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Mesospheric ozone connects solar electrons to middle atmosphere dynamics and ground-level regional climate

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Solar energetic electrons precipitate into middle atmosphere in the polar regions and affect the ozone chemistry. Ionization caused by electrons results in production of odd hydrogen (HOx) through ion chemistry, which further leads to mesospheric ozone decrease through catalytic reaction cycles. During strong precipitation events lasting days, ozone has been observed to decrease by tens of percent in the wintertime polar region. Here we present evidence of electrons causing longer-term (i.e. solar-cycle) variability in polar mesospheric ozone, and that this leads to modulation of middle atmospheric dynamics and ground-level regional climate through the so-called top-down mechanism. We use satellite observations and chemistry-climate modelling to show that there is less (more) mesospheric ozone during years of high (low) electron forcing. Such ozone perturbation causes zonal wind anomalies through wave-mean flow interaction which propagate to lower altitudes during the polar winter and affect stratospheric temperature. This suggests a stronger polar vortex, modulation of the Northern Annular Mode/North Atlantic Oscillation, and warmer wintertime surface temperatures in Northern Hemisphere during years of high electron forcing. Thus electron precipitation and mesospheric ozone seem to contribute significantly to the top-down atmospheric coupling, in a similar manner that has been previously suggested for solar ultraviolet radiation and mid-latitude stratospheric ozone.