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Is high Si:N uptake ratio in the Southern Ocean neccessary to explain global silicate distribution?

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We investigate controls on the global distribution of silicate with a coupled physical-biogeochemical model using a set of experiments designed to test the sensitivity of an idealized non-limiting nutrient (Xnu). In a fixed steady-state circulation dissolution lengthscale for Xnu and its uptake ratio by phytoplankton with respect to phosphate were varied across a wide range and over different regions. Steady state solutions for Xnu were then compared with observed climatological silicate. Both deep dissolution and high uptake ratio were able to cause the sharp meridional gradient observed for silicate at the surface of the Southern Ocean. However, only the former was able to determine the meridional gradient in concentration between the deep North Pacific and the deep Southern Ocean. Experiments with regional variations in the two parameters revealed an important role for the deep dissolution in the North Pacific, pointing to locally recycled silicate being determinant in the build-up of deep silicate. Although it's not possible to tell which of the two studied processes is the main driver in the Southern Ocean, only a deep dissolution lengthscale was able to reproduce both main characteristics of the global silicate distribution. We speculate that the high uptake ratio of silicate with respect to other macro-nutrients observed in the Southern Ocean would then be only a consequence (rather than a driver) of the high surface silicate concentration.