From (6.12), it follows that

\[ n_\sigma(D) = D \text{ (ln 10)} \frac{dN}{dD} = D \text{ (ln 10)} n_\sigma(D), \]  

(6.14)

which is the relation between the distribution function \( n_\sigma(D) \) for logarithmic increments of diameter and the function \( n_\sigma(D) \) for linear increments.

Plots of \( \log n_\sigma(D) \) versus \( \log D \) for aerosol particles can sometimes be fit by straight lines over a limited range of diameter. This implies a power law dependence of \( n_\sigma \) on \( D \) of the form

\[ n_\sigma(D) = cD^{-\beta}, \]  

(6.15)

where \( c \) is a constant and \( -\beta \) is the slope of the straight line. \( \beta = 3 \) is often cited as typical over the diameter range from about \( 10^{-4} \) to \( 10 \mu m \); aerosol populations having this form are said to follow a Junge distribution, after the atmospheric chemist Christian Junge, an authority on aerosols. From (6.14), it is seen that a power law of the form (6.15) for \( n_\sigma(D) \) corresponds to a power law for \( n_\sigma(D) \) given by

\[ n_\sigma(D) = \frac{c}{\text{ln 10}} D^{-1}. \]  

The differences among aerosol samples are emphasized by comparing the contributions of given size intervals to the total particulate volume or surface area rather than to the total number of particles. For example, the surface area of particles with diameters smaller than \( D \) is given by

\[ S(D) = \int_0^D \pi D^2 n_\sigma(D') dD'. \]  

(6.16)

The contribution of particles in \( d(\log D) \) to the surface area is

\[ \frac{dS}{d(\log D)} = D \text{ (ln 10)} \frac{dN}{dD} = \pi D^2 \frac{dN}{d(\log D)} = \pi D^2 n_\sigma(D). \]  

(6.17)

Similarly, the volume of particles with diameters smaller than \( D \) is

\[ V(D) = \int_0^D \frac{\pi}{6} D^3 n_\sigma(D') dD', \]  

(6.18)

and the contribution of particles in \( d(\log D) \) to the volume is

\[ \frac{dV}{d(\log D)} = \frac{\pi}{6} D^3 n_\sigma(D). \]  

(6.19)

Figure 6.3 shows the size distributions of aerosols collected by airplane over a north-central region of the United States (Miles City, Montana).

![Figure 6.3](image)

The hatching defines an envelope that includes many individual samples. The data are plotted three ways: as distributions of particle number \( dN/d(\log D) \), surface area \( dS/d(\log D) \), and volume \( dV/d(\log D) \). The Junge distribution or any other power law provides only a crude fit to the data and is unable to capture the inflection points, maxima, and minima, which are conspicuous features of the volume and surface area distributions. The maximum in these distributions between 0.1 and 1 \( \mu m \) is called the accumulation mode; that between 10 and 20 \( \mu m \) is called the coarse particle mode. Not evident here is another mode near 10^{-2} \( \mu m \) occasionally observed near industrial centers and other sources of combustion, called the nucleation mode.

The accumulation mode is explained by the tendency of particles smaller than 0.1 \( \mu m \) to collide with one another as a result of Brownian motion and to clump together. The large particle mode is dominated by dust, combustion products, and sea spray, and depends on surface wind speed and distance from the sources of the particulates. An upper limit to the sizes is established by sedimentation, which preferentially removes the larger particles from the distribution.

The most important removal process for aerosol particles is precipitation. Some particles serve as centers for cloud condensation; others are