

A) List of input data (distances and thicknesses) used for the case study eruptions shown in this study from equatorial and midlatitude belts.

Equatorial belt volcanoes	Eruption/layer	Distances (d_0, d_1) in km	Thicknesses (T_0, T_1) in cm	References
Apoyo caldera (Nicaragua)	Upper Apoyo Tuff (UAT)	85, 394	40, 10	Kutterolf et al. (2008)
Atitlán caldera (Guatemala)	Los Chocoyos	160, 1360	100, 3	Kutterolf et al (2008)
Citlaltépetl (Mexico)	Citlaltépetl - F	16, 81	1500, 2.5	Rossotti et al. (2006)
Colima (Mexico)	1913 – C1	4.6, 31	65, 15	Saucedo et al. (2010)
Coatepeque caldera (Ecuador)	Congo Tephra	75, 625	100, 5	Kutterolf et al. (2008)
Cotopaxi (Ecuador)	L5 (ca. 1180 BP)	5, 26	115, 8	Biass and Bonadonna (2011)
El Chichon (Mexico)	1982 - A	16, 88	20, 0.5	Bonasia et al. (2012)
Fuego (Guatemala)	1971	79.5, 223	10, 0.2	Rose et al. (1973)
Huaynaputina (Perù)	1600 AD	1, 260	200, 5	Adams et al. (2001)
Las Cumbres VC (Mexico)	Quetzalapa – Umpf	2, 15	90, 40	Rodriguez et al. (2002)
Masaya Caldera (Nicaragua)	Fontana Lapilli D+E+F	3.5, 17.5	300, 60	Costantini et al. (2009)
Pinatubo (Philippines)	1991 - C	3.7	5.6	Wiesner et al. (2004)
Pululagua (Ecuador)	2450 BP	0.6	4.8	Papale and Rosi (1993)
Santa Maria (Guatemala)	1902	3.5, 703	100, 0.1	Williams and Self (1983)

Tambora (Indonesia)	1815 - F4	17.6, 65	16, 7	Kandlbauer and Sparks (2014)
Toba caldera (Indonesia)	YTT	594, 2969	40, 5	Costa et al. (2014)
Valle Central (Costa Rica)	Tiribi Tuff	100, 780	1000, 1	Pérez et al. (2006)
Mid-latitude belt volcanoes	Eruption/layer	Distances (d_0, d_I) in km	Thicknesses (T_0, T_I) in cm	References
Askja (Iceland)	1875 - D	4.6, 150	100, 1	Carey et al. (2010)
Aso (Japan)	Aso 4	143, 3125	45, 1	Tarakada and Hoshizumi (2020)
Calbuco (Chile)	2015	6, 28	8, 1	Romero et al. (2016)
Campi Flegrei (Italy)	Agnano Monte Spina - B1	12, 43	30, 19	De Vita et al. (1999)
Crater Lake (Oregon, USA)	Mazama eruption	600, 1500	159, 10	Buckland et al. (2020)
Fogo (Azores)	Fogo A	1.3, 20.6	20, 0.25	Yang and Bursik (2016)
Hekla (Iceland)	1766	37.5, 140	10, 0.5	Janebo et al. (2016)
Hudson (Chile)	1991	77, 1652	10, 0.1	Scasso et al. (1994)
Ksudach (Kamchatka, Russia)	240 AD	1778, 800	8, 1	Sulpizio (2005)
Minoan (Santorini)	3.6 ky BP	154, 646	10, 2	Karstens et al. (2023)
Mt St. Helens (Oregon, USA)	May 1980	25, 203	100, 10	Durant et al. (2009)
Novarupta (Alaska, USA)	1912 - (F+G+H)	4, 16	300, 30	Houghton et al. (2004)

Quizapu (Chile)	1932	77, 1110	10, 1	Hildreth and Drake (1992)
Somma-Vesuvius (Italy)	Avellino EU2	16, 40	50, 10	Sulpizio (2010)
Somma-Vesuvius (Italy)	Avellino EU3	38, 100	25, 1	Sulpizio (2010)
Somma-Vesuvius (Italy)	Greenish Pumice	4, 19	240, 18	Cioni et al. (2003)
Tarawera (New Zealand)	1886	6.4, 36.4	100, 8	Walker (1984)
Taupo Volcanic Center (NZ)	Taupo Pumice	35, 200	150, 12	Walker (1980)
Taupo Volcanic Center (NZ)	Waimihia	11.3, 229	400, 12	Walker (1981)
Taupo Volcanic Center (NZ)	Hatepe	58.5, 213.3	200, 3	Walker (1981)

B) Sensitivity test showing the influence of the number of samplings for a single set of input data (one couple of distances and thicknesses) by launching 100 and 1000 runs. In Tables two case studies from equatorial and midlatitude belts are shown. This test is carried out using the ESM7_plotting.py.

Cotopaxi (Ecuador) – L5 (ca. 1180 BP)

d ₀ (km)	d ₁ (km)	T ₀ (cm)	T ₁ (cm)	n. sampling	Magnitude Lower Bound	Magnitude Upper Bound
5	26	115	8	100	3.71	4.73
5	26	115	8	1000	4.08	4.72

mean	3.90	4.73
st.dev	0.26	0.01
st.dev./mean	6.72 %	0.15 %

Calbuco (Chile) – 2015 eruption

d ₀ (km)	d ₁ (km)	T ₀ (cm)	T ₁ (cm)	n. sampling	Magnitude Lower Bound	Magnitude Upper Bound
6	28	8	1	100	3.97	4.86
6	28	8	1	1000	3.87	4.82

mean	3.92	4.84
st.dev	0.07	0.03
st.dev./mean	1.80 %	0.58 %

C) Sensitivity test showing the influence of the position of the input data considering the downwind and upwind direction along the same isopach. In this case, two couple of distances have the same thickness data. In Tables two case studies from equatorial and midlatitude belts are shown. This test is carried out using the ESM6_runs_using_distances.py.

El Chichon (Mexico) – 1982 A eruption

d ₀ (km)	d ₁ (km)	T ₀ (cm)	T ₁ (cm)	ε	Magnitude Lower Bound	Magnitude Upper Bound
14	70	100	5	0.61	4.6	5.5
10	42	100	5	0.48	4.31	5.1
10	70	100	5	0.64	4.68	5.58
14	42	100	5	0.39	4.33	5.06

mean	4.48	5.31
st.dev	0.19	0.27
st.dev./mean	4.19 %	5.05 %

Novarupta (Alaska) – 1912 FGH eruption

d ₀ (km)	d ₁ (km)	T ₀ (cm)	T ₁ (cm)	ε	Magnitude Lower Bound	Magnitude Upper Bound
4.70	20.58	200	30	0.51	3.98	4.8
3.23	17.94	200	30	0.57	3.92	4.76
3.23	20.58	200	30	0.40	4.12	4.74
4.70	17.94	200	30	0.45	3.88	4.67

mean	3.98	4.74
st.dev	0.11	0.05
st.dev./mean	2.64 %	1.15 %