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Long-term trends in geomagnetic observatory data: ingredients of the observed field, consequences on recent secular variation

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The analysis of 100-150 years-long series of geomagnetic annual means from several observatories reveals the presence of components with periods of 11, 22, and ˜80 years, superimposed on a steady variation. The first one is clearly related to the sunspot cycle of the solar activity, while reasons related to phase and amplitude in case of the other two point to core sources. Characteristics of the steady variations are presented in terms of magnitude and direction of the surface field, and in terms of magnetic moments and direction of equivalent centered dipoles. The magnetic moment of the steady variation dipole is of about 8*10**24 nT m**3, constant or slightly increasing (HAD, CLF, VAL, ESK, BFE, ABG) or slightly decreasing (COI, HON, FRD). The direction of the dipole was drifting northwestward by 2 (latitude) /5 (longitude) degrees between 1947 and 1961. The 22- and ˜80-year variations can be interpreted in terms of moving sources on the core surface (either vortices on top of a westward equatorial jet of core fluid, or as propagation of magnetohydrodynamic waves riding on a thermally driven azimuthal flow). In terms of the present analysis, the geomagnetic jerks seem to be a result of the superposition of the 11-year solar-cycle-related variation on the 22- and ˜80-year variations. The way the three combine makes the difference in timing, magnitude, and length of jerks as observed. All variations discussed contain the response of the Earth to their source variations, by magnetic induction in the crustal rocks and by electromagnetic induction in the conductive mantle and crustal structures. The analysis reveals that the secular variation one determines from data is in fact the result of the modulation of the main field secular variation by the differential magnetic induction in the crustal rocks and by the differential electromagnetic

induction in the mantle and crust.