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Magnetic flux expulsion from the core as a possible cause of the unusually large acceleration of the North magnetic pole during the 1990s

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The North magnetic pole (NMP) has been drifting in a north-northwesterly direction since the 19th century. Both local surveys and geomagnetic models derived from observatory and satellite data show that the NMP suddenly accelerated during the 1990s. Its speed increased from about 15 km/yr in 1989 to about 60 km/yr in 2002, after which it started to decrease slightly. Using a Green's function, we show that this acceleration is mainly caused by a large, negative secular variation change in the radial magnetic field at the core surface, under the New Siberian Islands. This change occurs in a region of the core surface where there is a pair of secular variation patches of opposite polarities, which we suggest could be the signature of a so-called 'polar magnetic upwelling' of the type observed in some recent dynamo numerical simulations. Indeed, a local analysis of the radial secular variation and magnetic field gradient suggests that the secular variation change under the New Siberian Islands is accompanied by a significant amount of magnetic diffusion, in good agreement with such a mechanism. We thus hypothesize that the negative secular variation change under the New Siberian Islands that produced the NMP acceleration could result from a slowdown of the polar magnetic upwelling during the 1990s. We finally note that the NMP drift speed is determined by such a combination of factors that it is very difficult, if not impossible, to forecast its future evolution.