Reports

Volcanic Ash over Arizona in the Spring of 1982: Astronomical Observations

Abstract. *Astronomical observations in Arizona recorded the passage of one, and possibly more, volcanic dust clouds between January and June 1982. On 15 May the increase in extinction in visible wavelengths at Tucson was more than 40 percent or 0.4 in optical depth. At Flagstaff, 325 kilometers north, the increase in extinction on the same day was 25 percent. A detailed time history of atmospheric extinction plus evidence for nongray absorption from the cloud is presented.*

In early May 1982 astronomers in Arizona became aware of increasing atmospheric extinction, evidently caused by a high-elevation volcanic ash layer traceable to the eruption of El Chichón (*1*) in the Mexican state of Chiapas. By 15 May the transparency at noon in Tucson was 40 percent less than normal, reduced enough so that the solar intensity was noticeably weakened even to the casual observer. Soon thereafter the cloud diminished, although in the fall of 1982 coronal observations were compromised and the twilight colors, indicative of its presence, remained vivid. We report here a variety of observations pertaining to the spring 1982 ash-cloud phenomenon.

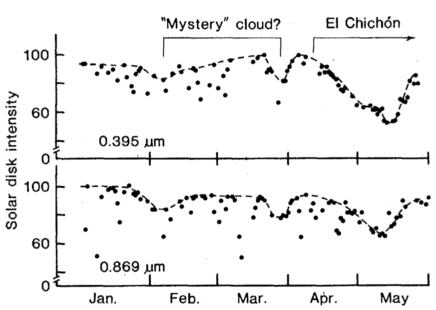
Table 1. Observed change in the photometry signal due to the dust cloud.

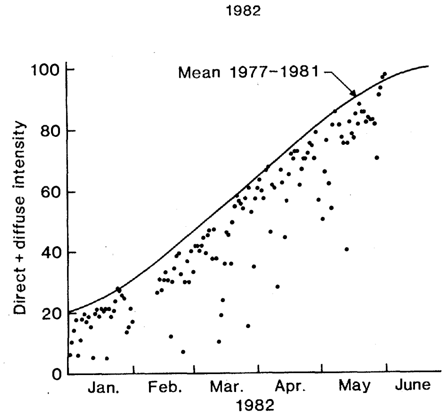
Color	Wave-length (μm)	Date (1982)	Change		Source
			Stellar magnitude	Percent loss	
U	0.36	1 March to 15 May	0.50	37	(*13*)
B	0.44	1 March to 15 May	0.48	36	
V	0.55	1 March to 15 May	0.46	35	
R	0.70	29 March to 12 May	0.49	36	(*14*)
J	1.25	7 April to 12 May	0.14	12	
H	1.66	7 April to 12 May	0.08	7	
K	2.22	7 April to 12 May	0.06	5	
L	3.45	7 April to 12 May	0.05	5	
M	4.60	7 April to 12 May	0.0	0	

Figure 1 shows the time history of direct solar intensity at wavelengths of 0.395 and 0.869 μm during the first 5 months of 1982. These are raw uncorrected intensities of the solar disk at noon. Here we must depend on instrument stability and sky transparency, the downward scatter being indicative of thin cirrus or incipient clouds. The intensities at 0.395 μm were derived from the measurements of a calcium K-line photometer (*2*) located in Tucson (32.2°N). Intensities at 0.869 μm are recorded daily during synoptic full-disk magnetogram observations at Kitt Peak Mountain 65 km southwest of Tucson (*3*). The agreement between the two records indicates that the instrument sensitivity was reasonably constant.

According to the 0.395-μm photometric record, the El Chichón cloud arrived between 10 and 15 April, after which extinction increased more or less linearly until 15 May when the intensity had fallen to 47 percent of the March-April high. The intensity drop at 0.869 μm was less (28 percent), an indication that the cloud was not precisely gray over this span in wavelength (factor of 2).

Figure 1 shows a well-defined dip from 23 to 30 March and a diffuse dip in January-February. These cannot be signatures of El Chichón since its eruptions





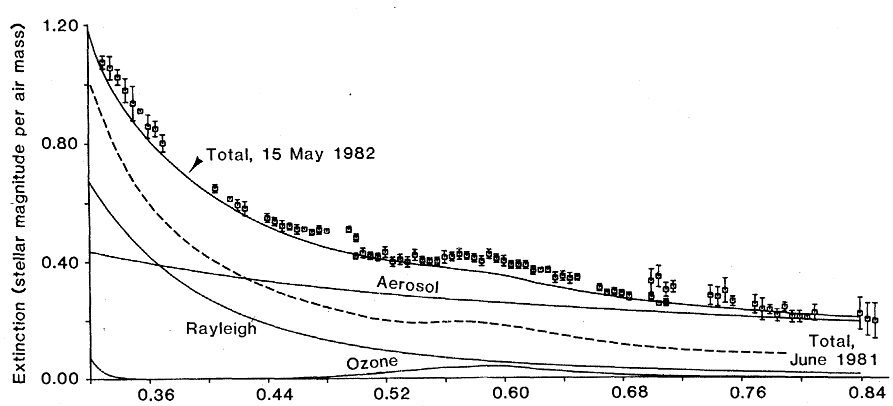


Fig. 1 (top left). Relative solar disk intensity at noon in Tucson (0.395 μm) and at Kitt Peak (0.869 μm) during the spring of 1982. Fig. 2 (bottom left). Direct plus diffuse insolation at noon in Tucson at < 0.320 μm. Downward scatter arises from variable cloudiness. Fig. 3 (above). Wavelength dependence of extinction for 15 May 1982 with component parts displayed. The total extinction [in units of stellar magnitude per air mass or (−2.5 log transmission)] is the upper solid line fitted to the observations. The total is the sum of the components indicated (aerosol scattering, Rayleigh scattering, and ozone absorption). The total extinction for June 1981 is shown as a dashed line.

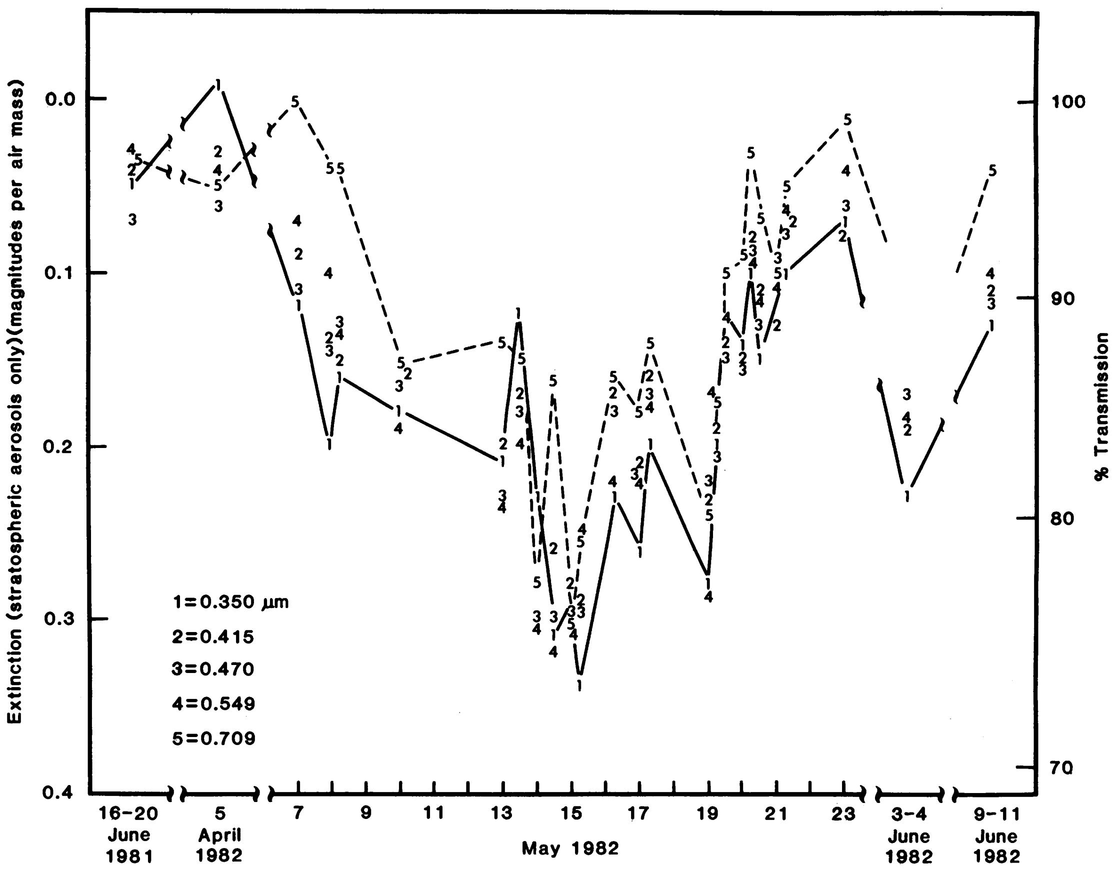


Fig. 4. Time variations of the extinction due to stratospheric aerosols only at Flagstaff. Data are shown for five representative wavelengths referred to the baseline level of June 1981.

occurred between 28 March and 4 April. It may be that the January-February event was caused by the "mystery" cloud, so called because of its unknown origin (*4*). This cloud was first detected over Japan on 23 January with later sightings over Hawaii, and there was a direct aircraft sensing from Wallops Island Flight Center, Virginia, on 13–14 February that indicated volcanic particles.

A measure of direct plus (full sky) diffuse ultraviolet insolation at < 0.320 μm is continuously monitored at the Health Sciences Center in Tucson (*5*). This time record (Fig. 2) fails to show any significant dips. In the ultraviolet, forward scattering dominates over particle absorption, and so the insolation is insensibly altered by the ash cloud.

The wavelength dependence of the dust cloud extinction has been determined from spectrophotometric observations obtained at Flagstaff (35.2°N) for the sun and Vega (*6*). The spectrum was measured at 0.005-μm intervals from 0.330 to 0.850 μm. The total extinction consisting of components due to Rayleigh scattering, ozone absorption, local aerosol scattering, and volcanic cloud scattering and absorption was determined from the slope of the observed stellar magnitude as a function of air mass. Figure 3 shows the wavelength dependence of the total extinction for the

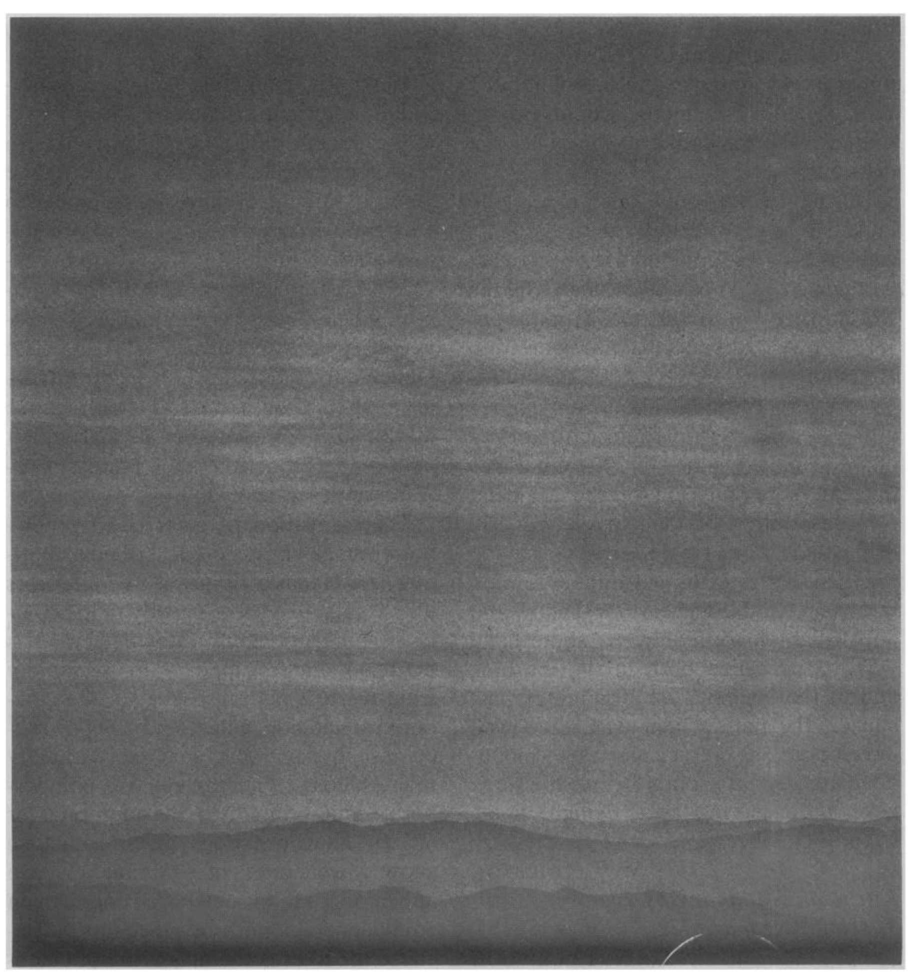


Fig. 5. High-contrast print showing the striation in the ash cloud that regularly displayed a maximum 10 to 15 minutes after sunset (in this example 1921 local standard time, 7 May 1982).

worst day, 15 May, along with curves for the three components of extinction (*7*). An average curve for June 1981 is also shown, from which the excess extinction due to the cloud alone is inferred to be 0.3 mag (~ 25 percent).

Figure 4 shows the time variations of the cloud extinction at five representative wavelengths. Mean extinction values have been subtracted based on the data of Hayes (*8*), so that Fig. 4 displays just the cloud extinction plus a small component of the seasonally variable local aerosol (~ 0.05 mag). The cloud appeared slightly blue with the excess extinction at 0.350 μm being ~ 0.1 mag (10 percent) greater than that at 0.709 μm. At the time of greatest extinction, 15 May, the cloud seemed more nearly gray but may have been changing during the ~ 4-hour period required for each set of measurements. By early June the initial conditions prevailed. These changes imply that the particle size distribution during mid-May was different from that before and after.

From stellar photometry records we also gain information on the color and amplitude of extinction change. The extreme values are given in Table 1. Although the cloud was fairly gray in the visible, the falloff in the red indicates an upper limit to the particle size of about 1 μm. Detailed modeling would be required to better define the particle size distribution.

During early May we repeatedly looked for, but did not see, a Bishop's ring, the diffraction halo of somewhat variable size that was seen all around the world after the Krakatoa eruption of 1883 (*9*). A Bishop's ring was seen from Houston, Texas, in May 1982 (*10*). Almost every evening, about 10 minutes after sunset, the striated structure of the cloud became visible (Fig. 5). What was evident is reminiscent of the Meinels' (*11*) description of the November 1974 ash cloud. Fine ripple patterns having apparent lifetimes of ~ 1 minute formed in certain bands. The earth's shadow and antitwilight arch (*12*) were abnormally weak or invisible both in the morning and in the evening. At 30 minutes past sunset, the purple light was often well developed and crepuscular rays, modulated by distant clouds below the horizon, were serving as a twilight finale even in October.

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15. We thank G. Mechler, K. Pierce, and J. Goad for helpful discussions.

19 July 1982; revised 22 October 1982

Potential Role of Galactokinase in Neonatal Carbohydrate Assimilation

Abstract. *Glucose given to the newborn human may result in hyperglycemia, suggesting that its utilization is impaired at this developmental stage. Galactose is thought to be a more appropriate carbohydrate source for the newborn. The enzymes involved in hexose phosphorylation may, in part, be responsible for these observations. A key regulatory enzyme of hepatic glucose assimilation, glucokinase, is diminished in newborns compared to adults, whereas galactokinase activity is increased. When newborn dogs were fasted and then fed either glucose or galactose, their plasma insulin responses to glucose were similar, but the pups fed galactose demonstrated an attenuated systemic appearance rate of glucose. Hexose incorporation into hepatic glycogen and net glycogen synthesis was augmented in the galactose-fed dogs. In vitro, liver from neonatal dogs showed enhanced galactokinase activity relative to that for hexokinase or glucokinase. Neonatal hexose assimilation may be independent of insulin action and, instead, be related to the developmental presence of hexose phosphorylating enzymes.*

Newborn mammals given carbohydrates show an attenuated rate of systemic glucose utilization (*1, 2*). Newborn rats and humans show a diabetic-like glucose tolerance curve in response to exogenous glucose (*3, 4*). Newborn humans of low birth weight develop excessively high concentrations of blood glucose when glucose is administered intravenously at conventional rates (*5*). The higher mortality rate of such infants may, in part, be related to their glucose intolerance (*6*). As the normal infant matures, glucose tolerance increases toward adult values (*3, 4*).

The utilization of galactose by newborn humans has been described as optimal (*7*). Hepatic tissue of neonatal rats utilize galactose more readily than hepatic tissue from adult rats; galactose is oxidized and disappears more rapidly from the less mature tissue. In the newborn rat and dog, galactose is incorporated into hepatic glycogen more rapidly than glucose, whereas glucose is incorporated more rapidly in the adult rat liver (*8, 9*). Newborn dogs given galactose show lower rates of systemic glucose appearance than newborn dogs given equivalent amounts of glucose (*9*). Because the liver is the major site of disposition of orally administered carbohydrate, we suggested that hepatic carbohydrate uptake is augmented in the newborn when galactose, rather than glucose, is administered. This might be explained on the basis of the availability of the enzymes that phosphorylate these monosaccharides: galactokinase, hexokinase, and glucokinase. We have studied these enzymes in fed and fasted newborn beagle pups during the first day after birth. The results confirm our earlier studies (*9*) and suggest that high levels of galactokinase activity may account for the better utilization of galactose than glucose in the newborn human.

Umbilical artery and venous catheters were placed in newborn pups delivered by Cesarean section at term (*9*). Fasting glucose turnover was measured by the primed-continuous infusion of [6-^{3}H]glucose and analysis of the data with Steele's equations (*9*). The pups were then randomly fed physiological quantities (0.625 g/kg) of an isotonic solution of either [U-^{14}C]glucose or [U-^{14}C]galactose, and blood glucose and galactose concentrations, as well as glucose kinetics, were determined as described (*9*). Four hours after enteric feeding, hepatic tissue was quickly sampled and cooled rapidly to the temperature of liquid nitrogen; hepatic glycogen, galactokinase, hexokinase, and glucokinase activity were then analyzed (*9–11*).