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Field aligned currents triggered in the mid-latitude ionosphere by very intense lightning discharges

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Intense positive cloud-to-ground (+CG) lightning discharges are known for their influence on higher atmospheric layers below 90 km of altitude. These discharges are linked to high-altitude luminous phenomena, sprites, which occur above the thunderclouds, and which are thought to originate from an electric field pulse traveling upward to the ionosphere. We show observations of the DEMETER spacecraft demonstrating for the first time that these electric fields can penetrate through the ionosphere to even higher altitudes on its top side. In connection with a +CG lightning stroke carrying 180 kA of lightning current, we have identified a broad-band electric pulse followed by a dispersed 0+ whistler at the spacecraft altitude of 670 km. Variations of the observed magnetic field suggest the existence of a localized (300 m wide) perturbation region containing the total downward field-aligned current of 0.8 A. This current is connected with the electric field on the order of 10 mV/m, and, most probably, also with a very localized depletion of the ionospheric plasma density.