Primary productivity in the ocean's sunlit surface incorporates dissolved nutrients into organic matter, a fraction of which sinks to the ocean interior. In the absence of vertical mixing and advection, this slow but relentless leakage of organic material to the dense ocean interior would entirely deplete nutrients in the ocean's upper kilometer and force primary productivity to a halt in a little over 1000 years. We suggest a two-step process for returning these nutrients to the euphotic zone of the subtropical gyres. First, upwelling and vertical mixing outside of the subtropical gyres--particularly in the Southern Ocean--restore nutrients to shallower depths. Second, advection and mixing across the fronts that define the subtropical gyre boundaries redistribute these nutrients back into the gyre regions where they are consumed and exported to depth. In this presentation, I present the results of a novel set of modeling experiments that explore these nutrient return pathways. The models reveal the relative contributions to global productivity of the nutrients that are restored to shallow depths in the Southern Ocean, the northern high latitudes, and directly across the low-latitude thermocline, as well as the sensitivity of this result to the model-dependent configuration of the Meridional Overturning Circulation. Finally, I explore the observational evidence that suggests a critical role for cross-frontal exchange in controlling low-latitude productivity.