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Potentiality of glider data assimilation in the Solomon Sea: Control of the mass field in some simple scenarios and estimation of the tidal mixing parameter

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Among the recently developped ocean observing systems are the steerable underwater gliders. In this study, we explore the potentialities of glider data assimilation to control some characteristics of the ocean using an ocean Observing System Simulation Experiments (OSSE) methodology. The region of study is chosen to be the Solomon Sea, notably because a glider monitoring has been carried out in this region since 2007 and high-resolution numerical simulations have been implemented as part of the WCRP/CLIVAR/Southwest Pacific Circulation and Climate Experiment (SPICE) program. Improving our knowledge of this potentially important region for decadal climate variability is indeed a key issue of SPICE. A notable source of error in our numerical model of the Solomon Sea lies in the vertical mixing due to the dissipation of internal-tides. Therefore, the main objectives of the present study are to assess the potentialities of glider data assimilation in an OSSE framework to control misfits in the Solomon Sea due to an erroneous tidal-mixing parameterization, using two complementary strategies: - The control of the water mass characteristics for several scenarios of deployment of fleets of gliders. - The control of the source of error itself through a direct estimation of the erroneous parameter. Multivariate sequential data assimilation is performed using a reduced-order Kalman filter whose methodology has been extended to work with multigrid model configurations. On the one hand, the results of the exploration of the different scenarios of deployment for fleets of gliders show that their ability to control the Solomon Sea thermohaline characteristics strongly depends on the design of the fleet. As for the dimension of the array, a fairly good control can be achieved with a somewhat unrealistic fleet of 50 gliders. When the observational array is impaired by reducing the number of gliders to a more realistic configuration of 10 vehicles, the quality of the error control depends on the distribution of the vehicles, and is improved when a collective motion pattern is imposed to coordinate the gliders trajectories and yield efficient collection of information-rich data. A substantial control of the Solomon Sea thermohaline characteristics can then be achieved. Mass field errors can be further controlled by complementing glider data with synoptic sea surface temperature data. On the other hand, since the source of error in the model comes from uncertainty on the tidal-mixing efficiency parameter, this one is estimated through assimilation of data provided by the 10 coordinated gliders over one day using an ensemble simulations method. This potentiality of data assimilation allows to directly correct the model instead of continuously correcting the state variables. An accurate estimation of the parameter, and therefore an efficient correction of the water mass thermohaline characteristics, is made possible by this promising strategy.