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Magnetic field stretching at the top of Earth's core

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Magnetic field stretching transfers kinetic energy to magnetic energy and by that maintains the dynamo against Ohmic dissipation. Stretching at the top of the outer core may play an important role in specific regions. High-latitudes intense flux patches may be concentrated by flow convergence. Reversed flux patches may emerge due to expulsion of toroidal field advected to the core-mantle boundary by fluid upwelling. Here we analyze snapshots derived from self-consistent 3D numerical dynamos to unravel the nature of field-flow interactions and the contribution of magnetic field stretching to the geomagnetic secular variation at the top of the core. In each snapshot, intense normal and reversed flux patches are locally diagnosed in order to explore their kinematic origins. Our results show that stretching has a larger influence on the secular variation than what may be expected from the relative strength of the poloidal flow. Locally, stretching may dominate the secular variation near high-latitudes intense flux patches where the radial field is nearly aligned with the toroidal flow and advection is not effective. In contrast, near low-latitudes reversed flux patches advection is more efficient than stretching. In both cases stretching locally intensifies the field. Our results may shed light on the kinematic origin of intense geomagnetic flux patches and may provide insight to the convective state of the upper outer core.