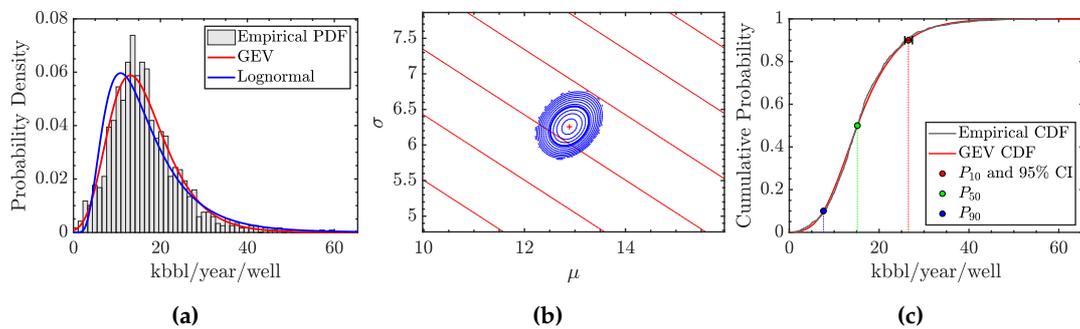
**Figure S17.** Distribution of oil production rates for 1352 horizontal wells with one year on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0950$ ,  $\mu = 55.8250$ ,  $\sigma = 22.9713$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



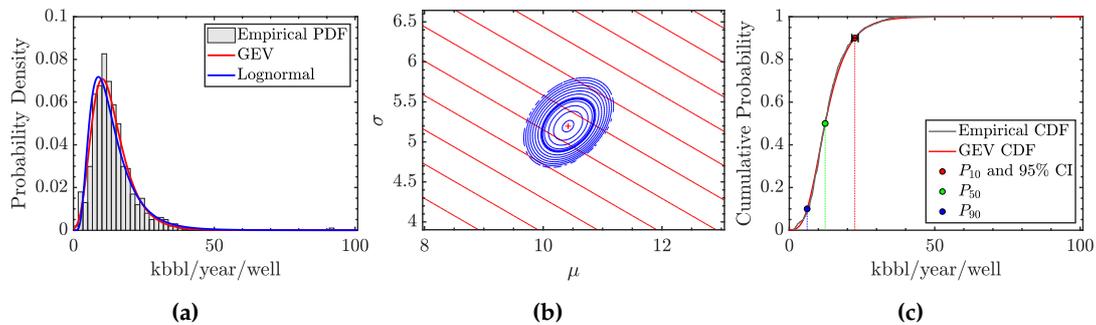
**Figure S18.** Distribution of oil production rates for 1348 horizontal wells with two years on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0950$ ,  $\mu = 26.2886$ ,  $\sigma = 12.0407$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



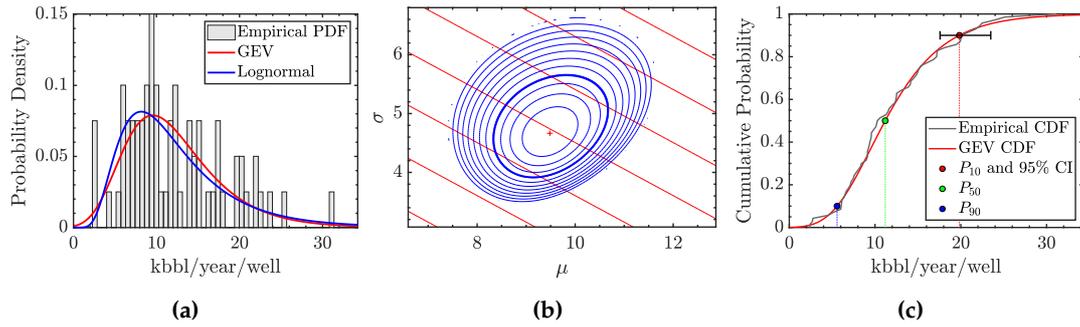
**Figure S19.** Distribution of oil production rates for 1267 horizontal wells with three years on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0419$ ,  $\mu = 17.2759$ ,  $\sigma = 8.2635$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



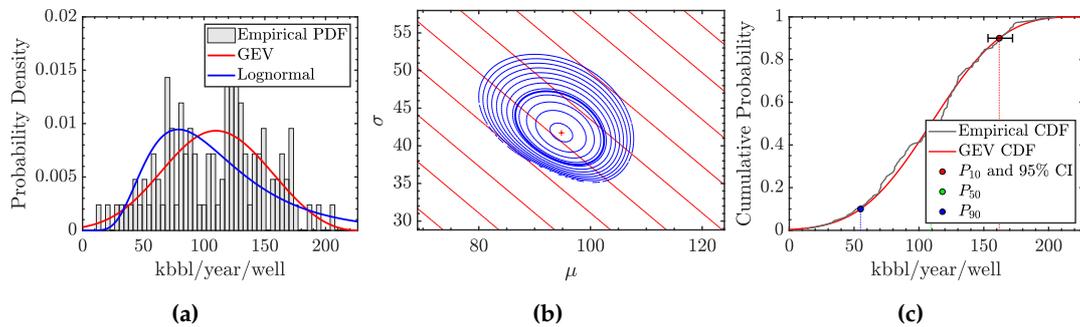
**Figure S20.** Distribution of oil production rates for 1094 horizontal wells with four years on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0288$ ,  $\mu = 12.8894$ ,  $\sigma = 6.2561$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



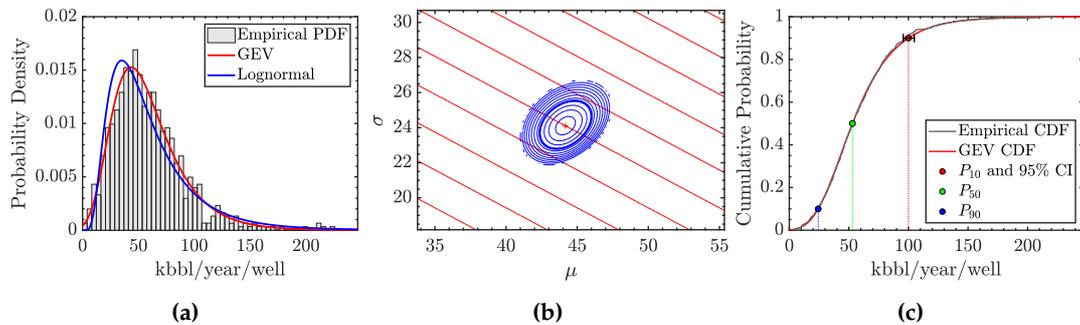
**Figure S21.** Distribution of oil production rates for 597 horizontal wells with five years on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = 0.0305$ ,  $\mu = 10.4185$ ,  $\sigma = 5.1962$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



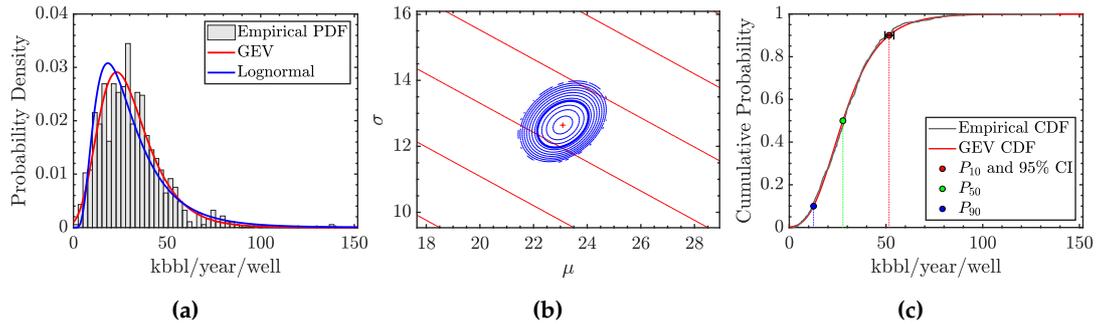
**Figure S22.** Distribution of oil production rates for 70 horizontal wells with six years on production, completed between the year 2013 and 2016 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.0126$ ,  $\mu = 9.4835$ ,  $\sigma = 4.6646$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



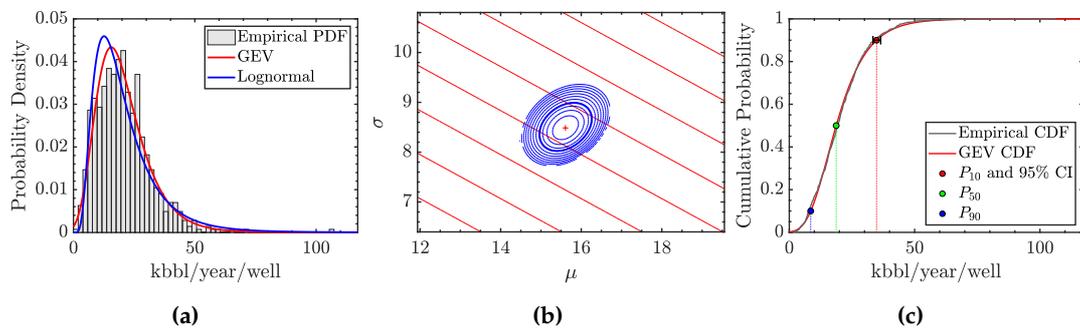
**Figure S23.** Distribution of oil production rates for 111 horizontal wells with one year on production, completed between the year 2017 and 2019 in the Middle Bakken noncore area. (a) GEV PDF:  $\xi = -0.3168$ ,  $\mu = 94.7978$ ,  $\sigma = 41.7273$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



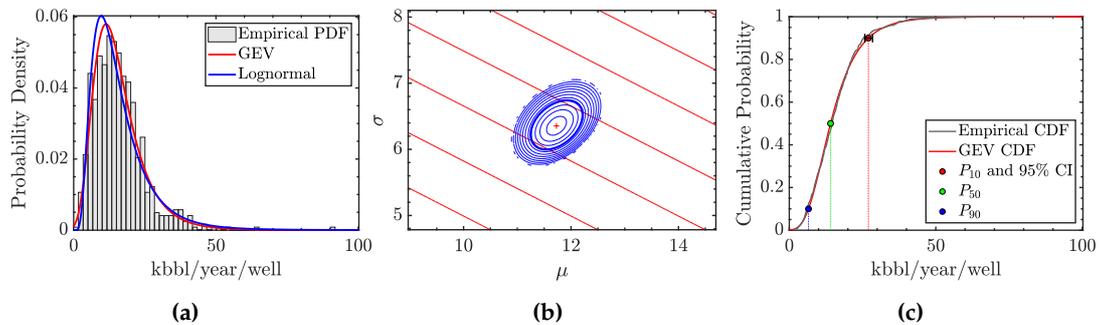
**Figure S24.** Distribution of oil production rates for 735 horizontal wells with one year on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0255$ ,  $\mu = 44.1701$ ,  $\sigma = 24.1066$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



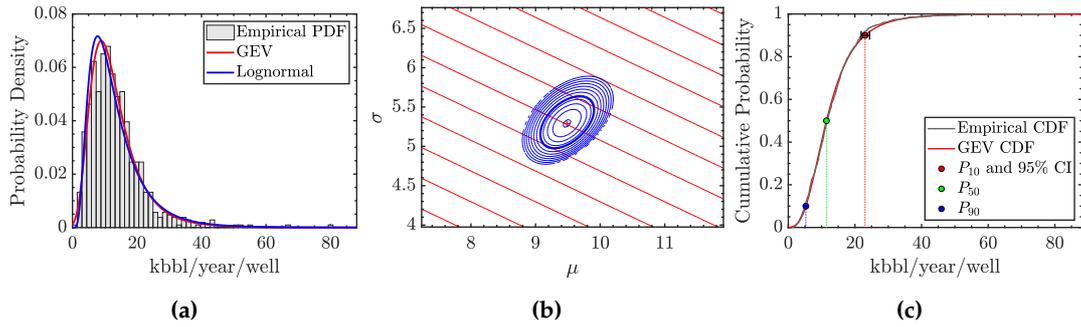
**Figure S25.** Distribution of oil production rates for 734 horizontal wells with two years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0015$ ,  $\mu = 23.0894$ ,  $\sigma = 12.6412$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



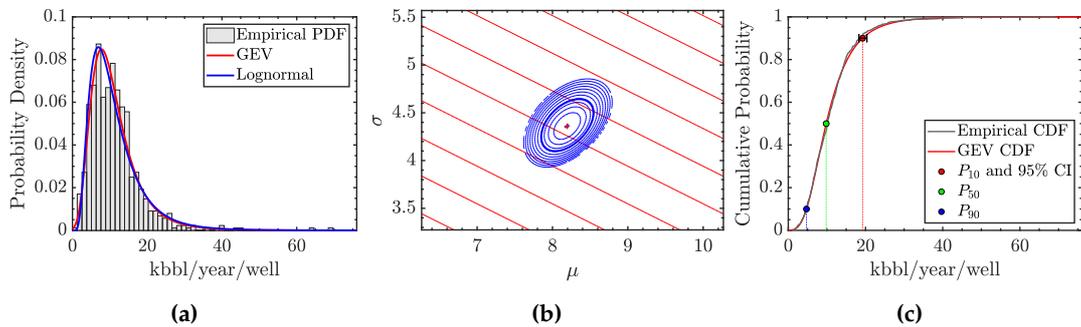
**Figure S26.** Distribution of oil production rates for 734 horizontal wells with three years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0054$ ,  $\mu = 15.6076$ ,  $\sigma = 8.4863$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



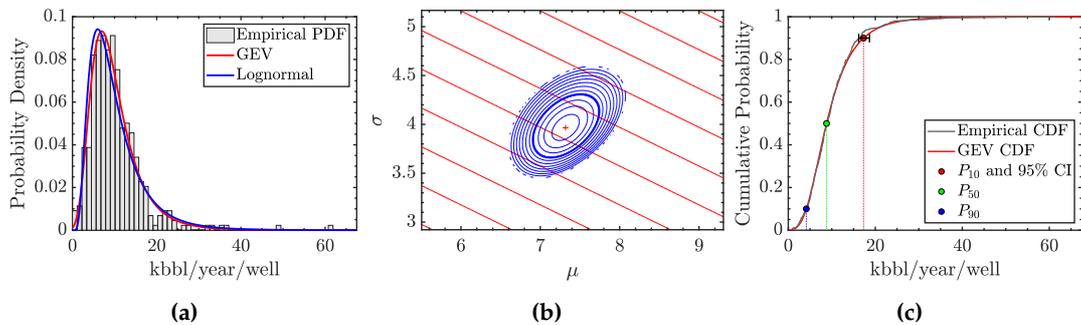
**Figure S27.** Distribution of oil production rates for 733 horizontal wells with four years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0581$ ,  $\mu = 11.7288$ ,  $\sigma = 6.3537$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



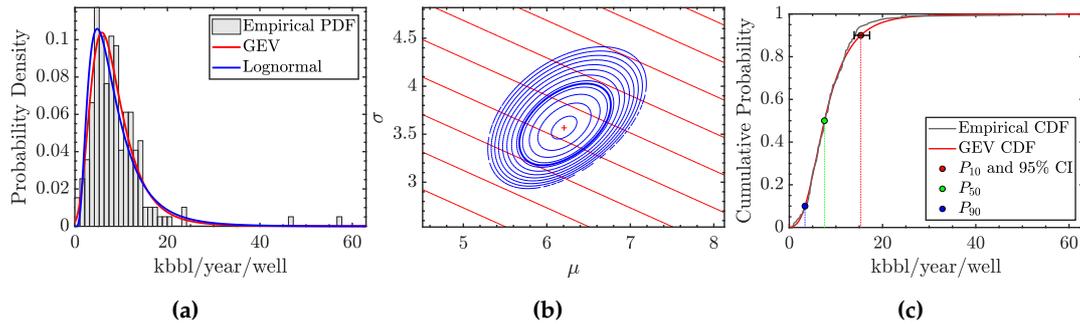
**Figure S28.** Distribution of oil production rates for 722 horizontal wells with five years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.1124$ ,  $\mu = 9.4842$ ,  $\sigma = 5.2917$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



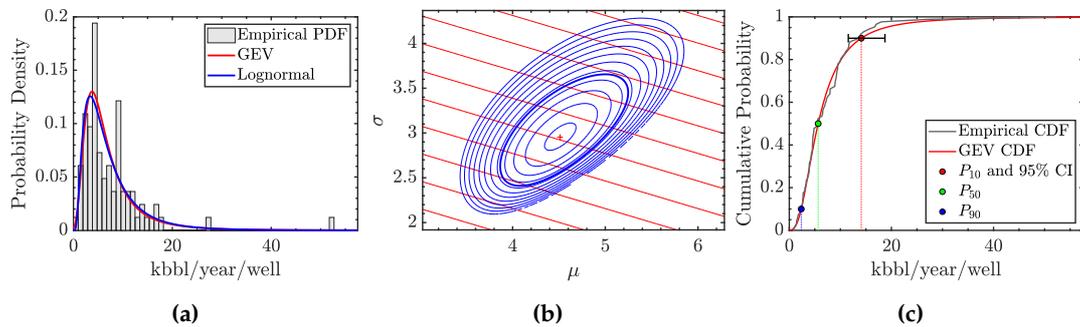
**Figure S29.** Distribution of oil production rates for 696 horizontal wells with six years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.1047$ ,  $\mu = 8.1929$ ,  $\sigma = 4.3587$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



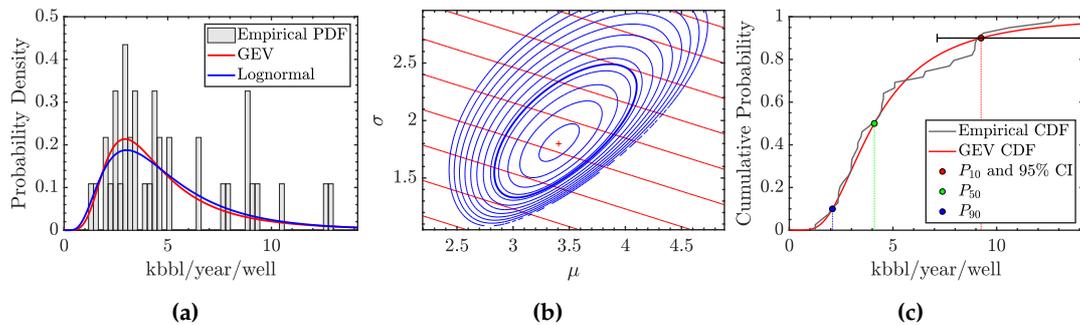
**Figure S30.** Distribution of oil production rates for 390 horizontal wells with seven years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0984$ ,  $\mu = 7.3182$ ,  $\sigma = 3.9652$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



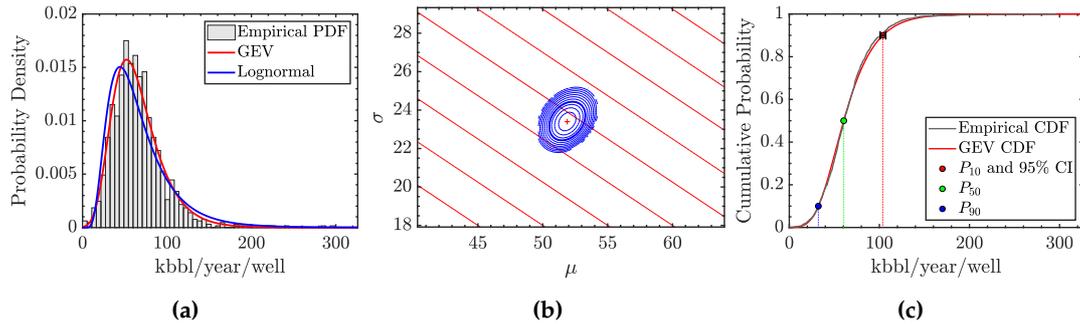
**Figure S31.** Distribution of oil production rates for 187 horizontal wells with eight years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.1127$ ,  $\mu = 6.2062$ ,  $\sigma = 3.5657$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



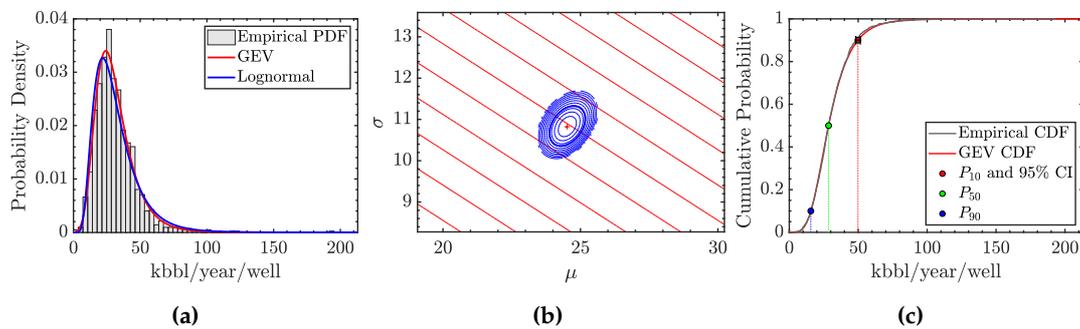
**Figure S32.** Distribution of oil production rates for 86 horizontal wells with nine years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.3080$ ,  $\mu = 4.5119$ ,  $\sigma = 2.9541$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



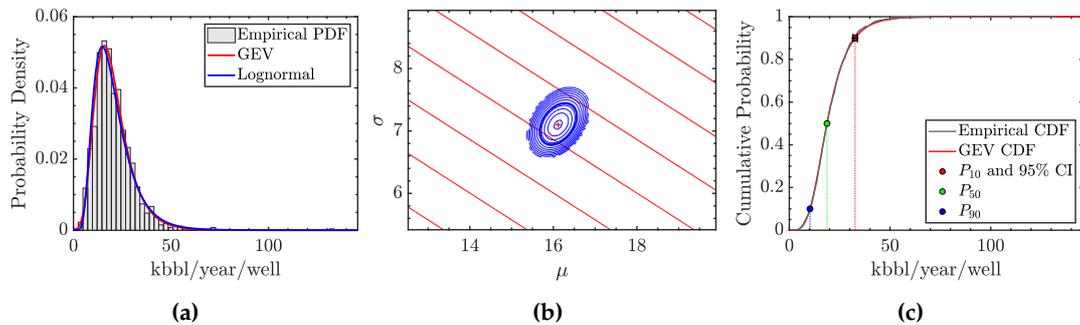
**Figure S33.** Distribution of oil production rates for 39 horizontal wells with ten years on production, completed between the year 2000 and 2012 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.3086$ ,  $\mu = 3.4055$ ,  $\sigma = 1.7988$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



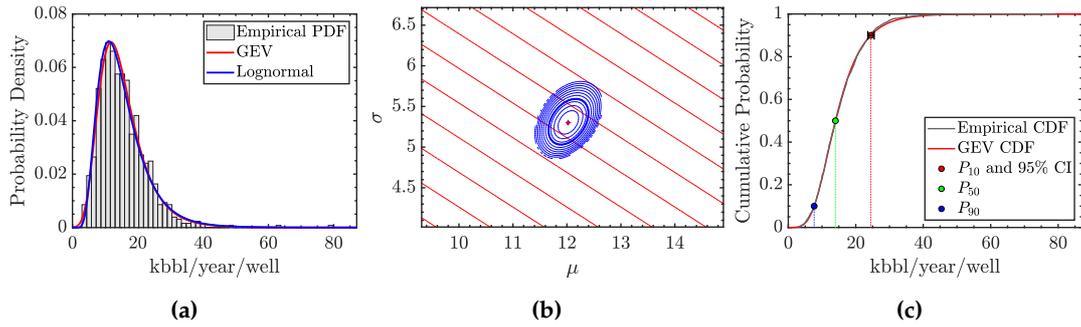
**Figure S34.** Distribution of oil production rates for 1199 horizontal wells with one year on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = -0.0112$ ,  $\mu = 51.8838$ ,  $\sigma = 23.3963$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



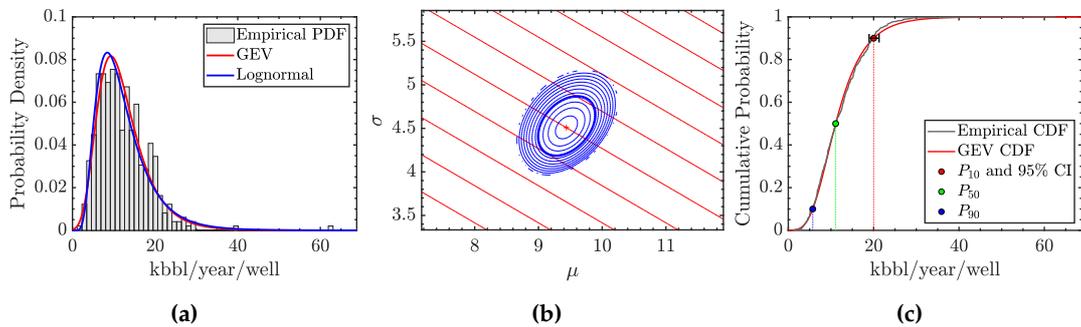
**Figure S35.** Distribution of oil production rates for 1193 horizontal wells with two years on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0337$ ,  $\mu = 24.5201$ ,  $\sigma = 10.8235$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



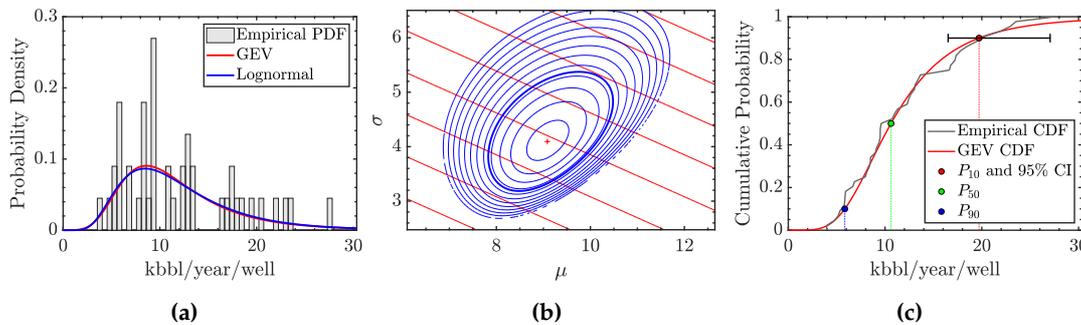
**Figure S36.** Distribution of oil production rates for 1114 horizontal wells with three years on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0313$ ,  $\mu = 16.1152$ ,  $\sigma = 7.0995$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



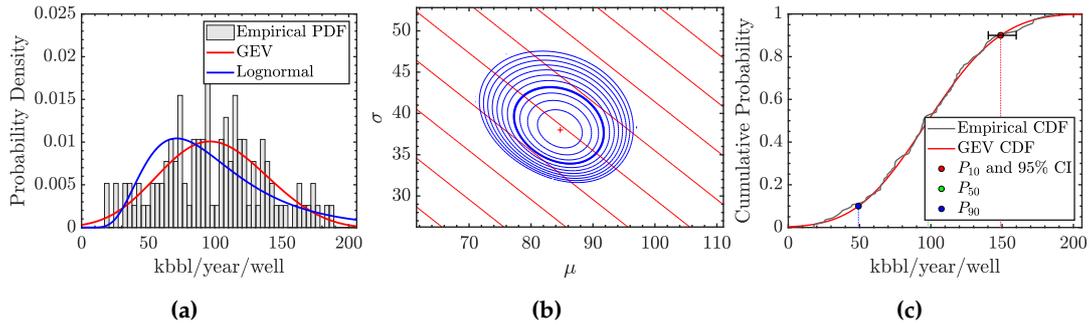
**Figure S37.** Distribution of oil production rates for 887 horizontal wells with four years on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0367$ ,  $\mu = 12.0257$ ,  $\sigma = 5.3011$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



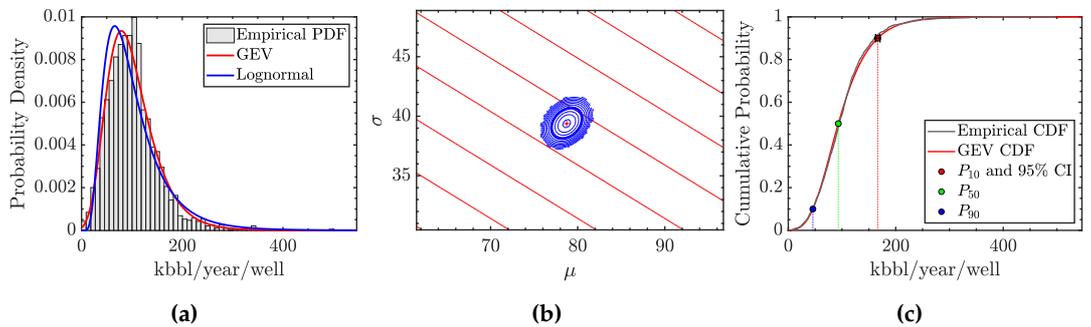
**Figure S38.** Distribution of oil production rates for 428 horizontal wells with five years on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.0356$ ,  $\mu = 9.4385$ ,  $\sigma = 4.5086$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



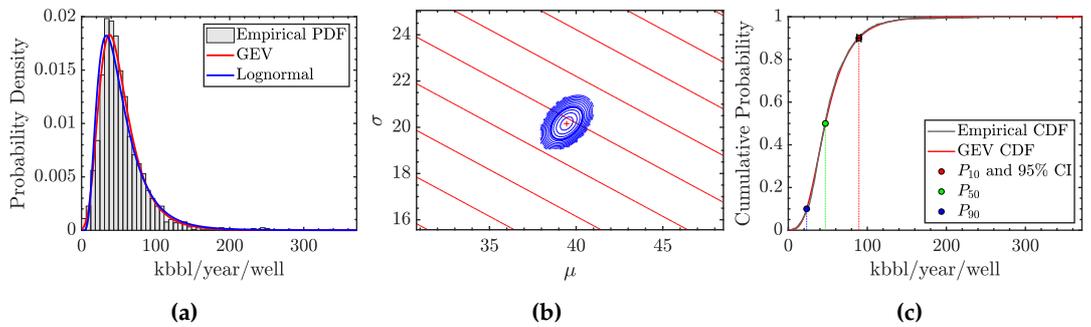
**Figure S39.** Distribution of oil production rates for 44 horizontal wells with six years on production, completed between the year 2013 and 2016 in the Three Forks noncore area. (a) GEV PDF:  $\xi = 0.1246$ ,  $\mu = 9.0841$ ,  $\sigma = 4.0937$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



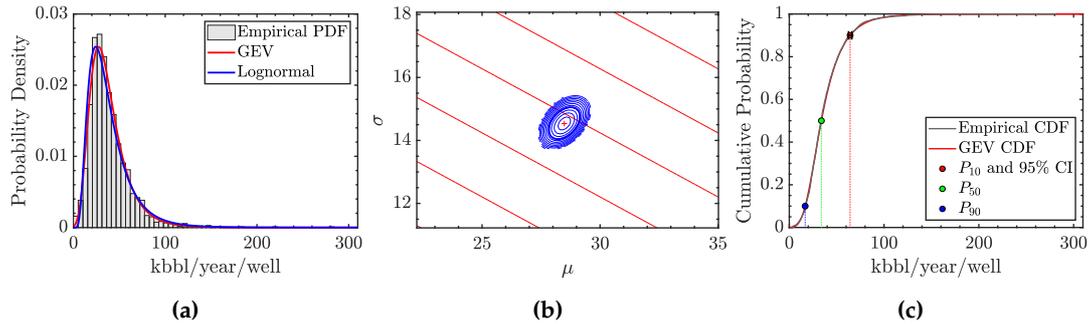
**Figure S40.** Distribution of oil production rates for 113 horizontal wells with one year on production, completed between the year 2017 and 2019 in the Three Forks noncore area. (a) GEV PDF:  $\xi = -0.2675$ ,  $\mu = 84.7197$ ,  $\sigma = 37.9968$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



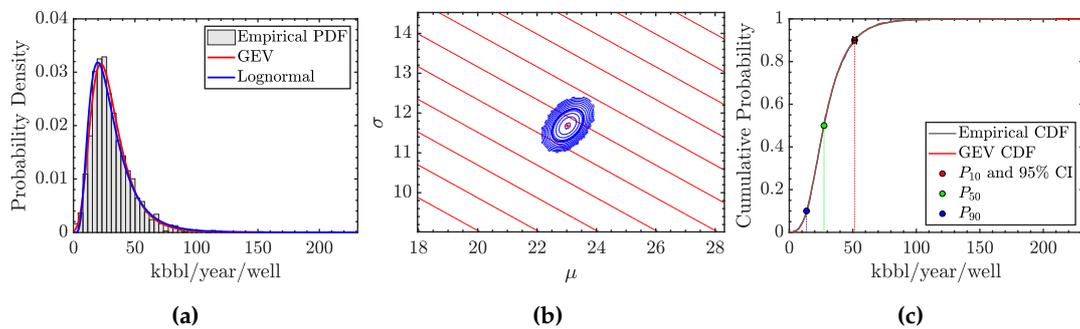
**Figure S41.** Distribution of oil production rates for 2081 horizontal wells with one year on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = -0.0088$ ,  $\mu = 78.7381$ ,  $\sigma = 39.3782$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



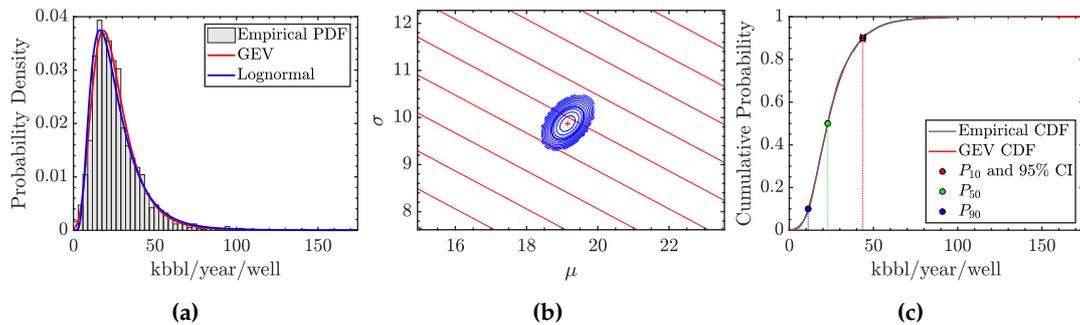
**Figure S42.** Distribution of oil production rates for 2077 horizontal wells with two years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.0840$ ,  $\mu = 39.4513$ ,  $\sigma = 20.1567$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



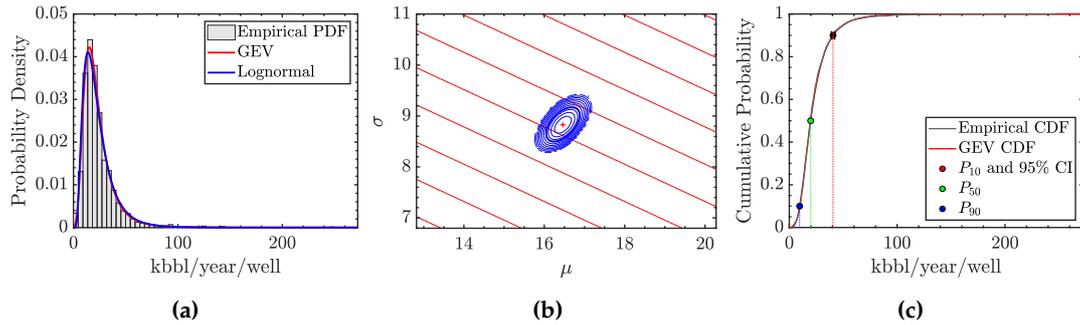
**Figure S43.** Distribution of oil production rates for 2075 horizontal wells with three years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\zeta = 0.0772$ ,  $\mu = 28.4853$ ,  $\sigma = 14.5350$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



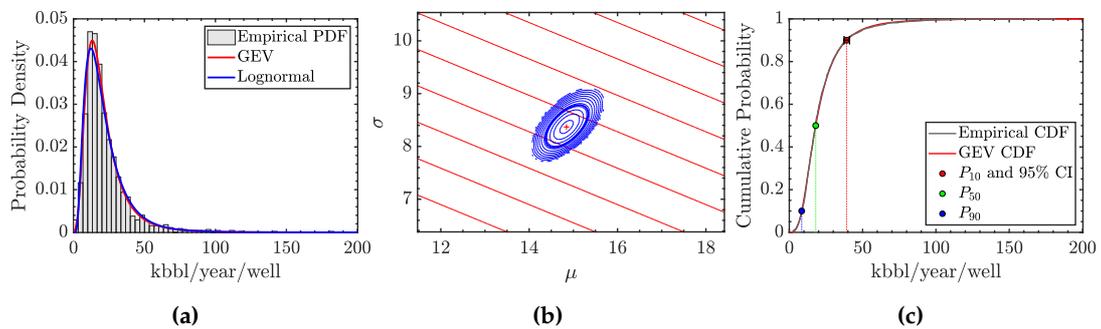
**Figure S44.** Distribution of oil production rates for 2068 horizontal wells with four years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\zeta = 0.0679$ ,  $\mu = 23.0291$ ,  $\sigma = 11.6792$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



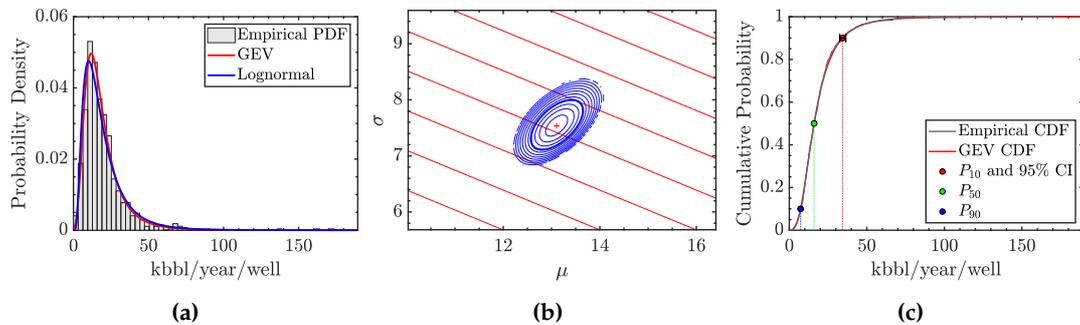
**Figure S45.** Distribution of oil production rates for 2048 horizontal wells with five years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\zeta = 0.0857$ ,  $\mu = 19.1505$ ,  $\sigma = 9.8681$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



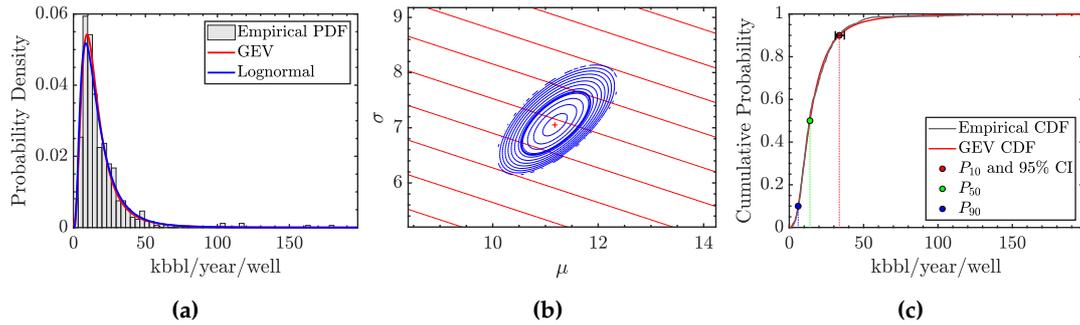
**Figure S46.** Distribution of oil production rates for 1969 horizontal wells with six years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1671$ ,  $\mu = 16.4612$ ,  $\sigma = 8.8255$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



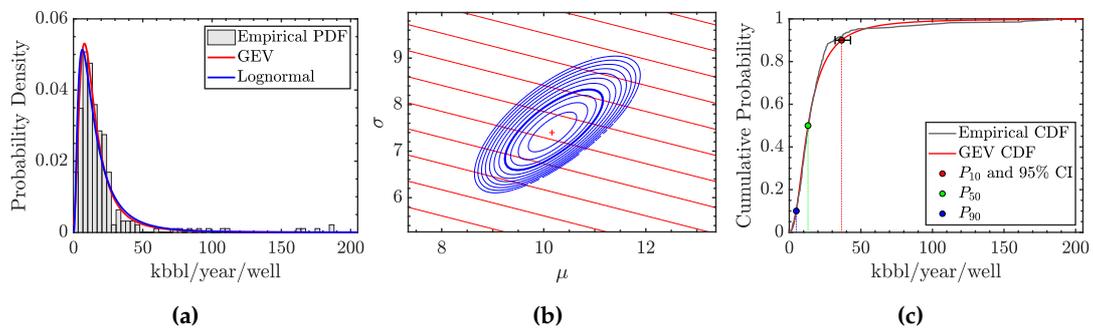
**Figure S47.** Distribution of oil production rates for 1339 horizontal wells with seven years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.2165$ ,  $\mu = 14.8450$ ,  $\sigma = 8.3690$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



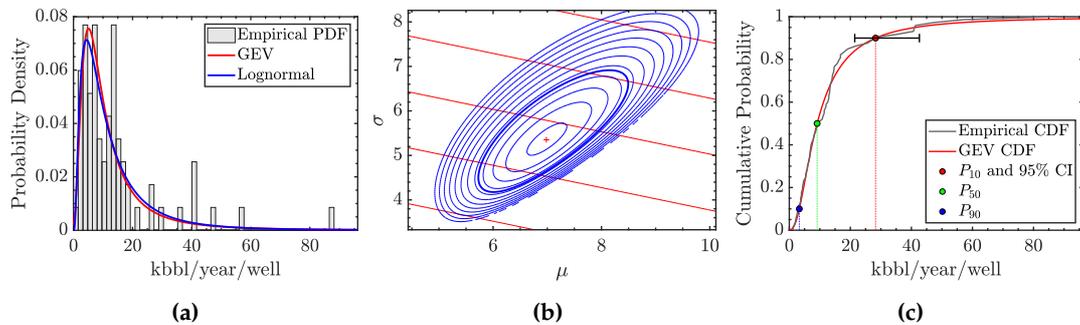
**Figure S48.** Distribution of oil production rates for 860 horizontal wells with eight years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1927$ ,  $\mu = 13.1039$ ,  $\sigma = 7.5363$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



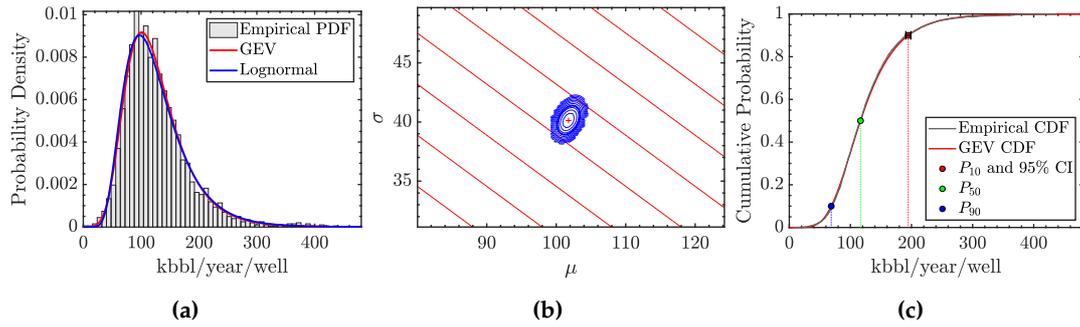
**Figure S49.** Distribution of oil production rates for 527 horizontal wells with nine years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.2935$ ,  $\mu = 11.1776$ ,  $\sigma = 7.0512$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



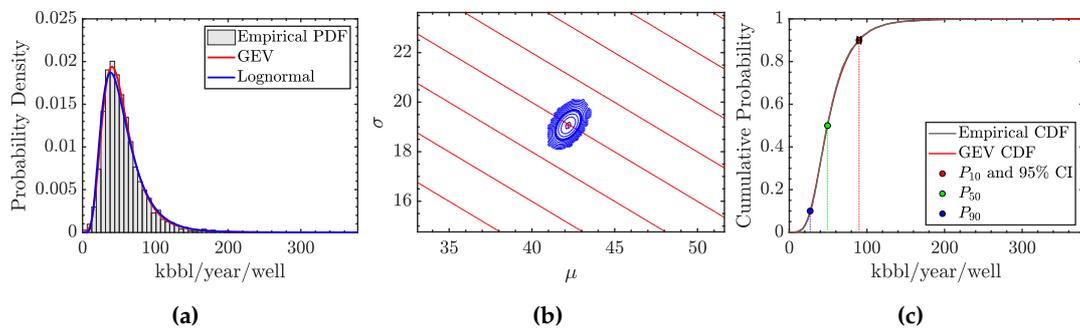
**Figure S50.** Distribution of oil production rates for 277 horizontal wells with ten years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.3819$ ,  $\mu = 10.1612$ ,  $\sigma = 7.3975$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



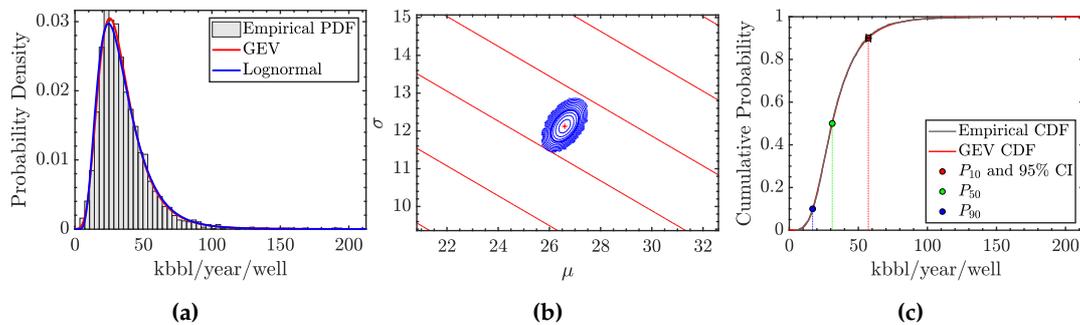
**Figure S51.** Distribution of oil production rates for 73 horizontal wells with eleven years on production, completed between the year 2000 and 2012 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.4657$ ,  $\mu = 6.9834$ ,  $\sigma = 5.3514$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



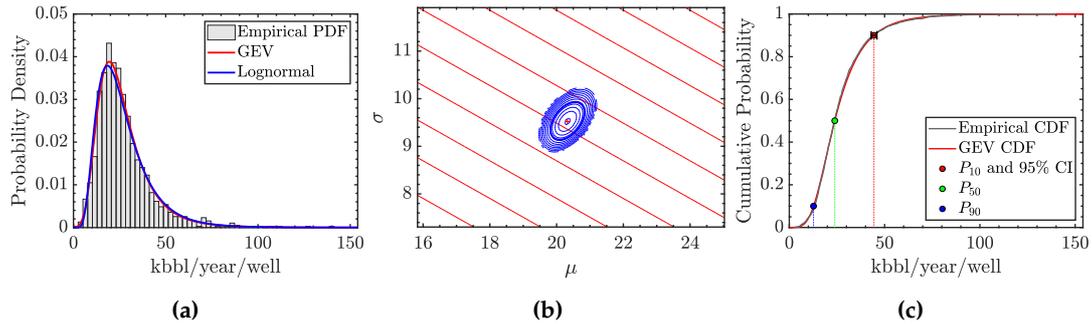
**Figure S52.** Distribution of oil production rates for 2532 horizontal wells with one year on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.0250$ ,  $\mu = 101.7754$ ,  $\sigma = 40.1247$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



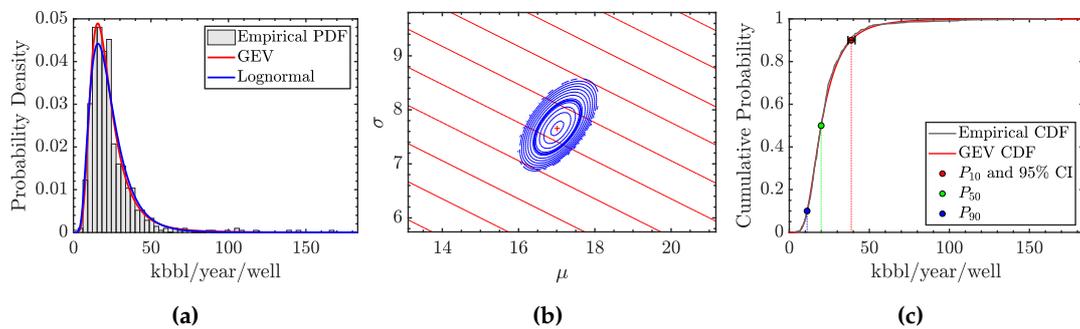
**Figure S53.** Distribution of oil production rates for 2510 horizontal wells with two years on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.0923$ ,  $\mu = 42.1917$ ,  $\sigma = 19.0582$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



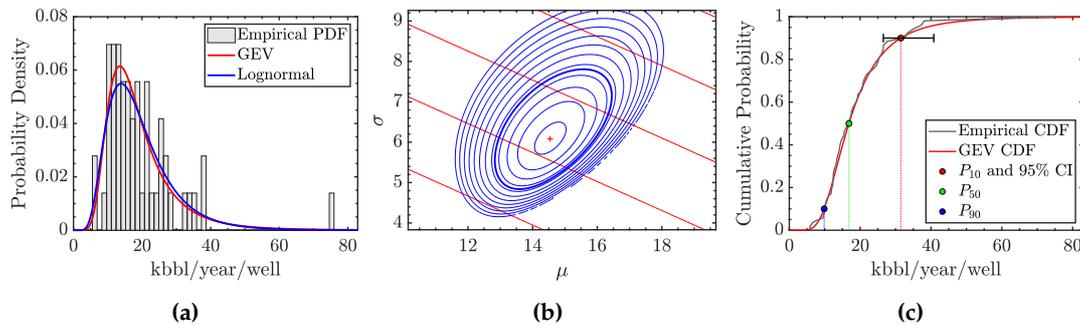
**Figure S54.** Distribution of oil production rates for 2168 horizontal wells with three years on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1016$ ,  $\mu = 26.5972$ ,  $\sigma = 12.1223$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



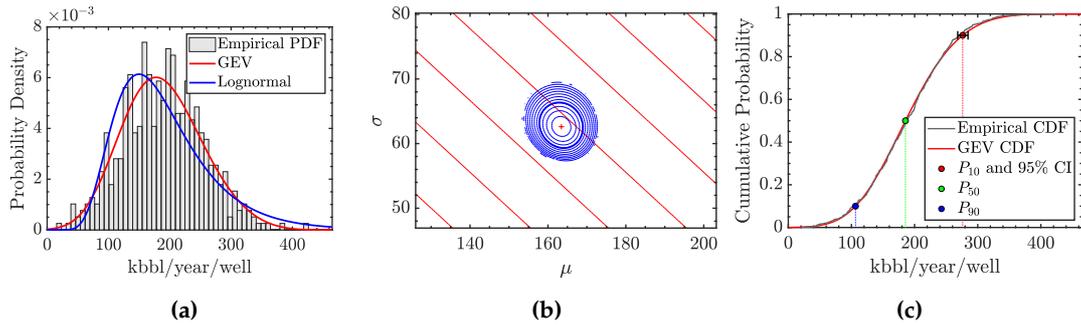
**Figure S55.** Distribution of oil production rates for 1525 horizontal wells with four years on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1022$ ,  $\mu = 20.3236$ ,  $\sigma = 9.5202$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



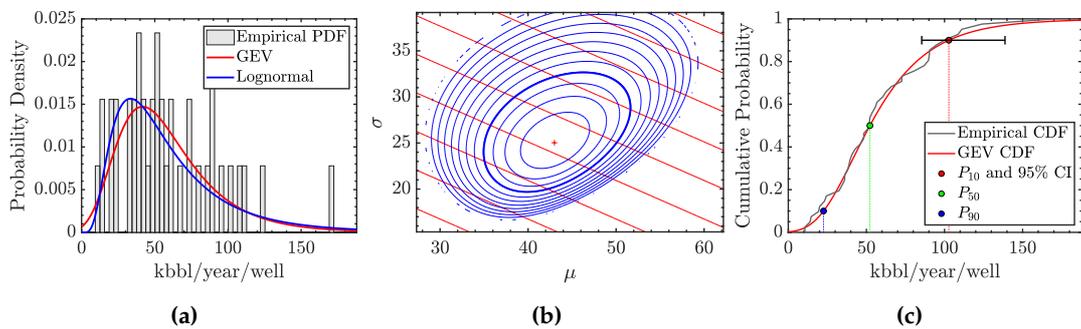
**Figure S56.** Distribution of oil production rates for 695 horizontal wells with five years on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1975$ ,  $\mu = 17.0128$ ,  $\sigma = 7.6560$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



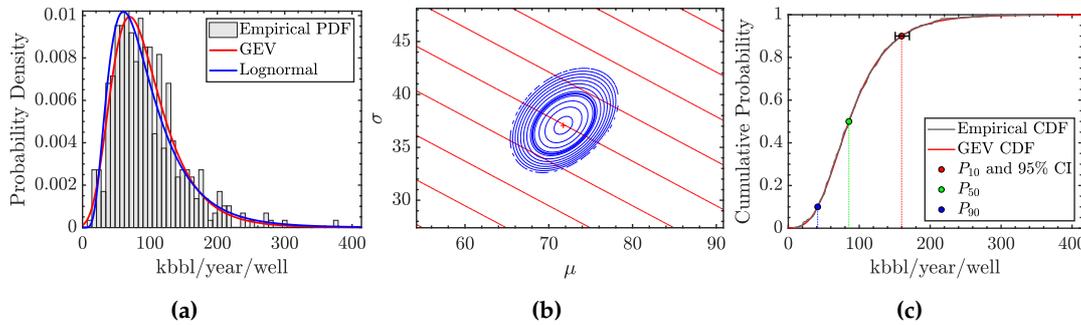
**Figure S57.** Distribution of oil production rates for 52 horizontal wells with six years on production, completed between the year 2013 and 2016 in the Middle Bakken core area. (a) GEV PDF:  $\xi = 0.1835$ ,  $\mu = 14.5393$ ,  $\sigma = 6.0805$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



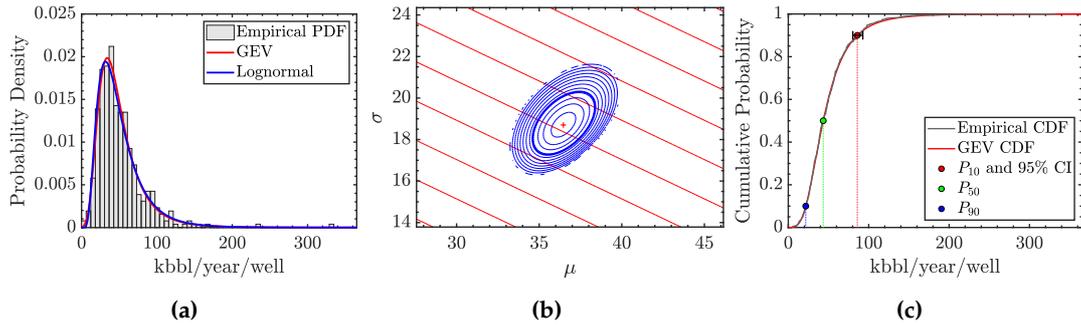
**Figure S58.** Distribution of oil production rates for 506 horizontal wells with one year on production, completed between the year 2017 and 2019 in the Middle Bakken core area. (a) GEV PDF:  $\zeta = -0.2064$ ,  $\mu = 163.4423$ ,  $\sigma = 62.6093$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



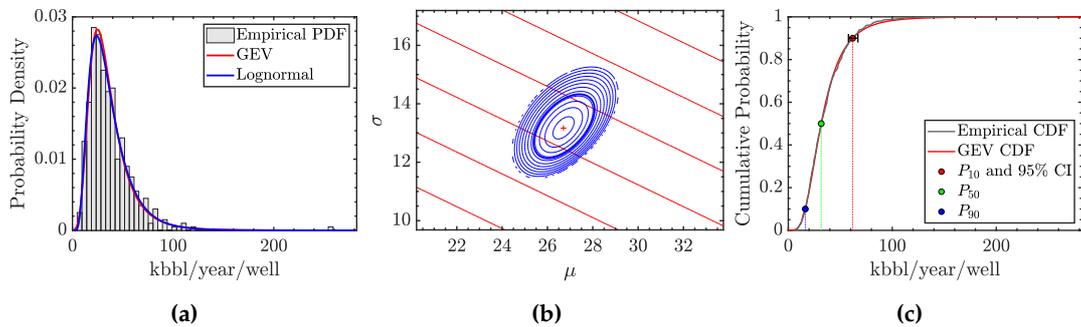
**Figure S59.** Distribution of oil production rates for 41 horizontal wells with two years on production, completed between the year 2017 and 2019 in the Middle Bakken core area. (a) GEV PDF:  $\zeta = 0.0523$ ,  $\mu = 42.9929$ ,  $\sigma = 25.0273$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



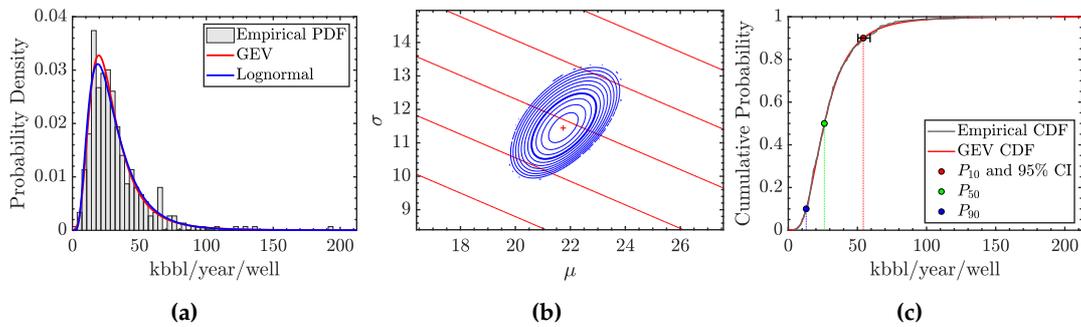
**Figure S60.** Distribution of oil production rates for 426 horizontal wells with one year on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.0474$ ,  $\mu = 71.7351$ ,  $\sigma = 37.0635$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



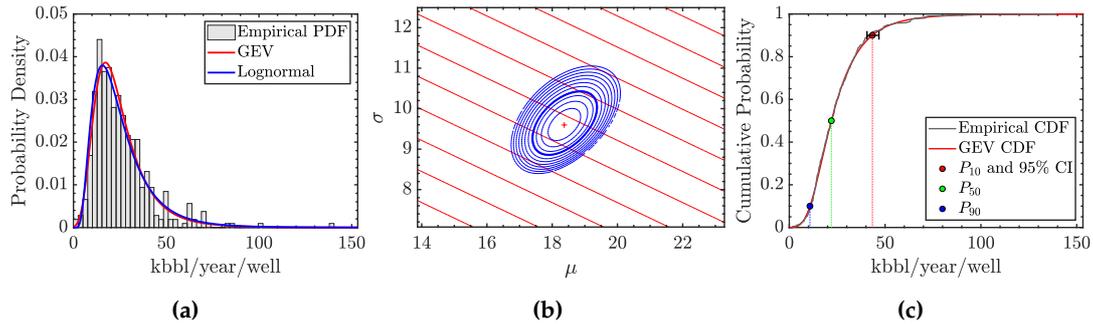
**Figure S61.** Distribution of oil production rates for 426 horizontal wells with two years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.1389$ ,  $\mu = 36.4635$ ,  $\sigma = 18.7013$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



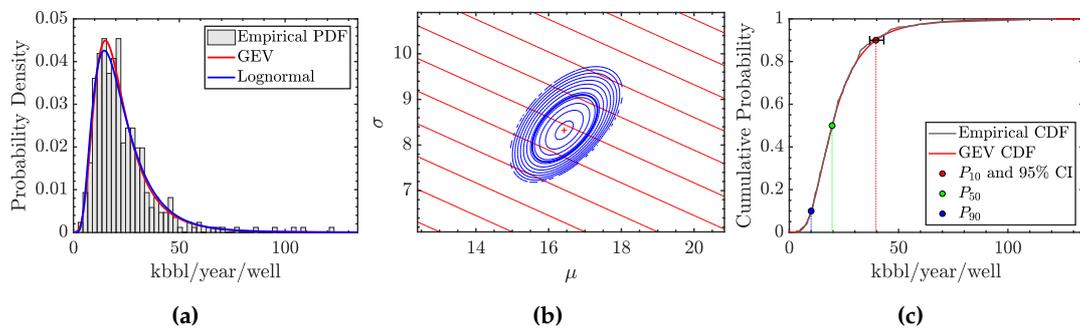
**Figure S62.** Distribution of oil production rates for 425 horizontal wells with three years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.1486$ ,  $\mu = 26.7071$ ,  $\sigma = 13.1692$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



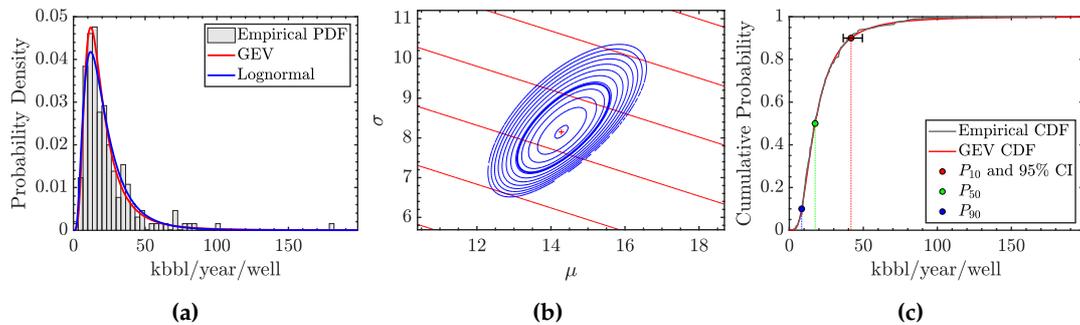
**Figure S63.** Distribution of oil production rates for 423 horizontal wells with four years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.2003$ ,  $\mu = 21.7381$ ,  $\sigma = 11.4412$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



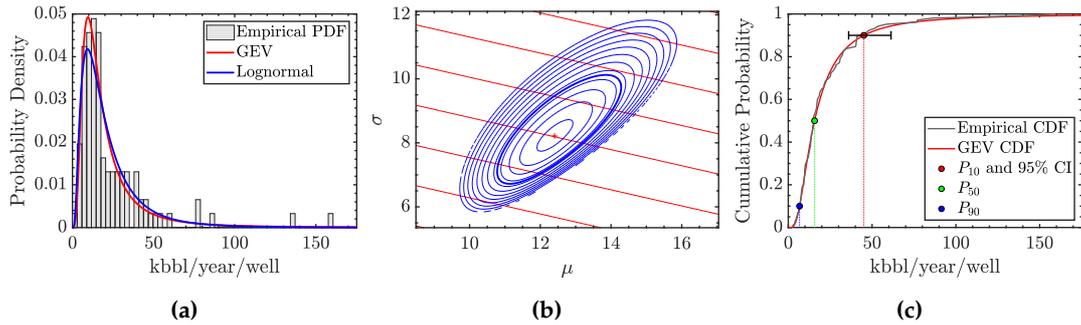
**Figure S64.** Distribution of oil production rates for 418 horizontal wells with five years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.1268$ ,  $\mu = 18.3693$ ,  $\sigma = 9.5965$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



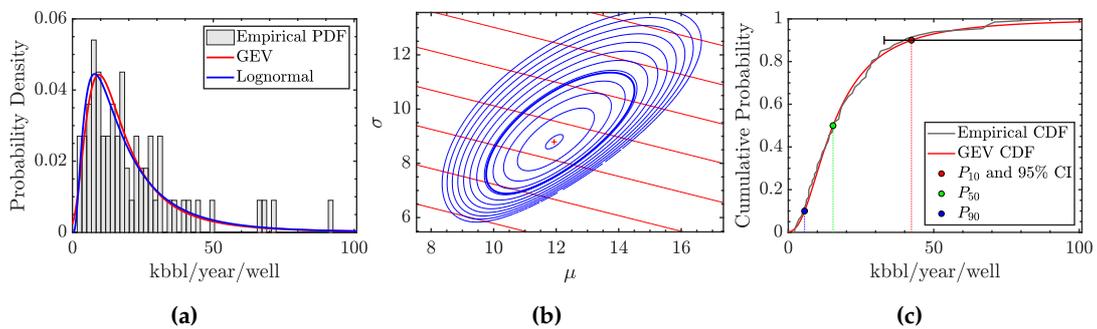
**Figure S65.** Distribution of oil production rates for 384 horizontal wells with six years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.1843$ ,  $\mu = 16.4268$ ,  $\sigma = 8.3212$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



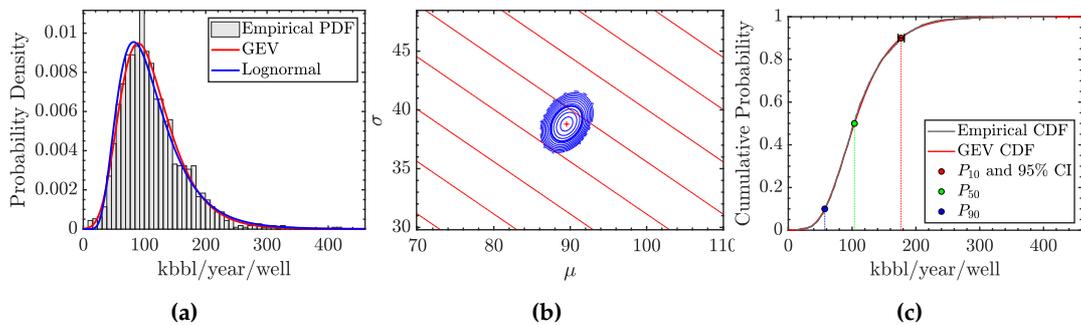
**Figure S66.** Distribution of oil production rates for 197 horizontal wells with seven years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.3368$ ,  $\mu = 14.2825$ ,  $\sigma = 8.1499$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



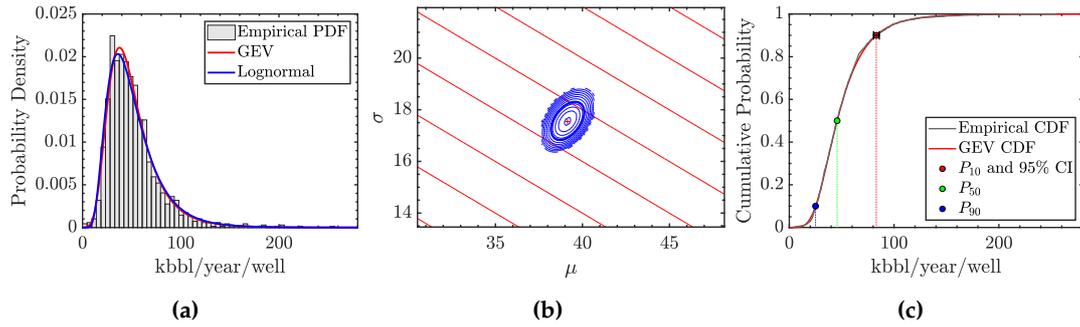
**Figure S67.** Distribution of oil production rates for 105 horizontal wells with eight years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.4664$ ,  $\mu = 12.4026$ ,  $\sigma = 8.2134$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



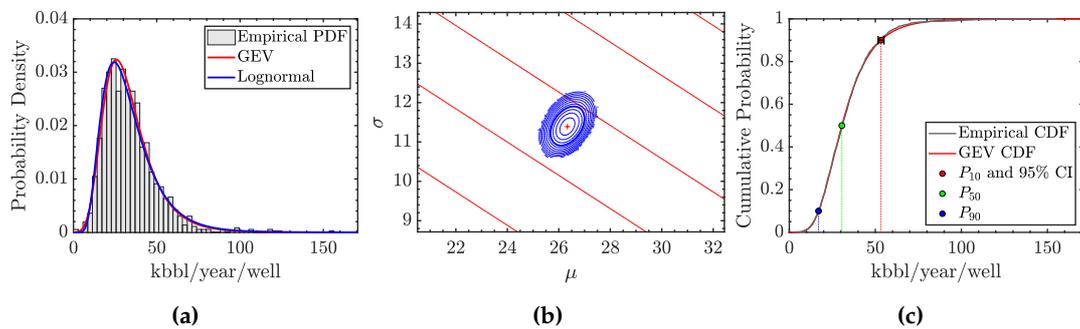
**Figure S68.** Distribution of oil production rates for 66 horizontal wells with nine years on production, completed between the year 2000 and 2012 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.3578$ ,  $\mu = 11.9365$ ,  $\sigma = 8.7922$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



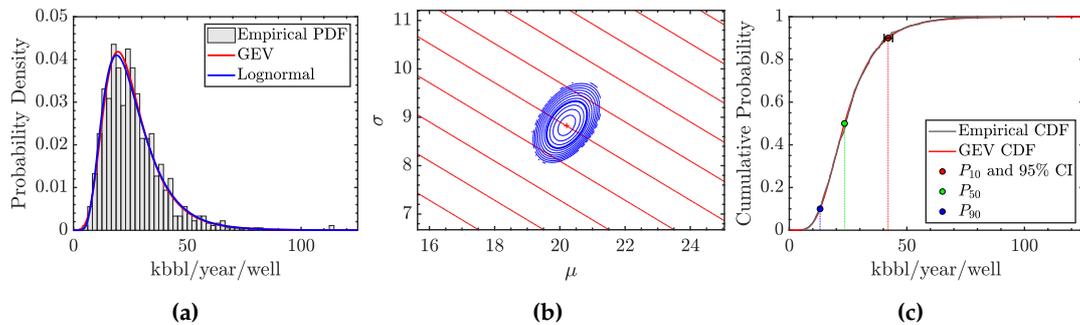
**Figure S69.** Distribution of oil production rates for 1495 horizontal wells with one year on production, completed between the year 2013 and 2016 in the Three Forks core area. (a) GEV PDF:  $\zeta = -0.0010$ ,  $\mu = 89.5261$ ,  $\sigma = 38.7894$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



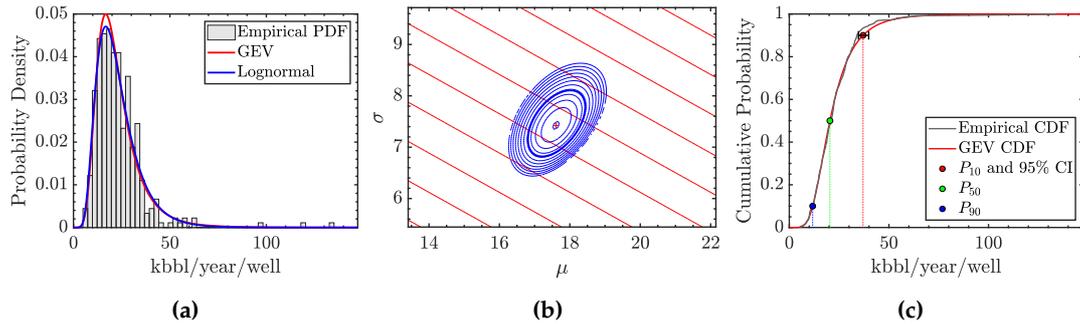
**Figure S70.** Distribution of oil production rates for 1479 horizontal wells with two years on production, completed between the year 2013 and 2016 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.0922$ ,  $\mu = 39.1416$ ,  $\sigma = 17.5436$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



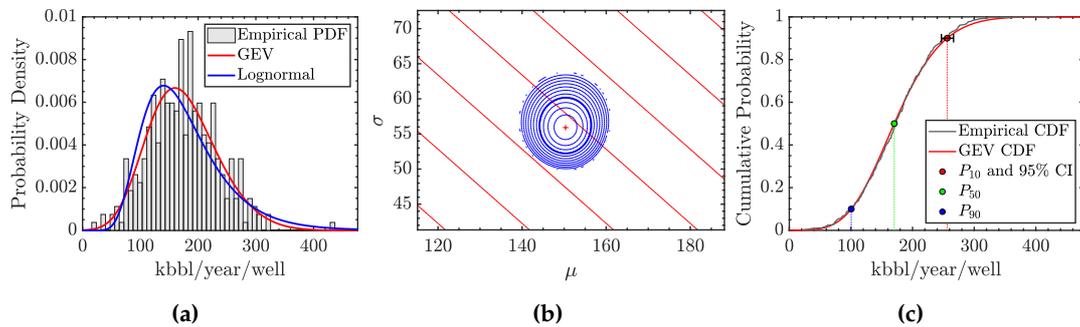
**Figure S71.** Distribution of oil production rates for 1276 horizontal wells with three years on production, completed between the year 2013 and 2016 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.0434$ ,  $\mu = 26.3341$ ,  $\sigma = 11.3894$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



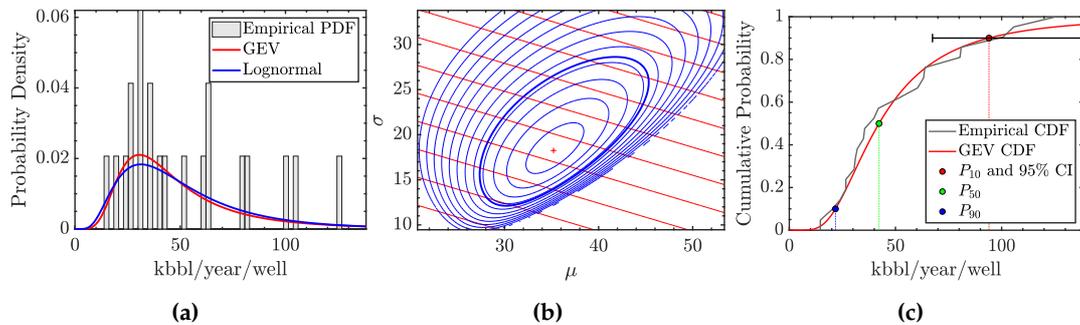
**Figure S72.** Distribution of oil production rates for 872 horizontal wells with four years on production, completed between the year 2013 and 2016 in the Three Forks core area. (a) GEV PDF:  $\zeta = 0.0818$ ,  $\mu = 20.2079$ ,  $\sigma = 8.8285$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



**Figure S73.** Distribution of oil production rates for 368 horizontal wells with five years on production, completed between the year 2013 and 2016 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.1300$ ,  $\mu = 17.6085$ ,  $\sigma = 7.4242$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



**Figure S74.** Distribution of oil production rates for 338 horizontal wells with one year on production, completed between the year 2017 and 2019 in the Three Forks core area. (a) GEV PDF:  $\xi = -0.1585$ ,  $\mu = 150.3367$ ,  $\sigma = 55.9051$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.



**Figure S75.** Distribution of oil production rates for 21 horizontal wells with two years on production, completed between the year 2017 and 2019 in the Three Forks core area. (a) GEV PDF:  $\xi = 0.3026$ ,  $\mu = 35.2056$ ,  $\sigma = 18.2461$ . (b) Maximum Likelihood Estimate, 95% CI for  $\mu$  and  $\sigma$ . (c) GEV CDF with the 90% confidence limits (CIs) on the residual for the  $P_{10}$  well.