Iron-light colimitation increases sensitivity of oceanic CO_2 drawdown to dust deposition

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The iron hypothesis suggests that in large areas of the ocean phytoplankton growth and thus CO_2-uptake is limited by the micronutrient iron. Indeed, iron fertilization experiments show that phytoplankton needs iron in particular for nitrate uptake, light harvesting, synthesis of chlorophyll and in the electron transport chain of photosynthesis. One important source of iron to the open ocean is dust deposition. Previous global biogeochemical model studies about the sensitivity of oceanic CO_2-uptake to dust deposition do not consider direct effects of iron availability on light limitation. Here we show that this sensitivity is increased significantly when iron-light colimitation, i.e. the impact of iron on light harvesting capabilities and chlorophyll synthesis, is explicitly considered in a global biogeochemical ocean model. Iron-light colimitation increases the shift of export production to higher latitudes at high dust deposition and amplifies iron limitation at low dust deposition. Our results suggest that iron fertilization by increased dust deposition may explain a larger portion of the observed past CO_2 variability than thought previously. Our results emphasize the role of iron as a key limiting nutrient for phytoplankton in the ocean, with a high potential for changes in oceanic iron supply affecting the global carbon cycle and climate.