A dustfall event in November 1996 in Genoa, Italy

P. Ozer[1], M. Erpicum[2], G. C. Cortemiglia[1] and G. Lucchetti[3]
[1]Laboratory of Sedimentology, Department of Earth Sciences, University of Genoa, Italy
[2]Laboratory of Climatology, Department of Physical Geography, University of Liège, Belgium
[3]Laboratory of Mineralogy, Department of Earth Sciences, University of Genoa, Italy

Arid regions in north and west Africa contribute to the aeolian dust input through a large part of the Northern Hemisphere, from the eastern Mediterranean westward to the North American Atlantic coast. Atmospheric investigations based on meteorological data and remote-sensing analysis have shown that Saharan dust often travels several thousands of kilometres. Chemical and mineralogical dust composition and airborne dust load over the Atlantic Ocean have been well documented from the Canary and the Cape Verde Islands as far as Florida, Barbados and the Amazon Basin.

The dustfall of 12/13 November 1996

On 13 November 1996, a brownish-yellow coloured dust was observed on cars in the province of Genoa, Italy. The phenomenon, which occurred in two successive events (late afternoon of 12 November and early morning of the 13th), was reported in the regional daily newspapers. These muddy rains are not uncommon; they can occur several times in the year and have become more frequent since the 1980s (Bücher 1994; De Angelis and Gaudichet 1991; Dessens and Van Dinh 1990; Sala *et al.* 1996) (see Table 1).

We present this study of the dust samples collected in downtown Genoa on 12 November 1996 because the dustfall probability over Europe is very low (less than 8 per cent) from November to February (Dessens and Van Dinh 1990). This observation has been confirmed by De Angelis and Gaudichet (1991) who found, on analysing ice cores from Mont Blanc (French Alps), high peaks of dust in summer that contrasted with concentration minima in winter. Littmann (1991), studying 92 deposition cases in West Germany, does not present any Saharan dustfall events for the period 15 November to 15 December. Moreover, in the Valencia of region Spain, only

Table 1 Frequency of occurrence of dustfalls over Europe according to different authors

Area	Annual average occurrence	Time period (years)	Authors
Europe	7.7	10 (1980–89)	Bücher 1994
Alps	3.4	10 (1967–77)	Prodi and Fea 1978
Spain (Elche)	2.2	46 (1949–94)	Sala *et al.* 1996
	3.1	10 (1980–89)	
	8.4	5 (1990–94)	
French Pyrenees	9.1	7 (1983–89)	Dessens and Van Dinh 1990
West Germany	5.7	19 months (Oct. 1987–Apr. 1989)	Littmann 1991
British Isles	1	10 (1977–86)	File 1986
British Isles	1.8	10 (1981–90)	Burt 1991
British Isles (Dover)	4	2 (1991–92)	Thomas 1993

10 per cent of the dust rains noted in the Meteorological Observatory at Elche over 46 years have occurred during the November–January period (Sala *et al.* 1996).

The meteorological situation

The *European Meteorological Bulletin* was used to study the meteorological situation for 10–13 November 1996. During the days preceding the dustfall in Genoa, a low pressure area moved slowly from 60°N, 30°W (0000 GMT on 10 November) southwards to the Portuguese coast (0000 GMT on 12 November). These synoptic conditions produced some locally strong surface winds in north-eastern Morocco as well as in north-western Algeria and, on 11 and 12 November at 1200 GMT, drifting and blowing dust were reported in this area (see Figs. 1(a) and (b)). The trajectory of the north African dust originating here was almost straight, ending in Genoa and carried by south-westerly winds as shown by the 850 mbar analysis (see Figs. 2(a) and (b)). Two very light falls of rain which washed out the dust were generated by low-level clouds.

Sampling and laboratory procedure

Two dust samples (S1 and S2) were collected on a 50 cm × 25 cm surface on the body of two cars parked in downtown Genoa the day after the event. (We made sure that the cars were clean the day before the dust-bearing rain fell.) To help select a representative sample, the dust was taken from the centre of two horizontal and smooth surfaces on the car boots. Moreover, the cars had not been driven since the rain although the wind was strong. The dust was carefully collected with a paintbrush. The estimation of dustfall rate per square metre, as well as its granulometry, was done in a laboratory.

Dust amounts

The quantity of dust deposited per unit area was calculated knowing the amount of sediment on the $0.125\,m^2$ surface. Total amounts of dust brought down in Genoa on 12 November 1996 were 4.09 and $3.99\,g\,m^{-2}$, respectively, for the two samples S1 and S2, giving a mean of $4.04\,g\,m^{-2}$. Such concentrations are quite rare (see Table 2) for a single event. In fact, these values are five times higher than the quantity deposited in Bologna in 1977 (Prodi and Fea 1979) which was $0.833\,g\,m^{-2}$. But higher values of deposited dust have been recorded as, for example, in south-west France with $8\,g\,m^{-2}$ in February 1972 (Bücher and Lucas 1972) and $6\,g\,m^{-2}$ in July 1983 (Bücher and Lucas 1984).

Granulometry of dust

The two dust samples were mostly composed of silts, having median diameters of 16.1 and $13.2\,\mu m$ for S1 and S2, respectively, giving a mean of $14.6\,\mu m$. This is a high value when compared to other analyses available in the literature (Table 3) which all range from 2.2 to $16\,\mu m$. The grain size distribution is unimodal. This shows, according to Littmann (1991), that the dust from both events came from a single source.

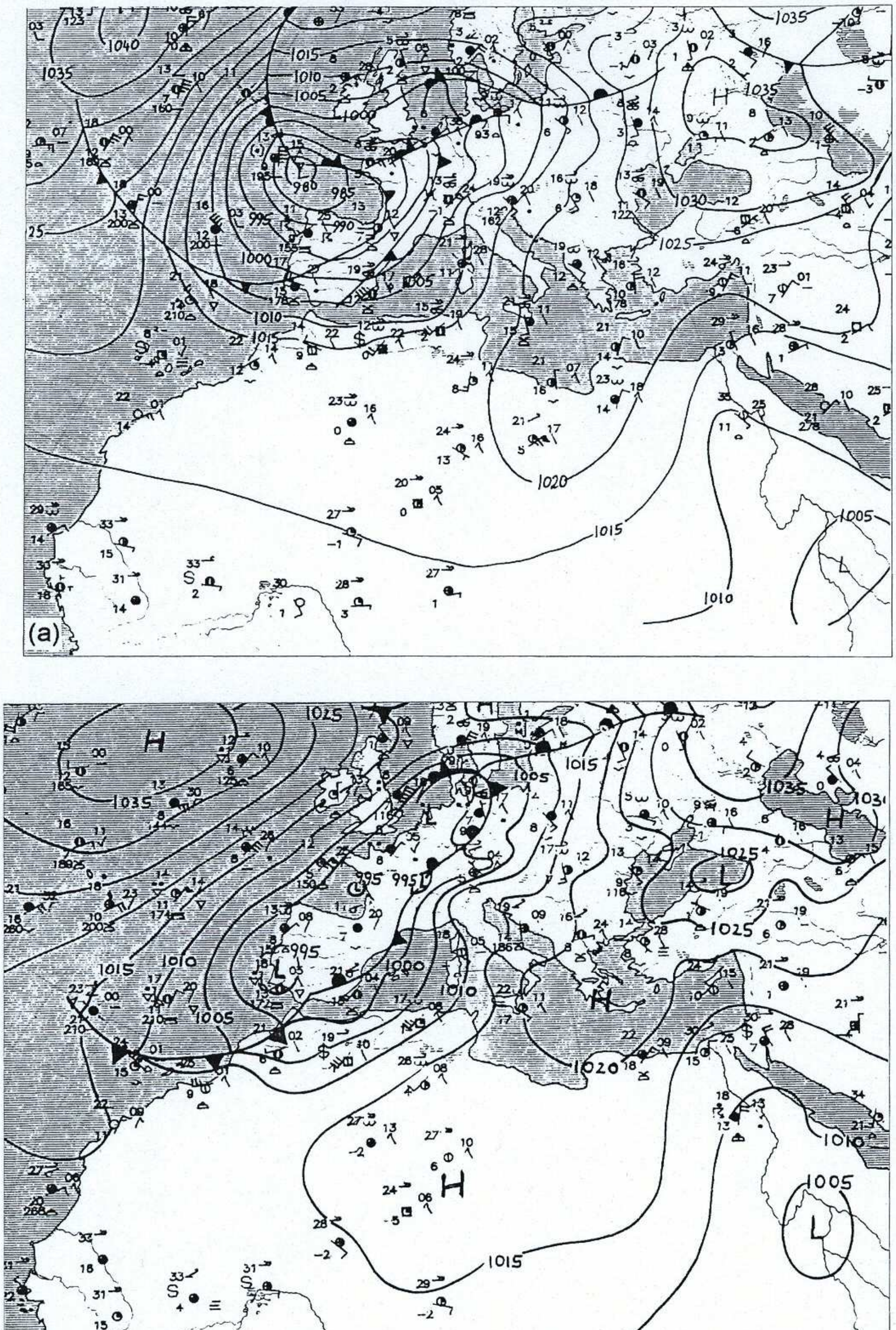

Fig. 1 Surface chart at 1200 GMT on (a) 11 and (b) 12 November 1996. Note the blowing dust observed on the Morocco–Algeria border on both days.

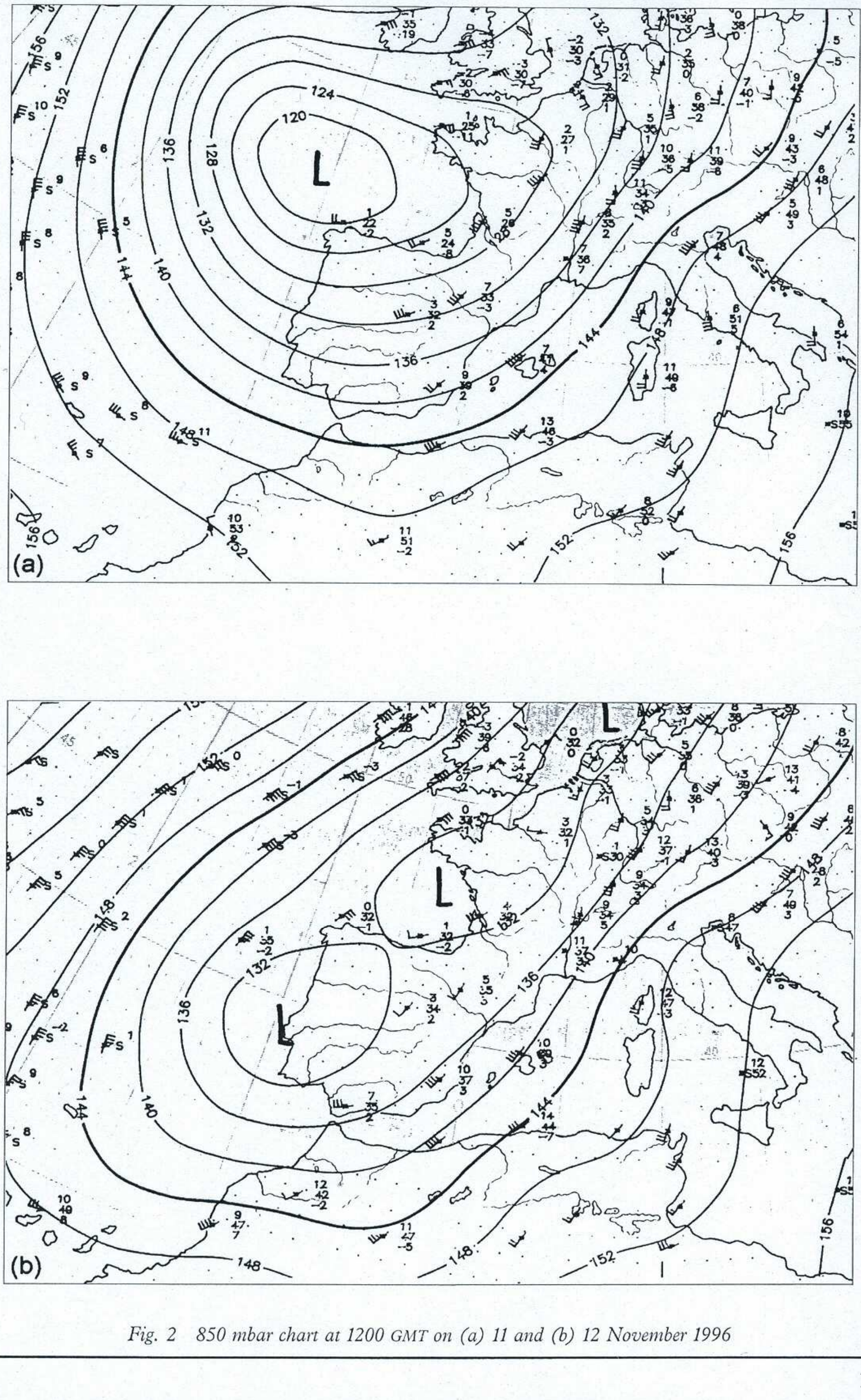

Fig. 2 850 mbar chart at 1200 GMT on (a) 11 and (b) 12 November 1996

Table 2 Annual dust deposition amounts in Europe according to different authors

Area	Annual deposition ($g m^{-2}$)	Time period (years)	Authors
Aegean area	11.2–36.5	5 (1988–92)	Nihlén and Olsson 1995
Southern Sardinia	6–13	5 (1990–95)	Le Bolloch *et al.* 1996
Swiss Alps	0.4	47 (1936–82)	Wagenbach and Geis 1989
French Alps	0.2	31 (1955–85)	De Angelis and Gaudichet 1991

Table 3 Median size of dust particles observed to fall over Europe according to different authors

Area	Median size (μm)	No. of observations	Authors
Europe	4–12	77 (1980–89)	Bücher 1994
Aegean area	8	? (1988–92)	Nihlén and Olsson 1995
Swiss Alps	4.5±1.5	? (1936–82)	Wagenbach and Geis 1989
British Isles	10	1 (9 Nov. 1984)	File 1986
West Germany	2.2–16	9 (Oct. 1987–Apr. 1989)	Littmann 1991

Also, Tomadin *et al.* (1984) estimate that, under normal conditions, significant quantities of particles greater than 16 μm in diameter are usually deposited during the first thousand kilometres of transport; the median size of the samples analysed attests to the very turbulent wind conditions that were able to maintain quite large particles in suspension in the air over more than 2000 km. Moreover, a significant number of particles had a size larger than 30 μm in our samples. The difference found between the two samples is probably due to the location of the two cars after the dustfall as the wind was strong.

Conclusion

This African dustfall event observed in the province of Genoa on 13 November 1996 is part of a phenomenon affecting Europe that has been well documented since the mid-1980s. The evidence of an increased frequency of favourable synoptic situations to transport the Saharan dust through Europe has been shown by several authors. But, it would also be interesting to know, given the important quantity of dust (4.04 $g m^{-2}$) carried over a 2000 km distance, if the reported increase in frequency of such events is also accompanied by an increasing quantity of material in such dust falls, testifying to the change in the Saharan duststorms' importance and location, or if the 13 November 1996 dustfall event was just an extreme one.

Acknowledgements

The authors thank Mr A. Demergasso, DISTER, University of Genoa, for the granulometry analysis. The contribution of P. Ozer has been supported by the Environment Programme (Climatology) of the DG XII, European Commission (Contract No. EV5V-CT-94-5244).

References

Bücher, A. (1994) Etude en Europe des retombées de poussières d'origine saharienne. *Rev. Geomorpholog. Dyn.*, **43**, pp. 23–25

Bücher, A. and Lucas, C. (1972) Le nuage de poussière rouge du 7 février 1972. *Bull. Soc. Hist. Nat. Toulouse*, **108**, pp. 437–445

—— (1984) Sédimentation éolienne intercontinentale, poussières sahariennes et géologie. *Bull. Centres Rech. Explor. Prod. Elf-Aquitaine*, **8**, pp. 151–165

Burt, S. (1991) Falls of dust rain within the British Isles. *Weather*, **46**, pp. 347–353

De Angelis, M. and Gaudichet, A. (1991) Saharan dust deposition over Mont Blanc (French Alps) during the last 30 years. *Tellus*, **43B**, pp. 61–75

Dessens, J. and Van Dinh, P. (1990) Frequent Saharan dust outbreaks north of the Pyrenees: a sign of a climatic change? *Weather*, **45**, pp. 327–333

File, R. F. (1986) Dust deposits in England on 9 November 1984. *Weather*, **41**, pp. 191–195

Le Bolloch, O., Guerzoni, S. and Molinaroli, E. (1996)

Atmosphere–ocean mass fluxes at two coastal sites in Sardinia (39–41 °N, 8–10 °E). In: Guerzoni, S. and Chester, R. (Eds.) *The impact of desert dust across the Mediterranean,* Kluwer Academic Publishers, pp. 217–222

Littmann, T. (1991) Recent African dust deposition in West Germany – Sediment characteristics and climatological aspects. *Catena Suppl.,* **20**, pp. 57–73

Nihlén, T. and Olsson, S. (1995) Influence of eolian dust on soil formation in the Aegean area. *Z. Geomorph. N. F.,* **39**, pp. 341–361

Prodi, F. and Fea, G. (1978) Transport and deposition of Saharan dust over the Alps. *Proc. 15 Int. Tagung Meteorol.,* **1**, pp. 179–182

—— (1979) A case of transport and deposition of Saharan dust over the Italian peninsula and southern Europe. *J. Geophys. Res.,* **84**, pp. 6951–6960

Sala, J. Q., Cantos, J. O. and Chiva, E. M. (1996) Red dust rain within the Spanish Mediterranean area. *Clim. Change,* **32**, pp. 215–228

Thomas, F. G. (1993) Dust rain. *Weather,* **48**, p. 193

Tomadin, L., Lenaz, R., Landuzzi, V., Mazzucotelli, A. and Vannucci, R. (1984) Wind- blown dusts over the central Mediterranean. *Oceanol. Acta,* **7**, pp. 13–23

Wagenbach, D. and Geis, K. (1989) The mineral dust record in a high alpine glacier (Colle Gnifetti, Swiss Alps). In: Leinen, M. and Sarnthein, M. (Eds.) *Paleoclimatology and paleometeorology: modern and past patterns of global atmospheric transport,* Kluwer Academic Publishers, NATO ASI Series, Series C282, pp. 543–564

Correspondence to: Prof. Dr M. D. J. Erpicum, University of Liège, Department of Physical Geography Climatology, Bât. B11 - Sart Tilman 4000 - Liège, Belgium.