second counting interval or, equivalently, a one-way range rate error of 0.3 mm/sec over the same interval.

The distance of closest approach of Pioneer 11 to the center of Jupiter was about 1.62 Jupiter radii (R_J). Two-way Doppler data were taken up to 1.75 R_J on the incoming trajectory to Jupiter, and again starting at 2.0 R_J on the outgoing trajectory. The remaining 1 hour of data down to 1.62 R_J was lost because of occultation by the planet. Because Pioneer 11 was inside the closest approach distance of Pioneer 10 (2.8 R_J) for 2.7 hours, it has been possible to obtain unprecedented detail in the Jupiter gravity field from the Pioneer 11 data.

The zonal harmonic coefficients J_2, J_3, J_4, and J_6 in Jupiter's gravity field are given in Table 1 for Pioneer 10 and Pioneer 11 for an assumed equatorial radius of 71,398 km. Because our analysis of spacecraft gas leaks and other systematic errors is incomplete, we have assigned conservative standard errors to our Pioneer 11 results. These results are in excellent consistency with those from Pioneer 10. The solution for parameters depending on higher inverse powers of distance in the potential function (J_3, J_4, and J_6) was much improved by the close Pioneer 11 flyby. On the other hand, the more distant Pioneer 10 trajectory had yielded only a loose bound on J_3 and no significant solution for J_6. The small values obtained for J_3 and J_6 from Pioneer 11 support the assumption that Jupiter is in hydrostatic equilibrium.

The zonal coefficients J_2, J_4, and J_6 are used as boundary conditions for interior modeling of Jupiter. In particular, the higher coefficients J_4 and J_6 determine the pressure-density profile in the outer envelope, which is currently limited in accuracy by the error in J_4 (*1*). The profile from Pioneer 10 has been used along with other modeling assumptions to derive a temperature of 250° ± 40°K at a pressure of 1 bar (*1*).

Table 1. Jupiter gravity harmonics from an analysis of Doppler data from Pioneer 10 (*2*) and Pioneer 11. Values are based on an assumed equatorial radius of 71,398 km.

Coefficient ($\times 10^6$)	Pioneer 10	Pioneer 11
J_2	14,720 ± 40	14,750 ± 50
J_3	< 150	10 ± 40
J_4	− 650 ± 150	− 580 ± 40
J_6	Assumed zero	50 ± 60

Values for the masses of Jupiter and its four Galilean satellites were obtained simultaneously with solutions for the harmonic coefficients. These values were consistent with those from Pioneer 10 (*2*) but less accurate by a factor of 3 because of our incomplete analysis of unpredictable nongravitational accelerations. Satellite and planet masses will be presented elsewhere (*3*).

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Stratospheric Dust-Aerosol Event of November 1974

Abstract. *A strong incursion of dust and aerosol at an altitude of 20 kilometers was noted over Baja California and southern Arizona in mid-November 1974, as indicated by bluish-ashen daylight skies and colorful twilight glows of the type usually associated with volcanic eruptions. Infrared satellite observations and reports from other sources eliminated a possible oceanic origin in the eastern Pacific. The stratum is probably from the extensive eruption of Volcan de Fuego in Gautemala in October 1974.*

Major volcanic eruptions inject sufficient gas and ash into the high atmosphere to produce worldwide effects. The last volcano to cause such effects was Agung on Bali in 1963, but this event was undoubtedly augmented by the subsequent eruptions the same year of Irazu in Costa Rica and Surtsey in Iceland. The effect on the 20-km aerosol layer of the SO_2 and other material emitted in that eruption lasted 4 years, long after the initial ash particles would have precipitated out of the atmosphere. There have been minor enhancements of the aerosol layer from lesser eruptions since then.

The high ash clouds and aerosol layer associated with volcanic eruptions cause the appearance of highly colored twilight glows, first described in scientific detail after the eruption of Krakatoa in 1883 (*1*). This glow stratum is illuminated by sunlight after lower clouds are in the earth's shadow. When skies are free from clouds 200 to 500 km westward of the observer at sunset (or eastward at sunrise) the sunlight passing through a long atmospheric path is reddened, so that the aerosol stratum is deeply colored. The maximum display occurs about 35 to 40 minutes after sunset (or before sunrise), when the upper edge of the glow shows the curved limb of the earth projected on the stratum with the deepest red coloration at the upper edge of the glow. The altitude of the stratum can readily be deduced from the time the upper edge sets on the horizon. At Tucson (32°N) this glow-set time averages 45 to 47 minutes after apparent sunset, which yields altitudes in the range of 20 km. When distant clouds are present the time is shortened in proportion to the height of the screening cloud deck. The intense orange and red colors are also absent on these occasions. When only scattered clouds are present over the horizon these clouds often cast spectacular shadows on the glowing stratum.

Continued surveillance of the twilight sky from Tucson, which we began shortly after the appearance of twilight glows from the 1963 eruption of Agung (*2*), showed that the aerosol layer had remained at its normal level since 1970; an exception to this was a brief stratospheric cloud in 1971 reported by Volz (*3*), which he traced to an unreported eruption in the Aleutian chain. It should be noted that even during quiescent years the 20-km aerosol layer shows a fall enhancement beginning in late September or early October, apparently when the ozone concentration rises in the lower ozonosphere. On the night of 9 November 1974, however, we saw a brilliant twilight glow while we were flying southeast out of Mazatlan, Mexico. Timing of the glow set was complicated since our aircraft was flying toward Guadalajara, but after estimating our velocity and altitude and the time of disappearance of the glow, we became suspicious that the glow was due to an unusual enhancement of the 20-km aerosol layer. All the usual color and intensity were observed, along with the phenomenon of lower atmospheric clouds being projected on the glow stratum (*4*). The glow was not visible from 10 to 15 November from Puebla, Mexico, even though the weather was satisfactory. On returning to Mazatlan on the evening of 16 November, we again saw the glow stratum from the same vicinity along the flight path, but with maximum intensity shifted northward. The layer was even more brilliant and showed distinctly the ripples and modulations in intensity we had suspected on 9 November.

We began a systematic patrol for the enhanced glow stratum from our home east of Tucson after our return from Mexico, but saw nothing of the nature of what we had just seen from Mexico, even though the weather was ideal. Just at sunset on the evening of 21 November we saw a bluish-white band low in the western sky, at a time when the sky would have been too bright to distinguish the stratum produced by the Agung event, and we started a sequence of camera pictures. Intense coloration appeared on this band 15 to 45 minutes after sunset, typical of solar illumination of the volcanic ash layer reported after Krakatoa (*1*) and with the patchy striated bands and ripple structure reported by Volz (*3*). The strong coloration was limited to the ashen band, the sky above it being quite bluish, indicating that the aerosol layer in general had not yet been perturbed.

During the day of 22 November the principal portion of the ash layer passed over Tucson, drifting eastward at about 40 km/hour. The layer was visible all day as a smoky-white haze layer with striated bands and ripple structure extending from northeast to southwest. Included in the layer was a circumsolar silvery-blue disk with a reddish edge and a radius of about 27 degrees. This silvery disk apparently was a faint indication of "Bishop's ring," discovered by S. E. Bishop from Hawaii after the Krakatoa event (*1*). The twilight coloration was actually inhibited by self-absorption of the stratum, parts of which cast greatly elongated shadows on the ash layer. The time of glow set on this night was about 45 minutes after local sunset, but on subsequent nights increased to 47 minutes. The altitude for the layer and aerosol stratum was therefore 19 $\pm$ 2 km. The cover photograph was made from a color slide of the heavily striated glow stratum after sunset on 22 November 1974.

The major portion of the layer was distinctly east of Tucson on the morning of 23 November, with only the slightest visible trace of the silvery layer during midday. This day, like the preceding ones, was sparkling clear otherwise. The evening twilight glow, however, was spectacular, indicating that the ash-aerosol stratum had not ceased flowing over southern Arizona. From 24 to 28 November the stratum continued to be visible all day only on the southern horizon, which indicated that the flow was mainly over northern Mexico. The sunset skies showed brilliant sunset glows of a rather uniform pellucid nature, which grew in intensity for about a week after the last sighting of the daylight ash stratum; this may indicate that the enhanced aerosol layer is somewhat different from the ash cloud itself, consistent with the hypothesis (*5*) that the aerosol enhancement is a photochemical smog from the reaction of SO_2 with O_3 to form sulfate particles.

The reappearance of the ashen skies on 22 to 30 December 1974, distinctly weaker than on 21 to 28 November, would indicate the encircling of the earth by the initial cloud. This time of reappearance is compatible with a mean eastward drift velocity of about 40 km/hour, the approximate velocity we noted from angular drift when the cloud was overhead on 22 November.

The opacity of the stratum, its detailed structure, and its small extent of about 500 km indicated that its point of origin was not far from where we first observed it in Mexico. Examination of satellite infrared observations eliminated any source in the eastern Pacific, such as the Revilla Gigedo Islands. The only major nearby eruption was that of Volcan de Fuego in Guatemala on 10 to 23 October, and this is the probable source of the stratospheric event. The 4- to 6-week delay in appearance of the main cloud over the United States is explained satisfactorily by its probable trajectory in the upper air. The ash cloud from the eruption flowed westward from Guatemala, depositing ash as far as 200 km up the west coast of Mexico before moving over the Pacific (*6*). Some of the material went as far west as Hawaii before being acquired by the eastward stratospheric flow over the United States and Mexico (*7*). Lidar measurements have confirmed the existence and altitude of this dust-aerosol cloud (*8*).

The continued strength of the ash layer after its second passage over the United States indicates that the sunset effects will be observable until early spring, when the seasonal minimum begins, and will probably resume their beauty in the fall of 1975. With so much interest centered on man-caused perturbations to the atmospheric aerosols and the ozonosphere, perhaps we are fortunate to have this very large natural perturbation to study.

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Self-Control of Occipital Theta Activity and Task Performance

Beatty *et al.* (*1*) claim to have demonstrated a "lawful relationship between operantly regulated cortical activity and behavior in man." There are, however, a number of aspects of this experiment which merit closer attention.

The use of the concept "operant" must be questioned. Lynch and Paskewitz (*2*), in a review of brain wave feedback experiments, feel that there is often insufficient evidence to justify the use of this term, particularly in the absence of a consideration of mediating mechanisms, and they question whether it will ever be possible to demonstrate true operant learning of brain wave activity in man. It seems preferable, therefore, to think in terms of self-control or feedback control rather than operant control.

It is not clear whether Beatty's experiment does in fact demonstrate self-control of theta activity. It is unfortunate that a noncontingent control group was not included in the experi-