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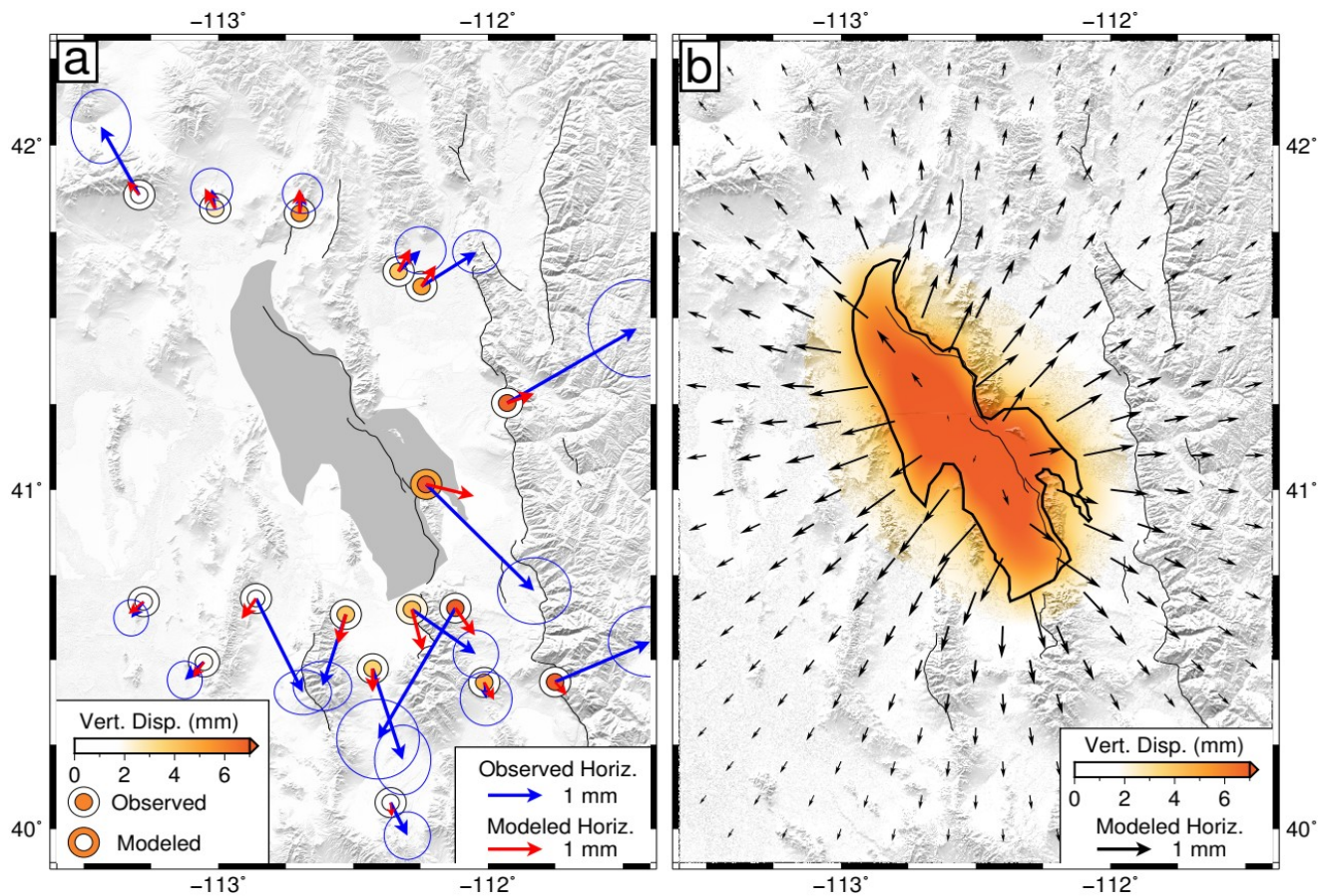
Supporting Information for

**Drought Induced Groundwater Loss Around Great Salt Lake, Utah,  
Inferred from 3D GPS Displacements**

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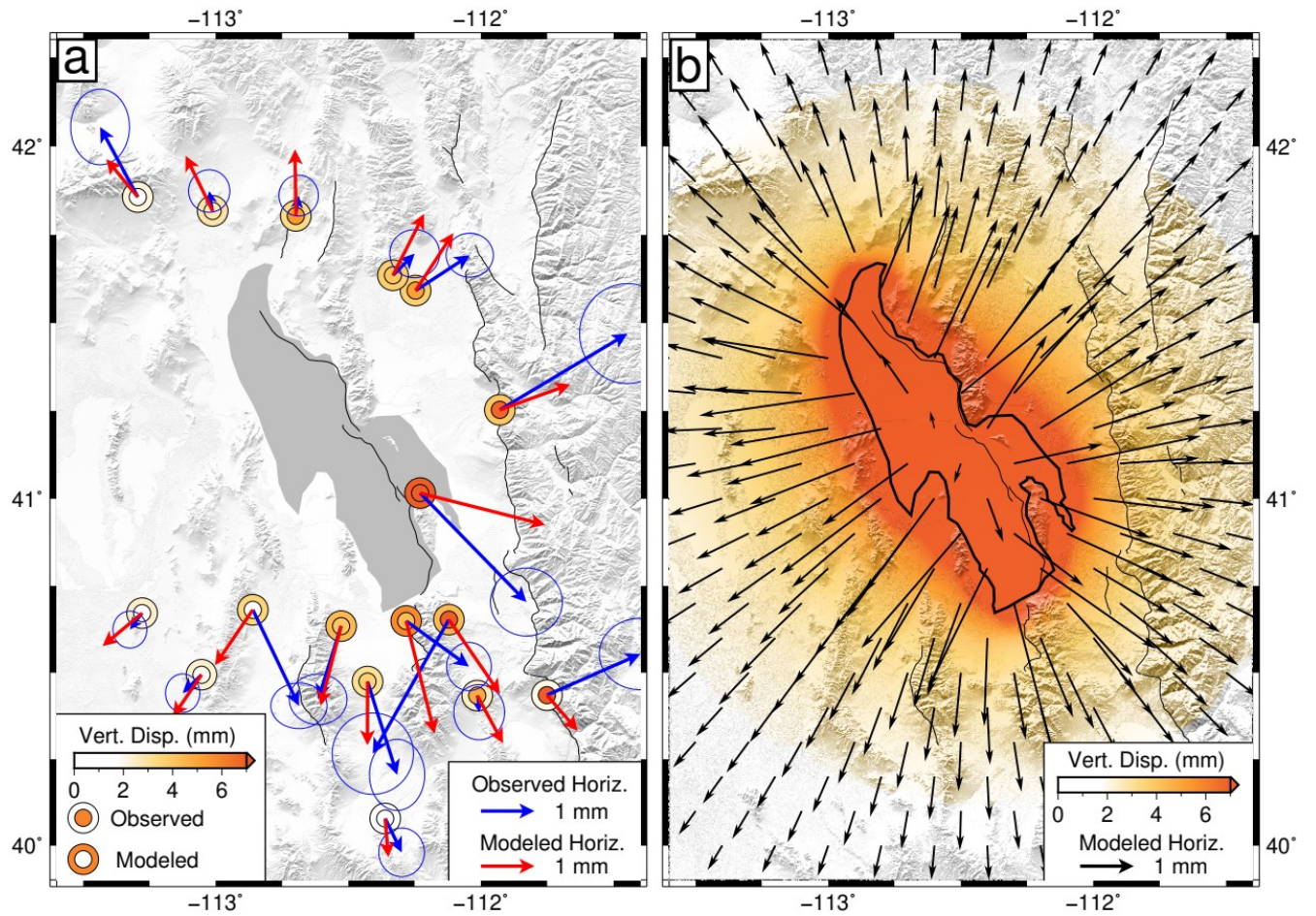
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This supporting information consists of  
Figures S1 to S3 and Tables S1 to S4



**Figure S1.**

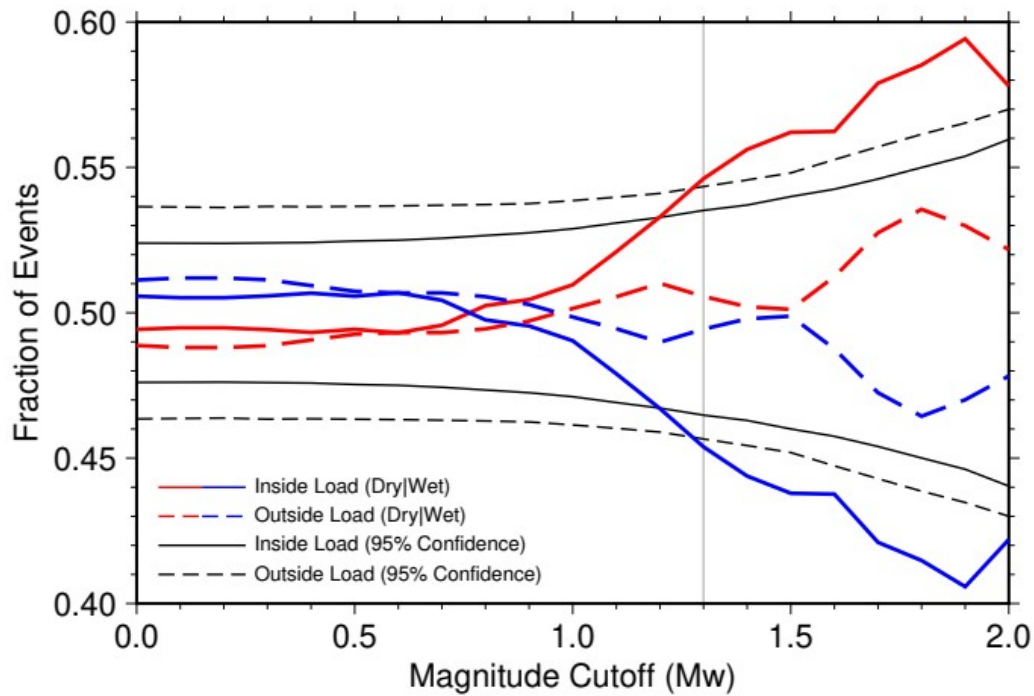
Modeled displacements for a load equivalent to the observed lake level change between 2012 and 2016 (-1.89 m). Displacements are calculated with LoadDef. Applied load is constrained to the bounds of GSL. **a)** Comparison of observed and modeled displacements at GPS stations. Blue arrows represent observed horizontal displacements with 95% confidence ellipses. Red arrows represent modeled horizontal displacements. Inner circles represent the observed GPS displacements while outer circles represent modeled displacements. Faults are represented as thin black lines. The 3D data misfit for this model is 2.49 mm. **b)** Modeled displacement field on a grid. Black arrows show horizontal displacements, while the background shading shows vertical displacements. The bounds of the region where the load is applied is shown by the thick black line. Note the poor fit to the vertical component.



**Figure S2.**

Modeled displacements for the inferred load on GSL. The distribution of load is constrained to the bounds of GSL and applied equally. Key as described in Figure S1. The inferred load is  $5.01 \pm 0.26$  m with a data misfit of 1.85 mm. Note that the fit improves but the load is significantly higher than the observed GSL water loss and unrealistic.





**Figure S3.**

Confidence level plot comparing dry and wet period events, for the inside and outside load regions, across a range of cutoff magnitudes of the earthquake catalog. Reds indicate events which occur during dry periods as identified by the PDSI. Blues indicate events which occur during wet periods. Solid colored lines reflect events within the inside load region. Dashed colored lines reflect events within the outside load region. Black lines show two sigma confidence bounds for the inside region (solid) and outside region (dashed) following 100,000 randomizations of the catalog at each magnitude. Grey vertical bar reflects the chosen cutoff magnitude of 1.3. Note that for the inside load region, the number of dry events is above the significance level for all magnitudes above 1.2.

Well ID	Location	Longitude	Latitude	Drought Displacement Calculation Method				
				Theil-Sen		MIDAS		Net Diff.
				Water Level Disp. (m)	$\sigma$ (m)	Water Level Disp. (m)	$\sigma$ (m)	Water Level Disp. (m)
403339112152501	Ring 1	-112.2588	40.5619	<b>-3.79</b>	<b>0.452</b>	-4.37	1.06	-3.27
403355112173601	Ring 1	-112.2947	40.5647	<b>-2.14</b>	<b>0.112</b>	~	~	~
403400112144001	Ring 1	-112.2461	40.5647	<b>-4.95</b>	<b>0.613</b>	-4.25	0.323	-7.34
403555112230303	Ring 1	-112.3850	40.5986	<b>-0.84</b>	<b>0.102</b>	~	~	~
403949112043301	Ring 1	-112.0766	40.6636	0.28	0.294	~	~	-0.61
405412111525701	Ring 1	-111.8833	40.9019	<b>-6.21</b>	<b>0.707</b>	~	~	-6.40
410523112053301	Ring 1	-112.0933	41.0897	<b>-2.91</b>	<b>0.404</b>	~	~	-2.47
410852111580501	Ring 1	-111.9688	41.1477	<b>-5.16</b>	<b>0.699</b>	~	~	-3.46
411035111594501	Ring 1	-111.9966	41.1763	-0.22	1.147	~	~	-0.77
411348112013601	Ring 1	-112.0274	41.2299	<b>-2.98</b>	<b>0.931</b>	-3.30	0.130	-2.24
414411112543701	Ring 1	-112.9111	41.7363	<b>-0.29</b>	<b>0.094</b>	-0.26	0.002	-0.24
401818112014501	Ring 2	-112.0299	40.3049	0.01	0.065	0.02	0.004	0.02
401818112034201	Ring 2	-112.0624	40.3049	<b>-0.51</b>	<b>0.174</b>	~	~	~
402317111554401	Ring 2	-111.9292	40.3881	<b>-1.54</b>	<b>0.135</b>	~	~	~
402333111513401	Ring 2	-111.8579	40.3930	<b>-3.27</b>	<b>1.546</b>	-3.16	0.075	-3.87
403126112444501	Ring 2	-112.7480	40.5236	<b>-2.14</b>	<b>0.233</b>	~	~	~
403511111541501	Ring 2	-111.9049	40.5863	<b>-0.45</b>	<b>0.127</b>	~	~	0.14
403916111575901	Ring 2	-111.9672	40.6544	0.08	0.162	0.32	0.021	0.13
404152111525101	Ring 2	-111.8816	40.6977	<b>-2.18</b>	<b>0.220</b>	~	~	-1.25
404531111510101	Ring 2	-111.8510	40.7586	<b>-2.01</b>	<b>0.248</b>	~	~	-1.59
405735112593001	Ring 2	-112.9925	40.9597	-0.06	0.046	~	~	~
411928111581001	Ring 2	-111.9702	41.3244	-0.80	0.548	~	~	0.61
414236112101201	Ring 2	-112.1708	41.7099	<b>-0.90</b>	<b>0.202</b>	-0.93	0.018	-0.85
414406112163601	Ring 2	-112.2775	41.7349	<b>-1.77</b>	<b>0.060</b>	~	~	-1.55
414406112173601	Ring 2	-112.2941	41.7349	<b>-1.16</b>	<b>0.159</b>	~	~	-1.29
414418112154801	Ring 2	-112.2641	41.7383	<b>-1.27</b>	<b>0.269</b>	~	~	-1.00
414813113075401	Ring 2	-113.1325	41.8035	<b>-4.55</b>	<b>1.072</b>	~	~	~
415703112514501	Ring 2	-112.8633	41.9508	-0.39	2.343	-0.11	0.022	-0.17
415754112551301	Ring 2	-112.9211	41.9649	<b>-9.34</b>	<b>4.196</b>	~	~	-2.36

**Table S1.**

Observed groundwater level change for wells within the inferred load rings by three methods. Water level trends are calculated with Theil-Sen slope estimation method and the MIDAS algorithm and applied to the duration of the drought. The net difference results indicate the difference in the average well water level positions at the start ( $2012 \pm 0.1$  yr) and end ( $2016 \pm 0.1$  yr) of the drought. Bold Theil-Sen data reflect accepted wells which exhibit water level changes greater than two sigma. All MIDAS values are greater than two sigma.

Station	Longitude	Latitude
AHID	-111.0637	42.2731
BBID	-111.5261	43.6850
BLW2	-109.5578	42.2671
CASP	-106.3841	42.3192
CAST	-110.6773	38.6910
ELKO	-115.8172	40.4147
FOOT	-113.8054	38.8694
GOSH	-114.1797	40.1402
HLID	-114.4140	43.0626
MYT5	-110.0482	39.6027
P007	-114.8197	41.2242
P012	-109.3338	37.5974
P032	-107.2559	41.2417
P684	-111.4505	43.4191
RUBY	-115.1228	40.1172
SMEL	-112.8449	38.9256
SPIC	-112.1275	38.8062
TCSG	-113.4782	43.1192
TSWY	-110.5975	43.1741

**Table S2.**

GPS stations included in the regional common mode calculation.

Station	Longitude	Latitude	Drought Disp. (mm)			Uncertainty (mm)		
			E	N	U	$\sigma_E$	$\sigma_N$	$\sigma_U$
CEDA	-112.8605	40.6807	0.86	-1.79	0.47	0.21	0.17	0.64
COON	-112.1210	40.6526	-1.42	-2.50	10.34	0.31	0.31	1.25
EOUT	-111.9289	41.2532	2.38	1.42	6.78	0.36	0.38	1.28
LTUT	-112.2468	41.5921	1.01	0.66	5.17	0.18	0.17	0.78
NAIU	-112.2296	41.0157	1.98	-2.04	9.67	0.27	0.26	1.18
P016	-112.3614	40.0781	0.31	-0.63	0.30	0.17	0.19	0.67
P057	-112.6231	41.7566	1.15	0.03	4.88	0.16	0.19	0.68
P084	-113.0540	40.4940	-0.35	-0.34	1.90	0.13	0.15	0.61
P086	-112.2821	40.6488	1.17	-0.85	4.30	0.17	0.18	0.79
P100	-113.2942	41.8568	-0.70	1.31	0.47	0.22	0.29	0.96
P111	-113.0122	41.8173	-0.06	0.37	2.69	0.16	0.16	0.73
P113	-113.2780	40.6713	-0.23	-0.31	1.80	0.13	0.14	0.57
P114	-112.5276	40.6340	-0.43	-1.37	4.00	0.22	0.19	0.78
P115	-112.4280	40.4744	0.55	-1.74	3.59	0.21	0.27	0.89
P116	-112.0142	40.4340	0.04	-0.31	4.84	0.19	0.21	0.73
P117	-111.7514	40.4352	1.74	0.77	10.12	0.31	0.27	1.09
P121	-112.6983	41.8034	0.05	0.38	5.36	0.15	0.16	0.60
P122	-112.3319	41.6354	0.40	0.40	3.99	0.19	0.18	0.79
SLCU	-111.9550	40.7722	4.77	0.93	3.84	0.49	0.33	1.47
ZLC1	-111.9522	40.7860	8.33	-0.78	11.79	0.38	0.25	1.02

**Table S3.**

Observed GPS relative displacements during the drought period. Values are calculated from the difference of the MIDAS velocities for the drought and base periods then applied to the duration of the drought (four years).

Modeled Displacements at GPS Stations

Station	Longitude	Latitude	Preferred Ring			Observed GSL Only (-1.89 m)			Solve For GSL Only (-5.01m)		
			E	N	U	E	N	U	E	N	U
CEDA	-112.8605	40.6807	-0.69	-0.87	4.66	-0.27	-0.39	1.33	-0.70	-1.03	3.52
COON	-112.1210	40.6526	0.55	-0.99	6.24	0.36	-0.52	1.68	0.95	-1.39	4.44
EOUT	-111.9289	41.2532	1.36	0.48	4.84	0.50	0.18	1.51	1.31	0.48	4.01
LTUT	-112.2468	41.5921	0.68	0.87	4.73	0.27	0.40	1.40	0.70	1.07	3.71
NAIU	-112.2296	41.0157	0.89	-0.27	8.82	0.88	-0.22	5.01	2.34	-0.59	13.29
P016	-112.3614	40.0781	0.07	-0.90	2.32	0.02	-0.27	0.63	0.06	-0.72	1.67
P084	-113.0540	40.4940	-0.62	-0.83	3.00	-0.20	-0.30	0.89	-0.54	-0.79	2.36
P086	-112.2821	40.6488	0.54	-1.11	7.25	0.20	-0.79	2.20	0.53	-2.11	5.84
P100	-113.2942	41.8568	-0.70	0.79	3.36	-0.22	0.27	0.83	-0.59	0.71	2.21
P111	-113.0122	41.8173	-0.64	1.13	5.26	-0.19	0.39	1.09	-0.50	1.03	2.88
P113	-113.2780	40.6713	-0.82	-0.63	2.94	-0.28	-0.23	0.91	-0.74	-0.62	2.41
P114	-112.5276	40.6340	-0.46	-1.08	6.75	-0.15	-0.56	1.67	-0.39	-1.49	4.42
P115	-112.4280	40.4744	-0.02	-1.33	5.11	0.00	-0.45	1.16	0.00	-1.19	3.09
P116	-112.0142	40.4340	0.53	-0.85	3.45	0.18	-0.34	0.94	0.48	-0.89	2.49
P117	-111.7514	40.4352	0.75	-0.62	2.79	0.22	-0.25	0.79	0.57	-0.67	2.09
P121	-112.6983	41.8034	0.18	1.17	6.10	-0.01	0.47	1.24	-0.02	1.24	3.29
P122	-112.3319	41.6354	0.58	0.94	4.80	0.22	0.43	1.40	0.58	1.14	3.71

**Table S4.**

Displacements at GPS sites, calculated with LoadDef, for the preferred ring load model, the observed fixed GSL load model, and the solved (inferred) GSL load model. The fixed load model only applies the observed load of -1.89 m to the bounds of the lake while the solved GSL model applies the inferred load of -5.01 m. The preferred ring model has a GSL load of -1.85 m, a 24 km inner ring at -1.16 m, and a 40 km outer ring at -0.32 m.