Sources of atmospheric particulate matter on Hawaii

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(Manuscript received September 24, 1971)

ABSTRACT

Sources and advection of atmospheric particulate matter on the Island of Hawaii were assessed to properly evaluate the benchmark qualities of the air at the Mauna Loa Geophysical Observatory. A manually operated Gardner counter, a continually recording Aitken counter and a nephelometer were used to measure diurnal and long term trends of concentrations and light scattering coefficients of atmospheric particulate. Significant sources of aerosol particles result from combustion activities on the island, both man-made and volcanic. Volcanic effluent can penetrate the tradewind inversion when conditions are right and show up on long term Aitken counts at the Mauna Loa Observatory. The relative contribution of marine aerosols to the total particle population in the air masses over the island is small. The difference in concentration and the light scattering coefficient of particles in the air masses above and below the tradewind inversion are in the order of one magnitude or more.

1. Introduction

The island of Hawaii by virtue of its distance (> 3 000 km) from continents, the persistence of a marine inversion separating higher air masses above 2 500 m from maritime air below, the presence of two major natural aerosol sources, viz., Pacific Ocean and Kilauea Volcano, and the absence of major sources of industrial pollution, has attracted many scientists in the past who have most extensively investigated the atmosphere in and around the island (e.g. Woodcock, 1953). Nevertheless, a study of the aerosol inventory of Hawaii has been necessary in conjunction with Mauna Loa Observatory's mission as a geophysical benchmark station. Information about the variability of the aerosol content of the atmosphere at Mauna Loa and its causes is essential for a meaningful interpretation of the geophysical data collected by the Observatory. For example, a recent evaluation of solar radiation data only for atmospheric conditions that apparently were unaffected by locally produced aerosols (Ellis & Pueschel, 1971) led to the conclusion that strong volcanic eruptions, but no human derived particulate loading, affect the turbidity of the higher atmosphere. This is in direct contradiction to the conclusion reached by Peterson & Bryson (1967) who evaluated radiation data from the same station irrespective of the contributions to atmospheric opacity by locally produced aerosols.

In order to assess properly the effect of particulate matter on the air quality in Hawaii, particularly at Mauna Loa, we investigated the Pacific Ocean, Kilauea Volcano, sugar cane harvesting activities, automobile traffic, and household activities as sources for atmospheric aerosols. The instruments employed in this study were a manually operated Gardner counter, a continuously recording Aitken counter and a nephelometer.

The findings indicate that: (1) long term trends (3 years) of Aitken nuclei monitored at Mauna Loa positively correlate with high fountaining of Kilauea Volcano; (2) combustion aerosols from Kilauea Volcano's larger vents and from sugar cane fires have been the most prolific sources of Aitken nuclei with a strong effect on atmospheric visibility; (3) automobile traffic and home heating produce the smallest size particles at a significant number concentration; (4) sea-salt aerosols, on the other hand, consist of relatively large particles at low concentrations; (5) the total mass concentration of sea-salt produced by the ocean is a function of both wind speed and humidity; (6) the presence of the tradewind inversion is necessary but not sufficient to

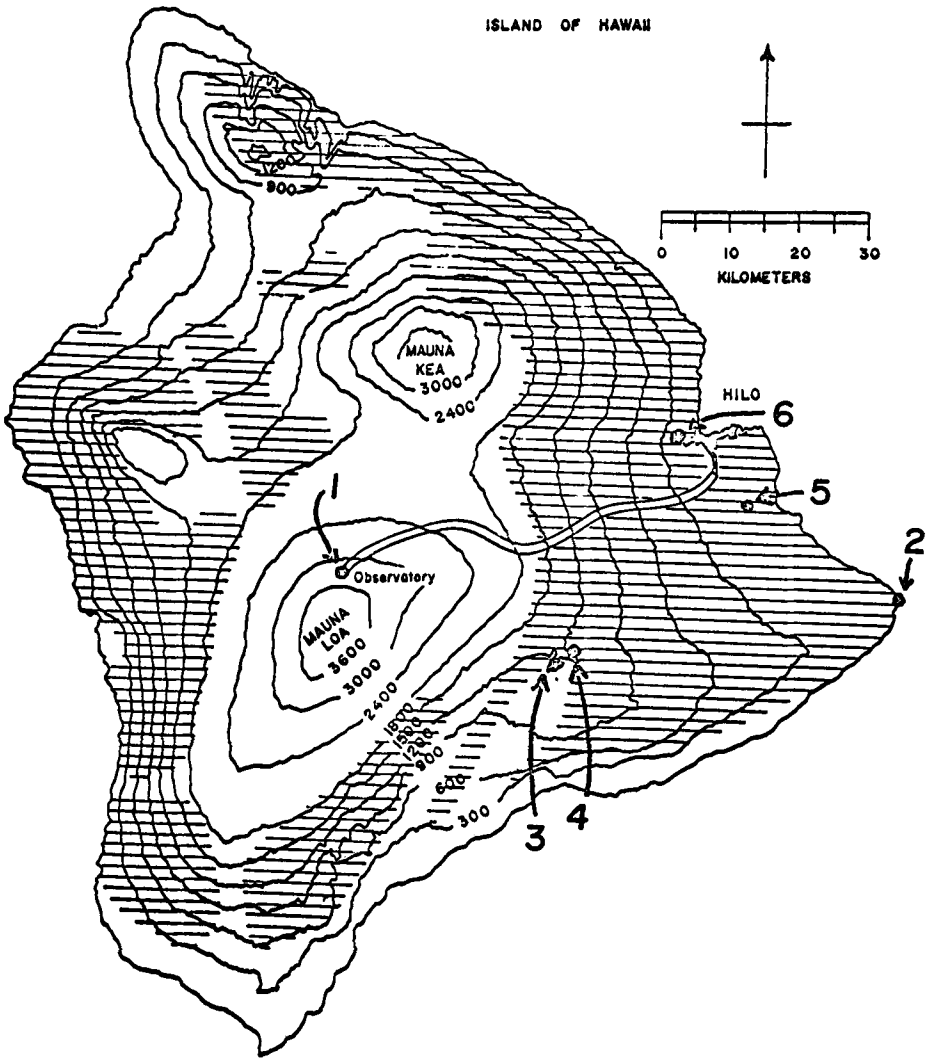

Fig. 1. Location of aerosol sampling sites on Hawaii: (1) Mauna Loa Observatory; (2) Cape Kumukahi; (3) Hawaii Volcanoes National Park residential area; (4) Halemaumau fire pit; (5) Puna sugar cane field; (6) Rural roadside.

inhibit the penetration of aerosols of low altitude terrestrial origin into the higher atmosphere.

2. Results and discussion

Fig. 1 shows the location of the sampling sites on Hawaii relative to each other. They are marked in the following sequence: (1) Mauna Loa Observatory, (2) Cape Kumukahi Station, (3) Kilauea Volcano, (4) Hawaii Volcanoes National Park residential area, (5) sugar cane field, and (6) a roadside in Kaumana west of Hilo. The data from all the sources are summarized in Table 1. The first two columns contain date, location and conditions under which sampling was performed. The third and fourth columns, contain the Aitken nuclei concentration and the light scattering coefficient, i.e. the two atmospheric parameters that were measured independently. The last three columns contain variables related to these two inde-

Table 1. *Parameters for aerosols on Hawaii*

Date and time	Location and condition	Aitken counts (cm^{-3})	Light scattering coefficient (m^{-1})	Visibility (m)	Mass concentration ($\mu g\ m^{-3}$)	Relative size (μm)
Aug. 14, 1971	Mauna Loa Observatory					
1630		2.5×10^3	0.9×10^{-4}	4.3×10^4	34	0.15
1730	Aerosols from volcanic	7.5×10^3	2.2×10^{-4}	1.8×10^4	83.6	0.14
1830	fountaining reaching	7.5×10^3	2.6×10^{-4}	1.5×10^4	98.8	0.15
2000	the Observatory site	1.5×10^4	2.5×10^{-4}	1.6×10^4	95.8	0.12
2030		7.8×10^3	1.4×10^{-4}	2.8×10^4	53.2	0.12
March 17, 1971	Mauna Loa Observatory					
0500	Before	$6. \times 10^2$	1.8×10^{-5}	2.2×10^5	1.0[a]	0.08
Afternoon	Upslope wind carrying haze	$5. \times 10^2$	2.1×10^{-4}	1.9×10^4	74	0.34
2100	After	$6. \times 10^2$	1.9×10^{-5}	2.1×10^5	1.5[a]	0.09
March 4, 1971	Mauna Loa Observatory					
1200	Upslope air movment	2×10^2	0.6×10^{-4}	6.6×10^4	17.0[a]	0.27
0000	Downslope air movement	$5. \times 10^2$	0.2×10^{-4}	2.0×10^5	1.90[a]	0.10
May 27, 1971	Cape Kumukahi					
1400	Onshore flow 90 % RH	$5. \times 10^2$	0.9×10^{-4}	4.4×10^4	34.2	0.25
May 26, 1971	Cape Kumukahi					
1400	60 % RH, Onshore	$4. \times 10^2$	0.7×10^{-4}	5.6×10^4	27.6	0.25
0600	Offshore flow	$5. \times 10^2$	0.4×10^{-5}	9.8×10^4	15.2	0.19
May 13, 1971	Kilauea Volcano					
1100	Upwind	$4. \times 10^3$	0.6×10^{-4}	6.5×10^4	22.8	0.11
1400	Downwind	$1. \times 10^4$	13.8×10^{-4}	2.8×10^3	524	0.23
May 12, 1971	Ranger residential area					
1830	Evening	$6. \times 10^4$	1.0×10^{-4}	3.9×10^4	38	0.05
0200	Night	$2. \times 10^2$	0.3×10^{-4}	1.3×10^5	11.4[a]	0.24
0630	Morning	$6. \times 10^4$	1.2×10^{-4}	3.2×10^4	46	0.06
May 18, 1971	Puna Sugar Field					
0830	Before burning offshore flow	$5. \times 10^3$	0.7×10^{-4}	5.6×10^4	26.6	0.11
0930	Before burning onshore flow	$3. \times 10^2$	0.7×10^{-4}	5.6×10^4	26.6	0.28
1100	During burning	$5. \times 10^5$	70.0×10^{-4}	5.6×10^2	2660	0.11
May 11/12, 1971	Roadside, downslope flow commencing at night					
	During traffic	$1. \times 10^5$	0.6×10^{-4}	6.5×10^4	17.0[a]	0.03
	Background	$2. \times 10^2$	0.4×10^{-4}	9.8×10^4	9.5[a]	0.23

[a] Light scattering value corrected for Rayleigh scattering.

pendent parameters. The visibility, given in the fifth column, is based on the Koschmieder (1924) relationship between visual range and the light scattering coefficient. Its basic assumption is that of atmospheric homogeneity throughout the entire path of sight. The aerosol mass concentration, given in the sixth column, is one of the usual quantities used in air pollution studies to describe the amount of aerosol present. Although independent and simultaneous measurements of this parameter can be performed and are contemplated for the future, the quantities in column six are derived from the light scattering measurements based on an empirical relationship found by Charlson et al. (1968) and Horvath & Noll (1969). It has been established for city pollution aerosols that this relationship, i.e., mass concentration in grams per cubic meter equals 0.38 times the light scattering coefficient in meters^{-1}, is of the factor-of-two characteristic for a confidence interval of 90 %. The seventh and last column

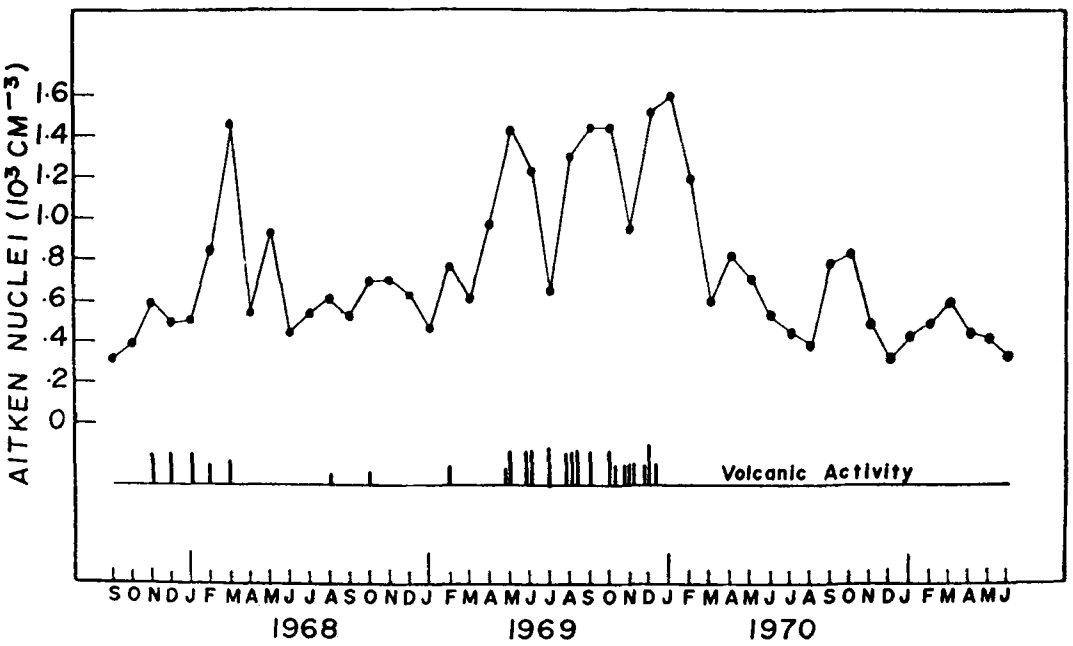

Fig. 2. Monthly means of the Aitken nuclei concentration at Mauna Loa (3 400 m) and its relation to local volcanic activity.

contains a relative size based on the mass and number concentration values. The same qualifications need to be considered as for the derivation of the aerosol mass concentration. Furthermore, a density of one is assumed regardless of the type of aerosol investigated. The error introduced by this assumption is, however, of the order of 50 %, i.e., less than we accept in the light scattering–mass concentration relationship.

2.1. *Mauna Loa data*

The first row in Table 1 represents data from Mauna Loa Observatory at 3 400 m elevation under "typical" conditions (4 March) and on "polluted" days (17 March and 14 August). On 14 August the haze was definitely of volcanic origin from active fountaining (200 feet) at Kilauea Volcano. The nighttime downslope flow conditions (southerly wind) are characterized by low atmospheric light scattering coefficients, i.e., excellent visibility, in any case. This is a characteristic property of the descending air in the nocturnal downslope flow. On 4 March the light scattering at night is essentially due to Rayleigh scattering by the air molecules. This is supported by the small number of Aitken nuclei (50 cm^{-3}) which approaches the limit of detectability of the instrument. Conditions are usually different during the day. Air from lower elevations penetrates the inversion layer at about noon, increases the Aitken nuclei counts (usually to several hundred per cubic centimeter) and reduces visibility. At other times, like on 14 August, Mauna Loa Observatory is directly downwind from Kilauea volcano whose effluents are carried to the monitoring site by southeast winds.

The size of the particles observed in the upslope flow are of a magnitude that is typical for disintegrated soil dust or aerosols from volcanic effluents. In particular, the latter gives the most significant contribution to the aerosol concentration on Mauna Loa (see Fig. 2) whenever volcanic fountaining coincides with a weak inversion layer.

Aitken nuclei at Mauna Loa Observatory have been monitored since 1967 with a manually operated Gardner counter. This instrument operates at high supersaturations to cause condensation of water vapor on any particle exceeding the minimum size of 10^{-6} cm radius. Monthly averages of the Aitken nuclei measured during daylight hours since the September of

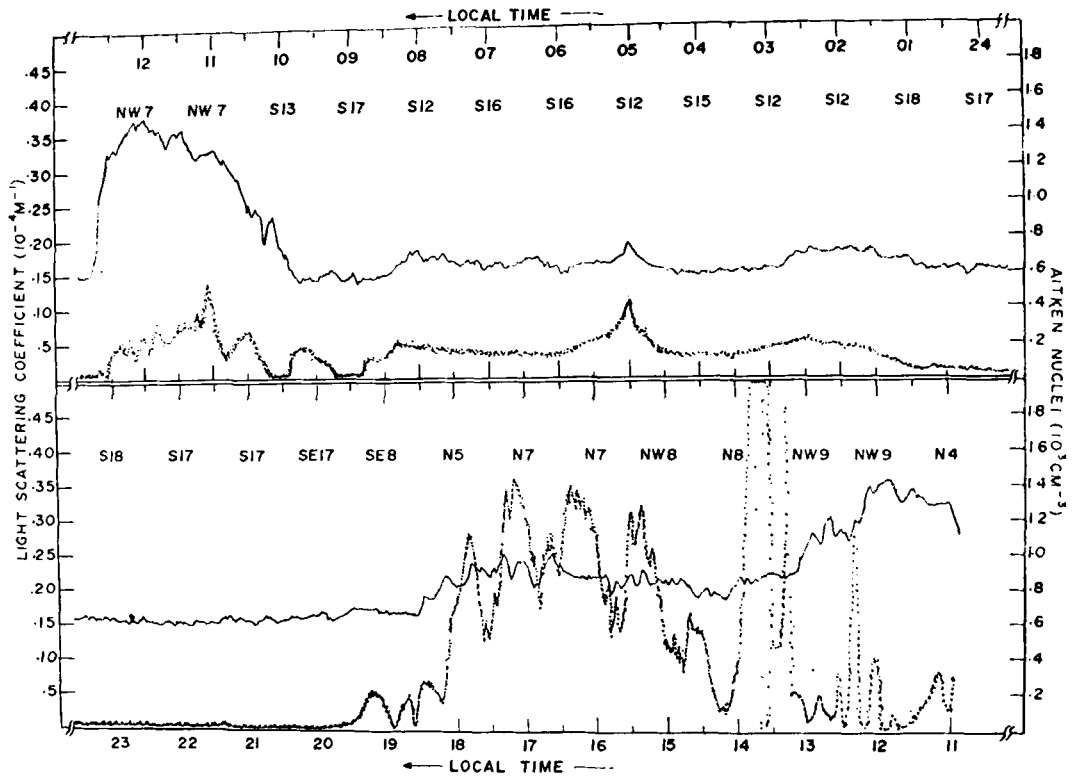

Fig. 3. Diurnal variations of light scattering coefficient (solid line) and Aitken nuclei concentration (dotted line) at Mauna Loa (3 400 m) on 3 and 4 March 1971. (Note that the time starts in the lower right corner and proceeds to the left.)

1967 are shown in Fig. 2. Indicated by vertical bars is the volcanic activity of Kilauea Volcano which is located on the south flank of Mauna Loa. Each bar represents an occurrence of significant fountaining (3.5×10^6 to 12×10^6 m^3 effluent) and heavy loading of particulate matter into the atmosphere.

The data compiled in Fig. 2 give evidence of a positive correlation between the Aitken nuclei concentration at Mauna Loa Observatory and local volcanic fountaining increasing the typical daytime background concentration of 400–500 cm^{-3} by a factor of up to four.

The Gardner counter has been supplemented recently by an Aitken nuclei monitor manufactured by the Environment/One Corporation. This unit performs automatically the measuring cycle which involves pulling in the sample at water vapor saturation, producing supersaturation by adiabatic expansion and flushing out the sample, at a frequency of one per second. An additional recording instrument that has been used to detect particulate matter is an integrating nephelometer (Charlson et al., 1967) which responds to the scattering coefficient due to aerosols. The device has sufficient sensitivity to distinguish particle-free gases on the basis of their Rayleigh scatter. Thus it is possible to utilize air, CO_2 and Freon 12 in the calibration of the instrument.

Fig. 3 shows a typical 24 hour strip chart record from both the Aitken nuclei monitor (dotted curve) and the integrating nephelometer (solid curve) at Mauna Loa Observatory with the following characteristic features: Starting at 1100 hours on 3 March in the lower graph, upslope winds generally from north–northwest during the day (Mendonca, 1969), carry enough particulate matter from terrestrial sources on the island to significantly affect both the Aitken count and the light scattering coefficient. At 1900 hours, after sunset, a downslope

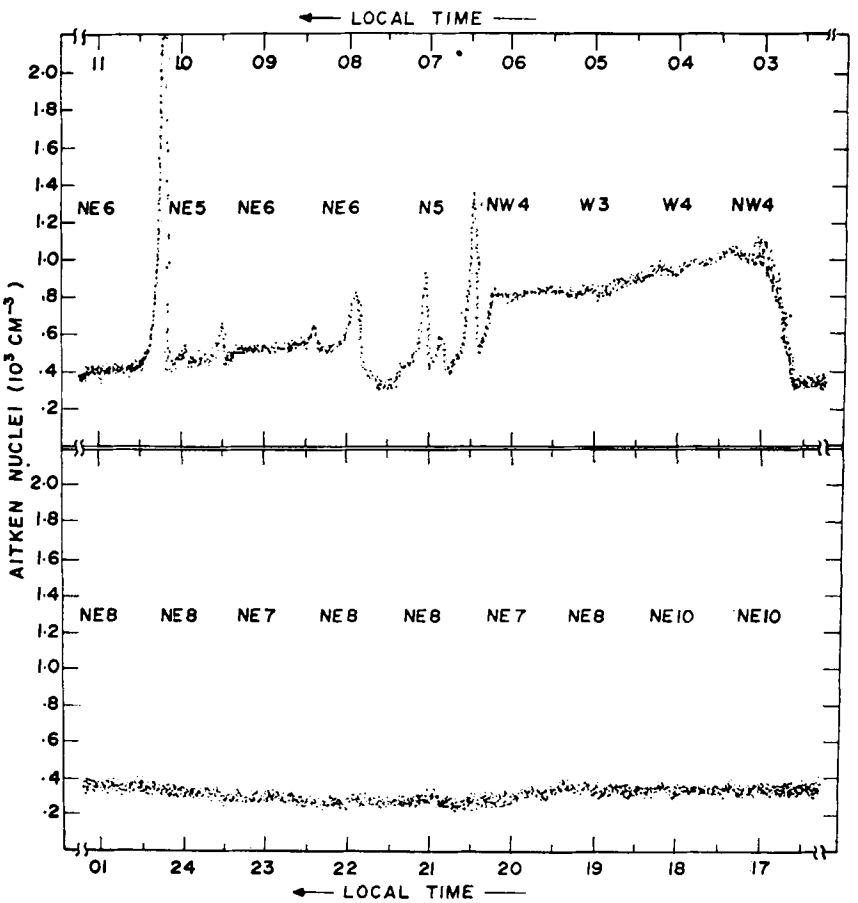

Fig. 4. Diurnal variation of Aitken nuclei concentration at Cape Kumukahi on 14 and 15 May. (Note that the time starts in the lower right corner and proceeds to the left.)

flow predominates, resulting from the cooling of the mountain. The purity of the air during these conditions is evident from both the low Aitken nuclei concentration (generally less than 100 cm^{-3}) and the atmospheric light scattering coefficient which occasionally approaches Rayleigh scattering of particle-free air. Contrary to the relationship prevailing during the day, the two parameters are positively correlated during downslope flow whenever they exceed their background values at a significant signal-to-noise ratio, for example, at 0500 hours on 4 March. This suggests a well-aged aerosol in a state of dynamic equilibrium in the night-time air, whereas the aerosol in the upslope air appears to be too young to have reached a stable size distribution (Junge, 1952*b*). After the reversal of air-mass movement at 1 000 hours on 4 March, an increase of the atmospheric aerosol loading is noted which is comparable to the amount that was observed during the day before. This diurnal pattern repeats itself daily with only a few exceptions.

2.2. *Cape Kumukahi data*

A typical diurnal pattern for atmospheric particulate matter also exists at Cape Kumukahi, the most eastern point of Hawaii. Fig. 4 shows a diurnal variation in the measurements of the Aitken nuclei concentration. (Note that the time scale goes from right to left.) During most of the day and early evening with northeasterly onshore flow and Aitken count is low (300 cm^{-3}) and steady, representing a background concentration that is typical for maritime air. With a wind shift from northeasterly

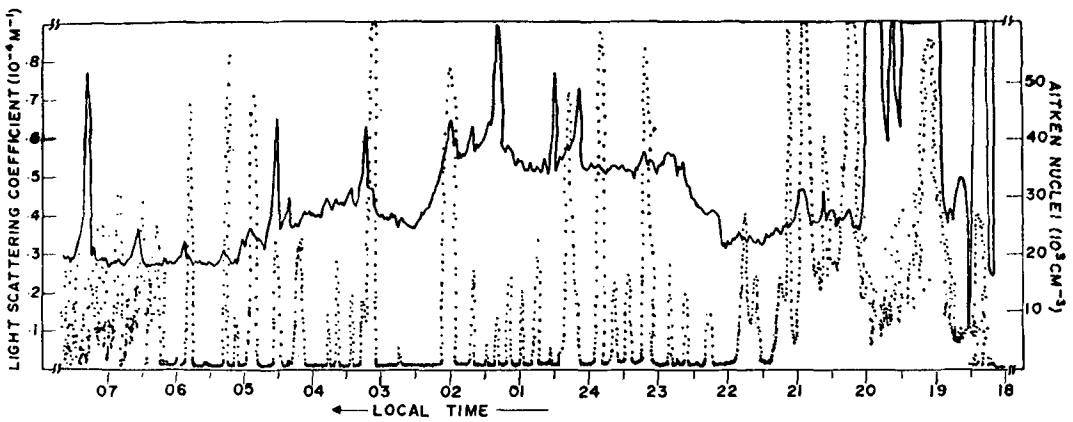

Fig. 5. Effect of human activities on Aitken nuclei concentration (dotted line) and light scattering coefficient (solid line) taken on 11 and 12 May 1971. (Note that time proceeds from right to left.)

to northwesterly the Aitken nuclei concentration increases by a factor of three due to the advection to the measurement site of particles from island related sources. This increased concentration persists for as long as there is a westerly component in the wind velocity. The onset of a northerly wind at 0615 hours causes the concentration to drop abruptly. Subsequent intermittent spikes are associated with westerly flows of short duration.

The sea-salt aerosol investigated at Cape Kumukahi is reported in the second row of Table 1 and shows the expected behavior: The background concentration of Aitken nuclei in the maritime air is 400–500 cm^{-3}. A visibility of between 40–60 km, depending slightly on the relative humidity, has been calculated from the nephelometer data. This humidity effect can result from the hygroscopic growth of individual particles. The data in Table 1 suggest also that an increase in their number concentration can result in visibility reduction which follows from the identical size of particles at two humidity levels in the last row. Apparently, the relative humidity above the ocean never reaches a value small enough to let the droplet overcome the hysteresis of phase change that would be necessary to completely dry out the sea-salt droplets produced by the bursting of bubbles to result in a significant change in size between 60 and 90 % relative humidity.

An increase in the sea-salt aerosol mass concentration by a factor of 2–3 was noted whenever the wind speed exceeded 14 knots. It is at this wind speed that white caps occur (Moore & Mason, 1954) an event which apparently has a noticeable effect on the maritime aerosol mass concentration.

2.3. *Data from terrestrial sources*

In order to compare the data from Mauna Loa Observatory's two permanent sampling stations with typical values in the proximity of aerosol origins, viz., human activities, volcanic vents and sugar cane burning, the same instrumentation was operated in the vicinity of these potential sources at different geographic locations on the island. A properly equipped bunk trailer served as a mobile laboratory for the duration of the test period.

Fig. 5 shows the temporal variations of light scattering and Aitken nuclei concentration at roadside in a rural community of Hilo. The effect of general human activity (traffic, cooking, etc.) in the evening and morning hours is clearly indicated. During the night there is a relatively small background concentration in Aitken counts except for short intervals at which diesel trucks hauling sugar cane pass by the sensors. The fact that the light scattering coefficient is influenced to a lesser degree is indicative of the small particles of which this combustion-produced aerosol consist, which also follows from the relative size in the last row of Table 1.

The effect of volcanic activity on the air quality at Mauna Loa, manifested by Fig. 2

and the first row of Table 1, necessitated measurements at Halemaumau (Kilauea's main vent which can be considered the largest source for Hawaiian air pollution). As can be seen from row 3 in Table 1, the source concentration has been found to be higher by a factor of 20 if compared with the concentration at Mauna Loa Observatory that was measured at times when volcanic fumes were advected to this measuring site on 17 March. The relative size of the particles at the source is slightly smaller than it was at this day at Mauna Loa. This suggests that coagulation takes place within this aerosol cloud during the time when it is transported to Mauna Loa Observatory. This, besides gravitational settling of the larger particles, is probably a significant sink for this type of aerosol. How efficient the coagulation process is remains to be established by performing measurements in the same aerosol cloud.

The aerosol investigated on 13 May at Kilauea has probably little in common with the one observed at Mauna Loa on 14 August. The latter resulted from active fountaining compared to the emission of fumes in the previous case. The slightly smaller relative size is indicative of the higher temperature (1 000°C) at which the aerosol formation took place in this latter case.

Our scattering-derived particle size is smaller in either case than that resulting from impactor samples by Cadle et al. (1967) at this same location. It must be borne in mind, however, that due to the hygroscopic nature of the volcanic particles their growth rate varies with the amount of water vapor available (a variable with time) while they are air-borne. The finding of sub-micron sizes of droplets is supported by the bluish appearance of the cloud during the times the samples were taken at Halemaumau and by the fact that the cloud is carried, at times, several hundred miles over the ocean.

Investigations of particulate loading from sugar cane fires, row 5, Table 1, permitted measurements at the same site in three different air masses: (1) air approaching the site from a rural area prior to burning, (2) maritime air being advected to the sampling site before the fire was started, and (3) air containing the effluents from the fire. It follows from the data that rural air contains several thousand particles of sizes less than one tenth of a micron, whereas maritime air contains only a few hundred particles of typical marine aerosol size. Visibility in these two air masses is approximately the same, i.e., the lower concentration of aerosol in the marine air is compensated by their larger size and greater light scattering capability. The fire increased the number and mass concentrations by a factor of 100 or more, if compared to the background concentration in rural air. Interestingly, the light scattering deduced size is still small, which is characteristic of a combustion-produced aerosol. The much lower visibility, then, is caused mainly by the increased number concentration and differences in the optical properties of the particles.

A comparison between human-derived particulate loading of the atmosphere and the natural background concentration is possible from the data in the fourth and sixth rows of Table 1 from measurements in the proximity of human activities. The background air in both cases was very similar and consisted of air descending down the mountain slopes from higher elevations as is typical during nights. A comparison of the background aerosol light scattering of $b = 1 \times 10^{-6}$ m^{-1} at Mauna Loa and $b = 1 \times 10^{-5}$ m^{-1} at sea level (both corrected for the contribution of molecular scattering) indicates that the difference in visual air quality above and below the marine inversion under otherwise similar conditions is of the order of a factor of ten. Both background levels of Aitken nuclei at the Hawaiian Volcanoes National Park residential area and at roadside in Kaumana, a rural community west of Hilo, are approximately the same during the night. Deviations from this background level are caused by two different kinds of human activities, viz., cooking and home heating at the National Park residential area versus automobile traffic at the roadside in Kaumana. Both of these activities produce about the same concentration of aerosols, with the size of the automobile exhaust aerosol being slightly smaller.

3. Significance

The island of Hawaii provides an ideal background for atmospheric aerosol research because of the possibilities of isolating particulate sources from each other. The geographic location of the island in the mid-Pacific and its topo-

graphy give, in conjunction with thermally induced mountain flow, an opportunity to investigate simultaneously air masses above the inversion layer and maritime air below. The diurnal air flow patterns at various geographic points on the island permit the choice of sampling sites to ensure the least interference between particulate sources. Thus it is possible to utilize instrumentation responsive to bulk aerosol properties, such as the total particle concentration or the integrated light scattering coefficients, to deduce secondary characteristic aerosol parameters, such as relative size and mass concentration, for a particular type of aerosol. These properties need to be known for all aerosol clouds to which the particulate sensors are exposed at various times, in order to establish air quality criteria that make Mauna Loa Observatory's mission as geophysical benchmark station possible.

It has been demonstrated that aerosols of different origin are advecting to the monitoring site at various rates. The positive correlation between volcanic fountaining and Aitken nuclei concentration, and between Aitken counts and light scattering, leads to the conclusion that the volcano is a significant source of aerosol that conceivably affects the solar radiation and particulate matter monitoring programs at Mauna Loa. This interference must be taken into account if global atmospheric properties are to be deduced from the solar radiation data collected at Mauna Loa Observatory.

It has been established very recently (Langer et al., 1971) that there exists a prolific source for freezing nuclei on Hawaii in the activities of sugar cane harvesting. It is conceivable and has been verified in preliminary tests that a positive correlation exists on Mauna Loa under upslope conditions between atmospheric light scattering and freezing nuclei concentration. This is an additional interference to be reckoned with in the aerosol monitoring program of Mauna Loa Observatory for globally distributed particulate matter.

Of probably little significance at Mauna Loa is the ocean-produced aerosol that is characteristic for maritime air. The relative humidity that exists below and within the trade-inversion should be high enough to allow each of the hygroscopic sea-salt particles to grow to precipitation size.

It appears as though the aerosol at Mauna Loa during downslope conditions is in dynamic equilibrium with its environment. This indicates a well aged aerosol which has established a stable size distribution (Junge, 1952*a*) and conceivably can be used to estimate the life history of air masses that reach the monitoring site.

The effect of automotive exhaust on the Aitken nuclei concentration has been clearly demonstrated. As a consequence, automotive traffic in the vicinity of a monitoring site completely obscures the background concentration of aerosols and makes monitoring of this parameter meaningless. The distance at which traffic can be tolerated depends on a number of parameters, such as variation of wind velocity and of the height of the tradewind inversion (Mendonca, 1969), the concentration of contaminants in auto exhaust, their emission rate, etc.

4. Summary and conclusion

An attempt has been made to classify aerosols from different sources on the island of Hawaii in regard to their number concentration, determined with Aitken counters, and light scattering coefficients, measured with an integrating nephelometer. Secondary parameters which are frequently used in the air pollution literature, such as visibility and aerosol mass concentration, have been deduced from these measurements. These are based on the assumptions of optical homogeneity of the atmosphere and an empirical light scattering–aerosol mass relationship that has been found to hold true for city pollutant aerosols. Unless these relationships have been verified for the Hawaiian aerosols, a task that is contemplated for the future, these secondary parameters should be applied with caution. From Table 1 it follows, nevertheless, that they appear physically meaningful: the combustion aerosol consists of relatively small particles as compared to those formed by condensation, from oceanic and volcanic effluents, and the smaller size of the longer lived aerosol reaching Mauna Loa Observatory under downslope conditions as compared to the younger island-produced aerosol measured during upslope conditions. Furthermore, our light scattering derived aerosol mass measured on a typical day on Mauna Loa agrees with the mass concentration determined from the weight of high-volume filter mats by NAPCA. Although this is part of a

continuing study for the purpose of determining interfering factors for MLO's benchmark program for globally distributed trace constituents, the data collected to date can be summarized as follows:

(1) The most prolific sources for Aitken nuclei have been found in activities associated with combustion, viz., automobile operation, cane burning and household activities (home heating). These aerosols, however, are relatively small and consequently have little effect on visibility with the exception of the smoke emanating from cane fires.

(2) Particles of larger sizes are produced by the sea, the fumes from Kilauea Volcano, and cane fire burning. The effect of sea-salt aerosols on visibility at prevailing environmental humidities is negligible due to their small number concentration. Smoke emanating from the volcano and from cane fires, on the other hand, has detrimental effects on visibility due to the high concentrations of particles that are formed.

(3) The atmospheric aerosol at Mauna Loa is subject to temporal variations. An upslope airflow during afternoons is rather regular and results in reduction of visibilities by about a factor of two. Occasionally, these conditions deteriorate appreciably due to the influx of volcanic haze to the Observatory level.

We conclude from the study that it is important to consider volcanic fumes as interference in the monitoring program for aerosol parameters and visibility. With respect to the freezing capabilities of certain particles termed ice nuclei, a recent investigation (Langer et al., 1971) suggests that terrestrial sources (e.g. sugar cane fires) are more important than Kilauea Volcano for this particular type of aerosol. Preliminary tests indicating a correlation between freezing nuclei concentration and light scatter strongly suggest an advection of aerosol cluds from these sources to Mauna Loa Observatory. Hence, the existence of the marine inversion is a necessary but not always sufficient condition to protect a monitoring station above it from atmospheric contamination below. Therefore care must be enforced in the evaluation of data collected at geophysical monitoring stations for the purpose of information on climatic changes by human activities.

The information presented in this study will help to eliminate by data evaluation procedure and/or experiment design the interference with the geophysical monitoring program at Mauna Loa from local aerosol sources.

Acknowledgements

The authors wish to acknowledge the Hawaii Volcanoes National Park Service for their assistance and guidance with the observations taken in the park and at the volcano; both Mauna Kea and Puna Sugar Companies for their permission in allowing the monitoring of sugar cane fires in the field; and to Mrs Judy Pereira for secretarial help and data tabulation in the preparation of this paper.

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ИСТОЧНИК ТВЕРДЫХ ЧАСТИЦ В АТМОСФЕРЕ НА О. ГАВАЙИ

Для правильной оценки степени чистоты воздуха над Геофизической обсерваторией Мауна Лоа были рассмотрены источники и адвекция посторонних частиц в атмосфере на о. Гавайи. Для измерения суточного и более длительного хода концентрации частиц и коэффициентов рассеяния света использовались ручной счетчик Гарднера, счетчик Айткена с непрерывной регистрацией и нефелометр. Значительным источником аэрозольных частиц являются процессы сгорания, как вулканические, так и связанные с деятельностью человека. Частицы вулканического происхождения при подходящих условиях могут проникать сквозь пассатную инверсию и затем в течение долгого времени регистрироваться счетчиком Айткена на обсерватории Мауна Лоа. Относительный вклад аэрозолей морского происхождения в полное число частиц в воздушных массах над островом невелик. Разница в концентрациях частиц и в коэффициентах рассеяния света в воздушных массах над пассатной инверсией и под ней достигает порядка величины или больших значений.