Multiple, migrating quasi-zonal jets in the eastern North Pacific

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Abstract

Low-frequency motions in the eastern part of the subtropical North Pacific are characterized by multiple, alternating quasi-zonal jet-like features (striations), which slowly, at a speed of about 0.3 km/day, propagate toward the equator. Their structure and energetics are studied using three data sets: satellite sea level anomaly observations, historical hydrographic data, and output of the Ocean general circulation model. For the Earth Simulator (OFES) we find that the striations’ energy cycle is dominated by two dynamically distinct components. The first one is attributable to baroclinic instability of the large-scale, weakly sheared meridional flow in the eastern limb of the subtropical gyre. Potential energy stored in the large-scale flow is accessible for conversion directly to the zonal striations. The latter, therefore, may have a profound effect on the thermohaline structure of the subtropical gyre and the mean circulation. The second component arises from nonlinear interactions between the zonal striations and eddies and can be put into the context of the geostrophic instability. While the baroclinic conversion from the zonal APE to KE (10-7 kg m-1 s-3) is substantial, it is much less than the nonlinear baroclinic conversion from the zonal APE to KE (10-7 kg m-1 s-3). This study was partly supported by NASA Ocean Surface Topography Science Team through grants NNX08AR49G and NNX13AK35G, and by NASA Physical Oceanography through grant NA11NMF4320128 through their sponsorship of the International Pacific Research Center. The OFES run was conducted on the Earth Simulator under the sponsorship of JAMSTEC.

1. Introduction

2. Having the correspondence between the model and observations established...proceed with energetics

3. Energetics

4. Spectral view

Question: (i) What are the primary generation mechanisms for propagating striations? (ii) How do they vary with depth? (iii) How do they interact with the mean circulation? (iv) What is their role in the ocean energy cycle?

Scenario: (i) Large-scale, weakly sheared meridional flow (ii) Baroclinic instabilities – eddies (iii) Feedback

4. Spectral view

For spectral component n = (kx, ky), the spectral KE budget for the transient motions can be written symbolically as (e.g., Hayashi, 1980)

\[ \frac{\partial}{\partial t} KE(n) = -[\nu(k) + C(n) + D(n)] \]

Spectral APE budget for the transient motions can be written symbolically as

\[ \frac{\partial}{\partial t} APE(n) = -[\nu(a) + C(a) + D(a)] \]