Tuning a North Pacific OGCM with regard to the Kuroshio Current System.

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Meteorological Research Institute/Japan has been developing the next generation of monitoring and forecasting system of the north western Pacific Ocean. One of the main targets is the Kuroshio Current System, which is composed of the Kuroshio, Kuroshio Extension (KE) and its recirculation gyres. Due to the enormous effects of the Kuroshio Current System on the various aspects of the North Pacific, its better representation is essential for the overall performance of the system. Here, we consider the performance of a North Pacific model in that system. The North Pacific model with a resolution of about 1/10 degree is nested in a global ocean model with a resolution of 1 x 1/2. This model is also used for nesting a Japan Model, which simulates ocean near Japan with about 2 km resolution. In hindcast experiments under JRA55-do forcing, the North Pacific model can represent a realistic KE separation. Nevertheless, it had following shortcomings until tunings were conducted. (1) The eastward extension of the KE was limited near Japan and the eddy kinetic energy around the KE and the recirculation gyres is too weak compared to the AVISO. (2) The path of the Kuroshio south of Japan south was too unstable, sometimes causing an unrealistic high frequency of large meander of the Kuroshio. After trial and error, we have found that following parameters can be used to mitigate the above problems. (A) Dependency of the ocean surface current to calculate the surface wind stress. (B) Boundary viscosity south of Japan. The former parameter (A) appears in the following bulk formulation in calculating wind stress. Tau = rho C|U - u|(U $-\alpha$ u), where rho is the density of air sea level, C is the drag coefficient, U is the wind velocity and u is the ocean surface velocity. We introduce "α", which describes the relative contribution of ocean surface velocity to the bulk formulation. Intuitively, this coefficient seems one, but in reality, it is not so simple because the momentum and energy transfer between the wind and ocean is caused not only by simple drag of the ocean current, but also through the excitation, spread, and break of ocean surface waves. We consider the parameter can take a value between 0 –1, and use this for a kind of turning parameter of the OGCM rather than going deeply into the detail mechanism. We have found that the KE is quite sensitive to the small change of this parameter. For the North Pacific model, the parameter is set to 0.05. Changing this value to 0.10 leads to significant reduction of eddy kinetic energy around the KE. We do not claim that this value is universal and physically correct. But we consider that this parameter can be a useful tuning parameter for the Kuroshio Extension. The latter parameter (B) is applied by using a large harmonic viscosity in the region near the southern coast of Japan. This works to stabilize the Kuroshio south of Japan, which tends to behave too vigorously. Too large value results in the failure of separation and reduction of eddy kinetic energy downstream along the KE. We set this as 2.5m^2/s. This parameter may represent unknown missing mechanism that stabilizes the Kuroshio path in reality. The former parameter, α, also can be used for this purpose. But to stabilize the path of the Kuroshio, the value of α should be increased and will not be suitable for the KE. The combined use of these two parameters enable us to tune the Kuroshio and KE separately.

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