CINTECMAR, BARRANQUILLA - COLOMBIA OCT 13 2016

STRATIFIED COASTAL OCEAN PROCESSES AND THEIR IMPACTS ON HURRICANE INTENSITY

(Magisterial conference)

Presenter: Scott M. Glenn
Research Director at the integrated Ocean Observing System

Abstract

An integrated ocean observing system operating during Hurricane Irene (2011) revealed widespread and significant ahead-of-eye cooling (at least 5°C and up to 11°C) as the storm crossed the seasonally stratified continental shelf of the Mid-Atlantic Bight of North America. Buoys and gliders deployed in the storm allow the detailed evolution of the surface temperature to be examined at select points, revealing 76%-94% of the total cooling occurs before eye passage.

A range of ocean models were used to diagnose the processes responsible for the observed cooling. In Irene, 1D vertical mixing models generate only 17% of the total cooling ahead of eye, while deepwater 3-D models forced by Irene's nearly symmetrical offshore windfield produce an approximately 50-50 split in the cooling between the front and back side. A 3-D coastal ocean model (ROMS) generates a wind-forced two-layer circulation in the stratified Mid-Atlantic that was validated by the observing system but was not present in the 1-D and 3-D deepwater models. The resultant shear-induced mixing more accurately reproduces both the magnitude and timing of the ocean surface cooling with respect to eye passage. Atmospheric simulations establish that this ocean cooling was the missing contribution required to reproduce Irene's accelerated reduction in intensity over the Mid Atlantic Bight.

Historical buoys from 1985 to present show that ahead-of-eye cooling occurred beneath all 11 tropical cyclones that traversed along the Mid Atlantic Bight continental shelf during stratified summer conditions. The buoys also reveal that an average of about 75% of the cooling in these 11 hurricanes occurs ahead of eye, indicating a robust process in the Mid Atlantic. Similar to the Mid Atlantic Bight, the Yellow Sea has had 26 typhoons cross its shallow highly stratified waters in summer before making landfall in China or Korea. Typhoon Muifa (2011), whose intensity was also overpredicted, generated significant SST cooling (up to 7C) in the Yellow Sea, and a Yellow Sea buoy array similarly revealed 85% of the cooling was ahead of eye. These findings establish that including realistic 3D coastal ocean processes in forecasts of landfalling storm intensity and impacts will be increasingly critical to mid-latitude population centers as sea levels rise and tropical cyclone maximum intensities migrate poleward.