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The 79 AD eruption of Somma: The relationship between the date of the eruption and the southeast tephra dispersion

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Abstract

Somma-Vesuvius is a composite volcano on the southern margin of the Campanian Plain which has been active during the last 39 ka BP and which poses a hazard and risk for the main population center situated around its base. The fieldwork and data analysis on which this report is based are related to the eight Plinian eruptions that have occurred in the last 25 ka. For six of these eruptions, the fallout products were dispersed to the east–northeast, whereas deposits from the 25 ka Codola and AD 79 eruptions were dispersed in a south-easterly direction. During the AD 79 eruption, in particular, the dispersal axis migrated from the east–southeast to south–southeast. New high level wind data collected at the weather stations of the Aereonautica Militare data centres at Pratica di Mare (Rome) and Brindisi have been compiled to characterize the prevailing wind condition in the Somma-Vesuvius region. The common north-easterly dispersal directions of the Plinian eruptions are consistent with the distribution of ash by high-altitude winds from October to June. In contrast, the south-easterly trend of the AD 79 products appears to be anomalous, because the eruption is conventionally believed to have occurred on the 24th of August, when its southeast dispersive trend falls in a transitional period from the Summer to Autumnal wind regimes. In fact, the AD 79 tephra dispersive direction towards the southeast is not in agreement with the June–August high-altitude wind directions that are toward the west. This poses serious doubt about the date of the eruption and the mismatch raises the hypothesis that the eruption occurred in the Autumnal climatic period, when high-altitude winds were also blowing towards the southeast. New archaeological findings presented in this study definitively place the date of eruption in the Autumn, in good agreement with the prevailing high-altitude wind directions above Somma-Vesuvius.

Moreover, wind data and past eruptive behaviour indicate that a future subplinian–Plinian eruption at Somma-Vesuvius has a good chance to occur when winds are blowing toward the eastern sectors (northeast–southeast), in the Autumnal–Winter period, and only a slightest chance in Summer, when winds are blowing toward the west, depositing ash fallout on the Neapolitan community.

Keywords: AD 79 eruption; stratospheric wind; archaeological data; tephra fall

1. Introduction

Somma-Vesuvius is one of the three active volcanic districts of the Campanian Plain located near the southern border of the Plain. Other active volcanic

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districts in the area are Campi Flegrei and Ischia Island. In the last decade, new volcanological studies have been carried out at Somma-Vesuvius volcano increasing the knowledge of past explosive and effusive activity (Arno et al., 1987; Barberi et al., 1990; Cioni et al., 1992; Lirer et al., 1993; Mastrolorenzo et al., 1993; Rosi et al., 1993; Rolandi et al., 1993a,b,c; Rolandi et al., 1998; Cioni, 2000; Arrighi et al., 2001; Lirer et al., 2001; Cioni et al., 2003a,b; Luongo et al., 2003; Rolandi et al., 2004). Somma-Vesuvius volcano has erupted frequently during the last 25,000 years, producing 8 Plinian eruptions whose effects have been recognized as far as 100 km from the volcano. Starting from the Avellino Plinian eruption (3.55 ka BP; Rolandi et al., 1993b), the activity of Somma-Vesuvius shows a regular trend which can be defined as a sequence of Plinian events alternating with interplinian activity characterized by vulcanian–strombolian events and some very intense effusive phases (Rolandi et al., 1998). This sequence of activity has occurred many times, and pyroclastic products interbedded with paleosoils commonly outcrop in the area surrounding the volcano. This sequence of activity provides the basis for reconstructing the volcanological history of Somma-Vesuvius and for assessing the volcanic hazard associated with future eruptions. The range of past eruptive behaviour at Somma-Vesuvius, as indicated by the age and distribution of Plinian deposits, constitutes a specific analogue for future explosive behaviour of Somma-Vesuvius. In particular, important factors that affect the distribution of the tephra are the speed and direction of modern winds at the same altitudes reached by the Plinian columns in the past. In order to establish a correlation with the dispersion of the products from the Plinian eruptions, high level wind data from weather stations of the Aereonautica Militare data centres at Pratica di Mare (Rome) and Brindisi have been compiled to characterize the prevailing wind condition in the Somma-Vesuvius region. The correlation includes the AD 79 eruption, for which the southeasterly dispersal trend has been considered to be anomalous for Somma-Vesuvius (Sigurdsson et al., 1985). This paper uses the distribution of past pyroclastic fall products and high level wind data to demonstrate that the AD 79 distribution is not anomalous, because the southeast dispersive trend is in agreement with the direction of the October–June high-altitude winds. This raises the hypothesis that the eruption in fact occurred in an Autumnal climatic period. In support of this hypothesis, we present new data from two Roman epigraphs that emphasize the recording of the fifteenth imperial acclamation of the emperor Titus on the silver coin found in Pompeii, which strongly supports an Autumnal date for the AD 79 eruption.

2. The Somma-Vesuvius volcano history and Plinian tephra dispersal

The sequence of eruptive events of Somma-Vesuvius in the last 25 ka BP is known in detail (Santacroce, 1987; Rolandi et al., 1993a,b,c; Rolandi, 1998). About 25,000 years ago a Plinian explosive eruption known as the "Codola eruption" deposited an eastern–southeastern widespread layer above the 39 ka BP Campanian Ignimbrite (Rolandi et al., 2003). Most remarkable are the next explosive Plinian eruptions which occurred between 18 ka BP and 8 ka BP, regarded as marking a partial destruction of Mt. Somma, the older volcano of the composite volcanic complex. The Avellino eruption (3.55 ka BP) is the first Plinian event characterized by predominantly phreatomagmatic activity (Rolandi et al., 1993b) indicating that excess water vapour pressure in the feeding system was responsible for an important failure of the western and south-western sectors of Mt. Somma (Rolandi et al., 2004). Between 3.55 ka BP and AD 472 eruptive activity at Mt. Somma was dominated by the two Plinian eruptions of Pompeii (AD 79) (Lirer et al., 1973; Sheridan et al., 1981; Sigurdsson et al., 1985; Gurioli et al., 2002) and AD 472 (Santacroce, 1987; Rolandi et al., 2004), and by the so-called "interplinian activity" (Rolandi et al., 1998) a weak explosive–effusive activity identified as: Protohistorical, Ancient historical, Medieval, and Modern historical periods.

According to Rolandi et al. (1998), prior to the AD 472 eruption there was a single peaked Somma caldera structure, and the Vesuvius cone was constructed during the Medieval effusive–weak explosive interplinian activity, which occurred between AD 472 and AD 1139. At this time, Somma-Vesuvius was a composite volcano consisting of the older Mt. Somma with a caldera-like structure, in which the modern cone of Vesuvius is nested. The last eruption with a Plinian character occurred in 1631 (Rolandi et al., 1993c; Rosi et al., 1993) from Vesuvius; afterwards the modern historic interplinian activity occurred until 1944.

Fig. 1 represents the orientation and width of Plinian tephra lobes from Mt Somma and Vesuvius cone. Each lobe consists of air fall tephra 10 cm thick from a single event. In Fig. 2, dispersal data are arranged to highlight the maximum percentage of the sectors covered by 10 cm isopach. Six Plinian eruptions (2–18 ka BP; 3–16 ka BP; 4–8 ka BP; 5–3.55 ka BP; 7–AD 472; 8–AD 1631) are shown to have occurred during periods of northeast–east winds producing thick bands of tephra extending far

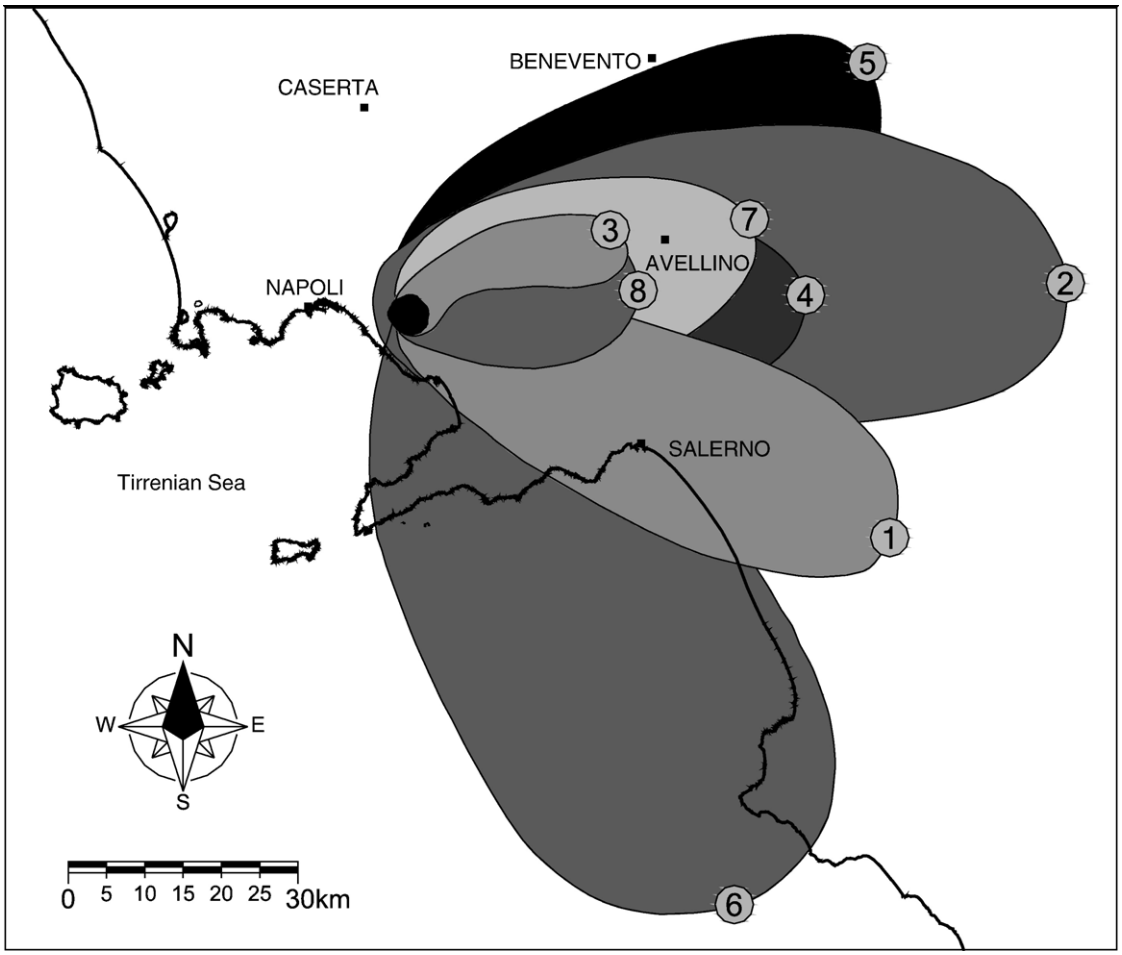

Fig. 1. Distribution map of pyroclastic fall deposits of the Somma-Vesuvius deposited in the last 25 ka BP. Each lobe consists of air fall tephra 10 cm thick from a single Plinian eruption. Numbers are arranged according to the chronological sequence of the eruption (see Fig. 2). Field data are: (1), (2), (3) Rolandi, unpublished data; (4); (5) Rolandi et al. (1993a,b,c); Rolandi et al., 2004. Chronological data are from: (1) Alessio et al. (1971); (2) Bertagnini et al. (1998); (3) Cioni et al. (2003a,b); (4) Rolandi et al. (1993a); (5) Rolandi et al. (1993b).

downwind from the volcano. The 25 ka BP (1) and the AD 79 (6) Plinian events (Fig. 1) show tephra lobes with the most southerly dispersion from Mt. Somma. The AD 79 Plinian event, in particular, produced air fall tephra consisting of a lower part of white pumice, and an upper part of grey pumice (Lirer et al., 1973; Sigurdsson et al., 1985). This abrupt change in the fall products has been attributed to complex changes in the eruption dynamics (Gurioli et al., 2005). During the last six hours of the AD 79 gray pumice eruption, the Plinian column was interrupted several times by pumiceous and lithic pyroclastic flows and surges, attributed to the collapse of the eruption column (Sigurdsson et al., 1985). Facies analysis and AMS data of these pyroclastic density currents indicate complex transport conditions due to effects of flow dynamics, local topographic irregularities, and presence of buildings (Gurioli et al., 2002; Nunziante et al., 2003).

The south–southeast dispersion of the AD 79 eruption is conventionally considered to be anomalous (Sigurdsson et al., 1985). To investigate the apparent anomaly, the next section presents the results of a comparative analysis of wind-direction frequencies associated with the dispersion directions from the past (Fig. 2) and the direction and speed of modern wind records.

3. Average modern wind direction and speed in atmosphere above Somma-Vesuvius

The meteorological data collected in the weather stations of Aereonautica Militare data center at Pratica di Mare (Rome) and Brindisi, in the period 1986–2004,

Dispersal of Plinian Fall Products around Somma-Vesuvius

Age of the Eruptions	N-NE	NE-E	E-SE	SE-S	S-SW	SW-W	W-NW	NW-N	Total area [kmq]
(8) A.D. 1631	28.0	258.8	122.3	8.8	4.3	4.9	4.6	5.1	**436.9**
	6.4%	59.2%	28.0%	2.0%	1.0%	1.1%	1.1%	1.2%	100.0%
(7) A.D. 472	118.8	584.8	178.5	15.5	4.2	3.2	6.3	24.2	**935.6**
	12.7%	62.5%	19.1%	1.7%	0.5%	0.3%	0.7%	2.6%	100.0%
(6) A.D. 79	8.5	29.7	631.5	2,311.8	221.5	11.8	6.6	6.4	**3,227.8**
	0.3%	0.9%	19.6%	71.6%	6.9%	0.4%	0.2%	0.2%	100.0%
(5) 3550 Y.B.P.	329.1	1,279.2	109.1	15.4	12.5	13.2	16.0	41.5	**1,816.0**
	18.1%	70.4%	6.0%	0.8%	0.7%	0.7%	0.9%	2.3%	100.0%
(4) 8000 Y.B.P.	66.9	552.1	451.2	42.9	10.0	5.6	7.0	17.3	**1,153.0**
	5.8%	47.9%	39.1%	3.7%	0.9%	0.5%	0.6%	1.5%	100.0%
(3) 16020 Y.B.P.	55.3	160.3	1.1	1.0	1.9	4.9	7.9	12.7	**245.1**
	22.6%	65.4%	0.5%	0.4%	0.8%	2.0%	3.2%	5.2%	100.0%
(2) 18000 Y.B.P.	138.2	1,617.4	954.2	49.2	17.4	14.6	21.1	38.3	**2,850.4**
	4.8%	56.7%	33.5%	1.7%	0.6%	0.5%	0.7%	1.3%	100.0%
(1) 25000 Y.B.P.	6.0	72.1	1,209.1	120.3	13.2	6.1	3.5	2.8	**1,433.1**
	0.4%	5.0%	84.4%	8.4%	0.9%	0.4%	0.2%	0.2%	100.0%

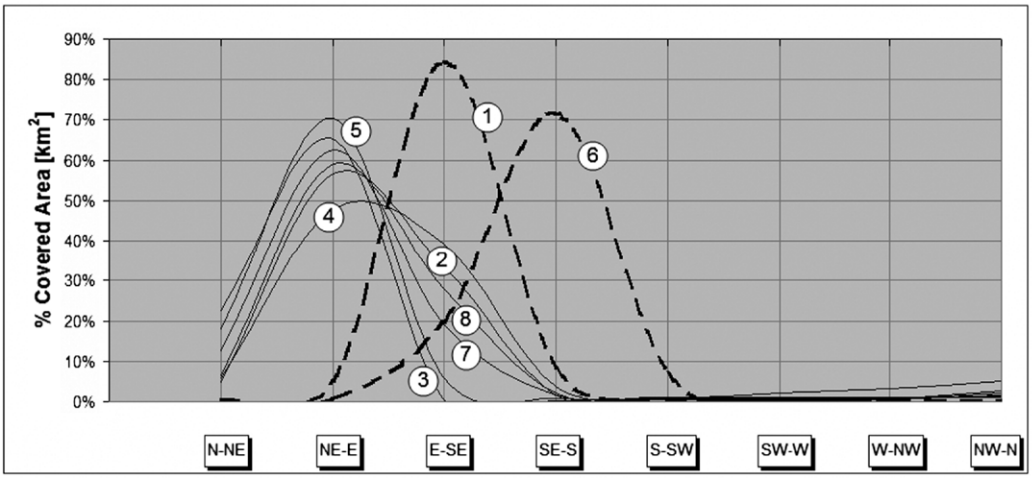

Fig. 2. Dispersal data arranged to highlight the maximum percentage of the sectors covered by 10 cm isopach numbered as in Fig. 1.

and 1976–2003 respectively, have been analysed referring to both direction and speed of the wind for five levels in the atmosphere, between 2 to 40 km elevation; here are presented only the data referring to the high level atmosphere between 20 and 40 km (Figs. 4 and 5). The more than 20-year dataset of meteorological measurements for Pratica di Mare and Brindisi more accurately reflects high level winds in the atmosphere above Mt. Somma-Vesuvius, as the volcano lies roughly equidistant between the two stations (Fig. 3). As the data are quite similar for both the stations, they fairly well characterize the prevailing wind conditions in the intermediate Somma-Vesuvius region (Fig. 4). Winds at 20–40 km altitude for Autumn and Winter seasons more commonly blow toward the northeast (260°) and less commonly blow towards the southeast (280°). In Summer the prevailing direction is from the east (90°), whereas in May and September months winds appear marked by an evident transitional high-altitude regime blowing toward both the west and the east directions only about 10% of the time (Fig. 4). The high level 10-year dataset of meteorological measurements collected over Brindisi by Cornell et al. (1983) show evidences for the significant change of wind azimuth above 14 km, from Autumn–Winter, with azimuth of 260°, to Summer, with azimuth of 90°. The data indicate the

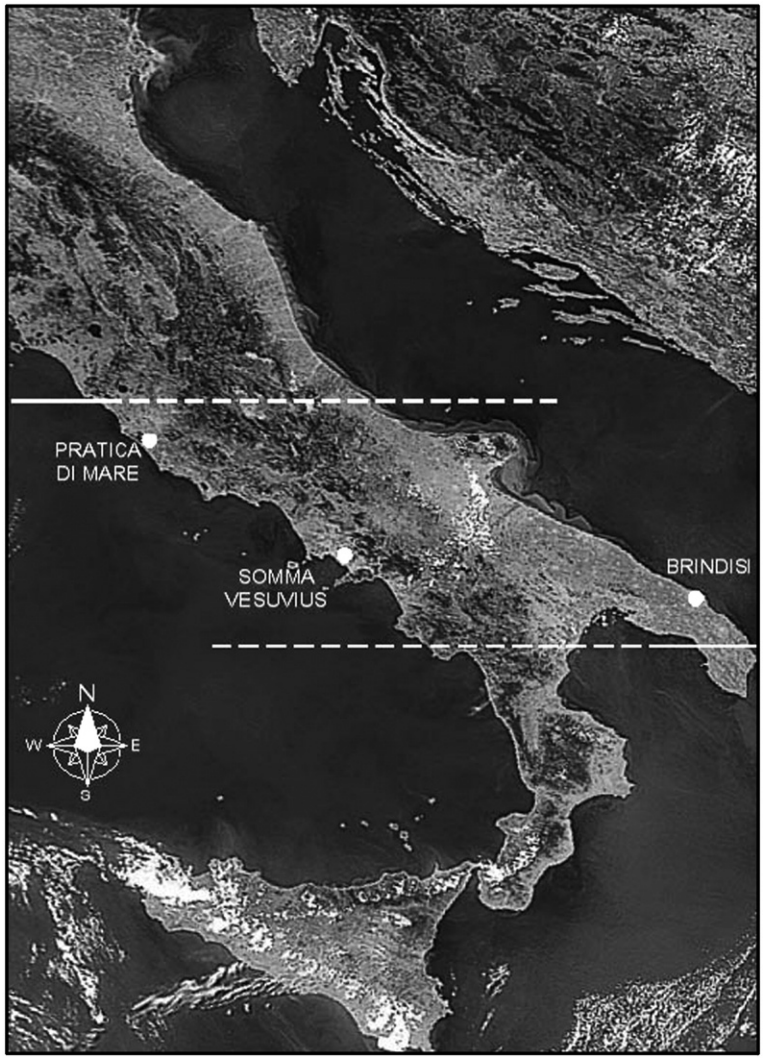

Fig. 3. Satellite image of the Italian peninsula showing the location of the two weather stations at Pratica di Mare (Rome) and Brindisi and the Mt. Somma-Vesuvius volcano.

average east–northeast wind direction for Autumn–Winter, but do not indicate clearly the presence of an east–southeast wind direction component for the same seasons. In addition, Barberi et al. (1990) have studied the wind regime in southern Italy by utilizing the 1962–1976 data from the Brindisi meteorological station and taking into account the prevailing high-velocity western winds operating between altitudes of 8–15 km. The intensity of most frequently occurring wind directions vary both as a function of altitude and season. Seasonal high level wind profiles are typically bell-shaped with maximum of 20–30 m/s at 20–30 km and 25–35 m/s at 30–40 km (Fig. 5). The records also show that windspeeds toward the east are twice those toward the west and that, during the transitional periods (May and September), the wind intensity is at much lower levels (Fig. 5). The typical east–northeast dispersion of Plinian tephra from Somma-Vesuvius is thus consistent with the stratospheric Autumn–Winter wind direction detected in modern wind records (Figs. 2, 4). In contrast, the southeast dispersion for the 25 ka BP and for the AD 79 eruptions indicate a southeast Autumn–Winter component, which is less common from a meteorological point of view. Note that this direction of dispersion has occurred two times out of eight in the last 25 ka. Such evidence poses a serious problem for the date of 24th August (a time when the winds are from east) that is normally attributed to the AD 79 eruption.

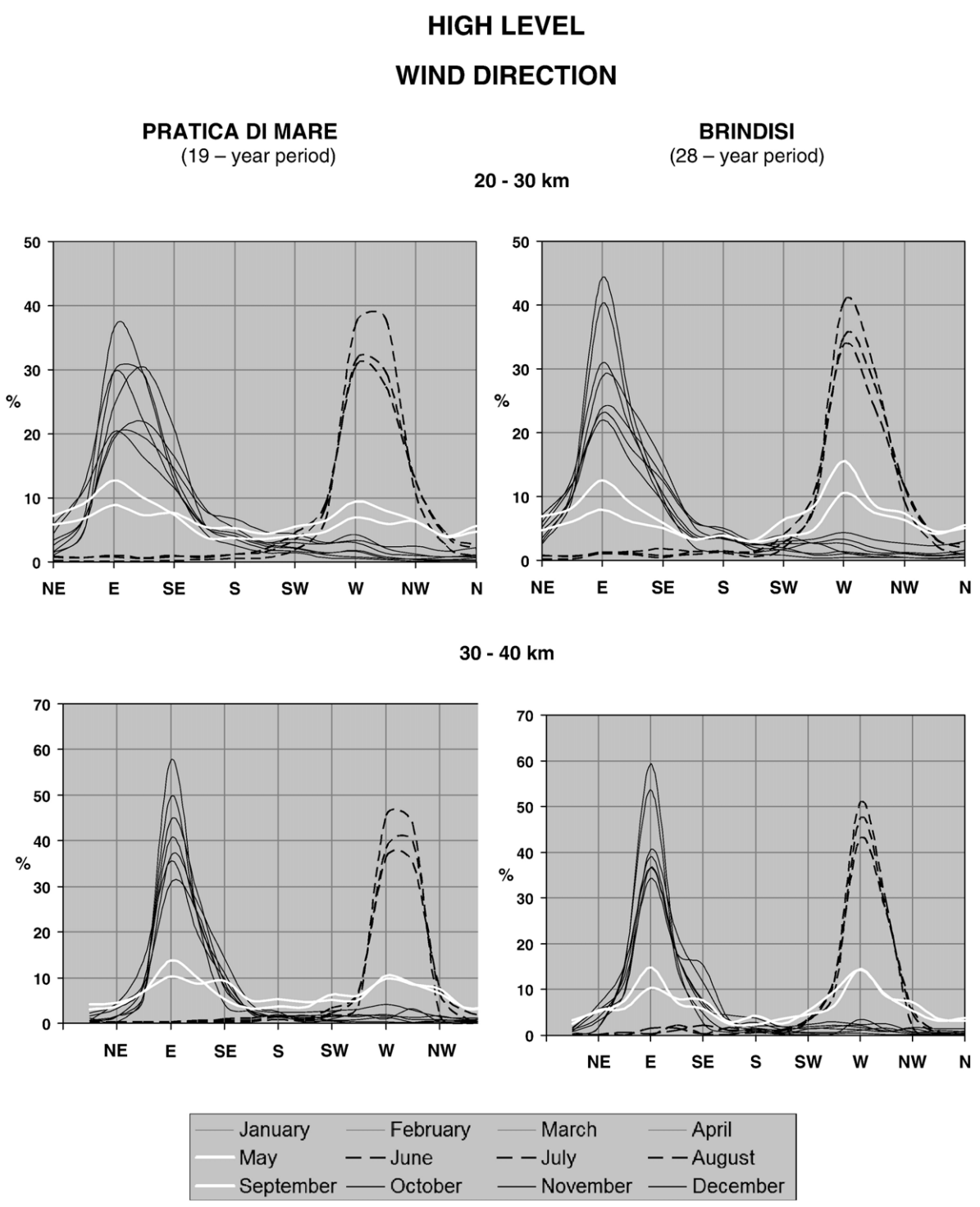

Fig. 4. Monthly average wind direction for 20–40 km altitude in atmosphere above Pratica di Mare (Rome) and Brindisi. Covering periods 1986–2004 and 1976–2003 respectively.

4. The date of the AD 79 eruption from archaeological and historical documents

The date of the Vesuvian eruption of AD 79 in which Pompeii and Herculaneum were destroyed has been the object of great debate. The date is present in a letter that Pliny the Younger (VI, 16) addressed to the historian Tacitus, attesting that the eruption of which he was a direct witness, started "nonum kal. Septembres" (24 August). This date traditionally has been recognized as correct, since it appears in a very old manuscript, the Codex Laurentianus Mediceus 47.36, and in the most famous printed edition (see Aldo Manozio in 1508). However, the manuscript tradition of the Plinian letters

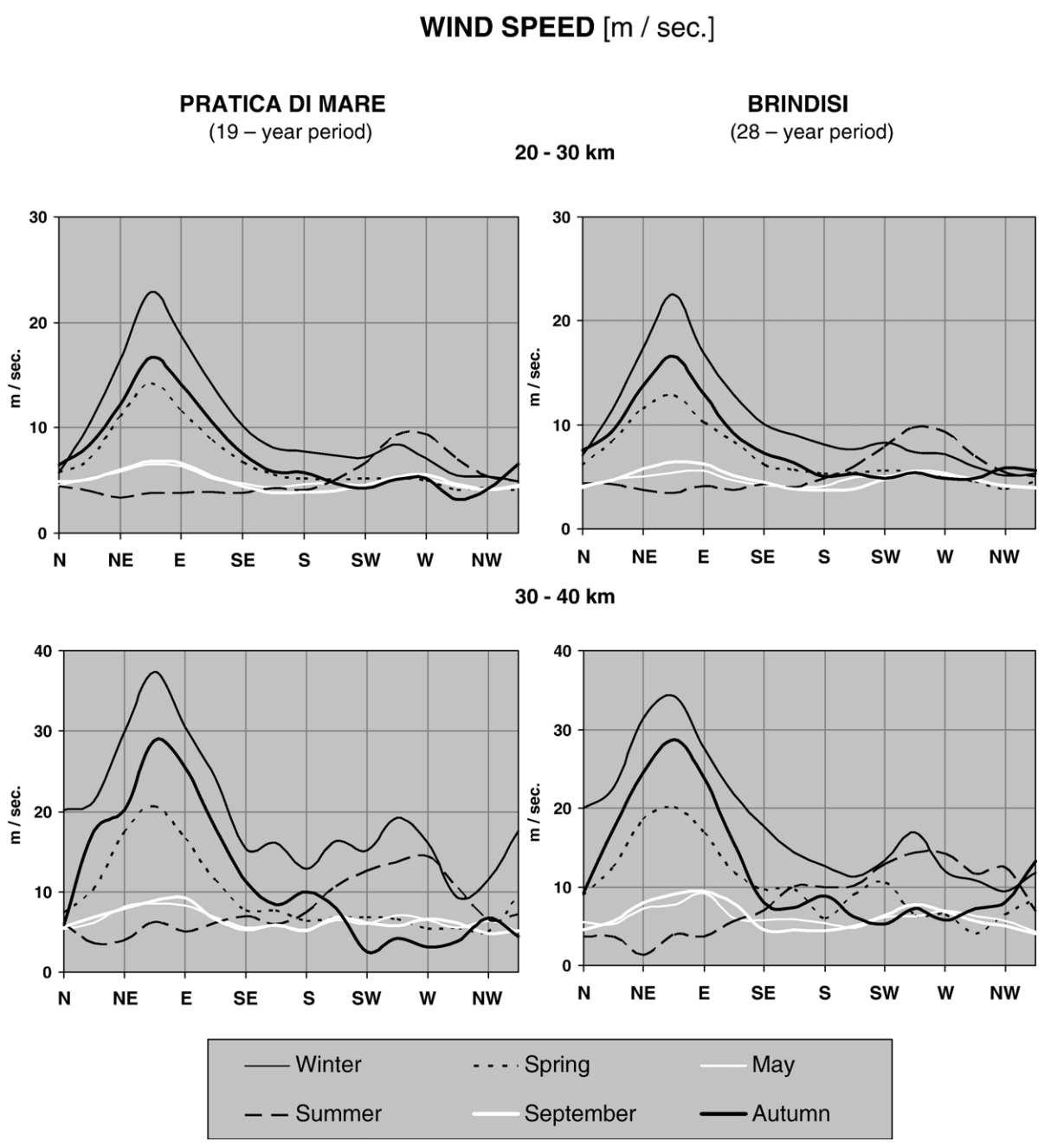

Fig. 5. Seasonal vertical variation in mean wind velocity along the most frequently occurring wind azimuth recorded in atmosphere above Pratica di Mare (Rome) and Brindisi. Covering periods 1986–2004 and 1976–2003 respectively.

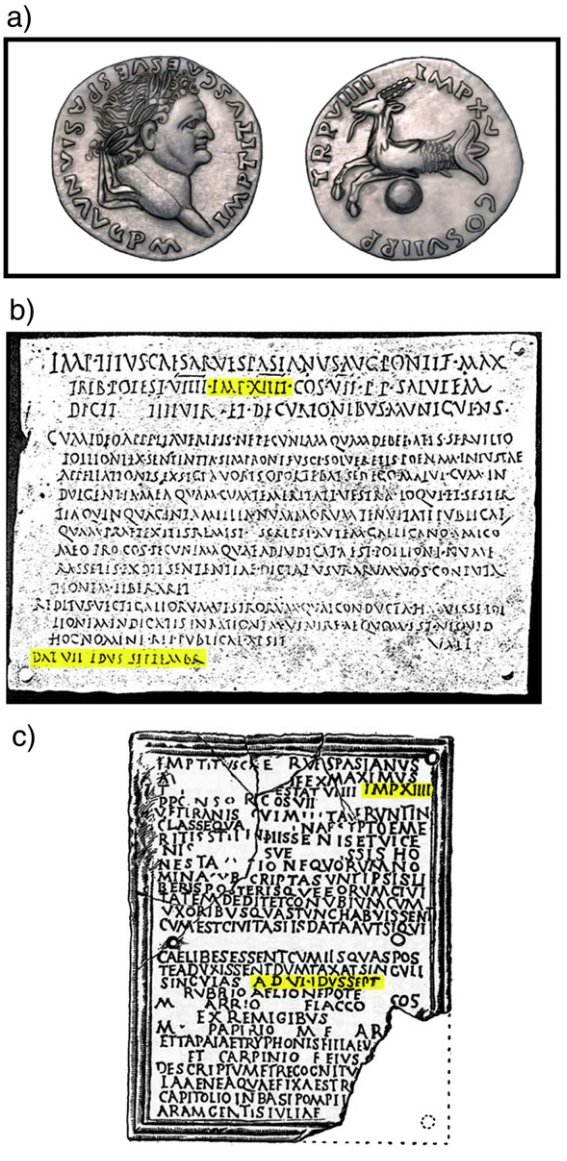

Fig. 6. a) Silver coin found in Pompeii (P 14312/176, now in National Archaeological Museum of Naples). The coin indicates the 15th imperial acclamation of Titus (draft by Cinzia Morlando, Grete Stefani property). b) Military diploma found in Egypt, now in British Museum (CIL XVI, 24). c) Letter on a bronze plate found in Villanueva de las Minas (ancient Munigua), now in Provincial Museum of Seville (AE 1962, 288). These documents both indicate the 14th imperial acclamation dated at 7th and 8th September of AD 79.

is not homogeneous (Rosini, 1797; Mau, 1880; Alfano and Friedlaender, 1929; Stout, 1962; Borgongino and Stefani, 2001). In fact, in some manuscripts and old editions the name of the month does not appear—the reference is truncated to read only "nonum kal." or "non. kal.", whereas in others the date is indicated as the "kal. novem(bres)" (1 November). Only in one manuscript, now lost, appears instead the temporal reference "III non (as) Novembr(es)," that corresponds to the 3 November or to 30 October if the text is corrected from *nonas* with *kalendas*, in as much as such terminology is utilized in the all other versions.

It is important to observe that in the annals of Cassius Dio, the eruption of AD 79 occurred in Autumn. On the basis of these inconsistencies, the archaeologist Carlo Maria Rosini in the *Dissertationis isagogicae ad Herculanensium voluminum explanationem pars prima* (1797), raised doubts about the traditional dating. He adduced archaeological data collected during excavations at Pompeii and Herculaneum, regarding his finding traces of pomegranate, chestnut, dry figs, raisin grape, pine cone, dates. Further, Rosini considered the discovery of a carpet on a mosaic floor, and the presence of fireplaces in the "atrium" of many houses of Pompeii. According to Rosini, these data clearly indicate that the Plinian manuscripts in which the name of month was absent ought to make reference to *Decembres*. Rosini, thus proposed the date be read as "nonum kal(endas) Decembres" (23 November).

Other archaeologists too, in the past and recent times, have proposed again the Autumnal hypothesis bringing to bear new archaeological data in support. Ruggiero (1879) for example in a chapter of the work *Pompei e la regione sotterrata dal Vesuvio*, confirmed the presence of the Autumnal fruit residue in the archaeological excavation, together with residue of the grape harvest—which would be executed surely in Autumn when the eruption occurred—and of a bay tree with its typically Autumnal fruits. More recently, Pappalardo (1990) remarks that there were found in Oplontis, during the excavation of the villa of Lucius Crassius Tertius, further traces of Autumnal fruit (grape, pomegranate, *etc*.), as well as a typically heavy Autumnal dress on the human victims of Pompeii and Herculaneum. Further, Borgongino and Stefani (2001) observe that pitchers (*dolia*) full of wine and closed were found in the *villa rustica* near the Villa Regina (Boscoreale).

Finally, the most important data has been found by Stefani (2006). She reported that a silver coin was found in a nest egg brought by a victim of the eruption (79 AD), found in the excavation of the House of the Gold Bracelet (Pompeii). The coin, now archived in the National Archaeological Museum of Naples, bears the image of the emperor Titus (Fig. 6) (Giove, 2003). The coin's legenda are, on the front face, IMP TITUS CAES VESPASIAN AVG PM, and on the reverse face, TR P VIIII IMP XV COS VII PP.: *Imperator Titus Caesar Vespasianus Augustus pontifex maximus, tribunicia potestate VIIII, imperator XV, consul VII, pater patriae*.

These elements allow the coin to be dated to AD 79, after 1 July, *i.e.* the ninth *potestas tribunicia*, when Titus still had the title imperator for the fourteenth time.

The data of this title are contained in the *Annals* of Cassius Dio, who refers to the victory in the war in Britannia, which occurred in the Summer of 79 for which Titus had received his fifteenth imperial acclamation. Later on, in the same documents, Cassius Dio reports that the AD 79 Vesuvius eruption occurred in Autumn (Stefani 2006).

We have further analysed two epigraphic documents that allow a more precise interpretation of the coin's legenda to date definitely the fifteenth imperial acclamation of the emperor Titus, that contributes decisive evidence in favor of an Autumnal date for the eruption.

The first document is a letter written by the emperor Titus to the Spanish city of Munigua, now maintained at the Provincial Archaeological Museum of Seville (Fig. 6), in which Titus defines himself *Imp(erator) Titus Caesar Vespasianus Aug(ustus), pontif(ex) max (imus), trib(unicia) potest(ate) VIIII, imp(erator) XIIII, co(n)s (ul) VII, p(ater) p(atriae)*. The document finishes with the date: *Dat(um) (ante diem) VII idus Septembr(es)*, that is "seven days before the ides of September," *i.e.* 7 September (Nesselhauf, 1960).

The second document is a military diploma found in Egypt and now maintained at the British Museum of London (Fig. 6): Titus' imperial nomenclature is the same and in particular he is still emperor for the fourteenth time. This document, too, concludes with the following date: *A(nte) d(iem) VI idus Sept(empres)*, that is "six days before the ides of September," *i.e.* 8 September (Smith 1926). Therefore, the coin found in Pompeii is surely struck after 8 September AD 79. It is, thus, definitely confirmed that the eruption cannot have happened on 24 August; and, reconsidering the manuscript version of the codex of the Pliny the Younger, it is plausible that the eruption happened 24 October, *i.e. nonum kalendas novembres*—a reading that does not appear completely in the codex, but unifies the two most frequent versions: "*non(um) kal*" and "*kal novem(bres)*," rather than introduce the name of Decembres that does not appear, as stated, in any source.

5. Discussion

The main factors affecting the distribution of tephra are the altitude reached by the tephra-laden eruption column, and the speed and the direction of winds at altitudes reached by the column. Most of these characteristics were analysed for past and ancient historic Plinian eruptions of the Mt. Somma volcano recorded in the time span 25 ka BP–AD 472 (Rolandi et al., 2004; and references therein), and for the sole recent historic eruption with a Plinian type of Vesuvius volcano that occurred in AD 1631 (Rolandi et al., 1993c; Rosi et al., 1993). These Plinian eruptions were formed by higher eruption columns propelling tephra from 20–40 km into the atmosphere, from where the orientation and width of the tephra lobes distribution cover an area of several square kilometres to the north-east of the volcano (Rolandi et al., 1993a,b,c; Cioni et al., 1999; Rolandi et al., 2004). Exceptions are the two Plinian eruptions of 25 ka BP and AD 79, from which volcanic products have had a dispersion towards the east–southeast and southeast, respectively. There are no data about the period of the year in which ancient Plinian eruptions of Mt. Somma have taken place. The only available data are for the Plinian eruptions that occurred in the historical epoch: AD 79––24th October (according to our new data), AD 472––6th November, AD 1631––16th December (Rolandi et al., 1993c, Rolandi et al., 2004). A review of wind records from more than 20 years taken from Pratica di Mare (Rome) and Brindisi meteorological stations indicate that high-altitude winds in the Somma-Vesuvius region blow much more frequently (Autumn–Winter) toward north-east–east and, to a lesser extent, toward east–southeast, in both directions with higher speeds (Figs. 4 and 5). Data about modern prevailing north-easterly winds above Somma-Vesuvius, exhibiting the maximum velocity of 24–40 m/s, appear to be similar in speed and direction to the winds at similar altitude operating during the AD 472 and AD 1631 eruptions, both with values of about 30 m/s (Rolandi et al., 1993c, 2004), which occurred during the Autumn–Winter period, with the direction of dispersions of the products both toward northeast. The oldest Plinian eruptions of Somma extended through several thousand years, probably occurring in the same period of the year, since more than 80% of tephra deposits lie in quadrants northeast of the volcano.

A dilemma is constituted by the eruption of AD 79, when we consider the date present in the letter of Pliny the younger (VI, 16) to the historian Tacitus, as it appears in a very old manuscript, the Codex Laurentianus Mediceus 47.36, attesting that the eruption started "nonum kal. Septembres" (24th of August). In fact, by comparing the wind regime of actual high-altitude of the Summer period with the direction of dispersion of the products of the eruption, we observe a conflict. The modern winds are blowing toward the west–northwest, whereas the volcanic products were dispersed toward

the southeast. The seasonal atmospheric wind directions based on the most frequently occurring azimuth (10-year period) recorded at Brindisi by Cornell et al. (1983) indicate that, in Summer (June–Aug.), a significant change of wind azimuth occurs above 14 km, from near 260° for Autumn–Winter to the dominant direction from the east (90°) in Summer (in apparent contrast to the model of Macedonio et al. (1988) who assumed that the high-altitude Summer winds tended on average towards the east). Moreover, Sigurdsson et al. (1985) observed that, according to the eruption data of 24 August, the AD 79 eruption occurred at a time when the stratospheric winds were shifting from their Summer to Autumn pattern. Such a trend was considered to be anomalous, and the result of the eruption having occurred during the transitional period from Summer to Autumnal patterns of the stratospheric winds. Nevertheless, wind records from more than 20 years taken from Pratica di Mare (Rome) and Brindisi meteorological stations analysed for this study indicate that the shift from Summer to Autumn patterns occurs in September (Fig. 5). Volcanological data (Lirer et al., 1973; Sigurdsson et al., 1985) show that the isopachs of the fall deposits of the AD 79 eruption are strongly elongated, suggesting that dispersion was controlled by relatively strong winds (Carey and Sparks, 1986), rather than by the weak winds with variable velocity (about 5 m/s) that normally occur at the shifting from the Summer to Autumn regimes and which would not have produced a significant elongation in the dispersal pattern (Fig. 5).The AD 79 south-easterly trend of dispersion is thus clearly coincident with Autumnal stratospheric wind directions, and is in full agreement with: (1) the report of Cassio Dio, which refers to the eruption of AD 79 occurring in the Autumn ("kat'auto to fzinoporon"); and (2) the most important evidence from the silver coin found in Pompeii, which, combined with the two Roman epigraphs, strongly supports an Autumnal date for the eruption.

Finally, we emphasize again that easterly–south-easterly is not an anomalous fallout direction for Somma-Vesuvius because it occurred not only for the AD 79 eruption but also for the 25 ka BP Codola eruption. Besides, a southeast dispersion trend characterizes the ash cloud fallout of 39 ka BP Campanian Ignimbrite (Cornell et al., 1983; Pyle et al., 2006), and a poorly studied 22 ka explosive eruption of Campi Flegrei from which the ash layer in the Tyrrhenian sea is called Y-3. The products of this eruption crop out in the Sorrento peninsula, overlying the 39 ka BP Campanian Ignimbrite (Rolandi et al., 2003; and references therein). The Y-3 ash layer dispersion shows the same trend of the AD 79 tephra, reaching the Policastro gulf (south of Salerno, see also Fig. 1) (Munno and Petrosino, 2004). In conclusion, modern wind dispersion data, together with archaeological data, indicate that the AD 79 eruption occurred at the time when the stratospheric winds were blowing in a climatic Autumnal context (*IX Kalendae Decembris or IX Kalendae Novembris*) toward southeast with higher speed (Figs. 4 and 5). Modern seasonal winds could be used as inputs to understanding not only the fallout pattern of the past Plinian eruptions, but also for a future events of the volcano with the same characteristics (Miller, 1980; Till et al., 1996).

It is beyond the scope of this work to discuss in detail the nature of volcanic hazard at Somma-Vesuvius, but is worth drawing attention to some relevant aspects derived from modern wind dispersion data. Because we are at present in a repose time for Vesuvius (Rolandi et al., 1998), a future volcanic eruption can be expected to have a Plinian character, able to send tephra more than tens of thousands of meters into the atmosphere. Fig. 4 shows that Autumn–Winter winds at altitudes between 20–40 km blow into a sector between northeast and southeast about 75% of the time, so a heavier concentration of tephra will be deposited directly downwind from the volcano in this sector if more violent explosive eruption will occur during these seasons (Barberi et al., 1990; Lirer et al., 2001). In the Summer period, the wind, predominant toward west, exhibits a low velocity (5–10 m/s) which will not significantly affect the main dispersal axis of a future subplinian–Plinian eruption (Carey and Sparks, 1986). In any case, the tephra fall could invade the area west of the volcano, coincidently with the most part of the urban area of Naples.

6. Conclusions

The more than 20-year meteorological data collected in the weather stations of Aereonautica Militare data centers of Pratica di Mare (Rome) and Brindisi provide a good model for characterizing the prevailing wind condition in the region of Somma-Vesuvius. Winds at 20 to 40 km height more commonly blow toward the northeast and less commonly toward the southeast in Autumn and Winter seasons. These data more accurately reflect typical fallout dispersive patterns of most Plinian eruptions of Somma-Vesuvius, trending toward east–northeast, and less commonly fallout dispersive patterns of two Plinian eruption trending toward east–southeast. For one of these, the AD 79 Plinian eruption, there is a misunderstanding about the data of

occurrence, but in any case, clear historical and archaeological evidences of Autumnal climatic context do exist, so that it is here referred to an Autumnal south-easterly wind direction prevailing during the eruption. Any future Plinian eruption of Somma-Vesuvius can be expected to send tephra mainly toward the northeast and to a minor extent toward the east–southeast, and if winds are more typical of Summer, tephra might be distributed in a westerly direction that is unusual but not improbable.

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