

# New reconstruction of energetic electron precipitation and atmospheric ionization for 1844-2023 using deep learning networks

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Reconstructions of energetic electron precipitation (EEP) and the atmospheric ionization it produces are important for state-of-the-art chemistry-climate models, which aim to model the climate impacts of EEP. The current version of the Coupled Model Inter-comparison Project, CMIP6, includes a reconstruction of EEP-induced ionization based on a parameterization dependent on geomagnetic Ap index. This reconstruction has been used in several climate studies over the past years. However, recent investigations have shown that the CMIP6 reconstruction underestimates the level of precipitation. Therefore, the atmospheric/climate impacts of EEP might be underestimated as well.

To address this issue we introduce here a new reconstruction of EEP and the ionization it produces. This reconstruction is based on a new composite of energetic electron measurements from POES satellites which have been corrected for various instrumental and sampling effects. A theoretically motivated form of a pitch angle distribution consistent with pitch angle diffusion is fitted to these data to obtain a more realistic estimate of electron precipitation into the atmosphere.

For the reconstruction we developed a deep learning network, which ingests homogenized geomagnetic aa index, sunspot number as well as seasonal variations and solar cycle phase. The network gives as output the daily latitude distributions of precipitating electron fluxes in three energy channels. This is then used to calculate the precipitating electron energy spectrum and associated atmospheric ionization from year 1844 to present.

Here we present the main aspects of this new reconstruction and also compare it with the earlier CMIP6 reconstruction.

## Solicited or Contributed

Contributed

## Author list and affiliations

Timo Asikainen and Henna-Riikka Putaala, University of Oulu, Finland

## Presenting author

Timo Asikainen

**Primary author:** ASIKAINEN, Timo (University of Oulu)

**Co-author:** PUTAALA, Henna-Riikka (university of Oulu)

**Presenter:** ASIKAINEN, Timo (University of Oulu)

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