

Title: Toward Sharper Multi-Messenger Triggers: Modelling Atmospheric Gamma-Ray Albedo effect in GRB Localization and Polarimetry

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Gamma-ray bursts (GRBs) are premier multi-messenger and multi-wavelength transients. Rapid, accurate position and polarization measurements of GRBs from wide-field gamma-ray monitors are what trigger the optical, radio, and gravitational-wave follow-up required for time-domain astronomy. Most such monitors operate in low Earth orbit (LEO), where a significant fraction of the burst flux, atmospheric "albedo", reaches the detector only after Compton-scattering off the Earth's atmosphere. This reflected component is direction-dependent and polarization-sensitive, and it can systematically bias both the reconstructed source position (for instruments that localize by comparing count rates or detector-plane shadows against simulated response templates) and any inferred polarization, because standard response models often omit it or treat it only approximately.

We are developing a mission-agnostic framework to model atmospheric gamma-ray albedo as a function of source geometry, orbital altitude, and burst spectrum, producing the scattered radiation field incident on a satellite that can be folded through any instrument's existing response. We will (i) quantify the albedo contribution to the spectral and localization systematic-error budget of representative LEO monitors, and (ii) assess how polarized albedo both contaminates and could serve as an external Compton analyzer for GRB polarimetry. We will present the physical motivation, the modelling approach, and preliminary estimates, as a first step toward reducing an under-modelled systematic in time-domain high-energy astronomy.