Geophysical Research Abstracts
Vol. 13, EGU2011-7492-1, 2011
EGU General Assembly 2011

Oceanic eddy response to atmospheric forcing: near- and far-field consequences

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Wind is known to a have a significant effect on the formation and propagation of oceanic eddies. Idealized numerical experiments were carried out to study the role of wind forcing on island-induced oceanic vortices. The study considered the immediate wind (near-field) effects, during and just after the birth of an eddy; as well as longer-term effects (far-field), as eddies propagates away form the island's influence (1000km offshore). The two-dimensional, simplified numerical model, introduced a wind stress term in the quasi-geostrophic equation. Constant and variable wind was superimposed on an oceanic channel with neutral side boundary conditions, prescribed inflow and Orlanski radiation condition at the outflow. Near-field results showed that, wind forcing acted as an extra source of oceanic energy. The generation of atmospheric vorticity, at the island's flanks, contributed to the increase in the vorticity of oceanic eddies. There was also a predictable phase shift of the oceanic eddy shedding frequencies, associated with the near-field wind-wake. Analysis of the adimensional terms of the geostrophic equation showed that significant changes of the eddy-shedding period occurred when the wind stress term was greater than the laplacian (1/Re) term. On the other hand, variable wind contributed to the asymmetry of successive eddy-shedding periods. For the far-field study, apart from considering constant wind, a Gaussian-like wind jet ('Bickley jet'), over the ocean as well as high frequency (hourly) changes of wind speed, were taken into account. The wind direction was maintained constant in all case studies but the presence of the island was removed from the far-field studies. Results showed that wind forcing over the ocean, without considering the atmospheric flow perturbations by the presence of the island, continues to contribute to oceanic eddy asymmetry as well as to progressive eddy deformation; wind also helps contain and re-organize an oceanic eddy corridor, in the far field. For the no eddy shedding wake regimes (weak oceanic Re), wind forcing strongly contributed to the stretching of the recirculation 'jet-like' features, consistent with the Sverdrup transport theory.