SPECTRAL TRANSPARENCY OF THE SEA AND COASTAL ATMOSPHERE SURFACE LAYER

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ABSTRACT

The coastal areas are characterized by specific processes, which are necessary to better understand for the atmospheric aerosol climate interaction. An empirical model was developed for the prediction of aerosols and their effect on extinction in the coastal atmosphere [1-3]. This works has been coupled with Mie theory to give a code for the aerosol extinction versus on change of meteorological parameters. These influences are important to laser propagation in the boundary layer, backscatter of light to space (including remote sensing & climate forcing), cloud properties etc.

1. INTRODUCTION

Aerosols in the surface layer are important to large number of processes. In particular, they transfer water vapor, heat and matter through the air-sea interface, interact with the temperature and humidity fields by evaporation and condensation, scatter radiation, and may act as condensation nuclei in the formations of cloud and fog. The aerosols are also very important to the propagation electro-optical radiation through the atmosphere. The performance of electro-optical systems can be substantially affected by molecular composition and aerosol particles that scatter and absorb electromagnetic radiation. While the molecular extinction is relatively constant and can be calculated using propagation codes such as MODTRAN, influence of the aerosols are much less well characterized. It depends from many factors. The coastal zone is characterized by specific processes, which are necessary to better understand for the atmospheric models used in the EO propagation. In particular, surf zone is a very strong source for sea spray aerosol. Indeed, concentrations and optical properties (chemical composition) of aerosol particles into the atmosphere are very variable both in time and in space. Estimations show that at low to moderate wind speed the aerosol concentration over the surf are 1-2 orders of magnitude higher than over the open ocean. For particulate extinction, the above mentioned MODTRAN uses the Navy Aerosol Model (NAM) and the Naval Oceanic Vertical Aerosol Model (NOVAM) proposed by S. Gathman [4,5], respectively. NAM is the kernel for NOVAM. Indeed, even though NAM provides reasonable predictions for the extinction over the open ocean, they are often less reliable in coastal regions [1] when, in an offshore wind, continental aerosols mix with the sea spray. Since NAM was developed from mainly open ocean data, the model cannot be expected to cover such situations. Piazzola et al. [2,3] proposed an extension of the Navy Aerosol Model based successively on the analysis of an extensive series of measurements on the island of Inisheer off the Irish Atlantic coast, in the Mediterranean and Black Sea coastal zones. The results were used to develop the extinction model MEDEX (Mediterranean Extinction). One of the objectives is now to show to what extent the coastal model MEDEX can be used to predict the aerosol extinction in different coastal sites. Indeed, even though NAM provides reasonable predictions for the extinction over the open ocean, they are often less reliable in coastal regions when, in an offshore wind, continental aerosols mix with the sea spray. Since NAM was developed from mainly open ocean data, the model cannot be expected to cover such situations then proposed an extension of the NAM based successively on the analysis of an extensive series of measurements on the island of Inisheer off the Irish Atlantic coast and in the Mediterranean coastal zone. The results were used to develop the extinction model MEDEX (Mediterranean Extinction). One of the objectives is now to show to what extent the coastal model MEDEX can be used to predict the aerosol extinction at any geographical location in the Northern hemisphere. The present results propose a comparison between extinction coefficient measured in Black Sea and the predictions of MEDEX [3,6].

2. RESULT AND DISCUSSION

Results of modeling confirm that the great influence of the relative humidity (RH) on the aerosol extinction $\sigma(\lambda)$. We can note that aerosol extinction increases within a factor of two when the relative humidity increases from 66% to 90% (Fig.1). This is in accordance with the enhancement of the concentration of particles of sizes larger than 0.1 μm as the humidity growths. $\sigma(\lambda)$ is logically observed to decrease in accordance with the decrease of the humidity, with a simultaneous alignment of the spectral behavior. In the

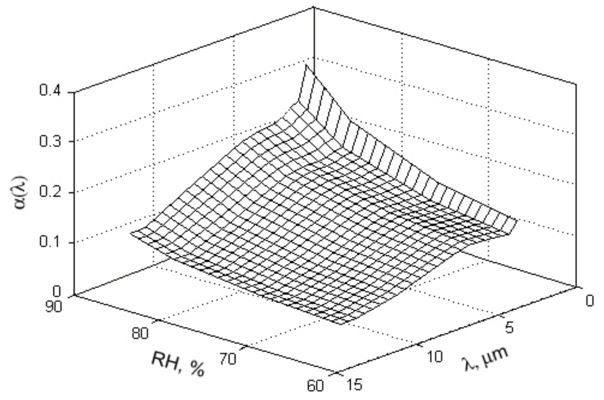

Fig. 1. Variation of extinction coefficient α (λ) versus wavelength (λ) and versus RH for fetch = 1 km and for height H = 20 meters at wind speed w = 3.3 m/s

range to 2 μm a significant spread of curves is observed

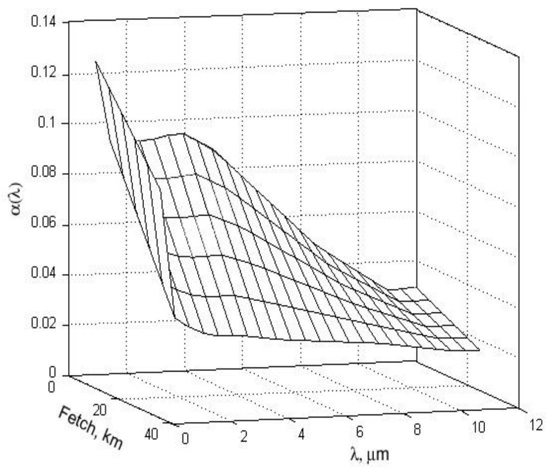

Fig. 2. Variation of extinction coefficient α (λ) versus wavelength (λ) and versus fetch for height H = 20 meters and for RH = 75% at wind speed w = 3.3 m/s

while in the range 2–12 μm curves come together. With increasing the wind velocity the total particles concentration raises, with increase in a share of the large particles concentration. The increase of α(λ) is observed. In IR band α(λ) depends monotonically versus the wind velocity. Therefore, we can draw the conclusion that the coarse particles, sea spray produced, are almost not varied in the range RH = 75 - 90%. This is agreeing with lidar measurements [7]. The variation of wind velocity also strongly affects the value of α(λ) (Fig. 2). With increasing the wind velocity α(λ) decreases in the IR band twice and in the visible range by ≈ 5%. In this case, the differences increase with decreasing RH. The results connected with the Fetch effect at the variation of the wind velocity are still unexpected. When the wind velocity is equals 15 m/s, α(λ) increases with the rise of fetch. For RH = 90% α(λ) increases more than twice and for RH=66% - more than four times. Curves become more sloping, especially it is observed in the visible spectral band due to the increase of the coarse particles concentration and at the wind velocity, equals 3.3 m/s, α(λ) decreases. In addition, if to set w=6-7 m/s α(λ) ceases to depend from value fetch in the range 1-30 km. We can propose the following hypothesis, which explain this regularity. It is probable that the two processes are in competition; namely, at weak wind with rising fetch the relative concentration of submicron particles increases at simultaneous decrease of the coarse particles. The spectral behavior of the extinction coefficient is given by steeply sloping curve, typical for the continental aerosol, and then it decreases slightly with increasing fetch. This underlines the known fact that the concentration of submicron particles of the continental zone is much higher than in the coastal and sea zones. Therefore, the spectral behavior of α(λ) is of more pronounced character. Under coastal conditions, this dependence is more elastic curve. Besides, it should noted that the extinction coefficient in the visible and IR band varies simultaneous with the coarse particles whose optical manifestation through the scattering is expanding to the visible and IR band almost equally. The experimental data also indicate that with decrease α (0.55) the spectral behavior becomes more sloping. This indicates of increase of the relative contribution of the coarse particles to the extinction. The results show the importance of the marine contribution for aerosol extinction in coastal areas. In turn, this induces a strong influence of the sea surface characteristics on the aerosol extinction.

3. REFEERNCES

1. Piazzola, J. A.M.J. Van Eijk and G. De Leeuw. *Opt. Eng.,* Vol. 39, No. 6, 1620-1631, 2000.
2. Piazzola, J. Bouchara, F. Van Eijk A.M.J., De Leeuw, G. *Opt. Eng.,* Vol. 42, No. 4, 912-924, 2003.
3. J. Piazzola and G. Kaloshin, Aerosol extinction in the Black Sea coast, *J. of Aerosol Sci.,* Vol. 36, No. 3, 341-359, 2005.
4. S. Gathman, Optical properties of the marine aerosol as predicted by the Navy aerosol model, *Opt. Eng.,* Vol. 22, No. 1, 57–62, 1983.
5. S. Gathman, A preliminary description of NOVAM, the Navy Oceanic Vertical Aerosol Model, NRL Report No. 9200, 1989.
6. G. Kaloshin. Influence of Meteorological Parameters on Aerosol Extinction in the Marine Environment, Proc. ICONO/LAT 2005, St. Petersburg, 33.
7. Lienert, B.R., J.N. Porter and S.K. Sharma, Real time analysis and display of scanning lidar scattering data, *Marine Geodesy,* 22, 259-265, 1999.