Comments on "Distribution and Steepness of Ripples on Carrier Waves"

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The study of the properties of ripples, or capillary waves, especially when superimposed on longer, and higher, gravity waves is a subject of great importance as a way to understand the optical and radar backscatter properties of the sea surface. Wind-water tunnels provide a means to study these properties under controlled laboratory conditions. However, there are difficulties in designing and interpreting wind-water tunnel experiments so that results can be applied to the open ocean. For the paper under discussion, these difficulties so dominate the experimental design that it is doubtful that the longer gravity waves were the causative factor for the variation of the properties of the ripples over the wave profile.

It would be possible to describe a multitude of ways in which conditions in a wind-tunnel do not correspond to ocean conditions. A few are the lack of a fully developed turbulent logarithmic wind profile, the lack of lateral turbulence components, and the presence of a roof on the wind-water tunnel.

The roof in this particular experiment was only 31 cm above the mean water surface. The shear of the flow so that the flow will decrease to zero at the roof and to appropriate values near the water surface constricts the actual air flow to a range even less than 31 cm. With a wave 5 cm high, the distance from the crest of the wave to the roof of the tunnel is 28.5 cm and the distance from the trough of the wave to the roof is 33.5.

The same volume of air must move through every cross section of the tunnel from continuity principles, and thus conditions similar to those implied by Eq. (1) must hold:

$$V_c[31 - (h/2)] = 31V = V_T[31 + (h/2)], \quad (1)$$

where V_c is the air velocity over the wave crests, V the velocity at mean elevation, V_T the velocity over the wave troughs and h the wave height.

Table 1, based on the design data given in Wu (1979), shows these values and the ratio by which

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TABLE 1. Wind speeds and other quantities related to air flow over the waves in the wind tunnel used by Wu.

	Wave height (cm)			
	5	6.5	8.6	10.6
V_c (m s^{-1})	4.55	7.73	11.2	14.8
V (m s^{-1})	4.18	6.92	9.6	12.25
V_T (m s^{-1})	3.87	6.26	8.4	10.5
V_c/V_T	1.18	1.23	1.32	1.41
V_c^2	20.7	59.8	124.2	218.3
V^2	17.5	47.9	92.2	150.1
V_T^2	14.4	39.2	71.1	109.4
V_c^2/V_{T^2}	1.43	1.52	1.74	1.99

winds over the wave crests exceed winds over the troughs. Waves in nature are often more nearly related to the square of the wind speed than to the wind speed; as a result values related to the squares of these speeds are also given.

The details of air motion in a section of a wind-water tunnel with an average height for the air portion of 31 cm can hardly be described by a single wind speed and a single friction velocity especially in the presence of mechanically generated waves. The complexity of the flow is illustrated, for example, by Resch and Selva (1978) who had an atmospheric test section 1.5 m high. Logarithmic profiles were not achieved, even for wind-generated waves only, and the effect of the roof was evident. The pseudo-log profile boundary layer grew with distance downwind. Eq. (1) is only the crudest of ways to suggest the variability of the wind over the wavy surface as dictated by the roof. The wind in the trough may be much less than that calculated.

To describe the variations of the ripples as an effect of the carrier waves *only* without a *thorough* study of the variation of the wind over the carrier waves as restricted by the roof of the wind tunnel oversimplifies an extremely complicated problem. The distribution of ripples on actual wind-generated waves in nature is still an unsolved question.

REFERENCE

Resch, F., and J. P. Selva, 1978: Experimental study of momentum transfer, heat and water vapor fluxes under different stability conditions *Turbulent Fluxes Through the Sea Surface, Wave Dynamics and Prediction NATO Conference Series* Favre, A. and K. Hasselman, Eds., Plenum Press, 81–95.

Wu, J. 1979: Distribution and steepness of ripples on carrier waves. *J. Phys. Oceanogr.*, **9**, 1014–1021.