Reply

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We would like to thank Joffre and Makkonen (referred as JM in this reply) for their comments on our paper referred to as SR (SethuRaman and Raynor, 1980).

One of the comments by JM was on the relative magnitudes of the ratios U_O/U_B for onshore and offshore flows. Although wind is generally observed to accelerate over water, this probably occurs at large distances (>5 km) for the near surface wind, particularly for stable atmospheric conditions due to lack of mixing. This might be the reason for the results shown in Fig. 7 in which ratios for onshore flows seem to be higher than the ones for offshore flows at low wind speeds. Conversely, for unstable downwind conditions one would expect a more uniform wind structure due to intense mixing.

Another question was the derivability of mean U_O/U_B from the observed mean $(\sigma_u)_O/(\sigma_u)_B$ for high winds. The results shown in Figs. 6 and 7 are the best-fit lines drawn by eye-average through the mean values of the ratios for each wind speed category. Hence, it will be possible to get only order of magnitude estimates of one from the other. Variations in friction velocity u_*, roughness length z_0 and the atmospheric stability are factors that can cause variations in the ratio of (U_O/U_B) by a factor of 2.

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The number of daytime (0800–1600), nighttime (2000–0400) and the transition (0400–0800 and 1600–2000) observations are given in Table 1. This might help in interpreting the results with a better perspective. Some of the variations in the ratios (10–50%) are probably due to the diurnal changes in stability over the beach.

TABLE 1. Diurnal classification of the observations.

Wind sector	Number of observations		
	Day	Night	Transition
Onshore	114	41	57
Offshore	26	20	12
Alongshore	34	44	29

Another comment by JM was about the measurement height at the beach being in the transition layer part of the time. The height of 8.5 m computed from Elliott's (1958) relationship is for neutral conditions. As indicated in Table 1 the majority of the data was obtained during daytime conditions when the minimum height of the thermal internal boundary layer was observed to be 10 m during several diffusion experiments conducted at this site (Raynor *et al.*, 1975).

A height of 8 m at a fetch of ~50 m is in a developing internal boundary layer for onshore flows; the same height will be in a developed layer for alongshore flows. The alongshore results of the turbulence intensity shown in Fig. 4 of SR shows a similar trend of high ratios for low wind speeds found for onshore flows. The ratio reaches a constant value of ~0.5 for higher winds as estimated by Eq. (7) of SR and Eq. 10 of JM. The larger values of σ_u over the ocean at small wind speeds for onshore flows cannot be explained by the transition layer alone since one would expect the σ_u value in this layer to be in between the values that might exist over the ocean and over the beach under fully developed boundary layers. This would result in the ratio $(\sigma_u/U)_O(\sigma_u/U)_B^{-1}$ being less than one. Hence the only plausible explanation seems to be the effect of variations in atmospheric stability and an increase in roughness due to developing waves. These waves are steeper than the fully developed waves and cause an increase in the surface drag (SethuRaman, 1978).

REFERENCES

Elliott, W. P., 1958: The growth of the atmospheric internal boundary layer. *Trans. Amer. Geophys. Union*, **39**, 1048–1054.

Raynor, G. S., P. Michael, R. M. Brown and S. SethuRaman, 1975: Studies of atmospheric diffusion from a nearshore oceanic site. *J. Appl. Meteor.*, **14**, 1080–1094.

SethuRaman, S., 1978: Influence of mean wind direction on sea surface wave development. *J. Phys. Oceanogr.*, **8**, 926–929.

——, and G. S. Raynor, 1980: Comparison of mean wind speeds and turbulence at a coastal site and an offshore location. *J. Appl. Meteor.*, **19**, 15–21.