Atmosphere-ocean interactions on the Earth Simulator

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The Kuroshio Current and Gulf Stream influence the midlatitude climate by transporting heat from the Tropics. Our group investigates the effects of eddies and filaments in these ocean currents and their impact on climate using the atmosphere, ocean and coupled models for the Earth Simulator.

Resolving small eddies and filaments in the Kuroshio Current

Sometimes the Kuroshio Current meanders to a great extent. These meanders are the Current with mesoscale (about 100 km) eddies (Fig 1a, 25-km mesh). Using 10-km mesh ocean general circulation model (OFES), these eddies are more realistically resolved than coarse resolution models and are able to represent their effects on the ocean general circulation (Fig. 1b).

Recent satellite observations revealed even smaller eddies and filaments of a few km scales in mesoscale eddies. It is suspected that these submesoscale structures influence ocean surface fields. In order to clarify effects of the submesoscale phenomena, super high resolution experiments in the Northern Pacific are being conducted. With 3-km mesh, submesoscale eddies and filaments are successfully resolved along the Kuroshio Current and Tsushima Warm Current (Fig. 1c).

Rising heat from the Gulf Stream

The fact that the heat from the Gulf Stream warms air in the midlatitudes to cause significant updraft has been revealed by recent satellite observations and simulations using the atmospheric general circulation model for the Earth Simulator (AFES).

Figure 2 is a three dimensional visualization of atmosphere-ocean interactions along the Gulf Stream in a high resolution (atmosphere 50 km, ocean 25 km) simulation using the coupled atmosphereocean model for the Earth Simulator (CFES). Above the Gulf Stream of 1000 m depth along the western boundary of the North Atlantic, the associated updraft reaches about 10,000 m from the sea surface in this simulation.

Fig. 1 Surface relative vorticity (x10^{-5} s^{-1}).

Fig. 2 Annual mean atmospheric vertical velocity and ocean current speed.