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Title
ACORDE: A new method to assess onboard radiation risks related to human factors

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Abstract
Atmospheric radiation is mainly produced during the interaction of high-energy cosmic rays with the atmosphere. After the first interaction of these primary cosmic rays, a series of radiative and decay processes generate a collective process known as Extensive Air Shower (EAS), with up to billions of secondary particles per primary at the altitude of the maximum development. As this process occurs for each impinging primary, the integrated flux of secondary particles at typical flight altitudes could easily reach up to 10^6 photons and other ionizing radiation per square meter per second [1]. This flux of secondary particles constitutes a risk factor for radiation exposure for crew members, passengers, and avionics during commercial flights [2]. Moreover, as the dominant, low-energy primary flux (below a few tens of GeV) is modulated by the heliospheric and geomagnetic conditions, the total radiation dose could be dramatically increased during transient heliospheric or geomagnetic disturbances [3].

Since the 00's decade, some computational methods have been implemented to estimate the integrated dose along with commercial flights. The main advantage of these methods is their short computing time, as they determine the dose from precalculated representative libraries based on Montecarlo simulations, and then interpolate and extrapolate atmospheric conditions along a predefined and theoretical route [4].

In this work, we present ACORDE (Application COde for the Radiation Dose Estimation), a new automatised framework to estimate the actual dose during commercial flights by integrating several Montecarlo-based codes, exploiting current HPC capabilities and cloud-based computing facilities [5,6]. In our method, the expected flux of the secondary radiation is calculated at each geographical sampling point of the actual route of commercial flights, using public flight tracker databases. For this, we also consider real-time local atmospheric conditions at each point (extracted from the GDAS database) and correct the total measured flux of primary cosmic rays by the modulation originated by real-time geomagnetic conditions [7]. Then, the obtained modulated flux of secondaries at each site of the route is propagated through digital models of different commercial aeroplanes and a human phantom to calculate the total integrated dose. As will be discussed in the presented examples, the flexibility of ACORDE allows us to easily forecast the impact of course or altitude changes in the total expected dose for a particular flight, providing valuable information that could help during operational decision-making.

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