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Modeling anthropogenic CO_2 in the North Atlantic

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Global ocean carbon models and observations pointed out that the North Atlantic is a region of substantial uptake of anthropogenic CO_2. In the basin-scale model used here at a resolution of 4/3 degrees, two methods of diagnosing anthropogenic CO_2 are compared. One uses a passive anthropogenic-CO_2 tracer (perturbation method; Sarmiento (92)) and the other runs a full ecosystem (NPZD) and carbon chemistry model under both rising and constant atmospheric pCO_2, with the difference in carbon content being defined as "true" anthropogenic CO_2 in the model context. The experiments show that the perturbation method underestimates the "true" anthropogenic increase of CO_2 in the ocean by about 10%. To improve the accuracy of the perturbation method for the North Atlantic, the constants describing the uptake kinematics of the passive anthropogenic CO_2 tracer were re-computed from the output of the full ecosystem-carbon cycle runs. These improved constants in the perturbation method are shown to yield close agreement with the "true" anthropogenic CO_2. We also test the observational method of Gruber et al. (1996) that is often used to seperate anthropogenic CO_2 from the large natural variability of DIC. By applying this method to the model output, using both CFC-age and model age, we find that anthropogenic CO_2 is overestimated. The reasons for this deviations are discussed and improvements to the method are suggested.