Geophysical Research Abstracts
Vol. 16, EGU2014-11046, 2014
EGU General Assembly 2014

High resolution modeling of small-scale air-sea interaction in the Gulf Stream region and impact on North Atlantic storm-tracks.

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Over the last few years, satellite observations and high resolution atmospheric and coupled simulations have suggested that the potential strength of the oceanic forcing might have been underestimated in the previous generation of climate models. There is now compelling evidence that sharp sea surface temperature (SST) fronts, as in western boundary currents, substantially affect the marine atmospheric boundary layer (MABL) and the free troposphere. In this presentation, our first objective is to assess whether the mean local and remote atmospheric response to a realistic SST frontal zone (such as that of the Gulf Stream) is sensitive to its small-scale spatial features. We explore the atmospheric response sensitivity to a range of large scale atmospheric circulation and SST conditions within a realistic setting.
We ask precisely the following questions: 1- How does the MABL respond to North Atlantic small-scale SST patterns of the Gulf Stream region? 2- Are the influence of the latter extending well above the boundary layer, in particular during winter? 3- Does this influence carry on to storm-track and large-scale circulation regimes properties ? 4- How does the atmosphere feed-backs the oceanic surface and mixing layer?
To answer the above questions, we first use a set of sensitivity experiments performed with a high-resolution atmospheric general circulation model (AGCM) forced by spatially high-resolution daily SSTs over the period ranging from 1st January 2003 to 31st July 2011. Two different types of SST boundary conditions are used to force the AGCM: the first type is simply the raw SST data set while the second one is obtained by spatially filtering the small-scale SST features over a rectangular area surrounding the Gulf Stream whereas SSTs outside this region are unchanged. AMIP-type AGCM simulations are then performed with the two SST datasets with potential differences between the two suggesting the influence of small-scale SST front and eddies on the MABL and the free troposphere as well as on the large scale atmospheric circulation.
First, the ability of the model to represent the air-sea interaction has been evaluated against satellite observations. Then, we study the influence of the Gulf Stream upon the surface atmospheric response in terms of surface fluxes and MABL stability. The local tropospheric dynamics is deeply impacted, following the observations analysis and the theoretical mechanisms proposed by recent studies. Indeed, not only surface fields are affected but also convective precipitation over surface wind divergence area. We then study changes of the extra-tropical storm-tracks generated in the North Atlantic basin and Europe during wintertime. A weather regimes classification has shown that the large-scale atmospheric configuration appears to be a determining condition in the SST front's influence on storm-track spatial distribution.
Finally, potential atmospheric feedbacks on the upper ocean variability in the Gulf Stream region are investigated through a set of coupled simulations with the same AGCM and an oceanic component at high resolution (0.25°) with a mixed-layer configuration.