26PB6

Lidar Prediction of EO Systems Performance

Luc R. Bissonnette and Geoffrey A. Findlay #
Defence Research Establishment Valcartier
P.O. Box 8800,Courcelette, Québec, Canada , G0A 1R0
Tel.: 418-844-4437; FAX: 418-844-4511; E-mail: lbisson@sv0.drev.dnd.ca
Defence Science and Technology Organization Salisbury
P.O. 1500, Salisbury, SA 5108, Australia

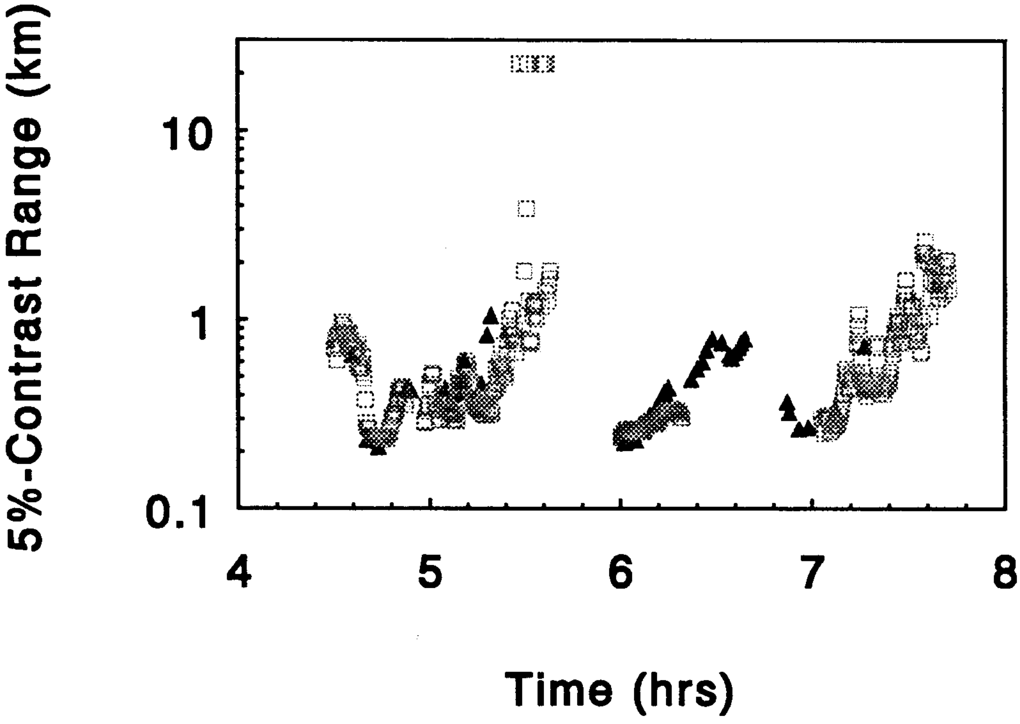
Electro-Optic (EO) systems are very much affected by low visibility conditions created by aerosol scattering. The difficulty with aerosols is their great variability which is beyond the predictive power of existing atmospheric models. Therefore, to assess the performance of EO systems in the field, we need to monitor the optical properties of aerosols. The lidar appears as the ideal sensor to do this but, in the past, it has been used with mixed success. One problem is the relation between the backscatter and extinction coefficients but the main source of difficulty is the requirement for a consistent boundary value.

An experiment was performed to specifically address the problem of correlating lidar measurements with EO system performance. The EO system was a thermal imager and the measurement method consisted in imaging pairs of warm and cold sources, and calculating the aerosol transmittance by image subtraction to eliminate the path and background radiances; the molecular absorption was calculated with LOWTRAN. The lidar was a four-wavelength system (0.53, 1.06, 3.8 and 10.6 μm) supplied and operated by SRI Int'l. The experiment was performed in conditions of haze and fog.

Of special interest here is the lidar inversion method. The backscatter-to-extinction relation was assumed linear, which is justified for the fog and haze lidar data at 0.53 μm used in this study. In lieu of a boundary value, we have assumed that the extinction is the same but unspecified at both ends of the lidar signal. In haze, this is a reasonable approximation. In fog, the assumption is less valid because of inhomogeneities but, since the optical depth is high, it has little consequence on the solutions except near the very end of the lidar signal.

Sample results of correlation between the lidar-derived and the measured performance of the imager are shown in Fig. 1. Wavelength extrapolation of the lidar results was performed. The agreement is quite good. Based on these and other results to be presented, it is concluded that lidar monitoring of adverse weather is a feasible option for predicting the atmospheric performance of EO systems. The main advantages of the proposed method of replacing the boundary value by assuming a relation between the extinction coefficient at both ends of the lidar signal are that it does not require calibrated returns, that it is uniformly applicable to a wide spectrum of conditions by allowing the solution to automatically adjust to large or small extinctions, and that it is unconditionally stable. There is still a fair amount of guesswork in the method, and that is inevitable, but the assumption seems easier to justify in many situations and the method has produced consistent results.

The experiment was a joint effort among several laboratories and we are indebted to many collaborators: Dean Cutten, George Koenig, Michael Richards, Pierre Roney, Gary Trusty, Vernon Turner, and Edward Uthe.



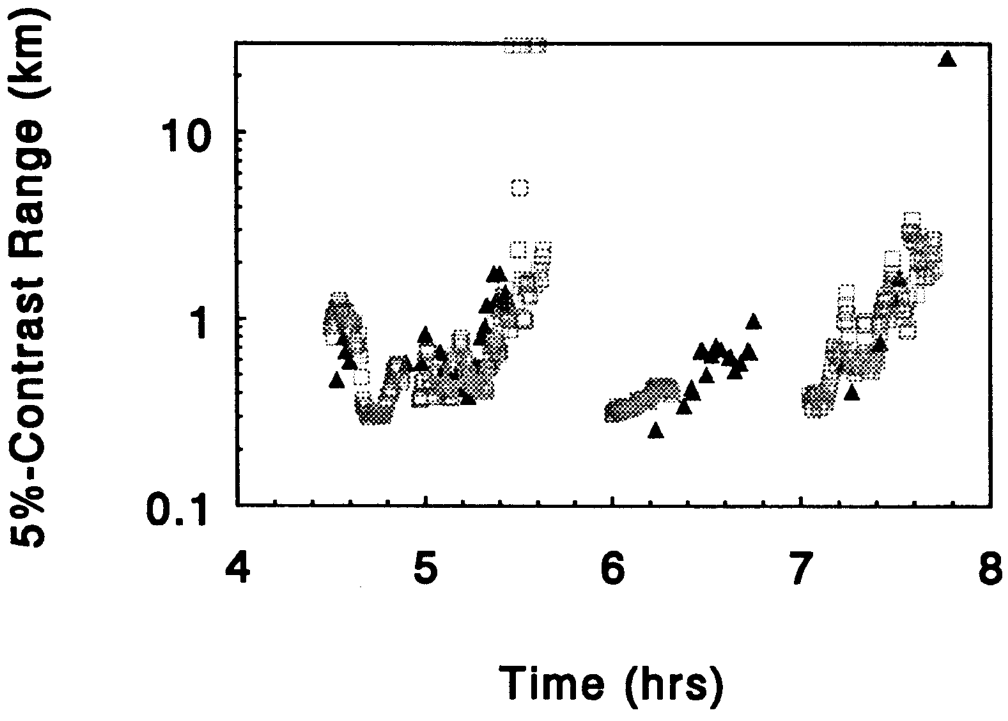


Figure 1: Comparison of observed (solid triangles) and lidar-predicted (open squares) imager performance expressed in terms of the range to a 5% image contrast in fog. a) 3-5 μm spectral band; and b) 8-13 μm spectral band.