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Global location of the maximum of very intense substorms

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Very intense sub-storms and super-substorms are typical for the main phase of strong magnetic storms. About 15 strong magnetic storms with SYM/H < -100 nT have been selected to study sub-storms during their main phases. It was found that, excluding the shock-induced sub-storms, there are, at least two different types of strong sub-storms. The first type represents the quasi-isolated sub-storms looking like classical (Akasofu-type) sub-storms with a clearly defined maximum intensity and a duration less than 2 h. The second type of storm-time sub-storms represents longer lasting magnetic disturbances without a clearly defined maximum intensity and looking like a chaotic sequence of short but very large peaks. Here we investigated the global distribution of ionospheric electrojets and field-aligned currents (FACs) in the time of the maximum (according to the AL-index) of the first type sub-storms using the global maps constructed in the AMPERE project basing on the magnetic measurements by the simultaneous 66 low-orbital (780 km) satellites. It was found that each sub-stom maximum was associated with the occurrence of a large-scale clockwise magnetic vortex in the early morning side indicating a local enhancement of downward FACs. It was confirmed by the FAC maps of AMPERE. A smaller vortex with the counterclockwise rotation was observed simultaneously in the dusk sector of the Earth. The super-substorms and very intense sub-storms observed in the main phase of selected two strong magnetic storms have been analyzed in detail. The obtained results can be explained by a formation of the addition sub-storm current wedge system.