Contribution ID: **30** Type: **Oral**

# Reconstruction of Past Solar Irradiance Variations from Sunspot Observations: A new approach

*Wednesday 18 September 2024 11:30 (20 minutes)*

Solar irradiance is one of the forcing agents of the Earth's climate system. Space-based monitoring of solar irradiance since the late 1970s has revealed variations across all observed time scales, providing crucial insights into the physical mechanisms behind solar irradiance changes. However, the relatively short duration of these records limits our ability to fully assess the Sun's impact on Earth's climate, necessitating reconstructions of past irradiance variations.
Solar variability on time scales relevant to climate is driven by the solar surface magnetism, and thus reconstructing past irradiance changes requires knowledge of the historical evolution of the Sun's magnetic field. The longest direct proxy for solar magnetic activity is the sunspot number record, which extends back 400 years.
However, existing reconstructions of solar irradiance from sunspot numbers have a serious limitation in that sunspot observations alone do not account for the evolution of bright features such as faculae and the network.
Unluckily, exactly these features are the main driver of irradiance changes on longer time scales. This leads to high uncertainty in estimates of the secular variability. Particularly problematic are extended periods without sunspots, such as the Maunder Minimum or other grand minima of solar activity.
This limitation has been addressed more realistically by a recent model of the evolution of the solar surface magnetic flux, which linked the emergence rate of faculae to that of sunspots using relationships based on modern observations of the Sun. This approach, in turn, allows a more realistic reconstruction of solar irradiance from sunspot observations, direct or reconstructed using cosmogenic isotope data.

## Solicited or Contributed

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**Session Classification:** Solar Irradiance and Particle Variability

**Track Classification:** Solar Irradiance and Particle Variability