ATMOSPHERIC FORCING OF MESOSCALE BAROTROPIC MOTIONS

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ABSTRACT

This study was planned to determine the importance of atmospheric forcing in generating sub-inertial to seasonal variability in bottom pressure in the North Pacific, as well as to determine the relative importance of such forcing variables as wind stress curl, wind stress divergence, and air pressure in generating the bottom pressure variability. Multiple regression analysis procedures were designed to take account of the spatially complex patterns of coherence between the ocean and the atmospheric variables, and between the atmospheric variables themselves, in an attempt to ascertain the relative importance of the forcing terms in generating the bottom pressure variability.

The regression analyses led to the conclusion that wind stress curl ($f\vec{\nabla} \times \vec{\tau}$) is the least useful predictor of bottom pressure variability, contrary to the physical expectation that wind stress curl is the dominant mechanism for forcing oceanic variability. An explanation for this result may be that wind stress curl has a lower signal to noise ratio than other atmospheric variables employed in the regression. There is some evidence that one of the reasons for the lower signal to noise ratio is that wind stress curl is obtained through a differentiation operation which can be expected to emphasize noise. In fact, there appears to be a fairly simple relationship between predictive value of bottom pressure and degree of differentiation of the atmospheric input, with the most differentiated (in time or space) variables being the least useful comparatively.

Given the results just discussed, a simplified regression analysis was undertaken to find the one or two atmospheric inputs, irrespective of physical appropriateness, that could account for the largest significant fraction of bottom pressure variability. The regression techniques, taking into account the biases that can occur from prediction with multiple inputs, led to the conclusion that, on the average, 72% of bottom pressure vari-

ance is explained using the best statistical predictor, $\beta\tau^{\phi}$ (β-plane contribution to wind stress curl), with the second best predictor, $D\beta\frac{\partial p_a}{\partial \phi}$, contributing only an additional 11%. Using five terms representing the dominant physical mechanisms of atmospheric forcing, the bottom pressure predictability increases to 93%; however, that is not a statistically significant increase. From the 90% confidence intervals of 72% (51-123%) and 11% (7-48%), it seems that by using FNOC data products, $\beta\tau^{\phi}$ can be used to predict at least 51% of bottom pressure variance while including $D\beta\frac{\partial p_a}{\partial \phi}$ in the calculations has only the possibility of increasing predictability since the predictive value of that term is 48% at the most.

Finally, the statistical significance of the coherence of bottom pressure with atmospheric variables is re-examined in detail, because, even though the bottom pressure was found to be coherent with one or another atmospheric variable at different locations over the North Pacific at all resolvable sub-inertial frequencies from one-year-long data sets, the significance of this coherence is at times hard to distinguish from that expected for incoherent random variables. Thus, a new metric was designed to clearly determine the significance of atmospherically forced variability from occasional random coherence, with the result that atmospheric forcing can be clearly deduced as an important agent for generating all sub-inertial bottom pressure variability at periods from just sub-inertial to $\sim$ 100 days.