Halley's lines, checked

Georeferencing Edmond Halley's 1701 chart of the variations of the compass and measuring its lines against gufm1, a model of the Earth's field rebuilt from four centuries of ships' logs

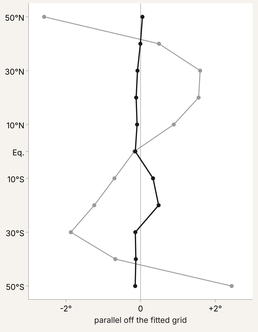
Halley's lines match a modern reconstruction where he sailed, date themselves to the first years of the 1700s, and were out of date within a generation.

1 A true Mercator, pinned to London · 2 Right where he sailed · 3 A chart with a shelf life

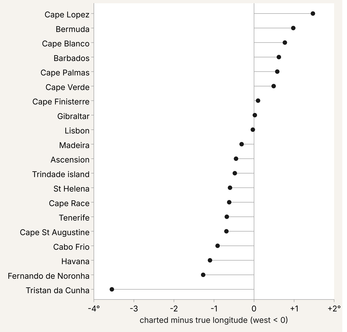
1 A true Mercator, pinned to London

I found the engraved graticule in the scan and fitted it at 91 line crossings. A Mercator projection fits to 0.24° rms; a plain latitude–longitude grid misses by 1.48°. Longitude is counted from London: the chart labels the meridian and grades the equator 20–10–0–10–20. Then I compared 20 coastal places with their true positions. Their longitudes are good to 1.1° rms; Tristan da Cunha sits 3.55° too far west.

Each parallel's offset from the fitted grid. Black: Mercator. Grey: plain grid.



Charted minus true longitude, 20 places.

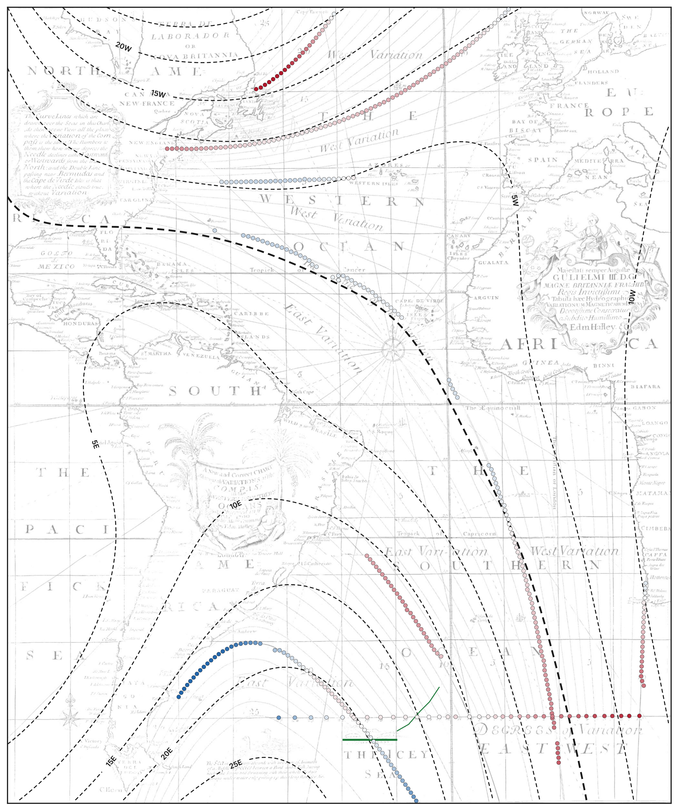


2 Right where he sailed

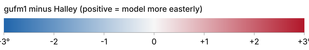
I traced 349 points along Halley's solid lines (0°, 10° and 20° east and west) and one dotted line I could verify (5°W, near 38°N), and read the 36 crossings of his own "Degrees of Variation" scale on 50°S. At each point I computed what gufm1 gives for 1700. The overall misfit is 1.27° rms. In the tropics it is 0.43°, most of it a constant offset (mean -0.37°); that is about the size of the 0.46° error gufm1 assumes for a single pre-1800 reading.

On 50°S the chart is within about 0.25° of the model from 38°W to 20°W, right beside the icebergs and track Halley drew. Away from them it misses: -2.2° at 52°W and +2.8° at 15°E, where his track does not go (scale rms 1.43°).

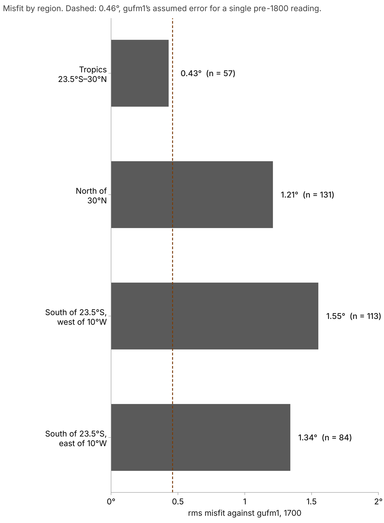
Halley's chart (faded) with gufm1 for 1700 (dashed, every 5°; heavy dashed = no variation). Dots: points read off Halley's lines, coloured by gufm1 minus Halley. Green: his track and icebergs as he drew them.



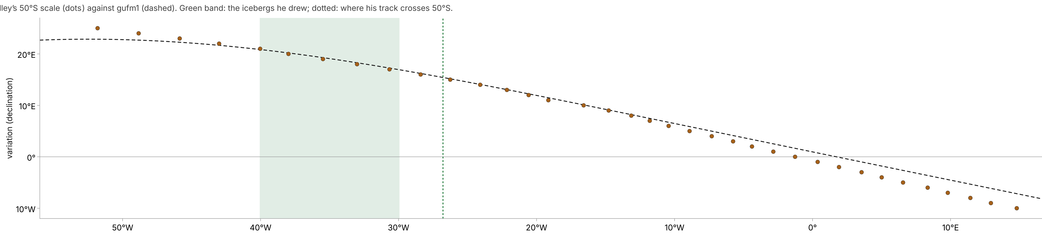
gufm1 minus Halley (positive = model more easterly)



Misfit by region. Dashed: 0.46°, gufm1's assumed error for a single pre-1800 reading.



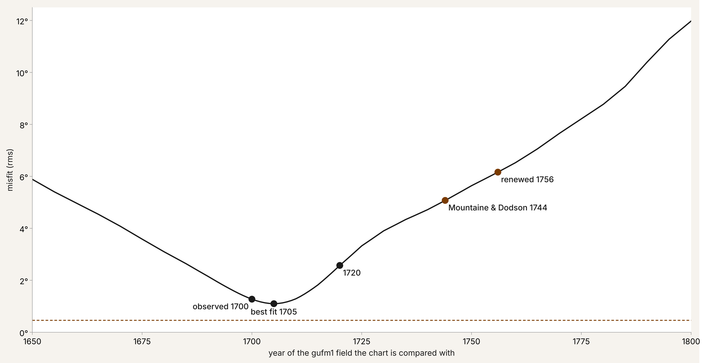
Halley's 50°S scale (dots) against gufm1 (dashed). Green band: the icebergs he drew; dotted: where his track crosses 50°S.



3 A chart with a shelf life

I repeated the comparison against gufm1 for every year from 1650 to 1800. The misfit is lowest at 1705 (1.10°; north 1704, south 1707). gufm1 is tabulated every 5 years, so that is the resolution, and the table's keying could move it to 1707.5, never earlier. Either way it sits within a few years of the cartouche's "Observed in ye Year 1700". The misfit doubles by 1720 (2.6°) and reaches 5.1° by 1744, when Mountaine and Dodson issued a renewed chart; they redrew it again for 1756 (6.2°).

Misfit of Halley's lines against the field of each year. Dashed: 0.46°.



What this does not show

gufm1 was built from historical logs, and it is plausible that Halley's own Paramore readings are among them: Jackson and colleagues mention his surveys, and their data reach back through Van Bemmelen's compilation. I could not confirm it either way. If they are inside, the agreement where he sailed, and the best-fit year, partly measure the chart agreeing with itself.

I traced the solid lines, one dotted line and the 50°S scale, not every dotted line. The no-variation line has a gap near the Cape Verde Islands, under lettering and the compass rose.

The georeference error (0.24°) shifts the model's declination by about 0.17° at the median gradient. The best year is resolved to about 5 years by the model's table.

What is new here, and what is not

I found no published comparison of this chart's lines with gufm1 in what I could reach. Mandea and colleagues (2010) made the same kind of test for Humboldt's charts; I follow their method.

Two studies of how Halley built the chart (Murray 2012; Imago Mundi 2017) could not be read here, so they may overlap with this.

The chart is often called the first published isoline map (Thrower). Earlier manuscript depth charts (1584, 1697) and Borri's lost chart make the wording matter.

Sources and method

Chart: scan supplied by the operator (copy and state not identified). Model: gufm1 (Jackson, Jonkers & Walker 2000), coefficients from pmagpy 4.5.2, synthesised by my own code checked against IGRF.

Thrower, History of Cartography vol. 4, p. 597. Mountaine & Dodson, Phil. Trans. 50 (1757). Mandea et al., Hist. Geo Space Sci. 1 (2010).

Every number on this sheet is computed from files in the reproducibility supplement: scan, fitted grid, traced points, coefficients, scripts.