"Ash Devils" Near Mount St. Helens

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Rotating whirlwinds have been observed to occur over a great range of scales and in numerous locations worldwide. These whirlwinds can be as small as a few centimeters, lasting on the order of 1–2 seconds, or as large as one or more kilometers, with lifetimes on the order of tens of minutes. Recent documentation of these smaller whirlwinds include those in dust (Sinclair, 1973); in morning fog (Moriarty, 1977); over geyser basins (Holle, 1977, 1983); cooling towers (Hanna et al., 1978); hot springs (Reinking, 1978); a bonfire (Minsinger, 1980); along the sea-breeze front (Meadon, 1981); on the lee slopes of a ridge (Hallet and Hoffer, 1971); and in a blizzard (Annett, 1981).

While visiting the Mount St. Helens National Monument in west-central Washington on 28 August 1985 at approximately local noon, the author had the opportunity to observe many "ash devils" and to photograph one of them. The location of these whirlwinds was on Windy Ridge at an elevation of approximately 1300 m MSL (mean sea level). This ridge is located about 6 km east of the Mount St. Helens crater and is oriented east-northeast–west-southwest. The top soil was composed of volcanic debris, including very fine grained volcanic ash from the 1980 eruption of Mount St. Helens. The ash devils formed on the west end of a small hill located along the ridge and moved slowly eastward. Their sizes were estimated to range from approximately 1 m in diameter and 3–5 m tall to approximately 2–3 m wide and an order of magnitude taller. No attempt was made to distinguish between clockwise and counterclockwise rotation of the whirlwinds. A sequence of six photographs of one of the larger ash devils was taken over a period of one-half minute. One of these photographs is presented in Fig. 1. A 50-mm lens was used with a polarizer to darken the background sky, and the film was deliberately underexposed one *f*-stop to compensate for the light-colored ash. This particular photograph was taken near the end of the ash devil's lifetime, when it had reached its greatest height of approximately 50 m. Fortunately, the location of the ash devils with respect to the sun was nearly perfect for providing the maximum polarization effect resulting in the light-colored ash showing up quite well against the dark background sky.

Owing to the informal nature of these observations, the temperature and wind speeds are at best an estimate made without benefit of any instrumentation. At the time of these observations, the sky was clear with no haze noted. Air temperature was estimated to be in the 17–20°C range, and winds were from the west at 2–4 m s^{-1}. Sounding data from Quillayute, Washington, indicates that the air temperature at 1300 m was approximately 8–9°C with the 850-mb (1513-m) wind from the west-southwest at approximately 5 m s^{-1}. An examination of the synoptic data reveals that cooling at 850 mb of approximately 8°C had occurred in the previous 12–24 hours, with similar changes noted at 700 mb. These changes were in response to the passage of a short wave 12–18 hours earlier. It is the author's opinion that the resultant near-surface lapse rate of approximately 8–12°C was at least partially responsible for the ash devils. However, it was noted that most of the observed ash devils formed below the crest of the windward (i.e., on the north) side of the ridge,

Fig. 1. Photography of an ash devil taken at approximately local noon using a 50-mm lens and a polarizer. View is to the east. The whirlwind had reached its maximum visible height of approximately 50 m at this time.

becoming more developed as they moved onto the top of the ridge. Thus, local topography played some role in the initiation of the whirlwinds (i.e., they formed on a side of the ridge not in direct sunlight), but it is reasonable to infer that buoyancy effects on the heated crest of the ridge maintained them long after mechanical-dissipative effects should have broken down the rotation.

These observations were particularly interesting for two reasons. First, the high altitude at which these whirlwinds occurred is probably more the exception than the norm. While whirlwinds have been observed on the high plains of east of the Rocky Mountains and on the high ground of the desert southwest, as well as other locations, it is less common to document such well-defined whirlwinds on a mountain ridge-top. There are, however, frequent occurrences of snow devils in mountainous regions, but these occur primarily in high-winds situations and are driven almost exclusively by mechanical rather than buoyant forces. Second, the volcanic ash was of a very fine consistency and was easily disturbed. For example, footsteps would lift a small cloud of ash a few mm above the ground. The whirlwinds, then, need not have been very strong in order to lift this ash to a great height. This was demonstrated by one ash devil which lifted the ash to a great height and, after rapidly dissipating, left it suspended there momentarily before it began to slowly settle out. Also, since the translation speed was only 1–2 m s^{-1}, the author was able to walk into the core of one of the larger ash devils. A rough estimate of the maximum wind speed in the lowest 1–2 m is on the order of 10–20 m s^{-1}, a fairly weak wind speed for such a well-developed whirlwind.

In summary, these whirlwinds were unique because of the high-altitude mountain ridge-top at which they occurred, their generation by turbulence and maintenance by buoyancy, and the fact that they passed over the volcanic ash which was so easily disturbed by even a weak whirlwind.

References

Annett, C. H., 1981: Snow devils. *Weatherwise*, **34**, 94.

Hallet, J., and T. Hoffer, 1971: Dust devil systems. *Weather*, **26**, 247–250.

Hanna, S. R., M. Pike, and K. Seitter, 1978: Observations of vortices in cooling tower plumes. *J. Appl. Meteor.*, **17**, 1068–1071.

Holle, R., L., 1983: Yellowstone steam devils. *Weatherwise*, **35**, 115–118.

Meadon, G. T., 1981: Whirlwind formation at a sea breeze front. *Weather*, **36**, 47–48.

Minsinger, W. E., 1980: Whirlwinds at a bonfire. *Weatherwise*, **33**, 92.

Moriarty, W. W., 1977: Fog-devil. *Weather*, **32**, 268–269.

Reinking, R. F., 1978: Steam devils over a hot springs pool. *Mon. Wea. Rev.*, **106**, 1636–1638.

Sinclair, P. C., 1973: The lower structure of dust devils. *J. Atmos. Sci.*, **30**, 1599–1619.