2012 Project Summary

Satellite Multi-Sensor Studies of Deep Ocean Convection in North Atlantic Ocean

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The objective of this project is [1) to analyze air-sea interaction and meridional heat and freshwater transport estimations to identify regions associated with preconditioning and lateral exchange prior to and post Deep Convection, 2) to analyze horizontal flow field and vertical water column analysis, and 3) to find linkage between DOC and subsurface thermal structure estimated from satellite multi-sensor data.

Recent Results

(1) Sea level trends in the North Atlantic based on different temporal scales based on Ensemble Empirical Mode Decomposition (EEMD) were analyzed to identify dominant forcing, resulting in that the trends are not geographically uniform over the ocean. While the areas of the relatively high sea level rise trends are associated with decadal time scales, the decreasing sea level rise trend in the Northern Recirculation Gyre (NRG) was associated with interannual variability (Li, et al., 2011a). The results related AMOC strength based on Complex Empirical Orthogonal Function (CEOF) shows that the AMOC strength was decreasing after 1999 (Jo et al., 2011).

(2) Geostrophic velocities derived from altimeter data shows that the trends of cyclonic circulation of the subpolar gyre (SPG) increased in the 2000s, resulting in weakening SPG. GRACE and ICESat measurements showed that this may be attributed to observed accelerated ice mass loss in the Canadian Arctic Archipelago (CAA) and the Greenland since 2005. Advancing of the sea ice edge towards the LS interior regulates the Deep Ocean Convection (DOC) development, which is influenced by North Atlantic Oscillation (NAO) phase (Li, 2011a).

(3) A dipole pattern, centered between the subpolar region and the region near the Gulf Stream, was recognized from the trends of the sea surface height anomaly (SSHA), associating with the inter-annual to decadal variability of the SSHA of the two regions. It was found that the subpolar region SSHA inversely correlates to the cumulative North Atlantic Oscillation (NAO) index ($r=-0.85$) compared to that of the region near the Gulf Stream ($r=-0.23$) revealing a primarily asymmetric cumulative response of the regional SSHA to the NAO forcing. A remarkable reversal of the SSHA trends was also found with opposite signs of the dipole pattern from the 1990s to the 2000s, which might be related to the time lag between high and mid-latitudes Atlantic meridional overturning circulation (AMOC) variations (Li, et al., 2011b).

(4) Regional Ocean Model System (ROMS) was used to study the impact of sub-mesoscale eddies in the Labrador Sea, suggesting that the sub-mesoscale eddies are generated by the topographic instability, with diameter of 35 to 55 km. Wintertime convections with mixed layer deeper than 1000 m are found south to the 3000 m isobath, approximately the area identified by the previous studies, and strong Labrador Current (70cm/s) in the west basin presents as a border between the fresh, cold water from Baffin Bay and the central Labrador Sea (Zhang et al., 2011).

Bibliography

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