

# Supporting information of “Volcanic hazard assessment for tephra fallout in Martinique”

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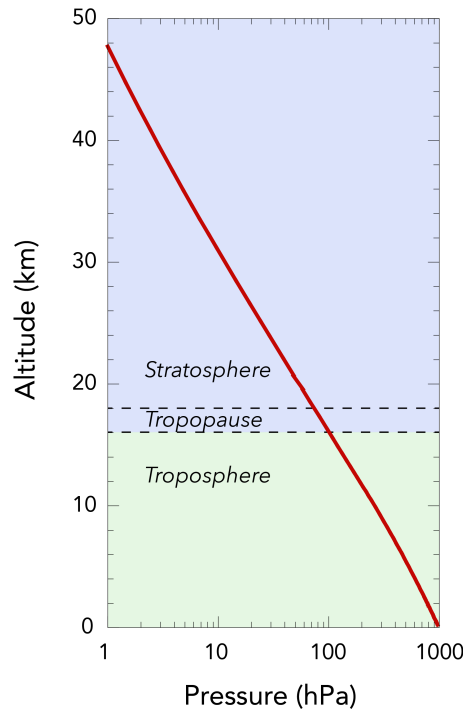
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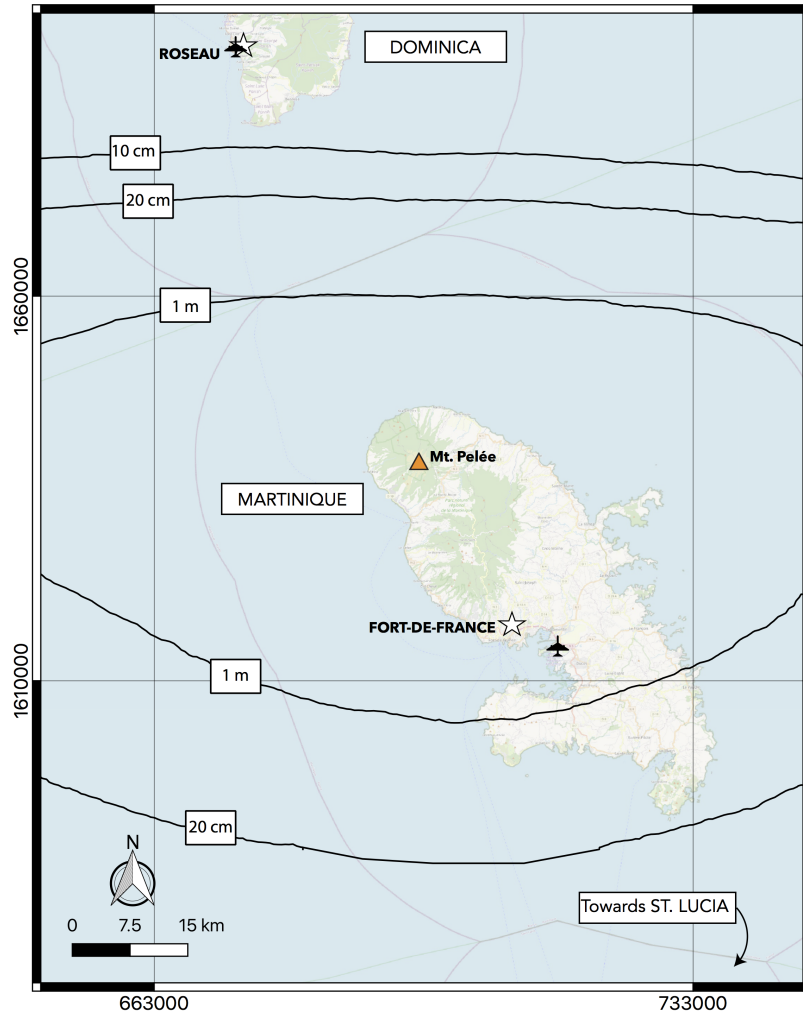
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## Introduction

This supporting file provides supplemental informations about the altitude model (Figure S1), the probability map for a catastrophic eruptive scenario in Martinique (Figure S2), total grain-size distributions (Table S1), and explosive volcanic eruptions taken from LaMEVE and IVESPA worldwide databases used in this work (Table S2).



**Figure S1:** Altitude model used to convert the 37 pressure levels of the original ERA5 files into the altitude levels required by HAZMAP (from Michaud-Dubuy et al (2019)). The different layers of atmosphere at tropical latitudes are indicated, including the tropopause (dotted lines).



**Figure S2:** Ash load probability map considering a catastrophic eruption of Mt. Pelée (see main text) and using the 41-year wind database, with the 5% probabilities of reaching a deposit thickness of 10 cm, 20 cm and 1 m. Note that the 1 mm and 1 cm thresholds, as well as the 10 cm threshold south of Martinique, are not shown because they are far beyond the limit of the simulation grid (i.e., a square of 100 km x 100 km centered at Mt Pelée volcano). This map was generated using the open source QGIS software (with base map and data from OpenStreetMap and OpenStreetMap Foundation), coordinates are in WGS84 – UTM Zone 20N system.

**Table S1:** Total grain-size distributions of the P1 (Carazzo et al, 2012), P2 (Carazzo et al, 2019), and P3 (Carazzo et al, 2020) eruptions, and their arithmetic average. Particle sizes are indicated using the  $\phi$  unit with  $d_\phi$  (diameter in mm) =  $2^{-\phi}$ .

| $\phi$ | P1 eruption<br>Total (wt%) | P2 eruption<br>Total (wt%) | P3 eruption<br>Total (wt%) | Average<br>Total (wt%) |
|--------|----------------------------|----------------------------|----------------------------|------------------------|
| -6     | 1.34                       | 1.44                       | 0.97                       | 1.25                   |
| -5     | 10.50                      | 11.20                      | 4.03                       | 8.58                   |
| -4     | 18.20                      | 14.11                      | 4.46                       | 12.26                  |
| -3     | 20.40                      | 18.24                      | 10.75                      | 16.46                  |
| -2     | 16.16                      | 18.60                      | 12.20                      | 15.65                  |
| -1     | 8.96                       | 12.01                      | 8.40                       | 9.79                   |
| 0      | 7.37                       | 11.06                      | 11.01                      | 9.81                   |
| 1      | 8.55                       | 6.95                       | 19.67                      | 11.72                  |
| 2      | 6.65                       | 3.46                       | 22.17                      | 10.76                  |
| 3      | 1.20                       | 1.43                       | 5.28                       | 2.64                   |
| 4      | 0.40                       | 0.84                       | 0.68                       | 0.64                   |
| 5      | 0.27                       | 0.54                       | 0.37                       | 0.39                   |
| 6      | 0.00                       | 0.12                       | 0.01                       | 0.05                   |

**Table S2:** Volcanic eruptions taken from LaMEVE (Brown et al, 2014) and IVESPA (Aubry et al, in revision) databases and used to calculate the probability distribution of the 16 eruptive scenarios considered in this study (see Figure 6).

| Eruption                         | Log (Mass) | log(MER) | Database |
|----------------------------------|------------|----------|----------|
| Agua de Pau 1563 AD              | 11.9       | 7.3      | LaMEVE   |
| Agung 1963                       | 11.8       | 7.4      | IVESPA   |
| Agung 1963                       | 11.7       | 7.5      | IVESPA   |
| Alaid 1981 AD                    | 11.7       | 7.1      | LaMEVE   |
| Aniakchak Collapse of Half cone  | 11.6       | 7.9      | LaMEVE   |
| Aniakchak Collapse of Half cone  | 11.6       | 7.9      | LaMEVE   |
| Apoyeque Mateare Tephra          | 12.0       | 6.5      | LaMEVE   |
| Apoyeque Mateare Tephra          | 12.0       | 6.5      | LaMEVE   |
| Apoyeque Los Cedros Tephra (CdT) | 12.0       | 7.1      | LaMEVE   |
| Askja 1875 AD                    | 11.9       | 7.9      | LaMEVE   |
| Augustine 1986 AD                | 11.0       | 6.8      | LaMEVE   |
| Augustine 1986 AD                | 11.0       | 6.8      | LaMEVE   |
| Augustine 1976 AD                | 11.7       | 7.1      | LaMEVE   |
| Augustine 1976 AD                | 11.7       | 7.1      | LaMEVE   |
| Augustine 1976 AD                | 11.7       | 7.1      | LaMEVE   |
| Avachinsky IAv24;AV2             | 12.0       | 7.3      | LaMEVE   |
| Azufres. Los Multi layered fall  | 12.0       | 6.5      | LaMEVE   |
| Bagana 1952 AD                   | 11.0       | 6.4      | LaMEVE   |
| Bezymianny 2005                  | 10.7       | 6.5      | IVESPA   |
| Calbuco 2015                     | 11.2       | 6.9      | IVESPA   |
| Calbuco 2015                     | 11.2       | 6.9      | IVESPA   |
| Calbuco 2015                     | 10.8       | 7.0      | IVESPA   |
| Calbuco 2015                     | 11.4       | 7.1      | IVESPA   |
| Calbuco 2015                     | 11.5       | 7.1      | IVESPA   |
| Calbuco 2015                     | 11.5       | 7.2      | IVESPA   |
| Calbuco 2015                     | 10.9       | 7.2      | IVESPA   |
| Calbuco 2015                     | 11.5       | 7.2      | IVESPA   |
| Calbuco 2015                     | 11.0       | 7.2      | IVESPA   |
| Calbuco 2015                     | 11.0       | 7.3      | IVESPA   |
| Calbuco 2015                     | 11.0       | 7.3      | IVESPA   |

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| Eruption                            | Log (Mass) | log(MER) | Database |
|-------------------------------------|------------|----------|----------|
| Calbuco 2015                        | 11.0       | 7.3      | IVESPA   |
| Calbuco 2015                        | 11.1       | 7.4      | IVESPA   |
| Campi Flegrei Averno 1-2            | 11.5       | 6.4      | LaMEVE   |
| Carrán-Los Venados Carran Maar      | 11.5       | 6.4      | LaMEVE   |
| Cerro Hudson 1991                   | 11.3       | 6.1      | IVESPA   |
| Chaitén 2008                        | 11.3       | 7.8      | IVESPA   |
| Colo [Una Una] 1983 AD              | 11.0       | 7.2      | LaMEVE   |
| Cotopaxi P                          | 11.7       | 6.4      | LaMEVE   |
| Cotopaxi MZ                         | 11.4       | 8.0      | LaMEVE   |
| Cotopaxi X                          | 12.0       | 8.0      | LaMEVE   |
| El Chichón 1982                     | 11.4       | 7.1      | IVESPA   |
| El Chichón 1982                     | 11.6       | 7.2      | IVESPA   |
| El Chichón 1982                     | 11.7       | 7.5      | IVESPA   |
| Etna 122 BC                         | 11.4       | 7.9      | LaMEVE   |
| Eyjafjallajökull 2010               | 11.1       | 6.0      | IVESPA   |
| Fayal C11                           | 11.3       | 7.1      | LaMEVE   |
| Fernandina 1968 AD                  | 11.4       | 7.9      | LaMEVE   |
| Fuego 1971                          | 10.9       | 6.3      | IVESPA   |
| Fuego 1971                          | 11.0       | 6.3      | IVESPA   |
| Fuego 1971                          | 10.9       | 6.4      | IVESPA   |
| Fuego 1971                          | 10.9       | 6.4      | IVESPA   |
| Fuego 1971                          | 11.0       | 6.4      | IVESPA   |
| Fuego 1974                          | 10.8       | 6.5      | IVESPA   |
| Fuego 1971                          | 11.3       | 6.6      | IVESPA   |
| Furnas I                            | 10.7       | 6.4      | LaMEVE   |
| Furnas C                            | 11.9       | 7.3      | LaMEVE   |
| Galunggung 1982 AD                  | 11.8       | 7.6      | LaMEVE   |
| Galunggung 1982 AD                  | 11.8       | 7.6      | LaMEVE   |
| Grímsvötn 1783 AD                   | 12.0       | 6.7      | LaMEVE   |
| Grímsvötn 2011                      | 11.8       | 6.9      | IVESPA   |
| Hekla 1980                          | 10.6       | 6.4      | IVESPA   |
| Hekla 1991                          | 10.0       | 6.4      | IVESPA   |
| Hekla 1970                          | 10.7       | 6.8      | IVESPA   |
| Hekla 1947                          | 10.5       | 7.2      | IVESPA   |
| Hekla 1947                          | 11.0       | 7.7      | IVESPA   |
| Hokkaido-Komagatake Ko-a            | 11.5       | 6.9      | LaMEVE   |
| Kelut 1951                          | 11.1       | 6.5      | IVESPA   |
| Kelut 1990                          | 11.7       | 7.5      | IVESPA   |
| Kelut 2014                          | 11.7       | 7.8      | IVESPA   |
| Kilauea Keanakakoi ash member       | 11.0       | 6.3      | LaMEVE   |
| Láscar 1993                         | 11.3       | 6.1      | IVESPA   |
| Lonquimay NE Flank (Navidad Crater) | 11.8       | 6.2      | LaMEVE   |
| Manam 2004 AD                       | 11.0       | 7.9      | LaMEVE   |
| Merapi 2010                         | 10.9       | 7.3      | LaMEVE   |
| Mono Craters 1350 AD                | 11.7       | 7.2      | LaMEVE   |
| Nevado del Ruiz 1985                | 10.5       | 7.5      | IVESPA   |
| Newberry Big Obsidian Flow          | 11.4       | 7.5      | LaMEVE   |
| Nisyros Upper Pumice                | 11.5       | 7.5      | LaMEVE   |
| Nisyros Upper Pumice                | 11.5       | 7.5      | LaMEVE   |
| Nisyros Upper Pumice                | 11.5       | 7.5      | LaMEVE   |
| Okataina Unit J (Awakeri)           | 11.7       | 7.8      | LaMEVE   |
| Okmok 2008                          | 11.3       | 7.1      | IVESPA   |
| Okmok Middle Scoria                 | 11.5       | 7.7      | LaMEVE   |
| Pagan 1981 AD                       | 11.7       | 7.2      | LaMEVE   |

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| Eruption                                           | Log (Mass) | log(MER) | Database |
|----------------------------------------------------|------------|----------|----------|
| Peléé P2                                           | 11.4       | 7.5      | LaMEVE   |
| Peléé P3                                           | 11.4       | 7.5      | LaMEVE   |
| Peléé P1                                           | 11.2       | 7.8      | LaMEVE   |
| Pinatubo 1991                                      | 10.1       | 6.8      | IVESPA   |
| Puyehue-Cordón Caulle 1960 AD                      | 11.4       | 6.7      | LaMEVE   |
| Rabaul 1937 AD                                     | 11.5       | 6.0      | LaMEVE   |
| Rabaul 1937 AD                                     | 11.5       | 6.0      | LaMEVE   |
| Rabaul 2006 AD                                     | 11.3       | 7.4      | LaMEVE   |
| Redoubt 2009                                       | 10.1       | 6.3      | IVESPA   |
| Redoubt 2009                                       | 10.0       | 6.5      | IVESPA   |
| Redoubt 1989                                       | 10.3       | 6.8      | IVESPA   |
| Redoubt 1990                                       | 10.6       | 6.9      | IVESPA   |
| Redoubt 2009                                       | 10.2       | 7.2      | IVESPA   |
| Rincón de la Vieja Rio Blanco                      | 11.4       | 7.0      | LaMEVE   |
| Ruang 2002 AD                                      | 11.0       | 7.6      | LaMEVE   |
| Rungwe Isongole Pumice                             | 11.4       | 7.4      | LaMEVE   |
| Salina Pollara Tuff Ring (Upper and Lower Pollara) | 11.3       | 6.9      | LaMEVE   |
| Salina Pollara Tuff Ring (Upper and Lower Pollara) | 11.3       | 6.9      | LaMEVE   |
| San Francisco Volcanic Field 1075 AD               | 11.0       | 7.6      | LaMEVE   |
| Santorini Lower Pumice 1 (LP1)                     | 11.4       | 7.1      | LaMEVE   |
| Sarychev Peak 2009                                 | 11.6       | 6.0      | IVESPA   |
| Sheveluch 1964 AD                                  | 11.8       | 7.1      | LaMEVE   |
| Sheveluch 1999 AD                                  | 11.0       | 7.6      | LaMEVE   |
| Shishaldin 1999                                    | 10.4       | 6.4      | IVESPA   |
| Soufrière St. Vincent 1902 AD                      | 11.6       | 7.2      | LaMEVE   |
| Soufrière St. Vincent 1902 AD                      | 11.6       | 7.2      | LaMEVE   |
| Spurr 1992                                         | 10.6       | 6.5      | IVESPA   |
| Spurr 1992                                         | 10.6       | 6.5      | IVESPA   |
| Spurr 1953 AD                                      | 11.0       | 7.7      | LaMEVE   |
| St. Helens 1980                                    | 11.4       | 6.9      | IVESPA   |
| St. Helens Ps/Pu                                   | 11.9       | 7.1      | LaMEVE   |
| St. Helens T                                       | 12.0       | 7.2      | LaMEVE   |
| St. Helens 1980                                    | 10.6       | 7.4      | IVESPA   |
| St. Helens 1980                                    | 10.7       | 7.4      | IVESPA   |
| St. Helens Yb                                      | 11.9       | 7.5      | LaMEVE   |
| St. Helens We                                      | 12.0       | 7.6      | LaMEVE   |
| Taal 1965 AD                                       | 10.9       | 7.6      | LaMEVE   |
| Taranaki Burrell Lapilli                           | 11.5       | 7.0      | LaMEVE   |
| Taupo Unit H                                       | 11.3       | 7.8      | LaMEVE   |
| Taupo Unit V                                       | 11.9       | 8.0      | LaMEVE   |
| Taupo Unit B                                       | 12.0       | 8.0      | LaMEVE   |
| Tenerife Montaña Blanca. Pico Viejo                | 11.7       | 7.2      | LaMEVE   |
| Ticsani 11600 BP dacitic pumice fall               | 11.6       | 7.2      | LaMEVE   |
| Tolbachik 1975 AD                                  | 11.7       | 7.4      | LaMEVE   |
| Towada G. Shingo pumice                            | 11.4       | 6.2      | LaMEVE   |
| Towada D. Oguni pumice. Nakanosawa                 | 11.6       | 7.0      | LaMEVE   |
| Towada B. Sobe ash. Mayogatai pumice               | 11.9       | 7.3      | LaMEVE   |
| Towada B. Sobe ash. Mayogatai pumice               | 11.9       | 7.3      | LaMEVE   |
| Towada F. Natsuzaka scoria. Kabayama ash           | 11.9       | 7.6      | LaMEVE   |
| Tungurahua 2006                                    | 10.4       | 6.1      | IVESPA   |
| Tungurahua 1916 AD                                 | 11.0       | 7.9      | LaMEVE   |
| Tungurahua 1916 AD                                 | 11.0       | 7.9      | LaMEVE   |
| Ulawun 2000 AD                                     | 11.0       | 7.1      | LaMEVE   |
| Vesuvius Pomici Verdoline                          | 12.0       | 7.6      | LaMEVE   |

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| Eruption   | Log (Mass) | log(MER) | Database |
|------------|------------|----------|----------|
| Vulsini P2 | 12.0       | 7.5      | LaMEVE   |
| Vulsini P2 | 12.0       | 7.5      | LaMEVE   |
| Vulsini P4 | 12.0       | 7.6      | LaMEVE   |

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