3.1.2. EXPERIMENTAL METHODS

Extensive aerosol properties monitored by CMDL include condensation nuclei (CN) concentration, aerosol optical depth (δ), and components of the aerosol extinction coefficient at one or more wavelengths (total scattering σ_{sp}, backwards hemispheric scattering σ_{bsp}, and absorption σ_{ap}). At the regional sites, size-resolved impactor and filter samples (submicrometer and supermicrometer size fractions) are obtained for gravimetric and chemical (ion chromatograph) analyses. All size-selective sampling, as well as the measurements of the components of the aerosol extinction coefficient at the regional stations, is performed at a low, controlled relative humidity (<40%) to eliminate confounding effects because of changes in ambient relative humidity. Data from the continuous sensors are screened to eliminate contamination from local pollution sources. At the regional stations, the screening algorithms use measured wind speed, direction, and total particle number concentration in real-time to prevent contamination of the chemical samples. Algorithms for the baseline stations use measured wind speed and direction to exclude data that are likely to have been locally contaminated.

Prior to 1995, data from the baseline stations were manually edited to remove spikes from local contamination. Since 1995 an automatic editing algorithm has been applied to the baseline data in addition to manual editing of local contamination spikes. For the baseline stations (Barrow, Alaska (BRW); Mauna Loa, Hawaii (MLO); American Samoa (SMO); and South Pole, Antarctica (SPO), as well as Sable Island (WSA)), data are automatically removed when the wind direction is from local sources of pollution (such as generators and buildings) as well as when the wind speed is less than a threshold value (0.5-1 m s^{-1}). In addition, at MLO, data for upslope conditions (1800-1000 UTC) are excluded since the air masses do not represent "background" free tropospheric air for this case. A summary of the data-editing criteria is given in Table 3.1.

TABLE 3.1. Data Editing Summary for NOAA Baseline and Regional Stations

Station	Editing	Clean Sector
South Pole	a,b,c	0° < WD < 110°, 330°<WD <360°
Samoa	a,b,c	0° < WD < 165°, 285°<WD < 360°
Mauna Loa	a,b,c,d	90° < WD < 270°
Barrow	a,b,c	0° < WD < 130°
Sable Island	a,b,c	0° < WD < 35°, 85° < WD < 360°
Southern Great Plains	a	
Bondville	a	

a: Manual removal of local contamination spikes
b: Automatic removal of data not in clean sector
c: Automatic removal of data for low wind speeds
d: Removal of data for upslope wind conditions
WD: Wind direction

Integrating nephelometers are used to determine the light scattering coefficient of the aerosol. These instruments operate by illuminating a fixed sample volume from the side and observing the amount of light that is scattered by particles and gas molecules in the direction of a photomultiplier tube. The instrument integrates over scattering angles of 7-170°. Depending on the station, measurements are performed at three or four wavelengths in the visible and near infrared. Newer instruments allow determination of the hemispheric back-scattering coefficient by using a shutter to prevent illumination of the portion of the instrument that yields scattering angles less than 90°. A particle filter is inserted periodically into the sample stream to measure the light scattered by gas molecules. This is then subtracted from the total scattered signal to determine the contribution from the particles alone. The instruments are calibrated by filling the sample volume with CO_2 gas that has a known scattering coefficient.

The aerosol light absorption coefficient is determined with a continuous light absorption photometer. This instrument continuously measures the amount of light transmitted through a quartz filter while particles are being deposited on the filter. The rate of decrease of transmissivity, divided by the sample flow rate, is directly proportional to the light absorption coefficient of the particles. Newer instruments were calibrated in terms of the difference of light extinction and scattering in a long-path extinction cell for laboratory test aerosols. Instruments at the baseline stations (aethalometers, Magee Scientific, Berkeley, California) were calibrated by the manufacturer in terms of the equivalent amount of black carbon (BC) from which the light absorption coefficient is calculated, assuming a mass absorption efficiency of the calibration aerosols of 10 m^2 g^{-1}.

Particle number concentration is determined with a CN counter that exposes the particles to a high supersaturation of butanol vapor. This causes the particles to grow to a size where they can be optically detected and counted. The instruments in use have lower particle-size detection limits of 10-20 nm diameter.

Summaries of the extensive measurements obtained at each site are given in Tables 3.2 and 3.3. Table 3.4 lists the intensive aerosol properties that can be determined from the directly measured extensive properties. These properties are used in chemical transport models to determine the radiative effects of the aerosol concentrations calculated by the models. Inversely, these properties are used by algorithms for interpreting satellite remote-sensing data to determine aerosol amounts based on measurements of the radiative effects of the aerosol.