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Estimation of Low-Frequency Wind Stress Fluctuations over the Open Ocean

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ABSTRACT

A simple, approximate formula for mean wind stress is given in terms of the mean and variance of the wind fluctuations over the averaging period. The formula is nonlinear with respect to the mean wind speed.

The formula is tested using 3 h wind observations from eight North Atlantic Ocean Weather Ships. Mean wind stress is calculated 1) by vector averaging the 3 h wind stresses and 2) by applying the approximate formula. For an averaging period of 4 months the two methods agree to within ± 0.025 Pa, 95% of the time. For an averaging period of 1 month the approximate formula slightly overestimates the stress. This is due to skewness in the probability density function of the observed 3 h wind fluctuations. An expression for the modification of the mean stress due to skewness is given.

A straightforward method is described for the estimation of vector mean wind and variance fields, and thus mean stress fields, over the open ocean. To check the method, the long-term stress field of the North Atlantic, and the seasonal Sverdrup transport across 31°N , are computed and compared with the values given by Willebrand, and Bunker and Leetma. Good agreement is obtained. The zonally integrated Sverdrup transport across 45°N is also calculated and shown to exhibit significant interannual fluctuations.

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