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Influence of energetic electron precipitation on wintertime electricity consumption in Finland and wind power generation in Europe

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Recent studies have shown that geomagnetic activity, used as a proxy for energetic electron precipitation (EEP), influences weather conditions, e.g. temperature and wind speed, during winter in certain regions of the Northern hemisphere. EEP forms ozone-depleting hydrogen and nitrogen oxides (HOx & NOx), which alter the radiative balance in wintertime atmosphere and enhance the northern polar vortex, the westerly wind system circulating the northern polar area during winter. In Northern (Southern) Europe a stronger polar vortex leads to mild, wet and windier (dry and less windy) winter weather, while a weaker vortex leads to cold and less windy (wet and windier) winters in Northern (Southern) Europe. The influence of EEP on the polar vortex has been found to be stronger when so called quasi-biennial oscillation (QBO), the equatorial stratospheric zonal wind varying between easterly and westerly phases every ca. 14 month, is in easterly phase.

It is known that in countries with cold winter temperatures a great amount of electricity consumption is used for heating houses. E.g. in North Europe, notably in Finland, electricity consumption is increased during cold winters and decreased during milder winters. Previously it has also been shown that polar vortex related changes in ground level wind speed have an influence on the electricity production by wind power in different European countries.

Here we show that the EEP effect on the polar vortex has a significant impact on wintertime electricity consumption in Finland and on wind power generation in Northern and Southern Europe through temperature and wind speed variations. We also find that this effect is valid only during easterly QBO winds.

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