Contribution ID: **117** Type: **Oral contribution**

Improved Calculation of Atmospheric Neutrino Fluxes using the Bartol Model

Thursday, September 3, 2026 3:50 PM (25 minutes)

Next generation neutrino oscillation experiments, such as JUNO, DUNE, and Hyper-Kamiokande, are positioned to collect unprecedented statistics in neutrino data, enabling high-precision measurements of oscillation parameters. A major fraction of the data will consist of atmospheric neutrinos, which allows for independently extracting oscillation parameters and placing constraints on neutrino mass ordering by probing the MSW parametric resonance. To make best use of the data, it is essential to understand and improve the current modelling of atmospheric neutrino fluxes and their uncertainties.

The Bartol model is a Monte Carlo simulation-based atmospheric neutrino flux model created in the 1980s for calculating the unoscillated flux at terrestrial detectors. The original model has become significantly outdated as it uses physics models which do not reflect recent experimental measurements on e.g. hadron production cross section or primary cosmic ray fluxes with drastically improved uncertainties. The geomagnetic field model likewise needs to be updated to include around 20 years of geomagnetic field observations. In the context of DSNB searches, there is growing interest in <100 MeV atmospheric neutrino fluxes, which is outside of the energy range described by the original Bartol model.

To accommodate for updates to the Bartol model, the codebase has been fully redesigned from the ground up to facilitate model development. I will demonstrate that predictions from the new simulation are consistent with previous results from the Bartol model and cover recent progress towards addressing the shortcomings of the original Bartol model.

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Session Classification: WG1 —Atmospheric Neutrinos & Phenomenology

Track Classification: WG1: Neutrino Oscillation Physics