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Why cyclones move westward

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Observations in an otherwise quiet geophysical flow show that monopolar vortices tend to have a westward propagation component. The steady westward propagation of anticyclones can be understood from the difference in strength of the Coriolis force on the swirling motion at poleward and equatorward sides of the vortex, the beta effect. This leads to a net equatorward force on the vortex that has to be compensated by a poleward force on the vortex. This poleward force is generated by the westward motion of the anticyclone. For cyclones the situation is not that clear, leading to confusion in the literature.

Careful analysis of the equations shows that the same mechanism is at work for cyclones. Only now the net Coriolis force on the swirling motion is poleward. For a steady motion an equatorward force is needed for compensation, and one tends to conclude that cyclones have to move eastward to generate the necessary Coriolis force. However, one has to realize that the cyclone has a negative mass anomaly, so that force and acceleration have opposite signs. So, to generate an equatorward Coriolis force the cyclone has to move westward as observed.

Obviously, negative masses are not present in our system. The above argument can be reformulated when it is realized that not only the vortex moves westward, but surrounding fluid has to move eastward to let the vortex pass. So, in fact, the westward propagation of the water in the cyclone leads to a poleward-directed Coriolis force, but the water surrounding the vortex moves eastward, leading to an equatorward force. Since that thickness of the layers inside the cyclone is smaller than that of the surrounding water, the latter Coriolis force is bigger, and the difference balances the net Coriolis force on the swirling motion. Now we can fully understand why the mass anomaly of the vortex is of importance, and not the mass of the vortex as a whole, which is always positive. And a simple explanation is given on why cyclones also

move westward.