***Calculating Changes in Isotopic Ratios***

We start by considering a reservoir called M that has an inflow Fin and an outflow Fout. The rate of change of the reservoir is just:

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If the inflow and outflow transfer mass with specific isotopic  values, in and out, and if we know the starting  for the reservoir, M, we can write a similar equation to the above that incorporates these isotopic ratios:

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But what we're really after is an equation that tells us how M changes with time, so we need to deconstruct the above equation (2). We apply the product rule of calculus to the above, giving:

,

and then we rearrange things in (3) to get:

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Then we substitute (1) into the last term in (4) to get the following:

 ,

which can be simplified by rearranging terms to give us our final equation:

 

This final equation then is essentially what gets entered as the equation for a flow that feeds in and out of a reservoir that is the isotopic ratio of the material contained in another reservoir. This is a rather unusual kind of quantity to keep track of in a reservoir -- not as intuitive as the mass of carbon in the atmosphere for instance.