Where do I err in my calculations?

Sir Isaac Newton shows how horizontal gravitational vectors cancel out, but physically, horizontal acceleration does not go away when vectors cancel out

—by Neil B. Christiansen

Geodesists solve earth's moment of inertia with an ideal world equation wherein no consideration is given to real world resistance to movement. I'm sure you encountered ideal world problems when you were studying physics. You were told to ignore the frictional forces acting on a block sliding down an inclined plane. Ignoring friction simplified the problem, but gave a skewed answer.

Sir Isaac Newton discusses gravitational accelerations in the *Principia* but confines his work to vectors. He ignores horizontal gravitational vectors because they do indeed balance out. This reasoning led geodesists to identify vertical gravitational acceleration as the only acceleration needed to be overcome before the earth's rotation would cause her to bulge (flatten). So in their ideal world equation, the difference (C-A) between the earth's moments of inertia, about polar and equatorial axes, are expressed in terms of flattening as: $f = 1.5(C\text{-}A)/Ma^2 + 0.5(\omega^2 a/g_e)$. The derived value for C, 80.378×10^{36} kg m^2, dictates most of her mass concentrate in her core. As a result, earth scientists abandoned the condensed cold-core model for a hot-core model—wherein heavy particles sink deep into the earth's molten core to give earth her low moment of inertia.

So, what skews the outcome in the geodesist's hydrostatic model? Picture if you would the skin of a rubber balloon, which resists pressure within the balloon. Force vectors in the balloon's skin form a 360 degree array of cohesive tension between molecules. Earth's surface is similar to the skin of a balloon; so, its molecules pull on their fellow molecules with a gravitationally induced 360 degree cohesive acceleration.

Cohesive acceleration is hard to recognize in solids, but it shows up in liquids as an additional pull needed to overcome surface tension. Lifting a wire ring out of a liquid requires an added pull, over and above the pull needed to lift the weight of the wire. In effect, the wire is forced to lift a portion of the liquid's surface. The elevated surface constitutes two masses (one on each side of the wire) which are lifted above the normal surface of the liquid. These lifted masses, m_1g and m_2g, add to the weight of the wire. In response to this phenomenon, physicists introduce a surface tension constant S in the equation; $S = P/2l$. The horizontal pull of cohesive surface tension holds these two masses in place until their lifted weights overcome that pull. Textbooks identify surface tension as a phenomenon associated with the existence of a boundary surface between a liquid and some other substance, but the geodesist's flattening equation does not consider this phenomenon.

Engineering handbooks give surface tension constants for a number of liquids. In reviewing these, against the liquid's density, there appears to be a relationship; namely, density and surface tension have something in common. We know liquid particles do not form permanent chemical bonds, so could horizontal gravitational acceleration be the primary cause of surface tension?

According to Newton's law of universal gravitation, $F = GM_1M_2/D^2$, a cubic centimeter of mercury will attract its neighboring cubic centimeter with a pull of 1.24×10^{-5} gmcm/sec^2—for water the pull is 6.67×10^{-8} gmcm/sec^2. The horizontal acceleration of gravity thus causes the masses of particles in a liquid to gravitationally resist separation; the denser the liquid the stronger its resistance and, in turn, the larger its surface tension constant.

But earth is a large sphere and all cubic centimeters of mass, or all gram masses, within its sphere pull on each other. So, the values of vertical and horizontal accelerations both need to be in the flattening equation. When considered, the cold-core model becomes a viable alternative. Or not?