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Use of PC indices in forecasts of substorm-related power grid disturbances

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The solar wind-magnetosphere interaction processes considered responsible for major magnetic disturbances such as magnetic storms and substorms are reflected in the transpolar plasma convection over the magnetically open polar caps. The convection may carry plasma and magnetic fields from the front of the magnetosphere to the tail region causing equatorward displacements of auroral regions and build-up of excessive energy in the tail configuration. The accumulated energy could be released in violent substorms, which among further adverse space weather effects, may induce strong Geomagnetically Induced Currents (GIC) in long distance power lines and thereby threaten power grids. The Polar Cap (PC) indices, PCN (North) and PCS (South), are based on polar geomagnetic observations from Qaanaaq (Thule) and Vostok processed to provide reliable measures of the transpolar plasma convection. Real-time on line PC indices are potentially very useful for advance warning of strong substorm-related GIC events since it usually takes several hours of sustained high PC index levels before a devastating GIC event may strike vulnerable power grids. The presentation shall consider past cases of power line disruptions in order to study the delay between elevation of PC index magnitude to levels above alert conditions (PC>10 mV/m) and actual strikes like the power disruption event on 13 March 1989 in Quebec. This delay may range from around 2 to 6 hours. The main reason for the extended delay, as will be shown, is the time it takes for the transpolar convection to widen the open polar cap enough to make violent substorm activity reach the subauroral latitudes, where important power grids are located