Geophysical Research Abstracts
Vol. 19, EGU2017-15306, 2017
EGU General Assembly 2017

Downscaling ocean conditions with application to the Gulf of Maine, Scotian Shelf and adjacent deep ocean

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A high resolution regional model (1/36 degree) of the Gulf of Maine, Scotian Shelf and adjacent deep ocean (GoMSS) is developed to downscale ocean conditions from an existing global operational system. First, predictions from the regional GoMSS model in a one-way nesting set up are evaluated using observations from multiple sources including satellite-borne sensors of surface temperature and sea level, CTDs, Argo floats and moored current meters. It is shown that on the shelf, the regional model predicts more realistic fields than the global system because it has higher resolution and includes tides that are absent from the global system. However, in deep water the regional model misplaces deep ocean eddies and meanders associated with the Gulf Stream. This is because of unrealistic internally generated variability (associated with the one-way nesting set up) that leads to decoupling of the regional model from the global system in the deep water. To overcome this problem, the large scales (length scales > 90 km) of the regional model are spectrally nudged towards the global system fields. This leads to more realistic predictions off the shelf. Wavenumber spectra show that even though spectral nudging constrains the large scales, it does not suppress the variability on small scales; on the contrary, it favours the formation of eddies with length scales below the cut-off wavelength of the spectral nudging.