

Supplementary Material

1 Supplementary Figures

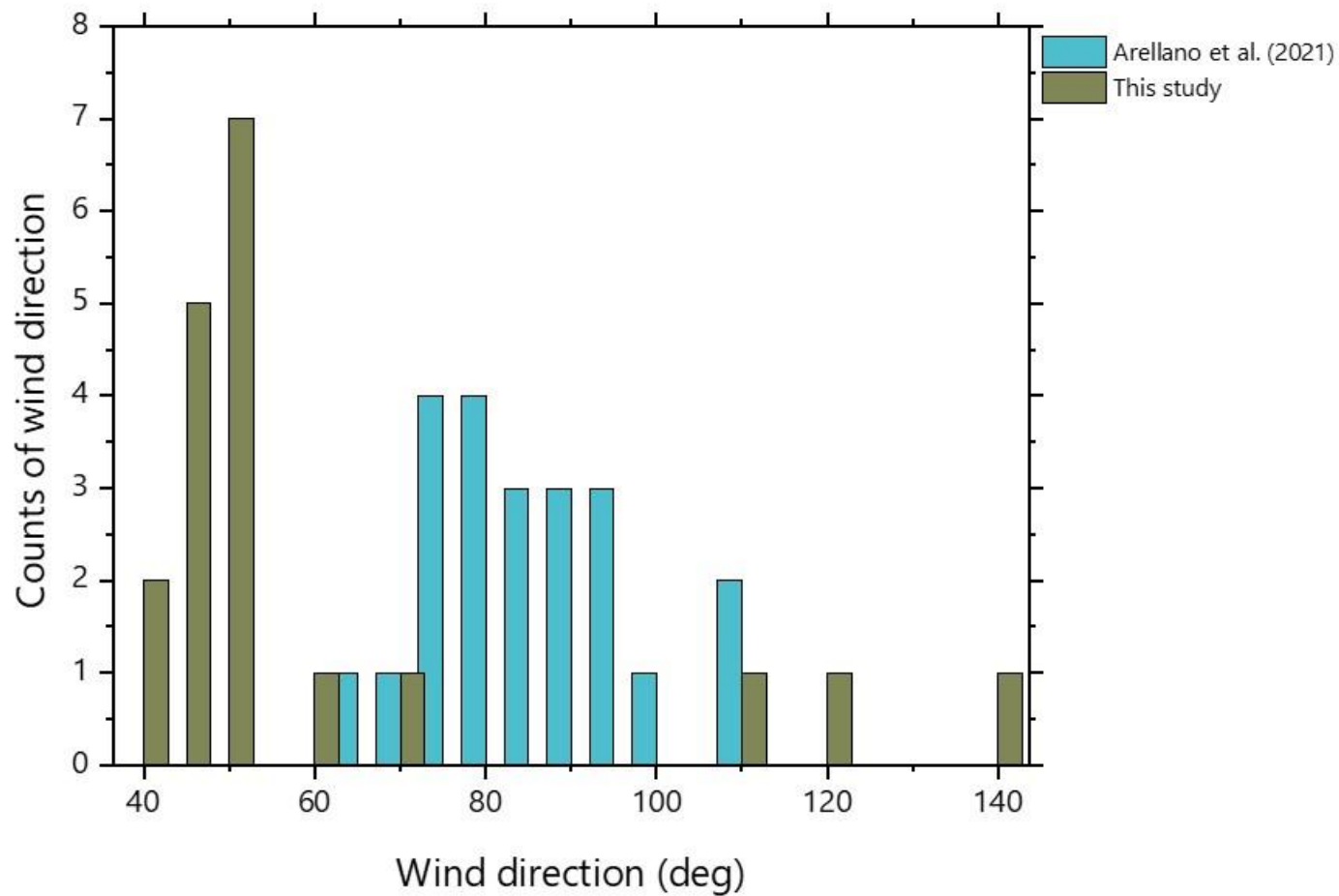


Figure S1. Comparison of the wind direction distribution used in Arellano et al. (2021) and this study.

2 Supplementary Tables

Table S1. Comparison of SO₂ fluxes and wind data for Santa Ana volcano obtained from the evaluation performed by Arellano et al. (2021) and this study.

	NOVAC inventory (Arellano et al., 2021)			This study		
Date	SO ₂ flux (t/d)	Wind speed (m/s)	Wind direction (deg)	SO ₂ flux (t/d)	Wind speed (m/s)	Wind direction (deg)
11/06/2008	57.89 ± 38.88	1.77 ± 1.40	72.60 ± 7.25	77.22 ± 64.82	1.91 ± 0.43	135.89 ± 16.71
13/06/2008	131.33 ± 20.74	6.10 ± 0.0	100.0 ± 0.0	n.a		
17/06/2008	122.89 ± 15.55	4.60 ± 0.0	74.30 ± 0.0	446.51 ± 331.26	4.73 ± 0.24	39.63 ± 2.0
21/06/2008	207.36 ± 27.65	9.77 ± 0.09	94.56 ± 2.02	520.35 ± 231.75	7.84 ± 0.40	47.17 ± 3.58
27/06/2008	177.98 ± 40.61	12.0 ± 1.10	84.23 ± 14.76	n.a	n.a	n.a
15/11/2008	116.64 ± 67.39	2.13 ± 0.96	78.77 ± 3.32	660.57 ± 535.26	7.57 ± 1.10	41.55 ± 1.63
08/12/2008	216.86 ± 86.4	5.60 ± 0.67	91.82 ± 14.93	n.a	n.a	n.a
27/01/2009	437.18 ± 156.38	12.0 ± 1.10	84.23 ± 14.76	471.20 ± 774.59	7.79 ± 0.51	119.88 ± 20.15
11/02/2009	260.93 ± 43.20	8.73 ± 0.36	89.97 ± 8.34	448.81 ± 632.47	6.25 ± 0.32	110.19 ± 30.28
13/02/2009	158.98 ± 42.34	4.45 ± 1.27	88.97 ± 1.34	313.0 ± 180.67	4.10 ± 0.09	47.55 ± 5.23

08/03/2009	188.35 ± 38.88	5.14 ± 1.64	78.02 ± 13.21	1,802.71 ± 1,291.44	6.08 ± 0.08	40.35 ± 0.008
16/03/2009	128.74 ± 24.19	4.14 ± 0.31	73.91 ± 3.91	384.48 ± 70.59	4.45 ± 0.009	50.15 ± 1.58
07/05/2009	113.18 ± 67.39	2.17 ± 1.28	76.90 ± 10.93	196.6 ± 79.57	3.07 ± 0.42	69.37 ± 27.56
10/05/2009	209.09 ± 37.15	6.20 ± 0.0	109.95 ± 10.11	441.55 ± 277.03	5.46 ± 0.69	48.41 ± 5.15
11/05/2009	171.94 ± 39.74	4.10 ± 0.0	89.30 ± 0.0	306.57 ± 98.69	4.50 ± 0.09	47.25 ± 1.93
27/05/2009	149.47 ± 39.74	3.69 ± 0.60	73.96 ± 11.40	147.07 ± 56.04	2.87 ± 0.02	57.45 ± 0.29
31/05/2009	95.90 ± 41.47	3.23 ± 0.51	110.08 ± 24.74	370.09 ± 235.67	4.73 ± 0.20	45.15 ± 1.48
05/06/2009	127.87 ± 50.11	4.12 ± 0.74	67.17 ± 19.38	227.08 ± 38.75	3.03 ± 0.03	45.08 ± 0.81
12/06/2009	128.74 ± 19.87	3.43 ± 0.41	82.33 ± 5.84	291.29 ± 114.48	3.71 ± 0.71	44.83 ± 0.24
12/08/2009	222.05 ± 95.04	6.51 ± 1.24	93.56 ± 10.27	480.01 ± 708.81	5.04 ± 0.38	49.60 ± 5.58
14/09/2009	177.98 ± 64.80	4.63 ± 1.30	76.05 ± 11.06	959.42 ± 1,253.38	2.76 ± 0.62	48.55 ± 2.16
23/09/2009	127.01 ± 13.82	4.55 ± 0.23	65.07 ± 16.30	441.01 ± 158.58	5.97 ± 0.65	41.41 ± 0.94

Table S2. Comparison of SO₂ fluxes and wind data for San Miguel volcano obtained from the evaluation performed by Arellano et al. (2021) and this study.

	NOVAC inventory (Arellano et al., 2021)			This study		
Date	SO ₂ flux (t/d)	Wind speed (m/s)	Wind direction (deg)	SO ₂ flux (t/d)	Wind speed (m/s)	Wind direction (deg)
30/12/2013	3,138.91 ± 921.02	8.59 ± 0.56	80.69 ± 1.94	2,912.25 ± 843.4	8.0 ± 0.10	77.88 ± 6.87
31/12/2013	2,369.09 ± 449.28	9.67 ± 0.56	77.22 ± 9.75	n.a	n.a	n.a
06/02/2014	338.88 ± 178.0	9.25 ± 0.68	68.64 ± 13.58	717.85 ± 139.47	8.83 ± 0.15	66.63 ± 0.70
10/02/2014	1,467.94 ± 143.78	9.77 ± 0.09	94.56 ± 2.02	1,429.19 ± 427.15	8.06 ± 0.29	86.52 ± 11.13

Table S3. CO₂/SO₂ molar ratios obtained from Santa Ana, El Salvador using MultiGAS (PT)

Date	Sampling site	SO ₂ max	CO ₂ /SO ₂	error	R ²	Data points
30/01/2019	SA plateau	11.90	5.34	0.32	0.719	417
30/01/2019	SA plateau	6.37	7.96	0.55	0.718	314
30/01/2019	SA plateau	12.22	5.59	0.39	0.904	121
30/01/2019	SA plateau	10.11	3.26	0.20	0.739	103
30/01/2019	SA plateau	9.26	3.90	0.44	0.752	357

30/01/2019	SA plateau	12.49	3.03	0.20	0.761	284
30/01/2019	SA plateau	4.90	9.35	1.14	0.631	202
30/01/2019	SA plateau	10.77	2.61	0.13	0.621	886
31/01/2019	SA plateau	6.76	5.16	0.90	0.709	101

Table S4. CO₂/SO₂ molar ratios obtained during drone flights above crater lake at Santa Ana, El Salvador using MultiGAS (SK)

Date	Flight	SO ₂ max	CO ₂ /SO ₂	error	R ²	Data points
30/01/2019	fligth 1	16.30	3.17	0.89	0.794	245
31/01/2019	fligth 1	17.30	2.10	1.55	0.638	405
31/01/2019	fligth 4	19.60	3.72	1.39	0.638	299

Table S5. CO₂, H₂S, H₂ and H₂O to SO₂ molar ratios obtained at Santa Ana, El Salvador with the SN instrument

Date	Sampling place	SO ₂ max	CO ₂ /SO ₂	error	R ²	H ₂ S/SO ₂	error	R ²	H ₂ /SO ₂	error	R ²	H ₂ O/SO ₂	error	R ²	Data points
29/01/2019	plateau	17.50	1.92	0.35	0.829	0.12	0.03	0.740							421
29/01/2019	plateau	32.15	2.39	0.29	0.869	0.13	0.02	0.828							688

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29/01/2019	plateau	26.16	2.72	0.41	0.870	0.14	0.02	0.884							467
29/01/2019	plateau	25.56	3.05	0.54	0.852	0.13	0.02	0.911	0.44	0.08	0.860				385
29/01/2019	plateau	28.66	2.85	0.29	0.896	0.14	0.02	0.875	0.42	0.09	0.656				779
29/01/2019	plateau	33.57	2.20	0.20	0.914	0.14	0.01	0.926				80.09	8.21	0.897	742
30/01/2019	plateau	21.00	2.05	0.33	0.826	0.14	0.01	0.933	0.20	0.03	0.813	68.09	10.36	0.845	543
30/01/2019	plateau	11.80	4.00	0.75	0.835	0.12	0.03	0.781	0.80	0.27	0.617				397
30/01/2019	plateau	21.30	3.32	0.37	0.909	0.13	0.02	0.898	0.63	0.10	0.839	54.80	12.40	0.712	543
30/01/2019	plateau	8.41	3.69	1.40	0.634	0.13	0.03	0.811							291
30/01/2019	plateau	18.76	3.63	0.53	0.859	0.12	0.02	0.829	0.53	0.17	0.612	56.71	16.56	0.604	530
30/01/2019	plateau	19.75	3.00	0.56	0.744	0.12	0.02	0.821				45.96	10.31	0.671	662
30/01/2019	plateau	23.69	2.77	0.42	0.766	0.11	0.02	0.718							887
30/01/2019	plateau	6.99				0.12	0.04	0.789							225
31/01/2019	plateau	7.40	7.36	1.68	0.834	0.12	0.02	0.872				81.24	28.97	0.673	280
31/01/2019	plateau	12.04	2.52	0.61	0.694	0.15	0.01	0.976	0.23	0.01	0.725	44.53	13.01	0.611	515
31/01/2019	plateau	11.47	2.97	0.78	0.687	0.14	0.02	0.927	0.21	0.05	0.743	73.80	23.44	0.600	460

31/01/2019	plateau	9.53				0.14	0.02	0.855	0.72	0.18	0.740	107.09	20.11	0.836	392
31/01/2019	plateau	7.94	11.83	5.09	0.812	0.12	0.03	0.943	0.73	0.37	0.758	81.83	42.50	0.748	112
31/01/2019	plateau	11.69				0.13	0.03	0.865				110.98	47.75	0.646	224
08/08/2019	SA rim	4.60				0.19	0.04	0.908				50.92	21.71	0.661	215
08/08/2019	SA rim	3.93	10.10	5.90	0.756	0.28	0.05	0.973				34.91	22.96	0.709	92
24/10/2019	SA rim	3.04				0.14	0.05	0.740							199
17/12/2019	SA rim	10.60	1.96	1.50	0.658	0.17	0.07	0.875							88
17/12/2019	SA rim	8.40	3.97	1.37	0.663	0.15	0.02	0.912	0.57	0.18	0.706				308
17/12/2019	SA rim	12.65	3.88	1.25	0.857	0.14	0.03	0.912	0.39	0.17	0.768	69.71	28.36	0.789	136
17/12/2019	SA rim	10.63	4.28	1.04	0.842	0.15	0.02	0.938	0.33	0.09	0.800	70.52	50.52	0.378	240
17/12/2019	SA rim	9.01	3.75	1.80	0.765	0.12	0.04	0.851	0.41	0.26	0.646	61.28	22.91	0.844	117
17/12/2019	SA rim	5.22	4.97	3.32	0.668	0.12	0.06	0.801							103
23/01/2020	SA rim	5.86	3.13	1.71	0.680	0.14	0.05	0.839				47.91	16.84	0.838	133
23/01/2020	SA rim	9.97	2.65	1.74	0.712	0.15	0.09	0.751							91
23/01/2020	SA rim	15.80				0.18	0.02	0.919				35.63	21.30	0.328	404
30/09/2020	SA rim	3.43				0.12	0.08	0.478							183

30/09/2020	SA rim	7.44	9.44	4.94	0.611	0.17	0.03	0.925				295.22	103.89	0.776	183
30/09/2020	SA rim	7.90	6.21	2.79	0.729	0.09	0.04	0.773							151
30/09/2020	SA rim	11.00	4.33	1.07	0.842	0.13	0.03	0.842	0.50	0.12	0.854	31.67	24.48	0.352	232
03/12/2020	SA rim					0.11	0.02	0.897				70.33	84.33	0.179	239
03/12/2020	SA rim	7.58	3.36	1.34	0.606	0.13	0.02	0.892				82.96	76.45	0.224	296
03/12/2020	SA rim	7.88	5.47	2.38	0.622	0.10	0.03	0.736	0.24	0.18	0.357	34.52	112.33	0.029	240
03/12/2020	SA rim					0.10	0.04	0.816	0.07	0.26	0.006	176.85	86.84	0.766	113

- Table S6. CO₂, H₂S, H₂ and H₂O to SO₂ molar ratios obtained at San Miguel, El Salvador with the SN instrument

Date	sampling place	SO ₂ max	CO ₂ /SO ₂	error	R ²	H ₂ S/SO ₂	error	R ²	H ₂ O/SO ₂	error	R ²	Data points
13/07/2018	SM plateau	3.52	9.19	4.74	0.661	0.10	0.03	0.880				157
06/02/2019	SM rim	5.20	7.01	2.14	0.625	0.12	0.02	0.841	221.06	56.47	0.704	449
06/02/2019	SM rim	5.25				0.13	0.03	0.902	59.90	27.85	0.645	197
07/02/2019	SM rim	4.60				0.07	0.02	0.709				372
07/02/2019	SM rim	5.74	5.15	1.51	0.695	0.14	0.01	0.972				362
07/02/2019	SM rim	4.70				0.12	0.04	0.852	70.54	29.51	0.758	150
27/03/2019	SM rim	3.18				0.19	0.06	0.886				121
27/03/2019	SM rim	3.29	11.11	5.00	0.624				111.82	46.07	0.664	225

27/03/2019	SM rim	6.07	5.57	1.47	0.787	0.11	0.02	0.866	83.44	19.70	0.822	284
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Table S7. Concentrations ($\pm$ error) of detected elements in the plume of Santa Ana and San Miguel volcanoes using the alkaline trap method.

Date	Place	F (ppm)	Cl (ppm)	S (ppm)	Br (ppt)	I (ppt)	CO ₂ (ppm)
<i>Santa Ana</i>							
29.01.2019	Rim	b.d.l	0.3 $\pm$ 0.04	0.5 $\pm$ 0.1	19.9 $\pm$ 3.4	b.d.l	54.1 $\pm$ 9.2
30.01.2019	Rim	b.d.l	n.a	n.a	n.a	b.d.l	107.5 $\pm$ 18.3
30.01.2019	Plateau	b.d.l	0.4 $\pm$ 0.06	3.0 $\pm$ 0.5	b.d.l	b.d.l	136.1 $\pm$ 23.1
31.01.2019	Rim	b.d.l	n.a	n.a	b.d.l	b.d.l	114.6 $\pm$ 19.5
31.01.2019	Plateau	b.d.l	0.5 $\pm$ 0.1	4.9 $\pm$ 0.8	8.3 $\pm$ 1.4	b.d.l	163.0 $\pm$ 27.7
02.12.2020	Rim	0.1 $\pm$ 0.01	0.3 $\pm$ 0.04	0.2 $\pm$ 0.03	b.d.l	b.d.l	153.6 $\pm$ 26.1
03.12.2020	Rim	0.006 $\pm$ 0.0001	0.2 $\pm$ 0.04	1.2 $\pm$ 0.2	14.38	b.d.l	289.5 $\pm$ 49.2
<i>San Miguel</i>							
05.02.2019	Rim	b.d.l	0.8 $\pm$ 0.1	b.d.l	555.8 $\pm$ 94.5	b.d.l	192.8 $\pm$ 32.8
06.02.2019	Rim	b.d.l	1.5 $\pm$ 0.3	1.5 $\pm$ 0.3	696.1 $\pm$ 118.3	34.0 $\pm$ 5.8	154.4 $\pm$ 26.3
07.02.2019	Rim	b.d.l	1.4 $\pm$ 0.2	1.3 $\pm$ 0.2	770.7 $\pm$ 131.0	17.0 $\pm$ 2.9	130.2 $\pm$ 22.1

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08.12.2020	Rim	0.001 ± 0.0002	b.d.l	b.d.l	b.d.l	b.d.l	737.9 ± 125.4
09.12.2020	Rim	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	414.6 ± 70.5

b.d.l: below detection limit

n.a.: not available