

Applications of an Ocean Model and its Adjoint for Global Data Assimilation and Sensitivity Study

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The adjoint of a forward model reflects the sensitivity of a dependent variable to the independent variables. It is equivalent to forward sensitivity obtained from many forward perturbation experiments where the independent variables are perturbed one at a time. For systems with a large number of independent variables, the adjoint provides a highly efficient way to compute model sensitivity. Here we describe applications of the adjoint of a state-of-the-art ocean general circulation model for global data assimilation and process-oriented sensitivity study. For the assimilation, the dependent variable is chosen to be a cost function penalizing the deviations of model state from various satellite and in-situ observations. The independent (control) variables are initial state and surface forcing. The adjoint sensitivity is used in a minimization algorithm to reduce the cost function by adjusting the control variables so as to account for model errors associated with uncertain initial and surface boundary conditions. The assimilation product, validated through the comparison with independent data, is used to quantify upper ocean heat balance. For process study, the adjoint sensitivity is used to elucidates effects of local and remote wind forcing on the transport of the Indo-Pacific throughflow, the only low-latitude connection between major oceans.