Simulation of the MDS lidar from ER-2 CLS data

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Data from the NASA Cloud and aerosol Lidar System (CLS) on the NASA ER-2 high altitude aircraft gives a comprehensive view of the backscatter structure variation of the atmosphere as would be seen from a space borne lidar. A model has been developed whereby CLS data is applied to the simulation of the performance of spaceborne lidar. The model includes a simulation of the system noise that is based on detailed physics of the performance of solid state detectors, analog APD at 1047 nm and photon counting GAPD at 532 nm. The model is described. The model has been applied to the parameters of the MDS mission. Results on the backscatter cross section and signal dynamic range will be presented in addition to signal-to-noise performance in relation to cloud and aerosol retrieval algorithms.

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Procedure:

- **ER-2 CLS lidar data is used to input backscatter cross section structure for simulation**
- **Background radiance for simulation is calculated from ER-2 radiometer data**
- **Signal levels are calculated from the lidar equation for the appropriate instrument parameters**
- **A signal levels are applied to a completed model of the detector physics to generate the signal noise level**
- **A random noise generator is applied to the signal based on the calculated noise**

Summary:

The MDS lidar will have good performance for most cloud retrievals in the day and night and for aerosol and thin clouds at night.

Fig. 1 Summary outline of the procedure that was followed to simulate the performance of the NASDA MDS Lidar mission

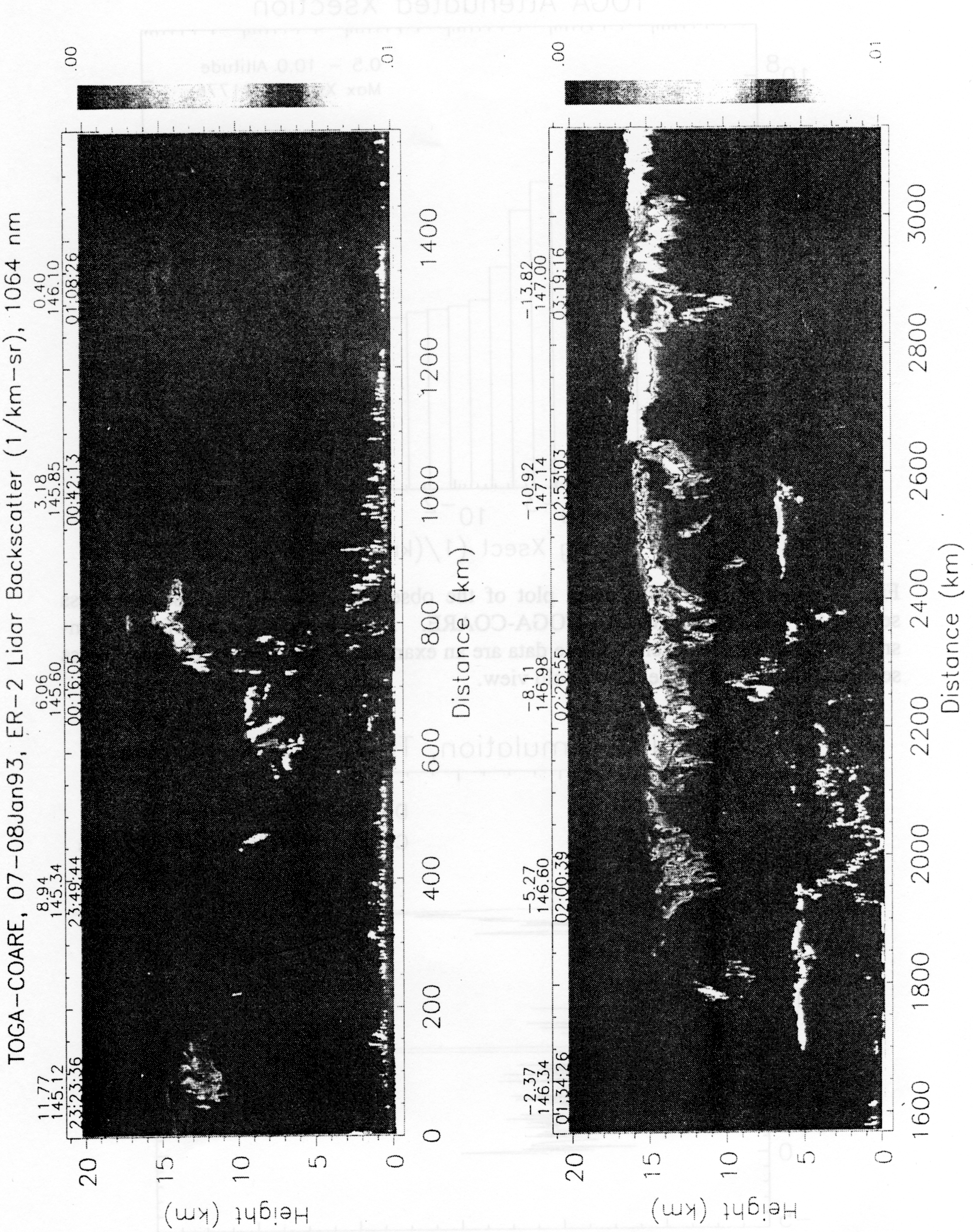

Fig. 2 The simulation procedure is based on calibrated cloud and aerosol lidar scattering cross section data from the NASA ER-2 high altitude aircraft. The ER-2 lidar data for a flight line from the TOGA-COARE experiment over the west Pacific is shown. The flight line was flown from Guam to Australia.

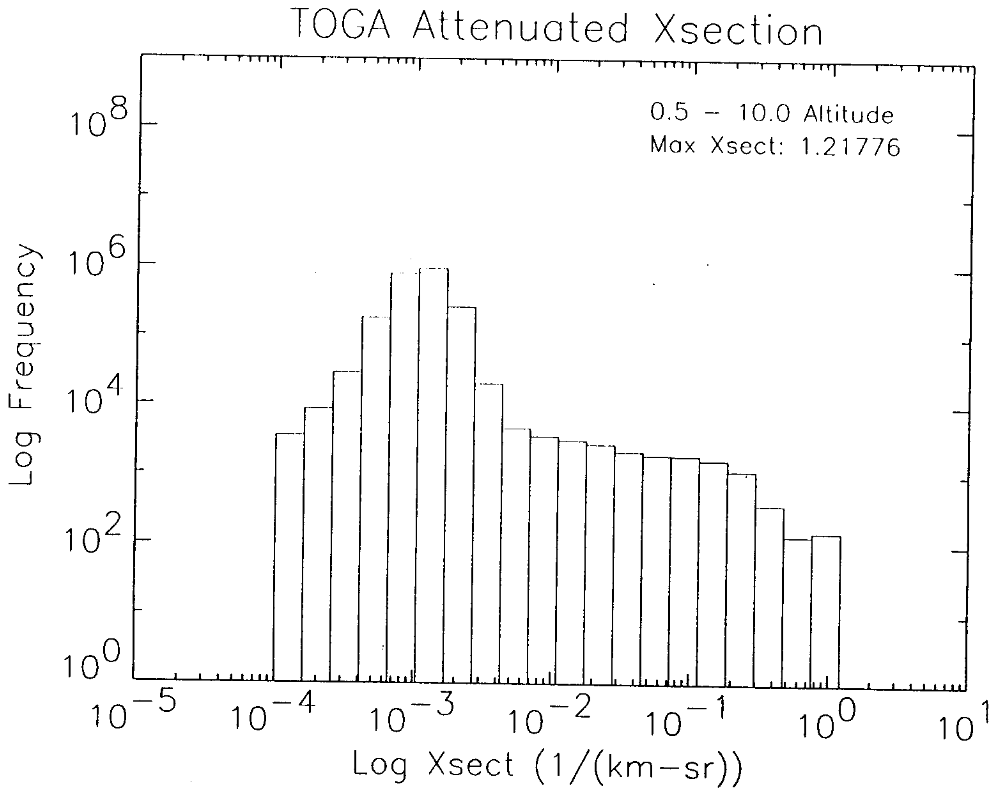

Fig. 3. A frequency distribution plot of the observed attenuated backscatter cross section for ER-2 lidar data from TOGA-COARE. A lower cut-off limit of 10-4 (km-sr)-1 was arbitrarily chosen. These data are an example of the range of observed cross sections that a space borne lidar would view.

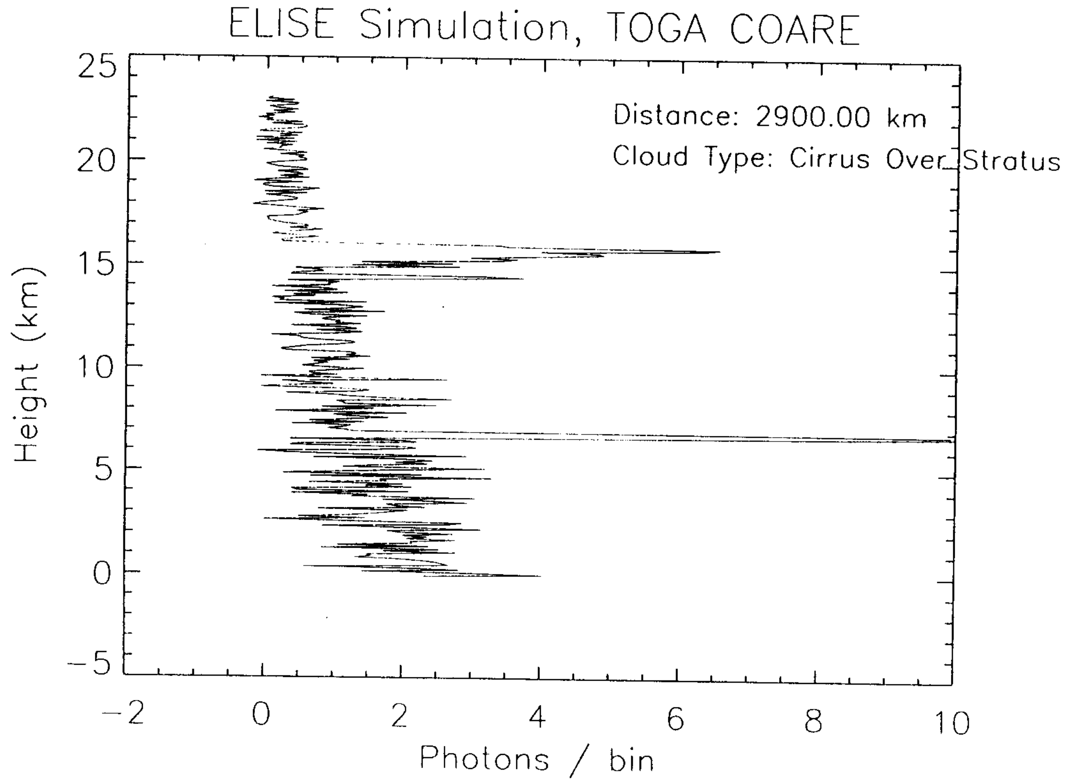

Fig. 4 A simulation of a single signal return for the parameters of the MDS lidar. The simulation is for the 523 nm photon counting channel with a night time background. The data the profile is based on includes two cloud layers and a surface return. The detector model saturates at 10 counts/msec.

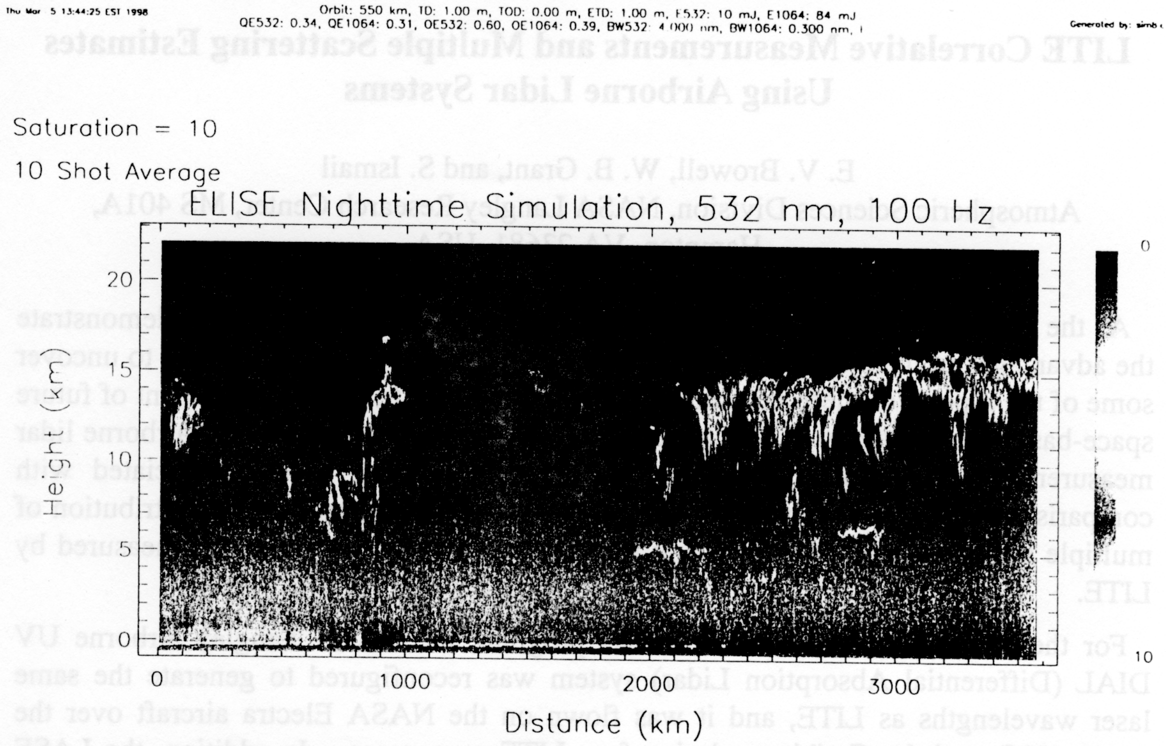

Fig. 5 Simulation of the return signal from the MDS lidar for the entire TOGA-COARE flight line. '10 shot average' refers to how the ER-2 data is applied and would be 200 m in basic resolution. The signal-to-noise displayed in the signal image accounts for the number of MDS pulses that would be averaged into each pixel line on the image. Each pixel line is over about 5 km. This simulation is for the 523 nm photon counting channel.

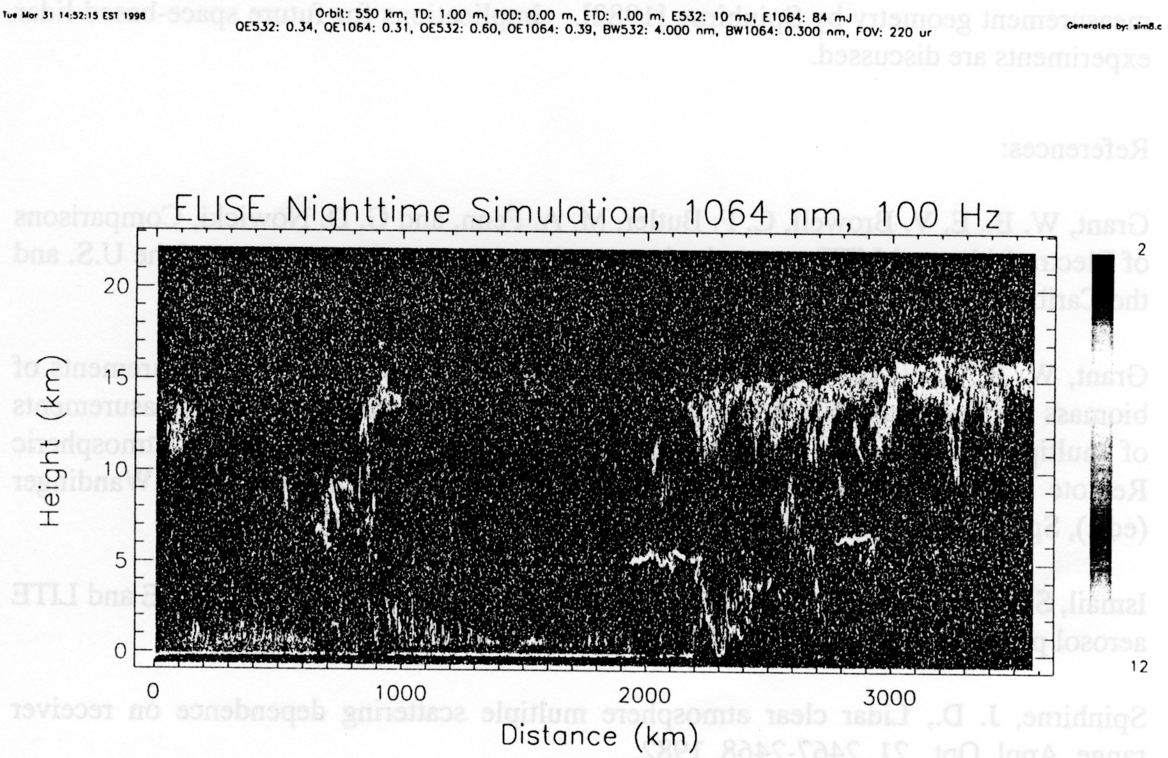

Fig. 6 As in Fig. 5 but for the 1047 nm analog detector channel.