Supplement of

Short high-accuracy tritium data time series for assessing groundwater mean transit times in the vadose and saturated zones of the Luxembourg Sandstone aquifer

Laurent Gourdol[1], Michael K. Stewart[2], Uwe Morgenstern[2], Laurent Pfister[1,3]

[1]Luxembourg Institute of Science and Technology (LIST), Belvaux, Luxembourg
[2]GNS Science, Tritium & Water Dating Laboratory, Lower Hutt, New Zealand
[3]University of Luxembourg, Faculty of Science, Technology and Communication, Belval, Luxembourg

Correspondence to: Laurent Gourdol (laurent.gourdol@list.lu)

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Table S1. Statistical summary of the ensembles of most likely EPM solutions retained.

Spring	N	NSE	Exponential to total flow (F)					Mean Transit Time (τ_m, years)					τ_{exp} (τ_m.F, years)					τ_{pf} (τ_m.(1-F), years)				
		median	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%
B01	1668	0.87	0.64	0.75	0.86	0.92	0.97	15.7	17.6	19.1	20.6	22.6	14.0	14.8	15.5	16.5	18.0	0.4	1.3	2.6	5.3	8.1
B02	1667	0.83	0.59	0.70	0.83	0.91	0.97	8.1	11.6	14.1	16.5	19.6	7.6	10.3	11.2	12.0	13.1	0.4	1.0	2.3	4.9	8.0
B03	1668	0.86	0.61	0.75	0.83	0.91	0.98	12.5	14.5	16.2	17.9	20.7	11.6	12.3	13.0	13.9	15.0	0.3	1.2	2.8	4.4	8.0
B06	1656	0.89	0.53	0.65	0.77	0.88	0.95	10.1	13.3	15.9	18.8	21.6	9.2	10.5	11.6	13.0	14.3	0.5	1.6	3.6	6.4	10.1
B07	1667	0.70	0.93	0.95	0.97	0.98	1.00	12.3	13.2	14.1	15.0	15.8	12.0	12.8	13.6	14.4	15.2	0.0	0.2	0.5	0.7	1.0
B09	1462	0.68	0.92	0.95	0.97	0.98	1.00	13.3	14.6	15.9	17.0	18.0	12.9	14.1	15.2	16.2	17.5	0.1	0.3	0.5	0.8	1.4
B10	1668	0.87	0.60	0.69	0.82	0.91	0.97	12.9	14.9	16.7	18.7	21.2	11.8	12.4	13.2	13.9	15.1	0.4	1.4	2.9	5.7	8.4
C01	1667	0.93	0.63	0.74	0.83	0.91	0.96	19.5	22.1	24.0	25.6	27.2	15.4	17.2	18.9	21.1	24.7	0.9	2.1	4.0	6.5	9.5
C03	1311	0.90	0.55	0.67	0.75	0.85	0.93	10.0	12.5	14.7	17.5	20.6	8.3	9.8	11.1	12.2	13.5	0.8	1.9	3.5	5.7	9.0
C04	1079	0.90	0.61	0.70	0.78	0.84	0.93	7.9	9.4	11.5	13.8	16.7	6.5	7.8	8.9	10.1	10.9	0.7	1.5	2.4	3.9	6.6
C05	1666	0.82	0.62	0.70	0.78	0.83	0.89	5.4	6.4	7.4	8.5	9.8	3.5	4.7	5.7	7.0	8.2	0.9	1.3	1.7	2.1	2.5
C07	1474	0.90	0.56	0.66	0.78	0.88	0.95	8.3	11.3	14.0	16.8	19.9	7.5	9.4	10.5	11.5	12.6	0.5	1.3	3.1	5.6	8.8
C09	1062	0.87	0.71	0.78	0.83	0.89	0.95	6.7	8.6	10.7	12.4	14.2	5.6	7.7	8.9	10.0	11.0	0.4	1.0	1.5	2.7	3.9
C10	1605	0.92	0.50	0.60	0.67	0.75	0.86	6.3	7.8	9.1	10.8	13.5	3.4	4.8	6.4	8.0	9.3	1.3	2.2	3.0	3.8	4.7
D01	1598	0.89	0.48	0.62	0.72	0.81	0.90	5.8	7.7	9.3	11.3	13.6	2.9	4.8	7.2	8.9	10.2	0.9	2.0	2.7	3.3	4.0
K01	1086	0.69	0.47	0.49	0.51	0.53	0.56	12.7	14.0	15.1	16.4	17.6	6.3	7.1	7.8	8.4	9.0	6.0	6.7	7.3	8.0	8.9
K02	1663	0.82	0.43	0.44	0.46	0.48	0.50	13.1	14.1	15.1	16.3	17.4	5.7	6.4	7.1	7.6	8.1	7.1	7.6	8.1	8.7	9.5
K03	1668	0.89	0.37	0.45	0.49	0.54	0.59	9.5	10.8	12.3	14.2	16.8	3.6	5.0	6.3	7.5	8.4	4.9	5.6	6.2	7.0	8.6
K07	1667	0.86	0.44	0.49	0.53	0.60	0.69	8.7	10.1	12.4	15.6	19.0	4.4	5.9	7.2	8.1	8.9	3.1	4.3	5.4	7.6	10.6
K13	1668	0.86	0.42	0.49	0.55	0.63	0.72	7.9	9.4	11.5	14.9	19.0	3.7	5.4	7.2	8.3	9.3	2.7	3.8	5.0	6.6	10.6
K17	1667	0.83	0.41	0.44	0.47	0.51	0.57	10.2	11.6	13.7	16.4	18.6	4.6	5.7	6.8	7.5	8.5	4.9	5.8	7.1	8.8	10.5
K19	1668	0.92	0.49	0.54	0.59	0.67	0.77	7.8	9.4	11.1	13.5	17.8	4.5	5.8	7.1	8.3	9.3	2.2	3.2	4.4	5.9	8.7
K21	1667	0.92	0.36	0.52	0.67	0.78	0.89	4.7	7.4	12.5	16.8	20.5	2.2	5.3	8.3	10.2	12.5	1.1	2.0	3.0	6.0	12.4
K21A	1522	0.86	0.25	0.36	0.48	0.55	0.64	9.0	11.4	13.6	15.2	17.1	3.5	4.9	6.1	7.1	8.3	3.8	5.1	7.1	9.6	11.3
K22	1667	0.92	0.47	0.53	0.58	0.65	0.74	7.8	9.3	10.9	13.4	17.7	4.2	5.4	6.8	8.1	9.2	2.5	3.5	4.6	5.7	8.6
K24	1580	0.79	0.44	0.46	0.49	0.51	0.53	12.2	13.3	14.7	16.3	17.7	5.5	6.4	7.3	8.1	8.7	6.3	6.8	7.5	8.3	9.3
K26	1668	0.81	0.46	0.48	0.51	0.55	0.61	10.0	11.3	13.4	15.9	18.1	5.3	6.2	6.9	7.9	8.9	4.1	5.2	6.6	8.0	9.6
K28	1669	0.88	0.47	0.51	0.55	0.62	0.70	8.8	9.9	11.6	14.5	17.9	4.8	5.9	6.8	7.8	9.0	2.7	4.1	5.3	6.8	9.1
K31	1667	0.92	0.48	0.53	0.59	0.66	0.76	7.8	9.2	10.7	12.9	17.8	4.3	5.4	6.8	8.1	9.1	2.3	3.3	4.3	5.5	8.6
K32	1667	0.91	0.40	0.48	0.53	0.61	0.70	8.6	9.7	11.2	13.5	17.1	3.8	5.3	6.4	7.6	8.8	2.8	4.3	5.4	6.4	8.6
M01	1550	0.89	0.54	0.66	0.76	0.83	0.90	5.0	6.3	7.6	9.8	12.0	2.8	4.2	5.9	8.1	9.8	0.8	1.4	2.0	2.5	3.0
P01	1666	0.93	0.56	0.67	0.78	0.87	0.95	14.6	17.0	19.3	21.2	23.6	12.3	13.1	14.3	15.5	17.4	0.8	2.2	4.1	7.0	10.1
S01	1668	0.91	0.54	0.62	0.69	0.76	0.85	6.4	7.9	9.5	11.6	15.0	3.9	5.3	6.9	8.4	9.4	1.3	2.1	2.8	3.9	6.0
S02	1667	0.89	0.51	0.62	0.70	0.79	0.90	6.2	8.1	10.9	14.0	18.0	3.4	5.6	8.4	10.4	11.7	1.1	2.1	3.0	4.1	7.1
S03	1667	0.91	0.45	0.57	0.64	0.73	0.82	6.7	8.3	10.4	13.8	18.0	3.6	5.0	7.3	9.4	10.6	1.6	2.6	3.7	5.0	8.0

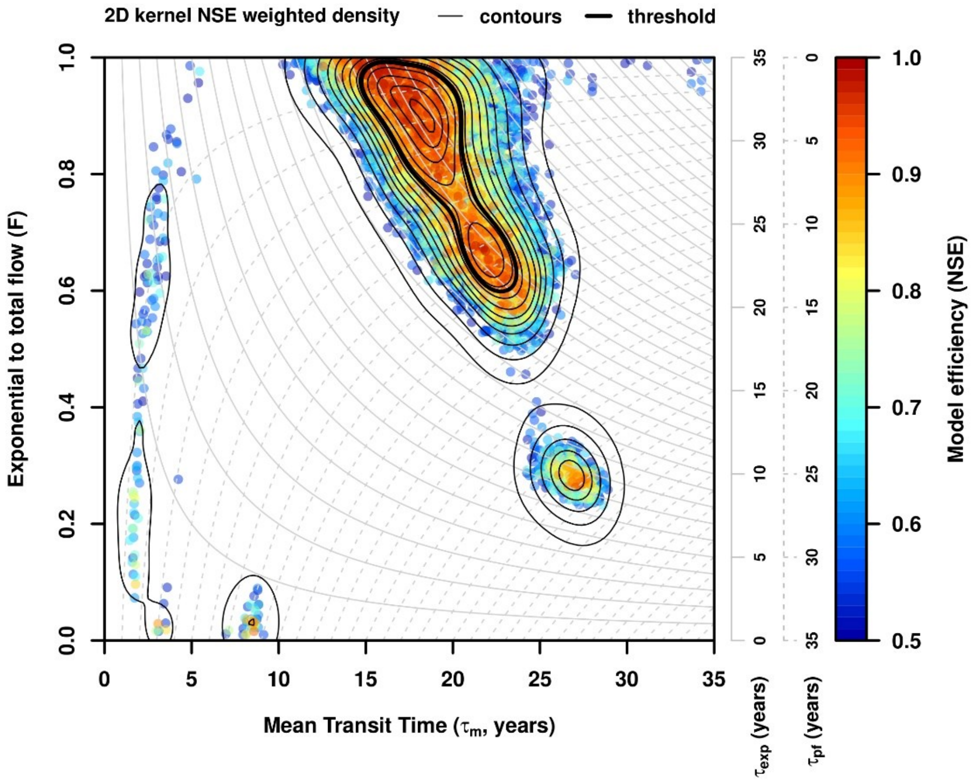
Table S2. Statistical summary of the spring discharge – effective precipitation cross-correlation analysis results.

Spring	Correlation peak value					Time lag to correlation peak (months)					Cumulative precipitation time window (months)					Mean response time of spring to precipitation (months)				
	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%	P5%	P25%	median	P75%	P95%
B01	0.76	0.83	0.87	0.90	0.92	0	0	0	0	1	8	10	11	21	47	5	5	6	11	23
B02	0.42	0.57	0.70	0.80	0.94	0	0	0	0	22	6	13	14	32	54	3	7	7	16	36
B03	0.69	0.79	0.83	0.87	0.91	0	0	0	1	2	9	10	17	20	46	5	6	9	10	23
B06	0.64	0.69	0.74	0.80	0.86	0	0	0	0	2	2	6	9	30	46	2	3	8	15	23
B07	0.71	0.77	0.82	0.89	0.92	0	0	0	0	1	7	8	10	19	32	4	4	5	10	16
B09	0.67	0.78	0.85	0.88	0.91	0	0	0	0	0	3	4	4	15	41	2	2	2	8	20
B10	0.73	0.77	0.80	0.85	0.91	0	0	0	0	1	8	12	16	29	35	4	6	8	14	17
C01	0.70	0.78	0.87	0.92	0.93	0	0	0	1	3	10	17	24	37	49	5	11	12	19	26
C03	0.68	0.80	0.85	0.95	0.98	0	0	0	1	5	13	24	25	36	52	9	13	13	18	26
C04	0.74	0.80	0.85	0.91	0.95	0	0	0	0	2	11	15	24	35	49	6	8	13	18	24
C05	0.73	0.81	0.85	0.91	0.95	0	0	1	3	4	16	23	24	36	49	9	12	14	18	25
C07	0.62	0.79	0.84	0.89	0.97	0	0	1	2	4	11	22	36	48	49	6	11	18	25	26
C09	0.58	0.70	0.77	0.82	0.89	0	0	0	1	1	11	16	26	47	56	6	8	13	24	28
C10	0.78	0.81	0.84	0.87	0.89	0	0	0	0	0	6	7	17	28	53	3	4	8	14	27
D01	0.69	0.77	0.83	0.88	0.96	0	0	1	2	6	12	12	23	32	51	7	8	12	17	26
K01	0.70	0.83	0.86	0.89	0.92	0	0	0	1	4	11	12	24	24	49	6	8	12	12	24
K02	0.74	0.80	0.88	0.91	0.96	0	0	1	2	5	12	19	25	38	42	8	10	13	19	21
K03	0.61	0.71	0.83	0.92	0.96	0	0	1	5	9	12	23	25	46	59	9	12	13	24	34
K07	0.54	0.79	0.87	0.91	0.96	0	0	0	0	10	12	24	26	37	44	10	13	17	19	22
K13	0.66	0.77	0.85	0.91	0.96	0	0	0	7	10	12	24	24	37	48	10	12	15	19	24
K17	0.66	0.76	0.82	0.87	0.96	0	0	3	8	10	11	23	35	48	50	8	15	18	25	28
K19	0.71	0.80	0.87	0.90	0.95	0	0	0	2	8	16	24	31	40	47	10	14	16	20	24
K21	0.69	0.79	0.87	0.92	0.96	0	0	0	1	10	21	24	29	40	49	12	14	16	20	25
K21A	0.62	0.74	0.82	0.89	0.97	0	0	1	9	14	13	22	37	50	50	14	15	20	25	25
K22	0.70	0.79	0.86	0.89	0.95	0	0	0	1	4	12	19	28	34	43	7	10	14	17	22
K24	0.68	0.85	0.90	0.94	0.97	0	0	0	2	3	23	24	24	25	47	12	12	13	14	24
K26	0.35	0.72	0.85	0.93	0.96	0	0	0	4	25	13	24	35	44	49	9	14	18	22	37
K28	0.66	0.79	0.87	0.92	0.97	0	0	0	3	6	23	24	36	47	55	12	14	18	24	29
K31	0.74	0.81	0.86	0.92	0.97	0	0	0	3	7	23	25	36	44	48	12	14	18	22	26
K32	0.62	0.81	0.87	0.92	0.95	0	0	0	0	4	17	24	25	36	48	9	13	14	18	26
M01	0.87	0.88	0.90	0.91	0.93	0	0	0	0	1	6	8	19	20	31	3	4	10	10	15
S	0.75	0.85	0.90	0.94	0.97	0	0	0	1	2	18	23	24	30	47	10	12	13	15	24

Table S3. Average physicochemical characteristics of spring waters.

Spring	O_2	pH	EC $^{(25°C)}$	SiO_2	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	TDS
	mg/L	pH unit	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
B01	7.57	7.15	994	8.29	33.9	1.46	2.95	171.8	89.3	48.6	374	730
B02	6.25	7.20	1122	8.91	42.9	2.30	3.53	189.8	113.8	105.2	352	818
B03	9.18	7.44	780	8.04	22.9	1.18	1.88	140.5	51.0	33.8	335	594
B06	4.65	7.33	962	7.24	30.9	1.34	10.93	151.6	110.6	87.2	283	682
B07	10.47	7.79	418	6.01	3.3	0.37	1.14	83.9	5.8	31.5	206	339
B09	6.65	7.26	763	8.61	14.3	1.99	4.48	146.0	22.9	66.9	360	625
B10	10.30	7.55	569	6.97	6.9	0.90	1.47	111.7	16.6	22.0	274	440
C01	9.57	7.55	587	6.63	12.3	0.59	1.36	108.8	34.8	37.7	247	449
C03	10.57	7.72	623	6.63	22.7	0.65	1.24	106.8	41.4	37.9	260	477
C04	10.13	7.55	606	6.56	17.4	0.59	1.30	109.4	34.3	39.8	261	470
C05	10.51	7.66	603	6.55	16.7	0.56	1.02	109.2	34.2	39.5	255	463
C07	10.59	7.81	591	6.45	17.7	0.60	0.93	105.0	39.3	37.8	243	451
C09	10.33	7.70	607	6.69	21.8	0.57	1.31	105.9	37.9	28.6	272	475
C10	7.45	7.51	583	6.75	8.8	0.90	6.36	105.9	18.8	48.2	263	459
D01	10.34	7.67	565	6.73	5.8	0.63	1.27	113.3	11.4	50.0	252	441
K01	9.74	7.47	699	7.17	16.2	1.18	2.61	125.3	44.5	54.5	259	511
K02	9.56	7.51	648	6.89	9.6	0.81	2.21	122.4	27.1	48.8	251	469
K03	7.94	7.41	619	6.74	7.7	0.73	2.12	118.7	21.3	46.5	247	451
K07	8.81	7.48	577	6.85	4.5	0.65	1.86	115.2	9.4	48.0	247	433
K13	9.44	7.56	569	6.89	4.5	0.60	1.17	114.1	9.3	46.5	242	426
K17	9.93	7.63	601	6.57	4.8	0.57	0.95	118.2	11.6	46.4	230	419
K19	7.86	7.53	586	6.85	4.7	0.64	1.80	115.6	9.8	49.3	242	431
K21	5.76	7.46	591	6.50	4.5	0.95	7.05	108.1	10.4	58.6	228	424
K21A	10.12	7.61	586	6.45	5.0	0.52	0.87	113.7	11.4	40.0	215	393
K22	10.04	7.55	533	6.69	5.8	0.53	1.35	104.7	12.7	31.5	244	408
K24	9.35	7.56	645	7.11	13.4	0.87	2.68	117.4	30.0	45.5	256	473
K26	9.09	7.51	665	7.15	15.0	0.84	2.13	120.2	33.5	44.4	257	480
K28	9.57	7.58	672	7.42	15.4	0.89	2.05	121.6	33.8	46.1	258	485
K31	8.71	7.56	690	7.31	18.5	1.05	2.10	122.3	38.9	47.1	262	499
K32	9.91	7.61	616	7.51	10.3	0.98	1.97	117.1	20.5	42.5	266	467
M01	6.36	7.46	856	6.58	19.2	1.48	8.85	152.0	47.3	111.9	303	650
P01	7.97	7.55	792	7.81	27.0	1.21	3.90	131.5	69.5	60.5	257	559
S01	9.29	7.58	651	7.39	13.5	0.69	1.90	122.1	32.0	58.4	271	507
S02	9.15	7.56	753	7.35	22.5	1.45	2.02	134.1	42.4	118.9	245	573
S03	8.57	7.57	734	7.58	21.1	1.16	2.36	129.8	44.8	84.7	262	553

(a)



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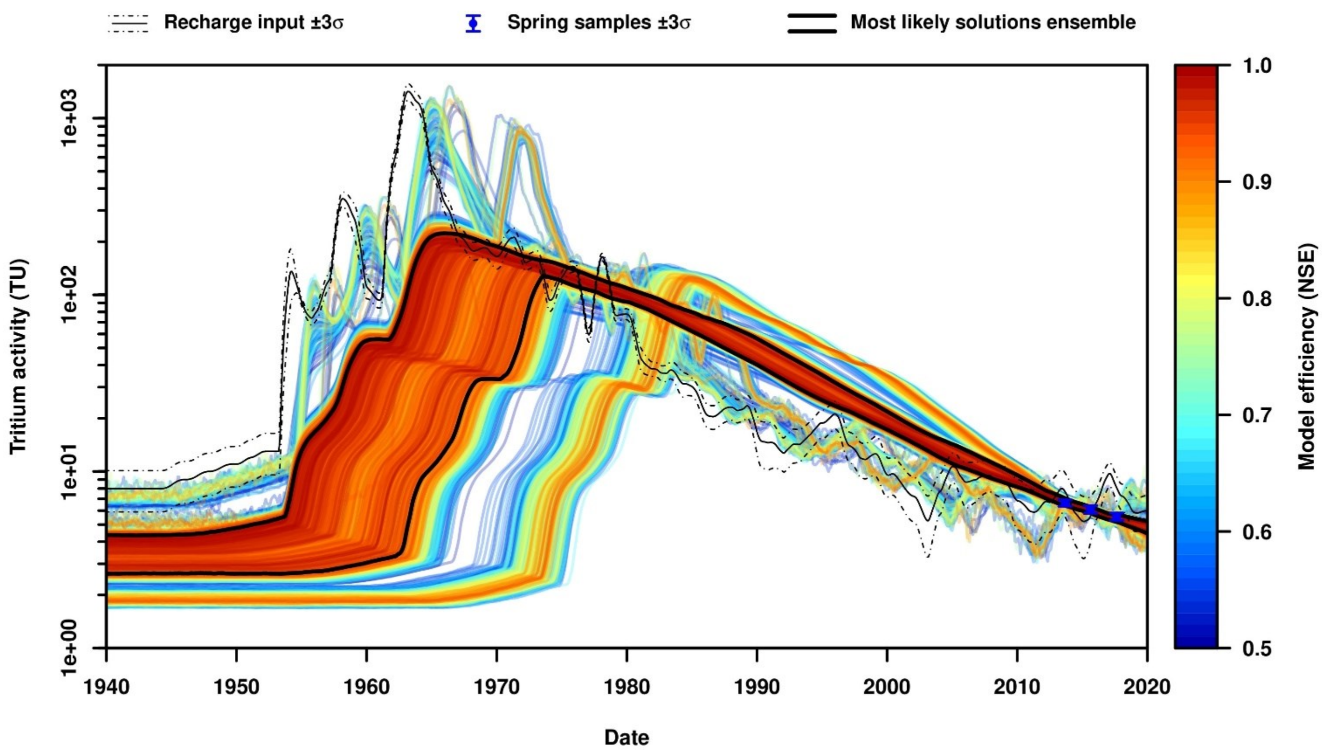


Figure S1: Modelling results of spring B01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

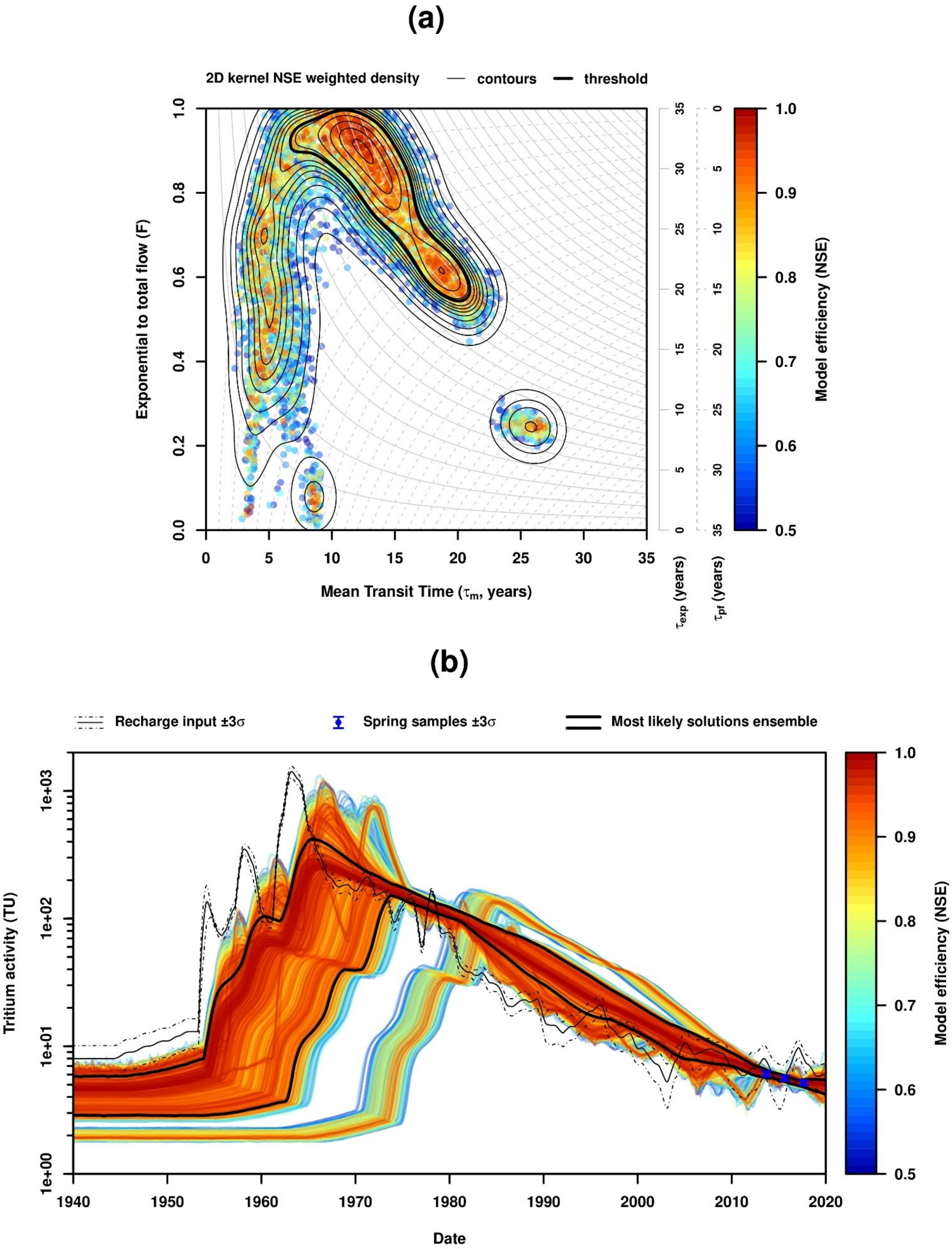
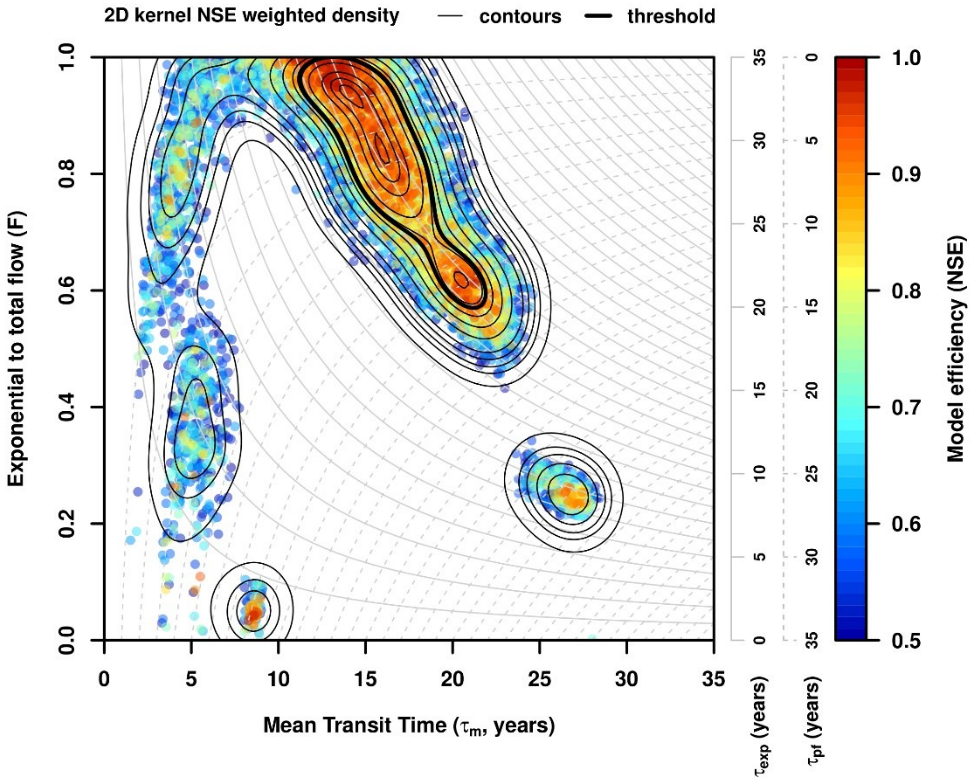


Figure S2: Modelling results of spring B02 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



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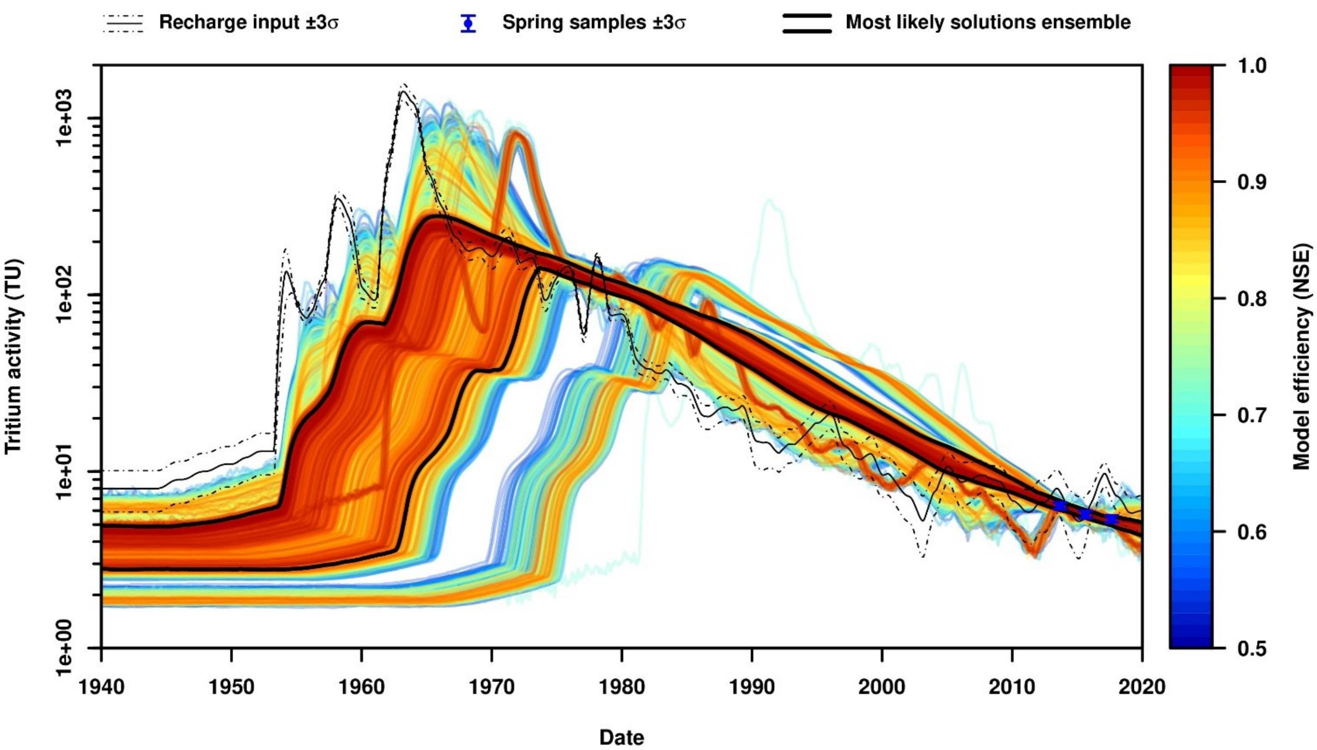
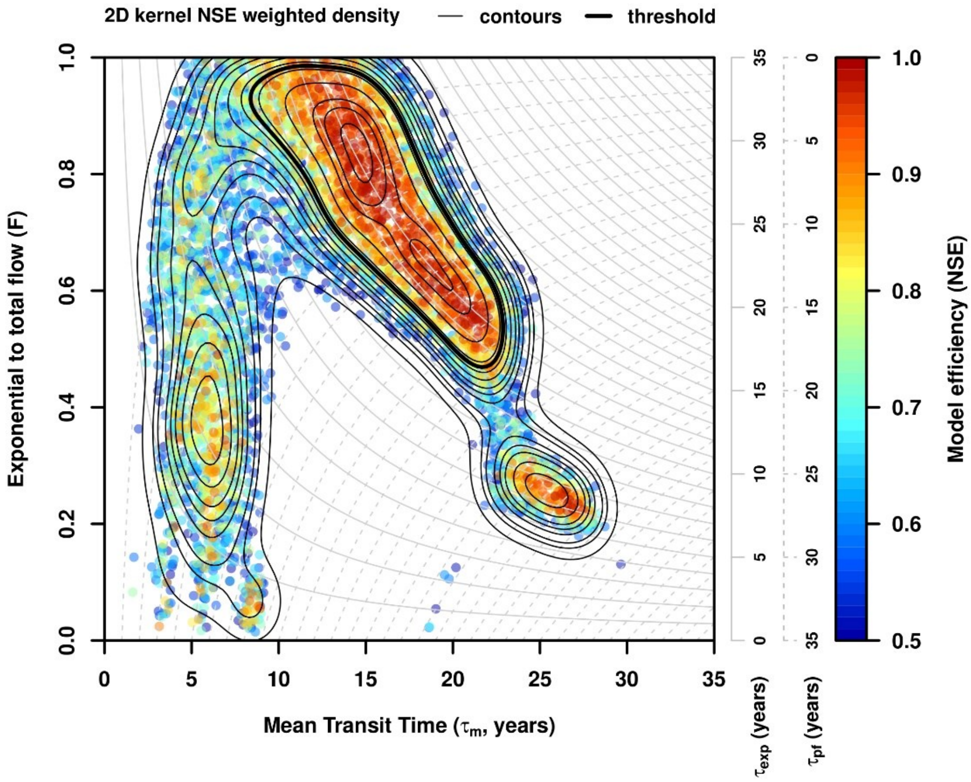


Figure S3: Modelling results of spring B03 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



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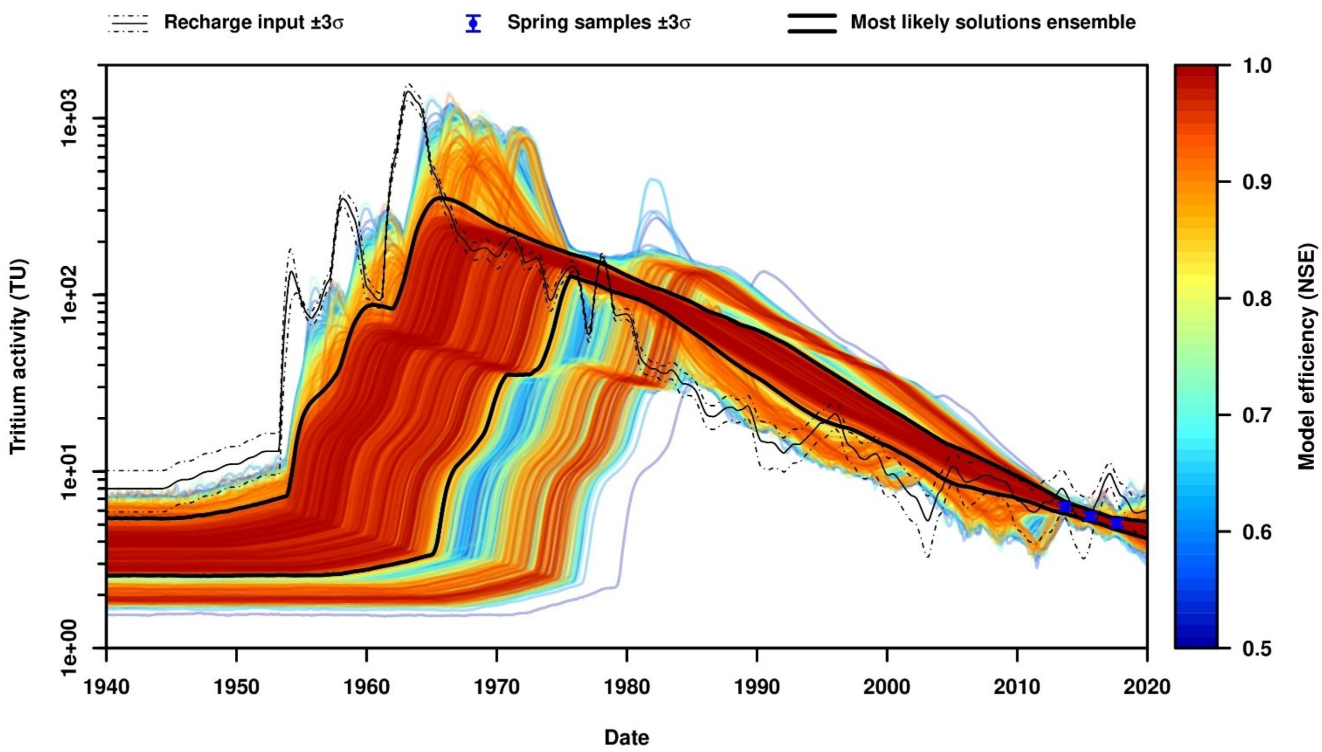


Figure S4: Modelling results of spring B06 in the EPM parameter space (a) and associated modelled tritium time-series (b).

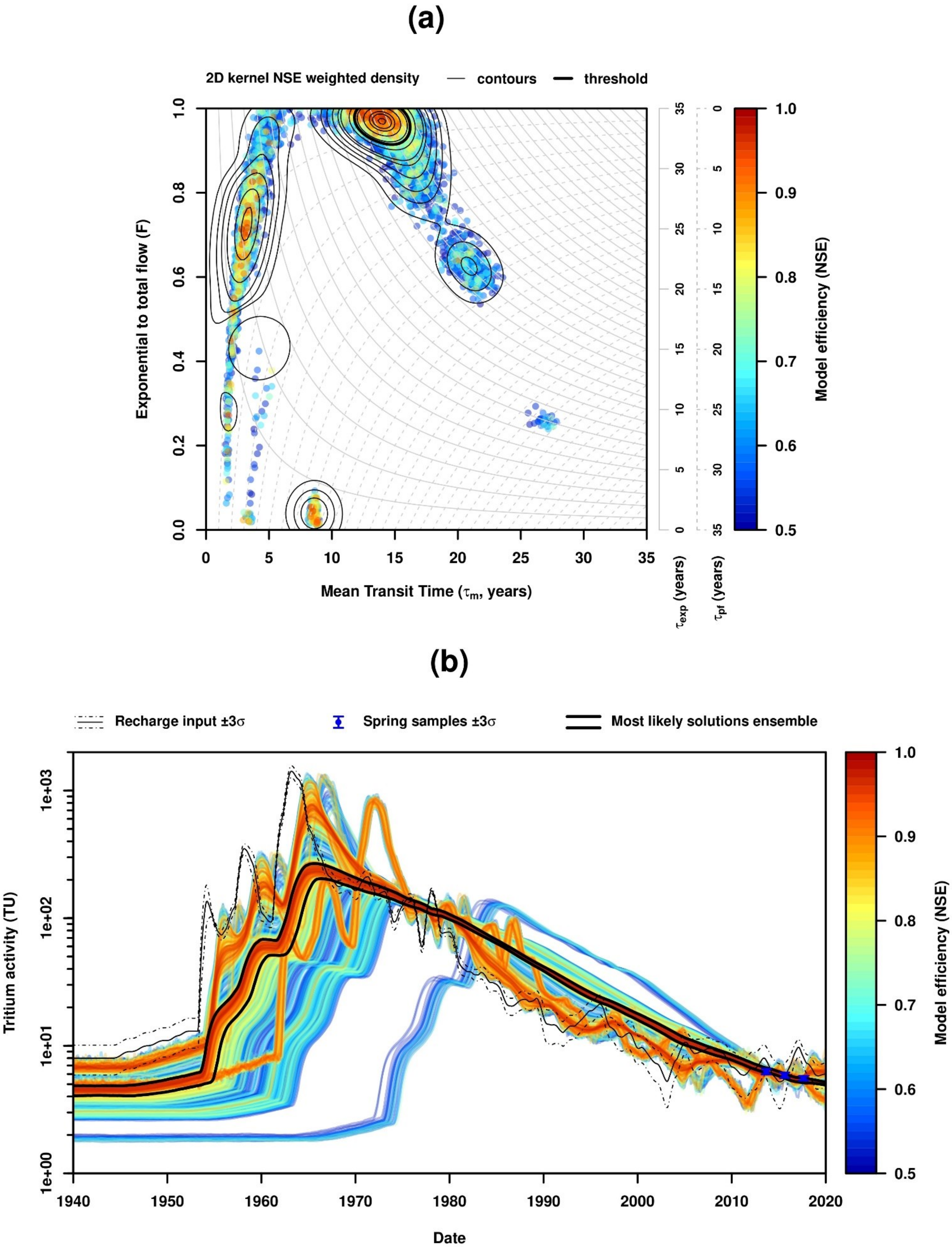
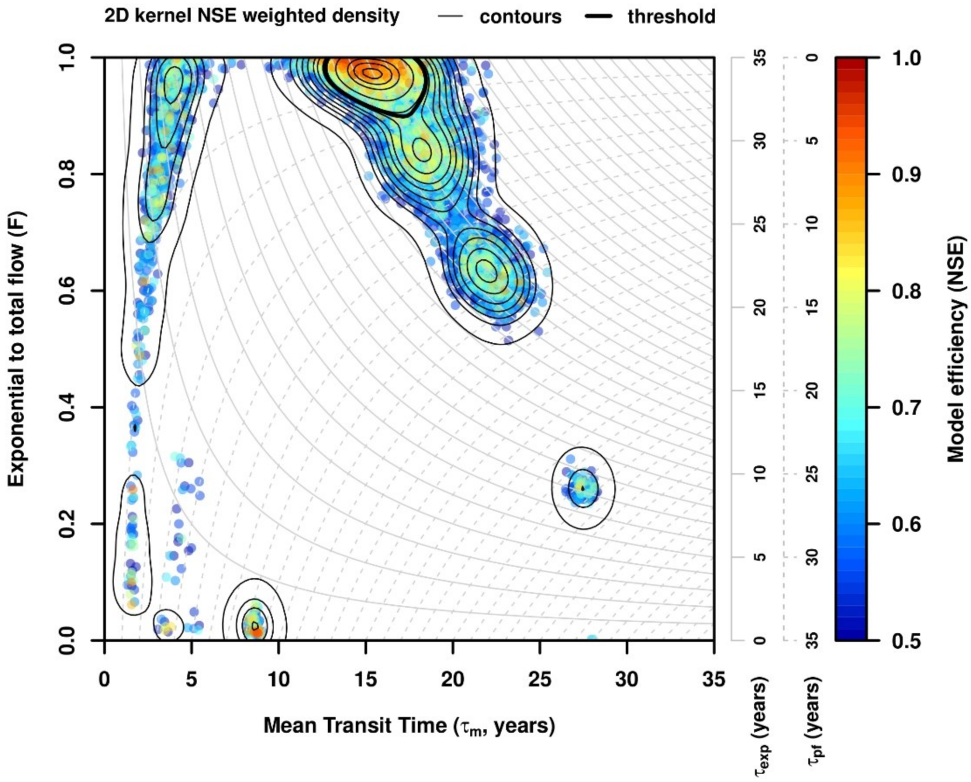


Figure S5: Modelling results of spring B07 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

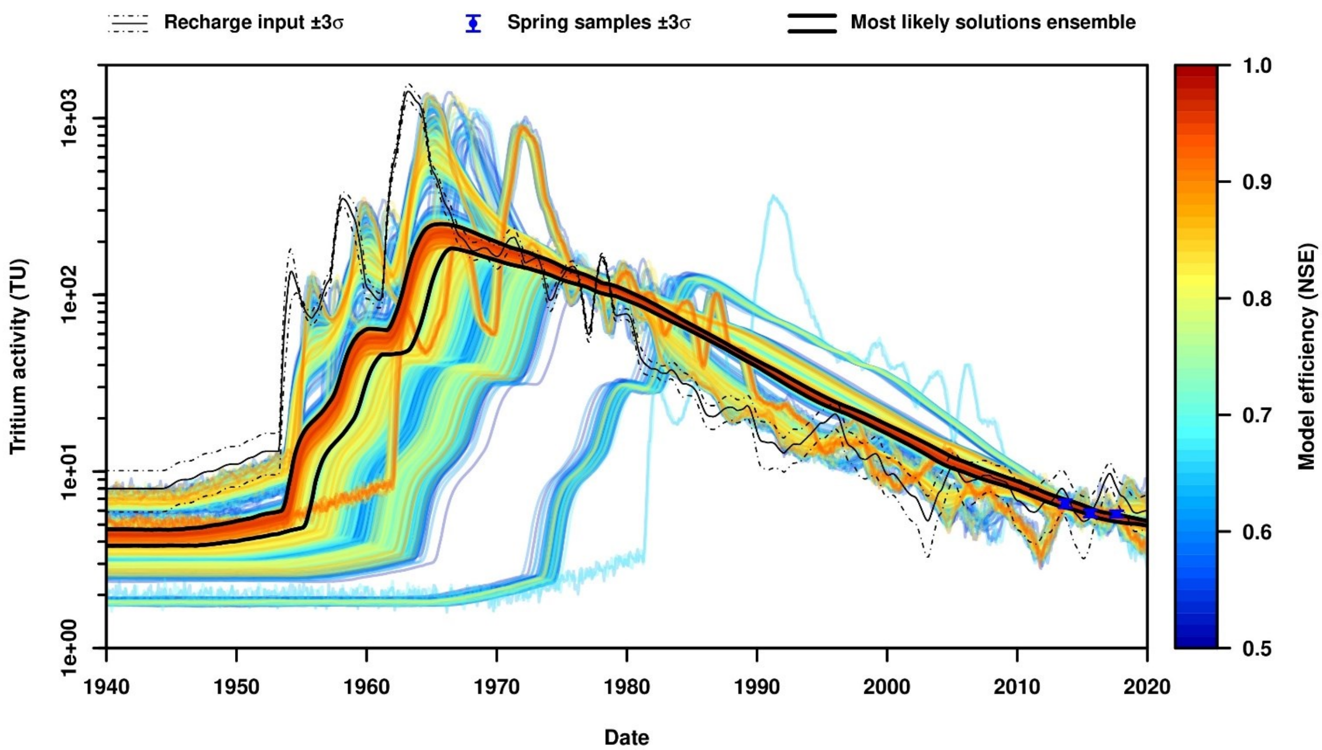
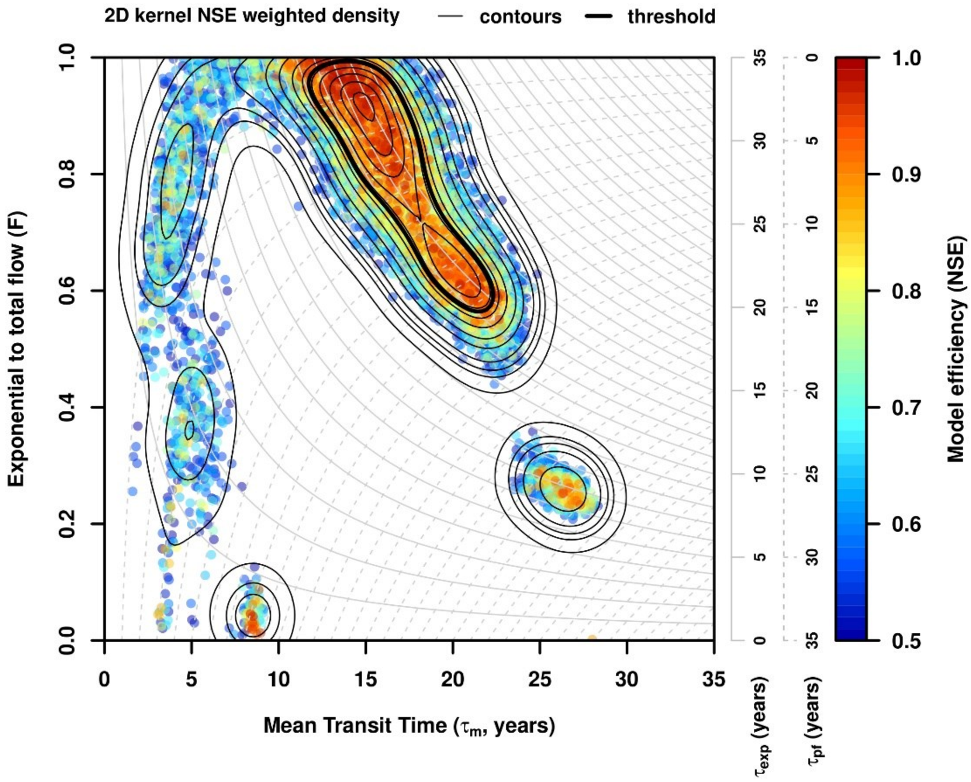


Figure S6: Modelling results of spring B09 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

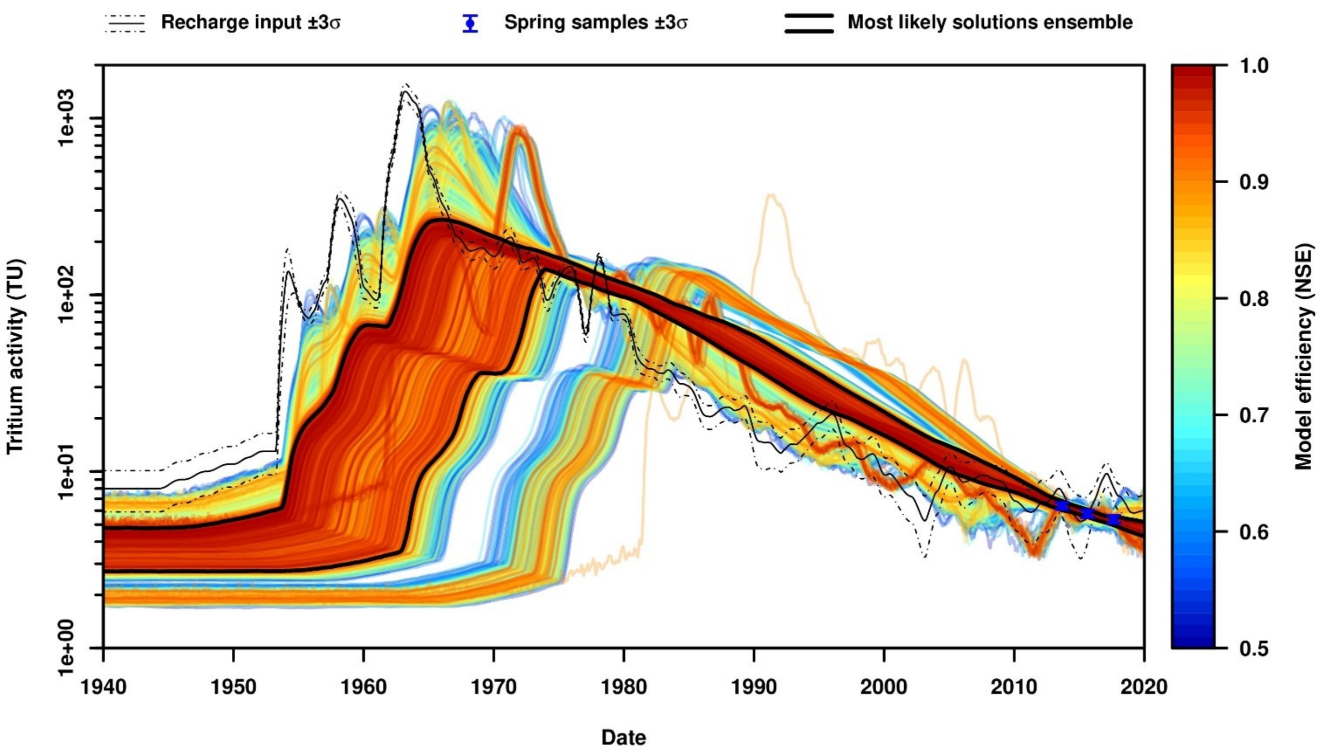
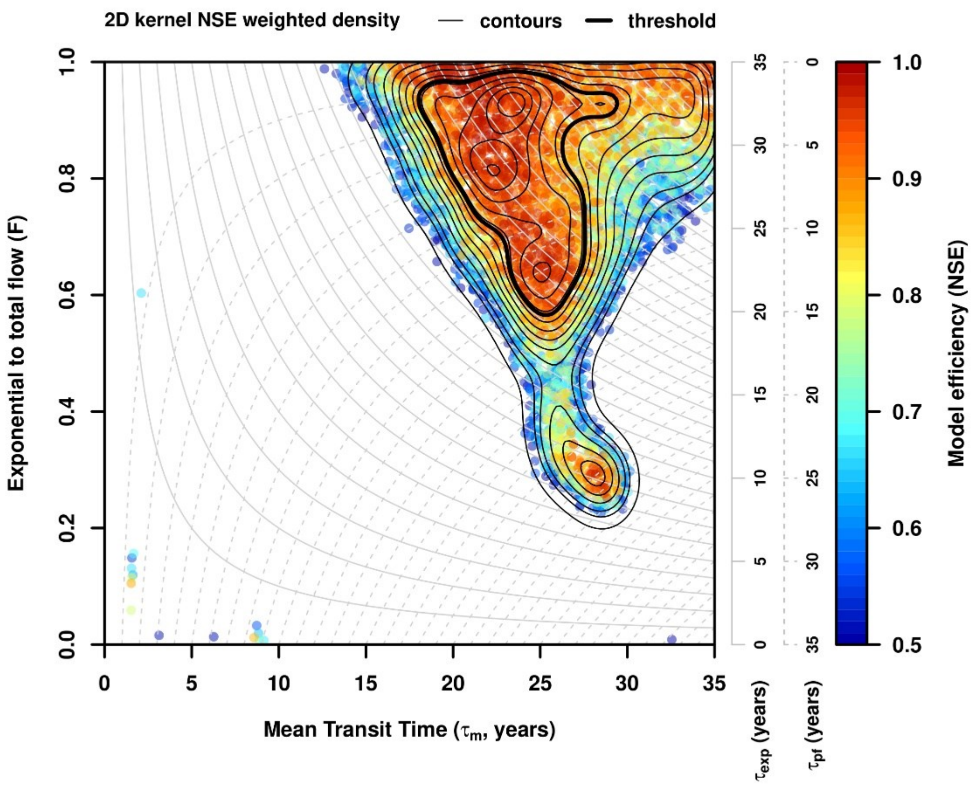


Figure S7: Modelling results of spring B10 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

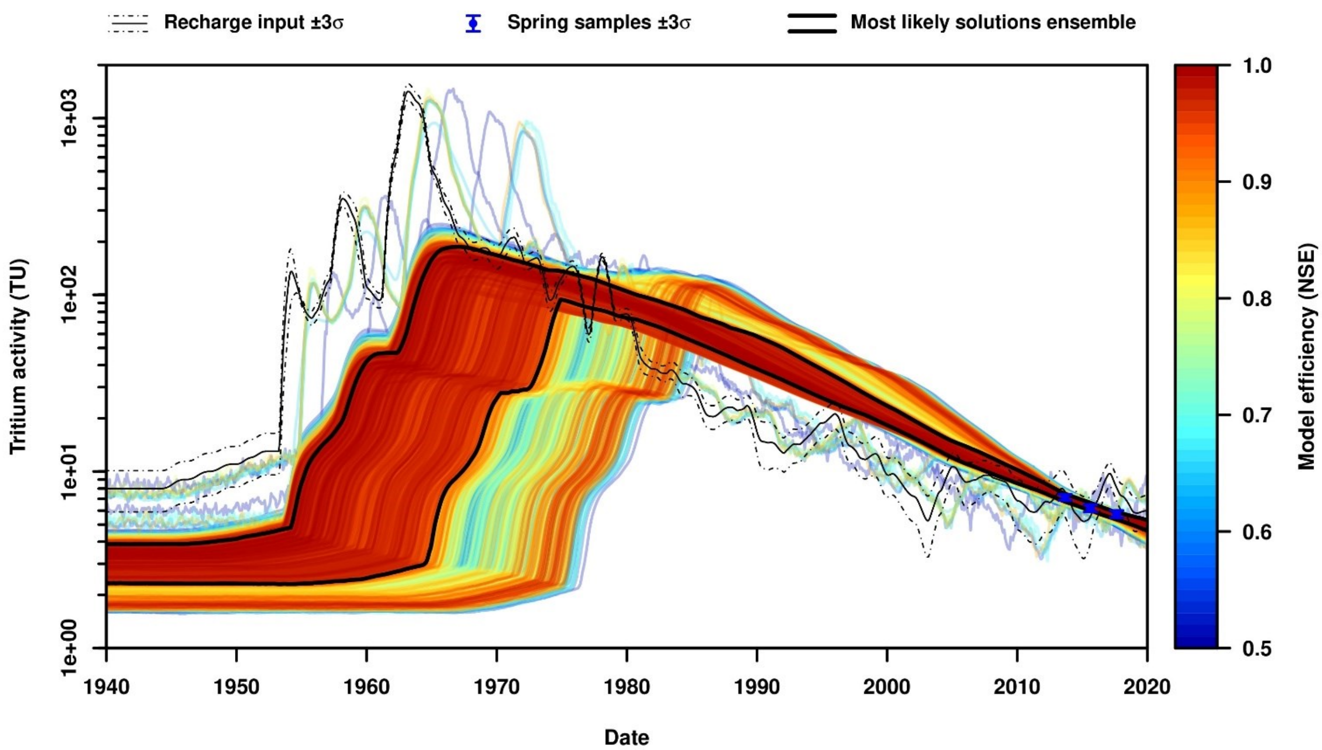


Figure S8: Modelling results of spring C01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

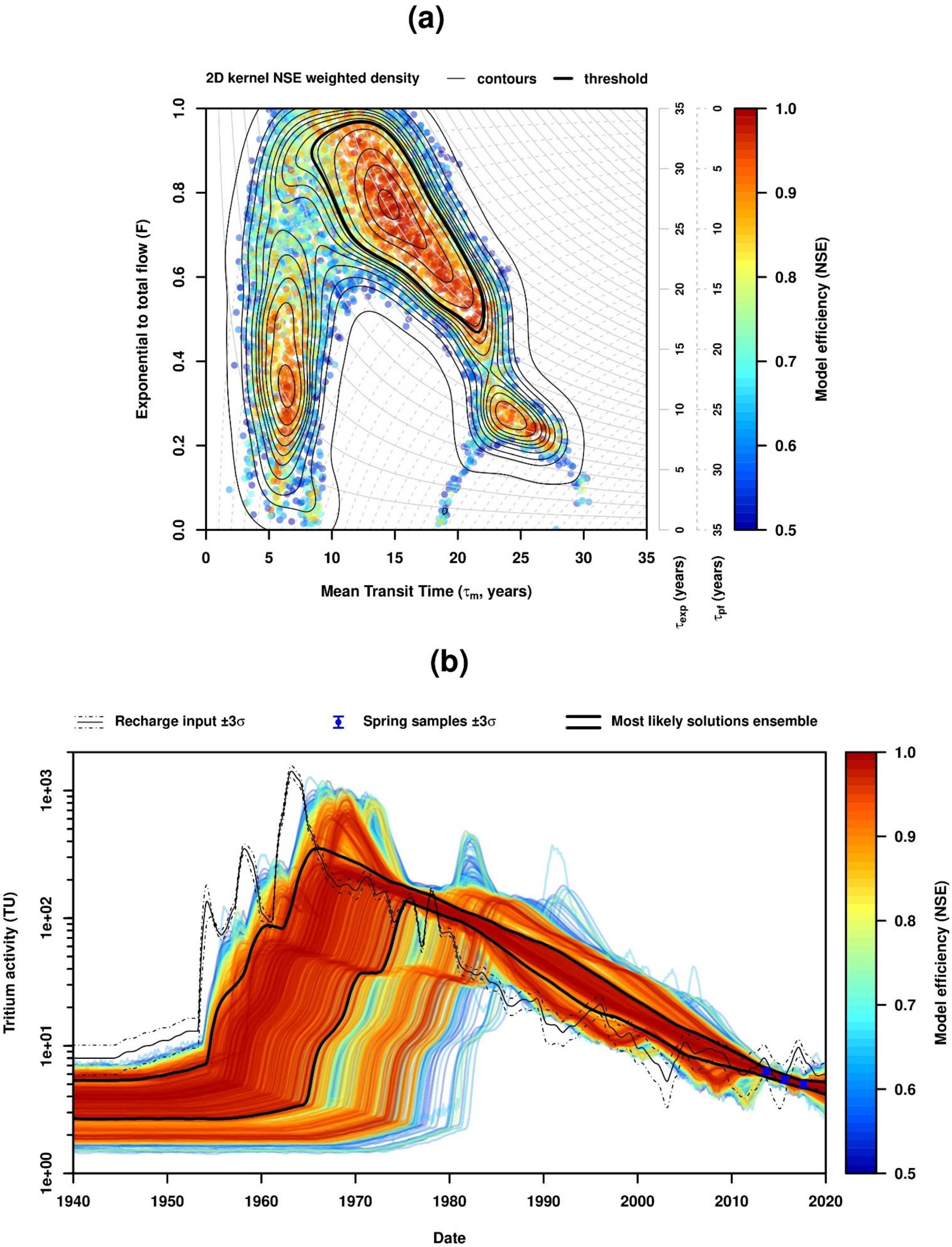
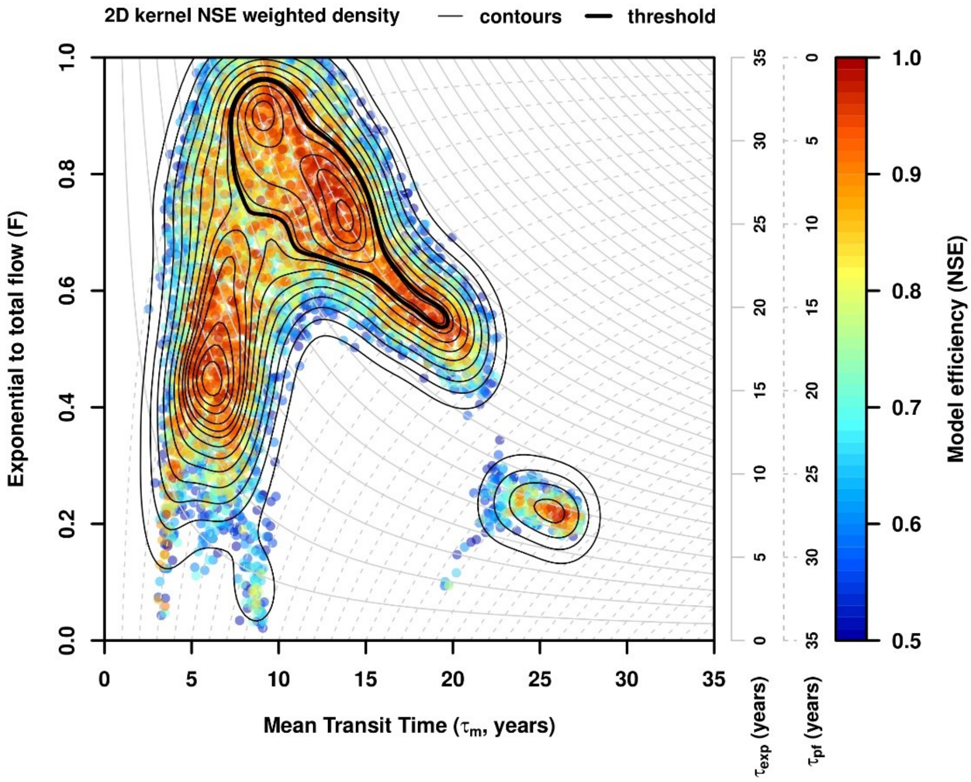


Figure S9: Modelling results of spring C03 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

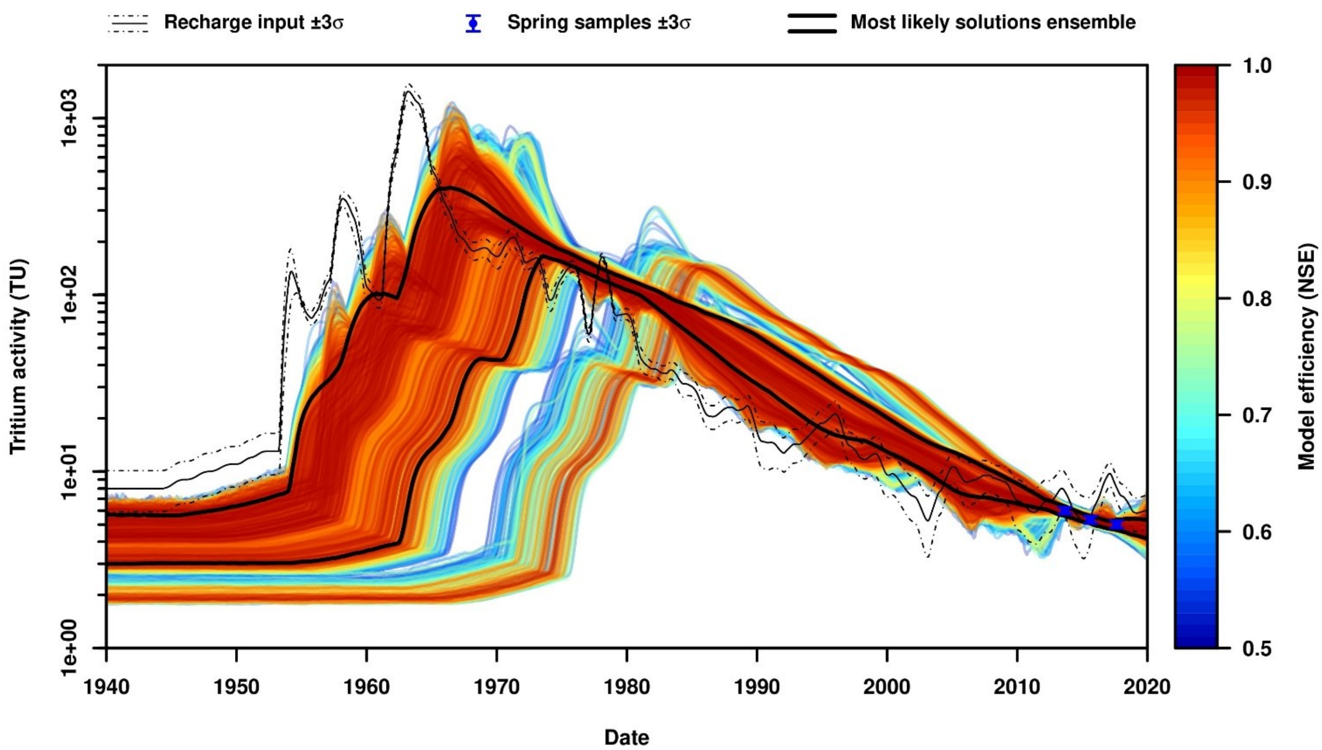
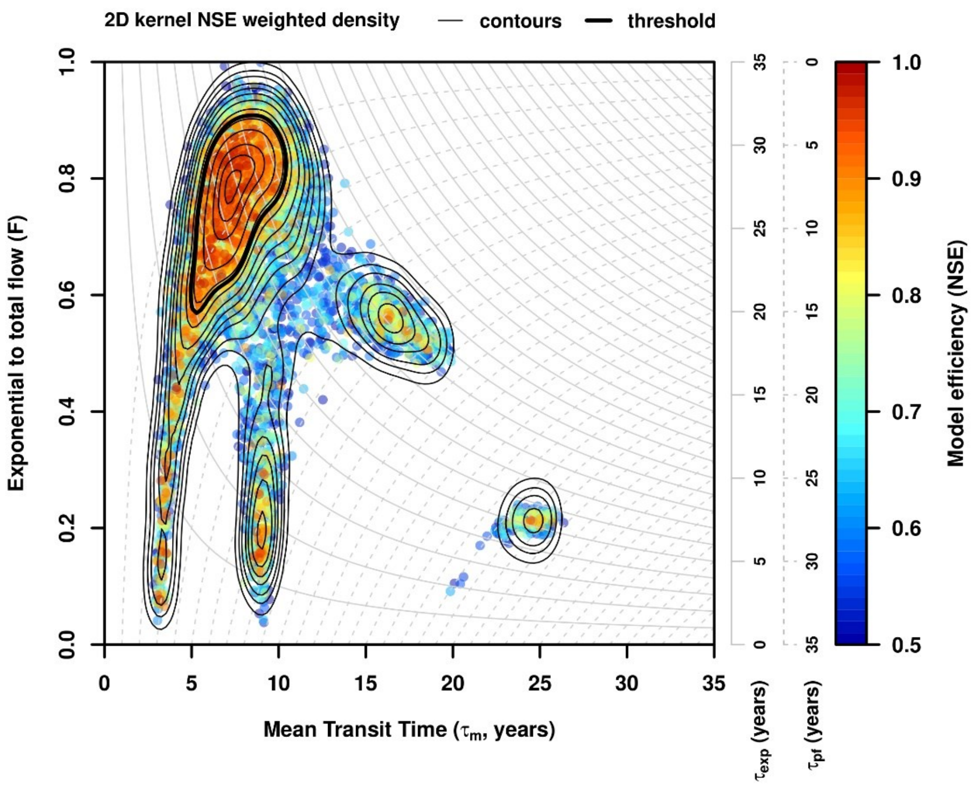


Figure S10: Modelling results of spring C04 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

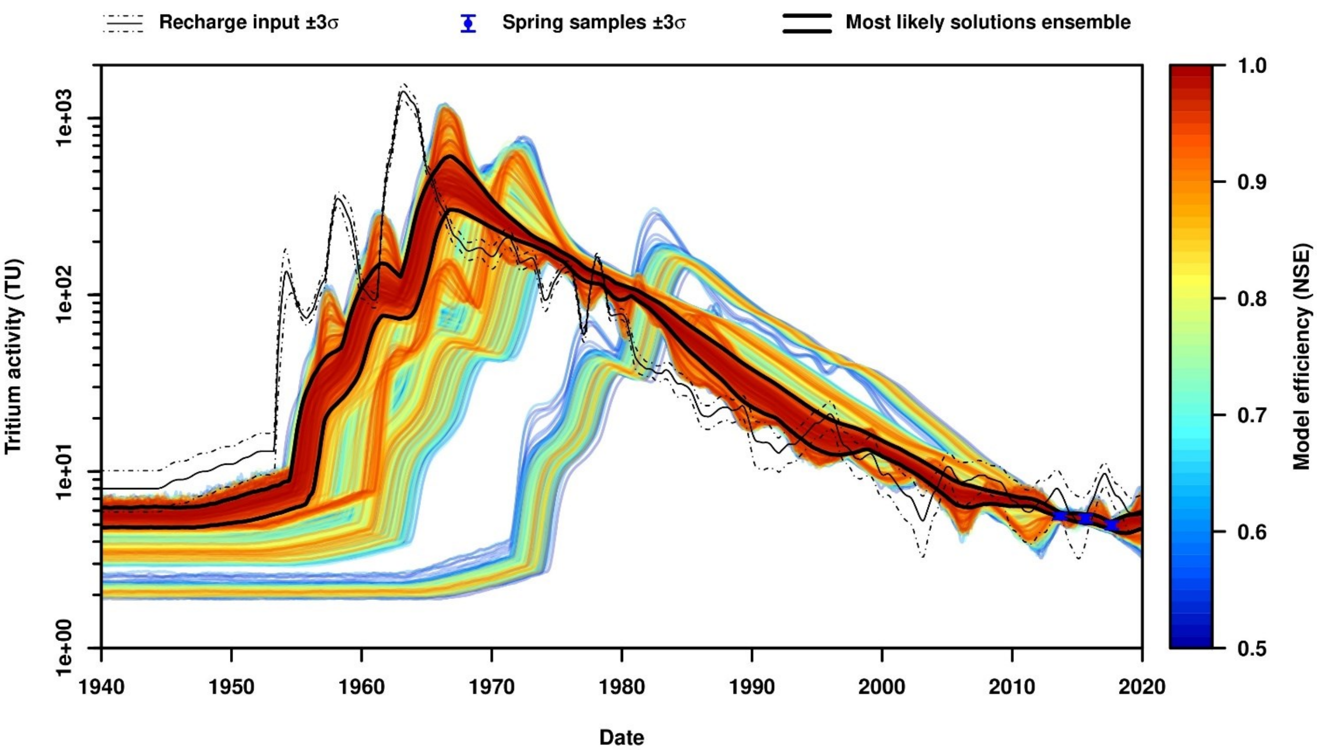
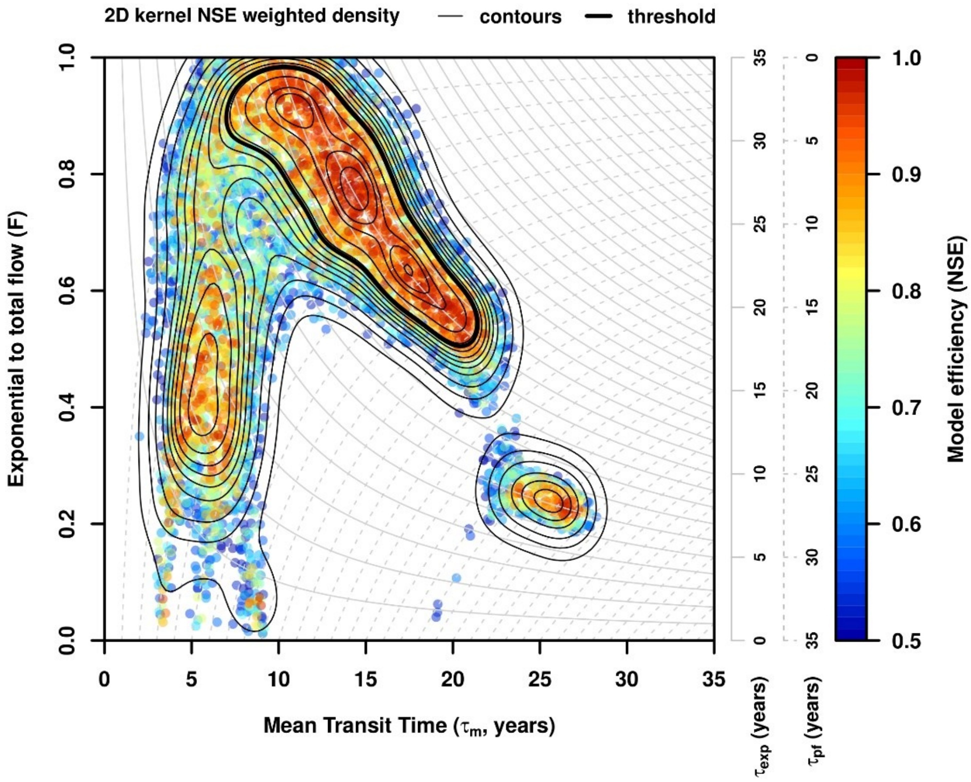


Figure S11: Modelling results of spring C05 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

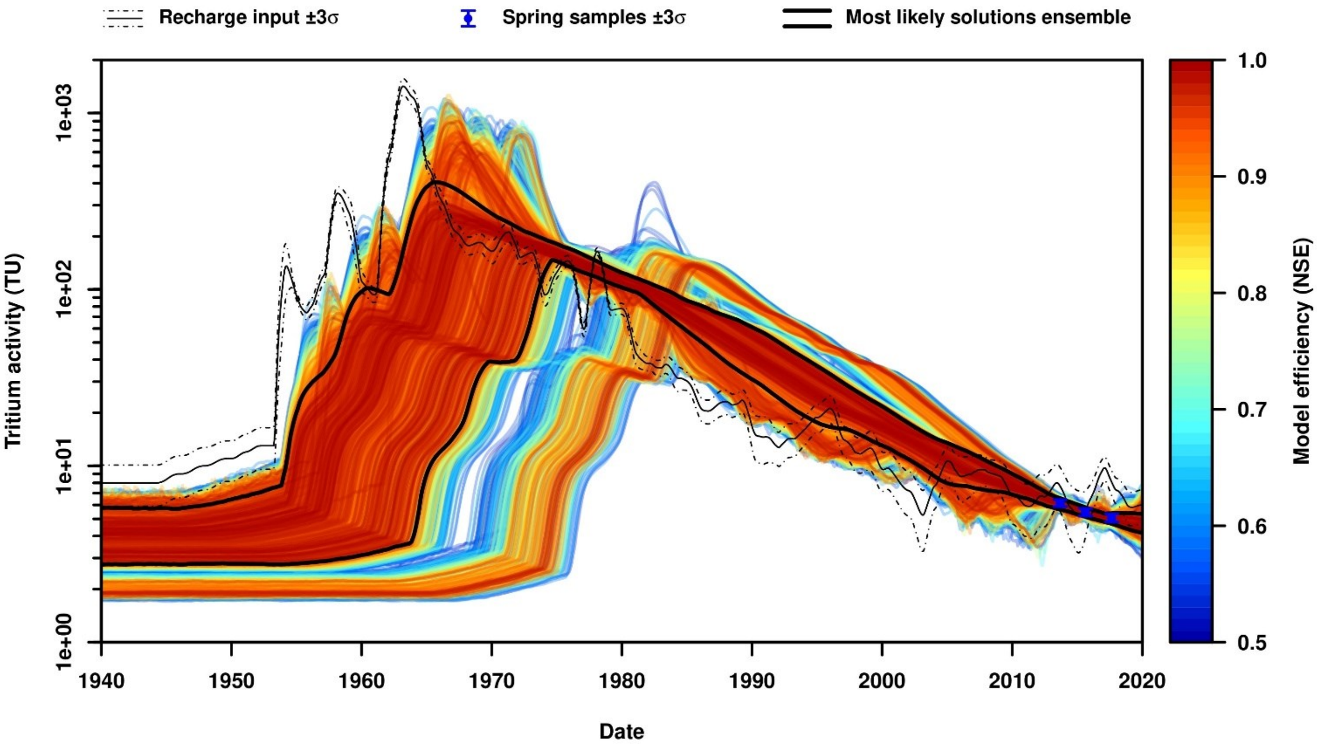
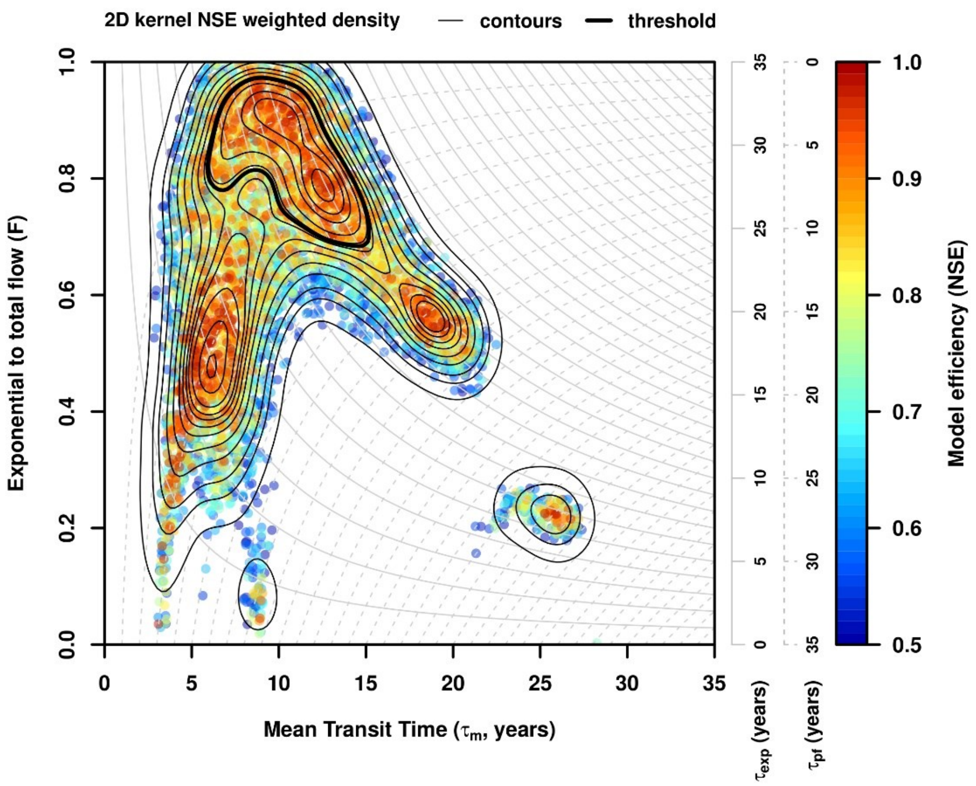


Figure S12: Modelling results of spring C07 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

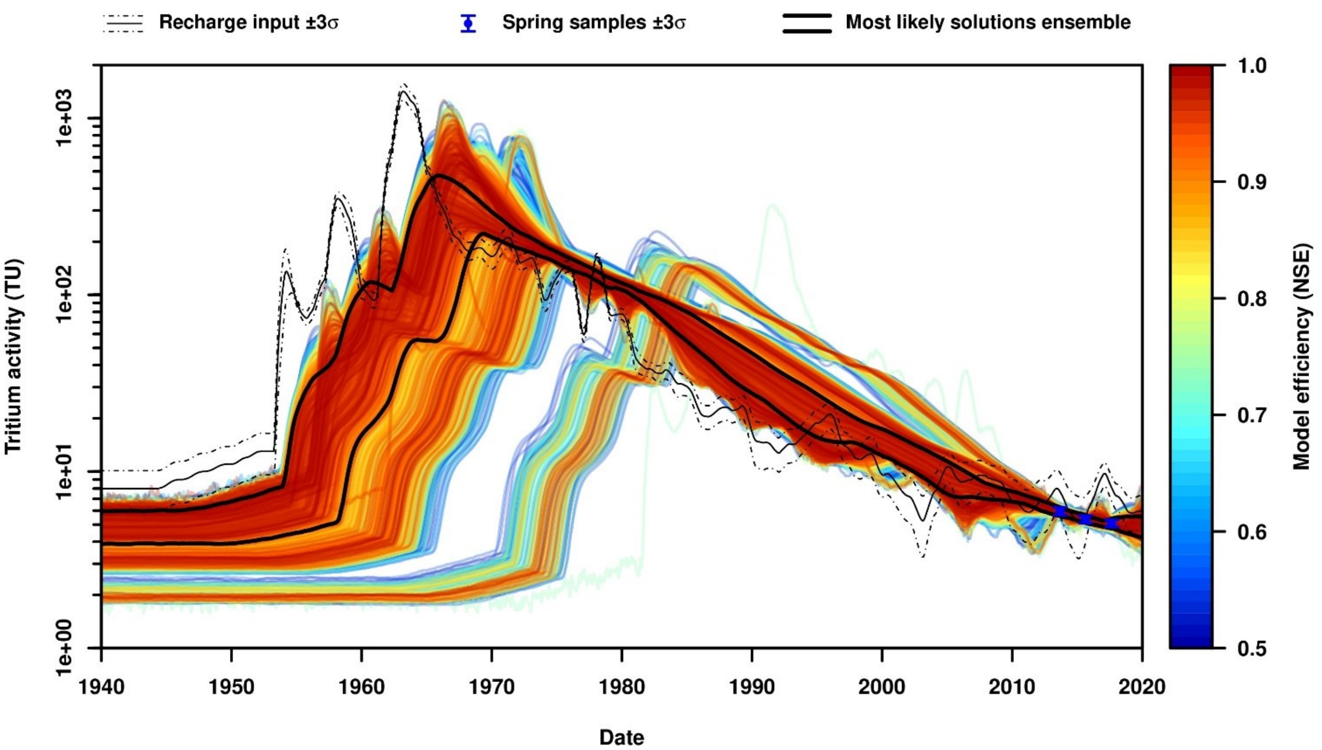
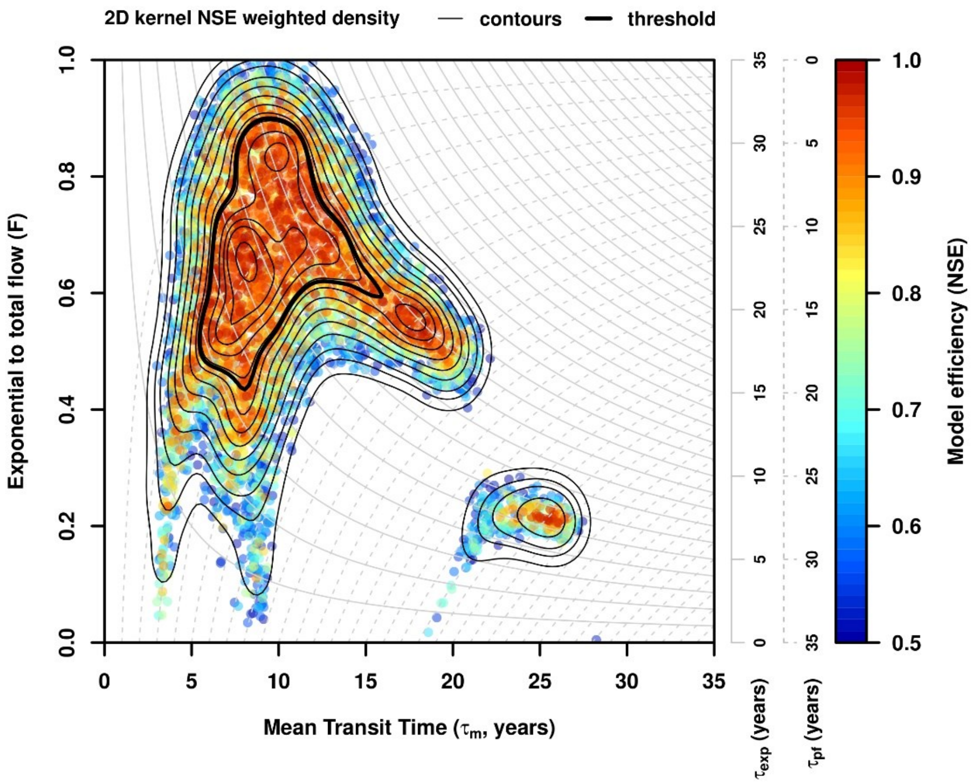


Figure S13: Modelling results of spring C09 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

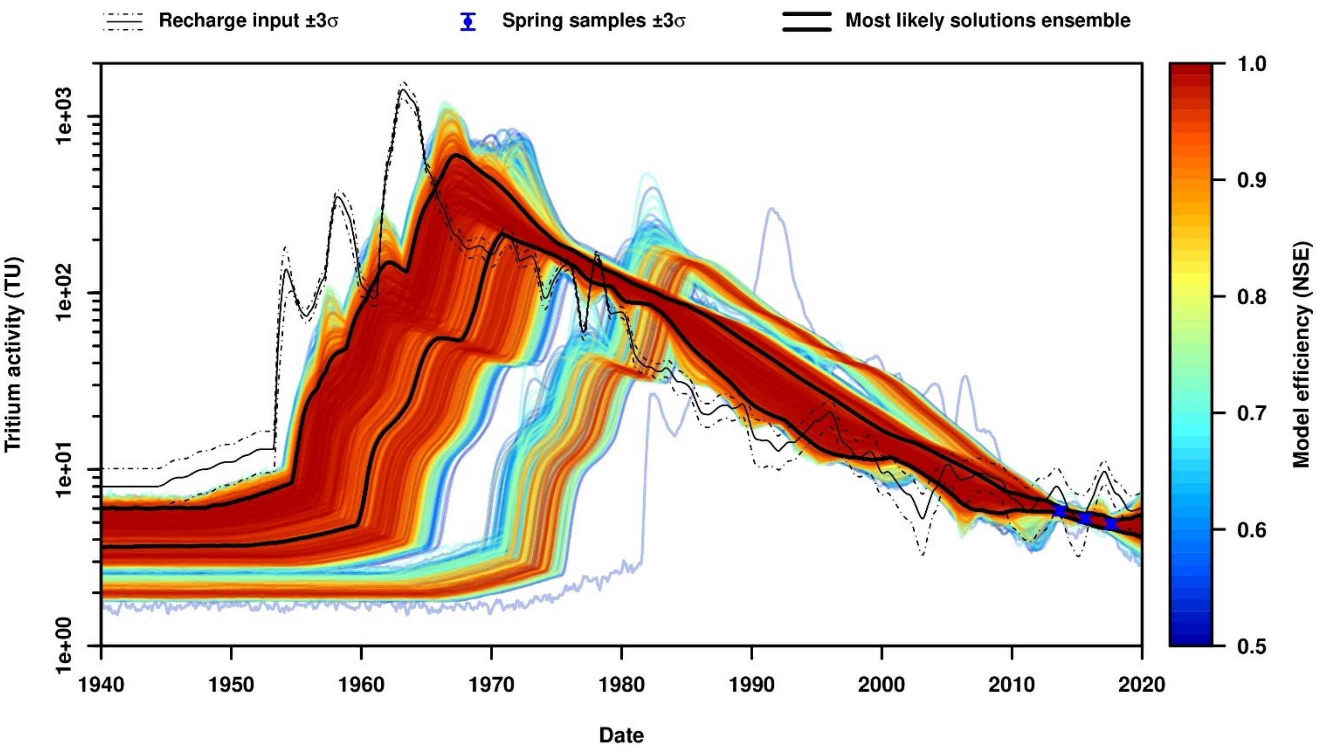
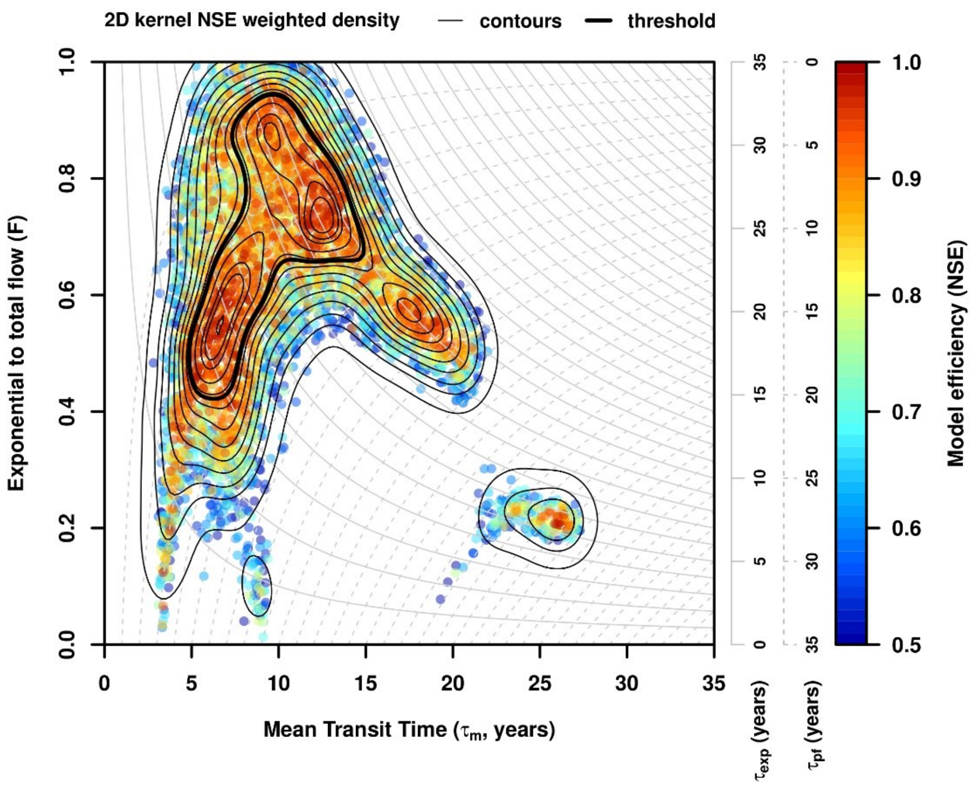


Figure S14: Modelling results of spring C10 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

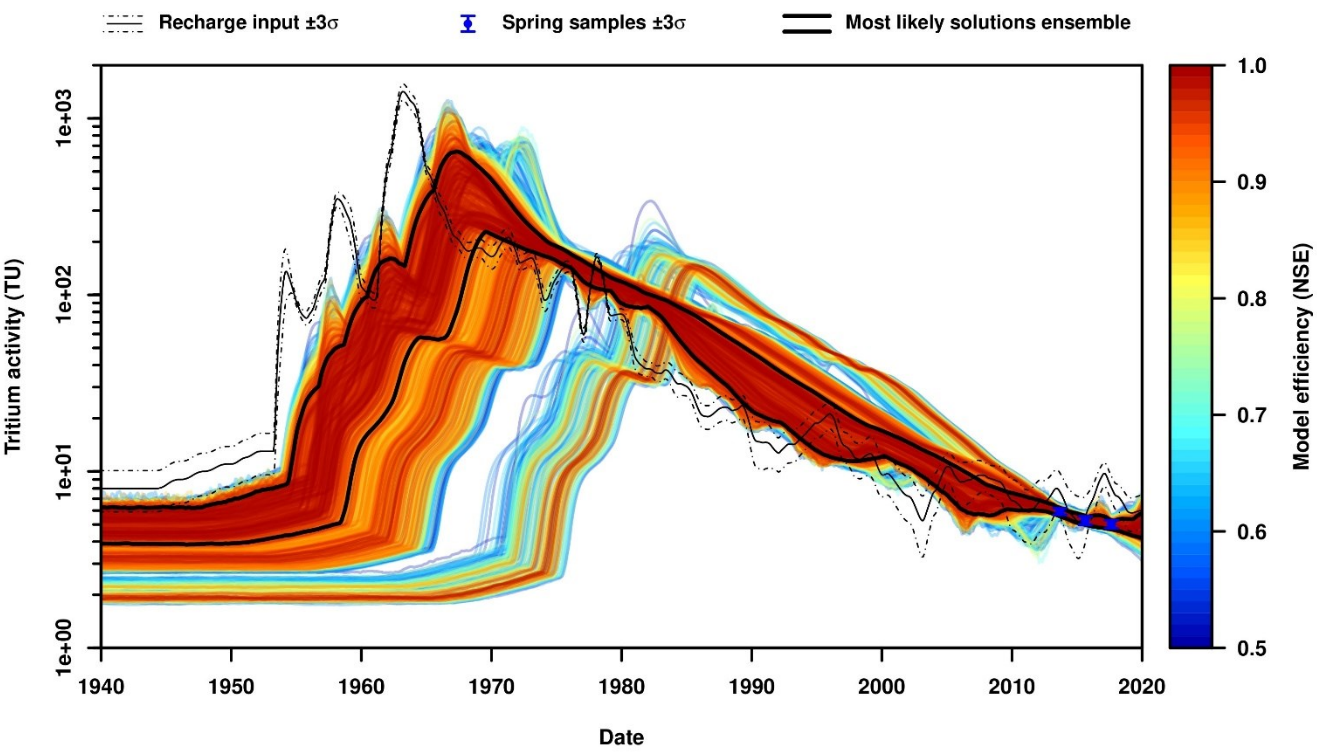
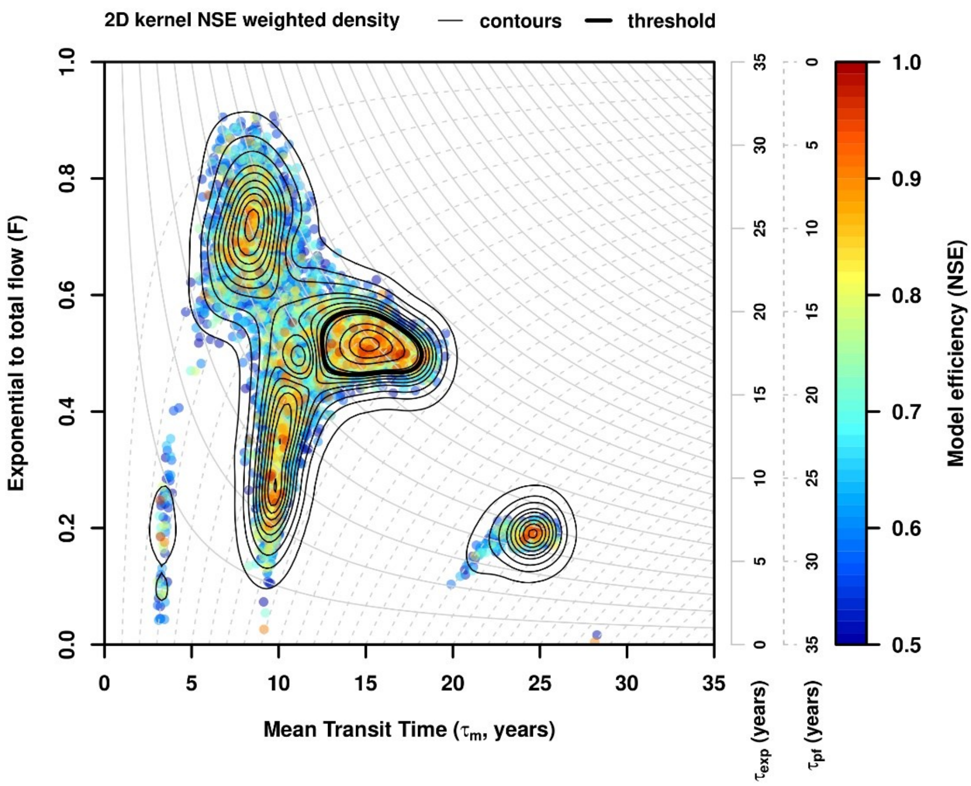


Figure S15: Modelling results of spring D01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

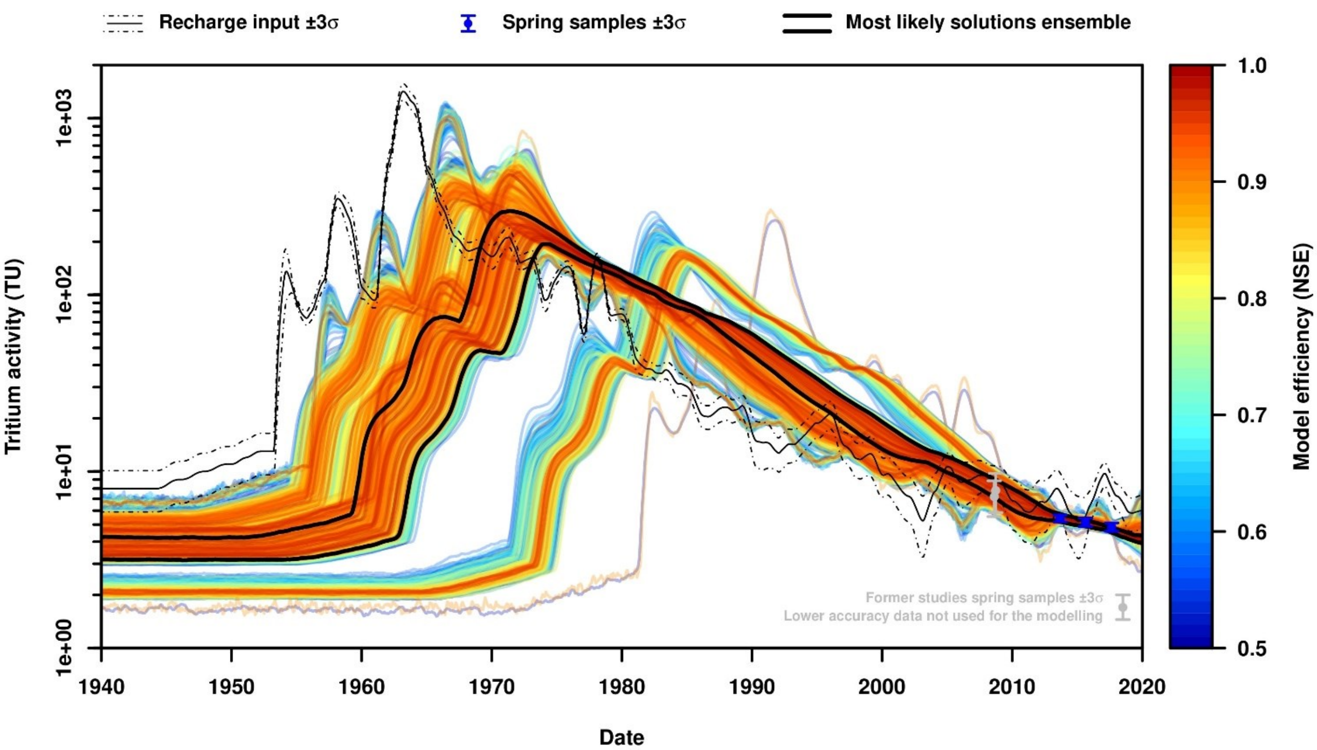
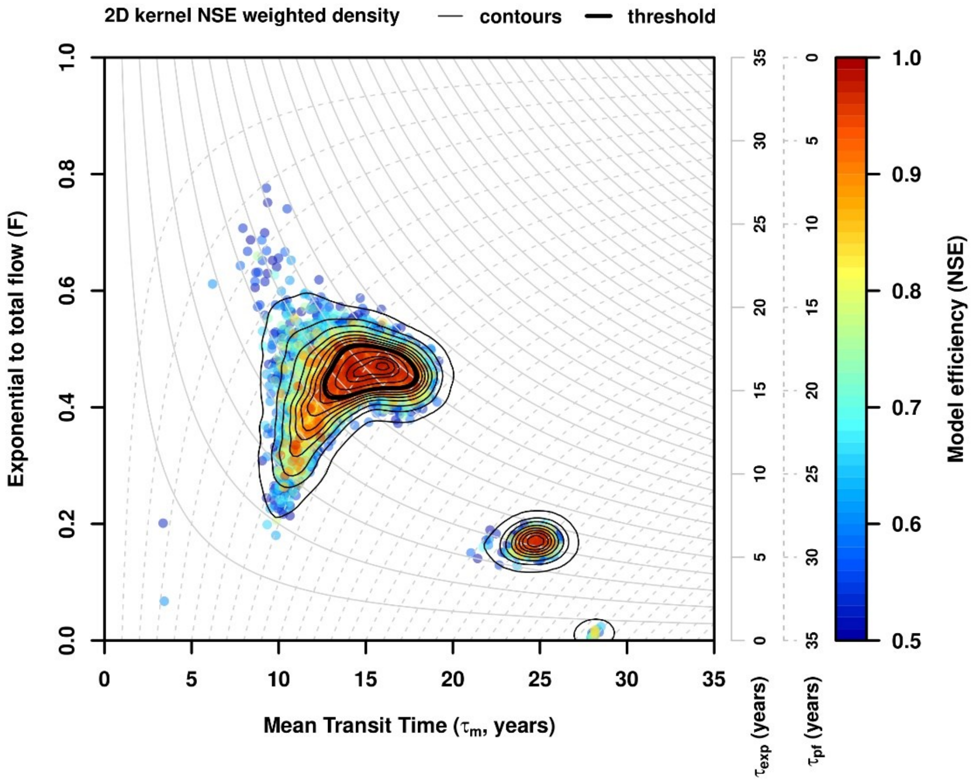


Figure S16: Modelling results of spring K01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

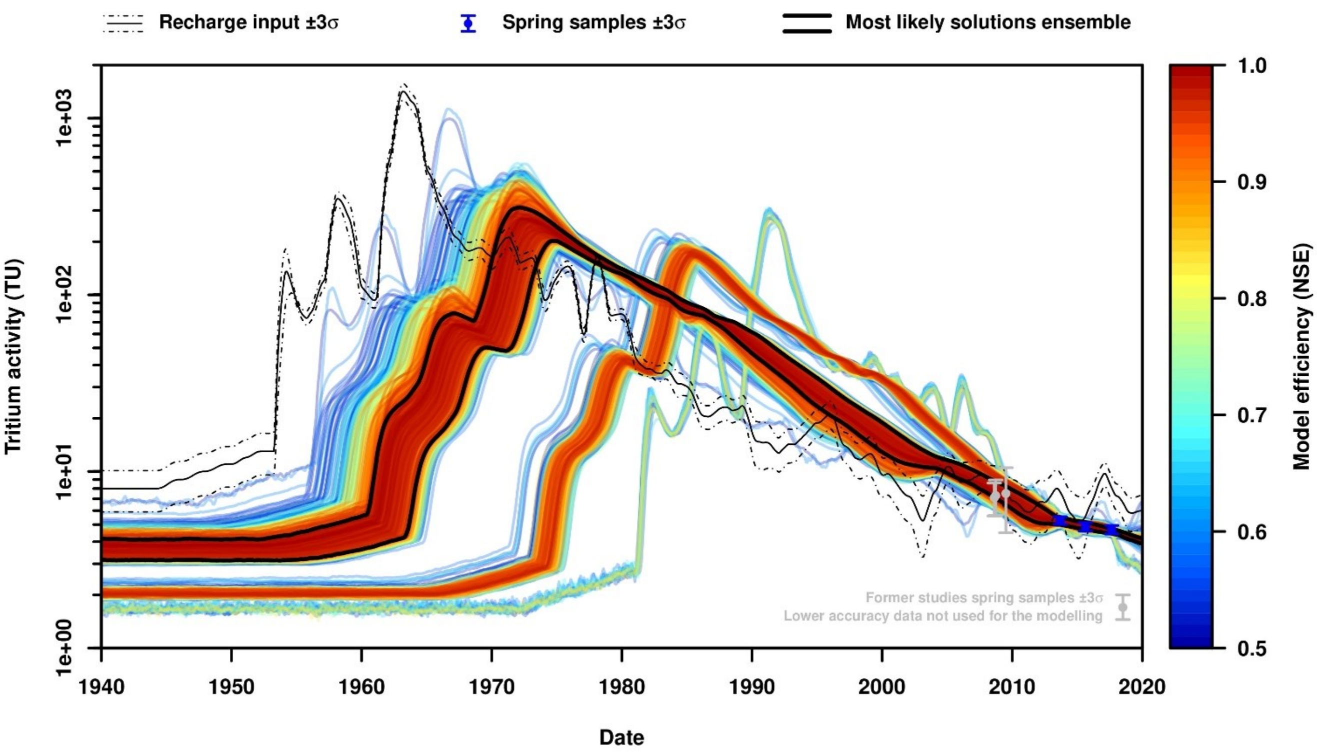
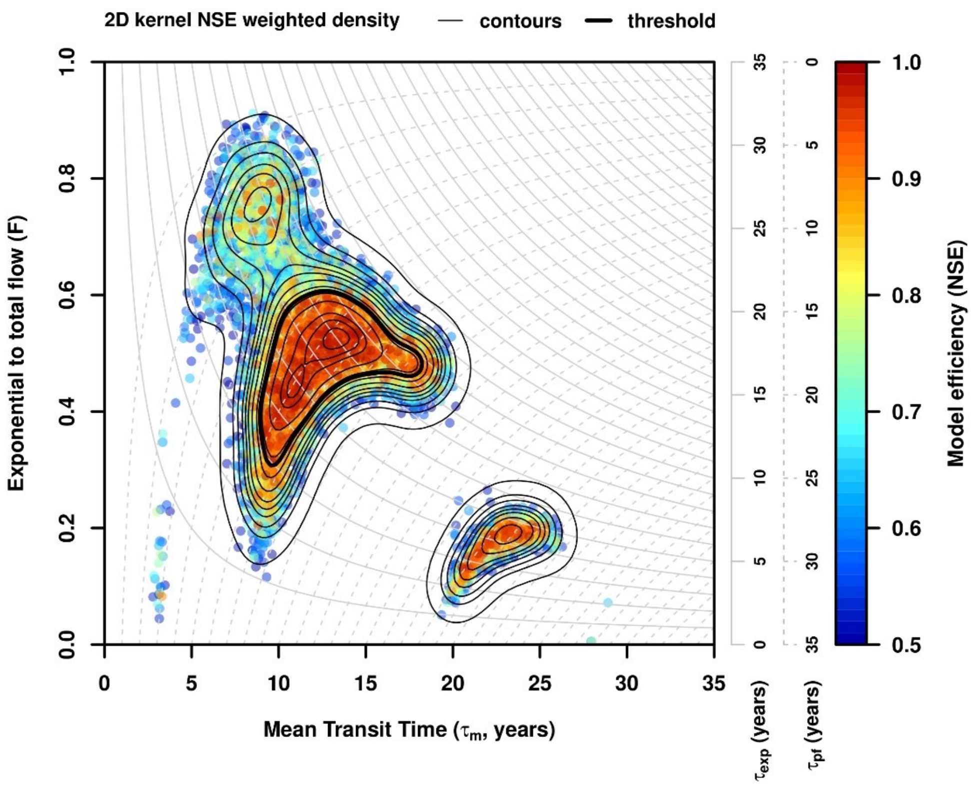


Figure S17: Modelling results of spring K02 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

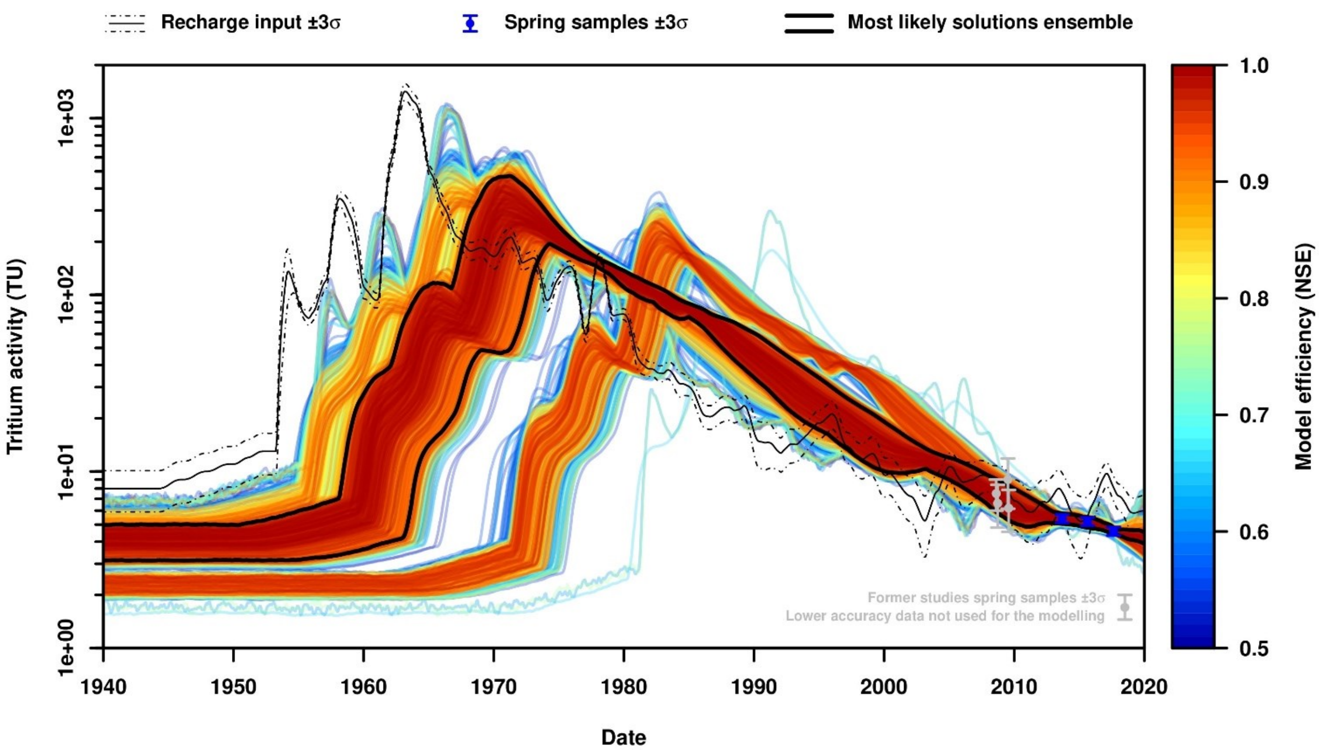
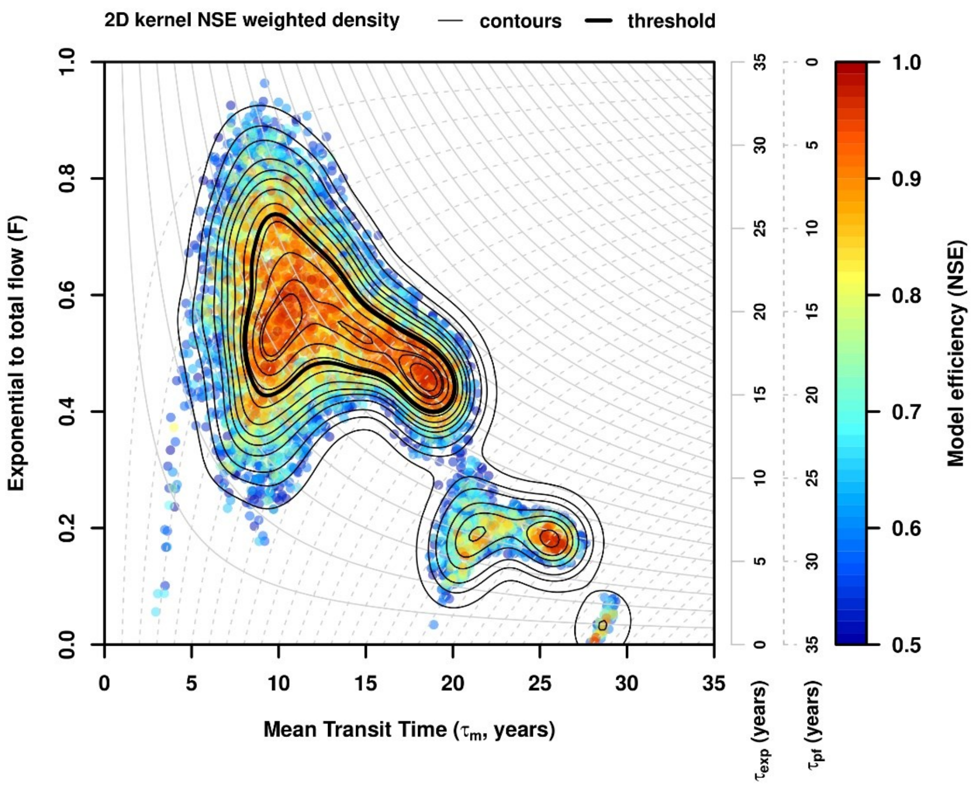


Figure S18: Modelling results of spring K03 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

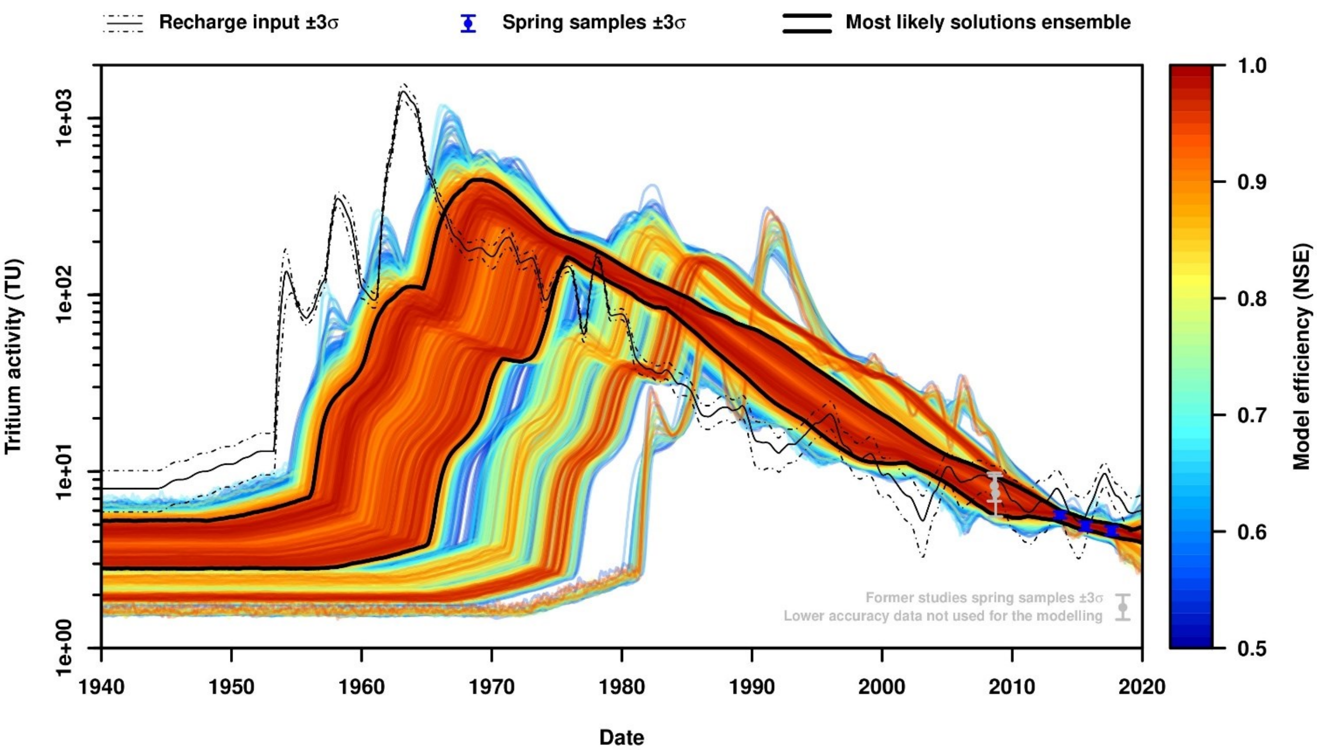
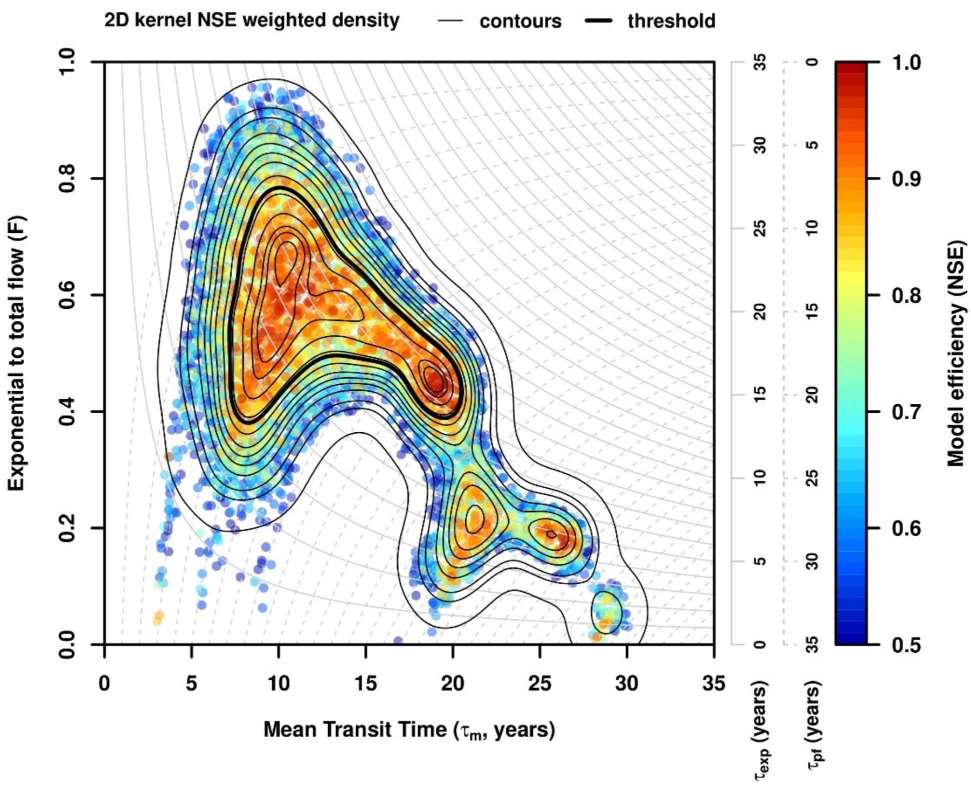


Figure S19: Modelling results of spring K07 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

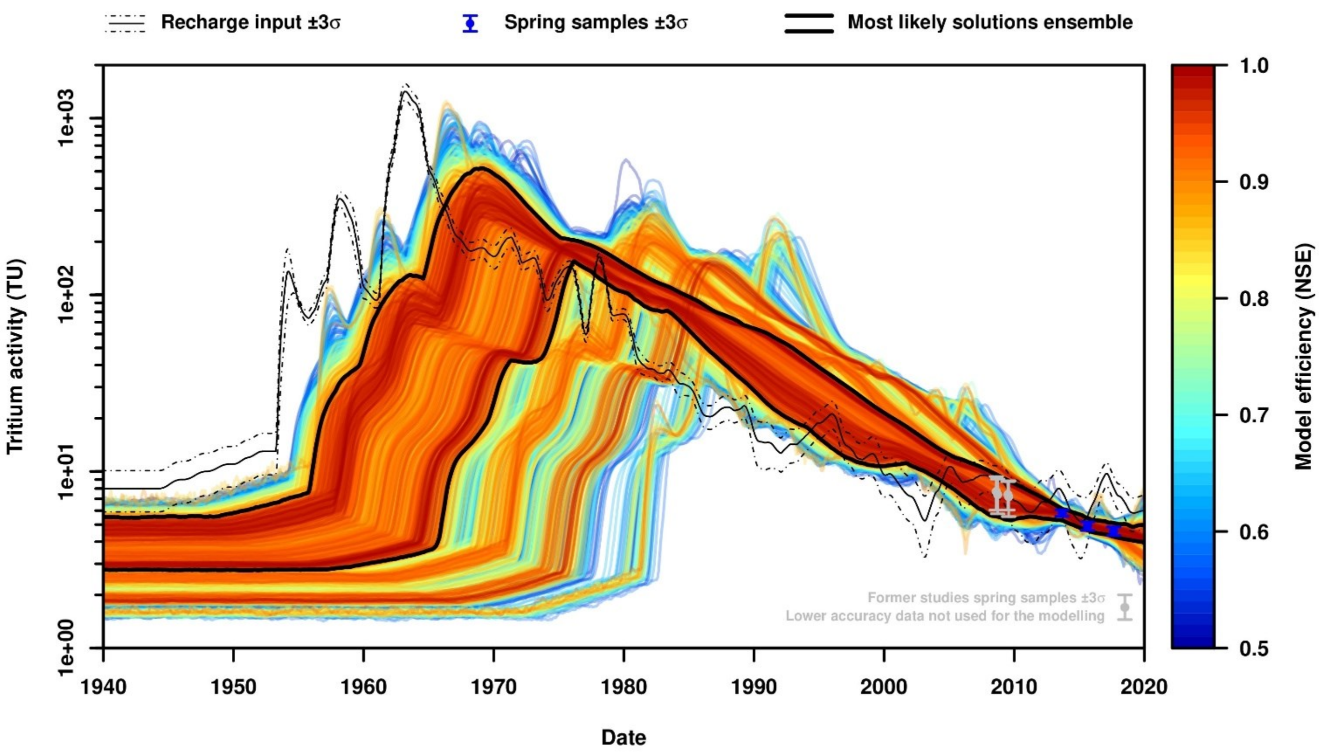


Figure S20: Modelling results of spring K13 in the EPM parameter space (a) and associated modelled tritium time-series (b).

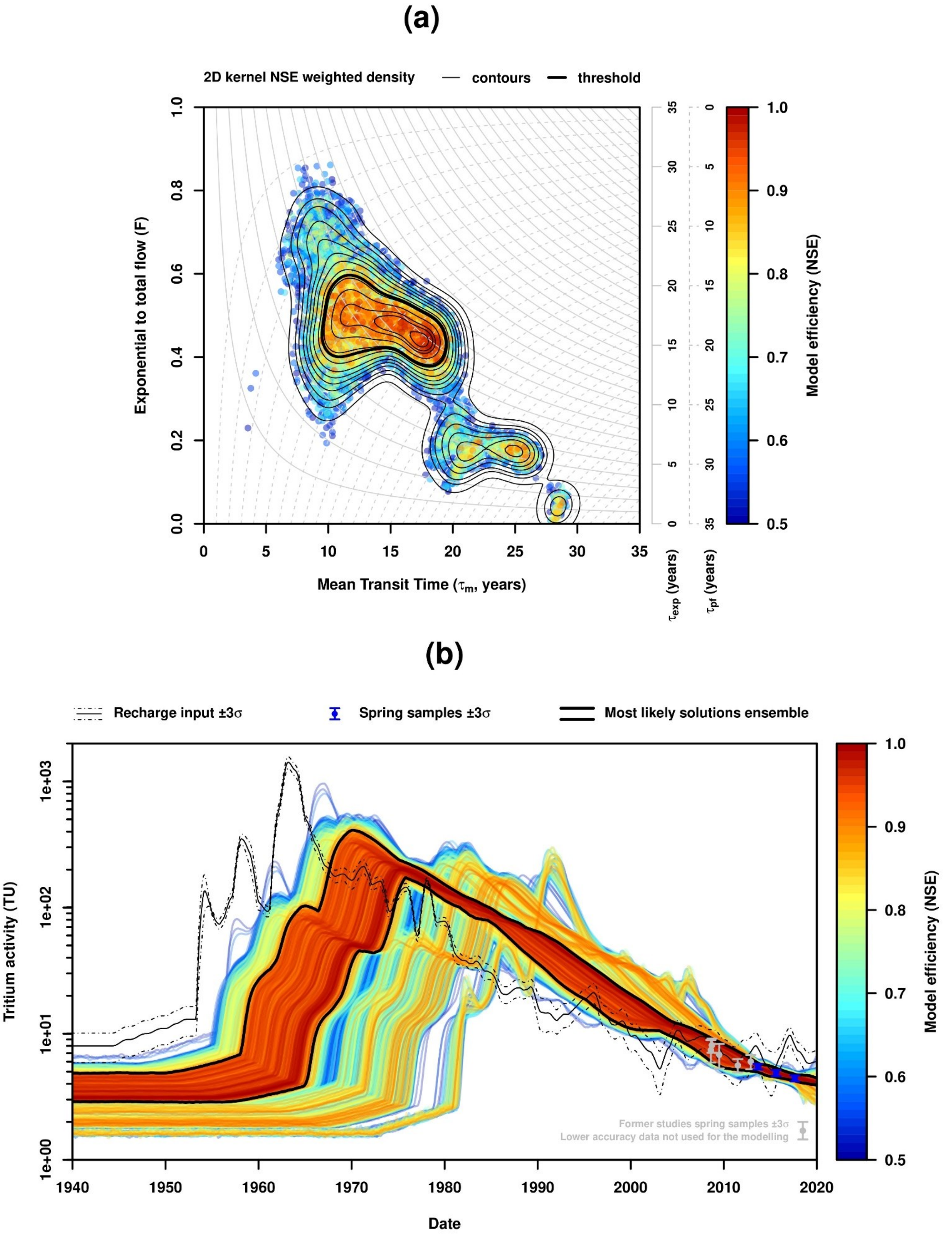
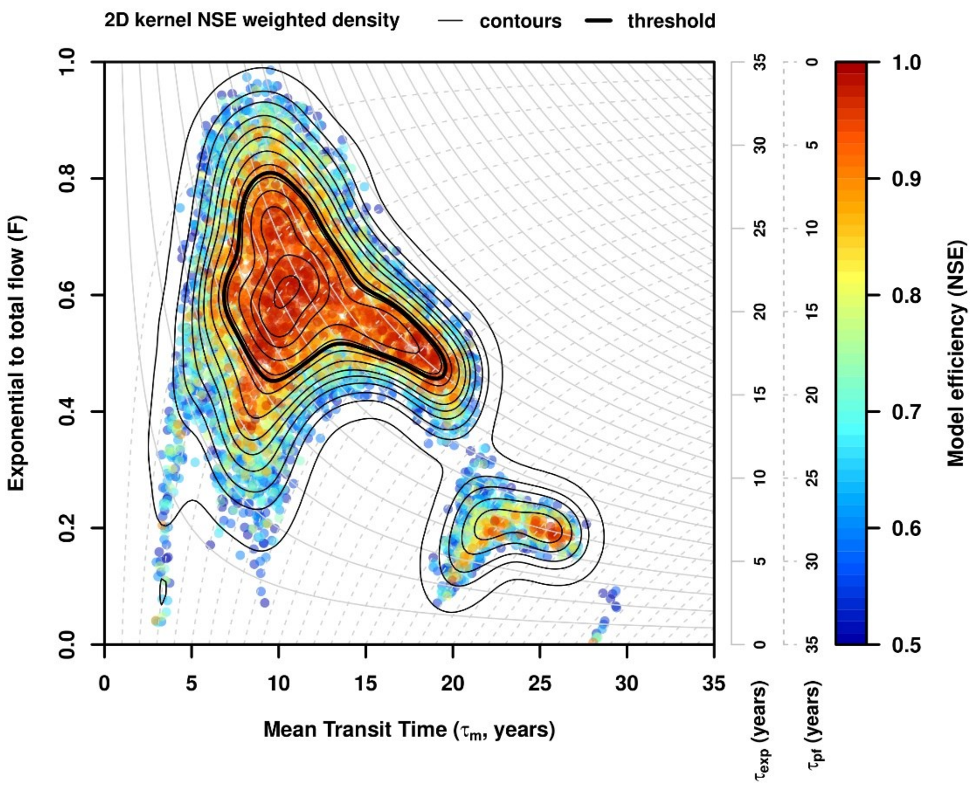


Figure S21: Modelling results of spring K17 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

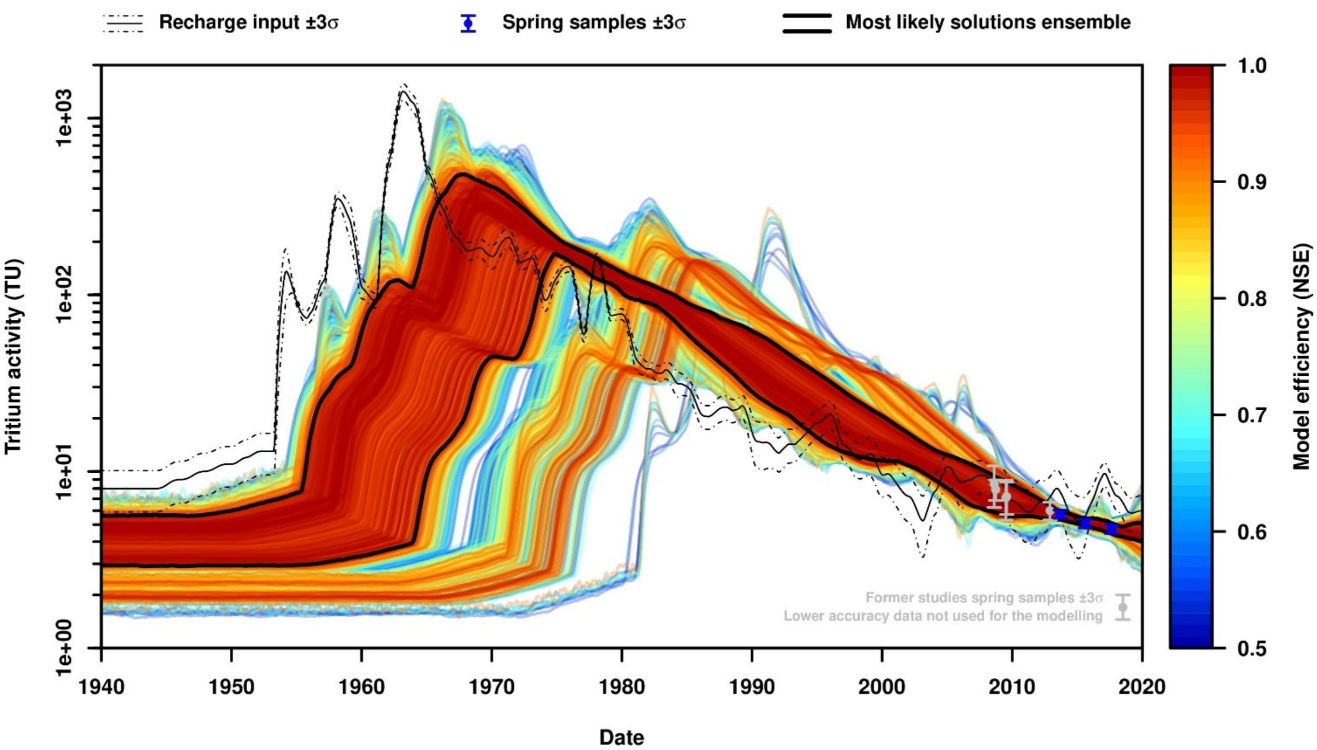


Figure S22: Modelling results of spring K19 in the EPM parameter space (a) and associated modelled tritium time-series (b).

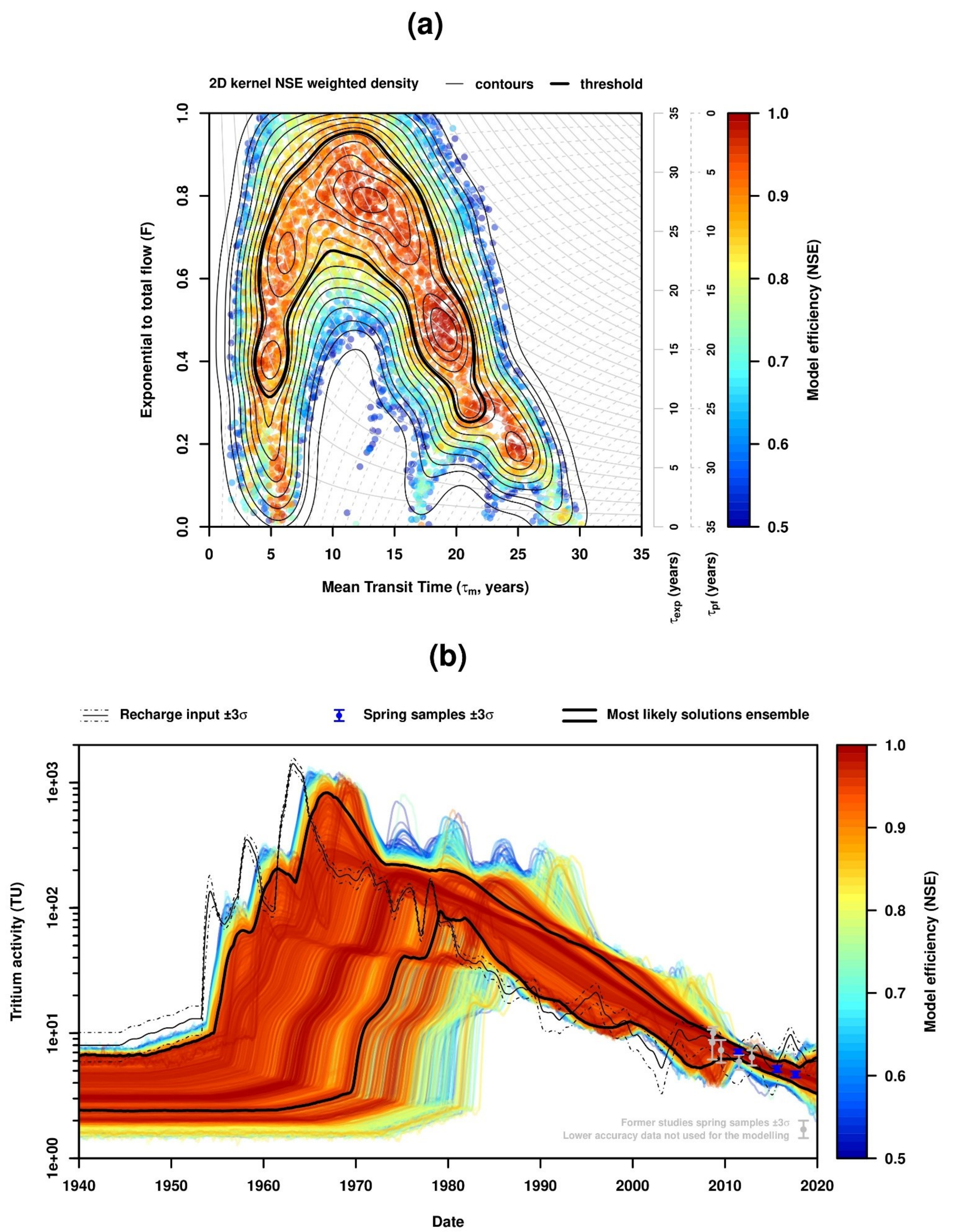
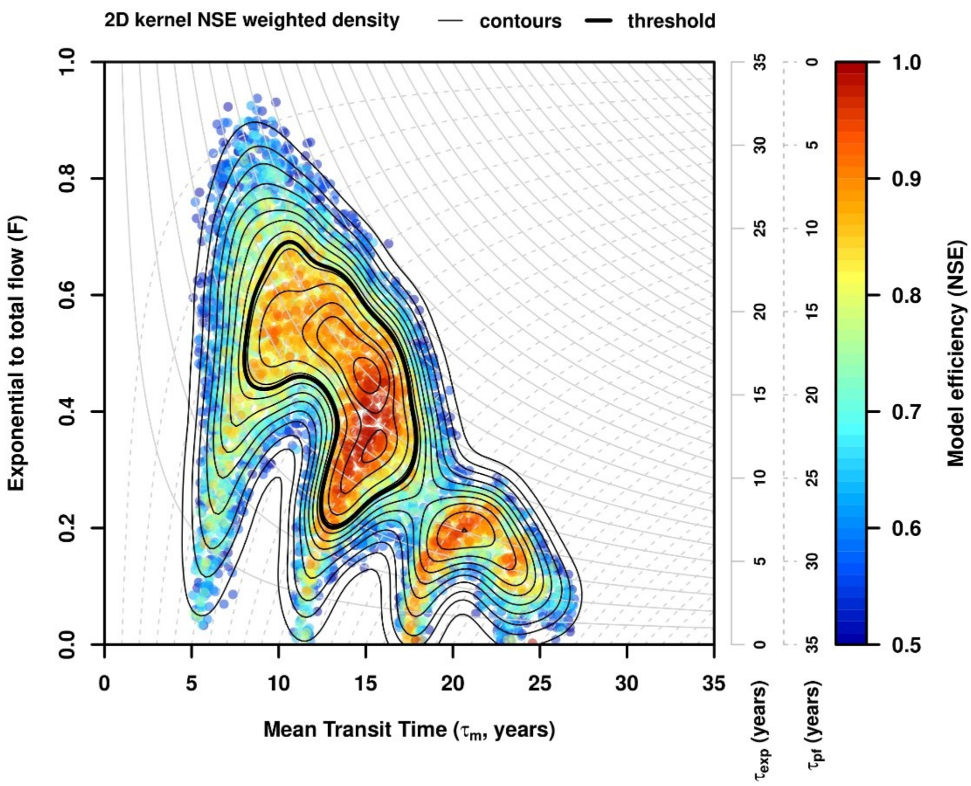


Figure S23: Modelling results of spring K21 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

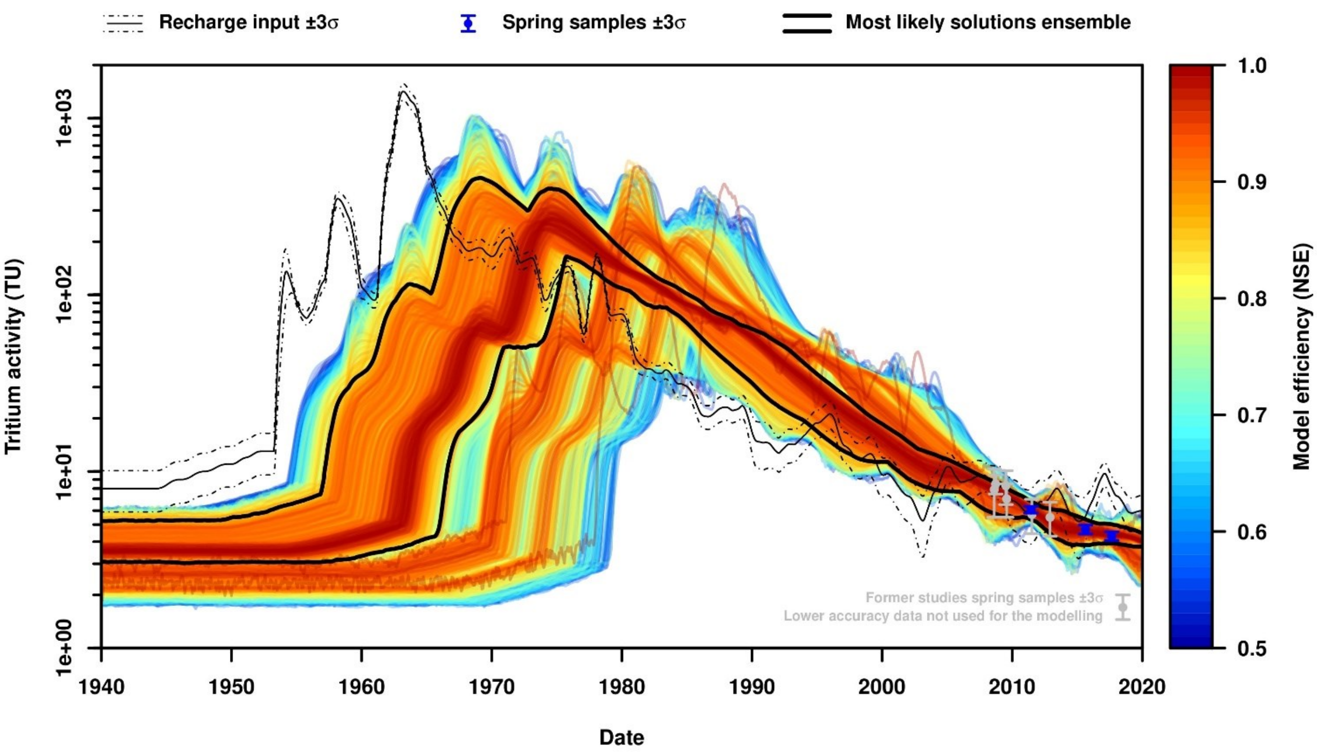
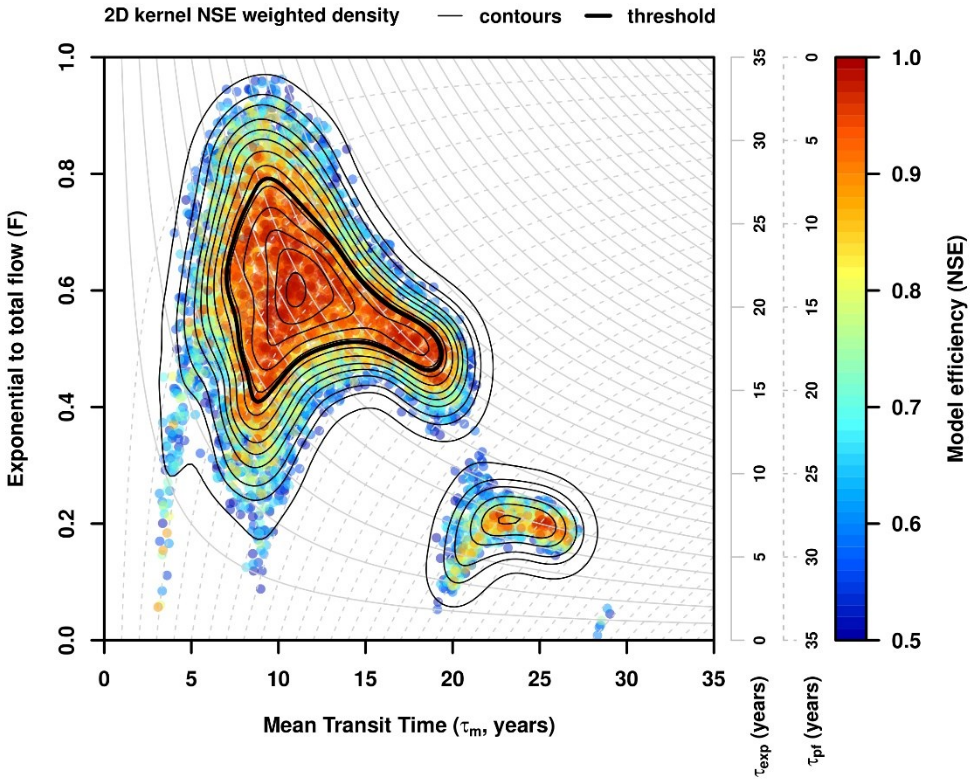


Figure S24: Modelling results of spring K21A in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

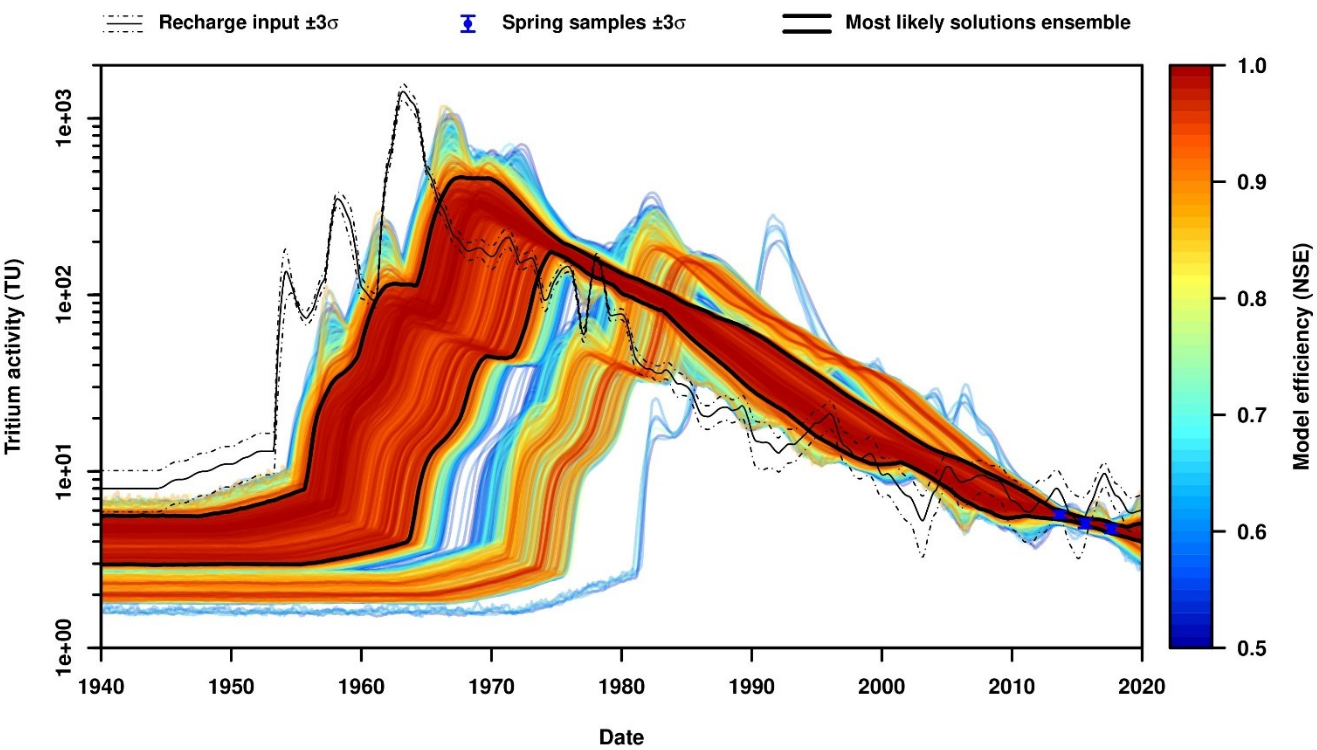
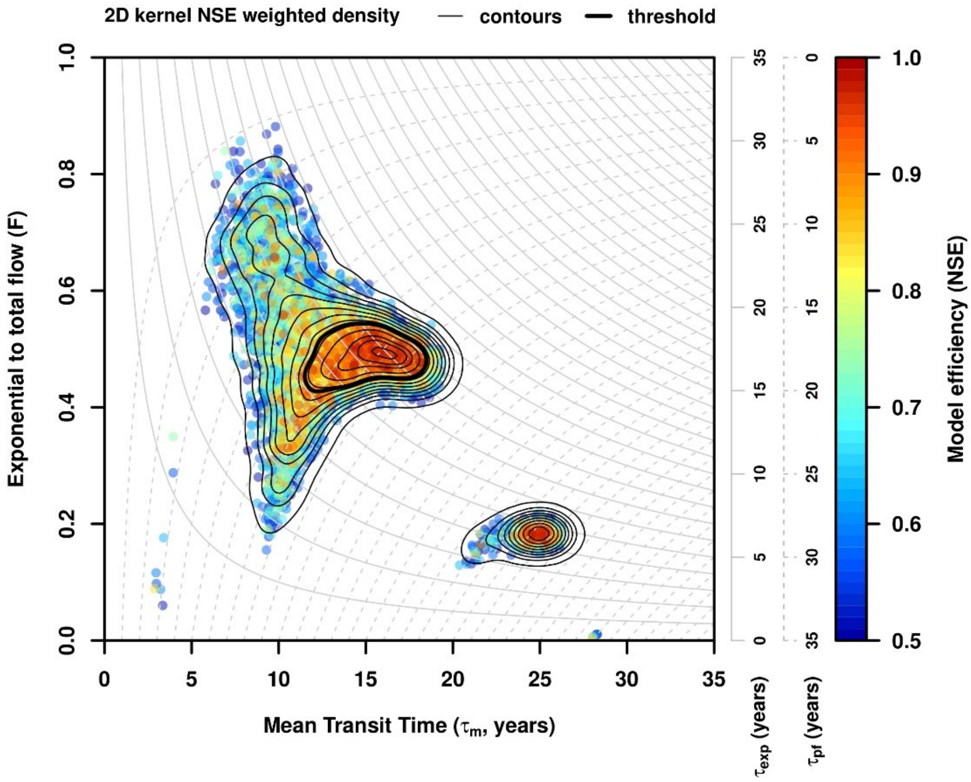


Figure S25: Modelling results of spring K22 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

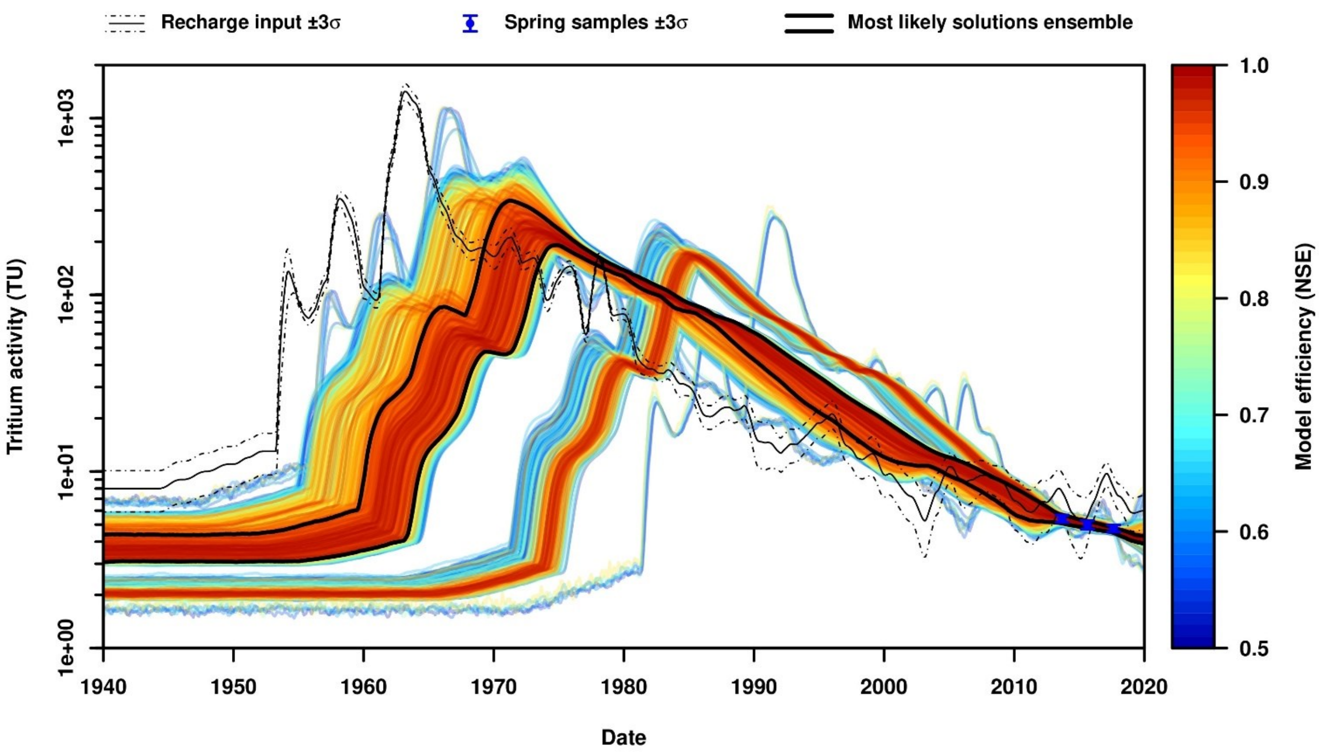
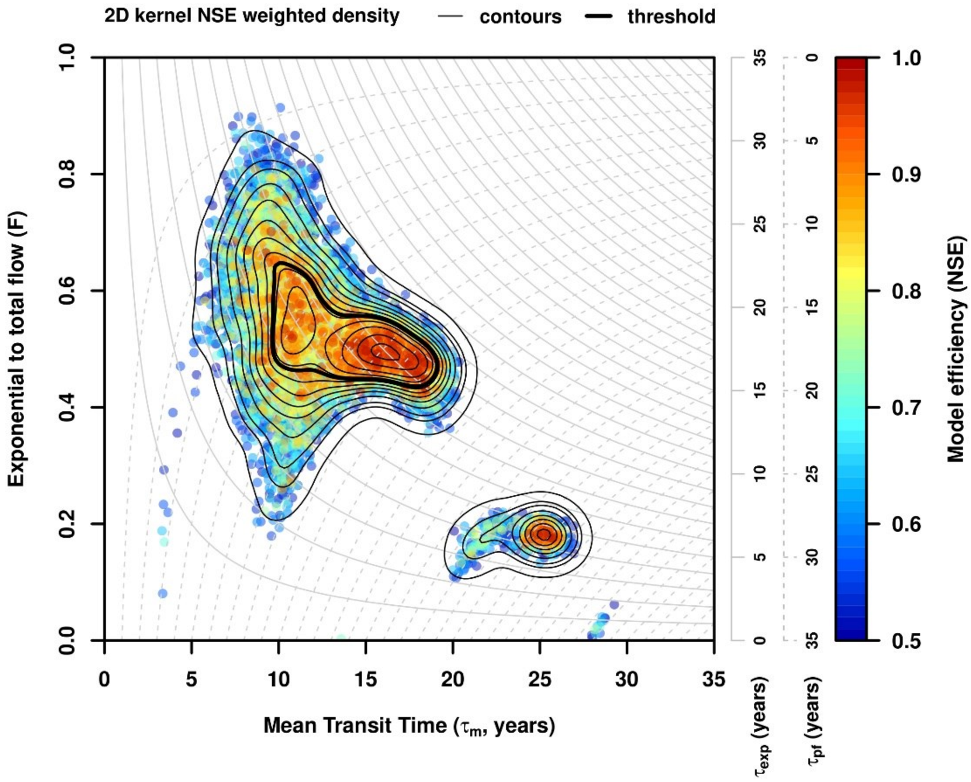


Figure S26: Modelling results of spring K24 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

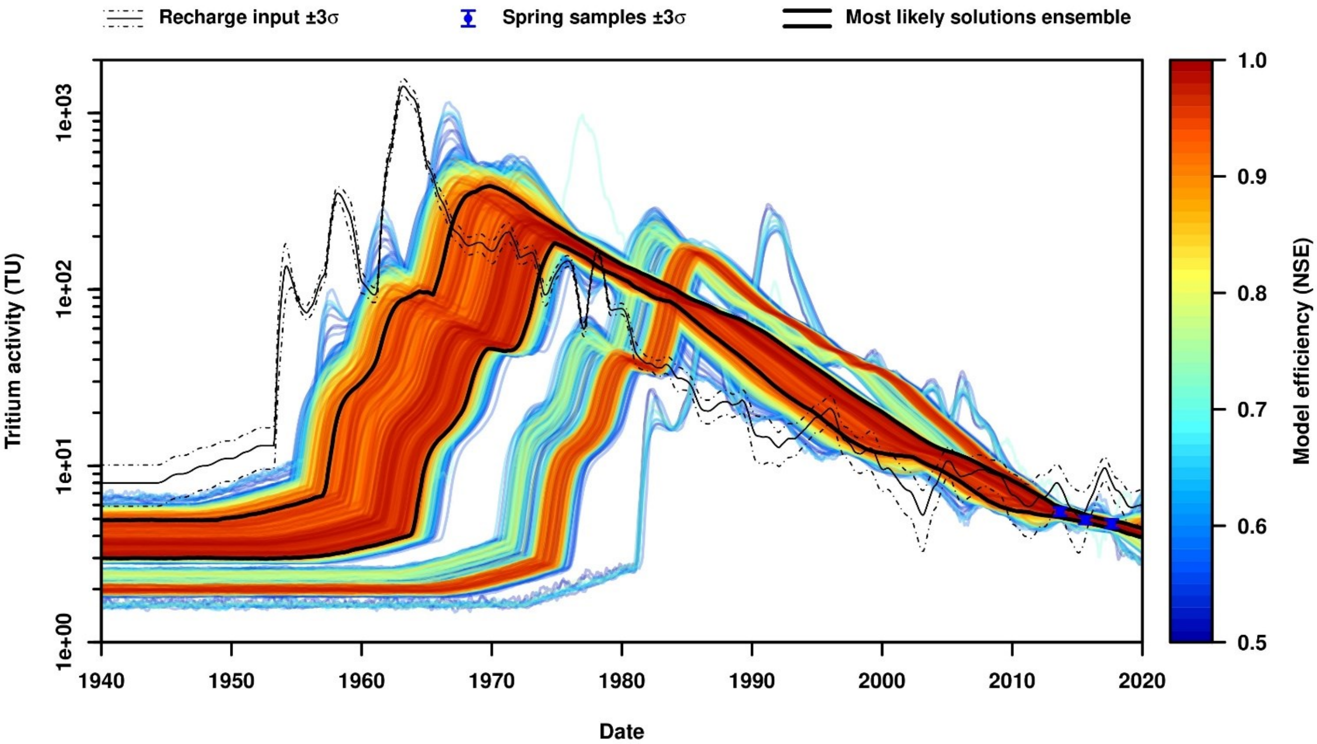
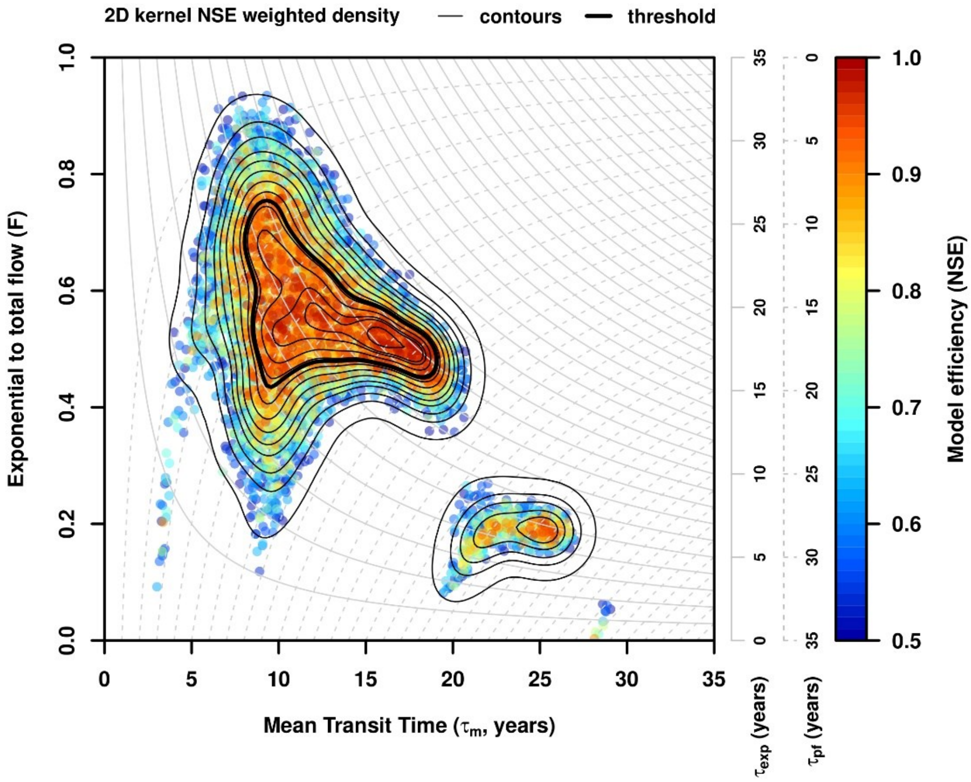


Figure S27: Modelling results of spring K26 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

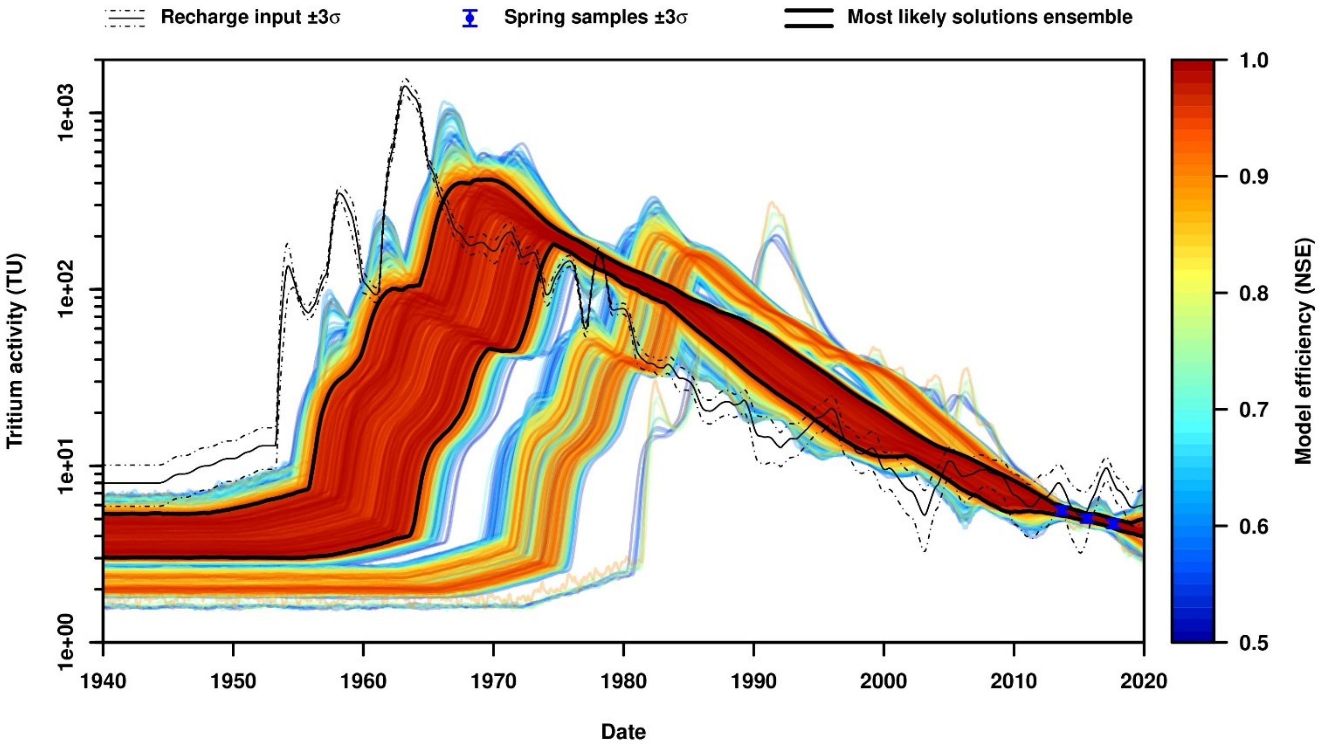


Figure S28: Modelling results of spring K28 in the EPM parameter space (a) and associated modelled tritium time-series (b).

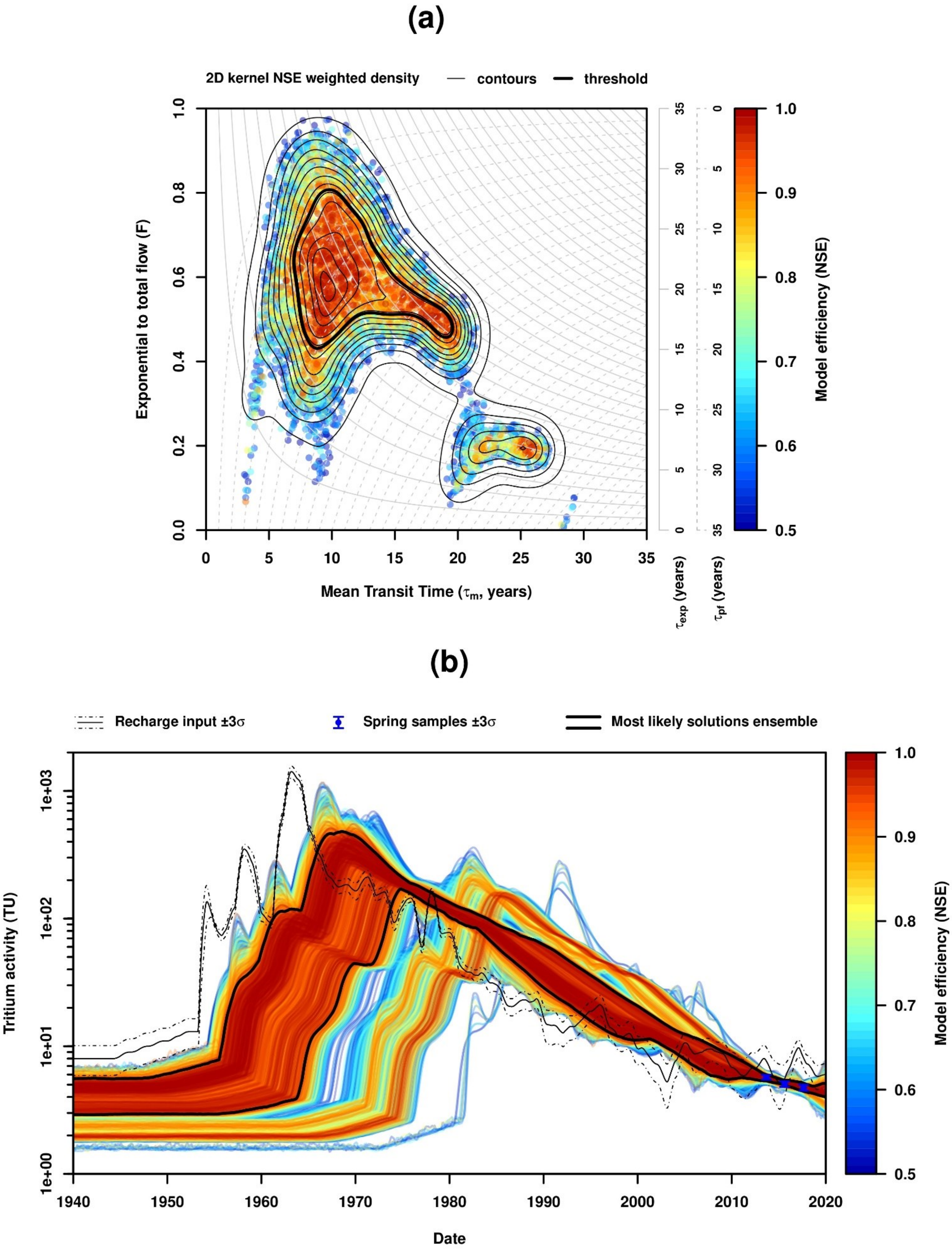
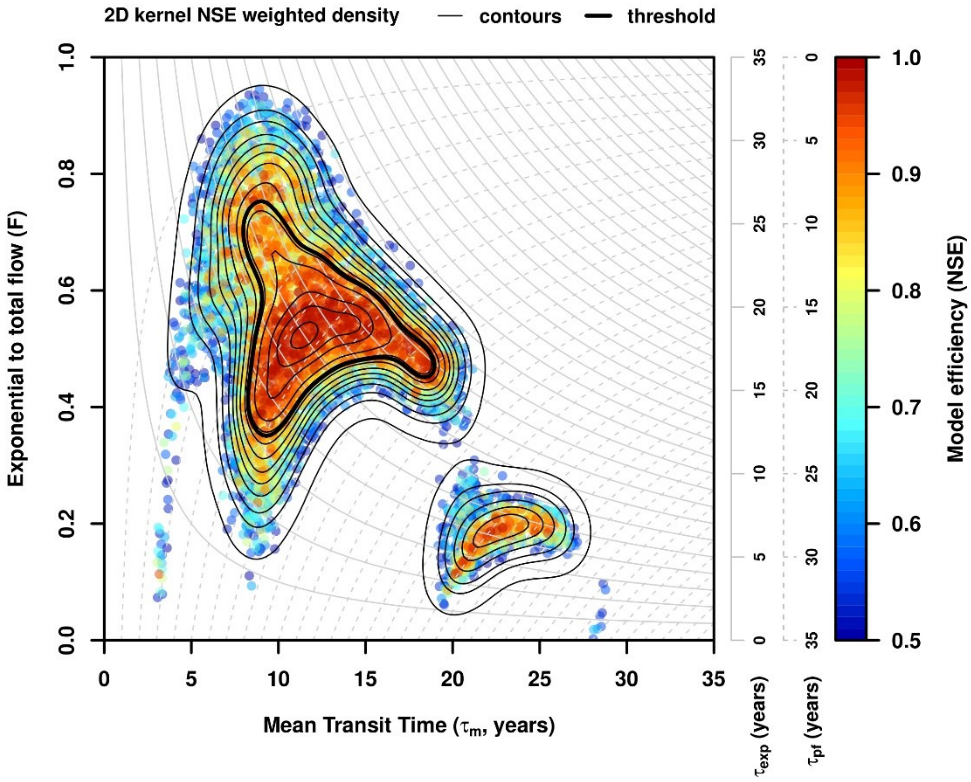


Figure S29: Modelling results of spring K31 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

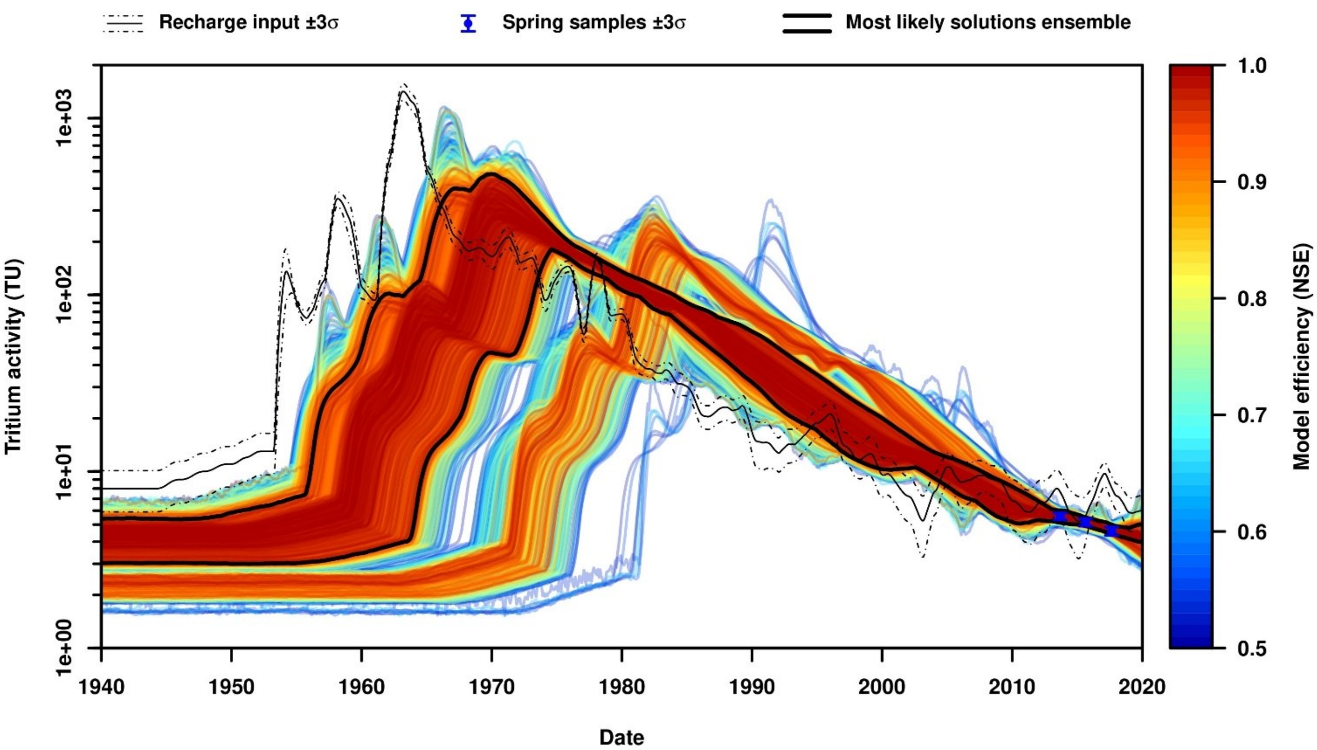
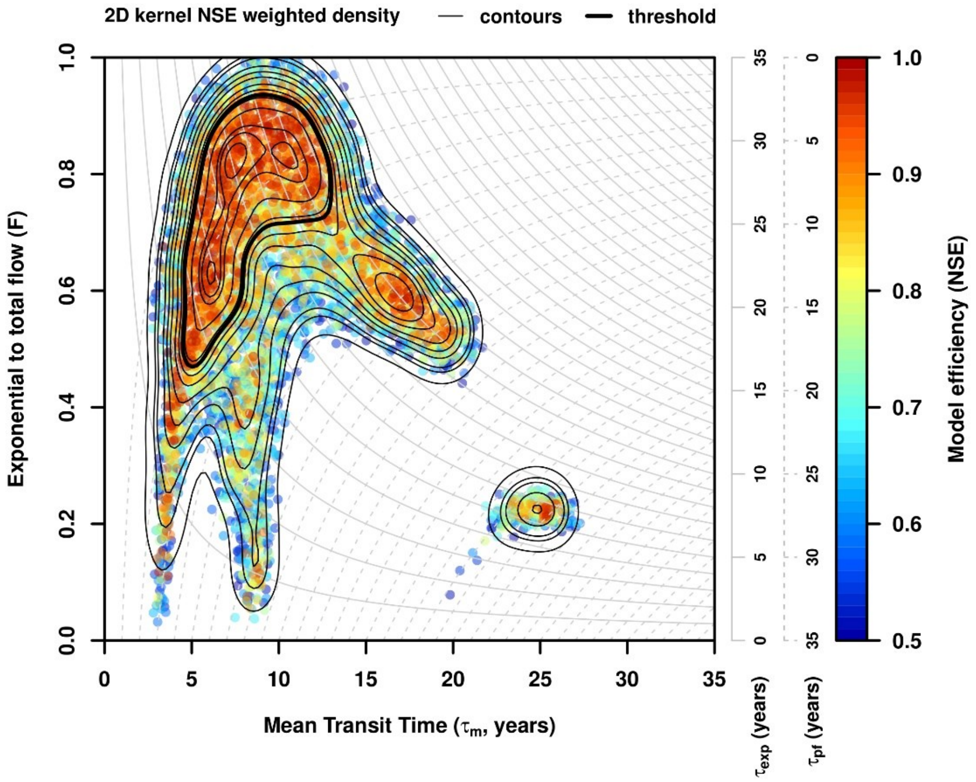


Figure S30: Modelling results of spring K32 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

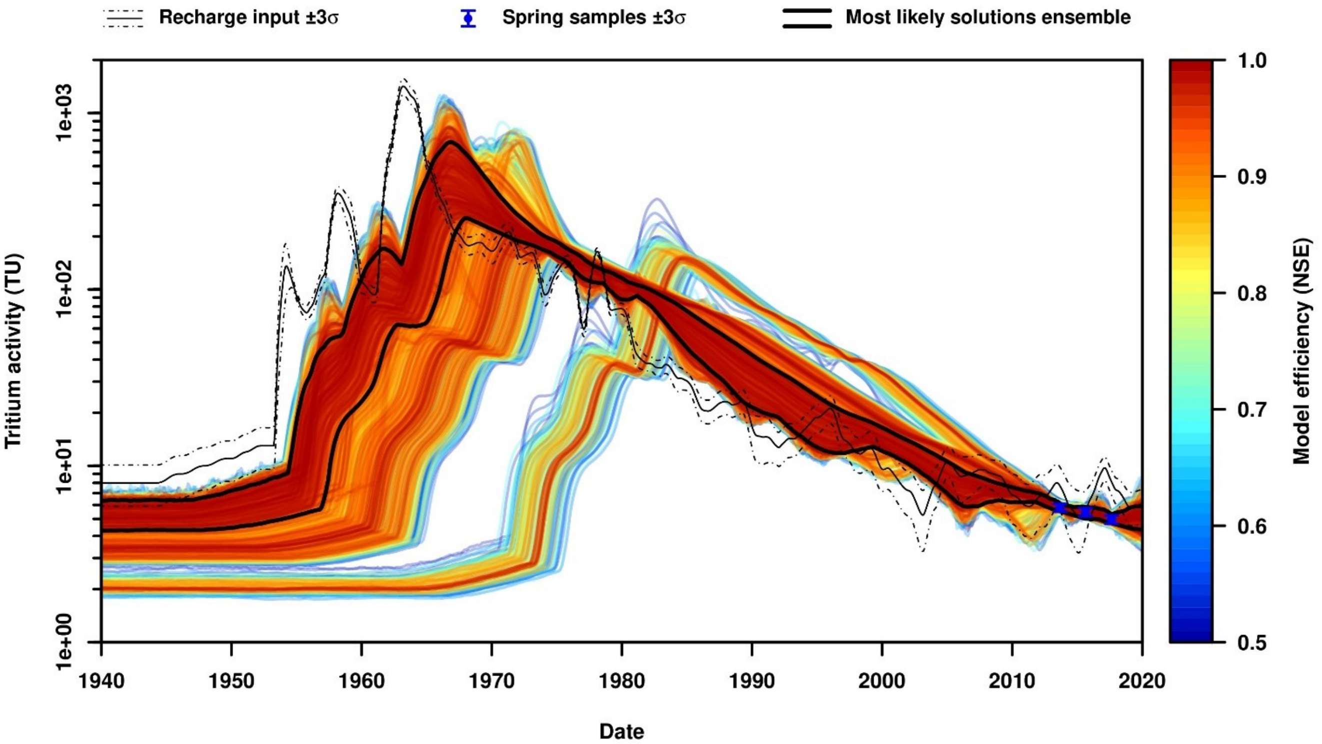
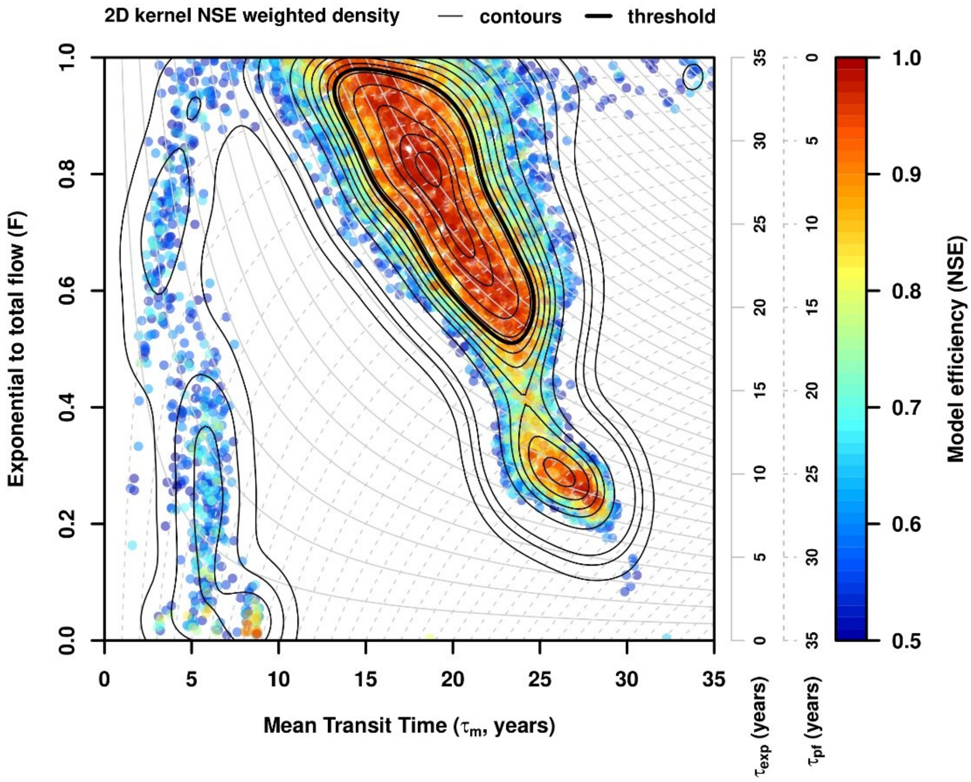


Figure S31: Modelling results of spring M01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

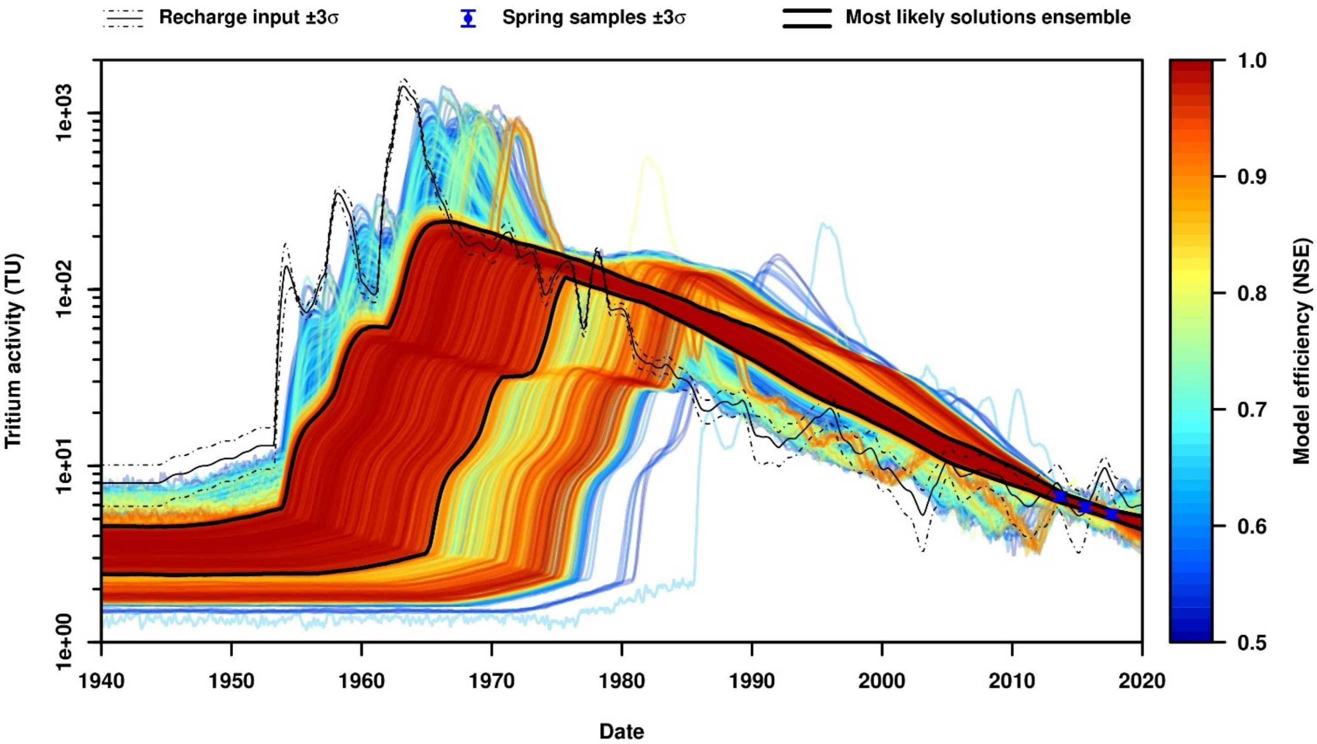


Figure S32: Modelling results of spring P01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)

(b)

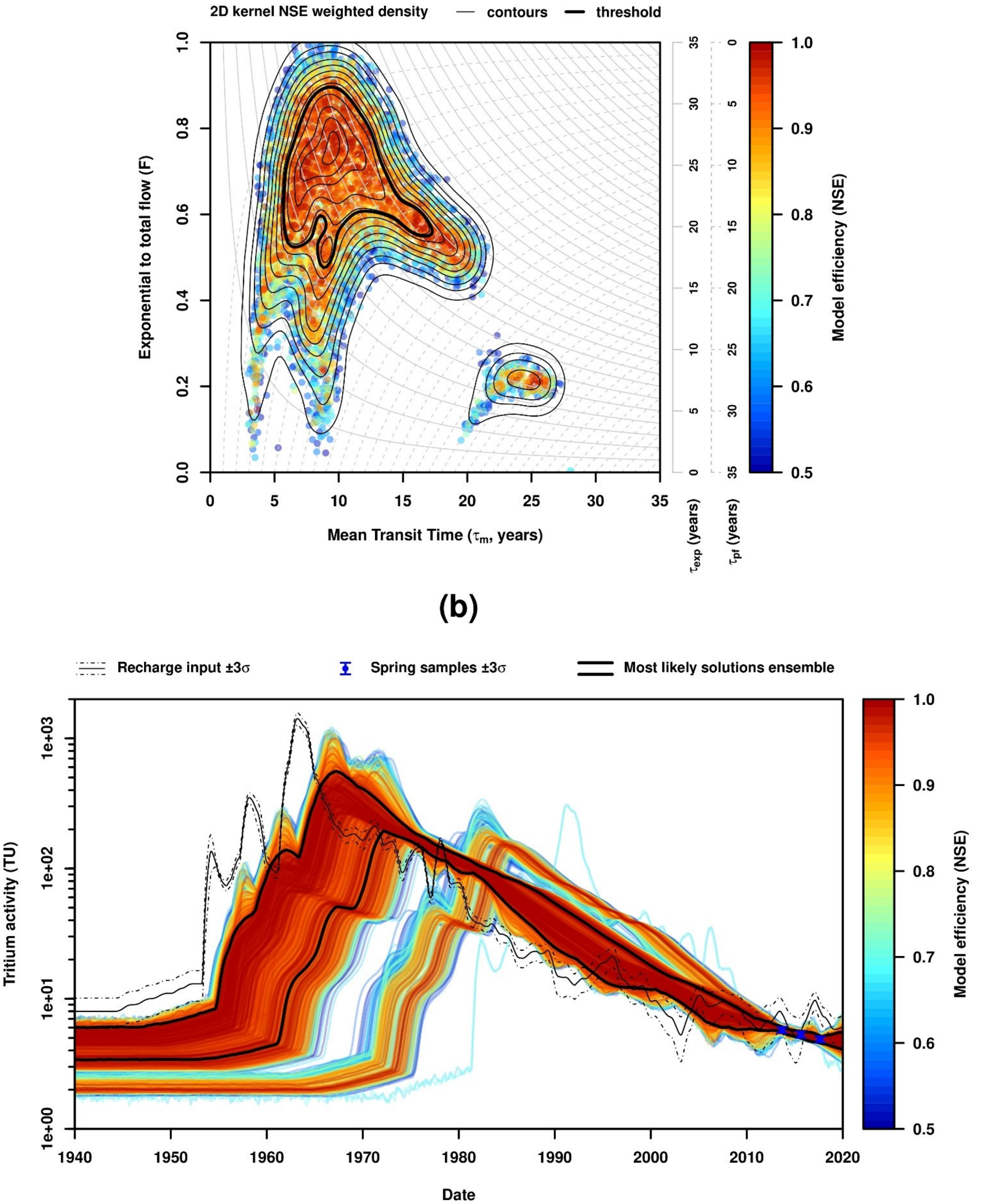
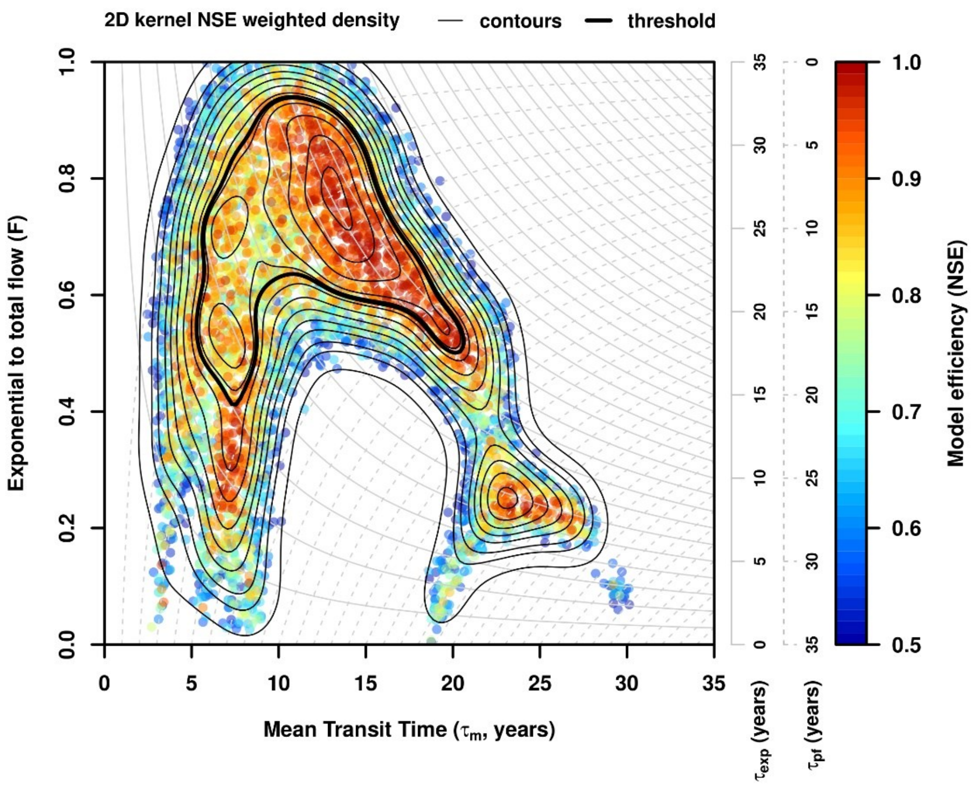


Figure S33: Modelling results of spring S01 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

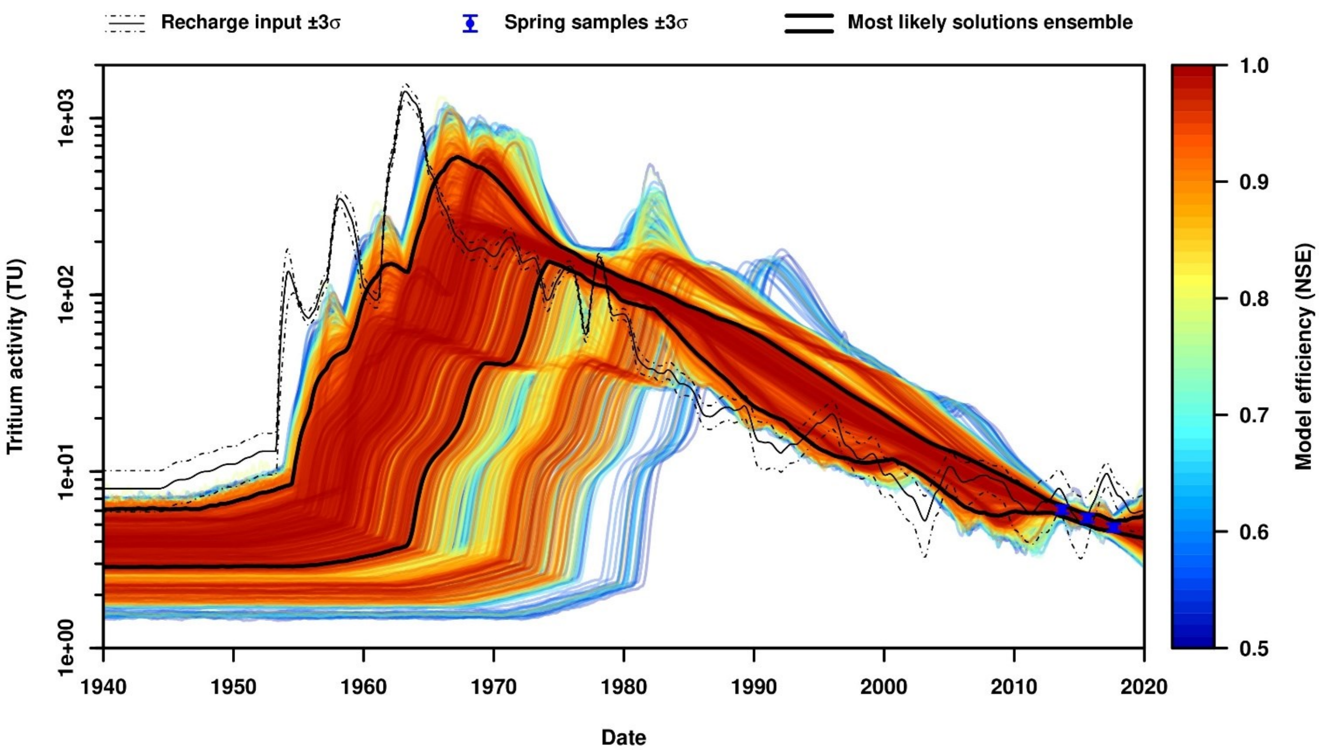
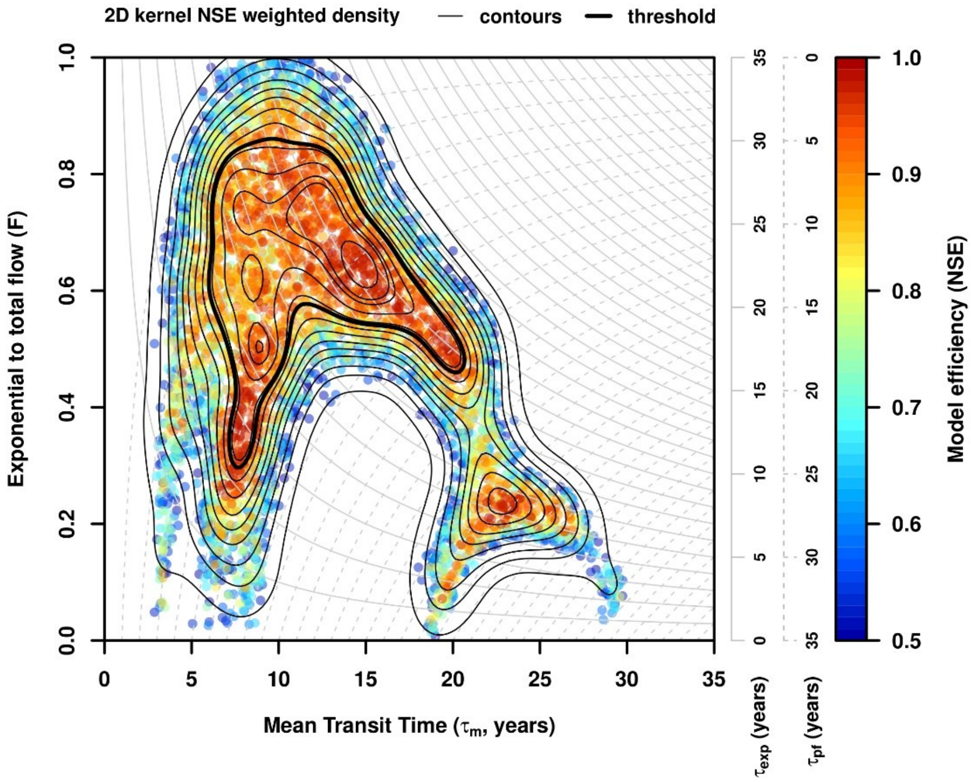


Figure S34: Modelling results of spring S02 in the EPM parameter space (a) and associated modelled tritium time-series (b).

(a)



(b)

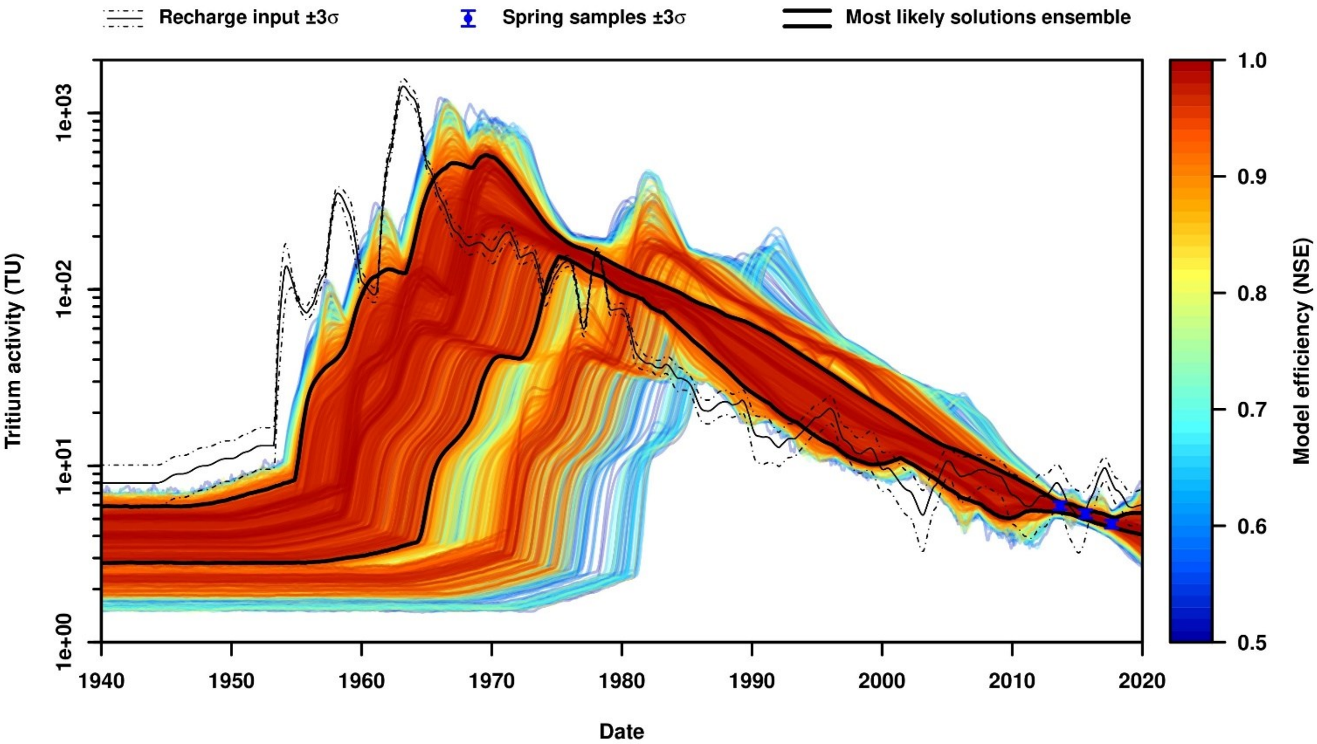


Figure S35: Modelling results of spring S03 in the EPM parameter space (a) and associated modelled tritium time-series (b).