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Meridional Distribution of Haze Particles in Venus Atmosphere at the Time of Mariner10 Fly-by

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Based on an analysis of the ground-based polarimetry data obtained in 1960's and early 1970, Hansen and Hovenier (1974) deduced that the aerosol particles comprising the main cloud of Venus are concentrated sulfuric acid droplets with the effective radius of about 1.05 micrometer and the effective variance of 0.07 for the size distribution (hereafter referred to as H-H particles). The excellent quality of their analysis was so overwhelming, that the observational results presented by several authors suggesting a possible presence of sub-micron particles mixed within the main cloud deck consisted of the H-H particles or above it were more or less overlooked or overshadowed.

However, the Pioneer Venus 1 and 2 of NASA, which reached Venus in Dec., 1978, discovered a significant amount of haze particles over the north and south polar regions of the planet. Hence, a question arises as to whether or not those haze particles were produced rather episodically coinciding with the arrival of the Pioneer probes or had been present more or less perpetually in the atmosphere of Venus. In order to answer to the above question, we tackle on a reanalysis of the photometric data obtained by Mariner 10 in three wavelengths (orange, blue, and ultraviolet) in Feb., 1975 along the central meridian of the illuminated disk of Venus, as given by Young and Kattawar(1978) with some corrections to the original.

Young and Kattawar (1978) concluded that both the equatorial and meridional intensity distributions observed at the wavelengths of 360 and 580 nm could be well accounted for by means of the cloud model composed solely of the H-H particles and carbon dioxide molecules. However, a careful inspection of their diagrams indicates that noticeable discrepancies exist between the observed data and the theoretical computations particularly in the polar regions of the planet. Hence, we decided to undertake a reanalysis of their data sets for the equator and the central meridian.

The main objective of our analysis is to investigate to what extent those discrepancies in the polar regions can be reduced by invoking sub-micron particles, and not a detailed study of the height distribution of such particles in the atmosphere, so that we employ a two layer model in which a haze layer is placed on top of a thick cloud deck to compute theoretical intensity distributions. We thereby vary the value of the effective radius of the haze particles in the range from 0.05 micrometer to 0.5 micrometer with a step size of 0.05 micrometer, although the value of the effective variance of the particle size distribution is fixed at 0.175 based on Kawabata et al. (1980). Furthermore, for simplicity, the values of the single scattering albedos of the gaseous molecules, haze particles, and cloud particles are assumed to be identical at each wavelength, and the value is adjusted so that the observed value of the spherical albedo of Venus at that wavelength can result.

Our analysis indicates that haze particles were actually present planet-wise from north to south despite the fact that the amount of them was minimal in the equatorial region. The optical thickness of the haze layer varies from latitude to latitude, but tends to increase more or less toward higher latitudes as was found by Kawabata et al. (1980): the conservatively scattering haze particles with the effective radius of 0.1 micrometer and the effective variance of 0.175 yields approximately 0.07 for the orange optical thickness of the haze layer in the equatorial region, 0.2-1 in the mi-latitudes, and 0.3-0.5 in the polar regions.

We conclude that sub-micron haze particles were already present globally over the planet Venus as early as 1975 in addition to the cloud particles represented by the H-H particles. In other words, it is highly likely that the haze particles such as those detected by the Pioneer Venus probes are a rather perpetual constituent of the Venus atmosphere.