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A biogeochemical patch model of a NE Pacific in situ iron fertilization experiment, SERIES

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The SERIES experiment studied the response of the pelagic ecosystem to iron fertilization in the high nutrient-low chlorophyll region of the subarctic Northeast Pacific, near station Papa. Here we show results from an ecosystem model study of this experiment that takes into account temporally variable dilution of the fertilized patch by surrounding waters. The patch is modelled as a physically homogeneous slab that expands and contracts in both the horizontal and the vertical, entraining and exchanging fluid as determined using CTD and sulphur hexafluoride observations. The ecological model (inside and outside of the patch) includes two size classes of phytoplankton (diatoms and non-diatoms), a detrital component, micro- and mesozooplankton. Carbon, nitrogen, silicic acid and iron are modelled independently. The model is able to reproduce the observed response to fertilization: An initial picophytoplankton bloom that is grazed down by microzooplankton after a few days, and a subsequent diatom bloom. The timing and amplitude of the bloom can be reproduced with only small changes in the ecosystem parameter set previously used to model the annual phytoplankton cycle at station Papa. However, the standard model is unable to reproduce the relatively short duration of the diatom bloom. The influence of factors such as nutrient stress-induced aggregation, and variations in the Fe:C quota of the diatoms are explored. Model runs that include only dissolved iron are contrasted with those that have a representation of the dissolved-colloidal-particulate iron cycling. We further discuss the role of horizontal entrainment on the evolution of nutrients and the pelagic ecosystem within the patch.