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60 years of solar radio proxies for assessing the long-term evolution of solar forcing

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A critical problem in determining the climate impact of solar radiative forcing on decadal time scales is the paucity of properly calibrated observations. Total irradiance observations started in the 1980s only, and their long-term trend is still subject to debate. Reconstructions further back into the past mostly rely on the sunspot number, which suffers from being only loosely connected to the radiative output of the Sun. However, radio observations in the centimetric range have been made since the early 1950s at several wavelengths, and with highly stable receivers, thus providing a unique record of past solar activity. So far only the 10.7 cm has been routinely used, whereas the other wavelengths have been almost totally ignored.

We have collected these daily radio observations at five wavelengths (3.2 to 30 cm) into a single composite dataset. By using blind source separation, we are able to decompose the variability on time scales of months, and below, into three components; these can be readily ascribed to thermal bremsstrahlung, and to gyroresonant emissions. We find that the 30 cm radio flux is a better proxy for the specification of the upper atmosphere than the better known 10.7 cm flux, presumably because it has a stronger bremsstrahlung contribution. This is confirmed by comparing the modelled and the observed neutral density of the thermosphere, using the DTM2012 drag temperature model. When considering long-term variations, we find tiny but significant differences between the various wavelengths, which allow us to constrain the variability of the solar UV forcing since the early 1950s. Particular attention will be given here to the possible existence of long-term trends and their relevance to climate studies.