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An upgraded SGSLR link analysis which includes the effects of atmospheric scintillation and target speckle

The present paper provides a comprehensive set of link analyses for NASA's new Space Geodesy Satellite Laser Ranging (SGSLR) System. Three representative satellites at different orbital altitudes are considered: Starlette, LAGEOS, and GNSS. In addition to the usual hardware contributions - laser pulse energy and divergence, optical throughput efficiencies, detector counting efficiency , telescope aperture, telescope pointing error and jitter, satellite range, and array optical cross-section - there are many aspects of the atmosphere that must be taken into account in order to obtain a realistic estimate of system performance. This includes transmission of the atmosphere over a wide range of visibility conditions (extremely clear to light fog or worse), transmission losses due to often invisible high altitude cirrus clouds, atmospheric turbulence effects resulting in long term beam wander and scintillation (fading), array induced target speckle, and the effects of "aperture averaging" at the receiver. Atmospheric attenuation and scintillation effects are most pronounced at low elevation angles. As a result, tracking a satellite over a wide range of elevation angles may necessitate adjusting the transmitter beam divergence during the pass in order to ensure adequate signal strengths for rapid normal point generation while simultaneously avoiding range bias effects due to too strong a signal. Based on SGSLR instrument and satellite contributions to the range error, we estimate that roughly 2000 satellite returns are adequate to generate a 1 mm RMS accuracy normal point.