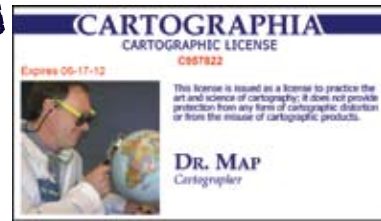


Ask Dr. Map!

**“E pur si muove” (And yet it moves)—
Galileo Galilei (1633)**



Dear Dr. Map:

Q:

What is the Chandler Circle?

A:

In the elementary model of our Earth there is one simple polar axis around which the Earth rotates, once a day, 365.25 (approx.) times a year. It is located at 90 degrees North and 90 degrees South. In reality, however, the pole is more dynamic. The Geographic North and South Poles are where all those meridians converge, but the instantaneous poles are where the Earth's rotational axis meets the Earth's surface. Because there is a slight wobble in the Earth's rotation, this position varies over time; the wobble moves the north instantaneous pole in a clockwise traced circle called the Chandler circle. The North pole of balance is at the center of the Chandler Circle, and it apparently moves about 6 inches (150 mm) toward North America each year. None of these are the magnetic poles, of course, the place toward which the north- and south-seeking arrows on a compass point. The North Magnetic pole is currently near Ellef Ringnes Island in northern Canada, and it is also moving.

The Earth's wobble was detected in 1891 by American astronomer Seth Caro Chandler, Jr., who detected two distinct wobbles, with periods of 12 and 14 months. The 12-month wobble is a forced motion caused by seasonal variation in the atmosphere, oceans, and water bodies. The 14-month Chandler wobble is a resonant, free oscillation that exists because the Earth is not rotating about its ideal axis. The Chandler wobble, which has been decaying over about 30-100 years, has been shown to be six different wobbles, not just one, all cyclic, and not all at the same time. It has been suggested that E Nino, volcanic eruptions, and much else are reflected (or caused by) the Chandler wobble. Indeed, the amplitude of the Chandler wobble has been observed to increase occasionally, with no clear cause.

So, a Chandler circle is that figure traced out by the Chandler wobble, a complex series of movements in the Earth's axis of rotation. The wobble is insufficient to make one fall over, even after drinking too much Egg Nog. However, over many years, it could confuse Santa Claus and his reindeer somewhat.

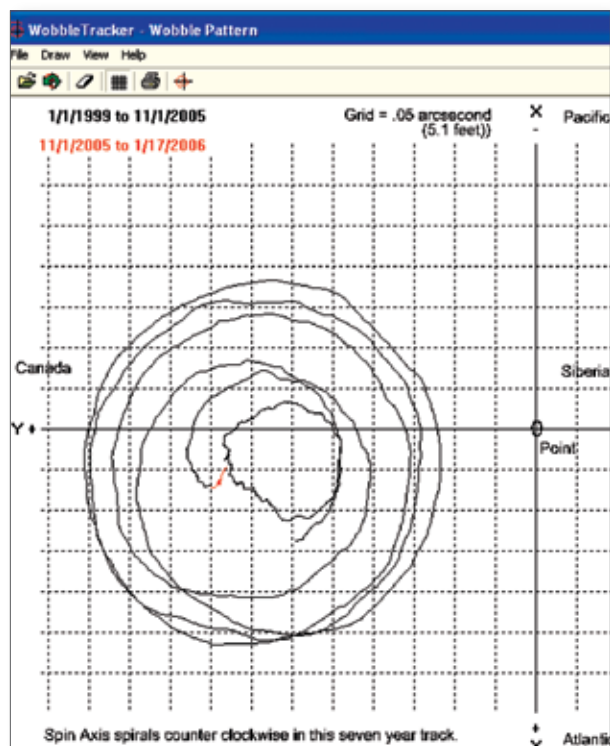


Figure source: http://www.michaelmandeville.com/earthmonitor/polar motion/2006_wobble_anomaly.htm

Q:

How long is a year?

A:

A calendar year is 365 days, with an extra leap year every four years, making a year 365.25 days. A day is one revolution of the earth about its axis, including its Chandler wobble.

AND YET IT MOVES...

If the transit of a particular star is observed from a fixed point, say through the transit instrument at the Greenwich observatory, it will reappear 24 hours later. Or rather not, because the Earth itself has also moved a bit around the sun during those 24 hours, meaning that the star reappears 23 hours, 56 minutes and 4.091 seconds later, about 4 minutes shorter than a 24-hour day. As the four minutes get repeated every day, after a year, the Earth has rotated a whole day less than we would think by counting days using the sun.

By formula, this makes a year 365.243 days within the measurement accuracy, which comes into play, too. With a 365-day year, and a leap year every 4 years, we still need to make corrections. So three of every four century years (years ending with 00, like 1900 and 2000) is not a leap year, subtracting 3 days every 400 years, or .0075 days per year. That gives us a year of 365.2425 days.

Accurate measurements give a year as 365.242198 days, give or take a leap second or so. So to answer the question, a year is about 365.242198 days, or 8765.812752 hours, not the expected 8766, a 0.002% difference. If the Earth turns through 15 degrees of longitude every hour, and each degree is from 111,321 m at the equator and 1,949 m at 89 degrees N, what error does that cause in location, and does the Chandler wobble matter enough to make your head spin?

Q

What is Coriolis effect?

A

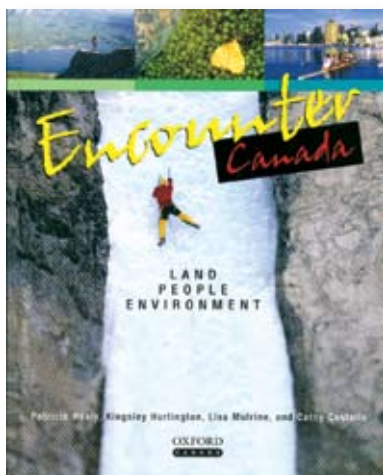
Named for Gaspard-Gustave Coriolis, the French scientist who first described it in 1835, Coriolis effect is the apparent deflection of moving objects from a straight path when they are viewed within a rotating ref-

erence frame, namely the Earth, and its latitude/longitude grid.

The effect is noticeable when a moving object (e.g., a rocket or a storm system) is deflected to the right of the direction of travel in the northern hemisphere, and to the left of the direction of travel in the southern hemisphere. The Coriolis effect is caused by the Coriolis force, a fictitious force which results when the reference frame itself is moving, as is the latitude/longitude grid.

So, for example, a rocket fired at a point would miss the point unless the movement of the point (at 15 degrees of longitude per hour, give or take 0.002%) during the rocket's flight is taken also into account. Coriolis effect is caused by the Earth's rotation, not by its curvature or shape. In spite of popular belief, Coriolis effect has nothing to do with how water goes down plug holes or toilets. That spin is caused by the Chandler effect (See U.S. Pat. No. 5,504,948).

BOOK REVIEW



Encounter Canada, Land—People—Environment—Student Book, by Patricia Healy, Kingsley Hurlington, Lisa Mulrine and Cathy Costello, Oxford University Press, 2007, ISBN-13: 978-0-19-542539-0, Hardcover, 440 p.

In the interest of full disclosure, let me state at the outset that this book is a 9th grade geography textbook for Canadian students. With that in mind, anyone interested in quickly learning more about the “land, people, and environment” of Canada will find this book informative. It covers a broad range of topics from the geology of the land, its natural resources, the various people who live in Canada and where they live, and the varying environments across the land. It also touches on current issues such as sustainability and climate change.

Richly illustrated with photographs, illustrations, graphs, and simple maps, which alone with their captions will provide a good overview of the material covered by the book. Because this is a textbook there are many learning activities, questions, and assignments

designed to get the students thinking about what they have read.

The book also has a short section on mapping and GIS, and one of the illustrations used is “Kayaking in Canada,” an image of a map that won the student award for printed map in the 2005 ACSM-CaGIS Map Design Competition.

Encounter Canada can be ordered online from Amazon.ca (www.amazon.ca) or Indigo Books & Music (www.chapters.indigo.ca). With time, it may also be available at the ACSM eStore.

As one who visits Canada regularly (my wife has French-speaking relatives in Ottawa), I enjoyed the book and, by reviewing it, I should be able to converse intelligently about Canada during our next visit.

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