

# nuSpaceSim: A Comprehensive Simulation for the Modeling of Optical and Radio Signals from Extensive Air Showers Induced by Cosmic Neutrinos for Space-based Experiments

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nuSpaceSim is a comprehensive end-to-end simulation package to model the optical and radio signals from extensive air showers (EAS) induced by cosmic neutrino interactions. The development has initially focused on modeling the upward-moving EASs sourced from tau neutrino interactions within the Earth that employs a new modeling package, nuPyProp. nuSpaceSim is designed to model all aspects of the processes that lead to the neutrino-induced EAS signals, including the modeling of the neutrino interactions inside the Earth, propagating the leptons into the atmosphere, modeling the tau-lepton decays, forming composite EAS, generating the air optical Cherenkov and radio signals, modeling their propagation through the atmosphere, including using a MERRA-2 database driven application to generate cloud maps, and modeling detector responses. nuSpaceSim uses a vectorized Python implementation of a sampled library approach to efficiently simulate neutrino-induced and background signals at a specific orbit or balloon altitude. A detector response module, based on user-inputted response parameters, subsequently is used to record the events and determine acceptance. The framework will allow for the calculation of the sky coverage and the pointing requirements needed for target-of-opportunity (ToO) follow-up observations of transients, as well as the assessment of the effects of dark-sky airglow and UHECR backgrounds. nuSpaceSim will provide an efficient and practical cosmic neutrino EAS signal generation modeling package to aid in the development of future sub-orbital and space-based experiments. In this paper, the nuSpaceSim framework, physics modeling, and the cosmic neutrino measurement capabilities of example experimental configurations will be presented.

## Keywords

nuSpaceSim, nuPyProp, neutrino, space-based, Cherenkov, simulation, modeling, tau lepton, upward moving, extensive air shower, Earth skimming

## Collaboration

other (fill field below)

## other Collaboration

nuSpaceSim

## Subcategory

Theoretical Methods

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