Aerosol model development for calculation of aerosol extinction in the coastal atmosphere surface layer

G.A. Kaloshin
V.E. Zuev Institute of Atmospheric Optics SB RAS,
1, Academicicheskii ave., 634055, Tomsk, Russia

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Extinction of radiation in the marine boundary layer is dominated by scattering and absorption due to atmospheric aerosol. This is important to optical retrievals from satellite, remote sensing at environmental monitoring, backscatter of light to space (including climate forcing), cloud properties etc. In unpolluted regions the greatest effects on near shore scattering extinction will be a result of sea-salt from breaking waves and variations in relative humidity. The role of breaking waves appears to be modulated by wind, tide, swell, wave spectra and coastal conditions. These influences will be superimposed upon aerosol generated by open ocean sea-salt aerosol that varies with wind speed.

The focus of our study is the extinction and optical effects due to aerosol in a specific coastal region. This involves linking coastal physical properties to oceanic and meteorological parameters in order to develop predictive algorithms that describe 3-D aerosol structure and variability.

The aerosol microphysical model of the marine and coastal atmosphere surface layer is considered. The model is made on the basis of the long-term experimental data received at researches of aerosol sizes distribution function (dN/dr) in the band particles sizes in 0.01 - 100 µk. The model is developed by present time for the band of heights is 0 - 25 m. Bands of wind speed is 3 - 18 km/s, sizes fetch is up to 120 km, RH = 40 - 98 %. dN/dr of the model is characterized by the four modified lognormal functions with modal radiuses, equal r1 = 0.03; r2 = 0.24; r3 = 2; r4 = 10 µk (Piazzola, Kaloshin, 2005, 2006).

The model distinctive feature is parameterization of amplitude and width of the modes as functions of fetch and wind speed. In the paper the dN/dr behavior depending at change meteorological parameters, heights above sea level, fetch (X), wind speed (U) and RH is show. The received results are compared to available microphysical models NAN and ANAM.

On the basis of the developed model with usage of Mie theory for spheres the description of the last version of developed code MaexPro 5.0 (Marine Aerosol Extinction Profiles) for spectral profiles of aerosol extinction coefficients α(λ) calculations in the wavelength band, equal λ = 0.2 - 12 µm, with step Δλ = 0.0001 µm is presented.

In Fig. 1 the composite window “extinction spectra” of the code MaexPro 5.0 is submitted on which aerosol extinction spectra for chosen input meteorological parameters are resulted. Here with use of a service command “the switch OverPlot” aerosol extinction spectra α(λ) calculated on a basis dN/dr are resulted which can be received with the help of aerosol counter AZ-5 with a range of aerosol particles measurement on radius Δr = 0.4 - 10 microns and dust counter OMPN-10.0 (OPTEK Spb), carrying out the control of fractions in standard PM 10, PM 2.5 and PM 1. Fig. 1 shows that for three spectra of the aerosol sizes in wavelength band Δλ = 2 - 12 µm α(λ) differ approximately twice and in wavelength band Δλ = 0.2 - 2 µm of distinction in values α(λ) reach 10 and more.

Figure 1. Composite window “Extinction spectra” including service commands

Also α(λ) profiles for various wind modes (combinations X and U) calculated by MaexPro 5.0 code are given. Results of α(λ) profiles calculations are presented at change RH = 40 - 98 % and heights H = 0 - 25 m. The calculated spectrums of α(λ) profiles are compared with experimental data of α(λ) received by a transmission method in various geographical areas.