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Poster Session II. Marine aerosols

EFFECT OF AEROSOLS ON COASTAL TRANSMISSION

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INTRODUCTION

Sea spray aerosol in the marine coastal atmosphere are important for various reasons. They offer a surface for condensation of chemically reactive species such as HNO_3, may play a role in corrosion of structures at sea or ashore, sustain fragile eco-systems, transport pollutants and micro-biological species from the sea surface into the atmosphere where they may cause health effects, etc. They also scatter electro-optical radiation and thus affect the transmission at wavelengths from the UV to the IR. An example of the effect on IR transmission in the coastal region is discussed in this contribution.

AEROSOL EFFECTS ON ATMOSPHERIC TRANSMISSION

The atmospheric transmission of electro-optical radiation is attenuated by the presence of gasses and aerosols. Gaseous species can well be accounted for by radiative transmission codes such as MODTRAN. Aerosols, however, are a large uncertainty, mainly because their concentrations are difficult to predict. Over the open ocean the aerosol concentrations may be obtained from parameterisations in terms of meteorological parameters, in the coastal area the presence of a variety of sources renders such parameterisations much less reliable. A major source is the surf zone, where sea spray aerosol concentrations may be enhanced by two orders of magnitude with respect to the open ocean [De Leeuw et al., 2000]. The effect of surf aerosols was clearly observed in transmission measurements over San Diego Bay (CA, USA), during the EOPACE (Electro-Optical Propagation Assessment in the Coastal Environment), in November 1996. Transmission experiments were undertaken over paths of 7 and 15 km, aerosol measurements were made with optical particle counters on the Imperial Beach Pier (IBP) outside the surf zone. A meteorological buoy was moored in the middle of each propagation path. The meteorological pattern was governed by the sea breeze effect, causing on-shore winds during day time and off-shore winds after sun set.

In Figure 1, transmission values at a wavelength of 4 μm are shown for the 15 km path. Molecular transmission was calculated with MODTRAN, using measured meteorological parameters. Molecular transmission in this wavelength band is relatively constant with values between 50 and 60%. Excursions to 70% occurred on 7-13 November when the humidity was very low due to the dry wind from the desert. Aerosol transmission was calculated from the particle size distributions measured on IBP using a Mie code. In on-shore wind, the aerosol transmission was usually 70% or more, but in off-shore wind surf-produced aerosol was transported over the ocean, leading to very low transmission values. Comparison between the measured and the calculated transmission values show that in off-shore winds the aerosols govern the transmission in this area. This applies both in the mid-wave band (around 4 μm) and the long wave band (around 10 μm).

The data in Figure 1 show that the aerosol transmission traces the measured transmission fairly well, with the aerosol transmission a bit high because molecular effects were not accounted for. However, even after multiplication of the aerosol transmission with the molecular contribution, deviations from the measured values are observed. The ratio of the measured transmission and the calculated total transmission in Figure

2a shows that discrepancies of a factor 10 may occur at times. Also shown in Figure 2a is the air-sea temperature difference (ASTD), a crude indication for atmospheric stability. The transmission ratio and the ASTD seem to be anti-correlated, which is confirmed by the scatter plot in Figure 2b. This is a strong indication for the effect of refraction: for a positive ASTD, when the air is warmer than the water, light rays curve toward the surface. *Vice versa,* when the air is colder than the water, the light beam curves away from the Earth' surface. For a non-linear temperature gradient, this may lead to atmospheric focussing or de-focussing, i.e. enhancement or reduction of the transmitted light intensity.

CONCLUSION

Aerosols are a governing but often quite uncertain factor for transmission in the coastal environment. Current models do not account for the large variability of the aerosol concentrations in the coastal zone. Residual transmission effects are strongly correlated with thermal stratification in the atmospheric surface layer, indicating the importance of refraction.

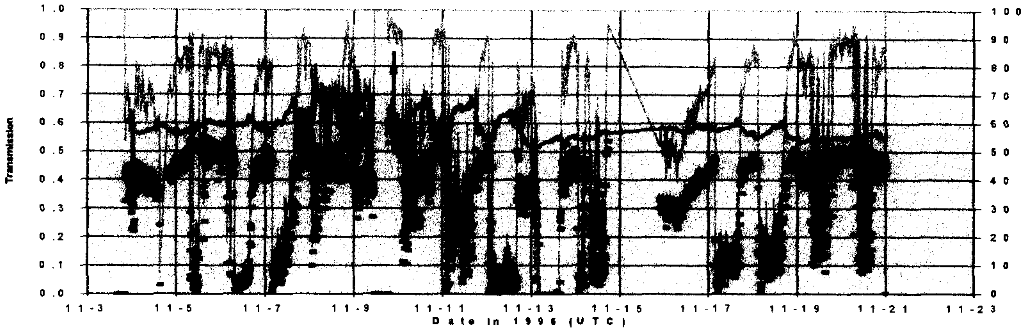
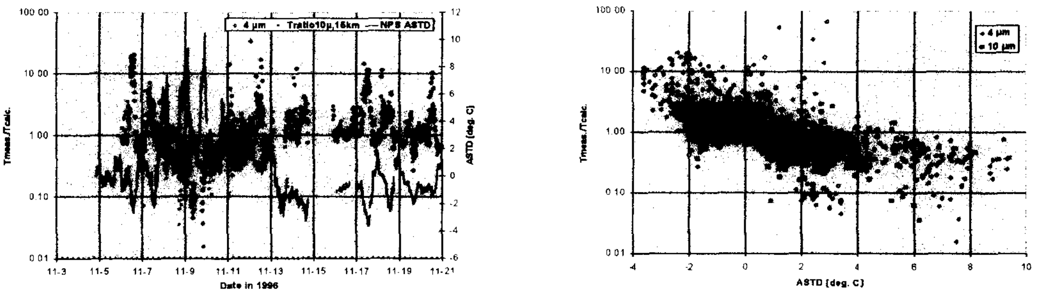


Figure 1. Transmission for a wavelength of 4 μm measured along a 15 km path across San Diego Bay during the EOPACE experiments in November 1996 (dots). The dark line is the MODTRAN calculated transmission and the grey line is the transmission derived from the aerosol particle size distributions.



(a) (b)

Figure 2. a) Ratio of measured and calculated transmission for wavelengths of 4 (◊) and 10.6 μm (■). The line presents the air-sea temperature difference (ASTD, in °C) measured in the middle of the over-water propagation path. b) Ratio of measured and calculated transmission plotted versus the ASTD.

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