Updated 1996 by MRF;
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Which Way Will my Bathtub Drain?

Question: Does my bathtub drain differently depending on whether I live in the northern or southern hemisphere?

Answer: No. There is a real effect, but it is far too small to be relevant when you pull the plug in your bathtub.

Because the earth rotates, a fluid that flows along the earth's surface feels a "Coriolis" acceleration perpendicular to its velocity. In the northern hemisphere, Coriolis acceleration makes low pressure storm systems spin counterclockwise; however, in the southern hemisphere, they spin clockwise because the direction of the Coriolis acceleration is reversed. This large-scale meteorological effect leads to the speculation that the small-scale bathtub vortex that you see when you pull the plug from the drain spins one way in the northern hemisphere and the other way in the southern hemisphere.

But this effect is VERY weak for bathtub-scale fluid motions. The order of magnitude of the Coriolis acceleration can be estimated from size of the "Rossby number" (1) (see below). The effect of the Coriolis acceleration on your bathtub vortex is SMALL. To detect its effect on your bathtub, you would have to get out and wait until the motion in the water is far less than one rotation per day. This would require removing thermal currents, vibration, and any other sources of noise. Under such conditions, never occurring in the typical home, you WOULD see an effect. To see what trouble it takes to actually see the effect, see the reference below. Experiments have been done in both the northern and southern hemispheres to verify that under carefully controlled conditions, bathtubs drain in opposite directions due to the Coriolis acceleration from the Earth's rotation (2).

Coriolis accelerations are significant when the Rossby number is SMALL. So, suppose we assume a Rossby number of 0.1 and a bathtub-vortex length scale of 0.1 meter. The Rossby number is defined as

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        Rossby number = U/(2*L*w)
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where U is the velocity of a fluid element, L is the scale of the fluid motion, and w is the earth's rotational velocity (= 1 rotation/day). In conventional units, the earth's rotation rate is about 10^{-4}/ second, so solving the above equation for the fluid velocity, we get that Coriolis acceleration in your bathtub is significant for fluid velocities of less than 2 x 10^{-6} meters/second. This is a very small fluid velocity. How small is it?

Well, we can take the analysis a step further and calculate another, more famous dimensionless parameter, the Reynolds number.

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        The Reynolds number is = L*U*density/viscosity
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Assuming that physicists bathe in hot water the viscosity will be about 0.005 poise and the density will be about 1.0, so the Reynolds Number is about 0.04.

Now, life at low Reynolds numbers is different from life at high Reynolds numbers. In particular, at low Reynolds numbers, fluid physics is dominated by friction and diffusion, rather than by inertia. That is, at low Reynolds numbers the time it would take for a small piece of fluid to move a significant distance due to an acceleration, is greater than the time it takes for that piece to break up due to diffusion.

Ideas about which way a bathtub will drain have also been cited for giving the direction water circulates when you flush a toilet. This is surely nonsense. In this case, the water rotates in the direction in which the pipe points, that carries the water from the tank to the bowl.

References:
(1) J. Pedlosky, "Geophysical Fluid Dynamics" section 1.2.
(2) Trefethen, L.M. et al, Nature **207**, 1084--5 (1965).