Researchers use centuries of data to map Earth's westward magnetic field drift

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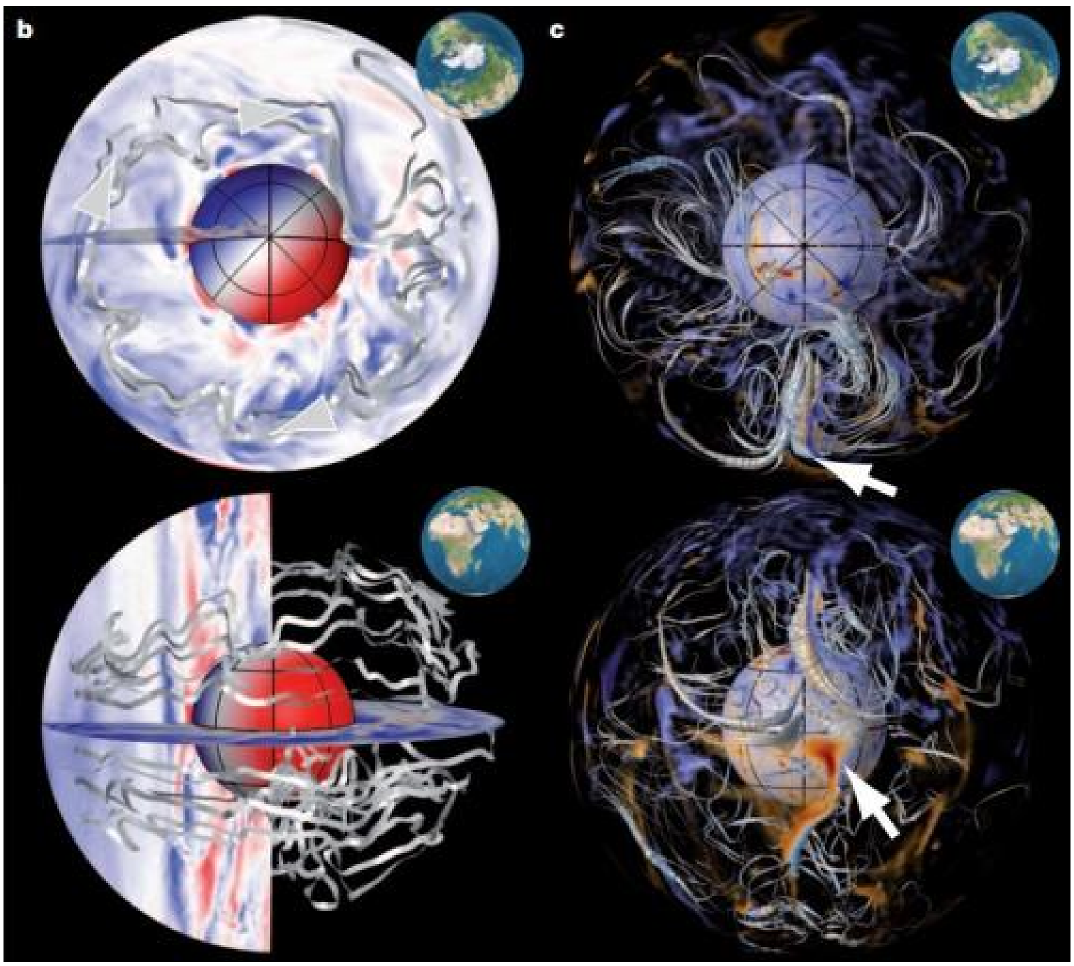

Internal fluid flow and magnetic structure. Credit: *Nature* 502, 219–223 (10 October 2013) doi:10.1038/nature12574

(Phys.org) —A trio of researchers from France and Denmark has combined data obtained over the past several centuries to create a model depicting the westward drift of the Earth's magnetic field. In so doing as they explain in their paper published in the journal *Nature*, the team believes it might be possible to predict where the field will drift in the future.

Scientists and explorers have known for centuries that the magnetic field that surrounds our planet drifts—ship captains made note of it in their logs as far back as the 1500's. Research over the years has found that the magnetic field is caused by the movement of liquid iron around a solid core causing the creation of an electric current. They've also learned that it's the magnetic field that protects the planet from charged particles that come streaming in from the sun—without it, life would not exist. Harder to explain is why there is more drift in the lower parts of the Western hemisphere than in the northern parts or in the east. In this new effort, the researchers used data old and new (from ship logs, to scientific observations to satellite data, etc.) to explain, they say, two reasons behind such differences in shift.

The first reason is tied to the impact gravity has on the inner core and the mantle—it forces the creation of huge rotating vortexes in the outer mantel known as gyres—which are apparently more concentrated at lower latitudes. Core convection tends to push them westward.

The second reason is due to the Earth cooling—as it does so, the outermost part of the liquid outer core cools as well, causing it to harden—but, it does so unevenly. The researchers say that more hardening under Indonesia causes more buoyancy which in turn causes distortions to the gyre leading to a westward shift in the magnetic field.

Taken together, the researchers say a model can be built that depicts with reasonable accuracy, the drift that has occurred over the past several hundred years, and may perhaps even be used as a means for predicting future drift. That matters because changes to the magnetic field have an impact on sensitive electronic equipment and also because it would be good to know how long we can expect to be protected from the sun by it.

More information: Bottom-up control of geomagnetic secular variation by the Earth's inner core, *Nature* 502, 219–223 (10 October 2013) DOI: 10.1038/nature12574

Abstract
Temporal changes in the Earth's magnetic field, known as geomagnetic secular variation, occur most prominently at low latitudes in the Atlantic hemisphere (that is, from ?90 degrees east to 90 degrees east), whereas in the Pacific hemisphere there is comparatively little activity. This is a consequence of the geographical localization of intense, westward drifting, equatorial magnetic flux patches at the core surface. Despite successes in explaining the morphology of the geomagnetic field, numerical models of the geodynamo have so far failed to account systematically for this striking pattern of geomagnetic secular variation. Here we show that it can be reproduced provided that two mechanisms relying on the inner core are jointly considered. First, gravitational coupling5 aligns the inner core with the mantle, forcing the flow of liquid metal in the outer core into a giant, westward drifting, sheet-like gyre. The resulting shear concentrates azimuthal magnetic flux at low latitudes close to the core–mantle boundary, where it is expelled by core convection and subsequently transported westward. Second, differential inner-core growth7, 8, fastest below Indonesia, causes an asymmetric buoyancy release in the outer core which in turn distorts the gyre, forcing it to become eccentric, in agreement with recent core flow inversions. This bottom-up heterogeneous driving of core convection dominates top-down driving from mantle thermal heterogeneities, and localizes magnetic variations in a longitudinal sector centred beneath the Atlantic, where the eccentric gyre reaches the core surface. To match the

observed pattern of geomagnetic secular variation, the solid material forming the inner core must now be in a state of differential growth rather than one of growth and melting induced by convective translation.

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