Geophysical Research Abstracts
Vol. 13, EGU2011-5185, 2011
EGU General Assembly 2011

Mechanisms of Near Surface Wind Convergence/Divergence over the Gulf Stream Analyzed by a New Diagnostics Method

Kohei Takatama (1), Shoshiro Minobe (1), Masaru Inatsu (1), and Richard Small (2)

(1) Hokkaido University, Graduate School of Science, Sapporo, Japan (minobe@mail.sci.hokudai.ac.jp), (2) National Center for Atmospheric Research, Climate and Global Dynamics Division, Boulder, CO, USA

Diagnostics of the momentum equation using outputs of atmospheric numerical model is an important research tool in order to understand the mechanisms for near surface wind response to SST, which is evident in satellite wind observation associated with the oceanic fronts and eddies. There are several mechanisms were proposed, and the two major hypotheses are the downward momentum mixing mechanism (Wallace et al. 1989) and the pressure adjustment mechanism (Lindzen and Nigam 1987). Thus, a diagnostics is desirable to be able to distinguish these and other mechanisms.

The conventional diagnostics examines momentum equation at a certain height and evaluate amplitudes of respective terms such as pressure gradient, vertical momentum mixing, horizontal advection of momentum, and Coriolis force. The vertical momentum mixing is judged to be active when this term works to accelerate the surface wind or passive (damping) when the term decelerates the wind. However, such diagnostics has a serious problem, when one try to separate the contribution of each mechanism quantitatively. For example, the famous schematics by Hayes et al. (1989) for the enhanced/weakened surface winds associated with the tropical instability waves can be understood by the balance between the downward momentum mixing from aloft and the damping due to the surface stress. In this case, the conventional momentum diagnostics would tell us that the all terms, including the vertical mixing term, are zero, because the two roles of the vertical mixing, i.e. downward momentum mixing and damping are balanced and thus cancel to each other.

In order to solve difficulty of the conventional diagnostics, we propose a new diagnostics method of the momentum equation for near surface winds. In this diagnostics, the two roles of the vertical mixing are explicitly separated. Furthermore, an assumption that the surface wind stress is proportional to the vertically integrated momentum enable us to formulate that the near surface zonal and meridional winds as a linear superposition of the components due to the downward momentum mixing, the pressure gradients, and the horizontal momentum advection.

This new diagnostics are applied to five year integration of the IPRC regional atmospheric model over the Gulf Stream region with respect to near surface wind convergence/divergence. It turns out that about 70% (30%) of wind convergence is due to the pressure adjustment mechanism (the downward momentum mixing mechanism). The pressure adjustment mechanism also explains the convergence just above the Gulf Stream current axis. Since this convergence is collocated with the Gulf Stream rain band and ascent in the middle troposphere, the pressure adjustment mechanisms is likely to play an important role in the deep penetration of the atmospheric influence over the Gulf Stream.