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Investigating the potential to document past solar storms using ^{36}Cl in the Greenland ice cores NGRIP and Dye-3 for the past 600 years

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Solar cosmic rays, which are mainly accelerated in shocks driven by coronal mass ejections, can represent a challenge to our technological society. Instrumental data on these events only date back to the advent of neutron monitors in the 1940s and of satellite measurements. However, the atmospheric production rates of the cosmogenic radionuclides ^{10}Be, ^{14}C, and ^{36}Cl have been shown to be enhanced by particularly extreme and rare solar events. Of these three nuclides, the production rate of ^{36}Cl has been proposed to have the greatest sensitivity to protons accelerated during solar events. Yet, no continuous and high resolution measurements of ice-core ^{36}Cl are available. Here we present two such ^{36}Cl records from the NGRIP and Dye-3 ice cores, both of which are from Greenland, that we investigate for hints of solar storms for the past six hundred years. We observe several potential increases that could be linked to solar storms including one that occurs simultaneously in both ice cores and around the period of an extreme geomagnetic storm that took place in September 1909. We also consider the different thresholds in energy spectra and fluence for solar cosmic rays to be detectable in ice-core ^{36}Cl and ^{10}Be data. Finally, we show that there was no significant enhancement in ^{36}Cl concentration data around the Carrington event of 1859 CE. Accordingly, we infer an upper limit to the flux of solar energetic protons related to the event, assuming they did hit Earth.