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Earth's core convective bursts detected in geomagnetic and geodetic data

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Historical records reveal a significant correlation between the decadal variations of Earth's magnetic field and length of the day. The dynamical nature of the time-dependent, highly structured underlying fluid motion in the outer core, together with the mechanism for core-mantle coupling through which the length of day can be influenced, have so far remained elusive in the theory of the geodynamo. I use numerical sequences of the coupled Earth numerical geodynamo model, initialised with states obtained from geomagnetic data by inverse modelling, to show how the coupled geomagnetic and length of day evolution throughout epochs 1920-1950 and 1980-2010 can be accounted for by convective plumes bursting from the inner core boundary into the outer core. The plumes create a large-scale columnar vortex beneath Africa that enriches the outer core in westward flow while pushing the inner core and the gravitationally coupled mantle eastwards, thus causing a drop in the length of day comparable to the observations. The time-dependent core flows associated with the plumes also yield detailed geomagnetic field variations and acceleration patterns in good agreement with the data, particularly regarding the deceleration of the dipole decay rate. The analysis also suggests that periods 1890-1920 and 1950-1980 in turn correspond to convective relaxation phases between bursts. The other possible signatures involve a transient super-rotation of the inner core at a rate up to 0.8 degrees per year shortly after the occurence of each burst.